TENTH EDITION

CRSI®

DESIGN HANDBOOK 2008

CRSI® CONCRETE REINFORCING STEEL INSTITUTE

CRSI

DESIGN HANDBOOK

2008

Based upon the 2008 ACI BUILDING CODE

Prepared under the Direction of the CRSI Engineering Practice Committee by
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FOREWORD

The Concrete Reinforcing Steel Institute (CRSI) was organized in 1924 as a cooperative, non-profit organization of producers and fabricators of reinforcing bars and accessories, together with persons or entities otherwise involved in reinforced concrete construction. The Institute has a "Professional Member" classification which opens CRSI activities to designers, specifiers, educators and research personnel actively engaged in reinforced concrete design and construction.

A major objective of the Concrete Reinforcing Steel Institute is to disseminate helpful structural design information for economical and efficient use of materials, and to save designers' time. CRSI has published Design Handbooks since 1952.

This new *CRSI Design Handbook*, 10th Edition, 2008, follows the long-established tradition of providing completed, tabulated designs of common reinforced concrete structural members. The tabulated designs are for normally encountered conditions, and are based on the latest applicable code provisions and materials specifications. All of the tabulated designs in this *Handbook* are prepared in accordance with "Building Code Requirements for Structural Concrete (ACI 318-08)." The majority of the notation used in this *Handbook* follows ACI 318-08. In those instances where other notation had to be introduced, the symbols are defined or shown on figures. Inch-pound units are used throughout this *Handbook*. The reader is encouraged to review the information about soft metric reinforcing bars on Page 1-5.

Since the first *CRSI Design Handbook* in 1952, users of these Handbooks have been cooperative in suggesting to the Design Aids Committee and CRSI Staff, many improvements, clarifications and additional design short-cuts. This professional assistance is very helpful, and is appreciated. Comments regarding this *Handbook* are welcome so that future Handbooks can be further improved. Direct comments to Neal S. Anderson, CRSI Vice President of Engineering.

ACKNOWLEDGEMENTS

A sincere note of appreciation goes to Dr. David P. Gustafson for his tireless efforts on the *Design Handbook*, both for past editions as Vice President of Engineering for CRSI and as Technical Consultant for this 10th edition. The Handbook would not be what it is today were it not for Dr. Gustafson's expertise in reinforced concrete design and construction and his attention to detail.

Also, a note of appreciation to Nicholas Gouwens for his expert assistance in typesetting and reviewing the Handbook manuscript and to Kurt S. Lepinski for his work in updating the Handbook computer programs.

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CHAPTER 1 – BASIS AND USE OF TABULATED DESIGNS

CHAPTERS 2, 3, AND 4

Columns. The purpose of Chapters 2, 3, and 4 is to provide designs of "short" columns in reinforced concrete by giving column dimensions, and sizes and quantities of reinforcement in accordance with the strength design method of "Building Code Requirements for Structural Concrete (ACI 318-08)." Selecting completed designs of columns from the tabulated designs in Chapters 3 and 4 eliminates the need for charts and diagrams. The appropriate table is entered with values of the factored load and moment, and the column dimensions and reinforcing steel are obtained.

The column tables provide capacities for bending about both major and minor axes. These data permit adjustment for the effects of slenderness in one or both directions, as well as simultaneous bending in both axes.

Load-Moment Tables Instead of Coefficients and Charts. It is extravagant to continually repeat computations to determine the nominal design strength of an assumed section, when a computer program can tabulate the same results for ready reference. Use of these tables eliminates routine calculations and helps prevent the oversight of one or more applicable criteria. However, no handbook can replace the judgment of an experienced Engineer.

Load and Strength-Reduction Factors. The strength design method makes use of two sets of factors. Load factors provide for variable conditions that lead to possible load variances. Strength-reduction factors, or ϕ-factors, provide for variable conditions that lead to possible understrengths. Because different load factors are prescribed for dead, live, wind and earthquake effects, and the factors vary with different combinations of such effects, it is only possible to tabulate nominal design strength in this Handbook. Appropriate load factors must be applied to each effect for as many combinations as circumstances require. Then these tables can be entered with the maximum of the total factored load effects and compared with the design strength.

Since the ϕ-factors are standardized (0.65 for tied columns, and 0.90 for flexure), they were incorporated into the tabulated designs. Hence the tabulated values are the nominal design strength for each column, i.e., the design axial load and moment strengths (ϕP_n and ϕM_n).

Basis and Scope of Tabulated Designs. These tables give the nominal design strength (with ϕ-factors included) for the usual range of sizes of square, rectangular, and round tied "short" columns—using "short" in the Code sense of a column that does not require reduction in capacity for slenderness effects (ACI 10.10).*

Designs are tabulated for Grade 60 (minimum f_y = 60,000 psi) reinforcing bars for the usual range of concrete strengths (f'_c). For the higher concrete strengths now available, designs are also tabulated for Grades 60 and 75. The tabulated designs for Grade 75 (minimum f_y = 75,000 psi) are limited to the use of the large size bars (#11, #14, and #18). Lower strength grades for these sizes are not recommended (by CRSI) for economy. The percentages of longitudinal reinforcement in the tabulated designs vary from one percent, the minimum allowed, to the maximum that can be fitted as single bars at minimum spacings in one layer or ring, but not more than eight percent, the maximum allowed (ACI 10.9.1).

CHAPTERS 5 THROUGH 14

Strength design of flexural members is discussed in Chapter 5. Also included in Chapter 5 is development of reinforcement and lap splices for reinforcing bars.

Strength design consists of two steps—first, a member is proportioned to ensure its strength with the appropriate safety factors, and second, the member must be checked to ensure that deflection and cracking at service load conditions will be controlled. These two design phases—strength and serviceability—are described in Chapters 5 and 6, respectively.

Chapter 7 covers design of one-way solid slabs. Tabulated designs are presented for single spans simply supported, end spans of continuous members simply supported at one end and continuous at the other, and interior spans continuous at both ends.

Chapters 8 through 14 provide designs of reinforced concrete floor systems, footings, pile caps and cantilevered retaining walls. Tabulated designs are given which indicate member dimensions and reinforcement for various span and load conditions. The empirical moment coefficients (ACI 8.3.3) for one-way slab systems and the Direct Design Method (ACI 13.6) for two-way systems are used.

*All references in this *Handbook* to "Building Code Requirements for Structural Concrete (ACI 318-08)" are given as "ACI" followed by appropriate section number.

The tabulated designs in Chapters 7, 8, 9, 10 and 11 give the factored usable superimposed loads (reduced by the proper ϕ-factors) of practical sizes of slabs, joists, flat plates, flat slabs, and waffle flat slabs, with a range of spans and loads, and required reinforcement.

Materials. The tabulated designs are based on a specified concrete compressive strength f'_c = 3,000 psi for footings and retaining walls, and on f'_c = 4,000 psi for one-way solid slabs, beams, joists, flat plates, flat slabs with drop panels, and waffle flat slabs. All designs for flexural members are based on Grade 60 reinforcing bars.

Except for Chapter 12—Beams, the tabulated designs in this *Handbook* give "factored usable superimposed loads" because different load factors are prescribed for different types of loads. The total factored load varies with different combinations of such effects.

Since ϕ-factors are standardized, all tabulated loads have been reduced by the appropriate ϕ-factor. Also, for floor systems, 1.2 times the dead weight of the floor system—based on a conservative unit weight of concrete of 150 pounds per cubic foot—was deducted in tabulating net usable superimposed loads. When transferring total floor loads onto supporting members, the augmented weight of the floor system must be included.

Supplementary References. The following references are recommended to the reader to supplement this *Handbook* and to ensure that the design, detailing and construction techniques meet standards and accepted practices.

1. *ACI Detailing Manual,* (SP-66).*
2. *Manual of Standard Practice,* CRSI**
3. *Reinforcing Bars: Anchorages and Splices,* CRSI.**

STRUCTURAL INTEGRITY

Requirements for "structural integrity" are included in the ACI Building Code (ACI 7.13 and 13.3.8.5). To comply with the provisions, members of a structure must be effectively tied together. The objective of structural integrity is: If a structure or a part of the structure is subjected to an abnormal loading condition, or if a primary supporting element sustains damage from an unanticipated event, tying the members together should result in confining the resulting damage to a relatively small area.

The Code requirements for achieving structural integrity in reinforced concrete construction focus on the structural detailing of reinforcement. Basically, prescribed amounts of longitudinal reinforcement must be continuous over supports or reinforcing bars that terminate at discontinuous ends of a member have to be anchored with standard hooks or headed bars.

Cast-in-place structural concrete members and systems which are affected by the structural integrity provisions are:

One-Way Joists (ACI 8.13). At least one reinforcing bar in the bottom of a rib has to be continuous over supports or the bar must be spliced with a Class B tension lap splice or a mechanical or welded splice to a bar in the adjacent span. At discontinuous ends of joists, anchorage of at least one bottom bar must be provided with a standard hook or headed bar. Fig. 1-1 shows the structural integrity reinforcement requirements for joist construction.

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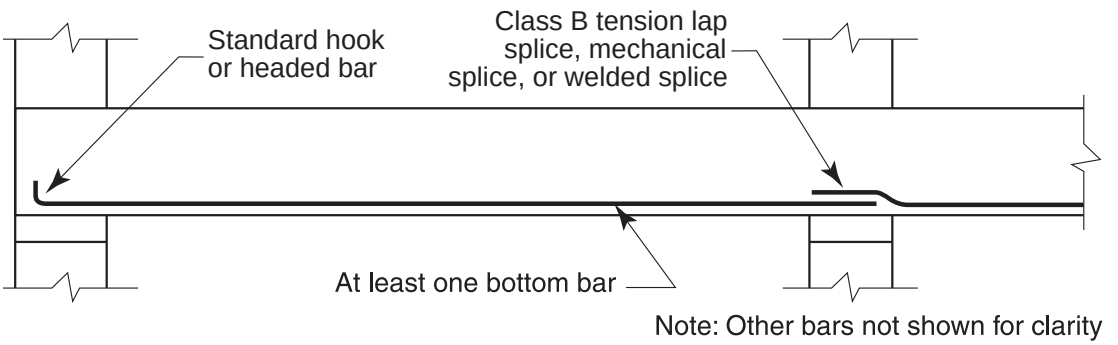


Figure 1-1 Structural Integrity Reinforcement for One-Way Joist Construction

Beams. Beams are categorized as either "perimeter" beams or "non-perimeter" beams. A spandrel beam would be a perimeter beam.

The detailing of top and bottom bars, and stirrups in perimeter beams, is impacted by the structural integrity provisions. At least one-sixth of the $-A_s$ required for negative factored moment at the face of supports (minimum of 2 bars) and one-quarter of the $+A_s$ required for positive factored moment at midspan (minimum of 2 bars) have to be made continuous around the perimeter of the structure. Closed stirrups are also required in perimeter beams. It is not necessary to place closed stirrups within the joints at columns or other supporting girders. It is permissible to provide continuity of the top and bottom bars by splicing the top bars at midspan and the bottom bars at or near the supports. Splicing with Class B tension lap splices, or mechanical or welded splices, is required. See Fig. 1-2.

For non-perimeter beams, the Engineer has two choices to satisfy the structural integrity requirements: (1) provide closed stirrups, or (2) make at least one-quarter of the $+A_s$ required for positive factored moment at midspan continuous (minimum of 2 bars). Splicing the prescribed number of bottom bars over the supports with Class B tension lap splices, mechanical or welded splices, is acceptable. At discontinuous ends of non-perimeter beams, the bottom bars must be anchored with standard hooks or headed bars. See Fig. 1-3.

Two-Way Slabs. In two-way slab construction, all bottom bars within the column strip, in each direction, must be spliced with Class B tension lap splices, mechanical or welded splices. Fig. 13.3.8 in the ACI Building Code shows the locations where the lap splices are permitted. At least two of the bottom bars in the column strip must

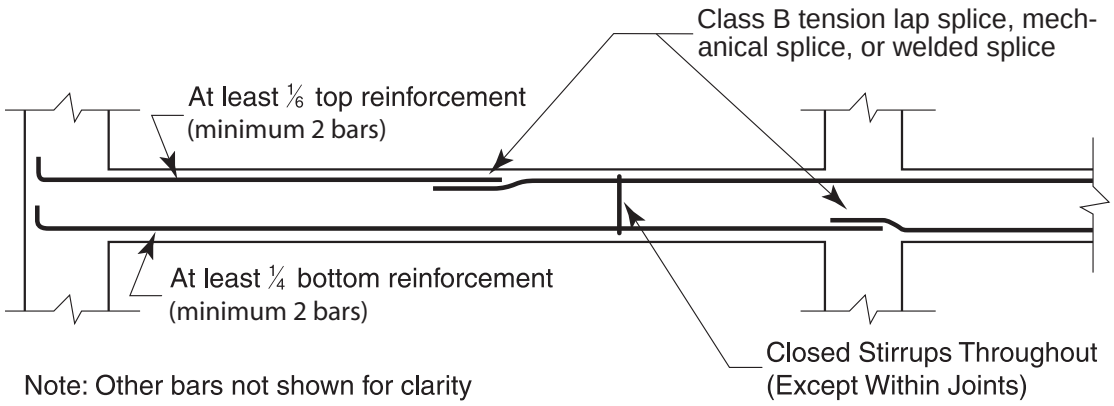


Figure 1-2 Structural Integrity Reinforcement for Perimeter Beams

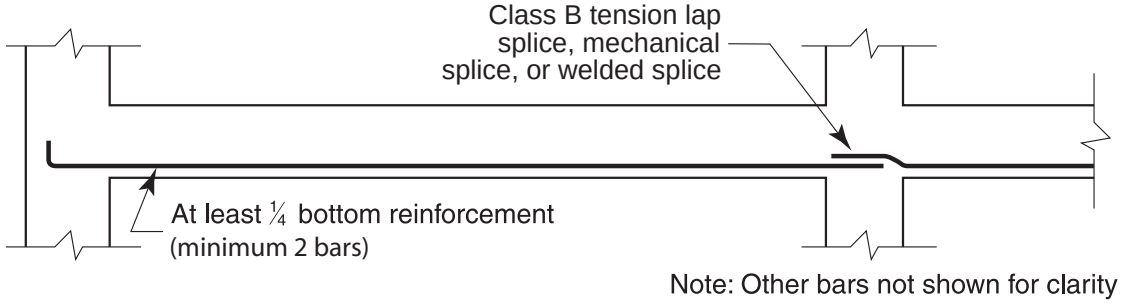


Figure 1-3 Structural Integrity Reinforcement for Non-Perimeter Beams

pass within the core of the columns and be anchored with a hook or headed bar at exterior supports. See Fig. 1-4.

The structural integrity requirements of the ACI Building Code were not incorporated into the various tabulated designs of this *Handbook.* One reason for this exclusion was due to the inability to determine where the bars would be truly continuous (i.e., one piece) and where the bars would be spliced.

As an example, consider a relatively short 14-foot span one-way joist system. Since stock lengths of reinforcing bars from steel mills vary from 40 to 60 feet, this would result in lap splicing the bottom bars within either every two or every three spans. Although the bars could have been assumed to be lap spliced at every support or at midspan, such details were felt to be unrealistic.

Another reason, which applies only to the tabulated designs of beams in Chapter 12, is that the structural integrity requirements are quite different for perimeter and non-perimeter beams. This would have necessitated preparation and printing of two sets of tables: one set for perimeter beams and another set for non-perimeter beams.

Therefore, the tabulated designs in this *Handbook* do not include the structural integrity requirements in order to make them as general as possible. The Engineer using this *Handbook* must evaluate the issue of structural integrity on a case-by-case basis.

NOTICE

The Institute does not prepare project drawings and project specifications. While every precaution is taken to ensure that all data and information furnished are as accurate as possible, the Institute cannot assume responsibility for errors or oversights in the use of such information or in the preparation of project drawings and project specifications. The information given in the tabulated designs should prove useful in preliminary design, in preliminary estimating of quantities of materials, for establishing sizes and clearances, and for comparing different types of construction. Obviously, the tabulated designs apply only to the particular condition of span, loading and material strengths specified. The information in this *Handbook* should not replace the judgment of an experienced structural engineer when selecting types of structural concrete members and systems, proper loads, providing proper stiffness and in obtaining the most economical design.

Tabulated solutions for common structural concrete members and systems are presented in this *Handbook* with examples to illustrate the application of ACI Building Code requirements. It is not possible to prepare tabulated solutions for connections of these members and systems in general. Structural integrity for the completed structure can be provided only by the Engineer familiar with the overall requirements involved.

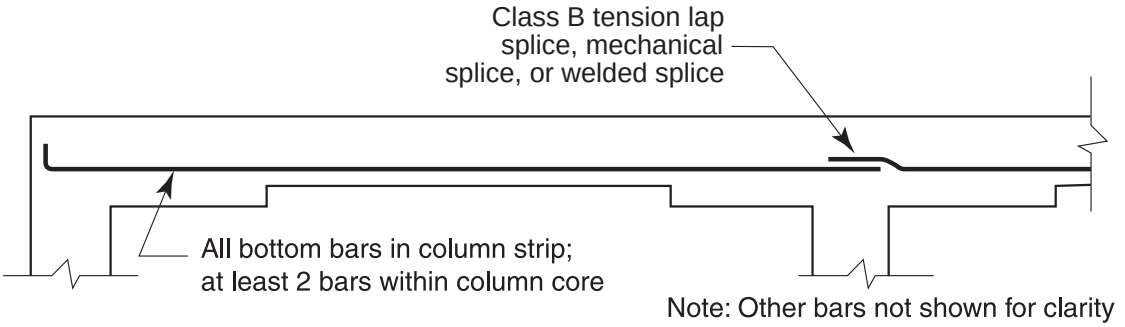


Figure 1-4 Structural Integrity Reinforcement for Two-Way Slab Construction

SOFT METRIC REINFORCING BARS

The tabulated designs in this *Handbook* are based on requirements in the inch-pound version of the ACI Building Code. Consequently, inch-pound units, including the designations for the sizes of reinforcing bars, are used throughout this *Handbook*. Space limitations precluded inclusion of companion tabulated designs in metric units, which would be based on ACI 318M.

It is important for users of this *Handbook* to be aware of current industry practice regarding soft metric reinforcing bars. The term "soft metric" is used in the context of bar sizes and bar size designations. "Soft metric conversion" means describing the nominal dimensions of inch-pound reinforcing bars in metric units, but not physically changing the bar sizes. In 1997, producers of reinforcing bars (the steel mills) began to phase in the production of soft metric bars. Within a few years, the shift to exclusive production of soft metric reinforcing bars was essentially achieved. Virtually all reinforcing bars currently produced and used in the USA are soft metric. The steel mills' initiative of soft metric conversion enables the industry to furnish the same reinforcing bars to inch-pound construction projects as well as to metric construction projects, and eliminates the need for the steel mills and fabricators to maintain a dual inventory. Thus, USA-produced reinforcing bars furnished to any construction project most likely will be soft metric.

Designations of Bar Sizes. The sizes of soft metric reinforcing bars are physically the same as the corresponding sizes of inch-pound bars. Soft metric bar sizes, which are designated #10, #13, #16, and so on, correspond to inch-pound bar sizes #3, #4, #5, and so on. The metric bar designations are simply a re-labeling of the inch-pound bar designations. The following table shows the one-to-one correspondence of the soft metric bar sizes to the inch-pound bar sizes.

Soft Metric Bar Sizes vs. Inch-Pound Bar Sizes

Soft Metric Bar Size Designation	Inch-Pound Bar Size Designation
#10	#3
#13	#4
#16	#5
#19	#6
#22	#7
#25	#8
#29	#9
#32	#10
#36	#11
#43	#14
#57	#18

Minimum Yield Strengths or Grades. Virtually all steel mills in the USA are producing reinforcing bars to meet the metric requirements of the ASTM specifications. Minimum yield strengths in metric units are 280, 350, 420 and 520 MPa (megapascals), which are equivalent to 40,000, 50,000, 60,000 and 75,000 psi, respectively. Metric Grade 420 is the counterpart of standard Grade 60.

Bar Marking. Soft metric reinforcing bars are required to be identified with the Producer's mill designation, bar size, type of steel, and minimum yield strength or grade. For example, consider the marking requirements for a #25, Grade 420 metric bar, which is the counterpart of an inch-pound #8, Grade 60 bar. Regarding the bar size and grade, the ASTM specifications require the number "25" to be rolled onto the surface of the metric bar to indicate its size. For identifying or designating the yield strength or grade, the ASTM specifications provide an option. A mill can choose to roll a "4" (the first digit in the grade number) onto the bar, or roll an additional longitudinal rib or grade line to indicate Grade 420.

Chapter 1 in the CRSI *Manual of Standard Practice* includes a detailed presentation of the inch-pound and metric requirements in the ASTM specifications for reinforcing bars. Appendix A in the *Manual* shows the bar marks used by USA producers to identify Grade 420 soft metric bars. More information about soft metric reinforcing bars is given in Engineering Data Report No. 42, "Using Soft Metric Reinforcing Bars in Non-Metric Construction Projects". EDR No. 42 can be found on CRSI's Website at **www.crsi.org**.

Users of this *Handbook* are also encouraged to visit the CRSI Website for:

- Descriptions of CRSI publications and software, and ordering information
- Institute documents available for downloading
- Technical information on epoxy-coated reinforcing bars
- Technical information on continuously reinforced concrete pavement
- Membership in CRSI and member web links
- General information on the CRSI Foundation
- Information on the CRSI Design Awards competition

CHAPTER 2 – STRENGTH DESIGN OF COLUMNS

General

Strength design of reinforced concrete columns is a complete design since there are no further serviceability requirements to be satisfied. Strength design of columns consists of determining the critical load combinations and resulting factored loadings for each; selecting a column cross section satisfying all design assumptions for the materials used under loads and moments equal to or larger than the factored loads and moments; and ensuring that slenderness effects do not reduce capacity.

Since the reduction in capacity for slenderness is dependent on the cross-sectional properties, including reinforcement of the column selected, and the factored moments are also dependent on the gross cross section, strength design of columns is in reality a two-stage review of a trial design. The manual calculations for such a review are formidable and become increasingly onerous if several trials are required. The column capacity tables in this *Handbook* can be used to avoid the need to make several trials since the tables cover most of the practicable range encountered in ordinary structures.

Load and Strength-Reduction Factors

The ACI Building Code provides seven principal load combinations with appropriate load factors for each to compute the factored load effects, axial load and moment. When these combinations are simplified by only concerning *D* (dead), *L* (live), and *W* (wind) loads, they result in the following three combinations:

$U = 1.4D$

$U = 1.2D + 1.6L$

$U = 1.2D + 1.0L + 1.6W$ (use whichever of the three is largest)

Use of the column capacity tables in this *Handbook* requires computation for the maximum effects, axial load and moment for the factored (augmented) load above. The load capacities tabulated in Chapters 3 and 4 have been computed for the stated concrete compressive strengths and Grade 60 bars (f_y = 60,000 psi) and Grade 75 bars (f_y = 75,000 psi), reduced by strength- reduction factors ϕ = 0.65 for compression, and ϕ = 0.90 for pure flexure only. The capacities tabulated are, therefore, the maximum usable design capacities for short columns. “Short” columns are those for which no reduction in load capacity for the effect of slenderness need be made.

Design Assumptions

The general assumptions prescribed in the ACI Building Code for strength design of reinforced concrete columns are given as follows:

10.2 – Design assumptions.

10.2.1 – Strength design of members for flexure and axial loads shall be based on the assumptions given in 10.2.2 through 10.2.7, and on satisfaction of applicable conditions of equilibrium and compatibility of strains.

10.2.2 – Strain in reinforcement and concrete shall be assumed directly proportional to the distance from the neutral axis . . .

10.2.3 – Maximum usable strain at extreme concrete compression fiber shall be assumed equal to 0.003.

10.2.4 – Stress in reinforcement below f_y shall be taken as E_s times steel strain. For strains greater than that corresponding to f_y, stress in reinforcement shall be considered independent of strain and equal to f_y.

10.2.5 – Tensile strength of concrete shall be neglected in axial and flexural calculations of reinforced concrete . . .

10.2.6 – The relationship between concrete compressive stress distribution and concrete strain shall be assumed to be rectangular, trapezoidal, parabolic, or any other shape that results in prediction of strength in substantial agreement with results of comprehensive tests.

10.2.7 – Requirements of 10.2.6 are satisfied by an equivalent rectangular concrete stress distribution defined by the following:

10.2.7.1 – Concrete stress of 0.85 f'_c shall be assumed uniformly distributed over an equivalent compression zone bounded by edges of the cross section and a straight line located parallel to the neutral axis at a distance $a = \beta_1 c$ from the fiber of maximum compressive strain.

10.2.7.2 – Distance from the fiber of maximum strain to the neutral axis, *c*, shall be measured in a direction perpendicular to the neutral axis.

10.2.7.3 – For f'_c between 2,500 and 4,000 psi, β_1 shall be taken as 0.85. For f'_c above 4,000 psi, β_1 shall be reduced linearly at a rate of 0.05 for each 1,000 psi of strength in excess of 4,000 psi, but β_1 shall not be taken less than 0.65.”

The computer program used for the preparation of the column capacity tables in this *Handbook* followed

all design assumptions required. An equivalent rectangular stress block for compressive stress distribution in concrete as specifically prescribed was used (ACI 10.2.7). The area of concrete displaced by vertical reinforcing bars was deducted from the total compression on concrete. Where the vertical reinforcing bars are located at varying distances from the neutral axis, such as bars in circular patterns for round columns, or in the sides parallel to the direction of bending for square or rectangular columns, actual bar area and location were considered for each bar.

Load-Moment Interaction Diagrams

Even with the advantage of tabulated load capacities at various control points as provided by this *Handbook*, it is frequently helpful to construct a load-moment interaction diagram. Such a diagram is particularly useful in the evaluation of load effects for the three different load combinations prescribed. The various load-moment capacities can be located conveniently on an interaction diagram, and the effect of changing bar size, or the number of bars, or their arrangement, can be quickly determined. Also, the increase in factored moment as an effect of slenderness may be added.

The intervals, or control points, at which design axial load strengths and moment strengths are tabulated were selected to permit convenient construction of interaction curves, complete from maximum design axial load strength to pure flexure. Sample interaction curves prepared from the load tables in Chapters 3 and 4 are discussed and shown. In the sample interaction curves that follow, attention is particularly directed to these considerations:

1. "Major" versus "minor" axes (MA and MI) capacities. Note that for a square column, if the unbraced height and end restraint conditions are equivalent in both directions, the *minor* axis capacity, except for 4-bar columns, will be smaller and will control the maximum load allowed. Maximum design axial load strength will be equal in both directions for a square column. See Fig. 2-1.

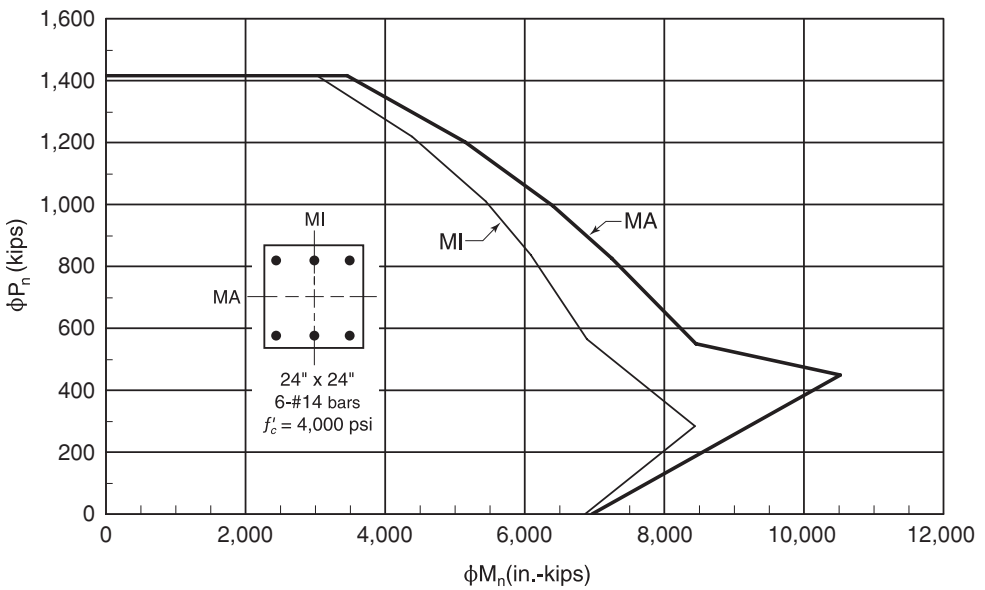


Figure 2-1 Major Axis vs. Minor Axis

2. Round-tied columns versus square. The round-tied column (or circular bar pattern) is less efficient for moment resistance. For equivalent areas of vertical reinforcing bars and concrete, the square column has more capacity than the round-tied column. At the point of maximum design axial load strength, the capacities of the two columns are the same. See Fig. 2-2.

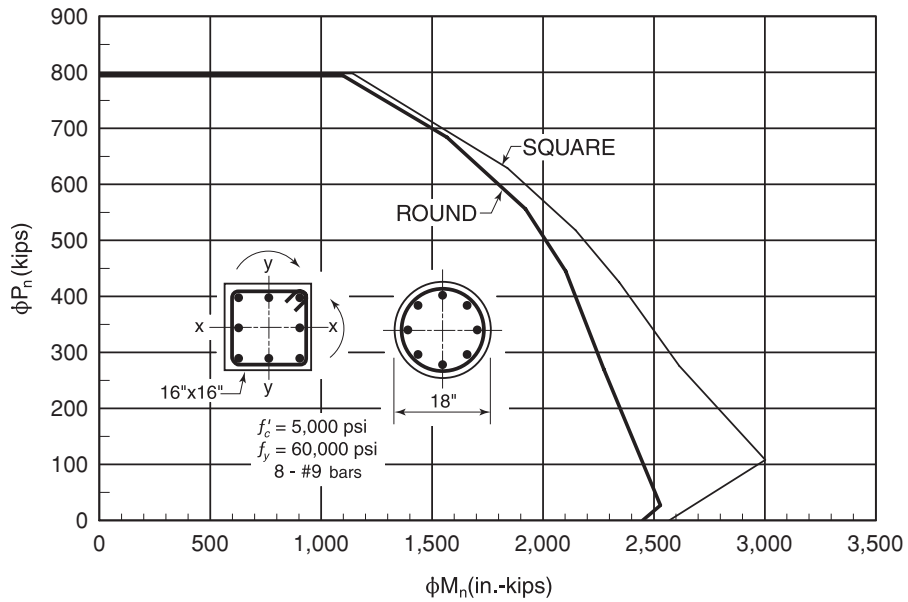


Figure 2-2 Round-Tied vs. Square

3. Grade 60 versus Grade 75 reinforcing bars. Tabulated capacities of columns reinforced with Grade 75 bars have been included in this *Handbook* (in bar sizes #11, #14, and #18). Load-moment interaction curve comparisons for a square column reinforced with Grade 60 and Grade 75 bars are shown in Fig. 2-3.

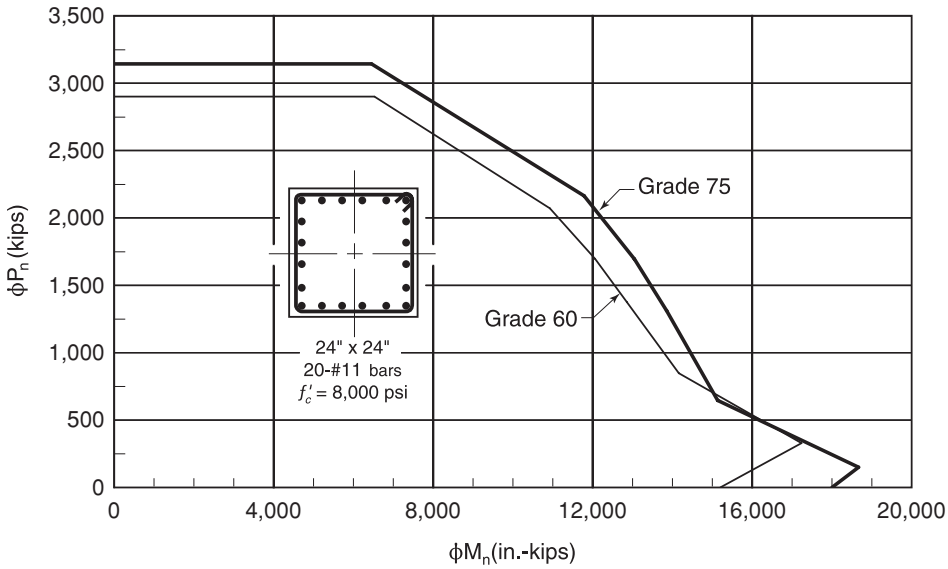


Figure 2-3 Grade 60 vs. Grade 75 Reinforcing Bars

Splices

See Chapter 5 for dowel embedment and lap splices in compression. Tables for tension development lengths and tension lap splice lengths are also provided in Chapter 5. For footing dowel design, see Chapter 13 – Footings.

Special requirements for splices in columns are prescribed by the Code (ACI 12.17). Selection of the tabulated combinations of design axial load and moment strengths in Chapters 3 and 4—the control points on the load-moment interaction diagram—was influenced by the splice provisions.

A point often overlooked in design for lap splices of offset column vertical bars is the reduction in effective depth of the offset bars. This effect can usually be safely neglected when the stress is always compressive with low reinforcement ratios. Particularly with reinforcement ratios in excess of 0.04 and large factored moments, however, nominal moment capacity should be reduced. An approximation for this reduction is:

$$R = (X - X_o)/X$$

where R = reduction of moment capacity
$X_o = 0.5h - d'_c$ for offset bar, and
$X = 0.5h - d_c$ for straight bar

See Fig. 2-4 for a sketch of an offset detail and definition of terms.

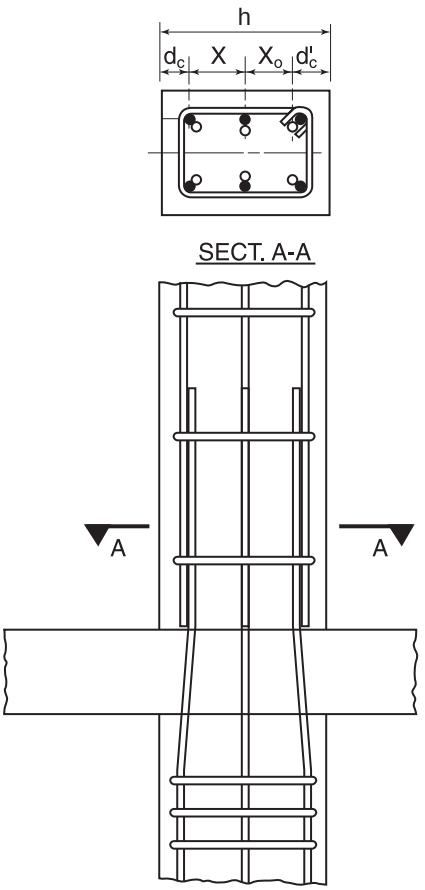


Figure 2-4 Offset Bar Lap Splices – Columns with Bending Moments, #11 Bars and Smaller

CHAPTER 3 – SQUARE AND RECTANGULAR COLUMNS

General. The variety of cross-sectional shapes used for reinforced concrete columns is unlimited, but many columns are square or rectangular because of practical requirements in layout of walls and partitions and ease of forming. In this Chapter, design strength tables for the three most used types of columns are furnished:

1. Square cross section with symmetrical groupings of reinforcing bars in four faces (4F).
2. Square cross section with symmetrical groups of reinforcing bars in two faces (2F).
3. Rectangular cross section with reinforcing bars in all faces; symmetrical groups of reinforcing bars in opposite faces.

Design strengths for the latter two types are tabulated for bending about each axis of symmetry. The major axis (MA) for the square sections (2F) is the axis equidistant from each parallel line through reinforcing bar centers. The minor axis (MI) is the axis through the center of the section at 90º to the major axis. For most (not all) combinations of column size, concrete cover, size and number of reinforcing bars, this type of column will have maximum design moment strength, ϕM_n, bending about the major axis (MA). For the rectangular columns, the major axis is a line parallel to the short sides passing through the center of the section. See Fig. 3-1.

Two separate tables for square columns are presented. Output and resulting format for the two tables are different. The square columns with symmetrical groupings of reinforcing bars in four faces provide the same design moment strength in each direction and require one line in the tables (Pages 3-12 through 3-15). Square columns with reinforcing bars in two faces only provide a different bending resistance in each direction. *Both directions must be evaluated separately for slenderness effects*, particularly when effective length differs due to different lateral bracing in the two directions. Since the same format was used for square columns with reinforcing bars in two faces and all rectangular columns, this type of square column design was tabulated at the beginning of each rectangular column design strength table.

Scope. The tabulated column designs presented on Pages 3-12 through 3-106 are for a concrete compressive strength, f'_c, of 4,000 psi and Grade 60 (f_y = 60,000 psi) reinforcing bars. Tabulated designs for concrete compressive strengths of 5,000, 6,000 and 8,000 psi in combination with Grade 60 bars are provided on the enclosed CD-ROM. Also included in the enclosed CD-ROM are tabulated designs for concrete strengths of 6,000, 8,000, and 10,000 psi in combination with Grade 75 (f_y = 75,000 psi) reinforcing bars.

CRSI recommends use of Grade 60 reinforcing bars as the standard grade for economy in the majority of structures. The ASTM A615 Specification for carbon-steel reinforcing bars includes Grade 75 bars in bar sizes #3 through #18. For example, Grade 75 could provide cost savings and other possible advantages in high-rise construction especially when combined with higher strength concretes. CRSI recommends that the availability of Grade 75 bars in any size should be investigated before the higher grade is specified. The ASTM A706 Specification covers low-alloy steel reinforcing bars in a single grade, i.e., Grade 60 (f_y = 60,000 psi).

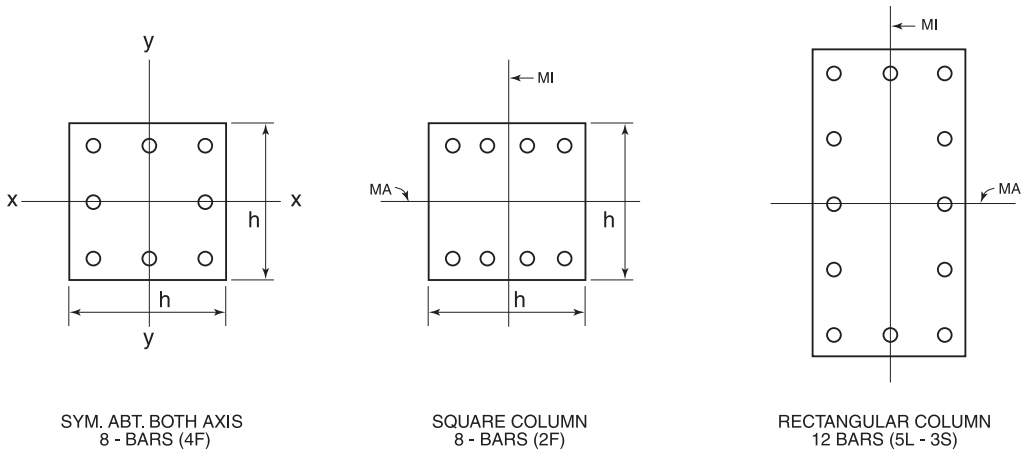


Figure 3-1 Bar Pattern Designation – Major and Minor Axis

Column sizes using Grade 60 reinforcing bars are shown for minimum size sides, 10 inches. For rectangular columns of each width, increasing depth increments up to depth = 2 times width are presented, maximum of 48 inches. Design strengths and reinforcement for various size combinations of rectangular columns with proportions exceeding 2:1 can be determined as fractions of strengths given. For bars in the two short faces only, 10 × 40 equals half the (MA) design moment strength of 20 × 40 if concrete cover and spacing permit use of half the number of bars. Similarly, 20 × 80 will provide twice the (MI) design moment strength of 20 × 40 for bars in long faces only.

Vertical reinforcing bar combinations are shown to provide reinforcing steel to concrete cross section ratios from 1 to 8 percent. Sizes of Grade 60 bars begin with #5 in smaller size columns and continue up to the largest size practicable for each size column. Not all bar combinations possible between 1 and 8 percent are shown. As column size increases, minimum bar size is increased to avoid designs with excessive numbers of vertical bars with equally excessive tie requirements. For Grade 75 bars, only the largest sizes, #11, #14 and #18, are used in the tabulated designs on the enclosed CD-ROM.

ACI Building Code Requirements. A number of Code requirements apply to square and rectangular columns.

1. *Design Assumptions.* See Chapter 2.
2. *Load Factors.* Three principal load factor combinations are prescribed for the required strength:

$U = 1.4D$
$U = 1.2D + 1.6L$
$U = 1.2D + 1.0L + 1.6W$

Column design must provide strength equal or larger than the largest value of U, determined by the three combinations above, or five in seismic design categories. Other factors apply for various special conditions.

In practice, the second load combination above will control most column designs, except in high-rise buildings, narrow buildings with few columns and no other lateral bracing greatly stiffer than the columns. For this reason, and for concise examples only, the final values of the required strength, U, (expressed as ϕP_n, ϕM_n) will be used in the examples in this Chapter. The required factored loads and factored moments (P_u, M_u) must be determined for the conditions of the structure to enter the column tables.

3. *Slenderness effects.* All design strengths tabulated in Chapters 3 and 4 are for "short" columns. Slenderness effects are not considered in the tabulated designs in Chapters 3 and 4.
4. *Biaxial Bending.* Column design strengths (ϕP_n, ϕM_n) are tabulated for uniaxial bending, with eccentricities in the direction of major (MA) and minor (MI) axis. A single value suffices for the table of square columns symmetrically reinforced where design axial load and moment strengths, MA and MI, are equal. Corner columns and any other columns subjected to known factored moments simultaneously about each axis must be designed for biaxial bending (ACI Commentary R10.3.6 and R10.3.7).
5. *Splices.* Special requirements for splices in columns are prescribed by the Code (ACI 12.17). Consideration of the splice requirements was made in the selection of the tabulated combinations of design axial load and moment strengths – the control or key points on the $\phi P_n - \phi M_n$ interaction diagram.
6. *Ties and Concrete Cover.* Recommended typical tie arrangements, suitable for prefabricated column cages or in-place free-standing erection, are shown in the *ACI Detailing Manual*. Each corner bar and alternate interior bars (with clear spacings equal or less than 6 inches) must have lateral support of a tie corner within an included angle not larger than 135º, (ACI 7.10.5.3). For cast-in-place columns, minimum concrete cover to ties is 1½ inches (ACI 7.7.1). Minimum sizes of ties are #3 for vertical (longitudinal) bars up to #10, and #4 for #11, #14, or #18 vertical bars. The calculated design strengths are based on depths, d', from the nearest face to the center of bars as shown in Table 3-1.

No column designs using mixed bar sizes are tabulated in this Chapter. If such designs are attempted, the largest bar size in the column face will establish depth, d'.

Table 3-1 Depth from Nearest Face to Center of Vertical Bars*

Bar Size	#5	#6	#7	#8	#9	#10	#11	#14	#18
Depth, d' (in.)	2.19	2.25	2.31	2.38	2.44	2.51	2.71	2.85	3.12

* Based on 1-1/2 in. concrete cover to the tie.

7. *Limiting Vertical (Longitudinal) Reinforcement.* The minimum number of vertical reinforcing bars is four in tied columns. The minimum area of vertical reinforcing bars is 0.01 and maximum 0.08 times the gross area of the column cross section (ACI 10.9.1). Where columns are larger than required for loadings,

the minimum limiting area of vertical bars can be reduced to 0.005 times the gross area. When the vertical bar area is reduced below 0.01 times gross area, computations for the design axial load strength, design moment strength, and minimum bar area must be based on an *effective gross area* reduced proportionately (ACI 10.8.4). This provision avoids waste of reinforcing steel for upper floors of a multi-story column made to a uniform size for form reuse from bottom to top. See Design from Tables Section in this Chapter. For lower floors in high-rise construction, the use of Grade 75 reinforcing bars in combination with maximum available concrete strength often can reduce congestion of vertical bars where compression controls design.

Costs for each item in reinforced concrete column construction vary in different localities. A few general principles for economy of column design are applicable, however, throughout the industry.

1. Form reuse through utilization of the same cross section over an entire floor and for all stories in a multi-story column saves form costs and erection time.
2. High placing costs of reinforcing steel can be reduced by designing for the fewest (or largest practicable size) reinforcing bars.
3. High cost per pound of ties versus vertical (longitudinal) bars can be reduced by using the least number of largest practicable size vertical bars.
4. Concrete costs can be reduced for both material and placing if interfering interior ties are eliminated as in 4-, 6-, or 8-bar columns requiring only one tie per set. Faster placing and easier consolidation with lower slump (less expensive) concrete will result.
5. Lap splices are least expensive where the required lap length is practicable, and where required design moment strength can be developed. #14 and #18 bars cannot be lap spliced except in compression to #11 or smaller bars; also for compression-only applications, staggered end-bearing mechanical splices offer economy. Partial lap splices in bundled bars staggered for one-half or two-thirds tensile capacity require no additional reinforcing steel. Two-story lengths for large bars eliminate one-half the required number of butt splices.

The design strength tables in this Chapter follow these principles for economy. No mixed bar size designs were used. The minimum size bar was gradually increased so that all practicable combinations for minimum numbers of bars are presented. The tables include design load and moment strengths at zero and 50 percent tension in the bars on the tension (convex) side of the columns. These values provide guidance to prescribe the most economical splicing arrangements without tedious calculations of critical tension. Bundled bar designs, as such, were not feasible for tabulation, but the design strengths shown for eight or more bars, #11 or less in size, can be applied where tabulated bars are arranged in bundles. In most cases, the bundled arrangement can be devised to increase the design moment strength above that tabulated in at least one, sometimes both directions.

Table 3-2 Maximum Spacing of Column Ties (ACI 7.10.5.2)*

Vertical bar size	Size and spacing of ties, (inches)		
	#3	#4	#5
#5	10	–	–
#6	12	–	–
#7	14	–	–
#8	16	16	–
#9	18	18	–
#10	18	20	–
#11	**	22	22
#14	**	24	27
#18	**	24	30

* Maximum spacing not to exceed least column dimension.
** Not allowed.

DESIGN FROM TABLES

Select interior rectangular columns for the conditions in Fig. 3-2, maintaining a uniform size for form reuse and a maximum width, not to exceed 16 in. Use f'_c = 4,000 psi, if possible. First floor story height is 16′-0″ and the unbraced length, ℓ_u, is 13′-3″. For all other floors, story height is 11′-6″ and the unbraced length, ℓ_u, from finished floor to the bottom of the beam is 8′-9″.

Assume the structure is braced (non-sway columns). For these conditions, the load factor combination of $1.2D + 1.6L$ will control the design, 1.2 times the dead load and dead load moment, if any, plus 1.6 times live load and unbalanced live load moments. See Fig. 3-2. Note that the factored moments are so small that it is unnecessary to consider separately the full load and partial load for unbalanced moment. Maximum $P_u \leq 0.80(0.65)[0.85f'_c\,(A_g - A_{st}) + f_y\,A_{st}]$(ACI 10.3.6.2) will control this column design for all floors if slenderness effects may be neglected.

Make a preliminary evaluation whether slenderness effects must be considered. For members braced against sidesway, slenderness effects can be neglected if $k\ell_u/r < 34 - 12\,M_1/M_2$ . . . (ACI 10.10.1)

Take $k = 1.0$ and $r = 0.30\ (16) = 4.8$ in.

$k\ell_u/r = (1)(105)/(4.8) = 22$

Roof: $34 - 12(91/262) = 30 > 22$

Intermediate Floors: $34 - 12(262/262) = 22$

First Floor: $k\ell_u/r = (1)(159)/(4.8) = 33$

First F1oor: 34 12(0/262) = 34 > 33

Slenderness effects can be neglected for this column stack. Final designs may, therefore, be selected directly from the tables. As a quick check for design strengths, find maximum design axial load strength ϕP_n and corresponding value of design moment strengths ϕM_n for comparison to maximum factored loads and moments P_u and M_u.

For f'_c = 4,000 psi and column size 16″ x 20″, enter table on Pages 3-28 and 3-29 for rectangular columns and read maximum ϕP_n and corresponding value of ϕM_n:

Location	Bars	ϕP_n (kips)	ϕM_n (in.-kips)
1st Floor	14-#10 5L-4S	1,089 ($>P_u$ = 1,036)	1,797 ($>M_u$ = 262)
2nd Floor	8-#11 3E	933 ($>P_u$ = 816)	1,614 ($>M_u$ = 262)
3rd Floor	6-#8 2L-3S	705 ($>P_u$ = 596)	1,438 ($>M_u$ = 262)
4th Floor	4-#9 2E	683 ($>P_u$ = 375)	1,389 ($>M_u$ = 262)

Note that P_u at the 4th floor level is only 375 kips. Read design strengths for 4-bar arrangements with rho nearest to 1.00% to apply oversize column reduction (ACI 10.8.4):

Calculate the ratio: $P_u/\phi P_n = 375/683 = 0.55$
For 4–#9 bars, $A_s = 4.00$ in.^{2}
Reduce A_s by ratio 0.55; $(0.55)(4.00) = 2.20$ in.^{2}
$\phi M_n \approx 0.55(1{,}389) = 764$ in.-kips > 262
Use 4–#7 bars; $A_s = (4)(0.60) = 2.40$ in.^{2}

Apply same procedure to roof column.

Roof: 155/683 < 0.5, use minimum $A_s = 0.005A_g$
Minimum $A_s = (0.005)(16 \times 20) = 1.60$ in.^{2}
$\phi M_n \approx 0.5(1{,}389) = 695$ in.-kips > 91
Use 4-#6 bars; $A_s = (4)(0.44) = 1.76$ in.^{2} > 1.60

Select minimum sizes and maximum spacings for ties from Table 3-2. See Fig. 3-3 for details.

Splices. All vertical (longitudinal) bars are in compression only. Select lap splice lengths as follows from Chapter 5, noting that the beam is 33-in. deep.

5th Floor: minimum standard lap splice length (Table 5-1) for #6 bars above = 23 in. Use lap length = 23 in.

4th Floor: minimum standard lap splice length (Table 5-1) for #7 is bars 27 in.; compression embedment length for #8 bars below is 22 in. Use lap length = 27 in.; cut off discontinued bars at 2 in. below finished floor. Extend 4-#8 bars.

3rd Floor: minimum standard lap splice length (Table 5-1) for #8 bars is 30 in.; minimum compression embedment length for #11 bars below is 31 in. Use lap length = 31 in.; cut off bars at 2 in. below finished floor. Extend 6-#11 bars.

2nd Floor: minimum standard lap splice length (Table 5-1) length for #11 bar is 43 in.; minimum compression embedment for #11 below is 31 in. Use lap length = 43 in.; cut-off bars at 2 in. below finished floor. Extend 8-#11 bars.

Footing. Design bearing strength of column (ACI 10.14.1) = $\phi(0.85f'_cA_1) = 0.65(0.85)(4)(16 \times 20) = 707$ kips. Excess compression on base of the column = 1,036 – 707 = 329 kips. Assuming the footing f'_c is at least equal to 3,000 psi and $\sqrt{A_2/A_1} = 2$, the design bearing strength of the footing = $(2)(0.60)(0.85)(3)(16 \times 20) = 1{,}061$ kips. Dowels must provide (ACI 15.8.2.1) $A_s = (0.005)(16 \times 20) = 1.60$ in.^{2}; and transfer (ACI 15.8.1.2) 329 kips by compression embedment.

Use 6– #10 dowels, 2L-3S; from Table 5-1, the required embedment length for f_y = 60 ksi is 28 in. For transferring 329 kips, the required embedment =

$$\frac{329(28)}{6(1.27)(60)} = (0.72)(28) = 20 \text{ in.}$$

Length of compression lap splice of #10 dowels to #10 column bars; from Table 5-1, the required lap length for f_y = 60 ksi is 38 in. For transferring 329 kips, the required lap length = 0.72(38) = 28 in.

See Figs. 3-2 and 3-3 for details of splice arrangements.

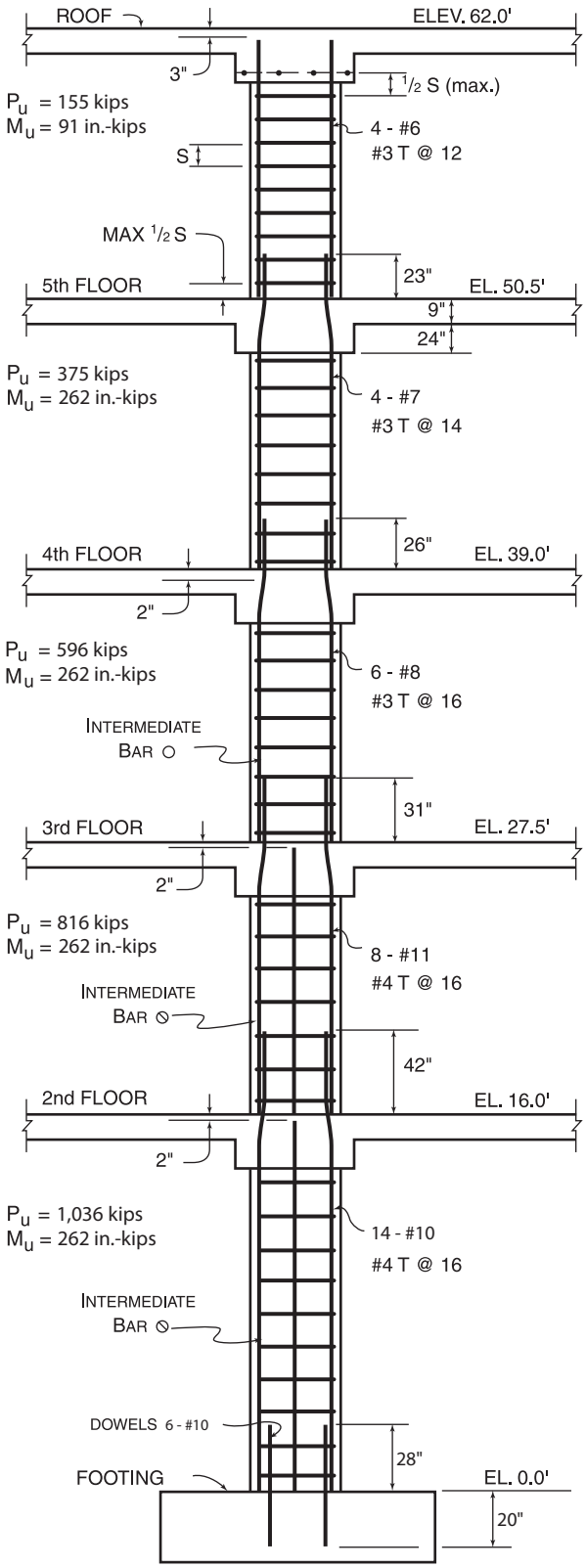


Figure 3-2 Lap Splices and Cut-off Details

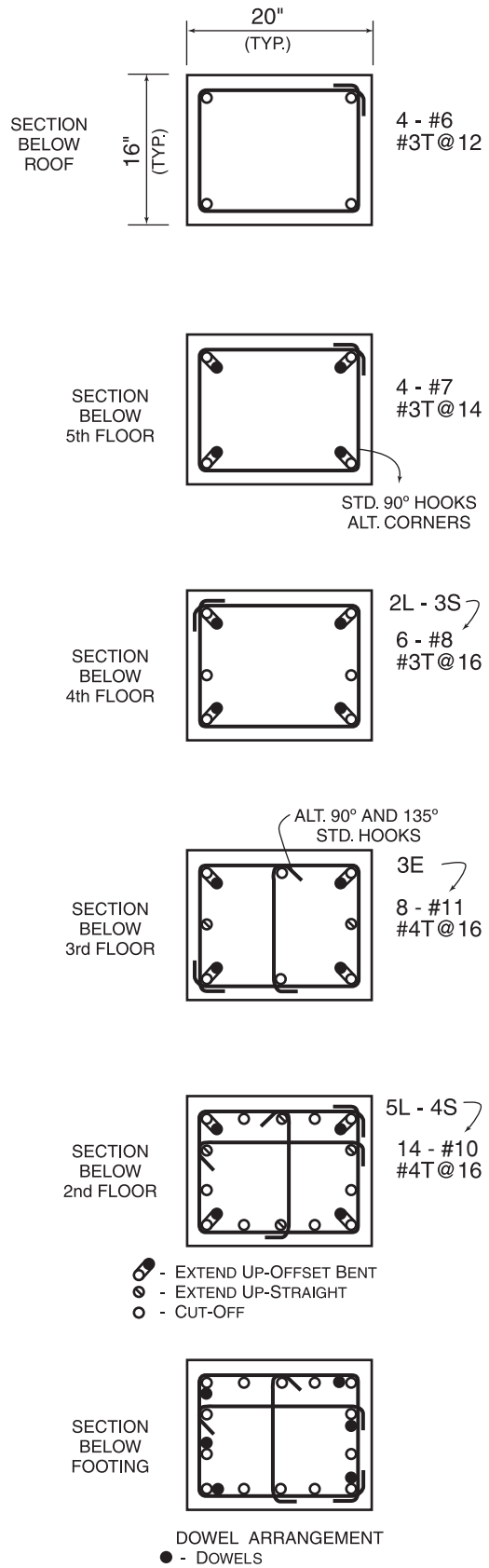


Figure 3-3 Multi-Story Column—Plan Sections

MANUAL EXAMPLE

Review a rectangular column 12″ × 24″ with f'_c = 6,000 psi and 10-#14 Grade 60 vertical (longitudinal) reinforcing bars. Compute values of ϕP_n and ϕM_n at control points (ϕM_n about major axis, MA). Compare computed values versus the tabulated values printed out for 10-#14, 5L-2S from the enclosed CD-ROM. The printed-out values are displayed in Table 3-3.

The dimensions in Fig. 3-4 are based on 1½ inches of concrete cover to the #4 ties. For f'_c = 6,000 psi, β_1 = 0.75 (ACI 10.2.7.3). E_s = 29 × 10^6 psi (ACI 8.5.2). Strength-reduction factors: ϕ = 0.65 for compression and ϕ = 0.90 for flexure (ACI 9.3.2).

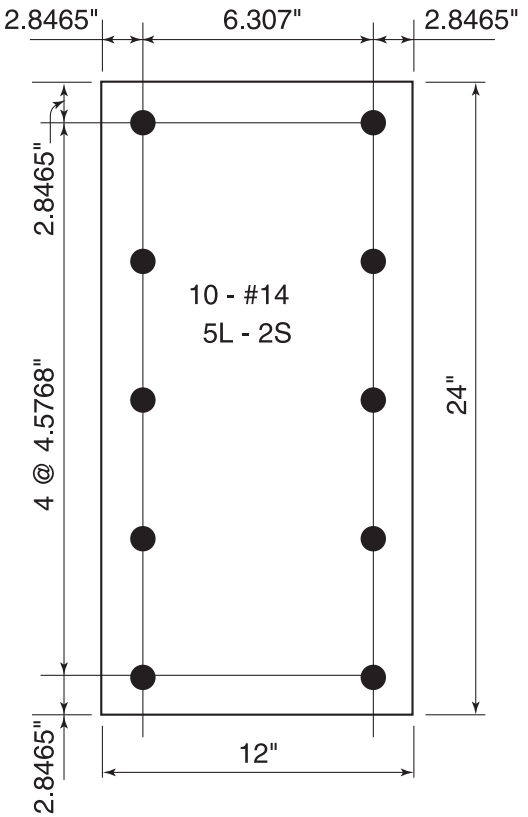


Figure 3-4 Dimensions – Manual Example

In the general case, (Fig. 3-5), the distance from the extreme compression fiber to the neutral axis, c, has to be determined by iteration. The distance, c, can be expressed in terms of the tensile strain, $\varepsilon_s = f_s/E_s$, in the outermost bars:

$$c = \frac{d_{sn}}{1 + f_s/(E_s \varepsilon_c)}$$

Where:

d_{sn} = maximum distance to bars from extreme compression surface. Maximum distance is d_{s5} in Fig. 3-5.

f_s = tensile stress in outermost bars.

ε_c = maximum compressive strain in concrete = 0.003 (ACI 10.2.3).

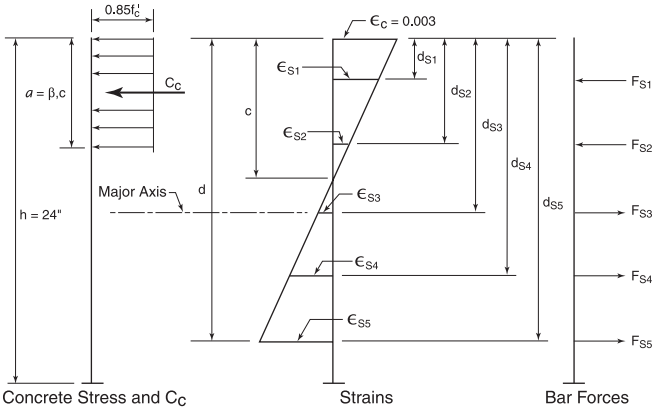


Figure 3-5 General Case

For bars located in the compression zone, i.e., $d_{si} < \beta_1 c$, the compressive force must be reduced by $0.85 f'_c A_b$ to subtract the force from the concrete resisting compression. In this example, the force reduction for 2-#14 bars in a row (stress = 0.85(6) = 5.1 ksi) = 0.85(6)(4.5) = 22.95 kips.

1. $\phi P_{n(max)}$ and ϕM_n

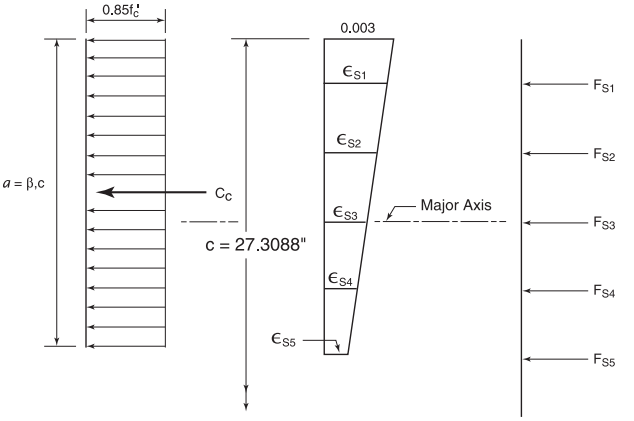


Figure 3-6 $\phi P_{n(max)}$ and ϕM_n

The value of $\phi P_{n(max)}$ can be solved directly by ACI Eq. 10-2:

$$\phi P_{n(max)} = 0.80\ \phi[0.85 f'_c\ (A_g - A_{st}) + f_y A_{st}]$$

$$\phi P_{n(max)} = 0.80(0.65)[0.85(6)(288 - 22.5) + 60(22.5)]$$

$$= 1{,}406 \text{ kips (tabulated = 1,406)}$$

Note that $\phi P_{n(max)}$ was calculated as 1,406.106 kips; then $P_n = 1{,}406.106/\phi = 1{,}406.106/0.65 = 2{,}163.240$ kips.

For this condition, the exact value of strain in the outermost bars (Row 5) is not evident (Fig. 3-6). The entire cross section will be in compression so $c > h$. Expressing the bar forces and the compression resultant in the concrete, C_c, in terms of c, and equating the sum of forces to 2,163.240 kips:

$C_c = 0.85 f'_c ab$
$C_c = 0.85(6)(0.75c)(12) = 45.90c$
Σ Bar Forces (Rows 1 through 5) + $45.90c$
$= 2{,}163.240$ kips
Solving, $c = 27.3088$ in.

From Fig. 3-5, the bar (row) strains, stresses, forces, and moments of the forces about the major axis of the column can be expressed:

$\varepsilon_{si} = \varepsilon_c(1 - d_{si}/c)$

$f_{si} = E_s \varepsilon_{si}$ ($\leq$ 60 ksi)

$F_{si} = f_{si} A_s$ (in this example. $A_s = 4.5$ in.^{2} for 2-#14 bars in a row)

General equation for force F_{si} in row i:

$$F_{si} = \left[(c\text{-}d_{si})\left(\frac{0.003}{c}\right)(E_s) - \beta f'_c\right] A_b \leq f_y A_b$$

where the $\beta f'_c$ term only applies if $d_{si} < \beta c$

$M_{si} = F_{si}(h/2 - d_{si})$

Bars (compression forces and moments about major axis):

Row	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	2.8465	0.0026873	60.000	247.050*	2,261.372
2	7.4233	0.0021845	60.000	247.050*	1,130.674
3	12.0000	0.0016817	48.769	196.510*	0
4	16.5768	0.0011790	34.191	130.909*	−599.144
5	21.1535	0.0006762	19.610	88.245	−807.751
				909.764	1,985.151

*F_{si} reduced by 22.95 kips/row.

Compute the concrete compression resultant, C_c, and moment, M_c, about the major axis.

The depth of the equivalent rectangular stress block:

$a = \beta_1 c = 0.75(27.3088) = 20.4816$ in.
$C_c = 0.85(6)(20.4816)(12) = 1{,}253.474$ kips
$M_c = 1{,}253.474(12 - 20.4816/2) = 2{,}205.111$ in.-kips

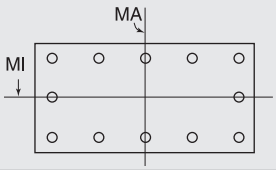
ΣForces = 0
$-P_n + 909.764 + 1{,}253.474 = 0$
$P_n = 2{,}163.238$ kips
$\phi P_{n(max)} = (0.65)(2{,}163.238) = 1{,}406$ kips
(tabulated = 1,406)

$\Sigma M_{MA} = 0$
$-M_n + 1{,}985.151 + 2{,}205.111 = 0$
$M_n = 4{,}190.262$ in.-kips
$\phi M_n = (0.65)(4{,}190.262) = 2{,}724$ in.-kips
(tabulated = 2,724)

Table 3-3 Print-Out from Enclosed CD-ROM – Values of ϕP_n and ϕM_n at Control Points

RECTANGULAR TIED COLUMNS 12″ X 24″

Short Columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in.-kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		ϕP_n = 0
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	7.81	MA	2724	1406	4473	1092	5212	881	5746	708	6588	375	8276	-111	8125
5L-2S		MI	1370	1406	2667	947	2934	723	3142	520	3501	149	3727	-174	3599

2. ϕP_{ot} and ϕM_{ot} (Point of Zero Tension in Extreme Bars)

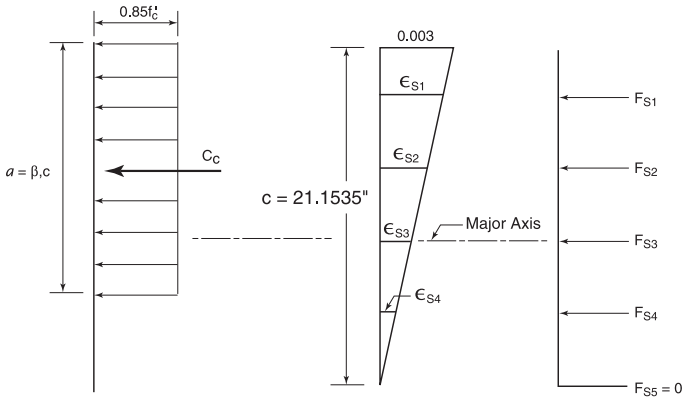


Figure 3-7 ϕP_{ot} and ϕM_{ot} (Point of Zero Tension)

For this condition, the c distance is easily determined by inspection from Fig. 3-7 because $\epsilon_{s5} = f_{s5}/E_s = 0$; hence, $c = 24 - 2.8465 = 21.1535$ in., or by the equation:

$$c = \frac{d_{sn}}{1 + f_s/(E_s \epsilon_c)}$$

$$c = \frac{21.1535}{1 + 0/(29{,}000 \times 0.003)} = 21.1535 \text{ in.}$$

Note that the point of "zero tension" is defined, in this Chapter, as the load/moment combination resulting in zero strain at the center of the vertical bars on the tension face. The diameter of the bar is neglected because the stress in the bar on either side of its center reverses sign and totals zero. Where two layers of bars are used, as with bundled bars, the same definition (to centroid of bundle) is satisfactory for practical use in designing splices.

Bars (compression forces and moments about major axis):

Row	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	2.8465	0.0025963	60.000	247.050*	2,261.372
2	7.4233	0.0019472	56.469	231.161*	1,057.955
3	12.0000	0.0012981	37.646	146.457*	0
4	16.5768	0.0006491	18.823	84.703*	–387.669
5	21.1535	0	0	0	0
				709.371	2,931.658

*F_{si} reduced by 22.95 kips/row.

Compute the concrete compression resultant, C_c, and moment, M_c, about the major axis:

$a = 0.75\ (21.1535) = 15.8651$ in.
$C_c = 0.85\ f'_c ab = 0.85(6)(15.8651)(12) = 970.944$ kips
$M_c = 970.944\ (12 - 15.8651/2) = 3{,}949.266$ in.-kips

ΣForces = 0
$-P_n + 709.371 + 970.944 = 0$
$P_n = 1{,}680.351$ kips
$\phi P_n = (0.65)(1{,}680.315) = 1{,}092$ kips
(tabulated = 1,092)

$\Sigma M_{MA} = 0$
$-M_n + 2{,}931.658 + 3{,}949.266 = 0$
$M_n = 6{,}880.924$ in.-kips
$\phi M_n = (0.65)(6{,}880.924) = 4{,}473$ in.-kips
(tabulated = 4,473)

3. 25% Tension

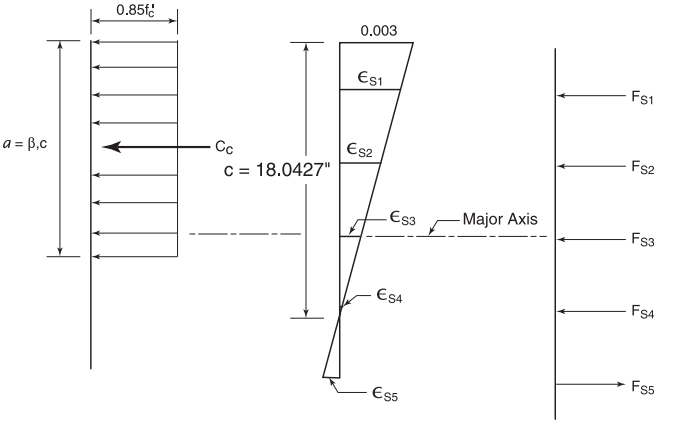


Figure 3-8 25% Tension

The tensile stress in the Row 5 bars = 0.25(60) = 15 ksi. The distance:

$$c = \frac{21.1535}{1 + 15/(29{,}000 \times 0.003)} = 18.0427 \text{ in.}$$

Bars (forces and moments about major axis):

Row	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	2.8465	0.0025267	60.000	247.050*	2,261.372
2	7.4233	0.0017657	51.205	207.472*	949.537
3	12.0000	0.0010047	29.136	108.162*	0
4	16.5768	0.0002437	7.067	31.801*	–145.547
5	21.1535	–0.0005172	–15.000	–67.500	617.861
				526.985	3,683.223

*F_{si} reduced by 22.95 kips/row.

Compute the concrete compression resultant, C_c, and moment, M_c, about the major axis:

$a = 0.75(18.0472) = 13.5320$ in.
$C_c = 0.85(6)(13.5320)(12) = 828.158$ kips
$M_c = 828.158(12 - 13.5320/2) = 4{,}334.579$ in.-kips

ΣForces = 0
$-P_n + 526.985 + 828.158 = 0$
$P_n = 1{,}355.143$ kips
$\phi P_n = (0.65)(1{,}355.143) = 881$ kips (tabulated = 881)

$\Sigma M_{MA} = 0$
$-M_n + 3{,}683.223 + 4{,}334.579 = 0$
$M_n = 8{,}017.802$ in.-kips
$\phi M_n = (0.65)(8{,}017.802) = 5{,}212$ in.-kips
(tabulated = 5,212)

4. 50% Tension

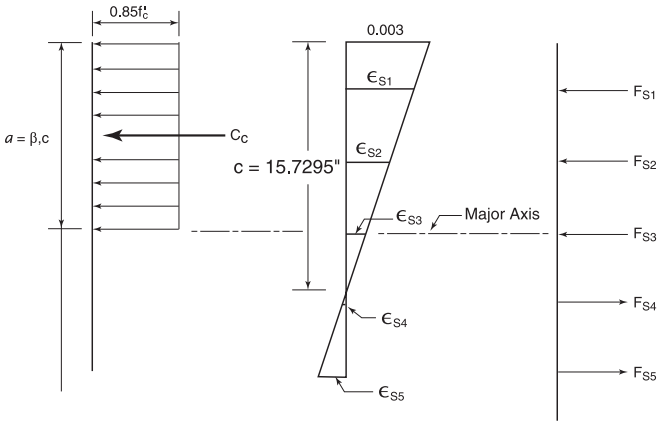


Figure 3-9 50% Tension

The tensile stress in the Row 5 bars = 0.50(60) = 30 ksi. The distance:

$$c = \frac{21.1535}{1 + 30/(29.000 \times 0.003)} = 15.7295 \text{ in.}$$

Bars (forces and moments about major axis):

Row	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	2.8465	0.0024571	60.000	247.050*	2,261.372
2	7.4233	0.0015842	45.942	183.789*	841.147
3	12.0000	0.0007113	20.628	92.826	0
4	16.5768	–0.0001616	–4.686	–21.087	96.511
5	21.1535	–0.0010345	–30.000	–135.000	1,235.723
				367.587	4,434.753

*F_{si} reduced by 22.95 kips/row.

Compute the concrete compression resultant, C_c, and moment, M_c, about the major axis:

$a = 0.75\ (15.7295) = 11.7971$ in.
$C_c = 0.85(6)\ (11.7971)(12) = 721.983$ kips
$M_c = 721.983\ (12 - 11.7971/2) = 4{,}405.143$ in.-kips

ΣForces = 0
$-P_n + 367.578 + 721.983 = 0$
$P_n = 1{,}089.561$ kips
$\phi P_n = (0.65)(1{,}089.561) = 708$ kips (tabulated = 708)

$\Sigma M_{MA} = 0$
$-M_n + 4{,}434.753 + 4{,}405.143 = 0$
$M_n = 8{,}839.896$ in.-kips
$\phi M_n = (0.65)(8{,}839.896) = 5{,}746$ in.-kips
(tabulated = 5,746)

5. 100% f_y (ϕP_b and ϕM_b, Balance Point on Interaction Diagram)

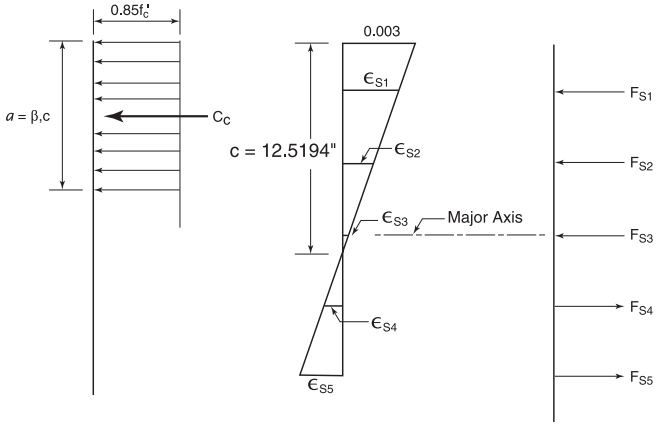


Figure 3-10 100% f_y (ϕP_b and ϕM_b Balance)

The tensile stress in the Row 5 bars = f_y = 60 ksi. The distance:

$$c = \frac{21.1535}{1 + 60/(29.000 \times 0.003)} = 12.5194 \text{ in.}$$

Bars (forces and moments about major axis):

Row	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	2.8465	0.0023179	60.000	247.050*	2,261.372
2	7.4233	0.0012212	35.415	136.417*	624.340
3	12.0000	0.0001245	3.610	16.245	0
4	16.5768	–0.0009723	–28.197	–126.886	580.732
5	21.1535	–0.0020690	–60.000	–270.000	2,471.445
				2.826	5,937.890

*F_{si} reduced by 22.95 kips/row.

Compute the concrete compression resultant, C_c, and moment, M_c, about the major axis:

$a = 0.75(12.5194) = 9.3895$ in.
$C_c = 0.85(6)(9.3895)(12) = 574.637$ kips
$M_c = 574.637(12 - 9.3895/2) = 4{,}197.867$ in.-kips

ΣForces = 0
$-P_n + 2.826 + 574.637 = 0$
$P_n = 577.463$ kips
$\phi P_n = 0.65(577.463) = 375$ kips (tabulated = 375)

$\Sigma M_{MA} = 0$
$-M_n + 5{,}937.890 + 4{,}197.867 = 0$
$M_n = 10{,}135.757$ in.-kips
$\phi M_n = (0.65)(10{,}135.757) = 6{,}588$ in.-kips
(tabulated = 6,588)

6. ϕP_n, ϕM_n ($\varepsilon_t = 0.005$)

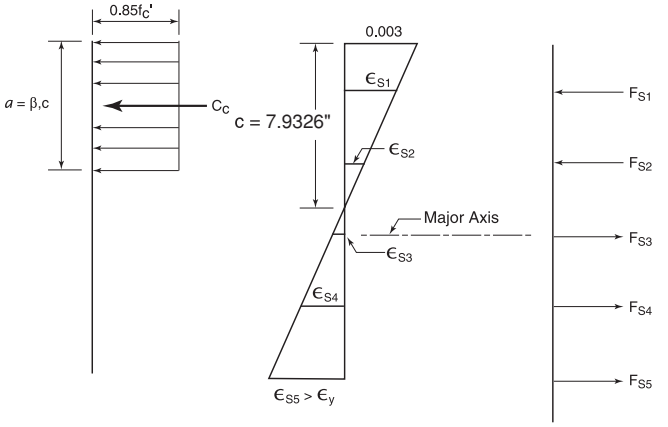


Figure 3-11 ϕP_n, ϕM_n ($\varepsilon_t = 0.005$)

For this condition, the tensile strain in the outermost bars (Row 5) is 0.005. The value of c can be solved for directly:

$c = d_{sn}(0.003)/(0.003 + 0.005)$
$= 21.1535(0.003)/(0.003 + 0.005)$
$= 7.9326$ in.

Bars (forces and moments about major axis):

Row	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	2.8465	0.0019235	55.781	228.065*	2,087.595
2	7.4233	0.0001926	5.586	25.136*	115.043
3	12.0000	–0.0015383	–44.609	–200.742	0
4	16.5768	–0.0032691	–60.000	–270.000	1,235.722
5	21.1535	–0.0050000	–60.000	–270.000	2,471.445
				–487.541	5,909.805

*F_{si} reduced by 22.95 kips/row.

Compute the concrete compression resultant, C_c, and moment, M_c, about the major axis:

$a = 0.75(7.9326) = 5.9494$ in.
$C_c = 0.85(6)(5.9494)(12) = 364.105$ kips
$M_c = 364.105(12 - 5.9494/2) = 3{,}286.150$ in.-kips

ΣForces = 0
$-P_n - 487.541 + 364.105 = 0$
$P_n = 123.436$ kips
$\phi P_n = (0.9)(-123.436) = -111$ kips (tabulated = –111)

$\Sigma M_{MA} = 0$
$-M_n + 5{,}909.805 + 3{,}286.150 = 0$
$M_n = 9{,}195.955$ in.-kips
$\phi M_n = (0.9)(9{,}195.955) = 8{,}276$ in.-kips
(tabulated = 8,276)

7. ϕM_n ($\phi P_n = 0$)

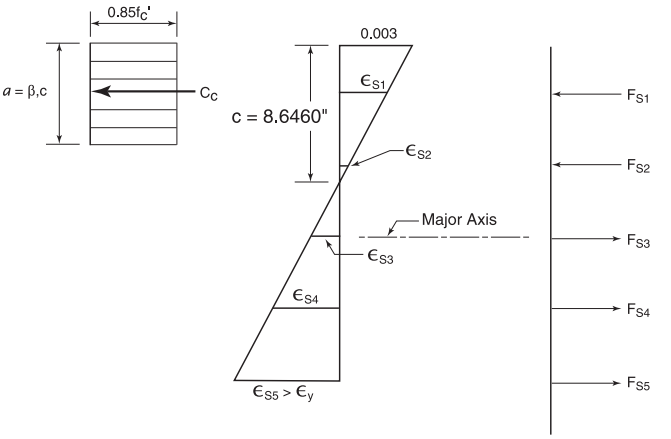


Figure 3-12 ϕM_n ($\phi P_n = 0$)

For this condition, the tensile stress in the outermost bars (Row 5) is 60 ksi, but the exact value of the strain is not evident: $\varepsilon_{s5} > \varepsilon_y$ (Fig. 3-12). *A trial-and-error solution is required.* After several trials (manually), the neutral axis is determined to be located between Row 2 and Row 3. Expressing the bar forces and the concrete compression resultant, C_c, in terms of c and summing forces:

$$[(c - 2.8465)\left(\frac{0.003}{c}\right)(29{,}000 - 5.1](4.5) +$$
$$(c - 7.4233)\left(\frac{0.003}{c}\right)(29{,}000)(4.5) + 0.85\,(6)(0.75c)(12)]$$
$$= (12 - c)\left(\frac{0.003}{c}\right)(29{,}000)(4.5) + 270 + 270$$

Solving, $c = 8.6460$ in.

Bars (forces and moments about major axis):

Row	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	2.8465	0.0020123	58.357	239.656*	2,193.691
2	7.4233	0.0004242	12.302	55.359	253.361
3	12.0000	–0.0011638	–33.750	–151.875	0
4	16.5768	–0.0027518	–60.000	–270.000	–1,235.736
5	21.1535	–0.0043399	–60.000	–270.000	2,471.445
				–396.860	6,154.233

*F_{si} reduced by 22.95 kips/row.

Compute the concrete compression resultant, C_c, and moment, M_c, about the major axis:

$a = 0.75(8.6460) = 6.4845$ in.
$C_c = 0.85(6)\ (6.4845)(12) = 396.851$ kips
$M_c = 396.851(12 - 6.4845/2) = 3,475.522$ in.-kips

Because $\varepsilon_t = 0.00434 > 0.00207$ and $\varepsilon_t < 0.005$, ϕ must be determined:

$$\phi = 0.65 + \frac{(0.9 - 0.65)}{(0.005 - 0.00207)}(\varepsilon_t - 0.00207)$$

$$\phi = 0.65 + 85.324(0.00434 - 0.00207)$$
$$= 0.8437$$

ΣForces = 0
$-P_n - 396.860 + 396.851 = 0$
$P_n = 0$; hence, $\phi P_n = 0$ (tabulated = 0)

$\Sigma M_{MA} = 0$
$-M_n + 6,154.233 + 3,475.522 = 0$
$M_n = 9,629.755$ in.-kips
$\phi M_n = (0.8437)(9,629.755) = 8,125$ in.-kips
(tabulated = 8,125)

SQUARE TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.24	200	213	311	170	351	141	368	118	380	80	410	53	254
4-#6	1.76	207	229	337	178	381	146	401	119	422	75	451	41	335
4-#7	2.40	216	247	369	189	415	153	440	122	470	69	497	25	429
4-#8	3.16	227	270	404	201	453	160	484	124	525	62	548	5	534
4-#9	4.00	237	295	439	214	492	168	528	126	581	53	613	-12	602
4-#10	5.08	250	326	479	231	539	177	581	128	647	41	672	-43	665
4-#11	6.24	257	360	499	241	558	179	601	123	671	18	666	-95	677
8-#5	2.48	204	250	343	192	390	157	414	127	438	73	471	8	450
8-#6	3.52	214	280	382	210	435	168	464	132	501	65	534	-24	532
8-#7	4.80	226	318	428	232	486	181	523	137	575	55	604	-65	601

SQUARE TIED COLUMNS 12" x 12"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.22	353	306	529	252	616	211	663	179	697	124	775	90	442
4-#7	1.67	367	325	574	263	669	219	724	182	773	120	857	79	573
4-#8	2.19	383	348	625	275	731	228	793	187	859	115	948	65	721
4-#9	2.78	399	372	679	289	797	238	865	191	950	109	1042	48	878
4-#10	3.53	419	404	747	307	880	251	954	196	1061	101	1155	25	1072
4-#11	4.33	431	438	808	324	931	258	1009	195	1128	85	1196	-15	1197
4-#14	6.25	474	519	957	372	1089	284	1189	204	1354	57	1399	-89	1404
8-#5	1.72	348	328	535	268	626	222	676	185	718	124	803	61	598
8-#6	2.44	364	358	590	286	693	235	756	193	814	119	909	34	803
8-#7	3.33	383	396	655	308	772	251	847	201	929	113	1032	1	1031
8-#8	4.39	405	441	730	334	865	270	950	210	1059	104	1171	-41	1157
8-#9	5.56	429	490	810	364	963	290	1059	220	1195	94	1313	-90	1283
8-#10	7.06	459	554	910	401	1086	317	1192	237	1363	79	1483	-155	1435

SQUARE TIED COLUMNS 14" x 14"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.22	571	417	832	352	986	295	1072	249	1157	178	1314	136	716
4-#8	1.61	594	440	898	364	1067	303	1168	255	1277	174	1450	125	907
4-#9	2.04	617	464	970	378	1153	313	1270	261	1404	170	1591	112	1112
4-#10	2.59	645	496	1059	396	1261	326	1399	269	1561	165	1765	95	1367
4-#11	3.18	665	530	1146	412	1360	338	1503	273	1675	152	1864	64	1603
4-#14	4.59	725	611	1350	459	1610	372	1775	288	2017	133	2215	8	2183
8-#5	1.27	545	420	780	358	928	299	1007	253	1079	182	1231	117	745
8-#6	1.80	568	450	851	376	1014	312	1108	261	1210	179	1382	95	1011
8-#7	2.45	594	488	935	398	1117	328	1231	270	1367	175	1562	67	1323
8-#8	3.22	624	533	1033	425	1237	348	1373	282	1547	169	1766	33	1677
8-#9	4.08	656	582	1138	455	1365	369	1527	295	1738	163	1980	-7	1975
8-#10	5.18	697	646	1269	493	1527	396	1720	311	1975	154	2242	-60	2200
8-#11	6.37	727	714	1393	529	1672	421	1876	321	2147	132	2395	-140	2318

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.23	866	546	1232	468	1483	392	1625	332	1782	239	2064	189	1092
4-#9	1.56	898	570	1321	481	1590	402	1752	338	1950	237	2255	179	1344
4-#10	1.98	936	602	1432	499	1724	415	1912	345	2159	234	2492	166	1660
4-#11	2.44	963	636	1547	514	1853	425	2059	351	2322	224	2653	141	1963
4-#14	3.52	1044	717	1806	561	2169	459	2435	372	2783	210	3161	98	2698
4-#18	6.25	1225	924	2412	681	2914	546	3289	419	3823	166	4254	-35	4222
8-#6	1.38	831	556	1170	481	1416	402	1550	339	1686	243	1968	160	1217
8-#7	1.88	867	594	1275	503	1543	418	1700	349	1885	240	2205	136	1602
8-#8	2.47	907	639	1395	530	1690	438	1875	361	2119	238	2477	107	2043
8-#9	3.13	949	688	1525	560	1849	459	2065	374	2371	235	2765	73	2513
8-#10	3.97	1001	752	1689	598	2049	487	2304	391	2686	230	3122	28	3056
8-#11	4.88	1041	820	1851	635	2237	512	2524	405	2932	214	3370	-40	3332
8-#14	7.03	1164	982	2232	733	2709	583	3088	447	3625	191	4136	-175	3976
12-#10	5.95	1138	901	2016	698	2447	565	2782	442	3323	221	3924	-60	3852

SQUARE TIED COLUMNS 18" x 18"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.23	1248	691	1738	600	2118	503	2336	426	2578	307	3048	250	1576
4-#10	1.57	1297	722	1872	617	2279	515	2527	433	2831	304	3349	240	1952
4-#11	1.93	1335	756	2015	632	2438	525	2708	439	3066	299	3575	220	2322
4-#14	2.78	1438	838	2330	678	2821	559	3163	459	3661	292	4245	185	3211
4-#18	4.94	1669	1044	3076	797	3734	645	4252	512	5005	260	5738	80	5313
8-#6	1.09	1165	676	1556	601	1909	504	2095	428	2263	314	2680	229	1421
8-#7	1.48	1208	714	1680	623	2059	521	2272	438	2499	312	2975	208	1880
8-#8	1.95	1257	759	1824	650	2234	540	2480	450	2775	310	3317	183	2407
8-#9	2.47	1312	808	1980	680	2424	562	2705	464	3076	307	3681	154	2973
8-#10	3.14	1378	872	2176	719	2663	590	2991	481	3456	304	4135	115	3677
8-#11	3.85	1429	940	2377	755	2895	615	3261	495	3810	297	4482	56	4332
8-#14	5.56	1581	1103	2840	854	3466	687	3943	539	4705	285	5491	-61	5407
12-#10	4.70	1543	1021	2566	820	3148	664	3559	534	4215	298	5142	36	4997
12-#11	5.78	1625	1124	2839	878	3457	712	3935	559	4711	287	5638	-48	5566

SQUARE TIED COLUMNS 20" x 20"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.00	1675	825	2230	733	2749	617	3035	525	3326	386	3983	327	1808
4-#10	1.27	1735	857	2387	751	2937	629	3256	533	3620	383	4349	319	2244
4-#11	1.56	1785	891	2559	765	3127	639	3472	537	3898	378	4642	302	2680
4-#14	2.25	1915	972	2931	810	3577	671	4006	557	4608	371	5476	274	3723
4-#18	4.00	2200	1178	3816	928	4658	757	5295	610	6317	356	7382	189	6213
8-#7	1.20	1627	848	2159	758	2678	636	2958	539	3232	392	3888	286	2156
8-#8	1.58	1687	893	2326	785	2880	655	3199	551	3551	390	4299	264	2770
8-#9	2.00	1751	943	2508	814	3101	677	3460	565	3899	388	4741	238	3430
8-#10	2.54	1830	1006	2736	853	3379	705	3792	582	4341	385	5294	204	4258
8-#11	3.12	1899	1075	2978	889	3656	731	4113	596	4760	378	5741	152	5061
8-#14	4.50	2082	1237	3523	989	4326	803	4912	641	5828	370	6999	49	6859
8-#18	8.00	2524	1649	4827	1242	5938	985	6842	753	8395	346	9870	-244	9447
12-#10	3.81	2031	1156	3189	956	3942	781	4451	637	5221	382	6509	131	5898
12-#11	4.68	2131	1258	3517	1014	4328	823	4899	663	5810	372	7151	57	6893
12-#14	6.75	2418	1502	4284	1168	5273	934	6022	735	7309	359	8946	-94	8749
16-#10	5.08	2226	1305	3667	1058	4514	863	5151	687	6151	384	7731	53	7539

SQUARE TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.05	2261	1005	2982	899	3707	756	4113	643	4541	471	5508	404	2535
4-#11	1.29	2321	1039	3185	912	3929	765	4364	647	4862	465	5868	389	3038
4-#14	1.86	2480	1121	3614	957	4447	797	4977	666	5677	459	6870	367	4235
4-#18	3.31	2827	1327	4641	1074	5697	882	6465	718	7659	444	9195	298	7112
8-#8	1.31	2204	1042	2909	934	3640	783	4044	663	4460	479	5440	350	3131
8-#9	1.65	2279	1091	3117	964	3891	805	4342	676	4855	477	5959	327	3886
8-#10	2.10	2373	1155	3378	1003	4209	833	4720	694	5358	475	6612	296	4836
8-#11	2.58	2452	1223	3661	1039	4531	858	5092	708	5843	468	7162	249	5772
8-#14	3.72	2674	1385	4288	1138	5300	931	6010	753	7067	461	8671	158	8018
8-#18	6.61	3191	1798	5799	1392	7163	1115	8238	867	10045	442	12175	-103	11941
12-#10	3.15	2599	1304	3893	1106	4849	910	5470	750	6359	473	8037	229	6833
12-#11	3.87	2728	1407	4277	1165	5297	952	5989	776	7041	464	8828	162	7998
12-#14	5.58	3062	1650	5160	1319	6384	1065	7279	850	8762	454	10987	26	10859
16-#10	4.20	2832	1454	4437	1210	5500	993	6267	801	7418	477	9465	160	8756
16-#11	5.16	2993	1590	4927	1291	6076	1053	6943	838	8307	467	10502	69	10231

SQUARE TIED COLUMNS 24" x 24"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.08	2953	1202	3899	1075	4855	903	5395	768	5973	561	7269	482	3395
4-#14	1.56	3140	1283	4386	1119	5441	935	6088	787	6892	554	8439	464	4746
4-#18	2.78	3555	1489	5556	1235	6862	1019	7776	838	9138	539	11189	408	8010
8-#8	1.10	2815	1204	3578	1098	4522	923	5029	785	5514	577	6724	440	3491
8-#9	1.39	2902	1254	3813	1128	4804	945	5363	799	5957	575	7332	420	4341
8-#10	1.76	3011	1317	4108	1167	5162	973	5788	816	6522	573	8105	394	5412
8-#11	2.17	3105	1386	4432	1202	5530	998	6211	831	7072	566	8758	351	6481
8-#14	3.13	3366	1548	5143	1302	6399	1071	7247	876	8453	560	10522	268	9039
8-#18	5.56	3962	1960	6861	1557	8513	1257	9774	992	11828	543	14664	34	14554
12-#10	2.65	3270	1467	4685	1271	5879	1052	6628	874	7643	573	9742	331	7804
12-#11	3.25	3411	1569	5125	1330	6391	1094	7220	900	8418	564	10683	269	9143
12-#14	4.69	3807	1813	6125	1485	7620	1207	8677	975	10362	556	13209	145	12407
16-#10	3.53	3525	1616	5295	1376	6610	1136	7523	926	8831	578	11377	268	9907
16-#11	4.33	3723	1753	5857	1457	7267	1196	8293	963	9842	569	12610	185	11733
16-#14	6.25	4219	2078	7163	1668	8862	1353	10198	1065	12381	561	15904	17	15833
20-#10	4.41	3760	1766	5906	1478	7377	1214	8428	984	10033	578	13044	190	12009
20-#11	5.42	3990	1937	6597	1583	8187	1291	9379	1033	11285	568	14570	84	14122

SQUARE TIED COLUMNS 26" x 26"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.33	3904	1460	5254	1296	6570	1086	7351	919	8266	659	10199	567	5256
4-#18	2.37	4392	1666	6569	1411	8162	1169	9240	969	10777	643	13377	521	8908
8-#9	1.18	3629	1431	4602	1307	5851	1098	6536	932	7219	682	8849	515	4795
8-#10	1.50	3754	1494	4931	1346	6249	1126	7007	950	7844	680	9708	489	5987
8-#11	1.85	3863	1562	5299	1381	6663	1151	7482	964	8460	673	10543	457	7188
8-#14	2.66	4150	1725	6095	1481	7633	1224	8637	1010	9997	667	12565	382	10057
8-#18	4.73	4845	2137	8022	1736	10000	1411	11462	1127	13769	653	17352	169	16742
12-#10	2.25	4046	1644	5571	1451	7044	1206	7938	1009	9087	681	11531	427	8730
12-#11	2.77	4209	1746	6068	1509	7620	1247	8602	1035	9955	673	12726	380	10326
12-#14	3.99	4661	1990	7187	1665	8992	1362	10227	1111	12120	666	15625	266	14002
12-#18	7.10	5724	2608	9903	2061	12340	1652	14203	1303	17427	644	22477	-52	22269

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	3.01	4332	1793	6248	1556	7854	1290	8930	1062	10403	687	13348	368	11080
16-#11	3.69	4547	1930	6882	1638	8593	1351	9794	1099	11537	679	14908	304	13141
16-#14	5.33	5121	2255	8342	1850	10373	1510	11920	1202	14367	674	18687	150	17993
20-#10	3.76	4581	1943	6918	1658	8705	1370	9934	1121	11736	688	15204	291	13524
20-#11	4.62	4861	2113	7695	1763	9616	1447	11001	1170	13140	679	17131	207	15913

SQUARE TIED COLUMNS 28" x 28"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.15	4781	1651	6225	1489	7845	1250	8778	1062	9812	773	12130	673	5765
4-#18	2.04	5340	1857	7686	1603	9609	1332	10868	1111	12587	757	15773	639	9805
8-#9	1.02	4467	1622	5493	1502	7043	1264	7873	1077	8653	798	10569	617	5247
8-#10	1.30	4608	1685	5856	1540	7481	1292	8391	1095	9339	795	11512	592	6560
8-#11	1.59	4733	1753	6268	1575	7942	1316	8918	1108	10020	789	12434	560	7894
8-#14	2.30	5059	1916	7149	1674	9013	1389	10191	1155	11714	783	14764	496	11073
8-#18	4.08	5846	2328	9286	1930	11633	1576	13316	1272	15883	770	20251	305	18709
12-#10	1.94	4935	1835	6558	1646	8354	1372	9413	1154	10703	797	13520	531	9594
12-#11	2.39	5121	1937	7114	1704	8994	1414	10149	1181	11664	790	14844	484	11505
12-#14	3.44	5607	2181	8352	1860	10509	1529	11942	1257	14052	783	18183	385	15643
12-#18	6.12	6819	2799	11364	2257	14217	1821	16342	1452	19922	765	26039	96	25430
16-#10	2.59	5253	1984	7302	1752	9243	1457	10501	1208	12147	805	15518	474	12275
16-#11	3.18	5496	2121	8010	1833	10065	1518	11461	1246	13404	798	17248	411	14573
16-#14	4.59	6141	2446	9624	2046	12031	1678	13807	1350	16526	794	21596	277	20121
20-#10	3.24	5530	2134	8031	1853	10177	1537	11604	1268	13611	807	17562	397	15028
20-#11	3.98	5826	2304	8895	1958	11190	1615	12788	1318	15167	799	19702	316	17757
20-#14	5.74	6621	2711	10892	2226	13630	1817	15694	1453	19033	794	25077	138	24263
24-#10	3.89	5845	2283	8762	1955	11103	1615	12723	1322	15095	814	19618	349	17588
24-#11	4.78	6230	2488	9726	2089	12315	1710	14137	1383	16955	807	22173	253	20858

SQUARE TIED COLUMNS 30" x 30"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.00	5779	1856	7306	1696	9276	1427	10382	1216	11544	896	14219	781	6273
4-#18	1.78	6411	2062	8915	1809	11213	1508	12674	1264	14584	879	18392	762	10702
8-#10	1.13	5582	1890	6889	1749	8868	1471	9950	1250	11020	920	13535	702	7133
8-#11	1.39	5724	1959	7346	1783	9376	1494	10530	1264	11766	913	14544	671	8598
8-#14	2.00	6089	2121	8312	1883	10549	1567	11922	1310	13617	908	17089	607	12086
8-#18	3.56	6974	2533	10662	2138	13423	1755	15347	1429	18183	895	23375	443	20510
12-#10	1.69	5946	2040	7654	1855	9818	1551	11064	1311	12505	922	15729	642	10455
12-#11	2.08	6154	2142	8269	1913	10524	1592	11873	1337	13559	915	17182	595	12566
12-#14	3.00	6695	2386	9626	2069	12182	1708	13834	1414	16169	910	20835	497	17331
12-#18	5.33	8044	3004	12936	2467	16251	2002	18659	1611	22603	895	29830	245	28145
16-#10	2.26	6296	2189	8464	1962	10787	1637	12249	1365	14078	931	17860	579	13491
16-#11	2.77	6569	2326	9246	2043	11692	1697	13304	1403	15457	924	19808	526	16029
16-#14	4.00	7263	2651	11017	2256	13845	1858	15870	1509	18871	922	24569	394	22135
16-#18	7.11	8967	3475	15342	2797	19129	2266	22184	1775	27280	911	36279	50	36023
20-#10	2.82	6603	2339	9252	2063	11805	1718	13450	1425	15672	934	20141	511	16462
20-#11	3.47	6933	2509	10204	2167	12920	1795	14752	1476	17380	926	22494	431	19652
20-#14	5.00	7815	2916	12389	2436	15592	1999	17932	1613	21609	924	28383	257	26829
24-#10	3.39	6950	2488	10048	2165	12805	1794	14670	1480	17289	942	22384	465	19355
24-#11	4.16	7348	2693	11166	2292	14137	1890	16224	1542	19331	935	25195	371	22969

SQUARE TIED COLUMNS 32" x 32"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.56	7613	2281	10261	2030	12984	1697	14670	1429	16779	1009	21078	877	11598
8-#11	1.22	6844	2178	8540	2006	10977	1685	12331	1430	13711	1045	16890	789	9300
8-#14	1.76	7249	2340	9592	2106	12251	1758	13842	1477	15718	1041	19648	726	13098
8-#18	3.13	8202	2752	12155	2361	15381	1946	17568	1596	20682	1029	26481	565	22307
12-#10	1.49	7085	2259	8864	2080	11449	1743	12903	1478	14506	1056	18173	760	11314
12-#11	1.83	7318	2361	9540	2137	12220	1784	13786	1504	15653	1049	19756	714	13624
12-#14	2.64	7916	2605	11017	2293	14022	1900	15915	1582	18485	1044	23723	617	19066
12-#18	4.69	9405	3223	14626	2692	18453	2195	21166	1780	25483	1032	33518	369	30922
16-#10	1.98	7470	2408	9740	2187	12497	1829	14186	1533	16207	1065	20482	700	14729
16-#11	2.44	7772	2545	10598	2267	13486	1890	15336	1571	17709	1059	22604	647	17509
16-#14	3.52	8537	2870	12525	2481	15826	2051	18124	1678	21415	1058	27778	518	24178
16-#18	6.25	10411	3694	17242	3023	21581	2461	24996	1947	30565	1052	40537	182	39775
20-#10	2.48	7807	2558	10587	2287	13599	1910	15485	1594	17932	1069	22956	631	17910
20-#11	3.05	8172	2729	11629	2392	14817	1988	16905	1645	19793	1062	25522	553	21407
20-#14	4.39	9105	3135	14002	2660	17722	2193	20360	1783	24384	1061	31926	381	29452
24-#10	2.98	8186	2708	11448	2390	14673	1987	16805	1649	19682	1078	25386	587	21157
24-#11	3.66	8625	2912	12671	2517	16125	2083	18500	1712	21906	1072	28453	496	25118
24-#14	5.27	9801	3400	15487	2840	19597	2330	22631	1879	27395	1075	36096	296	34630

SQUARE TIED COLUMNS 34" x 34"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.38	8954	2515	11732	2266	14934	1898	16867	1604	19187	1149	24013	999	12493
8-#11	1.08	8101	2411	9856	2245	12755	1889	14333	1608	15869	1187	19487	914	10002
8-#14	1.56	8548	2574	10996	2344	14132	1961	15963	1654	18032	1183	22459	852	14107
8-#18	2.77	9598	2986	13774	2599	17517	2149	19991	1773	23392	1172	29835	694	24101
12-#10	1.32	8362	2492	10195	2319	13256	1947	14944	1656	16719	1199	20870	886	12170
12-#11	1.62	8620	2595	10932	2376	14093	1988	15900	1682	17959	1191	22581	840	14680
12-#14	2.34	9276	2838	12531	2532	16040	2104	18198	1761	21013	1187	26862	745	20632
12-#18	4.15	10853	3457	16441	2932	20833	2400	23875	1960	28575	1177	37455	500	33762
16-#10	1.76	8781	2642	11138	2426	14384	2034	16324	1712	18549	1209	23356	827	15957
16-#11	2.16	9115	2778	12073	2507	15457	2094	17569	1750	20173	1202	25584	766	19013
16-#14	3.11	9953	3103	14157	2721	17985	2256	20579	1857	24171	1202	31141	635	26250
16-#18	5.54	12002	3927	19266	3264	24211	2668	28011	2129	34063	1199	45045	319	43594
20-#10	2.20	9149	2791	12044	2527	15567	2115	17738	1768	20405	1213	26019	760	19372
20-#11	2.70	9552	2962	13177	2631	16890	2194	19260	1824	22418	1206	28801	682	23174
20-#14	3.89	10570	3368	15739	2900	20028	2399	22989	1964	27372	1207	35720	513	32137
24-#10	2.64	9562	2941	12970	2630	16718	2192	19142	1829	22287	1223	28640	717	22946
24-#11	3.24	10044	3146	14297	2756	18291	2287	20977	1892	24694	1217	31962	627	27305
24-#14	4.67	11274	3633	17338	3080	22036	2535	25438	2061	30618	1222	40223	431	37644

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.23	10442	2762	13335	2517	17073	2112	19279	1791	21820	1298	27214	1130	13388
8-#14	1.39	9993	2821	12529	2597	16200	2177	18299	1843	20571	1333	25537	986	15116
8-#18	2.47	11143	3233	15523	2851	19841	2365	22627	1962	26329	1323	33457	829	25891
12-#10	1.18	9784	2740	11655	2573	15250	2164	17198	1846	19157	1350	23834	1019	13025
12-#11	1.44	10067	2842	12455	2629	16154	2205	18228	1872	20490	1342	25673	973	15732
12-#14	2.08	10784	3086	14175	2786	18246	2321	20695	1950	23767	1339	30269	879	22154
12-#18	3.70	12501	3704	18388	3186	23403	2617	26798	2150	31893	1330	41660	637	36664
16-#10	1.57	10239	2889	12660	2680	16457	2252	18675	1902	21117	1360	26497	962	17103
16-#11	1.93	10605	3026	13677	2761	17616	2311	20016	1940	22863	1354	28894	901	20542
16-#14	2.78	11517	3351	15919	2975	20331	2474	23247	2048	27153	1355	34861	772	28351
16-#18	4.94	13750	4175	21422	3520	27031	2887	31240	2321	37786	1355	49820	462	47245
20-#10	1.96	10639	3039	13629	2781	17719	2333	20189	1958	23103	1365	29351	896	20849
20-#11	2.41	11079	3210	14853	2885	19152	2411	21828	2015	25268	1359	32346	818	24957
20-#14	3.47	12185	3616	17606	3154	22523	2618	25832	2155	30586	1361	39782	651	34777
20-#18	6.17	14937	4646	24386	3838	30844	3140	35737	2510	43758	1363	58171	220	56740
24-#10	2.35	11087	3188	14620	2884	18949	2409	21689	2020	25118	1375	32162	853	24661
24-#11	2.89	11613	3393	16053	3011	20643	2505	23669	2083	27707	1371	35740	765	29532
24-#14	4.17	12944	3881	19319	3335	24663	2753	28459	2253	34066	1377	44617	572	40726

SQUARE TIED COLUMNS 38" x 38"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.11	12085	3024	15075	2784	19411	2339	21917	1989	24692	1456	30698	1268	14282
8-#14	1.25	11592	3083	14199	2865	18466	2406	20861	2042	23350	1492	28898	1127	16122
8-#18	2.22	12844	3495	17411	3119	22365	2593	25491	2162	29504	1483	37361	972	27679
12-#10	1.06	11360	3002	13249	2843	17442	2394	19677	2046	21834	1510	27081	1160	13879
12-#11	1.30	11669	3104	14113	2898	18414	2434	20782	2072	23261	1502	29049	1114	16783
12-#14	1.87	12447	3348	15956	3054	20650	2550	23418	2151	26760	1499	33958	1021	23672
12-#18	3.32	14307	3966	20473	3454	26171	2847	29948	2352	35449	1492	46148	781	39628
16-#10	1.41	11851	3151	14317	2949	18729	2482	21252	2103	23923	1521	29922	1104	18245
16-#11	1.73	12250	3288	15413	3030	19973	2541	22690	2141	25792	1515	32488	1044	22018
16-#14	2.49	13240	3613	17818	3244	22876	2704	26143	2249	30374	1517	38866	917	30482
16-#18	4.43	15596	4437	23716	3790	30050	3119	34695	2524	41748	1519	54684	587	50807
20-#10	1.76	12284	3301	15349	3051	20067	2563	22865	2160	26040	1526	32965	1040	22340
20-#11	2.16	12763	3471	16665	3153	21604	2641	24645	2209	28357	1520	36172	963	26756
20-#14	3.12	13960	3877	19609	3422	25216	2848	28902	2357	34038	1524	44124	797	37296
20-#18	5.54	16931	4908	26866	4108	34126	3373	39503	2714	48132	1528	63824	371	61211
24-#10	2.11	12767	3450	16405	3154	21379	2640	24457	2221	28187	1537	35968	997	26385
24-#11	2.59	13338	3655	17945	3280	23194	2735	26586	2285	30959	1533	39801	910	31689
24-#14	3.74	14775	4142	21437	3604	27488	2983	31706	2456	37754	1541	49295	720	43833

SQUARE TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.00	13891	3300	16961	3065	21959	2579	24795	2198	27816	1622	34481	1414	15175
8-#14	1.13	13354	3359	16012	3148	20942	2648	23661	2253	26380	1660	32558	1275	17128
8-#18	2.00	14711	3771	19444	3401	25099	2835	28594	2372	32931	1651	41563	1122	29465
12-#11	1.17	13434	3380	15914	3182	20881	2676	23574	2283	26283	1671	32724	1263	17832
12-#14	1.69	14274	3623	17880	3338	23263	2792	26379	2362	30005	1668	37947	1170	25188
12-#18	3.00	16281	4242	22703	3738	29150	3090	33337	2564	39258	1662	50935	933	42654
16-#10	1.27	13626	3427	16115	3233	21208	2725	24067	2315	26981	1690	33647	1254	19385
16-#11	1.56	14059	3563	17290	3313	22538	2784	25601	2352	28972	1684	36381	1194	23423
16-#14	2.25	15127	3888	19853	3528	25631	2947	29276	2461	33847	1686	43169	1068	32642
16-#18	4.00	17665	4712	26156	4074	33279	3363	38391	2738	45962	1691	60030	744	54392
20-#10	1.59	14092	3576	17211	3335	22624	2805	25780	2372	29229	1696	36880	1191	23846
20-#11	1.95	14611	3747	18621	3437	24265	2883	27679	2422	31699	1690	40298	1114	28571
20-#14	2.81	15900	4153	21756	3706	28108	3091	32245	2560	37743	1695	48763	951	39834
20-#18	5.00	19099	5183	29492	4392	37619	3618	43509	2929	52758	1702	69776	529	65819
24-#10	1.90	14611	3726	18331	3438	24016	2883	27463	2433	31509	1707	40073	1149	28119
24-#11	2.34	15229	3931	19980	3564	25954	2978	29732	2497	34463	1703	44161	1062	33795
24-#14	3.38	16773	4418	23699	3889	30522	3226	35191	2670	41693	1713	54272	875	46983

SQUARE TIED COLUMNS 42" x 42"

8-#14	1.02	15286	3649	17976	3445	23638	2902	26713	2475	29675	1837	36533	1432	18133
8-#18	1.81	16751	4061	21628	3699	28054	3088	31948	2594	36624	1828	46080	1280	31248
12-#11	1.06	15369	3670	17864	3480	23569	2931	26617	2506	29571	1848	36714	1419	18879
12-#14	1.53	16273	3913	19954	3636	26097	3047	29592	2585	33515	1846	42251	1327	26700
12-#18	2.72	18430	4531	25084	4036	32349	3345	36977	2787	43332	1841	56036	1091	45710
16-#10	1.15	15571	3717	18062	3532	23906	2980	27132	2538	30304	1868	37687	1411	20522
16-#11	1.41	16039	3853	19317	3611	25323	3039	28764	2575	32418	1862	40590	1352	24824
16-#14	2.04	17187	4178	22039	3826	28605	3202	32661	2684	37586	1865	47787	1227	34831
16-#18	3.63	19912	5002	28747	4374	36729	3619	42337	2962	50442	1872	65690	907	58016
20-#10	1.44	16071	3866	19221	3634	25400	3061	28946	2595	32683	1874	41110	1349	25367
20-#11	1.77	16632	4037	20725	3736	27146	3138	30964	2645	35305	1869	44740	1273	30402
20-#14	2.55	18015	4443	24053	4005	31220	3346	35806	2784	41713	1874	53717	1112	42390
20-#18	4.54	21339	5473	32269	4690	41330	3875	47766	3155	57649	1884	76035	695	70455
24-#10	1.73	16626	4016	20406	3738	26872	3138	30720	2656	35096	1886	44494	1307	29863
24-#11	2.12	17293	4221	22164	3863	28933	3233	33129	2720	38233	1883	48837	1222	35912
24-#14	3.06	18947	4708	26111	4188	33776	3482	38915	2893	45898	1893	59564	1037	50174
24-#18	5.44	23092	5944	35865	5014	45798	4115	53282	3330	64958	1915	86208	558	82582

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	1.65	18971	4365	23971	4011	31240	3355	35565	2827	40595	2014	50928	1445	33029
12-#14	1.39	18452	4218	22186	3950	29160	3315	33068	2818	37303	2033	46886	1491	28210
12-#18	2.48	20762	4836	27624	4349	35780	3612	40881	3021	47685	2028	61469	1257	48409
16-#10	1.05	17696	4021	20165	3846	26834	3249	30461	2772	33906	2055	42059	1576	21657
16-#11	1.29	18198	4157	21501	3925	28338	3307	32189	2809	36143	2049	45129	1517	26223
16-#14	1.86	19428	4482	24381	4139	31809	3471	36309	2919	41602	2052	52737	1394	37025
16-#18	3.31	22344	5306	31484	4686	40410	3888	46547	3197	55200	2060	71682	1077	61680
20-#10	1.31	18230	4170	21387	3948	28405	3329	32374	2830	36416	2061	45671	1515	26794
20-#11	1.61	18832	4341	22986	4050	30256	3406	34512	2879	39190	2056	49512	1440	32249
20-#14	2.32	20313	4747	26507	4318	34562	3614	39631	3019	45961	2062	59003	1281	44966
20-#18	4.13	23859	5777	35205	5004	45255	4143	52353	3374	62819	2075	82623	869	75174
24-#10	1.57	18823	4320	22637	4052	29957	3407	34239	2890	38962	2073	49247	1473	31617
24-#11	1.93	19537	4525	24504	4177	32142	3501	36790	2954	42281	2070	53844	1388	38040
24-#14	2.79	21305	5012	28679	4502	37260	3750	42902	3127	50382	2082	65188	1206	53323
24-#18	4.96	25584	6248	39005	5328	49976	4384	58116	3567	70546	2107	93398	733	87917

SQUARE TIED COLUMNS 46" x 46"

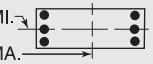
8-#18	1.51	21381	4683	26479	4338	34667	3634	39459	3070	44857	2208	56122	1617	34809
12-#14	1.28	20819	4536	24581	4278	32464	3595	36819	3063	41384	2228	51868	1663	29717
12-#18	2.27	23285	5154	30330	4677	39452	3893	45061	3266	52329	2224	67248	1431	51102
16-#11	1.18	20546	4476	23847	4253	31593	3588	35890	3054	40159	2244	50016	1690	27620
16-#14	1.70	21859	4801	26887	4467	35255	3751	40233	3164	45911	2248	58034	1568	39047
16-#18	3.02	24969	5625	34386	5014	44332	4169	51033	3443	60251	2258	78020	1253	65383
20-#10	1.20	20577	4489	23714	4277	31650	3610	36077	3075	40441	2257	50580	1688	28216
20-#11	1.47	21222	4659	25410	4378	33606	3687	38336	3125	43368	2252	54632	1614	34113
20-#14	2.13	22800	5066	29124	4647	38144	3894	43732	3265	50502	2258	64635	1456	47562
20-#18	3.78	26575	6096	38305	5332	49422	4424	57154	3621	68282	2273	89558	1049	79977
24-#10	1.44	21207	4638	25029	4382	33283	3688	38034	3136	43119	2270	54347	1647	33382
24-#11	1.77	21971	4843	27008	4506	35591	3782	40725	3199	46621	2267	59199	1563	40179
24-#14	2.55	23853	5330	31412	4830	40985	4031	47164	3373	55158	2279	71159	1382	56342
24-#18	4.54	28398	6567	42310	5657	54396	4666	63204	3814	76426	2307	100935	914	93282

SQUARE TIED COLUMNS 48" x 48"

8-#18	1.39	23988	5015	29159	4680	38346	3926	43641	3325	49425	2412	61679	1797	36587
12-#14	1.17	23382	4868	27147	4621	36020	3888	40858	3318	45769	2432	57213	1843	31222
12-#18	2.08	26006	5486	33207	5020	43376	4186	49530	3521	57279	2429	73389	1612	53790
16-#11	1.08	23090	4808	26363	4597	35100	3881	39879	3310	44481	2448	55266	1870	29014
16-#14	1.56	24487	5133	29563	4810	38951	4045	44444	3420	50525	2453	63693	1749	41065
16-#18	2.78	27796	5957	37460	5356	48507	4463	55808	3700	65606	2463	84721	1438	69126
20-#10	1.10	23121	4821	26210	4622	35145	3903	40067	3332	44771	2462	55852	1869	29635
20-#11	1.35	23808	4992	28003	4722	37208	3980	42447	3381	47850	2457	60115	1795	35893
20-#14	1.95	25486	5398	31913	4990	41978	4187	48120	3521	55348	2464	70631	1639	50177
20-#18	3.47	29494	6428	41578	5675	53841	4717	62243	3878	74049	2480	96856	1236	84500
24-#10	1.32	23788	4971	27590	4726	36858	3982	42115	3392	47581	2475	59810	1828	35156
24-#11	1.63	24603	5175	29681	4850	39291	4075	44949	3455	51267	2472	64917	1744	42329
24-#14	2.34	26602	5663	34315	5174	44962	4325	51714	3629	60238	2485	77494	1565	59374
24-#18	4.17	31418	6899	45787	6001	59069	4960	68581	4071	82611	2515	108834	1103	98711

RECTANGULAR TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.86	MA	210	232	343	181	390	149	414	122	438	76	471	42	353
2L-3S		MI	192	232	311	181	351	149	368	122	380	77	410	20	355
6-#6	2.64	MA	222	254	382	194	435	158	464	125	501	70	534	24	469
2L-3S		MI	198	255	337	194	381	157	401	126	422	71	451	-7	450
6-#7	3.60	MA	236	283	428	211	486	168	523	129	575	61	604	0	604
2L-3S		MI	205	283	369	210	415	166	440	130	470	63	497	-40	496

RECTANGULAR TIED COLUMNS 10" x 12"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.03	MA	289	249	424	207	494	174	530	148	556	105	620	80	321
2E		MI	235	249	360	199	405	166	423	139	432	97	467	68	264
4-#6	1.47	MA	302	264	461	216	539	180	583	151	620	102	690	71	430
2E		MI	243	264	387	207	435	171	457	141	474	92	508	56	347
4-#7	2.00	MA	316	283	505	226	592	188	644	155	696	99	772	60	558
2E		MI	252	283	419	217	470	177	496	143	523	86	554	40	443
4-#8	2.63	MA	331	305	556	239	654	197	713	160	783	94	864	46	705
2E		MI	262	305	455	230	508	184	539	145	577	79	604	20	550
4-#9	3.33	MA	347	330	610	253	720	207	785	164	873	88	959	29	860
2E		MI	273	330	489	243	547	192	583	147	633	70	668	2	662
4-#10	4.23	MA	367	362	677	272	802	221	874	170	985	80	1071	6	1051
2E		MI	285	362	531	259	594	201	636	149	699	58	728	-28	719
4-#11	5.20	MA	380	396	736	289	852	228	929	169	1052	64	1114	-33	1113
2E		MI	292	396	551	269	613	203	656	143	723	35	721	-80	731
6-#5	1.55	MA	306	267	468	219	549	182	597	153	641	104	718	72	453
2L-3S		MI	227	267	360	210	405	174	423	144	432	94	467	35	368
6-#5	1.55	MA	280	267	424	219	494	183	530	153	556	104	620	49	456
3L-2S		MI	246	267	392	210	445	174	469	144	490	94	528	57	365
6-#6	2.20	MA	323	290	522	232	616	192	676	159	737	100	824	60	612
2L-3S		MI	233	290	387	223	435	181	457	148	474	88	508	9	485
6-#6	2.20	MA	290	290	461	233	539	192	583	158	620	101	690	27	610
3L-2S		MI	258	290	432	223	489	182	519	147	554	87	591	39	483
6-#7	3.00	MA	344	318	587	248	695	204	767	165	852	94	948	43	798
2L-3S		MI	240	318	419	239	470	191	496	152	523	80	554	-25	553
6-#7	3.00	MA	302	318	505	249	592	204	644	164	696	96	772	-1	772
3L-2S		MI	271	318	478	240	541	192	578	150	627	78	661	15	620
6-#8	3.95	MA	315	352	556	269	654	217	713	171	783	89	864	-36	854
3L-2S		MI	286	352	531	259	598	203	643	154	709	68	737	-15	740
6-#9	5.00	MA	330	389	610	291	720	233	785	178	873	81	959	-76	937
3L-2S		MI	302	389	582	279	657	215	710	158	793	54	835	-41	821
6-#10	6.35	MA	350	436	677	319	802	252	874	191	985	70	1071	-130	1038
3L-2S		MI	322	436	642	304	726	229	789	161	893	36	925	-86	913

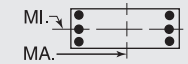
RECTANGULAR TIED COLUMNS 10" x 14"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.26	MA	411	299	597	253	710	212	775	179	842	128	961	98	525
2E		MI	279	299	437	236	489	196	512	163	527	110	564	71	358
4-#7	1.71	MA	431	318	653	264	779	220	856	184	946	126	1080	90	688
2E		MI	288	318	469	246	524	202	551	165	575	104	610	55	456
4-#8	2.26	MA	453	341	719	277	859	229	951	190	1066	123	1216	80	875
2E		MI	298	341	505	259	563	209	594	167	629	96	660	35	566
4-#9	2.86	MA	475	365	789	291	945	239	1054	196	1194	119	1359	67	1076
2E		MI	308	365	540	271	602	216	639	168	685	87	724	17	680
4-#10	3.63	MA	503	397	876	309	1053	253	1183	204	1351	114	1533	50	1325
2E		MI	321	397	582	287	649	225	691	170	751	74	783	-14	772
4-#11	4.46	MA	522	431	960	327	1149	265	1287	210	1466	102	1635	20	1553
2E		MI	327	431	603	296	668	226	711	163	774	51	775	-66	784

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 10" x 14"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

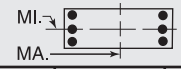
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.33	MA	417	302	604	256	723	214	791	181	868	129	995	99	554
2L-3S		MI	263	302	409	240	459	199	478	166	485	112	524	50	380
6-#5	1.33	MA	383	302	549	258	653	215	707	181	755	130	860	76	556
3L-2S		MI	282	302	441	240	499	199	524	165	543	111	586	72	376
6-#6	1.89	MA	441	325	674	269	808	224	892	187	999	127	1147	90	754
2L-3S		MI	268	325	437	252	489	206	512	169	527	105	564	24	500
6-#6	1.89	MA	397	325	597	271	710	225	775	187	842	128	961	58	753
3L-2S		MI	293	325	481	252	544	207	574	168	606	104	648	54	496
6-#7	2.57	MA	469	353	757	286	910	236	1015	194	1156	124	1328	78	993
2L-3S		MI	275	353	469	267	524	215	551	173	575	97	610	-10	610
6-#7	2.57	MA	414	353	653	288	779	237	856	195	946	125	1080	34	982
3L-2S		MI	307	353	528	268	595	217	633	172	679	96	718	30	636
6-#8	3.39	MA	433	387	719	309	859	252	951	203	1066	121	1216	5	1208
3L-2S		MI	322	387	581	288	653	228	698	176	761	85	794	0	793
6-#9	4.29	MA	454	424	789	331	945	268	1054	213	1194	116	1359	-29	1341
3L-2S		MI	338	424	633	307	711	239	765	179	845	71	891	-26	876
6-#10	5.44	MA	481	472	876	360	1053	288	1183	225	1351	109	1533	-74	1489
3L-2S		MI	357	472	694	332	781	253	844	182	945	53	981	-72	970
6-#11	6.69	MA	500	523	960	387	1149	307	1287	232	1466	94	1635	-139	1570
3L-2S		MI	368	523	723	348	810	257	875	174	981	20	972	-149	988
8-#5	1.77	MA	407	321	604	269	723	224	791	187	868	129	995	71	717
3E		MI	274	321	441	251	499	207	524	170	543	108	586	39	477
8-#5	1.77	MA	387	321	564	271	669	226	725	189	778	128	897	60	707
4L-2S		MI	292	321	473	251	539	208	570	170	601	107	647	61	475
8-#6	2.51	MA	429	351	674	287	808	237	892	195	999	126	1147	49	974
3E		MI	284	351	481	268	544	217	574	175	606	100	648	6	631
8-#6	2.51	MA	403	351	618	289	732	240	800	197	875	125	1011	35	908
4L-2S		MI	308	351	526	269	598	218	637	174	685	99	731	37	630
8-#7	3.43	MA	455	389	757	310	910	253	1015	205	1156	123	1328	22	1276
3E		MI	296	389	528	289	595	230	633	180	679	89	718	-35	717
8-#7	3.43	MA	422	389	682	313	808	257	890	208	990	121	1146	2	1139
4L-2S		MI	326	389	588	290	666	232	715	179	784	87	825	5	811
8-#8	4.51	MA	446	434	755	341	896	278	995	220	1123	116	1300	-37	1287
4L-2S		MI	346	434	657	317	743	247	802	184	893	73	927	-34	932
8-#9	5.71	MA	473	483	834	371	991	301	1108	234	1263	109	1460	-82	1422
4L-2S		MI	368	483	725	343	821	262	891	189	1005	56	1057	-69	1037

RECTANGULAR TIED COLUMNS 10" x 16"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.10	MA	536	335	743	291	900	244	987	207	1078	151	1260	123	620
2E		MI	314	335	486	265	544	221	567	184	579	127	621	86	369
4-#7	1.50	MA	562	354	812	301	984	252	1087	212	1211	150	1418	117	818
2E		MI	323	354	519	275	579	227	606	186	628	121	667	70	469
4-#8	1.98	MA	590	376	892	314	1082	261	1203	218	1366	148	1600	109	1046
2E		MI	333	376	556	287	617	233	649	188	682	113	717	50	580
4-#9	2.50	MA	620	401	979	328	1188	271	1330	224	1535	146	1792	100	1292
2E		MI	344	401	591	299	657	240	694	190	737	104	780	32	696
4-#10	3.17	MA	656	432	1087	347	1321	285	1489	232	1745	144	2030	87	1600
2E		MI	356	432	633	315	704	249	747	191	803	91	839	1	837
4-#11	3.90	MA	683	467	1195	365	1446	297	1635	240	1909	135	2196	63	1890
2E		MI	362	467	655	323	723	249	766	184	825	67	830	-52	835
6-#5	1.16	MA	542	338	751	294	914	246	1006	209	1105	152	1301	124	654
2L-3S		MI	298	338	459	269	514	224	534	188	538	129	581	65	390
6-#5	1.16	MA	500	338	685	296	830	248	904	210	968	153	1128	101	657
3L-2S		MI	317	338	491	269	553	224	579	187	596	128	643	87	386
6-#6	1.65	MA	574	361	836	307	1018	256	1129	215	1269	150	1501	117	897
2L-3S		MI	303	361	486	281	544	231	567	191	579	122	621	39	513
6-#6	1.65	MA	519	361	743	310	900	258	987	216	1078	152	1260	85	895
3L-2S		MI	329	361	531	281	598	232	630	190	659	121	704	69	509

RECTANGULAR TIED COLUMNS 10" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#7	2.25	MA	611	389	938	323	1143	268	1279	222	1469	148	1739	108	1187
2L-3S		MI	310	389	519	296	579	240	606	195	628	114	667	5	653
6-#7	2.25	MA	541	389	812	327	984	270	1087	224	1211	150	1418	64	1176
3L-2S		MI	342	389	578	297	650	241	688	193	732	113	774	45	651
6-#8	2.96	MA	567	422	892	347	1082	285	1203	233	1366	149	1600	39	1494
3L-2S		MI	358	422	632	316	707	252	753	197	814	101	850	15	810
6-#9	3.75	MA	594	459	979	370	1188	302	1330	243	1535	147	1792	10	1772
3L-2S		MI	373	459	683	336	766	263	820	200	897	88	947	-11	929
6-#10	4.76	MA	629	507	1087	400	1321	323	1489	256	1745	143	2030	-29	2002
3L-2S		MI	393	507	745	360	836	277	899	203	997	70	1036	-57	1025
6-#11	5.85	MA	656	558	1195	428	1446	342	1635	266	1909	132	2196	-84	2125
3L-2S		MI	403	558	775	375	865	281	930	194	1033	36	1026	-135	1043
8-#5	1.55	MA	530	356	751	307	914	256	1006	215	1105	152	1301	97	851
3E		MI	310	356	491	280	553	232	579	192	596	126	643	54	490
8-#5	1.55	MA	505	356	704	309	852	258	927	218	998	152	1177	86	846
4L-2S		MI	328	356	523	280	593	233	625	191	654	125	705	76	486
8-#6	2.20	MA	560	386	836	326	1018	270	1129	224	1269	151	1501	79	1164
3E		MI	319	386	531	297	598	242	630	197	659	117	704	21	647
8-#6	2.20	MA	526	386	770	328	931	272	1019	227	1119	151	1327	63	1107
4L-2S		MI	344	386	576	298	652	243	692	196	738	116	787	52	644
8-#7	3.00	MA	594	424	938	349	1143	287	1279	234	1469	149	1739	56	1535
3E		MI	330	424	578	318	650	255	688	202	732	106	774	-20	774
8-#7	3.00	MA	554	424	848	352	1026	289	1130	238	1266	149	1507	34	1393
4L-2S		MI	362	424	638	319	721	256	770	201	836	105	881	20	827
8-#8	3.95	MA	585	469	939	381	1136	310	1259	252	1438	146	1714	-1	1713
4L-2S		MI	382	469	708	345	797	271	857	206	945	90	983	-19	987
8-#9	5.00	MA	620	518	1036	412	1247	337	1399	266	1623	143	1932	-41	1903
4L-2S		MI	403	518	776	372	875	287	946	210	1057	73	1113	-54	1094
8-#10	6.35	MA	665	582	1159	453	1395	367	1575	285	1855	138	2201	-94	2123
4L-2S		MI	430	582	857	405	968	306	1052	215	1191	48	1233	-115	1217

RECTANGULAR TIED COLUMNS 10" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#7	1.33	MA	707	389	983	339	1206	284	1338	240	1490	172	1785	142	947
2E		MI	359	389	569	304	633	251	661	208	680	138	724	85	481
4-#8	1.76	MA	743	411	1078	352	1322	293	1476	246	1674	170	2013	136	1217
2E		MI	369	411	606	316	672	258	705	209	734	130	773	65	594
4-#9	2.22	MA	780	436	1180	366	1448	303	1626	252	1874	169	2256	129	1508
2E		MI	379	436	642	328	711	264	749	211	789	120	836	47	712
4-#10	2.82	MA	825	468	1310	384	1607	317	1816	260	2128	167	2560	119	1874
2E		MI	392	468	684	343	758	273	802	212	855	108	895	15	855
4-#11	3.47	MA	861	502	1441	402	1761	329	1996	268	2365	163	2792	100	2227
2E		MI	397	502	708	351	778	273	821	204	877	83	884	-38	902
6-#5	1.03	MA	682	373	910	331	1123	279	1241	237	1363	174	1635	147	755
2L-3S		MI	333	373	508	298	568	249	589	210	591	146	638	81	400
6-#5	1.03	MA	632	373	833	334	1025	280	1122	238	1203	176	1423	124	757
3L-2S		MI	353	373	540	298	608	250	635	209	649	146	700	103	396
6-#6	1.47	MA	722	396	1010	344	1245	288	1387	243	1558	172	1883	142	1039
2L-3S		MI	338	396	536	310	598	256	622	213	632	140	678	54	526
6-#6	1.47	MA	655	396	901	348	1107	291	1219	245	1332	175	1587	110	1038
3L-2S		MI	364	396	581	311	652	257	685	212	711	139	761	84	521
6-#7	2.00	MA	768	424	1130	361	1393	300	1563	250	1794	170	2180	136	1382
2L-3S		MI	345	424	569	325	633	265	661	216	680	131	724	20	669
6-#7	2.00	MA	682	424	983	365	1206	303	1338	253	1490	174	1785	92	1370
3L-2S		MI	378	424	628	326	704	266	743	215	784	130	831	60	665
6-#8	2.63	MA	716	458	1078	386	1322	319	1476	262	1674	173	2013	70	1750
3L-2S		MI	393	458	682	345	762	277	809	218	866	118	906	30	826
6-#9	3.33	MA	750	495	1180	409	1448	335	1626	273	1874	171	2256	44	2152
3L-2S		MI	409	495	734	364	821	288	875	221	949	105	1003	4	994

RECTANGULAR TIED COLUMNS 10" x 18"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#10	4.23	MA	793	543	1310	439	1607	357	1816	286	2128	169	2560	10	2538
3L-2S		MI	428	543	796	388	891	301	955	224	1049	86	1092	-43	1079
6-#11	5.20	MA	828	594	1441	468	1761	377	1996	298	2365	164	2792	-39	2743
3L-2S		MI	437	594	827	403	920	304	984	214	1084	52	1081	-121	1097
8-#5	1.38	MA	668	391	910	345	1123	289	1241	244	1363	175	1635	122	985
3E		MI	345	391	540	310	608	257	635	214	649	143	700	69	501
8-#5	1.38	MA	639	391	855	347	1051	291	1150	247	1239	176	1484	109	980
4L-2S		MI	364	391	572	310	647	258	680	213	707	142	762	91	497
8-#6	1.96	MA	704	422	1010	364	1245	303	1387	252	1558	174	1883	106	1354
3E		MI	354	422	581	326	652	267	685	218	711	134	761	37	661
8-#6	1.96	MA	665	422	933	367	1144	305	1258	256	1382	175	1672	89	1312
4L-2S		MI	379	422	625	327	707	268	748	217	791	133	844	67	657
8-#7	2.67	MA	748	460	1130	387	1393	320	1563	263	1794	173	2180	86	1795
3E		MI	365	460	628	347	704	280	743	223	784	123	831	-5	831
8-#7	2.67	MA	698	460	1026	391	1257	323	1389	268	1556	173	1898	63	1655
4L-2S		MI	397	460	688	348	775	281	826	222	888	122	938	35	843
8-#8	3.51	MA	739	504	1133	420	1388	344	1543	282	1761	172	2158	31	2043
4L-2S		MI	417	504	758	374	852	296	913	227	998	107	1039	-5	1040
8-#9	4.44	MA	782	554	1250	452	1530	367	1710	298	1982	169	2435	-5	2429
4L-2S		MI	439	554	827	400	930	311	1001	231	1109	89	1169	-39	1149
8-#10	5.64	MA	838	617	1396	494	1709	397	1921	317	2263	166	2780	-53	2721
4L-2S		MI	465	617	908	433	1023	330	1107	236	1243	65	1289	-101	1274
8-#11	6.93	MA	883	686	1542	534	1866	432	2118	334	2522	158	3041	-118	2911
4L-2S		MI	479	686	946	455	1061	335	1148	225	1291	21	1277	-203	1299
10-#10	7.06	MA	888	692	1505	548	1818	443	2060	343	2440	169	3011	-125	2872
5L-2S		MI	502	692	1020	478	1156	358	1260	248	1437	44	1486	-159	1462

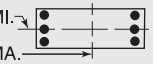
RECTANGULAR TIED COLUMNS 10" x 20"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#7	1.20	MA	867	424	1164	376	1446	316	1609	268	1791	194	2179	165	1077
2E		MI	394	424	619	333	688	276	716	229	732	155	780	100	492
4-#8	1.58	MA	910	447	1274	389	1580	325	1769	274	2004	192	2454	161	1387
2E		MI	404	447	656	344	726	282	760	231	786	147	829	80	608
4-#9	2.00	MA	956	471	1393	403	1726	335	1943	280	2236	191	2749	156	1724
2E		MI	415	471	692	356	766	289	804	232	841	137	892	61	728
4-#10	2.54	MA	1011	503	1543	422	1911	349	2164	288	2531	189	3119	148	2148
2E		MI	427	503	735	371	813	297	857	233	907	124	950	30	872
4-#11	3.12	MA	1056	537	1698	440	2093	361	2377	296	2811	185	3420	133	2564
2E		MI	432	537	760	378	834	296	876	225	928	100	939	-23	951
6-#6	1.32	MA	884	431	1195	382	1490	320	1664	271	1868	194	2293	166	1182
2L-3S		MI	374	431	586	339	653	281	678	234	684	157	735	69	538
6-#6	1.32	MA	806	431	1070	386	1331	323	1472	273	1609	198	1942	134	1180
3L-2S		MI	400	431	630	340	707	282	740	233	764	156	818	99	532
6-#7	1.80	MA	940	460	1334	398	1661	332	1869	278	2140	193	2649	162	1576
2L-3S		MI	380	460	619	354	688	289	716	238	732	148	780	35	684
6-#7	1.80	MA	839	460	1164	403	1446	336	1609	281	1791	197	2179	118	1565
3L-2S		MI	414	460	678	355	759	291	799	236	837	147	887	75	678
6-#8	2.37	MA	877	493	1274	424	1580	352	1769	291	2004	196	2454	98	2006
3L-2S		MI	429	493	732	374	817	301	864	239	918	135	962	45	841
6-#9	3.00	MA	917	530	1393	448	1726	369	1943	302	2236	195	2749	75	2476
3L-2S		MI	444	530	785	392	875	312	930	242	1001	122	1059	18	1011
6-#10	3.81	MA	973	578	1543	478	1911	391	2164	316	2531	194	3119	44	3012
3L-2S		MI	463	578	847	416	946	325	1010	245	1101	103	1147	-28	1132

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 10" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	4.68	MA	1017	629	1698	507	2093	411	2377	328	2811	189	3420	1	3419
3L-2S		MI	472	629	879	430	975	327	1039	235	1135	68	1135	-106	1150
8-#5	1.24	MA	821	427	1080	383	1349	321	1496	272	1644	198	1997	146	1119
3E		MI	380	427	589	339	662	282	690	236	701	160	757	84	512
8-#5	1.24	MA	787	427	1018	385	1268	323	1392	275	1502	199	1820	132	1114
4L-2S		MI	399	427	621	339	702	283	736	235	759	160	819	106	508
8-#6	1.76	MA	864	457	1195	402	1490	335	1664	281	1868	197	2293	132	1545
3E		MI	390	457	630	355	707	292	740	240	764	151	818	52	674
8-#6	1.76	MA	819	457	1107	405	1375	338	1518	285	1667	198	2045	113	1520
4L-2S		MI	415	457	675	356	761	293	803	239	843	150	901	82	670
8-#7	2.40	MA	915	495	1334	425	1661	352	1869	292	2140	196	2649	114	2054
3E		MI	401	495	678	376	759	304	799	245	837	140	887	10	860
8-#7	2.40	MA	858	495	1215	430	1505	356	1670	298	1869	197	2316	89	1924
4L-2S		MI	433	495	738	377	830	305	881	243	941	139	995	50	858
8-#8	3.16	MA	904	540	1340	460	1657	378	1848	312	2106	196	2631	60	2378
4L-2S		MI	453	540	809	403	907	320	968	248	1050	124	1096	10	1068
8-#9	4.00	MA	960	589	1475	492	1822	402	2042	328	2363	195	2968	27	2859
4L-2S		MI	474	589	877	428	985	335	1057	252	1161	106	1225	-25	1203
8-#10	5.08	MA	1027	653	1646	534	2031	432	2287	349	2690	193	3390	-17	3364
4L-2S		MI	500	653	959	461	1078	354	1163	257	1295	82	1345	-86	1330
8-#11	6.24	MA	1083	721	1819	575	2234	461	2522	367	2998	187	3731	-76	3621
4L-2S		MI	514	721	999	482	1116	359	1203	245	1343	37	1332	-189	1354
10-#10	6.35	MA	1080	727	1774	590	2160	480	2452	377	2899	198	3667	-84	3532
5L-2S		MI	537	727	1071	506	1210	382	1315	269	1489	61	1542	-144	1521

RECTANGULAR TIED COLUMNS 12" x 12"

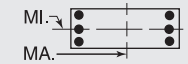
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.29	MA	357	309	535	255	626	214	676	181	718	125	803	91	465
2L-3S		MI	331	309	492	256	571	214	610	180	633	126	705	69	469
6-#6	1.83	MA	375	332	590	268	693	223	756	186	814	121	909	79	626
2L-3S		MI	341	332	529	269	616	223	663	185	697	122	775	46	627
6-#7	2.50	MA	396	361	655	285	772	235	847	192	929	116	1032	62	815
2L-3S		MI	352	361	574	286	669	235	724	191	773	117	857	18	810
6-#8	3.29	MA	419	394	730	304	865	249	950	199	1059	109	1171	41	1031
2L-3S		MI	365	394	625	305	731	248	793	198	859	111	948	-17	944
6-#9	4.17	MA	443	431	810	326	963	265	1059	207	1195	100	1313	16	1259
2L-3S		MI	380	431	679	327	797	263	865	204	950	103	1042	-58	1027
6-#10	5.29	MA	473	479	910	354	1086	285	1192	215	1363	89	1483	-18	1477
2L-3S		MI	398	479	747	355	880	283	954	218	1061	92	1155	-112	1128

RECTANGULAR TIED COLUMNS 12" x 14"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.05	MA	481	349	685	297	814	250	883	212	948	154	1078	121	537
2E		MI	404	349	597	289	693	243	742	206	774	146	859	109	453
4-#7	1.43	MA	501	368	743	308	883	257	964	217	1052	152	1197	113	702
2E		MI	419	368	642	299	747	250	803	209	849	142	941	98	586
4-#8	1.88	MA	523	390	809	320	963	266	1059	222	1172	148	1333	102	892
2E		MI	435	390	694	311	809	259	872	214	936	137	1032	84	737
4-#9	2.38	MA	546	415	879	334	1049	276	1162	228	1299	145	1475	90	1094
2E		MI	451	415	749	325	875	269	945	218	1026	131	1126	67	896
4-#10	3.02	MA	574	447	968	352	1157	290	1291	237	1456	139	1649	73	1346
2E		MI	471	447	817	343	957	282	1033	223	1137	122	1238	43	1092
4-#11	3.71	MA	594	481	1053	369	1255	302	1395	241	1571	127	1749	42	1579
2E		MI	483	481	879	359	1009	287	1088	221	1204	106	1277	4	1266
4-#14	5.36	MA	654	562	1256	417	1504	336	1667	256	1913	108	2101	-14	2095
2E		MI	525	562	1029	406	1168	313	1268	229	1430	78	1480	-72	1489
6-#5	1.11	MA	486	352	692	300	826	252	899	214	973	155	1113	122	566
2L-3S		MI	382	352	559	293	648	245	689	207	710	148	790	88	480

RECTANGULAR TIED COLUMNS 12" x 14"

Short columns – no sidesway
Bending on major or minor axis



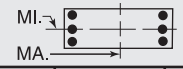
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.11	MA	452	352	637	302	756	253	815	214	861	156	978	99	569
3L-2S		MI	408	352	603	292	703	245	756	208	795	147	888	110	476
6-#6	1.57	MA	512	375	762	313	911	262	1000	220	1105	153	1265	113	768
2L-3S		MI	391	375	597	306	693	254	742	213	774	144	859	65	642
6-#6	1.57	MA	467	375	685	315	814	263	883	220	948	154	1078	80	770
3L-2S		MI	427	375	658	305	770	254	835	213	891	143	993	98	639
6-#7	2.14	MA	540	403	846	330	1014	273	1123	227	1261	150	1445	101	1009
2L-3S		MI	403	403	642	322	747	266	803	218	849	139	941	37	830
6-#7	2.14	MA	483	403	743	332	883	275	964	227	1052	151	1197	57	1004
3L-2S		MI	448	403	724	321	850	266	926	219	1005	137	1116	81	830
6-#8	2.82	MA	572	437	943	349	1133	288	1265	236	1441	145	1649	85	1287
2L-3S		MI	415	437	694	341	809	279	872	225	936	132	1032	2	1029
6-#8	2.82	MA	502	437	809	352	963	289	1059	236	1172	147	1333	27	1268
3L-2S		MI	471	437	799	340	942	280	1030	226	1136	130	1255	60	1049
6-#9	3.57	MA	606	474	1047	371	1261	303	1419	246	1632	140	1864	67	1583
2L-3S		MI	429	474	749	363	875	294	945	231	1026	124	1126	-39	1116
6-#9	3.57	MA	522	474	879	374	1049	305	1162	245	1299	142	1475	-7	1471
3L-2S		MI	495	474	880	362	1041	296	1138	233	1272	122	1396	34	1280
6-#10	4.54	MA	647	521	1178	399	1422	324	1612	258	1870	132	2126	42	1954
2L-3S		MI	447	521	817	390	957	313	1033	244	1137	113	1238	-93	1217
6-#10	4.54	MA	548	521	968	403	1157	325	1291	257	1456	135	1649	-52	1620
3L-2S		MI	525	521	980	390	1164	316	1271	242	1439	110	1566	0	1565
6-#11	5.57	MA	566	573	1053	430	1255	343	1395	264	1571	119	1749	-117	1698
3L-2S		MI	544	573	1068	417	1239	327	1354	241	1540	86	1629	-58	1626
8-#5	1.48	MA	508	370	747	312	895	261	983	219	1086	155	1248	117	730
2L-4S		MI	383	370	571	305	660	255	703	214	727	145	815	71	613
8-#5	1.48	MA	476	370	692	313	826	262	899	220	973	155	1113	94	732
3E		MI	399	370	603	305	703	254	756	213	795	146	888	80	611
8-#5	1.48	MA	455	370	652	315	772	264	833	222	884	155	1014	83	731
4L-2S		MI	425	370	646	304	758	254	822	213	880	145	985	103	609
8-#6	2.10	MA	541	401	839	330	1008	274	1118	227	1261	152	1451	105	996
2L-4S		MI	393	401	613	323	709	268	761	221	798	140	893	41	788
8-#6	2.10	MA	498	401	762	332	911	275	1000	228	1105	153	1265	72	994
3E		MI	415	401	658	322	770	266	835	220	891	141	993	53	821
8-#6	2.10	MA	471	401	706	334	836	278	908	230	980	152	1128	58	953
4L-2S		MI	448	401	719	321	846	266	928	221	1009	140	1127	86	820
8-#7	2.86	MA	525	438	846	354	1014	291	1123	238	1261	149	1445	45	1301
3E		MI	434	438	724	344	850	282	926	228	1005	134	1116	20	1064
8-#7	2.86	MA	490	438	771	357	912	295	998	240	1096	147	1263	25	1190
4L-2S		MI	476	438	805	343	953	282	1050	229	1161	133	1292	64	1070
8-#8	3.76	MA	555	483	943	381	1133	310	1265	249	1441	144	1649	10	1628
3E		MI	455	483	799	370	942	301	1030	237	1136	126	1255	-22	1248
8-#8	3.76	MA	513	483	845	384	1000	315	1103	253	1228	142	1417	-14	1413
4L-2S		MI	507	483	905	369	1075	301	1188	239	1335	124	1477	36	1355
8-#9	4.76	MA	588	532	1047	411	1261	332	1419	262	1632	137	1864	-29	1842
3E		MI	478	532	880	400	1041	321	1138	247	1272	115	1396	-71	1374
8-#9	4.76	MA	538	532	925	415	1095	338	1216	266	1368	135	1576	-60	1558
4L-2S		MI	539	532	1011	399	1206	323	1332	249	1517	113	1667	2	1658
8-#10	6.05	MA	630	596	1178	450	1422	359	1612	279	1870	128	2126	-83	2065
3E		MI	508	596	980	437	1164	347	1271	263	1439	100	1566	-136	1527

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#7	1.25	MA	653	410	925	353	1117	296	1227	250	1349	180	1573	143	832
2E		MI	470	410	711	335	824	281	883	237	926	163	1025	117	599
4-#8	1.65	MA	683	432	1006	365	1215	305	1344	256	1505	178	1755	136	1062
2E		MI	486	432	763	347	886	289	952	241	1012	158	1116	102	751
4-#9	2.08	MA	713	457	1093	379	1322	315	1470	262	1673	176	1946	126	1310
2E		MI	503	457	819	361	953	299	1024	245	1103	152	1209	85	912
4-#10	2.65	MA	750	489	1202	398	1456	328	1630	270	1883	174	2184	113	1621
2E		MI	523	489	887	379	1035	312	1113	249	1213	144	1321	62	1111
4-#11	3.25	MA	777	523	1312	414	1582	340	1776	277	2047	165	2348	89	1916
2E		MI	534	523	951	394	1087	317	1168	247	1279	126	1359	22	1289
4-#14	4.69	MA	856	604	1568	462	1897	375	2153	298	2508	151	2858	46	2640
2E		MI	576	604	1102	441	1246	343	1348	255	1505	98	1561	-54	1571
6-#6	1.38	MA	666	417	948	359	1150	300	1270	253	1408	181	1656	144	911
2L-3S		MI	442	417	665	343	770	286	822	240	851	166	944	84	656
6-#6	1.38	MA	609	417	854	361	1033	302	1127	255	1217	182	1416	112	913
3L-2S		MI	478	417	726	342	847	286	915	241	968	165	1078	117	651
6-#7	1.88	MA	704	445	1050	375	1276	312	1419	261	1608	179	1894	135	1204
2L-3S		MI	453	445	711	358	824	297	883	245	926	160	1025	56	848
6-#7	1.88	MA	631	445	925	378	1117	314	1227	262	1349	181	1573	91	1199
3L-2S		MI	499	445	792	357	927	297	1006	247	1082	159	1201	100	845
6-#8	2.47	MA	746	479	1169	394	1422	326	1594	269	1842	177	2167	124	1543
2L-3S		MI	466	479	763	378	886	310	952	251	1012	153	1116	20	1060
6-#8	2.47	MA	657	479	1006	399	1215	329	1344	271	1505	179	1755	66	1524
3L-2S		MI	523	479	868	376	1019	311	1110	253	1212	152	1339	78	1065
6-#9	3.13	MA	789	516	1297	416	1581	342	1783	279	2095	174	2456	110	1907
2L-3S		MI	479	516	819	399	953	325	1024	258	1103	145	1209	-20	1205
6-#9	3.13	MA	684	516	1093	421	1322	345	1470	281	1673	177	1946	36	1866
3L-2S		MI	547	516	950	398	1118	326	1218	260	1348	143	1480	53	1299
6-#10	3.97	MA	842	564	1459	444	1780	362	2022	292	2410	171	2814	91	2366
2L-3S		MI	496	564	887	426	1035	344	1113	271	1213	134	1321	-75	1306
6-#10	3.97	MA	718	564	1202	450	1456	366	1630	294	1883	173	2184	-2	2182
3L-2S		MI	577	564	1050	425	1242	346	1351	268	1515	131	1649	19	1587
6-#11	4.88	MA	744	615	1312	478	1582	385	1776	304	2047	162	2348	-58	2302
3L-2S		MI	596	615	1140	452	1318	357	1434	267	1616	107	1711	-40	1712
6-#14	7.03	MA	825	737	1568	552	1897	438	2153	335	2508	144	2858	-173	2729
3L-2S		MI	661	737	1363	523	1555	396	1704	280	1956	66	2018	-152	2018
8-#5	1.29	MA	661	412	928	357	1130	299	1247	253	1380	182	1631	147	864
2L-4S		MI	433	412	638	342	736	287	783	241	805	167	900	90	627
8-#5	1.29	MA	621	412	862	359	1046	301	1146	254	1244	183	1457	124	866
3E		MI	450	412	670	341	780	285	835	240	872	168	973	99	624
8-#5	1.29	MA	595	412	815	361	985	302	1067	256	1137	183	1333	113	865
4L-2S		MI	476	412	714	341	835	285	902	241	957	167	1070	122	620
8-#6	1.83	MA	704	443	1041	375	1268	312	1412	261	1600	180	1897	138	1186
2L-4S		MI	443	443	681	360	786	300	841	248	875	162	978	60	821
8-#6	1.83	MA	650	443	948	377	1150	314	1270	262	1408	181	1656	106	1184
3E		MI	466	443	726	359	847	298	915	247	968	163	1078	72	837
8-#6	1.83	MA	616	443	881	380	1064	316	1159	265	1258	181	1483	90	1160
4L-2S		MI	500	443	787	358	923	298	1008	248	1086	162	1211	105	834
8-#7	2.50	MA	685	481	1050	400	1276	331	1419	272	1608	179	1894	82	1560
3E		MI	484	481	792	381	927	313	1006	255	1082	156	1201	38	1084
8-#7	2.50	MA	643	481	960	404	1159	333	1270	277	1405	179	1663	61	1454
4L-2S		MI	528	481	874	379	1030	313	1129	257	1238	154	1376	83	1086
8-#8	3.29	MA	725	525	1169	428	1422	350	1594	285	1842	177	2167	54	1991
3E		MI	506	525	868	407	1019	331	1110	264	1212	147	1339	-4	1338

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

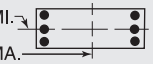
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#8	3.29	MA	673	525	1052	432	1270	353	1399	290	1576	176	1869	26	1784
4L-2S		MI	559	525	974	406	1153	332	1267	266	1412	145	1561	55	1374
8-#9	4.17	MA	767	575	1297	458	1581	372	1783	298	2095	175	2456	20	2409
3E		MI	528	575	950	435	1118	352	1218	273	1348	136	1480	-52	1465
8-#9	4.17	MA	707	575	1150	463	1381	380	1539	304	1762	173	2086	-15	2077
4L-2S		MI	591	575	1081	435	1284	353	1412	275	1594	134	1750	21	1679
8-#10	5.29	MA	821	638	1459	497	1780	401	2022	315	2410	170	2814	-25	2784
3E		MI	557	638	1050	473	1242	378	1351	290	1515	121	1649	-118	1618
8-#10	5.29	MA	750	638	1274	503	1529	410	1716	323	1993	168	2355	-68	2311
4L-2S		MI	631	638	1213	472	1448	381	1589	287	1817	118	1977	-25	1970
10-#10	6.61	MA	859	713	1530	550	1853	444	2108	345	2520	164	2985	-90	2888
4L-3S		MI	616	713	1213	519	1448	412	1589	308	1817	109	1977	-161	1924

RECTANGULAR TIED COLUMNS 12" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#7	1.11	MA	823	453	1120	398	1373	334	1515	284	1666	207	1984	172	961
2E		MI	521	453	780	372	901	312	962	264	1003	185	1109	136	611
4-#8	1.46	MA	860	475	1216	410	1489	343	1653	289	1850	205	2211	166	1233
2E		MI	537	475	832	384	964	320	1031	267	1089	180	1200	121	765
4-#9	1.85	MA	898	500	1320	424	1616	353	1803	295	2050	203	2454	159	1526
2E		MI	554	500	888	397	1030	330	1104	271	1179	173	1292	104	928
4-#10	2.35	MA	944	531	1450	443	1775	367	1994	304	2304	201	2757	149	1895
2E		MI	574	531	957	414	1113	342	1192	276	1290	165	1404	80	1129
4-#11	2.89	MA	980	566	1584	460	1930	378	2174	310	2540	197	2988	130	2252
2E		MI	586	566	1022	429	1166	347	1247	273	1355	147	1441	40	1311
4-#14	4.17	MA	1080	647	1893	507	2310	413	2628	332	3137	190	3661	96	3126
2E		MI	628	647	1175	475	1325	372	1427	281	1580	118	1642	-36	1651
4-#18	7.41	MA	1310	853	2626	630	3218	502	3716	388	4484	160	5161	-7	5146
2E		MI	721	853	1459	575	1648	426	1793	287	2039	31	2062	-239	2057
6-#6	1.22	MA	838	460	1147	404	1411	339	1564	287	1734	207	2082	173	1053
2L-3S		MI	493	460	733	379	847	317	901	267	927	187	1029	103	669
6-#6	1.22	MA	770	460	1037	407	1273	341	1396	289	1509	210	1787	141	1055
3L-2S		MI	529	460	794	378	924	317	994	268	1045	186	1162	136	663
6-#7	1.67	MA	885	488	1268	420	1560	350	1741	294	1970	205	2379	166	1398
2L-3S		MI	504	488	780	395	901	328	962	272	1003	182	1109	75	864
6-#7	1.67	MA	797	488	1120	424	1373	354	1515	297	1666	209	1984	122	1393
3L-2S		MI	551	488	861	394	1004	328	1085	274	1159	180	1285	119	859
6-#8	2.19	MA	938	521	1409	439	1733	365	1948	303	2247	203	2721	158	1799
2L-3S		MI	516	521	832	414	964	341	1031	278	1089	175	1200	39	1081
6-#8	2.19	MA	828	521	1216	445	1489	369	1653	306	1850	207	2211	100	1780
3L-2S		MI	574	521	937	413	1097	342	1189	280	1289	173	1422	97	1082
6-#9	2.78	MA	992	558	1561	461	1921	380	2173	313	2548	201	3087	148	2231
2L-3S		MI	530	558	888	435	1030	355	1104	285	1179	166	1292	-2	1292
6-#9	2.78	MA	864	558	1320	468	1616	385	1803	316	2050	206	2454	74	2190
3L-2S		MI	599	558	1019	434	1196	357	1298	287	1425	164	1563	72	1318
6-#10	3.53	MA	1058	606	1754	489	2159	401	2458	326	2929	198	3543	133	2777
2L-3S		MI	546	606	957	462	1113	374	1192	298	1290	155	1404	-56	1393
6-#10	3.53	MA	907	606	1450	497	1775	407	1994	329	2304	204	2757	40	2666
3L-2S		MI	629	606	1120	461	1319	377	1430	295	1591	152	1732	37	1608
6-#11	4.33	MA	941	657	1584	525	1930	426	2174	340	2540	198	2988	-9	2977
3L-2S		MI	647	657	1212	486	1396	386	1513	293	1692	128	1793	-22	1795
6-#14	6.25	MA	1043	779	1893	601	2310	480	2628	373	3137	190	3661	-109	3534
3L-2S		MI	712	779	1435	558	1633	426	1783	306	2032	86	2099	-134	2106
8-#5	1.15	MA	832	455	1123	402	1387	338	1536	286	1700	208	2047	176	998
2L-4S		MI	484	455	706	379	813	318	862	269	882	189	985	109	639
8-#5	1.15	MA	783	455	1046	404	1288	339	1418	288	1540	210	1835	153	1000
3E		MI	501	455	738	378	856	317	915	268	949	190	1057	118	635

RECTANGULAR TIED COLUMNS 12" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#5	1.15	MA	753	455	991	407	1217	341	1326	291	1415	211	1684	140	999
4L-2S		MI	528	455	781	377	911	317	981	268	1034	189	1155	141	631
8-#6	1.63	MA	885	485	1256	420	1549	350	1731	294	1959	206	2377	169	1376
2L-4S		MI	494	485	749	396	863	331	920	276	952	183	1062	79	852
8-#6	1.63	MA	819	485	1147	423	1411	353	1564	296	1734	209	2082	137	1374
3E		MI	517	485	794	395	924	329	994	275	1045	184	1162	91	851
8-#6	1.63	MA	779	485	1069	426	1310	356	1435	300	1559	210	1872	119	1359
4L-2S		MI	552	485	855	394	1000	329	1087	276	1163	183	1296	124	847
8-#7	2.22	MA	862	523	1268	446	1560	370	1741	307	1970	207	2379	117	1819
3E		MI	535	523	861	417	1004	344	1085	282	1159	177	1285	57	1102
8-#7	2.22	MA	811	523	1163	450	1423	373	1567	312	1733	208	2096	93	1726
4L-2S		MI	580	523	942	416	1107	344	1209	284	1315	176	1461	101	1102
8-#8	2.93	MA	913	568	1409	474	1733	390	1948	320	2247	206	2721	92	2332
3E		MI	556	568	937	443	1097	362	1189	291	1289	168	1422	15	1384
8-#8	2.93	MA	848	568	1272	479	1555	394	1720	326	1937	206	2356	61	2122
4L-2S		MI	611	568	1043	442	1230	363	1347	293	1488	167	1645	73	1392
8-#9	3.70	MA	966	617	1561	504	1921	412	2173	333	2548	204	3087	63	2880
3E		MI	578	617	1019	471	1196	382	1298	300	1425	157	1563	-34	1554
8-#9	3.70	MA	893	617	1389	511	1697	417	1887	341	2158	204	2633	25	2541
4L-2S		MI	643	617	1150	470	1362	384	1491	302	1670	155	1834	40	1700
8-#10	4.70	MA	1032	681	1754	544	2159	441	2458	351	2929	201	3543	24	3482
3E		MI	607	681	1120	508	1319	408	1430	316	1591	142	1732	-99	1708
8-#10	4.70	MA	947	681	1537	552	1877	447	2098	361	2439	201	2977	-23	2955
4L-2S		MI	683	681	1283	508	1526	411	1669	313	1893	139	2060	-6	2059
8-#11	5.78	MA	990	749	1686	591	2035	481	2296	377	2697	192	3237	-88	3154
4L-2S		MI	709	749	1401	544	1626	426	1779	313	2029	108	2145	-83	2139
10-#10	5.88	MA	1080	756	1840	598	2261	481	2562	383	3063	198	3764	-39	3703
4L-3S		MI	666	756	1283	555	1526	443	1669	335	1893	130	2060	-142	2017
10-#10	5.88	MA	998	756	1646	606	1986	493	2238	387	2616	203	3208	-95	3131
5L-2S		MI	737	756	1446	555	1732	445	1907	332	2195	127	2388	-49	2370
12-#10	7.06	MA	1127	830	1949	653	2370	527	2702	409	3241	200	3994	-111	3861
5L-3S		MI	724	830	1446	602	1732	477	1907	354	2195	117	2388	-186	2321

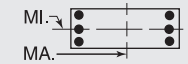
RECTANGULAR TIED COLUMNS 12" x 20"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.00	MA	1010	495	1329	443	1650	373	1827	317	2009	233	2427	200	1091
2E		MI	572	495	848	408	978	343	1042	291	1080	206	1193	155	622
4-#8	1.32	MA	1054	517	1440	455	1784	382	1987	323	2222	232	2701	195	1404
2E		MI	589	517	901	420	1041	351	1111	294	1166	201	1284	140	778
4-#9	1.67	MA	1101	542	1560	469	1931	392	2161	329	2454	230	2996	190	1742
2E		MI	605	542	958	433	1108	360	1183	298	1255	195	1376	122	944
4-#10	2.12	MA	1158	574	1712	488	2116	405	2382	337	2749	228	3365	183	2169
2E		MI	626	574	1027	450	1191	373	1272	303	1366	186	1487	99	1147
4-#11	2.60	MA	1203	608	1870	505	2300	417	2596	344	3029	224	3665	167	2589
2E		MI	637	608	1094	464	1244	377	1327	299	1431	168	1523	58	1333
4-#14	3.75	MA	1325	689	2232	552	2745	451	3129	365	3741	219	4504	140	3612
2E		MI	679	689	1247	509	1404	401	1507	306	1655	139	1723	-18	1729
4-#18	6.67	MA	1603	895	3099	675	3818	541	4415	421	5453	206	6420	58	6065
2E		MI	771	895	1533	608	1727	454	1872	312	2114	50	2141	-222	2140
6-#6	1.10	MA	1028	502	1359	449	1693	377	1882	320	2086	234	2541	201	1196
2L-3S		MI	544	502	801	416	924	348	981	294	1004	209	1113	122	680
6-#6	1.10	MA	948	502	1234	452	1534	380	1690	323	1828	237	2191	169	1198
3L-2S		MI	581	502	862	415	1001	348	1074	295	1122	208	1247	155	675

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 20"

Short columns – no sidesway
Bending on major or minor axis

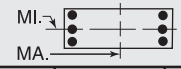


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.50	MA	1085	530	1499	465	1864	389	2086	328	2359	232	2897	196	1592
2L-3S		MI	555	530	848	431	978	359	1042	299	1080	203	1193	93	878
6-#7	1.50	MA	981	530	1329	470	1650	393	1827	331	2009	236	2427	152	1588
3L-2S		MI	602	530	929	430	1081	359	1165	301	1236	202	1369	137	872
6-#8	1.98	MA	1148	564	1662	484	2065	403	2326	336	2679	230	3311	190	2054
2L-3S		MI	567	564	901	450	1041	372	1111	305	1166	196	1284	58	1100
6-#8	1.98	MA	1018	564	1440	491	1784	408	1987	340	2222	235	2701	132	2036
3L-2S		MI	626	564	1007	449	1174	373	1269	307	1365	194	1506	116	1097
6-#9	2.50	MA	1214	601	1839	506	2283	419	2587	346	3027	228	3754	182	2555
2L-3S		MI	580	601	958	470	1108	386	1183	311	1255	188	1376	17	1329
6-#9	2.50	MA	1059	601	1560	514	1931	425	2161	351	2454	234	2996	109	2514
3L-2S		MI	651	601	1089	470	1274	388	1377	313	1501	185	1647	90	1335
6-#10	3.17	MA	1294	649	2062	534	2559	439	2918	359	3470	225	4309	171	3189
2L-3S		MI	596	649	1027	497	1191	404	1272	324	1366	176	1487	-38	1480
6-#10	3.17	MA	1114	649	1712	544	2116	447	2382	365	2749	233	3365	78	3108
3L-2S		MI	680	649	1190	497	1397	407	1510	321	1667	173	1815	56	1628
6-#11	3.90	MA	1157	700	1870	572	2300	467	2596	376	3029	228	3665	34	3581
3L-2S		MI	699	700	1283	521	1474	416	1593	319	1767	148	1875	-4	1876
6-#14	5.63	MA	1280	822	2232	648	2745	522	3129	410	3741	223	4504	-55	4416
3L-2S		MI	762	822	1508	592	1712	455	1863	331	2107	107	2180	-116	2191
8-#5	1.03	MA	1020	497	1332	447	1664	376	1850	320	2046	235	2497	203	1132
2L-4S		MI	535	497	773	416	890	350	942	296	959	211	1070	128	650
8-#5	1.03	MA	963	497	1243	450	1552	378	1714	322	1862	237	2246	180	1134
3E		MI	552	497	805	415	933	348	994	295	1026	211	1142	137	646
8-#5	1.03	MA	929	497	1180	452	1470	380	1610	325	1720	239	2068	167	1133
4L-2S		MI	579	497	848	414	988	348	1061	296	1111	211	1240	160	642
8-#6	1.47	MA	1083	528	1485	465	1852	389	2074	328	2345	233	2892	199	1566
2L-4S		MI	544	528	817	433	940	362	1000	303	1029	205	1147	98	868
8-#6	1.47	MA	1007	528	1359	468	1693	392	1882	330	2086	236	2541	166	1564
3E		MI	568	528	862	432	1001	360	1074	302	1122	206	1247	110	865
8-#6	1.47	MA	960	528	1271	472	1578	395	1735	335	1886	238	2293	148	1549
4L-2S		MI	603	528	923	431	1078	360	1167	303	1240	205	1381	143	860
8-#7	2.00	MA	1058	566	1499	492	1864	409	2086	341	2359	235	2897	148	2078
3E		MI	586	566	929	453	1081	375	1165	309	1236	199	1369	76	1119
8-#7	2.00	MA	999	566	1380	497	1709	413	1888	347	2087	237	2564	124	2006
4L-2S		MI	631	566	1011	452	1184	375	1288	311	1392	197	1545	120	1117
8-#8	2.63	MA	1117	610	1662	520	2065	429	2326	354	2679	234	3311	126	2673
3E		MI	607	610	1007	479	1174	393	1269	318	1365	190	1506	34	1405
8-#8	2.63	MA	1044	610	1506	526	1861	434	2066	362	2324	236	2878	94	2469
4L-2S		MI	662	610	1112	478	1308	394	1426	320	1565	188	1729	92	1410
8-#9	3.33	MA	1183	660	1839	551	2283	452	2587	368	3027	232	3754	101	3312
3E		MI	629	660	1089	507	1274	413	1377	327	1501	179	1647	-15	1643
8-#9	3.33	MA	1093	660	1642	558	2027	458	2260	377	2581	234	3215	61	2960
4L-2S		MI	695	660	1220	506	1439	415	1571	329	1747	176	1917	58	1719
8-#10	4.23	MA	1262	723	2062	590	2559	481	2918	387	3470	230	4309	67	4111
3E		MI	656	723	1190	544	1397	439	1510	343	1667	163	1815	-81	1797
8-#10	4.23	MA	1164	723	1814	600	2236	488	2506	398	2908	232	3636	17	3568
4L-2S		MI	735	723	1353	543	1604	441	1748	340	1969	161	2143	12	2102
8-#11	5.20	MA	1218	792	1991	640	2441	517	2741	415	3216	225	3975	-42	3921
4L-2S		MI	760	792	1472	579	1705	456	1858	339	2104	129	2227	-65	2226
8-#14	7.50	MA	1379	954	2401	745	2943	593	3332	465	4002	217	4929	-167	4687
4L-2S		MI	847	954	1769	675	2020	509	2219	356	2558	74	2636	-215	2631
10-#10	5.29	MA	1319	798	2164	646	2679	523	3041	420	3629	229	4580	6	4556
4L-3S		MI	715	798	1353	591	1604	473	1748	361	1969	151	2143	-124	2108
10-#10	5.29	MA	1218	798	1942	655	2365	536	2671	425	3117	237	3913	-50	3859
5L-2S		MI	788	798	1517	590	1810	476	1986	359	2271	148	2471	-31	2462
12-#10	6.35	MA	1369	873	2292	702	2808	570	3206	447	3838	234	4858	-61	4760
5L-3S		MI	774	873	1517	637	1810	507	1986	380	2271	138	2471	-167	2415

RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#8	1.20	MA	1267	560	1678	501	2101	420	2345	356	2620	258	3225	223	1574
2E		MI	640	560	970	456	1118	382	1190	321	1242	222	1368	159	791
4-#9	1.52	MA	1322	584	1815	515	2267	430	2544	362	2884	257	3572	219	1958
2E		MI	657	584	1027	469	1186	391	1263	325	1332	216	1459	141	958
4-#10	1.92	MA	1389	616	1987	533	2478	443	2795	371	3220	254	4008	214	2444
2E		MI	677	616	1097	486	1269	403	1351	329	1442	207	1570	117	1164
4-#11	2.36	MA	1446	650	2170	550	2690	455	3042	377	3544	251	4377	201	2926
2E		MI	689	650	1166	499	1322	407	1406	325	1506	188	1605	76	1353
4-#14	3.41	MA	1590	732	2585	597	3202	490	3654	399	4361	246	5385	180	4098
2E		MI	730	732	1320	544	1482	431	1586	332	1731	159	1805	0	1805
4-#18	6.06	MA	1918	938	3584	720	4440	579	5138	455	6347	234	7724	114	6929
2E		MI	821	938	1608	642	1806	482	1952	337	2188	70	2221	-204	2222
6-#6	1.00	MA	1236	544	1585	494	1996	415	2225	354	2465	261	3027	227	1338
2L-3S		MI	595	544	869	453	1001	379	1060	321	1081	231	1198	141	691
6-#6	1.00	MA	1143	544	1444	498	1817	419	2009	357	2173	264	2623	195	1340
3L-2S		MI	632	544	930	452	1078	379	1153	322	1199	230	1331	174	686
6-#7	1.36	MA	1302	573	1744	510	2190	427	2457	361	2774	259	3449	225	1787
2L-3S		MI	605	573	917	468	1056	390	1121	326	1156	225	1278	112	892
6-#7	1.36	MA	1182	573	1552	515	1948	432	2164	365	2379	264	2903	180	1782
3L-2S		MI	654	573	998	467	1159	390	1244	328	1312	224	1453	156	885
6-#8	1.80	MA	1376	606	1929	530	2418	441	2729	370	3137	257	3934	220	2310
2L-3S		MI	618	606	970	486	1118	403	1190	332	1242	218	1368	77	1118
6-#8	1.80	MA	1226	606	1678	536	2101	447	2345	375	2620	263	3225	162	2292
3L-2S		MI	678	606	1076	485	1252	403	1348	334	1442	216	1590	135	1112
6-#9	2.27	MA	1454	643	2130	551	2666	457	3026	380	3533	254	4455	215	2879
2L-3S		MI	630	643	1027	506	1186	417	1263	338	1332	209	1459	36	1351
6-#9	2.27	MA	1274	643	1815	560	2267	464	2544	386	2884	262	3572	141	2838
3L-2S		MI	702	643	1158	505	1351	418	1457	340	1577	207	1730	109	1352
6-#10	2.89	MA	1549	691	2384	580	2980	478	3402	393	4037	252	5111	207	3600
2L-3S		MI	646	691	1097	533	1269	435	1351	351	1442	197	1570	-19	1567
6-#10	2.89	MA	1334	691	1987	590	2478	486	2795	400	3220	261	4008	113	3520
3L-2S		MI	732	691	1261	532	1475	438	1590	348	1744	194	1898	74	1648
6-#11	3.55	MA	1391	742	2170	619	2690	507	3042	412	3544	257	4377	74	4177
3L-2S		MI	750	742	1355	556	1553	446	1672	345	1843	169	1957	14	1911
6-#14	5.11	MA	1536	864	2585	696	3202	563	3654	447	4361	253	5385	-7	5370
3L-2S		MI	814	864	1580	626	1791	484	1942	357	2182	127	2261	-98	2275
8-#6	1.33	MA	1300	570	1727	510	2175	427	2442	361	2757	260	3431	226	1756
2L-4S		MI	595	570	885	470	1017	393	1079	330	1106	227	1231	117	882
8-#6	1.33	MA	1211	570	1585	514	1996	431	2225	364	2465	264	3027	194	1754
3E		MI	619	570	930	469	1078	391	1153	329	1199	228	1331	129	877
8-#6	1.33	MA	1159	570	1486	518	1867	434	2061	369	2240	265	2743	175	1740
4L-2S		MI	655	570	991	468	1155	391	1246	330	1317	227	1465	162	873
8-#7	1.82	MA	1271	608	1744	537	2190	448	2457	375	2774	262	3449	178	2338
3E		MI	637	608	998	490	1159	406	1244	336	1312	220	1453	95	1135
8-#7	1.82	MA	1204	608	1610	543	2015	452	2234	382	2469	265	3064	153	2293
4L-2S		MI	683	608	1079	489	1262	406	1368	338	1469	219	1629	139	1131
8-#8	2.39	MA	1341	653	1929	565	2418	469	2729	388	3137	261	3934	159	3015
3E		MI	658	653	1076	515	1252	424	1348	345	1442	211	1590	53	1425
8-#8	2.39	MA	1257	653	1753	572	2189	474	2437	397	2738	264	3433	125	2825
4L-2S		MI	714	653	1181	514	1385	425	1506	347	1642	209	1813	111	1426
8-#9	3.03	MA	1414	702	2130	596	2666	491	3026	403	3533	260	4455	136	3744
3E		MI	679	702	1158	543	1351	444	1457	353	1577	200	1730	4	1723
8-#9	3.03	MA	1315	702	1909	605	2377	498	2658	413	3031	263	3831	94	3389
4L-2S		MI	747	702	1289	542	1517	445	1651	356	1823	198	2001	77	1738

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

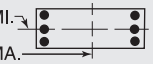
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#10	3.85	MA	1512	766	2384	636	2980	521	3402	422	4037	258	5111	106	4660
3E		MI	706	766	1261	580	1475	469	1590	369	1744	184	1898	-62	1885
8-#10	3.85	MA	1398	766	2105	647	2617	529	2938	434	3403	262	4330	53	4088
4L-2S		MI	786	766	1424	579	1681	472	1828	366	2045	182	2226	31	2123
8-#11	4.73	MA	1463	834	2310	688	2854	559	3211	453	3761	257	4749	-1	4747
4L-2S		MI	811	834	1544	614	1783	485	1938	365	2180	150	2309	-47	2310
8-#14	6.82	MA	1652	997	2781	794	3432	636	3890	505	4665	251	5899	-117	5685
4L-2S		MI	898	997	1841	709	2099	538	2299	382	2634	95	2717	-197	2720
10-#10	4.81	MA	1578	841	2502	693	3118	564	3545	456	4221	259	5433	46	5213
4L-3S		MI	765	841	1424	626	1681	503	1828	388	2045	172	2226	-105	2199
10-#10	4.81	MA	1455	841	2253	704	2766	578	3129	463	3645	269	4654	-9	4642
5L-2S		MI	840	841	1587	626	1888	506	2066	385	2347	169	2554	-12	2551
10-#11	5.91	MA	1535	926	2484	757	3031	617	3437	487	4047	263	5129	-82	5022
5L-2S		MI	873	926	1733	671	2013	525	2204	385	2517	130	2661	-109	2652
12-#10	5.77	MA	1630	915	2649	750	3268	612	3736	485	4462	266	5758	-16	5725
5L-3S		MI	823	915	1587	673	1888	538	2066	407	2347	159	2554	-149	2508
12-#10	5.77	MA	1489	915	2407	760	2948	621	3329	498	3900	270	5002	-84	4879
6L-2S		MI	894	915	1750	673	2094	541	2304	404	2649	156	2882	-55	2863
14-#10	6.73	MA	1669	990	2803	806	3450	655	3936	520	4717	267	6106	-92	5925
6L-3S		MI	881	990	1750	720	2094	572	2304	425	2649	147	2882	-192	2813

RECTANGULAR TIED COLUMNS 12" x 24"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#8	1.10	MA	1497	602	1929	546	2438	459	2729	390	3045	285	3761	248	1745
2E		MI	691	602	1039	492	1196	413	1270	348	1319	244	1451	177	804
4-#9	1.39	MA	1560	627	2082	560	2624	469	2951	396	3341	283	4168	246	2174
2E		MI	708	627	1097	505	1263	422	1342	351	1408	237	1543	160	973
4-#10	1.76	MA	1638	659	2276	578	2861	482	3233	404	3718	281	4684	244	2718
2E		MI	729	659	1168	521	1347	434	1431	356	1518	228	1653	136	1180
4-#11	2.17	MA	1705	693	2483	595	3102	494	3514	411	4085	277	5124	233	3263
2E		MI	740	693	1237	534	1401	436	1486	351	1582	209	1687	94	1373
4-#14	3.13	MA	1875	774	2951	642	3679	528	4203	432	5007	272	6303	217	4584
2E		MI	781	774	1392	578	1561	460	1666	357	1806	180	1886	18	1830
4-#18	5.56	MA	2256	980	4083	765	5082	618	5886	488	7259	261	9070	164	7793
2E		MI	872	980	1682	675	1885	511	2031	362	2262	90	2300	-187	2302
6-#7	1.25	MA	1537	615	2002	555	2537	466	2852	395	3215	285	3999	248	1981
2L-3S		MI	656	615	985	504	1133	421	1201	353	1233	246	1362	131	905
6-#7	1.25	MA	1401	615	1788	561	2267	471	2525	399	2775	291	3389	205	1976
3L-2S		MI	705	615	1067	503	1236	421	1324	355	1389	245	1538	175	898
6-#8	1.65	MA	1622	649	2209	575	2792	480	3157	403	3622	283	4559	246	2566
2L-3S		MI	668	649	1039	522	1196	433	1270	359	1319	239	1451	96	1134
6-#8	1.65	MA	1452	649	1929	582	2438	486	2729	409	3045	291	3761	189	2548
3L-2S		MI	729	649	1145	521	1329	434	1428	361	1519	237	1674	154	1127
6-#9	2.08	MA	1712	686	2434	596	3069	496	3489	413	4066	281	5171	243	3203
2L-3S		MI	681	686	1097	542	1263	447	1342	365	1408	230	1543	54	1371
6-#9	2.08	MA	1507	686	2082	605	2624	504	2951	420	3341	290	4168	170	3162
3L-2S		MI	754	686	1228	541	1429	449	1536	367	1654	228	1813	128	1369
6-#10	2.65	MA	1823	733	2719	625	3422	516	3911	426	4631	278	5948	240	4012
2L-3S		MI	697	733	1168	569	1347	465	1431	377	1518	218	1653	-1	1653
6-#10	2.65	MA	1576	733	2276	636	2861	526	3233	434	3718	289	4684	146	3931
3L-2S		MI	784	733	1331	568	1553	468	1669	374	1820	215	1981	93	1667
6-#11	3.25	MA	1637	785	2483	665	3102	547	3514	447	4085	286	5124	110	4685
3L-2S		MI	802	785	1426	591	1631	476	1752	371	1919	190	2039	33	1934
6-#14	4.69	MA	1811	907	2951	743	3679	604	4203	483	5007	283	6303	36	6204
3L-2S		MI	865	907	1653	661	1869	514	2022	382	2257	147	2342	-81	2356

RECTANGULAR TIED COLUMNS 12" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

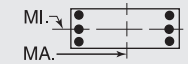
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#6	1.22	MA	1534	613	1983	555	2520	466	2835	395	3195	286	3973	249	1946
2L-4S		MI	646	613	953	506	1094	424	1159	357	1183	248	1316	136	895
8-#6	1.22	MA	1434	613	1825	559	2320	470	2593	398	2870	291	3523	218	1944
3E		MI	670	613	998	505	1155	423	1233	356	1276	249	1416	149	889
8-#6	1.22	MA	1374	613	1715	563	2177	473	2411	404	2620	293	3211	199	1930
4L-2S		MI	706	613	1059	504	1232	423	1326	357	1393	248	1550	181	884
8-#7	1.67	MA	1503	650	2002	583	2537	487	2852	409	3215	290	3999	204	2597
3E		MI	688	650	1067	526	1236	437	1324	363	1389	242	1538	114	1150
8-#7	1.67	MA	1426	650	1853	588	2343	492	2604	416	2876	293	3574	178	2552
4L-2S		MI	734	650	1148	525	1339	437	1447	365	1545	241	1713	158	1145
8-#8	2.19	MA	1582	695	2209	611	2792	508	3157	423	3622	289	4559	187	3356
3E		MI	708	695	1145	551	1329	455	1428	372	1519	233	1674	72	1444
8-#8	2.19	MA	1488	695	2014	618	2538	514	2832	432	3178	293	4001	153	3189
4L-2S		MI	766	695	1250	550	1462	456	1585	373	1718	231	1897	130	1442
8-#9	2.78	MA	1667	745	2434	642	3069	531	3489	437	4066	288	5171	167	4176
3E		MI	730	745	1228	579	1429	474	1536	380	1654	221	1813	22	1749
8-#9	2.78	MA	1555	745	2189	651	2749	538	3080	448	3507	292	4467	124	3826
4L-2S		MI	799	745	1359	578	1595	476	1730	382	1899	219	2084	96	1757
8-#10	3.53	MA	1780	808	2719	682	3422	560	3911	456	4631	286	5948	142	5209
3E		MI	757	808	1331	615	1553	500	1669	396	1820	206	1981	-44	1973
8-#10	3.53	MA	1641	808	2409	694	3018	570	3395	470	3926	292	5057	87	4618
4L-2S		MI	838	808	1494	615	1759	502	1907	393	2122	203	2309	50	2144
8-#11	4.33	MA	1727	876	2642	735	3289	600	3706	489	4333	287	5559	36	5382
4L-2S		MI	863	876	1615	649	1861	515	2017	391	2256	170	2391	-29	2393
8-#14	6.25	MA	1945	1039	3175	843	3941	679	4474	543	5355	283	6906	-71	6747
4L-2S		MI	949	1039	1914	743	2178	568	2378	408	2709	115	2798	-179	2807
10-#10	4.41	MA	1856	883	2853	740	3579	604	4074	492	4839	289	6321	83	5882
4L-3S		MI	816	883	1494	662	1759	534	1907	414	2122	193	2309	-87	2288
10-#10	4.41	MA	1704	883	2577	751	3188	619	3611	500	4199	300	5429	29	5328
5L-2S		MI	892	883	1657	661	1966	537	2145	412	2423	190	2637	6	2616
10-#11	5.42	MA	1803	968	2841	805	3490	660	3963	525	4658	296	5997	-39	5933
5L-2S		MI	924	968	1804	706	2092	555	2283	411	2593	151	2743	-91	2739
10-#14	7.81	MA	2051	1171	3455	943	4224	764	4835	594	5813	294	7518	-184	7104
5L-2S		MI	1034	1171	2175	826	2486	622	2734	433	3160	83	3255	-277	3243
12-#10	5.29	MA	1910	958	3020	798	3748	654	4290	522	5113	297	6693	25	6600
5L-3S		MI	874	958	1657	709	1966	568	2145	433	2423	180	2637	-130	2600
12-#10	5.29	MA	1750	958	2743	807	3394	663	3838	536	4489	302	5832	-46	5718
6L-2S		MI	946	958	1820	708	2172	571	2383	430	2725	178	2965	-37	2954
12-#11	6.50	MA	1853	1060	3047	874	3735	713	4232	568	5002	297	6467	-132	6223
6L-2S		MI	986	1060	1994	763	2322	594	2549	431	2929	131	3095	-152	3075
14-#10	6.17	MA	1954	1032	3187	853	3955	698	4516	558	5402	300	7096	-50	6920
6L-3S		MI	931	1032	1820	755	2172	603	2383	452	2725	168	2965	-173	2907

RECTANGULAR TIED COLUMNS 14" x 14"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#6	1.35	MA	582	424	851	358	1014	299	1108	253	1210	179	1382	136	781
2L-3S		MI	535	424	774	360	917	300	991	253	1053	180	1196	103	785
6-#7	1.84	MA	611	452	935	374	1117	311	1231	260	1367	175	1562	123	1025
2L-3S		MI	552	452	832	376	986	312	1072	260	1157	177	1314	79	1024
6-#8	2.42	MA	644	486	1033	393	1237	325	1373	268	1547	171	1766	108	1305
2L-3S		MI	571	486	898	396	1067	326	1168	268	1277	173	1450	50	1294
6-#9	3.06	MA	677	523	1138	414	1365	340	1527	278	1738	165	1980	89	1604
2L-3S		MI	591	523	970	418	1153	342	1270	277	1404	168	1591	16	1562
6-#10	3.89	MA	719	571	1269	442	1527	361	1720	291	1975	158	2242	64	1977
2L-3S		MI	616	571	1059	446	1261	362	1399	289	1561	161	1765	-29	1749
6-#11	4.78	MA	748	622	1393	469	1672	380	1876	299	2147	141	2395	20	2317
2L-3S		MI	633	622	1146	472	1360	379	1503	295	1675	144	1864	-95	1824

RECTANGULAR TIED COLUMNS 14" x 14"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#6	1.80	MA	612	450	928	374	1111	311	1226	260	1367	178	1569	127	1010
2L-4S		MI	540	450	795	378	939	315	1016	263	1086	178	1246	81	994
8-#7	2.45	MA	649	488	1039	396	1248	327	1389	270	1576	173	1809	111	1329
2L-4S		MI	558	488	860	401	1015	332	1106	273	1201	173	1380	48	1238
8-#8	3.22	MA	692	533	1167	422	1407	346	1579	282	1816	168	2082	91	1697
2L-4S		MI	581	533	935	428	1104	353	1211	285	1333	168	1533	8	1509
8-#9	4.08	MA	736	582	1306	451	1578	367	1784	295	2071	161	2368	67	2090
2L-4S		MI	605	582	1015	458	1199	375	1324	298	1474	161	1693	-37	1683

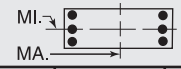
RECTANGULAR TIED COLUMNS 14" x 16"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.07	MA	745	467	1037	404	1250	339	1368	288	1488	210	1729	170	845
2E		MI	641	467	921	395	1090	332	1180	282	1263	204	1432	158	728
4-#8	1.41	MA	775	489	1119	416	1349	348	1485	294	1643	209	1910	162	1078
2E		MI	664	489	988	408	1170	341	1276	287	1382	200	1567	148	922
4-#9	1.79	MA	806	514	1207	430	1456	358	1611	300	1812	207	2101	153	1328
2E		MI	688	514	1061	421	1257	350	1378	293	1509	196	1708	135	1128
4-#10	2.27	MA	843	546	1317	448	1590	371	1771	308	2021	204	2338	139	1641
2E		MI	716	546	1151	439	1366	363	1507	301	1666	190	1881	117	1386
4-#11	2.79	MA	870	580	1429	464	1717	383	1917	314	2184	194	2501	115	1940
2E		MI	735	580	1240	454	1465	374	1611	304	1780	177	1978	87	1626
4-#14	4.02	MA	950	661	1687	511	2033	417	2294	335	2646	181	3010	72	2669
2E		MI	796	661	1445	501	1715	408	1884	319	2121	158	2329	30	2212
4-#18	7.14	MA	1132	867	2290	633	2776	505	3147	383	3687	137	4104	-60	4042
2E		MI	932	867	1917	621	2247	483	2475	347	2864	96	3035	-141	3001
6-#6	1.18	MA	758	474	1059	410	1283	344	1410	292	1547	211	1812	171	924
2L-3S		MI	604	474	862	404	1020	338	1098	286	1159	206	1313	126	799
6-#6	1.18	MA	700	474	966	413	1166	346	1268	293	1355	213	1572	138	928
3L-2S		MI	652	474	939	402	1117	337	1216	285	1316	205	1500	159	794
6-#7	1.61	MA	796	502	1162	426	1409	356	1560	299	1747	209	2049	162	1219
2L-3S		MI	621	502	921	420	1090	350	1180	293	1263	203	1432	102	1042
6-#7	1.61	MA	721	502	1037	430	1250	358	1368	300	1488	211	1729	118	1219
3L-2S		MI	682	502	1025	418	1221	348	1339	292	1472	201	1679	146	1039
6-#8	2.12	MA	839	536	1282	446	1556	370	1735	307	1980	207	2322	150	1561
2L-3S		MI	640	536	988	440	1170	364	1276	301	1382	199	1567	73	1316
6-#8	2.12	MA	747	536	1119	450	1349	373	1485	309	1643	209	1910	92	1550
3L-2S		MI	715	536	1123	437	1340	362	1481	301	1652	197	1883	131	1321
6-#9	2.68	MA	883	573	1411	467	1715	385	1924	317	2233	204	2611	136	1928
2L-3S		MI	659	573	1061	461	1257	379	1378	310	1509	193	1708	39	1604
6-#9	2.68	MA	774	573	1207	472	1456	389	1611	319	1812	207	2101	63	1899
3L-2S		MI	749	573	1228	458	1469	377	1635	310	1843	191	2096	112	1623
6-#10	3.40	MA	937	620	1574	495	1915	406	2163	330	2548	201	2968	117	2388
2L-3S		MI	684	620	1151	489	1366	399	1507	321	1666	186	1881	-7	1877
6-#10	3.40	MA	808	620	1317	501	1590	409	1771	331	2021	203	2338	24	2289
3L-2S		MI	790	620	1360	486	1631	398	1828	323	2080	183	2357	86	1999
6-#11	4.18	MA	977	672	1733	522	2102	425	2382	341	2795	188	3218	82	2822
2L-3S		MI	700	672	1240	514	1465	415	1611	327	1780	169	1978	-73	1949
6-#11	4.18	MA	832	672	1429	528	1717	428	1917	341	2184	191	2501	-32	2476
3L-2S		MI	819	672	1486	512	1777	416	1984	330	2252	166	2509	42	2343
6-#14	6.03	MA	911	793	1687	601	2033	480	2294	371	2646	174	3010	-147	2904
3L-2S		MI	910	793	1789	584	2150	468	2392	353	2765	137	3038	-42	3014
8-#6	1.57	MA	796	500	1152	426	1401	356	1552	299	1739	210	2053	165	1200
2L-4S		MI	609	500	884	422	1042	353	1124	296	1192	204	1364	104	1024

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#6	1.57	MA	741	500	1059	429	1283	358	1410	301	1547	212	1812	133	1201
3E		MI	637	500	939	420	1117	350	1216	293	1316	205	1500	118	1027
8-#6	1.57	MA	706	500	992	432	1197	360	1300	304	1397	212	1639	116	1193
4L-2S		MI	682	500	1016	418	1215	349	1334	293	1473	204	1686	150	1024
8-#7	2.14	MA	846	537	1288	448	1568	372	1752	309	2005	208	2370	153	1589
2L-4S		MI	627	537	949	445	1119	370	1214	306	1307	199	1498	71	1283
8-#7	2.14	MA	776	537	1162	452	1409	374	1560	311	1747	210	2049	109	1582
3E		MI	664	537	1025	442	1221	366	1339	303	1472	201	1679	90	1343
8-#7	2.14	MA	731	537	1072	455	1292	377	1411	315	1543	209	1818	87	1510
4L-2S		MI	720	537	1128	440	1352	365	1497	303	1682	199	1926	134	1346
8-#8	2.82	MA	900	582	1446	475	1763	391	1985	321	2317	205	2735	138	2038
2L-4S		MI	648	582	1025	472	1208	390	1319	318	1439	194	1650	31	1560
8-#8	2.82	MA	816	582	1282	479	1556	394	1735	323	1980	208	2322	80	2018
3E		MI	693	582	1123	469	1340	385	1481	314	1652	195	1883	56	1702
8-#8	2.82	MA	762	582	1165	483	1403	397	1540	328	1715	206	2023	52	1848
4L-2S		MI	763	582	1257	466	1510	383	1687	314	1922	194	2199	114	1715
8-#9	3.57	MA	958	631	1616	504	1973	412	2237	334	2654	202	3121	120	2522
2L-4S		MI	672	631	1106	501	1303	412	1432	331	1579	186	1809	-15	1806
8-#9	3.57	MA	858	631	1411	509	1715	416	1924	336	2233	205	2611	46	2482
3E		MI	725	631	1228	498	1469	406	1635	327	1843	189	2096	16	2063
8-#9	3.57	MA	795	631	1264	514	1515	424	1680	342	1900	203	2241	12	2202
4L-2S		MI	808	631	1396	495	1682	405	1892	328	2177	186	2485	89	2111
8-#10	4.54	MA	911	695	1574	548	1915	444	2163	353	2548	200	2968	1	2965
3E		MI	766	695	1360	536	1631	433	1828	343	2080	179	2357	-38	2333
8-#10	4.54	MA	836	695	1389	554	1663	453	1856	360	2131	198	2509	-41	2485
4L-2S		MI	862	695	1570	532	1897	432	2149	345	2493	176	2834	56	2606
8-#11	5.57	MA	952	763	1733	585	2102	470	2382	368	2795	185	3218	-66	3152
3E		MI	794	763	1486	572	1777	457	1984	353	2252	157	2509	-118	2449
10-#10	5.67	MA	945	770	1645	601	1988	488	2249	382	2658	194	3139	-64	3078
4L-3S		MI	845	770	1570	583	1897	467	2149	365	2493	172	2834	-69	2779

RECTANGULAR TIED COLUMNS 14" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#8	1.25	MA	976	539	1355	469	1656	393	1830	333	2026	240	2410	197	1248
2E		MI	734	539	1078	451	1274	378	1384	320	1488	226	1683	170	936
4-#9	1.59	MA	1015	563	1459	483	1783	403	1981	339	2226	238	2652	190	1544
2E		MI	758	563	1151	464	1361	388	1486	325	1614	222	1824	157	1144
4-#10	2.02	MA	1063	595	1591	501	1943	416	2171	347	2480	235	2954	180	1915
2E		MI	787	595	1242	482	1470	400	1615	333	1771	216	1996	140	1404
4-#11	2.48	MA	1099	629	1728	517	2100	427	2352	353	2715	231	3184	160	2277
2E		MI	806	629	1333	497	1570	410	1720	336	1884	202	2093	109	1648
4-#14	3.57	MA	1200	710	2039	564	2481	462	2807	374	3311	224	3855	126	3155
2E		MI	866	710	1540	543	1821	443	1992	350	2225	182	2442	52	2239
4-#18	6.35	MA	1429	916	2776	685	3390	550	3895	429	4658	193	5354	22	5239
2E		MI	1002	916	2014	662	2353	518	2583	377	2967	120	3147	-120	3126
6-#6	1.05	MA	954	523	1283	463	1577	389	1741	331	1910	242	2282	204	1066
2L-3S		MI	674	523	951	448	1123	376	1206	319	1265	232	1431	149	811
6-#6	1.05	MA	884	523	1174	466	1439	392	1573	333	1685	245	1986	171	1070
3L-2S		MI	722	523	1028	446	1221	375	1324	318	1422	231	1617	182	806
6-#7	1.43	MA	1002	551	1405	479	1726	401	1918	338	2146	240	2578	197	1413
2L-3S		MI	690	551	1010	464	1193	387	1288	325	1368	229	1549	125	1058
6-#7	1.43	MA	912	551	1258	483	1539	404	1692	340	1842	244	2183	153	1413
3L-2S		MI	752	551	1114	461	1324	386	1447	325	1578	227	1796	169	1053
6-#8	1.88	MA	1056	585	1547	498	1900	415	2125	347	2423	238	2920	188	1817
2L-3S		MI	709	585	1078	483	1274	401	1384	333	1488	224	1683	95	1337
6-#8	1.88	MA	943	585	1355	503	1656	419	1830	350	2026	242	2410	130	1806
3L-2S		MI	785	585	1213	480	1444	399	1589	333	1757	223	2000	153	1338
6-#9	2.38	MA	1111	622	1701	520	2089	430	2350	356	2724	236	3285	178	2252
2L-3S		MI	728	622	1151	505	1361	416	1486	342	1614	219	1824	61	1630

RECTANGULAR TIED COLUMNS 14" x 18"

Short columns – no sidesway
Bending on major or minor axis

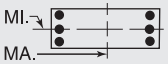
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#9	2.38	MA	979	622	1459	526	1783	435	1981	360	2226	240	2652	105	2223
3L-2S		MI	820	622	1319	501	1573	415	1743	343	1948	217	2212	135	1642
6-#10	3.02	MA	1178	670	1894	548	2327	450	2635	369	3105	233	3741	164	2800
2L-3S		MI	753	670	1242	532	1470	435	1615	353	1771	212	1996	16	1967
6-#10	3.02	MA	1021	670	1591	555	1943	456	2171	373	2480	238	2954	70	2739
3L-2S		MI	861	670	1452	529	1736	434	1936	355	2185	209	2473	109	2020
6-#11	3.71	MA	1231	721	2089	574	2557	470	2905	380	3460	228	4090	135	3327
2L-3S		MI	768	721	1333	557	1570	451	1720	358	1884	194	2093	-51	2074
6-#11	3.71	MA	1054	721	1728	583	2100	475	2352	383	2715	232	3184	21	3137
3L-2S		MI	890	721	1580	554	1882	452	2092	362	2356	191	2624	64	2368
6-#14	5.36	MA	1153	843	2039	657	2481	529	2807	415	3311	223	3855	-80	3766
3L-2S		MI	981	843	1884	625	2256	504	2501	385	2869	162	3152	-21	3142
8-#6	1.40	MA	1001	549	1392	479	1715	401	1908	338	2136	241	2577	200	1390
2L-4S		MI	677	549	972	466	1145	391	1232	328	1298	230	1481	126	1042
8-#6	1.40	MA	934	549	1283	482	1577	403	1741	340	1910	244	2282	168	1391
3E		MI	707	549	1028	464	1221	388	1324	326	1422	231	1617	141	1041
8-#6	1.40	MA	894	549	1206	485	1477	406	1612	344	1735	245	2071	150	1384
4L-2S		MI	752	549	1105	462	1318	386	1442	326	1578	230	1804	173	1038
8-#7	1.90	MA	1063	587	1553	501	1913	417	2144	348	2450	239	2973	191	1848
2L-4S		MI	696	587	1039	488	1222	407	1322	338	1412	225	1615	94	1326
8-#7	1.90	MA	977	587	1405	505	1726	420	1918	351	2146	242	2578	147	1841
3E		MI	733	587	1114	486	1324	403	1447	336	1578	227	1796	113	1361
8-#7	1.90	MA	925	587	1301	509	1590	423	1744	356	1909	243	2295	124	1792
4L-2S		MI	791	587	1217	483	1455	402	1605	335	1787	225	2043	157	1361
8-#8	2.51	MA	1132	632	1740	527	2144	436	2420	360	2820	236	3430	180	2379
2L-4S		MI	717	632	1115	515	1312	427	1427	350	1544	219	1767	54	1609
8-#8	2.51	MA	1029	632	1547	533	1900	440	2125	363	2423	240	2920	122	2360
3E		MI	763	632	1213	512	1444	422	1589	347	1757	221	2000	78	1725
8-#8	2.51	MA	962	632	1410	538	1722	444	1898	370	2113	241	2554	92	2197
4L-2S		MI	834	632	1347	509	1614	421	1795	347	2027	219	2316	136	1734
8-#9	3.17	MA	1203	681	1942	556	2394	457	2720	373	3221	233	3918	167	2954
2L-4S		MI	740	681	1196	545	1407	449	1540	363	1684	212	1925	8	1903
8-#9	3.17	MA	1081	681	1701	563	2089	462	2350	377	2724	238	3285	93	2914
3E		MI	795	681	1319	541	1573	443	1743	359	1948	214	2212	38	2109
8-#9	3.17	MA	1006	681	1529	569	1865	467	2065	385	2334	239	2831	55	2623
4L-2S		MI	879	681	1487	538	1786	442	2000	360	2282	212	2601	112	2132
8-#10	4.03	MA	1147	745	1894	602	2327	491	2635	395	3105	235	3741	54	3597
3E		MI	834	745	1452	579	1736	470	1936	375	2185	205	2473	-15	2464
8-#10	4.03	MA	1058	745	1678	610	2045	497	2276	404	2614	235	3175	7	3149
4L-2S		MI	934	745	1662	575	2001	469	2257	377	2598	202	2950	78	2628
8-#11	4.95	MA	1200	813	2089	640	2557	517	2905	410	3460	229	4090	-4	4085
3E		MI	862	813	1580	614	1882	494	2092	384	2356	182	2624	-96	2577
8-#11	4.95	MA	1099	813	1830	648	2204	530	2474	420	2872	226	3433	-58	3385
4L-2S		MI	974	813	1826	611	2194	494	2465	388	2828	179	3155	19	3080
10-#10	5.04	MA	1191	819	1981	657	2429	531	2740	426	3239	232	3961	-9	3949
4L-3S		MI	913	819	1662	626	2001	504	2257	397	2598	198	2950	-46	2915
10-#10	5.04	MA	1110	819	1786	665	2154	542	2416	430	2792	238	3405	-65	3356
5L-2S		MI	1006	819	1871	622	2266	503	2578	399	3011	195	3427	47	3234
10-#11	6.19	MA	1254	905	2191	706	2661	572	3027	447	3617	223	4339	-83	4232
4L-3S		MI	953	905	1826	672	2194	536	2465	410	2828	171	3155	-141	3071
12-#10	6.05	MA	1239	894	2090	711	2538	577	2880	452	3416	235	4192	-81	4100
5L-3S		MI	991	894	1871	673	2266	539	2578	419	3011	191	3427	-77	3359

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis



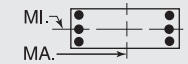
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.13	MA	1198	588	1606	522	1988	438	2205	372	2440	271	2949	230	1419
2E		MI	804	588	1168	495	1378	415	1492	352	1593	252	1800	193	949
4-#9	1.43	MA	1245	613	1728	535	2135	448	2380	378	2672	269	3243	224	1760
2E		MI	828	613	1242	508	1465	425	1594	358	1719	247	1940	180	1160
4-#10	1.81	MA	1303	645	1881	553	2321	461	2601	386	2967	267	3611	217	2189
2E		MI	857	645	1333	525	1575	437	1723	365	1876	241	2112	162	1421
4-#11	2.23	MA	1350	679	2043	570	2507	472	2815	392	3246	262	3909	201	2614
2E		MI	876	679	1426	539	1675	446	1828	367	1989	228	2208	131	1669
4-#14	3.21	MA	1474	760	2407	617	2953	506	3348	413	3958	257	4747	174	3641
2E		MI	937	760	1635	585	1927	479	2100	381	2329	207	2556	73	2265
4-#18	5.71	MA	1753	966	3278	738	4028	595	4635	468	5669	244	6661	91	6103
2E		MI	1072	966	2111	703	2460	552	2692	407	3070	144	3259	-99	3248
6-#7	1.29	MA	1229	601	1664	531	2068	445	2304	377	2577	271	3145	231	1608
2L-3S		MI	760	601	1100	508	1297	425	1396	358	1474	255	1666	148	1073
6-#7	1.29	MA	1122	601	1494	536	1853	449	2045	380	2227	276	2675	187	1607
3L-2S		MI	822	601	1203	505	1428	423	1555	358	1683	253	1913	192	1067
6-#8	1.69	MA	1293	635	1828	551	2269	459	2544	386	2897	269	3558	224	2072
2L-3S		MI	778	635	1168	527	1378	438	1492	366	1593	250	1800	118	1356
6-#8	1.69	MA	1160	635	1606	557	1988	465	2205	390	2440	275	2949	166	2061
3L-2S		MI	856	635	1303	524	1548	437	1697	366	1863	249	2116	176	1353
6-#9	2.14	MA	1361	672	2006	572	2487	475	2805	395	3245	267	4001	217	2576
2L-3S		MI	797	672	1242	548	1465	453	1594	374	1719	245	1940	84	1653
6-#9	2.14	MA	1201	672	1728	580	2135	481	2380	400	2672	273	3243	143	2547
3L-2S		MI	890	672	1410	545	1678	452	1851	375	2053	243	2329	157	1659
6-#10	2.72	MA	1443	719	2230	600	2764	495	3136	408	3687	264	4556	206	3211
2L-3S		MI	821	719	1333	576	1575	472	1723	385	1876	237	2112	38	2016
6-#10	2.72	MA	1252	719	1881	609	2321	503	2601	414	2967	271	3611	112	3151
3L-2S		MI	932	719	1543	572	1840	471	2044	387	2290	234	2589	131	2040
6-#11	3.34	MA	1509	771	2461	627	3036	514	3455	419	4108	259	5008	183	3833
2L-3S		MI	836	771	1426	599	1675	488	1828	390	1989	219	2208	-29	2197
6-#11	3.34	MA	1297	771	2043	637	2507	522	2815	425	3246	266	3909	68	3731
3L-2S		MI	961	771	1673	597	1987	488	2201	393	2461	216	2738	86	2392
6-#14	4.82	MA	1418	892	2407	713	2953	577	3348	458	3958	261	4747	-22	4714
3L-2S		MI	1052	892	1978	667	2362	540	2609	416	2973	187	3266	1	3261
8-#6	1.26	MA	1227	599	1648	532	2054	446	2292	378	2563	272	3140	233	1581
2L-4S		MI	746	599	1061	510	1248	428	1340	361	1403	256	1599	149	1058
8-#6	1.26	MA	1149	599	1523	535	1896	449	2100	380	2305	276	2789	201	1581
3E		MI	776	599	1116	508	1324	425	1432	359	1527	257	1735	164	1055
8-#6	1.26	MA	1101	599	1435	539	1781	452	1953	385	2104	277	2541	182	1574
4L-2S		MI	823	599	1193	506	1421	424	1549	359	1684	256	1921	196	1050
8-#7	1.71	MA	1301	636	1834	553	2282	462	2564	387	2927	270	3615	227	2107
2L-4S		MI	764	636	1128	532	1326	445	1430	371	1518	251	1732	116	1367
8-#7	1.71	MA	1200	636	1664	558	2068	466	2304	391	2577	274	3145	183	2100
3E		MI	803	636	1203	530	1428	441	1555	368	1683	253	1913	136	1379
8-#7	1.71	MA	1139	636	1545	563	1912	470	2106	397	2306	276	2812	158	2070
4L-2S		MI	862	636	1306	527	1558	439	1713	368	1893	251	2160	180	1376
8-#8	2.26	MA	1385	681	2050	580	2549	481	2883	399	3353	267	4167	219	2721
2L-4S		MI	785	681	1205	559	1415	464	1535	383	1649	245	1883	76	1655
8-#8	2.26	MA	1260	681	1828	586	2269	486	2544	403	2897	273	3558	161	2701
3E		MI	832	681	1303	556	1548	459	1697	379	1863	247	2116	101	1746
8-#8	2.26	MA	1184	681	1672	592	2065	491	2284	411	2542	275	3125	129	2555
4L-2S		MI	905	681	1437	553	1718	458	1903	379	2132	245	2433	159	1751
8-#9	2.86	MA	1471	730	2284	609	2839	502	3231	413	3818	264	4759	209	3386
2L-4S		MI	807	730	1287	588	1512	486	1648	395	1789	238	2042	31	1954

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

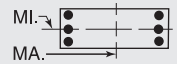
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.86	MA	1326	730	2006	616	2487	508	2805	417	3245	271	4001	135	3346
3E		MI	864	730	1410	585	1678	480	1851	391	2053	240	2329	61	2134
8-#9	2.86	MA	1233	730	1810	624	2231	514	2478	427	2799	273	3461	95	3055
4L-2S		MI	951	730	1577	582	1890	479	2108	392	2387	238	2717	134	2151
8-#10	3.63	MA	1405	794	2230	656	2764	537	3136	435	3687	269	4556	101	4154
3E		MI	903	794	1543	622	1840	507	2044	407	2290	230	2589	7	2574
8-#10	3.63	MA	1302	794	1983	665	2441	544	2724	447	3126	271	3882	51	3672
4L-2S		MI	1006	794	1753	619	2105	506	2365	409	2703	227	3066	100	2650
8-#11	4.46	MA	1472	862	2461	695	3036	564	3455	451	4108	263	5008	50	4864
3E		MI	930	862	1673	657	1987	530	2201	416	2461	208	2738	-74	2704
8-#11	4.46	MA	1354	862	2163	705	2648	572	2960	464	3433	264	4219	-9	4209
4L-2S		MI	1045	862	1919	654	2299	531	2573	419	2933	204	3269	41	3106
8-#14	6.43	MA	1510	1025	2575	809	3151	648	3551	513	4219	255	5172	-134	4994
4L-2S		MI	1166	1025	2322	750	2797	601	3118	450	3618	167	3975	-71	3932
10-#10	4.54	MA	1458	869	2333	712	2884	579	3260	469	3846	268	4827	40	4654
4L-3S		MI	982	869	1753	669	2105	541	2365	429	2703	223	3066	-24	3049
10-#10	4.54	MA	1357	869	2111	721	2570	592	2889	474	3335	276	4159	-16	4143
5L-2S		MI	1078	869	1963	665	2371	540	2686	431	3116	220	3543	69	3257
10-#11	5.57	MA	1537	954	2582	762	3178	614	3601	491	4295	260	5319	-27	5271
4L-3S		MI	1021	954	1919	714	2299	572	2573	442	2933	196	3269	-119	3202
12-#10	5.44	MA	1509	944	2461	768	3013	626	3425	496	4056	273	5104	-27	5063
5L-3S		MI	1060	944	1963	716	2371	575	2686	451	3116	216	3543	-55	3497

RECTANGULAR TIED COLUMNS 14" x 22"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.03	MA	1441	638	1874	574	2345	483	2608	411	2885	302	3527	262	1590
2E		MI	874	638	1258	539	1482	452	1600	385	1698	278	1917	216	962
4-#9	1.30	MA	1496	662	2012	588	2512	493	2807	417	3149	300	3873	258	1976
2E		MI	898	662	1333	551	1569	462	1702	390	1825	273	2057	202	1174
4-#10	1.65	MA	1564	694	2186	606	2724	506	3059	425	3484	298	4308	252	2464
2E		MI	927	694	1425	568	1679	474	1831	397	1981	267	2228	185	1438
4-#11	2.03	MA	1622	728	2373	622	2938	517	3307	431	3807	293	4675	238	2951
2E		MI	947	728	1520	582	1780	483	1936	399	2093	253	2322	153	1690
4-#14	2.92	MA	1771	809	2790	669	3451	551	3918	452	4624	288	5682	217	4127
2E		MI	1008	809	1729	626	2032	515	2208	412	2433	232	2670	95	2291
4-#18	5.19	MA	2102	1015	3796	791	4691	640	5403	507	6609	276	8018	151	6967
2E		MI	1142	1015	2209	744	2566	587	2800	438	3174	169	3371	-77	3366
6-#7	1.17	MA	1476	650	1938	584	2434	490	2720	416	3038	302	3751	263	1802
2L-3S		MI	828	650	1189	552	1400	462	1504	390	1579	281	1783	171	1087
6-#7	1.17	MA	1354	650	1747	589	2191	495	2426	420	2643	308	3205	219	1802
3L-2S		MI	892	650	1292	549	1531	461	1662	390	1789	279	2030	215	1080
6-#8	1.54	MA	1552	684	2125	603	2662	504	2992	425	3401	300	4235	258	2328
2L-3S		MI	847	684	1258	571	1482	475	1600	398	1698	276	1917	141	1374
6-#8	1.54	MA	1398	684	1874	610	2345	510	2608	430	2885	307	3527	200	2317
3L-2S		MI	926	684	1393	568	1652	474	1805	398	1968	274	2233	199	1368
6-#9	1.95	MA	1631	721	2327	625	2911	520	3289	434	3798	298	4756	253	2900
2L-3S		MI	866	721	1333	592	1569	490	1702	406	1825	271	2057	106	1675
6-#9	1.95	MA	1446	721	2012	633	2512	527	2807	440	3149	306	3873	179	2871
3L-2S		MI	961	721	1500	588	1782	489	1959	407	2158	268	2445	180	1676
6-#10	2.47	MA	1729	769	2583	653	3226	540	3666	447	4301	295	5412	245	3623
2L-3S		MI	890	769	1425	619	1679	509	1831	417	1981	263	2228	60	2043
6-#10	2.47	MA	1506	769	2186	663	2724	549	3059	454	3484	304	4308	151	3562
3L-2S		MI	1003	769	1634	615	1944	508	2152	419	2395	260	2705	154	2060
6-#11	3.04	MA	1810	820	2849	680	3540	559	4035	458	4788	290	5969	226	4338
2L-3S		MI	904	820	1520	642	1780	524	1936	421	2093	244	2322	-7	2320
6-#11	3.04	MA	1562	820	2373	691	2938	569	3307	466	3807	300	4675	111	4236
3L-2S		MI	1032	820	1766	639	2092	525	2309	425	2565	241	2853	108	2416
6-#14	4.38	MA	1705	942	2790	768	3451	625	3918	500	4624	296	5682	30	5604
3L-2S		MI	1123	942	2073	709	2467	576	2717	447	3077	212	3379	23	3289

RECTANGULAR TIED COLUMNS 14" x 22"

Short columns – no sidesway
Bending on major or minor axis



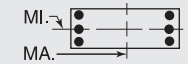
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#18	7.79	MA	2059	1251	3796	962	4691	765	5403	587	6609	283	8018	-197	7650
3L-2S		MI	1329	1251	2778	891	3263	689	3605	490	4193	120	4442	-233	4373
8-#6	1.14	MA	1474	648	1920	584	2418	491	2705	417	3022	304	3734	264	1771
2L-4S		MI	815	648	1149	554	1351	466	1448	394	1509	282	1716	172	1072
8-#6	1.14	MA	1384	648	1779	588	2239	494	2488	420	2730	307	3330	232	1771
3E		MI	845	648	1205	552	1427	463	1540	392	1633	283	1852	187	1067
8-#6	1.14	MA	1329	648	1680	592	2110	497	2323	424	2505	309	3046	213	1764
4L-2S		MI	893	648	1282	550	1524	462	1657	392	1790	282	2039	219	1063
8-#7	1.56	MA	1561	686	2130	606	2676	507	3013	426	3434	301	4297	261	2366
2L-4S		MI	833	686	1217	576	1429	482	1538	404	1623	277	1849	139	1392
8-#7	1.56	MA	1444	686	1938	611	2434	511	2720	430	3038	306	3751	217	2360
3E		MI	872	686	1292	574	1531	478	1662	401	1789	279	2030	159	1395
8-#7	1.56	MA	1374	686	1805	616	2259	516	2497	437	2733	309	3366	191	2330
4L-2S		MI	932	686	1396	571	1662	477	1821	401	1998	277	2278	203	1391
8-#8	2.05	MA	1659	731	2375	632	2979	526	3376	438	3918	298	4943	255	3062
2L-4S		MI	854	731	1295	603	1519	502	1643	415	1755	271	2000	99	1700
8-#8	2.05	MA	1514	731	2125	639	2662	531	2992	443	3401	305	4235	197	3042
3E		MI	902	731	1393	600	1652	497	1805	412	1968	273	2233	124	1766
8-#8	2.05	MA	1427	731	1949	646	2433	537	2700	452	3002	308	3735	163	2923
4L-2S		MI	976	731	1527	597	1822	495	2011	412	2238	271	2549	182	1767
8-#9	2.60	MA	1761	780	2642	662	3309	547	3771	452	4446	296	5640	248	3818
2L-4S		MI	875	780	1378	632	1616	523	1756	427	1894	263	2158	53	2003
8-#9	2.60	MA	1588	780	2327	670	2911	554	3289	458	3798	303	4756	174	3778
3E		MI	933	780	1500	628	1782	517	1959	424	2158	266	2445	83	2158
8-#9	2.60	MA	1485	780	2106	678	2623	561	2921	468	3295	307	4131	132	3497
4L-2S		MI	1022	780	1668	625	1994	516	2216	424	2492	263	2834	157	2170
8-#10	3.30	MA	1686	844	2583	710	3226	583	3666	476	4301	302	5412	144	4702
3E		MI	972	844	1634	666	1944	543	2152	439	2395	256	2705	29	2641
8-#10	3.30	MA	1558	844	2304	720	2862	592	3202	489	3668	305	4630	91	4207
4L-2S		MI	1077	844	1844	662	2210	542	2473	441	2808	253	3182	123	2672
8-#11	4.05	MA	1765	912	2849	749	3540	611	4035	493	4788	296	5969	99	5601
3E		MI	998	912	1766	699	2092	566	2309	447	2565	233	2853	-52	2830
8-#11	4.05	MA	1629	912	2513	760	3102	620	3476	507	4025	299	5048	36	4885
4L-2S		MI	1116	912	2013	696	2404	567	2682	451	3037	229	3384	63	3132
8-#14	5.84	MA	1813	1074	2987	866	3681	698	4155	558	4928	293	6196	-79	6064
4L-2S		MI	1237	1074	2417	792	2902	637	3226	482	3722	191	4089	-49	4062
10-#10	4.12	MA	1748	918	2701	767	3364	626	3809	511	4485	303	5733	84	5325
4L-3S		MI	1051	918	1844	712	2210	578	2473	461	2808	249	3182	-1	3181
10-#10	4.12	MA	1625	918	2451	777	3011	640	3392	518	3909	312	4954	29	4859
5L-2S		MI	1150	918	2054	708	2475	577	2794	463	3221	246	3659	92	3280
10-#11	5.06	MA	1843	1004	2989	818	3704	663	4204	534	5005	296	6341	24	6229
4L-3S		MI	1089	1004	2013	757	2404	608	2682	473	3037	221	3384	-97	3332
10-#11	5.06	MA	1702	1004	2687	829	3278	679	3701	541	4310	306	5428	-44	5373
5L-2S		MI	1199	1004	2259	754	2716	609	3054	477	3509	217	3915	18	3843
12-#10	4.95	MA	1801	993	2848	824	3513	675	3999	540	4726	309	6058	22	5982
5L-3S		MI	1129	993	2054	759	2475	612	2794	483	3221	242	3659	-32	3633
12-#10	4.95	MA	1654	993	2605	833	3194	683	3592	552	4164	313	5302	-46	5238
6L-2S		MI	1222	993	2264	755	2740	611	3115	485	3634	239	4136	61	3886
12-#11	6.08	MA	1909	1096	3163	886	3881	721	4429	568	5291	303	6721	-57	6619
5L-3S		MI	1179	1096	2259	814	2716	650	3054	499	3509	209	3915	-141	3826
14-#10	5.77	MA	1835	1068	3002	880	3695	718	4199	574	4981	310	6406	-54	6303
6L-3S		MI	1206	1068	2264	806	2740	646	3115	505	3634	235	4136	-63	4078

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis

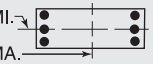


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#9	1.19	MA	1768	712	2312	641	2914	538	3263	456	3656	331	4528	288	2192
2E		MI	968	712	1423	595	1673	499	1810	422	1930	299	2173	225	1189
4-#10	1.51	MA	1847	744	2507	659	3151	551	3546	464	4033	329	5044	285	2738
2E		MI	998	744	1516	611	1783	511	1940	429	2086	293	2344	207	1454
4-#11	1.86	MA	1915	778	2719	675	3394	562	3827	470	4400	325	5481	274	3288
2E		MI	1017	778	1613	624	1886	519	2044	431	2198	278	2437	175	1710
4-#14	2.68	MA	2090	859	3190	722	3973	596	4517	491	5321	319	6659	258	4613
2E		MI	1078	859	1824	668	2138	551	2317	443	2537	257	2783	117	2316
4-#18	4.76	MA	2476	1065	4329	843	5379	684	6201	546	7572	307	9423	205	7831
2E		MI	1212	1065	2306	784	2673	622	2908	468	3277	193	3482	-56	3482
6-#7	1.07	MA	1744	700	2229	637	2825	535	3164	455	3531	334	4360	291	1997
2L-3S		MI	898	700	1278	596	1504	499	1612	423	1685	307	1900	193	1100
6-#7	1.07	MA	1605	700	2015	642	2554	540	2837	460	3090	339	3750	248	1996
3L-2S		MI	962	700	1382	593	1635	498	1770	423	1894	305	2147	237	1092
6-#8	1.41	MA	1831	734	2437	656	3080	549	3469	464	3937	331	4920	288	2584
2L-3S		MI	916	734	1348	614	1585	513	1708	431	1804	302	2033	163	1390
6-#8	1.41	MA	1656	734	2157	663	2726	556	3041	469	3361	339	4122	231	2573
3L-2S		MI	996	734	1483	611	1756	511	1913	431	2073	300	2350	221	1383
6-#9	1.79	MA	1923	771	2664	677	3359	565	3801	474	4381	329	5531	285	3224
2L-3S		MI	936	771	1423	635	1673	527	1810	439	1930	296	2173	129	1695
6-#9	1.79	MA	1712	771	2312	686	2914	573	3263	480	3656	338	4528	212	3195
3L-2S		MI	1031	771	1591	632	1886	526	2067	439	2264	294	2561	202	1693
6-#10	2.27	MA	2035	818	2950	705	3712	585	4224	486	4946	326	6307	281	4034
2L-3S		MI	959	818	1516	662	1783	546	1940	449	2086	288	2344	83	2069
6-#10	2.27	MA	1781	818	2507	716	3151	595	3546	494	4033	337	5044	188	3974
3L-2S		MI	1074	818	1726	658	2049	545	2261	451	2500	285	2821	176	2078
6-#11	2.79	MA	2133	870	3252	732	4069	604	4643	497	5499	321	6971	266	4844
2L-3S		MI	973	870	1613	684	1886	560	2044	453	2198	270	2437	15	2408
6-#11	2.79	MA	1841	870	2719	745	3394	615	3827	506	4400	333	5481	151	4741
3L-2S		MI	1103	870	1860	681	2197	561	2417	456	2670	266	2968	130	2439
6-#14	4.02	MA	2014	991	3190	822	3973	671	4517	542	5321	330	6659	77	6439
3L-2S		MI	1194	991	2168	751	2573	611	2825	478	3182	237	3493	45	3318
6-#18	7.14	MA	2422	1300	4329	1018	5379	814	6201	631	7572	320	9423	-129	9117
3L-2S		MI	1398	1300	2876	932	3370	724	3713	520	4296	144	4553	-212	4501
8-#6	1.05	MA	1741	698	2208	637	2807	535	3146	456	3511	335	4335	292	1961
2L-4S		MI	884	698	1238	598	1455	504	1555	427	1615	308	1834	195	1085
8-#6	1.05	MA	1639	698	2050	641	2607	539	2905	459	3186	339	3885	260	1961
3E		MI	915	698	1293	596	1530	501	1648	425	1739	309	1970	210	1080
8-#6	1.05	MA	1578	698	1941	645	2464	543	2722	464	2936	341	3573	242	1954
4L-2S		MI	963	698	1370	594	1627	499	1765	424	1895	308	2156	242	1074
8-#7	1.43	MA	1841	735	2443	659	3095	551	3491	466	3971	332	4970	289	2625
2L-4S		MI	902	735	1306	620	1533	520	1646	436	1729	303	1966	162	1411
8-#7	1.43	MA	1708	735	2229	664	2825	556	3164	470	3531	338	4360	246	2619
3E		MI	942	735	1382	618	1635	516	1770	433	1894	305	2147	181	1410
8-#7	1.43	MA	1630	735	2080	670	2631	561	2916	477	3192	341	3936	220	2589
4L-2S		MI	1003	735	1485	615	1765	514	1929	433	2104	303	2395	225	1405
8-#8	1.88	MA	1953	780	2717	685	3434	571	3897	478	4513	330	5718	286	3403
2L-4S		MI	922	780	1385	646	1623	539	1751	448	1860	297	2117	122	1742
8-#8	1.88	MA	1788	780	2437	692	3080	577	3469	483	3937	337	4920	229	3383
3E		MI	971	780	1483	643	1756	534	1913	444	2073	299	2350	146	1785
8-#8	1.88	MA	1691	780	2242	699	2826	583	3144	492	3493	341	4362	195	3300
4L-2S		MI	1047	780	1617	640	1926	532	2119	444	2343	297	2666	204	1783
8-#9	2.38	MA	2071	830	3015	714	3804	592	4339	491	5106	327	6535	282	4250
2L-4S		MI	944	830	1468	675	1720	560	1865	460	2000	289	2274	76	2051
8-#9	2.38	MA	1874	830	2664	723	3359	600	3801	498	4381	336	5531	209	4210
3E		MI	1002	830	1591	672	1886	554	2067	456	2264	291	2561	106	2181
8-#9	2.38	MA	1757	830	2418	732	3039	607	3392	509	3822	340	4827	166	3949
4L-2S		MI	1093	830	1759	668	2098	553	2324	457	2597	289	2950	179	2189

RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

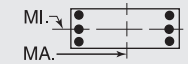
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	3.02	MA	1981	893	2950	763	3712	629	4224	516	4946	334	6307	184	5251
3E		MI	1041	893	1726	709	2049	580	2261	471	2500	281	2821	52	2669
8-#10	3.02	MA	1842	893	2641	774	3308	639	3708	530	4241	339	5417	129	4753
4L-2S		MI	1148	893	1936	705	2314	579	2582	473	2913	278	3298	145	2693
8-#11	3.71	MA	2081	961	3252	802	4069	657	4643	533	5499	330	6971	143	6275
3E		MI	1067	961	1860	742	2197	602	2417	479	2670	258	2968	-30	2955
8-#11	3.71	MA	1916	961	2878	815	3581	668	4020	549	4647	335	5917	78	5529
4L-2S		MI	1187	961	2106	739	2509	603	2790	482	3142	254	3498	85	3157
8-#14	5.36	MA	2139	1124	3414	922	4235	747	4788	602	5669	330	7262	-30	7200
4L-2S		MI	1308	1124	2512	834	3008	672	3334	513	3826	216	4203	-27	4190
10-#10	3.78	MA	2048	968	3084	821	3869	673	4386	552	5154	337	6681	125	6009
4L-3S		MI	1121	968	1936	755	2314	615	2582	493	2913	274	3298	21	3248
10-#10	3.78	MA	1906	968	2808	832	3477	688	3924	560	4515	348	5789	71	5534
5L-2S		MI	1221	968	2145	752	2579	614	2903	495	3326	271	3775	114	3302
10-#11	4.64	MA	2170	1053	3411	872	4256	710	4836	576	5746	331	7406	70	7042
4L-3S		MI	1158	1053	2106	799	2509	644	2790	505	3142	246	3498	-75	3460
10-#11	4.64	MA	2003	1053	3077	885	3782	728	4276	585	4973	343	6354	2	6346
5L-2S		MI	1270	1053	2353	796	2821	645	3163	508	3614	243	4029	40	3870
10-#14	6.70	MA	2247	1256	3694	1022	4518	832	5150	653	6127	341	7874	-143	7565
5L-2S		MI	1423	1256	2855	917	3443	733	3843	548	4470	196	4913	-99	4848
12-#10	4.54	MA	2115	1043	3251	879	4038	723	4602	582	5428	345	7052	67	6798
5L-3S		MI	1199	1043	2145	802	2579	649	2903	515	3326	267	3775	-10	3767
12-#10	4.54	MA	1938	1043	2975	887	3684	732	4151	596	4804	350	6191	-4	6184
6L-2S		MI	1294	1043	2355	798	2845	648	3224	517	3739	264	4251	83	3909
12-#11	5.57	MA	2240	1145	3610	943	4457	770	5093	612	6072	340	7844	-6	7831
5L-3S		MI	1247	1145	2353	856	2821	687	3163	531	3614	234	4029	-119	3958
12-#11	5.57	MA	2048	1145	3283	954	4027	781	4546	628	5316	345	6825	-90	6680
6L-2S		MI	1353	1145	2599	854	3133	687	3535	534	4086	231	4560	-5	4557
14-#10	5.29	MA	2154	1117	3418	934	4245	767	4829	618	5717	347	7455	-8	7428
6L-3S		MI	1275	1117	2355	849	2845	683	3224	537	3739	260	4251	-41	4216
14-#11	6.50	MA	2291	1237	3816	1011	4702	823	5362	654	6415	341	8314	-99	8099
6L-3S		MI	1336	1237	2599	914	3133	729	3535	557	4086	222	4560	-164	4448

RECTANGULAR TIED COLUMNS 14" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.10	MA	2060	761	2628	693	3340	583	3748	495	4195	362	5191	316	2408
2E		MI	1038	761	1514	638	1777	536	1919	454	2035	325	2289	248	1202
4-#10	1.40	MA	2150	793	2844	711	3603	596	4061	503	4612	360	5765	313	3012
2E		MI	1068	793	1607	655	1888	547	2048	461	2191	318	2460	229	1470
4-#11	1.71	MA	2229	827	3081	727	3875	607	4377	509	5023	356	6325	309	3625
2E		MI	1087	827	1706	666	1991	555	2153	462	2302	303	2551	197	1729
4-#14	2.47	MA	2430	908	3605	774	4519	641	5145	531	6049	350	7676	296	5099
2E		MI	1148	908	1919	710	2244	586	2425	475	2641	282	2897	139	2340
4-#18	4.40	MA	2874	1114	4878	896	6091	729	7027	586	8565	338	10873	254	8695
2E		MI	1282	1114	2403	825	2780	657	3016	498	3380	217	3594	-35	3596
6-#8	1.30	MA	2131	783	2765	709	3523	594	3974	503	4504	362	5622	315	2840
2L-3S		MI	986	783	1438	658	1689	550	1816	463	1909	328	2150	186	1405
6-#8	1.30	MA	1935	783	2456	716	3132	601	3502	509	3868	371	4741	260	2829
3L-2S		MI	1066	783	1573	655	1859	548	2021	463	2179	326	2466	244	1397
6-#9	1.65	MA	2235	820	3016	730	3831	610	4343	513	4995	360	6299	313	3548
2L-3S		MI	1005	820	1514	678	1777	564	1919	471	2035	322	2289	151	1714
6-#9	1.65	MA	1998	820	2628	739	3340	618	3748	520	4195	370	5191	242	3519
3L-2S		MI	1102	820	1682	675	1990	563	2175	472	2369	320	2678	225	1709
6-#10	2.09	MA	2363	868	3334	758	4223	630	4811	525	5622	357	7163	309	4446
2L-3S		MI	1028	868	1607	705	1888	583	2048	482	2191	314	2460	105	2092
6-#10	2.09	MA	2077	868	2844	770	3603	640	4061	534	4612	369	5765	218	4385
3L-2S		MI	1145	868	1817	701	2153	582	2369	483	2605	311	2937	199	2097

RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis



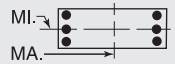
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	2.57	MA	2477	919	3672	785	4623	649	5281	536	6241	352	8010	304	5349
2L-3S		MI	1042	919	1706	727	1991	596	2153	485	2302	295	2551	37	2444
6-#11	2.57	MA	2147	919	3081	798	3875	661	4377	547	5023	366	6325	189	5247
3L-2S		MI	1174	919	1953	724	2303	597	2525	488	2774	291	3082	152	2462
6-#14	3.71	MA	2345	1041	3605	876	4519	718	5145	583	6049	363	7676	121	7289
3L-2S		MI	1264	1041	2262	793	2679	647	2934	509	3286	261	3607	67	3345
6-#18	6.59	MA	2808	1350	4878	1073	6091	863	7027	674	8565	356	10873	-69	10674
3L-2S		MI	1468	1350	2973	972	3477	759	3821	550	4399	168	4665	-190	4627
8-#7	1.32	MA	2142	785	2771	711	3539	596	3998	505	4540	363	5676	316	2885
2L-4S		MI	970	785	1396	664	1636	557	1754	469	1834	329	2083	185	1428
8-#7	1.32	MA	1993	785	2535	717	3240	602	3637	509	4054	370	5003	274	2878
3E		MI	1011	785	1471	662	1738	553	1878	466	2000	331	2265	204	1424
8-#7	1.32	MA	1905	785	2372	723	3027	607	3365	517	3682	373	4540	249	2848
4L-2S		MI	1073	785	1574	659	1869	552	2037	466	2209	329	2512	248	1418
8-#8	1.74	MA	2269	830	3074	738	3913	615	4447	517	5140	361	6503	313	3744
2L-4S		MI	991	830	1475	690	1727	576	1859	480	1965	323	2234	144	1784
8-#8	1.74	MA	2084	830	2765	745	3523	622	3974	523	4504	369	5622	258	3725
3E		MI	1041	830	1573	687	1859	571	2021	477	2179	325	2466	169	1803
8-#8	1.74	MA	1974	830	2551	753	3243	629	3617	532	4015	373	5013	224	3651
4L-2S		MI	1117	830	1707	684	2029	570	2227	477	2449	323	2783	227	1799
8-#9	2.20	MA	2403	879	3405	767	4323	637	4937	530	5796	358	7407	309	4682
2L-4S		MI	1012	879	1559	719	1824	597	1973	492	2105	315	2391	98	2097
8-#9	2.20	MA	2181	879	3016	776	3831	645	4343	537	4995	368	6299	239	4642
3E		MI	1072	879	1682	715	1990	591	2175	488	2369	317	2678	129	2203
8-#9	2.20	MA	2050	879	2747	786	3479	654	3892	549	4380	373	5531	196	4410
4L-2S		MI	1164	879	1849	712	2202	590	2432	489	2703	315	3066	202	2206
8-#10	2.79	MA	2302	943	3334	816	4223	675	4811	556	5622	367	7163	214	5800
3E		MI	1110	943	1817	752	2153	617	2369	504	2605	307	2937	74	2695
8-#10	2.79	MA	2146	943	2993	828	3779	685	4243	571	4845	373	6190	160	5310
4L-2S		MI	1220	943	2027	748	2418	616	2690	505	3018	304	3414	168	2713
8-#11	3.43	MA	2410	1011	3672	856	4623	703	5281	574	6241	362	8010	185	6949
3E		MI	1135	1011	1953	784	2303	638	2525	511	2774	283	3082	-8	3079
8-#11	3.43	MA	2232	1011	3259	870	4084	715	4593	591	5301	369	6823	117	6184
4L-2S		MI	1258	1011	2199	781	2614	639	2898	514	3246	279	3613	107	3182
8-#14	4.95	MA	2486	1173	3857	978	4814	795	5450	645	6441	367	8370	15	8290
4L-2S		MI	1379	1173	2606	876	3114	708	3442	544	3930	241	4316	-6	4314
10-#10	3.49	MA	2378	1017	3484	875	4399	720	4993	593	5855	370	7588	156	6703
4L-3S		MI	1190	1017	2027	799	2418	651	2690	525	3018	300	3414	43	3294
10-#10	3.49	MA	2214	1017	3180	887	3968	736	4484	602	5151	382	6609	105	6227
5L-2S		MI	1293	1017	2237	795	2684	650	3011	527	3431	297	3890	137	3324
10-#11	4.29	MA	2519	1103	3850	927	4832	757	5497	618	6518	365	8509	112	7866
4L-3S		MI	1226	1103	2199	841	2614	681	2898	536	3246	271	3613	-52	3588
10-#11	4.29	MA	2315	1103	3482	941	4310	776	4881	628	5666	379	7319	46	7148
5L-2S		MI	1342	1103	2446	839	2926	681	3271	540	3718	268	4144	62	3896
10-#14	6.18	MA	2599	1306	4172	1079	5133	882	5856	698	6956	380	9066	-91	8758
5L-2S		MI	1494	1306	2950	959	3549	769	3951	579	4574	221	5026	-78	4981
12-#10	4.19	MA	2439	1092	3670	934	4588	770	5234	624	6161	380	8007	101	7633
5L-3S		MI	1268	1092	2237	845	2684	686	3011	547	3431	293	3890	12	3859
12-#10	4.19	MA	2251	1092	3360	942	4199	781	4738	639	5475	386	7067	31	6925
6L-2S		MI	1365	1092	2447	842	2949	685	3332	549	3844	290	4367	106	3931
12-#11	5.14	MA	2592	1195	4073	998	5058	818	5785	655	6883	376	9005	41	8842
5L-3S		MI	1316	1195	2446	899	2926	723	3271	562	3718	259	4144	-97	4088

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

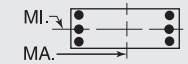
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#11	5.14	MA	2376	1195	3704	1009	4586	830	5183	672	6052	382	7857	-46	7730
6L-2S		MI	1425	1195	2692	896	3238	724	3643	566	4190	256	4675	17	4606
14-#10	4.88	MA	2480	1167	3850	988	4819	815	5488	661	6484	383	8465	27	8341
6L-3S		MI	1345	1167	2447	892	2949	720	3332	569	3844	286	4367	-19	4352
14-#10	4.88	MA	2324	1167	3497	1002	4430	824	5008	670	5817	395	7537	-16	7499
7L-2S		MI	1437	1167	2656	888	3215	719	3653	571	4258	283	4844	75	4537
14-#11	6.00	MA	2649	1286	4295	1066	5333	872	6087	699	7269	379	9542	-51	9342
6L-3S		MI	1405	1286	2692	956	3238	765	3643	588	4190	248	4675	-142	4582
16-#10	5.58	MA	2572	1242	3988	1048	5050	858	5758	692	6826	393	8935	-20	8866
7L-3S		MI	1421	1242	2656	939	3215	754	3653	591	4258	279	4844	-50	4798

RECTANGULAR TIED COLUMNS 14" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#9	1.02	MA	2372	811	2959	746	3791	627	4262	534	4764	393	5891	343	2624
2E		MI	1108	811	1604	682	1882	573	2027	487	2140	350	2406	270	1216
4-#10	1.30	MA	2473	843	3197	764	4080	640	4606	542	5223	391	6522	340	3287
2E		MI	1138	843	1699	698	1992	584	2156	493	2296	344	2576	252	1485
4-#11	1.59	MA	2564	877	3458	780	4381	652	4955	549	5678	387	7141	336	3962
2E		MI	1157	877	1800	709	2096	591	2261	494	2406	328	2666	219	1748
4-#14	2.30	MA	2791	958	4036	827	5090	686	5802	570	6808	382	8699	330	5585
2E		MI	1219	958	2013	752	2349	622	2533	506	2745	306	3010	160	2363
4-#18	4.08	MA	3297	1164	5443	948	6828	774	7882	625	9589	369	12365	299	9559
2E		MI	1352	1164	2500	866	2886	692	3125	529	3483	241	3706	-14	3707
6-#8	1.21	MA	2452	833	3109	761	3990	639	4508	542	5101	394	6361	343	3096
2L-3S		MI	1055	833	1528	702	1793	587	1924	495	2014	354	2267	209	1420
6-#8	1.21	MA	2234	833	2771	769	3563	646	3991	549	4405	402	5397	289	3085
3L-2S		MI	1136	833	1662	699	1963	586	2129	496	2284	352	2583	267	1410
6-#9	1.53	MA	2569	870	3384	783	4329	654	4913	552	5641	391	7104	340	3872
2L-3S		MI	1074	870	1604	722	1882	601	2027	503	2140	348	2406	174	1732
6-#9	1.53	MA	2305	870	2959	793	3791	664	4262	560	4764	402	5891	271	3843
3L-2S		MI	1172	870	1772	718	2094	600	2283	504	2474	345	2794	247	1724
6-#10	1.94	MA	2712	917	3733	811	4759	675	5427	564	6329	388	8053	336	4857
2L-3S		MI	1097	917	1699	748	1992	620	2156	514	2296	339	2576	128	2115
6-#10	1.94	MA	2393	917	3197	823	4080	686	4606	574	5223	401	6522	248	4797
3L-2S		MI	1215	917	1909	745	2257	618	2477	515	2710	337	3053	221	2114
6-#11	2.39	MA	2842	969	4106	837	5201	694	5947	576	7013	383	8990	331	5855
2L-3S		MI	1110	969	1800	769	2096	632	2261	516	2406	320	2666	59	2473
6-#11	2.39	MA	2473	969	3458	852	4381	707	4955	587	5678	398	7141	220	5752
3L-2S		MI	1244	969	2046	766	2408	633	2634	520	2879	316	3197	174	2483
6-#14	3.44	MA	2683	1090	4036	930	5090	764	5802	624	6808	397	8699	159	8018
3L-2S		MI	1335	1090	2357	835	2784	683	3042	540	3390	286	3720	88	3372
6-#18	6.12	MA	3216	1399	5443	1128	6828	910	7882	717	9589	392	12365	-14	12316
3L-2S		MI	1538	1399	3070	1013	3583	794	3929	581	4502	193	4777	-169	4750
8-#7	1.22	MA	2463	834	3115	764	4007	641	4534	544	5140	395	6418	343	3144
2L-4S		MI	1039	834	1485	708	1740	595	1862	502	1940	355	2200	208	1443
8-#7	1.22	MA	2298	834	2857	770	3681	647	4139	549	4609	401	5682	303	3137
3E		MI	1080	834	1560	706	1842	591	1986	499	2105	357	2382	227	1438
8-#7	1.22	MA	2201	834	2679	776	3448	652	3842	557	4202	405	5181	278	3107
4L-2S		MI	1143	834	1664	703	1972	589	2145	499	2315	355	2629	271	1431
8-#8	1.61	MA	2606	879	3447	790	4418	660	5025	556	5797	392	7325	340	4086
2L-4S		MI	1060	879	1565	734	1830	613	1967	512	2071	349	2350	167	1816
8-#8	1.61	MA	2400	879	3109	798	3990	668	4508	562	5101	400	6361	286	4066
3E		MI	1110	879	1662	731	1963	608	2129	509	2284	350	2583	192	1819
8-#8	1.61	MA	2278	879	2876	806	3685	675	4119	572	4569	406	5702	253	3992
4L-2S		MI	1188	879	1797	728	2133	607	2335	509	2554	349	2900	250	1814
8-#9	2.04	MA	2756	929	3810	819	4867	682	5563	569	6517	389	8318	337	5114
2L-4S		MI	1081	929	1650	762	1928	634	2081	524	2210	341	2507	121	2142

RECTANGULAR TIED COLUMNS 14" x 28"

Short columns – no sidesway
Bending on major or minor axis



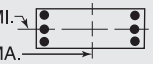
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#9	2.04	MA	2508	929	3384	829	4329	691	4913	577	5641	400	7104	268	5074
3E		MI	1141	929	1772	759	2094	628	2283	521	2474	343	2794	151	2223
8-#9	2.04	MA	2363	929	3091	839	3945	700	4421	590	4969	406	6272	226	4881
4L-2S		MI	1234	929	1940	755	2306	627	2540	521	2808	341	3183	224	2224
8-#10	2.59	MA	2644	992	3733	870	4759	720	5427	596	6329	399	8053	244	6348
3E		MI	1180	992	1909	795	2257	654	2477	536	2710	332	3053	97	2720
8-#10	2.59	MA	2471	992	3362	882	4274	732	4807	612	5480	406	6998	190	5876
4L-2S		MI	1291	992	2118	791	2523	653	2798	537	3123	330	3529	190	2733
8-#11	3.18	MA	2767	1060	4106	909	5201	749	5947	614	7013	395	8990	215	7623
3E		MI	1204	1060	2046	826	2408	675	2634	542	2879	308	3197	14	3165
8-#11	3.18	MA	2568	1060	3656	924	4613	762	5195	632	5986	403	7703	148	6850
4L-2S		MI	1329	1060	2293	824	2720	675	3006	546	3351	305	3728	129	3206
8-#14	4.59	MA	2834	1223	4316	1033	5418	843	6141	688	7244	402	9484	55	9188
4L-2S		MI	1450	1223	2701	918	3219	744	3551	575	4034	266	4430	16	4367
10-#10	3.24	MA	2728	1067	3899	929	4953	766	5628	634	6586	403	8530	187	7408
4L-3S		MI	1260	1067	2118	842	2523	688	2798	558	3123	325	3529	66	3321
10-#10	3.24	MA	2543	1067	3569	941	4484	783	5074	644	5819	417	7465	138	6879
5L-2S		MI	1364	1067	2328	838	2788	687	3119	559	3536	323	4006	159	3345
10-#11	3.98	MA	2872	1152	4304	981	5433	804	6186	659	7321	399	9552	143	8703
4L-3S		MI	1295	1152	2293	884	2720	717	3006	568	3351	296	3728	-30	3714
10-#11	3.98	MA	2657	1152	3903	996	4864	824	5514	670	6391	414	8258	80	7969
5L-2S		MI	1413	1152	2539	881	3031	718	3379	571	3823	293	4258	84	3921
10-#14	5.74	MA	2973	1355	4665	1136	5773	931	6592	742	7816	417	10264	-46	10107
5L-2S		MI	1564	1355	3045	1001	3654	805	4059	610	4678	245	5140	-56	5110
12-#10	3.89	MA	2793	1142	4105	988	5163	817	5895	666	6925	414	8997	134	8437
5L-3S		MI	1338	1142	2328	888	2788	723	3119	580	3536	318	4006	35	3918
12-#10	3.89	MA	2585	1142	3760	996	4739	828	5355	681	6177	421	7978	65	7654
6L-2S		MI	1437	1142	2538	885	3054	722	3440	581	3949	316	4483	128	3954
12-#11	4.78	MA	2965	1244	4551	1053	5684	866	6506	697	7726	411	10107	76	9836
5L-3S		MI	1385	1244	2539	941	3031	759	3379	594	3823	284	4258	-75	4217
12-#11	4.78	MA	2710	1244	4140	1063	5169	879	5850	715	6818	419	8863	-10	8828
6L-2S		MI	1496	1244	2786	938	3343	760	3752	597	4295	281	4789	39	4633
12-#14	6.89	MA	3071	1488	5009	1234	6204	1010	7067	806	8421	422	11111	-178	10563
6L-2S		MI	1679	1488	3389	1083	4089	865	4568	645	5323	225	5850	-128	5764
14-#10	4.54	MA	2839	1216	4297	1043	5418	863	6176	703	7283	418	9509	61	9205
6L-3S		MI	1415	1216	2538	935	3054	757	3440	601	3949	311	4483	4	4473
14-#10	4.54	MA	2665	1216	3955	1051	4985	871	5653	713	6555	432	8502	20	8423
7L-2S		MI	1509	1216	2748	931	3319	756	3761	603	4363	308	4960	97	4560
14-#11	5.57	MA	3028	1336	4789	1121	5989	921	6842	742	8154	415	10712	-15	10639
6L-3S		MI	1473	1336	2786	999	3343	801	3752	620	4295	273	4789	-120	4714
14-#11	5.57	MA	2828	1336	4323	1137	5474	932	6206	753	7271	430	9485	-69	9304
7L-2S		MI	1579	1336	3032	996	3655	802	4124	623	4767	269	5320	-6	5316
16-#10	5.18	MA	2923	1291	4492	1097	5664	905	6475	735	7661	429	10034	16	9970
7L-3S		MI	1491	1291	2748	982	3319	791	3761	623	4363	304	4960	-27	4936
16-#10	5.18	MA	2767	1291	4115	1112	5200	919	5956	745	6935	436	9064	-38	8969
8L-2S		MI	1581	1291	2958	978	3584	790	4082	625	4776	301	5437	66	5165
16-#11	6.37	MA	3138	1428	4971	1194	6294	974	7198	780	8606	427	11334	-73	11051
7L-3S		MI	1561	1428	3032	1056	3655	843	4124	646	4767	261	5320	-165	5205
18-#10	5.83	MA	3035	1366	4652	1159	5880	953	6777	766	8041	434	10595	-42	10452
8L-3S		MI	1566	1366	2958	1029	3584	826	4082	645	4776	297	5437	-58	5380

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

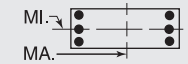
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.41	MA	888	559	1275	478	1543	400	1700	337	1885	239	2205	188	1234
2L-3S		MI	812	559	1149	481	1384	402	1508	339	1627	242	1884	144	1236
6-#8	1.85	MA	932	592	1395	497	1690	413	1875	345	2119	237	2477	177	1577
2L-3S		MI	836	592	1232	501	1483	416	1625	347	1782	240	2064	119	1572
6-#9	2.34	MA	976	629	1525	518	1849	429	2065	355	2371	235	2765	163	1947
2L-3S		MI	864	629	1321	523	1590	432	1752	357	1950	237	2255	89	1928
6-#10	2.98	MA	1031	677	1689	546	2049	449	2304	367	2686	231	3122	143	2410
2L-3S		MI	897	677	1432	552	1724	453	1912	369	2159	233	2492	50	2365
6-#11	3.66	MA	1071	728	1851	572	2237	467	2524	378	2932	217	3370	108	2848
2L-3S		MI	921	728	1547	578	1853	470	2059	378	2322	221	2653	-6	2649
6-#14	5.27	MA	1191	850	2232	644	2709	520	3088	411	3625	198	4136	44	3930
2L-3S		MI	998	850	1806	651	2169	522	2435	408	2783	203	3161	-122	3077
8-#7	1.88	MA	939	594	1400	500	1701	416	1892	347	2144	238	2525	180	1605
2L-4S		MI	820	594	1185	507	1426	421	1551	353	1682	240	1973	114	1564
8-#8	2.47	MA	994	639	1559	526	1896	435	2125	359	2455	235	2890	165	2057
2L-4S		MI	851	639	1278	534	1537	441	1681	366	1853	237	2178	79	1908
8-#9	3.13	MA	1052	688	1730	555	2107	456	2378	372	2793	232	3275	146	2543
2L-4S		MI	883	688	1378	565	1649	467	1821	380	2039	233	2395	38	2268
8-#10	3.97	MA	1123	752	1945	592	2373	483	2697	389	3213	228	3752	121	3154
2L-4S		MI	924	752	1503	605	1798	496	1997	398	2269	228	2663	-15	2655

RECTANGULAR TIED COLUMNS 16" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.10	MA	1092	602	1493	528	1823	443	2008	377	2202	274	2608	227	1263
2E		MI	958	602	1345	519	1616	436	1766	370	1920	269	2219	215	1106
4-#9	1.39	MA	1132	627	1599	541	1951	453	2158	382	2402	272	2850	220	1560
2E		MI	990	627	1435	532	1724	445	1893	376	2088	267	2410	205	1360
4-#10	1.76	MA	1180	659	1732	559	2111	466	2349	390	2656	270	3152	210	1934
2E		MI	1028	659	1547	550	1859	458	2052	383	2297	264	2646	192	1678
4-#11	2.17	MA	1217	693	1872	574	2269	476	2530	396	2890	265	3379	190	2300
2E		MI	1056	693	1664	564	1988	468	2200	388	2460	253	2806	167	1985
4-#14	3.13	MA	1319	774	2185	621	2651	510	2985	416	3486	258	4050	156	3184
2E		MI	1137	774	1925	610	2305	501	2576	409	2920	239	3313	123	2725
4-#18	5.56	MA	1549	980	2926	741	3562	598	4073	471	4831	226	5546	51	5276
2E		MI	1318	980	2535	730	3051	588	3430	454	3959	195	4403	-10	4395
6-#7	1.25	MA	1118	615	1543	538	1893	451	2095	382	2323	275	2776	228	1428
2L-3S		MI	902	615	1261	533	1517	446	1649	377	1766	272	2040	171	1252
6-#7	1.25	MA	1026	615	1395	542	1706	454	1869	384	2019	278	2381	184	1431
3L-2S		MI	980	615	1387	529	1676	443	1841	375	2024	270	2360	215	1248
6-#8	1.65	MA	1173	649	1686	557	2067	465	2302	390	2599	273	3118	219	1833
2L-3S		MI	927	649	1345	552	1616	460	1766	385	1920	270	2219	145	1593
6-#8	1.65	MA	1057	649	1493	562	1823	469	2008	393	2202	277	2608	161	1828
3L-2S		MI	1024	649	1508	548	1823	457	2016	384	2257	267	2632	203	1594
6-#9	2.08	MA	1230	686	1840	578	2256	480	2528	400	2900	270	3483	208	2271
2L-3S		MI	955	686	1435	574	1724	476	1893	394	2088	267	2410	116	1954
6-#9	2.08	MA	1091	686	1599	585	1951	485	2158	403	2402	275	2850	135	2252
3L-2S		MI	1069	686	1639	569	1983	472	2206	393	2510	265	2920	189	1966
6-#10	2.65	MA	1298	733	2035	606	2495	500	2813	412	3280	267	3938	194	2822
2L-3S		MI	988	733	1547	602	1859	496	2052	407	2297	263	2646	76	2398
6-#10	2.65	MA	1135	733	1732	614	2111	506	2349	416	2656	273	3152	100	2776
3L-2S		MI	1124	733	1803	596	2183	492	2445	405	2824	261	3276	170	2431
6-#11	3.25	MA	1351	785	2233	632	2726	519	3083	423	3635	262	4286	165	3353
2L-3S		MI	1011	785	1664	628	1988	513	2200	415	2460	250	2806	19	2765
6-#11	3.25	MA	1167	785	1872	640	2269	524	2530	426	2890	266	3379	51	3261
3L-2S		MI	1165	785	1968	622	2373	510	2665	415	3070	247	3523	134	2873
6-#14	4.69	MA	1500	907	2694	704	3295	571	3764	455	4530	252	5296	115	4659
2L-3S		MI	1086	907	1925	700	2305	564	2576	445	2920	232	3313	-96	3249
6-#14	4.69	MA	1265	907	2185	714	2651	577	2985	458	3486	257	4050	-50	3996
3L-2S		MI	1285	907	2352	693	2845	562	3229	447	3763	227	4287	69	3960

RECTANGULAR TIED COLUMNS 16" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#7	1.67	MA	1180	650	1690	560	2079	467	2321	392	2627	274	3172	222	1864
2L-4S		MI	910	650	1297	558	1559	465	1692	391	1821	270	2129	141	1608
8-#7	1.67	MA	1093	650	1543	564	1893	470	2095	395	2323	277	2776	178	1861
3E		MI	957	650	1387	555	1676	462	1841	387	2024	271	2360	163	1621
8-#7	1.67	MA	1039	650	1438	568	1756	474	1921	400	2085	278	2494	154	1842
4L-2S		MI	1031	650	1512	551	1835	460	2033	386	2283	269	2681	207	1620
8-#8	2.19	MA	1251	695	1878	586	2311	486	2597	404	2996	271	3629	211	2398
2L-4S		MI	941	695	1391	586	1670	484	1821	404	1992	267	2333	105	1965
8-#8	2.19	MA	1142	695	1686	591	2067	490	2302	407	2599	275	3118	153	2384
3E		MI	998	695	1508	581	1823	481	2016	399	2257	268	2632	133	2066
8-#8	2.19	MA	1075	695	1549	597	1889	494	2075	413	2289	276	2753	122	2267
4L-2S		MI	1088	695	1672	577	2030	478	2266	397	2594	266	3045	191	2075
8-#9	2.78	MA	1323	745	2082	615	2561	507	2897	417	3397	268	4116	197	2975
2L-4S		MI	972	745	1492	616	1783	511	1961	418	2177	263	2549	65	2332
8-#9	2.78	MA	1197	745	1840	621	2256	512	2528	420	2900	273	3483	123	2945
3E		MI	1039	745	1639	611	1983	503	2206	412	2510	265	2920	99	2541
8-#9	2.78	MA	1118	745	1668	628	2032	517	2242	428	2510	273	3029	86	2700
4L-2S		MI	1146	745	1844	606	2241	499	2519	410	2931	263	3430	173	2564
8-#10	3.53	MA	1411	808	2338	652	2879	534	3277	434	3905	264	4724	178	3703
2L-4S		MI	1012	808	1618	655	1932	540	2138	436	2408	258	2817	11	2781
8-#10	3.53	MA	1262	808	2035	660	2495	540	2813	438	3280	270	3938	84	3643
3E		MI	1092	808	1803	649	2183	530	2445	429	2824	260	3276	54	3129
8-#10	3.53	MA	1170	808	1818	668	2213	546	2454	447	2790	270	3372	37	3234
4L-2S		MI	1217	808	2060	643	2508	526	2837	427	3351	258	3906	147	3177
8-#11	4.33	MA	1314	876	2233	698	2726	566	3083	453	3635	263	4286	26	4217
3E		MI	1131	876	1968	685	2373	555	2665	442	3070	244	3523	-14	3510
8-#11	4.33	MA	1209	876	1973	706	2374	579	2652	463	3048	260	3629	-28	3608
4L-2S		MI	1272	876	2272	679	2757	552	3130	442	3680	240	4239	101	3754
8-#14	6.25	MA	1468	1039	2694	797	3295	638	3764	497	4530	251	5296	-91	5168
3E		MI	1252	1039	2352	783	2845	625	3229	484	3763	220	4287	-150	4156
10-#10	4.41	MA	1384	883	2338	707	2879	575	3277	460	3905	267	4724	68	4511
3L-4S		MI	1121	883	1875	702	2257	574	2530	458	2934	254	3447	-11	3438
10-#10	4.41	MA	1303	883	2122	715	2597	580	2917	469	3415	267	4159	21	4076
4L-3S		MI	1192	883	2060	696	2508	565	2837	450	3351	257	3906	32	3823
10-#10	4.41	MA	1222	883	1927	723	2322	592	2593	473	2967	272	3603	-35	3578
5L-2S		MI	1308	883	2317	690	2832	561	3230	449	3878	254	4537	125	3920
10-#11	5.42	MA	1364	968	2335	763	2831	621	3205	489	3792	257	4535	-53	4472
4L-3S		MI	1247	968	2272	742	2757	597	3130	469	3680	238	4239	-47	4187
12-#10	5.29	MA	1430	958	2425	762	2980	615	3381	491	4040	264	4945	5	4923
4E		MI	1226	958	2131	749	2581	608	2923	480	3461	251	4077	-33	4041
12-#10	5.29	MA	1352	958	2230	769	2706	626	3057	495	3592	269	4389	-51	4334
5L-3S		MI	1290	958	2317	743	2832	599	3230	472	3878	254	4537	9	4510

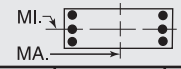
RECTANGULAR TIED COLUMNS 16" x 20"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.25	MA	1389	683	1895	601	2340	504	2598	427	2890	308	3489	259	1776
2E		MI	1081	683	1549	583	1858	489	2033	413	2227	297	2564	232	1376
4-#10	1.59	MA	1448	715	2049	619	2526	517	2819	435	3184	306	3857	251	2208
2E		MI	1120	715	1662	600	1993	501	2193	421	2436	294	2800	218	1695
4-#11	1.95	MA	1496	749	2215	635	2713	528	3034	440	3463	301	4153	234	2637
2E		MI	1148	749	1781	614	2124	510	2341	425	2597	283	2959	193	2006
4-#14	2.81	MA	1622	831	2581	681	3161	561	3567	461	4175	295	4990	207	3670
2E		MI	1230	831	2044	660	2442	543	2718	445	3057	268	3464	149	2751
4-#18	5.00	MA	1903	1037	3457	801	4238	649	4855	515	5885	281	6901	123	6140
2E		MI	1411	1037	2657	778	3189	629	3571	490	4096	223	4553	15	4485

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#7	1.13	MA	1372	672	1829	598	2271	502	2522	426	2795	311	3393	265	1623
2L-3S		MI	993	672	1374	584	1650	490	1789	415	1904	303	2195	198	1267
6-#7	1.13	MA	1264	672	1659	603	2056	506	2263	430	2446	315	2923	221	1625
3L-2S		MI	1071	672	1499	580	1809	487	1981	414	2163	300	2516	242	1261
6-#8	1.48	MA	1438	705	1994	617	2473	516	2762	435	3115	308	3805	259	2089
2L-3S		MI	1017	705	1458	603	1750	504	1906	423	2059	300	2374	172	1612
6-#8	1.48	MA	1302	705	1773	623	2192	521	2423	439	2658	314	3196	201	2084
3L-2S		MI	1116	705	1621	599	1957	501	2157	422	2396	298	2787	230	1609
6-#9	1.88	MA	1506	742	2173	638	2692	531	3023	444	3463	306	4247	251	2595
2L-3S		MI	1045	742	1549	625	1858	519	2033	432	2227	297	2564	142	1977
6-#9	1.88	MA	1342	742	1895	646	2340	537	2598	449	2890	312	3489	177	2576
3L-2S		MI	1162	742	1753	620	2117	516	2346	431	2648	295	3074	216	1983
6-#10	2.38	MA	1590	790	2399	666	2969	551	3355	457	3905	303	4802	240	3233
2L-3S		MI	1078	790	1662	653	1993	539	2193	444	2436	293	2800	103	2428
6-#10	2.38	MA	1393	790	2049	675	2526	559	2819	462	3184	310	3857	146	3188
3L-2S		MI	1218	790	1918	647	2318	535	2586	443	2962	291	3430	196	2451
6-#11	2.92	MA	1657	841	2633	692	3243	570	3674	467	4326	297	5252	216	3859
2L-3S		MI	1100	841	1781	678	2124	555	2341	452	2597	280	2959	45	2851
6-#11	2.92	MA	1439	841	2215	702	2713	578	3034	473	3463	305	4153	102	3779
3L-2S		MI	1259	841	2085	672	2508	553	2806	452	3208	276	3675	160	2898
6-#14	4.22	MA	1838	963	3174	764	3910	622	4473	500	5394	290	6513	177	5388
2L-3S		MI	1175	963	2044	749	2442	606	2718	482	3057	261	3464	-70	3419
6-#14	4.22	MA	1558	963	2581	777	3161	632	3567	506	4175	299	4990	12	4961
3L-2S		MI	1379	963	2471	743	2981	604	3370	484	3900	256	4439	95	3990
6-#18	7.50	MA	1851	1272	3457	968	4238	769	4855	589	5885	280	6901	-240	6572
3L-2S		MI	1652	1272	3374	925	4096	737	4650	556	5462	192	6082	-103	5971
8-#7	1.50	MA	1446	707	1999	620	2486	518	2782	437	3145	309	3863	261	2123
2L-4S		MI	1001	707	1409	609	1692	508	1832	430	1959	301	2284	168	1631
8-#7	1.50	MA	1343	707	1829	625	2271	522	2522	440	2795	314	3393	217	2120
3E		MI	1048	707	1499	606	1809	506	1981	425	2163	301	2516	189	1638
8-#7	1.50	MA	1280	707	1710	629	2115	526	2324	446	2524	315	3059	193	2101
4L-2S		MI	1123	707	1625	603	1968	504	2173	424	2421	299	2836	233	1635
8-#8	1.98	MA	1531	752	2216	646	2753	537	3101	449	3571	307	4414	253	2739
2L-4S		MI	1028	752	1504	637	1804	528	1962	442	2130	297	2488	132	2020
8-#8	1.98	MA	1402	752	1994	652	2473	542	2762	453	3115	312	3805	195	2726
3E		MI	1089	752	1621	632	1957	525	2157	437	2396	298	2787	160	2087
8-#8	1.98	MA	1325	752	1838	658	2269	547	2502	460	2760	314	3372	163	2637
4L-2S		MI	1181	752	1785	628	2164	522	2407	435	2733	296	3199	218	2092
8-#9	2.50	MA	1619	801	2452	675	3044	558	3449	462	4036	304	5005	243	3407
2L-4S		MI	1061	801	1606	667	1917	554	2102	456	2315	293	2704	91	2392
8-#9	2.50	MA	1466	801	2173	682	2692	564	3023	466	3463	310	4247	170	3377
3E		MI	1130	801	1753	662	2117	546	2346	450	2648	295	3074	126	2566
8-#9	2.50	MA	1373	801	1977	690	2436	571	2697	476	3017	312	3708	129	3144
4L-2S		MI	1240	801	1958	657	2375	543	2659	448	3070	293	3584	199	2583
8-#10	3.17	MA	1725	865	2749	713	3412	586	3890	479	4626	300	5746	229	4252
2L-4S		MI	1100	865	1733	706	2067	583	2279	473	2546	288	2971	38	2848
8-#10	3.17	MA	1549	865	2399	722	2969	593	3355	484	3905	308	4802	135	4192
3E		MI	1182	865	1918	700	2318	573	2586	466	2962	290	3430	80	3160
8-#10	3.17	MA	1434	865	2152	731	2646	601	2943	496	3343	310	4128	85	3770
4L-2S		MI	1312	865	2175	694	2642	570	2978	465	3489	288	4060	174	3199
8-#11	3.90	MA	1614	933	2633	760	3243	620	3674	500	4326	301	5252	84	4976
3E		MI	1221	933	2085	735	2508	598	2806	479	3208	273	3675	12	3646
8-#11	3.90	MA	1491	933	2335	770	2855	628	3179	512	3650	302	4464	25	4362
4L-2S		MI	1366	933	2389	729	2893	595	3271	479	3818	270	4392	127	3780
8-#14	5.63	MA	1799	1096	3174	860	3910	693	4473	545	5394	294	6513	-18	6477
3E		MI	1340	1096	2471	832	2981	667	3370	521	3900	249	4439	-124	4334
8-#14	5.63	MA	1643	1096	2750	873	3359	703	3771	561	4436	293	5415	-100	5297
4L-2S		MI	1525	1096	2897	825	3521	665	4023	523	4742	244	5413	41	5220

RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#10	3.97	MA	1693	940	2749	768	3412	627	3890	506	4626	305	5746	124	5197
3L-4S		MI	1209	940	1990	753	2391	617	2671	495	3073	284	3601	15	3549
10-#10	3.97	MA	1598	940	2502	778	3089	635	3478	518	4064	307	5073	74	4747
4L-3S		MI	1283	940	2175	747	2642	608	2978	488	3489	287	4060	58	3893
10-#10	3.97	MA	1497	940	2280	787	2775	648	3108	523	3553	315	4405	18	4351
5L-2S		MI	1403	940	2431	740	2967	604	3371	487	4016	284	4691	151	3943
10-#11	4.88	MA	1675	1025	2754	827	3384	670	3820	539	4513	299	5563	7	5532
4L-3S		MI	1337	1025	2389	792	2893	640	3271	506	3818	267	4392	-21	4370
10-#14	7.03	MA	1900	1228	3342	956	4108	763	4677	600	5656	288	6937	-131	6702
4L-3S		MI	1501	1228	2897	915	3521	728	4023	559	4742	237	5413	-178	5231
12-#10	4.76	MA	1749	1014	2852	824	3532	669	4014	539	4785	304	6017	63	5730
4E		MI	1315	1014	2246	799	2716	652	3064	517	3599	281	4231	-7	4224
12-#10	4.76	MA	1650	1014	2630	834	3218	682	3643	545	4274	312	5350	7	5326
5L-3S		MI	1381	1014	2431	793	2967	642	3371	510	4016	284	4691	36	4589
14-#10	5.56	MA	1797	1089	2979	880	3661	717	4179	567	4994	309	6294	-4	6287
5L-4S		MI	1417	1089	2503	846	3040	686	3456	539	4126	278	4862	-30	4824

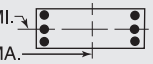
RECTANGULAR TIED COLUMNS 16" x 22"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#9	1.14	MA	1670	740	2209	662	2757	556	3070	472	3413	344	4173	296	1992
2E		MI	1173	740	1663	634	1992	532	2174	451	2365	327	2719	258	1390
4-#10	1.44	MA	1739	772	2385	679	2970	568	3322	480	3748	341	4608	290	2483
2E		MI	1212	772	1777	651	2128	544	2334	458	2574	324	2954	245	1712
4-#11	1.77	MA	1798	806	2576	695	3186	579	3571	485	4071	336	4974	276	2974
2E		MI	1240	806	1899	664	2259	553	2482	463	2735	312	3111	219	2027
4-#14	2.56	MA	1950	887	2996	741	3700	613	4183	506	4887	331	5979	255	4156
2E		MI	1323	887	2163	709	2578	585	2859	482	3194	298	3616	174	2777
4-#18	4.55	MA	2285	1093	4007	862	4943	700	5669	560	6872	318	8313	188	7004
2E		MI	1504	1093	2779	826	3326	670	3713	526	4232	252	4702	40	4520
6-#7	1.02	MA	1649	728	2133	658	2678	553	2983	471	3303	346	4053	301	1817
2L-3S		MI	1083	728	1486	635	1784	534	1930	453	2043	333	2350	224	1281
6-#7	1.02	MA	1525	728	1941	663	2435	558	2689	475	2908	351	3507	257	1820
3L-2S		MI	1163	728	1611	632	1942	531	2122	452	2302	331	2671	268	1274
6-#8	1.35	MA	1726	762	2321	677	2906	567	3255	480	3666	344	4536	297	2345
2L-3S		MI	1108	762	1571	655	1884	547	2047	461	2198	330	2529	198	1629
6-#8	1.35	MA	1570	762	2070	684	2589	573	2872	484	3150	350	3828	239	2340
3L-2S		MI	1208	762	1735	650	2091	544	2297	460	2534	328	2942	256	1624
6-#9	1.70	MA	1807	799	2524	698	3156	583	3552	489	4062	341	5057	291	2919
2L-3S		MI	1134	799	1663	676	1992	563	2174	470	2365	328	2719	169	1999
6-#9	1.70	MA	1618	799	2209	707	2757	590	3070	495	3413	349	4173	217	2900
3L-2S		MI	1255	799	1867	671	2251	559	2487	469	2787	325	3229	242	2000
6-#10	2.16	MA	1906	847	2781	726	3471	603	3929	501	4566	338	5712	283	3644
2L-3S		MI	1168	847	1777	704	2128	582	2334	482	2574	323	2954	129	2455
6-#10	2.16	MA	1678	847	2385	736	2970	611	3322	509	3748	348	4608	189	3599
3L-2S		MI	1311	847	2033	698	2452	579	2727	480	3101	321	3584	222	2471
6-#11	2.66	MA	1990	898	3052	752	3788	621	4299	512	5052	333	6267	264	4364
2L-3S		MI	1190	898	1899	728	2259	598	2482	489	2735	309	3111	71	2886
6-#11	2.66	MA	1728	898	2576	764	3186	631	3571	519	4071	343	4974	149	4285
3L-2S		MI	1352	898	2203	722	2644	595	2947	489	3345	306	3828	186	2922
6-#14	3.84	MA	2204	1020	3671	824	4553	674	5216	545	6278	326	7781	233	6117
2L-3S		MI	1263	1020	2163	799	2578	648	2859	518	3194	291	3616	-45	3588
6-#14	3.84	MA	1875	1020	2996	840	3700	686	4183	554	4887	338	5979	68	5798
3L-2S		MI	1472	1020	2590	792	3117	646	3512	521	4037	286	4590	121	4018

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis



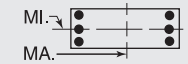
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	6.82	MA	2222	1329	4007	1033	4943	826	5669	640	6872	325	8313	-160	8021
3L-2S		MI	1745	1329	3496	973	4233	778	4791	592	5598	220	6231	-78	6154
8-#7	1.36	MA	1736	764	2325	680	2920	570	3276	481	3698	345	4599	299	2382
2L-4S		MI	1091	764	1521	661	1825	552	1973	468	2098	331	2439	194	1651
8-#7	1.36	MA	1617	764	2133	685	2678	574	2983	485	3303	350	4053	255	2380
3E		MI	1138	764	1611	657	1942	550	2122	464	2302	332	2671	216	1654
8-#7	1.36	MA	1545	764	1999	690	2503	579	2759	492	2998	352	3668	229	2360
4L-2S		MI	1215	764	1737	654	2101	547	2314	462	2560	329	2992	260	1650
8-#8	1.80	MA	1835	808	2571	706	3223	589	3639	493	4182	342	5245	294	3081
2L-4S		MI	1118	808	1617	688	1938	572	2102	480	2269	328	2643	159	2073
8-#8	1.80	MA	1686	808	2321	713	2906	594	3255	498	3666	349	4536	236	3067
3E		MI	1178	808	1735	684	2091	569	2297	475	2534	329	2942	186	2107
8-#8	1.80	MA	1598	808	2145	720	2678	600	2963	506	3267	352	4036	202	3012
4L-2S		MI	1273	808	1898	679	2297	566	2547	473	2871	326	3354	244	2109
8-#9	2.27	MA	1939	858	2839	735	3554	610	4034	506	4711	339	5940	286	3839
2L-4S		MI	1151	858	1720	718	2051	597	2243	494	2454	324	2858	118	2451
8-#9	2.27	MA	1761	858	2524	743	3156	617	3552	512	4062	347	5057	213	3809
3E		MI	1221	858	1867	713	2251	590	2487	488	2787	325	3229	152	2590
8-#9	2.27	MA	1654	858	2304	752	2868	624	3184	522	3560	350	4432	170	3599
4L-2S		MI	1333	858	2072	708	2510	586	2800	486	3208	323	3739	226	2602
8-#10	2.89	MA	2066	921	3178	773	3973	637	4536	523	5383	335	6815	275	4800
2L-4S		MI	1189	921	1848	757	2201	626	2420	511	2684	318	3125	64	2912
8-#10	2.89	MA	1854	921	2781	783	3471	646	3929	530	4566	345	5712	182	4740
3E		MI	1273	921	2033	751	2452	617	2727	504	3101	320	3584	107	3190
8-#10	2.89	MA	1727	921	2503	793	3108	654	3465	543	3932	349	4930	129	4320
4L-2S		MI	1405	921	2290	744	2777	613	3119	502	3627	318	4214	200	3220
8-#11	3.55	MA	1939	990	3052	821	3788	673	4299	546	5052	339	6267	136	5650
3E		MI	1311	990	2203	785	2644	640	2947	516	3345	303	3828	38	3735
8-#11	3.55	MA	1797	990	2716	833	3350	682	3740	561	4288	342	5346	74	5009
4L-2S		MI	1460	990	2507	779	3028	637	3412	516	3956	300	4544	153	3806
8-#14	5.11	MA	2156	1152	3671	922	4553	747	5216	593	6278	333	7781	46	7642
3E		MI	1429	1152	2590	882	3117	709	3512	557	4037	279	4590	-98	4510
8-#14	5.11	MA	1977	1152	3192	938	3930	759	4420	612	5192	336	6493	-42	6428
4L-2S		MI	1619	1152	3016	875	3657	707	4164	560	4880	274	5565	67	5251
10-#10	3.61	MA	2028	996	3178	830	3973	680	4536	552	5383	342	6815	175	5882
3L-4S		MI	1298	996	2105	803	2526	660	2812	533	3211	314	3755	42	3611
10-#10	3.61	MA	1918	996	2900	840	3610	689	4072	565	4749	346	6034	122	5432
4L-3S		MI	1374	996	2290	797	2777	651	3119	526	3627	317	4214	84	3923
10-#10	3.61	MA	1788	996	2650	850	3257	703	3656	572	4173	355	5254	67	5030
5L-2S		MI	1498	996	2546	791	3101	647	3511	524	4154	314	4845	178	3966
10-#11	4.43	MA	2011	1081	3192	890	3952	724	4468	588	5269	339	6640	61	6346
4L-3S		MI	1427	1081	2507	842	3028	682	3412	543	3956	297	4544	5	4531
10-#11	4.43	MA	1871	1081	2890	902	3526	741	3965	595	4574	349	5726	-7	5718
5L-2S		MI	1566	1081	2810	836	3413	680	3877	543	4566	293	5261	120	4686
10-#14	6.39	MA	2275	1285	3867	1021	4783	820	5453	651	6582	331	8294	-64	8144
4L-3S		MI	1590	1285	3016	964	3657	770	4164	596	4880	267	5565	-152	5414
12-#10	4.33	MA	2092	1071	3296	887	4112	723	4679	587	5566	343	7137	115	6551
4E		MI	1404	1071	2361	850	2850	695	3205	555	3738	311	4385	19	4317
12-#10	4.33	MA	1973	1071	3047	897	3759	737	4263	594	4991	353	6358	60	6146
5L-3S		MI	1473	1071	2546	844	3101	685	3511	548	4154	314	4845	62	4657
12-#10	4.33	MA	1821	1071	2804	906	3439	746	3856	607	4428	356	5602	-8	5592
6L-2S		MI	1589	1071	2803	838	3426	682	3904	546	4681	311	5475	155	4709

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

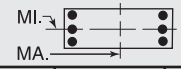
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	5.32	MA	2079	1173	3366	959	4128	783	4694	622	5555	345	7020	-19	6987
5L-3S		MI	1541	1173	2810	900	3413	725	3877	570	4566	290	5261	-28	5228
14-#10	5.05	MA	2143	1146	3444	944	4261	772	4870	616	5808	350	7461	53	7265
5L-4S		MI	1507	1146	2618	897	3175	729	3597	577	4264	308	5016	-3	5012
14-#10	5.05	MA	2003	1146	3201	953	3941	780	4463	629	5246	354	6706	-16	6677
6L-3S		MI	1569	1146	2803	891	3426	720	3904	570	4681	311	5475	40	5355
16-#10	5.77	MA	2178	1220	3598	999	4443	815	5070	651	6063	351	7810	-23	7754
6L-4S		MI	1607	1220	2874	944	3499	763	3990	599	4791	305	5646	-26	5609

RECTANGULAR TIED COLUMNS 16" x 24"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.04	MA	1975	797	2542	722	3203	607	3575	516	3972	379	4888	330	2208
2E		MI	1264	797	1777	685	2126	576	2315	489	2503	357	2873	285	1405
4-#10	1.32	MA	2055	828	2738	739	3441	620	3858	524	4348	377	5403	327	2757
2E		MI	1304	828	1892	702	2262	587	2475	496	2712	354	3108	271	1729
4-#11	1.63	MA	2124	863	2955	755	3687	630	4141	530	4715	372	5839	316	3311
2E		MI	1332	863	2016	714	2395	596	2623	500	2872	342	3264	245	2047
4-#14	2.34	MA	2303	944	3429	801	4266	664	4831	551	5635	366	7015	299	4642
2E		MI	1415	944	2282	759	2714	627	3000	519	3332	327	3767	200	2802
4-#18	4.17	MA	2694	1150	4574	922	5676	751	6516	605	7885	354	9776	245	7868
2E		MI	1597	1150	2902	875	3464	711	3854	562	4368	280	4851	65	4554
6-#8	1.23	MA	2039	818	2665	737	3368	618	3781	524	4253	379	5280	330	2601
2L-3S		MI	1198	818	1684	706	2017	591	2188	499	2336	361	2684	225	1646
6-#8	1.23	MA	1861	818	2385	744	3014	625	3353	530	3676	387	4483	273	2596
3L-2S		MI	1300	818	1848	701	2224	588	2438	498	2673	358	3097	283	1639
6-#9	1.56	MA	2132	856	2893	758	3648	634	4114	534	4696	377	5892	327	3243
2L-3S		MI	1224	856	1777	727	2126	606	2315	508	2503	358	2873	195	2019
6-#9	1.56	MA	1916	856	2542	767	3203	642	3575	540	3972	386	4888	255	3224
3L-2S		MI	1347	856	1981	722	2385	603	2628	506	2925	355	3383	269	2017
6-#10	1.98	MA	2246	903	3182	786	4002	654	4537	546	5261	374	6667	323	4056
2L-3S		MI	1258	903	1892	754	2262	626	2475	520	2712	353	3108	155	2480
6-#10	1.98	MA	1986	903	2738	797	3441	664	3858	554	4348	385	5403	230	4011
3L-2S		MI	1403	903	2148	748	2587	622	2867	518	3239	351	3738	249	2490
6-#11	2.44	MA	2346	954	3488	812	4361	672	4957	557	5814	368	7328	308	4870
2L-3S		MI	1280	954	2016	778	2395	641	2623	526	2872	339	3264	97	2919
6-#11	2.44	MA	2045	954	2955	825	3687	683	4141	566	4715	380	5839	193	4790
3L-2S		MI	1445	954	2320	772	2779	638	3088	527	3483	336	3980	212	2945
6-#14	3.52	MA	2596	1076	4187	884	5225	725	5991	589	7196	361	9098	284	6846
2L-3S		MI	1352	1076	2282	848	2714	691	3000	555	3332	320	3767	-19	3756
6-#14	3.52	MA	2218	1076	3429	902	4266	739	4831	601	5635	377	7015	119	6637
3L-2S		MI	1566	1076	2709	841	3254	688	3653	558	4174	315	4742	146	4047
6-#18	6.25	MA	2619	1385	4574	1096	5676	881	6516	690	7885	366	9776	-89	9572
3L-2S		MI	1838	1385	3619	1022	4371	819	4933	628	5734	249	6381	-53	6333
8-#7	1.25	MA	2049	820	2669	740	3383	621	3803	526	4287	380	5331	331	2642
2L-4S		MI	1181	820	1634	712	1959	596	2113	506	2237	362	2595	221	1670
8-#7	1.25	MA	1914	820	2455	746	3112	626	3476	531	3847	386	4722	288	2639
3E		MI	1229	820	1724	709	2076	594	2262	502	2440	362	2826	243	1669
8-#7	1.25	MA	1833	820	2307	751	2918	631	3228	538	3508	389	4297	263	2619
4L-2S		MI	1307	820	1849	705	2234	591	2454	500	2699	360	3147	287	1664
8-#8	1.65	MA	2163	865	2945	766	3722	640	4209	538	4829	378	6078	328	3422
2L-4S		MI	1208	865	1730	739	2071	615	2243	518	2407	358	2798	185	2112
8-#8	1.65	MA	1994	865	2665	773	3368	646	3781	543	4253	385	5280	271	3408
3E		MI	1269	865	1848	735	2224	612	2438	513	2673	359	3097	213	2126
8-#8	1.65	MA	1894	865	2471	781	3114	653	3456	552	3809	389	4723	237	3354
4L-2S		MI	1366	865	2011	731	2431	609	2688	511	3010	357	3509	271	2125
8-#9	2.08	MA	2283	914	3245	795	4093	661	4652	551	5421	375	6895	324	4271
2L-4S		MI	1240	914	1834	769	2185	641	2384	532	2592	354	3013	144	2507

RECTANGULAR TIED COLUMNS 16" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.08	MA	2080	914	2893	804	3648	669	4114	558	4696	384	5892	251	4241
3E		MI	1312	914	1981	764	2385	633	2628	525	2925	356	3383	179	2613
8-#9	2.08	MA	1960	914	2648	813	3328	677	3705	569	4138	388	5187	208	4065
4L-2S		MI	1426	914	2186	759	2644	630	2941	524	3346	353	3893	252	2621
8-#10	2.65	MA	2430	978	3625	833	4563	688	5215	568	6175	371	7931	319	5349
2L-4S		MI	1278	978	1963	807	2336	669	2561	549	2822	348	3279	90	2975
8-#10	2.65	MA	2187	978	3182	844	4002	698	4537	576	5261	382	6667	226	5289
3E		MI	1364	978	2148	801	2587	660	2867	542	3239	350	3738	133	3217
8-#10	2.65	MA	2043	978	2872	855	3598	708	4021	590	4556	387	5776	171	4881
4L-2S		MI	1499	978	2405	795	2911	656	3260	540	3766	348	4368	226	3241
8-#11	3.25	MA	2289	1046	3488	882	4361	725	4957	593	5814	377	7328	185	6324
3E		MI	1401	1046	2320	835	2779	683	3088	553	3483	333	3980	64	3786
8-#11	3.25	MA	2116	1046	3114	895	3873	736	4333	608	4962	382	6274	119	5668
4L-2S		MI	1554	1046	2624	829	3164	680	3553	554	4093	329	4697	179	3831
8-#14	4.69	MA	2540	1209	4187	984	5225	800	5991	640	7196	372	9098	103	8754
3E		MI	1518	1209	2709	931	3254	751	3653	594	4174	308	4742	-73	4684
8-#14	4.69	MA	2335	1209	3653	1002	4529	815	5102	661	5983	378	7618	11	7565
4L-2S		MI	1713	1209	3135	924	3793	749	4305	597	5017	303	5716	92	5281
10-#10	3.31	MA	2380	1053	3625	891	4563	732	5215	598	6175	379	7931	222	6568
3L-4S		MI	1388	1053	2219	854	2660	704	2953	571	3349	344	3909	68	3671
10-#10	3.31	MA	2251	1053	3316	902	4159	742	4699	612	5470	384	7040	167	6130
4L-3S		MI	1466	1053	2405	848	2911	694	3260	564	3766	347	4368	111	3952
10-#10	3.31	MA	2109	1053	3039	913	3767	757	4237	620	4830	395	6148	113	5730
5L-2S		MI	1592	1053	2661	842	3236	690	3652	562	4292	344	4998	204	3988
10-#11	4.06	MA	2372	1138	3647	952	4548	778	5149	635	6061	378	7764	111	7174
4L-3S		MI	1518	1138	2624	892	3164	725	3553	580	4093	326	4697	31	4614
10-#11	4.06	MA	2196	1138	3313	965	4074	796	4590	644	5287	390	6712	44	6556
5L-2S		MI	1660	1138	2928	886	3548	722	4018	581	4704	323	5414	146	4712
10-#14	5.86	MA	2675	1341	4411	1084	5487	875	6262	700	7544	373	9701	-4	9689
4L-3S		MI	1679	1341	3135	1014	3793	812	4305	633	5017	296	5716	-127	5595
10-#14	5.86	MA	2446	1341	3933	1102	4811	900	5464	712	6441	388	8230	-102	8075
5L-2S		MI	1859	1341	3562	1007	4333	810	4958	635	5859	291	6691	39	6510
12-#10	3.97	MA	2461	1127	3759	948	4720	776	5377	634	6383	382	8304	163	7385
4E		MI	1494	1127	2476	901	2985	738	3345	593	3876	341	4539	45	4375
12-#10	3.97	MA	2311	1127	3483	960	4328	792	4915	642	5743	393	7412	109	6987
5L-3S		MI	1565	1127	2661	895	3236	729	3652	585	4292	344	4998	88	4687
12-#10	3.97	MA	2138	1127	3206	968	3974	801	4463	656	5119	398	6551	38	6374
6L-2S		MI	1684	1127	2918	889	3560	725	4045	584	4819	341	5629	182	4732
12-#11	4.88	MA	2443	1230	3846	1023	4749	838	5406	671	6386	387	8201	36	8067
5L-3S		MI	1632	1230	2928	950	3548	767	4018	607	4704	320	5414	-2	5411
12-#11	4.88	MA	2245	1230	3519	1034	4319	849	4860	687	5631	392	7183	-49	7108
6L-2S		MI	1766	1230	3232	944	3933	764	4483	608	5314	316	6130	112	5590
12-#14	7.03	MA	2775	1474	4691	1185	5770	961	6623	751	8002	383	10313	-117	10056
5L-3S		MI	1837	1474	3562	1097	4333	873	4958	672	5859	284	6691	-181	6491
14-#10	4.63	MA	2514	1202	3926	1006	4889	826	5593	664	6657	390	8676	105	8247
5L-4S		MI	1596	1202	2732	947	3309	772	3738	615	4403	338	5170	23	5084
14-#10	4.63	MA	2354	1202	3650	1015	4535	836	5142	678	6032	395	7815	34	7651
6L-3S		MI	1662	1202	2918	941	3560	763	4045	607	4819	341	5629	66	5421
14-#11	5.69	MA	2489	1322	4052	1091	4994	891	5676	714	6730	388	8672	-57	8550
6L-3S		MI	1745	1322	3232	1007	3933	809	4483	634	5314	313	6130	-35	6085
16-#10	5.29	MA	2553	1277	4093	1062	5096	870	5820	700	6946	392	9078	30	8929
6L-4S		MI	1697	1277	2989	994	3634	807	4130	637	4929	335	5800	1	5797

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 26"

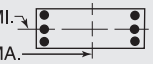
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.22	MA	2394	885	3110	799	3941	671	4427	569	4983	412	6189	359	3031
2E		MI	1395	885	2007	752	2397	631	2616	534	2850	384	3262	297	1744
4-#11	1.50	MA	2474	919	3352	815	4215	682	4743	575	5393	407	6747	354	3648
2E		MI	1424	919	2133	764	2530	638	2764	537	3010	372	3416	271	2066
4-#14	2.16	MA	2678	1000	3880	861	4861	715	5513	595	6418	402	8096	341	5128
2E		MI	1508	1000	2401	808	2850	670	3141	556	3469	356	3919	226	2826
4-#18	3.85	MA	3131	1206	5160	982	6436	803	7396	649	8934	389	11290	298	8732
2E		MI	1690	1206	3024	923	3602	753	3996	598	4504	309	5001	90	4588
6-#8	1.14	MA	2375	875	3028	797	3859	670	4339	569	4874	415	6047	361	2857
2L-3S		MI	1289	875	1797	757	2151	635	2328	537	2475	391	2839	252	1661
6-#8	1.14	MA	2175	875	2719	805	3468	677	3867	575	4238	423	5166	306	2852
3L-2S		MI	1391	875	1961	753	2358	632	2578	536	2811	389	3252	310	1653
6-#9	1.44	MA	2481	912	3281	819	4168	685	4708	578	5366	412	6724	359	3567
2L-3S		MI	1315	912	1891	778	2260	649	2455	546	2642	388	3028	222	2038
6-#9	1.44	MA	2238	912	2892	828	3676	694	4114	586	4565	422	5616	288	3548
3L-2S		MI	1439	912	2095	773	2519	646	2768	544	3063	385	3538	295	2033
6-#10	1.83	MA	2611	960	3600	846	4561	705	5177	591	5992	409	7587	355	4467
2L-3S		MI	1349	960	2007	805	2397	669	2616	557	2850	383	3262	182	2504
6-#10	1.83	MA	2317	960	3110	858	3941	716	4427	600	4983	422	6189	264	4422
3L-2S		MI	1496	960	2263	799	2721	665	3008	556	3377	381	3892	275	2508
6-#11	2.25	MA	2726	1011	3943	872	4963	724	5647	602	6611	404	8432	349	5375
2L-3S		MI	1370	1011	2133	827	2530	683	2764	564	3010	369	3416	123	2949
6-#11	2.25	MA	2387	1011	3352	886	4215	736	4743	612	5393	418	6747	235	5296
3L-2S		MI	1538	1011	2437	822	2915	680	3229	564	3621	365	4133	238	2967
6-#14	3.25	MA	3015	1133	4720	944	5924	776	6799	634	8150	397	10462	331	7575
2L-3S		MI	1442	1133	2401	898	2850	733	3141	592	3469	349	3919	7	3905
6-#14	3.25	MA	2573	1133	3880	963	4861	792	5513	648	6418	415	8096	166	7366
3L-2S		MI	1659	1133	2828	891	3390	730	3794	594	4311	344	4893	172	4074
6-#18	5.77	MA	3042	1442	5160	1159	6436	936	7396	738	8934	407	11290	-25	11221
3L-2S		MI	1931	1442	3741	1070	4508	861	5074	664	5871	277	6530	-28	6507
8-#7	1.15	MA	2385	877	3032	800	3874	672	4363	571	4911	416	6102	362	2901
2L-4S		MI	1271	877	1746	764	2092	640	2254	544	2375	392	2750	248	1687
8-#7	1.15	MA	2234	877	2796	806	3575	677	4002	576	4425	422	5429	321	2898
3E		MI	1320	877	1836	760	2209	638	2403	540	2579	393	2982	269	1683
8-#7	1.15	MA	2144	877	2633	812	3362	683	3729	583	4053	426	4966	295	2878
4L-2S		MI	1398	877	1961	757	2368	635	2595	539	2838	390	3302	313	1677
8-#8	1.52	MA	2515	921	3337	826	4249	691	4812	583	5511	413	6928	359	3763
2L-4S		MI	1298	921	1843	790	2205	659	2384	556	2546	388	2953	212	2136
8-#8	1.52	MA	2325	921	3028	834	3859	698	4339	589	4874	421	6047	304	3750
3E		MI	1360	921	1961	786	2358	656	2578	551	2811	389	3252	240	2144
8-#8	1.52	MA	2213	921	2814	842	3579	705	3982	598	4386	426	5439	270	3695
4L-2S		MI	1458	921	2124	782	2565	653	2829	549	3148	387	3664	298	2140
8-#9	1.92	MA	2652	971	3669	855	4659	712	5303	596	6166	410	7832	355	4703
2L-4S		MI	1327	971	1948	820	2319	684	2524	569	2730	384	3167	171	2561
8-#9	1.92	MA	2423	971	3281	865	4168	721	4708	603	5366	420	6724	285	4673
3E		MI	1403	971	2095	815	2519	677	2768	563	3063	386	3538	205	2635
8-#9	1.92	MA	2288	971	3011	874	3816	729	4258	615	4751	426	5956	242	4541
4L-2S		MI	1519	971	2300	809	2778	673	3081	562	3485	383	4047	279	2638
8-#10	2.44	MA	2819	1035	4090	893	5181	740	5927	613	7002	407	8985	351	5898
2L-4S		MI	1367	1035	2078	858	2470	713	2701	586	2960	378	3433	117	3035
8-#10	2.44	MA	2544	1035	3600	905	4561	750	5177	622	5992	419	7587	260	5837
3E		MI	1455	1035	2263	852	2721	703	3008	579	3377	380	3892	159	3244
8-#10	2.44	MA	2383	1035	3260	917	4116	761	4609	637	5216	425	6614	206	5453
4L-2S		MI	1592	1035	2520	846	3046	699	3401	578	3904	378	4522	253	3262
8-#11	3.00	MA	2653	1103	3943	943	4963	778	5647	639	6611	414	8432	230	6998
3E		MI	1492	1103	2437	885	2915	725	3229	591	3621	362	4133	90	3819
8-#11	3.00	MA	2468	1103	3530	957	4425	790	4960	656	5671	421	7245	162	6341
4L-2S		MI	1647	1103	2741	879	3299	723	3694	591	4231	359	4849	205	3856

RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis



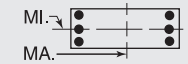
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	4.33	MA	2949	1265	4720	1046	5924	853	6799	687	8150	410	10462	156	9788
3E		MI	1608	1265	2828	981	3390	794	3794	631	4311	337	4893	-47	4857
8-#14	4.33	MA	2718	1265	4132	1065	5156	869	5818	710	6810	418	8790	61	8469
4L-2S		MI	1807	1265	3254	974	3930	791	4447	633	5154	332	5868	118	5310
8-#18	7.69	MA	3318	1677	5588	1337	6939	1069	7914	845	9599	407	12439	-216	11879
4L-2S		MI	2172	1677	4458	1217	5415	969	6153	729	7237	246	8060	-146	7899
10-#10	3.05	MA	2762	1109	4090	951	5181	784	5927	644	7002	416	8985	256	7254
3L-4S		MI	1477	1109	2334	905	2794	747	3094	608	3487	374	4063	94	3730
10-#10	3.05	MA	2617	1109	3750	963	4736	795	5359	659	6225	422	8012	202	6839
4L-3S		MI	1557	1109	2520	899	3046	737	3401	601	3904	377	4522	137	3980
10-#10	3.05	MA	2453	1109	3447	975	4306	811	4850	668	5522	435	7033	151	6370
5L-2S		MI	1686	1109	2776	892	3370	734	3793	600	4431	374	5152	230	4010
10-#11	3.75	MA	2742	1195	4121	1014	5172	832	5864	683	6888	417	8931	157	8015
4L-3S		MI	1609	1195	2741	942	3299	768	3694	617	4231	356	4849	57	4686
10-#11	3.75	MA	2553	1195	3753	1028	4651	851	5248	693	6036	431	7741	91	7388
5L-2S		MI	1755	1195	3045	936	3684	765	4159	618	4841	352	5566	171	4738
10-#14	5.41	MA	3101	1398	4972	1148	6219	930	7104	749	8542	413	11157	51	10873
4L-3S		MI	1769	1398	3254	1063	3930	854	4447	670	5154	325	5868	-101	5775
10-#14	5.41	MA	2834	1398	4446	1166	5475	956	6224	762	7325	431	9486	-46	9402
5L-2S		MI	1953	1398	3681	1056	4469	852	5099	672	5997	320	6842	64	6541
12-#10	3.66	MA	2840	1184	4240	1010	5356	829	6109	681	7235	420	9410	198	8231
4E		MI	1583	1184	2591	951	3119	781	3486	630	4014	371	4693	72	4432
12-#10	3.66	MA	2680	1184	3937	1022	4926	845	5600	690	6531	432	8432	147	7782
5L-3S		MI	1656	1184	2776	945	3370	772	3793	623	4431	374	5152	115	4716
12-#10	3.66	MA	2487	1184	3626	1030	4537	856	5104	705	5845	438	7491	77	7126
6L-2S		MI	1779	1184	3033	939	3695	768	4186	622	4957	371	5783	208	4754
12-#11	4.50	MA	2832	1286	4344	1086	5398	893	6152	720	7253	427	9427	86	9072
5L-3S		MI	1724	1286	3045	1000	3684	810	4159	644	4841	349	5566	24	5498
12-#11	4.50	MA	2596	1286	3975	1096	4926	905	5550	737	6422	434	8279	-1	8277
6L-2S		MI	1860	1286	3349	994	4068	807	4624	645	5452	346	6283	138	5617
12-#14	6.49	MA	3205	1530	5287	1249	6538	1017	7510	801	9057	426	11852	-56	11704
5L-3S		MI	1926	1530	3681	1146	4469	915	5099	709	5997	313	6842	-155	6676
14-#10	4.27	MA	2899	1259	4427	1069	5546	880	6350	712	7541	429	9830	143	9197
5L-4S		MI	1686	1259	2847	998	3443	816	3879	652	4541	368	5323	49	5139
14-#10	4.27	MA	2717	1259	4116	1077	5157	890	5854	727	6855	435	8889	73	8543
6L-3S		MI	1754	1259	3033	992	3695	806	4186	645	4957	371	5783	92	5450
14-#10	4.27	MA	2556	1259	3764	1090	4767	899	5374	736	6187	448	7961	30	7852
7L-2S		MI	1870	1259	3289	986	4019	802	4578	644	5484	368	6413	186	5497
14-#11	5.25	MA	2883	1378	4566	1154	5673	947	6454	764	7639	431	9964	-5	9941
6L-3S		MI	1836	1378	3349	1057	4068	852	4624	671	5452	343	6283	-9	6271
16-#10	4.88	MA	2954	1334	4606	1123	5777	924	6604	749	7864	433	10287	69	9961
6L-4S		MI	1787	1334	3104	1045	3768	850	4271	674	5068	365	5954	27	5851
16-#10	4.88	MA	2789	1334	4254	1137	5387	933	6124	758	7197	445	9359	26	9264
7L-3S		MI	1850	1334	3289	1039	4019	841	4578	667	5484	368	6413	70	6185
18-#10	5.50	MA	3033	1408	4744	1183	6008	968	6874	780	8206	442	10757	22	10676
7L-4S		MI	1887	1408	3360	1092	4092	884	4664	696	5594	362	6584	5	6566

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis

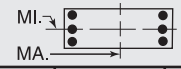


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.13	MA	2756	942	3500	860	4469	722	5029	614	5653	448	7016	390	3306
2E		MI	1487	942	2121	803	2531	674	2757	572	2988	414	3416	324	1760
4-#11	1.39	MA	2848	976	3767	875	4773	733	5379	619	6107	443	7633	385	3985
2E		MI	1516	976	2251	814	2666	681	2905	574	3148	401	3569	297	2085
4-#14	2.01	MA	3079	1057	4349	922	5484	767	6227	640	7237	437	9189	379	5614
2E		MI	1600	1057	2520	857	2986	712	3283	592	3606	385	4070	251	2849
4-#18	3.57	MA	3595	1263	5763	1042	7226	854	8309	694	10018	425	12851	348	9596
2E		MI	1783	1263	3146	971	3739	794	4137	634	4641	338	5150	115	4621
6-#8	1.06	MA	2734	932	3408	857	4377	721	4931	614	5532	451	6857	393	3113
2L-3S		MI	1380	932	1910	808	2285	678	2469	576	2613	421	2994	278	1675
6-#8	1.06	MA	2512	932	3071	865	3950	728	4414	620	4836	459	5893	339	3108
3L-2S		MI	1482	932	2074	804	2491	675	2719	574	2950	419	3407	336	1666
6-#9	1.34	MA	2853	969	3686	879	4716	736	5335	623	6071	448	7599	390	3891
2L-3S		MI	1405	969	2004	829	2394	693	2596	584	2780	418	3182	248	2056
6-#9	1.34	MA	2583	969	3260	889	4178	745	4685	631	5195	459	6386	321	3872
3L-2S		MI	1530	969	2209	824	2653	690	2909	582	3202	416	3692	321	2048
6-#10	1.70	MA	2999	1016	4037	906	5148	756	5851	636	6759	445	8547	386	4879
2L-3S		MI	1439	1016	2121	856	2531	712	2757	595	2988	413	3416	208	2526
6-#10	1.70	MA	2672	1016	3500	919	4469	768	5029	646	5653	458	7016	298	4834
3L-2S		MI	1588	1016	2378	850	2856	708	3149	593	3515	411	4046	301	2526
6-#11	2.09	MA	3130	1068	4415	932	5593	775	6371	646	7443	440	9482	380	5881
2L-3S		MI	1461	1068	2251	877	2666	726	2905	601	3148	398	3569	149	2978
6-#11	2.09	MA	2751	1068	3767	947	4773	788	5379	657	6107	454	7633	269	5801
3L-2S		MI	1630	1068	2555	871	3050	723	3370	601	3758	395	4285	264	2989
6-#14	3.01	MA	3459	1189	5272	1004	6652	827	7639	679	9139	433	11823	372	8304
2L-3S		MI	1531	1189	2520	947	2986	775	3283	629	3606	378	4070	32	4001
6-#14	3.01	MA	2961	1189	4349	1024	5484	845	6227	694	7237	453	9189	208	8095
3L-2S		MI	1752	1189	2947	940	3526	773	3935	631	4449	373	5045	198	4101
6-#18	5.36	MA	3490	1498	5763	1222	7226	990	8309	786	10018	447	12851	34	12748
3L-2S		MI	2024	1498	3863	1118	4646	902	5216	700	6007	306	6679	-3	6677
8-#7	1.07	MA	2745	933	3412	860	4393	723	4956	616	5571	452	6915	394	3160
2L-4S		MI	1362	933	1858	815	2225	684	2394	582	2514	422	2905	274	1702
8-#7	1.07	MA	2577	933	3154	867	4066	729	4561	621	5039	458	6179	353	3157
3E		MI	1411	933	1948	812	2342	681	2543	578	2718	423	3137	296	1697
8-#7	1.07	MA	2478	933	2976	873	3834	735	4264	628	4633	462	5677	328	3138
4L-2S		MI	1489	933	2074	808	2501	679	2735	577	2976	421	3458	340	1690
8-#8	1.41	MA	2891	978	3746	886	4804	742	5448	627	6228	449	7820	390	4104
2L-4S		MI	1388	978	1956	842	2339	703	2524	594	2684	419	3108	238	2157
8-#8	1.41	MA	2680	978	3408	894	4377	750	4931	634	5532	457	6857	336	4091
3E		MI	1451	978	2074	837	2491	700	2719	589	2950	420	3407	266	2161
8-#8	1.41	MA	2556	978	3175	902	4072	757	4541	644	4999	463	6198	303	4036
4L-2S		MI	1550	978	2237	833	2698	697	2969	588	3287	417	3819	324	2156
8-#9	1.79	MA	3044	1028	4111	915	5254	763	5986	640	6947	446	8812	387	5135
2L-4S		MI	1417	1028	2062	871	2453	728	2665	607	2869	414	3322	197	2614
8-#9	1.79	MA	2789	1028	3686	925	4716	772	5335	649	6071	456	7599	318	5105
3E		MI	1494	1028	2209	866	2653	720	2909	601	3202	416	3692	232	2655
8-#9	1.79	MA	2640	1028	3392	935	4332	781	4844	661	5400	463	6767	276	4992
4L-2S		MI	1611	1028	2414	860	2912	717	3222	600	3623	413	4202	305	2656
8-#10	2.27	MA	3232	1091	4574	953	5827	791	6672	658	7865	442	10078	382	6446
2L-4S		MI	1457	1091	2193	909	2604	756	2842	624	3098	408	3587	143	3094
8-#10	2.27	MA	2926	1091	4037	965	5148	802	5851	667	6759	455	8547	294	6386
3E		MI	1546	1091	2378	903	2856	746	3149	617	3515	410	4046	186	3268
8-#10	2.27	MA	2747	1091	3665	978	4662	813	5230	683	5911	463	7492	240	6036
4L-2S		MI	1686	1091	2634	896	3180	743	3541	615	4042	408	4676	279	3282
8-#11	2.79	MA	3049	1159	4415	1004	5593	830	6371	684	7443	451	9482	264	7672
3E		MI	1582	1159	2555	935	3050	768	3370	628	3758	392	4285	116	3850
8-#11	2.79	MA	2843	1159	3965	1019	5004	843	5619	703	6416	459	8195	197	7025
4L-2S		MI	1740	1159	2859	929	3435	765	3835	628	4369	388	5002	231	3880

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#14	4.02	MA	3383	1322	5272	1107	6652	906	7639	733	9139	448	11823	201	10760
3E		MI	1697	1322	2947	1030	3526	836	3935	668	4449	366	5045	-22	5029
8-#14	4.02	MA	3105	1322	4628	1127	5812	923	6566	758	7673	458	9974	104	9388
4L-2S		MI	1901	1322	3374	1023	4066	833	4588	670	5291	361	6019	144	5339
8-#18	7.14	MA	3798	1734	6241	1402	7786	1126	8887	896	10761	451	14162	-155	13580
4L-2S		MI	2265	1734	4580	1266	5553	1010	6294	765	7373	275	8209	-121	8084
10-#10	2.83	MA	3168	1166	4574	1012	5827	836	6672	689	7865	453	10078	290	7940
3L-4S		MI	1567	1166	2449	955	2929	790	3235	646	3625	404	4217	120	3787
10-#10	2.83	MA	3006	1166	4202	1025	5342	848	6052	705	7016	460	9024	236	7560
4L-3S		MI	1648	1166	2634	949	3180	781	3541	639	4042	407	4676	163	4007
10-#10	2.83	MA	2820	1166	3872	1037	4872	864	5497	715	6249	473	7960	188	7017
5L-2S		MI	1780	1166	2891	943	3505	777	3934	637	4569	404	5306	257	4031
10-#11	3.48	MA	3149	1251	4613	1076	5824	885	6611	730	7751	456	10044	193	8868
4L-3S		MI	1700	1251	2859	992	3435	810	3835	655	4369	385	5002	83	4719
10-#11	3.48	MA	2933	1251	4212	1091	5255	905	5939	741	6820	470	8750	130	8240
5L-2S		MI	1848	1251	3163	986	3819	807	4300	655	4979	382	5719	197	4764
10-#14	5.02	MA	3552	1454	5552	1210	6980	984	7979	797	9575	453	12608	97	12039
4L-3S		MI	1858	1454	3374	1113	4066	897	4588	706	5291	354	6019	-75	5952
10-#14	5.02	MA	3230	1454	4978	1230	6166	1012	7018	812	8245	473	10754	3	10745
5L-2S		MI	2047	1454	3800	1106	4605	894	5241	709	6134	349	6994	90	6571
12-#10	3.40	MA	3255	1241	4739	1071	6021	882	6873	727	8122	457	10555	232	9089
4E		MI	1673	1241	2706	1002	3253	824	3627	668	4152	401	4847	98	4487
12-#10	3.40	MA	3073	1241	4409	1084	5552	899	6319	737	7355	470	9491	184	8567
5L-3S		MI	1748	1241	2891	996	3505	815	3934	661	4569	404	5306	141	4743
12-#10	3.40	MA	2859	1241	4064	1092	5128	910	5778	753	6607	478	8472	114	7895
6L-2S		MI	1873	1241	3147	990	3829	811	4326	659	5096	401	5937	234	4777
12-#11	4.18	MA	3231	1343	4860	1148	6075	947	6930	768	8156	467	10599	125	10100
5L-3S		MI	1815	1343	3163	1050	3819	852	4300	682	4979	379	5719	50	5575
12-#11	4.18	MA	2982	1343	4449	1158	5560	960	6274	786	7248	475	9355	39	9164
6L-2S		MI	1955	1343	3466	1044	4204	850	4765	682	5589	375	6435	164	5644
12-#14	6.03	MA	3660	1587	5901	1313	7334	1073	8430	851	10147	468	13388	-4	13368
5L-3S		MI	2016	1587	3800	1195	4605	957	5241	745	6134	342	6994	-129	6860
12-#14	6.03	MA	3336	1587	5322	1328	6598	1090	7492	876	8850	478	11602	-129	11210
6L-2S		MI	2193	1587	4227	1189	5145	955	5893	748	6976	337	7969	36	7800
14-#10	3.97	MA	3316	1315	4946	1130	6231	933	7140	759	8461	468	11022	180	10120
5L-4S		MI	1777	1315	2962	1049	3578	859	4020	690	4679	398	5477	76	5193
14-#10	3.97	MA	3114	1315	4601	1138	5807	944	6599	775	7713	475	10004	110	9447
6L-3S		MI	1846	1315	3147	1043	3829	849	4326	683	5096	401	5937	119	5479
14-#10	3.97	MA	2936	1315	4259	1146	5374	953	6076	784	6985	488	8996	70	8712
7L-2S		MI	1965	1315	3404	1037	4154	846	4719	681	5622	398	6567	212	5520
14-#11	4.88	MA	3302	1435	5098	1216	6380	1002	7266	813	8583	472	11204	34	11036
6L-3S		MI	1927	1435	3466	1107	4204	895	4765	709	5589	373	6435	17	6385
14-#11	4.88	MA	3078	1435	4631	1232	5866	1013	6631	824	7700	486	9977	-19	9928
7L-2S		MI	2060	1435	3770	1101	4588	892	5230	709	6200	369	7152	131	6522
14-#14	7.03	MA	3762	1719	6245	1411	7766	1151	8905	915	10752	473	14235	-136	13655
6L-3S		MI	2172	1719	4227	1278	5145	1018	5893	784	6976	330	7969	-183	7754
16-#10	4.54	MA	3362	1390	5137	1185	6486	979	7421	796	8819	472	11535	107	10999
6L-4S		MI	1878	1390	3219	1096	3902	893	4412	712	5206	395	6108	53	5903
16-#10	4.54	MA	3195	1390	4795	1193	6053	987	6898	806	8091	485	10528	66	10259
7L-3S		MI	1942	1390	3404	1089	4154	884	4719	705	5622	398	6567	96	6214
16-#10	4.54	MA	3038	1390	4419	1208	5589	1000	6379	816	7365	493	9558	12	9521
8L-2S		MI	2055	1390	3660	1083	4478	880	5111	703	6149	395	7197	189	6263

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

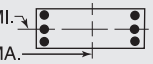
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#11	5.57	MA	3406	1527	5280	1289	6686	1055	7623	851	9036	483	11826	-24	11737
7L-3S		MI	2039	1527	3770	1164	4588	937	5230	736	6200	366	7152	-17	7130
18-#10	5.10	MA	3466	1465	5332	1240	6732	1021	7719	828	9197	483	12059	62	11807
7L-4S		MI	1977	1465	3475	1142	4227	928	4805	734	5733	392	6738	31	6617
18-#10	5.10	MA	3292	1465	4955	1255	6268	1035	7201	838	8471	490	11089	8	11064
8L-3S		MI	2037	1465	3660	1136	4478	918	5111	727	6149	395	7197	74	6950
20-#10	5.67	MA	3557	1540	5492	1301	6947	1069	8022	860	9577	487	12620	4	12608
8L-4S		MI	2075	1540	3732	1189	4551	962	5197	756	6260	389	7368	9	7334

RECTANGULAR TIED COLUMNS 16" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#10	1.06	MA	3142	998	3908	920	5025	773	5664	658	6358	483	7885	421	3580
2E		MI	1578	998	2236	854	2666	717	2897	609	3126	444	3570	350	1775
4-#11	1.30	MA	3245	1032	4200	935	5358	784	6048	664	6857	479	8562	416	4322
2E		MI	1608	1032	2368	864	2801	723	3046	611	3285	431	3721	323	2103
4-#14	1.88	MA	3503	1114	4836	982	6135	818	6974	685	8091	473	10262	410	6100
2E		MI	1692	1114	2639	907	3123	754	3424	629	3743	415	4222	277	2871
4-#18	3.33	MA	4085	1320	6385	1102	8043	905	9254	739	11137	460	14460	395	10460
2E		MI	1875	1320	3269	1020	3877	835	4278	670	4777	366	5299	141	4654
6-#9	1.25	MA	3248	1025	4109	939	5293	788	5996	668	6811	484	8517	421	4215
2L-3S		MI	1496	1025	2118	880	2528	736	2737	622	2919	448	3337	274	2073
6-#9	1.25	MA	2951	1025	3647	949	4708	797	5289	676	5859	495	7199	353	4196
3L-2S		MI	1622	1025	2323	875	2787	733	3050	620	3340	446	3846	348	2063
6-#10	1.59	MA	3411	1073	4491	966	5763	808	6557	680	7560	481	9549	417	5290
2L-3S		MI	1528	1073	2236	907	2666	755	2897	633	3126	443	3570	234	2547
6-#10	1.59	MA	3050	1073	3908	979	5025	820	5664	691	6358	495	7885	331	5245
3L-2S		MI	1680	1073	2493	900	2990	751	3290	631	3653	441	4200	328	2543
6-#11	1.95	MA	3559	1124	4906	993	6250	826	7127	691	8311	475	10575	412	6386
2L-3S		MI	1551	1124	2368	927	2801	768	3046	638	3285	428	3721	175	3005
6-#11	1.95	MA	3140	1124	4200	1008	5358	840	6048	703	6857	491	8562	303	6307
3L-2S		MI	1722	1124	2672	921	3186	766	3511	638	3896	424	4438	290	3010
6-#14	2.81	MA	3926	1246	5842	1064	7408	879	8513	724	10164	468	13131	403	9033
2L-3S		MI	1621	1246	2639	997	3123	817	3424	665	3743	408	4222	58	4072
6-#14	2.81	MA	3373	1246	4836	1086	6135	898	6974	740	8091	490	10262	243	8824
3L-2S		MI	1845	1246	3066	990	3662	815	4076	668	4586	403	5196	223	4127
6-#18	5.00	MA	3963	1555	6385	1284	8043	1044	9254	834	11137	486	14460	89	14171
3L-2S		MI	2117	1555	3986	1167	4783	943	5357	736	6143	335	6829	23	6727
8-#7	1.00	MA	3128	990	3811	920	4940	775	5582	660	6266	487	7770	425	3419
2L-4S		MI	1452	990	1970	867	2358	728	2535	621	2653	453	3061	301	1717
8-#7	1.00	MA	2943	990	3530	927	4586	781	5153	666	5689	494	6971	385	3416
3E		MI	1502	990	2060	863	2475	725	2684	617	2856	453	3292	323	1710
8-#7	1.00	MA	2835	990	3338	933	4334	786	4831	674	5249	499	6432	360	3397
4L-2S		MI	1581	990	2186	860	2634	723	2876	615	3115	451	3613	367	1703
8-#8	1.32	MA	3290	1035	4174	947	5388	794	6117	672	6980	484	8755	421	4446
2L-4S		MI	1479	1035	2070	893	2472	746	2665	632	2823	449	3263	265	2177
8-#8	1.32	MA	3057	1035	3807	955	4924	801	5555	679	6224	494	7709	368	4432
3E		MI	1541	1035	2187	888	2625	743	2860	627	3088	450	3561	293	2177
8-#8	1.32	MA	2921	1035	3555	963	4594	809	5133	689	5647	499	6999	336	4377
4L-2S		MI	1641	1035	2350	884	2832	740	3110	626	3425	447	3974	351	2170
8-#9	1.67	MA	3460	1084	4571	976	5878	815	6703	685	7763	481	9835	418	5567
2L-4S		MI	1507	1084	2176	922	2587	771	2806	645	3007	444	3476	224	2658
8-#9	1.67	MA	3179	1084	4109	986	5293	824	5996	694	6811	493	8517	350	5537
3E		MI	1585	1084	2323	917	2787	763	3050	639	3340	446	3846	258	2675
8-#9	1.67	MA	3015	1084	3791	996	4877	834	5464	707	6084	500	7621	309	5424
4L-2S		MI	1704	1084	2528	911	3046	760	3363	637	3761	443	4356	332	2672
8-#10	2.12	MA	3669	1148	5075	1013	6501	842	7450	702	8763	478	11214	413	6995
2L-4S		MI	1546	1148	2308	959	2739	799	2983	662	3237	438	3741	169	3151

RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis



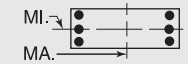
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	2.12	MA	3330	1148	4491	1026	5763	854	6557	713	7560	492	9549	327	6935
3E		MI	1637	1148	2493	953	2990	790	3290	655	3653	440	4200	212	3292
8-#10	2.12	MA	3133	1148	4089	1039	5237	866	5884	729	6641	500	8413	274	6630
4L-2S		MI	1778	1148	2749	947	3315	786	3682	653	4180	438	4830	305	3301
8-#11	2.60	MA	3469	1216	4906	1065	6250	882	7127	730	8311	488	10575	298	8346
3E		MI	1673	1216	2672	985	3186	811	3511	665	3896	421	4438	142	3880
8-#11	2.60	MA	3242	1216	4417	1080	5612	896	6311	749	7196	497	9187	232	7721
4L-2S		MI	1834	1216	2976	979	3570	808	3976	665	4506	418	5154	256	3903
8-#14	3.75	MA	3825	1378	5842	1168	7408	958	8513	779	10164	485	13131	236	11732
3E		MI	1787	1378	3066	1079	3662	878	4076	704	4586	396	5196	4	5186
8-#14	3.75	MA	3533	1378	5143	1190	6496	977	7347	806	8571	497	11139	140	10321
4L-2S		MI	1994	1378	3493	1072	4202	876	4729	707	5428	391	6171	169	5367
8-#18	6.67	MA	4303	1790	6912	1466	8661	1182	9893	947	11958	494	15932	-97	15343
4L-2S		MI	2358	1790	4702	1314	5690	1051	6436	801	7510	303	8358	-96	8266
10-#10	2.65	MA	3598	1222	5075	1073	6501	888	7450	735	8763	489	11214	323	8626
3L-4S		MI	1657	1222	2564	1006	3063	833	3375	684	3764	434	4371	147	3842
10-#10	2.65	MA	3420	1222	4672	1086	5975	900	6777	751	7843	497	10078	270	8292
4L-3S		MI	1740	1222	2749	1000	3315	824	3682	677	4180	437	4830	190	4032
10-#10	2.65	MA	3211	1222	4315	1099	5467	917	6177	762	7012	511	8880	216	7670
5L-2S		MI	1874	1222	3006	994	3639	820	4075	675	4707	434	5460	283	4052
10-#11	3.25	MA	3580	1308	5123	1138	6505	938	7391	776	8649	494	11200	227	9734
4L-3S		MI	1791	1308	2976	1042	3570	853	3976	692	4506	415	5154	109	4751
10-#11	3.25	MA	3337	1308	4689	1153	5888	959	6662	788	7640	510	9801	167	9041
5L-2S		MI	1942	1308	3280	1036	3955	850	4441	692	5117	411	5871	223	4789
10-#14	4.69	MA	4027	1511	6149	1272	7768	1038	8887	844	10643	492	14008	134	13219
4L-3S		MI	1949	1511	3493	1162	4202	939	4729	743	5428	384	6171	-50	6128
10-#14	4.69	MA	3664	1511	5528	1294	6886	1067	7844	861	9200	514	12003	44	11842
5L-2S		MI	2141	1511	3919	1155	4742	936	5382	746	6271	379	7145	115	6601
12-#10	3.17	MA	3694	1297	5256	1132	6714	934	7670	773	9045	495	11743	266	9959
4E		MI	1763	1297	2821	1053	3388	868	3768	706	4290	431	5001	124	4541
12-#10	3.17	MA	3490	1297	4899	1145	6206	952	7070	784	8214	509	10545	212	9359
5L-3S		MI	1840	1297	3006	1047	3639	858	4075	699	4707	434	5460	167	4770
12-#10	3.17	MA	3254	1297	4520	1153	5747	964	6485	800	7404	517	9497	151	8661
6L-2S		MI	1967	1297	3262	1041	3963	854	4467	697	5234	431	6091	261	4799
12-#11	3.90	MA	3665	1400	5394	1210	6781	1001	7742	815	9094	506	11813	162	11088
5L-3S		MI	1906	1400	3280	1100	3955	895	4441	719	5117	408	5871	76	5620
12-#11	3.90	MA	3391	1400	4942	1220	6223	1014	7031	834	8110	515	10473	77	10059
6L-2S		MI	2049	1400	3584	1094	4339	892	4906	719	5727	405	6588	190	5670
12-#14	5.63	MA	4139	1643	6534	1376	8159	1128	9384	900	11273	509	14873	37	14737
5L-3S		MI	2107	1643	3919	1245	4742	1000	5382	782	6271	372	7145	-104	7041
12-#14	5.63	MA	3782	1643	5894	1391	7361	1147	8366	926	9866	521	12948	-87	12657
6L-2S		MI	2287	1643	4346	1238	5281	997	6035	785	7113	367	8120	62	7831
14-#10	3.70	MA	3758	1372	5482	1192	6944	986	7963	806	9416	506	12209	208	11050
5L-4S		MI	1867	1372	3077	1100	3712	902	4160	728	4817	428	5631	102	5245
14-#10	3.70	MA	3536	1372	5103	1200	6485	998	7378	822	8606	514	11161	147	10348
6L-3S		MI	1938	1372	3262	1093	3963	893	4467	721	5234	431	6091	145	5507
14-#10	3.70	MA	3339	1372	4732	1208	6009	1006	6812	833	7818	528	10075	109	9591
7L-2S		MI	2059	1372	3519	1087	4288	889	4860	719	5761	428	6721	238	5543
14-#11	4.55	MA	3725	1491	5647	1277	7116	1057	8111	861	9564	512	12486	72	12098
6L-3S		MI	2019	1491	3584	1157	4339	937	4906	746	5727	402	6588	42	6458
14-#11	4.55	MA	3497	1491	5198	1287	6548	1067	7423	873	8607	528	11162	22	11068
7L-2S		MI	2155	1491	3888	1151	4724	934	5371	746	6338	399	7304	157	6549
14-#14	6.56	MA	4251	1776	6900	1474	8634	1207	9906	965	11938	516	15817	-94	15378
6L-3S		MI	2262	1776	4346	1328	5281	1060	6035	821	7113	360	8120	-157	7941

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

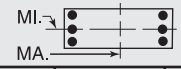
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	4.23	MA	3808	1447	5687	1246	7224	1032	8271	844	9808	511	12826	143	12035
6L-4S		MI	1968	1447	3334	1146	4037	936	4553	750	5344	425	6262	80	5954
16-#10	4.23	MA	3624	1447	5316	1255	6747	1040	7705	855	9021	525	11739	105	11273
7L-3S		MI	2035	1447	3519	1140	4288	927	4860	742	5761	428	6721	123	6243
16-#10	4.23	MA	3449	1447	4908	1270	6244	1054	7133	863	8236	534	10693	53	10501
8L-2S		MI	2150	1447	3775	1134	4612	923	5252	741	6287	425	7351	216	6286
16-#11	5.20	MA	3835	1583	5903	1345	7441	1109	8503	900	10060	524	13174	17	13101
7L-3S		MI	2131	1583	3888	1214	4724	979	5371	773	6338	396	7304	9	7275
18-#10	4.76	MA	3900	1521	5900	1302	7485	1075	8598	877	10223	523	13404	101	12955
7L-4S		MI	2068	1521	3590	1193	4361	971	4945	772	5871	422	6892	57	6667
18-#10	4.76	MA	3728	1521	5491	1317	6983	1088	8026	885	9438	531	12357	49	12186
8L-3S		MI	2130	1521	3775	1187	4612	961	5252	764	6287	425	7351	100	6978
20-#10	5.29	MA	3999	1596	6075	1364	7721	1123	8919	907	10640	528	14022	45	13864
8L-4S		MI	2166	1596	3847	1240	4686	1005	5338	794	6398	419	7522	35	7383

RECTANGULAR TIED COLUMNS 16" x 32"

4-#11	1.22	MA	3666	1089	4651	995	5971	835	6749	709	7642	514	9533	448	4659
2E		MI	1699	1089	2486	914	2937	766	3187	648	3423	460	3874	349	2121
4-#14	1.76	MA	3952	1170	5341	1042	6814	869	7754	729	8981	509	11377	441	6586
2E		MI	1784	1170	2759	956	3259	796	3565	666	3881	444	4373	303	2893
4-#18	3.13	MA	4600	1376	7025	1162	8888	956	10233	784	12292	496	15942	426	11324
2E		MI	1968	1376	3391	1068	4014	876	4420	706	4913	395	5449	166	4686
6-#9	1.17	MA	3667	1082	4550	999	5898	839	6689	713	7587	519	9477	452	4539
2L-3S		MI	1586	1082	2232	931	2662	780	2878	660	3057	478	3491	301	2089
6-#9	1.17	MA	3342	1082	4051	1010	5267	849	5925	722	6559	531	8054	386	4520
3L-2S		MI	1713	1082	2437	926	2921	776	3191	658	3478	476	4001	374	2078
6-#10	1.49	MA	3847	1129	4964	1027	6406	859	7296	725	8397	516	10594	449	5702
2L-3S		MI	1618	1129	2351	957	2800	798	3038	670	3265	473	3724	261	2567
6-#10	1.49	MA	3452	1129	4333	1040	5609	871	6332	736	7099	531	8796	364	5657
3L-2S		MI	1772	1129	2608	951	3124	795	3431	669	3791	471	4354	354	2560
6-#11	1.83	MA	4012	1181	5415	1053	6937	878	7917	736	9214	511	11710	443	6892
2L-3S		MI	1641	1181	2486	977	2937	811	3187	675	3423	457	3874	201	3031
6-#11	1.83	MA	3551	1181	4651	1068	5971	892	6749	749	7642	528	9533	336	6812
3L-2S		MI	1815	1181	2789	971	3321	808	3652	675	4033	454	4590	316	3030
6-#14	2.64	MA	4417	1303	6429	1125	8192	930	9420	768	11224	504	14483	434	9762
2L-3S		MI	1711	1303	2759	1046	3259	859	3565	702	3881	437	4373	84	4109
6-#14	2.64	MA	3809	1303	5341	1147	6814	950	7754	786	8981	527	11377	278	9553
3L-2S		MI	1938	1303	3185	1039	3799	857	4218	705	4723	432	5348	249	4153
6-#18	4.69	MA	4461	1612	7025	1346	8888	1097	10233	881	12292	525	15942	127	15626
3L-2S		MI	2210	1612	4108	1215	4921	984	5498	772	6280	363	6978	48	6762
8-#8	1.23	MA	3713	1091	4620	1007	5999	845	6818	717	7768	520	9733	453	4787
2L-4S		MI	1569	1091	2183	944	2606	790	2806	670	2962	479	3418	291	2196
8-#8	1.23	MA	3458	1091	4224	1015	5498	853	6213	724	6952	530	8603	401	4773
3E		MI	1632	1091	2300	940	2759	787	3000	665	3227	480	3716	319	2192
8-#8	1.23	MA	3309	1091	3952	1024	5143	861	5758	735	6331	536	7843	368	4719
4L-2S		MI	1733	1091	2463	935	2966	784	3250	664	3564	478	4129	377	2185
8-#9	1.56	MA	3900	1141	5049	1036	6529	866	7452	730	8615	517	10900	449	5999
2L-4S		MI	1597	1141	2290	973	2721	815	2946	683	3146	474	3631	250	2683
8-#9	1.56	MA	3592	1141	4550	1046	5898	876	6689	739	7587	529	9477	383	5969
3E		MI	1674	1141	2437	968	2921	807	3191	677	3478	476	4001	285	2694
8-#9	1.56	MA	3412	1141	4208	1057	5450	886	6116	752	6803	536	8517	342	5856
4L-2S		MI	1796	1141	2642	962	3180	803	3504	675	3900	474	4511	358	2689
8-#10	1.98	MA	4130	1204	5594	1073	7204	893	8260	747	9696	513	12392	445	7544
2L-4S		MI	1636	1204	2422	1010	2873	842	3124	699	3375	468	3895	195	3206
8-#10	1.98	MA	3759	1204	4964	1087	6406	906	7296	758	8397	528	10594	360	7483
3E		MI	1728	1204	2608	1004	3124	833	3431	692	3791	470	4354	238	3315

RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	1.98	MA	3543	1204	4530	1100	5840	918	6571	775	7407	537	9377	307	7233
4L-2S		MI	1871	1204	2864	998	3449	829	3823	691	4318	468	4984	332	3320
8-#11	2.44	MA	3913	1273	5415	1126	6937	934	7917	776	9214	524	11710	331	9019
3E		MI	1764	1273	2789	1035	3321	853	3652	702	4033	451	4590	168	3909
8-#11	2.44	MA	3664	1273	4888	1142	6249	948	7037	795	8011	535	10223	266	8428
4L-2S		MI	1926	1273	3093	1029	3706	850	4117	702	4644	447	5307	282	3926
8-#14	3.52	MA	4305	1435	6429	1229	8192	1011	9420	825	11224	522	14483	271	12704
3E		MI	1877	1435	3185	1129	3799	920	4218	741	4723	425	5348	30	5275
8-#14	3.52	MA	3984	1435	5676	1252	7208	1031	8162	853	9504	536	12346	176	11267
4L-2S		MI	2088	1435	3612	1122	4338	918	4870	744	5566	420	6322	195	5395
8-#18	6.25	MA	4832	1847	7602	1530	9565	1238	10933	996	13191	536	17576	-57	17203
4L-2S		MI	2451	1847	4825	1362	5828	1093	6577	837	7646	332	8508	-70	8444
10-#10	2.48	MA	4052	1279	5594	1133	7204	940	8260	780	9696	525	12392	356	9311
3L-4S		MI	1746	1279	2679	1057	3198	877	3516	721	3902	464	4525	173	3896
10-#10	2.48	MA	3857	1279	5161	1147	6637	952	7536	797	8705	534	11175	303	9034
4L-3S		MI	1831	1279	2864	1051	3449	867	3823	714	4318	467	4984	216	4057
10-#10	2.48	MA	3626	1279	4777	1160	6091	970	6890	808	7810	549	9888	251	8330
5L-2S		MI	1967	1279	3121	1045	3773	863	4216	713	4845	464	5614	309	4072
10-#11	3.05	MA	4034	1364	5651	1199	7214	991	8204	822	9583	531	12399	261	10612
4L-3S		MI	1882	1364	3093	1092	3706	895	4117	729	4644	444	5307	135	4782
10-#11	3.05	MA	3764	1364	5184	1215	6550	1012	7419	835	8495	548	10895	204	9827
5L-2S		MI	2036	1364	3397	1086	4090	893	4582	729	5254	441	6024	249	4813
10-#14	4.39	MA	4498	1567	6765	1334	8585	1091	9827	892	11747	531	15452	169	14413
4L-3S		MI	2039	1567	3612	1212	4338	981	4870	780	5566	413	6322	-24	6302
10-#14	4.39	MA	4122	1567	6096	1356	7634	1121	8704	909	10191	554	13295	84	12961
5L-2S		MI	2235	1567	4038	1205	4878	979	5523	782	6408	408	7297	141	6630
10-#18	7.81	MA	5057	2082	8323	1714	10296	1396	11865	1094	14371	565	19192	-232	17959
5L-2S		MI	2692	2082	5542	1510	6735	1201	7656	902	9012	300	10037	-188	9827
12-#10	2.98	MA	4157	1354	5791	1193	7435	987	8500	819	10003	532	12973	300	10839
4E		MI	1853	1354	2935	1103	3522	911	3909	743	4429	461	5155	151	4593
12-#10	2.98	MA	3930	1354	5407	1207	6888	1005	7854	830	9108	546	11686	247	10157
5L-3S		MI	1932	1354	3121	1097	3773	902	4216	736	4845	464	5614	194	4796
12-#10	2.98	MA	3673	1354	4993	1214	6395	1017	7225	847	8237	556	10564	187	9438
6L-2S		MI	2061	1354	3377	1091	4098	898	4608	735	5372	461	6245	287	4820
12-#11	3.66	MA	4124	1456	5947	1272	7515	1054	8587	862	10067	545	13071	199	12040
5L-3S		MI	1997	1456	3397	1150	4090	938	4582	756	5254	438	6024	102	5652
12-#11	3.66	MA	3824	1456	5452	1282	6915	1069	7821	882	9007	555	11635	115	10968
6L-2S		MI	2143	1456	3701	1144	4475	935	5047	756	5865	435	6740	216	5696
12-#14	5.27	MA	4644	1700	7185	1439	9012	1182	10370	948	12434	549	16401	77	16095
5L-3S		MI	2197	1700	4038	1294	4878	1042	5523	819	6408	401	7297	-78	7221
12-#14	5.27	MA	4225	1700	6484	1453	8152	1202	9274	976	10917	563	14337	-46	14168
6L-2S		MI	2381	1700	4465	1287	5417	1039	6176	821	7251	396	8272	87	7861
14-#10	3.47	MA	4224	1429	6037	1254	7685	1039	8819	852	10407	544	13483	243	11986
5L-4S		MI	1957	1429	3192	1150	3847	945	4301	765	4955	458	5785	128	5297
14-#10	3.47	MA	3981	1429	5624	1261	7192	1051	8189	869	9535	553	12362	183	11261
6L-3S		MI	2030	1429	3377	1144	4098	936	4608	758	5372	461	6245	171	5533
14-#10	3.47	MA	3766	1429	5224	1270	6672	1059	7580	880	8687	568	11196	146	10487
7L-2S		MI	2154	1429	3634	1138	4422	932	5001	757	5899	458	6875	264	5565
14-#11	4.27	MA	4189	1548	6215	1339	7880	1111	8989	909	10579	551	13812	110	13173
6L-3S		MI	2111	1548	3701	1207	4475	980	5047	783	5865	432	6740	68	6521
14-#11	4.27	MA	3940	1548	5730	1349	7258	1121	8248	922	9549	568	12390	62	12104
7L-2S		MI	2249	1548	4005	1201	4859	977	5512	783	6475	428	7457	183	6576
14-#14	6.15	MA	4764	1832	7573	1536	9530	1263	10940	1015	13160	558	17443	-53	17171
6L-3S		MI	2353	1832	4465	1377	5417	1103	6176	858	7251	389	8272	-132	8126
14-#14	6.15	MA	4438	1832	6880	1550	8651	1278	9880	1033	11685	581	15402	-125	14996
7L-2S		MI	2527	1832	4892	1370	5957	1100	6828	860	8093	384	9246	33	9089

RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

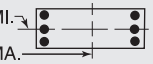
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	3.97	MA	4278	1503	6254	1308	7990	1086	9153	891	10833	550	14159	179	13084
6L-4S		MI	2059	1503	3449	1197	4171	980	4694	787	5482	455	6416	106	6005
16-#10	3.97	MA	4077	1503	5855	1317	7469	1093	8545	902	9986	565	12994	142	12304
7L-3S		MI	2127	1503	3634	1191	4422	970	5001	780	5899	458	6875	149	6270
16-#10	3.97	MA	3883	1503	5415	1332	6928	1108	7920	911	9141	574	11870	92	11446
8L-2S		MI	2245	1503	3890	1185	4747	966	5393	779	6426	455	7505	242	6309
16-#11	4.88	MA	4310	1640	6493	1407	8224	1163	9416	949	11121	565	14566	57	14302
7L-3S		MI	2222	1640	4005	1264	4859	1022	5512	810	6475	425	7457	35	7345
16-#11	4.88	MA	4082	1640	5959	1426	7566	1180	8670	960	10093	575	13196	-7	13176
8L-2S		MI	2354	1640	4309	1258	5244	1019	5977	810	7086	422	8174	150	7454
16-#14	7.03	MA	4962	1965	7968	1633	10028	1339	11546	1072	13928	576	18508	-131	17887
7L-3S		MI	2507	1965	4892	1460	5957	1163	6828	897	8093	377	9246	-186	9019
18-#10	4.46	MA	4378	1578	6485	1363	8267	1128	9509	924	11284	562	14792	139	14121
7L-4S		MI	2159	1578	3705	1244	4496	1014	5086	809	6009	452	7046	84	6717
18-#10	4.46	MA	4188	1578	6045	1379	7725	1142	8885	933	10440	571	13668	88	13266
8L-3S		MI	2223	1578	3890	1238	4747	1005	5393	802	6426	455	7505	126	7006
18-#10	4.46	MA	3952	1578	5667	1390	7222	1152	8243	946	9606	586	12506	34	12357
9L-2S		MI	2336	1578	4147	1231	5071	1001	5785	801	6952	452	8135	220	7051
18-#11	5.48	MA	4444	1732	6722	1483	8531	1222	9837	987	11665	572	15373	-12	15326
8L-3S		MI	2333	1732	4309	1322	5244	1064	5977	837	7086	419	8174	2	8166
20-#10	4.96	MA	4484	1653	6675	1426	8522	1176	9849	955	11738	568	15466	84	15087
8L-4S		MI	2258	1653	3962	1290	4820	1048	5479	831	6536	449	7676	61	7431
20-#10	4.96	MA	4259	1653	6297	1437	8019	1186	9207	968	10905	583	14304	30	14174
9L-3S		MI	2317	1653	4147	1284	5071	1039	5785	824	6952	452	8135	104	7743
22-#10	5.46	MA	4558	1728	6927	1484	8816	1220	10172	990	12203	580	16102	26	15990
9L-4S		MI	2355	1728	4218	1337	5145	1083	5871	853	7063	446	8306	39	8149

RECTANGULAR TIED COLUMNS 18" x 18"

6-#8	1.46	MA	1290	712	1824	616	2234	515	2480	434	2775	307	3317	249	1850
2L-3S		MI	1172	712	1632	621	1990	519	2185	437	2379	312	2806	191	1849
6-#9	1.85	MA	1348	749	1980	637	2424	530	2705	443	3076	305	3681	239	2290
2L-3S		MI	1205	749	1738	643	2118	535	2336	447	2578	310	3048	165	2278
6-#10	2.35	MA	1416	797	2176	664	2663	550	2991	455	3456	302	4135	224	2843
2L-3S		MI	1250	797	1872	672	2279	556	2527	459	2831	307	3349	131	2809
6-#11	2.89	MA	1470	848	2377	689	2895	568	3261	465	3810	296	4482	195	3379
2L-3S		MI	1281	848	2015	698	2438	573	2708	468	3066	300	3575	81	3317
6-#14	4.17	MA	1621	970	2840	761	3466	620	3943	498	4705	286	5491	145	4689
2L-3S		MI	1378	970	2330	771	2821	626	3163	500	3661	291	4245	-21	4223
6-#18	7.41	MA	1964	1279	3940	944	4827	753	5574	581	6726	240	7742	-11	7718
2L-3S		MI	1613	1279	3076	958	3734	759	4252	579	5005	249	5738	-305	5458
8-#8	1.95	MA	1369	759	2017	645	2478	536	2774	447	3172	306	3827	241	2416
2L-4S		MI	1189	759	1687	655	2056	544	2252	457	2465	310	2951	153	2334
8-#9	2.47	MA	1442	808	2221	673	2729	557	3074	460	3573	303	4314	227	2996
2L-4S		MI	1228	808	1808	686	2200	567	2420	472	2686	308	3227	116	2774
8-#10	3.14	MA	1531	872	2479	711	3047	584	3454	477	4081	299	4922	208	3726
2L-4S		MI	1282	872	1959	726	2381	596	2631	491	2966	304	3570	68	3315
8-#11	3.85	MA	1602	940	2738	747	3352	610	3813	492	4554	292	5388	171	4428
2L-4S		MI	1320	940	2117	763	2543	628	2830	505	3223	294	3825	1	3819
10-#10	3.92	MA	1642	947	2782	757	3430	618	3918	499	4706	296	5708	192	4606
2L-5S		MI	1335	947	2068	781	2490	642	2771	516	3143	307	3800	-5	3797
10-#10	3.92	MA	1500	947	2479	765	3047	624	3454	503	4081	301	4922	99	4546
3L-4S		MI	1415	947	2262	773	2765	630	3095	513	3591	301	4356	52	4153
10-#11	4.81	MA	1571	1032	2738	812	3352	658	3813	522	4554	293	5388	32	5296
3L-4S		MI	1476	1032	2478	821	3000	670	3383	532	3967	291	4731	-23	4705

RECTANGULAR TIED COLUMNS 18" x 20"

Short columns – no sidesway
Bending on major or minor axis



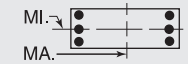
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.11	MA	1532	754	2063	667	2544	561	2816	476	3108	347	3736	293	1792
2E		MI	1364	754	1878	658	2286	553	2513	469	2754	342	3246	281	1592
4-#10	1.41	MA	1592	786	2218	685	2732	573	3038	484	3402	344	4103	285	2227
2E		MI	1413	786	2013	675	2447	565	2704	477	3007	339	3546	270	1970
4-#11	1.73	MA	1641	820	2387	700	2920	583	3253	489	3680	339	4398	268	2659
2E		MI	1452	820	2159	689	2608	574	2886	481	3241	333	3771	249	2343
4-#14	2.50	MA	1768	901	2756	746	3369	616	3787	509	4391	333	5233	241	3697
2E		MI	1556	901	2476	735	2992	607	3341	501	3836	325	4439	215	3237
4-#18	4.44	MA	2052	1107	3637	865	4448	703	5075	563	6101	319	7142	156	6177
2E		MI	1788	1107	3225	853	3906	693	4431	554	5179	293	5931	109	5349
6-#8	1.32	MA	1582	776	2160	683	2677	572	2980	484	3333	347	4052	293	2105
2L-3S		MI	1287	776	1770	680	2157	569	2362	480	2555	346	3005	222	1868
6-#8	1.32	MA	1444	776	1939	689	2396	577	2641	488	2877	353	3443	235	2105
3L-2S		MI	1406	776	1963	674	2401	565	2657	477	2951	342	3515	280	1865
6-#9	1.67	MA	1651	813	2341	704	2896	588	3242	493	3681	345	4494	285	2614
2L-3S		MI	1320	813	1878	701	2286	585	2513	490	2754	344	3246	196	2301
6-#9	1.67	MA	1484	813	2063	712	2544	594	2816	498	3108	351	3736	212	2602
3L-2S		MI	1464	813	2119	695	2591	580	2883	487	3252	339	3879	269	2307
6-#10	2.12	MA	1737	861	2568	732	3174	607	3573	506	4123	342	5048	274	3254
2L-3S		MI	1361	861	2013	730	2447	605	2704	502	3007	341	3546	161	2839
6-#10	2.12	MA	1535	861	2218	741	2732	615	3038	511	3402	349	4103	181	3221
3L-2S		MI	1535	861	2316	722	2831	599	3168	499	3632	336	4333	254	2863
6-#11	2.60	MA	1805	912	2806	757	3450	625	3894	516	4543	336	5497	250	3884
2L-3S		MI	1396	912	2159	755	2608	622	2886	511	3241	334	3771	110	3356
6-#11	2.60	MA	1580	912	2387	767	2920	633	3253	521	3680	343	4398	136	3823
3L-2S		MI	1589	912	2520	747	3065	617	3439	508	3985	330	4678	225	3403
6-#14	3.75	MA	1988	1034	3348	828	4118	677	4693	548	5611	328	6756	211	5418
2L-3S		MI	1491	1034	2476	828	2992	675	3341	542	3836	324	4439	9	4419
6-#14	3.75	MA	1698	1034	2756	842	3369	687	3787	554	4391	337	5233	45	5121
3L-2S		MI	1741	1034	2985	818	3636	668	4121	540	4880	319	5686	174	4719
6-#18	6.67	MA	2404	1343	4648	1012	5728	811	6622	632	8179	309	9630	86	9097
2L-3S		MI	1722	1343	3225	1014	3906	807	4431	620	5179	282	5931	-276	5683
6-#18	6.67	MA	1986	1343	3637	1031	4448	823	5075	637	6101	318	7142	-207	6864
3L-2S		MI	2084	1343	4089	1000	4999	801	5753	623	6899	274	7934	18	7839
8-#8	1.76	MA	1676	822	2382	712	2957	594	3319	498	3790	346	4661	288	2757
2L-4S		MI	1303	822	1826	714	2223	594	2430	501	2641	345	3150	183	2398
8-#8	1.76	MA	1545	822	2160	718	2677	599	2980	502	3333	351	4052	230	2749
3E		MI	1372	822	1963	709	2401	590	2657	494	2951	345	3515	214	2429
8-#8	1.76	MA	1465	822	2004	724	2473	604	2721	509	2978	353	3620	197	2708
4L-2S		MI	1486	822	2155	703	2645	586	2952	491	3348	340	4025	272	2433
8-#9	2.22	MA	1766	872	2619	741	3248	615	3667	511	4254	343	5252	277	3428
2L-4S		MI	1341	872	1948	745	2367	617	2597	515	2862	342	3424	146	2845
8-#9	2.22	MA	1608	872	2341	748	2896	621	3242	515	3681	349	4494	204	3405
3E		MI	1428	872	2119	738	2591	612	2883	507	3252	342	3879	184	2998
8-#9	2.22	MA	1513	872	2144	756	2640	627	2915	525	3235	351	3955	164	3230
4L-2S		MI	1561	872	2361	732	2896	607	3252	504	3749	337	4512	258	3015
8-#10	2.82	MA	1874	936	2918	778	3617	642	4109	528	4844	339	5992	263	4274
2L-4S		MI	1395	936	2100	785	2549	645	2809	534	3142	338	3767	98	3394
8-#10	2.82	MA	1692	936	2568	787	3174	649	3573	533	4123	346	5048	169	4226
3E		MI	1493	936	2316	777	2831	640	3168	524	3632	339	4333	145	3709
8-#10	2.82	MA	1573	936	2320	797	2852	657	3161	544	3561	349	4374	119	3865
4L-2S		MI	1651	936	2619	769	3215	634	3632	521	4257	333	5119	238	3748
8-#11	3.47	MA	1962	1004	3224	814	3979	668	4534	543	5405	332	6596	232	5102
2L-4S		MI	1432	1004	2261	821	2712	677	3008	548	3398	328	4020	31	3906

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

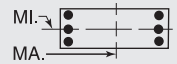
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	3.47	MA	1757	1004	2806	824	3450	675	3894	548	4543	340	5497	118	5020
3E		MI	1544	1004	2520	813	3065	664	3439	538	3985	331	4678	86	4387
8-#11	3.47	MA	1629	1004	2507	835	3062	683	3398	560	3867	340	4708	59	4466
4L-2S		MI	1722	1004	2882	804	3522	659	3991	535	4730	326	5584	200	4454
8-#14	5.00	MA	1940	1166	3348	925	4118	748	4693	593	5611	332	6756	15	6713
3E		MI	1694	1166	2985	911	3636	735	4121	581	4880	318	5686	-31	5644
8-#14	5.00	MA	1778	1166	2925	938	3567	758	3990	609	4653	331	5658	-67	5585
4L-2S		MI	1920	1166	3495	900	4280	729	4900	579	5923	313	6932	134	6192
10-#10	3.53	MA	2007	1010	3268	825	4060	676	4644	550	5565	336	6936	252	5292
2L-5S		MI	1448	1010	2208	839	2658	691	2949	560	3319	341	3997	26	3928
10-#10	3.53	MA	1837	1010	2918	834	3617	684	4109	555	4844	344	5992	158	5232
3L-4S		MI	1529	1010	2403	831	2933	680	3273	556	3766	336	4553	82	4228
10-#10	3.53	MA	1738	1010	2670	843	3294	691	3697	566	4282	346	5319	108	4837
4L-3S		MI	1617	1010	2619	823	3215	674	3632	546	4257	336	5119	129	4578
10-#10	3.53	MA	1632	1010	2448	853	2981	704	3327	572	3770	353	4652	53	4492
5L-2S		MI	1763	1010	2923	816	3598	668	4096	543	4881	330	5905	222	4629
10-#11	4.33	MA	1926	1096	3224	882	3979	717	4534	575	5405	336	6596	100	6220
3L-4S		MI	1587	1096	2622	878	3169	719	3561	575	4142	325	4927	7	4901
10-#11	4.33	MA	1814	1096	2926	892	3591	725	4039	587	4730	337	5807	41	5630
4L-3S		MI	1687	1096	2882	870	3522	707	3991	565	4730	327	5584	61	5402
10-#14	6.25	MA	2035	1299	3517	1021	4316	818	4896	648	5873	326	7181	-97	7016
4L-3S		MI	1891	1299	3495	994	4280	796	4900	620	5923	313	6932	-72	6816
12-#10	4.23	MA	1978	1085	3268	881	4060	718	4644	577	5565	341	6936	147	6238
3L-5S		MI	1579	1085	2511	886	3042	726	3413	582	3944	338	4784	10	4756
12-#10	4.23	MA	1890	1085	3020	890	3737	725	4232	588	5003	343	6263	97	5815
4E		MI	1657	1085	2706	878	3316	714	3737	578	4391	333	5340	66	5069
12-#10	4.23	MA	1791	1085	2798	899	3423	738	3862	594	4491	351	5596	42	5462
5L-3S		MI	1736	1085	2923	870	3598	708	4096	568	4881	333	5905	113	5448
12-#11	5.20	MA	1991	1187	3345	949	4121	767	4680	614	5593	334	6907	23	6802
4E		MI	1737	1187	2983	936	3626	761	4114	602	4887	321	5833	-18	5809
14-#10	4.94	MA	2036	1160	3370	937	4180	760	4768	610	5724	340	7207	86	6799
4L-5S		MI	1705	1160	2815	933	3425	760	3877	604	4568	335	5570	-6	5562
14-#10	4.94	MA	1939	1160	3148	946	3866	773	4397	616	5212	348	6540	30	6437
5L-4S		MI	1782	1160	3009	925	3700	748	4201	600	5016	330	6126	50	5915

RECTANGULAR TIED COLUMNS 18" x 22"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.01	MA	1843	818	2407	735	3002	618	3334	526	3678	387	4474	334	2008
2E		MI	1479	818	2018	717	2453	603	2691	513	2930	376	3444	311	1606
4-#10	1.28	MA	1913	850	2584	752	3215	631	3586	534	4013	384	4908	328	2501
2E		MI	1529	850	2154	734	2615	615	2882	520	3183	373	3744	300	1987
4-#11	1.58	MA	1973	884	2779	767	3433	641	3835	539	4335	379	5272	314	2996
2E		MI	1568	884	2303	747	2777	624	3064	524	3416	367	3967	279	2364
4-#14	2.27	MA	2128	965	3202	813	3949	674	4448	559	5150	373	6276	292	4183
2E		MI	1674	965	2622	792	3162	656	3520	543	4011	359	4634	244	3263
4-#18	4.04	MA	2466	1171	4218	932	5194	761	5934	613	7134	360	8607	224	7041
2E		MI	1907	1171	3375	909	4078	741	4609	595	5353	326	6123	138	5384
6-#8	1.20	MA	1901	840	2517	751	3151	630	3518	534	3931	387	4838	335	2361
2L-3S		MI	1402	840	1909	738	2325	619	2540	524	2731	381	3203	252	1885
6-#8	1.20	MA	1742	840	2266	757	2834	636	3135	539	3414	394	4129	277	2361
3L-2S		MI	1522	840	2101	733	2568	615	2834	521	3128	377	3714	310	1880
6-#9	1.52	MA	1982	877	2722	772	3401	645	3815	544	4326	385	5358	329	2938
2L-3S		MI	1435	877	2018	760	2453	635	2691	533	2930	379	3444	226	2323
6-#9	1.52	MA	1789	877	2407	780	3002	652	3334	550	3678	393	4474	256	2926
3L-2S		MI	1581	877	2259	753	2759	630	3060	530	3428	374	4077	299	2324
6-#10	1.92	MA	2083	924	2980	799	3717	665	4193	556	4830	382	6012	321	3665
2L-3S		MI	1476	924	2154	788	2615	655	2882	546	3183	376	3744	191	2866

RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis



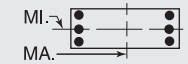
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#10	1.92	MA	1849	924	2584	809	3215	674	3586	563	4013	391	4908	227	3632
3L-2S		MI	1653	924	2457	780	2999	649	3346	542	3808	370	4530	284	2882
6-#11	2.36	MA	2168	976	3255	825	4036	683	4563	566	5316	376	6565	301	4390
2L-3S		MI	1510	976	2303	813	2777	671	3064	554	3416	368	3967	140	3392
6-#11	2.36	MA	1899	976	2779	836	3433	692	3835	573	4335	386	5272	187	4328
3L-2S		MI	1708	976	2664	804	3234	666	3617	551	4160	364	4873	255	3427
6-#14	3.41	MA	2385	1097	3877	896	4802	735	5480	598	6541	368	8078	270	6147
2L-3S		MI	1604	1097	2622	885	3162	723	3520	585	4011	358	4634	39	4545
6-#14	3.41	MA	2046	1097	3202	912	3949	747	4448	607	5150	381	6276	105	5974
3L-2S		MI	1860	1097	3131	875	3806	717	4299	582	5054	353	5880	204	4747
6-#18	6.06	MA	2878	1406	5376	1080	6660	869	7707	682	9521	351	11586	171	10393
2L-3S		MI	1831	1406	3375	1070	4078	854	4609	662	5353	315	6123	-247	5907
6-#18	6.06	MA	2387	1406	4218	1103	5194	886	5934	693	7134	367	8607	-123	8387
3L-2S		MI	2204	1406	4239	1056	5171	849	5931	664	7073	307	8127	47	7877
8-#8	1.60	MA	2011	886	2767	780	3468	651	3902	548	4447	386	5546	332	3099
2L-4S		MI	1417	886	1964	773	2390	645	2607	544	2817	380	3348	214	2428
8-#8	1.60	MA	1859	886	2517	787	3151	657	3518	553	3931	392	4838	274	3090
3E		MI	1488	886	2101	767	2568	640	2834	538	3128	379	3714	244	2449
8-#8	1.60	MA	1768	886	2341	793	2922	663	3226	561	3531	395	4338	240	3050
4L-2S		MI	1603	886	2294	762	2812	636	3129	535	3524	375	4224	302	2450
8-#9	2.02	MA	2116	936	3037	809	3799	672	4297	561	4975	383	6241	324	3860
2L-4S		MI	1455	936	2087	803	2535	667	2775	559	3038	377	3622	177	2913
8-#9	2.02	MA	1934	936	2722	817	3401	679	3815	567	4326	390	5358	251	3837
3E		MI	1540	936	2259	797	2759	662	3060	551	3428	377	4077	215	3022
8-#9	2.02	MA	1825	936	2501	825	3113	686	3448	577	3824	394	4733	209	3697
4L-2S		MI	1679	936	2500	790	3064	657	3429	547	3925	372	4710	288	3034
8-#10	2.57	MA	2246	999	3377	846	4219	699	4800	578	5647	379	7115	313	4823
2L-4S		MI	1503	999	2240	843	2717	695	2986	577	3318	373	3964	128	3469
8-#10	2.57	MA	2027	999	2980	856	3717	708	4193	585	4830	388	6012	220	4775
3E		MI	1609	999	2457	835	2999	689	3346	568	3808	373	4530	175	3738
8-#10	2.57	MA	1896	999	2702	866	3354	717	3729	598	4196	392	5230	167	4427
4L-2S		MI	1770	999	2760	827	3383	683	3810	564	4432	368	5316	268	3769
8-#11	3.15	MA	2353	1067	3731	882	4638	725	5292	593	6296	372	7859	289	5776
2L-4S		MI	1544	1067	2404	878	2882	726	3186	591	3573	362	4216	61	3989
8-#11	3.15	MA	2112	1067	3255	894	4036	735	4563	600	5316	382	6565	174	5694
3E		MI	1659	1067	2664	870	3234	714	3617	581	4160	365	4873	116	4424
8-#11	3.15	MA	1956	1067	2918	905	3597	744	4004	615	4552	385	5644	111	5127
4L-2S		MI	1841	1067	3025	862	3691	708	4169	578	4905	360	5780	230	4480
8-#14	4.55	MA	2329	1230	3877	994	4802	808	5480	646	6541	376	8078	83	7819
3E		MI	1808	1230	3131	968	3806	784	4299	624	5054	352	5880	-2	5878
8-#14	4.55	MA	2142	1230	3398	1010	4179	820	4685	665	5455	378	6790	-5	6783
4L-2S		MI	2041	1230	3641	957	4451	778	5078	621	6098	347	7127	163	6223
10-#10	3.21	MA	2401	1074	3774	893	4721	734	5407	600	6464	376	8219	306	5977
2L-5S		MI	1559	1074	2349	897	2826	741	3126	603	3495	376	4195	56	4040
10-#10	3.21	MA	2203	1074	3377	903	4219	742	4800	607	5647	385	7115	213	5917
3L-4S		MI	1642	1074	2544	889	3101	729	3450	599	3942	370	4751	112	4300
10-#10	3.21	MA	2079	1074	3098	913	3856	751	4336	620	5013	389	6334	160	5535
4L-3S		MI	1733	1074	2760	882	3383	724	3810	590	4432	370	5316	159	4609
10-#10	3.21	MA	1959	1074	2849	923	3503	765	3919	627	4438	399	5554	105	5194
5L-2S		MI	1884	1074	3063	874	3766	718	4274	586	5057	365	6103	252	4651
10-#11	3.94	MA	2309	1159	3731	951	4638	777	5292	627	6296	379	7859	162	7062
3L-4S		MI	1700	1159	2765	936	3339	768	3739	618	4318	359	5123	37	4980
10-#11	3.94	MA	2180	1159	3395	963	4200	786	4732	641	5533	382	6938	99	6458
4L-3S		MI	1803	1159	3025	927	3691	756	4169	608	4905	361	5780	91	5457

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

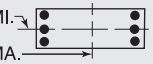
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#11	3.94	MA	2040	1159	3093	974	3774	803	4230	649	4838	392	6024	31	5923
5L-2S		MI	1972	1159	3386	919	4148	750	4722	605	5649	357	6686	206	5528
10-#14	5.68	MA	2440	1362	4073	1093	5032	881	5717	704	6845	374	8591	-27	8532
4L-3S		MI	2005	1362	3641	1051	4451	845	5078	663	6098	346	7127	-42	7060
12-#10	3.85	MA	2367	1149	3774	950	4721	777	5407	629	6464	383	8219	206	7061
3L-5S		MI	1693	1149	2652	944	3210	775	3590	625	4119	373	4981	40	4864
12-#10	3.85	MA	2264	1149	3495	960	4357	785	4943	641	5831	387	7437	153	6648
4E		MI	1771	1149	2847	936	3484	764	3914	621	4567	367	5537	96	5138
12-#10	3.85	MA	2144	1149	3246	970	4005	800	4526	649	5255	396	6658	98	6304
5L-3S		MI	1853	1149	3063	928	3766	758	4274	612	5057	367	6103	143	5480
12-#10	3.85	MA	1981	1149	3003	979	3685	808	4119	661	4693	400	5903	30	5777
6L-2S		MI	1995	1149	3367	920	4150	752	4738	608	5682	362	6889	236	5532
12-#11	4.73	MA	2386	1251	3871	1020	4802	828	5461	668	6514	378	8232	86	7796
4E		MI	1850	1251	3127	993	3796	810	4292	645	5062	355	6029	12	5980
12-#11	4.73	MA	2249	1251	3569	1031	4376	845	4958	676	5819	388	7318	19	7253
5L-3S		MI	1942	1251	3386	985	4148	798	4722	635	5649	358	6686	67	6473
14-#10	4.49	MA	2434	1223	3892	1007	4859	820	5550	663	6648	384	8541	146	7767
4L-5S		MI	1820	1223	2955	991	3593	810	4054	647	4744	370	5767	24	5694
14-#10	4.49	MA	2316	1223	3643	1017	4507	834	5133	670	6072	393	7762	91	7418
5L-4S		MI	1896	1223	3150	983	3868	798	4378	643	5192	364	6323	80	5982
14-#10	4.49	MA	2171	1223	3400	1026	4187	843	4726	683	5510	397	7006	22	6907
6L-3S		MI	1971	1223	3367	975	4150	792	4738	634	5682	365	6889	127	6351
14-#11	5.52	MA	2451	1343	4045	1089	4978	887	5686	703	6799	385	8611	6	8589
5L-4S		MI	1995	1343	3488	1051	4253	853	4844	672	5806	352	6936	-12	6915
16-#10	5.13	MA	2483	1298	4039	1063	5008	868	5740	692	6889	390	8865	84	8535
5E		MI	1943	1298	3259	1037	3977	844	4518	669	5369	367	6554	8	6529
16-#10	5.13	MA	2347	1298	3797	1073	4689	877	5333	705	6327	394	8110	15	8040
6L-4S		MI	2018	1298	3453	1030	4252	832	4842	665	5816	362	7110	64	6830

RECTANGULAR TIED COLUMNS 18" x 24"

4-#10	1.18	MA	2262	913	2970	820	3731	688	4171	584	4663	424	5763	369	2775
2E		MI	1645	913	2294	792	2783	664	3059	563	3359	408	3941	331	2003
4-#11	1.44	MA	2332	947	3191	835	3979	699	4454	589	5029	419	6196	357	3333
2E		MI	1685	947	2446	804	2946	673	3242	567	3591	401	4163	309	2384
4-#14	2.08	MA	2513	1029	3668	881	4560	732	5145	610	5949	413	7371	341	4669
2E		MI	1792	1029	2768	849	3332	704	3698	586	4185	393	4829	274	3288
4-#18	3.70	MA	2911	1235	4820	1000	5972	818	6831	663	8198	400	10129	286	7905
2E		MI	2026	1235	3525	965	4250	788	4788	637	5527	359	6315	167	5418
6-#8	1.10	MA	2246	903	2893	818	3657	688	4093	585	4568	428	5641	372	2617
2L-3S		MI	1516	903	2047	797	2492	669	2717	568	2907	416	3402	283	1902
6-#8	1.10	MA	2065	903	2614	826	3303	694	3665	590	3992	435	4843	315	2617
3L-2S		MI	1638	903	2240	792	2735	665	3012	565	3304	412	3912	341	1895
6-#9	1.39	MA	2340	940	3123	839	3937	703	4426	594	5012	425	6252	369	3262
2L-3S		MI	1549	940	2157	818	2621	684	2868	577	3106	413	3641	256	2343
6-#9	1.39	MA	2121	940	2771	848	3492	711	3888	601	4287	434	5248	297	3250
3L-2S		MI	1697	940	2398	812	2926	680	3238	574	3603	409	4275	330	2341
6-#10	1.76	MA	2456	988	3413	867	4292	723	4850	606	5576	422	7026	365	4077
2L-3S		MI	1590	988	2294	846	2783	705	3059	589	3359	410	3941	221	2892
6-#10	1.76	MA	2190	988	2970	878	3731	732	4171	614	4663	433	5763	272	4044
3L-2S		MI	1770	988	2597	839	3167	699	3523	585	3983	405	4727	315	2901
6-#11	2.17	MA	2557	1039	3724	892	4653	741	5270	616	6128	416	7686	349	4895
2L-3S		MI	1624	1039	2446	870	2946	720	3242	597	3591	402	4163	170	3424
6-#11	2.17	MA	2250	1039	3191	905	3979	751	4454	625	5029	428	6196	235	4834
3L-2S		MI	1825	1039	2807	862	3403	715	3795	594	4336	398	5069	285	3450
6-#14	3.13	MA	2813	1161	4426	964	5518	793	6305	649	7510	408	9454	325	6876
2L-3S		MI	1718	1161	2768	942	3332	772	3698	627	4185	392	4829	68	4668

RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis



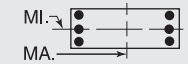
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	3.13	MA	2422	1161	3668	981	4560	807	5145	660	5949	424	7371	160	6703
3L-2S		MI	1979	1161	3277	932	3977	765	4477	625	5229	387	6075	233	4776
6-#18	5.56	MA	3384	1470	6125	1147	7624	926	8828	732	10888	391	13605	246	11689
2L-3S		MI	1941	1470	3525	1126	4250	902	4788	703	5527	349	6315	-218	6129
6-#18	5.56	MA	2818	1470	4820	1175	5972	948	6831	748	8198	413	10129	-48	10021
3L-2S		MI	2324	1470	4389	1112	5343	896	6110	706	7247	340	8319	76	7914
8-#8	1.46	MA	2372	950	3173	847	4011	709	4521	598	5144	426	6439	370	3440
2L-4S		MI	1531	950	2103	831	2557	695	2784	588	2994	415	3547	244	2454
8-#8	1.46	MA	2200	950	2893	855	3657	715	4093	604	4568	433	5641	313	3431
3E		MI	1603	950	2240	826	2735	690	3012	581	3304	414	3912	275	2467
8-#8	1.46	MA	2097	950	2699	862	3403	722	3768	613	4124	437	5084	279	3391
4L-2S		MI	1719	950	2432	821	2979	686	3306	578	3700	410	4422	333	2466
8-#9	1.85	MA	2494	999	3475	876	4382	730	4964	611	5736	423	7255	366	4292
2L-4S		MI	1569	999	2227	862	2702	716	2952	602	3214	412	3820	207	2979
8-#9	1.85	MA	2286	999	3123	885	3937	738	4426	618	5012	432	6252	294	4269
3E		MI	1655	999	2398	855	2926	711	3238	594	3603	411	4275	245	3045
8-#9	1.85	MA	2162	999	2878	894	3617	746	4017	629	4453	436	5548	250	4175
4L-2S		MI	1797	999	2640	849	3231	707	3607	591	4101	406	4908	318	3053
8-#10	2.35	MA	2643	1063	3857	914	4853	757	5528	628	6490	419	8290	361	5372
2L-4S		MI	1617	1063	2381	901	2885	745	3164	620	3493	407	4162	158	3542
8-#10	2.35	MA	2393	1063	3413	925	4292	767	4850	636	5576	430	7026	268	5323
3E		MI	1724	1063	2597	893	3167	739	3523	611	3983	408	4727	205	3766
8-#10	2.35	MA	2246	1063	3104	936	3888	776	4333	650	4871	435	6136	213	5003
4L-2S		MI	1889	1063	2901	885	3551	733	3987	607	4608	402	5514	299	3790
8-#11	2.89	MA	2772	1131	4258	950	5328	783	6087	643	7227	412	9175	341	6449
2L-4S		MI	1657	1131	2548	936	3051	775	3364	633	3749	396	4412	91	4069
8-#11	2.89	MA	2487	1131	3724	962	4653	794	5270	652	6128	424	7686	226	6368
3E		MI	1774	1131	2807	927	3403	763	3795	624	4336	399	5069	146	4459
8-#11	2.89	MA	2317	1131	3350	975	4165	804	4647	668	5277	429	6632	161	5802
4L-2S		MI	1961	1131	3169	919	3861	757	4347	621	5080	394	5976	260	4505
8-#14	4.17	MA	2746	1294	4426	1064	5518	868	6305	699	7510	419	9454	144	8879
3E		MI	1923	1294	3277	1025	3977	833	4477	666	5229	386	6075	28	6002
8-#14	4.17	MA	2533	1294	3892	1081	4822	882	5416	720	6297	425	7974	52	7718
4L-2S		MI	2161	1294	3786	1014	4621	826	5257	664	6273	381	7321	193	6253
8-#18	7.41	MA	3354	1706	6125	1322	7624	1056	8828	817	10888	404	13605	-88	13339
3E		MI	2278	1706	4389	1273	5343	1010	6110	773	7247	329	8319	-309	7972
8-#18	7.41	MA	3050	1706	5199	1349	6417	1078	7288	851	8787	408	11119	-243	10620
4L-2S		MI	2619	1706	5253	1259	6436	1005	7432	775	8967	321	10323	-15	10291
10-#10	2.94	MA	2824	1138	4300	960	5414	791	6206	650	7403	416	9554	357	6663
2L-5S		MI	1671	1138	2489	956	2994	790	3304	646	3671	410	4392	86	4145
10-#10	2.94	MA	2589	1138	3857	971	4853	801	5528	658	6490	427	8290	264	6603
3L-4S		MI	1756	1138	2684	948	3269	779	3628	642	4118	405	4948	142	4370
10-#10	2.94	MA	2454	1138	3547	982	4449	811	5012	672	5785	432	7400	209	6246
4L-3S		MI	1849	1138	2901	940	3551	773	3987	633	4608	405	5514	189	4638
10-#10	2.94	MA	2312	1138	3271	994	4057	826	4549	680	5145	443	6508	155	5838
5L-2S		MI	2004	1138	3204	932	3934	767	4451	629	5233	399	6300	283	4674
10-#11	3.61	MA	2722	1223	4258	1020	5328	836	6087	679	7227	421	9175	218	7904
3L-4S		MI	1813	1223	2909	993	3508	817	3917	660	4493	393	5318	66	5058
10-#11	3.61	MA	2562	1223	3883	1032	4840	847	5463	695	6376	426	8121	153	7300
4L-3S		MI	1918	1223	3169	985	3861	805	4347	651	5080	395	5976	121	5493
10-#11	3.61	MA	2399	1223	3549	1045	4366	864	4904	704	5602	438	7069	85	6759
5L-2S		MI	2092	1223	3530	977	4318	799	4900	648	5824	391	6882	236	5554
10-#14	5.21	MA	2874	1426	4650	1164	5781	943	6576	759	7858	420	10058	37	9867
4L-3S		MI	2120	1426	3786	1108	4621	893	5257	705	6273	380	7321	-13	7302

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

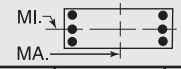
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	5.21	MA	2645	1426	4172	1181	5105	968	5778	771	6755	435	8586	-61	8498
5L-2S		MI	2339	1426	4296	1097	5265	887	6036	703	7317	375	8568	152	7725
12-#10	3.53	MA	2784	1212	4300	1018	5414	835	6206	680	7403	424	9554	260	7884
3L-5S		MI	1808	1212	2793	1002	3378	825	3768	668	4295	407	5178	70	4969
12-#10	3.53	MA	2655	1212	3990	1029	5010	845	5690	694	6698	429	8663	205	7495
4E		MI	1885	1212	2987	994	3652	813	4092	664	4743	402	5734	126	5206
12-#10	3.53	MA	2515	1212	3714	1040	4618	860	5228	702	6058	440	7771	151	7106
5L-3S		MI	1970	1212	3204	987	3934	808	4451	655	5233	402	6300	173	5510
12-#10	3.53	MA	2339	1212	3438	1049	4264	870	4776	716	5434	446	6910	80	6540
6L-2S		MI	2116	1212	3507	979	4318	802	4915	651	5858	396	7086	267	5555
12-#11	4.33	MA	2809	1315	4417	1090	5515	889	6279	722	7474	422	9610	144	8806
4E		MI	1963	1315	3270	1051	3965	859	4470	687	5237	389	6225	42	6055
12-#11	4.33	MA	2647	1315	4082	1103	5041	907	5720	731	6701	434	8559	77	8262
5L-3S		MI	2058	1315	3530	1042	4318	847	4900	678	5824	392	6882	97	6528
12-#11	4.33	MA	2433	1315	3755	1114	4612	917	5173	746	5945	439	7540	-7	7530
6L-2S		MI	2222	1315	3891	1034	4775	841	5453	675	6569	387	7789	211	6601
12-#14	6.25	MA	2976	1558	4930	1264	6064	1028	6937	810	8316	430	10669	-76	10508
5L-3S		MI	2313	1558	4296	1190	5265	954	6036	744	7317	374	8568	-53	8474
14-#10	4.12	MA	2860	1287	4434	1076	5571	879	6369	716	7612	427	9927	201	8750
4L-5S		MI	1935	1287	3096	1049	3761	859	4232	690	4920	404	5965	54	5796
14-#10	4.12	MA	2721	1287	4158	1087	5179	895	5906	724	6972	438	9035	147	8378
5L-4S		MI	2011	1287	3291	1041	4036	848	4556	686	5367	399	6521	110	6047
14-#10	4.12	MA	2545	1287	3881	1096	4825	904	5455	738	6347	443	8174	76	7808
6L-3S		MI	2088	1287	3507	1033	4318	842	4915	677	5858	399	7086	157	6381
14-#11	5.06	MA	2877	1407	4616	1160	5716	949	6536	758	7800	431	10048	69	9769
5L-4S		MI	2109	1407	3632	1108	4422	902	5022	714	5981	386	7132	18	7058
14-#11	5.06	MA	2688	1407	4288	1171	5286	960	5989	773	7044	436	9029	-15	8997
6L-3S		MI	2196	1407	3891	1100	4775	889	5453	705	6569	388	7789	72	7544
16-#10	4.70	MA	2911	1362	4601	1134	5740	929	6585	746	7885	435	10299	143	9652
5E		MI	2058	1362	3399	1096	4145	894	4696	712	5545	402	6751	38	6627
16-#10	4.70	MA	2757	1362	4324	1142	5385	939	6133	760	7261	440	9438	72	9075
6L-4S		MI	2133	1362	3594	1088	4420	882	5020	708	5992	396	7307	94	6894
16-#11	5.78	MA	2924	1498	4822	1229	5961	1002	6806	800	8143	432	10519	-24	10454
6L-4S		MI	2252	1498	3993	1165	4879	944	5575	741	6726	383	8038	-7	8025
18-#10	5.29	MA	2951	1437	4768	1189	5946	973	6811	782	8174	437	10702	68	10349
6L-5S		MI	2179	1437	3702	1142	4529	928	5160	734	6169	399	7538	22	7463

RECTANGULAR TIED COLUMNS 18" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.09	MA	2637	977	3376	888	4278	746	4793	635	5353	464	6613	405	3050
2E		MI	1761	977	2435	850	2951	714	3237	606	3535	442	4138	361	2019
4-#11	1.33	MA	2718	1011	3623	902	4555	756	5110	640	5763	459	7169	399	3670
2E		MI	1801	1011	2590	862	3116	722	3420	609	3767	435	4358	339	2403
4-#14	1.92	MA	2925	1092	4155	948	5203	789	5880	660	6788	453	8517	387	5155
2E		MI	1909	1092	2913	906	3503	753	3876	628	4360	426	5023	303	3312
4-#18	3.42	MA	3387	1298	5442	1068	6782	876	7765	713	9302	440	11707	343	8769
2E		MI	2144	1298	3674	1021	4422	836	4967	678	5701	392	6508	196	5452
6-#8	1.01	MA	2617	967	3290	886	4194	745	4705	635	5245	468	6473	408	2873
2L-3S		MI	1631	967	2186	856	2659	719	2894	611	3083	451	3600	313	1917
6-#8	1.01	MA	2415	967	2982	894	3804	752	4232	641	4609	476	5592	352	2873
3L-2S		MI	1754	967	2378	850	2902	715	3189	608	3480	446	4110	371	1909
6-#9	1.28	MA	2725	1004	3545	907	4505	761	5074	644	5736	465	7149	404	3586
2L-3S		MI	1664	1004	2297	877	2788	734	3046	620	3282	448	3839	287	2362
6-#9	1.28	MA	2478	1004	3156	917	4013	769	4479	652	4936	475	6041	334	3574
3L-2S		MI	1813	1004	2538	870	3094	729	3415	617	3779	443	4473	360	2357

RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#10	1.63	MA	2857	1052	3866	934	4898	780	5543	656	6363	462	8011	401	4488
2L-3S		MI	1705	1052	2435	905	2951	754	3237	632	3535	445	4138	252	2915
6-#10	1.63	MA	2557	1052	3376	946	4278	791	4793	666	5353	474	6613	310	4455
3L-2S		MI	1887	1052	2738	897	3335	748	3701	628	4159	439	4925	345	2919
6-#11	2.00	MA	2974	1103	4214	960	5303	798	6014	667	6980	456	8854	395	5400
2L-3S		MI	1739	1103	2590	928	3116	769	3420	639	3767	436	4358	200	3455
6-#11	2.00	MA	2627	1103	3623	974	4555	810	5110	677	5763	469	7169	280	5339
3L-2S		MI	1943	1103	2951	919	3573	764	3973	636	4511	432	5265	314	3473
6-#14	2.88	MA	3269	1225	4995	1031	6266	850	7166	699	8519	448	10883	377	7605
2L-3S		MI	1831	1225	2913	999	3503	820	3876	669	4360	425	5023	98	4721
6-#14	2.88	MA	2812	1225	4155	1050	5203	866	5880	712	6788	466	8517	211	7432
3L-2S		MI	2098	1225	3423	988	4147	814	4656	667	5404	420	6270	263	4803
6-#18	5.13	MA	3923	1534	6894	1215	8619	984	9987	783	12295	431	15683	314	12985
2L-3S		MI	2052	1534	3674	1182	4422	950	4967	745	5701	382	6508	-189	6350
6-#18	5.13	MA	3277	1534	5442	1245	6782	1009	7765	802	9302	458	11707	20	11650
3L-2S		MI	2443	1534	4538	1168	5515	944	6289	748	7421	373	8511	105	7951
8-#8	1.35	MA	2760	1013	3599	915	4585	767	5177	649	5881	466	7354	405	3781
2L-4S		MI	1645	1013	2241	890	2724	745	2962	632	3170	449	3745	275	2477
8-#8	1.35	MA	2566	1013	3290	923	4194	774	4705	655	5245	474	6473	350	3773
3E		MI	1718	1013	2378	885	2902	741	3189	625	3480	449	4110	305	2485
8-#8	1.35	MA	2452	1013	3077	930	3915	781	4347	664	4757	478	5865	316	3732
4L-2S		MI	1836	1013	2571	879	3146	736	3484	622	3876	445	4621	363	2482
8-#9	1.71	MA	2898	1063	3933	944	4996	788	5668	662	6537	463	8257	401	4724
2L-4S		MI	1683	1063	2366	920	2870	766	3130	646	3390	446	4018	237	3035
8-#9	1.71	MA	2665	1063	3545	953	4505	796	5074	669	5736	473	7149	331	4701
3E		MI	1771	1063	2538	914	3094	761	3415	638	3779	446	4473	275	3067
8-#9	1.71	MA	2526	1063	3275	963	4153	805	4624	681	5122	478	6381	288	4613
4L-2S		MI	1913	1063	2779	907	3399	756	3784	634	4277	441	5106	349	3070
8-#10	2.17	MA	3068	1126	4357	981	5518	815	6293	678	7372	459	9410	397	5920
2L-4S		MI	1730	1126	2522	959	3053	794	3342	664	3669	442	4359	188	3612
8-#10	2.17	MA	2787	1126	3866	993	4898	825	5543	688	6363	471	8011	306	5872
3E		MI	1836	1126	2738	951	3335	788	3701	654	4159	442	4925	236	3792
8-#10	2.17	MA	2621	1126	3526	1005	4454	836	4975	702	5586	477	7038	252	5590
4L-2S		MI	2007	1126	3041	943	3719	783	4165	650	4784	437	5711	329	3810
8-#11	2.67	MA	3219	1195	4805	1017	6050	841	6918	694	8198	452	10540	390	7123
2L-4S		MI	1769	1195	2691	993	3220	824	3542	676	3924	430	4608	121	4147
8-#11	2.67	MA	2895	1195	4214	1031	5303	852	6014	704	6980	466	8854	275	7042
3E		MI	1889	1195	2951	985	3573	812	3973	666	4511	433	5265	175	4493
8-#11	2.67	MA	2704	1195	3802	1045	4765	864	5327	721	6041	473	7667	208	6491
4L-2S		MI	2079	1195	3312	977	4030	806	4525	663	5255	428	6172	290	4530
8-#14	3.85	MA	3192	1357	4995	1133	6266	927	7166	751	8519	461	10883	201	9851
3E		MI	2037	1357	3423	1082	4147	881	4656	708	5404	420	6270	57	6116
8-#14	3.85	MA	2934	1357	4407	1152	5498	943	6185	775	7180	470	9211	106	8642
4L-2S		MI	2281	1357	3932	1071	4791	875	5435	706	6448	415	7516	222	6282
8-#18	6.84	MA	3882	1769	6894	1392	8619	1117	9987	871	12295	449	15683	-9	15648
3E		MI	2389	1769	4538	1329	5515	1058	6289	814	7421	363	8511	-280	8204
8-#18	6.84	MA	3541	1769	5870	1423	7284	1142	8282	909	9968	458	12857	-172	12432
4L-2S		MI	2739	1769	5403	1315	6608	1052	7611	817	9141	354	10515	14	10440
10-#10	2.71	MA	3272	1201	4847	1028	6138	849	7043	700	8382	456	10808	393	7349
2L-5S		MI	1778	1201	2630	1014	3162	840	3482	689	3846	444	4589	116	4209
10-#10	2.71	MA	3007	1201	4357	1040	5518	860	6293	710	7372	468	9410	302	7289
3L-4S		MI	1870	1201	2825	1006	3437	829	3806	686	4294	439	5145	172	4438
10-#10	2.71	MA	2856	1201	4016	1051	5074	870	5725	724	6596	475	8436	248	6969
4L-3S		MI	1965	1201	3041	998	3719	823	4165	676	4784	439	5711	220	4666

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 26"

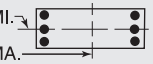
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#10	2.71	MA	2692	1201	3713	1063	4643	886	5216	733	5892	487	7458	197	6488
5L-2S		MI	2123	1201	3345	990	4102	817	4629	672	5409	434	6497	313	4695
10-#11	3.33	MA	3153	1287	4805	1088	6050	895	6918	731	8198	462	10540	271	8747
3L-4S		MI	1926	1287	3053	1051	3677	866	4095	703	4668	427	5514	96	5133
10-#11	3.33	MA	2981	1287	4392	1102	5512	907	6231	748	7258	469	9353	203	8157
4L-3S		MI	2034	1287	3312	1042	4030	854	4525	693	5255	429	6172	151	5528
10-#11	3.33	MA	2791	1287	4025	1116	4991	925	5615	758	6406	483	8163	136	7619
5L-2S		MI	2212	1287	3674	1034	4487	848	5078	690	6000	425	7078	266	5581
10-#14	4.81	MA	3336	1490	5247	1235	6561	1004	7471	814	8911	465	11577	96	11035
4L-3S		MI	2235	1490	3932	1165	4791	942	5435	747	6448	414	7516	17	7467
10-#14	4.81	MA	3070	1490	4721	1253	5816	1030	6592	827	7695	483	9907	-1	9905
5L-2S		MI	2460	1490	4441	1154	5436	935	6214	745	7492	409	8762	182	7756
12-#10	3.26	MA	3220	1276	4847	1086	6138	894	7043	732	8382	465	10808	298	8707
3L-5S		MI	1921	1276	2933	1060	3546	874	3945	711	4471	442	5376	100	5057
12-#10	3.26	MA	3082	1276	4506	1098	5694	904	6475	746	7605	472	9834	244	8355
4E		MI	2000	1276	3128	1053	3820	863	4270	708	4918	436	5932	156	5272
12-#10	3.26	MA	2921	1276	4203	1110	5263	921	5966	755	6902	484	8856	193	7894
5L-3S		MI	2087	1276	3345	1045	4102	857	4629	698	5409	436	6497	204	5538
12-#10	3.26	MA	2723	1276	3892	1118	4874	931	5470	770	6215	491	7915	123	7312
6L-2S		MI	2236	1276	3648	1037	4486	851	5093	694	6033	431	7284	297	5577
12-#11	4.00	MA	3261	1378	4983	1159	6260	949	7135	775	8475	466	11038	198	9830
4E		MI	2076	1378	3414	1108	4135	908	4648	730	5412	423	6421	72	6127
12-#11	4.00	MA	3060	1378	4615	1173	5738	968	6519	785	7623	479	9849	132	9295
5L-3S		MI	2175	1378	3674	1100	4487	896	5078	720	6000	426	7078	126	6563
12-#11	4.00	MA	2831	1378	4246	1184	5266	980	5917	802	6791	486	8701	45	8478
6L-2S		MI	2342	1378	4035	1091	4944	890	5631	717	6744	421	7985	241	6628
12-#14	5.77	MA	3443	1622	5562	1336	6880	1091	7878	866	9426	478	12273	-11	12245
5L-3S		MI	2428	1622	4441	1247	5436	1003	6214	786	7492	408	8762	-24	8722
14-#10	3.80	MA	3300	1351	4996	1145	6314	939	7225	768	8615	469	11232	240	9746
4L-5S		MI	2050	1351	3237	1107	3929	909	4409	733	5096	439	6162	84	5895
14-#10	3.80	MA	3141	1351	4693	1157	5883	955	6716	777	7911	481	10254	189	9303
5L-4S		MI	2126	1351	3431	1099	4204	897	4734	730	5543	433	6718	140	6111
14-#10	3.80	MA	2954	1351	4382	1165	5494	965	6220	792	7225	488	9313	119	8720
6L-3S		MI	2206	1351	3648	1091	4486	892	5093	720	6033	434	7284	188	6411
14-#10	3.80	MA	2789	1351	4030	1178	5105	974	5740	801	6557	500	8385	75	8098
7L-2S		MI	2348	1351	3951	1084	4869	886	5557	716	6658	428	8070	281	6457
14-#11	4.67	MA	3331	1470	5206	1230	6485	1010	7423	812	8840	476	11534	127	10975
5L-4S		MI	2223	1470	3775	1165	4592	951	5200	757	6157	420	7327	47	7128
14-#11	4.67	MA	3119	1470	4837	1241	6013	1022	6821	829	8009	482	10386	40	10180
6L-3S		MI	2313	1470	4035	1157	4944	938	5631	747	6744	422	7985	102	7599
16-#10	4.34	MA	3367	1425	5183	1203	6503	989	7466	799	8921	478	11652	185	10715
5E		MI	2174	1425	3540	1154	4313	943	4873	755	5720	436	6949	68	6724
16-#10	4.34	MA	3179	1425	4872	1212	6114	1000	6970	814	8235	485	10711	115	10131
6L-4S		MI	2249	1425	3735	1146	4588	932	5198	752	6168	431	7504	125	6955
16-#10	4.34	MA	3023	1425	4520	1225	5725	1009	6490	823	7567	497	9784	72	9511
7L-3S		MI	2323	1425	3951	1138	4869	926	5557	742	6658	431	8070	172	7283
16-#11	5.33	MA	3384	1562	5428	1298	6761	1064	7725	856	9226	479	12072	35	11884
6L-4S		MI	2366	1562	4137	1223	5049	993	5753	784	6901	417	8234	23	8136
18-#10	4.88	MA	3412	1500	5363	1258	6734	1034	7720	836	9244	482	12109	111	11543
6L-5S		MI	2295	1500	3843	1201	4697	977	5337	777	6345	433	7735	52	7557
18-#10	4.88	MA	3251	1500	5010	1272	6345	1043	7240	845	8577	494	11182	68	10924
7L-4S		MI	2369	1500	4038	1193	4971	966	5661	773	6793	428	8291	109	7803
20-#10	5.43	MA	3491	1575	5500	1318	6965	1077	7990	867	9586	491	12580	64	12337
7L-5S		MI	2414	1575	4146	1247	5080	1012	5801	799	6970	430	8521	36	8394

RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis



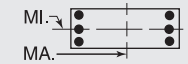
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#10	1.01	MA	3038	1041	3803	955	4857	804	5453	685	6083	504	7510	440	3324
2E		MI	1876	1041	2575	908	3119	764	3415	650	3710	477	4336	391	2034
4-#11	1.24	MA	3131	1075	4076	970	5164	814	5804	690	6537	499	8125	435	4007
2E		MI	1917	1075	2733	919	3285	771	3598	652	3942	469	4554	369	2422
4-#14	1.79	MA	3365	1156	4662	1016	5877	847	6652	710	7666	493	9679	428	5641
2E		MI	2026	1156	3059	963	3673	802	4055	670	4535	460	5218	333	3335
4-#18	3.17	MA	3891	1362	6084	1135	7623	934	8735	764	10446	480	13338	396	9633
2E		MI	2262	1362	3824	1077	4594	884	5145	720	5875	425	6700	225	5485
6-#9	1.19	MA	3136	1068	3987	975	5104	818	5758	695	6501	505	8094	440	3910
2L-3S		MI	1779	1068	2436	935	2956	784	3223	664	3458	483	4037	317	2380
6-#9	1.19	MA	2862	1068	3562	985	4566	827	5108	703	5625	516	6881	371	3898
3L-2S		MI	1929	1068	2677	929	3261	779	3593	660	3955	478	4671	391	2372
6-#10	1.51	MA	3284	1115	4340	1002	5537	838	6274	707	7189	502	9041	436	4900
2L-3S		MI	1820	1115	2575	963	3119	804	3415	676	3710	479	4336	282	2938
6-#10	1.51	MA	2951	1115	3803	1014	4857	849	5453	717	6083	515	7510	347	4867
3L-2S		MI	2003	1115	2879	955	3503	798	3879	672	4335	474	5122	375	2937
6-#11	1.86	MA	3418	1167	4724	1027	5984	856	6795	717	7872	496	9974	430	5906
2L-3S		MI	1853	1167	2733	985	3285	818	3598	682	3942	470	4554	230	3484
6-#11	1.86	MA	3030	1167	4076	1042	5164	869	5804	728	6537	511	8125	318	5844
3L-2S		MI	2060	1167	3095	977	3742	813	4151	679	4686	466	5461	344	3494
6-#14	2.68	MA	3751	1288	5585	1099	7045	908	8065	749	9568	488	12313	421	8334
2L-3S		MI	1945	1288	3059	1056	3673	869	4055	712	4535	459	5218	127	4762
6-#14	2.68	MA	3240	1288	4662	1119	5877	926	6652	764	7666	509	9679	257	8161
3L-2S		MI	2216	1288	3568	1045	4317	862	4834	709	5579	454	6464	292	4830
6-#18	4.76	MA	4493	1597	7684	1282	9647	1042	11183	833	13742	471	17816	376	14281
2L-3S		MI	2163	1597	3824	1237	4594	997	5145	786	5875	415	6700	-160	6569
6-#18	4.76	MA	3765	1597	6084	1315	7623	1070	8735	856	10446	502	13338	83	13081
3L-2S		MI	2563	1597	4688	1224	5687	992	6467	789	7595	406	8704	134	7987
8-#8	1.25	MA	3175	1077	4046	983	5191	824	5870	699	6658	506	8316	440	4123
2L-4S		MI	1759	1077	2380	949	2891	795	3139	675	3346	484	3943	305	2498
8-#8	1.25	MA	2959	1077	3708	991	4764	832	5353	705	5962	514	7352	386	4114
3E		MI	1833	1077	2517	943	3069	791	3366	669	3656	484	4309	336	2502
8-#8	1.25	MA	2833	1077	3475	999	4459	839	4964	716	5429	520	6694	353	4074
4L-2S		MI	1952	1077	2709	938	3313	786	3661	666	4053	479	4819	394	2497
8-#9	1.59	MA	3330	1127	4412	1011	5642	845	6409	712	7377	503	9307	437	5156
2L-4S		MI	1797	1127	2506	979	3037	816	3307	689	3566	481	4216	268	3064
8-#9	1.59	MA	3070	1127	3987	1021	5104	854	5758	720	6501	513	8094	367	5133
3E		MI	1886	1127	2677	972	3261	811	3593	681	3955	480	4671	306	3087
8-#9	1.59	MA	2917	1127	3693	1031	4720	863	5267	732	5830	520	7262	325	5045
4L-2S		MI	2030	1127	2919	966	3566	806	3962	678	4453	476	5304	379	3088
8-#10	2.02	MA	3521	1190	4877	1049	6216	873	7095	729	8295	499	10573	432	6469
2L-4S		MI	1844	1190	2662	1017	3221	844	3519	707	3845	476	4556	219	3681
8-#10	2.02	MA	3207	1190	4340	1061	5537	884	6274	739	7189	512	9041	343	6420
3E		MI	1951	1190	2879	1009	3503	838	3879	697	4335	476	5122	266	3817
8-#10	2.02	MA	3023	1190	3968	1074	5051	895	5653	754	6341	520	7987	290	6189
4L-2S		MI	2125	1190	3182	1002	3887	832	4343	694	4960	471	5908	359	3830
8-#11	2.48	MA	3692	1258	5372	1085	6804	898	7787	744	9208	492	11823	425	7797
2L-4S		MI	1882	1258	2835	1051	3390	873	3720	719	4099	464	4804	151	4223
8-#11	2.48	MA	3330	1258	4724	1099	5984	911	6795	755	7872	507	9974	314	7716
3E		MI	2005	1258	3095	1042	3742	861	4151	709	4686	467	5461	205	4524
8-#11	2.48	MA	3118	1258	4274	1114	5396	924	6044	773	6845	515	8687	247	7192
4L-2S		MI	2198	1258	3456	1034	4199	855	4703	706	5430	462	6367	320	4554
8-#14	3.57	MA	3652	1421	5585	1202	7045	986	8065	803	9568	504	12313	250	10823
3E		MI	2152	1421	3568	1139	4317	930	4834	751	5579	453	6464	87	6213

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis

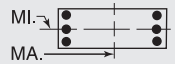


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#14	3.57	MA	3377	1421	4941	1222	6205	1004	6991	828	8102	514	10465	153	9581
4L-2S		MI	2400	1421	4078	1128	4962	923	5613	748	6623	448	7711	252	6311
8-#18	6.35	MA	4440	1833	7684	1463	9647	1178	11183	925	13742	493	17816	63	17591
3E		MI	2500	1833	4688	1385	5687	1105	6467	856	7595	396	8704	-251	8435
8-#18	6.35	MA	4059	1833	6562	1495	8183	1206	9314	966	11189	507	14649	-106	14333
4L-2S		MI	2859	1833	5552	1371	6780	1100	7789	858	9315	387	10708	43	10477
10-#10	2.52	MA	3749	1265	5414	1096	6895	907	7917	751	9401	496	12104	428	8035
2L-5S		MI	1890	1265	2771	1072	3330	890	3659	733	4022	479	4787	146	4271
10-#10	2.52	MA	3452	1265	4877	1108	6216	918	7095	761	8295	509	10573	340	7975
3L-4S		MI	1984	1265	2966	1064	3605	878	3983	729	4470	473	5343	203	4504
10-#10	2.52	MA	3284	1265	4505	1120	5730	929	6475	776	7447	517	9518	286	7705
4L-3S		MI	2081	1265	3182	1056	3887	872	4343	719	4960	474	5908	250	4692
10-#10	2.52	MA	3098	1265	4175	1133	5261	946	5921	786	6679	530	8454	237	7146
5L-2S		MI	2242	1265	3485	1048	4270	867	4807	716	5584	468	6695	343	4717
10-#11	3.10	MA	3618	1350	5372	1157	6804	953	7787	782	9208	504	11823	309	9589
3L-4S		MI	2039	1350	3196	1108	3847	915	4273	746	4843	461	5710	126	5206
10-#11	3.10	MA	3426	1350	4922	1171	6216	966	7035	800	8181	512	10536	242	9027
4L-3S		MI	2150	1350	3456	1100	4199	903	4703	736	5430	463	6367	181	5561
10-#11	3.10	MA	3210	1350	4521	1186	5647	986	6363	811	7250	527	9241	179	8407
5L-2S		MI	2332	1350	3817	1091	4656	897	5256	733	6175	459	7274	295	5606
10-#14	4.46	MA	3827	1553	5864	1305	7373	1065	8404	867	10004	509	13098	146	12219
4L-3S		MI	2350	1553	4078	1222	4962	991	5613	790	6623	447	7711	46	7574
10-#14	4.46	MA	3505	1553	5291	1325	6560	1092	7443	882	8674	529	11245	52	11056
5L-2S		MI	2581	1553	4587	1211	5606	984	6393	787	7667	442	8957	212	7786
10-#18	7.94	MA	4779	2068	8162	1643	10207	1314	11761	1035	14485	498	19127	-126	18528
4L-3S		MI	2828	2068	5552	1532	6780	1214	7789	925	9315	377	10708	-341	10263
12-#10	3.02	MA	3689	1340	5414	1155	6895	952	7917	783	9401	506	12104	336	9530
3L-5S		MI	2034	1340	3074	1119	3714	924	4123	755	4647	476	5573	130	5117
12-#10	3.02	MA	3536	1340	5042	1167	6410	964	7296	798	8553	514	11049	282	9228
4E		MI	2114	1340	3269	1111	3988	913	4447	751	5094	471	6129	187	5335
12-#10	3.02	MA	3353	1340	4712	1179	5940	980	6742	808	7785	527	9985	233	8689
5L-3S		MI	2204	1340	3485	1103	4270	907	4807	741	5584	471	6695	234	5566
12-#10	3.02	MA	3134	1340	4367	1187	5517	992	6201	824	7037	535	8966	164	8098
6L-2S		MI	2356	1340	3788	1095	4654	901	5271	738	6209	465	7481	327	5600
12-#11	3.71	MA	3722	1442	5570	1229	7036	1008	8027	827	9516	508	12385	237	10868
4E		MI	2190	1442	3558	1165	4304	957	4826	773	5588	457	6617	102	6198
12-#11	3.71	MA	3510	1442	5169	1243	6467	1028	7355	838	8585	523	11091	174	10276
5L-3S		MI	2292	1442	3817	1157	4656	945	5256	763	6175	460	7274	156	6598
12-#11	3.71	MA	3255	1442	4758	1253	5952	1041	6699	857	7678	531	9847	88	9399
6L-2S		MI	2463	1442	4179	1149	5113	939	5809	760	6919	455	8180	271	6655
12-#14	5.36	MA	3937	1686	6214	1408	7728	1153	8855	921	10576	524	13878	45	13715
5L-3S		MI	2544	1686	4587	1304	5606	1051	6393	828	7667	441	8957	6	8938
12-#14	5.36	MA	3604	1686	5635	1423	6991	1171	7917	946	9279	534	12092	-80	11851
6L-2S		MI	2759	1686	5096	1294	6250	1045	7172	826	8710	437	10203	171	9258
14-#10	3.53	MA	3779	1414	5579	1214	7089	998	8118	820	9658	511	12580	278	10755
4L-5S		MI	2165	1414	3377	1165	4097	958	4587	777	5272	473	6360	114	5967
14-#10	3.53	MA	3598	1414	5249	1226	6620	1015	7563	830	8891	524	11516	230	10236
5L-4S		MI	2241	1414	3572	1157	4372	947	4911	773	5719	468	6915	171	6173
14-#10	3.53	MA	3391	1414	4904	1234	6196	1026	7023	846	8143	532	10498	160	9647
6L-3S		MI	2324	1414	3788	1150	4654	941	5271	763	6209	468	7481	218	6439
14-#10	3.53	MA	3207	1414	4562	1242	5763	1034	6500	856	7415	545	9491	120	8989
7L-2S		MI	2468	1414	4092	1142	5037	935	5735	760	6834	463	8268	311	6480
14-#11	4.33	MA	3814	1534	5817	1301	7287	1070	8347	865	9921	520	12940	169	12148
5L-4S		MI	2337	1534	3919	1223	4761	1000	5378	800	6332	454	7523	77	7197
14-#11	4.33	MA	3559	1534	5406	1311	6772	1083	7690	884	9013	528	11696	83	11273
6L-3S		MI	2430	1534	4179	1215	5113	987	5809	790	6919	456	8180	132	7634
14-#11	4.33	MA	3347	1534	4940	1327	6257	1094	7055	895	8130	543	10468	30	10349
7L-2S		MI	2592	1534	4540	1206	5570	981	6362	787	7663	452	9087	246	7701

RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#14	6.25	MA	4031	1818	6558	1505	8159	1232	9330	985	11181	529	14725	-87	14355
6L-3S		MI	2734	1818	5096	1387	6250	1112	7172	867	8710	436	10203	-35	10139
16-#10	4.03	MA	3837	1489	5786	1273	7299	1049	8385	852	9997	521	13048	226	11785
5E		MI	2289	1489	3680	1212	4481	993	5051	799	5896	470	7146	98	6818
16-#10	4.03	MA	3640	1489	5441	1281	6875	1060	7844	868	9249	529	12029	156	11198
6L-4S		MI	2364	1489	3875	1204	4756	981	5375	795	6344	465	7702	155	7015
16-#10	4.03	MA	3468	1489	5099	1289	6442	1069	7321	878	8521	542	11022	116	10537
7L-3S		MI	2441	1489	4092	1196	5037	975	5735	785	6834	465	8268	202	7312
16-#10	4.03	MA	3307	1489	4722	1304	5978	1082	6803	887	7796	550	10052	61	9818
8L-2S		MI	2579	1489	4395	1189	5421	970	6198	782	7458	460	9054	295	7360
16-#11	4.95	MA	3872	1626	6055	1368	7592	1125	8682	911	10348	524	13545	79	13150
6L-4S		MI	2480	1626	4280	1280	5218	1042	5931	827	7076	451	8430	53	8202
16-#11	4.95	MA	3676	1626	5588	1384	7078	1136	8047	922	9465	539	12317	25	12217
7L-3S		MI	2566	1626	4540	1272	5570	1029	6362	817	7663	453	9087	107	8670
18-#10	4.54	MA	3882	1564	5978	1328	7554	1095	8666	890	10355	526	13560	152	12750
6L-5S		MI	2411	1564	3984	1259	4865	1027	5515	821	6521	468	7932	82	7649
18-#10	4.54	MA	3720	1564	5636	1336	7121	1103	8143	900	9627	539	12553	112	12085
7L-4S		MI	2485	1564	4178	1251	5139	1016	5839	817	6968	462	8488	139	7862
18-#10	4.54	MA	3567	1564	5259	1351	6657	1116	7624	909	8902	547	11583	57	11369
8L-3S		MI	2556	1564	4395	1243	5421	1010	6198	807	7458	462	9054	186	8184
18-#11	5.57	MA	3977	1718	6237	1442	7898	1179	9039	949	10801	536	14167	21	14085
7L-4S		MI	2621	1718	4641	1338	5675	1084	6484	854	7820	447	9336	28	9212
20-#10	5.04	MA	3987	1639	6172	1382	7800	1137	8964	922	10733	537	14085	108	13633
7L-5S		MI	2530	1639	4287	1306	5248	1061	5979	843	7146	465	8719	66	8483
20-#10	5.04	MA	3815	1639	5796	1397	7336	1151	8445	931	10007	544	13115	53	12919
8L-4S		MI	2604	1639	4482	1298	5523	1050	6303	839	7593	459	9274	123	8712
22-#10	5.54	MA	4076	1713	6332	1444	8015	1185	9267	953	11113	541	14646	50	14470
8L-5S		MI	2648	1713	4590	1352	5632	1096	6443	864	7770	462	9505	51	9322

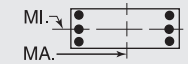
RECTANGULAR TIED COLUMNS 18" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#11	1.16	MA	3570	1138	4549	1038	5804	872	6534	740	7351	539	9129	470	4344
2E		MI	2032	1138	2877	977	3455	820	3776	695	4117	503	4750	399	2440
4-#14	1.67	MA	3831	1220	5189	1084	6584	905	7461	761	8585	533	10827	463	6127
2E		MI	2143	1220	3205	1020	3843	850	4233	713	4710	494	5412	362	3357
4-#18	2.96	MA	4425	1426	6746	1203	8496	991	9743	814	11629	520	15022	447	10497
2E		MI	2380	1426	3974	1132	4766	931	5324	762	6049	458	6892	254	5518
6-#9	1.11	MA	3573	1131	4449	1042	5735	876	6480	745	7306	545	9087	475	4234
2L-3S		MI	1893	1131	2576	994	3123	834	3401	707	3634	517	4235	347	2397
6-#9	1.11	MA	3271	1131	3987	1053	5151	885	5773	753	6354	556	7769	407	4222
3L-2S		MI	2045	1131	2817	987	3429	829	3770	704	4131	512	4868	421	2387
6-#10	1.41	MA	3738	1179	4834	1070	6206	896	7042	757	8055	542	10119	471	5311
2L-3S		MI	1934	1179	2716	1021	3287	853	3592	719	3886	514	4533	312	2959
6-#10	1.41	MA	3370	1179	4250	1083	5468	908	6149	768	6852	556	8454	384	5278
3L-2S		MI	2120	1179	3019	1013	3671	848	4056	715	4511	508	5319	405	2955
6-#11	1.73	MA	3888	1230	5255	1095	6697	914	7613	767	8804	536	11142	465	6411
2L-3S		MI	1965	1230	2877	1042	3455	867	3776	725	4117	504	4750	260	3511
6-#11	1.73	MA	3460	1230	4549	1110	5804	927	6534	779	7351	552	9129	356	6350
3L-2S		MI	2178	1230	3238	1034	3912	862	4329	722	4861	500	5657	374	3515
6-#14	2.50	MA	4261	1352	6195	1166	7856	966	9000	799	10657	528	13697	456	9063
2L-3S		MI	2060	1352	3205	1113	3843	917	4233	754	4710	493	5412	157	4801

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis

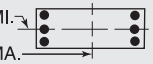


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#14	2.50	MA	3693	1352	5189	1188	6584	985	7461	816	8585	550	10827	296	8890
3L-2S		MI	2334	1352	3714	1102	4487	911	5012	752	5754	488	6659	322	4856
6-#18	4.44	MA	5093	1661	8493	1350	10706	1099	12416	883	15228	511	20004	435	15577
2L-3S		MI	2275	1661	3974	1293	4766	1045	5324	828	6049	448	6892	-131	6788
6-#18	4.44	MA	4281	1661	6746	1385	8496	1130	9743	909	11629	546	15022	141	14547
3L-2S		MI	2682	1661	4838	1280	5859	1039	6646	831	7769	439	8896	163	8023
8-#8	1.17	MA	3615	1141	4512	1050	5829	882	6601	749	7475	546	9326	475	4464
2L-4S		MI	1874	1141	2518	1007	3058	845	3316	719	3522	519	4142	336	2518
8-#8	1.17	MA	3378	1141	4145	1059	5365	890	6039	756	6719	555	8280	422	4455
3E		MI	1948	1141	2655	1002	3236	841	3544	712	3832	518	4507	366	2518
8-#8	1.17	MA	3239	1141	3893	1067	5035	897	5617	767	6142	561	7570	390	4415
4L-2S		MI	2068	1141	2848	997	3480	837	3838	709	4229	514	5018	424	2512
8-#9	1.48	MA	3788	1190	4911	1079	6320	903	7187	762	8258	543	10405	472	5588
2L-4S		MI	1911	1190	2645	1037	3205	866	3484	733	3742	515	4414	298	3090
8-#9	1.48	MA	3501	1190	4449	1089	5735	913	6480	771	7306	554	9087	404	5565
3E		MI	2001	1190	2817	1031	3429	861	3770	725	4131	515	4868	336	3107
8-#9	1.48	MA	3333	1190	4131	1100	5319	922	5948	784	6578	561	8191	363	5477
4L-2S		MI	2147	1190	3058	1024	3734	856	4139	721	4629	510	5502	409	3104
8-#10	1.88	MA	4000	1254	5417	1116	6945	930	7935	779	9257	539	11783	467	7018
2L-4S		MI	1957	1254	2803	1076	3389	894	3697	750	4021	511	4754	249	3747
8-#10	1.88	MA	3653	1254	4834	1129	6206	942	7042	790	8055	553	10119	380	6969
3E		MI	2067	1254	3019	1068	3671	888	4056	741	4511	511	5319	296	3841
8-#10	1.88	MA	3451	1254	4431	1142	5681	954	6369	806	7135	561	8983	328	6793
4L-2S		MI	2243	1254	3323	1060	4055	882	4520	737	5136	505	6106	389	3850
8-#11	2.31	MA	4193	1322	5960	1152	7590	956	8693	794	10258	532	13155	460	8471
2L-4S		MI	1996	1322	2979	1108	3559	922	3898	762	4274	498	4999	180	4297
8-#11	2.31	MA	3792	1322	5255	1168	6697	970	7613	806	8804	548	11142	351	8390
3E		MI	2120	1322	3238	1100	3912	910	4329	752	4861	501	5657	235	4554
8-#11	2.31	MA	3558	1322	4766	1183	6059	983	6797	825	7689	558	9754	285	7906
4L-2S		MI	2316	1322	3600	1092	4369	904	4882	749	5606	496	6563	350	4577
8-#14	3.33	MA	4150	1484	6195	1270	7856	1045	9000	855	10657	545	13697	289	11795
3E		MI	2266	1484	3714	1196	4487	978	5012	793	5754	487	6659	116	6254
8-#14	3.33	MA	3846	1484	5496	1292	6944	1064	7834	881	9064	557	11704	193	10534
4L-2S		MI	2520	1484	4223	1185	5132	972	5792	791	6798	482	7905	282	6339
8-#18	5.93	MA	5027	1897	8493	1532	10706	1238	12416	978	15228	537	20004	129	19507
3E		MI	2612	1897	4838	1440	5859	1153	6646	897	7769	429	8896	-222	8663
8-#18	5.93	MA	4606	1897	7274	1567	9114	1269	10382	1022	12450	554	16494	-45	16233
4L-2S		MI	2978	1897	5702	1427	6952	1147	7968	900	9489	420	10900	72	10515
10-#10	2.35	MA	4253	1329	6001	1163	7683	965	8827	801	10459	536	13448	463	8721
2L-5S		MI	2003	1329	2911	1130	3498	939	3837	776	4198	513	4984	177	4330
10-#10	2.35	MA	3924	1329	5417	1176	6945	976	7935	812	9257	550	11783	377	8661
3L-4S		MI	2093	1329	3106	1122	3773	928	4161	772	4645	508	5540	233	4568
10-#10	2.35	MA	3739	1329	5015	1189	6419	988	7262	828	8337	559	10647	324	8453
4L-3S		MI	2198	1329	3323	1114	4055	922	4520	763	5136	508	6106	280	4718
10-#10	2.35	MA	3531	1329	4658	1202	5911	1006	6662	839	7506	573	9449	269	7811
5L-2S		MI	2361	1329	3626	1107	4438	916	4984	759	5760	503	6892	373	4738
10-#11	2.89	MA	4110	1414	5960	1225	7590	1012	8693	833	10258	545	13155	346	10432
3L-4S		MI	2153	1414	3340	1166	4016	964	4451	789	5019	495	5906	156	5277
10-#11	2.89	MA	3899	1414	5472	1240	6952	1025	7877	852	9143	554	11767	281	9910
4L-3S		MI	2266	1414	3600	1157	4369	952	4882	779	5606	497	6563	211	5593
10-#11	2.89	MA	3655	1414	5037	1255	6335	1046	7148	865	8134	570	10368	220	9200
5L-2S		MI	2451	1414	3961	1149	4826	946	5434	776	6350	493	7470	325	5631
10-#14	4.17	MA	4318	1617	6502	1374	8217	1125	9373	920	11137	552	14574	187	13419
4L-3S		MI	2466	1617	4223	1278	5132	1039	5792	832	6798	481	7905	76	7678
10-#14	4.17	MA	3980	1617	5881	1396	7335	1154	8331	937	9694	574	12569	97	12201
5L-2S		MI	2701	1617	4733	1268	5776	1033	6571	830	7841	476	9151	241	7816
10-#18	7.41	MA	5399	2132	9021	1714	11324	1377	13055	1091	16049	545	21476	-57	20962
4L-3S		MI	2939	2132	5702	1588	6952	1261	7968	966	9489	410	10900	-312	10502

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis



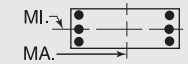
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#18	7.41	MA	4826	2132	7933	1749	9782	1425	11233	1117	13529	579	17960	-228	16869
5L-2S		MI	3274	2132	6566	1574	8045	1256	9290	969	11209	401	12904	-19	12864
12-#10	2.82	MA	4186	1403	6001	1223	7683	1011	8827	834	10459	547	13448	373	10353
3L-5S		MI	2147	1403	3215	1177	3882	974	4301	798	4823	510	5770	161	5175
12-#10	2.82	MA	4016	1403	5598	1236	7157	1022	8155	850	9539	556	12312	320	10112
4E		MI	2229	1403	3409	1169	4156	962	4625	794	5270	505	6326	217	5398
12-#10	2.82	MA	3812	1403	5241	1249	6649	1040	7555	861	8708	570	11114	266	9492
5L-3S		MI	2321	1403	3626	1161	4438	956	4984	785	5760	505	6892	264	5593
12-#10	2.82	MA	3570	1403	4862	1256	6191	1052	6970	877	7898	578	10066	205	8899
6L-2S		MI	2476	1403	3929	1153	4822	951	5448	781	6385	500	7679	357	5621
12-#11	3.47	MA	4225	1506	6177	1298	7844	1068	8957	879	10597	551	13780	276	11920
4E		MI	2304	1506	3701	1223	4473	1006	5004	816	5763	491	6812	132	6266
12-#11	3.47	MA	3986	1506	5743	1313	7227	1088	8228	892	9587	567	12381	216	11239
5L-3S		MI	2408	1506	3961	1215	4826	994	5434	806	6350	494	7470	186	6631
12-#11	3.47	MA	3706	1506	5290	1323	6670	1102	7517	911	8604	576	11041	130	10340
6L-2S		MI	2583	1506	4322	1206	5283	988	5987	803	7094	489	8376	301	6681
12-#14	5.00	MA	4459	1749	6887	1478	8607	1215	9870	976	11766	569	15438	90	15097
5L-3S		MI	2660	1749	4733	1361	5776	1100	6571	871	7841	475	9151	35	9039
12-#14	5.00	MA	4068	1749	6247	1493	7810	1234	8853	1002	10359	581	13513	-34	13398
6L-2S		MI	2880	1749	5242	1351	6421	1093	7350	868	8885	470	10398	201	9289
14-#10	3.29	MA	4284	1478	6182	1282	7895	1057	9048	872	10742	553	13977	316	11777
4L-5S		MI	2280	1478	3518	1224	4265	1008	4765	820	5447	508	6557	145	6023
14-#10	3.29	MA	4082	1478	5825	1295	7387	1074	8448	882	9910	567	12779	262	11176
5L-4S		MI	2356	1478	3713	1216	4540	997	5089	816	5895	502	7113	201	6233
14-#10	3.29	MA	3854	1478	5446	1303	6929	1086	7863	899	9100	575	11731	201	10588
6L-3S		MI	2441	1478	3929	1208	4822	991	5448	807	6385	502	7679	248	6467
14-#10	3.29	MA	3652	1478	5075	1311	6453	1094	7297	909	8313	589	10644	162	9900
7L-2S		MI	2589	1478	4232	1200	5205	985	5912	803	7010	497	8465	341	6503
14-#11	4.04	MA	4305	1598	6449	1370	8120	1130	9308	918	11041	563	14393	211	13280
5L-4S		MI	2451	1598	4063	1280	4930	1049	5556	843	6507	488	7719	107	7264
14-#11	4.04	MA	4041	1598	5996	1380	7563	1144	8597	938	10057	573	13053	126	12380
6L-3S		MI	2547	1598	4322	1272	5283	1036	5987	833	7094	490	8376	162	7668
14-#11	4.04	MA	3807	1598	5546	1390	6995	1155	7909	950	9100	589	11729	75	11401
7L-2S		MI	2713	1598	4684	1264	5740	1030	6540	830	7839	486	9283	276	7728
14-#14	5.83	MA	4562	1882	7253	1576	9082	1294	10393	1041	12432	576	16383	-41	16187
6L-3S		MI	2850	1882	5242	1444	6421	1161	7350	910	8885	469	10398	-5	10389
16-#10	3.76	MA	4345	1553	6408	1342	8126	1109	9341	904	11113	564	14443	258	12863
5E		MI	2405	1553	3821	1270	4649	1042	5229	842	6072	505	7343	129	6876
16-#10	3.76	MA	4128	1553	6029	1350	7667	1120	8755	921	10303	573	13395	197	12276
6L-4S		MI	2480	1553	4016	1262	4924	1031	5553	838	6519	499	7899	185	7074
16-#10	3.76	MA	3939	1553	5659	1358	7191	1128	8190	931	9515	587	12309	158	11583
7L-3S		MI	2559	1553	4232	1255	5205	1025	5912	829	7010	500	8465	232	7340
16-#10	3.76	MA	3762	1553	5250	1374	6688	1142	7618	940	8730	595	11262	106	10775
8L-2S		MI	2700	1553	4536	1247	5589	1019	6376	825	7634	494	9251	325	7383
16-#11	4.62	MA	4365	1689	6701	1437	8455	1186	9676	965	11511	569	15066	121	14403
6L-4S		MI	2595	1689	4424	1338	5387	1091	6109	870	7251	485	8625	83	8267
16-#11	4.62	MA	4147	1689	6252	1447	7887	1197	8989	977	10554	585	13741	71	13434
7L-3S		MI	2683	1689	4684	1329	5740	1078	6540	860	7839	487	9283	137	8704
18-#10	4.23	MA	4395	1628	6613	1396	8405	1155	9648	943	11505	570	15060	193	13964
6L-5S		MI	2527	1628	4124	1317	5033	1077	5693	864	6697	502	8130	113	7731
18-#10	4.23	MA	4216	1628	6242	1405	7929	1163	9082	953	10717	584	13973	154	13265
7L-4S		MI	2601	1628	4319	1309	5307	1065	6017	860	7144	497	8685	169	7920

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

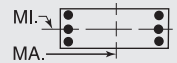
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
18-#10	4.23	MA	4044	1628	5834	1420	7426	1177	8511	962	9932	592	12927	102	12461
8L-3S		MI	2675	1628	4536	1301	5589	1059	6376	851	7634	497	9251	216	8213
18-#11	5.20	MA	4503	1781	6958	1505	8780	1239	10068	1004	12008	582	15754	66	15468
7L-4S		MI	2736	1781	4785	1395	5844	1133	6662	896	7996	481	9532	58	9275
20-#10	4.70	MA	4487	1702	6826	1452	8667	1197	9975	975	11919	581	15638	151	14948
7L-5S		MI	2647	1702	4428	1364	5416	1111	6157	886	7321	499	8916	97	8571
20-#10	4.70	MA	4317	1702	6417	1467	8164	1211	9404	984	11134	589	14591	98	14147
8L-4S		MI	2721	1702	4622	1356	5691	1100	6481	882	7769	494	9472	153	8768
22-#10	5.17	MA	4584	1777	7001	1514	8903	1245	10297	1006	12336	587	16256	94	15833
8L-5S		MI	2765	1777	4731	1410	5800	1145	6621	908	7946	496	9702	81	9407

RECTANGULAR TIED COLUMNS 18" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#11	1.08	MA	4035	1202	5042	1105	6476	929	7301	791	8204	579	10181	505	4681
2E		MI	2148	1202	3021	1034	3624	869	3954	738	4292	537	4946	428	2458
4-#14	1.56	MA	4325	1283	5736	1151	7322	962	8307	811	9543	573	12023	498	6613
2E		MI	2259	1283	3350	1076	4013	899	4411	755	4885	527	5607	392	3379
4-#18	2.78	MA	4984	1489	7429	1271	9400	1049	10788	864	12853	560	16584	482	11361
2E		MI	2498	1489	4124	1188	4938	979	5503	803	6223	491	7085	283	5550
6-#9	1.04	MA	4036	1195	4932	1110	6398	934	7239	795	8150	585	10128	510	4558
2L-3S		MI	2008	1195	2715	1052	3291	884	3578	751	3810	552	4433	378	2413
6-#9	1.04	MA	3706	1195	4433	1121	5767	944	6475	804	7122	597	8705	443	4546
3L-2S		MI	2161	1195	2957	1046	3596	879	3947	747	4307	547	5066	451	2402
6-#10	1.32	MA	4219	1243	5348	1137	6908	954	7846	807	8960	582	11244	506	5723
2L-3S		MI	2049	1243	2857	1079	3455	903	3770	762	4062	548	4730	342	2979
6-#10	1.32	MA	3816	1243	4717	1151	6111	966	6882	819	7662	596	9446	421	5690
3L-2S		MI	2236	1243	3160	1071	3839	897	4234	758	4687	543	5517	435	2972
6-#11	1.63	MA	4386	1294	5805	1163	7442	971	8468	817	9776	576	12357	500	6917
2L-3S		MI	2079	1294	3021	1100	3624	916	3954	768	4292	538	4946	289	3536
6-#11	1.63	MA	3916	1294	5042	1179	6476	986	7301	830	8204	593	10181	393	6855
3L-2S		MI	2294	1294	3382	1092	4081	911	4507	765	5037	534	5852	404	3536
6-#14	2.34	MA	4798	1416	6825	1234	8699	1023	9973	850	11786	568	15128	491	9792
2L-3S		MI	2174	1416	3350	1170	4013	966	4411	796	4885	526	5607	186	4838
6-#14	2.34	MA	4174	1416	5736	1256	7322	1043	8307	868	9543	592	12023	335	9619
3L-2S		MI	2452	1416	3860	1159	4658	959	5190	794	5929	522	6853	352	4882
6-#18	4.17	MA	5725	1725	9323	1418	11797	1157	13686	933	16755	551	21987	470	16873
2L-3S		MI	2387	1725	4124	1349	4938	1093	5503	870	6223	481	7085	-102	7005
6-#18	4.17	MA	4797	1725	7429	1455	9400	1190	10788	962	12853	589	16584	183	16047
3L-2S		MI	2801	1725	4988	1335	6031	1087	6825	872	7943	472	9088	192	8058
8-#8	1.10	MA	4082	1204	4999	1118	6499	940	7368	799	8331	586	10384	510	4805
2L-4S		MI	1988	1204	2657	1066	3225	895	3494	763	3698	554	4340	366	2537
8-#8	1.10	MA	3823	1204	4603	1127	5998	948	6762	807	7515	595	9255	458	4796
3E		MI	2063	1204	2794	1061	3403	891	3721	756	4008	553	4706	396	2534
8-#8	1.10	MA	3672	1204	4332	1135	5643	956	6307	818	6894	601	8495	426	4756
4L-2S		MI	2184	1204	2986	1056	3647	887	4015	753	4405	549	5216	455	2526
8-#9	1.39	MA	4272	1254	5431	1147	7030	961	8002	812	9178	583	11551	507	6020
2L-4S		MI	2025	1254	2785	1096	3372	916	3662	776	3918	550	4612	328	3115
8-#9	1.39	MA	3958	1254	4932	1157	6398	971	7239	821	8150	595	10128	440	5997
3E		MI	2116	1254	2957	1089	3596	911	3947	768	4307	550	5066	366	3126
8-#9	1.39	MA	3774	1254	4589	1168	5951	980	6666	835	7366	602	9168	399	5909
4L-2S		MI	2263	1254	3198	1083	3901	906	4317	765	4805	545	5700	440	3121
8-#10	1.76	MA	4506	1317	5978	1184	7705	988	8811	829	10259	579	13042	502	7566
2L-4S		MI	2071	1317	2944	1134	3557	943	3875	793	4196	545	4951	279	3811
8-#10	1.76	MA	4126	1317	5348	1197	6908	1000	7846	841	8960	594	11244	417	7518
3E		MI	2182	1317	3160	1126	3839	937	4234	784	4687	545	5517	326	3863
8-#10	1.76	MA	3905	1317	4914	1211	6342	1012	7122	857	7969	603	10027	365	7341
4L-2S		MI	2360	1317	3463	1118	4223	932	4698	780	5311	540	6303	419	3868

RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis

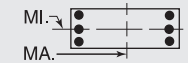


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#11	2.17	MA	4721	1386	6568	1220	8407	1014	9636	844	11348	572	14534	495	9145
2L-4S		MI	2109	1386	3122	1166	3729	971	4076	804	4450	532	5195	210	4368
8-#11	2.17	MA	4281	1386	5805	1236	7442	1028	8468	857	9776	590	12357	388	9064
3E		MI	2235	1386	3382	1157	4081	959	4507	795	5037	535	5852	265	4583
8-#11	2.17	MA	4025	1386	5279	1252	6754	1042	7588	877	8573	600	10870	323	8632
4L-2S		MI	2434	1386	3743	1149	4538	953	5060	792	5781	530	6759	379	4600
8-#14	3.13	MA	4675	1548	6825	1339	8699	1104	9973	906	11786	587	15128	328	12767
3E		MI	2381	1548	3860	1253	4658	1027	5190	835	5929	521	6853	146	6294
8-#14	3.13	MA	4342	1548	6072	1361	7715	1124	8714	934	10066	601	12992	233	11502
4L-2S		MI	2639	1548	4369	1242	5302	1020	5970	833	6972	516	8100	311	6367
8-#18	5.56	MA	5643	1960	9323	1602	11797	1298	13686	1031	16755	580	21987	171	21459
3E		MI	2724	1960	4988	1496	6031	1201	6825	939	7943	462	9088	-193	8891
8-#18	5.56	MA	5179	1960	8006	1639	10077	1331	11488	1077	13752	600	18218	-1	18214
4L-2S		MI	3098	1960	5852	1483	7124	1195	8147	941	9663	453	11092	101	10552
10-#10	2.20	MA	4784	1392	6608	1231	8503	1022	9775	851	11557	576	14840	498	9406
2L-5S		MI	2116	1392	3052	1188	3666	989	4014	819	4374	548	5181	207	4388
10-#10	2.20	MA	4424	1392	5978	1244	7705	1035	8811	863	10259	591	13042	413	9346
3L-4S		MI	2207	1392	3247	1180	3941	978	4339	815	4821	542	5737	263	4631
10-#10	2.20	MA	4221	1392	5545	1258	7139	1047	8086	879	9268	600	11825	361	9165
4L-3S		MI	2313	1392	3463	1173	4223	972	4698	806	5311	542	6303	310	4742
10-#10	2.20	MA	3989	1392	5161	1271	6592	1065	7440	891	8373	615	10538	309	8482
5L-2S		MI	2479	1392	3766	1165	4606	966	5162	802	5936	537	7090	404	4758
10-#11	2.71	MA	4630	1478	6568	1293	8407	1070	9636	884	11348	586	14534	384	11274
3L-4S		MI	2266	1478	3484	1223	4186	1013	4629	831	5194	529	6102	186	5346
10-#11	2.71	MA	4398	1478	6042	1309	7719	1085	8756	904	10145	596	13047	319	10805
4L-3S		MI	2382	1478	3743	1215	4538	1001	5060	821	5781	531	6759	240	5624
10-#11	2.71	MA	4127	1478	5574	1325	7055	1106	7971	917	9057	613	11542	261	10001
5L-2S		MI	2570	1478	4105	1206	4995	995	5612	819	6525	527	7665	355	5656
10-#14	3.91	MA	4859	1681	7160	1444	9093	1185	10380	973	12309	596	16097	226	14634
4L-3S		MI	2581	1681	4369	1335	5302	1088	5970	874	6972	515	8100	105	7748
10-#14	3.91	MA	4483	1681	6491	1466	8142	1215	9257	991	10753	619	13941	140	13359
5L-2S		MI	2821	1681	4879	1325	5946	1081	6749	872	8016	510	9346	271	7845
10-#18	6.94	MA	6048	2196	9900	1786	12473	1439	14386	1146	17654	591	23621	-13	23495
4L-3S		MI	3052	2196	5852	1644	7124	1309	8147	1008	9663	443	11092	-283	10739
10-#18	6.94	MA	5408	2196	8727	1823	10808	1489	12419	1175	14932	629	19834	-176	18857
5L-2S		MI	3394	2196	6716	1630	8217	1303	9469	1011	11383	434	13096	10	13040
12-#10	2.65	MA	4711	1467	6608	1291	8503	1069	9775	884	11557	588	14840	409	11176
3L-5S		MI	2260	1467	3355	1235	4050	1023	4478	841	4998	545	5968	191	5231
12-#10	2.65	MA	4524	1467	6175	1304	7936	1081	9050	901	10566	597	13623	357	10992
4E		MI	2344	1467	3550	1227	4324	1012	4802	837	5446	539	6524	247	5458
12-#10	2.65	MA	4297	1467	5791	1318	7390	1099	8405	913	9671	612	12336	305	10301
5L-3S		MI	2437	1467	3766	1219	4606	1006	5162	828	5936	540	7090	294	5619
12-#10	2.65	MA	4033	1467	5377	1325	6897	1111	7775	929	8799	621	11214	244	9701
6L-2S		MI	2595	1467	4070	1211	4990	1000	5626	824	6561	534	7876	388	5643
12-#11	3.25	MA	4756	1569	6805	1366	8684	1127	9923	931	11717	593	15223	314	12984
4E		MI	2418	1569	3845	1280	4643	1055	5182	858	5938	525	7008	161	6334
12-#11	3.25	MA	4490	1569	6337	1382	8020	1148	9138	944	10629	610	13719	256	12209
5L-3S		MI	2525	1569	4105	1272	4995	1043	5612	848	6525	528	7665	216	6663
12-#11	3.25	MA	4183	1569	5842	1392	7420	1162	8373	964	9570	620	12283	172	11275
6L-2S		MI	2702	1569	4466	1264	5452	1037	6165	846	7270	523	8572	331	6707
12-#14	4.69	MA	4985	1813	7580	1549	9519	1276	10923	1030	12996	614	17047	134	16494
5L-3S		MI	2775	1813	4879	1418	5946	1148	6749	913	8016	509	9346	65	9138
12-#14	4.69	MA	4579	1813	6879	1563	8660	1296	9827	1058	11479	628	14983	11	14923
6L-2S		MI	3000	1813	5388	1408	6591	1142	7528	911	9060	504	10592	230	9319
14-#10	3.09	MA	4817	1542	6805	1351	8734	1116	10015	923	11865	594	15421	353	12810
4L-5S		MI	2395	1542	3659	1282	4433	1058	4942	863	5623	542	6754	175	6078
14-#10	3.09	MA	4593	1542	6421	1364	8187	1133	9369	935	10970	609	14134	301	12124
5L-4S		MI	2471	1542	3853	1274	4708	1046	5266	859	6071	537	7310	231	6293

RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#10	3.09	MA	4344	1542	6008	1372	7694	1146	8739	951	10098	618	13012	240	11525
6L-3S		MI	2558	1542	4070	1266	4990	1040	5626	850	6561	537	7876	278	6493
14-#10	3.09	MA	4123	1542	5608	1381	7174	1154	8131	963	9250	633	11846	204	10777
7L-2S		MI	2709	1542	4373	1258	5373	1035	6090	846	7185	531	8662	372	6525
14-#11	3.79	MA	4839	1661	7100	1440	8985	1190	10306	971	12201	606	15895	252	14420
5L-4S		MI	2566	1661	4206	1338	5100	1098	5734	885	6682	522	7915	137	7329
14-#11	3.79	MA	4550	1661	6605	1449	8385	1205	9540	991	11141	617	14459	167	13481
6L-3S		MI	2664	1661	4466	1329	5452	1085	6165	875	7270	524	8572	192	7701
14-#11	3.79	MA	4294	1661	6121	1459	7763	1215	8800	1004	10111	634	13037	119	12473
7L-2S		MI	2833	1661	4827	1321	5909	1079	6718	872	8014	520	9478	306	7755
14-#14	5.47	MA	5120	1945	7968	1645	10037	1356	11493	1096	13722	623	18089	4	18067
6L-3S		MI	2966	1945	5388	1501	6591	1209	7528	952	9060	503	10592	25	10510
14-#14	5.47	MA	4755	1945	7275	1660	9158	1371	10432	1114	12247	646	16048	-68	15834
7L-2S		MI	3178	1945	5897	1490	7235	1203	8308	950	10104	498	11839	190	10790
16-#10	3.53	MA	4881	1616	7052	1411	8985	1168	10333	957	12268	606	15931	297	13948
5E		MI	2521	1616	3962	1328	4817	1092	5406	885	6248	539	7541	159	6929
16-#10	3.53	MA	4643	1616	6638	1418	8491	1180	9704	973	11396	616	14809	236	13348
6L-4S		MI	2596	1616	4157	1321	5092	1081	5730	881	6695	534	8096	215	7132
16-#10	3.53	MA	4436	1616	6239	1427	7971	1188	9095	985	10549	630	13644	200	12602
7L-3S		MI	2677	1616	4373	1313	5373	1075	6090	872	7185	534	8662	262	7367
16-#10	3.53	MA	4242	1616	5799	1443	7429	1202	8471	993	9704	639	12520	150	11747
8L-2S		MI	2821	1616	4676	1305	5757	1069	6554	868	7810	529	9449	356	7406
16-#11	4.33	MA	4905	1753	7369	1506	9350	1247	10708	1018	12713	613	16636	162	15687
6L-4S		MI	2710	1753	4567	1395	5557	1140	6287	912	7427	519	8821	112	8331
16-#11	4.33	MA	4666	1753	6884	1517	8729	1257	9967	1031	11683	630	15214	115	14672
7L-3S		MI	2801	1753	4827	1387	5909	1127	6718	902	8014	521	9478	167	8738
16-#11	4.33	MA	4438	1753	6349	1536	8071	1274	9222	1042	10656	640	13844	50	13657
8L-2S		MI	2962	1753	5188	1379	6366	1122	7271	899	8758	517	10385	282	8802
16-#14	6.25	MA	5310	2078	8364	1743	10536	1432	12098	1153	14490	641	19154	-75	18812
7L-3S		MI	3154	2078	5897	1584	7235	1270	8308	991	10104	497	11839	-16	11808
18-#10	3.97	MA	4935	1691	7268	1465	9289	1214	10668	995	12695	613	16607	233	15171
6L-5S		MI	2643	1691	4265	1375	5201	1126	5870	907	6872	537	8327	143	7783
18-#10	3.97	MA	4739	1691	6869	1474	8769	1222	10060	1007	11847	627	15442	196	14428
7L-4S		MI	2718	1691	4460	1367	5475	1115	6194	903	7320	531	8883	199	7976
18-#10	3.97	MA	4549	1691	6429	1490	8227	1236	9435	1015	11002	637	14318	146	13569
8L-3S		MI	2793	1691	4676	1359	5757	1109	6554	894	7810	531	9449	246	8241
18-#10	3.97	MA	4308	1691	6051	1501	7724	1246	8793	1029	10169	651	13156	91	12716
9L-2S		MI	2932	1691	4979	1352	6141	1103	7018	890	8435	526	10235	340	8286
18-#11	4.88	MA	5026	1845	7647	1574	9694	1299	11135	1058	13255	627	17390	110	16872
7L-4S		MI	2852	1845	4929	1453	6014	1182	6840	939	8171	515	9728	88	9338
18-#11	4.88	MA	4802	1845	7112	1593	9036	1316	10389	1069	12228	637	16020	45	15851
8L-3S		MI	2936	1845	5188	1444	6366	1169	7271	929	8758	518	10385	143	9775
20-#10	4.41	MA	5035	1766	7499	1521	9566	1257	11024	1029	13145	625	17240	192	16254
7L-5S		MI	2764	1766	4568	1422	5584	1161	6334	929	7497	534	9113	127	8640
20-#10	4.41	MA	4847	1766	7059	1537	9024	1271	10399	1037	12301	634	16116	142	15390
8L-4S		MI	2837	1766	4763	1414	5859	1149	6658	925	7945	528	9669	183	8823
20-#10	4.41	MA	4617	1766	6681	1548	8521	1280	9758	1051	11468	649	14954	88	14534
9L-3S		MI	2908	1766	4979	1406	6141	1143	7018	916	8435	528	10235	230	9114
20-#11	5.42	MA	5156	1937	7876	1650	10001	1358	11556	1096	13799	633	18197	41	18045
8L-4S		MI	2991	1937	5290	1510	6471	1224	7393	966	8915	512	10634	63	10348
22-#10	4.85	MA	5138	1841	7690	1583	9821	1305	11364	1059	13599	631	17914	138	17211
8L-5S		MI	2882	1841	4871	1469	5968	1195	6798	951	8122	531	9900	111	9491
22-#10	4.85	MA	4917	1841	7311	1594	9318	1315	10722	1073	12766	646	16752	84	16351
9L-4S		MI	2956	1841	5066	1461	6242	1184	7122	947	8569	525	10456	167	9674
24-#10	5.29	MA	5211	1915	7942	1641	10116	1349	11686	1095	14064	643	18550	80	18168
9L-5S		MI	2999	1915	5175	1515	6351	1229	7262	973	8747	528	10686	95	10329

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis

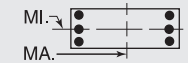
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.02	MA	4526	1266	5556	1173	7180	987	8105	841	9097	619	11280	540	5018
2E		MI	2264	1266	3164	1092	3793	918	4132	780	4468	571	5142	458	2475
4-#14	1.47	MA	4845	1347	6304	1219	8092	1020	9189	861	10540	613	13266	533	7099
2E		MI	2375	1347	3496	1133	4184	947	4589	797	5060	561	5802	422	3401
4-#18	2.61	MA	5570	1553	8132	1338	10337	1107	11869	915	14116	600	18193	518	12225
2E		MI	2616	1553	4273	1244	5110	1026	5681	845	6397	524	7277	312	5581
6-#10	1.25	MA	4725	1306	5882	1205	7641	1011	8688	858	9906	622	12417	541	6134
2L-3S		MI	2164	1306	2997	1137	3623	953	3948	805	4238	583	4928	372	2998
6-#10	1.25	MA	4287	1306	5205	1219	6785	1024	7652	869	8511	637	10486	458	6101
3L-2S		MI	2352	1306	3301	1130	4007	947	4412	802	4862	577	5714	466	2988
6-#11	1.53	MA	4910	1357	6376	1230	8218	1029	9360	868	10787	616	13621	535	7422
2L-3S		MI	2194	1358	3164	1157	3793	965	4132	810	4468	572	5142	319	3561
6-#11	1.53	MA	4398	1357	5556	1247	7180	1044	8105	881	9097	634	11280	430	7361
3L-2S		MI	2411	1357	3526	1149	4250	960	4685	807	5212	568	6048	434	3556
6-#14	2.21	MA	5362	1479	7475	1302	9574	1081	10982	900	12954	609	16608	526	10521
2L-3S		MI	2288	1479	3496	1227	4184	1015	4589	839	5060	560	5802	216	4873
6-#14	2.21	MA	4681	1479	6304	1325	8092	1102	9189	919	10540	633	13266	373	10348
3L-2S		MI	2570	1479	4006	1216	4828	1008	5369	836	6103	555	7048	381	4907
6-#18	3.92	MA	6385	1788	10174	1485	12919	1215	14993	984	18321	591	24015	505	18169
2L-3S		MI	2499	1788	4273	1405	5110	1140	5681	911	6397	514	7277	-73	7221
6-#18	3.92	MA	5363	1788	8132	1524	10337	1249	11869	1014	14116	632	18193	224	17490
3L-2S		MI	2920	1788	5137	1391	6203	1135	7003	914	8117	505	9281	221	8093
8-#8	1.03	MA	4575	1268	5506	1186	7200	998	8172	850	9227	626	11490	546	5146
2L-4S		MI	2102	1268	2795	1125	3392	945	3671	806	3874	588	4539	397	2554
8-#8	1.03	MA	4294	1268	5081	1194	6662	1006	7522	857	8352	636	10278	494	5138
3E		MI	2178	1268	2932	1120	3570	941	3898	800	4184	588	4904	427	2548
8-#8	1.03	MA	4130	1268	4791	1203	6282	1014	7035	868	7686	642	9468	462	5097
4L-2S		MI	2300	1268	3125	1114	3814	937	4193	797	4581	584	5414	485	2540
8-#9	1.31	MA	4783	1317	5970	1214	7771	1018	8854	863	10137	623	12745	542	6452
2L-4S		MI	2139	1317	2924	1154	3540	966	3839	819	4094	585	4810	359	3137
8-#9	1.31	MA	4441	1317	5435	1225	7093	1029	8034	872	9034	635	11217	477	6429
3E		MI	2231	1317	3096	1148	3764	961	4125	812	4483	584	5264	397	3143
8-#9	1.31	MA	4242	1317	5068	1236	6613	1039	7420	886	8194	643	10193	436	6341
4L-2S		MI	2379	1317	3337	1141	4069	956	4494	808	4981	579	5897	470	3137
8-#10	1.66	MA	5039	1381	6559	1252	8498	1046	9724	880	11300	619	14349	537	8115
2L-4S		MI	2185	1381	3084	1192	3725	993	4052	837	4372	580	5148	309	3853
8-#10	1.66	MA	4625	1381	5882	1265	7641	1058	8688	891	9906	634	12417	454	8066
3E		MI	2297	1381	3301	1184	4007	987	4412	827	4862	580	5714	356	3885
8-#10	1.66	MA	4385	1381	5418	1279	7035	1071	7911	909	8843	644	11119	402	7890
4L-2S		MI	2477	1381	3604	1176	4391	981	4876	823	5487	574	6501	450	3887
8-#11	2.04	MA	5276	1449	7197	1288	9256	1071	10616	895	12477	612	15961	530	9819
2L-4S		MI	2223	1449	3266	1223	3898	1020	4254	847	4625	566	5391	240	4438
8-#11	2.04	MA	4796	1449	6376	1304	8218	1086	9360	908	10787	630	13621	426	9738
3E		MI	2350	1449	3526	1215	4250	1008	4685	837	5212	569	6048	295	4610
8-#11	2.04	MA	4517	1449	5812	1320	7480	1101	8416	929	9497	641	12034	361	9368
4L-2S		MI	2552	1449	3887	1206	4707	1002	5238	834	5956	564	6955	409	4623
8-#14	2.94	MA	5227	1612	7475	1407	9574	1163	10982	958	12954	628	16608	366	13739
3E		MI	2496	1612	4006	1310	4828	1075	5369	878	6103	554	7048	175	6331
8-#14	2.94	MA	4865	1612	6667	1430	8518	1184	9631	987	11108	643	14327	272	12484
4L-2S		MI	2758	1612	4515	1299	5472	1069	6148	875	7147	549	8294	341	6395
8-#18	5.23	MA	6289	2024	10174	1671	12919	1357	14993	1083	18321	623	24015	212	23435
3E		MI	2837	2024	5137	1552	6203	1248	7003	980	8117	495	9281	-164	9116
8-#18	5.23	MA	5733	2024	8759	1709	11071	1392	12630	1132	15093	645	19990	42	19745
4L-2S		MI	3218	2024	6001	1538	7296	1243	8325	983	9837	486	11285	130	10589

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis

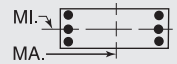


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.08	MA	5342	1456	7236	1298	9354	1080	10760	902	12695	616	16280	533	10092
2L-5S		MI	2229	1456	3193	1246	3834	1039	4192	863	4550	582	5379	237	4443
10-#10	2.08	MA	4949	1456	6559	1312	8498	1093	9724	913	11300	632	14349	450	10032
3L-4S		MI	2321	1456	3387	1239	4109	1027	4516	859	4997	577	5935	293	4692
10-#10	2.08	MA	4728	1456	6095	1326	7891	1105	8947	931	10238	641	13051	398	9851
4L-3S		MI	2426	1456	3604	1231	4391	1021	4876	849	5487	577	6501	340	4766
10-#10	2.08	MA	4474	1456	5683	1340	7306	1124	8256	943	9279	657	11674	347	9160
5L-2S		MI	2597	1456	3907	1223	4774	1016	5339	845	6112	571	7287	434	4778
10-#11	2.55	MA	5176	1541	7197	1361	9256	1128	10616	935	12477	627	15961	421	12116
3L-4S		MI	2380	1541	3627	1280	4355	1062	4807	874	5369	563	6297	216	5414
10-#11	2.55	MA	4923	1541	6632	1378	8518	1143	9672	956	11187	638	14374	356	11712
4L-3S		MI	2498	1541	3887	1272	4707	1050	5238	864	5956	565	6955	270	5654
10-#11	2.55	MA	4625	1541	6132	1394	7806	1165	8830	970	10021	656	12697	291	10808
5L-2S		MI	2688	1541	4248	1264	5164	1044	5790	861	6700	561	7861	385	5680
10-#14	3.68	MA	5427	1744	7839	1513	10000	1244	11424	1026	13521	638	17669	265	15863
4L-3S		MI	2696	1744	4515	1392	5472	1136	6148	917	7147	548	8294	135	7787
10-#14	3.68	MA	5012	1744	7122	1536	8981	1275	10219	1044	11852	663	15264	169	14540
5L-2S		MI	2941	1744	5024	1382	6117	1130	6927	914	8191	543	9541	300	7874
10-#18	6.54	MA	6726	2259	10800	1857	13654	1500	15754	1201	19298	637	25813	30	25639
4L-3S		MI	3164	2259	6001	1699	7296	1357	8325	1049	9837	476	11285	-254	10974
10-#18	6.54	MA	6018	2259	9542	1895	11867	1552	13643	1231	16375	677	21757	-126	20921
5L-2S		MI	3513	2259	6865	1686	8389	1351	9647	1052	11557	467	13288	39	13078
12-#10	2.49	MA	5262	1531	7236	1359	9354	1127	10760	935	12695	629	16280	446	11999
3L-5S		MI	2367	1531	3496	1293	4218	1073	4656	885	5174	579	6165	221	5285
12-#10	2.49	MA	5058	1531	6772	1373	8747	1140	9983	953	11633	639	14982	394	11815
4E		MI	2458	1531	3691	1285	4492	1062	4980	881	5622	574	6721	277	5518
12-#10	2.49	MA	4808	1531	6360	1386	8162	1158	9291	964	10674	654	13605	343	11118
5L-3S		MI	2554	1531	3907	1278	4774	1056	5339	871	6112	574	7287	324	5644
12-#10	2.49	MA	4522	1531	5913	1393	7633	1171	8634	976	9740	664	12407	284	10515
6L-2S		MI	2714	1531	4210	1270	5158	1050	5803	867	6736	569	8073	418	5664
12-#11	3.06	MA	5313	1633	7453	1435	9556	1186	10927	983	12877	635	16714	351	14061
4E		MI	2532	1633	3989	1338	4812	1104	5360	901	6113	559	7204	191	6400
12-#11	3.06	MA	5020	1633	6952	1451	8844	1208	10086	997	11711	653	15037	287	13186
5L-3S		MI	2641	1633	4248	1330	5164	1092	5790	891	6700	562	7861	246	6694
12-#11	3.06	MA	4686	1633	6415	1460	8202	1223	9266	1017	10575	664	13574	212	12224
6L-2S		MI	2822	1633	4610	1321	5621	1086	6343	888	7445	557	8768	360	6732
12-#14	4.41	MA	5558	1877	8293	1619	10463	1336	12012	1083	14266	658	18606	162	17913
5L-3S		MI	2891	1877	5024	1475	6117	1197	6927	955	8191	543	9541	95	9235
12-#14	4.41	MA	5116	1877	7532	1632	9542	1357	10837	1112	12639	673	16502	54	16179
6L-2S		MI	3121	1877	5534	1465	6761	1191	7707	953	9235	538	10787	260	9349
12-#18	7.84	MA	6932	2495	11584	2042	14449	1660	16766	1300	20581	668	27579	-138	26339
5L-3S		MI	3485	2495	6865	1847	8389	1465	9647	1119	11557	457	13288	-345	12801
14-#10	2.91	MA	5377	1605	7449	1419	9604	1174	11019	975	13028	636	16913	390	13781
4L-5S		MI	2508	1605	3799	1340	4601	1107	5120	906	5799	577	6952	205	6131
14-#10	2.91	MA	5131	1605	7037	1433	9019	1192	10327	986	12069	651	15537	340	13078
5L-4S		MI	2586	1605	3994	1332	4876	1096	5444	903	6246	571	7507	261	6350
14-#10	2.91	MA	4859	1605	6590	1440	8490	1205	9670	998	11135	661	14338	280	12474
6L-3S		MI	2676	1605	4210	1324	5158	1090	5803	893	6736	571	8073	308	6519
14-#10	2.91	MA	4620	1605	6162	1450	7927	1213	9002	1016	10228	676	13096	245	11651
7L-2S		MI	2829	1605	4514	1316	5541	1084	6267	889	7361	566	8860	402	6548
14-#11	3.57	MA	5400	1725	7773	1509	9882	1250	11341	1024	13401	649	17377	282	15568
5L-4S		MI	2680	1725	4350	1395	5269	1147	5912	928	6858	556	8111	167	7394
14-#11	3.57	MA	5085	1725	7235	1518	9239	1265	10521	1044	12266	660	15914	207	14597
6L-3S		MI	2781	1725	4610	1387	5621	1134	6343	918	7445	558	8768	221	7733
14-#11	3.57	MA	4807	1725	6715	1529	8564	1274	9728	1058	11161	678	14395	162	13566
7L-2S		MI	2953	1725	4971	1379	6078	1128	6896	915	8189	554	9674	336	7781
14-#14	5.15	MA	5671	2009	8704	1715	11024	1418	12630	1151	15053	668	19843	47	19562
6L-3S		MI	3083	2009	5534	1558	6761	1258	7707	994	9235	537	10787	54	10604

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



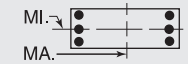
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#14	5.15	MA	5307	2009	7960	1730	10068	1432	11494	1170	13472	693	17662	-21	17591
7L-2S		MI	3299	2009	6043	1547	7405	1251	8486	992	10279	532	12033	219	10821
16-#10	3.32	MA	5444	1680	7714	1480	9875	1227	11363	1008	13463	648	17468	336	15040
5E		MI	2636	1680	4102	1387	4985	1142	5584	928	6424	574	7738	189	6981
16-#10	3.32	MA	5185	1680	7267	1487	9346	1239	10706	1020	12530	658	16269	277	14432
6L-4S		MI	2711	1680	4297	1379	5260	1130	5908	925	6871	568	8294	245	7189
16-#10	3.32	MA	4960	1680	6839	1496	8783	1247	10038	1038	11622	674	15027	241	13613
7L-3S		MI	2795	1680	4514	1371	5541	1124	6267	915	7361	569	8860	292	7394
16-#10	3.32	MA	4746	1680	6368	1512	8203	1262	9360	1046	10718	683	13827	192	12735
8L-2S		MI	2942	1680	4817	1363	5925	1119	6731	911	7986	563	9646	386	7429
16-#11	4.08	MA	5471	1817	8056	1575	10277	1307	11776	1071	13956	657	18254	203	16969
6L-4S		MI	2825	1817	4711	1453	5726	1189	6465	955	7602	553	9017	142	8394
16-#11	4.08	MA	5211	1817	7536	1586	9602	1316	10983	1085	12852	675	16735	157	15931
7L-3S		MI	2918	1817	4971	1444	6078	1176	6896	945	8189	555	9674	197	8771
16-#11	4.08	MA	4960	1817	6963	1606	8896	1334	10172	1095	11751	686	15270	95	14826
8L-2S		MI	3083	1817	5332	1436	6535	1171	7449	942	8933	551	10581	311	8829
16-#14	5.88	MA	5871	2142	9131	1813	11550	1493	13286	1209	15885	688	21004	-28	20867
7L-3S		MI	3271	2142	6043	1641	7405	1319	8486	1033	10279	531	12033	14	11986
18-#10	3.74	MA	5502	1755	7944	1534	10202	1274	11741	1042	13925	655	18200	273	16391
6L-5S		MI	2760	1755	4406	1433	5369	1176	6048	950	7048	571	8524	173	7834
18-#10	3.74	MA	5289	1755	7516	1543	9640	1281	11074	1060	13017	671	16959	237	15575
7L-4S		MI	2834	1755	4600	1426	5643	1165	6372	947	7496	566	9080	229	8031
18-#10	3.74	MA	5080	1755	7045	1559	9059	1296	10396	1068	12113	681	15758	188	14691
8L-3S		MI	2912	1755	4817	1418	5925	1159	6731	937	7986	566	9646	276	8268
18-#10	3.74	MA	4817	1755	6639	1571	8520	1306	9709	1082	11221	696	14520	134	13815
9L-2S		MI	3053	1755	5120	1410	6309	1153	7195	933	8611	560	10432	370	8309
18-#11	4.59	MA	5602	1908	8356	1644	10640	1359	12239	1112	14542	671	19075	153	18296
7L-4S		MI	2967	1908	5072	1510	6183	1231	7018	982	8346	549	9924	118	9399
18-#11	4.59	MA	5355	1908	7783	1663	9934	1376	11428	1122	13441	682	17611	90	17196
8L-3S		MI	3054	1908	5332	1502	6535	1218	7449	972	8933	552	10581	172	9809
20-#10	4.15	MA	5610	1830	8193	1590	10496	1316	12110	1081	14412	668	18890	233	17536
7L-5S		MI	2880	1830	4709	1480	5752	1210	6512	972	7673	568	9311	157	8690
20-#10	4.15	MA	5403	1830	7722	1606	9916	1330	11432	1089	13507	678	17690	184	16648
8L-4S		MI	2954	1830	4904	1472	6027	1199	6836	969	8120	563	9867	213	8877
20-#10	4.15	MA	5153	1830	7316	1617	9377	1340	10744	1104	12615	693	16452	131	15767
9L-3S		MI	3027	1830	5120	1464	6309	1193	7195	959	8611	563	10432	260	9142
20-#10	4.15	MA	4919	1830	6890	1625	8848	1351	10082	1113	11718	703	15248	88	14852
10L-2S		MI	3163	1830	5423	1457	6692	1187	7659	955	9235	557	11219	354	9188
20-#11	5.10	MA	5739	2000	8604	1720	10972	1418	12683	1149	15131	679	19951	86	19565
8L-4S		MI	3107	2000	5434	1567	6640	1273	7571	1009	9090	546	10830	93	10408
22-#10	4.57	MA	5719	1904	8399	1653	10772	1365	12468	1111	14902	675	19621	181	18604
8L-5S		MI	2999	1904	5012	1527	6136	1245	6976	994	8298	565	10097	141	9548
22-#10	4.57	MA	5479	1904	7993	1664	10233	1375	11780	1126	14010	690	18383	127	17719
9L-4S		MI	3073	1904	5207	1519	6410	1233	7300	990	8745	560	10653	197	9727
22-#10	4.57	MA	5256	1904	7567	1672	9705	1385	11118	1135	13113	700	17179	84	16801
10L-3S		MI	3141	1904	5423	1511	6692	1227	7659	981	9235	560	11219	244	10016
24-#10	4.98	MA	5798	1979	8670	1711	11090	1409	12816	1148	15405	688	20314	123	19672
9L-5S		MI	3117	1979	5315	1574	6519	1279	7440	1016	8922	563	10883	125	10407
24-#10	4.98	MA	5585	1979	8244	1719	10561	1420	12153	1157	14507	697	19110	80	18750
10L-4S		MI	3190	1979	5510	1566	6794	1268	7764	1012	9370	557	11439	181	10579

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis

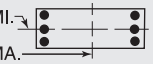


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.39	MA	5391	1411	6892	1287	8893	1078	10109	911	11578	654	14558	568	7585
2E		MI	2492	1411	3642	1190	4354	996	4768	840	5234	595	5996	451	3422
4-#18	2.47	MA	6184	1617	8856	1406	11305	1164	12988	965	15419	640	19850	553	13089
2E		MI	2733	1617	4423	1300	5282	1074	5860	886	6571	557	7469	341	5612
6-#10	1.18	MA	5258	1370	6437	1273	8407	1069	9567	908	10891	662	13638	576	6546
2L-3S		MI	2278	1370	3138	1196	3792	1002	4125	849	4414	617	5125	403	3016
6-#10	1.18	MA	4784	1370	5713	1287	7491	1082	8460	920	9400	678	11574	494	6513
3L-2S		MI	2468	1370	3441	1188	4175	997	4589	845	5038	612	5912	496	3004
6-#11	1.44	MA	5461	1421	6967	1298	9026	1087	10289	918	11838	656	14932	570	7928
2L-3S		MI	2308	1421	3308	1215	3963	1014	4310	853	4643	606	5337	349	3585
6-#11	1.44	MA	4906	1421	6090	1315	7916	1102	8946	932	10030	675	12428	467	7866
3L-2S		MI	2527	1421	3669	1207	4420	1009	4863	850	5387	602	6244	464	3576
6-#14	2.08	MA	5954	1543	8146	1369	10480	1139	12028	950	14162	649	18136	561	11250
2L-3S		MI	2402	1543	3642	1284	4354	1063	4768	881	5234	594	5996	245	4906
6-#14	2.08	MA	5214	1543	6892	1393	8893	1160	10109	970	11578	675	14558	411	11077
3L-2S		MI	2687	1543	4151	1273	4998	1057	5547	879	6278	589	7243	411	4932
6-#18	3.70	MA	7076	1852	11044	1553	14073	1273	16336	1034	19927	631	26092	540	19465
2L-3S		MI	2612	1852	4423	1461	5282	1188	5860	953	6571	547	7469	-44	7436
6-#18	3.70	MA	5956	1852	8856	1593	11305	1309	12988	1066	15419	674	19850	264	18786
3L-2S		MI	3039	1852	5287	1447	6375	1182	7182	955	8291	538	9473	250	8128
8-#9	1.23	MA	5320	1381	6530	1282	8544	1076	9743	913	11137	663	13986	577	6884
2L-4S		MI	2253	1381	3064	1212	3707	1016	4017	863	4270	619	5008	389	3159
8-#9	1.23	MA	4950	1381	5958	1293	7820	1087	8867	923	9958	676	12353	513	6861
3E		MI	2346	1381	3236	1206	3931	1011	4302	855	4659	619	5462	427	3160
8-#9	1.23	MA	4736	1381	5567	1304	7308	1097	8212	937	9062	684	11266	472	6773
4L-2S		MI	2495	1381	3477	1199	4236	1006	4672	852	5157	614	6095	500	3153
8-#10	1.57	MA	5599	1445	7160	1319	9322	1103	10674	930	12382	659	15703	572	8663
2L-4S		MI	2299	1445	3225	1250	3893	1043	4230	880	4548	614	5346	340	3881
8-#10	1.57	MA	5150	1445	6437	1333	8407	1116	9567	942	10891	675	13638	490	8615
3E		MI	2412	1445	3441	1242	4175	1037	4589	871	5038	614	5912	387	3906
8-#10	1.57	MA	4891	1445	5942	1347	7759	1130	8738	960	9757	685	12260	439	8438
4L-2S		MI	2593	1445	3745	1234	4559	1031	5053	867	5663	609	6698	480	3905
8-#11	1.93	MA	5859	1513	7845	1355	10137	1129	11632	945	13647	653	17436	565	10493
2L-4S		MI	2331	1513	3410	1281	4067	1069	4432	890	4800	600	5587	270	4507
8-#11	1.93	MA	5337	1513	6967	1372	9026	1145	10289	959	11838	671	14932	462	10411
3E		MI	2465	1513	3669	1272	4420	1057	4863	880	5387	603	6244	325	4637
8-#11	1.93	MA	5036	1513	6365	1389	8239	1160	9282	981	10460	683	13245	398	10115
4L-2S		MI	2669	1513	4031	1264	4877	1051	5416	877	6131	598	7151	439	4644
8-#14	2.78	MA	5806	1675	8146	1476	10480	1221	12028	1009	14162	670	18136	404	14711
3E		MI	2611	1675	4151	1366	4998	1124	5547	920	6278	588	7243	205	6368
8-#14	2.78	MA	5413	1675	7283	1499	9352	1243	10586	1039	12189	686	15711	311	13478
4L-2S		MI	2876	1675	4661	1356	5643	1117	6326	918	7322	583	8489	370	6422
8-#18	4.94	MA	6962	2087	11044	1740	14073	1417	16336	1136	19927	665	26092	252	25163
3E		MI	2950	2087	5287	1608	6375	1296	7182	1022	8291	528	9473	-135	9341
8-#18	4.94	MA	6356	2087	9532	1780	12098	1453	13810	1186	16474	690	21811	84	21283
4L-2S		MI	3337	2087	6151	1594	7468	1290	8504	1024	10011	519	11477	159	10625
10-#10	1.96	MA	5928	1519	7884	1366	10238	1138	11782	952	13873	656	17767	569	10778
2L-5S		MI	2342	1519	3333	1305	4002	1088	4370	906	4725	617	5576	267	4497
10-#10	1.96	MA	5501	1519	7160	1380	9322	1151	10674	964	12382	672	15703	486	10718
3L-4S		MI	2435	1519	3528	1297	4277	1077	4694	902	5173	611	6132	324	4751
10-#10	1.96	MA	5262	1519	6665	1394	8675	1164	9845	982	11248	683	14324	435	10537
4L-3S		MI	2541	1519	3745	1289	4559	1071	5053	893	5663	611	6698	371	4789
10-#10	1.96	MA	4984	1519	6223	1408	8051	1183	9108	994	10226	699	12859	386	9844
5L-2S		MI	2715	1519	4048	1281	4942	1065	5517	889	6288	606	7484	464	4798
10-#11	2.41	MA	5750	1605	7845	1430	10137	1187	11632	986	13647	668	17436	458	12959
3L-4S		MI	2494	1605	3771	1338	4524	1111	4985	917	5544	597	6493	245	5480
10-#11	2.41	MA	5475	1605	7243	1446	9349	1202	10625	1007	12269	680	15749	394	12630
4L-3S		MI	2613	1605	4031	1330	4877	1099	5416	907	6131	599	7151	300	5682

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis

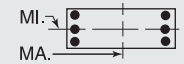


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.41	MA	5149	1605	6709	1463	8590	1225	9727	1022	11025	698	13962	331	11622
5L-2S		MI	2807	1605	4392	1321	5334	1093	5968	904	6876	595	8057	415	5704
10-#14	3.47	MA	6022	1808	8538	1582	10939	1304	12505	1078	14773	681	19289	304	17106
4L-3S		MI	2812	1808	4661	1449	5643	1185	6326	959	7322	582	8489	165	7825
10-#14	3.47	MA	5568	1808	7773	1606	9851	1335	11219	1098	12991	707	16726	211	15719
5L-2S		MI	3060	1808	5170	1439	6287	1178	7106	957	8366	577	9735	330	7903
10-#18	6.17	MA	7431	2323	11721	1927	14866	1561	17158	1255	20982	681	28053	72	27603
4L-3S		MI	3277	2323	6151	1755	7468	1404	8504	1091	10011	509	11477	-225	11208
10-#18	6.17	MA	6655	2323	10378	1967	12958	1615	14903	1287	17859	724	23728	-78	23059
5L-2S		MI	3633	2323	7015	1742	8561	1399	9826	1094	11731	500	13481	68	13116
12-#10	2.35	MA	5840	1594	7884	1427	10238	1185	11782	986	13873	669	17767	482	12822
3L-5S		MI	2481	1594	3637	1351	4386	1123	4834	928	5350	614	6363	251	5338
12-#10	2.35	MA	5619	1594	7389	1441	9590	1198	10953	1004	12739	680	16388	431	12638
4E		MI	2573	1594	3831	1344	4660	1111	5158	924	5797	608	6918	308	5576
12-#10	2.35	MA	5346	1594	6947	1454	8966	1217	10215	1016	11717	696	14923	382	11940
5L-3S		MI	2670	1594	4048	1336	4942	1105	5517	915	6288	609	7484	355	5668
12-#10	2.35	MA	5037	1594	6469	1462	8397	1229	9515	1028	10721	706	13648	324	11341
6L-2S		MI	2833	1594	4351	1328	5326	1100	5981	911	6912	603	8271	448	5685
12-#11	2.89	MA	5897	1697	8121	1504	10460	1244	11968	1034	14077	676	18253	389	15150
4E		MI	2647	1697	4132	1395	4981	1153	5538	944	6289	594	7400	221	6464
12-#11	2.89	MA	5576	1697	7587	1520	9700	1267	11070	1049	12833	695	16466	326	14171
5L-3S		MI	2757	1697	4392	1387	5334	1141	5968	934	6876	596	8057	276	6724
12-#11	2.89	MA	5216	1697	7008	1529	9015	1282	10196	1070	11621	707	14910	253	13187
6L-2S		MI	2941	1697	4753	1379	5791	1135	6521	931	7620	591	8964	390	6757
12-#14	4.17	MA	6158	1940	9027	1688	11438	1396	13138	1136	15576	702	20304	204	19354
5L-3S		MI	3008	1940	5170	1532	6287	1246	7106	998	8366	576	9735	124	9282
12-#14	4.17	MA	5680	1940	8205	1701	10456	1418	11885	1166	13840	718	18069	97	17450
6L-2S		MI	3241	1940	5679	1521	6931	1239	7885	995	9410	571	10982	289	9379
12-#18	7.41	MA	7643	2558	12566	2114	15726	1723	18252	1356	22367	715	29970	-90	28979
5L-3S		MI	3598	2558	7015	1902	8561	1512	9826	1160	11731	490	13481	-316	13043
12-#18	7.41	MA	6923	2558	11153	2138	14002	1759	16052	1406	19323	740	25836	-308	24511
6L-2S		MI	3929	2558	7879	1889	9654	1507	11148	1163	13451	481	15484	-22	15437
14-#10	2.74	MA	5964	1669	8113	1488	10506	1233	12060	1026	14230	677	18453	427	14742
4L-5S		MI	2622	1669	3940	1398	4769	1157	5298	950	5975	611	7149	235	6183
14-#10	2.74	MA	5695	1669	7670	1501	9882	1251	11323	1038	13208	693	16988	378	14039
5L-4S		MI	2702	1669	4135	1390	5044	1146	5622	946	6422	606	7705	292	6407
14-#10	2.74	MA	5402	1669	7193	1509	9312	1264	10622	1050	12212	703	15712	320	13435
6L-3S		MI	2793	1669	4351	1382	5326	1140	5981	936	6912	606	8271	339	6545
14-#10	2.74	MA	5143	1669	6736	1518	8712	1272	9907	1068	11245	719	14395	285	12536
7L-2S		MI	2948	1669	4654	1375	5709	1134	6445	933	7537	600	9057	432	6569
14-#11	3.37	MA	5988	1788	8465	1578	10811	1309	12413	1076	14641	691	18970	321	16723
5L-4S		MI	2795	1788	4493	1453	5438	1196	6091	971	7033	590	8306	197	7457
14-#11	3.37	MA	5647	1788	7886	1587	10126	1325	11539	1097	13430	703	17414	248	15725
6L-3S		MI	2898	1788	4753	1444	5791	1183	6521	961	7620	592	8964	251	7764
14-#11	3.37	MA	5347	1788	7330	1598	9396	1334	10693	1111	12252	722	15800	204	14678
7L-2S		MI	3073	1788	5114	1436	6248	1178	7074	958	8364	588	9870	366	7808
14-#14	4.86	MA	6280	2073	9460	1784	12043	1479	13804	1205	16424	713	21647	90	21072
6L-3S		MI	3199	2073	5679	1615	6931	1306	7885	1037	9410	570	10982	84	10697
14-#14	4.86	MA	5886	2073	8665	1800	11009	1493	12592	1225	14736	739	19325	25	19201
7L-2S		MI	3420	2073	6189	1604	7576	1300	8664	1034	10454	565	12228	249	10852
16-#10	3.14	MA	6034	1744	8394	1548	10797	1286	12430	1060	14699	690	19052	374	16139
5E		MI	2752	1744	4243	1445	5153	1191	5762	972	6599	608	7935	219	7032
16-#10	3.14	MA	5754	1744	7916	1555	10228	1298	11729	1072	13703	701	17776	316	15529
6L-4S		MI	2827	1744	4438	1437	5428	1180	6086	968	7047	603	8491	276	7244
16-#10	3.14	MA	5510	1744	7460	1565	9627	1306	11014	1090	12736	717	16459	281	14633
7L-3S		MI	2912	1744	4654	1429	5709	1174	6445	958	7537	603	9057	323	7420
16-#10	3.14	MA	5277	1744	6957	1582	9008	1321	10287	1098	11772	727	15182	234	13736
8L-2S		MI	3062	1744	4957	1421	6093	1168	6909	955	8162	598	9843	416	7451

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis



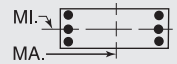
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	3.85	MA	6064	1880	8764	1644	11236	1367	12882	1124	15238	700	19918	243	18264
6L-4S		MI	2940	1880	4855	1510	5895	1238	6643	998	7777	587	9213	172	8455
16-#11	3.85	MA	5783	1880	8208	1655	10507	1376	12036	1138	14060	718	18304	199	17208
7L-3S		MI	3036	1880	5114	1502	6248	1225	7074	988	8364	589	9870	227	8803
16-#11	3.85	MA	5508	1880	7597	1675	9753	1394	11160	1148	12887	730	16745	139	15995
8L-2S		MI	3203	1880	5476	1493	6705	1220	7627	985	9109	585	10777	341	8855
16-#14	5.56	MA	6494	2205	9919	1883	12596	1553	14511	1264	17320	734	22903	18	22814
7L-3S		MI	3388	2205	6189	1698	7576	1367	8664	1076	10454	565	12228	43	12075
16-#14	5.56	MA	6110	2205	9043	1911	11517	1579	13270	1279	15638	750	20666	-72	20417
8L-2S		MI	3598	2205	6698	1687	8220	1361	9444	1073	11497	560	13474	208	12323
18-#10	3.53	MA	6096	1818	8640	1602	11143	1332	12837	1094	15194	698	19841	312	17623
6L-5S		MI	2876	1818	4546	1492	5537	1226	6225	994	7224	605	8722	203	7884
18-#10	3.53	MA	5865	1818	8183	1612	10543	1340	12122	1112	14227	714	18523	277	16730
7L-4S		MI	2950	1818	4741	1484	5811	1214	6550	990	7671	600	9278	260	8085
18-#10	3.53	MA	5637	1818	7681	1628	9923	1355	11394	1120	13263	724	17247	230	15828
8L-3S		MI	3030	1818	4957	1476	6093	1208	6909	980	8162	600	9843	307	8295
18-#10	3.53	MA	5354	1818	7244	1639	9349	1366	10661	1134	12312	740	15933	176	14932
9L-2S		MI	3174	1818	5261	1468	6477	1203	7373	977	8786	595	10630	400	8332
18-#11	4.33	MA	6205	1972	9086	1713	11617	1418	13379	1165	15869	715	20808	195	19739
7L-4S		MI	3083	1972	5216	1568	6352	1280	7196	1025	8521	583	10119	148	9459
18-#11	4.33	MA	5936	1972	8474	1733	10864	1436	12503	1175	14695	727	19249	134	18531
8L-3S		MI	3172	1972	5476	1559	6705	1268	7627	1015	9109	586	10777	202	9841
18-#11	4.33	MA	5606	1972	7949	1746	10165	1448	11611	1192	13537	746	17640	68	17289
9L-2S		MI	3332	1972	5837	1551	7162	1262	8179	1012	9853	581	11683	317	9902
18-#14	6.25	MA	6705	2338	10298	1994	13104	1639	15189	1318	18223	745	24244	-79	23871
8L-3S		MI	3575	2338	6698	1780	8220	1428	9444	1115	11497	559	13474	3	13465
20-#10	3.92	MA	6211	1893	8907	1658	11458	1375	13229	1134	15718	711	20588	273	18828
7L-5S		MI	2997	1893	4850	1538	5920	1260	6689	1016	7849	603	9508	187	8739
20-#10	3.92	MA	5986	1893	8404	1675	10839	1390	12501	1142	14754	721	19311	226	17920
8L-4S		MI	3071	1893	5044	1530	6195	1249	7014	1012	8296	597	10064	244	8931
20-#10	3.92	MA	5715	1893	7968	1686	10264	1400	11768	1156	13803	737	17998	173	17020
9L-3S		MI	3146	1893	5261	1523	6477	1243	7373	1002	8786	597	10630	291	9169
20-#10	3.92	MA	5462	1893	7513	1695	9701	1411	11062	1166	12834	746	16717	131	16059
10L-2S		MI	3284	1893	5564	1515	6860	1237	7837	999	9411	592	11416	384	9211
20-#11	4.81	MA	6350	2064	9352	1790	11974	1478	13846	1202	16503	723	21753	129	21067
8L-4S		MI	3223	2064	5577	1625	6809	1322	7749	1052	9266	580	11026	123	10467
20-#11	4.81	MA	6036	2064	8826	1804	11275	1490	12954	1219	15346	742	20144	63	19819
9L-3S		MI	3306	2064	5837	1617	7162	1310	8179	1042	9853	582	11683	178	10880
22-#10	4.31	MA	6327	1968	9128	1722	11755	1424	13609	1164	16245	718	21376	222	20012
8L-5S		MI	3117	1968	5153	1585	6304	1294	7153	1038	8473	600	10294	171	9596
22-#10	4.31	MA	6067	1968	8692	1733	11180	1435	12876	1178	15294	734	20062	169	19107
9L-4S		MI	3190	1968	5348	1577	6578	1283	7478	1034	8921	594	10850	228	9779
22-#10	4.31	MA	5826	1968	8237	1741	10617	1446	12169	1188	14325	743	18782	127	18149
10L-3S		MI	3260	1968	5564	1569	6860	1277	7837	1024	9411	595	11416	275	10043
22-#11	5.30	MA	6455	2156	9704	1861	12385	1533	14297	1246	17154	739	22648	58	22349
9L-4S		MI	3361	2156	5939	1682	7267	1364	8302	1079	10010	576	11932	99	11479
24-#10	4.70	MA	6411	2043	9415	1780	12095	1469	13983	1200	16785	732	22126	165	21194
9L-5S		MI	3234	2043	5456	1632	6687	1329	7617	1060	9098	597	11081	155	10455
24-#10	4.70	MA	6181	2043	8961	1788	11532	1480	13276	1210	15816	741	20846	123	20239
10L-4S		MI	3307	2043	5651	1624	6962	1317	7941	1056	9546	592	11637	212	10630

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.19	MA	1725	847	2326	749	2880	629	3199	533	3551	387	4299	327	2121
2L-3S		MI	1585	847	2105	755	2600	634	2859	537	3095	392	3690	269	2124
6-#9	1.50	MA	1796	884	2508	770	3101	644	3460	542	3899	384	4741	319	2631
2L-3S		MI	1626	884	2230	778	2749	650	3035	547	3326	390	3983	246	2625
6-#10	1.90	MA	1882	931	2736	797	3379	663	3792	554	4341	380	5294	308	3274
2L-3S		MI	1676	931	2387	806	2937	671	3256	560	3620	388	4349	215	3251
6-#11	2.34	MA	1952	983	2978	822	3656	681	4113	564	4760	374	5741	284	3909
2L-3S		MI	1717	983	2559	832	3127	689	3472	569	3898	382	4642	169	3862
6-#14	3.38	MA	2137	1105	3523	893	4326	732	4912	596	5828	366	6999	244	5448
2L-3S		MI	1838	1105	2931	906	3577	742	4006	602	4608	375	5476	79	5275
6-#18	6.00	MA	2554	1414	4827	1075	5938	865	6842	679	8395	347	9870	119	9135
2L-3S		MI	2121	1414	3816	1095	4658	877	5295	684	6317	355	7382	-174	7154
8-#8	1.58	MA	1821	893	2548	778	3161	650	3538	547	4008	385	4909	322	2775
2L-4S		MI	1606	893	2170	791	2677	660	2939	559	3196	392	3867	232	2741
8-#9	2.00	MA	1912	943	2786	807	3453	671	3886	560	4472	382	5499	312	3447
2L-4S		MI	1653	943	2312	822	2845	683	3133	574	3453	390	4201	198	3311
8-#10	2.54	MA	2022	1006	3086	844	3822	698	4327	576	5062	378	6238	297	4296
2L-4S		MI	1713	1006	2489	862	3057	713	3380	593	3779	387	4620	153	3955
8-#11	3.12	MA	2111	1075	3396	879	4186	723	4753	591	5623	371	6840	266	5128
2L-4S		MI	1768	1075	2680	900	3268	738	3617	609	4085	379	4953	92	4565
8-#14	4.50	MA	2351	1237	4115	976	5075	793	5818	635	7048	362	8521	214	7164
2L-4S		MI	1914	1237	3099	1002	3775	813	4210	657	4870	369	5901	-34	5868
10-#10	3.17	MA	2156	1081	3436	891	4265	732	4863	598	5783	375	7182	286	5315
2L-5S		MI	1772	1081	2617	918	3186	760	3545	621	3988	392	4898	87	4628
10-#10	3.17	MA	1982	1081	3086	900	3822	740	4327	604	5062	383	6238	193	5264
3L-4S		MI	1879	1081	2839	909	3499	747	3915	615	4500	385	5565	142	4923
10-#11	3.90	MA	2070	1166	3396	947	4186	773	4753	623	5623	375	6840	134	6261
3L-4S		MI	1953	1166	3098	957	3798	781	4258	636	4947	375	6052	75	5725
10-#14	5.63	MA	2315	1369	4115	1072	5075	864	5818	680	7048	365	8521	19	8463
3L-4S		MI	2171	1369	3691	1085	4524	873	5116	696	6089	364	7424	-64	7322

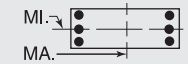
RECTANGULAR TIED COLUMNS 20" x 22"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.15	MA	2087	927	2783	826	3461	693	3850	588	4277	428	5208	366	2518
2E		MI	1879	927	2555	816	3142	685	3475	581	3838	422	4596	353	2261
4-#11	1.42	MA	2147	962	2982	840	3681	703	4099	593	4599	422	5570	351	3017
2E		MI	1928	962	2731	830	3334	694	3691	585	4115	416	4887	335	2701
4-#14	2.05	MA	2304	1043	3408	885	4198	735	4712	613	5414	416	6573	330	4209
2E		MI	2060	1043	3105	874	3785	726	4226	605	4825	410	5720	308	3749
4-#18	3.64	MA	2647	1249	4429	1003	5446	821	6200	666	7397	402	8901	261	7077
2E		MI	2348	1249	3995	992	4868	811	5515	657	6532	394	7623	222	6248
6-#8	1.08	MA	2074	917	2713	825	3395	693	3781	589	4195	431	5139	373	2377
2L-3S		MI	1727	917	2271	822	2804	690	3078	587	3313	431	3938	304	2141
6-#8	1.08	MA	1913	917	2462	831	3078	699	3398	594	3679	438	4431	315	2380
3L-2S		MI	1869	917	2493	816	3084	685	3417	583	3769	426	4547	362	2136
6-#9	1.36	MA	2157	955	2919	845	3646	708	4079	598	4591	428	5658	367	2955
2L-3S		MI	1768	955	2397	844	2953	706	3253	596	3544	429	4229	280	2647
6-#9	1.36	MA	1961	955	2604	854	3247	715	3597	604	3942	436	4775	294	2949
3L-2S		MI	1940	955	2675	836	3305	700	3678	592	4117	423	4987	354	2648
6-#10	1.73	MA	2259	1002	3179	872	3963	728	4456	610	5094	425	6312	359	3686
2L-3S		MI	1818	1002	2555	872	3142	727	3475	609	3838	427	4596	249	3278
6-#10	1.73	MA	2021	1002	2783	883	3461	736	3850	617	4277	434	5208	265	3662
3L-2S		MI	2027	1002	2905	863	3584	720	4010	603	4559	419	5540	342	3294

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis

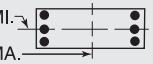


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	2.13	MA	2345	1053	3458	897	4283	745	4828	620	5579	419	6864	339	4414
2L-3S		MI	1858	1053	2731	897	3334	744	3691	618	4115	420	4887	203	3897
6-#11	2.13	MA	2071	1053	2982	909	3681	754	4099	627	4599	429	5570	224	4367
3L-2S		MI	2098	1053	3150	887	3863	736	4332	612	4977	413	5986	318	3932
6-#14	3.07	MA	2566	1175	4083	968	5051	796	5745	652	6804	411	8374	308	6177
2L-3S		MI	1979	1175	3105	971	3785	797	4226	650	4825	413	5720	112	5357
6-#14	3.07	MA	2217	1175	3408	984	4198	809	4712	661	5414	423	6573	142	6033
3L-2S		MI	2285	1175	3697	957	4534	787	5132	644	6045	405	7242	278	5476
6-#18	5.45	MA	3061	1484	5588	1150	6911	929	7972	735	9783	393	11880	208	10431
2L-3S		MI	2258	1484	3995	1158	4868	931	5515	731	6532	393	7623	-141	7442
6-#18	5.45	MA	2554	1484	4429	1174	5446	947	6200	746	7397	409	8901	-86	8751
3L-2S		MI	2704	1484	5007	1139	6148	919	7062	726	8611	384	10111	152	9173
8-#8	1.44	MA	2186	964	2963	854	3712	714	4165	603	4712	429	5848	370	3116
2L-4S		MI	1747	964	2337	857	2881	717	3157	608	3415	431	4114	266	2769
8-#8	1.44	MA	2031	964	2713	860	3395	720	3781	608	4195	436	5139	312	3111
3E		MI	1830	964	2493	851	3084	712	3417	600	3769	430	4547	298	2790
8-#8	1.44	MA	1939	964	2537	867	3166	726	3489	616	3796	439	4639	278	3082
4L-2S		MI	1965	964	2714	845	3365	707	3756	596	4226	424	5156	356	2791
8-#9	1.82	MA	2293	1013	3234	882	4044	735	4561	616	5240	426	6542	362	3879
2L-4S		MI	1794	1013	2479	888	3049	739	3352	623	3671	429	4448	232	3390
8-#9	1.82	MA	2106	1013	2919	890	3646	742	4079	621	4591	434	5658	289	3862
3E		MI	1893	1013	2675	880	3305	733	3678	614	4117	427	4987	272	3454
8-#9	1.82	MA	1995	1013	2698	899	3358	749	3711	632	4089	437	5034	247	3790
4L-2S		MI	2057	1013	2954	873	3657	727	4104	609	4690	421	5745	346	3466
8-#10	2.31	MA	2424	1077	3576	919	4465	762	5063	632	5911	422	7415	351	4845
2L-4S		MI	1853	1077	2658	928	3262	769	3599	642	3997	426	4866	187	4042
8-#10	2.31	MA	2200	1077	3179	929	3963	771	4456	639	5094	432	6312	258	4806
3E		MI	1973	1077	2905	919	3584	761	4010	631	4559	424	5540	238	4287
8-#10	2.31	MA	2066	1077	2901	940	3600	779	3992	652	4460	435	5530	205	4530
4L-2S		MI	2169	1077	3255	910	4027	754	4546	625	5280	417	6484	331	4318
8-#11	2.84	MA	2533	1145	3934	954	4886	787	5556	647	6560	415	8157	326	5802
2L-4S		MI	1907	1145	2852	965	3475	794	3837	657	4302	417	5197	126	4661
8-#11	2.84	MA	2285	1145	3458	966	4283	796	4828	654	5579	425	6864	212	5735
3E		MI	2042	1145	3150	954	3863	786	4332	645	4977	417	5986	185	5098
8-#11	2.84	MA	2125	1145	3121	978	3845	806	4268	668	4816	428	5943	149	5240
4L-2S		MI	2259	1145	3569	944	4393	778	4972	639	5840	409	7085	300	5154
8-#14	4.09	MA	2817	1308	4758	1051	5905	857	6778	691	8195	406	10176	286	8136
2L-4S		MI	2051	1308	3274	1067	3983	868	4429	705	5086	407	6144	0	6144
8-#14	4.09	MA	2501	1308	4083	1066	5051	869	5745	700	6804	419	8374	120	7965
3E		MI	2224	1308	3697	1053	4534	858	5132	689	6045	408	7242	82	7002
8-#14	4.09	MA	2308	1308	3604	1082	4428	882	4949	719	5718	421	7087	33	6941
4L-2S		MI	2501	1308	4290	1040	5283	848	6038	683	7265	400	8764	247	7195
8-#18	7.27	MA	3023	1720	5588	1322	6911	1055	7972	815	9783	400	11880	-140	11556
3E		MI	2661	1720	5007	1305	6148	1040	7062	800	8611	383	10111	-211	9754
10-#10	2.89	MA	2582	1152	3973	966	4967	796	5670	654	6728	419	8519	344	6000
2L-5S		MI	1913	1152	2786	984	3391	816	3764	670	4206	431	5144	121	4721
10-#10	2.89	MA	2378	1152	3576	976	4465	805	5063	661	5911	429	7415	251	5950
3L-4S		MI	2012	1152	3008	975	3705	803	4134	664	4718	423	5811	176	5006
10-#10	2.89	MA	2250	1152	3297	986	4101	814	4599	674	5278	433	6634	198	5633
4L-3S		MI	2126	1152	3255	966	4027	796	4546	653	5280	421	6484	227	5295
10-#10	2.89	MA	2129	1152	3048	997	3749	828	4183	681	4702	442	5855	143	5287
5L-2S		MI	2305	1152	3605	956	4470	788	5081	647	6001	414	7429	320	5337
10-#11	3.55	MA	2484	1237	3934	1023	4886	839	5556	681	6560	422	8157	199	7103
3L-4S		MI	2093	1237	3270	1022	4005	836	4477	684	5165	414	6296	108	5816
10-#11	3.55	MA	2350	1237	3598	1035	4447	848	4997	695	5797	425	7236	137	6565
4L-3S		MI	2213	1237	3569	1012	4393	828	4972	672	5840	413	7085	168	6299
10-#11	3.55	MA	2203	1237	3296	1047	4021	864	4494	703	5102	435	6323	69	6093
5L-2S		MI	2416	1237	3987	1002	4922	821	5613	666	6702	406	8184	282	6370

RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

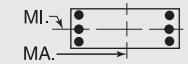
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	5.11	MA	2774	1440	4758	1149	5905	930	6778	739	8195	414	10176	98	9835
3L-4S		MI	2308	1440	3866	1150	4732	928	5335	744	6306	402	7667	-30	7621
10-#14	5.11	MA	2607	1440	4279	1165	5281	943	5982	758	7109	416	8888	11	8838
4L-3S		MI	2458	1440	4290	1136	5283	919	6038	728	7265	403	8764	52	8599
12-#10	3.46	MA	2544	1226	3973	1023	4967	839	5670	683	6728	426	8519	244	7094
3L-5S		MI	2074	1226	3136	1031	3834	850	4299	692	4927	428	6088	110	5709
12-#10	3.46	MA	2436	1226	3694	1033	4603	848	5206	696	6095	430	7737	191	6742
4E		MI	2173	1226	3357	1021	4147	837	4669	686	5439	421	6755	165	5978
12-#10	3.46	MA	2308	1226	3445	1043	4251	862	4790	703	5519	439	6958	136	6414
5L-3S		MI	2269	1226	3605	1012	4470	830	5081	675	6001	419	7429	216	6303
12-#10	3.46	MA	2149	1226	3202	1052	3931	871	4383	716	4957	443	6203	68	5916
6L-2S		MI	2438	1226	3955	1003	4913	823	5617	669	6722	411	8373	309	6355
12-#11	4.25	MA	2557	1329	4074	1092	5050	890	5725	722	6777	421	8530	124	7899
4E		MI	2271	1329	3689	1079	4534	878	5118	711	6027	410	7395	91	6980
12-#11	4.25	MA	2420	1329	3772	1104	4624	907	5222	730	6082	431	7616	56	7417
5L-3S		MI	2379	1329	3987	1069	4922	870	5613	699	6702	410	8184	150	7501
12-#14	6.14	MA	2893	1573	4954	1247	6135	1004	7015	797	8499	411	10690	-11	10659
4E		MI	2555	1573	4458	1232	5481	989	6241	783	7526	397	9189	-60	9068
14-#10	4.04	MA	2607	1301	4091	1080	5105	882	5813	718	6912	427	8841	184	7857
4L-5S		MI	2224	1301	3485	1077	4276	885	4835	714	5648	426	7032	99	6688
14-#10	4.04	MA	2489	1301	3842	1090	4752	896	5397	725	6336	437	8062	129	7545
5L-4S		MI	2321	1301	3707	1068	4590	872	5205	708	6160	418	7699	154	6955
14-#10	4.04	MA	2341	1301	3599	1099	4433	905	4990	738	5774	440	7306	61	7040
6L-3S		MI	2409	1301	3955	1059	4913	864	5617	697	6722	416	8373	204	7311
14-#11	4.96	MA	2623	1421	4248	1161	5226	949	5951	757	7063	428	8910	44	8747
5L-4S		MI	2444	1421	4108	1137	5064	920	5758	738	6890	407	8494	73	8151
16-#10	4.62	MA	2657	1376	4238	1137	5254	931	6004	747	7153	434	9165	122	8679
5E		MI	2370	1376	3835	1124	4719	919	5370	736	6369	423	7977	88	7658
16-#10	4.62	MA	2517	1376	3996	1146	4934	939	5597	760	6591	438	8410	53	8167
6L-4S		MI	2465	1376	4057	1115	5033	906	5740	730	6881	415	8644	143	7937

RECTANGULAR TIED COLUMNS 20" x 24"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.06	MA	2468	998	3201	901	4021	757	4484	644	4978	472	6122	411	2793
2E		MI	2022	998	2724	882	3347	741	3693	630	4056	461	4842	387	2277
4-#11	1.30	MA	2540	1032	3427	915	4271	767	4768	649	5344	467	6554	399	3354
2E		MI	2072	1032	2903	895	3540	749	3910	634	4332	455	5131	369	2721
4-#14	1.88	MA	2723	1114	3907	960	4853	800	5460	669	6263	460	7727	382	4695
2E		MI	2206	1114	3280	939	3993	781	4445	653	5042	448	5963	341	3774
4-#18	3.33	MA	3127	1320	5065	1078	6269	885	7146	721	8512	446	10483	327	7941
2E		MI	2496	1320	4175	1055	5078	865	5735	704	6748	431	7864	255	6282
6-#9	1.25	MA	2548	1025	3353	920	4226	772	4738	654	5327	473	6612	411	3279
2L-3S		MI	1909	1025	2565	910	3158	763	3471	645	3762	468	4476	314	2667
6-#9	1.25	MA	2325	1025	3001	929	3781	780	4200	661	4602	482	5609	339	3273
3L-2S		MI	2083	1025	2843	902	3510	756	3897	641	4335	462	5234	388	2665
6-#10	1.59	MA	2666	1073	3645	948	4582	792	5162	666	5891	469	7386	407	4097
2L-3S		MI	1960	1073	2724	938	3347	783	3693	658	4056	466	4842	283	3303
6-#10	1.59	MA	2395	1073	3201	959	4021	801	4484	674	4978	480	6122	314	4074
3L-2S		MI	2171	1073	3074	929	3790	776	4229	652	4777	458	5786	376	3313
6-#11	1.95	MA	2768	1124	3960	972	4946	809	5584	676	6443	463	8043	391	4920
2L-3S		MI	2000	1124	2903	962	3540	799	3910	666	4332	459	5131	237	3930
6-#11	1.95	MA	2454	1124	3427	985	4271	820	4768	685	5344	475	6554	276	4872
3L-2S		MI	2244	1124	3322	952	4070	792	4551	661	5195	451	6230	351	3956
6-#14	2.81	MA	3028	1246	4665	1043	5812	860	6619	708	7824	455	9810	366	6906
2L-3S		MI	2120	1246	3280	1035	3993	852	4445	698	5042	452	5963	146	5405
6-#14	2.81	MA	2616	1246	3907	1060	4853	875	5460	719	6263	471	7727	201	6762
3L-2S		MI	2432	1246	3872	1022	4742	842	5351	692	6262	443	7485	311	5505

RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

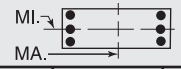
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	5.00	MA	3604	1555	6371	1226	7920	993	9144	791	11201	438	13958	286	11727
2L-3S		MI	2396	1555	4175	1222	5078	985	5735	778	6748	430	7864	-109	7728
6-#18	5.00	MA	3018	1555	5065	1253	6269	1015	7146	806	8512	459	10483	-7	10467
3L-2S		MI	2854	1555	5186	1202	6357	973	7282	773	8827	422	10352	185	9210
8-#8	1.32	MA	2580	1035	3401	929	4299	778	4833	659	5460	474	6800	412	3457
2L-4S		MI	1888	1035	2503	923	3085	773	3375	657	3633	471	4361	300	2795
8-#8	1.32	MA	2405	1035	3122	936	3945	785	4405	664	4883	481	6002	355	3452
3E		MI	1972	1035	2659	917	3288	768	3635	650	3988	469	4794	333	2809
8-#8	1.32	MA	2300	1035	2927	943	3691	791	4080	673	4440	485	5445	321	3423
4L-2S		MI	2109	1035	2880	911	3569	763	3974	645	4444	463	5403	391	2807
8-#9	1.67	MA	2703	1084	3705	957	4671	799	5277	672	6052	471	7615	408	4311
2L-4S		MI	1935	1084	2646	954	3254	796	3570	672	3889	468	4695	266	3436
8-#9	1.67	MA	2492	1084	3353	966	4226	807	4738	678	5327	480	6612	336	4294
3E		MI	2036	1084	2843	946	3510	790	3897	663	4335	466	5234	307	3477
8-#9	1.67	MA	2366	1084	3108	975	3906	815	4329	689	4768	484	5908	292	4226
4L-2S		MI	2202	1084	3121	939	3862	783	4322	658	4908	460	5992	380	3485
8-#10	2.12	MA	2855	1148	4088	994	5143	826	5841	688	6805	467	8650	403	5394
2L-4S		MI	1994	1148	2826	994	3467	825	3817	691	4215	465	5113	221	4126
8-#10	2.12	MA	2600	1148	3645	1005	4582	836	5162	696	5891	478	7386	310	5355
3E		MI	2115	1148	3074	985	3790	817	4229	680	4777	463	5786	272	4315
8-#10	2.12	MA	2448	1148	3335	1016	4178	845	4646	710	5186	483	6495	255	5119
4L-2S		MI	2316	1148	3424	975	4232	810	4764	674	5497	455	6730	365	4339
8-#11	2.60	MA	2987	1216	4494	1030	5620	851	6400	703	7542	460	9533	382	6476
2L-4S		MI	2040	1216	3024	1030	3682	849	4056	705	4519	456	5441	160	4753
8-#11	2.60	MA	2693	1216	3960	1042	4946	862	5584	712	6443	472	8043	268	6408
3E		MI	2185	1216	3322	1019	4070	842	4551	693	5195	455	6230	219	5133
8-#11	2.60	MA	2518	1216	3586	1055	4457	873	4960	727	5591	477	6989	202	5930
4L-2S		MI	2407	1216	3741	1009	4600	834	5191	688	6057	448	7329	334	5179
8-#14	3.75	MA	3316	1378	5423	1126	6770	921	7778	747	9385	450	11893	351	9108
2L-4S		MI	2188	1378	3449	1131	4191	923	4648	753	5303	445	6388	33	6252
8-#14	3.75	MA	2953	1378	4665	1143	5812	936	6619	758	7824	466	9810	186	8937
3E		MI	2366	1378	3872	1118	4742	913	5351	737	6262	447	7485	116	7095
8-#14	3.75	MA	2732	1378	4131	1161	5116	950	5730	779	6612	472	8330	94	7866
4L-2S		MI	2650	1378	4464	1104	5491	903	6257	731	7482	438	9008	281	7225
8-#18	6.67	MA	3555	1790	6371	1400	7920	1123	9144	875	11201	450	13958	-48	13818
3E		MI	2799	1790	5186	1369	6357	1094	7282	847	8827	421	10352	-178	10057
8-#18	6.67	MA	3240	1790	5444	1428	6713	1145	7604	909	9100	455	11472	-203	11078
4L-2S		MI	3205	1790	6197	1349	7637	1081	8829	842	10906	412	12840	115	12130
10-#10	2.65	MA	3038	1222	4532	1041	5704	860	6519	710	7718	464	9913	399	6686
2L-5S		MI	2054	1222	2954	1050	3596	872	3982	719	4424	470	5390	155	4796
10-#10	2.65	MA	2797	1222	4088	1052	5143	870	5841	718	6805	475	8650	306	6636
3L-4S		MI	2153	1222	3176	1040	3910	859	4353	713	4936	462	6057	210	5087
10-#10	2.65	MA	2658	1222	3779	1063	4739	880	5324	732	6100	480	7759	251	6357
4L-3S		MI	2270	1222	3424	1031	4232	852	4764	702	5497	460	6730	261	5324
10-#10	2.65	MA	2516	1222	3502	1074	4347	895	4862	740	5460	491	6867	197	5939
5L-2S		MI	2454	1222	3774	1022	4675	844	5300	696	6218	453	7675	354	5359
10-#11	3.25	MA	2931	1308	4494	1100	5620	904	6400	739	7542	468	9533	260	7946
3L-4S		MI	2233	1308	3443	1087	4211	891	4696	732	5382	452	6541	142	5905
10-#11	3.25	MA	2765	1308	4119	1112	5132	915	5777	754	6690	473	8479	194	7422
4L-3S		MI	2357	1308	3741	1077	4600	884	5191	720	6057	452	7329	201	6336
10-#11	3.25	MA	2601	1308	3785	1125	4658	933	5217	763	5916	485	7427	127	6955
5L-2S		MI	2565	1308	4159	1067	5129	876	5832	715	6920	444	8428	316	6397
10-#14	4.69	MA	3265	1511	5423	1226	6770	997	7778	797	9385	461	11893	170	11117
3L-4S		MI	2446	1511	4041	1214	4940	983	5554	792	6523	440	7910	3	7896

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	4.69	MA	3074	1511	4889	1243	6075	1011	6890	818	8173	467	10414	78	10006
4L-3S		MI	2602	1511	4464	1201	5491	974	6257	776	7482	442	9008	85	8731
10-#14	4.69	MA	2846	1511	4411	1261	5399	1035	6092	830	7069	482	8942	-19	8915
5L-2S		MI	2863	1511	5056	1187	6240	964	7163	770	8702	433	10530	251	8940
12-#10	3.17	MA	2987	1297	4532	1099	5704	904	6519	740	7718	472	9913	302	7917
3L-5S		MI	2210	1297	3304	1096	4039	906	4518	741	5145	467	6334	144	5781
12-#10	3.17	MA	2860	1297	4222	1110	5300	914	6003	754	7013	477	9023	247	7601
4E		MI	2315	1297	3526	1087	4352	893	4888	735	5656	460	7001	199	6055
12-#10	3.17	MA	2720	1297	3946	1121	4908	929	5540	762	6373	488	8131	193	7203
5L-3S		MI	2414	1297	3774	1078	4675	886	5300	724	6218	458	7675	250	6333
12-#10	3.17	MA	2540	1297	3669	1130	4554	939	5089	776	5749	493	7270	122	6691
6L-2S		MI	2588	1297	4124	1069	5118	879	5835	718	6939	450	8619	343	6378
12-#11	3.90	MA	3014	1400	4653	1170	5807	957	6593	781	7789	470	9968	186	8922
4E		MI	2412	1400	3861	1144	4741	934	5337	759	6244	449	7640	124	7065
12-#11	3.90	MA	2841	1400	4318	1183	5333	975	6033	790	7015	482	8916	119	8451
5L-3S		MI	2524	1400	4159	1134	5129	926	5832	747	6920	448	8428	183	7539
12-#11	3.90	MA	2633	1400	3991	1194	4904	986	5487	806	6260	487	7898	34	7739
6L-2S		MI	2719	1400	4578	1124	5659	918	6473	742	7782	441	9527	298	7612
12-#14	5.63	MA	3401	1643	5647	1326	7033	1072	8049	857	9733	462	12497	63	12155
4E		MI	2693	1643	4633	1297	5689	1044	6460	831	7743	435	9433	-27	9381
12-#14	5.63	MA	3178	1643	5169	1344	6357	1096	7251	869	8630	477	11026	-35	10954
5L-3S		MI	2831	1643	5056	1283	6240	1034	7163	815	8702	437	10530	55	10339
14-#10	3.70	MA	3067	1372	4665	1157	5861	948	6681	776	7927	474	10287	243	8852
4L-5S		MI	2367	1372	3654	1143	4481	941	5053	763	5866	464	7278	133	6770
14-#10	3.70	MA	2918	1372	4389	1168	5469	964	6219	784	7287	485	9395	189	8470
5L-4S		MI	2464	1372	3876	1134	4795	928	5423	757	6377	457	7946	188	7030
14-#10	3.70	MA	2747	1372	4113	1176	5114	973	5767	798	6663	491	8534	118	7954
6L-3S		MI	2555	1372	4124	1125	5118	920	5835	746	6939	455	8619	239	7341
14-#11	4.55	MA	3083	1491	4852	1240	6008	1017	6849	817	8114	478	10406	111	9951
5L-4S		MI	2586	1491	4280	1202	5271	976	5977	786	7107	445	8739	107	8233
14-#11	4.55	MA	2889	1491	4524	1251	5579	1028	6303	833	7359	483	9387	26	9262
6L-3S		MI	2687	1491	4578	1192	5659	968	6473	774	7782	445	9527	166	8742
14-#14	6.56	MA	3498	1776	5927	1426	7316	1157	8410	908	10191	472	13109	-50	12976
5L-4S		MI	2934	1776	5225	1380	6438	1105	7366	870	8963	431	10955	-57	10822
16-#10	4.23	MA	3119	1447	4833	1214	6030	998	6897	806	8200	483	10658	185	9741
5E		MI	2513	1447	4004	1190	4924	975	5589	784	6587	462	8223	122	7762
16-#10	4.23	MA	2960	1447	4556	1223	5675	1008	6446	820	7576	488	9797	114	9220
6L-4S		MI	2609	1447	4226	1181	5238	962	5959	779	7098	454	8890	177	8009
16-#11	5.20	MA	3126	1583	5058	1309	6253	1070	7119	860	8458	480	10876	18	10788
6L-4S		MI	2755	1583	4699	1259	5800	1018	6618	813	7969	442	9838	89	9407
18-#10	4.76	MA	3156	1521	4999	1270	6236	1042	7124	842	8489	485	11061	110	10488
6L-5S		MI	2656	1521	4354	1237	5367	1009	6124	806	7308	459	9167	111	8746

RECTANGULAR TIED COLUMNS 20" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.20	MA	2961	1103	3894	990	4896	831	5477	705	6133	511	7591	445	3691
2E		MI	2215	1103	3076	959	3747	805	4129	682	4549	493	5375	403	2740
4-#14	1.73	MA	3171	1184	4430	1035	5545	864	6248	725	7157	505	8937	432	5181
2E		MI	2351	1184	3455	1003	4201	836	4665	701	5259	486	6206	375	3798
4-#18	3.08	MA	3640	1390	5723	1154	7127	949	8133	777	9671	491	12125	388	8805
2E		MI	2643	1390	4354	1118	5288	919	5955	751	6964	469	8104	288	6316

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 26"

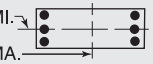
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#9	1.15	MA	2968	1096	3809	996	4841	836	5439	710	6107	517	7574	450	3603
2L-3S		MI	2051	1096	2732	976	3362	819	3689	694	3980	507	4723	349	2686
6-#9	1.15	MA	2718	1096	3421	1005	4350	845	4845	718	5307	527	6466	380	3597
3L-2S		MI	2227	1096	3010	968	3714	813	4115	690	4553	501	5481	422	2681
6-#10	1.47	MA	3102	1144	4133	1023	5236	856	5909	722	6733	514	8436	447	4509
2L-3S		MI	2101	1144	2893	1004	3552	839	3912	707	4273	505	5088	317	3327
6-#10	1.47	MA	2798	1144	3643	1034	4616	866	5159	731	5723	526	7038	356	4485
3L-2S		MI	2315	1144	3242	994	3995	832	4447	701	4994	497	6032	410	3331
6-#11	1.80	MA	3221	1195	4485	1047	5643	873	6381	732	7350	508	9277	440	5425
2L-3S		MI	2141	1195	3076	1027	3747	855	4129	714	4549	497	5375	271	3960
6-#11	1.80	MA	2867	1195	3894	1061	4896	885	5477	742	6133	521	7591	326	5378
3L-2S		MI	2389	1195	3494	1017	4277	847	4770	709	5412	490	6474	385	3978
6-#14	2.60	MA	3520	1317	5270	1118	6608	924	7534	764	8889	500	11303	422	7635
2L-3S		MI	2261	1317	3455	1100	4201	907	4665	746	5259	490	6206	179	5450
6-#14	2.60	MA	3052	1317	4430	1137	5545	941	6248	777	7157	518	8937	257	7491
3L-2S		MI	2579	1317	4047	1086	4950	897	5571	740	6479	481	7728	344	5532
6-#18	4.62	MA	4182	1626	7176	1301	8964	1057	10356	846	12663	482	16100	358	13023
2L-3S		MI	2534	1626	4354	1285	5288	1040	5955	825	6964	468	8104	-76	8012
6-#18	4.62	MA	3514	1626	5723	1331	7127	1082	8133	866	9671	509	12125	65	11933
3L-2S		MI	3003	1626	5365	1266	6567	1027	7502	820	9043	459	10592	218	9247
8-#8	1.22	MA	3004	1105	3862	1004	4921	843	5542	715	6252	518	7779	451	3799
2L-4S		MI	2030	1105	2669	989	3289	830	3593	706	3851	510	4609	335	2818
8-#8	1.22	MA	2807	1105	3553	1011	4530	849	5070	721	5616	526	6898	396	3794
3E		MI	2114	1105	2825	983	3492	825	3853	699	4206	508	5041	367	2827
8-#8	1.22	MA	2691	1105	3339	1019	4251	856	4713	730	5128	531	6290	362	3765
4L-2S		MI	2253	1105	3047	977	3773	820	4192	695	4662	502	5650	425	2823
8-#9	1.54	MA	3144	1155	4198	1032	5333	863	6034	727	6907	515	8682	447	4743
2L-4S		MI	2076	1155	2814	1020	3458	852	3788	721	4107	507	4941	301	3467
8-#9	1.54	MA	2906	1155	3809	1042	4841	872	5439	735	6107	525	7574	377	4726
3E		MI	2178	1155	3010	1012	3714	846	4115	712	4553	505	5481	341	3499
8-#9	1.54	MA	2765	1155	3540	1051	4489	880	4989	747	5492	530	6806	334	4658
4L-2S		MI	2346	1155	3288	1005	4066	840	4541	707	5126	499	6239	414	3502
8-#10	1.95	MA	3316	1218	4623	1069	5856	890	6659	744	7743	511	9834	443	5942
2L-4S		MI	2134	1218	2995	1059	3672	881	4036	740	4432	504	5359	256	4207
8-#10	1.95	MA	3029	1218	4133	1081	5236	901	5909	753	6733	523	8436	352	5903
3E		MI	2258	1218	3242	1050	3995	873	4447	729	4994	502	6032	306	4341
8-#10	1.95	MA	2859	1218	3792	1093	4791	911	5341	768	5956	530	7462	298	5721
4L-2S		MI	2461	1218	3592	1041	4437	866	4983	723	5715	494	6976	399	4359
8-#11	2.40	MA	3469	1287	5076	1105	6390	915	7285	759	8567	504	10962	435	7150
2L-4S		MI	2180	1287	3196	1095	3889	905	4275	754	4737	494	5686	194	4843
8-#11	2.40	MA	3138	1287	4485	1118	5643	927	6381	769	7350	518	9277	321	7082
3E		MI	2327	1287	3494	1084	4277	897	4770	741	5412	494	6474	253	5167
8-#11	2.40	MA	2942	1287	4073	1132	5105	939	5694	786	6411	524	8089	253	6635
4L-2S		MI	2554	1287	3913	1074	4806	889	5410	736	6275	486	7574	367	5203
8-#14	3.46	MA	3849	1449	6111	1201	7671	985	8820	802	10620	495	13669	412	10080
2L-4S		MI	2326	1449	3623	1196	4398	977	4868	801	5520	484	6631	67	6356
8-#14	3.46	MA	3435	1449	5270	1220	6608	1001	7534	816	8889	513	11303	247	9909
3E		MI	2508	1449	4047	1182	4950	968	5571	785	6479	485	7728	149	7141
8-#14	3.46	MA	3169	1449	4681	1239	5840	1018	6553	839	7549	521	9631	151	8808
4L-2S		MI	2799	1449	4639	1169	5699	958	6477	779	7698	476	9251	314	7254
8-#18	6.15	MA	4121	1861	7176	1478	8964	1191	10356	935	12663	500	16100	35	15979
3E		MI	2938	1861	5365	1432	6567	1148	7502	894	9043	458	10592	-146	10357
8-#18	6.15	MA	3766	1861	6152	1509	7629	1216	8651	973	10336	509	13274	-127	12976
4L-2S		MI	3356	1861	6376	1413	7847	1135	9049	889	11121	450	13080	148	12168
10-#10	2.44	MA	3523	1293	5113	1116	6476	924	7409	766	8752	508	11232	439	7372
2L-5S		MI	2194	1293	3123	1115	3801	928	4201	767	4642	509	5636	189	4868
10-#10	2.44	MA	3251	1293	4623	1128	5856	935	6659	775	7743	520	9834	348	7322
3L-4S		MI	2294	1293	3345	1106	4115	915	4571	762	5153	501	6303	244	5165

RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis



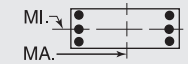
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.44	MA	3095	1293	4282	1140	5411	945	6091	790	6966	527	8860	294	7094
4L-3S		MI	2409	1293	3592	1097	4437	908	4983	751	5715	499	6976	295	5352
10-#10	2.44	MA	2931	1293	3979	1152	4981	962	5582	799	6262	539	7882	242	6600
5L-2S		MI	2601	1293	3942	1088	4880	900	5518	745	6436	492	7921	388	5381
10-#11	3.00	MA	3397	1378	5076	1176	6390	969	7285	796	8567	514	10962	316	8788
3L-4S		MI	2374	1378	3615	1152	4418	947	4915	781	5599	491	6785	176	5991
10-#11	3.00	MA	3219	1378	4664	1190	5852	981	6598	813	7628	521	9775	248	8293
4L-3S		MI	2501	1378	3913	1142	4806	939	5410	768	6275	490	7574	235	6371
10-#11	3.00	MA	3030	1378	4296	1203	5331	1000	5982	823	6776	534	8586	182	7750
5L-2S		MI	2713	1378	4332	1132	5336	931	6051	763	7137	483	8673	350	6423
10-#14	4.33	MA	3788	1582	6111	1303	7671	1062	8820	855	10620	508	13669	237	12332
3L-4S		MI	2584	1582	4215	1278	5147	1038	5774	840	6740	479	8153	37	7995
10-#14	4.33	MA	3573	1582	5522	1322	6903	1079	7839	878	9281	516	11998	141	11191
4L-3S		MI	2745	1582	4639	1265	5699	1029	6477	824	7698	480	9251	119	8835
10-#14	4.33	MA	3292	1582	4996	1340	6158	1105	6959	892	8064	534	10327	44	10159
5L-2S		MI	3014	1582	5231	1252	6448	1019	7383	817	8918	471	10773	284	8971
10-#18	7.69	MA	4413	2097	7605	1656	9467	1324	10874	1042	13329	500	17249	-156	16707
4L-3S		MI	3328	2097	6376	1579	7847	1256	9049	963	11121	449	13080	-215	12657
12-#10	2.93	MA	3466	1368	5113	1175	6476	969	7409	797	8752	518	11232	344	8740
3L-5S		MI	2351	1368	3473	1162	4244	962	4736	789	5363	506	6580	178	5850
12-#10	2.93	MA	3323	1368	4772	1186	6031	980	6841	812	7976	524	10258	290	8475
4E		MI	2457	1368	3695	1153	4557	949	5107	784	5874	498	7247	233	6130
12-#10	2.93	MA	3161	1368	4469	1198	5601	996	6332	821	7272	536	9280	239	8000
5L-3S		MI	2559	1368	3942	1144	4880	942	5518	773	6436	496	7921	284	6361
12-#10	2.93	MA	2960	1368	4158	1207	5212	1006	5836	836	6586	543	8339	169	7482
6L-2S		MI	2737	1368	4292	1135	5323	935	6054	767	7157	489	8865	377	6400
12-#11	3.60	MA	3487	1470	5255	1247	6600	1023	7502	840	8845	517	11460	244	9960
4E		MI	2554	1470	4034	1209	4948	989	5556	808	6462	487	7884	158	7148
12-#11	3.60	MA	3300	1470	4887	1261	6078	1042	6886	850	7993	531	10271	177	9442
5L-3S		MI	2669	1470	4332	1199	5336	981	6051	795	7137	487	8673	217	7574
12-#11	3.60	MA	3066	1470	4518	1271	5606	1054	6284	867	7161	538	9123	90	8674
6L-2S		MI	2869	1470	4750	1189	5866	974	6692	790	8000	479	9772	332	7639
12-#14	5.19	MA	3942	1714	6362	1404	7966	1139	9125	917	11012	511	14364	131	13584
4E		MI	2832	1714	4808	1361	5897	1099	6680	879	7960	474	9676	7	9646
12-#14	5.19	MA	3681	1714	5837	1423	7221	1165	8245	931	9796	529	12693	34	12555
5L-3S		MI	2975	1714	5231	1348	6448	1089	7383	863	8918	475	10773	89	10463
14-#10	3.42	MA	3543	1443	5263	1233	6651	1014	7591	834	8985	521	11656	286	9860
4L-5S		MI	2509	1443	3823	1209	4686	997	5272	811	6083	503	7525	167	6837
14-#10	3.42	MA	3384	1443	4959	1245	6221	1030	7082	843	8282	533	10678	235	9405
5L-4S		MI	2606	1443	4045	1200	5000	984	5642	806	6595	496	8192	222	7102
14-#10	3.42	MA	3193	1443	4649	1253	5832	1041	6586	858	7595	540	9737	165	8885
6L-3S		MI	2701	1443	4292	1190	5323	976	6054	795	7157	494	8865	273	7371
14-#10	3.42	MA	3023	1443	4296	1266	5443	1050	6106	867	6928	552	8810	121	8326
7L-2S		MI	2869	1443	4642	1181	5766	969	6589	789	7878	486	9809	366	7417
14-#11	4.20	MA	3574	1562	5478	1318	6826	1084	7790	877	9210	527	11956	172	11139
5L-4S		MI	2728	1562	4452	1267	5477	1031	6197	835	7324	484	8983	140	8313
14-#11	4.20	MA	3341	1562	5109	1329	6353	1096	7188	894	8379	534	10809	85	10359
6L-3S		MI	2833	1562	4750	1257	5866	1024	6692	822	8000	483	9772	199	8778
14-#14	6.06	MA	4041	1846	6677	1506	8285	1226	9531	970	11527	524	15059	24	14955
5L-4S		MI	3073	1846	5400	1444	6646	1160	7586	917	9180	469	11198	-24	11145
16-#10	3.91	MA	3600	1517	5449	1292	6841	1065	7832	865	9291	531	12076	231	10812
5E		MI	2657	1517	4173	1256	5129	1031	5807	833	6804	501	8469	156	7827

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

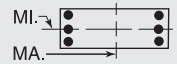
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	3.91	MA	3418	1517	5139	1300	6452	1075	7336	880	8605	537	11135	161	10289
6L-4S		MI	2752	1517	4395	1246	5443	1018	6177	828	7316	493	9136	211	8080
16-#10	3.91	MA	3259	1517	4786	1313	6063	1084	6856	889	7937	549	10208	117	9738
7L-3S		MI	2839	1517	4642	1237	5766	1011	6589	816	7878	491	9809	262	8380
16-#11	4.80	MA	3623	1654	5699	1386	7101	1139	8092	921	9596	531	12494	81	12056
6L-4S		MI	2898	1654	4871	1324	6007	1073	6837	862	8187	480	10082	122	9484
18-#10	4.40	MA	3638	1592	5629	1347	7072	1109	8086	902	9615	534	12534	157	11696
6L-5S		MI	2800	1592	4523	1302	5572	1065	6343	855	7525	498	9413	145	8820
18-#10	4.40	MA	3487	1592	5276	1360	6683	1118	7606	911	8947	546	11606	114	11150
7L-4S		MI	2895	1592	4745	1293	5886	1052	6713	850	8037	490	10080	200	9061
20-#10	4.88	MA	3729	1667	5766	1407	7303	1153	8356	933	9957	544	13004	110	12564
7L-5S		MI	2941	1667	4873	1349	6015	1100	6878	877	8246	495	10358	134	9816

RECTANGULAR TIED COLUMNS 20" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.11	MA	3413	1174	4385	1065	5556	895	6228	761	6967	556	8617	484	4028
2E		MI	2358	1174	3248	1024	3954	860	4348	730	4767	531	5620	437	2759
4-#14	1.61	MA	3650	1255	4974	1111	6271	928	7077	781	8096	549	10169	477	5667
2E		MI	2494	1255	3629	1068	4409	891	4884	749	5476	524	6449	408	3821
4-#18	2.86	MA	4185	1461	6404	1229	8020	1013	9162	833	10874	535	13825	445	9669
2E		MI	2789	1461	4533	1182	5498	973	6175	798	7180	506	8345	321	6349
6-#9	1.07	MA	3418	1167	4288	1071	5492	900	6181	766	6931	562	8589	489	3927
2L-3S		MI	2193	1167	2899	1042	3567	875	3908	743	4198	547	4970	383	2704
6-#9	1.07	MA	3140	1167	3863	1081	4954	909	5530	774	6055	572	7376	420	3921
3L-2S		MI	2370	1167	3177	1034	3919	869	4333	739	4771	540	5727	456	2696
6-#10	1.36	MA	3568	1214	4643	1098	5925	920	6697	778	7619	558	9535	486	4920
2L-3S		MI	2243	1214	3061	1069	3757	895	4130	756	4491	544	5334	351	3349
6-#10	1.36	MA	3229	1214	4106	1110	5246	931	5876	788	6513	572	8004	397	4896
3L-2S		MI	2459	1214	3411	1060	4200	888	4666	750	5212	536	6278	444	3349
6-#11	1.67	MA	3703	1266	5033	1123	6376	937	7220	788	8302	552	10466	479	5930
2L-3S		MI	2283	1266	3248	1092	3954	910	4348	763	4767	536	5620	304	3989
6-#11	1.67	MA	3309	1266	4385	1137	5556	950	6228	799	6967	567	8617	368	5883
3L-2S		MI	2533	1266	3666	1082	4483	902	4989	757	5629	528	6719	419	4000
6-#14	2.41	MA	4042	1387	5898	1193	7439	989	8490	819	9997	544	12803	470	8364
2L-3S		MI	2403	1387	3629	1164	4409	962	4884	794	5476	528	6449	213	5491
6-#14	2.41	MA	3518	1387	4974	1213	6271	1006	7077	835	8096	565	10169	306	8220
3L-2S		MI	2726	1387	4221	1151	5158	952	5790	788	6695	519	7971	378	5559
6-#18	4.29	MA	4795	1696	8004	1376	10044	1121	11610	902	14170	527	18303	425	14319
2L-3S		MI	2673	1696	4533	1348	5498	1094	6175	872	7180	506	8345	-43	8294
6-#18	4.29	MA	4041	1696	6404	1409	8020	1149	9162	925	10874	557	13825	131	13404
3L-2S		MI	3152	1696	5545	1329	6777	1081	7722	867	9259	497	10833	251	9283
8-#8	1.13	MA	3457	1176	4345	1079	5578	907	6293	771	7089	563	8812	490	4140
2L-4S		MI	2171	1176	2835	1055	3493	886	3811	756	4069	549	4856	369	2840
8-#8	1.13	MA	3239	1176	4007	1087	5151	914	5776	777	6393	571	7848	436	4135
3E		MI	2256	1176	2991	1049	3696	881	4071	748	4424	547	5288	402	2843
8-#8	1.13	MA	3110	1176	3774	1095	4846	921	5386	787	5860	577	7189	403	4106
4L-2S		MI	2396	1176	3213	1043	3977	876	4410	744	4880	542	5897	460	2838
8-#9	1.43	MA	3615	1226	4713	1107	6030	927	6832	783	7808	560	9802	486	5175
2L-4S		MI	2217	1226	2981	1086	3663	908	4007	770	4325	546	5188	335	3496
8-#9	1.43	MA	3350	1226	4288	1117	5492	936	6181	791	6931	570	8589	417	5158
3E		MI	2320	1226	3177	1078	3919	902	4333	761	4771	544	5727	375	3519
8-#9	1.43	MA	3194	1226	3994	1127	5108	945	5690	804	6260	576	7757	375	5090
4L-2S		MI	2490	1226	3456	1071	4271	896	4759	756	5344	538	6485	449	3520
8-#10	1.81	MA	3808	1289	5180	1145	6604	954	7519	800	8725	556	11067	482	6491
2L-4S		MI	2275	1289	3164	1125	3877	937	4254	789	4650	543	5605	290	4285
8-#10	1.81	MA	3488	1289	4643	1157	5925	965	6697	810	7619	569	9535	393	6452
3E		MI	2400	1289	3411	1116	4200	929	4666	778	5212	541	6278	340	4366

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



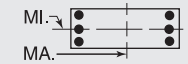
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#10	1.81	MA	3300	1289	4272	1169	5440	977	6077	825	6771	576	8481	340	6308
4L-2S		MI	2606	1289	3761	1107	4643	922	5201	772	5933	533	7222	433	4379
8-#11	2.23	MA	3982	1357	5681	1180	7196	979	8212	815	9637	549	12315	474	7824
2L-4S		MI	2320	1357	3368	1160	4095	960	4494	802	4954	533	5930	227	4930
8-#11	2.23	MA	3612	1357	5033	1194	6376	992	7220	826	8302	564	10466	363	7756
3E		MI	2465	1357	3666	1149	4483	952	4989	790	5629	532	6719	287	5198
8-#11	2.23	MA	3394	1357	4582	1209	5787	1005	6468	844	7275	572	9179	296	7352
4L-2S		MI	2700	1357	4085	1139	5013	945	5630	784	6492	525	7818	401	5228
8-#14	3.21	MA	4415	1520	6821	1276	8607	1049	9902	858	11899	539	15437	463	11052
2L-4S		MI	2465	1520	3798	1260	4606	1032	5087	849	5737	522	6874	100	6457
8-#14	3.21	MA	3934	1520	5898	1296	7439	1067	8490	873	9997	560	12803	299	10881
3E		MI	2651	1520	4221	1247	5158	1023	5790	833	6695	523	7971	183	7185
8-#14	3.21	MA	3650	1520	5254	1316	6599	1085	7416	899	8531	570	10955	202	9766
4L-2S		MI	2948	1520	4813	1233	5907	1013	6696	827	7915	514	9494	348	7283
8-#18	5.71	MA	4720	1932	8004	1556	10044	1258	11610	995	14170	549	18303	111	17894
3E		MI	3078	1932	5545	1495	6777	1202	7722	941	9259	496	10833	-113	10655
8-#18	5.71	MA	4323	1932	6882	1589	8580	1286	9740	1035	11617	562	15135	-57	14976
4L-2S		MI	3506	1932	6556	1476	8057	1190	9269	937	11337	487	13321	181	12205
10-#10	2.27	MA	4040	1364	5717	1191	7284	989	8340	822	9831	553	12598	478	8058
2L-5S		MI	2333	1364	3292	1181	4006	984	4419	816	4859	548	5882	223	4937
10-#10	2.27	MA	3736	1364	5180	1204	6604	1000	7519	832	8725	566	11067	389	8007
3L-4S		MI	2435	1364	3514	1172	4320	971	4790	811	5371	540	6549	279	5240
10-#10	2.27	MA	3563	1364	4809	1216	6119	1011	6898	847	7877	573	10012	336	7844
4L-3S		MI	2552	1364	3761	1163	4643	964	5201	799	5933	538	7222	329	5378
10-#10	2.27	MA	3376	1364	4478	1229	5650	1028	6344	857	7109	587	8948	287	7268
5L-2S		MI	2749	1364	4111	1154	5085	956	5737	794	6654	530	8167	422	5402
10-#11	2.79	MA	3902	1449	5681	1252	7196	1034	8212	853	9637	560	12315	358	9630
3L-4S		MI	2514	1449	3787	1217	4625	1002	5134	829	5816	529	7029	210	6074
10-#11	2.79	MA	3704	1449	5231	1266	6608	1047	7460	871	8610	568	11028	291	9179
4L-3S		MI	2645	1449	4085	1207	5013	995	5630	817	6492	529	7818	269	6404
10-#11	2.79	MA	3487	1449	4830	1281	6038	1067	6787	882	7679	583	9733	228	8546
5L-2S		MI	2861	1449	4504	1197	5543	987	6270	811	7354	521	8917	383	6448
10-#14	4.02	MA	4343	1652	6821	1379	8607	1128	9902	912	11899	555	15437	293	13547
3L-4S		MI	2723	1652	4390	1343	5355	1093	5993	888	6957	517	8396	70	8092
10-#14	4.02	MA	4080	1652	6177	1399	7767	1146	8829	937	10433	565	13588	195	12394
4L-3S		MI	2888	1652	4813	1330	5907	1084	6696	872	7915	518	9494	152	8880
10-#14	4.02	MA	3780	1652	5604	1419	6953	1173	7868	953	9103	585	11735	101	11338
5L-2S		MI	3164	1652	5406	1316	6656	1074	7602	865	9135	509	11016	318	9001
10-#18	7.14	MA	5044	2167	8482	1736	10604	1394	12188	1104	14913	553	19613	-78	19294
4L-3S		MI	3468	2167	6556	1643	8057	1310	9269	1011	11337	486	13321	-183	12970
12-#10	2.72	MA	3975	1439	5717	1250	7284	1034	8340	854	9831	563	12598	385	9563
3L-5S		MI	2493	1439	3641	1228	4449	1019	4955	838	5580	545	6826	212	5917
12-#10	2.72	MA	3816	1439	5345	1263	6798	1045	7720	869	8983	571	11543	332	9361
4E		MI	2591	1439	3863	1219	4763	1005	5325	833	6092	537	7493	268	6203
12-#10	2.72	MA	3633	1439	5015	1275	6329	1062	7165	879	8215	584	10479	283	8805
5L-3S		MI	2704	1439	4111	1209	5085	998	5737	821	6654	535	8167	318	6389
12-#10	2.72	MA	3409	1439	4670	1283	5905	1073	6625	895	7467	591	9461	214	8289
6L-2S		MI	2885	1439	4461	1200	5528	991	6272	816	7375	528	9111	411	6423
12-#11	3.34	MA	4002	1541	5879	1324	7428	1089	8452	898	9946	565	12877	287	11013
4E		MI	2695	1541	4206	1274	5155	1045	5775	856	6679	526	8128	192	7229
12-#11	3.34	MA	3789	1541	5478	1338	6858	1109	7779	909	9015	580	11582	224	10407
5L-3S		MI	2814	1541	4504	1264	5543	1037	6270	844	7354	525	8917	251	7609
12-#11	3.34	MA	3529	1541	5067	1348	6344	1122	7123	927	8107	588	10338	138	9617
6L-2S		MI	3018	1541	4922	1254	6072	1029	6911	838	8217	518	10016	365	7666

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#14	4.82	MA	4514	1785	7100	1482	8935	1206	10242	976	12335	560	16222	188	15030
4E		MI	2972	1785	4982	1426	6104	1154	6899	926	8177	512	9919	40	9739
12-#14	4.82	MA	4216	1785	6527	1502	8121	1234	9281	992	11005	580	14368	94	13986
5L-3S		MI	3119	1785	5406	1412	6656	1144	7602	910	9135	513	11016	122	10576
12-#14	4.82	MA	3853	1785	5947	1517	7385	1252	8342	1017	9708	590	12582	-31	12487
6L-2S		MI	3376	1785	5998	1399	7405	1135	8508	904	10355	504	12539	287	10716
14-#10	3.17	MA	4061	1513	5882	1310	7477	1080	8541	891	10089	568	13075	328	10883
4L-5S		MI	2652	1513	3991	1275	4892	1053	5490	860	6301	542	7771	201	6902
14-#10	3.17	MA	3880	1513	5552	1322	7008	1096	7987	901	9321	581	12010	279	10347
5L-4S		MI	2749	1513	4213	1265	5205	1040	5861	855	6813	535	8438	256	7173
14-#10	3.17	MA	3668	1513	5207	1330	6584	1108	7446	917	8573	588	10992	210	9831
6L-3S		MI	2847	1513	4461	1256	5528	1032	6272	843	7375	532	9111	307	7399
14-#10	3.17	MA	3480	1513	4865	1338	6152	1116	6923	927	7845	602	9985	169	9246
7L-2S		MI	3019	1513	4811	1247	5971	1025	6808	838	8096	525	10055	400	7441
14-#11	3.90	MA	4080	1633	6126	1396	7678	1151	8771	936	10350	576	13431	219	12273
5L-4S		MI	2870	1633	4624	1332	5684	1087	6416	883	7541	522	9228	174	8391
14-#11	3.90	MA	3835	1633	5715	1406	7164	1164	8115	954	9443	584	12188	133	11482
6L-3S		MI	2979	1633	4922	1322	6072	1079	6911	871	8217	522	10016	233	8813
14-#11	3.90	MA	3617	1633	5249	1422	6649	1175	7480	965	8559	599	10960	79	10636
7L-2S		MI	3172	1633	5341	1311	6602	1071	7551	865	9079	514	11115	348	8881
14-#14	5.63	MA	4617	1917	7450	1585	9289	1295	10693	1030	12907	575	17002	87	16638
5L-4S		MI	3213	1917	5574	1508	6854	1215	7805	965	9397	507	11441	10	11396
14-#14	5.63	MA	4302	1917	6871	1600	8553	1312	9755	1056	11610	585	15216	-38	15047
6L-3S		MI	3345	1917	5998	1495	7405	1205	8508	949	10355	508	12539	92	12197
16-#10	3.63	MA	4121	1588	6089	1369	7687	1131	8808	923	10427	578	13542	275	11891
5E		MI	2800	1588	4341	1321	5334	1087	6026	882	7022	539	8715	190	7890
16-#10	3.63	MA	3919	1588	5744	1377	7264	1142	8267	939	9679	586	12523	206	11375
6L-4S		MI	2896	1588	4563	1312	5648	1074	6396	877	7534	532	9382	245	8148
16-#10	3.63	MA	3742	1588	5402	1385	6831	1150	7744	949	8951	599	11516	165	10802
7L-3S		MI	2986	1588	4811	1303	5971	1067	6808	865	8096	530	10055	296	8409
16-#10	3.63	MA	3577	1588	5025	1400	6367	1164	7226	958	8226	606	10546	111	10055
8L-2S		MI	3150	1588	5161	1294	6413	1059	7343	860	8817	522	11000	389	8457
16-#11	4.46	MA	4150	1725	6363	1463	7984	1206	9107	981	10778	581	14037	128	13349
6L-4S		MI	3041	1725	5043	1389	6214	1129	7056	910	8404	519	10327	156	9559
16-#11	4.46	MA	3927	1725	5897	1479	7469	1217	8472	992	9895	595	12809	75	12505
7L-3S		MI	3140	1725	5341	1379	6602	1121	7551	898	9079	518	11115	215	10018
16-#14	6.43	MA	4715	2050	7794	1683	9721	1373	11168	1094	13512	580	17849	-45	17593
6L-4S		MI	3449	2050	6166	1591	7603	1276	8711	1004	10616	502	12964	-20	12913
18-#10	4.08	MA	4163	1663	6281	1423	7943	1176	9089	961	10785	583	14055	202	12922
6L-5S		MI	2945	1663	4691	1368	5777	1122	6561	904	7743	537	9659	179	8882
18-#10	4.08	MA	3996	1663	5939	1431	7510	1185	8566	971	10057	596	13047	161	12353
7L-4S		MI	3039	1663	4913	1359	6091	1109	6931	899	8255	529	10326	234	9128
18-#10	4.08	MA	3841	1663	5562	1446	7046	1198	8047	980	9332	604	12077	107	11606
8L-3S		MI	3123	1663	5161	1350	6413	1101	7343	887	8817	527	11000	285	9419
18-#11	5.01	MA	4250	1817	6546	1537	8289	1260	9463	1019	11230	592	14658	70	14374
7L-4S		MI	3208	1817	5462	1446	6743	1171	7697	937	9266	515	11426	138	10733
20-#10	4.54	MA	4243	1738	6476	1478	8189	1219	9387	993	11163	593	14579	158	13901
7L-5S		MI	3086	1738	5041	1415	6220	1156	7096	926	8464	534	10604	168	9876
20-#10	4.54	MA	4092	1738	6099	1493	7725	1232	8869	1002	10438	601	13609	103	13157
8L-4S		MI	3180	1738	5263	1406	6533	1143	7467	920	8976	526	11271	223	10111
22-#10	4.99	MA	4355	1812	6636	1540	8404	1267	9690	1024	11544	598	15140	99	14709
8L-5S		MI	3225	1812	5391	1461	6662	1190	7632	948	9185	531	11548	157	10872

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis

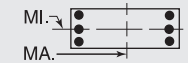
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.04	MA	3893	1244	4898	1140	6251	959	7020	816	7844	600	9696	523	4365
2E		MI	2501	1244	3420	1089	4161	916	4567	779	4984	570	5864	470	2777
4-#14	1.50	MA	4158	1326	5542	1186	7032	992	7948	836	9078	594	11392	516	6153
2E		MI	2638	1326	3804	1132	4616	946	5104	797	5692	562	6692	442	3843
4-#18	2.67	MA	4760	1532	7108	1304	8949	1077	10231	889	12122	580	15583	500	10533
2E		MI	2936	1532	4713	1245	5708	1027	6395	845	7396	544	8586	354	6382
6-#9	1.00	MA	3897	1237	4789	1146	6178	964	6964	822	7800	606	9658	528	4251
2L-3S		MI	2334	1237	3067	1108	3771	931	4126	793	4416	586	5216	417	2721
6-#9	1.00	MA	3591	1237	4327	1156	5593	974	6257	830	6848	618	8339	461	4245
3L-2S		MI	2513	1237	3345	1100	4123	925	4552	788	4989	579	5974	491	2711
6-#10	1.27	MA	4064	1285	5176	1173	6650	984	7526	834	8549	603	10688	525	5332
2L-3S		MI	2385	1285	3230	1135	3962	951	4349	804	4709	583	5580	385	3370
6-#10	1.27	MA	3690	1285	4593	1186	5912	996	6634	845	7347	617	9024	438	5308
3L-2S		MI	2603	1285	3580	1126	4405	944	4884	799	5430	575	6524	479	3366
6-#11	1.56	MA	4216	1336	5603	1198	7144	1001	8099	843	9298	597	11709	518	6436
2L-3S		MI	2424	1336	3420	1157	4161	966	4567	811	4984	574	5864	338	4016
6-#11	1.56	MA	3780	1336	4898	1213	6251	1015	7020	856	7844	613	9696	409	6389
3L-2S		MI	2677	1336	3839	1147	4690	958	5208	806	5847	566	6963	453	4021
6-#14	2.25	MA	4594	1458	6548	1268	8305	1053	9487	875	11150	589	14262	509	9093
2L-3S		MI	2544	1458	3804	1228	4616	1017	5104	842	5692	566	6692	246	5530
6-#14	2.25	MA	4014	1458	5542	1290	7032	1072	7948	892	9078	611	11392	349	8949
3L-2S		MI	2872	1458	4396	1215	5365	1007	6010	836	6912	557	8215	411	5585
6-#18	4.00	MA	5440	1767	8855	1451	11159	1186	12904	958	15721	571	20566	487	15615
2L-3S		MI	2813	1767	4713	1412	5708	1148	6395	919	7396	543	8586	-10	8574
6-#18	4.00	MA	4600	1767	7108	1486	8949	1216	10231	984	12122	606	15583	194	14912
3L-2S		MI	3300	1767	5724	1392	6987	1135	7942	914	9475	534	11074	284	9319
8-#8	1.05	MA	3939	1247	4851	1154	6270	971	7084	826	7969	607	9897	529	4481
2L-4S		MI	2312	1247	3001	1122	3697	943	4029	805	4287	588	5103	404	2860
8-#8	1.05	MA	3699	1247	4484	1162	5806	978	6523	833	7213	616	8851	476	4476
3E		MI	2398	1247	3157	1116	3900	938	4289	797	4642	586	5536	436	2859
8-#8	1.05	MA	3558	1247	4231	1171	5476	986	6101	844	6636	622	8141	444	4447
4L-2S		MI	2539	1247	3379	1110	4181	933	4628	793	5099	581	6145	494	2853
8-#9	1.33	MA	4114	1296	5252	1183	6762	991	7671	839	8752	604	10976	525	5607
2L-4S		MI	2358	1296	3148	1152	3867	965	4225	819	4543	585	5435	369	3522
8-#9	1.33	MA	3822	1296	4789	1193	6178	1001	6964	848	7800	615	9658	458	5590
3E		MI	2463	1296	3345	1144	4123	958	4552	810	4989	583	5974	409	3539
8-#9	1.33	MA	3651	1296	4471	1203	5762	1010	6432	861	7073	622	8761	416	5522
4L-2S		MI	2634	1296	3623	1137	4475	952	4977	805	5562	577	6732	483	3536
8-#10	1.69	MA	4330	1360	5760	1220	7388	1018	8419	856	9751	600	12353	521	7040
2L-4S		MI	2416	1360	3332	1191	4082	993	4473	838	4868	582	5851	324	4338
8-#10	1.69	MA	3976	1360	5176	1233	6650	1030	7526	866	8549	614	10688	434	7001
3E		MI	2543	1360	3580	1182	4405	985	4884	826	5430	580	6524	374	4389
8-#10	1.69	MA	3769	1360	4774	1246	6124	1042	6854	883	7629	622	9552	381	6857
4L-2S		MI	2751	1360	3930	1173	4848	978	5420	821	6151	572	7469	467	4398
8-#11	2.08	MA	4525	1428	6309	1255	8036	1043	9179	870	10752	593	13722	513	8498
2L-4S		MI	2460	1428	3540	1224	4302	1016	4713	850	5171	571	6175	261	5015
8-#11	2.08	MA	4115	1428	5603	1270	7144	1057	8099	883	9298	609	11709	404	8430
3E		MI	2607	1428	3839	1214	4690	1008	5208	838	5847	571	6963	320	5228
8-#11	2.08	MA	3875	1428	5115	1285	6506	1071	7284	902	8183	618	10321	339	8083
4L-2S		MI	2846	1428	4257	1204	5220	1000	5849	833	6709	563	8062	435	5251
8-#14	3.00	MA	5010	1591	7554	1351	9578	1113	11026	914	13223	584	17132	502	12024
2L-4S		MI	2604	1591	3972	1325	4814	1087	5307	897	5954	560	7117	134	6556
8-#14	3.00	MA	4474	1591	6548	1372	8305	1132	9487	931	11150	606	14262	342	11853
3E		MI	2793	1591	4396	1311	5365	1078	6010	881	6912	561	8215	216	7226

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis

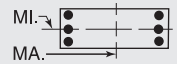


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	3.00	MA	4161	1591	5849	1394	7393	1151	8321	957	9557	618	12269	246	10739
4L-2S		MI	3096	1591	4988	1298	6115	1068	6916	874	8132	552	9737	381	7311
8-#18	5.33	MA	5351	2003	8855	1633	11159	1324	12904	1053	15721	597	20566	181	19850
3E		MI	3217	2003	5724	1559	6987	1256	7942	989	9475	534	11074	-80	10950
8-#18	5.33	MA	4911	2003	7635	1668	9567	1355	10871	1097	12943	614	17055	8	17010
4L-2S		MI	3655	2003	6735	1539	8267	1244	9489	984	11553	525	13562	214	12243
10-#10	2.12	MA	4586	1435	6343	1266	8126	1053	9312	878	10953	597	14017	517	8744
2L-5S		MI	2473	1435	3460	1247	4211	1040	4638	865	5077	587	6128	257	5003
10-#10	2.12	MA	4250	1435	5760	1279	7388	1064	8419	888	9751	611	12353	430	8693
3L-4S		MI	2577	1435	3682	1238	4525	1027	5008	860	5589	579	6795	313	5314
10-#10	2.12	MA	4059	1435	5357	1292	6862	1076	7747	905	8832	620	11217	377	8542
4L-3S		MI	2695	1435	3930	1228	4848	1020	5420	848	6151	577	7469	363	5404
10-#10	2.12	MA	3850	1435	5000	1305	6355	1094	7147	915	8000	634	10019	323	7943
5L-2S		MI	2894	1435	4280	1219	5290	1012	5955	843	6872	569	8413	456	5423
10-#11	2.60	MA	4437	1520	6309	1328	8036	1099	9179	910	10752	606	13722	400	10473
3L-4S		MI	2655	1520	3959	1282	4832	1058	5353	877	6034	568	7274	243	6156
10-#11	2.60	MA	4218	1520	5820	1343	7398	1113	8363	929	9637	615	12334	334	10078
4L-3S		MI	2788	1520	4257	1272	5220	1050	5849	865	6709	567	8062	302	6436
10-#11	2.60	MA	3974	1520	5386	1358	6781	1134	7634	941	8627	631	10935	274	9351
5L-2S		MI	3008	1520	4676	1262	5749	1042	6489	860	7572	560	9161	417	6474
10-#14	3.75	MA	4930	1723	7554	1455	9578	1193	11026	970	13223	601	17132	335	14762
3L-4S		MI	2863	1723	4565	1407	5563	1148	6213	936	7174	555	8639	104	8186
10-#14	3.75	MA	4636	1723	6855	1476	8666	1212	9860	996	11630	613	15139	240	13612
4L-3S		MI	3032	1723	4988	1394	6115	1138	6916	919	8132	556	9737	186	8922
10-#14	3.75	MA	4297	1723	6234	1498	7784	1241	8818	1013	10187	635	13134	150	12544
5L-2S		MI	3313	1723	5580	1381	6864	1129	7822	913	9352	547	11260	351	9031
10-#18	6.67	MA	5707	2238	9382	1815	11777	1463	13544	1166	16542	605	22038	-5	21999
4L-3S		MI	3608	2238	6735	1706	8267	1364	9489	1058	11553	524	13562	-150	13280
10-#18	6.67	MA	5135	2238	8294	1850	10235	1511	11722	1192	14021	639	18521	-175	17644
5L-2S		MI	4007	2238	7746	1687	9546	1352	11036	1053	13632	515	16050	144	15162
12-#10	2.54	MA	4515	1509	6343	1326	8126	1099	9312	910	10953	608	14017	426	10386
3L-5S		MI	2635	1509	3810	1294	4654	1075	5173	887	5798	584	7072	246	5981
12-#10	2.54	MA	4339	1509	5941	1339	7601	1111	8640	927	10034	617	12881	373	10229
4E		MI	2733	1509	4032	1284	4968	1062	5544	882	6310	576	7739	302	6275
12-#10	2.54	MA	4133	1509	5584	1352	7093	1128	8040	937	9202	631	11683	319	9618
5L-3S		MI	2844	1509	4280	1275	5290	1054	5955	870	6872	574	8413	352	6416
12-#10	2.54	MA	3887	1509	5205	1359	6634	1140	7454	954	8392	639	10635	258	9110
6L-2S		MI	3033	1509	4630	1266	5733	1047	6491	865	7593	567	9357	445	6444
12-#11	3.12	MA	4547	1612	6526	1400	8291	1155	9443	956	11090	611	14347	329	12080
4E		MI	2836	1612	4378	1339	5361	1100	5994	904	6896	564	8373	226	7307
12-#11	3.12	MA	4308	1612	6092	1415	7674	1176	8714	968	10081	627	12948	269	11381
5L-3S		MI	2958	1612	4676	1329	5749	1092	6489	892	7572	564	9161	285	7642
12-#11	3.12	MA	4021	1612	5639	1425	7117	1189	8003	987	9097	637	11608	184	10577
6L-2S		MI	3167	1612	5095	1319	6279	1084	7130	887	8434	556	10261	399	7692
12-#14	4.50	MA	5117	1855	7861	1559	9938	1273	11400	1035	13702	608	18009	233	16494
4E		MI	3112	1855	5157	1490	6312	1209	7119	974	8394	550	10162	73	9829
12-#14	4.50	MA	4758	1855	7240	1580	9056	1302	10357	1052	12259	630	16003	143	15444
5L-3S		MI	3263	1855	5580	1477	6864	1199	7822	958	9352	551	11260	156	10619
12-#14	4.50	MA	4379	1855	6600	1595	8258	1321	9340	1078	10852	642	14078	19	13979
6L-2S		MI	3526	1855	6172	1463	7613	1190	8728	952	10572	542	12782	321	10747
12-#18	8.00	MA	5906	2474	10041	1998	12445	1619	14395	1261	17620	630	23504	-188	22195
5L-3S		MI	3990	2474	7746	1853	9546	1472	11036	1127	13632	514	16050	-220	15571
14-#10	2.96	MA	4609	1584	6525	1386	8339	1145	9533	949	11236	614	14546	369	11918
4L-5S		MI	2788	1584	4160	1340	5097	1109	5709	909	6519	581	8017	235	6964
14-#10	2.96	MA	4406	1584	6167	1399	7831	1162	8932	959	10405	628	13348	315	11297
5L-4S		MI	2892	1584	4382	1331	5410	1096	6079	903	7031	573	8684	291	7242
14-#10	2.96	MA	4173	1584	5788	1406	7372	1174	8347	976	9595	636	12300	254	10793
6L-3S		MI	2992	1584	4630	1322	5733	1088	6491	892	7593	571	9357	341	7427

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#10	2.96	MA	3966	1584	5418	1415	6896	1182	7781	986	8807	650	11214	216	10119
7L-2S		MI	3168	1584	4980	1313	6176	1081	7026	887	8314	564	10302	434	7463
14-#11	3.64	MA	4629	1704	6797	1473	8567	1218	9794	995	11535	624	14960	264	13415
5L-4S		MI	3012	1704	4797	1397	5891	1142	6635	931	7759	561	9472	208	8467
14-#11	3.64	MA	4358	1704	6344	1482	8009	1232	9083	1014	10551	633	13620	179	12615
6L-3S		MI	3124	1704	5095	1387	6279	1134	7130	919	8434	560	10261	267	8847
14-#11	3.64	MA	4119	1704	5895	1492	7441	1242	8395	1026	9594	649	12296	129	11722
7L-2S		MI	3322	1704	5513	1376	6809	1127	7770	914	9297	553	11360	381	8908
14-#14	5.25	MA	5223	1988	8246	1663	10329	1363	11897	1091	14332	625	18873	136	18341
5L-4S		MI	3354	1988	5749	1573	7061	1270	8025	1013	9613	545	11684	43	11483
14-#14	5.25	MA	4875	1988	7606	1678	9531	1381	10880	1117	12925	637	16948	12	16884
6L-3S		MI	3490	1988	6172	1560	7613	1260	8728	997	10572	546	12782	126	12311
16-#10	3.39	MA	4672	1659	6751	1445	8569	1197	9825	981	11607	625	15013	311	12978
5E		MI	2944	1659	4510	1387	5539	1143	6244	931	7240	578	8961	224	7951
16-#10	3.39	MA	4449	1659	6372	1453	8111	1208	9240	998	10797	634	13965	250	12477
6L-4S		MI	3039	1659	4732	1378	5853	1130	6614	925	7752	571	9628	279	8216
16-#10	3.39	MA	4254	1659	6001	1461	7634	1217	8674	1008	10009	648	12878	212	11810
7L-3S		MI	3132	1659	4980	1369	6176	1123	7026	914	8314	569	10302	330	8437
16-#10	3.39	MA	4073	1659	5593	1477	7131	1230	8103	1017	9224	656	11831	160	11037
8L-2S		MI	3301	1659	5330	1359	6618	1115	7562	909	9035	561	11246	423	8480
16-#11	4.16	MA	4685	1795	7050	1540	8902	1274	10163	1041	12005	630	15633	174	14654
6L-4S		MI	3183	1795	5215	1454	6421	1184	7275	958	8621	557	10571	190	9633
16-#11	4.16	MA	4460	1795	6601	1550	8334	1284	9475	1053	11048	646	14308	124	13756
7L-3S		MI	3287	1795	5513	1444	6809	1177	7770	946	9297	557	11360	249	10052
16-#14	6.00	MA	5330	2120	8612	1760	10804	1442	12419	1156	14997	632	19818	5	19789
6L-4S		MI	3590	2120	6341	1656	7810	1331	8931	1052	10833	540	13207	13	13144
18-#10	3.81	MA	4718	1734	6955	1500	8849	1243	10133	1019	11999	631	15629	246	14163
6L-5S		MI	3089	1734	4860	1434	5982	1178	6780	953	7961	576	9905	213	8941
18-#10	3.81	MA	4534	1734	6585	1508	8373	1251	9567	1030	11211	645	14543	208	13501
7L-4S		MI	3183	1734	5082	1425	6296	1165	7150	947	8473	568	10572	268	9193
18-#10	3.81	MA	4362	1734	6176	1524	7870	1265	8996	1039	10426	653	13496	156	12724
8L-3S		MI	3270	1734	5330	1415	6618	1157	7562	936	9035	566	11246	319	9447
18-#11	4.68	MA	4791	1887	7306	1607	9226	1326	10554	1080	12501	642	16321	119	15790
7L-4S		MI	3351	1887	5634	1511	6950	1226	7916	985	9484	554	11670	172	10805
20-#10	4.23	MA	4806	1808	7168	1555	9111	1285	10460	1052	12413	642	16207	204	15192
7L-5S		MI	3231	1808	5210	1480	6425	1212	7315	975	8682	573	10850	202	9934
20-#10	4.23	MA	4636	1808	6760	1570	8608	1299	9889	1061	11628	650	15161	152	14411
8L-4S		MI	3325	1808	5432	1471	6739	1199	7685	969	9194	565	11517	257	10175
22-#10	4.66	MA	4905	1883	7343	1617	9346	1333	10781	1083	12831	648	16825	148	16097
8L-5S		MI	3371	1883	5560	1527	6868	1246	7850	997	9403	570	11794	191	10928

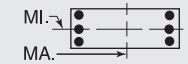
RECTANGULAR TIED COLUMNS 20" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.41	MA	4696	1396	6131	1261	7829	1056	8859	892	10104	638	12668	555	6639
2E		MI	2782	1396	3978	1197	4824	1001	5323	845	5909	600	6935	475	3865
4-#18	2.50	MA	5364	1602	7834	1379	9912	1142	11342	945	13414	624	17226	539	11397
2E		MI	3082	1602	4892	1308	5918	1081	6615	892	7612	581	8826	387	6414
6-#10	1.19	MA	4589	1356	5732	1248	7410	1048	8397	890	9523	647	11894	564	5743
2L-3S		MI	2526	1356	3398	1201	4167	1007	4568	853	4927	621	5826	419	3390
6-#10	1.19	MA	4180	1356	5102	1261	6613	1060	7432	901	8225	662	10096	479	5719
3L-2S		MI	2746	1356	3748	1192	4610	1000	5103	848	5648	614	6770	513	3383

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis

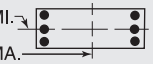


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#11	1.46	MA	4758	1407	6196	1273	7947	1065	9020	899	10338	641	13005	557	6941
2L-3S		MI	2566	1407	3592	1222	4367	1021	4787	859	5201	612	6108	372	4042
6-#11	1.46	MA	4280	1407	5433	1289	6982	1080	7853	912	8766	658	10828	450	6894
3L-2S		MI	2821	1407	4011	1212	4897	1013	5427	854	6064	605	7208	486	4041
6-#14	2.11	MA	5176	1529	7220	1344	9207	1117	10525	931	12347	633	15774	548	9822
2L-3S		MI	2680	1529	3978	1293	4824	1072	5323	890	5909	604	6935	280	5567
6-#14	2.11	MA	4539	1529	6131	1366	7829	1137	8859	949	10104	657	12668	392	9678
3L-2S		MI	3018	1529	4571	1279	5573	1062	6229	883	7129	595	8458	445	5611
6-#18	3.75	MA	6119	1838	9728	1526	12309	1250	14240	1014	17316	615	22629	526	16911
2L-3S		MI	2952	1838	4892	1475	5918	1202	6615	967	7612	581	8826	23	8768
6-#18	3.75	MA	5160	1838	7834	1563	9912	1282	11342	1042	13414	653	17226	239	16319
3L-2S		MI	3448	1838	5903	1456	7197	1190	8162	962	9691	572	11314	317	9354
8-#9	1.25	MA	4643	1367	5812	1258	7530	1055	8552	895	9741	648	12202	564	6039
2L-4S		MI	2499	1367	3316	1218	4072	1021	4443	868	4761	624	5682	403	3547
8-#9	1.25	MA	4324	1367	5313	1268	6899	1065	7788	904	8713	660	10779	498	6022
3E		MI	2605	1367	3512	1210	4328	1015	4770	859	5207	622	6221	444	3558
8-#9	1.25	MA	4137	1367	4971	1279	6451	1075	7215	918	7929	668	9819	457	5954
4L-2S		MI	2778	1367	3790	1203	4680	1009	5196	854	5780	616	6979	517	3553
8-#10	1.59	MA	4881	1431	6362	1295	8207	1082	9361	912	10821	644	13692	560	7588
2L-4S		MI	2557	1431	3501	1257	4287	1049	4691	886	5086	621	6097	358	4371
8-#10	1.59	MA	4493	1431	5732	1308	7410	1095	8397	923	9523	659	11894	475	7549
3E		MI	2685	1431	3748	1247	4610	1042	5103	875	5648	619	6770	408	4412
8-#10	1.59	MA	4267	1431	5299	1322	6843	1107	7672	940	8532	668	10677	422	7406
4L-2S		MI	2895	1431	4098	1238	5053	1034	5638	870	6369	611	7715	502	4417
8-#11	1.95	MA	5098	1499	6959	1330	8912	1107	10188	926	11910	638	15181	552	9171
2L-4S		MI	2600	1499	3713	1289	4509	1071	4932	899	5388	610	6419	295	5097
8-#11	1.95	MA	4648	1499	6196	1346	7947	1122	9020	939	10338	655	13005	446	9104
3E		MI	2750	1499	4011	1279	4897	1063	5427	886	6064	609	7208	354	5257
8-#11	1.95	MA	4386	1499	5669	1362	7259	1136	8140	959	9135	665	11518	380	8826
4L-2S		MI	2992	1499	4429	1269	5427	1055	6068	881	6926	602	8307	469	5274
8-#14	2.81	MA	5634	1661	8309	1426	10584	1178	12191	970	14590	628	18880	541	12996
2L-4S		MI	2743	1661	4147	1389	5022	1142	5526	945	6171	598	7360	167	6653
8-#14	2.81	MA	5044	1661	7220	1448	9207	1198	10525	988	12347	652	15774	385	12825
3E		MI	2935	1661	4571	1376	5573	1133	6229	928	7129	599	8458	249	7266
8-#14	2.81	MA	4701	1661	6467	1471	8223	1217	9267	1016	10628	665	13637	290	11728
4L-2S		MI	3243	1661	5163	1362	6322	1123	7135	922	8349	590	9980	415	7339
8-#18	5.00	MA	6014	2073	9728	1710	12309	1390	14240	1112	17316	644	22629	227	21816
3E		MI	3358	2073	5903	1622	7197	1310	8162	1036	9691	571	11314	-47	11243
8-#18	5.00	MA	5487	2073	8411	1747	10589	1423	12042	1158	14313	664	18860	56	18555
4L-2S		MI	3805	2073	6915	1603	8477	1298	9709	1031	11769	562	13802	247	12280
10-#10	1.98	MA	5163	1505	6992	1342	9005	1117	10326	934	12120	642	15490	556	9429
2L-5S		MI	2613	1505	3629	1313	4416	1096	4856	914	5295	626	6374	291	5067
10-#10	1.98	MA	4794	1505	6362	1355	8207	1129	9361	945	10821	656	13692	471	9379
3L-4S		MI	2718	1505	3851	1303	4730	1083	5227	908	5807	618	7041	347	5373
10-#10	1.98	MA	4585	1505	5929	1368	7641	1141	8636	962	9831	666	12475	418	9228
4L-3S		MI	2838	1505	4098	1294	5053	1076	5638	897	6369	616	7715	397	5428
10-#10	1.98	MA	4353	1505	5545	1382	7094	1159	7991	973	8936	680	11188	366	8625
5L-2S		MI	3040	1505	4448	1285	5495	1068	6174	892	7090	608	8659	490	5444
10-#11	2.44	MA	5001	1591	6959	1403	8912	1164	10188	966	11910	651	15181	441	11315
3L-4S		MI	2788	1591	4131	1347	5038	1113	5573	926	6251	606	7518	277	6235
10-#11	2.44	MA	4762	1591	6432	1419	8224	1178	9308	986	10707	661	13694	376	10990
4L-3S		MI	2932	1591	4429	1337	5427	1105	6068	913	6926	606	8307	336	6466
10-#11	2.44	MA	4490	1591	5965	1435	7560	1200	8523	999	9620	678	12190	318	10163
5L-2S		MI	3156	1591	4848	1327	5956	1098	6708	908	7789	598	9406	451	6498
10-#14	3.52	MA	5526	1794	8309	1531	10584	1258	12191	1027	14590	647	18880	378	15977
3L-4S		MI	3003	1794	4739	1472	5771	1203	6432	983	7390	593	8883	137	8279
10-#14	3.52	MA	5221	1794	7556	1553	9600	1278	10933	1055	12871	660	16743	283	14847
4L-3S		MI	3175	1794	5163	1458	6322	1193	7135	967	8349	594	9980	219	8963

RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	3.52	MA	4845	1794	6886	1575	8649	1308	9809	1072	11315	684	14587	197	13744
5L-2S		MI	3462	1794	5755	1445	7072	1184	8041	961	9569	585	11503	385	9060
10-#18	6.25	MA	6402	2309	10305	1894	12985	1531	14940	1227	18215	655	24263	43	24025
4L-3S		MI	3749	2309	6915	1769	8477	1418	9709	1105	11769	562	13802	-117	13587
10-#18	6.25	MA	5762	2309	9132	1931	11320	1582	12974	1255	15493	693	20476	-120	19743
5L-2S		MI	4157	2309	7926	1750	9756	1406	11256	1100	13848	553	16290	177	15200
12-#10	2.38	MA	5084	1580	6992	1402	9005	1163	10326	967	12120	654	15490	467	11209
3L-5S		MI	2777	1580	3979	1359	4859	1131	5392	936	6016	623	7318	280	6044
12-#10	2.38	MA	4891	1580	6559	1415	8438	1176	9601	984	11129	663	14273	415	11052
4E		MI	2874	1580	4201	1350	5173	1118	5762	930	6528	615	7986	336	6344
12-#10	2.38	MA	4663	1580	6175	1428	7892	1194	8955	995	10234	678	12986	362	10438
5L-3S		MI	2988	1580	4448	1341	5495	1110	6174	919	7090	613	8659	386	6442
12-#10	2.38	MA	4394	1580	5762	1436	7398	1206	8325	1012	9362	687	11864	302	9946
6L-2S		MI	3180	1580	4798	1332	5938	1103	6709	914	7811	605	9603	479	6466
12-#11	2.92	MA	5122	1682	7195	1477	9189	1221	10475	1013	12279	658	15871	371	13161
4E		MI	2978	1682	4550	1404	5568	1155	6213	953	7113	603	8617	259	7384
12-#11	2.92	MA	4856	1682	6728	1492	8525	1242	9690	1026	11192	675	14366	313	12363
5L-3S		MI	3103	1682	4848	1394	5956	1148	6708	940	7789	602	9406	318	7674
12-#11	2.92	MA	4542	1682	6233	1502	7925	1256	8925	1046	10132	685	12930	229	11551
6L-2S		MI	3315	1682	5267	1384	6486	1140	7349	935	8651	595	10505	433	7718
12-#14	4.22	MA	5719	1926	8645	1636	10978	1339	12599	1093	15114	655	19849	276	17974
4E		MI	3252	1926	5331	1555	6520	1264	7338	1022	8610	588	10405	107	9918
12-#14	4.22	MA	5350	1926	7975	1658	10027	1369	11475	1111	13558	679	17692	190	16879
5L-3S		MI	3408	1926	5755	1541	7072	1254	8041	1006	9569	589	11503	189	10661
12-#14	4.22	MA	4934	1926	7275	1672	9167	1389	10379	1139	12041	692	15629	68	15247
6L-2S		MI	3677	1926	6347	1528	7821	1245	8947	1000	10789	580	13025	354	10777
12-#18	7.50	MA	6606	2544	11026	2078	13717	1690	15872	1324	19395	684	25879	-132	24790
5L-3S		MI	4131	2544	7926	1917	9756	1526	11256	1174	13848	552	16290	-187	15892
14-#10	2.78	MA	5187	1655	7189	1462	9235	1210	10565	1006	12427	660	16071	411	12879
4L-5S		MI	2931	1655	4329	1406	5302	1165	5927	958	6737	620	8263	269	7025
14-#10	2.78	MA	4962	1655	6805	1475	8689	1228	9919	1017	11532	675	14784	358	12254
5L-4S		MI	3027	1655	4551	1397	5616	1152	6298	952	7249	612	8930	325	7310
14-#10	2.78	MA	4707	1655	6392	1482	8196	1240	9290	1034	10661	684	13662	298	11769
6L-3S		MI	3137	1655	4798	1388	5938	1145	6709	941	7811	610	9603	375	7454
14-#10	2.78	MA	4481	1655	5992	1491	7676	1248	8681	1045	9813	699	12496	261	11003
7L-2S		MI	3317	1655	5148	1378	6381	1137	7245	935	8532	603	10548	468	7486
14-#11	3.41	MA	5208	1774	7491	1550	9490	1284	10858	1053	12763	672	16543	309	14567
5L-4S		MI	3154	1774	4969	1462	6098	1198	6854	980	7976	599	9716	241	8542
14-#11	3.41	MA	4912	1774	6996	1559	8890	1298	10092	1073	11704	682	15107	224	13758
6L-3S		MI	3269	1774	5267	1452	6486	1190	7349	967	8651	599	10505	301	8880
14-#11	3.41	MA	4650	1774	6511	1570	8269	1308	9352	1086	10673	699	13685	177	12829
7L-2S		MI	3471	1774	5685	1441	7016	1182	7989	962	9514	591	11604	415	8934
14-#14	4.92	MA	5861	2059	9064	1741	11404	1430	13141	1150	15801	674	20798	183	20015
5L-4S		MI	3494	2059	5924	1637	7269	1325	8244	1061	9830	583	11928	77	11568
14-#14	4.92	MA	5448	2059	8364	1755	10545	1450	12045	1178	14284	687	18734	61	18392
6L-3S		MI	3635	2059	6347	1624	7821	1315	8947	1045	10789	584	13025	159	12360
14-#14	4.92	MA	5104	2059	7670	1769	9666	1465	10985	1196	12809	711	16694	-11	16660
7L-2S		MI	3888	2059	6939	1611	8570	1305	9853	1039	12009	575	14548	324	12491
16-#10	3.17	MA	5253	1730	7436	1522	9486	1262	10884	1039	12831	672	16581	354	14073
5E		MI	3087	1730	4679	1453	5745	1199	6463	980	7458	617	9207	258	8010
16-#10	3.17	MA	5009	1730	7022	1529	8993	1275	10254	1056	11959	681	15459	294	13594
6L-4S		MI	3183	1730	4901	1443	6058	1186	6833	974	7970	610	9874	314	8281
16-#10	3.17	MA	4796	1730	6623	1538	8473	1282	9646	1067	11111	696	14294	258	12829
7L-3S		MI	3278	1730	5148	1434	6381	1179	7245	963	8532	607	10548	364	8465
16-#10	3.17	MA	4598	1730	6183	1554	7931	1297	9021	1075	10267	705	13171	207	12036
8L-2S		MI	3450	1730	5498	1425	6824	1171	7780	957	9252	600	11492	457	8503
16-#11	3.90	MA	5269	1866	7759	1616	9856	1341	11260	1100	13276	678	17283	219	15965
6L-4S		MI	3326	1866	5387	1519	6627	1240	7494	1006	8838	596	10816	224	9706

RECTANGULAR TIED COLUMNS 20" x 32"

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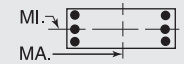


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	3.90	MA	5023	1866	7274	1627	9234	1351	10519	1113	12245	695	15861	172	15029
7L-3S		MI	3433	1866	5685	1509	7016	1232	7989	994	9514	595	11604	283	10086
16-#11	3.90	MA	4794	1866	6740	1646	8576	1367	9773	1124	11218	705	14491	107	13988
8L-2S		MI	3625	1866	6104	1499	7545	1224	8630	989	10376	588	12703	397	10149
16-#14	5.63	MA	5976	2191	9452	1838	11922	1511	13711	1217	16527	682	21840	54	21537
6L-4S		MI	3731	2191	6516	1720	8018	1386	9150	1100	11050	578	13450	47	13226
16-#14	5.63	MA	5661	2191	8759	1852	11043	1526	12651	1235	15052	706	19799	-18	19720
7L-3S		MI	3859	2191	6939	1707	8570	1376	9853	1084	12009	579	14548	129	14041
18-#10	3.57	MA	5303	1804	7652	1576	9790	1309	11219	1078	13257	678	17257	290	15421
6L-5S		MI	3233	1804	5029	1499	6187	1234	6998	1002	8179	614	10151	247	8999
18-#10	3.57	MA	5101	1804	7253	1585	9270	1317	10610	1089	12410	693	16092	254	14656
7L-4S		MI	3328	1804	5251	1490	6501	1221	7368	996	8690	607	10819	303	9257
18-#10	3.57	MA	4911	1804	6813	1601	8729	1331	9985	1097	11565	702	14968	203	13858
8L-3S		MI	3417	1804	5498	1481	6824	1213	7780	985	9252	605	11492	353	9475
18-#10	3.57	MA	4664	1804	6435	1612	8225	1341	9344	1111	10732	717	13806	149	13063
9L-2S		MI	3582	1804	5848	1472	7266	1206	8316	979	9973	597	12436	446	9520
18-#11	4.39	MA	5385	1958	8037	1684	10199	1393	11687	1140	13817	692	18038	167	17229
7L-4S		MI	3495	1958	5806	1576	7157	1282	8135	1033	9701	592	11915	206	10876
18-#11	4.39	MA	5162	1958	7503	1703	9541	1410	10941	1151	12790	702	16668	102	16193
8L-3S		MI	3593	1958	6104	1566	7545	1274	8630	1021	10376	592	12703	265	11292
18-#14	6.33	MA	6170	2324	9848	1935	12421	1587	14317	1274	17295	701	22905	-25	22761
7L-4S		MI	3963	2324	7108	1803	8767	1447	10056	1139	12270	573	14973	16	14892
20-#10	3.97	MA	5399	1879	7883	1632	10068	1351	11574	1111	13708	690	17890	250	16483
7L-5S		MI	3376	1879	5379	1546	6630	1268	7534	1024	8900	612	11096	236	9990
20-#10	3.97	MA	5211	1879	7443	1647	9526	1365	10950	1119	12864	699	16766	199	15680
8L-4S		MI	3470	1879	5601	1537	6944	1255	7904	1018	9411	604	11763	291	10238
20-#10	3.97	MA	4975	1879	7065	1658	9023	1375	10308	1133	12030	714	15604	145	14881
9L-3S		MI	3553	1879	5848	1528	7266	1248	8316	1007	9973	602	12436	342	10486
20-#11	4.88	MA	5517	2050	8266	1761	10506	1452	12108	1178	14362	699	18844	98	18397
8L-4S		MI	3660	2050	6225	1634	7687	1324	8776	1060	10563	589	13014	188	12050
22-#10	4.37	MA	5504	1954	8074	1694	10323	1400	11914	1141	14162	697	18564	196	17502
8L-5S		MI	3517	1954	5729	1593	7073	1302	8069	1046	9621	609	12040	225	10984
22-#10	4.37	MA	5278	1954	7695	1705	9820	1409	11272	1155	13329	711	17402	141	16698
9L-4S		MI	3610	1954	5951	1584	7386	1289	8439	1040	10132	601	12707	280	11221
24-#10	4.76	MA	5573	2029	8326	1752	10617	1444	12237	1177	14627	709	19200	137	18516
9L-5S		MI	3655	2029	6079	1640	7515	1337	8604	1068	10342	606	12984	214	11979

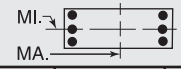
RECTANGULAR TIED COLUMNS 20" x 34"

4-#14	1.32	MA	5264	1467	6744	1336	8661	1120	9812	948	11175	683	13998	594	7125
2E		MI	2925	1467	4153	1261	5032	1056	5542	892	6126	638	7178	509	3887
4-#18	2.35	MA	5999	1673	8582	1454	10911	1206	12494	1001	14750	669	18920	578	12261
2E		MI	3227	1673	5072	1372	6128	1135	6835	940	7828	619	9067	420	6445
6-#10	1.12	MA	5143	1427	6310	1323	8205	1112	9308	946	10541	692	13153	603	6155
2L-3S		MI	2668	1427	3567	1266	4373	1063	4786	902	5145	660	6072	454	3409
6-#10	1.12	MA	4698	1427	5633	1337	7349	1125	8272	957	9147	707	11222	519	6131
3L-2S		MI	2889	1427	3917	1257	4815	1056	5322	897	5866	653	7016	547	3400
6-#11	1.38	MA	5330	1478	6811	1348	8785	1129	9982	955	11422	686	14354	596	7447
2L-3S		MI	2707	1478	3764	1287	4574	1076	5006	908	5419	651	6353	406	4066
6-#11	1.38	MA	4809	1478	5991	1364	7747	1144	8727	969	9732	703	12014	491	7400
3L-2S		MI	2964	1478	4183	1277	5104	1069	5646	902	6281	643	7452	520	4061

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.99	MA	5789	1600	7915	1419	10143	1181	11605	987	13589	678	17340	587	10551
2L-3S		MI	2821	1600	4153	1357	5032	1127	5542	937	6126	642	7178	313	5602
6-#14	1.99	MA	5093	1600	6744	1442	8661	1202	9812	1006	11175	703	13998	434	10407
3L-2S		MI	3163	1600	4745	1344	5781	1117	6448	931	7346	633	8701	478	5636
6-#18	3.53	MA	6831	1909	10624	1601	13494	1314	15617	1070	18955	660	24743	566	18207
2L-3S		MI	3092	1909	5072	1538	6128	1256	6835	1014	7828	618	9067	56	8924
6-#18	3.53	MA	5774	1909	8582	1640	10911	1348	12494	1100	14750	700	18920	284	17615
3L-2S		MI	3596	1909	6083	1519	7407	1244	8382	1009	9907	609	11555	350	9389
8-#9	1.18	MA	5201	1438	6396	1333	8333	1120	9473	951	10773	693	13482	603	6471
2L-4S		MI	2640	1438	3483	1284	4276	1077	4662	917	4979	664	5928	438	3569
8-#9	1.18	MA	4854	1438	5860	1344	7655	1130	8654	960	9670	705	11954	538	6454
3E		MI	2747	1438	3680	1276	4532	1071	4988	908	5425	661	6468	478	3575
8-#9	1.18	MA	4651	1438	5493	1355	7176	1140	8040	974	8830	713	10930	497	6386
4L-2S		MI	2921	1438	3958	1269	4884	1065	5414	903	5998	655	7225	551	3569
8-#10	1.49	MA	5461	1501	6987	1370	9061	1146	10344	968	11936	689	15085	599	8137
2L-4S		MI	2697	1501	3670	1322	4493	1105	4910	935	5304	660	6343	392	4401
8-#10	1.49	MA	5039	1501	6310	1384	8205	1159	9308	979	10541	704	13153	515	8098
3E		MI	2827	1501	3917	1313	4815	1098	5322	924	5866	658	7016	442	4434
8-#10	1.49	MA	4794	1501	5846	1397	7598	1172	8531	997	9479	714	11855	463	7954
4L-2S		MI	3039	1501	4267	1304	5258	1090	5857	918	6587	650	7961	536	4435
8-#11	1.84	MA	5702	1570	7632	1405	9823	1172	11237	982	13113	682	16694	591	9845
2L-4S		MI	2741	1570	3885	1354	4716	1126	5151	947	5606	648	6663	329	5177
8-#11	1.84	MA	5211	1570	6811	1422	8785	1187	9982	996	11422	700	14354	487	9778
3E		MI	2892	1570	4183	1344	5104	1119	5646	935	6281	647	7452	388	5284
8-#11	1.84	MA	4925	1570	6247	1438	8048	1202	9038	1016	10132	711	12767	422	9533
4L-2S		MI	3137	1570	4602	1334	5633	1111	6287	929	7144	640	8551	502	5297
8-#14	2.65	MA	6290	1732	9087	1502	11626	1242	13397	1026	16002	673	20681	580	13968
2L-4S		MI	2882	1732	4322	1453	5230	1197	5746	992	6387	636	7603	201	6747
8-#14	2.65	MA	5644	1732	7915	1524	10143	1263	11605	1045	13589	698	17340	427	13797
3E		MI	3078	1732	4745	1440	5781	1188	6448	976	7346	637	8701	283	7303
8-#14	2.65	MA	5271	1732	7107	1547	9088	1283	10254	1074	11743	713	15059	333	12731
4L-2S		MI	3390	1732	5337	1427	6530	1178	7354	970	8566	629	10223	448	7367
8-#18	4.71	MA	6708	2144	10624	1787	13494	1456	15617	1170	18955	691	24743	272	23544
3E		MI	3498	2144	6083	1686	7407	1364	8382	1083	9907	609	11555	-14	11534
8-#18	4.71	MA	6130	2144	9209	1825	11646	1491	13255	1218	15727	714	20718	102	20108
4L-2S		MI	3954	2144	7094	1666	8687	1352	9929	1078	11985	600	14043	280	12317
10-#10	1.87	MA	5769	1576	7664	1417	9918	1181	11380	990	13331	686	17016	595	10115
2L-5S		MI	2753	1576	3798	1378	4622	1152	5075	963	5513	665	6620	326	5129
10-#10	1.87	MA	5367	1576	6987	1430	9061	1194	10344	1001	11936	702	15085	511	10065
3L-4S		MI	2859	1576	4019	1369	4935	1139	5445	957	6025	657	7287	381	5406
10-#10	1.87	MA	5140	1576	6523	1444	8455	1206	9567	1019	10874	711	13787	459	9913
4L-3S		MI	2981	1576	4267	1360	5258	1132	5857	946	6587	655	7961	431	5452
10-#10	1.87	MA	4884	1576	6111	1458	7869	1225	8876	1030	9915	727	12410	409	9315
5L-2S		MI	3185	1576	4617	1351	5701	1124	6392	940	7307	647	8905	525	5464
10-#11	2.29	MA	5596	1661	7632	1479	9823	1229	11237	1023	13113	697	16694	482	12158
3L-4S		MI	2929	1661	4303	1412	5245	1169	5792	974	6468	645	7762	311	6313
10-#11	2.29	MA	5334	1661	7067	1495	9085	1244	10293	1043	11822	708	15107	417	11907
4L-3S		MI	3075	1661	4602	1402	5633	1161	6287	962	7144	644	8551	370	6496
10-#11	2.29	MA	5035	1661	6567	1512	8373	1266	9452	1057	10656	726	13430	353	10983
5L-2S		MI	3302	1661	5020	1392	6163	1153	6927	956	8006	637	9650	484	6522
10-#14	3.31	MA	6170	1864	9087	1607	11626	1323	13397	1084	16002	693	20681	420	17192
3L-4S		MI	3143	1864	4914	1536	5979	1258	6652	1031	7607	631	9126	171	8369
10-#14	3.31	MA	5837	1864	8279	1630	10570	1344	12047	1113	14156	708	18401	326	16097
4L-3S		MI	3319	1864	5337	1523	6530	1248	7354	1015	8566	632	10223	253	9002

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RECTANGULAR TIED COLUMNS 20" x 34"

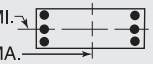
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	3.31	MA	5421	1864	7562	1653	9550	1375	10842	1131	12487	732	15995	230	14870
5L-2S		MI	3611	1864	5929	1509	7279	1239	8260	1009	9786	624	11746	418	9089
10-#18	5.88	MA	7127	2380	11250	1973	14228	1599	16378	1287	19932	705	26540	90	26005
4L-3S		MI	3890	2380	7094	1833	8687	1472	9929	1152	11985	599	14043	-84	13891
10-#18	5.88	MA	6420	2380	9992	2011	12442	1651	14267	1318	17009	745	22484	-66	21924
5L-2S		MI	4307	2380	8105	1813	9966	1460	11476	1147	14064	590	16531	210	15238
12-#10	2.24	MA	5683	1651	7664	1477	9918	1228	11380	1023	13331	699	17016	507	12032
3L-5S		MI	2917	1651	4147	1425	5064	1187	5610	985	6234	662	7565	314	6104
12-#10	2.24	MA	5473	1651	7200	1491	9311	1241	10603	1041	12269	709	15718	456	11875
4E		MI	3016	1651	4369	1416	5378	1174	5981	979	6745	654	8232	370	6410
12-#10	2.24	MA	5222	1651	6788	1505	8726	1259	9912	1052	11310	724	14341	405	11265
5L-3S		MI	3131	1651	4617	1407	5701	1166	6392	968	7307	652	8905	420	6467
12-#10	2.24	MA	4930	1651	6341	1512	8197	1272	9254	1064	10376	734	13143	346	10752
6L-2S		MI	3327	1651	4967	1397	6143	1159	6928	962	8028	644	9849	514	6487
12-#11	2.75	MA	5727	1753	7888	1553	10123	1286	11549	1070	13512	704	17447	413	14255
4E		MI	3120	1753	4722	1469	5775	1211	6432	1001	7331	641	8862	293	7459
12-#11	2.75	MA	5433	1753	7387	1569	9411	1308	10707	1084	12346	722	15770	348	13353
5L-3S		MI	3247	1753	5020	1459	6163	1203	6927	989	8006	641	9650	352	7705
12-#11	2.75	MA	5093	1753	6850	1578	8769	1323	9887	1105	11211	733	14307	273	12526
6L-2S		MI	3463	1753	5439	1449	6693	1195	7568	983	8869	633	10749	467	7743
12-#14	3.97	MA	6379	1997	9451	1713	12052	1405	13839	1151	16570	703	21742	319	19470
4E		MI	3393	1997	5506	1619	6728	1319	7558	1070	8827	626	10648	140	10005
12-#14	3.97	MA	5971	1997	8733	1736	11032	1436	12635	1170	14901	727	19337	223	18267
5L-3S		MI	3552	1997	5929	1606	7279	1309	8260	1054	9786	627	11746	223	10701
12-#14	3.97	MA	5519	1997	7972	1749	10112	1457	11460	1199	13274	742	17233	115	16533
6L-2S		MI	3826	1997	6522	1592	8028	1300	9166	1048	11006	619	13268	388	10807
12-#18	7.06	MA	7338	2615	12034	2158	15024	1759	17391	1387	21215	737	28307	-78	27478
5L-3S		MI	4273	2615	8105	1980	9966	1580	11476	1221	14064	590	16531	-154	16209
14-#10	2.61	MA	5795	1726	7877	1538	10167	1275	11639	1063	13663	706	17649	452	13839
4L-5S		MI	3073	1726	4497	1472	5507	1221	6146	1007	6955	659	8509	303	7084
14-#10	2.61	MA	5548	1726	7465	1551	9582	1293	10947	1074	12704	721	16273	401	13219
5L-4S		MI	3169	1726	4719	1462	5821	1208	6516	1001	7466	651	9176	359	7376
14-#10	2.61	MA	5270	1726	7018	1558	9053	1306	10290	1086	11771	731	15074	342	12720
6L-3S		MI	3282	1726	4967	1453	6143	1201	6928	990	8028	649	9849	409	7480
14-#10	2.61	MA	5025	1726	6590	1568	8490	1314	9622	1104	10863	746	13832	306	11896
7L-2S		MI	3465	1726	5317	1444	6586	1193	7463	984	8749	641	10794	502	7508
14-#11	3.21	MA	5817	1845	8208	1626	10449	1350	11963	1111	14037	719	18110	343	15726
5L-4S		MI	3297	1845	5141	1527	6304	1253	7073	1028	8193	638	9961	275	8615
14-#11	3.21	MA	5495	1845	7670	1635	9807	1365	11143	1132	12901	730	16647	269	14899
6L-3S		MI	3415	1845	5439	1516	6693	1245	7568	1016	8869	637	10749	334	8912
14-#11	3.21	MA	5210	1845	7150	1646	9131	1375	10350	1145	11797	748	15128	223	13937
7L-2S		MI	3620	1845	5858	1506	7222	1237	8209	1010	9731	630	11849	449	8961
14-#14	4.63	MA	6500	2129	9905	1819	12514	1497	14427	1209	17314	722	22679	216	21664
5L-4S		MI	3636	2129	6098	1702	7477	1380	8464	1109	10047	621	12171	110	11652
14-#14	4.63	MA	6077	2129	9144	1832	11594	1518	13252	1238	15688	737	20575	108	19917
6L-3S		MI	3780	2129	6522	1688	8028	1370	9166	1093	11006	622	13268	192	12401
14-#14	4.63	MA	5703	2129	8400	1847	10638	1532	12116	1257	14106	762	18394	40	18202
7L-2S		MI	4039	2129	7114	1675	8778	1360	10072	1087	12225	614	14791	358	12522
16-#10	2.99	MA	5864	1800	8142	1598	10439	1328	11983	1096	14099	718	18204	397	15175
5E		MI	3230	1800	4847	1518	5950	1255	6681	1029	7676	656	9453	292	8068
16-#10	2.99	MA	5599	1800	7695	1605	9910	1340	11326	1108	13166	728	17005	338	14689
6L-4S		MI	3326	1800	5069	1509	6263	1242	7052	1023	8187	648	10120	348	8346
16-#10	2.99	MA	5367	1800	7267	1615	9347	1348	10658	1126	12258	744	15763	302	13859
7L-3S		MI	3424	1800	5317	1500	6586	1235	7463	1012	8749	646	10794	398	8491
16-#10	2.99	MA	5152	1800	6796	1631	8766	1363	9980	1134	11354	753	14563	254	13051
8L-2S		MI	3599	1800	5667	1491	7029	1228	7999	1006	9470	639	11738	491	8526
16-#11	3.67	MA	5884	1937	8491	1693	10845	1407	12398	1159	14591	726	18987	264	17272
6L-4S		MI	3469	1937	5560	1584	6834	1295	7713	1055	9056	634	11060	257	9777

RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

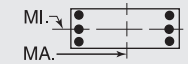
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	3.67	MA	5616	1937	7971	1704	10169	1417	11605	1172	13487	744	17468	218	16314
7L-3S		MI	3579	1937	5858	1574	7222	1287	8209	1043	9731	634	11849	316	10119
16-#11	3.67	MA	5365	1937	7398	1723	9463	1434	10794	1183	12386	755	16004	156	15172
8L-2S		MI	3775	1937	6276	1564	7752	1280	8849	1037	10594	626	12948	431	10176
16-#14	5.29	MA	6616	2262	10315	1915	13076	1579	15045	1277	18101	732	23917	101	23302
6L-4S		MI	3873	2262	6690	1785	8226	1441	9370	1148	11267	616	13693	80	13307
16-#14	5.29	MA	6269	2262	9571	1930	12120	1593	13909	1296	16520	757	21736	33	21577
7L-3S		MI	4004	2262	7114	1771	8778	1431	10072	1132	12225	617	14791	162	14101
18-#10	3.36	MA	5918	1875	8372	1652	10766	1375	12361	1130	14560	725	18936	334	16657
6L-5S		MI	3377	1875	5197	1565	6392	1290	7217	1051	8397	653	10398	281	9055
18-#10	3.36	MA	5699	1875	7944	1661	10203	1382	11694	1147	13653	741	17695	298	15821
7L-4S		MI	3472	1875	5419	1556	6706	1277	7587	1045	8908	646	11065	337	9320
18-#10	3.36	MA	5489	1875	7473	1678	9623	1397	11016	1155	12748	751	16494	250	15008
8L-3S		MI	3564	1875	5667	1547	7029	1269	7999	1034	9470	644	11738	387	9503
18-#10	3.36	MA	5221	1875	7067	1689	9084	1407	10329	1170	11856	766	15256	196	14196
9L-2S		MI	3732	1875	6017	1538	7471	1262	8534	1028	10191	636	12682	480	9543
18-#11	4.13	MA	6009	2029	8791	1761	11207	1459	12860	1199	15177	741	19808	214	18689
7L-4S		MI	3638	2029	5978	1641	7364	1337	8354	1082	9918	631	12159	240	10945
18-#11	4.13	MA	5763	2029	8218	1781	10501	1476	12049	1210	14077	752	18344	151	17542
8L-3S		MI	3740	2029	6276	1631	7752	1330	8849	1070	10594	630	12948	299	11325
18-#14	5.96	MA	6862	2394	10743	2013	13602	1654	15702	1335	18933	752	25077	26	24952
7L-4S		MI	4105	2394	7282	1867	8975	1502	10276	1187	12487	611	15216	50	14970
20-#10	3.74	MA	6022	1950	8621	1708	11060	1417	12730	1169	15047	738	19626	295	17783
7L-5S		MI	3521	1950	5547	1612	6835	1324	7752	1073	9118	650	11342	270	10045
20-#10	3.74	MA	5815	1950	8150	1724	10479	1431	12052	1177	14143	748	18426	246	16965
8L-4S		MI	3615	1950	5769	1603	7149	1311	8122	1067	9629	643	12009	326	10299
20-#10	3.74	MA	5559	1950	7744	1736	9940	1441	11364	1192	13251	763	17188	192	16149
9L-3S		MI	3701	1950	6017	1593	7471	1304	8534	1056	10191	641	12682	376	10514
20-#10	3.74	MA	5319	1950	7318	1744	9412	1452	10702	1201	12354	773	15984	149	15238
10L-2S		MI	3863	1950	6367	1584	7914	1296	9070	1050	10912	633	13627	469	10560
20-#11	4.59	MA	6149	2121	9039	1838	11539	1519	13304	1237	15767	748	20684	147	19913
8L-4S		MI	3804	2121	6397	1699	7893	1380	8995	1109	10781	627	13258	222	12118
22-#10	4.11	MA	6133	2025	8827	1771	11336	1466	13088	1199	15538	745	20357	242	18923
8L-5S		MI	3662	2025	5897	1659	7278	1358	8288	1095	9838	648	12286	259	11038
22-#10	4.11	MA	5887	2025	8421	1782	10797	1476	12400	1214	14646	760	19119	188	18102
9L-4S		MI	3755	2025	6119	1649	7591	1345	8658	1089	10350	640	12953	314	11281
22-#10	4.11	MA	5658	2025	7995	1791	10268	1486	11738	1223	13748	770	17915	145	17194
10L-3S		MI	3836	2025	6367	1640	7914	1338	9070	1078	10912	638	13627	365	11524
24-#10	4.48	MA	6208	2099	9098	1829	11653	1510	13436	1236	16041	758	21050	184	20055
9L-5S		MI	3801	2099	6247	1705	7720	1393	8823	1117	10559	645	13231	248	12032
24-#10	4.48	MA	5989	2099	8672	1837	11125	1521	12774	1245	15143	767	19846	141	19150
10L-4S		MI	3894	2099	6469	1696	8034	1380	9193	1111	11071	637	13898	303	12266

RECTANGULAR TIED COLUMNS 20" x 36"

4-#14	1.25	MA	5860	1538	7379	1411	9529	1184	10806	1004	12290	727	15380	633	7611
2E		MI	3068	1538	4328	1326	5240	1111	5762	940	6343	677	7422	542	3908
4-#18	2.22	MA	6665	1744	9353	1529	11946	1270	13687	1057	16130	713	20668	617	13125
2E		MI	3373	1744	5251	1435	6338	1189	7055	987	8044	656	9307	453	6476
6-#10	1.06	MA	5725	1497	6911	1398	9035	1176	10261	1001	11604	736	14466	642	6566
2L-3S		MI	2810	1497	3736	1332	4578	1119	5005	951	5362	699	6318	488	3427
6-#10	1.06	MA	5245	1497	6187	1412	8120	1189	9153	1014	10113	752	12401	559	6542
3L-2S		MI	3033	1497	4086	1323	5020	1112	5540	945	6083	692	7262	581	3416
6-#11	1.30	MA	5931	1548	7449	1423	9659	1193	10985	1011	12551	730	15756	635	7952
2L-3S		MI	2849	1548	3936	1352	4781	1132	5225	956	5636	689	6597	439	4090

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis



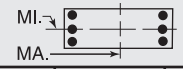
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.30	MA	5367	1548	6571	1440	8548	1209	9642	1025	10743	749	13252	532	7905
3L-2S		MI	3108	1548	4355	1342	5310	1124	5865	951	6498	682	7696	554	4081
6-#14	1.88	MA	6432	1670	8633	1494	11116	1245	12725	1043	14874	722	18958	626	11280
2L-3S		MI	2962	1670	4328	1422	5240	1182	5762	985	6343	680	7422	347	5635
6-#14	1.88	MA	5676	1670	7379	1518	9529	1267	10806	1063	12290	748	15380	475	11136
3L-2S		MI	3309	1670	4920	1408	5989	1172	6668	979	7563	672	8944	512	5661
6-#18	3.33	MA	7574	1979	11542	1676	14714	1378	17035	1126	20638	704	26910	605	19503
2L-3S		MI	3232	1979	5251	1602	6338	1310	7055	1061	8044	656	9307	89	9078
6-#18	3.33	MA	6418	1979	9353	1716	11946	1414	13687	1158	16130	747	20668	328	18911
3L-2S		MI	3743	1979	6262	1582	7617	1298	8602	1056	10123	647	11795	383	9424
8-#9	1.11	MA	5789	1508	7001	1408	9171	1184	10436	1007	11850	737	14815	642	6903
2L-4S		MI	2781	1508	3651	1350	4481	1133	4880	966	5197	703	6175	472	3591
8-#9	1.11	MA	5413	1508	6429	1419	8447	1194	9560	1017	10671	750	13182	578	6886
3E		MI	2889	1508	3847	1342	4737	1127	5207	957	5643	701	6714	512	3592
8-#9	1.11	MA	5194	1508	6038	1431	7935	1205	8905	1031	9775	759	12094	538	6818
4L-2S		MI	3065	1508	4125	1335	5089	1121	5632	952	6216	694	7472	586	3585
8-#10	1.41	MA	6071	1572	7634	1445	9951	1211	11368	1023	13095	733	16530	638	8685
2L-4S		MI	2838	1572	3838	1388	4698	1161	5128	984	5521	699	6589	426	4430
8-#10	1.41	MA	5614	1572	6911	1459	9035	1224	10261	1036	11604	749	14466	555	8647
3E		MI	2969	1572	4086	1379	5020	1154	5540	973	6083	696	7262	477	4455
8-#10	1.41	MA	5349	1572	6416	1473	8388	1237	9432	1054	10470	760	13087	504	8503
4L-2S		MI	3183	1572	4436	1370	5463	1146	6076	967	6804	689	8207	570	4453
8-#11	1.73	MA	6335	1640	8327	1480	10769	1236	12328	1038	14359	727	18260	630	10519
2L-4S		MI	2882	1640	4057	1419	4922	1182	5370	995	5823	687	6908	362	5253
8-#11	1.73	MA	5802	1640	7449	1497	9659	1251	10985	1052	12551	745	15756	527	10452
3E		MI	3034	1640	4355	1409	5310	1174	5865	983	6498	686	7696	421	5311
8-#11	1.73	MA	5494	1640	6847	1514	8871	1267	9977	1074	11173	757	14070	463	10207
4L-2S		MI	3281	1640	4774	1399	5840	1166	6506	978	7361	678	8795	536	5318
8-#14	2.50	MA	6976	1803	9887	1577	12702	1306	14644	1082	17458	717	22536	619	14940
2L-4S		MI	3022	1803	4496	1518	5438	1252	5965	1040	6604	674	7846	234	6839
8-#14	2.50	MA	6274	1803	8633	1600	11116	1327	12725	1102	14874	743	18958	468	14769
3E		MI	3220	1803	4920	1505	5989	1243	6668	1024	7563	675	8944	316	7340
8-#14	2.50	MA	5870	1803	7770	1624	9988	1349	11282	1131	12902	759	16534	375	13747
4L-2S		MI	3537	1803	5512	1491	6738	1233	7574	1018	8783	667	10466	482	7394
8-#18	4.44	MA	7434	2215	11542	1863	14714	1522	17035	1227	20638	738	26910	316	25272
3E		MI	3639	2215	6262	1749	7617	1418	8602	1130	10123	646	11795	19	11740
8-#18	4.44	MA	6803	2215	10030	1903	12739	1558	14509	1277	17185	763	22629	148	21678
4L-2S		MI	4103	2215	7273	1730	8897	1406	10149	1125	12201	637	14284	313	12353
10-#10	1.76	MA	6405	1647	8358	1492	10866	1245	12475	1045	14586	731	18595	634	10801
2L-5S		MI	2893	1647	3966	1444	4827	1208	5293	1012	5731	703	6866	360	5190
10-#10	1.76	MA	5969	1647	7634	1506	9951	1258	11368	1058	13095	747	16530	552	10751
3L-4S		MI	3001	1647	4188	1435	5140	1195	5664	1006	6242	696	7533	415	5436
10-#10	1.76	MA	5723	1647	7139	1520	9304	1271	10539	1075	11961	757	15151	500	10599
4L-3S		MI	3124	1647	4436	1426	5463	1188	6076	995	6804	694	8207	465	5475
10-#10	1.76	MA	5445	1647	6697	1534	8680	1290	9802	1088	10939	773	13686	451	10011
5L-2S		MI	3330	1647	4786	1416	5906	1181	6611	989	7525	686	9151	559	5484
10-#11	2.17	MA	6220	1732	8327	1555	10769	1293	12328	1079	14359	742	18260	523	13000
3L-4S		MI	3070	1732	4476	1477	5452	1224	6011	1022	6685	683	8007	345	6389
10-#11	2.17	MA	5937	1732	7724	1571	9982	1309	11320	1100	12981	754	16574	459	12750
4L-3S		MI	3213	1732	4774	1467	5840	1216	6506	1010	7361	682	8795	404	6525
10-#11	2.17	MA	5609	1732	7191	1588	9222	1331	10423	1115	11737	772	14787	396	11811
5L-2S		MI	3448	1732	5192	1457	6370	1209	7146	1005	8223	675	9895	518	6546
10-#14	3.13	MA	6844	1935	9887	1683	12702	1388	14644	1141	17458	738	22536	461	18407
3L-4S		MI	3283	1935	5089	1601	6187	1313	6871	1079	7824	669	9369	204	8457

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	3.13	MA	6483	1935	9025	1707	11575	1410	13202	1170	15486	754	20112	368	17361
4L-3S		MI	3462	1935	5512	1587	6738	1303	7574	1063	8783	670	10466	286	9040
10-#14	3.13	MA	6027	1935	8260	1730	10487	1442	11916	1190	13704	780	17548	275	15989
5L-2S		MI	3759	1935	6104	1574	7487	1294	8480	1057	10003	662	11989	451	9118
10-#18	5.56	MA	7884	2450	12218	2050	15507	1666	17857	1347	21694	754	28871	136	28001
4L-3S		MI	4032	2450	7273	1896	8897	1526	10149	1199	12201	637	14284	-51	14193
10-#18	5.56	MA	7065	2450	10875	2090	13599	1720	15602	1379	18570	797	24546	-14	24186
5L-2S		MI	4457	2450	8285	1877	10176	1514	11696	1194	14280	628	16772	243	15276
12-#10	2.12	MA	6312	1722	8358	1553	10866	1292	12475	1080	14586	744	18595	548	12855
3L-5S		MI	3058	1722	4316	1491	5269	1243	5829	1034	6452	701	7811	349	6163
12-#10	2.12	MA	6083	1722	7863	1567	10219	1306	11647	1097	13452	754	17216	496	12698
4E		MI	3158	1722	4538	1481	5583	1230	6199	1028	6963	693	8478	404	6442
12-#10	2.12	MA	5810	1722	7421	1580	9595	1324	10909	1110	12430	770	15750	447	12099
5L-3S		MI	3275	1722	4786	1472	5906	1222	6611	1017	7525	691	9151	454	6491
12-#10	2.12	MA	5495	1722	6943	1588	9025	1337	10208	1122	11434	781	14475	389	11533
6L-2S		MI	3473	1722	5136	1463	6348	1215	7146	1011	8246	683	10095	548	6508
12-#11	2.60	MA	6362	1824	8602	1629	11092	1351	12663	1127	14790	750	19078	454	15297
4E		MI	3262	1824	4894	1534	5982	1266	6651	1049	7548	680	9106	327	7533
12-#11	2.60	MA	6040	1824	8069	1646	10333	1374	11766	1142	13546	769	17291	391	14350
5L-3S		MI	3391	1824	5192	1524	6370	1258	7146	1037	8223	679	9895	386	7735
12-#11	2.60	MA	5672	1824	7489	1654	9648	1389	10891	1163	12334	781	15735	318	13515
6L-2S		MI	3610	1824	5611	1514	6899	1251	7787	1032	9086	672	10994	500	7768
12-#14	3.75	MA	7069	2068	10279	1789	13162	1471	15121	1209	18070	749	23689	362	20981
4E		MI	3534	2068	5681	1683	6936	1374	7777	1118	9044	664	10891	174	10090
12-#14	3.75	MA	6622	2068	9514	1813	12073	1503	13835	1229	16288	775	21126	268	19627
5L-3S		MI	3697	2068	6104	1670	7487	1364	8480	1102	10003	665	11989	256	10740
12-#14	3.75	MA	6133	2068	8692	1826	11091	1524	12582	1259	14552	791	18891	161	17835
6L-2S		MI	3976	2068	6696	1657	8236	1354	9386	1096	11222	657	13511	421	10837
12-#18	6.67	MA	8101	2686	13064	2237	16367	1828	18951	1448	23078	788	30789	-26	30258
5L-3S		MI	4414	2686	8285	2043	10176	1634	11696	1268	14280	627	16772	-121	16523
12-#18	6.67	MA	7360	2686	11650	2262	14643	1864	16751	1498	20034	813	26655	-244	25619
6L-2S		MI	4808	2686	9296	2024	11455	1622	13244	1263	16358	618	19260	173	18195
14-#10	2.47	MA	6432	1796	8587	1613	11135	1340	12754	1119	14943	751	19280	492	14800
4L-5S		MI	3215	1796	4666	1537	5712	1277	6364	1056	7173	698	8755	338	7141
14-#10	2.47	MA	6162	1796	8144	1627	10511	1359	12017	1132	13921	767	17815	443	14191
5L-4S		MI	3312	1796	4888	1528	6026	1264	6735	1050	7684	690	9422	393	7440
14-#10	2.47	MA	5862	1796	7667	1634	9941	1371	11316	1144	12925	778	16539	385	13638
6L-3S		MI	3422	1796	5136	1519	6348	1257	7146	1039	8246	688	10095	443	7505
14-#10	2.47	MA	5598	1796	7210	1644	9341	1379	10601	1161	11958	794	15222	350	12800
7L-2S		MI	3612	1796	5486	1510	6791	1249	7682	1033	8967	680	11040	537	7529
14-#11	3.03	MA	6456	1916	8947	1703	11443	1416	13109	1169	15354	765	19795	386	16893
5L-4S		MI	3439	1916	5313	1592	6511	1308	7292	1076	8410	676	10205	309	8686
14-#11	3.03	MA	6107	1916	8367	1712	10758	1431	12234	1190	14142	777	18239	313	16054
6L-3S		MI	3560	1916	5611	1581	6899	1301	7787	1064	9086	676	10994	368	8943
14-#11	3.03	MA	5799	1916	7812	1723	10029	1440	11389	1204	12964	796	16625	269	15004
7L-2S		MI	3769	1916	6030	1571	7429	1293	8428	1059	9948	668	12093	483	8987
14-#14	4.38	MA	7195	2200	10769	1896	13660	1563	15754	1268	18872	770	24704	262	23264
5L-4S		MI	3777	2200	6273	1766	7685	1435	8683	1157	10264	659	12414	144	11734
14-#14	4.38	MA	6737	2200	9947	1909	12678	1585	14501	1298	17136	786	22469	154	21459
6L-3S		MI	3926	2200	6696	1753	8236	1425	9386	1141	11222	661	13511	226	12440
14-#14	4.38	MA	6331	2200	9152	1925	11644	1599	13289	1318	15448	812	20148	89	19687
7L-2S		MI	4189	2200	7288	1739	8985	1415	10292	1135	12442	652	15034	391	12553
14-#18	7.78	MA	8384	2921	13839	2409	17411	1973	20100	1567	24542	804	32897	-256	31393
6L-3S		MI	4791	2921	9296	2190	11455	1742	13244	1337	16358	618	19260	-191	18819

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 36"

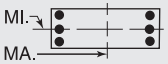
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.82	MA	6505	1871	8868	1674	11426	1393	13124	1154	15412	765	19879	439	16285
5E		MI	3367	1871	5016	1584	6155	1311	6900	1078	7893	695	9699	326	8124
16-#10	2.82	MA	6218	1871	8390	1681	10857	1405	12423	1166	14416	775	18604	382	15743
6L-4S		MI	3470	1871	5238	1575	6468	1298	7270	1072	8405	687	10366	382	8408
16-#10	2.82	MA	5967	1871	7934	1691	10256	1413	11708	1183	13449	791	17286	346	14898
7L-3S		MI	3570	1871	5486	1566	6791	1291	7682	1061	8967	685	11040	432	8518
16-#10	2.82	MA	5734	1871	7431	1707	9637	1428	10980	1191	12485	801	16010	299	14081
8L-2S		MI	3748	1871	5836	1557	7234	1284	8217	1055	9688	678	11984	525	8549
16-#11	3.47	MA	6528	2008	9245	1769	11869	1473	13577	1217	15951	774	20742	308	18593
6L-4S		MI	3612	2008	5732	1649	7041	1351	7933	1103	9273	673	11304	291	9847
16-#11	3.47	MA	6238	2008	8690	1780	11140	1483	12732	1231	14773	793	19128	264	17547
7L-3S		MI	3725	2008	6030	1639	7429	1343	8428	1091	9948	672	12093	350	10151
16-#11	3.47	MA	5963	2008	8078	1800	10386	1501	11856	1241	13599	804	17570	204	16372
8L-2S		MI	3925	2008	6448	1629	7959	1335	9068	1085	10811	665	13192	465	10203
16-#14	5.00	MA	7319	2333	11201	1992	14265	1646	16420	1337	19720	782	26047	147	25084
6L-4S		MI	4015	2333	6865	1849	8434	1496	9589	1196	11484	654	13936	114	13387
16-#14	5.00	MA	6943	2333	10406	2007	13231	1660	15208	1356	18032	808	23726	82	23301
7L-3S		MI	4150	2333	7288	1836	8985	1486	10292	1180	12442	656	15034	196	14141
16-#14	5.00	MA	6559	2333	9530	2035	12153	1685	13967	1371	16351	824	21488	-7	21464
8L-2S		MI	4401	2333	7881	1822	9735	1476	11198	1174	13662	647	16556	361	14267
18-#10	3.17	MA	6563	1946	9114	1728	11772	1440	13530	1188	15907	772	20668	378	17847
6L-5S		MI	3521	1946	5366	1631	6598	1346	7435	1100	8614	692	10644	315	9110
18-#10	3.17	MA	6325	1946	8657	1738	11172	1448	12816	1205	14940	788	19351	342	16996
7L-4S		MI	3616	1946	5588	1622	6911	1333	7806	1094	9126	684	11311	371	9382
18-#10	3.17	MA	6096	1946	8155	1754	10552	1463	12088	1213	13976	799	18074	295	16173
8L-3S		MI	3710	1946	5836	1612	7234	1325	8217	1083	9688	682	11984	421	9529
18-#10	3.17	MA	5807	1946	7718	1765	9978	1473	11355	1228	13025	815	16760	242	15328
9L-2S		MI	3881	1946	6186	1603	7677	1318	8753	1077	10409	675	12928	514	9566
18-#11	3.90	MA	6663	2099	9567	1838	12250	1525	14075	1258	16581	789	21632	259	20090
7L-4S		MI	3782	2099	6150	1706	7570	1393	8573	1130	10135	669	12403	273	11013
18-#11	3.90	MA	6393	2099	8956	1858	11497	1543	13199	1268	15408	801	20074	199	18909
8L-3S		MI	3887	2099	6448	1696	7959	1385	9068	1118	10811	669	13192	332	11358
18-#11	3.90	MA	6056	2099	8430	1872	10797	1555	12307	1285	14250	820	18465	133	17738
9L-2S		MI	4078	2099	6867	1686	8488	1377	9709	1112	11673	661	14291	447	11418
18-#14	5.63	MA	7584	2465	11660	2090	14818	1721	17127	1395	20616	803	27304	76	26915
7L-4S		MI	4248	2465	7457	1932	9183	1557	10495	1235	12704	649	15459	83	15048
18-#14	5.63	MA	7157	2465	10785	2118	13740	1746	15886	1410	18935	819	25066	-14	25001
8L-3S		MI	4372	2465	7881	1918	9735	1547	11198	1219	13662	651	16556	166	15843
20-#10	3.53	MA	6674	2021	9381	1784	12087	1482	13923	1227	16431	785	21415	339	19094
7L-5S		MI	3666	2021	5716	1678	7040	1380	7971	1122	9335	689	11588	304	10099
20-#10	3.53	MA	6449	2021	8878	1801	11468	1497	13195	1235	15467	796	20138	291	18266
8L-4S		MI	3760	2021	5938	1668	7354	1367	8341	1116	9847	682	12255	360	10359
20-#10	3.53	MA	6171	2021	8442	1812	10893	1508	12462	1250	14516	812	18825	238	17423
9L-3S		MI	3848	2021	6186	1659	7677	1360	8753	1105	10409	680	12928	410	10541
20-#10	3.53	MA	5913	2021	7987	1821	10330	1519	11755	1260	13547	821	17545	197	16453
10L-2S		MI	4013	2021	6535	1650	8119	1352	9288	1099	11130	672	13873	503	10583
20-#11	4.33	MA	6811	2191	9834	1915	12607	1585	14542	1295	17216	797	22578	194	21445
8L-4S		MI	3949	2191	6569	1764	8100	1435	9214	1157	10998	666	13503	256	12184
20-#11	4.33	MA	6489	2191	9308	1929	11908	1597	13650	1312	16058	816	20969	128	20270
9L-3S		MI	4046	2191	6867	1754	8488	1427	9709	1145	11673	665	14291	315	12564
20-#14	6.25	MA	7782	2597	12039	2201	15326	1807	17805	1449	21519	814	28644	-21	28522
8L-4S		MI	4477	2597	8049	2015	9932	1617	11401	1274	13924	644	16981	53	16715
22-#10	3.88	MA	6792	2095	9602	1848	12383	1531	14303	1257	16958	793	22203	287	20358
8L-5S		MI	3808	2095	6066	1724	7483	1414	8506	1144	10056	687	12532	293	11091
22-#10	3.88	MA	6526	2095	9166	1859	11809	1542	13569	1272	16007	809	20889	234	19518
9L-4S		MI	3901	2095	6288	1715	7797	1401	8876	1138	10568	679	13199	349	11340
22-#10	3.88	MA	6279	2095	8711	1867	11245	1553	12863	1282	15038	818	19609	193	18544
10L-3S		MI	3984	2095	6535	1706	8119	1394	9288	1127	11130	677	13873	399	11552

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
22-#11	4.77	MA	6910	2283	10186	1986	13018	1639	14993	1339	17867	813	23473	123	22801
9L-4S		MI	4113	2283	6988	1821	8630	1477	9854	1184	11860	662	14602	238	13359
24-#10	4.23	MA	6872	2170	9889	1905	12724	1576	14677	1294	17498	806	22954	230	21612
9L-5S		MI	3947	2170	6416	1771	7926	1449	9042	1165	10777	684	13477	282	12084
24-#10	4.23	MA	6636	2170	9435	1914	12161	1587	13970	1304	16529	815	21673	189	20621
10L-4S		MI	4040	2170	6638	1762	8239	1436	9412	1160	11289	676	14144	338	12324

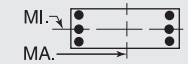
RECTANGULAR TIED COLUMNS 20" x 38"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.18	MA	6486	1609	8036	1486	10431	1248	11841	1060	13449	772	16816	672	8097
2E		MI	3211	1609	4502	1390	5448	1166	5981	988	6560	715	7665	575	3929
4-#18	2.11	MA	7360	1815	10147	1604	13015	1334	14921	1113	17554	758	22469	656	13989
2E		MI	3518	1815	5430	1499	6548	1244	7275	1034	8260	694	9548	486	6506
6-#10	1.00	MA	6337	1568	7534	1474	9901	1240	11254	1057	12711	781	15831	681	6978
2L-3S		MI	2951	1568	3904	1398	4783	1175	5223	1000	5580	738	6564	522	3445
6-#10	1.00	MA	5820	1568	6763	1488	8926	1254	10076	1070	11123	797	13634	600	6954
3L-2S		MI	3175	1568	4254	1389	5225	1168	5759	994	6301	730	7509	615	3432
6-#11	1.23	MA	6561	1619	8109	1498	10568	1258	12029	1067	13724	774	17212	674	8458
2L-3S		MI	2991	1619	4109	1417	4988	1187	5444	1004	5853	728	6842	473	4112
6-#11	1.23	MA	5953	1619	7174	1515	9385	1274	10598	1082	11797	794	14544	573	8410
3L-2S		MI	3251	1619	4527	1407	5517	1180	6084	999	6716	720	7941	588	4100
6-#14	1.78	MA	7104	1741	9373	1569	12123	1309	13887	1099	16204	767	20630	665	12009
2L-3S		MI	3104	1741	4502	1486	5448	1237	5981	1033	6560	719	7665	380	5667
6-#14	1.78	MA	6289	1741	8036	1593	10431	1331	11841	1119	13449	794	16816	516	11865
3L-2S		MI	3453	1741	5094	1473	6197	1227	6887	1027	7780	710	9187	545	5684
6-#18	3.16	MA	8344	2050	12483	1752	15970	1442	18495	1182	22366	749	29131	644	20799
2L-3S		MI	3373	2050	5430	1665	6548	1364	7275	1108	8260	693	9548	122	9229
6-#18	3.16	MA	7092	2050	10147	1793	13015	1480	14921	1216	17554	794	22469	372	20207
3L-2S		MI	3891	2050	6441	1646	7827	1352	8822	1103	10339	684	12036	416	9458
8-#9	1.05	MA	6405	1579	7630	1483	10045	1248	11440	1063	12971	782	16200	681	7335
2L-4S		MI	2923	1579	3818	1416	4685	1190	5098	1015	5415	742	6422	506	3611
8-#9	1.05	MA	6001	1579	7020	1495	9274	1259	10508	1073	11716	795	14463	618	7318
3E		MI	3031	1579	4014	1408	4941	1184	5425	1006	5861	740	6961	546	3609
8-#9	1.05	MA	5766	1579	6605	1506	8730	1269	9812	1087	10764	804	13311	578	7250
4L-2S		MI	3208	1579	4292	1401	5293	1177	5851	1001	6434	733	7719	620	3600
8-#10	1.34	MA	6710	1643	8304	1520	10876	1275	12433	1079	14298	778	18029	677	9234
2L-4S		MI	2980	1643	4007	1454	4903	1217	5347	1033	5739	737	6835	460	4457
8-#10	1.34	MA	6218	1643	7534	1535	9901	1288	11254	1092	12711	794	15831	596	9195
3E		MI	3111	1643	4254	1445	5225	1210	5759	1022	6301	735	7509	511	4475
8-#10	1.34	MA	5933	1643	7008	1549	9213	1302	10374	1110	11506	805	14371	544	9052
4L-2S		MI	3327	1643	4604	1435	5668	1202	6294	1016	7022	728	8453	604	4471
8-#11	1.64	MA	6997	1711	9044	1556	11751	1300	13460	1094	15650	771	19879	669	11193
2L-4S		MI	3022	1711	4229	1484	5129	1237	5589	1044	6040	725	7152	396	5290
8-#11	1.64	MA	6423	1711	8109	1573	10568	1316	12029	1109	13724	790	17212	568	11126
3E		MI	3176	1711	4527	1474	5517	1229	6084	1031	6716	724	7941	455	5336
8-#11	1.64	MA	6091	1711	7469	1590	9731	1332	10957	1130	12258	803	15426	504	10881
4L-2S		MI	3425	1711	4946	1464	6047	1222	6725	1026	7578	717	9040	570	5340
8-#14	2.37	MA	7692	1873	10710	1652	13814	1370	15933	1138	18958	762	24444	658	15912
2L-4S		MI	3153	1873	4671	1582	5646	1307	6184	1088	6821	712	8090	268	6929
8-#14	2.37	MA	6933	1873	9373	1676	12123	1392	13887	1158	16204	789	20630	510	15741
3E		MI	3363	1873	5094	1569	6197	1298	6887	1072	7780	714	9187	350	7374
8-#14	2.37	MA	6497	1873	8456	1700	10923	1415	12352	1189	14105	806	18062	417	14777
4L-2S		MI	3683	1873	5687	1556	6946	1288	7793	1066	9000	705	10710	515	7421

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

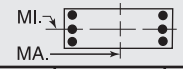


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#18	4.21	MA	8150	2286	12483	1940	15970	1588	18495	1285	22366	785	29131	360	27000
3E		MI	3780	2286	6441	1812	7827	1472	8822	1177	10339	684	12036	52	11884
8-#18	4.21	MA	7506	2286	10873	1981	13867	1625	15804	1337	18688	812	24594	193	23265
4L-2S		MI	4252	2286	7453	1793	9107	1460	10369	1172	12417	675	14524	346	12390
10-#10	1.67	MA	7071	1717	9075	1567	11850	1309	13612	1101	15885	775	20227	673	11487
2L-5S		MI	3034	1717	4135	1510	5032	1264	5512	1061	5948	742	7112	394	5248
10-#10	1.67	MA	6601	1717	8304	1581	10876	1323	12433	1114	14298	792	18029	592	11436
3L-4S		MI	3142	1717	4357	1500	5345	1251	5882	1055	6460	735	7779	449	5465
10-#10	1.67	MA	6336	1717	7778	1596	10188	1336	11552	1132	13093	803	16569	541	11285
4L-3S		MI	3267	1717	4604	1491	5668	1244	6294	1044	7022	733	8453	500	5497
10-#10	1.67	MA	6034	1717	7305	1609	9525	1355	10769	1145	12007	819	15015	493	10713
5L-2S		MI	3474	1717	4954	1482	6111	1237	6830	1038	7743	725	9397	593	5503
10-#11	2.05	MA	6873	1803	9044	1630	11751	1358	13460	1136	15650	787	19879	563	13842
3L-4S		MI	3211	1803	4648	1542	5659	1279	6230	1071	6903	722	8251	378	6463
10-#11	2.05	MA	6568	1803	8404	1647	10914	1374	12388	1157	14185	799	18093	500	13592
4L-3S		MI	3356	1803	4946	1532	6047	1272	6725	1058	7578	721	9040	437	6552
10-#11	2.05	MA	6212	1803	7834	1664	10107	1397	11434	1172	12862	819	16197	439	12645
5L-2S		MI	3594	1803	5365	1522	6577	1264	7366	1053	8441	713	10139	552	6570
10-#14	2.96	MA	7549	2006	10710	1759	13814	1453	15933	1197	18958	784	24444	503	19622
3L-4S		MI	3423	2006	5263	1665	6395	1368	7090	1127	8041	707	9612	237	8544
10-#14	2.96	MA	7158	2006	9793	1783	12615	1476	14398	1228	16859	801	21876	411	18639
4L-3S		MI	3606	2006	5687	1652	6946	1358	7793	1111	9000	709	10710	320	9077
10-#14	2.96	MA	6662	2006	8981	1807	11458	1508	13031	1249	14965	828	19155	320	17115
5L-2S		MI	3906	2006	6279	1638	7695	1349	8699	1105	10219	700	12232	485	9146
10-#18	5.26	MA	8608	2521	13209	2128	16821	1733	19378	1406	23500	803	31256	181	30013
4L-3S		MI	4173	2521	7453	1960	9107	1580	10369	1246	12417	674	14524	-18	14493
10-#18	5.26	MA	7778	2521	11781	2169	14791	1789	16978	1440	20175	848	26468	12	26497
5L-2S		MI	4607	2521	8464	1940	10386	1568	11916	1241	14496	665	17012	276	15313
12-#10	2.01	MA	6970	1792	9075	1628	11850	1357	13612	1136	15885	789	20227	588	13678
3L-5S		MI	3198	1792	4485	1556	5475	1299	6047	1083	6669	739	8057	383	6220
12-#10	2.01	MA	6724	1792	8549	1643	11162	1370	12731	1154	14680	800	18767	537	13521
4E		MI	3300	1792	4707	1547	5788	1286	6418	1077	7181	732	8724	438	6472
12-#10	2.01	MA	6427	1792	8075	1656	10500	1390	11948	1167	13594	816	17213	489	12940
5L-3S		MI	3418	1792	4954	1538	6111	1278	6830	1066	7743	730	9397	489	6515
12-#10	2.01	MA	6089	1792	7567	1664	9890	1402	11204	1179	12537	827	15860	432	12318
6L-2S		MI	3619	1792	5304	1529	6554	1271	7365	1060	8464	722	10342	582	6528
12-#11	2.46	MA	7026	1895	9339	1705	12097	1416	13819	1184	16111	796	20761	495	16308
4E		MI	3403	1895	5066	1599	6188	1322	6870	1097	7765	718	9350	361	7605
12-#11	2.46	MA	6677	1895	8769	1721	11290	1439	12865	1199	14789	815	18865	434	15355
5L-3S		MI	3535	1895	5365	1589	6577	1314	7366	1085	8441	717	10139	420	7764
12-#11	2.46	MA	6281	1895	8151	1730	10555	1454	11959	1214	13501	828	17214	362	14518
6L-2S		MI	3757	1895	5783	1579	7106	1306	8006	1080	9303	710	11238	534	7793
12-#14	3.55	MA	7789	2138	11130	1866	14306	1536	16444	1267	19614	796	25690	404	22506
4E		MI	3675	2138	5855	1748	7144	1429	7996	1166	9261	702	11135	207	10174
12-#14	3.55	MA	7303	2138	10318	1890	13150	1569	15077	1287	17719	823	22969	313	20994
5L-3S		MI	3841	2138	6279	1735	7695	1419	8699	1150	10219	704	12232	290	10778
12-#14	3.55	MA	6776	2138	9435	1903	12107	1591	13745	1318	15874	840	20599	208	19154
6L-2S		MI	4125	2138	6871	1721	8444	1409	9605	1144	11439	695	13755	455	10866
12-#18	6.32	MA	8895	2756	14117	2316	17745	1897	20552	1509	24987	839	33130	0	33215
5L-3S		MI	4557	2756	8464	2107	10386	1688	11916	1315	14496	665	17012	-88	16835
12-#18	6.32	MA	8037	2756	12595	2340	15912	1934	18213	1561	21747	866	28945	-192	28072
6L-2S		MI	4958	2756	9475	2087	11665	1676	13464	1310	16574	656	19500	206	18233
14-#10	2.34	MA	7099	1867	9319	1689	12137	1405	13910	1176	16268	797	20965	533	15760
4L-5S		MI	3358	1867	4835	1603	5917	1333	6583	1105	7390	737	9001	372	7197
14-#10	2.34	MA	6806	1867	8846	1703	11475	1424	13127	1189	15181	813	19410	485	15169
5L-4S		MI	3454	1867	5057	1594	6231	1320	6953	1099	7902	729	9668	427	7478
14-#10	2.34	MA	6484	1867	8338	1710	10864	1436	12383	1201	14124	824	18058	428	14559
6L-3S		MI	3567	1867	5304	1585	6554	1313	7365	1088	8464	727	10342	477	7530

RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.34	MA	6199	1867	7852	1720	10226	1444	11616	1219	13097	841	16665	394	13725
7L-2S		MI	3760	1867	5654	1576	6996	1305	7900	1082	9185	719	11286	571	7551
14-#11	2.87	MA	7125	1986	9704	1779	12473	1481	14296	1226	16715	812	21532	429	18067
5L-4S		MI	3582	1986	5485	1657	6718	1364	7511	1124	8628	715	10450	343	8756
14-#11	2.87	MA	6749	1986	9087	1788	11739	1497	13390	1241	15428	824	19882	357	17223
6L-3S		MI	3705	1986	5783	1646	7106	1356	8006	1112	9303	714	11238	402	8974
14-#11	2.87	MA	6417	1986	8496	1800	10962	1506	12468	1263	14177	844	18175	314	16080
7L-2S		MI	3917	1986	6202	1636	7636	1348	8647	1107	10166	707	12337	516	9013
14-#14	4.14	MA	7920	2271	11655	1973	14841	1630	17122	1326	20474	818	26783	306	24873
5L-4S		MI	3919	2271	6447	1831	7893	1490	8902	1205	10481	698	12657	177	11815
14-#14	4.14	MA	7426	2271	10772	1985	13798	1652	15790	1357	18628	835	24413	201	23018
6L-3S		MI	4071	2271	6871	1817	8444	1480	9605	1189	11439	699	13755	259	12479
14-#14	4.14	MA	6989	2271	9926	2002	12687	1665	14503	1378	16835	862	21955	138	21196
7L-2S		MI	4339	2271	7463	1804	9193	1470	10511	1183	12659	690	15277	425	12583
14-#18	7.37	MA	9195	2992	14931	2487	18867	2043	21786	1630	26559	857	35607	-204	34328
6L-3S		MI	4934	2992	9475	2254	11665	1797	13464	1385	16574	655	19500	-158	19142
16-#10	2.67	MA	7175	1942	9616	1749	12449	1458	14306	1211	16769	811	21608	481	17401
5E		MI	3510	1942	5185	1650	6360	1367	7118	1127	8111	734	9945	361	8179
16-#10	2.67	MA	6866	1942	9108	1757	11839	1470	13562	1223	15711	822	20256	425	16801
6L-4S		MI	3605	1942	5407	1641	6674	1354	7489	1121	8623	726	10612	416	8470
16-#10	2.67	MA	6596	1942	8623	1767	11201	1479	12795	1241	14684	838	18863	390	15959
7L-3S		MI	3716	1942	5654	1631	6996	1347	7900	1110	9185	724	11286	466	8543
16-#10	2.67	MA	6343	1942	8089	1784	10542	1494	12022	1249	13661	849	17510	344	15125
8L-2S		MI	3896	1942	6004	1622	7439	1340	8436	1104	9906	716	12230	560	8571
16-#11	3.28	MA	7201	2078	10022	1845	12922	1539	14820	1268	17355	821	22549	353	19929
6L-4S		MI	3756	2078	5904	1714	7248	1406	8152	1151	9490	711	11549	325	9915
16-#11	3.28	MA	6889	2078	9431	1857	12145	1548	13899	1290	16103	840	20842	309	18790
7L-3S		MI	3870	2078	6202	1704	7636	1398	8647	1139	10166	711	12337	384	10182
16-#11	3.28	MA	6591	2078	8781	1877	11344	1567	12958	1299	14857	853	19190	251	17589
8L-2S		MI	4074	2078	6621	1694	8165	1390	9287	1134	11028	703	13436	499	10230
16-#14	4.74	MA	8052	2403	12109	2068	15490	1713	17836	1396	21383	830	28227	194	26882
6L-4S		MI	4157	2403	7040	1913	8642	1551	9808	1244	11701	693	14179	147	13466
16-#14	4.74	MA	7647	2403	11263	2085	14378	1726	16549	1416	19589	857	25770	131	25048
7L-3S		MI	4296	2403	7463	1900	9193	1541	10511	1228	12659	694	15277	229	14180
16-#14	4.74	MA	7229	2403	10332	2113	13231	1752	15213	1431	17802	874	23396	44	23207
8L-2S		MI	4551	2403	8055	1887	9942	1531	11417	1222	13879	685	16800	394	14298
18-#10	3.01	MA	7238	2016	9879	1804	12813	1505	14741	1245	17299	819	22453	421	19042
6L-5S		MI	3665	2016	5535	1697	6803	1402	7654	1148	8832	731	10890	349	9164
18-#10	3.01	MA	6981	2016	9393	1814	12175	1513	13974	1263	16271	835	21060	386	18193
7L-4S		MI	3760	2016	5757	1687	7116	1389	8024	1143	9344	723	11557	405	9442
18-#10	3.01	MA	6733	2016	8859	1831	11517	1528	13201	1271	15248	846	19707	340	17353
8L-3S		MI	3857	2016	6004	1678	7439	1381	8436	1132	9906	721	12230	455	9556
18-#10	3.01	MA	6422	2016	8392	1842	10907	1539	12422	1286	14239	863	18318	287	16433
9L-2S		MI	4031	2016	6354	1669	7882	1374	8971	1126	10627	714	13175	549	9589
18-#11	3.69	MA	7346	2170	10366	1914	13328	1591	15330	1317	18030	837	23510	304	21500
7L-4S		MI	3926	2170	6323	1771	7777	1448	8792	1178	10353	708	12648	307	11080
18-#11	3.69	MA	7053	2170	9716	1935	12527	1609	14389	1326	16783	849	21857	246	20291
8L-3S		MI	4033	2170	6621	1761	8165	1440	9287	1166	11028	707	13436	366	11389
18-#11	3.69	MA	6690	2170	9153	1948	11784	1621	13441	1344	15553	869	20155	180	19093
9L-2S		MI	4228	2170	7039	1751	8695	1433	9928	1161	11891	700	14536	481	11445
18-#14	5.33	MA	8282	2536	12600	2167	16070	1787	18595	1455	22344	852	29584	124	28901
7L-4S		MI	4390	2536	7632	1996	9391	1611	10714	1283	12921	688	15702	117	15124
18-#14	5.33	MA	7872	2536	11669	2196	14922	1813	17259	1470	20557	869	27210	37	27051
8L-3S		MI	4518	2536	8055	1983	9942	1602	11417	1267	13879	689	16800	199	15883

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

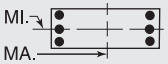
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	3.34	MA	7356	2091	10164	1860	13150	1547	15153	1285	17859	832	23258	382	20427
7L-5S		MI	3810	2091	5885	1743	7245	1436	8189	1170	9553	728	11834	338	10152
20-#10	3.34	MA	7112	2091	9630	1877	12492	1563	14380	1293	16835	843	21905	336	19581
8L-4S		MI	3904	2091	6107	1734	7559	1423	8560	1165	10065	721	12501	394	10418
20-#10	3.34	MA	6813	2091	9162	1888	11881	1573	13601	1308	15826	860	20516	283	18664
9L-3S		MI	3995	2091	6354	1725	7882	1416	8971	1154	10627	719	13175	444	10567
20-#10	3.34	MA	6535	2091	8679	1897	11283	1585	12850	1318	14786	868	19159	243	17671
10L-2S		MI	4163	2091	6704	1716	8324	1408	9507	1148	11348	711	14119	537	10606
20-#11	4.11	MA	7502	2262	10651	1992	13710	1651	15820	1353	18710	846	24525	241	22994
8L-4S		MI	4093	2262	6741	1829	8307	1490	9433	1205	11215	704	13747	289	12250
20-#11	4.11	MA	7156	2262	10089	2006	12967	1664	14872	1371	17480	865	22823	175	21790
9L-3S		MI	4193	2262	7039	1819	8695	1483	9928	1193	11891	704	14536	348	12597
20-#11	4.11	MA	6832	2262	9501	2016	12239	1677	13958	1383	16232	877	21166	124	20539
10L-2S		MI	4381	2262	7458	1808	9225	1475	10568	1188	12753	696	15635	463	12659
20-#14	5.92	MA	8496	2668	13006	2279	16614	1874	19305	1509	23311	864	31024	30	30895
8L-4S		MI	4620	2668	8224	2079	10140	1672	11620	1322	14140	683	17224	87	16789
22-#10	3.68	MA	7481	2166	10400	1924	13466	1597	15559	1315	18423	840	24103	332	21809
8L-5S		MI	3953	2166	6235	1790	7688	1470	8725	1192	10274	725	12778	327	11143
22-#10	3.68	MA	7194	2166	9933	1935	12856	1608	14780	1330	17413	857	22713	279	20894
9L-4S		MI	4046	2166	6457	1781	8002	1457	9095	1187	10786	718	13445	383	11398
22-#10	3.68	MA	6928	2166	9450	1944	12258	1619	14029	1340	16373	866	21357	239	19897
10L-3S		MI	4132	2166	6704	1772	8324	1450	9507	1176	11348	716	14119	433	11579
22-#10	3.68	MA	6674	2166	8976	1954	11655	1630	13290	1351	15337	880	20040	191	18879
11L-2S		MI	4294	2166	7054	1762	8767	1443	10042	1170	12069	708	15063	526	11623
22-#11	4.52	MA	7608	2354	11024	2063	14150	1706	16303	1398	19407	862	25491	170	24487
9L-4S		MI	4258	2354	7160	1886	8836	1533	10073	1232	12078	701	14846	271	13424
22-#11	4.52	MA	7300	2354	10436	2073	13422	1719	15389	1410	18159	873	23833	119	23231
10L-3S		MI	4352	2354	7458	1876	9225	1525	10568	1220	12753	700	15635	331	13804
24-#10	4.01	MA	7566	2241	10703	1982	13831	1642	15958	1352	19000	854	24911	275	23125
9L-5S		MI	4093	2241	6585	1837	8131	1505	9260	1214	10995	723	13723	316	12135
24-#10	4.01	MA	7311	2241	10220	1991	13232	1654	15208	1362	17960	863	23554	235	22123
10L-4S		MI	4186	2241	6807	1828	8444	1492	9630	1209	11507	715	14390	372	12381
24-#10	4.01	MA	7069	2241	9747	2000	12630	1664	14469	1373	16924	877	22237	187	21101
11L-3S		MI	4267	2241	7054	1818	8767	1484	10042	1197	12069	713	15063	422	12590
24-#11	4.93	MA	7756	2446	11371	2131	14605	1761	16820	1437	20085	870	26501	114	25923
10L-4S		MI	4420	2446	7579	1944	9366	1575	10714	1259	12940	697	15945	254	14601

RECTANGULAR TIED COLUMNS 20" x 40"

4-#14	1.13	MA	7141	1679	8716	1561	11369	1312	12917	1116	14652	816	18304	711	8583
2E		MI	3354	1679	4677	1454	5656	1221	6201	1036	6777	753	7908	609	3949
4-#18	2.00	MA	8086	1885	10963	1680	14120	1398	16196	1168	19023	802	24323	695	14853
2E		MI	3663	1885	5610	1562	6758	1298	7495	1081	8476	731	9789	518	6535
6-#11	1.17	MA	7220	1690	8792	1573	11512	1322	13114	1123	14941	819	18720	713	8963
2L-3S		MI	3132	1690	4281	1482	5194	1243	5663	1053	6070	766	7086	507	4134
6-#11	1.17	MA	6569	1690	7800	1591	10256	1338	11595	1138	12896	839	15889	613	8916
3L-2S		MI	3394	1690	4699	1472	5724	1235	6303	1047	6933	759	8185	621	4119
6-#14	1.69	MA	7806	1812	10136	1644	13165	1373	15090	1155	17578	811	22354	704	12738
2L-3S		MI	3245	1812	4677	1551	5656	1292	6201	1081	6777	757	7908	413	5698
6-#14	1.69	MA	6930	1812	8716	1669	11369	1396	12917	1176	14652	839	18304	558	12594
3L-2S		MI	3598	1812	5269	1537	6405	1282	7107	1075	7997	748	9430	579	5708
6-#18	3.00	MA	9145	2121	13446	1827	17261	1506	19995	1238	24138	793	31405	683	22095
2L-3S		MI	3513	2121	5610	1729	6758	1418	7495	1155	8476	731	9789	155	9310
6-#18	3.00	MA	7796	2121	10963	1869	14120	1545	16196	1273	19023	840	24323	415	21503
3L-2S		MI	4037	2121	6621	1709	8037	1406	9042	1150	10555	722	12277	449	9491
8-#9	1.00	MA	7050	1650	8281	1558	10953	1312	12485	1118	14137	826	17640	720	7767
2L-4S		MI	3064	1650	3985	1482	4890	1246	5317	1064	5633	781	6668	540	3630

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis



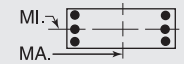
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#9	1.00	MA	6617	1650	7634	1570	10136	1323	11496	1129	12806	840	15797	658	7750
3E		MI	3173	1650	4182	1474	5146	1240	5643	1055	6079	779	7208	581	3625
8-#9	1.00	MA	6366	1650	7195	1582	9561	1334	10759	1144	11798	849	14582	618	7682
4L-2S		MI	3351	1650	4460	1467	5498	1234	6069	1050	6652	772	7966	654	3615
8-#10	1.27	MA	7379	1713	8997	1595	11836	1339	13539	1135	15545	822	19581	716	9783
2L-4S		MI	3121	1713	4176	1519	5108	1273	5565	1082	5957	776	7081	494	4482
8-#10	1.27	MA	6851	1713	8180	1610	10802	1353	12289	1148	13862	839	17250	636	9744
3E		MI	3254	1713	4423	1510	5431	1266	5977	1071	6519	774	7755	545	4495
8-#10	1.27	MA	6546	1713	7623	1625	10073	1366	11356	1167	12586	851	15709	585	9600
4L-2S		MI	3470	1713	4773	1501	5873	1258	6513	1065	7240	767	8699	638	4488
8-#11	1.56	MA	7690	1782	9785	1631	12768	1364	14633	1150	16985	815	21551	708	11867
2L-4S		MI	3163	1782	4401	1549	5336	1293	5808	1092	6257	763	7397	430	5324
8-#11	1.56	MA	7073	1782	8792	1648	11512	1380	13114	1165	14941	835	18720	608	11800
3E		MI	3318	1782	4699	1539	5724	1285	6303	1080	6933	763	8185	489	5361
8-#11	1.56	MA	6717	1782	8114	1666	10625	1397	11979	1187	13387	849	16835	545	11555
4L-2S		MI	3569	1782	5118	1529	6254	1277	6944	1074	7795	755	9284	604	5361
8-#14	2.25	MA	8439	1944	11556	1727	14962	1434	17262	1194	20503	806	26405	697	16884
2L-4S		MI	3293	1944	4846	1647	5854	1362	6404	1136	7038	751	8333	301	7017
8-#14	2.25	MA	7622	1944	10136	1752	13165	1457	15090	1215	17578	834	22354	551	16713
3E		MI	3505	1944	5269	1633	6405	1352	7107	1120	7997	752	9430	383	7408
8-#14	2.25	MA	7154	1944	9164	1777	11894	1480	13462	1246	15352	852	19643	459	15820
4L-2S		MI	3829	1944	5861	1620	7154	1343	8013	1114	9216	743	10953	549	7447
8-#18	4.00	MA	8932	2356	13446	2016	17261	1653	19995	1342	24138	831	31405	403	28728
3E		MI	3922	2356	6621	1876	8037	1526	9042	1224	10555	721	12277	85	12025
8-#18	4.00	MA	8239	2356	11739	2058	15030	1692	17141	1395	20235	860	26612	238	24867
4L-2S		MI	4400	2356	7632	1856	9317	1514	10589	1219	12633	712	14765	379	12425
10-#10	1.59	MA	7766	1788	9814	1642	12869	1373	14790	1157	17229	820	21912	712	12173
2L-5S		MI	3174	1788	4303	1575	5237	1320	5731	1109	6166	781	7358	428	5305
10-#10	1.59	MA	7261	1788	8997	1657	11836	1387	13539	1170	15545	837	19581	632	12122
3L-4S		MI	3284	1788	4525	1566	5551	1307	6101	1104	6678	774	8026	483	5493
10-#10	1.59	MA	6977	1788	8440	1671	11107	1401	12607	1189	14269	848	18040	581	11971
4L-3S		MI	3410	1788	4773	1557	5873	1300	6513	1093	7240	771	8699	534	5519
10-#10	1.59	MA	6651	1788	7936	1685	10406	1420	11778	1202	13119	865	16397	534	11421
5L-2S		MI	3619	1788	5123	1548	6316	1293	7048	1087	7961	764	9643	627	5521
10-#11	1.95	MA	7556	1874	9785	1706	12768	1422	14633	1192	16985	832	21551	603	14685
3L-4S		MI	3353	1874	4820	1607	5865	1335	6449	1119	7120	760	8496	412	6524
10-#11	1.95	MA	7228	1874	9107	1723	11881	1439	13497	1214	15432	845	19666	540	14435
4L-3S		MI	3499	1874	5118	1597	6254	1327	6944	1107	7795	759	9284	471	6579
10-#11	1.95	MA	6843	1874	8498	1740	11026	1462	12487	1230	14032	865	17661	481	13487
5L-2S		MI	3740	1874	5537	1587	6783	1319	7585	1101	8658	752	10383	586	6593
10-#14	2.81	MA	8283	2077	11556	1835	14962	1518	17262	1254	20503	829	26405	544	20837
3L-4S		MI	3564	2077	5438	1730	6603	1423	7310	1175	8258	746	9855	271	8629
10-#14	2.81	MA	7862	2077	10584	1859	13690	1541	15635	1285	18277	847	23693	452	19930
4L-3S		MI	3749	2077	5861	1716	7154	1413	8013	1159	9216	747	10953	353	9113
10-#14	2.81	MA	7326	2077	9717	1883	12465	1574	14187	1307	16270	875	20815	364	18250
5L-2S		MI	4054	2077	6453	1703	7903	1404	8919	1153	10436	738	12475	518	9174
10-#18	5.00	MA	9419	2592	14222	2205	18171	1800	20939	1465	25350	851	33694	226	32041
4L-3S		MI	4315	2592	7632	2023	9317	1634	10589	1293	12633	712	14765	15	14717
10-#18	5.00	MA	8521	2592	12710	2248	16018	1857	18395	1500	21824	898	28625	61	28417
5L-2S		MI	4756	2592	8643	2004	10596	1622	12136	1288	14712	703	17253	309	15350
12-#10	1.90	MA	7658	1863	9814	1704	12869	1421	14790	1192	17229	834	21912	628	14501
3L-5S		MI	3339	1863	4653	1622	5680	1355	6266	1131	6887	778	8303	417	6276
12-#10	1.90	MA	7393	1863	9257	1718	12141	1435	13857	1211	15952	845	20371	577	14344
4E		MI	3442	1863	4875	1613	5993	1342	6636	1126	7399	771	8970	472	6501

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

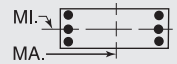


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#10	1.90	MA	7073	1863	8753	1731	11440	1455	13028	1224	14803	862	18728	530	13787
5L-3S		MI	3562	1863	5123	1604	6316	1334	7048	1115	7961	769	9643	523	6538
12-#10	1.90	MA	6711	1863	8214	1739	10789	1467	12241	1237	13684	873	17299	475	13108
6L-2S		MI	3764	1863	5473	1595	6759	1327	7584	1109	8682	761	10588	616	6549
12-#11	2.34	MA	7719	1965	10099	1781	13136	1481	15016	1241	17477	842	22498	536	17318
4E		MI	3537	1965	5239	1664	6395	1377	7090	1146	7982	757	9595	394	7676
12-#11	2.34	MA	7342	1965	9491	1797	12282	1504	14006	1257	16076	862	20492	476	16367
5L-3S		MI	3679	1965	5537	1654	6783	1369	7585	1134	8658	756	10383	453	7793
12-#11	2.34	MA	6918	1965	8836	1806	11498	1519	13046	1272	14713	875	18747	406	15534
6L-2S		MI	3904	1965	5955	1644	7313	1362	8225	1128	9520	748	11483	568	7817
12-#14	3.38	MA	8539	2209	12004	1942	15487	1602	17807	1324	21203	842	27743	445	24045
4E		MI	3816	2209	6030	1812	7352	1484	8216	1214	9478	741	11378	241	10256
12-#14	3.38	MA	8014	2209	11137	1966	14262	1635	16359	1346	19195	870	24865	357	22369
5L-3S		MI	3985	2209	6453	1799	7903	1474	8919	1198	10436	742	12475	323	10815
12-#14	3.38	MA	7449	2209	10200	1979	13147	1657	14983	1367	17240	888	22358	254	20488
6L-2S		MI	4273	2209	7046	1786	8652	1464	9825	1192	11656	733	13998	488	10896
12-#18	6.00	MA	9720	2827	15192	2395	19159	1965	22194	1569	26939	889	35707	49	35558
5L-3S		MI	4699	2827	8643	2170	10596	1742	12136	1363	14712	702	17253	-55	17144
12-#18	6.00	MA	8796	2827	13563	2418	17217	2004	19715	1623	23505	918	31289	-142	30605
6L-2S		MI	5109	2827	9654	2151	11875	1730	13684	1358	16790	693	19741	239	18270
14-#10	2.22	MA	7795	1938	10074	1765	13175	1469	15107	1233	17636	842	22702	573	16720
4L-5S		MI	3499	1938	5003	1669	6122	1389	6801	1153	7608	776	9247	406	7252
14-#10	2.22	MA	7480	1938	9570	1778	12474	1489	14278	1246	16486	859	21059	526	16154
5L-4S		MI	3597	1938	5225	1660	6436	1376	7172	1148	8120	768	9914	461	7508
14-#10	2.22	MA	7134	1938	9032	1786	11823	1501	13491	1259	15367	871	19630	471	15485
6L-3S		MI	3710	1938	5473	1650	6759	1369	7584	1137	8682	766	10588	512	7554
14-#10	2.22	MA	6830	1938	8517	1796	11146	1509	12673	1276	14280	888	18161	437	14648
7L-2S		MI	3906	1938	5823	1641	7201	1361	8119	1131	9403	758	11532	605	7572
14-#11	2.73	MA	7823	2057	10483	1854	13538	1547	15525	1284	18121	858	23324	471	19249
5L-4S		MI	3724	2057	5657	1722	6925	1419	7730	1173	8845	753	10694	376	8825
14-#11	2.73	MA	7419	2057	9828	1864	12753	1562	14565	1299	16758	871	21578	401	18406
6L-3S		MI	3849	2057	5955	1711	7313	1411	8225	1161	9520	752	11483	436	9003
14-#11	2.73	MA	7064	2057	9203	1876	11931	1572	13581	1320	15433	891	19778	358	17168
7L-2S		MI	4064	2057	6374	1701	7843	1404	8866	1155	10383	745	12582	550	9038
14-#14	3.94	MA	8675	2342	12557	2049	16058	1696	18532	1384	22120	865	28915	350	26489
5L-4S		MI	4060	2342	6622	1895	8101	1545	9122	1253	10698	736	12900	211	11895
14-#14	3.94	MA	8144	2342	11620	2062	14943	1718	17155	1406	20165	883	26409	247	24592
6L-3S		MI	4216	2342	7046	1882	8652	1535	9825	1237	11656	737	13998	293	12517
14-#14	3.94	MA	7676	2342	10723	2079	13764	1732	15757	1437	18265	911	23817	185	22727
7L-2S		MI	4489	2342	7638	1868	9401	1525	10731	1231	12876	728	15520	458	12613
14-#18	7.00	MA	10037	3063	16046	2565	20358	2112	23514	1692	28620	909	38371	-154	37353
6L-3S		MI	5076	3063	9654	2317	11875	1851	13684	1432	16790	693	19741	-125	19462
16-#10	2.54	MA	7875	2012	10387	1825	13507	1523	15529	1268	18170	856	23390	523	18525
5E		MI	3652	2012	5353	1716	6565	1423	7337	1175	8329	773	10191	395	8232
16-#10	2.54	MA	7543	2012	9849	1833	12856	1535	14742	1281	17051	868	21961	467	17863
6L-4S		MI	3748	2012	5575	1706	6879	1410	7707	1170	8841	765	10859	450	8515
16-#10	2.54	MA	7254	2012	9335	1843	12180	1544	13924	1298	15964	885	20492	433	17018
7L-3S		MI	3861	2012	5823	1697	7201	1403	8119	1159	9403	763	11532	500	8568
16-#10	2.54	MA	6981	2012	8769	1860	11483	1560	13105	1306	14881	896	19063	388	16184
8L-2S		MI	4044	2012	6173	1688	7644	1396	8654	1153	10124	755	12476	594	8593
16-#11	3.12	MA	7904	2149	10821	1921	14009	1604	16084	1326	18803	868	24409	397	21277
6L-4S		MI	3899	2149	6076	1779	7454	1461	8371	1200	9707	750	11793	359	9982
16-#11	3.12	MA	7569	2149	10195	1933	13186	1614	15099	1347	17478	888	22610	354	20044
7L-3S		MI	4016	2149	6374	1769	7843	1454	8866	1187	10383	749	12582	418	10213
16-#11	3.12	MA	7247	2149	9506	1954	12338	1633	14102	1357	16158	901	20863	297	18821
8L-2S		MI	4222	2149	6793	1759	8372	1446	9506	1182	11245	742	13681	532	10256
16-#14	4.50	MA	8815	2474	13040	2145	16739	1779	19328	1445	23090	878	30459	240	28696
6L-4S		MI	4299	2474	7214	1978	8850	1606	10028	1292	11917	731	14423	180	13543

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

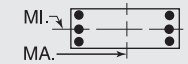


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#14	4.50	MA	8380	2474	12143	2162	15560	1792	17929	1476	21191	906	27867	178	26819
7L-3S		MI	4442	2474	7638	1965	9401	1596	10731	1276	12876	732	15520	263	14219
16-#14	4.50	MA	7928	2474	11156	2191	14344	1819	16501	1490	19298	924	25358	93	24927
8L-2S		MI	4702	2474	8230	1951	10150	1586	11637	1270	14096	723	17043	428	14329
18-#10	2.86	MA	7942	2087	10666	1880	13890	1570	15992	1303	18734	865	24292	463	20240
6L-5S		MI	3802	2087	5703	1762	7008	1458	7872	1197	9050	770	11136	384	9217
18-#10	2.86	MA	7667	2087	10152	1890	13214	1578	15174	1320	17647	882	22823	429	19388
7L-4S		MI	3904	2087	5925	1753	7321	1445	8243	1192	9562	762	11803	439	9501
18-#10	2.86	MA	7399	2087	9586	1907	12517	1594	14355	1328	16564	893	21394	384	18547
8L-3S		MI	4003	2087	6173	1744	7644	1437	8654	1180	10124	760	12476	489	9581
18-#10	2.86	MA	7066	2087	9088	1918	11871	1605	13530	1344	15496	910	19929	331	17551
9L-2S		MI	4179	2087	6523	1735	8087	1430	9190	1175	10845	753	13421	583	9612
18-#11	3.51	MA	8059	2241	11188	1991	14442	1656	16618	1374	19523	885	25441	349	22920
7L-4S		MI	4069	2241	6495	1836	7984	1504	9011	1227	10570	746	12892	341	11146
18-#11	3.51	MA	7742	2241	10499	2011	13593	1675	15621	1384	18203	898	23695	292	21690
8L-3S		MI	4179	2241	6793	1826	8372	1496	9506	1214	11245	746	13681	400	11421
18-#11	3.51	MA	7353	2241	9898	2025	12806	1688	14617	1403	16901	918	21900	226	20469
9L-2S		MI	4378	2241	7211	1816	8902	1488	10147	1209	12108	738	14780	514	11472
18-#14	5.06	MA	9060	2606	13563	2244	17357	1853	20102	1515	24116	901	31917	171	30910
7L-4S		MI	4533	2606	7806	2061	9599	1666	10934	1331	13137	726	15945	150	15199
18-#14	5.06	MA	8617	2606	12576	2273	16141	1880	18673	1529	22223	919	29408	86	29009
8L-3S		MI	4665	2606	8230	2047	10150	1657	11637	1315	14096	727	17043	232	15921
18-#14	5.06	MA	8102	2606	11721	2293	15012	1898	17234	1554	20356	947	26824	-9	26792
9L-2S		MI	4913	2606	8822	2034	10899	1647	12543	1309	15316	718	18565	398	16043
20-#10	3.17	MA	8068	2162	10969	1936	14248	1612	16424	1342	19331	879	25154	425	21757
7L-5S		MI	3955	2162	6053	1809	7450	1492	8408	1219	9771	767	12080	373	10204
20-#10	3.17	MA	7804	2162	10403	1954	13551	1628	15605	1350	18248	891	23725	380	20911
8L-4S		MI	4049	2162	6275	1800	7764	1479	8778	1214	10283	759	12747	428	10476
20-#10	3.17	MA	7484	2162	9905	1964	12905	1639	14781	1366	17180	907	22260	328	19917
9L-3S		MI	4142	2162	6523	1791	8087	1472	9190	1202	10845	757	13421	478	10594
20-#10	3.17	MA	7186	2162	9394	1973	12272	1651	13986	1376	16068	916	20827	289	18905
10L-2S		MI	4313	2162	6873	1781	8530	1464	9725	1197	11566	750	14365	572	10629
20-#11	3.90	MA	8223	2333	11492	2069	14849	1717	17140	1411	20248	894	26526	287	24559
8L-4S		MI	4237	2333	6913	1894	8514	1546	9652	1254	11432	743	13991	323	12314
20-#11	3.90	MA	7852	2333	10891	2082	14062	1730	16135	1430	18946	914	24731	222	23332
9L-3S		MI	4340	2333	7211	1884	8902	1538	10147	1241	12108	742	14780	382	12628
20-#11	3.90	MA	7504	2333	10268	2093	13290	1744	15168	1442	17610	925	22980	172	22009
10L-2S		MI	4532	2333	7630	1873	9431	1530	10788	1236	12970	735	15879	497	12687
20-#14	5.63	MA	9284	2739	13996	2356	17937	1941	20846	1568	25148	914	33459	79	33091
8L-4S		MI	4763	2739	8399	2143	10348	1727	11840	1370	14357	721	17468	120	16862
20-#14	5.63	MA	8797	2739	13141	2376	16808	1959	19406	1593	23281	942	30875	-15	30793
9L-3S		MI	4885	2739	8822	2130	10899	1718	12543	1354	15316	722	18565	202	17624
22-#10	3.49	MA	8199	2237	11221	2000	14585	1663	16856	1372	19931	888	26056	376	23274
8L-5S		MI	4098	2237	6403	1856	7893	1526	8943	1241	10492	764	13024	361	11194
22-#10	3.49	MA	7892	2237	10723	2011	13938	1674	16031	1388	18863	905	24591	324	22283
9L-4S		MI	4191	2237	6625	1847	8207	1513	9314	1236	11004	757	13692	417	11455
22-#10	3.49	MA	7606	2237	10211	2020	13305	1685	15237	1398	17751	913	23158	285	21266
10L-3S		MI	4279	2237	6873	1837	8530	1506	9725	1224	11566	755	14365	467	11606
22-#10	3.49	MA	7335	2237	9709	2030	12663	1695	14454	1409	16655	927	21767	238	20227
11L-2S		MI	4444	2237	7223	1828	8972	1499	10261	1219	12287	747	15309	560	11646
22-#11	4.29	MA	8336	2425	11884	2140	15317	1772	17654	1457	20991	911	27562	217	26194
9L-4S		MI	4403	2425	7332	1951	9043	1588	10292	1281	12295	739	15090	305	13487
22-#11	4.29	MA	8005	2425	11261	2150	14546	1786	16686	1469	19655	921	25811	167	24876
10L-3S		MI	4499	2425	7630	1941	9431	1580	10788	1268	12970	739	15879	364	13836
22-#14	6.19	MA	9472	2871	14561	2459	18604	2020	21579	1632	26206	938	34925	-22	34774
9L-4S		MI	4991	2871	8991	2226	11097	1788	12746	1409	15577	716	18990	90	18530

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
24-#10	3.81	MA	8290	2311	11540	2058	14972	1708	17281	1410	20547	902	26922	320	24649
9L-5S		MI	4239	2311	6753	1902	8336	1561	9479	1263	11213	762	13969	350	12186
24-#10	3.81	MA	8016	2311	11028	2067	14339	1720	16487	1420	19435	910	25489	281	23628
10L-4S		MI	4332	2311	6975	1893	8650	1548	9849	1258	11725	754	14636	406	12437
24-#10	3.81	MA	7757	2311	10527	2077	13696	1730	15705	1431	18338	925	24098	234	22585
11L-3S		MI	4415	2311	7223	1884	8972	1540	10261	1246	12287	752	15309	456	12617
24-#11	4.68	MA	8493	2516	12253	2208	15802	1828	18205	1496	21700	918	28642	162	27743
10L-4S		MI	4566	2516	7751	2009	9573	1630	10933	1308	13157	736	16190	287	14663

RECTANGULAR TIED COLUMNS 22" x 22"

6-#9	1.24	MA	2331	1032	3117	919	3891	771	4342	653	4855	472	5959	405	2972
2L-3S		MI	2133	1032	2802	927	3492	778	3860	659	4206	480	5076	332	2971
6-#10	1.57	MA	2434	1080	3378	946	4209	790	4720	665	5358	468	6612	397	3705
2L-3S		MI	2192	1080	2982	956	3707	799	4113	672	4541	478	5508	303	3689
6-#11	1.93	MA	2521	1131	3661	970	4531	807	5092	674	5843	462	7162	376	4438
2L-3S		MI	2242	1131	3185	981	3929	816	4364	681	4862	472	5868	262	4402
6-#14	2.79	MA	2746	1253	4288	1040	5300	858	6010	705	7067	454	8671	345	6205
2L-3S		MI	2388	1253	3614	1055	4447	870	4977	714	5677	466	6870	180	6086
6-#18	4.96	MA	3244	1562	5799	1221	7163	990	8238	787	10045	435	12175	244	10469
2L-3S		MI	2721	1562	4641	1245	5697	1007	6465	798	7659	451	9195	-49	9111
8-#8	1.31	MA	2360	1042	3160	927	3957	777	4428	658	4976	473	6149	408	3133
2L-4S		MI	2110	1042	2733	941	3411	789	3752	671	4061	482	4940	317	3111
8-#9	1.65	MA	2468	1091	3432	956	4289	798	4824	670	5504	470	6843	401	3898
2L-4S		MI	2165	1091	2896	972	3603	812	3974	686	4353	481	5334	285	3833
8-#10	2.10	MA	2601	1155	3775	992	4711	824	5327	687	6176	465	7716	390	4866
2L-4S		MI	2236	1155	3100	1013	3845	842	4256	706	4725	479	5830	243	4630
8-#11	2.58	MA	2713	1223	4137	1027	5133	849	5820	701	6824	458	8456	364	5828
2L-4S		MI	2294	1223	3324	1050	4093	868	4533	722	5079	471	6241	187	5349
8-#14	3.72	MA	2999	1385	4963	1123	6154	919	7042	744	8458	449	10473	323	8167
2L-4S		MI	2474	1385	3810	1154	4677	943	5214	772	5982	464	7384	70	7067
10-#10	2.62	MA	2762	1229	4172	1039	5212	859	5934	709	6993	463	8819	382	6023
2L-5S		MI	2300	1229	3247	1070	3994	890	4446	735	4966	485	6155	181	5374
10-#10	2.62	MA	2546	1229	3775	1049	4711	867	5327	716	6176	472	7716	289	5981
3L-4S		MI	2421	1229	3496	1060	4347	876	4863	728	5542	476	6934	236	5728
10-#11	3.22	MA	2896	1315	4613	1084	5736	891	6549	728	7805	455	9749	351	7213
2L-5S		MI	2373	1315	3499	1119	4269	926	4758	757	5365	478	6621	106	6258
10-#11	3.22	MA	2659	1315	4137	1096	5133	900	5820	735	6824	465	8456	237	7142
3L-4S		MI	2520	1315	3800	1107	4695	910	5261	749	6060	468	7535	174	6669
10-#14	4.65	MA	2948	1518	4963	1221	6154	992	7042	792	8458	456	10473	136	9954
3L-4S		MI	2775	1518	4485	1237	5530	1004	6247	811	7372	459	9185	48	8957

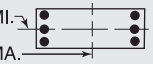
RECTANGULAR TIED COLUMNS 22" x 24"

4-#11	1.18	MA	2747	1117	3663	995	4563	835	5081	708	5658	514	6911	440	3375
2E		MI	2495	1117	3388	985	4176	826	4628	701	5126	508	6167	427	3058
4-#14	1.70	MA	2931	1198	4147	1040	5147	867	5774	728	6578	507	8083	423	4721
2E		MI	2655	1198	3819	1029	4696	858	5242	720	5940	501	7167	404	4260
4-#18	3.03	MA	3342	1404	5311	1157	6565	952	7461	780	8825	493	10836	367	7976
2E		MI	3006	1404	4852	1145	5949	942	6731	771	7921	486	9489	335	7146
6-#9	1.14	MA	2755	1110	3583	1001	4515	841	5051	714	5642	521	6972	453	3296
2L-3S		MI	2304	1110	2999	1001	3737	840	4123	713	4471	523	5376	370	2991
6-#9	1.14	MA	2529	1110	3231	1010	4070	849	4513	721	4918	530	5969	381	3295
3L-2S		MI	2505	1110	3314	992	4136	833	4605	708	5120	515	6260	444	2989

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis



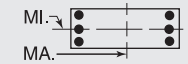
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#10	1.44	MA	2874	1158	3876	1028	4872	861	5475	726	6207	517	7745	449	4117
2L-3S		MI	2364	1158	3181	1029	3953	861	4377	726	4805	521	5809	341	3715
6-#10	1.44	MA	2599	1158	3433	1039	4311	870	4797	734	5293	528	6482	356	4101
3L-2S		MI	2609	1158	3577	1019	4454	852	4984	719	5623	512	6912	435	3724
6-#11	1.77	MA	2977	1209	4196	1052	5238	877	5898	735	6757	511	8401	432	4943
2L-3S		MI	2414	1209	3388	1054	4176	878	4628	735	5126	514	6167	300	4435
6-#11	1.77	MA	2658	1209	3663	1065	4563	888	5081	744	5658	522	6911	318	4908
3L-2S		MI	2697	1209	3864	1042	4779	869	5356	728	6107	504	7460	414	4461
6-#14	2.56	MA	3242	1331	4904	1123	6106	928	6933	767	8139	502	10166	408	6934
2L-3S		MI	2551	1331	3819	1127	4696	931	5242	768	5940	509	7167	217	6134
6-#14	2.56	MA	2820	1331	4147	1140	5147	943	5774	778	6578	518	8083	242	6815
3L-2S		MI	2924	1331	4494	1112	5549	919	6274	759	7331	496	8968	382	6234
6-#18	4.55	MA	3823	1640	6616	1304	8217	1060	9459	849	11514	484	14311	327	11765
2L-3S		MI	2890	1640	4852	1316	5949	1068	6731	851	7921	493	9489	-12	9469
6-#18	4.55	MA	3219	1640	5311	1331	6565	1082	7461	865	8825	506	10836	33	10743
3L-2S		MI	3427	1640	6010	1292	7414	1050	8503	840	10308	477	12469	281	10506
8-#8	1.20	MA	2788	1120	3630	1010	4587	848	5145	719	5775	522	7161	454	3474
2L-4S		MI	2281	1120	2930	1014	3655	852	4015	726	4325	526	5242	355	3136
8-#8	1.20	MA	2610	1120	3350	1017	4233	854	4717	725	5199	529	6363	397	3472
3E		MI	2376	1120	3105	1008	3884	846	4307	717	4724	523	5742	389	3150
8-#8	1.20	MA	2504	1120	3155	1024	3979	860	4392	734	4755	533	5805	363	3452
4L-2S		MI	2534	1120	3356	1001	4201	840	4691	713	5241	517	6450	447	3149
8-#9	1.52	MA	2912	1169	3935	1038	4960	868	5589	732	6367	519	7975	450	4330
2L-4S		MI	2336	1169	3093	1046	3848	875	4237	741	4617	524	5635	323	3868
8-#9	1.52	MA	2697	1169	3583	1047	4515	876	5051	738	5642	527	6972	378	4318
3E		MI	2452	1169	3314	1037	4136	867	4605	731	5120	521	6260	365	3909
8-#9	1.52	MA	2569	1169	3338	1056	4195	884	4642	750	5084	532	6268	334	4265
4L-2S		MI	2643	1169	3629	1029	4534	860	5087	725	5769	513	7144	439	3917
8-#10	1.92	MA	3065	1233	4320	1075	5433	895	6153	748	7120	514	9009	445	5415
2L-4S		MI	2406	1233	3299	1086	4091	904	4520	761	4989	522	6130	281	4725
8-#10	1.92	MA	2806	1233	3876	1086	4872	905	5475	756	6207	525	7745	352	5384
3E		MI	2546	1233	3577	1076	4454	895	4984	748	5623	518	6912	334	4863
8-#10	1.92	MA	2651	1233	3567	1097	4468	914	4959	770	5501	531	6855	297	5231
4L-2S		MI	2777	1233	3974	1066	4956	887	5591	741	6440	509	8016	428	4887
8-#11	2.36	MA	3199	1301	4730	1110	5913	919	6714	762	7856	507	9890	424	6502
2L-4S		MI	2464	1301	3527	1123	4340	930	4797	776	5343	514	6539	224	5455
8-#11	2.36	MA	2899	1301	4196	1122	5238	930	5898	771	6757	519	8401	309	6446
3E		MI	2625	1301	3864	1111	4779	920	5356	762	6107	511	7460	287	5807
8-#11	2.36	MA	2720	1301	3822	1135	4749	941	5274	787	5906	524	7347	244	6054
4L-2S		MI	2891	1301	4340	1099	5381	911	6085	755	7088	501	8754	402	5853
8-#14	3.41	MA	3534	1463	5662	1205	7064	989	8092	806	9699	497	12249	392	9139
2L-4S		MI	2642	1463	4016	1226	4926	1005	5479	826	6245	506	7681	107	7189
8-#14	3.41	MA	3160	1463	4904	1223	6106	1003	6933	817	8139	513	10166	227	8990
3E		MI	2847	1463	4494	1210	5549	992	6274	807	7331	504	8968	195	8067
8-#14	3.41	MA	2917	1463	4371	1240	5410	1018	6045	839	6926	519	8687	135	8009
4L-2S		MI	3181	1463	5169	1195	6403	980	7307	798	8721	491	10770	360	8197
8-#18	6.06	MA	3759	1875	6616	1479	8217	1190	9459	934	11514	497	14311	-7	14292
3E		MI	3361	1875	6010	1463	7414	1176	8503	920	10308	484	12469	-66	12322
8-#18	6.06	MA	3431	1875	5690	1506	7010	1212	7919	967	9413	501	11825	-162	11531
4L-2S		MI	3837	1875	7169	1439	8880	1158	10275	909	12694	468	15448	228	13858
10-#10	2.41	MA	3251	1307	4763	1122	5994	929	6832	770	8033	512	10273	441	6709
2L-5S		MI	2471	1307	3446	1143	4240	953	4710	790	5230	529	6455	219	5457
10-#10	2.41	MA	3004	1307	4320	1133	5433	939	6153	778	7120	523	9009	348	6666
3L-4S		MI	2592	1307	3695	1133	4593	938	5126	783	5806	519	7234	274	5819

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis

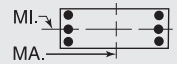


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#10	2.41	MA	2862	1307	4010	1144	5029	949	5637	792	6415	528	8119	293	6464
4L-3S		MI	2720	1307	3974	1123	4956	930	5591	770	6440	515	8016	327	6010
10-#10	2.41	MA	2719	1307	3734	1155	4637	964	5175	800	5775	539	7227	239	6035
5L-2S		MI	2941	1307	4371	1112	5458	921	6197	763	7257	506	9119	420	6045
10-#11	2.95	MA	3411	1393	5263	1167	6587	962	7530	789	8955	504	11380	416	8055
2L-5S		MI	2543	1393	3702	1192	4517	988	5022	810	5629	520	6919	144	6378
10-#11	2.95	MA	3131	1393	4730	1180	5913	972	6714	798	7856	516	9890	301	7984
3L-4S		MI	2680	1393	4003	1180	4943	972	5525	803	6324	511	7833	212	6770
10-#11	2.95	MA	2968	1393	4355	1192	5424	983	6090	814	7005	521	8836	236	7539
4L-3S		MI	2834	1393	4340	1168	5381	962	6085	789	7088	508	8754	274	7178
10-#11	2.95	MA	2804	1393	4021	1205	4950	1001	5531	823	6231	532	7784	169	7072
5L-2S		MI	3076	1393	4816	1157	5983	953	6813	782	8068	498	10048	389	7239
10-#14	4.26	MA	3473	1596	5662	1305	7064	1064	8092	856	9699	508	12249	212	11169
3L-4S		MI	2943	1596	4691	1309	5779	1065	6511	865	7635	501	9482	85	9073
10-#14	4.26	MA	3276	1596	5128	1323	6368	1079	7204	877	8487	514	10770	119	10140
4L-3S		MI	3123	1596	5169	1293	6403	1053	7307	846	8721	499	10770	173	10003
10-#14	4.26	MA	3047	1596	4651	1340	5692	1103	6406	889	7384	529	9299	22	9221
5L-2S		MI	3430	1596	5844	1277	7257	1041	8340	837	10112	486	12572	338	10155
10-#18	7.58	MA	4005	2111	6995	1653	8661	1320	9916	1036	12103	492	15301	-202	14752
4L-3S		MI	3814	2111	7169	1610	8880	1284	10275	989	12694	475	15448	-119	15125
12-#10	2.89	MA	3432	1382	5206	1168	6555	964	7510	792	8947	509	11537	437	8000
2L-6S		MI	2488	1382	3600	1199	4422	996	4910	825	5485	530	6803	144	6170
12-#10	2.89	MA	3197	1382	4763	1180	5994	973	6832	800	8033	520	10273	344	7949
3L-5S		MI	2652	1382	3843	1190	4742	987	5317	812	6048	526	7558	212	6577
12-#10	2.89	MA	3065	1382	4453	1191	5590	983	6316	814	7328	525	9382	289	7704
4E		MI	2770	1382	4092	1179	5095	973	5733	805	6623	517	8338	267	6921
12-#10	2.89	MA	2925	1382	4177	1202	5198	998	5853	822	6689	536	8490	235	7295
5L-3S		MI	2896	1382	4371	1169	5458	964	6197	792	7257	513	9119	320	7156
12-#10	2.89	MA	2742	1382	3901	1210	4843	1008	5402	836	6064	541	7629	164	6837
6L-2S		MI	3098	1382	4767	1159	5960	956	6804	785	8074	503	10223	413	7201
12-#11	3.55	MA	3361	1484	5263	1237	6587	1015	7530	825	8955	512	11380	293	9523
3L-5S		MI	2763	1484	4178	1249	5119	1030	5751	837	6610	517	8213	131	7725
12-#11	3.55	MA	3219	1484	4889	1250	6099	1025	6906	841	8104	517	10325	227	9034
4E		MI	2900	1484	4479	1237	5545	1014	6254	830	7305	507	9126	199	8095
12-#11	3.55	MA	3046	1484	4554	1263	5625	1043	6347	850	7330	529	9274	160	8590
5L-3S		MI	3029	1484	4816	1226	5983	1004	6813	816	8068	504	10048	262	8549
12-#11	3.55	MA	2833	1484	4227	1274	5196	1054	5800	865	6575	534	8255	76	7907
6L-2S		MI	3257	1484	5292	1214	6585	995	7541	809	9049	494	11341	376	8623
12-#14	5.11	MA	3604	1728	5886	1406	7327	1140	8363	916	10048	509	12853	104	12283
4E		MI	3231	1728	5365	1391	6633	1126	7544	904	9026	496	11284	63	10969
12-#14	5.11	MA	3381	1728	5408	1423	6651	1164	7565	928	8945	524	11382	7	11357
5L-3S		MI	3389	1728	5844	1376	7257	1114	8340	885	10112	494	12572	151	11943
14-#10	3.37	MA	3391	1457	5206	1226	6555	1008	7510	822	8947	517	11537	340	9231
3L-6S		MI	2671	1457	3997	1246	4924	1030	5517	846	6303	527	7907	137	7285
14-#10	3.37	MA	3262	1457	4897	1237	6150	1017	6994	836	8242	522	10646	285	8950
4L-5S		MI	2827	1457	4240	1236	5244	1021	5924	834	6865	523	8662	205	7702
14-#10	3.37	MA	3124	1457	4621	1248	5759	1032	6532	844	7602	533	9754	231	8559
5L-4S		MI	2954	1457	4489	1226	5597	1007	6340	827	7441	514	9441	260	8030
14-#10	3.37	MA	2950	1457	4344	1257	5404	1042	6080	858	6978	538	8893	160	8095
6L-3S		MI	3060	1457	4767	1216	5960	998	6804	814	8074	510	10223	313	8301
14-#11	4.14	MA	3449	1576	5422	1307	6774	1067	7722	868	9203	514	11815	219	10536
4L-5S		MI	2968	1576	4654	1306	5721	1072	6479	864	7590	514	9506	119	9051
14-#11	4.14	MA	3289	1576	5088	1320	6300	1085	7163	877	8429	525	10763	152	10113
5L-4S		MI	3102	1576	4956	1295	6147	1056	6982	857	8285	504	10420	187	9427
14-#11	4.14	MA	3091	1576	4760	1331	5871	1096	6616	892	7674	530	9744	68	9422
6L-3S		MI	3219	1576	5292	1283	6585	1047	7541	843	9049	501	11341	249	9921
14-#14	5.97	MA	3702	1861	6166	1506	7609	1225	8725	967	10505	519	13465	-9	13442
5L-4S		MI	3510	1861	6040	1474	7487	1187	8577	943	10416	491	13086	41	12873

RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#10	3.85	MA	3465	1532	5340	1284	6711	1052	7672	858	9155	519	11910	281	10202
4L-6S		MI	2859	1532	4394	1292	5426	1064	6124	868	7120	524	9010	129	8403
16-#10	3.85	MA	3328	1532	5064	1295	6320	1067	7210	866	8515	530	11018	227	9826
5E		MI	3006	1532	4636	1283	5746	1056	6531	856	7682	520	9766	198	8830
16-#10	3.85	MA	3152	1532	4787	1304	5965	1076	6758	880	7891	536	10157	156	9356
6L-4S		MI	3122	1532	4885	1273	6098	1041	6947	849	8258	511	10545	253	9143
16-#11	4.73	MA	3515	1668	5621	1377	6975	1127	7979	904	9528	522	12253	144	11628
5E		MI	3166	1668	5130	1364	6323	1115	7208	891	8571	510	10800	106	10376
16-#11	4.73	MA	3329	1668	5294	1389	6545	1138	7433	919	8773	527	11234	59	10936
6L-4S		MI	3298	1668	5432	1352	6749	1098	7710	884	9266	500	11714	174	10766
18-#10	4.33	MA	3516	1606	5507	1342	6881	1101	7888	888	9429	528	12281	223	11095
5L-6S		MI	3033	1606	4790	1339	5928	1099	6731	890	7937	521	10114	122	9525
18-#10	4.33	MA	3361	1606	5231	1351	6526	1111	7437	902	8805	533	11420	152	10619
6L-5S		MI	3172	1606	5033	1330	6247	1090	7138	878	8499	518	10869	191	9961
18-#11	5.32	MA	3560	1760	5827	1446	7220	1180	8249	946	9872	524	12723	51	12460
6L-5S		MI	3360	1760	5606	1421	6926	1157	7936	918	9552	507	12094	94	11706

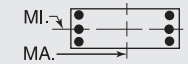
RECTANGULAR TIED COLUMNS 22" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#11	1.09	MA	3204	1195	4166	1077	5236	906	5844	770	6503	563	8013	490	3712
2E		MI	2668	1195	3590	1057	4424	888	4892	755	5390	551	6465	464	3077
4-#14	1.57	MA	3416	1276	4704	1122	5886	938	6615	789	7527	556	9358	477	5207
2E		MI	2829	1276	4025	1101	4945	920	5507	773	6204	544	7464	442	4284
4-#18	2.80	MA	3892	1482	6005	1240	7472	1023	8502	841	10039	542	12542	432	8840
2E		MI	3184	1482	5063	1216	6200	1002	6996	824	8184	528	9784	372	7180
6-#9	1.05	MA	3211	1188	4074	1084	5178	912	5805	776	6478	570	7999	496	3620
2L-3S		MI	2476	1188	3197	1074	3982	903	4387	768	4735	567	5677	408	3010
6-#9	1.05	MA	2958	1188	3685	1094	4686	920	5210	783	5677	580	6891	426	3619
3L-2S		MI	2678	1188	3512	1066	4381	896	4869	762	5384	559	6561	482	3005
6-#10	1.33	MA	3347	1236	4399	1111	5574	931	6275	788	7103	566	8860	492	4528
2L-3S		MI	2536	1236	3379	1102	4198	924	4640	781	5070	564	6109	379	3738
6-#10	1.33	MA	3038	1236	3909	1123	4954	942	5525	797	6094	578	7462	402	4512
3L-2S		MI	2783	1236	3776	1092	4700	915	5247	774	5887	555	7212	473	3742
6-#11	1.64	MA	3466	1287	4757	1135	5983	948	6748	797	7720	559	9699	486	5449
2L-3S		MI	2585	1287	3590	1126	4424	940	4892	789	5390	557	6465	337	4466
6-#11	1.64	MA	3107	1287	4166	1149	5236	960	5844	807	6503	573	8013	371	5413
3L-2S		MI	2872	1287	4067	1115	5026	930	5620	782	6370	547	7759	452	4483
6-#14	2.36	MA	3769	1409	5545	1205	6950	999	7901	828	9258	551	11724	467	7663
2L-3S		MI	2723	1409	4025	1199	4945	993	5507	821	6204	551	7464	254	6179
6-#14	2.36	MA	3292	1409	4704	1224	5886	1015	6615	842	7527	569	9358	302	7544
3L-2S		MI	3103	1409	4700	1184	5798	980	6539	812	7594	539	9265	420	6261
6-#18	4.20	MA	4440	1718	7458	1387	9310	1131	10725	910	13032	533	16517	403	13061
2L-3S		MI	3059	1718	5063	1387	6200	1128	6996	904	8184	535	9784	24	9719
6-#18	4.20	MA	3752	1718	6005	1417	7472	1156	8502	930	10039	560	12542	109	12210
3L-2S		MI	3609	1718	6221	1363	7666	1111	8769	893	10570	519	12763	318	10543
8-#8	1.10	MA	3247	1197	4125	1093	5257	918	5908	781	6623	571	8205	497	3815
2L-4S		MI	2452	1197	3126	1088	3899	915	4278	781	4590	570	5543	393	3160
8-#8	1.10	MA	3048	1197	3816	1100	4866	925	5435	787	5987	579	7324	442	3814
3E		MI	2548	1197	3301	1081	4128	909	4570	772	4989	567	6043	427	3168
8-#8	1.10	MA	2930	1197	3602	1108	4587	932	5078	796	5498	583	6716	408	3793
4L-2S		MI	2708	1197	3552	1075	4445	903	4954	767	5505	560	6752	485	3164
8-#9	1.40	MA	3389	1247	4462	1121	5669	939	6399	793	7278	567	9107	493	4762
2L-4S		MI	2507	1247	3291	1119	4093	937	4501	796	4882	568	5936	361	3899

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis

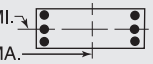


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#9	1.40	MA	3147	1247	4074	1130	5178	947	5805	801	6478	577	7999	423	4750
3E		MI	2624	1247	3512	1111	4381	930	4869	785	5384	564	6561	403	3931
8-#9	1.40	MA	3004	1247	3804	1140	4826	956	5355	813	5863	583	7231	380	4697
4L-2S		MI	2818	1247	3827	1103	4779	923	5351	780	6033	557	7444	477	3934
8-#10	1.78	MA	3563	1310	4889	1158	6194	965	7025	810	8113	563	10258	489	5964
2L-4S		MI	2577	1310	3498	1159	4337	967	4783	815	5253	565	6431	319	4811
8-#10	1.78	MA	3271	1310	4399	1169	5574	976	6275	819	7103	575	8860	398	5933
3E		MI	2718	1310	3776	1149	4700	958	5247	803	5887	562	7212	372	4889
8-#10	1.78	MA	3098	1310	4058	1181	5129	986	5707	834	6327	582	7887	343	5815
4L-2S		MI	2953	1310	4173	1139	5202	949	5854	796	6704	552	8316	466	4908
8-#11	2.18	MA	3718	1379	5347	1192	6731	990	7652	824	8937	556	11384	481	7175
2L-4S		MI	2633	1379	3730	1195	4588	991	5061	830	5607	557	6838	262	5557
8-#11	2.18	MA	3380	1379	4757	1206	5983	1002	6748	834	7720	569	9699	366	7120
3E		MI	2797	1379	4067	1184	5026	982	5620	816	6370	554	7759	325	5840
8-#11	2.18	MA	3179	1379	4344	1220	5445	1014	6060	851	6781	576	8511	299	6773
4L-2S		MI	3069	1379	4543	1172	5629	973	6349	809	7351	544	9052	439	5877
8-#14	3.15	MA	4105	1541	6385	1288	8013	1060	9187	867	10990	546	14090	457	10111
2L-4S		MI	2810	1541	4221	1298	5175	1066	5743	879	6508	549	7977	145	7308
8-#14	3.15	MA	3666	1541	5545	1307	6950	1076	7901	881	9258	564	11724	292	9962
3E		MI	3020	1541	4700	1282	5798	1054	6539	860	7594	546	9265	232	8113
8-#14	3.15	MA	3404	1541	4956	1326	6182	1092	6920	904	7919	573	10052	196	8968
4L-2S		MI	3361	1541	5375	1267	6652	1041	7572	851	8984	534	11067	398	8226
8-#18	5.59	MA	4362	1953	7458	1564	9310	1264	10725	999	13032	551	16517	80	16239
3E		MI	3531	1953	6221	1534	7666	1236	8769	973	10570	526	12763	-29	12700
8-#18	5.59	MA	3993	1953	6434	1595	7974	1289	9020	1037	10705	560	13691	-83	13507
4L-2S		MI	4021	1953	7380	1510	9131	1219	10541	962	12956	510	15742	265	13896
10-#10	2.22	MA	3773	1385	5379	1204	6814	1000	7775	832	9123	561	11656	485	7395
2L-5S		MI	2642	1385	3645	1216	4486	1015	4974	844	5495	572	6755	257	5537
10-#10	2.22	MA	3495	1385	4889	1216	6194	1010	7025	841	8113	573	10258	394	7352
3L-4S		MI	2763	1385	3894	1206	4839	1001	5390	837	6070	563	7534	312	5908
10-#10	2.22	MA	3335	1385	4548	1228	5749	1021	6457	856	7336	579	9285	340	7214
4L-3S		MI	2894	1385	4173	1196	5202	992	5854	825	6704	559	8316	365	6038
10-#10	2.22	MA	3171	1385	4245	1240	5319	1037	5948	865	6633	591	8306	288	6705
5L-2S		MI	3118	1385	4570	1186	5704	984	6461	818	7521	549	9419	458	6067
10-#11	2.73	MA	3961	1470	5938	1250	7478	1032	8556	851	10154	553	13069	476	8898
2L-5S		MI	2714	1470	3905	1264	4764	1050	5287	864	5893	563	7217	182	6469
10-#11	2.73	MA	3642	1470	5347	1263	6731	1044	7652	861	8937	566	11384	362	8827
3L-4S		MI	2851	1470	4206	1252	5190	1034	5789	857	6588	553	8131	250	6868
10-#11	2.73	MA	3458	1470	4935	1277	6192	1056	6964	878	7998	573	10197	294	8425
4L-3S		MI	3008	1470	4543	1241	5629	1024	6349	843	7351	550	9052	312	7213
10-#11	2.73	MA	3268	1470	4567	1291	5671	1075	6349	888	7146	586	9008	227	7870
5L-2S		MI	3256	1470	5019	1229	6231	1015	7077	836	8332	541	10346	427	7265
10-#14	3.93	MA	4034	1674	6385	1390	8013	1137	9187	920	10990	559	14090	282	12384
3L-4S		MI	3112	1674	4896	1381	6028	1127	6776	918	7899	544	9779	123	9186
10-#14	3.93	MA	3810	1674	5797	1408	7245	1153	8206	943	9650	568	12418	186	11342
4L-3S		MI	3297	1674	5375	1365	6652	1114	7572	899	8984	541	11067	210	10050
10-#14	3.93	MA	3529	1674	5271	1427	6500	1179	7327	956	8434	586	10748	90	10402
5L-2S		MI	3612	1674	6050	1349	7506	1102	8604	890	10375	529	12869	376	10186
10-#18	6.99	MA	4641	2189	7886	1742	9812	1397	11243	1106	13698	551	17667	-112	17294
4L-3S		MI	3985	2189	7380	1681	9131	1344	10541	1042	12956	517	15742	-83	15524
12-#10	2.66	MA	3977	1460	5869	1251	7434	1034	8525	854	10133	558	13054	481	8823
2L-6S		MI	2657	1460	3799	1272	4668	1058	5174	879	5750	573	7103	182	6290
12-#10	2.66	MA	3712	1460	5379	1263	6814	1045	7775	863	9123	570	11656	390	8772
3L-5S		MI	2824	1460	4042	1263	4988	1049	5581	866	6312	569	7859	250	6654
12-#10	2.66	MA	3564	1460	5039	1275	6369	1055	7207	878	8346	576	10683	336	8590
4E		MI	2942	1460	4291	1253	5340	1035	5997	859	6888	560	8638	305	7007
12-#10	2.66	MA	3402	1460	4735	1287	5939	1071	6698	887	7642	588	9704	284	8101
5L-3S		MI	3065	1460	4570	1242	5704	1027	6461	847	7521	556	9419	358	7184

RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis

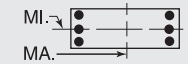


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	2.66	MA	3197	1460	4425	1295	5549	1082	6202	901	6956	595	8764	214	7647
6L-2S		MI	3279	1460	4966	1232	6206	1018	7068	840	8338	547	10523	451	7223
12-#11	3.27	MA	3895	1562	5938	1321	7478	1086	8556	888	10154	563	13069	357	10534
3L-5S		MI	2935	1562	4381	1321	5367	1092	6015	891	6873	560	8511	169	7812
12-#11	3.27	MA	3727	1562	5526	1334	6940	1098	7869	905	9215	569	11882	289	10086
4E		MI	3071	1562	4682	1310	5793	1076	6518	884	7568	550	9425	237	8189
12-#11	3.27	MA	3541	1562	5158	1348	6418	1117	7253	915	8363	583	10693	223	9557
5L-3S		MI	3205	1562	5019	1298	6231	1066	7077	870	8332	547	10346	300	8585
12-#11	3.27	MA	3302	1562	4789	1359	5946	1129	6651	932	7531	589	9545	136	8853
6L-2S		MI	3439	1562	5495	1287	6833	1057	7806	863	9313	537	11639	414	8650
12-#14	4.72	MA	4181	1806	6637	1491	8308	1214	9492	982	11382	563	14784	176	13727
4E		MI	3401	1806	5571	1463	6882	1188	7809	957	9289	539	11581	101	11076
12-#14	4.72	MA	3921	1806	6111	1510	7563	1240	8613	995	10165	581	13114	80	12787
5L-3S		MI	3565	1806	6050	1448	7506	1175	8604	938	10375	536	12869	188	11990
14-#10	3.11	MA	3923	1535	5869	1310	7434	1079	8525	885	10133	567	13054	386	10191
3L-6S		MI	2841	1535	4196	1319	5170	1092	5781	901	6567	570	8207	175	7401
14-#10	3.11	MA	3786	1535	5529	1321	6989	1089	7956	899	9356	574	12081	332	9971
4L-5S		MI	3000	1535	4438	1310	5490	1084	6187	888	7129	567	8962	243	7776
14-#10	3.11	MA	3626	1535	5226	1333	6559	1105	7448	909	8652	586	11102	281	9501
5L-4S		MI	3127	1535	4688	1299	5842	1070	6604	881	7705	557	9741	298	8112
14-#10	3.11	MA	3431	1535	4915	1341	6169	1116	6952	923	7966	592	10162	211	9043
6L-3S		MI	3237	1535	4966	1289	6206	1061	7068	869	8338	553	10523	351	8331
14-#10	3.11	MA	3259	1535	4562	1355	5780	1125	6472	933	7298	604	9234	167	8531
7L-2S		MI	3434	1535	5363	1279	6707	1052	7675	862	9156	544	11627	444	8378
14-#11	3.82	MA	4003	1654	6117	1392	7687	1140	8773	932	10432	566	13568	284	11754
4L-5S		MI	3140	1654	4857	1379	5969	1134	6743	918	7854	556	9805	157	9161
14-#11	3.82	MA	3804	1654	5749	1406	7166	1159	8157	942	9580	579	12378	218	11248
5L-4S		MI	3274	1654	5158	1367	6395	1118	7246	911	8549	547	10718	224	9518
14-#11	3.82	MA	3578	1654	5380	1416	6693	1171	7555	959	8748	586	11231	131	10539
6L-3S		MI	3396	1654	5495	1356	6833	1109	7806	897	9313	544	11639	287	9957
14-#14	5.51	MA	4283	1938	6952	1593	8627	1301	9899	1034	11897	576	15480	70	15179
5L-4S		MI	3681	1938	6246	1546	7736	1248	8841	996	10679	534	13383	79	12976
16-#10	3.55	MA	4002	1609	6019	1368	7609	1124	8706	921	10366	571	13479	328	11357
4L-6S		MI	3031	1609	4592	1366	5672	1127	6388	923	7384	568	9310	167	8516
16-#10	3.55	MA	3844	1609	5716	1380	7179	1140	8198	931	9662	583	12500	277	10905
5E		MI	3180	1609	4835	1356	5991	1118	6794	910	7946	564	10066	236	8901
16-#10	3.55	MA	3658	1609	5405	1388	6789	1150	7702	945	8976	589	11560	207	10442
6L-4S		MI	3297	1609	5084	1346	6344	1104	7211	903	8522	554	10845	291	9223
16-#10	3.55	MA	3495	1609	5052	1401	6400	1159	7222	955	8308	602	10632	163	9945
7L-3S		MI	3398	1609	5363	1336	6707	1095	7675	891	9156	550	11627	344	9477
16-#11	4.36	MA	4072	1746	6340	1463	7913	1201	9061	969	10797	576	14064	213	12943
5E		MI	3340	1746	5333	1436	6571	1176	7472	945	8835	553	11098	144	10513
16-#11	4.36	MA	3862	1746	5971	1474	7441	1213	8459	986	9966	582	12916	126	12228
6L-4S		MI	3472	1746	5635	1425	6997	1160	7975	938	9530	543	12012	212	10853
18-#10	4.00	MA	4057	1684	6206	1427	7799	1174	8948	953	10672	580	13898	273	12311
5L-6S		MI	3205	1684	4989	1412	6174	1161	6994	945	8201	565	10414	160	9635
18-#10	4.00	MA	3879	1684	5895	1435	7409	1185	8452	967	9985	587	12958	203	11844
6L-5S		MI	3347	1684	5232	1403	6493	1153	7401	932	8763	561	11169	229	10030
18-#10	4.00	MA	3725	1684	5543	1448	7020	1194	7972	977	9318	599	12030	159	11354
7L-4S		MI	3462	1684	5481	1393	6846	1138	7818	925	9339	551	11948	283	10338
18-#11	4.91	MA	4122	1838	6562	1531	8188	1255	9363	1013	11183	579	14601	121	13921
6L-5S		MI	3535	1838	5809	1494	7173	1219	8200	972	9816	550	12392	131	11843
20-#10	4.44	MA	4111	1759	6385	1482	8029	1219	9202	989	10995	584	14356	199	13248
6E		MI	3375	1759	5386	1459	6675	1195	7601	967	9018	562	11517	153	10756
20-#10	4.44	MA	3948	1759	6033	1495	7640	1228	8722	998	10327	596	13428	155	12763
7L-5S		MI	3511	1759	5628	1450	6995	1187	8008	954	9581	558	12273	221	11161

RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

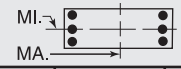
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.01	MA	3694	1273	4694	1160	5947	976	6652	831	7396	612	9109	533	4049
2E		MI	2841	1273	3793	1130	4672	950	5156	809	5653	594	6763	502	3096
4-#14	1.46	MA	3934	1354	5287	1205	6664	1008	7502	851	8525	605	10660	526	5693
2E		MI	3004	1354	4231	1173	5194	981	5771	827	6467	586	7761	479	4307
4-#18	2.60	MA	4478	1560	6725	1322	8417	1093	9588	903	11303	591	14312	494	9704
2E		MI	3362	1560	5274	1287	6452	1063	7262	876	8446	570	10078	408	7213
6-#10	1.24	MA	3852	1313	4946	1194	6314	1002	7121	849	8049	615	10029	535	4940
2L-3S		MI	2707	1313	3578	1176	4444	986	4904	835	5334	608	6409	417	3761
6-#10	1.24	MA	3508	1313	4410	1206	5635	1013	6299	859	6943	628	8498	447	4924
3L-2S		MI	2957	1313	3975	1165	4946	977	5511	828	6151	598	7512	511	3760
6-#11	1.52	MA	3988	1365	5342	1218	6767	1018	7644	858	8732	608	10958	528	5954
2L-3S		MI	2756	1365	3793	1199	4672	1002	5156	843	5653	600	6763	375	4494
6-#11	1.52	MA	3587	1365	4694	1232	5947	1031	6652	869	7396	623	9109	417	5919
3L-2S		MI	3047	1365	4269	1187	5274	992	5885	836	6634	590	8057	489	4505
6-#14	2.19	MA	4330	1486	6210	1288	7832	1069	8915	890	10427	600	13293	519	8392
2L-3S		MI	2894	1486	4231	1271	5194	1054	5771	875	6467	594	7761	292	6220
6-#14	2.19	MA	3797	1486	5287	1308	6664	1087	7502	905	8525	620	10660	355	8273
3L-2S		MI	3280	1486	4906	1256	6047	1042	6804	866	7857	581	9562	457	6288
6-#18	3.90	MA	5094	1795	8325	1469	10441	1201	12036	972	14598	582	18790	473	14357
2L-3S		MI	3228	1795	5274	1458	6452	1189	7262	956	8446	577	10078	61	9913
6-#18	3.90	MA	4319	1795	6725	1502	8417	1229	9588	995	11303	613	14312	180	13718
3L-2S		MI	3790	1795	6433	1434	7917	1171	9034	946	10832	561	13057	355	10579
8-#8	1.03	MA	3739	1275	4644	1175	5965	989	6715	842	7519	620	9307	540	4156
2L-4S		MI	2623	1275	3322	1162	4144	977	4541	835	4854	613	5844	431	3181
8-#8	1.03	MA	3518	1275	4306	1183	5537	996	6198	849	6823	628	8344	486	4155
3E		MI	2720	1275	3497	1155	4373	972	4833	827	5254	610	6345	465	3185
8-#8	1.03	MA	3387	1275	4073	1191	5233	1003	5809	859	6290	634	7685	453	4135
4L-2S		MI	2881	1275	3748	1148	4690	966	5217	822	5770	604	7053	523	3179
8-#9	1.30	MA	3898	1325	5015	1204	6418	1009	7255	855	8238	616	10297	536	5194
2L-4S		MI	2678	1325	3488	1193	4338	1000	4764	850	5146	611	6237	399	3928
8-#9	1.30	MA	3629	1325	4589	1213	5880	1018	6604	863	7362	627	9084	467	5182
3E		MI	2796	1325	3709	1184	4626	993	5132	840	5649	608	6862	442	3951
8-#9	1.30	MA	3471	1325	4295	1223	5496	1027	6113	875	6691	633	8252	425	5129
4L-2S		MI	2992	1325	4024	1176	5024	986	5614	834	6297	600	7745	515	3952
8-#10	1.65	MA	4094	1388	5483	1240	6993	1036	7942	871	9155	612	11561	531	6512
2L-4S		MI	2747	1388	3696	1232	4583	1029	5047	870	5517	609	6731	357	4850
8-#10	1.65	MA	3768	1388	4946	1253	6314	1047	7121	881	8049	625	10029	443	6482
3E		MI	2891	1388	3975	1222	4946	1020	5511	857	6151	605	7512	410	4914
8-#10	1.65	MA	3576	1388	4575	1265	5829	1058	6500	897	7201	633	8975	389	6364
4L-2S		MI	3129	1388	4372	1212	5448	1012	6118	850	6968	595	8616	504	4928
8-#11	2.03	MA	4270	1456	5990	1275	7587	1060	8636	885	10067	605	12807	524	7849
2L-4S		MI	2803	1456	3933	1268	4836	1053	5325	884	5871	600	7136	300	5656
8-#11	2.03	MA	3893	1456	5342	1289	6767	1073	7644	896	8732	620	10958	412	7794
3E		MI	2970	1456	4269	1256	5274	1044	5885	870	6634	597	8057	362	5872
8-#11	2.03	MA	3670	1456	4891	1304	6179	1086	6892	915	7704	628	9671	345	7506
4L-2S		MI	3245	1456	4746	1244	5876	1034	6613	863	7615	587	9350	477	5901
8-#14	2.92	MA	4710	1619	7134	1371	9000	1130	10328	929	12329	595	15927	512	11083
2L-4S		MI	2967	1619	4427	1370	5424	1127	6008	933	6772	591	8274	182	7424
8-#14	2.92	MA	4215	1619	6210	1391	7832	1148	8915	944	10427	615	13293	348	10934
3E		MI	3193	1619	4906	1354	6047	1115	6804	914	7857	589	9562	270	8157
8-#14	2.92	MA	3924	1619	5567	1411	6992	1165	7842	969	8960	626	11445	251	9944
4L-2S		MI	3541	1619	5581	1339	6901	1103	7837	905	9248	576	11364	435	8255
8-#18	5.19	MA	5001	2031	8325	1649	10441	1337	12036	1064	14598	604	18790	160	18190
3E		MI	3702	2031	6433	1605	7917	1297	9034	1026	10832	568	13057	8	13034

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#18	5.19	MA	4589	2031	7203	1682	8977	1365	10167	1105	12046	617	15622	-9	15599
4L-2S		MI	4204	2031	7591	1581	9383	1279	10806	1015	13219	552	16037	301	13933
10-#10	2.06	MA	4329	1463	6020	1287	7672	1070	8763	893	10261	609	13092	528	8081
2L-5S		MI	2813	1463	3844	1289	4732	1078	5237	899	5759	615	7055	295	5613
10-#10	2.06	MA	4018	1463	5483	1299	6993	1081	7942	903	9155	623	11561	439	8038
3L-4S		MI	2934	1463	4093	1279	5084	1063	5654	892	6335	606	7834	350	5987
10-#10	2.06	MA	3841	1463	5112	1312	6508	1093	7321	919	8307	630	10506	385	7911
4L-3S		MI	3068	1463	4372	1269	5448	1055	6118	879	6968	602	8616	403	6064
10-#10	2.06	MA	3654	1463	4782	1324	6039	1109	6767	929	7539	643	9442	337	7383
5L-2S		MI	3295	1463	4768	1259	5950	1046	6725	872	7785	593	9720	496	6088
10-#11	2.53	MA	4542	1548	6638	1332	8407	1103	9628	912	11402	601	14656	519	9740
2L-5S		MI	2884	1548	4108	1337	5012	1112	5551	918	6156	606	7516	219	6557
10-#11	2.53	MA	4185	1548	5990	1347	7587	1115	8636	923	10067	616	12807	407	9669
3L-4S		MI	3022	1548	4409	1325	5438	1095	6054	911	6851	596	8429	287	6963
10-#11	2.53	MA	3982	1548	5540	1361	6999	1128	7884	942	9040	624	11520	341	9325
4L-3S		MI	3183	1548	4746	1313	5876	1086	6613	897	7615	593	9350	350	7246
10-#11	2.53	MA	3765	1548	5138	1376	6430	1148	7212	953	8109	639	10225	278	8678
5L-2S		MI	3435	1548	5222	1302	6479	1077	7342	890	8596	583	10644	464	7291
10-#14	3.65	MA	4629	1751	7134	1474	9000	1208	10328	983	12329	610	15927	342	13599
3L-4S		MI	3281	1751	5102	1453	6277	1188	7041	972	8162	586	10076	160	9296
10-#14	3.65	MA	4356	1751	6490	1494	8160	1226	9254	1008	10862	621	14079	244	12562
4L-3S		MI	3472	1751	5581	1437	6901	1176	7837	953	9248	584	11364	248	10095
10-#14	3.65	MA	4056	1751	5916	1514	7347	1254	8293	1023	9532	641	12225	150	11612
5L-2S		MI	3794	1751	6256	1421	7755	1163	8869	944	10638	571	13166	413	10216
10-#18	6.49	MA	5312	2266	8802	1829	11001	1474	12615	1174	15341	608	20100	-29	19985
4L-3S		MI	4157	2266	7591	1752	9383	1405	10806	1095	13219	559	16037	-46	15918
12-#10	2.47	MA	4557	1538	6557	1334	8352	1105	9585	915	11367	607	14623	524	9646
2L-6S		MI	2827	1538	3998	1345	4914	1121	5437	933	6014	617	7403	220	6407
12-#10	2.47	MA	4261	1538	6020	1346	7672	1116	8763	925	10261	620	13092	435	9594
3L-5S		MI	2996	1538	4241	1336	5234	1112	5844	921	6576	613	8159	288	6728
12-#10	2.47	MA	4096	1538	5649	1359	7187	1127	8143	941	9413	627	12037	382	9460
4E		MI	3114	1538	4490	1326	5586	1098	6261	914	7152	603	8938	343	7090
12-#10	2.47	MA	3912	1538	5318	1371	6718	1144	7589	951	8645	640	10973	333	8916
5L-3S		MI	3240	1538	4768	1316	5950	1089	6725	901	7785	599	9720	396	7212
12-#10	2.47	MA	3685	1538	4974	1379	6294	1155	7048	966	7897	648	9955	264	8472
6L-2S		MI	3458	1538	5165	1305	6451	1080	7332	894	8603	590	10823	489	7246
12-#11	3.04	MA	4469	1640	6638	1404	8407	1158	9628	950	11402	613	14656	403	11545
3L-5S		MI	3098	1640	4584	1394	5614	1154	6279	945	7137	603	8809	207	7897
12-#11	3.04	MA	4281	1640	6188	1419	7819	1170	8876	969	10375	621	13369	336	11153
4E		MI	3243	1640	4885	1382	6040	1138	6782	938	7832	593	9723	275	8280
12-#11	3.04	MA	4068	1640	5787	1433	7250	1190	8204	980	9444	636	12074	273	10533
5L-3S		MI	3381	1640	5222	1371	6479	1128	7342	924	8596	590	10644	337	8619
12-#11	3.04	MA	3804	1640	5376	1443	6735	1203	7547	998	8537	644	10830	187	9817
6L-2S		MI	3619	1640	5698	1359	7081	1119	8070	916	9576	580	11938	452	8677
12-#14	4.38	MA	4793	1884	7413	1576	9328	1287	10667	1047	12764	616	16712	237	15190
4E		MI	3571	1884	5777	1535	7131	1249	8073	1011	9552	581	11878	138	11181
12-#14	4.38	MA	4475	1884	6840	1597	8515	1315	9706	1062	11434	636	14859	143	14249
5L-3S		MI	3741	1884	6256	1520	7755	1237	8869	992	10638	579	13166	226	12034
12-#14	4.38	MA	4124	1884	6260	1612	7778	1332	8768	1087	10137	646	13072	18	12984
6L-2S		MI	4042	1884	6931	1504	8609	1224	9902	983	12028	566	14967	391	12174
14-#10	2.89	MA	4496	1612	6557	1393	8352	1150	9585	947	11367	617	14623	431	11151
3L-6S		MI	3012	1612	4395	1392	5416	1155	6044	955	6831	614	8507	213	7515
14-#10	2.89	MA	4343	1612	6186	1405	7866	1161	8964	963	10519	624	13569	378	11006
4L-5S		MI	3173	1612	4637	1383	5735	1146	6451	943	7393	610	9262	281	7848
14-#10	2.89	MA	4162	1612	5855	1418	7397	1178	8410	973	9751	638	12505	329	10453
5L-4S		MI	3290	1612	4886	1373	6088	1132	6867	936	7969	600	10041	336	8192
14-#10	2.89	MA	3945	1612	5510	1426	6973	1189	7869	988	9003	645	11486	260	10008
6L-3S		MI	3414	1612	5165	1362	6451	1123	7332	923	8603	597	10823	389	8359

RECTANGULAR TIED COLUMNS 22" x 28"

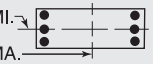
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#10	2.89	MA	3754	1612	5168	1434	6541	1198	7346	998	8275	658	10479	219	9417
7L-2S		MI	3615	1612	5562	1352	6953	1115	7938	916	9420	587	11927	482	8401
14-#11	3.55	MA	4572	1732	6836	1476	8639	1213	9868	996	11711	617	15218	331	12988
4L-5S		MI	3313	1732	5060	1451	6217	1196	7008	972	8118	599	10103	194	9242
14-#11	3.55	MA	4362	1732	6435	1491	8070	1232	9195	1007	10780	632	13923	268	12392
5L-4S		MI	3447	1732	5361	1440	6642	1180	7511	965	8813	589	11017	262	9606
14-#11	3.55	MA	4111	1732	6024	1501	7555	1245	8539	1025	9872	640	12679	182	11675
6L-3S		MI	3573	1732	5698	1428	7081	1170	8070	951	9576	586	11938	325	9992
14-#11	3.55	MA	3889	1732	5558	1517	7041	1256	7904	1036	8989	655	11452	129	10909
7L-2S		MI	3800	1732	6174	1417	7683	1161	8798	943	10557	577	13231	439	10060
14-#14	5.11	MA	4898	2016	7763	1679	9683	1375	11118	1101	13336	631	17492	136	16891
5L-4S		MI	3852	2016	6452	1618	7985	1310	9106	1050	10943	577	13679	116	13076
14-#14	5.11	MA	4575	2016	7183	1694	8946	1393	10180	1126	12039	641	15706	11	15651
6L-3S		MI	4004	2016	6931	1602	8609	1298	9902	1031	12028	574	14967	204	13976
16-#10	3.30	MA	4584	1687	6722	1452	8545	1196	9786	985	11625	622	15100	374	12528
4L-6S		MI	3191	1687	4791	1439	5917	1189	6651	977	7648	611	9610	205	8626
16-#10	3.30	MA	4405	1687	6392	1464	8076	1212	9231	995	10857	635	14036	325	11992
5E		MI	3355	1687	5034	1430	6237	1181	7058	965	8210	607	10366	274	8971
16-#10	3.30	MA	4198	1687	6047	1472	7652	1224	8691	1010	10109	642	13017	256	11547
6L-4S		MI	3471	1687	5283	1419	6590	1166	7474	958	8786	598	11145	329	9301
16-#10	3.30	MA	4017	1687	5705	1480	7220	1232	8168	1020	9381	656	12010	215	10971
7L-3S		MI	3576	1687	5562	1409	6953	1158	7938	945	9420	594	11927	382	9506
16-#10	3.30	MA	3848	1687	5328	1495	6756	1245	7649	1029	8656	663	11040	161	10282
8L-2S		MI	3768	1687	5958	1399	7455	1149	8545	938	10237	584	13030	475	9554
16-#11	4.05	MA	4663	1824	7083	1548	8890	1275	10187	1034	12115	629	15772	263	14255
5E		MI	3514	1824	5536	1509	6819	1238	7736	999	9099	596	11396	182	10592
16-#11	4.05	MA	4408	1824	6672	1558	8375	1287	9531	1052	11208	637	14528	177	13535
6L-4S		MI	3646	1824	5838	1497	7245	1222	8239	992	9794	586	12310	250	10939
16-#11	4.05	MA	4199	1824	6206	1574	7861	1298	8896	1063	10324	652	13301	124	12778
7L-3S		MI	3761	1824	6174	1486	7683	1213	8798	978	10557	583	13231	312	11366
16-#14	5.84	MA	4989	2149	8107	1777	10114	1454	11593	1165	13941	636	18339	5	18317
6L-4S		MI	4125	2149	7127	1701	8839	1371	10139	1088	12333	572	15481	94	14980
18-#10	3.71	MA	4641	1762	6929	1511	8755	1247	10053	1016	11963	632	15567	321	13535
5L-6S		MI	3377	1762	5188	1486	6419	1224	7258	999	8465	608	10714	198	9741
18-#10	3.71	MA	4443	1762	6584	1519	8331	1258	9512	1032	11215	640	14549	252	13087
6L-5S		MI	3523	1762	5431	1476	6739	1215	7665	987	9028	604	11469	267	10097
18-#10	3.71	MA	4272	1762	6242	1527	7899	1266	8989	1042	10487	653	13542	211	12526
7L-4S		MI	3638	1762	5680	1466	7092	1201	8081	980	9603	595	12249	321	10414
18-#10	3.71	MA	4113	1762	5865	1542	7435	1280	8471	1051	9762	660	12571	157	11834
8L-3S		MI	3735	1762	5958	1456	7455	1192	8545	967	10237	591	13030	374	10653
18-#11	4.56	MA	4718	1916	7321	1616	9195	1330	10523	1079	12543	633	16378	173	15398
6L-5S		MI	3710	1916	6012	1566	7421	1280	8464	1026	10079	593	12690	169	11946
18-#11	4.56	MA	4501	1916	6854	1632	8681	1341	9888	1090	11660	648	15150	119	14649
7L-4S		MI	3840	1916	6314	1555	7847	1264	8967	1019	10774	583	13604	237	12277
20-#10	4.12	MA	4683	1837	7121	1566	9011	1292	10334	1054	12321	637	16080	248	14630
6E		MI	3548	1837	5585	1532	6921	1258	7865	1021	9283	605	11817	191	10860
20-#10	4.12	MA	4520	1837	6779	1574	8578	1301	9811	1064	11593	650	15073	207	14082
7L-5S		MI	3687	1837	5827	1523	7241	1249	8272	1009	9845	601	12573	260	11227
20-#10	4.12	MA	4369	1837	6402	1589	8114	1314	9292	1073	10868	657	14103	153	13386
8L-4S		MI	3801	1837	6077	1513	7593	1235	8688	1002	10421	592	13352	314	11531
20-#11	5.06	MA	4820	2007	7503	1689	9501	1383	10880	1117	12995	645	16999	115	16522
7L-5S		MI	3901	2007	6488	1623	8023	1323	9193	1053	11060	589	13984	157	13303
22-#10	4.54	MA	4764	1911	7316	1621	9257	1335	10632	1086	12699	647	16604	203	15639
7L-6S		MI	3716	1911	5981	1579	7423	1292	8472	1043	10100	602	12921	184	11981
22-#10	4.54	MA	4614	1911	6939	1636	8793	1348	10113	1095	11974	655	15634	149	14938
8L-5S		MI	3848	1911	6224	1570	7743	1284	8879	1031	10662	599	13676	252	12359

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis

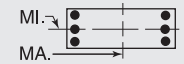


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.36	MA	4484	1432	5895	1288	7481	1079	8435	912	9571	654	11958	569	6179
2E		MI	3178	1432	4437	1245	5443	1042	6036	880	6730	629	8058	516	4329
4-#18	2.42	MA	5093	1638	7469	1405	9401	1164	10720	964	12614	640	16145	552	10568
2E		MI	3540	1638	5486	1358	6703	1123	7527	929	8709	612	10372	445	7246
6-#10	1.15	MA	4389	1391	5519	1276	7094	1072	8011	911	9043	664	11258	578	5351
2L-3S		MI	2879	1391	3777	1249	4690	1048	5167	890	5598	651	6709	456	3782
6-#10	1.15	MA	4010	1391	4935	1289	6355	1084	7118	921	7841	678	9593	492	5335
3L-2S		MI	3131	1391	4174	1239	5192	1040	5774	883	6415	642	7813	549	3778
6-#11	1.42	MA	4543	1442	5952	1300	7590	1089	8585	920	9792	657	12276	571	6460
2L-3S		MI	2928	1442	3996	1271	4919	1063	5421	897	5917	643	7062	412	4522
6-#11	1.42	MA	4100	1442	5246	1315	6698	1102	7506	932	8338	673	10263	462	6424
3L-2S		MI	3221	1442	4472	1260	5522	1054	6149	889	6898	633	8355	527	4526
6-#14	2.05	MA	4925	1564	6901	1371	8754	1140	9974	951	11644	649	14827	562	9121
2L-3S		MI	3065	1564	4437	1343	5443	1116	6036	928	6730	636	8058	329	6259
6-#14	2.05	MA	4334	1564	5895	1392	7481	1159	8435	968	9571	671	11958	402	9002
3L-2S		MI	3456	1564	5112	1328	6296	1103	7069	919	8121	624	9859	494	6314
6-#18	3.64	MA	5785	1873	9216	1552	11611	1272	13393	1033	16213	631	21128	540	15653
2L-3S		MI	3398	1873	5486	1529	6703	1249	7527	1009	8709	619	10372	98	10103
6-#18	3.64	MA	4894	1873	7469	1587	9401	1302	10720	1059	12614	665	16145	246	15133
3L-2S		MI	3970	1873	6644	1505	8169	1232	9300	998	11095	603	13352	392	10615
8-#9	1.21	MA	4440	1402	5592	1286	7205	1080	8156	916	9246	665	11546	579	5626
2L-4S		MI	2849	1402	3686	1266	4583	1063	5027	905	5411	655	6538	437	3954
8-#9	1.21	MA	4143	1402	5130	1297	6620	1089	7449	925	8294	677	10228	512	5614
3E		MI	2968	1402	3906	1258	4871	1055	5395	895	5913	651	7162	480	3971
8-#9	1.21	MA	3969	1402	4812	1307	6204	1099	6916	938	7567	683	9332	470	5561
4L-2S		MI	3166	1402	4221	1250	5269	1048	5877	889	6562	644	8046	553	3968
8-#10	1.54	MA	4658	1466	6102	1323	7832	1106	8904	933	10245	661	12922	574	7061
2L-4S		MI	2918	1466	3895	1306	4828	1091	5310	924	5782	652	7031	395	4886
8-#10	1.54	MA	4298	1466	5519	1336	7094	1118	8011	943	9043	675	11258	488	7030
3E		MI	3063	1466	4174	1295	5192	1083	5774	912	6415	648	7813	448	4938
8-#10	1.54	MA	4087	1466	5116	1349	6568	1130	7339	960	8124	684	10122	435	6913
4L-2S		MI	3304	1466	4571	1285	5694	1074	6381	905	7233	639	8916	542	4947
8-#11	1.89	MA	4855	1534	6657	1358	8483	1131	9665	947	11245	654	14289	567	8523
2L-4S		MI	2973	1534	4136	1340	5083	1115	5590	938	6134	643	7434	337	5752
8-#11	1.89	MA	4438	1534	5952	1373	7590	1145	8585	959	9792	670	12276	458	8468
3E		MI	3142	1534	4472	1329	5522	1106	6149	924	6898	640	8355	400	5902
8-#11	1.89	MA	4193	1534	5463	1388	6952	1158	7770	978	8677	679	10889	392	8253
4L-2S		MI	3420	1534	4949	1317	6124	1096	6877	916	7879	630	9649	514	5925
8-#14	2.73	MA	5346	1697	7907	1453	10026	1201	11513	990	13716	644	17697	555	12055
2L-4S		MI	3136	1697	4633	1442	5673	1189	6273	986	7035	634	8571	219	7536
8-#14	2.73	MA	4797	1697	6901	1474	8754	1219	9974	1007	11644	666	14827	395	11906
3E		MI	3366	1697	5112	1426	6296	1176	7069	967	8121	631	9859	307	8198
8-#14	2.73	MA	4477	1697	6202	1496	7842	1238	8808	1033	10051	678	12835	299	10937
4L-2S		MI	3720	1697	5787	1411	7150	1164	8101	958	9511	619	11661	472	8283
8-#18	4.85	MA	5675	2109	9216	1734	11611	1410	13393	1128	16213	656	21128	234	20185
3E		MI	3873	2109	6644	1676	8169	1357	9300	1078	11095	610	13352	44	13213
8-#18	4.85	MA	5219	2109	7997	1769	10020	1441	11359	1172	13435	673	17617	60	17254
4L-2S		MI	4387	2109	7802	1652	9634	1340	11072	1067	13481	594	16331	338	13971
10-#10	1.92	MA	4917	1541	6686	1370	8570	1141	9797	955	11447	658	14587	570	8766
2L-5S		MI	2984	1541	4043	1363	4978	1140	5501	953	6023	659	7355	333	5687
10-#10	1.92	MA	4574	1541	6102	1383	7832	1153	8904	965	10245	672	12922	484	8724
3L-4S		MI	3105	1541	4292	1352	5330	1126	5917	946	6599	649	8134	388	6024
10-#10	1.92	MA	4379	1541	5700	1396	7306	1164	8232	982	9326	681	11786	431	8597
4L-3S		MI	3241	1541	4571	1342	5694	1117	6381	934	7233	645	8916	441	6090
10-#10	1.92	MA	4169	1541	5343	1408	6798	1182	7631	992	8494	695	10588	377	8069
5L-2S		MI	3471	1541	4967	1332	6195	1109	6988	927	8050	636	10020	534	6109
10-#11	2.36	MA	5158	1626	7363	1415	9375	1173	10745	974	12699	650	16302	562	10582
2L-5S		MI	3055	1626	4311	1409	5260	1174	5815	972	6420	649	7814	257	6642

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis



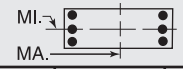
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#11	2.36	MA	4762	1626	6657	1430	8483	1187	9665	986	11245	666	14289	453	10511
3L-4S		MI	3192	1626	4612	1397	5686	1157	6318	965	7115	639	8728	325	7055
10-#11	2.36	MA	4537	1626	6169	1445	7845	1200	8849	1005	10130	676	12901	387	10240
4L-3S		MI	3349	1626	4949	1386	6124	1148	6877	951	7879	636	9649	387	7278
10-#11	2.36	MA	4293	1626	5735	1461	7228	1221	8120	1017	9121	692	11502	327	9493
5L-2S		MI	3614	1626	5425	1374	6726	1138	7606	943	8859	626	10942	502	7316
10-#14	3.41	MA	5241	1829	7907	1557	10026	1280	11513	1046	13716	661	17697	388	14814
3L-4S		MI	3451	1829	5308	1524	6526	1250	7306	1025	8425	629	10373	197	9403
10-#14	3.41	MA	4953	1829	7208	1578	9114	1299	10347	1072	12123	673	15704	292	13799
4L-3S		MI	3646	1829	5787	1509	7150	1237	8101	1006	9511	626	11661	285	10137
10-#14	3.41	MA	4615	1829	6587	1600	8232	1328	9305	1089	10680	695	13699	203	12843
5L-2S		MI	3976	1829	6461	1493	8004	1225	9134	997	10901	614	13463	450	10246
10-#18	6.06	MA	6017	2344	9744	1916	12230	1549	14032	1241	17034	664	22600	48	22294
4L-3S		MI	4329	2344	7802	1823	9634	1465	11072	1148	13481	601	16331	-9	16308
10-#18	6.06	MA	5446	2344	8656	1951	10687	1597	12211	1267	14514	699	19083	-123	18409
5L-2S		MI	4796	2344	8961	1799	11100	1448	12844	1137	15868	585	19310	285	17322
12-#10	2.31	MA	5170	1615	7270	1416	9308	1175	10690	977	12650	656	16251	567	10469
2L-6S		MI	2997	1615	4197	1419	5160	1183	5701	988	6278	660	7703	258	6521
12-#10	2.31	MA	4842	1615	6686	1429	8570	1187	9797	987	11447	670	14587	480	10417
3L-5S		MI	3168	1615	4440	1409	5479	1174	6108	975	6840	656	8459	326	6799
12-#10	2.31	MA	4660	1615	6284	1442	8044	1199	9124	1003	10528	678	13451	427	10283
4E		MI	3286	1615	4689	1399	5832	1160	6524	968	7416	647	9238	381	7163
12-#10	2.31	MA	4454	1615	5926	1455	7536	1216	8524	1014	9697	692	12253	373	9738
5L-3S		MI	3414	1615	4967	1389	6195	1152	6988	956	8050	643	10020	434	7239
12-#10	2.31	MA	4204	1615	5547	1463	7078	1228	7939	1030	8887	700	11205	312	9313
6L-2S		MI	3635	1615	5364	1379	6697	1143	7595	948	8867	633	11123	527	7267
12-#11	2.84	MA	5076	1718	7363	1488	9375	1229	10745	1013	12699	663	16302	448	12556
3L-5S		MI	3269	1718	4787	1466	5862	1216	6543	999	7401	646	9108	244	7978
12-#11	2.84	MA	4869	1718	6875	1503	8737	1243	9929	1032	11584	672	14914	382	12235
4E		MI	3415	1718	5088	1455	6288	1199	7046	992	8096	636	10021	312	8370
12-#11	2.84	MA	4629	1718	6440	1518	8121	1263	9200	1044	10575	688	13515	322	11517
5L-3S		MI	3556	1718	5425	1443	6726	1190	7606	978	8859	633	10942	375	8653
12-#11	2.84	MA	4337	1718	5987	1528	7563	1277	8489	1063	9591	697	12175	237	10799
6L-2S		MI	3800	1718	5901	1432	7328	1181	8334	970	9840	623	12236	489	8703
12-#14	4.09	MA	5411	1962	8214	1661	10387	1360	11887	1111	14196	668	18574	286	16671
4E		MI	3742	1962	5983	1607	7380	1310	8338	1064	9816	624	12175	175	11283
12-#14	4.09	MA	5079	1962	7593	1682	9505	1389	10844	1128	12753	690	16569	196	15741
5L-3S		MI	3917	1962	6461	1592	8004	1298	9134	1045	10901	622	13463	263	12077
12-#14	4.09	MA	4692	1962	6953	1697	8707	1408	9827	1154	11346	702	14644	72	14262
6L-2S		MI	4225	1962	7136	1576	8858	1286	10167	1036	12292	609	15264	428	12205
12-#18	7.27	MA	6219	2580	10403	2099	12897	1705	14883	1336	18113	690	24066	-135	23063
5L-3S		MI	4773	2580	8961	1970	11100	1573	12844	1217	15868	592	19310	-63	19126
14-#10	2.69	MA	5102	1690	7270	1476	9308	1221	10690	1009	12650	667	16251	476	12111
3L-6S		MI	3182	1690	4594	1465	5661	1217	6308	1010	7095	657	8807	251	7625
14-#10	2.69	MA	4933	1690	6867	1489	8782	1233	10017	1025	11730	675	15115	423	11971
4L-5S		MI	3346	1690	4836	1456	5981	1209	6715	997	7658	653	9562	319	7917
14-#10	2.69	MA	4730	1690	6510	1502	8275	1250	9417	1036	10899	689	13917	369	11412
5L-4S		MI	3463	1690	5085	1446	6334	1194	7131	990	8233	644	10342	374	8271
14-#10	2.69	MA	4492	1690	6131	1509	7816	1262	8832	1052	10089	698	12869	308	10989
6L-3S		MI	3583	1690	5364	1436	6697	1186	7595	977	8867	640	11123	427	8387
14-#10	2.69	MA	4281	1690	5760	1518	7340	1270	8266	1063	9301	712	11783	269	10315
7L-2S		MI	3795	1690	5761	1425	7199	1177	8202	970	9684	630	12227	520	8423
14-#11	3.31	MA	5190	1810	7580	1560	9630	1285	11009	1059	13038	669	16927	377	14238
4L-5S		MI	3486	1810	5263	1524	6464	1258	7272	1026	8382	642	10401	232	9321

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#11	3.31	MA	4953	1810	7146	1575	9013	1305	10280	1071	12028	685	15527	317	13545
5L-4S		MI	3620	1810	5564	1512	6890	1242	7775	1019	9077	632	11315	300	9692
14-#11	3.31	MA	4676	1810	6693	1585	8456	1319	9569	1090	11045	694	14187	232	12828
6L-3S		MI	3750	1810	5901	1501	7328	1232	8334	1005	9840	629	12236	362	10026
14-#11	3.31	MA	4432	1810	6243	1595	7888	1330	8881	1102	10088	710	12863	182	12032
7L-2S		MI	3981	1810	6377	1489	7931	1223	9063	997	10821	619	13530	477	10087
14-#14	4.77	MA	5548	2094	8599	1765	10778	1450	12384	1166	14825	685	19438	189	18635
5L-4S		MI	4023	2094	6658	1690	8234	1371	9371	1103	11206	619	13976	153	13174
14-#14	4.77	MA	5163	2094	7959	1780	9980	1468	11366	1193	13418	697	17513	65	17168
6L-3S		MI	4181	2094	7136	1674	8858	1359	10167	1084	12292	617	15264	241	14019
16-#10	3.08	MA	5199	1765	7451	1536	9521	1267	10910	1047	12932	672	16780	419	13662
4L-6S		MI	3362	1765	4990	1512	6163	1252	6915	1032	7912	654	9910	243	8733
16-#10	3.08	MA	4998	1765	7094	1549	9013	1285	10310	1058	12101	686	15582	365	13089
5E		MI	3519	1765	5233	1503	6483	1243	7322	1019	8475	650	10666	312	9038
16-#10	3.08	MA	4770	1765	6714	1556	8554	1297	9725	1074	11291	695	14534	304	12667
6L-4S		MI	3646	1765	5482	1493	6836	1229	7738	1012	9051	641	11445	367	9377
16-#10	3.08	MA	4571	1765	6344	1565	8078	1305	9159	1085	10503	709	13448	266	12008
7L-3S		MI	3753	1765	5761	1482	7199	1220	8202	999	9684	637	12227	420	9534
16-#10	3.08	MA	4386	1765	5935	1580	7575	1318	8588	1094	9718	717	12401	213	11290
8L-2S		MI	3950	1765	6157	1472	7701	1212	8809	992	10501	628	13330	513	9578
16-#11	3.78	MA	5268	1902	7852	1633	9906	1348	11359	1098	13482	681	17540	313	15577
5E		MI	3688	1902	5739	1581	7066	1300	8000	1053	9362	639	11695	219	10669
16-#11	3.78	MA	5005	1902	7399	1642	9348	1361	10649	1117	12498	690	16200	227	14860
6L-4S		MI	3820	1902	6040	1570	7492	1284	8503	1046	10057	629	12609	287	11022
16-#11	3.78	MA	4775	1902	6949	1652	8780	1372	9961	1129	11541	707	14875	177	14067
7L-3S		MI	3939	1902	6377	1558	7931	1274	9063	1032	10821	626	13530	350	11400
16-#14	5.45	MA	5647	2226	8965	1862	11252	1529	12906	1232	15491	692	20383	58	20075
6L-4S		MI	4298	2226	7333	1773	9088	1432	10403	1142	12596	614	15778	131	15074
18-#10	3.46	MA	5259	1840	7677	1595	9751	1319	11203	1080	13303	684	17247	361	14768
5L-6S		MI	3550	1840	5387	1559	6665	1286	7522	1054	8730	651	11014	236	9845
18-#10	3.46	MA	5041	1840	7298	1603	9292	1331	10618	1096	12493	692	16199	300	14348
6L-5S		MI	3698	1840	5630	1550	6985	1277	7928	1041	9292	648	11769	305	10163
18-#10	3.46	MA	4852	1840	6927	1612	8816	1339	10052	1107	11705	706	15112	262	13700
7L-4S		MI	3813	1840	5879	1539	7337	1263	8345	1034	9868	638	12549	359	10488
18-#10	3.46	MA	4677	1840	6519	1627	8313	1353	9481	1116	10920	714	14065	209	12977
8L-3S		MI	3914	1840	6157	1529	7701	1255	8809	1021	10501	634	13330	412	10682
18-#11	4.25	MA	5324	1993	8104	1700	10241	1403	11728	1144	13952	687	18213	223	16895
6L-5S		MI	3884	1993	6215	1639	7669	1342	8729	1080	10343	635	12988	207	12020
18-#11	4.25	MA	5107	1993	7655	1710	9673	1414	11040	1156	12995	703	16888	172	16102
7L-4S		MI	4015	1993	6517	1627	8095	1326	9232	1073	11038	625	13902	275	12358
20-#10	3.85	MA	5305	1914	7881	1650	10031	1365	11511	1118	13695	689	17863	296	16030
6E		MI	3721	1914	5784	1605	7167	1320	8129	1076	9547	649	12118	229	10961
20-#10	3.85	MA	5126	1914	7511	1658	9554	1373	10945	1129	12908	703	16777	258	15391
7L-5S		MI	3863	1914	6026	1596	7487	1312	8535	1063	10109	645	12873	298	11290
20-#10	3.85	MA	4956	1914	7102	1674	9051	1387	10373	1138	12123	712	15730	206	14664
8L-4S		MI	3977	1914	6275	1586	7839	1298	8952	1056	10685	635	13652	352	11603
20-#11	4.73	MA	5431	2085	8360	1767	10566	1456	12120	1183	14449	700	18901	168	18137
7L-5S		MI	4077	2085	6691	1696	8271	1384	9457	1107	11324	632	14282	194	13375
22-#10	4.23	MA	5393	1989	8094	1705	10293	1408	11838	1151	14110	700	18441	254	17083
7L-6S		MI	3890	1989	6180	1652	7669	1355	8735	1098	10364	646	13221	222	12079
22-#10	4.23	MA	5226	1989	7686	1720	9790	1421	11266	1160	13325	709	17395	202	16351
8L-5S		MI	4025	1989	6423	1643	7988	1346	9142	1085	10926	642	13977	290	12421
24-#10	4.62	MA	5490	2064	8270	1767	10528	1456	12159	1182	14527	706	19059	198	18038
8L-6S		MI	4055	2064	6577	1699	8170	1389	9342	1120	11181	643	14325	215	13200

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

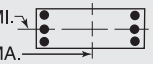
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.28	MA	5066	1510	6527	1370	8337	1149	9412	974	10666	703	13314	612	6665
2E		MI	3351	1510	4642	1317	5692	1104	6301	934	6994	671	8354	554	4351
4-#18	2.27	MA	5743	1716	8238	1487	10424	1234	11897	1026	13975	688	17868	595	11432
2E		MI	3716	1716	5697	1429	6955	1184	7793	982	8971	654	10666	482	7278
6-#10	1.08	MA	4958	1469	6116	1359	7912	1143	8947	972	10086	713	12544	621	5763
2L-3S		MI	3050	1469	3976	1322	4936	1111	5431	944	5862	694	7009	494	3802
6-#10	1.08	MA	4544	1469	5486	1372	7114	1155	7983	983	8787	728	10746	536	5747
3L-2S		MI	3304	1469	4373	1312	5438	1102	6038	937	6680	685	8113	587	3794
6-#11	1.33	MA	5129	1520	6587	1383	8452	1159	9572	981	10900	706	13652	614	6965
2L-3S		MI	3099	1520	4199	1344	5167	1125	5685	951	6181	686	7360	450	4547
6-#11	1.33	MA	4644	1520	5824	1399	7487	1174	8404	994	9328	723	11476	508	6930
3L-2S		MI	3395	1520	4675	1332	5769	1116	6413	943	7162	676	8653	565	4547
6-#14	1.92	MA	5553	1642	7616	1453	9714	1210	11078	1013	12909	698	16420	605	9850
2L-3S		MI	3236	1642	4642	1415	5692	1177	6301	982	6994	679	8354	366	6296
6-#14	1.92	MA	4903	1642	6527	1475	8337	1230	9412	1030	10666	722	13314	448	9731
3L-2S		MI	3632	1642	5317	1400	6545	1165	7333	973	8384	666	10156	532	6340
6-#18	3.41	MA	6511	1951	10133	1635	12821	1342	14795	1095	17877	680	23271	583	16949
2L-3S		MI	3568	1951	5697	1600	6955	1309	7793	1062	8971	661	10666	135	10290
6-#18	3.41	MA	5523	1951	8238	1672	10424	1375	11897	1123	13975	717	17868	296	16429
3L-2S		MI	4150	1951	6855	1576	8420	1292	9565	1051	11357	645	13646	429	10650
8-#9	1.14	MA	5013	1480	6194	1369	8031	1150	9102	978	10304	714	12853	622	6058
2L-4S		MI	3020	1480	3883	1340	4828	1125	5291	960	5675	698	6838	476	3979
8-#9	1.14	MA	4689	1480	5695	1380	7400	1160	8338	987	9276	726	11430	556	6046
3E		MI	3140	1480	4104	1331	5116	1118	5659	949	6178	695	7463	518	3990
8-#9	1.14	MA	4499	1480	5353	1390	6952	1170	7765	1000	8492	734	10470	515	5993
4L-2S		MI	3340	1480	4419	1323	5514	1111	6140	944	6826	687	8347	591	3985
8-#10	1.44	MA	5253	1544	6746	1406	8709	1177	9912	994	11384	710	14342	617	7610
2L-4S		MI	3088	1544	4094	1379	5074	1154	5574	979	6046	695	7331	433	4919
8-#10	1.44	MA	4859	1544	6116	1419	7912	1189	8947	1005	10086	725	12544	532	7579
3E		MI	3235	1544	4373	1369	5438	1145	6038	966	6680	692	8113	486	4961
8-#10	1.44	MA	4629	1544	5683	1432	7345	1202	8222	1022	9095	734	11327	480	7461
4L-2S		MI	3478	1544	4770	1358	5939	1137	6645	959	7497	682	9216	580	4966
8-#11	1.77	MA	5474	1612	7350	1440	9417	1201	10739	1008	12472	703	15829	610	9197
2L-4S		MI	3144	1612	4339	1413	5331	1177	5854	992	6398	686	7732	375	5845
8-#11	1.77	MA	5015	1612	6587	1456	8452	1216	9572	1021	10900	720	13652	503	9142
3E		MI	3315	1612	4675	1401	5769	1167	6413	978	7162	683	8653	438	5931
8-#11	1.77	MA	4747	1612	6060	1472	7764	1230	8692	1041	9698	730	12165	438	8937
4L-2S		MI	3596	1612	5151	1389	6372	1158	7142	970	8142	673	9947	552	5948
8-#14	2.56	MA	6017	1774	8704	1536	11092	1271	12744	1052	15152	693	19526	598	13027
2L-4S		MI	3305	1774	4839	1514	5922	1250	6538	1040	7298	677	8868	257	7646
8-#14	2.56	MA	5413	1774	7616	1558	9714	1291	11078	1069	12909	717	16420	442	12878
3E		MI	3531	1774	5317	1498	6545	1238	7333	1021	8384	674	10156	344	8238
8-#14	2.56	MA	5061	1774	6862	1580	8730	1311	9820	1097	11190	730	14283	347	11945
4L-2S		MI	3899	1774	5992	1482	7399	1225	8366	1012	9774	662	11958	510	8311
8-#18	4.55	MA	6384	2186	10133	1819	12821	1483	14795	1192	17877	708	23271	284	21914
3E		MI	4044	2186	6855	1747	8420	1418	9565	1131	11357	652	13646	81	13390
8-#18	4.55	MA	5839	2186	8815	1856	11101	1516	12597	1238	14874	728	19502	112	18856
4L-2S		MI	4569	2186	8014	1723	9886	1400	11338	1120	13744	636	16625	375	14008
10-#10	1.80	MA	5539	1618	7377	1452	9506	1211	10876	1016	12683	707	16140	613	9452
2L-5S		MI	3155	1618	4242	1436	5223	1203	5764	1008	6287	702	7655	371	5758
10-#10	1.80	MA	5163	1618	6746	1466	8709	1224	9912	1027	11384	722	14342	528	9410
3L-4S		MI	3276	1618	4491	1426	5576	1188	6181	1001	6863	693	8435	426	6059

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis



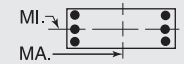
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.80	MA	4949	1618	6313	1479	8143	1236	9187	1044	10393	731	13125	476	9282
4L-3S		MI	3414	1618	4770	1415	5939	1180	6645	988	7497	689	9216	479	6114
10-#10	1.80	MA	4716	1618	5929	1492	7596	1254	8541	1055	9498	746	11838	424	8761
5L-2S		MI	3647	1618	5166	1405	6441	1171	7252	981	8314	679	10320	572	6130
10-#11	2.22	MA	5807	1704	8113	1498	10382	1244	11907	1035	14044	699	18005	605	11425
2L-5S		MI	3224	1704	4514	1482	5507	1235	6079	1026	6684	692	8112	295	6723
10-#11	2.22	MA	5372	1704	7350	1513	9417	1258	10739	1048	12472	716	15829	498	11354
3L-4S		MI	3363	1704	4815	1470	5933	1219	6582	1019	7379	682	9026	362	7145
10-#11	2.22	MA	5125	1704	6823	1529	8729	1272	9859	1068	11269	727	14342	433	11140
4L-3S		MI	3523	1704	5151	1458	6372	1210	7142	1005	8142	679	9947	425	7309
10-#11	2.22	MA	4853	1704	6356	1545	8065	1294	9074	1081	10182	744	12837	375	10318
5L-2S		MI	3792	1704	5628	1447	6974	1200	7870	997	9123	669	11241	540	7341
10-#14	3.20	MA	5899	1907	8704	1641	11092	1352	12744	1108	15152	712	19526	435	16029
3L-4S		MI	3621	1907	5514	1596	6775	1311	7570	1079	8689	672	10670	235	9508
10-#14	3.20	MA	5584	1907	7951	1663	10108	1372	11486	1136	13433	725	17389	340	15053
4L-3S		MI	3821	1907	5992	1581	7399	1299	8366	1060	9774	669	11958	322	10178
10-#14	3.20	MA	5207	1907	7282	1685	9157	1402	10362	1154	11877	749	15232	254	13971
5L-2S		MI	4156	1907	6667	1565	8253	1286	9399	1051	11165	657	13760	488	10275
10-#18	5.68	MA	6757	2422	10709	2003	13497	1624	15495	1308	18776	720	24905	100	24338
4L-3S		MI	4501	2422	8014	1894	9886	1526	11338	1200	13744	643	16625	28	16529
10-#18	5.68	MA	6118	2422	9536	2040	11832	1674	13529	1336	16054	757	21118	-63	20868
5L-2S		MI	4980	2422	9172	1870	11351	1508	13110	1189	16130	627	19605	322	17360
12-#10	2.16	MA	5817	1693	8007	1499	10304	1246	11840	1038	13981	704	17938	609	11292
2L-6S		MI	3167	1693	4396	1492	5405	1246	5964	1042	6542	703	8003	296	6632
12-#10	2.16	MA	5456	1693	7377	1512	9506	1258	10876	1049	12683	719	16140	525	11240
3L-5S		MI	3339	1693	4639	1483	5725	1237	6371	1030	7105	699	8759	364	6868
12-#10	2.16	MA	5257	1693	6943	1526	8940	1270	10151	1066	11692	728	14923	472	11106
4E		MI	3458	1693	4888	1472	6078	1223	6788	1023	7680	690	9538	419	7199
12-#10	2.16	MA	5029	1693	6559	1539	8393	1288	9505	1077	10797	743	13636	420	10568
5L-3S		MI	3588	1693	5166	1462	6441	1214	7252	1010	8314	686	10320	472	7265
12-#10	2.16	MA	4756	1693	6146	1546	7900	1300	8876	1094	9925	752	12514	359	10106
6L-2S		MI	3813	1693	5563	1452	6943	1205	7859	1003	9131	677	11423	565	7289
12-#11	2.66	MA	5716	1796	8113	1571	10382	1300	11907	1075	14044	713	18005	493	13567
3L-5S		MI	3441	1796	4990	1539	6110	1278	6808	1053	7665	689	9406	282	8057
12-#11	2.66	MA	5489	1796	7586	1587	9695	1314	11027	1095	12841	723	16518	428	13332
4E		MI	3576	1796	5291	1527	6536	1261	7311	1046	8360	679	10320	350	8457
12-#11	2.66	MA	5222	1796	7119	1602	9030	1336	10242	1108	11754	740	15014	371	12510
5L-3S		MI	3731	1796	5628	1516	6974	1252	7870	1032	9123	676	11241	412	8685
12-#11	2.66	MA	4903	1796	6624	1612	8430	1350	9476	1128	10694	750	13578	286	11797
6L-2S		MI	3979	1796	6104	1504	7576	1242	8598	1024	10104	666	12534	527	8729
12-#14	3.84	MA	6085	2039	9040	1746	11485	1433	13152	1175	15676	720	20495	333	18169
4E		MI	3913	2039	6189	1679	7629	1372	8603	1118	10079	667	12472	213	11384
12-#14	3.84	MA	5715	2039	8371	1768	10534	1462	12028	1193	14120	744	18338	247	17131
5L-3S		MI	4093	2039	6667	1664	8253	1359	9399	1099	11165	664	13760	300	12119
12-#14	3.84	MA	5291	2039	7670	1782	9675	1482	10932	1220	12603	757	16274	125	15558
6L-2S		MI	4408	2039	7342	1648	9107	1347	10431	1090	12555	652	15561	466	12235
12-#18	6.82	MA	6966	2657	11431	2187	14229	1782	16427	1405	19956	748	26521	-75	26076
5L-3S		MI	4946	2657	9172	2041	11351	1634	13110	1269	16130	634	19605	-26	19530
14-#10	2.53	MA	5742	1768	8007	1559	10304	1292	11840	1071	13981	716	17938	521	13071
3L-6S		MI	3353	1768	4793	1539	5907	1280	6571	1064	7360	700	9107	289	7733
14-#10	2.53	MA	5556	1768	7574	1573	9737	1305	11116	1088	12990	726	16721	468	12932
4L-5S		MI	3518	1768	5035	1529	6227	1271	6978	1052	7922	697	9862	357	7984
14-#10	2.53	MA	5331	1768	7189	1586	9191	1322	10470	1099	12095	740	15434	416	12379
5L-4S		MI	3636	1768	5284	1519	6580	1257	7395	1045	8498	687	10642	412	8339

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

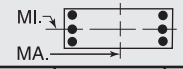


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.53	MA	5070	1768	6776	1593	8698	1335	9840	1116	11223	749	14312	355	11934
6L-3S		MI	3758	1768	5563	1509	6943	1248	7859	1032	9131	683	11423	465	8414
14-#10	2.53	MA	4840	1768	6377	1602	8177	1343	9232	1127	10376	764	13146	319	11228
7L-2S		MI	3975	1768	5960	1499	7445	1240	8466	1025	9948	674	12527	558	8446
14-#11	3.10	MA	5840	1887	8349	1644	10660	1357	12194	1122	14413	720	18695	423	15502
4L-5S		MI	3659	1887	5466	1596	6712	1320	7536	1080	8645	685	10699	269	9398
14-#11	3.10	MA	5577	1887	7882	1660	9995	1378	11409	1135	13326	737	17190	366	14707
5L-4S		MI	3793	1887	5767	1585	7138	1303	8039	1073	9340	675	11613	337	9777
14-#11	3.10	MA	5274	1887	7387	1669	9395	1392	10644	1155	12266	747	15754	281	13999
6L-3S		MI	3926	1887	6104	1573	7576	1294	8598	1059	10104	672	12534	400	10059
14-#11	3.10	MA	5007	1887	6902	1680	8774	1402	9903	1168	11235	764	14332	234	13124
7L-2S		MI	4162	1887	6580	1562	8178	1285	9327	1051	11085	662	13828	515	10114
14-#14	4.47	MA	6205	2172	9459	1851	11911	1523	13694	1232	16363	739	21444	240	20295
5L-4S		MI	4195	2172	6864	1762	8483	1433	9636	1157	11469	662	14273	191	13271
14-#14	4.47	MA	5807	2172	8759	1864	11052	1543	12598	1259	14846	752	19380	118	18704
6L-3S		MI	4358	2172	7342	1746	9107	1420	10431	1138	12555	659	15561	278	14061
14-#14	4.47	MA	5455	2172	8066	1879	10173	1558	11538	1277	13371	776	17339	46	17131
7L-2S		MI	4655	2172	8017	1731	9961	1408	11464	1128	13945	647	17363	444	14192
16-#10	2.89	MA	5847	1843	8204	1619	10535	1339	12080	1110	14289	723	18519	464	14759
4L-6S		MI	3534	1843	5189	1585	6409	1314	7178	1086	8177	698	10211	281	8838
16-#10	2.89	MA	5624	1843	7820	1633	9988	1357	11434	1121	13394	738	17232	412	14193
5E		MI	3693	1843	5432	1576	6729	1306	7585	1074	8739	694	10966	350	9103
16-#10	2.89	MA	5375	1843	7406	1640	9495	1369	10805	1138	12522	747	16110	352	13763
6L-4S		MI	3809	1843	5681	1566	7081	1291	8002	1067	9315	684	11745	405	9451
16-#10	2.89	MA	5157	1843	7007	1649	8975	1377	10196	1149	11674	761	14944	315	13044
7L-3S		MI	3931	1843	5960	1556	7445	1283	8466	1054	9948	680	12527	458	9562
16-#10	2.89	MA	4955	1843	6567	1665	8433	1391	9571	1158	10829	771	13821	265	12314
8L-2S		MI	4131	1843	6356	1545	7947	1274	9073	1047	10766	671	13630	551	9601
16-#11	3.55	MA	5922	1979	8645	1717	10961	1420	12577	1162	14898	733	19367	361	16907
5E		MI	3862	1979	5942	1654	7314	1362	8265	1107	9626	682	11993	257	10743
16-#11	3.55	MA	5634	1979	8150	1727	10361	1435	11811	1182	13838	743	17931	277	16203
6L-4S		MI	3994	1979	6243	1642	7740	1346	8767	1100	10321	672	12907	325	11104
16-#11	3.55	MA	5382	1979	7665	1737	9739	1445	11071	1195	12807	760	16509	229	15335
7L-3S		MI	4117	1979	6580	1631	8178	1336	9327	1086	11085	669	13828	387	11434
16-#11	3.55	MA	5148	1979	7131	1756	9081	1461	10325	1206	11780	771	15139	164	14292
8L-2S		MI	4342	1979	7056	1619	8781	1327	10055	1078	12065	659	15121	502	11497
16-#14	5.11	MA	6339	2304	9848	1947	12429	1604	14264	1298	17089	747	22486	111	21851
6L-4S		MI	4471	2304	7538	1845	9337	1493	10668	1195	12860	657	16075	169	15167
16-#14	5.11	MA	5978	2304	9155	1962	11551	1619	13204	1316	15614	771	20445	39	20268
7L-3S		MI	4618	2304	8017	1829	9961	1481	11464	1176	13945	654	17363	256	16004
18-#10	3.25	MA	5910	1917	8450	1679	10785	1391	12398	1143	14692	735	19029	408	16009
5L-6S		MI	3710	1917	5586	1632	6911	1349	7785	1108	8994	695	11314	274	9947
18-#10	3.25	MA	5671	1917	8037	1687	10292	1403	11769	1160	13820	744	17907	348	15593
6L-5S		MI	3873	1917	5829	1623	7231	1340	8192	1096	9556	691	12070	343	10226
18-#10	3.25	MA	5464	1917	7637	1696	9772	1411	11160	1171	12973	759	16742	311	14872
7L-4S		MI	3989	1917	6078	1613	7583	1326	8608	1089	10132	681	12849	397	10560
18-#10	3.25	MA	5273	1917	7197	1711	9230	1425	10536	1180	12128	768	15618	261	14136
8L-3S		MI	4092	1917	6356	1602	7947	1317	9073	1076	10766	678	13630	450	10710
18-#10	3.25	MA	5022	1917	6819	1723	8727	1435	9894	1193	11295	783	14456	206	13397
9L-2S		MI	4285	1917	6753	1592	8448	1308	9679	1069	11583	668	14734	544	10755
18-#11	3.99	MA	5984	2071	8913	1784	11326	1477	12979	1209	15410	740	20107	272	18410
6L-5S		MI	4059	2071	6418	1711	7916	1404	8993	1134	10607	678	13287	244	12092
18-#11	3.99	MA	5746	2071	8428	1794	10704	1487	12238	1222	14379	757	18685	224	17545
7L-4S		MI	4190	2071	6719	1700	8342	1388	9496	1127	11302	668	14200	312	12437
18-#11	3.99	MA	5522	2071	7894	1813	10046	1504	11493	1233	13352	767	17315	160	16497
8L-3S		MI	4304	2071	7056	1688	8781	1378	10055	1113	12065	665	15121	375	12808
18-#14	5.75	MA	6525	2437	10243	2044	12928	1680	14870	1355	17857	766	23551	32	23405
7L-4S		MI	4740	2437	8213	1928	10191	1554	11701	1234	14250	652	17877	147	17071

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
20-#10	3.61	MA	5960	1992	8667	1733	11090	1438	12733	1182	15119	741	19705	344	17425
6E		MI	3895	1992	5983	1679	7413	1383	8392	1130	9811	692	12418	267	11060
20-#10	3.61	MA	5764	1992	8267	1742	10569	1446	12125	1193	14271	756	18540	307	16699
7L-5S		MI	4039	1992	6225	1670	7732	1374	8799	1118	10373	688	13173	336	11353
20-#10	3.61	MA	5575	1992	7828	1758	10028	1460	11500	1202	13426	765	17416	257	15959
8L-4S		MI	4154	1992	6474	1659	8085	1360	9215	1110	10949	679	13952	390	11673
20-#10	3.61	MA	5334	1992	7449	1769	9524	1469	10858	1215	12593	780	16254	203	15216
9L-3S		MI	4250	1992	6753	1649	8448	1351	9679	1098	11583	675	14734	443	11857
20-#11	4.43	MA	6100	2163	9191	1852	11669	1529	13406	1249	15951	754	20862	219	19756
7L-5S		MI	4253	2163	6894	1768	8519	1446	9721	1161	11588	675	14580	232	13445
20-#11	4.43	MA	5880	2163	8657	1871	11012	1546	12660	1260	14924	764	19492	155	18702
8L-4S		MI	4382	2163	7196	1757	8944	1430	10224	1154	12282	665	15494	300	13775
22-#10	3.97	MA	6056	2067	8898	1789	11367	1480	13089	1215	15569	753	20338	303	18527
7L-6S		MI	4064	2067	6379	1725	7914	1417	8999	1152	10628	689	13521	260	12176
22-#10	3.97	MA	5870	2067	8458	1805	10825	1494	12464	1224	14725	762	19214	253	17781
8L-5S		MI	4202	2067	6622	1716	8234	1409	9406	1139	11191	685	14277	328	12481
22-#10	3.97	MA	5639	2067	8079	1816	10322	1504	11823	1237	13892	777	18052	199	17034
9L-4S		MI	4316	2067	6871	1706	8587	1394	9822	1132	11766	676	15056	383	12790
22-#11	4.88	MA	6229	2255	9420	1928	11977	1588	13828	1287	16496	760	21668	150	20907
8L-5S		MI	4443	2255	7370	1826	9121	1488	10450	1188	12568	671	15874	219	14801
24-#10	4.33	MA	6159	2142	9088	1852	11622	1528	13429	1246	16023	759	21012	249	19604
8L-6S		MI	4230	2142	6776	1772	8416	1452	9606	1174	11445	686	14625	253	13295
24-#10	4.33	MA	5936	2142	8710	1863	11119	1538	12787	1259	15190	774	19850	195	18853
9L-5S		MI	4363	2142	7019	1763	8736	1443	10013	1161	12008	682	15380	321	13612

RECTANGULAR TIED COLUMNS 22" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.20	MA	5681	1587	7184	1453	9231	1220	10435	1035	11810	752	14729	655	7151
2E		MI	3525	1587	4848	1389	5941	1165	6565	987	7257	714	8651	591	4373
4-#18	2.14	MA	6426	1793	9032	1570	11486	1305	13119	1087	15384	737	19648	638	12296
2E		MI	3893	1793	5908	1500	7206	1244	8058	1035	9233	696	10961	519	7309
6-#10	1.02	MA	5559	1547	6738	1442	8769	1213	9928	1034	11177	762	13889	664	6174
2L-3S		MI	3222	1547	4175	1395	5181	1173	5695	999	6127	738	7309	532	3821
6-#10	1.02	MA	5109	1547	6061	1455	7912	1226	8892	1045	9782	777	11958	581	6158
3L-2S		MI	3477	1547	4572	1385	5683	1165	6301	992	6944	728	8413	625	3811
6-#11	1.25	MA	5748	1598	7246	1466	9352	1230	10604	1043	12058	755	15087	657	7471
2L-3S		MI	3271	1598	4402	1416	5415	1187	5949	1005	6445	729	7658	488	4572
6-#11	1.25	MA	5220	1598	6426	1482	8315	1245	9348	1056	10367	773	12747	552	7435
3L-2S		MI	3569	1598	4878	1405	6017	1178	6677	997	7425	719	8952	602	4567
6-#14	1.80	MA	6213	1720	8355	1536	10713	1281	12227	1074	14223	747	18071	648	10579
2L-3S		MI	3408	1720	4848	1487	5941	1238	6565	1035	7257	722	8651	404	6331
6-#14	1.80	MA	5505	1720	7184	1559	9231	1302	10435	1093	11810	772	14729	494	10460
3L-2S		MI	3807	1720	5523	1472	6794	1226	7598	1026	8647	709	10453	569	6365
6-#18	3.21	MA	7272	2029	11074	1717	14068	1413	16242	1156	19589	729	25470	626	18245
2L-3S		MI	3738	2029	5908	1671	7206	1370	8058	1115	9233	703	10961	172	10429
6-#18	3.21	MA	6185	2029	9032	1756	11486	1447	13119	1187	15384	769	19648	345	17725
3L-2S		MI	4330	2029	7066	1647	8672	1353	9831	1104	11620	687	13940	465	10685
8-#9	1.07	MA	5618	1558	6821	1451	8895	1221	10093	1039	11409	763	14219	665	6490
2L-4S		MI	3190	1558	4081	1413	5073	1188	5554	1014	5940	742	7139	514	4001
8-#9	1.07	MA	5266	1558	6285	1462	8218	1231	9273	1049	10306	775	12691	600	6478
3E		MI	3312	1558	4301	1405	5361	1181	5922	1004	6442	738	7764	556	4007
8-#9	1.07	MA	5060	1558	5918	1473	7738	1241	8659	1062	9466	783	11667	559	6425
4L-2S		MI	3513	1558	4616	1397	5759	1174	6404	998	7091	731	8647	630	4001
8-#10	1.36	MA	5881	1621	7415	1488	9625	1247	10964	1056	12572	759	15821	660	8158
2L-4S		MI	3259	1621	4293	1452	5320	1216	5837	1033	6310	739	7631	471	4950
8-#10	1.36	MA	5452	1621	6738	1502	8769	1260	9928	1067	11177	774	13889	577	8127
3E		MI	3408	1621	4572	1442	5683	1208	6301	1021	6944	735	8413	524	4982

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis

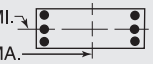
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#10	1.36	MA	5203	1621	6274	1516	8162	1273	9152	1085	10115	784	12591	525	8010
4L-2S		MI	3653	1621	4969	1432	6185	1199	6908	1013	7761	725	9516	618	4984
8-#11	1.67	MA	6125	1690	8067	1523	10390	1272	11859	1070	13748	752	17427	652	9871
2L-4S		MI	3314	1690	4542	1485	5579	1239	6118	1046	6662	729	8031	413	5888
8-#11	1.67	MA	5625	1690	7246	1539	9352	1287	10604	1083	12058	770	15087	548	9816
3E		MI	3487	1690	4878	1473	6017	1229	6677	1032	7425	725	8952	475	5958
8-#11	1.67	MA	5334	1690	6682	1556	8615	1302	9660	1104	10767	781	13500	483	9611
4L-2S		MI	3771	1690	5354	1462	6619	1220	7406	1024	8406	716	10245	590	5971
8-#14	2.41	MA	6721	1852	9527	1619	12195	1342	14020	1113	16637	742	21413	641	13999
2L-4S		MI	3474	1852	5045	1586	6171	1311	6802	1093	7561	719	9165	294	7753
8-#14	2.41	MA	6060	1852	8355	1641	10713	1362	12227	1132	14223	767	18071	487	13850
3E		MI	3703	1852	5523	1570	6794	1299	7598	1074	8647	717	10453	382	8275
8-#14	2.41	MA	5678	1852	7547	1664	9657	1383	10877	1161	12377	782	15790	394	12968
4L-2S		MI	4077	1852	6198	1554	7648	1287	8631	1065	10038	704	12255	547	8339
8-#18	4.28	MA	7128	2264	11074	1903	14068	1555	16242	1256	19589	760	25470	332	23642
3E		MI	4216	2264	7066	1818	8672	1478	9831	1184	11620	694	13940	118	13563
8-#18	4.28	MA	6530	2264	9659	1941	12221	1590	13880	1304	16361	783	21445	163	20457
4L-2S		MI	4751	2264	8225	1794	10137	1461	11603	1173	14006	678	16919	412	14045
10-#10	1.70	MA	6193	1696	8092	1535	10481	1282	12000	1077	13967	756	17752	656	10138
2L-5S		MI	3326	1696	4441	1509	5469	1265	6028	1062	6552	745	7955	409	5827
10-#10	1.70	MA	5783	1696	7415	1549	9625	1294	10964	1089	12572	772	15821	573	10095
3L-4S		MI	3448	1696	4690	1499	5822	1251	6444	1055	7127	736	8735	464	6092
10-#10	1.70	MA	5551	1696	6951	1563	9018	1307	10187	1107	11510	781	14523	521	9968
4L-3S		MI	3587	1696	4969	1489	6185	1242	6908	1042	7761	732	9516	517	6138
10-#10	1.70	MA	5295	1696	6539	1576	8433	1326	9496	1118	10551	797	13146	470	9461
5L-2S		MI	3823	1696	5365	1478	6687	1233	7515	1035	8578	723	10620	610	6150
10-#11	2.09	MA	6489	1782	8887	1580	11428	1314	13114	1097	15438	748	19768	648	12267
2L-5S		MI	3393	1782	4717	1554	5755	1297	6344	1080	6948	735	8411	332	6802
10-#11	2.09	MA	6014	1782	8067	1597	10390	1329	11859	1110	13748	766	17427	543	12196
3L-4S		MI	3534	1782	5018	1542	6181	1281	6846	1073	7643	725	9324	400	7233
10-#11	2.09	MA	5745	1782	7502	1613	9653	1344	10915	1131	12457	777	15841	478	11983
4L-3S		MI	3696	1782	5354	1531	6619	1271	7406	1059	8406	722	10245	463	7338
10-#11	2.09	MA	5445	1782	7002	1629	8941	1366	10074	1144	11291	795	14163	414	11150
5L-2S		MI	3968	1782	5830	1519	7222	1262	8134	1051	9387	712	11539	577	7365
10-#14	3.01	MA	6592	1985	9527	1724	12195	1423	14020	1171	16637	762	21413	481	17244
3L-4S		MI	3791	1985	5719	1668	7024	1372	7835	1132	8952	714	10967	272	9610
10-#14	3.01	MA	6247	1985	8719	1747	11140	1444	12669	1200	14791	777	19132	387	16322
4L-3S		MI	3995	1985	6198	1653	7648	1360	8631	1113	10038	712	12255	360	10217
10-#14	3.01	MA	5831	1985	8002	1770	10120	1475	11465	1218	13122	802	16727	291	15107
5L-2S		MI	4337	1985	6873	1637	8502	1348	9663	1104	11428	699	14056	525	10304
10-#18	5.35	MA	7531	2500	11700	2089	14803	1698	17003	1373	20566	774	27268	150	26356
4L-3S		MI	4674	2500	8225	1965	10137	1586	11603	1253	14006	685	16919	65	16694
10-#18	5.35	MA	6785	2500	10442	2127	13016	1750	14892	1404	17643	814	23212	-6	23188
5L-2S		MI	5163	2500	9383	1941	11603	1569	13375	1242	16392	669	19899	358	17398
12-#10	2.04	MA	6496	1771	8769	1582	11338	1316	13036	1099	15361	753	19683	652	12115
2L-6S		MI	3338	1771	4595	1565	5651	1308	6228	1097	6807	747	8304	334	6707
12-#10	2.04	MA	6103	1771	8092	1595	10481	1329	12000	1111	13967	769	17752	569	12063
3L-5S		MI	3511	1771	4837	1556	5971	1299	6635	1084	7369	743	9059	402	6935
12-#10	2.04	MA	5886	1771	7628	1609	9875	1342	11223	1129	12904	779	16454	517	11929
4E		MI	3630	1771	5087	1546	6323	1285	7051	1077	7945	733	9838	457	7233
12-#10	2.04	MA	5635	1771	7216	1623	9289	1360	10532	1140	11946	794	15077	466	11406
5L-3S		MI	3762	1771	5365	1535	6687	1276	7515	1064	8578	729	10620	510	7290
12-#10	2.04	MA	5339	1771	6769	1630	8760	1373	9874	1152	11012	804	13879	407	10895
6L-2S		MI	3989	1771	5762	1525	7189	1268	8122	1057	9395	720	11723	603	7310

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis



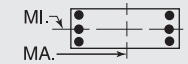
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.50	MA	6389	1873	8887	1654	11428	1371	13114	1137	15438	763	19768	538	14577
3L-5S		MI	3613	1873	5193	1611	6357	1339	7072	1107	7928	732	9704	320	8134
12-#11	2.50	MA	6141	1873	8323	1670	10690	1386	12170	1158	14147	774	18181	474	14358
4E		MI	3748	1873	5494	1600	6783	1323	7575	1100	8623	722	10618	388	8542
12-#11	2.50	MA	5847	1873	7822	1687	9978	1408	11329	1171	12982	792	16503	409	13511
5L-3S		MI	3906	1873	5830	1588	7222	1314	8134	1085	9387	719	11539	450	8716
12-#11	2.50	MA	5500	1873	7285	1696	9336	1423	10509	1192	11846	803	15040	334	12811
6L-2S		MI	4158	1873	6307	1577	7824	1304	8863	1078	10368	709	12833	565	8754
12-#14	3.61	MA	6793	2117	9891	1830	12622	1505	14462	1238	17204	772	22474	380	19684
4E		MI	4084	2117	6394	1751	7878	1433	8868	1171	10342	709	12769	250	11482
12-#14	3.61	MA	6384	2117	9174	1853	11602	1536	13257	1257	15535	797	20069	284	18506
5L-3S		MI	4268	2117	6873	1736	8502	1421	9663	1152	11428	707	14056	338	12159
12-#14	3.61	MA	5923	2117	8412	1866	10681	1557	12083	1286	13909	812	17964	176	16873
6L-2S		MI	4590	2117	7548	1720	9356	1408	10696	1143	12818	694	15858	503	12265
12-#18	6.42	MA	7746	2735	12484	2274	15599	1858	18015	1473	21849	805	29034	-18	28921
5L-3S		MI	5120	2735	9383	2112	11603	1694	13375	1322	16392	676	19899	11	19857
14-#10	2.38	MA	6414	1846	8769	1642	11338	1363	13036	1133	15361	766	19683	565	14032
3L-6S		MI	3524	1846	4991	1612	6153	1342	6835	1119	7624	744	9407	327	7830
14-#10	2.38	MA	6212	1846	8305	1656	10731	1376	12259	1151	14299	776	18385	513	13892
4L-5S		MI	3691	1846	5234	1603	6473	1334	7242	1106	8186	740	10163	395	8049
14-#10	2.38	MA	5964	1846	7893	1670	10146	1394	11567	1162	13340	791	17009	462	13354
5L-4S		MI	3809	1846	5483	1592	6825	1319	7658	1099	8762	730	10942	450	8374
14-#10	2.38	MA	5681	1846	7446	1677	9617	1407	10910	1174	12407	801	15810	403	12860
6L-3S		MI	3933	1846	5762	1582	7189	1311	8122	1086	9395	727	11723	503	8440
14-#10	2.38	MA	5431	1846	7018	1686	9054	1415	10242	1192	11499	816	14568	368	12139
7L-2S		MI	4153	1846	6159	1572	7690	1302	8729	1079	10213	717	12827	596	8468
14-#11	2.92	MA	6524	1965	9143	1728	11728	1428	13426	1185	15838	770	20521	469	16737
4L-5S		MI	3822	1965	5669	1669	6960	1382	7800	1134	8909	728	10998	307	9472
14-#11	2.92	MA	6234	1965	8643	1744	11016	1450	12584	1198	14672	788	18844	404	15877
5L-4S		MI	3966	1965	5970	1657	7385	1365	8303	1127	9604	718	11911	375	9859
14-#11	2.92	MA	5905	1965	8105	1753	10374	1465	11764	1219	13536	799	17380	330	15186
6L-3S		MI	4103	1965	6307	1646	7824	1356	8863	1112	10368	715	12833	438	10091
14-#11	2.92	MA	5614	1965	7585	1764	9698	1475	10971	1233	12432	817	15861	284	14199
7L-2S		MI	4343	1965	6783	1634	8426	1346	9591	1105	11348	705	14126	552	10140
14-#14	4.21	MA	6917	2250	10345	1936	13084	1597	15050	1296	17949	792	23410	277	21905
5L-4S		MI	4368	2250	7069	1834	8732	1494	9900	1210	11733	704	14570	228	13366
14-#14	4.21	MA	6484	2250	9584	1949	12164	1618	13875	1325	16323	807	21306	169	20259
6L-3S		MI	4535	2250	7548	1818	9356	1482	10696	1191	12818	702	15858	316	14102
14-#14	4.21	MA	6101	2250	8840	1964	11207	1632	12739	1344	14741	831	19125	101	18632
7L-2S		MI	4838	2250	8223	1803	10210	1469	11729	1182	14209	689	17660	481	14223
16-#10	2.72	MA	6528	1921	8982	1703	11587	1410	13295	1173	15694	773	20316	509	15856
4L-6S		MI	3705	1921	5388	1658	6655	1377	7442	1141	8441	741	10511	319	8940
16-#10	2.72	MA	6283	1921	8570	1716	11002	1429	12603	1184	14735	788	18940	459	15305
5E		MI	3866	1921	5631	1649	6974	1368	7849	1128	9003	737	11266	388	9167
16-#10	2.72	MA	6012	1921	8123	1724	10473	1441	11946	1196	13801	798	17741	399	14827
6L-4S		MI	3983	1921	5880	1639	7327	1354	8265	1121	9579	728	12045	443	9515
16-#10	2.72	MA	5775	1921	7695	1733	9911	1449	11278	1214	12894	814	16499	364	14102
7L-3S		MI	4108	1921	6159	1629	7690	1345	8729	1108	10213	724	12827	496	9589
16-#10	2.72	MA	5556	1921	7223	1749	9330	1464	10600	1222	11989	823	15299	315	13354
8L-2S		MI	4312	1921	6555	1619	8192	1336	9336	1101	11030	714	13931	589	9623
16-#11	3.34	MA	6610	2057	9463	1801	12054	1492	13839	1225	16362	785	21184	399	18246
5E		MI	4035	2057	6145	1726	7562	1424	8529	1161	9890	725	12291	295	10815
16-#11	3.34	MA	6296	2057	8926	1810	11412	1507	13019	1246	15226	796	19721	325	17562
6L-4S		MI	4168	2057	6446	1715	7988	1407	9032	1154	10585	715	13205	362	11184

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis

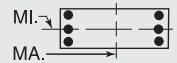


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	3.34	MA	6022	2057	8406	1821	10736	1517	12226	1260	14122	814	18201	280	16577
7L-3S		MI	4294	2057	6783	1703	8426	1398	9591	1139	11348	712	14126	425	11466
16-#11	3.34	MA	5767	2057	7833	1841	10031	1534	11415	1270	13022	825	16737	217	15504
8L-2S		MI	4524	2057	7259	1691	9028	1389	10320	1132	12329	702	15420	540	11524
16-#14	4.81	MA	7026	2382	10756	2032	13646	1678	15668	1364	18736	802	24648	162	23645
6L-4S		MI	4644	2382	7744	1917	9586	1555	10933	1249	13123	699	16372	206	15259
16-#14	4.81	MA	6670	2382	10011	2047	12689	1693	14532	1383	17155	826	22467	94	22008
7L-3S		MI	4796	2382	8223	1901	10210	1542	11729	1230	14209	697	17660	294	16045
18-#10	3.06	MA	6594	1995	9247	1763	11859	1463	13639	1206	16130	786	20871	455	17258
5L-6S		MI	3882	1995	5785	1705	7157	1411	8049	1163	9258	738	11614	312	10047
18-#10	3.06	MA	6334	1995	8800	1770	11330	1476	12982	1218	15196	795	19672	395	16796
6L-5S		MI	4038	1995	6028	1696	7476	1402	8456	1150	9820	734	12370	381	10288
18-#10	3.06	MA	6109	1995	8372	1780	10767	1483	12314	1235	14288	811	18431	360	16066
7L-4S		MI	4164	1995	6277	1686	7829	1388	8872	1143	10396	725	13149	436	10631
18-#10	3.06	MA	5899	1995	7900	1796	10186	1498	11636	1243	13384	821	17230	311	15312
8L-3S		MI	4270	1995	6555	1676	8192	1379	9336	1130	11030	721	13931	488	10737
18-#10	3.06	MA	5626	1995	7495	1807	9647	1508	10949	1258	12492	836	15992	257	14514
9L-2S		MI	4466	1995	6952	1665	8694	1371	9943	1123	11847	711	15034	582	10778
18-#11	3.75	MA	6677	2149	9746	1868	12450	1550	14275	1273	16916	792	22061	320	19936
6L-5S		MI	4234	2149	6621	1784	8164	1466	9257	1188	10870	721	13585	282	12163
18-#11	3.75	MA	6418	2149	9226	1879	11774	1559	13482	1287	15812	810	20542	275	18954
7L-4S		MI	4365	2149	6922	1772	8590	1450	9760	1181	11565	711	14499	350	12515
18-#11	3.75	MA	6171	2149	8653	1898	11068	1577	12671	1297	14712	821	19077	212	17876
8L-3S		MI	4482	2149	7259	1760	9028	1440	10320	1166	12329	708	15420	413	12841
18-#14	5.41	MA	7220	2514	11183	2130	14171	1754	16324	1422	19568	821	25809	87	25383
7L-4S		MI	4914	2514	8419	2000	10440	1616	11966	1288	14513	694	18174	184	17159
20-#10	3.40	MA	6649	2070	9477	1817	12186	1510	14017	1240	16591	793	21603	392	18765
6E		MI	4068	2070	6182	1752	7658	1445	8656	1185	10075	735	12718	305	11157
20-#10	3.40	MA	6434	2070	9049	1826	11623	1518	13350	1257	15683	808	20362	356	18029
7L-5S		MI	4215	2070	6424	1743	7978	1437	9063	1172	10638	731	13473	374	11413
20-#10	3.40	MA	6227	2070	8577	1843	11043	1532	12672	1265	14779	818	19162	307	17270
8L-4S		MI	4330	2070	6673	1733	8331	1422	9479	1165	11213	722	14252	428	11742
20-#10	3.40	MA	5965	2070	8172	1854	10504	1542	11985	1280	13887	833	17924	253	16474
9L-3S		MI	4429	2070	6952	1722	8694	1414	9943	1152	11847	718	15034	481	11885
20-#10	3.40	MA	5721	2070	7746	1862	9975	1553	11322	1289	12989	843	16720	211	15586
10L-2S		MI	4619	2070	7349	1712	9196	1405	10550	1145	12664	709	16138	575	11931
20-#11	4.17	MA	6803	2241	10047	1936	12812	1601	14737	1314	17502	807	22882	270	21331
7L-5S		MI	4428	2241	7097	1841	8766	1508	9986	1215	11851	718	14879	270	13514
20-#11	4.17	MA	6560	2241	9474	1955	12106	1619	13926	1324	16402	818	21417	208	20247
8L-4S		MI	4558	2241	7399	1829	9192	1492	10488	1208	12546	708	15792	337	13851
22-#10	3.74	MA	6752	2145	9726	1873	12480	1552	14386	1279	17078	805	22293	352	19992
7L-6S		MI	4238	2145	6578	1799	8160	1480	9263	1207	10893	732	13821	298	12271
22-#10	3.74	MA	6548	2145	9255	1889	11899	1567	13708	1287	16174	815	21093	303	19228
8L-5S		MI	4379	2145	6821	1789	8480	1471	9669	1194	11455	729	14577	366	12540
22-#10	3.74	MA	6296	2145	8849	1901	11360	1577	13020	1302	15282	830	19855	249	18434
9L-4S		MI	4493	2145	7070	1779	8833	1457	10086	1187	12031	719	15356	421	12857
22-#10	3.74	MA	6062	2145	8423	1909	10832	1587	12358	1311	14384	840	18651	207	17542
10L-3S		MI	4587	2145	7349	1769	9196	1448	10550	1174	12664	715	16138	474	13033
22-#11	4.59	MA	6939	2333	10294	2013	13144	1661	15181	1351	18092	814	23758	203	22618
8L-5S		MI	4619	2333	7573	1898	9368	1550	10714	1242	12832	714	16172	257	14868
24-#10	4.07	MA	6861	2220	9932	1936	12756	1601	14744	1309	17568	812	23024	299	21186
8L-6S		MI	4405	2220	6975	1845	8662	1514	9870	1229	11710	730	14925	291	13387
24-#10	4.07	MA	6619	2220	9526	1947	12217	1611	14056	1324	16676	828	21786	246	20394
9L-5S		MI	4541	2220	7218	1836	8982	1505	10276	1216	12272	726	15680	359	13670
24-#10	4.07	MA	6395	2220	9100	1956	11688	1622	13394	1333	15779	837	20582	203	19499
10L-4S		MI	4653	2220	7467	1826	9334	1491	10693	1209	12848	716	16460	414	13976

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis

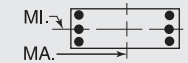


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.14	MA	6328	1665	7866	1536	10164	1290	11503	1097	13002	801	16202	698	7637
2E		MI	3698	1665	5054	1461	6190	1226	6830	1041	7520	757	8948	628	4394
4-#18	2.02	MA	7142	1871	9851	1653	12587	1375	14386	1148	16841	786	21486	681	13160
2E		MI	4069	1871	6119	1571	7458	1305	8324	1087	9496	738	11255	556	7340
6-#11	1.18	MA	6399	1676	7930	1548	10292	1300	11680	1104	13264	804	16581	700	7976
2L-3S		MI	3442	1676	4605	1489	5662	1249	6213	1058	6708	772	7956	525	4595
6-#11	1.18	MA	5828	1676	7053	1565	9181	1316	10337	1118	11455	823	14077	597	7941
3L-2S		MI	3742	1676	5081	1477	6265	1240	6942	1051	7689	762	9250	640	4586
6-#14	1.70	MA	6907	1798	9120	1618	11751	1351	13422	1136	15586	796	19780	691	11308
2L-3S		MI	3579	1798	5054	1559	6190	1300	6830	1089	7520	764	8948	441	6364
6-#14	1.70	MA	6138	1798	7866	1642	10164	1373	11503	1155	13002	822	16202	540	11189
3L-2S		MI	3982	1798	5729	1544	7043	1287	7863	1080	8910	752	10750	606	6390
6-#18	3.03	MA	8063	2107	12040	1800	15355	1483	17734	1218	21350	777	27729	669	19541
2L-3S		MI	3909	2107	6119	1742	7458	1430	8324	1167	9496	744	11255	208	10491
6-#18	3.03	MA	6880	2107	9851	1840	12587	1519	14386	1250	16841	820	21486	393	19021
3L-2S		MI	4509	2107	7278	1718	8923	1413	10096	1156	11882	729	14234	502	10720
8-#9	1.01	MA	6255	1636	7472	1534	9799	1291	11129	1101	12564	812	15643	708	6922
2L-4S		MI	3361	1636	4278	1487	5318	1251	5817	1069	6204	785	7440	552	4023
8-#9	1.01	MA	5875	1636	6900	1545	9074	1302	10253	1110	11384	825	14010	644	6910
3E		MI	3484	1636	4499	1478	5606	1244	6185	1059	6706	782	8065	594	4024
8-#9	1.01	MA	5653	1636	6509	1557	8563	1312	9598	1125	10488	833	12922	603	6857
4L-2S		MI	3687	1636	4814	1470	6004	1236	6667	1053	7355	774	8948	668	4017
8-#10	1.28	MA	6542	1699	8108	1571	10580	1318	12062	1117	13808	808	17357	703	8707
2L-4S		MI	3430	1699	4492	1525	5566	1279	6101	1088	6574	782	7931	509	4979
8-#10	1.28	MA	6078	1699	7385	1585	9664	1331	10955	1129	12317	824	15293	621	8676
3E		MI	3580	1699	4771	1515	5929	1270	6565	1075	7208	778	8713	562	5004
8-#10	1.28	MA	5808	1699	6890	1599	9017	1344	10126	1147	11183	834	13914	569	8559
4L-2S		MI	3827	1699	5167	1505	6431	1262	7172	1068	8025	769	9816	656	5002
8-#11	1.58	MA	6809	1768	8808	1606	11402	1342	13024	1131	15072	801	19085	695	10545
2L-4S		MI	3485	1768	4745	1558	5826	1301	6382	1100	6925	771	8329	450	5927
8-#11	1.58	MA	6267	1768	7930	1622	10292	1358	11680	1145	13264	819	16581	592	10490
3E		MI	3659	1768	5081	1546	6265	1291	6942	1085	7689	768	9250	513	5985
8-#11	1.58	MA	5952	1768	7328	1639	9504	1373	10673	1167	11885	831	14894	528	10285
4L-2S		MI	3946	1768	5557	1534	6867	1282	7670	1078	8670	758	10544	627	5992
8-#14	2.27	MA	7459	1930	10374	1701	13338	1412	15341	1174	18170	791	23358	684	14971
2L-4S		MI	3644	1930	5250	1658	6420	1373	7067	1147	7825	762	9462	332	7857
8-#14	2.27	MA	6741	1930	9120	1725	11751	1434	13422	1194	15586	817	19780	533	14822
3E		MI	3876	1930	5729	1642	7043	1360	7863	1128	8910	759	10750	419	8312
8-#14	2.27	MA	6326	1930	8257	1748	10623	1455	11979	1224	13614	833	17356	440	14006
4L-2S		MI	4255	1930	6404	1626	7897	1348	8895	1119	10301	747	12552	584	8366
8-#18	4.04	MA	7868	2342	12040	1987	15355	1627	17734	1319	21350	811	27729	380	25370
3E		MI	4388	2342	7278	1889	8923	1539	10096	1237	11882	736	14234	155	13734
8-#18	4.04	MA	7253	2342	10528	2027	13380	1664	15208	1369	17896	836	23447	212	22058
4L-2S		MI	4932	2342	8436	1865	10389	1521	11869	1226	14268	720	17214	449	14081
10-#10	1.60	MA	6880	1774	8832	1618	11495	1352	13169	1139	15299	805	19422	699	10824
2L-5S		MI	3497	1774	4640	1582	5715	1327	6291	1117	6816	789	8256	447	5894
10-#10	1.60	MA	6436	1774	8108	1632	10580	1365	12062	1151	13808	821	17357	617	10781
3L-4S		MI	3619	1774	4889	1572	6067	1313	6708	1110	7392	779	9035	502	6122
10-#10	1.60	MA	6184	1774	7613	1646	9932	1379	11233	1169	12674	831	15978	565	10654
4L-3S		MI	3760	1774	5167	1562	6431	1305	7172	1097	8025	775	9816	555	6161
10-#10	1.60	MA	5905	1774	7171	1659	9308	1397	10496	1181	11652	847	14513	516	10168
5L-2S		MI	3998	1774	5564	1552	6933	1296	7779	1090	8842	766	10920	648	6169
10-#11	1.97	MA	7204	1859	9686	1663	12513	1385	14367	1158	16880	797	21588	691	13110
2L-5S		MI	3563	1859	4920	1626	6003	1359	6608	1134	7211	778	8709	370	6879
10-#11	1.97	MA	6688	1859	8808	1680	11402	1400	13024	1172	15072	816	19085	587	13039
3L-4S		MI	3705	1859	5221	1615	6429	1343	7111	1127	7906	768	9623	438	7292
10-#11	1.97	MA	6398	1859	8206	1696	10615	1416	12016	1194	13694	828	17398	524	12825
4L-3S		MI	3869	1859	5557	1603	6867	1333	7670	1112	8670	765	10544	500	7367

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



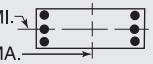
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.97	MA	6069	1859	7672	1713	9855	1438	11118	1208	12450	846	15611	461	11989
5L-2S		MI	4144	1859	6033	1592	7469	1324	8399	1105	9651	755	11837	615	7389
10-#14	2.84	MA	7317	2062	10374	1808	13338	1495	15341	1233	18170	812	23358	526	18459
3L-4S		MI	3948	2062	5925	1740	7273	1434	8100	1186	9215	757	11264	310	9710
10-#14	2.84	MA	6943	2062	9512	1831	12210	1516	13898	1263	16198	828	20934	433	17606
4L-3S		MI	4169	2062	6404	1725	7897	1421	8895	1167	10301	754	12552	397	10255
10-#14	2.84	MA	6487	2062	8747	1855	11122	1548	12612	1283	14416	854	18371	340	16242
5L-2S		MI	4516	2062	7079	1709	8751	1409	9928	1158	11691	742	14353	562	10333
10-#18	5.05	MA	8281	2578	12716	2174	16148	1772	18556	1438	22405	827	29690	200	28383
4L-3S		MI	4847	2578	8436	2036	10389	1647	11869	1306	14268	727	17214	101	16857
10-#18	5.05	MA	7519	2578	11373	2214	14239	1826	16301	1471	19281	870	25364	50	25147
5L-2S		MI	5346	2578	9594	2012	11854	1629	13641	1295	16655	711	20193	395	17436
12-#10	1.92	MA	7209	1849	9556	1664	12411	1387	14277	1161	16790	802	21486	695	12938
2L-6S		MI	3508	1849	4794	1638	5897	1370	6491	1151	7071	790	8604	372	6772
12-#10	1.92	MA	6783	1849	8832	1678	11495	1400	13169	1173	15299	818	19422	613	12886
3L-5S		MI	3683	1849	5036	1629	6217	1362	6898	1139	7633	786	9359	440	7000
12-#10	1.92	MA	6547	1849	8337	1693	10848	1413	12341	1191	14165	829	18043	562	12752
4E		MI	3802	1849	5286	1619	6569	1348	7315	1132	8209	777	10138	495	7265
12-#10	1.92	MA	6273	1849	7895	1706	10224	1432	11603	1203	13143	845	16578	512	12250
5L-3S		MI	3936	1849	5564	1609	6933	1339	7779	1119	8842	773	10920	548	7314
12-#10	1.92	MA	5953	1849	7417	1714	9654	1444	10902	1215	12148	855	15302	455	11689
6L-2S		MI	4166	1849	5961	1598	7434	1330	8386	1112	9660	763	12024	641	7331
12-#11	2.36	MA	7095	1951	9686	1737	12513	1442	14367	1199	16880	812	21588	583	15588
3L-5S		MI	3784	1951	5396	1684	6605	1401	7336	1161	8192	774	10002	357	8208
12-#11	2.36	MA	6826	1951	9084	1754	11725	1458	13359	1220	15502	824	19902	519	15369
4E		MI	3919	1951	5697	1672	7031	1385	7839	1154	8887	765	10916	425	8625
12-#11	2.36	MA	6504	1951	8550	1771	10966	1480	12461	1235	14258	843	18115	456	14520
5L-3S		MI	4073	1951	6033	1661	7469	1375	8399	1139	9651	761	11837	488	8746
12-#11	2.36	MA	6130	1951	7971	1779	10281	1496	11587	1256	13046	855	16559	383	13829
6L-2S		MI	4337	1951	6509	1649	8071	1366	9127	1132	10631	752	13131	602	8779
12-#14	3.41	MA	7534	2195	10766	1914	13797	1577	15818	1302	18782	823	24512	426	21214
4E		MI	4255	2195	6600	1823	8127	1495	9132	1225	10606	752	13066	287	11579
12-#14	3.41	MA	7086	2195	10001	1938	12709	1609	14532	1322	17000	849	21949	333	19881
5L-3S		MI	4444	2195	7079	1808	8751	1482	9928	1206	11691	749	14353	375	12198
12-#14	3.41	MA	6587	2195	9179	1951	11727	1630	13278	1351	15264	865	19713	226	18206
6L-2S		MI	4771	2195	7754	1792	9605	1470	10961	1197	13082	737	16155	540	12295
12-#18	6.06	MA	8561	2813	13562	2361	17008	1934	19650	1540	23790	861	31607	38	31443
5L-3S		MI	5294	2813	9594	2183	11854	1755	13641	1375	16655	718	20193	48	20012
12-#18	6.06	MA	7749	2813	12148	2385	15284	1970	17450	1590	20745	886	27473	-180	26718
6L-2S		MI	5755	2813	10753	2159	13319	1737	15413	1364	19041	702	23172	342	20787
14-#10	2.24	MA	7120	1924	9556	1725	12411	1434	14277	1195	16790	815	21486	609	14992
3L-6S		MI	3695	1924	5190	1685	6399	1405	7098	1173	7888	787	9707	365	7894
14-#10	2.24	MA	6899	1924	9061	1739	11763	1447	13448	1213	15656	826	20107	558	14852
4L-5S		MI	3863	1924	5433	1676	6718	1396	7505	1161	8450	783	10463	433	8112
14-#10	2.24	MA	6629	1924	8618	1753	11140	1466	12710	1225	14634	842	18642	508	14336
5L-4S		MI	3981	1924	5682	1666	7071	1382	7922	1153	9026	774	11242	488	8407
14-#10	2.24	MA	6323	1924	8141	1760	10570	1478	12010	1237	13639	852	17367	451	13792
6L-3S		MI	4108	1924	5961	1655	7434	1373	8386	1141	9660	770	12024	541	8465
14-#10	2.24	MA	6054	1924	7684	1770	9969	1486	11295	1255	12671	868	16049	416	13061
7L-2S		MI	4330	1924	6358	1645	7936	1365	8993	1134	10477	760	13127	634	8489
14-#11	2.76	MA	7241	2043	9962	1811	12836	1500	14702	1247	17311	821	22406	514	17916
4L-5S		MI	3994	2043	5872	1741	7207	1443	8065	1188	9173	771	11296	345	9544
14-#11	2.76	MA	6923	2043	9428	1828	12076	1522	13804	1262	16066	839	20619	451	17055
5L-4S		MI	4139	2043	6173	1730	7633	1427	8568	1181	9868	761	12210	413	9940

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



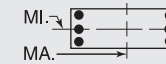
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.76	MA	6567	2043	8849	1837	11391	1538	12930	1283	14855	851	19063	378	16369
6L-3S		MI	4278	2043	6509	1718	8071	1418	9127	1166	10631	758	13131	475	10123
14-#11	2.76	MA	6253	2043	8293	1848	10662	1547	12084	1297	13677	870	17449	334	15286
7L-2S		MI	4523	2043	6986	1707	8674	1408	9855	1159	11612	748	14424	590	10166
14-#14	3.98	MA	7663	2327	11256	2020	14296	1670	16451	1361	19584	844	25527	326	23521
5L-4S		MI	4540	2327	7275	1906	8981	1555	10165	1264	11996	747	14867	265	13459
14-#14	3.98	MA	7194	2327	10434	2033	13314	1691	15198	1390	17848	860	23291	219	21831
6L-3S		MI	4711	2327	7754	1890	9605	1543	10961	1245	13082	744	16155	353	14141
14-#14	3.98	MA	6779	2327	9639	2049	12280	1705	13986	1410	16160	886	20970	154	20158
7L-2S		MI	5021	2327	8429	1875	10459	1531	11993	1235	14472	732	17957	518	14254
14-#18	7.07	MA	8828	3048	14337	2532	18052	2078	20799	1659	25254	877	33715	-192	32600
6L-3S		MI	5732	3048	10753	2330	13319	1863	15413	1444	19041	709	23172	-6	23155
16-#10	2.57	MA	7242	1998	9784	1786	12679	1482	14555	1235	17147	823	22172	554	16954
4L-6S		MI	3877	1998	5587	1732	6900	1439	7705	1195	8705	784	10811	357	9019
16-#10	2.57	MA	6974	1998	9342	1800	12055	1500	13818	1247	16125	839	20706	505	16424
5E		MI	4040	1998	5830	1723	7220	1430	8112	1182	9267	780	11566	426	9229
16-#10	2.57	MA	6681	1998	8864	1807	11485	1513	13117	1259	15129	849	19431	447	15897
6L-4S		MI	4156	1998	6079	1712	7573	1416	8529	1175	9843	771	12345	481	9549
16-#10	2.57	MA	6425	1998	8408	1817	10885	1521	12402	1277	14162	865	18114	412	15160
7L-3S		MI	4277	1998	6358	1702	7936	1408	8993	1163	10477	767	13127	534	9615
16-#10	2.57	MA	6188	1998	7905	1833	10266	1536	11674	1285	13198	876	16837	364	14411
8L-2S		MI	4492	1998	6754	1692	8438	1399	9600	1156	11294	758	14231	627	9646
16-#11	3.15	MA	7331	2135	10306	1885	13187	1565	15147	1289	17875	836	23123	446	19594
5E		MI	4209	2135	6348	1799	7809	1486	8793	1215	10153	768	12590	332	10886
16-#11	3.15	MA	6991	2135	9727	1894	12502	1580	14273	1310	16663	848	21567	373	18909
6L-4S		MI	4342	2135	6649	1787	8235	1469	9296	1208	10848	758	13503	400	11262
16-#11	3.15	MA	6694	2135	9171	1906	11772	1589	13427	1324	15485	867	19953	329	17830
7L-3S		MI	4471	2135	6986	1776	8674	1460	9855	1193	11612	755	14424	463	11498
16-#11	3.15	MA	6419	2135	8560	1925	11019	1607	12551	1334	14312	878	18394	269	16734
8L-2S		MI	4705	2135	7462	1764	9276	1450	10584	1186	12593	745	15718	577	11551
16-#14	4.55	MA	7780	2460	11688	2116	14901	1752	17117	1429	20432	855	26869	212	25456
6L-4S		MI	4817	2460	7950	1989	9835	1616	11198	1302	13386	742	16669	243	15349
16-#14	4.55	MA	7394	2460	10893	2132	13867	1766	15905	1449	18745	881	24548	147	23773
7L-3S		MI	4974	2460	8429	1973	10459	1604	11993	1283	14472	739	17957	331	16085
16-#14	4.55	MA	7009	2460	10017	2160	12788	1791	14664	1464	17063	897	22310	58	22072
8L-2S		MI	5267	2460	9104	1957	11312	1592	13026	1274	15862	727	19758	496	16211
18-#10	2.89	MA	7311	2073	10066	1846	12971	1535	14925	1269	17616	836	22771	501	18515
5L-6S		MI	4055	2073	5984	1778	7402	1473	8312	1217	9522	781	11914	350	10144
18-#10	2.89	MA	7030	2073	9588	1854	12401	1547	14224	1281	16620	847	21495	443	18003
6L-5S		MI	4212	2073	6226	1769	7722	1465	8719	1204	10085	778	12670	419	10349
18-#10	2.89	MA	6786	2073	9131	1863	11801	1555	13509	1299	15653	863	20178	408	17259
7L-4S		MI	4328	2073	6476	1759	8075	1451	9136	1197	10660	768	13449	474	10692
18-#10	2.89	MA	6556	2073	8629	1880	11181	1570	12782	1307	14689	873	18901	361	16504
8L-3S		MI	4448	2073	6754	1749	8438	1442	9600	1185	11294	764	14231	527	10764
18-#10	2.89	MA	6262	2073	8192	1891	10606	1581	12049	1322	13739	889	17588	307	15630
9L-2S		MI	4648	2073	7151	1739	8940	1433	10207	1178	12111	755	15334	620	10801
18-#11	3.55	MA	7402	2227	10604	1952	13612	1622	15616	1337	18472	844	24071	368	21449
6L-5S		MI	4409	2227	6824	1856	8412	1528	9521	1242	11134	764	13883	320	12231
18-#11	3.55	MA	7122	2227	10049	1963	12883	1632	14770	1351	17294	863	22457	324	20374
7L-4S		MI	4539	2227	7125	1845	8838	1511	10024	1235	11829	754	14797	388	12592
18-#11	3.55	MA	6852	2227	9437	1983	12129	1649	13894	1361	16120	875	20898	264	19272
8L-3S		MI	4661	2227	7462	1833	9276	1502	10584	1220	12593	751	15718	450	12874
18-#11	3.55	MA	6508	2227	8912	1997	11430	1662	13002	1378	14963	894	19289	198	18174
9L-2S		MI	4885	2227	7938	1821	9878	1493	11312	1213	13573	741	17012	565	12934

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

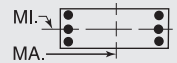
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	5.11	MA	7988	2592	12147	2215	15454	1827	17824	1488	21329	876	28126	140	27388
7L-4S		MI	5088	2592	8625	2071	10689	1677	12230	1341	14777	737	18471	221	17246
18-#14	5.11	MA	7611	2592	11272	2243	14375	1852	16583	1503	19647	892	25888	51	25678
8L-3S		MI	5231	2592	9104	2056	11312	1665	13026	1322	15862	734	19758	309	18030
20-#10	3.21	MA	7370	2148	10312	1900	13317	1581	15332	1303	18111	844	23560	439	20111
6E		MI	4229	2148	6380	1825	7904	1508	8919	1239	10340	779	13018	343	11252
20-#10	3.21	MA	7137	2148	9855	1910	12716	1589	14617	1321	17144	860	22242	404	19358
7L-5S		MI	4391	2148	6623	1816	8224	1499	9326	1226	10902	775	13773	412	11472
20-#10	3.21	MA	6911	2148	9352	1927	12097	1604	13889	1329	16180	870	20966	357	18597
8L-4S		MI	4506	2148	6872	1806	8576	1485	9743	1219	11478	765	14553	466	11810
20-#10	3.21	MA	6628	2148	8916	1938	11522	1615	13156	1344	15230	886	19652	303	17726
9L-3S		MI	4608	2148	7151	1795	8940	1476	10207	1207	12111	761	15334	519	11912
20-#10	3.21	MA	6364	2148	8461	1946	10959	1626	12449	1353	14261	895	18372	262	16817
10L-2S		MI	4801	2148	7548	1785	9442	1468	10814	1200	12928	752	16438	613	11955
20-#11	3.94	MA	7538	2319	10927	2020	13993	1674	16114	1378	19102	860	24961	320	22918
7L-5S		MI	4604	2319	7300	1913	9014	1570	10250	1269	12115	761	15177	307	13581
20-#11	3.94	MA	7272	2319	10315	2040	13240	1692	15237	1388	17929	871	23402	259	21809
8L-4S		MI	4734	2319	7601	1902	9440	1554	10753	1261	12810	751	16091	375	13926
20-#11	3.94	MA	6943	2319	9790	2054	12540	1704	14345	1405	16771	890	21793	193	20705
9L-3S		MI	4847	2319	7938	1890	9878	1544	11312	1247	13573	748	17012	438	14249
20-#14	5.68	MA	8195	2725	12526	2326	15962	1913	18502	1542	22231	887	29466	44	29285
8L-4S		MI	5354	2725	9300	2154	11542	1738	13263	1380	16167	732	20272	199	19151
22-#10	3.53	MA	7481	2223	10579	1957	13632	1624	15724	1343	18635	857	24307	400	21457
7L-6S		MI	4412	2223	6777	1872	8406	1542	9526	1261	11157	776	14122	336	12363
22-#10	3.53	MA	7257	2223	10076	1973	13012	1639	14996	1351	17671	867	23030	353	20691
8L-5S		MI	4556	2223	7020	1863	8726	1533	9933	1248	11719	772	14877	404	12598
22-#10	3.53	MA	6985	2223	9640	1985	12438	1649	14263	1365	16720	883	21716	299	19822
9L-4S		MI	4670	2223	7269	1852	9078	1519	10349	1241	12295	763	15656	459	12924
22-#10	3.53	MA	6732	2223	9185	1993	11874	1660	13557	1375	15752	892	20436	258	18909
10L-3S		MI	4766	2223	7548	1842	9442	1511	10814	1229	12928	759	16438	512	13061
22-#11	4.33	MA	7682	2410	11193	2098	14350	1734	16580	1415	19737	868	25906	255	24346
8L-5S		MI	4796	2410	7776	1971	9616	1612	10978	1296	13096	757	16470	295	14934
22-#11	4.33	MA	7367	2410	10667	2111	13651	1746	15688	1432	18579	887	24297	188	23237
9L-4S		MI	4925	2410	8078	1959	10042	1596	11481	1288	13791	747	17384	363	15265
24-#10	3.85	MA	7596	2297	10800	2020	13928	1673	16104	1373	19162	865	25095	349	22784
8L-6S		MI	4580	2297	7174	1919	8908	1576	10133	1283	11974	773	15225	329	13478
24-#10	3.85	MA	7334	2297	10363	2031	13353	1684	15371	1387	18211	881	23781	295	21917
9L-5S		MI	4718	2297	7416	1909	9227	1568	10540	1270	12536	769	15981	397	13727
24-#10	3.85	MA	7091	2297	9909	2040	12790	1695	14664	1397	17242	890	22501	254	21000
10L-4S		MI	4831	2297	7666	1899	9580	1554	10956	1263	13112	760	16760	452	14041
24-#11	4.73	MA	7781	2502	11545	2169	14761	1788	17032	1459	20388	883	26801	183	25769
9L-5S		MI	4985	2502	8252	2028	10218	1654	11707	1323	14076	754	17764	282	16289

RECTANGULAR TIED COLUMNS 22" x 38"

4-#14	1.08	MA	7007	1743	8572	1618	11136	1361	12616	1158	14243	850	17734	741	8123
2E		MI	3871	1743	5260	1533	6439	1288	7095	1094	7783	799	9245	666	4415
4-#18	1.91	MA	7892	1949	10695	1735	13726	1446	15698	1210	18347	835	23383	724	14024
2E		MI	4245	1949	6331	1641	7710	1365	8589	1140	9758	780	11549	592	7370
6-#11	1.12	MA	7082	1754	8640	1631	11270	1371	12803	1166	14518	853	18132	743	8481
2L-3S		MI	3614	1754	4808	1561	5910	1311	6478	1112	6972	815	8255	563	4618
6-#11	1.12	MA	6467	1754	7704	1648	10087	1387	11372	1180	12591	872	15465	641	8446
3L-2S		MI	3915	1754	5284	1550	6512	1301	7206	1105	7953	805	9548	678	4606
6-#14	1.61	MA	7633	1875	9909	1701	12828	1422	14662	1197	16998	845	21548	734	12037
2L-3S		MI	3750	1875	5260	1631	6439	1361	7095	1142	7783	807	9245	479	6396
6-#14	1.61	MA	6803	1875	8572	1725	11136	1444	12616	1218	14243	872	17734	585	11918
3L-2S		MI	4157	1875	5935	1616	7292	1349	8127	1133	9174	794	11047	644	6413

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

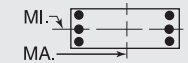


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#18	2.87	MA	8889	2184	13030	1883	16681	1554	19272	1279	23159	826	30045	712	20837
2L-3S		MI	4079	2184	6331	1812	7710	1491	8589	1220	9758	786	11549	245	10550
6-#18	2.87	MA	7607	2184	10695	1924	13726	1591	15698	1313	18347	871	23383	440	20317
3L-2S		MI	4687	2184	7489	1789	9175	1473	10362	1209	12144	771	14528	539	10754
8-#10	1.22	MA	7234	1777	8827	1654	11573	1388	13205	1178	15093	857	18953	746	9255
2L-4S		MI	3601	1777	4691	1599	5811	1341	6365	1142	6839	825	8231	547	5005
8-#10	1.22	MA	6734	1777	8056	1668	10599	1402	12026	1191	13506	873	16755	665	9225
3E		MI	3752	1777	4970	1588	6175	1333	6829	1129	7472	822	9013	600	5024
8-#10	1.22	MA	6444	1777	7530	1682	9911	1415	11145	1209	12301	884	15295	614	9107
4L-2S		MI	4001	1777	5366	1578	6677	1324	7436	1122	8290	812	10117	694	5019
8-#11	1.49	MA	7525	1845	9575	1688	12453	1413	14233	1193	16445	849	20800	738	11219
2L-4S		MI	3655	1845	4948	1630	6074	1362	6647	1154	7189	814	8627	488	5964
8-#11	1.49	MA	6940	1845	8640	1705	11270	1429	12803	1207	14518	869	18132	637	11163
3E		MI	3831	1845	5284	1618	6512	1353	7206	1139	7953	811	9548	550	6010
8-#11	1.49	MA	6602	1845	7999	1723	10432	1445	11731	1229	13052	881	16347	573	10959
4L-2S		MI	4120	1845	5760	1607	7115	1344	7934	1132	8933	801	10842	665	6014
8-#14	2.15	MA	8229	2008	11247	1784	14519	1483	16708	1236	19752	840	25362	727	15943
2L-4S		MI	3814	2008	5456	1730	6669	1434	7332	1200	8088	804	9759	369	7959
8-#14	2.15	MA	7454	2008	9909	1808	12828	1505	14662	1257	16998	867	21548	578	15794
3E		MI	4048	2008	5935	1714	7292	1422	8127	1181	9174	802	11047	457	8346
8-#14	2.15	MA	7007	2008	8992	1832	11628	1527	13127	1287	14899	884	18980	486	15058
4L-2S		MI	4433	2008	6610	1698	8146	1410	9160	1172	10564	789	12849	622	8393
8-#18	3.83	MA	8674	2420	13030	2071	16681	1699	19272	1382	23159	862	30045	428	27098
3E		MI	4560	2420	7489	1960	9175	1599	10362	1289	12144	778	14528	192	13855
8-#18	3.83	MA	8009	2420	11421	2112	14577	1737	16582	1434	19481	889	25508	261	23675
4L-2S		MI	5113	2420	8647	1936	10640	1582	12134	1278	14531	762	17508	485	14118
10-#10	1.52	MA	7599	1852	9597	1700	12548	1423	14384	1200	16680	854	21150	742	11510
2L-5S		MI	3667	1852	4839	1656	5961	1390	6555	1171	7080	832	8556	485	5959
10-#10	1.52	MA	7120	1852	8827	1715	11573	1436	13205	1213	15093	871	18953	661	11467
3L-4S		MI	3790	1852	5088	1645	6313	1376	6971	1164	7656	823	9335	540	6151
10-#10	1.52	MA	6850	1852	8301	1729	10885	1450	12324	1231	13888	881	17493	610	11340
4L-3S		MI	3933	1852	5366	1635	6677	1367	7436	1151	8290	819	10117	593	6183
10-#10	1.52	MA	6546	1852	7827	1742	10223	1469	11541	1244	12802	898	15939	562	10882
5L-2S		MI	4173	1852	5763	1625	7178	1358	8042	1144	9107	809	11220	687	6188
10-#11	1.87	MA	7952	1937	10510	1746	13636	1455	15664	1219	18371	846	23468	734	13952
2L-5S		MI	3732	1937	5123	1699	6250	1421	6872	1188	7475	821	9007	407	6953
10-#11	1.87	MA	7395	1937	9575	1763	12453	1471	14233	1234	16445	865	20800	632	13881
3L-4S		MI	3876	1937	5424	1687	6676	1405	7375	1181	8170	811	9921	475	7330
10-#11	1.87	MA	7082	1937	8935	1780	11616	1487	13162	1256	14979	878	19014	568	13668
4L-3S		MI	4042	1937	5760	1676	7115	1395	7934	1166	8933	808	10842	538	7395
10-#11	1.87	MA	6725	1937	8364	1797	10809	1510	12208	1271	13657	897	17118	507	12837
5L-2S		MI	4319	1937	6236	1664	7717	1386	8663	1159	9914	798	12136	653	7412
10-#14	2.69	MA	8075	2140	11247	1891	14519	1566	16708	1295	19752	862	25362	571	19674
3L-4S		MI	4119	2140	6131	1812	7522	1495	8364	1239	9478	799	11561	347	9809
10-#14	2.69	MA	7672	2140	10329	1915	13320	1588	15173	1326	17653	879	22794	479	18905
4L-3S		MI	4343	2140	6610	1797	8146	1483	9160	1220	10564	797	12849	435	10292
10-#14	2.69	MA	7175	2140	9517	1939	12163	1621	13806	1347	15759	906	20073	389	17385
5L-2S		MI	4695	2140	7285	1781	9000	1470	10193	1211	11955	784	14650	600	10361
10-#18	4.78	MA	9116	2655	13757	2259	17532	1845	20155	1503	24293	881	32170	249	30426
4L-3S		MI	5020	2655	8647	2107	10640	1707	12134	1358	14531	769	17508	138	17017
10-#18	4.78	MA	8286	2655	12329	2300	15501	1900	17756	1537	20968	925	27382	80	27091
5L-2S		MI	5529	2655	9806	2083	12106	1690	13906	1347	16917	753	20487	432	17473
12-#10	1.82	MA	7954	1927	10367	1747	13523	1457	15563	1222	18267	851	23348	738	13761
2L-6S		MI	3679	1927	4993	1711	6143	1433	6755	1206	7335	833	8904	410	6835
12-#10	1.82	MA	7494	1927	9597	1761	12548	1471	14384	1235	16680	868	21150	657	13709
3L-5S		MI	3855	1927	5235	1702	6462	1424	7162	1193	7897	829	9659	478	7063
12-#10	1.82	MA	7241	1927	9071	1776	11860	1484	13503	1253	15475	879	19691	606	13575
4E		MI	3974	1927	5484	1692	6815	1410	7578	1186	8473	820	10438	533	7295

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis



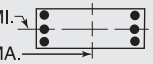
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#10	1.82	MA	6943	1927	8598	1789	11198	1503	12720	1266	14389	895	18137	558	13102
5L-3S		MI	4110	1927	5763	1682	7178	1401	8042	1173	9107	816	11220	586	7337
12-#10	1.82	MA	6600	1927	8090	1797	10587	1515	11976	1279	13332	906	16784	502	12487
6L-2S		MI	4342	1927	6160	1672	7680	1393	8649	1166	9924	807	12324	679	7351
12-#11	2.24	MA	7834	2029	10510	1820	13636	1513	15664	1261	18371	862	23468	627	16599
3L-5S		MI	3956	2029	5599	1756	6853	1463	7600	1215	8456	817	10301	395	8280
12-#11	2.24	MA	7544	2029	9870	1837	12799	1529	14593	1283	16906	874	21682	564	16380
4E		MI	4091	2029	5900	1745	7279	1447	8103	1207	9151	807	11214	463	8696
12-#11	2.24	MA	7193	2029	9299	1854	11992	1552	13639	1298	15583	894	19786	503	15537
5L-3S		MI	4247	2029	6236	1733	7717	1437	8663	1193	9914	804	12136	525	8775
12-#11	2.24	MA	6791	2029	8682	1863	11257	1567	12732	1313	14296	906	18135	431	14804
6L-2S		MI	4515	2029	6712	1722	8319	1428	9391	1186	10895	794	13429	640	8804
12-#14	3.23	MA	8308	2273	11666	1998	15011	1649	17219	1365	20408	874	26609	472	22760
4E		MI	4427	2273	6806	1895	8376	1556	9397	1278	10869	794	13363	325	11673
12-#14	3.23	MA	7821	2273	10854	2022	13855	1681	15851	1386	18513	901	23888	382	21266
5L-3S		MI	4619	2273	7285	1880	9000	1544	10193	1259	11955	792	14650	412	12236
12-#14	3.23	MA	7283	2273	9971	2035	12811	1704	14519	1416	16668	918	21518	276	19586
6L-2S		MI	4952	2273	7960	1864	9854	1531	11225	1250	13345	779	16452	578	12324
12-#18	5.74	MA	9358	2891	14664	2447	18456	2009	21329	1606	25780	916	34044	68	33810
5L-3S		MI	5468	2891	9806	2254	12106	1815	13906	1428	16917	760	20487	85	20166
12-#18	5.74	MA	8531	2891	13143	2471	16623	2046	18990	1658	22540	944	29859	-124	29302
6L-2S		MI	5939	2891	10964	2230	13571	1798	15679	1417	19303	744	23467	378	20825
14-#10	2.13	MA	7857	2001	10367	1808	13523	1505	15563	1257	18267	865	23348	653	15952
3L-6S		MI	3866	2001	5389	1758	6644	1467	7362	1228	8152	830	10007	403	7956
14-#10	2.13	MA	7619	2001	9842	1823	12835	1518	14682	1275	17062	876	21888	602	15812
4L-5S		MI	4036	2001	5632	1749	6964	1459	7769	1215	8715	827	10763	471	8174
14-#10	2.13	MA	7326	2001	9368	1836	12172	1538	13899	1288	15976	892	20334	554	15325
5L-4S		MI	4154	2001	5881	1739	7317	1444	8185	1208	9290	817	11542	526	8438
14-#10	2.13	MA	6997	2001	8860	1844	11562	1550	13155	1301	14919	903	18982	498	14729
6L-3S		MI	4283	2001	6160	1729	7680	1436	8649	1195	9924	813	12324	579	8490
14-#10	2.13	MA	6708	2001	8375	1854	10924	1558	12388	1318	13892	920	17589	463	13993
7L-2S		MI	4507	2001	6556	1718	8182	1427	9256	1188	10741	804	13427	672	8511
14-#11	2.61	MA	7991	2121	10805	1895	13982	1571	16024	1310	18832	871	24349	559	19096
4L-5S		MI	4167	2121	6075	1814	7455	1505	8329	1242	9436	814	11594	382	9615
14-#11	2.61	MA	7645	2121	10234	1911	13175	1594	15070	1325	17510	890	22453	498	18242
5L-4S		MI	4300	2121	6376	1802	7881	1489	8832	1234	10131	804	12508	450	10019
14-#11	2.61	MA	7262	2121	9617	1920	12440	1610	14163	1340	16222	903	20803	426	17523
6L-3S		MI	4454	2121	6712	1791	8319	1479	9391	1220	10895	801	13429	513	10153
14-#11	2.61	MA	6924	2121	9026	1932	11664	1619	13242	1361	14971	922	19096	383	16384
7L-2S		MI	4702	2121	7189	1779	8921	1470	10120	1213	11876	791	14723	627	10192
14-#14	3.77	MA	8442	2405	12191	2105	15546	1742	17897	1425	21268	896	27702	375	25146
5L-4S		MI	4712	2405	7481	1978	9230	1617	10430	1317	12259	789	15164	303	13550
14-#14	3.77	MA	7937	2405	11308	2117	14503	1765	16565	1455	19422	913	25332	269	23451
6L-3S		MI	4888	2405	7960	1962	9854	1604	11225	1298	13345	787	16452	390	14180
14-#14	3.77	MA	7490	2405	10462	2134	13392	1778	15278	1476	17629	940	22874	206	21709
7L-2S		MI	5203	2405	8634	1947	10708	1592	12258	1289	14735	774	18254	556	14284
14-#18	6.70	MA	9694	3126	15479	2618	19577	2154	22564	1727	27352	935	36521	-136	35678
6L-3S		MI	5907	3126	10964	2401	13571	1924	15679	1497	19303	751	23467	31	23341
16-#10	2.43	MA	7988	2076	10612	1869	13809	1553	15861	1297	18650	873	24086	598	18051
4L-6S		MI	4048	2076	5786	1805	7146	1502	7969	1250	8969	828	11111	396	9080
16-#10	2.43	MA	7698	2076	10139	1883	13147	1572	15078	1310	17564	890	22532	550	17551
5E		MI	4213	2076	6029	1796	7466	1493	8376	1237	9532	824	11866	464	9289
16-#10	2.43	MA	7383	2076	9631	1890	12537	1584	14334	1323	16506	900	21179	494	16972
6L-4S		MI	4329	2076	6278	1786	7819	1479	8792	1230	10108	814	12646	519	9581

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis



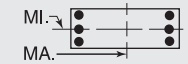
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.43	MA	7107	2076	9145	1900	11898	1592	13567	1340	15479	917	19786	459	16228
7L-3S		MI	4452	2076	6556	1775	8182	1470	9256	1217	10741	810	13427	572	9640
16-#10	2.43	MA	6853	2076	8611	1917	11240	1608	12794	1348	14456	928	18433	413	15462
8L-2S		MI	4670	2076	6953	1765	8684	1461	9863	1210	11558	801	14531	665	9668
16-#11	2.99	MA	8084	2213	11170	1969	14358	1636	16501	1352	19436	887	25121	493	20949
5E		MI	4383	2213	6551	1871	8057	1547	9057	1269	10417	810	12888	370	10954
16-#11	2.99	MA	7718	2213	10552	1978	13623	1652	15594	1367	18149	900	23470	422	20242
6L-4S		MI	4515	2213	6852	1860	8483	1531	9560	1261	11112	801	13802	438	11340
16-#11	2.99	MA	7398	2213	9961	1990	12847	1661	14673	1388	16898	919	21763	378	19094
7L-3S		MI	4648	2213	7189	1848	8921	1522	10120	1247	11876	798	14723	500	11530
16-#11	2.99	MA	7099	2213	9311	2010	12046	1680	13732	1398	15651	931	20111	319	17981
8L-2S		MI	4886	2213	7665	1836	9524	1512	10848	1240	12856	788	16016	615	11578
16-#14	4.31	MA	8567	2538	12645	2200	16194	1826	18611	1494	22177	908	29146	263	27317
6L-4S		MI	4990	2538	8156	2061	10084	1678	11462	1356	13650	784	16966	281	15437
16-#14	4.31	MA	8151	2538	11799	2217	15083	1839	17324	1515	20383	935	26688	199	25563
7L-3S		MI	5151	2538	8634	2045	10708	1665	12258	1337	14735	782	18254	368	16124
16-#14	4.31	MA	7733	2538	10868	2245	13936	1865	15988	1529	18596	953	24315	112	23792
8L-2S		MI	5451	2538	9309	2029	11561	1653	13291	1328	16126	769	20055	534	16242
18-#10	2.73	MA	8061	2151	10909	1929	14122	1606	16256	1332	19151	887	24730	546	19779
5L-6S		MI	4227	2151	6183	1852	7648	1536	8576	1272	9787	825	12215	388	10206
18-#10	2.73	MA	7758	2151	10401	1937	13511	1618	15512	1344	18094	898	23377	490	19216
6L-5S		MI	4386	2151	6425	1842	7968	1527	8983	1259	10349	821	12970	457	10408
18-#10	2.73	MA	7495	2151	9916	1947	12873	1627	14746	1362	17066	914	21984	455	18463
7L-4S		MI	4502	2151	6675	1832	8320	1513	9399	1252	10925	811	13749	512	10724
18-#10	2.73	MA	7246	2151	9381	1964	12215	1642	13973	1370	16043	925	20631	409	17699
8L-3S		MI	4625	2151	6953	1822	8684	1504	9863	1239	11558	808	14531	565	10790
18-#10	2.73	MA	6930	2151	8914	1975	11604	1653	13194	1385	15034	942	19242	356	16759
9L-2S		MI	4828	2151	7350	1812	9186	1496	10470	1232	12376	798	15634	658	10824
18-#11	3.36	MA	8161	2304	11487	2035	14806	1694	17025	1394	20076	896	26138	417	22961
6L-5S		MI	4583	2304	7027	1929	8659	1590	9786	1296	11398	807	14182	357	12299
18-#11	3.36	MA	7858	2304	10897	2047	14030	1704	16104	1415	18824	915	24431	373	21805
7L-4S		MI	4714	2304	7328	1917	9085	1573	10289	1288	12093	797	15095	425	12667
18-#11	3.36	MA	7565	2304	10247	2067	13229	1722	15163	1425	17578	928	22778	315	20685
8L-3S		MI	4838	2304	7665	1905	9524	1564	10848	1274	12856	794	16016	488	12906
18-#11	3.36	MA	7195	2304	9684	2081	12486	1735	14215	1443	16348	947	21076	249	19568
9L-2S		MI	5067	2304	8141	1894	10126	1554	11576	1267	13837	784	17310	602	12961
18-#14	4.84	MA	8790	2670	13137	2299	16775	1900	19369	1554	23138	930	30502	192	29417
7L-4S		MI	5262	2670	8831	2143	10938	1738	12495	1395	15040	780	18768	259	17332
18-#14	4.84	MA	8379	2670	12205	2328	15627	1926	18034	1568	21351	948	28129	105	27653
8L-3S		MI	5410	2670	9309	2128	11561	1726	13291	1376	16126	777	20055	346	18070
20-#10	3.04	MA	8124	2226	11171	1984	14486	1653	16691	1366	19681	895	25575	486	21461
6E		MI	4402	2226	6579	1898	8150	1570	9183	1294	10604	822	13318	381	11336
20-#10	3.04	MA	7873	2226	10686	1994	13848	1661	15925	1384	18654	911	24182	451	20697
7L-5S		MI	4556	2226	6822	1889	8470	1562	9590	1281	11166	818	14074	450	11530
20-#10	3.04	MA	7627	2226	10152	2011	13189	1676	15151	1392	17630	922	22829	405	19935
8L-4S		MI	4681	2226	7071	1879	8822	1547	10006	1274	11742	809	14853	504	11868
20-#10	3.04	MA	7323	2226	9685	2022	12579	1687	14373	1407	16621	939	21439	352	18991
9L-3S		MI	4787	2226	7350	1869	9186	1539	10470	1261	12376	805	15634	557	11939
20-#10	3.04	MA	7039	2226	9201	2030	11981	1699	13622	1417	15580	947	20083	312	18066
10L-2S		MI	4983	2226	7746	1858	9687	1530	11077	1254	13193	795	16738	651	11978
20-#11	3.73	MA	8306	2396	11832	2104	15213	1746	17535	1442	20751	912	27098	369	24516
7L-5S		MI	4779	2396	7503	1986	9262	1632	10514	1323	12379	804	15475	345	13647
20-#11	3.73	MA	8017	2396	11182	2125	14412	1764	16594	1452	19504	925	25446	310	23388
8L-4S		MI	4909	2396	7804	1974	9687	1615	11017	1315	13074	794	16389	413	13999

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

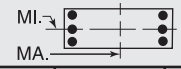
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.73	MA	7663	2396	10619	2138	13669	1777	15646	1470	18274	944	23744	244	22265
9L-3S		MI	5025	2396	8141	1963	10126	1606	11576	1301	13837	791	17310	475	14281
20-#11	3.73	MA	7332	2396	10031	2149	12940	1790	14732	1482	17027	955	22087	193	21004
10L-2S		MI	5246	2396	8617	1951	10728	1597	12305	1294	14818	781	18604	590	14344
20-#14	5.38	MA	9007	2802	13542	2411	17319	1986	20080	1607	24105	943	31943	98	31505
8L-4S		MI	5529	2802	9506	2226	11791	1799	13528	1434	16430	775	20569	237	19234
22-#10	3.34	MA	8242	2300	11456	2040	14822	1695	17104	1406	20241	909	26379	447	22932
7L-6S		MI	4586	2300	6976	1945	8652	1605	9790	1315	11421	819	14422	374	12455
22-#10	3.34	MA	8000	2300	10922	2057	14164	1711	16330	1414	19217	919	25026	401	22169
8L-5S		MI	4732	2300	7219	1936	8971	1596	10197	1303	11983	815	15177	442	12655
22-#10	3.34	MA	7707	2300	10455	2068	13554	1722	15551	1429	18208	936	23637	348	21222
9L-4S		MI	4846	2300	7468	1926	9324	1582	10613	1296	12559	806	15956	497	12989
22-#10	3.34	MA	7434	2300	9972	2077	12955	1733	14801	1439	17168	944	22281	308	20293
10L-3S		MI	4946	2300	7746	1915	9687	1573	11077	1283	13193	802	16738	550	13088
22-#10	3.34	MA	7176	2300	9498	2087	12353	1743	14062	1450	16132	958	20963	260	19340
11L-2S		MI	5135	2300	8143	1905	10189	1564	11684	1276	14010	793	17842	643	13131
22-#11	4.11	MA	8458	2488	12117	2182	15595	1806	18025	1479	21431	921	28113	305	26092
8L-5S		MI	4972	2488	7979	2043	9864	1674	11242	1350	13359	800	16769	332	14998
22-#11	4.11	MA	8118	2488	11554	2196	14852	1819	17077	1497	20201	940	26411	239	24963
9L-4S		MI	5101	2488	8280	2032	10290	1658	11745	1342	14054	790	17682	400	15337
22-#11	4.11	MA	7803	2488	10967	2206	14123	1832	16163	1508	18953	952	24754	188	23705
10L-3S		MI	5210	2488	8617	2020	10728	1648	12305	1328	14818	787	18604	463	15657
24-#10	3.65	MA	8364	2375	11693	2104	15139	1745	17509	1436	20805	917	27224	398	24397
8L-6S		MI	4755	2375	7373	1992	9153	1639	10397	1337	12238	816	15525	367	13567
24-#10	3.65	MA	8081	2375	11226	2115	14528	1756	16730	1451	19795	933	25835	345	23453
9L-5S		MI	4895	2375	7615	1983	9473	1630	10804	1325	12800	813	16281	435	13783
24-#10	3.65	MA	7820	2375	10742	2124	13930	1767	15980	1461	18755	942	24478	304	22520
10L-4S		MI	5008	2375	7865	1972	9826	1616	11220	1318	13376	803	17060	490	14105
24-#10	3.65	MA	7573	2375	10269	2134	13328	1778	15241	1472	17719	956	23161	256	21563
11L-3S		MI	5102	2375	8143	1962	10189	1607	11684	1305	14010	799	17842	543	14236
24-#11	4.48	MA	8563	2580	12489	2253	16035	1861	18507	1524	22128	937	29079	235	27660
9L-5S		MI	5162	2580	8455	2101	10466	1716	11971	1377	14340	797	18062	320	16352
24-#11	4.48	MA	8262	2580	11902	2263	15307	1874	17594	1535	20880	948	27422	183	26406
10L-4S		MI	5290	2580	8757	2089	10892	1700	12474	1369	15035	787	18976	388	16678

RECTANGULAR TIED COLUMNS 22" x 40"

4-#14	1.02	MA	7717	1821	9304	1701	12147	1431	13774	1220	15533	899	19325	783	8609
2E		MI	4044	1821	5466	1605	6688	1349	7359	1148	8047	842	9542	703	4435
4-#18	1.82	MA	8675	2027	11563	1818	14904	1516	17056	1271	19902	884	25339	767	14888
2E		MI	4420	2027	6542	1712	7961	1426	8855	1193	10021	822	11843	629	7399
6-#11	1.06	MA	7797	1831	9374	1713	12287	1441	13970	1227	15821	902	19743	786	8987
2L-3S		MI	3785	1831	5011	1634	6158	1373	6742	1166	7236	858	8553	601	4639
6-#11	1.06	MA	7137	1831	8381	1731	11031	1458	12451	1242	13776	922	16912	686	8951
3L-2S		MI	4089	1831	5487	1622	6760	1363	7470	1159	8216	848	9847	715	4625
6-#14	1.53	MA	8391	1953	10724	1784	13943	1492	15947	1258	18458	894	23375	777	12766
2L-3S		MI	3922	1953	5466	1703	6688	1422	7359	1196	8047	849	9542	516	6427
6-#14	1.53	MA	7500	1953	9304	1809	12147	1515	13774	1280	15533	922	19325	630	12647
3L-2S		MI	4331	1953	6141	1688	7541	1410	8392	1187	9437	837	11344	681	6437
6-#18	2.73	MA	9748	2262	14046	1965	18045	1624	20855	1341	25017	875	32421	754	22133
2L-3S		MI	4250	2262	6542	1883	7961	1551	8855	1273	10021	828	11843	282	10606
6-#18	2.73	MA	8367	2262	11563	2007	14904	1663	17056	1376	19902	922	25339	487	21613
3L-2S		MI	4865	2262	7700	1859	9426	1534	10627	1262	12407	813	14823	576	10787
8-#10	1.15	MA	7958	1855	9570	1736	12606	1459	14393	1240	16426	906	20607	789	9804
2L-4S		MI	3772	1855	4890	1672	6057	1404	6628	1197	7103	869	8531	585	5031
8-#10	1.15	MA	7423	1855	8752	1751	11572	1473	13143	1253	14743	923	18276	709	9773
3E		MI	3924	1855	5169	1662	6421	1395	7092	1184	7737	865	9313	638	5043

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	1.15	MA	7112	1855	8196	1766	10844	1487	12210	1272	13467	934	16735	658	9656
4L-2S		MI	4174	1855	5565	1651	6922	1386	7699	1177	8554	856	10417	732	5037
8-#11	1.42	MA	8273	1923	10366	1771	13542	1483	15489	1254	17866	898	22574	781	11893
2L-4S		MI	3826	1923	5151	1703	6322	1424	6911	1207	7453	857	8926	526	5998
8-#11	1.42	MA	7646	1923	9374	1788	12287	1500	13970	1269	15821	918	19743	681	11837
3E		MI	4003	1923	5487	1691	6760	1415	7470	1193	8216	854	9847	588	6035
8-#11	1.42	MA	7283	1923	8695	1806	11400	1516	12834	1292	14268	932	17858	618	11633
4L-2S		MI	4294	1923	5963	1679	7362	1405	8199	1186	9197	844	11140	703	6035
8-#14	2.05	MA	9033	2086	12144	1867	15739	1553	18119	1297	21383	889	27425	770	16915
2L-4S		MI	3984	2086	5662	1802	6918	1496	7596	1254	8351	847	10056	406	8059
8-#14	2.05	MA	8199	2086	10724	1891	13943	1576	15947	1319	18458	917	23375	623	16766
3E		MI	4221	2086	6141	1786	7541	1483	8392	1235	9437	844	11344	494	8380
8-#14	2.05	MA	7719	2086	9752	1916	12672	1599	14320	1350	16232	935	20663	532	16123
4L-2S		MI	4609	2086	6815	1770	8395	1471	9425	1226	10827	832	13146	659	8419
8-#18	3.64	MA	9513	2498	14046	2155	18045	1771	20855	1445	25017	913	32421	475	28826
3E		MI	4732	2498	7700	2031	9426	1660	10627	1342	12407	820	14823	229	13913
8-#18	3.64	MA	8797	2498	12339	2197	15814	1810	18000	1498	21114	942	27628	310	25309
4L-2S		MI	5294	2498	8859	2007	10892	1642	12400	1331	14793	804	17802	522	14153
10-#10	1.44	MA	8351	1930	10387	1783	13639	1493	15644	1262	18110	903	22938	785	12195
2L-5S		MI	3837	1930	5038	1729	6206	1452	6819	1226	7344	875	8856	524	6022
10-#10	1.44	MA	7837	1930	9570	1798	12606	1507	14393	1275	16426	920	20607	705	12153
3L-4S		MI	3962	1930	5287	1719	6559	1438	7235	1218	7920	866	9635	578	6179
10-#10	1.44	MA	7546	1930	9013	1812	11877	1521	13461	1294	15150	931	19066	654	12026
4L-3S		MI	4106	1930	5565	1708	6922	1429	7699	1206	8554	862	10417	631	6204
10-#10	1.44	MA	7220	1930	8508	1826	11176	1540	12632	1307	14000	948	17423	607	11603
5L-2S		MI	4348	1930	5962	1698	7424	1421	8306	1199	9371	853	11520	725	6207
10-#11	1.77	MA	8732	2015	11359	1828	14798	1526	17007	1281	19911	895	25405	776	14794
2L-5S		MI	3902	2015	5326	1771	6498	1483	7136	1242	7739	864	9305	445	7025
10-#11	1.77	MA	8134	2015	10366	1846	13542	1542	15489	1296	17866	915	22574	676	14723
3L-4S		MI	4048	2015	5627	1760	6924	1466	7639	1234	8434	854	10219	513	7366
10-#11	1.77	MA	7798	2015	9688	1863	12655	1558	14353	1318	16313	928	20689	613	14510
4L-3S		MI	4215	2015	5963	1748	7362	1457	8199	1220	9197	851	11140	576	7422
10-#11	1.77	MA	7412	2015	9079	1880	11801	1582	13343	1334	14912	948	18684	554	13691
5L-2S		MI	4495	2015	6439	1737	7965	1448	8927	1213	10178	841	12434	690	7435
10-#14	2.56	MA	8866	2218	12144	1974	15739	1637	18119	1358	21383	912	27425	616	20889
3L-4S		MI	4289	2218	6337	1884	7771	1556	8629	1293	9742	842	11858	384	9905
10-#14	2.56	MA	8432	2218	11171	1999	14468	1660	16492	1389	19158	930	24714	525	20219
4L-3S		MI	4517	2218	6815	1869	8395	1544	9425	1274	10827	839	13146	472	10328
10-#14	2.56	MA	7895	2218	10305	2023	13243	1693	15044	1410	17150	958	21835	437	18536
5L-2S		MI	4874	2218	7490	1853	9249	1532	10457	1265	12218	827	14947	637	10389
10-#18	4.55	MA	9984	2733	14822	2344	18955	1918	21799	1568	26229	933	34710	298	32486
4L-3S		MI	5194	2733	8859	2178	10892	1768	12400	1411	14793	811	17802	175	17175
10-#18	4.55	MA	9085	2733	13309	2386	16802	1975	19255	1603	22704	980	29641	133	29063
5L-2S		MI	5711	2733	10017	2154	12357	1750	14172	1400	17180	795	20781	469	17510
12-#10	1.73	MA	8732	2004	11204	1830	14673	1528	16894	1284	19793	900	25268	781	14584
2L-6S		MI	3849	2004	5192	1785	6388	1495	7019	1260	7599	877	9204	448	6896
12-#10	1.73	MA	8238	2004	10387	1844	13639	1541	15644	1297	18110	917	22938	701	14532
3L-5S		MI	4027	2004	5434	1776	6708	1487	7426	1247	8162	873	9959	516	7125
12-#10	1.73	MA	7965	2004	9830	1859	12911	1555	14711	1315	16834	928	21397	650	14398
4E		MI	4146	2004	5683	1765	7061	1472	7842	1240	8737	863	10739	571	7324
12-#10	1.73	MA	7644	2004	9326	1872	12210	1575	13882	1328	15684	945	19754	603	13960
5L-3S		MI	4283	2004	5962	1755	7424	1464	8306	1228	9371	859	11520	624	7360
12-#10	1.73	MA	7277	2004	8787	1880	11559	1587	13095	1342	14565	957	18324	548	13290
6L-2S		MI	4517	2004	6359	1745	7926	1455	8913	1221	10188	850	12624	717	7372

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 40"

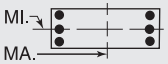
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.13	MA	8606	2107	11359	1903	14798	1584	17007	1323	19911	912	25405	671	17610
3L-5S		MI	4127	2107	5802	1829	7100	1525	7865	1269	8719	860	10599	433	8351
12-#11	2.13	MA	8293	2107	10681	1921	13911	1601	15872	1345	18358	925	23520	608	17391
4E		MI	4263	2107	6103	1817	7526	1509	8368	1261	9414	850	11513	500	8734
12-#11	2.13	MA	7914	2107	10072	1937	13056	1624	14862	1361	16957	945	21515	549	16562
5L-3S		MI	4421	2107	6439	1806	7965	1499	8927	1247	10178	847	12434	563	8804
12-#11	2.13	MA	7483	2107	9417	1947	12272	1639	13902	1376	15594	958	19770	479	15762
6L-2S		MI	4691	2107	6915	1794	8567	1490	9655	1240	11159	837	13727	678	8828
12-#14	3.07	MA	9115	2351	12591	2082	16264	1721	18665	1428	22083	925	28764	518	24320
4E		MI	4598	2351	7012	1967	8625	1617	9662	1332	11132	837	13659	362	11766
12-#14	3.07	MA	8588	2351	11725	2106	15039	1754	17217	1449	20075	953	25885	430	22658
5L-3S		MI	4794	2351	7490	1951	9249	1605	10457	1313	12218	834	14947	450	12273
12-#14	3.07	MA	8011	2351	10788	2119	13924	1776	15840	1471	18120	971	23379	327	20954
6L-2S		MI	5132	2351	8165	1936	10103	1593	11490	1304	13608	822	16749	615	12354
12-#18	5.45	MA	10234	2969	15792	2533	19943	2083	23054	1672	27819	971	36723	121	36206
5L-3S		MI	5642	2969	10017	2325	12357	1876	14172	1480	17180	802	20781	122	20317
12-#18	5.45	MA	9346	2969	14163	2556	18001	2122	20575	1726	24385	1000	32305	-70	31973
6L-2S		MI	6123	2969	11175	2301	13822	1858	15944	1469	19566	786	23761	415	20862
14-#10	2.02	MA	8628	2079	11204	1891	14673	1576	16894	1319	19793	914	25268	697	16912
3L-6S		MI	4037	2079	5588	1831	6890	1530	7626	1282	8417	874	10307	441	8016
14-#10	2.02	MA	8372	2079	10647	1906	13945	1590	15961	1337	18517	926	23728	646	16772
4L-5S		MI	4208	2079	5831	1822	7210	1521	8032	1269	8979	870	11063	509	8234
14-#10	2.02	MA	8055	2079	10143	1919	13244	1609	15132	1350	17367	943	22085	600	16321
5L-4S		MI	4326	2079	6080	1812	7563	1507	8449	1262	9555	860	11842	564	8468
14-#10	2.02	MA	7703	2079	9604	1927	12593	1621	14345	1363	16248	954	20655	544	15670
6L-3S		MI	4457	2079	6359	1802	7926	1498	8913	1250	10188	857	12624	617	8514
14-#10	2.02	MA	7393	2079	9090	1937	11917	1630	13527	1380	15161	971	19187	510	14935
7L-2S		MI	4684	2079	6755	1792	8428	1489	9520	1243	11005	847	13727	710	8532
14-#11	2.48	MA	8773	2199	11673	1978	15167	1643	17390	1372	20402	921	26352	604	20275
4L-5S		MI	4339	2199	6278	1886	7703	1567	8593	1296	9700	857	11893	420	9683
14-#11	2.48	MA	8400	2199	11065	1995	14312	1666	16381	1388	19002	941	24346	544	19435
5L-4S		MI	4473	2199	6579	1875	8128	1551	9096	1288	10395	847	12806	488	10096
14-#11	2.48	MA	7988	2199	10410	2004	13528	1681	15421	1403	17639	954	22601	474	18649
6L-3S		MI	4630	2199	6915	1863	8567	1541	9655	1274	11159	844	13727	551	10183
14-#11	2.48	MA	7626	2199	9784	2016	12705	1691	14436	1424	16314	974	20801	431	17492
7L-2S		MI	4881	2199	7391	1852	9169	1532	10384	1267	12139	834	15021	665	10217
14-#14	3.58	MA	9255	2483	13145	2188	16835	1815	19389	1488	23000	948	29935	423	26779
5L-4S		MI	4885	2483	7687	2050	9479	1678	10694	1371	12522	832	15461	340	13640
14-#14	3.58	MA	8711	2483	12207	2201	15721	1837	18013	1510	21045	966	27429	320	25059
6L-3S		MI	5065	2483	8165	2034	10103	1666	11490	1352	13608	829	16749	428	14218
14-#14	3.58	MA	8232	2483	11311	2218	14542	1851	16614	1541	19146	994	24837	257	23285
7L-2S		MI	5385	2483	8840	2019	10957	1653	12523	1342	14999	817	18551	593	14314
14-#18	6.36	MA	10592	3204	16645	2703	21141	2230	24374	1795	29499	991	39387	-82	38853
6L-3S		MI	6082	3204	11175	2472	13822	1984	15944	1549	19566	793	23761	68	23486
16-#10	2.31	MA	8767	2154	11464	1952	14979	1624	17211	1359	20201	923	26059	642	19148
4L-6S		MI	4220	2154	5985	1878	7392	1564	8232	1304	9234	871	11411	434	9138
16-#10	2.31	MA	8454	2154	10960	1966	14277	1643	16383	1372	19051	940	24416	596	18685
5E		MI	4386	2154	6228	1869	7712	1555	8639	1291	9796	867	12166	502	9348
16-#10	2.31	MA	8116	2154	10422	1974	13626	1655	15595	1385	17932	951	22986	540	18051
6L-4S		MI	4503	2154	6477	1859	8064	1541	9056	1284	10372	858	12946	557	9612
16-#10	2.31	MA	7821	2154	9907	1984	12950	1664	14777	1402	16845	968	21518	506	17306
7L-3S		MI	4627	2154	6755	1848	8428	1532	9520	1272	11005	854	13727	610	9665
16-#10	2.31	MA	7547	2154	9342	2001	12253	1680	13958	1411	15762	979	20088	461	16482
8L-2S		MI	4847	2154	7152	1838	8930	1524	10127	1265	11823	844	14831	703	9690
16-#11	2.84	MA	8870	2290	12057	2052	15568	1708	17899	1415	21047	938	27178	539	22313
5E		MI	4546	2290	6754	1944	8305	1609	9322	1323	10681	853	13186	408	11022
16-#11	2.84	MA	8477	2290	11402	2061	14784	1723	16939	1430	19683	951	25432	469	21535
6L-4S		MI	4689	2290	7055	1932	8731	1593	9824	1315	11376	843	14100	475	11415

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis



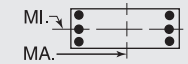
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.84	MA	8134	2290	10777	2073	13961	1733	15955	1451	18359	971	23632	426	20370
7L-3S		MI	4825	2290	7391	1921	9169	1584	10384	1301	12139	840	15021	538	11560
16-#11	2.84	MA	7811	2290	10088	2094	13112	1752	14958	1462	17039	984	21886	369	19245
8L-2S		MI	5066	2290	7868	1909	9771	1574	11112	1294	13120	830	16315	653	11604
16-#14	4.09	MA	9387	2615	13627	2284	17517	1898	20185	1549	23971	961	31479	313	29164
6L-4S		MI	5163	2615	8362	2133	10333	1739	11727	1410	13913	827	17263	318	15524
16-#14	4.09	MA	8940	2615	12731	2301	16338	1912	18787	1580	22071	989	28888	250	27378
7L-3S		MI	5329	2615	8840	2117	10957	1727	12523	1390	14999	824	18551	406	16163
16-#14	4.09	MA	8488	2615	11743	2330	15122	1938	17358	1594	20178	1007	26379	166	25455
8L-2S		MI	5634	2615	9515	2101	11810	1714	13555	1381	16389	812	20352	571	16273
18-#10	2.60	MA	8843	2229	11777	2012	15311	1678	17633	1394	20734	937	26747	592	21051
5L-6S		MI	4399	2229	6382	1925	7894	1598	8839	1326	10051	868	12515	426	10264
18-#10	2.60	MA	8518	2229	11239	2020	14660	1690	16846	1407	19615	948	25317	536	20430
6L-5S		MI	4560	2229	6624	1916	8214	1590	9246	1313	10613	864	13270	495	10466
18-#10	2.60	MA	8236	2229	10725	2031	13984	1698	16028	1424	18528	965	23849	502	19676
7L-4S		MI	4676	2229	6873	1905	8566	1575	9663	1306	11189	855	14049	550	10756
18-#10	2.60	MA	7967	2229	10159	2048	13287	1714	15209	1433	17446	977	22419	457	18854
8L-3S		MI	4794	2229	7152	1895	8930	1567	10127	1294	11823	851	14831	603	10816
18-#10	2.60	MA	7629	2229	9661	2059	12641	1725	14384	1449	16377	994	20955	405	17901
9L-2S		MI	5008	2229	7549	1885	9431	1558	10734	1287	12640	841	15935	696	10846
18-#11	3.19	MA	8952	2382	12395	2119	16039	1765	18458	1457	21728	947	28263	464	24422
6L-5S		MI	4757	2382	7230	2001	8907	1651	10050	1350	11662	850	14480	395	12365
18-#11	3.19	MA	8627	2382	11769	2131	15216	1776	17474	1478	20403	967	26464	422	23247
7L-4S		MI	4889	2382	7531	1989	9333	1635	10553	1342	12357	840	15394	463	12741
18-#11	3.19	MA	8310	2382	11080	2151	14368	1794	16477	1488	19084	981	24717	364	22115
8L-3S		MI	5016	2382	7868	1978	9771	1626	11112	1328	13120	837	16315	525	12937
18-#11	3.19	MA	7914	2382	10480	2165	13581	1807	15472	1507	17782	1001	22922	299	20955
9L-2S		MI	5248	2382	8344	1966	10373	1616	11841	1321	14101	827	17608	640	12988
18-#14	4.60	MA	9624	2748	14151	2384	18134	1972	20959	1619	24996	984	32938	243	31470
7L-4S		MI	5436	2748	9037	2215	11187	1800	12760	1448	15303	822	19065	296	17416
18-#14	4.60	MA	9180	2748	13163	2413	16918	1999	19530	1633	23103	1002	30429	159	29555
8L-3S		MI	5589	2748	9515	2200	11810	1787	13555	1429	16389	820	20352	384	18108
18-#14	4.60	MA	8654	2748	12309	2433	15790	2017	18091	1658	21236	1030	27845	64	27459
9L-2S		MI	5879	2748	10190	2184	12664	1775	14588	1420	17779	807	22154	549	18230
20-#10	2.89	MA	8910	2303	12056	2067	15694	1724	18096	1429	21299	946	27648	533	22808
6E		MI	4575	2303	6778	1972	8396	1633	9446	1348	10868	865	13618	419	11392
20-#10	2.89	MA	8641	2303	11542	2077	15018	1733	17278	1446	20212	963	26180	498	22047
7L-5S		MI	4731	2303	7021	1962	8715	1624	9853	1335	11430	861	14374	488	11587
20-#10	2.89	MA	8376	2303	10976	2094	14321	1748	16459	1455	19129	974	24750	453	21227
8L-4S		MI	4857	2303	7270	1952	9068	1610	10270	1328	12006	852	15153	542	11900
20-#10	2.89	MA	8050	2303	10478	2105	13675	1759	15634	1470	18061	991	23286	401	20268
9L-3S		MI	4965	2303	7549	1942	9431	1601	10734	1316	12640	848	15935	595	11965
20-#10	2.89	MA	7746	2303	9966	2114	13042	1771	14840	1481	16949	999	21853	362	19332
10L-2S		MI	5164	2303	7945	1932	9933	1593	11341	1309	13457	839	17038	689	12001
20-#11	3.55	MA	9107	2474	12762	2188	16472	1818	18993	1505	22448	964	29295	417	26125
7L-5S		MI	4955	2474	7706	2058	9509	1694	10778	1377	12642	846	15773	382	13711
20-#11	3.55	MA	8794	2474	12073	2209	15623	1836	17995	1515	21128	977	27548	360	24984
8L-4S		MI	5085	2474	8007	2047	9935	1677	11281	1369	13337	837	16687	450	14072
20-#11	3.55	MA	8415	2474	11473	2222	14836	1849	16991	1534	19827	997	25754	294	23828
9L-3S		MI	5204	2474	8344	2035	10373	1668	11841	1355	14101	834	17608	513	14313
20-#11	3.55	MA	8060	2474	10850	2233	14065	1863	16023	1546	18491	1008	24002	244	22477
10L-2S		MI	5428	2474	8820	2024	10976	1658	12569	1348	15082	824	18902	627	14372
20-#14	5.11	MA	9852	2880	14583	2496	18714	2060	21703	1671	26028	997	34479	152	33656
8L-4S		MI	5704	2880	9711	2298	12040	1861	13792	1487	16694	817	20866	274	19316

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

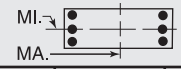
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	5.11	MA	9353	2880	13729	2516	17586	2078	20263	1697	24161	1025	31895	57	31551
9L-3S		MI	5845	2880	10190	2283	12664	1848	14588	1468	17779	815	22154	362	20054
22-#10	3.17	MA	9036	2378	12359	2124	16052	1767	18528	1468	21895	960	28511	494	24417
7L-6S		MI	4760	2378	7175	2018	8897	1667	10053	1370	11685	863	14722	412	12522
22-#10	3.17	MA	8775	2378	11793	2141	15355	1783	17709	1477	20813	971	27081	450	23599
8L-5S		MI	4908	2378	7418	2009	9217	1658	10460	1357	12248	859	15477	480	12711
22-#10	3.17	MA	8460	2378	11295	2152	14708	1794	16885	1492	19744	988	25617	397	22635
9L-4S		MI	5022	2378	7667	1999	9570	1644	10877	1350	12823	849	16256	535	13044
22-#10	3.17	MA	8169	2378	10784	2161	14075	1805	16090	1503	18632	996	24184	358	21694
10L-3S		MI	5124	2378	7945	1989	9933	1636	11341	1338	13457	845	17038	588	13114
22-#10	3.17	MA	7891	2378	10282	2171	13433	1816	15308	1514	17536	1011	22792	311	20716
11L-2S		MI	5318	2378	8342	1978	10435	1627	11948	1331	14274	836	18142	681	13155
22-#11	3.90	MA	9267	2566	13066	2266	16879	1879	19514	1542	23173	974	30380	355	27854
8L-5S		MI	5148	2566	8182	2116	10111	1736	11507	1404	13623	843	17067	370	15061
22-#11	3.90	MA	8902	2566	12465	2280	16092	1892	18510	1561	21871	994	28585	290	26701
9L-4S		MI	5277	2566	8483	2104	10537	1719	12010	1396	14318	833	17981	438	15407
22-#11	3.90	MA	8564	2566	11842	2290	15321	1905	17542	1573	20536	1004	26834	240	25345
10L-3S		MI	5389	2566	8820	2093	10976	1710	12569	1382	15082	830	18902	500	15689
22-#14	5.63	MA	10031	3013	15149	2598	19382	2139	22436	1736	27086	1020	35945	50	35643
9L-4S		MI	5968	3013	10386	2381	12894	1921	14825	1526	18084	812	22668	252	21221
24-#10	3.46	MA	9165	2453	12611	2188	16388	1817	18960	1499	22496	968	29412	446	25971
8L-6S		MI	4929	2453	7572	2065	9399	1701	10660	1392	12502	860	15825	405	13654
24-#10	3.46	MA	8861	2453	12113	2199	15742	1828	18135	1514	21428	985	27947	393	25002
9L-5S		MI	5072	2453	7814	2056	9719	1693	11067	1379	13065	856	16581	473	13837
24-#10	3.46	MA	8581	2453	11601	2208	15109	1840	17341	1525	20316	993	26515	354	24056
10L-4S		MI	5186	2453	8063	2046	10072	1678	11484	1372	13641	846	17360	528	14167
24-#10	3.46	MA	8316	2453	11099	2218	14466	1850	16558	1536	19220	1008	25123	307	23080
11L-3S		MI	5282	2453	8342	2035	10435	1670	11948	1360	14274	843	18142	581	14263
24-#11	4.25	MA	9378	2658	13458	2337	17348	1934	20029	1588	23916	990	31416	285	29574
9L-5S		MI	5339	2658	8658	2173	10714	1778	12235	1431	14604	840	18361	357	16414
24-#11	4.25	MA	9055	2658	12835	2348	16576	1948	19061	1600	22581	1001	29665	235	28212
10L-4S		MI	5467	2658	8959	2162	11140	1762	12738	1423	15299	830	19274	425	16747

RECTANGULAR TIED COLUMNS 22" x 42"

4-#18	1.73	MA	9490	2105	12456	1901	16121	1587	18459	1333	21506	933	27352	810	15752
2E		MI	4595	2105	6753	1783	8213	1486	9120	1245	10283	864	12138	666	7427
6-#11	1.01	MA	8544	1909	10132	1796	13342	1512	15182	1288	17173	951	21412	829	9492
2L-3S		MI	3957	1909	5214	1706	6405	1434	7006	1220	7499	901	8851	638	4660
6-#11	1.01	MA	7839	1909	9082	1814	12014	1528	13576	1304	15010	971	18417	730	9457
3L-2S		MI	4262	1909	5690	1694	7008	1425	7734	1213	8480	891	10145	753	4643
6-#14	1.46	MA	9182	2031	11563	1866	15097	1563	17277	1320	19966	943	25260	820	13495
2L-3S		MI	4093	2031	5671	1775	6937	1484	7624	1249	8310	892	9839	553	6456
6-#14	1.46	MA	8229	2031	10060	1892	13196	1586	14978	1342	16871	972	20973	675	13376
3L-2S		MI	4505	2031	6346	1759	7790	1471	8657	1240	9700	879	11641	719	6460
6-#18	2.60	MA	10641	2340	15086	2048	19448	1695	22483	1402	26924	924	34854	797	23429
2L-3S		MI	4421	2340	6753	1954	8213	1612	9120	1326	10283	870	12138	319	10659
6-#18	2.60	MA	9160	2340	12456	2091	16121	1735	18459	1439	21506	973	27352	534	22909
3L-2S		MI	5043	2340	7911	1930	9678	1594	10893	1315	12669	855	15117	613	10820
8-#10	1.10	MA	8714	1933	10337	1819	13677	1529	15627	1301	17808	955	22319	832	10353
2L-4S		MI	3943	1933	5089	1745	6303	1466	6892	1251	7367	912	8832	623	5055
8-#10	1.10	MA	8142	1933	9473	1834	12584	1543	14305	1315	16029	972	19855	753	10322
3E		MI	4096	1933	5368	1735	6666	1458	7356	1238	8001	908	9613	676	5062
8-#10	1.10	MA	7812	1933	8886	1849	11815	1558	13320	1334	14681	984	18233	702	10205
4L-2S		MI	4348	1933	5764	1725	7168	1449	7963	1231	8818	899	10717	770	5054
8-#11	1.35	MA	9053	2001	11182	1854	14670	1554	16789	1315	19336	947	24407	824	12567
2L-4S		MI	3997	2001	5354	1775	6569	1486	7175	1261	7717	900	9224	563	6030

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#11	1.35	MA	8383	2001	10132	1871	13342	1571	15182	1331	17173	968	21412	725	12511
3E		MI	4175	2001	5690	1763	7008	1477	7734	1247	8480	897	10145	626	6059
8-#11	1.35	MA	7995	2001	9416	1889	12405	1587	13983	1354	15532	982	19427	662	12307
4L-2S		MI	4468	2001	6166	1752	7610	1467	8463	1240	9461	887	11439	740	6055
8-#14	1.95	MA	9870	2163	13065	1949	16998	1624	19576	1359	23062	938	29546	813	17887
2L-4S		MI	4154	2163	5868	1873	7167	1557	7861	1307	8615	890	10353	444	8157
8-#14	1.95	MA	8976	2163	11563	1974	15097	1647	17277	1381	19966	967	25260	668	17738
3E		MI	4393	2163	6346	1858	7790	1545	8657	1288	9700	887	11641	531	8413
8-#14	1.95	MA	8463	2163	10536	2000	13754	1671	15558	1413	17615	985	22405	577	17192
4L-2S		MI	4784	2163	7021	1842	8644	1532	9689	1279	11091	874	13443	697	8445
8-#18	3.46	MA	10385	2575	15086	2238	19448	1843	22483	1508	26924	964	34854	521	30554
3E		MI	4904	2575	7911	2101	9678	1720	10893	1395	12669	862	15117	265	13968
8-#18	3.46	MA	9618	2575	13282	2281	17089	1883	19465	1563	22796	994	29807	358	26959
4L-2S		MI	5474	2575	9070	2078	11143	1703	12665	1384	15056	846	18096	559	14189
10-#10	1.37	MA	9134	2007	11201	1866	14770	1564	16949	1323	19588	952	24783	828	12881
2L-5S		MI	4008	2007	5237	1802	6452	1515	7082	1280	7609	919	9156	562	6084
10-#10	1.37	MA	8585	2007	10337	1881	13677	1578	15627	1337	17808	969	22319	749	12839
3L-4S		MI	4133	2007	5486	1792	6805	1501	7499	1273	8184	909	9935	616	6205
10-#10	1.37	MA	8275	2007	9750	1895	12908	1592	14642	1356	16461	981	20698	698	12711
4L-3S		MI	4278	2007	5764	1782	7168	1492	7963	1260	8818	906	10717	669	6225
10-#10	1.37	MA	7924	2007	9215	1909	12168	1612	13767	1369	15248	998	18966	653	12329
5L-2S		MI	4522	2007	6161	1771	7670	1483	8570	1253	9635	896	11820	763	6225
10-#11	1.69	MA	9545	2093	12232	1911	15999	1596	18396	1342	21499	944	27402	819	15637
2L-5S		MI	4072	2093	5529	1844	6746	1545	7401	1296	8002	907	9604	483	7096
10-#11	1.69	MA	8905	2093	11182	1929	14670	1613	16789	1358	19336	964	24407	720	15566
3L-4S		MI	4219	2093	5830	1832	7172	1528	7903	1288	8697	897	10517	551	7401
10-#11	1.69	MA	8545	2093	10466	1947	13734	1630	15590	1381	17695	978	22422	658	15352
4L-3S		MI	4388	2093	6166	1821	7610	1519	8463	1274	9461	894	11439	613	7448
10-#11	1.69	MA	8131	2093	9820	1963	12832	1653	14523	1397	16216	999	20308	600	14553
5L-2S		MI	4670	2093	6642	1809	8212	1509	9191	1267	10442	884	12732	728	7458
10-#14	2.44	MA	9690	2296	13065	2057	16998	1708	19576	1420	23062	962	29546	661	22104
3L-4S		MI	4460	2296	6543	1956	8020	1618	8894	1346	10005	885	12155	422	9999
10-#14	2.44	MA	9225	2296	12039	2083	15655	1732	17857	1452	20710	981	26691	570	21546
4L-3S		MI	4682	2296	7021	1941	8644	1605	9689	1327	11091	882	13443	509	10363
10-#14	2.44	MA	8647	2296	11117	2106	14362	1765	16328	1474	18590	1009	23655	484	19696
5L-2S		MI	5052	2296	7696	1925	9498	1593	10722	1318	12481	869	15244	674	10417
10-#18	4.33	MA	10886	2811	15912	2429	20416	1991	23488	1632	28214	985	37308	345	34562
4L-3S		MI	5367	2811	9070	2249	11143	1828	12665	1464	15056	853	18096	212	17281
10-#18	4.33	MA	9917	2811	14315	2472	18142	2049	20800	1669	24488	1034	31959	185	31063
5L-2S		MI	5893	2811	10228	2225	12609	1811	14437	1453	17442	837	21076	506	17547
12-#10	1.65	MA	9542	2082	12065	1912	15863	1598	18270	1345	21368	949	27247	824	15407
2L-6S		MI	4020	2082	5391	1858	6634	1558	7282	1315	7864	920	9504	486	6955
12-#10	1.65	MA	9014	2082	11201	1927	14770	1612	16949	1359	19588	966	24783	745	15355
3L-5S		MI	4198	2082	5633	1849	6954	1549	7689	1302	8426	916	10259	554	7185
12-#10	1.65	MA	8722	2082	10614	1942	14001	1626	15964	1378	18241	978	23162	694	15221
4E		MI	4318	2082	5882	1839	7306	1535	8106	1295	9002	907	11039	609	7352
12-#10	1.65	MA	8377	2082	10078	1955	13261	1646	15089	1391	17027	996	21430	649	14825
5L-3S		MI	4457	2082	6161	1828	7670	1526	8570	1282	9635	903	11820	662	7383
12-#10	1.65	MA	7987	2082	9510	1963	12569	1658	14259	1404	15847	1007	19924	594	14097
6L-2S		MI	4693	2082	6558	1818	8172	1518	9177	1275	10452	893	12924	755	7391
12-#11	2.03	MA	9410	2185	12232	1986	15999	1655	18396	1385	21499	961	27402	715	18621
3L-5S		MI	4297	2185	6005	1901	7348	1587	8129	1323	8983	903	10897	470	8420
12-#11	2.03	MA	9075	2185	11516	2004	15062	1672	17196	1408	19858	975	25417	653	18402
4E		MI	4435	2185	6306	1890	7774	1570	8632	1315	9678	893	11811	538	8770

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 42"

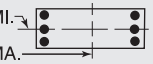
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#11	2.03	MA	8667	2185	10870	2020	14160	1696	16130	1424	18380	995	23303	595	17593
5L-3S		MI	4595	2185	6642	1878	8212	1561	9191	1301	10442	890	12732	601	8831
12-#11	2.03	MA	8208	2185	10178	2030	13326	1710	15117	1439	16940	1009	21463	526	16725
6L-2S		MI	4867	2185	7118	1867	8814	1552	9920	1294	11422	880	14026	715	8852
12-#14	2.92	MA	9954	2428	13541	2165	17556	1793	20156	1491	23806	976	30978	563	25895
4E		MI	4770	2428	7218	2039	8874	1679	9926	1385	11395	880	13956	400	11858
12-#14	2.92	MA	9387	2428	12620	2189	16263	1826	18627	1513	21686	1004	27941	477	24059
5L-3S		MI	4970	2428	7696	2023	9498	1666	10722	1366	12481	877	15244	487	12309
12-#14	2.92	MA	8771	2428	11629	2203	15076	1848	17174	1535	19622	1023	25299	376	22337
6L-2S		MI	5312	2428	8371	2008	10352	1654	11755	1357	13872	865	17046	652	12382
12-#18	5.19	MA	11144	3046	16945	2619	21469	2157	24824	1738	29906	1025	39460	173	38631
5L-3S		MI	5817	3046	10228	2396	12609	1936	14437	1533	17442	844	21076	158	20466
12-#18	5.19	MA	10194	3046	15207	2641	19416	2197	22205	1792	26278	1055	34801	-14	34730
6L-2S		MI	6306	3046	11387	2372	14074	1919	16210	1522	19828	828	24055	452	20900
14-#10	1.92	MA	9430	2157	12065	1974	15863	1647	18270	1381	21368	964	27247	741	17872
3L-6S		MI	4208	2157	5787	1905	7136	1592	7889	1337	8681	917	10608	479	8073
14-#10	1.92	MA	9156	2157	11478	1989	15094	1661	17286	1400	20020	975	25626	690	17732
4L-5S		MI	4381	2157	6030	1895	7456	1583	8296	1324	9243	913	11363	547	8293
14-#10	1.92	MA	8816	2157	10942	2002	14354	1680	16411	1413	18807	993	23894	645	17324
5L-4S		MI	4499	2157	6279	1885	7808	1569	8712	1317	9819	904	12142	602	8498
14-#10	1.92	MA	8441	2157	10373	2010	13662	1692	15581	1426	17626	1005	22388	590	16612
6L-3S		MI	4631	2157	6558	1875	8172	1561	9177	1304	10452	900	12924	655	8537
14-#10	1.92	MA	8111	2157	9831	2021	12948	1701	14711	1443	16480	1022	20844	556	15886
7L-2S		MI	4860	2157	6954	1865	8674	1552	9783	1297	11270	890	14028	748	8553
14-#11	2.36	MA	9587	2276	12566	2061	16390	1714	18803	1435	22021	971	28412	648	21454
4L-5S		MI	4511	2276	6481	1959	7950	1629	8857	1350	9964	900	12191	458	9751
14-#11	2.36	MA	9186	2276	11920	2078	15488	1738	17736	1451	20543	992	26298	590	20637
5L-4S		MI	4645	2276	6782	1947	8376	1613	9360	1342	10659	890	13105	526	10139
14-#11	2.36	MA	8747	2276	11228	2087	14654	1753	16724	1466	19103	1005	24458	521	19780
6L-3S		MI	4797	2276	7118	1936	8814	1603	9920	1328	11422	887	14026	588	10212
14-#11	2.36	MA	8360	2276	10566	2100	13785	1763	15676	1487	17705	1026	22565	479	18611
7L-2S		MI	5060	2276	7594	1924	9417	1594	10648	1321	12403	877	15319	703	10242
14-#14	3.41	MA	10100	2561	14123	2272	18164	1887	20926	1552	24781	999	32228	470	28421
5L-4S		MI	5057	2561	7892	2122	9728	1739	10959	1424	12786	875	15758	378	13729
14-#14	3.41	MA	9519	2561	13131	2285	16977	1909	19473	1574	22717	1018	29585	369	26682
6L-3S		MI	5241	2561	8371	2106	10352	1727	11755	1405	13872	872	17046	465	14255
14-#14	3.41	MA	9006	2561	12184	2303	15731	1923	17983	1605	20711	1047	26859	307	24884
7L-2S		MI	5566	2561	9046	2091	11206	1715	12787	1396	15262	860	18848	630	14344
14-#18	6.06	MA	11444	3282	17837	2788	22743	2305	26229	1862	31696	1047	42303	-26	42121
6L-3S		MI	6257	3282	11387	2543	14074	2044	16210	1602	19828	835	24055	105	23630
14-#18	6.06	MA	10667	3282	16173	2818	20557	2329	23697	1898	28168	1095	37473	-139	36821
7L-2S		MI	6715	3282	12545	2519	15539	2027	17982	1591	22215	819	27034	399	24251
16-#10	2.20	MA	9578	2232	12342	2036	16187	1695	18607	1422	21800	973	28090	687	20246
4L-6S		MI	4391	2232	6184	1951	7638	1626	8496	1358	9498	914	11711	472	9195
16-#10	2.20	MA	9242	2232	11806	2049	15447	1715	17733	1435	20587	990	26358	641	19825
5E		MI	4559	2232	6427	1942	7957	1618	8903	1346	10060	910	12467	540	9406
16-#10	2.20	MA	8881	2232	11237	2057	14755	1727	16902	1448	19406	1002	24852	586	19127
6L-4S		MI	4676	2232	6676	1932	8310	1604	9319	1339	10636	901	13246	595	9642
16-#10	2.20	MA	8566	2232	10695	2067	14041	1735	16033	1465	18259	1019	23308	553	18393
7L-3S		MI	4802	2232	6954	1922	8674	1595	9783	1326	11270	897	14028	648	9690
16-#10	2.20	MA	8273	2232	10098	2085	13305	1751	15168	1474	17117	1031	21802	509	17509
8L-2S		MI	5025	2232	7351	1911	9175	1586	10390	1319	12087	888	15131	741	9711
16-#11	2.70	MA	9689	2368	12970	2135	16817	1780	19343	1478	22706	988	29293	585	23684
5E		MI	4719	2368	6957	2016	8552	1671	9586	1377	10945	896	13485	445	11087
16-#11	2.70	MA	9269	2368	12278	2145	15982	1795	18330	1493	21267	1002	27453	516	22833
6L-4S		MI	4863	2368	7258	2005	8978	1655	10089	1369	11640	886	14398	513	11489
16-#11	2.70	MA	8902	2368	11616	2157	15113	1805	17282	1514	19868	1023	25560	474	21656
7L-3S		MI	5001	2368	7594	1993	9417	1645	10648	1355	12403	883	15319	576	11590

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

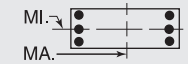
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.70	MA	8555	2368	10889	2178	14217	1824	16229	1525	18475	1036	23720	418	20525
8L-2S		MI	5246	2368	8070	1981	10019	1636	11377	1348	13384	873	16613	690	11630
16-#14	3.90	MA	10240	2693	14634	2368	18878	1970	21772	1613	25813	1013	33871	362	31027
6L-4S		MI	5337	2693	8567	2205	10582	1800	11992	1463	14176	870	17560	356	15610
16-#14	3.90	MA	9761	2693	13687	2385	17632	1984	20282	1643	23807	1042	31146	301	29216
7L-3S		MI	5506	2693	9046	2189	11206	1788	12787	1444	15262	867	18848	443	16201
16-#14	3.90	MA	9275	2693	12644	2415	16347	2011	18773	1658	21809	1061	28501	218	27136
8L-2S		MI	5816	2693	9721	2173	12059	1776	13820	1435	16652	855	20649	608	16303
16-#18	6.93	MA	12033	3517	18803	2965	23884	2437	27721	1968	33586	1086	44975	-151	43959
7L-3S		MI	6691	3517	12545	2690	15539	2153	17982	1671	22215	826	27034	51	26817
18-#10	2.47	MA	9658	2306	12670	2095	16540	1749	19055	1457	22366	987	28823	637	22329
5L-6S		MI	4571	2306	6581	1998	8140	1661	9103	1380	10315	911	12815	464	10320
18-#10	2.47	MA	9310	2306	12101	2104	15848	1761	18224	1470	21186	999	27316	583	21642
6L-5S		MI	4734	2306	6823	1989	8459	1652	9510	1368	10877	908	13570	533	10522
18-#10	2.47	MA	9009	2306	11558	2114	15134	1770	17355	1487	20039	1016	25773	549	20899
7L-4S		MI	4849	2306	7072	1979	8812	1638	9926	1361	11453	898	14349	588	10787
18-#10	2.47	MA	8721	2306	10961	2131	14398	1786	16490	1496	18897	1028	24267	505	20018
8L-3S		MI	4970	2306	7351	1968	9175	1629	10390	1348	12087	894	15131	641	10841
18-#10	2.47	MA	8360	2306	10433	2142	13716	1797	15620	1512	17760	1045	22726	452	19055
9L-2S		MI	5188	2306	7748	1958	9677	1621	10997	1341	12904	885	16235	734	10868
18-#11	3.04	MA	9776	2460	13328	2202	17311	1837	19937	1520	23430	999	30448	512	25887
6L-5S		MI	4932	2460	7433	2074	9155	1713	10314	1404	11925	893	14778	433	12429
18-#11	3.04	MA	9428	2460	12666	2215	16441	1847	18889	1541	22031	1019	28555	469	24700
7L-4S		MI	5063	2460	7734	2062	9581	1697	10817	1396	12620	883	15692	501	12813
18-#11	3.04	MA	9087	2460	11939	2235	15545	1866	17836	1552	20638	1033	26715	414	23561
8L-3S		MI	5193	2460	8070	2050	10019	1688	11377	1382	13384	880	16613	563	12968
18-#11	3.04	MA	8664	2460	11301	2249	14714	1880	16775	1571	19264	1053	24827	349	22310
9L-2S		MI	5429	2460	8547	2039	10621	1678	12105	1375	14365	870	17907	678	13015
18-#14	4.38	MA	10491	2826	15189	2468	19533	2045	22582	1682	26903	1037	35432	294	33548
7L-4S		MI	5611	2826	9242	2287	11436	1861	13024	1502	15567	865	19361	333	17500
18-#14	4.38	MA	10014	2826	14146	2498	18248	2072	21072	1697	24904	1056	32788	211	31476
8L-3S		MI	5767	2826	9721	2272	12059	1849	13820	1483	16652	862	20649	421	18146
18-#14	4.38	MA	9452	2826	13238	2517	17056	2091	19551	1723	22933	1085	30070	117	29355
9L-2S		MI	6063	2826	10396	2256	12913	1836	14853	1474	18043	850	22451	586	18261
20-#10	2.75	MA	9729	2381	12965	2150	16941	1795	19546	1492	22966	996	29781	579	24157
6E		MI	4747	2381	6977	2045	8641	1695	9710	1402	11132	909	13918	457	11447
20-#10	2.75	MA	9441	2381	12422	2161	16227	1804	18676	1509	21819	1013	28237	545	23405
7L-5S		MI	4905	2381	7220	2036	8961	1687	10117	1390	11695	905	14674	526	11642
20-#10	2.75	MA	9156	2381	11825	2178	15491	1820	17812	1518	20676	1025	26731	501	22526
8L-4S		MI	5020	2381	7469	2025	9314	1672	10533	1383	12270	895	15453	580	11931
20-#10	2.75	MA	8809	2381	11297	2189	14809	1831	16942	1534	19540	1042	25190	449	21558
9L-3S		MI	5142	2381	7748	2015	9677	1664	10997	1370	12904	891	16235	633	11991
20-#10	2.75	MA	8484	2381	10756	2198	14141	1843	16103	1545	18366	1051	23681	411	20615
10L-2S		MI	5345	2381	8144	2005	10179	1655	11604	1363	13721	882	17338	727	12024
20-#11	3.38	MA	9940	2552	13716	2272	17770	1889	20496	1568	24194	1016	31550	465	27744
7L-5S		MI	5130	2552	7909	2131	9757	1755	11043	1430	12906	889	16072	420	13774
20-#11	3.38	MA	9604	2552	12989	2293	16873	1909	19442	1579	22801	1029	29710	409	26597
8L-4S		MI	5260	2552	8210	2119	10183	1739	11545	1423	13601	879	16985	488	14143
20-#11	3.38	MA	9199	2552	12351	2306	16042	1922	18382	1597	21428	1050	27822	344	25349
9L-3S		MI	5382	2552	8547	2108	10621	1730	12105	1409	14365	876	17907	551	14345
20-#11	3.38	MA	8820	2552	11693	2317	15228	1936	17360	1610	20004	1060	25977	295	23989
10L-2S		MI	5610	2552	9023	2096	11223	1720	12833	1402	15345	866	19200	665	14399
20-#14	4.87	MA	10730	2958	15649	2581	20149	2133	23371	1736	28000	1051	37074	204	35816
8L-4S		MI	5879	2958	9917	2370	12289	1922	14057	1541	16957	860	21163	311	19397

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

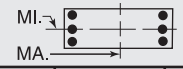
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	4.87	MA	10196	2958	14740	2600	18957	2151	21851	1762	26029	1080	34356	110	33686
9L-3S		MI	6024	2958	10396	2355	12913	1910	14853	1522	18043	857	22451	399	20092
22-#10	3.02	MA	9863	2456	13286	2208	17320	1838	19998	1531	23599	1011	30701	541	25912
7L-6S		MI	4921	2456	7374	2092	9143	1729	10317	1424	11950	906	15022	450	12577
22-#10	3.02	MA	9582	2456	12689	2225	16584	1854	19134	1540	22456	1022	29195	497	25034
8L-5S		MI	5084	2456	7617	2082	9463	1721	10724	1412	12512	902	15777	518	12765
22-#10	3.02	MA	9246	2456	12160	2236	15902	1866	18263	1556	21319	1039	27655	445	24060
9L-4S		MI	5199	2456	7866	2072	9816	1707	11140	1405	13088	893	16557	573	13076
22-#10	3.02	MA	8935	2456	11620	2245	15234	1878	17425	1566	20146	1048	26146	407	23112
10L-3S		MI	5303	2456	8144	2062	10179	1698	11604	1392	13721	889	17338	626	13141
22-#10	3.02	MA	8639	2456	11091	2255	14551	1888	16600	1578	18989	1063	24680	361	22058
11L-2S		MI	5499	2456	8541	2052	10681	1689	12211	1385	14538	879	18442	719	13178
22-#11	3.71	MA	10108	2644	14039	2350	18202	1951	21049	1606	24964	1026	32705	404	29633
8L-5S		MI	5324	2644	8385	2188	10359	1798	11771	1457	13887	886	17365	408	15123
22-#11	3.71	MA	9719	2644	13401	2364	17371	1964	19988	1624	23591	1046	30817	339	28389
9L-4S		MI	5453	2644	8686	2177	10785	1781	12274	1450	14582	876	18279	475	15477
22-#11	3.71	MA	9357	2644	12743	2375	16556	1978	18967	1637	22167	1057	28972	291	27023
10L-3S		MI	5568	2644	9023	2165	11223	1772	12833	1436	15345	873	19200	538	15721
22-#11	3.71	MA	9012	2644	12098	2387	15733	1991	17960	1650	20757	1074	27181	232	25629
11L-2S		MI	5788	2644	9499	2154	11826	1762	13562	1429	16326	863	20494	653	15781
22-#14	5.36	MA	10919	3091	16243	2683	20858	2212	24150	1801	29125	1075	38642	103	38017
9L-4S		MI	6144	3091	10592	2453	13143	1983	15090	1580	18347	855	22965	289	21300
24-#10	3.30	MA	9998	2531	13553	2272	17677	1889	20456	1562	24236	1020	31659	493	27542
8L-6S		MI	5104	2531	7771	2138	9645	1764	10924	1446	12767	903	16125	443	13708
24-#10	3.30	MA	9674	2531	13024	2282	16995	1900	19585	1578	23099	1036	30119	441	26563
9L-5S		MI	5249	2531	8013	2129	9965	1755	11331	1434	13329	899	16881	511	13891
24-#10	3.30	MA	9374	2531	12484	2292	16327	1912	18747	1588	21926	1045	28610	403	25610
10L-4S		MI	5363	2531	8262	2119	10317	1741	11747	1427	13905	890	17660	566	14220
24-#10	3.30	MA	9091	2531	11955	2302	15644	1922	17922	1600	20769	1060	27144	357	24558
11L-3S		MI	5462	2531	8541	2109	10681	1732	12211	1414	14538	886	18442	619	14290
24-#10	3.30	MA	8759	2531	11435	2313	14912	1937	17078	1617	19615	1069	25659	318	23450
12L-2S		MI	5652	2531	8938	2098	11183	1724	12818	1407	15356	876	19545	712	14332
24-#11	4.05	MA	10226	2736	14451	2421	18699	2006	21595	1651	25754	1043	33812	334	31429
9L-5S		MI	5516	2736	8861	2246	10961	1840	12499	1484	14868	882	18659	395	16475
24-#11	4.05	MA	9880	2736	13793	2432	17885	2020	20573	1664	24330	1053	31967	286	30056
10L-4S		MI	5644	2736	9162	2234	11387	1823	13002	1477	15563	873	19573	463	16815
24-#11	4.05	MA	9552	2736	13148	2444	17061	2033	19567	1677	22920	1071	30176	227	28657
11L-3S		MI	5752	2736	9499	2223	11826	1814	13562	1463	16326	870	20494	526	17097

RECTANGULAR TIED COLUMNS 22" x 44"

4-#18	1.65	MA	10337	2182	13374	1983	17376	1657	19907	1394	23158	982	29425	853	16616
2E		MI	4770	2182	6964	1854	8464	1547	9386	1298	10545	905	12432	703	7455
6-#14	1.39	MA	10004	2109	12426	1949	16290	1633	18652	1381	21524	992	27203	862	14224
2L-3S		MI	4265	2109	5877	1847	7186	1545	7889	1303	8573	935	10136	591	6484
6-#14	1.39	MA	8989	2109	10841	1975	14285	1657	16227	1404	18258	1021	22681	719	14105
3L-2S		MI	4679	2109	6552	1831	8039	1533	8922	1294	9964	922	11938	756	6483
6-#18	2.48	MA	11568	2418	16151	2131	20889	1765	24156	1463	28879	973	37346	840	24725
2L-3S		MI	4592	2418	6964	2025	8464	1672	9386	1378	10545	912	12432	356	10710
6-#18	2.48	MA	9985	2418	13374	2175	17376	1806	19907	1502	23158	1023	29425	580	24205
3L-2S		MI	5221	2418	8123	2001	9929	1655	11158	1367	12932	897	15411	649	10853
8-#10	1.05	MA	9502	2010	11130	1902	14787	1600	16906	1363	19239	1004	24090	875	10901
2L-4S		MI	4114	2010	5288	1818	6549	1529	7155	1305	7632	956	9132	661	5077
8-#10	1.05	MA	8894	2010	10219	1917	13635	1614	15512	1376	17363	1021	21492	796	10871
3E		MI	4268	2010	5567	1808	6912	1520	7619	1293	8265	952	9913	714	5080
8-#10	1.05	MA	8543	2010	9601	1932	12825	1629	14475	1396	15944	1033	19790	746	10753
4L-2S		MI	4521	2010	5963	1798	7414	1511	8226	1286	9082	942	11017	808	5070

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.29	MA	9866	2079	12023	1936	15837	1624	18135	1377	20855	996	26298	867	13241
2L-4S		MI	4167	2079	5557	1848	6817	1548	7439	1315	7980	943	9522	601	6060
8-#11	1.29	MA	9152	2079	10916	1954	14436	1642	16440	1393	18573	1017	23139	769	13185
3E		MI	4347	2079	5893	1836	7255	1538	7999	1301	8744	940	10443	663	6082
8-#11	1.29	MA	8740	2079	10162	1972	13450	1659	15177	1416	16845	1031	21055	707	12981
4L-2S		MI	4642	2079	6369	1824	7858	1529	8727	1294	9725	930	11737	778	6076
8-#14	1.86	MA	10739	2241	14012	2032	18296	1694	21078	1420	24790	987	31726	856	18859
2L-4S		MI	4324	2241	6073	1945	7416	1618	8126	1361	8878	932	10650	481	8254
8-#14	1.86	MA	9786	2241	12426	2058	16290	1718	18652	1443	21524	1016	27203	712	18710
3E		MI	4565	2241	6552	1930	8039	1606	8922	1342	9964	930	11938	569	8444
8-#14	1.86	MA	9239	2241	11345	2083	14876	1742	16841	1476	19046	1036	24205	622	18164
4L-2S		MI	4960	2241	7227	1914	8893	1594	9954	1333	11354	917	13740	734	8470
8-#18	3.31	MA	11290	2653	16151	2322	20889	1914	24156	1571	28879	1014	37346	568	32282
3E		MI	5076	2653	8123	2172	9929	1780	11158	1447	12932	903	15411	302	14021
8-#18	3.31	MA	10471	2653	14250	2366	18403	1955	20974	1626	24527	1046	32044	405	28625
4L-2S		MI	5653	2653	9281	2148	11395	1763	12931	1436	15318	888	18390	596	14224
10-#10	1.31	MA	9949	2085	12041	1948	15939	1634	18299	1385	21115	1001	26687	871	13567
2L-5S		MI	4178	2085	5435	1875	6698	1577	7346	1334	7873	962	9456	600	6144
10-#10	1.31	MA	9365	2085	11130	1963	14787	1649	16906	1398	19239	1019	24090	792	13524
3L-4S		MI	4304	2085	5685	1865	7050	1563	7762	1327	8449	953	10235	654	6230
10-#10	1.31	MA	9035	2085	10512	1979	13977	1663	15869	1418	17820	1031	22388	742	13397
4L-3S		MI	4451	2085	5963	1855	7414	1554	8226	1315	9082	949	11017	707	6246
10-#10	1.31	MA	8660	2085	9945	1992	13199	1683	14949	1431	16543	1048	20567	697	13062
5L-2S		MI	4696	2085	6360	1845	7916	1546	8833	1308	9900	939	12121	801	6243
10-#11	1.61	MA	10391	2171	13131	1994	17238	1667	19829	1404	23136	993	29456	862	16479
2L-5S		MI	4242	2171	5732	1916	6993	1606	7665	1350	8266	950	9902	520	7164
10-#11	1.61	MA	9708	2171	12023	2012	15837	1684	18135	1420	20855	1014	26298	764	16408
3L-4S		MI	4390	2171	6033	1905	7419	1590	8168	1342	8961	940	10816	588	7434
10-#11	1.61	MA	9325	2171	11269	2030	14851	1701	16871	1443	19126	1028	24214	702	16195
4L-3S		MI	4560	2171	6369	1893	7858	1581	8727	1328	9725	937	11737	651	7473
10-#11	1.61	MA	8881	2171	10585	2046	13902	1725	15749	1459	17569	1049	21990	645	15421
5L-2S		MI	4845	2171	6845	1882	8460	1571	9456	1321	10705	927	13030	765	7480
10-#14	2.32	MA	10546	2374	14012	2140	18296	1779	21078	1482	24790	1011	31726	706	23319
3L-4S		MI	4631	2374	6748	2028	8269	1679	9158	1400	10268	927	12452	459	10092
10-#14	2.32	MA	10049	2374	12931	2166	16881	1803	19267	1514	22312	1031	28728	615	22786
4L-3S		MI	4856	2374	7227	2013	8893	1667	9954	1381	11354	925	13740	547	10396
10-#14	2.32	MA	9431	2374	11955	2190	15519	1837	17657	1537	20079	1061	25534	531	20864
5L-2S		MI	5230	2374	7902	1997	9747	1655	10987	1372	12744	912	15541	712	10444
10-#18	4.13	MA	11820	2889	17027	2513	21916	2064	25223	1696	30248	1037	39965	393	36654
4L-3S		MI	5541	2889	9281	2319	11395	1889	12931	1517	15318	895	18390	249	17336
10-#18	4.13	MA	10781	2889	15333	2556	19520	2122	22391	1734	26321	1087	34335	236	33092
5L-2S		MI	6075	2889	10439	2296	12860	1871	14703	1506	17704	879	21370	542	17584
12-#10	1.57	MA	10385	2160	12951	1995	17091	1669	19692	1407	22991	998	29285	867	16230
2L-6S		MI	4191	2160	5589	1931	6880	1620	7546	1369	8128	963	9804	524	7012
12-#10	1.57	MA	9821	2160	12041	2010	15939	1683	18299	1420	21115	1016	26687	789	16178
3L-5S		MI	4370	2160	5832	1922	7200	1612	7953	1356	8690	959	10560	592	7244
12-#10	1.57	MA	9511	2160	11422	2025	15129	1697	17262	1440	19696	1028	24985	738	16044
4E		MI	4490	2160	6081	1912	7552	1597	8369	1349	9266	950	11339	647	7379
12-#10	1.57	MA	9142	2160	10856	2038	14351	1717	16342	1453	18419	1046	23165	694	15696
5L-3S		MI	4630	2160	6360	1901	7916	1589	8833	1337	9900	946	12121	700	7405
12-#10	1.57	MA	8727	2160	10257	2047	13618	1729	15468	1467	17177	1058	21581	640	14905
6L-2S		MI	4868	2160	6757	1891	8417	1580	9440	1330	10717	937	13224	793	7411
12-#11	1.93	MA	10246	2262	13131	2069	17238	1726	19829	1447	23136	1010	29456	759	19632
3L-5S		MI	4467	2262	6208	1974	7596	1649	8393	1377	9247	946	11196	508	8487

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 44"

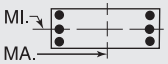
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.93	MA	9888	2262	12377	2087	16252	1743	18566	1470	21408	1025	27373	697	19413
4E		MI	4606	2262	6509	1962	8022	1632	8896	1369	9942	936	12109	576	8805
12-#11	1.93	MA	9452	2262	11692	2103	15302	1767	17443	1486	19851	1046	25149	640	18632
5L-3S		MI	4768	2262	6845	1951	8460	1623	9456	1355	10705	933	13030	638	8859
12-#11	1.93	MA	8964	2262	10963	2113	14418	1782	16377	1502	18336	1060	23215	573	17693
6L-2S		MI	5043	2262	7321	1939	9062	1613	10184	1348	11686	923	14324	753	8876
12-#14	2.79	MA	10826	2506	14516	2249	18887	1864	21693	1553	25578	1026	33250	608	27413
4E		MI	4942	2506	7423	2111	9123	1740	10191	1439	11659	922	14253	437	11947
12-#14	2.79	MA	10219	2506	13540	2272	17525	1898	20083	1576	23345	1056	30056	524	25467
5L-3S		MI	5145	2506	7902	2095	9747	1728	10987	1420	12744	920	15541	525	12345
12-#14	2.79	MA	9563	2506	12495	2286	16266	1920	18553	1599	21171	1075	27277	425	23737
6L-2S		MI	5491	2506	8577	2080	10601	1715	12020	1411	14135	907	17343	690	12411
12-#18	4.96	MA	12086	3124	18110	2703	23033	2231	26640	1803	32042	1078	42257	224	41084
5L-3S		MI	5991	3124	10439	2467	12860	1997	14703	1586	17704	886	21370	195	20614
12-#18	4.96	MA	11073	3124	16276	2726	20853	2270	23948	1841	28219	1110	37355	41	37102
6L-2S		MI	6489	3124	11598	2443	14325	1979	16475	1575	20091	870	24349	489	20938
14-#10	1.84	MA	10265	2235	12951	2057	17091	1717	19692	1442	22991	1013	29285	785	18832
3L-6S		MI	4379	2235	5986	1978	7382	1655	8153	1391	8945	960	10908	517	8129
14-#10	1.84	MA	9972	2235	12333	2072	16281	1732	18655	1462	21572	1025	27583	734	18692
4L-5S		MI	4553	2235	6229	1969	7701	1646	8560	1378	9507	957	11663	585	8350
14-#10	1.84	MA	9609	2235	11767	2085	15503	1752	17735	1475	20295	1043	25762	690	18333
5L-4S		MI	4671	2235	6478	1958	8054	1632	8976	1371	10083	947	12442	640	8526
14-#10	1.84	MA	9210	2235	11167	2093	14770	1763	16861	1489	19053	1055	24179	636	17556
6L-3S		MI	4805	2235	6757	1948	8417	1623	9440	1359	10717	943	13224	693	8560
14-#10	1.84	MA	8859	2235	10596	2104	14019	1772	15940	1505	17847	1073	22560	603	16847
7L-2S		MI	5036	2235	7153	1938	8919	1614	10047	1352	11534	934	14328	786	8573
14-#11	2.26	MA	10434	2354	13484	2145	17653	1785	20260	1497	23689	1021	30532	692	22634
4L-5S		MI	4684	2354	6684	2031	8198	1691	9122	1403	10228	943	12489	495	9816
14-#11	2.26	MA	10004	2354	12800	2161	16703	1809	19138	1513	22132	1042	28308	636	21846
5L-4S		MI	4817	2354	6985	2020	8624	1674	9625	1396	10923	933	13403	563	10175
14-#11	2.26	MA	9537	2354	12070	2171	15819	1824	18072	1529	20617	1056	26373	568	20915
6L-3S		MI	4971	2354	7321	2008	9062	1665	10184	1382	11686	930	14324	626	10240
14-#11	2.26	MA	9126	2354	11374	2183	14903	1835	16961	1550	19145	1077	24388	526	19759
7L-2S		MI	5238	2354	7797	1997	9664	1656	10912	1375	12667	920	15618	740	10267
14-#14	3.25	MA	10977	2639	15125	2355	19530	1959	22508	1615	26611	1051	34579	518	30070
5L-4S		MI	5230	2639	8098	2194	9977	1801	11224	1478	13049	917	16055	415	13816
14-#14	3.25	MA	10358	2639	14080	2369	18271	1980	20979	1638	24438	1070	31800	418	28322
6L-3S		MI	5417	2639	8577	2178	10601	1789	12020	1459	14135	915	17343	503	14291
14-#14	3.25	MA	9812	2639	13082	2387	16959	1995	19398	1668	22326	1100	28940	357	26446
7L-2S		MI	5747	2639	9252	2163	11455	1776	13052	1450	15525	902	19145	668	14374
14-#18	5.79	MA	12403	3360	19053	2873	24366	2378	28197	1910	33940	1102	45277	28	45118
6L-3S		MI	6433	3360	11598	2614	14325	2105	16475	1655	20091	877	24349	142	23772
14-#18	5.79	MA	11573	3360	17299	2903	22060	2403	25461	1966	30225	1151	40209	-83	39797
7L-2S		MI	6898	3360	12756	2590	15791	2088	18248	1644	22477	861	27329	435	24289
16-#10	2.10	MA	10421	2309	13244	2119	17433	1766	20049	1484	23448	1022	30180	731	21343
4L-6S		MI	4563	2309	6383	2025	7883	1689	8760	1413	9762	958	12011	510	9250
16-#10	2.10	MA	10063	2309	12677	2132	16655	1786	19128	1497	22171	1040	28360	686	20973
5E		MI	4732	2309	6625	2015	8203	1680	9167	1400	10324	954	12767	578	9462
16-#10	2.10	MA	9679	2309	12078	2140	15922	1798	18255	1511	20929	1052	26776	632	20207
6L-4S		MI	4849	2309	6875	2005	8556	1666	9583	1393	10900	944	13546	633	9671
16-#10	2.10	MA	9344	2309	11507	2151	15171	1807	17334	1527	19723	1070	25157	599	19489
7L-3S		MI	4977	2309	7153	1995	8919	1657	10047	1381	11534	940	14328	686	9714
16-#10	2.10	MA	9030	2309	10878	2168	14396	1823	16423	1537	18521	1082	23575	556	18544
8L-2S		MI	5201	2309	7550	1985	9421	1649	10654	1374	12351	931	15431	779	9733
16-#11	2.58	MA	10540	2446	13907	2218	18104	1851	20832	1540	24413	1039	31466	631	25062
5E		MI	4892	2446	7160	2089	8800	1733	9850	1430	11208	939	13783	483	11152
16-#11	2.58	MA	10092	2446	13177	2228	17220	1866	19766	1556	22898	1053	29532	563	24136
6L-4S		MI	5024	2446	7461	2077	9226	1717	10353	1423	11903	929	14697	551	11544

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

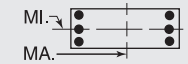


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#11	2.58	MA	9702	2446	12481	2241	16304	1877	18655	1577	21427	1074	27547	521	22970
7L-3S		MI	5177	2446	7797	2066	9664	1707	10912	1409	12667	926	15618	613	11620
16-#11	2.58	MA	9331	2446	11715	2262	15360	1896	17546	1588	19961	1088	25613	467	21821
8L-2S		MI	5425	2446	8273	2054	10267	1698	11641	1402	13648	916	16911	728	11655
16-#14	3.72	MA	11125	2771	15666	2452	20277	2041	23405	1677	27704	1065	36322	411	32906
6L-4S		MI	5510	2771	8773	2277	10831	1862	12256	1517	14439	912	17857	393	15694
16-#14	3.72	MA	10615	2771	14667	2470	18964	2056	21823	1707	25592	1095	33463	350	31037
7L-3S		MI	5683	2771	9252	2261	11455	1849	13052	1497	15525	910	19145	481	16238
16-#14	3.72	MA	10094	2771	13569	2500	17611	2084	20233	1722	23488	1114	30683	270	28836
8L-2S		MI	5998	2771	9927	2245	12308	1837	14085	1488	16916	897	20946	646	16333
16-#18	6.61	MA	12926	3595	20077	3050	25574	2511	29710	2035	35946	1143	48130	-95	47456
7L-3S		MI	6867	3595	12756	2761	15791	2213	18248	1724	22477	868	27329	88	26953
18-#10	2.36	MA	10505	2384	13588	2178	17807	1820	20522	1519	24047	1037	30957	682	23615
5L-6S		MI	4743	2384	6780	2071	8385	1723	9367	1435	10579	955	13115	502	10374
18-#10	2.36	MA	10135	2384	12989	2187	17074	1832	19648	1533	22805	1049	29374	628	22859
6L-5S		MI	4907	2384	7022	2062	8705	1715	9773	1422	11142	951	13870	571	10578
18-#10	2.36	MA	9814	2384	12417	2197	16323	1841	18727	1549	21599	1067	27755	595	22131
7L-4S		MI	5023	2384	7271	2052	9058	1700	10190	1415	11717	941	14650	626	10816
18-#10	2.36	MA	9506	2384	11789	2215	15548	1857	17817	1559	20397	1079	26172	552	21188
8L-3S		MI	5146	2384	7550	2042	9421	1692	10654	1403	12351	938	15431	679	10866
18-#10	2.36	MA	9122	2384	11229	2226	14831	1869	16901	1575	19191	1096	24557	500	20221
9L-2S		MI	5364	2384	7947	2031	9923	1683	11261	1395	13168	928	16535	772	10890
18-#11	2.90	MA	10632	2538	14285	2286	18621	1908	21460	1583	25180	1049	32691	559	27358
6L-5S		MI	5106	2538	7636	2146	9402	1775	10578	1457	12189	936	15076	470	12492
18-#11	2.90	MA	10262	2538	13588	2298	17705	1919	20349	1604	23708	1071	30706	517	26181
7L-4S		MI	5238	2538	7937	2134	9828	1759	11081	1450	12884	926	15990	538	12885
18-#11	2.90	MA	9896	2538	12822	2319	16761	1938	19240	1615	22242	1085	28771	462	25023
8L-3S		MI	5370	2538	8273	2123	10267	1749	11641	1436	13648	923	16911	601	12998
18-#11	2.90	MA	9447	2538	12146	2333	15886	1952	18124	1634	20790	1105	26791	398	23678
9L-2S		MI	5610	2538	8749	2111	10869	1740	12369	1429	14628	913	18205	715	13041
18-#14	4.18	MA	11390	2903	16253	2552	20970	2117	24249	1746	28858	1090	37985	343	35628
7L-4S		MI	5785	2903	9448	2359	11685	1923	13289	1555	15830	907	19658	371	17582
18-#14	4.18	MA	10880	2903	15154	2582	19617	2145	22659	1761	26754	1110	35205	263	33416
8L-3S		MI	5945	2903	9927	2344	12308	1910	14085	1536	16916	905	20946	458	18184
18-#14	4.18	MA	10281	2903	14191	2602	18361	2164	21057	1788	24679	1139	32353	169	31242
9L-2S		MI	6246	2903	10602	2328	13162	1898	15117	1527	18306	892	22748	624	18292
20-#10	2.62	MA	10580	2459	13899	2234	18226	1866	21041	1555	24681	1047	31971	625	25510
6E		MI	4920	2459	7176	2118	8887	1758	9973	1457	11397	952	14218	495	11501
20-#10	2.62	MA	10273	2459	13328	2244	17475	1875	20120	1571	23474	1064	30352	591	24773
7L-5S		MI	5079	2459	7419	2109	9207	1749	10380	1444	11959	948	14974	564	11697
20-#10	2.62	MA	9969	2459	12699	2262	16700	1892	19210	1581	22273	1076	28770	548	23833
8L-4S		MI	5195	2459	7668	2099	9559	1735	10797	1437	12535	939	15753	618	11961
20-#10	2.62	MA	9599	2459	12140	2272	15983	1903	18294	1597	21067	1093	27154	496	22859
9L-3S		MI	5320	2459	7947	2088	9923	1726	11261	1424	13168	935	16535	671	12016
20-#10	2.62	MA	9254	2459	11571	2282	15280	1915	17412	1608	19832	1102	25569	459	21914
10L-2S		MI	5525	2459	8343	2078	10425	1717	11868	1417	13985	925	17638	765	12046
20-#11	3.22	MA	10806	2630	14696	2356	19106	1961	22044	1631	25989	1067	33864	512	29392
7L-5S		MI	5305	2630	8112	2203	10005	1817	11307	1484	13170	932	16370	458	13837
20-#11	3.22	MA	10446	2630	13930	2377	18162	1981	20935	1642	24523	1081	31930	457	28225
8L-4S		MI	5435	2630	8413	2192	10430	1801	11810	1477	13865	922	17284	526	14213
20-#11	3.22	MA	10014	2630	13254	2390	17287	1994	19818	1661	23071	1102	29950	393	26884
9L-3S		MI	5560	2630	8749	2180	10869	1792	12369	1463	14628	919	18205	588	14375
20-#11	3.22	MA	9611	2630	12561	2401	16430	2009	18742	1674	21566	1112	28011	346	25499
10L-2S		MI	5791	2630	9226	2169	11471	1782	13098	1456	15609	909	19498	703	14425
20-#14	4.65	MA	11641	3036	16740	2665	21622	2205	25085	1800	30021	1105	39728	256	37996
8L-4S		MI	6054	3036	10123	2442	12538	1983	14322	1594	17220	902	21460	349	19477
20-#14	4.65	MA	11072	3036	15776	2685	20367	2225	23483	1827	27946	1134	36876	162	35812
9L-3S		MI	6203	3036	10602	2426	13162	1971	15117	1575	18306	900	22748	436	20130

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
22-#10	2.89	MA	10721	2534	14238	2291	18627	1910	21513	1593	25350	1061	32950	587	27416
7L-6S		MI	5094	2534	7573	2165	9389	1792	10580	1479	12214	949	15322	488	12629
22-#10	2.89	MA	10421	2534	13610	2308	17852	1926	20603	1603	24149	1074	31367	544	26477
8L-5S		MI	5249	2534	7816	2156	9709	1783	10987	1466	12776	945	16077	557	12819
22-#10	2.89	MA	10064	2534	13050	2319	17135	1938	19687	1619	22943	1090	29752	492	25497
9L-4S		MI	5375	2534	8065	2145	10061	1769	11404	1459	13352	936	16857	611	13106
22-#10	2.89	MA	9732	2534	12481	2329	16432	1950	18805	1630	21708	1099	28166	455	24547
10L-3S		MI	5481	2534	8343	2135	10425	1760	11868	1446	13985	932	17638	664	13167
22-#10	2.89	MA	9418	2534	11924	2339	15708	1960	17937	1641	20490	1114	26627	410	23414
11L-2S		MI	5680	2534	8740	2125	10927	1752	12475	1439	14803	923	18742	758	13201
22-#11	3.55	MA	10982	2722	15037	2434	19563	2023	22629	1669	26804	1078	35089	453	31427
8L-5S		MI	5500	2722	8588	2261	10607	1859	12035	1511	14151	929	17664	445	15184
22-#11	3.55	MA	10567	2722	14361	2447	18688	2036	21512	1688	25353	1098	33108	388	30091
9L-4S		MI	5629	2722	8889	2249	11033	1843	12538	1504	14845	919	18577	513	15545
22-#11	3.55	MA	10182	2722	13668	2459	17831	2051	20437	1701	23847	1109	31170	341	28699
10L-3S		MI	5747	2722	9226	2238	11471	1834	13098	1490	15609	916	19498	576	15752
22-#11	3.55	MA	9815	2722	12989	2471	16958	2063	19377	1715	22363	1127	29287	283	27279
11L-2S		MI	5971	2722	9702	2226	12073	1824	13826	1483	16590	906	20792	690	15809
22-#14	5.11	MA	11840	3168	17362	2767	22373	2286	25909	1866	31212	1129	41398	155	40382
9L-4S		MI	6320	3168	10798	2525	13392	2044	15354	1633	18611	897	23262	327	21378
24-#10	3.15	MA	10864	2609	14521	2355	19004	1960	21997	1625	26025	1071	33965	540	29121
8L-6S		MI	5279	2609	7970	2211	9891	1826	11187	1501	13031	946	16426	481	13760
24-#10	3.15	MA	10518	2609	13961	2366	18286	1972	21081	1641	24819	1087	32349	488	28136
9L-5S		MI	5425	2609	8212	2202	10210	1818	11594	1488	13593	943	17181	549	13944
24-#10	3.15	MA	10199	2609	13392	2375	17584	1984	20198	1652	23584	1096	30764	451	27180
10L-4S		MI	5539	2609	8461	2192	10563	1803	12011	1481	14169	933	17960	604	14251
24-#10	3.15	MA	9898	2609	12835	2386	16860	1994	19330	1663	22366	1111	29224	406	26050
11L-3S		MI	5641	2609	8740	2182	10927	1795	12475	1468	14803	929	18742	657	14316
24-#10	3.15	MA	9543	2609	12288	2397	16090	2010	18442	1681	21152	1121	27598	360	24923
12L-2S		MI	5834	2609	9137	2172	11428	1786	13082	1461	15620	920	19846	750	14355
24-#11	3.87	MA	11107	2813	15469	2505	20089	2079	23207	1715	27634	1095	36267	383	33297
9L-5S		MI	5692	2813	9064	2318	11209	1902	12764	1538	15131	925	18957	433	16535
24-#11	3.87	MA	10738	2813	14775	2516	19232	2093	22131	1728	26128	1105	34328	336	31899
10L-4S		MI	5821	2813	9365	2307	11635	1885	13267	1531	15826	915	19871	501	16883
24-#11	3.87	MA	10388	2813	14096	2529	18359	2106	21072	1742	24644	1123	32446	279	30473
11L-3S		MI	5932	2813	9702	2295	12073	1876	13826	1517	16590	912	20792	563	17129

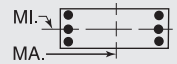
RECTANGULAR TIED COLUMNS 24" x 24"

6-#9	1.04	MA	2962	1195	3813	1082	4804	910	5363	775	5957	569	7332	496	3313
2L-3S		MI	2734	1195	3461	1091	4359	918	4825	781	5233	578	6329	423	3315
6-#10	1.32	MA	3082	1243	4108	1109	5162	929	5788	786	6522	565	8105	491	4136
2L-3S		MI	2803	1243	3664	1120	4601	939	5109	795	5608	576	6841	398	4126
6-#11	1.63	MA	3186	1294	4432	1132	5530	945	6211	795	7072	558	8758	474	4967
2L-3S		MI	2863	1294	3899	1145	4855	956	5395	804	5973	570	7269	359	4941
6-#14	2.34	MA	3454	1416	5143	1202	6399	996	7247	826	8453	550	10522	449	6963
2L-3S		MI	3024	1416	4386	1219	5441	1010	6088	837	6892	565	8439	284	6863
6-#18	4.17	MA	4042	1725	6861	1382	8513	1127	9774	907	11828	530	14664	368	11802
2L-3S		MI	3421	1725	5556	1410	6862	1149	7776	923	9138	552	11189	74	10977
8-#8	1.10	MA	2995	1204	3858	1091	4876	917	5457	780	6091	570	7522	497	3490
2L-4S		MI	2708	1204	3384	1106	4268	930	4704	794	5071	581	6166	406	3478
8-#9	1.39	MA	3121	1254	4164	1119	5249	937	5901	792	6682	566	8336	492	4349
2L-4S		MI	2772	1254	3567	1137	4484	953	4954	810	5399	580	6628	377	4300

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

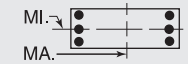
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#10	1.76	MA	3275	1317	4551	1156	5723	964	6466	808	7435	562	9369	487	5436
2L-4S		MI	2854	1317	3798	1178	4758	983	5271	830	5817	578	7214	339	5316
8-#11	2.17	MA	3410	1386	4966	1190	6205	988	7027	822	8171	554	10248	466	6527
2L-4S		MI	2923	1386	4058	1215	5041	1009	5587	846	6220	571	7704	286	6173
8-#14	3.13	MA	3750	1548	5901	1285	7358	1057	8406	865	10014	545	12605	433	9169
2L-4S		MI	3118	1548	4610	1320	5703	1086	6359	898	7240	566	9043	176	8147
8-#18	5.56	MA	4512	1960	8167	1530	10165	1235	11771	976	14517	522	18140	328	15586
2L-4S		MI	3624	1960	5935	1585	7306	1278	8234	1026	9726	547	12179	-121	11968
10-#10	2.20	MA	3463	1392	4994	1202	6284	998	7145	830	8349	559	10632	483	6731
2L-5S		MI	2923	1392	3965	1236	4927	1033	5487	860	6090	587	7586	280	6127
10-#10	2.20	MA	3211	1392	4551	1214	5723	1008	6466	838	7435	570	9369	390	6696
3L-4S		MI	3066	1392	4241	1225	5319	1017	5950	852	6730	576	8478	335	6567
10-#11	2.71	MA	3627	1478	5499	1247	6879	1030	7843	849	9270	551	11737	457	8082
2L-5S		MI	3008	1478	4257	1285	5243	1069	5844	882	6546	580	8142	210	7177
10-#11	2.71	MA	3339	1478	4966	1260	6205	1041	7027	858	8171	563	10248	343	8021
3L-4S		MI	3171	1478	4591	1272	5716	1051	6404	873	7319	568	9194	277	7653
10-#14	3.91	MA	4036	1681	6659	1368	8316	1118	9566	904	11575	540	14688	418	11370
2L-5S		MI	3249	1681	4890	1420	5986	1171	6720	948	7698	576	9655	63	9429
10-#14	3.91	MA	3682	1681	5901	1385	7358	1132	8406	915	10014	555	12605	253	11218
3L-4S		MI	3477	1681	5367	1402	6662	1147	7518	937	8801	561	11126	161	10271
10-#18	6.94	MA	4481	2196	8167	1704	10165	1365	11771	1061	14517	534	18140	-6	18118
3L-4S		MI	4199	2196	7241	1732	8958	1387	10231	1095	12416	539	15654	-161	15231

RECTANGULAR TIED COLUMNS 24" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#11	1.00	MA	3446	1287	4437	1165	5576	980	6211	835	6873	615	8435	536	3732
2E		MI	3159	1287	4135	1155	5147	971	5708	827	6287	609	7626	524	3414
4-#14	1.44	MA	3660	1368	4979	1209	6228	1012	6983	854	7896	608	9778	522	5232
2E		MI	3347	1368	4625	1199	5734	1003	6402	846	7206	602	8795	506	4770
4-#18	2.56	MA	4143	1574	6287	1325	7817	1096	8871	905	10408	593	12959	477	8874
2E		MI	3768	1574	5801	1314	7158	1086	8091	896	9451	586	11542	449	8044
6-#10	1.22	MA	3590	1328	4665	1199	5911	1006	6641	853	7474	618	9284	538	4547
2L-3S		MI	3008	1328	3896	1201	4891	1008	5422	855	5923	624	7201	440	4150
6-#10	1.22	MA	3278	1328	4175	1211	5291	1017	5891	863	6464	630	7886	447	4538
3L-2S		MI	3289	1328	4339	1190	5452	998	6100	846	6837	613	8464	533	4154
6-#11	1.50	MA	3711	1379	5028	1222	6323	1022	7115	862	8090	611	10121	531	5472
2L-3S		MI	3067	1379	4135	1225	5147	1024	5708	863	6287	617	7626	401	4971
6-#11	1.50	MA	3347	1379	4437	1236	5576	1034	6211	872	6873	625	8435	417	5446
3L-2S		MI	3394	1379	4668	1212	5822	1014	6525	854	7386	605	9116	515	4989
6-#14	2.16	MA	4017	1501	5820	1292	7291	1073	8269	893	9628	603	12144	512	7692
2L-3S		MI	3228	1501	4625	1299	5734	1078	6402	896	7206	612	8795	325	6908
6-#14	2.16	MA	3532	1501	4979	1311	6228	1089	6983	906	7896	621	9778	347	7592
3L-2S		MI	3664	1501	5383	1281	6693	1064	7561	885	8767	597	10878	490	6990
6-#18	3.85	MA	4697	1810	7740	1473	9655	1204	11094	974	13401	584	16935	448	13098
2L-3S		MI	3624	1810	5801	1488	7158	1216	8091	981	9451	599	11542	115	11207
6-#18	3.85	MA	3990	1810	6287	1503	7817	1229	8871	994	10408	611	12959	154	12480
3L-2S		MI	4259	1810	7107	1461	8810	1194	10089	965	12141	577	15018	409	11839
8-#8	1.01	MA	3490	1289	4387	1181	5593	994	6273	847	6994	623	8631	543	3831
2L-4S		MI	2911	1289	3612	1187	4556	999	5016	855	5386	629	6527	448	3501
8-#8	1.01	MA	3289	1289	4078	1189	5202	1001	5800	853	6357	631	7750	488	3833
3E		MI	3020	1289	3806	1180	4810	993	5341	846	5830	625	7085	482	3509
8-#8	1.01	MA	3169	1289	3865	1197	4922	1008	5443	862	5869	636	7141	455	3819
4L-2S		MI	3201	1289	4086	1172	5164	986	5769	840	6406	618	7883	539	3505
8-#9	1.28	MA	3633	1339	4727	1209	6006	1014	6765	859	7649	620	9532	539	4781
2L-4S		MI	2976	1339	3797	1218	4773	1022	5267	870	5714	628	6988	419	4331
8-#9	1.28	MA	3388	1339	4338	1219	5515	1023	6170	866	6848	630	8424	469	4773
3E		MI	3108	1339	4042	1209	5093	1014	5676	859	6273	623	7692	462	4363

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



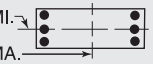
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#9	1.28	MA	3243	1339	4068	1228	5163	1031	5720	878	6233	635	7656	426	4732
4L-2S		MI	3328	1339	4394	1200	5538	1006	6214	852	6997	614	8696	535	4366
8-#10	1.63	MA	3809	1402	5155	1246	6531	1041	7391	875	8484	616	10682	534	5985
2L-4S		MI	3057	1402	4029	1259	5048	1052	5584	890	6132	626	7574	381	5359
8-#10	1.63	MA	3512	1402	4665	1258	5911	1051	6641	884	7474	628	9284	444	5961
3E		MI	3217	1402	4339	1248	5452	1042	6100	877	6837	621	8464	436	5438
8-#10	1.63	MA	3336	1402	4325	1270	5466	1062	6073	899	6697	634	8311	389	5864
4L-2S		MI	3484	1402	4783	1236	6013	1033	6779	868	7750	610	9728	529	5456
8-#11	2.00	MA	3965	1471	5619	1280	7071	1065	8019	889	9307	608	11806	526	7201
2L-4S		MI	3125	1471	4294	1295	5334	1077	5901	906	6535	619	8062	327	6288
8-#11	2.00	MA	3621	1471	5028	1293	6323	1076	7115	899	8090	621	10121	412	7155
3E		MI	3311	1471	4668	1282	5822	1067	6525	890	7386	614	9116	393	6514
8-#11	2.00	MA	3417	1471	4615	1307	5785	1088	6427	916	7151	628	8933	344	6906
4L-2S		MI	3620	1471	5202	1270	6497	1056	7341	881	8485	602	10605	507	6551
8-#14	2.88	MA	4358	1633	6660	1375	8355	1134	9555	932	11359	598	14510	502	10141
2L-4S		MI	3318	1633	4849	1399	5997	1153	6673	957	7554	613	9399	217	8281
8-#14	2.88	MA	3908	1633	5820	1394	7291	1150	8269	945	9628	616	12144	337	10011
3E		MI	3573	1633	5383	1382	6693	1139	7561	935	8767	607	10878	309	9085
8-#14	2.88	MA	3640	1633	5231	1413	6523	1166	7288	969	8288	624	10472	241	9123
4L-2S		MI	3965	1633	6140	1364	7651	1125	8720	924	10328	592	12961	475	9198
8-#18	5.13	MA	5230	2045	9192	1620	11492	1312	13316	1043	16393	575	20910	418	17314
2L-4S		MI	3819	2045	6180	1663	7603	1345	8549	1084	10040	594	12532	-80	12398
8-#18	5.13	MA	4603	2045	7740	1650	9655	1337	11094	1063	13401	602	16935	125	16493
3E		MI	4167	2045	7107	1635	8810	1324	10089	1050	12141	590	15018	75	14770
8-#18	5.13	MA	4222	2045	6715	1681	8319	1362	9389	1101	11074	611	14109	-38	14028
4L-2S		MI	4733	2045	8412	1608	10461	1302	12086	1035	14830	568	18493	368	15624
10-#10	2.04	MA	4022	1477	5645	1293	7151	1075	8141	897	9493	613	12080	530	7417
2L-5S		MI	3127	1477	4197	1316	5217	1102	5800	920	6405	634	7946	322	6215
10-#10	2.04	MA	3738	1477	5155	1304	6531	1085	7391	906	8484	625	10682	440	7381
3L-4S		MI	3270	1477	4473	1305	5608	1086	6263	912	7045	623	8838	377	6632
10-#10	2.04	MA	3575	1477	4815	1316	6086	1096	6823	921	7707	631	9709	385	7274
4L-3S		MI	3418	1477	4783	1294	6013	1077	6779	898	7750	618	9728	432	6723
10-#10	2.04	MA	3410	1477	4512	1328	5656	1112	6314	930	7003	644	8730	334	6806
5L-2S		MI	3674	1477	5226	1283	6573	1067	7457	890	8664	607	10992	525	6753
10-#11	2.50	MA	4211	1562	6210	1337	7818	1107	8923	916	10524	604	13491	521	8924
2L-5S		MI	3211	1562	4493	1365	5535	1137	6158	942	6860	627	8499	252	7277
10-#11	2.50	MA	3885	1562	5619	1351	7071	1119	8019	926	9307	618	11806	407	8863
3L-4S		MI	3375	1562	4827	1352	6008	1120	6717	933	7634	615	9551	319	7763
10-#11	2.50	MA	3698	1562	5206	1365	6532	1131	7331	943	8368	624	10619	339	8552
4L-3S		MI	3546	1562	5202	1340	6497	1109	7341	917	8485	610	10605	384	8055
10-#11	2.50	MA	3507	1562	4838	1378	6011	1149	6715	953	7515	638	9430	273	7985
5L-2S		MI	3840	1562	5735	1327	7172	1098	8157	908	9584	598	12095	499	8108
10-#14	3.61	MA	4683	1765	7501	1458	9418	1195	10841	971	13091	593	16876	492	12585
2L-5S		MI	3439	1765	5129	1499	6280	1239	7034	1007	8012	623	10011	105	9631
10-#14	3.61	MA	4280	1765	6660	1477	8355	1211	9555	984	11359	611	14510	327	12433
3L-4S		MI	3680	1765	5607	1482	6955	1214	7832	996	9115	608	11482	202	10398
10-#14	3.61	MA	4029	1765	6072	1495	7587	1227	8574	1008	10020	619	12839	231	11489
4L-3S		MI	3891	1765	6140	1464	7651	1200	8720	974	10328	602	12961	294	11265
10-#14	3.61	MA	3767	1765	5546	1514	6842	1253	7694	1021	8803	637	11168	135	10638
5L-2S		MI	4254	1765	6898	1447	8610	1185	9880	963	11889	587	15044	459	11401
10-#18	6.41	MA	5188	2281	9192	1797	11492	1445	13316	1132	16393	593	20910	95	20537
3L-4S		MI	4394	2281	7486	1810	9254	1453	10546	1153	12729	585	16007	-121	15702
10-#18	6.41	MA	4871	2281	8168	1828	10157	1470	11612	1170	14066	602	18084	-67	17868
4L-3S		MI	4687	2281	8412	1783	10461	1432	12086	1120	14830	581	18493	34	18367

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



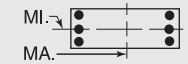
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	2.44	MA	4228	1552	6136	1339	7771	1109	8891	919	10503	610	13478	527	8846
2L-6S		MI	3146	1552	4363	1372	5423	1145	6027	956	6694	637	8348	248	7115
12-#10	2.44	MA	3957	1552	5645	1351	7151	1120	8141	928	9493	622	12080	436	8802
3L-5S		MI	3335	1552	4640	1363	5778	1136	6479	942	7319	631	9209	318	7468
12-#10	2.44	MA	3805	1552	5305	1363	6707	1130	7573	943	8717	629	11107	381	8685
4E		MI	3475	1552	4916	1352	6169	1121	6941	934	7959	621	10101	373	7900
12-#10	2.44	MA	3643	1552	5002	1375	6276	1146	7064	952	8013	641	10128	330	8198
5L-3S		MI	3614	1552	5226	1341	6573	1111	7457	920	8664	615	10992	428	8007
12-#10	2.44	MA	3435	1552	4691	1383	5887	1157	6568	967	7327	647	9188	260	7805
6L-2S		MI	3859	1552	5669	1330	7134	1101	8136	912	9577	604	12256	521	8046
12-#11	3.00	MA	4451	1654	6800	1395	8565	1149	9827	943	11742	601	15177	517	10645
2L-6S		MI	3235	1654	4699	1434	5780	1190	6427	984	7204	629	8970	159	8211
12-#11	3.00	MA	4141	1654	6210	1408	7818	1161	8923	953	10524	614	13491	402	10571
3L-5S		MI	3455	1654	5026	1423	6209	1179	6974	969	7959	624	9989	243	8787
12-#11	3.00	MA	3968	1654	5797	1422	7280	1173	8235	970	9585	621	12304	334	10208
4E		MI	3615	1654	5361	1410	6683	1162	7533	960	8733	612	11040	311	9249
12-#11	3.00	MA	3781	1654	5429	1436	6758	1192	7619	980	8733	635	11115	268	9667
5L-3S		MI	3782	1654	5735	1397	7172	1151	8157	944	9584	607	12095	376	9596
12-#11	3.00	MA	3539	1654	5060	1446	6286	1203	7018	997	7901	641	9967	181	9027
6L-2S		MI	4051	1654	6269	1384	7846	1140	8973	935	10683	595	13584	491	9661
12-#14	4.33	MA	4625	1898	7501	1559	9418	1272	10841	1023	13091	606	16876	317	14859
3L-5S		MI	3788	1898	5887	1582	7238	1300	8193	1046	9573	618	12094	89	11751
12-#14	4.33	MA	4421	1898	6912	1578	8650	1288	9860	1047	11751	614	15205	221	13866
4E		MI	4011	1898	6364	1565	7914	1275	8991	1035	10676	603	13565	187	12528
12-#14	4.33	MA	4161	1898	6386	1597	7905	1314	8980	1060	10534	632	13534	125	13015
5L-3S		MI	4198	1898	6898	1547	8610	1261	9880	1013	11889	597	15044	279	13448
12-#18	7.69	MA	5491	2516	9621	1975	11995	1579	13834	1239	17059	593	22060	-96	21660
4E		MI	4945	2516	8791	1957	10906	1562	12544	1222	15419	576	19483	-161	18956
14-#10	2.85	MA	4170	1627	6136	1398	7771	1154	8891	950	10503	619	13478	432	10222
3L-6S		MI	3356	1627	4807	1419	5984	1180	6705	978	7608	634	9612	244	8364
14-#10	2.85	MA	4029	1627	5795	1410	7327	1165	8322	965	9726	626	12505	378	10078
4L-5S		MI	3536	1627	5084	1410	6339	1170	7157	964	8232	629	10473	314	8725
14-#10	2.85	MA	3869	1627	5492	1422	6896	1181	7814	974	9023	638	11526	326	9594
5L-4S		MI	3675	1627	5360	1399	6730	1155	7619	956	8872	618	11365	369	9139
14-#10	2.85	MA	3670	1627	5181	1430	6507	1191	7318	989	8336	644	10586	256	9197
6L-3S		MI	3804	1627	5669	1388	7134	1145	8136	942	9577	612	12256	424	9291
14-#10	2.85	MA	3494	1627	4829	1443	6118	1200	6838	998	7669	657	9658	213	8675
7L-2S		MI	4040	1627	6113	1377	7695	1136	8814	934	10491	602	13519	517	9338
14-#11	3.50	MA	4398	1746	6800	1466	8565	1203	9827	980	11742	611	15177	397	12280
3L-6S		MI	3482	1746	5232	1491	6455	1232	7243	1011	8303	625	10459	151	9715
14-#11	3.50	MA	4230	1746	6388	1479	8027	1215	9139	997	10802	618	13990	330	11871
4L-5S		MI	3690	1746	5560	1480	6884	1222	7790	996	9058	620	11478	235	10302
14-#11	3.50	MA	4046	1746	6020	1493	7506	1234	8523	1007	9950	631	12800	263	11353
5L-4S		MI	3862	1746	5894	1467	7358	1204	8350	987	9832	608	12530	302	10742
14-#11	3.50	MA	3816	1746	5651	1504	7033	1246	7922	1024	9118	638	11653	176	10706
6L-3S		MI	4001	1746	6269	1455	7846	1193	8973	971	10683	603	13584	368	11137
14-#14	5.05	MA	4780	2030	7753	1661	9713	1349	11146	1085	13482	609	17571	211	16253
4L-5S		MI	4112	2030	6644	1665	8197	1360	9353	1085	11134	613	14177	74	13878
14-#14	5.05	MA	4524	2030	7227	1680	8968	1375	10266	1099	12266	627	15900	115	15398
5L-4S		MI	4331	2030	7122	1647	8872	1336	10151	1073	12237	598	15648	171	14668
16-#10	3.26	MA	4246	1701	6285	1456	7947	1199	9072	987	10736	623	13903	374	11461
4L-6S		MI	3560	1701	5250	1465	6545	1214	7384	1000	8521	631	10876	240	9616
16-#10	3.26	MA	4088	1701	5982	1468	7516	1215	8564	996	10032	635	12924	322	10994
5E		MI	3732	1701	5527	1457	6900	1205	7835	986	9146	626	11737	310	9986

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

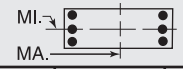
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	3.26	MA	3898	1701	5671	1476	7127	1226	8068	1011	9346	642	11984	252	10591
6L-4S		MI	3869	1701	5803	1446	7291	1189	8298	978	9785	615	12629	365	10384
16-#10	3.26	MA	3732	1701	5319	1490	6738	1235	7588	1020	8678	654	11056	209	10084
7L-3S		MI	3998	1701	6113	1434	7695	1180	8814	964	10491	610	13519	420	10575
16-#11	4.00	MA	4500	1838	6979	1537	8775	1257	10044	1024	12019	614	15675	325	13541
4L-6S		MI	3735	1838	5766	1549	7130	1275	8060	1038	9402	622	11949	142	11224
16-#11	4.00	MA	4303	1838	6611	1550	8253	1276	9428	1034	11167	628	14486	258	13044
5E		MI	3930	1838	6093	1537	7559	1264	8606	1023	10157	617	12968	227	11822
16-#11	4.00	MA	4084	1838	6242	1561	7781	1288	8826	1051	10335	634	13338	172	12390
6L-4S		MI	4088	1838	6428	1525	8033	1246	9166	1014	10931	605	14019	294	12243
16-#14	5.77	MA	4877	2163	8067	1763	10032	1436	11552	1138	13997	622	18267	105	17787
5E		MI	4426	2163	7402	1748	9155	1421	10512	1124	12695	608	16260	58	16013
18-#10	3.66	MA	4303	1776	6472	1515	8136	1249	9314	1018	11042	632	14322	319	12397
5L-6S		MI	3758	1776	5694	1512	7106	1249	8062	1022	9435	628	12139	236	10871
18-#10	3.66	MA	4121	1776	6161	1523	7747	1260	8818	1033	10356	639	13382	249	11988
6L-5S		MI	3924	1776	5970	1503	7461	1239	8514	1008	10059	623	13000	306	11250
18-#10	3.66	MA	3962	1776	5809	1536	7358	1269	8338	1042	9688	651	12454	205	11495
7L-4S		MI	4071	1776	6247	1492	7852	1224	8976	1000	10699	612	13892	361	11633
18-#11	4.50	MA	4566	1930	7202	1608	9001	1318	10332	1061	12384	624	16171	254	14738
5L-6S		MI	3968	1930	6299	1606	7805	1317	8876	1065	10501	618	13438	134	12736
18-#11	4.50	MA	4363	1930	6833	1618	8528	1330	9730	1078	11553	631	15023	167	14076
6L-5S		MI	4153	1930	6627	1595	8234	1306	9423	1050	11256	613	14457	219	13345
20-#10	4.07	MA	4338	1851	6651	1570	8367	1294	9568	1055	11365	636	14780	245	13388
6E		MI	3967	1851	6137	1559	7667	1283	8741	1044	10348	626	13403	232	12129
20-#10	4.07	MA	4187	1851	6299	1583	7978	1303	9088	1064	10698	648	13852	201	12908
7L-5S		MI	4121	1851	6414	1550	8021	1273	9192	1030	10973	620	14264	302	12517
20-#11	5.00	MA	4618	2022	7424	1676	9276	1372	10634	1105	12770	627	16709	162	15766
6E		MI	4196	2022	6833	1663	8479	1359	9692	1092	11600	615	14928	126	14252

RECTANGULAR TIED COLUMNS 24" x 28"

4-#14	1.34	MA	4217	1453	5600	1300	7058	1089	7928	921	8954	661	11150	575	5718
2E		MI	3555	1453	4864	1278	6028	1071	6716	905	7520	649	9151	547	4793
4-#18	2.38	MA	4766	1659	7045	1416	8814	1173	10015	972	11731	646	14799	542	9738
2E		MI	3980	1659	6047	1392	7455	1153	8406	955	9765	632	11895	490	8077
6-#10	1.13	MA	4134	1412	5250	1289	6703	1083	7544	920	8479	672	10524	585	4959
2L-3S		MI	3212	1412	4127	1282	5181	1077	5735	915	6238	671	7560	482	4172
6-#10	1.13	MA	3786	1412	4713	1302	6024	1094	6723	930	7373	685	8992	497	4949
3L-2S		MI	3496	1412	4571	1271	5742	1067	6413	906	7152	661	8824	575	4172
6-#11	1.39	MA	4272	1464	5651	1313	7159	1099	8069	929	9161	665	11450	578	5977
2L-3S		MI	3271	1464	4371	1305	5439	1093	6022	923	6602	664	7984	442	5000
6-#11	1.39	MA	3866	1464	5002	1327	6339	1112	7077	940	7826	679	9601	466	5952
3L-2S		MI	3602	1464	4904	1292	6114	1082	6838	914	7701	653	9473	557	5010
6-#14	2.01	MA	4618	1585	6523	1382	8226	1150	9340	960	10856	656	13784	568	8421
2L-3S		MI	3432	1585	4864	1378	6028	1146	6716	956	7520	659	9151	366	6949
6-#14	2.01	MA	4075	1585	5600	1402	7058	1167	7928	975	8954	676	11150	404	8321
3L-2S		MI	3874	1585	5622	1361	6986	1132	7875	944	9081	644	11234	531	7017
6-#18	3.57	MA	5393	1894	8645	1563	10838	1281	12463	1041	15027	637	19277	522	14394
2L-3S		MI	3827	1894	6047	1567	7455	1282	8406	1040	9765	645	11895	156	11432
6-#18	3.57	MA	4596	1894	7045	1596	8814	1309	10015	1064	11731	668	14799	228	13935
3L-2S		MI	4475	1894	7352	1539	9106	1261	10404	1024	12454	623	15371	449	11875
8-#9	1.19	MA	4181	1424	5316	1300	6805	1091	7678	926	8668	673	10792	586	5213
2L-4S		MI	3179	1424	4027	1299	5062	1091	5579	930	6029	676	7349	461	4360
8-#9	1.19	MA	3909	1424	4891	1309	6267	1100	7027	934	7792	684	9579	517	5205
3E		MI	3313	1424	4272	1290	5382	1083	5988	919	6588	671	8053	504	4383
8-#9	1.19	MA	3748	1424	4597	1319	5883	1109	6536	947	7121	690	8747	475	5164
4L-2S		MI	3536	1424	4624	1281	5827	1075	6526	912	7313	662	9056	577	4384

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#10	1.51	MA	4379	1487	5787	1336	7382	1118	8365	942	9585	669	12055	581	6533
2L-4S		MI	3260	1487	4261	1339	5337	1121	5897	950	6447	674	7933	423	5399
8-#10	1.51	MA	4048	1487	5250	1348	6703	1129	7544	952	8479	682	10524	493	6509
3E		MI	3422	1487	4571	1328	5742	1111	6413	937	7152	669	8824	478	5463
8-#10	1.51	MA	3853	1487	4878	1361	6218	1140	6923	968	7631	690	9469	439	6413
4L-2S		MI	3693	1487	5014	1317	6302	1101	7092	928	8065	658	10088	571	5476
8-#11	1.86	MA	4557	1555	6299	1370	7979	1141	9061	956	10497	661	13299	573	7875
2L-4S		MI	3328	1555	4530	1375	5626	1146	6214	965	6849	666	8419	369	6399
8-#11	1.86	MA	4173	1555	5651	1384	7159	1154	8069	967	9161	676	11450	462	7829
3E		MI	3516	1555	4904	1362	6114	1135	6838	950	7701	661	9473	434	6546
8-#11	1.86	MA	3946	1555	5200	1399	6571	1167	7317	985	8134	684	10163	395	7654
4L-2S		MI	3830	1555	5438	1350	6789	1124	7654	941	8800	649	10963	549	6575
8-#14	2.68	MA	5002	1718	7446	1465	9394	1211	10753	999	12758	651	16417	561	11113
2L-4S		MI	3520	1718	5088	1479	6291	1221	6987	1016	7868	660	9755	259	8411
8-#14	2.68	MA	4497	1718	6523	1485	8226	1228	9340	1014	10856	671	13784	398	10983
3E		MI	3768	1718	5622	1461	6986	1207	7875	994	9081	654	11234	351	9129
8-#14	2.68	MA	4199	1718	5880	1505	7386	1246	8267	1039	9389	682	11935	300	10117
4L-2S		MI	4180	1718	6380	1444	7945	1192	9035	983	10642	639	13317	516	9227
8-#18	4.76	MA	5990	2130	10245	1710	12862	1389	14911	1110	18322	628	23755	502	19042
2L-4S		MI	4015	2130	6426	1741	7899	1412	8864	1142	10353	640	12885	-40	12822
8-#18	4.76	MA	5282	2130	8645	1743	10838	1417	12463	1134	15027	659	19277	208	18480
3E		MI	4372	2130	7352	1714	9106	1391	10404	1109	12454	636	15371	115	14982
8-#18	4.76	MA	4857	2130	7523	1776	9375	1445	10594	1174	12474	673	16109	40	15886
4L-2S		MI	4952	2130	8658	1686	10758	1369	12401	1093	15144	614	18846	409	15661
10-#10	1.89	MA	4616	1562	6323	1383	8061	1152	9187	964	10691	666	13586	577	8103
2L-5S		MI	3331	1562	4428	1397	5507	1170	6113	981	6720	682	8305	364	6300
10-#10	1.89	MA	4301	1562	5787	1395	7382	1163	8365	974	9585	679	12055	489	8067
3L-4S		MI	3474	1562	4704	1386	5898	1155	6575	972	7360	671	9197	419	6673
10-#10	1.89	MA	4119	1562	5415	1408	6897	1174	7745	990	8737	687	11000	435	7960
4L-3S		MI	3625	1562	5014	1375	6302	1145	7092	958	8065	666	10088	474	6750
10-#10	1.89	MA	3932	1562	5085	1420	6428	1191	7191	1000	7969	700	9936	386	7493
5L-2S		MI	3884	1562	5457	1364	6863	1136	7770	950	8979	655	11351	567	6774
10-#11	2.32	MA	4833	1647	6947	1427	8799	1184	10052	983	11832	658	15148	568	9766
2L-5S		MI	3415	1647	4729	1445	5827	1206	6471	1001	7175	674	8857	293	7374
10-#11	2.32	MA	4468	1647	6299	1442	7979	1196	9061	994	10497	673	13299	457	9705
3L-4S		MI	3578	1647	5063	1432	6300	1188	7031	992	7948	663	9909	360	7870
10-#11	2.32	MA	4260	1647	5848	1456	7391	1209	8309	1012	9469	681	12012	390	9467
4L-3S		MI	3753	1647	5438	1420	6789	1177	7654	977	8800	658	10963	426	8089
10-#11	2.32	MA	4042	1647	5447	1471	6821	1229	7636	1023	8539	695	10717	327	8803
5L-2S		MI	4051	1647	5971	1407	7464	1166	8471	968	9899	646	12452	540	8133
10-#14	3.35	MA	5369	1850	8370	1548	10562	1271	12165	1038	14660	646	19051	554	13800
2L-5S		MI	3642	1850	5368	1579	6573	1306	7348	1066	8326	670	10367	146	9829
10-#14	3.35	MA	4900	1850	7446	1568	9394	1289	10753	1053	12758	666	16417	391	13648
3L-4S		MI	3882	1850	5846	1561	7249	1282	8146	1055	9429	655	11838	243	10522
10-#14	3.35	MA	4632	1850	6803	1588	8554	1307	9679	1078	11291	677	14569	293	12725
4L-3S		MI	4100	1850	6380	1544	7945	1268	9035	1033	10642	649	13317	335	11310
10-#14	3.35	MA	4332	1850	6229	1608	7740	1334	8718	1093	9962	697	12715	199	11879
5L-2S		MI	4472	1850	7137	1527	8904	1253	10194	1022	12203	634	15400	501	11431
10-#18	5.95	MA	5936	2365	10245	1890	12862	1525	14911	1203	18322	650	23755	188	22962
3L-4S		MI	4591	2365	7731	1889	9551	1520	10861	1211	13042	631	16360	-80	16165
10-#18	5.95	MA	5581	2365	9123	1923	11398	1553	13041	1243	15770	664	20587	19	20471
4L-3S		MI	4893	2365	8658	1861	10758	1499	12401	1178	15144	627	18846	75	18568
12-#10	2.27	MA	4847	1637	6860	1430	8740	1186	10008	986	11797	663	15118	573	9669
2L-6S		MI	3349	1637	4595	1453	5713	1214	6340	1016	7010	685	8708	290	7248

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 28"

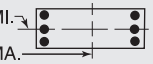
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#10	2.27	MA	4545	1637	6323	1442	8061	1197	9187	996	10691	676	13586	485	9625
3L-5S		MI	3540	1637	4872	1444	6068	1205	6791	1002	7634	679	9569	360	7549
12-#10	2.27	MA	4376	1637	5952	1454	7576	1209	8566	1012	9843	684	12532	431	9508
4E		MI	3680	1637	5148	1433	6459	1189	7254	994	8274	668	10461	415	7948
12-#10	2.27	MA	4192	1637	5622	1467	7107	1225	8012	1022	9075	697	11467	383	9021
5L-3S		MI	3822	1637	5457	1422	6863	1180	7770	980	8979	663	11351	470	8035
12-#10	2.27	MA	3961	1637	5277	1475	6683	1237	7471	1037	8327	705	10449	313	8649
6L-2S		MI	4071	1637	5901	1411	7424	1170	8448	972	9892	652	12615	563	8068
12-#11	2.79	MA	5101	1739	7595	1485	9619	1226	11044	1010	13167	654	16997	563	11656
2L-6S		MI	3437	1739	4935	1514	6072	1259	6741	1044	7518	676	9328	200	8357
12-#11	2.79	MA	4754	1739	6947	1499	8799	1239	10052	1021	11832	669	15148	452	11582
3L-5S		MI	3659	1739	5262	1503	6502	1248	7287	1028	8274	671	10346	285	8880
12-#11	2.79	MA	4561	1739	6497	1514	8211	1252	9300	1039	10805	677	13861	385	11289
4E		MI	3820	1739	5597	1490	6975	1230	7847	1019	9047	659	11398	352	9352
12-#11	2.79	MA	4348	1739	6096	1528	7641	1271	8628	1050	9874	692	12566	322	10652
5L-3S		MI	3982	1739	5971	1477	7464	1219	8471	1004	9899	654	12452	418	9630
12-#11	2.79	MA	4079	1739	5685	1538	7127	1284	7972	1069	8966	700	11322	236	10011
6L-2S		MI	4266	1739	6505	1464	8139	1208	9287	995	10998	642	13942	532	9687
12-#14	4.02	MA	5301	1983	8370	1651	10562	1350	12165	1092	14660	661	19051	384	16317
3L-5S		MI	3992	1983	6126	1661	7532	1367	8507	1105	9887	665	12450	130	11941
12-#14	4.02	MA	5049	1983	7726	1671	9722	1368	11092	1117	13193	672	17202	287	15345
4E		MI	4215	1983	6604	1644	8208	1343	9305	1094	10990	650	13921	228	12646
12-#14	4.02	MA	4754	1983	7152	1691	8908	1395	10131	1132	11864	692	15349	192	14506
5L-3S		MI	4409	1983	7137	1627	8904	1328	10194	1072	12203	644	15400	320	13492
12-#14	4.02	MA	4396	1983	6573	1706	8172	1413	9193	1157	10566	702	13562	67	13216
6L-2S		MI	4756	1983	7895	1609	9862	1314	11353	1061	13764	629	17483	485	13632
12-#18	7.14	MA	6272	2601	10723	2070	13422	1661	15489	1313	19066	655	25065	-1	25062
4E		MI	5142	2601	9037	2036	11202	1629	12859	1280	15732	622	19836	-120	19455
14-#10	2.65	MA	4783	1711	6860	1489	8740	1232	10008	1018	11797	674	15118	481	11182
3L-6S		MI	3559	1711	5038	1499	6274	1249	7018	1038	7923	682	9972	286	8492
14-#10	2.65	MA	4625	1711	6489	1501	8255	1243	9388	1034	10949	681	14063	427	11059
4L-5S		MI	3742	1711	5315	1491	6629	1239	7470	1024	8547	676	10833	356	8804
14-#10	2.65	MA	4443	1711	6159	1513	7786	1260	8833	1044	10181	694	12999	379	10554
5L-4S		MI	3881	1711	5591	1480	7020	1224	7932	1016	9187	666	11724	411	9224
14-#10	2.65	MA	4223	1711	5814	1521	7362	1271	8293	1059	9433	702	11980	309	10179
6L-3S		MI	4014	1711	5901	1468	7424	1214	8448	1002	9892	660	12615	466	9319
14-#10	2.65	MA	4028	1711	5472	1529	6929	1279	7770	1069	8705	715	10973	269	9576
7L-2S		MI	4253	1711	6344	1457	7985	1204	9127	994	10806	649	13879	559	9361
14-#11	3.25	MA	5032	1831	7595	1557	9619	1281	11044	1048	13167	666	16997	447	13459
3L-6S		MI	3684	1831	5468	1571	6747	1301	7557	1071	8617	673	10817	192	9856
14-#11	3.25	MA	4854	1831	7145	1571	9031	1294	10292	1066	12140	674	15710	380	13118
4L-5S		MI	3896	1831	5796	1560	7176	1290	8104	1055	9373	668	11836	277	10392
14-#11	3.25	MA	4643	1831	6744	1586	8462	1313	9620	1077	11209	689	14415	317	12506
5L-4S		MI	4068	1831	6130	1547	7650	1272	8663	1046	10146	656	12887	344	10841
14-#11	3.25	MA	4387	1831	6333	1596	7947	1326	8964	1096	10302	697	13171	231	11861
6L-3S		MI	4212	1831	6505	1535	8139	1261	9287	1031	10998	651	13942	409	11172
14-#11	3.25	MA	4161	1831	5867	1612	7432	1337	8329	1107	9418	711	11944	178	11163
7L-2S		MI	4473	1831	7038	1522	8813	1251	10103	1022	12097	639	15431	524	11239
14-#14	4.69	MA	5473	2115	8649	1754	10890	1428	12505	1156	15095	667	19836	280	17974
4L-5S		MI	4317	2115	6884	1744	8490	1428	9667	1144	11448	660	14533	115	14062
14-#14	4.69	MA	5180	2115	8076	1774	10076	1456	11544	1171	13766	687	17982	185	17139
5L-4S		MI	4536	2115	7361	1727	9166	1404	10465	1133	12551	645	16004	212	14781
14-#14	4.69	MA	4825	2115	7496	1789	9340	1474	10605	1196	12468	697	16196	60	15882
6L-3S		MI	4710	2115	7895	1709	9862	1389	11353	1111	13764	639	17483	304	15677
16-#10	3.02	MA	4867	1786	7026	1548	8934	1277	10209	1056	12055	678	15594	424	12612
4L-6S		MI	3764	1786	5482	1546	6835	1283	7697	1060	8836	679	11235	282	9740
16-#10	3.02	MA	4688	1786	6695	1560	8465	1294	9655	1066	11287	692	14530	375	12090
5E		MI	3940	1786	5758	1537	7190	1273	8148	1046	9461	674	12096	352	10062

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



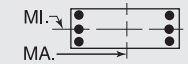
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#10	3.02	MA	4477	1786	6350	1568	8041	1305	9114	1081	10539	699	13511	305	11712
6L-4S		MI	4077	1786	6035	1526	7581	1258	8611	1038	10101	663	12988	407	10471
16-#10	3.02	MA	4292	1786	6009	1576	7608	1314	8591	1091	9811	712	12504	265	11124
7L-3S		MI	4202	1786	6344	1515	7985	1248	9127	1024	10806	657	13879	462	10604
16-#10	3.02	MA	4121	1786	5632	1591	7144	1327	8073	1101	9086	720	11534	210	10501
8L-2S		MI	4431	1786	6788	1504	8546	1239	9805	1016	11719	647	15142	555	10652
16-#11	3.71	MA	5157	1923	7793	1629	9851	1336	11284	1093	13476	670	17559	376	14955
4L-6S		MI	3925	1923	6002	1629	7422	1343	8373	1098	9716	669	12306	184	11360
16-#11	3.71	MA	4930	1923	7392	1643	9282	1356	10612	1104	12545	685	16264	313	14365
5E		MI	4138	1923	6329	1617	7851	1332	8920	1082	10472	664	13325	268	11908
16-#11	3.71	MA	4686	1923	6981	1653	8767	1369	9956	1123	11637	693	15020	227	13715
6L-4S		MI	4296	1923	6664	1605	8325	1314	9479	1073	11245	652	14377	336	12338
16-#11	3.71	MA	4473	1923	6515	1669	8252	1380	9320	1134	10754	708	13793	173	13025
7L-3S		MI	4428	1923	7038	1592	8813	1304	10103	1058	12097	647	15431	401	12714
16-#14	5.36	MA	5573	2248	8999	1857	11244	1517	12956	1210	15668	682	20616	178	19777
5E		MI	4633	2248	7641	1827	9449	1489	10826	1183	13009	655	16616	100	16190
16-#14	5.36	MA	5265	2248	8419	1872	10508	1534	12018	1235	14370	692	18830	54	18551
6L-4S		MI	4848	2248	8119	1810	10125	1465	11624	1171	14112	640	18087	197	16924
18-#10	3.40	MA	4927	1861	7232	1607	9144	1328	10476	1088	12393	689	16061	371	13629
5L-6S		MI	3964	1861	5925	1593	7396	1317	8375	1082	9750	676	12499	278	10992
18-#10	3.40	MA	4724	1861	6887	1615	8720	1340	9936	1103	11645	696	15043	302	13248
6L-5S		MI	4133	1861	6202	1584	7750	1308	8827	1068	10374	671	13360	348	11324
18-#10	3.40	MA	4548	1861	6545	1623	8288	1348	9412	1113	10917	709	14036	261	12674
7L-4S		MI	4281	1861	6478	1573	8142	1292	9289	1060	11014	660	14252	403	11718
18-#10	3.40	MA	4387	1861	6169	1638	7824	1361	8894	1123	10192	717	13066	207	12054
8L-3S		MI	4392	1861	6788	1562	8546	1283	9805	1046	11719	655	15142	458	11888
18-#11	4.18	MA	5226	2015	8040	1700	10102	1398	11604	1131	13880	682	18113	308	16227
5L-6S		MI	4173	2015	6535	1686	8097	1385	9189	1125	10815	666	13796	176	12868
18-#11	4.18	MA	4999	2015	7629	1711	9587	1411	10947	1150	12973	690	16869	222	15572
6L-5S		MI	4362	2015	6862	1675	8526	1374	9736	1109	11571	661	14815	260	13428
18-#11	4.18	MA	4776	2015	7163	1727	9072	1422	10312	1161	12089	705	15642	169	14889
7L-4S		MI	4518	2015	7197	1662	9000	1357	10296	1100	12344	649	15866	327	13841
18-#14	6.03	MA	5668	2380	9343	1954	11676	1595	13431	1274	16272	687	21463	47	21223
6L-5S		MI	4940	2380	8399	1910	10407	1550	11985	1222	14570	650	18699	84	18326
20-#10	3.78	MA	4966	1936	7424	1662	9399	1374	10757	1125	12751	693	16574	298	14786
6E		MI	4159	1936	6369	1640	7957	1352	9053	1104	10663	673	13763	274	12247
20-#10	3.78	MA	4799	1936	7082	1670	8967	1382	10234	1135	12023	707	15567	257	14225
7L-5S		MI	4332	1936	6645	1631	8311	1342	9505	1090	11288	668	14624	344	12589
20-#10	3.78	MA	4645	1936	6705	1685	8503	1396	9715	1144	11298	714	14597	203	13607
8L-4S		MI	4467	1936	6921	1620	8703	1327	9967	1082	11927	657	15516	399	12969
20-#11	4.64	MA	5283	2106	8278	1768	10407	1453	11939	1176	14308	686	18718	217	17432
6E		MI	4402	2106	7069	1743	8771	1427	10006	1152	11914	662	15285	167	14380
20-#11	4.64	MA	5096	2106	7811	1784	9892	1464	11304	1188	13425	701	17491	164	16755
7L-5S		MI	4581	2106	7396	1732	9201	1416	10552	1136	12670	657	16304	252	14952
22-#10	4.16	MA	5043	2010	7619	1716	9646	1417	11055	1157	13129	704	17098	253	15778
7L-6S		MI	4365	2010	6812	1686	8518	1386	9732	1126	11577	671	15026	270	13504
22-#10	4.16	MA	4894	2010	7242	1731	9182	1430	10537	1166	12404	711	16128	199	15159
8L-5S		MI	4516	2010	7089	1678	8872	1376	10183	1112	12201	665	15887	340	13856
22-#11	5.11	MA	5386	2198	8460	1841	10712	1506	12296	1215	14760	698	19340	159	18623
7L-6S		MI	4626	2198	7602	1801	9446	1469	10822	1179	13013	659	16775	159	15895

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

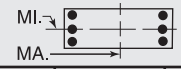


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.25	MA	4809	1538	6247	1390	7930	1166	8922	988	10064	715	12523	622	6204
2E		MI	3762	1538	5103	1358	6322	1138	7030	964	7834	696	9507	588	4815
4-#18	2.22	MA	5424	1744	7831	1506	9854	1250	11209	1039	13107	699	16707	604	10602
2E		MI	4191	1744	6292	1471	7751	1220	8722	1013	10078	678	12248	530	8110
6-#10	1.06	MA	4712	1497	5861	1380	7537	1160	8496	987	9537	725	11827	632	5370
2L-3S		MI	3416	1497	4359	1362	5471	1146	6047	975	6554	719	7920	524	4193
6-#10	1.06	MA	4329	1497	5278	1392	6799	1172	7603	998	8335	739	10163	545	5361
3L-2S		MI	3703	1497	4802	1351	6031	1136	6726	966	7467	708	9183	617	4189
6-#11	1.30	MA	4868	1548	6300	1403	8037	1176	9071	996	10285	718	12843	625	6483
2L-3S		MI	3475	1548	4607	1385	5731	1161	6335	982	6917	712	8341	484	5027
6-#11	1.30	MA	4420	1548	5595	1418	7144	1190	7992	1008	8832	734	10830	516	6457
3L-2S		MI	3809	1548	5140	1372	6406	1150	7152	973	8016	700	9831	598	5031
6-#14	1.88	MA	5255	1670	7254	1473	9203	1227	10461	1027	12137	710	15393	615	9150
2L-3S		MI	3636	1670	5103	1458	6322	1214	7030	1015	7834	706	9507	407	6988
6-#14	1.88	MA	4654	1670	6247	1494	7930	1246	8922	1044	10064	732	12523	455	9050
3L-2S		MI	4084	1670	5861	1440	7280	1199	8189	1003	9395	691	11590	573	7043
6-#18	3.33	MA	6127	1979	9578	1653	12064	1358	13882	1108	16706	690	21690	592	15690
2L-3S		MI	4030	1979	6292	1645	7751	1349	8722	1098	10078	691	12248	196	11589
6-#18	3.33	MA	5213	1979	7831	1688	9854	1388	11209	1134	13107	725	16707	298	15231
3L-2S		MI	4690	1979	7598	1618	9403	1328	10719	1082	12767	670	15724	490	11911
8-#9	1.11	MA	4764	1508	5932	1390	7647	1168	8640	993	9741	727	12116	633	5645
2L-4S		MI	3383	1508	4257	1380	5351	1160	5891	991	6345	724	7709	503	4386
8-#9	1.11	MA	4464	1508	5470	1400	7063	1177	7933	1002	8789	738	10798	565	5637
3E		MI	3517	1508	4502	1371	5671	1152	6300	979	6903	719	8413	546	4403
8-#9	1.11	MA	4287	1508	5152	1410	6647	1187	7401	1015	8061	745	9902	524	5596
4L-2S		MI	3742	1508	4854	1362	6116	1145	6839	973	7628	710	9416	619	4400
8-#10	1.41	MA	4984	1572	6445	1426	8275	1194	9389	1009	10739	722	13492	628	7082
2L-4S		MI	3463	1572	4492	1420	5627	1190	6210	1010	6762	722	8293	464	5435
8-#10	1.41	MA	4619	1572	5861	1439	7537	1206	8496	1020	9537	736	11827	541	7058
3E		MI	3627	1572	4802	1409	6031	1180	6726	997	7467	716	9183	520	5487
8-#10	1.41	MA	4405	1572	5459	1452	7011	1218	7823	1036	8618	745	10691	488	6962
4L-2S		MI	3901	1572	5245	1398	6592	1170	7404	988	8380	706	10447	613	5496
8-#11	1.73	MA	5184	1640	7006	1460	8929	1218	10151	1023	11739	715	14856	620	8548
2L-4S		MI	3531	1640	4766	1455	5918	1214	6528	1025	7164	713	8777	410	6475
8-#11	1.73	MA	4760	1640	6300	1475	8037	1232	9071	1035	10285	731	12843	511	8503
3E		MI	3722	1640	5140	1442	6406	1203	7152	1009	8016	708	9831	476	6576
8-#11	1.73	MA	4510	1640	5812	1491	7399	1246	8256	1054	9170	740	11456	445	8332
4L-2S		MI	4039	1640	5674	1430	7081	1192	7968	1000	9115	696	11320	590	6599
8-#14	2.50	MA	5681	1803	8260	1555	10475	1288	12000	1066	14209	705	18262	608	12085
2L-4S		MI	3721	1803	5327	1558	6584	1289	7301	1075	8182	707	10111	300	8538
8-#14	2.50	MA	5121	1803	7254	1576	9203	1306	10461	1082	12137	727	15393	448	11955
3E		MI	3974	1803	5861	1541	7280	1275	8189	1054	9395	701	11590	392	9170
8-#14	2.50	MA	4793	1803	6555	1598	8291	1325	9295	1109	10544	739	13400	352	11128
4L-2S		MI	4393	1803	6619	1523	8239	1260	9349	1042	10956	686	13673	557	9255
8-#18	4.44	MA	6791	2215	11325	1800	14274	1466	16555	1177	20305	682	26673	580	20770
2L-4S		MI	4211	2215	6671	1820	8196	1479	9179	1200	10666	687	13238	1	13234
8-#18	4.44	MA	6000	2215	9578	1835	12064	1496	13882	1203	16706	716	21690	286	20276
3E		MI	4577	2215	7598	1792	9403	1457	10719	1167	12767	683	15724	156	15191
8-#18	4.44	MA	5491	2215	8358	1870	10472	1527	11848	1247	13928	733	18179	112	17491
4L-2S		MI	5171	2215	8903	1765	11055	1436	12717	1151	15457	661	19200	450	15699
10-#10	1.76	MA	5247	1647	7029	1473	9014	1229	10282	1031	11942	719	15156	624	8788
2L-5S		MI	3534	1647	4660	1478	5797	1239	6426	1041	7036	730	8665	406	6381
10-#10	1.76	MA	4898	1647	6445	1486	8275	1241	9389	1042	10739	733	13492	537	8753
3L-4S		MI	3678	1647	4936	1467	6188	1224	6888	1032	7675	719	9556	460	6710
10-#10	1.76	MA	4699	1647	6043	1499	7749	1252	8716	1058	9820	742	12356	485	8645
4L-3S		MI	3831	1647	5245	1456	6592	1214	7404	1019	8380	714	10447	516	6775
10-#10	1.76	MA	4488	1647	5685	1512	7242	1270	8116	1069	8989	756	11158	430	8188
5L-2S		MI	4094	1647	5689	1445	7153	1205	8083	1010	9294	703	11711	609	6795

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#11	2.17	MA	5490	1732	7712	1518	9822	1261	11231	1050	13193	711	16869	615	10609
2L-5S		MI	3618	1732	4965	1525	6119	1274	6785	1061	7489	722	9214	335	7467
10-#11	2.17	MA	5087	1732	7006	1533	8929	1274	10151	1062	11739	727	14856	506	10548
3L-4S		MI	3782	1732	5299	1512	6593	1256	7344	1052	8263	710	10266	402	7974
10-#11	2.17	MA	4857	1732	6518	1548	8291	1288	9335	1081	10624	736	13468	440	10365
4L-3S		MI	3960	1732	5674	1500	7081	1245	7968	1036	9115	705	11320	467	8121
10-#11	2.17	MA	4612	1732	6083	1563	7675	1308	8606	1093	9615	752	12069	380	9629
5L-2S		MI	4262	1732	6207	1487	7756	1235	8784	1027	10214	693	12810	582	8158
10-#14	3.13	MA	6094	1935	9266	1638	11748	1348	13539	1105	16282	700	21132	601	15015
2L-5S		MI	3844	1935	5607	1658	6867	1374	7662	1125	8640	717	10723	187	10008
10-#14	3.13	MA	5568	1935	8260	1659	10475	1367	12000	1121	14209	722	18262	441	14863
3L-4S		MI	4068	1935	6085	1641	7543	1350	8460	1114	9743	702	12194	285	10643
10-#14	3.13	MA	5272	1935	7561	1680	9563	1386	10834	1148	12616	734	16270	345	13980
4L-3S		MI	4308	1935	6619	1623	8239	1335	9349	1092	10956	696	13673	377	11352
10-#14	3.13	MA	4933	1935	6940	1702	8681	1415	9792	1164	11173	755	14264	256	13011
5L-2S		MI	4688	1935	7376	1606	9197	1321	10508	1081	12517	681	15756	542	11461
10-#18	5.56	MA	6723	2450	11325	1982	14274	1605	16555	1273	20305	707	26673	274	25334
3L-4S		MI	4788	2450	7977	1967	9847	1587	11177	1270	13356	678	16714	-39	16621
10-#18	5.56	MA	6329	2450	10105	2017	12682	1635	14521	1316	17527	724	23162	100	22515
4L-3S		MI	5100	2450	8903	1939	11055	1566	12717	1236	15457	674	19200	116	18766
10-#18	5.56	MA	5759	2450	9017	2052	11140	1683	12699	1342	15006	759	19645	-71	19395
5L-2S		MI	5640	2450	10209	1912	12706	1544	14714	1220	18146	652	22675	410	19482
12-#10	2.12	MA	5503	1722	7612	1520	9752	1263	11175	1053	13144	717	16821	620	10492
2L-6S		MI	3552	1722	4826	1533	6003	1283	6652	1076	7325	732	9067	332	7354
12-#10	2.12	MA	5169	1722	7029	1533	9014	1275	10282	1064	11942	731	15156	534	10447
3L-5S		MI	3744	1722	5103	1525	6358	1274	7104	1063	7949	727	9928	402	7628
12-#10	2.12	MA	4982	1722	6626	1546	8488	1287	9609	1080	11022	739	14020	481	10331
4E		MI	3885	1722	5379	1514	6749	1258	7566	1054	8589	716	10820	456	7986
12-#10	2.12	MA	4775	1722	6269	1558	7980	1304	9009	1091	10191	753	12822	426	9853
5L-3S		MI	4030	1722	5689	1503	7153	1249	8083	1040	9294	711	11711	512	8062
12-#10	2.12	MA	4522	1722	5890	1566	7521	1316	8424	1107	9381	761	11774	365	9440
6L-2S		MI	4282	1722	6132	1491	7714	1239	8761	1032	10207	700	12974	605	8090
12-#11	2.60	MA	5788	1824	8417	1575	10715	1303	12310	1077	14646	708	18881	610	12666
2L-6S		MI	3639	1824	5171	1594	6364	1327	7054	1103	7833	723	9685	242	8498
12-#11	2.60	MA	5403	1824	7712	1590	9822	1316	11231	1089	13193	724	16869	501	12593
3L-5S		MI	3864	1824	5498	1583	6794	1316	7601	1088	8588	718	10704	326	8969
12-#11	2.60	MA	5190	1824	7223	1605	9184	1330	10415	1108	12078	733	15481	435	12385
4E		MI	4025	1824	5833	1570	7267	1298	8160	1079	9362	706	11755	394	9452
12-#11	2.60	MA	4950	1824	6789	1620	8567	1351	9686	1120	11068	749	14082	375	11647
5L-3S		MI	4190	1824	6207	1557	7756	1287	8784	1063	10214	701	12810	459	9664
12-#11	2.60	MA	4654	1824	6336	1630	8010	1364	8975	1139	10085	758	12742	290	11013
6L-2S		MI	4480	1824	6741	1544	8431	1277	9600	1054	11312	690	14299	574	9714
12-#14	3.75	MA	6016	2068	9266	1742	11748	1428	13539	1160	16282	717	21132	435	17775
3L-5S		MI	4196	2068	6365	1741	7825	1435	8822	1164	10201	712	12806	172	12128
12-#14	3.75	MA	5732	2068	8567	1763	10836	1447	12373	1187	14689	729	19139	339	16843
4E		MI	4419	2068	6843	1724	8501	1411	9620	1153	11304	697	14277	269	12762
12-#14	3.75	MA	5399	2068	7946	1784	9954	1476	11331	1203	13246	751	17134	249	15915
5L-3S		MI	4619	2068	7376	1706	9197	1396	10508	1131	12517	691	15756	361	13535
12-#14	3.75	MA	5005	2068	7306	1799	9156	1495	10314	1230	11839	762	15209	125	14535
6L-2S		MI	4975	2068	8134	1689	10156	1382	11667	1120	14078	676	17839	526	13663
12-#18	6.67	MA	7092	2686	11852	2164	14892	1743	17194	1385	21126	715	28144	88	27551
4E		MI	5340	2686	9282	2114	11499	1695	13174	1339	16045	669	20189	-80	19945
12-#18	6.67	MA	6535	2686	10764	2200	13350	1791	15372	1411	18605	750	24628	-83	24188
5L-3S		MI	5608	2686	10209	2087	12706	1674	14714	1305	18146	665	22675	76	22370

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 30"

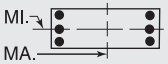
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#10	2.47	MA	5431	1796	7612	1579	9752	1309	11175	1086	13144	728	16821	530	12142
3L-6S		MI	3763	1796	5270	1580	6564	1318	7331	1098	8238	730	10331	328	8617
14-#10	2.47	MA	5257	1796	7210	1592	9226	1321	10502	1102	12224	736	15685	477	12019
4L-5S		MI	3948	1796	5546	1571	6919	1308	7782	1084	8862	724	11192	398	8880
14-#10	2.47	MA	5053	1796	6852	1605	8718	1338	9902	1113	11393	750	14487	423	11522
5L-4S		MI	4087	1796	5823	1560	7310	1293	8245	1076	9502	713	12084	452	9263
14-#10	2.47	MA	4811	1796	6473	1613	8260	1350	9317	1129	10583	759	13439	362	11124
6L-3S		MI	4223	1796	6132	1549	7714	1283	8761	1062	10207	708	12974	508	9347
14-#10	2.47	MA	4597	1796	6103	1621	7783	1358	8751	1140	9795	773	12353	323	10495
7L-2S		MI	4466	1796	6576	1538	8275	1273	9440	1054	11121	697	14238	601	9383
14-#11	3.03	MA	5711	1916	8417	1648	10715	1359	12310	1116	14646	720	18881	497	14639
3L-6S		MI	3887	1916	5704	1651	7039	1369	7870	1130	8932	720	11174	234	9993
14-#11	3.03	MA	5513	1916	7929	1663	10077	1372	11495	1135	13531	729	17494	431	14382
4L-5S		MI	4102	1916	6032	1640	7469	1358	8417	1115	9687	715	12193	318	10478
14-#11	3.03	MA	5276	1916	7495	1678	9460	1393	10766	1147	12522	745	16094	371	13669
5L-4S		MI	4261	1916	6366	1627	7942	1340	8977	1106	10461	703	13245	385	10938
14-#11	3.03	MA	4995	1916	7042	1688	8902	1406	10055	1166	11538	755	14754	285	13035
6L-3S		MI	4423	1916	6741	1615	8431	1330	9600	1090	11312	698	14299	451	11206
14-#11	3.03	MA	4745	1916	6592	1697	8334	1417	9367	1179	10581	771	13430	235	12269
7L-2S		MI	4690	1916	7274	1602	9105	1319	10416	1081	12411	686	15789	565	11266
14-#14	4.38	MA	6204	2200	9573	1846	12109	1508	13913	1226	16761	724	22009	332	19714
4L-5S		MI	4523	2200	7123	1824	8784	1496	9981	1203	11762	707	14889	156	14242
14-#14	4.38	MA	5849	2200	8952	1867	11226	1537	12870	1242	15318	746	20004	242	18825
5L-4S		MI	4742	2200	7600	1806	9460	1472	10779	1192	12865	692	16360	254	14892
14-#14	4.38	MA	5478	2200	8312	1882	10428	1555	11853	1269	13911	758	18079	118	17442
6L-3S		MI	4921	2200	8134	1789	10156	1457	11667	1170	14078	686	17839	346	15720
14-#18	7.78	MA	7278	2921	12511	2347	15560	1900	18045	1480	22204	741	29610	-95	28939
5L-4S		MI	5875	2921	10588	2261	13151	1804	15172	1408	18735	660	23665	-120	23221
16-#10	2.82	MA	5525	1871	7793	1639	9964	1355	11395	1124	13427	733	17350	473	13709
4L-6S		MI	3969	1871	5713	1627	7125	1352	8009	1120	9152	727	11595	324	9862
16-#10	2.82	MA	5323	1871	7436	1652	9456	1373	10795	1135	12595	747	16152	419	13195
5E		MI	4146	1871	5990	1618	7479	1342	8461	1106	9776	721	12456	394	10136
16-#10	2.82	MA	5091	1871	7057	1659	8998	1385	10210	1151	11785	756	15103	358	12811
6L-4S		MI	4284	1871	6266	1607	7871	1327	8923	1098	10416	711	13348	448	10541
16-#10	2.82	MA	4888	1871	6686	1668	8521	1393	9644	1162	10997	770	14017	319	12182
7L-3S		MI	4412	1871	6576	1596	8275	1317	9440	1084	11121	705	14238	504	10632
16-#10	2.82	MA	4699	1871	6278	1683	8018	1406	9072	1171	10212	778	12970	267	11533
8L-2S		MI	4648	1871	7019	1585	8836	1308	10118	1076	12034	694	15502	597	10675
16-#11	3.47	MA	5828	2008	8634	1720	10969	1414	12574	1162	14985	726	19507	426	16385
4L-6S		MI	4128	2008	6238	1709	7714	1411	8687	1157	10031	716	12664	226	11492
16-#11	3.47	MA	5594	2008	8200	1735	10352	1435	11845	1174	13976	742	18107	366	15696
5E		MI	4346	2008	6565	1697	8143	1400	9233	1142	10786	711	13683	310	11992
16-#11	3.47	MA	5325	2008	7747	1745	9795	1449	11135	1193	12992	751	16767	281	15060
6L-4S		MI	4504	2008	6900	1685	8617	1383	9793	1133	11560	700	14734	377	12432
16-#11	3.47	MA	5090	2008	7298	1755	9227	1459	10447	1205	12035	767	15443	230	14314
7L-3S		MI	4641	2008	7274	1672	9105	1372	10416	1117	12411	695	15789	443	12748
16-#14	5.00	MA	6307	2333	9958	1950	12499	1597	14410	1281	17391	741	22873	235	21738
5E		MI	4840	2333	7880	1907	9743	1557	11140	1242	13323	702	16972	141	16365
16-#14	5.00	MA	5965	2333	9318	1964	11701	1616	13393	1308	15984	753	20948	111	20350
6L-4S		MI	5055	2333	8358	1889	10418	1532	11938	1231	14426	687	18443	238	17030
18-#10	3.17	MA	5587	1946	8020	1699	10195	1407	11688	1157	13797	745	17816	415	14870
5L-6S		MI	4169	1946	6157	1674	7686	1386	8688	1142	10065	724	12858	320	11110
18-#10	3.17	MA	5364	1946	7640	1706	9736	1419	11103	1173	12987	753	16768	354	14499
6L-5S		MI	4341	1946	6433	1665	8040	1377	9139	1128	10689	719	13719	390	11396
18-#10	3.17	MA	5170	1946	7270	1715	9260	1427	10537	1184	12200	767	15682	315	13869
7L-4S		MI	4477	1946	6709	1654	8432	1361	9602	1120	11329	708	14611	444	11801
18-#10	3.17	MA	4992	1946	6861	1730	8757	1441	9965	1193	11415	775	14635	263	13220
8L-3S		MI	4605	1946	7019	1643	8836	1352	10118	1106	12034	702	15502	500	11916

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	3.90	MA	5903	2099	8906	1793	11245	1477	12925	1201	15429	739	20120	361	17726
5L-6S		MI	4378	2099	6771	1766	8389	1453	9503	1184	11130	713	14153	217	12996
18-#11	3.90	MA	5646	2099	8453	1802	10688	1491	12214	1220	14446	748	18780	276	17088
6L-5S		MI	4571	2099	7098	1755	8818	1443	10050	1169	11885	708	15172	302	13509
18-#11	3.90	MA	5424	2099	8003	1812	10120	1501	11526	1232	13489	764	17455	226	16361
7L-4S		MI	4727	2099	7433	1742	9292	1425	10609	1160	12659	696	16224	369	13932
18-#14	5.63	MA	6410	2465	10324	2047	12974	1677	14932	1347	18056	748	23818	104	23257
6L-5S		MI	5148	2465	8638	1989	10701	1618	12299	1281	14884	697	19055	125	18494
20-#10	3.53	MA	5630	2021	8224	1753	10474	1453	11996	1195	14190	750	18433	350	16189
6E		MI	4366	2021	6600	1720	8247	1421	9366	1164	10978	721	14122	316	12362
20-#10	3.53	MA	5446	2021	7853	1762	9998	1461	11430	1206	13402	764	17346	311	15559
7L-5S		MI	4531	2021	6877	1712	8601	1411	9818	1150	11603	716	14983	386	12659
20-#10	3.53	MA	5276	2021	7445	1777	9495	1475	10858	1214	12617	773	16299	259	14908
8L-4S		MI	4678	2021	7153	1700	8993	1396	10280	1142	12243	705	15875	440	13050
20-#11	4.33	MA	5961	2191	9159	1860	11580	1533	13294	1247	15899	744	20793	271	19119
6E		MI	4608	2191	7305	1823	9064	1495	10319	1211	12229	710	15643	209	14505
20-#11	4.33	MA	5749	2191	8709	1870	11012	1544	12606	1259	14942	760	19468	221	18407
7L-5S		MI	4791	2191	7632	1812	9493	1485	10866	1196	12984	705	16662	294	15031
22-#10	3.88	MA	5715	2095	8437	1808	10736	1496	12323	1228	14604	761	19011	308	17247
7L-6S		MI	4573	2095	7043	1767	8808	1455	10045	1186	11892	718	15386	312	13616
22-#10	3.88	MA	5547	2095	8029	1824	10233	1509	11751	1236	13819	770	17964	255	16596
8L-5S		MI	4728	2095	7320	1758	9162	1445	10496	1172	12516	713	16247	382	13924
22-#11	4.77	MA	6098	2283	9415	1927	11905	1586	13686	1286	16396	757	21481	216	20452
7L-6S		MI	4833	2283	7838	1881	9738	1538	11135	1238	13328	706	17132	201	16016
24-#10	4.23	MA	5813	2170	8612	1870	10971	1544	12644	1258	15021	767	19629	251	18283
8L-6S		MI	4761	2170	7487	1814	9369	1489	10723	1208	12805	716	16650	308	14873

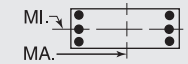
RECTANGULAR TIED COLUMNS 24" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.17	MA	5436	1623	6922	1480	8844	1243	9965	1055	11228	768	13960	669	6690
2E		MI	3968	1623	5343	1437	6615	1206	7344	1023	8148	743	9863	629	4837
4-#18	2.08	MA	6119	1829	8643	1596	10936	1327	12451	1106	14536	753	18510	651	11466
2E		MI	4402	1829	6538	1549	8048	1286	9037	1071	10391	725	12602	571	8142
6-#11	1.22	MA	5499	1633	6977	1493	8957	1253	10124	1063	11463	771	14300	671	6988
2L-3S		MI	3680	1633	4843	1465	6023	1229	6649	1042	7231	759	8699	525	5053
6-#11	1.22	MA	5008	1633	6214	1509	7992	1267	8956	1076	9891	788	12123	565	6962
3L-2S		MI	4016	1633	5376	1452	6698	1218	7465	1033	8330	747	10188	640	5052
6-#14	1.76	MA	5927	1755	8011	1563	10222	1304	11631	1094	13471	763	17066	662	9879
2L-3S		MI	3840	1755	5343	1537	6615	1282	7344	1074	8148	753	9863	449	7025
6-#14	1.76	MA	5268	1755	6922	1585	8844	1324	9965	1112	11228	786	13960	505	9779
3L-2S		MI	4293	1755	6100	1520	7574	1267	8503	1062	9709	738	11946	614	7069
6-#18	3.13	MA	6901	2064	10537	1743	13333	1435	15350	1175	18438	744	23913	639	16986
2L-3S		MI	4233	2064	6538	1724	8048	1416	9037	1156	10391	738	12602	237	11659
6-#18	3.13	MA	5887	2064	8643	1780	10936	1467	12451	1204	14536	781	18510	352	16527
3L-2S		MI	4905	2064	7843	1696	9700	1395	11034	1140	13081	716	16077	531	11946
8-#9	1.04	MA	5382	1593	6576	1480	8531	1245	9651	1060	10866	780	13504	680	6077
2L-4S		MI	3586	1593	4486	1461	5640	1229	6204	1051	6660	772	8069	545	4411
8-#9	1.04	MA	5054	1593	6077	1491	7900	1255	8888	1069	9839	792	12081	613	6069
3E		MI	3722	1593	4732	1452	5960	1221	6613	1040	7219	767	8773	588	4422
8-#9	1.04	MA	4861	1593	5734	1501	7452	1265	8315	1083	9055	799	11121	572	6028
4L-2S		MI	3949	1593	5083	1443	6405	1214	7151	1033	7943	758	9776	661	4417

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

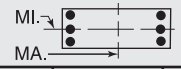


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	1.32	MA	5625	1657	7130	1516	9211	1271	10462	1076	11947	776	14992	675	7630
2L-4S		MI	3667	1657	4724	1501	5917	1258	6522	1070	7077	770	8652	506	5468
8-#10	1.32	MA	5225	1657	6500	1530	8413	1284	9498	1088	10649	790	13194	590	7606
3E		MI	3833	1657	5034	1490	6321	1249	7039	1057	7782	764	9543	561	5509
8-#10	1.32	MA	4991	1657	6067	1543	7847	1296	8773	1105	9658	800	11977	537	7510
4L-2S		MI	4109	1657	5477	1479	6882	1239	7717	1048	8696	753	10807	655	5514
8-#11	1.63	MA	5848	1725	7740	1550	9922	1295	11291	1090	13034	768	16476	667	9222
2L-4S		MI	3734	1725	5002	1535	6210	1282	6842	1084	7479	761	9134	452	6520
8-#11	1.63	MA	5382	1725	6977	1566	8957	1310	10124	1103	11463	785	14300	560	9177
3E		MI	3927	1725	5376	1522	6698	1271	7465	1069	8330	756	10188	517	6605
8-#11	1.63	MA	5109	1725	6451	1582	8269	1324	9244	1123	10260	795	12813	495	9006
4L-2S		MI	4248	1725	5910	1510	7373	1261	8281	1060	9429	744	11678	632	6622
8-#14	2.34	MA	6397	1888	9100	1645	11599	1364	13297	1133	15714	758	20171	655	13057
2L-4S		MI	3923	1888	5567	1637	6878	1357	7615	1134	8497	754	10467	341	8661
8-#14	2.34	MA	5781	1888	8011	1668	10222	1384	11631	1151	13471	781	17066	498	12927
3E		MI	4179	1888	6100	1620	7574	1342	8503	1113	9709	748	11946	433	9210
8-#14	2.34	MA	5421	1888	7258	1690	9238	1404	10373	1179	11751	795	14929	404	12155
4L-2S		MI	4606	1888	6858	1603	8532	1328	9663	1101	11270	733	14029	599	9283
8-#18	4.17	MA	7633	2300	12431	1890	15729	1543	18248	1245	22340	735	29316	627	22498
2L-4S		MI	4409	2300	6917	1898	8493	1546	9494	1259	10979	733	13591	42	13389
8-#18	4.17	MA	6755	2300	10537	1927	13333	1575	15350	1273	18438	773	23913	340	22004
3E		MI	4782	2300	7843	1871	9700	1524	11034	1225	13081	729	16077	197	15395
8-#18	4.17	MA	6193	2300	9220	1964	11613	1608	13151	1319	15435	793	20144	168	19118
4L-2S		MI	5389	2300	9149	1843	11351	1503	13032	1210	15770	707	19553	491	15736
10-#10	1.65	MA	5914	1732	7761	1563	10008	1306	11426	1098	13245	773	16790	671	9474
2L-5S		MI	3738	1732	4891	1559	6087	1308	6738	1101	7351	778	9024	448	6459
10-#10	1.65	MA	5531	1732	7130	1577	9211	1318	10462	1110	11947	788	14992	586	9439
3L-4S		MI	3882	1732	5167	1548	6478	1293	7201	1092	7990	767	9916	502	6745
10-#10	1.65	MA	5313	1732	6697	1590	8644	1330	9737	1127	10956	797	13775	534	9331
4L-3S		MI	4038	1732	5477	1537	6882	1283	7717	1079	8696	761	10807	557	6800
10-#10	1.65	MA	5079	1732	6313	1603	8098	1348	9091	1138	10061	812	12488	481	8891
5L-2S		MI	4303	1732	5920	1525	7443	1274	8395	1070	9609	751	12070	651	6815
10-#11	2.03	MA	6185	1817	8503	1608	10888	1337	12459	1117	14606	764	18653	662	11451
2L-5S		MI	3822	1817	5201	1605	6411	1342	7098	1120	7804	769	9572	376	7556
10-#11	2.03	MA	5741	1817	7740	1623	9922	1352	11291	1130	13034	781	16476	555	11390
3L-4S		MI	3986	1817	5535	1592	6885	1324	7658	1111	8578	757	10624	443	8050
10-#11	2.03	MA	5489	1817	7214	1639	9234	1366	10411	1150	11832	792	14989	490	11207
4L-3S		MI	4166	1817	5910	1580	7373	1314	8281	1096	9429	752	11678	509	8151
10-#11	2.03	MA	5216	1817	6746	1655	8570	1387	9626	1163	10744	809	13485	433	10465
5L-2S		MI	4473	1817	6443	1567	8048	1303	9098	1087	10528	740	13167	623	8183
10-#14	2.93	MA	6851	2020	10189	1728	12976	1425	14963	1172	17957	753	23277	648	16230
2L-5S		MI	4047	2020	5847	1738	7161	1442	7976	1184	8954	764	11079	228	10119
10-#14	2.93	MA	6272	2020	9100	1750	11599	1445	13297	1190	15714	776	20171	492	16078
3L-4S		MI	4271	2020	6324	1720	7836	1418	8774	1173	10057	749	12550	326	10761
10-#14	2.93	MA	5947	2020	8347	1772	10615	1465	12038	1217	13994	790	18034	397	15252
4L-3S		MI	4516	2020	6858	1703	8532	1403	9663	1152	11270	743	14029	418	11393
10-#14	2.93	MA	5569	2020	7677	1795	9664	1495	10915	1235	12438	813	15878	311	14152
5L-2S		MI	4903	2020	7616	1685	9491	1389	10822	1140	12831	728	16112	583	11490
10-#18	5.21	MA	7550	2535	12431	2074	15729	1684	18248	1342	22340	764	29316	328	27494
3L-4S		MI	4987	2535	8222	2045	10144	1654	11492	1328	13669	724	17067	1	17059
10-#18	5.21	MA	7115	2535	11114	2111	14009	1716	16049	1388	19337	784	25547	156	24582
4L-3S		MI	5307	2535	9149	2018	11351	1633	13032	1294	15770	720	19553	157	18960
10-#18	5.21	MA	6442	2535	9941	2148	12344	1767	14083	1417	16615	821	21760	-7	21733
5L-2S		MI	5861	2535	10454	1990	13003	1611	15029	1279	18460	698	23028	450	19520
12-#10	1.98	MA	6195	1806	8391	1610	10805	1340	12391	1120	14544	770	18588	667	11315
2L-6S		MI	3755	1806	5058	1614	6293	1352	6965	1136	7640	780	9427	373	7431
12-#10	1.98	MA	5828	1806	7761	1623	10008	1352	11426	1132	13245	785	16790	582	11270
3L-5S		MI	3949	1806	5334	1605	6648	1342	7417	1123	8264	775	10288	444	7704

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



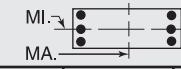
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	1.98	MA	5623	1806	7327	1637	9442	1365	10702	1149	12255	794	15573	530	11154
4E		MI	4090	1806	5611	1594	7039	1327	7879	1114	8904	764	11180	498	8022
12-#10	1.98	MA	5394	1806	6943	1650	8895	1383	10056	1160	11359	809	14286	477	10693
5L-3S		MI	4237	1806	5920	1583	7443	1318	8395	1101	9609	759	12070	553	8088
12-#10	1.98	MA	5117	1806	6530	1657	8402	1395	9426	1177	10488	818	13164	417	10231
6L-2S		MI	4493	1806	6364	1572	8004	1308	9074	1092	10522	748	13334	647	8112
12-#11	2.44	MA	6512	1909	9266	1665	11853	1380	13626	1144	16178	761	20829	657	13677
2L-6S		MI	3841	1909	5407	1674	6656	1395	7368	1163	8148	771	10043	284	8636
12-#11	2.44	MA	6089	1909	8503	1681	10888	1394	12459	1157	14606	778	18653	550	13604
3L-5S		MI	4068	1909	5734	1663	7086	1384	7914	1147	8903	766	11061	368	9056
12-#11	2.44	MA	5855	1909	7977	1697	10200	1408	11579	1177	13404	788	17166	485	13413
4E		MI	4229	1909	6069	1650	7560	1367	8474	1138	9677	754	12113	435	9550
12-#11	2.44	MA	5587	1909	7509	1712	9535	1430	10794	1190	12316	805	15661	428	12650
5L-3S		MI	4398	1909	6443	1637	8048	1356	9098	1123	10528	749	13167	501	9696
12-#11	2.44	MA	5263	1909	7014	1722	8935	1444	10028	1210	11256	815	14226	343	12033
6L-2S		MI	4692	1909	6977	1624	8723	1345	9914	1114	11627	737	14657	615	9740
12-#14	3.52	MA	6746	2152	10189	1833	12976	1506	14963	1229	17957	772	23277	485	19233
3L-5S		MI	4401	2152	6604	1820	8119	1503	9136	1223	10515	759	13162	213	12268
12-#14	3.52	MA	6451	2152	9435	1855	11992	1526	13704	1256	16238	785	21140	390	18358
4E		MI	4624	2152	7082	1803	8795	1479	9934	1212	11618	744	14633	310	12875
12-#14	3.52	MA	6081	2152	8766	1877	11041	1556	12581	1274	14681	809	18984	304	17302
5L-3S		MI	4829	2152	7616	1786	9491	1464	10822	1190	12831	738	16112	402	13577
12-#14	3.52	MA	5649	2152	8066	1891	10182	1576	11485	1302	13165	822	16920	181	15884
6L-2S		MI	5192	2152	8373	1768	10449	1450	11981	1179	14392	723	18195	568	13693
12-#18	6.25	MA	7950	2771	13008	2258	16405	1824	18948	1457	23239	775	30950	144	30056
4E		MI	5540	2771	9528	2192	11796	1762	13489	1397	16358	715	20542	-39	20427
12-#18	6.25	MA	7327	2771	11835	2295	14741	1875	16981	1486	20517	813	27163	-19	27053
5L-3S		MI	5817	2771	10454	2165	13003	1741	15029	1364	18460	711	23028	116	22555
14-#10	2.32	MA	6116	1881	8391	1670	10805	1387	12391	1154	14544	782	18588	578	13102
3L-6S		MI	3967	1881	5501	1661	6854	1386	7644	1158	8553	777	10690	369	8692
14-#10	2.32	MA	5925	1881	7958	1683	10239	1399	11666	1170	13553	791	17371	526	12979
4L-5S		MI	4154	1881	5778	1652	7208	1377	8095	1144	9178	772	11551	440	8953
14-#10	2.32	MA	5698	1881	7574	1697	9693	1417	11020	1182	12658	806	16084	473	12498
5L-4S		MI	4293	1881	6054	1641	7600	1362	8558	1136	9817	761	12443	494	9299
14-#10	2.32	MA	5434	1881	7160	1704	9199	1429	10391	1199	11786	815	14962	413	12053
6L-3S		MI	4432	1881	6364	1630	8004	1352	9074	1122	10522	756	13334	549	9374
14-#10	2.32	MA	5200	1881	6761	1713	8679	1437	9782	1210	10938	830	13796	376	11421
7L-2S		MI	4679	1881	6807	1619	8565	1342	9752	1114	11436	745	14598	643	9406
14-#11	2.84	MA	6427	2001	9266	1738	11853	1436	13626	1184	16178	775	20829	546	15818
3L-6S		MI	4090	2001	5940	1731	7331	1437	8184	1190	9246	767	11532	275	10126
14-#11	2.84	MA	6209	2001	8740	1754	11165	1451	12746	1204	14975	785	19342	480	15621
4L-5S		MI	4308	2001	6268	1720	7761	1426	8731	1174	10002	762	12551	360	10562
14-#11	2.84	MA	5945	2001	8273	1770	10500	1472	11961	1217	13888	802	17838	423	14841
5L-4S		MI	4466	2001	6602	1707	8234	1409	9290	1165	10776	750	13602	427	11033
14-#11	2.84	MA	5637	2001	7778	1779	9900	1486	11196	1237	12828	812	16402	338	14227
6L-3S		MI	4625	2001	6977	1695	8723	1398	9914	1150	11627	745	14657	492	11239
14-#11	2.84	MA	5365	2001	7293	1790	9279	1496	10455	1250	11798	829	14980	291	13355
7L-2S		MI	4905	2001	7510	1682	9398	1387	10730	1141	12726	733	16146	607	11293
14-#14	4.10	MA	6939	2285	10524	1938	13370	1587	15370	1295	18481	780	24246	383	21473
4L-5S		MI	4729	2285	7362	1903	9078	1564	10295	1262	12076	754	15245	197	14419
14-#14	4.10	MA	6573	2285	9855	1960	12419	1617	14247	1313	16925	804	22089	297	20456
5L-4S		MI	4948	2285	7840	1886	9753	1539	11093	1251	13179	739	16716	295	15000
14-#14	4.10	MA	6167	2285	9154	1974	11560	1637	13151	1341	15408	817	20026	175	19006
6L-3S		MI	5133	2285	8373	1868	10449	1525	11981	1229	14392	733	18195	387	15762

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

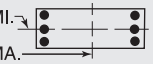


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	4.10	MA	5808	2285	8461	1988	10681	1652	12091	1359	13932	841	17985	103	17509
7L-2S		MI	5476	2285	9131	1851	11408	1510	13141	1218	15953	718	20279	552	15893
14-#18	7.29	MA	8141	3006	13729	2442	17137	1983	19879	1555	24419	804	32566	-31	32325
5L-4S		MI	6075	3006	10833	2340	13447	1870	15487	1466	19048	706	24018	-79	23733
16-#10	2.65	MA	6218	1956	8588	1730	11036	1433	12630	1192	14851	788	19169	522	14806
4L-6S		MI	4173	1956	5945	1708	7415	1421	8322	1180	9467	775	11954	365	9956
16-#10	2.65	MA	5994	1956	8204	1743	10490	1451	11984	1204	13956	803	17882	470	14308
5E		MI	4353	1956	6221	1699	7769	1411	8774	1166	10091	769	12815	436	10208
16-#10	2.65	MA	5740	1956	7790	1751	9997	1464	11355	1221	13085	812	16760	409	13877
6L-4S		MI	4491	1956	6497	1688	8161	1396	9236	1158	10731	758	13707	490	10578
16-#10	2.65	MA	5518	1956	7391	1760	9477	1471	10746	1232	12237	827	15594	373	13247
7L-3S		MI	4622	1956	6807	1677	8565	1386	9752	1144	11436	753	14598	545	10659
16-#10	2.65	MA	5312	1956	6951	1776	8935	1486	10122	1240	11392	836	14471	322	12581
8L-2S		MI	4861	1956	7251	1666	9126	1377	10431	1136	12349	742	15861	639	10698
16-#11	3.25	MA	6554	2092	9503	1811	12130	1493	13914	1231	16547	781	21519	476	17831
4L-6S		MI	4332	2092	6474	1789	8006	1479	9000	1217	10345	764	13021	267	11622
16-#11	3.25	MA	6293	2092	9036	1827	11466	1514	13129	1244	15460	798	20014	418	17036
5E		MI	4541	2092	6801	1777	8435	1469	9547	1201	11101	759	14040	352	12073
16-#11	3.25	MA	5999	2092	8541	1837	10866	1528	12363	1264	14400	809	18578	334	16424
6L-4S		MI	4711	2092	7136	1765	8909	1451	10106	1192	11874	747	15092	419	12524
16-#11	3.25	MA	5742	2092	8056	1847	10244	1538	11623	1277	13369	826	17156	286	15566
7L-3S		MI	4852	2092	7510	1752	9398	1440	10730	1176	12726	742	16146	484	12782
16-#11	3.25	MA	5502	2092	7521	1866	9586	1555	10877	1287	12342	836	15786	222	14585
8L-2S		MI	5112	2092	8043	1739	10072	1429	11546	1168	13825	730	17635	599	12845
16-#14	4.69	MA	7078	2417	10944	2043	13796	1678	15913	1352	19168	799	25195	290	23614
5E		MI	5047	2417	8120	1986	10036	1625	11454	1301	13637	749	17328	182	16536
16-#14	4.69	MA	6668	2417	10243	2057	12937	1698	14817	1380	17651	812	23132	168	22153
6L-4S		MI	5263	2417	8597	1969	10712	1600	12252	1290	14740	734	18799	280	17135
16-#14	4.69	MA	6333	2417	9550	2071	12058	1713	13757	1397	16175	836	21091	96	20647
7L-3S		MI	5431	2417	9131	1951	11408	1586	13141	1268	15953	728	20279	372	17948
18-#10	2.98	MA	6283	2031	8834	1790	11287	1486	12949	1226	15255	800	19679	466	16120
5L-6S		MI	4375	2031	6388	1754	7976	1455	9000	1202	10380	772	13218	361	11223
18-#10	2.98	MA	6039	2031	8421	1797	10794	1498	12319	1243	14383	809	18557	405	15703
6L-5S		MI	4548	2031	6665	1746	8330	1445	9452	1188	11004	766	14079	432	11466
18-#10	2.98	MA	5827	2031	8021	1806	10274	1506	11711	1254	13535	824	17392	369	15074
7L-4S		MI	4685	2031	6941	1735	8722	1430	9914	1180	11644	756	14971	486	11857
18-#10	2.98	MA	5632	2031	7581	1822	9732	1520	11086	1262	12691	833	16269	318	14404
8L-3S		MI	4809	2031	7251	1723	9126	1421	10431	1166	12349	750	15861	542	11944
18-#10	2.98	MA	5381	2031	7203	1833	9229	1530	10444	1276	11857	848	15106	264	13657
9L-2S		MI	5039	2031	7694	1712	9687	1411	11109	1158	13263	739	17125	635	11989
18-#11	3.66	MA	6633	2184	9799	1885	12431	1556	14296	1271	17032	795	22191	413	19234
5L-6S		MI	4584	2184	7007	1846	8681	1522	9816	1244	11444	760	14511	259	13122
18-#11	3.66	MA	6351	2184	9304	1894	11831	1571	13531	1291	15972	805	20755	329	18623
6L-5S		MI	4780	2184	7334	1835	9110	1511	10363	1228	12200	755	15530	343	13588
18-#11	3.66	MA	6107	2184	8819	1904	11209	1581	12790	1304	14941	822	19333	281	17778
7L-4S		MI	4936	2184	7669	1822	9584	1493	10923	1219	12973	743	16581	410	14021
18-#11	3.66	MA	5882	2184	8285	1923	10551	1597	12044	1314	13914	832	17963	217	16791
8L-3S		MI	5067	2184	8043	1809	10072	1482	11546	1203	13825	738	17635	476	14324
18-#14	5.27	MA	7190	2550	11332	2140	14314	1758	16483	1419	19894	807	26237	161	25300
6L-5S		MI	5357	2550	8877	2069	10995	1685	12614	1340	15198	744	19411	167	18660
18-#14	5.27	MA	6882	2550	10639	2154	13435	1773	15422	1436	18419	831	24196	89	23785
7L-4S		MI	5570	2550	9355	2051	11670	1661	13412	1329	16301	729	20882	264	19277
20-#10	3.31	MA	6330	2105	9051	1844	11591	1532	13284	1264	15681	807	20355	401	17531
6E		MI	4572	2105	6831	1801	8537	1489	9679	1224	11294	769	14482	358	12474
20-#10	3.31	MA	6128	2105	8652	1853	11071	1540	12675	1276	14834	821	19190	365	16902
7L-5S		MI	4740	2105	7108	1792	8891	1480	10130	1210	11918	764	15343	428	12727
20-#10	3.31	MA	5940	2105	8212	1869	10529	1554	12050	1284	13989	831	18066	315	16227
8L-4S		MI	4875	2105	7384	1781	9283	1465	10593	1202	12558	753	16235	482	13129

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

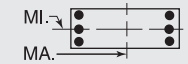
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	3.31	MA	5695	2105	7833	1880	10026	1564	11409	1298	13156	845	16904	260	15483
9L-3S		MI	4999	2105	7694	1770	9687	1455	11109	1188	13263	747	17125	538	13229
20-#11	4.06	MA	6695	2276	10067	1951	12796	1613	14698	1318	17544	802	22931	324	20825
6E		MI	4814	2276	7541	1903	9356	1564	10633	1271	12543	757	16000	251	14627
20-#11	4.06	MA	6464	2276	9582	1962	12175	1623	13958	1330	16513	819	21509	277	19989
7L-5S		MI	5001	2276	7868	1892	9785	1553	11179	1255	13299	752	17019	335	15107
20-#11	4.06	MA	6243	2276	9048	1981	11517	1640	13212	1341	15486	829	20139	212	18997
8L-4S		MI	5156	2276	8203	1879	10259	1535	11739	1246	14072	740	18071	402	15523
20-#14	5.86	MA	7379	2682	11728	2237	14813	1834	17088	1475	20662	826	27302	82	26923
7L-5S		MI	5661	2682	9635	2152	11953	1746	13773	1379	16759	739	21494	151	20790
22-#10	3.64	MA	6423	2180	9282	1900	11869	1574	13639	1298	16132	819	20988	361	18731
7L-6S		MI	4766	2180	7275	1848	9098	1524	10357	1246	12207	766	15745	354	13725
22-#10	3.64	MA	6237	2180	8842	1916	11327	1589	13015	1306	15288	828	19864	311	18050
8L-5S		MI	4939	2180	7551	1839	9452	1514	10809	1232	12831	761	16606	424	13990
22-#10	3.64	MA	6001	2180	8464	1927	10824	1598	12373	1320	14454	843	18702	256	17308
9L-4S		MI	5073	2180	7828	1828	9844	1499	11271	1224	13471	750	17498	478	14379
22-#11	4.47	MA	6812	2368	10345	2019	13140	1665	15125	1357	18085	815	23686	272	22201
7L-6S		MI	5040	2368	8074	1961	10030	1606	11449	1298	13642	753	17490	242	16135
22-#11	4.47	MA	6594	2368	9811	2038	12482	1682	14379	1368	17058	825	22316	207	21202
8L-5S		MI	5219	2368	8401	1950	10460	1595	11996	1282	14398	748	18509	327	16630
24-#10	3.97	MA	6528	2255	9472	1962	12124	1623	13979	1328	16586	825	21662	307	19873
8L-6S		MI	4970	2255	7718	1894	9659	1558	11036	1268	13120	763	17009	350	14980
24-#10	3.97	MA	6300	2255	9094	1973	11621	1633	13338	1342	15753	840	20500	252	19133
9L-5S		MI	5122	2255	7995	1886	10013	1548	11487	1254	13745	758	17870	420	15257
24-#11	4.88	MA	6938	2460	10574	2095	13447	1724	15547	1395	18630	822	24492	202	23408
8L-6S		MI	5262	2460	8608	2018	10705	1648	12265	1325	14741	750	18979	234	17647

RECTANGULAR TIED COLUMNS 24" x 34"

4-#14	1.10	MA	6097	1708	7624	1570	9801	1320	11057	1122	12445	821	15460	716	7176
2E		MI	4175	1708	5582	1517	6909	1274	7658	1082	8463	790	10219	671	4859
4-#18	1.96	MA	6851	1914	9482	1686	12061	1403	13744	1173	16018	806	20375	698	12330
2E		MI	4611	1914	6783	1627	8345	1353	9352	1130	10704	771	12955	612	8173
6-#11	1.15	MA	6165	1718	7681	1583	9920	1330	11225	1130	12693	825	15821	718	7494
2L-3S		MI	3884	1718	5079	1545	6315	1297	6962	1101	7546	807	9056	567	5077
6-#11	1.15	MA	5631	1718	6861	1599	8882	1345	9970	1144	11003	843	13480	613	7468
3L-2S		MI	4223	1718	5612	1532	6990	1287	7779	1092	8645	795	10546	681	5072
6-#14	1.65	MA	6636	1840	8795	1653	11283	1380	12850	1161	14858	816	18802	709	10608
2L-3S		MI	4045	1840	5582	1617	6909	1349	7658	1133	8463	800	10219	490	7060
6-#14	1.65	MA	5916	1840	7624	1676	9801	1401	11057	1180	12445	841	15460	555	10508
3L-2S		MI	4501	1840	6339	1599	7867	1335	8817	1121	10024	785	12302	655	7094
6-#18	2.94	MA	7707	2149	11524	1833	14643	1512	16867	1242	20223	797	26198	686	18282
2L-3S		MI	4437	2149	6783	1802	8345	1483	9352	1214	10704	784	12955	278	11725
6-#18	2.94	MA	6596	2149	9482	1872	12061	1546	13744	1273	16018	838	20375	405	17823
3L-2S		MI	5119	2149	8088	1775	9996	1461	11349	1199	13394	762	16430	571	11981
8-#10	1.25	MA	6300	1742	7843	1607	10189	1348	11584	1144	13208	829	16557	722	8179
2L-4S		MI	3870	1742	4955	1582	6207	1327	6835	1130	7392	817	9012	548	5499
8-#10	1.25	MA	5865	1742	7166	1620	9332	1361	10548	1155	11813	844	14625	638	8155
3E		MI	4038	1742	5265	1571	6611	1318	7351	1117	8097	812	9902	603	5531
8-#10	1.25	MA	5612	1742	6702	1634	8725	1374	9772	1173	10751	854	13327	586	8059
4L-2S		MI	4316	1742	5708	1559	7172	1308	8030	1108	9011	801	11166	697	5533
8-#11	1.53	MA	6547	1810	8502	1640	10957	1372	12480	1157	14383	821	18161	713	9896
2L-4S		MI	3937	1810	5238	1615	6502	1350	7155	1144	7793	808	9492	493	6562
8-#11	1.53	MA	6039	1810	7681	1657	9920	1387	11225	1171	12693	839	15821	609	9851
3E		MI	4132	1810	5612	1602	6990	1340	7779	1128	8645	803	10546	559	6632
8-#11	1.53	MA	5742	1810	7117	1673	9182	1402	10281	1191	11402	850	14234	544	9680
4L-2S		MI	4456	1810	6146	1590	7665	1329	8595	1119	9744	791	12035	673	6644

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

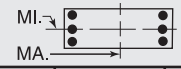
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.21	MA	7150	1972	9967	1736	12765	1441	14643	1200	17272	811	22144	702	14029
2L-4S		MI	4126	1972	5806	1717	7172	1425	7929	1193	8811	801	10823	383	8782
8-#14	2.21	MA	6476	1972	8795	1759	11283	1462	12850	1219	14858	836	18802	548	13899
3E		MI	4385	1972	6339	1700	7867	1410	8817	1172	10024	795	12302	475	9247
8-#14	2.21	MA	6085	1972	7987	1781	10227	1483	11500	1248	13012	851	16522	454	13198
4L-2S		MI	4816	1972	7097	1682	8826	1396	9977	1160	11584	780	14385	640	9311
8-#18	3.92	MA	8514	2385	13565	1980	17225	1620	19990	1312	24428	788	32021	674	24226
2L-4S		MI	4607	2385	7162	1977	8789	1613	9809	1317	11293	779	13944	82	13541
8-#18	3.92	MA	7514	2385	11524	2019	14643	1654	16867	1342	20223	829	26198	393	23732
3E		MI	4988	2385	8088	1949	9996	1591	11349	1284	13394	775	16430	237	15461
8-#18	3.92	MA	6931	2385	10109	2057	12795	1689	14504	1390	16995	851	22173	223	20766
4L-2S		MI	5606	2385	9394	1922	11648	1570	13347	1268	16083	754	19906	531	15773
10-#10	1.56	MA	6616	1816	8520	1653	11045	1383	12620	1165	14602	826	18488	718	10160
2L-5S		MI	3942	1816	5123	1639	6377	1377	7051	1161	7666	825	9384	490	6536
10-#10	1.56	MA	6199	1816	7843	1667	10189	1395	11584	1177	13208	842	16557	634	10125
3L-4S		MI	4086	1816	5399	1628	6768	1362	7513	1152	8306	815	10275	544	6777
10-#10	1.56	MA	5962	1816	7379	1681	9582	1408	10807	1195	12145	851	15259	582	10017
4L-3S		MI	4244	1816	5708	1617	7172	1352	8030	1139	9011	809	11166	599	6823
10-#10	1.56	MA	5705	1816	6967	1695	8996	1427	10116	1206	11187	867	13882	532	9602
5L-2S		MI	4512	1816	6152	1606	7733	1342	8708	1130	9924	798	12430	693	6835
10-#11	1.91	MA	6915	1902	9322	1698	11995	1414	13736	1184	16073	818	20501	709	12294
2L-5S		MI	4025	1902	5437	1685	6703	1410	7412	1180	8118	816	9930	418	7643
10-#11	1.91	MA	6431	1902	8502	1714	10957	1429	12480	1198	14383	836	18161	604	12233
3L-4S		MI	4190	1902	5771	1673	7177	1393	7971	1171	8892	805	10981	485	8093
10-#11	1.91	MA	6156	1902	7937	1730	10220	1444	11537	1218	13093	847	16574	539	12050
4L-3S		MI	4372	1902	6146	1660	7665	1382	8595	1155	9744	800	12035	550	8181
10-#11	1.91	MA	5855	1902	7437	1747	9508	1466	10695	1232	11927	865	14897	475	11308
5L-2S		MI	4683	1902	6679	1647	8340	1371	9411	1146	10843	788	13525	665	8207
10-#14	2.76	MA	7646	2105	11139	1818	14247	1502	16435	1239	19685	806	25486	695	17445
2L-5S		MI	4250	2105	6086	1817	7454	1510	8290	1244	9269	811	11435	270	10227
10-#14	2.76	MA	7012	2105	9967	1841	12765	1523	14643	1258	17272	831	22144	541	17293
3L-4S		MI	4474	2105	6563	1800	8130	1485	9088	1232	10372	796	12906	367	10876
10-#14	2.76	MA	6658	2105	9159	1864	11709	1544	13292	1287	15426	846	19863	448	16540
4L-3S		MI	4724	2105	7097	1782	8826	1471	9977	1211	11584	790	14385	459	11432
10-#14	2.76	MA	6240	2105	8442	1887	10690	1575	12087	1305	13757	871	17458	351	15304
5L-2S		MI	5118	2105	7855	1765	9784	1457	11136	1199	13145	775	16468	624	11519
10-#18	4.90	MA	8415	2620	13565	2166	17225	1762	19990	1411	24428	820	32021	380	29654
3L-4S		MI	5186	2620	8468	2124	10441	1721	11807	1386	13982	771	17420	42	17203
10-#18	4.90	MA	7937	2620	12150	2204	15378	1797	17628	1459	21200	842	27995	211	26671
4L-3S		MI	5515	2620	9394	2096	11648	1699	13347	1353	16083	766	19906	197	19152
10-#18	4.90	MA	7190	2620	10892	2243	13591	1849	15517	1490	18277	883	23939	55	23715
5L-2S		MI	6080	2620	10700	2069	13299	1678	15344	1337	18773	745	23381	491	19558
12-#10	1.87	MA	6923	1891	9197	1700	11901	1417	13656	1187	15997	823	20419	714	12138
2L-6S		MI	3958	1891	5289	1695	6583	1421	7278	1196	7955	828	9786	415	7505
12-#10	1.87	MA	6522	1891	8520	1714	11045	1430	12620	1199	14602	839	18488	630	12093
3L-5S		MI	4154	1891	5566	1686	6937	1411	7729	1183	8579	823	10647	486	7777
12-#10	1.87	MA	6300	1891	8056	1728	10438	1443	11843	1217	13540	849	17190	578	11977
4E		MI	4295	1891	5842	1675	7329	1396	8192	1174	9219	812	11539	540	8056
12-#10	1.87	MA	6047	1891	7644	1741	9853	1461	11152	1228	12581	864	15813	528	11540
5L-3S		MI	4444	1891	6152	1664	7733	1386	8708	1161	9924	806	12430	595	8113
12-#10	1.87	MA	5747	1891	7197	1748	9324	1473	10494	1240	11648	874	14615	469	11028
6L-2S		MI	4703	1891	6595	1653	8294	1377	9387	1152	10838	795	13693	689	8133
12-#11	2.29	MA	7273	1994	10142	1755	13033	1457	14991	1211	17763	814	22841	704	14688
2L-6S		MI	4044	1994	5643	1754	6948	1463	7681	1222	8462	818	10400	325	8771

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#11	2.29	MA	6810	1994	9322	1772	11995	1472	13736	1225	16073	832	20501	599	14615
3L-5S		MI	4273	1994	5970	1743	7378	1452	8228	1207	9217	813	11419	410	9140
12-#11	2.29	MA	6555	1994	8758	1788	11258	1486	12792	1245	14783	843	18914	535	14423
4E		MI	4434	1994	6305	1730	7852	1435	8787	1198	9991	801	12470	477	9625
12-#11	2.29	MA	6260	1994	8257	1804	10546	1508	11951	1259	13617	861	17237	470	13663
5L-3S		MI	4606	1994	6679	1717	8340	1424	9411	1182	10843	796	13525	542	9727
12-#11	2.29	MA	5908	1994	7720	1813	9903	1523	11130	1279	12481	872	15774	395	13063
6L-2S		MI	4904	1994	7213	1704	9015	1413	10227	1173	11942	784	15014	657	9765
12-#14	3.31	MA	7529	2237	11139	1924	14247	1584	16435	1297	19685	826	25486	534	20691
3L-5S		MI	4591	2237	6843	1900	8413	1571	9450	1282	10830	806	13518	254	12370
12-#14	3.31	MA	7207	2237	10331	1947	13191	1605	15085	1326	17839	841	23205	441	19891
4E		MI	4828	2237	7321	1883	9089	1546	10248	1271	11933	791	14989	352	12986
12-#14	3.31	MA	6798	2237	9614	1970	12172	1636	13880	1344	16170	866	20800	345	18699
5L-3S		MI	5039	2237	7855	1865	9784	1532	11136	1250	13145	785	16468	444	13617
12-#14	3.31	MA	6328	2237	8852	1983	11251	1657	12705	1373	14544	881	18696	236	17228
6L-2S		MI	5409	2237	8613	1848	10743	1517	12295	1238	14706	770	18552	609	13723
12-#18	5.88	MA	8847	2855	14192	2352	17960	1905	20751	1529	25405	834	33818	198	32585
4E		MI	5740	2855	9773	2271	12092	1829	13804	1455	16672	762	20896	2	20885
12-#18	5.88	MA	8156	2855	12934	2390	16173	1957	18640	1559	22482	874	29762	42	29588
5L-3S		MI	6026	2855	10700	2243	13299	1808	15344	1422	18773	758	23381	157	22738
14-#10	2.18	MA	6837	1966	9197	1761	11901	1464	13656	1221	15997	836	20419	626	14062
3L-6S		MI	4170	1966	5733	1742	7144	1455	7956	1218	8868	825	11050	411	8764
14-#10	2.18	MA	6628	1966	8733	1774	11295	1477	12879	1239	14935	846	19121	574	13940
4L-5S		MI	4359	1966	6009	1733	7498	1446	8408	1205	9493	820	11911	482	9025
14-#10	2.18	MA	6379	1966	8321	1788	10709	1495	12188	1250	13976	861	17745	524	13483
5L-4S		MI	4499	1966	6286	1722	7890	1430	8870	1196	10132	809	12803	536	9334
14-#10	2.18	MA	6091	1966	7874	1795	10180	1508	11530	1262	13042	871	16546	465	12987
6L-3S		MI	4640	1966	6595	1711	8294	1421	9387	1183	10838	804	13693	591	9400
14-#10	2.18	MA	5838	1966	7446	1804	9618	1515	10862	1280	12135	886	15304	429	12358
7L-2S		MI	4890	1966	7039	1700	8855	1411	10065	1174	11751	793	14957	685	9428
14-#11	2.68	MA	7179	2085	10142	1829	13033	1514	14991	1252	17763	829	22841	594	16997
3L-6S		MI	4293	2085	6176	1811	7623	1505	8498	1249	9561	815	11889	317	10257
14-#11	2.68	MA	6941	2085	9578	1845	12295	1529	14047	1272	16473	840	21254	530	16800
4L-5S		MI	4513	2085	6504	1800	8053	1495	9044	1234	10316	810	12908	401	10643
14-#11	2.68	MA	6650	2085	9078	1862	11583	1551	13206	1286	15307	858	19577	465	16022
5L-4S		MI	4672	2085	6838	1787	8526	1477	9604	1225	11090	798	13960	468	11125
14-#11	2.68	MA	6315	2085	8540	1871	10941	1566	12386	1306	14171	869	18114	391	15436
6L-3S		MI	4834	2085	7213	1775	9015	1466	10227	1209	11942	793	15014	534	11271
14-#11	2.68	MA	6019	2085	8020	1882	10266	1575	11593	1320	13067	887	16595	345	14449
7L-2S		MI	5120	2085	7746	1762	9690	1455	11044	1200	13041	781	16504	649	11320
14-#14	3.86	MA	7738	2370	11502	2030	14673	1666	16877	1364	20253	836	26547	434	23250
4L-5S		MI	4935	2370	7601	1983	9371	1632	10609	1321	12390	801	15601	239	14522
14-#14	3.86	MA	7334	2370	10785	2053	13654	1696	15672	1383	18584	861	24142	338	22098
5L-4S		MI	5154	2370	8079	1965	10047	1607	11407	1310	13493	786	17072	336	15107
14-#14	3.86	MA	6892	2370	10024	2066	12733	1717	14498	1412	16957	876	22038	230	20615
6L-3S		MI	5345	2370	8613	1948	10743	1593	12295	1288	14706	780	18552	428	15803
14-#14	3.86	MA	6501	2370	9280	2081	11777	1732	13362	1431	15376	901	19856	161	19049
7L-2S		MI	5695	2370	9370	1930	11701	1578	13455	1277	16267	765	20635	594	15924
14-#18	6.86	MA	9043	3091	14975	2537	18756	2065	21764	1628	26688	865	35584	30	35461
5L-4S		MI	6276	3091	11079	2418	13744	1937	15802	1525	19361	753	24371	-38	24236
16-#10	2.49	MA	6947	2041	9410	1821	12151	1511	13915	1261	16329	843	21052	571	15903
4L-6S		MI	4378	2041	6176	1788	7705	1490	8635	1240	9782	822	12314	407	10026
16-#10	2.49	MA	6701	2041	8998	1835	11566	1530	13223	1272	15371	858	19676	520	15429
5E		MI	4560	2041	6453	1780	8059	1480	9086	1226	10406	817	13175	478	10277

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 34"

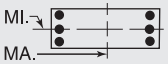
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#10	2.49	MA	6425	2041	8551	1842	11037	1542	12566	1284	14437	868	18477	461	14949
6L-4S		MI	4698	2041	6729	1769	8451	1465	9549	1218	11046	806	14067	532	10613
16-#10	2.49	MA	6183	2041	8123	1851	10474	1550	11898	1301	13529	884	17235	425	14323
7L-3S		MI	4832	2041	7039	1757	8855	1455	10065	1204	11751	801	14957	587	10686
16-#10	2.49	MA	5960	2041	7651	1867	9893	1564	11220	1309	12625	893	16035	376	13647
8L-2S		MI	5074	2041	7482	1746	9416	1445	10743	1196	12664	790	16221	681	10721
16-#11	3.06	MA	7317	2177	10398	1903	13333	1571	15302	1299	18163	836	23594	525	19179
4L-6S		MI	4536	2177	6710	1869	8298	1548	9314	1276	10660	811	13379	309	11749
16-#11	3.06	MA	7029	2177	9898	1919	12621	1593	14461	1313	16997	854	21917	460	18385
5E		MI	4747	2177	7037	1857	8728	1537	9860	1261	11415	806	14398	393	12152
16-#11	3.06	MA	6709	2177	9361	1928	11979	1608	13641	1333	15861	865	20454	386	17805
6L-4S		MI	4905	2177	7372	1845	9201	1519	10420	1252	12189	794	15449	460	12613
16-#11	3.06	MA	6429	2177	8841	1939	11303	1617	12848	1347	14757	883	18935	341	16827
7L-3S		MI	5064	2177	7746	1832	9690	1508	11044	1236	13041	789	16504	526	12814
16-#11	3.06	MA	6169	2177	8268	1958	10598	1635	12037	1357	13657	894	17470	278	15825
8L-2S		MI	5329	2177	8279	1819	10364	1498	11860	1227	14140	777	17993	640	12872
16-#14	4.41	MA	7855	2502	11957	2135	15136	1757	17465	1422	20997	856	27484	331	25501
5E		MI	5254	2502	8359	2065	10330	1692	11768	1360	13951	796	17684	223	16680
16-#14	4.41	MA	7437	2502	11196	2149	14215	1778	16290	1451	19371	871	25379	223	24002
6L-4S		MI	5470	2502	8837	2048	11006	1668	12566	1349	15054	781	19155	321	17237
16-#14	4.41	MA	7072	2502	10451	2164	13259	1793	15154	1470	17789	896	23198	155	22425
7L-3S		MI	5644	2502	9370	2031	11701	1654	13455	1327	16267	775	20635	413	17989
18-#10	2.80	MA	7015	2116	9675	1881	12422	1564	14259	1294	16765	856	21607	516	17378
5L-6S		MI	4580	2116	6619	1835	8266	1524	9313	1262	10695	820	13577	403	11291
18-#10	2.80	MA	6750	2116	9228	1889	11893	1577	13602	1306	15832	865	20408	457	16912
6L-5S		MI	4756	2116	6896	1826	8620	1514	9765	1248	11320	814	14438	474	11533
18-#10	2.80	MA	6519	2116	8800	1898	11331	1584	12934	1323	14924	881	19167	421	16287
7L-4S		MI	4893	2116	7172	1815	9012	1499	10227	1240	11959	803	15330	528	11892
18-#10	2.80	MA	6308	2116	8328	1914	10750	1599	12256	1331	14020	891	17966	373	15605
8L-3S		MI	5020	2116	7482	1804	9416	1489	10743	1226	12664	798	16221	583	11972
18-#10	2.80	MA	6032	2116	7923	1925	10211	1609	11569	1346	13128	906	16728	319	14782
9L-2S		MI	5255	2116	7925	1793	9977	1480	11422	1218	13578	787	17485	677	12012
18-#11	3.44	MA	7399	2269	10718	1976	13659	1635	15716	1340	18687	851	24257	456	20752
5L-6S		MI	4773	2269	7243	1926	8973	1590	10130	1303	11759	808	14868	300	13245
18-#11	3.44	MA	7092	2269	10181	1985	13017	1650	14896	1360	17551	862	22794	381	20177
6L-5S		MI	4988	2269	7570	1915	9402	1579	10677	1288	12514	803	15887	385	13665
18-#11	3.44	MA	6827	2269	9661	1996	12341	1660	14103	1374	16447	880	21275	336	19205
7L-4S		MI	5145	2269	7905	1902	9876	1561	11236	1279	13288	791	16939	452	14108
18-#11	3.44	MA	6579	2269	9088	2016	11636	1677	13292	1384	15347	891	19811	273	18197
8L-3S		MI	5280	2269	8279	1889	10364	1551	11860	1263	14140	786	17993	517	14358
18-#14	4.96	MA	7966	2635	12367	2232	15697	1839	18083	1490	21785	866	28721	216	27361
6L-5S		MI	5565	2635	9117	2148	11288	1753	12928	1399	15512	791	19767	208	18823
18-#14	4.96	MA	7624	2635	11623	2247	14741	1853	16947	1509	20203	891	26540	148	25802
7L-4S		MI	5779	2635	9594	2131	11964	1729	13726	1388	16615	776	21238	305	19376
20-#10	3.11	MA	7067	2190	9905	1935	12750	1611	14637	1328	17226	863	22339	453	18877
6E		MI	4778	2190	7063	1882	8827	1558	9992	1284	11609	817	14841	399	12559
20-#10	3.11	MA	6847	2190	9477	1945	12187	1618	13970	1345	16319	878	21098	417	18251
7L-5S		MI	4949	2190	7340	1873	9181	1549	10443	1270	12233	811	15702	470	12793
20-#10	3.11	MA	6639	2190	9005	1961	11606	1633	13292	1353	15415	888	19898	369	17563
8L-4S		MI	5084	2190	7616	1862	9573	1533	10905	1262	12873	800	16594	524	13172
20-#10	3.11	MA	6373	2190	8600	1972	11067	1643	12605	1368	14523	903	18660	315	16742
9L-3S		MI	5212	2190	7925	1851	9977	1524	11422	1248	13578	795	17485	579	13257
20-#10	3.11	MA	6124	2190	8174	1980	10539	1654	11942	1377	13625	913	17456	272	15908
10L-2S		MI	5430	2190	8369	1840	10538	1514	12100	1240	14491	784	18748	673	13303
20-#11	3.82	MA	7466	2361	11002	2043	14055	1692	16152	1387	19242	859	25134	376	22550
6E		MI	5021	2361	7777	1983	9648	1632	10946	1330	12858	804	16358	292	14747
20-#11	3.82	MA	7214	2361	10482	2054	13379	1702	15359	1401	18137	876	23615	331	21583
7L-5S		MI	5211	2361	8104	1972	10077	1621	11493	1315	13613	799	17377	377	15182

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

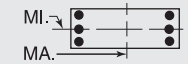
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.82	MA	6971	2361	9909	2073	12673	1719	14548	1411	17037	888	22151	269	20569
8L-4S		MI	5366	2361	8439	1959	10551	1603	12052	1306	14387	787	18428	444	15608
20-#14	5.51	MA	8210	2767	12795	2330	16223	1914	18739	1548	22617	886	29882	141	29179
7L-5S		MI	5870	2767	9874	2231	12247	1814	14087	1438	17073	787	21850	192	20948
22-#10	3.42	MA	7167	2265	10154	1991	13043	1653	15006	1367	17714	875	23029	413	20215
7L-6S		MI	4973	2265	7506	1928	9388	1593	10670	1306	12522	814	16105	395	13829
22-#10	3.42	MA	6962	2265	9682	2008	12463	1667	14328	1375	16809	885	21829	365	19522
8L-5S		MI	5138	2265	7783	1920	9742	1583	11121	1292	13146	809	16966	466	14055
22-#10	3.42	MA	6705	2265	9277	2019	11924	1678	13640	1390	15917	900	20591	311	18703
9L-4S		MI	5285	2265	8059	1909	10134	1568	11584	1284	13786	798	17858	520	14452
22-#10	3.42	MA	6467	2265	8851	2027	11395	1688	12978	1399	15020	910	19387	268	17865
10L-3S		MI	5392	2265	8369	1898	10538	1558	12100	1270	14491	792	18748	575	14542
22-#11	4.21	MA	7593	2453	11302	2111	14417	1744	16614	1428	19828	873	25955	326	23961
7L-6S		MI	5247	2453	8310	2041	10323	1674	11762	1357	13957	801	17847	284	16252
22-#11	4.21	MA	7352	2453	10729	2130	13711	1761	15803	1438	18727	884	24491	264	22941
8L-5S		MI	5430	2453	8637	2030	10752	1663	12309	1342	14712	796	18866	368	16703
24-#10	3.74	MA	7278	2340	10359	2054	13319	1702	15364	1397	18204	882	23760	361	21480
8L-6S		MI	5179	2340	7950	1975	9948	1627	11348	1328	13436	811	17369	391	15084
24-#10	3.74	MA	7030	2340	9954	2066	12780	1712	14676	1412	17312	898	22522	307	20664
9L-5S		MI	5334	2340	8226	1967	10303	1617	11800	1314	14060	806	18230	462	15320
24-#10	3.74	MA	6801	2340	9528	2074	12252	1722	14014	1421	16414	907	21318	264	19822
10L-4S		MI	5468	2340	8503	1955	10694	1602	12262	1306	14700	795	19121	516	15707
24-#11	4.59	MA	7726	2545	11550	2188	14749	1803	17058	1465	20417	881	26831	259	25312
8L-6S		MI	5470	2545	8844	2098	10997	1716	12579	1384	15056	797	19337	276	17760

RECTANGULAR TIED COLUMNS 24" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.04	MA	6794	1792	8353	1660	10800	1397	12199	1189	13714	875	17025	762	7662
2E		MI	4381	1792	5821	1596	7203	1342	7972	1142	8777	837	10575	712	4880
4-#18	1.85	MA	7618	1998	10349	1776	13227	1480	15085	1240	17553	859	22304	745	13194
2E		MI	4819	1998	7028	1706	8641	1420	9667	1188	11018	818	13308	652	8204
6-#11	1.08	MA	6867	1803	8412	1673	10924	1407	12376	1197	13976	878	17405	765	7999
2L-3S		MI	4088	1803	5315	1625	6608	1366	7276	1161	7860	854	9414	608	5101
6-#11	1.08	MA	6288	1803	7534	1690	9814	1422	11033	1211	12168	897	14901	662	7973
3L-2S		MI	4430	1803	5848	1612	7282	1355	8092	1152	8959	842	10903	723	5092
6-#14	1.56	MA	7380	1925	9607	1743	12387	1457	14119	1228	16298	870	20603	755	11337
2L-3S		MI	4249	1925	5821	1696	7203	1417	7972	1192	8777	847	10575	531	7093
6-#14	1.56	MA	6599	1925	8353	1767	10800	1479	12199	1248	13714	896	17025	605	11237
3L-2S		MI	4709	1925	6579	1679	8161	1403	9132	1180	10338	832	12658	696	7119
6-#18	2.78	MA	8550	2234	12537	1923	15996	1589	18433	1309	22061	851	28547	733	19578
2L-3S		MI	4640	2234	7028	1880	8641	1550	9667	1273	11018	831	13308	318	11787
6-#18	2.78	MA	7342	2234	10349	1963	13227	1625	15085	1342	17553	893	22304	457	19119
3L-2S		MI	5333	2234	8334	1853	10293	1528	11664	1257	13707	809	16783	612	12016
8-#10	1.18	MA	7011	1827	8582	1697	11209	1425	12756	1211	14521	882	18185	768	8728
2L-4S		MI	4074	1827	5187	1662	6497	1396	7148	1190	7707	865	9371	590	5527
8-#10	1.18	MA	6540	1827	7859	1711	10293	1438	11648	1223	13030	898	16120	686	8704
3E		MI	4242	1827	5496	1651	6901	1387	7664	1177	8412	860	10262	645	5552
8-#10	1.18	MA	6266	1827	7363	1725	9646	1452	10820	1241	11897	909	14741	635	8608
4L-2S		MI	4524	1827	5940	1640	7462	1377	8342	1168	9326	849	11525	739	5550
8-#11	1.44	MA	7281	1895	9290	1731	12035	1449	13719	1224	15784	875	19909	760	10570
2L-4S		MI	4140	1895	5474	1695	6794	1419	7469	1203	8108	855	9849	535	6601
8-#11	1.44	MA	6731	1895	8412	1747	10924	1465	12376	1238	13976	893	17405	657	10525
3E		MI	4337	1895	5848	1682	7282	1408	8092	1188	8959	850	10903	600	6659
8-#11	1.44	MA	6410	1895	7810	1764	10137	1480	11368	1260	12598	905	15719	593	10354
4L-2S		MI	4664	1895	6382	1670	7957	1397	8908	1179	10058	839	12393	715	6666
8-#14	2.08	MA	7939	2057	10861	1826	13973	1518	16038	1267	18883	865	24181	749	15001
2L-4S		MI	4328	2057	6045	1796	7465	1492	8243	1252	9125	848	11179	424	8900

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

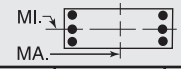
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.08	MA	7207	2057	9607	1849	12387	1540	14119	1287	16298	891	20603	598	14871
3E		MI	4591	2057	6579	1779	8161	1478	9132	1231	10338	842	12658	516	9284
8-#14	2.08	MA	6784	2057	8744	1873	11259	1562	12676	1317	14326	907	18178	505	14256
4L-2S		MI	5026	2057	7336	1762	9120	1464	10291	1219	11899	827	14741	681	9338
8-#18	3.70	MA	9434	2469	14726	2071	18764	1697	21782	1379	26569	842	34789	721	25954
2L-4S		MI	4806	2469	7407	2055	9086	1680	10124	1375	11606	826	14297	123	13691
8-#18	3.70	MA	8337	2469	12537	2110	15996	1733	18433	1411	22061	884	28547	444	25460
3E		MI	5194	2469	8334	2028	10293	1658	11664	1342	13707	822	16783	278	15523
8-#18	3.70	MA	7704	2469	11025	2150	14020	1769	15907	1461	18608	909	24266	277	22423
4L-2S		MI	5823	2469	9639	2000	11944	1637	13662	1326	16397	800	20259	572	15809
10-#10	1.47	MA	7353	1901	9306	1743	12124	1460	13863	1233	16012	880	20249	765	10846
2L-5S		MI	4146	1901	5354	1720	6666	1446	7364	1221	7981	873	9743	532	6609
10-#10	1.47	MA	6902	1901	8582	1758	11209	1473	12756	1245	14521	896	18185	682	10810
3L-4S		MI	4290	1901	5630	1709	7058	1431	7826	1212	8621	862	10635	586	6808
10-#10	1.47	MA	6645	1901	8087	1772	10561	1486	11927	1263	13388	906	16806	631	10703
4L-3S		MI	4450	1901	5940	1698	7462	1421	8342	1199	9326	857	11525	641	6846
10-#10	1.47	MA	6365	1901	7645	1785	9937	1505	11190	1275	12365	922	15340	582	10319
5L-2S		MI	4721	1901	6383	1687	8023	1411	9021	1190	10239	846	12789	735	6855
10-#11	1.81	MA	7681	1987	10168	1788	13145	1491	15062	1251	17593	871	22413	756	13136
2L-5S		MI	4229	1987	5673	1765	6995	1479	7725	1239	8433	864	10287	459	7727
10-#11	1.81	MA	7156	1987	9290	1805	12035	1507	13719	1265	15784	890	19909	652	13075
3L-4S		MI	4393	1987	6007	1753	7469	1461	8285	1230	9207	852	11339	527	8134
10-#11	1.81	MA	6859	1987	8687	1822	11247	1522	12711	1287	14406	902	18223	588	12892
4L-3S		MI	4579	1987	6382	1740	7957	1450	8908	1215	10058	847	12393	592	8209
10-#11	1.81	MA	6529	1987	8154	1838	10488	1545	11814	1301	13162	920	16436	526	12160
5L-2S		MI	4892	1987	6915	1727	8632	1439	9725	1206	11157	835	13882	707	8231
10-#14	2.60	MA	8478	2190	12116	1909	15560	1579	17957	1306	21467	860	27759	742	18660
2L-5S		MI	4453	2190	6325	1897	7748	1578	8605	1303	9583	858	11791	311	10331
10-#14	2.60	MA	7788	2190	10861	1932	13973	1601	16038	1326	18883	886	24181	591	18508
3L-4S		MI	4678	2190	6803	1879	8424	1553	9402	1291	10686	843	13262	408	10989
10-#14	2.60	MA	7404	2190	9999	1956	12846	1622	14595	1356	16910	902	21756	498	17844
4L-3S		MI	4920	2190	7336	1862	9120	1539	10291	1270	11899	837	14741	500	11470
10-#14	2.60	MA	6947	2190	9234	1979	11758	1654	13309	1375	15128	928	19193	405	16465
5L-2S		MI	5332	2190	8094	1844	10078	1524	11450	1258	13460	822	16825	666	11548
10-#18	4.63	MA	9318	2705	14726	2258	18764	1841	21782	1480	26569	876	34789	432	31814
3L-4S		MI	5386	2705	8713	2202	10737	1788	12122	1445	14295	817	17773	83	17344
10-#18	4.63	MA	8737	2705	13214	2297	16789	1877	19255	1530	23116	901	30508	264	28750
4L-3S		MI	5722	2705	9639	2175	11944	1766	13662	1411	16397	813	20259	238	19268
10-#18	4.63	MA	7975	2705	11871	2337	14880	1931	17000	1563	19993	943	26183	114	25676
5L-2S		MI	6300	2705	10945	2147	13596	1745	15659	1395	19086	791	23735	532	19596
12-#10	1.76	MA	7686	1976	10030	1790	13040	1494	14971	1254	17503	877	22313	761	12961
2L-6S		MI	4161	1976	5521	1776	6873	1490	7591	1256	8270	876	10146	457	7576
12-#10	1.76	MA	7252	1976	9306	1804	12124	1507	13863	1267	16012	893	20249	678	12916
3L-5S		MI	4358	1976	5797	1767	7227	1480	8042	1243	8894	870	11007	528	7849
12-#10	1.76	MA	7011	1976	8811	1818	11477	1520	13034	1285	14879	903	18870	627	12800
4E		MI	4500	1976	6074	1756	7619	1465	8504	1234	9534	859	11899	582	8088
12-#10	1.76	MA	6735	1976	8368	1832	10853	1539	12297	1297	13856	919	17405	578	12395
5L-3S		MI	4651	1976	6383	1745	8023	1455	9021	1221	10239	854	12789	637	8137
12-#10	1.76	MA	6412	1976	7891	1839	10283	1551	11596	1309	12861	930	16129	520	11830
6L-2S		MI	4913	1976	6827	1734	8584	1446	9699	1212	11153	843	14053	731	8154
12-#11	2.17	MA	8069	2079	11045	1845	14256	1533	16405	1278	19401	868	24917	751	15699
2L-6S		MI	4246	2079	5879	1834	7241	1531	7995	1282	8777	865	10758	367	8902
12-#11	2.17	MA	7567	2079	10168	1862	13145	1549	15062	1292	17593	886	22413	648	15626
3L-5S		MI	4477	2079	6206	1823	7670	1521	8542	1266	9532	860	11776	451	9222

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#11	2.17	MA	7291	2079	9565	1879	12358	1564	14054	1313	16215	898	20726	584	15434
4E		MI	4639	2079	6541	1810	8144	1503	9101	1257	10306	849	12828	518	9667
12-#11	2.17	MA	6967	2079	9032	1896	11598	1587	13157	1328	14971	917	18940	521	14683
5L-3S		MI	4813	2079	6915	1797	8632	1492	9725	1242	11157	844	13882	584	9757
12-#11	2.17	MA	6587	2079	8453	1904	10913	1602	12282	1349	13759	929	17384	448	14026
6L-2S		MI	5115	2079	7449	1784	9307	1481	10541	1233	12256	832	15372	698	9790
12-#14	3.13	MA	8349	2322	12116	2015	15560	1662	17957	1365	21467	881	27759	584	22149
3L-5S		MI	4795	2322	7083	1979	8706	1638	9764	1342	11144	853	13874	295	12470
12-#14	3.13	MA	7999	2322	11253	2039	14433	1683	16514	1394	19494	897	25334	491	21440
4E		MI	5033	2322	7560	1962	9382	1614	10562	1330	12247	838	15345	393	13094
12-#14	3.13	MA	7550	2322	10488	2062	13344	1715	15228	1414	17712	923	22771	398	20106
5L-3S		MI	5248	2322	8094	1945	10078	1600	11450	1309	13460	832	16825	485	13656
12-#14	3.13	MA	7042	2322	9666	2075	12363	1737	13975	1444	15976	939	20536	291	18590
6L-2S		MI	5625	2322	8852	1927	11037	1585	12610	1297	15020	817	18908	650	13753
12-#18	5.56	MA	9781	2940	15402	2445	19557	1985	22604	1599	27625	892	36750	252	35076
4E		MI	5941	2940	10019	2349	12389	1896	14119	1514	16985	808	21249	43	21019
12-#18	5.56	MA	9023	2940	14059	2484	17649	2039	20349	1632	24501	934	32425	102	31973
5L-3S		MI	6235	2940	10945	2322	13596	1874	15659	1480	19086	804	23735	198	22918
12-#18	5.56	MA	8193	2940	12646	2509	15925	2075	18149	1682	21457	959	28291	-115	27810
6L-2S		MI	6768	2940	12250	2294	15247	1853	17657	1465	21776	782	27210	491	23379
14-#10	2.06	MA	7593	2051	10030	1851	13040	1541	14971	1289	17503	890	22313	674	15022
3L-6S		MI	4374	2051	5964	1822	7434	1524	8269	1278	9183	873	11409	453	8833
14-#10	2.06	MA	7366	2051	9535	1865	12392	1555	14142	1307	16369	900	20935	623	14900
4L-5S		MI	4565	2051	6241	1814	7788	1515	8720	1265	9808	868	12270	524	9095
14-#10	2.06	MA	7094	2051	9092	1879	11768	1573	13404	1319	15347	916	19469	574	14475
5L-4S		MI	4704	2051	6517	1803	8180	1499	9183	1256	10448	857	13162	578	9367
14-#10	2.06	MA	6784	2051	8615	1886	11199	1586	12703	1331	14352	927	18194	516	13927
6L-3S		MI	4848	2051	6827	1791	8584	1490	9699	1243	11153	851	14053	633	9425
14-#10	2.06	MA	6510	2051	8158	1896	10598	1594	11989	1349	13384	943	16876	481	13299
7L-2S		MI	5101	2051	7270	1780	9145	1480	10378	1234	12066	840	15317	727	9450
14-#11	2.53	MA	7967	2170	11045	1920	14256	1591	16405	1319	19401	883	24917	643	18177
3L-6S		MI	4496	2170	6412	1891	7915	1574	8811	1309	9876	862	12247	358	10385
14-#11	2.53	MA	7709	2170	10443	1936	13468	1607	15397	1340	18023	895	23230	579	17979
4L-5S		MI	4719	2170	6740	1880	8345	1563	9358	1293	10631	857	13266	443	10723
14-#11	2.53	MA	7390	2170	9910	1953	12709	1629	14500	1355	16779	914	21444	516	17211
5L-4S		MI	4878	2170	7074	1867	8819	1545	9917	1284	11405	845	14317	510	11201
14-#11	2.53	MA	7027	2170	9330	1962	12024	1645	13625	1376	15567	925	19887	443	16577
6L-3S		MI	5042	2170	7449	1855	9307	1534	10541	1269	12256	840	15372	575	11302
14-#11	2.53	MA	6708	2170	8775	1973	11295	1654	12780	1390	14390	944	18273	399	15555
7L-2S		MI	5333	2170	7982	1842	9982	1524	11357	1260	13355	828	16861	690	11346
14-#14	3.65	MA	8574	2455	12507	2121	16019	1744	18434	1433	22078	892	28912	484	25045
4L-5S		MI	5140	2455	7840	2062	9665	1699	10923	1380	12705	848	15957	280	14618
14-#14	3.65	MA	8132	2455	11743	2145	14931	1776	17148	1453	20296	918	26349	391	23751
5L-4S		MI	5360	2455	8318	2045	10341	1675	11721	1369	13808	833	17428	377	15211
14-#14	3.65	MA	7652	2455	10921	2158	13949	1798	15894	1483	18560	934	24114	284	22217
6L-3S		MI	5556	2455	8852	2027	11037	1660	12610	1348	15020	827	18908	470	15842
14-#14	3.65	MA	7229	2455	10126	2174	12916	1811	14682	1503	16873	960	21792	219	20615
7L-2S		MI	5913	2455	9609	2010	11995	1646	13769	1336	16581	812	20991	635	15955
14-#18	6.48	MA	9982	3176	16248	2632	20417	2147	23697	1701	29009	926	38668	90	38270
5L-4S		MI	6478	3176	11324	2496	14040	2004	16117	1583	19674	799	24724	2	24711
14-#18	6.48	MA	9276	3176	14834	2656	18693	2183	21498	1751	25965	951	34534	-128	33795
6L-3S		MI	6736	3176	12250	2469	15247	1983	17657	1549	21776	795	27210	157	26522
16-#10	2.35	MA	7711	2126	10258	1912	13308	1589	15249	1328	17860	898	22999	619	17001
4L-6S		MI	4582	2126	6408	1869	7995	1558	8947	1300	10097	870	12673	449	10094

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

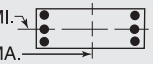
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#10	2.35	MA	7443	2126	9816	1925	12684	1608	14512	1341	16838	914	21534	570	16558
5E		MI	4766	2126	6684	1860	8349	1549	9399	1287	10721	865	13534	520	10345
16-#10	2.35	MA	7144	2126	9338	1933	12114	1620	13811	1353	15843	924	20258	512	16026
6L-4S		MI	4904	2126	6960	1849	8741	1534	9861	1278	11361	854	14426	574	10646
16-#10	2.35	MA	6884	2126	8881	1942	11514	1628	13096	1371	14875	940	18941	477	15398
7L-3S		MI	5041	2126	7270	1838	9145	1524	10378	1265	12066	849	15317	629	10712
16-#10	2.35	MA	6643	2126	8379	1959	10894	1643	12368	1378	13911	950	17664	430	14678
8L-2S		MI	5286	2126	7713	1827	9706	1514	11056	1256	12980	838	16580	723	10743
16-#11	2.89	MA	8116	2262	11321	1994	14579	1649	16741	1367	19832	891	25734	574	20527
4L-6S		MI	4740	2262	6946	1949	8590	1616	9627	1336	10975	858	13736	350	11873
16-#11	2.89	MA	7801	2262	10787	2011	13819	1671	15843	1382	18587	910	23948	511	19743
5E		MI	4954	2262	7273	1937	9020	1605	10174	1320	11730	854	14755	435	12229
16-#11	2.89	MA	7454	2262	10208	2019	13134	1687	14968	1403	17376	922	22391	438	19130
6L-4S		MI	5111	2262	7608	1925	9493	1587	10733	1311	12504	842	15807	502	12701
16-#11	2.89	MA	7151	2262	9653	2031	12405	1696	14123	1417	16198	941	20777	394	18100
7L-3S		MI	5275	2262	7982	1912	9982	1577	11357	1295	13355	837	16861	567	12846
16-#11	2.89	MA	6870	2262	9041	2050	11652	1714	13247	1427	15024	952	19219	334	17083
8L-2S		MI	5545	2262	8515	1899	10657	1566	12173	1287	14454	825	18351	682	12899
16-#14	4.17	MA	8695	2587	12997	2228	16518	1837	19067	1492	22880	913	29927	384	27398
5E		MI	5461	2587	8598	2145	10623	1760	12082	1419	14266	844	18040	265	16773
16-#14	4.17	MA	8242	2587	12175	2241	15536	1858	17814	1522	21144	929	27692	277	25843
6L-4S		MI	5677	2587	9076	2128	11299	1736	12880	1408	15369	828	19511	362	17338
16-#14	4.17	MA	7846	2587	11380	2257	14502	1872	16602	1542	19457	955	25370	212	24231
7L-3S		MI	5857	2587	9609	2110	11995	1721	13769	1386	16581	822	20991	454	18029
16-#14	4.17	MA	7462	2587	10504	2285	13424	1897	15360	1557	17775	971	23133	122	22555
8L-2S		MI	6195	2587	10367	2093	12954	1707	14928	1375	18142	807	23074	619	18155
16-#18	7.41	MA	10264	3411	17023	2803	21462	2291	24846	1820	30473	942	40776	-140	39743
6L-4S		MI	7002	3411	12630	2644	15692	2112	18114	1652	22364	790	28200	-38	28050
18-#10	2.65	MA	7783	2200	10540	1972	13600	1642	15619	1363	18329	911	23598	566	18644
5L-6S		MI	4785	2200	6851	1916	8556	1593	9626	1322	11010	867	13937	445	11357
18-#10	2.65	MA	7496	2200	10062	1980	13030	1654	14918	1375	17334	921	22323	508	18127
6L-5S		MI	4964	2200	7128	1907	8910	1583	10077	1308	11635	862	14798	516	11600
18-#10	2.65	MA	7247	2200	9605	1989	12429	1662	14203	1392	16366	937	21005	473	17498
7L-4S		MI	5100	2200	7404	1896	9302	1568	10540	1300	12274	851	15690	570	11926
18-#10	2.65	MA	7016	2200	9102	2006	11810	1677	13476	1400	15402	947	19729	426	16779
8L-3S		MI	5230	2200	7713	1885	9706	1558	11056	1286	12980	846	16580	625	11998
18-#10	2.65	MA	6717	2200	8666	2017	11235	1688	12742	1415	14452	963	18415	372	15920
9L-2S		MI	5468	2200	8157	1874	10267	1549	11734	1278	13893	835	17844	719	12035
18-#11	3.25	MA	8201	2354	11665	2068	14930	1713	17186	1409	20396	907	26451	507	22278
5L-6S		MI	4978	2354	7479	2006	9265	1658	10444	1363	12074	855	15226	342	13366
18-#11	3.25	MA	7869	2354	11086	2077	14245	1729	16312	1430	19184	918	24895	433	21685
6L-5S		MI	5184	2354	7806	1995	9695	1647	10990	1347	12829	850	16245	426	13740
18-#11	3.25	MA	7581	2354	10531	2088	13515	1738	15466	1444	18006	937	23281	389	20645
7L-4S		MI	5354	2354	8141	1982	10168	1630	11550	1338	13603	838	17296	494	14194
18-#11	3.25	MA	7311	2354	9919	2108	12762	1756	14590	1454	16833	949	21723	329	19621
8L-3S		MI	5492	2354	8515	1969	10657	1619	12173	1322	14454	833	18351	559	14390
18-#11	3.25	MA	6961	2354	9393	2122	12063	1768	13698	1471	15675	968	20114	263	18595
9L-2S		MI	5751	2354	9049	1957	11331	1608	12990	1314	15553	821	19840	674	14451
18-#14	4.69	MA	8814	2720	13429	2323	17123	1919	19733	1561	23729	924	31270	270	29470
6L-5S		MI	5774	2720	9356	2228	11582	1821	13242	1458	15826	839	20123	249	18933
18-#14	4.69	MA	8443	2720	12634	2339	16089	1933	18521	1581	22041	950	28948	205	27846
7L-4S		MI	5987	2720	9833	2210	12258	1797	14040	1447	16929	823	21594	347	19473
18-#14	4.69	MA	8066	2720	11759	2367	15011	1958	17280	1595	20359	966	26711	115	26178
8L-3S		MI	6152	2720	10367	2193	12954	1782	14928	1425	18142	817	23074	439	20217
20-#10	2.94	MA	7839	2275	10786	2026	13945	1689	16026	1397	18825	918	24387	504	20230
6E		MI	4984	2275	7294	1962	9117	1627	10304	1344	11924	864	15201	441	12623
20-#10	2.94	MA	7600	2275	10329	2036	13345	1697	15311	1414	17857	934	23070	469	19598
7L-5S		MI	5157	2275	7571	1954	9471	1618	10756	1330	12548	859	16062	512	12858

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

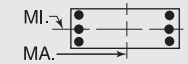
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
20-#10	2.94	MA	7374	2275	9826	2052	12726	1712	14583	1422	16893	945	21793	422	18880
8L-4S		MI	5293	2275	7847	1943	9863	1602	11218	1322	13188	848	16953	566	13206
20-#10	2.94	MA	7086	2275	9390	2064	12151	1722	13850	1437	15943	961	20479	369	18016
9L-3S		MI	5417	2275	8157	1932	10267	1593	11734	1308	13893	843	17844	621	13284
20-#10	2.94	MA	6817	2275	8935	2072	11588	1733	13143	1447	14974	970	19199	327	17169
10L-2S		MI	5647	2275	8600	1921	10828	1583	12413	1300	14806	832	19108	715	13326
20-#11	3.61	MA	8273	2446	11964	2134	15355	1771	17655	1457	20993	915	27399	429	24241
6E		MI	5227	2446	8013	2063	9940	1700	11260	1390	13173	852	16715	334	14864
20-#11	3.61	MA	8000	2446	11408	2145	14626	1780	16809	1471	19815	934	25785	385	23190
7L-5S		MI	5421	2446	8340	2052	10369	1689	11806	1374	13928	847	17734	418	15256
20-#11	3.61	MA	7734	2446	10797	2165	13873	1798	15933	1481	18641	946	24227	324	22159
8L-4S		MI	5576	2446	8675	2039	10843	1672	12366	1365	14702	835	18786	485	15691
20-#11	3.61	MA	7399	2446	10271	2179	13173	1810	15041	1498	17483	964	22618	258	21128
9L-3S		MI	5706	2446	9049	2027	11331	1661	12990	1349	15553	830	19840	551	15934
20-#14	5.21	MA	9024	2852	13889	2422	17676	1994	20440	1619	24625	945	32526	198	31462
7L-5S		MI	6080	2852	10113	2310	12540	1882	14401	1497	17387	834	22206	234	21098
20-#14	5.21	MA	8653	2852	13013	2450	16597	2019	19199	1634	22943	961	30289	108	29800
8L-4S		MI	6292	2852	10591	2293	13216	1857	15199	1486	18490	818	23677	331	21616
22-#10	3.23	MA	7946	2350	11053	2083	14261	1731	16418	1436	19348	931	25134	465	21697
7L-6S		MI	5180	2350	7738	2009	9677	1662	10983	1366	12837	862	16464	437	13891
22-#10	3.23	MA	7722	2350	10550	2099	13641	1746	15690	1444	18384	942	23857	418	20981
8L-5S		MI	5347	2350	8014	2001	10032	1652	11434	1352	13462	856	17325	508	14118
22-#10	3.23	MA	7445	2350	10113	2110	13066	1757	14957	1459	17434	958	22544	365	20113
9L-4S		MI	5482	2350	8291	1989	10423	1637	11897	1344	14101	845	18217	562	14487
22-#10	3.23	MA	7187	2350	9659	2119	12503	1768	14251	1469	16465	967	21264	323	19261
10L-3S		MI	5606	2350	8600	1978	10828	1627	12413	1330	14806	840	19108	617	14569
22-#11	3.97	MA	8409	2538	12286	2203	15736	1823	18152	1498	21623	930	28289	380	25734
7L-6S		MI	5455	2538	8546	2121	10615	1742	12076	1417	14272	848	18205	325	16366
22-#11	3.97	MA	8146	2538	11675	2223	14983	1840	17276	1508	20450	942	26730	319	24697
8L-5S		MI	5641	2538	8873	2110	11044	1732	12623	1401	15027	843	19224	410	16774
22-#11	3.97	MA	7824	2538	11149	2236	14284	1853	16384	1525	19292	961	25122	253	23660
9L-4S		MI	5795	2538	9208	2097	11518	1714	13182	1392	15801	831	20275	477	17194
22-#14	5.73	MA	9273	2984	14267	2533	18184	2080	21118	1673	25527	956	33867	102	33423
8L-5S		MI	6381	2984	10871	2393	13499	1943	15560	1536	18948	829	24289	218	23231
24-#10	3.53	MA	8064	2425	11274	2146	14557	1780	16798	1466	19875	939	25922	414	23082
8L-6S		MI	5372	2425	8181	2056	10238	1696	11661	1388	13751	859	17728	433	15162
24-#10	3.53	MA	7796	2425	10837	2157	13982	1791	16064	1481	18925	955	24608	361	22209
9L-5S		MI	5546	2425	8458	2047	10593	1686	12113	1374	14375	854	18589	504	15382
24-#10	3.53	MA	7548	2425	10383	2166	13419	1802	15358	1491	17956	964	23328	319	21353
10L-4S		MI	5680	2425	8734	2036	10984	1671	12575	1366	15015	843	19481	558	15768
24-#11	4.33	MA	8550	2629	12552	2280	16094	1883	18619	1535	22258	939	29234	315	27235
8L-6S		MI	5678	2629	9080	2178	11290	1785	12892	1444	15370	845	19694	317	17872
24-#11	4.33	MA	8241	2629	12027	2294	15394	1895	17727	1552	21100	957	27625	248	26193
9L-5S		MI	5857	2629	9407	2167	11719	1774	13439	1428	16126	840	20713	402	18296

RECTANGULAR TIED COLUMNS 24" x 38"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#18	1.75	MA	8422	2083	11242	1866	14436	1557	16476	1307	19141	913	24298	792	14058
2E		MI	5028	2083	7274	1784	8938	1487	9982	1246	11331	864	13661	693	8234
6-#11	1.03	MA	7602	1888	9170	1763	11972	1484	13576	1264	15312	931	19053	812	8505
2L-3S		MI	4292	1888	5551	1705	6900	1434	7590	1220	8175	901	9771	650	5123
6-#11	1.03	MA	6980	1888	8235	1781	10789	1500	12145	1279	13386	951	16386	710	8479
3L-2S		MI	4636	1888	6084	1692	7575	1423	8406	1211	9274	889	11261	765	5111
6-#14	1.48	MA	8159	2010	10446	1833	13533	1534	15437	1295	17792	923	22467	802	12066
2L-3S		MI	4453	2010	6060	1776	7496	1485	8286	1251	9091	894	10931	573	7125
6-#14	1.48	MA	7317	2010	9108	1857	11841	1557	13391	1316	15037	950	18653	654	11966
3L-2S		MI	4917	2010	6818	1758	8455	1470	9446	1240	10652	879	13014	738	7142

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



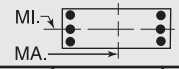
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#18	2.63	MA	9431	2319	13578	2014	17391	1665	20049	1377	23952	904	30960	780	20874
2L-3S		MI	4829	2319	7274	1959	8938	1617	9982	1331	11331	877	13661	359	11846
6-#18	2.63	MA	8123	2319	11242	2055	14436	1703	16476	1411	19141	949	24298	508	20415
3L-2S		MI	5545	2319	8579	1931	10589	1595	11979	1315	14020	855	17137	653	12050
8-#10	1.11	MA	7756	1911	9349	1787	12271	1502	13977	1278	15888	936	19877	815	9276
2L-4S		MI	4277	1911	5418	1743	6787	1465	7460	1251	8022	913	9731	632	5554
8-#10	1.11	MA	7250	1911	8578	1801	11296	1516	12798	1290	14301	952	17679	734	9252
3E		MI	4447	1911	5728	1732	7191	1455	7977	1237	8728	908	10621	687	5572
8-#10	1.11	MA	6956	1911	8052	1816	10609	1529	11917	1309	13096	963	16219	683	9156
4L-2S		MI	4730	1911	6171	1721	7752	1446	8655	1229	9641	897	11885	781	5568
8-#11	1.37	MA	8050	1980	10105	1821	13155	1526	15007	1291	17239	928	21721	807	11244
2L-4S		MI	4343	1980	5710	1775	7086	1487	7782	1263	8422	903	10207	576	6637
8-#11	1.37	MA	7457	1980	9170	1838	11972	1542	13576	1306	15312	947	19053	706	11199
3E		MI	4542	1980	6084	1762	7575	1476	8406	1247	9274	898	11261	642	6684
8-#11	1.37	MA	7112	1980	8530	1855	11134	1558	12505	1328	13847	960	17268	642	11028
4L-2S		MI	4872	1980	6618	1750	8249	1465	9222	1238	10373	886	12750	756	6688
8-#14	1.97	MA	8764	2142	11783	1916	15224	1595	17482	1334	20546	918	26281	795	15973
2L-4S		MI	4530	2142	6284	1876	7759	1560	8557	1311	9439	895	11535	465	9015
8-#14	1.97	MA	7973	2142	10446	1940	13533	1618	15437	1355	17792	945	22467	647	15843
3E		MI	4796	2142	6818	1859	8455	1546	9446	1290	10652	889	13014	557	9318
8-#14	1.97	MA	7517	2142	9528	1964	12333	1640	13902	1385	15693	962	19899	555	15329
4L-2S		MI	5236	2142	7576	1841	9413	1531	10605	1278	12213	874	15098	722	9365
8-#18	3.51	MA	10393	2554	15914	2161	20346	1774	23623	1446	28764	895	37622	767	27682
2L-4S		MI	5005	2554	7653	2133	9382	1747	10439	1434	11919	872	14651	164	13837
8-#18	3.51	MA	9197	2554	13578	2202	17391	1811	20049	1480	23952	940	30960	496	27188
3E		MI	5399	2554	8579	2106	10589	1725	11979	1400	14020	868	17137	319	15583
8-#18	3.51	MA	8513	2554	11968	2243	15288	1849	17359	1531	20274	967	26423	330	24070
4L-2S		MI	6039	2554	9885	2079	12241	1703	13977	1384	16710	846	20612	613	15846
10-#10	1.39	MA	8126	1986	10119	1834	13246	1536	15156	1300	17475	933	22074	811	11532
2L-5S		MI	4350	1986	5585	1801	6956	1515	7676	1281	8296	921	10102	574	6681
10-#10	1.39	MA	7639	1986	9349	1848	12271	1550	13977	1312	15888	949	19877	730	11496
3L-4S		MI	4494	1986	5862	1790	7348	1499	8139	1272	8936	910	10994	628	6837
10-#10	1.39	MA	7363	1986	8823	1862	11583	1563	13096	1330	14683	960	18417	679	11389
4L-3S		MI	4655	1986	6171	1779	7752	1490	8655	1259	9641	905	11885	683	6869
10-#10	1.39	MA	7059	1986	8349	1876	10921	1583	12313	1343	13597	977	16863	631	11044
5L-2S		MI	4929	1986	6615	1768	8313	1480	9333	1250	10554	894	13149	777	6874
10-#11	1.71	MA	8482	2072	11040	1878	14338	1568	16438	1318	19166	925	24389	802	13978
2L-5S		MI	4433	2072	5909	1845	7287	1547	8039	1299	8748	911	10645	501	7809
10-#11	1.71	MA	7916	2072	10105	1895	13155	1584	15007	1333	17239	944	21721	701	13917
3L-4S		MI	4597	2072	6243	1833	7761	1529	8598	1290	9521	899	11696	568	8172
10-#11	1.71	MA	7595	2072	9465	1913	12317	1600	13935	1355	15773	956	19935	637	13735
4L-3S		MI	4785	2072	6618	1820	8249	1518	9222	1274	10373	894	12750	634	8237
10-#11	1.71	MA	7237	2072	8894	1929	11510	1623	12982	1370	14451	976	18039	576	13019
5L-2S		MI	5101	2072	7151	1807	8924	1507	10038	1265	11472	882	14240	748	8255
10-#14	2.47	MA	9346	2275	13120	1999	16916	1656	19528	1373	23301	913	30095	788	19875
2L-5S		MI	4657	2275	6564	1976	8042	1645	8919	1362	9897	905	12147	352	10432
10-#14	2.47	MA	8600	2275	11783	2023	15224	1678	17482	1394	20546	940	26281	640	19723
3L-4S		MI	4881	2275	7042	1959	8717	1621	9717	1350	11000	890	13618	450	11100
10-#14	2.47	MA	8186	2275	10865	2047	14025	1701	15948	1424	18447	957	23713	548	19163
4L-3S		MI	5127	2275	7576	1941	9413	1607	10605	1329	12213	884	15098	542	11507
10-#14	2.47	MA	7688	2275	10053	2071	12868	1733	14581	1445	16553	984	20992	457	17636
5L-2S		MI	5545	2275	8333	1924	10372	1592	11764	1317	13774	869	17181	707	11576
10-#18	4.39	MA	10220	2790	15914	2349	20346	1919	23623	1549	28764	931	37622	484	33974
3L-4S		MI	5586	2790	8958	2281	11034	1855	12437	1503	14609	863	18126	124	17483

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#18	4.39	MA	9626	2790	14304	2390	18243	1957	20933	1601	25086	958	33085	317	30823
4L-3S		MI	5930	2790	9885	2253	12241	1833	13977	1469	16710	859	20612	279	19328
10-#18	4.39	MA	8795	2790	12876	2431	16212	2012	18533	1635	21761	1003	28297	148	27668
5L-2S		MI	6518	2790	11190	2226	13892	1812	15974	1454	19399	838	24088	572	19633
12-#10	1.67	MA	8485	2061	10890	1880	14220	1571	16334	1322	19062	930	24272	807	13784
2L-6S		MI	4364	2061	5752	1856	7163	1559	7903	1316	8585	924	10505	499	7644
12-#10	1.67	MA	8017	2061	10119	1895	13246	1584	15156	1334	17475	947	22074	726	13739
3L-5S		MI	4563	2061	6029	1848	7517	1549	8355	1303	9209	918	11366	570	7919
12-#10	1.67	MA	7757	2061	9593	1909	12558	1598	14275	1352	16270	958	20614	675	13623
4E		MI	4705	2061	6305	1837	7909	1534	8817	1294	9849	907	12258	624	8118
12-#10	1.67	MA	7458	2061	9120	1923	11895	1617	13492	1365	15184	974	19060	627	13257
5L-3S		MI	4858	2061	6615	1825	8313	1524	9333	1281	10554	902	13149	679	8160
12-#10	1.67	MA	7111	2061	8612	1930	11285	1629	12748	1378	14127	985	17708	571	12636
6L-2S		MI	5122	2061	7058	1814	8874	1514	10012	1272	11468	891	14412	773	8174
12-#11	2.05	MA	8902	2163	11976	1936	15521	1610	17869	1345	21092	921	27056	798	16710
2L-6S		MI	4449	2163	6115	1914	7533	1600	8308	1341	9091	913	11115	408	8990
12-#11	2.05	MA	8359	2163	11040	1953	14338	1626	16438	1360	19166	940	24389	696	16636
3L-5S		MI	4682	2163	6442	1903	7962	1589	8855	1326	9847	908	12134	493	9301
12-#11	2.05	MA	8061	2163	10400	1970	13500	1642	15366	1382	17700	953	22603	633	16445
4E		MI	4844	2163	6777	1890	8436	1571	9415	1317	10620	896	13186	560	9707
12-#11	2.05	MA	7709	2163	9830	1987	12693	1665	14413	1396	16378	972	20707	571	15712
5L-3S		MI	5020	2163	7151	1877	8924	1560	10038	1301	11472	891	14240	625	9786
12-#11	2.05	MA	7301	2163	9212	1996	11959	1681	13506	1411	15090	985	19056	500	14994
6L-2S		MI	5325	2163	7685	1864	9599	1550	10854	1292	12571	879	15729	740	9815
12-#14	2.96	MA	9205	2407	13120	2106	16916	1739	19528	1433	23301	935	30095	633	23607
3L-5S		MI	4999	2407	7322	2059	9000	1706	10078	1401	11458	900	14230	337	12567
12-#14	2.96	MA	8827	2407	12202	2130	15716	1762	17993	1463	21202	952	27527	541	23006
4E		MI	5220	2407	7800	2041	9676	1682	10876	1389	12561	885	15701	434	13200
12-#14	2.96	MA	8338	2407	11390	2154	14559	1794	16626	1484	19307	979	24806	450	21522
5L-3S		MI	5457	2407	8333	2024	10372	1667	11764	1368	13774	879	17181	526	13694
12-#14	2.96	MA	7791	2407	10507	2167	13516	1817	15294	1514	17462	996	22436	345	19970
6L-2S		MI	5841	2407	9091	2007	11330	1653	12924	1356	15335	864	19264	691	13782
12-#18	5.26	MA	10753	3025	16640	2537	21197	2065	24506	1670	29897	949	39747	305	37576
4E		MI	6142	3025	10264	2428	12685	1963	14434	1572	17298	855	21602	83	21150
12-#18	5.26	MA	9872	3025	15212	2578	19167	2120	22107	1704	26573	994	34959	136	34389
5L-3S		MI	6444	3025	11190	2400	13892	1941	15974	1539	19399	850	24088	238	23079
12-#18	5.26	MA	9028	3025	13691	2602	17333	2158	19767	1756	23334	1021	30774	-56	30523
6L-2S		MI	6989	3025	12496	2373	15544	1920	17972	1523	22089	829	27563	532	23417
14-#10	1.95	MA	8384	2136	10890	1941	14220	1619	16334	1356	19062	944	24272	722	15982
3L-6S		MI	4578	2136	6196	1903	7724	1593	8582	1338	9499	921	11769	495	8900
14-#10	1.95	MA	8139	2136	10364	1956	13532	1632	15454	1374	17857	955	22812	671	15860
4L-5S		MI	4770	2136	6472	1894	8078	1583	9033	1325	10123	915	12630	566	9163
14-#10	1.95	MA	7844	2136	9890	1969	12870	1651	14671	1387	16771	971	21258	623	15474
5L-4S		MI	4910	2136	6748	1883	8470	1568	9496	1316	10763	904	13522	620	9398
14-#10	1.95	MA	7511	2136	9382	1977	12260	1663	13926	1400	15714	982	19906	567	14871
6L-3S		MI	5056	2136	7058	1872	8874	1558	10012	1303	11468	899	14412	675	9450
14-#10	1.95	MA	7217	2136	8897	1987	11621	1672	13160	1417	14687	999	18513	532	14249
7L-2S		MI	5312	2136	7501	1861	9435	1549	10690	1294	12381	888	15676	769	9471
14-#11	2.39	MA	8791	2255	11976	2010	15521	1669	17869	1387	21092	937	27056	691	19356
3L-6S		MI	4700	2255	6648	1971	8207	1642	9125	1368	10190	909	12605	400	10502
14-#11	2.39	MA	8512	2255	11335	2027	14684	1685	16797	1409	19627	950	25270	628	19159
4L-5S		MI	4924	2255	6975	1960	8637	1631	9671	1353	10946	904	13623	484	10800
14-#11	2.39	MA	8165	2255	10765	2044	13877	1707	15843	1423	18304	969	23374	567	18408
5L-4S		MI	5084	2255	7310	1947	9111	1613	10231	1344	11719	892	14675	552	11242

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

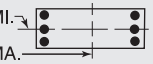
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#11	2.39	MA	7775	2255	10147	2053	13142	1723	14937	1438	17017	981	21723	495	17715
6L-3S		MI	5251	2255	7685	1935	9599	1603	10854	1328	12571	887	15729	617	11332
14-#11	2.39	MA	7431	2255	9557	2065	12366	1732	14016	1460	15765	1001	20016	452	16688
7L-2S		MI	5545	2255	8218	1922	10274	1592	11671	1319	13670	876	17219	732	11371
14-#14	3.45	MA	9446	2540	13540	2213	17408	1823	20039	1502	23957	947	31341	534	26855
4L-5S		MI	5346	2540	8080	2142	9959	1767	11237	1440	13019	896	16313	321	14712
14-#14	3.45	MA	8965	2540	12727	2237	16251	1855	18672	1523	22062	974	28620	443	25404
5L-4S		MI	5566	2540	8557	2124	10634	1743	12035	1428	14122	880	17784	419	15314
14-#14	3.45	MA	8448	2540	11844	2250	15208	1877	17340	1553	20216	991	26251	338	23837
6L-3S		MI	5767	2540	9091	2107	11330	1728	12924	1407	15335	874	19264	511	15881
14-#14	3.45	MA	7992	2540	10998	2266	14096	1891	16053	1574	18423	1019	23793	275	22208
7L-2S		MI	6130	2540	9849	2089	12289	1714	14083	1395	16896	859	21347	676	15985
14-#18	6.14	MA	10960	3261	17548	2725	22121	2228	25680	1773	31384	985	41621	124	41110
5L-4S		MI	6680	3261	11569	2575	14337	2071	16432	1641	19988	846	25077	43	24836
14-#18	6.14	MA	10195	3261	16026	2749	20288	2266	23341	1825	28145	1012	37436	-68	37015
6L-3S		MI	6946	3261	12496	2547	15544	2050	17972	1608	22089	842	27563	198	26692
16-#10	2.23	MA	8511	2210	11134	2003	14507	1667	16633	1396	19445	952	25010	667	18098
4L-6S		MI	4787	2210	6639	1950	8285	1627	9260	1360	10412	918	13033	491	10159
16-#10	2.23	MA	8220	2210	10661	2016	13845	1686	15849	1409	18358	968	23456	620	17694
5E		MI	4973	2210	6916	1941	8639	1618	9712	1347	11036	913	13894	562	10411
16-#10	2.23	MA	7899	2210	10153	2024	13234	1698	15105	1422	17301	979	22103	563	17108
6L-4S		MI	5111	2210	7192	1930	9031	1602	10174	1338	11676	902	14786	616	10679
16-#10	2.23	MA	7618	2210	9667	2034	12596	1706	14339	1439	16274	996	20710	528	16484
7L-3S		MI	5250	2210	7501	1919	9435	1593	10690	1325	12381	896	15676	671	10738
16-#10	2.23	MA	7359	2210	9133	2050	11938	1722	13566	1447	15251	1007	19357	482	15704
8L-2S		MI	5498	2210	7945	1908	9996	1583	11369	1316	13295	885	16940	765	10765
16-#11	2.74	MA	8950	2347	12271	2085	15867	1727	18228	1436	21553	946	27938	623	21875
4L-6S		MI	4944	2347	7182	2029	8882	1684	9941	1395	11289	906	14094	392	11994
16-#11	2.74	MA	8608	2347	11700	2101	15060	1750	17274	1450	20231	965	26042	562	21109
5E		MI	5160	2347	7509	2017	9312	1673	10487	1380	12045	901	15113	476	12304
16-#11	2.74	MA	8234	2347	11082	2110	14325	1765	16368	1465	18943	978	24391	490	20437
6L-4S		MI	5318	2347	7844	2005	9786	1656	11047	1371	12818	889	16164	543	12777
16-#11	2.74	MA	7908	2347	10492	2122	13549	1775	15447	1487	17692	997	22684	447	19400
7L-3S		MI	5476	2347	8218	1992	10274	1645	11671	1355	13670	884	17219	609	12878
16-#11	2.74	MA	7606	2347	9842	2142	12748	1793	14506	1497	16445	1010	21032	388	18359
8L-2S		MI	5760	2347	8751	1979	10949	1634	12487	1346	14769	872	18708	723	12925
16-#14	3.95	MA	9572	2672	14064	2320	17943	1916	20718	1562	24816	969	32434	437	29286
5E		MI	5668	2672	8837	2224	10917	1828	12397	1478	14580	891	18396	306	16863
16-#14	3.95	MA	9083	2672	13181	2332	16899	1938	19386	1592	22971	987	30065	331	27703
6L-4S		MI	5885	2672	9315	2207	11593	1804	13195	1467	15683	875	19867	403	17437
16-#14	3.95	MA	8656	2672	12336	2349	15788	1952	18098	1613	21177	1014	27607	268	26062
7L-3S		MI	6069	2672	9849	2190	12289	1789	14083	1446	16896	869	21347	495	18068
16-#14	3.95	MA	8238	2672	11404	2377	14641	1977	16763	1627	19390	1031	25234	181	24232
8L-2S		MI	6415	2672	10606	2172	13247	1775	15242	1434	18456	854	23430	661	18186
16-#18	7.02	MA	11258	3496	18362	2896	23243	2374	26915	1894	32957	1003	44098	-80	43467
6L-4S		MI	7205	3496	12875	2722	15988	2179	18429	1710	22677	837	28553	3	28536
18-#10	2.51	MA	8586	2285	11431	2063	14819	1720	17028	1431	19946	966	25653	616	19918
5L-6S		MI	4991	2285	7082	1996	8846	1662	9938	1382	11325	915	14296	487	11421
18-#10	2.51	MA	8277	2285	10923	2070	14209	1732	16284	1444	18889	977	24301	559	19347
6L-5S		MI	5171	2285	7359	1988	9200	1652	10390	1369	11950	910	15157	558	11664
18-#10	2.51	MA	8009	2285	10438	2080	13571	1740	15518	1461	17861	993	22908	524	18719
7L-4S		MI	5308	2285	7635	1977	9592	1637	10852	1360	12590	899	16049	612	11959
18-#10	2.51	MA	7759	2285	9904	2097	12912	1756	14744	1469	16838	1004	21555	478	17941
8L-3S		MI	5440	2285	7945	1966	9996	1627	11369	1347	13295	894	16940	667	12024
18-#10	2.51	MA	7438	2285	9436	2108	12302	1767	13965	1484	15829	1020	20166	425	17071
9L-2S		MI	5682	2285	8388	1955	10557	1617	12047	1338	14208	883	18204	761	12058
18-#11	3.08	MA	9039	2439	12635	2159	16243	1792	18705	1477	22157	962	28709	557	23813
5L-6S		MI	5183	2439	7715	2086	9557	1726	10757	1422	12388	902	15583	383	13484

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



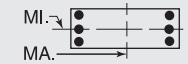
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	3.08	MA	8681	2439	12018	2168	15508	1807	17799	1492	20870	975	27059	486	23162
6L-5S		MI	5392	2439	8042	2075	9987	1715	11304	1407	13144	897	16602	468	13814
18-#11	3.08	MA	8371	2439	11427	2180	14732	1817	16878	1514	19619	994	25352	442	22111
7L-4S		MI	5562	2439	8377	2062	10460	1698	11863	1398	13917	886	17654	535	14277
18-#11	3.08	MA	8077	2439	10777	2200	13931	1835	15936	1524	18372	1006	23699	384	21064
8L-3S		MI	5704	2439	8751	2049	10949	1687	12487	1382	14769	881	18708	601	14422
18-#11	3.08	MA	7701	2439	10214	2213	13188	1848	14988	1541	17142	1026	21997	318	19961
9L-2S		MI	5968	2439	9285	2037	11624	1676	13303	1373	15868	869	20197	715	14478
18-#14	4.44	MA	9698	2804	14519	2415	18591	1999	21432	1631	25726	982	33879	324	31569
6L-5S		MI	5982	2804	9595	2307	11876	1889	13556	1517	16141	886	20479	290	19020
18-#14	4.44	MA	9298	2804	13673	2432	17479	2012	20144	1652	23932	1009	31421	261	29917
7L-4S		MI	6196	2804	10073	2290	12551	1864	14354	1506	17244	870	21950	388	19569
18-#14	4.44	MA	8888	2804	12741	2460	16332	2038	18809	1666	22145	1026	29048	174	28094
8L-3S		MI	6366	2804	10606	2272	13247	1850	15242	1484	18456	864	23430	480	20257
20-#10	2.79	MA	8646	2360	11694	2117	15184	1766	17463	1466	20476	974	26499	555	21587
6E		MI	5190	2360	7526	2043	9406	1696	10617	1404	12239	912	15560	483	12686
20-#10	2.79	MA	8389	2360	11208	2127	14545	1775	16697	1483	19449	990	25106	521	20955
7L-5S		MI	5365	2360	7802	2035	9761	1686	11068	1390	12863	907	16421	554	12921
20-#10	2.79	MA	8143	2360	10674	2144	13887	1790	15923	1491	18425	1001	23753	475	20179
8L-4S		MI	5501	2360	8079	2023	10152	1671	11531	1382	13503	896	17313	608	13239
20-#10	2.79	MA	7834	2360	10207	2155	13277	1801	15144	1506	17416	1018	22363	422	19303
9L-3S		MI	5628	2360	8388	2012	10557	1661	12047	1368	14208	891	18204	663	13311
20-#10	2.79	MA	7545	2360	9724	2164	12679	1812	14394	1516	16375	1026	21007	381	18447
10L-2S		MI	5862	2360	8832	2001	11117	1652	12726	1360	15122	880	19467	757	13350
20-#11	3.42	MA	9117	2531	12953	2225	16691	1849	19230	1519	22797	971	29726	481	25882
6E		MI	5417	2531	8249	2143	10232	1768	11573	1449	13487	899	17073	375	14979
20-#11	3.42	MA	8822	2531	12362	2237	15915	1859	18308	1541	21545	990	28019	437	24807
7L-5S		MI	5630	2531	8576	2132	10661	1758	12120	1434	14242	894	18092	460	15327
20-#11	3.42	MA	8532	2531	11712	2257	15114	1877	17367	1550	20299	1003	26367	379	23768
8L-4S		MI	5786	2531	8910	2119	11135	1740	12679	1425	15016	882	19143	527	15773
20-#11	3.42	MA	8171	2531	11149	2271	14371	1890	16419	1568	19069	1022	24665	313	22669
9L-3S		MI	5919	2531	9285	2107	11624	1729	13303	1409	15868	877	20197	592	15966
20-#11	3.42	MA	7835	2531	10562	2281	13642	1903	15505	1580	17821	1034	23007	261	21439
10L-2S		MI	6173	2531	9818	2094	12298	1718	14119	1400	16967	865	21687	707	16029
20-#14	4.93	MA	9923	2937	15010	2514	19171	2073	22190	1691	26686	1004	35235	254	33771
7L-5S		MI	6290	2937	10353	2390	12834	1950	14715	1556	17702	881	22562	275	21182
20-#14	4.93	MA	9519	2937	14078	2543	18024	2099	20855	1705	24899	1021	32862	167	31956
8L-4S		MI	6502	2937	10830	2373	13510	1925	15513	1545	18805	865	24034	372	21709
22-#10	3.06	MA	8761	2435	11979	2174	15520	1809	17875	1505	21036	987	27303	517	23190
7L-6S		MI	5387	2435	7969	2090	9967	1730	11295	1426	13152	909	16824	479	13953
22-#10	3.06	MA	8518	2435	11445	2191	14862	1825	17102	1513	20012	998	25950	471	22416
8L-5S		MI	5557	2435	8246	2081	10322	1721	11747	1412	13777	904	17685	550	14180
22-#10	3.06	MA	8219	2435	10977	2202	14251	1835	16323	1528	19003	1015	24561	418	21535
9L-4S		MI	5692	2435	8522	2070	10713	1705	12209	1404	14416	893	18577	604	14520
22-#10	3.06	MA	7942	2435	10494	2210	13653	1847	15573	1538	17963	1023	23204	378	20675
10L-3S		MI	5820	2435	8832	2059	11117	1696	12726	1390	15122	888	19467	659	14597
22-#10	3.06	MA	7678	2435	10021	2220	13051	1857	14834	1549	16927	1037	21887	329	19744
11L-2S		MI	6038	2435	9275	2048	11678	1686	13404	1382	16035	877	20731	753	14640
22-#11	3.76	MA	9262	2623	13297	2294	17098	1901	19739	1568	23472	987	30687	433	27519
7L-6S		MI	5662	2623	8782	2201	10907	1811	12389	1476	14586	896	18562	367	16479
22-#11	3.76	MA	8976	2623	12647	2315	16297	1919	18798	1577	22225	1000	29034	374	26472
8L-5S		MI	5851	2623	9109	2190	11336	1800	12936	1461	15341	891	19581	451	16844
22-#11	3.76	MA	8629	2623	12085	2328	15554	1932	17850	1595	20995	1019	27332	308	25376
9L-4S		MI	6005	2623	9444	2177	11810	1782	13496	1452	16115	879	20633	519	17274

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

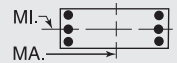
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.76	MA	8307	2623	11497	2339	14825	1945	16936	1607	19748	1030	25675	257	24141
10L-3S		MI	6131	2623	9818	2164	12298	1771	14119	1436	16967	874	21687	584	17510
22-#14	5.43	MA	10133	3069	15416	2626	19715	2160	22901	1744	27654	1016	36676	160	35818
8L-5S		MI	6592	3069	11110	2473	13793	2010	15874	1595	19262	876	24646	260	23349
24-#10	3.34	MA	8886	2510	12215	2237	15836	1859	18281	1535	21600	996	28148	467	24653
8L-6S		MI	5580	2510	8413	2137	10528	1765	11974	1448	14066	907	18087	475	15222
24-#10	3.34	MA	8597	2510	11748	2248	15226	1870	17502	1550	20590	1012	26759	414	23768
9L-5S		MI	5745	2510	8689	2128	10883	1755	12425	1434	14690	901	18948	546	15443
24-#10	3.34	MA	8330	2510	11265	2257	14628	1881	16752	1560	19550	1021	25402	374	22902
10L-4S		MI	5892	2510	8965	2117	11274	1740	12888	1426	15330	890	19840	600	15802
24-#10	3.34	MA	8077	2510	10791	2267	14025	1891	16012	1571	18514	1035	24085	325	21974
11L-3S		MI	5999	2510	9275	2106	11678	1730	13404	1412	16035	885	20731	655	15882
24-#11	4.11	MA	9411	2714	13583	2372	17480	1962	20229	1604	24152	996	31702	369	29176
8L-6S		MI	5887	2714	9316	2258	11582	1853	13206	1503	15685	892	20052	359	17982
24-#11	4.11	MA	9077	2714	13020	2386	16737	1974	19281	1622	22922	1016	30000	303	28084
9L-5S		MI	6069	2714	9643	2247	12011	1842	13752	1487	16440	887	21070	443	18364
24-#11	4.11	MA	8768	2714	12432	2396	16008	1988	18367	1634	21674	1027	28343	252	26843
10L-4S		MI	6222	2714	9977	2234	12485	1824	14312	1479	17214	875	22122	510	18780

RECTANGULAR TIED COLUMNS 24" x 40"

4-#18	1.67	MA	9261	2168	12163	1957	15688	1634	17916	1374	20782	966	26354	839	14922
2E		MI	5236	2168	7519	1863	9234	1554	10297	1304	11644	910	14014	734	8263
6-#14	1.41	MA	8974	2095	11311	1923	14721	1611	16804	1362	19338	976	24395	849	12795
2L-3S		MI	4657	2095	6299	1855	7790	1553	8600	1310	9405	941	11287	614	7156
6-#14	1.41	MA	8070	2095	9891	1948	12925	1634	14631	1384	16413	1004	20345	703	12695
3L-2S		MI	5125	2095	7057	1838	8748	1538	9760	1299	10966	926	13371	779	7166
6-#18	2.50	MA	10348	2404	14646	2104	18829	1742	21715	1444	25896	957	33436	826	22170
2L-3S		MI	5033	2404	7519	2037	9234	1684	10297	1389	11644	923	14014	400	11902
6-#18	2.50	MA	8939	2404	12163	2146	15688	1781	17916	1479	20782	1004	26354	559	21711
3L-2S		MI	5758	2404	8825	2010	10886	1662	12295	1374	14334	902	17490	694	12083
8-#10	1.06	MA	8536	1996	10142	1877	13376	1579	15247	1345	17307	989	21632	862	9825
2L-4S		MI	4481	1996	5650	1824	7077	1534	7773	1311	8337	961	10090	674	5579
8-#10	1.06	MA	7993	1996	9325	1892	12342	1593	13997	1358	15624	1006	19301	782	9801
3E		MI	4652	1996	5959	1813	7481	1524	8289	1297	9043	955	10981	729	5592
8-#10	1.06	MA	7679	1996	8768	1906	11614	1607	13064	1376	14348	1017	17761	731	9705
4L-2S		MI	4937	1996	6403	1802	8042	1515	8968	1289	9956	944	12244	822	5585
8-#11	1.30	MA	8854	2065	10948	1911	14317	1603	16344	1358	18747	981	23597	854	11918
2L-4S		MI	4547	2065	5946	1855	7378	1555	8096	1322	8737	950	10564	618	6672
8-#11	1.30	MA	8218	2065	9955	1929	13061	1619	14826	1373	16702	1001	20765	754	11873
3E		MI	4747	2065	6320	1842	7867	1544	8719	1307	9588	945	11618	683	6709
8-#11	1.30	MA	7849	2065	9277	1946	12174	1636	13690	1396	15149	1014	18880	691	11702
4L-2S		MI	5079	2065	6854	1830	8541	1534	9536	1298	10687	933	13108	798	6709
8-#14	1.88	MA	9624	2227	12731	2006	16517	1672	18976	1401	22263	971	28445	842	16945
2L-4S		MI	4733	2227	6523	1955	8052	1628	8871	1370	9753	942	11891	506	9127
8-#14	1.88	MA	8774	2227	11311	2031	14721	1695	16804	1423	19338	999	24395	696	16815
3E		MI	5001	2227	7057	1938	8748	1614	9760	1349	10966	936	13371	598	9352
8-#14	1.88	MA	8285	2227	10339	2056	13450	1718	15177	1454	17113	1017	21684	604	16344
4L-2S		MI	5445	2227	7815	1921	9707	1599	10919	1338	12527	921	15454	764	9391
8-#18	3.33	MA	11383	2639	17128	2251	21969	1850	25514	1513	31011	948	40518	814	29410
2L-4S		MI	5205	2639	7898	2212	9679	1814	10755	1492	12233	919	15004	205	13981
8-#18	3.33	MA	10093	2639	14646	2293	18829	1889	21715	1548	25896	995	33436	547	28916
3E		MI	5605	2639	8825	2184	10886	1792	12295	1459	14334	915	17490	360	15641
8-#18	3.33	MA	9357	2639	12939	2335	16598	1928	18860	1601	21994	1024	28644	382	25734
4L-2S		MI	6254	2639	10130	2157	12537	1770	14292	1443	17023	893	20965	653	15881
10-#10	1.32	MA	8933	2071	10960	1924	14410	1613	16497	1367	18991	986	23963	858	12217
2L-5S		MI	4554	2071	5817	1882	7246	1584	7989	1341	8611	969	10462	616	6751

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

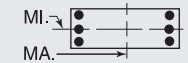


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#10	1.32	MA	8411	2071	10142	1938	13376	1627	15247	1380	17307	1003	21632	778	12182
3L-4S		MI	4698	2071	6093	1871	7638	1568	8451	1333	9251	958	11354	670	6864
10-#10	1.32	MA	8115	2071	9586	1953	12647	1641	14314	1398	16031	1015	20092	727	12074
4L-3S		MI	4861	2071	6403	1859	8042	1559	8968	1319	9956	953	12244	725	6890
10-#10	1.32	MA	7788	2071	9081	1966	11946	1660	13485	1411	14882	1032	18449	681	11775
5L-2S		MI	5136	2071	6846	1848	8603	1549	9646	1311	10870	942	13508	818	6893
10-#11	1.63	MA	9319	2156	11940	1968	15572	1645	17863	1385	20791	978	26428	849	14821
2L-5S		MI	4637	2156	6145	1925	7579	1615	8352	1358	9062	959	11002	542	7889
10-#11	1.63	MA	8711	2156	10948	1986	14317	1661	16344	1400	18747	998	23597	749	14760
3L-4S		MI	4801	2156	6479	1913	8053	1597	8912	1349	9836	947	12054	610	8209
10-#11	1.63	MA	8367	2156	10269	2003	13430	1678	15209	1423	17193	1011	21712	686	14577
4L-3S		MI	4991	2156	6854	1900	8541	1587	9536	1334	10687	942	13108	675	8264
10-#11	1.63	MA	7980	2156	9661	2020	12575	1701	14199	1438	15793	1031	19706	626	13886
5L-2S		MI	5310	2156	7387	1887	9216	1576	10352	1325	11786	930	14597	790	8278
10-#14	2.34	MA	10251	2359	14151	2089	18313	1733	21149	1440	25188	966	32496	835	21090
2L-5S		MI	4860	2359	6803	2056	8335	1713	9233	1421	10211	952	12503	393	10530
10-#14	2.34	MA	9448	2360	12731	2114	16517	1756	18976	1461	22263	994	28445	689	20938
3L-4S		MI	5084	2360	7281	2038	9011	1689	10031	1409	11314	937	13974	491	11208
10-#14	2.34	MA	9002	2359	11759	2138	15246	1779	17349	1493	20038	1013	25734	597	20471
4L-3S		MI	5333	2360	7815	2021	9707	1674	10919	1388	12527	931	15454	583	11543
10-#14	2.34	MA	8464	2359	10893	2162	14021	1812	15901	1514	18030	1041	22855	509	18807
5L-2S		MI	5757	2360	8572	2003	10665	1660	12078	1376	14088	916	17537	748	11604
10-#18	4.17	MA	11191	2875	17128	2440	21969	1998	25514	1617	31011	986	40518	534	36134
3L-4S		MI	5787	2875	9204	2359	11330	1922	12752	1561	14922	910	18479	164	17619
10-#18	4.17	MA	10551	2875	15422	2482	19739	2036	22659	1671	27108	1015	35726	370	32914
4L-3S		MI	6138	2875	10130	2332	12537	1900	14292	1528	17023	906	20965	319	19385
10-#18	4.17	MA	9650	2875	13909	2525	17586	2093	20115	1706	23583	1062	30657	205	29691
5L-2S		MI	6736	2875	11436	2304	14189	1878	16290	1512	19713	884	24441	613	19670
12-#10	1.59	MA	9319	2146	11777	1971	15443	1648	17748	1389	20674	983	26294	854	14607
2L-6S		MI	4567	2146	5984	1937	7453	1628	8216	1376	8900	971	10865	541	7710
12-#10	1.59	MA	8816	2146	10960	1985	14410	1662	16497	1402	18991	1000	23963	774	14562
3L-5S		MI	4768	2146	6260	1928	7807	1618	8667	1363	9525	966	11726	612	7987
12-#10	1.59	MA	8538	2146	10403	2000	13681	1675	15565	1420	17715	1012	22423	723	14446
4E		MI	4909	2146	6536	1917	8199	1603	9130	1354	10164	955	12618	666	8147
12-#10	1.59	MA	8215	2146	9898	2013	12980	1695	14736	1433	16565	1029	20780	677	14126
5L-3S		MI	5064	2146	6846	1906	8603	1593	9646	1341	10870	950	13508	721	8183
12-#10	1.59	MA	7844	2146	9360	2021	12329	1707	13948	1446	15446	1040	19350	621	13447
6L-2S		MI	5331	2146	7290	1895	9164	1583	10325	1332	11783	939	14772	814	8195
12-#11	1.95	MA	9771	2248	12933	2026	16828	1687	19382	1412	22836	974	29259	844	17721
2L-6S		MI	4652	2248	6351	1994	7825	1668	8622	1401	9406	960	11473	450	9069
12-#11	1.95	MA	9187	2248	11940	2043	15572	1704	17863	1427	20791	994	26428	744	17647
3L-5S		MI	4887	2248	6678	1983	8254	1657	9169	1385	10161	955	12491	534	9378
12-#11	1.95	MA	8866	2248	11262	2061	14685	1720	16728	1450	19238	1008	24543	681	17456
4E		MI	5048	2248	7013	1970	8728	1639	9728	1376	10935	943	13543	601	9745
12-#11	1.95	MA	8486	2248	10653	2077	13831	1743	15718	1465	17838	1028	22538	622	16748
5L-3S		MI	5227	2248	7387	1957	9216	1629	10352	1361	11786	938	14597	667	9814
12-#11	1.95	MA	8049	2248	9999	2087	13047	1758	14758	1480	16474	1041	20792	552	15968
6L-2S		MI	5536	2248	7920	1944	9891	1618	11168	1352	12885	926	16087	781	9839
12-#14	2.81	MA	10098	2492	14151	2196	18313	1817	21149	1500	25188	989	32496	682	25065
3L-5S		MI	5204	2492	7561	2138	9294	1774	10392	1460	11772	948	14586	378	12662
12-#14	2.81	MA	9690	2492	13179	2221	17042	1840	19522	1532	22963	1008	29784	590	24586
4E		MI	5424	2492	8039	2121	9969	1750	11190	1448	12875	932	16057	475	13305
12-#14	2.81	MA	9162	2492	12313	2245	15817	1873	18074	1553	20955	1036	26906	502	22930
5L-3S		MI	5667	2492	8572	2104	10665	1735	12078	1427	14088	926	17537	567	13731
12-#14	2.81	MA	8575	2492	11375	2258	14702	1895	16697	1575	19001	1054	24399	399	21368
6L-2S		MI	6055	2492	9330	2086	11624	1721	13238	1415	15649	911	19620	733	13812
12-#18	5.00	MA	11762	3110	17905	2630	22879	2145	26458	1740	32223	1006	42808	357	40093
4E		MI	6344	3110	10509	2506	12982	2030	14750	1630	17611	901	21955	124	21280
12-#18	5.00	MA	10806	3110	16392	2672	20727	2201	23914	1775	28698	1053	37739	193	36836
5L-3S		MI	6653	3110	11436	2479	14189	2008	16290	1597	19713	897	24441	279	23137

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



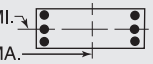
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#18	5.00	MA	9899	3110	14762	2695	18785	2240	21435	1829	25264	1082	33321	2	33305
6L-2S		MI	7209	3110	12741	2451	15840	1987	18287	1581	22402	875	27916	573	23454
14-#10	1.85	MA	9210	2221	11777	2032	15443	1696	17748	1424	20674	998	26294	770	16942
3L-6S		MI	4782	2221	6427	1984	8014	1662	8894	1398	9814	968	12128	537	8964
14-#10	1.85	MA	8947	2221	11220	2047	14715	1710	16815	1442	19398	1009	24754	719	16820
4L-5S		MI	4976	2221	6704	1975	8368	1652	9346	1385	10438	963	12989	608	9229
14-#10	1.85	MA	8629	2221	10716	2060	14014	1729	15986	1455	18248	1026	23111	673	16481
5L-4S		MI	5116	2221	6980	1964	8760	1637	9808	1376	11078	952	13881	662	9429
14-#10	1.85	MA	8272	2221	10177	2068	13363	1741	15199	1468	17130	1037	21681	617	15820
6L-3S		MI	5263	2221	7290	1953	9164	1627	10325	1363	11783	947	14772	717	9474
14-#10	1.85	MA	7958	2221	9663	2078	12687	1750	14381	1485	16043	1054	20213	583	15209
7L-2S		MI	5522	2221	7733	1942	9725	1618	11003	1354	12696	936	16036	810	9492
14-#11	2.27	MA	9650	2340	12933	2101	16828	1746	19382	1454	22836	991	29259	739	20535
3L-6S		MI	4903	2340	6884	2051	8500	1710	9438	1428	10505	957	12962	441	10579
14-#11	2.27	MA	9350	2340	12255	2118	15941	1762	18246	1477	21283	1004	27374	676	20338
4L-5S		MI	5129	2340	7211	2040	8929	1699	9985	1412	11260	952	13981	526	10875
14-#11	2.27	MA	8975	2340	11646	2135	15087	1786	17236	1492	19883	1024	25369	617	19614
5L-4S		MI	5289	2340	7546	2027	9403	1682	10544	1403	12034	940	15032	593	11281
14-#11	2.27	MA	8557	2340	10991	2144	14302	1801	16277	1507	18519	1037	23623	547	18858
6L-3S		MI	5459	2340	7920	2015	9891	1671	11168	1387	12885	935	16087	659	11362
14-#11	2.27	MA	8189	2340	10365	2156	13480	1811	15292	1529	17194	1057	21824	504	17817
7L-2S		MI	5757	2340	8454	2002	10566	1660	11984	1379	13984	923	17576	773	11397
14-#14	3.28	MA	10354	2624	14599	2304	18838	1901	21694	1571	25888	1003	33834	583	28682
4L-5S		MI	5552	2624	8319	2221	10252	1835	11551	1499	13333	943	16669	363	14803
14-#14	3.28	MA	9834	2624	13733	2328	17613	1934	20246	1592	23880	1031	30956	495	27053
5L-4S		MI	5772	2624	8796	2204	10928	1810	12349	1487	14436	927	18140	460	15414
14-#14	3.28	MA	9279	2624	12795	2341	16498	1956	18870	1613	21926	1049	28449	392	25474
6L-3S		MI	5977	2624	9330	2186	11624	1796	13238	1466	15649	921	19620	552	15919
14-#14	3.28	MA	8790	2624	11898	2358	15319	1970	17471	1645	20026	1077	25858	330	23807
7L-2S		MI	6347	2624	10088	2169	12582	1782	14397	1454	17210	906	21703	717	16015
14-#18	5.83	MA	11974	3345	18875	2819	23868	2309	27713	1845	33813	1044	44821	181	43981
5L-4S		MI	6883	3345	11815	2653	14633	2138	16747	1699	20301	892	25431	84	24960
14-#18	5.83	MA	11076	3345	17245	2842	21925	2348	25234	1898	30379	1073	40403	-10	40338
6L-3S		MI	7157	3345	12741	2626	15840	2116	18287	1666	22402	888	27916	239	26860
16-#10	2.12	MA	9346	2295	12037	2093	15749	1744	18065	1464	21082	1006	27085	716	19195
4L-6S		MI	4991	2295	6870	2030	8575	1696	9573	1420	10727	966	13392	533	10222
16-#10	2.12	MA	9032	2295	11533	2107	15047	1764	17236	1477	19932	1023	25442	669	18838
5E		MI	5179	2295	7147	2022	8929	1687	10024	1407	11351	960	14253	604	10476
16-#10	2.12	MA	8688	2295	10994	2115	14396	1775	16449	1490	18813	1035	24012	613	18195
6L-4S		MI	5317	2295	7423	2011	9321	1671	10487	1398	11991	949	15145	658	10710
16-#10	2.12	MA	8388	2295	10480	2125	13720	1784	15631	1507	17726	1051	22544	579	17580
7L-3S		MI	5458	2295	7733	2000	9725	1662	11003	1385	12696	944	16036	713	10763
16-#10	2.12	MA	8111	2295	9915	2142	13023	1800	14812	1516	16643	1063	21114	534	16739
8L-2S		MI	5710	2295	8176	1989	10286	1652	11681	1376	13610	933	17299	806	10787
16-#11	2.60	MA	9820	2432	13247	2176	17197	1804	19765	1504	23328	1001	30206	672	23223
4L-6S		MI	5148	2432	7418	2109	9174	1752	10254	1455	11604	953	14451	433	12093
16-#11	2.60	MA	9450	2432	12639	2192	16342	1828	18755	1519	21927	1021	28200	612	22484
5E		MI	5367	2432	7745	2097	9604	1742	10801	1439	12359	948	15470	518	12378
16-#11	2.60	MA	9050	2432	11984	2201	15558	1843	17795	1534	20564	1034	26455	542	21746
6L-4S		MI	5525	2432	8080	2085	10078	1724	11361	1430	13133	936	16522	585	12817
16-#11	2.60	MA	8700	2432	11358	2214	14735	1853	16811	1556	19239	1054	24655	499	20696
7L-3S		MI	5686	2432	8454	2072	10566	1713	11984	1414	13984	931	17576	650	12908
16-#11	2.60	MA	8376	2432	10669	2234	13887	1872	15814	1566	17919	1067	22908	442	19653
8L-2S		MI	5974	2432	8987	2059	11241	1702	12800	1406	15083	919	19066	765	12952

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

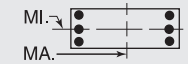
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.75	MA	10484	2757	15152	2411	19409	1995	22419	1631	26806	1026	35006	489	31176
5E		MI	5876	2757	9076	2304	11211	1896	12711	1538	14894	938	18752	347	16952
16-#14	3.75	MA	9959	2757	14215	2424	18294	2017	21042	1652	24851	1044	32500	385	29580
6L-4S		MI	6092	2757	9554	2286	11886	1871	13509	1526	15997	922	20223	445	17535
16-#14	3.75	MA	9501	2757	13318	2441	17116	2031	19644	1684	22951	1072	29908	323	27919
7L-3S		MI	6281	2757	10088	2269	12582	1857	14397	1505	17210	916	21703	537	18107
16-#14	3.75	MA	9049	2757	12331	2470	15900	2057	18215	1697	21058	1090	27399	238	25930
8L-2S		MI	6633	2757	10846	2252	13541	1842	15556	1493	18771	901	23786	702	18217
16-#18	6.67	MA	12289	3581	19728	2989	25066	2456	29032	1967	35493	1064	47485	-22	47302
6L-4S		MI	7409	3581	13120	2800	16285	2246	18745	1769	22990	883	28906	44	28654
18-#10	2.38	MA	9425	2370	12350	2153	16081	1798	18487	1499	21615	1020	27773	665	21199
5L-6S		MI	5196	2370	7314	2077	9135	1731	10251	1442	11641	963	14656	529	11483
18-#10	2.38	MA	9093	2370	11812	2161	15430	1810	17699	1512	20497	1032	26343	610	20571
6L-5S		MI	5378	2370	7591	2069	9490	1721	10703	1429	12265	958	15517	600	11728
18-#10	2.38	MA	8806	2370	11297	2171	14754	1818	16882	1529	19410	1049	24875	575	19951
7L-4S		MI	5515	2370	7867	2057	9881	1706	11165	1420	12905	947	16409	654	11991
18-#10	2.38	MA	8536	2370	10732	2189	14057	1834	16063	1538	18327	1060	23445	530	19112
8L-3S		MI	5650	2370	8176	2046	10286	1696	11681	1407	13610	941	17299	709	12050
18-#10	2.38	MA	8192	2370	10234	2199	13411	1845	15238	1553	17258	1077	21980	478	18236
9L-2S		MI	5894	2370	8620	2035	10846	1686	12360	1398	14523	930	18563	802	12080
18-#11	2.92	MA	9913	2524	13631	2249	17598	1870	20274	1546	23972	1017	31031	607	25357
5L-6S		MI	5388	2524	7951	2166	9849	1795	11071	1482	12703	950	15941	425	13601
18-#11	2.92	MA	9529	2524	12976	2259	16814	1885	19314	1561	22609	1030	29286	537	24633
6L-5S		MI	5599	2524	8278	2155	10279	1784	11617	1466	13458	945	16960	509	13886
18-#11	2.92	MA	9196	2524	12351	2271	15991	1895	18330	1583	21284	1050	27486	494	23574
7L-4S		MI	5755	2524	8613	2142	10752	1766	12177	1457	14232	933	18011	577	14354
18-#11	2.92	MA	8878	2524	11662	2291	15142	1914	17333	1593	19964	1063	25740	437	22524
8L-3S		MI	5916	2524	8987	2129	11241	1755	12800	1441	15083	928	19066	642	14453
18-#11	2.92	MA	8475	2524	11061	2305	14355	1927	16328	1611	18662	1084	23945	372	21328
9L-2S		MI	6184	2524	9521	2117	11916	1744	13617	1433	16182	916	20555	757	14505
18-#14	4.22	MA	10619	2889	15635	2507	20091	2078	23215	1691	27776	1039	36550	378	33686
6L-5S		MI	6191	2889	9834	2387	12169	1957	13870	1576	16455	933	20835	332	19106
18-#14	4.22	MA	10189	2889	14738	2524	18912	2091	21816	1722	25876	1067	33958	316	32013
7L-4S		MI	6405	2889	10312	2369	12845	1932	14668	1565	17558	917	22307	429	19664
18-#14	4.22	MA	9745	2889	13751	2553	17696	2118	20388	1736	23983	1085	31449	231	30031
8L-3S		MI	6579	2889	10846	2352	13541	1918	15556	1544	18771	911	23786	521	20295
18-#14	4.22	MA	9209	2889	12897	2572	16567	2136	18948	1762	22116	1113	28865	136	28060
9L-2S		MI	6915	2889	11603	2334	14499	1903	16716	1532	20332	896	25869	686	20417
20-#10	2.65	MA	9489	2445	12629	2208	16464	1844	18950	1534	22180	1029	28674	606	22949
6E		MI	5397	2445	7757	2124	9696	1765	10930	1464	12554	960	15920	525	12746
20-#10	2.65	MA	9213	2445	12115	2218	15788	1853	18132	1551	21093	1046	27206	571	22322
7L-5S		MI	5573	2445	8034	2115	10051	1755	11381	1451	13178	955	16781	596	12983
20-#10	2.65	MA	8948	2445	11549	2235	15091	1868	17313	1560	20010	1057	25776	527	21485
8L-4S		MI	5709	2445	8310	2104	10442	1740	11844	1442	13818	944	17672	650	13272
20-#10	2.65	MA	8616	2445	11051	2246	14445	1880	16488	1575	18942	1074	24311	474	20604
9L-3S		MI	5838	2445	8620	2093	10846	1730	12360	1429	14523	939	18563	705	13337
20-#10	2.65	MA	8307	2445	10539	2255	13812	1891	15694	1586	17830	1082	22878	435	19744
10L-2S		MI	6076	2445	9063	2082	11407	1721	13038	1420	15437	928	19827	798	13373
20-#11	3.25	MA	9996	2616	13969	2316	18069	1927	20833	1588	24654	1027	32117	532	27521
6E		MI	5623	2616	8485	2223	10524	1837	11887	1509	13802	946	17430	417	15093
20-#11	3.25	MA	9679	2616	13343	2328	17247	1937	19848	1610	23329	1047	30318	490	26453
7L-5S		MI	5839	2616	8812	2212	10954	1826	12433	1493	14557	941	18449	501	15398
20-#11	3.25	MA	9366	2616	12654	2349	16398	1956	18851	1620	22009	1060	28571	432	25394
8L-4S		MI	5995	2616	9146	2199	11427	1808	12993	1484	15331	929	19501	568	15854

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

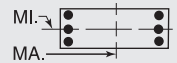
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.25	MA	8979	2616	12054	2362	15611	1969	17847	1638	20707	1080	26776	367	24202
9L-3S		MI	6132	2616	9521	2187	11916	1797	13617	1468	16182	924	20555	634	15998
20-#11	3.25	MA	8618	2616	11431	2373	14839	1983	16879	1650	19372	1091	25025	317	22946
10L-2S		MI	6390	2616	10054	2174	12590	1787	14433	1460	17281	913	22044	748	16056
20-#14	4.69	MA	10858	3022	16158	2606	20708	2152	23989	1761	28801	1062	38008	309	36107
7L-5S		MI	6499	3022	10592	2469	13128	2017	15029	1615	18016	928	22919	316	21266
20-#14	4.69	MA	10421	3022	15171	2635	19492	2179	22560	1775	26908	1080	35499	224	34133
8L-4S		MI	6711	3022	11070	2452	13803	1993	15827	1604	19119	912	24390	414	21801
20-#14	4.69	MA	9911	3022	14317	2655	18364	2197	21121	1801	25041	1108	32915	129	32153
9L-3S		MI	6872	3022	11603	2435	14499	1979	16716	1582	20332	907	25869	506	22484
22-#10	2.91	MA	9612	2520	12932	2265	16822	1887	19382	1573	22776	1043	29537	567	24694
7L-6S		MI	5594	2520	8201	2171	10257	1799	11608	1486	13467	957	17183	521	14012
22-#10	2.91	MA	9350	2520	12366	2282	16125	1903	18563	1582	21694	1054	28107	523	23859
8L-5S		MI	5766	2520	8477	2162	10612	1790	12060	1472	14092	952	18044	592	14241
22-#10	2.91	MA	9029	2520	11868	2293	15478	1914	17739	1597	20625	1071	26642	470	22972
9L-4S		MI	5901	2520	8754	2151	11003	1774	12522	1464	14732	941	18936	646	14553
22-#10	2.91	MA	8732	2520	11356	2302	14846	1926	16944	1608	19514	1080	25209	431	22107
10L-3S		MI	6024	2520	9063	2140	11407	1765	13038	1450	15437	936	19827	701	14623
22-#10	2.91	MA	8450	2520	10855	2312	14203	1936	16162	1619	18417	1094	23818	384	21099
11L-2S		MI	6255	2520	9507	2129	11968	1755	13717	1442	16350	925	21090	794	14664
22-#11	3.57	MA	10151	2707	14336	2386	18502	1979	21367	1637	25374	1043	33149	485	29331
7L-6S		MI	5870	2707	9018	2281	11199	1879	12703	1536	14901	943	18920	408	16589
22-#11	3.57	MA	9842	2707	13647	2406	17654	1998	20370	1647	24054	1057	31402	428	28265
8L-5S		MI	6062	2707	9345	2270	11628	1868	13250	1520	15656	938	19939	493	16913
22-#11	3.57	MA	9469	2707	13047	2420	16866	2011	19366	1665	22752	1077	29607	362	27076
9L-4S		MI	6216	2707	9680	2257	12102	1850	13809	1511	16430	926	20990	560	17353
22-#11	3.57	MA	9124	2707	12424	2431	16095	2025	18398	1677	21416	1087	27856	312	25815
10L-3S		MI	6345	2707	10054	2244	12590	1840	14433	1495	17281	921	22044	626	17543
22-#14	5.16	MA	11079	3154	16591	2718	21288	2240	24733	1814	29834	1075	39550	218	38235
8L-5S		MI	6803	3154	11350	2552	14086	2078	16189	1654	19577	923	25002	301	23430
22-#14	5.16	MA	10592	3154	15736	2738	20160	2258	23293	1840	27966	1103	36966	123	36246
9L-4S		MI	7013	3154	11827	2535	14762	2054	16987	1643	20680	907	26473	398	23944
24-#10	3.17	MA	9743	2594	13183	2329	17158	1937	19814	1604	23377	1052	30438	519	26232
8L-6S		MI	5788	2594	8644	2217	10818	1834	12286	1508	14381	954	18447	517	15280
24-#10	3.17	MA	9433	2594	12685	2340	16512	1948	18989	1619	22309	1069	28973	466	25339
9L-5S		MI	5955	2594	8921	2209	11173	1824	12738	1494	15005	949	19308	588	15502
24-#10	3.17	MA	9147	2594	12174	2349	15879	1960	18194	1630	21197	1077	27540	427	24469
10L-4S		MI	6089	2594	9197	2198	11564	1809	13200	1486	15645	938	20200	642	15834
24-#10	3.17	MA	8876	2594	11672	2359	15237	1970	17412	1641	20101	1091	26149	380	23464
11L-3S		MI	6214	2594	9507	2187	11968	1799	13717	1472	16350	933	21090	697	15909
24-#11	3.90	MA	10307	2799	14640	2464	18909	2040	21889	1674	26099	1053	34234	423	31135
8L-6S		MI	6095	2799	9551	2338	11874	1921	13519	1563	16000	939	20409	400	18090
24-#11	3.90	MA	9949	2799	14039	2477	18122	2053	20884	1692	24797	1073	32439	358	29950
9L-5S		MI	6280	2799	9879	2327	12303	1910	14066	1547	16755	934	21428	485	18432
24-#11	3.90	MA	9617	2799	13416	2488	17351	2067	19917	1704	23461	1084	30688	308	28683
10L-4S		MI	6433	2799	10213	2314	12777	1893	14625	1538	17529	923	22480	552	18856
24-#14	5.63	MA	11258	3287	17156	2821	21956	2319	25466	1879	30892	1098	41016	116	40339
9L-5S		MI	7101	3287	12107	2635	15045	2139	17348	1693	21138	918	27085	285	25598

RECTANGULAR TIED COLUMNS 24" x 42"

4-#18	1.59	MA	10135	2253	13110	2047	16981	1711	19405	1441	22476	1020	28475	885	15786
2E		MI	5443	2253	7765	1941	9531	1621	10612	1363	11958	957	14367	775	8291
6-#14	1.34	MA	9823	2179	12204	2014	15951	1688	18221	1429	20937	1030	26387	896	13524
2L-3S		MI	4861	2179	6539	1935	8083	1620	8915	1369	9719	988	11643	655	7185
6-#14	1.34	MA	8857	2179	10701	2039	14050	1712	15921	1451	17842	1059	22101	751	13424
3L-2S		MI	5332	2179	7296	1917	9042	1606	10074	1358	11280	973	13727	820	7189

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



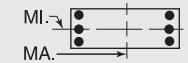
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	2.38	MA	11301	2489	15740	2194	20308	1819	23429	1511	27894	1011	35977	873	23466
2L-3S		MI	5237	2489	7765	2116	9531	1751	10612	1448	11958	970	14367	441	11955
6-#18	2.38	MA	9790	2489	13110	2237	16981	1859	19405	1547	22476	1059	28475	609	23007
3L-2S		MI	5970	2489	9070	2088	11182	1729	12610	1432	14647	948	17843	734	12116
8-#10	1.01	MA	9350	2081	10963	1967	14523	1656	16567	1412	18780	1042	23452	909	10374
2L-4S		MI	4684	2081	5881	1905	7367	1603	8086	1371	8653	1008	10450	716	5603
8-#10	1.01	MA	8771	2081	10099	1982	13430	1670	15245	1425	17000	1060	20988	830	10350
3E		MI	4857	2081	6191	1893	7771	1593	8602	1357	9358	1003	11340	771	5611
8-#10	1.01	MA	8436	2081	9512	1997	12661	1684	14260	1444	15653	1072	19366	779	10254
4L-2S		MI	5143	2081	6634	1882	8332	1584	9280	1349	10271	992	12604	864	5602
8-#11	1.24	MA	9693	2149	11817	2001	15521	1680	17731	1425	20307	1035	25536	901	12592
2L-4S		MI	4750	2149	6182	1935	7670	1623	8409	1382	9051	997	10922	659	6704
8-#11	1.24	MA	9013	2149	10767	2019	14193	1697	16125	1441	18144	1055	22541	802	12546
3E		MI	4952	2149	6556	1922	8159	1613	9033	1366	9903	992	11976	725	6733
8-#11	1.24	MA	8620	2149	10051	2037	13256	1713	14925	1464	16503	1069	20557	739	12376
4L-2S		MI	5286	2149	7090	1910	8834	1602	9849	1357	11002	981	13465	839	6729
8-#14	1.79	MA	10520	2312	13707	2096	17852	1749	20520	1468	24033	1025	30673	889	17917
2L-4S		MI	4936	2312	6763	2035	8346	1696	9185	1430	10067	989	12247	548	9238
8-#14	1.79	MA	9611	2312	12204	2122	15951	1773	18221	1490	20937	1054	26387	744	17787
3E		MI	5206	2312	7296	2017	9042	1681	10074	1408	11280	983	13727	640	9385
8-#14	1.79	MA	9087	2312	11177	2147	14608	1796	16501	1522	18586	1073	23533	653	17316
4L-2S		MI	5654	2312	8054	2000	10000	1667	11233	1397	12841	968	15810	805	9417
8-#18	3.17	MA	12411	2724	18370	2341	23635	1927	27453	1580	33312	1002	43479	861	31138
2L-4S		MI	5405	2724	8144	2290	9975	1880	11070	1550	12546	965	15357	245	14122
8-#18	3.17	MA	11025	2724	15740	2384	20308	1967	23429	1617	27894	1050	35977	597	30644
3E		MI	5811	2724	9070	2263	11182	1859	12610	1517	14647	961	17843	400	15696
8-#18	3.17	MA	10237	2724	13936	2427	17950	2007	20411	1671	23766	1081	30929	433	27416
4L-2S		MI	6469	2724	10376	2235	12834	1837	14607	1501	17337	939	21318	694	15917
10-#10	1.26	MA	9775	2156	11827	2014	15616	1690	17889	1434	20560	1040	25916	905	12903
2L-5S		MI	4758	2156	6048	1962	7536	1652	8302	1401	8926	1017	10821	658	6819
10-#10	1.26	MA	9218	2156	10963	2029	14523	1704	16567	1447	18780	1057	23452	826	12868
3L-4S		MI	4902	2156	6325	1951	7928	1637	8764	1393	9566	1006	11713	712	6891
10-#10	1.26	MA	8902	2156	10375	2044	13754	1719	15582	1466	17433	1069	21831	775	12760
4L-3S		MI	5066	2156	6634	1940	8332	1628	9280	1379	10271	1000	12604	767	6911
10-#10	1.26	MA	8551	2156	9840	2057	13014	1738	14707	1479	16219	1086	20099	730	12501
5L-2S		MI	5344	2156	7078	1929	8893	1618	9959	1371	11185	989	13868	860	6911
10-#11	1.55	MA	10192	2241	12867	2059	16849	1722	19338	1452	22470	1031	28531	896	15663
2L-5S		MI	4840	2241	6381	2005	7871	1683	8666	1418	9377	1006	11360	584	7966
10-#11	1.55	MA	9540	2241	11817	2076	15521	1739	17731	1468	20307	1052	25536	797	15602
3L-4S		MI	5005	2241	6715	1993	8345	1666	9225	1409	10150	994	12411	651	8243
10-#11	1.55	MA	9173	2241	11101	2094	14584	1756	16532	1491	18666	1065	23552	734	15419
4L-3S		MI	5196	2241	7090	1980	8834	1655	9849	1393	11002	989	13465	717	8290
10-#11	1.55	MA	8757	2241	10454	2111	13682	1779	15466	1506	17188	1086	21437	676	14760
5L-2S		MI	5518	2241	7623	1967	9508	1644	10665	1384	12101	977	14955	831	8300
10-#14	2.23	MA	11192	2444	15209	2179	19753	1810	22819	1507	27129	1020	34960	882	22305
2L-5S		MI	5063	2444	7043	2135	8629	1781	9547	1480	10525	1000	12859	435	10625
10-#14	2.23	MA	10331	2444	13707	2204	17852	1833	20520	1529	24033	1049	30673	737	22153
3L-4S		MI	5288	2444	7520	2118	9305	1757	10345	1468	11628	984	14330	532	11314
10-#14	2.23	MA	9853	2444	12680	2230	16509	1857	18800	1561	21681	1068	27819	646	21686
4L-3S		MI	5540	2444	8054	2100	10000	1742	11233	1447	12841	978	15810	624	11578
10-#14	2.23	MA	9274	2444	11759	2253	15216	1891	17271	1583	19561	1096	24782	561	19984
5L-2S		MI	5967	2444	8812	2083	10959	1728	12392	1436	14402	963	17893	789	11632
10-#18	3.97	MA	12200	2959	18370	2531	23635	2076	27453	1686	33312	1041	43479	585	38294
3L-4S		MI	5988	2959	9449	2437	11627	1989	13067	1619	15235	956	18833	205	17753

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

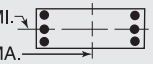


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.97	MA	11511	2959	16566	2575	21277	2116	24435	1740	29184	1072	38431	421	35021
4L-3S		MI	6345	2959	10376	2410	12834	1967	14607	1586	17337	952	21318	360	19441
10-#18	3.97	MA	10541	2959	14969	2618	19002	2173	21747	1777	25458	1120	33081	261	31744
5L-2S		MI	6953	2959	11681	2382	14485	1945	16605	1570	20026	930	24794	654	19707
12-#10	1.51	MA	10189	2231	12691	2061	16709	1725	19210	1456	22340	1037	28380	901	15430
2L-6S		MI	4771	2231	6215	2018	7743	1696	8529	1437	9215	1019	11224	583	7773
12-#10	1.51	MA	9651	2231	11827	2076	15616	1739	17889	1469	20560	1054	25916	822	15385
3L-5S		MI	4972	2231	6492	2009	8097	1687	8980	1423	9840	1014	12085	654	8053
12-#10	1.51	MA	9353	2231	11239	2091	14847	1753	16904	1488	19212	1066	24295	771	15269
4E		MI	5114	2231	6768	1998	8489	1671	9443	1415	10479	1003	12977	708	8175
12-#10	1.51	MA	9007	2231	10704	2104	14107	1773	16029	1501	17999	1083	22563	726	15002
5L-3S		MI	5271	2231	7078	1987	8893	1662	9959	1401	11185	998	13868	763	8206
12-#10	1.51	MA	8611	2231	10135	2112	13415	1784	15199	1515	16819	1095	21056	671	14263
6L-2S		MI	5540	2231	7521	1976	9454	1652	10637	1393	12098	987	15131	856	8214
12-#11	1.86	MA	10675	2333	13917	2116	18178	1764	20944	1479	24633	1028	31526	891	18732
2L-6S		MI	4855	2333	6587	2074	8117	1736	8935	1460	9720	1007	11830	491	9144
12-#11	1.86	MA	10050	2333	12867	2134	16849	1781	19338	1495	22470	1048	28531	792	18658
3L-5S		MI	5091	2333	6914	2063	8546	1725	9482	1445	10476	1002	12849	576	9454
12-#11	1.86	MA	9707	2333	12151	2152	15913	1798	18138	1518	20830	1062	26547	730	18467
4E		MI	5253	2333	7249	2050	9020	1708	10042	1436	11249	991	13901	643	9781
12-#11	1.86	MA	9298	2333	11504	2168	15011	1821	17072	1533	19351	1083	24432	671	17792
5L-3S		MI	5434	2333	7623	2037	9508	1697	10665	1420	12101	986	14955	708	9842
12-#11	1.86	MA	8832	2333	10812	2178	14177	1836	16059	1549	17912	1096	22592	603	16943
6L-2S		MI	5745	2333	8156	2024	10183	1686	11481	1411	13200	974	16444	823	9863
12-#14	2.68	MA	11026	2577	15209	2287	19753	1894	22819	1568	27129	1044	34960	731	26523
3L-5S		MI	5408	2577	7800	2218	9587	1842	10706	1519	12086	995	14942	419	12755
12-#14	2.68	MA	10588	2577	14183	2312	18410	1918	21100	1600	24777	1063	32105	640	26061
4E		MI	5629	2577	8278	2200	10263	1817	11504	1507	13189	979	16413	517	13407
12-#14	2.68	MA	10020	2577	13261	2336	17117	1952	19570	1622	22657	1091	29069	554	24348
5L-3S		MI	5875	2577	8812	2183	10959	1803	12392	1486	14402	973	17893	609	13767
12-#14	2.68	MA	9394	2577	12270	2350	15930	1973	18117	1644	20592	1110	26426	453	22783
6L-2S		MI	6270	2577	9569	2166	11918	1789	13552	1474	15963	958	19976	774	13840
12-#18	4.76	MA	12727	3195	19196	2722	24604	2224	28459	1810	34602	1063	45933	409	42627
4E		MI	6546	3195	10755	2585	13278	2097	15065	1689	17925	947	22308	165	21408
12-#18	4.76	MA	11775	3195	17599	2765	22329	2281	25771	1846	30876	1111	40583	249	39313
5L-3S		MI	6863	3195	11681	2557	14485	2075	16605	1655	20026	943	24794	320	23192
12-#18	4.76	MA	10805	3195	15861	2787	20276	2321	23152	1901	27248	1142	35924	62	35499
6L-2S		MI	7428	3195	12987	2530	16137	2053	18602	1639	22715	922	28270	614	23492
14-#10	1.76	MA	10072	2305	12691	2122	16709	1773	19210	1491	22340	1051	28380	818	17903
3L-6S		MI	4986	2305	6659	2065	8304	1731	9207	1458	10129	1016	12488	579	9026
14-#10	1.76	MA	9790	2305	12103	2137	15940	1787	18226	1510	20992	1063	26759	767	17780
4L-5S		MI	5181	2305	6935	2056	8658	1721	9659	1445	10753	1011	13349	650	9293
14-#10	1.76	MA	9449	2305	11568	2150	15200	1807	17351	1523	19779	1081	25027	722	17494
5L-4S		MI	5321	2305	7211	2045	9050	1706	10121	1436	11393	1000	14241	704	9458
14-#10	1.76	MA	9068	2305	10999	2159	14508	1819	16521	1537	18598	1092	23521	667	16774
6L-3S		MI	5471	2305	7521	2034	9454	1696	10637	1423	12098	995	15131	759	9497
14-#10	1.76	MA	8733	2305	10456	2169	13794	1828	15651	1553	17451	1110	21977	633	16179
7L-2S		MI	5732	2305	7964	2023	10015	1687	11316	1414	13012	984	16395	852	9513
14-#11	2.17	MA	10545	2425	13917	2191	18178	1823	20944	1522	24633	1045	31526	787	21715
3L-6S		MI	5107	2425	7120	2131	8792	1778	9752	1487	10819	1004	13320	483	10653
14-#11	2.17	MA	10223	2425	13201	2209	17241	1840	19745	1545	22993	1059	29542	725	21517
4L-5S		MI	5335	2425	7447	2120	9221	1768	10298	1472	11575	999	14338	567	10949
14-#11	2.17	MA	9821	2425	12554	2225	16339	1864	18679	1560	21514	1079	27427	667	20827
5L-4S		MI	5495	2425	7782	2107	9695	1750	10858	1463	12348	987	15390	635	11318
14-#11	2.17	MA	9374	2425	11862	2235	15505	1878	17666	1576	20075	1093	25587	598	19999
6L-3S		MI	5667	2425	8156	2095	10183	1739	11481	1447	13200	982	16444	700	11391
14-#11	2.17	MA	8981	2425	11201	2247	14636	1889	16618	1597	18676	1113	23695	556	18957
7L-2S		MI	5967	2425	8690	2082	10858	1728	12298	1438	14299	970	17934	815	11422

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



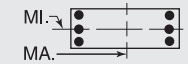
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.13	MA	11298	2709	15685	2395	20311	1979	23399	1639	27873	1058	36391	633	30440
4L-5S		MI	5742	2709	8558	2301	10546	1903	11865	1558	13647	990	17025	404	14893
14-#14	3.13	MA	10738	2709	14764	2419	19018	2012	21870	1661	25752	1086	33355	547	28711
5L-4S		MI	5978	2709	9036	2283	11222	1878	12663	1546	14750	974	18496	501	15513
14-#14	3.13	MA	10145	2709	13773	2432	17831	2034	20417	1683	23688	1105	30712	446	27129
6L-3S		MI	6188	2709	9569	2266	11918	1864	13552	1525	15963	968	19976	593	15956
14-#14	3.13	MA	9623	2709	12825	2450	16585	2049	18927	1714	21682	1134	27987	384	25335
7L-2S		MI	6563	2709	10327	2248	12876	1849	14711	1513	17524	953	22059	759	16045
14-#18	5.56	MA	13027	3430	20229	2912	25656	2390	29795	1916	36294	1102	48085	236	46883
5L-4S		MI	7086	3430	12060	2732	14930	2205	17062	1758	20614	939	25784	125	25082
14-#18	5.56	MA	12062	3430	18491	2934	23603	2429	27176	1970	32666	1133	43426	49	43090
6L-3S		MI	7368	3430	12987	2704	16137	2183	18602	1724	22715	934	28270	280	26948
14-#18	5.56	MA	11265	3430	16828	2964	21417	2453	24644	2007	29138	1181	38596	-63	38307
7L-2S		MI	7896	3430	14292	2677	17788	2162	20600	1709	25405	913	31745	573	27275
16-#10	2.02	MA	10216	2380	12967	2184	17032	1822	19547	1532	22772	1060	29223	764	20293
4L-6S		MI	5196	2380	7102	2111	8864	1765	9885	1480	11042	1013	13752	575	10283
16-#10	2.02	MA	9879	2380	12432	2197	16293	1841	18673	1545	21558	1078	27491	718	19990
5E		MI	5385	2380	7379	2103	9219	1755	10337	1467	11667	1008	14613	646	10539
16-#10	2.02	MA	9512	2380	11863	2205	15601	1853	17842	1559	20378	1090	25985	663	19287
6L-4S		MI	5524	2380	7655	2091	9610	1740	10799	1458	12306	997	15504	700	10740
16-#10	2.02	MA	9192	2380	11320	2216	14887	1862	16973	1575	19231	1107	24441	630	18686
7L-3S		MI	5667	2380	7964	2080	10015	1731	11316	1445	13012	992	16395	755	10787
16-#10	2.02	MA	8896	2380	10723	2233	14151	1878	16108	1584	18089	1119	22935	586	17782
8L-2S		MI	5920	2380	8408	2069	10575	1721	11994	1436	13925	981	17659	848	10809
16-#11	2.48	MA	10726	2517	14251	2266	18569	1882	21351	1572	25156	1055	32537	720	24571
4L-6S		MI	5353	2517	7654	2189	9467	1821	10568	1514	11918	1001	14809	475	12165
16-#11	2.48	MA	10328	2517	13604	2283	17667	1906	20285	1587	23677	1076	30422	662	23866
5E		MI	5573	2517	7981	2177	9896	1810	11115	1499	12674	996	15828	559	12450
16-#11	2.48	MA	9900	2517	12912	2292	16833	1921	19272	1603	22238	1089	28582	593	23054
6L-4S		MI	5731	2517	8316	2165	10370	1792	11674	1490	13447	984	16879	626	12855
16-#11	2.48	MA	9527	2517	12251	2305	15964	1931	18225	1624	20840	1110	26690	551	22003
7L-3S		MI	5894	2517	8690	2152	10858	1781	12298	1474	14299	979	17934	692	12938
16-#11	2.48	MA	9178	2517	11524	2326	15068	1950	17171	1635	19447	1124	24850	495	20961
8L-2S		MI	6186	2517	9223	2139	11533	1770	13114	1465	15398	967	19423	806	12977
16-#14	3.57	MA	11434	2842	16267	2502	20918	2073	24169	1700	28848	1081	37641	540	33075
5E		MI	6083	2842	9316	2383	11504	1964	13025	1597	15208	985	19108	388	17038
16-#14	3.57	MA	10871	2842	15276	2515	19732	2095	22716	1722	26784	1100	34999	439	31475
6L-4S		MI	6299	2842	9793	2366	12180	1939	13823	1585	16311	969	20580	486	17631
16-#14	3.57	MA	10381	2842	14328	2533	18486	2109	21226	1753	24778	1129	32273	377	29687
7L-3S		MI	6493	2842	10327	2349	12876	1925	14711	1564	17524	963	22059	578	18145
16-#14	3.57	MA	9895	2842	13285	2562	17201	2136	19716	1767	22780	1148	29629	294	27647
8L-2S		MI	6851	2842	11085	2331	13835	1910	15870	1552	19085	948	24142	743	18247
16-#18	6.35	MA	13358	3666	21121	3082	26930	2538	31200	2039	38083	1124	50928	37	50682
6L-4S		MI	7613	3666	13366	2879	16581	2313	19060	1827	23304	930	29259	84	28771
16-#18	6.35	MA	12543	3666	19458	3111	24744	2561	28668	2076	34556	1173	46098	-75	45603
7L-3S		MI	7864	3666	14292	2851	17788	2291	20600	1794	25405	926	31745	239	30632
18-#10	2.27	MA	10299	2455	13296	2244	17386	1876	19995	1567	23338	1075	29956	714	22488
5L-6S		MI	5401	2455	7545	2158	9425	1799	10564	1502	11956	1011	15015	571	11543
18-#10	2.27	MA	9945	2455	12727	2252	16694	1887	19164	1580	22158	1087	28449	660	21801
6L-5S		MI	5585	2455	7822	2149	9780	1790	11015	1489	12580	1005	15876	642	11790
18-#10	2.27	MA	9637	2455	12184	2262	15980	1896	18295	1597	21011	1104	26905	626	21193
7L-4S		MI	5722	2455	8098	2138	10171	1775	11478	1480	13220	994	16768	696	12021
18-#10	2.27	MA	9348	2455	11587	2280	15244	1912	17430	1606	19869	1116	25400	582	20291
8L-3S		MI	5859	2455	8408	2127	10575	1765	11994	1467	13925	989	17659	751	12075

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

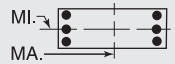


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.27	MA	8982	2455	11058	2290	14562	1924	16560	1622	18732	1133	23859	530	19414
9L-2S		MI	6106	2455	8851	2116	11136	1755	12673	1458	14838	978	18922	844	12103
18-#11	2.79	MA	10823	2609	14654	2340	18995	1948	21892	1614	25840	1072	33417	657	26909
5L-6S		MI	5593	2609	8187	2246	10141	1863	11384	1541	13017	997	16298	467	13682
18-#11	2.79	MA	10412	2609	13962	2350	18161	1963	20879	1630	24401	1086	31577	588	26109
6L-5S		MI	5806	2609	8514	2235	10571	1852	11931	1526	13773	992	17317	551	13956
18-#11	2.79	MA	10056	2609	13301	2362	17292	1973	19831	1651	23003	1106	29685	546	25048
7L-4S		MI	5963	2609	8849	2222	11045	1834	12490	1517	14546	980	18369	618	14392
18-#11	2.79	MA	9714	2609	12574	2383	16396	1992	18778	1662	21610	1120	27845	490	24001
8L-3S		MI	6118	2609	9223	2209	11533	1823	13114	1501	15398	975	19423	684	14484
18-#11	2.79	MA	9284	2609	11936	2396	15565	2006	17717	1680	20236	1141	25957	425	22710
9L-2S		MI	6399	2609	9757	2197	12208	1813	13930	1492	16497	963	20912	798	14531
18-#14	4.02	MA	11576	2974	16778	2598	21633	2156	25015	1761	29879	1095	39285	432	35820
6L-5S		MI	6399	2974	10073	2466	12463	2024	14184	1636	16769	980	21191	373	19190
18-#14	4.02	MA	11115	2974	15831	2615	20387	2170	23525	1792	27874	1124	36559	370	34039
7L-4S		MI	6613	2974	10551	2449	13139	2000	14982	1624	17872	964	22663	470	19757
18-#14	4.02	MA	10638	2974	14788	2645	19102	2197	22016	1806	25875	1143	33915	288	31989
8L-3S		MI	6792	2974	11085	2431	13835	1986	15870	1603	19085	959	24142	562	20333
18-#14	4.02	MA	10065	2974	13879	2665	17910	2216	20495	1833	23904	1172	31197	193	29968
9L-2S		MI	7134	2974	11842	2414	14793	1971	17030	1591	20646	943	26225	728	20448
18-#18	7.14	MA	13880	3901	22088	3258	28071	2670	32692	2145	39974	1164	53599	-88	52850
7L-4S		MI	8129	3901	14671	3026	18233	2421	21057	1896	25993	921	32735	44	32474
20-#10	2.52	MA	10367	2530	13591	2299	17787	1922	20486	1602	23937	1084	30913	656	24316
6E		MI	5603	2530	7989	2205	9986	1834	11242	1524	12869	1008	16279	567	12805
20-#10	2.52	MA	10072	2530	13048	2309	17073	1931	19616	1619	22791	1101	29370	622	23700
7L-5S		MI	5781	2530	8265	2196	10341	1824	11694	1511	13493	1003	17140	638	13043
20-#10	2.52	MA	9787	2530	12451	2326	16337	1947	18752	1628	21648	1113	27864	578	22800
8L-4S		MI	5917	2530	8542	2185	10732	1809	12156	1502	14133	992	18032	692	13303
20-#10	2.52	MA	9433	2530	11922	2337	15655	1958	17881	1644	20511	1130	26323	526	21917
9L-3S		MI	6049	2530	8851	2174	11136	1799	12673	1489	14838	986	18922	747	13363
20-#10	2.52	MA	9104	2530	11382	2346	14987	1970	17043	1655	19338	1138	24814	488	21015
10L-2S		MI	6289	2530	9295	2163	11697	1790	13351	1480	15752	975	20186	840	13395
20-#11	3.10	MA	10911	2700	15012	2407	19490	2005	22485	1657	26564	1082	34572	584	29164
6E		MI	5829	2700	8721	2303	10816	1905	12200	1568	14116	994	17788	458	15202
20-#11	3.10	MA	10571	2700	14351	2420	18620	2015	21438	1678	25166	1103	32680	541	28093
7L-5S		MI	6035	2700	9048	2292	11246	1894	12747	1553	14872	989	18807	543	15466
20-#11	3.10	MA	10234	2700	13624	2440	17724	2035	20385	1689	23773	1117	30840	485	27037
8L-4S		MI	6205	2700	9382	2279	11719	1876	13306	1544	15645	977	19858	610	15930
20-#11	3.10	MA	9821	2700	12986	2454	16893	2048	19324	1707	22399	1137	28952	421	25750
9L-3S		MI	6345	2700	9757	2267	12208	1866	13930	1528	16497	972	20912	675	16029
20-#11	3.10	MA	9436	2700	12327	2465	16079	2062	18302	1720	20975	1148	27107	372	24473
10L-2S		MI	6607	2700	10290	2254	12883	1855	14746	1519	17596	960	22402	790	16083
20-#14	4.46	MA	11829	3107	17333	2698	22288	2231	25824	1831	30969	1119	40846	363	38391
7L-5S		MI	6709	3107	10831	2549	13421	2085	15343	1674	18330	975	23275	358	21347
20-#14	4.46	MA	11358	3107	16290	2728	21003	2258	24315	1845	28971	1138	38201	281	36330
8L-4S		MI	6921	3107	11309	2532	14097	2061	16141	1663	19433	959	24746	455	21891
20-#14	4.46	MA	10813	3107	15382	2747	19811	2277	22794	1872	27000	1167	35483	186	34300
9L-3S		MI	7087	3107	11842	2514	14793	2046	17030	1642	20646	954	26225	547	22522
22-#10	2.77	MA	10498	2604	13912	2356	18166	1965	20938	1641	24570	1098	31834	618	26207
7L-6S		MI	5800	2604	8432	2251	10547	1868	11921	1546	13783	1005	17543	563	14070
22-#10	2.77	MA	10216	2604	13315	2373	17430	1981	20074	1650	23428	1110	30328	574	25310
8L-5S		MI	5974	2604	8709	2243	10902	1858	12372	1533	14407	1000	18404	634	14301
22-#10	2.77	MA	9874	2604	12786	2384	16748	1992	19203	1666	22291	1127	28788	522	24421
9L-4S		MI	6110	2604	8985	2232	11293	1843	12835	1524	15047	989	19296	688	14584
22-#10	2.77	MA	9556	2604	12246	2393	16080	2004	18365	1677	21118	1136	27279	484	23520
10L-3S		MI	6235	2604	9295	2221	11697	1834	13351	1510	15752	984	20186	743	14649
22-#10	2.77	MA	9255	2604	11716	2404	15397	2014	17540	1688	19961	1150	25813	438	22482
11L-2S		MI	6470	2604	9738	2209	12258	1824	14029	1502	16665	973	21450	836	14687

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
22-#11	3.40	MA	11075	2792	15401	2477	19949	2058	23044	1705	27329	1100	35675	536	31138
7L-6S		MI	6077	2792	9254	2361	11491	1947	13017	1595	15215	990	19277	450	16698
22-#11	3.40	MA	10742	2792	14674	2498	19052	2077	21991	1716	25936	1113	33835	481	30074
8L-5S		MI	6272	2792	9581	2350	11920	1936	13563	1579	15971	985	20296	535	16980
22-#11	3.40	MA	10345	2792	14036	2511	18221	2090	20930	1734	24562	1134	31947	416	28791
9L-4S		MI	6426	2792	9916	2337	12394	1919	14123	1571	16744	973	21348	602	17430
22-#11	3.40	MA	9976	2792	13377	2522	17407	2104	19909	1747	23138	1144	30102	367	27508
10L-3S		MI	6558	2792	10290	2324	12883	1908	14746	1555	17596	968	22402	667	17574
22-#11	3.40	MA	9624	2792	12733	2535	16584	2117	18903	1760	21728	1162	28311	309	26194
11L-2S		MI	6812	2792	10824	2311	13557	1897	15563	1546	18695	956	23891	782	17635
22-#14	4.91	MA	12060	3239	17793	2811	22904	2319	26614	1884	32067	1133	42488	274	40671
8L-5S		MI	7013	3239	11589	2632	14380	2146	16503	1713	19891	970	25358	342	23509
22-#14	4.91	MA	11540	3239	16884	2830	21712	2338	25093	1910	30095	1162	39770	180	38632
9L-4S		MI	7224	3239	12066	2614	15056	2122	17301	1702	20994	954	26829	440	24032
24-#10	3.02	MA	10636	2679	14179	2420	18523	2015	21396	1672	25208	1107	32792	570	27819
8L-6S		MI	5995	2679	8876	2298	11108	1902	12599	1568	14696	1002	18806	559	15337
24-#10	3.02	MA	10304	2679	13650	2431	17841	2027	20525	1688	24071	1124	31252	518	26924
9L-5S		MI	6165	2679	9152	2289	11463	1893	13051	1554	15320	997	19667	630	15561
24-#10	3.02	MA	9999	2679	13110	2440	17173	2039	19687	1699	22897	1133	29743	480	26025
10L-4S		MI	6299	2679	9428	2278	11854	1878	13513	1546	15960	986	20559	684	15866
24-#10	3.02	MA	9709	2679	12580	2450	16490	2049	18862	1710	21740	1148	28277	434	24983
11L-3S		MI	6428	2679	9738	2267	12258	1868	14029	1532	16665	981	21450	739	15936
24-#10	3.02	MA	9377	2679	12061	2462	15758	2064	18018	1727	20587	1157	26792	395	23930
12L-2S		MI	6647	2679	10181	2256	12819	1858	14708	1524	17579	970	22714	832	15978
24-#11	3.71	MA	11239	2884	15724	2555	20381	2119	23598	1743	28099	1110	36830	476	33111
8L-6S		MI	6303	2884	9787	2418	12166	1989	13833	1622	16314	987	20767	442	18196
24-#11	3.71	MA	10856	2884	15086	2569	19549	2132	22537	1761	26725	1130	34942	411	31831
9L-5S		MI	6491	2884	10115	2407	12595	1978	14379	1606	17070	982	21785	526	18498
24-#11	3.71	MA	10502	2884	14427	2580	18735	2146	21515	1774	25301	1141	33097	362	30542
10L-4S		MI	6645	2884	10449	2394	13069	1961	14939	1598	17843	970	22837	593	18932
24-#11	3.71	MA	10166	2884	13783	2592	17912	2159	20509	1787	23891	1158	31306	304	29223
11L-3S		MI	6769	2884	10824	2382	13557	1950	15563	1582	18695	965	23891	659	19119
24-#14	5.36	MA	12249	3371	18387	2913	23613	2399	27392	1949	33191	1157	44056	173	42964
9L-5S		MI	7313	3371	12346	2714	15338	2207	17662	1752	21452	965	27441	327	25675

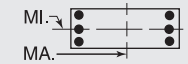
RECTANGULAR TIED COLUMNS 24" x 44"

4-#18	1.52	MA	11045	2338	14085	2137	18317	1788	20944	1508	24223	1073	30660	932	16650
2E		MI	5651	2338	8010	2019	9827	1688	10927	1421	12271	1003	14720	815	8319
6-#14	1.28	MA	10708	2264	13124	2104	17224	1765	19687	1496	22590	1083	28443	943	14253
2L-3S		MI	5065	2264	6778	2014	8377	1688	9229	1428	10033	1035	12000	696	7213
6-#14	1.28	MA	9678	2264	11538	2129	15218	1789	17261	1519	19323	1113	23920	800	14153
3L-2S		MI	5539	2264	7535	1997	9336	1674	10388	1417	11594	1020	14083	862	7212
6-#18	2.27	MA	12291	2573	16862	2284	21830	1896	25193	1578	29944	1064	38581	920	24762
2L-3S		MI	5440	2573	8010	2194	9827	1818	10927	1506	12271	1016	14720	481	12006
6-#18	2.27	MA	10677	2573	14085	2328	18317	1937	20944	1616	24223	1114	30660	660	24303
3L-2S		MI	6181	2573	9316	2167	11479	1796	12925	1490	14960	994	18196	775	12149
8-#11	1.18	MA	10567	2234	12714	2091	16768	1757	19167	1492	21921	1088	27540	948	13266
2L-4S		MI	4953	2234	6418	2015	7962	1692	8723	1441	9366	1045	11279	701	6734
8-#11	1.18	MA	9844	2234	11606	2109	15367	1774	17473	1508	19640	1109	24381	850	13220
3E		MI	5157	2234	6792	2002	8451	1681	9346	1426	10218	1040	12333	766	6756
8-#11	1.18	MA	9425	2234	10852	2128	14380	1791	16209	1531	17911	1123	22297	787	13050
4L-2S		MI	5493	2234	7326	1990	9126	1670	10163	1417	11317	1028	13823	881	6750

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

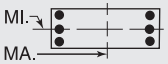


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#14	1.70	MA	11452	2397	14709	2186	19230	1826	22112	1535	25856	1078	32965	936	18889
2L-4S		MI	5139	2397	7002	2114	8640	1764	9500	1489	10382	1036	12603	589	9290
8-#14	1.70	MA	10482	2397	13124	2212	17224	1850	19687	1558	22590	1108	28443	793	18759
3E		MI	5412	2397	7535	2097	9336	1749	10388	1467	11594	1030	14083	681	9416
8-#14	1.70	MA	9924	2397	12042	2238	15809	1874	17875	1591	20112	1127	25445	702	18288
4L-2S		MI	5863	2397	8293	2080	10294	1735	11547	1456	13155	1015	16166	846	9442
8-#18	3.03	MA	13476	2809	19639	2431	25343	2004	29443	1647	35665	1055	46503	908	32866
2L-4S		MI	5583	2809	8389	2369	10272	1947	11385	1609	12859	1011	15710	286	14261
8-#18	3.03	MA	11993	2809	16862	2475	21830	2045	25193	1685	29944	1105	38581	647	32372
3E		MI	6017	2809	9316	2341	11479	1926	12925	1575	14960	1007	18196	441	15749
8-#18	3.03	MA	11151	2809	14961	2519	19344	2086	22011	1741	25592	1137	33279	485	29113
4L-2S		MI	6683	2809	10621	2314	13130	1904	14922	1559	17650	986	21672	735	15952
10-#10	1.20	MA	10652	2241	12721	2104	16864	1767	19329	1501	22182	1093	27933	952	13589
2L-5S		MI	4962	2241	6280	2043	7826	1721	8614	1461	9241	1064	11181	700	6860
10-#10	1.20	MA	10059	2241	11811	2119	15712	1782	17936	1514	20306	1111	25335	873	13554
3L-4S		MI	5106	2241	6556	2032	8218	1706	9077	1453	9881	1053	12073	754	6916
10-#10	1.20	MA	9723	2241	11192	2134	14903	1796	16899	1534	18887	1123	23633	823	13446
4L-3S		MI	5272	2241	6866	2021	8622	1696	9593	1439	10586	1048	12963	809	6932
10-#10	1.20	MA	9348	2241	10626	2147	14124	1816	15979	1547	17610	1141	21812	778	13187
5L-2S		MI	5551	2241	7309	2010	9183	1687	10272	1431	11500	1037	14227	902	6929
10-#11	1.48	MA	11099	2326	13821	2149	18169	1799	20861	1519	24202	1085	30698	943	16506
2L-5S		MI	5043	2326	6617	2085	8164	1751	8979	1477	9691	1053	11717	626	8042
10-#11	1.48	MA	10405	2326	12714	2167	16768	1816	19167	1535	21921	1106	27540	845	16445
3L-4S		MI	5209	2326	6951	2073	8637	1734	9539	1468	10465	1041	12769	693	8276
10-#11	1.48	MA	10014	2326	11960	2185	15781	1833	17904	1558	20193	1120	25456	783	16262
4L-3S		MI	5402	2326	7326	2060	9126	1723	10163	1453	11317	1036	13823	758	8316
10-#11	1.48	MA	9569	2326	11275	2201	14832	1857	16782	1575	18636	1141	23232	726	15642
5L-2S		MI	5726	2326	7859	2047	9801	1712	10979	1444	12416	1024	15312	873	8322
10-#14	2.13	MA	12169	2529	16295	2269	21235	1887	24538	1574	29122	1073	37488	929	23520
2L-5S		MI	5267	2529	7282	2214	8922	1849	9861	1539	10839	1047	13215	476	10719
10-#14	2.13	MA	11250	2529	14709	2295	19230	1911	22112	1597	25856	1103	32965	786	23368
3L-4S		MI	5491	2529	7759	2197	9598	1824	10659	1528	11942	1031	14686	573	11418
10-#14	2.13	MA	10740	2529	13628	2321	17815	1935	20301	1629	23378	1122	29967	696	22901
4L-3S		MI	5746	2529	8293	2180	10294	1810	11547	1506	13155	1025	16166	665	11611
10-#14	2.13	MA	10119	2529	12652	2344	16453	1969	18691	1652	21145	1152	26774	612	21168
5L-2S		MI	6177	2529	9051	2162	11253	1796	12707	1495	14716	1010	18249	831	11659
10-#18	3.79	MA	13245	3044	19639	2622	25343	2154	29443	1754	35665	1096	46503	635	40454
3L-4S		MI	6189	3044	9695	2516	11923	2055	13382	1678	15549	1003	19186	246	17885
10-#18	3.79	MA	12508	3044	17738	2667	22857	2195	26260	1810	31313	1128	41200	472	37145
4L-3S		MI	6553	3044	10621	2488	13130	2034	14922	1644	17650	999	21672	401	19496
10-#18	3.79	MA	11467	3044	16043	2709	20461	2253	23428	1848	27386	1178	35570	316	33826
5L-2S		MI	7170	3044	11927	2461	14782	2012	16920	1629	20339	977	25147	695	19744
12-#10	1.44	MA	11093	2316	13632	2151	18016	1802	20722	1523	24058	1090	30530	948	16253
2L-6S		MI	4974	2316	6447	2099	8033	1765	8841	1497	9530	1067	11584	625	7835
12-#10	1.44	MA	10520	2316	12721	2166	16864	1816	19329	1536	22182	1108	27933	869	16208
3L-5S		MI	5177	2316	6723	2090	8387	1756	9293	1483	10155	1062	12445	696	8117
12-#10	1.44	MA	10203	2316	12103	2181	16055	1830	18292	1556	20763	1120	26231	819	16092
4E		MI	5319	2316	6999	2079	8779	1740	9755	1475	10795	1051	13337	750	8202
12-#10	1.44	MA	9833	2316	11537	2194	15276	1850	17372	1569	19486	1138	24410	775	15835
5L-3S		MI	5477	2316	7309	2068	9183	1731	10272	1461	11500	1045	14227	805	8228
12-#10	1.44	MA	9413	2316	10937	2203	14544	1862	16498	1583	18244	1150	22827	721	15084
6L-2S		MI	5748	2316	7752	2057	9744	1721	10950	1453	12413	1034	15491	898	8234
12-#11	1.77	MA	11615	2418	14928	2206	19569	1841	22556	1546	26484	1081	33857	938	19743
2L-6S		MI	5058	2418	6823	2154	8409	1804	9249	1520	10035	1055	12188	533	9217
12-#11	1.77	MA	10948	2418	13821	2224	18169	1858	20861	1562	24202	1102	30698	840	19669
3L-5S		MI	5295	2418	7150	2143	8838	1794	9796	1504	10790	1050	13206	617	9527
12-#11	1.77	MA	10582	2418	13067	2242	17182	1875	19598	1585	22474	1116	28615	778	19478
4E		MI	5458	2418	7485	2130	9312	1776	10355	1495	11564	1038	14258	684	9816

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



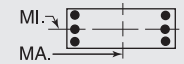
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.77	MA	10144	2418	12382	2259	16233	1899	18476	1602	20917	1137	26391	721	18843
5L-3S		MI	5641	2418	7859	2117	9801	1765	10979	1479	12416	1033	15312	750	9869
12-#11	1.77	MA	9649	2418	11653	2268	15349	1914	17410	1618	19402	1152	24457	653	17922
6L-2S		MI	5954	2418	8392	2104	10475	1754	11795	1471	13515	1021	16802	864	9887
12-#14	2.56	MA	11990	2662	16295	2378	21235	1972	24538	1636	29122	1098	37488	779	27981
3L-5S		MI	5612	2662	8039	2297	9881	1910	11020	1578	12400	1042	15298	461	12845
12-#14	2.56	MA	11522	2662	15213	2403	19821	1996	22727	1668	26644	1117	34490	689	27519
4E		MI	5833	2662	8517	2280	10557	1885	11818	1566	13503	1026	16769	558	13508
12-#14	2.56	MA	10913	2662	14237	2427	18459	2030	21117	1691	24411	1147	31296	605	25773
5L-3S		MI	6072	2662	9051	2262	11253	1871	12707	1545	14716	1020	18249	650	13803
12-#14	2.56	MA	10247	2662	13192	2441	17200	2051	19587	1714	22237	1167	28517	505	24215
6L-2S		MI	6483	2662	9809	2245	12211	1856	13866	1534	16277	1005	20332	815	13869
12-#18	4.55	MA	13801	3280	20515	2814	26371	2303	30509	1879	37034	1119	49122	460	45177
4E		MI	6748	3280	11000	2663	13575	2164	15380	1747	18238	994	22661	205	21534
12-#18	4.55	MA	12781	3280	18821	2856	23974	2361	27677	1917	33107	1169	43492	304	41820
5L-3S		MI	7072	3280	11927	2636	14782	2142	16920	1713	20339	990	25147	361	23247
12-#18	4.55	MA	11747	3280	16987	2880	21794	2401	24985	1955	29284	1201	38590	120	37714
6L-2S		MI	7647	3280	13232	2608	16434	2120	18917	1698	23029	968	28623	654	23530
14-#10	1.68	MA	10969	2390	13632	2213	18016	1850	20722	1558	24058	1105	30530	866	18863
3L-6S		MI	5190	2390	6890	2145	8593	1800	9520	1519	10444	1064	12847	621	9087
14-#10	1.68	MA	10668	2390	13014	2228	17207	1865	19686	1578	22639	1117	28828	815	18740
4L-5S		MI	5386	2390	7167	2137	8948	1790	9971	1505	11068	1059	13708	692	9356
14-#10	1.68	MA	10303	2390	12447	2241	16428	1885	18765	1591	21362	1135	27007	771	18485
5L-4S		MI	5526	2390	7443	2125	9339	1775	10434	1497	11708	1048	14600	746	9486
14-#10	1.68	MA	9899	2390	11848	2249	15696	1896	17892	1605	20120	1147	25424	717	17733
6L-3S		MI	5678	2390	7752	2114	9744	1765	10950	1483	12413	1043	15491	801	9521
14-#10	1.68	MA	9543	2390	11277	2260	14944	1905	16970	1621	18913	1165	23805	683	17113
7L-2S		MI	5941	2390	8196	2103	10304	1755	11628	1474	13327	1032	16755	894	9533
14-#11	2.07	MA	11476	2510	14928	2282	19569	1900	22556	1589	26484	1099	33857	835	22894
3L-6S		MI	5310	2510	7356	2211	9084	1847	10065	1547	11134	1051	13677	525	10724
14-#11	2.07	MA	11132	2510	14174	2300	18583	1918	21292	1612	24755	1113	31774	773	22697
4L-5S		MI	5540	2510	7683	2200	9513	1836	10612	1531	11889	1046	14696	609	11021
14-#11	2.07	MA	10701	2510	13490	2316	17634	1942	20170	1629	23198	1134	29550	716	22048
5L-4S		MI	5700	2510	8018	2187	9987	1818	11171	1522	12663	1034	15747	676	11354
14-#11	2.07	MA	10226	2510	12760	2326	16749	1956	19104	1645	21683	1148	27615	649	21144
6L-3S		MI	5874	2510	8392	2175	10475	1807	11795	1506	13515	1029	16802	742	11420
14-#11	2.07	MA	9808	2510	12064	2339	15834	1967	17993	1666	20212	1169	25630	607	20109
7L-2S		MI	6178	2510	8926	2162	11150	1797	12611	1498	14613	1018	18291	856	11446
14-#14	2.98	MA	12278	2794	16799	2486	21826	2057	25153	1707	29910	1112	39012	682	32141
4L-5S		MI	5948	2794	8797	2380	10839	1970	12180	1617	13961	1037	17381	445	14980
14-#14	2.98	MA	11678	2794	15823	2510	20464	2091	23542	1730	27677	1142	35818	598	30378
5L-4S		MI	6184	2794	9275	2363	11515	1946	12977	1605	15064	1021	18852	543	15611
14-#14	2.98	MA	11047	2794	14778	2524	19205	2112	22013	1753	25504	1162	33039	498	28800
6L-3S		MI	6398	2794	9809	2345	12211	1932	13866	1584	16277	1016	20332	635	15992
14-#14	2.98	MA	10490	2794	13779	2541	17893	2127	20432	1783	23392	1191	30180	437	26875
7L-2S		MI	6778	2794	10566	2328	13170	1917	15025	1572	17838	1000	22415	800	16075
14-#18	5.30	MA	14041	3515	21598	3004	27487	2470	31926	1986	38829	1160	51413	291	49813
5L-4S		MI	7289	3515	12306	2810	15226	2272	17377	1816	20928	985	26137	165	25202
14-#18	5.30	MA	13082	3515	19764	3027	25307	2509	29234	2024	35006	1192	46511	108	45732
6L-3S		MI	7578	3515	13232	2783	16434	2250	18917	1783	23029	981	28623	320	27002
14-#18	5.30	MA	12233	3515	18010	3057	23001	2534	26499	2080	31290	1242	41443	-3	41428
7L-2S		MI	8117	3515	14538	2755	18085	2229	20915	1767	25718	959	32098	614	27313
16-#10	1.92	MA	11122	2465	13924	2275	18359	1899	21079	1599	24515	1114	31426	811	21390
4L-6S		MI	5400	2465	7333	2192	9154	1834	10198	1540	11357	1061	14111	617	10342

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

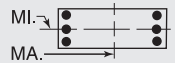


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	1.92	MA	10761	2465	13358	2288	17580	1919	20159	1613	23238	1132	29605	767	21138
5E		MI	5591	2465	7610	2183	9509	1824	10650	1527	11982	1056	14972	688	10601
16-#10	1.92	MA	10371	2465	12759	2296	16848	1931	19285	1627	21996	1144	28022	713	20383
6L-4S		MI	5730	2465	7886	2172	9900	1809	11112	1518	12621	1045	15864	742	10769
16-#10	1.92	MA	10030	2465	12187	2307	16096	1940	18364	1643	20789	1162	26403	680	19765
7L-3S		MI	5875	2465	8196	2161	10304	1799	11628	1505	13327	1040	16755	797	10811
16-#10	1.92	MA	9715	2465	11559	2324	15322	1956	17454	1653	19588	1174	24820	637	18832
8L-2S		MI	6131	2465	8639	2150	10865	1790	12307	1496	14240	1029	18018	890	10830
16-#11	2.36	MA	11667	2602	15282	2357	19984	1960	22987	1639	27036	1109	34932	768	25918
4L-6S		MI	5557	2602	7890	2269	9759	1889	10881	1574	12233	1048	15166	516	12236
16-#11	2.36	MA	11242	2602	14597	2373	19034	1984	21865	1656	25480	1131	32709	711	25257
5E		MI	5779	2602	8217	2257	10188	1878	11428	1558	12988	1043	16185	601	12520
16-#11	2.36	MA	10786	2602	13868	2383	18150	1998	20799	1672	23965	1145	30774	644	24367
6L-4S		MI	5937	2602	8552	2245	10662	1860	11988	1549	13762	1031	17237	668	12892
16-#11	2.36	MA	10388	2602	13171	2396	17235	2009	19688	1692	22493	1166	28789	602	23321
7L-3S		MI	6103	2602	8926	2232	11150	1850	12611	1533	14613	1026	18291	733	12968
16-#11	2.36	MA	10015	2602	12405	2417	16291	2029	18578	1703	21027	1180	26855	547	22208
8L-2S		MI	6398	2602	9459	2219	11825	1839	13427	1525	15712	1014	19781	848	13003
16-#14	3.41	MA	12419	2927	17408	2593	22470	2152	25968	1769	30943	1137	40341	591	34982
5E		MI	6290	2927	9555	2463	11798	2031	13339	1656	15522	1032	19464	430	17123
16-#14	3.41	MA	11819	2927	16363	2606	21211	2173	24439	1792	28770	1157	37562	492	33386
6L-4S		MI	6507	2927	10033	2445	12474	2007	14137	1644	16625	1016	20936	527	17725
16-#14	3.41	MA	11297	2927	15365	2624	19898	2188	22857	1822	26658	1186	34703	430	31467
7L-3S		MI	6705	2927	10566	2428	13170	1992	15025	1623	17838	1011	22415	619	18182
16-#14	3.41	MA	10775	2927	14266	2654	18545	2216	21267	1837	24554	1206	31923	350	29385
8L-2S		MI	7068	2927	11324	2411	14128	1978	16185	1611	19399	995	24498	784	18277
16-#18	6.06	MA	14463	3751	22541	3174	28820	2617	33483	2093	40727	1184	54433	96	53749
6L-4S		MI	7817	3751	13611	2957	16878	2380	19375	1885	23617	976	29612	125	28887
16-#18	6.06	MA	13591	3751	20787	3204	26515	2642	30748	2149	37011	1233	49365	-15	49258
7L-3S		MI	8075	3751	14538	2930	18085	2358	20915	1852	25718	972	32098	280	30762
18-#10	2.16	MA	11208	2540	14269	2334	18732	1953	21552	1635	25114	1129	32202	763	23783
5L-6S		MI	5606	2540	7777	2239	9715	1868	10877	1562	12271	1058	15375	613	11601
18-#10	2.16	MA	10831	2540	13669	2343	18000	1965	20678	1649	23872	1142	30619	709	23035
6L-5S		MI	5792	2540	8053	2230	10070	1859	11328	1549	12895	1053	16236	684	11850
18-#10	2.16	MA	10504	2540	13098	2353	17248	1974	19757	1665	22665	1159	29000	676	22416
7L-4S		MI	5929	2540	8330	2219	10461	1843	11791	1540	13535	1042	17128	738	12051
18-#10	2.16	MA	10194	2540	12469	2371	16474	1990	18847	1675	21463	1171	27418	633	21478
8L-3S		MI	6068	2540	8639	2208	10865	1834	12307	1527	14240	1037	18018	793	12100
18-#10	2.16	MA	9805	2540	11910	2381	15756	2002	17931	1691	20258	1188	25802	581	20604
9L-2S		MI	6318	2540	9083	2197	11426	1824	12985	1518	15154	1026	19282	886	12125
18-#11	2.66	MA	11768	2693	15705	2431	20435	2026	23559	1682	27761	1127	35867	707	28468
5L-6S		MI	5798	2693	8423	2326	10433	1931	11698	1601	13332	1044	16656	508	13751
18-#11	2.66	MA	11330	2693	14975	2441	19551	2041	22493	1699	26246	1141	33933	639	27590
6L-5S		MI	6013	2693	8750	2315	10863	1920	12244	1585	14087	1039	17675	593	14025
18-#11	2.66	MA	10951	2693	14279	2453	18636	2051	21382	1719	24774	1162	31948	597	26533
7L-4S		MI	6170	2693	9085	2302	11337	1903	12804	1576	14861	1028	18726	660	14430
18-#11	2.66	MA	10585	2693	13513	2474	17692	2071	20273	1730	23308	1177	30013	543	25423
8L-3S		MI	6328	2693	9459	2289	11825	1892	13427	1560	15712	1023	19781	725	14514
18-#11	2.66	MA	10128	2693	12837	2488	16817	2084	19156	1749	21856	1197	28033	478	24105
9L-2S		MI	6614	2693	9993	2277	12500	1881	14244	1552	16811	1011	21270	840	14557
18-#14	3.84	MA	12568	3059	17949	2689	23217	2234	26864	1830	32036	1152	42084	485	37971
6L-5S		MI	6608	3059	10313	2546	12757	2092	14498	1695	17083	1027	21548	414	19273
18-#14	3.84	MA	12077	3059	16950	2707	21904	2249	25283	1861	29924	1181	39225	424	36060
7L-4S		MI	6822	3059	10790	2528	13432	2068	15296	1683	18186	1011	23019	512	19849
18-#14	3.84	MA	11566	3059	15852	2737	20551	2276	23693	1876	27820	1201	36445	343	33966
8L-3S		MI	7005	3059	11324	2511	14128	2053	16185	1662	19399	1006	24498	604	20371
18-#14	3.84	MA	10956	3059	14888	2756	19295	2296	22091	1903	25745	1231	33593	249	31902
9L-2S		MI	7353	3059	12082	2493	15087	2039	17344	1650	20960	990	26581	769	20479
18-#18	6.82	MA	15013	3986	23565	3351	30028	2750	34997	2218	42732	1225	57286	-28	57037
7L-4S		MI	8334	3986	14917	3104	18529	2488	21372	1954	26306	967	33088	85	32585

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

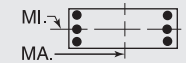


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
20-#10	2.41	MA	11280	2615	14580	2389	19152	1999	22072	1671	25748	1139	33217	705	25689
6E		MI	5808	2615	8220	2285	10276	1903	11555	1584	13184	1056	16638	609	12862
20-#10	2.41	MA	10966	2615	14008	2400	18400	2008	21150	1687	24541	1157	31598	672	25068
7L-5S		MI	5989	2615	8497	2277	10631	1893	12007	1571	13809	1050	17499	680	13103
20-#10	2.41	MA	10661	2615	13380	2418	17626	2025	20240	1697	23339	1169	30015	629	24123
8L-4S		MI	6125	2615	8773	2266	11022	1878	12469	1562	14448	1039	18391	734	13333
20-#10	2.41	MA	10285	2615	12820	2428	16908	2036	19324	1713	22134	1185	28400	577	23243
9L-3S		MI	6258	2615	9083	2255	11426	1868	12985	1549	15154	1034	19282	789	13388
20-#10	2.41	MA	9935	2615	12251	2438	16205	2048	18442	1724	20899	1194	26814	540	22276
10L-2S		MI	6502	2615	9526	2243	11987	1858	13664	1540	16067	1023	20546	882	13418
20-#11	2.95	MA	11861	2785	16083	2498	20952	2083	24187	1726	28527	1138	37092	634	30813
6E		MI	6034	2785	8957	2383	11108	1973	12514	1628	14431	1041	18145	500	15269
20-#11	2.95	MA	11499	2785	15386	2511	20036	2093	23076	1746	27056	1159	35106	592	29745
7L-5S		MI	6243	2785	9284	2372	11538	1962	13061	1612	15186	1036	19164	584	15534
20-#11	2.95	MA	11138	2785	14620	2532	19093	2113	21967	1757	25589	1173	33172	538	28637
8L-4S		MI	6399	2785	9618	2359	12012	1945	13620	1603	15960	1024	20216	651	15968
20-#11	2.95	MA	10699	2785	13944	2545	18218	2127	20850	1776	24138	1194	31192	473	27312
9L-3S		MI	6557	2785	9993	2347	12500	1934	14244	1587	16811	1019	21270	717	16060
20-#11	2.95	MA	10289	2785	13251	2556	17361	2141	19775	1789	22632	1204	29253	426	26019
10L-2S		MI	6823	2785	10526	2334	13175	1923	15060	1579	17910	1007	22759	831	16110
20-#14	4.26	MA	12835	3191	18536	2790	23910	2310	27709	1900	33190	1176	43747	417	40652
7L-5S		MI	6919	3191	11070	2628	13715	2153	15657	1734	18644	1022	23631	399	21428
20-#14	4.26	MA	12332	3191	17437	2820	22556	2337	26119	1915	31087	1196	40967	336	38547
8L-4S		MI	7131	3191	11548	2611	14391	2129	16455	1722	19747	1006	25102	496	21980
20-#14	4.26	MA	11751	3191	16474	2839	21301	2357	24517	1942	29012	1226	38115	242	36473
9L-3S		MI	7301	3191	12082	2594	15087	2114	17344	1701	20960	1001	26581	588	22560
22-#10	2.65	MA	11418	2689	14919	2447	19552	2043	22544	1709	26417	1154	34195	668	27720
7L-6S		MI	6007	2689	8664	2332	10837	1937	12233	1606	14098	1053	17902	605	14126
22-#10	2.65	MA	11117	2689	14291	2464	18777	2059	21634	1719	25215	1166	32613	625	26768
8L-5S		MI	6183	2689	8940	2323	11192	1927	12685	1593	14722	1048	18763	676	14359
22-#10	2.65	MA	10753	2689	13731	2475	18060	2071	20717	1735	24010	1182	30997	573	25882
9L-4S		MI	6318	2689	9216	2312	11583	1912	13147	1584	15362	1037	19655	730	14615
22-#10	2.65	MA	10416	2689	13162	2484	17357	2083	19835	1746	22775	1191	29412	536	24917
10L-3S		MI	6446	2689	9526	2301	11987	1902	13664	1571	16067	1031	20546	785	14675
22-#10	2.65	MA	10095	2689	12605	2495	16634	2093	18967	1757	21557	1206	27872	491	23867
11L-2S		MI	6684	2689	9969	2290	12548	1893	14342	1562	16980	1020	21809	878	14710
22-#11	3.25	MA	12035	2877	16494	2568	21437	2136	24771	1773	29337	1155	38265	588	32957
7L-6S		MI	6267	2877	9490	2441	11783	2015	13330	1655	15530	1038	19635	492	16791
22-#11	3.25	MA	11679	2877	15728	2589	20493	2155	23661	1784	27871	1170	36331	533	31851
8L-5S		MI	6482	2877	9817	2430	12213	2005	13877	1639	16285	1033	20654	576	17047
22-#11	3.25	MA	11255	2877	15052	2602	19618	2169	22545	1803	26419	1190	34350	469	30519
9L-4S		MI	6636	2877	10152	2417	12686	1987	14436	1630	17059	1021	21705	643	17507
22-#11	3.25	MA	10862	2877	14358	2614	18761	2183	21469	1816	24913	1201	32412	421	29220
10L-3S		MI	6772	2877	10526	2404	13175	1976	15060	1614	17910	1016	22759	709	17606
22-#11	3.25	MA	10488	2877	13679	2626	17888	2196	20410	1830	23429	1219	30529	364	27887
11L-2S		MI	7029	2877	11060	2391	13850	1965	15876	1606	19009	1004	24249	823	17662
22-#14	4.69	MA	13078	3324	19023	2903	24562	2398	28545	1954	34353	1191	45490	329	43128
8L-5S		MI	7224	3324	11828	2711	14674	2214	16817	1772	20205	1017	25714	383	23587
22-#14	4.69	MA	12523	3324	18059	2922	23307	2417	26943	1981	32278	1221	42638	235	41044
9L-4S		MI	7434	3324	12306	2694	15349	2189	17615	1761	21308	1001	27185	481	24119
24-#10	2.89	MA	11563	2764	15201	2511	19929	2093	23027	1741	27091	1163	35210	621	29413
8L-6S		MI	6203	2764	9107	2379	11398	1971	12912	1628	15011	1050	19166	601	15392
24-#10	2.89	MA	11211	2764	14642	2522	19212	2105	22111	1757	25886	1179	33595	569	28521
9L-5S		MI	6374	2764	9384	2370	11753	1962	13363	1615	15635	1045	20027	672	15618
24-#10	2.89	MA	10885	2764	14073	2531	18509	2117	21229	1768	24651	1188	32009	532	27558
10L-4S		MI	6509	2764	9660	2359	12144	1946	13826	1606	16275	1034	20919	726	15897
24-#10	2.89	MA	10578	2764	13515	2542	17786	2127	20360	1779	23433	1204	30470	487	26504
11L-3S		MI	6632	2764	9969	2348	12548	1937	14342	1592	16980	1028	21809	781	15962

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
24-#10	2.89	MA	10223	2764	12969	2553	17015	2143	19472	1797	22219	1214	28844	441	25439
12L-2S		MI	6863	2764	10413	2337	13109	1927	15021	1584	17894	1018	23073	874	16001
24-#11	3.55	MA	12207	2969	16835	2647	21894	2197	25356	1811	30152	1166	39490	528	35065
8L-6S		MI	6511	2969	10023	2498	12458	2058	14146	1682	16629	1034	21124	483	18301
24-#11	3.55	MA	11798	2969	16159	2660	21019	2211	24239	1830	28700	1187	37509	464	33726
9L-5S		MI	6702	2969	10351	2487	12887	2047	14693	1666	17384	1029	22143	568	18563
24-#11	3.55	MA	11421	2969	15466	2671	20162	2225	23163	1843	27195	1197	35570	417	32421
10L-4S		MI	6856	2969	10685	2474	13361	2029	15252	1657	18158	1017	23195	635	19007
24-#11	3.55	MA	11064	2969	14787	2684	19289	2238	22104	1857	25710	1215	33688	359	31083
11L-3S		MI	6984	2969	11060	2462	13850	2018	15876	1641	19009	1012	24249	700	19151
24-#14	5.11	MA	13276	3456	19645	3005	25312	2478	29369	2020	35544	1216	47160	229	45615
9L-5S		MI	7524	3456	12586	2794	15632	2275	17976	1811	21766	1012	27797	368	25751

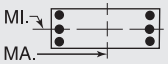
RECTANGULAR TIED COLUMNS 24" x 46"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#18	1.45	MA	11990	2423	15087	2227	19695	1865	22532	1576	26023	1126	32908	979	17514
2E		MI	5858	2423	8255	2098	10124	1755	11242	1479	12584	1050	15074	856	8347
6-#14	1.22	MA	11627	2349	14070	2194	18539	1842	21202	1563	24295	1137	30562	990	14982
2L-3S		MI	5269	2349	7017	2094	8671	1756	9543	1487	10348	1082	12356	738	7241
6-#14	1.22	MA	10534	2349	12402	2220	16429	1867	18649	1587	20858	1167	25804	848	14882
3L-2S		MI	5746	2349	7775	2076	9629	1742	10702	1476	11908	1067	14439	903	7234
6-#18	2.17	MA	13317	2658	18011	2374	23395	1973	27007	1645	32047	1117	41249	967	26058
2L-3S		MI	5644	2658	8255	2272	10124	1884	11242	1564	12584	1063	15074	522	12055
6-#18	2.17	MA	11598	2658	15087	2419	19695	2015	22532	1684	26023	1169	32908	709	25599
3L-2S		MI	6392	2658	9561	2245	11776	1863	13240	1549	15274	1041	18549	816	12181
8-#11	1.13	MA	11476	2319	13637	2181	18057	1834	20652	1559	23588	1141	29607	994	13940
2L-4S		MI	5157	2319	6654	2095	8255	1760	9036	1501	9681	1092	11637	742	6763
8-#11	1.13	MA	10708	2319	12472	2200	16583	1851	18870	1576	21188	1163	26284	897	13894
3E		MI	5362	2319	7028	2082	8743	1749	9660	1485	10532	1087	12691	808	6779
8-#11	1.13	MA	10264	2319	11681	2218	15547	1869	17543	1599	19372	1178	24102	835	13723
4L-2S		MI	5700	2319	7562	2070	9418	1738	10476	1476	11631	1075	14180	922	6770
8-#14	1.63	MA	12419	2482	15739	2277	20650	1903	23754	1602	27732	1132	35321	983	19861
2L-4S		MI	5341	2482	7241	2194	8933	1831	9814	1548	10696	1083	12959	630	9336
8-#14	1.63	MA	11387	2482	14070	2303	18539	1927	21202	1626	24295	1162	30562	841	19731
3E		MI	5617	2482	7775	2176	9629	1817	10702	1526	11908	1077	14439	722	9447
8-#14	1.63	MA	10795	2482	12934	2329	17053	1952	19298	1659	21691	1182	27421	751	19260
4L-2S		MI	6071	2482	8532	2159	10588	1802	11861	1515	13469	1062	16522	887	9467
8-#18	2.90	MA	14579	2894	20935	2521	27094	2081	31481	1714	38072	1109	49590	955	34594
2L-4S		MI	5784	2894	8634	2447	10568	2014	11700	1667	13172	1058	16063	327	14397
8-#18	2.90	MA	12997	2894	18011	2566	23395	2123	27007	1753	32047	1160	41249	697	34100
3E		MI	6223	2894	9561	2420	11776	1993	13240	1633	15274	1054	18549	482	15801
8-#18	2.90	MA	12100	2894	16013	2611	20781	2165	23661	1810	27471	1193	35692	535	30827
4L-2S		MI	6897	2894	10866	2392	13427	1971	15237	1618	17963	1032	22025	776	15987
10-#10	1.15	MA	11564	2326	13643	2194	18155	1844	20819	1568	23857	1146	30013	999	14275
2L-5S		MI	5166	2326	6511	2124	8116	1790	8927	1521	9556	1112	11540	742	6893
10-#10	1.15	MA	10935	2326	12685	2210	16944	1859	19354	1582	21885	1164	27282	921	14239
3L-4S		MI	5310	2326	6787	2113	8508	1775	9390	1513	10196	1101	12432	796	6940
10-#10	1.15	MA	10579	2326	12036	2225	16094	1873	18265	1601	20395	1177	25500	871	14132
4L-3S		MI	5477	2326	7097	2102	8912	1765	9906	1499	10901	1096	13323	851	6951
10-#10	1.15	MA	10179	2326	11439	2238	15277	1894	17299	1615	19054	1195	23590	827	13872
5L-2S		MI	5758	2326	7540	2091	9473	1756	10584	1491	11815	1085	14587	944	6947
10-#11	1.41	MA	12041	2411	14802	2239	19530	1876	22435	1586	25987	1138	32929	990	17348
2L-5S		MI	5246	2411	6853	2165	8456	1820	9293	1537	10006	1101	12075	667	8116

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



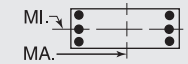
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.41	MA	11304	2411	13637	2257	18057	1893	20652	1603	23588	1159	29607	893	17287
3L-4S		MI	5413	2411	7187	2153	8929	1802	9852	1528	10780	1089	13126	734	8308
10-#11	1.41	MA	10889	2411	12845	2276	17020	1911	19325	1626	21772	1174	27424	831	17104
4L-3S		MI	5608	2411	7562	2140	9418	1791	10476	1512	11631	1084	14180	800	8341
10-#11	1.41	MA	10414	2411	12123	2292	16024	1935	18147	1643	20137	1196	25091	775	16531
5L-2S		MI	5934	2411	8095	2127	10093	1780	11292	1503	12730	1072	15670	914	8344
10-#14	2.04	MA	13182	2614	17407	2359	22760	1964	26307	1641	31168	1127	40079	976	24735
2L-5S		MI	5470	2614	7521	2294	9216	1917	10175	1598	11154	1094	13571	517	10810
10-#14	2.04	MA	12204	2614	15739	2386	20650	1988	23754	1664	27732	1157	35321	834	24583
3L-4S		MI	5695	2614	7999	2277	9892	1892	10973	1587	12257	1078	15042	615	11507
10-#14	2.04	MA	11661	2614	14603	2412	19163	2013	21851	1698	25128	1177	32180	744	24116
4L-3S		MI	5953	2614	8532	2259	10588	1878	11861	1565	13469	1072	16522	707	11644
10-#14	2.04	MA	10999	2614	13572	2435	17733	2048	20160	1721	22782	1207	28829	662	22361
5L-2S		MI	6387	2614	9290	2242	11546	1863	13021	1554	15030	1057	18605	872	11686
10-#18	3.62	MA	14326	3129	20935	2713	27094	2231	31481	1822	38072	1151	49590	685	42614
3L-4S		MI	6391	3129	9940	2594	12220	2122	13697	1736	15862	1049	19539	286	18015
10-#18	3.62	MA	13540	3129	18937	2758	24480	2273	28135	1879	33495	1184	44033	523	39286
4L-3S		MI	6761	3129	10866	2567	13427	2101	15237	1703	17963	1045	22025	442	19548
10-#18	3.62	MA	12429	3129	17145	2801	21962	2333	25159	1918	29368	1235	38123	370	35938
5L-2S		MI	7386	3129	12172	2539	15079	2079	17235	1687	20653	1023	25500	735	19780
12-#10	1.38	MA	12032	2400	14600	2241	19366	1878	22284	1590	25829	1144	32744	995	17076
2L-6S		MI	5177	2400	6678	2179	8322	1834	9154	1557	9846	1115	11943	667	7895
12-#10	1.38	MA	11424	2400	13643	2256	18155	1893	20819	1604	23857	1162	30013	917	17031
3L-5S		MI	5381	2400	6955	2171	8677	1824	9606	1543	10470	1109	12804	738	8169
12-#10	1.38	MA	11087	2400	12994	2272	17305	1908	19730	1623	22367	1174	28230	867	16915
4E		MI	5523	2400	7231	2159	9068	1809	10068	1535	11110	1098	13696	792	8227
12-#10	1.38	MA	10693	2400	12396	2285	16488	1928	18764	1637	21026	1192	26321	823	16658
5L-3S		MI	5683	2400	7540	2148	9473	1800	10584	1521	11815	1093	14587	847	8249
12-#10	1.38	MA	10249	2400	11767	2293	15715	1939	17847	1651	19722	1205	24661	770	15909
6L-2S		MI	5956	2400	7984	2137	10033	1790	11263	1513	12728	1082	15850	940	8253
12-#11	1.70	MA	12590	2503	15967	2296	21004	1918	24217	1613	28387	1135	36252	985	20753
2L-6S		MI	5261	2503	7059	2234	8701	1873	9563	1579	10350	1102	12545	574	9288
12-#11	1.70	MA	11881	2503	14802	2315	19530	1935	22435	1630	25987	1156	32929	888	20680
3L-5S		MI	5500	2503	7386	2223	9131	1862	10109	1564	11105	1097	13564	659	9600
12-#11	1.70	MA	11491	2503	14010	2333	18494	1953	21107	1653	24171	1171	30747	826	20489
4E		MI	5662	2503	7721	2210	9604	1844	10669	1555	11879	1085	14616	726	9849
12-#11	1.70	MA	11025	2503	13288	2349	17497	1977	19929	1670	22536	1192	28414	770	19902
5L-3S		MI	5847	2503	8095	2197	10093	1833	11292	1539	12730	1080	15670	791	9896
12-#11	1.70	MA	10500	2503	12521	2359	16563	1992	18810	1686	20946	1207	26385	704	18905
6L-2S		MI	6163	2503	8628	2184	10767	1823	12109	1530	13829	1068	17159	906	9910
12-#14	2.45	MA	12990	2747	17407	2468	22760	2049	26307	1703	31168	1152	40079	827	29439
3L-5S		MI	5817	2747	8279	2377	10175	1977	11334	1637	12715	1089	15654	502	12933
12-#14	2.45	MA	12491	2747	16271	2494	21274	2074	24403	1736	28564	1172	36939	737	28977
4E		MI	6038	2747	8756	2359	10850	1953	12132	1626	13818	1073	17125	599	13607
12-#14	2.45	MA	11842	2747	15240	2518	19843	2108	22712	1760	26218	1202	33587	655	27206
5L-3S		MI	6279	2747	9290	2342	11546	1939	13021	1604	15030	1068	18605	691	13837
12-#14	2.45	MA	11134	2747	14141	2532	18512	2130	21106	1783	23936	1223	30672	558	25662
6L-2S		MI	6696	2747	10048	2325	12505	1924	14180	1593	16591	1052	20688	857	13897
12-#18	4.35	MA	14912	3365	21861	2905	28180	2382	32609	1948	39519	1175	52374	511	47744
4E		MI	6951	3365	11246	2741	13871	2230	15695	1805	18551	1040	23014	246	21658
12-#18	4.35	MA	13823	3365	20069	2948	25662	2441	29633	1987	35392	1227	46464	358	44356
5L-3S		MI	7281	3365	12172	2714	15079	2209	17235	1772	20653	1036	25500	401	23300
12-#18	4.35	MA	12723	3365	18140	2972	23353	2480	26805	2027	31375	1260	41320	178	39951
6L-2S		MI	7865	3365	13478	2686	16730	2187	19232	1756	23342	1014	28976	695	23567

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

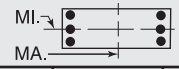


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	1.61	MA	11900	2475	14600	2303	19366	1927	22284	1626	25829	1159	32744	913	19823
3L-6S		MI	5394	2475	7121	2226	8883	1868	9832	1579	10759	1112	13207	663	9145
14-#10	1.61	MA	11581	2475	13951	2318	18516	1942	21195	1645	24339	1171	30961	863	19700
4L-5S		MI	5591	2475	7398	2217	9238	1859	10284	1565	11383	1107	14068	734	9418
14-#10	1.61	MA	11192	2475	13354	2331	17699	1962	20229	1659	22999	1189	29052	819	19445
5L-4S		MI	5732	2475	7674	2206	9629	1844	10746	1557	12023	1096	14960	788	9513
14-#10	1.61	MA	10764	2475	12724	2340	16926	1974	19312	1673	21695	1202	27392	767	18696
6L-3S		MI	5885	2475	7984	2195	10033	1834	11263	1543	12728	1090	15850	843	9543
14-#10	1.61	MA	10387	2475	12124	2351	16136	1983	18339	1689	20428	1220	25697	733	18037
7L-2S		MI	6150	2475	8427	2184	10594	1824	11941	1535	13642	1079	17114	936	9554
14-#11	1.98	MA	12442	2595	15967	2372	21004	1978	24217	1657	28387	1153	36252	883	24074
3L-6S		MI	5514	2595	7592	2291	9376	1915	10379	1606	11449	1099	14035	566	10794
14-#11	1.98	MA	12076	2595	15175	2390	19967	1995	22890	1680	26571	1167	34069	821	23876
4L-5S		MI	5745	2595	7919	2280	9805	1904	10925	1591	12204	1094	15053	651	11091
14-#11	1.98	MA	11616	2595	14452	2407	18971	2019	21711	1697	24936	1189	31736	765	23277
5L-4S		MI	5905	2595	8254	2267	10279	1886	11485	1582	12978	1082	16105	718	11389
14-#11	1.98	MA	11112	2595	13686	2417	18036	2034	20592	1713	23345	1203	29707	699	22295
6L-3S		MI	6082	2595	8628	2255	10767	1876	12109	1566	13829	1077	17159	783	11447
14-#11	1.98	MA	10669	2595	12954	2430	17074	2045	19418	1734	21800	1225	27629	657	21270
7L-2S		MI	6388	2595	9162	2242	11442	1865	12925	1557	14928	1065	18649	898	11471
14-#14	2.85	MA	13293	2879	17939	2577	23384	2135	26956	1775	32001	1167	41697	731	33842
4L-5S		MI	6153	2879	9036	2460	11133	2038	12494	1676	14275	1084	17737	486	15066
14-#14	2.85	MA	12654	2879	16908	2601	21953	2169	25265	1799	29655	1198	38346	648	32052
5L-4S		MI	6371	2879	9514	2442	11809	2014	13292	1664	15378	1068	19209	584	15707
14-#14	2.85	MA	11983	2879	15809	2615	20622	2190	23658	1822	27372	1218	35430	551	30488
6L-3S		MI	6608	2879	10048	2425	12505	1999	14180	1643	16591	1063	20688	676	16028
14-#14	2.85	MA	11392	2879	14760	2633	19243	2206	21986	1852	25155	1248	32437	490	28428
7L-2S		MI	6993	2879	10805	2407	13463	1985	15339	1632	18152	1047	22771	841	16104
14-#18	5.07	MA	15160	3600	22994	3095	29361	2549	34107	2057	41416	1218	54806	346	52773
5L-4S		MI	7493	3600	12551	2889	15523	2339	17692	1874	21241	1031	26490	206	25321
14-#18	5.07	MA	14139	3600	21064	3119	27052	2588	31279	2096	37399	1251	49661	166	48394
6L-3S		MI	7789	3600	13478	2861	16730	2317	19232	1841	23342	1027	28976	361	27055
14-#18	5.07	MA	13236	3600	19220	3150	24628	2614	28381	2151	33495	1302	44355	56	43999
7L-2S		MI	8337	3600	14783	2834	18382	2295	21230	1825	26031	1006	32451	655	27351
16-#10	1.84	MA	12062	2550	14908	2365	19727	1976	22660	1667	26311	1169	33692	859	22487
4L-6S		MI	5605	2550	7565	2273	9444	1903	10511	1601	11672	1109	14471	659	10400
16-#10	1.84	MA	11678	2550	14311	2378	18910	1997	21694	1681	24971	1187	31782	815	22235
5E		MI	5797	2550	7841	2264	9799	1893	10962	1587	12297	1104	15332	730	10662
16-#10	1.84	MA	11264	2550	13681	2387	18137	2008	20777	1695	23667	1199	30122	763	21484
6L-4S		MI	5936	2550	8118	2253	10190	1878	11425	1579	12937	1093	16223	784	10797
16-#10	1.84	MA	10903	2550	13081	2397	17347	2017	19804	1711	22401	1217	28428	729	20825
7L-3S		MI	6082	2550	8427	2242	10594	1868	11941	1565	13642	1087	17114	839	10835
16-#10	1.84	MA	10567	2550	12421	2415	16534	2034	18848	1721	21139	1230	26769	687	19890
8L-2S		MI	6341	2550	8871	2231	11155	1859	12620	1556	14555	1077	18378	932	10851
16-#11	2.26	MA	12644	2686	16340	2448	21441	2037	24672	1707	28970	1164	37391	816	27266
4L-6S		MI	5761	2686	8126	2349	10051	1957	11195	1633	12547	1095	15524	558	12304
16-#11	2.26	MA	12190	2686	15617	2464	20444	2062	23493	1724	27335	1185	35059	761	26655
5E		MI	5985	2686	8453	2337	10480	1946	11742	1618	13303	1090	16543	642	12589
16-#11	2.26	MA	11706	2686	14850	2474	19510	2076	22374	1740	25745	1200	33030	694	25685
6L-4S		MI	6143	2686	8788	2325	10954	1929	12301	1609	14077	1078	17594	709	12928
16-#11	2.26	MA	11284	2686	14119	2487	18548	2087	21200	1761	24200	1221	30952	653	24649
7L-3S		MI	6312	2686	9162	2312	11442	1918	12925	1593	14928	1073	18649	775	12997
16-#11	2.26	MA	10886	2686	13314	2508	17556	2107	20035	1772	22660	1236	28924	599	23464
8L-2S		MI	6609	2686	9695	2299	12117	1907	13741	1584	16027	1061	20138	890	13028
16-#14	3.26	MA	13440	3011	18577	2683	24064	2230	27817	1838	33092	1193	43104	642	36898
5E		MI	6497	3011	9794	2542	12092	2099	13653	1715	15836	1079	19821	471	17206

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#14	3.26	MA	12802	3011	17478	2698	22733	2251	26211	1861	30809	1213	40189	544	35313
6L-4S		MI	6714	3011	10272	2525	12767	2075	14451	1703	16939	1063	21292	568	17818
16-#14	3.26	MA	12247	3011	16428	2716	21353	2267	24538	1891	28591	1243	37196	483	33261
7L-3S		MI	6916	3011	10805	2508	13463	2060	15339	1682	18152	1058	22771	660	18218
16-#14	3.26	MA	11691	3011	15274	2746	19931	2295	22867	1906	26382	1263	34281	404	31142
8L-2S		MI	7284	3011	11563	2490	14422	2046	16499	1670	19713	1042	24854	826	18307
16-#18	5.80	MA	15502	3836	23989	3266	30751	2696	35753	2165	43423	1242	58003	153	56838
6L-4S		MI	8022	3836	13857	3036	17175	2447	19690	1944	23930	1022	29966	166	29001
16-#18	5.80	MA	14674	3836	22144	3297	28327	2722	32855	2220	39519	1294	52696	43	52419
7L-3S		MI	8287	3836	14783	3008	18382	2425	21230	1910	26031	1018	32451	321	30815
16-#18	5.80	MA	13732	3836	20115	3349	25827	2770	29917	2245	35629	1327	47549	-104	47051
8L-2S		MI	8803	3836	16089	2981	20033	2404	23227	1894	28721	997	35927	615	31134
18-#10	2.07	MA	12152	2625	15268	2425	20121	2031	23159	1703	26943	1184	34513	812	25026
5L-6S		MI	5811	2625	8008	2319	10005	1937	11189	1622	12586	1106	15734	655	11658
18-#10	2.07	MA	11752	2625	14639	2433	19348	2042	22242	1717	25639	1196	32853	759	24274
6L-5S		MI	5998	2625	8285	2311	10360	1928	11641	1609	13210	1101	16595	726	11909
18-#10	2.07	MA	11405	2625	14039	2444	18558	2052	21269	1733	24373	1214	31159	725	23614
7L-4S		MI	6136	2625	8561	2300	10751	1912	12103	1600	13850	1090	17487	780	12080
18-#10	2.07	MA	11075	2625	13379	2462	17745	2068	20313	1743	23112	1227	29500	683	22672
8L-3S		MI	6277	2625	8871	2289	11155	1903	12620	1587	14555	1085	18378	835	12124
18-#10	2.07	MA	10663	2625	12788	2472	16992	2080	19351	1759	21837	1243	27809	632	21807
9L-2S		MI	6529	2625	9314	2277	11716	1893	13298	1578	15469	1074	19641	928	12146
18-#11	2.54	MA	12749	2778	16782	2521	21918	2104	25275	1751	29735	1182	38381	756	30036
5L-6S		MI	6003	2778	8659	2406	10726	1999	12011	1660	13646	1092	17013	550	13818
18-#11	2.54	MA	12283	2778	16015	2531	20983	2118	24157	1767	28144	1196	36352	689	29075
6L-5S		MI	6220	2778	8986	2395	11155	1988	12558	1645	14402	1087	18032	634	14092
18-#11	2.54	MA	11881	2778	15284	2544	20021	2129	22982	1788	26599	1218	34274	648	28028
7L-4S		MI	6377	2778	9321	2382	11629	1971	13117	1636	15175	1075	19084	701	14466
18-#11	2.54	MA	11490	2778	14479	2566	19030	2149	21817	1799	25060	1233	32246	595	26846
8L-3S		MI	6538	2778	9695	2369	12117	1960	13741	1620	16027	1070	20138	767	14544
18-#11	2.54	MA	11006	2778	13765	2579	18111	2163	20644	1818	23524	1253	30173	530	25514
9L-2S		MI	6827	2778	10229	2357	12792	1949	14557	1611	17126	1058	21627	881	14584
18-#14	3.67	MA	13597	3144	19146	2780	24843	2312	28763	1900	34246	1208	44947	537	40139
6L-5S		MI	6816	3144	10552	2625	13050	2160	14812	1754	17397	1074	21904	455	19354
18-#14	3.67	MA	13074	3144	18097	2799	23463	2327	27091	1930	32028	1238	41955	476	38094
7L-4S		MI	7030	3144	11029	2608	13726	2136	15610	1742	18500	1058	23375	553	19939
18-#14	3.67	MA	12528	3144	16943	2829	22041	2355	25420	1945	29819	1259	39039	397	35963
8L-3S		MI	7218	3144	11563	2590	14422	2121	16499	1721	19713	1053	24854	645	20408
18-#14	3.67	MA	11881	3144	15925	2848	20723	2375	23737	1973	27634	1288	36053	304	33861
9L-2S		MI	7571	3144	12321	2573	15380	2107	17658	1709	21274	1037	26937	810	20509
18-#18	6.52	MA	16061	4071	25069	3444	32026	2830	37330	2289	45543	1285	61038	31	60838
7L-4S		MI	8540	4071	15162	3183	18826	2555	21687	2013	26620	1014	33441	126	32694
18-#18	6.52	MA	15137	4071	23039	3497	29526	2878	34392	2315	41654	1318	55890	-116	55136
8L-3S		MI	8778	4071	16089	3155	20033	2533	23227	1979	28721	1010	35927	281	34561
20-#10	2.30	MA	12228	2699	15596	2480	20559	2077	23707	1739	27611	1193	35584	755	27065
6E		MI	6014	2699	8452	2366	10566	1971	11868	1644	13499	1103	16998	651	12918
20-#10	2.30	MA	11895	2699	14996	2491	19770	2086	22734	1755	26345	1212	33889	722	26402
7L-5S		MI	6196	2699	8728	2357	10921	1962	12319	1631	14124	1098	17859	722	13161
20-#10	2.30	MA	11570	2699	14336	2509	18956	2103	21778	1765	25084	1224	32231	680	25453
8L-4S		MI	6333	2699	9004	2346	11312	1947	12782	1622	14763	1087	18751	776	13362

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

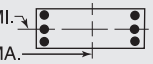
Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
20-#10	2.30	MA	11171	2699	13746	2519	18203	2114	20816	1781	23810	1240	30540	628	24581
9L-3S		MI	6468	2699	9314	2335	11716	1937	13298	1609	15469	1082	19641	831	13413
20-#10	2.30	MA	10800	2699	13148	2529	17465	2127	19890	1792	22513	1249	28878	592	23548
10L-2S		MI	6714	2699	9758	2324	12277	1927	13976	1600	16382	1071	20905	924	13440
20-#11	2.83	MA	12847	2870	17180	2589	22457	2160	25939	1794	30544	1193	39674	685	32466
6E		MI	6240	2870	9193	2463	11400	2041	12827	1687	14745	1088	18503	541	15335
20-#11	2.83	MA	12462	2870	16448	2602	21495	2171	24764	1815	28999	1215	37597	643	31407
7L-5S		MI	6451	2870	9520	2452	11830	2031	13374	1671	15501	1083	19522	626	15600
20-#11	2.83	MA	12077	2870	15644	2623	20503	2191	23599	1826	27459	1229	35569	590	30227
8L-4S		MI	6606	2870	9854	2439	12304	2013	13934	1663	16274	1071	20573	693	16005
20-#11	2.83	MA	11611	2870	14930	2636	19584	2205	22426	1845	25923	1249	33496	526	28888
9L-3S		MI	6768	2870	10229	2427	12792	2002	14557	1647	17126	1066	21627	758	16091
20-#11	2.83	MA	11176	2870	14201	2648	18685	2220	21297	1859	24342	1260	31463	479	27584
10L-2S		MI	7038	2870	10762	2414	13467	1991	15373	1638	18225	1055	23117	873	16137
20-#14	4.08	MA	13878	3276	19765	2881	25574	2388	29643	1969	35465	1233	46713	469	42927
7L-5S		MI	7128	3276	11309	2708	14009	2221	15972	1793	18958	1069	23987	440	21507
20-#14	4.08	MA	13341	3276	18611	2912	24152	2416	27972	1984	33255	1254	43798	391	40784
8L-4S		MI	7340	3276	11787	2690	14684	2196	16769	1781	20061	1053	25458	538	22068
20-#14	4.08	MA	12723	3276	17593	2931	22833	2436	26289	2012	31070	1283	40812	297	38671
9L-3S		MI	7515	3276	12321	2673	15380	2182	17658	1760	21274	1048	26937	630	22597
20-#14	4.08	MA	12146	3276	16548	2947	21542	2457	24669	2030	28802	1298	37890	229	36472
10L-2S		MI	7854	3276	13079	2656	16339	2167	18817	1748	22835	1032	29020	795	22709
20-#18	7.25	MA	16604	4306	25963	3644	33225	2986	38866	2384	47678	1309	64231	-128	63181
8L-4S		MI	9050	4306	16468	3330	20478	2663	23685	2082	29309	1005	36917	85	36399
22-#10	2.53	MA	12374	2774	15953	2538	20981	2120	24198	1777	28317	1209	36620	718	29190
7L-6S		MI	6214	2774	8895	2413	11127	2006	12546	1666	14413	1101	18262	647	14181
22-#10	2.53	MA	12053	2774	15293	2555	20167	2137	23243	1787	27056	1221	34962	676	28235
8L-5S		MI	6391	2774	9172	2404	11482	1996	12998	1653	15037	1095	19123	718	14416
22-#10	2.53	MA	11667	2774	14703	2566	19414	2149	22281	1803	25782	1237	33271	624	27356
9L-4S		MI	6527	2774	9448	2393	11873	1981	13460	1644	15677	1084	20015	772	14645
22-#10	2.53	MA	11309	2774	14105	2576	18677	2161	21355	1814	24485	1247	31609	588	26325
10L-3S		MI	6657	2774	9758	2382	12277	1971	13976	1631	16382	1079	20905	827	14701
22-#10	2.53	MA	10970	2774	13520	2586	17913	2171	20443	1826	23207	1262	29995	543	25267
11L-2S		MI	6897	2774	10201	2371	12838	1962	14655	1622	17296	1068	22169	920	14733
22-#11	3.11	MA	13030	2962	17613	2659	22968	2214	26546	1842	31398	1211	40919	638	34786
7L-6S		MI	6473	2962	9726	2521	12075	2084	13644	1714	15844	1085	19992	533	16855
22-#11	3.11	MA	12650	2962	16808	2681	21977	2233	25381	1853	29859	1226	38891	585	33609
8L-5S		MI	6678	2962	10053	2510	12505	2073	14190	1698	16600	1080	21011	618	17112
22-#11	3.11	MA	12200	2962	16095	2694	21058	2247	24208	1872	28323	1246	36818	521	32261
9L-4S		MI	6846	2962	10388	2497	12978	2055	14750	1690	17373	1068	22063	685	17544
22-#11	3.11	MA	11783	2962	15366	2705	20158	2262	23079	1886	26742	1257	34786	475	30951
10L-3S		MI	6985	2962	10762	2484	13467	2044	15373	1674	18225	1063	23117	750	17636
22-#11	3.11	MA	11387	2962	14653	2718	19235	2274	21967	1900	25183	1275	32812	418	29541
11L-2S		MI	7246	2962	11296	2471	14142	2034	16190	1665	19324	1051	24606	865	17689
22-#14	4.48	MA	14132	3409	20279	2995	26262	2477	30525	2023	36692	1249	48556	384	45604
8L-5S		MI	7434	3409	12067	2791	14967	2282	17131	1832	20519	1064	26070	425	23664
22-#14	4.48	MA	13541	3409	19261	3014	24944	2497	28842	2051	34507	1278	45571	291	43482
9L-4S		MI	7645	3409	12545	2773	15643	2257	17929	1820	21622	1048	27541	522	24205
22-#14	4.48	MA	12993	3409	18217	3030	23652	2518	27221	2069	32239	1293	42649	222	41281
10L-3S		MI	7808	3409	13079	2756	16339	2243	18817	1799	22835	1043	29020	614	24787
24-#10	2.76	MA	12526	2849	16251	2602	21378	2171	24708	1809	29028	1218	37692	672	31016
8L-6S		MI	6410	2849	9338	2460	11688	2040	13225	1688	15326	1098	19525	643	15447
24-#10	2.76	MA	12152	2849	15660	2613	20625	2183	23746	1825	27754	1235	36001	620	30131
9L-5S		MI	6583	2849	9615	2451	12042	2031	13676	1675	15951	1092	20386	714	15674
24-#10	2.76	MA	11807	2849	15063	2622	19888	2195	22820	1836	26457	1244	34340	584	29102
10L-4S		MI	6718	2849	9891	2440	12434	2015	14139	1666	16590	1082	21278	768	15927

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#10	2.76	MA	11480	2849	14478	2633	19124	2205	21908	1848	25179	1259	32726	540	28039
11L-3S		MI	6843	2849	10201	2429	12838	2006	14655	1653	17296	1076	22169	823	15988
24-#10	2.76	MA	11103	2849	13904	2645	18315	2221	20972	1866	23905	1270	31024	494	26966
12L-2S		MI	7078	2849	10644	2418	13399	1996	15333	1644	18209	1065	23433	916	16024
24-#11	3.39	MA	13211	3054	17973	2738	23450	2276	27163	1880	32258	1222	42214	580	36990
8L-6S		MI	6720	3054	10259	2578	12750	2126	14460	1741	16943	1081	21482	525	18378
24-#11	3.39	MA	12776	3054	17259	2751	22531	2290	25990	1899	30722	1243	40140	516	35635
9L-5S		MI	6913	3054	10587	2567	13180	2115	15006	1725	17699	1076	22500	609	18627
24-#11	3.39	MA	12375	3054	16531	2763	21632	2304	24861	1913	29141	1253	38108	470	34318
10L-4S		MI	7067	3054	10921	2554	13653	2097	15566	1717	18472	1065	23552	677	19081
24-#11	3.39	MA	11996	3054	15818	2775	20709	2317	23749	1927	27582	1272	36135	414	32911
11L-3S		MI	7198	3054	11296	2542	14142	2086	16190	1701	19324	1060	24606	742	19182
24-#11	3.39	MA	11547	3054	15118	2789	19723	2336	22612	1948	26027	1284	34048	357	31392
12L-2S		MI	7451	3054	11829	2529	14816	2076	17006	1692	20423	1048	26096	857	19240
24-#14	4.89	MA	14339	3541	20929	3096	27054	2558	31394	2089	37944	1273	50329	284	48292
9L-5S		MI	7736	3541	12825	2873	15926	2342	18290	1870	22080	1059	28153	409	25826
24-#14	4.89	MA	13818	3541	19885	3113	25762	2578	29774	2108	35675	1288	47407	215	46083
10L-4S		MI	7945	3541	13303	2856	16601	2318	19088	1859	23183	1043	29624	507	26347

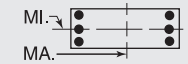
RECTANGULAR TIED COLUMNS 24" x 48"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.39	MA	12970	2508	16115	2317	21116	1942	24170	1643	27876	1180	35220	1026	18378
2E		MI	6065	2508	8501	2176	10421	1822	11557	1538	12897	1096	15427	897	8374
6-#14	1.17	MA	12581	2434	15044	2284	19897	1919	22766	1630	26053	1190	32745	1036	15711
2L-3S		MI	5474	2434	7256	2173	8964	1824	9857	1546	10662	1129	12712	779	7267
6-#14	1.17	MA	11425	2434	13293	2311	17682	1944	20087	1654	22446	1221	27751	896	15611
3L-2S		MI	5952	2434	8014	2156	9923	1809	11016	1535	12223	1114	14795	944	7256
6-#18	2.08	MA	14379	2743	19187	2464	25001	2050	28869	1712	34204	1171	43981	1014	27354
2L-3S		MI	5848	2743	8501	2351	10421	1951	11557	1623	12897	1109	15427	563	12102
6-#18	2.08	MA	12554	2743	16115	2510	21116	2093	24170	1752	27876	1223	35220	759	26895
3L-2S		MI	6603	2743	9806	2323	12072	1930	13555	1607	15587	1087	18902	856	12213
8-#11	1.08	MA	12419	2404	14588	2272	19388	1911	22187	1626	25307	1195	31738	1041	14614
2L-4S		MI	5360	2404	6890	2175	8547	1828	9350	1560	9995	1139	11994	784	6791
8-#11	1.08	MA	11607	2404	13366	2290	17842	1928	20317	1643	22790	1217	28252	945	14568
3E		MI	5566	2404	7264	2162	9035	1817	9973	1545	10847	1135	13048	849	6800
8-#11	1.08	MA	11138	2404	12536	2309	16756	1946	18926	1667	20886	1232	25970	883	14397
4L-2S		MI	5906	2404	7798	2150	9710	1806	10790	1536	11946	1123	14538	964	6789
8-#14	1.56	MA	13421	2567	16795	2367	22112	1980	25446	1669	29661	1185	37740	1029	20833
2L-4S		MI	5544	2567	7480	2273	9227	1899	10128	1607	11010	1130	13315	671	9380
8-#14	1.56	MA	12328	2567	15044	2393	19897	2005	22766	1693	26053	1216	32745	889	20703
3E		MI	5822	2567	8014	2256	9923	1885	11016	1585	12223	1124	14795	763	9477
8-#14	1.56	MA	11701	2567	13854	2420	18339	2030	20771	1727	23323	1237	29462	800	20232
4L-2S		MI	6279	2567	8772	2238	10881	1870	12175	1574	13784	1109	16878	929	9491
8-#18	2.78	MA	15718	2979	22258	2612	28887	2158	33569	1781	40531	1162	52742	1001	36322
2L-4S		MI	5985	2979	8880	2525	10865	2081	12015	1725	13486	1104	16416	367	14532
8-#18	2.78	MA	14036	2979	19187	2657	25001	2201	28869	1821	34204	1214	43981	747	35828
3E		MI	6428	2979	9806	2498	12072	2059	13555	1692	15587	1100	18902	522	15851
8-#18	2.78	MA	13085	2979	17091	2703	22260	2244	25360	1879	29402	1249	38169	586	32557
4L-2S		MI	7110	2979	11112	2471	13724	2038	15552	1676	18276	1078	22378	816	16021

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

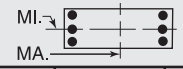


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.10	MA	12510	2411	14591	2284	19488	1921	22358	1635	25585	1200	32157	1045	14961
2L-5S		MI	5370	2411	6743	2205	8406	1859	9240	1581	9872	1160	11900	784	6924
10-#10	1.10	MA	11845	2411	13587	2300	18218	1936	20822	1649	23516	1218	29293	968	14925
3L-4S		MI	5514	2411	7019	2194	8797	1844	9702	1573	10511	1149	12792	838	6963
10-#10	1.10	MA	11468	2411	12907	2316	17327	1951	19681	1669	21955	1231	27430	919	14818
4L-3S		MI	5682	2411	7329	2182	9202	1834	10219	1559	11217	1144	13682	893	6971
10-#10	1.10	MA	11044	2411	12279	2328	16472	1971	18669	1683	20551	1249	25432	876	14558
5L-2S		MI	5965	2411	7772	2171	9762	1824	10897	1551	12130	1133	14946	986	6964
10-#11	1.35	MA	13019	2496	15810	2329	20934	1953	24057	1653	27825	1191	35224	1036	18190
2L-5S		MI	5448	2496	7088	2245	8748	1888	9606	1596	10321	1148	12432	709	8188
10-#11	1.35	MA	12238	2496	14588	2348	19388	1970	22187	1670	25307	1213	31738	940	18130
3L-4S		MI	5617	2496	7423	2233	9222	1870	10166	1587	11094	1136	13484	776	8338
10-#11	1.35	MA	11798	2496	13758	2366	18302	1988	20796	1694	23404	1228	29456	879	17947
4L-3S		MI	5813	2496	7798	2220	9710	1859	10790	1572	11946	1131	14538	841	8365
10-#11	1.35	MA	11295	2496	12997	2382	17258	2013	19562	1711	21691	1250	27014	824	17426
5L-2S		MI	6142	2496	8331	2207	10385	1849	11606	1563	13045	1119	16027	956	8365
10-#14	1.95	MA	14231	2699	18546	2450	24327	2041	28125	1708	33268	1180	42735	1023	25950
2L-5S		MI	5673	2699	7760	2373	9510	1984	10489	1657	11468	1141	13927	558	10899
10-#14	1.95	MA	13192	2699	16795	2476	22112	2066	25446	1732	29661	1211	37740	882	25798
3L-4S		MI	5899	2699	8238	2356	10186	1960	11287	1646	12571	1125	15398	656	11553
10-#14	1.95	MA	12616	2699	15605	2503	20554	2091	23450	1766	26930	1232	34456	793	25331
4L-3S		MI	6159	2699	8772	2339	10881	1946	12175	1624	13784	1120	16878	748	11676
10-#14	1.95	MA	11913	2699	14519	2526	19055	2126	21678	1789	24472	1263	30948	712	23561
5L-2S		MI	6597	2699	9529	2321	11840	1931	13335	1613	15344	1104	18961	913	11712
10-#18	3.47	MA	15445	3214	22258	2804	28887	2309	33569	1890	40531	1205	52742	734	44774
3L-4S		MI	6593	3214	10185	2673	12517	2189	14012	1794	16175	1095	19892	327	18143
10-#18	3.47	MA	14608	3214	20163	2850	26146	2352	30059	1948	35730	1240	46930	574	41442
4L-3S		MI	6968	3214	11112	2645	13724	2168	15552	1761	18276	1091	22378	482	19600
10-#18	3.47	MA	13426	3214	18273	2892	23506	2413	26939	1988	31402	1293	40740	424	37952
5L-2S		MI	7602	3214	12417	2618	15375	2146	17550	1745	20966	1070	25853	776	19816
12-#10	1.32	MA	13006	2485	15595	2331	20758	1955	23894	1657	27653	1197	35021	1042	17899
2L-6S		MI	5381	2485	6909	2260	8612	1903	9467	1617	10161	1162	12303	709	7953
12-#10	1.32	MA	12362	2485	14591	2347	19488	1970	22358	1671	25585	1215	32157	965	17854
3L-5S		MI	5585	2485	7186	2251	8967	1893	9918	1603	10785	1157	13164	780	8202
12-#10	1.32	MA	12005	2485	13911	2362	18597	1985	21217	1691	24024	1228	30294	915	17738
4E		MI	5728	2485	7462	2240	9358	1878	10381	1595	11425	1146	14056	834	8252
12-#10	1.32	MA	11588	2485	13283	2375	17742	2005	20206	1705	22620	1247	28296	872	17481
5L-3S		MI	5889	2485	7772	2229	9762	1868	10897	1581	12130	1141	14946	889	8270
12-#10	1.32	MA	11119	2485	12623	2384	16928	2017	19246	1719	21254	1259	26559	820	16738
6L-2S		MI	6164	2485	8215	2218	10323	1859	11575	1573	13043	1130	16210	982	8271
12-#11	1.63	MA	13600	2588	17032	2386	22480	1995	25927	1680	30343	1188	38710	1032	21764
2L-6S		MI	5464	2588	7295	2314	8993	1941	9876	1639	10664	1149	12903	616	9357
12-#11	1.63	MA	12849	2588	15810	2405	20934	2013	24057	1697	27825	1210	35224	936	21691
3L-5S		MI	5704	2588	7622	2303	9423	1930	10423	1623	11419	1144	13921	700	9670
12-#11	1.63	MA	12436	2588	14980	2424	19848	2030	22666	1721	25922	1225	32942	874	21500
4E		MI	5867	2588	7957	2290	9896	1912	10982	1614	12193	1133	14973	768	9881
12-#11	1.63	MA	11940	2588	14220	2440	18804	2055	21432	1738	24209	1247	30500	819	20968
5L-3S		MI	6054	2588	8331	2277	10385	1902	11606	1598	13045	1128	16027	833	9922
12-#11	1.63	MA	11386	2588	13416	2450	17820	2069	20260	1755	22542	1262	28377	754	19892
6L-2S		MI	6372	2588	8864	2264	11060	1891	12422	1590	14144	1116	17517	948	9933
12-#14	2.34	MA	14026	2831	18546	2559	24327	2126	28125	1771	33268	1206	42735	876	30897
3L-5S		MI	6021	2831	8518	2456	10468	2045	11648	1696	13029	1136	16010	543	13019
12-#14	2.34	MA	13495	2831	17356	2585	22769	2152	26129	1805	30538	1227	39451	786	30435
4E		MI	6242	2831	8996	2439	11144	2021	12446	1685	14132	1120	17482	641	13704
12-#14	2.34	MA	12805	2831	16270	2609	21270	2187	24357	1828	28079	1258	35942	706	28648
5L-3S		MI	6486	2831	9529	2421	11840	2006	13335	1663	15344	1115	18961	733	13871

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#14	2.34	MA	12057	2831	15117	2623	19867	2208	22674	1852	25687	1279	32891	609	27127
6L-2S		MI	6909	2831	10287	2404	12798	1992	14494	1652	16905	1099	21044	898	13925
12-#18	4.17	MA	16059	3449	23234	2997	30031	2460	34758	2017	42057	1231	55691	561	50327
4E		MI	7154	3449	11491	2820	14168	2297	16010	1864	18865	1087	23368	287	21781
12-#18	4.17	MA	14900	3449	21345	3039	27391	2521	31638	2057	37730	1284	49501	412	46852
5L-3S		MI	7490	3449	12417	2792	15375	2276	17550	1830	20966	1083	25853	442	23352
12-#18	4.17	MA	13735	3449	19320	3064	24955	2559	28674	2098	33518	1318	44114	235	42209
6L-2S		MI	8083	3449	13723	2765	17027	2254	19547	1814	23655	1061	29329	736	23604
14-#10	1.54	MA	12867	2560	15595	2393	20758	2004	23894	1693	27653	1213	35021	961	20783
3L-6S		MI	5597	2560	7353	2307	9173	1937	10145	1639	11074	1160	13566	705	9203
14-#10	1.54	MA	12528	2560	14915	2409	19868	2019	22754	1713	26092	1225	33158	911	20660
4L-5S		MI	5796	2560	7630	2298	9528	1928	10597	1625	11698	1154	14427	776	9479
14-#10	1.54	MA	12116	2560	14287	2422	19012	2040	21742	1727	24688	1244	31160	868	20405
5L-4S		MI	5937	2560	7906	2287	9919	1912	11059	1617	12338	1143	15319	830	9539
14-#10	1.54	MA	11663	2560	13627	2431	18198	2051	20782	1741	23323	1257	29423	816	19663
6L-3S		MI	6091	2560	8215	2276	10323	1903	11575	1603	13043	1138	16210	885	9565
14-#10	1.54	MA	11265	2560	12998	2441	17371	2061	19757	1757	21996	1275	27653	783	18964
7L-2S		MI	6359	2560	8659	2265	10884	1893	12254	1595	13957	1127	17473	978	9574
14-#11	1.90	MA	13443	2680	17032	2462	22480	2055	25927	1724	30343	1206	38710	931	25253
3L-6S		MI	5718	2680	7828	2371	9668	1983	10692	1666	11763	1146	14392	608	10861
14-#11	1.90	MA	13054	2680	16203	2481	21394	2073	24536	1748	28440	1221	36428	869	25056
4L-5S		MI	5950	2680	8155	2360	10097	1972	11239	1650	12518	1141	15411	692	11160
14-#11	1.90	MA	12566	2680	15442	2497	20350	2097	23302	1765	26726	1243	33986	815	24512
5L-4S		MI	6111	2680	8490	2347	10571	1955	11798	1641	13292	1129	16462	759	11422
14-#11	1.90	MA	12033	2680	14638	2507	19366	2111	22130	1782	25060	1258	31863	749	23450
6L-3S		MI	6289	2680	8864	2335	11060	1944	12422	1625	14144	1124	17517	825	11475
14-#11	1.90	MA	11565	2680	13871	2521	18357	2123	20892	1802	23441	1280	29693	708	22442
7L-2S		MI	6598	2680	9398	2322	11734	1933	13238	1617	15243	1112	19006	939	11495
14-#14	2.73	MA	14344	2964	19107	2668	24984	2212	28808	1843	34145	1222	44446	779	35543
4L-5S		MI	6358	2964	9276	2539	11427	2106	12808	1735	14590	1131	18094	528	15150
14-#14	2.73	MA	13664	2964	18021	2691	23485	2247	27036	1867	31686	1253	40937	699	33734
5L-4S		MI	6577	2964	9753	2522	12103	2082	13606	1724	15693	1115	19565	625	15801
14-#14	2.73	MA	12954	2964	16868	2706	22082	2268	25353	1891	29294	1274	37885	602	32192
6L-3S		MI	6817	2964	10287	2504	12798	2067	14494	1702	16905	1110	21044	717	16063
14-#14	2.73	MA	12329	2964	15768	2724	20635	2284	23589	1921	26970	1305	34759	542	29993
7L-2S		MI	7208	2964	11045	2487	13757	2053	15653	1691	18466	1094	23127	882	16133
14-#18	4.86	MA	16314	3685	24416	3186	31277	2629	36338	2127	44057	1275	58262	399	55752
5L-4S		MI	7697	3685	12796	2967	15820	2406	18007	1933	21554	1078	26843	247	25439
14-#18	4.86	MA	15232	3685	22391	3211	28840	2667	33373	2167	39845	1310	52875	222	51078
6L-3S		MI	8000	3685	13723	2940	17027	2384	19547	1899	23655	1074	29329	402	27107
14-#18	4.86	MA	14274	3685	20457	3242	26297	2693	30313	2221	35753	1362	47331	113	46565
7L-2S		MI	8556	3685	15028	2912	18678	2362	21545	1884	26345	1052	32805	696	27389
16-#10	1.76	MA	13037	2635	15919	2456	21138	2054	24290	1735	28161	1223	36022	907	23584
4L-6S		MI	5809	2635	7796	2353	9734	1972	10824	1661	11988	1157	14830	701	10456
16-#10	1.76	MA	12630	2635	15291	2468	20282	2074	23278	1749	26757	1241	34024	864	23332
5E		MI	6002	2635	8073	2345	10089	1962	11275	1647	12612	1152	15691	772	10721
16-#10	1.76	MA	12192	2635	14631	2477	19468	2085	22318	1763	25391	1254	32287	812	22590
6L-4S		MI	6142	2635	8349	2334	10480	1947	11738	1639	13252	1141	16583	826	10824
16-#10	1.76	MA	11810	2635	14002	2488	18641	2095	21294	1779	24065	1272	30517	779	21889
7L-3S		MI	6290	2635	8659	2323	10884	1937	12254	1625	13957	1135	17473	881	10858
16-#10	1.76	MA	11454	2635	13311	2506	17789	2112	20292	1789	22744	1285	28782	738	20968
8L-2S		MI	6551	2635	9102	2311	11445	1927	12932	1617	14870	1124	18737	974	10872
16-#11	2.17	MA	13655	2771	17425	2539	22940	2115	26406	1775	30957	1218	39914	864	28614
4L-6S		MI	5965	2771	8362	2429	10343	2025	11508	1693	12862	1143	15881	599	12370

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

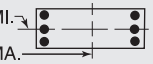
f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#11	2.17	MA	13173	2771	16664	2554	21896	2139	25171	1792	29244	1240	37472	810	28060
5E		MI	6191	2771	8689	2417	10772	2014	12055	1677	13617	1138	16900	684	12657
16-#11	2.17	MA	12661	2771	15860	2565	20912	2154	23999	1809	27578	1255	35349	744	27008
6L-4S		MI	6350	2771	9024	2405	11246	1997	12615	1668	14391	1126	17952	751	12962
16-#11	2.17	MA	12214	2771	15093	2578	19903	2165	22762	1829	25959	1277	33179	703	25988
7L-3S		MI	6520	2771	9398	2392	11734	1986	13238	1652	15243	1121	19006	816	13025
16-#11	2.17	MA	11792	2771	14250	2600	18864	2185	21540	1840	24347	1292	31057	651	24729
8L-2S		MI	6820	2771	9931	2379	12409	1975	14055	1644	16342	1109	20496	931	13053
16-#14	3.13	MA	14496	3096	19772	2774	25700	2308	29715	1906	35293	1248	45932	692	38821
5E		MI	6704	3096	10033	2622	12385	2167	13967	1774	16151	1126	20177	512	17288
16-#14	3.13	MA	13820	3096	18619	2789	24297	2329	28033	1930	32901	1269	42880	596	37257
6L-4S		MI	6921	3096	10511	2604	13061	2142	14765	1762	17254	1110	21648	610	17910
16-#14	3.13	MA	13232	3096	17519	2807	22850	2345	26269	1960	30578	1300	39754	536	35067
7L-3S		MI	7127	3096	11045	2587	13757	2128	15653	1741	18466	1105	23127	702	18254
16-#14	3.13	MA	12641	3096	16309	2838	21359	2373	24517	1976	28263	1321	36703	458	32919
8L-2S		MI	7500	3096	11802	2570	14715	2114	16813	1730	20027	1089	25210	867	18337
16-#18	5.56	MA	16672	3920	25463	3358	32725	2775	38073	2236	46173	1301	61636	210	59947
6L-4S		MI	8227	3920	14102	3114	17471	2514	20005	2002	24244	1069	30319	206	29114
16-#18	5.56	MA	15793	3920	23528	3389	30182	2802	35012	2290	42080	1353	56092	101	55409
7L-3S		MI	8499	3920	15028	3087	18678	2492	21545	1968	26345	1065	32805	362	30866
16-#18	5.56	MA	14792	3920	21400	3443	27559	2850	31931	2317	38003	1388	50704	-43	50487
8L-2S		MI	9024	3920	16334	3059	20330	2470	23542	1953	29034	1043	36280	655	31172
18-#10	1.98	MA	13131	2710	16295	2515	21552	2108	24815	1771	28825	1238	36888	860	26260
5L-6S		MI	6016	2710	8240	2400	10295	2006	11502	1683	12901	1154	16094	697	11713
18-#10	1.98	MA	12708	2710	15635	2524	20738	2120	23855	1785	27460	1251	35151	808	25517
6L-5S		MI	6205	2710	8516	2392	10650	1996	11954	1669	13525	1149	16955	768	11968
18-#10	1.98	MA	12341	2710	15006	2535	19911	2129	22830	1801	26133	1269	33381	775	24814
7L-4S		MI	6343	2710	8793	2380	11041	1981	12416	1661	14165	1138	17847	822	12108
18-#10	1.98	MA	11990	2710	14315	2553	19059	2146	21829	1811	24813	1282	31646	734	23886
8L-3S		MI	6485	2710	9102	2369	11445	1971	12932	1647	14870	1132	18737	877	12148
18-#10	1.98	MA	11555	2710	13694	2563	18270	2158	20821	1827	23470	1298	29880	682	23015
9L-2S		MI	6739	2710	9546	2358	12006	1962	13611	1638	15784	1122	20001	970	12168
18-#11	2.44	MA	13765	2863	17886	2612	23442	2182	27041	1819	31762	1236	40959	805	31611
5L-6S		MI	6208	2863	8895	2486	11018	2067	12325	1720	13961	1139	17371	591	13883
18-#11	2.44	MA	13272	2863	17082	2622	22458	2196	25869	1835	30095	1251	38835	740	30566
6L-5S		MI	6427	2863	9222	2475	11447	2057	12871	1704	14716	1134	18390	676	14159
18-#11	2.44	MA	12845	2863	16315	2635	21449	2207	24632	1856	28477	1273	36665	698	29534
7L-4S		MI	6584	2863	9557	2462	11921	2039	13431	1695	15490	1122	19441	743	14502
18-#11	2.44	MA	12430	2863	15472	2657	20410	2227	23410	1867	26865	1288	34543	646	28277
8L-3S		MI	6747	2863	9931	2449	12409	2028	14055	1679	16342	1117	20496	808	14573
18-#11	2.44	MA	11918	2863	14720	2670	19447	2241	22181	1887	25244	1308	32377	582	26936
9L-2S		MI	7039	2863	10465	2437	13084	2017	14871	1671	17441	1105	21985	923	14609
18-#14	3.52	MA	14661	3229	20370	2871	26512	2390	30712	1969	36509	1264	47875	589	42322
6L-5S		MI	7024	3229	10791	2705	13344	2228	15126	1813	17711	1121	22260	497	19433
18-#14	3.52	MA	14106	3229	19270	2890	25065	2406	28948	1998	34185	1295	44748	529	40140
7L-4S		MI	7238	3229	11269	2687	14020	2203	15924	1801	18814	1105	23731	594	20029
18-#14	3.52	MA	13526	3229	18060	2921	23574	2434	27196	2015	31870	1316	41698	451	37979
8L-3S		MI	7430	3229	11802	2670	14715	2189	16813	1780	20027	1100	25210	686	20444
18-#14	3.52	MA	12841	3229	16988	2940	22193	2454	25432	2042	29564	1345	38578	359	35846
9L-2S		MI	7789	3229	12560	2652	15674	2174	17972	1768	21588	1084	27293	852	20539
18-#18	6.25	MA	17258	4156	26600	3537	34067	2910	39712	2359	48408	1344	64853	89	64254
7L-4S		MI	8746	4156	15408	3261	19123	2622	22003	2071	26933	1060	33794	166	32803
18-#18	6.25	MA	16276	4156	24471	3590	31445	2959	36630	2386	44331	1379	59465	-55	59089
8L-3S		MI	8991	4156	16334	3234	20330	2600	23542	2038	29034	1056	36280	321	34629

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

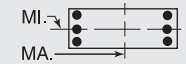


f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
20-#10	2.20	MA	13212	2784	16639	2571	22009	2154	25391	1807	29528	1248	38015	804	28442
6E		MI	6220	2784	8683	2447	10856	2040	12180	1704	13814	1151	17357	693	12973
20-#10	2.20	MA	12858	2784	16011	2582	21181	2164	24366	1823	28202	1266	36245	771	27739
7L-5S		MI	6403	2784	8960	2438	11211	2031	12632	1691	14439	1146	18218	764	13219
20-#10	2.20	MA	12513	2784	15319	2600	20329	2180	23365	1833	26881	1279	34510	730	26803
8L-4S		MI	6540	2784	9236	2427	11602	2015	13094	1682	15079	1135	19110	818	13391
20-#10	2.20	MA	12092	2784	14698	2610	19540	2192	22357	1849	25538	1295	32744	678	25932
9L-3S		MI	6677	2784	9546	2416	12006	2006	13611	1669	15784	1130	20001	873	13437
20-#10	2.20	MA	11700	2784	14072	2620	18768	2205	21388	1861	24180	1305	31006	643	24830
10L-2S		MI	6926	2784	9989	2405	12567	1996	14289	1660	16697	1119	21265	966	13462
20-#11	2.71	MA	13868	2955	18304	2680	24004	2238	27739	1862	32613	1248	42321	735	34123
6E		MI	6446	2955	9429	2543	11692	2110	13141	1747	15060	1136	18860	583	15399
20-#11	2.71	MA	13460	2955	17537	2693	22995	2249	26501	1883	30995	1270	40151	694	33079
7L-5S		MI	6658	2955	9756	2532	12122	2099	13688	1731	15815	1131	19879	667	15665
20-#11	2.71	MA	13051	2955	16694	2714	21956	2269	25280	1894	29382	1285	38029	641	31826
8L-4S		MI	6814	2955	10090	2520	12596	2081	14247	1722	16589	1119	20931	735	16041
20-#11	2.71	MA	12557	2955	15942	2727	20994	2284	24051	1914	27762	1305	35863	577	30476
9L-3S		MI	6970	2955	10465	2507	13084	2070	14871	1706	17441	1114	21985	800	16120
20-#11	2.71	MA	12098	2955	15179	2739	20051	2299	22868	1928	26105	1316	33738	532	29167
10L-2S		MI	7253	2955	10998	2494	13759	2060	15687	1698	18540	1102	23474	915	16163
20-#14	3.91	MA	14956	3361	21021	2973	27280	2467	31627	2037	37792	1290	49743	522	45213
7L-5S		MI	7337	3361	11549	2787	14302	2289	16286	1852	19272	1116	24343	481	21584
20-#14	3.91	MA	14385	3361	19812	3004	25789	2495	29875	2053	35477	1311	46692	444	43039
8L-4S		MI	7550	3361	12026	2770	14978	2264	17084	1840	20375	1100	25814	579	22155
20-#14	3.91	MA	13731	3361	18739	3022	24408	2515	28111	2081	33171	1340	43573	352	40895
9L-3S		MI	7728	3361	12560	2753	15674	2250	17972	1819	21588	1095	27293	671	22634
20-#14	3.91	MA	13120	3361	17644	3039	23055	2536	26413	2101	30793	1355	40516	285	38546
10L-2S		MI	8073	3361	13318	2735	16632	2235	19131	1807	23149	1079	29376	836	22740
20-#18	6.94	MA	17711	4391	27542	3737	35330	3067	41330	2455	50658	1370	68226	-67	67647
8L-4S		MI	9256	4391	16713	3408	20774	2730	24000	2140	29622	1051	37270	126	36504
22-#10	2.43	MA	13365	2859	17015	2628	22451	2198	25903	1845	30270	1264	39109	767	30664
7L-6S		MI	6420	2859	9126	2494	11417	2075	12859	1726	14728	1148	18621	689	14235
22-#10	2.43	MA	13024	2859	16323	2646	21599	2215	24901	1855	28950	1276	37375	726	29721
8L-5S		MI	6599	2859	9403	2485	11771	2065	13310	1713	15352	1143	19482	760	14473
22-#10	2.43	MA	12616	2859	15702	2657	20810	2227	23894	1871	27607	1292	35608	674	28842
9L-4S		MI	6735	2859	9679	2474	12163	2050	13773	1704	15992	1132	20374	814	14674
22-#10	2.43	MA	12237	2859	15076	2667	20038	2239	22924	1883	26248	1302	33870	639	27743
10L-3S		MI	6867	2859	9989	2463	12567	2040	14289	1691	16697	1127	21265	869	14726
22-#10	2.43	MA	11879	2859	14463	2678	19234	2249	21969	1895	24910	1318	32183	596	26681
11L-2S		MI	7109	2859	10432	2452	13128	2031	14968	1682	17611	1116	22528	962	14755
22-#11	2.98	MA	14060	3047	18760	2750	24541	2291	28371	1910	33512	1266	43637	689	36625
7L-6S		MI	6679	3047	9962	2601	12367	2152	13957	1774	16159	1132	20350	575	16919
22-#11	2.98	MA	13657	3047	17916	2772	23502	2311	27150	1921	31900	1282	41515	636	35374
8L-5S		MI	6886	3047	10289	2590	12797	2141	14504	1758	16914	1127	21369	659	17176
22-#11	2.98	MA	13180	3047	17165	2785	22540	2326	25921	1941	30280	1302	39350	573	34017
9L-4S		MI	7056	3047	10624	2577	13271	2123	15063	1749	17688	1115	22420	726	17581
22-#11	2.98	MA	12739	3047	16401	2796	21597	2341	24738	1955	28623	1313	37224	527	32700
10L-3S		MI	7197	3047	10998	2564	13759	2113	15687	1733	18540	1110	23474	792	17667
22-#11	2.98	MA	12319	3047	15654	2810	20625	2353	23573	1969	26989	1331	35159	472	31195
11L-2S		MI	7462	3047	11532	2551	14434	2102	16503	1724	19639	1098	24964	906	17716
22-#14	4.30	MA	15221	3494	21563	3086	28005	2556	32554	2092	39085	1306	51687	438	48099
8L-5S		MI	7645	3494	12306	2870	15261	2349	17445	1891	20833	1111	26426	466	23740
22-#14	4.30	MA	14595	3494	20490	3105	26623	2576	30790	2120	36778	1335	48567	345	45944
9L-4S		MI	7855	3494	12784	2853	15937	2325	18243	1879	21936	1095	27897	563	24289
22-#14	4.30	MA	14015	3494	19395	3122	25270	2597	29092	2140	34400	1350	45511	278	43602
10L-3S		MI	8022	3494	13318	2835	16632	2311	19131	1858	23149	1090	29376	655	24824

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
24-#10	2.65	MA	13524	2934	17327	2693	22870	2249	26438	1877	31018	1274	40239	722	32626
8L-6S		MI	6617	2934	9570	2540	11978	2109	13537	1748	15641	1146	19885	685	15500
24-#10	2.65	MA	13128	2934	16706	2703	22081	2261	25430	1893	29675	1290	38472	671	31752
9L-5S		MI	6792	2934	9847	2532	12332	2099	13989	1735	16266	1140	20746	756	15730
24-#10	2.65	MA	12763	2934	16080	2713	21308	2274	24460	1905	28317	1299	36734	635	30656
10L-4S		MI	6927	2934	10123	2521	12724	2084	14451	1726	16905	1129	21638	810	15957
24-#10	2.65	MA	12417	2934	15467	2724	20504	2283	23506	1917	26978	1315	35047	592	29588
11L-3S		MI	7054	2934	10432	2509	13128	2074	14968	1713	17611	1124	22528	865	16013
24-#10	2.65	MA	12007	2934	14866	2736	19657	2299	22520	1934	25643	1326	33269	546	28485
12L-2S		MI	7291	2934	10876	2498	13689	2065	15646	1704	18524	1113	23792	958	16047
24-#11	3.25	MA	14249	3139	19139	2829	25048	2354	29020	1948	34418	1278	45002	632	38923
8L-6S		MI	6910	3139	10495	2658	13042	2194	14773	1801	17258	1129	21839	566	18440
24-#11	3.25	MA	13789	3139	18387	2842	24086	2368	27791	1968	32798	1298	42836	568	37557
9L-5S		MI	7123	3139	10823	2647	13472	2183	15320	1785	18013	1124	22858	651	18690
24-#11	3.25	MA	13365	3139	17623	2854	23143	2383	26608	1982	31141	1309	40710	523	36233
10L-4S		MI	7277	3139	11157	2634	13945	2166	15879	1776	18787	1112	23910	718	19121
24-#11	3.25	MA	12963	3139	16876	2867	22171	2395	25443	1996	29507	1328	38645	467	34732
11L-3S		MI	7411	3139	11532	2622	14434	2155	16503	1760	19639	1107	24964	784	19213
24-#11	3.25	MA	12486	3139	16143	2881	21137	2414	24252	2018	27878	1340	36466	411	33187
12L-2S		MI	7668	3139	12065	2609	15109	2144	17319	1751	20738	1095	26453	898	19268
24-#14	4.69	MA	15438	3626	22241	3188	28838	2637	33469	2159	40385	1330	53562	338	50994
9L-5S		MI	7947	3626	13064	2953	16219	2410	18604	1930	22394	1106	28509	450	25900
24-#14	4.69	MA	14885	3626	21146	3205	27485	2658	31771	2178	38008	1346	50505	271	48658
10L-4S		MI	8157	3626	13542	2935	16895	2386	19402	1918	23497	1090	29980	548	26429

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

CHAPTER 4 – ROUND-TIED COLUMNS

General. Reinforced concrete round columns are most frequently used for structures with large, open areas and few partitions. The round column is usually formed with standard prefabricated forms available in diameter multiples of 1 or 2 inches, which leave a smooth finish suitable for exposed use. Paint or decorative finish treatment, if used, is ordinarily applied directly to the structural concrete. Reusable round column steel forms or one-use waterproofed fiber forms are both commercially available.

The ACI Building Code permits round columns provided with either tied or spiral lateral reinforcement. Other variations possible include conical column capitals to increase available perimeter for shear resistance. Round, spirally reinforced columns with capitals and flat slabs with drop panels are the original heavy duty concrete floor system developed as the preferred construction to replace earlier systems of timber and masonry.

In this Chapter, the design axial load and moment strengths (capacities) of "short", round-tied columns are tabulated for 12-inch to 36-inch diameters in 2-inch increments with f'_c = 4,000, 5,000, 6,000, and 8,000 psi, and Grade 60 reinforcing bars; and for 24-inch to 48-inch diameters in 2-inch increments with f'_c = 6,000, 8,000, and 10,000 psi, and Grade 75 reinforcing bars. The tabulated capacities cover the allowable range of vertical bar areas (0.01 to 0.08 times A_g).

Spirals Versus Ties. Spiral reinforcement conforming to minimum code requirements (ACI 10.9.3, Eq. 10-5) ensures maximum ductile behavior for concrete columns, even at loading to failure. This property is essential for earthquake resistance (ductile frames), for blast resistance, and desirable in ordinary structures. For absolute minimum size round columns (maximum capacity for a given size), spiral reinforcement must be used. The Code permits use of

$$\phi P_{n\,(\max)} = 0.85\phi[0.85 f'_c\,(A_g - A_{st}) + f_y A_{st}],$$

for spiral columns (ACI 10.3.6.1) compared to

$$\phi P_{n(\max)} = 0.80\phi[0.85 f'_c\,(A_g - A_{st}) + f_y A_{st}],$$

for tied columns (ACI 10.3.6.2).

The reduction in design strength for spiral columns is also less than for tied columns, i.e., the strength-reduction factor, ϕ = 0.75, for spirally reinforced columns versus ϕ = 0.65 for tied columns (ACI 9.3.2.2). For columns with heavy axial loads, subject to relatively small factored moments, and using the maximum allowed vertical bar area, these two code provisions encourage the use of spiral reinforcement to achieve the minimum size of a round column.

Spiral reinforcement is more costly, by weight, than vertical reinforcing bars. The spiral weight for the minimum column area to qualify for the two special code provisions cited above is considerable. For this reason, it will ordinarily be more economical to achieve the required load capacity for a designated size round-tied column by increasing the vertical bar area or concrete strength, where possible.

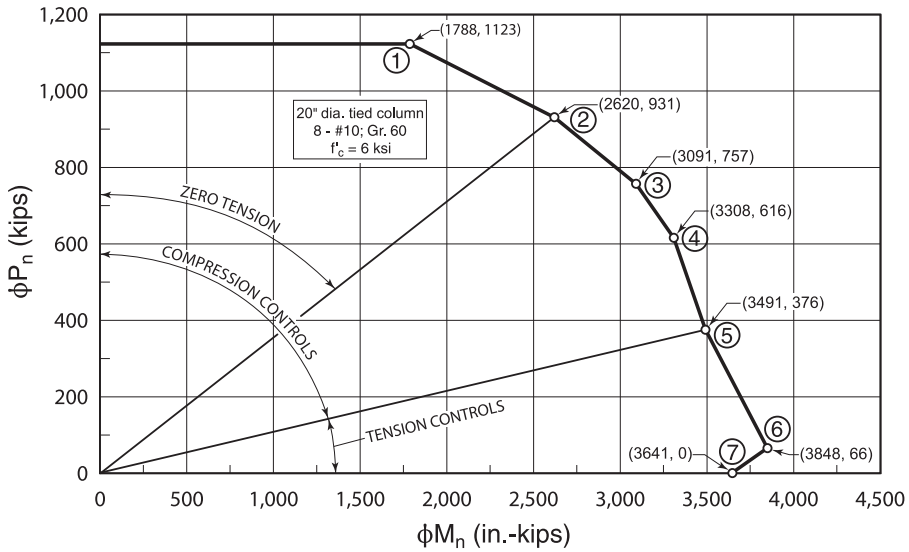


Figure 4-1 Control Points for Load-Moment Interaction Curves

Tabulated designs for "short" spirally reinforced columns are provided on the enclosed CD-ROM. The tables cover 12-inch to 36-inch diameters in 2-inch increments with f'_c = 4,000, 5,000, 6,000, and 8,000 psi and Grade 60 reinforcing bars; and for 24-inch to 48-inch diameters in 2-inch increments with f'_c = 6,000, 8,000, and 10,000 psi and Grade 75 reinforcing bars. In all of the tables, the minimum yield strength of the spiral reinforcement is 60,000 psi.

Load-Moment Interaction Curves. Fig. 4-1 was constructed from the tabulated values for column capacity on Page 4-28. "Control points" for column load-moment interaction curves refer to values of ϕP_n and ϕM_n necessary to construct the interaction diagram from maximum design axial load and corresponding moment strength to pure design moment strength, and limiting values convenient for compliance with various Code requirements.

The control points on the load-moment interaction diagram in Fig. 4-1 identify:

1. The coordinates of Point 1 are the maximum design axial load strength, $\phi P_{n(max)}=0.80\phi\,[0.85f'_c\,(A_g - A_{st}) + f_y A_{st}]$, for round-tied columns (ACI 10.3.6.2); and the corresponding design moment strength, ϕM_n.

2. Point 2 is the zero tension point. Location of this point is convenient where end-bearing splices are used (ACI 12.17.4). At Point 2, the stress in the bars nearest the tension face is zero. For a larger factored moment, the stress becomes tensile. The coordinates of Point 2 are designated ϕP_{ot} and ϕM_{ot}.

3. At Point 3, the tensile stress in the bars nearest the tension face of the column is 25 percent of the specified yield strength. For Grade 60 reinforcing bars, the tensile stress is 0.25 (60,000) = 15,000 psi. Point 3 is not a "control point", per se. The coordinates of the point, ϕP_{15}, ϕM_{15}, are tabulated for convenience in constructing the load-moment ($\phi P_n - \phi M_n$) interaction curve.

4. At Point 4, the tensile stress in the bars nearest the tension face of the column is 50 percent of f_y, that is, 30,000 psi for Grade 60 reinforcing bars. The coordinates of Point 4 are designated ϕP_{30} and ϕM_{30}.

5. At Point 5, ϕP_b and ϕM_b are the design axial load and moment strengths at balanced strain conditions. At this point, the tensile steel reaches the strain corresponding to its specified yield strength, f_y, i.e., "100% f_y", and concrete compressive strain reaches its assumed ultimate value of 0.003.

ACI 10.3.3 defines the column section as being compression-controlled, with ϕ = 0.65 (tied) or 0.75 (spiral), when the extreme steel strain is less than or equal to f_y/E_s.

6. Point 6 is the condition where the strain in the extreme tension steel is equal to 0.005. ACI 10.3.4 defines the column section as being tension-controlled, with ϕ = 0.90, when the extreme steel strain is equal to or greater than 0.005.

When the extreme steel strain is between f_y/E_s (compression-controlled) and 0.005 (tension-controlled), the column section is in a transition region where the ϕ-factor is assumed to vary linearly with the extreme steel strain.

7. Point 7, the last control point, is the pure design moment strength when the design axial load strength is zero.

Concrete Cover. All column design axial load and moment strengths (capacities) tabulated in this *Handbook* were calculated using the specified concrete cover prescribed for cast-in-place columns, 1½ inches to ties or spirals (ACI 7.7.1). For all column vertical bars, #10 and smaller; 3/8 inch was allowed for #3 ties, and for #11, #14, and #18 vertical bars, ½ inch for #4 ties, as the minimum sizes of ties permitted (ACI 7.10.5.1).

The radial distances, d_r, from the nearest point on the face of the column to the center of vertical bars, used in calculations are shown in Table 4-1:

Table 4-1 Depth from Nearest Face to Center of Vertical Bars*

Bar Size	#5	#6	#7	#8	#9	#10	#11	#14	#18
d_r (in.)	2.19	2.25	2.31	2.38	2.44	2.51	2.71	2.85	3.12

* Based on 1-1/2 in. concrete cover to the tie or spiral.

Steel Areas and Bar Orientation. In some design handbooks, calculations for tabulated design axial load and moment strengths of round columns are based on the assumption that the behavior of the vertical bars is the same as that of a vertical steel tube of equivalent cross-sectional area and average diameter equal to ($h - 2d_r$). The equivalent area tube method increases in accuracy with increasing numbers of vertical bars and gives a single average design moment strength for bending in any direction. Since the ACI Building Code permits the use of round-tied columns with a minimum of four vertical bars (minimum of six vertical bars with spirals), the design axial load and moment strengths in this Chapter have been computed using actual bar areas, oriented so that one bar is located on the x-axis for bending about the x-axis. See Fig. 4-2. The bar-by-bar method is, of course, more accurate than the equivalent tube method.

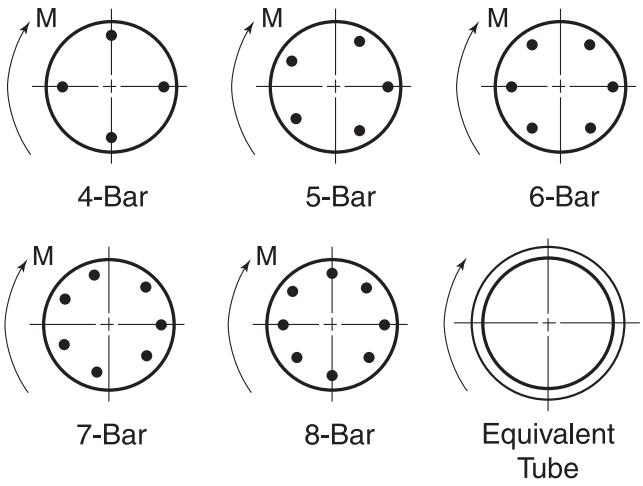


Figure 4-2 Orientation of Bar Patterns Used for Calculation of Load Capacity Tables

It is not practicable to prescribe orientation of vertical bars in round columns when more than four bars are used, and not advisable without rigorous field inspection when using only four bars. For this reason, it is prudent to base calculations on the bar arrangement giving minimum design moment strength and to use this value for the design moment strength in any direction.

Tie Patterns. As a general rule, in selecting column reinforcement for maximum economy, the required steel area should be furnished in the largest size bars practicable. Fewer bars simplify and speed up field assembly. For this reason, 4-bar arrangements should be considered when feasible. Note that for the 4-bar round column an economical square tie may be used. See Fig. 4-3 and Table 4-2 for suggested tie arrangements.

TABLE 4-2 Minimum Tie Sizes and Maximum Spacings*

Column Diameter *h* (in.)	Vertical Bar Size									
	#3 Ties						#4 Ties			#5 Ties
	#5	#6	#7	#8	#9	#10	#11	#14	#18	#18
12	10	12	12	12	12	12	12	12	12	12
14	10	12	14	14	14	14	14	14	14	14
16	10	12	14	16	16	16	16	16	16	16
18	10	12	14	16	18	18	18	18	18	18
20	10	12	14	16	18	18	20	20	20	20
22	10	12	14	16	18	18	22	22	22	22
24	10	12	14	16	18	18	22	24	24	24
26	10	12	14	16	18	18	22	24	24	26
28	10	12	14	16	18	18	22	24	24	28
30	10	12	14	16	18	18	22	24	24	30
32	10	12	14	16	18	18	22	24	24	30
34	10	12	14	16	18	18	22	24	24	30
36	10	12	14	16	18	18	22	24	24	30
38	10	12	14	16	18	18	22	24	24	30
40	10	12	14	16	18	18	22	24	24	30
42	10	12	14	16	18	18	22	24	24	30
44	10	12	14	16	18	18	22	24	24	30
46	10	12	14	16	18	18	22	24	24	30
48	10	12	14	16	18	18	22	24	24	30

* Based on ACI 7.10.5.1 and ACI 7.10.5.2.

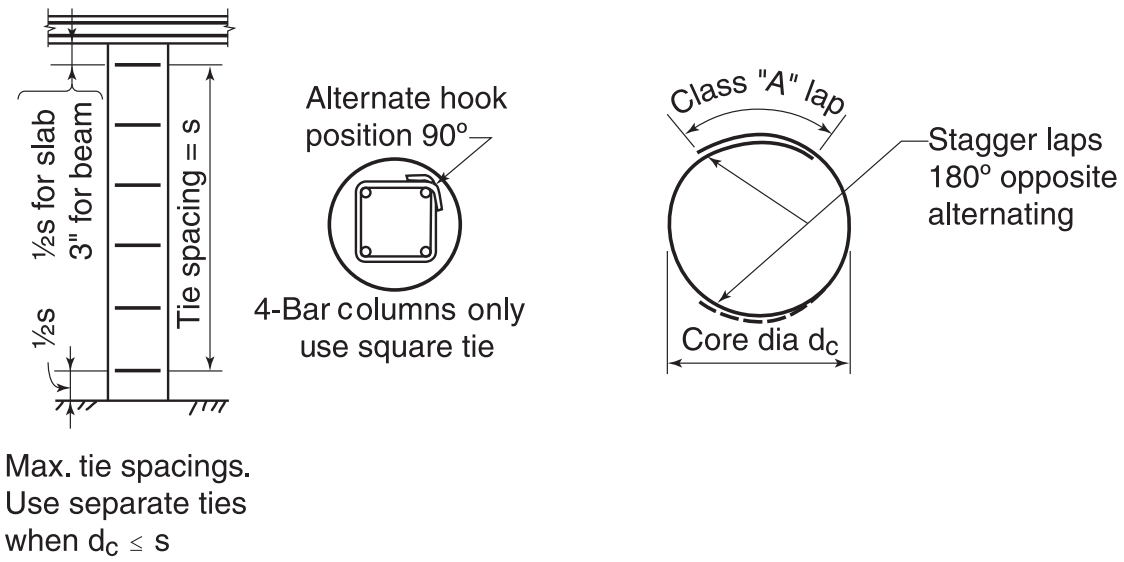


Figure 4-3 Suggested Ties

USE OF TABLES FOR ROUND-TIED COLUMNS

Example 1

Select a round-tied column for an intermediate floor in a flat slab parking garage. Story height is 9′-0″. Concrete compressive strength, f'_c, in the columns above is 4,000 psi. Grade 60 reinforcing bars are used throughout. Column height (clear) between floor and drop panel is 8′-0″. The entire structure at this level is braced against sidesway. The service dead load is 200 kips; the service live load, using loads per square foot specified in the applicable building code after all reductions permitted in live load by the local building code, is 160 kips. Unbalanced factored live load on the floor above requires that the column resist a factored moment of 147 ft-kips.

$P_u = 1.2(200) + 1.6(160) = 240 + 256 = 496$ kips
$M_u = 147$ ft-kips = 1,764 in.-kips

For this example, assume the column above has an 18-in. diameter, and that it is desired to maintain the same size through this floor and two floors below. Previous investigation of the column above indicates that slenderness effects need not be considered since $k\ell_u/r = [(1.0)(96)/(0.25)(18)] = 21.4 < 22$ (ACI 10.10.1(b) with $M_1 = M_2$).

Enter the table on Page 4-13 with $P_u = 496$ kips and $M_u = 1{,}765$ in.-kips. Interpolating as necessary, read:

Vertical Bars	ϕP_n (kips)	ϕM_n (in.-kips)	*Rho*,%
5 – #14	496	1,901	4.42
6 – #14	496	2,184	5.31
7 – #11	496	1,907	4.29

Use an 18-in. diameter column with 7 – #11 vertical bars and #4 ties spaced at 18 in.; $f'_c = 4{,}000$ psi.

Example 2

Select a column design for the columns that are two floors below those of Example 1. From structural analysis, $P_u = 1{,}104$ kips and the factored moment M_u due to unbalanced gravity load is 127 ft-kips = 1,524 in.-kips.

Refer to the table on Page 4-13; none of the tabulated designs provide the required combination of

$$\phi P_n \geq 1{,}104 \text{ kips and } \phi M_n \geq 1{,}524 \text{ in.-kips}$$

Tied columns with an 18-in. diameter and with $f'_c = 4{,}000$ psi will not suffice. At this point, there are three options:

1. Use a larger diameter column
2. Use a higher f'_c
3. Use a spiral in combination with options (1) or (2) if minimum diameter is essential.

Consider Option 1; try a 22-in. diameter column with $f'_c = 4{,}000$ psi; enter the table on Page 4-14 and read for 11 – #11 vertical bars:

$\phi P_n = 1{,}177$ kips and $\phi M_n = 1{,}879$ in.-kips, okay

Consider Option 2; try an 18-in. diameter column with $f'_c = 8{,}000$ psi; enter the table on Page 4-35 and read for 10 – #10 vertical bars:

$\phi P_n = 1{,}251$ kips and $\phi M_n = 1{,}787$ in.-kips, okay

Example 3

Part of the structure in Examples 1 and 2 includes a ground floor with a ceiling height of 15 feet. For these exterior columns, $P_u = 828$ kips and factored moments due to unbalanced gravity load are $M_u = +62$ ft.-kips at the top and –35 ft.-kips at the bottom. For evaluating slenderness effects, this floor is also braced by elements other than columns against sidesway. Again, it is desired to use an 18-in. round column.

Slenderness effects have to be considered since $k\ell_u/r = 1.0(15)(12)/(0.25)(18) = 40 > 22$

$$e = \frac{M_u}{P_u} = \frac{(62)(12)}{828} = 0.9 \text{ in.}$$

Min. $e = 0.6 + 0.03h = 0.6 + 0.03(18) = 1.14$ in.
Use min. $e = 1.14$ in.

Refer to the table on Page 4-28 for $f' = 6{,}000$ psi. Allow about 100 percent reserve in ϕM_n for slenderness effects; required $\phi M_n = 828(1.14)(2) = 1{,}890$ in.-kips.

Try an 18-in. diameter column with 6-#11 vertical bars:

$E_c = 57{,}000\sqrt{f'_c}$ (ACI 8.5.1)

$E_c = 57{,}000\sqrt{6{,}000} = 4.4 \times 10^6$ psi

$$I_g = \frac{\pi h^4}{64} = \frac{\pi(18)^4}{64} = 5{,}150 \text{ in.}^4$$

For a tube equivalent in area to 6 – #11 vertical bars, $A_s = (6)(1.56) = 9.36$ in.^{2}; $d = 18 - 2(1.50) - 2(0.5) - 1.41 = 12.59$ in.; $\Delta = 6(1.56)/\pi(12.59) = 0.24$ in.; the inner diameter $d_1 = 12.59 - 0.24 = 12.35$ in.; and the outer diameter $d_2 = 12.59 + 0.24 = 12.83$ in.

The moment of inertia for the reinforcing steel:

$$I_{se} = \frac{\pi(d_2^4 - d_1^4)}{64} = \frac{\pi(27{,}096 - 23{,}263)}{64} = 188 \text{ in.}^4$$

The total factored axial load, $P_u = 828$ kips is given in this example. To calculate β_{dns}, the factored dead load and factored live load are required. Assume the dead load and live load are in same proportions as in Example 1. Then

$$\beta_{dns} = \frac{1.2(200)}{1.2(200) + 1.6(160)} = 0.48$$

$$EI = \frac{0.2E_c I_g + E_s I_{se}}{1 + \beta_{dns}} \text{ . . . . . .(ACI 10.10.6.1, Eq. 10-14)}$$

$$EI = \frac{0.2(4.4 \times 10^6)(5{,}150) + (29 \times 10^6)(188)}{1 + 0.48} = 6.75 \times 10^9$$

Critical load, P_c, for $k = 1.0$ (braced frame):

$$P_c = \frac{\pi^2 EI}{(k\ell_u)^2} = \frac{\pi^2 (6.75 \times 10^9)}{(1 \times 15 \times 12)^2} = 2{,}056 \text{ kips}$$

Moment magnification factor, δ_{ns},

$$\delta_{ns} = \frac{C_m}{1 - \dfrac{P_u}{0.75 P_c}} \geq 1.0 \quad \text{(ACI 10.10.6, Eq. 10-12)}$$

$$C_m = 0.6 + 0.4 \frac{M_1}{M_2} \quad \text{(ACI 10.10.6.4, Eq. 10-16)}$$

$$C_m = 0.6 + 0.4(35/62) = 0.826$$

$$\delta_{ns} = \frac{0.826}{1 - \dfrac{828}{(0.75)(2{,}056)}} = 1.78$$

Magnified moment, $M_c = \delta_{ns} M_2 = (1.78)(828)(1.14)$

$$M_c = 1{,}680 \text{ in.-kips}$$

The column must be able to resist

$$P_u = 828 \text{ kips and } M_u = M_c = 1{,}680 \text{ in.-kips}$$

From Page 4-28, for an 18-in. diameter column with 6 – #11 vertical bars, and interpolating as necessary:

$\phi P_n = 828$ kips and $\phi M_n = 1{,}676$ in.-kips, okay.

Example 4

The interior columns in the 15-ft high portion of the structure of Example 3 must support a factored load, $P_u = 1{,}104$ kips and resist factored moments 994 in.-kips at the top and –427 in.-kips at the footing

$$e = \frac{994}{1104} = 0.9 \text{ in.} < \text{min. } e = 0.6 + 0.03h = 1.14 \text{ in.}$$

$$C_m = 0.6 + 0.4\left(\frac{-427}{944}\right) = 0.43$$

For architectural reasons, 18-in. diameter round columns are desired. Use $f'_c = 6{,}000$ psi to match the exterior columns in Example 3. See table on Page 4-28. Try 11-#11 vertical bars.

From Example 3:

$E_c = 4.4 \times 10^6$ psi

$I_g = 5{,}150$ in.^{4}

$\beta_{dns} = 0.48$

$A_s = (11)(1.56) = 17.16$ in.^{2} The equivalent tube has $\Delta = 11(1.56)/\pi\,(12.59) = 0.43$ in.; an inner diameter $d_1 = 12.59 - 0.43 = 12.16$ in.; and an outer diameter $d_2 = 12.59 + 0.43 = 13.02$ in.

The moment of inertia for the reinforcing steel:

$$I_{se} = (0.0491)\,(d_2^4 - d_1^4) = (0.0491)\,(28{,}737 - 21{,}864)$$

$I_{se} = 337$ in.^{4}

$$EI = \frac{0.2E_c I_g + E_s I_{se}}{1 + \beta_{dns}}$$

$$EI = \frac{(0.2)(4.4 \times 10^6)(5.15 \times 10^3) + (29 \times 10^6)(337)}{1 + 0.48}$$

$$EI = 9.67 \times 10^9$$

Critical load, $P_c = \dfrac{\pi^2 EI}{(k\ell_u)^2}$

$$P_c = \frac{(\pi)^2 (9.67 \times 10^9)}{(180)^2} = 2{,}946 \text{ kips}$$

Moment magnification factor,

$$\delta_{ns} = \frac{C_m}{1 - \dfrac{P_u}{0.75 P_c}} \geq 1.0$$

$$\delta_{ns} = \frac{0.43}{1 - \dfrac{1104}{(0.75)(2{,}946)}} = 0.86 < 1.0,\ \delta_{ns} = 1.0$$

Magnified moment, $M_c = \delta_{ns} M_2 = (1.00)(1{,}104)(1.14)$

$$M_c = 1{,}259 \text{ in.-kips}$$

The column must be able to resist $P_u = 1{,}104$ kips and $M_u = M_c = 1{,}259$ in.-kips.

From Page 4-28, for an 18-in. diameter column with 11-#11 vertical bars, and interpolating as necessary: $\phi P_n = 1{,}104$ kips and $\phi M_n = 1{,}738$ in.-kips, okay.

Manual Example

Review a round-tied column 20 inches in diameter with $f'_c = 6{,}000$ psi and 6–#9 vertical (longitudinal) reinforcing bars. Compute values of ϕP_n and ϕM_n at control points. Compare computed values versus the tabulated values in this Chapter. The printed-out values are displayed in Table 4-3.

The dimensions in Fig. 4-4 are based on 1½ inches of concrete cover to the #3 ties. For $f'_c = 6{,}000$ psi, $\beta_1 = 0.75$ (ACI 10.2.7.3), $E_s = 29 \times 10^6$ psi (ACI 8.5.2). Strength–reduction factors: $\phi = 0.65$ for compression and $\phi = 0.90$ for flexure (ACI 9.3.2).

Table 4-3 Interaction Table for Chapter 4 Manual Example

ROUND TIED COLUMNS 20" DIAMETER														
Short Columns – no sidesway												$f_c' = 6{,}000$ psi ϕM_n in inch-kips		$f_y = 60{,}000$ psi ϕP_n in.-kips
BARS	RHO	Max. Cap		0% f_y		25% f_y		50% f_y		100% f_y		$\varepsilon_t = 0.005$		$\phi P_n = 0$
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#9	1.91	1645	1004	2487	789	2794	638	2913	523	2927	333	2949	111	2353

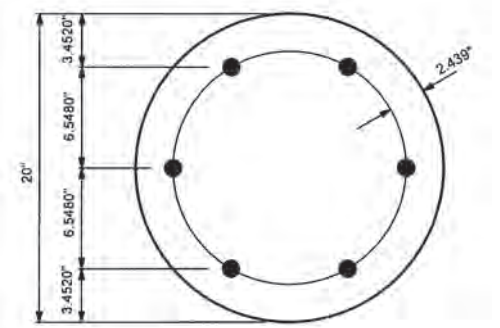


Figure 4-4 Dimensions – Manual Example

In the general case, (Fig. 4-5), the distance from the extreme compression fiber to the neutral axis, c, has to be determined by iteration. The distance, c, can be expressed in terms of the tensile strain, $\varepsilon_s = f_s / E_s$, in the outermost bars:

$$c = \frac{d_{sn}}{1 + f_s/(E_s \varepsilon_c)}$$

Where:

d_{sn} = Maximum distance to bars from extreme compression surface

f_s = Tensile stress in outermost bars.

ε_c = Maximum compressive strain in concrete
= 0.003 (ACI 10.2.3)

E_s = Modulus of elasticity of bars
$= 29 \times 10^6$ psi

For those bars which are located in the concrete compression zone ($d_{si} < \beta_1 c$), their compressive stress must be reduced by $0.85 f_c'$ to account for the area of the concrete occupied by the reinforcing bar or their compressive force must be reduced by $0.85 f_c' A_b$. In this example, the reduction for a #9 bar is:

$$0.85(6) = 5.1 \text{ ksi, or}$$
$$5.1(1) = 5.1 \text{ kips}$$

1. $\phi P_{n(max)}$ and ϕM_n

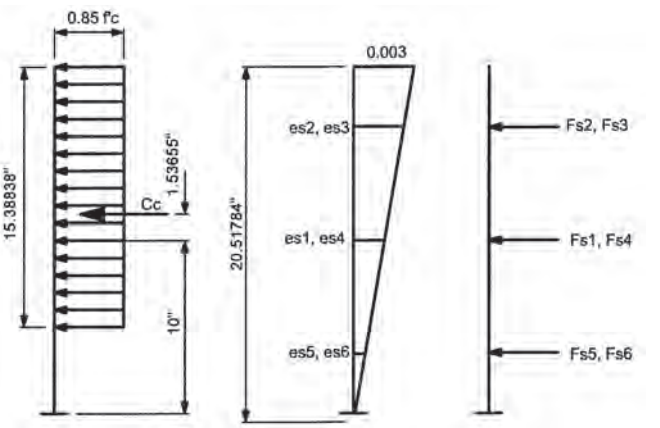


Figure 4-6 $\phi P_{n(max)}$ and ϕM_n

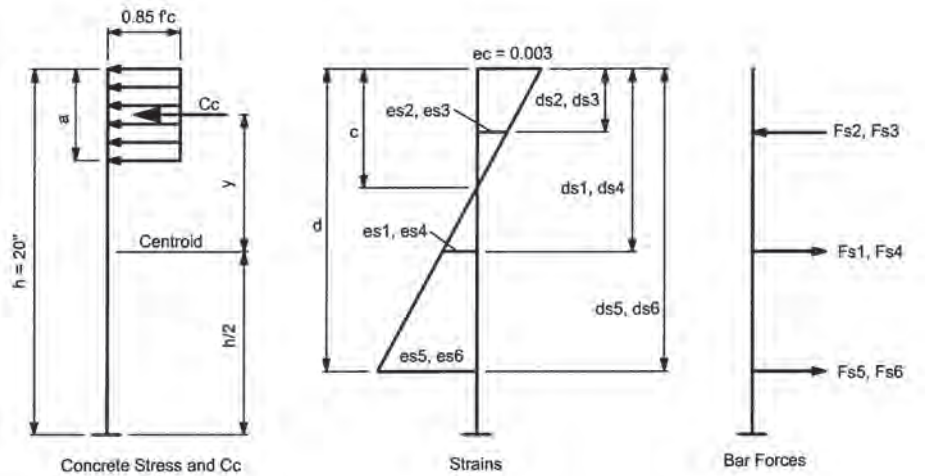


Figure 4-5 General Case

The value of $\phi P_{n(max)}$ can be solved directly by ACI Eq. 10-2:

$$\phi P_{n(max)} = 0.80\phi[0.85 f'_c (A_g - A_{st}) + f_y A_{st}]$$
$$= 0.80(0.65)[0.85(6)(314.16 - 6) + 60(6)]$$
$$= 1{,}004 \text{ kips (tabulated = 1,004)}$$

For this condition, the exact value of strain in the outermost bars (bars 5 and 6) is not evident (Fig. 4-6). The entire cross-section will be in compression, so $c > h$.

Through iteration, $c = 20.51791$ in.

From Fig. 4-5, the bar strains, stresses, forces, and moments of the forces about the column centroid can be expressed:

$$\varepsilon_{si} = \varepsilon_c (1 - d_{si}/c)$$
$$f_{si} = E_s \varepsilon_{si} (\leq 60 \text{ ksi})$$
$$F_{si} = f_{si} A_b (A_b = 1 \text{ in.}^2)$$
$$M_{si} = F_{si}(h/2 - d_{si})$$

Bars forces and moments about column centroid are tabulated below:

Bar	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	10.0000	0.0015379	44.598	39.498*	0
2	3.4520	0.0024953	60.000	54.900*	359.486
3	3.4520	0.0024953	60.000	54.900*	359.486
4	10.0000	0.0015379	44.598	39.498*	0
5	16.5480	0.0005804	16.833	16.833	-110.222
6	16.5480	0.0005804	16.833	16.833	-110.222
				222.462	498.525

*F_{si} reduced by 5.1 kips

Compute the concrete compression resultant based on the rectangular stress block, C_c, and moment, M_c, about the column centroid. For a circular segment with a height of a:

α = One-half the subtended angle (radians)
$= \cos^{-1}[(h - 2a)/h]$

A_c = Area of concrete compression zone
$= h^2 [2\alpha - \sin(2\alpha)]/8$

y = Distance of concrete compression zone centroid from the column centroid
$= 2h^3 \sin \alpha^3/(24 A_c)$

The depth of the equivalent stress block:

$a = \beta_1 c = 0.75(20.51791) = 15.38843$ in.

Properties of the concrete compression zone:

$\alpha = \cos^{-1}[(20 - 2(15.38843))/20]$
$= 2.13985$ rad

$A_c = 20^2 [2(2.13985) - \sin(2 \times 2.13985)]/8$
$= 259.37708$ in.^{2}

$y = 2(20)^3 \sin(2.13985)^3/(24 \times 259.37708)$
$= 1.53656$ in.

Concrete compression resultant, C_c, and moment, M_c, about the column centroid:

$C_c = 0.85 f'_c A_c$
$= 0.85(6)259.37708 = 1{,}322.823$ kips

$M_c = C_c(y)$
$= 1{,}322.823(1.53656) = 2{,}032.597$ in.-kips

Σ Forces = 0
$-P_n + 222.462 + 1{,}322.823 = 0$
$P_n = 1{,}545.285$ kips
$\phi P_n = (0.65)(1{,}545.285) = 1{,}004$ kips
(tabulated = 1,004)

Σ Moments = 0
$-M_n + 498.528 + 2{,}032.597 = 0$
$M_n = 2{,}531.125$ in.-kips
$\phi M_n = (0.65)(2{,}531.125) = 1{,}645$ in.-kips
(tabulated = 1,645)

2. ϕP_{ot} and ϕM_{ot} (Point of zero tension)

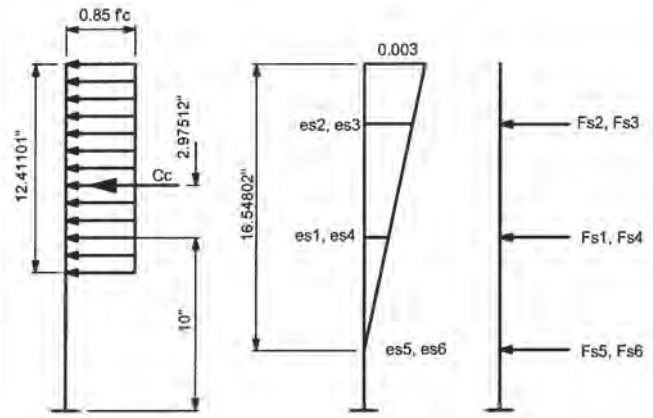


Figure 4-7 ϕP_{ot} and ϕM_{ot} (Point of Zero Tension)

For this condition, the c distance is easily determined by inspection from Fig. 4-7 because ε_{s5}, $\varepsilon_{s6} = f_{s5}/E_s = f_{s6}/E_s = 0$; hence, $c = 20 - 3.4520 = 16.5480$ in., or by the equation:

$$c = \frac{d_{sn}}{1 + f_s/(E_s \varepsilon_c)}$$

$$= \frac{16.5480}{1 + 0/(29{,}000 \times 0.003)} = 16.5480 \text{ in.}$$

Note that the point of "zero tension" is defined in this Chapter as the load-moment combination resulting in zero strain at the center of the column longitudinal bar on the tension face. The diameter of the bar is neglected because the stress in the bar on either side of its center reverses sign and totals zero. Where two layers of bars are used, as with bundled bars, the same definition (to centroid of bundle) is satisfactory for practical use in designing splices.

Bars forces and moments about column centroid are tabulated below:

Bar	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	10.0000	0.0011871	34.426	29.326*	0
2	3.4520	0.0023742	60.000	54.900*	359.486
3	3.4520	0.0023742	60.000	54.900*	359.486
4	10.0000	0.0011871	34.426	29.326*	0
5	16.5480	0	0	0	0
6	16.5480	0	0	0	0
				168.451	718.972

*F_{si} reduced by 5.1 kips

The depth of the equivalent stress block:

$a = 0.75(16.5480) = 12.4110$ in.

Properties of the concrete compression zone:

$$\alpha = \cos^{-1}[(20 - 2(12.4110))/20]$$
$$= 1.81430 \text{ rad}$$

$$A_c = 20^2[2(1.81430) - \sin(2 \times 1.81430)]/8$$
$$= 204.82916 \text{ in.}^2$$

$$y = 2(20)^3 \sin(1.81430)^3/(24 \times 204.82916)$$
$$= 2.97511 \text{ in.}$$

Concrete compression resultant, C_c, and moment, M_c, about the column centroid:

$C_c = 0.85(6)204.82916 = 1{,}044.629$ kips

$M_c = 1{,}044.629(2.97511) = 3{,}107.886$ in.-kips

Σ Forces = 0

$-P_n + 168.451 + 1{,}044.629 = 0$

$P_n = 1{,}213.080$ kips

$\phi P_n = (0.65)(1{,}213.080) = 789$ kips

(tabulated = 789)

Σ Moments = 0

$-M_n + 718.972 + 3{,}107.886 = 0$

$M_n = 3{,}826.858$ in.-kips

$\phi M_n = (0.65)(3{,}826.858) = 2{,}487$ in.-kips

(tabulated = 2,487)

3. 25% Tension

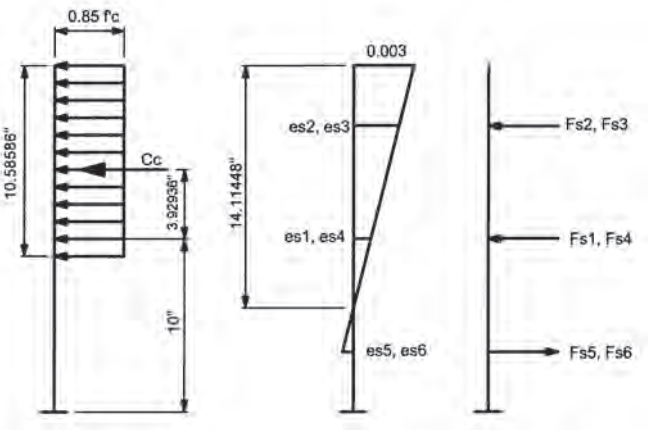


Figure 4-8 25% Tension

The tensile stress in bars 5 and 6 = 0.25(60) = 15 ksi.

$$c = \frac{16.5480}{1 + 15/(29{,}000 \times 0.003)} = 14.11448 \text{ in.}$$

Bars forces and moments about column centroid are tabulated below:

Bar	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	10.0000	0.0008745	25.361	20.261*	0
2	3.4520	0.0022663	60.000	54.900*	359.486
3	3.4520	0.0022663	60.000	54.900*	359.486
4	10.0000	0.0008745	25.361	20.261*	0
5	16.5480	-0.0005172	-15.000	-15.000	98.220
6	16.5480	-0.0005172	-15.000	-15.000	98.220
				120.322	915.413

*F_{si} reduced by 5.1 kips

The depth of the equivalent stress block:

$a = 0.75(14.11448) = 10.58586$ in.

Properties of the concrete compression zone:

$$\alpha = \cos^{-1}[(20 - 2(10.58586))/20]$$
$$= 1.62942 \text{ rad}$$

$$A_c = 20^2[2(1.62942) - \sin(2 \times 1.62942)]/8$$
$$= 168.79013 \text{ in.}^2$$

$$y = 2(20)^3 \sin(1.62942)^3/(24 \times 168.79013)$$
$$= 3.92936 \text{ in.}$$

Concrete compression resultant, C_c, and moment, M_c, about the column centroid:

$C_c = 0.85(6)168.79013 = 860.830$ kips

$M_c = 860.830(3.92936) = 3{,}382.511$ in.-kips

Σ Forces = 0
$-P_n + 120.322 + 860.830 = 0$
$P_n = 981.152$ kips
$\phi P_n = (0.65)(981.152) = 638$ kips
(tabulated = 638)

Σ Moments = 0
$-M_n + 915.913 + 3{,}382.511 = 0$
$M_n = 4{,}297.924$ in.-kips
$\phi M_n = (0.65)(4{,}297.924) = 2{,}794$ in.-kips
(tabulated = 2,794)

4. 50% Tension

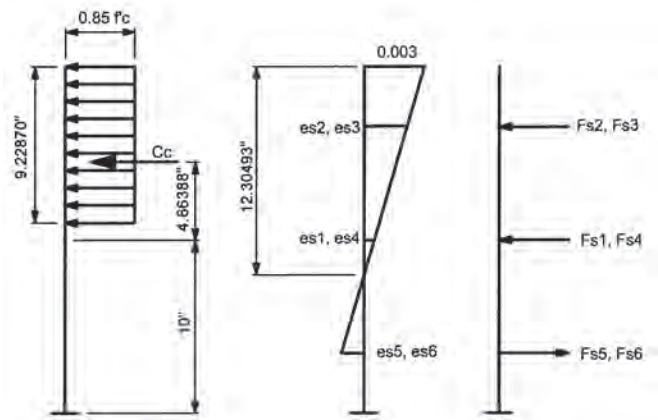


Figure 4-9 50% Tension

The tensile stress in bars 5 and 6 = 0.50(60) = 30 ksi.

$$c = \frac{16.5480}{1 + 30/(29{,}000 \times 0.003)} = 12.30493 \text{ in.}$$

Bars forces and moments about column centroid are tabulated below:

Bar	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	10.0000	0.0005620	16.297	16.297	0
2	3.4520	0.0021584	60.000	54.900*	359.486
3	3.4520	0.0021584	60.000	54.900*	359.486
4	10.0000	0.0005620	16.297	16.297	0
5	16.5480	-0.0010345	-30.000	-30.000	196.441
6	16.5480	-0.0010345	-30.000	-30.000	196.441
				82.393	1,111.854

*F_{si} reduced by 5.1 kips

The depth of the equivalent stress block:
$a = 0.75(12.30493) = 9.22870$ in.

Properties of the concrete compression zone:
$\alpha = \cos^{-1}[(20 - 2(9.22870))/20]$
$= 1.49359$ rad
$A_c = 20^2[2(1.49359) - \sin(2 \times 1.49359)]/8$
$= 141.66901$ in.^{2}
$y = 2(20)^3 \sin(1.49359)^3/(24 \times 141.66901)$
$= 4.66388$ in.

Concrete compression resultant, C_c, and moment, M_c, about the column centroid:
$C_c = 0.85(6)141.66901 = 722.512$ kips
$M_c = 722.512(4.66388) = 3{,}369.709$ in.-kips

Σ Forces = 0
$-P_n + 82.393 + 722.512 = 0$
$P_n = 804.905$ kips
$\phi P_n = (0.65)(804.905) = 523$ kips
(tabulated = 523)

Σ Moments = 0
$-M_n + 1{,}111.854 + 3{,}369.709 = 0$
$M_n = 4{,}481.563$ in.-kips
$\phi M_n = (0.65)(4{,}481.563) = 2{,}913$ in.-kips
(tabulated = 2,913)

5. 100% f_y (ϕP_b and ϕM_b, Balance)

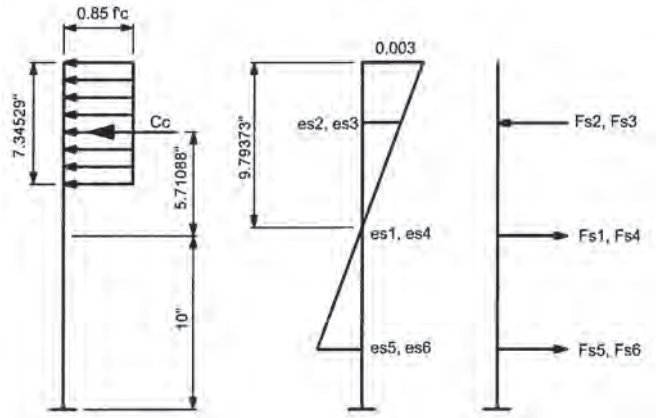


Figure 4-10 100% f_y (ϕP_b and ϕM_b, Balance)

The tensile stress in bars 5 and 6 = f_y = 60 ksi.

$$c = \frac{16.5480}{1 + 60/(29{,}000 \times 0.003)} = 9.79373 \text{ in.}$$

Bars forces and moments about column centroid are tabulated below:

Bar	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	10.0000	-0.0000632	-1.832	-1.832	0
2	3.4520	0.0019426	56.335	51.235*	335.489
3	3.4520	0.0019426	56.335	51.235*	335.489
4	10.0000	-0.0000632	-1.832	-1.832	0
5	16.5480	-0.0020690	-60.000	-60.000	392.881
6	16.5480	-0.0020690	-60.000	-60.000	392.881
				-21.194	1,456.740

*F_{si} reduced by 5.1 kips

The depth of the equivalent stress block:

$a = 0.75(9.79373) = 7.34529$ in.

Properties of the concrete compression zone:

$$\alpha = \cos^{-1}[(20 - 2(7.34529))/20] = 1.30210 \text{ rad}$$

$$A_c = 20^2[2(1.30210) - \sin(2 \times 1.30210)]/8 = 104.61592 \text{ in.}^2$$

$$y = 2(20)^3 \sin(1.30210)^3/(24 \times 104.61592) = 5.71088 \text{ in.}$$

Concrete compression resultant, C_c, and moment, M_c, about the column centroid:

$$C_c = 0.85(6)104.61592 = 533.541 \text{ kips}$$

$$M_c = 533.541(5.71088) = 3{,}046.988 \text{ in.-kips}$$

Σ Forces = 0

$-P_n - 21.194 + 533.541 = 0$

$P_n = 512.347$ kips

$\phi P_n = (0.65)(512.347) = 333$ kips (tabulated = 333)

Σ Moments = 0

$-M_n + 1{,}456.740 + 3{,}046.988 = 0$

$M_n = 4{,}503.728$ in.-kips

$\phi M_n = (0.65)(4{,}503.728) = 2{,}927$ in.-kips (tabulated = 2,927)

6. $\varepsilon_t = 0.005$

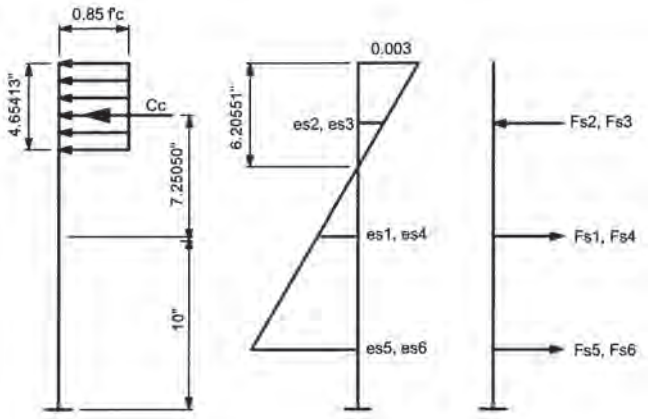


Figure 4-11 $\varepsilon_t = 0.005$

$c = 16.5480(0.003)/(0.003 + 0.005) = 6.20551$ in.

Bars forces and moments about column centroid are tabulated below:

Bar	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	10.0000	-0.0018344	-53.198	-53.198	0
2	3.4520	0.0013312	38.604	33.504*	219.384
3	3.4520	0.0013312	38.604	33.504*	219.384
4	10.0000	-0.0018344	-53.198	-53.198	0
5	16.5480	-0.0050000	-60.000	-60.000	392.881
6	16.5480	-0.0050000	-60.000	-60.000	392.881
				-159.388	1,224.530

*F_{si} reduced by 5.1 kips

The depth of the equivalent stress block:

$a = 0.75(6.20551) = 4.65413$ in.

Properties of the concrete compression zone:

$$\alpha = \cos^{-1}[(20 - 2(4.65413))/20] = 1.00678 \text{ rad}$$

$$A_c = 20^2[2(1.00678) - \sin(2 \times 1.00678)]/8 = 55.49907 \text{ in.}^2$$

$$y = 2(20)^3 \sin(1.00678)^3/(24 \times 55.49907) = 7.25050 \text{ in.}$$

Concrete compression resultant, C_c, and moment, M_c, about the column centroid:

$$C_c = 0.85(6)55.49907 = 283.045 \text{ kips}$$

$$M_c = 283.045(7.25050) = 2{,}052.220 \text{ in.-kips}$$

Σ Forces = 0
$-P_n - 159.388 + 283.045 = 0$
$P_n = 123.657$ kips
$\phi P_n = (0.90)(123.657) = 111$ kips
(tabulated = 111)

Σ Moments = 0
$-M_n + 1{,}224.530 + 2{,}052.220 = 0$
$M_n = 3{,}276.750$ in.-kips
$\phi M_n = (0.90)(3{,}276.750) = 2{,}949$ in.-kips
(tabulated = 2,949)

7. ϕM_n ($\phi P_n = 0$)

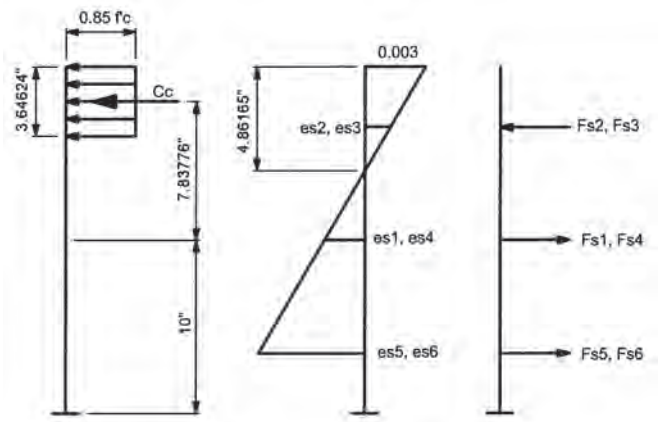


Figure 4-12 ϕM_n ($\phi P_n = 0$)

Through iteration, $c = 4.86165$ in.

Bars forces and moments about column centroid are tabulated below:

Bar	d_{si} (in.)	ε_{si}	f_{si} (ksi)	F_{si} (kips)	M_{si} (in.-kips)
1	10.0000	-0.0031707	-60.000	-60.000	0
2	3.4520	0.0008699	25.226	20.126*	131.787
3	3.4520	0.0008699	25.226	20.126*	131.787
4	10.0000	-0.0031707	-60.000	-60.000	0
5	16.5480	-0.0072114	-60.000	-60.000	392.881
6	16.5480	-0.0072114	-60.000	-60.000	392.881
				-199.747	1,049.337

*F_{si} reduced by 5.1 kips

The depth of the equivalent stress block:
$a = 0.75(4.86165) = 3.64624$ in.

Properties of the concrete compression zone:

$\alpha = \cos^{-1}[(20 - 2(3.64624))/20]$
$= 0.88230$ rad

$A_c = 20^2[2(0.88230) - \sin(2 \times 0.88230)]/8$
$= 39.16617$ in.^{2}

$y = 2(20)^3 \sin(0.88230)^3/(24 \times 39.16617)$
$= 7.83776$ in.

Concrete compression resultant, C_c, and moment, M_c, about the column centroid:

$C_c = 0.85(6)39.16617 = 199.747$ kips
$M_c = 199.747(7.83776) = 1{,}565.569$ in.-kips

Σ Forces = 0
$-P_n - 199.747 + 199.747 = 0$
$P_n = 0$ kips
$\phi P_n = (0.90)(0) = 0$ kips

Σ Moments = 0
$-M_n + 1{,}049.337 + 1{,}565.569 = 0$
$M_n = 2{,}614.906$ in.-kips
$\phi M_n = (0.90)(2{,}614.906) = 2{,}353$ in.-kips
(tabulated = 2,353)

ROUND TIED COLUMNS 12" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi

ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.10	219	236	292	209	357	171	384	141	388	94	396	33	293
4-#6	1.56	222	252	312	218	380	177	411	144	420	91	430	15	393
4-#7	2.12	226	271	336	228	407	184	441	147	458	88	470	-8	471
4-#8	2.79	231	293	363	241	439	193	476	151	500	83	515	-36	518
4-#9	3.54	236	318	391	255	473	202	512	155	545	78	561	-68	565
4-#10	4.49	243	349	426	273	514	214	556	165	600	70	617	-111	619
4-#11	5.52	245	384	461	288	541	220	584	165	632	55	635	-164	644
4-#14	7.96	261	465	538	332	621	245	674	175	744	29	735	-276	750
5-#5	1.37	228	246	315	211	378	172	403	139	408	88	415	27	336
5-#6	1.95	234	265	341	222	407	179	436	143	449	84	458	6	442
5-#7	2.65	242	288	371	236	442	189	474	147	496	79	508	-19	517
5-#8	3.49	251	316	405	252	481	199	517	153	551	72	564	-51	582
5-#9	4.42	261	347	441	270	521	210	563	158	607	64	621	-86	647
5-#10	5.61	274	387	485	293	571	225	619	165	677	53	689	-133	714
5-#11	6.90	279	430	523	312	603	232	653	163	718	33	708	-195	738
6-#5	1.64	230	255	347	209	403	168	424	134	430	79	423	9	396
6-#6	2.33	237	278	379	221	438	175	464	138	480	73	473	-18	480
6-#7	3.18	246	306	417	237	480	185	512	142	539	65	531	-50	545
6-#8	4.19	256	339	459	256	528	196	566	147	607	55	595	-90	615
6-#9	5.31	267	377	503	276	578	208	622	152	678	44	679	-129	686
6-#10	6.74	282	424	556	302	638	223	691	157	765	28	761	-187	770
7-#5	1.92	234	264	335	226	403	183	436	147	451	88	467	12	438
7-#6	2.72	244	291	370	242	443	194	481	152	507	83	528	-16	535
7-#7	3.71	255	324	411	261	491	208	534	159	574	77	604	-49	616
7-#8	4.89	268	363	458	284	545	224	594	167	649	68	685	-92	699
7-#9	6.19	283	406	507	310	602	241	657	177	729	58	767	-141	778
8-#5	2.19	240	273	340	235	414	190	450	152	473	90	500	5	490
8-#6	3.11	252	304	379	254	459	203	502	159	536	85	571	-27	572
8-#7	4.24	265	341	424	277	512	219	562	167	612	79	655	-67	660
8-#8	5.59	281	386	476	305	573	237	631	176	698	70	749	-115	756

ROUND TIED COLUMNS 14" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.14	353	324	451	294	567	242	620	199	644	135	672	52	493
4-#7	1.56	359	343	482	305	603	249	661	203	695	133	730	32	642
4-#8	2.05	366	365	517	318	644	258	709	208	755	130	797	8	784
4-#9	2.60	374	390	555	332	688	268	761	213	818	126	867	-20	866
4-#10	3.30	385	422	601	351	744	281	825	221	896	121	952	-57	949
4-#11	4.05	390	456	651	366	795	290	878	223	951	109	998	-108	995
4-#14	5.85	413	537	757	413	922	322	1014	236	1120	92	1171	-215	1159
5-#5	1.01	361	318	462	286	568	235	614	194	627	131	650	62	425
5-#6	1.43	370	337	494	298	607	243	659	198	682	128	713	44	563
5-#7	1.95	382	360	534	312	653	253	712	203	747	124	787	21	723
5-#8	2.57	396	388	579	328	706	264	773	210	822	119	871	-6	873
5-#9	3.25	412	419	627	347	763	277	838	217	902	114	958	-37	970
5-#10	4.13	431	459	687	371	833	293	918	225	1001	106	1066	-79	1084
5-#11	5.07	441	502	745	392	896	306	976	226	1072	90	1121	-136	1145
5-#14	7.31	485	603	879	451	1048	344	1147	247	1286	63	1334	-254	1345
6-#5	1.21	363	327	507	280	607	229	646	186	655	120	659	42	497
6-#6	1.71	373	350	549	293	657	238	701	190	723	115	732	18	667
6-#7	2.34	386	378	598	309	716	249	767	197	805	109	817	-13	820
6-#8	3.08	401	412	655	329	782	261	842	204	899	102	914	-49	923
6-#9	3.90	416	449	716	350	852	275	921	211	998	93	1015	-90	1027
6-#10	4.95	436	496	792	378	939	293	1020	219	1122	81	1138	-144	1151
6-#11	6.08	450	548	865	404	1004	304	1091	221	1210	59	1202	-213	1229

ROUND TIED COLUMNS 14" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi

ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
7-#5	1.41	369	336	482	302	601	248	656	203	684	132	723	49	560
7-#6	2.00	383	363	528	318	654	260	716	209	760	129	812	25	739
7-#7	2.73	399	396	583	338	717	274	789	218	851	125	916	-6	919
7-#8	3.59	418	435	645	363	789	292	873	228	956	119	1035	-43	1047
7-#9	4.55	439	478	713	390	867	310	964	238	1067	112	1159	-86	1175
7-#10	5.78	466	534	796	424	963	335	1076	252	1205	103	1310	-142	1320
7-#11	7.09	483	594	872	455	1045	354	1158	256	1304	82	1407	-216	1401
8-#5	1.61	376	345	488	312	613	256	674	208	712	135	762	42	627
8-#6	2.29	392	376	540	332	673	270	742	217	799	132	863	14	833
8-#7	3.12	411	413	600	357	744	287	824	227	902	128	983	-21	987
8-#8	4.11	434	458	670	385	826	307	919	239	1021	123	1134	-60	1125
8-#9	5.20	458	508	744	417	913	329	1020	251	1147	117	1280	-108	1266
8-#10	6.60	489	571	836	457	1021	357	1146	267	1304	107	1458	-172	1436

ROUND TIED COLUMNS 16" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.19	535	426	659	394	849	324	939	267	991	182	1059	75	778
4-#8	1.57	544	448	703	407	900	334	998	273	1068	181	1147	53	986
4-#9	1.99	555	473	750	421	955	344	1062	279	1151	179	1241	28	1188
4-#10	2.53	568	505	809	440	1024	357	1142	286	1255	176	1358	-5	1358
4-#11	3.10	575	539	874	456	1092	367	1216	290	1335	167	1435	-50	1429
4-#14	4.48	610	620	1009	504	1253	400	1405	309	1563	154	1685	-144	1660
4-#18	7.96	693	826	1324	624	1630	482	1833	349	2080	114	2225	-405	2151
5-#6	1.09	549	420	685	384	858	317	939	261	977	177	1034	84	687
5-#7	1.49	565	444	736	398	915	327	1005	267	1061	174	1132	64	886
5-#8	1.96	584	472	794	415	982	339	1081	274	1158	171	1246	39	1110
5-#9	2.49	604	503	856	433	1053	352	1164	281	1261	167	1365	12	1334
5-#10	3.16	629	542	934	457	1143	369	1268	291	1390	161	1513	-25	1519
5-#11	3.88	648	585	1002	481	1226	383	1361	297	1491	148	1609	-76	1625
5-#14	5.60	705	687	1176	542	1433	425	1595	318	1781	129	1923	-181	1927
6-#6	1.31	551	433	759	376	923	307	1000	251	1028	162	1055	58	809
6-#7	1.79	568	461	820	393	996	319	1083	257	1132	158	1169	30	1054
6-#8	2.36	588	495	890	412	1081	333	1180	264	1253	152	1300	-3	1300
6-#9	2.98	609	532	966	434	1173	348	1283	271	1383	145	1438	-41	1442
6-#10	3.79	635	580	1061	462	1289	367	1412	281	1544	135	1609	-92	1611
6-#11	4.66	653	631	1156	488	1392	383	1516	291	1670	118	1719	-158	1727
6-#14	6.71	716	753	1377	559	1645	428	1804	312	2032	87	2079	-295	2079
7-#5	1.08	546	419	662	390	848	323	934	267	977	181	1047	89	687
7-#6	1.53	564	446	718	406	914	335	1010	274	1074	179	1164	68	910
7-#7	2.09	586	479	786	427	994	350	1101	283	1192	177	1303	40	1169
7-#8	2.75	610	518	864	452	1085	369	1207	294	1327	173	1463	7	1443
7-#9	3.48	637	562	947	479	1184	388	1321	306	1471	169	1632	-31	1637
7-#10	4.42	673	617	1052	514	1307	414	1463	321	1650	162	1841	-81	1847
7-#11	5.43	697	677	1158	547	1418	435	1588	331	1792	147	1978	-150	1987
7-#14	7.83	781	819	1402	636	1699	497	1917	365	2196	123	2421	-294	2387
8-#5	1.23	555	428	663	401	863	332	956	274	1011	185	1097	84	762
8-#6	1.75	575	459	727	421	937	347	1041	283	1120	184	1230	59	1023
8-#7	2.39	600	497	803	446	1026	365	1144	294	1251	181	1389	28	1318
8-#8	3.14	628	541	891	476	1129	386	1263	307	1405	179	1572	-11	1573
8-#9	3.98	658	591	986	509	1240	409	1391	321	1570	175	1765	-55	1765
8-#10	5.05	699	655	1105	551	1378	439	1552	339	1776	170	2004	-113	1995
8-#11	6.21	729	723	1220	590	1502	464	1691	351	1937	154	2199	-183	2154
9-#10	5.68	728	692	1179	569	1469	455	1664	349	1911	161	2178	-136	2146
9-#11	6.98	763	769	1307	613	1614	485	1821	363	2094	143	2360	-222	2314
10-#10	6.32	764	729	1291	580	1575	461	1785	348	2058	147	2313	-180	2268

ROUND TIED COLUMNS 18" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.24	770	543	924	508	1212	420	1353	346	1445	237	1575	101	1165
4-#9	1.57	784	568	980	523	1278	430	1430	352	1544	235	1694	78	1429
4-#10	2.00	801	599	1051	542	1360	444	1526	360	1670	233	1843	48	1740
4-#11	2.45	812	634	1133	558	1445	454	1618	365	1785	227	1951	7	1937
4-#14	3.54	851	715	1298	607	1641	488	1847	384	2080	220	2281	-78	2259
4-#18	6.29	960	921	1686	730	2105	573	2393	433	2749	192	3020	-311	2915
5-#7	1.18	795	538	973	497	1237	411	1365	339	1441	229	1554	109	1053
5-#8	1.55	818	566	1043	514	1317	423	1458	346	1561	227	1697	87	1323
5-#9	1.96	843	597	1119	533	1403	437	1557	354	1690	224	1850	62	1609
5-#10	2.50	874	637	1213	557	1511	454	1683	365	1851	221	2040	28	1952
5-#11	3.07	897	679	1313	578	1616	468	1799	371	1984	210	2177	-18	2180
5-#14	4.42	970	781	1532	640	1870	512	2096	396	2351	196	2595	-112	2580
5-#18	7.86	1143	1039	2014	802	2467	622	2791	456	3198	149	3522	-374	3440
6-#6	1.04	776	528	1014	471	1252	387	1361	319	1403	215	1451	101	951
6-#7	1.41	798	556	1086	488	1339	399	1463	325	1531	211	1595	75	1245
6-#8	1.86	822	589	1170	507	1440	412	1582	334	1679	206	1760	44	1579
6-#9	2.36	848	626	1261	529	1550	428	1712	342	1838	201	1936	10	1911
6-#10	2.99	883	674	1374	557	1688	448	1876	354	2038	193	2156	-36	2156
6-#11	3.68	907	725	1493	583	1823	465	2012	359	2204	178	2315	-98	2314
6-#14	5.31	984	847	1762	655	2152	515	2378	382	2662	154	2797	-227	2775
7-#6	1.21	793	541	945	507	1230	420	1371	347	1455	235	1593	114	1086
7-#7	1.65	821	574	1026	527	1325	436	1481	357	1596	233	1767	89	1398
7-#8	2.17	852	613	1119	552	1435	454	1608	369	1760	231	1969	58	1752
7-#9	2.75	886	656	1219	580	1554	475	1746	381	1937	228	2184	24	2107
7-#10	3.49	928	712	1345	616	1705	502	1919	398	2161	224	2452	-22	2453
7-#11	4.29	963	771	1478	649	1850	525	2077	409	2354	213	2649	-84	2652
7-#14	6.19	1066	913	1774	739	2198	590	2483	447	2865	196	3239	-213	3207
8-#6	1.38	807	554	949	523	1258	434	1407	357	1510	241	1676	107	1212
8-#7	1.89	837	591	1039	548	1365	452	1531	369	1668	239	1875	78	1579
8-#8	2.48	872	636	1144	578	1490	474	1675	383	1853	238	2105	43	1980
8-#9	3.14	910	685	1257	611	1624	498	1830	398	2052	236	2351	4	2341
8-#10	3.99	957	749	1399	653	1792	529	2025	418	2304	233	2656	-49	2649
8-#11	4.90	999	817	1550	694	1951	556	2202	431	2526	222	2883	-121	2865
8-#14	7.07	1115	980	1887	803	2343	632	2659	477	3112	208	3558	-271	3496
9-#10	4.49	992	786	1498	673	1895	544	2157	427	2474	226	2859	-75	2850
9-#11	5.52	1040	863	1658	717	2077	575	2363	444	2725	213	3134	-149	3087
10-#10	4.99	1038	824	1639	683	2027	549	2299	424	2665	214	3043	-112	2990
10-#11	6.13	1091	909	1818	731	2227	582	2529	442	2936	197	3329	-201	3257
11-#10	5.49	1067	861	1658	724	2103	583	2394	455	2790	227	3277	-126	3220
11-#11	6.74	1125	955	1852	780	2320	622	2642	477	3094	212	3595	-220	3504
12-#10	5.99	1115	898	1726	753	2182	608	2513	472	2940	232	3489	-149	3412

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 20" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.01	1049	648	1182	622	1586	516	1784	429	1902	299	2091	152	1342
4-#9	1.27	1067	673	1249	637	1663	527	1872	435	2016	298	2235	131	1654
4-#10	1.62	1088	705	1332	656	1760	540	1984	443	2162	296	2416	104	2038
4-#11	1.99	1103	739	1432	672	1863	550	2095	448	2299	290	2555	65	2400
4-#14	2.86	1151	820	1627	721	2093	585	2364	468	2652	286	2967	-12	2963
4-#18	5.09	1284	1026	2088	847	2644	673	3011	520	3502	270	3911	-225	3801
5-#8	1.26	1105	672	1335	626	1717	518	1910	427	2037	288	2234	138	1540
5-#9	1.59	1136	703	1424	645	1818	531	2027	435	2188	286	2420	115	1876
5-#10	2.02	1173	742	1535	669	1946	549	2174	446	2379	283	2652	84	2293
5-#11	2.48	1203	785	1657	691	2073	564	2314	453	2554	276	2832	42	2689
5-#14	3.58	1288	887	1918	753	2375	609	2666	480	3003	266	3358	-45	3359
5-#18	6.37	1499	1144	2533	910	3091	722	3505	545	4046	231	4551	-283	4462
6-#7	1.15	1081	661	1402	594	1751	488	1917	402	2008	270	2103	123	1437
6-#8	1.51	1111	695	1500	614	1868	502	2055	410	2184	266	2304	95	1829
6-#9	1.91	1143	732	1605	636	1996	517	2206	419	2373	262	2519	62	2245
6-#10	2.43	1182	780	1738	664	2157	537	2397	430	2612	256	2788	20	2731
6-#11	2.98	1217	831	1880	690	2317	555	2581	439	2818	243	2996	-37	2994
6-#14	4.30	1310	953	2197	763	2704	606	3033	467	3374	223	3603	-156	3574
6-#18	7.64	1543	1262	2954	946	3635	735	4069	528	4677	162	4977	-482	4844
7-#7	1.34	1109	679	1305	640	1720	531	1935	439	2080	296	2318	140	1635
7-#8	1.76	1147	718	1414	665	1848	550	2085	452	2271	295	2563	112	2051
7-#9	2.23	1189	761	1532	693	1987	571	2247	465	2480	293	2824	80	2493
7-#10	2.83	1240	817	1679	729	2163	598	2451	482	2743	290	3152	38	3014
7-#11	3.48	1280	877	1839	763	2339	622	2643	494	2982	281	3409	-19	3410
7-#14	5.01	1408	1019	2189	854	2759	690	3127	535	3609	271	4150	-137	4127
8-#7	1.53	1129	697	1313	662	1764	549	1993	453	2165	304	2448	132	1832
8-#8	2.01	1172	741	1435	692	1911	572	2161	468	2381	303	2727	100	2322
8-#9	2.55	1217	791	1566	725	2071	597	2344	484	2615	302	3025	63	2823
8-#10	3.23	1274	854	1732	768	2271	629	2574	504	2911	300	3399	15	3354
8-#11	3.97	1320	923	1911	808	2464	657	2789	519	3180	292	3694	-51	3683
8-#14	5.73	1462	1085	2307	918	2933	736	3334	568	3884	283	4540	-188	4474
9-#10	3.64	1316	892	1852	787	2393	639	2721	512	3113	294	3643	-11	3642
9-#11	4.47	1370	969	2050	833	2604	674	2970	531	3418	284	3978	-83	3963
9-#14	6.45	1536	1151	2490	954	3132	763	3594	587	4217	272	4934	-234	4829
10-#10	4.04	1363	929	2030	797	2545	646	2889	509	3327	281	3862	-45	3814
10-#11	4.97	1433	1015	2247	846	2787	681	3166	528	3683	270	4236	-126	4159
10-#14	7.16	1615	1218	2749	975	3380	775	3866	585	4585	252	5298	-298	5119
11-#10	4.45	1399	967	2038	840	2622	682	2999	542	3484	298	4147	-57	4112
11-#11	5.46	1473	1060	2271	896	2889	723	3298	566	3856	286	4563	-143	4481
12-#10	4.85	1457	1004	2115	870	2713	708	3129	559	3662	305	4402	-77	4368
12-#11	5.96	1541	1106	2365	932	2999	753	3460	587	4065	293	4859	-171	4748
13-#10	5.26	1479	1041	2217	895	2850	724	3277	571	3848	299	4632	-108	4572
14-#10	5.66	1527	1079	2347	911	2993	738	3448	575	4049	290	4848	-139	4777

ROUND TIED COLUMNS 22" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.05	1408	790	1559	763	2119	634	2398	527	2577	367	2872	188	1879
4-#10	1.34	1435	822	1655	782	2230	647	2526	535	2744	366	3085	162	2324
4-#11	1.64	1454	856	1773	798	2350	657	2655	539	2901	360	3257	126	2759
4-#14	2.37	1513	937	1999	848	2616	693	2964	561	3306	356	3752	54	3621
4-#18	4.21	1655	1143	2535	974	3254	783	3712	614	4292	345	4903	-143	4813
5-#8	1.04	1452	788	1672	749	2190	622	2446	516	2602	356	2855	190	1762
5-#9	1.32	1488	819	1775	768	2306	636	2580	525	2774	354	3070	168	2149
5-#10	1.67	1533	859	1904	793	2453	655	2749	536	2993	352	3342	138	2630
5-#11	2.05	1569	902	2049	814	2603	669	2914	543	3198	345	3584	102	3103
5-#14	2.96	1671	1003	2352	878	2953	715	3321	571	3727	338	4218	22	4138
5-#18	5.26	1919	1261	3072	1037	3789	832	4299	640	4987	314	5684	-198	5579
6-#8	1.25	1459	812	1884	732	2373	602	2614	494	2776	332	2939	148	2079
6-#9	1.58	1497	849	2005	754	2518	617	2786	503	2996	328	3193	117	2559
6-#10	2.00	1544	896	2157	782	2702	637	3004	515	3274	323	3512	78	3155
6-#11	2.46	1582	948	2323	808	2889	654	3217	524	3521	312	3771	25	3693
6-#14	3.55	1698	1069	2688	881	3334	706	3745	554	4176	295	4504	-87	4483
6-#18	6.31	1968	1378	3565	1066	4410	836	5013	628	5728	245	6195	-389	6036
7-#7	1.10	1457	796	1629	765	2186	637	2470	530	2652	365	2965	196	1877
7-#8	1.45	1503	835	1753	791	2332	656	2641	542	2872	364	3252	169	2356
7-#9	1.84	1552	878	1888	818	2491	677	2828	556	3110	363	3561	140	2867
7-#10	2.34	1614	934	2057	855	2692	704	3064	574	3413	361	3950	101	3501
7-#11	2.87	1663	993	2245	888	2898	728	3293	588	3694	353	4268	48	4080
7-#14	4.14	1806	1136	2649	980	3382	798	3855	631	4421	346	5162	-62	5148
7-#18	7.37	2176	1496	3617	1214	4549	973	5203	737	6168	321	7227	-362	7021
8-#7	1.26	1479	813	1628	788	2229	657	2538	546	2750	374	3118	189	2089
8-#8	1.66	1530	858	1766	818	2397	679	2731	561	2998	374	3445	159	2652
8-#9	2.10	1584	908	1917	851	2579	705	2941	577	3266	374	3797	125	3255
8-#10	2.67	1651	971	2106	894	2810	738	3207	599	3607	374	4240	80	3960
8-#11	3.28	1707	1039	2316	935	3047	767	3460	615	3924	366	4605	19	4541
8-#14	4.74	1865	1202	2770	1045	3594	849	4094	667	4741	362	5624	-107	5575
9-#10	3.01	1699	1008	2249	913	2955	748	3368	605	3840	368	4527	55	4302
9-#11	3.69	1766	1085	2480	959	3212	780	3659	625	4199	359	4942	-12	4939
9-#14	5.33	1959	1268	2991	1082	3827	869	4379	683	5129	352	6095	-152	6026
10-#10	3.34	1755	1046	2469	923	3136	753	3565	601	4073	352	4741	14	4700
10-#11	4.10	1830	1131	2723	972	3420	788	3889	621	4489	342	5242	-53	5174
10-#14	5.92	2048	1334	3306	1103	4106	885	4698	681	5552	331	6524	-212	6342
11-#10	3.68	1794	1083	2460	967	3211	791	3688	637	4256	371	5117	12	5070
11-#11	4.51	1879	1177	2733	1024	3523	832	4038	662	4703	363	5632	-68	5580
11-#14	6.51	2120	1401	3351	1173	4272	945	4913	735	5842	356	7054	-237	6845
12-#10	4.01	1863	1121	2546	998	3314	818	3828	654	4474	381	5415	-5	5412
12-#11	4.92	1957	1223	2839	1061	3648	864	4213	682	4949	372	5980	-92	5931
13-#10	4.34	1885	1158	2660	1023	3473	834	4000	666	4675	375	5686	-36	5666
13-#11	5.33	1990	1269	2976	1092	3834	884	4416	698	5200	366	6296	-130	6210
14-#10	4.68	1934	1195	2815	1038	3634	846	4202	671	4906	366	5938	-65	5898
14-#11	5.75	2057	1315	3153	1112	4028	900	4652	703	5475	355	6593	-167	6489
15-#10	5.01	1973	1233	2882	1076	3733	877	4318	696	5100	378	6254	-84	6189
16-#10	5.35	2023	1270	2957	1106	3858	903	4469	713	5299	384	6547	-101	6470

ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.12	1846	949	2023	921	2775	765	3158	636	3422	442	3861	225	2609
4-#11	1.38	1871	983	2159	936	2914	775	3306	640	3601	437	4066	191	3110
4-#14	1.99	1941	1065	2417	986	3215	811	3656	662	4058	434	4644	123	4272
4-#18	3.54	2108	1271	3030	1114	3942	902	4506	717	5176	425	6005	-61	5959
5-#9	1.11	1905	947	2174	904	2873	751	3226	623	3458	429	3839	228	2426
5-#10	1.40	1958	987	2321	929	3039	770	3417	635	3705	427	4153	200	2972
5-#11	1.72	2002	1029	2491	950	3213	784	3607	642	3939	420	4415	162	3515
5-#14	2.49	2120	1131	2838	1014	3611	831	4069	671	4539	414	5185	91	4792
5-#18	4.42	2398	1388	3664	1176	4569	950	5187	743	5997	397	6927	-114	6824
6-#8	1.05	1872	939	2327	862	2962	711	3268	587	3461	403	3675	205	2330
6-#9	1.33	1917	976	2463	884	3125	726	3460	597	3716	400	3968	176	2874
6-#10	1.68	1972	1024	2635	912	3332	746	3705	608	4033	396	4338	138	3552
6-#11	2.07	2018	1075	2826	938	3546	763	3948	617	4321	386	4648	88	4223
6-#14	2.98	2144	1197	3240	1011	4049	815	4545	648	5076	372	5509	-17	5504
6-#18	5.31	2463	1506	4237	1197	5271	947	6001	725	6879	331	7521	-300	7362
7-#8	1.22	1923	963	2140	928	2893	773	3289	642	3569	440	4048	231	2671
7-#9	1.55	1980	1006	2292	956	3072	794	3498	656	3839	440	4404	202	3250
7-#10	1.97	2051	1061	2483	992	3299	821	3764	674	4181	439	4853	166	3972
7-#11	2.41	2112	1121	2699	1026	3535	845	4030	688	4504	432	5234	116	4682
7-#14	3.48	2278	1263	3158	1119	4083	915	4677	734	5332	427	6283	13	6229
7-#18	6.19	2702	1624	4262	1354	5411	1093	6223	845	7333	409	8736	-267	8576
8-#8	1.40	1955	986	2142	957	2957	797	3391	663	3712	452	4261	221	2986
8-#9	1.77	2018	1035	2312	990	3162	823	3629	680	4016	452	4670	190	3668
8-#10	2.25	2096	1099	2525	1033	3422	856	3930	702	4401	453	5188	148	4519
8-#11	2.76	2162	1167	2765	1074	3694	886	4223	718	4765	447	5625	91	5281
8-#14	3.98	2343	1330	3280	1184	4326	970	4947	772	5697	445	6819	-27	6804
8-#18	7.07	2805	1742	4523	1465	5831	1179	6689	905	7947	433	9615	-350	9345
9-#10	2.53	2150	1136	2710	1049	3594	866	4107	707	4658	446	5517	123	4926
9-#11	3.10	2227	1213	2978	1094	3889	898	4439	727	5079	440	6013	60	5745
9-#14	4.48	2443	1396	3536	1221	4588	989	5257	787	6140	436	7366	-71	7328
9-#18	7.96	2992	1859	4934	1532	6249	1226	7239	937	8698	417	10530	-428	10118
10-#10	2.81	2213	1174	2953	1059	3806	870	4333	701	4917	429	5760	83	5434
10-#11	3.45	2301	1259	3251	1110	4132	905	4704	722	5392	420	6304	11	6262
10-#14	4.97	2552	1462	3914	1242	4913	1004	5623	784	6597	412	7859	-128	7697
11-#10	3.09	2259	1211	2929	1107	3876	910	4465	740	5124	451	6195	83	5818
11-#11	3.79	2354	1305	3242	1164	4233	952	4870	766	5637	444	6810	8	6777
11-#14	5.47	2624	1528	3942	1314	5081	1065	5865	841	6937	441	8477	-150	8315
12-#10	3.37	2332	1248	3022	1139	3990	937	4617	757	5368	462	6537	68	6260
12-#11	4.14	2447	1351	3358	1202	4373	984	5057	786	5933	457	7212	-13	7204
12-#14	5.97	2743	1594	4116	1367	5283	1110	6139	870	7340	456	9036	-183	8808
13-#10	3.65	2363	1286	3150	1162	4172	954	4813	770	5600	456	6848	37	6679
13-#11	4.48	2479	1397	3511	1232	4586	1005	5289	802	6202	449	7578	-51	7544
13-#14	6.47	2822	1661	4329	1412	5580	1141	6464	893	7733	446	9548	-238	9271
14-#10	3.93	2419	1323	3331	1177	4353	964	5037	773	5862	447	7135	10	7093
14-#11	4.83	2546	1443	3718	1251	4802	1019	5560	807	6514	438	7918	-85	7857

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#10	4.21	2462	1361	3395	1216	4460	997	5174	801	6074	460	7501	-8	7494
15-#11	5.17	2598	1489	3809	1297	4936	1057	5719	839	6774	453	8345	-110	8245
16-#10	4.49	2510	1398	3478	1247	4595	1024	5343	818	6295	466	7837	-23	7813
16-#11	5.52	2665	1534	3910	1335	5103	1090	5921	859	7041	460	8740	-130	8622
17-#10	4.77	2567	1435	3623	1271	4767	1038	5525	830	6544	464	8173	-50	8092
18-#10	5.05	2614	1473	3805	1287	4955	1050	5726	835	6813	459	8452	-77	8378

ROUND TIED COLUMNS 26" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.18	2358	1122	2595	1087	3560	903	4056	750	4407	520	4990	259	3461
4-#14	1.70	2440	1204	2884	1137	3897	939	4446	772	4916	517	5652	194	4781
4-#18	3.01	2634	1410	3574	1266	4713	1031	5399	828	6166	510	7225	21	7171
5-#10	1.20	2453	1126	2791	1076	3711	895	4186	742	4522	508	5078	265	3321
5-#11	1.47	2505	1168	2986	1098	3909	910	4400	749	4785	501	5383	229	3934
5-#14	2.12	2642	1270	3379	1162	4356	957	4918	779	5456	497	6225	155	5373
5-#18	3.77	2961	1527	4313	1326	5436	1078	6176	853	7095	482	8287	-31	8200
6-#9	1.13	2407	1115	2986	1026	3824	846	4238	698	4524	477	4853	238	3189
6-#10	1.44	2471	1163	3178	1054	4054	866	4509	710	4884	474	5274	202	3949
6-#11	1.76	2525	1214	3394	1079	4295	882	4782	718	5227	466	5636	154	4708
6-#14	2.54	2670	1336	3857	1153	4856	935	5447	749	6082	454	6625	55	6422
6-#18	4.52	3035	1645	4976	1340	6224	1067	7076	828	8138	419	8962	-213	8827
7-#9	1.32	2480	1145	2747	1106	3737	921	4268	765	4673	523	5362	269	3642
7-#10	1.67	2562	1200	2961	1142	3989	949	4564	783	5055	522	5873	234	4452
7-#11	2.06	2632	1260	3206	1175	4256	972	4863	797	5420	516	6317	187	5256
7-#14	2.97	2824	1402	3720	1269	4869	1043	5586	844	6349	513	7521	90	7102
7-#18	5.27	3287	1763	4960	1506	6358	1222	7345	961	8606	500	10366	-174	10243
8-#9	1.51	2522	1174	2755	1141	3827	951	4416	791	4871	537	5644	256	4087
8-#10	1.91	2612	1238	2992	1184	4115	984	4753	813	5302	538	6227	217	5042
8-#11	2.35	2690	1306	3264	1225	4422	1014	5085	831	5713	533	6761	165	5988
8-#14	3.39	2896	1468	3838	1336	5126	1099	5899	886	6759	533	8132	54	7921
8-#18	6.03	3399	1881	5229	1617	6844	1315	7868	1024	9299	528	11373	-249	11144
9-#10	2.15	2674	1275	3205	1200	4316	995	4945	817	5579	530	6619	194	5529
9-#11	2.64	2763	1352	3508	1245	4650	1027	5320	837	6056	525	7201	135	6520
9-#14	3.81	3009	1535	4164	1367	5432	1119	6234	899	7256	525	8755	11	8706
9-#18	6.78	3624	1998	5699	1685	7331	1351	8461	1053	10149	514	12425	-325	12073
10-#10	2.39	2745	1312	3489	1207	4562	997	5202	810	5867	512	6894	155	6102
10-#11	2.94	2846	1398	3828	1258	4932	1033	5621	831	6401	504	7527	86	7168
10-#14	4.24	3115	1601	4579	1393	5807	1133	6650	895	7749	498	9229	-58	9189
10-#18	7.53	3802	2116	6374	1731	7930	1385	9154	1053	11039	477	13388	-424	12800
11-#10	2.63	2796	1350	3447	1258	4624	1039	5338	850	6100	537	7356	151	6569
11-#11	3.23	2907	1444	3801	1316	5027	1081	5797	877	6677	531	8106	85	7688
11-#14	4.66	3211	1667	4585	1467	5974	1196	6917	956	8133	531	10021	-64	9924
12-#10	2.87	2879	1387	3546	1291	4749	1068	5506	869	6362	547	7750	141	7123
12-#11	3.53	3004	1490	3926	1355	5180	1115	6001	899	7001	544	8561	67	8267
12-#14	5.09	3344	1733	4775	1521	6198	1242	7208	984	8600	549	10655	-93	10563

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
13-#10	3.11	2912	1425	3689	1314	4950	1084	5726	882	6631	543	8112	112	7559
13-#11	3.82	3047	1536	4096	1384	5422	1136	6262	914	7311	537	8977	30	8833
13-#14	5.51	3422	1800	5010	1565	6534	1273	7575	1008	9027	538	11240	-147	11070
14-#10	3.35	2978	1462	3898	1328	5156	1093	5972	883	6923	533	8450	87	8050
14-#11	4.11	3123	1581	4335	1403	5661	1148	6559	918	7660	526	9362	-3	9359
14-#14	5.93	3527	1866	5325	1595	6866	1295	7997	1017	9523	524	11788	-194	11578
15-#10	3.59	3022	1499	3958	1368	5270	1127	6122	913	7150	547	8847	68	8518
15-#11	4.41	3180	1627	4423	1450	5805	1188	6742	953	7942	542	9848	-26	9824
16-#10	3.83	3078	1537	4047	1400	5436	1148	6317	932	7398	554	9219	55	8976
16-#11	4.70	3244	1673	4534	1488	5985	1221	6969	974	8237	549	10296	-44	10239
17-#10	4.07	3139	1574	4210	1424	5607	1168	6513	943	7676	552	9604	28	9469
17-#11	5.00	3320	1719	4726	1518	6214	1238	7210	989	8569	547	10745	-78	10608
18-#10	4.31	3195	1611	4416	1439	5824	1181	6740	948	7967	547	9929	4	9913
18-#11	5.29	3383	1765	4968	1537	6464	1254	7478	995	8927	542	11118	-110	10987
19-#10	4.54	3260	1649	4480	1477	5931	1211	6915	971	8204	557	10335	-14	10314
20-#10	4.78	3308	1686	4605	1506	6087	1234	7092	990	8465	564	10690	-32	10643

ROUND TIED COLUMNS 28" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.01	2922	1272	3082	1251	4295	1042	4913	868	5328	610	6007	328	3809
4-#14	1.46	3017	1354	3404	1301	4668	1078	5344	890	5889	607	6770	268	5287
4-#18	2.60	3239	1560	4173	1430	5574	1171	6399	948	7270	602	8573	105	8266
5-#10	1.03	3026	1276	3318	1236	4476	1031	5064	858	5454	596	6128	335	3674
5-#11	1.27	3086	1318	3538	1257	4698	1045	5303	865	5747	589	6476	300	4359
5-#14	1.83	3242	1420	3973	1322	5194	1093	5877	895	6489	585	7428	230	5962
5-#18	3.25	3604	1677	5021	1487	6397	1215	7276	971	8308	573	9696	42	9527
6-#10	1.24	3047	1313	3789	1207	4874	995	5426	820	5841	556	6329	269	4347
6-#11	1.52	3109	1364	4032	1232	5142	1011	5728	828	6228	549	6743	224	5195
6-#14	2.19	3275	1486	4544	1306	5762	1064	6461	859	7202	541	7862	129	7183
6-#18	3.90	3688	1795	5785	1493	7277	1197	8263	939	9512	512	10526	-126	10434
7-#9	1.14	3056	1295	3256	1268	4492	1058	5146	882	5623	612	6426	338	4043
7-#10	1.44	3150	1350	3493	1304	4770	1086	5471	901	6044	612	7002	305	4942
7-#11	1.77	3230	1410	3767	1337	5069	1110	5804	915	6451	606	7524	261	5841
7-#14	2.56	3449	1552	4337	1431	5746	1181	6602	962	7481	605	8885	169	7963
7-#18	4.55	3969	1913	5716	1669	7398	1362	8557	1082	9994	597	12126	-80	12061
8-#9	1.30	3103	1324	3249	1305	4580	1091	5306	911	5842	629	6745	328	4509
8-#10	1.65	3206	1388	3510	1348	4897	1124	5682	934	6317	630	7391	289	5567
8-#11	2.03	3295	1456	3814	1388	5238	1153	6055	952	6777	626	7990	239	6628
8-#14	2.92	3529	1618	4449	1499	6015	1238	6959	1009	7937	628	9556	135	8977
8-#18	5.20	4091	2030	5990	1782	7914	1455	9155	1150	10767	628	13262	-149	13104
9-#10	1.86	3275	1425	3753	1362	5125	1133	5890	937	6615	621	7826	266	6145
9-#11	2.28	3377	1502	4092	1407	5502	1166	6308	957	7144	616	8510	211	7256
9-#14	3.29	3649	1685	4818	1530	6368	1259	7320	1020	8470	617	10272	94	9787
9-#18	5.85	4321	2148	6581	1841	8477	1494	9791	1177	11716	615	14452	-224	14202
10-#10	2.06	3354	1462	4082	1368	5411	1133	6179	927	6931	601	8152	229	6754
10-#11	2.53	3470	1548	4461	1418	5824	1170	6646	948	7525	594	8876	164	8020
10-#14	3.65	3772	1751	5289	1553	6794	1271	7786	1014	9016	590	10800	27	10677
10-#18	6.50	4536	2266	7302	1896	9155	1526	10568	1176	12669	575	15377	-342	14983

ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#10	2.27	3413	1500	4016	1422	5462	1178	6318	970	7190	628	8649	226	7305
11-#11	2.79	3539	1594	4414	1479	5911	1221	6828	997	7832	624	9484	159	8622
11-#14	4.02	3872	1817	5281	1632	6958	1336	8065	1077	9443	626	11651	17	11573
11-#18	7.15	4729	2384	7389	2017	9516	1629	11089	1275	13385	625	16842	-360	16173
12-#10	2.48	3503	1537	4121	1456	5596	1208	6502	989	7472	639	9089	217	7912
12-#11	3.04	3646	1640	4546	1520	6077	1256	7052	1020	8179	637	10005	146	9313
12-#14	4.38	4028	1883	5486	1687	7202	1384	8386	1107	9944	643	12387	-4	12382
13-#10	2.68	3542	1575	4279	1478	5816	1224	6746	1002	7772	635	9493	188	8437
13-#11	3.29	3696	1686	4734	1548	6341	1276	7342	1035	8535	631	10484	110	9901
13-#14	4.75	4103	1950	5744	1730	7576	1415	8794	1130	10437	635	13062	-55	12977
14-#10	2.89	3616	1612	4521	1491	6049	1232	7015	1002	8100	626	9860	164	9046
14-#11	3.55	3780	1731	5008	1566	6611	1287	7666	1038	8922	620	10932	81	10538
14-#14	5.12	4228	2016	6103	1759	7942	1435	9253	1138	10987	621	13674	-101	13553
15-#10	3.09	3665	1649	4572	1532	6168	1268	7177	1034	8343	641	10313	146	9533
15-#11	3.80	3838	1777	5091	1614	6764	1329	7866	1074	9222	637	11455	57	11162
15-#14	5.48	4311	2082	6256	1824	8177	1490	9543	1185	11420	643	14428	-135	14187
16-#10	3.30	3727	1687	4668	1565	6346	1289	7397	1054	8616	648	10728	135	10063
16-#11	4.05	3913	1823	5210	1653	6986	1355	8124	1097	9549	645	11947	40	11755
16-#14	5.85	4436	2148	6435	1879	8459	1537	9903	1216	11882	653	15116	-161	14835
17-#10	3.51	3795	1724	4850	1589	6536	1309	7609	1065	8924	647	11131	104	10580
17-#11	4.31	3993	1869	5425	1683	7211	1379	8383	1111	9917	643	12456	8	12416
18-#10	3.71	3849	1761	5079	1603	6780	1321	7861	1069	9236	640	11492	83	11095
18-#11	4.56	4067	1915	5694	1701	7497	1395	8682	1117	10302	636	12887	-22	12847
19-#10	3.92	3929	1799	5144	1642	6893	1353	8047	1093	9498	652	11958	68	11625
19-#11	4.81	4153	1961	5782	1747	7639	1432	8915	1146	10615	649	13423	-44	13350
20-#10	4.13	3981	1836	5276	1671	7064	1376	8242	1112	9795	660	12368	51	12115
20-#11	5.07	4217	2007	5947	1783	7846	1460	9149	1168	10960	657	13892	-67	13783
21-#10	4.33	4057	1874	5422	1698	7248	1396	8479	1124	10075	657	12767	27	12650
22-#10	4.54	4111	1911	5624	1719	7464	1409	8720	1134	10384	653	13130	0	13129

ROUND TIED COLUMNS 30" DIA.

4-#14	1.27	3677	1515	3980	1476	5535	1227	6358	1018	6986	704	7992	343	5792
4-#18	2.26	3929	1721	4828	1606	6532	1321	7516	1077	8499	700	10058	191	9427
5-#11	1.10	3749	1479	4152	1429	5587	1191	6323	990	6832	684	7702	375	4790
5-#14	1.59	3925	1581	4630	1493	6133	1239	6953	1020	7645	680	8763	308	6558
5-#18	2.83	4333	1838	5786	1659	7459	1362	8493	1097	9645	670	11310	128	10685
6-#10	1.08	3705	1474	4474	1372	5800	1134	6462	938	6921	645	7513	340	4745
6-#11	1.32	3777	1525	4743	1397	6096	1150	6794	946	7345	638	7978	296	5683
6-#14	1.91	3963	1647	5305	1470	6775	1202	7596	977	8408	630	9228	205	7878
6-#18	3.40	4403	1956	6670	1658	8438	1336	9571	1058	11011	609	12220	-39	12190
7-#10	1.26	3820	1511	4083	1479	5648	1234	6495	1027	7157	709	8257	380	5441
7-#11	1.54	3912	1571	4388	1511	5978	1258	6861	1041	7606	703	8848	338	6438
7-#14	2.23	4154	1713	5015	1605	6721	1329	7735	1089	8737	703	10384	251	8780
7-#18	3.96	4739	2074	6531	1845	8536	1511	9880	1210	11507	699	14022	14	13953
8-#10	1.44	3881	1549	4083	1524	5773	1274	6715	1062	7457	729	8692	366	6098
8-#11	1.77	3984	1617	4420	1564	6150	1303	7139	1081	7964	725	9356	318	7271

ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.55	4247	1780	5116	1675	6999	1388	8134	1139	9239	728	11085	217	10029
8-#18	4.53	4870	2192	6807	1958	9081	1605	10558	1284	12359	734	15290	-50	15203
9-#10	1.62	3960	1586	4358	1538	6029	1282	6951	1065	7774	718	9169	343	6774
9-#11	1.99	4076	1663	4734	1583	6447	1315	7412	1085	8356	714	9929	290	8005
9-#14	2.86	4379	1846	5530	1705	7400	1409	8521	1149	9808	716	11903	178	10907
9-#18	5.09	5123	2309	7466	2017	9722	1646	11239	1309	13381	719	16618	-124	16467
10-#10	1.80	4047	1624	4737	1540	6359	1281	7274	1053	8119	697	9543	308	7415
10-#11	2.21	4178	1709	5156	1590	6815	1317	7789	1074	8773	690	10359	245	8816
10-#14	3.18	4515	1912	6062	1725	7881	1419	9039	1141	10407	688	12505	114	11940
10-#18	5.66	5360	2427	8277	2070	10481	1677	12101	1307	14422	677	17645	-238	17340
11-#10	1.98	4110	1661	4640	1598	6395	1328	7413	1098	8404	727	10078	304	8057
11-#11	2.43	4255	1755	5081	1655	6890	1370	7974	1126	9111	723	11009	240	9517
11-#14	3.50	4626	1978	6035	1808	8038	1487	9328	1206	10878	727	13420	103	12868
11-#18	6.22	5547	2545	8353	2196	10847	1782	12654	1409	15214	732	19282	-252	18691
12-#10	2.16	4212	1698	4751	1633	6538	1359	7612	1119	8705	738	10516	290	8697
12-#11	2.65	4373	1801	5222	1697	7068	1407	8217	1149	9482	736	11585	229	10325
12-#14	3.82	4787	2044	6254	1865	8302	1536	9678	1238	11413	744	14225	85	13820
12-#18	6.79	5807	2662	8765	2291	11323	1863	13266	1459	16167	761	20609	-301	19793
13-#10	2.34	4256	1736	4949	1652	6777	1374	7881	1131	9034	734	11009	268	9308
13-#11	2.87	4425	1847	5428	1725	7356	1426	8538	1165	9877	731	12115	193	10995
13-#14	4.14	4881	2111	6535	1907	8707	1566	10128	1261	11971	738	14977	34	14796
13-#18	7.36	6013	2780	9237	2370	12020	1921	14031	1502	17087	746	21851	-395	20895
14-#10	2.52	4332	1773	5201	1667	7039	1381	8173	1130	9401	725	11388	242	9951
14-#11	3.09	4523	1893	5739	1741	7659	1437	8889	1166	10307	720	12602	164	11742
14-#14	4.46	5017	2177	6940	1936	9116	1586	10625	1267	12575	724	15698	-6	15689
15-#10	2.70	4392	1810	5242	1709	7162	1419	8348	1163	9659	740	11906	228	10532
15-#11	3.31	4586	1938	5814	1791	7819	1480	9105	1204	10626	737	13191	142	12386
15-#14	4.77	5108	2243	7090	2002	9366	1643	10941	1317	13035	746	16490	-43	16411
16-#10	2.87	4461	1848	5343	1742	7350	1440	8582	1184	9958	748	12373	218	11171
16-#11	3.53	4669	1984	5942	1830	8054	1506	9394	1228	10985	746	13735	127	13071
16-#14	5.09	5223	2309	7283	2057	9712	1679	11346	1350	13543	757	17253	-66	17131
17-#10	3.05	4533	1885	5543	1766	7559	1460	8826	1192	10295	747	12794	187	11725
17-#11	3.75	4756	2030	6179	1860	8302	1530	9672	1242	11389	744	14268	90	13763
17-#14	5.41	5348	2375	7611	2101	10059	1715	11745	1371	14116	755	18006	-120	17758
18-#10	3.23	4595	1923	5800	1779	7827	1471	9098	1199	10628	739	13191	165	12317
18-#11	3.97	4828	2076	6477	1878	8622	1546	10002	1248	11800	737	14743	64	14419
19-#10	3.41	4680	1960	5863	1819	7950	1505	9293	1224	10916	752	13707	152	12872
19-#11	4.19	4932	2122	6566	1925	8772	1584	10248	1277	12145	751	15354	45	15131
20-#10	3.59	4741	1997	6003	1848	8135	1528	9506	1243	11236	761	14165	136	13437
20-#11	4.41	5002	2168	6741	1961	8997	1613	10504	1300	12534	761	15888	24	15761
21-#10	3.77	4819	2035	6164	1875	8334	1548	9766	1255	11548	758	14599	112	14006
21-#11	4.63	5102	2214	6932	1994	9238	1637	10815	1315	12902	757	16415	-6	16403
22-#10	3.95	4883	2072	6387	1896	8573	1561	10026	1264	11887	754	14999	86	14545
23-#10	4.13	4959	2109	6491	1929	8725	1592	10235	1286	12176	764	15495	73	15141
24-#10	4.31	5029	2147	6617	1961	8906	1614	10465	1306	12477	770	15933	52	15674

ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.12	4425	1687	4614	1665	6504	1387	7494	1155	8215	808	9359	423	6295
4-#18	1.99	4708	1893	5543	1794	7592	1481	8755	1214	9860	804	11602	274	10477
5-#14	1.40	4697	1753	5353	1677	7177	1396	8155	1154	8934	781	10242	390	7162
5-#18	2.49	5152	2011	6615	1842	8628	1519	9837	1232	11115	773	13069	217	11753
6-#11	1.16	4532	1697	5534	1574	7164	1299	7989	1072	8593	733	9352	373	6171
6-#14	1.68	4741	1819	6146	1647	7902	1351	8859	1104	9746	726	10731	285	8574
6-#18	2.98	5230	2128	7635	1835	9712	1485	11007	1185	12600	708	14054	50	13834
7-#10	1.11	4578	1684	4735	1665	6630	1393	7642	1163	8403	812	9657	459	5954
7-#11	1.36	4682	1743	5072	1698	6992	1416	8042	1177	8894	807	10305	418	7045
7-#14	1.96	4952	1885	5755	1792	7800	1488	8992	1225	10126	807	11992	334	9611
7-#18	3.48	5601	2246	7411	2032	9779	1671	11328	1347	13153	807	16065	109	15452
8-#10	1.26	4645	1721	4714	1713	6750	1434	7871	1199	8729	834	10137	448	6634
8-#11	1.55	4762	1789	5085	1753	7163	1463	8334	1218	9284	830	10868	401	7919
8-#14	2.24	5055	1952	5841	1864	8085	1548	9429	1278	10674	835	12760	303	10942
8-#18	3.98	5744	2364	7684	2147	10350	1766	12085	1427	14086	844	17380	45	17187
9-#10	1.42	4733	1758	5024	1725	7035	1442	8136	1201	9066	822	10657	424	7417
9-#11	1.75	4864	1835	5437	1770	7493	1475	8640	1222	9700	818	11493	372	8769
9-#14	2.52	5200	2018	6303	1893	8531	1569	9847	1286	11279	821	13657	264	11957
9-#18	4.48	6020	2481	8414	2206	11071	1809	12811	1449	15172	827	18927	-22	18884
10-#10	1.58	4829	1796	5458	1725	7412	1438	8493	1187	9440	799	11037	387	8084
10-#11	1.94	4976	1881	5917	1774	7913	1474	9057	1209	10153	792	11985	330	9621
10-#14	2.80	5350	2084	6902	1910	9075	1577	10418	1276	11930	791	14355	204	13254
10-#18	4.97	6241	2599	9314	2255	11915	1838	13759	1445	16309	785	20060	-134	19874
11-#10	1.74	4899	1833	5323	1786	7430	1489	8631	1236	9751	832	11653	387	8826
11-#11	2.13	5059	1927	5808	1843	7972	1531	9244	1263	10524	828	12679	324	10430
11-#14	3.08	5472	2150	6846	1997	9220	1648	10715	1344	12446	834	15325	192	14203
11-#18	5.47	6481	2717	9379	2386	12282	1945	14337	1549	17177	843	21754	-159	21401
12-#10	1.89	5011	1870	5438	1823	7580	1521	8845	1257	10072	843	12134	374	9493
12-#11	2.33	5191	1973	5956	1886	8161	1568	9506	1288	10918	841	13312	316	11281
12-#14	3.36	5647	2217	7080	2055	9504	1698	11094	1377	13014	851	16210	176	15286
12-#18	5.97	6765	2835	9821	2483	12797	2028	15002	1601	18189	872	23248	-196	22606
13-#10	2.05	5060	1908	5656	1841	7841	1535	9139	1270	10429	839	12668	352	10200
13-#11	2.52	5249	2019	6213	1910	8473	1587	9857	1303	11347	837	13893	280	12052
13-#14	3.64	5750	2283	7387	2096	9941	1728	11587	1401	13625	845	17036	125	16301
13-#18	6.47	6963	2952	10331	2561	13550	2084	15841	1646	19225	861	24660	-286	23854
14-#10	2.21	5144	1945	5943	1854	8133	1540	9455	1266	10834	830	13061	325	10871
14-#11	2.72	5350	2065	6534	1929	8810	1596	10237	1302	11825	826	14394	249	12905
14-#14	3.92	5900	2349	7840	2124	10393	1746	12121	1404	14297	832	17793	84	17364
14-#18	6.96	7298	3070	11035	2618	14286	2125	16768	1661	20365	840	25994	-358	24871
15-#10	2.37	5210	1983	5971	1898	8257	1580	9641	1302	11107	846	13633	312	11537
15-#11	2.91	5426	2111	6597	1980	8976	1641	10467	1342	12163	844	15067	230	13636
15-#14	4.20	5990	2415	7984	2191	10658	1805	12461	1457	14783	854	18700	51	18400
16-#10	2.53	5285	2020	6076	1932	8455	1602	9890	1322	11433	855	14164	305	12208
16-#11	3.10	5516	2157	6731	2020	9224	1668	10775	1367	12554	854	15671	218	14430
16-#14	4.48	6123	2481	8189	2248	11024	1842	12909	1491	15337	867	19538	30	19375
17-#10	2.68	5364	2057	6294	1955	8684	1622	10160	1331	11792	853	14603	273	12849
17-#11	3.30	5612	2202	6992	2050	9496	1692	11092	1378	12994	852	16225	179	15148
17-#14	4.76	6251	2548	8550	2292	11404	1878	13338	1512	15962	865	20357	-23	20300

ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.84	5432	2095	6580	1967	8977	1632	10458	1338	12154	845	15035	251	13534
18-#11	3.49	5690	2248	7321	2066	9844	1707	11446	1387	13432	843	16745	153	15895
18-#14	5.04	6384	2614	8993	2319	11887	1902	13844	1522	16596	855	21099	-60	20954
19-#10	3.00	5526	2132	6640	2009	9106	1666	10663	1363	12467	859	15601	239	14146
19-#11	3.69	5800	2294	7410	2115	10006	1747	11704	1416	13807	858	17416	136	16638
19-#14	5.32	6521	2680	9148	2385	12130	1956	14226	1562	17126	874	22036	-88	21810
20-#10	3.16	5586	2169	6787	2038	9308	1691	10893	1383	12808	868	16084	223	14800
20-#11	3.88	5881	2340	7594	2151	10250	1776	11982	1440	14226	869	18017	117	17358
21-#10	3.32	5677	2207	6964	2065	9521	1710	11176	1395	13154	866	16578	201	15394
21-#11	4.07	5983	2386	7803	2184	10509	1800	12321	1455	14632	866	18580	87	18112
22-#10	3.47	5748	2244	7209	2085	9785	1722	11456	1403	13522	862	17015	175	16014
22-#11	4.27	6066	2432	8092	2209	10820	1816	12661	1466	15075	861	19103	55	18798
23-#10	3.63	5830	2282	7316	2119	9942	1754	11680	1426	13829	871	17542	162	16624
23-#11	4.46	6166	2478	8232	2250	11021	1854	12934	1493	15453	873	19749	38	19553
24-#10	3.79	5907	2319	7453	2151	10138	1777	11926	1446	14156	878	18018	141	17230
25-#10	3.95	5983	2356	7641	2175	10376	1796	12194	1458	14512	878	18537	126	17853
26-#10	4.11	6075	2394	7893	2193	10615	1812	12477	1469	14874	875	19038	105	18438

ROUND TIED COLUMNS 34" DIA.

4-#18	1.76	5582	2076	6322	1994	8760	1652	10126	1360	11363	916	13301	361	11379
5-#14	1.24	5563	1936	6147	1873	8335	1562	9490	1296	10364	889	11872	476	7773
5-#18	2.20	6067	2194	7516	2038	9911	1687	11314	1376	12726	883	14980	309	12775
6-#11	1.03	5382	1881	6408	1762	8353	1457	9320	1207	9981	834	10872	454	6660
6-#14	1.49	5613	2003	7071	1835	9149	1509	10260	1239	11224	827	12382	368	9272
6-#18	2.64	6153	2312	8685	2023	11108	1644	12581	1320	14306	810	16036	142	15359
7-#11	1.20	5547	1927	5821	1897	8116	1585	9355	1321	10323	917	11916	503	7662
7-#14	1.73	5845	2069	6561	1991	8990	1657	10381	1369	11657	918	13747	421	10456
7-#18	3.08	6561	2429	8359	2231	11133	1840	12908	1493	14940	920	18236	205	16999
8-#10	1.12	5503	1904	5503	1904	7835	1605	9158	1346	10143	946	11739	534	7174
8-#11	1.37	5632	1973	5810	1954	8283	1634	9660	1365	10746	942	12534	488	8573
8-#14	1.98	5958	2135	6629	2065	9279	1719	10840	1425	12251	948	14590	393	11862
8-#18	3.52	6717	2547	8625	2348	11728	1938	13745	1577	15954	961	19625	142	18955
9-#10	1.26	5601	1942	5753	1925	8150	1612	9451	1347	10499	933	12299	510	8063
9-#11	1.55	5746	2018	6204	1970	8648	1644	9999	1368	11187	928	13212	459	9548
9-#14	2.23	6117	2201	7141	2093	9769	1739	11304	1433	12892	933	15566	354	13020
9-#18	3.97	7002	2665	9427	2406	12528	1981	14515	1597	17104	942	21318	76	20883
10-#10	1.40	5705	1979	6248	1921	8578	1605	9846	1331	10901	907	12683	470	8761
10-#11	1.72	5869	2064	6748	1971	9124	1642	10459	1352	11674	901	13719	415	10436
10-#14	2.48	6281	2267	7813	2106	10382	1745	11931	1420	13595	901	16356	297	14386
10-#18	4.41	7256	2782	10422	2451	13463	2008	15552	1592	18337	898	22631	-28	22589

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#10	1.54	5782	2016	6069	1986	8574	1660	9980	1382	11240	943	13382	474	9610
11-#11	1.89	5960	2110	6597	2043	9163	1702	10645	1409	12077	940	14504	413	11362
11-#14	2.73	6414	2334	7720	2197	10512	1819	12233	1491	14156	947	17386	284	15498
11-#18	4.85	7498	2900	10467	2589	13827	2118	16151	1698	19282	961	24412	-57	24282
12-#10	1.68	5904	2054	6186	2025	8730	1693	10208	1405	11579	955	13907	463	10301
12-#11	2.06	6104	2156	6752	2088	9362	1740	10925	1435	12495	953	15126	397	12249
12-#14	2.97	6605	2400	7969	2258	10814	1871	12640	1525	14758	964	18253	257	16801
12-#18	5.29	7825	3018	10940	2687	14380	2203	16869	1752	20353	989	26044	-89	25612
13-#10	1.82	5959	2091	6426	2042	9012	1706	10528	1417	11965	951	14467	440	11108
13-#11	2.23	6169	2202	7032	2111	9699	1758	11307	1451	12959	949	15826	370	13130
13-#14	3.22	6711	2466	8348	2293	11284	1899	13176	1549	15419	959	19251	220	17848
13-#18	5.73	8017	3136	11489	2764	15187	2258	17782	1797	21497	981	27590	-178	27127
14-#10	1.96	6050	2129	6750	2054	9336	1710	10870	1412	12405	941	14887	413	11804
14-#11	2.41	6278	2248	7394	2128	10072	1766	11716	1448	13485	938	16341	338	14023
14-#14	3.47	6880	2532	8806	2324	11782	1916	13750	1551	16160	946	20032	177	19046
14-#18	6.17	8353	3253	12267	2820	15993	2298	18774	1810	22744	960	29069	-245	28322
15-#10	2.10	6121	2166	6761	2099	9460	1752	11065	1449	12698	959	15515	400	12562
15-#11	2.58	6362	2294	7442	2181	10241	1813	11960	1490	13842	957	17079	320	14853
15-#14	3.72	6978	2599	8941	2393	12058	1978	14114	1605	16673	969	21050	148	20123
15-#18	6.61	8542	3371	12619	2932	16531	2394	19428	1895	23658	995	30683	-312	29765
16-#10	2.24	6206	2203	6870	2134	9667	1774	11328	1470	13050	968	16101	395	13262
16-#11	2.75	6461	2340	7583	2222	10501	1840	12286	1515	14265	968	17762	311	15742
16-#14	3.97	7122	2665	9158	2450	12445	2015	14588	1640	17272	983	21980	130	21225
17-#10	2.38	6292	2241	7107	2157	9917	1794	11625	1479	13430	966	16567	363	13990
17-#11	2.92	6562	2386	7865	2251	10798	1864	12636	1526	14733	965	18338	272	16547
17-#14	4.21	7261	2731	9549	2494	12858	2051	15075	1657	17949	981	22830	75	22393
18-#10	2.52	6365	2278	7424	2168	10236	1803	11949	1485	13821	957	17035	341	14707
18-#11	3.09	6650	2432	8230	2267	11175	1878	13021	1534	15205	956	18902	245	17415
18-#14	4.46	7405	2797	10034	2520	13379	2074	15613	1671	18622	970	23640	38	23423
19-#10	2.66	6468	2315	7479	2211	10369	1839	12163	1511	14160	972	17651	331	15404
19-#11	3.26	6770	2478	8315	2317	11348	1919	13291	1565	15611	973	19634	230	18184
19-#14	4.71	7554	2863	10193	2588	13643	2129	16014	1712	19197	990	24661	13	24597
20-#10	2.80	6533	2353	7632	2240	10588	1864	12410	1531	14521	981	18160	313	16126
20-#11	3.44	6849	2523	8508	2353	11610	1949	13591	1589	16056	983	20265	210	19001
20-#14	4.96	7677	2930	10483	2639	14021	2171	16443	1745	19838	1005	25578	-15	25531
21-#10	2.94	6630	2390	7825	2267	10816	1883	12714	1543	14897	979	18695	293	16788
21-#11	3.61	6968	2569	8737	2386	11887	1973	13958	1604	16504	981	20901	183	19783
22-#10	3.08	6710	2428	8094	2286	11104	1895	13016	1551	15299	976	19186	267	17511
22-#11	3.78	7058	2615	9052	2410	12227	1988	14322	1614	16982	976	21470	151	20572
23-#10	3.22	6795	2465	8203	2321	11283	1924	13256	1575	15624	986	19741	254	18147
23-#11	3.95	7166	2661	9196	2452	12436	2027	14615	1642	17383	988	22159	135	21384
24-#10	3.36	6883	2502	8350	2354	11477	1950	13516	1595	15977	992	20259	234	18829
24-#11	4.12	7265	2707	9375	2492	12692	2054	14936	1667	17808	995	22775	109	22144

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
25-#10	3.50	6965	2540	8552	2377	11735	1969	13806	1607	16361	993	20794	216	19476
25-#11	4.30	7369	2753	9619	2521	13001	2077	15284	1682	18271	995	23450	90	22952
26-#10	3.64	7059	2577	8829	2395	11992	1985	14118	1618	16746	989	21346	197	20136
27-#10	3.78	7138	2614	8929	2431	12183	2013	14352	1638	17089	999	21877	182	20793
28-#10	3.92	7230	2652	9098	2459	12392	2039	14610	1658	17460	1006	22429	163	21427

ROUND TIED COLUMNS 36" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.57	6558	2271	7167	2208	10044	1833	11636	1515	13016	1033	15163	453	12277
5-#14	1.11	6530	2131	7015	2081	9613	1739	10966	1447	11944	1004	13629	563	8392
5-#18	1.96	7085	2388	8492	2246	11315	1864	12933	1528	14487	998	17055	405	13807
6-#14	1.33	6586	2197	8085	2035	10526	1678	11806	1382	12851	935	14190	455	9970
6-#18	2.36	7179	2506	9825	2222	12633	1812	14301	1464	16161	918	18176	236	16695
7-#11	1.07	6512	2121	6640	2108	9357	1764	10809	1474	11903	1033	13691	593	8295
7-#14	1.55	6839	2263	7438	2202	10297	1836	11910	1523	13338	1035	15666	512	11313
7-#18	2.75	7624	2624	9377	2443	12605	2020	14629	1647	16879	1040	20523	302	18508
8-#11	1.23	6603	2167	6603	2167	9518	1816	11124	1520	12359	1061	14366	580	9232
8-#14	1.77	6963	2329	7483	2278	10587	1901	12390	1580	13979	1068	16586	487	12784
8-#18	3.14	7793	2741	9632	2562	13220	2120	15524	1734	17973	1083	22037	243	20786
9-#10	1.12	6568	2136	6568	2136	9380	1793	10906	1502	12083	1050	14106	601	8676
9-#11	1.38	6729	2213	7038	2182	9918	1825	11498	1523	12823	1046	15095	551	10340
9-#14	1.99	7136	2396	8047	2305	11124	1920	12901	1588	14655	1051	17639	448	14099
9-#18	3.54	8101	2859	10510	2619	14091	2162	16359	1754	19188	1062	23874	177	22772
10-#10	1.25	6682	2173	7110	2130	9863	1783	11340	1483	12513	1022	14491	558	9445
10-#11	1.53	6863	2259	7652	2180	10455	1819	12002	1504	13346	1016	15609	504	11259
10-#14	2.21	7314	2462	8797	2315	11809	1923	13585	1573	15410	1017	18448	388	15529
10-#18	3.93	8377	2977	11604	2660	15131	2188	17487	1747	20515	1017	25365	80	24911
11-#10	1.37	6765	2211	6881	2199	9832	1841	11468	1538	12879	1061	15277	566	10360
11-#11	1.69	6962	2305	7453	2256	10469	1883	12186	1565	13781	1058	16494	506	12311
11-#14	2.43	7459	2528	8661	2410	11920	2001	13891	1647	16016	1066	19611	380	16786
11-#18	4.32	8638	3095	11618	2802	15488	2301	18106	1856	21537	1084	27236	49	26931
12-#10	1.50	6898	2248	6995	2239	9993	1876	11710	1562	13237	1074	15846	556	11120
12-#11	1.84	7118	2351	7613	2303	10677	1923	12483	1592	14222	1072	17169	491	13231
12-#14	2.65	7666	2594	8923	2472	12238	2054	14326	1683	16651	1084	20553	355	18184
12-#18	4.72	8993	3212	12126	2903	16078	2388	18876	1912	22668	1112	29006	20	28894
13-#10	1.62	6958	2286	7261	2256	10297	1888	12056	1573	13651	1069	16430	531	12005
13-#11	1.99	7189	2396	7918	2324	11039	1940	12896	1607	14722	1067	17901	464	14232
13-#14	2.87	7780	2660	9333	2506	12742	2081	14905	1706	17363	1079	21629	319	19391
13-#18	5.11	9197	3330	12715	2978	16940	2441	19864	1956	23902	1104	30687	-68	30506
14-#10	1.75	7058	2323	7627	2266	10656	1891	12424	1566	14118	1058	16878	504	12752
14-#11	2.15	7308	2442	8323	2340	11450	1946	13336	1602	15296	1056	18451	431	15156
14-#14	3.09	7964	2727	9843	2536	13288	2097	15520	1706	18174	1066	22435	274	20778
14-#18	5.50	9554	3448	13569	3033	17819	2480	20922	1968	25273	1086	32215	-138	31778
15-#10	1.87	7134	2360	7616	2313	10777	1934	12627	1605	14439	1078	17563	493	13609
15-#11	2.30	7397	2488	8354	2394	11621	1996	13593	1646	15671	1077	19256	415	16094
15-#14	3.32	8070	2793	9965	2607	13574	2161	15905	1762	18713	1091	23544	246	21890
15-#18	5.89	9731	3566	13921	3147	18387	2580	21621	2055	26234	1121	34047	-198	33388

ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.00	7227	2398	7727	2348	10993	1957	12904	1626	14817	1088	18179	488	14333
16-#11	2.45	7507	2534	8499	2436	11893	2023	13936	1672	16126	1088	20018	409	17021
16-#14	3.54	8225	2859	10193	2665	13979	2198	16406	1797	19359	1105	24588	233	23127
16-#18	6.29	10054	3683	14353	3246	19130	2643	22521	2115	27347	1142	35731	-235	35054
17-#10	2.12	7320	2435	7984	2371	11264	1976	13224	1636	15219	1085	18697	458	15155
17-#11	2.61	7617	2580	8804	2465	12214	2047	14318	1683	16622	1085	20616	369	17928
17-#14	3.76	8376	2925	10613	2708	14427	2234	16939	1815	20075	1103	25470	177	24335
18-#10	2.25	7401	2472	8335	2381	11609	1984	13580	1641	15638	1076	19199	435	15904
18-#11	2.76	7712	2626	9206	2480	12622	2059	14736	1691	17128	1076	21224	342	18871
18-#14	3.98	8511	2992	11145	2733	14988	2256	17522	1829	20799	1091	26345	140	25489
19-#10	2.37	7512	2510	8382	2425	11745	2021	13802	1668	16003	1092	19830	422	16684
19-#11	2.91	7843	2672	9286	2531	12801	2102	15017	1722	17566	1093	22017	328	19737
19-#14	4.20	8692	3058	11304	2803	15268	2313	17941	1870	21418	1113	27452	116	26748
20-#10	2.50	7583	2547	8541	2455	11981	2048	14066	1689	16385	1101	20401	408	17433
20-#11	3.07	7928	2718	9488	2567	13085	2133	15338	1747	18036	1104	22680	307	20690
20-#14	4.42	8824	3124	11608	2854	15676	2355	18402	1904	22096	1127	28413	87	27897
21-#10	2.62	7687	2585	8751	2482	12224	2066	14389	1700	16788	1099	20977	388	18179
21-#11	3.22	8057	2764	9736	2600	13380	2156	15732	1762	18522	1102	23373	282	21501
21-#14	4.64	9001	3190	11950	2902	16095	2390	18962	1927	22783	1125	29392	49	29120
22-#10	2.74	7775	2622	9045	2500	12539	2077	14716	1707	17226	1096	21523	364	18933
22-#11	3.37	8155	2810	10079	2624	13750	2171	16122	1771	19040	1097	24003	250	22378
22-#14	4.86	9129	3256	12414	2939	16604	2414	19513	1943	23517	1119	30271	3	30253
23-#10	2.87	7866	2659	9154	2536	12722	2108	14971	1732	17569	1106	22106	351	19663
23-#11	3.52	8266	2856	10226	2666	13986	2207	16434	1800	19463	1109	24725	234	23220
24-#10	2.99	7962	2697	9307	2569	12929	2134	15246	1753	17948	1113	22667	331	20431
24-#11	3.68	8378	2902	10419	2707	14238	2238	16773	1825	19920	1117	25394	209	24070
25-#10	3.12	8051	2734	9528	2592	13207	2152	15557	1764	18357	1113	23242	314	21136
25-#11	3.83	8485	2947	10680	2736	14572	2261	17148	1840	20418	1117	26121	191	24929
26-#10	3.24	8152	2771	9830	2610	13484	2168	15898	1776	18768	1110	23819	293	21879
26-#11	3.98	8614	2993	11033	2758	14903	2282	17549	1853	20919	1114	26807	164	25763
27-#10	3.37	8234	2809	9930	2646	13686	2196	16143	1796	19136	1120	24398	279	22563
27-#11	4.14	8708	3039	11168	2801	15154	2315	17854	1878	21362	1125	27485	144	26623
28-#10	3.49	8336	2846	10110	2675	13906	2222	16419	1816	19529	1127	25008	262	23267
29-#10	3.62	8410	2884	10305	2702	14170	2241	16728	1828	19925	1127	25523	241	23980
30-#10	3.74	8501	2921	10557	2723	14454	2259	17045	1839	20342	1126	26077	216	24670

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 12" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.10	274	286	385	240	444	196	463	162	452	109	448	44	303
4-#6	1.56	278	301	405	248	467	201	489	166	483	106	481	25	407
4-#7	2.12	283	320	428	258	493	208	519	169	520	102	520	2	517
4-#8	2.79	288	342	455	270	524	216	553	174	562	97	565	-26	569
4-#9	3.54	296	366	483	283	557	224	588	178	606	91	610	-59	617
4-#10	4.49	304	397	517	300	598	236	631	184	660	84	664	-102	673
4-#11	5.52	307	431	550	314	623	240	657	183	690	68	680	-155	699
4-#14	7.96	325	511	626	356	701	264	745	192	800	41	805	-260	806
5-#5	1.37	283	295	408	241	464	196	481	160	471	102	466	37	350
5-#6	1.95	290	314	433	252	492	203	512	163	510	98	508	16	461
5-#7	2.65	299	337	462	265	526	211	550	167	557	92	558	-10	563
5-#8	3.49	311	364	495	280	564	222	592	172	610	85	613	-41	631
5-#9	4.42	322	395	530	298	604	232	637	177	666	77	669	-77	699
5-#10	5.61	336	434	574	320	652	246	691	182	734	66	735	-124	778
5-#11	6.90	342	476	610	338	682	252	723	180	773	44	771	-181	807
6-#5	1.64	285	304	438	237	487	190	499	153	490	93	471	18	410
6-#6	2.33	293	326	469	249	521	197	538	156	539	86	520	-8	525
6-#7	3.18	303	354	507	264	562	206	585	160	597	78	591	-37	592
6-#8	4.19	315	387	549	283	609	217	638	165	664	68	658	-76	665
6-#9	5.31	327	424	591	302	658	228	693	169	734	56	727	-120	737
6-#10	6.74	343	471	643	327	717	242	761	174	820	39	808	-177	823
7-#5	1.92	290	313	428	255	489	207	513	167	514	102	521	23	457
7-#6	2.72	300	339	462	271	528	217	557	173	569	97	583	-5	585
7-#7	3.71	314	372	502	290	575	231	609	179	634	90	654	-40	666
7-#8	4.89	328	410	548	312	628	246	669	187	709	81	734	-82	756
7-#9	6.19	344	453	596	337	683	262	730	194	787	70	815	-131	836
8-#5	2.19	295	322	433	265	500	214	528	173	535	104	551	15	514
8-#6	3.11	308	352	470	283	544	226	579	180	598	99	623	-16	629
8-#7	4.24	323	389	515	306	596	241	638	189	672	92	706	-57	712
8-#8	5.59	341	433	565	333	656	259	706	198	757	83	798	-106	810

ROUND TIED COLUMNS 14" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.14	440	391	599	337	708	276	748	229	748	156	757	67	507
4-#7	1.56	447	410	630	347	743	283	788	234	798	153	814	47	662
4-#8	2.05	456	432	665	360	783	291	835	240	857	150	880	22	835
4-#9	2.60	464	456	702	373	826	301	886	246	918	146	948	-6	949
4-#10	3.30	476	487	748	391	880	313	949	253	995	141	1032	-43	1034
4-#11	4.05	485	521	796	405	930	321	999	256	1048	128	1076	-96	1081
4-#14	5.85	511	601	900	450	1054	351	1133	272	1215	110	1245	-203	1248
5-#5	1.01	447	385	609	329	707	269	741	222	729	151	734	76	442
5-#6	1.43	458	404	642	340	745	276	784	227	783	148	796	58	584
5-#7	1.95	471	427	680	353	790	286	836	232	847	143	868	35	750
5-#8	2.57	487	455	725	369	842	297	896	239	921	138	952	8	932
5-#9	3.25	503	485	772	387	897	309	960	245	1000	132	1038	-24	1048
5-#10	4.13	525	524	831	410	967	324	1038	253	1097	124	1144	-66	1167
5-#11	5.07	538	566	887	429	1027	336	1094	255	1165	107	1197	-124	1240
5-#14	7.31	584	666	1018	487	1175	372	1261	271	1376	80	1407	-242	1441
6-#5	1.21	448	394	654	320	743	261	769	214	753	139	739	55	512
6-#6	1.71	460	417	695	333	792	269	823	218	820	134	810	31	689
6-#7	2.34	474	445	743	348	850	280	887	223	901	128	893	0	893
6-#8	3.08	491	478	799	367	915	292	961	230	993	120	989	-37	1000
6-#9	3.90	509	514	859	388	983	305	1039	236	1092	110	1088	-78	1107
6-#10	4.95	531	561	934	414	1069	321	1136	244	1214	98	1209	-132	1234
6-#11	6.08	546	612	1005	439	1132	332	1205	244	1299	76	1315	-190	1313

ROUND TIED COLUMNS 14" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
7-#5	1.41	456	403	630	344	740	282	782	231	787	152	808	63	582
7-#6	2.00	471	429	676	360	792	293	842	238	862	149	895	39	768
7-#7	2.73	489	462	729	380	854	307	913	246	951	144	998	8	977
7-#8	3.59	509	501	791	403	925	324	996	256	1055	138	1115	-30	1127
7-#9	4.55	531	543	857	429	1001	342	1085	267	1164	131	1250	-69	1260
7-#10	5.78	562	598	940	463	1096	365	1195	280	1300	120	1403	-125	1414
7-#11	7.09	581	657	1014	491	1175	383	1274	284	1396	99	1484	-203	1496
8-#5	1.61	463	412	636	356	753	290	801	237	816	156	854	59	649
8-#6	2.29	480	442	687	375	812	304	869	247	901	152	957	32	867
8-#7	3.12	500	479	746	399	881	320	949	257	1003	148	1079	-3	1080
8-#8	4.11	524	523	815	426	961	340	1042	269	1120	142	1217	-45	1209
8-#9	5.20	549	572	887	457	1047	361	1141	282	1244	135	1362	-94	1353
8-#10	6.60	584	635	977	496	1154	388	1266	298	1399	125	1538	-158	1526

ROUND TIED COLUMNS 16" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.19	664	514	881	452	1060	371	1133	305	1149	210	1188	95	798
4-#8	1.57	675	536	924	464	1110	379	1190	310	1225	208	1276	72	1015
4-#9	1.99	687	560	971	478	1164	389	1253	315	1307	206	1368	47	1241
4-#10	2.53	702	592	1029	496	1232	401	1332	322	1409	203	1483	14	1456
4-#11	3.10	712	625	1093	510	1298	410	1403	333	1485	193	1556	-32	1556
4-#14	4.48	746	705	1226	556	1455	441	1589	354	1711	180	1802	-127	1793
4-#18	7.96	841	908	1535	672	1826	519	2008	400	2219	138	2333	-390	2289
5-#6	1.09	676	508	903	442	1068	362	1130	298	1133	204	1162	103	711
5-#7	1.49	694	531	952	455	1124	372	1194	305	1215	201	1259	83	917
5-#8	1.96	713	559	1008	472	1189	383	1270	312	1310	197	1371	58	1148
5-#9	2.49	734	589	1068	490	1259	396	1351	320	1411	192	1489	30	1393
5-#10	3.16	761	628	1142	514	1346	412	1453	330	1539	186	1635	-7	1638
5-#11	3.88	781	670	1218	534	1427	424	1542	335	1636	173	1727	-58	1748
5-#14	5.60	844	770	1388	593	1629	465	1772	357	1922	152	2037	-165	2078
6-#6	1.31	679	521	979	430	1128	350	1185	289	1177	188	1175	76	832
6-#7	1.79	697	549	1039	446	1200	361	1267	295	1280	183	1288	48	1086
6-#8	2.36	718	582	1108	465	1283	374	1362	302	1399	176	1417	14	1373
6-#9	2.98	741	618	1182	485	1374	388	1464	310	1527	169	1552	-25	1558
6-#10	3.79	772	665	1275	512	1487	407	1591	320	1686	159	1721	-76	1733
6-#11	4.66	793	716	1368	537	1587	421	1690	323	1809	141	1827	-143	1850
6-#14	6.71	860	836	1586	606	1836	464	1974	344	2166	109	2182	-281	2208
7-#5	1.08	674	507	884	448	1059	369	1128	305	1135	209	1177	109	712
7-#6	1.53	694	534	940	463	1124	381	1202	312	1230	206	1292	87	943
7-#7	2.09	717	566	1006	483	1202	395	1291	320	1346	203	1429	59	1212
7-#8	2.75	744	605	1083	507	1292	413	1395	330	1479	199	1587	25	1510
7-#9	3.48	773	647	1166	534	1388	432	1507	344	1621	194	1754	-13	1758
7-#10	4.42	810	702	1269	568	1509	457	1647	359	1798	187	1960	-64	1975
7-#11	5.43	840	761	1373	598	1617	476	1768	368	1936	171	2093	-133	2123
7-#14	7.83	927	901	1613	684	1893	536	2091	402	2334	145	2564	-270	2533
8-#5	1.23	682	516	885	460	1075	379	1151	312	1170	213	1228	104	786
8-#6	1.75	704	546	948	479	1148	393	1234	321	1277	211	1359	78	1055
8-#7	2.39	731	583	1023	503	1235	410	1335	331	1407	209	1516	46	1371
8-#8	3.14	761	628	1109	532	1336	431	1452	343	1558	205	1696	7	1685
8-#9	3.98	794	676	1202	564	1445	453	1578	356	1721	201	1886	-37	1891
8-#10	5.05	835	739	1320	605	1581	482	1736	373	1924	195	2159	-86	2126
8-#11	6.21	871	806	1433	642	1701	505	1871	392	2082	178	2321	-165	2288
9-#10	5.68	865	776	1393	622	1670	497	1846	387	2056	186	2297	-119	2287
9-#11	6.98	906	851	1519	663	1811	525	1998	400	2235	166	2475	-206	2455
10-#10	6.32	905	813	1484	638	1772	501	1963	388	2201	171	2429	-163	2402

ROUND TIED COLUMNS 18" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.24	954	654	1239	583	1515	479	1632	395	1673	272	1763	126	1193
4-#9	1.57	969	678	1296	597	1580	489	1707	401	1771	271	1880	103	1467
4-#10	2.00	989	710	1366	615	1661	502	1801	408	1894	268	2026	73	1804
4-#11	2.45	1003	743	1447	629	1743	510	1890	411	2005	261	2130	31	2062
4-#14	3.54	1047	823	1609	676	1935	542	2114	429	2297	253	2455	-55	2447
4-#18	6.29	1167	1026	1990	794	2390	624	2651	495	2955	223	3183	-290	3113
5-#7	1.18	974	649	1283	572	1537	469	1640	387	1665	264	1739	134	1087
5-#8	1.55	999	677	1351	589	1616	481	1730	393	1782	261	1880	112	1366
5-#9	1.96	1026	707	1423	607	1700	494	1828	401	1910	258	2031	86	1660
5-#10	2.50	1059	746	1514	631	1806	511	1951	411	2069	254	2219	52	2025
5-#11	3.07	1085	788	1610	651	1908	523	2064	420	2197	242	2352	6	2334
5-#14	4.42	1160	889	1820	712	2157	565	2355	445	2559	227	2765	-90	2786
5-#18	7.86	1345	1142	2310	865	2742	670	3038	506	3394	178	3681	-354	3655
6-#6	1.04	957	639	1329	541	1548	443	1629	367	1620	248	1628	124	975
6-#7	1.41	980	667	1400	557	1633	454	1729	374	1746	244	1769	98	1279
6-#8	1.86	1006	700	1482	576	1732	467	1846	382	1892	239	1932	67	1624
6-#9	2.36	1035	736	1571	597	1839	481	1974	392	2049	233	2105	32	1989
6-#10	2.99	1070	783	1683	624	1975	500	2136	404	2246	225	2322	-15	2324
6-#11	3.68	1102	834	1799	648	2106	516	2267	409	2408	209	2476	-77	2487
6-#14	5.31	1185	954	2064	718	2430	564	2627	434	2861	183	2951	-208	2956
7-#6	1.21	975	652	1261	581	1533	480	1649	396	1682	271	1780	139	1124
7-#7	1.65	1005	684	1341	601	1625	494	1756	405	1820	268	1952	113	1446
7-#8	2.17	1039	723	1433	625	1734	512	1881	416	1982	265	2152	83	1811
7-#9	2.75	1076	765	1532	652	1851	532	2016	428	2157	262	2364	48	2197
7-#10	3.49	1121	820	1656	686	1998	558	2187	444	2378	258	2628	2	2623
7-#11	4.29	1156	879	1787	717	2139	579	2340	453	2566	245	2820	-61	2833
7-#14	6.19	1270	1019	2079	805	2481	642	2739	496	3070	227	3403	-192	3416
8-#6	1.38	988	664	1264	599	1561	494	1687	407	1739	277	1864	132	1247
8-#7	1.89	1021	702	1353	623	1667	512	1808	418	1895	275	2060	103	1625
8-#8	2.48	1059	746	1456	652	1789	533	1949	431	2077	273	2287	68	2055
8-#9	3.14	1099	794	1567	684	1921	556	2102	445	2274	270	2529	27	2449
8-#10	3.99	1150	857	1707	725	2087	586	2294	464	2522	266	2831	-26	2831
8-#11	4.90	1191	924	1855	764	2241	611	2466	476	2739	255	3052	-99	3053
8-#14	7.07	1310	1084	2187	869	2626	684	2915	519	3317	239	3792	-234	3692
9-#10	4.49	1188	894	1805	743	2187	600	2423	473	2689	259	3052	-48	3036
9-#11	5.52	1235	969	1964	785	2363	629	2623	488	2934	245	3306	-126	3287
10-#10	4.99	1227	931	1922	758	2315	603	2560	468	2876	246	3216	-89	3212
10-#11	6.13	1290	1015	2094	805	2510	634	2785	493	3141	227	3497	-179	3448
11-#10	5.49	1258	967	1953	797	2386	642	2657	500	3002	259	3449	-103	3437
11-#11	6.74	1322	1060	2142	851	2597	679	2899	520	3308	247	3761	-198	3727
12-#10	5.99	1310	1004	2033	822	2470	663	2775	517	3152	265	3661	-126	3640

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 20" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.01	1299	786	1616	717	2006	592	2171	491	2220	344	2354	185	1370
4-#9	1.27	1318	810	1682	731	2082	601	2258	496	2333	343	2496	163	1692
4-#10	1.62	1342	842	1764	749	2177	614	2367	504	2476	341	2674	135	2091
4-#11	1.99	1361	875	1863	763	2276	622	2474	507	2608	334	2808	96	2477
4-#14	2.86	1415	955	2056	810	2502	655	2738	525	2956	328	3214	17	3175
4-#18	5.09	1547	1158	2510	930	3043	739	3374	573	3794	311	4144	-198	4073
5-#8	1.26	1352	809	1759	719	2131	591	2289	487	2347	332	2491	169	1587
5-#9	1.59	1384	839	1845	738	2230	604	2404	495	2495	329	2674	145	1933
5-#10	2.02	1424	878	1952	762	2355	621	2548	505	2684	326	2904	114	2362
5-#11	2.48	1456	920	2070	782	2479	634	2684	510	2854	317	3079	71	2781
5-#14	3.58	1547	1020	2320	844	2774	677	3029	541	3296	306	3599	-16	3603
5-#18	6.37	1772	1274	2910	1000	3477	786	3854	607	4325	268	4779	-257	4723
6-#7	1.15	1328	799	1834	682	2158	558	2287	462	2308	312	2347	153	1472
6-#8	1.51	1361	832	1930	700	2273	571	2423	471	2481	308	2545	124	1876
6-#9	1.91	1395	868	2034	721	2398	586	2571	480	2668	303	2757	91	2305
6-#10	2.43	1438	915	2165	749	2556	605	2759	492	2904	296	3022	48	2837
6-#11	2.98	1473	966	2304	773	2713	620	2938	501	3105	282	3225	-10	3226
6-#14	4.30	1580	1086	2616	843	3093	669	3383	531	3654	261	3823	-131	3820
6-#18	7.64	1824	1390	3360	1021	4009	792	4404	597	4941	197	5177	-460	5105
7-#7	1.34	1359	816	1738	734	2136	606	2318	501	2393	340	2578	172	1688
7-#8	1.76	1400	855	1846	758	2262	624	2465	512	2582	338	2819	143	2118
7-#9	2.23	1444	897	1962	785	2399	644	2624	525	2787	336	3077	111	2572
7-#10	2.83	1501	952	2107	819	2571	670	2825	541	3047	332	3402	68	3135
7-#11	3.48	1545	1011	2265	850	2743	692	3011	551	3281	322	3653	11	3614
7-#14	5.01	1674	1151	2610	939	3155	758	3487	590	3899	310	4385	-109	4387
8-#7	1.53	1378	833	1744	757	2182	625	2378	515	2481	349	2709	164	1882
8-#8	2.01	1423	878	1863	785	2327	647	2544	529	2694	347	2983	131	2386
8-#9	2.55	1472	926	1993	818	2484	671	2723	544	2925	346	3278	93	2922
8-#10	3.23	1533	989	2156	859	2680	702	2950	563	3218	344	3647	44	3502
8-#11	3.97	1584	1056	2334	898	2868	727	3159	576	3481	334	3935	-22	3935
8-#14	5.73	1726	1216	2723	1004	3329	804	3696	623	4176	324	4770	-161	4740
9-#10	3.64	1576	1026	2277	877	2791	714	3093	571	3415	336	3889	19	3823
9-#11	4.47	1638	1101	2472	921	3004	744	3335	587	3713	325	4245	-49	4219
9-#14	6.45	1805	1281	2905	1038	3524	830	3950	641	4503	311	5200	-199	5112
10-#10	4.04	1624	1062	2427	891	2946	716	3256	565	3623	322	4107	-16	4106
10-#11	4.97	1691	1147	2635	939	3183	748	3526	582	3973	309	4475	-98	4465
10-#14	7.16	1891	1347	3117	1068	3766	840	4216	649	4864	290	5528	-270	5390
11-#10	4.45	1661	1099	2447	932	3018	756	3368	600	3784	339	4392	-28	4389
11-#11	5.46	1735	1192	2675	987	3279	796	3660	622	4148	326	4801	-115	4781
12-#10	4.85	1716	1136	2538	958	3116	779	3497	617	3961	346	4648	-47	4637
12-#11	5.96	1806	1237	2786	1018	3396	822	3821	642	4357	333	5097	-142	5062
13-#10	5.26	1746	1173	2636	983	3251	794	3643	629	4145	340	4872	-80	4848
14-#10	5.66	1792	1210	2766	998	3390	807	3811	632	4342	330	5084	-111	5050

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 22" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.05	1740	956	2135	879	2679	726	2916	602	3004	423	3226	228	1916
4-#10	1.34	1770	987	2230	897	2788	739	3042	610	3168	421	3436	201	2376
4-#11	1.64	1793	1021	2347	911	2905	747	3166	613	3320	414	3602	165	2830
4-#14	2.37	1859	1101	2571	958	3166	780	3469	632	3719	410	4089	91	3843
4-#18	4.21	2016	1304	3100	1080	3793	866	4205	681	4692	396	5224	-108	5174
5-#8	1.04	1777	955	2239	864	2745	713	2957	590	3020	410	3214	231	1814
5-#9	1.32	1815	985	2339	883	2859	726	3088	598	3190	407	3431	209	2212
5-#10	1.67	1863	1024	2463	908	3003	743	3254	609	3405	405	3703	180	2706
5-#11	2.05	1903	1066	2603	927	3149	756	3413	614	3604	396	3920	140	3195
5-#14	2.96	2011	1166	2895	990	3492	800	3812	640	4125	388	4547	58	4320
5-#18	5.26	2265	1420	3586	1148	4313	912	4774	716	5368	361	5998	-164	5989
6-#8	1.25	1789	978	2459	839	2916	687	3109	568	3178	383	3266	184	2128
6-#9	1.58	1829	1014	2578	860	3059	701	3278	578	3395	379	3516	153	2622
6-#10	2.00	1880	1061	2728	887	3240	720	3492	590	3669	373	3831	112	3235
6-#11	2.46	1923	1111	2891	911	3422	736	3699	599	3910	361	4084	58	3840
6-#14	3.55	2040	1231	3250	981	3859	785	4220	631	4558	343	4807	-54	4804
6-#18	6.31	2338	1536	4113	1161	4919	910	5469	709	6091	290	6475	-360	6382
7-#7	1.10	1787	962	2205	881	2744	729	2985	606	3076	420	3317	235	1937
7-#8	1.45	1836	1000	2328	905	2887	747	3153	617	3292	418	3600	208	2431
7-#9	1.84	1888	1043	2461	932	3044	768	3336	630	3527	417	3905	178	2957
7-#10	2.34	1953	1098	2629	967	3241	794	3569	647	3826	414	4289	138	3606
7-#11	2.87	2010	1157	2814	998	3442	816	3791	659	4100	405	4601	84	4244
7-#14	4.14	2162	1297	3213	1087	3917	883	4344	700	4817	396	5485	-27	5485
7-#18	7.37	2532	1652	4169	1313	5064	1052	5670	801	6543	367	7525	-331	7420
8-#7	1.26	1807	979	2201	905	2789	750	3056	622	3178	430	3472	229	2143
8-#8	1.66	1862	1023	2338	934	2954	772	3246	637	3421	429	3795	198	2721
8-#9	2.10	1920	1072	2486	966	3133	796	3453	652	3687	428	4142	163	3339
8-#10	2.67	1991	1135	2673	1008	3361	828	3714	672	4023	427	4579	117	4109
8-#11	3.28	2053	1202	2880	1046	3592	855	3961	686	4333	419	4936	55	4739
8-#14	4.74	2220	1362	3328	1153	4130	934	4585	736	5140	412	5942	-73	5924
9-#10	3.01	2042	1171	2816	1025	3493	840	3870	678	4250	420	4862	92	4464
9-#11	3.69	2113	1247	3044	1069	3743	870	4154	696	4602	410	5269	24	5177
9-#14	5.33	2312	1427	3548	1187	4343	958	4863	752	5520	401	6454	-110	6384
10-#10	3.34	2096	1208	3004	1038	3677	840	4060	671	4476	403	5114	59	4888
10-#11	4.10	2176	1292	3250	1086	3954	873	4377	689	4884	392	5569	-17	5567
10-#14	5.92	2394	1492	3809	1217	4630	967	5174	746	5935	379	6840	-177	6696
11-#10	3.68	2140	1245	3010	1081	3747	883	4187	709	4663	423	5452	49	5243
11-#11	4.51	2228	1338	3277	1136	4051	922	4530	732	5103	414	5959	-33	5953
11-#14	6.51	2476	1558	3879	1283	4784	1033	5391	802	6228	404	7366	-203	7222
12-#10	4.01	2203	1282	3111	1109	3856	906	4327	726	4881	434	5752	32	5629
12-#11	4.92	2303	1383	3401	1169	4183	950	4704	752	5349	423	6308	-56	6291
13-#10	4.34	2240	1319	3221	1133	4013	922	4496	738	5079	426	6015	0	6015
13-#11	5.33	2346	1428	3533	1199	4368	969	4903	767	5596	415	6616	-96	6579
14-#10	4.68	2293	1356	3376	1147	4170	933	4693	741	5306	416	6263	-29	6252
14-#11	5.75	2408	1473	3710	1217	4556	984	5135	771	5865	404	6908	-133	6856
15-#10	5.01	2327	1392	3424	1188	4270	964	4811	768	5507	433	6602	-45	6555
16-#10	5.35	2374	1429	3513	1216	4393	991	4960	783	5699	435	6871	-66	6838

ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.12	2278	1147	2769	1060	3504	876	3834	727	3979	509	4324	272	2660
4-#11	1.38	2306	1181	2905	1074	3639	884	3976	729	4152	502	4522	237	3180
4-#14	1.99	2384	1261	3160	1121	3935	918	4319	749	4602	498	5091	168	4389
4-#18	3.54	2569	1464	3766	1243	4649	1004	5155	800	5705	487	6433	-18	6423
5-#9	1.11	2328	1145	2909	1042	3596	860	3891	712	4004	493	4311	277	2495
5-#10	1.40	2383	1184	3050	1067	3758	877	4079	723	4247	491	4626	249	3055
5-#11	1.72	2431	1226	3216	1087	3927	890	4262	728	4474	483	4885	211	3616
5-#14	2.49	2556	1326	3550	1150	4318	935	4716	755	5065	476	5621	135	4928
5-#18	4.42	2851	1580	4344	1310	5258	1049	5815	823	6504	455	7345	-72	7338
6-#8	1.05	2298	1137	3075	991	3672	814	3916	672	3989	465	4106	248	2380
6-#9	1.33	2345	1174	3210	1012	3833	828	4105	680	4240	461	4395	219	2939
6-#10	1.68	2404	1221	3379	1039	4036	847	4346	691	4553	457	4760	180	3635
6-#11	2.07	2455	1271	3567	1063	4244	863	4582	707	4834	445	5063	129	4329
6-#14	2.98	2591	1391	3974	1133	4739	912	5170	739	5580	430	5912	23	5830
6-#18	5.31	2938	1696	4956	1314	5941	1038	6605	821	7362	386	7898	-264	7807
7-#8	1.22	2352	1160	2886	1066	3619	883	3959	733	4122	506	4507	277	2752
7-#9	1.55	2413	1203	3037	1093	3795	903	4165	746	4387	505	4859	249	3349
7-#10	1.97	2489	1258	3226	1128	4017	930	4427	763	4725	503	5303	211	4088
7-#11	2.41	2554	1316	3440	1159	4248	952	4685	776	5040	495	5676	160	4820
7-#14	3.48	2734	1456	3894	1249	4786	1019	5321	819	5856	488	6712	56	6463
7-#18	6.19	3162	1811	4983	1477	6091	1191	6843	925	7833	466	9138	-227	9055
8-#8	1.40	2381	1183	2884	1097	3685	909	4067	755	4269	519	4722	268	3060
8-#9	1.77	2448	1232	3051	1129	3887	934	4300	771	4569	518	5126	236	3759
8-#10	2.25	2532	1294	3262	1171	4142	965	4596	791	4949	518	5638	193	4631
8-#11	2.76	2604	1362	3500	1209	4409	993	4882	806	5305	511	6065	135	5497
8-#14	3.98	2797	1522	4007	1316	5030	1075	5594	857	6225	507	7244	15	7188
8-#18	7.07	3263	1927	5231	1590	6511	1277	7310	983	8449	491	10006	-313	9826
9-#10	2.53	2591	1331	3430	1188	4300	977	4767	796	5200	510	5962	168	5069
9-#11	3.10	2673	1407	3692	1231	4587	1008	5091	814	5612	502	6448	104	5965
9-#14	4.48	2897	1587	4263	1350	5269	1097	5896	871	6659	496	7786	-29	7779
9-#18	7.96	3454	2043	5641	1654	6918	1323	7848	1014	9188	472	11001	-376	10628
10-#10	2.81	2651	1368	3657	1198	4515	975	4984	787	5449	491	6245	136	5599
10-#11	3.45	2745	1452	3945	1247	4834	1009	5347	806	5915	481	6790	64	6523
10-#14	4.97	2994	1652	4582	1379	5602	1104	6253	865	7107	471	8280	-85	8149
11-#10	3.09	2702	1405	3647	1245	4581	1021	5122	828	5663	514	6640	128	6015
11-#11	3.79	2805	1497	3954	1300	4929	1061	5518	852	6166	506	7245	51	7005
11-#14	5.47	3081	1717	4637	1448	5759	1173	6498	924	7451	501	8896	-109	8845
12-#10	3.37	2772	1442	3756	1274	4702	1046	5275	845	5907	525	6984	113	6490
12-#11	4.14	2888	1542	4090	1334	5076	1090	5705	872	6462	519	7648	31	7518
12-#14	5.97	3206	1783	4840	1494	5972	1212	6771	953	7853	516	9456	-141	9370
13-#10	3.65	2813	1478	3881	1297	4881	1061	5467	858	6135	519	7287	82	6896
13-#11	4.48	2941	1588	4238	1363	5288	1109	5933	887	6727	510	8005	-8	8002
13-#14	6.47	3274	1848	5045	1539	6267	1241	7090	975	8240	504	9955	-197	9805
14-#10	3.93	2878	1515	4062	1310	5057	1070	5685	859	6390	509	7569	54	7332
14-#11	4.83	3012	1633	4445	1380	5497	1122	6198	891	7032	498	8340	-43	8321

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#10	4.21	2915	1552	4105	1353	5165	1103	5824	888	6605	522	7934	35	7771
15-#11	5.17	3057	1678	4511	1431	5632	1161	6357	924	7302	518	8797	-62	8724
16-#10	4.49	2969	1589	4203	1381	5298	1130	5992	905	6826	528	8270	21	8179
16-#11	5.52	3122	1723	4630	1465	5797	1194	6559	943	7559	520	9160	-88	9106
17-#10	4.77	3023	1626	4347	1404	5458	1146	6170	917	7077	529	8604	-7	8600
18-#10	5.05	3070	1662	4492	1424	5633	1161	6368	921	7336	521	8875	-35	8852

ROUND TIED COLUMNS 26" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.18	2907	1354	3543	1251	4487	1033	4915	856	5116	598	5578	314	3529
4-#14	1.70	2998	1434	3830	1298	4819	1067	5298	876	5617	594	6231	249	4896
4-#18	3.01	3212	1637	4512	1421	5621	1154	6234	928	6849	585	7783	73	7572
5-#10	1.20	2991	1357	3722	1240	4631	1023	5034	847	5219	584	5654	319	3411
5-#11	1.47	3047	1399	3912	1260	4823	1036	5241	853	5474	576	5986	287	4043
5-#14	2.12	3191	1499	4291	1323	5262	1081	5750	880	6136	570	6831	215	5520
5-#18	3.77	3530	1753	5189	1485	6322	1197	6986	950	7752	553	8831	20	8743
6-#9	1.13	2949	1347	3937	1178	4728	967	5065	798	5197	549	5404	289	3257
6-#10	1.44	3016	1394	4126	1205	4954	986	5332	809	5552	546	5819	253	4035
6-#11	1.76	3075	1445	4339	1228	5189	1001	5597	815	5887	536	6172	204	4819
6-#14	2.54	3232	1565	4795	1299	5741	1051	6252	856	6732	524	7149	103	6652
6-#18	4.52	3604	1869	5897	1480	7087	1178	7857	940	8765	486	9456	-169	9386
7-#9	1.32	3026	1376	3694	1269	4661	1052	5123	872	5378	600	5948	324	3751
7-#10	1.67	3113	1431	3905	1304	4908	1078	5414	889	5755	599	6454	289	4583
7-#11	2.06	3189	1490	4149	1335	5169	1100	5705	902	6111	591	6888	240	5408
7-#14	2.97	3391	1630	4657	1425	5771	1168	6416	946	7027	586	8078	142	7358
7-#18	5.27	3884	1985	5883	1654	7235	1341	8147	1057	9256	570	10893	-125	10839
8-#9	1.51	3064	1405	3695	1308	4753	1084	5277	899	5583	616	6234	312	4184
8-#10	1.91	3160	1468	3929	1349	5037	1115	5608	921	6007	616	6810	271	5160
8-#11	2.35	3245	1535	4200	1387	5337	1143	5932	936	6409	610	7332	218	6137
8-#14	3.39	3466	1695	4766	1494	6029	1224	6733	989	7442	608	8686	105	8245
8-#18	6.03	3993	2101	6137	1768	7720	1433	8672	1119	9951	599	11888	-203	11749
9-#10	2.15	3228	1505	4124	1365	5222	1127	5793	924	6277	607	7195	248	5688
9-#11	2.64	3324	1580	4421	1408	5547	1158	6159	942	6743	600	7767	187	6708
9-#14	3.81	3579	1760	5059	1527	6311	1248	7058	1001	7929	597	9303	61	9000
9-#18	6.78	4209	2217	6605	1832	8165	1477	9252	1148	10788	582	12933	-280	12721
10-#10	2.39	3295	1542	4391	1372	5471	1123	6039	913	6552	587	7453	206	6254
10-#11	2.94	3404	1626	4720	1421	5832	1156	6448	932	7076	577	8147	148	7418
10-#14	4.24	3687	1826	5441	1555	6693	1253	7462	992	8409	569	9859	7	9828
10-#18	7.53	4371	2333	7166	1892	8782	1497	9930	1143	11663	543	13903	-376	13414
11-#10	2.63	3352	1578	4384	1420	5539	1168	6182	956	6794	613	7955	209	6754
11-#11	3.23	3473	1671	4711	1478	5921	1211	6631	981	7361	605	8671	138	7952
11-#14	4.66	3786	1891	5476	1627	6849	1324	7734	1056	8799	603	10567	-13	10561
12-#10	2.87	3431	1615	4481	1453	5661	1197	6351	975	7058	624	8330	196	7319
12-#11	3.53	3565	1716	4859	1513	6084	1242	6836	1002	7685	619	9128	120	8566
12-#14	5.09	3913	1956	5699	1675	7085	1365	8026	1084	9266	621	11204	-42	11175
13-#10	3.11	3480	1652	4619	1475	5860	1212	6567	987	7322	618	8682	165	7795
13-#11	3.82	3622	1761	5023	1542	6322	1261	7091	1017	7990	611	9534	82	9113
13-#14	5.51	4001	2021	5925	1718	7418	1394	8385	1107	9686	609	11775	-98	11700

ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	3.35	3546	1689	4830	1487	6059	1220	6806	986	7606	608	9013	140	8330
14-#11	4.11	3708	1806	5263	1558	6555	1272	7381	1019	8331	599	9911	48	9686
14-#14	5.93	4126	2087	6241	1745	7741	1415	8799	1114	10173	594	12315	-146	12199
15-#10	3.59	3594	1726	4866	1531	6175	1255	6959	1018	7837	622	9410	120	8787
15-#11	4.41	3757	1852	5323	1610	6701	1313	7567	1055	8615	615	10396	25	10277
16-#10	3.83	3655	1762	4971	1560	6316	1282	7153	1036	8084	629	9783	107	9273
16-#11	4.70	3830	1897	5454	1645	6877	1346	7792	1075	8910	623	10844	7	10812
17-#10	4.07	3712	1799	5134	1583	6497	1298	7345	1048	8358	627	10165	81	9753
17-#11	5.00	3900	1942	5645	1673	7091	1365	8029	1090	9246	623	11291	-27	11269
18-#10	4.31	3767	1836	5298	1603	6700	1313	7567	1051	8644	620	10480	55	10219
18-#11	5.29	3963	1987	5837	1698	7324	1384	8292	1095	9590	613	11653	-61	11605
19-#10	4.54	3835	1873	5380	1638	6817	1341	7738	1078	8888	634	10889	37	10711
20-#10	4.78	3885	1910	5483	1671	6962	1366	7919	1093	9142	638	11239	18	11152

ROUND TIED COLUMNS 28" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.01	3604	1542	4265	1443	5458	1195	5993	994	6222	702	6751	394	3877
4-#14	1.46	3708	1622	4585	1490	5826	1229	6416	1014	6774	698	7504	333	5400
4-#18	2.60	3953	1825	5346	1613	6716	1316	7453	1067	8135	690	9282	167	8737
5-#10	1.03	3695	1545	4484	1428	5630	1182	6130	982	6332	685	6855	398	3772
5-#11	1.27	3759	1587	4698	1447	5846	1194	6362	987	6616	678	7193	362	4477
5-#14	1.83	3923	1687	5118	1511	6333	1239	6925	1015	7348	672	8187	299	6120
5-#18	3.25	4306	1941	6128	1674	7514	1356	8300	1086	9142	657	10466	114	9907
6-#10	1.24	3724	1582	4975	1385	6005	1136	6460	936	6684	641	7019	329	4436
6-#11	1.52	3792	1632	5215	1408	6266	1151	6754	942	7062	632	7422	282	5309
6-#14	2.19	3969	1752	5719	1478	6876	1200	7476	971	8024	623	8527	186	7352
6-#18	3.90	4389	2057	6942	1659	8367	1328	9251	1068	10308	591	11158	-73	11124
7-#9	1.14	3735	1564	4438	1460	5651	1212	6221	1008	6512	703	7168	403	4161
7-#10	1.44	3833	1619	4673	1495	5924	1238	6541	1026	6927	703	7737	370	5085
7-#11	1.77	3920	1677	4947	1525	6216	1260	6864	1038	7324	695	8248	325	6008
7-#14	2.56	4149	1817	5510	1615	6881	1328	7649	1083	8339	692	9594	231	8181
7-#18	4.55	4706	2173	6872	1846	8505	1503	9574	1196	10821	680	12800	-23	12789
8-#9	1.30	3776	1593	4423	1500	5742	1246	6388	1038	6739	721	7491	393	4613
8-#10	1.65	3884	1655	4681	1542	6054	1278	6758	1060	7208	722	8130	354	5695
8-#11	2.03	3983	1723	4984	1579	6388	1305	7121	1076	7656	716	8716	303	6784
8-#14	2.92	4232	1883	5610	1687	7152	1387	8011	1130	8802	716	10263	196	9350
8-#18	5.20	4824	2288	7129	1961	9022	1596	10174	1265	11598	712	13924	-93	13852
9-#10	1.86	3961	1692	4905	1556	6265	1289	6958	1062	7496	711	8557	330	6320
9-#11	2.28	4071	1768	5238	1599	6631	1320	7366	1080	8014	705	9228	274	7461
9-#14	3.29	4359	1948	5944	1719	7477	1411	8361	1140	9324	704	10971	154	10140
9-#18	5.85	5066	2404	7658	2025	9539	1642	10796	1290	12531	696	15106	-169	14972
10-#10	2.06	4036	1729	5216	1560	6553	1282	7234	1049	7797	689	8862	291	6918
10-#11	2.53	4160	1813	5583	1609	6957	1315	7690	1068	8379	681	9572	224	8218
10-#14	3.65	4478	2013	6380	1743	7911	1413	8812	1130	9854	674	11587	102	11098
10-#18	6.50	5242	2520	8315	2085	10235	1661	11555	1285	13465	654	16193	-261	15741

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#10	2.27	4099	1766	5187	1612	6611	1330	7382	1095	8068	718	9405	293	7511
11-#11	2.79	4235	1858	5582	1666	7037	1374	7881	1120	8698	712	10231	226	8862
11-#14	4.02	4589	2078	6440	1814	8063	1487	9099	1196	10290	711	12390	84	11934
11-#18	7.15	5441	2636	8459	2200	10569	1775	12079	1387	14186	704	17492	-304	17010
12-#10	2.48	4187	1803	5289	1647	6743	1361	7567	1114	8352	730	9824	282	8109
12-#11	3.04	4339	1904	5713	1707	7214	1405	8105	1142	9047	725	10726	209	9617
12-#14	4.38	4728	2144	6643	1869	8322	1530	9420	1225	10791	729	13088	57	12820
13-#10	2.68	4243	1839	5444	1668	6960	1375	7806	1126	8646	725	10217	251	8673
13-#11	3.29	4404	1949	5895	1735	7476	1424	8390	1157	9395	719	11193	172	10223
13-#14	4.75	4822	2209	6892	1912	8692	1559	9820	1248	11276	719	13746	4	13727
14-#10	2.89	4317	1876	5686	1678	7185	1381	8066	1124	8965	714	10575	226	9272
14-#11	3.55	4493	1994	6170	1749	7737	1434	8705	1157	9773	706	11633	141	10896
14-#14	5.12	4969	2274	7252	1938	9047	1578	10269	1253	11815	704	14349	-43	14312
15-#10	3.09	4368	1913	5711	1725	7307	1418	8233	1157	9212	729	11029	209	9807
15-#11	3.80	4555	2039	6221	1803	7892	1476	8908	1195	10077	723	12155	117	11511
15-#14	5.48	5041	2339	7362	2010	9283	1633	10561	1302	12250	726	15099	-78	14990
16-#10	3.30	4439	1950	5824	1754	7458	1446	8452	1177	9485	737	11445	197	10406
16-#11	4.05	4636	2084	6362	1839	8080	1510	9165	1218	10403	732	12648	101	12135
16-#14	5.85	5159	2404	7571	2059	9560	1680	10919	1332	12711	736	15787	-104	15643
17-#10	3.51	4501	1987	6006	1777	7658	1462	8660	1188	9788	735	11870	171	10906
17-#11	4.31	4710	2130	6576	1867	8318	1529	9419	1232	10766	728	13154	68	12781
18-#10	3.71	4563	2024	6190	1795	7886	1476	8906	1191	10094	727	12195	144	11454
18-#11	4.56	4784	2175	6791	1891	8586	1548	9712	1236	11144	721	13571	37	13387
19-#10	3.92	4638	2060	6274	1832	8011	1505	9087	1219	10365	742	12665	129	11965
19-#11	4.81	4873	2220	6902	1934	8742	1582	9938	1269	11466	738	14111	15	14042
20-#10	4.13	4693	2097	6383	1865	8170	1531	9287	1234	10654	748	13069	112	12496
20-#11	5.07	4948	2265	7039	1974	8934	1613	10178	1287	11802	742	14573	-8	14563
21-#10	4.33	4775	2134	6548	1888	8362	1548	9515	1249	10936	747	13466	87	13026
22-#10	4.54	4832	2171	6774	1904	8587	1556	9756	1254	11234	739	13879	69	13525

ROUND TIED COLUMNS 30" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.27	4521	1823	5431	1697	6965	1403	7685	1162	8084	810	8906	418	5903
4-#18	2.26	4797	2026	6272	1820	7944	1491	8822	1216	9575	803	10944	264	9831
5-#11	1.10	4573	1788	5583	1649	7005	1364	7633	1131	7911	786	8594	447	4917
5-#14	1.59	4757	1888	6045	1712	7541	1409	8252	1160	8712	781	9641	379	6728
5-#18	2.83	5187	2142	7160	1876	8843	1527	9766	1232	10684	768	12259	210	11016
6-#10	1.08	4534	1783	5935	1579	7198	1298	7742	1073	7966	743	8371	410	4838
6-#11	1.32	4611	1834	6201	1601	7486	1312	8065	1079	8380	735	8824	365	5800
6-#14	1.91	4810	1954	6755	1671	8153	1362	8854	1108	9430	726	10058	272	8052
6-#18	3.40	5280	2258	8100	1852	9789	1490	10800	1183	12004	701	13014	24	12910
7-#10	1.26	4655	1820	5534	1700	7074	1411	7819	1173	8252	814	9171	455	5597
7-#11	1.54	4754	1879	5839	1730	7396	1432	8175	1184	8690	807	9750	412	6624
7-#14	2.23	5011	2019	6459	1820	8126	1501	9034	1230	9805	804	11269	323	9018
7-#18	3.96	5635	2374	7959	2051	9910	1676	11145	1345	12540	796	14869	82	14422

ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	1.44	4711	1857	5523	1750	7203	1453	8047	1209	8562	835	9611	442	6234
8-#11	1.77	4821	1924	5859	1786	7571	1479	8461	1226	9057	830	10261	392	7437
8-#14	2.55	5103	2084	6546	1894	8407	1561	9440	1281	10316	832	11969	289	10270
8-#18	4.53	5763	2490	8214	2169	10456	1771	11828	1419	13398	832	16125	17	16048
9-#10	1.62	4798	1894	5778	1763	7439	1462	8274	1210	8868	823	10079	417	6967
9-#11	1.99	4922	1969	6148	1805	7846	1493	8723	1228	9437	817	10825	363	8231
9-#14	2.86	5243	2149	6922	1925	8778	1586	9814	1289	10871	817	12778	249	11208
9-#18	5.09	6013	2606	8806	2232	11046	1819	12491	1442	14401	814	17443	-58	17394
10-#10	1.80	4880	1930	6139	1763	7770	1453	8580	1194	9194	799	10429	379	7592
10-#11	2.21	5019	2014	6546	1811	8217	1487	9083	1213	9835	791	11229	315	9029
10-#14	3.18	5374	2214	7418	1945	9266	1585	10315	1277	11450	786	13351	182	12420
10-#18	5.66	6222	2722	9549	2289	11825	1835	13332	1435	15421	770	18645	-146	18260
11-#10	1.98	4950	1967	6080	1819	7816	1505	8731	1244	9495	831	11016	383	8285
11-#11	2.43	5103	2060	6520	1873	8301	1544	9280	1268	10188	825	11937	318	9782
11-#14	3.50	5498	2280	7464	2022	9431	1657	10614	1346	11934	827	14339	181	13279
11-#18	6.22	6442	2838	9684	2409	12162	1953	13892	1540	16220	825	20103	-186	19712
12-#10	2.16	5047	2004	6188	1856	7956	1537	8932	1265	9799	843	11480	373	8911
12-#11	2.65	5217	2105	6658	1915	8476	1581	9525	1292	10561	839	12485	303	10579
12-#14	3.82	5650	2345	7679	2079	9690	1707	10964	1377	12470	845	15102	156	14300
12-#18	6.79	6717	2954	10164	2492	12663	2025	14501	1589	17171	855	21433	-235	21022
13-#10	2.34	5109	2041	6359	1876	8193	1550	9196	1276	10120	838	11913	342	9568
13-#11	2.87	5290	2150	6858	1942	8761	1599	9838	1307	10948	833	13002	266	11298
13-#14	4.14	5755	2410	7952	2119	10091	1735	11406	1400	13019	837	15836	103	15246
13-#18	7.36	6890	3070	10619	2570	13355	2079	15253	1632	18077	838	22646	-332	22034
14-#10	2.52	5192	2078	6637	1884	8445	1555	9478	1272	10476	828	12281	315	10198
14-#11	3.09	5390	2195	7171	1955	9053	1607	10180	1305	11367	821	13478	235	12095
14-#14	4.46	5919	2475	8357	2144	10487	1752	11891	1402	13610	821	16546	62	16211
15-#10	2.70	5248	2114	6648	1932	8572	1594	9657	1307	10740	844	12802	301	10821
15-#11	3.31	5458	2241	7211	2011	9217	1652	10399	1345	11692	838	14068	213	12778
15-#14	4.77	5996	2541	8460	2218	10740	1810	12209	1454	14074	843	17335	25	17194
16-#10	2.87	5327	2151	6767	1963	8730	1622	9891	1328	11040	852	13270	291	11455
16-#11	3.53	5548	2286	7361	2047	9416	1686	10688	1370	12050	848	14613	199	13505
16-#14	5.09	6127	2606	8685	2268	11034	1857	12612	1486	14580	855	18099	2	18090
17-#10	3.05	5395	2188	6968	1986	8951	1638	10124	1339	11371	850	13713	264	12049
17-#11	3.75	5629	2331	7599	2076	9678	1705	10960	1383	12448	845	15173	166	14177
17-#14	5.41	6241	2671	9013	2310	11401	1887	13004	1507	15146	851	18891	-45	18817
18-#10	3.23	5463	2225	7175	2002	9201	1651	10395	1341	11697	842	14071	237	12700
18-#11	3.97	5710	2376	7837	2098	9976	1723	11283	1387	12851	837	15602	133	14878
19-#10	3.41	5546	2262	7259	2041	9337	1682	10587	1370	11988	854	14592	224	13261
19-#11	4.19	5809	2421	7952	2143	10142	1759	11522	1420	13206	855	16218	115	15564
20-#10	3.59	5607	2299	7372	2074	9509	1709	10804	1386	12307	863	15044	208	13870
20-#11	4.41	5882	2467	8096	2183	10351	1791	11784	1439	13586	861	16745	93	16245

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
21-#10	3.77	5694	2335	7555	2096	9729	1721	11055	1401	12621	863	15476	183	14421
21-#11	4.63	5990	2512	8312	2211	10603	1811	12084	1457	13957	860	17269	63	16950
22-#10	3.95	5761	2372	7804	2111	9966	1732	11315	1405	12947	855	15930	165	14995
23-#10	4.13	5837	2409	7878	2149	10115	1764	11518	1431	13242	868	16395	148	15566
24-#10	4.31	5909	2446	8025	2178	10295	1786	11752	1448	13536	871	16856	131	16133

ROUND TIED COLUMNS 32" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.12	5444	2038	6375	1919	8245	1589	9114	1321	9558	930	10479	510	6405
4-#18	1.99	5753	2241	7296	2042	9314	1677	10352	1375	11178	923	12692	358	10731
5-#14	1.40	5702	2104	7076	1928	8894	1592	9741	1314	10240	898	11320	472	7344
5-#18	2.49	6181	2357	8294	2091	10319	1710	11394	1388	12390	886	14108	295	12046
6-#11	1.16	5540	2049	7306	1808	8858	1485	9540	1225	9859	844	10389	452	6293
6-#14	1.68	5761	2169	7910	1878	9583	1535	10397	1254	10998	835	11752	362	8753
6-#18	2.98	6283	2473	9377	2059	11365	1663	12513	1330	13819	814	15034	124	14449
7-#10	1.11	5588	2035	6495	1920	8366	1596	9257	1330	9741	933	10777	546	6115
7-#11	1.36	5699	2094	6832	1949	8720	1617	9646	1342	10220	926	11412	503	7246
7-#14	1.96	5984	2234	7508	2039	9514	1685	10580	1387	11435	924	13079	417	9869
7-#18	3.48	6664	2589	9147	2271	11459	1862	12879	1503	14423	919	17111	189	15984
8-#10	1.26	5648	2072	6460	1972	8492	1640	9497	1369	10080	957	11265	535	6778
8-#11	1.55	5770	2139	6831	2008	8895	1666	9948	1385	10622	951	11979	486	8095
8-#14	2.24	6085	2299	7579	2115	9803	1748	11026	1442	11994	954	13848	386	11190
8-#18	3.98	6816	2705	9397	2391	12032	1959	13642	1583	15364	959	18414	123	17842
9-#10	1.42	5745	2109	6750	1984	8755	1648	9750	1369	10404	943	11773	510	7618
9-#11	1.75	5884	2184	7156	2025	9200	1679	10241	1387	11024	937	12594	457	9016
9-#14	2.52	6239	2364	8000	2146	10215	1772	11429	1448	12583	938	14734	346	12277
9-#18	4.48	7089	2821	10054	2453	12697	2008	14348	1604	16429	938	19950	55	19625
10-#10	1.58	5835	2146	7166	1980	9133	1636	10088	1350	10755	917	12124	469	8273
10-#11	1.94	5990	2230	7612	2028	9624	1670	10639	1369	11454	909	13055	411	9849
10-#14	2.80	6383	2430	8562	2162	10766	1769	11979	1433	13211	905	15398	282	13562
10-#18	4.97	7317	2937	10882	2505	13562	2021	15273	1594	17540	893	21039	-62	20975
11-#10	1.74	5912	2182	7071	2041	9161	1692	10241	1403	11086	952	12763	472	9075
11-#11	2.13	6082	2275	7554	2094	9693	1731	10841	1428	11843	946	13814	414	10721
11-#14	3.08	6515	2495	8582	2243	10922	1844	12289	1506	13743	949	16451	281	14603
11-#18	5.47	7558	3053	11086	2622	13899	2142	15858	1703	18419	953	22858	-70	22733
12-#10	1.89	6018	2219	7182	2079	9309	1725	10458	1425	11410	964	13310	469	9724
12-#11	2.33	6207	2320	7699	2138	9879	1770	11104	1453	12240	961	14418	401	11555
12-#14	3.36	6685	2560	8812	2302	11200	1896	12669	1538	14313	968	17291	259	15831
12-#18	5.97	7830	3169	11525	2718	14442	2216	16521	1753	19430	982	24270	-118	24052
13-#10	2.05	6087	2256	7371	2098	9566	1737	10745	1436	11759	959	13777	438	10484
13-#11	2.52	6288	2365	7919	2164	10187	1786	11447	1468	12661	954	14984	364	12384
13-#14	3.64	6800	2625	9109	2342	11633	1923	13152	1561	14913	960	18097	206	16809
13-#18	6.47	8047	3285	12017	2794	15188	2269	17346	1797	20451	969	25651	-211	25213
14-#10	2.21	6178	2293	7686	2105	9848	1741	11050	1430	12152	948	14158	410	11138
14-#11	2.72	6398	2411	8273	2176	10513	1793	11815	1464	13126	942	15473	331	13221
14-#14	3.92	6967	2691	9565	2365	12072	1939	13674	1562	15570	945	18841	164	17920
14-#18	6.96	8354	3401	12721	2846	15904	2307	18256	1809	21573	946	26970	-285	26370

ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#10	2.37	6240	2330	7680	2155	9977	1782	11241	1468	12433	966	14734	396	11856
15-#11	2.91	6470	2456	8298	2233	10682	1840	12051	1506	13471	961	16148	312	14008
15-#14	4.20	7065	2756	9656	2441	12339	1999	14017	1616	16061	968	19746	131	18947
16-#10	2.53	6323	2366	7805	2186	10143	1811	11491	1488	12759	975	15268	390	12518
16-#11	3.10	6573	2501	8456	2270	10891	1874	12359	1530	13862	971	16753	300	14847
16-#14	4.48	7208	2821	9896	2492	12649	2047	14463	1650	16614	981	20585	110	19958
17-#10	2.68	6400	2403	8024	2208	10384	1826	11748	1500	13112	972	15730	361	13205
17-#11	3.30	6660	2546	8717	2298	11179	1894	12661	1544	14295	969	17337	267	15597
17-#14	4.76	7327	2886	10257	2534	13051	2076	14884	1670	17230	978	21447	63	21064
18-#10	2.84	6476	2440	8258	2224	10657	1838	12045	1501	13465	963	16119	334	13887
18-#11	3.49	6750	2591	8983	2320	11503	1910	13015	1547	14723	959	17806	234	16414
18-#14	5.04	7457	2951	10607	2569	13502	2104	15380	1678	17854	967	22120	17	22026
19-#10	3.00	6564	2477	8339	2264	10802	1870	12246	1531	13782	977	16691	323	14527
19-#11	3.69	6857	2637	9098	2366	11684	1948	13267	1582	15101	974	18483	217	17137
19-#14	5.32	7601	3017	10802	2631	13769	2152	15751	1724	18398	991	23063	-10	23041
20-#10	3.16	6633	2514	8458	2297	10989	1898	12482	1548	14122	986	17169	306	15206
20-#11	3.88	6937	2682	9249	2406	11909	1980	13551	1602	15519	985	19076	197	17904
21-#10	3.32	6728	2551	8658	2320	11225	1910	12755	1562	14470	987	17659	284	15833
21-#11	4.07	7051	2727	9486	2434	12197	1996	13878	1620	15928	985	19636	167	18637
22-#10	3.47	6796	2587	8932	2334	11485	1921	13033	1566	14824	979	18084	256	16511
22-#11	4.27	7137	2772	9808	2453	12504	2010	14218	1626	16355	975	20231	145	19366
23-#10	3.63	6885	2624	9006	2372	11640	1954	13253	1593	15139	992	18648	248	17103
23-#11	4.46	7237	2818	9909	2499	12701	2049	14484	1657	16742	991	20835	123	20127
24-#10	3.79	6963	2661	9165	2402	11835	1975	13502	1610	15458	995	19150	231	17749
25-#10	3.95	7043	2698	9325	2428	12054	1997	13761	1624	15815	998	19606	208	18356
26-#10	4.11	7128	2735	9550	2447	12304	2009	14044	1631	16166	991	20102	186	18963

ROUND TIED COLUMNS 34" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.76	6827	2470	8424	2278	10835	1876	12053	1544	12957	1051	14624	457	11629
5-#14	1.24	6764	2333	8219	2158	10403	1786	11403	1480	11942	1022	13178	569	7968
5-#18	2.20	7292	2586	9541	2321	11950	1904	13196	1554	14270	1012	16244	399	13087
6-#11	1.03	6587	2278	8536	2028	10392	1670	11190	1382	11510	961	12128	543	6786
6-#14	1.49	6830	2398	9190	2098	11175	1719	12115	1411	12737	952	13619	457	9456
6-#18	2.64	7405	2702	10781	2279	13103	1847	14402	1486	15783	932	17229	226	15821
7-#11	1.20	6760	2323	7931	2183	10196	1814	11289	1509	11925	1052	13255	600	7879
7-#14	1.73	7074	2463	8665	2273	11055	1882	12297	1554	13240	1052	15066	516	10734
7-#18	3.08	7823	2818	10444	2505	13162	2059	14784	1672	16481	1049	19508	297	17523
8-#10	1.12	6702	2301	7499	2209	9930	1840	11117	1539	11774	1086	13103	633	7326
8-#11	1.37	6838	2368	7904	2245	10369	1866	11606	1555	12363	1080	13881	586	8759
8-#14	1.98	7179	2528	8714	2352	11349	1947	12767	1612	13848	1084	15912	488	12119
8-#18	3.52	7989	2934	10684	2627	13759	2158	15629	1757	17505	1092	20888	232	19698

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
9-#10	1.26	6809	2338	7825	2219	10222	1847	11397	1538	12115	1070	13651	608	8234
9-#11	1.55	6963	2414	8270	2261	10706	1877	11931	1556	12787	1064	14546	556	9816
9-#14	2.23	7354	2594	9183	2381	11802	1970	13215	1618	14470	1066	16874	448	13366
9-#18	3.97	8287	3050	11409	2689	14498	2208	16377	1775	18632	1069	22566	165	21547
10-#10	1.40	6907	2375	8303	2211	10650	1832	11769	1516	12491	1042	14000	565	8964
10-#11	1.72	7079	2459	8790	2259	11184	1865	12367	1535	13248	1034	15018	508	10679
10-#14	2.48	7510	2659	9816	2393	12422	1965	13817	1600	15146	1032	17625	387	14714
10-#18	4.41	8535	3166	12327	2736	15455	2219	17386	1763	19833	1023	23829	56	23592
11-#10	1.54	6991	2411	8164	2277	10658	1891	11922	1573	12853	1081	14728	572	9832
11-#11	1.89	7179	2504	8691	2330	11236	1930	12572	1597	13673	1075	15830	509	11679
11-#14	2.73	7654	2724	9803	2479	12564	2043	14136	1676	15727	1079	18747	385	15904
11-#18	4.85	8797	3282	12522	2859	15830	2332	17997	1875	20793	1087	25749	45	25472
12-#10	1.68	7106	2448	8276	2317	10812	1926	12153	1596	13197	1093	15324	570	10550
12-#11	2.06	7315	2549	8842	2376	11431	1970	12855	1624	14095	1090	16536	504	12545
12-#14	2.97	7839	2789	10048	2540	12860	2097	14544	1710	16331	1098	19665	366	17237
12-#18	5.29	9090	3398	12990	2957	16371	2419	18713	1927	21864	1116	27293	1	27288
13-#10	1.82	7182	2485	8485	2335	11089	1937	12466	1607	13573	1088	15811	537	11387
13-#11	2.23	7405	2594	9083	2401	11764	1986	13227	1638	14550	1084	17150	466	13493
13-#14	3.22	7966	2854	10371	2579	13325	2123	15069	1733	16981	1091	20543	313	18374
13-#18	5.73	9327	3514	13520	3032	17171	2471	19610	1971	22991	1105	28806	-92	28615
14-#10	1.96	7283	2522	8842	2340	11403	1939	12794	1599	13999	1076	16217	509	12094
14-#11	2.41	7525	2640	9482	2410	12125	1991	13623	1632	15060	1071	17650	432	14365
14-#14	3.47	8147	2920	10879	2600	13808	2137	15628	1731	17705	1076	21308	269	19683
14-#18	6.17	9661	3630	14298	3083	17955	2508	20583	1980	24217	1083	30267	-160	29851
15-#10	2.10	7349	2559	8815	2392	11532	1983	12996	1639	14301	1095	16851	497	12912
15-#11	2.58	7604	2685	9488	2470	12298	2041	13874	1677	15425	1091	18392	415	15262
15-#14	3.72	8255	2985	10956	2678	14088	2200	15996	1788	18224	1100	22326	239	20735
15-#18	6.61	9832	3746	14554	3207	18494	2605	21237	2067	25134	1117	31868	-229	31316
16-#10	2.24	7440	2596	8944	2424	11704	2012	13260	1660	14654	1105	17439	493	13606
16-#11	2.75	7716	2730	9654	2508	12517	2075	14200	1702	15849	1102	19077	406	16138
16-#14	3.97	8411	3050	11210	2730	14414	2248	16470	1822	18823	1114	23257	222	21882
17-#10	2.38	7525	2632	9183	2446	11968	2027	13543	1671	15028	1102	17894	459	14381
17-#11	2.92	7811	2775	9936	2535	12830	2094	14533	1716	16310	1099	19685	372	16992
17-#14	4.21	8539	3115	11602	2772	14852	2277	16934	1843	19491	1111	24154	174	23030
18-#10	2.52	7607	2669	9445	2460	12265	2037	13866	1672	15408	1092	18352	436	15089
18-#11	3.09	7909	2821	10234	2556	13182	2109	14918	1718	16770	1089	20193	338	17900
18-#14	4.46	8680	3181	11988	2805	15338	2304	17474	1850	20151	1099	24887	127	24117
19-#10	2.66	7703	2706	9522	2502	12414	2071	14076	1702	15752	1108	18976	427	15819
19-#11	3.26	8023	2866	10347	2604	13373	2149	15182	1754	17181	1105	20933	324	18705
19-#14	4.71	8837	3246	12189	2869	15628	2355	17864	1897	20727	1119	25916	103	25301
20-#10	2.80	7778	2743	9644	2535	12649	2093	14330	1720	16113	1117	19478	409	16526
20-#11	3.44	8112	2911	10504	2644	13617	2182	15488	1774	17624	1116	21556	303	19605
20-#14	4.96	8965	3311	12427	2926	15978	2401	18302	1925	21366	1134	26820	73	26385
21-#10	2.94	7882	2780	9862	2558	12871	2111	14622	1734	16482	1114	20010	388	17239
21-#11	3.61	8237	2956	10762	2672	13925	2197	15843	1792	18075	1117	22188	276	20368
22-#10	3.08	7955	2816	10162	2571	13155	2121	14923	1737	16876	1110	20487	361	17949
22-#11	3.78	8323	3001	11114	2690	14260	2210	16206	1797	18536	1107	22742	241	21194

ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
23-#10	3.22	8050	2853	10235	2610	13315	2155	15159	1765	17210	1123	21083	353	18644
23-#11	3.95	8439	3047	11216	2737	14465	2250	16492	1830	18946	1123	23478	232	21984
24-#10	3.36	8138	2890	10406	2641	13524	2177	15423	1782	17555	1127	21629	337	19370
24-#11	4.12	8540	3092	11424	2772	14720	2277	16818	1850	19361	1127	24128	211	22793
25-#10	3.50	8224	2927	10579	2666	13762	2199	15703	1796	17941	1129	22123	314	20031
25-#11	4.30	8643	3137	11631	2804	15004	2304	17154	1868	19825	1130	24722	182	23597
26-#10	3.64	8317	2964	10826	2685	14030	2210	16014	1803	18313	1122	22643	291	20726
27-#10	3.78	8401	3001	10951	2718	14205	2242	16248	1824	18662	1135	23170	275	21378
28-#10	3.92	8499	3037	11089	2750	14426	2265	16503	1843	19025	1139	23721	256	22041

ROUND TIED COLUMNS 36" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.57	8026	2713	9662	2528	12515	2088	13936	1724	14922	1187	16750	562	12524
5-#14	1.11	7951	2576	9480	2403	12075	1992	13249	1655	13829	1154	15193	669	8599
5-#18	1.96	8530	2829	10906	2565	13747	2111	15181	1730	16335	1145	18573	507	14139
6-#14	1.33	8024	2641	10603	2333	12940	1915	14019	1577	14658	1076	15671	555	10160
6-#18	2.36	8654	2945	12319	2513	15013	2043	16477	1652	17930	1057	19609	332	17052
7-#11	1.07	7947	2566	9143	2432	11833	2023	13115	1687	13815	1187	15293	703	8501
7-#14	1.55	8290	2706	9935	2522	12757	2092	14198	1732	15231	1187	17247	620	11613
7-#18	2.75	9109	3061	11856	2754	15027	2269	16873	1850	18726	1186	22053	406	18967
8-#11	1.23	8030	2611	9085	2496	12001	2078	13444	1735	14290	1217	15980	691	9428
8-#14	1.77	8402	2771	9957	2603	13053	2159	14691	1792	15888	1222	18172	595	13055
8-#18	3.14	9290	3177	12080	2878	15645	2370	17778	1939	19833	1233	23559	345	21622
9-#10	1.12	7997	2581	9010	2470	11848	2058	13226	1718	14013	1206	15723	712	8855
9-#11	1.38	8167	2657	9494	2510	12372	2088	13803	1736	14736	1200	16693	660	10599
9-#14	1.99	8594	2837	10478	2630	13550	2180	15183	1798	16543	1202	19209	555	14473
9-#18	3.54	9612	3293	12877	2938	16450	2418	18588	1957	21021	1208	25378	278	23520
10-#10	1.25	8103	2618	9557	2457	12330	2039	13633	1693	14411	1174	16068	666	9662
10-#11	1.53	8292	2702	10085	2504	12909	2072	14279	1712	15226	1167	17165	609	11519
10-#14	2.21	8764	2902	11189	2638	14241	2172	15838	1777	17266	1165	19972	490	15879
10-#18	3.93	9881	3409	13891	2982	17512	2428	19684	1942	22312	1159	26813	176	25823
11-#10	1.37	8195	2654	9367	2528	12313	2103	13785	1753	14806	1217	16888	677	10588
11-#11	1.69	8401	2747	9939	2581	12938	2142	14485	1778	15690	1212	18084	615	12645
11-#14	2.43	8919	2967	11135	2729	14367	2255	16165	1856	17897	1217	21168	486	17229
11-#18	4.32	10165	3525	14062	3110	17883	2545	20317	2057	23354	1228	28836	163	27748
12-#10	1.50	8319	2691	9474	2569	12472	2139	14030	1778	15170	1230	17535	676	11387
12-#11	1.84	8549	2792	10093	2628	13143	2183	14786	1805	16136	1227	18850	611	13548
12-#14	2.65	9120	3032	11392	2793	14679	2310	16601	1892	18536	1236	22235	477	18620
12-#18	4.72	10481	3641	14564	3211	18459	2634	21086	2112	24485	1257	30514	123	29785
13-#10	1.62	8401	2728	9708	2587	12772	2150	14367	1788	15574	1224	18041	642	12276
13-#11	1.99	8647	2837	10357	2652	13500	2198	15189	1819	16624	1220	19490	572	14624
13-#14	2.87	9258	3097	11742	2830	15177	2335	17169	1915	19235	1228	23182	424	19914
13-#18	5.11	10723	3757	15133	3285	19314	2684	22057	2155	25700	1246	32158	31	31951

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	1.75	8512	2765	10110	2590	13118	2149	14720	1778	16022	1211	18471	613	13065
14-#11	2.15	8778	2883	10803	2660	13898	2201	15613	1811	17179	1207	20021	538	15525
14-#14	3.09	9455	3163	12307	2850	15707	2348	17766	1910	20026	1214	23970	378	21329
14-#18	5.50	11100	3873	15990	3333	20169	2720	23093	2162	27048	1226	33665	-41	33557
15-#10	1.87	8584	2802	10058	2644	13245	2196	14933	1820	16356	1232	19164	603	13930
15-#11	2.30	8863	2928	10786	2722	14073	2253	15878	1858	17566	1229	20833	522	16540
15-#14	3.32	9567	3228	12365	2930	15997	2414	18157	1970	20574	1239	25080	350	22528
15-#18	5.89	11281	3989	16238	3460	20740	2820	23794	2252	28012	1261	35485	-102	35204
16-#10	2.00	8682	2839	10190	2677	13424	2225	15210	1841	16735	1243	19784	599	14704
16-#11	2.45	8980	2973	10959	2760	14301	2288	16222	1883	18022	1241	21597	517	17448
16-#14	3.54	9741	3293	12632	2983	16338	2461	18657	2004	21219	1254	26126	337	23863
16-#18	6.29	11583	4105	16740	3549	21368	2902	24689	2310	29122	1282	37169	-138	36836
17-#10	2.12	8775	2875	10449	2698	13709	2240	15515	1853	17130	1239	20289	567	15547
17-#11	2.61	9088	3018	11264	2787	14640	2307	16587	1898	18509	1237	22180	475	18422
17-#14	3.76	9879	3358	13054	3024	16811	2491	19167	2026	21925	1250	27057	288	25046
18-#10	2.25	8864	2912	10742	2711	14032	2249	15869	1853	17537	1229	20779	543	16312
18-#11	2.76	9195	3064	11595	2806	15021	2321	17003	1900	19003	1226	22776	448	19358
18-#14	3.98	10032	3424	13480	3056	17335	2515	19750	2032	22634	1238	27850	242	26266
19-#10	2.37	8967	2949	10812	2754	14185	2284	16087	1884	17908	1246	21448	535	17135
19-#11	2.91	9318	3109	11704	2856	15220	2362	17278	1936	19446	1244	23579	435	20268
19-#14	4.20	10202	3489	13684	3122	17643	2569	20158	2080	23256	1259	28966	219	27493
20-#10	2.50	9049	2986	10937	2788	14438	2307	16359	1902	18290	1255	21984	517	17868
20-#11	3.07	9415	3154	11866	2896	15484	2396	17607	1957	19915	1255	24233	413	21205
20-#14	4.42	10339	3554	13932	3179	18021	2616	20629	2109	23932	1274	29913	188	28712
21-#10	2.62	9162	3023	11205	2807	14675	2325	16669	1916	18687	1252	22556	496	18674
21-#11	3.22	9549	3199	12147	2925	15812	2411	17986	1975	20395	1252	24922	387	22088
21-#14	4.64	10526	3619	14320	3221	18487	2638	21170	2136	24624	1276	30887	150	29950
22-#10	2.74	9240	3059	11502	2822	14985	2334	16994	1919	19115	1248	23087	471	19410
22-#11	3.37	9643	3244	12530	2941	16176	2423	18375	1979	20903	1246	25534	354	23029
22-#14	4.86	10666	3685	14839	3249	18991	2660	21721	2145	25333	1264	31744	102	31104
23-#10	2.87	9343	3096	11571	2863	15148	2369	17245	1948	19468	1262	23675	458	20192
23-#11	3.52	9769	3290	12631	2989	16388	2464	18682	2013	21337	1263	26309	344	23886
24-#10	2.99	9439	3133	11751	2893	15371	2392	17524	1965	19839	1266	24305	447	20948
24-#11	3.68	9878	3335	12854	3026	16660	2491	19025	2033	21783	1267	27013	324	24794
25-#10	3.12	9532	3170	11940	2919	15628	2413	17825	1979	20249	1268	24837	425	21692
25-#11	3.83	9989	3380	13077	3057	16967	2518	19388	2051	22282	1270	27653	296	25635
26-#10	3.24	9633	3207	12211	2937	15916	2424	18165	1986	20646	1261	25379	400	22448
26-#11	3.98	10108	3425	13392	3081	17313	2533	19788	2060	22767	1262	28333	268	26494
27-#10	3.37	9721	3244	12337	2971	16100	2456	18411	2007	21021	1274	25953	386	23178
27-#11	4.14	10217	3471	13560	3121	17542	2571	20094	2084	23218	1276	29005	247	27358
28-#10	3.49	9829	3280	12483	3003	16334	2479	18684	2027	21406	1278	26563	369	23939
29-#10	3.62	9910	3317	12706	3027	16578	2500	18989	2038	21803	1281	27068	346	24652
30-#10	3.74	10007	3354	12928	3050	16872	2514	19298	2049	22207	1275	27617	321	25399

ROUND TIED COLUMNS 12" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.10	328	335	483	264	530	214	537	178	508	120	490	51	310
4-#6	1.56	333	350	502	271	551	219	562	181	539	116	523	33	418
4-#7	2.12	339	368	525	281	577	225	591	184	575	112	561	9	542
4-#8	2.79	346	390	550	292	607	233	624	189	616	108	604	-19	609
4-#9	3.54	353	414	577	305	639	241	658	193	659	102	648	-52	659
4-#10	4.49	362	445	611	321	679	252	701	198	712	94	702	-96	716
4-#11	5.52	370	478	642	334	702	266	724	196	740	77	740	-142	742
4-#14	7.96	391	557	715	375	778	292	810	205	848	50	844	-253	851
5-#5	1.37	338	344	504	264	547	214	552	174	525	113	507	44	361
5-#6	1.95	347	363	528	275	575	220	583	178	564	108	549	23	476
5-#7	2.65	357	386	556	287	608	229	620	181	609	102	597	-3	599
5-#8	3.49	369	413	589	302	645	238	661	186	662	95	651	-35	670
5-#9	4.42	383	443	623	319	683	249	704	190	717	86	707	-70	740
5-#10	5.61	399	481	665	340	730	266	758	195	784	75	792	-112	821
5-#11	6.90	407	523	699	357	758	272	787	193	831	58	810	-174	857
6-#5	1.64	340	353	532	259	567	209	568	167	542	103	519	28	422
6-#6	2.33	349	375	562	270	601	217	606	170	590	96	570	2	563
6-#7	3.18	361	403	598	285	641	227	652	174	648	88	630	-30	630
6-#8	4.19	374	435	639	303	686	238	704	178	713	77	697	-69	704
6-#9	5.31	388	471	681	322	734	250	758	182	782	65	765	-113	779
6-#10	6.74	405	517	731	345	792	265	825	186	866	48	847	-170	866
7-#5	1.92	346	362	523	280	573	225	586	182	570	114	563	30	472
7-#6	2.72	357	388	556	295	611	235	628	187	625	109	623	2	618
7-#7	3.71	371	420	594	314	656	248	679	194	690	102	694	-33	711
7-#8	4.89	387	458	638	336	708	263	737	201	764	93	773	-75	798
7-#9	6.19	406	500	684	360	762	278	798	208	842	83	853	-125	883
8-#5	2.19	351	371	530	289	585	232	601	188	591	115	594	23	529
8-#6	3.11	364	400	566	307	628	244	651	195	652	110	664	-9	668
8-#7	4.24	380	437	610	328	678	259	709	203	725	102	746	-49	764
8-#8	5.59	399	480	659	354	737	276	775	212	809	93	838	-99	868

ROUND TIED COLUMNS 14" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.14	526	458	758	371	847	303	869	251	840	171	826	78	518
4-#7	1.56	535	477	787	381	881	309	908	256	889	168	882	57	678
4-#8	2.05	545	498	821	393	920	317	953	261	947	165	947	32	858
4-#9	2.60	555	522	857	406	962	326	1003	267	1007	161	1014	4	1007
4-#10	3.30	568	553	902	423	1014	337	1065	274	1083	155	1096	-34	1101
4-#11	4.05	576	586	947	435	1061	344	1112	276	1133	142	1138	-86	1149
4-#14	5.85	611	665	1049	478	1182	372	1242	291	1297	123	1304	-195	1319
5-#5	1.01	532	452	765	362	844	295	859	244	820	166	802	87	454
5-#6	1.43	543	471	797	373	881	302	901	248	872	162	863	68	602
5-#7	1.95	558	494	835	386	924	311	952	253	935	158	935	46	772
5-#8	2.57	574	521	878	401	975	321	1011	259	1008	153	1017	18	963
5-#9	3.25	591	551	924	418	1029	333	1073	265	1085	146	1102	-14	1110
5-#10	4.13	613	590	981	441	1096	348	1149	273	1181	138	1206	-56	1232
5-#11	5.07	630	631	1034	459	1153	358	1202	273	1246	120	1258	-115	1308
5-#14	7.31	682	729	1162	514	1298	392	1366	288	1453	92	1464	-234	1544
6-#5	1.21	534	461	807	352	875	285	882	234	839	153	803	65	524
6-#6	1.71	547	484	846	364	922	293	935	238	905	148	872	40	707
6-#7	2.34	562	511	893	379	979	303	998	243	984	141	955	9	919
6-#8	3.08	580	544	948	397	1042	315	1070	249	1076	133	1049	-28	1060
6-#9	3.90	601	580	1006	417	1110	327	1147	255	1173	124	1146	-70	1170
6-#10	4.95	625	626	1079	443	1193	351	1242	262	1293	111	1311	-113	1300
6-#11	6.08	643	675	1147	465	1253	362	1308	262	1376	88	1377	-180	1380

ROUND TIED COLUMNS 14" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
7-#5	1.41	543	470	786	379	878	308	902	253	878	168	876	74	600
7-#6	2.00	559	496	829	394	928	319	960	259	951	164	969	51	791
7-#7	2.73	578	528	880	414	988	333	1030	267	1039	158	1073	21	1013
7-#8	3.59	601	566	940	437	1058	349	1111	276	1141	152	1192	-17	1189
7-#9	4.55	625	608	1003	463	1132	366	1197	286	1249	144	1315	-59	1326
7-#10	5.78	655	662	1082	496	1224	388	1306	299	1391	138	1466	-115	1488
7-#11	7.09	680	720	1152	525	1300	405	1381	302	1485	116	1545	-194	1572
8-#5	1.61	548	479	794	390	892	317	922	260	908	171	924	70	666
8-#6	2.29	567	509	843	409	949	330	987	268	992	168	1026	42	890
8-#7	3.12	589	545	902	431	1017	345	1066	278	1092	163	1147	7	1129
8-#8	4.11	614	589	968	458	1095	364	1157	290	1207	157	1284	-35	1295
8-#9	5.20	641	637	1039	488	1179	385	1255	302	1330	149	1427	-84	1447
8-#10	6.60	676	698	1127	526	1283	411	1377	318	1482	139	1603	-149	1597

ROUND TIED COLUMNS 16" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.19	792	602	1120	497	1271	406	1316	338	1290	231	1294	109	814
4-#8	1.57	805	623	1162	509	1320	414	1372	344	1364	229	1380	87	1037
4-#9	1.99	819	647	1207	522	1372	423	1433	350	1444	226	1471	61	1272
4-#10	2.53	837	678	1264	540	1438	435	1510	358	1545	223	1584	27	1526
4-#11	3.10	849	711	1325	552	1500	442	1578	361	1618	212	1654	-19	1656
4-#14	4.48	888	790	1454	596	1654	472	1760	381	1840	198	1896	-115	1898
4-#18	7.96	995	990	1755	708	2015	546	2171	425	2340	155	2418	-379	2400
5-#6	1.09	802	596	1140	487	1275	397	1310	328	1270	224	1266	118	731
5-#7	1.49	820	619	1187	500	1330	406	1373	333	1350	220	1362	97	941
5-#8	1.96	841	646	1241	516	1393	417	1446	340	1444	216	1472	72	1179
5-#9	2.49	863	676	1299	533	1461	429	1526	347	1544	212	1589	44	1430
5-#10	3.16	891	714	1372	556	1546	445	1626	357	1669	205	1734	6	1716
5-#11	3.88	914	756	1444	574	1623	456	1711	361	1763	191	1823	-46	1845
5-#14	5.60	978	854	1610	632	1820	494	1936	381	2045	169	2129	-153	2183
6-#6	1.31	806	609	1209	472	1328	383	1357	316	1308	207	1273	89	850
6-#7	1.79	826	636	1267	487	1398	393	1438	321	1409	202	1383	61	1112
6-#8	2.36	849	669	1334	505	1480	406	1531	329	1527	195	1510	26	1408
6-#9	2.98	873	705	1407	525	1568	419	1631	336	1653	187	1644	-13	1649
6-#10	3.79	904	751	1498	552	1680	437	1755	345	1810	177	1810	-64	1827
6-#11	4.66	933	800	1588	574	1775	450	1852	348	1929	158	1913	-132	1948
6-#14	6.71	1005	919	1800	641	2019	506	2130	367	2282	125	2354	-251	2311
7-#5	1.08	801	595	1120	494	1270	405	1311	335	1275	230	1283	123	728
7-#6	1.53	822	621	1174	510	1333	416	1383	342	1368	227	1396	101	969
7-#7	2.09	848	653	1238	530	1409	430	1470	350	1482	223	1532	73	1245
7-#8	2.75	878	691	1311	553	1497	447	1572	361	1613	219	1687	39	1556
7-#9	3.48	909	733	1390	579	1591	465	1681	372	1753	213	1852	0	1852
7-#10	4.42	948	787	1489	613	1708	489	1819	386	1928	206	2055	-51	2074
7-#11	5.43	978	845	1588	643	1812	507	1935	394	2062	188	2215	-114	2228
7-#14	7.83	1069	983	1818	729	2082	565	2252	426	2454	161	2657	-258	2650
8-#5	1.23	808	604	1125	507	1287	415	1336	344	1311	234	1346	121	805
8-#6	1.75	832	634	1186	525	1358	428	1417	352	1417	232	1480	96	1081
8-#7	2.39	860	670	1259	549	1443	445	1516	363	1545	229	1640	65	1405
8-#8	3.14	893	714	1343	576	1542	465	1631	376	1694	225	1824	28	1747
8-#9	3.98	927	762	1435	607	1648	486	1754	390	1854	220	2019	-16	2023
8-#10	5.05	971	823	1549	647	1781	514	1909	407	2055	214	2260	-73	2229
8-#11	6.21	1007	889	1658	683	1898	536	2040	418	2208	196	2419	-152	2394
9-#10	5.68	1005	860	1622	663	1868	529	2016	413	2192	208	2393	-106	2417
9-#11	6.98	1046	934	1743	703	2004	556	2164	424	2368	188	2567	-194	2568
10-#10	6.32	1037	896	1708	678	1967	532	2130	413	2325	189	2523	-150	2541

ROUND TIED COLUMNS 18" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.24	1137	765	1582	642	1819	525	1897	438	1877	299	1917	145	1215
4-#9	1.57	1154	789	1637	656	1882	534	1970	444	1972	297	2032	122	1497
4-#10	2.00	1176	820	1705	673	1961	546	2062	452	2094	295	2176	91	1845
4-#11	2.45	1193	853	1783	685	2039	553	2146	456	2201	287	2276	48	2160
4-#14	3.54	1243	932	1941	730	2226	584	2366	477	2488	278	2596	-38	2595
4-#18	6.29	1361	1132	2313	844	2670	661	2892	529	3137	247	3312	-275	3271
5-#7	1.18	1153	760	1622	630	1836	514	1900	425	1864	290	1890	153	1114
5-#8	1.55	1179	788	1688	646	1912	526	1988	432	1979	287	2030	130	1399
5-#9	1.96	1207	818	1758	664	1995	538	2084	440	2104	284	2178	104	1702
5-#10	2.50	1241	856	1847	687	2098	554	2204	450	2261	279	2364	70	2076
5-#11	3.07	1270	898	1939	705	2195	565	2312	455	2385	266	2493	23	2418
5-#14	4.42	1350	996	2144	764	2438	606	2597	479	2741	250	2902	-74	2929
5-#18	7.86	1549	1246	2621	913	3010	706	3267	536	3563	198	3807	-339	3871
6-#6	1.04	1136	750	1661	596	1837	486	1880	402	1811	273	1771	141	994
6-#7	1.41	1161	778	1730	611	1920	496	1978	409	1935	269	1910	115	1305
6-#8	1.86	1189	810	1810	629	2018	508	2093	417	2079	263	2070	84	1660
6-#9	2.36	1219	846	1897	649	2123	522	2219	426	2233	257	2241	48	2036
6-#10	2.99	1257	892	2007	676	2256	540	2377	437	2428	248	2455	1	2452
6-#11	3.68	1289	942	2118	698	2382	555	2504	441	2586	232	2605	-62	2621
6-#14	5.31	1377	1060	2377	766	2700	601	2858	465	3033	205	3072	-194	3100
7-#6	1.21	1157	763	1599	642	1835	526	1912	435	1884	297	1933	157	1153
7-#7	1.65	1188	795	1676	661	1926	540	2018	444	2020	294	2103	132	1484
7-#8	2.17	1224	833	1764	685	2031	557	2140	455	2179	291	2300	100	1859
7-#9	2.75	1263	875	1859	712	2146	576	2273	467	2352	287	2510	65	2256
7-#10	3.49	1314	929	1978	746	2290	601	2440	482	2569	282	2771	18	2707
7-#11	4.29	1353	987	2102	776	2426	621	2587	492	2753	269	2958	-45	2975
7-#14	6.19	1466	1124	2383	863	2760	682	2979	528	3249	249	3533	-177	3570
8-#6	1.38	1167	775	1607	659	1867	541	1953	448	1943	304	2018	151	1275
8-#7	1.89	1202	812	1694	682	1970	558	2072	459	2097	302	2211	121	1662
8-#8	2.48	1243	855	1795	710	2089	578	2210	473	2276	299	2435	85	2102
8-#9	3.14	1285	903	1903	741	2218	601	2360	488	2470	296	2674	44	2550
8-#10	3.99	1339	965	2040	781	2380	629	2549	507	2715	291	3025	2	3020
8-#11	4.90	1384	1031	2184	818	2529	652	2715	519	2927	279	3251	-70	3199
8-#14	7.07	1510	1189	2508	921	2906	723	3156	564	3497	262	3932	-217	3848
9-#10	4.49	1379	1001	2137	798	2477	643	2674	511	2879	283	3194	-31	3202
9-#11	5.52	1430	1076	2290	838	2647	670	2868	526	3130	273	3444	-110	3466
10-#10	4.99	1417	1037	2248	811	2599	644	2806	510	3061	270	3355	-72	3363
10-#11	6.13	1476	1120	2414	856	2789	674	3025	526	3320	250	3632	-163	3646
11-#10	5.49	1452	1074	2281	851	2674	684	2905	538	3197	287	3587	-87	3595
11-#11	6.74	1517	1165	2465	903	2879	719	3141	557	3491	270	3894	-183	3889
12-#10	5.99	1497	1110	2337	883	2758	705	3024	559	3339	288	3800	-110	3797

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 20" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.01	1547	923	2091	792	2430	650	2541	543	2505	379	2570	208	1392
4-#9	1.27	1569	947	2155	805	2503	659	2626	550	2615	377	2710	187	1722
4-#10	1.62	1596	978	2235	822	2596	671	2733	558	2757	374	2885	158	2131
4-#11	1.99	1617	1011	2330	835	2690	678	2834	562	2883	367	3015	119	2533
4-#14	2.86	1678	1090	2518	880	2910	709	3092	583	3226	360	3415	39	3317
4-#18	5.09	1823	1290	2962	995	3438	788	3715	638	4052	341	4331	-178	4288
5-#8	1.26	1596	946	2227	792	2545	647	2650	535	2623	364	2701	192	1624
5-#9	1.59	1630	976	2310	810	2641	660	2761	543	2768	361	2882	168	1979
5-#10	2.02	1671	1014	2415	833	2763	676	2903	553	2954	358	3110	137	2418
5-#11	2.48	1707	1056	2528	851	2881	688	3033	559	3119	348	3280	93	2850
5-#14	3.58	1803	1154	2772	911	3169	729	3370	584	3554	336	3794	5	3778
5-#18	6.37	2030	1404	3347	1063	3856	834	4179	647	4568	295	4962	-238	4996
6-#7	1.15	1575	936	2292	750	2559	611	2634	506	2572	343	2545	174	1499
6-#8	1.51	1609	968	2386	768	2671	624	2768	514	2743	338	2740	145	1912
6-#9	1.91	1645	1004	2487	789	2794	638	2913	523	2927	333	2949	111	2353
6-#10	2.43	1691	1051	2615	815	2949	656	3098	535	3160	326	3211	68	2899
6-#11	2.98	1730	1100	2749	837	3099	670	3271	543	3356	311	3409	9	3379
6-#14	4.30	1836	1219	3054	905	3472	717	3709	571	3899	289	3998	-113	4012
6-#18	7.64	2110	1518	3782	1078	4372	835	4713	634	5170	223	5333	-445	5312
7-#7	1.34	1608	953	2203	810	2555	664	2683	549	2674	374	2790	195	1730
7-#8	1.76	1651	991	2307	833	2678	681	2828	561	2860	371	3028	166	2170
7-#9	2.23	1698	1033	2418	860	2811	700	2983	573	3061	368	3284	133	2636
7-#10	2.83	1757	1087	2558	894	2979	725	3180	590	3317	364	3604	90	3212
7-#11	3.48	1806	1145	2708	924	3145	746	3359	600	3545	353	3849	31	3727
7-#14	5.01	1946	1283	3040	1012	3549	810	3827	639	4155	339	4573	-90	4591
8-#7	1.53	1624	970	2216	832	2604	683	2747	566	2765	382	2922	187	1922
8-#8	2.01	1672	1014	2334	860	2746	704	2910	580	2974	381	3193	153	2437
8-#9	2.55	1724	1062	2460	891	2899	728	3086	596	3202	379	3483	115	2986
8-#10	3.23	1788	1123	2620	931	3091	757	3308	616	3491	376	3848	66	3641
8-#11	3.97	1843	1189	2792	968	3273	781	3511	630	3747	365	4129	-2	4130
8-#14	5.73	1994	1347	3173	1071	3725	855	4037	678	4433	353	5057	-122	4948
9-#10	3.64	1835	1159	2738	948	3198	769	3446	619	3683	367	4115	45	3934
9-#11	4.47	1899	1234	2928	989	3404	797	3681	635	3975	355	4442	-27	4448
9-#14	6.45	2073	1411	3353	1103	3913	881	4285	689	4754	339	5389	-179	5335
10-#10	4.04	1879	1196	2881	960	3346	769	3602	616	3886	352	4306	6	4285
10-#11	4.97	1951	1279	3083	1005	3575	799	3865	633	4229	339	4667	-77	4672
10-#14	7.16	2146	1475	3555	1131	4148	888	4544	689	5109	317	5711	-251	5684
11-#10	4.45	1922	1232	2905	1002	3423	811	3719	648	4059	374	4590	-7	4591
11-#11	5.46	2001	1323	3127	1054	3675	848	4003	669	4417	360	4991	-95	4997
12-#10	4.85	1973	1268	2969	1036	3520	833	3849	668	4227	377	4846	-26	4845
12-#11	5.96	2062	1368	3204	1094	3792	874	4164	694	4615	363	5289	-122	5279
13-#10	5.26	2009	1304	3079	1056	3646	852	3991	676	4415	374	5093	-54	5062
14-#10	5.66	2064	1341	3193	1073	3787	859	4154	682	4601	360	5274	-91	5262

ROUND TIED COLUMNS 22" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#9	1.05	2071	1122	2770	971	3247	798	3414	667	3387	465	3517	257	1946
4-#10	1.34	2103	1153	2862	989	3353	810	3536	676	3548	463	3724	230	2416
4-#11	1.64	2129	1186	2975	1000	3464	816	3654	679	3694	455	3884	193	2884
4-#14	2.37	2203	1265	3193	1045	3718	848	3950	701	4087	450	4364	119	3972
4-#18	4.21	2376	1465	3710	1162	4330	929	4671	758	5046	434	5483	-82	5457
5-#8	1.04	2102	1121	2867	954	3303	783	3444	650	3394	450	3500	260	1854
5-#9	1.32	2141	1151	2964	972	3414	795	3572	658	3560	447	3713	237	2261
5-#10	1.67	2190	1189	3085	996	3554	812	3734	668	3772	444	3983	208	2766
5-#11	2.05	2232	1231	3220	1014	3693	823	3886	674	3965	435	4194	167	3270
5-#14	2.96	2346	1329	3504	1074	4028	865	4277	700	4478	425	4815	84	4447
5-#18	5.26	2614	1579	4179	1228	4830	973	5220	767	5703	396	6250	-139	6267
6-#8	1.25	2117	1143	3071	923	3454	752	3575	622	3533	421	3532	210	2165
6-#9	1.58	2159	1179	3187	943	3593	766	3740	631	3747	416	3779	179	2672
6-#10	2.00	2213	1226	3334	969	3770	784	3951	643	4017	410	4090	137	3300
6-#11	2.46	2259	1275	3491	991	3945	798	4152	651	4252	397	4336	83	3924
6-#14	3.55	2385	1394	3842	1059	4374	845	4664	681	4892	378	5049	-31	5053
6-#18	6.31	2709	1693	4686	1233	5414	965	5893	756	6407	322	6695	-340	6653
7-#7	1.10	2115	1128	2830	974	3308	801	3479	666	3455	461	3605	264	1973
7-#8	1.45	2167	1166	2949	998	3448	818	3643	677	3668	459	3885	236	2489
7-#9	1.84	2222	1208	3077	1024	3600	838	3823	690	3899	457	4187	206	3026
7-#10	2.34	2291	1262	3237	1059	3793	863	4050	707	4194	454	4566	165	3694
7-#11	2.87	2350	1320	3414	1089	3987	883	4265	718	4461	443	4871	110	4346
7-#14	4.14	2517	1458	3798	1177	4452	948	4808	760	5168	433	5745	-2	5745
7-#18	7.37	2906	1807	4716	1403	5575	1111	6110	861	6871	400	7762	-309	7729
8-#7	1.26	2133	1145	2835	998	3358	822	3555	685	3561	472	3763	257	2185
8-#8	1.66	2189	1189	2969	1026	3519	843	3741	700	3802	471	4081	226	2776
8-#9	2.10	2250	1236	3114	1057	3695	867	3943	716	4063	469	4424	191	3407
8-#10	2.67	2327	1298	3296	1097	3917	897	4200	737	4395	467	4855	144	4192
8-#11	3.28	2392	1364	3498	1134	4141	923	4439	751	4697	458	5204	81	4926
8-#14	4.74	2569	1522	3936	1238	4668	999	5052	802	5493	450	6197	-50	6194
9-#10	3.01	2381	1334	3437	1113	4043	908	4350	738	4617	459	5167	124	4568
9-#11	3.69	2457	1409	3659	1154	4285	937	4625	754	4960	448	5572	56	5324
9-#14	5.33	2662	1586	4153	1270	4873	1022	5322	810	5867	436	6714	-85	6660
10-#10	3.34	2431	1371	3617	1124	4219	906	4531	733	4834	441	5385	86	5038
10-#11	4.10	2516	1453	3856	1170	4487	937	4839	751	5234	429	5834	9	5801
10-#14	5.92	2743	1650	4403	1297	5150	1028	5623	810	6272	414	7094	-153	7069
11-#10	3.68	2479	1407	3627	1169	4295	951	4665	768	5026	462	5725	75	5384
11-#11	4.51	2575	1498	3887	1221	4590	989	4998	790	5469	456	6222	-7	6223
11-#14	6.51	2827	1715	4477	1365	5309	1096	5845	860	6586	446	7616	-180	7565
12-#10	4.01	2538	1443	3697	1204	4405	974	4805	789	5245	472	6025	59	5786
12-#11	4.92	2644	1543	3974	1263	4723	1016	5172	815	5703	460	6573	-30	6570
13-#10	4.34	2581	1479	3822	1224	4551	993	4970	797	5448	468	6282	25	6174
13-#11	5.33	2694	1587	4123	1288	4894	1039	5367	825	5956	457	6912	-64	6865
14-#10	4.68	2641	1516	3958	1240	4709	999	5162	802	5661	454	6525	-4	6525
14-#11	5.75	2771	1632	4279	1309	5085	1048	5593	832	6210	439	7161	-109	7140
15-#10	5.01	2678	1552	4037	1274	4805	1034	5282	825	5864	470	6868	-19	6864
16-#10	5.35	2729	1588	4126	1301	4933	1057	5431	845	6055	472	7132	-41	7120

ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#10	1.12	2707	1345	3595	1171	4246	962	4484	805	4481	559	4705	307	2699
4-#11	1.38	2739	1378	3726	1182	4373	969	4618	808	4647	552	4896	271	3234
4-#14	1.99	2825	1457	3975	1227	4662	1000	4954	830	5089	547	5457	202	4479
4-#18	3.54	3028	1657	4567	1344	5359	1082	5772	889	6175	534	6781	13	6744
5-#9	1.11	2749	1342	3726	1150	4324	944	4528	784	4492	542	4684	311	2549
5-#10	1.40	2805	1381	3864	1174	4482	961	4711	794	4731	539	4995	283	3121
5-#11	1.72	2855	1422	4023	1192	4643	972	4886	800	4951	530	5248	244	3696
5-#14	2.49	2986	1521	4349	1252	5024	1015	5330	827	5533	521	5977	167	5039
5-#18	4.42	3297	1771	5124	1408	5943	1124	6407	896	6951	498	7683	-42	7688
6-#8	1.05	2721	1335	3876	1093	4377	893	4528	741	4456	511	4458	280	2419
6-#9	1.33	2770	1371	4007	1113	4534	907	4714	750	4704	507	4743	250	2990
6-#10	1.68	2832	1417	4173	1139	4733	925	4950	762	5013	502	5103	211	3702
6-#11	2.07	2887	1467	4354	1161	4933	939	5178	770	5287	490	5398	159	4415
6-#14	2.98	3032	1585	4752	1229	5417	986	5756	801	6023	473	6237	52	6040
6-#18	5.31	3378	1885	5713	1403	6598	1107	7169	880	7784	426	8197	-238	8154
7-#8	1.22	2779	1358	3698	1179	4354	969	4604	805	4617	555	4884	312	2816
7-#9	1.55	2842	1400	3843	1205	4526	989	4805	818	4879	554	5232	283	3426
7-#10	1.97	2922	1454	4025	1240	4743	1014	5061	835	5211	551	5671	245	4184
7-#11	2.41	2992	1511	4230	1269	4965	1034	5311	847	5518	542	6036	193	4936
7-#14	3.48	3180	1649	4666	1358	5492	1099	5935	891	6323	533	7061	87	6652
7-#18	6.19	3638	1999	5714	1585	6770	1265	7430	997	8274	507	9460	-200	9428
8-#8	1.40	2803	1380	3709	1209	4427	996	4717	825	4771	569	5102	303	3118
8-#9	1.77	2873	1428	3873	1240	4624	1020	4947	840	5066	568	5500	270	3831
8-#10	2.25	2960	1490	4078	1280	4874	1050	5237	868	5441	567	6006	226	4722
8-#11	2.76	3040	1556	4310	1316	5131	1076	5513	883	5788	558	6423	167	5609
8-#14	3.98	3243	1714	4806	1420	5740	1155	6213	936	6696	553	7588	45	7409
8-#18	7.07	3732	2113	6004	1686	7192	1350	7900	1067	8891	533	10315	-287	10200
9-#10	2.53	3025	1526	4243	1295	5025	1061	5400	868	5685	558	6326	201	5184
9-#11	3.10	3114	1601	4499	1336	5302	1090	5715	885	6087	549	6845	143	6107
9-#14	4.48	3350	1778	5058	1452	5970	1177	6505	942	7121	540	8186	11	8136
9-#18	7.96	3919	2227	6410	1747	7587	1395	8425	1084	9619	512	11323	-348	11027
10-#10	2.81	3081	1562	4460	1303	5229	1057	5606	861	5923	538	6606	169	5713
10-#11	3.45	3180	1645	4740	1349	5538	1088	5958	879	6379	527	7142	96	6720
10-#14	4.97	3441	1842	5364	1478	6291	1180	6849	940	7557	514	8621	-55	8610
11-#10	3.09	3136	1599	4456	1352	5302	1104	5752	899	6145	562	7003	160	6151
11-#11	3.79	3246	1690	4755	1404	5640	1142	6138	922	6638	552	7598	83	7190
11-#14	5.47	3537	1906	5425	1549	6454	1251	7101	994	7926	551	9234	-79	9215
12-#10	3.37	3202	1635	4531	1389	5425	1129	5907	921	6390	573	7349	146	6675
12-#11	4.14	3324	1734	4849	1448	5789	1171	6326	947	6934	565	8003	63	7724
12-#14	5.97	3644	1971	5567	1608	6668	1290	7375	1029	8309	559	9794	-111	9751
13-#10	3.65	3251	1671	4671	1407	5592	1148	6094	928	6623	570	7644	113	7078
13-#11	4.48	3383	1779	5016	1471	5985	1194	6548	957	7206	560	8350	22	8241
13-#14	6.47	3727	2035	5800	1644	6942	1324	7687	1044	8706	554	10282	-169	10193
14-#10	3.93	3322	1707	4832	1422	5768	1151	6305	932	6862	555	7920	85	7526
14-#11	4.83	3466	1823	5200	1492	6197	1201	6806	964	7493	543	8681	-13	8678

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#10	4.21	3361	1744	4910	1458	5873	1189	6447	958	7088	573	8316	72	7957
15-#11	5.17	3514	1868	5306	1534	6326	1245	6968	993	7767	563	9141	-32	9132
16-#10	4.49	3422	1780	5007	1486	6012	1212	6616	979	7300	575	8621	52	8381
16-#11	5.52	3584	1912	5425	1567	6499	1273	7169	1017	8022	565	9498	-58	9476
17-#10	4.77	3469	1816	5129	1512	6163	1232	6790	986	7549	575	8953	24	8834
18-#10	5.05	3523	1852	5289	1528	6339	1241	6982	993	7802	566	9215	-5	9213

ROUND TIED COLUMNS 26" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.18	3454	1586	4593	1381	5430	1134	5742	949	5753	657	6062	355	3582
4-#14	1.70	3553	1665	4873	1426	5753	1166	6116	971	6246	653	6706	289	4984
4-#18	3.01	3787	1865	5540	1543	6535	1248	7032	1030	7459	641	8236	111	7886
5-#10	1.20	3526	1589	4762	1368	5560	1123	5847	932	5843	642	6161	364	3482
5-#11	1.47	3584	1631	4946	1385	5743	1134	6045	937	6090	633	6455	327	4129
5-#14	2.12	3733	1729	5316	1447	6171	1177	6542	965	6741	625	7292	254	5639
5-#18	3.77	4088	1979	6193	1603	7207	1288	7754	1036	8334	605	9272	57	9008
6-#9	1.13	3487	1579	4958	1299	5628	1061	5847	880	5795	604	5853	327	3308
6-#10	1.44	3557	1626	5142	1325	5849	1079	6109	892	6145	600	6263	290	4104
6-#11	1.76	3620	1675	5348	1346	6075	1092	6364	899	6472	589	6607	240	4907
6-#14	2.54	3785	1793	5793	1413	6615	1139	7008	930	7306	576	7572	138	6785
6-#18	4.52	4180	2093	6872	1588	7936	1261	8588	1010	9314	535	9850	-137	9820
7-#9	1.32	3568	1608	4727	1402	5600	1153	5946	957	6012	659	6430	365	3835
7-#10	1.67	3659	1662	4931	1437	5841	1179	6231	975	6383	657	6930	329	4684
7-#11	2.06	3740	1720	5164	1466	6092	1198	6511	986	6729	648	7355	279	5534
7-#14	2.97	3954	1858	5653	1555	6681	1264	7209	1031	7632	641	8532	179	7522
7-#18	5.27	4478	2207	6831	1783	8115	1431	8909	1142	9832	620	11317	-91	11300
8-#9	1.51	3601	1636	4745	1440	5700	1186	6108	983	6224	675	6718	353	4261
8-#10	1.91	3700	1698	4975	1480	5977	1217	6433	1003	6642	675	7287	311	5257
8-#11	2.35	3790	1764	5237	1515	6267	1242	6746	1026	7034	667	7798	257	6257
8-#14	3.39	4025	1922	5791	1619	6945	1321	7532	1081	8053	664	9136	142	8503
8-#18	6.03	4579	2322	7134	1886	8604	1523	9439	1217	10531	651	12299	-171	12218
9-#10	2.15	3775	1734	5166	1493	6154	1228	6609	1005	6903	664	7667	287	5815
9-#11	2.64	3877	1809	5455	1534	6468	1256	6963	1026	7359	656	8228	225	6858
9-#14	3.81	4145	1986	6081	1650	7216	1344	7847	1085	8530	651	9815	108	9253
9-#18	6.78	4791	2436	7596	1947	9035	1566	10004	1231	11353	631	13454	-230	13222
10-#10	2.39	3837	1771	5420	1497	6388	1220	6840	1000	7165	643	7980	256	6377
10-#11	2.94	3951	1853	5740	1544	6738	1251	7237	1018	7678	632	8605	187	7568
10-#14	4.24	4246	2050	6447	1675	7583	1345	8235	1081	8995	622	10303	44	10101
10-#18	7.53	4956	2550	8136	2004	9634	1581	10665	1236	12211	591	14316	-342	13889
11-#10	2.63	3899	1807	5401	1552	6457	1271	6995	1037	7418	669	8426	249	6904
11-#11	3.23	4025	1898	5740	1604	6838	1309	7432	1065	7972	661	9131	176	8139
11-#14	4.66	4356	2115	6490	1749	7748	1419	8517	1139	9393	655	11010	23	10891
12-#10	2.87	3973	1843	5479	1590	6592	1297	7167	1055	7684	681	8803	235	7466
12-#11	3.53	4113	1942	5841	1648	7002	1339	7638	1091	8298	674	9591	159	8805
12-#14	5.09	4473	2179	6644	1810	7985	1459	8809	1174	9860	674	11648	-5	11646

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
13-#10	3.11	4029	1879	5635	1607	6776	1315	7377	1067	7952	679	9147	204	7967
13-#11	3.82	4179	1987	6026	1671	7224	1363	7888	1100	8610	670	9986	119	9351
13-#14	5.51	4568	2243	6902	1845	8295	1494	9161	1189	10292	668	12205	-63	12176
14-#10	3.35	4110	1916	5824	1620	6976	1317	7606	1073	8218	664	9472	178	8531
14-#11	4.11	4274	2032	6239	1690	7458	1367	8168	1106	8930	653	10357	85	9937
14-#14	5.93	4711	2307	7181	1877	8623	1506	9564	1201	10751	645	12738	-112	12677
15-#10	3.59	4152	1952	5897	1658	7088	1357	7764	1097	8462	682	9904	164	9001
15-#11	4.41	4328	2076	6344	1733	7599	1413	8358	1137	9229	674	10883	68	10519
16-#10	3.83	4222	1988	6003	1687	7238	1381	7959	1115	8700	685	10241	145	9508
16-#11	4.70	4407	2121	6475	1768	7784	1442	8583	1162	9512	677	11288	43	11074
17-#10	4.07	4273	2024	6141	1713	7415	1396	8147	1126	8978	686	10622	118	9980
17-#11	5.00	4469	2165	6637	1800	7985	1465	8815	1172	9844	677	11733	9	11683
18-#10	4.31	4334	2061	6321	1727	7611	1410	8362	1128	9249	675	10926	91	10482
18-#11	5.29	4542	2210	6848	1819	8220	1478	9071	1180	10180	666	12083	-26	12070
19-#10	4.54	4399	2097	6384	1767	7731	1438	8535	1156	9496	689	11338	74	10960
20-#10	4.78	4453	2133	6504	1796	7873	1464	8715	1171	9748	692	11754	66	11425

ROUND TIED COLUMNS 28" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.01	4283	1811	5583	1596	6645	1314	7036	1091	7027	771	7364	442	3930
4-#14	1.46	4395	1890	5895	1641	7003	1346	7449	1109	7569	767	8107	380	5487
4-#18	2.60	4661	2090	6639	1758	7871	1428	8463	1183	8910	757	9861	212	9104
5-#10	1.03	4361	1814	5790	1578	6800	1299	7155	1081	7121	753	7492	450	3849
5-#11	1.27	4427	1856	5997	1595	7005	1309	7375	1085	7395	744	7828	415	4569
5-#14	1.83	4595	1954	6407	1656	7481	1352	7927	1114	8115	737	8773	345	6247
5-#18	3.25	4995	2204	7394	1814	8634	1464	9274	1186	9883	719	11029	157	10208
6-#10	1.24	4396	1851	6252	1525	7132	1246	7440	1033	7433	704	7581	373	4506
6-#11	1.52	4468	1900	6483	1546	7383	1258	7723	1039	7802	695	7975	325	5401
6-#14	2.19	4654	2018	6976	1614	7979	1306	8433	1071	8752	684	9066	227	7488
6-#18	3.90	5098	2318	8173	1788	9442	1428	10180	1151	11009	649	11664	-35	11656
7-#9	1.14	4409	1833	5738	1616	6833	1331	7259	1105	7312	772	7778	451	4236
7-#10	1.44	4511	1887	5963	1650	7100	1357	7572	1121	7721	771	8341	417	5196
7-#11	1.77	4603	1945	6225	1679	7380	1376	7883	1137	8106	762	8842	371	6144
7-#14	2.56	4844	2083	6767	1768	8031	1442	8653	1182	9108	757	10172	275	8359
7-#18	4.55	5423	2432	8078	1997	9621	1611	10543	1296	11556	741	13345	19	13246
8-#9	1.30	4444	1861	5740	1656	6934	1367	7437	1136	7549	791	8105	441	4695
8-#10	1.65	4555	1923	5993	1696	7239	1397	7799	1157	8011	791	8736	401	5796
8-#11	2.03	4657	1989	6288	1731	7561	1422	8150	1170	8448	784	9310	348	6911
8-#14	2.92	4923	2147	6901	1835	8310	1501	9024	1222	9578	782	10838	240	9531
8-#18	5.20	5545	2547	8389	2102	10144	1704	11150	1377	12338	775	14456	-54	14428
9-#10	1.86	4640	1959	6213	1708	7440	1407	7989	1157	8289	779	9157	377	6460
9-#11	2.28	4756	2034	6537	1748	7793	1436	8383	1173	8794	771	9815	319	7627
9-#14	3.29	5057	2211	7230	1864	8622	1524	9361	1238	10087	768	11539	198	10374
9-#18	5.85	5781	2661	8911	2162	10643	1749	11755	1388	13255	756	15758	-112	15563
10-#10	2.06	4708	1996	6510	1708	7710	1397	8246	1150	8573	755	9521	347	7051
10-#11	2.53	4837	2078	6868	1754	8101	1428	8689	1169	9143	745	10234	281	8379
10-#14	3.65	5168	2275	7648	1885	9037	1523	9793	1232	10599	737	12154	146	11413
10-#18	6.50	5963	2775	9544	2218	11319	1762	12492	1391	14169	712	16725	-220	16573

ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#10	2.27	4777	2032	6468	1767	7771	1452	8410	1190	8858	786	10004	340	7682
11-#11	2.79	4920	2123	6850	1819	8195	1490	8895	1213	9475	777	10818	272	9057
11-#14	4.02	5287	2340	7680	1965	9201	1600	10092	1293	11047	774	12957	128	12228
11-#18	7.15	6178	2889	9696	2335	11660	1880	13025	1483	14897	761	18013	-265	17775
12-#10	2.48	4858	2068	6550	1807	7917	1479	8598	1210	9144	797	10427	329	8268
12-#11	3.04	5017	2167	6955	1865	8374	1521	9121	1235	9825	791	11316	255	9809
12-#14	4.38	5420	2404	7846	2028	9461	1642	10414	1315	11549	793	13657	101	13148
13-#10	2.68	4922	2104	6723	1823	8118	1496	8830	1221	9432	791	10809	297	8860
13-#11	3.29	5091	2212	7160	1887	8617	1543	9399	1250	10181	789	11771	217	10454
13-#14	4.75	5526	2468	8129	2061	9806	1677	10806	1345	12045	789	14300	45	14042
14-#10	2.89	5011	2141	6941	1835	8343	1497	9080	1217	9741	780	11160	271	9456
14-#11	3.55	5198	2256	7406	1904	8880	1547	9703	1258	10534	770	12202	185	11183
14-#14	5.12	5675	2532	8448	2092	10166	1687	11243	1355	12553	766	14894	-1	14894
15-#10	3.09	5060	2177	7008	1875	8462	1539	9253	1252	10004	800	11653	260	10016
15-#11	3.80	5255	2301	7507	1950	9030	1595	9911	1287	10855	793	12772	168	11786
15-#14	5.48	5765	2596	8627	2151	10392	1750	11539	1398	13009	794	15707	-27	15679
16-#10	3.30	5134	2213	7121	1904	8621	1563	9473	1271	10268	803	12031	243	10621
16-#11	4.05	5348	2346	7648	1985	9228	1624	10169	1309	11170	796	13217	145	12441
16-#14	5.85	5892	2661	8836	2200	10681	1790	11896	1419	13451	797	16327	-63	16258
17-#10	3.51	5194	2249	7277	1930	8818	1578	9675	1282	10574	804	12453	216	11157
17-#11	4.31	5415	2390	7830	2017	9462	1642	10417	1323	11538	797	13721	112	13077
18-#10	3.71	5262	2286	7478	1943	9038	1591	9914	1283	10864	792	12766	187	11753
18-#11	4.56	5496	2435	8065	2035	9720	1660	10702	1325	11897	784	14125	79	13726
19-#10	3.92	5331	2322	7541	1985	9167	1620	10098	1312	11139	808	13241	173	12247
19-#11	4.81	5580	2479	8152	2084	9880	1694	10931	1359	12223	801	14668	57	14364
20-#10	4.13	5394	2358	7669	2013	9323	1647	10297	1327	11426	813	13718	167	12792
20-#11	5.07	5653	2524	8311	2119	10069	1725	11169	1377	12555	805	15218	47	14966
21-#10	4.33	5472	2394	7832	2035	9512	1662	10521	1341	11705	812	14071	136	13314
22-#10	4.54	5530	2431	8008	2057	9708	1677	10756	1345	11996	803	14449	113	13836

ROUND TIED COLUMNS 30" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.27	5361	2132	7050	1873	8424	1539	8967	1273	9073	890	9657	474	5989
4-#18	2.26	5659	2331	7872	1990	9379	1622	10079	1348	10541	881	11669	317	10027
5-#11	1.10	5393	2097	7188	1821	8442	1498	8892	1245	8879	864	9378	508	5016
5-#14	1.59	5580	2196	7639	1882	8964	1541	9496	1274	9667	857	10432	441	6864
5-#18	2.83	6027	2446	8729	2039	10237	1654	10980	1347	11610	841	12964	262	11240
6-#10	1.08	5358	2092	7513	1742	8593	1425	8957	1184	8896	817	9071	461	4910
6-#11	1.32	5439	2142	7770	1761	8870	1437	9268	1191	9299	807	9514	415	5894
6-#14	1.91	5646	2260	8312	1829	9523	1485	10043	1222	10337	797	10732	320	8192
6-#18	3.40	6142	2560	9627	2004	11127	1607	11957	1303	12879	770	13652	69	13334
7-#10	1.26	5485	2128	7130	1880	8530	1549	9098	1284	9239	893	9924	510	5717
7-#11	1.54	5590	2186	7422	1908	8839	1568	9440	1294	9664	885	10490	466	6766
7-#14	2.23	5858	2324	8019	1998	9553	1634	10283	1344	10763	881	11993	376	9210
7-#18	3.96	6503	2674	9462	2227	11300	1803	12356	1460	13461	868	15555	131	14801
8-#10	1.44	5533	2165	7144	1929	8671	1592	9340	1322	9560	916	10367	497	6341
8-#11	1.77	5647	2231	7471	1963	9026	1616	9739	1336	10043	909	11004	446	7570

ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.55	5938	2388	8143	2067	9845	1695	10700	1389	11284	909	12691	341	10456
8-#18	4.53	6638	2788	9777	2334	11854	1898	13048	1547	14327	906	16799	64	16490
9-#10	1.62	5628	2201	7394	1939	8895	1600	9553	1321	9854	902	10827	472	7119
9-#11	1.99	5759	2275	7754	1979	9288	1629	9988	1338	10410	894	11559	416	8411
9-#14	2.86	6093	2453	8514	2095	10200	1718	11060	1396	11825	892	13491	300	11444
9-#18	5.09	6899	2902	10362	2393	12425	1945	13691	1555	15311	885	18107	-11	18101
10-#10	1.80	5702	2237	7739	1935	9205	1587	9837	1311	10160	876	11239	443	7733
10-#11	2.21	5847	2320	8135	1981	9638	1618	10325	1330	10787	867	12042	380	9201
10-#14	3.18	6215	2517	8990	2111	10666	1714	11536	1394	12382	860	14184	251	12658
10-#18	5.66	7097	3017	11077	2446	13178	1956	14506	1557	16306	839	19316	-98	19243
11-#10	1.98	5779	2273	7667	1999	9256	1646	10008	1355	10479	910	11764	437	8471
11-#11	2.43	5938	2364	8092	2051	9724	1684	10541	1377	11157	902	12671	371	9995
11-#14	3.50	6346	2581	9005	2197	10826	1795	11852	1451	12881	901	15051	232	13601
11-#18	6.22	7335	3131	11223	2569	13527	2077	15078	1652	17116	894	20764	-140	20624
12-#10	2.16	5868	2310	7753	2041	9412	1675	10213	1376	10786	922	12233	428	9082
12-#11	2.65	6045	2409	8202	2099	9917	1717	10789	1401	11533	916	13223	357	10786
12-#14	3.82	6492	2645	9181	2262	11108	1838	12205	1482	13418	920	15818	208	14681
12-#18	6.79	7568	3245	11561	2675	14027	2147	15686	1712	18065	924	22095	-188	21821
13-#10	2.34	5939	2346	7944	2056	9631	1691	10468	1387	11100	916	12653	396	9774
13-#11	2.87	6128	2454	8428	2119	10181	1738	11094	1416	11912	909	13726	318	11539
13-#14	4.14	6610	2710	9490	2294	11481	1872	12636	1505	13979	918	16534	153	15605
13-#18	7.36	7775	3359	12080	2739	14672	2212	16424	1741	18996	917	23281	-289	22839
14-#10	2.52	6035	2382	8195	2065	9882	1690	10738	1381	11444	905	13012	369	10397
14-#11	3.09	6244	2498	8708	2135	10473	1740	11422	1411	12318	896	14193	287	12333
14-#14	4.46	6772	2774	9852	2323	11882	1880	13107	1519	14536	894	17233	111	16602
15-#10	2.70	6091	2418	8251	2108	10007	1735	10925	1418	11726	925	13534	354	11050
15-#11	3.31	6309	2543	8803	2182	10633	1791	11650	1453	12662	919	14834	271	13046
15-#14	4.77	6870	2838	10030	2384	12124	1946	13431	1558	15022	923	18093	83	17593
16-#10	2.87	6173	2455	8371	2138	10175	1759	11161	1438	12016	930	14004	345	11691
16-#11	3.53	6407	2587	8953	2218	10843	1820	11939	1477	13008	924	15329	250	13849
16-#14	5.09	7016	2902	10255	2434	12432	1987	13834	1589	15509	928	18782	50	18506
17-#10	3.05	6239	2491	8543	2164	10392	1773	11387	1448	12351	931	14444	317	12309
17-#11	3.75	6485	2632	9156	2251	11101	1838	12204	1490	13412	925	15886	217	14511
17-#14	5.41	7116	2967	10533	2482	12795	2014	14217	1610	16083	930	19572	3	19554
18-#10	3.23	6315	2527	8769	2175	10632	1785	11650	1449	12659	918	14789	288	12950
18-#11	3.97	6575	2676	9417	2267	11388	1855	12518	1492	13794	911	16300	183	15265
19-#10	3.41	6389	2563	8830	2218	10773	1817	11845	1478	12961	935	15314	276	13537
19-#11	4.19	6665	2721	9504	2317	11559	1890	12760	1526	14153	929	16920	165	15924
20-#10	3.59	6459	2600	8964	2247	10943	1844	12062	1494	13271	940	15761	259	14181
20-#11	4.41	6748	2765	9673	2352	11765	1923	13021	1545	14530	935	17543	157	16621
21-#10	3.77	6545	2636	9145	2269	11147	1859	12308	1509	13582	939	16231	240	14746
21-#11	4.63	6849	2810	9887	2379	12013	1942	13316	1563	14897	934	18010	119	17321
22-#10	3.95	6609	2672	9340	2290	11364	1873	12561	1512	13900	930	16647	217	15347
23-#10	4.13	6695	2708	9440	2324	11528	1902	12766	1538	14198	944	17107	199	15918
24-#10	4.31	6766	2745	9560	2357	11695	1927	12999	1555	14489	946	17568	182	16496

ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.12	6458	2390	8346	2121	10027	1747	10682	1449	10771	1022	11403	574	6489
4-#18	1.99	6790	2590	9248	2238	11070	1830	11893	1497	12365	1013	13587	419	10924
5-#14	1.40	6698	2454	9020	2123	10635	1744	11265	1445	11411	986	12283	542	7488
5-#18	2.49	7192	2704	10210	2281	12026	1857	12884	1520	13529	971	15092	370	12284
6-#11	1.16	6542	2400	9219	1993	10549	1629	11012	1352	10985	928	11236	509	6388
6-#14	1.68	6771	2518	9809	2060	11259	1676	11853	1384	12109	918	12581	418	8898
6-#18	2.98	7318	2818	11245	2235	13005	1799	13934	1465	14897	894	15824	177	14868
7-#10	1.11	6592	2387	8466	2122	10144	1755	10821	1458	10950	1024	11700	609	6211
7-#11	1.36	6708	2445	8765	2154	10484	1773	11195	1468	11414	1015	12321	566	7400
7-#14	1.96	7005	2582	9416	2243	11260	1839	12110	1511	12612	1012	13971	478	10084
7-#18	3.48	7718	2932	10994	2473	13165	2009	14367	1635	15559	1003	17961	246	16410
8-#10	1.26	6642	2423	8434	2178	10284	1801	11077	1498	11304	1049	12194	598	6891
8-#11	1.55	6769	2489	8795	2212	10673	1824	11513	1513	11831	1042	12893	548	8235
8-#14	2.24	7090	2647	9527	2315	11562	1903	12571	1567	13184	1044	14740	446	11388
8-#18	3.98	7865	3046	11309	2583	13748	2106	15143	1701	16510	1044	19253	178	18359
9-#10	1.42	6747	2459	8718	2187	10534	1807	11315	1497	11613	1034	12692	573	7748
9-#11	1.75	6893	2534	9115	2226	10964	1836	11790	1513	12218	1026	13498	518	9211
9-#14	2.52	7263	2711	9942	2342	11957	1925	12956	1572	13756	1025	15615	406	12533
9-#18	4.48	8151	3161	11958	2641	14391	2154	15825	1734	17553	1021	20776	110	20128
10-#10	1.58	6829	2495	9116	2178	10886	1791	11626	1475	11939	1006	13015	530	8424
10-#11	1.94	6990	2578	9551	2223	11361	1822	12160	1502	12622	996	14042	484	10032
10-#14	2.80	7395	2775	10481	2354	12481	1918	13478	1568	14357	990	16406	360	13813
10-#18	4.97	8366	3275	12754	2688	15226	2162	16719	1733	18635	973	22102	25	21963
11-#10	1.74	6913	2532	9008	2248	10924	1854	11804	1531	12293	1043	13719	540	9244
11-#11	2.13	7090	2623	9474	2299	11436	1891	12386	1554	13033	1035	14718	476	10961
11-#14	3.08	7538	2839	10470	2445	12634	2003	13810	1628	14908	1036	17331	341	14904
11-#18	5.47	8629	3389	12895	2819	15577	2287	17321	1818	19528	1033	23682	-15	23660
12-#10	1.89	7010	2568	9095	2291	11089	1884	12026	1554	12621	1056	14235	532	9909
12-#11	2.33	7205	2667	9590	2349	11642	1926	12654	1579	13434	1050	15327	463	11777
12-#14	3.36	7698	2904	10657	2512	12938	2048	14192	1661	15481	1055	18175	319	16178
12-#18	5.97	8880	3503	13257	2927	16120	2359	17984	1867	20539	1063	25096	-63	25001
13-#10	2.05	7086	2604	9306	2305	11326	1899	12304	1564	12961	1049	14689	500	10701
13-#11	2.52	7298	2712	9837	2368	11927	1946	12987	1593	13845	1043	15878	424	12648
13-#14	3.64	7828	2968	10993	2543	13340	2081	14664	1683	16070	1045	18962	264	17226
13-#18	6.47	9107	3617	13818	2990	16817	2423	18792	1910	21585	1060	26446	-159	26175
14-#10	2.21	7192	2640	9641	2304	11605	1896	12593	1556	13339	1037	15057	471	11354
14-#11	2.72	7424	2756	10156	2381	12252	1946	13339	1587	14295	1029	16355	391	13479
14-#14	3.92	8004	3032	11401	2570	13782	2087	15168	1680	16711	1029	19693	222	18361
14-#18	6.96	9421	3732	14444	3050	17547	2446	19683	1944	22647	1023	27751	-233	27356
15-#10	2.37	7255	2677	9636	2357	11745	1940	12795	1595	13642	1059	15638	458	12116
15-#11	2.91	7497	2801	10240	2431	12418	2000	13585	1631	14663	1054	17031	372	14302
15-#14	4.20	8112	3096	11574	2634	14039	2156	15520	1736	17229	1060	20675	198	19379
16-#10	2.53	7344	2713	9761	2389	11910	1968	13046	1615	13958	1065	16173	452	12773
16-#11	3.10	7604	2845	10399	2469	12640	2029	13894	1655	15040	1059	17637	360	15142
16-#14	4.48	8274	3161	11815	2684	14366	2197	15966	1770	17761	1066	21434	167	20428
17-#10	2.68	7416	2749	9948	2413	12148	1983	13297	1627	14314	1065	16631	423	13486
17-#11	3.30	7690	2890	10622	2500	12922	2047	14189	1668	15479	1060	18218	326	15931
17-#14	4.76	8382	3225	12122	2732	14762	2224	16377	1790	18387	1068	22293	120	21520

ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.84	7500	2785	10203	2423	12409	1993	13583	1626	14647	1051	17006	394	14154
18-#11	3.49	7788	2934	10912	2515	13234	2062	14531	1669	15884	1045	18670	292	16787
18-#14	5.04	8523	3289	12508	2758	15198	2251	16861	1795	18980	1049	22945	72	22524
19-#10	3.00	7581	2822	10260	2469	12559	2026	13790	1657	14978	1070	17584	384	14830
19-#11	3.69	7885	2979	10998	2567	13420	2100	14787	1705	16277	1065	19353	276	17524
19-#14	5.32	8661	3353	12660	2828	15470	2300	17234	1842	19529	1074	23892	45	23648
20-#10	3.16	7658	2858	10400	2498	12745	2055	14025	1673	15308	1075	18055	365	15502
20-#11	3.88	7976	3024	11175	2603	13643	2133	15071	1724	16683	1071	19938	255	18328
21-#10	3.32	7751	2894	10599	2519	12963	2069	14292	1688	15652	1075	18586	349	16166
21-#11	4.07	8087	3068	11410	2630	13909	2152	15392	1742	17087	1071	20548	232	19053
22-#10	3.47	7821	2930	10813	2539	13202	2082	14563	1690	15997	1066	19040	326	16838
22-#11	4.27	8172	3113	11661	2656	14191	2169	15723	1747	17504	1060	21093	204	19811
23-#10	3.63	7915	2967	10915	2575	13373	2112	14785	1717	16315	1080	19529	308	17475
23-#11	4.46	8284	3157	11795	2697	14408	2204	15991	1778	17894	1076	21691	181	20574
24-#10	3.79	7989	3003	11047	2608	13554	2137	15033	1734	16632	1082	20031	291	18159
25-#10	3.95	8077	3039	11230	2630	13783	2154	15287	1748	16986	1085	20478	267	18754
26-#10	4.11	8158	3076	11426	2651	14014	2170	15564	1754	17329	1077	20969	244	19385

ROUND TIED COLUMNS 34" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.76	8062	2865	10775	2502	12956	2051	13917	1685	14395	1154	15711	528	11819
5-#14	1.24	7956	2729	10560	2381	12503	1959	13245	1628	13360	1122	14336	648	8121
5-#18	2.20	8498	2979	11852	2538	14015	2073	15000	1703	15652	1109	17424	483	13339
6-#11	1.03	7785	2675	10839	2239	12432	1834	12968	1525	12871	1056	13155	609	6883
6-#14	1.49	8036	2793	11479	2306	13198	1881	13875	1556	14082	1046	14627	521	9604
6-#18	2.64	8637	3093	13036	2481	15087	2003	16123	1638	17092	1023	18193	287	16104
7-#11	1.20	7967	2720	10293	2411	12324	1992	13161	1653	13370	1155	14358	672	8039
7-#14	1.73	8292	2857	10968	2505	13164	2058	14149	1696	14666	1153	16149	586	10964
7-#18	3.08	9072	3207	12681	2735	15226	2228	16590	1807	17863	1145	20546	363	17872
8-#10	1.12	7893	2698	9873	2444	12091	2023	13025	1687	13253	1191	14230	706	7447
8-#11	1.37	8032	2764	10268	2477	12514	2046	13496	1701	13825	1184	14991	657	8906
8-#14	1.98	8383	2922	11061	2581	13474	2125	14637	1755	15290	1187	16997	557	12327
8-#18	3.52	9235	3321	12991	2848	15836	2328	17449	1893	18899	1190	21915	296	20284
9-#10	1.26	8006	2734	10193	2451	12367	2028	13287	1685	13578	1174	14765	680	8369
9-#11	1.55	8167	2809	10627	2489	12834	2056	13803	1700	14232	1167	15643	626	10017
9-#14	2.23	8573	2986	11523	2606	13908	2145	15064	1759	15893	1166	17946	516	13643
9-#18	3.97	9546	3436	13708	2904	16551	2376	18171	1910	20002	1164	23580	228	22105
10-#10	1.40	8096	2770	10651	2438	12765	2008	13627	1659	13923	1143	15082	634	9125
10-#11	1.72	8273	2853	11125	2482	13282	2038	14206	1676	14662	1134	16081	575	10874
10-#14	2.48	8717	3050	12130	2612	14495	2135	15631	1752	16536	1129	18831	473	14981
10-#18	4.41	9780	3550	14591	2947	17472	2381	19143	1919	21169	1115	25094	151	24192

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#10	1.54	8187	2807	10499	2513	12786	2076	13810	1719	14313	1184	15882	649	10001
11-#11	1.89	8382	2898	11008	2563	13343	2113	14441	1741	15115	1177	16974	585	11938
11-#14	2.73	8873	3114	12085	2709	14638	2225	15978	1817	17142	1179	19818	454	16231
11-#18	4.85	10054	3664	14718	3084	17824	2510	19776	2008	22147	1180	26759	109	26050
12-#10	1.68	8292	2843	10586	2558	12960	2108	14048	1743	14662	1198	16446	643	10748
12-#11	2.06	8507	2942	11128	2615	13561	2149	14729	1768	15541	1192	17640	575	12782
12-#14	2.97	9045	3179	12284	2779	14962	2272	16391	1850	17750	1198	20742	435	17565
12-#18	5.29	10337	3778	15104	3195	18408	2584	20493	2059	23218	1210	28307	65	27928
13-#10	1.82	8376	2879	10818	2571	13216	2122	14350	1753	15029	1191	16918	609	11591
13-#11	2.23	8607	2987	11398	2633	13868	2168	15091	1782	15985	1185	18237	536	13780
13-#14	3.22	9188	3243	12648	2809	15393	2303	16902	1873	18387	1189	21598	381	18763
13-#18	5.73	10585	3892	15708	3256	19154	2646	21372	2102	24371	1209	29785	-31	29734
14-#10	1.96	8490	2915	11196	2568	13524	2117	14659	1743	15437	1178	17310	579	12327
14-#11	2.41	8744	3031	11822	2634	14226	2166	15467	1773	16478	1171	18723	501	14641
14-#14	3.47	9378	3307	13105	2833	15879	2308	17441	1868	19092	1173	22349	335	20100
14-#18	6.17	10904	4006	16401	3314	19952	2668	22321	2107	25532	1172	31230	-100	31008
15-#10	2.10	8560	2952	11170	2623	13667	2162	14876	1784	15764	1202	17949	568	13150
15-#11	2.58	8826	3076	11828	2697	14398	2222	15731	1820	16870	1197	19468	484	15583
15-#14	3.72	9498	3371	13270	2900	16150	2380	17820	1926	19642	1204	23364	305	21216
15-#18	6.61	11130	4121	16806	3416	20464	2779	22981	2196	26490	1219	32968	-152	32478
16-#10	2.24	8657	2988	11299	2655	13839	2192	15141	1805	16106	1208	18539	563	13873
16-#11	2.75	8942	3120	11995	2735	14631	2252	16058	1844	17279	1203	20155	475	16466
16-#14	3.97	9675	3436	13525	2951	16493	2420	18293	1960	20219	1211	24296	288	22409
17-#10	2.38	8734	3024	11504	2680	14097	2206	15417	1816	16484	1208	19027	535	14673
17-#11	2.92	9036	3165	12236	2766	14938	2270	16384	1858	17746	1204	20758	440	17356
17-#14	4.21	9791	3500	13858	2998	16924	2448	18747	1981	20896	1214	25189	239	23538
18-#10	2.52	8827	3060	11788	2688	14381	2215	15728	1815	16841	1193	19431	505	15379
18-#11	3.09	9144	3209	12560	2779	15275	2284	16755	1858	18180	1187	21248	405	18249
18-#14	4.46	9945	3564	14284	3023	17394	2473	19273	1985	21523	1194	25899	191	24675
19-#10	2.66	8914	3097	11838	2735	14538	2250	15944	1847	17201	1213	20062	496	16151
19-#11	3.26	9248	3254	12642	2834	15474	2324	17025	1895	18608	1209	21994	392	19090
19-#14	4.71	10089	3628	14438	3095	17690	2524	19666	2033	22120	1221	26934	167	25862
20-#10	2.80	8998	3133	11984	2765	14740	2279	16198	1864	17552	1218	20558	478	16847
20-#11	3.44	9347	3299	12827	2869	15715	2358	17331	1915	19039	1215	22610	369	19983
20-#14	4.96	10231	3692	14716	3145	18035	2571	20103	2060	22740	1228	27825	136	26990
21-#10	2.94	9097	3169	12201	2786	14974	2293	16484	1878	17925	1219	21087	457	17604
21-#11	3.61	9468	3343	13084	2896	15999	2376	17679	1933	19484	1216	23296	349	20806
22-#10	3.08	9175	3205	12437	2805	15234	2305	16776	1879	18301	1210	21641	440	18302
22-#11	3.78	9559	3388	13358	2921	16307	2392	18032	1936	19934	1205	23887	321	21690
23-#10	3.22	9278	3242	12540	2842	15413	2336	17015	1908	18639	1224	22157	422	19026
23-#11	3.95	9682	3432	13496	2964	16534	2428	18321	1969	20348	1221	24525	299	22479
24-#10	3.36	9356	3278	12682	2876	15607	2362	17278	1925	18981	1227	22703	406	19748
24-#11	4.12	9776	3477	13669	3005	16770	2459	18645	1989	20759	1224	25175	278	23312

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
25-#10	3.50	9452	3314	12879	2897	15854	2379	17552	1939	19363	1229	23188	382	20436
25-#11	4.30	9892	3521	13906	3031	17066	2480	18975	2007	21220	1227	25756	247	24108
26-#10	3.64	9542	3350	13096	2918	16103	2393	17856	1945	19726	1221	23701	358	21158
27-#10	3.78	9630	3387	13245	2948	16292	2421	18086	1969	20078	1234	24270	348	21842
28-#10	3.92	9724	3423	13410	2975	16499	2448	18345	1984	20438	1238	24775	323	22555

ROUND TIED COLUMNS 36" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.57	9483	3156	12462	2784	15048	2286	16165	1884	16644	1303	18055	642	12712
5-#14	1.11	9363	3021	12268	2656	14582	2189	15449	1814	15525	1267	16478	747	8763
5-#18	1.96	9955	3270	13662	2812	16214	2302	17341	1897	17993	1255	19974	600	14406
6-#14	1.33	9450	3085	13331	2568	15355	2098	16123	1740	16268	1183	16881	629	10312
6-#18	2.36	10106	3385	15010	2742	17387	2220	18538	1821	19500	1160	20771	402	17341
7-#11	1.07	9375	3011	11955	2690	14372	2225	15350	1850	15544	1303	16614	783	8631
7-#14	1.55	9729	3149	12732	2776	15276	2290	16411	1893	16938	1301	18546	700	11858
7-#18	2.75	10575	3499	14533	3013	17497	2461	19036	2005	20384	1296	23303	481	19340
8-#11	1.23	9444	3056	11899	2759	14561	2282	15703	1900	16039	1335	17310	772	9583
8-#14	1.77	9826	3213	12754	2862	15591	2361	16926	1954	17615	1338	19475	674	13273
8-#18	3.14	10742	3613	14834	3129	18131	2564	19960	2094	21508	1344	24800	419	22114
9-#10	1.12	9415	3026	11828	2732	14407	2263	15483	1884	15761	1323	17058	793	8995
9-#11	1.38	9591	3100	12301	2769	14912	2290	16040	1899	16465	1316	18009	740	10776
9-#14	1.99	10034	3278	13266	2886	16066	2380	17395	1958	18248	1316	20498	633	14771
9-#18	3.54	11093	3727	15621	3184	18908	2610	20741	2110	22668	1316	26604	351	24077
10-#10	1.25	9512	3062	12352	2713	14853	2238	15852	1854	16124	1289	17365	744	9834
10-#11	1.53	9706	3145	12866	2757	15414	2269	16477	1871	16920	1280	18442	686	11726
10-#14	2.21	10189	3342	13948	2887	16720	2365	18010	1932	18933	1276	21217	565	16161
10-#18	3.93	11345	3841	16597	3221	19930	2612	21793	2116	23919	1265	28305	281	26495
11-#10	1.37	9611	3098	12150	2794	14854	2312	16040	1919	16552	1334	18266	763	10766
11-#11	1.69	9824	3189	12703	2844	15457	2348	16719	1941	17416	1327	19450	701	12865
11-#14	2.43	10357	3406	13861	2990	16849	2460	18370	2016	19594	1330	22527	573	17582
11-#18	4.32	11641	3956	16696	3365	20278	2746	22454	2209	24985	1334	30058	236	28389
12-#10	1.50	9724	3134	12231	2841	15036	2345	16294	1944	16923	1349	18879	759	11599
12-#11	1.84	9959	3234	12824	2898	15686	2386	17028	1969	17868	1343	20175	693	13801
12-#14	2.65	10544	3470	14069	3062	17192	2509	18812	2052	20238	1350	23531	556	18969
12-#18	4.72	11947	4070	17111	3479	20903	2823	23225	2263	26117	1364	31741	197	30502
13-#10	1.62	9814	3171	12489	2853	15311	2358	16619	1954	17316	1341	19369	723	12492
13-#11	1.99	10067	3278	13118	2915	16015	2404	17418	1982	18344	1335	20796	652	14900
13-#14	2.87	10699	3534	14464	3090	17654	2539	19364	2074	20923	1340	24454	501	20325
13-#18	5.11	12216	4184	17759	3538	21698	2883	24175	2306	27313	1351	33347	102	32634
14-#10	1.75	9938	3207	12912	2847	15651	2350	16950	1941	17744	1326	19782	694	13327
14-#11	2.15	10215	3323	13592	2913	16408	2399	17819	1971	18879	1321	21311	617	15821
14-#14	3.09	10903	3599	15070	3098	18184	2541	19938	2066	21692	1325	25224	454	21722
14-#18	5.50	12558	4298	18524	3595	22566	2903	25184	2308	28635	1329	34835	29	34658
15-#10	1.87	10015	3243	12862	2906	15795	2399	17179	1985	18093	1349	20483	683	14183
15-#11	2.30	10305	3367	13576	2979	16601	2454	18101	2020	19296	1348	22127	601	16898
15-#14	3.32	11035	3663	15126	3182	18490	2609	20343	2128	22275	1357	26334	426	22984
15-#18	5.89	12805	4412	18932	3699	23110	3018	25894	2400	29646	1376	36804	-16	36576

ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.00	10120	3280	12995	2939	15974	2429	17460	2006	18475	1360	21105	679	14990
16-#11	2.45	10431	3412	13749	3018	16827	2489	18447	2045	19738	1355	22894	596	17800
16-#14	3.54	11215	3727	15394	3235	18827	2658	20844	2162	22897	1365	27381	413	24384
16-#18	6.29	13139	4526	19434	3786	23769	3087	26785	2457	30711	1385	38326	-71	38185
17-#10	2.12	10203	3316	13217	2962	16253	2443	17756	2017	18873	1359	21645	652	15835
17-#11	2.61	10530	3456	14010	3048	17159	2507	18802	2059	20230	1355	23521	560	18809
17-#14	3.76	11352	3791	15753	3281	19293	2685	21341	2183	23612	1367	28307	363	25607
18-#10	2.25	10304	3352	13533	2970	16560	2450	18096	2015	19255	1344	22077	622	16625
18-#11	2.76	10650	3501	14368	3060	17524	2519	19203	2059	20695	1338	24047	524	19734
18-#14	3.98	11519	3856	16221	3304	19797	2708	21909	2187	24285	1346	29074	315	26943
19-#10	2.37	10398	3388	13575	3019	16722	2487	18322	2048	19643	1365	22755	614	17460
19-#11	2.91	10761	3546	14444	3117	17731	2560	19486	2097	21158	1362	24858	512	20687
19-#14	4.20	11673	3920	16375	3378	20113	2762	22322	2236	24931	1375	30198	293	28112
20-#10	2.50	10488	3425	13726	3048	16940	2517	18594	2066	20015	1370	23284	595	18216
20-#11	3.07	10869	3590	14637	3152	17993	2596	19815	2117	21614	1367	25504	489	21614
20-#14	4.42	11827	3984	16667	3428	20486	2810	22791	2264	25586	1383	31131	260	29382
21-#10	2.62	10595	3461	13961	3070	17190	2530	18897	2080	20415	1371	23852	575	19055
21-#11	3.22	10997	3635	14915	3179	18296	2613	20186	2135	22097	1369	26250	471	22554
21-#14	4.64	12005	4048	17052	3468	20918	2837	23322	2291	26271	1384	32189	232	30577
22-#10	2.74	10679	3497	14221	3087	17473	2542	19212	2080	20823	1362	24465	559	19791
22-#11	3.37	11098	3679	15216	3203	18630	2629	20564	2137	22583	1358	26902	443	23476
22-#14	4.86	12148	4113	17454	3507	21381	2864	23860	2297	26964	1370	33105	192	31770
23-#10	2.87	10790	3533	14323	3125	17658	2573	19467	2110	21182	1376	25008	541	20610
23-#11	3.52	11231	3724	15356	3247	18866	2666	20873	2172	23021	1374	27572	421	24378
24-#10	2.99	10875	3570	14470	3160	17865	2600	19746	2127	21550	1380	25599	526	21356
24-#11	3.68	11332	3768	15541	3289	19118	2698	21216	2192	23464	1378	28277	400	25333
25-#10	3.12	10978	3606	14686	3181	18131	2617	20041	2141	21957	1382	26120	502	22142
25-#11	3.83	11458	3813	15795	3315	19437	2719	21571	2209	23959	1381	28904	371	26189
26-#10	3.24	11076	3642	14924	3201	18398	2631	20372	2147	22343	1373	26655	477	22893
26-#11	3.98	11570	3857	16071	3341	19758	2737	21962	2217	24433	1371	29577	342	27082
27-#10	3.37	11171	3678	15076	3231	18598	2660	20613	2172	22721	1387	27275	468	23652
27-#11	4.14	11685	3902	16270	3377	20005	2771	22262	2246	24886	1387	30303	328	27940
28-#10	3.49	11272	3715	15252	3260	18817	2686	20891	2187	23103	1391	27835	445	24410
29-#10	3.62	11364	3751	15440	3287	19084	2698	21185	2202	23496	1393	28376	428	25145
30-#10	3.74	11471	3787	15687	3304	19372	2712	21493	2208	23892	1387	28873	396	25925

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 12" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.10	437	434	674	292	681	238	659	195	592	131	544	59	319
4-#6	1.56	444	449	691	298	700	243	682	197	621	128	575	40	433
4-#7	2.12	452	466	711	307	724	250	709	201	656	123	612	16	565
4-#8	2.79	461	487	734	318	752	258	740	204	695	118	671	-8	659
4-#9	3.54	471	511	758	329	781	268	773	208	737	112	718	-40	711
4-#10	4.49	483	540	789	344	819	280	813	213	788	103	774	-82	771
4-#11	5.52	492	573	814	355	836	284	832	210	813	86	790	-135	799
4-#14	7.96	519	649	882	413	907	309	912	218	916	58	893	-246	911
5-#5	1.37	445	443	689	291	693	235	670	191	609	125	566	53	377
5-#6	1.95	455	461	710	301	719	242	699	193	647	121	609	33	497
5-#7	2.65	467	483	736	312	749	250	733	196	692	115	659	7	636
5-#8	3.49	481	509	766	327	784	260	772	200	744	108	716	-24	732
5-#9	4.42	496	538	797	342	819	270	813	204	799	100	774	-58	792
5-#10	5.61	514	576	836	362	863	283	864	208	866	88	843	-104	878
5-#11	6.90	528	616	864	384	886	288	889	204	901	67	860	-167	921
6-#5	1.64	449	451	707	284	705	228	679	182	617	113	570	35	438
6-#6	2.33	460	473	735	295	737	236	715	185	664	106	621	9	587
6-#7	3.18	473	500	769	314	775	245	759	188	720	97	680	-23	695
6-#8	4.19	489	531	807	332	818	255	808	191	784	86	746	-62	777
6-#9	5.31	506	566	846	351	862	267	860	195	850	73	814	-106	859
6-#10	6.74	529	611	893	376	917	281	924	198	932	55	895	-164	921
7-#5	1.92	457	460	709	307	720	247	704	198	652	125	616	37	494
7-#6	2.72	471	485	739	321	756	257	745	203	705	119	675	9	649
7-#7	3.71	488	516	775	339	798	269	793	208	768	112	757	-22	762
7-#8	4.89	507	553	815	360	847	283	848	214	840	103	839	-64	862
7-#9	6.19	528	594	858	383	898	299	905	221	915	92	921	-113	957
8-#5	2.19	460	469	718	316	734	255	721	204	673	126	647	30	552
8-#6	3.11	476	497	752	333	774	267	768	211	732	120	716	-2	718
8-#7	4.24	494	533	792	353	822	282	824	218	803	112	797	-43	818
8-#8	5.59	516	575	838	378	877	300	886	226	883	102	905	-87	926

ROUND TIED COLUMNS 14" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.14	699	593	1070	411	1096	336	1070	275	979	187	915	88	533
4-#7	1.56	710	611	1097	420	1127	343	1107	279	1026	184	969	68	701
4-#8	2.05	722	632	1127	430	1163	352	1150	284	1081	181	1031	42	891
4-#9	2.60	735	655	1160	442	1202	361	1196	289	1140	176	1096	13	1069
4-#10	3.30	752	685	1201	458	1251	374	1255	296	1213	170	1176	-25	1183
4-#11	4.05	765	717	1239	469	1291	382	1296	298	1258	156	1213	-78	1235
4-#14	5.85	802	793	1332	508	1404	413	1420	311	1416	136	1431	-174	1411
5-#5	1.01	700	587	1072	401	1088	326	1056	267	955	182	890	97	471
5-#6	1.43	713	605	1100	411	1121	333	1095	270	1005	178	949	79	625
5-#7	1.95	728	627	1135	423	1162	341	1143	275	1066	173	1019	55	804
5-#8	2.57	746	654	1174	438	1209	352	1199	280	1136	167	1099	27	1005
5-#9	3.25	766	683	1216	454	1259	363	1258	286	1210	160	1182	-5	1186
5-#10	4.13	790	720	1269	475	1323	378	1330	293	1318	156	1284	-48	1314
5-#11	5.07	810	760	1314	491	1372	388	1376	292	1380	139	1370	-97	1395
5-#14	7.31	866	856	1432	543	1508	422	1532	305	1588	111	1587	-213	1645
6-#5	1.21	704	596	1098	388	1105	315	1068	256	966	168	899	78	541
6-#6	1.71	719	617	1134	399	1150	323	1118	259	1030	162	973	55	731
6-#7	2.34	736	644	1178	413	1203	334	1178	264	1107	155	1060	25	953
6-#8	3.08	757	675	1229	430	1263	346	1247	269	1196	147	1160	-11	1166
6-#9	3.90	779	710	1283	449	1327	359	1320	274	1290	136	1264	-50	1287
6-#10	4.95	806	755	1352	473	1406	376	1412	281	1407	123	1392	-103	1382
6-#11	6.08	829	803	1412	507	1459	385	1471	280	1484	99	1456	-171	1466

ROUND TIED COLUMNS 14" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
7-#5	1.41	714	604	1095	418	1124	339	1100	276	1017	185	970	86	624
7-#6	2.00	733	630	1135	433	1171	350	1155	282	1089	181	1056	61	825
7-#7	2.73	755	661	1182	451	1227	363	1222	289	1176	175	1159	31	1055
7-#8	3.59	781	697	1237	474	1293	379	1299	297	1276	169	1275	-7	1280
7-#9	4.55	810	738	1296	498	1363	396	1382	307	1382	161	1397	-50	1426
7-#10	5.78	846	790	1370	530	1450	418	1485	318	1514	151	1545	-107	1598
7-#11	7.09	873	846	1431	555	1517	433	1553	320	1603	128	1660	-176	1697
8-#5	1.61	719	613	1107	430	1142	349	1123	284	1046	187	1015	81	691
8-#6	2.29	739	642	1153	447	1195	362	1186	291	1127	183	1115	53	924
8-#7	3.12	764	677	1207	469	1259	378	1261	300	1224	177	1234	18	1187
8-#8	4.11	793	719	1269	495	1333	397	1348	311	1336	171	1369	-25	1381
8-#9	5.20	823	766	1335	523	1412	418	1441	323	1455	162	1510	-75	1539
8-#10	6.60	862	825	1417	559	1511	445	1558	337	1603	151	1682	-140	1727

ROUND TIED COLUMNS 16" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#7	1.19	1049	777	1598	551	1654	452	1626	371	1503	253	1431	123	836
4-#8	1.57	1065	798	1637	562	1699	460	1679	376	1575	250	1514	100	1069
4-#9	1.99	1082	822	1678	574	1747	470	1736	381	1652	248	1602	74	1316
4-#10	2.53	1103	851	1729	590	1808	483	1809	389	1750	244	1711	40	1616
4-#11	3.10	1121	884	1780	600	1861	491	1869	391	1816	232	1776	-7	1778
4-#14	4.48	1169	960	1899	641	2005	523	2041	409	2031	217	2011	-104	2030
4-#18	7.96	1283	1154	2178	744	2346	605	2434	450	2516	171	2516	-372	2542
5-#6	1.09	1052	772	1607	539	1648	438	1611	359	1477	245	1400	132	756
5-#7	1.49	1072	794	1651	551	1699	447	1671	364	1555	241	1494	111	976
5-#8	1.96	1094	820	1700	566	1758	458	1740	370	1645	236	1602	85	1225
5-#9	2.49	1118	849	1754	583	1821	470	1815	377	1742	231	1716	56	1485
5-#10	3.16	1149	887	1821	604	1901	486	1911	385	1863	224	1857	18	1798
5-#11	3.88	1175	927	1882	620	1968	496	1987	388	1950	208	1942	-34	1965
5-#14	5.60	1246	1022	2036	675	2154	535	2202	406	2252	195	2241	-143	2317
6-#6	1.31	1060	784	1653	521	1680	423	1641	345	1502	227	1396	101	876
6-#7	1.79	1082	811	1707	535	1746	434	1718	350	1601	221	1503	72	1147
6-#8	2.36	1107	842	1770	552	1824	447	1807	357	1715	214	1626	38	1457
6-#9	2.98	1135	877	1838	571	1907	461	1903	363	1837	205	1815	10	1786
6-#10	3.79	1170	922	1923	595	2014	480	2022	372	1990	194	1991	-39	1943
6-#11	4.66	1199	970	2002	616	2100	493	2110	373	2103	174	2102	-104	2069
6-#14	6.71	1280	1084	2203	678	2332	536	2378	391	2446	139	2475	-238	2440
7-#5	1.08	1054	771	1597	549	1651	447	1619	367	1491	252	1428	139	749
7-#6	1.53	1077	796	1646	563	1709	458	1687	373	1583	250	1541	117	1007
7-#7	2.09	1105	827	1705	582	1781	471	1770	381	1694	246	1678	90	1292
7-#8	2.75	1137	864	1773	604	1864	488	1867	390	1823	242	1835	56	1616
7-#9	3.48	1172	905	1847	629	1952	506	1972	400	1961	236	2001	18	1942
7-#10	4.42	1216	957	1939	661	2064	529	2104	413	2133	229	2206	-33	2225
7-#11	5.43	1256	1013	2026	688	2156	546	2210	420	2261	211	2335	-103	2390
7-#14	7.83	1360	1147	2242	770	2413	603	2514	449	2648	184	2770	-247	2797
8-#5	1.23	1060	780	1608	562	1674	459	1649	376	1527	256	1487	136	831
8-#6	1.75	1085	808	1664	579	1740	472	1726	384	1629	253	1619	111	1118
8-#7	2.39	1116	844	1732	601	1821	489	1820	394	1753	249	1776	80	1454
8-#8	3.14	1152	886	1811	627	1914	509	1930	406	1898	245	1958	41	1832
8-#9	3.98	1191	932	1896	657	2015	531	2048	419	2053	239	2150	-2	2151
8-#10	5.05	1239	992	2003	695	2141	559	2197	435	2248	232	2387	-60	2408
8-#11	6.21	1281	1056	2100	727	2245	581	2317	444	2393	212	2541	-140	2585
9-#10	5.68	1276	1027	2061	714	2220	568	2298	439	2383	225	2510	-95	2552
9-#11	6.98	1323	1099	2168	751	2345	593	2434	449	2550	204	2721	-175	2737
10-#10	6.32	1303	1062	2145	722	2310	574	2403	439	2507	204	2636	-140	2679

ROUND TIED COLUMNS 18" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#8	1.24	1501	987	2276	712	2376	584	2348	480	2188	328	2116	163	1246
4-#9	1.57	1522	1010	2326	724	2433	594	2417	485	2280	325	2227	139	1541
4-#10	2.00	1548	1040	2388	740	2507	607	2503	493	2397	322	2367	108	1906
4-#11	2.45	1570	1072	2453	750	2573	614	2577	496	2496	314	2460	65	2263
4-#14	3.54	1631	1149	2598	791	2748	648	2786	515	2774	304	2771	-23	2775
4-#18	6.29	1774	1342	2943	897	3167	733	3289	564	3403	269	3467	-264	3469
5-#7	1.18	1509	983	2300	698	2378	568	2338	466	2165	317	2085	171	1152
5-#8	1.55	1536	1009	2360	713	2448	579	2421	472	2276	314	2222	147	1449
5-#9	1.96	1565	1038	2425	730	2525	591	2512	479	2397	309	2367	121	1761
5-#10	2.50	1602	1075	2506	751	2622	607	2626	488	2549	304	2549	86	2150
5-#11	3.07	1635	1116	2585	767	2707	618	2723	491	2664	290	2672	39	2530
5-#14	4.42	1722	1211	2775	823	2935	658	2995	513	3009	272	3072	-59	3108
5-#18	7.86	1928	1453	3220	963	3477	759	3636	565	3807	216	3957	-328	4079
6-#6	1.04	1494	973	2309	660	2353	537	2295	441	2097	299	1953	158	1021
6-#7	1.41	1521	999	2373	674	2431	548	2389	447	2217	294	2088	131	1342
6-#8	1.86	1552	1031	2448	691	2523	561	2500	454	2357	288	2244	99	1710
6-#9	2.36	1585	1066	2529	710	2623	576	2620	462	2507	281	2410	62	2103
6-#10	2.99	1627	1111	2632	734	2749	594	2773	473	2697	272	2618	15	2572
6-#11	3.68	1664	1159	2730	754	2863	609	2889	476	2846	254	2864	-31	2784
6-#14	5.31	1763	1273	2973	818	3167	657	3230	498	3281	225	3361	-157	3276
7-#6	1.21	1514	985	2289	712	2388	580	2360	477	2198	327	2130	175	1188
7-#7	1.65	1548	1016	2359	730	2473	594	2460	485	2332	324	2296	149	1536
7-#8	2.17	1587	1053	2441	753	2572	611	2576	495	2488	321	2514	122	1925
7-#9	2.75	1629	1093	2529	778	2680	630	2703	506	2658	317	2725	87	2337
7-#10	3.49	1682	1146	2641	810	2816	654	2863	520	2873	312	2988	41	2832
7-#11	4.29	1730	1202	2750	838	2938	673	2998	527	3049	298	3174	-22	3188
7-#14	6.19	1855	1336	3013	920	3256	733	3374	561	3539	279	3755	-152	3761
8-#6	1.38	1524	997	2306	730	2427	597	2408	490	2257	332	2242	174	1314
8-#7	1.89	1561	1033	2386	752	2524	615	2521	500	2405	329	2439	145	1715
8-#8	2.48	1604	1075	2480	778	2637	635	2653	513	2579	326	2668	111	2172
8-#9	3.14	1652	1121	2582	807	2759	658	2796	527	2768	322	2912	71	2659
8-#10	3.99	1711	1181	2710	846	2913	687	2977	545	3006	316	3216	19	3154
8-#11	4.90	1763	1245	2838	879	3047	710	3131	555	3207	302	3435	-53	3453
8-#14	7.07	1902	1398	3144	977	3407	783	3555	598	3762	282	4107	-202	4143
9-#10	4.49	1756	1216	2788	866	3000	694	3094	547	3175	311	3373	-16	3381
9-#11	5.52	1816	1288	2923	904	3156	720	3275	560	3406	296	3613	-96	3657
10-#10	4.99	1787	1251	2893	872	3110	699	3214	545	3335	292	3528	-57	3547
10-#11	6.13	1853	1331	3044	913	3284	728	3419	559	3583	270	3796	-149	3841
11-#10	5.49	1828	1286	2930	918	3193	735	3321	573	3478	310	3794	-66	3817
11-#11	6.74	1902	1375	3095	967	3382	768	3542	590	3760	291	4097	-162	4089
12-#10	5.99	1865	1321	2995	945	3279	760	3441	594	3618	310	3969	-97	3990

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 20" DIA.

Short columns – no sidesway f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.01	2043	1198	3062	882	3211	724	3176	597	2944	415	2851	232	1423
4-#9	1.27	2068	1222	3120	893	3279	733	3255	603	3050	412	2987	210	1765
4-#10	1.62	2099	1251	3193	909	3364	746	3356	610	3186	410	3157	181	2191
4-#11	1.99	2126	1283	3272	918	3444	753	3444	613	3303	401	3279	140	2614
4-#14	2.86	2199	1360	3445	960	3650	787	3689	633	3635	393	3668	59	3501
4-#18	5.09	2371	1553	3856	1067	4147	875	4284	684	4437	372	4559	-161	4552
5-#8	1.26	2083	1220	3168	878	3299	715	3260	586	3043	398	2973	215	1679
5-#9	1.59	2118	1249	3245	895	3388	727	3365	593	3184	395	3150	190	2047
5-#10	2.02	2161	1287	3341	916	3502	743	3500	602	3363	390	3373	158	2498
5-#11	2.48	2201	1327	3438	932	3605	754	3616	606	3517	380	3535	114	2950
5-#14	3.58	2304	1422	3664	988	3877	795	3938	629	3939	365	4039	24	3945
5-#18	6.37	2551	1664	4201	1132	4527	900	4713	687	4923	320	5183	-221	5266
6-#7	1.15	2065	1210	3193	831	3275	677	3212	554	2970	376	2798	195	1538
6-#8	1.51	2102	1242	3280	847	3381	690	3340	562	3136	370	2987	165	1964
6-#9	1.91	2141	1277	3374	866	3497	704	3480	570	3315	364	3191	131	2422
6-#10	2.43	2190	1322	3494	891	3644	723	3657	581	3542	356	3446	86	2992
6-#11	2.98	2235	1370	3612	910	3780	737	3817	587	3727	340	3634	26	3542
6-#14	4.30	2353	1484	3898	974	4137	786	4239	613	4256	316	4208	-98	4243
6-#18	7.64	2634	1775	4587	1137	4998	911	5209	671	5496	246	5798	-388	5566
7-#7	1.34	2096	1227	3161	898	3323	732	3306	601	3103	408	3065	217	1788
7-#8	1.76	2142	1264	3257	920	3439	749	3444	612	3283	405	3297	188	2242
7-#9	2.23	2191	1305	3360	945	3564	768	3592	623	3493	405	3547	154	2725
7-#10	2.83	2253	1357	3490	978	3723	792	3780	638	3745	401	3860	110	3324
7-#11	3.48	2311	1413	3622	1005	3872	811	3944	646	3964	390	4150	60	3897
7-#14	5.01	2459	1547	3933	1088	4255	874	4392	683	4566	377	4879	-60	4906
8-#7	1.53	2112	1244	3186	921	3384	755	3380	619	3201	418	3237	216	1978
8-#8	2.01	2163	1286	3295	948	3517	776	3535	632	3404	415	3513	184	2511
8-#9	2.55	2217	1332	3414	977	3663	800	3703	647	3625	412	3810	147	3080
8-#10	3.23	2286	1392	3563	1015	3845	830	3916	666	3905	408	4182	100	3788
8-#11	3.97	2352	1456	3716	1048	4009	853	4103	677	4149	396	4467	34	4346
8-#14	5.73	2517	1609	4075	1146	4439	929	4609	723	4817	381	5310	-102	5327
9-#10	3.64	2343	1427	3658	1035	3940	835	4043	667	4103	404	4372	65	4086
9-#11	4.47	2415	1499	3826	1073	4128	862	4262	680	4384	390	4688	-9	4693
9-#14	6.45	2605	1671	4221	1185	4613	944	4843	730	5150	374	5618	-163	5662
10-#10	4.04	2377	1462	3792	1039	4069	837	4183	662	4278	382	4555	25	4456
10-#11	4.97	2457	1542	3974	1081	4280	867	4429	677	4608	366	4906	-59	4926
10-#14	7.16	2664	1733	4420	1201	4827	956	5084	730	5466	342	5933	-235	5962
11-#10	4.45	2426	1497	3823	1088	4160	876	4311	694	4462	405	4880	19	4797
11-#11	5.46	2514	1586	4022	1137	4393	911	4577	712	4806	389	5277	-69	5300
12-#10	4.85	2468	1532	3898	1117	4260	903	4443	715	4628	407	5093	-8	5095
12-#11	5.96	2565	1629	4112	1171	4512	943	4740	738	5000	390	5523	-105	5543
13-#10	5.26	2514	1568	3993	1141	4378	915	4579	721	4813	403	5339	-36	5348
14-#10	5.66	2562	1603	4103	1151	4508	926	4731	726	5024	399	5505	-75	5517

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 22" DIA.

Short columns – no sidesway f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.05	2731	1455	4076	1081	4300	888	4269	733	3980	509	3896	285	1988
4-#10	1.34	2767	1485	4160	1097	4398	901	4384	741	4134	506	4097	258	2474
4-#11	1.64	2799	1517	4254	1106	4491	908	4486	743	4269	498	4248	220	2964
4-#14	2.37	2884	1593	4455	1147	4728	942	4767	763	4648	491	4715	144	4105
4-#18	4.21	3088	1787	4933	1255	5304	1030	5454	816	5579	473	5805	-60	5801
5-#8	1.04	2747	1453	4141	1061	4326	866	4273	713	3966	493	3870	288	1913
5-#9	1.32	2787	1482	4230	1078	4429	878	4394	720	4127	489	4079	265	2335
5-#10	1.67	2837	1520	4341	1100	4560	894	4548	730	4332	485	4343	235	2852
5-#11	2.05	2884	1560	4457	1115	4681	905	4684	733	4511	475	4546	193	3376
5-#14	2.96	3004	1655	4721	1171	4996	947	5056	757	5009	463	5154	109	4598
5-#18	5.26	3291	1897	5349	1317	5754	1054	5959	819	6199	429	6562	-118	6609
6-#8	1.25	2769	1475	4281	1021	4417	832	4353	681	4068	461	3871	235	2219
6-#9	1.58	2814	1510	4389	1040	4549	847	4511	690	4276	455	4111	203	2741
6-#10	2.00	2871	1555	4526	1064	4717	866	4714	700	4539	449	4414	161	3394
6-#11	2.46	2924	1603	4664	1083	4875	880	4899	706	4762	434	4649	105	4049
6-#14	3.55	3060	1718	4994	1147	5283	929	5392	735	5385	413	5345	-12	5349
6-#18	6.31	3389	2008	5791	1311	6279	1055	6581	805	6863	353	6948	-327	6983
7-#7	1.10	2762	1460	4126	1084	4351	885	4325	730	4040	504	3981	292	2024
7-#8	1.45	2814	1497	4235	1106	4482	902	4481	741	4246	501	4254	264	2568
7-#9	1.84	2871	1538	4354	1131	4625	921	4652	752	4470	498	4549	232	3124
7-#10	2.34	2943	1590	4504	1164	4807	946	4870	768	4755	494	4921	191	3813
7-#11	2.87	3009	1646	4659	1190	4981	965	5066	777	5033	489	5213	135	4496
7-#14	4.14	3181	1780	5018	1274	5422	1028	5587	815	5731	479	6155	33	6004
7-#18	7.37	3595	2119	5881	1489	6492	1190	6839	909	7413	447	8191	-269	8092
8-#7	1.26	2780	1477	4147	1110	4416	910	4415	751	4156	516	4185	292	2245
8-#8	1.66	2838	1519	4272	1136	4568	931	4592	764	4389	514	4509	262	2854
8-#9	2.10	2901	1565	4407	1165	4734	955	4786	779	4642	512	4858	228	3505
8-#10	2.67	2980	1625	4578	1203	4945	986	5031	799	4965	509	5298	184	4319
8-#11	3.28	3054	1689	4757	1236	5148	1011	5252	811	5251	497	5652	122	5126
8-#14	4.74	3250	1842	5169	1334	5649	1088	5841	859	6026	486	6667	-3	6668
9-#10	3.01	3047	1660	4690	1222	5056	990	5168	798	5191	504	5522	150	4718
9-#11	3.69	3132	1733	4887	1260	5276	1017	5423	812	5522	492	5914	81	5527
9-#14	5.33	3353	1904	5346	1373	5836	1101	6094	864	6412	480	7037	-63	7056
10-#10	3.34	3085	1695	4856	1223	5206	990	5326	791	5375	479	5730	111	5216
10-#11	4.10	3178	1776	5071	1265	5453	1020	5614	807	5758	465	6167	32	6029
10-#14	5.92	3419	1967	5588	1387	6087	1112	6371	862	6772	446	7406	-131	7422
11-#10	3.68	3142	1731	4879	1277	5303	1032	5478	827	5593	505	6068	99	5591
11-#11	4.51	3245	1819	5112	1326	5575	1068	5789	846	6008	493	6611	25	6494
11-#14	6.51	3513	2029	5664	1465	6262	1172	6606	911	7098	480	8003	-147	7928
12-#10	4.01	3189	1766	4962	1307	5418	1060	5621	848	5799	511	6370	83	6001
12-#11	4.92	3302	1862	5214	1361	5711	1101	5966	872	6239	496	6902	-8	6904
13-#10	4.34	3243	1801	5069	1330	5554	1073	5777	854	5997	506	6657	55	6387
13-#11	5.33	3366	1905	5342	1391	5872	1117	6152	879	6487	492	7239	-42	7249
14-#10	4.68	3295	1836	5199	1339	5697	1082	5955	859	6196	490	6850	18	6771
14-#11	5.75	3429	1948	5492	1404	6048	1130	6363	886	6776	487	7468	-89	7479
15-#10	5.01	3344	1871	5265	1384	5801	1113	6082	882	6426	513	7198	3	7181
16-#10	5.35	3403	1906	5348	1410	5930	1140	6231	901	6630	519	7545	-5	7545

ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.12	3563	1740	5304	1304	5626	1072	5606	884	5258	613	5202	341	2757
4-#11	1.38	3601	1772	5414	1312	5733	1078	5722	886	5409	604	5381	305	3312
4-#14	1.99	3699	1849	5643	1353	6001	1112	6039	906	5837	598	5928	234	4609
4-#18	3.54	3934	2042	6189	1461	6655	1201	6818	961	6890	582	7218	42	7087
5-#9	1.11	3585	1738	5394	1279	5664	1044	5615	860	5243	593	5170	345	2628
5-#10	1.40	3642	1775	5521	1301	5812	1061	5788	869	5473	589	5475	316	3213
5-#11	1.72	3696	1815	5658	1316	5951	1070	5944	873	5678	579	5717	277	3810
5-#14	2.49	3833	1911	5959	1373	6309	1113	6367	898	6242	568	6431	198	5199
5-#18	4.42	4163	2153	6681	1519	7178	1222	7397	961	7619	540	8106	-14	8113
6-#8	1.05	3564	1731	5469	1213	5648	990	5556	813	5164	559	4908	311	2475
6-#9	1.33	3616	1766	5591	1231	5796	1004	5733	821	5405	555	5186	280	3062
6-#10	1.68	3681	1810	5745	1256	5984	1023	5960	832	5706	549	5537	240	3797
6-#11	2.07	3741	1859	5904	1274	6164	1036	6170	838	5965	535	5819	187	4542
6-#14	2.98	3897	1973	6277	1338	6625	1085	6726	866	6683	517	6637	77	6281
6-#18	5.31	4274	2264	7184	1502	7754	1212	8091	940	8401	465	8548	-219	8570
7-#8	1.22	3615	1753	5393	1311	5719	1071	5712	882	5383	607	5375	346	2891
7-#9	1.55	3679	1793	5527	1336	5880	1089	5904	894	5636	604	5715	316	3531
7-#10	1.97	3761	1846	5696	1368	6085	1114	6148	910	5958	601	6145	276	4313
7-#11	2.41	3837	1902	5876	1394	6283	1133	6377	920	6248	589	6495	223	5094
7-#14	3.48	4033	2035	6283	1478	6783	1197	6975	960	7030	578	7498	115	6928
7-#18	6.19	4506	2374	7267	1695	7999	1360	8411	1059	8997	563	10017	-153	9878
8-#8	1.40	3642	1774	5425	1343	5813	1102	5844	909	5549	622	5594	336	3201
8-#9	1.77	3713	1821	5577	1372	5999	1126	6062	924	5835	620	5983	302	3936
8-#10	2.25	3803	1881	5769	1410	6235	1157	6340	944	6199	618	6581	273	4855
8-#11	2.76	3888	1945	5975	1442	6468	1182	6594	957	6528	607	7003	215	5777
8-#14	3.98	4106	2098	6441	1541	7047	1262	7266	1007	7411	599	8192	97	7765
8-#18	7.07	4640	2485	7571	1794	8433	1461	8891	1131	9551	572	10982	-222	10942
9-#10	2.53	3880	1916	5901	1427	6367	1161	6486	942	6447	612	6837	239	5348
9-#11	3.10	3979	1988	6127	1465	6619	1188	6778	956	6834	602	7306	173	6305
9-#14	4.48	4231	2160	6646	1578	7255	1273	7538	1009	7850	593	8624	39	8427
9-#18	7.96	4841	2596	7906	1866	8799	1487	9389	1143	10307	563	11708	-326	11647
10-#10	2.81	3923	1951	6097	1426	6538	1158	6663	933	6645	585	7068	200	5881
10-#11	3.45	4030	2031	6349	1468	6821	1188	6992	949	7082	572	7590	126	6976
10-#14	4.97	4304	2222	6939	1591	7541	1281	7851	1006	8231	556	9046	-27	9049
11-#10	3.09	3987	1986	6112	1484	6641	1203	6834	972	6898	615	7466	191	6349
11-#11	3.79	4106	2074	6381	1533	6951	1239	7194	992	7373	604	8043	111	7463
11-#14	5.47	4412	2284	7007	1673	7728	1345	8123	1060	8618	595	9649	-54	9657
12-#10	3.37	4039	2021	6204	1516	6769	1233	6993	994	7131	621	7814	177	6879
12-#11	4.14	4169	2118	6494	1570	7104	1273	7386	1018	7653	610	8450	92	8007
12-#14	5.97	4501	2347	7172	1723	7945	1392	8398	1095	8994	600	10210	-86	10206
13-#10	3.65	4100	2056	6323	1537	6924	1245	7169	1000	7358	617	8143	150	7316
13-#11	4.48	4242	2161	6636	1598	7288	1289	7597	1026	7918	605	8839	58	8531
13-#14	6.47	4604	2409	7373	1766	8204	1416	8697	1107	9384	594	10757	-134	10738
14-#10	3.93	4159	2092	6474	1545	7081	1252	7363	1003	7580	600	8362	113	7790
14-#11	4.83	4312	2204	6810	1609	7481	1300	7836	1032	8188	585	9101	13	9040

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#10	4.21	4214	2127	6540	1591	7198	1286	7515	1029	7814	619	8764	100	8232
15-#11	5.17	4378	2247	6899	1664	7621	1338	8008	1059	8496	613	9568	-5	9569
16-#10	4.49	4280	2162	6632	1618	7339	1313	7684	1050	8064	631	9162	94	8689
16-#11	5.52	4458	2290	7012	1696	7793	1372	8208	1084	8769	620	10037	-15	10036
17-#10	4.77	4331	2197	6764	1639	7481	1326	7850	1056	8287	625	9437	58	9123
18-#10	5.05	4401	2232	6895	1657	7643	1340	8030	1061	8544	620	9727	35	9553

ROUND TIED COLUMNS 26" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.18	4543	2050	6767	1536	7185	1263	7169	1041	6741	720	6693	396	3660
4-#14	1.70	4654	2126	7024	1577	7485	1297	7522	1062	7216	714	7320	328	5112
4-#18	3.01	4921	2320	7640	1685	8218	1387	8393	1118	8392	699	8812	146	8287
5-#10	1.20	4588	2053	6895	1520	7276	1242	7239	1021	6804	702	6783	404	3580
5-#11	1.47	4648	2093	7053	1535	7434	1251	7414	1024	7033	691	7065	366	4250
5-#14	2.12	4803	2189	7395	1592	7836	1294	7888	1050	7664	682	7885	291	5809
5-#18	3.77	5175	2431	8212	1739	8814	1404	9046	1115	9210	656	9829	91	9367
6-#9	1.13	4558	2043	6995	1440	7255	1175	7163	965	6701	661	6428	363	3383
6-#10	1.44	4630	2088	7167	1464	7464	1194	7413	976	7042	656	6828	325	4201
6-#11	1.76	4699	2136	7347	1482	7666	1207	7648	981	7352	644	7157	274	5035
6-#14	2.54	4875	2251	7764	1546	8180	1256	8267	1010	8165	628	8098	169	6988
6-#18	4.52	5301	2541	8781	1710	9442	1384	9792	1084	10125	583	10322	-112	10334
7-#9	1.32	4628	2071	6894	1559	7347	1273	7366	1049	6992	720	7058	405	3949
7-#10	1.67	4719	2123	7083	1591	7575	1298	7637	1065	7351	717	7547	367	4824
7-#11	2.06	4806	2179	7288	1616	7798	1316	7893	1074	7678	706	7956	317	5705
7-#14	2.97	5026	2313	7744	1701	8355	1381	8561	1115	8555	696	9109	214	7766
7-#18	5.27	5559	2652	8850	1918	9719	1546	10195	1219	10771	686	11836	-62	11848
8-#9	1.51	4666	2099	6939	1598	7474	1304	7550	1082	7220	738	7348	391	4371
8-#10	1.91	4767	2158	7153	1636	7736	1332	7861	1103	7626	736	7903	349	5396
8-#11	2.35	4863	2223	7387	1667	7997	1368	8148	1116	7997	726	8534	312	6433
8-#14	3.39	5107	2375	7906	1766	8642	1447	8903	1167	8988	720	9899	201	8869
8-#18	6.03	5714	2763	9172	2019	10226	1653	10738	1295	11402	700	13131	-99	13110
9-#10	2.15	4853	2194	7305	1652	7889	1347	8016	1098	7890	729	8326	332	5993
9-#11	2.64	4966	2266	7561	1689	8174	1373	8343	1113	8328	720	8878	270	7074
9-#14	3.81	5251	2438	8141	1802	8885	1459	9193	1167	9478	714	10392	143	9582
9-#18	6.78	5941	2873	9554	2091	10621	1676	11271	1304	12255	692	13971	-201	13949
10-#10	2.39	4901	2229	7531	1646	8081	1340	8209	1087	8103	700	8583	294	6556
10-#11	2.94	5022	2309	7820	1688	8402	1371	8580	1103	8595	687	9191	223	7790
10-#14	4.24	5330	2500	8487	1812	9208	1465	9541	1161	9879	674	10863	78	10472
10-#18	7.53	6077	2984	10088	2126	11174	1702	11889	1307	13020	634	14815	-315	14725
11-#10	2.63	4972	2264	7540	1709	8189	1389	8398	1129	8395	733	9032	286	7121
11-#11	3.23	5108	2352	7844	1758	8538	1425	8806	1150	8929	723	9717	211	8400
11-#14	4.66	5452	2562	8545	1899	9406	1532	9851	1220	10323	716	11562	55	11254
12-#10	2.87	5030	2299	7638	1743	8331	1410	8576	1153	8648	739	9413	273	7682
12-#11	3.53	5177	2395	7967	1797	8709	1461	9017	1177	9238	730	10179	194	9110
12-#14	5.09	5550	2624	8726	1951	9648	1581	10146	1255	10762	726	12202	27	12067
13-#10	3.11	5098	2334	7770	1764	8502	1432	8772	1158	8909	737	9793	247	8209
13-#11	3.82	5259	2438	8124	1824	8916	1477	9253	1184	9542	726	10620	161	9668
13-#14	5.51	5667	2687	8947	1993	9940	1605	10482	1267	11185	719	12824	-21	12823

ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	3.35	5163	2369	7944	1769	8677	1437	8981	1159	9155	719	10053	213	8790
14-#11	4.11	5336	2482	8324	1833	9125	1485	9511	1188	9840	706	10915	117	10281
14-#14	5.93	5776	2749	9217	2012	10242	1623	10861	1278	11619	692	13253	-84	13240
15-#10	3.59	5226	2404	8020	1812	8806	1473	9152	1187	9411	739	10494	199	9282
15-#11	4.41	5411	2525	8413	1890	9281	1526	9713	1219	10150	728	11449	101	10878
16-#10	3.83	5298	2439	8109	1846	8958	1490	9348	1210	9646	741	10819	179	9856
16-#11	4.70	5498	2568	8537	1923	9468	1560	9939	1245	10483	743	11978	93	11475
17-#10	4.07	5356	2475	8258	1866	9117	1515	9527	1215	9939	747	11252	159	10306
17-#11	5.00	5567	2611	8713	1948	9658	1576	10160	1252	10780	736	12347	49	12060
18-#10	4.31	5433	2510	8404	1883	9304	1528	9727	1220	10215	740	11587	138	10820
18-#11	5.29	5659	2654	8886	1971	9875	1593	10401	1260	11123	729	12736	21	12624
19-#10	4.54	5483	2545	8494	1919	9425	1550	9906	1243	10446	749	11948	113	11312
20-#10	4.78	5551	2580	8598	1952	9575	1570	10086	1262	10711	756	12327	99	11783

ROUND TIED COLUMNS 28" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.01	5637	2350	8329	1780	8867	1451	8845	1210	8281	845	8168	490	4006
4-#14	1.46	5761	2426	8614	1821	9198	1498	9234	1231	8803	840	8891	426	5614
4-#18	2.60	6060	2620	9301	1929	10011	1588	10196	1287	10101	826	10603	255	9416
5-#10	1.03	5685	2353	8482	1758	8969	1438	8917	1186	8340	824	8281	498	3953
5-#11	1.27	5753	2393	8659	1772	9146	1447	9112	1189	8593	814	8603	461	4698
5-#14	1.83	5925	2489	9039	1828	9592	1490	9636	1215	9290	805	9530	389	6428
5-#18	3.25	6341	2731	9958	1977	10680	1601	10923	1282	11005	781	11744	199	10522
6-#10	1.24	5732	2388	8808	1691	9174	1380	9092	1131	8570	771	8301	415	4606
6-#11	1.52	5810	2436	9010	1708	9397	1392	9351	1136	8920	760	8678	366	5530
6-#14	2.19	6005	2551	9471	1771	9964	1441	10033	1165	9846	747	9743	265	7696
6-#18	3.90	6481	2841	10598	1935	11360	1569	11718	1240	12048	707	12280	-3	12280
7-#9	1.14	5729	2371	8472	1801	9043	1468	9056	1216	8555	845	8576	498	4335
7-#10	1.44	5830	2423	8681	1833	9294	1497	9354	1232	8951	842	9127	463	5346
7-#11	1.77	5927	2479	8910	1857	9542	1515	9637	1241	9314	831	9609	415	6328
7-#14	2.56	6171	2613	9416	1942	10157	1579	10374	1282	10286	823	10913	317	8619
7-#18	4.55	6765	2952	10645	2159	11668	1745	12189	1389	12668	800	14021	55	13709
8-#9	1.30	5771	2399	8509	1844	9178	1506	9263	1253	8813	865	8908	488	4811
8-#10	1.65	5883	2458	8745	1881	9466	1534	9610	1274	9261	864	9523	446	5943
8-#11	2.03	5990	2523	9006	1911	9755	1555	9931	1287	9674	854	10075	392	7095
8-#14	2.92	6261	2675	9581	2010	10466	1649	10769	1339	10773	850	11568	280	9798
8-#18	5.20	6921	3063	10982	2263	12215	1854	12816	1472	13461	835	15480	25	15359
9-#10	1.86	5979	2494	8919	1895	9638	1542	9773	1267	9540	855	9990	429	6663
9-#11	2.28	6105	2566	9205	1931	9957	1574	10137	1282	10025	846	10638	371	7859
9-#14	3.29	6424	2737	9847	2044	10745	1660	11076	1337	11295	842	12356	251	10689
9-#18	5.85	7195	3173	11413	2334	12673	1880	13381	1477	14410	828	16434	-76	16426
10-#10	2.06	6032	2529	9178	1884	9855	1538	9983	1253	9767	824	10289	392	7240
10-#11	2.53	6167	2609	9500	1925	10212	1568	10396	1269	10312	811	10984	325	8615
10-#14	3.65	6510	2800	10237	2050	11106	1663	11459	1328	11732	799	12874	187	11834
10-#18	6.50	7342	3284	12034	2368	13290	1903	14067	1478	15217	765	17377	-185	17319

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#10	2.27	6111	2564	9174	1953	9966	1586	10190	1299	10100	860	10780	385	7911
11-#11	2.79	6262	2652	9516	2002	10354	1626	10642	1320	10693	851	11571	315	9340
11-#14	4.02	6645	2862	10292	2143	11313	1734	11796	1390	12234	846	13672	167	12666
11-#18	7.15	7576	3395	12183	2504	13666	2008	14627	1568	16014	830	18638	-235	18536
12-#10	2.48	6174	2599	9281	1989	10122	1613	10387	1324	10373	867	11207	374	8498
12-#11	3.04	6338	2695	9648	2043	10542	1651	10877	1348	11026	858	12073	298	10091
12-#14	4.38	6753	2924	10490	2198	11580	1785	12123	1428	12707	856	14375	141	13596
13-#10	2.68	6249	2634	9425	2008	10307	1629	10604	1329	10664	865	11629	348	9124
13-#11	3.29	6428	2738	9820	2068	10768	1679	11137	1355	11372	855	12576	267	10769
13-#14	4.75	6881	2986	10731	2238	11904	1809	12495	1440	13193	851	15089	95	14504
14-#10	2.89	6320	2669	9624	2011	10501	1637	10827	1328	10936	847	11907	314	9734
14-#11	3.55	6513	2781	10049	2076	10999	1685	11414	1357	11699	834	12923	225	11532
14-#14	5.12	7001	3049	11036	2255	12232	1824	12903	1448	13671	824	15567	34	15377
15-#10	3.09	6390	2704	9698	2057	10643	1671	11019	1358	11215	868	12412	302	10318
15-#11	3.80	6597	2825	10152	2128	11171	1729	11640	1391	12035	858	13503	208	12179
15-#14	5.48	7119	3111	11183	2333	12475	1880	13213	1490	14140	854	16390	9	16339
16-#10	3.30	6468	2739	9794	2092	10806	1694	11241	1383	11476	870	12777	284	10925
16-#11	4.05	6692	2868	10271	2169	11371	1750	11899	1418	12345	860	13932	183	12892
16-#14	5.85	7254	3173	11379	2380	12765	1928	13569	1527	14658	875	16986	-31	16967
17-#10	3.51	6533	2775	9959	2112	10982	1712	11432	1387	11799	877	13255	264	11482
17-#11	4.31	6768	2911	10466	2194	11581	1780	12135	1425	12734	867	14505	159	13498
18-#10	3.71	6618	2810	10122	2127	11190	1719	11652	1392	12092	868	13602	242	12096
18-#11	4.56	6871	2954	10658	2215	11829	1796	12401	1432	13100	859	14950	133	14162
19-#10	3.92	6675	2845	10216	2165	11322	1754	11846	1416	12351	879	14021	220	12638
19-#11	4.81	6937	2997	10779	2259	11989	1823	12637	1460	13404	870	15426	103	14803
20-#10	4.13	6750	2880	10327	2198	11487	1775	12044	1435	12653	888	14458	208	13196
20-#11	5.07	7026	3040	10917	2299	12187	1848	12874	1483	13754	879	15927	85	15428
21-#10	4.33	6811	2915	10478	2218	11659	1794	12259	1444	12905	881	14794	175	13727
22-#10	4.54	6882	2950	10644	2239	11847	1802	12480	1452	13200	876	15166	152	14262

ROUND TIED COLUMNS 30" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.27	7032	2748	10429	2083	11157	1695	11191	1413	10614	975	10640	528	6114
4-#18	2.26	7364	2942	11186	2191	12049	1804	12246	1469	12033	962	12604	367	10312
5-#11	1.10	7022	2715	10495	2027	11106	1658	11055	1366	10374	945	10347	562	5152
5-#14	1.59	7211	2811	10911	2083	11595	1700	11629	1392	11136	936	11380	493	7054
5-#18	2.83	7672	3053	11925	2231	12794	1812	13044	1460	13020	915	13867	311	11571
6-#10	1.08	6998	2710	10686	1935	11132	1580	11012	1299	10313	894	9972	510	5012
6-#11	1.32	7084	2758	10909	1951	11377	1592	11296	1303	10694	883	10396	463	6026
6-#14	1.91	7300	2873	11415	2013	11997	1641	12040	1332	11705	871	11584	366	8402
6-#18	3.40	7825	3163	12653	2177	13527	1768	13885	1408	14187	839	14436	109	13886
7-#10	1.26	7104	2745	10504	2093	11259	1706	11317	1412	10774	976	10907	564	5864
7-#11	1.54	7212	2802	10760	2117	11532	1729	11628	1421	11173	966	11453	518	6963
7-#14	2.23	7481	2935	11316	2201	12206	1793	12433	1463	12240	959	12926	426	9488
7-#18	3.96	8136	3274	12669	2419	13864	1960	14423	1570	14863	939	16416	174	15319
8-#10	1.44	7162	2781	10560	2145	11441	1752	11595	1457	11121	1001	11355	550	6495
8-#11	1.77	7281	2845	10850	2174	11759	1772	11961	1471	11576	992	11967	497	7763

ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.55	7580	2997	11479	2272	12535	1846	12882	1524	12782	989	13615	388	10734
8-#18	4.53	8308	3385	13017	2526	14450	2072	15140	1659	15745	978	18042	151	17236
9-#10	1.62	7267	2816	10757	2157	11631	1758	11777	1449	11413	990	11863	532	7313
9-#11	1.99	7408	2888	11075	2193	11985	1783	12177	1464	11945	982	12584	476	8661
9-#14	2.86	7758	3060	11779	2305	12852	1877	13205	1520	13335	979	14508	361	11783
9-#18	5.09	8614	3495	13498	2596	14972	2098	15738	1662	16762	969	19109	51	18790
10-#10	1.80	7326	2851	11053	2141	11875	1750	12003	1431	11652	956	12200	496	7934
10-#11	2.21	7476	2931	11409	2181	12269	1780	12456	1447	12250	945	12983	432	9449
10-#14	3.18	7854	3122	12215	2305	13250	1875	13622	1508	13805	934	15092	300	13009
10-#18	5.66	8773	3606	14193	2625	15655	2119	16490	1660	17636	904	20149	-56	20131
11-#10	1.98	7413	2886	11031	2216	11989	1803	12229	1482	12028	997	12738	490	8715
11-#11	2.43	7580	2974	11411	2264	12417	1836	12725	1502	12680	988	13619	422	10300
11-#14	3.50	8002	3184	12265	2406	13467	1951	13986	1574	14369	985	15957	279	14016
11-#18	6.22	9031	3717	14345	2768	16049	2227	17099	1755	18526	974	21571	-102	21533
12-#10	2.16	7482	2921	11146	2254	12159	1832	12445	1508	12323	1004	13212	481	9328
12-#11	2.65	7663	3017	11553	2307	12622	1869	12983	1532	13038	996	14177	408	11086
12-#14	3.82	8120	3246	12477	2462	13759	1984	14347	1613	14876	995	16729	256	15185
12-#18	6.79	9231	3827	14732	2858	16554	2312	17709	1816	19414	988	22904	-149	22755
13-#10	2.34	7564	2956	11304	2272	12358	1847	12682	1513	12639	1002	13675	455	10073
13-#11	2.87	7762	3060	11742	2331	12865	1889	13268	1539	13421	993	14732	376	11881
13-#14	4.14	8260	3309	12739	2501	14108	2017	14755	1625	15424	992	17521	210	16118
13-#18	7.36	9478	3938	15180	2934	17167	2358	18416	1840	20329	981	24228	-232	23984
14-#10	2.52	7641	2991	11530	2273	12573	1842	12919	1509	12940	984	13953	419	10694
14-#11	3.09	7855	3104	12000	2336	13120	1901	13563	1538	13781	972	15104	335	12697
14-#14	4.46	8391	3371	13082	2516	14469	2040	15191	1630	15946	964	18092	154	17138
15-#10	2.70	7719	3026	11599	2321	12726	1889	13131	1542	13243	1005	14533	410	11379
15-#11	3.31	7947	3147	12100	2391	13306	1941	13813	1575	14144	996	15760	320	13439
15-#14	4.77	8522	3433	13254	2587	14734	2089	15534	1676	16450	995	18965	127	18132
16-#10	2.87	7803	3062	11701	2357	12899	1913	13370	1567	13530	1009	14946	394	12011
16-#11	3.53	8050	3190	12228	2434	13520	1969	14105	1604	14486	1000	16238	297	14249
16-#14	5.09	8668	3495	13442	2645	15044	2127	15937	1715	16928	997	19629	91	19152
17-#10	3.05	7874	3097	11883	2376	13092	1931	13584	1572	13857	1010	15382	366	12663
17-#11	3.75	8135	3233	12445	2458	13752	1991	14356	1610	14911	1007	16869	273	14957
17-#14	5.41	8788	3558	13744	2682	15371	2162	16303	1725	17536	1009	20525	57	20153
18-#10	3.23	7966	3132	12064	2390	13317	1936	13824	1576	14192	1006	15827	350	13304
18-#11	3.97	8246	3276	12656	2477	14025	2000	14647	1616	15299	998	17327	245	15753
19-#10	3.41	8031	3167	12162	2430	13465	1973	14032	1601	14480	1018	16294	331	13935
19-#11	4.19	8321	3319	12783	2523	14198	2042	14900	1645	15637	1010	17875	218	16432
20-#10	3.59	8114	3202	12280	2463	13645	1995	14249	1621	14807	1027	16783	320	14573
20-#11	4.41	8420	3363	12929	2564	14415	2068	15161	1669	16033	1021	18444	203	17138
21-#10	3.77	8180	3237	12446	2483	13829	2014	14484	1630	15087	1021	17148	288	15177
21-#11	4.63	8500	3406	13127	2589	14642	2092	15443	1680	16365	1013	18888	163	17851
22-#10	3.95	8258	3272	12628	2503	14036	2021	14721	1636	15408	1016	17556	264	15824
23-#10	4.13	8332	3308	12733	2537	14201	2055	14941	1663	15691	1024	18067	252	16408
24-#10	4.31	8406	3343	12859	2570	14374	2075	15163	1679	15995	1031	18466	227	17024

ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.12	8478	3093	12483	2365	13380	1927	13413	1609	12665	1119	12615	637	6613
4-#18	1.99	8844	3286	13313	2471	14352	2001	14559	1664	14205	1107	14745	479	11206
5-#14	1.40	8673	3155	13029	2357	13863	1926	13885	1582	13219	1077	13451	603	7690
5-#18	2.49	9178	3397	14135	2504	15173	2038	15429	1650	15272	1057	16210	427	12631
6-#11	1.16	8533	3103	13062	2211	13623	1806	13500	1483	12699	1016	12324	565	6523
6-#14	1.68	8769	3217	13613	2274	14295	1854	14307	1511	13794	1003	13637	472	9109
6-#18	2.98	9346	3508	14962	2437	15959	1982	16311	1587	16515	974	16805	224	15293
7-#10	1.11	8554	3090	12569	2372	13488	1936	13543	1606	12835	1120	12911	672	6349
7-#11	1.36	8672	3146	12851	2395	13787	1951	13881	1614	13270	1110	13509	627	7609
7-#14	1.96	8966	3280	13458	2479	14520	2023	14755	1655	14432	1103	15125	537	10371
7-#18	3.48	9683	3618	14935	2697	16325	2190	16919	1764	17297	1086	19037	298	16907
8-#10	1.26	8617	3125	12613	2428	13679	1985	13844	1653	13221	1147	13412	660	7052
8-#11	1.55	8747	3189	12932	2457	14027	2005	14242	1667	13717	1138	14084	608	8436
8-#14	2.24	9074	3342	13617	2554	14868	2078	15256	1722	15032	1137	15888	502	11678
8-#18	3.98	9871	3729	15293	2807	16949	2269	17729	1860	18269	1130	20300	225	19190
9-#10	1.42	8731	3160	12836	2438	13887	1989	14044	1645	13526	1135	13961	642	7936
9-#11	1.75	8885	3232	13185	2472	14274	2014	14481	1658	14105	1126	14753	587	9494
9-#14	2.52	9269	3404	13951	2585	15217	2098	15599	1715	15614	1124	16862	475	12896
9-#18	4.48	10205	3840	15826	2875	17536	2332	18359	1859	19346	1118	22006	180	20775
10-#10	1.58	8796	3195	13173	2416	14160	1977	14285	1622	13773	1098	14292	603	8637
10-#11	1.94	8961	3275	13563	2456	14592	2007	14780	1638	14424	1087	15203	544	10295
10-#14	2.80	9375	3466	14439	2580	15660	2103	16048	1700	16115	1077	17531	417	14183
10-#18	4.97	10381	3950	16592	2898	18285	2348	19176	1855	20290	1051	23145	76	22688
11-#10	1.74	8890	3230	13129	2498	14276	2036	14531	1678	14196	1143	14921	602	9475
11-#11	2.13	9074	3319	13545	2545	14743	2069	15071	1698	14906	1134	15892	535	11281
11-#14	3.08	9536	3529	14475	2687	15884	2174	16441	1770	16744	1133	18458	397	15349
11-#18	5.47	10663	4061	16748	3050	18697	2461	19828	1953	21278	1126	24701	32	24494
12-#10	1.89	8965	3265	13250	2538	14459	2066	14768	1705	14513	1151	15445	594	10170
12-#11	2.33	9164	3362	13698	2590	14965	2103	15353	1729	15290	1143	16508	523	12096
12-#14	3.36	9663	3591	14705	2746	16201	2219	16834	1811	17286	1143	19309	375	16623
12-#18	5.97	10879	4172	17166	3143	19246	2513	20495	2017	22223	1140	26118	-16	26102
13-#10	2.05	9054	3301	13423	2555	14673	2080	15025	1710	14854	1148	15874	560	10982
13-#11	2.52	9272	3405	13903	2613	15225	2122	15663	1736	15705	1140	17114	491	13017
13-#14	3.64	9816	3653	14988	2783	16575	2250	17279	1822	17883	1140	20178	331	17717
13-#18	6.47	11151	4282	17648	3217	19906	2593	21268	2041	23251	1136	27617	-94	27511
14-#10	2.21	9137	3336	13678	2553	14908	2073	15274	1703	15183	1129	16223	530	11670
14-#11	2.72	9372	3448	14193	2616	15505	2118	15975	1732	16101	1118	17487	448	13864
14-#14	3.92	9958	3715	15371	2796	16970	2271	17741	1825	18459	1113	20768	273	18959
14-#18	6.96	11389	4393	18260	3256	20583	2627	22110	2060	24260	1093	28689	-193	28480
15-#10	2.37	9223	3371	13739	2604	15072	2123	15507	1739	15511	1153	16867	523	12447
15-#11	2.91	9474	3491	14289	2673	15706	2174	16250	1772	16493	1144	18236	436	14725
15-#14	4.20	10101	3777	15543	2869	17257	2323	18118	1873	19000	1145	21766	250	19976
16-#10	2.53	9313	3406	13847	2641	15256	2147	15764	1764	15826	1157	17342	510	13115
16-#11	3.10	9584	3534	14424	2717	15933	2203	16563	1802	16867	1148	18770	415	15569
16-#14	4.48	10258	3840	15744	2928	17586	2362	18565	1915	19523	1148	22499	216	21144
17-#10	2.68	9391	3441	14045	2659	15466	2165	16000	1770	16173	1157	17795	481	13870
17-#11	3.30	9677	3577	14661	2741	16185	2225	16841	1808	17296	1149	19344	381	16389
17-#14	4.76	10390	3902	16075	2965	17944	2396	18957	1924	20184	1161	23472	183	22182

ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi

ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.84	9490	3476	14247	2671	15709	2168	16259	1772	16533	1152	18277	465	14535
18-#11	3.49	9797	3621	14894	2758	16479	2232	17156	1813	17737	1145	19928	363	17245
18-#14	5.04	10561	3964	16391	2996	18365	2411	19411	1936	20790	1148	24195	144	23263
19-#10	3.00	9562	3511	14348	2713	15869	2208	16482	1798	16849	1166	18794	447	15262
19-#11	3.69	9881	3664	15026	2806	16671	2277	17427	1843	18110	1159	20534	338	18037
19-#14	5.32	10680	4026	16598	3059	18634	2469	19795	1974	21302	1165	25028	104	24349
20-#10	3.16	9654	3546	14470	2748	16066	2231	16718	1820	17199	1175	19310	435	15924
20-#11	3.88	9990	3707	15181	2847	16907	2304	17711	1868	18537	1170	21174	324	18885
21-#10	3.32	9724	3582	14652	2767	16263	2249	16974	1828	17510	1170	19728	405	16621
21-#11	4.07	10076	3750	15397	2872	17149	2327	18018	1878	18903	1163	21647	285	19637
22-#10	3.47	9809	3617	14852	2786	16488	2255	17224	1834	17856	1165	20172	382	17321
22-#11	4.27	10177	3793	15633	2897	17418	2336	18329	1887	19324	1157	22182	256	20417
23-#10	3.63	9890	3652	14961	2821	16663	2290	17455	1856	18159	1173	20718	370	17977
23-#11	4.46	10276	3836	15773	2938	17634	2378	18616	1920	19693	1167	22847	240	21177
24-#10	3.79	9970	3687	15099	2855	16851	2311	17702	1877	18490	1180	21153	345	18671
25-#10	3.95	10056	3722	15267	2875	17061	2332	17955	1891	18817	1177	21643	326	19301
26-#10	4.11	10135	3757	15452	2895	17282	2341	18207	1895	19162	1173	22065	296	19990

ROUND TIED COLUMNS 34" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.76	10511	3653	15695	2771	16936	2248	17154	1873	16632	1262	17126	596	12097
5-#14	1.24	10322	3522	15408	2649	16414	2168	16422	1785	15555	1228	15757	718	8334
5-#18	2.20	10872	3764	16607	2795	17835	2280	18093	1853	17775	1209	18789	548	13703
6-#11	1.03	10169	3469	15484	2489	16151	2034	15981	1674	14949	1157	14477	673	7022
6-#14	1.49	10426	3584	16080	2551	16876	2082	16850	1702	16128	1145	15915	583	9818
6-#18	2.64	11054	3874	17542	2714	18674	2209	19014	1778	19064	1116	19399	343	16537
7-#11	1.20	10319	3512	15200	2692	16323	2196	16416	1819	15622	1263	15803	742	8222
7-#14	1.73	10638	3646	15858	2776	17114	2258	17358	1861	16878	1257	17557	654	11269
7-#18	3.08	11419	3985	17461	2993	19068	2435	19697	1970	19985	1243	21869	424	18404
8-#10	1.12	10259	3491	14920	2730	16198	2234	16375	1862	15578	1303	15712	777	7615
8-#11	1.37	10401	3556	15269	2758	16575	2253	16805	1875	16116	1294	16442	726	9116
8-#14	1.98	10755	3708	16010	2855	17482	2326	17896	1930	17538	1294	18402	623	12629
8-#18	3.52	11622	4096	17824	3107	19730	2517	20599	2072	21050	1290	23210	353	21057
9-#10	1.26	10381	3527	15170	2737	16425	2237	16593	1853	15895	1289	16299	758	8563
9-#11	1.55	10549	3599	15552	2771	16844	2260	17066	1866	16520	1281	17162	704	10265
9-#14	2.23	10965	3771	16381	2884	17862	2344	18273	1923	18148	1279	19455	595	14030
9-#18	3.97	11984	4206	18412	3174	20379	2579	21261	2069	22185	1276	25069	308	22819
10-#10	1.40	10453	3562	15552	2709	16726	2209	16848	1826	16148	1250	16620	716	9349
10-#11	1.72	10633	3642	15977	2749	17196	2249	17384	1842	16852	1238	17614	658	11150
10-#14	2.48	11082	3833	16924	2872	18352	2345	18755	1904	18678	1229	20205	539	15369
10-#18	4.41	12178	4317	19252	3191	21198	2592	22142	2061	23197	1206	26378	211	25002
11-#10	1.54	10555	3597	15481	2798	16844	2284	17115	1886	16621	1298	17345	719	10242
11-#11	1.89	10756	3685	15935	2845	17350	2316	17699	1906	17389	1290	18406	654	12244
11-#14	2.73	11257	3895	16940	2986	18582	2422	19176	1978	19374	1290	21200	519	16707
11-#18	4.85	12483	4428	19407	3350	21626	2692	22838	2163	24285	1287	28022	164	26847

ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi

ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	1.68	10635	3632	15607	2840	17040	2316	17372	1916	16960	1307	17919	714	11025
12-#11	2.06	10852	3728	16097	2892	17589	2353	18005	1939	17799	1299	19081	644	13120
12-#14	2.97	11394	3957	17187	3048	18924	2468	19604	2021	19951	1300	22131	501	18036
12-#18	5.29	12716	4538	19856	3446	22220	2764	23562	2229	25288	1300	29575	122	28799
13-#10	1.82	10731	3667	15797	2856	17268	2329	17648	1919	17325	1304	18364	678	11886
13-#11	2.23	10969	3771	16320	2914	17867	2370	18340	1945	18245	1296	19646	602	14183
13-#14	3.22	11560	4020	17493	3084	19323	2498	20085	2032	20596	1297	23075	456	19290
13-#18	5.73	13006	4649	20373	3518	22924	2825	24401	2254	26420	1299	31212	44	30902
14-#10	1.96	10821	3702	16083	2851	17524	2319	17911	1910	17677	1284	18731	647	12662
14-#11	2.41	11077	3815	16644	2913	18171	2363	18668	1939	18677	1274	20108	567	15050
14-#14	3.47	11713	4082	17918	3094	19752	2497	20573	2033	21228	1270	23671	396	20642
14-#18	6.17	13267	4760	21047	3555	23660	2874	25294	2270	27520	1256	32404	-51	32321
15-#10	2.10	10914	3737	16134	2906	17699	2373	18166	1949	18036	1309	19442	642	13485
15-#11	2.58	11187	3858	16732	2975	18386	2423	18969	1981	19098	1301	20935	557	16038
15-#14	3.72	11869	4144	18087	3170	20061	2573	20984	2084	21806	1303	24793	377	21834
15-#18	6.61	13536	4870	21419	3670	24199	2953	25975	2344	28501	1305	34160	-102	34015
16-#10	2.24	11011	3773	16247	2944	17893	2397	18439	1975	18378	1315	19969	631	14239
16-#11	2.75	11305	3901	16875	3019	18626	2452	19302	2012	19505	1306	21544	540	16911
16-#14	3.97	12037	4206	18302	3231	20410	2612	21461	2126	22375	1308	25611	346	23189
17-#10	2.38	11096	3808	16461	2961	18121	2415	18697	1980	18744	1314	20450	602	15061
17-#11	2.92	11407	3944	17130	3042	18900	2475	19608	2018	19960	1307	22140	505	17852
17-#14	4.21	12181	4269	18659	3267	20797	2646	21892	2136	23038	1311	26496	298	24264
18-#10	2.52	11202	3843	16686	2971	18381	2416	18976	1982	19129	1308	20967	585	15787
18-#11	3.09	11536	3987	17390	3058	19215	2480	19947	2022	20432	1301	22770	486	18739
18-#14	4.46	12364	4331	19006	3296	21248	2659	22383	2146	23727	1307	27411	273	25490
19-#10	2.66	11281	3878	16787	3016	18552	2457	19213	2009	19476	1324	21535	569	16596
19-#11	3.26	11630	4030	17525	3108	19424	2527	20236	2054	20839	1317	23435	463	19643
19-#14	4.71	12496	4393	19222	3361	21545	2720	22791	2186	24286	1325	28325	235	26614
20-#10	2.80	11381	3913	16915	3050	18767	2482	19469	2031	19847	1333	22080	556	17300
20-#11	3.44	11747	4074	17687	3150	19679	2554	20543	2079	21294	1329	24110	448	20526
20-#14	4.96	12664	4455	19463	3419	21906	2758	23225	2221	24937	1340	29299	215	27777
21-#10	2.94	11456	3948	17113	3070	18977	2499	19741	2039	20185	1328	22534	528	18096
21-#11	3.61	11839	4117	17922	3174	19936	2577	20875	2090	21698	1322	24648	411	21397
22-#10	3.08	11549	3983	17331	3087	19221	2505	20010	2044	20561	1322	23030	505	18819
22-#11	3.78	11950	4160	18179	3198	20229	2586	21204	2097	22150	1316	25228	382	22295
23-#10	3.22	11635	4018	17444	3124	19405	2541	20260	2068	20884	1332	23607	493	19569
23-#11	3.95	12054	4203	18325	3241	20457	2628	21503	2125	22544	1326	25938	368	23144
24-#10	3.36	11722	4054	17592	3159	19608	2562	20523	2089	21243	1339	24082	469	20289
24-#11	4.12	12159	4246	18504	3282	20702	2653	21825	2150	22973	1334	26502	337	24058
25-#10	3.50	11815	4089	17774	3178	19836	2583	20786	2097	21594	1336	24612	451	21008
25-#11	4.30	12270	4289	18723	3306	20975	2679	22154	2167	23398	1330	27139	314	24821

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
26-#10	3.64	11900	4124	17977	3198	20072	2591	21071	2106	21959	1331	25051	419	21734
27-#10	3.78	11996	4159	18122	3226	20261	2624	21316	2132	22295	1339	25696	417	22451
28-#10	3.92	12081	4194	18283	3252	20475	2645	21564	2146	22668	1347	26252	398	23174

ROUND TIED COLUMNS 36" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.57	12376	4042	18348	3090	19818	2511	20048	2094	19332	1426	19761	720	12986
5-#14	1.11	12169	3910	18064	2959	19264	2424	19256	2000	18159	1387	18276	837	8986
5-#18	1.96	12765	4152	19356	3104	20797	2536	21055	2069	20547	1369	21619	675	14787
6-#14	1.33	12281	3973	18833	2846	19759	2325	19688	1906	18723	1295	18432	699	10529
6-#18	2.36	12961	4263	20408	3008	21691	2451	22010	1981	21873	1266	22234	466	17782
7-#11	1.07	12164	3901	17823	3008	19158	2457	19249	2038	18245	1425	18351	863	8817
7-#14	1.55	12509	4035	18531	3091	20008	2518	20260	2080	19596	1420	20243	777	12182
7-#18	2.75	13353	4374	20261	3308	22111	2677	22773	2189	22944	1408	24907	552	19901
8-#11	1.23	12253	3944	17876	3078	19421	2517	19666	2097	18787	1460	19058	851	9802
8-#14	1.77	12635	4097	18674	3175	20394	2590	20836	2152	20316	1460	21172	749	13587
8-#18	3.14	13573	4484	20627	3426	22808	2780	23750	2295	24103	1459	26377	485	22690
9-#10	1.12	12230	3915	17776	3056	19261	2499	19441	2074	18505	1448	18815	873	9195
9-#11	1.38	12412	3988	18191	3089	19713	2522	19950	2087	19206	1444	19827	828	11031
9-#14	1.99	12861	4159	19083	3201	20805	2606	21247	2144	20953	1444	22304	721	15184
9-#18	3.54	13962	4595	21270	3491	23510	2823	24462	2291	25295	1442	28387	441	24743
10-#10	1.25	12308	3951	18207	3022	19593	2467	19708	2043	18792	1410	19198	836	10070
10-#11	1.53	12504	4031	18668	3060	20100	2493	20286	2058	19548	1398	20269	779	12016
10-#14	2.21	12989	4222	19685	3183	21343	2603	21759	2120	21509	1391	23057	661	16568
10-#18	3.93	14174	4706	22189	3501	24411	2850	25407	2279	26373	1370	29863	350	27391
11-#10	1.37	12418	3986	18104	3118	19710	2548	19998	2108	19317	1463	20025	844	11017
11-#11	1.69	12636	4074	18597	3163	20256	2580	20626	2128	20144	1455	21175	780	13179
11-#14	2.43	13178	4284	19677	3304	21580	2685	22211	2200	22277	1456	24197	648	18090
11-#18	4.32	14504	4816	22332	3668	24854	2956	26147	2386	27563	1456	31600	302	29264
12-#10	1.50	12504	4021	18230	3162	19918	2582	20275	2139	19680	1473	20650	840	11914
12-#11	1.84	12739	4117	18765	3213	20511	2618	20956	2162	20581	1465	21911	772	14158
12-#14	2.65	13324	4346	19939	3369	21946	2734	22672	2245	22889	1466	25211	632	19466
12-#18	4.72	14753	4927	22817	3768	25493	3030	26929	2454	28625	1470	33289	263	31468
13-#10	1.62	12608	4056	18441	3176	20162	2593	20571	2142	20069	1469	21109	802	12801
13-#11	1.99	12864	4160	19007	3233	20807	2634	21316	2167	21057	1461	22496	728	15284
13-#14	2.87	13503	4408	20269	3403	22370	2762	23190	2255	23580	1464	26088	573	20892
13-#18	5.11	15066	5038	23370	3838	26240	3089	27834	2479	29844	1468	35065	186	33639
14-#10	1.75	12704	4091	18760	3168	20439	2581	20846	2130	20434	1447	21494	771	13669
14-#11	2.15	12981	4203	19368	3230	21137	2625	21660	2159	21522	1438	22983	692	16254
14-#14	3.09	13667	4471	20738	3410	22834	2759	23704	2253	24267	1436	26829	525	22296
14-#18	5.50	15346	5148	24108	3872	27036	3102	28777	2492	31050	1428	36279	87	35689

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#10	1.87	12804	4126	18799	3227	20624	2638	21123	2172	20834	1475	22274	768	14536
15-#11	2.30	13100	4247	19446	3294	21365	2688	21987	2204	21976	1467	23890	684	17331
15-#14	3.32	13836	4533	20902	3490	23164	2838	24149	2307	24884	1471	28056	507	23647
15-#18	5.89	15637	5259	24487	3990	27615	3220	29515	2569	32090	1477	38270	44	37936
16-#10	2.00	12907	4161	18916	3266	20828	2663	21413	2198	21203	1482	22830	756	15382
16-#11	2.45	13226	4290	19596	3340	21618	2718	22341	2235	22416	1474	24574	670	18274
16-#14	3.54	14015	4595	21129	3552	23532	2877	24655	2349	25499	1477	28982	481	25056
16-#18	6.29	15948	5370	24904	4092	28274	3286	30404	2640	33134	1482	39735	-17	39712
17-#10	2.12	12999	4196	19147	3282	21074	2680	21690	2203	21589	1480	23362	729	16244
17-#11	2.61	13336	4333	19871	3362	21912	2739	22675	2242	22895	1473	25192	634	19340
17-#14	3.76	14171	4657	21513	3587	23949	2911	25127	2360	26199	1479	29898	432	26325
18-#10	2.25	13112	4232	19397	3290	21352	2679	21992	2204	21937	1463	23759	697	17061
18-#11	2.76	13473	4376	20157	3376	22249	2742	23038	2245	23397	1467	25867	614	20257
18-#14	3.98	14367	4720	21893	3614	24430	2923	25653	2370	26935	1474	30884	406	27757
19-#10	2.37	13198	4267	19496	3337	21533	2723	22244	2233	22375	1491	24525	697	17909
19-#11	2.91	13576	4419	20293	3429	22472	2792	23344	2277	23841	1485	26594	593	21282
19-#14	4.20	14511	4782	22117	3682	24750	2986	26086	2411	27543	1494	31879	371	28934
20-#10	2.50	13307	4302	19629	3372	21767	2748	22519	2255	22769	1500	25107	684	18700
20-#11	3.07	13704	4462	20462	3471	22750	2821	23675	2304	24324	1496	27303	578	22194
20-#14	4.42	14693	4844	22370	3740	25142	3025	26554	2447	28233	1509	32902	349	30248
21-#10	2.62	13387	4337	19843	3391	21990	2765	22807	2263	23131	1495	25595	656	19557
21-#11	3.22	13802	4505	20717	3495	23023	2843	24029	2314	24762	1490	27891	542	23180
21-#14	4.64	14832	4906	22726	3777	25535	3058	27064	2463	28856	1501	33735	297	31476
22-#10	2.74	13487	4372	20081	3407	22253	2769	23095	2267	23537	1489	26144	634	20344
22-#11	3.37	13922	4549	20996	3517	23338	2850	24379	2320	25249	1483	28530	514	24140
22-#14	4.86	15002	4969	23107	3814	25981	3074	27571	2476	29558	1494	34637	257	32685
23-#10	2.87	13579	4407	20196	3446	22446	2807	23364	2292	23882	1499	26753	622	21170
23-#11	3.52	14033	4592	21147	3562	23578	2894	24701	2349	25667	1494	29278	499	25070
24-#10	2.99	13673	4442	20352	3481	22663	2828	23643	2313	24268	1507	27269	599	21936
24-#11	3.68	14146	4635	21340	3604	23841	2919	25043	2375	26130	1503	29890	470	26031
25-#10	3.12	13772	4478	20550	3500	22908	2849	23925	2322	24642	1504	27839	581	22751
25-#11	3.83	14265	4678	21574	3628	24135	2945	25396	2392	26586	1499	30577	447	26919
26-#10	3.24	13864	4513	20771	3519	23159	2856	24234	2331	25028	1499	28293	548	23500
26-#11	3.98	14376	4721	21833	3653	24442	2955	25752	2397	27062	1494	31153	409	27883
27-#10	3.37	13967	4548	20921	3548	23362	2890	24494	2357	25392	1507	28919	539	24310
27-#11	4.14	14500	4764	22026	3686	24688	2995	26070	2427	27495	1503	31978	405	28750
28-#10	3.49	14058	4583	21092	3575	23588	2911	24761	2371	25787	1515	29611	530	25058
29-#10	3.62	14163	4618	21274	3602	23822	2932	25053	2386	26179	1517	30070	505	25838
30-#10	3.74	14251	4653	21499	3617	24084	2943	25333	2389	26548	1509	30611	479	26604

ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.38	2669	1427	3868	1197	4589	936	4767	746	4647	459	5091	250	3946
4-#14	1.99	2715	1527	4176	1249	4932	969	5160	766	5156	441	5735	171	5152
4-#18	3.54	2809	1781	4889	1381	5744	1052	6098	813	6376	391	7260	-41	7206
5-#11	1.72	2745	1483	4147	1206	4827	935	5007	731	4942	425	5550	202	4457
5-#14	2.49	2817	1609	4516	1272	5255	977	5504	752	5590	398	6404	106	5907
5-#18	4.42	2968	1927	5384	1438	6270	1082	6688	802	7142	323	8421	-150	8221
6-#11	2.07	2809	1540	4515	1181	5116	903	5279	697	5263	372	5737	117	5246
6-#14	2.98	2901	1690	4966	1256	5648	948	5901	717	6079	332	6718	-9	6709
6-#18	5.31	3120	2072	6029	1444	6913	1060	7386	763	8027	222	9027	-346	8554
7-#11	2.41	2828	1597	4421	1292	5214	998	5489	772	5591	421	6464	130	5816
7-#14	3.48	2926	1772	4923	1389	5804	1062	6179	805	6494	387	7670	-4	7664
7-#18	6.19	3165	2217	6105	1633	7207	1221	7824	883	8653	292	10509	-362	9802
8-#11	2.76	2862	1653	4516	1341	5392	1037	5724	804	5912	431	6896	104	6480
8-#14	3.98	2972	1854	5087	1455	6060	1112	6506	846	6936	397	8259	-46	8191
8-#18	7.07	3250	2363	6428	1739	7651	1298	8373	946	9386	301	11471	-449	10651
9-#11	3.10	2914	1710	4739	1364	5609	1054	5970	806	6247	417	7400	58	7113
9-#14	4.48	3052	1936	5383	1491	6363	1140	6854	851	7413	378	8974	-111	8691
9-#18	7.96	3389	2508	6898	1806	8156	1351	8963	957	10202	267	12681	-564	11281
10-#11	3.45	2952	1767	4988	1377	5864	1052	6242	799	6571	383	7745	12	7693
10-#14	4.97	3099	2018	5699	1517	6714	1143	7240	846	7882	333	9477	-176	9172
11-#11	3.79	3002	1823	5049	1439	6009	1107	6450	838	6881	405	8272	-19	8237
11-#14	5.47	3176	2099	5826	1597	6926	1214	7529	894	8303	359	10193	-228	9728
12-#11	4.14	3061	1880	5168	1485	6198	1138	6685	862	7182	403	8734	-42	8661
12-#14	5.97	3252	2181	6005	1660	7196	1255	7858	927	8723	354	10832	-263	10257
13-#11	4.48	3086	1937	5366	1513	6410	1160	6930	868	7515	393	9136	-95	8956
13-#14	6.47	3313	2263	6276	1701	7492	1288	8205	937	9195	339	11401	-340	10631
14-#11	4.83	3125	1994	5583	1537	6648	1167	7197	870	7844	368	9538	-139	9266
15-#11	5.17	3179	2050	5705	1580	6812	1211	7411	898	8149	380	10046	-165	9641
16-#11	5.52	3228	2107	5859	1618	7006	1238	7647	920	8452	375	10482	-206	10012

ROUND TIED COLUMNS 26" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.18	3382	1635	4750	1396	5697	1096	5924	878	5744	553	6280	334	4384
4-#14	1.70	3440	1735	5096	1448	6086	1130	6369	898	6319	537	7014	259	6008
4-#18	3.01	3560	1990	5925	1582	7014	1216	7439	948	7709	492	8769	57	8589
5-#11	1.47	3474	1692	5095	1401	5972	1091	6193	860	6068	518	6789	285	4979
5-#14	2.12	3564	1817	5516	1467	6457	1134	6756	882	6802	493	7766	193	6753
5-#18	3.77	3753	2135	6509	1637	7617	1243	8107	936	8570	424	10093	-51	10018
6-#11	1.76	3560	1748	5543	1367	6307	1052	6496	819	6416	461	6983	198	5991
6-#14	2.54	3678	1899	6056	1443	6910	1099	7201	841	7339	423	8106	77	7775
6-#18	4.52	3960	2280	7273	1635	8355	1214	8895	892	9561	321	10773	-245	10397

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
7-#11	2.06	3574	1805	5384	1489	6402	1158	6735	904	6800	517	7830	216	6621
7-#14	2.97	3700	1981	5960	1588	7072	1223	7516	939	7821	486	9208	88	8748
7-#18	5.27	3970	2426	7316	1837	8674	1387	9392	1023	10282	399	12484	-253	11946
8-#11	2.35	3621	1862	5477	1542	6597	1199	6997	938	7164	529	8322	194	7417
8-#14	3.39	3757	2062	6122	1656	7356	1277	7883	983	8322	499	9881	50	9656
8-#18	6.03	4094	2571	7668	1946	9172	1469	10012	1091	11113	413	13586	-333	12902
9-#11	2.64	3682	1918	5735	1564	6845	1216	7274	940	7537	515	8842	141	8072
9-#14	3.81	3843	2144	6467	1692	7699	1304	8275	988	8857	480	10689	-14	10578
9-#18	6.78	4255	2717	8208	2014	9746	1522	10680	1102	12034	380	14965	-446	13718
10-#11	2.94	3722	1975	6039	1575	7136	1211	7579	931	7896	480	9272	103	8768
10-#14	4.24	3897	2226	6847	1716	8100	1305	8710	981	9380	434	11253	-77	11107
10-#18	7.53	4355	2862	8769	2071	10408	1536	11428	1100	12952	305	15957	-558	14270
11-#11	3.23	3781	2032	6080	1640	7292	1271	7813	973	8249	506	9873	75	9500
11-#14	4.66	3980	2308	6960	1800	8332	1381	9035	1034	9859	464	12069	-124	11789
12-#11	3.53	3846	2088	6210	1687	7503	1303	8076	999	8588	505	10401	54	10137
12-#14	5.09	4089	2389	7155	1865	8633	1423	9405	1068	10332	461	12799	-157	12446
13-#11	3.82	3883	2145	6435	1715	7742	1324	8352	1005	8961	495	10853	3	10841
13-#14	5.51	4135	2471	7463	1906	8968	1456	9795	1078	10862	447	13441	-231	12872
14-#11	4.11	3929	2202	6680	1737	8012	1331	8651	1007	9328	470	11307	-42	11222
14-#14	5.93	4190	2553	7796	1943	9343	1470	10219	1083	11389	413	14089	-294	13325
15-#11	4.41	3993	2259	6815	1784	8193	1377	8891	1037	9672	484	11882	-64	11737
16-#11	4.70	4028	2315	6984	1823	8410	1406	9156	1060	10014	481	12379	-104	12126
17-#11	5.00	4092	2372	7170	1857	8645	1430	9431	1068	10384	473	12867	-140	12516
18-#11	5.29	4159	2429	7408	1879	8904	1442	9725	1075	10790	463	13313	-195	12805

ROUND TIED COLUMNS 28" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.01	4211	1860	5755	1611	6960	1269	7254	1020	7001	655	7637	424	4820
4-#14	1.46	4281	1960	6140	1663	7403	1304	7751	1041	7643	640	8462	351	6690
4-#18	2.60	4428	2215	7063	1797	8449	1391	8953	1094	9202	599	10448	158	9882
5-#11	1.27	4318	1916	6168	1611	7282	1260	7552	998	7352	617	8194	373	5507
5-#14	1.83	4426	2042	6647	1679	7826	1304	8181	1022	8172	594	9294	284	7545
5-#18	3.25	4657	2360	7768	1850	9132	1415	9700	1079	10157	530	11932	49	11676
6-#11	1.52	4426	1973	6713	1569	7668	1213	7886	951	7723	556	8387	283	6606
6-#14	2.19	4571	2124	7288	1646	8343	1261	8674	974	8754	520	9653	166	8853
6-#18	3.90	4922	2505	8661	1840	9969	1380	10578	1030	11250	424	12681	-143	12441
7-#11	1.77	4437	2030	6473	1703	7756	1330	8153	1045	8168	619	9363	308	7358
7-#14	2.56	4586	2205	7115	1803	8505	1397	9026	1082	9309	591	10915	184	9848
7-#18	4.55	4917	2651	8657	2056	10308	1565	11135	1172	12071	512	14631	-143	14323
8-#11	2.03	4495	2087	6562	1759	7959	1374	8444	1083	8576	634	9919	288	8398
8-#14	2.92	4661	2287	7281	1874	8815	1453	9434	1130	9869	607	11673	151	10924
8-#18	5.20	5030	2796	9009	2166	10859	1651	11826	1243	13001	529	15874	-216	15385
9-#11	2.28	4567	2143	6856	1779	8245	1390	8751	1083	8987	620	10496	236	9066
9-#14	3.29	4761	2369	7672	1908	9201	1480	9870	1134	10460	588	12500	76	12078
9-#18	5.85	5217	2942	9636	2235	11503	1703	12573	1255	14027	498	17423	-328	16357

ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.53	4607	2200	7209	1787	8575	1382	9090	1072	9380	583	10966	197	9889
10-#14	3.65	4815	2451	8127	1931	9653	1478	10354	1125	11038	541	13196	24	13073
10-#18	6.50	5344	3087	10292	2291	12248	1716	13408	1252	15048	423	18531	-436	17077
11-#11	2.79	4678	2257	7237	1857	8738	1446	9349	1119	9778	612	11645	173	10651
11-#14	4.02	4911	2533	8219	2018	9904	1559	10715	1182	11575	575	14115	-18	14071
11-#18	7.15	5510	3232	10581	2424	12706	1838	14012	1334	15924	468	20031	-528	18301
12-#11	3.04	4760	2313	7375	1906	8964	1479	9641	1146	10156	613	12238	153	11402
12-#14	4.38	5044	2614	8430	2085	10236	1603	11126	1218	12103	573	14938	-49	14820
13-#11	3.29	4792	2370	7627	1933	9235	1501	9947	1152	10568	603	12740	104	12226
13-#14	4.75	5078	2696	8776	2126	10610	1636	11560	1228	12690	560	15653	-121	15335
14-#11	3.55	4853	2427	7902	1953	9542	1507	10279	1153	10972	578	13245	59	12923
14-#14	5.12	5156	2778	9143	2161	11030	1648	12031	1233	13274	526	16379	-184	15883
15-#11	3.80	4914	2484	8041	2002	9734	1555	10546	1185	11357	594	13889	39	13700
15-#14	5.48	5250	2860	9371	2225	11317	1712	12405	1274	13806	545	17269	-217	16544
16-#11	4.05	4961	2540	8234	2043	9970	1584	10839	1209	11737	592	14447	0	14445
16-#14	5.85	5334	2942	9644	2280	11658	1753	12819	1307	14339	540	18047	-274	17200
17-#11	4.31	5028	2597	8434	2076	10234	1609	11144	1218	12147	584	14990	-34	14900
18-#11	4.56	5107	2654	8704	2098	10529	1620	11470	1224	12595	574	15487	-89	15239
19-#11	4.81	5151	2710	8830	2151	10736	1662	11743	1250	12956	580	16093	-109	15782
20-#11	5.07	5210	2767	9023	2188	10976	1689	12037	1272	13355	581	16739	-135	16201

ROUND TIED COLUMNS 30" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.27	5245	2202	7317	1895	8882	1489	9320	1194	9140	751	10093	449	7322
4-#18	2.26	5421	2456	8335	2029	10062	1580	10655	1249	10869	713	12310	263	11251
5-#11	1.10	5285	2158	7378	1838	8772	1442	9098	1147	8807	724	9777	466	6042
5-#14	1.59	5412	2284	7906	1905	9374	1486	9793	1171	9712	702	11000	380	8289
5-#18	2.83	5687	2602	9169	2079	10827	1600	11481	1231	11915	642	13951	154	13072
6-#11	1.32	5417	2215	8034	1786	9211	1386	9460	1093	9196	657	9962	372	7221
6-#14	1.91	5590	2365	8673	1863	9959	1434	10332	1117	10335	623	11371	260	9984
6-#18	3.40	5968	2747	10203	2060	11767	1557	12448	1176	13107	532	14762	-39	14692
7-#11	1.54	5425	2272	7698	1933	9284	1515	9758	1197	9708	729	11076	404	8101
7-#14	2.23	5600	2447	8406	2033	10116	1583	10723	1236	10968	703	12802	285	10988
7-#18	3.96	5993	2892	10114	2288	12121	1754	13065	1330	14033	630	16960	-31	16889
8-#11	1.77	5494	2328	7780	1992	9494	1561	10078	1238	10161	746	11698	388	9207
8-#14	2.55	5690	2529	8573	2108	10436	1641	11172	1286	11589	721	13648	255	12246
8-#18	4.53	6125	3038	10485	2402	12723	1844	13828	1405	15065	651	18347	-98	18107
9-#11	1.99	5574	2385	8113	2011	9813	1576	10415	1237	10588	726	12332	335	10045
9-#14	2.86	5802	2611	9013	2141	10878	1668	11652	1289	12206	695	14560	181	13440
9-#18	5.09	6333	3183	11187	2470	13438	1896	14653	1417	16195	620	19925	-227	19255

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.21	5618	2442	8515	2014	10192	1566	10787	1223	11035	693	12839	296	11056
10-#14	3.18	5860	2692	9523	2159	11385	1664	12185	1278	12867	654	15320	129	14598
10-#18	5.66	6413	3329	11958	2525	14270	1907	15576	1412	17318	545	21289	-314	20072
11-#11	2.43	5696	2498	8528	2090	10353	1634	11072	1274	11479	725	13599	276	11839
11-#14	3.50	5971	2774	9612	2252	11646	1748	12581	1340	13465	691	16345	91	15854
11-#18	6.22	6622	3474	12229	2662	14766	2034	16243	1500	18290	594	22958	-399	21518
12-#11	2.65	5787	2555	8673	2141	10598	1668	11392	1303	11896	727	14259	257	12714
12-#14	3.82	6093	2856	9838	2321	12000	1794	13034	1378	14048	692	17262	62	16917
12-#18	6.79	6835	3619	12651	2775	15400	2108	17016	1560	19275	588	24488	-458	22916
13-#11	2.87	5832	2612	8947	2166	10898	1690	11729	1309	12347	718	14810	209	13582
13-#14	4.14	6163	2938	10219	2361	12419	1827	13512	1388	14692	679	18049	-8	18025
13-#18	7.36	6996	3765	13287	2851	16098	2169	17835	1580	20389	566	25844	-586	23811
14-#11	3.09	5904	2668	9261	2185	11245	1694	12094	1308	12789	692	15364	164	14382
14-#14	4.46	6252	3020	10627	2394	12896	1839	14031	1392	15332	644	18851	-71	18652
15-#11	3.31	5968	2725	9400	2237	11446	1745	12387	1343	13215	710	16080	146	15295
15-#14	4.77	6351	3101	10865	2461	13196	1905	14442	1436	15920	666	19838	-101	19428
16-#11	3.53	6022	2782	9607	2278	11703	1775	12708	1368	13634	709	16700	108	16053
16-#14	5.09	6418	3183	11174	2519	13565	1946	14897	1469	16508	662	20704	-157	20187
17-#11	3.75	6099	2839	9831	2312	11995	1799	13044	1376	14083	702	17296	75	16890
17-#14	5.41	6538	3265	11477	2568	13975	1982	15373	1483	17148	652	21552	-206	20867
18-#11	3.97	6168	2895	10135	2332	12314	1810	13403	1382	14530	681	17845	21	17722
19-#11	4.19	6239	2952	10266	2387	12545	1853	13702	1410	14972	698	18513	3	18499
20-#11	4.41	6306	3009	10468	2425	12809	1882	14025	1433	15411	701	19224	-21	19008
21-#11	4.63	6362	3065	10725	2455	13093	1907	14360	1443	15838	690	19768	-58	19582

ROUND TIED COLUMNS 32" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.12	6341	2460	8635	2143	10549	1688	11088	1358	10822	868	11918	552	7951
4-#18	1.99	6548	2714	9750	2277	11845	1779	12557	1415	12721	833	14368	372	12696
5-#14	1.40	6531	2542	9315	2148	11114	1681	11604	1331	11435	817	12898	481	9041
5-#18	2.49	6852	2860	10708	2322	12714	1796	13461	1394	13856	761	16162	262	14521
6-#11	1.16	6530	2473	9518	2019	10949	1571	11234	1244	10847	765	11721	467	7837
6-#14	1.68	6737	2624	10221	2096	11770	1620	12189	1269	12095	733	13273	358	10885
6-#18	2.98	7187	3005	11909	2294	13761	1744	14517	1331	15142	646	17028	69	16681
7-#11	1.36	6545	2530	9069	2180	10995	1712	11562	1360	11432	846	12983	506	8851
7-#14	1.96	6748	2705	9844	2279	11912	1781	12620	1399	12812	821	14884	390	12090
7-#18	3.48	7207	3151	11716	2535	14125	1956	15196	1497	16180	753	19484	84	18958
8-#11	1.55	6619	2586	9138	2242	11216	1762	11904	1403	11931	865	13673	493	10021
8-#14	2.24	6854	2787	10006	2358	12246	1843	13110	1453	13495	842	15820	364	13689
8-#18	3.98	7359	3296	12105	2654	14759	2048	16030	1576	17314	778	21017	23	20898
9-#11	1.75	6710	2643	9513	2259	11569	1775	12279	1402	12393	844	14362	439	10989
9-#14	2.52	6971	2869	10499	2390	12732	1868	13634	1455	14165	816	16816	289	14844
9-#18	4.48	7578	3441	12884	2721	15565	2101	16934	1587	18548	748	22752	-106	22422

ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.94	6762	2700	9969	2258	12001	1762	12684	1385	12873	810	14904	400	12137
10-#14	2.80	7040	2951	11069	2403	13309	1861	14216	1442	14879	773	17636	238	16178
10-#18	4.97	7669	3587	13749	2772	16484	2109	17946	1581	19771	672	24241	-191	23299
11-#11	2.13	6850	2757	9958	2339	12156	1834	12995	1440	13366	845	15748	383	13052
11-#14	3.08	7166	3032	11148	2502	13569	1950	14648	1507	15540	814	18770	204	17481
11-#18	5.47	7905	3732	14021	2915	17017	2241	18675	1673	20843	726	26084	-270	25159
12-#11	2.33	6948	2813	10112	2392	12420	1870	13337	1469	13823	849	16476	366	14072
12-#14	3.36	7295	3114	11387	2573	13952	1997	15142	1547	16178	816	19782	176	18703
12-#18	5.97	8129	3878	14476	3031	17690	2317	19520	1736	21923	722	27776	-326	26625
13-#11	2.52	7007	2870	10410	2416	12749	1891	13710	1476	14313	839	17076	318	14967
13-#14	3.64	7375	3196	11798	2611	14412	2030	15664	1557	16880	804	20641	108	20068
13-#18	6.47	8283	4023	15177	3107	18470	2379	20418	1757	23141	701	29264	-450	27583
14-#11	2.72	7078	2927	10765	2432	13123	1893	14109	1474	14791	812	17678	273	15890
14-#14	3.92	7486	3278	12257	2642	14939	2041	16231	1560	17574	769	21518	45	21241
14-#18	6.96	8503	4168	15888	3174	19336	2407	21397	1770	24362	644	30796	-557	28620
15-#11	2.91	7156	2983	10902	2487	13346	1947	14425	1510	15259	833	18410	250	16840
15-#14	4.20	7579	3360	12501	2713	15260	2109	16679	1606	18220	792	22604	18	22507
16-#11	3.10	7219	3040	11116	2529	13625	1978	14771	1536	15716	832	19149	221	17710
16-#14	4.48	7665	3441	12827	2771	15661	2152	17176	1641	18863	790	23559	-37	23436
17-#11	3.30	7299	3097	11371	2563	13939	2002	15141	1545	16205	826	19799	188	18681
17-#14	4.76	7786	3523	13169	2821	16110	2188	17696	1655	19561	781	24485	-84	24190
18-#11	3.49	7378	3154	11710	2582	14286	2011	15535	1550	16690	805	20398	134	19529
18-#14	5.04	7910	3605	13622	2853	16596	2205	18252	1665	20258	752	25346	-161	24755
19-#11	3.69	7455	3210	11837	2638	14534	2057	15857	1579	17152	818	21129	119	20446
19-#14	5.32	8003	3687	13840	2928	16958	2266	18712	1703	20934	776	26367	-187	25672
20-#11	3.88	7540	3267	12054	2677	14830	2086	16206	1603	17652	826	21794	82	21365
21-#11	4.07	7597	3324	12336	2708	15142	2106	16574	1613	18118	816	22503	60	22200
22-#11	4.27	7666	3380	12628	2737	15469	2125	16964	1622	18623	804	23151	19	23062
23-#11	4.46	7751	3437	12808	2782	15739	2161	17290	1647	19063	808	23826	-8	23797

ROUND TIED COLUMNS 34" DIA.

4-#18	1.76	7816	2989	11316	2541	13819	1991	14671	1591	14771	960	16634	486	14215
5-#14	1.24	7791	2817	10882	2407	13057	1889	13628	1501	13354	939	14999	588	9800
5-#18	2.20	8159	3135	12398	2581	14806	2005	15654	1566	15993	886	18577	375	16020
6-#11	1.03	7779	2748	11174	2266	12896	1768	13220	1405	12688	880	13676	567	8454
6-#14	1.49	8010	2899	11941	2344	13789	1818	14259	1431	14045	849	15372	460	11766
6-#18	2.64	8533	3280	13788	2543	15964	1944	16799	1496	17368	766	19491	179	18496
7-#11	1.20	7806	2805	10625	2437	12908	1923	13580	1533	13353	970	15097	614	9612
7-#14	1.73	8037	2980	11436	2542	13902	1992	14730	1573	14852	946	17172	501	13138
7-#18	3.08	8565	3426	13475	2799	16332	2170	17540	1674	18524	883	22215	203	20833

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.37	7889	2861	10646	2508	13139	1975	13938	1578	13900	991	15857	604	10839
8-#14	1.98	8159	3062	11590	2624	14255	2057	15248	1629	15599	970	18201	478	14997
8-#18	3.52	8739	3571	13876	2922	16987	2264	18446	1756	19762	911	23898	147	23049
9-#11	1.55	7987	2918	11066	2524	13526	1988	14351	1576	14396	970	16599	549	11949
9-#14	2.23	8283	3144	12138	2654	14788	2081	15829	1631	16322	943	19280	403	16290
9-#18	3.97	8948	3716	14736	2987	17877	2317	19429	1767	21035	868	25789	18	25665
10-#11	1.72	8048	2975	11582	2517	14007	1971	14794	1556	14907	933	17053	494	13155
10-#14	2.48	8362	3226	12775	2662	15437	2071	16460	1615	17087	899	20156	351	17813
10-#18	4.41	9073	3862	15684	3033	18904	2323	20529	1759	22421	804	27399	-65	27196
11-#11	1.89	8146	3032	11536	2604	14160	2048	15121	1615	15450	972	18105	496	14201
11-#14	2.73	8499	3307	12829	2768	15693	2164	16928	1685	17812	944	21404	322	19152
11-#18	4.85	9308	4007	15967	3184	19444	2459	21321	1856	23594	862	29420	-138	28916
12-#11	2.06	8250	3088	11701	2659	14442	2085	15490	1646	15947	977	18903	479	15403
12-#14	2.97	8640	3389	13088	2841	16105	2213	17450	1725	18507	947	22512	295	20545
12-#18	5.29	9574	4153	16453	3302	20172	2537	22239	1922	24770	861	31276	-192	30566
13-#11	2.23	8324	3145	12023	2682	14801	2106	15894	1652	16476	968	19550	433	16390
13-#14	3.22	8740	3471	13529	2878	16607	2246	18025	1736	19266	935	23443	228	22000
13-#18	5.73	9723	4298	17202	3376	21022	2599	23215	1943	26091	841	32896	-313	31669
14-#11	2.41	8403	3202	12487	2686	15204	2105	16336	1649	16989	940	20199	386	17444
14-#14	3.47	8866	3553	14042	2907	17171	2254	18644	1738	20014	899	24393	165	23294
14-#18	6.17	9918	4443	17989	3442	21996	2628	24279	1955	27415	784	34568	-420	32827
15-#11	2.58	8483	3258	12554	2754	15440	2162	16668	1688	17501	962	21002	367	18424
15-#14	3.72	8962	3635	14290	2980	17525	2326	19124	1786	20719	925	25495	130	24747
15-#18	6.61	10135	4589	18522	3553	22607	2738	25110	2028	28591	819	36547	-476	34305
16-#11	2.75	8559	3315	12775	2797	15747	2194	17043	1714	17997	963	21808	338	19416
16-#14	3.97	9060	3716	14628	3039	17957	2370	19655	1822	21417	924	26624	87	26048
17-#11	2.92	8648	3372	13057	2830	16081	2218	17443	1723	18526	956	22512	306	20445
17-#14	4.21	9194	3798	15012	3089	18437	2405	20224	1836	22173	915	27629	41	27383
18-#11	3.09	8732	3428	13437	2849	16460	2226	17872	1728	19047	935	23160	251	21417
18-#14	4.46	9300	3880	15512	3121	18964	2421	20835	1846	22926	887	28565	-36	28430
19-#11	3.26	8818	3485	13558	2906	16724	2273	18218	1758	19550	950	23955	239	22438
19-#14	4.71	9430	3962	15729	3197	19352	2484	21325	1885	23626	904	29673	-58	29444
20-#11	3.44	8904	3542	13790	2945	17038	2303	18596	1782	20047	948	24677	204	23374
20-#14	4.96	9563	4043	16070	3252	19810	2526	21861	1919	24393	916	30690	-112	30235
21-#11	3.61	8979	3599	14098	2976	17382	2323	18994	1793	20596	948	25449	181	24336
22-#11	3.78	9055	3655	14414	3004	17738	2341	19410	1801	21141	936	26149	142	25329
23-#11	3.95	9143	3712	14608	3051	18028	2378	19770	1827	21619	942	26887	115	26237
24-#11	4.12	9215	3769	14822	3095	18324	2411	20150	1851	22136	944	27642	89	27173
25-#11	4.30	9303	3825	15113	3126	18670	2433	20543	1862	22642	935	28331	48	28057

ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.57	9234	3281	13042	2823	16007	2217	17006	1777	17031	1095	19122	606	15474
5-#14	1.11	9200	3108	12618	2681	15210	2109	15879	1682	15480	1068	17225	689	10568
5-#18	1.96	9618	3426	14258	2856	17115	2227	18074	1748	18337	1017	21210	492	17425
6-#14	1.33	9433	3190	13844	2607	16030	2028	16553	1603	16197	972	17678	568	12649
6-#18	2.36	10014	3572	15852	2807	18389	2155	19306	1669	19796	892	22162	294	20383
7-#11	1.07	9216	3096	12315	2716	15035	2146	15818	1716	15483	1101	17429	728	10384
7-#14	1.55	9477	3272	13241	2814	16106	2216	17066	1757	17101	1079	19679	617	14199
7-#18	2.75	10060	3717	15399	3078	18732	2394	20111	1860	21077	1019	25167	326	22763
8-#11	1.23	9309	3153	12312	2791	15274	2202	16198	1764	16078	1125	18263	720	11664
8-#14	1.77	9605	3354	13333	2907	16478	2284	17608	1815	17913	1105	20804	597	16158
8-#18	3.14	10272	3863	15807	3205	19428	2493	21083	1946	22420	1050	27002	275	25273
9-#11	1.38	9414	3210	12779	2805	15697	2213	16643	1761	16608	1103	19058	665	12924
9-#14	1.99	9745	3435	13938	2936	17058	2306	18242	1817	18688	1078	21964	522	17651
9-#18	3.54	10490	4008	16751	3270	20395	2544	22151	1957	23792	1008	29047	147	27979
10-#11	1.53	9483	3266	13362	2793	16218	2192	17129	1738	17148	1064	19531	609	14182
10-#14	2.21	9836	3517	14648	2938	17769	2293	18930	1798	19502	1031	22711	449	19502
10-#18	3.93	10632	4153	17788	3309	21541	2548	23338	1946	25279	942	30777	65	30361
11-#11	1.69	9592	3323	13275	2886	16377	2274	17472	1801	17744	1106	20684	614	15378
11-#14	2.43	9988	3599	14669	3050	18031	2392	19420	1872	20295	1080	24260	444	20868
11-#18	4.32	10893	4299	18072	3468	22086	2689	24193	2049	26555	1005	32979	-3	32966
12-#11	1.84	9703	3380	13448	2943	16677	2313	17868	1833	18282	1112	21552	599	16626
12-#14	2.65	10138	3681	14947	3125	18471	2442	19981	1914	21046	1085	25466	419	22443
12-#18	4.72	11132	4444	18591	3588	22868	2769	25179	2116	27828	1006	35001	-55	34787
13-#11	1.99	9791	3437	13796	2965	17063	2333	18304	1839	18849	1103	22246	552	17748
13-#14	2.87	10258	3763	15421	3161	19015	2474	20601	1924	21862	1073	26468	353	23943
13-#18	5.11	11351	4590	19388	3661	23789	2831	26239	2137	29253	987	36751	-174	36034
14-#11	2.15	9879	3493	14313	2966	17498	2330	18780	1834	19396	1074	22941	505	19007
14-#14	3.09	10380	3844	16088	3173	19617	2479	21283	1925	22664	1036	27489	289	25405
14-#18	5.50	11566	4735	20256	3725	24826	2857	27389	2149	30678	930	38563	-281	37366
15-#11	2.30	9965	3550	14365	3037	17746	2390	19137	1875	19953	1098	23816	488	20048
15-#14	3.32	10499	3926	16238	3264	19992	2555	21785	1976	23428	1064	28687	257	27010
15-#18	5.89	11756	4880	20811	3840	25500	2971	28286	2225	31952	967	40710	-332	38978
16-#11	2.45	10050	3607	14591	3080	18081	2424	19540	1903	20488	1100	24690	460	21171
16-#14	3.54	10608	4008	16588	3324	20467	2600	22357	2013	24182	1064	29913	215	28373
16-#18	6.29	11989	5026	21479	3941	26312	3045	29279	2285	33240	962	42627	-431	40585
17-#11	2.61	10150	3663	14899	3114	18434	2446	19971	1912	21056	1093	25447	429	22245
17-#14	3.76	10758	4090	17009	3374	20973	2635	22970	2027	24995	1056	30996	170	29890
18-#11	2.76	10239	3720	15326	3131	18847	2453	20424	1914	21615	1071	26144	374	23326
18-#14	3.98	10868	4172	17565	3404	21545	2650	23628	2036	25803	1027	32006	93	31339
19-#11	2.91	10334	3777	15438	3190	19127	2502	20804	1947	22159	1088	27004	364	24409
19-#14	4.20	11000	4253	17778	3482	21959	2715	24157	2077	26561	1046	33203	74	32752

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.07	10434	3833	15684	3230	19456	2532	21212	1972	22695	1087	27784	330	25436
20-#14	4.42	11165	4335	18141	3538	22441	2757	24734	2111	27318	1044	34303	22	34195
21-#11	3.22	10507	3890	16019	3261	19834	2553	21634	1982	23285	1087	28617	308	26530
21-#14	4.64	11249	4417	18606	3583	22965	2787	25343	2127	28162	1044	35488	-9	35448
22-#11	3.37	10599	3947	16360	3287	20221	2570	22079	1990	23869	1075	29368	268	27544
22-#14	4.86	11369	4499	19070	3627	23505	2815	25980	2141	29002	1028	36571	-65	36282
23-#11	3.52	10695	4004	16561	3336	20522	2608	22466	2017	24386	1081	30171	243	28581
24-#11	3.68	10772	4060	16795	3381	20839	2641	22885	2042	24943	1085	30986	218	29647
25-#11	3.83	10868	4117	17104	3411	21213	2663	23298	2053	25487	1076	31731	177	30651
26-#11	3.98	10965	4174	17427	3441	21602	2684	23741	2063	26070	1065	32478	143	31645
27-#11	4.14	11053	4230	17688	3481	21906	2718	24132	2088	26589	1070	33355	117	32621

ROUND TIED COLUMNS 38" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.41	10811	3589	14937	3120	18420	2455	19557	1973	19514	1236	21845	731	16597
5-#18	1.76	11235	3735	16296	3146	19652	2461	20733	1940	20901	1156	24073	614	18729
6-#14	1.19	11014	3498	15940	2886	18504	2249	19086	1784	18563	1101	20205	681	13532
6-#18	2.12	11655	3880	18110	3087	21048	2378	22052	1852	22438	1024	25055	413	22342
7-#14	1.39	11075	3580	15172	3109	18537	2452	19633	1951	19572	1218	22420	738	15284
7-#18	2.47	11728	4025	17496	3374	21358	2632	22921	2057	23852	1162	28352	455	24746
8-#11	1.10	10888	3461	14145	3091	17634	2443	18697	1961	18480	1266	20904	842	12493
8-#14	1.59	11216	3662	15243	3207	18925	2524	20207	2013	20450	1248	23643	722	17324
8-#18	2.82	11968	4171	17907	3506	22094	2734	23936	2145	25301	1197	30342	408	27570
9-#11	1.24	10999	3518	14663	3102	18093	2451	19174	1956	19043	1243	21750	787	13915
9-#14	1.79	11366	3744	15909	3233	19554	2545	20888	2013	21276	1219	24883	646	19006
9-#18	3.17	12195	4316	18937	3568	23140	2785	25112	2157	26770	1154	32541	279	30393
10-#11	1.38	11077	3575	15319	3085	18658	2425	19704	1930	19609	1201	22239	729	15219
10-#14	1.98	11469	3826	16698	3230	20319	2527	21639	1991	22138	1170	25667	572	21007
10-#18	3.53	12355	4462	20071	3602	24407	2786	26388	2142	28357	1087	34385	198	33016
11-#11	1.51	11197	3631	15182	3184	18820	2514	20062	1997	20260	1248	23497	737	16566
11-#14	2.18	11636	3907	16679	3348	20595	2632	22150	2069	23000	1223	27351	572	22600
11-#18	3.88	12643	4607	20335	3767	24954	2931	27298	2250	29739	1154	36773	135	35953
12-#11	1.65	11315	3688	15362	3243	19136	2554	20486	2031	20840	1255	24437	723	17861
12-#14	2.38	11796	3989	16974	3426	21062	2684	22752	2113	23809	1230	28655	548	24397
12-#18	4.23	12893	4752	20898	3891	25789	3013	28336	2318	31109	1157	38963	85	38372
13-#11	1.79	11418	3745	15737	3264	19546	2573	20953	2036	21445	1245	25178	677	19124
13-#14	2.58	11936	4071	17481	3461	21643	2715	23417	2123	24681	1217	29727	482	25955
13-#18	4.59	13143	4898	21744	3962	26783	3075	29487	2341	32638	1138	40843	-32	40706
14-#11	1.93	11515	3802	16310	3263	20020	2568	21454	2029	22025	1215	25915	629	20436
14-#14	2.78	12071	4153	18216	3470	22290	2718	24146	2122	25535	1180	30819	418	27573
14-#18	4.94	13382	5043	22696	4023	27881	3098	30739	2352	34163	1081	42793	-138	42185
15-#11	2.06	11605	3858	16345	3337	20276	2630	21845	2074	22628	1242	26865	614	21627
15-#14	2.98	12198	4234	18355	3565	22684	2797	24686	2176	26360	1210	32116	389	29229
15-#18	5.29	13580	5189	23270	4143	28614	3217	31681	2430	35537	1121	44940	-204	43989

ROUND TIED COLUMNS 38" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.20	11702	3915	16575	3381	20635	2666	22276	2102	23203	1244	27808	587	22955
16-#14	3.17	12319	4316	18715	3624	23202	2844	25299	2213	27170	1211	33438	347	30756
16-#18	5.64	13760	5334	23964	4244	29489	3292	32740	2491	36922	1117	47184	-283	45771
17-#11	2.34	11811	3972	16910	3414	21013	2687	22734	2110	23809	1237	28617	557	24072
17-#14	3.37	12472	4398	19171	3674	23735	2877	25956	2227	28040	1203	34598	304	32468
17-#18	6.00	14072	5479	24719	4336	30434	3357	33878	2518	38438	1103	49204	-363	47391
18-#11	2.48	11905	4028	17384	3430	21460	2693	23214	2112	24404	1215	29362	501	25285
18-#14	3.57	12598	4480	19788	3704	24353	2891	26648	2235	28903	1174	35682	227	33939
19-#11	2.61	12007	4085	17486	3490	21769	2739	23621	2146	24991	1233	30288	494	26398
19-#14	3.77	12744	4562	19995	3784	24791	2958	27225	2278	29720	1195	36970	210	35531
20-#11	2.75	12124	4142	17745	3531	22098	2774	24067	2173	25566	1233	31127	460	27550
20-#14	3.97	12908	4643	20380	3840	25295	3000	27847	2314	30532	1193	38152	160	37155
21-#11	2.89	12202	4198	18107	3562	22504	2795	24510	2182	26172	1228	31956	431	28712
21-#14	4.17	13018	4725	20881	3885	25868	3031	28489	2329	31435	1194	39427	129	38634
22-#11	3.03	12293	4255	18476	3587	22929	2812	24987	2189	26820	1220	32823	399	29812
22-#14	4.36	13149	4807	21379	3927	26452	3059	29169	2342	32333	1178	40586	74	40180
23-#11	3.16	12405	4312	18682	3637	23241	2850	25401	2218	27376	1228	33692	375	31000
23-#14	4.56	13299	4889	21709	3994	26917	3110	29756	2380	33112	1186	41795	35	41579
24-#11	3.30	12490	4369	18935	3683	23580	2885	25843	2242	27973	1232	34567	351	32069
25-#11	3.44	12596	4425	19263	3713	23981	2906	26293	2253	28556	1223	35368	311	33198
26-#11	3.58	12699	4482	19614	3742	24392	2926	26767	2263	29178	1213	36167	277	34321
27-#11	3.71	12791	4539	19887	3783	24723	2962	27185	2289	29736	1218	37110	253	35400
28-#11	3.85	12897	4595	20169	3821	25071	2995	27618	2312	30331	1221	37906	223	36481

ROUND TIED COLUMNS 40" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.27	12555	3914	17008	3435	21070	2707	22361	2179	22231	1385	24815	861	17718
5-#18	1.59	13020	4060	18522	3453	22415	2707	23645	2142	23697	1301	26996	724	20043
6-#14	1.07	12762	3823	18240	3180	21225	2484	21871	1975	21156	1237	22965	799	14416
6-#18	1.91	13464	4205	20573	3381	23954	2613	25050	2045	25307	1162	28180	536	24234
7-#14	1.25	12840	3905	17285	3421	21207	2702	22446	2156	22276	1365	25406	866	16372
7-#18	2.23	13566	4350	19874	3672	24223	2882	25984	2264	26860	1312	31783	588	26783
8-#14	1.43	12996	3987	17330	3523	21609	2778	23059	2221	23222	1398	26730	853	18498
8-#18	2.55	13833	4496	20185	3822	24998	2989	27042	2355	28418	1350	33931	545	29939
9-#11	1.12	12749	3843	16722	3416	20727	2703	21957	2162	21711	1391	24689	914	14921
9-#14	1.61	13155	4069	18059	3547	22288	2797	23785	2219	24098	1368	28048	776	20379
9-#18	2.86	14070	4641	21305	3883	26124	3038	28305	2366	29983	1307	36282	416	32822
10-#11	1.24	12838	3900	17461	3393	21339	2671	22531	2133	22303	1346	25191	854	16265
10-#14	1.79	13271	4150	18935	3539	23109	2773	24601	2194	25006	1317	28867	700	22465
10-#18	3.18	14249	4787	22541	3911	27482	3034	29691	2349	31668	1237	37874	298	35744
11-#11	1.37	12969	3956	17268	3499	21500	2766	22904	2204	23012	1397	26558	867	17772
11-#14	1.97	13453	4232	18867	3663	23397	2885	25133	2277	25940	1374	30689	704	24246
11-#18	3.50	14565	4932	22776	4083	28061	3186	30637	2461	33159	1309	40816	277	38773

ROUND TIED COLUMNS 40" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.49	13094	4013	17442	3560	21832	2809	23356	2240	23629	1405	27570	854	19111
12-#14	2.15	13622	4314	19176	3743	23890	2939	25774	2323	26807	1381	32093	682	26323
12-#18	3.82	14826	5077	23382	4210	28949	3270	31746	2531	34627	1314	43174	229	41462
13-#11	1.61	13210	4070	17855	3579	22266	2826	23854	2244	24276	1395	28357	808	20523
13-#14	2.33	13780	4396	19719	3777	24503	2969	26485	2332	27734	1369	33235	617	27991
13-#18	4.14	15082	5223	24280	4279	30015	3332	32977	2553	36258	1296	45184	114	44451
14-#11	1.74	13319	4126	18489	3575	22780	2819	24380	2235	24888	1363	29136	759	21881
14-#14	2.51	13931	4478	20525	3783	25202	2969	27251	2329	28640	1330	34395	552	29798
14-#18	4.46	15373	5368	25513	4312	31176	3352	34342	2564	37883	1237	47270	7	47215
15-#11	1.86	13414	4183	18497	3653	23044	2884	24803	2282	25537	1392	30163	746	23212
15-#14	2.69	14058	4559	20649	3881	25614	3051	27839	2386	29528	1363	35793	525	31496
15-#18	4.77	15551	5513	25908	4461	31951	3474	35322	2644	39358	1281	49580	-55	49316
16-#11	1.99	13512	4240	18734	3698	23417	2920	25265	2312	26148	1395	31175	720	24599
16-#14	2.86	14200	4641	21018	3942	26165	3100	28493	2425	30394	1365	37212	485	33199
16-#18	5.09	15774	5659	26627	4562	32904	3552	36454	2707	40840	1279	51993	-132	51315
17-#11	2.11	13640	4297	19096	3730	23829	2942	25745	2319	26798	1389	32037	690	25858
17-#14	3.04	14366	4723	21511	3991	26734	3133	29189	2438	31320	1357	38450	442	34980
17-#18	5.41	16078	5804	27439	4655	33896	3616	37671	2734	42460	1265	54153	-210	53055
18-#11	2.23	13740	4353	19616	3745	24310	2946	26257	2320	27428	1366	32828	634	27247
18-#14	3.22	14500	4805	22191	4020	27399	3146	29920	2444	32238	1328	39606	365	36601
18-#18	5.73	16330	5950	28489	4717	35013	3650	38973	2756	44084	1219	56194	-342	54346
19-#11	2.36	13851	4410	19709	3807	24631	2994	26690	2356	28058	1385	33821	629	28432
19-#14	3.40	14660	4886	22389	4101	27882	3207	30535	2490	33113	1350	40985	351	38411
20-#11	2.48	13984	4467	19981	3849	24977	3030	27170	2383	28668	1385	34719	596	29714
20-#14	3.58	14842	4968	22795	4159	28387	3257	31212	2527	33982	1349	42251	302	40034
21-#11	2.61	14066	4523	20366	3879	25411	3050	27638	2392	29318	1381	35605	568	30908
21-#14	3.76	14960	5050	23333	4204	28999	3287	31885	2541	34906	1343	43516	261	41690
22-#11	2.73	14165	4580	20769	3903	25876	3066	28147	2398	30006	1373	36526	536	32132
22-#14	3.94	15103	5132	23867	4244	29637	3315	32611	2554	35900	1334	44850	217	43409
23-#11	2.86	14285	4637	20978	3955	26196	3106	28588	2429	30601	1382	37461	512	33382
23-#14	4.12	15249	5214	24208	4312	30118	3367	33237	2593	36734	1343	46151	180	44973
24-#11	2.98	14379	4693	21242	4000	26557	3141	29051	2453	31235	1386	38397	489	34545
24-#14	4.30	15378	5295	24602	4377	30636	3416	33908	2627	37637	1348	47474	145	46591
25-#11	3.10	14488	4750	21597	4031	26985	3162	29537	2465	31858	1377	39254	449	35807
25-#14	4.48	15540	5377	25092	4421	31242	3448	34591	2644	38524	1336	48695	87	48120
26-#11	3.23	14603	4807	21979	4059	27420	3181	30045	2474	32521	1367	40104	416	36952
27-#11	3.35	14707	4864	22258	4101	27772	3218	30482	2500	33116	1373	41114	393	38157
28-#11	3.48	14808	4920	22555	4140	28147	3252	30943	2524	33749	1376	41968	364	39353
29-#11	3.60	14913	4977	22874	4177	28557	3274	31429	2536	34374	1368	42891	331	40526
30-#11	3.72	15012	5034	23286	4204	28983	3295	31943	2549	35037	1360	43702	291	41729

ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.15	14474	4256	19266	3766	23969	2972	25430	2396	25196	1542	28047	998	18835
5-#18	1.44	14982	4401	20944	3776	25427	2965	26822	2355	26737	1454	30347	857	21369
6-#18	1.73	15450	4547	23250	3691	27121	2860	28313	2247	28414	1307	31551	665	25789
7-#14	1.14	14781	4247	19589	3749	24129	2965	25526	2371	25226	1519	28650	999	17475
7-#18	2.02	15580	4692	22351	4001	27341	3145	29295	2480	30115	1468	35473	726	28660
8-#14	1.30	14951	4328	19600	3856	24542	3045	26176	2440	26236	1554	30079	990	19677
8-#18	2.31	15877	4837	22648	4155	28152	3256	30414	2575	31783	1510	37782	688	32379
9-#11	1.01	14676	4185	18967	3746	23612	2968	25005	2379	24627	1546	27889	1047	15940
9-#14	1.46	15120	4410	20393	3877	25272	3062	26949	2437	27167	1524	31474	912	21772
9-#18	2.60	16123	4983	23862	4214	29360	3304	31759	2584	33444	1466	40283	559	35309
10-#11	1.13	14774	4241	19799	3718	24272	2931	25613	2345	25241	1498	28399	985	17320
10-#14	1.62	15248	4492	21368	3863	26153	3033	27829	2408	28118	1470	32323	834	23934
10-#18	2.89	16322	5128	25208	4235	30803	3294	33260	2565	35224	1394	41961	440	38545
11-#11	1.24	14917	4298	19539	3830	24426	3032	26011	2422	26009	1553	29879	1002	18997
11-#14	1.79	15446	4574	21241	3994	26448	3151	28381	2496	29127	1531	34288	843	25915
11-#18	3.18	16667	5274	25407	4414	31419	3454	34242	2681	36825	1471	45121	424	41654
12-#11	1.35	15049	4355	19705	3892	24777	3076	26491	2460	26659	1562	30966	991	20373
12-#14	1.95	15625	4656	21551	4076	26967	3207	29062	2543	30046	1540	35793	821	28072
12-#18	3.46	16940	5419	26053	4545	32358	3541	35421	2753	38392	1478	47649	378	44628
13-#11	1.46	15174	4411	20159	3912	25236	3092	27020	2463	27349	1552	31798	945	21943
13-#14	2.11	15798	4737	22143	4109	27613	3236	29818	2552	31036	1528	37004	757	29952
13-#18	3.75	17219	5564	27003	4612	33485	3601	36733	2776	40126	1460	49788	264	47964
14-#11	1.58	15299	4468	20857	3905	25791	3083	27572	2451	27997	1519	32616	894	23343
14-#14	2.27	15968	4819	23025	4112	28365	3234	30620	2546	31991	1488	38230	691	32079
14-#18	4.04	17548	5710	28339	4642	34723	3618	38175	2785	41850	1401	52007	157	50750
15-#11	1.69	15399	4525	20833	3986	26061	3151	28021	2501	28687	1550	33722	884	24834
15-#14	2.44	16103	4901	23123	4214	28793	3319	31255	2606	32943	1523	39732	667	33811
15-#18	4.33	17730	5855	28734	4795	35538	3744	39230	2868	43427	1447	54483	98	53789
16-#11	1.80	15506	4581	21076	4031	26448	3188	28519	2532	29335	1553	34805	858	26252
16-#14	2.60	16259	4983	23506	4275	29367	3368	31952	2646	33859	1526	41250	627	35700
16-#18	4.62	17973	6000	29477	4897	36570	3825	40434	2932	45007	1446	57065	22	56885
17-#11	1.91	15647	4638	21468	4063	26894	3209	29021	2539	30025	1547	35718	829	27652
17-#14	2.76	16440	5065	24036	4324	29983	3401	32680	2659	34849	1518	42564	585	37528
17-#18	4.91	18301	6146	30347	4990	37608	3887	41730	2960	46729	1433	59366	-53	59080
18-#11	2.03	15753	4695	22030	4076	27412	3212	29565	2538	30700	1524	36554	772	29088
18-#14	2.92	16581	5146	24774	4351	30696	3413	33458	2664	35820	1488	43790	507	39377
18-#18	5.20	18507	6291	31495	5051	38802	3920	43093	2979	48455	1387	61542	-186	60492
19-#11	2.14	15873	4752	22118	4141	27739	3261	30025	2576	31363	1544	37617	769	30427
19-#14	3.09	16755	5228	24968	4435	31199	3476	34111	2711	36755	1512	45263	497	41240
19-#18	5.49	18824	6437	31973	5183	39727	4017	44222	3050	50033	1419	64030	-219	62781

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.25	16019	4808	22402	4183	28105	3298	30527	2604	32012	1545	38574	738	31879
20-#14	3.25	16947	5310	25395	4493	31728	3526	34837	2749	37673	1512	46613	449	42975
21-#11	2.36	16107	4865	22810	4212	28568	3318	31032	2613	32700	1540	39517	709	33166
21-#14	3.41	17070	5392	25965	4538	32380	3556	35546	2764	38661	1506	47961	408	44819
22-#11	2.48	16215	4922	23248	4235	29064	3334	31573	2618	33439	1532	40491	677	34505
22-#14	3.57	17237	5473	26541	4577	33072	3584	36318	2775	39714	1496	49375	364	46569
23-#11	2.59	16338	4978	23459	4288	29401	3375	32040	2650	34063	1542	41493	655	35787
23-#14	3.74	17390	5555	26893	4647	33570	3637	36984	2816	40603	1507	50769	329	48320
24-#11	2.70	16446	5035	23731	4335	29783	3410	32525	2675	34738	1546	42490	633	37075
24-#14	3.90	17531	5637	27303	4712	34119	3686	37684	2850	41558	1512	52179	295	50157
25-#11	2.81	16564	5092	24116	4365	30239	3432	33041	2686	35399	1538	43403	592	38394
25-#14	4.06	17707	5719	27832	4756	34764	3718	38420	2868	42505	1500	53482	237	51794
26-#11	2.93	16685	5148	24530	4393	30698	3450	33589	2696	36103	1527	44303	560	39639
26-#14	4.22	17861	5801	28386	4801	35415	3748	39190	2884	43517	1487	54782	191	53509
27-#11	3.04	16801	5205	24813	4436	31068	3488	34045	2722	36735	1534	45309	530	40978
28-#11	3.15	16912	5262	25126	4474	31472	3523	34535	2746	37408	1538	46293	509	42227
29-#11	3.27	17017	5319	25467	4512	31902	3544	35051	2759	38072	1530	47274	477	43496
30-#11	3.38	17131	5375	25905	4538	32356	3565	35589	2770	38770	1521	48136	437	44770
31-#11	3.49	17249	5432	26126	4588	32739	3600	36058	2795	39409	1526	49174	416	45995
32-#11	3.60	17353	5489	26449	4626	33133	3633	36552	2818	40080	1529	50118	382	47292

ROUND TIED COLUMNS 44" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.05	16578	4614	21717	4113	27130	3251	28777	2624	28421	1706	31554	1140	19950
5-#18	1.32	17128	4759	23573	4116	28706	3236	30279	2578	30034	1613	33966	996	22704
6-#18	1.58	17620	4905	26151	4016	30560	3120	31854	2459	31771	1459	35180	798	27344
7-#14	1.04	16907	4605	22091	4094	27314	3241	28884	2597	28435	1681	32167	1138	18591
7-#18	1.84	17781	5050	25029	4345	30722	3421	32878	2707	33628	1632	39435	870	30503
8-#14	1.18	17091	4687	22064	4205	27736	3325	29571	2669	29500	1718	33703	1132	20863
8-#18	2.10	18083	5196	25306	4505	31568	3537	34065	2805	35408	1677	41908	836	34889
9-#14	1.33	17270	4768	22921	4224	28519	3340	30391	2665	30495	1688	35173	1053	23183
9-#18	2.37	18364	5341	26617	4561	32858	3583	35492	2813	37163	1633	44558	706	37851
10-#11	1.03	16895	4599	22342	4058	27472	3203	28968	2568	28435	1657	31875	1123	18385
10-#14	1.48	17411	4850	24005	4203	29462	3305	31320	2631	31487	1630	36049	974	25415
10-#18	2.63	18583	5486	28081	4576	34389	3567	37108	2792	39036	1558	46319	586	41419
11-#11	1.13	17050	4656	22005	4178	27612	3311	29397	2651	29257	1716	33475	1144	20180
11-#14	1.63	17625	4932	23812	4342	29758	3431	31908	2725	32574	1696	38161	986	27607
11-#18	2.89	18940	5632	28234	4762	35040	3735	38125	2913	40752	1640	49700	576	44594
12-#11	1.23	17188	4713	22161	4242	27983	3357	29904	2690	29949	1726	34637	1133	21648
12-#14	1.78	17813	5014	24118	4425	30305	3489	32629	2774	33536	1706	39769	967	29836
12-#18	3.16	19242	5777	28918	4896	36030	3824	39376	2987	42418	1649	52399	531	47869

ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
13-#11	1.33	17323	4770	22657	4260	28467	3372	30465	2692	30676	1716	35513	1087	23383
13-#14	1.92	18002	5096	24762	4457	30985	3516	33430	2782	34591	1694	41048	902	31912
13-#18	3.42	19546	5923	29923	4962	37211	3882	40768	3008	44254	1630	54666	419	51310
14-#11	1.44	17464	4826	23424	4250	29065	3360	31042	2678	31365	1682	36368	1035	24821
14-#14	2.07	18192	5177	25724	4458	31792	3511	34269	2773	35601	1652	42338	835	34150
14-#18	3.68	19912	6068	31366	4989	38535	3897	42275	3014	46075	1570	57018	311	54363
15-#11	1.54	17569	4883	23363	4334	29339	3432	31517	2731	32094	1714	37556	1028	26468
15-#14	2.22	18333	5259	25791	4563	32234	3600	34941	2837	36608	1690	43946	814	36112
15-#18	3.95	20101	6213	31755	5146	39387	4027	43416	3102	47756	1619	59662	256	57796
16-#11	1.64	17685	4940	23612	4381	29740	3469	32051	2763	32782	1719	38710	1003	27925
16-#14	2.37	18493	5341	26187	4626	32829	3649	35690	2879	37575	1693	45562	775	38259
16-#18	4.21	20364	6359	32520	5249	40480	4109	44693	3168	49434	1620	62413	181	60872
17-#11	1.74	17835	4996	24033	4413	30221	3490	32576	2769	33510	1712	39674	973	29473
17-#14	2.52	18700	5423	26756	4674	33494	3683	36451	2890	38625	1685	46954	734	40125
17-#18	4.47	20717	6504	33451	5340	41582	4171	46056	3195	51259	1607	64854	107	64034
18-#11	1.85	17950	5053	24642	4423	30775	3492	33152	2767	34224	1688	40550	916	30951
18-#14	2.66	18848	5505	27547	4699	34255	3693	37275	2894	39662	1655	48249	656	42159
18-#18	4.74	20930	6650	34699	5401	42856	4203	47491	3213	53085	1561	67165	-26	67016
19-#11	1.95	18080	5110	24720	4490	31109	3543	33639	2807	34927	1710	41687	915	32431
19-#14	2.81	19029	5586	27741	4785	34772	3757	37966	2943	40642	1680	49817	647	44069
19-#18	5.00	21272	6795	35174	5535	43830	4302	48689	3286	54763	1595	69809	-55	69484
20-#11	2.05	18235	5167	25015	4534	31494	3580	34162	2835	35615	1711	42705	884	33929
20-#14	2.96	19239	5668	28188	4844	35330	3809	38723	2982	41615	1681	51251	601	45979
20-#18	5.26	21615	6940	35995	5634	44825	4388	50012	3349	56453	1591	72269	-143	71398
21-#11	2.15	18335	5223	25447	4562	31985	3600	34705	2845	36343	1707	43704	856	35360
21-#14	3.11	19378	5750	28790	4888	36023	3839	39486	2996	42660	1675	52682	560	47967
22-#11	2.26	18451	5280	25922	4584	32510	3614	35278	2849	37111	1698	44730	824	36866
22-#14	3.26	19541	5832	29411	4926	36760	3865	40304	3007	43788	1666	54176	517	49793
23-#11	2.36	18581	5337	26133	4639	32868	3657	35764	2881	37786	1709	45801	803	38238
23-#14	3.40	19721	5913	29771	4998	37283	3920	41008	3049	44717	1677	55664	482	51730
24-#11	2.46	18691	5393	26413	4685	33270	3693	36277	2907	38501	1714	46859	782	39658
24-#14	3.55	19874	5995	30196	5063	37863	3970	41740	3084	45730	1683	57161	450	53602
25-#11	2.56	18827	5450	26828	4716	33748	3714	36824	2918	39200	1706	47827	741	41010
25-#14	3.70	20063	6077	30765	5108	38548	4002	42519	3101	46733	1671	58544	392	55477
26-#11	2.67	18955	5507	27274	4743	34237	3731	37411	2927	39933	1694	48777	709	42381
26-#14	3.85	20225	6159	31361	5151	39231	4031	43346	3117	47806	1658	59920	346	57402
27-#11	2.77	19076	5563	27561	4787	34626	3770	37886	2955	40611	1702	49847	681	43782
27-#14	4.00	20399	6241	31819	5210	39801	4082	44034	3153	48749	1665	61420	302	59152
28-#11	2.87	19203	5620	27889	4826	35051	3805	38405	2979	41328	1707	50895	660	45127
28-#14	4.14	20601	6322	32300	5265	40412	4132	44774	3187	49761	1670	62900	271	60938

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
29-#11	2.98	19314	5677	28252	4863	35508	3827	38951	2991	42023	1699	51932	628	46524
30-#11	3.08	19426	5734	28718	4888	35992	3847	39514	3002	42757	1690	52845	588	47826
31-#11	3.18	19565	5790	28948	4939	36394	3883	40014	3028	43435	1695	53949	568	49180
32-#11	3.28	19676	5847	29290	4978	36804	3917	40540	3052	44157	1699	54952	535	50519
33-#11	3.39	19797	5904	29685	5010	37273	3939	41074	3064	44849	1691	55971	507	51830
34-#11	3.49	19932	5960	30080	5042	37762	3962	41631	3077	45583	1684	57069	478	53206

ROUND TIED COLUMNS 46" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
5-#18	1.20	19468	5134	26417	4471	32263	3521	34028	2812	33599	1780	37866	1140	24051
6-#18	1.44	19984	5280	29288	4356	34284	3391	35687	2681	35390	1617	39079	936	28901
7-#18	1.68	20175	5425	27917	4706	34381	3711	36754	2944	37411	1803	43682	1019	32364
8-#14	1.08	19423	5062	24730	4571	31204	3619	33258	2910	33036	1890	37616	1281	22056
8-#18	1.93	20502	5571	28166	4870	35258	3831	38007	3047	39296	1851	46323	989	36946
9-#14	1.22	19610	5143	25655	4587	32042	3631	34125	2903	34093	1859	39156	1201	24612
9-#18	2.17	20799	5716	29571	4924	36633	3874	39517	3053	41154	1806	49119	859	40301
10-#14	1.35	19767	5225	26857	4560	33050	3591	35096	2865	35125	1798	40056	1119	26907
10-#18	2.41	21039	5861	31170	4932	38254	3853	41249	3028	43118	1729	50958	737	44365
11-#11	1.03	19375	5031	24676	4543	31072	3603	33075	2891	32746	1881	37280	1284	21343
11-#14	1.49	19997	5307	26586	4706	33338	3723	35727	2965	36278	1868	42322	1136	29338
11-#18	2.65	21423	6007	31266	5127	38936	4029	42301	3154	44950	1815	54566	733	47594
12-#11	1.13	19521	5088	24818	4608	31462	3652	33609	2931	33512	1899	38597	1282	22937
12-#14	1.62	20196	5389	26885	4791	33917	3783	36488	3016	37298	1879	44034	1118	31617
12-#18	2.89	21741	6152	31964	5262	39976	4119	43623	3230	46708	1826	57438	690	51184
13-#11	1.22	19666	5145	25358	4625	31973	3665	34194	2932	34276	1887	39516	1236	24753
13-#14	1.76	20400	5471	27585	4823	34632	3809	37334	3023	38409	1866	45379	1054	33900
13-#18	3.13	22070	6297	33047	5327	41212	4176	45095	3251	48654	1808	59833	579	54711
14-#11	1.31	19822	5201	26199	4612	32616	3650	34805	2915	35003	1852	40406	1183	26316
14-#14	1.90	20610	5552	28631	4820	35495	3801	38210	3011	39482	1824	46731	985	36209
14-#18	3.37	22427	6443	34602	5352	42623	4189	46667	3254	50572	1747	62314	470	58053
15-#11	1.41	19933	5258	26096	4700	32892	3725	35305	2972	35772	1887	41678	1177	28090
15-#14	2.03	20758	5634	28661	4929	35949	3894	38919	3078	40539	1863	48448	967	38365
15-#18	3.61	22671	6588	34971	5513	43512	4322	47892	3347	52358	1798	65129	418	61822
16-#11	1.50	20058	5315	26348	4748	33305	3763	35875	3005	36501	1892	42904	1153	29618
16-#14	2.17	20931	5716	29070	4992	36565	3944	39721	3121	41563	1868	50164	929	40704
16-#18	3.85	22954	6734	35767	5616	44647	4405	49244	3414	54125	1800	68051	345	64939
17-#11	1.60	20219	5371	26801	4779	33818	3784	36422	3010	37268	1885	43919	1124	31321
17-#14	2.30	21155	5798	29678	5040	37279	3978	40513	3132	42670	1860	51631	888	42766
17-#18	4.09	23310	6879	36759	5708	45832	4468	50664	3439	56062	1788	70632	272	68418
18-#11	1.69	20341	5428	27458	4787	34414	3784	37031	3007	38007	1860	44833	1067	32837
18-#14	2.44	21312	5879	30527	5063	38090	3986	41383	3135	43771	1829	52991	810	45001
18-#18	4.33	23554	7024	38095	5767	47185	4498	52182	3457	57988	1741	73076	139	71827

ROUND TIED COLUMNS 46" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
19-#11	1.78	20481	5485	27524	4857	34752	3837	37544	3049	38764	1883	46046	1066	34465
19-#14	2.57	21506	5961	30717	5152	38619	4052	42113	3186	44801	1856	54659	803	46952
19-#18	4.57	23893	7170	38579	5903	48201	4599	53448	3532	59767	1777	75877	113	75073
20-#11	1.88	20645	5541	27829	4901	35156	3875	38089	3077	39492	1885	47124	1037	36004
20-#14	2.71	21727	6043	31183	5212	39206	4104	42902	3225	45830	1857	56178	758	49043
20-#18	4.81	24284	7315	39441	6003	49240	4686	54859	3597	61546	1774	78484	27	78321
21-#11	1.97	20753	5598	28286	4929	35677	3894	38666	3086	40259	1881	48179	1008	37575
21-#14	2.84	21883	6125	31816	5255	39940	4134	43718	3240	46932	1851	57692	718	51082
21-#18	5.05	24533	7461	40526	6085	50501	4742	56239	3624	63473	1766	81121	-44	80841
22-#11	2.07	20882	5655	28801	4950	36230	3907	39274	3090	40996	1860	49100	962	39126
22-#14	2.98	22058	6207	32486	5292	40715	4159	44583	3250	48106	1841	59264	674	53081
22-#18	5.30	24842	7606	41579	6162	51823	4798	57744	3651	65547	1753	83913	-118	82515
23-#11	2.16	21019	5712	29009	5006	36607	3952	39780	3124	41776	1883	50398	956	40635
23-#14	3.11	22249	6288	32852	5365	41269	4216	45315	3293	49104	1854	60847	641	55191
24-#11	2.25	21138	5768	29296	5052	37031	3988	40321	3149	42537	1889	51517	936	42209
24-#14	3.25	22414	6370	33290	5431	41880	4267	46087	3328	50175	1860	62432	609	57112
25-#11	2.35	21285	5825	29738	5083	37531	4009	40898	3161	43264	1880	52541	895	43664
25-#14	3.38	22606	6452	33901	5476	42597	4298	46910	3345	51233	1849	63896	552	59172
26-#11	2.44	21421	5882	30223	5109	38051	4025	41511	3169	44035	1869	53540	863	45218
26-#14	3.52	22787	6534	34540	5519	43322	4326	47795	3362	52349	1835	65346	506	61135
27-#11	2.53	21550	5938	30510	5154	38457	4066	42020	3198	44753	1877	54675	836	46610
27-#14	3.66	22974	6616	35007	5578	43919	4379	48510	3398	53358	1844	66936	464	63104
28-#11	2.63	21690	5995	30853	5194	38899	4101	42567	3223	45521	1883	55785	816	48083
28-#14	3.79	23170	6697	35512	5633	44565	4429	49291	3432	54432	1849	68506	433	65148
29-#11	2.72	21807	6052	31240	5231	39388	4122	43142	3235	46243	1874	56879	785	49516
29-#14	3.93	23333	6779	36050	5688	45249	4460	50114	3451	55483	1838	70073	388	66983
30-#11	2.82	21928	6108	31734	5255	39901	4142	43731	3245	47017	1865	57843	744	50941
31-#11	2.91	22077	6165	31969	5307	40317	4179	44258	3272	47734	1871	59012	725	52409
32-#11	3.00	22195	6222	32332	5346	40749	4213	44820	3296	48489	1875	60076	692	53792
33-#11	3.10	22324	6279	32746	5378	41244	4236	45377	3308	49226	1868	61152	665	55251
34-#11	3.19	22467	6335	33169	5409	41762	4258	45965	3320	50000	1861	62310	636	56636
35-#11	3.29	22588	6392	33479	5454	42194	4287	46498	3345	50746	1870	63365	612	58048
36-#11	3.38	22711	6449	33790	5497	42652	4315	47051	3369	51464	1868	64494	586	59473

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
5-#18	1.11	22009	5526	29485	4843	36111	3818	38071	3055	37446	1954	42062	1291	25408
6-#18	1.33	22550	5671	32669	4712	38306	3674	39824	2912	39283	1783	43261	1080	30458
7-#18	1.55	22773	5817	31023	5083	38327	4013	40935	3192	41478	1982	48227	1174	34245
8-#18	1.77	23123	5962	31239	5253	39234	4138	42254	3299	43449	2032	51039	1148	38997
9-#14	1.12	22153	5535	28604	4966	35851	3936	38164	3153	37962	2037	43438	1355	26060
9-#18	1.99	23437	6107	32736	5303	40695	4179	43848	3303	45429	1987	53980	1017	42669
10-#14	1.24	22325	5617	29932	4933	36928	3889	39176	3109	39045	1973	44358	1270	28411
10-#18	2.21	23699	6253	34483	5305	42411	4152	45673	3273	47481	1906	55893	894	47296
11-#14	1.37	22571	5699	29574	5087	37204	4028	39851	3216	40221	2039	46665	1282	31075
11-#18	2.43	24110	6398	34514	5508	43113	4335	46782	3406	49433	1998	59733	894	50653
12-#11	1.03	22055	5479	27684	4991	35227	3960	37619	3183	37360	2078	42859	1437	24238
12-#14	1.49	22780	5780	29864	5174	37815	4091	40651	3268	41346	2059	48600	1275	33414
12-#18	2.65	24445	6544	35218	5645	44208	4428	48175	3484	51263	2009	62779	853	54574
13-#11	1.12	22211	5536	28271	5007	35764	3971	38229	3183	38160	2066	43820	1390	26133
13-#14	1.62	22996	5862	30621	5204	38565	4115	41534	3274	42511	2046	50012	1211	35914
13-#18	2.87	24800	6689	36385	5710	45500	4484	49728	3505	53333	1992	65300	743	58174
14-#11	1.21	22382	5593	29190	4990	36454	3953	38872	3164	38914	2029	44742	1336	27845
14-#14	1.74	23230	5944	31755	5199	39487	4105	42455	3260	43647	2003	51422	1141	38288
14-#18	3.09	25190	6834	38057	5731	47000	4493	51365	3505	55352	1930	67910	633	61820
15-#11	1.29	22498	5649	29040	5082	36730	4032	39398	3223	39736	2066	46102	1333	29673
15-#14	1.87	23386	6026	31744	5311	39950	4201	43201	3330	44756	2044	53251	1126	40648
15-#18	3.32	25447	6980	38398	5895	47923	4631	52656	3601	57230	1984	70898	585	65686
16-#11	1.38	22632	5706	29295	5131	37156	4071	40000	3258	40506	2073	47400	1309	31330
16-#14	1.99	23572	6107	32163	5376	40587	4252	44056	3375	45837	2050	55068	1088	43077
16-#18	3.54	25753	7125	39225	6000	49099	4714	54101	3670	59082	1986	73991	513	69086
17-#11	1.47	22806	5763	29780	5161	37699	4091	40574	3262	41311	2065	48465	1280	33135
17-#14	2.11	23813	6189	32812	5423	41346	4285	44880	3385	47000	2041	56611	1048	45311
17-#18	3.76	26126	7271	40279	6091	50368	4778	55578	3694	61131	1975	76711	441	72897
18-#11	1.55	22935	5820	30488	5167	38340	4090	41215	3257	42073	2039	49415	1223	34746
18-#14	2.24	23978	6271	33720	5443	42212	4292	45797	3386	48139	2009	58030	969	47742
18-#18	3.98	26387	7416	41697	6148	51803	4806	57178	3711	63176	1928	79288	308	76354
19-#11	1.64	23084	5876	30537	5240	38681	4144	41754	3301	42885	2064	50707	1224	36543
19-#14	2.36	24186	6353	33905	5535	42752	4360	46565	3439	49244	2038	59803	965	49884
19-#18	4.20	26750	7561	42197	6288	52848	4909	58512	3788	65034	1965	82248	286	79906
20-#11	1.72	23257	5933	30853	5285	39103	4183	42321	3330	43654	2067	51846	1196	38104
20-#14	2.49	24420	6435	34388	5596	43367	4413	47385	3478	50330	2040	61407	921	52169
20-#18	4.42	27115	7707	43099	6389	53941	4997	59980	3853	66905	1963	85002	202	83616
21-#11	1.81	23377	5990	31335	5312	39653	4202	42928	3339	44451	2062	52957	1167	39822
21-#14	2.61	24592	6516	35055	5638	44142	4443	48253	3494	51489	2034	63004	880	54251
21-#18	4.64	27434	7852	44235	6470	55273	5053	61455	3882	68938	1955	87789	131	86835
22-#11	1.90	23516	6046	31891	5331	40236	4214	43576	3342	45222	2041	53920	1120	41413
22-#14	2.74	24779	6598	35774	5674	44956	4466	49166	3503	52619	2008	64418	816	56432
22-#18	4.86	27763	7998	45359	6546	56676	5108	63042	3908	71146	1943	90728	57	90345

ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
23-#11	1.98	23660	6103	32095	5389	40631	4260	44101	3377	46047	2065	55296	1115	43063
23-#14	2.86	24973	6680	36144	5749	45542	4525	49926	3547	53771	2038	66333	804	58616
23-#18	5.08	28075	8143	46141	6664	57713	5197	64402	3975	72918	1958	93557	-9	93495
24-#11	2.07	23787	6160	32389	5436	41076	4297	44670	3403	46859	2072	56477	1096	44681
24-#14	2.98	25159	6762	36595	5815	46184	4576	50739	3583	54905	2045	68005	774	60687
25-#11	2.16	23942	6217	32858	5466	41599	4317	45278	3414	47613	2062	57556	1055	46283
25-#14	3.11	25364	6844	37244	5860	46931	4607	51606	3600	56005	2033	69550	717	62929
26-#11	2.24	24089	6273	33382	5492	42150	4333	45917	3422	48422	2050	58604	1023	47925
26-#14	3.23	25555	6925	37931	5902	47699	4635	52530	3615	57176	2019	71074	672	64934
27-#11	2.33	24227	6330	33670	5538	42574	4374	46458	3452	49181	2060	59804	997	49457
27-#14	3.36	25756	7007	38406	5962	48324	4689	53291	3653	58242	2028	72755	631	67088
28-#11	2.41	24381	6387	34027	5578	43033	4410	47034	3477	49981	2065	60978	977	51094
28-#14	3.48	25967	7089	38934	6018	48994	4739	54113	3688	59388	2035	74414	600	69170
29-#11	2.50	24504	6443	34437	5615	43553	4432	47633	3489	50749	2057	62129	946	52558
29-#14	3.61	26130	7171	39503	6072	49723	4771	54980	3707	60480	2024	76065	556	71238
30-#11	2.59	24633	6500	34961	5638	44096	4451	48252	3498	51561	2048	63143	906	54112
30-#14	3.73	26328	7252	40218	6110	50484	4802	55864	3723	61651	2012	77529	499	73440
31-#11	2.67	24787	6557	35201	5691	44526	4488	48807	3526	52319	2055	64378	888	55632
31-#14	3.85	26522	7334	40602	6183	51121	4852	56656	3759	62720	2019	79267	470	75358
32-#11	2.76	24918	6613	35584	5731	44979	4522	49401	3551	53105	2059	65502	855	57123
33-#11	2.84	25057	6670	36018	5762	45501	4545	49985	3563	53885	2052	66634	828	58673
34-#11	2.93	25207	6727	36469	5793	46044	4567	50604	3575	54702	2044	67853	799	60126
35-#11	3.02	25340	6784	36788	5839	46500	4597	51164	3600	55480	2054	68966	776	61670
36-#11	3.10	25471	6840	37110	5882	46981	4625	51740	3623	56235	2052	70156	751	63122
37-#11	3.19	25605	6897	37552	5915	47475	4653	52340	3637	57046	2051	71207	718	64619

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.38	3540	1821	5556	1327	5878	1039	5768	816	5296	503	5577	284	4060
4-#14	1.99	3606	1919	5843	1375	6201	1075	6143	834	5790	484	6206	203	5421
4-#18	3.54	3754	2167	6511	1497	6971	1166	7043	877	6979	431	7697	-12	7684
5-#11	1.72	3630	1876	5781	1330	6066	1028	5965	797	5559	466	6018	235	4599
5-#14	2.49	3728	1999	6127	1392	6471	1070	6441	815	6190	437	6859	137	6153
5-#18	4.42	3950	2309	6941	1550	7437	1175	7580	859	7703	357	8843	-122	8724
6-#11	2.07	3722	1932	6065	1294	6281	995	6175	758	5837	411	6158	145	5485
6-#14	2.98	3852	2078	6491	1365	6790	1042	6777	776	6635	368	7118	16	7049
6-#18	5.31	4138	2451	7500	1543	8004	1160	8215	817	8543	254	9378	-327	9025
7-#11	2.41	3738	1987	6067	1417	6462	1091	6453	837	6236	468	6924	160	6064
7-#14	3.48	3877	2158	6540	1509	7025	1154	7117	867	7129	434	8107	24	7985
7-#18	6.19	4200	2593	7659	1743	8368	1310	8707	938	9267	340	11066	-315	10342
8-#11	2.76	3795	2042	6181	1467	6657	1136	6701	870	6538	472	7475	152	6752
8-#14	3.98	3953	2238	6723	1575	7297	1213	7457	909	7539	435	8863	6	8835
8-#18	7.07	4312	2734	7995	1846	8823	1403	9263	1002	9934	332	12138	-384	11178
9-#11	3.10	3854	2098	6367	1494	6856	1146	6930	870	6864	457	7861	89	7380
9-#14	4.48	4038	2318	6971	1617	7578	1229	7784	911	8007	415	9412	-83	9292
9-#18	7.96	4477	2876	8395	1926	9299	1436	9826	1007	10741	297	13066	-542	11833
10-#11	3.45	3893	2153	6597	1496	7079	1146	7175	861	7163	421	8193	42	7991
10-#14	4.97	4091	2398	7274	1629	7895	1238	8143	904	8447	367	9901	-149	9697
11-#11	3.79	3957	2208	6674	1567	7249	1198	7403	900	7489	444	8717	9	8680
11-#14	5.47	4180	2477	7409	1721	8131	1302	8448	952	8883	394	10608	-203	10261
12-#11	4.14	4022	2264	6812	1607	7443	1234	7641	925	7786	441	9181	-14	9163
12-#14	5.97	4274	2557	7610	1775	8403	1351	8779	985	9387	407	11248	-238	10825
13-#11	4.48	4064	2319	6985	1639	7642	1248	7891	936	8143	437	9624	-59	9533
13-#14	6.47	4339	2637	7850	1823	8684	1373	9133	1002	9802	382	11876	-304	11177
14-#11	4.83	4125	2374	7193	1655	7861	1260	8125	930	8482	417	9959	-114	9789
15-#11	5.17	4175	2430	7299	1711	8036	1298	8361	964	8764	423	10473	-139	10230
16-#11	5.52	4223	2485	7445	1747	8230	1331	8583	979	9085	423	11021	-163	10546

ROUND TIED COLUMNS 26" DIA.

4-#11	1.18	4480	2099	6924	1552	7362	1218	7218	961	6585	607	6911	375	4496
4-#14	1.70	4558	2197	7247	1599	7728	1254	7643	980	7144	589	7629	298	6249
4-#18	3.01	4735	2445	8025	1724	8608	1347	8670	1026	8498	541	9345	92	9012
5-#11	1.47	4586	2154	7202	1550	7573	1202	7434	938	6869	567	7398	324	5128
5-#14	2.12	4703	2276	7595	1613	8033	1244	7973	958	7583	540	8360	230	7028
5-#18	3.77	4967	2587	8529	1773	9136	1353	9273	1006	9307	466	10649	-17	10631
6-#11	1.76	4688	2209	7542	1504	7813	1160	7657	893	7161	507	7533	232	6173
6-#14	2.54	4849	2356	8027	1575	8390	1209	8338	912	8064	467	8633	109	8116
6-#18	4.52	5210	2729	9182	1757	9777	1331	9979	958	10240	360	11245	-220	10981
7-#11	2.06	4714	2265	7508	1640	8018	1268	7985	982	7634	573	8431	253	6848
7-#14	2.97	4878	2436	8051	1734	8657	1333	8738	1014	8644	542	9784	123	9080
7-#18	5.27	5266	2870	9335	1972	10190	1494	10550	1091	11080	456	13003	-224	12623

ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	2.35	4776	2320	7626	1694	8237	1317	8267	1018	7979	579	9058	248	7726
8-#14	3.39	4971	2516	8237	1803	8963	1396	9122	1060	9111	546	10643	110	10100
8-#18	6.03	5400	3012	9706	2079	10704	1591	11181	1160	11840	453	14418	-261	13555
9-#11	2.64	4844	2375	7840	1719	8460	1326	8522	1017	8341	564	9493	186	8370
9-#14	3.81	5059	2596	8527	1844	9279	1411	9489	1061	9634	526	11267	21	11146
9-#18	6.78	5561	3154	10165	2159	11244	1625	11818	1166	12749	420	15483	-417	14589
10-#11	2.94	4891	2431	8118	1719	8711	1323	8792	1006	8669	526	9858	139	9106
10-#14	4.24	5123	2675	8887	1854	9637	1417	9889	1052	10123	477	11813	-43	11749
10-#18	7.53	5667	3296	10721	2194	11860	1650	12526	1162	13622	339	16456	-531	15328
11-#11	3.23	4961	2486	8184	1794	8902	1379	9054	1049	9044	553	10459	110	9856
11-#14	4.66	5228	2755	9015	1950	9901	1486	10237	1105	10622	508	12621	-92	12448
12-#11	3.53	5035	2541	8336	1836	9119	1417	9322	1076	9380	551	10990	89	10507
12-#14	5.09	5326	2835	9237	2006	10207	1537	10610	1140	11088	503	13353	-125	13126
13-#11	3.82	5092	2597	8532	1868	9343	1431	9584	1080	9779	548	11487	45	11271
13-#14	5.51	5403	2915	9509	2054	10524	1560	11008	1157	11656	499	14060	-189	13673
14-#11	4.11	5151	2652	8765	1881	9590	1442	9862	1080	10155	527	11865	-9	11850
14-#14	5.93	5502	2994	9832	2079	10873	1579	11385	1151	12200	471	14604	-266	14021
15-#11	4.41	5216	2707	8884	1940	9785	1483	10129	1117	10476	536	12448	-31	12391
16-#11	4.70	5272	2763	9046	1978	10003	1517	10379	1133	10837	538	13069	-54	12793
17-#11	5.00	5337	2818	9245	2005	10227	1534	10656	1146	11173	523	13481	-100	13272
18-#11	5.29	5401	2873	9445	2031	10469	1550	10923	1145	11550	507	13966	-148	13633

ROUND TIED COLUMNS 28" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.01	5573	2399	8501	1796	9068	1410	8894	1118	8068	718	8441	472	4931
4-#14	1.46	5663	2496	8859	1843	9485	1448	9369	1138	8692	702	9247	397	6880
4-#18	2.60	5869	2745	9725	1968	10476	1542	10522	1187	10211	658	11190	201	10369
5-#11	1.27	5694	2454	8830	1788	9312	1390	9126	1091	8370	676	8969	419	5664
5-#14	1.83	5830	2576	9278	1851	9826	1433	9728	1112	9168	651	10051	329	7774
5-#18	3.25	6139	2887	10332	2013	11068	1544	11189	1164	11103	582	12648	91	12132
6-#11	1.52	5803	2509	9239	1731	9575	1339	9358	1038	8671	611	9090	324	6789
6-#14	2.19	5986	2656	9783	1803	10221	1389	10120	1059	9679	573	10330	205	9238
6-#18	3.90	6415	3028	11086	1987	11781	1514	11964	1109	12124	472	13297	-111	13153
7-#11	1.77	5842	2565	9159	1882	9805	1460	9742	1138	9226	685	10131	352	7588
7-#14	2.56	6034	2736	9764	1976	10520	1526	10582	1172	10353	656	11655	226	10250
7-#18	4.55	6474	3170	11225	2218	12244	1691	12619	1254	13087	578	15307	-107	15129
8-#11	2.03	5914	2620	9280	1939	10039	1512	10058	1178	9615	694	10684	331	8644
8-#14	2.92	6143	2816	9961	2049	10858	1592	11013	1221	10879	663	12403	190	11422
8-#18	5.20	6646	3312	11603	2328	12818	1793	13327	1327	13942	579	16897	-137	16181
9-#11	2.28	5987	2675	9524	1963	10295	1519	10339	1176	10013	678	11320	288	9397
9-#14	3.29	6234	2895	10290	2088	11211	1607	11420	1222	11456	644	13317	129	12507
9-#18	5.85	6812	3454	12138	2407	13421	1826	14036	1334	14953	547	18098	-292	17410

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.53	6042	2731	9842	1958	10574	1514	10633	1162	10368	639	11716	241	10268
10-#14	3.65	6310	2975	10715	2096	11610	1609	11859	1211	11991	593	13917	65	13552
10-#18	6.50	6935	3596	12782	2440	14110	1849	14823	1328	15921	466	19184	-401	18307
11-#11	2.79	6123	2786	9903	2040	10783	1575	10930	1209	10794	669	12398	216	11043
11-#14	4.02	6423	3055	10830	2196	11903	1684	12252	1268	12555	628	14830	21	14730
11-#18	7.15	7136	3738	13068	2593	14600	1957	15451	1409	16820	512	20656	-498	19359
12-#11	3.04	6201	2841	10068	2083	11018	1613	11228	1237	11170	669	12995	196	11816
12-#14	4.38	6534	3135	11073	2255	12242	1737	12668	1305	13076	625	15656	-10	15638
13-#11	3.29	6274	2897	10288	2114	11272	1628	11519	1241	11573	659	13546	154	12653
13-#14	4.75	6632	3215	11378	2302	12595	1759	13083	1312	13705	621	16442	-72	16285
14-#11	3.55	6341	2952	10545	2124	11549	1637	11825	1241	12022	645	13965	99	13373
14-#14	5.12	6727	3294	11731	2324	12984	1777	13527	1315	14306	594	17052	-148	16732
15-#11	3.80	6406	3007	10686	2180	11761	1680	12123	1280	12383	655	14621	80	14192
15-#14	5.48	6823	3374	11926	2406	13288	1833	13936	1366	14797	604	17952	-181	17508
16-#11	4.05	6476	3062	10857	2227	11999	1715	12401	1297	12785	658	15163	39	14932
16-#14	5.85	6914	3454	12188	2460	13628	1882	14325	1389	15361	606	18706	-242	18064
17-#11	4.31	6550	3118	11070	2253	12250	1732	12709	1310	13157	644	15774	13	15701
18-#11	4.56	6618	3173	11296	2278	12525	1748	13002	1309	13573	628	16313	-34	16238
19-#11	4.81	6693	3228	11457	2325	12740	1784	13294	1341	13932	632	16851	-63	16697
20-#11	5.07	6771	3284	11629	2369	12980	1817	13574	1357	14331	634	17448	-97	17198

ROUND TIED COLUMNS 30" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.27	6932	2819	10695	2105	11475	1654	11337	1307	10451	822	11076	503	7508
4-#18	2.26	7168	3067	11649	2230	12593	1752	12617	1358	12135	781	13245	313	11805
5-#11	1.10	6966	2776	10685	2044	11298	1592	11059	1256	10078	793	10745	520	6206
5-#14	1.59	7121	2898	11178	2107	11867	1636	11724	1277	10958	769	11948	432	8528
5-#18	2.83	7477	3209	12366	2271	13248	1749	13346	1332	13106	704	14853	203	13580
6-#11	1.32	7082	2831	11173	1975	11585	1531	11296	1194	10380	722	10844	421	7405
6-#14	1.91	7287	2978	11777	2048	12300	1582	12137	1216	11494	686	12224	305	10299
6-#18	3.40	7770	3351	13229	2233	14035	1709	14186	1270	14208	589	15547	1	15542
7-#11	1.54	7135	2887	11036	2142	11838	1666	11740	1306	11026	804	12039	457	8339
7-#14	2.23	7354	3058	11703	2236	12631	1733	12669	1341	12271	778	13735	335	11407
7-#18	3.96	7860	3492	13320	2479	14548	1901	14930	1428	15304	706	17821	12	17742
8-#11	1.77	7216	2942	11158	2204	12086	1721	12091	1349	11462	816	12661	439	9460
8-#14	2.55	7467	3138	11909	2313	12987	1802	13147	1394	12857	788	14572	302	12800
8-#18	4.53	8060	3634	13725	2594	15180	2007	15716	1505	16256	710	19589	-11	19062
9-#11	1.99	7294	2997	11433	2225	12370	1727	12398	1345	11894	800	13356	395	10351
9-#14	2.86	7575	3218	12278	2351	13390	1816	13593	1393	13488	768	15577	241	13912
9-#18	5.09	8231	3776	14324	2673	15848	2040	16498	1511	17367	679	20927	-165	20511
10-#11	2.21	7358	3053	11789	2215	12685	1718	12716	1328	12274	759	13780	348	11454
10-#14	3.18	7663	3297	12749	2353	13832	1816	14070	1379	14067	716	16228	178	15132
10-#18	5.66	8373	3918	15074	2704	16610	2060	17361	1504	18428	598	22122	-272	21485

ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#11	2.43	7449	3108	11848	2303	12905	1783	13048	1381	12754	793	14547	327	12269
11-#14	3.50	7790	3377	12871	2461	14147	1895	14510	1442	14699	755	17251	138	16389
11-#18	6.22	8601	4060	15350	2861	17150	2174	18061	1590	19431	649	23765	-361	22771
12-#11	2.65	7532	3163	12024	2349	13162	1824	13378	1410	13170	794	15213	308	13173
12-#14	3.82	7907	3457	13134	2521	14510	1949	14969	1481	15276	753	18172	109	17499
12-#18	6.79	8792	4202	15821	2958	17788	2263	18835	1651	20397	639	25297	-419	24060
13-#11	2.87	7616	3219	12261	2378	13441	1838	13696	1414	13610	784	15816	267	14040
13-#14	4.14	8023	3537	13468	2568	14906	1972	15425	1488	15909	740	19036	49	18772
13-#18	7.36	9005	4344	16387	3046	18454	2305	19624	1667	21594	635	26791	-529	24904
14-#11	3.09	7697	3274	12552	2386	13752	1846	14029	1412	14097	769	16276	211	14881
14-#14	4.46	8135	3617	13858	2587	15344	1989	15910	1490	16620	722	19710	-28	19647
15-#11	3.31	7765	3329	12698	2446	13979	1891	14360	1454	14500	781	17005	195	15800
15-#14	4.77	8238	3696	14089	2663	15667	2047	16364	1543	17167	735	20710	-57	20566
16-#11	3.53	7846	3385	12882	2493	14240	1927	14667	1472	14944	786	17608	155	16632
16-#14	5.09	8341	3776	14361	2729	16036	2096	16794	1567	17789	739	21550	-117	21235
17-#11	3.75	7930	3440	13120	2519	14517	1944	15004	1485	15352	771	18279	131	17495
17-#14	5.41	8459	3856	14688	2768	16428	2122	17274	1588	18371	719	22505	-152	21923
18-#11	3.97	8001	3495	13373	2543	14811	1959	15325	1483	15805	755	18872	83	18328
19-#11	4.19	8082	3551	13545	2592	15055	1997	15648	1517	16203	761	19468	57	19132
20-#11	4.41	8176	3606	13725	2636	15319	2031	15956	1534	16642	764	20125	25	20006
21-#11	4.63	8241	3661	13965	2665	15590	2049	16292	1549	17093	758	20646	-14	20608

ROUND TIED COLUMNS 32" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.12	8377	3163	12771	2387	13730	1876	13566	1489	12434	951	13130	615	8135
4-#18	1.99	8643	3411	13815	2510	14957	1974	14973	1541	14283	913	15526	431	13320
5-#14	1.40	8588	3243	13324	2381	14174	1853	13979	1454	12971	894	14066	542	9290
5-#18	2.49	8992	3553	14633	2546	15695	1967	15762	1510	15330	833	17280	319	15081
6-#11	1.16	8537	3176	13361	2237	13860	1737	13487	1361	12303	840	12809	523	8022
6-#14	1.68	8764	3323	14025	2310	14645	1788	14409	1384	13523	805	14329	411	11184
6-#18	2.98	9302	3695	15626	2496	16554	1917	16662	1440	16506	713	18009	116	17358
7-#11	1.36	8604	3231	13155	2421	14129	1886	13997	1486	13049	932	14171	567	9101
7-#14	1.96	8851	3402	13886	2515	15001	1954	15015	1522	14411	907	16038	449	12458
7-#18	3.48	9425	3837	15658	2759	17118	2125	17501	1611	17744	840	20560	136	19624
8-#11	1.55	8694	3286	13276	2487	14398	1944	14379	1531	13534	946	14864	553	10282
8-#14	2.24	8977	3482	14097	2597	15381	2026	15542	1578	15061	920	16968	420	14234
8-#18	3.98	9653	3979	16089	2878	17791	2234	18366	1693	18795	849	22064	70	21813
9-#11	1.75	8777	3342	13584	2506	14708	1949	14717	1527	13999	930	15617	508	11314
9-#14	2.52	9093	3562	14508	2633	15822	2039	16025	1576	15744	900	18063	359	15362
9-#18	4.48	9829	4121	16753	2956	18541	2268	19220	1699	20006	818	23982	-35	23897

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.94	8850	3397	13981	2491	15063	1937	15056	1506	14401	886	16065	460	12476
10-#14	2.80	9193	3642	15028	2629	16320	2035	16540	1559	16364	846	18761	295	16770
10-#18	4.97	9992	4262	17586	2982	19377	2284	20159	1689	21157	736	25284	-140	24938
11-#11	2.13	8951	3452	14029	2585	15291	2007	15427	1564	14938	924	16921	443	13453
11-#14	3.08	9334	3722	15154	2744	16648	2119	17028	1626	17068	889	19898	260	18066
11-#18	5.47	10247	4404	17874	3146	19967	2404	20933	1781	22268	792	27103	-223	26446
12-#11	2.33	9040	3508	14219	2633	15571	2049	15781	1594	15395	926	17657	426	14579
12-#14	3.36	9458	3801	15434	2806	17044	2176	17531	1667	17701	889	20916	232	19347
12-#18	5.97	10445	4546	18385	3246	20646	2494	21781	1845	23329	784	28798	-279	27975
13-#11	2.52	9135	3563	14475	2661	15876	2062	16133	1598	15873	917	18312	385	15466
13-#14	3.64	9589	3881	15793	2851	17477	2198	18027	1674	18389	876	21858	174	20776
13-#18	6.47	10662	4688	19008	3334	21390	2538	22644	1860	24530	763	30435	-385	28899
14-#11	2.72	9230	3618	14801	2667	16207	2067	16493	1594	16397	900	18810	329	16439
14-#14	3.92	9721	3961	16227	2868	17958	2213	18554	1675	19159	857	22593	97	21941
14-#18	6.96	10924	4830	19705	3380	22204	2577	23578	1872	25899	736	31734	-517	29956
15-#11	2.91	9302	3674	14950	2729	16462	2117	16836	1632	16843	915	19616	315	17409
15-#14	4.20	9822	4041	16470	2948	18307	2275	19052	1731	19763	873	23696	70	23271
16-#11	3.10	9384	3729	15141	2778	16747	2154	17186	1658	17329	920	20281	276	18345
16-#14	4.48	9947	4121	16757	3015	18711	2325	19523	1757	20444	878	24623	12	24540
17-#11	3.30	9486	3784	15410	2804	17044	2170	17556	1671	17772	906	20925	243	19313
17-#14	4.76	10078	4200	17123	3054	19139	2351	20047	1777	21078	858	25665	-21	25442
18-#11	3.49	9562	3840	15692	2826	17361	2183	17908	1668	18261	890	21656	205	20194
18-#14	5.04	10183	4280	17505	3091	19593	2374	20551	1776	21788	837	26596	-88	26316
19-#11	3.69	9651	3895	15865	2877	17626	2223	18258	1704	18701	897	22311	181	21129
19-#14	5.32	10317	4360	17778	3159	19968	2426	21041	1823	22393	844	27503	-128	27091
20-#11	3.88	9752	3950	16060	2922	17923	2259	18592	1721	19180	901	23030	152	22041
21-#11	4.07	9830	4006	16323	2950	18210	2276	18959	1736	19670	895	23602	112	22944
22-#11	4.27	9913	4061	16600	2978	18525	2294	19317	1738	20122	875	24241	71	23865
23-#11	4.46	10000	4116	16785	3023	18795	2329	19661	1768	20596	886	24982	51	24685

ROUND TIED COLUMNS 34" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.76	10306	3778	16236	2810	17595	2211	17606	1735	16672	1052	18049	555	14780
5-#14	1.24	10243	3609	15730	2674	16765	2084	16508	1642	15219	1028	16419	657	10060
5-#18	2.20	10694	3920	17154	2838	18425	2200	18453	1700	17790	969	19942	440	16608
6-#11	1.03	10178	3542	15818	2516	16419	1956	15948	1539	14454	965	14998	631	8639
6-#14	1.49	10429	3689	16542	2589	17272	2007	16951	1562	15780	932	16659	522	12070
6-#18	2.64	11022	4062	18294	2776	19357	2139	19409	1621	19033	844	20697	235	19250
7-#11	1.20	10260	3598	15533	2718	16703	2121	16532	1677	15268	1061	16542	684	9876
7-#14	1.73	10535	3769	16326	2813	17648	2189	17638	1714	16791	1044	18580	568	13523
7-#18	3.08	11178	4203	18255	3057	19972	2363	20349	1806	20422	982	23538	264	21562
8-#11	1.37	10359	3653	15647	2789	16993	2183	16939	1725	15846	1084	17309	673	11109
8-#14	1.98	10675	3849	16540	2899	18058	2265	18202	1773	17506	1060	19606	543	15404
8-#18	3.52	11437	4345	18709	3181	20675	2475	21294	1892	21575	994	25193	203	24056

ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
9-#11	1.55	10446	3708	15990	2806	17330	2186	17308	1720	16344	1067	18119	627	12293
9-#14	2.23	10798	3929	16995	2932	18537	2276	18735	1771	18239	1039	20789	481	16797
9-#18	3.97	11618	4487	19440	3257	21502	2508	22219	1897	22886	963	27278	98	26550
10-#11	1.72	10530	3764	16434	2784	17718	2169	17672	1696	16764	1021	18586	578	13507
10-#14	2.48	10910	4008	17568	2922	19091	2269	19285	1750	18898	983	21530	418	18464
10-#18	4.41	11801	4629	20345	3276	22429	2521	23233	1884	24124	879	28683	-5	28671
11-#11	1.89	10642	3819	16463	2886	17961	2245	18074	1757	17362	1063	19537	564	14626
11-#14	2.73	11067	4088	17684	3045	19433	2358	19823	1822	19676	1030	22786	387	19825
11-#18	4.85	12067	4771	20656	3450	23042	2646	24082	1982	25345	940	30683	-82	30427
12-#11	2.06	10735	3874	16669	2936	18263	2289	18458	1790	17862	1067	20344	549	15835
12-#14	2.97	11198	4168	17990	3110	19861	2416	20358	1864	20367	1032	23902	361	21253
12-#18	5.29	12290	4913	21205	3552	23780	2738	25006	2048	26503	935	32544	-136	32125
13-#11	2.23	10838	3930	16945	2963	18594	2301	18837	1793	18376	1057	20959	499	16880
13-#14	3.22	11344	4248	18374	3153	20331	2438	20904	1872	21110	1019	24921	303	22729
13-#18	5.73	12532	5055	21867	3638	24588	2782	25943	2064	27805	915	34323	-239	33216
14-#11	2.41	10951	3985	17308	2965	18944	2304	19234	1788	18850	1026	21585	452	18046
14-#14	3.47	11497	4328	18855	3168	20840	2450	21475	1871	21937	1000	25716	225	24062
14-#18	6.17	12790	5196	22635	3682	25501	2822	26954	2075	29285	888	35742	-371	34419
15-#11	2.58	11026	4040	17458	3032	19222	2356	19599	1827	19427	1056	22469	440	19041
15-#14	3.72	11603	4407	19106	3251	21231	2516	21984	1919	22600	1017	26924	202	25593
15-#18	6.61	12982	5338	23135	3807	26138	2917	27854	2163	30366	906	37739	-426	36141
16-#11	2.75	11117	4096	17655	3081	19536	2395	19979	1855	19955	1063	23197	402	20109
16-#14	3.97	11730	4487	19405	3318	21668	2568	22517	1956	23339	1024	27939	145	26878
17-#11	2.92	11229	4151	17951	3106	19850	2410	20379	1868	20433	1049	23893	370	21107
17-#14	4.21	11884	4567	19814	3358	22123	2593	23090	1977	24025	1005	28936	99	28317
18-#11	3.09	11311	4206	18267	3127	20194	2422	20760	1864	20958	1032	24682	332	22112
18-#14	4.46	11998	4647	20234	3394	22613	2615	23641	1976	24791	983	30078	46	29743
19-#11	3.26	11410	4262	18441	3180	20480	2464	21139	1901	21439	1041	25396	311	23162
19-#14	4.71	12138	4726	20513	3463	23018	2669	24167	2024	25452	992	31065	10	31008
20-#11	3.44	11517	4317	18649	3226	20796	2500	21501	1919	21959	1045	26177	282	24114
20-#14	4.96	12288	4806	20816	3526	23476	2719	24678	2047	26184	996	32165	-33	32048
21-#11	3.61	11609	4372	18937	3254	21112	2518	21899	1935	22445	1032	26801	243	25150
22-#11	3.78	11699	4428	19234	3280	21454	2535	22277	1935	22974	1019	27490	203	26114
23-#11	3.95	11792	4483	19436	3328	21745	2571	22658	1968	23491	1031	28300	184	27089
24-#11	4.12	11889	4538	19657	3372	22050	2605	23023	1984	23968	1027	28968	149	28092
25-#11	4.30	11987	4594	19930	3401	22373	2624	23416	2000	24495	1022	29714	114	28986

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.57	12168	4167	18928	3129	20533	2462	20528	1941	19316	1199	20828	684	15900
5-#14	1.11	12096	3998	18413	2985	19651	2330	19330	1842	17719	1169	19023	779	10839
5-#18	1.96	12596	4308	19952	3148	21457	2446	21437	1901	20502	1113	22855	567	17918
6-#14	1.33	12292	4078	19346	2886	20201	2241	19780	1751	18281	1066	19229	638	12956
6-#18	2.36	12942	4450	21250	3074	22462	2373	22444	1812	21803	981	23624	358	21216
7-#11	1.07	12114	3986	18183	3034	19577	2370	19355	1880	17780	1204	19166	807	10662
7-#14	1.55	12419	4158	19040	3129	20595	2438	20554	1917	19358	1179	21376	694	14603
7-#18	2.75	13132	4592	21127	3373	23104	2613	23491	2012	23354	1130	26770	397	23557
8-#11	1.23	12224	4042	18289	3110	19888	2436	19795	1931	18415	1231	20010	799	11942
8-#14	1.77	12572	4238	19253	3220	21035	2518	21153	1979	20206	1208	22501	673	16576
8-#18	3.14	13392	4734	21600	3503	23861	2729	24512	2102	24612	1146	28579	341	26374
9-#11	1.38	12315	4097	18669	3124	20252	2437	20188	1924	18943	1213	20875	753	13287
9-#14	1.99	12703	4317	19755	3251	21553	2528	21732	1976	20989	1187	23770	610	18159
9-#18	3.54	13608	4876	22401	3576	24755	2761	25513	2106	26019	1115	30831	236	28939
10-#11	1.53	12409	4152	19163	3096	20663	2415	20581	1897	19380	1164	21358	701	14548
10-#14	2.21	12828	4397	20385	3234	22152	2516	22323	1952	21683	1127	24551	545	20099
10-#18	3.93	13812	5018	23381	3589	25782	2772	26600	2090	27342	1029	32335	134	31387
11-#11	1.69	12531	4208	19169	3205	20931	2497	21014	1963	20042	1210	22408	692	15819
11-#14	2.43	12999	4477	20485	3364	22518	2612	22898	2029	22540	1179	25930	519	21596
11-#18	4.32	14103	5160	23708	3771	26418	2902	27527	2194	28678	1095	34520	62	34153
12-#11	1.84	12630	4263	19390	3258	21256	2543	21430	1997	20584	1215	23288	678	17077
12-#14	2.65	13138	4557	20817	3432	22979	2672	23477	2073	23289	1183	27146	494	23217
12-#18	4.72	14338	5301	24297	3877	27214	2997	28521	2262	29933	1093	36549	11	36473
13-#11	1.99	12742	4318	19685	3283	21610	2555	21836	2000	21134	1205	23947	628	18263
13-#14	2.87	13299	4637	21226	3474	23486	2692	24063	2079	24086	1170	28102	424	24732
13-#18	5.11	14605	5443	24999	3961	28088	3040	29537	2278	31336	1073	38469	-90	37826
14-#11	2.15	12871	4374	20089	3283	21983	2554	22259	1993	21636	1172	24613	580	19556
14-#14	3.09	13473	4716	21756	3485	24023	2702	24689	2078	24838	1129	29094	359	26243
14-#18	5.50	14899	5585	25840	4002	29054	3076	30625	2288	32925	1045	40007	-222	39218
15-#11	2.30	12950	4429	20236	3353	22281	2610	22657	2035	22266	1205	25579	571	20664
15-#14	3.32	13584	4796	22014	3572	24445	2771	25228	2129	25692	1169	30409	339	27853
15-#18	5.89	15102	5727	26366	4131	29762	3176	31602	2379	34101	1067	42177	-273	41112
16-#11	2.45	13049	4484	20439	3403	22626	2651	23067	2063	22837	1212	26370	534	21923
16-#14	3.54	13724	4876	22323	3641	24926	2825	25804	2166	26491	1177	31513	283	29354
16-#18	6.29	15340	5869	26949	4247	30573	3264	32536	2422	35461	1075	44036	-377	42460
17-#11	2.61	13166	4540	20760	3428	22956	2665	23497	2076	23349	1199	27118	503	22945
17-#14	3.76	13888	4956	22769	3680	25405	2849	26420	2187	27229	1158	32587	238	30913
18-#11	2.76	13261	4595	21114	3447	23328	2675	23895	2071	23910	1181	27964	464	24082
18-#14	3.98	14015	5036	23237	3715	25934	2869	27011	2185	28049	1136	33816	185	32362
19-#11	2.91	13369	4650	21287	3502	23635	2720	24313	2110	24433	1192	28739	445	25186
19-#14	4.20	14167	5115	23520	3786	26370	2926	27581	2235	28767	1146	34885	152	33816
20-#11	3.07	13483	4706	21509	3549	23967	2756	24706	2129	24994	1196	29583	418	26240
20-#14	4.42	14326	5195	23844	3850	26852	2976	28132	2260	29557	1151	36074	111	35371

ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
21-#11	3.22	13584	4761	21820	3577	24315	2774	25126	2144	25516	1184	30258	379	27386
21-#14	4.64	14472	5275	24280	3892	27337	3003	28743	2283	30305	1134	37034	55	36692
22-#11	3.37	13687	4816	22140	3601	24684	2790	25529	2143	26083	1171	30996	339	28396
22-#14	4.86	14613	5355	24723	3933	27861	3030	29328	2285	31126	1118	38103	-1	38098
23-#11	3.52	13785	4872	22352	3651	24988	2827	25941	2177	26642	1184	31877	322	29505
24-#11	3.68	13881	4927	22594	3696	25317	2861	26345	2195	27156	1180	32600	287	30548
25-#11	3.83	13999	4982	22883	3724	25665	2881	26757	2211	27723	1176	33404	253	31625
26-#11	3.98	14097	5038	23189	3753	26039	2901	27165	2213	28252	1159	34055	210	32731
27-#11	4.14	14200	5093	23443	3791	26343	2935	27573	2244	28805	1168	35031	194	33683

ROUND TIED COLUMNS 38" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.41	14241	4578	21907	3466	23789	2729	23740	2157	22231	1354	23879	819	17016
5-#18	1.76	14710	4720	23044	3477	24808	2707	24731	2113	23479	1265	26033	700	19240
6-#14	1.19	14366	4489	22453	3200	23448	2487	22915	1951	21038	1207	22052	761	13840
6-#18	2.12	15073	4861	24509	3388	25885	2621	25783	2014	24830	1125	26806	486	23257
7-#14	1.39	14513	4569	22044	3463	23861	2702	23774	2132	22255	1332	24440	826	15697
7-#18	2.47	15298	5003	24289	3708	26554	2878	26945	2230	26555	1286	30272	535	25607
8-#11	1.10	14298	4453	21216	3450	23101	2705	22963	2149	21255	1386	22985	932	12780
8-#14	1.59	14680	4649	22252	3559	24331	2787	24417	2197	23177	1364	25668	808	17754
8-#18	2.82	15581	5145	24778	3843	27364	2999	28020	2321	27919	1305	32238	484	28768
9-#11	1.24	14394	4508	21636	3462	23492	2703	23380	2140	21812	1366	23802	875	14298
9-#14	1.79	14815	4728	22803	3588	24887	2794	25033	2193	24009	1342	27022	745	19541
9-#18	3.17	15810	5287	25651	3914	28327	3029	29120	2327	29423	1275	34655	379	31387
10-#11	1.38	14498	4563	22185	3427	23927	2675	23799	2109	22261	1314	24396	831	15599
10-#14	1.98	14957	4808	23495	3565	25520	2777	25672	2166	24735	1280	27837	678	21565
10-#18	3.53	16036	5429	26711	3920	29455	3037	30278	2307	30827	1187	36253	277	34137
11-#11	1.51	14631	4619	22161	3543	24219	2765	24266	2180	22992	1364	25551	826	17031
11-#14	2.18	15143	4888	23573	3702	25921	2880	26285	2247	25674	1336	29346	657	23265
11-#18	3.88	16353	5571	27034	4110	30113	3172	31276	2416	32281	1257	38630	211	37076
12-#11	1.65	14735	4674	22395	3599	24566	2813	24714	2216	23578	1371	26505	813	18332
12-#14	2.38	15289	4968	23930	3773	26415	2942	26908	2293	26483	1341	30663	633	25239
12-#18	4.23	16600	5713	27677	4219	30967	3269	32327	2485	33635	1257	40828	161	39589
13-#11	1.79	14857	4729	22712	3622	24939	2823	25147	2218	24163	1360	27207	764	19669
13-#14	2.58	15461	5048	24365	3813	26954	2961	27535	2299	27334	1328	31685	564	26783
13-#18	4.59	16893	5854	28419	4301	31907	3312	33429	2502	35137	1237	42889	63	42473
14-#11	1.93	15003	4785	23158	3619	25339	2819	25587	2208	24691	1327	27911	715	21008
14-#14	2.78	15662	5127	24947	3822	27525	2968	28200	2296	28130	1286	32742	498	28484
14-#18	4.94	17223	5996	29335	4340	32924	3345	34609	2511	36835	1209	44542	-70	44287

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 38" DIA.

Short columns – no sidesway f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#11	2.06	15086	4840	23301	3693	25657	2879	26027	2254	25376	1362	28961	708	22258
15-#14	2.98	15777	5207	25208	3913	27976	3040	28784	2349	29056	1329	34167	481	30137
15-#18	5.29	17419	6138	29886	4474	33700	3450	35584	2587	38108	1234	46888	-116	46425
16-#11	2.20	15193	4895	23507	3743	26029	2921	26468	2283	25990	1370	29817	672	23595
16-#14	3.17	15929	5287	25527	3982	28503	3096	29403	2388	29915	1338	35361	426	31818
16-#18	5.64	17698	6280	30491	4589	34576	3539	36640	2649	39571	1244	48901	-219	47957
17-#11	2.34	15316	4951	23855	3768	26381	2935	26923	2296	26537	1356	30616	641	24784
17-#14	3.37	16105	5367	26008	4020	29006	3119	30062	2409	30704	1319	36511	382	33497
17-#18	6.00	17968	6422	31302	4663	35480	3586	37791	2689	40952	1211	50908	-299	49599
18-#11	2.48	15422	5006	24249	3786	26779	2943	27341	2289	27132	1338	31317	582	26103
18-#14	3.57	16244	5447	26527	4054	29573	3138	30680	2405	31577	1296	37825	328	35046
19-#11	2.61	15539	5061	24419	3843	27108	2990	27793	2330	27698	1350	32355	585	27234
19-#14	3.77	16410	5526	26813	4127	30039	3197	31304	2458	32353	1308	38979	299	36690
20-#11	2.75	15660	5117	24654	3890	27456	3026	28223	2350	28301	1356	33262	559	28420
20-#14	3.97	16577	5606	27158	4192	30545	3248	31900	2483	33202	1314	40257	259	38274
21-#11	2.89	15771	5172	24990	3918	27829	3044	28664	2365	28859	1344	33987	521	29598
21-#14	4.17	16739	5686	27627	4234	31075	3275	32543	2506	34003	1298	41291	204	39822
22-#11	3.03	15886	5227	25333	3941	28232	3059	29093	2363	29462	1330	34774	481	30734
22-#14	4.36	16896	5766	28100	4274	31639	3301	33165	2508	34879	1281	42434	148	41499
23-#11	3.16	15990	5283	25553	3992	28550	3098	29537	2399	30065	1344	35727	464	31950
23-#14	4.56	17040	5845	28437	4341	32101	3352	33784	2554	35718	1297	43758	121	42937
24-#11	3.30	16095	5338	25816	4038	28901	3133	29963	2417	30617	1341	36505	431	33093
25-#11	3.44	16219	5393	26122	4066	29274	3152	30410	2433	31223	1337	37369	397	34254
26-#11	3.58	16328	5449	26454	4094	29669	3171	30846	2435	31787	1319	38063	354	35384
27-#11	3.71	16439	5504	26721	4133	30001	3206	31284	2467	32382	1330	39013	330	36496
28-#11	3.85	16564	5559	26997	4170	30356	3240	31701	2483	32937	1326	39980	318	37672

ROUND TIED COLUMNS 40" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.27	16536	5011	25188	3823	27380	3010	27281	2386	25431	1517	27216	961	18131
5-#18	1.59	17046	5153	26445	3825	28479	2981	28351	2337	26737	1424	29492	838	20572
6-#14	1.07	16662	4922	25879	3531	27031	2748	26370	2162	24068	1356	25143	889	14725
6-#18	1.91	17427	5295	28088	3720	29644	2882	29443	2226	28130	1276	30256	620	24886
7-#14	1.25	16830	5002	25353	3817	27462	2981	27317	2358	25436	1493	27789	964	16805
7-#18	2.23	17687	5436	27758	4061	30340	3157	30727	2458	29910	1432	34058	679	27601
8-#14	1.43	17011	5082	25553	3918	27962	3070	28010	2427	26435	1528	29123	950	18939
8-#18	2.55	17994	5578	28259	4201	31204	3283	31857	2553	31513	1473	36186	633	31235
9-#11	1.12	16695	4941	24902	3817	27068	2984	26901	2368	24966	1528	27109	1013	15342
9-#14	1.61	17152	5162	26154	3944	28557	3075	28664	2421	27313	1505	30407	872	20941
9-#18	2.86	18236	5720	29205	4270	32234	3311	33034	2557	33112	1441	38765	527	33895
10-#11	1.24	16810	4997	25514	3776	27527	2950	27345	2333	25424	1473	27714	968	16660
10-#14	1.79	17308	5241	26913	3914	29224	3052	29347	2390	28068	1440	31405	817	23042
10-#18	3.18	18484	5862	30350	4269	33432	3313	34283	2535	34594	1351	40453	425	36964

ROUND TIED COLUMNS 40" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#11	1.37	16953	5052	25456	3900	27843	3047	27847	2410	26227	1527	28980	967	18263
11-#14	1.97	17510	5321	26964	4059	29661	3162	30002	2477	29094	1500	33048	800	24944
11-#18	3.50	18827	6004	30664	4467	34144	3456	35336	2648	36170	1427	43027	364	39982
12-#11	1.49	17063	5107	25693	3958	28212	3097	28328	2447	26854	1535	30009	955	19602
12-#14	2.15	17663	5401	27343	4133	30186	3226	30669	2524	29963	1507	34468	778	27030
12-#18	3.82	19087	6146	31358	4580	35056	3556	36462	2720	37623	1428	45396	317	42785
13-#11	1.61	17195	5163	26069	3973	28603	3106	28788	2448	27478	1524	30754	906	21098
13-#14	2.33	17849	5481	27807	4171	30752	3244	31337	2530	30867	1494	35555	710	28812
13-#18	4.14	19406	6288	32142	4660	36062	3598	37639	2737	39225	1409	47322	195	46023
14-#11	1.74	17352	5218	26532	3973	29032	3099	29242	2436	28031	1489	31494	855	22478
14-#14	2.51	18071	5561	28443	4176	31363	3248	32027	2524	31706	1451	36674	643	30783
14-#18	4.46	19773	6429	33136	4695	37129	3627	38921	2745	40770	1345	49364	87	48648
15-#11	1.86	17444	5273	26663	4051	29369	3162	29725	2485	28724	1520	32630	851	23878
15-#14	2.69	18194	5640	28705	4272	31843	3324	32670	2581	32705	1496	38212	629	32511
15-#18	4.77	19977	6571	33709	4834	37958	3736	39943	2823	42401	1408	51889	44	51565
16-#11	1.99	17560	5329	26877	4103	29758	3205	30199	2515	29426	1536	33551	816	25259
16-#14	2.86	18358	5720	29032	4341	32407	3382	33333	2621	33625	1506	39497	575	34343
16-#18	5.09	20283	6713	34336	4950	38915	3828	41074	2887	43968	1419	54057	-57	53814
17-#11	2.11	17690	5384	27252	4127	30141	3219	30653	2520	30011	1522	34402	785	26590
17-#14	3.04	18540	5800	29550	4380	32942	3404	34029	2642	34465	1487	40723	532	36066
17-#18	5.41	20565	6855	35206	5024	39861	3874	42303	2927	45443	1388	56203	-135	55593
18-#11	2.23	17801	5439	27680	4143	30567	3226	31116	2519	30639	1503	35144	726	27988
18-#14	3.22	18697	5880	30122	4412	33548	3422	34678	2636	35391	1464	41818	450	37792
18-#18	5.73	20818	6997	36101	5095	40911	3918	43491	2929	47103	1353	58685	-226	56847
19-#11	2.36	17932	5495	27852	4202	30913	3274	31602	2562	31250	1516	36259	731	29273
19-#14	3.40	18876	5960	30408	4487	34045	3483	35348	2691	36225	1478	43360	451	39605
20-#11	2.48	18060	5550	28100	4250	31280	3311	32066	2583	31890	1522	37230	706	30652
20-#14	3.58	19053	6039	30773	4553	34573	3534	35997	2718	37134	1485	44729	413	41242
21-#11	2.61	18180	5605	28456	4278	31678	3329	32531	2597	32488	1511	38005	668	31857
21-#14	3.76	19229	6119	31276	4595	35140	3561	36670	2740	37987	1468	45837	358	43024
22-#11	2.73	18309	5661	28828	4299	32115	3344	32987	2595	33126	1497	38839	628	33126
22-#14	3.94	19403	6199	31780	4633	35752	3587	37332	2741	38917	1451	47052	302	44689
23-#11	2.86	18419	5716	29056	4352	32447	3383	33462	2632	33773	1512	39866	613	34399
23-#14	4.12	19555	6279	32133	4701	36235	3639	37995	2789	39817	1468	48478	276	46370
24-#11	2.98	18531	5771	29331	4399	32821	3419	33909	2650	34360	1509	40698	580	35645
24-#14	4.30	19715	6359	32538	4767	36768	3688	38638	2814	40650	1464	49651	228	48093
25-#11	3.10	18667	5827	29662	4426	33220	3438	34392	2666	35008	1505	41622	547	36898
25-#14	4.48	19908	6438	32997	4808	37335	3717	39321	2838	41575	1458	50969	180	49640
26-#11	3.23	18782	5882	30078	4439	33634	3456	34857	2668	35608	1488	42360	504	38095
27-#11	3.35	18902	5937	30296	4494	33989	3492	35318	2700	36243	1499	43378	481	39341
28-#11	3.48	19034	5993	30588	4531	34373	3527	35763	2717	36834	1496	44414	469	40540
29-#11	3.60	19146	6048	30898	4568	34757	3546	36246	2734	37480	1493	45225	427	41765
30-#11	3.72	19266	6103	31280	4591	35166	3567	36723	2739	38088	1477	46095	393	42980

ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.15	19065	5466	28786	4198	31325	3306	31169	2626	28933	1689	30856	1109	19243
5-#18	1.44	19616	5608	30172	4190	32500	3269	32316	2572	30292	1591	33246	983	21915
6-#18	1.73	20014	5750	32005	4069	33757	3157	33442	2449	31715	1435	33988	759	26448
7-#14	1.14	19380	5457	28982	4189	31418	3274	31205	2596	28916	1662	31437	1109	17927
7-#18	2.02	20311	5892	31548	4432	34479	3451	34836	2697	33686	1604	38144	829	29479
8-#14	1.30	19575	5537	29169	4296	31945	3368	31951	2670	29989	1700	32881	1098	20131
8-#18	2.31	20642	6034	32056	4579	35397	3581	36042	2796	35408	1648	40436	787	33744
9-#11	1.01	19230	5397	28485	4192	30998	3280	30768	2608	28420	1698	30716	1158	16303
9-#14	1.46	19722	5617	29820	4318	32581	3371	32641	2661	30918	1676	34237	1019	22362
9-#18	2.60	20897	6176	33079	4645	36496	3607	37290	2799	37100	1616	43176	681	36460
10-#11	1.13	19355	5452	29168	4143	31480	3239	31225	2568	28884	1639	31329	1110	17730
10-#14	1.62	19893	5697	30655	4281	33282	3341	33367	2627	31698	1607	35268	963	24531
10-#18	2.89	21167	6317	34314	4636	37753	3603	38632	2773	38657	1522	44949	577	39866
11-#11	1.24	19509	5507	29068	4276	31817	3344	31775	2651	29763	1699	32711	1114	19476
11-#14	1.79	20111	5777	30673	4435	33753	3459	34065	2719	32814	1673	37053	950	26647
11-#18	3.18	21538	6459	34613	4843	38529	3755	39743	2892	40360	1603	47726	522	42952
12-#11	1.35	19624	5563	29304	4336	32211	3382	32290	2690	30425	1707	33818	1103	20884
12-#14	1.95	20272	5856	31061	4511	34311	3526	34778	2768	33739	1681	38576	930	28806
12-#18	3.46	21809	6601	35357	4960	39498	3857	40945	2966	41913	1607	50268	477	46060
13-#11	1.46	19766	5618	29716	4350	32621	3403	32776	2690	31089	1696	34603	1054	22569
13-#14	2.11	20472	5936	31609	4538	34904	3542	35485	2773	34701	1668	39728	861	30788
13-#18	3.75	22155	6743	36184	5038	40559	3897	42196	2982	43614	1588	52316	357	49471
14-#11	1.58	19932	5673	30226	4346	33078	3394	33244	2675	31669	1660	35376	1002	23965
14-#14	2.27	20705	6016	32260	4550	35555	3543	36201	2764	35582	1623	40907	793	32977
14-#18	4.04	22547	6885	37260	5070	41689	3923	43543	2988	45248	1522	54486	248	52299
15-#11	1.69	20036	5729	30340	4428	33435	3461	33764	2727	32412	1693	36603	1001	25524
15-#14	2.44	20846	6096	32513	4649	36063	3623	36901	2825	36583	1661	42561	782	34863
15-#18	4.33	22772	7027	37850	5213	42570	4037	44650	3071	46996	1589	57193	209	55552
16-#11	1.80	20161	5784	30562	4481	33841	3490	34277	2759	33157	1709	37590	966	26943
16-#14	2.60	21022	6176	32853	4720	36652	3681	37609	2867	37632	1681	43937	729	36928
16-#18	4.62	23106	7169	38497	5330	43607	4132	45855	3136	48668	1602	59517	109	58556
17-#11	1.91	20297	5839	30965	4505	34254	3517	34750	2763	33778	1695	38491	936	28424
17-#14	2.76	21213	6255	33408	4758	37231	3704	38303	2876	38528	1663	45238	687	38688
17-#18	4.91	23400	7310	39428	5403	44596	4176	47162	3176	50235	1570	61802	33	61537
18-#11	2.03	20417	5895	31427	4518	34708	3523	35239	2760	34446	1676	39272	876	29865
18-#14	2.92	21386	6335	34026	4788	37877	3720	39022	2879	39505	1639	46398	604	40601
18-#18	5.20	23674	7452	40407	5473	45715	4219	48400	3176	51995	1536	64443	-58	63357
19-#11	2.14	20560	5950	31602	4581	35068	3573	35758	2806	35093	1690	40466	883	31293
19-#14	3.09	21578	6415	34320	4866	38400	3783	39738	2936	40400	1655	48046	608	42461
19-#18	5.49	24007	7594	41015	5592	46630	4314	49602	3262	53478	1552	66655	-114	66080

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.25	20694	6005	31861	4630	35457	3597	36245	2827	35774	1697	41502	859	32741
20-#14	3.25	21764	6495	34704	4933	38955	3835	40436	2965	41361	1662	49505	571	44275
21-#11	2.36	20824	6061	32238	4656	35880	3628	36746	2841	36408	1685	42327	821	34104
21-#14	3.41	21948	6575	35236	4974	39558	3862	41144	2986	42273	1646	50687	517	46245
22-#11	2.48	20967	6116	32641	4676	36345	3642	37228	2838	37091	1671	43207	781	35571
22-#14	3.57	22147	6654	35777	5010	40220	3887	41845	2986	43257	1628	51974	462	47945
23-#11	2.59	21082	6171	32874	4731	36698	3683	37734	2876	37773	1687	44198	757	36873
23-#14	3.74	22306	6734	36145	5081	40722	3940	42553	3035	44217	1647	53501	437	49815
24-#11	2.70	21203	6227	33160	4778	37095	3706	38202	2895	38398	1685	45196	736	38253
24-#14	3.90	22478	6814	36568	5147	41288	3990	43226	3060	45100	1643	54753	390	51610
25-#11	2.81	21346	6282	33518	4806	37518	3738	38715	2911	39085	1681	46179	702	39537
25-#14	4.06	22683	6894	37063	5188	41891	4019	43960	3085	46085	1638	56158	342	53385
26-#11	2.93	21463	6337	33965	4818	37953	3755	39215	2913	39721	1663	46960	659	40863
26-#14	4.22	22848	6974	37677	5210	42520	4047	44671	3090	47006	1614	57292	281	55319
27-#11	3.04	21601	6393	34187	4873	38329	3793	39699	2946	40398	1676	48047	638	42190
28-#11	3.15	21740	6448	34494	4911	38743	3815	40172	2963	41026	1673	49152	626	43468
29-#11	3.27	21863	6503	34826	4947	39145	3847	40684	2980	41711	1670	50013	585	44829
30-#11	3.38	21993	6559	35230	4970	39580	3867	41183	2984	42351	1654	50938	551	46066
31-#11	3.49	22117	6614	35470	5022	39964	3895	41672	3015	43075	1671	51876	521	47374
32-#11	3.60	22237	6669	35786	5059	40364	3922	42149	3031	43753	1674	52890	495	48659

ROUND TIED COLUMNS 44" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.05	21839	5944	32717	4593	35640	3617	35422	2879	32752	1868	34814	1263	20353
5-#18	1.32	22431	6086	34239	4574	36892	3572	36643	2819	34157	1765	37310	1133	23270
6-#18	1.58	22848	6228	36274	4435	38242	3445	37797	2683	35601	1601	38016	903	28010
7-#14	1.04	22171	5935	32947	4579	35744	3582	35456	2846	32709	1839	35400	1260	19064
7-#18	1.84	23181	6370	35674	4823	38990	3759	39303	2948	37775	1783	42543	985	31353
8-#14	1.18	22385	6015	33118	4692	36300	3662	36256	2924	33849	1880	36958	1253	21329
8-#18	2.10	23536	6511	36187	4975	39960	3895	40591	3051	39620	1831	45005	947	35797
9-#14	1.33	22538	6095	33817	4711	36975	3682	36981	2914	34837	1855	38383	1173	23801
9-#18	2.37	23805	6653	37289	5038	41129	3918	41910	3052	41404	1798	47606	816	39011
10-#11	1.03	22146	5930	33161	4529	35805	3543	35461	2814	32655	1814	35255	1259	18811
10-#14	1.48	22725	6175	34738	4666	37711	3645	37734	2874	35639	1783	39442	1114	26032
10-#18	2.63	24098	6795	38619	5021	42447	3907	43344	3023	43031	1701	49756	736	42844
11-#11	1.13	22311	5985	33013	4671	36158	3655	36067	2904	33604	1877	36760	1267	20645
11-#14	1.63	22957	6254	34715	4830	38212	3771	38492	2973	36850	1854	41374	1106	28374
11-#18	2.89	24495	6937	38897	5238	43285	4068	44514	3148	44865	1788	52743	686	45983

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.23	22431	6040	33248	4733	36580	3696	36616	2945	34313	1888	37945	1258	22181
12-#14	1.78	23126	6334	35108	4908	38806	3820	39251	3024	37822	1862	43003	1087	30599
12-#18	3.16	24779	7079	39689	5358	44312	4172	45792	3224	46521	1793	55459	642	49412
13-#11	1.33	22583	6096	33696	4746	37009	3709	37128	2944	35011	1876	38771	1209	23957
13-#14	1.92	23340	6414	35704	4934	39426	3855	39998	3028	38845	1849	44218	1019	32791
13-#18	3.42	25152	7221	40560	5434	45419	4211	47117	3239	48319	1774	57629	523	52909
14-#11	1.44	22758	6151	34256	4738	37495	3703	37609	2926	35622	1838	39574	1155	25468
14-#14	2.07	23586	6494	36413	4941	40117	3852	40738	3015	39771	1803	45454	950	35052
14-#18	3.68	25563	7363	41720	5462	46620	4234	48517	3242	50040	1707	59923	414	56031
15-#11	1.54	22873	6206	34350	4824	37870	3767	38168	2982	36412	1873	40893	1156	27181
15-#14	2.22	23743	6574	36652	5045	40654	3937	41488	3080	40836	1843	47228	941	37134
15-#18	3.95	25816	7504	42325	5610	47553	4352	49721	3329	51908	1777	62816	379	59638
16-#11	1.64	23007	6262	34579	4879	38294	3804	38720	3015	37205	1890	41948	1122	28647
16-#14	2.37	23933	6653	37007	5118	41268	3976	42251	3123	41945	1864	48696	889	39418
16-#18	4.21	26141	7646	42992	5728	48654	4449	51001	3396	53684	1791	65296	280	62670
17-#11	1.74	23151	6317	35010	4901	38738	3824	39211	3018	37859	1876	42898	1093	30309
17-#14	2.52	24133	6733	37599	5154	41891	4018	42973	3132	42894	1846	50072	847	41362
17-#18	4.47	26484	7788	43984	5801	49701	4492	52375	3435	55344	1760	67720	206	65973
18-#11	1.85	23279	6372	35507	4912	39219	3834	39725	3014	38563	1856	43714	1032	31765
18-#14	2.66	24321	6813	38259	5182	42576	4032	43730	3133	43934	1822	51295	764	43471
18-#18	4.74	26780	7930	45049	5870	50890	4534	53673	3434	57204	1726	69926	66	69448
19-#11	1.95	23434	6428	35683	4978	39593	3880	40279	3061	39252	1872	44992	1041	33343
19-#14	2.81	24526	6893	38564	5263	43120	4098	44494	3192	44877	1839	53050	771	45372
19-#18	5.00	27135	8072	45666	5991	51859	4632	54952	3522	58784	1744	72874	62	72440
20-#11	2.05	23575	6483	35954	5028	40005	3912	40788	3083	39976	1879	46093	1019	34831
20-#14	2.96	24723	6972	38967	5331	43708	4130	45223	3222	45896	1847	54600	736	47371
20-#18	5.26	27463	8214	46397	6105	52892	4719	56213	3569	60546	1754	75530	-7	75490
21-#11	2.15	23713	6538	36352	5053	40453	3936	41325	3097	40644	1868	46967	980	36338
21-#14	3.11	24919	7052	39527	5371	44346	4177	45983	3243	46860	1831	55856	681	49392
22-#11	2.26	23871	6594	36786	5072	40940	3955	41832	3093	41352	1852	47893	941	37884
22-#14	3.26	25138	7132	40109	5406	45049	4201	46723	3243	47913	1814	57214	626	51268
23-#11	2.36	23991	6649	37025	5128	41318	3991	42364	3133	42037	1863	48953	917	39315
23-#14	3.40	25305	7212	40489	5479	45580	4256	47475	3294	48920	1833	58678	589	53338
24-#11	2.46	24121	6704	37320	5176	41738	4021	42861	3152	42754	1868	50013	897	40858
24-#14	3.55	25489	7292	40928	5545	46179	4286	48178	3319	49857	1829	60175	557	55159
25-#11	2.56	24272	6760	37739	5197	42181	4046	43402	3168	43479	1865	51055	863	42226
25-#14	3.70	25698	7371	41462	5587	46818	4335	48955	3343	50899	1825	61665	509	57169
26-#11	2.67	24397	6815	38185	5215	42642	4055	43937	3169	44139	1846	51878	820	43688
26-#14	3.85	25884	7451	42118	5608	47476	4362	49718	3348	51876	1801	62865	449	59112
27-#11	2.77	24546	6870	38409	5271	43040	4101	44444	3203	44865	1860	53035	800	45073
27-#14	4.00	26080	7531	42472	5684	48044	4413	50439	3393	52879	1817	64484	416	60951
28-#11	2.87	24693	6926	38732	5310	43477	4130	44946	3220	45536	1857	53980	770	46453
28-#14	4.14	26283	7611	42943	5737	48667	4443	51151	3417	53823	1812	66145	399	62923

ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
29-#11	2.98	24826	6981	39085	5346	43903	4156	45488	3238	46253	1854	55121	748	47874
30-#11	3.08	24966	7036	39514	5367	44365	4168	46007	3241	46924	1838	56100	714	49213
31-#11	3.18	25097	7092	39764	5421	44770	4211	46529	3273	47642	1849	57099	685	50658
32-#11	3.28	25225	7147	40100	5458	45188	4238	47039	3290	48423	1860	58176	659	51966
33-#11	3.39	25375	7202	40438	5495	45628	4266	47568	3307	49081	1851	59197	631	53388
34-#11	3.49	25502	7258	40847	5518	46099	4281	48087	3312	49807	1843	60093	585	54760

ROUND TIED COLUMNS 46" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
5-#18	1.20	25504	6586	38663	4977	41673	3889	41349	3077	38348	1948	41699	1290	24635
6-#18	1.44	25939	6728	40913	4819	43116	3747	42524	2928	39803	1774	42356	1053	29574
7-#18	1.68	26304	6869	40154	5232	43890	4082	44150	3210	42194	1970	47272	1146	33246
8-#14	1.08	25452	6515	37413	5108	41042	3990	40944	3190	38041	2068	41369	1414	22534
8-#18	1.93	26688	7011	40665	5391	44912	4223	45522	3318	44155	2021	49908	1113	37858
9-#14	1.22	25612	6595	38165	5123	41758	4007	41703	3178	39085	2042	42858	1333	25259
9-#18	2.17	26963	7153	41842	5450	46150	4244	46911	3317	46037	1988	52649	981	41399
10-#14	1.35	25813	6674	39176	5070	42529	3963	42472	3132	39906	1967	43942	1272	27545
10-#18	2.41	27287	7295	43280	5425	47529	4225	48435	3284	47731	1888	54889	899	45896
11-#11	1.03	25369	6485	37307	5085	40888	3975	40741	3169	37777	2065	41141	1427	21821
11-#14	1.49	26061	6754	39106	5243	43055	4098	43301	3238	41203	2042	46028	1269	30125
11-#18	2.65	27711	7437	43530	5651	48430	4395	49667	3415	49701	1980	58092	855	49075
12-#11	1.13	25495	6540	37537	5149	41337	4025	41325	3212	38534	2076	42407	1419	23490
12-#14	1.62	26237	6834	39502	5323	43689	4149	44107	3291	42237	2052	47765	1251	32408
12-#18	2.89	28008	7579	44347	5773	49514	4502	51022	3493	51451	1987	60984	814	52842
13-#11	1.22	25657	6596	38024	5160	41786	4036	41855	3210	39264	2064	43271	1370	25344
13-#14	1.76	26466	6914	40147	5348	44336	4182	44893	3294	43311	2038	49041	1183	34822
13-#18	3.13	28409	7721	45369	5831	50669	4539	52420	3508	53356	1968	63274	696	56412
14-#11	1.31	25840	6651	38637	5149	42301	4027	42355	3189	39904	2025	44101	1315	26989
14-#14	1.90	26724	6994	40918	5352	45069	4177	45655	3279	44291	1991	50332	1112	37179
14-#18	3.37	28837	7862	46533	5873	51940	4560	53871	3507	55162	1900	65691	585	59844
15-#11	1.41	25968	6706	38708	5239	42694	4095	42953	3248	40745	2062	45517	1319	28774
15-#14	2.03	26899	7073	41140	5460	45633	4255	46456	3347	45415	2033	52228	1107	39437
15-#18	3.61	29119	8004	47139	6026	52924	4682	55171	3599	57008	1955	68773	554	63625
16-#11	1.50	26111	6762	38942	5295	43135	4133	43545	3283	41585	2080	46640	1286	30372
16-#14	2.17	27101	7153	41507	5534	46272	4305	47275	3392	46590	2056	53790	1056	41788
16-#18	3.85	29466	8146	47835	6145	54071	4779	56530	3668	59024	1988	71411	456	66868
17-#11	1.60	26261	6817	39403	5317	43606	4153	44055	3285	42273	2066	47639	1256	32148
17-#14	2.30	27311	7233	42138	5570	46939	4337	48025	3399	47590	2037	55240	1014	43938
17-#18	4.09	29828	8288	48888	6217	55196	4823	57894	3688	60786	1958	73972	383	70616

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 46" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.69	26398	6872	39937	5325	44120	4161	44592	3279	42997	2044	48487	1195	33688
18-#14	2.44	27504	7313	42843	5595	47664	4359	48820	3399	48690	2013	56520	931	46317
18-#18	4.33	30146	8430	50027	6284	56454	4863	59327	3703	62743	1922	76303	243	74034
19-#11	1.78	26563	6928	40112	5394	44507	4209	45182	3329	43743	2062	49733	1196	35424
19-#14	2.57	27733	7393	43156	5680	48228	4417	49631	3461	49684	2031	58388	940	48381
19-#18	4.57	30525	8572	50666	6408	57471	4964	60684	3794	64424	1942	79428	243	77351
20-#11	1.88	26713	6983	40393	5445	44940	4241	45714	3351	44510	2070	51018	1184	36948
20-#14	2.71	27939	7472	43577	5749	48848	4460	50392	3490	50763	2040	60030	906	50532
20-#18	4.81	30869	8714	51435	6523	58552	5051	62032	3842	66279	1953	82242	176	81005
21-#11	1.97	26861	7038	40813	5469	45414	4265	46283	3365	45214	2058	51942	1146	38605
21-#14	2.84	28148	7552	44166	5788	49523	4497	51204	3512	51779	2024	61359	851	52596
21-#18	5.05	31237	8855	52454	6600	59724	5102	63417	3882	68064	1927	84561	80	83949
22-#11	2.07	27032	7094	41281	5487	45924	4268	46819	3360	45945	2042	52911	1106	40190
22-#14	2.98	28387	7632	44789	5821	50258	4529	51983	3511	52872	2005	62786	797	54657
22-#18	5.30	31635	8997	53463	6673	61011	5155	64804	3889	70017	1900	87115	-14	87036
23-#11	2.16	27156	7149	41522	5545	46327	4321	47376	3401	46678	2054	54043	1084	41765
23-#14	3.11	28563	7712	45181	5896	50826	4576	52769	3563	53874	2016	64346	760	56791
24-#11	2.25	27297	7204	41826	5593	46770	4351	47901	3420	47442	2060	55165	1064	43350
24-#14	3.25	28758	7792	45636	5962	51459	4617	53512	3589	54946	2023	65931	729	58775
25-#11	2.35	27455	7260	42272	5614	47232	4376	48472	3436	48196	2056	56265	1030	44871
25-#14	3.38	28978	7871	46257	5994	52126	4655	54332	3613	56045	2019	67508	682	60985
26-#11	2.44	27589	7315	42753	5631	47719	4384	49027	3436	48888	2037	57129	988	46477
26-#14	3.52	29179	7951	46907	6024	52820	4692	55147	3618	57057	1994	68771	622	62956
27-#11	2.53	27745	7370	42978	5688	48139	4431	49572	3472	49659	2051	58358	969	47968
27-#14	3.66	29388	8031	47268	6101	53420	4734	55900	3663	58132	2011	70488	591	64982
28-#11	2.63	27903	7426	43317	5727	48594	4461	50102	3490	50379	2050	59361	939	49497
28-#14	3.79	29601	8111	47763	6155	54079	4775	56652	3688	59135	2007	71902	546	67037
29-#11	2.72	28045	7481	43691	5763	49050	4487	50672	3507	51124	2047	60564	917	50948
29-#14	3.93	29803	8191	48287	6209	54720	4813	57471	3714	60221	2004	73627	515	68986
30-#11	2.82	28199	7536	44144	5784	49537	4498	51212	3509	51830	2030	61596	883	52419
31-#11	2.91	28332	7592	44404	5838	49959	4542	51766	3542	52590	2042	62656	855	53905
32-#11	3.00	28472	7647	44760	5876	50399	4569	52311	3560	53408	2053	63798	830	55393
33-#11	3.10	28632	7702	45115	5913	50865	4596	52862	3577	54109	2044	64754	793	56872
34-#11	3.19	28765	7757	45550	5936	51362	4611	53409	3582	54872	2036	65821	756	58289
35-#11	3.29	28916	7813	45832	5987	51775	4651	53961	3612	55574	2039	66968	739	59745
36-#11	3.38	29076	7868	46180	6024	52221	4678	54497	3629	56325	2043	67981	704	61179

ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
5-#18	1.11	28845	7108	43459	5398	46860	4220	46440	3346	42880	2139	46428	1453	26012
6-#18	1.33	29298	7250	45937	5220	48397	4062	47641	3183	44334	1954	47020	1209	31139
7-#18	1.55	29690	7392	45001	5659	49196	4419	49395	3484	46956	2165	52346	1315	35159
8-#18	1.77	30110	7533	45507	5825	50270	4566	50853	3597	49017	2219	55160	1286	39929
9-#14	1.12	28953	7117	42877	5554	46947	4347	46824	3454	43667	2237	47679	1500	26736
9-#18	1.99	30395	7675	46757	5880	51578	4584	52311	3594	51016	2185	58039	1152	43813
10-#14	1.24	29170	7197	43986	5493	47754	4296	47607	3402	44515	2158	48783	1436	29070
10-#18	2.21	30745	7817	48315	5847	53018	4558	53900	3556	52773	2082	60363	1069	48502
11-#14	1.37	29434	7276	43862	5675	48304	4429	48509	3516	45902	2238	51029	1438	31899
11-#18	2.43	31196	7959	48529	6083	53975	4737	55218	3693	54884	2180	63788	1031	52190
12-#11	1.03	28827	7062	42189	5584	46500	4369	46433	3492	43102	2273	47218	1588	24814
12-#14	1.49	29618	7356	44259	5758	48978	4493	49362	3571	46999	2250	52876	1422	34234
12-#18	2.65	31507	8101	49365	6207	55122	4847	56651	3774	56709	2187	66859	991	56348
13-#11	1.12	29000	7118	42715	5594	46968	4378	46981	3488	43864	2261	48120	1538	26742
13-#14	1.62	29861	7436	44953	5782	49652	4514	50177	3573	48124	2235	54213	1354	36880
13-#18	2.87	31923	8243	50464	6264	56324	4882	58123	3788	58733	2169	69269	873	59980
14-#11	1.21	29192	7173	43385	5578	47512	4365	47499	3464	44520	2219	48974	1481	28526
14-#14	1.74	30132	7516	45789	5781	50426	4515	50971	3554	49154	2187	55555	1281	39294
14-#18	3.09	32382	8385	51714	6303	57666	4899	59623	3784	60628	2100	71805	761	63736
15-#11	1.29	29332	7228	43428	5673	47924	4438	48138	3527	45424	2259	50490	1488	30381
15-#14	1.87	30324	7596	45991	5894	51018	4598	51823	3626	50342	2231	57577	1279	41771
15-#18	3.32	32694	8526	52315	6459	58702	5026	61003	3880	62577	2157	75079	734	67602
16-#11	1.38	29484	7284	43667	5731	48381	4477	48766	3563	46313	2278	51682	1455	32116
16-#14	1.99	30538	7675	46370	5969	51682	4649	52698	3673	51583	2255	59233	1229	44183
16-#18	3.54	33063	8668	53041	6581	59894	5124	62459	3951	64691	2191	77876	638	71148
17-#11	1.47	29641	7339	44158	5751	48878	4496	49298	3564	47033	2263	52729	1426	33959
17-#14	2.11	30759	7755	47040	6004	52390	4680	53476	3679	52633	2236	60756	1188	46540
17-#18	3.76	33444	8810	54157	6652	61097	5168	63874	3970	66555	2161	80574	566	75254
18-#11	1.55	29786	7394	44732	5757	49426	4488	49858	3557	47776	2240	53607	1365	35633
18-#14	2.24	30963	7835	47791	6026	53159	4701	54308	3677	53767	2210	62090	1104	48985
18-#18	3.98	33785	8952	55360	6716	62425	5206	65380	3983	68628	2126	83028	425	78705
19-#11	1.64	29962	7450	44902	5829	49826	4553	50461	3602	48582	2260	54936	1367	37457
19-#14	2.36	31210	7915	48111	6115	53742	4761	55168	3741	54838	2230	64076	1115	51266
19-#18	4.20	34186	9094	56031	6844	63479	5309	66816	4077	70387	2147	86332	429	82349
20-#11	1.72	30120	7505	45195	5881	50282	4586	51039	3631	49392	2269	56294	1356	39091
20-#14	2.49	31425	7994	48550	6185	54395	4805	55960	3771	55978	2240	65810	1082	53715
20-#18	4.42	34547	9236	56836	6961	64617	5398	68219	4125	72340	2159	89305	363	86063
21-#11	1.81	30277	7560	45636	5905	50781	4609	51637	3645	50122	2257	57266	1317	40916
21-#14	2.61	31647	8074	49167	6223	55106	4841	56822	3793	57045	2224	67212	1027	55856
21-#18	4.64	34940	9378	57902	7036	65854	5449	69698	4166	74223	2133	91757	268	89500

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.90	30463	7616	46139	5920	51313	4611	52204	3639	50884	2240	58278	1277	42525
22-#14	2.74	31907	8154	49834	6255	55873	4852	57642	3791	58175	2204	68707	973	58110
22-#18	4.86	35369	9519	58976	7108	67217	5501	71157	4173	76301	2107	94444	175	93122
23-#11	1.98	30591	7671	46382	5981	51740	4665	52787	3681	51663	2253	59482	1256	44251
23-#14	2.86	32090	8234	50236	6331	56478	4921	58462	3844	59247	2218	70365	937	60290
23-#18	5.08	35674	9661	59768	7226	68242	5589	72585	4255	78208	2136	97214	104	96470
24-#11	2.07	30742	7726	46695	6029	52208	4696	53341	3701	52478	2260	60667	1237	45873
24-#14	2.98	32298	8314	50705	6398	57144	4963	59247	3870	60383	2226	72038	907	62554
25-#11	2.16	30908	7782	47166	6049	52688	4721	53942	3717	53260	2255	61826	1204	47539
25-#14	3.11	32529	8393	51365	6430	57838	5001	60109	3895	61525	2221	73700	860	64737
26-#11	2.24	31050	7837	47684	6065	53203	4728	54517	3716	53984	2236	62730	1161	49185
26-#14	3.23	32730	8473	52060	6459	58570	5016	60957	3899	62585	2195	75026	801	66870
27-#11	2.33	31217	7892	47909	6124	53643	4776	55099	3753	54801	2251	64030	1143	50816
27-#14	3.36	32966	8553	52426	6537	59201	5080	61760	3946	63722	2214	76842	771	69092
28-#11	2.41	31383	7948	48264	6164	54117	4806	55658	3771	55552	2250	65092	1114	52465
28-#14	3.48	33190	8633	52945	6592	59887	5121	62553	3971	64794	2211	78339	727	71178
29-#11	2.50	31534	8003	48659	6200	54602	4832	56251	3788	56343	2247	66357	1092	54042
29-#14	3.61	33405	8713	53499	6645	60570	5159	63415	3996	65922	2207	80155	696	73314
30-#11	2.59	31701	8058	49138	6219	55116	4843	56818	3790	57082	2230	67441	1058	55684
30-#14	3.73	33639	8792	54162	6679	61301	5179	64236	4002	66998	2184	81724	649	75478
31-#11	2.67	31840	8114	49405	6274	55553	4887	57402	3823	57886	2243	68563	1031	57229
31-#14	3.85	33837	8872	54572	6753	61937	5239	65057	4047	68124	2199	83294	606	77581
32-#11	2.76	31989	8169	49783	6313	56017	4915	57979	3842	58738	2254	69769	1006	58822
33-#11	2.84	32157	8224	50154	6349	56507	4942	58556	3859	59481	2245	70776	969	60335
34-#11	2.93	32298	8280	50616	6371	57025	4956	59130	3863	60285	2237	71898	933	61881
35-#11	3.02	32459	8335	50908	6424	57465	4997	59713	3894	61018	2240	73108	917	63429
36-#11	3.10	32628	8390	51269	6461	57934	5024	60271	3911	61809	2244	74177	883	64933
37-#11	3.19	32776	8446	51691	6492	58419	5052	60864	3929	62557	2236	75307	857	66514

ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.38	4367	2215	6768	1620	7130	1271	6953	1003	6286	633	6539	392	4135
4-#14	1.99	4427	2311	7053	1663	7445	1304	7318	1018	6769	612	7151	309	5741
4-#18	3.54	4561	2553	7713	1775	8196	1389	8194	1056	7930	555	8605	89	8301
5-#11	1.72	4455	2269	6998	1615	7304	1251	7129	977	6523	591	6958	339	4733
5-#14	2.49	4548	2389	7336	1673	7697	1290	7590	992	7138	559	7783	240	6467
5-#18	4.42	4753	2691	8132	1820	8634	1387	8696	1029	8615	473	9732	-25	9716
6-#11	2.07	4543	2323	7296	1564	7504	1208	7311	929	6766	528	7040	241	5680
6-#14	2.98	4663	2466	7713	1630	7999	1252	7897	943	7546	484	7978	110	7487
6-#18	5.31	4925	2829	8697	1796	9180	1362	9298	977	9416	363	10186	-241	9986
7-#11	2.41	4557	2377	7267	1704	7693	1316	7613	1017	7205	594	7857	264	6309
7-#14	3.48	4686	2544	7730	1791	8240	1375	8259	1044	8081	558	9017	124	8385
7-#18	6.19	4986	2968	8819	2013	9542	1521	9804	1105	10179	457	11964	-216	11448
8-#11	2.76	4608	2431	7371	1757	7887	1365	7864	1054	7506	599	8437	259	7137
8-#14	3.98	4760	2622	7900	1859	8509	1437	8599	1089	8485	558	9808	112	9291
8-#18	7.07	5088	3106	9141	2116	9992	1617	10358	1172	10830	447	13047	-283	12239
9-#11	3.10	4668	2485	7554	1781	8077	1371	8082	1050	7825	583	8797	193	7711
9-#14	4.48	4838	2700	8143	1898	8779	1449	8914	1086	8945	537	10324	19	10227
9-#18	7.96	5218	3244	9528	2193	10450	1644	10901	1172	11627	411	13922	-448	13183
10-#11	3.45	4704	2539	7789	1777	8292	1367	8314	1037	8102	542	9111	144	8386
10-#14	4.97	4889	2778	8448	1903	9087	1453	9257	1076	9360	484	10796	-50	10743
11-#11	3.79	4761	2593	7850	1854	8461	1422	8547	1079	8441	568	9637	111	9062
11-#14	5.47	4974	2855	8565	2001	9317	1520	9565	1125	9808	514	11497	-105	11348
12-#11	4.14	4828	2647	7981	1894	8651	1459	8783	1105	8733	564	10104	89	9653
12-#14	5.97	5063	2933	8758	2054	9584	1570	9892	1160	10326	530	12139	-139	11953
13-#11	4.48	4865	2701	8150	1925	8844	1471	9029	1115	9093	561	10544	43	10350
13-#14	6.47	5110	3011	8990	2101	9856	1589	10241	1176	10723	502	12763	-206	12440
14-#11	4.83	4912	2755	8358	1936	9057	1480	9250	1106	9423	539	10853	-15	10837
15-#11	5.17	4972	2809	8452	1995	9227	1519	9488	1142	9702	545	11375	-39	11323
16-#11	5.52	5016	2863	8593	2031	9418	1553	9704	1156	10024	546	11941	-60	11857

ROUND TIED COLUMNS 26" DIA.

4-#11	1.18	5534	2562	8459	1901	8958	1494	8736	1184	7857	762	8151	503	4571
4-#14	1.70	5606	2658	8780	1944	9316	1527	9149	1200	8403	742	8850	424	6372
4-#18	3.01	5767	2900	9550	2058	10175	1614	10148	1241	9725	689	10524	214	9686
5-#11	1.47	5638	2616	8746	1890	9155	1468	8925	1153	8109	716	8610	448	5274
5-#14	2.12	5748	2736	9132	1948	9601	1507	9448	1169	8805	686	9553	353	7221
5-#18	3.77	5996	3038	10045	2097	10673	1608	10710	1210	10488	606	11803	100	11265
6-#11	1.76	5736	2670	9107	1826	9377	1413	9113	1096	8356	648	8673	347	6299
6-#14	2.54	5890	2814	9582	1892	9939	1459	9777	1112	9240	605	9747	221	8632
6-#18	4.52	6221	3177	10710	2061	11288	1573	11376	1151	11372	492	12301	-114	12197

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
7-#11	2.06	5759	2724	9032	1983	9591	1537	9473	1198	8882	723	9637	378	7056
7-#14	2.97	5913	2891	9564	2071	10212	1597	10205	1226	9872	690	10964	244	9543
7-#18	5.27	6278	3315	10816	2296	11701	1748	11967	1293	12263	598	14122	-111	13991
8-#11	2.35	5818	2778	9137	2040	9808	1590	9759	1237	9226	731	10298	377	8017
8-#14	3.39	6004	2969	9734	2142	10515	1664	10592	1275	10334	694	11864	237	10636
8-#18	6.03	6402	3453	11169	2404	12209	1849	12597	1365	13006	592	15597	-139	14898
9-#11	2.64	5884	2832	9349	2062	10023	1594	10002	1232	9580	714	10703	311	8734
9-#14	3.81	6087	3047	10020	2180	10819	1675	10943	1271	10848	673	12449	143	11607
9-#18	6.78	6553	3592	11615	2481	12728	1876	13211	1365	13904	558	16602	-303	16047
10-#11	2.94	5928	2886	9635	2054	10265	1586	10256	1217	9882	671	11046	261	9568
10-#14	4.24	6146	3125	10385	2182	11166	1675	11325	1258	11306	618	12973	76	12575
10-#18	7.53	6647	3730	12171	2505	13329	1896	13897	1357	14735	470	17552	-419	16851
11-#11	3.23	5994	2940	9679	2137	10453	1647	10524	1263	10273	702	11652	233	10267
11-#14	4.66	6239	3203	10490	2285	11425	1748	11677	1313	11820	653	13778	27	13659
12-#11	3.53	6065	2994	9822	2179	10667	1686	10791	1291	10604	700	12187	213	10983
12-#14	5.09	6340	3280	10701	2341	11726	1801	12047	1350	12278	646	14514	-5	14506
13-#11	3.82	6117	3048	10015	2209	10884	1698	11044	1293	11005	697	12679	169	11741
13-#14	5.51	6408	3358	10966	2387	12032	1819	12439	1366	12850	644	15216	-70	15097
14-#11	4.11	6172	3102	10250	2217	11124	1705	11312	1291	11371	675	13027	110	12407
14-#14	5.93	6506	3436	11289	2406	12372	1836	12797	1355	13384	614	15722	-152	15476
15-#11	4.41	6232	3156	10354	2280	11315	1748	11581	1330	11690	683	13622	90	13166
16-#11	4.70	6290	3210	10510	2317	11528	1782	11825	1345	12052	686	14263	70	13873
17-#11	5.00	6350	3264	10707	2342	11745	1797	12098	1358	12376	669	14653	21	14545
18-#11	5.29	6412	3318	10903	2366	11981	1811	12352	1353	12745	652	15130	-27	15085

ROUND TIED COLUMNS 28" DIA.

4-#11	1.01	6891	2937	10411	2206	11066	1734	10800	1379	9671	900	10007	623	5005
4-#14	1.46	6975	3033	10768	2248	11474	1768	11261	1396	10280	882	10792	547	7001
4-#18	2.60	7164	3275	11626	2361	12442	1856	12383	1439	11763	833	12688	345	11160
5-#11	1.27	7011	2991	10755	2187	11294	1703	11000	1343	9934	851	10499	565	5823
5-#14	1.83	7139	3111	11195	2246	11794	1742	11585	1361	10711	823	11561	473	7983
5-#18	3.25	7431	3413	12228	2396	13000	1845	13004	1405	12601	747	14113	230	12741
6-#11	1.52	7115	3045	11194	2109	11537	1636	11190	1277	10177	776	10533	460	6919
6-#14	2.19	7290	3188	11727	2176	12166	1682	11931	1294	11165	736	11744	338	9615
6-#18	3.90	7699	3552	13001	2347	13686	1799	13730	1337	13560	628	14645	15	14573
7-#11	1.77	7151	3099	11059	2285	11778	1776	11614	1392	10799	862	11657	499	7817
7-#14	2.56	7332	3266	11652	2373	12473	1837	12431	1422	11905	831	13152	370	10667
7-#18	4.55	7743	3690	13080	2602	14149	1992	14412	1494	14588	746	16736	28	16568
8-#11	2.03	7219	3153	11163	2346	12010	1832	11935	1436	11191	872	12213	478	8841
8-#14	2.92	7427	3344	11830	2449	12808	1908	12866	1475	12427	838	13894	332	12044
8-#18	5.20	7911	3828	13436	2713	14715	2098	15120	1571	15427	745	18395	7	18358
9-#11	2.28	7290	3207	11407	2366	12257	1835	12202	1429	11578	855	12851	435	9693
9-#14	3.29	7525	3422	12155	2485	13148	1918	13255	1470	12993	817	14818	273	13037
9-#18	5.85	8066	3967	13958	2789	15297	2124	15803	1571	16424	712	19528	-155	19227

ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.53	7343	3261	11736	2352	12526	1823	12478	1410	11901	810	13220	385	10701
10-#14	3.65	7596	3500	12590	2482	13535	1914	13673	1454	13492	760	15390	207	14185
10-#18	6.50	8178	4105	14604	2810	15968	2141	16564	1561	17344	623	20585	-268	20100
11-#11	2.79	7418	3315	11771	2442	12733	1890	12783	1462	12348	845	13912	362	11505
11-#14	4.02	7701	3577	12676	2592	13822	1993	14071	1515	14076	800	16304	163	15322
11-#18	7.15	8369	4243	14855	2971	16445	2251	17189	1642	18261	673	22036	-367	21232
12-#11	3.04	7494	3369	11925	2486	12963	1930	13080	1492	12719	844	14515	343	12366
12-#14	4.38	7809	3655	12906	2650	14155	2048	14484	1554	14588	795	17135	133	16361
13-#11	3.29	7562	3423	12141	2516	13209	1942	13360	1493	13115	834	15059	300	13151
13-#14	4.75	7899	3733	13205	2696	14497	2066	14885	1557	15221	793	17915	70	17555
14-#11	3.55	7624	3477	12403	2520	13479	1947	13654	1489	13561	819	15444	241	13942
14-#14	5.12	7987	3811	13559	2711	14876	2081	15315	1558	15808	763	18481	-12	18461
15-#11	3.80	7688	3531	12530	2579	13686	1993	13957	1531	13921	830	16114	223	14798
15-#14	5.48	8083	3889	13734	2798	15172	2138	15727	1611	16294	773	19395	-43	19311
16-#11	4.05	7756	3585	12689	2627	13919	2029	14228	1548	14325	833	16641	181	15562
16-#14	5.85	8168	3967	13985	2850	15505	2188	16106	1632	16858	776	20126	-106	19909
17-#11	4.31	7825	3639	12901	2650	14163	2043	14530	1561	14683	817	17265	157	16370
18-#11	4.56	7891	3693	13124	2673	14431	2057	14811	1556	15089	800	17795	109	17124
19-#11	4.81	7958	3747	13275	2721	14641	2093	15103	1590	15445	804	18321	78	17875
20-#11	5.07	8032	3801	13436	2766	14875	2127	15376	1604	15842	805	18919	45	18684

ROUND TIED COLUMNS 30" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.27	8548	3436	13036	2576	13927	2027	13677	1607	12419	1032	12997	677	7628
4-#18	2.26	8767	3678	13983	2688	15020	2117	14923	1652	14064	986	15114	482	12721
5-#11	1.10	8588	3394	13048	2507	13743	1955	13377	1548	12017	996	12645	690	6380
5-#14	1.59	8735	3513	13534	2565	14296	1995	14023	1566	12875	969	13826	601	8755
5-#18	2.83	9072	3816	14699	2717	15639	2099	15598	1613	14971	898	16680	366	14277
6-#11	1.32	8699	3448	13577	2414	14007	1876	13561	1471	12249	914	12638	579	7540
6-#14	1.91	8895	3591	14169	2481	14704	1922	14382	1490	13340	875	13987	461	10506
6-#18	3.40	9356	3954	15590	2653	16394	2042	16380	1536	15999	772	17237	149	16434
7-#11	1.54	8748	3502	13369	2609	14272	2033	14056	1601	12977	1011	13938	628	8591
7-#14	2.23	8956	3669	14024	2698	15044	2095	14960	1632	14198	981	15601	502	11731
7-#18	3.96	9431	4093	15606	2927	16909	2253	17161	1708	17175	902	19611	172	18486
8-#11	1.77	8826	3556	13470	2676	14518	2093	14415	1648	13417	1024	14565	610	9670
8-#14	2.55	9064	3747	14207	2779	15396	2169	15444	1689	14783	992	16435	469	13369
8-#18	4.53	9629	4231	15985	3044	17533	2364	17947	1790	18111	906	21458	158	20572
9-#11	1.99	8902	3610	13746	2694	14792	2094	14705	1641	13837	1006	15262	567	10670
9-#14	2.86	9169	3825	14573	2813	15785	2178	15869	1683	15400	971	17449	410	14515
9-#18	5.09	9787	4369	16570	3119	18176	2389	18699	1789	19207	873	22720	-4	22712

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.21	8963	3664	14119	2673	15098	2078	15001	1617	14179	959	15651	516	11733
10-#14	3.18	9251	3902	15058	2803	16214	2170	16322	1663	15936	911	18066	343	15859
10-#18	5.66	9918	4508	17327	3137	18920	2402	19533	1776	20212	783	23880	-115	23660
11-#11	2.43	9048	3718	14144	2771	15314	2150	15345	1675	14685	998	16434	497	12675
11-#14	3.50	9371	3980	15144	2921	16523	2255	16769	1730	16594	956	19094	304	17066
11-#18	6.22	10136	4646	17560	3303	19446	2519	20232	1864	21238	839	25504	-206	25018
12-#11	2.65	9129	3772	14307	2818	15567	2193	15674	1707	15097	998	17107	479	13733
12-#14	3.82	9485	4058	15392	2982	16880	2311	17226	1771	17161	953	20022	276	18246
12-#18	6.79	10317	4784	18012	3399	20071	2610	20997	1928	22183	826	27040	-263	26428
13-#11	2.87	9210	3826	14542	2845	15837	2203	15980	1707	15530	988	17703	437	14605
13-#14	4.14	9596	4136	15720	3026	17263	2330	17666	1774	17785	939	20878	215	19550
13-#18	7.36	10492	4922	18561	3486	20716	2647	21762	1937	23391	825	28526	-374	27233
14-#11	3.09	9283	3880	14839	2847	16140	2207	16299	1702	16011	972	18123	377	15532
14-#14	4.46	9696	4214	16112	3039	17691	2343	18135	1773	18494	921	21502	133	20650
15-#11	3.31	9350	3933	14968	2910	16361	2255	16636	1747	16415	985	18870	363	16417
15-#14	4.77	9790	4291	16326	3117	18005	2403	18593	1830	19036	933	22520	105	21912
16-#11	3.53	9419	3987	15138	2959	16617	2293	16935	1765	16861	990	19458	321	17309
16-#14	5.09	9897	4369	16580	3185	18367	2454	19011	1853	19659	938	23336	43	23059
17-#11	3.75	9507	4041	15375	2982	16886	2307	17266	1777	17253	974	20142	299	18187
17-#14	5.41	10006	4447	16904	3220	18747	2476	19484	1872	20220	915	24312	11	24249
18-#11	3.97	9577	4095	15626	3002	17173	2319	17573	1771	17695	956	20723	250	19024
19-#11	4.19	9652	4149	15785	3053	17410	2358	17897	1807	18090	962	21308	223	19912
20-#11	4.41	9742	4203	15953	3098	17668	2392	18197	1823	18528	965	21967	192	20738
21-#11	4.63	9803	4257	16192	3124	17932	2408	18527	1837	18975	959	22464	150	21596

ROUND TIED COLUMNS 32" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.12	10341	3866	15604	2927	16712	2304	16417	1833	14839	1192	15485	815	8253
4-#18	1.99	10589	4108	16641	3039	17912	2394	17787	1879	16645	1148	17823	626	13927
5-#14	1.40	10551	3944	16178	2907	17131	2266	16783	1786	15315	1125	16366	735	9536
5-#18	2.49	10933	4246	17465	3060	18610	2371	18516	1834	17618	1057	19524	507	15692
6-#11	1.16	10502	3878	16276	2741	16809	2132	16250	1679	14587	1061	15007	706	8161
6-#14	1.68	10720	4022	16928	2808	17573	2179	17149	1698	15781	1023	16493	590	11393
6-#18	2.98	11233	4385	18497	2981	19434	2301	19346	1747	18705	925	20093	287	18379
7-#11	1.36	10565	3932	15983	2958	17091	2307	16823	1825	15434	1169	16498	764	9378
7-#14	1.96	10800	4099	16700	3046	17941	2370	17813	1856	16770	1142	18329	642	12812
7-#18	3.48	11342	4523	18436	3276	20001	2531	20233	1936	20041	1068	22767	321	20468
8-#11	1.55	10652	3986	16075	3029	17358	2372	17213	1876	15926	1186	17200	750	10506
8-#14	2.24	10921	4177	16883	3132	18316	2448	18347	1918	17420	1156	19259	613	14545
8-#18	3.98	11545	4661	18835	3398	20665	2646	21100	2022	21077	1075	24249	252	22871
9-#11	1.75	10731	4040	16387	3044	17657	2371	17533	1866	16376	1167	17953	706	11681
9-#14	2.52	11033	4255	17293	3164	18742	2455	18808	1911	18087	1133	20361	553	15900
9-#18	4.48	11731	4800	19487	3471	21390	2671	21921	2021	22270	1042	26194	151	25124

ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.94	10802	4094	16808	3017	18002	2350	17846	1839	16734	1116	18359	653	12777
10-#14	2.80	11128	4333	17832	3147	19226	2443	19294	1886	18658	1071	21018	485	17596
10-#18	4.97	11882	4938	20331	3483	22205	2679	22825	2004	23358	951	27453	43	27186
11-#11	2.13	10897	4148	16814	3123	18226	2428	18231	1902	17303	1160	19237	639	13867
11-#14	3.08	11261	4411	17914	3274	19548	2534	19792	1959	19392	1121	22166	452	18828
11-#18	5.47	12108	5076	20568	3658	22780	2804	23600	2099	24496	1012	29257	-42	29151
12-#11	2.33	10983	4202	16989	3172	18501	2473	18586	1935	17757	1162	19983	623	14977
12-#14	3.36	11382	4488	18177	3337	19937	2593	20293	2002	20017	1120	23192	425	20196
12-#18	5.97	12315	5215	21056	3757	23446	2897	24440	2166	25536	1002	30958	-97	30722
13-#11	2.52	11072	4256	17243	3198	18797	2483	18924	1936	18225	1151	20629	581	15991
13-#14	3.64	11508	4566	18530	3380	20356	2611	20772	2005	20694	1106	24124	366	21542
13-#18	6.47	12520	5353	21662	3843	24166	2934	25277	2175	26722	980	32585	-204	32024
14-#11	2.72	11162	4310	17578	3197	19119	2483	19268	1928	18742	1134	21082	521	17134
14-#14	3.92	11628	4644	18970	3389	20826	2622	21280	2002	21460	1087	24804	283	22817
14-#18	6.96	12718	5491	22359	3879	24962	2969	26185	2183	28096	954	33804	-345	32830
15-#11	2.91	11232	4364	17706	3263	19368	2536	19614	1968	19191	1150	21909	509	18077
15-#14	4.20	11726	4722	19191	3472	21166	2686	21784	2062	22061	1102	25928	259	24243
16-#11	3.10	11309	4418	17881	3313	19647	2574	19961	1995	19679	1156	22559	469	19113
16-#14	4.48	11835	4800	19457	3540	21561	2737	22242	2086	22742	1109	26830	199	25522
17-#11	3.30	11406	4472	18149	3336	19935	2588	20325	2008	20104	1140	23195	435	20016
17-#14	4.76	11970	4877	19821	3576	21976	2760	22758	2106	23353	1086	27894	168	26825
18-#11	3.49	11483	4526	18430	3355	20245	2598	20659	2001	20581	1122	23933	398	20983
18-#14	5.04	12073	4955	20197	3610	22420	2780	23240	2100	24050	1063	28811	99	28121
19-#11	3.69	11567	4580	18589	3408	20503	2640	21011	2039	21018	1129	24578	374	21963
19-#14	5.32	12192	5033	20454	3679	22784	2833	23731	2149	24647	1069	29697	58	29335
20-#11	3.88	11666	4634	18770	3454	20793	2676	21337	2055	21497	1133	25298	344	22853
21-#11	4.07	11738	4688	19032	3480	21072	2691	21698	2070	21982	1127	25845	302	23850
22-#11	4.27	11814	4742	19305	3506	21380	2707	22042	2068	22414	1105	26473	260	24720
23-#11	4.46	11900	4796	19478	3552	21642	2742	22386	2100	22892	1116	27221	242	25657

ROUND TIED COLUMNS 34" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.76	12646	4566	19619	3413	21148	2690	20998	2121	19527	1321	20832	777	15047
5-#14	1.24	12600	4402	19149	3273	20321	2554	19887	2020	18050	1291	19200	878	10325
5-#18	2.20	13030	4705	20550	3425	21937	2660	21777	2070	20560	1225	22661	656	17018
6-#11	1.03	12539	4337	19312	3090	19964	2406	19277	1901	17211	1217	17657	840	8785
6-#14	1.49	12778	4480	20024	3156	20796	2453	20254	1920	18509	1180	19280	727	12281
6-#18	2.64	13345	4843	21742	3330	22829	2576	22651	1971	21696	1085	23230	432	20408
7-#11	1.20	12616	4391	18918	3329	20264	2600	19935	2063	18135	1329	19356	909	10178
7-#14	1.73	12878	4558	19698	3417	21185	2663	21011	2095	19640	1312	21355	789	13909
7-#18	3.08	13487	4981	21589	3647	23448	2826	23651	2178	23205	1242	26222	477	22605

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.37	12711	4445	18999	3407	20551	2669	20354	2117	18735	1358	20137	899	11348
8-#14	1.98	13012	4635	19877	3509	21590	2746	21584	2160	20358	1329	22385	765	15728
8-#18	3.52	13713	5120	22005	3775	24142	2945	24600	2269	24344	1253	27856	413	25255
9-#11	1.55	12795	4499	19349	3418	20877	2666	20703	2107	19214	1338	20944	853	12694
9-#14	2.23	13132	4713	20335	3538	22053	2751	22093	2152	21073	1306	23573	704	17284
9-#18	3.97	13912	5258	22725	3846	24940	2969	25489	2266	25633	1221	29968	312	27565
10-#11	1.72	12876	4552	19822	3383	21253	2640	21036	2075	19584	1284	21361	798	13831
10-#14	2.48	13239	4791	20933	3514	22593	2734	22610	2124	21675	1241	24265	635	19074
10-#18	4.41	14083	5396	23647	3850	25846	2973	26463	2246	26799	1126	31322	204	29925
11-#11	1.89	12981	4606	19801	3499	21492	2725	21456	2144	20221	1332	22342	789	15081
11-#14	2.73	13386	4869	20996	3649	22926	2832	23162	2203	22491	1295	25538	606	20552
11-#18	4.85	14333	5535	23897	4036	26442	3104	27316	2348	28055	1194	33312	126	32524
12-#11	2.06	13072	4660	19989	3550	21789	2772	21841	2179	20718	1336	23161	774	16236
12-#14	2.97	13514	4947	21282	3716	23347	2893	23694	2247	23174	1296	26665	582	22211
12-#18	5.29	14551	5673	24421	4138	27166	3200	28231	2417	29191	1186	35181	74	34671
13-#11	2.23	13170	4714	20263	3575	22110	2781	22205	2178	21221	1325	23743	721	17399
13-#14	3.22	13655	5024	21660	3756	23802	2910	24221	2250	23904	1282	27673	523	23589
13-#18	5.73	14781	5811	25066	4221	27950	3237	29139	2426	30476	1164	36948	-30	36861
14-#11	2.41	13276	4768	20640	3569	22452	2778	22583	2169	21663	1289	24339	671	18589
14-#14	3.47	13795	5102	22150	3762	24300	2917	24771	2245	24724	1262	28406	439	25050
14-#18	6.17	15013	5949	25835	4255	28843	3271	30122	2433	31959	1139	38277	-171	37794
15-#11	2.58	13350	4822	20763	3641	22722	2834	22953	2211	22267	1325	25250	663	19673
15-#14	3.72	13899	5180	22375	3850	24681	2986	25280	2296	25386	1280	29639	419	26523
15-#18	6.61	15207	6088	26305	4382	29460	3367	31025	2525	33022	1156	40297	-223	39597
16-#11	2.75	13435	4876	20943	3691	23030	2875	23330	2240	22798	1332	25962	623	20858
16-#14	3.97	14018	5258	22650	3919	25108	3039	25808	2333	26127	1288	30627	360	27979
17-#11	2.92	13542	4930	21239	3714	23334	2887	23722	2252	23257	1316	26650	591	21887
17-#14	4.21	14171	5336	23058	3954	25550	3060	26371	2353	26788	1266	31615	313	29465
18-#11	3.09	13625	4984	21555	3731	23671	2896	24084	2244	23768	1297	27445	553	22999
18-#14	4.46	14280	5413	23474	3987	26029	3079	26899	2347	27537	1242	32772	262	30797
19-#11	3.26	13718	5038	21712	3787	23949	2939	24466	2284	24247	1306	28150	531	24007
19-#14	4.71	14410	5491	23733	4058	26423	3135	27426	2398	28191	1250	33739	224	32198
20-#11	3.44	13823	5092	21905	3833	24258	2976	24820	2301	24767	1311	28933	503	25027
20-#14	4.96	14557	5569	24017	4122	26871	3186	27923	2420	28922	1255	34841	182	33614
21-#11	3.61	13904	5146	22191	3859	24565	2992	25211	2316	25237	1296	29529	461	26077
22-#11	3.78	13992	5200	22486	3883	24900	3006	25574	2313	25754	1282	30205	420	27052
23-#11	3.95	14084	5254	22674	3931	25182	3043	25954	2347	26277	1295	31025	402	28128
24-#11	4.12	14166	5308	22882	3976	25481	3077	26311	2363	26742	1290	31671	365	29125
25-#11	4.30	14269	5362	23151	4003	25795	3095	26696	2378	27264	1285	32412	330	30118

ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.57	14951	5052	22935	3811	24760	3003	24572	2378	22728	1503	24162	936	16163
5-#14	1.11	14898	4888	22466	3661	23880	2861	23357	2269	21099	1467	22347	1029	11123
5-#18	1.96	15375	5191	23982	3812	25639	2968	25404	2320	23816	1404	26112	811	18356
6-#14	1.33	15085	4966	23478	3527	24395	2744	23718	2156	21540	1347	22367	871	13171
6-#18	2.36	15707	5329	25347	3701	26600	2868	26316	2209	24991	1255	26667	582	22187
7-#11	1.07	14915	4877	22195	3724	23813	2911	23409	2316	21204	1508	22532	1061	10990
7-#14	1.55	15205	5044	23039	3812	24805	2974	24577	2349	22745	1479	24698	944	15021
7-#18	2.75	15883	5467	25087	4041	27249	3138	27437	2433	26685	1425	29994	639	24599
8-#11	1.23	15020	4931	22260	3807	24120	2986	23864	2374	21864	1540	23395	1055	12195
8-#14	1.77	15352	5121	23210	3910	25239	3063	25187	2417	23616	1513	25831	924	16918
8-#18	3.14	16131	5606	25514	4176	27995	3262	28463	2529	27931	1441	31785	581	27722
9-#11	1.38	15107	4985	22651	3816	24472	2980	24234	2361	22371	1519	24254	1008	13725
9-#14	1.99	15476	5199	23717	3935	25739	3065	25738	2408	24377	1488	27104	862	18690
9-#18	3.54	16343	5744	26306	4244	28859	3284	29425	2525	29314	1408	34063	480	30074
10-#11	1.53	15199	5038	23182	3773	24871	2946	24592	2325	22748	1461	24677	951	14896
10-#14	2.21	15600	5277	24380	3903	26323	3042	26292	2375	25006	1420	27826	791	20557
10-#18	3.93	16535	5882	27309	4239	29863	3285	30466	2501	30555	1311	35505	372	32750
11-#11	1.69	15314	5092	23127	3897	25134	3040	25047	2400	23458	1515	25766	946	16317
11-#14	2.43	15761	5355	24416	4048	26681	3148	26884	2460	25908	1480	29231	768	22236
11-#18	4.32	16809	6021	27565	4436	30481	3422	31400	2610	31933	1384	37687	300	35431
12-#11	1.84	15410	5146	23326	3952	25453	3089	25464	2437	23999	1520	26660	934	17510
12-#14	2.65	15896	5433	24725	4118	27133	3211	27461	2506	26650	1482	30460	745	24091
12-#18	4.72	17038	6159	28125	4541	31261	3520	32386	2681	33165	1379	39726	251	37864
13-#11	1.99	15517	5200	23622	3975	25796	3097	25855	2436	24536	1509	27283	881	18851
13-#14	2.87	16047	5510	25129	4156	27625	3227	28028	2508	27433	1468	31368	670	25657
13-#18	5.11	17294	6297	28810	4622	32109	3557	33371	2691	34549	1358	41632	149	40669
14-#11	2.15	15639	5254	24043	3965	26160	3090	26256	2424	25002	1471	27915	829	20064
14-#14	3.09	16212	5588	25672	4159	28150	3230	28629	2502	28142	1422	32325	603	27350
14-#18	5.50	17561	6435	29655	4652	33055	3587	34427	2695	36140	1331	43070	7	43015
15-#11	2.30	15716	5308	24159	4041	26450	3151	26660	2470	25663	1510	28912	824	21297
15-#14	3.32	16321	5666	25898	4251	28560	3303	29170	2556	29031	1468	33671	586	28900
15-#18	5.89	17745	6574	30147	4785	33741	3689	35408	2792	37300	1352	45269	-40	45139
16-#11	2.45	15809	5362	24341	4093	26789	3193	27067	2499	26238	1518	29687	785	22527
16-#14	3.54	16452	5744	26182	4321	29032	3359	29740	2595	29832	1477	34747	527	30505
16-#18	6.29	17992	6712	30691	4903	34535	3778	36316	2832	38659	1361	47073	-149	46565
17-#11	2.61	15923	5416	24664	4115	27109	3205	27489	2512	26729	1502	30426	753	23697
17-#14	3.76	16617	5822	26626	4356	29497	3379	30345	2614	30542	1454	35811	482	32036
18-#11	2.76	16017	5470	25021	4130	27472	3211	27866	2501	27272	1482	31275	715	24944
18-#14	3.98	16737	5900	27091	4387	30013	3396	30911	2607	31343	1430	37054	430	33543
19-#11	2.91	16118	5524	25172	4188	27771	3258	28288	2544	27795	1493	32043	696	26074
19-#14	4.20	16879	5977	27352	4460	30437	3454	31483	2660	32055	1441	38104	396	35145

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.07	16229	5578	25378	4236	28096	3295	28672	2562	28357	1498	32891	669	27260
20-#14	4.42	17035	6055	27654	4526	30908	3506	32020	2683	32844	1446	39295	355	36582
21-#11	3.22	16322	5632	25687	4261	28434	3310	29085	2576	28862	1484	33534	627	28338
21-#14	4.64	17171	6133	28086	4564	31380	3529	32621	2706	33569	1426	40213	296	38134
22-#11	3.37	16420	5686	26006	4283	28795	3324	29471	2572	29414	1469	34257	586	29446
22-#14	4.86	17301	6211	28523	4602	31892	3554	33183	2704	34374	1408	41265	238	39619
23-#11	3.52	16517	5740	26201	4333	29091	3362	29883	2608	29981	1483	35150	570	30587
24-#11	3.68	16607	5794	26429	4380	29412	3397	30277	2625	30483	1479	35850	534	31679
25-#11	3.83	16717	5848	26715	4405	29750	3414	30682	2640	31044	1474	36650	499	32793
26-#11	3.98	16819	5902	27017	4432	30117	3433	31075	2639	31552	1454	37265	452	33840
27-#11	4.14	16915	5956	27263	4469	30412	3466	31481	2671	32108	1465	38272	440	34923

ROUND TIED COLUMNS 38" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.41	17519	5566	26610	4233	28769	3336	28514	2648	26267	1696	27831	1103	17276
5-#18	1.76	17984	5704	27781	4223	29741	3293	29418	2584	27404	1591	29894	974	19707
6-#14	1.19	17655	5480	27311	3919	28393	3052	27563	2406	24892	1523	25770	1022	14062
6-#18	2.12	18332	5843	29331	4093	30769	3176	30361	2460	28608	1433	30421	739	23758
7-#14	1.39	17795	5557	26741	4230	28822	3304	28523	2617	26262	1669	28378	1107	16149
7-#18	2.47	18543	5981	28947	4459	31446	3468	31611	2703	30501	1618	34102	808	26462
8-#11	1.10	17591	5444	25878	4232	28086	3321	27764	2646	25333	1733	26993	1219	13049
8-#14	1.59	17955	5635	26900	4334	29286	3398	29181	2689	27213	1707	29619	1091	18116
8-#18	2.82	18813	6119	29382	4600	32245	3597	32695	2803	31856	1638	36054	756	30265
9-#11	1.24	17682	5498	26312	4237	28464	3312	28155	2631	25864	1710	27777	1160	14688
9-#14	1.79	18085	5713	27459	4356	29824	3397	29766	2678	28018	1681	30973	1028	20116
9-#18	3.17	19038	6258	30248	4665	33176	3617	33751	2799	33332	1604	38495	654	32647
10-#11	1.38	17785	5552	26907	4186	28887	3272	28535	2590	26246	1649	28325	1112	15972
10-#14	1.98	18223	5791	28192	4316	30441	3367	30361	2641	28670	1609	31718	955	22054
10-#18	3.53	19252	6396	31339	4652	34280	3613	34858	2769	34644	1504	40022	545	35660
11-#11	1.51	17910	5606	26811	4320	29174	3374	29028	2671	27032	1707	29529	1112	17535
11-#14	2.18	18399	5869	28195	4470	30833	3482	30997	2731	29663	1674	33263	937	23947
11-#18	3.88	19551	6534	31579	4859	34918	3758	35867	2885	36148	1584	42402	480	38409
12-#11	1.65	18010	5660	27020	4378	29514	3425	29478	2710	27619	1714	30501	1101	18799
12-#14	2.38	18541	5946	28524	4543	31317	3547	31619	2780	30466	1678	34596	916	25875
12-#18	4.23	19792	6673	32188	4968	35755	3859	36909	2958	37479	1581	44613	433	41145
13-#11	1.79	18127	5714	27339	4398	29875	3431	29894	2708	28189	1702	31162	1048	20310
13-#14	2.58	18705	6024	28957	4580	31840	3562	32224	2782	31300	1664	35565	842	27641
13-#18	4.59	20074	6811	32914	5047	36668	3894	37978	2968	38961	1560	46657	333	44201
14-#11	1.93	18265	5768	27807	4385	30267	3421	30309	2693	28676	1663	31826	995	21557
14-#14	2.78	18894	6102	29556	4578	32399	3562	32861	2773	32049	1616	36581	773	29600
14-#18	4.94	20375	6949	33839	5073	37662	3921	39122	2972	40657	1532	48202	191	46673
15-#11	2.06	18346	5822	27912	4466	30576	3486	30758	2743	29398	1704	32914	992	22949
15-#14	2.98	19007	6180	29779	4675	32837	3639	33449	2830	33014	1665	38043	759	31277
15-#18	5.29	20567	7088	34348	5211	38416	4029	40089	3049	41916	1557	50582	148	49525

ROUND TIED COLUMNS 38" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.20	18447	5876	28096	4519	30940	3530	31196	2774	30016	1714	33753	955	24218
16-#14	3.17	19150	6258	30070	4746	33353	3697	34062	2870	33877	1675	39208	702	33098
16-#18	5.64	20842	7226	34912	5329	39273	4120	41132	3113	43379	1568	52538	40	52216
17-#11	2.34	18568	5930	28446	4540	31282	3540	31642	2785	30540	1697	34542	923	25561
17-#14	3.37	19319	6335	30551	4781	33841	3716	34710	2890	34635	1653	40347	657	34666
17-#18	6.00	21099	7364	35716	5397	40151	4161	42265	3151	44712	1530	54530	-40	54383
18-#11	2.48	18666	5984	28845	4553	31671	3545	32036	2773	31115	1676	35195	860	26828
18-#14	3.57	19459	6413	31069	4810	34396	3731	35299	2880	35487	1628	41674	605	36360
19-#11	2.61	18782	6038	28990	4613	31990	3594	32494	2818	31683	1689	36277	867	28101
19-#14	3.77	19614	6491	31328	4886	34849	3792	35926	2936	36258	1640	42809	574	38021
20-#11	2.75	18900	6092	29207	4662	32331	3632	32915	2837	32286	1696	37189	842	29395
20-#14	3.97	19779	6569	31649	4952	35343	3844	36507	2961	37106	1647	44090	535	39623
21-#11	2.89	19005	6146	29541	4687	32694	3647	33347	2851	32825	1681	37881	801	30608
21-#14	4.17	19926	6647	32114	4990	35859	3867	37139	2982	37881	1627	45080	476	41376
22-#11	3.03	19113	6200	29885	4707	33088	3660	33758	2845	33412	1666	38649	760	31956
22-#14	4.36	20075	6724	32582	5027	36410	3891	37737	2979	38740	1608	46203	419	42883
23-#11	3.16	19215	6254	30086	4759	33397	3700	34202	2883	34024	1681	39617	744	33069
23-#14	4.56	20217	6802	32898	5094	36859	3942	38355	3028	39586	1626	47541	393	44532
24-#11	3.30	19313	6307	30333	4807	33740	3735	34618	2900	34564	1677	40371	709	34295
25-#11	3.44	19433	6361	30636	4832	34104	3752	35058	2916	35163	1673	41229	675	35440
26-#11	3.58	19534	6415	30965	4857	34490	3769	35477	2914	35704	1653	41885	628	36616
27-#11	3.71	19646	6469	31223	4896	34812	3805	35914	2948	36303	1664	42844	606	37801
28-#11	3.85	19769	6523	31490	4932	35159	3839	36321	2963	36846	1659	43837	596	38932

ROUND TIED COLUMNS 40" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.27	20365	6108	30662	4678	33197	3687	32868	2933	30163	1899	31859	1278	18388
5-#18	1.59	20871	6246	31966	4656	34246	3634	33841	2863	31343	1789	34026	1145	21069
6-#14	1.07	20502	6021	31544	4332	32810	3377	31810	2669	28585	1709	29508	1180	14955
6-#18	1.91	21235	6384	33715	4506	35359	3502	34807	2724	32564	1621	34509	903	25329
7-#14	1.25	20663	6099	30825	4671	33259	3651	32875	2899	30134	1869	32412	1279	17293
7-#18	2.23	21481	6523	33189	4900	36064	3816	36196	2988	34510	1799	38565	985	28347
8-#14	1.43	20836	6177	30966	4782	33752	3751	33586	2977	31168	1911	33766	1266	19321
8-#18	2.55	21775	6661	33628	5048	36915	3951	37338	3091	36139	1846	40683	937	32328
9-#11	1.12	20535	6040	30348	4682	32876	3663	32488	2916	29714	1911	31774	1331	15649
9-#14	1.61	20972	6255	31580	4801	34328	3748	34205	2963	32015	1883	35009	1185	21564
9-#18	2.86	22013	6799	34571	5109	37912	3969	38467	3085	37706	1810	43285	835	35220
10-#11	1.24	20648	6094	31017	4622	33323	3615	32887	2869	30095	1846	32324	1281	17059
10-#14	1.79	21125	6332	32390	4751	34979	3710	34840	2921	32686	1808	35962	1127	23563
10-#18	3.18	22248	6938	35755	5087	39084	3957	39658	3052	39085	1707	44889	725	38654
11-#11	1.37	20783	6148	30873	4766	33632	3726	33420	2957	30964	1910	33651	1286	18709
11-#14	1.97	21315	6410	32352	4916	35405	3834	35522	3018	33775	1878	37653	1114	25684
11-#18	3.50	22572	7076	35973	5304	39775	4112	40727	3174	40721	1792	47476	667	41455

ROUND TIED COLUMNS 40" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.49	20889	6202	31081	4826	33994	3780	33905	2998	31593	1919	34701	1276	20103
12-#14	2.15	21464	6488	32701	4992	35920	3902	36189	3069	34639	1885	39091	1095	27678
12-#18	3.82	22825	7214	36629	5418	40669	4215	41845	3249	42151	1792	49861	621	44514
13-#11	1.61	21015	6256	31468	4836	34373	3784	34345	2995	32199	1906	35400	1223	21700
13-#14	2.33	21642	6566	33162	5027	36469	3915	36832	3069	35524	1870	40121	1021	29656
13-#18	4.14	23133	7352	37397	5494	41646	4250	42985	3259	43730	1771	51699	492	47655
14-#11	1.74	21168	6310	31952	4828	34793	3770	34772	2976	32705	1865	36094	1169	23069
14-#14	2.51	21854	6644	33822	5021	37067	3911	37492	3057	36311	1820	41193	950	31718
14-#18	4.46	23471	7491	38405	5517	42690	4272	44228	3262	45206	1698	53689	380	50422
15-#11	1.86	21254	6364	32038	4913	35121	3840	35265	3031	33429	1901	37275	1169	24607
15-#14	2.69	21972	6721	34038	5123	37533	3993	38141	3119	37354	1872	42775	940	33560
15-#18	4.77	23671	7629	38929	5660	43494	4385	45243	3342	46890	1770	56256	342	53627
16-#11	1.99	21364	6417	32227	4968	35502	3884	35737	3063	34149	1919	38180	1132	25932
16-#14	2.86	22127	6799	34334	5196	38085	4053	38797	3161	38279	1883	44030	884	35609
16-#18	5.09	23937	7767	39510	5779	44431	4479	46360	3407	48457	1783	58363	236	56348
17-#11	2.11	21491	6471	32605	4988	35873	3895	36175	3065	34709	1903	39017	1101	27435
17-#14	3.04	22305	6877	34853	5229	38604	4071	39481	3179	39086	1861	45242	840	37354
17-#18	5.41	24242	7906	40374	5846	45350	4518	47570	3446	49880	1746	60493	157	59274
18-#11	2.23	21596	6525	33042	4998	36290	3897	36619	3059	35313	1881	39706	1037	28738
18-#14	3.22	22460	6955	35426	5256	39198	4084	40098	3168	39987	1835	46272	753	39246
18-#18	5.73	24480	8044	41255	5912	46378	4559	48713	3440	51511	1709	63014	70	62417
19-#11	2.36	21724	6579	33184	5062	36626	3949	37111	3107	35928	1896	40871	1047	30163
19-#14	3.40	22627	7033	35681	5335	39680	4148	40773	3227	40818	1850	47874	760	40991
20-#11	2.48	21849	6633	33411	5112	36985	3987	37565	3127	36570	1902	41848	1023	31497
20-#14	3.58	22801	7110	36020	5402	40197	4200	41407	3253	41726	1857	49247	722	42735
21-#11	2.61	21962	6687	33768	5136	37372	4002	38021	3140	37147	1888	42587	981	32854
21-#14	3.76	22962	7188	36520	5440	40748	4224	42068	3273	42552	1838	50307	663	44551
22-#11	2.73	22084	6741	34142	5154	37801	4014	38456	3134	37768	1872	43400	940	34245
22-#14	3.94	23129	7266	37020	5474	41348	4246	42703	3270	43462	1818	51500	606	46222
23-#11	2.86	22191	6795	34347	5209	38123	4055	38933	3173	38425	1889	44444	926	35530
23-#14	4.12	23279	7344	37348	5544	41816	4299	43365	3320	44371	1838	52941	582	48070
24-#11	2.98	22297	6849	34605	5257	38488	4092	39370	3190	38999	1886	45252	892	36916
24-#14	4.30	23428	7422	37731	5611	42337	4349	43993	3343	45184	1831	54077	530	49703
25-#11	3.10	22428	6903	34933	5282	38876	4108	39844	3206	39639	1882	46168	858	38144
25-#14	4.48	23610	7499	38184	5649	42889	4375	44664	3367	46099	1826	55387	482	51504
26-#11	3.23	22533	6957	35362	5289	39282	4124	40291	3204	40214	1861	46865	812	39455
27-#11	3.35	22656	7011	35554	5346	39627	4161	40751	3239	40855	1874	47893	790	40700
28-#11	3.48	22787	7065	35837	5382	40002	4196	41186	3254	41432	1869	48958	781	41933
29-#11	3.60	22888	7119	36136	5418	40376	4213	41660	3271	42071	1866	49735	736	43209
30-#11	3.72	23002	7173	36520	5438	40776	4232	42122	3273	42657	1847	50593	702	44405

ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.15	23503	6677	35111	5147	38067	4057	37655	3233	34436	2112	36265	1461	19497
5-#18	1.44	24050	6815	36558	5113	39190	3994	38695	3156	35652	1996	38527	1323	22444
6-#18	1.73	24430	6954	38520	4942	40391	3844	39677	3002	36878	1818	38950	1074	26901
7-#14	1.14	23823	6668	35309	5136	38139	4018	37658	3196	34379	2080	36820	1458	18452
7-#18	2.02	24712	7092	37833	5364	41124	4182	41195	3286	39044	2011	43402	1169	30253
8-#14	1.30	24010	6746	35428	5254	38659	4123	38426	3279	35493	2125	38291	1450	20533
8-#18	2.31	25029	7230	38270	5519	42027	4324	42416	3394	40799	2063	45690	1127	34401
9-#11	1.01	23680	6609	34781	5150	37730	4032	37253	3215	33939	2123	36148	1511	16615
9-#14	1.46	24151	6824	36096	5268	39274	4117	39078	3263	36388	2096	39600	1367	23034
9-#18	2.60	25281	7369	39293	5577	43091	4338	43612	3386	42454	2026	48451	1023	37624
10-#11	1.13	23803	6663	35532	5081	38201	3976	37658	3162	34315	2053	36693	1457	18156
10-#14	1.62	24319	6902	36994	5210	39958	4071	39749	3215	37072	2016	40575	1306	25086
10-#18	2.89	25538	7507	40578	5545	44322	4319	44889	3348	43895	1919	50127	912	41701
11-#11	1.24	23948	6717	35332	5235	38529	4097	38246	3258	35270	2123	38149	1468	19893
11-#14	1.79	24524	6980	36908	5385	40418	4205	40479	3319	38263	2092	42419	1299	27447
11-#18	3.18	25887	7645	40765	5773	45075	4484	46020	3477	45668	2011	52926	860	44570
12-#11	1.35	24059	6771	35536	5298	38915	4136	38765	3301	35937	2133	39280	1460	21456
12-#14	1.95	24680	7057	37260	5464	40965	4276	41193	3372	39184	2100	43966	1281	29499
12-#18	3.46	26152	7783	41467	5891	46025	4590	47214	3555	47200	2013	55487	817	47969
13-#11	1.46	24195	6825	35961	5307	39313	4155	39230	3297	36581	2120	40016	1406	23095
13-#14	2.11	24871	7135	37819	5485	41540	4286	41874	3372	40124	2085	45055	1208	31701
13-#18	3.75	26488	7922	42279	5965	47054	4623	48426	3564	48875	1992	57442	689	51182
14-#11	1.58	24357	6879	36497	5294	39761	4138	39668	3275	37109	2077	40736	1350	24600
14-#14	2.27	25100	7213	38488	5487	42177	4279	42555	3356	40946	2033	46179	1136	33825
14-#18	4.04	26862	8060	43372	5983	48160	4641	49729	3563	50433	1917	59552	576	54260
15-#11	1.69	24454	6933	36559	5384	40107	4212	40201	3333	37886	2115	42014	1354	26210
15-#14	2.44	25230	7291	38689	5594	42670	4366	43264	3423	41980	2076	47884	1129	35879
15-#18	4.33	27070	8198	43907	6132	49015	4759	50831	3649	52240	1993	62308	542	57667
16-#11	1.80	24572	6987	36753	5440	40505	4241	40712	3367	38652	2135	42986	1318	27668
16-#14	2.60	25397	7369	38995	5668	43247	4426	43966	3466	43053	2101	49231	1074	37994
16-#18	4.62	27355	8337	44504	6252	50032	4857	52022	3716	53913	2008	64569	437	60573
17-#11	1.91	24706	7041	37160	5460	40906	4268	41167	3368	39245	2118	43872	1287	29272
17-#14	2.76	25584	7446	39551	5701	43809	4444	44638	3471	43913	2079	50517	1030	39947
17-#18	4.91	27680	8475	45430	6319	50990	4894	53310	3754	55425	1971	66835	360	63953
18-#11	2.03	24819	7095	37634	5467	41351	4268	41634	3361	39887	2095	44595	1222	30674
18-#14	2.92	25745	7524	40174	5725	44442	4455	45331	3470	44862	2052	51605	942	42088
18-#18	5.20	27939	8613	46397	6383	52086	4932	54497	3746	57153	1933	69516	273	67031
19-#11	2.14	24959	7149	37774	5534	41700	4322	42162	3411	40540	2112	45844	1234	32258
19-#14	3.09	25934	7602	40431	5807	44949	4522	46053	3531	45756	2069	53319	952	43979
19-#18	5.49	28250	8752	46963	6504	52974	5029	55698	3836	58615	1948	71676	213	69989

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.25	25090	7203	38011	5585	42080	4344	42638	3431	41224	2119	46886	1211	33628
20-#14	3.25	26117	7680	40787	5876	45492	4575	46735	3559	46718	2077	54783	916	45919
21-#11	2.36	25212	7256	38388	5608	42492	4376	43130	3444	41835	2105	47673	1170	35161
21-#14	3.41	26291	7758	41316	5913	46079	4598	47430	3579	47599	2058	55913	857	47777
22-#11	2.48	25347	7310	38795	5625	42948	4386	43589	3437	42498	2089	48529	1129	36566
22-#14	3.57	26477	7835	41855	5945	46728	4620	48103	3574	48562	2038	57175	801	49634
23-#11	2.59	25458	7364	39003	5682	43289	4429	44098	3478	43193	2107	49512	1104	37997
23-#14	3.74	26634	7913	42195	6018	47214	4674	48810	3626	49532	2059	58721	778	51557
24-#11	2.70	25574	7418	39269	5730	43677	4449	44556	3496	43804	2104	50512	1083	39424
24-#14	3.90	26795	7991	42593	6085	47768	4725	49466	3650	50394	2053	59934	728	53443
25-#11	2.81	25715	7472	39625	5755	44089	4483	45059	3511	44483	2099	51487	1049	40804
25-#14	4.06	26991	8069	43083	6123	48355	4750	50188	3674	51370	2047	61329	679	55345
26-#11	2.93	25826	7526	40087	5761	44515	4497	45540	3509	45091	2078	52223	1002	42250
26-#14	4.22	27159	8147	43712	6137	48970	4777	50874	3674	52255	2020	62406	614	57119
27-#11	3.04	25956	7580	40280	5819	44881	4536	46023	3544	45775	2092	53323	982	43605
28-#11	3.15	26097	7634	40578	5856	45285	4555	46485	3560	46390	2088	54458	973	44998
29-#11	3.27	26210	7688	40898	5892	45676	4589	46988	3577	47067	2085	55284	929	46305
30-#11	3.38	26334	7742	41306	5911	46102	4607	47469	3578	47682	2066	56194	894	47633
31-#11	3.49	26453	7796	41521	5965	46475	4633	47956	3610	48422	2086	57114	863	49002
32-#11	3.60	26568	7850	41827	6001	46866	4659	48422	3625	49099	2090	58128	837	50324

ROUND TIED COLUMNS 44" DIA.

4-#18	1.05	26948	7274	39976	5640	43400	4446	42897	3548	39104	2336	41068	1653	20605
5-#18	1.32	27536	7412	41575	5593	44597	4372	44000	3464	40349	2214	43415	1510	23831
6-#18	1.58	27932	7551	43767	5399	45887	4204	44991	3293	41567	2024	43762	1252	28475
7-#14	1.04	27286	7265	40213	5624	43482	4403	42896	3508	39017	2301	41621	1646	19606
7-#18	1.84	28250	7689	42899	5851	46648	4566	46643	3598	43970	2234	48631	1361	32181
8-#14	1.18	27490	7343	40305	5749	44029	4490	43721	3596	40205	2349	43215	1642	21753
8-#18	2.10	28591	7827	43328	6014	47602	4715	47948	3712	45855	2290	51095	1324	36484
9-#14	1.33	27637	7421	41026	5759	44683	4505	44405	3577	41154	2319	44586	1557	24512
9-#18	2.37	28846	7966	44435	6068	48734	4726	49211	3702	47596	2252	53640	1189	40057
10-#11	1.03	27263	7260	40472	5563	43543	4356	42877	3470	38924	2271	41450	1643	19264
10-#14	1.48	27820	7499	42022	5692	45403	4451	45095	3523	41847	2235	45577	1493	26621
10-#18	2.63	29136	8104	45827	6027	50024	4698	50573	3659	49095	2141	55752	1106	44289
11-#11	1.13	27421	7314	40208	5728	43887	4486	43527	3574	39962	2346	43044	1658	21085
11-#14	1.63	28040	7577	41880	5878	45890	4594	45892	3636	43145	2317	47582	1492	29236
11-#18	2.89	29510	8242	45976	6266	50838	4874	51768	3795	51011	2239	58773	1060	47713
12-#11	1.23	27536	7368	40405	5794	44300	4528	44082	3619	40677	2358	44259	1652	22790
12-#14	1.78	28203	7654	42232	5959	46472	4643	46653	3691	44115	2326	49239	1476	31338
12-#18	3.16	29788	8381	46720	6387	51844	4983	53040	3875	52645	2243	61513	1019	51509

ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
13-#11	1.33	27681	7422	40869	5801	44716	4537	44571	3614	41353	2344	45029	1598	24503
13-#14	1.92	28408	7732	42841	5979	47073	4677	47371	3690	45114	2311	50385	1402	33777
13-#18	3.42	30138	8519	47578	6459	52919	5014	54322	3884	54415	2222	63581	892	54781
14-#11	1.44	27851	7476	41462	5783	45193	4524	45018	3588	41905	2299	45771	1540	26150
14-#14	2.07	28648	7810	43574	5976	47751	4665	48073	3670	45975	2257	51559	1329	35956
14-#18	3.68	30546	8657	48761	6473	54094	5029	55673	3879	56052	2145	65808	778	58188
15-#11	1.54	27961	7530	41496	5879	45556	4594	45592	3650	42736	2340	47151	1547	27828
15-#14	2.22	28796	7888	43753	6089	48271	4757	48833	3741	47077	2303	53392	1325	38232
15-#18	3.95	30778	8796	49303	6628	54999	5151	56875	3970	57986	2225	68758	748	61677
16-#11	1.64	28087	7584	41693	5937	45970	4633	46143	3686	43551	2361	48190	1512	29427
16-#14	2.37	28974	7966	44069	6164	48873	4794	49591	3786	48213	2328	54831	1271	40407
16-#18	4.21	31084	8934	49915	6749	56078	5251	58141	4039	59765	2241	71173	645	65106
17-#11	1.74	28228	7638	42130	5955	46402	4651	46616	3686	44176	2343	49124	1481	31095
17-#14	2.52	29171	8043	44665	6196	49478	4836	50289	3790	49124	2306	56189	1228	42570
17-#18	4.47	31428	9072	50903	6814	57095	5288	59493	4076	61366	2205	73576	569	68610
18-#11	1.85	28349	7692	42643	5959	46875	4657	47105	3677	44850	2320	49875	1415	32635
18-#14	2.66	29343	8121	45333	6217	50150	4845	51018	3787	50132	2279	57334	1139	44776
18-#18	4.74	31709	9211	51958	6877	58259	5324	60737	4066	63189	2167	75671	420	71740
19-#11	1.95	28498	7746	42779	6030	47236	4705	47669	3729	45547	2338	51215	1430	34286
19-#14	2.81	29549	8199	45596	6303	50677	4914	51789	3851	51075	2297	59161	1152	46869
19-#18	5.00	32042	9349	52528	7001	59199	5424	62016	4159	64750	2184	78718	426	75028
20-#11	2.05	28639	7800	43025	6082	47639	4737	48168	3751	46275	2346	52324	1408	35788
20-#14	2.96	29742	8277	45968	6373	51251	4943	52502	3879	52095	2306	60718	1118	49077
20-#18	5.26	32365	9487	53213	7117	60209	5513	63245	4203	66507	2195	81377	357	78380
21-#11	2.15	28769	7854	43424	6105	48075	4760	48694	3764	46919	2332	53157	1366	37441
21-#14	3.11	29927	8355	46526	6409	51873	4991	53248	3899	53027	2287	61918	1059	51065
22-#11	2.26	28919	7908	43865	6119	48553	4776	49177	3755	47604	2314	54055	1325	38919
22-#14	3.26	30133	8432	47108	6440	52561	5011	53957	3893	54056	2267	63247	1002	53119
23-#11	2.36	29033	7961	44074	6178	48919	4814	49712	3797	48290	2325	55109	1301	40504
23-#14	3.40	30298	8510	47456	6514	53076	5068	54709	3948	55075	2289	64691	963	55134
24-#11	2.46	29159	8015	44348	6227	49330	4843	50198	3816	49007	2332	56172	1281	41966
24-#14	3.55	30470	8588	47869	6582	53662	5094	55396	3971	55990	2283	66190	932	57160
25-#11	2.56	29307	8069	44774	6243	49760	4867	50729	3831	49722	2327	57205	1247	43521
25-#14	3.70	30677	8666	48397	6620	54284	5145	56159	3995	57022	2278	67670	884	59122
26-#11	2.67	29426	8123	45229	6256	50212	4872	51243	3828	50351	2305	57979	1201	44979
26-#14	3.85	30845	8744	49071	6633	54927	5169	56896	3995	57960	2250	68807	819	61066
27-#11	2.77	29566	8177	45421	6316	50598	4920	51750	3864	51086	2321	59151	1182	46476
27-#14	4.00	31043	8821	49387	6712	55479	5220	57613	4042	58970	2268	70439	787	63084
28-#11	2.87	29716	8231	45733	6354	51026	4949	52241	3881	51744	2317	60071	1150	47963
28-#14	4.14	31244	8899	49844	6764	56089	5246	58308	4064	59892	2261	72144	774	64965

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
29-#11	2.98	29840	8285	46074	6389	51441	4974	52772	3898	52452	2314	61232	1130	49408
30-#11	3.08	29973	8339	46508	6407	51892	4982	53272	3897	53097	2294	62194	1095	50960
31-#11	3.18	30097	8393	46731	6462	52286	5027	53793	3931	53819	2307	63174	1064	52325
32-#11	3.28	30222	8447	47056	6499	52694	5053	54291	3947	54611	2320	64252	1039	53783
33-#11	3.39	30367	8501	47383	6535	53123	5080	54810	3964	55248	2308	65266	1011	55142
34-#11	3.49	30489	8555	47793	6555	53585	5092	55312	3966	55962	2300	66120	962	56555

ROUND TIED COLUMNS 46" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
5-#18	1.20	31343	8037	47039	6096	50492	4768	49779	3786	45454	2441	48710	1704	25230
6-#18	1.44	31756	8176	49475	5878	51870	4580	50771	3598	46651	2239	48961	1437	30045
7-#18	1.68	32110	8314	48405	6362	52658	4969	52565	3925	49307	2467	54272	1561	34130
8-#14	1.08	31291	7968	45615	6268	49884	4899	49494	3929	45331	2583	48556	1842	22981
8-#18	1.93	32474	8452	48821	6532	53663	5124	53959	4045	51316	2526	56918	1529	38576
9-#14	1.22	31444	8046	46394	6274	50579	4911	50208	3907	46331	2552	49984	1757	25887
9-#18	2.17	32740	8590	50008	6582	54863	5132	55286	4032	53151	2488	59595	1392	42520
10-#14	1.35	31643	8124	47496	6196	51333	4848	50908	3845	47030	2463	50986	1689	28170
10-#18	2.41	33056	8729	51521	6531	56213	5096	56730	3984	54702	2372	61785	1307	46895
11-#11	1.03	31214	7939	45519	6245	49729	4885	49286	3905	45068	2580	48355	1857	22285
11-#14	1.49	31877	8201	47288	6394	51844	5002	51782	3967	48427	2551	53161	1694	30939
11-#18	2.65	33456	8867	51624	6782	57087	5282	57993	4128	56767	2477	65036	1268	50665
12-#11	1.13	31334	7993	45706	6314	50169	4939	49876	3953	45833	2593	49654	1852	24139
12-#14	1.62	32047	8279	47638	6479	52465	5054	52591	4025	49461	2562	54930	1679	33196
12-#18	2.89	33746	9005	52387	6906	58149	5395	59343	4211	58496	2483	67956	1229	54991
13-#11	1.22	31489	8047	46212	6319	50604	4946	50381	3946	46538	2578	50459	1799	25923
13-#14	1.76	32266	8357	48299	6496	53093	5085	53346	4022	50509	2546	56132	1605	35885
13-#18	3.13	34120	9144	53419	6954	59270	5423	60696	4218	60370	2462	70137	1103	58452
14-#11	1.31	31668	8101	46865	6296	51110	4929	50844	3916	47113	2531	51219	1738	27718
14-#14	1.90	32518	8435	49100	6489	53811	5070	54066	3998	51414	2491	57351	1530	38109
14-#18	3.37	34549	9282	54591	6985	60515	5434	62093	4209	62083	2383	72477	987	62203
15-#11	1.41	31789	8155	46867	6398	51491	5004	51460	3983	48000	2575	52705	1748	29462
15-#14	2.03	32683	8513	49252	6607	54358	5154	54880	4073	52584	2539	59316	1530	40620
15-#18	3.61	34809	9420	55125	7146	61469	5562	63393	4306	63967	2445	75625	962	65763
16-#11	1.50	31924	8209	47066	6457	51921	5043	52051	4020	48866	2597	53813	1714	31207
16-#14	2.17	32873	8590	49578	6684	54983	5204	55694	4121	53788	2566	60848	1477	42846
16-#18	3.85	35136	9559	55761	7269	62592	5662	64737	4376	66023	2484	78196	860	69520
17-#11	1.60	32071	8263	47534	6474	52380	5061	52541	4019	49521	2579	54793	1683	32938
17-#14	2.30	33079	8668	50214	6715	55632	5234	56418	4124	54746	2544	62278	1434	45231
17-#18	4.09	35485	9697	56812	7334	63685	5700	66062	4390	67722	2448	80734	786	73109
18-#11	1.69	32201	8317	48088	6475	52884	5065	53052	4008	50211	2554	55570	1617	34622
18-#14	2.44	33263	8746	50930	6733	56343	5253	57182	4119	55810	2516	63473	1344	47495
18-#18	4.33	35803	9835	57943	7394	64917	5734	67453	4400	69638	2409	82945	636	76544

ROUND TIED COLUMNS 46" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
19-#11	1.78	32360	8371	48218	6550	53258	5116	53654	4063	50970	2574	56854	1621	36333
19-#14	2.57	33486	8824	51196	6823	56889	5312	58003	4186	56808	2535	65421	1360	49798
19-#18	4.57	36158	9974	58529	7521	65904	5836	68812	4497	71301	2429	86178	646	80179
20-#11	1.88	32509	8425	48472	6603	53682	5148	54175	4085	51741	2583	58179	1612	38021
20-#14	2.71	33688	8902	51584	6894	57495	5355	58746	4214	57888	2545	67071	1326	52069
20-#18	4.81	36497	10112	59248	7639	66960	5926	70126	4542	73152	2441	88996	579	83574
21-#11	1.97	32648	8478	48893	6624	54144	5170	54732	4098	52418	2569	59058	1571	39688
21-#14	2.84	33886	8980	52171	6929	58152	5390	59544	4235	58870	2526	68340	1268	54266
21-#18	5.05	36851	10250	60257	7708	68101	5971	71488	4581	74883	2409	91218	476	86996
22-#11	2.07	32812	8532	49371	6637	54644	5168	55241	4088	53123	2550	59996	1529	41303
22-#14	2.98	34111	9057	52797	6957	58872	5421	60289	4227	59935	2505	69735	1211	56581
22-#18	5.30	37212	10389	61252	7777	69363	6020	72825	4580	76802	2379	93736	381	90600
23-#11	2.16	32930	8586	49579	6698	55034	5225	55803	4132	53860	2563	61124	1507	42974
23-#14	3.11	34284	9135	53152	7035	59423	5467	61077	4283	60933	2516	71277	1174	58716
24-#11	2.25	33065	8640	49860	6748	55467	5255	56317	4151	54624	2570	62250	1487	44543
24-#14	3.25	34468	9213	53578	7103	60041	5507	61803	4307	62002	2524	72864	1143	60953
25-#11	2.35	33221	8694	50313	6764	55916	5279	56878	4166	55368	2565	63341	1453	46237
25-#14	3.38	34685	9291	54207	7128	60690	5544	62608	4331	63089	2519	74429	1095	62955
26-#11	2.44	33347	8748	50805	6776	56394	5282	57410	4162	56026	2542	64152	1407	47745
26-#14	3.52	34864	9369	54865	7152	61370	5580	63394	4331	64060	2490	75625	1030	65089
27-#11	2.53	33498	8802	50995	6837	56801	5332	57955	4199	56808	2559	65397	1389	49391
27-#14	3.66	35078	9446	55184	7233	61952	5621	64144	4379	65143	2509	77357	1001	67164
28-#11	2.63	33651	8856	51322	6875	57246	5361	58474	4217	57513	2557	66374	1357	50915
28-#14	3.79	35289	9524	55663	7285	62597	5660	64879	4402	66123	2503	78732	953	69218
29-#11	2.72	33790	8910	51684	6910	57690	5386	59033	4233	58249	2552	67598	1338	52504
29-#14	3.93	35479	9602	56169	7338	63220	5697	65683	4427	67198	2499	80488	925	71397
30-#11	2.82	33935	8964	52144	6927	58167	5394	59553	4232	58926	2533	68611	1303	54096
31-#11	2.91	34064	9018	52373	6984	58576	5439	60104	4267	59692	2546	69653	1274	55615
32-#11	3.00	34198	9072	52718	7021	59007	5465	60638	4284	60523	2559	70795	1249	57198
33-#11	3.10	34353	9126	53061	7056	59460	5492	61178	4300	61201	2548	71715	1209	58677
34-#11	3.19	34480	9180	53499	7076	59947	5504	61706	4301	61951	2539	72766	1171	60246
35-#11	3.29	34626	9234	53755	7130	60348	5546	62255	4333	62642	2542	73922	1155	61703
36-#11	3.38	34779	9288	54092	7165	60783	5571	62779	4349	63391	2545	74906	1118	63176

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
5-#18	1.11	35486	8690	52968	6622	56894	5182	56043	4122	50985	2679	54430	1907	26642
6-#18	1.33	35915	8828	55665	6379	58361	4973	57038	3917	52147	2464	54567	1630	31615
7-#18	1.55	36296	8966	54371	6896	59176	5390	58985	4267	55075	2710	60344	1769	36100
8-#18	1.77	36694	9105	54769	7074	60231	5552	60468	4392	57191	2773	63176	1742	40679
9-#14	1.12	35587	8698	52219	6812	56981	5336	56510	4252	51927	2795	55815	1964	27267
9-#18	1.99	36970	9243	56033	7119	61499	5557	61860	4377	59138	2733	65983	1604	45011
10-#14	1.24	35801	8776	53433	6724	57772	5264	57215	4182	52640	2702	56821	1892	29732
10-#18	2.21	37313	9381	57681	7058	62910	5511	63361	4322	60736	2613	68244	1516	49518
11-#14	1.37	36050	8854	53151	6934	58304	5415	58170	4313	54141	2796	59174	1903	32627
11-#18	2.43	37739	9520	57729	7321	63837	5709	64717	4475	62955	2725	71732	1484	53652
12-#11	1.03	35468	8646	51460	6857	56545	5368	56170	4302	51423	2839	55487	2062	25502
12-#14	1.49	36227	8932	53497	7021	58965	5483	59028	4374	55241	2809	61058	1890	35071
12-#18	2.65	38041	9658	58505	7448	64961	5825	66146	4561	64762	2732	74835	1447	58118
13-#11	1.12	35633	8700	52010	6861	57000	5373	56691	4292	52158	2823	56324	2007	27355
13-#14	1.62	36460	9010	54211	7038	59619	5500	59810	4369	56336	2792	62314	1816	37874
13-#18	2.87	38439	9796	59616	7495	66128	5851	67568	4567	66751	2711	77128	1321	61987
14-#11	1.21	35820	8753	52728	6832	57535	5352	57167	4259	52740	2773	57099	1945	29305
14-#14	1.74	36724	9088	55086	7025	60379	5493	60557	4342	57285	2735	63575	1739	40285
14-#18	3.09	38889	9935	60882	7521	67444	5857	69011	4553	68545	2631	79578	1204	66306
15-#11	1.29	35952	8807	52691	6940	57932	5432	57827	4330	53699	2821	58695	1958	31112
15-#14	1.87	36906	9165	55206	7149	60951	5582	61425	4421	58524	2786	65676	1742	42976
15-#18	3.32	39178	10073	61399	7688	68447	5991	70393	4655	70538	2695	82928	1183	69924
16-#11	1.38	36097	8861	52891	7001	58379	5473	58455	4369	54615	2844	59873	1925	33009
16-#14	1.99	37108	9243	55540	7228	61601	5634	62296	4471	59797	2814	67303	1690	45313
16-#18	3.54	39526	10211	62061	7813	69614	6093	71833	4729	72695	2736	85656	1082	74024
17-#11	1.47	36250	8915	53392	7017	58863	5489	58966	4367	55300	2826	60899	1894	34800
17-#14	2.11	37324	9321	56217	7258	62290	5663	63047	4472	60802	2791	68804	1648	47973
17-#18	3.76	39891	10350	63176	7876	70783	6130	73207	4741	74492	2700	88329	1009	77687
18-#11	1.55	36388	8969	53990	7015	59401	5474	59497	4354	56005	2798	61698	1827	36634
18-#14	2.24	37519	9399	56984	7272	63044	5679	63845	4465	61896	2761	70044	1558	50245
18-#18	3.98	40236	10488	64375	7933	72084	6162	74667	4749	76519	2661	90653	858	81441
19-#11	1.64	36559	9023	54108	7093	59787	5545	60107	4403	56826	2821	63072	1833	38402
19-#14	2.36	37759	9477	57249	7366	63608	5741	64715	4535	62974	2783	72118	1575	52769
19-#18	4.20	40613	10626	64986	8065	73106	6267	76107	4849	78262	2682	94074	872	85307
20-#11	1.72	36715	9077	54372	7148	60232	5579	60681	4434	57641	2831	64472	1825	40237
20-#14	2.49	37971	9554	57652	7438	64246	5785	65491	4564	64116	2794	73861	1543	55096
20-#18	4.42	40967	10765	65738	8184	74219	6358	77475	4894	80212	2695	97052	808	88865
21-#11	1.81	36863	9131	54816	7168	60719	5600	61267	4447	58343	2816	65396	1783	41959
21-#14	2.61	38181	9632	58269	7472	64939	5820	66336	4585	65147	2775	75199	1484	57502
21-#18	4.64	41330	10903	66794	8252	75422	6403	78929	4934	82037	2663	99402	705	92752
22-#11	1.90	37041	9185	55331	7178	61241	5596	61805	4435	59076	2796	66373	1741	43718
22-#14	2.74	38427	9710	58941	7499	65691	5824	67120	4576	66246	2752	76658	1428	59936
22-#18	4.86	41738	11041	67855	8319	76758	6450	80335	4932	84078	2635	102049	610	96285

ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
23-#11	1.98	37164	9239	55537	7242	61654	5655	62394	4481	59861	2810	67576	1720	45444
23-#14	2.86	38603	9788	59302	7579	66277	5898	67943	4633	67315	2766	78299	1392	62214
23-#18	5.08	42039	11180	68599	8439	77751	6538	81757	5019	85998	2666	104764	535	99947
24-#11	2.07	37308	9293	55825	7292	62111	5685	62937	4501	60677	2819	68766	1702	47153
24-#14	2.98	38803	9866	59740	7647	66927	5938	68709	4658	68448	2775	79975	1362	64636
25-#11	2.16	37471	9347	56305	7308	62579	5709	63525	4515	61448	2813	69913	1668	48902
25-#14	3.11	39031	9943	60408	7672	67604	5975	69556	4682	69578	2769	81626	1314	66836
26-#11	2.24	37605	9401	56836	7318	63083	5711	64076	4510	62135	2790	70760	1621	50548
26-#14	3.23	39221	10021	61114	7695	68321	5985	70373	4680	70593	2739	82879	1250	69188
27-#11	2.33	37767	9455	57022	7381	63510	5763	64659	4550	62964	2807	72081	1605	52297
27-#14	3.36	39445	10099	61434	7778	68933	6052	71174	4730	71740	2760	84713	1221	71359
28-#11	2.41	37926	9509	57363	7420	63973	5791	65206	4568	63700	2805	73115	1573	53907
28-#14	3.48	39673	10177	61936	7831	69603	6091	71949	4754	72789	2755	86168	1175	73550
29-#11	2.50	38075	9563	57747	7455	64446	5817	65788	4583	64481	2802	74401	1554	55675
29-#14	3.61	39874	10255	62471	7883	70268	6129	72795	4779	73904	2750	88016	1147	75778
30-#11	2.59	38233	9617	58234	7470	64949	5823	66333	4581	65189	2781	75464	1519	57274
30-#14	3.73	40093	10332	63138	7911	70985	6144	73588	4780	74941	2724	89564	1098	77904
31-#11	2.67	38367	9671	58468	7528	65374	5870	66915	4617	66000	2796	76569	1491	58939
31-#14	3.85	40283	10410	63509	7988	71601	6206	74404	4826	76071	2741	91101	1054	80181
32-#11	2.76	38510	9724	58833	7566	65826	5897	67480	4635	66866	2809	77776	1466	60559
33-#11	2.84	38676	9778	59192	7601	66304	5923	68046	4651	67585	2798	78744	1426	62180
34-#11	2.93	38808	9832	59658	7620	66812	5934	68600	4652	68375	2789	79848	1389	63820
35-#11	3.02	38964	9886	59921	7675	67238	5977	69179	4685	69097	2792	81069	1374	65425
36-#11	3.10	39124	9940	60271	7711	67697	6003	69725	4700	69885	2796	82107	1338	67059
37-#11	3.19	39270	9994	60690	7739	68169	6030	70308	4718	70611	2785	83229	1311	68616

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

CHAPTER 5 – STRENGTH DESIGN OF FLEXURAL MEMBERS AND DEVELOPMENT AND LAP SPLICE DESIGN DATA FOR REINFORCING BARS

INTRODUCTION

Strength design of flexural members utilizes the design assumptions given in Chapter 2 for columns. These assumptions recognize that, as the nominal strength of reinforced concrete is approached, the plastic range of the materials is reached, and stress and strain are no longer proportional. At nominal strength, the actual concrete stress distribution in the member is not triangular but curvilinear. It is also assumed that the reinforcing steel behaves elastically. The tabulated designs in this *Handbook* are based on an assumed rectangular concrete stress distribution at nominal strength (ACI 10.2.7).

Strength design consists of two steps: first, a member is proportioned to ensure its strength using appropriate safety factors; and second, the member must be checked to ensure that deflection and cracking at service load conditions will be within acceptable limits. Strength design is described in this Chapter; serviceability, in Chapter 6.

STRENGTH DESIGN–GENERAL PRINCIPLES

General. Strength design of flexural members is based on the concept that after the yield strength of the reinforcement is reached, the reinforcement continues to elongate until the maximum compressive fiber strain of the concrete section is reached. The design limitations of the ACI Building Code ensure that sections will be underreinforced for flexure, so that yielding of the reinforcement occurs before the concrete crushes. The nominal flexural strength of a section is computed as the resistance when the reinforcement reaches the yield strength.

Load Factors. Load factors provide for safety against overloads. The ACI Building Code requires that the actual or specified dead, live, wind, earthquake and other service load effects each be increased by an appropriate load factor to determine the factored loads. The design strength at each section of a member must be equal to, or greater than, the effect of the factored loads. The greatest factored load combination controls the design. The combinations to be reviewed (ACI 9.2.1) are:

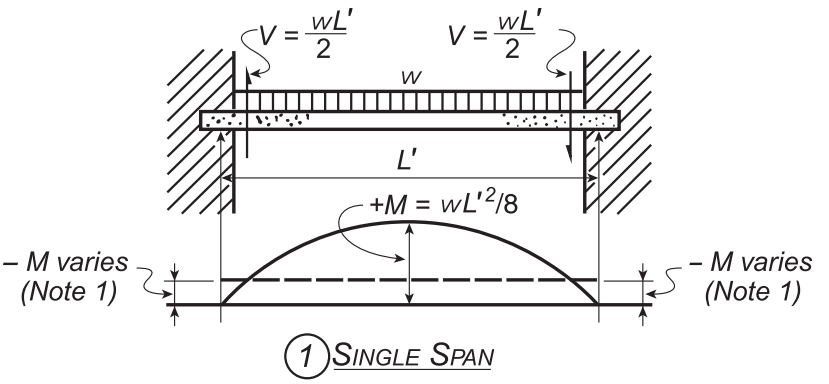
$$U = 1.4(D + F)$$
$$U = 1.2(D + F + T) + 1.6(L + H) + 0.5(L_r \text{ or } S \text{ or } R)$$
$$U = 1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (1.0L \text{ or } 0.8W)$$
$$U = 1.2D + 1.6W + 1.0L + 0.5(L_r \text{ or } S \text{ or } R)$$
$$U = 1.2D + 1.0E + 1.0L + 0.2S$$
$$U = 0.9D + 1.6W + 1.6H$$
$$U = 0.9D + 1.0E + 1.6H$$

where:

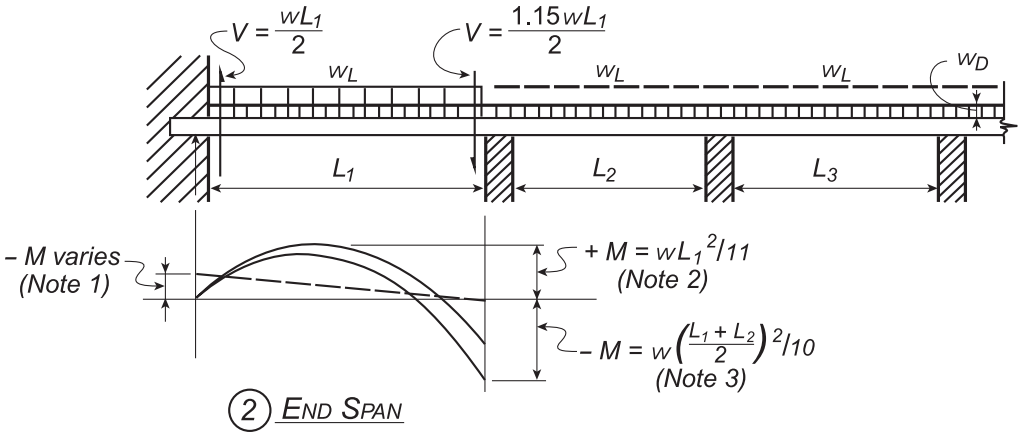
D = **Dead Load**
E = **Earthquake Load**
F = **Fluid Load**
H = **Soil Load**
L = **Live Load**
L_r = **Roof Live Load**
R = **Rain Load**
S = **Snow Load**
T = **Temperature, Creep and Shrinkage Load**
W = **Wind Load**

Strength-Reduction Factors. The second portion of the safety factor, called strength-reduction factor or ϕ-factor, is prescribed to recognize possible sources of understrength, such as variations in quality (strength) of materials, permissible tolerances in dimensions and in location of reinforcement, and approximations in structural analysis. The Code permits the following ϕ-factors for flexural members: 0.90 for flexure, and 0.75 for shear and torsion. In this *Handbook*, the term **usable** indicates that all relevant ϕ-factors have been applied in the computation of the tabulated usable factored load capacities. No further consideration of the proper ϕ-factors is required in these tables.

Maximum Usable Superimposed Factored Load. Factored load capacity in the tabulated designs is the least value as determined by shear, development of reinforcement, and flexure. As tabulated in Chapters 7 through 11 of this *Handbook*, factored load capacity is the combination of live loads and any dead load other than the weight of the floor system itself, multiplied by their appropriate load factors, that are *superimposed* on the structural member being designed. Except in Chapter 12 (Beams), 1.2 (the dead load factor) times the weight of the floor has been deducted from the total factored load capacity to obtain the tabulated values of the net *superimposed* factored load capacity. When the required load capacity is computed, only superimposed dead loads, such as ceilings, floor finishes, partitions, and the like times the load

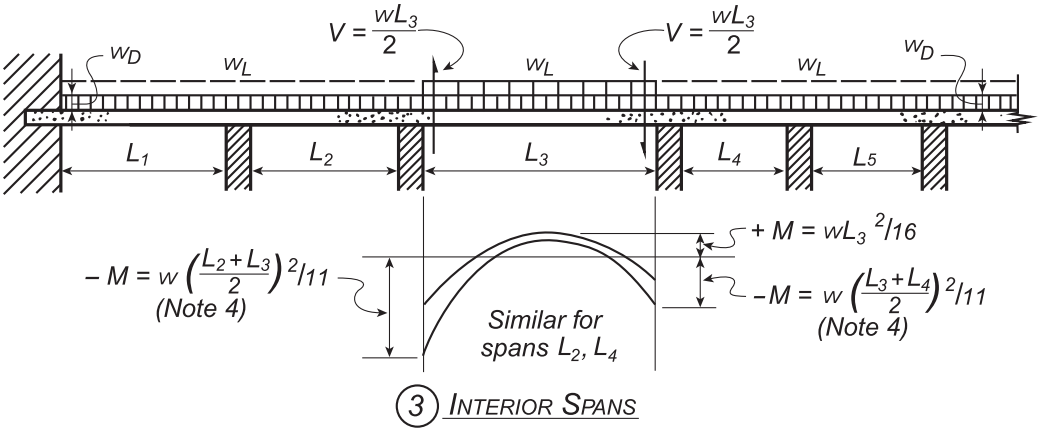


Note 1. For a single span, $+M = wL'^2/8$ and no theoretical negative moment is developed. When members are built into masonry walls or made monolithic with concrete walls, beams, or columns, restraint occurs causing some negative moment. In the tabulated designs in this *Handbook*, to prevent top cracking adjacent to the supports, separate hooked top bars are shown in the tops of members at supports. The hooks on these bars can be placed in an inclined position when the depth of the member is insufficient to accommodate them in a vertical position.



Note 2. For all end spans, a coefficient for positive moment, $+M = wL_1^2/11$, was used for the condition of no restraint at the discontinuous end. If the discontinuous end is monolithic with the support, the ACI Building Code permits use of the coefficient $+M = wL'^2/14$ and the total tabulated capacities (when positive moment governs) may increase up to 27 percent.

Note 3. When only two spans are continuous, the ACI Building Code requires an increase in negative moment to $-M = wL^2/9$ and capacities should be reduced or reinforcement may be increased to maintain tabulated capacity.



Note 4. For continuous slabs with spans ≦10'-0", the ACI Building Code permits a negative moment of $-M = wL^2/12$. The tabulated designs are based upon $-M = wL^2/11$ throughout, except in those short span slabs.

Figure 5-1 Moment and Shear Coefficients for One-Way Members

factor for dead load, need be included along with other loads times their prescribed load factors. An example problem reviews the use of the tabulated designs.

Frame Analysis. The ACI Building Code prescribes an elastic analysis for all indeterminate concrete structures. For buildings of the usual type of construction, spans, and story heights, the Code permits the use of approximate methods of analysis for the determination of elastic moments and shears within certain ranges of variation in span lengths and loads. The tabulated designs for all continuous floor systems in this *Handbook* are based on the approximate methods of analysis (ACI 8.3.3 and 13.6). The limitations on the use of one-way moment coefficients are that two or more spans be continuous, that the longer of adjacent spans not exceed the shorter by more than 20 percent, that loads are uniformly distributed, and that the (unfactored) unit live load does not exceed three times the (unfactored) unit dead load (ACI 8.3.3). For two-way slabs, according to ACI 13.6, the number of continuous spans must be three or more, the length-to-width ratio of panels cannot exceed 2.0, successive span lengths must not differ by more than one-third of the longer span, live load cannot exceed two times the dead load, and the direct design method is applicable to uniformly distributed gravity loads only.

Conservatively, no consideration for redistribution of stress due to inelastic behavior of frames loaded beyond first yielding has been made. The two-way slab factored moments in the tabulated designs in Chapters 9, 10 and 11 can be adjusted up to 10 percent (ACI 13.6.7).

Moments and shears for beams and one-way slab systems have been computed as shown in Fig. 5-1.

Flexural Computations. For flexural members, which are reinforced with tension steel only, the design moment strength, from equilibrium of internal moment and forces (Fig. 5-2), is:

$$\phi M_n = \phi A_s f_y (d - a/2) \qquad (1)$$

where:

$$a = \frac{A_s f_y}{0.85 f_c' b} \qquad (2)$$

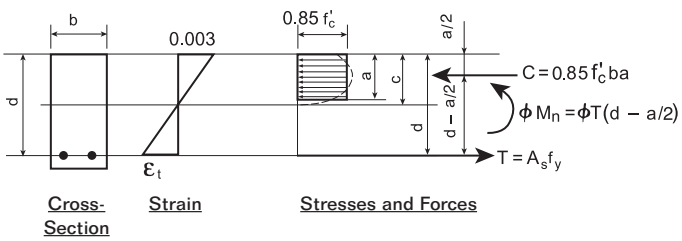


Figure 5-2 Reinforced Concrete Section with Tension Steel Only

It is conservative to use these equations if there is no compression reinforcement. Substituting Equation (2) into Equation (1), replacing φM_n with M_u, and then solving for the required A_s:

$$A_s = \frac{0.85 f_c' b d}{f_y} - \sqrt{\left(\frac{0.85 f_c' b d}{f_y}\right)^2 - \frac{1.7 f_c' M_u b}{\phi f_y^2}} \qquad (3)$$

Equation (3) can be simplified for different concrete compressive strengths. If b = 12 inches (1 ft. width), f_y = 60,000 psi, assuming φ = 0.90, and M_u is in units of in.-kips/ft:

f_c', psi	Equation (3) per ft. width
3,000 psi	$A_s = 0.510\,d - \sqrt{0.260\,d^2 - 0.0189\,M_u}$
4,000 psi	$A_s = 0.680\,d - \sqrt{0.462\,d^2 - 0.0252\,M_u}$
5,000 psi	$A_s = 0.850\,d - \sqrt{0.723\,d^2 - 0.0315\,M_u}$
6,000 psi	$A_s = 1.020\,d - \sqrt{1.040\,d^2 - 0.0378\,M_u}$

By introducing the variable R_n:

$$R_n = \frac{M_u}{\phi b d^2}$$

it is possible to develop a somewhat simpler expression for the required A_s:

$$A_s = \frac{0.85 f_c' b d}{f_y}\left[1 - \sqrt{1 - \frac{2 R_n}{0.85 f_c'}}\right] \qquad (4)$$

Likewise, Equation (4) can be simplified for different concrete compressive strengths. If b = 12 inches (1 ft. width), f_y = 60,000 psi, assuming φ = 0.90, and M_u is in units of in.-kips/ft:

f_c', psi	Equation (4) per ft. width
3,000	$A_s = (0.510\,d)\left[1 - \sqrt{1 - 0.0726\,M_u/d^2}\right]$
4,000	$A_s = (0.680\,d)\left[1 - \sqrt{1 - 0.0545\,M_u/d^2}\right]$
5,000	$A_s = (0.850\,d)\left[1 - \sqrt{1 - 0.0436\,M_u/d^2}\right]$
6,000	$A_s = (1.020\,d)\left[1 - \sqrt{1 - 0.0363\,M_u/d^2}\right]$

The strength-reduction factor, φ, is equal to 0.90 when the net tensile strain, ε_t, in the extreme tension steel is ≥ 0.005 (ACI 10.3.4). Referring to Fig. 5-2, ε_t can be expressed as:

$$\varepsilon_t = 0.003\,(d/c - 1) \geq 0.005$$

Solving for c with $\varepsilon_t \geq 0.005$:

$$c \leq 0.003\,d/0.008$$

From Equation (2) with $c = a/\beta_1$:

$$c = \frac{A_s\,f_y}{0.85\,f_c'\,\beta_1\,b}$$

where:

f_c', psi	β_1
$\leq$ 4,000	0.85
5,000	0.80
6,000	0.75
7,000	0.70
$\geq$ 8,000	0.65

Equating and solving for ρ where $\rho = A_s/bd$:

$$\rho \leq \left(\frac{0.85\,f_c'\,\beta_1}{f_y}\right)\left(\frac{3}{8}\right) \qquad (5)$$

Note that Equation (5) is an expression for the maximum value of ρ for which ε_t is not less than 0.005 and, therefore, $\varphi = 0.90$, i.e., a "tension-controlled" section.

The variable ρ in Equation (5) can be solved for different concrete strengths. If f_y = 60,000 psi:

f_c', psi	Equation (5)
3,000	$\rho \leq 0.0135$
4,000	$\rho \leq 0.0181$
5,000	$\rho \leq 0.0213$
6,000	$\rho \leq 0.0239$

In summary, for flexural members which are reinforced with tension steel only, the required A_s can be determined by two methods:

Method 1:

$$A_s = \frac{0.85\,f_c'\,b\,d}{f_y} - \sqrt{\left(\frac{0.85\,f_c'\,b\,d}{f_y}\right)^2 - \frac{1.7\,f_c'\,M_u\,b}{\phi\,f_y^{\,2}}}$$

Method 2:

$$A_s = \left(\frac{0.85\,f_c'\,b\,d}{f_y}\right)\left[1 - \sqrt{1 - \frac{2\,R_n}{0.85\,f_c'}}\right]$$

where:

$$R_n = \frac{M_u}{\phi\,b\,d^2}$$

Use Equation (5) as a check for $\varepsilon_t \geq 0.005$ (to confirm $\varphi = 0.90$).

Example: f_c' = 4,000 psi; f_y = 60,000 psi; b = 24 in.; d = 12.5 in.; M_u = 250 ft-k; φ = 0.90 (assumed)

Method 1:

$$\frac{0.85\,f_c'\,b\,d}{f_y} = \frac{0.85\,(4{,}000)\,24\,(12.5)}{60{,}000} = 17.00\ \text{in}^2.$$

$$\frac{1.7\,f_c'\,M_u\,b}{\phi\,f_y^2} = \frac{1.7\,(4{,}000)\,250\,(12{,}000)\,24}{0.9\,(60{,}000)^2} = 151.1\ \text{in}^4.$$

$$\text{Required } A_s = 17.00 - \sqrt{(17.00)^2 - 151.1} = 5.26\ \text{in}^2.$$

Method 2:

$$R_n = \frac{M_u}{\phi\,b\,d^2} = \frac{250\,(12{,}000)}{0.9\,(24)\,12.5^2} = 889\ \text{psi}$$

$$\frac{2\,R_n}{0.85\,f_c'} = \frac{2\,(889)}{0.85\,(4{,}000)} = 0.523$$

$$\frac{0.85\,f_c'\,b\,d}{f_y} = \frac{0.85\,(4{,}000)\,24\,(12.5)}{60{,}000} = 17.00\ \text{in.}^2$$

$$\text{Required } A_s = 17.00\,[1 - \sqrt{1 - 0.523}] = 5.26\ \text{in.}^2$$

From Equation (5):

$$\rho \leq \frac{0.85\,f_c'\,\beta_1}{f_y}\left(\frac{3}{8}\right) = \frac{0.85\,(4{,}000)\,0.85}{60{,}000}\left(\frac{3}{8}\right) = 0.0181$$

$$\rho_{act} = A_s/(b\,d) = 5.26/(24\ x\ 12.5) = 0.0175$$

0.0175 < 0.0181

OK ($\rho_{act} \leq \rho_{max}$, $\varepsilon_t \geq 0.005$ and $\varphi = 0.90$)

Comparison to Earlier Codes

Alternatively, the maximum ρ, based on a minimum value of ε_t of 0.005, can be compared to the previous Code limit of 0.75 ρ_b. The expression for ρ_b is:

$$\rho_b = \frac{0.85\,\beta_1\,f_c'}{f_y}\,\frac{87{,}000}{87{,}000 + f_y} \qquad (6)$$

Calculating the ratio of maximum ρ from Equation (5) divided by Equation (6):

$$\frac{\rho_{max}}{\rho_b} = \left(\frac{3}{8}\right)\left(\frac{87{,}000 + f_y}{87{,}000}\right)$$

For f_y of 60,000 psi, this ratio equals 0.634. Therefore, with the ε_t limit of 0.005, the maximum ρ in the current Code when f_y = 60,000 psi is 63 percent of ρ_b, compared to the previous limit of 75 percent of ρ_b.

Other Simplifications

From Equation (1), if M_u is substituted for φM_n and re-arranging the terms, the required area of steel is:

$$A_s = \frac{M_u}{(\phi f_y j) d} \quad (7)$$

where:

$$j = 1 - a/2d \quad (8)$$

Substituting Equation (2) into Equation (8):

$$j = 1 - \frac{f_y \rho}{0.85\,(2)\,f'_c} \quad (9)$$

If the reinforcement ratio is assumed to be the maximum value from Equation (5), then substituting into Equation (9):

$$j \geq 1 - \frac{3\beta_1}{16}$$

The variable j can be tabulated for different values of concrete compressive strength:

f'_c, psi	j
3,000	0.841
4,000	0.841
5,000	0.850
6,000	0.859

This minimum value for j can be used to approximate the required A_s. For the example:

$$j \geq 1 - \frac{3\beta_1}{16} = 1 - \frac{3\,(0.85)}{16} = 0.841$$

The required area of steel is:

$$A_s \approx \frac{M_u}{\phi f_y j d} = \frac{M_u}{0.90\,(60{,}000)\,0.841\,(d)} = \frac{M_u}{45{,}400\,d}$$

$$A_s \approx \frac{250\,(12{,}000)}{45{,}400\,(12.5)} = 5.28 \text{ in.}^2$$ which is equivalent to the required A_s of 5.26 in^2.

This approximate Equation (7) for determining the required A_s can be derived for other concrete compressive strengths:

f'_c, psi	Equation (7)
3,000	$A_s \approx \frac{M_u}{45{,}400\,d}$
4,000	$A_s \approx \frac{M_u}{45{,}400\,d}$
5,000	$A_s \approx \frac{M_u}{45{,}900\,d}$
6,000	$A_s \approx \frac{M_u}{46{,}400\,d}$

For manually determining the required A_s, Equation (7) can be simplified further by assuming φ = 0.90, $j \approx 0.90$, f_y = 60 ksi, and with M_u in units of ft-kips, the required area of steel is:

$$A_s \approx \frac{M_u}{\phi f_y j d} \approx \frac{M_u\,(12)}{0.90\,(60)\;0.9(d)} \approx \frac{M_u}{4d}$$

After calculating the approximate required A_s and selecting the reinforcement, the actual design moment strength, ϕM_n, should be calculated for the selected reinforcement and compared to M_u; and the steel reinforcement ratio, ρ, for the required selected reinforcement should be compared with 0.63 ρ_b (when f_y = 60,000 psi) to confirm that φ = 0.90 (a tension-controlled section).

For the example:

$$A_s \approx \frac{M_u}{4d} \approx \frac{250(12)}{4(12.5)} \approx 5.00 \text{ in.}^2$$

Instead of selecting the reinforcement in this example, calculate ϕM_n for A_s = 5.00 in.^{2}:

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{5.00(60)}{0.85(4)(24)} = 3.68 \text{ in.}$$

$$\phi M_n = \phi A_s f_y (d - a/2)$$
$$= 0.90(5.00)(60)(12.5 - \frac{3.68}{2})/12$$

ϕM_n = 239.9 ft-kips < M_u; need larger amount of A_s

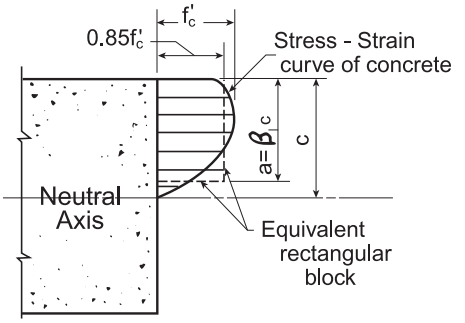
Need 4 to 5 percent additional design moment strength because of simplifying assumption of $j = 0.9$; hence try approximately 4 to 5 percent more A_s. If the required A_s is 1.05(5.00) = 5.25 in.^{2}, then:

$$a = \frac{5.25(60)}{0.85(4)(24)} = 3.86 \text{ in.}$$

$$\phi M_n = 0.90(5.25)(60)(12.5 - \frac{3.68}{2})/12$$
$$= 249.7 \text{ ft-kips} \approx M_u$$

confirm that $\varphi = 0.90$:

$$\rho = \frac{A_s}{b\,d} = \frac{5.25}{(24)(12.5)} = 0.0175 < 0.63\rho_b;\ \varphi = 0.90$$



For doubly-reinforced sections, additional tensile reinforcement balanced by force in compression reinforcement need not be reduced by the 0.75 factor (ACI 10.3.3).

Figure 5-3 Rectangular Stress Block for Strength Design

Rectangular Beam with Compression Reinforcement. When effects of the compression reinforcement are neglected in flexural computations, the same formulas and limit on tension reinforcement percentage apply. For designs tabulated in this *Handbook*, compression reinforcement has been neglected, but should be considered when it is necessary to compute creep deflection.

T-Beams. When the flange thickness h equals or exceeds the depth of the equivalent rectangular stress block a, the section may be designed as rectangular beam with an effective flange width (ACI 8.12).

When the flange thickness is less than a:

$$\phi M_n = \phi[(A_s - A_{sf})f_y(d - a/2) + A_{sf}f_y(d - 0.5h)]$$

where A_{sf} = the steel area necessary to develop the compressive strength of the overhanging flanges, i.e.:

$$A_{sf} = 0.85(b - b')hf'_c/f_y$$

and $a = (A_s - A_{sf})f_y/0.85f'_c\,b'$

DEVELOPMENT AND LAP SPLICE DESIGN DATA FOR REINFORCING BARS

COMPRESSION DEVELOPMENT LENGTHS AND COMPRESSION LAP SPLICES

TABLE 5-1 – Compression Dowel Embedment and Compression Lap Splices for Grade 60 Bars and All Concrete with $f'_c \geq 3{,}000$ psi

Bar Size	Dowel Embedment $22d_b$	Minimum Lap Length	
		Standard Lap $30d_b$	With Column* Spirals $22.5d_b$
#3	9″	12″	12″
#4	11″	15″	12″
#5	14″	19″	14″
#6	17″	23″	17″
#7	19″	27″	20″
#8	22″	30″	23″
#9	25″	34″	25″
#10	28″	38″	29″
#11	31″	43″	32″
#14	38″	–	–
#18	50″	–	–

*For use in spirally-reinforced columns with spirals conforming to ACI 7.10.4 and 10.9.3. Regarding anchorage and lap splicing of spirals, the ACI Building Code requirements are:

7.10.4.4 – Anchorage of spiral reinforcement shall be provided by 1-1/2 extra turns of spiral bar or wire at each end of a spiral unit.

7.10.4.5 – Spiral reinforcement shall be spliced, if needed, by any one of the following methods:

(a) Lap splices not less than the larger of 12 in. and the length indicated in one of (1) through (5) below:

(1) deformed uncoated bar or wire . . . . . .48 d_b

(2) plain uncoated bar or wire . . . . . .72 d_b

(3) epoxy-coated deformed bar or wire . . . . . .72 d_b

(4) plain uncoated bar or wire with a standard stirrup or tie hook in accordance with ACI 7.1.3 at ends of lapped spiral reinforcement.The hooks shall be embedded within the core confined by the spiral reinforcement . . . . . .48 d_b

(5) epoxy-coated deformed bar or wire with a standard stirrup or tie hook in accordance with ACI 7.1.3 at ends of lapped spiral reinforcement. The hooks shall be embedded within the core confined by the spiral reinforcement . . . . . .48 d_b

(b) Full mechanical or welded splices in accordance with 12.14.3.

DOWEL EMBEDMENT

Minimum compression dowel embedment required by ACI 12.3.2 for Grade 60 (f_y = 60,000 psi) reinforcing bars and all concrete with $f'_c \geq$ 3,000 psi = 22 bar diameters ($22d_b$). See Table 5-1.

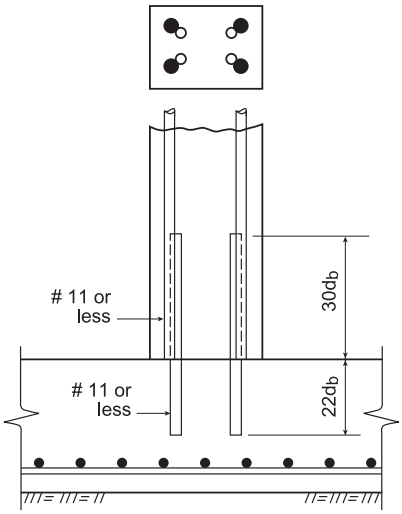


Figure 5-4 Footing Dowels to Column Vertical Bars—Lap Splices for Compression Only (#11 Bars or Smaller)

COMPRESSION LAP SPLICES

Based on the provisions in ACI 12.16.1, for Grade 60 bars, bar sizes #3 through #11, and all concrete with $f'_c \geq$ 3,000 psi, lap lengths = 30 bar diameters ($30d_b$). See Table 5-1. Lap splices are not permitted for #14 and #18 bars, except if spliced to #11 and smaller bars (ACI 12.16.2 and 15.8.2.3). Use the $30d_b$ dimension with the smaller bar.

TENSION DEVELOPMENT LENGTHS AND TENSION LAP SPLICE LENGTHS

ACI 12.2.2 and 12.2.3 present the provisions for determining tension development length ℓ_d. ACI 12.2.1 requires that ℓ_d be not less than 12 inches.

Section 12.2.2 Provisions for Tension ℓ_d

For the following conditions:

- bars with clear spacing not less than d_b, with concrete cover not less than d_b, and for bars in beams or columns with stirrups or ties throughout ℓ_d not less than the minimum required by the Code;
- bars with clear spacing not less than 2 d_b and with concrete cover not less than d_b,

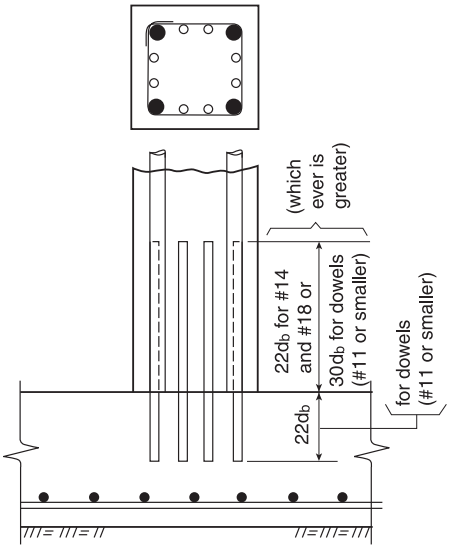


Figure 5-5 Footing Dowels (#11 Bars or Smaller) to Column Vertical Bars (#14 or #18)—Lap Splices for Compression Only

the tension development lengths are:

Bar sizes #3 through #6 $\ell_d = (0.04 f_y\ \psi_t\ \psi_e / \lambda\sqrt{f'_c})\ d_b$

Bar sizes #7 through #18 $\ell_d = (0.05 f_y\ \psi_t\ \psi_e / \lambda\sqrt{f'_c})\ d_b$

For other cases:

Bar sizes #3 through #6 $\ell_d = (0.06 f_y\ \psi_t\ \psi_e / \lambda\sqrt{f'_c})\ d_b$

Bar sizes #7 through #18 $\ell_d = (0.075 f_y\ \psi_t\ \psi_e / \lambda\sqrt{f'_c})\ d_b$

Where:

ψ_t = 1.3 for "top" bars

ψ_t = 1.0 for "other" bars

ψ_e = 1.0 for uncoated bars and zinc-coated (galvanized) bars

ψ_e = 1.5 for epoxy-coated bars with concrete cover < $3d_b$, or clear spacing < $6d_b$

ψ_e = 1.2 for other concrete cover and clear spacing conditions of epoxy-coated bars

The product of $\psi_t\ \psi_e$ need not be taken greater than 1.7.

λ = 0.75 for lightweight aggregate concrete

λ = 1.0 for normal-weight concrete

Tables 5-2(a) through 5-2(h) and Tables 5-4(a) through 5-4(b) present values of tension ℓ_d based on ACI 12.2.2. All tabulated data are for Grade 60 (f_y = 60,000 psi) reinforcing bars, uncoated and epoxy-coated, in normal-weight concrete having a compressive strength, f'_c , ranging from 3,000 to 10,000 psi. Tables 5-4(a) and (b) list ℓ_d in terms of multiples of d_b.

Tension Lap Splices

Tension lap splices (minimum of 12 inches) are specified as Class A or Class B (ACI 12.15.1). The classes are multiples of tension development lengths: Class A = $1.0\ell_d$ and Class B = $1.3\ell_d$ without the 12 inch minimum of ACI 12.2.1. Tables 5-2(a) through 5-2(h) and Tables 5-4(a) through 5-4(b) present values of Class A and Class B tension lap splice lengths based on ACI 12.2.2 and 12.15.1. All tabulated data are for Grade 60 (f_y = 60,000 psi) reinforcing bars, uncoated and epoxy-coated, in normal-weight concrete having a compressive strength, f'_c, ranging from 3,000 to 10,000 psi.

The lap Class depends on the ratio of area of reinforcing steel provided to that required and the percentage of reinforcement spliced at any one location, as shown in the following table:

$\frac{A_{s\ provided}}{A_{s\ required}}$	Maximum Percent of A_s Spliced within Required Lap Length	
	50%	100%
≥ 2	Class A	Class B
≤ 2	Class B	Class B

Section 12.2.3 Provisions for Tension ℓ_d

The provisions in Section 12.2.3 are applicable to all conditions of clear spacing, concrete cover and transverse reinforcement. Tension development length is calculated by ACI Code Eq. 12-1:

$$\ell_d = \left(\frac{3}{40} \frac{f_y}{\lambda \sqrt{f'_c}} \frac{\psi_t \psi_e \psi_s}{\left(\frac{c_b + K_{tr}}{d_b} \right)} \right) d_b$$

where:

c_b = spacing or concrete cover dimension; use the smaller of either the distance from the center of the bar to the nearest concrete surface or one-half the center-to-center spacing of the bars being developed

ψ_s = 0.8 for bar sizes #3 through #6

ψ_s = 1.0 for bar sizes #7 through #18

The quantity $(c_b + K_{tr})/d_b$ is limited to a maximum value of 2.5. The K_{tr} term accounts for the beneficial effect of transverse reinforcement.

$K_{tr} = 40A_{tr}/sn$

A_{tr} = total area of all transverse reinforcement within the spacing s, which crosses the potential plane of splitting through the bars being developed

s = maximum c.-c. spacing of transverse reinforcement within ℓ_d

n = number of bars being developed along the plane of splitting

The notation ψ_t, ψ_e and λ are defined in the preceding discussion of Section 12.2.2.

For simplification, K_{tr} can be taken as zero even if transverse reinforcement is present.

The provisions in ACI 12.2.3 normally do not lend themselves to extensive tabulation of tension development lengths and tension lap splices. Only limited cases and conditions can be tabulated. Tables 5-3(a) through 5-3(h) are examples of such limited tabulation. The tables give values of tension ℓ_d and tension lap splice lengths, based on Code Section 12.2.3, for walls and slabs. The values for "Lap Class A" are also the values of ℓ_d, because the required lap length for a Class A tension lap splice is 1.0 ℓ_d.

An important restriction on the use of Tables 5-3(a) through 5-3(h) is described in Note 3, i.e., it is assumed that the notation c_b in the quantity, $(c_b + K_{tr})/d_b$, in ACI Code Eq. 12-1 is governed by concrete cover rather than by one-half the center-to-center spacing of the bars.

Standard End Hooks

Tables 5-5(a) and 5-5(b) give the minimum tension development (embedment) lengths ℓ_{dh} for standard end hooks on Grade 60 (f_y = 60,000 psi) uncoated and epoxy-coated reinforcing bars in normal-weight concrete.

For 180º hooks at right angles to exposed concrete surfaces, CRSI recommends that a minimum 2 inches of concrete cover be provided to the tail of the hook (ACI 7.7). The minimum tension embedment lengths which will provide the recommended 2 inches of concrete cover to the tail of the hook are given in Table 5-7.

Headed Reinforcing Bars

ACI 318-08 contains new provisions for the development of headed and mechanically anchored deformed bars in tension. Tables 5-6(a) and 5-6(b) give the minimum development (embedment) lengths ℓ_{dt} for headed reinforcing bars of Grade 60 (f_y = 60,000 psi) uncoated and epoxy-coated bars in normal-weight concrete (ACI 12.6). Use of headed reinforcing bars is limited to the following conditions:

- $f_y \leq$ 60,000 psi
- Bar Size ≤ #11
- Normal-weight concrete
- Net bearing area, A_{brg}, ≥ 4 A_b where A_b is the area of the headed bar. Net bearing area is equal to the total area of the head, minus the area of the bar, A_b.
- Clear concrete cover for bars ≥ 2 d_b, and
- Clear spacing between bars ≥ 4 d_b

Code Provisions Used in Tabulated Designs

The provisions in ACI 12.2.2 and 12.2.3 are used in the computer programs for producing the tabulated designs in the *Handbook*. Whenever the required tension development length is checked versus the available embedment length and other criteria of Code Chapter 12, the programs select the shorter ℓ_d calculated from ACI 12.2.2 or 12.2.3.

Table 5-2(a) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
f'_c = 3,000 psi

BAR SIZE	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP BARS		OTHER BARS		TOP BARS		OTHER BARS	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3	A	22	32	17	25	28	42	25	37
	B	28	42	22	32	37	55	32	48
#4	A	29	43	22	33	38	56	33	50
	B	37	56	29	43	49	73	43	64
#5	A	36	54	28	41	47	70	41	62
	B	47	70	36	54	61	91	54	80
#6	A	43	64	33	50	56	84	50	74
	B	56	84	43	64	73	109	64	96
#7	A	63	94	48	72	82	123	72	108
	B	81	122	63	94	106	159	94	140
#8	A	72	107	55	82	93	140	82	124
	B	93	139	72	107	121	182	107	161
#9	A	81	121	62	93	105	158	93	139
	B	105	157	81	121	137	205	121	181
#10	A	91	136	70	105	119	178	105	157
	B	118	177	91	136	154	231	136	204
#11	A	101	151	78	116	132	197	116	174
	B	131	196	101	151	171	256	151	226
#14	N/A	121	181	93	139	158	237	139	209
#18	N/A	161	241	124	186	210	316	186	278

Notes:

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths and tension lap splice lengths are calculated per ACI 318-08, Sections 12.2.2 and 12.15, respectively.
3. Tabulated values for beams or columns are based on transverse reinforcement and concrete cover meeting minimum Code requirements.
4. Cases 1 and 2, which depend on the type of structural member, concrete cover, and center-to-center spacing of the bars, are defined as:

Beams, Columns	Case 1	Concrete cover at least 1.0 d_b **and** c.-c. spacing at least 2.0 d_b
	Case 2	Concrete cover less than 1.0 d_b **or** c.-c. spacing less than 2.0 d_b
All Others	Case 1	Concrete cover at least 1.0 d_b **and** c.-c. spacing at least 3.0 d_b
	Case 2	Concrete cover less than 1.0 d_b **or** c.-c. spacing less than 3.0 d_b

5. Lap splice lengths (minimum of 12 inches) are multiples of tension development lengths; Class A = 1.0 ℓ_d and Class B = 1.3 ℓ_d (ACI 12.15.1). When determining the lap splice length, ℓ_d is calculated without the 12-inch minimum of ACI 12.2.1.
6. ACI 318 does not allow tension lap splices of #14 or #18 [#43 or #57] bars. The tabulated values for those bar sizes are the tension development lengths.
7. Top bars are horizontal bars with more than 12 inches of concrete cast below the bars.
8. For epoxy-coated bars, if the c.-c. spacing is at least 7.0 d_b and the concrete cover is at least 3.0 d_b, then Case 1 lengths may be multiplied by 0.918 (for top bars) or 0.8 (for other bars).
9. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
10. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

Table 5-2(b) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
f'_c = 4,000 psi

BAR SIZE	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP BARS		OTHER BARS		TOP BARS		OTHER BARS	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3	A	19	28	15	22	24	37	22	32
	B	24	36	19	28	32	47	28	42
#4	A	25	37	19	29	33	49	29	43
	B	32	48	25	37	42	63	37	56
#5	A	31	47	24	36	41	61	36	54
	B	40	60	31	47	53	79	47	70
#6	A	37	56	29	43	49	73	43	64
	B	48	72	37	56	63	95	56	84
#7	A	54	81	42	63	71	106	63	94
	B	70	106	54	81	92	138	81	122
#8	A	62	93	48	71	81	121	71	107
	B	80	121	62	93	105	158	93	139
#9	A	70	105	54	81	91	137	81	121
	B	91	136	70	105	119	178	105	157
#10	A	79	118	61	91	103	154	91	136
	B	102	153	79	118	133	200	118	177
#11	A	87	131	67	101	114	171	101	151
	B	113	170	87	131	148	222	131	196
#14	N/A	105	157	81	121	137	205	121	181
#18	N/A	139	209	107	161	182	273	161	241

Reference Table 5-2(a) Notes.

Table 5-2(c) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
f'_c = 5,000 psi

BAR SIZE	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP BARS		OTHER BARS		TOP BARS		OTHER BARS	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3	A	17	25	13	19	22	33	19	29
	B	22	33	17	25	28	42	25	38
#4	A	22	33	17	26	29	44	26	38
	B	29	43	22	33	38	57	33	50
#5	A	28	42	22	32	36	54	32	48
	B	36	54	28	42	47	71	42	62
#6	A	33	50	26	38	44	65	38	58
	B	43	65	33	50	57	85	50	75
#7	A	49	73	37	56	63	95	56	84
	B	63	94	49	73	82	123	73	109
#8	A	55	83	43	64	72	108	64	96
	B	72	108	55	83	94	141	83	124
#9	A	63	94	48	72	82	122	72	108
	B	81	122	63	94	106	159	94	140
#10	A	70	105	54	81	92	138	81	122
	B	91	137	70	105	119	179	105	158
#11	A	78	117	60	90	102	153	90	135
	B	101	152	78	117	133	199	117	175
#14	N/A	94	140	72	108	122	183	108	162
#18	N/A	125	187	96	144	163	244	144	216

Reference Table 5-2(a) Notes.

Table 5-2(d) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
f'_c = 6,000 psi

BAR SIZE	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP BARS		OTHER BARS		TOP BARS		OTHER BARS	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3	A	15	23	12	18	20	30	18	26
	B	20	30	15	23	26	39	23	34
#4	A	20	31	16	24	27	40	24	35
	B	26	40	20	31	35	52	31	46
#5	A	25	38	20	29	33	50	29	44
	B	33	49	25	38	43	64	38	57
#6	A	31	46	24	35	40	60	35	53
	B	40	59	31	46	52	77	46	68
#7	A	44	66	34	51	58	87	51	77
	B	58	86	44	66	75	113	66	99
#8	A	51	76	39	58	66	99	58	87
	B	66	98	51	76	86	129	76	114
#9	A	57	85	44	66	75	112	66	99
	B	74	111	57	85	97	145	85	128
#10	A	64	96	49	74	84	126	74	111
	B	83	125	64	96	109	163	96	144
#11	A	71	107	55	82	93	140	82	123
	B	93	139	71	107	121	181	107	160
#14	N/A	86	128	66	99	112	168	99	148
#18	N/A	114	171	88	131	149	223	131	197

Reference Table 5-2(a) Notes.

Table 5-2(e) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
f'_c = 7,000 psi

BAR SIZE	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP BARS		OTHER BARS		TOP BARS		OTHER BARS	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3	A	14	21	12	16	19	28	16	25
	B	18	28	14	21	24	36	21	32
#4	A	19	28	15	22	25	37	22	33
	B	25	37	19	28	32	48	28	42
#5	A	24	35	18	27	31	46	27	41
	B	31	46	24	35	40	60	35	53
#6	A	28	42	22	33	37	55	33	49
	B	37	55	28	42	48	72	42	63
#7	A	41	61	32	47	54	80	47	71
	B	53	80	41	61	70	104	61	92
#8	A	47	70	36	54	61	92	54	81
	B	61	91	47	70	80	119	70	105
#9	A	53	79	41	61	69	103	61	91
	B	69	103	53	79	90	134	79	119
#10	A	59	89	46	69	78	116	69	103
	B	77	116	59	89	101	151	89	133
#11	A	66	99	51	76	86	129	76	114
	B	86	128	66	99	112	168	99	148
#14	N/A	79	119	61	91	103	155	91	137
#18	N/A	106	158	81	122	138	207	122	182

Reference Table 5-2(a) Notes.

Table 5-2(f) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
f'_c = 8,000 psi

BAR SIZE	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP BARS		OTHER BARS		TOP BARS		OTHER BARS	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3	A	13	20	12	15	17	26	15	23
	B	17	26	13	20	23	34	20	30
#4	A	18	26	14	20	23	35	20	30
	B	23	34	18	26	30	45	26	40
#5	A	22	33	17	25	29	43	25	38
	B	29	43	22	33	37	56	33	49
#6	A	26	40	20	30	35	52	30	46
	B	34	51	26	40	45	67	40	59
#7	A	38	58	30	44	50	75	44	66
	B	50	75	38	58	65	98	58	86
#8	A	44	66	34	51	57	86	51	76
	B	57	85	44	66	74	111	66	98
#9	A	49	74	38	57	65	97	57	85
	B	64	96	49	74	84	126	74	111
#10	A	56	83	43	64	73	109	64	96
	B	72	108	56	83	94	142	83	125
#11	A	62	93	48	71	81	121	71	107
	B	80	120	62	93	105	157	93	139
#14	N/A	74	111	57	85	97	145	85	128
#18	N/A	99	148	76	114	129	193	114	171

Reference Table 5-2(a) Notes.

Table 5-2(g) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
f'_c = 9,000 psi

BAR SIZE	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP BARS		OTHER BARS		TOP BARS		OTHER BARS	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3	A	13	19	12	15	16	24	15	22
	B	16	24	13	19	21	32	19	28
#4	A	17	25	13	19	22	33	19	29
	B	22	32	17	25	28	42	25	37
#5	A	21	31	16	24	27	41	24	36
	B	27	40	21	31	35	53	31	47
#6	A	25	37	19	29	33	49	29	43
	B	32	48	25	37	42	63	37	56
#7	A	36	54	28	42	47	71	42	63
	B	47	70	36	54	61	92	54	81
#8	A	41	62	32	48	54	81	48	71
	B	54	80	41	62	70	105	62	93
#9	A	47	70	36	54	61	91	54	81
	B	61	91	47	70	79	119	70	105
#10	A	53	79	40	61	69	103	61	91
	B	68	102	53	79	89	133	79	118
#11	A	58	87	45	67	76	114	67	101
	B	76	113	58	87	99	148	87	131
#14	N/A	70	105	54	81	91	137	81	121
#18	N/A	93	139	72	107	122	182	107	161

Reference Table 5-2(a) Notes.

Table 5-2(h) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
$f'_c \geq$ 10,000 psi

BAR SIZE	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP BARS		OTHER BARS		TOP BARS		OTHER BARS	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3	A	12	18	12	14	16	23	14	21
	B	16	23	12	18	20	30	18	27
#4	A	16	24	12	18	21	31	18	27
	B	21	31	16	24	27	40	24	35
#5	A	20	30	15	23	26	39	23	34
	B	26	38	20	30	33	50	30	44
#6	A	24	35	18	27	31	46	27	41
	B	31	46	24	35	40	60	35	53
#7	A	34	51	27	40	45	67	40	59
	B	45	67	34	51	58	87	51	77
#8	A	39	59	30	45	51	77	45	68
	B	51	76	39	59	67	100	59	88
#9	A	44	66	34	51	58	87	51	76
	B	57	86	44	66	75	112	66	99
#10	A	50	75	38	57	65	97	57	86
	B	65	97	50	75	85	127	75	112
#11	A	55	83	43	64	72	108	64	95
	B	72	108	55	83	94	141	83	124
#14	N/A	66	99	51	76	87	130	76	115
#18	N/A	88	132	68	102	115	173	102	153

Notes:

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths and tension lap splice lengths are calculated per ACI 318-08, Sections 12.2.2 and 12.15, respectively.
3. Tabulated values for beams or columns are based on transverse reinforcement and concrete cover meeting minimum Code requirements.
4. Cases 1 and 2, which depend on the type of structural member, concrete cover, and center-to-center spacing of the bars, are defined as:

Beams, Columns	Case 1	Concrete cover at least 1.0 d_b **and** c.-c. spacing at least 2.0 d_b
	Case 2	Concrete cover less than 1.0 d_b **or** c.-c. spacing less than 2.0 d_b
All Others	Case 1	Concrete cover at least 1.0 d_b **and** c.-c. spacing at least 3.0 d_b
	Case 2	Concrete cover less than 1.0 d_b **or** c.-c. spacing less than 3.0 d_b

5. Lap splice lengths (minimum of 12 inches) are multiples of tension development lengths; Class A = 1.0 ℓ_d and Class B = 1.3 ℓ_d (ACI 12.15.1). When determining the lap splice length, ℓ_d is calculated without the 12-inch minimum of ACI 12.2.1.
6. ACI 318 does not allow tension lap splices of #14 or #18 [#43 or #57] bars. The tabulated values for those bar sizes are the tension development lengths.
7. Top bars are horizontal bars with more than 12 inches of concrete cast below the bars.
8. For epoxy-coated bars, if the c.-c. spacing is at least 7.0 d_b and the concrete cover is at least 3.0 d_b, then Case 1 lengths may be multiplied by 0.918 (for top bars) or 0.8 (for other bars).
9. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
10. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

Table 5-3(a) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
f'_c = 3,000 psi

BAR SIZE	LAP CLASS	CONCRETE COVER = 0.75 in.				CONCRETE COVER = 1.00 in.				CONCRETE COVER = 1.5 in.				CONCRETE COVER = 2.00 in.			
		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED	
		Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other
#3	A	13	12	17	15	13	12	17	15	13	12	17	15	13	12	17	15
	B	17	13	22	20	17	13	22	20	17	13	22	20	17	13	22	20
#4	A	22	17	28	25	17	13	23	20	17	13	23	20	17	13	23	20
	B	28	22	37	32	23	17	29	26	23	17	29	26	23	17	29	26
#5	A	32	24	41	37	26	20	34	30	22	17	28	25	22	17	28	25
	B	41	32	54	47	33	26	44	38	28	22	37	32	28	22	37	32
#6	A	43	33	56	50	35	27	46	41	26	20	34	30	26	20	34	30
	B	56	43	73	64	46	35	60	53	34	26	44	39	34	26	44	39
#7	A	69	53	90	80	57	44	75	66	43	33	55	49	38	29	49	43
	B	90	69	117	104	74	57	97	86	55	43	72	64	49	38	64	56
#8	A	86	66	112	99	72	55	93	82	54	41	70	62	43	33	56	50
	B	111	86	146	128	93	72	121	107	70	54	91	80	56	43	73	64
#9	A	104	80	136	120	87	67	114	101	66	51	86	76	53	41	70	61
	B	135	104	176	155	113	87	148	131	86	66	112	99	69	53	90	80
#10	A	125	96	163	144	106	81	138	122	81	62	106	93	66	51	86	76
	B	162	125	212	187	137	106	179	158	105	81	137	121	85	66	111	98
#11	A	146	113	191	169	125	96	163	144	97	74	126	111	79	61	103	91
	B	190	146	248	219	162	125	212	187	125	97	164	145	102	79	134	118

Notes:

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths and tension lap splice lengths are calculated per ACI 318-08, Sections 12.2.3 and 12.15, respectively, with bar sizes limited to #3 through #11.
3. When the variable "c_b" from ACI 12.2.3 was calculated, it was assumed that concrete cover controlled. That is, c.-c. spacing was assumed to be greater than 1.0 d_b plus twice the concrete cover.
4. Lap splice lengths (minimum of 12 inches) are multiples of tension development lengths; Class A = 1.0 ℓ_d and Class B = 1.3 ℓ_d (ACI 318 12.15.1). When determining the lap splice length, ℓ_d is calculated without the 12-inch minimum of ACI 12.2.1.
5. Top bars are horizontal bars with more than 12 inches of concrete cast below the bars.
6. For epoxy-coated bars, if the c.-c. spacing is at least 7.0 d_b and the concrete cover is at least 3.0 d_b, then lengths may be multiplied by 0.918 (for top bars) or 0.8 (for other bars).
7. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
8. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

Table 5-3(b) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
f'_c = 4,000 psi

BAR SIZE	LAP CLASS	CONCRETE COVER = 0.75 in.				CONCRETE COVER = 1.00 in.				CONCRETE COVER = 1.5 in.				CONCRETE COVER = 2.00 in.			
		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED	
		Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other
#3	A	12	12	15	13	12	12	15	13	12	12	15	13	12	12	15	13
	B	15	12	19	17	15	12	19	17	15	12	19	17	15	12	19	17
#4	A	19	15	24	22	15	12	20	17	15	12	20	17	15	12	20	17
	B	24	19	32	28	20	15	25	22	20	15	25	22	20	15	25	22
#5	A	28	21	36	32	22	17	29	26	19	15	24	22	19	15	24	22
	B	36	28	47	41	29	22	38	33	24	19	32	28	24	19	32	28
#6	A	37	29	49	43	31	24	40	35	22	17	29	26	22	17	29	26
	B	48	37	63	56	40	31	52	46	29	22	38	34	29	22	38	34
#7	A	60	46	78	69	50	38	65	57	37	28	48	42	33	25	43	38
	B	78	60	102	90	64	50	84	74	48	37	62	55	42	33	55	49
#8	A	74	57	97	86	62	48	81	71	47	36	61	54	37	29	49	43
	B	96	74	126	111	80	62	105	93	60	47	79	70	48	37	63	56
#9	A	90	69	117	104	76	58	99	87	57	44	75	66	46	36	60	53
	B	117	90	153	135	98	76	128	113	74	57	97	86	60	46	78	69
#10	A	108	83	141	125	92	70	120	106	70	54	92	81	57	44	74	66
	B	140	108	183	162	119	92	155	137	91	70	119	105	74	57	97	85
#11	A	127	98	166	146	108	83	141	125	84	64	109	97	68	53	89	79
	B	165	127	215	190	141	108	184	162	109	84	142	125	89	68	116	102

Reference Table 5-3(a) Notes.

Table 5-3(c) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
f'_c = 5,000 psi

BAR SIZE	LAP CLASS	CONCRETE COVER = 0.75 in.				CONCRETE COVER = 1.00 in.				CONCRETE COVER = 1.5 in.				CONCRETE COVER = 2.00 in.			
		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED	
		Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other
#3	A	12	12	13	12	12	12	13	12	12	12	13	12	12	12	13	12
	B	13	12	17	15	13	12	17	15	13	12	17	15	13	12	17	15
#4	A	17	13	22	19	14	12	18	16	14	12	18	16	14	12	18	16
	B	22	17	28	25	18	14	23	20	18	14	23	20	18	14	23	20
#5	A	25	19	32	28	20	15	26	23	17	13	22	19	17	13	22	19
	B	32	25	42	37	26	20	34	30	22	17	28	25	22	17	28	25
#6	A	33	26	44	38	27	21	36	32	20	16	26	23	20	16	26	23
	B	43	33	57	50	35	27	46	41	26	20	34	30	26	20	34	30
#7	A	54	41	70	62	44	34	58	51	33	25	43	38	29	23	38	34
	B	70	54	91	80	58	44	75	66	43	33	56	49	38	29	50	44
#8	A	66	51	87	77	55	43	72	64	42	32	54	48	33	26	44	38
	B	86	66	113	100	72	55	94	83	54	42	71	62	43	33	57	50
#9	A	80	62	105	93	68	52	88	78	51	40	67	59	41	32	54	48
	B	104	80	136	120	88	68	115	101	67	51	87	77	54	41	70	62
#10	A	97	74	126	111	82	63	107	94	63	48	82	72	51	39	67	59
	B	126	97	164	145	106	82	139	123	82	63	107	94	66	51	86	76
#11	A	113	87	148	131	97	75	126	112	75	58	98	86	61	47	80	70
	B	147	113	192	170	126	97	164	145	97	75	127	112	79	61	104	92

Reference Table 5-3(a) Notes.

Table 5-3(d) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
f'_c = 6,000 psi

BAR SIZE	LAP CLASS	CONCRETE COVER = 0.75 in.				CONCRETE COVER = 1.00 in.				CONCRETE COVER = 1.5 in.				CONCRETE COVER = 2.00 in.			
		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED	
		Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other
#3	A	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	B	12	12	16	14	12	12	16	14	12	12	16	14	12	12	16	14
#4	A	15	12	20	18	12	12	16	14	12	12	16	14	12	12	16	14
	B	20	15	26	23	16	12	21	18	16	12	21	18	16	12	21	18
#5	A	23	17	29	26	18	14	24	21	15	12	20	18	15	12	20	18
	B	29	23	38	34	24	18	31	27	20	15	26	23	20	15	26	23
#6	A	31	24	40	35	25	19	33	29	18	14	24	21	18	14	24	21
	B	40	31	52	46	32	25	42	37	24	18	31	27	24	18	31	27
#7	A	49	38	64	56	41	31	53	47	30	23	39	35	27	21	35	31
	B	64	49	83	73	53	41	69	61	39	30	51	45	35	27	45	40
#8	A	61	47	79	70	51	39	66	58	38	29	50	44	31	24	40	35
	B	79	61	103	91	66	51	86	76	49	38	64	57	40	31	52	46
#9	A	73	57	96	85	62	48	81	71	47	36	61	54	38	29	49	44
	B	95	73	125	110	80	62	105	92	61	47	79	70	49	38	64	57
#10	A	88	68	115	102	75	58	98	86	57	44	75	66	47	36	61	54
	B	115	88	150	132	97	75	127	112	74	57	97	86	60	47	79	70
#11	A	103	80	135	119	88	68	115	102	68	53	89	79	56	43	73	64
	B	134	103	176	155	115	88	150	132	89	68	116	102	72	56	95	84

Reference Table 5-3(a) Notes.

Table 5-3(e) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
f'_c = 7,000 psi

BAR SIZE	LAP CLASS	CONCRETE COVER = 0.75 in.				CONCRETE COVER = 1.00 in.				CONCRETE COVER = 1.5 in.				CONCRETE COVER = 2.00 in.			
		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED	
		Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other
#3	A	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	B	12	12	15	13	12	12	15	13	12	12	15	13	12	12	15	13
#4	A	14	12	19	16	12	12	15	13	12	12	15	13	12	12	15	13
	B	18	14	24	21	15	12	19	17	15	12	19	17	15	12	19	17
#5	A	21	16	27	24	17	13	22	20	14	12	19	16	14	12	19	16
	B	27	21	35	31	22	17	29	25	18	14	24	21	18	14	24	21
#6	A	28	22	37	33	23	18	30	27	17	13	22	20	17	13	22	20
	B	37	28	48	42	30	23	39	35	22	17	29	25	22	17	29	25
#7	A	45	35	59	52	38	29	49	43	28	22	36	32	25	19	32	29
	B	59	45	77	68	49	38	64	56	36	28	47	42	32	25	42	37
#8	A	56	43	73	65	47	36	61	54	35	27	46	41	28	22	37	33
	B	73	56	95	84	61	47	80	70	46	35	60	53	37	28	48	42
#9	A	68	52	89	78	57	44	75	66	43	33	57	50	35	27	46	40
	B	88	68	115	102	74	57	97	86	56	43	74	65	45	35	59	52
#10	A	82	63	107	94	69	53	90	80	53	41	69	61	43	33	56	50
	B	106	82	139	122	90	69	118	104	69	53	90	80	56	43	73	64
#11	A	96	74	125	111	82	63	107	94	63	49	83	73	52	40	68	60
	B	125	96	163	144	106	82	139	123	82	63	107	95	67	52	88	77

Reference Table 5-3(a) Notes.

Table 5-3(f) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
f'_c = 8,000 psi

BAR SIZE	LAP CLASS	CONCRETE COVER = 0.75 in.				CONCRETE COVER = 1.00 in.				CONCRETE COVER = 1.5 in.				CONCRETE COVER = 2.00 in.			
		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED	
		Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other
#3	A	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	B	12	12	14	12	12	12	14	12	12	12	14	12	12	12	14	12
#4	A	13	12	17	15	12	12	14	12	12	12	14	12	12	12	14	12
	B	17	13	23	20	14	12	18	16	14	12	18	16	14	12	18	16
#5	A	20	15	25	22	16	12	21	18	13	12	17	15	13	12	17	15
	B	25	20	33	29	21	16	27	24	17	13	23	20	17	13	23	20
#6	A	26	20	35	30	22	17	28	25	16	12	21	18	16	12	21	18
	B	34	26	45	40	28	22	37	32	21	16	27	24	21	16	27	24
#7	A	42	33	55	49	35	27	46	40	26	20	34	30	23	18	30	27
	B	55	42	72	64	46	35	60	53	34	26	44	39	30	23	39	35
#8	A	53	41	69	61	44	34	57	51	33	25	43	38	26	20	35	30
	B	68	53	89	79	57	44	74	66	43	33	56	49	34	26	45	40
#9	A	64	49	83	73	54	41	70	62	41	31	53	47	33	25	43	38
	B	83	64	108	95	69	54	91	80	53	41	69	61	42	33	55	49
#10	A	76	59	100	88	65	50	85	75	50	38	65	57	40	31	53	46
	B	99	76	130	115	84	65	110	97	65	50	84	74	52	40	68	60
#11	A	90	69	117	103	77	59	100	88	59	46	77	68	48	37	63	56
	B	116	90	152	134	99	77	130	115	77	59	101	89	63	48	82	72

Reference Table 5-3(a) Notes.

Table 5-3(g) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
f'_c = 9,000 psi

BAR SIZE	LAP CLASS	CONCRETE COVER = 0.75 in.				CONCRETE COVER = 1.00 in.				CONCRETE COVER = 1.5 in.				CONCRETE COVER = 2.00 in.			
		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED	
		Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other
#3	A	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	B	12	12	13	12	12	12	13	12	12	12	13	12	12	12	13	12
#4	A	13	12	16	15	12	12	13	12	12	12	13	12	12	12	13	12
	B	16	13	21	19	13	12	17	15	13	12	17	15	13	12	17	15
#5	A	18	14	24	21	15	12	19	17	13	12	16	15	13	12	16	15
	B	24	18	31	28	19	15	25	22	16	13	21	19	16	13	21	19
#6	A	25	19	33	29	20	16	27	24	15	12	20	17	15	12	20	17
	B	32	25	42	37	27	20	35	31	20	15	25	22	20	15	25	22
#7	A	40	31	52	46	33	26	43	38	25	19	32	28	22	17	29	25
	B	52	40	68	60	43	33	56	50	32	25	42	37	28	22	37	33
#8	A	50	38	65	57	41	32	54	48	31	24	41	36	25	19	33	29
	B	64	50	84	74	54	41	70	62	40	31	53	47	32	25	42	37
#9	A	60	46	78	69	50	39	66	58	38	30	50	44	31	24	40	36
	B	78	60	102	90	66	50	86	76	50	38	65	57	40	31	52	46
#10	A	72	56	94	83	61	47	80	70	47	36	61	54	38	29	50	44
	B	94	72	122	108	79	61	104	92	61	47	79	70	49	38	64	57
#11	A	85	65	110	98	72	56	94	83	56	43	73	64	46	35	60	53
	B	110	85	144	127	94	72	123	108	73	56	95	84	59	46	77	68

Reference Table 5-3(a) Notes.

Table 5-3(h) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
$f'_c \geq$ 10,000 psi

BAR SIZE	LAP CLASS	CONCRETE COVER = 0.75 in.				CONCRETE COVER = 1.00 in.				CONCRETE COVER = 1.5 in.				CONCRETE COVER = 2.00 in.			
		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED		UNCOATED		EPOXY-COATED	
		Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other	Top	Other
#3	A	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	B	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
#4	A	12	12	16	14	12	12	13	12	12	12	13	12	12	12	13	12
	B	16	12	20	18	12	12	16	14	12	12	16	14	12	12	16	14
#5	A	18	14	23	20	14	12	19	16	12	12	16	14	12	12	16	14
	B	23	18	30	26	18	14	24	21	16	12	20	18	16	12	20	18
#6	A	24	18	31	27	19	15	25	22	14	12	19	17	14	12	19	17
	B	31	24	40	35	25	19	33	29	19	14	24	21	19	14	24	21
#7	A	38	29	50	44	31	24	41	36	23	18	31	27	21	16	27	24
	B	49	38	64	57	41	31	53	47	30	23	40	35	27	21	35	31
#8	A	47	36	61	54	39	30	51	45	30	23	39	34	24	18	31	27
	B	61	47	80	71	51	39	67	59	38	30	50	44	31	24	40	35
#9	A	57	44	74	66	48	37	63	55	36	28	47	42	29	23	38	34
	B	74	57	97	85	62	48	81	72	47	36	62	54	38	29	50	44
#10	A	68	53	89	79	58	45	76	67	44	34	58	51	36	28	47	42
	B	89	68	116	102	75	58	98	87	58	44	75	67	47	36	61	54
#11	A	80	62	105	93	69	53	90	79	53	41	69	61	43	33	57	50
	B	104	80	136	120	89	69	116	103	69	53	90	79	56	43	73	65

Notes:

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths and tension lap splice lengths are calculated per ACI 318-08, Sections 12.2.3 and 12.15, respectively, with bar sizes limited to #3 through #11.
3. When the variable "c_b" from ACI 12.2.3 was calculated, it was assumed that concrete cover controlled. That is, c.-c. spacing was assumed to be greater than 1.0 d_b plus twice the concrete cover.
4. Lap splice lengths (minimum of 12 inches) are multiples of tension development lengths; Class A = 1.0 ℓ_d and Class B = 1.3 ℓ_d (ACI 318 12.15.1). When determining the lap splice length, ℓ_d is calculated without the 12-inch minimum of ACI 12.2.1.
5. Top bars are horizontal bars with more than 12 inches of concrete cast below the bars.
6. For epoxy-coated bars, if the c.-c. spacing is at least 7.0 d_b and the concrete cover is at least 3.0 d_b, then lengths may be multiplied by 0.918 (for top bars) or 0.8 (for other bars).
7. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
8. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

Table 5-4(a) – Tension Development and Lap Splice Lengths for Bars, Multiples of Bar Diameter

f'_c = 3,000 psi

BAR SIZES	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP		OTHER		TOP		OTHER	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 to #6	A	$57d_b$	$86d_b$	$44d_b$	$66d_b$	$75d_b$	$112d_b$	$66d_b$	$99d_b$
	B	$74d_b$	$111d_b$	$57d_b$	$86d_b$	$97d_b$	$146d_b$	$86d_b$	$128d_b$
#7 to #18	A	$72d_b$	$107d_b$	$55d_b$	$82d_b$	$93d_b$	$140d_b$	$82d_b$	$124d_b$
	B	$93d_b$	$139d_b$	$72d_b$	$107d_b$	$121d_b$	$182d_b$	$107d_b$	$161d_b$

f'_c = 4,000 psi

BAR SIZES	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP		OTHER		TOP		OTHER	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 to #6	A	$50d_b$	$74d_b$	$38d_b$	$57d_b$	$65d_b$	$97d_b$	$57d_b$	$86d_b$
	B	$64d_b$	$96d_b$	$50d_b$	$74d_b$	$84d_b$	$126d_b$	$74d_b$	$111d_b$
#7 to #18	A	$62d_b$	$93d_b$	$48d_b$	$71d_b$	$81d_b$	$121d_b$	$71d_b$	$107d_b$
	B	$80d_b$	$121d_b$	$62d_b$	$93d_b$	$105d_b$	$158d_b$	$93d_b$	$139d_b$

f'_c = 5,000 psi

BAR SIZES	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP		OTHER		TOP		OTHER	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 to #6	A	$44d_b$	$66d_b$	$34d_b$	$51d_b$	$58d_b$	$87d_b$	$51d_b$	$77d_b$
	B	$58d_b$	$86d_b$	$44d_b$	$66d_b$	$75d_b$	$113d_b$	$66d_b$	$100d_b$
#7 to #18	A	$55d_b$	$83d_b$	$43d_b$	$64d_b$	$72d_b$	$108d_b$	$64d_b$	$96d_b$
	B	$72d_b$	$108d_b$	$55d_b$	$83d_b$	$94d_b$	$141d_b$	$83d_b$	$124d_b$

Notes:

1. ACI 318-08 facilitates expressing tension development lengths and tension lap splice lengths as multiples of bar diameters. These tables present these values, for various concrete strengths, for both uncoated and epoxy-coated bars.
2. Tabulated values are based on a minimum yield strength of 60,000 psi.
3. Tension development lengths and tension lap splice lengths are calculated per ACI 318, Sections 12.2.2 and 12.15, respectively.
4. Tabulated values for beams or columns are based on transverse reinforcement and concrete cover meeting minimum Code requirements.
5. Cases 1 and 2, which depend on the type of structural member, concrete cover, and center-to-center spacing of the bars, are defined as:

Beams, Columns	Case 1	Concrete cover at least 1.0 *db* **and** c.-c. spacing at least 2.0 d_b
	Case 2	Concrete cover less than 1.0 d_b **or** c.-c. spacing less than 2.0 d_b
All Others	Case 1	Concrete cover at least 1.0 d_b **and** c.-c. spacing at least 3.0 d_b
	Case 2	Concrete cover less than 1.0 d_b **or** c.-c. spacing less than 3.0 d_b

6. Lap splice lengths (minimum of 12 inches) are multiples of tension development lengths; Class A = 1.0 ℓ_d and Class B = 1.3 ℓ_d (ACI 12.15.1). When determining lap splice length, ℓ_d is calculated without the 12-inch minimum of ACI 12.2.1.
7. ACI 318 does not allow tension lap splices of #14 or #18 bars. The tabulated values for those bar sizes are the tension development lengths.
8. Top bars are horizontal bars with more than 12 inches of concrete cast below the bars.
9. For epoxy-coated bars, if the c.-c. spacing is at least 7.0 d_b and the concrete cover is at least 3.0 d_b, then Case 1 lengths may be multiplied by 0.918 (for top bars) or 0.8 (for other bars).
10. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
11. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

Table 5-4(b) – Tension Development and Lap Splice Lengths for Bars, Multiples of Bar Diameter

f'_c = 6,000 psi

BAR SIZES	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP		OTHER		TOP		OTHER	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 to #6 [#10 to #19]	A	$41d_b$	$61d_b$	$31d_b$	$47d_b$	$53d_b$	$79d_b$	$47d_b$	$70d_b$
	B	$53d_b$	$79d_b$	$41d_b$	$61d_b$	$69d_b$	$103d_b$	$61d_b$	$91d_b$
#7 to #18 [#22 to #57]	A	$51d_b$	$76d_b$	$39d_b$	$58d_b$	$66d_b$	$99d_b$	$58d_b$	$87d_b$
	B	$66d_b$	$98d_b$	$51d_b$	$76d_b$	$86d_b$	$129d_b$	$76d_b$	$114d_b$

f'_c = 7,000 psi

BAR SIZES	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP		OTHER		TOP		OTHER	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 to #6 [#10 to #19]	A	$38d_b$	$56d_b$	$29d_b$	$43d_b$	$49d_b$	$73d_b$	$43d_b$	$65d_b$
	B	$49d_b$	$73d_b$	$38d_b$	$56d_b$	$64d_b$	$95d_b$	$56d_b$	$84d_b$
#7 to #18 [#22 to #57]	A	$47d_b$	$70d_b$	$36d_b$	$54d_b$	$61d_b$	$92d_b$	$54d_b$	$81d_b$
	B	$61d_b$	$91d_b$	$47d_b$	$70d_b$	$80d_b$	$119d_b$	$70d_b$	$105d_b$

f'_c = 8,000 psi

BAR SIZES	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP		OTHER		TOP		OTHER	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 to #6 [#10 to #19]	A	$35d_b$	$53d_b$	$27d_b$	$41d_b$	$46d_b$	$69d_b$	$41d_b$	$61d_b$
	B	$46d_b$	$68d_b$	$35d_b$	$53d_b$	$60d_b$	$89d_b$	$53d_b$	$79d_b$
#7 to #18 [#22 to #57]	A	$44d_b$	$66d_b$	$34d_b$	$51d_b$	$57d_b$	$86d_b$	$51d_b$	$76d_b$
	B	$57d_b$	$85d_b$	$44d_b$	$66d_b$	$74d_b$	$111d_b$	$66d_b$	$98d_b$

f'_c = 9,000 psi

BAR SIZES	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP		OTHER		TOP		OTHER	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 to #6 [#10 to #19]	A	$33d_b$	$50d_b$	$26d_b$	$38d_b$	$43d_b$	$65d_b$	$38d_b$	$57d_b$
	B	$43d_b$	$64d_b$	$33d_b$	$50d_b$	$56d_b$	$84d_b$	$50d_b$	$74d_b$
#7 to #18 [#22 to #57]	A	$41d_b$	$62d_b$	$32d_b$	$48d_b$	$54d_b$	$81d_b$	$48d_b$	$71d_b$
	B	$54d_b$	$80d_b$	$41d_b$	$62d_b$	$70d_b$	$105d_b$	$62d_b$	$93d_b$

$f'_c \geq$ 10,000 psi

BAR SIZES	LAP CLASS	UNCOATED BARS				EPOXY-COATED BARS			
		TOP		OTHER		TOP		OTHER	
		Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
#3 to #6 [#10 to #19]	A	$32d_b$	$47d_b$	$24d_b$	$36d_b$	$41d_b$	$61d_b$	$36d_b$	$54d_b$
	B	$41d_b$	$61d_b$	$32d_b$	$47d_b$	$53d_b$	$80d_b$	$47d_b$	$71d_b$
#7 to #18 [#22 to #57]	A	$39d_b$	$59d_b$	$30d_b$	$45d_b$	$51d_b$	$77d_b$	$45d_b$	$68d_b$
	B	$51d_b$	$76d_b$	$39d_b$	$59d_b$	$67d_b$	$100d_b$	$59d_b$	$88d_b$

Reference Table 5-4(a) Notes.

Table 5-5(a) – Tension Development Lengths for Standard Hooks

BAR SIZE	f'_c = 3,000 psi		f'_c = 4,000 psi		f'_c = 5,000 psi		f'_c = 6,000 psi	
	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated
#3	9	10	7	9	7	8	6	7
#4	11	13	10	12	9	10	8	10
#5	14	17	12	15	11	13	10	12
#6	17	20	15	17	13	16	12	14
#7	19	23	17	20	15	18	14	17
#8	22	27	19	23	17	21	16	19
#9	25	30	22	26	19	23	18	21
#10	28	34	24	29	22	26	20	24
#11	31	37	27	32	24	29	22	27
#14	37	45	32	39	29	35	27	32
#18	50	60	43	52	39	46	35	42

Notes:

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths of standard hooks are calculated per ACI 318-08, Section 12.5.
3. For bar sizes #3 through #11 only:
   a. If concrete cover conforms to ACI 12.5.3(a), then a modification factor of 0.7 may be applied but the length must not be less than 8.0 d_b nor 6 inches.
   b. If hook is enclosed in ties or stirrups per ACI 12.5.3(b) or 12.5.3(c), then a modification factor of 0.8 may be applied but the length must not be less than 8.0 d_b nor 6 inches.
   b. When applying modification factors noted above, see Table 5-7 for minimum hook embedment needed to provide 2 inches of concrete cover to tail of 180° hooks.
4. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
5. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

Table 5-5(b) – Tension Development Lengths for Standard Hooks

BAR SIZE	f'_c = 7,000 psi		f'_c = 8,000 psi		f'_c = 9,000 psi		$f'_c \geq$ 10,000 psi	
	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated
#3 [#10]	6	7	6	6	6	6	6	6
#4 [#13]	7	9	7	8	7	8	6	7
#5 [#16]	9	11	9	10	8	10	8	9
#6 [#19]	11	13	10	12	10	12	9	11
#7 [#22]	13	15	12	14	11	14	11	13
#8 [#25]	15	18	14	16	13	15	12	15
#9 [#29]	16	20	15	18	15	17	14	17
#10 [#32]	19	22	17	21	16	20	16	19
#11 [#36]	21	25	19	23	18	22	17	21
#14 [#43]	25	29	23	28	22	26	21	25
#18 [#57]	33	39	31	37	29	35	27	33

Reference Table 5-5(a) Notes.

Table 5-6(a) – Tension Development Lengths for Headed Reinforcing Bars

BAR SIZE	f'_c = 3,000 psi		f'_c = 4,000 psi		f'_c = 5,000 psi		f'_c = 6,000 psi	
	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated
#3	7	8	6	7	6	6	6	6
#4	9	11	8	9	7	8	6	8
#5	11	13	10	12	9	10	8	10
#6	13	16	12	14	10	13	10	11
#7	16	19	14	16	12	15	11	13
#8	18	21	15	19	14	17	13	15
#9	20	24	17	21	16	19	14	17
#10	23	27	20	23	18	21	16	19
#11	25	30	22	26	19	23	18	21

Notes:

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths of headed bars are calculated per ACI 318-08, Section 12.6.

Table 5-6(b) – Tension Development Lengths for Headed Reinforcing Bars

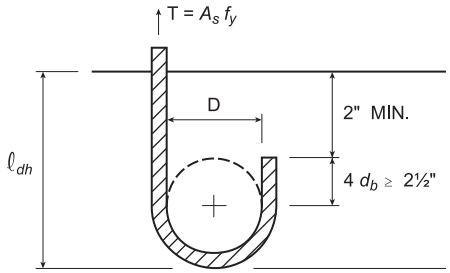
BAR SIZE	f'_c = 7,000 psi		f'_c = 8,000 psi		f'_c = 9,000 psi		f'_c = 10,000 psi	
	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated	Uncoated	Epoxy-Coated
#3	6	6	6	6	6	6	6	6
#4	6	7	6	7	6	6	6	6
#5	7	9	7	8	7	8	6	8
#6	9	11	8	10	8	9	8	9
#7	10	12	10	12	9	11	9	10
#8	12	14	11	13	10	12	10	12
#9	13	16	12	15	12	14	11	13
#10	15	18	14	17	13	16	12	15
#11	16	20	15	18	15	17	14	17

Notes:

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths of headed bars are calculated per ACI 318-08, Section 12.6.

TABLE 5-7 Minimum Embedment Lengths to Provide 2 inches of Concrete Cover to Tail of Standard 180° End Hooks

#3	#4	#5	#6	#7	#8	#9	#10	#11	#14	#18
6″	7″	7″	8″	9″	10″	12″	14″	15″	20″	25″



Standard 180° End Hooks (ACI 7.1)

STANDARD HOOKS

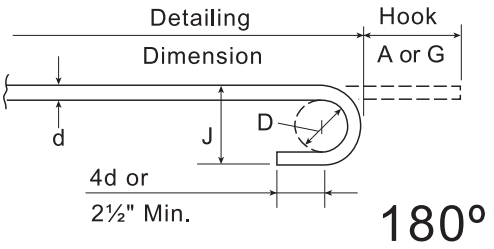
All specific sizes recommended by CRSI below meet minimum requirements of ACI 318.

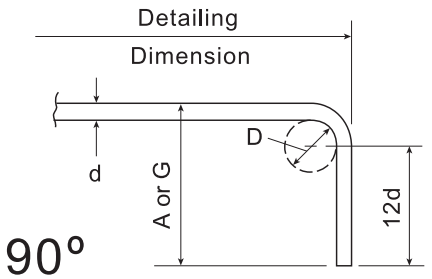
RECOMMENDED END HOOKS

All grades of steel (minimum yield strengths)

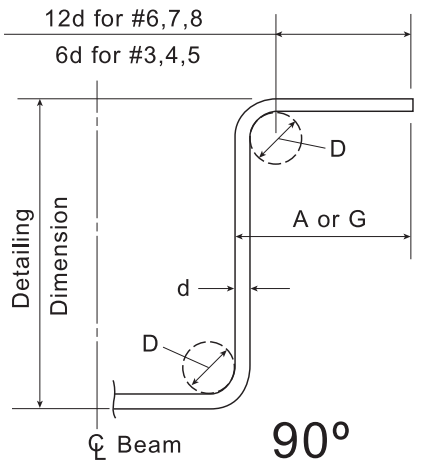
D = Finished inside bend diameter
d = Bar diameter

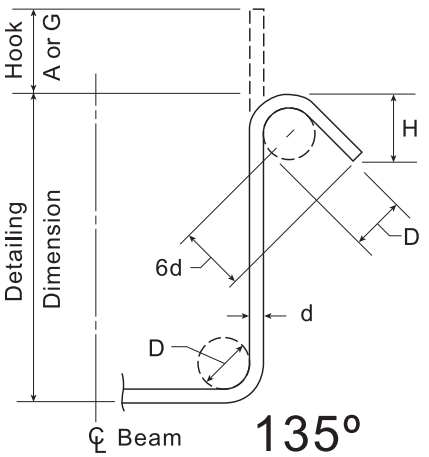
Bar Size	D	180° HOOKS		90° HOOKS
		A or G	J	A or G
#3	2¼″	5″	3″	6″
#4	3″	6″	4″	8″
#5	3¾″	7″	5″	10″
#6	4½″	8″	6″	1′-0″
#7	5¼″	10″	7″	1′-2″
#8	6″	11″	8″	1′-4″
#9	9½″	1′-3″	11¾″	1′-7″
#10	10¾″	1′-5″	1′-1¼″	1′-10″
#11	12″	1′-7″	1′-2¾″	2′-0″
#14	18¼″	2′-3″	1′-9¾″	2′-7″
#18	24″	3′-0″	2′-4½″	3′-5″



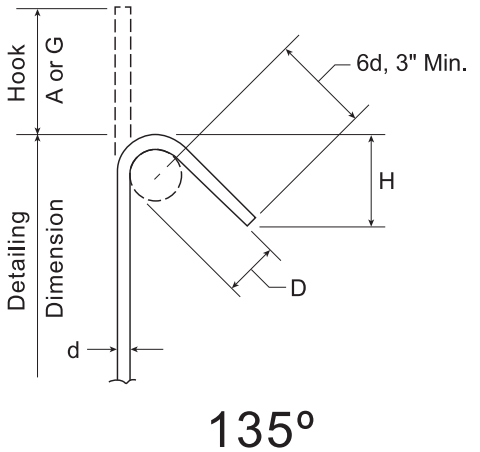


STIRRUP/TIE HOOKS





SEISMIC STIRRUP/TIE HOOKS



STIRRUP/TIE HOOK DIMENSIONS

Bar Size	D	90° Hook	135° Hook	
		Hook A or G	Hook A or G	H (Approx.)
#3	1½″	4″	4″	2½″
#4	2″	4½″	4½″	3″
#5	2½″	6″	5½″	3¾″
#6	4½″	1′-0″	8″	4½″
#7	5¼″	1′-2″	9″	5¼″
#8	6″	1′-4″	10½″	6″

SEISMIC STIRRUP/TIE HOOK DIMENSIONS

Bar Size	D	135° Hook	
		Hook A or G	H (Approx.)
#3	1½″	4¼″	3″
#4	2″	4½″	3″
#5	2½″	5½″	3¾″
#6	4½″	8″	4½″
#7	5¼″	9″	5¼″
#8	6″	10½″	6″

CHAPTER 6 – SERVICEABILITY REQUIREMENTS

General. Strength design permits the utilization of larger percentages of tension reinforcement without compression reinforcement, and allows advantageous use of higher strength reinforcement. Shallower construction can result. Once the safety of the member or floor system is determined by strength design, it is necessary to confirm that both deflection and cracking are within tolerable limits at service load levels. If the required reinforcement is provided as small bars spaced close together, crack control requirements are easier to satisfy.

Deflection Control. Deflections must be computed and compared to allowable limits for particular loading combinations when the thickness used is less than the minimums tabulated below (ACI 9.5.2.1).

For one-way construction:

Member	Minimum Thickness, h †			
	Simply Supported	One End Continuous	Both Ends Continuous	Cantilever
Solid slabs	$\ell/20$	$\ell/24$	$\ell/28$	$\ell/10$
Beams or joists	$\ell/16$	$\ell/18.5$	$\ell/21$	$\ell/8$

† Members not supporting or attached to partitions or other construction likely to be damaged by large deflections.

Values of h for normal-weight concrete and Grade 60 reinforcing bars.

ℓ = c.-c. spans.

For two-way flat plate construction without beams: Exterior and interior panels: $h \geq \ell_n/33$ (5 in. min.). For the effects of edge beams, drop panels, rectangular panels, edge panels, and corner panels, see Table 10-1.

Computed deflections are limited to values that are acceptable for various conditions of loading and design requirements. These acceptable limits are given as fractions of the span lengths and vary with the use of a structure. For example, a floor supporting partitions or supporting a ceiling below can tolerate much less deflection, because of cracking of the supported elements, than the same floor without a ceiling or partitions. If the problem is that of establishing clearance under a flexural member and over, say, a plate glass store front, many factors, such as age, moisture content, actual E_c, settlement of supports, realistic end restraints, and the like, have an influence on the actual deflection.

When the computed long-term deflection exceeds the allowable, one of the most satisfactory means of decreasing these creep-caused deflections is the addition of compressive reinforcement.

Deflection Computations.†† The calculation of deflections requires the computation of E_c, the modulus of elasticity of the concrete, and I_e, the effective moment of inertia of the cross-section.

The modulus of elasticity for concrete $E_c = w^{1.5}\, 33\sqrt{f'_c}$. Use the specified concrete compressive strength f'_c for preliminary calculations. For normal-weight concrete, E_c may be taken as $57{,}000\sqrt{f'_c}$ (ACI 8.5.1). Taking f'_c as 3000 psi, E_c = 3,122,000 psi; and for f'_c = 4,000 psi, E_c = 3,605,000 psi.

The effective moment of inertia, I_e, is a function of the gross moment of inertia, I_g, the cracked moment of inertia, I_{cr}, and the ratio of the cracking moment, M_{cr}, to the actual (service load) moment, M_a.

For values of I_g and I_{cr} for solid sections, see Table 12-1; for standard joist or waffle slab sections, see Table 8-1, Gross Section Properties, for I_g, and the load capacity tables footnote for I_{cr} with each individual combination of bars and for M_{cr}. Determining the cracking moment:

$$M_{cr} = f_r I_g / y_t$$

where $f_r = 7.5\sqrt{f'_c}$ for normal-weight concrete and y_t is the distance from the neutral axis of the solid section to the tension fiber.

Code Equation (9-8) for calculating the effective moment of inertia I_e is

$$I_e = (M_{cr}/M_a)^3 I_g + [1 - (M_{cr}/M_a)^3] I_{cr}$$

One-way slabs, joists and beams. For the uniform load conditions upon which all of the tabulated designs in this *Handbook* are based, deflections can be estimated from the relationship $\Delta = KwL'^4\, 1728/E_c I_e$ where K is a constant related to the degree of restraint at either

†† It should be emphasized that the calculations illustrated result in a *computed* deflection only. The results are useful to determine compliance with minimum code limits. These results may be used as a starting point to estimate *actual* deflections, but must be modified to reflect other parameters such as the need for camber, effects of restraint, shrinkage, probable curing and construction sequences — all of which influence the actual deflection. The *computed* deflections tabulated in this *Handbook* should be evaluated to determine adjustments necessary for use in preparing estimates of *actual probable deflection*.

end; w is the uniform load, plf; L' is the appropriate span in feet; E_c is the modulus of elasticity of the concrete, psi; and I_e is the effective moment of inertia of the cross-section, in.^{4}, and Δ is in inches.

Three conditions of restraint have been tabulated for one-way flexural members:

(1) Simple, single span, $+M = wL'^2/8$;

The value of K for a single span when $+M = wL'^2/8$ is given in textbooks as $K = 5/384$. Settlement of the supports has little effect on this coefficient.

(2) End span of continuous member, $+M = wL'^2/11$.

For end spans with $+M = wL'^2/11$, the value of K is not so readily found in textbooks. A value of K for gravity loads is obtained by the conjugate beam concept as $K = 3.25/384$, assuming no settlement of supports.

(3) For interior spans with $+M = wL'^2/16$ the same limitations apply and the same method can be used, resulting in $K = 2/384$.

These coefficients are summarized in the table below:

Values of K in $\Delta = KwL'^4\ 1728/E_cI_e$		
Type of Restraint	Maximum Positive Moment	Value of K
Simple Span	$+wL'^2/8$	5/384
End Span	$+wL'^2/11$	3.25/384
Interior Span	$+wL'^2/16$	2/384

Applications

One-Way Systems. All factored load capacity tables in this *Handbook* can be used without the need to compute deflection for all floor and roof systems where they do not support non-structural elements liable to be damaged by service load deflections greater than $\ell/360$. For one-way systems where capacity is controlled by deflection, such values are so noted.

When the one-way floor or roof system supports elements liable to be damaged by deflections greater than $\ell/360$, the designs can be selected above the horizontal line in each table, which identifies minimum depth/span ratio above which the Code does not require deflection computations. Alternatively, design aids can be used to determine values of E_c and I_e for calculation of deflection, or deflection can be conservatively estimated from known loading conditions (tabulated) and the deflection equation for the tabulated loading pattern. See examples in Chapters 7 and 8.

Retaining Walls. Deflection at the top of all retaining wall designs has been computed assuming the base of the wall is fixed. Thickness/height proportions were selected for the tabulated designs so that deflection is less than $h_w/240$. The exposed face should be cambered if a vertical face design is desired. If a battered face is on the exposed side, no further precaution is needed.

Two-Way Slab Systems. Slab thickness, h, for flat plates and flat slabs; or rib-plus-slab, h, for waffle flat slabs may be compared to the limits in Table 10-1, to ensure that deflection computations are not required.

If it becomes necessary to compute deflections of two-way slab systems, due to use of less depth than that of the minumum depth/span ratios or to estimate camber required for level floors, some simplifications may be made. Since the cracking moment/actual moment ratio $(M_{cr}/M_a) \rightarrow 1.0$ for joist and waffle slabs, use of an average gross moment of inertia gives reasonable results. For solid slabs, use of an average (M_{cr}/M_a) ratio for computation of I_e and center-to-center spans should be conservative.

The simplest way to estimate maximum elastic deflection at service (elastic) loading for a two-way flat slab or a waffle slab is to use an elastic plate on point supports.* Simplifying assumptions, justifiable for such estimates, include, in addition to the usual assumptions of elasticity and homogeneity: (1) basically uncracked behavior, i.e., use of gross moment of inertia, (2) average moment of inertia based on ratio of twice the solid head or drop area to total area, (3) spans c.-c. of columns neglecting size of column, and capital, if any, and (4) load on panel is uniformly applied.

The basic plate formula* for deflection, Δ, at the center of interior panels is:

$$\Delta = k\,\frac{wL^4}{E_c t_e^{\,3}}\,(144) \text{ in inches, where}$$

w = service load, psf
L = longer span of panel, feet
L' = shorter span of panel, feet
t_e = equivalent average thickness, inches (Measure of moment of inertia)
k = coefficient depending on ratio of spans

Notes: All terms must be expressed in consistent units. This equation is similar in form to that for one-way slab deflection given previously.

*S. Timoshenko and S. Woinowsky-Krieger, *Theory of Plates and Shells*, Second Edition, McGraw-Hill Co., 1959.

For uniformly loaded rectangular panels, values for k are:

Ratio spans L/L' =	1	1.1	1.2	1.3	1.4	1.5	2.0*
k =	0.0634	0.0532	0.0467	0.0423	0.0391	0.0368	0.0319

* Limiting ratio for Direct Design – ACI 13.6.1.2.
For "checkerboard loading," square panels: k = 0.0539.
For alternate bays loaded, which produces largest deflections, basic formula is modified for square panels to: $\Delta = 0.1028 \frac{wL^4}{E_c t_e^3}$ and is applicable when five or more bays are continuous transversely to direction of loaded bays. These formulas conservatively assume point support at all columns.

Example

This example illustrates the deflection computation of a waffle slab. Deflection of a flat slab would be computed in a similar manner.

A typical load test following requirements of the ACI Building Code on a standard waffle flat slab will serve to illustrate the simplified procedure suggested for computing deflection.

Design Data:

Roof with square panels of 36-foot spans, 6-inch wide ribs on a 3′-0″ module with 30 × 30 × 12 standard forms; top slab thickness 4 inches. Total depth = 12 + 4 = 16 inches. Solid head of 18′-0″.

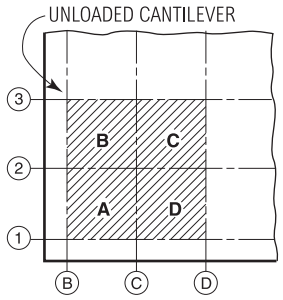
Load Test Data:

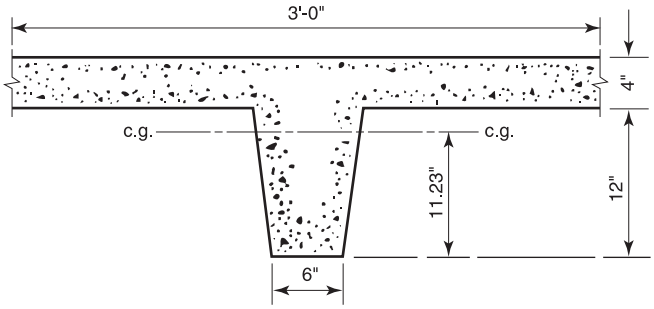
Test Load = Average 15-inch depth of water
= 78 psf

Four panels loaded between column centerlines 1 and 3 and centerlines B and D including one corner panel, two edge panels, and one interior panel. Immediate and 24-hour readings were taken at centers of each panel as follows:

Location	Mark	Immediate†	24-hour†
Corner panel	A	–0.240 in.	–0.288 in.
Edge panel	B	–0.180 in.	–0.192 in.
Interior panel	C	–0.096 in.	–0.108 in.
Edge panel	D	–0.204 in.	–0.264 in.

† Probable accuracy of measurement ± 0.024 in.





Solution: (Note: See Chapters 10 and 11 for explanation of procedure for computing equivalent average thickness, t_e, for solid flat slab and waffle flat slab respectively.)

Solid Head Area, $I_h = \frac{12 \times 16^3}{12}$ = 4,096 in.^{4} per 12 in. width

Waffle Area:

Use rib width 6 in.

$X_{c.g.}$ = 11.23 in. from bottom

For 36 in. width:

$$I_w = \frac{36 \times 4^3}{12} + (144)(2.77)^2 + \frac{6 \times 12^3}{12} + (72)(5.23)^2$$
$$= 4{,}130 \text{ in.}^4$$

For 12 in. width, I_w = 4,130/3 = 1,377 in.^{4}

$$\frac{\text{Area of Solid Head}}{\text{Area of Total Panel}} = \frac{(18)(18)}{(36)(36)} = \tfrac{1}{4}$$

Multiply ratio of solid area by two because stiffness in the area of maximum moment has most effect on deflection.

$$\text{Average } I_{gross} = \frac{4{,}096 \times 2 + 1{,}377 \times 3}{5} = 2{,}464 \text{ in.}^4/12 \text{ in.}$$

Compute equivalent average thickness, t_e:

$\frac{12 \times t_e^3}{12}$ = 2,464 in.^{4} $\quad t_e^3$ = 2,464 in.^{3} and t_e = 13.5 in.

Load $w = \frac{78}{144}$ psi

L = 36 × 12 in.

Take E_c = 3,500,000 psi

Estimated deflection $\Delta = k \frac{wL^4}{E_c t_e^3}$

The selection of the proper coefficient k usually requires some study of the loading pattern when attempting to predict results of a load test since the exact k values were derived for a uniform load pattern extending far beyond the usual practicable limits of test loading. For this example, approximate k as the coefficient for an interior panel with all the surrounding panels loaded at least two bays distant is usual. For a square interior panel, this computed deflection would be:

$$\Delta = 0.0634 \times \frac{78}{144} \times \frac{(36 \times 12)^4}{3.5 \times 10^6 \times 2{,}464} = 0.141 \text{ in.}$$

To correlate computed deflection with the conditions of this test in which half the surrounding panels were loaded, a lower coefficient than for all panels loaded is proper. The "checkerboard" loading coefficient of 0.0539 is probably more appropriate, although it does not model the load test either. Try a value of 0.055.

$$\Delta = \frac{0.055}{0.0634} \times 0.141 = 0.122 \text{ in.} = 0.01 \text{ ft}$$

Measured $\Delta = 0.009$ ft. This correlation is probably closer than could be usually expected.

Crack Control. To control crack widths, flexural reinforcement must be well-distributed in the zones of maximum concrete tension. Bar spacing in two-way slabs should not be greater than 2*h* (ACI 13.3.2).

The final crack width after a period of time depends on the magnitude of (1) flexural cracking, (2) shrinkage, (3) creep, and (4) temperature movements. The effects of the last three items may be partially counteracted in many ways.

T-Beams. Where the top flanges of major T-beams are in tension, part of the negative moment reinforcement must be distributed over an effective flange width (ACI 10.6.6). The effective flange width is the smaller of: the width defined for flexural design (ACI 8.12), or a width equal to 1/10 of the span. If the effective flange width exceeds 1/10 the span, some longitudinal reinforcement must be placed in the outer portions of the flange.

Skin Reinforcement. If the depth of the web of a beam exceeds 36 inches, longitudinal skin reinforcement must be provided in the vertical faces of the web to control the crack width in the web (ACI 10.6.7). Without web reinforcement, the crack width in the web could be wider than at the tension reinforcement level. The skin reinforcement must be uniformly distributed along both side faces of the web for a distance *h*/2 from the tension face. Spacing of the skin reinforcement should not exceed the same limits as flexural reinforcement for one-way slabs and beams (see next Section). The Code permits inclusion of the skin reinforcement in computation of design moment strength, provided a compatibility analysis is made to determine the stresses in the individual bars.

Maximum Spacings for Reinforcing Bars. It is generally agreed that the size and spacing of flexural cracks are a function of steel stress, the amount of concrete cover over bars, and the area of concrete surrounding and tributary to the area of an individual bar.

One-Way Slabs and Beams. According to the ACI Building Code, reinforcing bars must not be spaced farther apart than the spacing calculated from Code Eq. (10-4):

$$s = 15\left(\frac{40{,}000}{f_s}\right) - 2.5c_c \le 12\left(\frac{40{,}000}{f_s}\right)$$

where f_s can be taken as 40 ksi for Grade 60 bars and c_c = concrete cover.

For one-way slabs with ¾ inches of concrete cover to the flexural reinforcement, the maximum bar spacing is 12 inches. For beams with #4 stirrups and 1½ inches of concrete cover to the stirrups, the maximum bar spacing is 10 inches.

CHAPTER 7 – ONE-WAY SLABS

ONE-WAY SOLID SLABS

This Chapter presents tabulated designs for uniform depth solid concrete slabs reinforced for flexure in one direction and only for temperature and shrinkage in the other direction. The tabulated factored usable superimposed loads were obtained as the least value determined by shear, or positive or negative flexure.

GENERAL CODE CONSIDERATIONS

Factored moments are computed from the empirical coefficients of ACI 8.3.3,* as an elastic beam free to rotate on unyielding supports. ACI 8.3.3 limits the use of empirical moment coefficients to ratios of live load to dead load—unfactored gravity loads—of not more than three. Since part of the superimposed gravity load may be dead load, the ratio of live to dead load may vary in each instance. Therefore, superimposed gravity loads are tabulated well above three times the dead weight of the slab itself.

The recommended reinforcement details in Fig. 7-1 show where straight reinforcing bars are cut off, anchored, and extended in accordance with current standard practices and the *ACI Detailing Manual.* These practices have worked satisfactorily for many years for normal load and span ratios. Necessary modifications must be made when the conditions of an individual design require them. A practical, economical design should use no more than two or three bar sizes for slabs across an entire floor. The bar sizes tabulated in the load tables must be adjusted to fit tabulated areas for simple, fast placing in the entire floor or roof slab, which may include variable spans and loads. Such adjustments can be made with smaller bar sizes at closer spacings without checking anchorages. Larger bars may be substituted at larger spacings if tension development length and crack control requirements are satisfied. For example, some top bars should be extended to be continuous throughout the span if the ratio of live to dead load exceeds three.

SCOPE OF TABULATED DESIGNS

These tabulated designs for one-way solid slabs give the *factored usable superimposed load,* in pounds per square foot. In other words, the tabulated loads are net factored superimposed loads. Total factored load was calculated and reduced by the prescribed strength-reduction factors (ϕ-factors), from which 1.2 times the slab weight was deducted using a unit weight of 150 pounds per cubic foot (pcf). One set of material strengths is used: normal-weight concrete with $f_c' =$ 4,000 psi and reinforcing bars with $f_y =$ 60,000 psi.

Three cases of end restraint are considered: (1) single spans simply supported; (2) end spans free on one end and continuous on the other; and (3) interior spans continuous on both ends.

Factored usable superimposed loads are tabulated for slabs with various ratios of flexural reinforcement: single spans for the minimum, $\rho \geqq 0.0018bh$, $\rho \approx 0.0025bd$, $\rho \approx 0.0050bd$, $\rho \approx 0.0075bd$, and $\rho \approx 0.0100bd$; end and interior spans for minimum recommended top reinforcing steel, $\rho \approx 0.0018bh$, $\rho \approx 0.0025$, 0.0050, 0.0075, and $0.0100bd$.

For $f_c' = 4{,}000$ psi and $f_y = 60{,}000$ psi, the maximum $\rho = 0.0181$ for tension-controlled sections. All of the ratios of flexural reinforcement are less than 0.0181 so that the strength-reduction factor, ϕ, is 0.90 for flexure.

The recommended minimum reinforcement * is a variable percentage since for adequate rigidity of top bars under ordinary construction traffic in monolithic construction, minimum size #4 bars at a maximum spacing of 12 inches are recommended. For thin slabs, this practical minimum is well within Code limits, i.e., $A_s = 0.0018bh$ spaced at 18 inches or $3h$ maximum. An exception is made for thin single span slabs where cross traffic is not expected. The recommended maximum reinforcement ratio, $\rho \leq 0.010bd$, is the maximum for economy is most routine applications. Bar spacing is also limited by the Code's requirements for crack control (ACI 10.6.4). For ¾ inches of concrete cover, which is used in the tabulated designs, the maximum bar spacing is 12 inches. The limit on top reinforcement for a balanced design at continuous supports controls the bottom reinforcement where end spans and interior spans are equal.

Temperature-shrinkage reinforcement in structural floor and roof slabs is tabulated for reinforcing bars with $f_y =$ 60,000 psi.

BASIS FOR DESIGN

Flexural design is based on factored moments computed by the coefficients per ACI 8.3.3. See Chapter 5.

* In all cases, equal or greater than the minimum prescribed in ACI 10.5.4.

Design shear strength, ϕV_n, was calculated in accordance with ACI 11.2. Both "short" and "long" formulas were compared and the larger value of ϕV_n was used. Tension development of reinforcing bars has been checked in accordance with ACI Chapter 12, applied to bars anchored in accordance with the recommended reinforcement details in Fig. 7-1. Elastic deflections for all full tabulated superimposed loads divided by 1.6 are less than $\ell/360$. Thus, the tabulated designs need not be investigated for any live load deflection. Creep deflections will vary according to proportion of the superimposed service loads of long-term duration. Where long-term deflection limits of the Code apply, e.g., slabs supporting or attached to brittle partitions, long-term deflection must be computed. See example, Chapter 6.

ASSUMPTIONS IN DESIGN

It was assumed that end restraint at free ends of the slab has a negligible effect on the positive moment. Top bars tabulated in Single Span tables provide at least one-third of the area tabulated for bottom reinforcing steel but not less than #4 in size, except for short single span slabs, nor at spacings more than 12 inches. The top reinforcing steel is sufficient for free ends supported by monolithic beams or girders, where the Code moment coefficient = 1/24 $w_u \ell_n^2$ applies, as well as the ordinary incidental restraint when end bearing is provided by masonry walls.

For interior spans, tabulated top reinforcing steel at continuous supports is based upon an adjoining span equal to the span being considered. This condition will fit the typical case where the adjacent span slab thickness is equal, the span lengths are equal, and the spans are loaded with the same uniformly distributed load. This condition should always be adequate where the adjoining spans are shorter or more lightly loaded. In order to fit unequal spans, provide the top steel area tabulated for the longer span and have that reinforcement extend one-third the longer span length on both sides of the support.

For end spans, top reinforcing steel at the continuous interior supports is calculated for an interior span of the *same slab thickness.* This condition will fit the typical practical situation. Where slabs of varying thickness are used for special load-span conditions, the tabulated top steel area for the shallower span must be provided using added straight top bars for any deficiency.

USE OF LOAD TABLES — SINGLE SPAN

Single Span Example 1 – Design a single span solid slab floor to span 12′-8″ clear between masonry bearing walls for the following superimposed service loads. Space permits a 6-in. depth.

Live load	150 psf
Floor finish	13 psf
Ceiling	8 psf

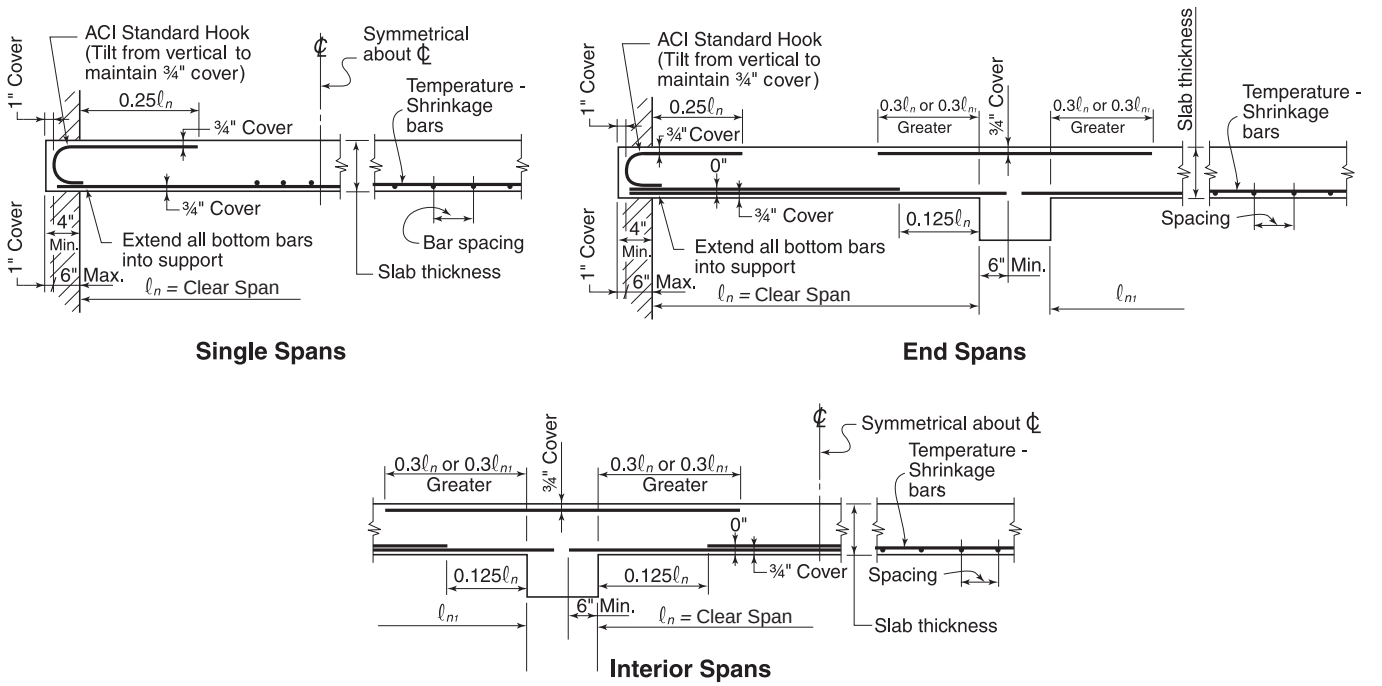


Figure 7-1 Recommended Bar Details – Solid Slabs

Solution:

Strength Design

The total factored superimposed load requirement is:

Live load $150 \times 1.6 = 240$ psf
Dead load $(13 + 8) \times 1.2 = \underline{25}$
$w_u = 265$ psf

Since the clear span is 12′-8″ and a minimum bearing width of 4 inches is recommended, the span center-to-center of bearings for design is 12′-8″ + 2″+ 2″ = 13′-0″.

Try each load table beginning with minimum reinforcement to determine if the 6-in. depth is feasible.

See Page 7-5, $\rho \approx 0.0018$: $w_u =$ 49 psf capacity < 265
See Page 7-6, $\rho \approx 0.0025$: $w_u =$ 83 psf capacity < 265
See Page 7-7, $\rho \approx 0.0050$: $w_u = 220$ psf capacity < 265
See Page 7-8, $\rho \approx 0.0075$: $w_u = 296$* psf capacity > 265
Use design from Page 7-8; $\rho \approx 0.0075$; $h = 6$ in.

Bottom bars	#6 spaced at 12 in.
Top bars	#4 spaced at 12 in.
Temp.-shrinkage bars	#3 spaced at 10 in.

Recommended bar details are shown in Fig. 7-1.

Serviceability Check

1. Deflection – Note asterisk on Page 7-8 load (296*) indicates an elastic deflection of $\ell/360$ at a service load of 296/1.6.

$$\text{Live load deflection} = \left(\frac{240}{296}\right)\left(\frac{13 \times 12}{360}\right) = 0.35 \text{ in.}$$

2. Crack control – The maximum spacing permitted by ACI 10.6.4: $s = 12(40{,}000/f_s) = 12(40{,}000/40{,}000) = 12$ in. The spacing of the #6 bottom bars is 12 in. = 12 in., Okay.

Single Span Example 2 – Design a minimum depth roof slab for a single clear span of 16 ft between supporting monolithic beams for the following superimposed service loads:

Live load, $L = 30$ psf
Roofing material, $D = 15$ psf

Solution:

Strength Design

Augment and accumulate loads for factored superimposed capacity required:**

$30 \times 1.6 + 15 \times 1.2 = 66$ psf. See table on Page 7-8, $\rho \approx 0.0075$. Select a 5-in. slab, $w_u = 89$* psf capacity.

** Note: Total factored load superimposed on the supporting beams is the sum of 1.2 times the slab weight, $1.2 \times 63 + 66$ psf = 142 psf times half span 8 feet = 1,136 plf.

Reinforcing bars required are:

Bottom bars	#5 spaced at 10 in.
Top bars	#3 spaced at 12 in.
Temp.-shrinkage bars	#3 spaced at 11 in.

Serviceability Check

1. Deflection – Note asterisk next to w_u. Live load deflections are approximately

$$\left(\frac{1.6 \times 30}{89}\right)\left(\frac{16 \times 12}{360}\right) = 0.29 \text{ in.}$$

2. Crack Control – Spacing of #5 bars is 10 in.< 12 in., Okay.

Single Span Example 3 – Repeat requirements of Example 1, $\ell_n = 13'\text{-}0''$; $D = 21$ psf, $L = 150$ psf and $w_u = 265$ psf, with the additional serviceability requirement that rigid partitions are to be attached to the slab so that the design must meet the deflection limit of $\ell_n/480$ for the sum of elastic live load deflection plus creep deflection. Assume that the partition weight is equivalent to 20 psf additional uniform dead load.

The computed long-term deflection occurring after installation of partitions plus the computed elastic deflection due to service live loads is limited by the Code to $\leq \ell_n/480$. Assume that partition installation will be scheduled last. An estimated 50 percent of the long-term deflection due to dead weight of slab, floor finish, and ceiling will have occurred. Determine minimum thickness required for these design conditions.

Strength Design

Accumulate total superimposed factored load

$$w_u = (1.2)(20 + 21) + (1.6)(150) = 289 \text{ psf}$$

From:
Page 7-7, 7-in. slab with $\rho \approx 0.0050$, $w_u = 343$ psf
Page 7-8, 6½-in. slab with $\rho \approx 0.0075$, $w_u = 389$* psf.

Serviceability Check

The deflection limit will control this design. Accumulate an equivalent factored load which would result in an immediate deflection equal to (360/480) times $\ell/360$. Try a 7½-in. slab. $D = 94$ psf.

Effect of partitions on long-term deflection; if duration ≥ 5 years, $\xi = 2.0$ (ACI 9.5.2.5); if no compression reinforcement, the multiplier $\lambda = 2.0$.

$$\begin{aligned}\text{Equiv. } w_u &= (D + L)(1.6)(480/360) = (D + L)(2.13)\\ &= [(2)(20) + 21 + 94 + 150](2.13)\\ &= (305)(2.13) = 650 \text{ psf}\end{aligned}$$

From Page 7-8, $\rho \approx 0.0075$, for 7½-in. slab: $w_u = 582$* psf

Try an 8-in. slab, D = 100 psf.

Equiv. w_u = (305 + 6)(2.13) = 662 psf

From Page 7-8, $\rho \approx 0.0075$, for 8-in. slab: w_u = 714* psf

Use the 8-in. slab (note asterisk).

Live load deflection = $\left(\frac{1.6 \times 150}{714}\right)\left(\frac{13 \times 12}{360}\right)$ = 0.15 in.

$\frac{\ell_n}{480} = \frac{13 \times 12}{360}$ = 0.33 in.

Select reinforcement from table on Page 7-8, ρ = 0.0075;

Bottom bars	#7 spaced at 11 in.
Top bars	#4 spaced at 12 in.
Temp.-shrinkage bars	#3 spaced at 7 in.

MANUAL CALCULATION—LOAD TABLES FOR SINGLE SPAN

Example 4. Single Span—Derive the factored usable superimposed load value tabulated for an 8-in. solid slab with recommended minimum reinforcement on a single span of 14 ft. From Page 7-5 with $\rho \geq 0.0018\,bh$ (recommended minimum reinforcement), h = 8 in. and #3 bottom bars spaced at 7 in., the factored usable superimposed load is 119 psf. Derive the load value of 119 psf.

Flexure

Compute the design moment strength,

$\phi M_n = \phi A_S f_y\ (d - a/2)$

Where A_S = 0.189 in.^{2}/ft for #3 bottom bars spaced at 7 in.

$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{0.189(60)}{0.85(4)(12)}$ = 0.28 in.

$d = h$ – cover – $0.5d_b$

d = 8 – 0.75 – 0.375/2 = 7.06 in.

ϕM_n = 0.90(0.189)(60)(7.06 – 0.28/2)/12 = 5.89 ft-kips/ft

Equate $M_u = \phi M_n$ where $M_u = w_u \ell^2/8$

$w_u\,(14)^2/8 = 5.89$

w_u = 0.240 klf or 240 psf

w_D = 8/12(150) = 100 psf (8-in. slab)

Factored usable superimposed load =
240 – 1.2(100) = 120 psf (tabulated = 119, Okay)

Shear

Design shear strength is the larger of (ACI 11.2):

$\phi V_c = 2\phi\sqrt{f_c'}\,b_w d$, or . . . . . (ACI Eq. 11-3)

$\phi V_c = \phi\left(1.9\sqrt{f_c'} + 2500\,\rho_w \frac{V_u d}{M_u}\right) b_w d$ (ACI Eq. 11-5)

$\phi V_c = 2(0.75)\sqrt{4{,}000}(12)(7.06)/1000$ = 8.04 kips/ft

At the critical section, a distance d from the face of the support, for uniformly distributed load,

$\frac{V_u d}{M_u} = \frac{w_u(\ell_n/2 - d)d}{w_u d(\ell_n/2 - d/2)} = \frac{\ell_n/2 - d}{\ell_n/2 - d/2}$

$\frac{V_u d}{M_u} = \frac{(14)(12)/2 - 7.06}{(14)(12)/2 - 7.06/2} = 0.96$

$\phi V_c = 0.75(1.9\sqrt{4{,}000}$
$+ 2500\left(\frac{0.189}{7.06 \times 12}\right)(0.96))(12)(7.06)1000)$
= 7.98 kips/ft

Take ϕV_c = 8.04 kips/ft

At a distance d from the face of the support,

$V_u = w_u(\ell_n/2 - d)$

Equate $V_u = \phi V_n$

$w_u\,(14/2 - 7.06/12) = 8.04$

w_u = 1.25 klf or 1,250 psf

Design moment strength governs; hence, w_u = 120 psf

Tension Development of #3 bottom bars

Check tension development of #3 bottom bars spaced at 7 in.

Concrete cover = 0.75 in. = 0.75/0.375 = $2d_b$

Spacing = 7 in. = 7/0.375 = $19d_b$

From Table 5-2(b) under "Uncoated Bars" and "Other Bars"; for "Case 1" and "Lap Class A":

ℓ_d = 15 in.

Check available embedment length vs. 15 in.

Maximum $+M_u$ occurs at midspan; the distance from midspan to the end of the #3 bars = 7 ft = 84 in. plus the embedment beyond the face of the support; total embedment provided, 84 + embedment > ℓ_d of 15 in., Okay.

Check $\ell_d \leq M_n/V_u + \ell_a$ . . . . . (ACI 12.11.3, Eq. 12-5)

Where $M_n = \phi M_n/\phi$ = 5.89/0.90 = 6.54 ft-kips/ft

V_u at support = $w_u(\ell_n/2)$

= 0.240(14/2) = 1.68 kips/ft

ℓ_a = embedment beyond center of support; assume ℓ_a is at least 1 in.

M_n/V_u = 6.54(12)/1.68 = 46.7

46.7 + 1 = 47.7 in. > ℓ_d, Okay

SOLID ONE-WAY SLABS—SINGLE SPAN

Recommended Minimum Reinforcement

f'_c = 4,000 psi — Grade 60 Bars — $\rho \geq 0.0018bh$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Bottom Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4	#4
Spacing (in.)	12	12	12	11	10	9	8	8	7	7	12	11	11
Top Bars	#3	#3	#3	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	12	12	12	12	12
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4
Spacing (in.)	12	12	12	11	10	9	8	8	7	7	6	11	11
Areas of Steel ($in.^2/ft$) Bottom	0.110	0.110	0.110	0.120	0.132	0.147	0.165	0.165	0.189	0.189	0.200	0.218	0.218
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	0.94	0.94	0.94	1.14	1.24	1.32	1.46	1.46	1.62	1.62	1.75	1.76	1.76
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	267	315	361	453	564	702	874	949					
6'-6"	219	258	297	374	468	584	729	792	991				
7'-0"	180	213	245	311	391	490	614	667	838	900			
7'-6"	149	177	204	260	329	414	521	566	715	768	869		
8'-0"	124	148	170	218	278	352	445	484	614	659	747	880	934
8'-6"	103	123	142	184	236	301	382	416	530	569	646	763	810
9'-0"	85	102	118	155	201	258	329	359	459	494	562	665	706
9'-6"	70	85	98	131	171	221	285	310	400	430	490	582	618
10'-0"	57	70	81	110	145	190	247	269	349	376	429	511	543
10'-6"	46	57	67	92	123	163	214	234	306	329	376	451	479
11'-0"		46	54	76	104	140	185	203	268	289	331	398	423
11'-6"			43	63	88	120	161	176	235	253	291	352	374
12'-0"				51	73	102	139	152	206	222	256	311	331
12'-6"				40	60	86	120	131	180	195	226	276	294
13'-0"					49	73	103	113	157	170	198	244	260
13'-6"						60	87	97	137	149	174	216	230
14'-0"						49	74	82	119	129	152	191	204
14'-6"							62	69	103	112	133	168	180
15'-0"							51	57	88	96	115	148	158
15'-6"							41	46	75	82	99	129	138
16'-0"									63	69	85	112	121
16'-6"									52	57	71	97	104
17'-0"									42	47	59	83	90
17'-6"											48	70	76
18'-0"												59	64
18'-6"												48	52
19'-0"													42
19'-6"													
20'-0"													

Note: CRSI recommendations for minimum reinforcement are based on practical considerations of rigidity against displacement under normal construction traffic. In all cases, these minimums satisfy minimum prescribed in ACI 10.5. See Fig. 7-1 for reinforcing bar details.

SOLID ONE-WAY SLABS—SINGLE SPAN

Bottom Steel for + M_u

f'_c = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0025$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Bottom Bars	#3	#3	#3	#3	#3	#3	#3	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	10	9	8	7	7	12	11	10	10	9	8
Top Bars	#3	#3	#3	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	12	12	12	12	12
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4
Spacing (in.)	12	12	12	11	10	9	8	8	7	7	6	11	11
Areas of Steel (in.^{2}/ft) Bottom	0.110	0.110	0.132	0.147	0.165	0.189	0.189	0.200	0.218	0.240	0.240	0.267	0.300
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	0.94	0.94	1.02	1.23	1.35	1.47	1.54	1.57	1.70	1.77	1.89	1.93	2.04
CLEAR SPAN	**FACTORED USABLE SUPERIMPOSED LOAD (psf)**												
6'-0"	267	315	447	570	724	925							
6'-6"	219	258	370	473	604	773	845	969					
7'-0"	180	213	308	396	508	653	714	820	975				
7'-6"	149	177	259	335	431	557	608	699	834	997			
8'-0"	124	148	218	284	368	477	522	601	719	861	920		
8'-6"	103	123	185	242	315	412	450	519	623	748	799	960	
9'-0"	85	102	156	207	272	357	390	451	542	653	698	840	
9'-6"	70	85	133	177	235	310	339	393	474	573	613	740	900
10'-0"	57	70	112	152	203	270	296	344	416	505	540	654	797
10'-6"	46	57	95	130	176	236	258	301	367	446	477	579	709
11'-0"		46	80	111	152	206	226	265	323	395	422	515	633
11'-6"			66	94	131	181	198	232	286	351	375	459	566
12'-0"			55	80	113	158	173	204	252	312	333	410	508
12'-6"			44	67	97	138	151	179	223	277	296	367	456
13'-0"				56	83	120	132	157	197	247	264	328	410
13'-6"				46	70	104	114	138	174	219	235	294	370
14'-0"					59	90	99	120	153	195	209	263	333
14'-6"					49	77	85	104	135	173	185	236	300
15'-0"					40	66	73	90	118	153	164	211	271
15'-6"						55	61	77	103	136	145	188	244
16'-0"						46	51	65	89	119	128	168	220
16'-6"							42	55	77	105	112	149	198
17'-0"								45	65	91	98	132	177
17'-6"									55	79	85	117	159
18'-0"									45	68	72	103	142
18'-6"										57	61	90	126
19'-0"										48	51	77	112
19'-6"											42	66	99
20'-0"												56	86

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

SOLID ONE-WAY SLABS—SINGLE SPAN

Bottom Steel for + M_u

f'_c = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0050$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Bottom Bars	#4	#4	#4	#4	#5	#5	#5	#5	#6	#6	#6	#6	#6
Spacing (in.)	12	11	10	8	12	11	10	9	12	11	11	10	9
Top Bars	#3	#3	#3	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	12	12	12	12	12
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4
Spacing (in.)	11	11	11	11	10	9	8	8	7	7	6	11	11
Areas of Steel (in.²/ft) Bottom	0.200	0.218	0.240	0.300	0.310	0.338	0.372	0.413	0.440	0.480	0.480	0.528	0.587
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	1.25	1.31	1.38	1.73	1.83	1.96	2.15	2.29	2.48	2.61	2.72	2.84	3.04
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	510	661	841										
6'-6"	425	553	705										
7'-0"	359	467	598	860	982								
7'-6"	305	398	511	738	844								
8'-0"	260	342	440	639	730	889							
8'-6"	224	295	381	556	637	776	943						
9'-0"	193	256	332	487	558	682	830						
9'-6"	167	223	290	429	492	602	734	898					
10'-0"	145	194	254	379	435	534	652	799	917				
10'-6"	126	170	223	336	386	475	582	714	821	973			
11'-0"	109	149	197	299	344	424	521	641	737	875	938		
11'-6"	95	131	174	266	307	380	467	577	664	790	847		
12'-0"	82	114	153	238	274	341	421	520	600	715	766	911	
12'-6"	71	100	135	212	246	306	379	471	544	649	696	828	991
13'-0"	61	87	119	190	220	276	343	427	493	590	633	755	905
13'-6"	52	76	105	170	198	249	310	387	449	538	577	690	828
14'-0"	44	66	92	152	178	225	281	352	409	491	527	631	759
14'-6"		57	81	136	159	203	255	321	373	449	482	579	698
15'-0"		49	71	122	143	183	231	292	341	411	441	531	642
15'-6"		41	61	109	128	165	210	266	311	377	405	488	592
16'-0"			53	97	115	149	190	243	285	346	372	450	546
16'-6"			45	86	102	134	172	222	261	318	341	414	504
17'-0"				77	91	121	156	202	239	292	314	382	466
17'-6"				68	81	109	142	185	218	268	288	352	432
18'-0"				59	72	97	128	168	200	247	265	325	400
18'-6"				52	63	87	115	153	183	227	244	300	370
19'-0"				45	55	77	104	139	167	208	224	277	343
19'-6"					48	68	93	127	152	191	206	256	318
20'-0"					41	60	83	115	139	176	189	236	295

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

SOLID ONE-WAY SLABS—SINGLE SPAN

Bottom Steel for + M_u

f'_c = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0075$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Bottom Bars	#4	#5	#5	#5	#6	#6	#6	#7	#7	#7	#7	#8	#8
Spacing (in.)	8	12	10	9	12	10	9	12	11	10	10	12	12
Top Bars	#3	#3	#3	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	12	12	12	12	12
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing (in.)	11	11	11	11	10	9	8	8	7	7	6	6	6
Areas of Steel (in.²/ft) Bottom	0.300	0.310	0.372	0.413	0.440	0.528	0.587	0.600	0.655	0.720	0.720	0.790	0.790
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	1.58	1.63	1.83	2.12	2.29	2.63	2.90	2.94	3.20	3.43	3.54	3.76	3.76
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	773	927											
6'-6"	650	780											
7'-0"	530*	663	925										
7'-6"	441*	569	796										
8'-0"	370*	492	690	878									
8'-6"	317*	428	586*	768	907								
9'-0"	267*	367*	497*	656*	799								
9'-6"	230*	313*	429*	565*	708	934*							
10'-0"	198*	273*	372*	494*	619*	814*							
10'-6"	172*	235*	324*	428*	544*	707*	895*						
11'-0"	149*	205*	284*	375*	475*	624*	786*	935					
11'-6"	130*	180*	251*	331*	422*	551*	691*	822*					
12'-0"	115*	160*	221*	293*	374*	488*	612*	733*	893*				
12'-6"	101*	139*	195*	260*	332*	435*	545*	653*	795*	970*			
13'-0"	88*	123*	174*	231*	296*	389*	487*	582*	714*	867*	981		
13'-6"	77*	110*	154*	208*	265*	348*	437*	522*	642*	781*	900		
14'-0"	69*	97*	138*	186*	238*	313*	393*	470*	579*	704*	815*	969	
14'-6"	60*	86*	123*	166*	212*	282*	355*	425*	521*	637*	734*	874*	954
15'-0"	54*	77*	110*	149*	192*	255*	321*	385*	472*	577*	666*	790*	882
15'-6"	47*	69*	99*	135*	173*	230*	291*	349*	429*	525*	607*	719*	816
16'-0"	42*	61*	89*	122*	157*	209*	265*	318*	391*	479*	554*	655*	750*
16'-6"		54*	79*	110*	142*	190*	241*	290*	357*	437*	507*	601*	684*
17'-0"		49*	72*	99*	129*	172*	220*	265*	326*	400*	464*	551*	627*
17'-6"		44*	65*	90*	117*	157*	201*	242*	299*	367*	426*	506*	576*
18'-0"			59*	82*	107*	144*	184*	222*	275*	338*	392*	466*	530*
18'-6"			53*	74*	97*	132*	169*	204*	253*	311*	361*	429*	489*
19'-0"			48*	68*	89*	121*	156*	188*	233*	286*	333*	396*	453*
19'-6"			44*	62*	81*	111*	143*	173*	215*	265*	308*	367*	419*
20'-0"			40*	56*	74*	102*	132*	160*	199*	245*	285*	340*	389*

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

SOLID ONE-WAY SLABS—SINGLE SPAN

Bottom Steel for + M_u

f'_c = 4,000 psi Grade 60 Bars $\rho \approx 0.0100$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Bottom Bars	#5	#5	#6	#6	#7	#7	#7	#8	#8	#8	#8	#9	#9
Spacing (in.)	10	9	11	10	12	11	10	12	11	10	10	12	11
Top Bars	#3	#3	#3	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	12	12	12	12	12
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing (in.)	11	11	11	11	10	9	8	8	7	7	6	6	6
Areas of Steel ($in.^2$/ft) Bottom	0.372	0.413	0.480	0.528	0.600	0.655	0.720	0.790	0.862	0.948	0.948	1.000	1.091
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	1.83	1.97	2.22	2.53	2.83	3.05	3.35	3.57	3.89	4.18	4.29	4.49	4.80

CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	835*												
6'-6"	675*												
7'-0"	549*	771*											
7'-6"	460*	644*											
8'-0"	386*	540*	730*										
8'-6"	327*	458*	622*	826*									
9'-0"	276*	388*	528*	706*									
9'-6"	237*	334*	455*	605*	786H*								
10'-0"	204*	289*	394*	524*	684H*								
10'-6"	177*	253*	343*	456*	596*	761*							
11'-0"	154*	221*	300*	400*	523*	667*							
11'-6"	135*	193*	264*	352*	461*	587*	747*						
12'-0"	118*	171*	233*	311*	408*	520*	660*						
12'-6"	104*	149*	208*	277*	363*	463*	587*	726*					
13'-0"	91*	133*	184*	246*	324*	413*	524*	649*					
13'-6"	81*	118*	164*	220*	290*	370*	470*	582*	718*				
14'-0"	71*	105*	146*	197*	260*	333*	423*	524*	647*				
14'-6"	63*	93*	131*	178*	234*	300*	381*	473*	584*	718*			
15'-0"	56*	84*	118*	160*	211*	271*	345*	428*	529*	651*	755*		
15'-6"	50*	75*	106*	144*	191*	246*	313*	389*	481*	592*	686*	801*	
16'-0"	44*	67*	95*	130*	172*	223*	285*	354*	438*	539*	626*	730*	
16'-6"	40*	60*	86*	118*	157*	203*	260*	323*	400*	492*	572*	668*	799*
17'-0"		54*	77*	107*	143*	186*	237*	295*	366*	451*	524*	612*	732*
17'-6"		49*	70*	97*	130*	170*	218*	270*	336*	414*	481*	562*	673*
18'-0"		44*	64*	89*	119*	155*	199*	248*	308*	380*	442*	518*	619*
18'-6"		40*	58*	81*	109*	143*	183*	228*	284*	350*	408*	477*	571*
19'-0"			53*	74*	100*	131*	168*	210*	262*	323*	376*	441*	528*
19'-6"			48*	68*	92*	120*	155*	194*	242*	299*	348*	408*	488*
20'-0"			44*	62*	84*	111*	143*	179*	224*	277*	322*	378*	453*

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

USE OF LOAD TABLES FOR END SPAN AND INTERIOR SPAN

Example 5. End Span and Interior Span—Select a solid slab design for a floor supported by monolithic beams at (clear) spacings of 15 ft. Superimposed service loads are: live load = 120 psf; celing construction = 10 psf; floor finish = 10 psf. No masonry partitions will be supported nor attached to the slab.

Augment and accumulate the superimposed factored loads:

Live load $120 \times 1.6 = 192$ psf
Dead load $20 \times 1.2 = \underline{24}$
Superimposed $w_u = 216$ psf

For equal loads and spans, the end span is most critical for thickness (factored shear is 1.15 times that in interior spans). Select end span design first, if it is desired to use the same depth of slab throughout.

See table for **End Span** mininum thickness tabulated, Page 7-18. Select thickness, h = 5½ in.; factored usable superimposed load w_u = 250* psf with $\rho \approx$ 0.0075.

Bottom bars: #5 spaced at 10 in.
Top bars: #5 spaced at 9 in.
Temperature-shrinkage bars: #3 spaced at 11 in.
Top bars at free end: #4 spaced at 12 in. Provide end hooks; see Fig. 7-1 for recommended bar details.

Interior Spans

Since exterior span top steel is used for interior span top steel, see table on Page 7-23 for minimum thickness. For h = 5½ in. (determined from end span), factored usable superimposed load w_u = 292 psf > 216.

Read reinforcement for $\rho \approx 0.0075$:
Bottom bars: #5 spaced at 12 in.
Top bars: #5 spaced at 9 in. (same as exterior span)
Temperature-shrinkage bars: #3 spaced at 11 in.

Serviceability Check

1. Deflection—Maximum deflection occurs in the end span. (See Chapter 6). At a service load, (1/1.6)(216) = 135 psf, the live load deflection limit is $\ell/360$. (Note asterisk in load capacity table.) Service live load, L = 120.

$$\text{Live load deflection} = \left(\frac{120}{135}\right)\left(\frac{15 \times 12}{360}\right) = 0.44\,\text{in.} < \ell/360$$

2. Crack Control—For ¾ in. of concrete cover, bar spacing is limited to 12 in. (ACI 10.6.4). Note that the maximum bar spacing used, #5 spaced at 12 in., is satisfactory.

Example 6. End Span and Interior Span—Some areas of interior spans in the same floor system described in Example 5 have to support partitions (service load = 10 psf) which would be damaged by large deflections. The partitions will be installed last, after an estimated 50 percent of other long-term load deflection occurs. Service live load (offices) in this area of the floor is 60 psf. Check long-term deflection.

Account for long-term sustained service load effects = (2) long-term load of partitions + (1)($D + L$) = (2)(10) + (69 + 10 + 10 + 60) = 169 psf equivalent superimposed load. Enter table for $\rho \approx 0.010$ on Page 7-24 with h = 5½ in. clear span = 15′-0″, and read factored usable superimposed load, w_u = 380 psf, which causes less deflection than $\ell/360$.

(380)(360/480) = 285 psf which causes less deflection than $\ell/480$.

Equivalent service live load, L = 285/1.6 = 178 psf > 169. Thus, long-term deflection should be satisfactory.

For a complete manual calculation, see Pages 7-11 through 7-14.

MANUAL CALCULATION

Example 7. End Span— Derive the factored usable superimposed load tabulated for an 7-in. solid slab with a percentage of reinforcement, $\rho \approx 0.0075$, on an 18-ft span. $f'_c = 4{,}000$ psi.

From the table on Page 7-18 with $\rho \approx 0.0075$, $h = 7$ in., and with #6 top bars at the first interior support which are spaced at 9 in. and #6 bottom bars spaced at 11 in., the factored usable superimposed load is 299 psf. Derive the load value of 299 psf.

Flexure

Compute the design positive moment strength based on the #6 bottom bars spaced at 11 in.:

$$\phi M_n = \phi A_s f_y (d - a/2)$$

Where $A_s = 12/11(0.44) = 0.480$ in.^{2}/ft for #6 bottom bars spaced at 11 in.

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.480(60)}{0.85(4)(12)} = 0.71 \text{ in.}$$

$$d = h - \text{cover} - 0.5d_b$$

$$d = 7.0 - 0.75 - 0.375 = 5.87 \text{ in.}$$

$$\phi M_n = 0.90(0.480)(60)(5.87 - 0.71/2)/12 = 11.91 \text{ ft-kips/ft}$$

Equate $+M_u = \phi M_n$ where $+M_u = w_u \ell_n^2/11$

$$w_u(18)^2/11 = 11.91$$

$$w_u = 0.404 \text{ klf or } 404 \text{ psf}$$

Compute the design moment strength based on the #6 top bars at the first interior support which are spaced at 9 in.:

$$\phi M_n = \phi A_s f_y (d - a/2)$$

Where $A_s = (12/9)(0.44) = 0.587$ in.^{2}/ft for #6 top bars spaced at 9 in.

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.587(60)}{0.85(4)(12)} = 0.86 \text{ in.}$$

$$d = h - \text{cover} - 0.5d_b$$

$$d = 7.0 - 0.75 - 0.375 = 5.87 \text{ in.}$$

$$\phi M_n = 0.90(0.587)(60)(5.87 - 0.86/2)/12 = 14.37 \text{ ft-kips/ft}$$

Equate $-M_u = \phi M_n$ where $-M_u = w_u \ell_n^2/10$

$$w_u(18)^2/10 = 14.37$$

$$w_u = 0.444 \text{ klf or } 444 \text{ psf}$$

Positive ϕM_n governs flexural capacity; hence, $w_u = 404$ psf

Factored usable superimposed load $= 404 - 1.2(150 \times 7/12) = 299$ psf (tabulated = 299, okay)

Recalculating – M_u:

$$-M_u = w_u(\ell_n)^2/10$$

$$= .404\ (18)^2/10$$

$$= 13.09 \text{ ft-kips/ft}$$

Shear

Compute design shear strength based on ACI Eq. 11-3,

$$\phi V_c = 2\phi\sqrt{f'_c}\, b_w d$$

$$= 2(0.75)\sqrt{4{,}000}(12)(5.87)/1{,}000 = 6.68 \text{ kips/ft}$$

A factored superimposed load based on ACI Eq. 11-5 cannot be derived directly because the quantity $V_u d/M_u$ is dependent on the load.

Equate $V_u = \phi V_c$

Compute V_u at a distance d from the face of the support; at the support, maximum $V_u = 1.15\ w_u \ell_n/2$ (ACI 8.3.3):

$$V_u = 1.15\ w_u(\ell_n/2 - d) \le \phi V_c$$

$$1.15\ w_u(18/2 - 5.87/12) = 6.68$$

$$w_u = 0.714 \text{ klf or } 714 \text{ psf}$$

Flexural capacity governs; hence, the factored usable superimposed load = 299 psf

Tension Development

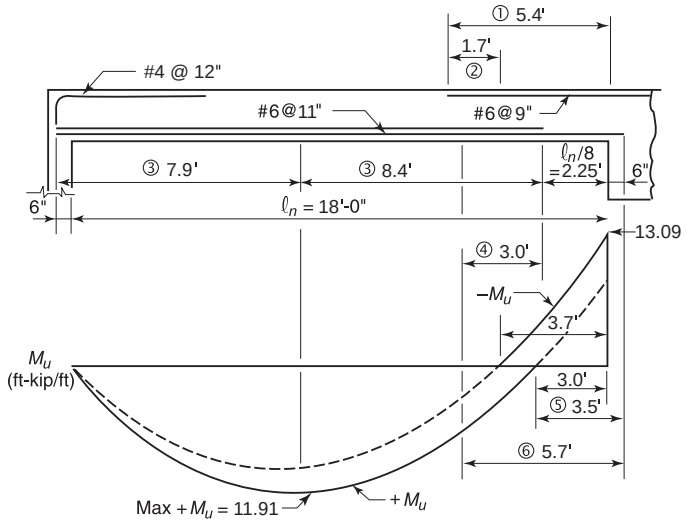
#6 top bars at the first interior support which are spaced at 9 in.

Concrete cover = 0.75 in. = $0.75/0.75 = 1.0d_b$

Spacing = 9 in. = $9/0.75 = 12.0d_b$

From Table 5-2(b) under "Uncoated Bars" and "Other Bars"; for "Case 1" and "Lap Class A" (for h = 7 in., this is less than 12 in. of concrete below the #6 bars):

ℓ_d = 29 in. = 2.42 ft



Top Bars:

Check ℓ_d = 29 in. vs. embedment length provided and check embedment lengths provided beyond the point where the bars are no longer required to resist flexure; i.e., check the Dimension labeled ① vs. ACI 12.1.1 and Dimension ② vs. ACI 12.10.3.

Dimension ① = 5.4 ft > ℓ_d = 2.42 ft, okay

Dimension ② = 1.7 ft > $12d_b$ = 12(0.75) = 9.0 in. = 0.75 ft, okay

Dimension ② = 1.7 ft > d = 5.87 in. = 0.49 ft, okay

Bottom Bars:

#6 bottom bars spaced at 11 in.

Concrete cover = 0.75 in. = 0.75/0.75 = $1.0d_b$
Spacing = 11 in. = 11/0.75 = $15d_b$

From Table 5-2(b) under "Uncoated Bars" and "Other Bars"; for "Case 1" and "Lap Class A":

ℓ_d = 29 in. = 2.42 ft

At the inflection point, ACI 12.11.3 requires checking,

$$\ell_d \le \frac{M_n}{V_u} + \ell_a \quad \text{. . . . . (ACI Eq. 12-5)}$$

Where $M_n = \frac{\phi M_n}{\phi} = \frac{11.91}{0.90}$ = 13.23 ft-kips/ft

$V_u = w_u\,(\ell_n/2 - 2.4) = 0.404(18/2 - 2.4)$ = 2.67 kips/ft

ℓ_a is the larger of $12d_b$ or d

$12d_b$ = 12(0.75) = 9 in.

d = 5.87 in.

Use $\ell_a = 12d_b$ = 9 in.

$$\frac{M_n}{V_u} + \ell_a = \frac{13.23(12)}{2.67} + 9 = 59.5 + 9 = 68.5 \text{ in.}$$

68.5 in. > ℓ_d = 29 in., okay

Check ℓ_d = 29 in. vs. embedment length provided, and check embedment lengths provided beyond the point where the bars are no longer required to resist flexure, i.e., check the Dimension labeled ③ vs. ACI 12.1.1, check the Dimensions labeled ④ and ⑤ vs. ACI 12.10.3, and check the Dimension labeled ⑥ vs. ACI 12.1.1.

Dimension ③ = 7.90 ft or 8.4 ft > ℓ_d = 2.42 ft, okay

Dimension ④ = 3.0 ft > $12d_b$ = 12(0.75) = 9 in. = 0.75 ft, okay

Dimension ④ = 3.0 ft > d = 5.87 in. = 0.49 ft, okay

Dimension ⑤ = 3.5 ft > $12d_b$ = 9 in. = 0.75 ft, okay

Dimension ⑤ = 3.5 ft > d = 5.87 in. = 0.49 ft, okay

Dimension ⑥ is the distance from the end of the bottom bars (#6 spaced at 22 in.) to the point on the factored moment diagram where ϕM_n of the #6 bars spaced at 22 in. = 6.15 ft-kips/ft = M_u.

MANUAL CALCULATION

Example 8. Interior Span— Derive the factored usable superimposed load tabulated for an 8-in. solid slab with minimum reinforcement on a 15-ft span.

From the table on Page 7-20 with minimum reinforcement, h = 8 in., and with #4 top bars spaced at 12 in. and #3 bottom bars spaced at 7 in., the factored usable superimposed load is 181 psf. Derive the load value of 181 psf.

Flexure

Compute the design positive moment strength based on the #3 bottom bars spaced at 7 in.:

$$\phi M_n = \phi A_s f_y\ (d - a/2)$$

Where A_s = 12/7(0.11) = 0.189 in.^{2}/ft for #3 bottom bars spaced at 7 in.

$$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{0.189(60)}{0.85(4)(12)} = 0.28 \text{ in.}$$

$$d = h - \text{cover} - 0.5d_b$$

$$d = 8.0 - 0.75 - 0.19 = 7.06 \text{ in.}$$

$$\phi M_n = 0.90(0.189)(60)(7.06 - 0.28/2)/12 = 5.88 \text{ ft-kips/ft}$$

Equate $+M_u = \phi M_n$ where $+M_u = w_u \ell_n^2/16$

$$w_u(15)^2/16 = 5.88$$

$$w_u = 0.418 \text{ klf or } 418 \text{ psf}$$

Compute the design moment strength based on the #4 top bars spaced at 12 in.:

$$\phi M_n = \phi A_s f_y\ (d - a/2)$$

Where A_s = 12/12(0.20) = 0.20 in.^{2}/ft for #4 top bars spaced at 12 in.

$$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{0.20(60)}{0.85(4)(12)} = 0.29 \text{ in.}$$

$$d = h - \text{cover} - 0.5d_b$$

$$d = 8.0 - 0.75 - 0.25 = 7.0 \text{ in.}$$

$$\phi M_n = 0.90(0.20)(60)(7.0 - 0.29/2)/12 = 6.17 \text{ ft-kips/ft}$$

Equate $-M_u = \phi M_n$ where $-M_u = w_u \ell_n^2/11$

$$w_u(15)^2/11 = 6.17$$

$$w_u = 0.301 \text{ klf or } 301 \text{ psf}$$

Negative ϕM_n governs flexural capacity; hence, w_u = 301 psf

Factored usable superimposed load = 301 – 1.2(100) = 181 psf (tabulated = 181, okay)

Recalculating $+M_u$:

$$+M_u = w_u \ell_n^2/16$$

$$= 0.301\ (15)^2/16$$

$$= 4.23 \text{ ft-kips/ft}$$

Shear

Compute the design shear strength based on ACI Eq. 11-3,

$$\phi V_c = 2\phi\sqrt{f_c'}\, b_w d$$

$$= 2(0.75)\sqrt{4{,}000}(12)(7)/1{,}000 = 7.97 \text{ kips/ft}$$

A factored usable superimposed load based on ACI Eq. 11-5 cannot be derived directly because the quantity $V_u d/M_u$ is dependent on the load.

Equate $V_u = \phi V_c$

Compute V_u at a distance d from the face of the support; at the support, maximum $V_u = w_u \ell_n/2$ (ACI 8.3.3):

$$V_u = w_u(\ell_n/2 - d\ )$$

$$w_u(15/2 - 7/12) = 7.97 \text{ k/ft}$$

$$w_u = 1.15 \text{ klf or } 1{,}150 \text{ psf}$$

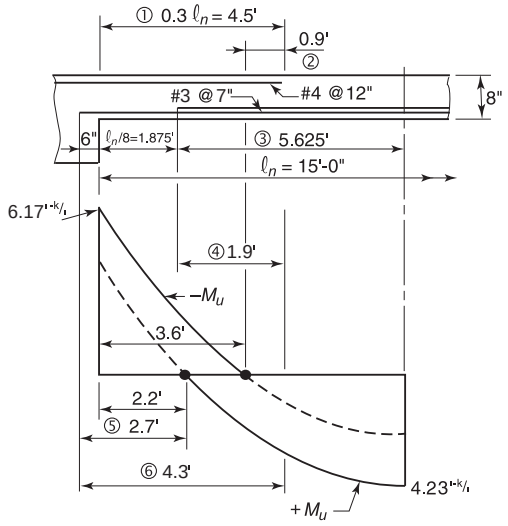
Flexural capacity governs; hence, the factored usable superimposed load = 181 psf

Tension Development

#4 top bars are spaced at 12 in.

Concrete cover = 0.75 in. = 0.75/0.5 = 1.5 d_b

Spacing = 12 in. = 12/0.5 = 24 d_b



From Table 5-2(b) under "Uncoated Bars" and "Other Bars"; for "Case 1" and "Lap Class A" (for h = 8 in., less than 12 in. of concrete will be cast below the #4 bars):

ℓ_d = 19 in. = 1.58 ft

Check ℓ_d = 19 in. vs. embedment length provided and check embedment lengths provided beyond the point where the bars are no longer required to resist flexure; i.e., check the Dimension labeled ① vs. ACI 12.1.1 and Dimension ② vs. ACI 12.10.3.

Dimension ① = 4.5 ft > ℓ_d = 1.58 ft, okay

Dimension ② = 0.9 ft > 12d_b = 12(0.5) = 6.0 in. = 0.5 ft, okay

Dimension ② = 0.9 ft > d = 7 in. = 0.58 ft, okay

#3 bottom bars spaced at 7 in.

From Table 5-2(b) under "Uncoated Bars" and "Other Bars"; for "Case 1" and "Lap Class A":

ℓ_d = 15 in. = 1.25 ft

At the inflection point, ACI 12.11.3 requires checking,

$$\ell_d \le \frac{M_n}{V_u} + \ell_a \quad \text{. . . . . (ACI Eq. 12-5)}$$

Where $M_n = \dfrac{\phi M_n}{\phi} = \dfrac{5.88}{0.90}$ = 6.53 ft-kips/ft

$V_u = w_u(\ell_n/2 - 2.2) = 0.301(15/2 - 2.2) = 1.59$ kips/ft

ℓ_a is the larger of 12 d_b or d

12d_b = 12(0.375) = 4.5 in.

d = 7 in.

Use ℓ_a = 7 in.

$$\frac{M_n}{V_u} + \ell_a = \frac{6.53(12)}{1.59} + 7 = 49.3 + 7 = 56.3 \text{ in.}$$

56.3 in. > ℓ_d = 15 in., okay

Check ℓ_d = 15 in. vs. embedment length provided, and check embedment lengths provided beyond the point where the bars are no longer required to resist flexure, i.e., check the Dimension labeled ③ vs. ACI 12.1.1, check the Dimensions labeled ④ and ⑤ vs. ACI 12.10.3, and check the Dimension labeled ⑥ vs. ACI 12.1.1.

Dimension ③ = 5.625 ft > ℓ_d = 1.25 ft, okay

Dimension ④ = 1.9 ft > 12 d_b = 12(0.375) = 4.5 in. = 0.4 ft, okay

Dimension ④ = 1.9 ft > d = 7 in. = 0.58 ft, okay

Dimension ⑤ = 2.7 ft > 12 d_b = 4.5 in. = 0.4 ft, okay

Dimension ⑤ = 2.7 ft > d = 7 in. = 0.58 ft, okay

Dimension ⑥ is the distance from the end of the bottom bars (#3 spaced at 14 in.) to the point on the factored moment diagram where ϕM_n of the #3 bars spaced at 14 in. = 2.96 ft-kips/ft = M_u.

Dimension ⑥ = 4.3 ft > ℓ_d = 1.25 ft, okay

SOLID ONE-WAY SLABS—END SPAN

Recommended Minimum Reinforcement

f'_c = 4,000 psi — Grade 60 Bars — $\rho \geq 0.0018bh$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Top Bars	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	12	12	12	11	11
Bottom Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4	#4
Spacing (in.)	12	12	12	11	10	9	8	8	7	7	12	11	11
Top Bars Free End	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	12	12	12	12	12
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4
Spacing (in.)	12	12	12	11	10	9	8	8	7	7	6	11	11
Areas of Steel ($in.^2/ft$)													
Top Interior	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.218	0.218
Bottom	0.110	0.110	0.110	0.120	0.132	0.147	0.165	0.165	0.189	0.189	0.200	0.218	0.218
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	1.10	1.10	1.10	1.15	1.24	1.33	1.46	1.46	1.61	1.61	1.75	1.77	1.77

CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	390	458	526	654	810								
6'-6"	323	381	437	545	677	839							
7'-0"	271	319	366	459	571	710	884	960					
7'-6"	228	269	309	389	486	606	756	821					
8'-0"	193	228	262	332	416	521	652	708	889	954			
8'-6"	164	194	224	284	358	450	565	614	774	831	939		
9'-0"	140	166	191	245	310	391	493	536	677	727	823	968	
9'-6"	119	142	164	211	269	341	431	469	595	640	725	854	907
10'-0"	102	122	141	182	234	298	379	412	525	565	641	757	804
10'-6"	87	104	120	158	204	261	334	364	439	472	505	599	636
11'-0"	74	89	103	136	177	229	295	321	389	419	448	533	566
11'-6"	62	76	88	117	155	202	261	284	346	372	398	476	505
12'-0"	52	64	74	101	135	177	231	252	308	332	354	425	452
12'-6"	43	54	63	87	117	156	204	223	274	296	316	380	405
13'-0"		44	52	74	101	136	181	198	244	264	282	341	363
13'-6"			43	62	87	119	160	175	218	235	252	306	325
14'-0"				52	75	104	141	155	194	210	224	274	292
14'-6"				43	64	91	125	137	173	187	200	246	262
15'-0"					54	78	109	120	153	166	178	220	235
15'-6"					44	67	96	106	136	148	158	197	211
16'-0"						57	83	92	120	131	140	176	188
16'-6"						48	72	80	106	115	123	157	168
17'-0"							62	69	93	101	108	140	150
17'-6"							52	58	81	88	95	124	133
18'-0"							44	49	70	76	82	109	117
18'-6"								40	60	66	70	96	103
19'-0"									50	56	60	83	90
19'-6"									42	46	50	72	78
20'-0"											41	61	66

Note: CRSI recommendations for minimum reinforcement are based on practical considerations of rigidity against displacement under normal construction traffic. In all cases, these minimums satisfy minimum prescribed in ACI 10.5. See Fig. 7-1 for reinforcing bar details.

SOLID ONE-WAY SLABS—END SPAN

Top Steel for $-M_u$

f'_c = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0025$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Top Bars Spacing (in.)	#4 12	#4 12	#4 12	#4 12	#4 12	#4 12	#4 12	#4 12	#4 11	#4 10	#4 10	#4 9	#4 8
Bottom Bars Spacing (in.)	#3 12	#3 12	#3 12	#3 10	#3 9	#3 8	#3 8	#3 7	#4 12	#4 11	#4 11	#4 10	#4 9
Top Bars Free End Spacing (in.)	#4 12	#4 12	#4 12	#4 12	#4 12	#4 12	#4 12	#4 12	#4 12	#4 12	#4 12	#4 12	#4 12
T-S Bars Spacing (in.)	#3 12	#3 12	#3 12	#3 11	#3 10	#3 9	#3 8	#3 8	#3 7	#3 7	#3 6	#4 11	#4 11
Areas of Steel ($in.^2/ft$) Top Interior	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.218	0.240	0.240	0.267	0.300
Bottom	0.110	0.110	0.110	0.132	0.147	0.165	0.165	0.189	0.200	0.218	0.218	0.240	0.267
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	1.10	1.10	1.10	1.19	1.29	1.38	1.46	1.54	1.65	1.73	1.84	1.89	2.00
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	390	458	526	727	908								
6'-6"	323	381	437	607	760	954							
7'-0"	271	319	366	512	643	809	884						
7'-6"	228	269	309	435	549	692	756	952					
8'-0"	193	228	262	372	471	596	652	823	939				
8'-6"	164	194	224	320	407	517	565	716	818	969			
9'-0"	140	166	191	277	353	451	493	627	717	850	909		
9'-6"	119	142	164	240	308	394	431	551	631	750	802	952	
10'-0"	102	122	141	208	269	346	379	486	558	665	710	845	
10'-6"	87	104	120	181	236	305	334	405	488	589	630	753	903
11'-0"	74	89	103	158	207	269	295	359	434	526	562	674	810
11'-6"	62	76	88	137	181	238	261	319	387	470	503	604	728
12'-0"	52	64	74	119	159	211	231	284	346	421	450	543	656
12'-6"	43	54	63	103	140	187	204	252	309	378	404	489	593
13'-0"		44	52	89	122	165	181	225	277	340	364	442	537
13'-6"			43	77	107	146	160	200	248	306	327	399	487
14'-0"				65	93	129	141	178	222	276	295	361	442
14'-6"				55	80	114	125	159	199	248	266	327	402
15'-0"				46	69	100	109	141	178	224	239	296	366
15'-6"					59	87	96	125	159	201	215	268	333
16'-0"					50	76	83	110	142	181	194	243	303
16'-6"					42	65	72	97	126	163	174	220	276
17'-0"						56	62	84	112	146	156	199	251
17'-6"						47	52	73	99	130	140	179	229
18'-0"							44	63	87	116	125	162	208
18'-6"								54	76	103	111	146	189
19'-0"								45	65	91	98	131	171
19'-6"									56	80	86	117	155
20'-0"									47	70	75	104	140

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

SOLID ONE-WAY SLABS—END SPAN

Top Steel for $-M_u$

f'_c = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0050$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Top Bars	#4	#4	#4	#4	#5	#5	#5	#5	#6	#6	#6	#6	#6
Spacing (in.)	12	11	10	8	12	11	10	9	12	11	11	10	9
Bottom Bars	#3	#4	#4	#4	#4	#5	#5	#5	#5	#5	#6	#6	#6
Spacing (in.)	7	12	11	9	8	12	11	10	9	9	12	11	11
Top Bars Free End	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	12	12	12	12	12
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4
Spacing (in.)	12	11	11	11	10	9	8	8	7	7	6	11	11
Areas of Steel ($in.^2/ft$)													
Top Interior	0.200	0.218	0.240	0.300	0.310	0.338	0.372	0.413	0.440	0.480	0.480	0.528	0.587
Bottom	0.189	0.200	0.218	0.267	0.300	0.310	0.338	0.372	0.413	0.413	0.440	0.480	0.480
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	1.35	1.41	1.49	1.70	1.87	1.97	2.17	2.32	2.56	2.60	2.82	2.95	3.01
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	697	854											
6'-6"	585	718	905										
7'-0"	496	609	770										
7'-6"	424	522	661	926									
8'-0"	366	451	572	804									
8'-6"	317	392	498	703	892								
9'-0"	276	342	436	618	785	889							
9'-6"	242	300	383	546	696	788	949						
10'-0"	212	264	338	485	619	701	846						
10'-6"	172	230	298	432	505	618	754	916					
11'-0"	152	203	265	386	452	555	677	824	951				
11'-6"	134	180	236	346	406	499	611	745	860	976			
12'-0"	118	160	211	311	366	451	552	675	780	886	992		
12'-6"	104	142	188	280	330	408	501	613	710	806	904		
13'-0"	91	126	168	253	298	369	455	558	647	736	825	979	
13'-6"	80	112	150	228	270	335	414	509	591	673	755	898	960
14'-0"	70	100	134	206	245	305	378	466	541	617	693	825	882
14'-6"	62	88	120	187	222	278	345	426	496	566	637	759	812
15'-0"	54	78	107	169	201	253	315	391	456	521	586	700	749
15'-6"	46	69	96	153	183	231	288	359	419	480	540	646	692
16'-0"	40	60	85	139	166	211	264	330	386	442	498	598	640
16'-6"		53	76	125	151	192	242	303	356	408	461	554	593
17'-0"		46	67	113	137	175	222	279	328	377	426	513	550
17'-6"			59	102	124	160	203	257	303	349	394	476	511
18'-0"			51	92	112	146	186	237	280	323	365	442	474
18'-6"			45	83	101	133	171	218	258	299	339	411	441
19'-0"				74	91	121	156	201	239	277	314	382	410
19'-6"				66	82	110	143	185	221	256	291	356	382
20'-0"				59	74	100	131	170	204	237	270	331	356

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

SOLID ONE-WAY SLABS—END SPAN

Top Steel for $-M_u$

$f_c' = 4{,}000$ psi — Grade 60 Bars — $\rho \approx 0.0075$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Top Bars	#4	#5	#5	#5	#6	#6	#6	#7	#7	#7	#7	#8	#8
Spacing (in.)	8	12	10	9	12	10	9	12	11	10	10	12	12
Bottom Bars	#4	#4	#5	#5	#5	#6	#6	#6	#6	#7	#7	#7	#7
Spacing (in.)	9	8	11	10	9	12	11	10	9	12	11	10	10
Top Bars Free End	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	12	12	11	10	10
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing (in.)	11	11	11	11	10	9	8	8	7	7	6	6	6
Areas of Steel ($in.^2/ft$)													
Top Interior	0.300	0.310	0.372	0.413	0.440	0.528	0.587	0.600	0.655	0.720	0.720	0.790	0.790
Bottom	0.267	0.300	0.338	0.372	0.413	0.440	0.480	0.528	0.587	0.600	0.655	0.720	0.720
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	1.70	1.81	2.00	2.15	2.37	2.60	2.87	3.03	3.35	3.46	3.76	4.05	4.05

CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	967												
6'-6"	815												
7'-0"	695	926											
7'-6"	597	798											
8'-0"	518	693	888										
8'-6"	452	606	778	978									
9'-0"	396	533	686	863									
9'-6"	349	472	608	766	960								
10'-0"	309	419	541	683	857								
10'-6"	275	338	480	612	727	900							
11'-0"	245	302	431	550	654	811	978						
11'-6"	219	271	388	496	591	734	886						
12'-0"	196	243	350	449	535	666	805	973H					
12'-6"	172*	219	316	407	486	606	733	888H					
13'-0"	154*	197	287	370	443	553	670	812H	983H				
13'-6"	137*	178	260	337	404	506	614	745H	903H	992H			
14'-0"	123*	161	233*	308	369	464	563	685H	831H	913H			
14'-6"	109*	145	210*	279*	338	425	518	631H	766H	843H	986H		
15'-0"	99*	131	191*	250*	310	391	477	582H	708H	779H	913H		
15'-6"	88*	119	173*	227*	285	360	440	538H	656H	722H	846H	991H	
16'-0"	79*	107	155*	208*	261	332	406	498H	608H	669H	786H	922H	984H
16'-6"	71*	97	142*	189*	240	306	376	461H	564H	622H	731H	858H	916H
17'-0"	64*	87	129*	173*	221	283	348	428H	525H	578H	680H	800H	854H
17'-6"	57*	78	116*	157*	204	261	322	398	484*	539	634	747H	798H
18'-0"	52*	70	107*	143*	188	238*	299	363*	445*	502	592	698H	746H
18'-6"	47*	63	97*	132*	172*	220*	277	336*	411*	468	553	653H	698H
19'-0"	42	56	88*	121*	158*	203*	255*	311*	381*	438	517	612H	654H
19'-6"		50	81*	110*	145*	187*	234*	288*	351*	409	484	574H	613H
20'-0"		44	74*	101*	133*	172*	216*	265*	325*	382	454	538	575

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

SOLID ONE-WAY SLABS—END SPAN

Top Steel for $-M_u$

f'_c = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0100$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Top Bars	#5	#5	#6	#6	#7	#7	#7	#8	#8	#8	#8	#9	#9
Spacing (in.)	10	9	11	10	12	11	10	12	11	10	10	12	11
Bottom Bars	#5	#5	#6	#6	#6	#7	#7	#7	#7	#8	#8	#8	#9
Spacing (in.)	11	10	12	11	10	12	11	10	9	12	11	10	12
Top Bars Free End	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	12	12	11	10	10
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing (in.)	11	11	11	11	10	9	8	8	7	7	6	6	6
Areas of Steel ($in.^2/ft$)													
Top Interior	0.372	0.413	0.480	0.528	0.600	0.655	0.720	0.790	0.862	0.948	0.948	1.000	1.091
Bottom	0.338	0.372	0.440	0.480	0.528	0.600	0.655	0.720	0.800	0.790	0.862	0.948	1.000
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	2.00	2.15	2.46	2.64	2.92	3.24	3.56	3.83	4.24	4.27	4.63	4.98	5.25

CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	995H												
6'-6"	907												
7'-0"	833	991											
7'-6"	718*	915											
8'-0"	578*	842	967										
8'-6"	481*	721*	901										
9'-0"	403*	614*	834*	964									
9'-6"	341*	536*	721*	904									
10'-0"	292*	463*	623*	824*	945H								
10'-6"	253*	409*	550*	722*	892H	996H							
11'-0"	219*	356*	480*	631*	814H*	942H							
11'-6"	228*	315*	429*	563*	720H*	893H	987H						
12'-0"	202*	279*	381*	497*	644H*	817H*	937H						
12'-6"	179*	251*	339*	444*	575H*	729H*	892H	967H					
13'-0"	158*	224*	301*	397*	516H*	654H*	817H*	921H					
13'-6"	142*	199*	270*	357*	461H*	585H*	732H*	880H	959H				
14'-0"	126*	180*	245*	322*	416H*	528H*	664H*	815H*	917H	994H			
14'-6"	112*	162*	219*	291*	377H*	478H*	601H*	742H*	879H	952H			
15'-0"	102*	146*	200*	265*	342H*	434H*	546H*	671H*	829H*	913H	983H		
15'-6"	91*	131*	179*	241*	311H*	395H*	498H*	611H*	754H*	877H	944H		
16'-0"	81*	118*	164*	217*	285H*	361H*	454H*	558H*	690H*	814H*	907H	964H	
16'-6"	73*	107*	149*	198*	260H*	330H*	416H*	511H*	630H*	748H*	873H	927H	992H
17'-0"	66*	97*	135*	182*	237H*	302H*	381H*	469H*	578H*	687H*	808H*	893H	955H
17'-6"	59*	88*	123*	166*	217*	277*	350*	431H*	531H*	632H*	746H*	861H	921H
18'-0"	54*	80*	112*	152*	198*	255*	322*	397H*	490H*	583H*	688H*	814H*	888H
18'-6"	49*	73*	102*	139*	182*	235*	297*	366H*	452H*	538H*	636H*	750H*	858H
19'-0"	44*	66*	93*	127*	168*	217*	274*	338H*	418H*	498H*	589H*	696H*	817H*
19'-6"	40*	60*	86*	117*	155*	200*	253*	313H*	387H*	462H*	546H*	645H*	756H*
20'-0"		55*	79*	108*	143*	185*	234*	290*	359*	429*	507*	600H*	702H*

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

SOLID ONE-WAY SLABS—INTERIOR SPAN

$f_c' = 4{,}000$ psi — Grade 60 Bars — Recommended Minimum Steel Top and Bottom

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Top Bars	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	12	12	12	11	11
Bottom Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4	#4
Spacing (in.)	12	12	12	11	10	9	8	8	7	7	12	11	11
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4
Spacing (in.)	12	12	12	11	10	9	8	8	7	7	6	11	11
Areas of Steel ($in.^2/ft$)													
Top Interior	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.218	0.218
Bottom	0.110	0.110	0.110	0.120	0.132	0.147	0.165	0.165	0.189	0.189	0.200	0.218	0.218
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	1.11	1.11	1.11	1.15	1.25	1.33	1.46	1.46	1.60	1.60	1.74	1.78	1.78
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	595	698	799	990									
6'-6"	498	584	670	831									
7'-0"	421	495	567	705	872								
7'-6"	359	422	484	603	748	926							
8'-0"	308	363	416	520	646	802	881	958					
8'-6"	266	314	360	451	562	699	768	836	903	971			
9'-0"	231	272	313	394	492	613	674	733	793	852	910		
9'-6"	201	238	273	345	432	540	594	647	699	752	803	945	
10'-0"	175	208	239	303	381	478	526	572	619	666	712	839	890
10'-6"	153	182	210	267	337	383	419	457	495	532	569	673	715
11'-0"	134	160	184	236	299	340	373	406	440	474	506	601	638
11'-6"	118	141	162	209	266	303	332	362	392	422	451	537	571
12'-0"	103	124	143	185	237	270	296	323	350	378	404	482	512
12'-6"	90	109	126	164	211	241	265	289	313	338	361	433	460
13'-0"	79	95	110	145	189	216	237	259	281	303	324	389	414
13'-6"	69	83	97	129	168	193	212	232	252	272	290	351	373
14'-0"	60	73	85	114	150	173	189	207	225	244	260	316	336
14'-6"	52	63	74	100	134	154	169	186	202	218	233	285	303
15'-0"	44	55	64	88	119	138	151	166	181	196	209	257	274
15'-6"		47	55	77	106	123	135	148	162	175	187	231	247
16'-0"		40	47	68	94	109	120	132	144	157	167	208	222
16'-6"			40	59	83	97	107	118	129	140	149	187	200
17'-0"				50	73	86	94	104	114	124	133	168	180
17'-6"				43	63	75	83	92	101	110	118	151	161
18'-0"					55	66	73	81	89	97	104	135	144
18'-6"					47	57	63	70	78	85	91	120	128
19'-0"					40	49	54	61	67	74	79	106	114
19'-6"						42	46	52	58	64	68	93	100
20'-0"								44	49	54	58	82	88

Note: CRSI recommendations for minimum reinforcement are based on practical considerations of rigidity against displacement under normal construction traffic. In all cases, these minimums satisfy minimum prescribed in ACI 10.5. See Fig. 7-1 for reinforcing bar details.

SOLID ONE-WAY SLABS—INTERIOR SPAN

Top Steel for $-M_u$

f'_c = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0025$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Top Bars	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4	#4
Spacing (in.)	12	12	12	12	12	12	12	12	11	10	10	9	8
Bottom Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4
Spacing (in.)	12	12	12	12	11	10	9	8	8	7	7	11	10
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4
Spacing (in.)	12	12	12	11	10	9	8	8	7	7	6	11	11
Areas of Steel (in.²/ft)													
Top Interior	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.218	0.240	0.240	0.267	0.300
Bottom	0.110	0.110	0.110	0.110	0.120	0.132	0.147	0.165	0.165	0.189	0.189	0.218	0.240
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	1.11	1.11	1.11	1.12	1.21	1.28	1.40	1.46	1.57	1.68	1.80	1.87	2.00
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	595	698	799	902									
6'-6"	498	584	670	756	926								
7'-0"	421	495	567	640	786	962							
7'-6"	359	422	484	547	673	825							
8'-0"	308	363	416	471	580	713	876	958					
8'-6"	266	314	360	408	504	621	764	836	994				
9'-0"	231	272	313	355	440	543	670	733	874				
9'-6"	201	238	273	310	385	477	590	647	772	924	987		
10'-0"	175	208	239	271	339	421	522	572	685	821	877		
10'-6"	153	182	210	238	299	373	419	457	549	661	707	851	
11'-0"	134	160	184	210	264	331	373	406	490	591	632	762	927
11'-6"	118	141	162	185	234	295	332	362	438	530	566	685	835
12'-0"	103	124	143	163	208	263	296	323	392	476	509	618	755
12'-6"	90	109	126	144	184	234	265	289	352	429	458	558	684
13'-0"	79	95	110	127	164	209	237	259	316	387	414	505	621
13'-6"	69	83	97	111	145	187	212	232	285	349	374	458	565
14'-0"	60	73	85	98	129	167	189	207	256	316	338	416	514
14'-6"	52	63	74	85	114	149	169	186	231	286	306	378	469
15'-0"	44	55	64	74	100	133	151	166	208	259	277	344	429
15'-6"		47	55	64	88	118	135	148	187	234	251	313	392
16'-0"		40	47	55	77	105	120	132	168	212	227	285	359
16'-6"			40	47	67	93	107	118	151	192	205	259	328
17'-0"					58	82	94	104	135	173	185	236	300
17'-6"					50	72	83	92	121	156	167	214	275
18'-0"					42	62	73	81	107	141	151	195	252
18'-6"						54	63	70	95	126	135	177	230
19'-0"						46	54	61	84	113	121	160	211
19'-6"							46	52	74	101	108	145	192
20'-0"								44	64	90	96	131	175

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

SOLID ONE-WAY SLABS—INTERIOR SPAN

Top Steel for $-M_u$

f'_c = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0050$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Top Bars	#4	#4	#4	#4	#5	#5	#5	#5	#6	#6	#6	#6	#6
Spacing (in.)	12	11	10	8	12	11	10	9	12	11	11	10	9
Bottom Bars	#3	#3	#3	#4	#4	#4	#4	#5	#5	#5	#5	#5	#5
Spacing (in.)	9	8	7	11	10	9	8	12	11	11	10	9	9
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#4	#4
Spacing (in.)	12	12	12	11	10	9	8	8	7	7	6	11	11
Areas of Steel ($in.^2/ft$)													
Top Interior	0.200	0.218	0.240	0.300	0.310	0.338	0.372	0.413	0.440	0.480	0.480	0.528	0.587
Bottom	0.147	0.165	0.189	0.218	0.240	0.267	0.300	0.310	0.338	0.338	0.372	0.413	0.413
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	1.22	1.31	1.42	1.63	1.78	1.95	2.19	2.31	2.54	2.62	2.83	3.00	3.12
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	795												
6'-6"	668	863											
7'-0"	568	735	935										
7'-6"	487	631	804										
8'-0"	421	547	698	981									
8'-6"	366	477	609	860	1000								
9'-0"	320	418	535	758	883								
9'-6"	281	368	473	672	783	952							
10'-0"	247	326	419	598	698	850							
10'-6"	196	259	336	493	565	690	840						
11'-0"	173	230	299	442	507	620	756	924					
11'-6"	153	205	267	397	456	559	682	835	958				
12'-0"	136	183	239	358	411	505	618	758	870				
12'-6"	120	163	214	323	372	458	561	690	793	940			
13'-0"	107	146	193	293	337	416	511	629	724	859	921		
13'-6"	94	130	173	265	306	379	466	575	662	788	844		
14'-0"	84	116	156	241	278	345	426	527	607	723	776	922	
14'-6"	74	104	140	219	253	315	390	483	558	666	714	849	
15'-0"	65	93	126	199	231	288	357	444	514	614	658	784	939
15'-6"	57	82	113	181	210	264	328	409	473	567	608	725	870
16'-0"	50	73	101	165	192	242	301	377	437	524	562	672	807
16'-6"	43	65	91	150	175	221	277	348	404	485	520	623	750
17'-0"		57	81	137	159	203	255	321	373	449	482	579	698
17'-6"		50	72	124	145	186	234	296	345	417	447	538	650
18'-0"		44	64	113	132	170	216	274	320	387	415	501	606
18'-6"			57	102	121	156	199	253	296	360	386	466	566
19'-0"			50	93	110	143	183	234	275	334	359	435	529
19'-6"			43	84	99	131	168	217	255	311	334	406	494
20'-0"				76	90	119	155	200	236	289	311	378	462

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

SOLID ONE-WAY SLABS—INTERIOR SPAN

Top Steel for $-M_u$

f'_c = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0075$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Top Bars	#4	#5	#5	#5	#6	#6	#6	#7	#7	#7	#7	#8	#8
Spacing (in.)	8	12	10	9	12	10	9	12	11	10	10	12	12
Bottom Bars	#4	#4	#4	#5	#5	#5	#5	#6	#6	#6	#6	#7	#7
Spacing (in.)	11	10	8	12	11	10	9	12	11	10	9	12	12
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing (in.)	11	11	11	11	10	9	8	8	7	7	6	6	6
Areas of Steel ($in.^2/ft$)													
Top Interior	0.300	0.310	0.372	0.413	0.440	0.528	0.587	0.600	0.655	0.720	0.720	0.790	0.790
Bottom	0.218	0.240	0.300	0.310	0.338	0.372	0.413	0.440	0.480	0.528	0.587	0.600	0.600
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	1.63	1.72	2.02	2.14	2.35	2.67	2.98	3.10	3.41	3.69	3.98	4.14	4.14
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"													
6'-6"	995												
7'-0"	849												
7'-6"	732	887											
8'-0"	636	772											
8'-6"	557	676	942										
9'-0"	490	595	832										
9'-6"	434	527	739	939									
10'-0"	385	469	660	839	991								
10'-6"	314	379	536	684	808								
11'-0"	281	339	481	615	729	979							
11'-6"	251	305	434	556	659	888							
12'-0"	226	274	392	504	598	807	992						
12'-6"	204	247	356	458	544	736	905						
13'-0"	184	224	323	417	496	673	829	918H					
13'-6"	166	202	294	381	453	617	761	843H					
14'-0"	150	184	268	348	415	567	700	776H	926H				
14'-6"	136	166	245	319	381	522	646	716H	855H				
15'-0"	123	151	224	292	350	481	596	662H	791H	947H			
15'-6"	111	137	205	269	322	445	552	612H	733H	878H	944H		
16'-0"	101	125	187	247	297	411	511	568H	681H	817H	878H		
16'-6"	91	113	172	227	274	381	474	527H	633H	760H	817H	958H	
17'-0"	82	103	157	209	252	353	441	490H	589H	709H	762H	894H	955H
17'-6"	74	93	144	193	233	328	410	456	549	662	711	836H	892H
18'-0"	67	84	132	178	215	304	382	425	513	618	665	782H	835H
18'-6"	60	76	121	164	199	283	356	396	479	579	622	733H	783H
19'-0"	54	69	111	151	184	263	332	370	448	542	583	687H	734H
19'-6"	48	62	101	139	170	245	310	345	419	508	546	645H	690H
20'-0"	43	55	93	128	157	228	289	323	392	477	513	606	648

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

SOLID ONE-WAY SLABS—INTERIOR SPAN

Top Steel for $-M_u$

f'_c = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0100$

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Top Bars	#5	#5	#6	#6	#7	#7	#7	#8	#8	#8	#8	#9	#9
Spacing (in.)	10	9	11	10	12	11	10	12	11	10	10	12	11
Bottom Bars	#4	#5	#5	#5	#6	#6	#6	#7	#7	#7	#7	#8	#8
Spacing (in.)	8	12	10	9	12	11	10	12	11	10	10	12	12
T-S Bars	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing (in.)	11	11	11	11	10	9	8	8	7	7	6	6	6
Areas of Steel ($in.^2/ft$)													
Top Interior	0.372	0.413	0.480	0.528	0.600	0.655	0.720	0.790	0.862	0.948	0.948	1.000	1.091
Bottom	0.300	0.310	0.372	0.413	0.440	0.480	0.528	0.600	0.655	0.720	0.720	0.790	0.790
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125
Steel Wt. (psf)	2.02	2.14	2.47	2.69	2.99	3.26	3.61	3.95	4.34	4.71	4.82	5.13	5.31

CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"													
6'-6"													
7'-0"	967												
7'-6"	891												
8'-0"	775	986											
8'-6"	680	900											
9'-0"	600	796	980										
9'-6"	532	707	920										
10'-0"	475	632	837	991									
10'-6"	384	514	683	862									
11'-0"	345	462	615	778	982H								
11'-6"	310	417	557	704	891H								
12'-0"	280	377	505	640	811H	989H							
12'-6"	253	343	459	583	740H	904H							
13'-0"	230	312	419	533	678H	828H	994H						
13'-6"	209	284	383	488	622H	761H	927H						
14'-0"	190	259	351	448	572H	701H	854H	985H					
14'-6"	173	237	322	412	527H	647H	789H	941H					
15'-0"	157	217	296	380	486H	598H	731H	872H	987H				
15'-6"	144	199	272	350	450H	554H	678H	809H	949H				
16'-0"	131	183	251	324	417H	514H	629H	753H	899H	988H			
16'-6"	119*	168	231	299	386H	477H	585H	701H	838H	952H			
17'-0"	107*	152*	210*	277	359H	444H	545H	654H	782H	918H	987H		
17'-6"	98*	139*	192*	257	331*	413	509	611H	731H	876H	944H		
18'-0"	89*	127*	176*	236*	304*	385	475	571H	685H	821H	885H	977H	
18'-6"	81*	116*	162*	216*	281*	358*	444	534H	642H	771H	831H	934H	
19'-0"	75	107*	149*	201*	258*	329*	415	501H	602H	724H	781H	878H	976H
19'-6"	68	98*	137*	186*	239*	306*	385*	470H	566H	681H	734H	827H	945H
20'-0"	62	90*	126*	172*	221*	284*	356*	441	532	641	691	779H	914H

Note: See Fig. 7-1 for reinforcing bar details.

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

"H" – Use hooked or headed bars.

CHAPTER 8 – ONE-WAY CONCRETE JOIST CONSTRUCTION

GENERAL CONSIDERATIONS

Description. Concrete joist construction is a method of construction consisting of a monolithic combination of regularly spaced joists (ribs) and a thin slab of concrete cast in place to form an integral unit with the supporting beams, columns, or walls. In *one-way concrete joist* construction, the joists are arranged in one direction between parallel supports. In the first part of this Chapter, the term "concrete joist construction" refers only to joists formed by removable standard size forms,* and limited to dimensions and proportions conforming to ACI 8.13. The limits in ACI 8.13 are: (1) maximum 30 in. clear spacing between ribs; (2) minimum width of rib = 1.0/3.5 times the depth of rib but not less than 4 in.; and (3) minimum slab thickness $^1/_{12}$ of clear distance between ribs but not less than 1½ in. Practical considerations for ease of placing reinforcing bars and vibrating concrete and tolerances in concrete cover usually make it desirable to use a minimum rib width of 5 in.

*Types and sizes listed in Chapter 10, "Recommended Industry Practice for Concrete Joist Construction", CRSI *Manual of Standard Practice*.

Wide-module joist construction is covered on Pages 8-90 through 8-168.

Standard Dimensions of Forms. Joist (rib) widths tabulated for design in this Chapter vary from 5 in. to 7 in. Standard forms for the pan spaces between ribs are 20-in. or 30-in. wide and 8, 10, 12, 14, 16, or 20 in. deep. Standard end forms consist of square end forms. Tapered end forms for the 20-in. width taper to 16-in. in a distance of three feet. The 30-in. wide tapered end form tapers to 25 in. in three feet. See Fig. 8-1. Note that the structural integrity requirements of ACI 7.13 are not included in the reinforcement details shown in Fig. 8-1.

Basic Features of Joist Construction. In general, joist construction was developed to save dead weight and reinforcement. As desired spans increase, the utility of solid slab construction is rapidly offset by the increase in dead load of the slab itself. Joist construction enables the designer to provide the depth required for adequate stiffness and efficient utilization of the reinforcement without excessively high dead load-live load ratios. Standard size re-usable forms make it pos-

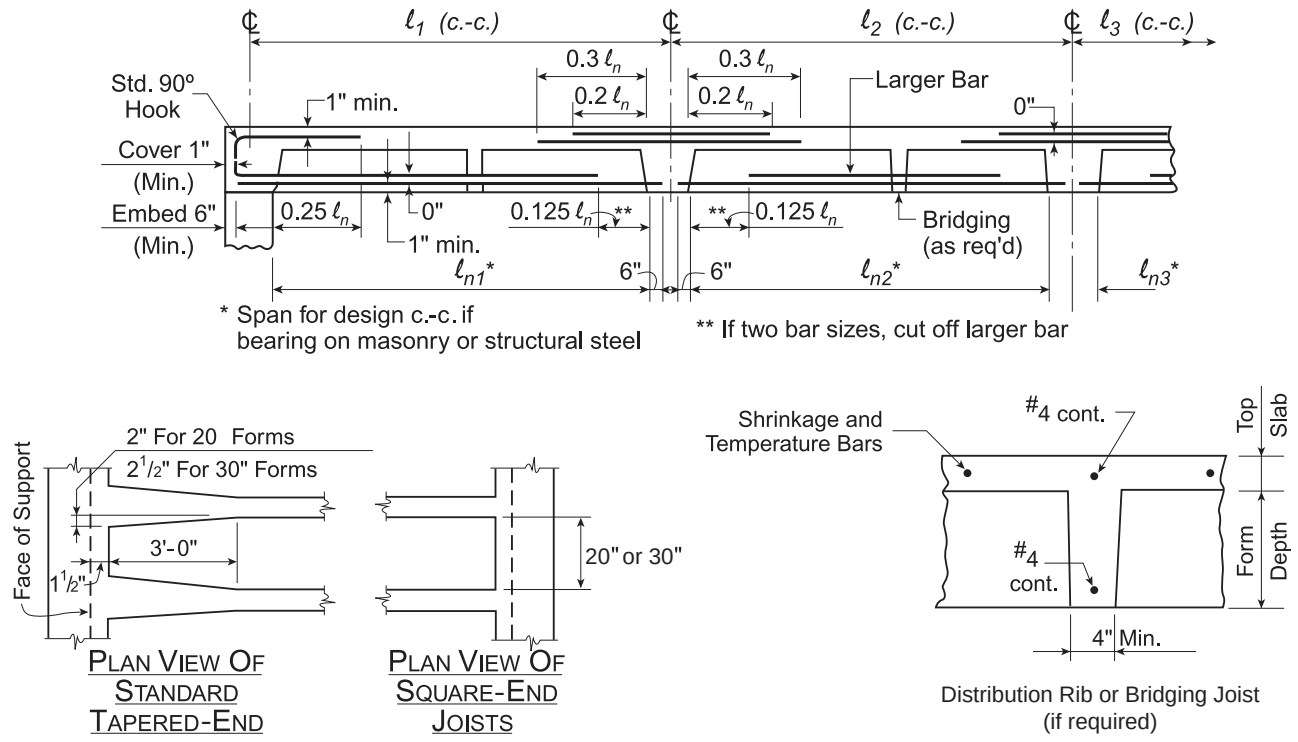


Figure 8-1 Recommended Bar Details – Multiple Spans

sible to reasonably optimize and eliminate unnecessary dead weight for overall economy. Longer spans or relatively heavy loads can be accommodated by using special tapered-end forms which permit widening of the ribs in areas of high shear. Special architectural ceiling effects may be achieved by leaving the rib patterns exposed or by integrating acoustic material and lighting fixtures with the rib patterns. Additional stiffness on column lines or under partitions in the direction of the joists is easily provided by an increased spacing of the standard forms leaving wider ribs at these points. Where openings are required under such partitions for piping or conduits, the use of two joist ribs with a special half-width filler form will provide the additional stiffness for the partition and a thin slab in the area of required openings.

Joist-Band System. Many span combinations can be designed for uniform depth construction by supporting the joists on wide "band-beams." Instead of selecting joist depth and supporting beam sizes separately to achieve minor reductions in material, the modern design for maximum overall economy is to make both joist system and framing beams the same depth. The usual procedure is to select a standard joist depth suitable for the beams as well, even if the joist is deeper than required for the joist design. Often, deflection limits for the beam can be satisfied by orienting the system so that beams span in the shorter direction. Alternatively, for live loads less than 100 psf, the live load reductions permitted in many adopted building codes for beams can often be applied for maximum economy in reinforcement to beams oriented in the long direction, when such reductions are not applicable to design of the joists.

Preliminary dimensions and flexural reinforcement required for wide band-beams, where factored shear is resisted by concrete, can be selected quickly from the joist load tables. See "Design From Load Tables" sections.

Separate beam forms are eliminated in one-way joist construction. The same deck forms the joist and beam soffit; ends of removable forms are used to form beam sides; and width of the beam can be adjusted for the occasional irregular spans. Overall building heights are reduced while maintaining the same clear ceiling height at a uniform depth. The simplified formwork, faster construction, level ceiling with no obstructing beams to complicate piping, conduit or ductwork, and reduced height of walls, columns and vertical services — all make for net overall economy in the complete building.

DESIGN CONSIDERATIONS FOR JOIST CONSTRUCTION

Economy. Maximum overall economy in joist construction, as in any reinforced concrete design, is achieved only by considering the relatively high costs of formwork and construction time versus material costs. Almost invariably overall economy is achieved by maximum re-use of the same forms throughout a project, not only throughout each floor, but also the same layout and size of forms for all floors and the roof. The use of special filler forms to match rib spacing module to column spacing can often be avoided by use of one wider joist at the edge or on column lines. Use of square-end joists (non-tapered) simplifies forming. Tapered-end load strength increases have been shown in load tables. Load strengths controlled by design shear strength are indicated by an asterisk. When the asterisk appears after the load strength for square-end joists (first line) and not on the load strength for tapered-end joists (second line), the tapered-end is required to develop the full design strength of the reinforcement.

For a continuous floor system with many identical spans, it will usually be advantageous to select a uniform design depth adequate for all interior spans with square ends and to utilize tapered ends to increase shear capacity in end spans only. For a continuous three-bay floor system with two end spans and only one interior span, select a uniform depth adequate with square-end joists in end spans is recommended.

Shrinkage and Temperature Reinforcement. Shrinkage and temperature reinforcement in the concrete top slab over forms and in a direction normal to the span of the joists should be of reinforcing bars or welded wire reinforcement at least equal in area to the values in the following table and increased where necessary for flexure in the slab, giving due consideration to concentrated loads:

Top Slab Thickness	Bars	Welded Wire Reinforcement**
3"	#3@15*	12 x 12 – W6.5 x W6.5
3½"	#3@17	12 x 12 – W7.6 x W7.6
4"	#3@15	12 x 12 – W8.6 x W8.6
4½"	#3@12	12 x 12 – W9.7 x W9.7
5"	#3@12	12 x 12 – W10.8 x W10.8

Reinforcement based on f_y = 60,000 psi.
* Maximum spacing permitted by ACI 7.12.2.2 (5 times slab thickness ≤ 18 in.).
** Commonly available styles.

Distribution Ribs or Bridging Joists. Load distribution ribs are ribs normal to direction of span. As the name implies, load distribution ribs are provided to equalize joist deflection and thus ensure that the effect of concentrated or unequal loads is resisted by a number of joists.* Load distribution ribs are often omitted for roofs designed for uniform load only. For floor construction, use distribution ribs at least 4 in. wide, reinforced with at least one #4 bar continuous in both top and bottom, and spaced as follows:

- None in spans less than 20 feet,
- One near the center of spans from 20 to 30 feet, and
- Two near the third points of spans over 30 feet

Openings. One of the inherent advantages of joist construction is that single openings can be located through the thin slab between ribs without significant loss of structural strength to the system. Larger openings which interrupt one or more joists must be provided with header joists normal to the interrupted joists to distribute the load to adjacent full-length joists. Joists adjacent to such openings will require additional reinforcement, or increased width, or both. Very large openings should be framed by supporting beams.

Control of Deflections. The ACI Building Code requires that computed deflection be limited (ACI 9.5.1). A method of computing deflections and limits for various loading conditions are prescribed (ACI 9.5.2). See "Manual Example" sections for a general explanation.

Under the prescribed method of computation for deflection, computed deflection is a function of continuity, concrete modulus of elasticity, and effective moment of inertia, in addition to load and span. Deflection coefficients are taken as 5/384, 3.25/384, and 2/384, respectively, for single, end, and interior spans for one-way joists designed with the approximate moment coefficients (ACI 8.3.3). The load strengths tabulated in this Chapter are for joists of normal-weight concrete (w = 150 pcf) and f'_c = 4,000 psi, for which $E_c = 3.6 \times 10^6$ psi (ACI 8.5.1). The effective moment of inertia, I_e, is a function of the ratio of the cracking moment, M_{cr}, to the actual maximum moment, M_a, as well as the ratio of the cracked to gross section moment of inertia.

Since M_a is a function of the service load causing the deflection, a direct solution is not feasible for the load limited by deflection as under previous ACI Codes. Tabulations of loads limited by a given deflection limit or elastic deflections resulting from the loads limited by strength design are not very useful, since deflection increments are not proportional to load increments but to the total previous load, plus the load increment.

To comply with the Code requirements for deflection conservatively without tedious iterative trial and error calculations, all joist load capacities tabulated in this Chapter have been investigated for deflection. Load strengths designated by a plus sign will cause a computed elastic live load(1) deflection equal to $\ell/480$ for multiple span joists and $\ell/360$ for single span joists. All other load strengths are controlled by strength in shear (marked *) or flexure (unmarked). The haunch effect for tapered ends has conservatively been neglected for deflection computations. Also, the value M_a has been taken conservatively as the maximum applied moment for an upper bound deflection solution in the computer program, since the maximum cracking in some cases will have occurred before the load pattern for maximum deflection occurs.

Long-Term Deflections. For loading conditions where much of the superimposed service load is added "dead load" or relatively long-term live load, it may be necessary to compute long-term deflection or to estimate deflection due to partial loads to establish required camber or clearance to other connected elements. For these purposes, the following design aids will provide all of the required data, except M_a for which the actual service load must be known:

a. Table 8-1 "Gross Section Properties."
b. Load strength table with "Properties for Design" table at bottom.
c. Code Equation (9-8) relating M_{cr}/M_a and I_{cr}/I_g to solution for I_e:
$$I_e = (M_{cr}/M_a)^3 I_g + [1 - (M_{cr}/M_a)^3] I_{cr}$$
d. Deflection coefficients for each span and continuity conditions in the load tables.

To determine the elastic deflection for a given service (actual) load, w_a, the five-step procedure is:

Step 1. Calculate M_a. (= $\frac{1}{8} w_a \ell^2$ for single spans; = $\frac{1}{11} w_a \ell^2$ for end spans; = $\frac{1}{16} w_a \ell^2$ for interior spans). Use actual service load for w_a.

Step 2. Read M_{cr} in Table 8-1. (Positive value only for single span; both positive and negative for continuous spans). Compute M_{cr}/M_a value or values.

* "Effective Width of One-Way Monolithic Joist Construction as a Two-Way System", Structural Bulletin No. 8, Concrete Reinforcing Steel Institute, 1983.

(1) "Live load" is actual service load (which is equal to the superimposed factored load divided by the load factor for live load, i.e., 1.6).

Step 3. Read I_{cr}/I_g under load strength table. (Positive for single spans; positive and negative for continuous spans.)

Step 4. Use Code Eq. 9-8 with values of M_{cr}/M_a, and I_{cr}/I_g and calculate values of I_e/I_g. (Positive only for single spans; positive and negative for continuous spans.) Compute average I_e (continuous spans only).

Step 5. Read "Deflection Coefficient" from load table. Compute deflection, Δ:

$$\Delta = (\text{Defl. Coeff.}) \frac{w_a}{I_e}$$

It will always be conservative to use this value for elastic deflection with the multiplier factors for long-term deflection given in ACI 9.5.2.5.

Crack Control. ACI 10.6 limits the spacing of flexural reinforcement in tension zones to control cracking. The maximum spacing of reinforcing bars, s, is limited to the smaller value calculated by:

$$s = 15\left(\frac{40}{f_s}\right) - 2.5c_c \text{ or } s = 12\ (40/f_s)$$

Where:

f_s = calculated flexural tensile stress in reinforcement at service loads, ksi. The value of f_s can be taken as $(2/3)\,f_y$.

c_c = clear concrete cover, in. (distance or dimension from nearest concrete surface in tension to the surface of the flexural tension reinforcement).

In this Chapter, two locations for maximum spacing are investigated: the approximation of the longer bottom bar tensile stress at the point in which the shorter bar starts (at 0.2 ℓ_n from the face of the support), and for the top bars at the center of the interior support.

Unequal Continuous Spans. Bending moments are computed from the clear span for factored positive moment in continuous spans and from the average of the two adjacent clear spans for factored negative moment. The limitations are that the larger of two adjacent spans does not exceed the shorter by more than 20 percent and that the unit live load (unfactored) does not exceed three times the unit dead load (unfactored). See ACI 8.3.3.

The values tabulated under End Spans apply accurately only when there are two additional approximately equal spans continuous with the one under consideration. If there is only one adjacent span, the factored negative moment should be $w_u\ell_n^2/9$ instead of $w_u\ell_n^2/10$, and load values should be reduced accordingly. Load values obtained from factored positive moment would not change.

The load strengths tabulated under Interior Spans apply accurately only when there are two additional approximately equal spans continuous with each end of the span under consideration. If either end is continuous with an end span, the factored negative moment should be $w_u\ell_n^2/10$ instead of $w_u\ell_n^2/11$ and the top reinforcement tabulated for End Spans should be used. Load values obtained from factored positive moment would not change.

TABULATED DESIGNS

Scope. Since the tables for standard joist construction cover many pages, a general outline of the table arrangement will be helpful. The tables are divided into two main sets: (1) multiple spans, and (2) single spans. Recommended requirements and an illustrative example for each set are shown. Each set is subdivided into two parts, the first for 20-in. wide forms and the second for 30-in. wide forms. Within each such set, the tables are divided by depth of form and thickness of top slab.

Load Strengths Tabulated. These tables are based upon the strength design method. These tables give the usable superimposed factored load strength in pounds per square foot of floor (psf). If the floor system is a part of the primary lateral force resisting structure, alternate combinations of factored loads including lateral force moments must also be considered. Capacities have been reduced by the applicable strength-reduction, ϕ-factors, and 1.2 times the dead weight of the joist construction itself has been deducted. Material strengths are f'_c = 4,000 and f_y = 60,000 psi. The practicable range of widths, depths, spacings, spans and joists, and combinations of reinforcing bars are shown. Strengths are computed as the least of those determined by design moment strength (positive or negative bending), design shear strength, development of reinforcement, or deflection.

The effects of superimposed dead loads (other than the weight of the joist construction itself) and of live loads augmented by the proper loads factors are combined: $w_u = 1.2D + 1.6L$. The total superimposed factored load is then compared with the tabulated capacities.

The appropriate empirical bending moment coefficients (ACI 8.3.3) are used; in the case of end spans, the factored positive moment is taken as $w_u\ell_n^2/11$, i.e., without restraint at the outer end.

Live Load Limitations. ACI 8.3.3 establishes moment and shear coefficients for cases where the unit live load (unfactored) does not exceed three times the unit dead load (unfactored). The tabulated designs are based upon these coefficients.

Since the dead load in such analyses includes not only the weight of the concrete slab but also any ceilings, floor finishes, partitions and similar immovable features, it is impossible to predetermine when the ratio of live load to dead load will exceed three. The user is cautioned to check the ratio of live to dead loads in the higher strengths. If the ratio is greater, the effect of unbalanced panel loads may require more accurate analysis and appropriate adjustments made in bar areas and cut-off points.

The tabulated designs in this Chapter apply for the particular conditions described. For final designs, the numerous variables in loads, stiffness, continuity and in the quality of materials have to be considered.

Details of Reinforcement. The arrangement of reinforcing bars, bar supports, the bar spacing, and the embedment of bars conform generally to the *ACI Detailing Manual*. Typical details recommended are shown in Figs. 8-1 and 8-2.

Basis of Load Tables. These tabulated designs were developed by a computer program. The program is based on the following procedures, assumptions, and Code provisions.

Factored moment coefficients from ACI 8.3.3:

End span factored positive moment = $w_u\ell_n^2/11$

End span factored negative moment = $w_u\ell_n^2/10$ at continuous end

End span "free end" factored negative moment = $w_u\ell_n^2/33$ (allow $^1/_3$ factored positive moment)

Interior span factored positive moment = $w_u\ell_n^2/16$

Interior span factored negative moment = $w_u\ell_n^2/11$

Single span factored positive moment = $w_u\ell'_n{}^2/8$ where ℓ' = clear span plus 4 in.

Single span "free end" factored negative moment = $w_u\ell'_n{}^2/24$ (allow $^1/_3$ factored positive moment)

Design moment strength was determined in accordance with the strength design method. See Chapter 5. The effect of compression reinforcement has been neglected. Compression reinforcement should be considered, however, if undertaking a computation of long-term deflection for camber or fitting to other attached elements. Critical sections investigated for minimum strength are (1) positive moment at midspan, (2) negative moment at face of support including average width of tapered end if used, (3) shear and moment at and development lengths from bar cut-off points and inflection points, (4) shear at a distance d from the face of the support with average width of square or tapered end, and (5) shear at root of taper where used.

Top Reinforcement. Combinations of two bottom reinforcing bars tabulated begin at the smaller of $\rho = \frac{3\sqrt{f'_c}}{f_y}$; $\rho = \frac{200}{f_y}$; or $\frac{4}{3}$ times the required tension reinforcement (ACI 10.5.1) where ρ, the tension reinforcement ratio, is based on a rectangular concrete area,

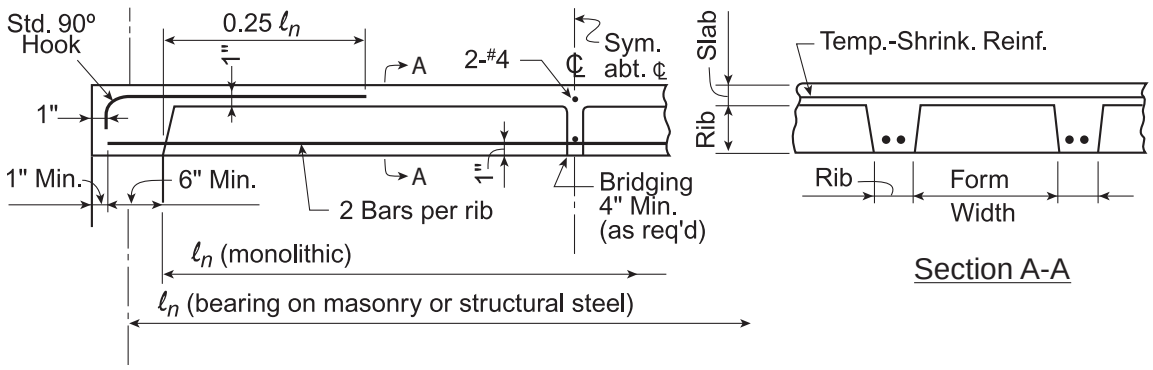


Figure 8-2 Recommended Bar Details – Single Span

bd, plus the two triangular areas inside the sloping form sides. The maximum size for bottom bars in the tabulated designs was determined as the least allowed for (1) maximum reinforcement such that $\varepsilon_t \geq 0.005$ so that the cross section is tension-controlled and therefore $\phi = 0.90$, (2) minimum bar spacing and concrete cover prescribed (ACI 7.6 and 7.7.1, respectively), or (3) load strength for flexure less than for shear with tapered end.

The areas of the two bottom bars control the joist capacity when load strength is controlled by flexure, since the strength established by the bottom bars is used to select top bars. The area of top steel tabulated is as near the theoretical area required as possible, for minimum number of bars, limited by the available choice of bar sizes and spacings in 0.5-in. increments. The computer program selects the largest size bar, with maximum spacings, not to exceed 107 percent of the theoretical area required.

Where tabulated areas of top steel for adjoining spans are unequal, the larger area of top steel as tabulated will be satisfactory, since the Code provides for calculating the factored moment on the basis of the average of adjacent spans (ACI 8.3.3). No redistribution of factored negative moment is permitted for adjustment of tabulated top bar areas (ACI 8.4).

Shear. Factored shear is calculated assuming full uniform load (no partial span loads) as $w_u \ell_n/2$ at all supports except the first interior support for continuous end span joists which is taken as 1.15 $w_u \ell_n/2$ (ACI 8.3.3).

Critical sections at which design shear strength is investigated are (1) distance, *d*, from face of support for interior supports (2) distance, *d*, from center of bearing for free ends (3) at the root of the taper, if used, (4) at bar cut-off points where tension steel ratio, ρ, is minimum. Design shear strength is computed by both prescribed formulas (ACI 11.2.1 and 11.2.2) and the maximum value was used. For standard joists, V_c is permitted to be 10 percent more than that specified in Chapter 11 of the ACI 318 Building Code (ACI 8.13.8). For tapered ends, factored shear was computed at sections three inches apart, beginning at *d* from the center of bearing to midspan. It was determined that critical sections for a full uniform load condition are at the root of the taper in spite of the variable design shear strength as reinforcement ratio changes with variable width.

Development of Reinforcement. Development of reinforcement is investigated, including end anchorage for tabulated bars cut off as shown in recommended bar details, Figs. 8-1 and 8-2. Substitution of equivalent areas of smaller top bars is conservative and requires no further computation of development. Bar sizes are selected so that development would satisfy Code requirements (ACI 12.10, 12.11, and 12.12) and, therefore, not limit the load strength as determined by flexure, shear, or deflection. See Fig. 8-10.

To understand how to extend the scope of the tabulated designs or to adapt same to non-typical conditions, a manual example is included preceding each of the sets of load tables.

DESIGN FROM LOAD TABLES (MULTIPLE SPAN JOIST CONSTRUCTION)

Example 1. Using 30-in. wide forms, select a joist floor design and review calculations to support a service live load equal to 65 psf and an allowance for superimposed service dead loads of 20 psf for partitions, 3 psf for bridging, and 12 psf for ceiling and mechanical loads on clear spans of 27 feet. A 3-in. thick top slab will satisfy the adopted building code for fire and use requirements. See Fig. 8-3 for layout.

Try: 12 + 3 with 6-in. ribs at 36 in. (Page 8-29) using standard square-end joists.

Superimposed factored load = (1.2)(20+3+12)+(1.6)(65)
= 42 + 104
= 146 psf

Read from table:

End span: Tabulated capacity = 147 psf
Top bars #4 at 8" at first interior support

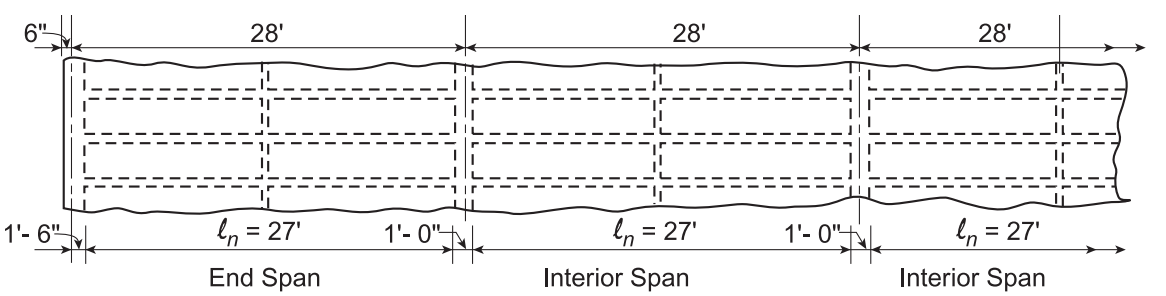


Figure 8-3 Multiple Span Layout – Example 1

Bottom bars 1-#5 and 1-#6 (per rib)
Weight of bars = 1.04 psf for above bars only.

See "Recommended Details," Fig. 8-1. Top bars at exterior edge, $A_s \approx {}^1/_3(0.31 + 0.44)$ in 36 in. $= \frac{0.75}{9} = 0.083$ in.^{2}/ft. Use # 4 at 12" with standard 90° end hooks.

Interior spans: Tabulated capacity = 147 psf
Top bars #4 at 9"
Bottom bars 1-#4 and 1-#5 (per rib)
Weight of bars = 0.93 psf. Add for shrinkage and temperature reinforcement, if required.

Concrete quantity (from Table 8-1, normal-weight concrete) = 67 psf

Including bridging (3 psf) $= \left(\frac{67+3}{150}\right)(144) = 0.67$ c.f./s.f.

Load capacities limited by deflection of $\ell_n/480$ are marked with double asterisks in the tabulated designs. The load strength for the design selected is not limited by deflection, and so the upper limit on the immediate live load deflection will be

$$\left(\frac{65}{146/1.6}\right)\left(\frac{\ell_n}{480}\right) = \ell_n/674 \text{ or less.}$$

This calculation is sufficient to satisfy the Code requirement (ACI 9.5.2.1) that deflection be computed for ℓ_n/h ratios above 18.5 for end spans and 21 for interior spans (values below horizontal lines in table exceed these limits). The estimated deflection above would be considered satisfactory without further calculations for all floors and roofs "not supporting or attached to non-structural elements likely to be damaged by large deflections." (ACI 9.5, Table 9.5(a)).

Example 2. *Unequal spans within limitations of table.* For the same loads as in Example 1, select a joist floor design for alternate clear spans: 22.5 ft., 27 ft., 22.5 ft., etc. Note that this variation in span is the maximum permitted without analysis to adjust the coefficients (ACI 8.3.3); the longer span exceeds shorter span 20 percent. See Fig. 8-4.

Try: 12 + 3 with 6-in. ribs at 36 in., using standard square-end joists as in Example 1, Superimposed factored load = 146 psf. See Page 8-29.

End span. Interpolate in second column between strengths 135 and 155 psf for spans of 22 and 25 feet, respectively.

Strength $= \frac{1}{2}(135 + 155) = 145$ psf, O.K.

Read Top bars: #4 at 11" at exterior span first interior support
Bottom bars: 1- #4 and 1- #5 (per rib)
Weight (of these bars) = 0.71 psf

For top bars at exterior edge, $A_s \approx 1/3\ (0.20 + 0.31)$ in 36 in. = 0.06 in.^{2}/ft. Use #3 at 12" with standard 90° end hooks. (CRSI recommends a minimum of #4 at 12" where cross traffic on top bars is expected, but at the exterior edge such traffic can be avoided.)

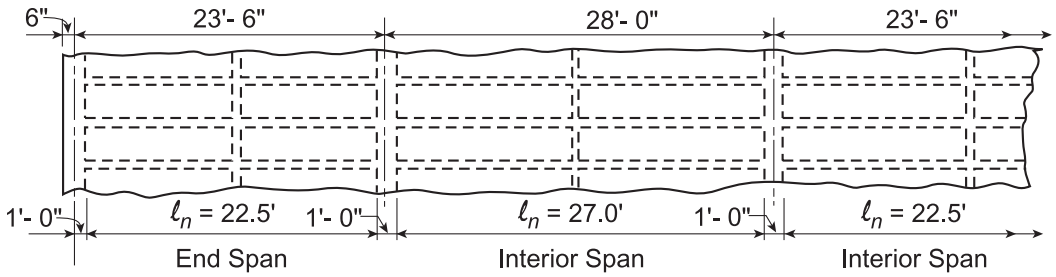


Figure 8-4 Multiple Span Layout – Example 2

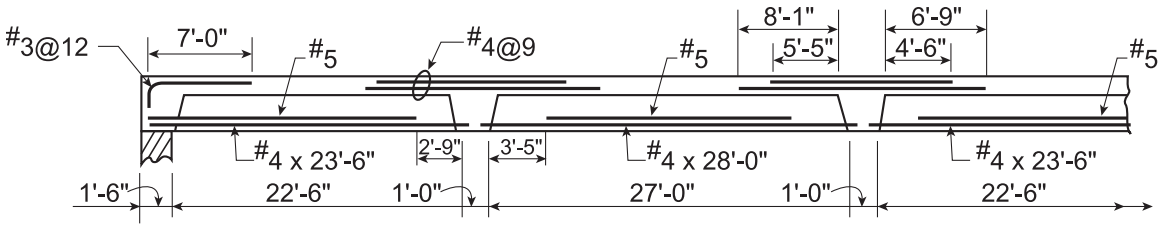


Figure 8-5 Bar Length Details – Example 2

Interior span. For tabulated capacity = 147 psf

(Check whether top bar design for interior or exterior span controls.)

Top bars #4 at 9" > #4 at 12". Use at *all* interior supports.

Bottom bars: 1- #4 and 1- #5 (per rib)

Weight (of these bars) = 0.93 psf

Concrete quantity (Table 8-1) = 67 psf for normal-weight concrete, including bridging:

$$\frac{(67+3)}{150}(144) = 0.67 \text{ c.f./s.f.}$$

Immediate deflection is less than $\ell_n/480$ for full superimposed load. Approximate live load deflection: $\Delta_{LL} \approx \ell_n/674$ as in Example 1.

Bar lengths. See Fig. 8-5 for details.

Example 3. Unequal loads within the limitation of $L \leq 3D$. For the layout in Fig. 8-3, Example 1, provide for a service live load = 100 psf in the first interior span and service live load in other spans = 50 psf. Dead load in all spans will be as in Example 1. Use the same joist sizes.

End span (same as Example 1):

Top bars, exterior edge #4 at 12

Bottom bars per rib 1- #5 plus 1- #6

Top bars, first interior support #4 at 8"; but check requirements of first interior span and use the larger.

1st Interior Span.

Superimposed factored load

$$= (1.2)(20+3+12)+(1.6)(100)$$
$$= 42 + 160$$
$$= 202 \text{ psf}$$

Read from table.

Superimposed load capacity = 199 * Square end

= 251 Tapered end

Bottom bars per rib 1- #5 plus 1- #6

For top bars, linearly interpolate for w_u = 202, between 251 for #5 at 9″ and 195 for #4 at 7″.

Top bars: Use #5 at 10½″ (spacing to nearest ½ in.)

Other Interior Spans – Same as Example 1

Bar length details. See Fig. 8-6.

Example 4. *Wide flat beams*. Assume the interior beams supporting the joist floor of Example 1 (see Fig. 8-3) have clear spans of 20 ft. Select a preliminary design for these beams to maintain a uniform depth for simple formwork.

From Example 1:

Service live load, L = 65 psf

Superimposed service dead load = 35 psf

Joist dead load = 67 psi

Total service dead load, D = 102 psf

Total superimposed factored load on interior beams,

$w_u = 1.2D + 1.6L$

$(28)[(1.2)(102) + (1.6)(65)]/1000 = 6.34$ klf

To estimate how wide the beams supporting the joist floor has to be, use the joist tabulated design for square ends. In the load table, Page 8-29, read the maximum superimposed load (controlled by shear on a square end) for an interior span of 20 ft = 322* psf. Load per linear foot = (3)(0.322) = 0.97 klf.

Ratio of effective beam depth to joist depth with 1 in. concrete cover for joists and 2 in. cover for beams = $\frac{12.5}{13.5}$

Ratio of allowable joist shear to beam shear = 1.10.

Required width of beam without stirrups,

$$b = \left(\frac{6.34}{1.10}\right)(6)\left(\frac{13.5}{12.5}\right)(1.10) = 41 \text{ in.}$$

Read in tabulated design, maximum superimposed load controlled by flexure for interior span joist with span = 20 ft, w_u = 247 psf.

Total load per linear ft = (3)[247 +(67)(1.2)] = 3(247 + 80)

Total load = (0.327)(3) = 0.98 klf

Required area of steel in joist system at d = 13.5 in.:

Top bars #4 at 11", $A_s = \left(\frac{36}{11}\right)(0.20) = 0.65$ in.^{2}

Bottom bars 2- #4, A_s = 0.40 in.^{2}

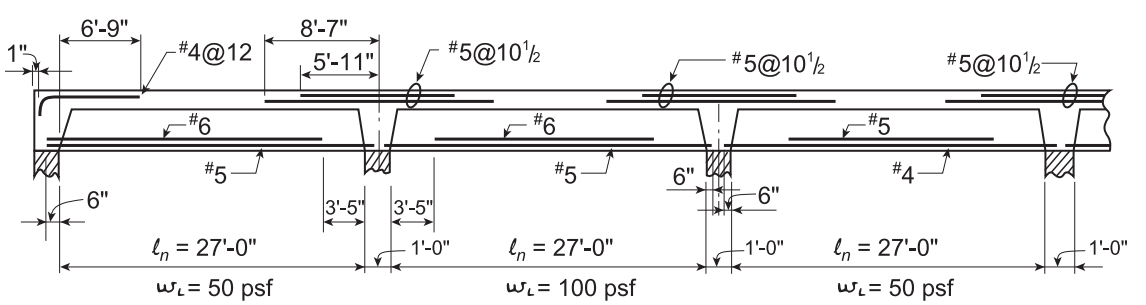


Figure 8-6 Bar Length Details – Example 3

Required beam reinforcement for d = 12.5 in.:

Beam, A_s = (Joist, A_s)$\left(\frac{6.34}{0.98}\right)\left(\frac{13.5}{12.5}\right)$ = 6.99 (Joist, A_s)

Top steel: A_s = (6.99) (0.65) = 4.54 in.^{2}
Use 6-#8 bars (A_s = 4.74 in.^{2})

Bottom steel: A_s = (6.99)(0.40) = 2.80 in.^{2}
Use 5-#7 bars (A_s = 3.00 in.^{2})

Note: To complete this preliminary design for interior spans, dead load of the solid beam area, reduced clear span for the joist design, possible live load reductions for the beam usually permitted for live loads equal to or less than 100 psf, and provision of nominal stirrups which will also support top beam bars (say #3 at 12") are possible refinements. See Chapter 12 for such examples.

MANUAL EXAMPLE

To extend designs beyond the scope of the tabulated designs and to know how the tabulated designs are computed, detailed computations are presented as a review for the design of the interior span used in Example 1.

Review

See Fig. 8-7

Joist $\left(\frac{192}{144}\right)(150)\left(\frac{12}{36}\right)$	=	67 psf
Bridging	=	3 psf
Partitions	=	20 psf
Ceiling and mechanical	=	12 psf
	D =	102 psf
	L =	65 psf

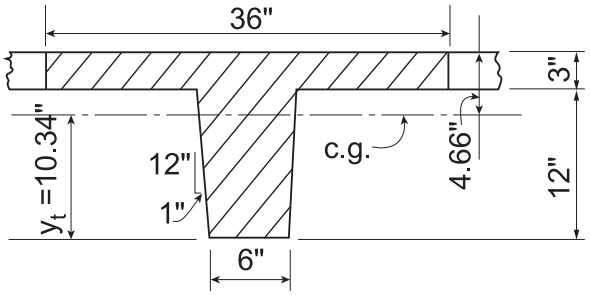


Figure 8-7 Gross Section – Example 1

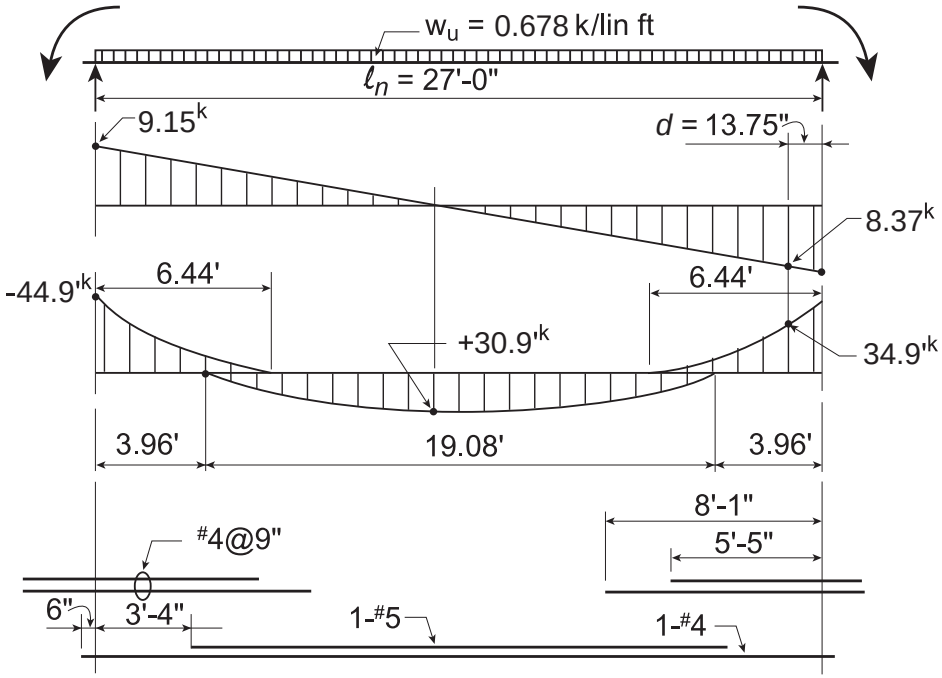


Figure 8-8 Strength Design – Example 1

Interior Span – See Fig. 8-8

$w_D + w_L = w_u = 1.2D + 1.6L = [(1.2)(0.102) + 1.6(0.065)]\frac{36}{12}$
$= (0.122 + 0.104)(3)$

$w_u = 0.678$ k/ft

Factored shear = 1/2 $w_u \ell_n = \frac{1}{2}(0.678)(27) = 9.15$ kips

Flexure

$-M_u = \frac{w_u \ell_n^2}{11} = (0.678)(27)^2/11 = -44.9$ ft-kips

$+M_u = \frac{w_u \ell_n^2}{16} = (0.678)(27)^2/16 = +30.9$ ft-kips

Required $A_s = \frac{M_u}{f_y(d - a/2)}$

$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{60}{3.4}\frac{A_s}{b} = 17.65\frac{A_s}{b}$

Try 1-#4 and 1-#5: $A_s = 0.51$ in^2.

$+\phi M_n$: $a = (17.65)\frac{(0.51)}{36} = 0.25$ in.

$c = a/\beta_1 = 0.25/0.85 = 0.29$ in.

$d = 15 - 1 - 0.625/2 = 13.69$ in.

$\varepsilon_t = 0.003\,(d/c - 1)$
$= 0.003\,(13.69/0.29 - 1) = 0.139$

$\varepsilon_t > 0.005$, so $\phi = 0.90$

Try #4@ 9″

$-\phi M_n$: $a = (17.65)\frac{(0.20)(12/9)(3)}{(6.19)} = 2.28$ in.

$c = 2.28/0.85 = 2.68$ in.

$d = 15 - 1 - 0.500/2 = 13.75$ in.

$\varepsilon_t = 0.003\,(13.75/2.68 - 1) = 0.012$

$\varepsilon_t > 0.005$, so $\phi = 0.90$

Design moment strength, ϕM_n, provided:

$\phi M_n = \phi A_s f_y (d - a/2)$

$+\phi M_n = (0.90)(0.51)(60)\left(13.69 - \frac{0.25}{2}\right)\frac{1}{12}$
$= +31.1$ ft-kips $> +M_u = 30.9$ ft-kips

$-\phi M_n = (0.90)(0.80)(60)\left(13.75 - \frac{2.28}{2}\right)\frac{1}{12}$
$= -45.4$ ft-kips $> -M_u = -44.9$ ft-kips

Note that the flexural strength is controlled by the two bottom bars per rib. Top bars are spaced to the nearest 0.5 in. to match the flexural strength predetermined by the bottom bar selection.

Shear. Factored shear, V_u, at distance d from support. See Fig. 8-8.

$V_u = 9.15 - (0.678)\left(\frac{13.75}{12}\right) = 8.37$ kips

Design shear strength ("short" formula)

$b_w = \left[\frac{8.29 + 6.0}{2}\right] = 7.14$ in.

$\phi V_c = (1.10)\,\phi\, 2\sqrt{f_c'}\, b_w d$
$= (1.10)(0.75)(2)\sqrt{4{,}000}\,(7.14)(13.75)/1{,}000$
$= 10.25$ kips > 8.37 kips, Okay.

Design shear strength was also computed by the "long" formula, compared to that by the short formula, and the larger value used as a basis for superimposed load capacities marked by one asterisk. In this case, the short formula gave the larger value. Long formula:

$\phi V_c = (1.10)\phi\left[1.9\sqrt{f_c'} + 2{,}500\,\rho_w\,\frac{V_u d}{M_u}\right] b_w d$

$A_s = 0.20\,(12/9)(3) = 0.80$ in^2.

$\rho_w = \frac{0.80}{(7.14)(13.75)} = 0.00815$

$\frac{V_u d}{M_u} = \frac{(8.37)(13.75)}{(34.9)(12)} = 0.275$

$\phi V_c = (1.10)(0.75)[1.9\sqrt{4{,}000} + (2{,}500)(0.00815)(0.275)]$
$(7.14)(13.75)/1{,}000$
$= 10.19$ kips < 10.25 kips by short formula

Development of reinforcement. See Fig. 8-10.

Bottom bars

#4; concrete cover = 1″ or $2d_b$
c.-c. spacing to #5 = 3.65″ or $7.3d_b$

#5; concrete cover = 1″ or $1.6d_b$
c.-c. spacing to #4 = 3.65″ or $5.8d_b$

Top bars #4 @ 9″
concrete cover = 1″ or $2d_b$
c.-c. spacing = 9″ or $18d_b$

Chapter 5; Table 5-3(b):

Bar Location	ℓ_d
#4 Bottom	12″ = 1′
#5 Bottom	17″ = 1.42′
#4 Top	15″ = 1.25′

Embedment from point of maximum tension to cut-off (ACI 12.1; 12.12.2):

Dimension ① = 5.40′ > ℓ_d = 1.25′ for shorter top bars

Dimension ② = 5.53′ > ℓ_d = 1.25′ for longer top bars

Dimension ③ = 10.12′ > ℓ_d = 1.42′ for shorter (#5) bottom bars

Extension of cut-off the greater of $12d_b$ or d beyond zero theoretical stress (ACI 12.10.3) or $\ell_n/16$ (ACI 12.12.3):

d for top bars $= \frac{13.75}{12} = 1.14$ ft

#4 bar: $12d_b = 6$ in.

$\ell_n/16 = 27/16 = 1.69$ ft

d for bottom bars $= \frac{13.69}{12} = 1.14$ ft

#5 bar: $12d_b = 7½$ in.

Dimension ④ $= 1.66' \approx 1.69'$ for longer top bar (#4)
Dimension ⑤ $= 2.83' > 1.14'$ for shorter top bar (#4)
Dimension ⑥ $= 2.71' > 1.14'$ for shorter bottom bar (# 5)
Dimension ⑦ $= 4.46' > 1.14'$ for longer bottom bar (#4)
Embedment of continuing bars, ℓ_d, beyond the point of zero theoretical stress in cut-off bars not less than ℓ_d (ACI 12.10.4):
Dimension ⑧ $= 6.59' > \ell_d = 1.0'$ for # 4 bottom bar

The shorter top bars are cut off in a tension zone, which is permissible if at the cut-off

$V_u < (2/3)\ \phi V_c$ (ACI 12.10.5.1):

$V_u = 5.49$ kips $< (0.667)\ \phi V_c = (0.667)(10.25) = 6.84$ kips

Bottom bars at inflection point (ACI 12.11.3):

The quantity $\left(\frac{M_n}{V_u} + \ell_a\right)$ must be larger than ℓ_d.

$M_n = \frac{30.9}{0.90} = 34.3$ ft-kips $\quad V_u = 6.47$ kips

ℓ_a = the greater value, d or $12d_b = 1.14$ ft

$\frac{M_n}{V_u} + \ell_a = \frac{34.3}{6.47} + 1.14 = 6.44$ ft > 1.42 ft: Okay

To conform to the requirements for structural integrity, the #4 bottom bar has to be lap spliced over the support to a bottom bar in the adjacent spans (ACI 7.13.2.1). A Class B tension lap splice is required. Detailing the #4 bar for structural integrity would affect the check of Dimension 8.

Interior Span-Serviceability Requirements

Cracked Section Properties – See Fig. 8-11

$n \quad = E_s/E_c = 29 \times 10^6/3.644 \times 10^6 = 7.96 = 8$

$+I_{cr} \quad = 643$ in.^{4}

$+I_{cr}/I_g = 643/3{,}541 = 0.181$ (Tabulated 0.181)

$-I_{cr} \quad = 734$, $-I_c/I_g = 0.207$ (Tabulated 0.207)

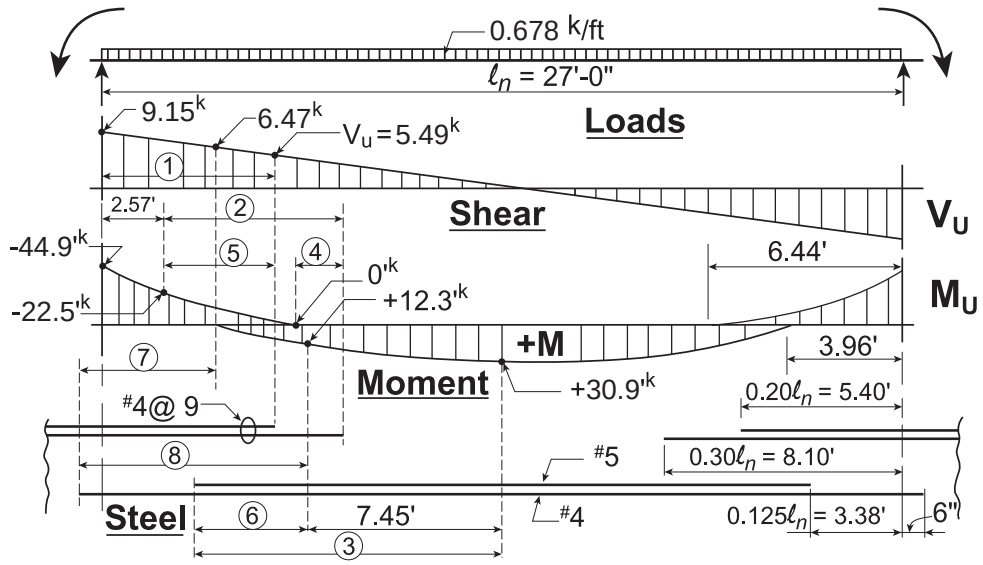


Figure 8-10 Embedment Lengths Available vs. Required Development Lengths

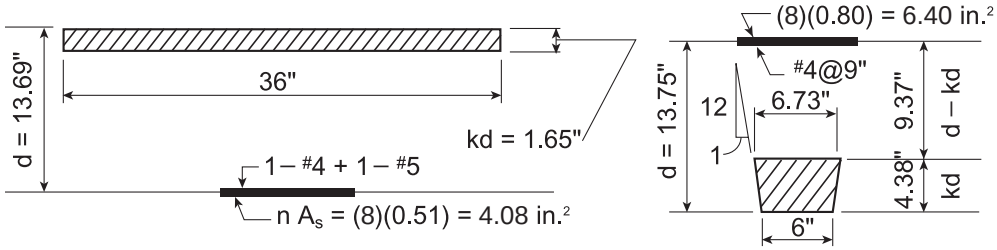


Figure 8-11 Cracked Section – Example 1

$+M_{cr}$ = 13.5 ft-kips, $-M_{cr}$ = 30.1 ft-kips
(From Table 8-1)

Total service load, w_s

$w_s = (102 + 65)\ 36/12 = 501$ plf

Maximum moment, M_a

$$\pm M_a \approx \frac{w_s \ell_n^2}{16} = (0.501)(27)^2/16 = 22.8 \text{ ft-kips}$$

$$I_e = \left(\frac{M_{cr}}{M_a}\right)^3 I_g + \left[1 - \left(\frac{M_{cr}}{M_a}\right)^3\right] I_{cr}$$

$\leq I_g$ (ACI 9.5.2.3, Eq. 9-8)

$$+I_e = \left(\frac{13.5}{22.8}\right)^3 (3{,}541) + \left[1 - \left(\frac{13.5}{22.8}\right)^3\right](643)$$

$= 735 + 510 = 1{,}245$ in.^{4}

$$-I_e = \left(\frac{30.1}{22.8}\right)^3 (3{,}541) + \left[1 - \left(\frac{30.1}{22.8}\right)^3\right] 734 > I_g$$

Use $-I_e = 3{,}541$ in.^{4}

Average effective moment of inertia,

I_e = Average of ($+I_e$ and $-I_e$) (ACI 9.5.2.4)
= (0.5)(1,245 + 3,541)
= 2,393 in.^{4}

Live load deflection $\Delta_L = \left(\frac{2}{384}\right) \frac{w \ell_n^4}{E_c I_e}$

where w is load per inch

Tabulated deflection coefficient, DC = 3.938 (Page 8-29)

$$\left(\frac{2}{384}\right) \frac{(27)^4(12)^3}{E_c} (3) = 3.9377$$

$$\Delta_L = \frac{(3.938)(65)}{(2{,}393)} = 0.11 \text{ in.}$$

$$< \frac{\ell_n}{480} = \frac{(27)(12)}{480} = 0.675 \text{ in.}$$

Note: The service load negative moment at the support is less than the service load positive moment at mid-span. The use of two bottom bars per rib is necessarily within all spacing limitations imposed for crack control. All spacings tabulated for top bars are within the crack control limits. For these reasons, no serviceability condition investigation for crack control is required for joist tabulated designs in this Chapter.

TABLE 8-1(a) GROSS SECTION PROPERTIES — STANDARD JOIST CONSTRUCTION [1]

[2] Joist	3-Inch Top Slab						4-Inch Top Slab					
	Gross Area[3] ($in.^2$)	Wt[4] (psf)	Y_{cg}[3] (in.)	I_g[3] ($in.^4$)	$+M_{cr}$ (ft-k)	$-M_{cr}$[3] (ft-k)	Gross Area[3] ($in.^2$)	Wt[4] (psf)	Y_{cg}[3] (in.)	I_g[3] ($in.^4$)	$+M_{cr}$ (ft-k)	$-M_{cr}$[3] (ft-k)
8 + 5 + 20	120.3	60	7.49	1,104	5.8	12.4	145.3	73	8.18	1,439	7.0	14.9
	152.3		6.75	1,582		14.7	177.3		7.42	2,067		17.9
8 + 6 + 20	131.3	63	7.32	1,254	6.8	13.5	157.3	76	8.01	1,636	8.1	16.2
	163.3		6.67	1,709		15.6	189.3		7.33	2,234		18.9
10 + 5 + 20	133.3	67	8.76	1,826	8.2	17.0	158.3	79	9.51	2,301	9.6	20.2
	173.3		7.89	2,594		20.1	198.3		8.60	3,283		24.0
10 + 6 + 20	146.3	70	8.56	2,069	9.6	18.4	172.3	83	9.30	2,610	11.1	22.0
	186.3		7.80	2,801		21.3	212.3		8.49	3,545		25.5
12 + 5 + 20	147.0	74	9.99	2,799	11.1	22.1	172.0	86	10.79	3,450	12.6	26.2
	195.0		9.01	3,951		26.1	220.0		9.75	4,887		30.9
12 + 6 + 20	162.0	78	9.76	3,165	12.8	23.9	188.0	90	10.55	3,905	14.6	28.3
	210.0		8.90	4,264		27.6	236.0		9.63	5,274		32.7
8 + 5 + 30	150.3	54	7.89	1,223	6.1	15.5	185.3	66	8.57	1,597	7.4	18.4
	190.3		7.07	1,914		19.3	225.3		7.76	2,497		23.3
8 + 6 + 30	161.3	56	7.73	1,393	7.1	16.8	197.3	69	8.41	1,815	8.5	20.0
	201.3		6.99	2,051		20.2	237.3		7.67	2,676		24.4
10 + 5 + 30	163.3	58	9.26	2,032	8.7	21.5	198.3	71	10.01	2,552	10.1	25.3
	213.3		8.26	3,145		26.2	248.3		9.00	3,972		31.4
10 + 6 + 30	176.3	61	9.06	2,307	10.1	23.1	212.3	74	9.81	2,899	11.7	27.4
	226.3		8.16	3,366		27.5	262.3		8.90	4,253		32.9
12 + 5 + 30	177.0	63	10.58	3,128	11.7	28.0	212.0	76	11.40	3,837	13.3	32.9
	237.0		9.42	4,790		34.0	272.0		10.21	5,919		40.4
12 + 6 + 30	192.0	67	10.34	3,541	13.5	30.1	228.0	79	11.16	4,350	15.4	35.5
	252.0		9.31	5,124		35.6	288.0		10.08	6,334		42.3
14 + 5 + 30	191.3	68	11.86	4,549	15.2	35.0	226.3	81	12.74	5,492	17.0	41.2
	261.3		10.56	6,905		42.4	296.3		11.38	8,394		50.1
14 + 6 + 30	208.3	72	11.59	5,135	17.5	37.5	244.3	85	12.46	6,210	19.7	44.3
	278.3		10.44	7,382		44.4	314.3		11.24	8,976		52.5
16 + 6 + 30	225.3	78	12.81	7,127	22.0	45.5	261.3	91	13.73	8,521	24.5	53.7
	305.3		11.55	10,197		54.1	341.3		12.39	12,237		63.5
16 + 7 + 30	244.3	83	12.55	7,890	24.9	48.3	281.3	95	13.46	9,446	27.7	57.1
	324.3		11.43	10,844		56.6	361.3		12.25	13,011		66.4
20 + 6 + 30	261.3	91	15.18	12,469	32.5	63.0	297.3	103	16.19	14,664	35.8	74.2
	361.3		13.74	17,741		75.8	397.3		14.63	20,860		88.0
20 + 7 + 30	284.3	96	14.88	13,769	36.6	67.0	321.3	109	15.87	16,205	40.4	78.8
	384.3		13.61	18,864		79.4	421.3		14.48	22,168		92.0

(1) f'_c = 4,000 psi, rib side slope = 1 to 12.
(2) First value is the pan depth, second value is the rib width, and the third value is the pan width (in.)
(3) First value is for a standard section; second value is at a tapered end.
(4) For normal-weight concrete, w = 150 pcf (added weight of tapers is neglected.)

TABLE 8-1(b) GROSS SECTION PROPERTIES — STANDARD JOIST CONSTRUCTION [1]

[2] Joist	4.5-Inch Top Slab						5-Inch Top Slab					
	Gross Area[3] ($in.^2$)	Wt[4] (psf)	Y_{cg}[3] (in.)	I_g[3] ($in.^4$)	$+M_{cr}$ (ft-k)	$-M_{cr}$[3] (ft-k)	Gross Area[3] ($in.^2$)	Wt[4] (psf)	Y_{cg}[3] (in.)	I_g[3] ($in.^4$)	$+M_{cr}$ (ft-k)	$-M_{cr}$[3] (ft-k)
8 + 5 + 20	157.8	79	8.50	1,630	7.6	16.1	170.3	85	8.81	1,840	8.3	17.4
	189.8		7.74	2,340		19.4	202.3		8.05	2,634		21.0
8 + 6 + 20	170.3	82	8.33	1,852	8.8	17.6	183.3	88	8.65	2,087	9.5	19.0
	202.3		7.65	2,528		20.6	215.3		7.96	2,846		22.3
10 + 5 + 20	170.8	85	9.86	2,561	10.3	21.8	183.3	92	10.19	2,841	11.0	23.3
	210.8		8.93	3,659		26.0	223.3		9.26	4,058		27.9
10 + 6 + 20	185.3	89	9.65	2,906	11.9	23.7	198.3	95	9.99	3,222	12.8	25.4
	225.3		8.83	3,951		27.5	238.3		9.15	4,383		29.6
12 + 5 + 20	184.5	92	11.16	3,797	13.4	28.1	197.0	99	11.52	4,163	14.3	30.0
	232.5		10.10	5,388		33.3	245.0		10.43	5,913		35.6
12 + 6 + 20	201.0	97	10.92	4,300	15.6	30.5	214.0	103	11.28	4,715	16.5	32.6
	249.0		9.97	5,815		35.2	262.0		10.31	6,382		37.7
8 + 5 + 30	202.8	72	8.89	1,813	8.1	19.8	220.3	79	9.19	2,054	8.8	21.3
	242.8		8.08	2,825		25.3	260.3		8.40	3,181		27.3
8 + 6 + 30	215.3	75	8.74	2,058	9.3	21.6	233.3	81	9.04	2,326	10.2	23.2
	255.3		7.99	3,028		26.6	273.3		8.31	3,409		28.7
10 + 5 + 30	215.8	77	10.35	2,841	10.8	27.1	233.3	83	10.68	3,155	11.7	28.9
	265.8		9.35	4,422		33.9	283.3		9.68	4,902		36.4
10 + 6 + 30	230.3	80	10.16	3,227	12.6	29.4	248.3	86	10.49	3,579	13.5	31.4
	280.3		9.24	4,737		35.6	298.3		9.57	5,251		38.2
12 + 5 + 30	229.5	82	11.77	4,219	14.2	35.2	247.0	88	12.12	4,623	15.1	37.4
	289.5		10.57	6,520		43.5	307.0		10.92	7,151		46.5
12 + 6 + 30	246.0	85	11.53	4,783	16.4	38.0	264.0	92	11.89	5,241	17.4	40.5
	306.0		10.45	6,979		45.6	324.0		10.80	7,655		48.8
14 + 5 + 30	243.8	87	13.13	5,986	18.0	44.1	261.3	93	13.51	6,502	19.0	46.8
	313.8		11.76	9,174		53.8	331.3		12.13	9,983		57.5
14 + 6 + 30	262.3	91	12.86	6,773	20.8	47.4	280.3	97	13.24	7,358	22.0	50.5
	332.3		11.62	9,812		56.4	350.3		11.99	10,679		60.2
16 + 6 + 30	279.3	97	14.15	9,238	25.8	57.5	297.3	103	14.55	9,975	27.1	61.1
	359.3		12.78	13,295		68.1	377.3		13.16	14,385		72.5
16 + 7 + 30	299.8	101	13.88	10,246	29.2	61.2	318.3	108	14.28	11,068	30.6	65.1
	379.8		12.64	14,137		71.1	398.3		13.02	15,297		75.8
20 + 6 + 30	315.3	109	16.65	15,768	37.4	79.4	333.3	116	17.08	16,887	39.1	84.3
	415.3		15.05	22,454		93.9	433.3		15.45	24,079		99.7
20 + 7 + 30	339.8	115	16.33	17,433	42.2	84.3	358.3	121	16.76	18,677	44.0	89.6
	439.8		14.89	23,861		98.1	458.3		15.29	25,587		104.1

(1) f'_c = 4,000 psi, rib side slope = 1 to 12.
(2) First value is the pan depth, second value is the rib width, and the third value is the pan width (in.)
(3) First value is for a standard section; second value is at a tapered end.
(4) For normal-weight concrete, w = 150 pcf (added weight of tapers is neglected.)

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 3.0″ Top Slab = 11.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 10.5	# 4 8	# 5 10	# 6 7	End Span Defl. Coeff. (3)	# 4 11	# 4 10	# 5 11	# 5 9	# 6 6	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 3	# 4	# 4	# 5	# 5		# 3	# 3	# 4	# 4	# 5	
	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
Steel (psf)		0.64	0.79	1.01	1.25	1.78		0.68	0.82	1.13	1.39	2.38	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
11'-0"		498*	502*	529*	552*		0.122						
		514	682	774*	796*								
12'-0"		421	440*	462*	478*	587*	0.173						
		0	562	684*	700*	746*							
13'-0"		348	388*	405*	418*	504*	0.239						
		0	468	608*	620*	658*							
14'-0"		290	345*	359*	370*	440*	0.321	305	396*	405*	415*	472*	0.198
		0	393	515	556*	595*		0	454	605	633*	689*	
15'-0"		243	310*	322*	330*	389*	0.423	256	358*	366*	374*	423*	0.260
		0	333	440	503*	550*		0	387	518	576*	623*	
16'-0"		205	281*	291*	298*	347*	0.548	217	326*	333*	340*	381*	0.337
		0	284	378	458*	493*		0	331	446	527*	568*	
17'-0"		173	243	264*	270*	312*	0.698	184	285	304*	310*	346*	0.430
		0	0	326	410	445*		0	0	387	486*	521*	
18'-0"		147	209	241*	246*	282*	0.878	156	246	279*	285*	316*	0.540
		0	0	283	358	404*		0	0	337	445	480*	
19'-0"		124	180	221*	225*	257*	1.090	133	214	258*	262*	290*	0.671
		0	0	247	314	370*		0	0	295	392	444*	
20'-0"		105	156	204*	207*	235*	1.338	113	186	238*	243*	267*	0.823
		0	0	216	276	340*		0	0	260	346	413*	
21'-0"		89	135	188*	191*	216*	1.626	95	162	221*	225*	247*	1.001
		0	0	189	244	306		0	0	229	307	381*	
22'-0"		74	116	166	177*	199*	1.959	80	141	202	210*	229*	1.205
		0	0	0	216	272		0	0	0	274	347	
23'-0"		62	100	145	164*	184*	2.340	67	123	179	195*	213*	1.440
		0	0	0	191	243		0	0	0	244	311	
24'-0"		51	86	128	153*	170*	2.774	56	107	158	183*	199*	1.707
		0	0	0	170	214+		0	0	0	218	280	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.40 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.45	0.48	0.62	0.77	1.57		0.45	0.50	0.70	0.86	1.83	
STEEL % (UNIFORM)	0.80	0.84	1.10	1.38	2.81		0.80	0.88	1.25	1.53	3.28	
(TAPERED)	0.48	0.50	0.65	0.82	1.67		0.48	0.52	0.74	0.91	1.94	
EFF. DEPTH, IN.	9.75	9.75	9.75	9.69	9.62		9.75	9.75	9.69	9.69	9.62	
$-I_{cr}/I_{gr}$	0.191	0.198	0.243	0.279	0.437		0.191	0.205	0.261	0.300	0.479	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.13	0.16	0.21	0.26	0.31		0.09	0.13	0.16	0.21	0.26	
EFF. DEPTH, IN.	9.75	9.75	9.69	9.69	9.62		9.81	9.75	9.75	9.69	9.69	
$+I_{cr}/I_{gr}$	0.176	0.222	0.271	0.322	0.374		0.130	0.176	0.222	0.271	0.322	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 3.0″ Top Slab = 11.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 8.5	# 5 10	# 5 8.5	End Span Defl. Coeff. (3)	# 4 11	# 4 10	# 4 8	# 5 9.5	# 5 7.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 3	# 4	# 4	# 5	# 5		# 3	# 3	# 4	# 4	# 5	
	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
Steel (psf)		0.63	0.76	0.97	1.22	1.46		0.67	0.81	1.04	1.33	1.68	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
14'-0"		272	372	400*	413*	426*	0.334	287	431	455*	463*	477*	0.206
		0	0	490	592*	605*		0	0	576	673*	687*	
15'-0"		227	314	359*	370*	381*	0.440	240	365	413*	419*	431*	0.271
		0	0	417	521	547*		0	0	492	613*	624*	
16'-0"		191	267	325*	335*	344*	0.570	202	312	376*	381*	392*	0.351
		0	0	357	448	498*		0	0	423	554	572*	
17'-0"		160	228	297*	304*	312*	0.726	170	268	345*	349*	358*	0.447
		0	0	307	388	457*		0	0	366	482	526*	
18'-0"		135	195	266	278*	285*	0.913	144	231	317*	321*	329*	0.562
		0	0	0	338	419		0	0	318	422	487*	
19'-0"		113	167	231	255*	261*	1.133	121	199	278	297*	303*	0.697
		0	0	0	296	369		0	0	0	371	453*	
20'-0"		95	144	201	236*	241*	1.391	102	172	243	275*	281*	0.856
		0	0	0	259	325		0	0	0	327	412	
21'-0"		79	123	175	218*	222*	1.691	85	149	214	256*	261*	1.041
		0	0	0	228	288		0	0	0	290	367	
22'-0"		65	105	153	201	206*	2.037	71	129	188	238*	243*	1.254
		0	0	0	0	256		0	0	0	257	327	
23'-0"		53	90	133	178	192*	2.433	58	112	165	223*	227*	1.497
		0	0	0	0	227		0	0	0	229	293	
24'-0"		42	76	116	157	179*	2.885	47	96	146	204	213*	1.775
		0	0	0	0	203		0	0	0	0	263	
25'-0"			64	101	139	159+	3.397		83	128	182	200*	2.090
			0	0	0	181			0	0	0	236	
26'-0"			54	88	122	138+	3.974		71	113	162	187*	2.445
			0	0	0	161			0	0	0	213	
27'-0"			44	76	108	121+	4.621		60	99	145	176*	2.844
			0	0	0	144			0	0	0	192	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.42 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.47	0.47	0.61	0.81	0.95		0.47	0.52	0.65	0.85	1.07	
STEEL % (UNIFORM)	0.71	0.71	0.92	1.22	1.44		0.71	0.78	0.98	1.29	1.63	
(TAPERED)	0.45	0.45	0.58	0.77	0.91		0.45	0.49	0.62	0.81	1.03	
EFF. DEPTH, IN.	9.75	9.75	9.75	9.69	9.69		9.75	9.75	9.75	9.69	9.69	
$-I_{cr}/I_{gr}$	0.180	0.180	0.220	0.266	0.298		0.180	0.194	0.230	0.276	0.325	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.12	0.16	0.20	0.25	0.30		0.09	0.12	0.16	0.20	0.25	
EFF. DEPTH, IN.	9.75	9.75	9.69	9.69	9.62		9.81	9.75	9.75	9.69	9.69	
$+I_{cr}/I_{gr}$	0.156	0.196	0.240	0.285	0.331		0.115	0.156	0.196	0.240	0.285	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 3.0″ Top Slab = 13.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 5 10	# 5 8	# 6 6	End Span Defl. Coeff. (3)	# 4 10	# 4 7.5	# 5 9	# 5 7	# 7 7	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.80	1.01	1.25	1.52	2.10		0.82	1.10	1.39	1.77	2.79	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
18'-0"		260	317*	324*	337*	390*	0.878	304	367*	372*	384*	424*	0.540
		0	349	441	487*	504*		0	414	545	571*	609*	
19'-0"		225	291*	297*	308*	354*	1.090	265	338*	343*	353*	388*	0.671
		0	305	387	445*	462*		0	364	481	528*	563*	
20'-0"		195	268	274*	283*	324*	1.338	231	314*	318*	327*	357*	0.823
		0	0	341	410*	425*		0	320	426	485*	523*	
21'-0"		169	235	253*	261*	297*	1.626	202	283	295*	303*	330*	1.001
		0	0	302	378	408*		0	0	379	444*	486*	
22'-0"		147	207	234*	242*	273*	1.959	177	251	275*	282*	306*	1.205
		0	0	268	337	377*		0	0	338	403*	450*	
23'-0"		128	183	218*	225*	253*	2.340	155	222	257*	263*	285*	1.440
		0	0	238	302	351*		0	0	303	369*	415*	
24'-0"		111	161	203*	209*	234*	2.774	136	198	241*	246*	266*	1.707
		0	0	212	271	327*		0	0	271	339*	382*	
25'-0"		96	142	189	195*	218*	3.266	119	176	226*	231*	249*	2.010
		0	0	0	243	298		0	0	244	312	350*	
26'-0"		82	125	169	182*	203*	3.821	104	156	212*	217*	233*	2.351
		0	0	0	219	269		0	0	219	283	323*	
27'-0"		70	110	151	171*	190*	4.443	90	139	197	204*	219*	2.734
		0	0	0	197	244		0	0	0	256	299*	
28'-0"		60	97	135	160*	178*	5.139	78	124	178	193*	206*	3.163
		0	0	0	177	221		0	0	0	233	278*	
29'-0"		50	85	120	150*	166*	5.914	67	110	160	182*	194*	3.639
		0	0	0	160	198+		0	0	0	211	259*	
30'-0"		42	74	107	139+	153+	6.772	58	97	144	172*	183*	4.168
		0	0	0	144	178+		0	0	0	192	242*	
31'-0"			64	95	124+	137+	7.722	49	86	130	163*	173*	4.752
			0	0	130	161+		0	0	0	175	226	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.50	0.62	0.77	0.97	1.83		0.50	0.67	0.86	1.11	2.14	
STEEL % (UNIFORM)	0.71	0.89	1.11	1.39	2.64		0.71	0.95	1.23	1.59	3.11	
(TAPERED)	0.43	0.53	0.66	0.83	1.58		0.43	0.57	0.74	0.95	1.86	
EFF. DEPTH, IN.	11.75	11.75	11.69	11.69	11.62		11.75	11.75	11.69	11.69	11.56	
$-I_{cr}/I_{gr}$	0.189	0.224	0.259	0.304	0.458		0.189	0.235	0.280	0.334	0.496	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.14	0.17	0.21	0.26	0.30		0.11	0.14	0.17	0.21	0.26	
EFF. DEPTH, IN.	11.75	11.69	11.69	11.62	11.62		11.75	11.75	11.69	11.69	11.62	
$+I_{cr}/I_{gr}$	0.198	0.244	0.290	0.339	0.389		0.157	0.198	0.244	0.290	0.339	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 3.0″ Top Slab = 13.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 8.5	# 4 7	# 5 8.5	# 5 7	End Span Defl. Coeff. (3)	# 4 10	# 4 8	# 5 9.5	# 5 7.5	# 5 6	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.76	0.97	1.19	1.46	1.75		0.81	1.04	1.33	1.68	2.04	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
18'-0"		243	330	363*	373*	386*	0.913	286	392	417*	427*	439*	0.562
		0	0	417	517	540*		0	0	518	607*	619*	
19'-0"		210	287	334*	342*	353*	1.133	248	343	386*	394*	405*	0.697
		0	0	366	455	499*		0	0	456	564*	574*	
20'-0"		181	251	308*	315*	325*	1.391	215	301	358*	365*	375*	0.856
		0	0	322	403	462*		0	0	403	507	535*	
21'-0"		156	220	284	292*	300*	1.691	188	266	333*	340*	348*	1.041
		0	0	0	357	431*		0	0	358	452	497*	
22'-0"		135	193	251	271*	279*	2.037	163	234	311*	317*	324*	1.254
		0	0	0	318	386		0	0	319	404	460*	
23'-0"		116	169	223	252*	259*	2.433	142	207	284	296*	303*	1.497
		0	0	0	284	346		0	0	0	363	423*	
24'-0"		100	148	198	235*	242*	2.885	124	184	254	278*	284*	1.775
		0	0	0	254	311		0	0	0	326	390*	
25'-0"		85	130	176	220*	226*	3.397	107	163	228	261*	267*	2.090
		0	0	0	227	280		0	0	0	294	360*	
26'-0"		73	114	156	204	212*	3.974	93	144	204	246*	251*	2.445
		0	0	0	0	252		0	0	0	265	335*	
27'-0"		61	100	139	183	198*	4.621	80	127	183	232*	236*	2.844
		0	0	0	0	228		0	0	0	240	304	
28'-0"		51	87	123	164	187*	5.345	69	112	164	217	223*	3.289
		0	0	0	0	206		0	0	0	0	277	
29'-0"		42	75	109	147	167+	6.150	58	99	148	197	211*	3.785
		0	0	0	0	186		0	0	0	0	252	
30'-0"			65	96	132	148+	7.043	49	87	132	178	200*	4.334
			0	0	0	169		0	0	0	0	230	
31'-0"			55	85	118	133+	8.030	40	76	119	162	189*	4.942
			0	0	0	152		0	0	0	0	210	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.47 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.47	0.61	0.74	0.95	1.15		0.52	0.65	0.85	1.07	1.34	
STEEL % (UNIFORM)	0.58	0.75	0.91	1.16	1.41		0.63	0.79	1.04	1.32	1.65	
(TAPERED)	0.37	0.47	0.58	0.74	0.90		0.40	0.50	0.66	0.84	1.05	
EFF. DEPTH, IN.	11.75	11.75	11.75	11.69	11.69		11.75	11.75	11.69	11.69	11.69	
$-I_{cr}/I_{gr}$	0.165	0.203	0.235	0.278	0.320		0.178	0.212	0.256	0.304	0.356	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.13	0.17	0.20	0.25	0.29		0.10	0.13	0.17	0.20	0.25	
EFF. DEPTH, IN.	11.75	11.69	11.69	11.62	11.62		11.75	11.75	11.69	11.69	11.62	
$+I_{cr}/I_{gr}$	0.176	0.216	0.257	0.301	0.345		0.139	0.176	0.216	0.257	0.301	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 3.0″ Top Slab = 15.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 5 10	# 5 8.5	# 5 7	End Span Defl. Coeff. (3)	# 4 10	# 4 8	# 5 9.5	# 5 7.5	# 6 6	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.80	1.01	1.25	1.50	1.80		0.82	1.06	1.35	1.71	2.54	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
20'-0"		234	320	347*	356*	368*	1.338	276	381	398*	408*	440*	0.823
		0	0	407	484*	499*		0	0	506	582*	622*	
21'-0"		204	282	320*	328*	339*	1.626	242	337	370*	379*	407*	1.001
		0	0	361	451	472*		0	0	451	533*	578*	
22'-0"		178	249	297*	304*	314*	1.959	213	299	345*	353*	378*	1.205
		0	0	321	403	439*		0	0	403	486*	535*	
23'-0"		155	220	276*	282*	291*	2.340	187	266	323*	330*	352*	1.440
		0	0	286	361	409*		0	0	361	446*	492*	
24'-0"		135	195	255	263*	271*	2.774	164	237	302*	309*	329*	1.707
		0	0	0	324	383*		0	0	324	411*	451*	
25'-0"		118	173	228	246*	253*	3.266	145	212	284*	290*	308*	2.010
		0	0	0	292	356		0	0	292	372	416*	
26'-0"		102	153	204	230*	237*	3.821	127	189	263	273*	290*	2.351
		0	0	0	263	323		0	0	0	338	385*	
27'-0"		88	135	183	216*	222*	4.443	111	169	237	257*	272*	2.734
		0	0	0	237	293		0	0	0	307	358*	
28'-0"		76	119	164	203*	208*	5.139	97	151	214	243*	257*	3.163
		0	0	0	214	266		0	0	0	279	333*	
29'-0"		64	105	147	191*	196*	5.914	84	134	194	229*	242*	3.639
		0	0	0	194	242		0	0	0	254	312*	
30'-0"		54	93	131	175	185*	6.772	73	120	175	217*	229*	4.168
		0	0	0	0	220		0	0	0	231	292*	
31'-0"		45	81	117	158	174*	7.722	63	106	158	206*	217*	4.752
		0	0	0	0	200		0	0	0	211	271	
32'-0"			71	104	143	165*	8.767	53	94	143	193	206*	5.395
			0	0	0	183		0	0	0	0	249	
33'-0"			61	93	129	156*	9.915	45	83	129	176	195*	6.102
			0	0	0	166		0	0	0	0	229	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.49 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.50	0.62	0.77	0.91	1.11		0.50	0.62	0.82	1.03	1.83	
STEEL % (UNIFORM)	0.59	0.74	0.92	1.08	1.32		0.59	0.74	0.97	1.23	2.19	
(TAPERED)	0.36	0.45	0.56	0.66	0.80		0.36	0.45	0.59	0.74	1.33	
EFF. DEPTH, IN.	13.75	13.75	13.69	13.69	13.69		13.75	13.75	13.69	13.69	13.62	
$-I_{cr}/I_{gr}$	0.174	0.208	0.242	0.273	0.314		0.174	0.208	0.252	0.299	0.436	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.12	0.15	0.18	0.22	0.26		0.09	0.12	0.15	0.18	0.22	
EFF. DEPTH, IN.	13.75	13.69	13.69	13.62	13.62		13.75	13.75	13.69	13.69	13.62	
$+I_{cr}/I_{gr}$	0.180	0.222	0.264	0.310	0.356		0.142	0.180	0.222	0.264	0.310	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 3.0″ Top Slab = 15.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 8.5	# 4 7	# 5 9	# 5 7.5	End Span Defl. Coeff. (3)	# 4 11	# 4 8	# 5 10	# 5 8	# 6 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.76	0.97	1.19	1.44	1.72		0.77	1.04	1.30	1.62	2.00	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
20'-0"		217	300	383	393*	404*	1.391	257	358	445*	453*	461*	0.856
		0	0	0	479	545*		0	0	478	600	636*	
21'-0"		188	263	339	364*	373*	1.691	225	316	414*	422*	429*	1.041
		0	0	0	425	511*		0	0	425	536	592*	
22'-0"		163	231	300	338*	346*	2.037	196	280	379	394*	400*	1.254
		0	0	0	379	459		0	0	0	480	548*	
23'-0"		141	204	267	314*	322*	2.433	172	248	339	368*	374*	1.497
		0	0	0	339	412		0	0	0	431	505*	
24'-0"		122	179	237	294*	301*	2.885	150	220	304	346*	350*	1.775
		0	0	0	304	371		0	0	0	388	466*	
25'-0"		105	158	211	272	281*	3.397	131	195	272	325*	329*	2.090
		0	0	0	0	335		0	0	0	350	432*	
26'-0"		90	139	188	245	264*	3.974	114	174	245	306*	310*	2.445
		0	0	0	0	302		0	0	0	317	399	
27'-0"		77	122	168	220	248*	4.621	99	154	220	287	292*	2.844
		0	0	0	0	273		0	0	0	0	363	
28'-0"		65	107	149	198	233*	5.345	85	137	198	260	276*	3.289
		0	0	0	0	248		0	0	0	0	331	
29'-0"		54	93	133	178	220*	6.150	73	121	178	236	261*	3.785
		0	0	0	0	224		0	0	0	0	302	
30'-0"		44	81	118	160	204	7.043	62	107	160	214	248*	4.334
		0	0	0	0	0		0	0	0	0	276	
31'-0"			70	105	144	185	8.030	52	94	144	195	235*	4.942
			0	0	0	0		0	0	0	0	253	
32'-0"			60	92	130	168	9.118	43	83	130	177	223*	5.611
			0	0	0	0		0	0	0	0	231	
33'-0"			50	81	116	152	10.312		72	116	161	212	6.346
			0	0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.47	0.61	0.74	0.90	1.07		0.47	0.65	0.81	1.01	1.27	
STEEL % (UNIFORM)	0.48	0.62	0.76	0.92	1.10		0.48	0.66	0.82	1.03	1.31	
(TAPERED)	0.31	0.40	0.48	0.59	0.70		0.31	0.42	0.53	0.66	0.84	
EFF. DEPTH, IN.	13.75	13.75	13.75	13.69	13.69		13.75	13.75	13.69	13.69	13.62	
$-I_{cr}/I_{gr}$	0.153	0.188	0.219	0.249	0.286		0.153	0.197	0.230	0.272	0.319	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.11	0.14	0.17	0.21	0.25		0.09	0.11	0.14	0.17	0.21	
EFF. DEPTH, IN.	13.75	13.69	13.69	13.62	13.62		13.75	13.75	13.69	13.69	13.62	
$+I_{cr}/I_{gr}$	0.159	0.197	0.235	0.275	0.317		0.126	0.159	0.197	0.235	0.275	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 4.0″ Top Slab = 12.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 10	# 4 8	# 5 10	# 5 8	End Span Defl. Coeff. (3)	# 4 11	# 4 10	# 4 7.5	# 5 9	# 6 6.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6		# 3 # 3	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	
Steel (psf)		0.64	0.80	1.01	1.25	1.52		0.68	0.82	1.10	1.39	2.26	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
12'-0"		456	497*	517*	538*	570*	0.173						
		0	612	756*	776*	808*							
13'-0"		376	440*	457*	473*	500*	0.239						
		0	509	665	691*	717*							
14'-0"		312	390*	404*	417*	438*	0.321						
		0	426	562	616*	638*							
15'-0"		260	349*	360*	370*	388*	0.423		400*		419*		0.260
		0	360	478	555*	573*			419		635*		
16'-0"		218	306	324*	332*	347*	0.548	231	357	372*	379*	420*	0.337
		0	0	409	505*	519*		0	0	485	580*	620*	
17'-0"		183	261	293*	300*	313*	0.698	194	306	340*	345*	380*	0.430
		0	0	352	446	474*		0	0	419	533*	567*	
18'-0"		154	223	267*	273*	284*	0.878	164	264	311*	316*	346*	0.540
		0	0	305	388	434*		0	0	365	484	522*	
19'-0"		129	191	244*	249*	259*	1.090	138	228	286*	291*	317*	0.671
		0	0	265	339	396*		0	0	318	425	483*	
20'-0"		108	164	224*	228*	237*	1.338	116	197	264*	268*	292*	0.823
		0	0	230	297	363*		0	0	279	375	447*	
21'-0"		90	141	201	210*	217*	1.626	97	170	244	248*	269*	1.001
		0	0	0	262	331		0	0	0	332	412*	
22'-0"		74	120	175	194*	200*	1.959	81	147	215	230*	249*	1.205
		0	0	0	231	293		0	0	0	295	375	
23'-0"		60	102	153	179*	185*	2.340	66	127	189	214*	231*	1.440
		0	0	0	203	261		0	0	0	262	336	
24'-0"		48	87	133	166*	171*	2.774	54	110	167	200*	215*	1.707
		0	0	0	180	232		0	0	0	233	301	
25'-0"			73	116	154*	159*	3.266	42	94	147	186*	200*	2.010
			0	0	159	207		0	0	0	208	271	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF) (4)

NEGATIVE MOMENT													
STEEL AREA (SQ. IN.)	0.45	0.50	0.62	0.77	0.98		0.45	0.50	0.67	0.86	1.69	
STEEL % (UNIFORM)	0.72	0.79	0.99	1.23	1.54		0.72	0.79	1.05	1.37	2.71	
(TAPERED)	0.43	0.47	0.59	0.73	0.92		0.43	0.47	0.63	0.81	1.61	
EFF. DEPTH, IN.	10.75	10.75	10.75	10.69	10.69		10.75	10.75	10.75	10.69	10.62	
$-I_{cr}/I_{gr}$	0.182	0.196	0.232	0.268	0.314		0.182	0.196	0.244	0.289	0.445	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.12	0.15	0.19	0.23	0.28		0.08	0.12	0.15	0.19	0.23	
EFF. DEPTH, IN.	10.75	10.75	10.69	10.69	10.62		10.81	10.75	10.75	10.69	10.69	
$+I_{cr}/I_{gr}$	0.166	0.209	0.256	0.304	0.314		0.122	0.166	0.209	0.256	0.304	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 4.0″ Top Slab = 12.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 8.5	# 4 7	# 5 8.5	End Span Defl. Coeff. (3)	# 4 11	# 4 10	# 4 8	# 5 9.5	# 5 7.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6		# 3 # 3	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	
Steel (psf)		0.63	0.76	0.97	1.19	1.46		0.67	0.81	1.04	1.33	1.68	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
14'-0"		293	403	449*	463*	480*	0.334						
		0	0	533	656*	672*							
15'-0"		243	339	402*	413*	428*	0.440		396		469*		0.271
		0	0	453	568	606*			0		677*		
16'-0"		203	287	363*	373*	384*	0.570	215	337	419*	426*	437*	0.351
		0	0	387	488	550*		0	0	459	604	631*	
17'-0"		169	244	329*	338*	348*	0.726	180	288	383*	389*	399*	0.447
		0	0	332	422	503*		0	0	396	525	580*	
18'-0"		141	208	286	308*	316*	0.913	151	247	344	357*	366*	0.562
		0	0	0	366	457		0	0	0	458	535*	
19'-0"		117	177	248	282*	289*	1.133	126	212	299	329*	336*	0.697
		0	0	0	319	401		0	0	0	402	496*	
20'-0"		97	151	215	260*	266*	1.391	105	182	261	304*	311*	0.856
		0	0	0	279	353		0	0	0	354	448	
21'-0"		79	128	186	240*	245*	1.691	86	157	228	282*	288*	1.041
		0	0	0	245	311		0	0	0	312	398	
22'-0"		64	109	161	215	226*	2.037	70	135	200	262*	268*	1.254
		0	0	0	0	275		0	0	0	276	354	
23'-0"		51	92	140	189	210*	2.433	57	116	175	245*	250*	1.497
		0	0	0	0	244		0	0	0	0	316	
24'-0"			77	121	166	195*	2.885	45	99	153	218	233*	1.775
			0	0	0	217		0	0	0	0	283	
25'-0"			63	104	146	182*	3.397		84	134	193	218*	2.090
			0	0	0	193			0	0	0	254	
26'-0"			52	90	128	169*	3.974		71	117	172	205*	2.445
			0	0	0	171			0	0	0	228	
27'-0"			41	76	112	152	4.621		59	102	153	192*	2.844
			0	0	0	0			0	0	0	204	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF) (4)

NEGATIVE MOMENT													
STEEL AREA (SQ. IN.)	0.47	0.47	0.61	0.74	0.95		0.47	0.52	0.65	0.85	1.07	
STEEL % (UNIFORM)	0.64	0.64	0.83	1.00	1.29		0.64	0.70	0.88	1.15	1.46	
(TAPERED)	0.40	0.40	0.52	0.63	0.81		0.40	0.44	0.55	0.73	0.92	
EFF. DEPTH, IN.	10.75	10.75	10.75	10.75	10.69		10.75	10.75	10.75	10.69	10.69	
$-I_{cr}/I_{gr}$	0.172	0.172	0.210	0.243	0.287		0.172	0.185	0.220	0.265	0.313	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.11	0.14	0.18	0.22	0.27		0.08	0.11	0.14	0.18	0.22	
EFF. DEPTH, IN.	10.75	10.75	10.69	10.69	10.62		10.81	10.75	10.75	10.69	10.69	
$+I_{cr}/I_{gr}$	0.146	0.184	0.226	0.269	0.314		0.108	0.146	0.184	0.226	0.269	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 4.0″ Top Slab = 14.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 5 10	# 5 8	# 5 7	End Span Defl. Coeff. (3)	# 4 10	# 4 7.5	# 5 9	# 5 7.5	# 7 7	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.80	1.01	1.25	1.52	1.80		0.82	1.10	1.39	1.71	2.79	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
18'-0"		275	348*	357*	371*	382*	0.878	323		409*	418*		0.540
		0	372	472	519*	537*		0		585	615*		
19'-0"		237	319*	326*	338*	347*	1.090	280	371*	376*	384*		0.671
		0	325	414	475*	491*		0	388	515	568*		
20'-0"		204	284	299*	310*	318*	1.338	243	340	348*	355*		0.823
		0	0	364	436*	451*		0	0	456	521*		
21'-0"		176	248	276*	285*	292*	1.626	212	300	322*	329*		1.001
		0	0	321	404	428*		0	0	405	475*		
22'-0"		152	218	255*	263*	270*	1.959	185	265	300*	305*		1.205
		0	0	284	360	397*		0	0	360	432*		
23'-0"		131	191	236*	244*	249*	2.340	161	234	280*	285*	311*	1.440
		0	0	252	321	370*		0	0	321	395*	449*	
24'-0"		113	168	220*	226*	231*	2.774	140	207	261*	266*	290*	1.707
		0	0	224	287	345*		0	0	287	363*	413*	
25'-0"		96	147	199	211*	215*	3.266	121	184	245*	249*	270*	2.010
		0	0	0	257	317		0	0	257	332	378*	
26'-0"		82	129	176	197*	201*	3.821	105	163	230*	233*	253*	2.351
		0	0	0	231	286		0	0	231	300	349*	
27'-0"		69	113	157	184*	187*	4.443	90	144	207	219*	237*	2.734
		0	0	0	207	258		0	0	0	271	322*	
28'-0"		58	98	139	172*	175*	5.139	77	127	186	206*	223*	3.163
		0	0	0	186	233		0	0	0	245	299*	
29'-0"		47	85	123	161*	164*	5.914	66	112	167	194*	209*	3.639
		0	0	0	167	211		0	0	0	222	278*	
30'-0"			73	109	149	154*	6.772	55	98	150	183*	197*	4.168
			0	0	0	191		0	0	0	202	260*	
31'-0"			62	96	134	144*	7.722	46	86	134	173*	186*	4.752
			0	0	0	173		0	0	0	183	238	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.50	0.62	0.77	0.97	1.11		0.50	0.67	0.86	1.03	2.14	
STEEL % (UNIFORM)	0.65	0.81	1.01	1.26	1.44		0.65	0.86	1.12	1.34	2.82	
(TAPERED)	0.39	0.49	0.61	0.76	0.87		0.39	0.52	0.67	0.81	1.70	
EFF. DEPTH, IN.	12.75	12.75	12.69	12.69	12.69		12.75	12.75	12.69	12.69	12.56	
$-I_{cr}/I_{gr}$	0.179	0.213	0.248	0.292	0.321		0.179	0.224	0.268	0.305	0.481	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.13	0.16	0.20	0.24	0.28		0.10	0.13	0.16	0.20	0.24	
EFF. DEPTH, IN.	12.75	12.69	12.69	12.62	12.62		12.75	12.75	12.69	12.69	12.62	
$+I_{cr}/I_{gr}$	0.187	0.230	0.274	0.320	0.368		0.148	0.187	0.230	0.274	0.320	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 4.0″ Top Slab = 14.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 8.5	# 4 7	# 5 9	# 5 7.5	End Span Defl. Coeff. (3)	# 4 11	# 4 8	# 5 10	# 5 8	# 6 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.76	0.97	1.19	1.44	1.72		0.77	1.04	1.30	1.62	2.00	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
18'-0"		256	350	398*	406*	419*	0.913	302		455*	465*	474*	0.562
		0	0	445	554	580*		0		555	655*	663*	
19'-0"		219	304	365*	371*	382*	1.133	261	364	420*	429*	437*	0.697
		0	0	389	487	535*		0	0	487	607*	614*	
20'-0"		188	264	336*	341*	351*	1.391	226	319	389*	397*	403*	0.856
		0	0	342	430	493*		0	0	430	543	571*	
21'-0"		161	231	301	315*	324*	1.691	195	280	361*	368*	374*	1.041
		0	0	0	381	460*		0	0	381	483	530*	
22'-0"		138	201	265	292*	299*	2.037	169	246	337*	343*	348*	1.254
		0	0	0	338	412		0	0	338	431	489*	
23'-0"		118	176	234	271*	278*	2.433	146	217	301	320*	325*	1.497
		0	0	0	301	368		0	0	0	386	450*	
24'-0"		100	153	207	252*	258*	2.885	126	191	268	300*	304*	1.775
		0	0	0	268	330		0	0	0	346	414*	
25'-0"		84	133	183	235*	241*	3.397	108	168	239	281*	285*	2.090
		0	0	0	239	296		0	0	0	311	382*	
26'-0"		70	116	161	213	225*	3.974	93	148	214	264*	267*	2.445
		0	0	0	0	266		0	0	0	280	355*	
27'-0"		58	100	142	191	211*	4.621	79	130	191	248*	251*	2.844
		0	0	0	0	240		0	0	0	253	323	
28'-0"		47	86	125	170	198*	5.345	66	114	170	228	237*	3.289
		0	0	0	0	216		0	0	0	0	293	
29'-0"			73	110	152	186*	6.150	55	99	152	206	223*	3.785
			0	0	0	195		0	0	0	0	266	
30'-0"			62	96	135	175*	7.043	45	86	136	186	211*	4.334
			0	0	0	0		0	0	0	0	242	
31'-0"			52	84	120	158	8.030		74	121	167	200*	4.942
			0	0	0	0			0	0	0	221	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.47	0.61	0.74	0.90	1.07		0.47	0.65	0.81	1.01	1.27	
STEEL % (UNIFORM)	0.52	0.68	0.82	1.00	1.20		0.52	0.72	0.90	1.13	1.43	
(TAPERED)	0.34	0.43	0.53	0.64	0.77		0.34	0.46	0.57	0.72	0.91	
EFF. DEPTH, IN.	12.75	12.75	12.75	12.69	12.69		12.75	12.75	12.69	12.69	12.62	
$-I_{cr}/I_{gr}$	0.157	0.193	0.224	0.255	0.291		0.157	0.202	0.235	0.278	0.324	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.12	0.15	0.19	0.23	0.27		0.09	0.12	0.15	0.19	0.23	
EFF. DEPTH, IN.	12.75	12.69	12.69	12.62	12.62		12.75	12.75	12.69	12.69	12.62	
$+I_{cr}/I_{gr}$	0.165	0.204	0.242	0.284	0.326		0.131	0.165	0.204	0.242	0.284	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 4.0″ Top Slab = 16.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 5 10	# 5 8.5	# 5 7	End Span Defl. Coeff. (3)	# 4 10	# 4 8	# 5 9.5	# 5 7.5	# 5 6	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6		# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	
Steel (psf)		0.80	1.01	1.25	1.50	1.80		0.82	1.06	1.35	1.71	2.08	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
20'-0"		243	336	376*	386*	400*	1.338						
		0	0	429	512*	527*							
21'-0"		211	295	346*	355*	368*	1.626	252	354	401*	410*	421*	1.001
		0	0	380	475*	496*		0	0	476	572*	591*	
22'-0"		183	260	321*	328*	339*	1.959	220	314	373*	381*	391*	1.205
		0	0	337	425	461*		0	0	425	521*	541*	
23'-0"		159	229	298*	304*	314*	2.340	193	278	348*	356*	365*	1.440
		0	0	299	380	429*		0	0	380	477*	495*	
24'-0"		137	202	266	283*	292*	2.774	169	247	326*	333*	341*	1.707
		0	0	0	341	401*		0	0	340	435	455*	
25'-0"		118	178	237	264*	272*	3.266	147	219	305	312*	319*	2.010
		0	0	0	306	375*		0	0	0	392	420*	
26'-0"		102	156	212	247*	254*	3.821	128	195	275	293*	300*	2.351
		0	0	0	275	339		0	0	0	355	389*	
27'-0"		87	137	189	231*	237*	4.443	111	173	247	275*	282*	2.734
		0	0	0	247	307		0	0	0	322	362*	
28'-0"		73	121	168	216*	222*	5.139	96	154	222	260*	265*	3.163
		0	0	0	223	278		0	0	0	292	338*	
29'-0"		61	105	150	201	209*	5.914	83	136	200	245*	250*	3.639
		0	0	0	0	252		0	0	0	265	316*	
30'-0"		51	92	133	181	196*	6.772	71	121	180	232*	236*	4.168
		0	0	0	0	229		0	0	0	241	297*	
31'-0"		41	79	118	163	185*	7.722	60	106	162	219	224*	4.752
		0	0	0	0	208		0	0	0	0	279*	
32'-0"			68	104	146	174*	8.767	49	94	146	199	212*	5.395
			0	0	0	189		0	0	0	0	260	
33'-0"			58	92	131	164*	9.915	40	82	131	181	201*	6.102
			0	0	0	171		0	0	0	0	238	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.50	0.62	0.77	0.91	1.11		0.50	0.62	0.82	1.03	1.29	
STEEL % (UNIFORM)	0.54	0.68	0.85	1.00	1.21		0.54	0.68	0.89	1.13	1.41	
(TAPERED)	0.33	0.41	0.52	0.61	0.74		0.33	0.41	0.54	0.69	0.86	
EFF. DEPTH, IN.	14.75	14.75	14.69	14.69	14.69		14.75	14.75	14.69	14.69	14.69	
$-I_{cr}/I_{gr}$	0.165	0.197	0.230	0.260	0.300		0.165	0.197	0.239	0.285	0.334	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.11	0.14	0.17	0.21	0.24		0.08	0.11	0.14	0.17	0.21	
EFF. DEPTH, IN.	14.75	14.69	14.69	14.62	14.62		14.75	14.75	14.69	14.69	14.62	
$+I_{cr}/I_{gr}$	0.169	0.209	0.249	0.292	0.336		0.134	0.169	0.209	0.249	0.292	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 4.0″ Top Slab = 16.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 8.5	# 4 7	# 5 9	# 5 7.5	End Span Defl. Coeff. (3)	# 4 11	# 4 8	# 5 10	# 5 8	# 6 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6		# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	
Steel (psf)		0.76	0.97	1.19	1.44	1.72		0.77	1.04	1.30	1.62	2.00	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
20'-0"		225	314	404	427*	439*	1.391						
		0	0	0	507	576*							
21'-0"		194	275	356	394*	405*	1.691	234	332	448*	457*	465*	1.041
		0	0	0	450	539*		0	0	449	568	635*	
22'-0"		167	241	315	365*	374*	2.037	203	293	400	426*	432*	1.254
		0	0	0	400	487		0	0	0	508	587*	
23'-0"		144	211	279	339*	348*	2.433	177	259	357	398*	404*	1.497
		0	0	0	357	436		0	0	0	455	541*	
24'-0"		123	185	248	316*	324*	2.885	153	229	319	373*	378*	1.775
		0	0	0	319	392		0	0	0	409	499*	
25'-0"		105	162	220	285	302*	3.397	133	202	285	350*	355*	2.090
		0	0	0	0	352		0	0	0	369	462*	
26'-0"		89	142	195	256	283*	3.974	115	179	255	329*	333*	2.445
		0	0	0	0	318		0	0	0	333	421	
27'-0"		75	123	173	229	265*	4.621	98	158	229	301	314*	2.844
		0	0	0	0	287		0	0	0	0	383	
28'-0"		62	107	153	206	249*	5.345	84	139	205	272	296*	3.289
		0	0	0	0	259		0	0	0	0	348	
29'-0"		50	93	135	184	234	6.150	71	122	184	246	280*	3.785
		0	0	0	0	0		0	0	0	0	317	
30'-0"		40	79	119	165	212	7.043	59	107	165	223	265*	4.334
		0	0	0	0	0		0	0	0	0	289	
31'-0"			67	105	148	191	8.030	48	94	147	202	251*	4.942
			0	0	0	0		0	0	0	0	264	
32'-0"			57	92	132	173	9.118		81	132	183	238*	5.611
			0	0	0	0			0	0	0	241	
33'-0"			47	80	118	156	10.312		70	117	165	220	6.346
			0	0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.47	0.61	0.74	0.90	1.07		0.47	0.65	0.81	1.01	1.27	
STEEL % (UNIFORM)	0.44	0.57	0.70	0.84	1.01		0.44	0.61	0.76	0.95	1.20	
(TAPERED)	0.29	0.37	0.45	0.54	0.65		0.29	0.39	0.49	0.61	0.77	
EFF. DEPTH, IN.	14.75	14.75	14.75	14.69	14.69		14.75	14.75	14.69	14.69	14.62	
$-I_{cr}/I_{gr}$	0.144	0.178	0.207	0.237	0.272		0.144	0.186	0.219	0.259	0.304	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.10	0.13	0.16	0.20	0.23		0.08	0.10	0.13	0.16	0.20	
EFF. DEPTH, IN.	14.75	14.69	14.69	14.62	14.62		14.75	14.75	14.69	14.69	14.62	
$+I_{cr}/I_{gr}$	0.150	0.185	0.221	0.259	0.298		0.118	0.150	0.185	0.221	0.259	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 4.5″ Top Slab = 12.5″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 5 10	# 5 8	# 6 6	End Span Defl. Coeff. (3)	# 4 10	# 4 7.5	# 5 9	# 6 6.5	# 6 5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.80	1.01	1.25	1.52	2.10		0.82	1.10	1.39	2.26	2.84	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
17'-0"		270	309*	317*	331*	388*	0.698	318	358*	364*	402*	426*	0.430
		0	366	464	495*	514*		0	436	558*	595*	620*	
18'-0"		231	281*	287*	299*	349*	0.878	273	328*	333*	365*	387*	0.540
		0	316	403	449*	467*		0	379	504	547*	568*	
19'-0"		197	257*	262*	272*	315*	1.090	235	301*	306*	334*	353*	0.671
		0	274	352	410*	426*		0	330	442	505*	524*	
20'-0"		169	235*	240*	249*	287*	1.338	203	278*	282*	307*	324*	0.823
		0	238	309	375*	391*		0	289	390	467*	485*	
21'-0"		144	207	220*	228*	262*	1.626	175	253	261*	283*	298*	1.001
		0	0	271	344	369*		0	0	345	431*	450*	
22'-0"		123	180	203*	210*	240*	1.959	151	222	242*	262*	275*	1.205
		0	0	239	305	340*		0	0	306	390	416*	
23'-0"		104	157	187*	194*	220*	2.340	130	195	225*	242*	255*	1.440
		0	0	210	271	315*		0	0	271	349	382*	
24'-0"		88	136	173*	179*	203*	2.774	112	171	209*	225*	237*	1.707
		0	0	185	241	292*		0	0	242	313	350*	
25'-0"		74	118	161*	166*	188*	3.266	96	150	195*	210*	220*	2.010
		0	0	163	214	266		0	0	215	281	320*	
26'-0"		61	102	144	154*	174*	3.821	81	132	182*	196*	205*	2.351
		0	0	0	191	239		0	0	192	252	293*	
27'-0"		50	88	126	143*	161*	4.443	68	115	171*	183*	192*	2.734
		0	0	0	170	215		0	0	0	227	270*	
28'-0"			75	111	133*	149*	5.139	57	101	152	171*	179*	3.163
			0	0	152	193		0	0	0	204	250*	
29'-0"			63	97	124*	139*	5.914	47	87	135	160*	168*	3.639
			0	0	135	174		0	0	0	184	231*	
30'-0"			53	84	115*	129*	6.772		75	120	150*	157*	4.168
			0	0	120	156			0	0	166	215*	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.50	0.62	0.77	0.97	1.83		0.50	0.67	0.86	1.69	2.20	
STEEL % (UNIFORM)	0.75	0.94	1.17	1.46	2.78		0.75	1.00	1.30	2.57	3.34	
(TAPERED)	0.45	0.56	0.70	0.87	1.66		0.45	0.60	0.77	1.53	1.99	
EFF. DEPTH, IN.	11.25	11.25	11.19	11.19	11.12		11.25	11.25	11.19	11.12	11.12	
$-I_{cr}/I_{gr}$	0.192	0.227	0.263	0.308	0.461		0.192	0.238	0.284	0.439	0.514	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.14	0.18	0.22	0.27	0.32		0.11	0.14	0.18	0.22	0.27	
EFF. DEPTH, IN.	11.25	11.19	11.19	11.12	11.12		11.25	11.25	11.19	11.19	11.12	
$+I_{cr}/I_{gr}$	0.203	0.249	0.296	0.346	0.397		0.161	0.203	0.249	0.296	0.346	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 4.5″ Top Slab = 12.5″ Total Depth

TOP BARS	Size @	# 4 11	# 4 8.5	# 4 7	# 5 8.5	# 5 7	End Span Defl. Coeff. (3)	# 4 10	# 4 8	# 5 9.5	# 5 7.5	# 5 4	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.76	0.97	1.19	1.46	1.75		0.81	1.04	1.33	1.68	2.57	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
17'-0"		253	345	356*	367*	381*	0.726	298	404*	410*	421*	465*	0.447
		0	0	439	527*	541*		0	412	547	607*	652*	
18'-0"		215	297	325*	334*	346*	0.913	255	357	376*	385*	424*	0.562
		0	0	381	476	495*		0	0	477	560*	599*	
19'-0"		182	257	297*	305*	315*	1.133	219	310	346*	354*	389*	0.697
		0	0	332	417	456*		0	0	418	519*	553*	
20'-0"		155	222	273*	280*	289*	1.391	188	270	320*	327*	358*	0.856
		0	0	290	367	422*		0	0	368	467	513*	
21'-0"		131	192	252*	257*	265*	1.691	161	236	296*	303*	330*	1.041
		0	0	254	323	392*		0	0	324	414	478*	
22'-0"		111	166	222	238*	245*	2.037	138	206	276*	281*	306*	1.254
		0	0	0	286	351		0	0	287	368	445*	
23'-0"		93	144	195	220*	227*	2.433	118	180	254	262*	284*	1.497
		0	0	0	253	313		0	0	0	329	412*	
24'-0"		77	124	171	204*	210*	2.885	100	158	225	245*	265*	1.775
		0	0	0	224	279		0	0	0	294	371	
25'-0"		64	106	150	190*	195*	3.397	85	137	200	229*	247*	2.090
		0	0	0	199	249		0	0	0	263	335	
26'-0"		51	91	131	177	182*	3.974	71	120	177	214*	231*	2.445
		0	0	0	0	223		0	0	0	236	302	
27'-0"		40	77	114	157	169*	4.621	59	104	157	201*	216*	2.844
		0	0	0	0	200		0	0	0	211	273	
28'-0"			65	99	139	158*	5.345	48	90	139	189*	203*	3.289
			0	0	0	179		0	0	0	190	247	
29'-0"			54	86	123	148*	6.150		77	123	170	191*	3.785
			0	0	0	160			0	0	0	223	
30'-0"			44	74	108	132+	7.043		65	109	152	180*	4.334
			0	0	0	143			0	0	0	202	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.47	0.61	0.74	0.95	1.15		0.52	0.65	0.85	1.07	2.02	
STEEL % (UNIFORM)	0.61	0.78	0.95	1.22	1.48		0.67	0.83	1.09	1.39	2.60	
(TAPERED)	0.38	0.50	0.60	0.78	0.94		0.42	0.53	0.69	0.88	1.65	
EFF. DEPTH, IN.	11.25	11.25	11.25	11.19	11.19		11.25	11.25	11.19	11.19	11.19	
$-I_{cr}/I_{gr}$	0.168	0.205	0.238	0.281	0.323		0.181	0.215	0.259	0.307	0.466	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.14	0.18	0.21	0.26	0.30		0.11	0.14	0.18	0.21	0.26	
EFF. DEPTH, IN.	11.25	11.19	11.19	11.12	11.12		11.25	11.25	11.19	11.19	11.12	
$+I_{cr}/I_{gr}$	0.179	0.220	0.262	0.306	0.351		0.142	0.179	0.220	0.262	0.306	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 4.5″ Top Slab = 14.5″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 5 10	# 5 8	# 5 7	End Span Defl. Coeff. (3)	# 4 10	# 4 7.5	# 5 9	# 5 7.5	# 7 7.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.80	1.01	1.25	1.52	1.80		0.82	1.10	1.39	1.71	2.68	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		243	333*	341*	354*	364*	1.090	287	388*	394*	402*		0.671
		0	334	427	489*	506*		0	399	533	590*		
20'-0"		209	292	312*	324*	333*	1.338	249	351	364*	371*		0.823
		0	0	375	449*	465*		0	0	471	541*		
21'-0"		180	255	288*	298*	305*	1.626	217	308	337*	343*		1.001
		0	0	331	417	440*		0	0	417	494*		
22'-0"		155	223	265*	275*	281*	1.959	188	272	313*	319*		1.205
		0	0	292	371	408*		0	0	371	448*		
23'-0"		133	195	246*	254*	260*	2.340	164	240	291*	297*	321*	1.440
		0	0	259	331	379*		0	0	331	410*	460*	
24'-0"		114	171	228*	236*	241*	2.774	142	212	272*	277*	298*	1.707
		0	0	229	295	353*		0	0	296	377*	421*	
25'-0"		97	150	203	219*	224*	3.266	123	187	255*	259*	278*	2.010
		0	0	0	264	326		0	0	264	342	386*	
26'-0"		82	131	180	204*	208*	3.821	106	166	237	243*	260*	2.351
		0	0	0	237	294		0	0	0	309	356*	
27'-0"		68	114	160	190*	194*	4.443	91	146	212	228*	244*	2.734
		0	0	0	212	265		0	0	0	279	329*	
28'-0"		56	99	141	178*	182*	5.139	77	129	190	214*	229*	3.163
		0	0	0	190	239		0	0	0	252	305*	
29'-0"		46	85	125	166*	170*	5.914	65	113	170	201*	215*	3.639
		0	0	0	170	216		0	0	0	228	284*	
30'-0"			73	110	152	159*	6.772	54	99	152	190*	202*	4.168
			0	0	0	195		0	0	0	206	265*	
31'-0"			62	96	136	149*	7.722	44	86	136	179*	190*	4.752
			0	0	0	176		0	0	0	187	244	
32'-0"			51	84	121	140*	8.767		74	121	169	180*	5.395
			0	0	0	159			0	0	0	223	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) [4]

NEGATIVE MOMENT													
STEEL AREA (SQ. IN.)	0.50	0.62	0.77	0.97	1.11		0.50	0.67	0.86	1.03	2.00	
STEEL % (UNIFORM)	0.62	0.77	0.96	1.20	1.38		0.62	0.82	1.07	1.28	2.51	
(TAPERED)	0.37	0.47	0.58	0.73	0.83		0.37	0.50	0.65	0.78	1.52	
EFF. DEPTH, IN.	13.25	13.25	13.19	13.19	13.19		13.25	13.25	13.19	13.19	13.06	
$-I_{cr}/I_{gr}$	0.176	0.209	0.243	0.286	0.315		0.176	0.220	0.263	0.300	0.455	
POSITIVE MOMENT													
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.12	0.15	0.19	0.23	0.27		0.09	0.12	0.15	0.19	0.23	
EFF. DEPTH, IN.	13.25	13.19	13.19	13.12	13.12		13.25	13.25	13.19	13.19	13.12	
$+I_{cr}/I_{gr}$	0.182	0.224	0.267	0.313	0.359		0.144	0.182	0.224	0.267	0.313	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 4.5″ Top Slab = 14.5″ Total Depth

TOP BARS	Size @	# 4 11	# 4 8.5	# 4 7	# 5 9	# 5 7.5	End Span Defl. Coeff. (3)	# 4 11	# 4 8	# 5 10	# 5 8	# 6 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.76	0.97	1.19	1.44	1.72		0.77	1.04	1.30	1.62	2.00	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		225	313	381*	388*	400*	1.133	268	376	439*	448*	457*	0.697
		0	0	402	504	553*		0	0	504	630*	639*	
20'-0"		192	272	351*	357*	367*	1.391	231	328	406*	415*	422*	0.856
		0	0	352	444	509*		0	0	444	561	593*	
21'-0"		164	237	310	329*	338*	1.691	200	288	377*	384*	391*	1.041
		0	0	0	393	477*		0	0	393	499	551*	
22'-0"		140	206	272	304*	312*	2.037	172	253	348	358*	363*	1.254
		0	0	0	348	425		0	0	0	445	508*	
23'-0"		119	179	240	282*	290*	2.433	149	222	310	334*	339*	1.497
		0	0	0	310	380		0	0	0	398	467*	
24'-0"		101	156	212	263*	269*	2.885	128	195	276	312*	317*	1.775
		0	0	0	276	340		0	0	0	357	429*	
25'-0"		84	135	187	245*	251*	3.397	109	172	246	293*	296*	2.090
		0	0	0	246	305		0	0	0	320	397*	
26'-0"		70	117	165	219	234*	3.974	93	151	219	275*	278*	2.445
		0	0	0	0	274		0	0	0	288	367	
27'-0"		57	101	145	195	219*	4.621	78	132	195	258*	261*	2.844
		0	0	0	0	246		0	0	0	259	333	
28'-0"		46	86	127	174	205*	5.345	65	115	174	234	246*	3.289
		0	0	0	0	222		0	0	0	0	302	
29'-0"			73	111	155	192*	6.150	54	100	155	211	232*	3.785
			0	0	0	199		0	0	0	0	274	
30'-0"			61	97	138	179	7.043	43	86	138	190	219*	4.334
			0	0	0	0		0	0	0	0	249	
31'-0"			50	84	122	161	8.030		74	122	171	207*	4.942
			0	0	0	0			0	0	0	226	
32'-0"			41	72	108	145	9.118		63	108	154	196*	5.611
			0	0	0	0			0	0	0	206	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF) [4]

NEGATIVE MOMENT													
STEEL AREA (SQ. IN.)	0.47	0.61	0.74	0.90	1.07		0.47	0.65	0.81	1.01	1.27	
STEEL % (UNIFORM)	0.50	0.65	0.79	0.96	1.15		0.50	0.69	0.86	1.08	1.37	
(TAPERED)	0.32	0.42	0.50	0.61	0.73		0.32	0.44	0.55	0.69	0.87	
EFF. DEPTH, IN.	13.25	13.25	13.25	13.19	13.19		13.25	13.25	13.19	13.19	13.12	
$-I_{cr}/I_{gr}$	0.153	0.188	0.219	0.250	0.286		0.153	0.198	0.231	0.273	0.319	
POSITIVE MOMENT													
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.12	0.15	0.18	0.22	0.26		0.09	0.12	0.15	0.18	0.22	
EFF. DEPTH, IN.	13.25	13.19	13.19	13.12	13.12		13.25	13.25	13.19	13.19	13.12	
$+I_{cr}/I_{gr}$	0.161	0.198	0.236	0.277	0.318		0.127	0.161	0.198	0.236	0.277	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth

TOP BARS	Size @	# 4 8	# 5 10	# 5 8.5	# 5 7	# 6 8	End Span Defl. Coeff. (3)	# 4 8	# 5 9.5	# 5 7.5	# 5 6	# 7 6	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
Steel (psf)		1.01	1.25	1.50	1.80	2.14		1.06	1.35	1.71	2.08	3.31	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
22'-0"		265	333*	341*	353*	366*	1.959	321	387*	396*	407*		1.205
		0	345	436	472*	497*		0	436	539*	560*		
23'-0"		233	306	316*	326*	338*	2.340	284	361*	369*	379*	417*	1.440
		0	0	390	439*	463*		0	389	493*	511*	576*	
24'-0"		205	272	293*	303*	313*	2.774	252	338*	345*	354*	388*	1.707
		0	0	349	410*	432*		0	348	446	470*	533*	
25'-0"		180	242	273*	282*	291*	3.266	223	312	323*	331*	362*	2.010
		0	0	313	384*	405*		0	0	402	434*	491*	
26'-0"		158	215	255*	263*	271*	3.821	198	280	303*	310*	338*	2.351
		0	0	281	347	380*		0	0	364	402*	453*	
27'-0"		139	192	239*	245*	253*	4.443	176	252	285*	292*	317*	2.734
		0	0	252	314	358*		0	0	329	374*	419*	
28'-0"		121	170	223*	230*	236*	5.139	156	226	269*	274*	298*	3.163
		0	0	227	284	335*		0	0	298	349*	389*	
29'-0"		105	151	204	215*	221*	5.914	137	204	253*	259*	280*	3.639
		0	0	0	257	311*		0	0	270	326*	362*	
30'-0"		91	134	183	202*	208*	6.772	121	183	239*	244*	264*	4.168
		0	0	0	233	290*		0	0	245	306*	338*	
31'-0"		78	119	165	190*	195*	7.722	106	164	223	231*	249*	4.752
		0	0	0	211	267		0	0	0	287*	316*	
32'-0"		67	104	148	179*	184*	8.767	93	147	202	218*	235*	5.395
		0	0	0	192	244		0	0	0	265	297*	
33'-0"		56	92	132	169*	173*	9.915	81	132	184	207*	222*	6.102
		0	0	0	174	223		0	0	0	243	279*	
34'-0"		46	80	118	157	163*	11.173	70	118	167	196*	211*	6.876
		0	0	0	0	203		0	0	0	222	262*	
35'-0"			69	105	142	153*	12.547	60	105	151	186*	200*	7.721
			0	0	0	186		0	0	0	204	247*	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	0.77	0.91	1.11	1.38		0.62	0.82	1.03	1.29	2.50	
STEEL % (UNIFORM)	0.65	0.81	0.96	1.16	1.45		0.65	0.86	1.09	1.36	2.65	
(TAPERED)	0.40	0.50	0.58	0.71	0.89		0.40	0.52	0.66	0.83	1.62	
EFF. DEPTH, IN.	15.25	15.19	15.19	15.19	15.12		15.25	15.19	15.19	15.19	15.06	
$-I_{cr}/I_{gr}$	0.193	0.226	0.255	0.294	0.339		0.193	0.235	0.280	0.328	0.496	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.62	0.75	0.88	1.04		0.40	0.51	0.62	0.75	0.88	
STEEL %	0.13	0.16	0.20	0.23	0.28		0.10	0.13	0.16	0.20	0.23	
EFF. DEPTH, IN.	15.19	15.19	15.12	15.12	15.06		15.25	15.19	15.19	15.12	15.12	
$+I_{cr}/I_{gr}$	0.203	0.242	0.285	0.328	0.376		0.164	0.203	0.242	0.285	0.328	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth

TOP BARS	Size @	# 4 8	# 4 7	# 5 9	# 5 7.5	# 6 9	End Span Defl. Coeff. (3)	# 4 8	# 5 10	# 5 8	# 6 9	# 7 10	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
Steel (psf)		0.98	1.19	1.44	1.72	2.02		1.04	1.30	1.62	2.00	2.44	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
22'-0"		245	321	378*	388*	396*	2.037	298	409	441*	448*		1.254
		0	0	410	499	529*		0	0	521	606*		
23'-0"		214	284	351*	360*	367*	2.433	263	364	412*	418*	425*	1.497
		0	0	365	447	493*		0	0	466	559*	573*	
24'-0"		187	251	325	335*	341*	2.885	232	325	385*	391*	397*	1.775
		0	0	0	401	460*		0	0	419	514*	528*	
25'-0"		163	223	291	312*	318*	3.397	205	290	362*	367*	372*	2.090
		0	0	0	360	431*		0	0	377	476*	488*	
26'-0"		142	197	260	292*	297*	3.974	180	260	340	344*	349*	2.445
		0	0	0	324	400		0	0	0	431	452*	
27'-0"		123	174	233	273*	278*	4.621	159	232	306	324*	329*	2.844
		0	0	0	292	363		0	0	0	391	421*	
28'-0"		106	154	208	256*	261*	5.345	139	208	277	306*	310*	3.289
		0	0	0	263	329		0	0	0	356	393*	
29'-0"		91	135	186	238	245*	6.150	122	186	250	288*	292*	3.785
		0	0	0	0	299		0	0	0	324	368*	
30'-0"		77	119	166	214	230*	7.043	106	166	226	273*	276*	4.334
		0	0	0	0	271		0	0	0	295	345*	
31'-0"		65	104	148	193	217*	8.030	92	148	204	258*	261*	4.942
		0	0	0	0	247		0	0	0	269	324*	
32'-0"		54	90	132	174	204*	9.118	79	132	184	245*	247*	5.611
		0	0	0	0	224		0	0	0	0	305*	
33'-0"		44	78	117	157	193*	10.312	68	117	166	223	235*	6.346
		0	0	0	0	204		0	0	0	0	281	
34'-0"			67	104	141	182*	11.620	57	103	150	204	223*	7.151
			0	0	0	185		0	0	0	0	258	
35'-0"			56	91	126	168	13.049	47	91	135	186	212*	8.030
			0	0	0	0		0	0	0	0	237	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.74	0.90	1.07	1.27		0.65	0.81	1.01	1.27	1.56	
STEEL % (UNIFORM)	0.59	0.67	0.81	0.97	1.16		0.59	0.73	0.91	1.16	1.43	
(TAPERED)	0.38	0.43	0.52	0.63	0.75		0.38	0.47	0.59	0.75	0.92	
EFF. DEPTH, IN.	15.25	15.25	15.19	15.19	15.12		15.25	15.19	15.19	15.12	15.06	
$-I_{cr}/I_{gr}$	0.182	0.203	0.232	0.266	0.298		0.182	0.214	0.254	0.298	0.342	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.62	0.75	0.88	1.04		0.40	0.51	0.62	0.75	0.88	
STEEL %	0.13	0.16	0.19	0.22	0.27		0.10	0.13	0.16	0.19	0.22	
EFF. DEPTH, IN.	15.19	15.19	15.12	15.12	15.06		15.25	15.19	15.19	15.12	15.12	
$+I_{cr}/I_{gr}$	0.180	0.215	0.253	0.291	0.334		0.146	0.180	0.215	0.253	0.291	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 5.0″ Top Slab = 13.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 10	# 4 8	# 5 10	# 5 8	End Span Defl. Coeff. (3)	# 4 11	# 4 10	# 4 7.5	# 5 9	# 5 7	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 3	# 4	# 4	# 5	# 5		# 3	# 3	# 4	# 4	# 5	
	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
Steel (psf)		0.64	0.80	1.01	1.25	1.52		0.68	0.82	1.10	1.39	1.77	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
17'-0"		194	279	326*	334*	349*	0.698	206	329	377*	384*	397*	0.430
		0	0	380	482	513*		0	0	453	584*	596*	
18'-0"		162	238	296*	303*	315*	0.878	173	282	345*	351*	362*	0.540
		0	0	328	419	465*		0	0	393	524	549*	
19'-0"		135	203	270*	276*	287*	1.090	145	243	317*	322*	332*	0.671
		0	0	284	365	424*		0	0	342	459	506*	
20'-0"		112	173	246	252*	262*	1.338	121	209	292*	296*	305*	0.823
		0	0	0	320	388*		0	0	299	405	464*	
21'-0"		92	148	214	231*	240*	1.626	100	180	261	274*	281*	1.001
		0	0	0	281	357		0	0	0	357	422*	
22'-0"		75	125	186	213*	220*	1.959	82	155	229	253*	261*	1.205
		0	0	0	247	316		0	0	0	317	382*	
23'-0"		60	106	161	196*	203*	2.340	66	133	201	235*	242*	1.440
		0	0	0	217	280		0	0	0	281	347*	
24'-0"		46	89	140	181*	187*	2.774	52	114	176	219*	225*	1.707
		0	0	0	191	249		0	0	0	250	318*	
25'-0"			74	121	168	173*	3.266	40	97	154	204*	209*	2.010
			0	0	0	221		0	0	0	222	291	
26'-0"			61	104	147	161*	3.821		82	135	191*	195*	2.351
			0	0	0	197			0	0	198	261	
27'-0"			49	89	129	149*	4.443		69	118	176	183*	2.734
			0	0	0	175			0	0	0	235	
28'-0"				75	113	139*	5.139		57	102	156	171*	3.163
				0	0	156			0	0	0	211	
29'-0"				63	98	129*	5.914		46	88	139	160*	3.639
				0	0	138			0	0	0	190	
30'-0"				52	85	120*	6.772			76	123	150*	4.168
				0	0	122				0	0	171	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) (4)

NEGATIVE MOMENT													
STEEL AREA (SQ. IN.)	0.45	0.50	0.62	0.77	0.97		0.45	0.50	0.67	0.86	1.11	
STEEL % (UNIFORM)	0.65	0.71	0.89	1.11	1.39		0.65	0.71	0.95	1.23	1.59	
(TAPERED)	0.39	0.43	0.53	0.66	0.83		0.39	0.43	0.57	0.74	0.95	
EFF. DEPTH, IN.	11.75	11.75	11.75	11.69	11.69		11.75	11.75	11.75	11.69	11.69	
$-I_{cr}/I_{gr}$	0.174	0.187	0.222	0.257	0.302		0.174	0.187	0.233	0.278	0.331	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.11	0.14	0.17	0.21	0.26		0.07	0.11	0.14	0.17	0.21	
EFF. DEPTH, IN.	11.75	11.75	11.69	11.69	11.62		11.81	11.75	11.75	11.69	11.69	
$+I_{cr}/I_{gr}$	0.156	0.197	0.242	0.288	0.336		0.115	0.156	0.197	0.242	0.288	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 5.0″ Top Slab = 13.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 8.5	# 4 7	# 5 8.5	End Span Defl. Coeff. (3)	# 4 11	# 4 10	# 4 8	# 5 9.5	# 5 7.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 3	# 4	# 4	# 5	# 5		# 3	# 3	# 4	# 4	# 5	
	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
Steel (psf)		0.63	0.76	0.97	1.19	1.46		0.67	0.81	1.04	1.33	1.68	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
17'-0"		179	261	358	376*	387*	0.726	191	309	426*	432*	443*	0.447
		0	0	0	456	551*		0	0	428	569	635*	
18'-0"		148	221	308	342*	351*	0.913	159	264	370	396*	406*	0.562
		0	0	0	396	495		0	0	0	496	586*	
19'-0"		122	188	266	312*	321*	1.133	132	226	322	364*	373*	0.697
		0	0	0	344	434		0	0	0	434	542*	
20'-0"		100	159	229	287*	294*	1.391	108	194	280	336*	344*	0.856
		0	0	0	300	381		0	0	0	382	485	
21'-0"		81	135	198	263	270*	1.691	88	166	244	311*	318*	1.041
		0	0	0	0	336		0	0	0	336	430	
22'-0"		64	113	171	230	249*	2.037	71	142	213	289*	295*	1.254
		0	0	0	0	296		0	0	0	297	382	
23'-0"		50	95	148	201	231*	2.433	56	121	186	263	275*	1.497
		0	0	0	0	262		0	0	0	0	341	
24'-0"			78	127	176	214*	2.885	43	102	162	233	256*	1.775
			0	0	0	232		0	0	0	0	304	
25'-0"			64	109	154	199*	3.397		86	141	206	240*	2.090
			0	0	0	206			0	0	0	272	
26'-0"			51	92	134	182	3.974		71	122	183	224*	2.445
			0	0	0	0			0	0	0	244	
27'-0"				78	117	161	4.621		58	106	162	210*	2.844
				0	0	0			0	0	0	218	
28'-0"				65	101	142	5.345		47	91	143	196	3.289
				0	0	0			0	0	0	0	
29'-0"				53	87	126	6.150			77	126	175	3.785
				0	0	0				0	0	0	
30'-0"				43	75	110	7.043			65	111	157	4.334
				0	0	0				0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF) (4)

NEGATIVE MOMENT													
STEEL AREA (SQ. IN.)	0.47	0.47	0.61	0.74	0.95		0.47	0.52	0.65	0.85	1.07	
STEEL % (UNIFORM)	0.58	0.58	0.75	0.91	1.16		0.58	0.63	0.79	1.04	1.32	
(TAPERED)	0.37	0.37	0.47	0.58	0.74		0.37	0.40	0.50	0.66	0.84	
EFF. DEPTH, IN.	11.75	11.75	11.75	11.75	11.69		11.75	11.75	11.75	11.69	11.69	
$-I_{cr}/I_{gr}$	0.164	0.164	0.201	0.233	0.276		0.164	0.177	0.210	0.254	0.302	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.10	0.13	0.17	0.20	0.25		0.07	0.10	0.13	0.17	0.20	
EFF. DEPTH, IN.	11.75	11.75	11.69	11.69	11.62		11.81	11.75	11.75	11.69	11.69	
$+I_{cr}/I_{gr}$	0.138	0.174	0.214	0.255	0.298		0.102	0.138	0.174	0.214	0.255	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 5.0″ Top Slab = 15.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 5 10	# 5 8.5	# 5 7	End Span Defl. Coeff. (3)	# 4 10	# 4 8	# 5 9.5	# 5 7.5	# 6 6	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.80	1.01	1.25	1.50	1.80		0.82	1.06	1.35	1.71	2.54	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		247	343	355*	365*	380*	1.090					456*	0.671
		0	0	439	503*	520*						648*	
20'-0"		212	298	325*	334*	346*	1.338	254	359	377*	386*	418*	0.823
		0	0	385	462*	477*		0	0	484	561*	600*	
21'-0"		182	260	299*	306*	318*	1.626	220	316	348*	357*	385*	1.001
		0	0	339	429	451*		0	0	429	512*	556*	
22'-0"		156	227	275*	282*	292*	1.959	191	278	323*	331*	356*	1.205
		0	0	299	381	417*		0	0	381	464*	513*	
23'-0"		134	199	255*	261*	270*	2.340	165	245	301*	308*	331*	1.440
		0	0	264	339	387*		0	0	339	424*	471*	
24'-0"		114	173	234	242*	250*	2.774	143	216	281*	287*	308*	1.707
		0	0	0	302	361*		0	0	302	389*	430*	
25'-0"		96	151	207	224*	231*	3.266	123	190	263*	268*	287*	2.010
		0	0	0	270	335		0	0	270	351	394*	
26'-0"		80	131	183	209*	215*	3.821	105	167	241	251*	268*	2.351
		0	0	0	241	301		0	0	0	316	363*	
27'-0"		67	114	161	195*	200*	4.443	90	147	216	235*	251*	2.734
		0	0	0	216	271		0	0	0	285	336*	
28'-0"		54	98	142	182*	187*	5.139	76	129	193	221*	235*	3.163
		0	0	0	193	244		0	0	0	257	312*	
29'-0"		43	84	125	170*	175*	5.914	63	113	172	208*	221*	3.639
		0	0	0	172	220		0	0	0	232	290*	
30'-0"			71	110	154	163*	6.772	51	98	154	196*	208*	4.168
			0	0	0	198		0	0	0	210	270*	
31'-0"			59	96	137	153*	7.722	41	85	137	184*	195*	4.752
			0	0	0	179		0	0	0	189	249	
32'-0"			49	83	122	143*	8.767		73	122	171	184*	5.395
			0	0	0	161			0	0	0	227	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.50	0.62	0.77	0.91	1.11		0.50	0.62	0.82	1.03	1.83	
STEEL % (UNIFORM)	0.59	0.74	0.92	1.08	1.32		0.59	0.74	0.97	1.23	2.19	
(TAPERED)	0.36	0.45	0.56	0.66	0.80		0.36	0.45	0.59	0.74	1.33	
EFF. DEPTH, IN.	13.75	13.75	13.69	13.69	13.69		13.75	13.75	13.69	13.69	13.62	
$-I_{cr}/I_{gr}$	0.172	0.205	0.239	0.269	0.309		0.172	0.205	0.248	0.295	0.430	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.12	0.15	0.18	0.22	0.26		0.09	0.12	0.15	0.18	0.22	
EFF. DEPTH, IN.	13.75	13.69	13.69	13.62	13.62		13.75	13.75	13.69	13.69	13.62	
$+I_{cr}/I_{gr}$	0.177	0.219	0.260	0.305	0.351		0.140	0.177	0.219	0.260	0.305	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 5.0″ Top Slab = 15.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 8.5	# 4 7	# 5 9	# 5 7.5	End Span Defl. Coeff. (3)	# 4 11	# 4 8	# 5 10	# 5 8	# 6 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.76	0.97	1.19	1.44	1.72		0.77	1.04	1.30	1.62	2.00	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		230	322	398*	406*	419*	1.133					478*	0.697
		0	0	414	520	571*						663*	
20'-0"		197	279	363	373*	384*	1.391	237	338	424*	433*	441*	0.856
		0	0	0	458	524*		0	0	458	580	616*	
21'-0"		168	243	318	343*	353*	1.691	204	296	394*	401*	408*	1.041
		0	0	0	405	491*		0	0	405	515	572*	
22'-0"		143	211	280	317*	326*	2.037	176	259	359	373*	379*	1.254
		0	0	0	359	439		0	0	0	459	528*	
23'-0"		121	183	246	294*	302*	2.433	151	228	318	348*	353*	1.497
		0	0	0	319	392		0	0	0	410	485*	
24'-0"		101	159	217	273*	280*	2.885	130	200	283	325*	330*	1.775
		0	0	0	283	351		0	0	0	368	446*	
25'-0"		85	137	191	252	261*	3.397	110	175	252	305*	309*	2.090
		0	0	0	0	314		0	0	0	330	411*	
26'-0"		70	118	168	224	243*	3.974	93	153	224	286*	289*	2.445
		0	0	0	0	282		0	0	0	296	378	
27'-0"		56	101	147	200	227*	4.621	78	134	200	266	272*	2.844
		0	0	0	0	253		0	0	0	0	343	
28'-0"		44	86	129	178	213*	5.345	65	116	178	240	256*	3.289
		0	0	0	0	227		0	0	0	0	311	
29'-0"			73	112	158	199*	6.150	53	101	158	216	241*	3.785
			0	0	0	204		0	0	0	0	282	
30'-0"			60	98	140	183	7.043	42	87	140	194	227*	4.334
			0	0	0	0		0	0	0	0	256	
31'-0"			49	84	124	164	8.030		74	124	174	215*	4.942
			0	0	0	0			0	0	0	232	
32'-0"				72	109	147	9.118		62	109	157	203*	5.611
				0	0	0			0	0	0	211	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.47	0.61	0.74	0.90	1.07		0.47	0.65	0.81	1.01	1.27	
STEEL % (UNIFORM)	0.48	0.62	0.76	0.92	1.10		0.48	0.66	0.82	1.03	1.31	
(TAPERED)	0.31	0.40	0.48	0.59	0.70		0.31	0.42	0.53	0.66	0.84	
EFF. DEPTH, IN.	13.75	13.75	13.75	13.69	13.69		13.75	13.75	13.69	13.69	13.62	
$-I_{cr}/I_{gr}$	0.150	0.184	0.215	0.245	0.280		0.150	0.193	0.226	0.267	0.313	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.11	0.14	0.17	0.21	0.25		0.09	0.11	0.14	0.17	0.21	
EFF. DEPTH, IN.	13.75	13.69	13.69	13.62	13.62		13.75	13.75	13.69	13.69	13.62	
$+I_{cr}/I_{gr}$	0.157	0.193	0.231	0.270	0.311		0.124	0.157	0.193	0.231	0.270	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 5.0″ Top Slab = 17.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 5 10	# 5 8.5	# 5 7	End Span Defl. Coeff. (3)	# 4 10	# 4 8	# 5 9.5	# 5 7.5	# 5 6	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6		# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	
Steel (psf)		0.80	1.01	1.25	1.50	1.80		0.82	1.06	1.35	1.71	2.08	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
22'-0"		187	269	344*	353*	365*	1.959	227		401*		421*	1.205
		0	0	352	446	482*		0		445		577*	
23'-0"		161	236	311	327*	337*	2.340	197	289	374*	382*	392*	1.440
		0	0	0	398	448*		0	0	397	507	527*	
24'-0"		138	207	276	303*	313*	2.774	172	255	349*	357*	366*	1.707
		0	0	0	356	418*		0	0	355	456	484*	
25'-0"		118	181	245	282*	291*	3.266	149	226	318	334*	342*	2.010
		0	0	0	319	391*		0	0	0	411	447*	
26'-0"		100	159	218	263*	271*	3.821	129	200	285	313*	320*	2.351
		0	0	0	286	354		0	0	0	371	414*	
27'-0"		84	138	193	245*	253*	4.443	111	177	256	294*	301*	2.734
		0	0	0	256	320		0	0	0	335	384*	
28'-0"		70	120	171	230*	236*	5.139	94	156	229	277*	283*	3.163
		0	0	0	0	289		0	0	0	303	358*	
29'-0"		57	104	152	206	221*	5.914	80	137	206	261*	266*	3.639
		0	0	0	0	261		0	0	0	275	335*	
30'-0"		46	89	134	185	207*	6.772	67	120	184	246*	251*	4.168
		0	0	0	0	236		0	0	0	249	314*	
31'-0"			76	118	166	195*	7.722	55	105	165	226	237*	4.752
			0	0	0	214		0	0	0	0	294*	
32'-0"			64	103	148	183*	8.767	44	91	148	204	224*	5.395
			0	0	0	193		0	0	0	0	270	
33'-0"			53	90	132	172*	9.915		79	132	185	212*	6.102
			0	0	0	175			0	0	0	246	
34'-0"			43	78	117	158	11.173		67	117	167	201*	6.876
			0	0	0	0			0	0	0	225	
35'-0"				67	104	142	12.547		57	104	151	190*	7.721
				0	0	0			0	0	0	206	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.50	0.62	0.77	0.91	1.11		0.50	0.62	0.82	1.03	1.29	
STEEL % (UNIFORM)	0.50	0.63	0.78	0.92	1.12		0.50	0.63	0.82	1.04	1.31	
(TAPERED)	0.31	0.38	0.48	0.56	0.68		0.31	0.38	0.50	0.64	0.80	
EFF. DEPTH, IN.	15.75	15.75	15.69	15.69	15.69		15.75	15.75	15.69	15.69	15.69	
$-I_{cr}/I_{gr}$	0.158	0.189	0.221	0.250	0.289		0.158	0.189	0.230	0.275	0.322	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.10	0.13	0.16	0.19	0.23		0.08	0.10	0.13	0.16	0.19	
EFF. DEPTH, IN.	15.75	15.69	15.69	15.62	15.62		15.75	15.75	15.69	15.69	15.62	
$+I_{cr}/I_{gr}$	0.160	0.199	0.237	0.278	0.320		0.127	0.160	0.199	0.237	0.278	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 5.0″ Top Slab = 17.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 8.5	# 4 7	# 5 9	# 5 7.5	End Span Defl. Coeff. (3)	# 4 11	# 4 8.5	# 5 10	# 5 8	# 6 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6		# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	
Steel (psf)		0.76	0.97	1.19	1.44	1.72		0.77	1.01	1.30	1.62	2.00	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
22'-0"		171	249	329	392*	403*	2.037	209		419		466*	1.254
		0	0	0	420	513		0		0		626*	
23'-0"		146	218	290	364*	374*	2.433	181	268	373	427*	434*	1.497
		0	0	0	374	458		0	0	0	479	577*	
24'-0"		124	190	257	333	347*	2.885	156	236	332	400*	406*	1.775
		0	0	0	0	411		0	0	0	430	531*	
25'-0"		104	165	227	297	323*	3.397	134	208	297	375*	380*	2.090
		0	0	0	0	369		0	0	0	386	489	
26'-0"		87	143	200	265	302*	3.974	114	183	265	348	357*	2.445
		0	0	0	0	332		0	0	0	0	443	
27'-0"		72	124	177	237	283*	4.621	97	161	237	313	336*	2.844
		0	0	0	0	299		0	0	0	0	401	
28'-0"		58	106	156	212	265*	5.345	81	141	211	283	316*	3.289
		0	0	0	0	269		0	0	0	0	365	
29'-0"		46	91	137	189	242	6.150	68	123	189	255	298*	3.785
		0	0	0	0	0		0	0	0	0	331	
30'-0"			77	119	169	218	7.043	55	107	168	230	282*	4.334
			0	0	0	0		0	0	0	0	302	
31'-0"			64	104	150	197	8.030	44	92	150	208	267*	4.942
			0	0	0	0		0	0	0	0	275	
32'-0"			52	90	133	177	9.118		79	133	187	250	5.611
			0	0	0	0			0	0	0	0	
33'-0"			42	77	118	159	10.312		66	117	169	228	6.346
			0	0	0	0			0	0	0	0	
34'-0"				66	104	142	11.620		55	103	152	207	7.151
				0	0	0			0	0	0	0	
35'-0"				55	91	127	13.049		45	91	136	189	8.030
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.47	0.61	0.74	0.90	1.07		0.47	0.61	0.81	1.01	1.27	
STEEL % (UNIFORM)	0.41	0.53	0.64	0.78	0.94		0.41	0.53	0.70	0.88	1.11	
(TAPERED)	0.27	0.34	0.42	0.50	0.61		0.27	0.34	0.45	0.57	0.72	
EFF. DEPTH, IN.	15.75	15.75	15.75	15.69	15.69		15.75	15.75	15.69	15.69	15.62	
$-I_{cr}/I_{gr}$	0.138	0.170	0.198	0.227	0.261		0.138	0.170	0.210	0.249	0.293	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.10	0.13	0.15	0.18	0.22		0.08	0.10	0.13	0.15	0.18	
EFF. DEPTH, IN.	15.75	15.69	15.69	15.62	15.62		15.75	15.75	15.69	15.69	15.62	
$+I_{cr}/I_{gr}$	0.142	0.176	0.210	0.247	0.284		0.112	0.142	0.176	0.210	0.247	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 3.0″ Top Slab = 11.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 11	# 4 9	# 5 7	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 10.5	# 4 8	# 4 4	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 3	# 4	# 4	# 5	# 5		# 3	# 3	# 4	# 4	# 5	
	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
Steel (psf)		0.51	0.61	0.72	0.89	1.26		0.59	0.67	0.78	1.00	1.63	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
14'-0"		194	244*	244*	253*	302*	0.450	205	275*	277*	286*	327*	0.277
		0	269	357	399*	411*		0	312	421	482*	522*	
15'-0"		161	217*	217*	225*	266*	0.593	170	248*	249*	257*	291*	0.365
		0	226	302	365*	380*		0	264	358	438*	472*	
16'-0"		133	191	195*	201*	236*	0.767	142	224	225*	232*	261*	0.472
		0	0	258	325*	338*		0	0	307	399*	430*	
17'-0"		111	161	176*	181*	211*	0.978	118	191	205*	211*	236*	0.602
		0	0	221	282	304*		0	0	264	351	393*	
18'-0"		92	137	159*	164*	189*	1.229	98	163	187*	192*	215*	0.756
		0	0	190	244	275*		0	0	229	306	361*	
19'-0"		76	116	145*	149*	171*	1.525	81	140	171*	176*	196*	0.939
		0	0	164	213	251*		0	0	199	268	329*	
20'-0"		62	98	132*	136*	156*	1.873	67	120	158*	162*	180*	1.153
		0	0	142	185	229*		0	0	173	236	298*	
21'-0"		50	83	121*	125*	142*	2.276	55	103	146*	149*	165*	1.401
		0	0	122	162	207		0	0	151	208	265	
22'-0"		40	70	106	114*	130*	2.742	44	88	132	138*	152*	1.687
		0	0	0	142	183		0	0	0	183	236	
23'-0"			59	91	105*	119*	3.276		75	115	128*	141*	2.016
			0	0	124	162			0	0	162	210	
24'-0"			48	78	97*	109*	3.884		63	100	119*	130*	2.390
			0	0	109	143			0	0	144	188	
25'-0"			40	67	89*	100*	4.572		53	87	110*	121*	2.814
			0	0	95	127			0	0	127	168	
26'-0"				57	82*	93*	5.349		44	76	103*	112*	3.292
				0	83	112			0	0	113	150	
27'-0"				48	72	85*	6.221			65	96*	105*	3.828
				0	0	99				0	100	135	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.36 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.64	0.78	1.55		0.64	0.64	0.67	0.88	1.75	
STEEL % (UNIFORM)	1.12	1.12	1.12	1.37	2.76		1.12	1.12	1.18	1.54	3.09	
(TAPERED)	0.60	0.60	0.60	0.74	1.48		0.60	0.60	0.63	0.83	1.66	
EFF. DEPTH, IN.	9.75	9.75	9.75	9.75	9.69		9.75	9.75	9.75	9.75	9.75	
$-I_{cr}/I_{gr}$	0.222	0.222	0.222	0.256	0.398		0.222	0.222	0.230	0.278	0.434	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.09	0.12	0.15	0.18	0.22		0.06	0.09	0.12	0.15	0.18	
EFF. DEPTH, IN.	9.75	9.75	9.69	9.69	9.62		9.81	9.75	9.75	9.69	9.69	
$+I_{cr}/I_{gr}$	0.164	0.207	0.254	0.303	0.353		0.121	0.164	0.207	0.254	0.303	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 3.0″ Top Slab = 11.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 11	# 4 9.5	# 5 11	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 11	# 4 8.5	# 5 10.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 3	# 4	# 4	# 5	# 5		# 3	# 3	# 4	# 4	# 5	
	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
Steel (psf)		0.50	0.60	0.71	0.86	1.07		0.58	0.66	0.75	0.95	1.20	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
14'-0"		185	257	279*	285*	299*	0.463	195	300	316*	325*	331*	0.285
		0	0	343	430	459*		0	0	405	515*	520*	
15'-0"		152	215	249*	255*	266*	0.610	161	252	285*	293*	298*	0.375
		0	0	290	366	416*		0	0	344	452	473*	
16'-0"		126	181	224*	229*	238*	0.789	134	213	259*	265*	270*	0.486
		0	0	247	313	376*		0	0	294	390	432*	
17'-0"		104	153	203*	207*	215*	1.006	111	181	236*	242*	245*	0.619
		0	0	211	270	337		0	0	253	337	397*	
18'-0"		85	129	181	189*	195*	1.264	91	154	217*	221*	224*	0.778
		0	0	0	233	293		0	0	218	294	364*	
19'-0"		69	109	155	172*	178*	1.569	75	132	189	204*	206*	0.966
		0	0	0	203	256		0	0	0	257	325	
20'-0"		56	92	133	158*	163*	1.926	61	112	164	188*	190*	1.185
		0	0	0	176	224		0	0	0	225	287	
21'-0"		45	77	115	145*	150*	2.342	49	96	142	174*	176*	1.441
		0	0	0	153	197		0	0	0	198	254	
22'-0"			64	99	134*	138*	2.820		81	124	161*	163*	1.736
			0	0	0	174			0	0	174	225	
23'-0"			53	84	117	127*	3.369		68	107	150*	151*	2.073
			0	0	0	153			0	0	154	201	
24'-0"			43	72	102	117*	3.995		57	93	136	141*	2.458
			0	0	0	135			0	0	0	179	
25'-0"				61	88	109*	4.703		47	81	120	131*	2.894
				0	0	119			0	0	0	159	
26'-0"				51	77	101*	5.502			69	105	123*	3.386
				0	0	105				0	0	142	
27'-0"				43	66	93	6.398			59	93	115*	3.938
				0	0	0				0	0	127	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.37 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.65	0.76	1.01		0.65	0.65	0.65	0.85	1.06	
STEEL % (UNIFORM)	0.99	0.99	0.99	1.14	1.54		0.99	0.99	0.99	1.28	1.61	
(TAPERED)	0.57	0.57	0.57	0.66	0.89		0.57	0.57	0.57	0.74	0.93	
EFF. DEPTH, IN.	9.75	9.75	9.75	9.75	9.69		9.75	9.75	9.75	9.75	9.69	
$-I_{cr}/I_{gr}$	0.208	0.208	0.208	0.232	0.282		0.208	0.208	0.208	0.252	0.291	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.09	0.11	0.15	0.18	0.22		0.06	0.09	0.11	0.15	0.18	
EFF. DEPTH, IN.	9.75	9.75	9.69	9.69	9.62		9.81	9.75	9.75	9.69	9.69	
$+I_{cr}/I_{gr}$	0.144	0.182	0.224	0.267	0.311		0.106	0.144	0.182	0.224	0.267	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 3.0″ Top Slab = 13.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 11	# 4 9	# 4 7.5	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 11	# 4 8	# 5 10	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6		# 3 # 3	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	
Steel (psf)		0.51	0.61	0.72	0.89	1.08		0.59	0.67	0.77	1.00	1.25	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
17'-0"		142	204	236*	244*	253*	0.978	151	239	271*	280*	286*	0.602
		0	0	276	350	370*		0	0	328	433	462*	
18'-0"		119	174	215*	222*	229*	1.229	127	206	248*	256*	261*	0.756
		0	0	239	304	335*		0	0	285	379	419*	
19'-0"		100	149	196*	202*	208*	1.525	107	177	229*	235*	239*	0.939
		0	0	207	266	306*		0	0	249	333	378*	
20'-0"		83	128	180*	185*	191*	1.873	90	153	211*	217*	220*	1.153
		0	0	0	233	280*		0	0	217	294	338*	
21'-0"		69	109	157	170*	175*	2.276	75	132	191	201*	204*	1.401
		0	0	0	205	260		0	0	0	260	303*	
22'-0"		57	93	137	157*	161*	2.742	62	114	168	186*	189*	1.687
		0	0	0	181	231		0	0	0	231	275*	
23'-0"		46	79	119	145*	149*	3.276	51	99	147	173*	175*	2.016
		0	0	0	159	205		0	0	0	205	250*	
24'-0"			67	104	134*	138*	3.884	41	85	130	161*	163*	2.390
			0	0	141	183		0	0	0	183	229*	
25'-0"			56	90	124	128*	4.572		73	114	151*	152*	2.814
			0	0	0	163			0	0	163	211*	
26'-0"			47	78	109	119*	5.349		62	100	141*	142*	3.292
			0	0	0	145			0	0	145	191	
27'-0"				67	96	110*	6.221		52	88	130	133*	3.828
				0	0	130			0	0	0	172	
28'-0"				58	85	103*	7.195		44	77	116	125*	4.428
				0	0	116			0	0	0	155	
29'-0"				49	74	96*	8.279			67	103	117*	5.095
				0	0	103				0	0	140	
30'-0"				41	65	89*	9.481			58	92	110*	5.835
				0	0	92				0	0	126	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.39 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.64	0.78	0.93		0.64	0.64	0.64	0.88	1.09	
STEEL % (UNIFORM)	0.91	0.91	0.91	1.11	1.33		0.91	0.91	0.91	1.25	1.55	
(TAPERED)	0.49	0.49	0.49	0.60	0.72		0.49	0.49	0.49	0.68	0.85	
EFF. DEPTH, IN.	11.75	11.75	11.75	11.75	11.75		11.75	11.75	11.75	11.75	11.69	
$-I_{cr}/I_{gr}$	0.204	0.204	0.204	0.237	0.270		0.204	0.204	0.204	0.258	0.296	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.08	0.10	0.12	0.15	0.18		0.05	0.08	0.10	0.12	0.15	
EFF. DEPTH, IN.	11.75	11.75	11.69	11.69	11.62		11.81	11.75	11.75	11.69	11.69	
$+I_{cr}/I_{gr}$	0.145	0.184	0.227	0.270	0.317		0.106	0.145	0.184	0.227	0.270	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 3.0″ Top Slab = 13.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 7.5	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 8.5	# 4 7	# 5 8.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6		# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	
Steel (psf)		0.60	0.71	0.86	1.05	1.25		0.66	0.75	0.95	1.18	1.46	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
17'-0"		192	263	275*	286*	292*	1.006	227	311*	318*	324*	332*	0.619
		0	0	335	411*	424*		0	313	416	498*	505*	
18'-0"		164	227	250*	260*	264*	1.264	194	272	291*	297*	303*	0.778
		0	0	291	363	385*		0	0	363	456	466*	
19'-0"		139	196	229*	237*	241*	1.569	167	236	268*	273*	279*	0.966
		0	0	253	319	352*		0	0	318	402	427*	
20'-0"		119	170	210*	218*	221*	1.926	143	206	248*	252*	257*	1.185
		0	0	221	280	323*		0	0	280	355	389*	
21'-0"		101	147	194	200*	203*	2.342	123	180	230*	234*	238*	1.441
		0	0	0	247	302		0	0	247	316	353*	
22'-0"		85	127	170	185*	188*	2.820	106	157	214*	217*	221*	1.736
		0	0	0	219	269		0	0	219	281	320*	
23'-0"		72	110	149	171*	174*	3.369	90	138	194	202*	206*	2.073
		0	0	0	194	239		0	0	0	251	292*	
24'-0"		60	95	131	159*	161*	3.995	77	120	172	189*	192*	2.458
		0	0	0	172	214		0	0	0	224	268*	
25'-0"		49	82	115	148*	150*	4.703	65	105	153	177*	179*	2.894
		0	0	0	153	191		0	0	0	201	247*	
26'-0"		40	70	101	136	139*	5.502	55	92	136	166*	168*	3.386
		0	0	0	0	171		0	0	0	180	228*	
27'-0"			60	88	121	130*	6.398	45	80	120	156*	158*	3.938
			0	0	0	154		0	0	0	162	209	
28'-0"			50	77	107	122*	7.400		69	107	145	148*	4.554
			0	0	0	138			0	0	0	189	
29'-0"			42	67	95	114*	8.516		59	95	130	139*	5.240
			0	0	0	123			0	0	0	171	
30'-0"				57	84	106*	9.752		51	84	117	131*	6.001
				0	0	110			0	0	0	155	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.41 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.76	0.96	1.12		0.65	0.65	0.85	1.03	1.31	
STEEL % (UNIFORM)	0.80	0.80	0.92	1.17	1.37		0.80	0.80	1.03	1.25	1.61	
(TAPERED)	0.47	0.47	0.54	0.68	0.80		0.47	0.47	0.60	0.73	0.94	
EFF. DEPTH, IN.	11.75	11.75	11.75	11.75	11.69		11.75	11.75	11.75	11.75	11.69	
$-I_{cr}/I_{gr}$	0.191	0.191	0.214	0.255	0.280		0.191	0.191	0.232	0.268	0.314	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.09	0.12	0.15	0.18	0.21		0.07	0.09	0.12	0.15	0.18	
EFF. DEPTH, IN.	11.75	11.69	11.69	11.62	11.62		11.75	11.75	11.69	11.69	11.62	
$+I_{cr}/I_{gr}$	0.162	0.200	0.239	0.280	0.323		0.128	0.162	0.200	0.239	0.280	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 3.0″ Top Slab = 15.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9	# 4 7.5	# 5 9.5	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 8.5	# 5 10	# 5 6	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.61	0.72	0.89	1.08	1.29		0.67	0.77	0.97	1.25	1.79	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		181	249	259*	267*	276*	1.525						
		0	0	318	363*	374*							
20'-0"		156	217	237*	245*	252*	1.873	185	261	274*	281*	303*	1.153
		0	0	280	333*	344*		0	0	351	413*	457*	
21'-0"		134	190	218*	225*	231*	2.276	161	230	254*	260*	280*	1.401
		0	0	247	312	328*		0	0	311	372*	415*	
22'-0"		115	166	202*	207*	213*	2.742	140	202	236*	241*	259*	1.687
		0	0	218	277	304*		0	0	277	337*	375*	
23'-0"		99	146	187*	192*	197*	3.276	122	179	220*	224*	241*	2.016
		0	0	193	247	282*		0	0	247	308*	341*	
24'-0"		85	128	171	178*	182*	3.884	106	158	206*	209*	224*	2.390
		0	0	0	221	263*		0	0	220	283*	311*	
25'-0"		72	112	152	165*	169*	4.572	91	140	192*	196*	209*	2.814
		0	0	0	198	244		0	0	197	255	286*	
26'-0"		61	98	135	154*	158*	5.349	79	123	176	183*	196*	3.292
		0	0	0	177	220		0	0	0	230	264*	
27'-0"		51	85	119	144*	147*	6.221	67	109	158	172*	183*	3.828
		0	0	0	158	198		0	0	0	208	244*	
28'-0"		42	74	106	134*	137*	7.195	57	96	142	162*	172*	4.428
		0	0	0	142	179		0	0	0	188	227*	
29'-0"			63	93	126*	128*	8.279	48	84	127	152*	162*	5.095
			0	0	127	162		0	0	0	170	211*	
30'-0"			54	82	114	120*	9.481	40	74	114	143*	152*	5.835
			0	0	0	146		0	0	0	154	197*	
31'-0"			46	72	102	113*	10.810		64	102	135*	144*	6.652
			0	0	0	132			0	0	139	183	
32'-0"				63	91	106*	12.274		56	91	126	135*	7.553
				0	0	119			0	0	0	167	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.42 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.78	0.93	1.14		0.64	0.64	0.82	1.09	1.81	
STEEL % (UNIFORM)	0.75	0.75	0.92	1.10	1.36		0.75	0.75	0.97	1.29	2.15	
(TAPERED)	0.42	0.42	0.51	0.61	0.75		0.42	0.42	0.54	0.71	1.19	
EFF. DEPTH, IN.	13.75	13.75	13.75	13.75	13.69		13.75	13.75	13.75	13.69	13.69	
$-I_{cr}/I_{gr}$	0.188	0.188	0.220	0.251	0.287		0.188	0.188	0.229	0.277	0.391	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.08	0.11	0.13	0.16	0.18		0.06	0.08	0.11	0.13	0.16	
EFF. DEPTH, IN.	13.75	13.69	13.69	13.62	13.62		13.75	13.75	13.69	13.69	13.62	
$+I_{cr}/I_{gr}$	0.165	0.205	0.245	0.288	0.332		0.130	0.165	0.205	0.245	0.288	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 3.0″ Top Slab = 15.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 8	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 9	# 4 7	# 5 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.60	0.71	0.86	1.04	1.25		0.66	0.75	0.93	1.18	1.42	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		169	235	290*	298*	307*	1.569						
		0	0	303	380	414*							
20'-0"		144	204	265	273*	281*	1.926	173	247	310*	318*	322*	1.185
		0	0	0	335	380*		0	0	334	423	467*	
21'-0"		123	178	233	252*	258*	2.342	150	216	288*	294*	298*	1.441
		0	0	0	296	360*		0	0	296	376	424*	
22'-0"		105	155	205	233*	239*	2.820	129	190	262	274*	277*	1.736
		0	0	0	263	321		0	0	0	335	386*	
23'-0"		89	135	181	216*	221*	3.369	111	167	233	255*	258*	2.073
		0	0	0	234	287		0	0	0	300	353*	
24'-0"		76	117	159	201*	205*	3.995	96	147	207	239*	241*	2.458
		0	0	0	208	257		0	0	0	269	325*	
25'-0"		63	102	141	185	191*	4.703	82	129	185	224*	226*	2.894
		0	0	0	0	231		0	0	0	241	300*	
26'-0"		52	88	124	165	179*	5.502	70	113	165	210*	212*	3.386
		0	0	0	0	207		0	0	0	217	277	
27'-0"		43	76	109	147	167*	6.398	59	99	147	195	199*	3.938
		0	0	0	0	186		0	0	0	0	251	
28'-0"			65	96	131	156*	7.400	49	86	131	176	188*	4.554
			0	0	0	167		0	0	0	0	228	
29'-0"			55	84	117	147*	8.516	40	75	116	159	177*	5.240
			0	0	0	151		0	0	0	0	207	
30'-0"			46	73	104	135	9.752		65	104	143	167*	6.001
			0	0	0	0			0	0	0	188	
31'-0"				63	92	122	11.119		55	92	129	158*	6.842
				0	0	0			0	0	0	171	
32'-0"				54	82	109	12.625		47	81	116	149*	7.769
				0	0	0			0	0	0	155	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.76	0.90	1.12		0.65	0.65	0.80	1.03	1.24	
STEEL % (UNIFORM)	0.67	0.67	0.77	0.92	1.14		0.67	0.67	0.81	1.05	1.27	
(TAPERED)	0.39	0.39	0.45	0.54	0.67		0.39	0.39	0.48	0.62	0.75	
EFF. DEPTH, IN.	13.75	13.75	13.75	13.75	13.69		13.75	13.75	13.75	13.75	13.69	
$-I_{cr}/I_{gr}$	0.177	0.177	0.198	0.226	0.262		0.177	0.177	0.207	0.250	0.283	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.08	0.10	0.13	0.15	0.18		0.06	0.08	0.10	0.13	0.15	
EFF. DEPTH, IN.	13.75	13.69	13.69	13.62	13.62		13.75	13.75	13.69	13.69	13.62	
$+I_{cr}/I_{gr}$	0.146	0.181	0.217	0.255	0.294		0.115	0.146	0.181	0.217	0.255	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

14″ Deep Rib + 3.0″ Top Slab = 17.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 7.5	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 8.5	# 4 7	# 5 8.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.61	0.72	0.88	1.08	1.28		0.67	0.77	0.97	1.20	1.48	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
22'-0"		137	196	249*	258*	263*	2.742	166		292*		304*	1.687
		0	0	256	324	346*		0		323		414*	
23'-0"		119	172	227	239*	243*	3.276	145	210	272*	277*	283*	2.016
		0	0	0	289	322*		0	0	288	367*	379*	
24'-0"		102	152	202	222*	226*	3.884	126	186	254*	259*	264*	2.390
		0	0	0	259	300*		0	0	258	331	348*	
25'-0"		88	133	179	207*	210*	4.572	110	165	231	242*	247*	2.814
		0	0	0	232	281*		0	0	0	298	321*	
26'-0"		75	117	160	193*	196*	5.349	95	146	208	228*	232*	3.292
		0	0	0	209	258		0	0	0	270	298*	
27'-0"		64	103	142	180*	183*	6.221	82	130	187	214*	218*	3.828
		0	0	0	187	233		0	0	0	244	277*	
28'-0"		53	90	126	169	171*	7.195	71	115	168	202*	205*	4.428
		0	0	0	0	211		0	0	0	221	259*	
29'-0"		44	78	112	152	161*	8.279	61	102	151	190*	193*	5.095
		0	0	0	0	191		0	0	0	201	242*	
30'-0"			68	99	136	151*	9.481	51	90	136	180*	182*	5.835
			0	0	0	174		0	0	0	182	227*	
31'-0"			58	88	122	142*	10.810	43	79	122	165	172*	6.652
			0	0	0	157		0	0	0	0	213*	
32'-0"			49	77	110	133*	12.274		69	109	150	163*	7.553
			0	0	0	143			0	0	0	197	
33'-0"			42	68	98	126*	13.882		60	98	136	154*	8.543
			0	0	0	129			0	0	0	180	
34'-0"				59	88	117	15.642		52	87	124	146*	9.626
				0	0	0			0	0	0	165	
35'-0"				51	78	106	17.565		44	78	112	139*	10.809
				0	0	0			0	0	0	151	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.46 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.74	0.93	1.09		0.64	0.64	0.82	1.00	1.28	
STEEL % (UNIFORM)	0.64	0.64	0.74	0.94	1.10		0.64	0.64	0.83	1.01	1.29	
(TAPERED)	0.36	0.36	0.41	0.52	0.61		0.36	0.36	0.46	0.56	0.72	
EFF. DEPTH, IN.	15.75	15.75	15.75	15.75	15.69		15.75	15.75	15.75	15.75	15.69	
$-I_{cr}/I_{gr}$	0.175	0.175	0.197	0.235	0.260		0.175	0.175	0.214	0.248	0.293	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.07	0.09	0.11	0.14	0.16		0.06	0.07	0.09	0.11	0.14	
EFF. DEPTH, IN.	15.75	15.69	15.69	15.62	15.62		15.75	15.75	15.69	15.69	15.62	
$+I_{cr}/I_{gr}$	0.151	0.187	0.224	0.264	0.305		0.119	0.151	0.187	0.224	0.264	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

14″ Deep Rib + 3.0″ Top Slab = 17.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 8	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 9	# 4 7	# 5 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.60	0.71	0.86	1.04	1.25		0.66	0.75	0.93	1.18	1.42	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
22'-0"		127	184	241	288*	296*	2.820	154		307		340*	1.736
		0	0	0	308	375		0		0		459*	
23'-0"		108	161	214	268*	274*	3.369	134	197	273	314*	318*	2.073
		0	0	0	274	336		0	0	0	350	420*	
24'-0"		92	140	189	245	255*	3.995	116	174	244	294*	297*	2.458
		0	0	0	0	302		0	0	0	314	387*	
25'-0"		78	123	167	219	238*	4.703	100	154	218	276*	279*	2.894
		0	0	0	0	271		0	0	0	283	358	
26'-0"		66	107	148	196	222*	5.502	86	135	195	255	262*	3.386
		0	0	0	0	244		0	0	0	0	324	
27'-0"		55	93	131	175	208*	6.398	73	119	174	230	246*	3.938
		0	0	0	0	220		0	0	0	0	294	
28'-0"		45	80	116	157	195*	7.400	62	105	156	208	232*	4.554
		0	0	0	0	198		0	0	0	0	268	
29'-0"			69	102	140	179	8.516	52	92	140	188	219*	5.240
			0	0	0	0		0	0	0	0	244	
30'-0"			59	90	125	162	9.752	43	80	125	170	207*	6.001
			0	0	0	0		0	0	0	0	222	
31'-0"			49	78	112	146	11.119		69	111	154	196*	6.842
			0	0	0	0			0	0	0	202	
32'-0"			41	68	100	132	12.625		60	99	139	185	7.769
			0	0	0	0			0	0	0	0	
33'-0"				59	89	119	14.278		51	88	125	168	8.787
				0	0	0			0	0	0	0	
34'-0"				51	78	107	16.089		43	78	113	154	9.901
				0	0	0			0	0	0	0	
35'-0"				43	69	96	18.067			69	102	140	11.118
				0	0	0				0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.76	0.90	1.12		0.65	0.65	0.80	1.03	1.24	
STEEL % (UNIFORM)	0.57	0.57	0.66	0.78	0.97		0.57	0.57	0.69	0.89	1.08	
(TAPERED)	0.34	0.34	0.39	0.46	0.58		0.34	0.34	0.41	0.53	0.64	
EFF. DEPTH, IN.	15.75	15.75	15.75	15.75	15.69		15.75	15.75	15.75	15.75	15.69	
$-I_{cr}/I_{gr}$	0.165	0.165	0.185	0.212	0.247		0.165	0.165	0.193	0.234	0.267	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.07	0.09	0.11	0.13	0.16		0.05	0.07	0.09	0.11	0.13	
EFF. DEPTH, IN.	15.75	15.69	15.69	15.62	15.62		15.75	15.75	15.69	15.69	15.62	
$+I_{cr}/I_{gr}$	0.134	0.166	0.199	0.234	0.271		0.105	0.134	0.166	0.199	0.234	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

16″ Deep Rib + 3.0″ Top Slab = 19.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 10	# 4 8	# 5 10	# 5 8.5	End Span Defl. Coeff. (3)	# 4 11	# 4 9	# 4 7	# 5 9	# 5 7.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
Steel (psf)		0.71	0.85	1.04	1.25	1.46		0.75	0.93	1.18	1.42	1.71	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
25'-0"		142	193	251	287*	294*	4.703		250		334*	340*	2.894
		0	0	0	310	369*			0		408	429*	
26'-0"		125	171	225	268*	275*	5.502	157	224	292	314*	320*	3.386
		0	0	0	280	345		0	0	0	370	399*	
27'-0"		109	152	202	251*	257*	6.398	138	201	264	296*	301*	3.938
		0	0	0	253	313		0	0	0	337	372*	
28'-0"		94	135	181	228	241*	7.400	122	180	239	279*	284*	4.554
		0	0	0	0	285		0	0	0	306	348*	
29'-0"		82	119	163	206	227*	8.516	107	162	216	264*	268*	5.240
		0	0	0	0	259		0	0	0	279	326*	
30'-0"		70	105	146	187	214*	9.752	94	145	196	250*	254*	6.001
		0	0	0	0	236		0	0	0	255	306*	
31'-0"		60	93	130	169	201*	11.119	82	130	177	233	240*	6.842
		0	0	0	0	215		0	0	0	0	289	
32'-0"		50	81	117	153	190*	12.625	71	116	161	212	228*	7.769
		0	0	0	0	196		0	0	0	0	265	
33'-0"		42	71	104	138	179	14.278	62	103	146	194	217*	8.787
		0	0	0	0	0		0	0	0	0	244	
34'-0"			61	93	125	163	16.089	52	92	132	177	206*	9.901
			0	0	0	0		0	0	0	0	224	
35'-0"			52	82	112	148	18.067	44	81	119	162	196*	11.118
			0	0	0	0		0	0	0	0	206	
36'-0"			44	72	101	135	20.222		72	107	148	187*	12.445
			0	0	0	0			0	0	0	190	
37'-0"				64	91	123	22.565		63	96	135	174	13.886
				0	0	0			0	0	0	0	
38'-0"				55	81	112	25.105		55	87	123	161	15.449
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.72	0.90	1.12	1.31		0.65	0.80	1.03	1.24	1.49	
STEEL % (UNIFORM)	0.49	0.54	0.68	0.84	0.99		0.49	0.60	0.77	0.94	1.13	
(TAPERED)	0.30	0.33	0.41	0.51	0.60		0.30	0.36	0.46	0.56	0.67	
EFF. DEPTH, IN.	17.75	17.75	17.75	17.69	17.69		17.75	17.75	17.75	17.69	17.69	
$-I_{cr}/I_{gr}$	0.155	0.167	0.199	0.233	0.263		0.155	0.181	0.221	0.252	0.288	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.62	0.75	0.88	1.04		0.40	0.51	0.62	0.75	0.88	
STEEL %	0.08	0.10	0.12	0.14	0.16		0.06	0.08	0.10	0.12	0.14	
EFF. DEPTH, IN.	17.69	17.69	17.62	17.62	17.56		17.75	17.69	17.69	17.62	17.62	
$+I_{cr}/I_{gr}$	0.153	0.184	0.217	0.251	0.290		0.123	0.153	0.184	0.217	0.251	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 7" Rib @ 37" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

16″ Deep Rib + 3.0″ Top Slab = 19.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8.5	# 4 7	# 5 9	# 5 8	End Span Defl. Coeff. (3)	# 4 9	# 4 7.5	# 5 9.5	# 5 8	# 6 9.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
	#	# 5	# 6	# 6	# 7	# 7		# 5	# 5	# 6	# 6	# 7	
Steel (psf)		0.83	1.00	1.20	1.41	1.63		0.92	1.13	1.36	1.63	1.93	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
25'-0"		179	236	294	320*	326*	4.834	235		367*	373*	378*	2.975
		0	0	0	362	408*		0		389	467*	476*	
26'-0"		158	211	264	300*	305*	5.655	209	276	345*	351*	355*	3.480
		0	0	0	328	383*		0	0	352	429	442*	
27'-0"		139	188	237	281*	286*	6.576	187	248	319	330*	334*	4.047
		0	0	0	296	356		0	0	0	391	413*	
28'-0"		123	168	214	264*	268*	7.606	167	224	290	312*	315*	4.681
		0	0	0	269	324		0	0	0	356	386*	
29'-0"		107	150	192	244	253*	8.752	149	202	263	295*	298*	5.386
		0	0	0	0	296		0	0	0	325	362*	
30'-0"		94	133	173	221	238*	10.023	132	182	239	279*	282*	6.168
		0	0	0	0	270		0	0	0	298	341*	
31'-0"		82	118	156	201	225*	11.428	118	164	218	265*	268*	7.033
		0	0	0	0	246		0	0	0	272	321*	
32'-0"		70	105	140	182	212*	12.975	104	148	198	249	254*	7.985
		0	0	0	0	225		0	0	0	0	303*	
33'-0"		60	93	126	165	201*	14.675	92	133	180	229	241*	9.031
		0	0	0	0	206		0	0	0	0	286	
34'-0"		51	82	113	150	188	16.536	81	120	164	209	230*	10.176
		0	0	0	0	0		0	0	0	0	264	
35'-0"		42	71	101	136	172	18.569	71	107	149	192	219*	11.427
		0	0	0	0	0		0	0	0	0	243	
36'-0"			62	90	123	157	20.784	61	96	136	176	208*	12.790
			0	0	0	0		0	0	0	0	224	
37'-0"			53	80	111	143	23.191	53	85	123	161	199*	14.272
			0	0	0	0		0	0	0	0	207	
38'-0"			45	70	100	130	25.802	45	76	111	148	190*	15.878
			0	0	0	0		0	0	0	0	191	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.74	0.87	1.06	1.27	1.43		0.82	0.99	1.21	1.43	1.71	
STEEL % (UNIFORM)	0.49	0.58	0.70	0.85	0.96		0.55	0.66	0.81	0.96	1.15	
(TAPERED)	0.31	0.36	0.44	0.53	0.60		0.34	0.41	0.51	0.60	0.72	
EFF. DEPTH, IN.	17.75	17.75	17.75	17.69	17.69		17.75	17.75	17.69	17.69	17.62	
$-I_{cr}/I_{gr}$	0.159	0.181	0.211	0.241	0.264		0.173	0.200	0.232	0.264	0.298	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	0.75	0.88	1.04	1.20		0.51	0.62	0.75	0.88	1.04	
STEEL %	0.09	0.12	0.13	0.16	0.18		0.08	0.09	0.12	0.13	0.16	
EFF. DEPTH, IN.	17.69	17.62	17.62	17.56	17.56		17.69	17.69	17.62	17.62	17.56	
$+I_{cr}/I_{gr}$	0.166	0.197	0.227	0.262	0.298		0.139	0.166	0.197	0.227	0.262	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

20″ Deep Rib + 3.0″ Top Slab = 23.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 4 7	# 5 9	# 5 7.5	End Span Defl. Coeff. (3)	# 4 9	# 4 7.5	# 5 9.5	# 5 8	# 6 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
	#	# 5	# 6	# 6	# 7	# 7		# 5	# 5	# 6	# 6	# 7	
Steel (psf)		0.85	1.04	1.23	1.44	1.69		0.93	1.14	1.38	1.66	2.01	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
30'-0"		135	185	236	293*	301*	9.752						
		0	0	0	297	355*							
31'-0"		120	166	214	271	284*	11.119	165	224	292	327*	333*	6.842
		0	0	0	0	329		0	0	0	361	384*	
32'-0"		105	149	194	247	268*	12.625	148	203	267	311*	316*	7.769
		0	0	0	0	302		0	0	0	332	363*	
33'-0"		93	134	176	226	254*	14.278	133	185	245	296*	300*	8.787
		0	0	0	0	277		0	0	0	306	344*	
34'-0"		81	120	159	207	241*	16.089	119	168	224	281*	286*	9.901
		0	0	0	0	255		0	0	0	0	326*	
35'-0"		70	107	144	189	228*	18.067	106	152	205	259	272*	11.118
		0	0	0	0	234		0	0	0	0	309*	
36'-0"		60	95	130	172	215	20.222	94	138	188	239	260*	12.445
		0	0	0	0	0		0	0	0	0	294*	
37'-0"		51	84	117	157	198	22.565	83	124	172	221	248*	13.886
		0	0	0	0	0		0	0	0	0	279	
38'-0"		43	74	106	144	182	25.105	73	112	158	203	237*	15.449
		0	0	0	0	0		0	0	0	0	259	
39'-0"			65	95	131	167	27.853	64	101	144	188	226*	17.141
			0	0	0	0		0	0	0	0	240	
40'-0"			56	85	119	153	30.822	55	91	132	173	216*	18.967
			0	0	0	0		0	0	0	0	223	
41'-0"			48	75	108	141	34.022	47	81	120	159	207	20.936
			0	0	0	0		0	0	0	0	0	
42'-0"			41	67	98	129	37.464	40	72	109	147	192	23.055
			0	0	0	0		0	0	0	0	0	
43'-0"				58	88	118	41.162		64	99	135	178	25.330
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.72	0.90	1.03	1.24	1.49		0.80	0.96	1.17	1.39	1.76	
STEEL % (UNIFORM)	0.42	0.53	0.61	0.73	0.88		0.47	0.56	0.69	0.82	1.04	
(TAPERED)	0.26	0.32	0.37	0.45	0.54		0.29	0.34	0.42	0.50	0.64	
EFF. DEPTH, IN.	21.75	21.75	21.75	21.69	21.69		21.75	21.75	21.69	21.69	21.62	
$-I_{cr}/I_{gr}$	0.149	0.179	0.199	0.228	0.262		0.162	0.188	0.219	0.250	0.295	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	0.75	0.88	1.04	1.20		0.51	0.62	0.75	0.88	1.04	
STEEL %	0.08	0.10	0.11	0.13	0.15		0.07	0.08	0.10	0.11	0.13	
EFF. DEPTH, IN.	21.69	21.62	21.62	21.56	21.56		21.69	21.69	21.62	21.62	21.56	
$+I_{cr}/I_{gr}$	0.160	0.190	0.220	0.255	0.290		0.134	0.160	0.190	0.220	0.255	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 7" Rib @ 37" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

20″ Deep Rib + 3.0″ Top Slab = 23.0″ Total Depth

TOP BARS	Size @	# 4 8	# 4 7	# 5 9.5	# 5 8	# 6 9.5	End Span Defl. Coeff. (3)	# 5 11	# 5 9.5	# 5 8	# 5 7	# 6 8	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 5	# 6	# 6	# 7	# 7		# 5	# 5	# 6	# 6	# 7	
	#	# 6	# 6	# 7	# 7	# 8		# 5	# 6	# 6	# 7	# 7	
Steel (psf)		1.02	1.20	1.40	1.63	1.89		1.16	1.36	1.63	1.88	2.29	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
30'-0"		171	220	280	328*	335*	10.023						
		0	0	0	340	394*							
31'-0"		153	199	255	309*	316*	11.428	209	275	342	365*	371*	7.033
		0	0	0	311	374*		0	0	0	419*	428*	
32'-0"		136	180	232	285	299*	12.975	189	251	314	347*	353*	7.985
		0	0	0	0	346		0	0	0	390	405*	
33'-0"		121	162	211	261	283*	14.675	171	229	288	330*	335*	9.031
		0	0	0	0	318		0	0	0	360	383*	
34'-0"		108	146	192	239	268*	16.536	154	209	265	315*	319*	10.176
		0	0	0	0	293		0	0	0	332	363*	
35'-0"		95	131	175	219	254*	18.569	139	191	244	300*	304*	11.427
		0	0	0	0	270		0	0	0	307	345*	
36'-0"		84	118	159	201	242*	20.784	125	174	224	284	290*	12.790
		0	0	0	0	249		0	0	0	0	328*	
37'-0"		73	105	144	184	229	23.191	112	159	206	262	277*	14.272
		0	0	0	0	0		0	0	0	0	313*	
38'-0"		63	94	131	168	211	25.802	100	144	189	243	265*	15.878
		0	0	0	0	0		0	0	0	0	297	
39'-0"		54	83	118	154	195	28.627	89	131	174	225	254*	17.617
		0	0	0	0	0		0	0	0	0	276	
40'-0"		46	73	107	140	180	31.678	79	119	159	208	243*	19.494
		0	0	0	0	0		0	0	0	0	257	
41'-0"			64	96	128	165	34.967	70	108	146	192	232*	21.518
			0	0	0	0		0	0	0	0	239	
42'-0"			56	86	117	152	38.505	61	97	134	178	222	23.695
			0	0	0	0		0	0	0	0	0	
43'-0"			48	77	106	140	42.305	53	87	122	164	207	26.034
			0	0	0	0		0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.06	1.21	1.43	1.71		1.04	1.21	1.43	1.64	2.04	
STEEL % (UNIFORM)	0.48	0.55	0.63	0.75	0.90		0.55	0.63	0.75	0.86	1.07	
(TAPERED)	0.31	0.35	0.40	0.48	0.57		0.35	0.40	0.48	0.55	0.68	
EFF. DEPTH, IN.	21.75	21.75	21.69	21.69	21.62		21.69	21.69	21.69	21.69	21.62	
$-I_{cr}/I_{gr}$	0.170	0.189	0.209	0.239	0.272		0.186	0.209	0.239	0.265	0.309	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.75	0.88	1.04	1.20	1.39		0.62	0.75	0.88	1.04	1.20	
STEEL %	0.09	0.11	0.13	0.15	0.17		0.08	0.09	0.11	0.13	0.15	
EFF. DEPTH, IN.	21.62	21.62	21.56	21.56	21.50		21.69	21.62	21.62	21.56	21.56	
$+I_{cr}/I_{gr}$	0.173	0.200	0.231	0.263	0.298		0.146	0.173	0.200	0.231	0.263	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 4.0″ Top Slab = 12.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 11	# 4 9	# 5 11	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 10.5	# 4 8	# 4 4	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 3	# 4	# 4	# 5	# 5		# 3	# 3	# 4	# 4	# 5	
	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
Steel (psf)		0.51	0.61	0.72	0.89	1.09		0.59	0.67	0.78	1.00	1.63	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
14'-0"		207	273*	273*	284*	298*	0.450						
		0	289	387	439*	452*							
15'-0"		170	241*	241*	251*	262*	0.593		275*		286*		0.365
		0	242	326	393*	407*			283		480*		
16'-0"		140	203	215*	223*	232*	0.767	149	239	249*	257*	291*	0.472
		0	0	277	349*	362*		0	0	331	437*	471*	
17'-0"		115	170	193*	200*	208*	0.978	122	203	226*	233*	262*	0.602
		0	0	237	304	325*		0	0	284	380	430*	
18'-0"		94	143	174*	180*	187*	1.229	101	172	206*	212*	237*	0.756
		0	0	202	262	293*		0	0	245	331	394*	
19'-0"		76	121	158*	163*	169*	1.525	82	147	188*	193*	216*	0.939
		0	0	173	227	266*		0	0	212	289	359*	
20'-0"		61	101	144*	148*	153*	1.873	66	124	172*	177*	197*	1.153
		0	0	149	197	242*		0	0	183	253	323	
21'-0"		48	84	128	135*	139*	2.276	53	105	158*	162*	180*	1.401
		0	0	0	172	222		0	0	159	222	286	
22'-0"			70	109	123*	127*	2.742	41	89	138	150*	166*	1.687
			0	0	149	195		0	0	0	195	253	
23'-0"			57	93	112*	116*	3.276		75	119	138*	152*	2.016
			0	0	130	171			0	0	172	225	
24'-0"			46	79	103*	106*	3.884		62	103	128*	141*	2.390
			0	0	113	151			0	0	151	200	
25'-0"				67	94*	97*	4.572		51	89	118*	130*	2.814
				0	98	133			0	0	133	178	
26'-0"				55	84	89*	5.349		41	76	109*	120*	3.292
				0	0	117			0	0	117	159	
27'-0"				46	72	82*	6.221			65	101*	112*	3.828
				0	0	103				0	103	141	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.64	0.78	0.99		0.64	0.64	0.67	0.88	1.75	
STEEL % (UNIFORM)	1.00	1.00	1.00	1.23	1.57		1.00	1.00	1.05	1.38	2.76	
(TAPERED)	0.54	0.54	0.54	0.66	0.85		0.54	0.54	0.57	0.75	1.49	
EFF. DEPTH, IN.	10.75	10.75	10.75	10.75	10.69		10.75	10.75	10.75	10.75	10.75	
$-I_{cr}/I_{gr}$	0.212	0.212	0.212	0.246	0.286		0.212	0.212	0.220	0.267	0.421	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.08	0.11	0.14	0.17	0.20		0.06	0.08	0.11	0.14	0.17	
EFF. DEPTH, IN.	10.75	10.75	10.69	10.69	10.62		10.81	10.75	10.75	10.69	10.69	
$+I_{cr}/I_{gr}$	0.153	0.194	0.239	0.285	0.334		0.113	0.153	0.194	0.239	0.285	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 4.0″ Top Slab = 12.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 11	# 4 9.5	# 5 11	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 11	# 4 8.5	# 4 7	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 3	# 4	# 4	# 5	# 5		# 3	# 3	# 4	# 4	# 5	
	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
Steel (psf)		0.50	0.60	0.71	0.86	1.07		0.58	0.66	0.75	0.95	1.18	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
14'-0"		195	275	310*	318*	335*	0.463						
		0	0	370	467	504*							
15'-0"		159	229	276*	283*	296*	0.610		270		325*		0.375
		0	0	312	396	452*			0		491		
16'-0"		130	191	247*	253*	264*	0.789	139	227	286*	293*	300*	0.486
		0	0	264	338	403*		0	0	316	422	475*	
17'-0"		106	160	223*	228*	237*	1.006	113	191	260*	266*	272*	0.619
		0	0	224	290	362*		0	0	271	364	436*	
18'-0"		85	134	191	206*	214*	1.264	92	162	232	243*	248*	0.778
		0	0	0	249	315		0	0	0	316	398*	
19'-0"		68	111	163	187*	194*	1.569	74	137	200	223*	227*	0.966
		0	0	0	215	275		0	0	0	275	351	
20'-0"		53	92	139	171*	177*	1.926	59	115	172	205*	209*	1.185
		0	0	0	186	240		0	0	0	240	309	
21'-0"		41	76	118	156*	162*	2.342	46	97	149	189*	192*	1.441
		0	0	0	161	210		0	0	0	210	272	
22'-0"			62	100	139	148*	2.820		81	128	174*	177*	1.736
			0	0	0	184			0	0	184	241	
23'-0"			50	85	120	136*	3.369		67	110	161	164*	2.073
			0	0	0	161			0	0	0	213	
24'-0"				71	104	125*	3.995		55	94	141	152*	2.458
				0	0	141			0	0	0	189	
25'-0"				59	89	115*	4.703		44	80	124	142*	2.894
				0	0	123			0	0	0	168	
26'-0"				48	76	106*	5.502			68	108	132*	3.386
				0	0	108				0	0	149	
27'-0"					65	94	6.398			57	94	123*	3.938
					0	0				0	0	132	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.46 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.65	0.76	1.01		0.65	0.65	0.65	0.85	1.03	
STEEL % (UNIFORM)	0.88	0.88	0.88	1.02	1.38		0.88	0.88	0.88	1.14	1.39	
(TAPERED)	0.51	0.51	0.51	0.59	0.80		0.51	0.51	0.51	0.66	0.80	
EFF. DEPTH, IN.	10.75	10.75	10.75	10.75	10.69		10.75	10.75	10.75	10.75	10.75	
$-I_{cr}/I_{gr}$	0.199	0.199	0.199	0.222	0.271		0.199	0.199	0.199	0.241	0.277	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.08	0.10	0.13	0.16	0.20		0.06	0.08	0.10	0.13	0.16	
EFF. DEPTH, IN.	10.75	10.75	10.69	10.69	10.62		10.81	10.75	10.75	10.69	10.69	
$+I_{cr}/I_{gr}$	0.135	0.171	0.211	0.252	0.294		0.099	0.135	0.171	0.211	0.252	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 4.0″ Top Slab = 14.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 11	# 4 9	# 4 7.5	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 11	# 4 8.5	# 5 10	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6		# 3 # 3	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	
Steel (psf)		0.51	0.61	0.72	0.89	1.08		0.59	0.67	0.77	0.97	1.25	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
17'-0"		145	211	256*	265*	275*	0.978						
		0	0	290	371	390*							
18'-0"		120	179	232*	239*	248*	1.229		214		276*	283*	0.756
		0	0	250	321	353*			0		402	450*	
19'-0"		99	152	211*	217*	224*	1.525	106	183	246*	252*	258*	0.939
		0	0	215	280	321*		0	0	260	352	405*	
20'-0"		81	129	186	198*	204*	1.873	88	157	226*	232*	237*	1.153
		0	0	0	244	294*		0	0	227	310	362*	
21'-0"		65	109	161	181*	187*	2.276	71	134	198	214*	218*	1.401
		0	0	0	213	273		0	0	0	273	325*	
22'-0"		52	92	139	166*	171*	2.742	57	115	172	198*	202*	1.687
		0	0	0	187	241		0	0	0	241	293*	
23'-0"		40	77	120	153*	157*	3.276	45	98	150	183*	187*	2.016
		0	0	0	164	214		0	0	0	213	266*	
24'-0"			63	103	141*	145*	3.884		83	131	170*	173*	2.390
			0	0	143	189			0	0	189	243*	
25'-0"			52	88	125	133*	4.572		69	114	158*	161*	2.814
			0	0	0	168			0	0	167	221	
26'-0"			41	75	109	123*	5.349		58	99	147*	150*	3.292
			0	0	0	148			0	0	148	198	
27'-0"				63	95	114*	6.221		47	86	131	140*	3.828
				0	0	131			0	0	0	177	
28'-0"				53	82	106*	7.195			74	116	130*	4.428
				0	0	116				0	0	159	
29'-0"				44	71	98*	8.279			63	102	122*	5.095
				0	0	103				0	0	142	
30'-0"					61	90	9.481			53	90	114*	5.835
					0	0				0	0	127	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.47 CF/SF) (4)

NEGATIVE MOMENT													
STEEL AREA (SQ. IN.)	0.64	0.64	0.64	0.78	0.93		0.64	0.64	0.64	0.82	1.09	
STEEL % (UNIFORM)	0.82	0.82	0.82	1.01	1.21		0.82	0.82	0.82	1.07	1.41	
(TAPERED)	0.45	0.45	0.45	0.55	0.66		0.45	0.45	0.45	0.58	0.77	
EFF. DEPTH, IN.	12.75	12.75	12.75	12.75	12.75		12.75	12.75	12.75	12.75	12.69	
$-I_{cr}/I_{gr}$	0.195	0.195	0.195	0.227	0.259		0.195	0.195	0.195	0.237	0.285	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.07	0.09	0.11	0.14	0.17		0.05	0.07	0.09	0.11	0.14	
EFF. DEPTH, IN.	12.75	12.75	12.69	12.69	12.62		12.81	12.75	12.75	12.69	12.69	
$+I_{cr}/I_{gr}$	0.137	0.173	0.214	0.256	0.300		0.100	0.137	0.173	0.214	0.256	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 4.0″ Top Slab = 14.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 8	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 8.5	# 5 7	# 5 8.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6		# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	
Steel (psf)		0.60	0.71	0.86	1.04	1.25		0.66	0.75	0.95	1.18	1.46	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
17'-0"		200	276	299*	308*	318*	1.006						
		0	0	354	435*	448*							
18'-0"		168	237	271*	279*	287*	1.264	202		316*	322*	330*	0.778
		0	0	306	386	406*		0		385	486	501*	
19'-0"		142	204	247*	253*	261*	1.569	172	247	290*	296*	302*	0.966
		0	0	266	337	370*		0	0	337	427	459*	
20'-0"		119	175	226*	232*	238*	1.926	146	214	267*	272*	278*	1.185
		0	0	231	296	339*		0	0	295	377	418*	
21'-0"		100	150	201	213*	218*	2.342	125	186	247*	251*	256*	1.441
		0	0	0	260	319		0	0	259	334	378*	
22'-0"		83	129	176	196*	200*	2.820	106	162	228	233*	237*	1.736
		0	0	0	229	283		0	0	0	296	342*	
23'-0"		69	111	153	180*	185*	3.369	89	140	201	216*	220*	2.073
		0	0	0	202	251		0	0	0	263	312*	
24'-0"		56	94	133	167*	171*	3.995	74	122	178	201*	205*	2.458
		0	0	0	178	224		0	0	0	235	285*	
25'-0"		44	80	116	155*	158*	4.703	62	105	157	188*	191*	2.894
		0	0	0	157	199		0	0	0	209	262*	
26'-0"			67	100	138	147*	5.502	50	90	138	176*	178*	3.386
			0	0	0	177		0	0	0	187	242	
27'-0"			56	87	122	136*	6.398	40	77	122	164*	167*	3.938
			0	0	0	158		0	0	0	167	218	
28'-0"			46	74	107	127*	7.400		66	107	149	156*	4.554
			0	0	0	141			0	0	0	196	
29'-0"				63	94	118*	8.516		55	94	132	146*	5.240
				0	0	125			0	0	0	177	
30'-0"				53	82	110*	9.752		46	82	118	137*	6.001
				0	0	111			0	0	0	160	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.49 CF/SF) (4)

NEGATIVE MOMENT													
STEEL AREA (SQ. IN.)	0.65	0.65	0.76	0.90	1.12		0.65	0.65	0.85	1.03	1.31	
STEEL % (UNIFORM)	0.73	0.73	0.84	1.00	1.25		0.73	0.73	0.94	1.14	1.47	
(TAPERED)	0.43	0.43	0.49	0.59	0.73		0.43	0.43	0.55	0.67	0.86	
EFF. DEPTH, IN.	12.75	12.75	12.75	12.75	12.69		12.75	12.75	12.75	12.75	12.69	
$-I_{cr}/I_{gr}$	0.183	0.183	0.205	0.233	0.269		0.183	0.183	0.223	0.257	0.302	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.09	0.11	0.14	0.17	0.19		0.07	0.09	0.11	0.14	0.17	
EFF. DEPTH, IN.	12.75	12.69	12.69	12.62	12.62		12.75	12.75	12.69	12.69	12.62	
$+I_{cr}/I_{gr}$	0.153	0.189	0.226	0.265	0.306		0.121	0.153	0.189	0.226	0.265	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 4.0″ Top Slab = 16.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 7.5	# 5 9.5	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 8.5	# 5 10	# 5 8.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.61	0.72	0.88	1.08	1.29		0.67	0.77	0.97	1.25	1.48	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		184	257	275*	287*	297*	1.525						
		0	0	332	380*	391*							
20'-0"		157	223	251*	261*	270*	1.873						
		0	0	291	348*	359*							
21'-0"		134	194	230*	239*	247*	2.276	163	236	271*	277*	283*	1.401
		0	0	255	325	340*		0	0	324	394*	407*	
22'-0"		114	169	212*	219*	226*	2.742	140	207	251*	256*	261*	1.687
		0	0	224	288	314*		0	0	287	357*	368*	
23'-0"		96	147	195*	202*	208*	3.276	121	182	233*	238*	242*	2.016
		0	0	197	256	291*		0	0	255	326*	335*	
24'-0"		81	127	174	187*	192*	3.884	103	159	217*	221*	225*	2.390
		0	0	0	227	271*		0	0	227	294	306*	
25'-0"		67	110	153	173*	177*	4.572	88	140	202	206*	210*	2.814
		0	0	0	202	252*		0	0	0	264	282*	
26'-0"		55	95	134	160*	164*	5.349	74	122	179	192*	196*	3.292
		0	0	0	180	227		0	0	0	237	260*	
27'-0"		45	81	118	149*	153*	6.221	62	107	160	180*	183*	3.828
		0	0	0	160	203		0	0	0	213	241*	
28'-0"			69	103	139*	142*	7.195	52	93	142	169*	172*	4.428
			0	0	143	183		0	0	0	192	223*	
29'-0"			58	90	127	132*	8.279	42	80	126	158*	161*	5.095
			0	0	0	164		0	0	0	173	208*	
30'-0"			48	78	112	123*	9.481		69	112	148*	151*	5.835
			0	0	0	147			0	0	155	194*	
31'-0"				67	100	115*	10.810		59	99	140*	142*	6.652
				0	0	132			0	0	0	181*	
32'-0"				58	88	107*	12.274		50	87	125	133*	7.553
				0	0	118			0	0	0	169	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.74	0.93	1.14		0.64	0.64	0.82	1.09	1.28	
STEEL % (UNIFORM)	0.69	0.69	0.80	1.02	1.25		0.69	0.69	0.90	1.19	1.40	
(TAPERED)	0.38	0.38	0.44	0.56	0.69		0.38	0.38	0.50	0.66	0.77	
EFF. DEPTH, IN.	14.75	14.75	14.75	14.75	14.69		14.75	14.75	14.75	14.69	14.69	
$-I_{cr}/I_{gr}$	0.180	0.180	0.201	0.240	0.275		0.180	0.180	0.219	0.266	0.298	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.08	0.10	0.12	0.15	0.17		0.06	0.08	0.10	0.12	0.15	
EFF. DEPTH, IN.	14.75	14.69	14.69	14.62	14.62		14.75	14.75	14.69	14.69	14.62	
$+I_{cr}/I_{gr}$	0.156	0.193	0.231	0.272	0.314		0.123	0.156	0.193	0.231	0.272	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 4.0″ Top Slab = 16.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 8	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 9	# 4 7	# 5 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.60	0.71	0.86	1.04	1.25		0.66	0.75	0.93	1.18	1.42	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		173	244	313*	321*	331*	1.569						
		0	0	317	400	435*							
20'-0"		146	211	276	294*	302*	1.926						
		0	0	0	351	399*							
21'-0"		124	183	242	270*	277*	2.342	152	224	309	316*	320*	1.441
		0	0	0	310	376*		0	0	0	395	452*	
22'-0"		104	158	212	249*	255*	2.820	130	195	273	293*	297*	1.736
		0	0	0	274	337		0	0	0	352	410*	
23'-0"		88	136	186	230*	236*	3.369	111	171	242	273*	276*	2.073
		0	0	0	243	300		0	0	0	314	375*	
24'-0"		73	117	163	213*	218*	3.995	94	149	214	255*	257*	2.458
		0	0	0	215	268		0	0	0	280	344*	
25'-0"		59	101	143	191	203*	4.703	79	130	190	238*	240*	2.894
		0	0	0	0	239		0	0	0	251	318*	
26'-0"		48	86	125	169	188*	5.502	66	113	168	223*	225*	3.386
		0	0	0	0	214		0	0	0	225	289	
27'-0"			73	109	150	176*	6.398	54	98	149	201	211*	3.938
			0	0	0	192		0	0	0	0	261	
28'-0"			61	94	133	164*	7.400	44	84	132	181	198*	4.554
			0	0	0	172		0	0	0	0	236	
29'-0"			50	82	117	153*	8.516		72	117	162	186*	5.240
			0	0	0	0			0	0	0	214	
30'-0"			41	70	103	137	9.752		61	103	145	175*	6.001
			0	0	0	0			0	0	0	194	
31'-0"				59	91	122	11.119		51	90	130	165*	6.842
				0	0	0			0	0	0	175	
32'-0"				50	79	109	12.625		42	79	116	156*	7.769
				0	0	0			0	0	0	159	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.76	0.90	1.12		0.65	0.65	0.80	1.03	1.24	
STEEL % (UNIFORM)	0.61	0.61	0.71	0.84	1.05		0.61	0.61	0.75	0.96	1.17	
(TAPERED)	0.36	0.36	0.42	0.50	0.62		0.36	0.36	0.44	0.57	0.69	
EFF. DEPTH, IN.	14.75	14.75	14.75	14.75	14.69		14.75	14.75	14.75	14.75	14.69	
$-I_{cr}/I_{gr}$	0.168	0.168	0.189	0.216	0.251		0.168	0.168	0.197	0.238	0.271	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.08	0.10	0.12	0.14	0.17		0.06	0.08	0.10	0.12	0.14	
EFF. DEPTH, IN.	14.75	14.69	14.69	14.62	14.62		14.75	14.75	14.69	14.69	14.62	
$+I_{cr}/I_{gr}$	0.138	0.171	0.204	0.241	0.278		0.109	0.138	0.171	0.204	0.241	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

14″ Deep Rib + 4.0″ Top Slab = 18.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 7.5	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 8.5	# 4 7	# 5 8.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.61	0.72	0.88	1.08	1.28		0.67	0.77	0.97	1.20	1.48	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
22'-0"		136	198	262	273*	278*	2.742						
		0	0	0	335	357*							
23'-0"		116	173	231	252*	257*	3.276						
		0	0	0	298	332*							
24'-0"		99	151	204	233*	237*	3.884	124	188	264	273*	278*	2.390
		0	0	0	266	309*		0	0	0	342	365*	
25'-0"		83	132	181	216*	220*	4.572	106	165	236	255*	260*	2.814
		0	0	0	237	288*		0	0	0	307	337*	
26'-0"		69	114	160	201*	204*	5.349	91	145	211	238*	243*	3.292
		0	0	0	212	265		0	0	0	277	311*	
27'-0"		57	99	141	187*	190*	6.221	77	128	188	224*	228*	3.828
		0	0	0	189	238		0	0	0	249	289*	
28'-0"		46	85	124	169	177*	7.195	65	112	168	210*	214*	4.428
		0	0	0	0	215		0	0	0	225	269*	
29'-0"			73	109	151	166*	8.279	54	98	150	197*	201*	5.095
			0	0	0	194		0	0	0	203	251*	
30'-0"			62	96	135	155*	9.481	44	85	134	183	189*	5.835
			0	0	0	174		0	0	0	0	235*	
31'-0"			51	83	120	145*	10.810		73	119	166	178*	6.652
			0	0	0	157			0	0	0	219	
32'-0"			42	72	107	136*	12.274		63	106	149	168*	7.553
			0	0	0	142			0	0	0	199	
33'-0"				62	94	127	13.882		53	94	135	159*	8.543
				0	0	0			0	0	0	182	
34'-0"				53	83	114	15.642		45	83	121	150*	9.626
				0	0	0			0	0	0	166	
35'-0"				44	73	102	17.565			72	109	142*	10.809
				0	0	0				0	0	151	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.74	0.93	1.09		0.64	0.64	0.82	1.00	1.28	
STEEL % (UNIFORM)	0.59	0.59	0.69	0.87	1.02		0.59	0.59	0.77	0.93	1.20	
(TAPERED)	0.33	0.33	0.39	0.49	0.57		0.33	0.33	0.43	0.52	0.67	
EFF. DEPTH, IN.	16.75	16.75	16.75	16.75	16.69		16.75	16.75	16.75	16.75	16.69	
$-I_{cr}/I_{gr}$	0.167	0.167	0.187	0.224	0.248		0.167	0.167	0.204	0.236	0.279	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.07	0.09	0.11	0.13	0.15		0.05	0.07	0.09	0.11	0.13	
EFF. DEPTH, IN.	16.75	16.69	16.69	16.62	16.62		16.75	16.75	16.69	16.69	16.62	
$+I_{cr}/I_{gr}$	0.142	0.176	0.211	0.249	0.287		0.112	0.142	0.176	0.211	0.249	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

14″ Deep Rib + 4.0″ Top Slab = 18.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 10	# 4 8	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 9	# 4 7	# 5 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.60	0.71	0.85	1.04	1.25		0.66	0.75	0.93	1.18	1.42	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
22'-0"		125	185	247	305*	314*	2.820						
		0	0	0	318	390							
23'-0"		105	161	217	282	290*	3.369						
		0	0	0	0	348							
24'-0"		88	139	191	251	269*	3.995	113	175	249	311*	314*	2.458
		0	0	0	0	311		0	0	0	325	407*	
25'-0"		73	120	168	223	250*	4.703	96	153	222	291*	294*	2.894
		0	0	0	0	279		0	0	0	0	371	
26'-0"		60	104	148	198	233*	5.502	81	134	197	261	275*	3.386
		0	0	0	0	250		0	0	0	0	335	
27'-0"		48	89	130	177	217*	6.398	68	117	176	235	259*	3.938
		0	0	0	0	224		0	0	0	0	303	
28'-0"			75	113	157	201	7.400	56	101	156	211	243*	4.554
			0	0	0	0		0	0	0	0	275	
29'-0"			63	99	139	181	8.516	45	88	139	190	229*	5.240
			0	0	0	0		0	0	0	0	249	
30'-0"			52	85	124	162	9.752		75	123	171	216*	6.001
			0	0	0	0			0	0	0	226	
31'-0"			43	74	109	145	11.119		64	108	154	204*	6.842
			0	0	0	0			0	0	0	205	
32'-0"				63	96	130	12.625		54	95	138	187	7.769
				0	0	0			0	0	0	0	
33'-0"				53	84	116	14.278		44	84	123	169	8.787
				0	0	0			0	0	0	0	
34'-0"				44	74	104	16.089			73	110	154	9.901
				0	0	0				0	0	0	
35'-0"					64	92	18.067			63	98	139	11.118
					0	0				0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.72	0.90	1.12		0.65	0.65	0.80	1.03	1.24	
STEEL % (UNIFORM)	0.53	0.53	0.58	0.73	0.90		0.53	0.53	0.65	0.83	1.01	
(TAPERED)	0.32	0.32	0.35	0.43	0.54		0.32	0.32	0.39	0.50	0.60	
EFF. DEPTH, IN.	16.75	16.75	16.75	16.75	16.69		16.75	16.75	16.75	16.75	16.69	
$-I_{cr}/I_{gr}$	0.156	0.156	0.169	0.201	0.235		0.156	0.156	0.183	0.222	0.254	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.07	0.08	0.10	0.13	0.15		0.05	0.07	0.08	0.10	0.13	
EFF. DEPTH, IN.	16.75	16.69	16.69	16.62	16.62		16.75	16.75	16.69	16.69	16.62	
$+I_{cr}/I_{gr}$	0.126	0.156	0.187	0.221	0.255		0.099	0.126	0.156	0.187	0.221	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

16″ Deep Rib + 4.0″ Top Slab = 20.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 10	# 4 8	# 5 10	# 5 9	End Span Defl. Coeff. (3)	# 4 11	# 4 9	# 4 7	# 5 9	# 5 7.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
Steel (psf)		0.71	0.85	1.04	1.25	1.44		0.75	0.93	1.18	1.42	1.71	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
25'-0"		140	194	255	301*	306*	4.703						
		0	0	0	318	376*							
26'-0"		121	171	228	281*	285*	5.502				329*		3.386
		0	0	0	286	352*					381		
27'-0"		105	150	203	257	266*	6.398	136	202	269	310*	315*	3.938
		0	0	0	0	321		0	0	0	346	387*	
28'-0"		90	132	181	231	249*	7.400	119	180	242	292*	297*	4.554
		0	0	0	0	291		0	0	0	314	362*	
29'-0"		76	116	162	208	234*	8.516	103	160	218	275*	280*	5.240
		0	0	0	0	264		0	0	0	285	339*	
30'-0"		64	101	144	187	219*	9.752	89	143	197	259	264*	6.001
		0	0	0	0	239		0	0	0	0	318*	
31'-0"		53	88	128	168	206*	11.119	77	127	177	236	250*	6.842
		0	0	0	0	217		0	0	0	0	295	
32'-0"		43	75	113	151	194*	12.625	65	112	160	214	236*	7.769
		0	0	0	0	197		0	0	0	0	270	
33'-0"			64	100	136	179	14.278	55	99	144	195	224*	8.787
			0	0	0	0		0	0	0	0	247	
34'-0"			54	88	122	162	16.089	45	87	129	177	212*	9.901
			0	0	0	0		0	0	0	0	227	
35'-0"			45	77	109	147	18.067		76	115	161	202*	11.118
			0	0	0	0			0	0	0	208	
36'-0"				66	97	133	20.222		66	103	146	190	12.445
				0	0	0			0	0	0	0	
37'-0"				57	86	120	22.565		56	92	133	174	13.886
				0	0	0			0	0	0	0	
38'-0"				48	75	108	25.105		48	81	120	160	15.449
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.72	0.90	1.12	1.24		0.65	0.80	1.03	1.24	1.49	
STEEL % (UNIFORM)	0.46	0.51	0.63	0.79	0.88		0.46	0.56	0.73	0.88	1.05	
(TAPERED)	0.28	0.31	0.38	0.48	0.53		0.28	0.34	0.44	0.53	0.63	
EFF. DEPTH, IN.	18.75	18.75	18.75	18.69	18.69		18.75	18.75	18.75	18.69	18.69	
$-I_{cr}/I_{gr}$	0.146	0.157	0.188	0.221	0.239		0.146	0.171	0.209	0.239	0.274	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.62	0.75	0.88	1.04		0.40	0.51	0.62	0.75	0.88	
STEEL %	0.08	0.09	0.11	0.13	0.16		0.06	0.08	0.09	0.11	0.13	
EFF. DEPTH, IN.	18.69	18.69	18.62	18.62	18.56		18.75	18.69	18.69	18.62	18.62	
$+I_{cr}/I_{gr}$	0.144	0.172	0.204	0.236	0.272		0.116	0.144	0.172	0.204	0.236	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 7" Rib @ 37" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

16″ Deep Rib + 4.0″ Top Slab = 20.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8.5	# 4 7	# 5 9	# 5 8	End Span Defl. Coeff. (3)	# 4 9	# 4 7.5	# 5 9.5	# 5 8	# 6 9.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
	#	# 5	# 6	# 6	# 7	# 7		# 5	# 5	# 6	# 6	# 7	
Steel (psf)		0.83	1.00	1.20	1.41	1.63		0.92	1.13	1.36	1.63	1.93	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
25'-0"		181	241	302	338*	345*	4.834						
		0	0	0	375	422*							
26'-0"		158	214	270	316*	322*	5.655			363		375*	3.480
		0	0	0	338	396*				0		464*	
27'-0"		139	190	242	295*	301*	6.576	189	254	329	348*	352*	4.047
		0	0	0	305	368		0	0	0	405	432*	
28'-0"		121	169	217	276	282*	7.606	168	228	298	328*	332*	4.681
		0	0	0	0	335		0	0	0	368	404*	
29'-0"		105	150	195	249	265*	8.752	148	205	270	310*	313*	5.386
		0	0	0	0	304		0	0	0	335	378*	
30'-0"		91	132	175	225	249*	10.023	131	184	244	293*	296*	6.168
		0	0	0	0	277		0	0	0	306	355*	
31'-0"		78	117	156	204	234*	11.428	116	165	222	277*	280*	7.033
		0	0	0	0	252		0	0	0	279	334*	
32'-0"		66	102	140	184	221*	12.975	101	148	201	255	266*	7.985
		0	0	0	0	229		0	0	0	0	315*	
33'-0"		55	89	124	166	209*	14.675	89	132	182	233	252*	9.031
		0	0	0	0	0		0	0	0	0	294	
34'-0"		45	78	111	150	190	16.536	77	118	165	213	239*	10.176
		0	0	0	0	0		0	0	0	0	270	
35'-0"			67	98	135	173	18.569	66	105	149	194	227*	11.427
			0	0	0	0		0	0	0	0	249	
36'-0"			57	86	121	157	20.784	56	93	135	177	216*	12.790
			0	0	0	0		0	0	0	0	229	
37'-0"			48	76	109	143	23.191	47	82	121	162	206*	14.272
			0	0	0	0		0	0	0	0	210	
38'-0"				66	97	129	25.802		71	109	148	194	15.878
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.74	0.87	1.06	1.27	1.43		0.82	0.99	1.21	1.43	1.71	
STEEL % (UNIFORM)	0.46	0.54	0.66	0.80	0.90		0.51	0.61	0.76	0.90	1.08	
(TAPERED)	0.29	0.34	0.42	0.50	0.57		0.32	0.39	0.48	0.57	0.68	
EFF. DEPTH, IN.	18.75	18.75	18.75	18.69	18.69		18.75	18.75	18.69	18.69	18.62	
$-I_{cr}/I_{gr}$	0.149	0.170	0.199	0.228	0.249		0.163	0.188	0.219	0.249	0.283	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	0.75	0.88	1.04	1.20		0.51	0.62	0.75	0.88	1.04	
STEEL %	0.09	0.11	0.13	0.15	0.17		0.07	0.09	0.11	0.13	0.15	
EFF. DEPTH, IN.	18.69	18.62	18.62	18.56	18.56		18.69	18.69	18.62	18.62	18.56	
$+I_{cr}/I_{gr}$	0.156	0.184	0.213	0.246	0.280		0.130	0.156	0.184	0.213	0.246	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

20″ Deep Rib + 4.0″ Top Slab = 24.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 4 7	# 5 9	# 5 7.5	End Span Defl. Coeff. (3)	# 4 9	# 4 7.5	# 5 9.5	# 5 8	# 6 9.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7		# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	
Steel (psf)		0.85	1.04	1.23	1.44	1.69		0.93	1.14	1.38	1.66	1.96	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
30'-0"		132	184	237	301	314*	9.752						
		0	0	0	0	363*							
31'-0"		116	165	214	274	295*	11.119						
		0	0	0	0	335							
32'-0"		101	147	194	250	278*	12.625	146		270		327*	7.769
		0	0	0	0	306		0		0		373*	
33'-0"		88	131	175	227	263*	14.278	129	184	247	307*	310*	8.787
		0	0	0	0	281		0	0	0	311	353*	
34'-0"		75	116	157	207	248*	16.089	115	166	225	285	295*	9.901
		0	0	0	0	257		0	0	0	0	334*	
35'-0"		64	103	142	188	235*	18.067	101	150	206	262	280*	11.118
		0	0	0	0	236		0	0	0	0	317*	
36'-0"		54	90	127	171	216	20.222	89	135	188	241	267*	12.445
		0	0	0	0	0		0	0	0	0	301*	
37'-0"		44	79	114	156	198	22.565	78	121	171	222	254*	13.886
		0	0	0	0	0		0	0	0	0	283	
38'-0"			68	101	141	181	25.105	67	108	156	204	243*	15.449
			0	0	0	0		0	0	0	0	261	
39'-0"			58	90	128	166	27.853	57	96	141	187	232*	17.141
			0	0	0	0		0	0	0	0	242	
40'-0"			49	79	115	151	30.822	49	85	128	172	221*	18.967
			0	0	0	0		0	0	0	0	224	
41'-0"			41	69	104	138	34.022	40	75	116	157	207	20.936
			0	0	0	0		0	0	0	0	0	
42'-0"				60	93	126	37.464		66	105	144	192	23.055
				0	0	0			0	0	0	0	
43'-0"				52	83	114	41.162		57	94	132	177	25.330
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.72	0.90	1.03	1.24	1.49		0.80	0.96	1.17	1.39	1.67	
STEEL % (UNIFORM)	0.40	0.50	0.57	0.69	0.83		0.45	0.53	0.66	0.78	0.93	
(TAPERED)	0.25	0.31	0.35	0.42	0.51		0.27	0.33	0.40	0.48	0.57	
EFF. DEPTH, IN.	22.75	22.75	22.75	22.69	22.69		22.75	22.75	22.69	22.69	22.62	
$-I_{cr}/I_{gr}$	0.140	0.168	0.187	0.215	0.247		0.152	0.177	0.206	0.235	0.267	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	0.75	0.88	1.04	1.20		0.51	0.62	0.75	0.88	1.04	
STEEL %	0.08	0.09	0.11	0.13	0.15		0.06	0.08	0.09	0.11	0.13	
EFF. DEPTH, IN.	22.69	22.62	22.62	22.56	22.56		22.69	22.69	22.62	22.62	22.56	
$+I_{cr}/I_{gr}$	0.150	0.178	0.206	0.238	0.271		0.125	0.150	0.178	0.206	0.238	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 7" Rib @ 37" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

20″ Deep Rib + 4.0″ Top Slab = 24.0″ Total Depth

TOP BARS	Size @	# 4 8	# 4 7	# 5 9.5	# 5 8	# 6 9.5	End Span Defl. Coeff. (3)	# 5 11	# 5 9.5	# 5 8	# 5 7	# 5 6	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8		# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	
Steel (psf)		1.02	1.20	1.40	1.63	1.89		1.16	1.36	1.63	1.88	2.20	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
30'-0"		169	221	283	340*	348*	10.023						
		0	0	0	346	403*							
31'-0"		150	198	256	315	328*	11.428						
		0	0	0	0	382*							
32'-0"		133	178	233	288	309*	12.975		253		360*	366*	7.985
		0	0	0	0	352			0		398	416*	
33'-0"		117	159	211	263	292*	14.675	168	230	292	342*	347*	9.031
		0	0	0	0	323		0	0	0	366	394*	
34'-0"		102	143	191	240	276*	16.536	151	209	267	326*	330*	10.176
		0	0	0	0	297		0	0	0	337	373*	
35'-0"		89	127	173	219	262*	18.569	135	190	245	310*	314*	11.427
		0	0	0	0	273		0	0	0	311	354*	
36'-0"		77	113	156	200	248*	20.784	120	172	224	287	300*	12.790
		0	0	0	0	250		0	0	0	0	336*	
37'-0"		66	100	141	182	230	23.191	107	156	205	265	286*	14.272
		0	0	0	0	0		0	0	0	0	320*	
38'-0"		56	88	127	166	211	25.802	95	141	188	244	273*	15.878
		0	0	0	0	0		0	0	0	0	301	
39'-0"		46	77	114	151	194	28.627	83	127	172	225	260*	17.617
		0	0	0	0	0		0	0	0	0	279	
40'-0"			67	102	137	178	31.678	73	114	157	207	249*	19.494
			0	0	0	0		0	0	0	0	259	
41'-0"			57	90	124	163	34.967	63	103	143	191	238*	21.518
			0	0	0	0		0	0	0	0	240	
42'-0"			48	80	112	149	38.505	54	92	130	176	223	23.695
			0	0	0	0		0	0	0	0	0	
43'-0"			40	70	101	136	42.305	45	81	118	162	206	26.034
			0	0	0	0		0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.06	1.21	1.43	1.71		1.04	1.21	1.43	1.64	1.91	
STEEL % (UNIFORM)	0.46	0.52	0.60	0.71	0.85		0.52	0.60	0.71	0.81	0.95	
(TAPERED)	0.29	0.33	0.38	0.45	0.55		0.33	0.38	0.45	0.52	0.61	
EFF. DEPTH, IN.	22.75	22.75	22.69	22.69	22.62		22.69	22.69	22.69	22.69	22.69	
$-I_{cr}/I_{gr}$	0.160	0.178	0.196	0.225	0.256		0.175	0.196	0.225	0.249	0.280	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.75	0.88	1.04	1.20	1.39		0.62	0.75	0.88	1.04	1.20	
STEEL %	0.09	0.11	0.12	0.14	0.17		0.07	0.09	0.11	0.12	0.14	
EFF. DEPTH, IN.	22.62	22.62	22.56	22.56	22.50		22.69	22.62	22.62	22.56	22.56	
$+I_{cr}/I_{gr}$	0.161	0.187	0.216	0.246	0.279		0.136	0.161	0.187	0.216	0.246	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 4.5″ Top Slab = 12.5″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9	# 5 11	# 5 6	End Span Defl. Coeff. (3)	# 4 11	# 4 10.5	# 4 8	# 4 4	# 6 7	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.61	0.72	0.89	1.09	1.49		0.67	0.78	1.00	1.63	2.03	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
16'-0"		209	226*	235*	245*	294*	0.767	247	262*	270*	306*	319*	0.472
		0	287	361*	374*	389*		0	343	456*	492*	503*	
17'-0"		175	203*	210*	218*	260*	0.978	209	237*	244*	275*	286*	0.602
		0	244	315	335*	349*		0	294	395	449*	458*	
18'-0"		147	182*	189*	196*	232*	1.229	177	215*	222*	249*	258*	0.756
		0	209	271	302*	314*		0	253	343	411*	420*	
19'-0"		123	165*	170*	176*	208*	1.525	150	196*	202*	226*	234*	0.939
		0	178	235	274*	285*		0	218	299	374*	385*	
20'-0"		102	150*	154*	160*	187*	1.873	127	180*	185*	206*	213*	1.153
		0	152	203	249*	260*		0	188	261	335	351*	
21'-0"		85	130	140*	145*	169*	2.276	107	163	169*	188*	194*	1.401
		0	0	176	229	245*		0	0	229	296	318*	
22'-0"		69	111	128*	132*	153*	2.742	90	141	156*	173*	178*	1.687
		0	0	153	201	224*		0	0	201	262	286*	
23'-0"		56	94	116*	120*	140*	3.276	75	121	143*	159*	163*	2.016
		0	0	133	176	206*		0	0	176	232	257*	
24'-0"		45	79	106*	110*	127*	3.884	62	104	132*	146*	150*	2.390
		0	0	115	155	190*		0	0	155	206	231*	
25'-0"			66	97*	100*	116*	4.572	50	89	122*	135*	138*	2.814
			0	99	136	174		0	0	136	183	210*	
26'-0"			55	85	92*	106*	5.349	40	76	113*	125*	128*	3.292
			0	0	119	154		0	0	119	163	191*	
27'-0"			44	72	84*	97*	6.221		64	104	115*	118*	3.828
			0	0	104	136			0	0	145	174*	
28'-0"				61	77*	89*	7.195		54	91	107*	109*	4.428
				0	91	121			0	0	128	160*	
29'-0"				51	70*	81*	8.279		44	79	99*	101*	5.095
				0	79	107			0	0	114	146*	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.78	0.99	1.81		0.64	0.67	0.88	1.75	2.20	
STEEL % (UNIFORM)	0.95	0.95	1.16	1.49	2.72		0.95	1.00	1.31	2.62	3.34	
(TAPERED)	0.52	0.52	0.63	0.81	1.48		0.52	0.54	0.71	1.42	1.81	
EFF. DEPTH, IN.	11.25	11.25	11.25	11.19	11.19		11.25	11.25	11.25	11.25	11.12	
$-I_{cr}/I_{gr}$	0.207	0.207	0.240	0.281	0.417		0.207	0.214	0.261	0.414	0.462	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.10	0.13	0.16	0.19	0.23		0.08	0.10	0.13	0.16	0.19	
EFF. DEPTH, IN.	11.25	11.19	11.19	11.12	11.12		11.25	11.25	11.19	11.19	11.12	
$+I_{cr}/I_{gr}$	0.188	0.232	0.276	0.324	0.373		0.149	0.188	0.232	0.276	0.324	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 4.5″ Top Slab = 12.5″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 7.5	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 8.5	# 4 7	# 6 8	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.60	0.71	0.86	1.05	1.25		0.66	0.75	0.95	1.18	1.85	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
16'-0"		197	260*	266*	278*	284*	0.789	234	301*	308*	316*	347*	0.486
		0	273	350	417*	431*		0	328	438	497*	527*	
17'-0"		164	232	239*	249*	254*	1.006	197	273*	280*	286*	313*	0.619
		0	0	300	374*	387*		0	280	378	455*	481*	
18'-0"		137	197	216*	225*	229*	1.264	166	240	255*	260*	284*	0.778
		0	0	258	327	350*		0	0	327	416*	441*	
19'-0"		113	167	196*	204*	207*	1.569	140	206	233*	238*	258*	0.966
		0	0	222	285	318*		0	0	285	364	406*	
20'-0"		94	142	179*	185*	188*	1.926	117	177	214*	218*	236*	1.185
		0	0	192	248	290*		0	0	248	320	373*	
21'-0"		76	121	163*	169*	172*	2.342	98	152	197*	201*	217*	1.441
		0	0	165	217	269		0	0	217	282	341*	
22'-0"		62	102	143	155*	157*	2.820	81	131	182*	185*	199*	1.736
		0	0	0	189	237		0	0	189	249	309*	
23'-0"		49	85	123	142*	144*	3.369	67	112	165	171*	184*	2.073
		0	0	0	165	209		0	0	0	220	279*	
24'-0"			71	105	130*	132*	3.995	54	95	145	159*	170*	2.458
			0	0	145	185		0	0	0	195	251	
25'-0"			58	90	120*	121*	4.703	43	81	126	147*	157*	2.894
			0	0	126	163		0	0	0	172	225	
26'-0"			47	77	110	112*	5.502		68	110	137*	146*	3.386
			0	0	0	144			0	0	152	201	
27'-0"				64	95	103*	6.398		56	95	127*	135*	3.938
				0	0	127			0	0	135	180	
28'-0"				53	82	95*	7.400		46	82	118*	126*	4.554
				0	0	112			0	0	119	161	
29'-0"				44	70	87*	8.516			71	105	117*	5.240
				0	0	98				0	0	144	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.76	0.96	1.12		0.65	0.65	0.85	1.03	1.98	
STEEL % (UNIFORM)	0.84	0.84	0.97	1.23	1.44		0.84	0.84	1.09	1.32	2.57	
(TAPERED)	0.49	0.49	0.56	0.71	0.84		0.49	0.49	0.63	0.77	1.49	
EFF. DEPTH, IN.	11.25	11.25	11.25	11.25	11.19		11.25	11.25	11.25	11.25	11.12	
$-I_{cr}/I_{gr}$	0.195	0.195	0.217	0.259	0.284		0.195	0.195	0.236	0.272	0.410	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.10	0.13	0.15	0.19	0.22		0.08	0.10	0.13	0.15	0.19	
EFF. DEPTH, IN.	11.25	11.19	11.19	11.12	11.12		11.25	11.25	11.19	11.19	11.12	
$+I_{cr}/I_{gr}$	0.166	0.205	0.244	0.286	0.330		0.131	0.166	0.205	0.244	0.286	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 4.5″ Top Slab = 14.5″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9	# 4 7.5	# 5 9.5	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 8.5	# 5 10	# 6 7.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.61	0.72	0.89	1.08	1.29		0.67	0.77	0.97	1.25	1.95	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		154	219*	226*	234*	242*	1.525	186	256*	263*	269*	299*	0.939
		0	220	287	330*	342*		0	267	363	420*	467*	
20'-0"		130	190	205*	212*	219*	1.873	159	232	241*	247*	273*	1.153
		0	0	250	301*	312*		0	0	318	375*	426*	
21'-0"		110	163	188*	193*	200*	2.276	136	202	222*	227*	250*	1.401
		0	0	218	280	297*		0	0	280	336*	387*	
22'-0"		92	141	172*	177*	182*	2.742	115	175	205*	209*	230*	1.687
		0	0	190	247	274*		0	0	247	303*	349*	
23'-0"		76	121	158*	162*	167*	3.276	98	153	189*	193*	212*	2.016
		0	0	166	218	253*		0	0	218	275*	315*	
24'-0"		62	103	145*	149*	153*	3.884	82	133	176*	179*	196*	2.390
		0	0	0	193	235*		0	0	193	251*	285*	
25'-0"		50	88	126	137*	141*	4.572	68	115	163*	166*	182*	2.814
		0	0	0	171	215		0	0	170	226	260*	
26'-0"			74	110	127*	130*	5.349	56	99	150	154*	169*	3.292
			0	0	151	192		0	0	0	202	238*	
27'-0"			62	95	117*	120*	6.221	45	85	133	144*	157*	3.828
			0	0	133	171		0	0	0	181	218*	
28'-0"			51	82	108*	111*	7.195		73	117	134*	146*	4.428
			0	0	117	153			0	0	161	201*	
29'-0"			42	70	100*	102*	8.279		61	103	125*	136*	5.095
			0	0	103	136			0	0	144	186*	
30'-0"				59	90	94*	9.481		51	90	117*	127*	5.835
				0	0	121			0	0	129	172*	
31'-0"				50	78	87*	10.810		42	78	109*	118*	6.652
				0	0	108			0	0	115	156	
32'-0"				41	68	81*	12.274			68	102*	110*	7.553
				0	0	95				0	0	141	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.51 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.78	0.93	1.14		0.64	0.64	0.82	1.09	2.05	
STEEL % (UNIFORM)	0.79	0.79	0.96	1.15	1.42		0.79	0.79	1.02	1.35	2.57	
(TAPERED)	0.43	0.43	0.53	0.63	0.78		0.43	0.43	0.56	0.74	1.41	
EFF. DEPTH, IN.	13.25	13.25	13.25	13.25	13.19		13.25	13.25	13.25	13.19	13.12	
$-I_{cr}/I_{gr}$	0.191	0.191	0.222	0.254	0.290		0.191	0.191	0.232	0.280	0.422	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.09	0.11	0.13	0.16	0.19		0.07	0.09	0.11	0.13	0.16	
EFF. DEPTH, IN.	13.25	13.19	13.19	13.12	13.12		13.25	13.25	13.19	13.19	13.12	
$+I_{cr}/I_{gr}$	0.169	0.209	0.249	0.293	0.338		0.133	0.169	0.209	0.249	0.293	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 4.5″ Top Slab = 14.5″ Total Depth

TOP BARS	Size @	# 4 11	# 4 9.5	# 4 8	# 5 10	# 5 8.5	End Span Defl. Coeff. (3)	# 4 11	# 4 8.5	# 4 7	# 5 9	# 6 6.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
Steel (psf)		0.71	0.86	1.04	1.25	1.46		0.75	0.95	1.18	1.42	2.26	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		208	257*	264*	272*	282*	1.569	253	302*	308*	313*	349*	0.966
		0	273	347	381*	393*		0	346	441	472*	513*	
20'-0"		178	235*	241*	248*	256*	1.926	219	278*	283*	287*	319*	1.185
		0	237	304	348*	360*		0	303	388	429*	474*	
21'-0"		153	206	221*	227*	234*	2.342	190	257*	261*	265*	293*	1.441
		0	0	267	329	344*		0	266	343	388*	437*	
22'-0"		131	179	203*	208*	214*	2.820	164	234	242*	245*	270*	1.736
		0	0	234	291	318*		0	0	304	351*	401*	
23'-0"		111	156	187*	191*	197*	3.369	142	206	224*	227*	250*	2.073
		0	0	206	258	294*		0	0	270	319*	367*	
24'-0"		94	135	172*	177*	182*	3.995	123	181	209*	211*	232*	2.458
		0	0	182	229	274*		0	0	240	292*	333*	
25'-0"		79	117	160*	163*	168*	4.703	106	159	194*	196*	215*	2.894
		0	0	0	203	255*		0	0	214	268*	304*	
26'-0"		66	101	140	151*	155*	5.502	90	140	181*	183*	200*	3.386
		0	0	0	181	229		0	0	190	248*	279*	
27'-0"		54	86	123	140*	144*	6.398	77	123	169*	171*	187*	3.938
		0	0	0	161	205		0	0	170	223	257*	
28'-0"		44	74	108	130*	134*	7.400	65	107	151	160*	174*	4.554
		0	0	0	143	184		0	0	0	201	237*	
29'-0"			62	94	121*	124*	8.516	54	94	134	150*	163*	5.240
			0	0	126	165		0	0	0	180	220*	
30'-0"			52	81	112	115*	9.752	44	81	119	140*	153*	6.001
			0	0	0	148		0	0	0	162	204*	
31'-0"			42	70	99	107*	11.119		70	105	132*	143*	6.842
			0	0	0	132			0	0	146	187	
32'-0"				60	87	100*	12.625		60	93	123*	134*	7.769
				0	0	118			0	0	131	170	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.76	0.90	1.12	1.31		0.65	0.85	1.03	1.24	2.44	
STEEL % (UNIFORM)	0.70	0.81	0.96	1.19	1.40		0.70	0.90	1.09	1.32	2.62	
(TAPERED)	0.41	0.47	0.56	0.70	0.82		0.41	0.53	0.64	0.78	1.54	
EFF. DEPTH, IN.	13.25	13.25	13.25	13.19	13.19		13.25	13.25	13.25	13.19	13.12	
$-I_{cr}/I_{gr}$	0.179	0.200	0.228	0.264	0.297		0.179	0.218	0.252	0.285	0.441	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.62	0.75	0.88	1.04		0.40	0.51	0.62	0.75	0.88	
STEEL %	0.11	0.13	0.16	0.19	0.22		0.08	0.11	0.13	0.16	0.19	
EFF. DEPTH, IN.	13.19	13.19	13.12	13.12	13.06		13.25	13.19	13.19	13.12	13.12	
$+I_{cr}/I_{gr}$	0.184	0.220	0.259	0.298	0.342		0.149	0.184	0.220	0.259	0.298	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth

TOP BARS	Size @	# 4 11	# 4 9.5	# 4 7.5	# 5 10	# 5 8	End Span Defl. Coeff. (3)	# 4 11	# 4 8.5	# 5 10	# 5 8.5	# 6 6.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
Steel (psf)		0.72	0.88	1.08	1.28	1.52		0.77	0.97	1.25	1.48	2.29	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
21'-0"		197	238*	247*	253*	266*	2.276						
		0	260	332*	342*	363*							
22'-0"		170	218*	227*	231*	243*	2.742	210	259*	265*	270*	300*	1.687
		0	228	294	316*	336*		0	293	368*	379*	438*	
23'-0"		147	200	208*	212*	223*	3.276	184	240*	245*	250*	277*	2.016
		0	0	260	292*	311*		0	259	335*	345*	396*	
24'-0"		127	176	192*	196*	205*	3.884	161	224*	228*	232*	256*	2.390
		0	0	231	272*	289*		0	230	301	315*	360*	
25'-0"		110	154	178*	181*	189*	4.572	140	204	212*	216*	238*	2.814
		0	0	205	253*	270*		0	0	269	290*	329*	
26'-0"		94	135	165*	167*	175*	5.349	122	182	198*	202*	221*	3.292
		0	0	182	230	252*		0	0	241	267*	301*	
27'-0"		80	118	153*	155*	162*	6.221	106	161	185*	188*	206*	3.828
		0	0	162	206	236*		0	0	217	247*	277*	
28'-0"		67	103	142*	144*	150*	7.195	92	143	173*	176*	193*	4.428
		0	0	144	185	221*		0	0	195	229*	256*	
29'-0"		56	89	127	134*	139*	8.279	79	127	162*	165*	180*	5.095
		0	0	0	166	207*		0	0	175	213*	237*	
30'-0"		46	77	112	124*	130*	9.481	67	112	152*	155*	168*	5.835
		0	0	0	148	188*		0	0	157	198*	220*	
31'-0"			66	99	116*	121*	10.810	57	98	140	145*	158*	6.652
			0	0	133	172*		0	0	0	185*	205*	
32'-0"			56	87	108*	112*	12.274	47	86	126	136*	148*	7.553
			0	0	118	156		0	0	0	171	191*	
33'-0"			46	76	100*	105*	13.882		75	112	128*	139*	8.543
			0	0	105	141			0	0	155	179*	
34'-0"				66	93*	97*	15.642		65	100	120*	131*	9.626
				0	94	127			0	0	140	167*	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.74	0.93	1.09	1.36		0.64	0.82	1.09	1.28	2.37	
STEEL % (UNIFORM)	0.67	0.77	0.98	1.14	1.43		0.67	0.86	1.14	1.34	2.50	
(TAPERED)	0.37	0.43	0.54	0.63	0.79		0.37	0.48	0.63	0.75	1.39	
EFF. DEPTH, IN.	15.25	15.25	15.25	15.19	15.19		15.25	15.25	15.19	15.19	15.12	
$-I_{cr}/I_{gr}$	0.176	0.197	0.236	0.261	0.305		0.176	0.215	0.261	0.293	0.437	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.62	0.75	0.88	1.04		0.40	0.51	0.62	0.75	0.88	
STEEL %	0.10	0.12	0.14	0.17	0.20		0.07	0.10	0.12	0.14	0.17	
EFF. DEPTH, IN.	15.19	15.19	15.12	15.12	15.06		15.25	15.19	15.19	15.12	15.12	
$+I_{cr}/I_{gr}$	0.189	0.225	0.266	0.307	0.353		0.152	0.189	0.225	0.266	0.307	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth

TOP BARS	Size @	# 4 11	# 4 9.5	# 4 8	# 5 10	# 5 8.5	End Span Defl. Coeff. (3)	# 4 11	# 4 9	# 4 7	# 5 9	# 5 7.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
Steel (psf)		0.71	0.86	1.04	1.25	1.46		0.75	0.93	1.18	1.42	1.71	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
21'-0"		185	246	279*	287*	296*	2.342						
		0	0	317	384*	399*							
22'-0"		159	215	257*	264*	272*	2.820	198	278	303*	307*	314*	1.736
		0	0	280	345	369*		0	0	360	423*	437*	
23'-0"		137	188	237*	243*	251*	3.369	172	246	282*	285*	292*	2.073
		0	0	247	307	342*		0	0	320	386*	398*	
24'-0"		118	165	219	225*	231*	3.995	150	218	263*	266*	271*	2.458
		0	0	0	273	319*		0	0	286	354*	365*	
25'-0"		100	144	193	209*	214*	4.703	130	192	245*	248*	253*	2.894
		0	0	0	244	297*		0	0	255	327*	336*	
26'-0"		85	125	171	194*	199*	5.502	113	170	228	232*	237*	3.386
		0	0	0	218	273		0	0	0	295	310*	
27'-0"		71	108	151	180*	185*	6.398	97	150	204	217*	221*	3.938
		0	0	0	194	246		0	0	0	266	288*	
28'-0"		59	94	133	168*	172*	7.400	83	133	183	204*	208*	4.554
		0	0	0	174	222		0	0	0	241	267*	
29'-0"		48	80	117	155	161*	8.516	70	117	164	191*	195*	5.240
		0	0	0	0	200		0	0	0	217	249*	
30'-0"			68	103	138	150*	9.752	59	102	146	180*	183*	6.001
			0	0	0	180		0	0	0	196	233*	
31'-0"			58	90	123	140*	11.119	49	89	130	169*	173*	6.842
			0	0	0	162		0	0	0	177	218*	
32'-0"			48	78	109	131*	12.625	40	78	116	160*	163*	7.769
			0	0	0	146		0	0	0	0	204*	
33'-0"				67	96	123*	14.278		67	103	144	153*	8.787
				0	0	131			0	0	0	187	
34'-0"				57	85	115*	16.089		57	91	130	145*	9.901
				0	0	117			0	0	0	170	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.76	0.90	1.12	1.31		0.65	0.80	1.03	1.24	1.49	
STEEL % (UNIFORM)	0.59	0.68	0.81	1.01	1.19		0.59	0.72	0.93	1.12	1.35	
(TAPERED)	0.35	0.41	0.48	0.60	0.70		0.35	0.43	0.55	0.67	0.80	
EFF. DEPTH, IN.	15.25	15.25	15.25	15.19	15.19		15.25	15.25	15.25	15.19	15.19	
$-I_{cr}/I_{gr}$	0.165	0.185	0.211	0.246	0.277		0.165	0.193	0.234	0.266	0.303	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.62	0.75	0.88	1.04		0.40	0.51	0.62	0.75	0.88	
STEEL %	0.09	0.11	0.14	0.16	0.19		0.07	0.09	0.11	0.14	0.16	
EFF. DEPTH, IN.	15.19	15.19	15.12	15.12	15.06		15.25	15.19	15.19	15.12	15.12	
$+I_{cr}/I_{gr}$	0.167	0.199	0.235	0.271	0.312		0.134	0.167	0.199	0.235	0.271	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth

TOP BARS	Size @	# 4 11	# 4 9.5	# 4 7.5	# 5 10	# 5 8	End Span Defl. Coeff. (3)	# 4 11	# 4 8.5	# 4 7	# 5 8.5	# 5 7	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
Steel (psf)		0.72	0.88	1.08	1.28	1.52		0.77	0.97	1.20	1.48	1.80	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
25'-0"		131	182	222*	226*	236*	4.572	166	239	262*	267*	274*	2.814
		0	0	240	293*	310*		0	0	312	345*	357*	
26'-0"		114	160	206*	209*	218*	5.349	146	213	245*	249*	256*	3.292
		0	0	214	269	290*		0	0	281	319*	329*	
27'-0"		98	141	191	195*	203*	6.221	127	190	229*	233*	239*	3.828
		0	0	0	241	272*		0	0	253	296*	305*	
28'-0"		83	124	170	181*	189*	7.195	111	169	215*	219*	224*	4.428
		0	0	0	217	255*		0	0	228	275*	283*	
29'-0"		71	108	151	169*	176*	8.279	96	150	202*	205*	210*	5.095
		0	0	0	195	240*		0	0	205	256*	264*	
30'-0"		59	94	135	158*	164*	9.481	83	134	185	193*	198*	5.835
		0	0	0	176	225		0	0	0	240*	246*	
31'-0"		49	82	119	147*	153*	10.810	71	119	166	182*	186*	6.652
		0	0	0	158	204		0	0	0	221	230*	
32'-0"			70	106	138*	143*	12.274	60	105	150	171*	175*	7.553
			0	0	142	185		0	0	0	201	216*	
33'-0"			60	93	127	134*	13.882	51	92	134	161*	165*	8.543
			0	0	0	167		0	0	0	183	203*	
34'-0"			50	82	113	126*	15.642	42	81	121	152*	156*	9.626
			0	0	0	152		0	0	0	166	190*	
35'-0"			41	71	101	118*	17.565		70	108	144*	147*	10.809
			0	0	0	137			0	0	151	179*	
36'-0"				61	90	110*	19.661		61	96	136*	139*	12.099
				0	0	124			0	0	137	169*	
37'-0"				53	80	103*	21.938		52	86	124	131*	13.500
				0	0	112			0	0	0	159*	
38'-0"				44	70	97*	24.407		44	76	112	124*	15.020
				0	0	100			0	0	0	149	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.74	0.93	1.09	1.36		0.64	0.82	1.00	1.28	1.55	
STEEL % (UNIFORM)	0.57	0.66	0.84	0.98	1.23		0.57	0.74	0.90	1.15	1.40	
(TAPERED)	0.32	0.37	0.47	0.55	0.69		0.32	0.42	0.51	0.65	0.79	
EFF. DEPTH, IN.	17.25	17.25	17.25	17.19	17.19		17.25	17.25	17.25	17.19	17.19	
$-I_{cr}/I_{gr}$	0.163	0.183	0.220	0.244	0.287		0.163	0.200	0.231	0.274	0.315	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.62	0.75	0.88	1.04		0.40	0.51	0.62	0.75	0.88	
STEEL %	0.08	0.10	0.13	0.15	0.17		0.07	0.08	0.10	0.13	0.15	
EFF. DEPTH, IN.	17.19	17.19	17.12	17.12	17.06		17.25	17.19	17.19	17.12	17.12	
$+I_{cr}/I_{gr}$	0.172	0.206	0.243	0.281	0.323		0.138	0.172	0.206	0.243	0.281	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth

TOP BARS	Size @	# 4 11	# 4 10	# 4 8	# 5 10	# 5 8.5	End Span Defl. Coeff. (3)	# 4 11	# 4 9	# 4 7	# 5 9	# 5 7.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
Steel (psf)		0.71	0.85	1.04	1.25	1.46		0.75	0.93	1.18	1.42	1.71	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
25'-0"		120	169	226	257*	264*	4.703	154	224	296	302*	308*	2.894
		0	0	0	283	341*		0	0	0	378	396*	
26'-0"		103	148	200	239*	245*	5.502	134	199	265	283*	289*	3.386
		0	0	0	254	317		0	0	0	341	367*	
27'-0"		87	129	178	223*	228*	6.398	116	177	238	266*	271*	3.938
		0	0	0	227	286		0	0	0	309	341*	
28'-0"		73	113	158	203	213*	7.400	100	157	214	250*	254*	4.554
		0	0	0	0	258		0	0	0	279	317*	
29'-0"		61	98	140	182	199*	8.516	86	139	192	235*	239*	5.240
		0	0	0	0	233		0	0	0	253	296*	
30'-0"		50	84	123	163	187*	9.752	73	122	172	221*	225*	6.001
		0	0	0	0	211		0	0	0	229	278*	
31'-0"		40	72	108	146	175*	11.119	62	108	154	208	213*	6.842
		0	0	0	0	190		0	0	0	0	260*	
32'-0"			60	95	130	164*	12.625	51	94	138	188	201*	7.769
			0	0	0	172		0	0	0	0	239	
33'-0"			50	83	116	154*	14.278	42	82	123	170	190*	8.787
			0	0	0	155		0	0	0	0	218	
34'-0"			41	72	103	140	16.089		71	110	154	179*	9.901
			0	0	0	0			0	0	0	199	
35'-0"				61	91	126	18.067		61	97	139	170*	11.118
				0	0	0			0	0	0	182	
36'-0"				52	80	113	20.222		51	86	126	161*	12.445
				0	0	0			0	0	0	166	
37'-0"				43	70	101	22.565		43	75	113	151	13.886
				0	0	0			0	0	0	0	
38'-0"					60	90	25.105			66	101	138	15.449
					0	0				0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.72	0.90	1.12	1.31		0.65	0.80	1.03	1.24	1.49	
STEEL % (UNIFORM)	0.51	0.56	0.70	0.87	1.03		0.51	0.62	0.80	0.97	1.16	
(TAPERED)	0.31	0.34	0.42	0.52	0.61		0.31	0.37	0.48	0.58	0.70	
EFF. DEPTH, IN.	17.25	17.25	17.25	17.19	17.19		17.25	17.25	17.25	17.19	17.19	
$-I_{cr}/I_{gr}$	0.153	0.165	0.197	0.230	0.259		0.153	0.179	0.218	0.249	0.284	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.62	0.75	0.88	1.04		0.40	0.51	0.62	0.75	0.88	
STEEL %	0.08	0.10	0.12	0.14	0.17		0.06	0.08	0.10	0.12	0.14	
EFF. DEPTH, IN.	17.19	17.19	17.12	17.12	17.06		17.25	17.19	17.19	17.12	17.12	
$+I_{cr}/I_{gr}$	0.152	0.182	0.215	0.249	0.287		0.122	0.152	0.182	0.215	0.249	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 5 10	# 5 9	# 5 7.5	End Span Defl. Coeff. (3)	# 4 9	# 4 7	# 5 9	# 5 7.5	# 6 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
	#	# 5	# 6	# 6	# 7	# 7		# 5	# 5	# 6	# 6	# 7	
Steel (psf)		0.85	1.04	1.25	1.44	1.69		0.93	1.18	1.42	1.71	2.01	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
27'-0"		150	205	260	273*	282*	6.398	203		318*		328*	3.938
		0	0	0	326	349*		0		351		404*	
28'-0"		131	182	233	255*	263*	7.400	181	244	299*	304*	308*	4.554
		0	0	0	295	329*		0	0	318	370*	376*	
29'-0"		115	162	210	239*	246*	8.516	161	220	282*	287*	290*	5.240
		0	0	0	267	310*		0	0	288	346*	352*	
30'-0"		99	144	188	224*	231*	9.752	142	198	262	270*	274*	6.001
		0	0	0	242	293*		0	0	0	324*	330*	
31'-0"		86	127	169	210*	217*	11.119	126	178	238	255*	258*	6.842
		0	0	0	219	270		0	0	0	299	310*	
32'-0"		73	112	151	198*	203*	12.625	111	160	216	241*	244*	7.769
		0	0	0	0	246		0	0	0	273	291*	
33'-0"		62	98	135	179	191*	14.278	97	143	196	229*	231*	8.787
		0	0	0	0	224		0	0	0	250	274*	
34'-0"		52	86	121	162	180*	16.089	85	128	178	217*	219*	9.901
		0	0	0	0	205		0	0	0	229	259*	
35'-0"		42	74	107	147	170*	18.067	74	114	161	205*	208*	11.118
		0	0	0	0	186		0	0	0	209	245*	
36'-0"			64	95	132	160*	20.222	63	102	146	191	197*	12.445
			0	0	0	170		0	0	0	0	231*	
37'-0"			54	84	119	151*	22.565	54	90	132	175	187*	13.886
			0	0	0	155		0	0	0	0	219*	
38'-0"			45	73	107	140	25.105	45	79	119	160	178*	15.449
			0	0	0	0		0	0	0	0	208*	
39'-0"				64	95	127	27.853		69	107	146	169*	17.141
				0	0	0			0	0	0	192	
40'-0"				55	85	115	30.822		60	96	133	161*	18.967
				0	0	0			0	0	0	176	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.72	0.90	1.12	1.24	1.49		0.80	1.03	1.24	1.49	1.76	
STEEL % (UNIFORM)	0.49	0.61	0.77	0.85	1.02		0.55	0.70	0.85	1.02	1.21	
(TAPERED)	0.30	0.37	0.46	0.51	0.62		0.33	0.42	0.51	0.62	0.73	
EFF. DEPTH, IN.	19.25	19.25	19.19	19.19	19.19		19.25	19.25	19.19	19.19	19.12	
$-I_{cr}/I_{gr}$	0.154	0.184	0.216	0.234	0.268		0.168	0.204	0.234	0.268	0.300	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	0.75	0.88	1.04	1.20		0.51	0.62	0.75	0.88	1.04	
STEEL %	0.09	0.11	0.13	0.15	0.17		0.07	0.09	0.11	0.13	0.15	
EFF. DEPTH, IN.	19.19	19.12	19.12	19.06	19.06		19.19	19.19	19.12	19.12	19.06	
$+I_{cr}/I_{gr}$	0.168	0.199	0.230	0.265	0.302		0.140	0.168	0.199	0.230	0.265	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 7" Rib @ 37" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8.5	# 4 7	# 5 9	# 5 8	End Span Defl. Coeff. (3)	# 4 9	# 4 7.5	# 5 9.5	# 5 8	# 6 9.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
	#	# 5	# 6	# 6	# 7	# 7		# 5	# 5	# 6	# 6	# 7	
Steel (psf)		0.83	1.00	1.20	1.41	1.63		0.92	1.13	1.36	1.63	1.93	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
27'-0"		138	191	245	303*	308*	6.576	190		333		362*	4.047
		0	0	0	309	374		0		0		442*	
28'-0"		120	169	219	279	289*	7.606	168	230	302	337*	341*	4.681
		0	0	0	0	340		0	0	0	374	413*	
29'-0"		104	150	196	252	271*	8.752	148	206	273	318*	321*	5.386
		0	0	0	0	308		0	0	0	340	387*	
30'-0"		89	132	175	227	254*	10.023	131	185	247	300*	303*	6.168
		0	0	0	0	280		0	0	0	310	363*	
31'-0"		76	116	156	205	239*	11.428	115	165	224	283	287*	7.033
		0	0	0	0	255		0	0	0	0	341*	
32'-0"		63	101	139	185	226*	12.975	100	147	202	258	272*	7.985
		0	0	0	0	232		0	0	0	0	322*	
33'-0"		52	88	124	167	210	14.675	87	131	183	235	258*	9.031
		0	0	0	0	0		0	0	0	0	298	
34'-0"		42	76	109	150	191	16.536	75	117	165	215	244*	10.176
		0	0	0	0	0		0	0	0	0	274	
35'-0"			65	96	135	174	18.569	64	103	149	196	232*	11.427
			0	0	0	0		0	0	0	0	251	
36'-0"			54	84	121	157	20.784	53	91	134	178	221*	12.790
			0	0	0	0		0	0	0	0	231	
37'-0"			45	73	108	143	23.191	44	80	121	162	210*	14.272
			0	0	0	0		0	0	0	0	212	
38'-0"				63	96	129	25.802		69	108	147	195	15.878
				0	0	0			0	0	0	0	
39'-0"				54	85	116	28.627		60	96	134	179	17.617
				0	0	0			0	0	0	0	
40'-0"				45	75	104	31.678		51	86	121	164	19.494
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.74	0.87	1.06	1.27	1.43		0.82	0.99	1.21	1.43	1.71	
STEEL % (UNIFORM)	0.45	0.53	0.64	0.77	0.87		0.50	0.60	0.73	0.87	1.04	
(TAPERED)	0.28	0.33	0.40	0.49	0.55		0.31	0.38	0.46	0.55	0.66	
EFF. DEPTH, IN.	19.25	19.25	19.25	19.19	19.19		19.25	19.25	19.19	19.19	19.12	
$-I_{cr}/I_{gr}$	0.146	0.166	0.194	0.223	0.244		0.159	0.184	0.214	0.244	0.277	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	0.75	0.88	1.04	1.20		0.51	0.62	0.75	0.88	1.04	
STEEL %	0.09	0.11	0.12	0.15	0.17		0.07	0.09	0.11	0.12	0.15	
EFF. DEPTH, IN.	19.19	19.12	19.12	19.06	19.06		19.19	19.19	19.12	19.12	19.06	
$+I_{cr}/I_{gr}$	0.152	0.180	0.208	0.240	0.273		0.127	0.152	0.180	0.208	0.240	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth

TOP BARS	Size @	# 4 8	# 4 7	# 5 9	# 5 7.5	# 6 9	End Span Defl. Coeff. (3)	# 5 11	# 5 9.5	# 5 8	# 6 9.5	# 6 8	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 5	# 6	# 6	# 7	# 7		# 5	# 5	# 6	# 6	# 7	
	#	# 6	# 6	# 7	# 7	# 8		# 5	# 6	# 6	# 7	# 7	
Steel (psf)		1.04	1.23	1.44	1.69	1.96		1.18	1.38	1.66	1.96	2.32	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
32'-0"		146	194	251	284*	290*	12.625						
		0	0	0	309	341*							
33'-0"		129	174	228	268*	274*	14.278	183	248	313*	316*	322*	8.787
		0	0	0	283	324*		0	0	0	358*	366*	
34'-0"		114	156	207	253*	258*	16.089	165	226	287	300*	306*	9.901
		0	0	0	259	306*		0	0	0	339*	346*	
35'-0"		100	140	188	237	244*	18.067	149	206	264	285*	291*	11.118
		0	0	0	0	287*		0	0	0	321*	328*	
36'-0"		88	125	171	217	231*	20.222	133	187	242	272*	276*	12.445
		0	0	0	0	270		0	0	0	305*	311*	
37'-0"		76	112	155	198	218*	22.565	119	170	222	259*	263*	13.886
		0	0	0	0	248		0	0	0	285	295*	
38'-0"		65	99	140	181	207*	25.105	106	155	204	246*	251*	15.449
		0	0	0	0	229		0	0	0	263	281*	
39'-0"		55	87	126	165	196*	27.853	94	140	187	235*	239*	17.141
		0	0	0	0	210		0	0	0	243	267*	
40'-0"		46	77	113	150	186*	30.822	83	127	171	224*	228*	18.967
		0	0	0	0	194		0	0	0	0	254*	
41'-0"			67	102	137	177*	34.022	73	114	157	207	218*	20.936
			0	0	0	178		0	0	0	0	242*	
42'-0"			57	91	124	163	37.464	63	103	143	191	208*	23.055
			0	0	0	0		0	0	0	0	231*	
43'-0"			49	80	113	150	41.162	54	92	130	177	199*	25.330
			0	0	0	0		0	0	0	0	220*	
44'-0"			41	71	102	137	45.127	46	82	119	163	190*	27.770
			0	0	0	0		0	0	0	0	207	
45'-0"				62	91	125	49.371		73	108	150	182*	30.382
				0	0	0			0	0	0	193	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.73 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.90	1.03	1.24	1.49	1.76		1.01	1.17	1.39	1.67	1.98	
STEEL % (UNIFORM)	0.49	0.56	0.67	0.81	0.96		0.55	0.64	0.76	0.91	1.08	
(TAPERED)	0.30	0.34	0.41	0.50	0.59		0.34	0.39	0.47	0.56	0.66	
EFF. DEPTH, IN.	23.25	23.25	23.19	23.19	23.12		23.19	23.19	23.19	23.12	23.12	
$-I_{cr}/I_{gr}$	0.164	0.182	0.210	0.241	0.272		0.179	0.201	0.230	0.261	0.296	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.75	0.88	1.04	1.20	1.39		0.62	0.75	0.88	1.04	1.20	
STEEL %	0.09	0.11	0.13	0.14	0.17		0.07	0.09	0.11	0.13	0.14	
EFF. DEPTH, IN.	23.12	23.12	23.06	23.06	23.00		23.19	23.12	23.12	23.06	23.06	
$+I_{cr}/I_{gr}$	0.173	0.200	0.232	0.264	0.299		0.146	0.173	0.200	0.232	0.264	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 7" Rib @ 37" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth

TOP BARS	Size @	# 4 8	# 4 7	# 5 9.5	# 5 8	# 5 7	End Span Defl. Coeff. (3)	# 5 11	# 5 9.5	# 5 8	# 5 7	# 5 6	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 5	# 6	# 6	# 7	# 7		# 5	# 5	# 6	# 6	# 7	
	#	# 6	# 6	# 7	# 7	# 8		# 5	# 6	# 6	# 7	# 7	
Steel (psf)		1.02	1.20	1.40	1.63	1.87		1.16	1.36	1.63	1.88	2.20	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
32'-0"		131	178	233	290	315*	12.975						
		0	0	0	0	355							
33'-0"		115	159	211	264	297*	14.675	168	231	294	349*	354*	9.031
		0	0	0	0	326		0	0	0	370	401*	
34'-0"		100	142	191	241	281*	16.536	150	209	269	332*	337*	10.176
		0	0	0	0	299		0	0	0	341	379*	
35'-0"		87	126	172	220	266*	18.569	134	190	246	314	320*	11.427
		0	0	0	0	274		0	0	0	0	360*	
36'-0"		75	111	155	200	252	20.784	119	172	225	289	305*	12.790
		0	0	0	0	0		0	0	0	0	342*	
37'-0"		63	98	140	182	231	23.191	105	155	205	266	291*	14.272
		0	0	0	0	0		0	0	0	0	325*	
38'-0"		53	86	125	165	212	25.802	93	140	188	245	277*	15.878
		0	0	0	0	0		0	0	0	0	303	
39'-0"		43	74	112	150	194	28.627	81	126	171	226	265*	17.617
		0	0	0	0	0		0	0	0	0	281	
40'-0"			64	100	136	178	31.678	70	113	156	208	253*	19.494
			0	0	0	0		0	0	0	0	260	
41'-0"			54	88	123	162	34.967	60	101	142	191	241	21.518
			0	0	0	0		0	0	0	0	0	
42'-0"			45	77	110	148	38.505	51	89	128	176	223	23.695
			0	0	0	0		0	0	0	0	0	
43'-0"				68	99	135	42.305	42	79	116	161	207	26.034
				0	0	0		0	0	0	0	0	
44'-0"				58	88	123	46.380		69	105	148	191	28.542
				0	0	0			0	0	0	0	
45'-0"				50	78	111	50.742		60	94	135	177	31.226
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.06	1.21	1.43	1.64		1.04	1.21	1.43	1.64	1.91	
STEEL % (UNIFORM)	0.45	0.51	0.58	0.69	0.79		0.50	0.58	0.69	0.79	0.92	
(TAPERED)	0.29	0.33	0.37	0.44	0.51		0.32	0.37	0.44	0.51	0.59	
EFF. DEPTH, IN.	23.25	23.25	23.19	23.19	23.19		23.19	23.19	23.19	23.19	23.19	
$-I_{cr}/I_{gr}$	0.156	0.173	0.192	0.219	0.243		0.170	0.192	0.219	0.243	0.273	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.75	0.88	1.04	1.20	1.39		0.62	0.75	0.88	1.04	1.20	
STEEL %	0.09	0.10	0.12	0.14	0.16		0.07	0.09	0.10	0.12	0.14	
EFF. DEPTH, IN.	23.12	23.12	23.06	23.06	23.00		23.19	23.12	23.12	23.06	23.06	
$+I_{cr}/I_{gr}$	0.157	0.181	0.210	0.239	0.272		0.132	0.157	0.181	0.210	0.239	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 5.0″ Top Slab = 13.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 11	# 4 9	# 4 7.5	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 11	# 4 8	# 5 10	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 3	# 4	# 4	# 5	# 5		# 3	# 3	# 4	# 4	# 5	
	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
Steel (psf)		0.51	0.61	0.72	0.89	1.08		0.59	0.67	0.77	1.00	1.25	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
14'-0"		218	303*	303*	316*	331*	0.450						
		0	308	415	478*	493*							
15'-0"		178	256	266*	277*	290*	0.593						
		0	0	349	420*	434*							
16'-0"		145	214	236*	246*	256*	0.767						
		0	0	296	372*	385*							
17'-0"		117	178	211*	219*	228*	0.978	126	214	246*	255*	260*	0.602
		0	0	251	325	344*		0	0	303	408	437*	
18'-0"		94	149	190*	196*	204*	1.229	102	180	223*	231*	236*	0.756
		0	0	213	279	310*		0	0	260	354	394*	
19'-0"		75	124	171*	177*	183*	1.525	82	152	203*	210*	214*	0.939
		0	0	182	241	281*		0	0	223	308	352*	
20'-0"		58	102	155*	160*	165*	1.873	64	128	186*	192*	195*	1.153
		0	0	0	208	255*		0	0	192	269	313*	
21'-0"		44	84	132	145*	150*	2.276	49	107	166	176*	178*	1.401
		0	0	0	180	235		0	0	0	235	278*	
22'-0"			68	111	131*	136*	2.742		89	142	161*	164*	1.687
			0	0	155	205			0	0	205	250*	
23'-0"			54	94	119*	123*	3.276		74	122	148*	150*	2.016
			0	0	134	180			0	0	180	225*	
24'-0"			42	78	109*	112*	3.884		60	104	136*	138*	2.390
			0	0	115	157			0	0	157	204*	
25'-0"				65	99	102*	4.572		48	89	125*	127*	2.814
				0	0	138			0	0	138	186*	
26'-0"				53	84	93*	5.349			75	116*	117*	3.292
				0	0	120				0	120	166	
27'-0"				42	71	85*	6.221			62	104	108*	3.828
				0	0	104				0	0	147	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.64	0.78	0.93		0.64	0.64	0.64	0.88	1.09	
STEEL % (UNIFORM)	0.91	0.91	0.91	1.11	1.33		0.91	0.91	0.91	1.25	1.55	
(TAPERED)	0.49	0.49	0.49	0.60	0.72		0.49	0.49	0.49	0.68	0.85	
EFF. DEPTH, IN.	11.75	11.75	11.75	11.75	11.75		11.75	11.75	11.75	11.75	11.69	
$-I_{cr}/I_{gr}$	0.202	0.202	0.202	0.234	0.267		0.202	0.202	0.202	0.255	0.293	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.08	0.10	0.12	0.15	0.18		0.05	0.08	0.10	0.12	0.15	
EFF. DEPTH, IN.	11.75	11.75	11.69	11.69	11.62		11.81	11.75	11.75	11.69	11.69	
$+I_{cr}/I_{gr}$	0.143	0.182	0.224	0.268	0.314		0.105	0.143	0.182	0.224	0.268	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

8″ Deep Rib + 5.0″ Top Slab = 13.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 11	# 4 9.5	# 4 7.5	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 11	# 4 8.5	# 4 7	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 3	# 4	# 4	# 5	# 5		# 3	# 3	# 4	# 4	# 5	
	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
Steel (psf)		0.50	0.60	0.71	0.86	1.05		0.58	0.66	0.75	0.95	1.18	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
14'-0"		207	295	346*	355*	374*	0.463						
		0	0	399	504	551*							
15'-0"		168	244	306*	314*	329*	0.610						
		0	0	335	427	486*							
16'-0"		136	203	273*	280*	293*	0.789						
		0	0	282	363	431*							
17'-0"		109	168	239	251*	262*	1.006	117	203	287*	294*	300*	0.619
		0	0	0	311	387*		0	0	289	392	474*	
18'-0"		87	140	203	226*	236*	1.264	94	170	248	267*	273*	0.778
		0	0	0	267	339		0	0	0	339	432	
19'-0"		68	115	172	205*	213*	1.569	74	143	212	244*	249*	0.966
		0	0	0	229	295		0	0	0	294	378	
20'-0"		52	95	146	186*	194*	1.926	58	119	182	224*	228*	1.185
		0	0	0	197	256		0	0	0	256	331	
21'-0"			77	123	170	176*	2.342	43	99	156	206*	210*	1.441
			0	0	0	223		0	0	0	223	292	
22'-0"			61	103	146	161*	2.820		82	133	190*	193*	1.736
			0	0	0	195			0	0	195	257	
23'-0"			48	86	125	147*	3.369		66	114	170	178*	2.073
			0	0	0	170			0	0	0	227	
24'-0"				71	107	135*	3.995		53	96	148	165*	2.458
				0	0	148			0	0	0	200	
25'-0"				58	91	124*	4.703		41	81	129	153*	2.894
				0	0	129			0	0	0	177	
26'-0"				46	77	112	5.502			68	112	142*	3.386
				0	0	0				0	0	156	
27'-0"					64	97	6.398			56	96	132*	3.938
					0	0				0	0	138	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.65	0.76	0.96		0.65	0.65	0.65	0.85	1.03	
STEEL % (UNIFORM)	0.80	0.80	0.80	0.92	1.17		0.80	0.80	0.80	1.03	1.25	
(TAPERED)	0.47	0.47	0.47	0.54	0.68		0.47	0.47	0.47	0.60	0.73	
EFF. DEPTH, IN.	11.75	11.75	11.75	11.75	11.75		11.75	11.75	11.75	11.75	11.75	
$-I_{cr}/I_{gr}$	0.190	0.190	0.190	0.212	0.253		0.190	0.190	0.190	0.231	0.266	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.07	0.09	0.12	0.15	0.18		0.05	0.07	0.09	0.12	0.15	
EFF. DEPTH, IN.	11.75	11.75	11.69	11.69	11.62		11.81	11.75	11.75	11.69	11.69	
$+I_{cr}/I_{gr}$	0.127	0.161	0.198	0.237	0.278		0.093	0.127	0.161	0.198	0.237	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 5.0″ Top Slab = 15.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 11	# 4 9	# 4 7.5	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 11	# 4 8.5	# 5 10	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6		# 3 # 3	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	
Steel (psf)		0.51	0.61	0.72	0.89	1.08		0.59	0.67	0.77	0.97	1.25	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
17'-0"		149	221	279*	289*	301*	0.978						
		0	0	306	393	413*							
18'-0"		122	186	251*	260*	270*	1.229						
		0	0	262	339	373*							
19'-0"		99	157	225	235*	243*	1.525						
		0	0	0	294	339*							
20'-0"		80	132	193	213*	221*	1.873	87	161	237	250*	257*	1.153
		0	0	0	256	309*		0	0	0	327	389*	
21'-0"		63	110	166	194*	201*	2.276	69	137	206	230*	236*	1.401
		0	0	0	223	288		0	0	0	287	348*	
22'-0"		49	91	142	178*	183*	2.742	54	116	178	212*	217*	1.687
		0	0	0	194	253		0	0	0	253	313*	
23'-0"			75	122	163*	168*	3.276	41	98	155	196*	200*	2.016
			0	0	169	223		0	0	0	223	284*	
24'-0"			61	104	147	154*	3.884		82	134	182*	185*	2.390
			0	0	0	197			0	0	196	259*	
25'-0"			48	88	128	141*	4.572		67	116	168*	172*	2.814
			0	0	0	174			0	0	173	231	
26'-0"				74	111	130*	5.349		55	99	152	159*	3.292
				0	0	153			0	0	0	206	
27'-0"				61	95	120*	6.221		43	85	134	148*	3.828
				0	0	134			0	0	0	184	
28'-0"				50	82	110*	7.195			72	118	138*	4.428
				0	0	118				0	0	164	
29'-0"					69	102*	8.279			60	103	128*	5.095
					0	103				0	0	146	
30'-0"					58	90	9.481			50	90	119*	5.835
					0	0				0	0	130	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.64	0.78	0.93		0.64	0.64	0.64	0.82	1.09	
STEEL % (UNIFORM)	0.75	0.75	0.75	0.92	1.10		0.75	0.75	0.75	0.97	1.29	
(TAPERED)	0.42	0.42	0.42	0.51	0.61		0.42	0.42	0.42	0.54	0.71	
EFF. DEPTH, IN.	13.75	13.75	13.75	13.75	13.75		13.75	13.75	13.75	13.75	13.69	
$-I_{cr}/I_{gr}$	0.187	0.187	0.187	0.218	0.249		0.187	0.187	0.187	0.227	0.275	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.31	0.40	0.51	0.62	0.75		0.22	0.31	0.40	0.51	0.62	
STEEL %	0.06	0.08	0.11	0.13	0.16		0.05	0.06	0.08	0.11	0.13	
EFF. DEPTH, IN.	13.75	13.75	13.69	13.69	13.62		13.81	13.75	13.75	13.69	13.69	
$+I_{cr}/I_{gr}$	0.129	0.164	0.203	0.243	0.285		0.095	0.129	0.164	0.203	0.243	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

10″ Deep Rib + 5.0″ Top Slab = 15.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 8	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 9	# 4 7	# 5 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6		# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	
Steel (psf)		0.60	0.71	0.86	1.04	1.25		0.66	0.75	0.93	1.18	1.42	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
17'-0"		208	291	326*	336*	349*	1.006						
		0	0	375	462*	475*							
18'-0"		174	249	295*	303*	314*	1.264						
		0	0	324	410	430*							
19'-0"		146	212	268*	275*	284*	1.569						
		0	0	280	357	391*							
20'-0"		122	182	242	250*	258*	1.926	151	224	288*	295*	299*	1.185
		0	0	0	312	358*		0	0	311	400	444*	
21'-0"		101	155	210	229*	236*	2.342	127	193	265*	272*	275*	1.441
		0	0	0	273	337*		0	0	273	353	401*	
22'-0"		82	132	182	210*	216*	2.820	106	167	239	251*	254*	1.736
		0	0	0	240	299		0	0	0	312	363*	
23'-0"		67	112	158	193*	198*	3.369	89	144	210	233*	235*	2.073
		0	0	0	211	264		0	0	0	277	330*	
24'-0"		53	94	137	178*	183*	3.995	73	124	185	216*	218*	2.458
		0	0	0	185	234		0	0	0	246	302*	
25'-0"		40	79	118	162	168*	4.703	59	106	162	201*	203*	2.894
		0	0	0	0	208		0	0	0	219	277*	
26'-0"			65	101	142	156*	5.502	47	90	142	187*	189*	3.386
			0	0	0	184		0	0	0	194	254	
27'-0"			53	86	124	144*	6.398		76	124	173	176*	3.938
			0	0	0	163			0	0	0	228	
28'-0"			42	73	108	134*	7.400		63	108	153	165*	4.554
			0	0	0	145			0	0	0	205	
29'-0"				61	94	124*	8.516		52	94	136	154*	5.240
				0	0	128			0	0	0	184	
30'-0"				50	81	113	9.752		42	81	120	144*	6.001
				0	0	0			0	0	0	165	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.76	0.90	1.12		0.65	0.65	0.80	1.03	1.24	
STEEL % (UNIFORM)	0.67	0.67	0.77	0.92	1.14		0.67	0.67	0.81	1.05	1.27	
(TAPERED)	0.39	0.39	0.45	0.54	0.67		0.39	0.39	0.48	0.62	0.75	
EFF. DEPTH, IN.	13.75	13.75	13.75	13.75	13.69		13.75	13.75	13.75	13.75	13.69	
$-I_{cr}/I_{gr}$	0.175	0.175	0.196	0.224	0.260		0.175	0.175	0.205	0.247	0.280	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.08	0.10	0.13	0.15	0.18		0.06	0.08	0.10	0.13	0.15	
EFF. DEPTH, IN.	13.75	13.69	13.69	13.62	13.62		13.75	13.75	13.69	13.69	13.62	
$+I_{cr}/I_{gr}$	0.145	0.179	0.214	0.252	0.291		0.114	0.145	0.179	0.214	0.252	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 5.0″ Top Slab = 17.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 7.5	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 8.5	# 4 7	# 5 8.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.61	0.72	0.88	1.08	1.28		0.67	0.77	0.97	1.20	1.48	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		188	267	296*	309*	317*	1.525						
		0	0	347	399*	410*							
20'-0"		159	231	269*	281*	287*	1.873						
		0	0	302	364*	375*							
21'-0"		135	199	246*	256*	262*	2.276						
		0	0	264	339*	349*							
22'-0"		113	172	225*	234*	239*	2.742	142		268*		280*	1.687
		0	0	232	300	322*		0		299		390*	
23'-0"		95	148	203	215*	219*	3.276	121	186	248*	253*	259*	2.016
		0	0	0	265	298*		0	0	264	343*	355*	
24'-0"		78	128	178	198*	202*	3.884	102	162	230*	235*	240*	2.390
		0	0	0	235	276*		0	0	234	307	324*	
25'-0"		64	109	155	183*	186*	4.572	86	141	207	218*	223*	2.814
		0	0	0	208	257*		0	0	0	274	297*	
26'-0"		51	93	136	169*	172*	5.349	71	122	184	204*	208*	3.292
		0	0	0	185	234		0	0	0	246	274*	
27'-0"		40	79	118	156*	159*	6.221	58	106	163	190*	194*	3.828
		0	0	0	163	209		0	0	0	220	253*	
28'-0"			66	102	145	147*	7.195	47	91	144	178*	181*	4.428
			0	0	0	187		0	0	0	197	235*	
29'-0"			54	88	128	137*	8.279		78	127	166*	169*	5.095
			0	0	0	167			0	0	177	218*	
30'-0"			44	75	112	127*	9.481		66	112	156*	158*	5.835
			0	0	0	150			0	0	158	203*	
31'-0"				64	98	118*	10.810		55	98	141	148*	6.652
				0	0	133			0	0	0	189*	
32'-0"				53	86	109*	12.274		45	85	126	139*	7.553
				0	0	119			0	0	0	173	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.74	0.93	1.09		0.64	0.64	0.82	1.00	1.28	
STEEL % (UNIFORM)	0.64	0.64	0.74	0.94	1.10		0.64	0.64	0.83	1.01	1.29	
(TAPERED)	0.36	0.36	0.41	0.52	0.61		0.36	0.36	0.46	0.56	0.72	
EFF. DEPTH, IN.	15.75	15.75	15.75	15.75	15.69		15.75	15.75	15.75	15.75	15.69	
$-I_{cr}/I_{gr}$	0.173	0.173	0.193	0.231	0.256		0.173	0.173	0.211	0.244	0.288	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.07	0.09	0.11	0.14	0.16		0.06	0.07	0.09	0.11	0.14	
EFF. DEPTH, IN.	15.75	15.69	15.69	15.62	15.62		15.75	15.75	15.69	15.69	15.62	
$+I_{cr}/I_{gr}$	0.148	0.184	0.220	0.260	0.300		0.117	0.148	0.184	0.220	0.260	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

12″ Deep Rib + 5.0″ Top Slab = 17.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 8	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 9	# 4 7	# 5 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.60	0.71	0.86	1.04	1.25		0.66	0.75	0.93	1.18	1.42	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
19'-0"		175	252	329	345*	356*	1.569						
		0	0	0	418	456*							
20'-0"		147	216	286	314*	324*	1.926						
		0	0	0	367	418*							
21'-0"		123	186	249	288*	296*	2.342						
		0	0	0	322	391*							
22'-0"		103	160	217	264*	272*	2.820	130		283		316*	1.736
		0	0	0	284	351		0		0		435*	
23'-0"		84	137	190	244*	250*	3.369	110	173	249	290*	294*	2.073
		0	0	0	250	312		0	0	0	326	396*	
24'-0"		68	116	165	221	231*	3.995	92	150	220	270*	273*	2.458
		0	0	0	0	278		0	0	0	290	363*	
25'-0"		54	99	143	195	214*	4.703	76	130	194	252*	255*	2.894
		0	0	0	0	247		0	0	0	259	334	
26'-0"		42	83	124	172	198*	5.502	62	111	171	231	238*	3.386
		0	0	0	0	220		0	0	0	0	300	
27'-0"			69	107	151	184*	6.398	49	95	150	206	222*	3.938
			0	0	0	196		0	0	0	0	270	
28'-0"			56	92	133	171*	7.400		81	132	184	208*	4.554
			0	0	0	174			0	0	0	244	
29'-0"			45	78	116	155	8.516		68	116	164	195*	5.240
			0	0	0	0			0	0	0	220	
30'-0"				66	101	138	9.752		56	101	146	183*	6.001
				0	0	0			0	0	0	198	
31'-0"				54	88	122	11.119		45	87	130	172*	6.842
				0	0	0			0	0	0	178	
32'-0"				44	76	108	12.625			75	115	161	7.769
				0	0	0				0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.76	0.90	1.12		0.65	0.65	0.80	1.03	1.24	
STEEL % (UNIFORM)	0.57	0.57	0.66	0.78	0.97		0.57	0.57	0.69	0.89	1.08	
(TAPERED)	0.34	0.34	0.39	0.46	0.58		0.34	0.34	0.41	0.53	0.64	
EFF. DEPTH, IN.	15.75	15.75	15.75	15.75	15.69		15.75	15.75	15.75	15.75	15.69	
$-I_{cr}/I_{gr}$	0.162	0.162	0.181	0.207	0.242		0.162	0.162	0.189	0.229	0.261	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.07	0.09	0.11	0.13	0.16		0.05	0.07	0.09	0.11	0.13	
EFF. DEPTH, IN.	15.75	15.69	15.69	15.62	15.62		15.75	15.75	15.69	15.69	15.62	
$+I_{cr}/I_{gr}$	0.131	0.163	0.195	0.230	0.265		0.103	0.131	0.163	0.195	0.230	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

14″ Deep Rib + 5.0″ Top Slab = 19.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 9.5	# 4 7.5	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 8.5	# 4 7	# 5 8.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.61	0.72	0.88	1.08	1.28		0.67	0.77	0.97	1.20	1.48	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
22'-0"		135	202	269	290*	297*	2.742						
		0	0	0	346	371*							
23'-0"		114	175	237	267*	272*	3.276						
		0	0	0	307	344*							
24'-0"		96	152	208	246*	251*	3.884						
		0	0	0	273	319*							
25'-0"		80	131	183	228*	232*	4.572	104		242		275*	2.814
		0	0	0	243	298*		0		0		353*	
26'-0"		65	113	161	211*	215*	5.349	88	146	215	251*	256*	3.292
		0	0	0	216	272		0	0	0	285	326*	
27'-0"		52	96	141	192	199*	6.221	73	127	191	235*	240*	3.828
		0	0	0	0	244		0	0	0	256	303*	
28'-0"		41	82	123	171	185*	7.195	60	110	170	220*	224*	4.428
		0	0	0	0	219		0	0	0	230	281*	
29'-0"			69	107	152	173*	8.279	49	95	151	207*	210*	5.095
			0	0	0	197		0	0	0	0	262*	
30'-0"			57	93	134	161*	9.481		82	134	186	198*	5.835
			0	0	0	177			0	0	0	244*	
31'-0"			46	80	119	150*	10.810		69	118	167	186*	6.652
			0	0	0	158			0	0	0	224	
32'-0"				68	105	140*	12.274		58	104	150	175*	7.553
				0	0	142			0	0	0	203	
33'-0"				57	92	127	13.882		48	91	134	164*	8.543
				0	0	0			0	0	0	184	
34'-0"				47	80	113	15.642			79	120	155*	9.626
				0	0	0				0	0	167	
35'-0"					69	100	17.565			68	107	146*	10.809
					0	0				0	0	151	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.64	0.64	0.74	0.93	1.09		0.64	0.64	0.82	1.00	1.28	
STEEL % (UNIFORM)	0.55	0.55	0.64	0.81	0.95		0.55	0.55	0.72	0.87	1.11	
(TAPERED)	0.31	0.31	0.36	0.46	0.53		0.31	0.31	0.40	0.49	0.63	
EFF. DEPTH, IN.	17.75	17.75	17.75	17.75	17.69		17.75	17.75	17.75	17.75	17.69	
$-I_{cr}/I_{gr}$	0.160	0.160	0.180	0.216	0.239		0.160	0.160	0.196	0.227	0.270	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.06	0.08	0.10	0.12	0.14		0.05	0.06	0.08	0.10	0.12	
EFF. DEPTH, IN.	17.75	17.69	17.69	17.62	17.62		17.75	17.75	17.69	17.69	17.62	
$+I_{cr}/I_{gr}$	0.135	0.168	0.201	0.237	0.274		0.106	0.135	0.168	0.201	0.237	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

14″ Deep Rib + 5.0″ Top Slab = 19.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 11	# 4 10	# 4 8	# 5 10	End Span Defl. Coeff. (3)	# 4 11	# 4 11	# 4 9	# 4 7	# 5 9	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 4	# 5	# 5	# 6		# 3	# 4	# 4	# 5	# 5	
	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
Steel (psf)		0.60	0.71	0.85	1.04	1.25		0.66	0.75	0.93	1.18	1.42	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
22'-0"		124	188	254	325*	334*	2.820						
		0	0	0	329	405							
23'-0"		103	162	222	291	308*	3.369						
		0	0	0	0	361							
24'-0"		85	140	195	258	285*	3.995						
		0	0	0	0	322							
25'-0"		70	120	170	228	264*	4.703	93		227		311*	2.894
		0	0	0	0	288		0		0		385	
26'-0"		55	102	148	202	245*	5.502	78	134	201	269	291*	3.386
		0	0	0	0	257		0	0	0	0	348	
27'-0"		43	86	129	179	228*	6.398	63	116	178	241	273*	3.938
		0	0	0	0	230		0	0	0	0	314	
28'-0"			72	112	158	206	7.400	51	99	157	216	256*	4.554
			0	0	0	0		0	0	0	0	284	
29'-0"			59	96	140	184	8.516		85	139	193	241*	5.240
			0	0	0	0			0	0	0	256	
30'-0"			47	82	123	164	9.752		71	122	173	227*	6.001
			0	0	0	0			0	0	0	232	
31'-0"				70	108	146	11.119		59	107	155	210	6.842
				0	0	0			0	0	0	0	
32'-0"				58	94	130	12.625		49	93	138	190	7.769
				0	0	0			0	0	0	0	
33'-0"				48	81	115	14.278			80	123	171	8.787
				0	0	0				0	0	0	
34'-0"					70	102	16.089			69	109	155	9.901
					0	0				0	0	0	
35'-0"					59	89	18.067			59	96	139	11.118
					0	0				0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.65	0.72	0.90	1.12		0.65	0.65	0.80	1.03	1.24	
STEEL % (UNIFORM)	0.49	0.49	0.54	0.68	0.84		0.49	0.49	0.60	0.77	0.94	
(TAPERED)	0.30	0.30	0.33	0.41	0.51		0.30	0.30	0.36	0.46	0.56	
EFF. DEPTH, IN.	17.75	17.75	17.75	17.75	17.69		17.75	17.75	17.75	17.75	17.69	
$-I_{cr}/I_{gr}$	0.150	0.150	0.162	0.193	0.226		0.150	0.150	0.176	0.214	0.244	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.40	0.51	0.62	0.75	0.88		0.31	0.40	0.51	0.62	0.75	
STEEL %	0.06	0.08	0.10	0.12	0.14		0.05	0.06	0.08	0.10	0.12	
EFF. DEPTH, IN.	17.75	17.69	17.69	17.62	17.62		17.75	17.75	17.69	17.69	17.62	
$+I_{cr}/I_{gr}$	0.119	0.149	0.178	0.210	0.243		0.094	0.119	0.149	0.178	0.210	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

16″ Deep Rib + 5.0″ Top Slab = 21.0″ Total Depth

TOP BARS	Size @	# 4 11	# 4 10	# 4 8	# 4 7	# 5 9	End Span Defl. Coeff. (3)	# 4 11	# 4 9	# 4 7.5	# 5 9	# 5 7.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 4	# 5	# 5	# 6	# 6		# 4	# 4	# 5	# 5	# 6	
	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
Steel (psf)		0.71	0.85	1.04	1.23	1.44		0.75	0.93	1.14	1.42	1.71	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
25'-0"		139	196	261	315*	323*	4.703						
		0	0	0	327	388*							
26'-0"		119	172	232	293	300*	5.502						
		0	0	0	0	363*							
27'-0"		102	150	206	262	280*	6.398						
		0	0	0	0	330							
28'-0"		86	131	183	235	261*	7.400		181	247	306*	312*	4.554
		0	0	0	0	298			0	0	322	377*	
29'-0"		72	114	162	211	244*	8.516	100	161	222	288*	294*	5.240
		0	0	0	0	270		0	0	0	292	353*	
30'-0"		59	98	143	189	229*	9.752	86	142	199	265	277*	6.001
		0	0	0	0	244		0	0	0	0	331*	
31'-0"		47	84	126	169	215*	11.119	72	125	178	240	261*	6.842
		0	0	0	0	221		0	0	0	0	302	
32'-0"			71	111	151	199	12.625	60	110	160	218	247*	7.769
			0	0	0	0		0	0	0	0	276	
33'-0"			59	97	135	180	14.278	49	96	143	197	233*	8.787
			0	0	0	0		0	0	0	0	252	
34'-0"			49	84	120	163	16.089		83	127	179	221*	9.901
			0	0	0	0			0	0	0	231	
35'-0"				72	106	146	18.067		71	113	162	209*	11.118
				0	0	0			0	0	0	211	
36'-0"				62	93	132	20.222		61	100	146	192	12.445
				0	0	0			0	0	0	0	
37'-0"				52	82	118	22.565		51	88	132	175	13.886
				0	0	0			0	0	0	0	
38'-0"				43	71	105	25.105		42	77	118	160	15.449
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.65	0.72	0.90	1.03	1.24		0.65	0.80	0.96	1.24	1.49	
STEEL % (UNIFORM)	0.43	0.48	0.60	0.68	0.82		0.43	0.53	0.64	0.82	0.99	
(TAPERED)	0.26	0.29	0.36	0.41	0.50		0.26	0.32	0.38	0.50	0.60	
EFF. DEPTH, IN.	19.75	19.75	19.75	19.75	19.69		19.75	19.75	19.75	19.69	19.69	
$-I_{cr}/I_{gr}$	0.140	0.151	0.180	0.200	0.230		0.140	0.164	0.190	0.230	0.263	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.62	0.75	0.88	1.04		0.40	0.51	0.62	0.75	0.88	
STEEL %	0.07	0.09	0.11	0.12	0.15		0.06	0.07	0.09	0.11	0.12	
EFF. DEPTH, IN.	19.69	19.69	19.62	19.62	19.56		19.75	19.69	19.69	19.62	19.62	
$+I_{cr}/I_{gr}$	0.137	0.164	0.194	0.225	0.260		0.110	0.137	0.164	0.194	0.225	

STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS	30" Forms + 7" Rib @ 37" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

16″ Deep Rib + 5.0″ Top Slab = 21.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8.5	# 4 7	# 5 9	# 5 8	End Span Defl. Coeff. (3)	# 4 9	# 4 7.5	# 5 9.5	# 5 8	# 6 9.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	#	# 5	# 5	# 6	# 6	# 7		# 4	# 5	# 5	# 6	# 6	
	#	# 5	# 6	# 6	# 7	# 7		# 5	# 5	# 6	# 6	# 7	
Steel (psf)		0.83	1.00	1.20	1.41	1.63		0.92	1.13	1.36	1.63	1.93	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
25'-0"		181	245	309	356*	363*	4.834						
		0	0	0	386	435*							
26'-0"		158	216	276	332*	338*	5.655						
		0	0	0	347	408*							
27'-0"		137	191	246	310*	315*	6.576						
		0	0	0	312	379							
28'-0"		118	169	220	281	295*	7.606	167	231	304	344*	348*	4.681
		0	0	0	0	344		0	0	0	379	421*	
29'-0"		101	148	196	253	276*	8.752	147	206	275	324*	328*	5.386
		0	0	0	0	311		0	0	0	344	394*	
30'-0"		86	130	175	228	259*	10.023	129	184	248	306*	310*	6.168
		0	0	0	0	283		0	0	0	313	369*	
31'-0"		72	114	155	205	243*	11.428	112	164	224	285	293*	7.033
		0	0	0	0	256		0	0	0	0	347*	
32'-0"		60	99	138	185	229*	12.975	97	146	202	260	277*	7.985
		0	0	0	0	233		0	0	0	0	327*	
33'-0"		48	85	122	166	211	14.675	84	130	183	236	262*	9.031
		0	0	0	0	0		0	0	0	0	301	
34'-0"			72	107	149	191	16.536	71	115	165	215	248*	10.176
			0	0	0	0		0	0	0	0	276	
35'-0"			61	94	133	173	18.569	60	101	148	196	236*	11.427
			0	0	0	0		0	0	0	0	253	
36'-0"			51	82	119	156	20.784	50	88	133	178	224*	12.790
			0	0	0	0		0	0	0	0	232	
37'-0"			41	70	105	141	23.191	40	77	119	161	213	14.272
			0	0	0	0		0	0	0	0	0	
38'-0"				60	93	127	25.802		66	106	146	195	15.878
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF) [4]

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.74	0.87	1.06	1.27	1.43		0.82	0.99	1.21	1.43	1.71	
STEEL % (UNIFORM)	0.43	0.51	0.62	0.75	0.84		0.48	0.58	0.71	0.84	1.01	
(TAPERED)	0.27	0.32	0.39	0.47	0.53		0.31	0.37	0.45	0.53	0.64	
EFF. DEPTH, IN.	19.75	19.75	19.75	19.69	19.69		19.75	19.75	19.69	19.69	19.62	
$-I_{cr}/I_{gr}$	0.143	0.163	0.190	0.219	0.239		0.156	0.180	0.210	0.239	0.272	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	0.75	0.88	1.04	1.20		0.51	0.62	0.75	0.88	1.04	
STEEL %	0.09	0.10	0.12	0.14	0.17		0.07	0.09	0.10	0.12	0.14	
EFF. DEPTH, IN.	19.69	19.62	19.62	19.56	19.56		19.69	19.69	19.62	19.62	19.56	
$+I_{cr}/I_{gr}$	0.148	0.175	0.203	0.235	0.267		0.124	0.148	0.175	0.203	0.235	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

20″ Deep Rib + 5.0″ Top Slab = 25.0″ Total Depth

TOP BARS	Size @	# 4 10	# 4 8	# 4 7	# 5 9	# 5 7.5	End Span Defl. Coeff. (3)	# 4 9	# 4 7.5	# 5 9.5	# 5 8	# 6 9.5	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7		# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	
Steel (psf)		0.85	1.04	1.23	1.44	1.69		0.93	1.14	1.38	1.66	1.96	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
30'-0"		128	183	238	305	326*	9.752						
		0	0	0	0	370*							
31'-0"		111	162	214	276	306*	11.119						
		0	0	0	0	340							
32'-0"		95	144	192	251	288*	12.625						
		0	0	0	0	310							
33'-0"		81	127	172	228	271*	14.278	125		248		321*	8.787
		0	0	0	0	283		0		0		363*	
34'-0"		69	111	154	206	256*	16.089	110	163	225	288	305*	9.901
		0	0	0	0	259		0	0	0	0	343*	
35'-0"		57	97	138	187	236	18.067	96	146	205	264	289*	11.118
		0	0	0	0	0		0	0	0	0	325*	
36'-0"		46	84	123	169	216	20.222	83	131	186	242	275*	12.445
		0	0	0	0	0		0	0	0	0	308*	
37'-0"			72	109	152	197	22.565	71	116	169	221	262*	13.886
			0	0	0	0		0	0	0	0	285	
38'-0"			61	96	137	179	25.105	60	103	153	203	249*	15.449
			0	0	0	0		0	0	0	0	263	
39'-0"			51	84	123	163	27.853	50	91	138	185	237*	17.141
			0	0	0	0		0	0	0	0	243	
40'-0"			42	73	110	148	30.822	41	79	124	169	224	18.967
			0	0	0	0		0	0	0	0	0	
41'-0"				63	98	134	34.022		69	111	154	206	20.936
				0	0	0			0	0	0	0	
42'-0"				53	87	121	37.464		59	99	141	190	23.055
				0	0	0			0	0	0	0	
43'-0"				44	77	109	41.162		50	88	128	175	25.330
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.72	0.90	1.03	1.24	1.49		0.80	0.96	1.17	1.39	1.67	
STEEL % (UNIFORM)	0.38	0.47	0.54	0.66	0.79		0.42	0.51	0.62	0.74	0.89	
(TAPERED)	0.23	0.29	0.33	0.40	0.48		0.26	0.31	0.38	0.45	0.54	
EFF. DEPTH, IN.	23.75	23.75	23.75	23.69	23.69		23.75	23.75	23.69	23.69	23.62	
$-I_{cr}/I_{gr}$	0.133	0.160	0.178	0.205	0.236		0.145	0.169	0.197	0.225	0.256	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	0.75	0.88	1.04	1.20		0.51	0.62	0.75	0.88	1.04	
STEEL %	0.07	0.09	0.10	0.12	0.14		0.06	0.07	0.09	0.10	0.12	
EFF. DEPTH, IN.	23.69	23.62	23.62	23.56	23.56		23.69	23.69	23.62	23.62	23.56	
$+I_{cr}/I_{gr}$	0.142	0.169	0.195	0.226	0.258		0.119	0.142	0.169	0.195	0.226	

STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS	30" Forms + 7" Rib @ 37" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF)	f'_c = 4,000 psi f_y = 60,000 psi

20″ Deep Rib + 5.0″ Top Slab = 25.0″ Total Depth

TOP BARS	Size @	# 4 8	# 4 7	# 5 9.5	# 5 8	# 5 7	End Span Defl. Coeff. (3)	# 5 11	# 5 9.5	# 5 8	# 5 7	# 5 6	Int. Span Defl. Coeff. (3)
BOTTOM BARS	# #	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8		# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	
Steel (psf)		1.02	1.20	1.40	1.63	1.87		1.16	1.36	1.63	1.88	2.20	
CLEAR SPAN		END SPAN						INTERIOR SPAN					
30'-0"		168	222	287	353	363*	10.023						
		0	0	0	0	411*							
31'-0"		148	199	259	321	341*	11.428						
		0	0	0	0	389*							
32'-0"		130	177	234	292	321*	12.975						
		0	0	0	0	359							
33'-0"		114	158	212	266	303*	14.675		231		356*		9.031
		0	0	0	0	329			0		374		
34'-0"		99	140	191	242	286*	16.536	149	210	271	339*	344*	10.176
		0	0	0	0	302		0	0	0	344	386*	
35'-0"		85	124	172	220	271*	18.569	133	190	247	317	327*	11.427
		0	0	0	0	276		0	0	0	0	365*	
36'-0"		72	110	155	200	253	20.784	117	171	226	291	311*	12.790
		0	0	0	0	0		0	0	0	0	347*	
37'-0"		61	96	139	182	232	23.191	103	154	206	268	296*	14.272
		0	0	0	0	0		0	0	0	0	330*	
38'-0"		50	83	124	165	212	25.802	90	139	188	246	282*	15.878
		0	0	0	0	0		0	0	0	0	306	
39'-0"		40	72	110	149	194	28.627	78	124	171	227	269*	17.617
		0	0	0	0	0		0	0	0	0	283	
40'-0"			61	98	135	177	31.678	67	111	155	208	257*	19.494
			0	0	0	0		0	0	0	0	262	
41'-0"			51	86	121	162	34.967	57	99	141	191	242	21.518
			0	0	0	0		0	0	0	0	0	
42'-0"			42	75	109	147	38.505	47	87	127	175	224	23.695
			0	0	0	0		0	0	0	0	0	
43'-0"				65	97	134	42.305		76	115	161	207	26.034
				0	0	0			0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.81 CF/SF) (4)

NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.06	1.21	1.43	1.64		1.04	1.21	1.43	1.64	1.91	
STEEL % (UNIFORM)	0.43	0.50	0.57	0.67	0.77		0.49	0.57	0.67	0.77	0.90	
(TAPERED)	0.28	0.32	0.36	0.43	0.50		0.32	0.36	0.43	0.50	0.58	
EFF. DEPTH, IN.	23.75	23.75	23.69	23.69	23.69		23.69	23.69	23.69	23.69	23.69	
$-I_{cr}/I_{gr}$	0.152	0.170	0.188	0.215	0.238		0.167	0.188	0.215	0.238	0.267	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.75	0.88	1.04	1.20	1.39		0.62	0.75	0.88	1.04	1.20	
STEEL %	0.09	0.10	0.12	0.14	0.16		0.07	0.09	0.10	0.12	0.14	
EFF. DEPTH, IN.	23.62	23.62	23.56	23.56	23.50		23.69	23.62	23.62	23.56	23.56	
$+I_{cr}/I_{gr}$	0.153	0.177	0.205	0.234	0.265		0.129	0.153	0.177	0.205	0.234	

DESIGN FROM LOAD TABLES (SINGLE SPAN JOIST CONSTRUCTION)

Example 5: Using 30-in. wide forms, select a design and review calculations for a service live load of 180 psf and an allowance of 26 psf for superimposed service dead loads (bridging joist, 3 psf, and floor finish, 23 psf) on a floor system. The clear span is 15.5 ft, bearing 6 in. at each end on masonry walls. Provide a 3-in. top slab. The bearing at each end is assumed to be 4 in.

For design, span ℓ_n = 15.5
+ 2 × dist. center to face of bearing
= 15.5 + 2 × 0.25
= 16′-0″

If available depth permits, select design with a total depth such that ℓ_n/h is about 20. Try 8″ + 3″; see table, Page 8-66.

Superimposed factored load
= 1.2 × 26 + 1.6 × 180 = 319 psf

Try 8 + 3 with 5 in. joists at 35 in. and ℓ_n = 16 ft.

Maximum tabulated capacity, square-end = 370 * psf
tapered-end = 374 * psf

Use the tapered-end design with two #6 straight bottom bars (max. tabulated capacity = 291* psf (square), = 330 psf (tapered)). Note that tabulated designs for square-end joist is controlled by shear (marked with one asterisk). The span, ℓ_n, is greater than 16 h (below solid line in table). For simple spans greater than 16 h, the Code requires that computed immediate deflection due to live load be less than $R_n/360$ for floors not supporting nor attached to non-structural elements likely to be damaged by large deflections (ACI 9.5.2.6). No deflection computations are required in using these tabulated designs unless they are intended to support such elements.

If the deflection was computed for this design, it would be less than $\ell_n/360$ for a live load = $\frac{330}{1.6}$ = 206 psf, > the live load = 180 psf.

(Note that a plus sign in these columns indicates factored load capacities (1.6L) for which deflection equals $\ell_n/360$.)

See recommended bar details, Fig. 8-2. Both bottom bars extend 5 in. into the support for minimum end cover of 1 in. Although not required for a perfectly free end, hooked top bars extending 0.25 ℓ_n into the span are recommended as a practical precaution against top cracking due to inadvertent end restraint at the supports. The total area of such top bars should be approximately equal to the area of the smaller bottom bar. Use 3-#4 bars with 90º end hooks to fit into the 11-in. depth with proper concrete cover. End hooks of 90º for # 4 bars are 0.8 × 10 = 8 in. deep. See Table 5-5(a), Chapter 5. Note that #4 bars will be fully developed 0.7 × 10 = 7 in. from end hook.

Provide per rib: 2 – #6 × 16′-4″ Bottom
3 – #4 × 4′-5″ Top

For a detailed review of this design, see the Manual Example on Page 8-52.

Example 6: *Single Span – Design Strength Controlled by Deflection*. As noted, all designs for single span joists have been investigated for deflection. The superimposed load causing an immediate deflection equal to $\ell_n/360$ was computed, multiplied by the live load factor, 1.6, and compared to the superimposed factored loads determined by flexure strength and shear strength. Superimposed factored load strengths limited by deflection equal to $\ell_n/360$ are designated by a plus sign. These superimposed loads were determined as follows for the joist slab design of Example 5, used on a span of ℓ_n = 23 ft.

Dead load (joist)	=	54 psf
Live load	=	85 psf
Total service load	=	139 psf
w_D = 1.2 × 54	=	65 psf
w_L = 1.6 × 85	=	136 psf
Factored load w_u	=	201 psf

From Table 8-1(a), I_g = 1,223 in.^{4}; M_{cr}, = 6.1 ft -kips
Read from load table, Page 8-66, I_{cr}/I_g = 0.406

Maximum actual moment, $M_a = \frac{(0.139)(35/12)(23)^2}{8}$
= 26.8 ft-kips
M_{cr}/M_a = 6.1/26.8 = 0.228

Using Code Equation (9-8):
$I_e/I_g = (M_{cr}/M_a)^3 + [1 - (M_{cr}/M_a)^3]I_{cr}/I_g$
$= 0.228^3 + [1 - (0.228)^3]0.406$
= 0.413
From load table, Page 8-66, deflection coefficient = 5.039. Immediate live load deflection,

$$\Delta_L = \frac{(DC)(w)}{I_c} = \frac{(5.039)(85)}{(0.413)(1{,}223)} = 0.85 \text{ in.}$$

$$\frac{\Delta}{\ell_n} = \frac{0.85}{(12)(23)} = \frac{\ell_n}{325} > \frac{\ell_n}{360}$$

Superimposed factored load = 1.6 × 85 = 136 psf
Therefore > 123 + tabulated

Note: It is very difficult to manually solve for the superimposed load causing a given deflection since the quantity, M_a, includes this load. The necessary trial and error iteration is, however, convenient by computer.

MANUAL EXAMPLE

To extend designs beyond the scope of the tabulated designs or to know how the tabulated strengths were computed, detailed computations are presented for the design in Example 5.

Review: Example 5
Loads: See Table 8-1 Gross Section Properties

Joist: (150.3)(150/144)(12/35) = 54 psf
Bridging: (Allow) = 3 psf
Wearing surface (floor finish) = 23 psf
Dead load = 80 psf

Factored load, w_u

$w_u = 1.2D + 1.6L = (1.2 \times 80) + (1.6 \times 180) = 384$ psf

Superimposed factored load = 384 – (1.2 × 54) = 319 psf

2 – #6 = 0.88 in.^{2}

$$\rho = \frac{0.88}{(35)(9.5)} = 0.00265$$

$$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{(0.88)(60)}{0.85(4)(35)} = 0.44 \text{ in.}$$

From Flexural Computations section in Chapter 5:
$\rho_{max} = 0.0181$
$\rho = 0.00265 < 0.0181$, so $\phi = 0.90$

Design moment strength, ϕM_n

$\phi M_n = (0.90)(0.88)(60)(9.5 - 0.44/2)/12$
= 36.7 ft-kip

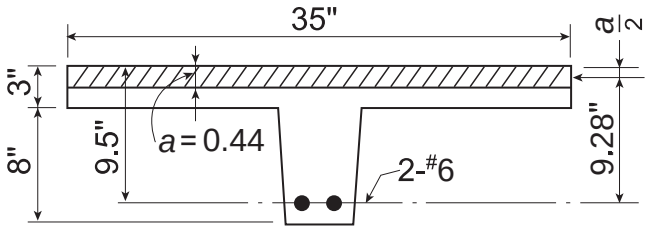


Figure 8-12 Section Dimensions

Maximum design strength for positive moment, w_u, in psf.

$$w_u = \frac{(8)(36.7)(1{,}000)}{(35/12)(16)^2} = 393 \text{ psf}$$

Maximum superimposed design strength for positive moment
= 393 – (1.2 × 54)
= 393 – 65 = 328 > 319 psf. Bending moment not critical.

Shear
For square-end, average width
b = ½(6.83 + 5.25) = 6.04 in.
d = 9.50 in.; A_s = 0.88 in.^{2}

$$\rho_w = \frac{0.88}{9.5 \text{ x } 6.04} = 0.0153$$

Short formula for shear strength, ϕV_c:

$\phi V_c = (1.10)\ \phi\ (2)\ \sqrt{f_c'}\ b_w d$
= (1.10)(0.75)(2) $\sqrt{4{,}000}$ (6.04)(9.5)/1,000
= 5.99 kips

Long formula for shear strength, ϕV_c, at a distance, d, from the support:

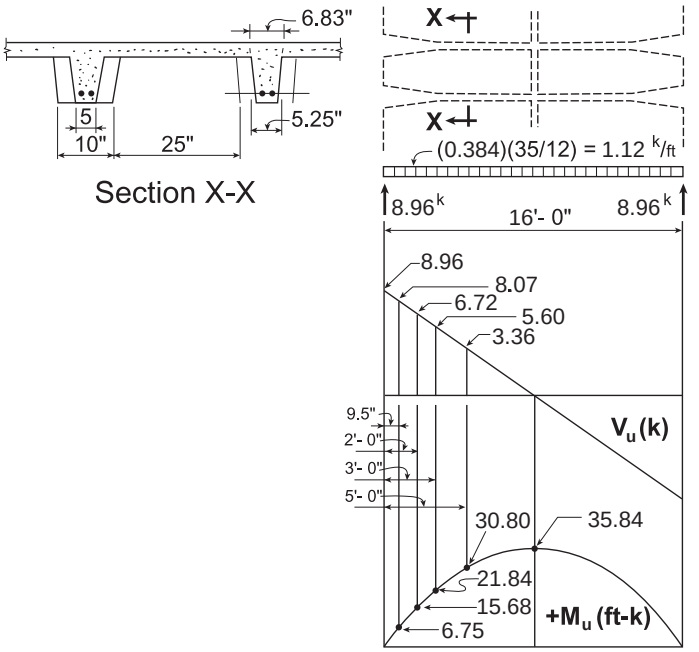


Figure 8-13 Simple Span Analysis

On Square End

$\phi V_c = (1.10)\ \phi\ (1.9\sqrt{f_c'} + 2{,}500\ \rho_w V_u d/M_u) b_w d$
= (1.10)(0.75)[1.9$\sqrt{4{,}000}$ + 2,500 (0.0153)
(8.07 × 9.5)/(6.75 × 12)](6.04)(9.5)/1,000
ϕV_c = 7.40 kips < 8.07, tapered end joist is required.

Maximum factored superimposed load with square end joists:

$$w_u = \frac{7{,}400}{(35/12)(8.00 - 9.5/12)} - 1.2 \text{ x } 54$$

= 287 psf (291 * Tabulated)

On Tapered End. Shear investigation of a tapered-end joist using the long formula is too complex for manual solution when straight bars are cut off within the taper. The simplest method is to have the allowable and actual shear checked every 2 in. from midspan to a distance, *d*, from the face of the support. Even with the simplification offered by full length bars, the solution is complex. Results of the manual solution are listed in Table 8-2. Note that the critical section with both long and short formulas for shear occurred at the root of the taper for a 16 foot span. Since the tapered length is a constant 36 in., the location of the critical section for all spans cannot be predicted.

TABLE 8-2 SUMMARY SHEAR CALCULATIONS – EXAMPLE 5

Quantity	Distance from Support			
	d	2'-0"	3'-0"	5'-0"
V_u, kips	8.07	6.72	5.60	3.36
M_u, ft-kips	6.75	15.68	21.84	30.80
d, in.	9.5	9.5	9.5	9.5
$V_u d/M_u$	0.946	0.339	0.203	0.086
Average b_w, in.	9.72	7.71	6.04	6.04
$b_w d$, in.^{2}	92.34	73.25	57.38	57.38
A_s, in.^{2}	0.88	0.88	0.88	0.88
ρ_w	0.00953	0.01201	0.01534	0.01534
ϕV_c (short formula), kips	9.64	7.64	5.99	5.99
ϕV_c (long formula), kips	10.87	7.88	6.06	5.85

Maximum ϕV_c at start of taper = 6,060 lb

$$\left.\begin{array}{l}\text{Maximum factored}\\ \text{superimposed load}\\ \text{for shear}\end{array}\right\} = \frac{6060}{\left(\frac{35}{12}\right)(5)} - (54)(1.2)$$

$$= 416 - 65 = 351 \text{ psf}$$

(330 Tabulated)

COMPUTED DEFLECTIONS

The computation procedure prescribed by the Code is too long for routine use as a manual calculation. For this reason, the necessary properties of the joist design sections, gross and cracked, have been tabulated in this Chapter. See Table 8-1 Gross Section Properties and "Design Properties" (cracked) under each load table. A deflection coefficient is also tabulated opposite each span for each joist section in the load tables.

This coefficient, DC = $\frac{k\ell_u^4(\text{spacing}/12)(1/12)}{384E_c}$, where k = 5 for single spans. The effect of the tapered haunch is conservatively neglected. Using these design aids, deflection is computed for the example as follows:

1. In load table, read DC = 1.18 for ℓ_n = 16′-0″. Under "Design Properties," read I_{cr}/I_g = 0.406.
2. In Table 8-1(a), read I_g = 1,223 in.^{4} and + M_{cr} = 6.1 ft-kips
3. Compute maximum moment at service load.
   $D + L$ = 80 + 180 = 260 psf.
   $$M_a = \frac{(0.260)(35/12)(16)^2}{8} = 24.3 \text{ ft-kips}$$
4. Using Code Equation (9-8):
   M_{cr}/M_a = 6.1/24.3 = 0.251
   I_{cr} = 0.406 (1,223) = 497 in.^{4}
   $I_e = (M_{cr}/M_a)^3 I_g + [1 - (M_{cr}/M_a)^3] I_{cr}$
   $= (0.251)^3(1{,}223) + [1 - (0.251)^3]497$
   = 508 in.^{4}
5. Immediate live load deflection, Δ_{LL}
   $$\Delta_{LL} = \frac{(DC)w = (1.18)(180)}{I_e \qquad 508} = 0.42 \text{ in.}$$
   $$= \frac{0.42\,\ell_n}{16 \times 12} = \ell_n/457$$

Development. Bar sizes in a single span must be small enough so that at the supports the quantity,

$$\left(\frac{M_n}{V_u} + \ell_a\right) \geq \ell_d$$

$M_n = \frac{36.7}{0.90} = 40.8$ ft-kips
V_u = 8.96 kips
ℓ_a = 2 in. (embedment beyond center of support)

Chapter 5; Table 5-2(b)

Bar Size	Cover	c.-c. spacing	ℓ_d
#6	1″ or 1.33d_b	2.50″ or 3.33d_b	43″= 3.58′

$$\frac{M_n}{V_u} + \ell_a = \frac{40.8}{8.96} + \frac{2}{12} = 4.72 \text{ ft} > 3.58 \text{ ft, OK}$$

The embedment length provided, from midspan (max. M_u) to the end of the bars, must be ≥ ℓ_d: 8.5′ > 3.58′, Okay.

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 3.0" Top Slab = 11.0" Total Depth										
BOTTOM BARS	# 3 # 3	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	Deflection Coeff. (3)
Steel (psf)	0.36	0.50	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
12'-0"	185	286	389	509	572*	592*	615*	639*	668*	697*	0.267
	0	0	0	0	632	770	873*	896*	913*	919*	
13'-0"	146	233	320	423	516*	534*	555*	578*	604*	631*	0.367
	0	0	0	0	528	645	758	767*	775*	780*	
14'-0"	116	191	266	355	445	486*	505*	526*	550*	576*	0.494
	0	0	0	0	0	546	643	662	672*	676*	
15'-0"	92	157	223	300	378	445*	463*	482*	505*	528*	0.651
	0	0	0	0	0	467	551	568	591*	595*	
16'-0"	72	129	187	255	324	401	426*	444*	465*	487*	0.843
	0	0	0	0	0	0	476	490	510	530*	
17'-0"	56	106	157	217	279	347	394*	411*	431*	452*	1.074
	0	0	0	0	0	0	407+	426	444	468	
18'-0"	42	87	132	186	241	302	343+	372	388	410	1.350
	0	0	0	0	0	0	0	0	0	0	
19'-0"		71	111	160	209	258+	291+	326	341	360	1.676
		0	0	0	0	0	0	0	0	0	
20'-0"		57	94	137	181	221+	249+	282+	301	318	2.058
		0	0	0	0	0	0	0	0	0	
21'-0"		45	78	117	158	191+	215+	243+	266	282	2.502
		0	0	0	0	0	0	0	0	0	
22'-0"			65	101	137	166+	187+	211+	236	250	3.013
			0	0	0	0	0	0	0	0	
23'-0"			53	86	119	145+	164+	185+	207+	223	3.600
			0	0	0	0	0	0	0	0	
24'-0"			43	73	104	127+	144+	163+	183+	199	4.268
			0	0	0	0	0	0	0	0	
25'-0"				62	90	112+	127+	144+	161+	178	5.025
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.40 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.22	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	
STEEL PERCENT	0.09	0.13	0.16	0.21	0.26	0.31	0.37	0.44	0.50	0.59	
DEPTH, D IN.	9.81	9.75	9.75	9.69	9.69	9.62	9.62	9.56	9.56	9.50	
$+I_{cr}/I_{gr}$	0.130	0.176	0.222	0.271	0.322	0.374	0.429	0.487	0.548	0.609	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 3.0" Top Slab = 11.0" Total Depth										
BOTTOM BARS	# 3 # 3	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	Deflection Coeff. (3)
Steel (psf)	0.35	0.48	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
12'-0"	171	269	368	484	602	647*	669*	692*	720*	748*	0.277
	0	0	0	0	0	735	871	939*	967*	993*	
13'-0"	135	218	302	401	502	584*	605*	626*	651*	677*	0.382
	0	0	0	0	0	615	731	851*	864*	868*	
14'-0"	106	177	250	335	422	520	550*	570*	593*	617*	0.514
	0	0	0	0	0	0	620	734	749*	753*	
15'-0"	82	145	208	282	358	443	504*	523*	544*	566*	0.677
	0	0	0	0	0	0	530	629	651	662*	
16'-0"	63	118	174	239	305	380	457	482*	502*	523*	0.877
	0	0	0	0	0	0	0	536+	563	578	
17'-0"	47	96	145	203	262	328	396	446*	465*	484*	1.117
	0	0	0	0	0	0	0	0	490	504	
18'-0"		77	121	173	225	284	336+	376+	421+	441	1.404
		0	0	0	0	0	0	0	0	0	
19'-0"		62	101	147	194	247	286+	319+	358+	388	1.743
		0	0	0	0	0	0	0	0	0	
20'-0"		48	84	125	168	216	245+	274+	307+	343	2.140
		0	0	0	0	0	0	0	0	0	
21'-0"			69	107	145	189	211+	236+	265+	294+	2.602
			0	0	0	0	0	0	0	0	
22'-0"			56	90	126	165	184+	205+	230+	255+	3.134
			0	0	0	0	0	0	0	0	
23'-0"			45	76	108	145	160+	180+	202+	223+	3.744
			0	0	0	0	0	0	0	0	
24'-0"				64	93	127	141+	158+	177+	197+	4.438
				0	0	0	0	0	0	0	
25'-0"				53	80	111	125+	140+	157+	174+	5.226
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.42 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.22	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	
STEEL PERCENT	0.09	0.12	0.16	0.20	0.25	0.30	0.35	0.42	0.48	0.56	
DEPTH, D IN.	9.81	9.75	9.75	9.69	9.69	9.62	9.62	9.56	9.56	9.50	
$+I_{cr}/I_{gr}$	0.115	0.156	0.196	0.240	0.285	0.331	0.380	0.431	0.486	0.540	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 3.0" Top Slab = 13.0" Total Depth										
BOTTOM BARS	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	Deflection Coeff. (3)
Steel (psf)	0.50	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	2.56	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	163	233	315	399	494	523*	541*	562*	585*	610*	0.843
	0	0	0	0	0	591	653*	660*	666*	675*	
17'-0"	135	197	270	344	429	483*	500*	520*	541*	565*	1.074
	0	0	0	0	0	514	587*	594*	600*	608*	
18'-0"	112	167	232	298	374	448*	465*	483*	503*	525*	1.350
	0	0	0	0	0	450	532*	539*	544*	552*	
19'-0"	92	141	200	259	327	396	433*	451*	469*	490*	1.676
	0	0	0	0	0	0	476	492*	497*	504*	
20'-0"	75	120	173	226	287	349	405*	422*	439*	459*	2.058
	0	0	0	0	0	0	422	440	453	463*	
21'-0"	60	101	149	198	253	309	368+	391	404	421	2.502
	0	0	0	0	0	0	0	0	0	0	
22'-0"	48	85	129	173	223	275	320+	349	361	376	3.013
	0	0	0	0	0	0	0	0	0	0	
23'-0"		71	111	151	197	244	280+	313	323	337	3.600
		0	0	0	0	0	0	0	0	0	
24'-0"		58	95	132	175	218	246+	277+	290	303	4.268
		0	0	0	0	0	0	0	0	0	
25'-0"		47	81	116	155	194	218+	245+	261	273	5.025
		0	0	0	0	0	0	0	0	0	
26'-0"			69	101	137	174	193+	217+	235	246	5.878
			0	0	0	0	0	0	0	0	
27'-0"			58	88	121	153+	173+	194+	212	222	6.836
			0	0	0	0	0	0	0	0	
28'-0"			48	76	107	139	155+	174+	192	201	7.906
			0	0	0	0	0	0	0	0	
29'-0"			40	65	94	124	139+	156+	173	182	9.098
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	
STEEL PERCENT	0.11	0.14	0.17	0.21	0.26	0.30	0.36	0.42	0.48	0.55	
DEPTH, D IN.	11.75	11.75	11.69	11.69	11.62	11.62	11.56	11.56	11.50	11.50	
$+I_{cr}/I_{gr}$	0.157	0.198	0.244	0.290	0.339	0.389	0.443	0.500	0.559	0.621	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 3.0" Top Slab = 13.0" Total Depth										
BOTTOM BARS	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	Deflection Coeff. (3)
Steel (psf)	0.48	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	2.46	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	150	217	297	377	469	562	589*	609*	630*	654*	0.877
	0	0	0	0	0	0	672	734*	739*	748*	
17'-0"	123	183	253	325	406	489	545*	564*	583*	606*	1.117
	0	0	0	0	0	0	586	661*	666*	674*	
18'-0"	101	154	217	280	353	427	506*	524*	542*	564*	1.404
	0	0	0	0	0	0	513	600*	604*	612*	
19'-0"	82	129	186	243	308	374	452	489*	506*	526*	1.743
	0	0	0	0	0	0	0	532	552*	559*	
20'-0"	65	108	159	211	270	330	400	457*	474*	493*	2.140
	0	0	0	0	0	0	0	466+	502	514*	
21'-0"	52	91	137	184	237	291	355	402+	445*	463*	2.602
	0	0	0	0	0	0	0	0	448	464	
22'-0"		75	117	160	208	258	316	350+	389+	415	3.134
		0	0	0	0	0	0	0	0	0	
23'-0"		61	100	139	183	229	275+	306+	340+	372	3.744
		0	0	0	0	0	0	0	0	0	
24'-0"		50	85	121	161	203	241+	269+	299+	331+	4.438
		0	0	0	0	0	0	0	0	0	
25'-0"			72	105	142	180	213+	238+	265+	293+	5.226
			0	0	0	0	0	0	0	0	
26'-0"			60	90	125	160	190+	211+	235+	261+	6.113
			0	0	0	0	0	0	0	0	
27'-0"			49	78	110	143	169+	189+	210+	233+	7.109
			0	0	0	0	0	0	0	0	
28'-0"			40	66	96	127	152+	169+	188+	208+	8.223
			0	0	0	0	0	0	0	0	
29'-0"				56	84	112	136+	152+	169+	188+	9.462
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.47 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	
STEEL PERCENT	0.10	0.13	0.17	0.20	0.25	0.29	0.35	0.40	0.46	0.53	
DEPTH, D IN.	11.75	11.75	11.69	11.69	11.62	11.62	11.56	11.56	11.50	11.50	
$+I_{cr}/I_{gr}$	0.139	0.176	0.216	0.257	0.301	0.345	0.394	0.444	0.496	0.552	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 3.0" Top Slab = 15.0" Total Depth										
BOTTOM BARS	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	Deflection Coeff. (3)
Steel (psf)	0.50	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	2.56	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	136	201	278	356	445	536	555*	574*	594*	616*	1.350
	0	0	0	0	0	0	643	656*	662*	671*	
19'-0"	113	171	240	310	390	472	517*	535*	554*	575*	1.676
	0	0	0	0	0	0	568	599*	605*	614*	
20'-0"	93	146	208	271	344	417	483*	500*	518*	538*	2.058
	0	0	0	0	0	0	504	551*	556*	565*	
21'-0"	76	124	181	238	303	370	448	469*	486*	505*	2.502
	0	0	0	0	0	0	0	509*	514*	522*	
22'-0"	62	105	157	209	268	329	401	441*	457*	475*	3.013
	0	0	0	0	0	0	0	472*	477*	484*	
23'-0"	49	89	136	183	238	293	359	416*	431*	448*	3.600
	0	0	0	0	0	0	0	426	444*	451*	
24'-0"		74	117	161	211	262	322	384	403	418	4.268
		0	0	0	0	0	0	0	0	0	
25'-0"		61	101	142	188	235	290	347	364	378	5.025
		0	0	0	0	0	0	0	0	0	
26'-0"		50	87	124	167	210	261	308+	330	343	5.878
		0	0	0	0	0	0	0	0	0	
27'-0"		40	74	109	148	188	236	275+	299	312	6.836
		0	0	0	0	0	0	0	0	0	
28'-0"			63	95	132	169	213	246+	272	283	7.906
			0	0	0	0	0	0	0	0	
29'-0"			52	82	117	151	193	222+	248	258	9.098
			0	0	0	0	0	0	0	0	
30'-0"			43	71	103	136	174	200+	226	235	10.419
			0	0	0	0	0	0	0	0	
31'-0"				61	91	121	157	181+	202+	215	11.879
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.49 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	
STEEL PERCENT	0.09	0.12	0.15	0.18	0.22	0.26	0.31	0.35	0.41	0.47	
DEPTH, D IN.	13.75	13.75	13.69	13.69	13.62	13.62	13.56	13.56	13.50	13.50	
$+I_{cr}/I_{gr}$	0.142	0.180	0.222	0.264	0.310	0.356	0.407	0.460	0.516	0.574	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 3.0" Top Slab = 15.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	2.46	2.80	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	185	259	334	420	507	604*	622*	641*	663*	684*	1.404
	0	0	0	0	0	610	715	731*	740*	747*	
19'-0"	157	223	290	367	446	538	580*	598*	618*	638*	1.743
	0	0	0	0	0	0	632	669*	677*	683*	
20'-0"	132	192	253	322	393	477	543*	559*	579*	597*	2.140
	0	0	0	0	0	0	562	615*	623*	629*	
21'-0"	111	166	221	284	348	423	501	525*	543*	561*	2.602
	0	0	0	0	0	0	0	568*	576*	582*	
22'-0"	93	143	193	250	308	378	448	494*	511*	528*	3.134
	0	0	0	0	0	0	0	528*	535*	540*	
23'-0"	77	122	168	221	274	337	402	466*	483*	499*	3.744
	0	0	0	0	0	0	0	475	498*	503*	
24'-0"	63	105	147	195	244	302	361	428	456*	472*	4.438
	0	0	0	0	0	0	0	0	464	0	
25'-0"	51	89	128	172	218	271	326	376+	420	430	5.226
	0	0	0	0	0	0	0	0	0	0	
26'-0"	40	75	111	152	194	244	294	334+	370+	390	6.113
	0	0	0	0	0	0	0	0	0	0	
27'-0"		63	96	134	173	219	266	298+	331+	355	7.109
		0	0	0	0	0	0	0	0	0	
28'-0"		52	83	118	154	197	240	267+	296+	324	8.223
		0	0	0	0	0	0	0	0	0	
29'-0"		42	71	104	138	177	218	241+	267+	292+	9.462
		0	0	0	0	0	0	0	0	0	
30'-0"			60	91	122	160	197	217+	241+	264+	10.836
			0	0	0	0	0	0	0	0	
31'-0"			50	79	109	143	179	197+	218+	239+	12.355
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.11	0.14	0.17	0.21	0.25	0.29	0.34	0.40	0.45	0.51	
DEPTH, D IN.	13.75	13.69	13.69	13.62	13.62	13.56	13.56	13.50	13.50	13.44	
$+I_{cr}/I_{gr}$	0.159	0.197	0.235	0.275	0.317	0.362	0.410	0.459	0.511	0.561	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)										f'_c = 4,000 psi f_y = 60,000 psi
	8" Deep Rib + 4.0" Top Slab = 12.0" Total Depth										
BOTTOM BARS	# 3 # 3	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	Deflection Coeff. (3)
Steel (psf)	0.36	0.50	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
12'-0"	195	308	421	555	631*	650*	673*	698*	726*	756*	0.267
	0	0	0	0	691	844	952*	975*	1004*	1021*	
13'-0"	153	249	346	460	567*	585*	606*	629*	655*	683*	0.367
	0	0	0	0	576	706	840	851*	860*	867*	
14'-0"	120	203	286	384	484	531*	550*	571*	596*	621*	0.494
	0	0	0	0	0	597	712	736*	744*	750*	
15'-0"	93	165	238	323	410	484*	503*	522*	545*	569*	0.651
	0	0	0	0	0	509	609	646*	654*	659*	
16'-0"	71	135	198	274	350	436	462*	480*	501*	523*	0.843
	0	0	0	0	0	0	525	574*	581*	586*	
17'-0"	53	109	166	232	300	377	426*	443*	463*	484*	1.074
	0	0	0	0	0	0	455	506	521*	526*	
18'-0"		88	138	198	258	326	395*	411*	430*	449*	1.350
		0	0	0	0	0	396	442	460	475	
19'-0"		70	115	168	223	284	346	382*	400*	417	1.676
		0	0	0	0	0	0	388	404	0	
20'-0"		54	95	143	192	248	304	341	356	368	2.058
		0	0	0	0	0	0	0	0	0	
21'-0"		41	78	122	166	216	268	301	315	326	2.502
		0	0	0	0	0	0	0	0	0	
22'-0"			63	103	144	189	233+	263+	279	289	3.013
			0	0	0	0	0	0	0	0	
23'-0"			51	87	124	166	204+	230+	248	257	3.600
			0	0	0	0	0	0	0	0	
24'-0"				73	107	145	179+	202+	220	229	4.268
				0	0	0	0	0	0	0	
25'-0"				60	91	127	158+	179+	196	204	5.025
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.22	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	
STEEL PERCENT	0.08	0.12	0.15	0.19	0.23	0.28	0.33	0.39	0.45	0.53	
DEPTH, D IN.	10.81	10.75	10.75	10.69	10.69	10.62	10.62	10.56	10.56	10.50	
$+I_{cr}/I_{gr}$	0.122	0.166	0.209	0.256	0.304	0.355	0.407	0.463	0.522	0.581	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)										f'_c = 4,000 psi f_y = 60,000 psi
	8" Deep Rib + 4.0" Top Slab = 12.0" Total Depth										
BOTTOM BARS	# 3 # 3	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	Deflection Coeff. (3)
Steel (psf)	0.35	0.48	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
12'-0"	181	289	398	527	658	713*	735*	758*	786*	814*	0.277
	0	0	0	0	0	806	957	1025*	1053*	1080*	
13'-0"	141	233	326	436	547	642*	663*	684*	709*	735*	0.382
	0	0	0	0	0	673	802	927*	952*	964*	
14'-0"	109	188	268	363	459	568	602*	621*	645*	669*	0.514
	0	0	0	0	0	0	679	808	829*	834*	
15'-0"	83	152	222	304	388	483	550*	568*	590*	612*	0.677
	0	0	0	0	0	0	579	692	729*	733*	
16'-0"	62	122	184	256	330	413	498	523*	543*	564*	0.877
	0	0	0	0	0	0	0	597	648*	652*	
17'-0"	44	98	152	217	282	355	431	483*	502*	521*	1.117
	0	0	0	0	0	0	0	519	582*	586*	
18'-0"		78	126	183	241	307	374	448*	466*	484*	1.404
		0	0	0	0	0	0	453	511	525	
19'-0"		60	104	155	207	266	327	397	434*	451*	1.743
		0	0	0	0	0	0	0	450	462	
20'-0"		45	85	131	178	231	286	341+	382+	408	2.140
		0	0	0	0	0	0	0	0	0	
21'-0"			68	110	153	201	251	295+	329+	361	2.602
			0	0	0	0	0	0	0	0	
22'-0"			54	92	131	175	220	256+	286+	321	3.134
			0	0	0	0	0	0	0	0	
23'-0"			42	77	112	153	194	224+	250+	278+	3.744
			0	0	0	0	0	0	0	0	
24'-0"				63	96	133	170	197+	220+	245+	4.438
				0	0	0	0	0	0	0	
25'-0"				51	81	115	150	174+	195+	217+	5.226
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.22	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	
STEEL PERCENT	0.08	0.11	0.14	0.18	0.22	0.27	0.32	0.38	0.44	0.51	
DEPTH, D IN.	10.81	10.75	10.75	10.69	10.69	10.62	10.62	10.56	10.56	10.50	
$+I_{cr}/I_{gr}$	0.108	0.146	0.184	0.226	0.269	0.314	0.360	0.410	0.462	0.515	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 4.0" Top Slab = 14.0" Total Depth										
BOTTOM BARS	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	Deflection Coeff. (3)
Steel (psf)	0.50	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	2.56	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	169	245	335	427	530	564*	583*	604*	627*	652*	0.843
	0	0	0	0	0	636	712*	720*	727*	737*	
17'-0"	139	206	286	367	459	521*	538*	558*	579*	603*	1.074
	0	0	0	0	0	553	639*	647*	653*	663*	
18'-0"	114	174	245	317	399	482*	499*	517*	537*	559*	1.350
	0	0	0	0	0	483	579*	586*	592*	601*	
19'-0"	92	146	210	275	348	423	464*	482*	500*	521*	1.676
	0	0	0	0	0	0	512	535*	540*	548*	
20'-0"	74	123	180	239	305	373	433*	450*	468*	487*	2.058
	0	0	0	0	0	0	453	490*	496*	503*	
21'-0"	58	102	155	208	268	329	402	421*	438*	457*	2.502
	0	0	0	0	0	0	0	452*	457*	464*	
22'-0"	45	85	132	181	236	292	358	396*	412*	430*	3.013
	0	0	0	0	0	0	0	403	416	0	
23'-0"		69	113	157	208	259	319	361	372	388	3.600
		0	0	0	0	0	0	0	0	0	
24'-0"		56	96	137	183	230	285	324	334	348	4.268
		0	0	0	0	0	0	0	0	0	
25'-0"		44	81	118	161	204	255	291	301	313	5.025
		0	0	0	0	0	0	0	0	0	
26'-0"			68	102	142	182	229	262	271	283	5.878
			0	0	0	0	0	0	0	0	
27'-0"			56	88	124	162	205	232+	244	255	6.836
			0	0	0	0	0	0	0	0	
28'-0"			45	75	109	144	184	208+	220	231	7.906
			0	0	0	0	0	0	0	0	
29'-0"				64	95	127	165	187+	199	208	9.098
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	
STEEL PERCENT	0.10	0.13	0.16	0.20	0.24	0.28	0.33	0.38	0.44	0.51	
DEPTH, D IN.	12.75	12.75	12.69	12.69	12.62	12.62	12.56	12.56	12.50	12.50	
$+I_{cr}/I_{gr}$	0.148	0.187	0.230	0.274	0.320	0.368	0.421	0.475	0.531	0.591	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 4.0" Top Slab = 14.0" Total Depth										
BOTTOM BARS	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	Deflection Coeff. (3)
Steel (psf)	0.48	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	2.46	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	154	227	314	402	502	604	635*	655*	676*	700*	0.877
	0	0	0	0	0	0	724	799*	805*	814*	
17'-0"	125	190	267	345	433	524	586*	605*	625*	648*	1.117
	0	0	0	0	0	0	630	718*	724*	733*	
18'-0"	101	159	227	297	376	456	543*	561*	580*	601*	1.404
	0	0	0	0	0	0	551	648	656*	665*	
19'-0"	80	132	194	256	327	399	484	523*	540*	560*	1.743
	0	0	0	0	0	0	0	571	599*	607*	
20'-0"	63	109	165	221	285	350	427	488*	505*	524*	2.140
	0	0	0	0	0	0	0	506	550*	557*	
21'-0"	48	90	140	191	249	309	378	449	473*	492*	2.602
	0	0	0	0	0	0	0	0	507*	514*	
22'-0"		73	119	165	218	272	336	401	445*	462*	3.134
		0	0	0	0	0	0	0	463	476*	
23'-0"		58	100	143	191	241	299	358	408+	429	3.744
		0	0	0	0	0	0	0	0	0	
24'-0"		45	84	123	168	213	266	321	359+	386	4.438
		0	0	0	0	0	0	0	0	0	
25'-0"			70	106	147	188	237	288	317+	348	5.226
			0	0	0	0	0	0	0	0	
26'-0"			57	90	128	167	212	254+	282+	314	6.113
			0	0	0	0	0	0	0	0	
27'-0"			45	76	111	147	189	227+	252+	279+	7.109
			0	0	0	0	0	0	0	0	
28'-0"				64	97	130	169	203+	226+	250+	8.223
				0	0	0	0	0	0	0	
29'-0"				53	83	114	151	183+	203+	225+	9.462
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	
STEEL PERCENT	0.09	0.12	0.15	0.19	0.23	0.27	0.32	0.37	0.43	0.49	
DEPTH, D IN.	12.75	12.75	12.69	12.69	12.62	12.62	12.56	12.56	12.50	12.50	
$+I_{cr}/I_{gr}$	0.131	0.165	0.204	0.242	0.284	0.326	0.373	0.421	0.472	0.524	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 4.0" Top Slab = 16.0" Total Depth										
BOTTOM BARS	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	Deflection Coeff. (3)
Steel (psf)	0.50	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	2.56	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	138	208	291	375	471	568	593*	612*	632*	655*	1.350
	0	0	0	0	0	0	684	706*	713*	723*	
19'-0"	114	176	250	326	412	499	552*	570*	588*	610*	1.676
	0	0	0	0	0	0	603	644*	651*	661*	
20'-0"	92	149	216	284	362	440	515*	532*	550*	570*	2.058
	0	0	0	0	0	0	534	592*	598*	607*	
21'-0"	74	125	186	248	318	390	475	498*	515*	534*	2.502
	0	0	0	0	0	0	0	546*	552*	560*	
22'-0"	58	105	160	217	281	346	423	468*	484*	502*	3.013
	0	0	0	0	0	0	0	502	512*	520*	
23'-0"	45	87	138	189	248	308	379	440*	456*	473*	3.600
	0	0	0	0	0	0	0	451	476*	484*	
24'-0"		72	118	165	219	274	339	405	430*	446*	4.268
		0	0	0	0	0	0	0	444*	451*	
25'-0"		58	101	144	194	245	304	365	407*	422*	5.025
		0	0	0	0	0	0	0	411	423*	
26'-0"		46	85	126	172	218	274	330	372	386	5.878
		0	0	0	0	0	0	0	0	0	
27'-0"			72	109	152	195	246	298	338	351	6.836
			0	0	0	0	0	0	0	0	
28'-0"			59	94	134	174	222	270	307	319	7.906
			0	0	0	0	0	0	0	0	
29'-0"			48	81	118	155	200	245	279	290	9.098
			0	0	0	0	0	0	0	0	
30'-0"				69	103	138	180	222	254	264	10.419
				0	0	0	0	0	0	0	
31'-0"				58	90	123	162	201	231	241	11.879
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	
STEEL PERCENT	0.08	0.11	0.14	0.17	0.21	0.24	0.29	0.33	0.38	0.44	
DEPTH, D IN.	14.75	14.75	14.69	14.69	14.62	14.62	14.56	14.56	14.50	14.50	
$+I_{cr}/I_{gr}$	0.134	0.169	0.209	0.249	0.292	0.336	0.385	0.435	0.489	0.544	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 4.0" Top Slab = 16.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	2.46	2.80	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	191	271	352	444	538	647*	665*	684*	706*	727*	1.404
	0	0	0	0	0	649	763	787*	797*	804*	
19'-0"	161	232	305	388	472	572	619*	637*	657*	677*	1.743
	0	0	0	0	0	0	673	719*	728*	735*	
20'-0"	134	199	264	339	415	505	578*	595*	614*	633*	2.140
	0	0	0	0	0	0	597	661*	670*	676*	
21'-0"	112	170	230	298	366	448	531	558*	576*	594*	2.602
	0	0	0	0	0	0	0	610*	619*	625*	
22'-0"	92	146	200	261	324	399	475	524*	542*	559*	3.134
	0	0	0	0	0	0	0	561	574*	580*	
23'-0"	75	124	173	230	287	356	425	494*	510*	527*	3.744
	0	0	0	0	0	0	0	504	534*	540*	
24'-0"	60	105	150	202	255	318	381	454	482*	498*	4.438
	0	0	0	0	0	0	0	0	499*	504*	
25'-0"	47	88	130	178	227	284	343	410	456*	471*	5.226
	0	0	0	0	0	0	0	0	467*	473*	
26'-0"		73	112	156	201	255	309	371	432	442	6.113
		0	0	0	0	0	0	0	0	0	
27'-0"		60	96	137	179	228	279	336	386+	402	7.109
		0	0	0	0	0	0	0	0	0	
28'-0"		48	82	120	159	205	251	305	346+	366	8.223
		0	0	0	0	0	0	0	0	0	
29'-0"			69	104	141	183	227	277	312+	334	9.462
			0	0	0	0	0	0	0	0	
30'-0"			57	90	124	164	205	251	281+	305	10.836
			0	0	0	0	0	0	0	0	
31'-0"			47	78	109	147	185	229	255+	279	12.355
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.10	0.13	0.16	0.20	0.23	0.27	0.32	0.37	0.42	0.48	
DEPTH, D IN.	14.75	14.69	14.69	14.62	14.62	14.56	14.56	14.50	14.50	14.44	
$+I_{cr}/I_{gr}$	0.150	0.185	0.221	0.259	0.298	0.342	0.387	0.434	0.484	0.531	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 4.5" Top Slab = 12.5" Total Depth										
BOTTOM BARS	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	Deflection Coeff. (3)
Steel (psf)	0.50	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	2.56	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
15'-0"	170	246	336	427	506*	524*	544*	567*	590*	617*	0.651
	0	0	0	0	530	636	678*	686*	692*	702*	
16'-0"	138	205	284	364	455	481*	500*	521*	543*	568*	0.843
	0	0	0	0	0	547	602*	610*	615*	624*	
17'-0"	111	170	240	311	392	443*	461*	480*	501*	525*	1.074
	0	0	0	0	0	474	540*	547*	552*	560*	
18'-0"	89	142	204	267	339	410*	427*	445*	465*	487*	1.350
	0	0	0	0	0	412	480	494*	499*	506*	
19'-0"	70	117	173	230	295	360	397*	414*	433*	454*	1.676
	0	0	0	0	0	0	421	438	453	461*	
20'-0"	54	97	147	198	257	316	370*	386	399	419	2.058
	0	0	0	0	0	0	371	0	0	0	
21'-0"	40	79	125	171	224	278	328	341	353	372	2.502
	0	0	0	0	0	0	0	0	0	0	
22'-0"		63	105	147	196	244	290	303	313	330	3.013
		0	0	0	0	0	0	0	0	0	
23'-0"		50	88	127	171	216	254+	269	279	294	3.600
		0	0	0	0	0	0	0	0	0	
24'-0"			73	109	149	190	223+	239	248	262	4.268
			0	0	0	0	0	0	0	0	
25'-0"			60	93	130	168	198+	213	221	234	5.025
			0	0	0	0	0	0	0	0	
26'-0"			48	79	113	148	176+	190	197	209	5.878
			0	0	0	0	0	0	0	0	
27'-0"				66	98	130	157+	169	176	187	6.836
				0	0	0	0	0	0	0	
28'-0"				55	84	114	140+	150	157	167	7.906
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	
STEEL PERCENT	0.11	0.14	0.18	0.22	0.27	0.32	0.38	0.43	0.51	0.57	
DEPTH, D IN.	11.25	11.25	11.19	11.19	11.12	11.12	11.06	11.06	11.00	11.00	
$+I_{cr}/I_{gr}$	0.161	0.203	0.249	0.296	0.346	0.397	0.452	0.509	0.568	0.631	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 4.5" Top Slab = 12.5" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	2.46	2.80	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	190	266	343	430	519	545*	565*	586*	610*	633*	0.877
	0	0	0	0	0	624	680*	685*	693*	698*	
17'-0"	157	224	292	370	449	503*	522*	541*	564*	586*	1.117
	0	0	0	0	0	541	610*	615*	623*	628*	
18'-0"	129	189	250	319	390	466*	484*	502*	523*	544*	1.404
	0	0	0	0	0	472	552*	556*	564*	568*	
19'-0"	106	160	214	276	340	414	450*	468*	488*	507*	1.743
	0	0	0	0	0	0	489	502	513*	518*	
20'-0"	86	134	184	240	297	364	420*	437*	456*	472	2.140
	0	0	0	0	0	0	422+	443	460	0	
21'-0"	69	113	158	208	260	321	364+	393	408	419	2.602
	0	0	0	0	0	0	0	0	0	0	
22'-0"	54	94	135	181	228	283	317+	349	363	373	3.134
	0	0	0	0	0	0	0	0	0	0	
23'-0"	41	78	115	157	200	248+	277+	311	324	333	3.744
	0	0	0	0	0	0	0	0	0	0	
24'-0"		63	97	136	176	218+	244+	271+	289	298	4.438
		0	0	0	0	0	0	0	0	0	
25'-0"		50	82	118	154	193+	216+	240+	259	267	5.226
		0	0	0	0	0	0	0	0	0	
26'-0"			68	101	135	171+	192+	213+	232	239	6.113
			0	0	0	0	0	0	0	0	
27'-0"			56	87	118	153+	171+	190+	208	215	7.109
			0	0	0	0	0	0	0	0	
28'-0"			45	74	103	137	153+	170+	186	193	8.223
			0	0	0	0	0	0	0	0	
29'-0"				62	89	121	138+	153+	167	173	9.462
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.14	0.18	0.21	0.26	0.30	0.36	0.42	0.49	0.55	0.63	
DEPTH, D IN.	11.25	11.19	11.19	11.12	11.12	11.06	11.06	11.00	11.00	10.94	
$+I_{cr}/I_{gr}$	0.179	0.220	0.262	0.306	0.351	0.400	0.451	0.504	0.559	0.611	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 4.5" Top Slab = 14.5" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	2.56	2.91	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	177	251	326	412	499	516*	535*	555*	577*	599*	1.350
	0	0	0	0	0	602	611*	617*	626*	633*	
19'-0"	148	215	282	359	437	480*	498*	517*	538*	559*	1.676
	0	0	0	0	0	530	557*	562*	571*	577*	
20'-0"	124	184	245	314	385	448*	465*	482*	502*	522*	2.058
	0	0	0	0	0	468	510*	516*	524*	530*	
21'-0"	103	157	213	275	339	415	435*	452*	471*	490*	2.502
	0	0	0	0	0	0	470*	475*	483*	0	
22'-0"	85	134	185	242	300	369	408*	424*	442*	460*	3.013
	0	0	0	0	0	0	432	440*	447*	0	
23'-0"	69	114	160	213	266	329	384*	399	415	427	3.600
	0	0	0	0	0	0	387	0	0	0	
24'-0"	55	97	139	187	236	294	347	358	372	384	4.268
	0	0	0	0	0	0	0	0	0	0	
25'-0"	42	81	120	164	209	263	311	322	335	346	5.025
	0	0	0	0	0	0	0	0	0	0	
26'-0"		67	103	144	186	235	280	290	302	312	5.878
		0	0	0	0	0	0	0	0	0	
27'-0"		55	88	126	165	210	252	261	273	282	6.836
		0	0	0	0	0	0	0	0	0	
28'-0"		44	75	110	146	189	228	236	246	255	7.906
		0	0	0	0	0	0	0	0	0	
29'-0"			63	96	129	169	205	213	223	231	9.098
			0	0	0	0	0	0	0	0	
30'-0"			52	83	114	151	185	192	201	209	10.419
			0	0	0	0	0	0	0	0	
31'-0"			42	71	100	135	167	173	182	189	11.879
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.12	0.15	0.19	0.23	0.27	0.32	0.37	0.43	0.49	0.55	
DEPTH, D IN.	13.25	13.19	13.19	13.12	13.12	13.06	13.06	13.00	13.00	12.94	
$+I_{cr}/I_{gr}$	0.182	0.224	0.267	0.313	0.359	0.411	0.464	0.520	0.578	0.633	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 4.5" Top Slab = 14.5" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	2.46	2.80	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	162	233	305	388	472	563*	581*	600*	622*	642*	1.404
	0	0	0	0	0	571	671	683*	692*	698*	
19'-0"	134	198	263	337	412	501	541*	559*	579*	599*	1.743
	0	0	0	0	0	0	592	624*	632*	638*	
20'-0"	111	168	227	294	362	442	505*	522*	541*	560*	2.140
	0	0	0	0	0	0	524	572*	580*	585*	
21'-0"	90	143	196	256	318	391	465	489*	507*	525*	2.602
	0	0	0	0	0	0	0	527*	535*	540*	
22'-0"	73	121	169	224	280	346	414	459*	476*	493*	3.134
	0	0	0	0	0	0	0	488*	495*	500*	
23'-0"	57	101	145	196	247	308	370	432*	449*	465*	3.744
	0	0	0	0	0	0	0	440	460*	0	
24'-0"	44	84	125	171	218	274	331	395	414	425	4.438
	0	0	0	0	0	0	0	0	0	0	
25'-0"		69	107	149	193	244	296	346+	373	383	5.226
		0	0	0	0	0	0	0	0	0	
26'-0"		56	90	130	170	218	266	307+	337	346	6.113
		0	0	0	0	0	0	0	0	0	
27'-0"		44	76	113	150	194	239	274+	305	313	7.109
		0	0	0	0	0	0	0	0	0	
28'-0"			63	97	132	173	215	246+	273+	284	8.223
			0	0	0	0	0	0	0	0	
29'-0"			52	83	116	154	193	221+	245+	257	9.462
			0	0	0	0	0	0	0	0	
30'-0"			41	71	101	137	173	200+	222+	233	10.836
			0	0	0	0	0	0	0	0	
31'-0"				60	88	121	155	181+	201+	212	12.355
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.12	0.15	0.18	0.22	0.26	0.31	0.35	0.41	0.47	0.53	
DEPTH, D IN.	13.25	13.19	13.19	13.12	13.12	13.06	13.06	13.00	13.00	12.94	
$+I_{cr}/I_{gr}$	0.161	0.198	0.236	0.277	0.318	0.364	0.411	0.461	0.513	0.562	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 4.5" Top Slab = 16.5" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	2.56	2.91	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
20'-0"	150	220	290	371	452	531*	548*	566*	586*	606*	2.058
	0	0	0	0	0	549	613*	619*	629*	636*	
21'-0"	126	189	253	326	400	488	513*	530*	549*	568*	2.502
	0	0	0	0	0	0	565*	571*	580*	587*	
22'-0"	105	162	220	287	355	435	481*	498*	516*	534*	3.013
	0	0	0	0	0	0	516	529*	538*	544*	
23'-0"	87	139	192	253	315	388	453*	468*	486*	503*	3.600
	0	0	0	0	0	0	463	492*	500*	507*	
24'-0"	70	119	168	223	280	348	416	442*	458*	475*	4.268
	0	0	0	0	0	0	0	459*	467*	0	
25'-0"	56	101	146	197	250	312	375	417*	433*	449*	5.025
	0	0	0	0	0	0	0	430*	437*	0	
26'-0"	44	85	126	174	222	280	338	395	409	421	5.878
	0	0	0	0	0	0	0	0	0	0	
27'-0"		71	109	153	198	251	305	358	372	383	6.836
		0	0	0	0	0	0	0	0	0	
28'-0"		58	94	135	176	226	276	325	338	348	7.906
		0	0	0	0	0	0	0	0	0	
29'-0"		46	80	118	157	203	250	296	307	317	9.098
		0	0	0	0	0	0	0	0	0	
30'-0"			67	103	139	183	226	269	280	289	10.419
			0	0	0	0	0	0	0	0	
31'-0"			56	90	124	164	205	245	255	263	11.879
			0	0	0	0	0	0	0	0	
32'-0"			46	77	109	147	186	223	233	240	13.488
			0	0	0	0	0	0	0	0	
33'-0"				66	96	132	168	203	212	219	15.255
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.10	0.13	0.16	0.20	0.23	0.28	0.32	0.37	0.42	0.48	
DEPTH, D IN.	15.25	15.19	15.19	15.12	15.12	15.06	15.06	15.00	15.00	14.94	
$+I_{cr}/I_{gr}$	0.164	0.203	0.242	0.285	0.328	0.376	0.425	0.478	0.532	0.584	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 4.5" Top Slab = 16.5" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	2.46	2.80	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
20'-0"	134	201	269	346	425	519	596*	613*	632*	651*	2.140
	0	0	0	0	0	0	614	683*	692*	699*	
21'-0"	111	172	233	303	375	459	546	574*	592*	610*	2.602
	0	0	0	0	0	0	0	631*	639*	646*	
22'-0"	91	146	202	266	331	408	487	539*	556*	573*	3.134
	0	0	0	0	0	0	0	576	593*	599*	
23'-0"	73	124	175	233	293	364	435	507*	524*	540*	3.744
	0	0	0	0	0	0	0	517	551*	557*	
24'-0"	57	104	151	205	259	324	390	466	494*	510*	4.438
	0	0	0	0	0	0	0	0	515*	520*	
25'-0"	44	87	130	180	230	290	351	420	467*	482*	5.226
	0	0	0	0	0	0	0	0	482*	487*	
26'-0"		71	111	157	204	259	315	379	443*	457*	6.113
		0	0	0	0	0	0	0	445	0	
27'-0"		58	95	137	180	232	284	343	404	425	7.109
		0	0	0	0	0	0	0	0	0	
28'-0"		45	80	119	160	207	256	311	367	387	8.223
		0	0	0	0	0	0	0	0	0	
29'-0"			67	103	141	185	231	282	335	353	9.462
			0	0	0	0	0	0	0	0	
30'-0"			55	89	124	166	208	256	305	322	10.836
			0	0	0	0	0	0	0	0	
31'-0"			44	76	109	148	187	232	275+	294	12.355
			0	0	0	0	0	0	0	0	
32'-0"				64	95	131	168	211	250+	269	14.027
				0	0	0	0	0	0	0	
33'-0"				53	82	117	151	191	228+	246	15.865
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.10	0.13	0.16	0.19	0.22	0.27	0.31	0.36	0.41	0.46	
DEPTH, D IN.	15.25	15.19	15.19	15.12	15.12	15.06	15.06	15.00	15.00	14.94	
$+I_{cr}/I_{gr}$	0.146	0.180	0.215	0.253	0.291	0.334	0.378	0.424	0.473	0.520	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)										f'_c = 4,000 psi f_y = 60,000 psi
	8" Deep Rib + 5.0" Top Slab = 13.0" Total Depth										
BOTTOM BARS	# 3 # 3	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	Deflection Coeff. (3)
Steel (psf)	0.36	0.50	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
12'-0"	207	331	455	602	694*	714*	737*	762*	790*	821*	0.267
	0	0	0	0	751	920	1035*	1058*	1087*	1116*	
13'-0"	161	266	372	498	623*	641*	662*	685*	711*	739*	0.367
	0	0	0	0	625	769	916	939*	949*	956*	
14'-0"	125	216	307	415	524	580*	600*	621*	645*	671*	0.494
	0	0	0	0	0	649	775	811*	820*	827*	
15'-0"	96	175	254	348	444	528*	547*	566*	589*	613*	0.651
	0	0	0	0	0	552	662	711*	720*	726*	
16'-0"	72	141	211	294	377	473	501*	519*	541*	563*	0.843
	0	0	0	0	0	0	570	631*	639*	645*	
17'-0"	52	113	175	248	323	407	461*	479*	499*	520*	1.074
	0	0	0	0	0	0	493	565*	573*	578*	
18'-0"		90	145	211	277	352	427*	443*	462*	481*	1.350
		0	0	0	0	0	429	510*	517*	522*	
19'-0"		70	120	178	238	305	374	411*	429*	448*	1.676
		0	0	0	0	0	0	455	470*	475*	
20'-0"		53	98	151	205	266	328	383*	400*	418*	2.058
		0	0	0	0	0	0	400	418	432	
21'-0"			79	127	176	231	288	354	370	382	2.502
			0	0	0	0	0	0	0	0	
22'-0"			63	107	151	202	253	313	328	339	3.013
			0	0	0	0	0	0	0	0	
23'-0"			49	89	130	176	223	278	291	302	3.600
			0	0	0	0	0	0	0	0	
24'-0"				74	111	153	196	247	259	269	4.268
				0	0	0	0	0	0	0	
25'-0"				60	94	133	173	219	231	240	5.025
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.22	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	
STEEL PERCENT	0.07	0.11	0.14	0.17	0.21	0.26	0.30	0.36	0.42	0.48	
DEPTH, D IN.	11.81	11.75	11.75	11.69	11.69	11.62	11.62	11.56	11.56	11.50	
$+I_{cr}/I_{gr}$	0.115	0.156	0.197	0.242	0.288	0.336	0.386	0.440	0.496	0.554	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)										f'_c = 4,000 psi f_y = 60,000 psi
	8" Deep Rib + 5.0" Top Slab = 13.0" Total Depth										
BOTTOM BARS	# 3 # 3	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	Deflection Coeff. (3)
Steel (psf)	0.35	0.48	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
12'-0"	192	310	430	571	715	784*	807*	830*	858*	886*	0.277
	0	0	0	0	0	878	1044	1115*	1143*	1170*	
13'-0"	148	249	351	471	593	705*	725*	747*	772*	798*	0.382
	0	0	0	0	0	732	874	1006*	1031*	1057*	
14'-0"	113	200	288	392	497	617	657*	677*	700*	725*	0.514
	0	0	0	0	0	0	739	882	913*	919*	
15'-0"	85	160	237	328	419	524	600*	618*	640*	662*	0.677
	0	0	0	0	0	0	630	755	802*	807*	
16'-0"	62	128	195	275	356	447	541	567*	587*	608*	0.877
	0	0	0	0	0	0	0	651	713*	718*	
17'-0"	42	101	161	232	303	384	467	523*	542*	562*	1.117
	0	0	0	0	0	0	0	564	639*	644*	
18'-0"		79	132	195	259	331	405	484*	502*	521*	1.404
		0	0	0	0	0	0	492	578*	582*	
19'-0"		60	108	164	221	286	353	430	467*	485*	1.743
		0	0	0	0	0	0	0	510	530*	
20'-0"		44	87	138	189	248	308	378	436*	452*	2.140
		0	0	0	0	0	0	0	450	481	
21'-0"			69	115	162	215	269	333	398	423*	2.602
			0	0	0	0	0	0	0	426	
22'-0"			53	95	138	187	236	294	349+	379	3.134
			0	0	0	0	0	0	0	0	
23'-0"			40	78	117	162	207	260	306+	338	3.744
			0	0	0	0	0	0	0	0	
24'-0"				63	99	140	181	230	269+	301	4.438
				0	0	0	0	0	0	0	
25'-0"				50	83	121	159	204	238+	264+	5.226
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.22	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	
STEEL PERCENT	0.07	0.10	0.13	0.17	0.20	0.25	0.29	0.35	0.40	0.46	
DEPTH, D IN.	11.81	11.75	11.75	11.69	11.69	11.62	11.62	11.56	11.56	11.50	
$+I_{cr}/I_{gr}$	0.102	0.138	0.174	0.214	0.255	0.298	0.342	0.390	0.441	0.492	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 5.0" Top Slab = 15.0" Total Depth										
BOTTOM BARS	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	Deflection Coeff. (3)
Steel (psf)	0.50	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	2.56	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	175	257	354	453	565	607*	626*	647*	670*	695*	0.843
	0	0	0	0	0	680	771*	780*	788*	798*	
17'-0"	142	215	301	388	488	559*	577*	597*	618*	641*	1.074
	0	0	0	0	0	590	692*	700*	707*	718*	
18'-0"	115	179	257	334	424	514	534*	552*	572*	595*	1.350
	0	0	0	0	0	0	621	634*	640*	650*	
19'-0"	92	150	219	289	369	450	496*	513*	532*	553*	1.676
	0	0	0	0	0	0	546	578*	584*	592*	
20'-0"	72	124	187	250	322	395	462*	478*	496*	516*	2.058
	0	0	0	0	0	0	482	529*	535*	543*	
21'-0"	55	102	159	216	282	348	427	447*	464*	483*	2.502
	0	0	0	0	0	0	0	487*	492*	500*	
22'-0"	40	83	135	187	247	307	379	419*	436*	454*	3.013
	0	0	0	0	0	0	0	450*	455*	463*	
23'-0"		67	114	162	216	272	337	394*	410*	427*	3.600
		0	0	0	0	0	0	404	423*	430*	
24'-0"		52	96	140	190	241	301	362	381	396	4.268
		0	0	0	0	0	0	0	0	0	
25'-0"		40	80	120	166	213	269	325	342	357	5.025
		0	0	0	0	0	0	0	0	0	
26'-0"			65	103	145	189	240	292	308	321	5.878
			0	0	0	0	0	0	0	0	
27'-0"			52	87	127	167	214	263	278	290	6.836
			0	0	0	0	0	0	0	0	
28'-0"			41	73	110	147	192	237	251	262	7.906
			0	0	0	0	0	0	0	0	
29'-0"				61	95	130	171	213	226	237	9.098
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	
STEEL PERCENT	0.09	0.12	0.15	0.18	0.22	0.26	0.31	0.35	0.41	0.47	
DEPTH, D IN.	13.75	13.75	13.69	13.69	13.62	13.62	13.56	13.56	13.50	13.50	
$+I_{cr}/I_{gr}$	0.140	0.177	0.219	0.260	0.305	0.351	0.401	0.454	0.508	0.566	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 5.0" Top Slab = 15.0" Total Depth										
BOTTOM BARS	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	Deflection Coeff. (3)
Steel (psf)	0.48	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	2.46	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	160	239	333	428	536	647	684*	705*	726*	750*	0.877
	0	0	0	0	0	0	777	866*	873*	883*	
17'-0"	129	199	282	366	462	560	631*	650*	670*	693*	1.117
	0	0	0	0	0	0	675	779*	785*	794*	
18'-0"	102	165	239	314	400	487	584*	602*	621*	642*	1.404
	0	0	0	0	0	0	590	695	711*	720*	
19'-0"	80	136	203	270	347	425	518	560*	577*	598*	1.743
	0	0	0	0	0	0	0	612	648*	657*	
20'-0"	61	112	172	233	302	373	456	522*	539*	558*	2.140
	0	0	0	0	0	0	0	541	595*	603*	
21'-0"	45	91	145	200	263	327	403	480	505*	523*	2.602
	0	0	0	0	0	0	0	0	548*	556*	
22'-0"		72	122	172	230	288	357	427	474*	491*	3.134
		0	0	0	0	0	0	0	507*	514*	
23'-0"		57	102	148	200	254	317	381	446*	462*	3.744
		0	0	0	0	0	0	0	454	478*	
24'-0"		43	84	127	175	224	282	341	408	436*	4.438
		0	0	0	0	0	0	0	0	443	
25'-0"			69	108	152	197	251	305	367	399	5.226
			0	0	0	0	0	0	0	0	
26'-0"			55	91	132	174	223	274	331	361	6.113
			0	0	0	0	0	0	0	0	
27'-0"			43	76	114	153	199	245	298	326	7.109
			0	0	0	0	0	0	0	0	
28'-0"				63	98	134	177	220	269	295	8.223
				0	0	0	0	0	0	0	
29'-0"				51	84	117	157	197	240+	267	9.462
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	
STEEL PERCENT	0.09	0.11	0.14	0.17	0.21	0.25	0.29	0.34	0.40	0.45	
DEPTH, D IN.	13.75	13.75	13.69	13.69	13.62	13.62	13.56	13.56	13.50	13.50	
$+I_{cr}/I_{gr}$	0.124	0.157	0.193	0.231	0.270	0.311	0.356	0.402	0.451	0.502	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 5.0" Top Slab = 17.0" Total Depth										
BOTTOM BARS	# 3 # 4	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	Deflection Coeff. (3)
Steel (psf)	0.50	0.64	0.82	1.00	1.22	1.44	1.70	1.96	2.26	2.56	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	139	214	303	392	495	599	632*	651*	671*	694*	1.350
	0	0	0	0	0	0	724	756*	764*	775*	
19'-0"	113	180	259	340	432	526	587*	605*	624*	645*	1.676
	0	0	0	0	0	0	637	690*	697*	707*	
20'-0"	90	150	222	295	378	463	547*	564*	582*	602*	2.058
	0	0	0	0	0	0	563	633*	640*	649*	
21'-0"	71	125	191	256	332	409	500	527*	544*	563*	2.502
	0	0	0	0	0	0	0	583*	590*	599*	
22'-0"	54	104	163	223	292	362	445	494*	511*	529*	3.013
	0	0	0	0	0	0	0	529	546*	555*	
23'-0"		85	139	194	257	321	397	465*	480*	497*	3.600
		0	0	0	0	0	0	474	508*	516*	
24'-0"		68	118	168	226	285	355	426	452*	469*	4.268
		0	0	0	0	0	0	0	473*	481*	
25'-0"		53	99	146	199	253	318	383	427*	443*	5.025
		0	0	0	0	0	0	0	442*	450*	
26'-0"		40	83	126	175	225	285	345	404*	419*	5.878
		0	0	0	0	0	0	0	414	422*	
27'-0"			68	108	154	200	255	311	375	392	6.836
			0	0	0	0	0	0	0	0	
28'-0"			55	92	135	178	229	281	341	356	7.906
			0	0	0	0	0	0	0	0	
29'-0"			43	78	117	158	205	254	309	324	9.098
			0	0	0	0	0	0	0	0	
30'-0"				65	102	139	184	230	281	295	10.419
				0	0	0	0	0	0	0	
31'-0"				53	88	123	165	207	256	269	11.879
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.31	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	
STEEL PERCENT	0.08	0.10	0.13	0.16	0.19	0.23	0.27	0.31	0.36	0.41	
DEPTH, D IN.	15.75	15.75	15.69	15.69	15.62	15.62	15.56	15.56	15.50	15.50	
$+I_{cr}/I_{gr}$	0.127	0.160	0.199	0.237	0.278	0.320	0.368	0.416	0.467	0.521	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 5.0" Top Slab = 17.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.62	0.79	0.96	1.17	1.39	1.64	1.89	2.18	2.46	2.80	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	196	282	368	467	568	687	709*	728*	750*	771*	1.404
	0	0	0	0	0	0	809	843*	854*	862*	
19'-0"	163	240	318	406	497	604	659*	677*	697*	717*	1.743
	0	0	0	0	0	0	713	770*	780*	787*	
20'-0"	135	205	274	355	436	533	615*	632*	651*	670*	2.140
	0	0	0	0	0	0	631	707*	716*	723*	
21'-0"	111	174	237	310	384	472	561	591*	609*	627*	2.602
	0	0	0	0	0	0	0	652*	661*	668*	
22'-0"	90	148	205	272	339	419	500	555*	572*	589*	3.134
	0	0	0	0	0	0	0	593	613*	619*	
23'-0"	72	124	177	238	300	373	447	522*	538*	555*	3.744
	0	0	0	0	0	0	0	532	570*	576*	
24'-0"	56	104	153	208	265	332	401	478	508*	523*	4.438
	0	0	0	0	0	0	0	0	532*	538*	
25'-0"	42	86	131	182	234	296	359	431	480*	495*	5.226
	0	0	0	0	0	0	0	0	498*	503*	
26'-0"		70	112	159	207	265	323	389	454*	469*	6.113
		0	0	0	0	0	0	0	457	472*	
27'-0"		56	95	139	183	236	290	352	415	445*	7.109
		0	0	0	0	0	0	0	0	0	
28'-0"		44	79	120	162	211	261	319	377	411	8.223
		0	0	0	0	0	0	0	0	0	
29'-0"			65	104	142	188	235	289	343	374	9.462
			0	0	0	0	0	0	0	0	
30'-0"			53	89	125	168	212	262	312	342	10.836
			0	0	0	0	0	0	0	0	
31'-0"			42	75	109	149	190	237	285	312	12.355
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.10	0.13	0.15	0.18	0.22	0.26	0.30	0.34	0.39	0.45	
DEPTH, D IN.	15.75	15.69	15.69	15.62	15.62	15.56	15.56	15.50	15.50	15.44	
$+I_{cr}/I_{gr}$	0.142	0.176	0.210	0.247	0.284	0.326	0.369	0.415	0.463	0.509	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 3.0" Top Slab = 11.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
14'-0"	178 0	242 0	307 0	333* 380	347* 451	362* 461*	380* 466*	398* 470*	418* 476*	438* 480*	0.692
15'-0"	146 0	202 0	259 0	304* 323	317* 384	331* 397	347* 408*	364* 411*	383* 417*	402* 421*	0.912
16'-0"	121 0	170 0	220 0	276 0	291* 330	304* 341	319* 357	335* 365*	352* 370*	370* 374*	1.180
17'-0"	100 0	143 0	187 0	237 0	268* 285	280* 295	294* 308	309* 326*	326* 332*	342* 0	1.504
18'-0"	82 0	120 0	160 0	204 0	247 0	256 0	268 0	285 0	302* 0	318* 0	1.890
19'-0"	67 0	101 0	137 0	177 0	215 0	223 0	234 0	249 0	281* 0	296* 0	2.347
20'-0"	54 0	85 0	117 0	153 0	188 0	195 0	205 0	218 0	255 0	277* 0	2.881
21'-0"	43 0	71 0	100 0	133 0	162+ 0	171 0	180 0	192 0	225 0	260* 0	3.502
22'-0"		59 0	85 0	115 0	141+ 0	150 0	158 0	169 0	200 0	231 0	4.219
23'-0"		48 0	73 0	100 0	123+ 0	131 0	139 0	149 0	177 0	206 0	5.039
24'-0"			61 0	86 0	108+ 0	115 0	122 0	132 0	157 0	184 0	5.975
25'-0"			51 0	74 0	95+ 0	101 0	108 0	116 0	140 0	164 0	7.035
26'-0"			43 0	64 0	84 0	89 0	94 0	102 0	124 0	147 0	8.229
27'-0"				55 0	74 0	77 0	83 0	90 0	111 0	131 0	9.570

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.36 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.12	0.15	0.18	0.22	0.26	0.31	0.36	0.42	0.48	0.54	
DEPTH, D IN.	9.75	9.69	9.69	9.62	9.62	9.56	9.56	9.50	9.50	9.44	
$+I_{cr}/I_{gr}$	0.207	0.254	0.303	0.353	0.406	0.463	0.523	0.583	0.649	0.708	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 3.0" Top Slab = 11.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.45	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
14'-0"	169 0	231 0	294 0	366 0	385* 439	399* 523*	416* 528*	433* 531*	453* 537*	472* 540*	0.712
15'-0"	138 0	192 0	248 0	310 0	351* 374	365* 447	380* 463*	396* 466*	415* 471*	433* 474*	0.938
16'-0"	113 0	161 0	209 0	264 0	320 0	335* 385	350* 400	365* 412	382* 419*	399* 421*	1.214
17'-0"	93 0	135 0	178 0	226 0	276 0	309* 333	323* 346	337* 357	353* 372	369* 378*	1.547
18'-0"	75 0	113 0	151 0	195 0	239 0	286* 0	299* 302	311 0	325 0	343* 0	1.944
19'-0"	61 0	94 0	129 0	168 0	208 0	243+ 0	264 0	272 0	284 0	319 0	2.414
20'-0"	48 0	79 0	110 0	145 0	181 0	208+ 0	231 0	239 0	250 0	281 0	2.964
21'-0"		65 0	93 0	125 0	158 0	180+ 0	204 0	211 0	221 0	249 0	3.602
22'-0"		53 0	79 0	108 0	138 0	156+ 0	176+ 0	186 0	195 0	221 0	4.339
23'-0"		43 0	66 0	93 0	120 0	137+ 0	154+ 0	164 0	173 0	196 0	5.183
24'-0"			55 0	80 0	105 0	120+ 0	135+ 0	145 0	153 0	175 0	6.145
25'-0"			46 0	68 0	91 0	106+ 0	119+ 0	129 0	136 0	156 0	7.235
26'-0"				58 0	79 0	94+ 0	106+ 0	114 0	120 0	139 0	8.464
27'-0"				49 0	69 0	84+ 0	95+ 0	101 0	107 0	124 0	9.844

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.37 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.11	0.15	0.18	0.22	0.25	0.30	0.35	0.41	0.46	0.53	
DEPTH, D IN.	9.75	9.69	9.69	9.62	9.62	9.56	9.56	9.50	9.50	9.44	
$+I_{cr}/I_{gr}$	0.182	0.224	0.267	0.311	0.358	0.408	0.461	0.515	0.573	0.625	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 3.0" Top Slab = 13.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
15'-0"	186	253	322	380*	394*	408*	424*	441*	460*	479*	0.912
	0	0	0	400	480	511*	517*	522*	529*	534*	
16'-0"	155	214	275	343	361*	374*	389*	405*	423*	441*	1.180
	0	0	0	0	414	454*	459*	464*	470*	475*	
17'-0"	129	182	235	296	333*	345*	359*	374*	391*	408*	1.504
	0	0	0	0	358	407*	412*	416*	422*	426*	
18'-0"	107	154	202	257	308*	320*	333*	347*	363*	379*	1.890
	0	0	0	0	312	368*	373*	376*	382*	386*	
19'-0"	89	131	174	223	273	297*	310*	323*	338*	353*	2.347
	0	0	0	0	0	332	339*	342*	348*	0	
20'-0"	74	112	151	195	240	277*	289*	302*	316*	330*	2.881
	0	0	0	0	0	293	306	314*	319*	0	
21'-0"	60	95	130	170	211	259	270*	281	293	309*	3.502
	0	0	0	0	0	0	271	0	0	0	
22'-0"	49	80	112	149	186	230	241	249	261	291*	4.219
	0	0	0	0	0	0	0	0	0	0	
23'-0"		67	97	130	164	204	214	222	233	261	5.039
		0	0	0	0	0	0	0	0	0	
24'-0"		56	83	114	145	182	191	198	208	234	5.975
		0	0	0	0	0	0	0	0	0	
25'-0"		46	71	99	128	162	170	177	186	210	7.035
		0	0	0	0	0	0	0	0	0	
26'-0"			60	87	113	144	152	159	167	189	8.229
			0	0	0	0	0	0	0	0	
27'-0"			51	75	100	129	136	142	150	170	9.570
			0	0	0	0	0	0	0	0	
28'-0"			42	65	88	115	122	127	134	153	11.069
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.39 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.10	0.12	0.15	0.18	0.22	0.26	0.30	0.35	0.39	0.45	
DEPTH, D IN.	11.75	11.69	11.69	11.62	11.62	11.56	11.56	11.50	11.50	11.44	
$+I_{cr}/I_{gr}$	0.184	0.227	0.270	0.317	0.365	0.418	0.473	0.530	0.591	0.648	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 3.0" Top Slab = 13.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.45	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	145	203	262	329	397	413*	427*	442*	460*	477*	1.214
	0	0	0	0	0	478	518*	521*	528*	532*	
17'-0"	120	171	223	283	343	381*	394*	409*	425*	441*	1.547
	0	0	0	0	0	415	465*	468*	474*	478*	
18'-0"	99	145	191	244	298	353*	366*	379*	394*	409*	1.944
	0	0	0	0	0	362	420*	424*	429*	433*	
19'-0"	81	122	164	212	260	317	340*	353*	367*	382*	2.414
	0	0	0	0	0	0	376	386*	391*	395*	
20'-0"	66	103	141	184	228	279	318*	330*	343*	357*	2.964
	0	0	0	0	0	0	332	354*	358*	362*	
21'-0"	53	87	121	160	200	246	294	309*	322*	335*	3.602
	0	0	0	0	0	0	0	315	328	0	
22'-0"	42	73	104	139	175	218	262	281	292	301	4.339
	0	0	0	0	0	0	0	0	0	0	
23'-0"		60	89	121	154	193	233	251	261	269	5.183
		0	0	0	0	0	0	0	0	0	
24'-0"		49	75	105	135	171	204+	224	234	241	6.145
		0	0	0	0	0	0	0	0	0	
25'-0"		40	64	91	119	152	181+	201	209	216	7.235
		0	0	0	0	0	0	0	0	0	
26'-0"			53	79	105	135	161+	180	188	194	8.464
			0	0	0	0	0	0	0	0	
27'-0"			44	68	92	120	143+	160+	169	175	9.844
			0	0	0	0	0	0	0	0	
28'-0"				58	80	106	128+	143+	152	157	11.385
				0	0	0	0	0	0	0	
29'-0"				49	70	94	115+	129+	137	142	13.101
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.41 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.09	0.12	0.15	0.18	0.21	0.25	0.29	0.34	0.38	0.43	
DEPTH, D IN.	11.75	11.69	11.69	11.62	11.62	11.56	11.56	11.50	11.50	11.44	
$+I_{cr}/I_{gr}$	0.162	0.200	0.239	0.280	0.323	0.369	0.418	0.469	0.523	0.573	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 3.0" Top Slab = 15.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	132	187	243	308	372*	384*	398*	412*	428*	444*	1.890
	0	0	0	0	373	450*	456*	461*	467*	473*	
19'-0"	111	160	211	268	327	357*	370*	383*	398*	413*	2.347
	0	0	0	0	0	397	416*	420*	426*	431*	
20'-0"	92	137	183	235	288	333*	345*	358*	372*	386*	2.881
	0	0	0	0	0	351	381*	385*	391*	396*	
21'-0"	77	117	159	206	254	311	323*	335*	348*	362*	3.502
	0	0	0	0	0	0	351*	355*	360*	365*	
22'-0"	63	100	138	181	225	277	303*	314*	327*	340*	4.219
	0	0	0	0	0	0	325*	328*	334*	0	
23'-0"	51	85	120	159	199	247	285*	296*	308*	320*	5.039
	0	0	0	0	0	0	295	305*	310*	0	
24'-0"	41	72	104	140	177	220	265	279*	291*	300	5.975
	0	0	0	0	0	0	0	0	0	0	
25'-0"		60	90	123	157	197	238	251	262	271	7.035
		0	0	0	0	0	0	0	0	0	
26'-0"		50	77	108	139	176	214	227	236	245	8.229
		0	0	0	0	0	0	0	0	0	
27'-0"		41	66	95	124	158	193	205	214	221	9.570
		0	0	0	0	0	0	0	0	0	
28'-0"			56	83	110	142	174	185	193	200	11.069
			0	0	0	0	0	0	0	0	
29'-0"			47	72	97	127	157	167	175	182	12.737
			0	0	0	0	0	0	0	0	
30'-0"				62	86	114	142	151	159	165	14.587
				0	0	0	0	0	0	0	
31'-0"				53	75	102	128	137	144	150	16.631
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.42 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.08	0.11	0.13	0.16	0.18	0.22	0.25	0.29	0.33	0.38	
DEPTH, D IN.	13.75	13.69	13.69	13.62	13.62	13.56	13.56	13.50	13.50	13.44	
$+I_{cr}/I_{gr}$	0.165	0.205	0.245	0.288	0.332	0.381	0.432	0.486	0.542	0.596	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 3.0" Top Slab = 15.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.45	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	121	175	230	292	356	424*	437*	450*	466*	481*	1.944
	0	0	0	0	0	432	509	515*	522*	526*	
19'-0"	101	149	198	254	311	379	406*	419*	433*	448*	2.414
	0	0	0	0	0	0	448	470*	476*	481*	
20'-0"	83	127	171	222	273	334	379*	391*	405*	418*	2.964
	0	0	0	0	0	0	397	431*	437*	441*	
21'-0"	68	107	147	193	240	296	352	366*	379*	392*	3.602
	0	0	0	0	0	0	0	398*	403*	407*	
22'-0"	54	91	127	169	212	262	314	344*	356*	369*	4.339
	0	0	0	0	0	0	0	368*	373*	377*	
23'-0"	43	76	109	148	187	233	280	324*	336*	347*	5.183
	0	0	0	0	0	0	0	334	347*	351*	
24'-0"		63	94	129	165	207	251	300	317*	328*	6.145
		0	0	0	0	0	0	0	323*	0	
25'-0"		52	80	113	146	185	225	270	295	303	7.235
		0	0	0	0	0	0	0	0	0	
26'-0"		42	68	98	129	165	202	244	266	274	8.464
		0	0	0	0	0	0	0	0	0	
27'-0"			57	85	113	147	181	220	241	248	9.844
			0	0	0	0	0	0	0	0	
28'-0"			48	73	100	131	163	199	218	225	11.385
			0	0	0	0	0	0	0	0	
29'-0"				63	87	117	146	180	198	204	13.101
				0	0	0	0	0	0	0	
30'-0"				54	76	104	131	163	180	185	15.004
				0	0	0	0	0	0	0	
31'-0"				45	66	92	118	148	163	169	17.106
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.08	0.10	0.13	0.15	0.18	0.21	0.25	0.29	0.33	0.37	
DEPTH, D IN.	13.75	13.69	13.69	13.62	13.62	13.56	13.56	13.50	13.50	13.44	
$+I_{cr}/I_{gr}$	0.146	0.181	0.217	0.255	0.294	0.338	0.383	0.431	0.481	0.529	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	14" Deep Rib + 3.0" Top Slab = 17.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
19'-0"	132	189	247	314	381	422*	435*	449*	464*	479*	2.347
	0	0	0	0	0	462	496*	501*	508*	514*	
20'-0"	111	163	215	275	336	394*	406*	419*	433*	447*	2.881
	0	0	0	0	0	409	455*	460*	467*	472*	
21'-0"	93	140	187	242	297	363	380*	392*	406*	419*	3.502
	0	0	0	0	0	0	420*	424*	431*	436*	
22'-0"	78	120	163	213	264	324	356*	368*	381*	394*	4.219
	0	0	0	0	0	0	385	393*	399*	404*	
23'-0"	64	103	143	188	234	289	335*	346*	358*	371*	5.039
	0	0	0	0	0	0	345	366*	371*	376*	
24'-0"	52	88	124	166	208	259	310	326*	338*	350*	5.975
	0	0	0	0	0	0	0	341*	347*	351*	
25'-0"	42	75	108	147	186	232	280	308*	320*	331*	7.035
	0	0	0	0	0	0	0	319*	324*	0	
26'-0"		63	94	129	165	208	252	292*	303*	314*	8.229
		0	0	0	0	0	0	299*	304*	0	
27'-0"		52	81	114	147	187	228	274	287	296	9.570
		0	0	0	0	0	0	0	0	0	
28'-0"		43	69	100	131	168	206	249	261	269	11.069
		0	0	0	0	0	0	0	0	0	
29'-0"			59	88	117	151	187	227	238	246	12.737
			0	0	0	0	0	0	0	0	
30'-0"			50	77	104	136	169	207	217	224	14.587
			0	0	0	0	0	0	0	0	
31'-0"			42	67	92	122	153	188	198	205	16.631
			0	0	0	0	0	0	0	0	
32'-0"				57	81	110	139	172	181	187	18.883
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.46 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.07	0.09	0.11	0.14	0.16	0.19	0.22	0.26	0.29	0.33	
DEPTH, D IN.	15.75	15.69	15.69	15.62	15.62	15.56	15.56	15.50	15.50	15.44	
$+I_{cr}/I_{gr}$	0.151	0.187	0.224	0.264	0.305	0.351	0.398	0.448	0.501	0.553	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)										f'_c = 4,000 psi f_y = 60,000 psi
	14" Deep Rib + 3.0" Top Slab = 17.0" Total Depth										
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)
Steel (psf)	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
20'-0"	151	202	261	320	391	447*	459*	473*	486*	502*	2.964
	0	0	0	0	0	463	513*	520*	525*	532*	
21'-0"	129	175	228	282	346	412	430*	443*	456*	470*	3.602
	0	0	0	0	0	0	474*	480*	485*	492*	
22'-0"	110	152	200	249	308	367	403*	416*	428*	442*	4.339
	0	0	0	0	0	0	436	445*	450*	456*	
23'-0"	93	132	176	221	274	329	380*	392*	403*	417*	5.183
	0	0	0	0	0	0	391	414*	419*	425*	
24'-0"	78	114	154	196	245	295	352	370*	381*	393*	6.145
	0	0	0	0	0	0	0	387*	391*	397*	
25'-0"	65	98	135	173	219	265	318	349*	360*	372*	7.235
	0	0	0	0	0	0	0	362*	366*	0	
26'-0"	54	84	119	154	196	238	287	331*	341*	353*	8.464
	0	0	0	0	0	0	0	337	344*	0	
27'-0"	44	72	104	136	175	215	260	306	324*	335*	9.844
	0	0	0	0	0	0	0	0	0	0	
28'-0"		61	90	121	157	194	236	279	304	314	11.385
		0	0	0	0	0	0	0	0	0	
29'-0"		51	78	107	140	175	214	254	277	287	13.101
		0	0	0	0	0	0	0	0	0	
30'-0"		42	68	94	125	157	194	231	253	262	15.004
		0	0	0	0	0	0	0	0	0	
31'-0"			58	82	112	142	176	211	232	240	17.106
			0	0	0	0	0	0	0	0	
32'-0"			49	72	100	128	160	193	212	220	19.423
			0	0	0	0	0	0	0	0	
33'-0"			41	63	89	115	145	176	194	202	21.967
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	
STEEL PERCENT	0.09	0.11	0.13	0.16	0.19	0.21	0.25	0.28	0.32	0.36	
DEPTH, D IN.	15.69	15.69	15.62	15.62	15.56	15.56	15.50	15.50	15.44	15.44	
$+I_{cr}/I_{gr}$	0.166	0.199	0.234	0.271	0.311	0.354	0.399	0.446	0.492	0.540	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	16" Deep Rib + 3.0" Top Slab = 19.0" Total Depth										
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)
Steel (psf)	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
21'-0"	150	202	262	323	396	470	497*	510*	523*	538*	3.602
	0	0	0	0	0	0	552*	559*	565*	572*	
22'-0"	128	175	230	286	352	420	466*	479*	491*	505*	4.339
	0	0	0	0	0	0	497	519*	524*	532*	
23'-0"	109	153	203	253	314	376	439*	451*	462*	476*	5.183
	0	0	0	0	0	0	447	483*	488*	495*	
24'-0"	93	132	178	225	281	338	403	425*	436*	449*	6.145
	0	0	0	0	0	0	0	451*	456*	463*	
25'-0"	78	115	157	200	251	304	364	402*	413*	425*	7.235
	0	0	0	0	0	0	0	423*	428*	434*	
26'-0"	65	99	138	178	225	274	329	381*	391*	403*	8.464
	0	0	0	0	0	0	0	386	402*	408*	
27'-0"	53	85	121	158	202	247	299	351	371*	382*	9.844
	0	0	0	0	0	0	0	0	379*	385*	
28'-0"	43	72	106	140	181	223	271	320	353*	364*	11.385
	0	0	0	0	0	0	0	0	358*	0	
29'-0"		61	93	124	163	202	246	292	336*	346*	13.101
		0	0	0	0	0	0	0	338*	0	
30'-0"		51	80	110	146	182	224	266	312	330*	15.004
		0	0	0	0	0	0	0	0	0	
31'-0"		42	69	97	131	165	204	244	286	311	17.106
		0	0	0	0	0	0	0	0	0	
32'-0"			59	85	117	149	185	223	262	286	19.423
			0	0	0	0	0	0	0	0	
33'-0"			50	75	104	134	169	204	241	264	21.967
			0	0	0	0	0	0	0	0	
34'-0"			42	65	93	121	153	187	222	243	24.753
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	
STEEL PERCENT	0.08	0.10	0.12	0.14	0.16	0.19	0.22	0.25	0.29	0.32	
DEPTH, D IN.	17.69	17.69	17.62	17.62	17.56	17.56	17.50	17.50	17.44	17.44	
$+I_{cr}/I_{gr}$	0.153	0.184	0.217	0.251	0.290	0.329	0.372	0.416	0.460	0.506	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	16" Deep Rib + 3.0" Top Slab = 19.0" Total Depth										
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)
Steel (psf)	0.55	0.68	0.83	0.97	1.15	1.33	1.53	1.73	1.97	2.21	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
21'-0"	137	188	246	306	377	449	532	550*	562*	577*	3.702
	0	0	0	0	0	0	0	610*	616*	623*	
22'-0"	116	162	216	270	334	400	476	516*	528*	542*	4.460
	0	0	0	0	0	0	0	553	572*	579*	
23'-0"	98	140	189	238	297	357	427	486*	497*	510*	5.327
	0	0	0	0	0	0	0	497	533*	539*	
24'-0"	81	120	165	211	265	320	384	448	469*	482*	6.316
	0	0	0	0	0	0	0	0	498*	504*	
25'-0"	67	103	144	186	236	287	346	405	444*	456*	7.436
	0	0	0	0	0	0	0	0	467*	473*	
26'-0"	55	88	126	165	211	258	312	367	421*	432*	8.700
	0	0	0	0	0	0	0	0	426	445*	
27'-0"	43	74	109	145	188	232	282	333	388	410*	10.117
	0	0	0	0	0	0	0	0	0	419*	
28'-0"		62	95	128	168	209	255	303	353	390*	11.701
		0	0	0	0	0	0	0	0	396*	
29'-0"		51	82	113	150	188	231	276	323	371	13.465
		0	0	0	0	0	0	0	0	0	
30'-0"		41	70	99	134	169	209	251	295	340	15.420
		0	0	0	0	0	0	0	0	0	
31'-0"			59	86	119	152	190	229	270	312	17.581
			0	0	0	0	0	0	0	0	
32'-0"			49	75	105	136	172	208	247	287	19.962
			0	0	0	0	0	0	0	0	
33'-0"			40	64	93	122	156	190	226	264	22.577
			0	0	0	0	0	0	0	0	
34'-0"				55	82	109	141	173	207	242	25.440
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	
STEEL PERCENT	0.08	0.09	0.12	0.13	0.16	0.18	0.21	0.24	0.28	0.31	
DEPTH, D IN.	17.69	17.69	17.62	17.62	17.56	17.56	17.50	17.50	17.44	17.44	
$+I_{cr}/I_{gr}$	0.139	0.166	0.197	0.227	0.262	0.298	0.337	0.377	0.417	0.459	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	20" Deep Rib + 3.0" Top Slab = 23.0" Total Depth										
BOTTOM BARS	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	# 9 #10	#10 #10	Deflection Coeff. (3)
Steel (psf)	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27	2.57	2.87	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
26'-0"	176	225	284	343	412	482	500*	512*	526*	541*	8.464
	0	0	0	0	0	0	524*	532*	539*	549*	
27'-0"	155	200	255	310	374	439	475*	486*	499*	514*	9.844
	0	0	0	0	0	0	494*	501*	509*	518*	
28'-0"	136	179	229	281	340	401	451*	462*	475*	489*	11.385
	0	0	0	0	0	0	466	474*	481*	490*	
29'-0"	120	159	206	254	310	366	427	440*	452*	466*	13.101
	0	0	0	0	0	0	0	449*	456*	0	
30'-0"	105	142	186	231	282	335	391	419*	431*	444*	15.004
	0	0	0	0	0	0	0	426*	433*	0	
31'-0"	91	126	167	209	258	307	360	400*	412*	424*	17.106
	0	0	0	0	0	0	0	405*	0	0	
32'-0"	79	111	150	189	235	281	331	381	393*	406*	19.423
	0	0	0	0	0	0	0	0	0	0	
33'-0"	67	98	134	172	214	258	304	352	377*	388*	21.967
	0	0	0	0	0	0	0	0	0	0	
34'-0"	57	86	120	155	196	237	280	325	361*	372*	24.753
	0	0	0	0	0	0	0	0	0	0	
35'-0"	48	75	107	140	178	217	258	301	346*	357*	27.796
	0	0	0	0	0	0	0	0	0	0	
36'-0"		65	95	127	163	199	238	278	328	343*	31.111
		0	0	0	0	0	0	0	0	0	
37'-0"		55	85	114	148	183	220	258	304	321	34.715
		0	0	0	0	0	0	0	0	0	
38'-0"		47	74	102	135	168	203	238	283	299	38.623
		0	0	0	0	0	0	0	0	0	
39'-0"			65	92	122	153	187	221	263	278	42.852
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	2.27	2.54	
STEEL PERCENT	0.10	0.11	0.13	0.15	0.18	0.20	0.23	0.26	0.30	0.33	
DEPTH, D IN.	21.62	21.62	21.56	21.56	21.50	21.50	21.44	21.44	21.36	21.36	
$+I_{cr}/I_{gr}$	0.190	0.220	0.255	0.290	0.328	0.368	0.408	0.449	0.497	0.546	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	20" Deep Rib + 3.0" Top Slab = 23.0" Total Depth										
BOTTOM BARS	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	# 9 #10	#10 #10	Deflection Coeff. (3)
Steel (psf)	0.83	0.97	1.15	1.33	1.53	1.73	1.97	2.21	2.50	2.79	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
26'-0"	162	210	267	325	393	461	534	551*	564*	579*	8.700
	0	0	0	0	0	0	0	577*	585*	594*	
27'-0"	142	186	239	293	356	419	487	523*	535*	550*	10.117
	0	0	0	0	0	0	0	545*	552*	561*	
28'-0"	124	165	214	265	322	381	444	497*	509*	523*	11.701
	0	0	0	0	0	0	0	509	522*	530*	
29'-0"	108	146	192	239	293	348	406	466	485*	498*	13.465
	0	0	0	0	0	0	0	0	494*	503*	
30'-0"	93	129	172	216	266	317	372	428	462*	475*	15.420
	0	0	0	0	0	0	0	0	469*	477*	
31'-0"	80	113	154	194	242	290	341	394	442*	454*	17.581
	0	0	0	0	0	0	0	0	446*	0	
32'-0"	68	99	137	175	220	265	313	362	422*	434*	19.962
	0	0	0	0	0	0	0	0	423	0	
33'-0"	57	86	122	158	200	242	287	334	391	416*	22.577
	0	0	0	0	0	0	0	0	0	0	
34'-0"	47	75	108	142	181	221	264	308	362	398*	25.440
	0	0	0	0	0	0	0	0	0	0	
35'-0"		64	96	128	165	202	243	284	335	382*	28.568
		0	0	0	0	0	0	0	0	0	
36'-0"		54	84	114	149	185	223	262	310	359	31.975
		0	0	0	0	0	0	0	0	0	
37'-0"		45	73	102	135	169	205	242	287	334	35.679
		0	0	0	0	0	0	0	0	0	
38'-0"			64	91	122	154	188	223	267	311	39.696
			0	0	0	0	0	0	0	0	
39'-0"			54	80	110	140	173	206	247	289	44.042
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	2.27	2.54	
STEEL PERCENT	0.09	0.11	0.13	0.15	0.17	0.20	0.23	0.25	0.29	0.32	
DEPTH, D IN.	21.62	21.62	21.56	21.56	21.50	21.50	21.44	21.44	21.36	21.36	
$+I_{cr}/I_{gr}$	0.173	0.200	0.231	0.263	0.298	0.334	0.371	0.408	0.452	0.497	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 4.0" Top Slab = 12.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
14'-0"	189	259	331	362*	376*	391*	409*	427*	447*	468*	0.692
	0	0	0	413	497	509*	515*	519*	526*	531*	
15'-0"	154	216	278	329*	342*	356*	372*	389*	408*	427*	0.912
	0	0	0	350	423	445*	450*	454*	460*	465*	
16'-0"	126	180	235	298	313*	326*	341*	357*	375*	393*	1.180
	0	0	0	0	362	393*	398*	402*	408*	412*	
17'-0"	102	150	199	255	288*	300*	314*	329*	346*	362*	1.504
	0	0	0	0	311	349	355*	359*	364*	368*	
18'-0"	83	125	169	218	265*	277*	290*	304*	320*	336*	1.890
	0	0	0	0	269	303	316	323*	328*	0	
19'-0"	66	104	144	188	233	256*	269*	282*	297*	312*	2.347
	0	0	0	0	0	264	276	286	0	0	
20'-0"	52	86	122	162	203	230	241	251	276	291*	2.881
	0	0	0	0	0	0	0	0	0	0	
21'-0"	40	71	103	139	177	201	211	220	243	272*	3.502
	0	0	0	0	0	0	0	0	0	0	
22'-0"		58	87	120	154	176	185	193	214	249	4.219
		0	0	0	0	0	0	0	0	0	
23'-0"		46	73	103	134	155	163	170	189	221	5.039
		0	0	0	0	0	0	0	0	0	
24'-0"			60	88	116	135	143	150	167	197	5.975
			0	0	0	0	0	0	0	0	
25'-0"			49	75	101	119	126	132	148	175	7.035
			0	0	0	0	0	0	0	0	
26'-0"			40	63	87	104	110	116	131	156	8.229
			0	0	0	0	0	0	0	0	
27'-0"				53	75	90	96	102	115	139	9.570
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.11	0.14	0.17	0.20	0.24	0.28	0.32	0.38	0.43	0.49	
DEPTH, D IN.	10.75	10.69	10.69	10.62	10.62	10.56	10.56	10.50	10.50	10.44	
$+I_{cr}/I_{gr}$	0.194	0.239	0.285	0.334	0.384	0.438	0.496	0.555	0.618	0.676	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 4.0" Top Slab = 12.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.45	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
14'-0"	178	247	317	396	417*	432*	449*	466*	486*	505*	0.712
	0	0	0	0	478	573	582*	585*	592*	596*	
15'-0"	144	204	265	334	380*	393*	409*	425*	444*	462*	0.938
	0	0	0	0	405	488	509*	513*	519*	523*	
16'-0"	116	169	223	284	346	360*	375*	390*	407*	424*	1.214
	0	0	0	0	0	419	451*	454*	460*	463*	
17'-0"	94	140	188	242	297	332*	345*	359*	376*	392*	1.547
	0	0	0	0	0	362	403*	406*	411*	415*	
18'-0"	75	116	159	207	256	306*	319*	333*	348*	363*	1.944
	0	0	0	0	0	314	357	366*	371*	374*	
19'-0"	58	96	134	177	221	273	296*	309*	323*	337*	2.414
	0	0	0	0	0	0	312	322	335	340*	
20'-0"	45	78	113	152	192	238	273	282	294	304	2.964
	0	0	0	0	0	0	0	0	0	0	
21'-0"		63	94	130	166	208	240	248	259	268	3.602
		0	0	0	0	0	0	0	0	0	
22'-0"		50	79	111	144	182	212	219	229	237	4.339
		0	0	0	0	0	0	0	0	0	
23'-0"			65	94	124	160	186	193	202	210	5.183
			0	0	0	0	0	0	0	0	
24'-0"			53	80	108	140	164	170	179	186	6.145
			0	0	0	0	0	0	0	0	
25'-0"			42	67	93	123	145	151	158	165	7.235
			0	0	0	0	0	0	0	0	
26'-0"				56	79	107	128	133	140	146	8.464
				0	0	0	0	0	0	0	
27'-0"				46	67	93	112	117	124	129	9.844
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.46 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.10	0.13	0.16	0.20	0.23	0.27	0.32	0.37	0.42	0.48	
DEPTH, D IN.	10.75	10.69	10.69	10.62	10.62	10.56	10.56	10.50	10.50	10.44	
$+I_{cr}/I_{gr}$	0.171	0.211	0.252	0.294	0.339	0.387	0.438	0.490	0.546	0.598	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 4.0" Top Slab = 14.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
15'-0"	192	266	341	408*	422*	436*	452*	469*	488*	507*	0.912
	0	0	0	426	513	554*	560*	565*	573*	579*	
16'-0"	158	223	289	364	386*	399*	414*	430*	448*	466*	1.180
	0	0	0	0	441	491*	497*	501*	509*	514*	
17'-0"	130	188	246	313	354*	367*	381*	396*	413*	430*	1.504
	0	0	0	0	380	439*	445*	449*	456*	461*	
18'-0"	107	158	210	270	327*	339*	352*	366*	382*	398*	1.890
	0	0	0	0	330	396*	401*	405*	412*	416*	
19'-0"	87	133	180	233	287	314*	326*	340*	355*	370*	2.347
	0	0	0	0	0	352	364*	368*	374*	378*	
20'-0"	70	112	154	202	251	292*	304*	316*	331*	345*	2.881
	0	0	0	0	0	309	333*	336*	342*	346*	
21'-0"	56	94	132	175	220	272*	283*	295*	309*	322*	3.502
	0	0	0	0	0	0	305*	309*	314*	0	
22'-0"	43	78	112	152	193	241	265*	277*	289*	302*	4.219
	0	0	0	0	0	0	274	284	0	0	
23'-0"		64	96	132	169	213	243	252	264	276	5.039
		0	0	0	0	0	0	0	0	0	
24'-0"		52	81	114	148	188	217	225	235	246	5.975
		0	0	0	0	0	0	0	0	0	
25'-0"		41	68	98	130	167	193	200	210	220	7.035
		0	0	0	0	0	0	0	0	0	
26'-0"			56	85	114	148	172	179	188	197	8.229
			0	0	0	0	0	0	0	0	
27'-0"			46	72	99	131	153	160	168	177	9.570
			0	0	0	0	0	0	0	0	
28'-0"				61	86	116	136	142	150	158	11.069
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.47 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.09	0.11	0.14	0.17	0.20	0.24	0.27	0.32	0.36	0.41	
DEPTH, D IN.	12.75	12.69	12.69	12.62	12.62	12.56	12.56	12.50	12.50	12.44	
$+I_{cr}/I_{gr}$	0.173	0.214	0.256	0.300	0.346	0.397	0.450	0.505	0.563	0.619	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 4.0" Top Slab = 14.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.45	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	148	211	275	348	423	441*	456*	471*	489*	506*	1.214
	0	0	0	0	0	511	560*	564*	571*	576*	
17'-0"	121	177	233	298	364	406*	420*	434*	451*	467*	1.547
	0	0	0	0	0	442	502*	506*	512*	517*	
18'-0"	98	148	199	256	315	375*	388*	402*	417*	432*	1.944
	0	0	0	0	0	385	453*	457*	463*	467*	
19'-0"	79	124	169	221	274	336	360*	373*	388*	402*	2.414
	0	0	0	0	0	0	400	416*	421*	425*	
20'-0"	63	103	144	191	238	295	336*	348*	362*	375*	2.964
	0	0	0	0	0	0	352	380*	385*	389*	
21'-0"	48	85	122	165	208	259	311	325*	338*	351*	3.602
	0	0	0	0	0	0	0	349*	354*	358*	
22'-0"		70	103	142	181	228	276	304*	317*	329*	4.339
		0	0	0	0	0	0	322	327*	330*	
23'-0"		56	87	122	158	201	245	286*	298*	307	5.183
		0	0	0	0	0	0	287	0	0	
24'-0"		44	73	105	138	177	217	256	266	274	6.145
		0	0	0	0	0	0	0	0	0	
25'-0"			60	90	120	156	193	229	238	246	7.235
			0	0	0	0	0	0	0	0	
26'-0"			49	76	105	138	172	205	214	221	8.464
			0	0	0	0	0	0	0	0	
27'-0"				64	90	121	153	184	192	198	9.844
				0	0	0	0	0	0	0	
28'-0"				54	78	107	136	164	172	178	11.385
				0	0	0	0	0	0	0	
29'-0"				44	67	93	121	147	154	160	13.101
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.49 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.09	0.11	0.14	0.17	0.19	0.23	0.27	0.31	0.35	0.40	
DEPTH, D IN.	12.75	12.69	12.69	12.62	12.62	12.56	12.56	12.50	12.50	12.44	
$+I_{cr}/I_{gr}$	0.153	0.189	0.226	0.265	0.306	0.351	0.397	0.446	0.498	0.547	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 4.0" Top Slab = 16.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	132	191	252	321	391	406*	420*	434*	450*	466*	1.890
	0	0	0	0	0	475	486*	492*	499*	505*	
19'-0"	109	162	216	278	342	376*	389*	403*	418*	433*	2.347
	0	0	0	0	0	417	443*	447*	454*	460*	
20'-0"	89	137	186	242	299	350*	362*	375*	389*	404*	2.881
	0	0	0	0	0	367	405*	410*	416*	421*	
21'-0"	72	116	160	211	263	325	338*	350*	364*	377*	3.502
	0	0	0	0	0	0	372*	377*	383*	388*	
22'-0"	58	98	138	184	232	288	316*	328*	341*	354*	4.219
	0	0	0	0	0	0	344*	348*	354*	358*	
23'-0"	45	82	119	161	204	255	297*	308*	320*	332*	5.039
	0	0	0	0	0	0	308	322*	328*	0	
24'-0"		67	101	140	180	227	275	290*	301*	313*	5.975
		0	0	0	0	0	0	300*	305*	0	
25'-0"		55	86	122	159	202	246	273*	284*	295*	7.035
		0	0	0	0	0	0	279*	0	0	
26'-0"		44	73	106	140	180	221	252	262	271	8.229
		0	0	0	0	0	0	0	0	0	
27'-0"			61	92	123	160	198	227	237	245	9.570
			0	0	0	0	0	0	0	0	
28'-0"			50	79	108	142	178	204	214	221	11.069
			0	0	0	0	0	0	0	0	
29'-0"			41	67	94	127	159	184	193	200	12.737
			0	0	0	0	0	0	0	0	
30'-0"				57	82	112	143	166	174	181	14.587
				0	0	0	0	0	0	0	
31'-0"				47	71	99	128	150	157	164	16.631
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.08	0.10	0.12	0.15	0.17	0.20	0.24	0.27	0.31	0.35	
DEPTH, D IN.	14.75	14.69	14.69	14.62	14.62	14.56	14.56	14.50	14.50	14.44	
$+I_{cr}/I_{gr}$	0.156	0.193	0.231	0.272	0.314	0.361	0.410	0.461	0.515	0.568	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 4.0" Top Slab = 16.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.45	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	122	180	238	306	374	451*	464*	477*	493*	508*	1.944
	0	0	0	0	0	456	539	552*	559*	564*	
19'-0"	100	152	204	265	326	399	430*	443*	458*	472*	2.414
	0	0	0	0	0	0	474	503*	509*	514*	
20'-0"	81	128	175	230	285	351	401*	413*	427*	440*	2.964
	0	0	0	0	0	0	418	461*	467*	471*	
21'-0"	64	107	150	199	250	310	371	386*	399*	412*	3.602
	0	0	0	0	0	0	0	424*	430*	434*	
22'-0"	50	89	128	173	219	274	329	362*	374*	386*	4.339
	0	0	0	0	0	0	0	392*	397*	402*	
23'-0"		73	109	150	192	242	293	340*	352*	363*	5.183
		0	0	0	0	0	0	351	369*	373*	
24'-0"		59	92	130	169	215	261	315	331*	342*	6.145
		0	0	0	0	0	0	0	343*	347*	
25'-0"		47	78	113	148	190	233	283	313*	323*	7.235
		0	0	0	0	0	0	0	321*	324*	
26'-0"			65	97	130	169	209	254	295*	306*	8.464
			0	0	0	0	0	0	299	0	
27'-0"			53	83	113	150	187	229	270	278	9.844
			0	0	0	0	0	0	0	0	
28'-0"			43	70	99	132	167	206	245	252	11.385
			0	0	0	0	0	0	0	0	
29'-0"				59	86	117	149	186	222	228	13.101
				0	0	0	0	0	0	0	
30'-0"				49	74	103	133	167	201	207	15.004
				0	0	0	0	0	0	0	
31'-0"				40	63	91	119	150	182	188	17.106
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.08	0.10	0.12	0.14	0.17	0.20	0.23	0.27	0.30	0.34	
DEPTH, D IN.	14.75	14.69	14.69	14.62	14.62	14.56	14.56	14.50	14.50	14.44	
$+I_{cr}/I_{gr}$	0.138	0.171	0.204	0.241	0.278	0.320	0.363	0.408	0.456	0.503	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	14" Deep Rib + 4.0" Top Slab = 18.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
19'-0"	130	191	253	324	396	445*	458*	471*	486*	501*	2.347
	0	0	0	0	0	482	524*	530*	538*	544*	
20'-0"	108	163	219	283	348	414*	426*	439*	453*	467*	2.881
	0	0	0	0	0	425	481*	486*	493*	499*	
21'-0"	89	139	189	247	306	377	397*	410*	423*	437*	3.502
	0	0	0	0	0	0	443*	448*	455*	460*	
22'-0"	72	118	164	217	270	335	372*	384*	397*	410*	4.219
	0	0	0	0	0	0	400	414*	421*	426*	
23'-0"	58	99	141	190	239	298	349*	360*	373*	385*	5.039
	0	0	0	0	0	0	358	384*	391*	396*	
24'-0"	45	83	122	166	212	266	320	339*	351*	363*	5.975
	0	0	0	0	0	0	0	358*	364*	369*	
25'-0"		69	105	146	187	237	288	319*	331*	342*	7.035
		0	0	0	0	0	0	334*	340*	345*	
26'-0"		56	89	127	166	212	259	302*	313*	324*	8.229
		0	0	0	0	0	0	312	318*	0	
27'-0"		45	76	111	147	189	233	282	296*	306*	9.570
		0	0	0	0	0	0	0	299*	0	
28'-0"			64	96	130	169	209	256	281*	291*	11.069
			0	0	0	0	0	0	0	0	
29'-0"			53	83	114	151	189	232	260	268	12.737
			0	0	0	0	0	0	0	0	
30'-0"			43	71	100	135	170	210	236	244	14.587
			0	0	0	0	0	0	0	0	
31'-0"				61	88	120	153	191	215	222	16.631
				0	0	0	0	0	0	0	
32'-0"				51	76	107	137	173	196	203	18.883
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.07	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.31	
DEPTH, D IN.	16.75	16.69	16.69	16.62	16.62	16.56	16.56	16.50	16.50	16.44	
$+I_{cr}/I_{gr}$	0.142	0.176	0.211	0.249	0.287	0.331	0.376	0.424	0.474	0.524	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)										f'_c = 4,000 psi f_y = 60,000 psi
	14" Deep Rib + 4.0" Top Slab = 18.0" Total Depth										
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)
Steel (psf)	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
20'-0"	151	205	267	331	406	470*	482*	496*	510*	525*	2.964
	0	0	0	0	0	483	543*	550*	556*	563*	
21'-0"	127	176	233	290	359	429	451*	464*	477*	491*	3.602
	0	0	0	0	0	0	501*	507*	513*	520*	
22'-0"	107	152	203	256	318	382	422*	435*	447*	461*	4.339
	0	0	0	0	0	0	454	470*	475*	482*	
23'-0"	89	130	177	225	282	340	397*	409*	420*	434*	5.183
	0	0	0	0	0	0	407	436*	441*	448*	
24'-0"	73	111	154	198	251	304	365	385*	396*	409*	6.145
	0	0	0	0	0	0	0	407*	411*	418*	
25'-0"	60	94	134	175	223	272	329	363*	374*	386*	7.235
	0	0	0	0	0	0	0	380*	385*	391*	
26'-0"	47	79	116	154	199	244	296	343*	354*	365*	8.464
	0	0	0	0	0	0	0	349	361*	367*	
27'-0"		66	100	135	177	219	267	317	335*	346*	9.844
		0	0	0	0	0	0	0	339*	0	
28'-0"		54	86	119	157	196	241	287	318*	329*	11.385
		0	0	0	0	0	0	0	319*	0	
29'-0"		44	73	104	139	176	218	261	302*	313*	13.101
		0	0	0	0	0	0	0	0	0	
30'-0"			62	90	124	158	197	237	278	287	15.004
			0	0	0	0	0	0	0	0	
31'-0"			51	78	109	141	178	215	254	263	17.106
			0	0	0	0	0	0	0	0	
32'-0"			42	67	96	126	161	196	232	240	19.423
			0	0	0	0	0	0	0	0	
33'-0"				57	84	113	145	178	212	220	21.967
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	
STEEL PERCENT	0.08	0.10	0.13	0.15	0.17	0.20	0.23	0.27	0.30	0.34	
DEPTH, D IN.	16.69	16.69	16.62	16.62	16.56	16.56	16.50	16.50	16.44	16.44	
$+I_{cr}/I_{gr}$	0.156	0.187	0.221	0.255	0.294	0.334	0.377	0.421	0.465	0.511	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	16" Deep Rib + 4.0" Top Slab = 20.0" Total Depth										
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)
Steel (psf)	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
21'-0"	148	203	267	331	408	487	520*	534*	547*	562*	3.602
	0	0	0	0	0	0	577	587*	594*	602*	
22'-0"	125	175	233	292	362	434	487*	500*	513*	527*	4.339
	0	0	0	0	0	0	516	544*	550*	558*	
23'-0"	105	151	204	258	322	388	458*	470*	482*	495*	5.183
	0	0	0	0	0	0	463	507*	512*	520*	
24'-0"	88	130	178	228	287	347	416	443*	454*	467*	6.145
	0	0	0	0	0	0	0	473*	478*	485*	
25'-0"	72	111	156	201	256	311	375	418*	428*	441*	7.235
	0	0	0	0	0	0	0	440	448*	454*	
26'-0"	58	94	136	178	228	279	338	395*	405*	417*	8.464
	0	0	0	0	0	0	0	398	420*	427*	
27'-0"	46	79	118	157	204	251	306	361	384*	395*	9.844
	0	0	0	0	0	0	0	0	395*	401*	
28'-0"		66	102	138	182	226	277	328	364*	375*	11.385
		0	0	0	0	0	0	0	373*	378*	
29'-0"		54	88	121	162	203	250	299	346*	357*	13.101
		0	0	0	0	0	0	0	350	358*	
30'-0"		44	75	106	144	183	227	272	320	340*	15.004
		0	0	0	0	0	0	0	0	0	
31'-0"			63	93	128	164	205	248	293	324*	17.106
			0	0	0	0	0	0	0	0	
32'-0"			52	80	113	147	186	226	268	309*	19.423
			0	0	0	0	0	0	0	0	
33'-0"			43	69	100	132	168	206	245	286	21.967
			0	0	0	0	0	0	0	0	
34'-0"				58	88	118	152	187	225	263	24.753
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	
STEEL PERCENT	0.08	0.09	0.11	0.13	0.16	0.18	0.21	0.24	0.27	0.30	
DEPTH, D IN.	18.69	18.69	18.62	18.62	18.56	18.56	18.50	18.50	18.44	18.44	
$+I_{cr}/I_{gr}$	0.144	0.172	0.204	0.236	0.272	0.309	0.350	0.392	0.433	0.477	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	16" Deep Rib + 4.0" Top Slab = 20.0" Total Depth										
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)
Steel (psf)	0.55	0.68	0.83	0.97	1.15	1.33	1.53	1.73	1.97	2.21	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
21'-0"	136	190	252	315	390	466	554	578*	590*	605*	3.702
	0	0	0	0	0	0	0	643*	649*	657*	
22'-0"	114	163	219	276	345	415	495	542*	554*	567*	4.460
	0	0	0	0	0	0	0	576	602*	609*	
23'-0"	94	139	191	243	306	370	443	509*	520*	534*	5.327
	0	0	0	0	0	0	0	518	560*	567*	
24'-0"	77	118	166	214	272	330	397	466	490*	503*	6.316
	0	0	0	0	0	0	0	0	523*	530*	
25'-0"	62	100	144	188	241	295	357	420	463*	475*	7.436
	0	0	0	0	0	0	0	0	488	497*	
26'-0"	49	84	124	165	214	264	322	380	438*	450*	8.700
	0	0	0	0	0	0	0	0	442	467*	
27'-0"		70	107	145	191	237	290	344	402	426*	10.117
		0	0	0	0	0	0	0	0	439*	
28'-0"		57	92	127	169	212	262	312	366	405*	11.701
		0	0	0	0	0	0	0	0	414*	
29'-0"		45	78	110	150	190	236	283	333	384	13.465
		0	0	0	0	0	0	0	0	0	
30'-0"			65	96	133	170	213	257	304	351	15.420
			0	0	0	0	0	0	0	0	
31'-0"			54	82	117	152	192	233	277	322	17.581
			0	0	0	0	0	0	0	0	
32'-0"			43	70	103	136	173	212	253	295	19.962
			0	0	0	0	0	0	0	0	
33'-0"				59	90	121	156	193	231	271	22.577
				0	0	0	0	0	0	0	
34'-0"				49	78	107	141	175	211	248	25.440
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	
STEEL PERCENT	0.07	0.09	0.11	0.13	0.15	0.17	0.20	0.23	0.26	0.29	
DEPTH, D IN.	18.69	18.69	18.62	18.62	18.56	18.56	18.50	18.50	18.44	18.44	
$+I_{cr}/I_{gr}$	0.130	0.156	0.184	0.213	0.246	0.280	0.317	0.354	0.392	0.432	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	20" Deep Rib + 4.0" Top Slab = 24.0" Total Depth										
BOTTOM BARS	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	# 9 #10	#10 #10	Deflection Coeff. (3)
Steel (psf)	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27	2.57	2.87	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
26'-0"	175	226	288	350	423	496	519*	531*	545*	561*	8.464
	0	0	0	0	0	0	545*	553*	562*	572*	
27'-0"	153	201	258	316	383	451	492*	504*	517*	532*	9.844
	0	0	0	0	0	0	514*	521*	529*	539*	
28'-0"	134	178	231	285	347	411	467*	478*	491*	505*	11.385
	0	0	0	0	0	0	479	492*	500*	509*	
29'-0"	116	157	207	257	315	374	438	455*	467*	480*	13.101
	0	0	0	0	0	0	0	466*	473*	482*	
30'-0"	100	139	185	232	287	342	401	433*	445*	458*	15.004
	0	0	0	0	0	0	0	442*	449*	0	
31'-0"	86	122	166	210	261	312	368	413*	424*	437*	17.106
	0	0	0	0	0	0	0	419*	426*	0	
32'-0"	73	107	148	189	237	285	337	390	405*	417*	19.423
	0	0	0	0	0	0	0	0	0	0	
33'-0"	61	93	132	170	215	261	310	360	387*	399*	21.967
	0	0	0	0	0	0	0	0	0	0	
34'-0"	51	81	117	153	196	239	285	332	370*	382*	24.753
	0	0	0	0	0	0	0	0	0	0	
35'-0"	41	69	103	138	178	218	262	306	355*	366*	27.796
	0	0	0	0	0	0	0	0	0	0	
36'-0"		58	91	123	161	199	240	282	334	351*	31.111
		0	0	0	0	0	0	0	0	0	
37'-0"		49	79	110	146	182	221	261	310	337*	34.715
		0	0	0	0	0	0	0	0	0	
38'-0"		40	69	98	132	166	203	241	287	319	38.623
		0	0	0	0	0	0	0	0	0	
39'-0"			59	87	119	152	187	222	266	296	42.852
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	2.27	2.54	
STEEL PERCENT	0.09	0.11	0.13	0.15	0.17	0.20	0.22	0.25	0.28	0.32	
DEPTH, D IN.	22.62	22.62	22.56	22.56	22.50	22.50	22.44	22.44	22.36	22.36	
$+I_{cr}/I_{gr}$	0.178	0.206	0.238	0.271	0.307	0.344	0.382	0.421	0.467	0.514	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	20" Deep Rib + 4.0" Top Slab = 24.0" Total Depth										
BOTTOM BARS	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	# 9 #10	#10 #10	Deflection Coeff. (3)
Steel (psf)	0.83	0.97	1.15	1.33	1.53	1.73	1.97	2.21	2.50	2.79	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
26'-0"	159	209	270	330	401	472	549	571*	584*	599*	8.700
	0	0	0	0	0	0	0	600*	608*	617*	
27'-0"	138	185	240	297	362	429	500	541*	554*	568*	10.117
	0	0	0	0	0	0	0	565*	573*	582*	
28'-0"	119	162	214	267	328	389	455	514*	526*	540*	11.701
	0	0	0	0	0	0	0	523	541*	550*	
29'-0"	102	143	191	240	296	354	416	478	501*	514*	13.465
	0	0	0	0	0	0	0	0	513*	521*	
30'-0"	87	125	170	215	268	322	380	438	477*	490*	15.420
	0	0	0	0	0	0	0	0	486*	494*	
31'-0"	73	108	151	193	243	293	347	402	455*	467*	17.581
	0	0	0	0	0	0	0	0	462*	470*	
32'-0"	61	94	133	173	220	267	318	369	434	446*	19.962
	0	0	0	0	0	0	0	0	0	447*	
33'-0"	49	80	118	155	199	243	291	340	400	427*	22.577
	0	0	0	0	0	0	0	0	0	0	
34'-0"		68	103	139	180	222	267	312	369	408*	25.440
		0	0	0	0	0	0	0	0	0	
35'-0"		57	90	123	162	202	244	287	341	391*	28.568
		0	0	0	0	0	0	0	0	0	
36'-0"		46	78	110	146	184	224	264	315	367	31.975
		0	0	0	0	0	0	0	0	0	
37'-0"			67	97	132	167	205	243	291	340	35.679
			0	0	0	0	0	0	0	0	
38'-0"			56	85	118	151	187	224	269	316	39.696
			0	0	0	0	0	0	0	0	
39'-0"			47	74	105	137	171	206	249	293	44.042
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	2.27	2.54	
STEEL PERCENT	0.09	0.11	0.12	0.14	0.17	0.19	0.22	0.24	0.27	0.31	
DEPTH, D IN.	22.62	22.62	22.56	22.56	22.50	22.50	22.44	22.44	22.36	22.36	
$+I_{cr}/I_{gr}$	0.161	0.187	0.216	0.246	0.279	0.313	0.347	0.383	0.424	0.467	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 4.5" Top Slab = 12.5" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
15'-0"	158	222	288	343*	356*	370*	386*	403*	422*	441*	0.912
	0	0	0	363	439	466*	471*	476*	482*	487*	
16'-0"	128	185	243	309	325*	338*	353*	369*	387*	405*	1.180
	0	0	0	0	376	411*	417*	420*	427*	431*	
17'-0"	104	154	205	263	298*	310*	324*	339*	356*	373*	1.504
	0	0	0	0	323	367*	372*	375*	381*	385*	
18'-0"	83	128	174	226	274*	286*	299*	313*	329*	345*	1.890
	0	0	0	0	279	328	334*	337*	343*	347*	
19'-0"	66	106	147	194	241	265*	277*	290*	305*	320*	2.347
	0	0	0	0	0	286	299	305*	310*	0	
20'-0"	51	87	124	166	209	245*	257*	270*	284*	298*	2.881
	0	0	0	0	0	249	261	271	0	0	
21'-0"		71	105	143	182	218	229	238	252	278*	3.502
		0	0	0	0	0	0	0	0	0	
22'-0"		57	88	122	158	191	201	209	222	259	4.219
		0	0	0	0	0	0	0	0	0	
23'-0"		45	73	104	137	167	176	184	195	229	5.039
		0	0	0	0	0	0	0	0	0	
24'-0"			60	89	119	147	155	162	172	204	5.975
			0	0	0	0	0	0	0	0	
25'-0"			48	75	103	128	136	142	152	181	7.035
			0	0	0	0	0	0	0	0	
26'-0"				63	88	112	119	125	134	161	8.229
				0	0	0	0	0	0	0	
27'-0"				52	76	98	104	110	118	143	9.570
				0	0	0	0	0	0	0	
28'-0"				42	64	85	91	96	104	126	11.069
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.10	0.13	0.16	0.19	0.23	0.27	0.31	0.36	0.41	0.47	
DEPTH, D IN.	11.25	11.19	11.19	11.12	11.12	11.06	11.06	11.00	11.00	10.94	
$+I_{cr}/I_{gr}$	0.188	0.232	0.276	0.324	0.373	0.426	0.482	0.540	0.602	0.659	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 4.5" Top Slab = 12.5" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.45	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
15'-0"	147	210	274	347	396*	409*	425*	441*	459*	478*	0.938
	0	0	0	0	422	509	534*	537*	544*	548*	
16'-0"	119	174	230	294	360	374*	389*	404*	421*	438*	1.214
	0	0	0	0	0	436	472*	475*	482*	485*	
17'-0"	95	144	194	250	308	344*	358*	372*	388*	404*	1.547
	0	0	0	0	0	376	422*	425*	431*	434*	
18'-0"	75	118	163	213	265	317*	330*	344*	359*	374*	1.944
	0	0	0	0	0	326	380*	383*	388*	391*	
19'-0"	58	97	137	182	229	283	306*	319*	333*	347*	2.414
	0	0	0	0	0	0	339	347*	352*	355*	
20'-0"	43	79	115	156	198	247	284*	296*	310*	324*	2.964
	0	0	0	0	0	0	297	306	319	0	
21'-0"		63	96	133	171	215	261	269	281	290	3.602
		0	0	0	0	0	0	0	0	0	
22'-0"		49	79	113	148	188	230	237	248	256	4.339
		0	0	0	0	0	0	0	0	0	
23'-0"			65	96	127	164	202	209	219	227	5.183
			0	0	0	0	0	0	0	0	
24'-0"			52	80	110	144	179	185	194	201	6.145
			0	0	0	0	0	0	0	0	
25'-0"			41	67	94	125	157	163	172	178	7.235
			0	0	0	0	0	0	0	0	
26'-0"				55	80	109	139	144	152	158	8.464
				0	0	0	0	0	0	0	
27'-0"				45	68	95	122	127	134	140	9.844
				0	0	0	0	0	0	0	
28'-0"					56	82	107	112	118	123	11.385
					0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.10	0.13	0.15	0.19	0.22	0.26	0.30	0.35	0.40	0.45	
DEPTH, D IN.	11.25	11.19	11.19	11.12	11.12	11.06	11.06	11.00	11.00	10.94	
$+I_{cr}/I_{gr}$	0.166	0.205	0.244	0.286	0.330	0.377	0.427	0.478	0.532	0.583	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 4.5" Top Slab = 14.5" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	161	228	297	375	399*	412*	427*	443*	462*	479*	1.180
	0	0	0	0	455	510*	516*	521*	529*	534*	
17'-0"	132	192	252	321	366*	379*	393*	408*	425*	442*	1.504
	0	0	0	0	392	456*	462*	467*	474*	479*	
18'-0"	107	161	215	277	337*	349*	363*	377*	393*	409*	1.890
	0	0	0	0	340	411*	416*	421*	427*	432*	
19'-0"	87	135	183	239	295	323*	336*	349*	364*	379*	2.347
	0	0	0	0	0	362	378*	382*	388*	393*	
20'-0"	69	113	156	206	257	300*	312*	325*	339*	353*	2.881
	0	0	0	0	0	318	345*	349*	354*	359*	
21'-0"	54	94	133	179	225	280*	291*	303*	316*	330*	3.502
	0	0	0	0	0	0	316*	320*	325*	0	
22'-0"	41	77	113	155	197	247	272*	283*	296*	309*	4.219
	0	0	0	0	0	0	291*	294*	299*	0	
23'-0"		62	96	133	172	218	254*	265*	278*	290*	5.039
		0	0	0	0	0	260	269	0	0	
24'-0"		50	80	115	150	192	231	239	251	260	5.975
		0	0	0	0	0	0	0	0	0	
25'-0"			67	99	131	170	206	213	224	232	7.035
			0	0	0	0	0	0	0	0	
26'-0"			55	84	114	150	183	190	200	208	8.229
			0	0	0	0	0	0	0	0	
27'-0"			44	71	99	132	163	170	179	186	9.570
			0	0	0	0	0	0	0	0	
28'-0"				60	86	117	145	151	160	166	11.069
				0	0	0	0	0	0	0	
29'-0"				49	74	102	129	135	142	149	12.737
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.51 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.09	0.11	0.13	0.16	0.19	0.23	0.26	0.31	0.35	0.40	
DEPTH, D IN.	13.25	13.19	13.19	13.12	13.12	13.06	13.06	13.00	13.00	12.94	
$+I_{cr}/I_{gr}$	0.169	0.209	0.249	0.293	0.338	0.387	0.439	0.493	0.550	0.605	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 4.5" Top Slab = 14.5" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.45	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	150	216	282	358	436	457*	472*	487*	505*	522*	1.214
	0	0	0	0	0	528	582*	587*	594*	599*	
17'-0"	122	180	239	307	375	420*	434*	448*	465*	481*	1.547
	0	0	0	0	0	457	521*	526*	532*	537*	
18'-0"	98	150	203	263	324	388*	401*	414*	430*	445*	1.944
	0	0	0	0	0	397	471*	475*	481*	485*	
19'-0"	78	125	172	226	281	346	372*	384*	399*	413*	2.414
	0	0	0	0	0	0	413	431*	437*	441*	
20'-0"	61	103	146	195	244	303	346*	358*	372*	385*	2.964
	0	0	0	0	0	0	363	394*	400*	404*	
21'-0"	47	85	123	168	213	266	320	334*	347*	360*	3.602
	0	0	0	0	0	0	0	362*	367*	371*	
22'-0"		69	104	144	185	234	283	313*	325*	337*	4.339
		0	0	0	0	0	0	334*	339*	342*	
23'-0"		55	87	124	161	206	251	293*	305*	317*	5.183
		0	0	0	0	0	0	303	313*	0	
24'-0"		42	72	106	140	181	223	270	285	293	6.145
		0	0	0	0	0	0	0	0	0	
25'-0"			59	90	122	159	198	241	255	262	7.235
			0	0	0	0	0	0	0	0	
26'-0"			47	76	105	140	175	216	228	235	8.464
			0	0	0	0	0	0	0	0	
27'-0"				63	90	123	156	193	205	211	9.844
				0	0	0	0	0	0	0	
28'-0"				52	77	107	138	173	183	190	11.385
				0	0	0	0	0	0	0	
29'-0"				42	66	94	122	155	164	170	13.101
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.08	0.11	0.13	0.16	0.19	0.22	0.26	0.30	0.34	0.38	
DEPTH, D IN.	13.25	13.19	13.19	13.12	13.12	13.06	13.06	13.00	13.00	12.94	
$+I_{cr}/I_{gr}$	0.149	0.184	0.220	0.259	0.298	0.342	0.388	0.436	0.487	0.535	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 4.5" Top Slab = 16.5" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	132 0	194 0	256 0	328 0	401 0	418* 487	432* 503*	446* 508*	462* 516*	478* 522*	1.890
19'-0"	108 0	164 0	220 0	284 0	350 0	387* 427	400* 457*	414* 462*	429* 469*	444* 475*	2.347
20'-0"	88 0	138 0	189 0	247 0	306 0	360* 376	372* 418*	385* 423*	399* 429*	413* 435*	2.881
21'-0"	71 0	116 0	162 0	215 0	268 0	332 0	347* 384*	359* 388*	373* 395*	386* 400*	3.502
22'-0"	56 0	97 0	139 0	187 0	236 0	294 0	324* 353	336* 358*	349* 364*	362* 369*	4.219
23'-0"	42 0	80 0	119 0	162 0	207 0	260 0	304* 314	315* 332*	327* 338*	340* 342*	5.039
24'-0"		66 0	101 0	141 0	182 0	231 0	281 0	296* 308*	308* 314*	319* 0	5.975
25'-0"		53 0	85 0	122 0	160 0	205 0	251 0	278* 287*	290* 292*	301* 0	7.035
26'-0"		41 0	71 0	106 0	141 0	182 0	224 0	263* 266	273* 0	284* 0	8.229
27'-0"			59 0	91 0	123 0	162 0	201 0	239 0	249 0	258 0	9.570
28'-0"			48 0	77 0	108 0	143 0	180 0	216 0	225 0	233 0	11.069
29'-0"				66 0	94 0	127 0	161 0	194 0	203 0	211 0	12.737
30'-0"				55 0	81 0	112 0	144 0	175 0	183 0	190 0	14.587
31'-0"				45 0	70 0	99 0	129 0	158 0	165 0	172 0	16.631

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.07	0.10	0.12	0.14	0.17	0.20	0.23	0.26	0.30	0.34	
DEPTH, D IN.	15.25	15.19	15.19	15.12	15.12	15.06	15.06	15.00	15.00	14.94	
$+I_{cr}/I_{gr}$	0.152	0.189	0.225	0.266	0.307	0.353	0.400	0.451	0.504	0.555	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 4.5" Top Slab = 16.5" Total Depth										
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)
Steel (psf)	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	182 0	243 0	313 0	383 0	465* 468	478* 554	491* 570*	507* 577*	522* 583*	539* 591*	1.944
19'-0"	153 0	207 0	270 0	334 0	409 0	443* 487	456* 519*	471* 526*	485* 531*	501* 539*	2.414
20'-0"	128 0	177 0	234 0	291 0	359 0	412* 429	424* 475*	438* 482*	452* 487*	467* 494*	2.964
21'-0"	107 0	151 0	202 0	255 0	317 0	380 0	396* 437*	409* 443*	422* 448*	437* 455*	3.602
22'-0"	88 0	129 0	175 0	223 0	279 0	337 0	371* 403	383* 410*	396* 414*	410* 421*	4.339
23'-0"	72 0	109 0	152 0	195 0	247 0	300 0	348* 360	360* 380*	372* 384*	385* 390*	5.183
24'-0"	58 0	92 0	131 0	171 0	218 0	267 0	322 0	339* 354*	350* 358*	363* 0	6.145
25'-0"	45 0	76 0	113 0	149 0	193 0	238 0	289 0	319* 330*	330* 334*	342* 0	7.235
26'-0"		63 0	96 0	130 0	171 0	212 0	259 0	302* 307	312* 0	324* 0	8.464
27'-0"		51 0	82 0	113 0	151 0	189 0	233 0	278 0	294 0	304 0	9.844
28'-0"		40 0	69 0	98 0	133 0	169 0	209 0	251 0	266 0	276 0	11.385
29'-0"			57 0	85 0	117 0	150 0	188 0	227 0	241 0	250 0	13.101
30'-0"			47 0	72 0	103 0	134 0	169 0	205 0	218 0	227 0	15.004
31'-0"				61 0	90 0	119 0	152 0	186 0	198 0	206 0	17.106

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	
STEEL PERCENT	0.09	0.11	0.14	0.16	0.19	0.22	0.26	0.29	0.33	0.37	
DEPTH, D IN.	15.19	15.19	15.12	15.12	15.06	15.06	15.00	15.00	14.94	14.94	
$+I_{cr}/I_{gr}$	0.167	0.199	0.235	0.271	0.312	0.354	0.399	0.446	0.492	0.541	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	14" Deep Rib + 4.5" Top Slab = 18.5" Total Depth										
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)
Steel (psf)	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	2.33	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
20'-0"	164	221	287	354	425*	437*	450*	464*	478*	494*	2.881
	0	0	0	0	434	494*	500*	507*	514*	522*	
21'-0"	139	191	251	311	384	407*	420*	433*	447*	462*	3.502
	0	0	0	0	0	455*	460*	467*	473*	481*	
22'-0"	117	164	219	274	341	381*	393*	406*	419*	433*	4.219
	0	0	0	0	0	408	425*	432*	438*	445*	
23'-0"	98	141	191	242	303	357*	368*	381*	393*	407*	5.039
	0	0	0	0	0	364	395*	401*	407*	413*	
24'-0"	82	121	167	214	270	326	346*	358*	370*	383*	5.975
	0	0	0	0	0	0	367*	373*	379*	385*	
25'-0"	67	104	146	189	240	292	326*	337*	349*	361*	7.035
	0	0	0	0	0	0	343*	349*	354*	0	
26'-0"	54	88	127	167	214	262	308*	319*	329*	342*	8.229
	0	0	0	0	0	0	318	326*	331*	0	
27'-0"	42	74	110	147	191	236	287	301*	312*	323*	9.570
	0	0	0	0	0	0	0	306*	0	0	
28'-0"		61	95	129	170	212	259	285*	295*	307*	11.069
		0	0	0	0	0	0	288*	0	0	
29'-0"		50	82	113	152	190	235	271*	280*	291*	12.737
		0	0	0	0	0	0	0	0	0	
30'-0"		40	69	99	135	171	212	247	255	265	14.587
		0	0	0	0	0	0	0	0	0	
31'-0"			58	86	120	153	192	225	232	242	16.631
			0	0	0	0	0	0	0	0	
32'-0"			48	74	106	138	174	204	212	221	18.883
			0	0	0	0	0	0	0	0	
33'-0"				64	93	123	157	186	193	201	21.356
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	
STEEL PERCENT	0.08	0.10	0.13	0.15	0.17	0.20	0.23	0.27	0.30	0.34	
DEPTH, D IN.	17.19	17.19	17.12	17.12	17.06	17.06	17.00	17.00	16.94	16.94	
$+I_{cr}/I_{gr}$	0.172	0.206	0.243	0.281	0.323	0.367	0.415	0.464	0.513	0.564	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	14" Deep Rib + 4.5" Top Slab = 18.5" Total Depth										
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)
Steel (psf)	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
20'-0"	151	207	271	337	415	483*	495*	509*	523*	538*	2.964
	0	0	0	0	0	494	559*	566*	572*	580*	
21'-0"	127	178	236	295	366	438	462*	475*	488*	503*	3.602
	0	0	0	0	0	0	515*	522*	527*	535*	
22'-0"	106	152	205	259	324	389	433*	445*	458*	472*	4.339
	0	0	0	0	0	0	464	483*	488*	495*	
23'-0"	88	130	179	228	287	347	406*	418*	430*	443*	5.183
	0	0	0	0	0	0	416	448*	453*	460*	
24'-0"	72	110	155	200	254	310	373	393*	405*	418*	6.145
	0	0	0	0	0	0	0	418*	423*	429*	
25'-0"	57	93	134	176	226	277	335	371*	382*	394*	7.235
	0	0	0	0	0	0	0	390*	395*	401*	
26'-0"	45	78	116	154	201	247	301	350*	361*	373*	8.464
	0	0	0	0	0	0	0	356	370*	376*	
27'-0"		64	99	135	178	222	271	322	342*	353*	9.844
		0	0	0	0	0	0	0	347*	0	
28'-0"		52	85	118	158	198	245	292	324*	335*	11.385
		0	0	0	0	0	0	0	327*	0	
29'-0"		41	72	103	140	177	221	265	308*	318*	13.101
		0	0	0	0	0	0	0	0	0	
30'-0"			60	89	123	159	199	240	284	301	15.004
			0	0	0	0	0	0	0	0	
31'-0"			49	76	109	142	179	218	259	275	17.106
			0	0	0	0	0	0	0	0	
32'-0"				65	95	126	162	198	236	252	19.423
				0	0	0	0	0	0	0	
33'-0"				54	83	112	145	180	216	230	21.967
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	
STEEL PERCENT	0.08	0.10	0.12	0.14	0.17	0.20	0.23	0.26	0.29	0.33	
DEPTH, D IN.	17.19	17.19	17.12	17.12	17.06	17.06	17.00	17.00	16.94	16.94	
$+I_{cr}/I_{gr}$	0.152	0.182	0.215	0.249	0.287	0.326	0.368	0.411	0.455	0.500	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)										f'_c = 4,000 psi f_y = 60,000 psi
	16" Deep Rib + 4.5" Top Slab = 20.5" Total Depth										
BOTTOM BARS	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	# 9 #10	Deflec-tion Coeff. (3)
Steel (psf)	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27	2.57	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
22'-0"	176	235	296	368	441	499*	512*	524*	538*	555*	4.339
	0	0	0	0	0	526	558*	564*	572*	580*	
23'-0"	151	205	261	327	394	468*	481*	492*	506*	521*	5.183
	0	0	0	0	0	471	519*	525*	532*	540*	
24'-0"	129	179	230	291	352	423	452*	464*	476*	491*	6.145
	0	0	0	0	0	0	484*	490*	497*	504*	
25'-0"	110	156	203	259	316	381	426*	437*	450*	464*	7.235
	0	0	0	0	0	0	448	458*	465*	472*	
26'-0"	93	135	178	230	283	344	403*	413*	425*	439*	8.464
	0	0	0	0	0	0	405	430*	437*	443*	
27'-0"	77	117	157	205	254	310	367	391*	403*	416*	9.844
	0	0	0	0	0	0	0	404*	411*	417*	
28'-0"	64	101	138	182	228	280	333	371*	382*	395*	11.385
	0	0	0	0	0	0	0	381*	387*	0	
29'-0"	52	86	121	162	204	253	303	352*	363*	375*	13.101
	0	0	0	0	0	0	0	356	365*	0	
30'-0"	40	73	105	144	183	229	275	325	345*	357*	15.004
	0	0	0	0	0	0	0	0	0	0	
31'-0"		60	91	127	164	207	250	297	329*	340*	17.106
		0	0	0	0	0	0	0	0	0	
32'-0"		50	78	112	147	187	228	271	314*	325*	19.423
		0	0	0	0	0	0	0	0	0	
33'-0"		40	66	99	131	169	207	248	290	307	21.967
		0	0	0	0	0	0	0	0	0	
34'-0"			56	86	117	152	188	227	266	282	24.753
			0	0	0	0	0	0	0	0	
35'-0"			46	75	104	137	171	207	244	260	27.796
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	2.27	
STEEL PERCENT	0.09	0.11	0.13	0.15	0.17	0.20	0.23	0.26	0.29	0.33	
DEPTH, D IN.	19.19	19.12	19.12	19.06	19.06	19.00	19.00	18.94	18.94	18.86	
$+I_{cr}/I_{gr}$	0.168	0.199	0.230	0.265	0.302	0.341	0.382	0.423	0.466	0.515	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)										f'_c = 4,000 psi f_y = 60,000 psi
	16" Deep Rib + 4.5" Top Slab = 20.5" Total Depth										
BOTTOM BARS	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	# 9 #10	#10 #10	Deflec-tion Coeff. (3)
Steel (psf)	0.83	0.97	1.15	1.33	1.53	1.73	1.97	2.21	2.50	2.79	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
24'-0"	166	216	275	335	404	475	501*	514*	528*	544*	6.316
	0	0	0	0	0	0	536*	543*	550*	559*	
25'-0"	144	189	244	299	363	428	473*	485*	499*	514*	7.436
	0	0	0	0	0	0	497	509*	515*	524*	
26'-0"	124	166	216	267	326	387	447*	459*	472*	487*	8.700
	0	0	0	0	0	0	451	478*	484*	492*	
27'-0"	106	145	192	239	294	350	409	435*	447*	462*	10.117
	0	0	0	0	0	0	0	449*	456*	463*	
28'-0"	90	126	170	214	265	317	372	413*	425*	439*	11.701
	0	0	0	0	0	0	0	424*	430*	0	
29'-0"	76	109	150	191	239	287	338	391	404*	417*	13.465
	0	0	0	0	0	0	0	0	406*	0	
30'-0"	63	94	132	171	215	260	308	357	385*	397*	15.420
	0	0	0	0	0	0	0	0	0	0	
31'-0"	51	81	116	152	194	236	281	327	367*	379*	17.581
	0	0	0	0	0	0	0	0	0	0	
32'-0"	40	68	101	135	174	214	256	299	350*	362*	19.962
	0	0	0	0	0	0	0	0	0	0	
33'-0"		57	88	120	157	194	234	274	324	346*	22.577
		0	0	0	0	0	0	0	0	0	
34'-0"		46	76	106	140	175	213	251	298	325	25.440
		0	0	0	0	0	0	0	0	0	
35'-0"			65	93	126	159	194	230	275	300	28.568
			0	0	0	0	0	0	0	0	
36'-0"			55	81	112	143	177	211	253	277	31.975
			0	0	0	0	0	0	0	0	
37'-0"			45	70	100	129	161	193	233	256	35.679
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	2.27	2.54	
STEEL PERCENT	0.11	0.12	0.15	0.17	0.20	0.22	0.26	0.29	0.33	0.36	
DEPTH, D IN.	19.12	19.12	19.06	19.06	19.00	19.00	18.94	18.94	18.86	18.86	
$+I_{cr}/I_{gr}$	0.180	0.208	0.240	0.273	0.309	0.346	0.383	0.421	0.466	0.513	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	20" Deep Rib + 4.5" Top Slab = 24.5" Total Depth										
BOTTOM BARS	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	# 9 #10	#10 #10	#10 #11	Deflection Coeff. (3)
Steel (psf)	1.00	1.18	1.36	1.57	1.78	2.02	2.27	2.57	2.87	3.21	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
29'-0"	156	207	259	318	378	443	462*	475*	488*	502*	13.101
	0	0	0	0	0	0	475*	482*	491*	0	
30'-0"	138	185	233	289	345	406	440*	452*	465*	478*	15.004
	0	0	0	0	0	0	450*	457*	466*	0	
31'-0"	120	165	210	262	315	372	419*	431*	443*	456*	17.106
	0	0	0	0	0	0	427*	434*	0	0	
32'-0"	105	147	189	238	287	341	395	411*	423*	435*	19.423
	0	0	0	0	0	0	0	412*	0	0	
33'-0"	91	130	170	216	262	312	363	392*	404*	416*	21.967
	0	0	0	0	0	0	0	0	0	0	
34'-0"	78	115	152	196	240	287	335	375*	387*	398*	24.753
	0	0	0	0	0	0	0	0	0	0	
35'-0"	66	101	136	177	219	263	308	359*	370*	381*	27.796
	0	0	0	0	0	0	0	0	0	0	
36'-0"	55	88	122	160	200	242	284	338	355*	366*	31.111
	0	0	0	0	0	0	0	0	0	0	
37'-0"	45	77	108	145	182	222	262	313	341*	351*	34.715
	0	0	0	0	0	0	0	0	0	0	
38'-0"		66	96	130	166	203	242	290	327*	337*	38.623
		0	0	0	0	0	0	0	0	0	
39'-0"		56	84	117	151	186	223	268	306	315	42.852
		0	0	0	0	0	0	0	0	0	
40'-0"		47	74	105	137	171	205	249	285	293	47.418
		0	0	0	0	0	0	0	0	0	
41'-0"			64	94	124	156	189	230	265	272	52.341
			0	0	0	0	0	0	0	0	
42'-0"			55	83	112	143	174	213	246	253	57.637
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.73 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.88	1.04	1.20	1.39	1.58	1.79	2.00	2.27	2.54	2.83	
STEEL PERCENT	0.11	0.13	0.14	0.17	0.19	0.22	0.24	0.28	0.31	0.34	
DEPTH, D IN.	23.12	23.06	23.06	23.00	23.00	22.94	22.94	22.86	22.86	22.80	
$+I_{cr}/I_{gr}$	0.200	0.232	0.264	0.299	0.336	0.373	0.411	0.455	0.502	0.547	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	20" Deep Rib + 4.5" Top Slab = 24.5" Total Depth										
BOTTOM BARS	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	# 9 #10	#10 #10	#10 #11	Deflection Coeff. (3)
Steel (psf)	0.97	1.15	1.33	1.53	1.73	1.97	2.21	2.50	2.79	3.12	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
28'-0"	162	215	269	331	394	462	524*	536*	550*	563*	11.701
	0	0	0	0	0	0	530	552*	561*	569*	
29'-0"	141	191	241	299	358	421	485	509*	523*	535*	13.465
	0	0	0	0	0	0	0	522*	531*	539*	
30'-0"	123	169	216	270	325	384	444	485*	498*	510*	15.420
	0	0	0	0	0	0	0	495*	504*	511*	
31'-0"	106	150	194	244	296	351	407	462*	475*	487*	17.581
	0	0	0	0	0	0	0	470*	478*	0	
32'-0"	91	132	173	221	269	321	374	439	453*	465*	19.962
	0	0	0	0	0	0	0	0	455*	0	
33'-0"	78	116	155	199	245	293	343	405	433*	444*	22.577
	0	0	0	0	0	0	0	0	0	0	
34'-0"	65	101	138	180	223	268	315	373	414*	425*	25.440
	0	0	0	0	0	0	0	0	0	0	
35'-0"	54	88	122	162	202	246	290	344	397*	407*	28.568
	0	0	0	0	0	0	0	0	0	0	
36'-0"	43	75	108	145	184	224	266	318	371	391*	31.975
	0	0	0	0	0	0	0	0	0	0	
37'-0"		64	95	130	166	205	245	294	344	375*	35.679
		0	0	0	0	0	0	0	0	0	
38'-0"		53	82	116	151	187	225	271	319	360*	39.696
		0	0	0	0	0	0	0	0	0	
39'-0"		44	71	103	136	171	206	250	296	342	44.042
		0	0	0	0	0	0	0	0	0	
40'-0"			61	91	122	156	189	231	274	318	48.736
			0	0	0	0	0	0	0	0	
41'-0"			51	80	110	141	173	213	254	296	53.795
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.88	1.04	1.20	1.39	1.58	1.79	2.00	2.27	2.54	2.83	
STEEL PERCENT	0.10	0.12	0.14	0.16	0.19	0.21	0.24	0.27	0.30	0.34	
DEPTH, D IN.	23.12	23.06	23.06	23.00	23.00	22.94	22.94	22.86	22.86	22.80	
$+I_{cr}/I_{gr}$	0.181	0.210	0.239	0.272	0.304	0.338	0.373	0.413	0.456	0.496	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 5.0" Top Slab = 13.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflec-tion Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
14'-0"	198 0	276 0	355 0	392* 445	406* 537	421* 557*	439* 564*	457* 568*	478* 576*	498* 582*	0.692
15'-0"	160 0	228 0	297 0	355* 375	368* 455	382* 486*	399* 492*	416* 496*	435* 503*	454* 508*	0.912
16'-0"	129 0	189 0	249 0	318 0	336* 389	349* 429*	364* 434*	380* 438*	398* 445*	416* 450*	1.180
17'-0"	104 0	156 0	210 0	271 0	308* 333	320* 382*	334* 387*	349* 391*	366* 397*	382* 401*	1.504
18'-0"	82 0	129 0	177 0	231 0	283* 287	294* 343*	308* 347*	322* 351*	338* 357*	353* 361*	1.890
19'-0"	64 0	106 0	149 0	198 0	248 0	272* 307	284* 314*	298* 317*	313* 323*	328* 0	2.347
20'-0"	48 0	87 0	125 0	169 0	214 0	252* 267	264* 281	276* 288*	290* 293*	305* 0	2.881
21'-0"		70 0	105 0	145 0	186 0	234 0	245* 246	255 0	268 0	284* 0	3.502
22'-0"		55 0	87 0	123 0	161 0	204 0	215 0	224 0	236 0	265* 0	4.219
23'-0"		42 0	72 0	105 0	139 0	179 0	189 0	197 0	208 0	236 0	5.039
24'-0"			58 0	88 0	120 0	157 0	166 0	173 0	183 0	209 0	5.975
25'-0"			46 0	74 0	103 0	137 0	145 0	152 0	161 0	185 0	7.035
26'-0"				61 0	88 0	119 0	127 0	133 0	142 0	164 0	8.229
27'-0"				50 0	75 0	104 0	111 0	117 0	125 0	145 0	9.570

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.10	0.12	0.15	0.18	0.22	0.26	0.30	0.35	0.39	0.45	
DEPTH, D IN.	11.75	11.69	11.69	11.62	11.62	11.56	11.56	11.50	11.50	11.44	
$+I_{cr}/I_{gr}$	0.182	0.224	0.268	0.314	0.361	0.413	0.468	0.524	0.585	0.641	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	8" Deep Rib + 5.0" Top Slab = 13.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflec-tion Coeff. (3)
Steel (psf)	0.45	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
14'-0"	188 0	263 0	340 0	428 0	454* 517	468* 622	485* 639*	502* 643*	522* 650*	542* 655*	0.712
15'-0"	151 0	217 0	284 0	360 0	412* 438	425* 529	441* 558*	457* 562*	476* 569*	494* 573*	0.938
16'-0"	121 0	179 0	238 0	305 0	373 0	389* 454	403* 494*	418* 497*	436* 504*	453* 508*	1.214
17'-0"	96 0	147 0	199 0	259 0	319 0	357* 391	370* 441*	385* 444*	401* 450*	417* 454*	1.547
18'-0"	75 0	121 0	167 0	220 0	274 0	329* 338	342* 396*	355* 400*	370* 405*	385* 409*	1.944
19'-0"	57 0	98 0	140 0	188 0	236 0	293 0	316* 352	329* 362*	343* 367*	358* 371*	2.414
20'-0"	42 0	79 0	117 0	160 0	204 0	255 0	294* 308	306* 330*	319* 334*	333* 338*	2.964
21'-0"		63 0	97 0	136 0	176 0	222 0	270 0	285* 291	298* 304	311* 0	3.602
22'-0"		49 0	80 0	115 0	151 0	194 0	238 0	257 0	268 0	277 0	4.339
23'-0"			65 0	97 0	130 0	169 0	209 0	227 0	237 0	245 0	5.183
24'-0"			51 0	81 0	111 0	147 0	184 0	200 0	210 0	217 0	6.145
25'-0"			40 0	67 0	95 0	128 0	162 0	177 0	185 0	192 0	7.235
26'-0"				55 0	81 0	111 0	142 0	156 0	164 0	170 0	8.464
27'-0"				44 0	68 0	96 0	125 0	138 0	145 0	151 0	9.844

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.09	0.12	0.15	0.18	0.21	0.25	0.29	0.34	0.38	0.43	
DEPTH, D IN.	11.75	11.69	11.69	11.62	11.62	11.56	11.56	11.50	11.50	11.44	
$+I_{cr}/I_{gr}$	0.161	0.198	0.237	0.278	0.320	0.366	0.415	0.465	0.518	0.569	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 5.0" Top Slab = 15.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
15'-0"	199	279	360	440*	453*	467*	483*	500*	520*	539*	0.912
	0	0	0	453	547	599*	606*	611*	620*	626*	
16'-0"	163	233	304	386	413*	426*	441*	458*	476*	494*	1.180
	0	0	0	0	469	530*	536*	542*	549*	555*	
17'-0"	133	195	258	330	379*	391*	405*	420*	437*	454*	1.504
	0	0	0	0	404	473*	479*	484*	492*	497*	
18'-0"	108	163	219	284	348*	360*	374*	388*	404*	420*	1.890
	0	0	0	0	349	426*	432*	437*	443*	449*	
19'-0"	87	136	187	244	303	333*	346*	359*	374*	389*	2.347
	0	0	0	0	0	373	392*	396*	402*	407*	
20'-0"	68	113	159	211	264	309*	321*	334*	348*	362*	2.881
	0	0	0	0	0	327	357*	361*	367*	372*	
21'-0"	53	93	135	182	230	287	299*	311*	324*	338*	3.502
	0	0	0	0	0	0	327*	331*	336*	341*	
22'-0"		76	114	157	201	253	279*	290*	303*	316*	4.219
		0	0	0	0	0	301*	304*	310*	0	
23'-0"		61	96	135	175	223	261*	272*	284*	296*	5.039
		0	0	0	0	0	271	281*	286*	0	
24'-0"		48	80	116	153	196	241	255*	267*	276	5.975
		0	0	0	0	0	0	0	0	0	
25'-0"			66	99	133	173	214	227	238	247	7.035
			0	0	0	0	0	0	0	0	
26'-0"			53	84	115	152	190	203	212	221	8.229
			0	0	0	0	0	0	0	0	
27'-0"			42	71	100	134	169	181	190	197	9.570
			0	0	0	0	0	0	0	0	
28'-0"				59	86	118	150	161	169	176	11.069
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.08	0.11	0.13	0.16	0.18	0.22	0.25	0.29	0.33	0.38	
DEPTH, D IN.	13.75	13.69	13.69	13.62	13.62	13.56	13.56	13.50	13.50	13.44	
$+I_{cr}/I_{gr}$	0.164	0.203	0.243	0.285	0.329	0.378	0.428	0.482	0.537	0.591	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	10" Deep Rib + 5.0" Top Slab = 15.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.45	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
16'-0"	152	221	290	369	449	473*	488*	503*	521*	538*	1.214
	0	0	0	0	0	545	605*	609*	617*	622*	
17'-0"	123	184	245	315	386	435*	448*	463*	479*	495*	1.547
	0	0	0	0	0	471	541*	546*	553*	558*	
18'-0"	99	152	207	270	333	401*	414*	427*	443*	458*	1.944
	0	0	0	0	0	409	486	492*	499*	504*	
19'-0"	78	126	175	231	289	356	383*	396*	411*	425*	2.414
	0	0	0	0	0	0	426	447*	453*	458*	
20'-0"	60	104	148	199	250	311	356*	368*	382*	396*	2.964
	0	0	0	0	0	0	374	408*	414*	418*	
21'-0"	45	85	125	171	217	273	330	343*	357*	369*	3.602
	0	0	0	0	0	0	0	375*	380*	384*	
22'-0"		68	104	146	189	239	291	321*	334*	346*	4.339
		0	0	0	0	0	0	345*	350*	354*	
23'-0"		53	87	125	164	210	257	301*	313*	324*	5.183
		0	0	0	0	0	0	311	324*	328*	
24'-0"		40	71	106	142	185	228	277	294*	305*	6.145
		0	0	0	0	0	0	0	301*	0	
25'-0"			57	90	123	162	202	247	272	280	7.235
			0	0	0	0	0	0	0	0	
26'-0"			45	75	106	142	179	221	243	251	8.464
			0	0	0	0	0	0	0	0	
27'-0"				62	91	124	158	197	218	225	9.844
				0	0	0	0	0	0	0	
28'-0"				51	77	108	140	176	196	202	11.385
				0	0	0	0	0	0	0	
29'-0"				40	65	94	123	157	175	181	13.101
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.08	0.10	0.13	0.15	0.18	0.21	0.25	0.29	0.33	0.37	
DEPTH, D IN.	13.75	13.69	13.69	13.62	13.62	13.56	13.56	13.50	13.50	13.44	
$+I_{cr}/I_{gr}$	0.145	0.179	0.214	0.252	0.291	0.334	0.379	0.426	0.476	0.524	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 5.0" Top Slab = 17.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	132	196	261	335	410	431*	444*	459*	475*	491*	1.890
	0	0	0	0	0	500	519*	525*	532*	539*	
19'-0"	108	165	223	290	357	398*	411*	425*	440*	455*	2.347
	0	0	0	0	0	438	472*	477*	484*	490*	
20'-0"	87	139	191	251	312	370*	382*	395*	409*	423*	2.881
	0	0	0	0	0	385	431*	436*	443*	448*	
21'-0"	69	116	163	218	273	339	356*	368*	382*	395*	3.502
	0	0	0	0	0	0	396*	400*	407*	412*	
22'-0"	54	96	139	189	240	300	332*	344*	357*	370*	4.219
	0	0	0	0	0	0	361	369*	375*	380*	
23'-0"	40	79	119	164	210	265	311*	322*	334*	347*	5.039
	0	0	0	0	0	0	321	342*	347*	352*	
24'-0"		64	100	142	184	235	286	302*	314*	326*	5.975
		0	0	0	0	0	0	317*	323*	327*	
25'-0"		51	84	123	162	208	256	284*	296*	307*	7.035
		0	0	0	0	0	0	295*	300*	0	
26'-0"			70	105	141	184	228	268*	279*	290*	8.229
			0	0	0	0	0	275*	280*	0	
27'-0"			57	90	123	163	204	250	263	272	9.570
			0	0	0	0	0	0	0	0	
28'-0"			45	76	107	144	182	225	237	245	11.069
			0	0	0	0	0	0	0	0	
29'-0"				64	93	127	163	203	214	222	12.737
				0	0	0	0	0	0	0	
30'-0"				53	80	112	145	183	193	200	14.587
				0	0	0	0	0	0	0	
31'-0"				43	68	98	129	164	174	181	16.631
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.07	0.09	0.11	0.14	0.16	0.19	0.22	0.26	0.29	0.33	
DEPTH, D IN.	15.75	15.69	15.69	15.62	15.62	15.56	15.56	15.50	15.50	15.44	
$+I_{cr}/I_{gr}$	0.148	0.184	0.220	0.260	0.300	0.345	0.391	0.441	0.493	0.544	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	12" Deep Rib + 5.0" Top Slab = 17.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.45	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
18'-0"	121	183	246	318	391	478*	491*	505*	520*	535*	1.944
	0	0	0	0	0	479	568	588*	595*	601*	
19'-0"	97	153	209	274	340	418	455*	468*	482*	497*	2.414
	0	0	0	0	0	0	498	535*	542*	547*	
20'-0"	77	127	178	237	296	367	423*	435*	449*	462*	2.964
	0	0	0	0	0	0	439	489*	496*	501*	
21'-0"	59	105	151	204	258	322	388	406*	419*	432*	3.602
	0	0	0	0	0	0	0	450*	456*	461*	
22'-0"	44	86	128	176	225	284	343	379*	392*	404*	4.339
	0	0	0	0	0	0	0	412	421*	426*	
23'-0"		69	108	152	197	250	305	356*	368*	379*	5.183
		0	0	0	0	0	0	367	390*	395*	
24'-0"		54	90	130	172	221	271	328	346*	357*	6.145
		0	0	0	0	0	0	0	363*	367*	
25'-0"		41	74	111	149	195	241	294	325*	336*	7.235
		0	0	0	0	0	0	0	338*	342*	
26'-0"			60	95	130	172	214	263	307*	317*	8.464
			0	0	0	0	0	0	313	320*	
27'-0"			48	80	112	151	191	236	282	300*	9.844
			0	0	0	0	0	0	0	0	
28'-0"				66	97	133	170	212	255	280	11.385
				0	0	0	0	0	0	0	
29'-0"				54	83	116	151	190	230	253	13.101
				0	0	0	0	0	0	0	
30'-0"				44	70	101	133	170	207	229	15.004
				0	0	0	0	0	0	0	
31'-0"					58	88	118	152	187	208	17.106
					0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.07	0.09	0.11	0.13	0.16	0.19	0.21	0.25	0.28	0.32	
DEPTH, D IN.	15.75	15.69	15.69	15.62	15.62	15.56	15.56	15.50	15.50	15.44	
$+I_{cr}/I_{gr}$	0.131	0.163	0.195	0.230	0.265	0.305	0.346	0.391	0.437	0.482	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	14" Deep Rib + 5.0" Top Slab = 19.0" Total Depth										
BOTTOM BARS	# 4 # 4	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	Deflection Coeff. (3)
Steel (psf)	0.46	0.59	0.72	0.87	1.03	1.22	1.40	1.62	1.83	2.08	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
19'-0"	129	194	260	335	412	470*	483*	496*	511*	527*	2.347
	0	0	0	0	0	503	555*	562*	570*	577*	
20'-0"	106	164	223	291	360	436*	448*	461*	476*	490*	2.881
	0	0	0	0	0	443	508*	514*	522*	528*	
21'-0"	85	139	192	254	317	391	418*	430*	444*	457*	3.502
	0	0	0	0	0	0	467*	473*	480*	487*	
22'-0"	68	116	165	221	278	347	390*	402*	415*	428*	4.219
	0	0	0	0	0	0	416	437*	444*	450*	
23'-0"	53	97	142	193	245	308	365*	377*	389*	401*	5.039
	0	0	0	0	0	0	371	405*	412*	417*	
24'-0"		80	121	168	216	273	332	354*	366*	377*	5.975
		0	0	0	0	0	0	377*	383*	388*	
25'-0"		65	103	146	190	243	297	333*	344*	356*	7.035
		0	0	0	0	0	0	351*	357*	362*	
26'-0"		51	86	127	168	216	266	314*	325*	336*	8.229
		0	0	0	0	0	0	323	334*	339*	
27'-0"		40	72	109	147	193	239	292	307*	317*	9.570
		0	0	0	0	0	0	0	313*	318*	
28'-0"			59	94	129	171	214	263	290*	300*	11.069
			0	0	0	0	0	0	294*	0	
29'-0"			47	80	113	152	192	238	275*	285*	12.737
			0	0	0	0	0	0	277*	0	
30'-0"				67	98	135	172	215	258	267	14.587
				0	0	0	0	0	0	0	
31'-0"				56	85	119	154	194	235	243	16.631
				0	0	0	0	0	0	0	
32'-0"				46	72	105	138	175	214	221	18.883
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.40	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	
STEEL PERCENT	0.06	0.08	0.10	0.12	0.14	0.17	0.20	0.23	0.26	0.29	
DEPTH, D IN.	17.75	17.69	17.69	17.62	17.62	17.56	17.56	17.50	17.50	17.44	
$+I_{cr}/I_{gr}$	0.135	0.168	0.201	0.237	0.274	0.316	0.359	0.406	0.454	0.502	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)										f'_c = 4,000 psi f_y = 60,000 psi	
	14" Deep Rib + 5.0" Top Slab = 19.0" Total Depth											
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)	
Steel (psf)	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27		
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)											
20'-0"	152	209	276	343	423	496*	508*	522*	536*	551*	2.964	
	0	0	0	0	0	505	575*	582*	588*	596*		
21'-0"	127	179	239	300	373	447	474*	487*	500*	515*	3.602	
	0	0	0	0	0	0	529*	536*	542*	550*		
22'-0"	105	153	207	263	329	397	443*	456*	468*	482*	4.339	
	0	0	0	0	0	0	474	496*	501*	509*		
23'-0"	86	130	180	231	291	353	416*	428*	440*	453*	5.183	
	0	0	0	0	0	0	424	460*	466*	473*		
24'-0"	70	110	156	202	258	315	380	402*	414*	426*	6.145	
	0	0	0	0	0	0	0	429*	434*	440*		
25'-0"	55	92	134	177	229	281	341	379*	390*	402*	7.235	
	0	0	0	0	0	0	0	400*	405*	411*		
26'-0"	42	76	115	155	203	251	306	358*	368*	380*	8.464	
	0	0	0	0	0	0	0	363	379*	385*		
27'-0"		62	98	135	179	224	276	328	348*	360*	9.844	
		0	0	0	0	0	0	0	356*	362*		
28'-0"		50	83	118	159	200	248	297	330*	341*	11.385	
		0	0	0	0	0	0	0	335*	0		
29'-0"			70	102	140	179	223	269	313*	324*	13.101	
			0	0	0	0	0	0	315*	0		
30'-0"			58	87	123	159	201	244	289	308*	15.004	
			0	0	0	0	0	0	0	0		
31'-0"			46	74	108	142	181	221	263	289	17.106	
			0	0	0	0	0	0	0	0		
32'-0"				63	94	126	163	200	240	264	19.423	
				0	0	0	0	0	0	0		
33'-0"				52	81	111	146	181	218	241	21.967	
				0	0	0	0	0	0	0		

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF)(4)												
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00		
STEEL PERCENT	0.08	0.10	0.12	0.14	0.16	0.19	0.22	0.25	0.29	0.32		
DEPTH, D IN.	17.69	17.69	17.62	17.62	17.56	17.56	17.50	17.50	17.44	17.44		
$+I_{cr}/I_{gr}$	0.149	0.178	0.210	0.243	0.280	0.319	0.360	0.403	0.445	0.490		

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi
	16" Deep Rib + 5.0" Top Slab = 21.0" Total Depth									
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)
Steel (psf)	0.57	0.70	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
21'-0"	147	205	273	341	422	505	546*	560*	573*	588*	3.602
	0	0	0	0	0	0	601	618*	625*	633*	
22'-0"	123	176	237	299	374	449	511*	524*	536*	550*	4.339
	0	0	0	0	0	0	536	572*	579*	587*	
23'-0"	102	151	207	263	331	400	479*	491*	503*	517*	5.183
	0	0	0	0	0	0	480	532*	538*	546*	
24'-0"	84	128	180	232	294	358	431	462*	473*	486*	6.145
	0	0	0	0	0	0	0	496*	502*	509*	
25'-0"	67	108	156	204	261	320	387	435*	446*	459*	7.235
	0	0	0	0	0	0	0	456	469*	476*	
26'-0"	53	91	135	179	232	286	349	411*	422*	433*	8.464
	0	0	0	0	0	0	0	412	440*	447*	
27'-0"	40	75	116	157	206	257	314	373	399*	410*	9.844
	0	0	0	0	0	0	0	0	413*	420*	
28'-0"		61	99	137	183	230	284	338	378*	389*	11.385
		0	0	0	0	0	0	0	389*	395*	
29'-0"		49	84	120	162	206	256	307	359*	369*	13.101
		0	0	0	0	0	0	0	361	373*	
30'-0"			70	104	144	184	231	279	329	351*	15.004
			0	0	0	0	0	0	0	353*	
31'-0"			58	89	127	165	208	253	301	334*	17.106
			0	0	0	0	0	0	0	0	
32'-0"			47	76	111	147	188	230	274	318*	19.423
			0	0	0	0	0	0	0	0	
33'-0"				64	97	131	169	209	251	293	21.967
				0	0	0	0	0	0	0	
34'-0"				53	84	116	152	189	229	269	24.753
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	
STEEL PERCENT	0.07	0.09	0.11	0.12	0.15	0.17	0.20	0.23	0.26	0.29	
DEPTH, D IN.	19.69	19.69	19.62	19.62	19.56	19.56	19.50	19.50	19.44	19.44	
$+I_{cr}/I_{gr}$	0.137	0.164	0.194	0.225	0.260	0.295	0.334	0.374	0.414	0.456	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi
	16" Deep Rib + 5.0" Top Slab = 21.0" Total Depth									
BOTTOM BARS	# 4 # 5	# 5 # 5	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	Deflection Coeff. (3)
Steel (psf)	0.55	0.68	0.83	0.97	1.15	1.33	1.53	1.73	1.97	2.21	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
21'-0"	134	191	256	322	402	482	575	606*	618*	633*	3.702
	0	0	0	0	0	0	0	670	682*	690*	
22'-0"	111	162	222	282	354	428	513	567*	579*	593*	4.460
	0	0	0	0	0	0	0	599	632*	640*	
23'-0"	90	137	192	247	313	380	458	532*	544*	557*	5.327
	0	0	0	0	0	0	0	537	587*	595*	
24'-0"	72	115	166	216	277	339	410	482	512*	524*	6.316
	0	0	0	0	0	0	0	0	548*	555*	
25'-0"	56	96	142	189	245	302	368	434	482*	494*	7.436
	0	0	0	0	0	0	0	0	506	520*	
26'-0"	42	79	122	165	217	269	330	392	456*	467*	8.700
	0	0	0	0	0	0	0	0	458	488*	
27'-0"		64	103	144	192	240	297	354	415	442*	10.117
		0	0	0	0	0	0	0	0	459*	
28'-0"		50	87	124	169	214	267	320	377	420*	11.701
		0	0	0	0	0	0	0	0	432*	
29'-0"			72	107	149	191	240	289	342	396	13.465
			0	0	0	0	0	0	0	0	
30'-0"			59	92	130	170	216	262	311	362	15.420
			0	0	0	0	0	0	0	0	
31'-0"			47	77	114	151	194	237	283	331	17.581
			0	0	0	0	0	0	0	0	
32'-0"				65	99	134	174	214	258	302	19.962
				0	0	0	0	0	0	0	
33'-0"				53	85	118	156	194	235	276	22.577
				0	0	0	0	0	0	0	
34'-0"				42	73	104	139	175	214	253	25.440
				0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.51	0.62	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	
STEEL PERCENT	0.07	0.09	0.10	0.12	0.14	0.17	0.19	0.22	0.25	0.28	
DEPTH, D IN.	19.69	19.69	19.62	19.62	19.56	19.56	19.50	19.50	19.44	19.44	
$+I_{cr}/I_{gr}$	0.124	0.148	0.175	0.203	0.235	0.267	0.302	0.338	0.375	0.413	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	20" Deep Rib + 5.0" Top Slab = 25.0" Total Depth										
BOTTOM BARS	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	# 9 #10	#10 #10	Deflection Coeff. (3)
Steel (psf)	0.85	1.00	1.18	1.36	1.57	1.78	2.02	2.27	2.57	2.87	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
26'-0"	172	226	291	356	432	509	538*	550*	564*	580*	8.464
	0	0	0	0	0	0	566*	574*	583*	594*	
27'-0"	150	199	259	320	390	461	509*	521*	534*	549*	9.844
	0	0	0	0	0	0	533*	541*	549*	559*	
28'-0"	129	176	231	288	353	419	483*	494*	507*	521*	11.385
	0	0	0	0	0	0	490	510*	518*	528*	
29'-0"	111	154	206	259	320	381	448	469*	481*	495*	13.101
	0	0	0	0	0	0	0	482*	490*	499*	
30'-0"	95	135	183	233	290	347	409	446*	458*	471*	15.004
	0	0	0	0	0	0	0	457*	464*	473*	
31'-0"	80	118	163	209	262	316	374	425*	436*	449*	17.106
	0	0	0	0	0	0	0	433*	440*	0	
32'-0"	66	102	144	188	238	288	343	398	416*	428*	19.423
	0	0	0	0	0	0	0	0	418*	0	
33'-0"	54	87	127	168	215	263	314	366	397*	409*	21.967
	0	0	0	0	0	0	0	0	398*	0	
34'-0"	43	74	112	150	194	239	288	337	379*	391*	24.753
	0	0	0	0	0	0	0	0	0	0	
35'-0"		62	98	134	176	218	264	310	363*	374*	27.796
		0	0	0	0	0	0	0	0	0	
36'-0"		51	85	119	158	198	241	285	340	358*	31.111
		0	0	0	0	0	0	0	0	0	
37'-0"		41	73	105	142	180	221	263	314	343*	34.715
		0	0	0	0	0	0	0	0	0	
38'-0"			62	92	128	164	202	242	291	329*	38.623
			0	0	0	0	0	0	0	0	
39'-0"			52	81	114	148	185	222	269	315	42.852
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	2.27	2.54	
STEEL PERCENT	0.09	0.10	0.12	0.14	0.16	0.19	0.21	0.24	0.27	0.30	
DEPTH, D IN.	23.62	23.62	23.56	23.56	23.50	23.50	23.44	23.44	23.36	23.36	
$+I_{cr}/I_{gr}$	0.169	0.195	0.226	0.258	0.292	0.328	0.364	0.401	0.445	0.491	

STANDARD (1) ONE-WAY JOISTS SINGLE SPAN	30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2)									f'_c = 4,000 psi f_y = 60,000 psi	
	20" Deep Rib + 5.0" Top Slab = 25.0" Total Depth										
BOTTOM BARS	# 5 # 6	# 6 # 6	# 6 # 7	# 7 # 7	# 7 # 8	# 8 # 8	# 8 # 9	# 9 # 9	# 9 #10	#10 #10	Deflection Coeff. (3)
Steel (psf)	0.83	0.97	1.15	1.33	1.53	1.73	1.97	2.21	2.50	2.79	
CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (PSF)										
26'-0"	158	210	273	337	411	485	566	594*	607*	622*	8.700
	0	0	0	0	0	0	0	624*	633*	643*	
27'-0"	136	184	243	302	370	439	514	562*	575*	589*	10.117
	0	0	0	0	0	0	0	588*	596*	606*	
28'-0"	116	161	215	270	334	398	468	533*	546*	559*	11.701
	0	0	0	0	0	0	0	538	563*	572*	
29'-0"	98	140	191	242	301	362	426	492	518*	532*	13.465
	0	0	0	0	0	0	0	0	532*	541*	
30'-0"	82	122	169	217	272	328	389	450	493*	506*	15.420
	0	0	0	0	0	0	0	0	504*	513*	
31'-0"	68	105	149	194	246	298	355	412	470*	482*	17.581
	0	0	0	0	0	0	0	0	479*	487*	
32'-0"	55	89	131	173	221	271	324	378	445	460*	19.962
	0	0	0	0	0	0	0	0	0	463*	
33'-0"	43	75	114	154	200	246	296	347	410	440*	22.577
	0	0	0	0	0	0	0	0	0	441*	
34'-0"		62	99	136	180	223	270	318	378	420*	25.440
		0	0	0	0	0	0	0	0	0	
35'-0"		51	85	121	161	203	247	292	348	402*	28.568
		0	0	0	0	0	0	0	0	0	
36'-0"		40	73	106	144	183	225	268	321	375	31.975
		0	0	0	0	0	0	0	0	0	
37'-0"			61	93	129	166	206	246	296	347	35.679
			0	0	0	0	0	0	0	0	
38'-0"			50	80	115	150	187	226	273	322	39.696
			0	0	0	0	0	0	0	0	
39'-0"			40	69	102	135	170	207	252	298	44.042
			0	0	0	0	0	0	0	0	

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.81 CF/SF)(4)											
POSITIVE MOMENT STEEL (SQ. IN.) AREA	0.75	0.88	1.04	1.20	1.39	1.58	1.79	2.00	2.27	2.54	
STEEL PERCENT	0.09	0.10	0.12	0.14	0.16	0.18	0.21	0.23	0.26	0.29	
DEPTH, D IN.	23.62	23.62	23.56	23.56	23.50	23.50	23.44	23.44	23.36	23.36	
$+I_{cr}/I_{gr}$	0.153	0.177	0.205	0.234	0.265	0.297	0.330	0.364	0.404	0.445	

WIDE-MODULE CONCRETE JOIST CONSTRUCTION

INTRODUCTION

Wide-module joist systems, which are also referred to as "skip-joist" systems, may be defined as joist systems with clear spacings between ribs of more than 30 in. Since this spacing exceeds the spacing limit for joists, as specified by ACI 8.13, the wide-module joists are subject to the design requirements for T-Beams (ACI 8.12).

Of the two types of joist construction, the standard and wide-module, the wide-module is preferred when a 4.5-inch top slab is used. The 4.5-inch top slab is needed when the floor/ceiling assembly is required to have a 2-hour fire-resistant rating. As a result of this floor slab thickness, the most economical system is the one which structurally takes advantage of this thickness, as the wide-module system does.

DIMENSIONS OF STANDARD FORMS

Joist widths for tabulated designs in this Chapter vary from 6 in. to 10 in. Standard forms for the pan spaces between ribs are 40-in., 53-in. and 66-in. wide and 12, 14, 16, 20 and 24-in. deep. Standard-end forms consist of square-end forms: tapered-end forms are usually not available.

See Fig. 8-14 for recommended bar details for wide-module joist construction.

When the supporting beam is wider than the column, it is recommended that the clear span of the joists be considered as ($\ell_{c\text{-}c}$ – column width).

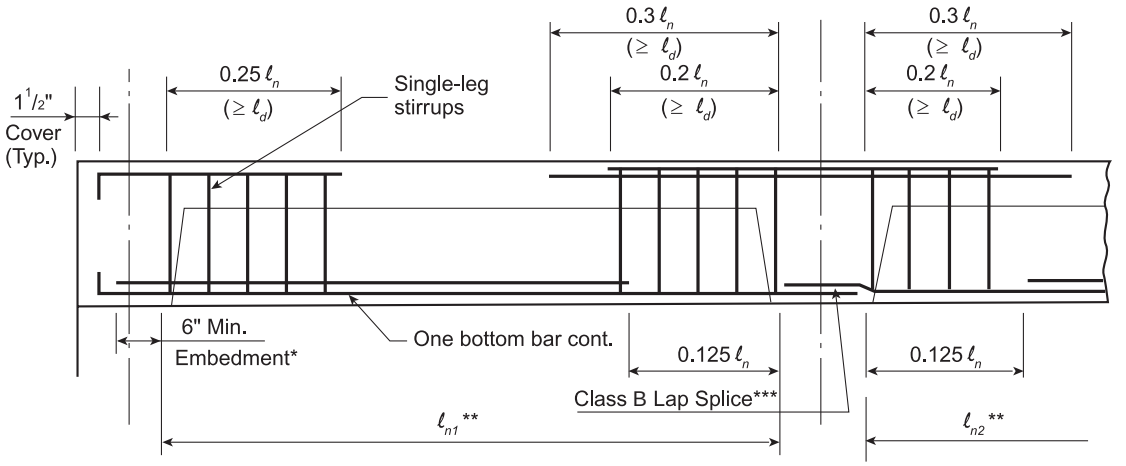
Since the top concrete cover of the joist and girder each have the same minimum value, e.g., 1½ in., it may be necessary to increase the girder top concrete cover by lowering the girder top reinforcement and reduce the effective depth for negative moment calculations, in order to avoid interference with the joist negative moment reinforcement.

The following tables will help in stirrup style selection and bar positioning.

MAXIMUM BAR SIZE FOR INDIVIDUAL BARS IN THE BOTTOM OF A WIDE-MODULE RIB

Stirrup Style	No. of Bars	Rib Width at Bottom				
		6″	7″	8″	9″	10″
"L"	2	#6	#9	#11	#14	#14
	3	–	#4	#6	#8	#10
"L" (alt.) or "U"	2	#4	#8	#10	#11	#14
	3	–	–	#5	#8	#9

1. Maximum bar sizes are based on clear spacing requirements of ACI 7.6.1.
2. Side taper of ribs not considered.
3. Based on 1½-in. concrete cover, #4 stirrups.



*If support width ≤ 12", hook two bottom bars.

**If bearing on masonry or structural steel, use c.-c. lengths.

***If lap area extends beyond 0.125 ℓ_n cut-off, consider lapping hooks (i.e., ⌐). ℓ_{dh}

Figure 8-14 Recommended Wide-Module Joist Bar Details

MAXIMUM BAR SIZE FOR 2-BAR BUNDLES IN THE BOTTOM OF A WIDE-MODULE RIB

Stirrup Style	No. of Bars	Rib Width at Bottom				
		6″	7″	8″	9″	10″
"L"	1	#9	#11	#11	#11	#11
	2	#3	#5	#6	#8	#9
"L" (alt.) or "U"	1	#8	#11	#11	#11	#11
	2	–	#4	#5	#7	#8

1. Maximum bar sizes are based on clear spacing requirements of ACI 7.6.1 and 7.6.6.5.
2. Side taper of ribs not considered.
3. Based on 1½-in. concrete cover, #4 stirrups.

GENERAL STRUCTURAL CONSIDERATIONS

Since the wide-module "joists" are technically classified as beams, their design must conform to the requirements of T-Beams (ACI 8.12). Principal requirements are:

1. **Minimum concrete cover.** 1½ in. to stirrups and main flexural bars (top, bottom, and sides) instead of ¾ in. (ACI 7.7.1).
2. **Design shear strength.** $\phi V_c = \phi 2\sqrt{f'_c}\, b_w d$ instead of $\phi V_c = \phi 2.2\sqrt{f'_c}\, b_w d$ (ACI 11.2.1.1).
3. **Minimum area of shear reinforcement.** $A_v = 50(b_w s)/f_y$ when factored shear $V_u > 0.5\phi V_c$ (ACI 11.4.6.3).
4. **Reinforcing steel requirements and recommended details.** Alternative arrangements to provide required shear reinforcement include the common open U-stirrup. With minimum rib widths, the maximum size of the main tensile reinforcement becomes limited by concrete cover requirements. Also with minimum rib widths, fabricating constraints may require wider U-stirrups. In these cases, the U-stirrups may be angled to fit. For minimum rib widths, the use of single leg stirrups simplifies placing the reinforcement. A special note should be included on placing drawings to require alternating the stirrup positions. See Fig. 8-15.

Welded wire reinforcement (plain or deformed) can also be used as shear reinforcement. The vertical wires are developed by two horizontal wires spaced at 2 in. maximum at the top and at the bottom.

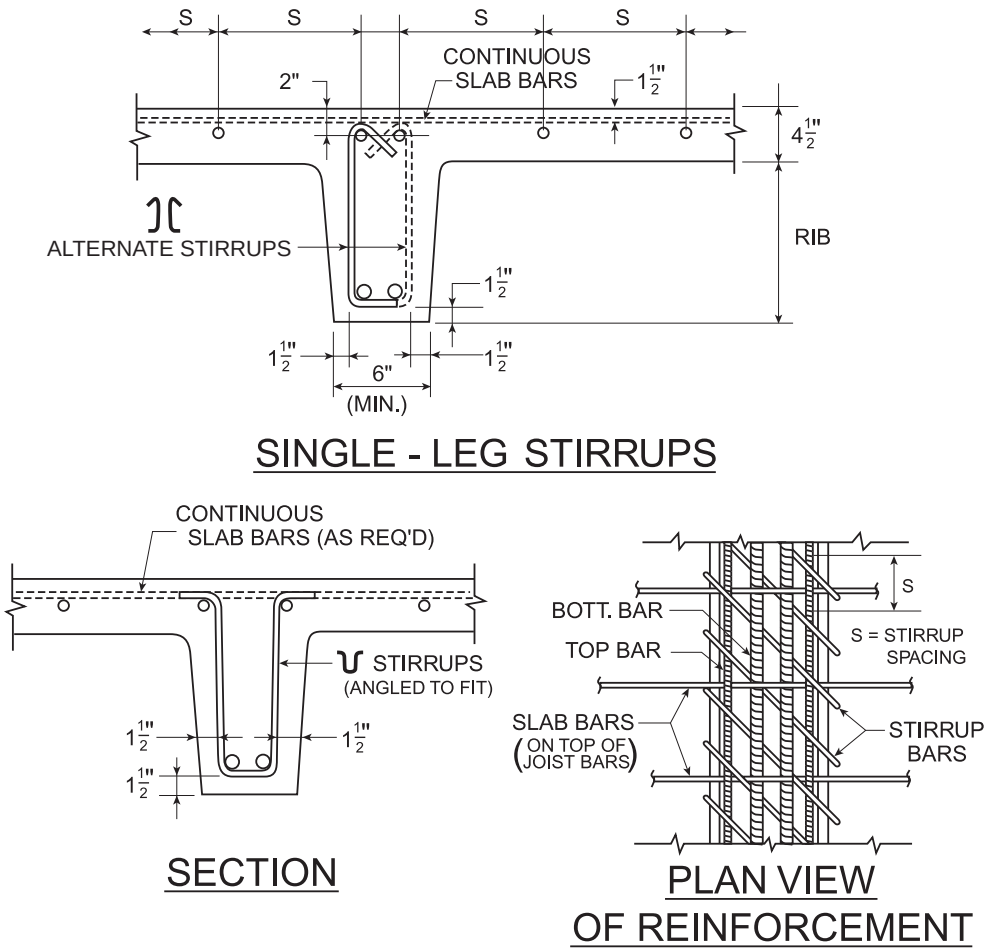


Figure 8-15 Details for Single Leg and Common U-Stirrup Applications for Shear Reinforcement in Wide-Module Joist Construction

TABULATED DESIGNS

Because the wide-module joist tabulated designs, and their use, are very similar to the standard size joists, only their differences will be discussed.

Scope. End spans and interior spans, but not single spans, are covered in the tabulated designs. Tapered-end forms are not considered, since stirrups are used to provide for shear capacity.

Load Strengths Tabulated. Usable superimposed factored load strength is given in pounds per foot. The first line for a specific clear span gives the superimposed load strength, the second line lists the single-leg stirrup size and minimum distance (in.) from the face of support that the stirrups must extend. Required constant stirrup spacing is noted at the bottom in each load table.

DESIGN FROM LOAD TABLES (MULTIPLE SPAN WIDE-MODULE JOIST CONSTRUCTION)

Example 1. Select a wide-module joist floor design with about a 6 ft. joist spacing and review calculations to support a service live load of 75 psf and an allowance of 30 psf for superimposed dead loads (partitions, ceiling, etc.) on a clear span of 28 ft. See Fig. 8-17 for layout.

Try: 16 + 4½ with 9-in. ribs 66 in. apart (6'-3" c.-c.)

Superimposed factored load $w_u = 1.2D + 1.6L$
$= 1.2(30) + 1.6(75)$
$= 156$ psf $(6.25) = 975$ plf

Read from table on Page 8-117:

End Span: Tabulated strength = 1,198 plf
Top bars #4 at 7.5" at first interior support
Bottom bars 2- #8 (per rib)
Single-leg stirrups: #3 spaced at 8" for 136" from face of support or 18- #3 spaced at 8"

Interior Span: Tabulated strength = 1,393 plf
#4 spaced at 7.5" top bars,
1- #5 and 2- #6 bottom bars
Single-leg stirrups: #3 spaced at 8" for 98" or 14 - #3 spaced at 8"

Concrete quantity (from Table 8-3):

524 plf = 524/6.25 = 84 psf

Load strength was not limited by deflection, so approximate immediate live load deflection will be:

$$\left(\frac{75}{30+75}\right)\left(\frac{\ell_n}{360}\right) = \frac{\ell_n}{504} \text{ (or less)}$$

This calculation is sufficient to satisfy ACI 9.5.2.1 that deflection be computed for ℓ_n/h ratios above 18.5 for end spans and 21 for interior spans. The estimated deflection above would be considered satisfactory, without further calculations for all floors and roofs "not supporting or attached to non-structural elements likely to be damaged by large deflections" (ACI Table 9.5(b)).

See Fig. 8-18 details of reinforcing bars for this example.

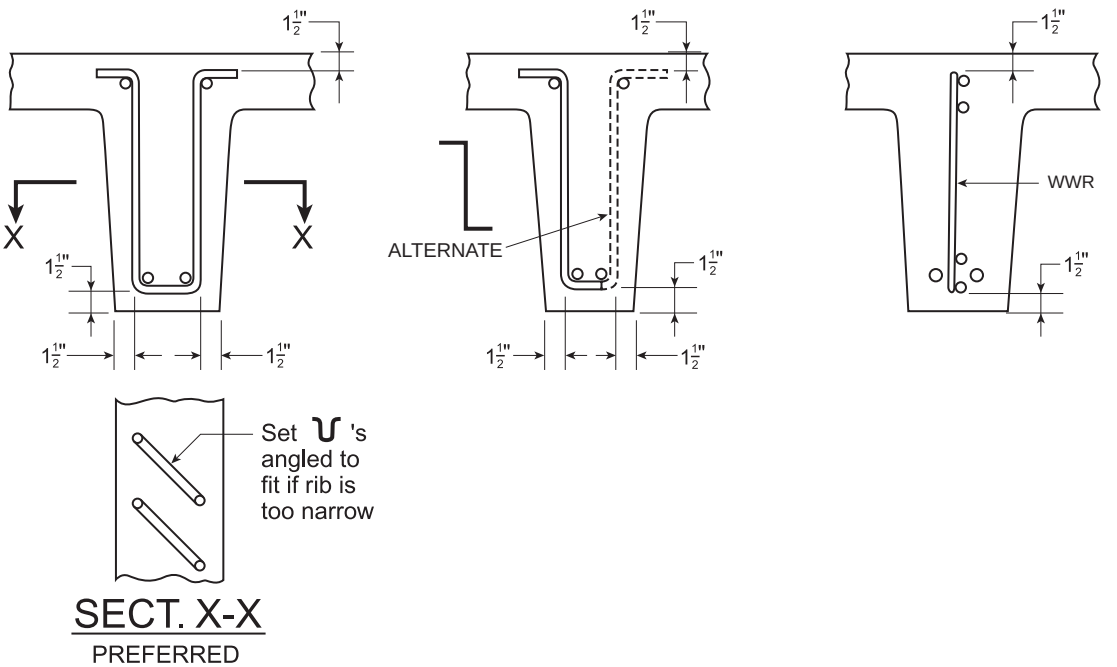


Figure 8-16 Alternative Stirrup Arrangements

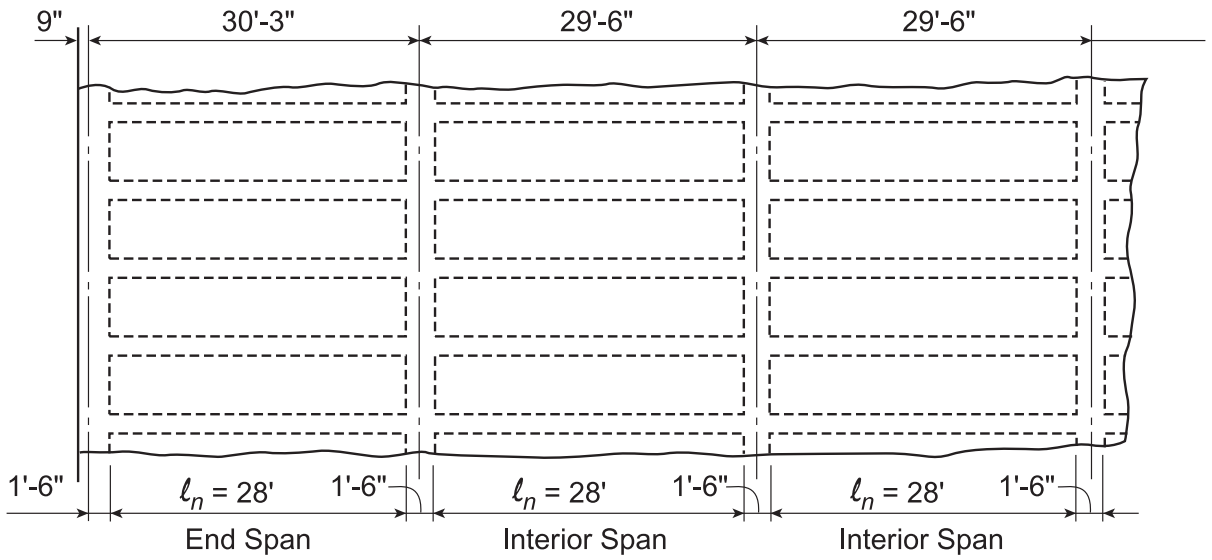


Figure 8-17 Multiple Span Wide-Module Layout – Example 1

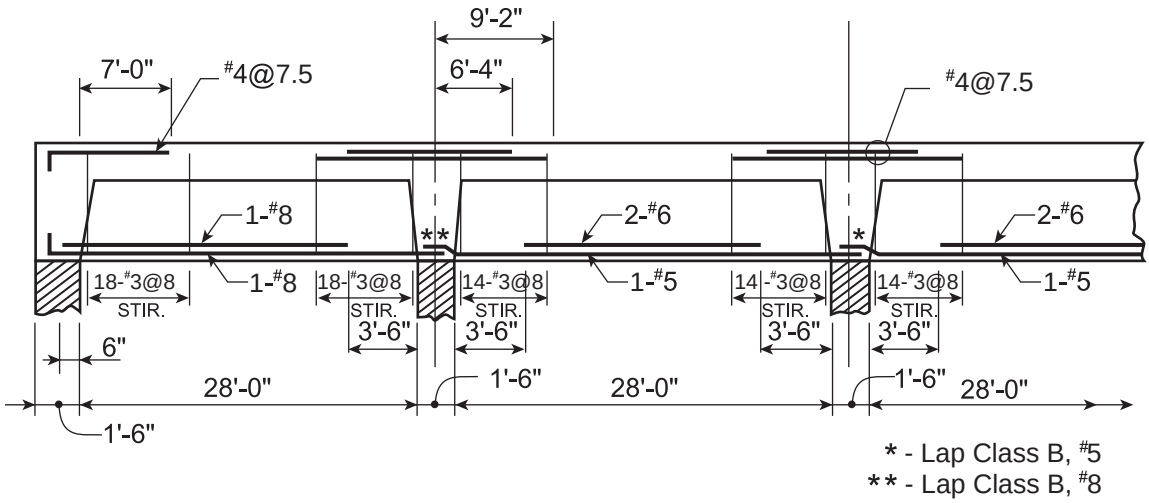


Figure 8-18 Wide-Module Bar Details – Example 1

TABLE 8-3(a) GROSS SECTION PROPERTIES — WIDE-MODULE JOIST CONSTRUCTION (1)

(2) Joist	4.5-Inch Top Slab					
	Gross Area(3) (in.²)	Wt.(4) (plf)	Y_{cg}(3) (in.)	I_g(3) (in.⁴)	$+M_{cr}$ (ft-k)	$-M_{cr}$(3) (ft-k)
12 + 8 + 40	324.0	338	11.57	6,295	21.5	50.5
	396.0		10.56	8,990		59.8
12 + 9 + 40	340.5	355	11.41	6,843	23.7	53.2
	412.5		10.47	9,448		61.9
12 + 10 + 40	357.0	372	11.27	7,375	25.9	55.7
	429.0		10.38	9,901		64.0
14 + 8 + 40	344.3	359	12.91	8,902	27.3	63.0
	428.3		11.75	12,635		74.0
14 + 9 + 40	362.8	378	12.73	9,665	30.0	66.2
	446.8		11.65	13,274		76.6
14 + 10 + 40	381.3	397	12.56	10,406	32.8	69.2
	465.3		11.55	13,904		79.1
16 + 8 + 40	365.3	381	14.22	12,128	33.7	76.3
	461.3		12.92	17,113		89.3
16 + 9 + 40	385.8	402	14.01	13,151	37.1	80.0
	481.8		12.81	17,972		92.4
16 + 10 + 40	406.3	423	13.82	14,144	40.5	83.6
	502.3		12.70	18,818		95.4
18 + 8 + 40	387.0	403	15.49	16,027	40.9	90.4
	495.0		14.07	22,497		105.5
18 + 9 + 40	409.5	427	15.26	17,358	45.0	94.7
	517.5		13.95	23,618		109.2
18 + 10 + 40	432.0	450	15.05	18,649	49.0	98.9
	540.0		13.84	24,724		112.8
20 + 8 + 40	409.3	426	16.74	20,652	48.8	105.1
	529.3		15.21	28,862		122.8
20 + 9 + 40	433.8	452	16.48	22,342	53.6	110.2
	553.8		15.08	30,292		127.1
20 + 10 + 40	458.3	477	16.26	23,983	58.3	115.0
	578.3		14.96	31,705		131.3
22 + 8 + 40	432.3	450	17.96	26,057	57.3	120.6
	564.3		16.33	36,282		141.1
22 + 9 + 40	458.8	478	17.69	28,162	62.9	126.4
	590.8		16.20	38,074		146.0
22 + 10 + 40	485.3	506	17.45	30,207	68.4	131.9
	617.3		16.07	39,844		151.0
24 + 8 + 40	456.0	475	19.17	32,297	66.6	136.8
	600.0		17.45	44,837		160.4
24 + 9 + 40	484.5	505	18.88	34,875	73.0	143.3
	628.5		17.30	47,044		166.1
24 + 10 + 40	513.0	534	18.62	37,382	79.3	149.6
	657.0		17.17	49,228		171.8

(2) Joist	4.5-Inch Top Slab					
	Gross Area (in.²)	Wt.(4) (plf)	Y_{cg} (in.)	I_g (in.⁴)	$+M_{cr}$ (ft-k)	$-M_{cr}$ (ft-k)
16 + 7 + 53	403.3	420	15.00	11,889	31.3	85.5
16 + 8 + 53	423.8	441	14.77	13,047	34.9	90.1
16 + 9 + 53	444.3	463	14.56	14,165	38.4	94.3
16 + 10 + 53	464.8	484	14.37	15,248	41.9	98.4
20 + 7 + 53	443.3	462	17.71	20,389	45.5	118.7
20 + 8 + 53	467.8	487	17.43	22,307	50.6	124.6
20 + 9 + 53	492.3	513	17.17	24,156	55.6	130.2
20 + 10 + 53	516.8	538	16.93	25,946	60.6	135.6
24 + 7 + 53	486.0	506	20.31	32,075	62.4	154.8
24 + 8 + 53	514.5	536	19.98	34,994	69.2	162.3
24 + 9 + 53	543.0	566	19.68	37,808	76.0	169.4
24 + 10 + 53	571.5	595	19.40	40,534	82.6	176.2
14 + 6 + 66	424.3	442	14.15	8,199	22.9	74.5
14 + 7 + 66	442.8	461	13.95	9,152	25.9	79.5
14 + 8 + 66	461.3	481	13.76	10,072	28.9	84.0
14 + 9 + 66	479.8	500	13.59	10,961	31.9	88.2
16 + 6 + 66	441.3	460	15.65	11,236	28.4	91.7
16 + 7 + 66	461.8	481	15.41	12,526	32.1	97.4
16 + 8 + 66	482.3	502	15.19	13,768	35.8	102.6
16 + 9 + 66	502.8	524	14.99	14,966	39.5	107.4
20 + 6 + 66	477.3	497	18.55	19,402	41.4	128.8
20 + 7 + 66	501.8	523	18.24	21,552	46.7	136.1
20 + 8 + 66	526.3	548	17.96	23,616	52.0	142.8
20 + 9 + 66	550.8	574	17.71	25,605	57.2	149.0
24 + 6 + 66	516.0	538	21.32	30,736	57.0	169.2
24 + 7 + 66	544.5	567	20.95	34,015	64.2	178.1
24 + 8 + 66	573.0	597	20.62	37,160	71.2	186.3
24 + 9 + 66	601.5	627	20.31	40,190	78.2	194.1

(1) f'_c = 4,000 psi, rib side slope = 1 to 12.
(2) First value is the pan depth, second value is the rib width, and the third value is the pan width (in.)
(3) First value is for a standard section; second value is at a tapered end.
(4) For normal-weight concrete, w = 150 pcf (added weight of tapers is neglected.)

TABLE 8-3(b) GROSS SECTION PROPERTIES — WIDE-MODULE JOIST CONSTRUCTION (1)

(2) Joist	5-Inch Top Slab					
	Gross Area(3) ($in.^2$)	Wt.(4) (plf)	Y_{cg}(3) (in.)	I_g(3) ($in.^4$)	$+M_{cr}$ (ft-k)	$-M_{cr}$(3) (ft-k)
12 + 8 + 40	348.0	363	11.93	6,894	22.8	53.8
	420.0		10.91	9,857		64.0
12 + 9 + 40	365.0	380	11.77	7,495	25.2	56.7
	437.0		10.82	10,362		66.3
12 + 10 + 40	382.0	398	11.63	8,078	27.5	59.4
	454.0		10.73	10,859		68.5
14 + 8 + 40	368.3	384	13.29	9,667	28.7	67.0
	452.3		12.12	13,748		79.0
14 + 9 + 40	387.3	403	13.11	10,499	31.7	70.4
	471.3		12.02	14,445		81.8
14 + 10 + 40	406.3	423	12.94	11,306	34.5	73.7
	490.3		11.92	15,133		84.5
16 + 8 + 40	389.3	406	14.62	13,090	35.4	81.1
	485.3		13.31	18,512		95.1
16 + 9 + 40	410.3	427	14.41	14,200	39.0	85.1
	506.3		13.19	19,442		98.4
16 + 10 + 40	431.3	449	14.22	15,277	42.5	89.0
	527.3		13.09	20,360		101.7
18 + 8 + 40	411.0	428	15.91	17,219	42.8	96.0
	519.0		14.47	24,221		112.3
18 + 9 + 40	434.0	452	15.68	18,657	47.0	100.7
	542.0		14.35	25,430		116.2
18 + 10 + 40	457.0	476	15.47	20,052	51.2	105.2
	565.0		14.23	26,623		120.0
20 + 8 + 40	433.3	451	17.18	22,108	50.9	111.7
	553.3		15.62	30,952		130.5
20 + 9 + 40	458.3	477	16.92	23,928	55.9	117.1
	578.3		15.49	32,488		135.0
20 + 10 + 40	483.3	503	16.70	25,694	60.8	122.3
	603.3		15.36	34,004		139.5
22 + 8 + 40	456.3	475	18.42	27,813	59.7	128.2
	588.3		16.76	38,780		149.7
22 + 9 + 40	483.3	503	18.15	30,072	65.5	134.3
	615.3		16.62	40,695		154.9
22 + 10 + 40	510.3	532	17.90	32,265	71.2	140.2
	642.3		16.48	42,586		160.1
24 + 8 + 40	480.0	500	19.65	34,389	69.2	145.4
	624.0		17.88	47,784		169.9
24 + 9 + 40	509.0	530	19.36	37,147	75.9	152.3
	653.0		17.73	50,134		175.9
24 + 10 + 40	538.0	560	19.09	39,826	82.4	158.9
	682.0		17.60	52,456		181.8

(2) Joist	5-Inch Top Slab					
	Gross Area ($in.^2$)	Wt.(4) (plf)	Y_{cg} (in.)	I_g ($in.^4$)	$+M_{cr}$ (ft-k)	$-M_{cr}$ (ft-k)
16 + 7 + 53	433.3	451	15.40	12,812	32.9	90.4
16 + 8 + 53	454.3	473	15.17	14,065	36.6	95.4
16 + 9 + 53	475.3	495	14.97	15,275	40.3	100.1
16 + 10 + 53	496.3	517	14.78	16,448	44.0	104.5
20 + 7 + 53	473.3	493	18.16	21,782	47.4	125.8
20 + 8 + 53	498.3	519	17.87	23,844	52.7	132.3
20 + 9 + 53	523.3	545	17.62	25,833	58.0	138.3
20 + 10 + 53	548.3	571	17.38	27,760	63.1	144.1
24 + 7 + 53	516.0	538	20.80	34,088	64.8	164.4
24 + 8 + 53	545.0	568	20.47	37,211	71.9	172.4
24 + 9 + 53	574.0	598	20.17	40,224	78.8	180.0
24 + 10 + 53	603.0	628	19.89	43,142	85.7	187.3
14 + 6 + 66	460.3	480	14.51	8,901	24.2	78.4
14 + 7 + 66	479.3	499	14.31	9,931	27.4	83.8
14 + 8 + 66	498.3	519	14.13	10,926	30.6	88.7
14 + 9 + 66	517.3	539	13.96	11,890	33.7	93.2
16 + 6 + 66	477.3	497	16.04	12,102	29.8	96.4
16 + 7 + 66	498.3	519	15.80	13,490	33.7	102.6
16 + 8 + 66	519.3	541	15.59	14,829	37.6	108.4
16 + 9 + 66	540.3	563	15.39	16,124	41.4	113.7
20 + 6 + 66	513.3	535	18.98	20,691	43.1	135.9
20 + 7 + 66	538.3	561	18.68	22,995	48.7	143.9
20 + 8 + 66	563.3	587	18.41	25,210	54.1	151.2
20 + 9 + 66	588.3	613	18.16	27,347	59.5	158.0
24 + 6 + 66	552.0	575	21.80	32,595	59.1	179.1
24 + 7 + 66	581.0	605	21.44	36,097	66.6	188.7
24 + 8 + 66	610.0	635	21.11	39,460	73.9	197.7
24 + 9 + 66	639.0	666	20.81	42,702	81.1	206.1

(1) f'_c = 4,000 psi, rib side slope = 1 to 12.
(2) First value is the pan depth, second value is the rib width, and the third value is the pan width (in.)
(3) First value is for a standard section; second value is at a tapered end.
(4) For normal-weight concrete, w = 150 pcf (added weight of tapers is neglected.)

TABLE 8-3(c) GROSS SECTION PROPERTIES — WIDE-MODULE JOIST CONSTRUCTION (1)

(2) Joist	5.5-Inch Top Slab					
	Gross Area(3) ($in.^2$)	Wt.(4) (plf)	Y_{cg}(3) (in.)	I_g(3) ($in.^4$)	$+M_{cr}$ (ft-k)	$-M_{cr}$(3) (ft-k)
12 + 8 + 40	372.0	388	12.27	7,530	24.3	57.0
	444.0		11.26	10,769		68.2
12 + 9 + 40	389.5	406	12.12	8,184	26.7	60.1
	461.5		11.16	11,321		70.6
12 + 10 + 40	407.0	424	11.97	8,821	29.1	63.1
	479.0		11.07	11,866		73.0
14 + 8 + 40	392.3	409	13.66	10,467	30.3	70.8
	476.3		12.48	14,906		84.0
14 + 9 + 40	411.8	429	13.47	11,369	33.4	74.6
	495.8		12.38	15,664		86.9
14 + 10 + 40	431.3	449	13.30	12,245	36.4	78.1
	515.3		12.28	16,411		89.8
16 + 8 + 40	413.3	431	15.00	14,085	37.1	85.7
	509.3		13.68	19,954		100.9
16 + 9 + 40	434.8	453	14.79	15,283	40.8	90.1
	530.8		13.56	20,960		104.4
16 + 10 + 40	456.3	475	14.60	16,446	44.5	94.3
	552.3		13.46	21,952		107.9
18 + 8 + 40	435.0	453	16.32	18,440	44.7	101.5
	543.0		14.86	25,989		118.9
18 + 9 + 40	458.5	478	16.08	19,987	49.1	106.5
	566.5		14.73	27,288		123.0
18 + 10 + 40	482.0	502	15.87	21,488	53.5	111.3
	590.0		14.61	28,571		127.1
20 + 8 + 40	457.3	476	17.60	23,590	53.0	118.1
	577.3		16.02	33,085		138.0
20 + 9 + 40	482.8	503	17.35	25,541	58.2	123.8
	602.8		15.88	34,728		142.8
20 + 10 + 40	508.3	530	17.12	27,434	63.4	129.3
	628.3		15.76	36,350		147.5
22 + 8 + 40	480.3	500	18.87	29,590	62.0	135.5
	612.3		17.17	41,319		158.1
22 + 9 + 40	507.8	529	18.59	32,003	68.1	142.0
	639.8		17.02	43,360		163.6
22 + 10 + 40	535.3	558	18.34	34,347	74.0	148.2
	667.3		16.89	45,375		169.0
24 + 8 + 40	504.0	525	20.11	36,496	71.7	153.6
	648.0		18.31	50,770		179.3
24 + 9 + 40	533.5	556	19.81	39,435	78.7	160.9
	677.5		18.15	53,266		185.5
24 + 10 + 40	563.0	586	19.55	42,291	85.5	167.9
	707.0		18.01	55,732		191.7

(2) Joist	5.5-Inch Top Slab					
	Gross Area ($in.^2$)	Wt.(4) (plf)	Y_{cg} (in.)	I_g ($in.^4$)	$+M_{cr}$ (ft-k)	$-M_{cr}$ (ft-k)
16 + 7 + 53	463.3	483	15.78	13,772	34.5	95.2
16 + 8 + 53	484.8	505	15.56	15,120	38.4	100.6
16 + 9 + 53	506.3	527	15.35	16,424	42.3	105.6
16 + 10 + 53	527.8	550	15.16	17,689	46.1	110.4
20 + 7 + 53	503.3	524	18.58	23,201	49.4	132.5
20 + 8 + 53	528.8	551	18.30	25,408	54.9	139.5
20 + 9 + 53	554.3	577	18.04	27,539	60.3	146.0
20 + 10 + 53	579.8	604	17.81	29,604	65.7	152.2
24 + 7 + 53	546.0	569	21.27	36,112	67.1	173.4
24 + 8 + 53	575.5	599	20.93	39,440	74.5	182.0
24 + 9 + 53	605.0	630	20.63	42,652	81.7	190.1
24 + 10 + 53	634.5	661	20.36	45,764	88.9	197.9
14 + 6 + 66	496.3	517	14.86	9,651	25.7	82.1
14 + 7 + 66	515.8	537	14.66	10,758	29.0	87.9
14 + 8 + 66	535.3	558	14.48	11,829	32.3	93.2
14 + 9 + 66	554.8	578	14.32	12,869	35.5	98.2
16 + 6 + 66	513.3	535	16.40	13,012	31.4	100.9
16 + 7 + 66	534.8	557	16.18	14,499	35.4	107.7
16 + 8 + 66	556.3	580	15.97	15,936	39.5	113.8
16 + 9 + 66	577.8	602	15.77	17,328	43.4	119.6
20 + 6 + 66	549.3	572	19.39	22,013	44.9	142.5
20 + 7 + 66	574.8	599	19.10	24,470	50.6	151.1
20 + 8 + 66	600.3	625	18.83	26,836	56.3	159.0
20 + 9 + 66	625.8	652	18.58	29,122	62.0	166.4
24 + 6 + 66	588.0	613	22.26	34,469	61.2	188.2
24 + 7 + 66	617.5	643	21.90	38,193	68.9	198.7
24 + 8 + 66	647.0	674	21.58	41,772	76.5	208.4
24 + 9 + 66	676.5	705	21.28	45,226	84.0	217.4

(1) f'_c = 4,000 psi, rib side slope = 1 to 12.
(2) First value is the pan depth, second value is the rib width, and the third value is the pan width (in.)
(3) First value is for a standard section; second value is at a tapered end.
(4) For normal-weight concrete, w = 150 pcf (added weight of tapers is neglected.)

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 8″ Ribs @ 48″ c.-c.
12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span	# 4	# 4	# 5	# 5	# 5	Int. Span
AT	10	10	9	7.5	10	Defl. Coeff. (2)	10	7.5	10	8	7	Defl. Coeff. (2)
BOTTOM BARS NO	1# 4	1# 5	1# 6	1# 6	1# 5		1# 4	1# 5	1# 6	1# 6	1# 5	
BARS NO	1# 5	1# 6	1# 6	1# 7	2# 6		1# 5	1# 6	1# 6	1# 7	2# 6	
STEEL (PSF)	0.60	0.78	0.92	1.08	1.20		0.84	1.18	1.41	1.70	1.90	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	235	530	688	881	1069	1.265	526	955	1185	1466	1740	0.779
STIR	#3- 49	#3- 86	#3- 98	#3-106	#3-118		#3- 64	#3- 90	#3- 85	#3-107	#3-112	
25'- 0"	185	457	603	780	954	1.490	453	848	1061	1319	1572	0.917
STIR	#3- 46	#3- 86	#3- 99	#3-110	#3-121		#3- 63	#3- 91	#3- 92	#3-110	#3-115	
26'- 0"	140	392	526	691	851	1.743	389	754	950	1189	1422	1.073
STIR	#3- 43	#3- 86	#3-100	#3-112	#3-108		#3- 62	#3- 92	#3-100	#3-112	#3-118	
27'- 0"	101	334	459	611	760	2.027	331	670	852	1073	1290	1.247
STIR	#3- 39	#3- 86	#3-100	#3-113	#3-116		#3- 61	#3- 93	#3-103	#3-115	#3-121	
28'- 0"	65	282	398	540	678	2.344	279	594	763	970	1171	1.443
STIR	#3- 34	#3- 85	#3-101	#3-115	#3-125		#3- 59	#3- 94	#3-105	#3-116	#3-123	
29'- 0"	33	235	344	476	605	2.698	233	526	684	876	1064	1.660
STIR	#3- 30	#3- 84	#3-101	#3-116	#3-127		#3- 57	#3- 94	#3-106	#3-106	#3-126	
30'- 0"	5	193	295	418	538	3.090	191	465	613	792	968	1.901
STIR	#3- 25	#3- 82	#3-101	#3-117	#3-129		#3- 55	#3- 95	#3-107	#3-113	#3-129	
31'- 0"		155	250	366	479	3.523	153	410	548	716	880	2.168
STIR		#3- 81	#3-100	#3-117	#3-130		#3- 52	#3- 95	#3-108	#3-120	#3-131	
32'- 0"		121	210	318	424	4.000	119	360	489	647	801	2.461
STIR		#3- 79	#3-100	#3-118	#3-132		#3- 49	#3- 95	#3-109	#3-122	#3-133	
33'- 0"		89	173	275	375	4.523	87	314	436	584	729	2.784
STIR		#3- 77	#3- 99	#3-118	#3-133		#3- 46	#3- 94	#3-110	#3-123	#3-135	
34'- 0"		61	139	236	329	5.097	59	272	387	527	663	3.137
STIR		#3- 74	#3- 98	#3-118	#3-134		#3- 43	#3- 94	#3-111	#3-125	#3-126	
35'- 0"		34	109	200	288	5.724	33	234	343	475	603	3.522
STIR		#3- 71	#3- 96	#3-118	#3-135		#3- 39	#3- 93	#3-111	#3-126	#3-134	
36'- 0"		10	81	166	250	6.407	9	199	302	426	548	3.942
STIR		#3- 68	#3- 95	#3-118	#3-135		#3- 35	#3- 93	#3-111	#3-127	#3-138	
PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.96	0.96	1.07	1.28	1.49		0.96	1.28	1.49	1.86	2.13	
ACTUAL STEEL %	0.726	0.726	0.807	0.968	1.131		0.726	0.968	1.131	1.414	1.616	
EFF. DEPTH, IN.	14.38	14.38	14.38	14.38	14.31		14.38	14.38	14.31	14.31	14.31	
$-I_{cr}/I_{gr}$	0.151	0.151	0.164	0.189	0.209		0.151	0.189	0.209	0.246	0.270	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.51	0.75	0.88	1.04	1.19		0.51	0.75	0.88	1.04	1.19	
ACTUAL STEEL %	0.364	0.537	0.631	0.748	0.853		0.364	0.537	0.631	0.748	0.853	
EFF. DEPTH, IN.	14.71	14.65	14.62	14.59	14.64		14.71	14.65	14.62	14.59	14.64	
$+I_{cr}/I_{gr}$	0.116	0.164	0.189	0.218	0.248		0.116	0.164	0.189	0.218	0.248	

SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 9″ Ribs @ 49″ c.-c.
12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span	# 4	# 4	# 5	# 5	# 6	Int. Span
AT	10	10	7.5	10	9	Defl. Coeff. (2)	10	7	8.5	7.5	9	Defl. Coeff. (2)
BOTTOM BARS NO	1# 4	1# 4	2# 4	1# 5	2# 6		1# 4	1# 4	2# 4	1# 5	2# 6	
BARS NO	1# 5	2# 5	2# 5	2# 6	1# 6		1# 5	2# 5	2# 5	2# 6	1# 6	
STEEL (PSF)	0.60	0.79	1.03	1.18	1.34		0.84	1.23	1.59	1.81	2.12	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	215	600	847	1049	1206	1.265	506	1066	1426	1720	1948	0.779
STIR	#3- 36	#3- 85	#3-101	#3-102	#3-118		#3- 56	#3- 89	#3-102	#3-108	#3-112	
25'- 0"	164	519	748	934	1078	1.490	433	949	1281	1552	1762	0.917
STIR	#3- 32	#3- 85	#3-102	#3-110	#3-120		#3- 54	#3- 90	#3-104	#3-111	#3-116	
26'- 0"	120	448	659	831	965	1.743	368	845	1152	1402	1597	1.073
STIR	#3- 28	#3- 85	#3-104	#3-114	#3-108		#3- 52	#3- 91	#3- 95	#3-113	#3-118	
27'- 0"	80	384	580	740	863	2.027	310	753	1037	1269	1450	1.247
STIR	#3- 23	#3- 84	#3-104	#3-116	#3-116		#3- 50	#3- 92	#3-103	#3-116	#3-121	
28'- 0"	45	327	510	658	773	2.344	259	670	935	1151	1318	1.443
STIR	#3- 17	#3- 84	#3-105	#3-118	#3-125		#3- 47	#3- 93	#3-108	#3-118	#3-124	
29'- 0"	13	276	446	584	692	2.698	212	596	843	1044	1200	1.660
STIR		#3- 82	#3-105	#3-119	#3-127		#3- 44	#3- 93	#3-110	#3-120	#3-126	
30'- 0"		230	389	518	618	3.090	170	529	759	947	1093	1.901
STIR		#3- 81	#3-106	#3-120	#3-129		#3- 41	#3- 94	#3-111	#3-109	#3-128	
31'- 0"		189	337	458	552	3.523	133	468	684	860	997	2.168
STIR		#3- 79	#3-106	#3-121	#3-130		#3- 38	#3- 94	#3-112	#3-117	#3-131	
32'- 0"		151	290	404	492	4.000	98	413	616	781	909	2.461
STIR		#3- 77	#3-105	#3-122	#3-131		#3- 34	#3- 94	#3-113	#3-124	#3-133	
33'- 0"		116	247	354	437	4.523	67	363	554	709	829	2.784
STIR		#3- 75	#3-105	#3-122	#3-133		#3- 30	#3- 93	#3-114	#3-126	#3-135	
34'- 0"		85	208	309	387	5.097	38	317	497	643	757	3.137
STIR		#3- 72	#3-104	#3-123	#3-134		#3- 25	#3- 93	#3-115	#3-127	#3-126	
35'- 0"		56	173	268	341	5.724	12	275	445	583	690	3.522
STIR		#3- 70	#3-103	#3-123	#3-134		#3- 21	#3- 92	#3-116	#3-129	#3-134	
36'- 0"		30	140	230	299	6.407		237	397	528	629	3.942
STIR		#3- 66	#3-102	#3-123	#3-135			#3- 91	#3-116	#3-130	#3-139	
PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.98	0.98	1.31	1.52	1.69		0.98	1.40	1.79	2.03	2.40	
ACTUAL STEEL %	0.669	0.669	0.891	1.041	1.157		0.669	0.955	1.225	1.388	1.650	
EFF. DEPTH, IN.	14.38	14.38	14.38	14.31	14.31		14.38	14.38	14.31	14.31	14.25	
$-I_{cr}/I_{gr}$	0.145	0.145	0.182	0.201	0.218		0.145	0.191	0.227	0.249	0.277	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.51	0.82	1.02	1.19	1.32		0.51	0.82	1.02	1.19	1.32	
ACTUAL STEEL %	0.329	0.530	0.659	0.772	0.857		0.329	0.530	0.659	0.772	0.857	
EFF. DEPTH, IN.	14.71	14.70	14.71	14.64	14.62		14.71	14.70	14.71	14.64	14.62	
$+I_{cr}/I_{gr}$	0.106	0.165	0.201	0.229	0.251		0.106	0.165	0.201	0.229	0.251	

SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	9	7.5	10	8		10	10	8.5	7	6	
BOTTOM BARS NO	2# 4	2# 5	2# 5	2# 5	2# 6		2# 4	2# 5	2# 5	2# 5	2# 6	
BARS NO	1# 4	1# 5	1# 6	2# 5	1# 7		1# 4	1# 5	1# 6	2# 5	1# 7	
STEEL (PSF)	0.64	0.89	1.06	1.25	1.50		0.88	1.38	1.62	1.95	2.28	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	308	714	872	1095	1377	1.265	652	1242	1471	1796	2206	0.779
STIR	#3- 45	#3- 88	#3- 97	#3-107	#3-119		#3- 62	#3- 91	#3- 86	#3-107	#4-113	
25'- 0"	249	623	768	974	1234	1.490	565	1109	1321	1620	1998	0.917
STIR	#3- 42	#3- 88	#3- 98	#3-109	#3-121		#3- 61	#3- 92	#3- 93	#3-109	#3-116	
26'- 0"	197	542	677	867	1107	1.743	489	992	1187	1464	1813	1.073
STIR	#3- 38	#3- 88	#3- 99	#3-111	#3-124		#3- 59	#3- 94	#3-101	#3-111	#3-118	
27'- 0"	150	470	595	771	994	2.027	421	887	1069	1325	1649	1.247
STIR	#3- 34	#3- 87	#3- 99	#3-112	#3-114		#3- 57	#3- 95	#3-103	#3-113	#3-122	
28'- 0"	108	406	522	686	893	2.344	360	794	962	1201	1502	1.443
STIR	#3- 29	#3- 87	#3-100	#3-114	#3-123		#3- 55	#3- 96	#3-104	#3-116	#3-124	
29'- 0"	70	348	456	609	802	2.698	305	710	867	1089	1370	1.660
STIR	#3- 24	#3- 86	#3-100	#3-115	#3-128		#3- 53	#3- 96	#3-106	#3-107	#3-127	
30'- 0"	37	296	397	540	720	3.090	256	634	781	989	1251	1.901
STIR	#3- 18	#3- 85	#3- 99	#3-116	#3-130		#3- 51	#3- 97	#3-107	#3-115	#3-129	
31'- 0"	6	249	344	477	646	3.523	212	565	703	897	1143	2.168
STIR		#3- 83	#3- 99	#3-116	#3-132		#3- 48	#3- 97	#3-108	#3-119	#3-132	
32'- 0"		206	295	421	579	4.000	171	503	632	815	1045	2.461
STIR		#3- 82	#3- 98	#3-117	#3-133		#3- 45	#3- 97	#3-109	#3-121	#3-134	
33'- 0"		167	251	369	518	4.523	134	446	568	739	956	2.784
STIR		#3- 80	#3- 97	#3-117	#3-134		#3- 41	#3- 97	#3-109	#3-122	#3-136	
34'- 0"		132	210	321	462	5.097	101	395	509	671	875	3.137
STIR		#3- 77	#3- 96	#3-117	#3-135		#3- 38	#3- 97	#3-110	#3-123	#3-124	
35'- 0"		99	173	278	411	5.724	70	347	455	608	801	3.522
STIR		#3- 75	#3- 95	#3-117	#3-136		#3- 34	#3- 96	#3-110	#3-125	#3-132	
36'- 0"		69	139	239	364	6.407	41	304	406	550	732	3.942
STIR		#3- 72	#3- 93	#3-116	#3-137		#3- 29	#3- 96	#3-110	#3-126	#3-139	
PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)												
ACTUAL STEEL %	1.00	1.11	1.33	1.55	1.94		1.00	1.55	1.82	2.21	2.58	
EFF. DEPTH, IN.	0.621	0.690	0.828	0.968	1.209		0.621	0.968	1.138	1.382	1.613	
$-I_{cr}/I_{gr}$	14.38	14.38	14.38	14.31	14.31		14.38	14.31	14.31	14.31	14.31	
	0.140	0.152	0.175	0.195	0.230		0.140	0.195	0.220	0.253	0.282	
POSITIVE MOMENT STEEL AREA (SQ. IN.)												
ACTUAL STEEL %	0.60	0.93	1.06	1.24	1.48		0.60	0.93	1.06	1.24	1.48	
EFF. DEPTH, IN.	0.353	0.549	0.627	0.732	0.879		0.353	0.549	0.627	0.732	0.879	
$+I_{cr}/I_{gr}$	14.75	14.69	14.66	14.69	14.60		14.75	14.69	14.66	14.69	14.60	
SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	9	7.5	10	8.5		10	10	8.5	7	5	
BOTTOM BARS NO	2# 4	1# 6	1# 6	1# 5	1# 7		2# 4	1# 6	1# 6	1# 5	1# 7	
BARS NO	1# 4	1# 6	1# 7	2# 6	1# 8		1# 4	1# 6	1# 7	2# 6	1# 8	
STEEL (PSF)	0.66	0.92	1.08	1.20	1.45		0.90	1.41	1.64	1.90	2.51	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	427	814	1035	1249	1513	1.265	817	1380	1701	2012	2396	0.779
STIR	#3- 65	#3- 97	#3-107	#3-117	#3-124		#3- 75	#3- 87	#3-106	#3-112	#4-116	
25'- 0"	360	717	920	1117	1360	1.490	719	1238	1534	1820	2175	0.917
STIR	#3- 63	#3- 97	#3-109	#3-119	#3-127		#3- 75	#3- 94	#3-109	#3-114	#4-120	
26'- 0"	300	630	818	1000	1225	1.743	632	1112	1385	1651	1978	1.073
STIR	#3- 61	#3- 98	#3-111	#3-110	#3-130		#3- 75	#3-101	#3-112	#3-118	#4-123	
27'- 0"	247	553	727	896	1105	2.027	555	1000	1253	1499	1803	1.247
STIR	#3- 59	#3- 99	#3-112	#3-118	#3-132		#3- 75	#3-102	#3-113	#3-120	#3-126	
28'- 0"	199	484	646	803	997	2.344	486	900	1135	1364	1646	1.443
STIR	#3- 56	#3- 99	#3-113	#3-124	#3-135		#3- 74	#3-104	#3-100	#3-123	#3-129	
29'- 0"	157	422	573	719	900	2.698	424	809	1029	1242	1505	1.660
STIR	#3- 53	#3- 99	#3-114	#3-126	#3-138		#3- 73	#3-105	#3-108	#3-125	#3-132	
30'- 0"	118	366	507	644	813	3.090	368	728	933	1133	1378	1.901
STIR	#3- 49	#3- 99	#3-115	#3-127	#3-126		#3- 72	#3-106	#3-115	#3-127	#3-135	
31'- 0"	83	315	447	576	734	3.523	317	655	847	1033	1264	2.168
STIR	#3- 45	#3- 98	#3-116	#3-129	#3-134		#3- 70	#3-107	#3-119	#3-129	#3-138	
32'- 0"	52	269	393	514	662	4.000	271	588	768	943	1159	2.461
STIR	#3- 41	#3- 97	#3-116	#3-130	#3-142		#3- 69	#3-108	#3-121	#3-132	#3-141	
33'- 0"	23	228	344	457	597	4.523	229	527	697	861	1064	2.784
STIR	#3- 36	#3- 96	#3-116	#3-131	#3-144		#3- 67	#3-108	#3-122	#3-121	#3-143	
34'- 0"		189	299	406	538	5.097	191	471	631	786	978	3.137
STIR		#3- 95	#3-116	#3-132	#3-146		#3- 65	#3-109	#3-123	#3-129	#3-145	
35'- 0"		155	258	359	483	5.724	156	421	571	718	898	3.522
STIR		#3- 93	#3-116	#3-133	#3-147		#3- 62	#3-109	#3-124	#3-135	#3-148	
36'- 0"		122	220	316	433	6.407	124	374	517	655	826	3.942
STIR		#3- 92	#3-115	#3-133	#3-149		#3- 60	#3-109	#3-125	#3-137	#3-150	
PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.96	1.07	1.28	1.49	1.75		0.96	1.49	1.75	2.13	2.98	
ACTUAL STEEL %	0.626	0.696	0.835	0.975	1.147		0.626	0.975	1.147	1.392	1.949	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.31	16.31		16.38	16.31	16.31	16.31	16.31	
$-I_{cr}/I_{gr}$	0.143	0.155	0.179	0.199	0.225		0.143	0.199	0.225	0.258	0.326	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.60	0.88	1.04	1.19	1.39		0.60	0.88	1.04	1.19	1.39	
ACTUAL STEEL %	0.370	0.546	0.646	0.737	0.867		0.370	0.546	0.646	0.737	0.867	
EFF. DEPTH, IN.	16.75	16.62	16.59	16.64	16.53		16.75	16.62	16.59	16.64	16.53	
$+I_{cr}/I_{gr}$	0.124	0.174	0.202	0.230	0.260		0.124	0.174	0.202	0.230	0.260	
SINGLE LEG STIRRUP AT IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 9″ Ribs @ 49″ c.-c.
14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	8	10	9	7.5		10	9	7.5	9.5	5	
BOTTOM BARS NO	2# 4	2# 4	1# 5	2# 6	1# 8		2# 4	2# 4	1# 5	2# 6	1# 8	
BARS NO	1# 4	2# 5	2# 6	1# 6	1# 8		1# 4	2# 5	2# 6	1# 6	1# 8	
STEEL (PSF)	0.65	1.01	1.18	1.34	1.64		0.89	1.54	1.81	2.06	3.31	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	277	780	977	1130	1422	1.743	609	1342	1628	1850	2275	1.073
STIR	#3- 48	#3-102	#3-113	#3-110	#3-131		#3- 66	#3- 97	#3-113	#3-117	#4-120	
27'- 0"	224	691	873	1015	1286	2.027	532	1211	1477	1682	2076	1.247
STIR	#3- 45	#3-103	#3-115	#3-118	#3-134		#3- 65	#3-104	#3-115	#3-120	#4-126	
28'- 0"	176	610	780	912	1164	2.344	463	1094	1341	1533	1899	1.443
STIR	#3- 41	#3-103	#3-116	#3-124	#3-136		#3- 64	#3-107	#3-118	#3-123	#4-130	
29'- 0"	134	538	697	819	1054	2.698	401	989	1220	1398	1739	1.660
STIR	#3- 37	#3-104	#3-118	#3-126	#3-139		#3- 62	#3-108	#3-104	#3-126	#3-133	
30'- 0"	95	473	621	736	955	3.090	345	895	1110	1276	1596	1.901
STIR	#3- 32	#3-104	#3-119	#3-127	#3-142		#3- 60	#3-110	#3-111	#3-128	#3-137	
31'- 0"	60	414	553	660	866	3.523	294	809	1011	1167	1465	2.168
STIR	#3- 27	#3-104	#3-119	#3-129	#3-131		#3- 58	#3-111	#3-119	#3-130	#3-139	
32'- 0"	29	361	491	592	784	4.000	248	731	920	1067	1347	2.461
STIR	#3- 22	#3-103	#3-120	#3-130	#3-140		#3- 55	#3-112	#3-123	#3-132	#3-142	
33'- 0"		312	435	529	711	4.523	206	661	838	976	1240	2.784
STIR		#3-103	#3-120	#3-131	#3-146		#3- 53	#3-113	#3-125	#3-121	#3-144	
34'- 0"		268	383	472	643	5.097	168	596	763	893	1142	3.137
STIR		#3-102	#3-121	#3-132	#3-148		#3- 50	#3-113	#3-126	#3-128	#3-147	
35'- 0"		227	336	420	581	5.724	133	537	695	817	1052	3.522
STIR		#3-101	#3-121	#3-133	#3-150		#3- 46	#3-114	#3-127	#3-136	#3-150	
36'- 0"		190	293	372	525	6.407	101	483	632	748	969	3.942
STIR		#3- 99	#3-121	#3-133	#3-151		#3- 43	#3-114	#3-128	#3-137	#3-151	
37'- 0"		156	253	328	472	7.149	71	433	574	684	893	4.399
STIR		#3- 98	#3-120	#3-133	#3-153		#3- 39	#3-115	#3-129	#3-139	#3-154	
38'- 0"		124	216	287	424	7.953	44	387	521	625	823	4.894
STIR		#3- 96	#3-120	#3-134	#3-154		#3- 35	#3-115	#3-130	#3-140	#3-156	
PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.98	1.23	1.52	1.69	2.03		0.98	1.69	2.03	2.27	4.31	
ACTUAL STEEL %	0.577	0.722	0.899	0.999	1.199		0.577	0.999	1.199	1.349	2.563	
EFF. DEPTH, IN.	16.38	16.38	16.31	16.31	16.31		16.38	16.31	16.31	16.25	16.25	
$-I_{cr}/I_{gr}$	0.137	0.164	0.191	0.207	0.237		0.137	0.207	0.237	0.255	0.393	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	1.02	1.19	1.32	1.58		0.60	1.02	1.19	1.32	1.58	
ACTUAL STEEL %	0.335	0.571	0.669	0.742	0.894		0.335	0.571	0.669	0.742	0.894	
EFF. DEPTH, IN.	16.75	16.71	16.64	16.62	16.50		16.75	16.71	16.64	16.62	16.50	
$+I_{cr}/I_{gr}$	0.115	0.186	0.212	0.232	0.269		0.115	0.186	0.212	0.232	0.269	

SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 10″ Ribs @ 50″ c.-c.
14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	8	10	8.5	7.5		8.5	9	7.5	6	7.5	
BOTTOM BARS NO	2# 4	1# 6	2# 5	2# 6	1# 6		2# 4	1# 6	2# 5	2# 6	1# 6	
BARS NO	1# 5	1# 7	2# 5	1# 7	2# 7		1# 5	1# 7	2# 5	1# 7	2# 7	
STEEL (PSF)	0.73	1.03	1.25	1.47	1.60		1.06	1.56	1.88	2.28	2.54	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	386	772	1018	1293	1479	1.743	778	1340	1698	2098	2368	1.073
STIR	#3- 58	#3- 96	#3-110	#3-108	#3-129		#3- 73	#3- 99	#3-111	#3-118	#4-122	
27'- 0"	323	681	909	1165	1337	2.027	687	1208	1540	1911	2161	1.247
STIR	#3- 55	#3- 96	#3-111	#3-116	#3-131		#3- 72	#3-100	#3-113	#3-121	#4-125	
28'- 0"	267	600	812	1050	1210	2.344	605	1090	1398	1744	1976	1.443
STIR	#3- 52	#3- 96	#3-112	#3-125	#3-134		#3- 71	#3-102	#3-102	#3-124	#4-129	
29'- 0"	216	527	725	946	1095	2.698	532	984	1271	1593	1810	1.660
STIR	#3- 48	#3- 96	#3-113	#3-127	#3-121		#3- 70	#3-103	#3-109	#3-126	#3-131	
30'- 0"	171	461	646	853	992	3.090	466	888	1157	1457	1660	1.901
STIR	#3- 45	#3- 95	#3-114	#3-129	#3-129		#3- 69	#3-104	#3-116	#3-129	#3-134	
31'- 0"	130	402	575	768	899	3.523	406	801	1053	1335	1524	2.168
STIR	#3- 40	#3- 94	#3-115	#3-130	#3-138		#3- 67	#3-105	#3-118	#3-131	#3-137	
32'- 0"	92	348	510	692	814	4.000	351	722	959	1223	1401	2.461
STIR	#3- 36	#3- 93	#3-115	#3-132	#3-140		#3- 65	#3-105	#3-120	#3-133	#3-139	
33'- 0"	58	298	451	622	737	4.523	302	651	873	1122	1289	2.784
STIR	#3- 31	#3- 92	#3-115	#3-133	#3-142		#3- 63	#3-106	#3-121	#3-119	#3-141	
34'- 0"	27	253	397	558	667	5.097	257	585	795	1029	1187	3.137
STIR	#3- 26	#3- 91	#3-115	#3-134	#3-143		#3- 61	#3-106	#3-122	#3-126	#3-144	
35'- 0"		212	348	500	602	5.724	215	526	723	944	1093	3.522
STIR		#3- 89	#3-115	#3-135	#3-145		#3- 58	#3-106	#3-123	#3-134	#3-146	
36'- 0"		174	303	446	543	6.407	178	471	657	866	1007	3.942
STIR		#3- 87	#3-114	#3-135	#3-146		#3- 55	#3-106	#3-124	#3-139	#3-149	
37'- 0"		140	261	397	489	7.149	143	420	597	795	928	4.399
STIR		#3- 85	#3-114	#3-136	#3-147		#3- 52	#3-106	#3-125	#3-140	#3-135	
38'- 0"		108	223	352	439	7.953	110	374	541	729	855	4.894
STIR		#3- 82	#3-113	#3-136	#3-148		#3- 49	#3-105	#3-125	#3-142	#3-142	
PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.00	1.25	1.55	1.82	2.07		1.18	1.72	2.07	2.58	2.93	
ACTUAL STEEL %	0.537	0.672	0.836	0.984	1.115		0.632	0.929	1.115	1.394	1.590	
EFF. DEPTH, IN.	16.38	16.38	16.31	16.31	16.31		16.38	16.31	16.31	16.31	16.25	
$-I_{cr}/I_{gr}$	0.132	0.158	0.185	0.209	0.230		0.150	0.201	0.230	0.270	0.293	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.04	1.24	1.48	1.64		0.71	1.04	1.24	1.48	1.64	
ACTUAL STEEL %	0.363	0.536	0.635	0.762	0.845		0.363	0.536	0.635	0.762	0.845	
EFF. DEPTH, IN.	16.72	16.59	16.69	16.60	16.58		16.72	16.59	16.69	16.60	16.58	
$+I_{cr}/I_{gr}$	0.124	0.174	0.206	0.239	0.261		0.124	0.174	0.206	0.239	0.261	

SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	7.5	10	8.5	7.5		9.5	8.5	7.5	9	5	
BOTTOM BARS NO	1# 5	1# 6	1# 5	1# 7	1# 8		1# 5	1# 6	1# 5	1# 7	1# 8	
BARS NO	1# 5	1# 7	2# 6	1# 8	1# 8		1# 5	1# 7	2# 6	1# 8	1# 8	
STEEL (PSF)	0.70	1.08	1.20	1.45	1.67		0.96	1.64	1.83	2.21	3.33	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	270	751	927	1146	1359	2.344	600	1300	1556	1875	2185	1.443
STIR	#3- 57	#3-112	#3-123	#3-135	#3-142		#3- 75	#3-102	#3-121	#3-129	#4-129	
29'- 0"	221	669	833	1038	1236	2.698	529	1181	1420	1717	2006	1.660
STIR	#3- 54	#3-113	#3-124	#3-120	#3-145		#3- 74	#3-109	#3-124	#3-131	#4-135	
30'- 0"	176	595	749	940	1125	3.090	464	1074	1297	1575	1845	1.901
STIR	#3- 51	#3-113	#3-126	#3-128	#3-147		#3- 73	#3-116	#3-126	#3-134	#4-140	
31'- 0"	136	528	672	851	1025	3.523	406	976	1185	1446	1698	2.168
STIR	#3- 47	#3-114	#3-127	#3-137	#3-150		#3- 72	#3-118	#3-109	#3-137	#4-143	
32'- 0"	99	468	603	771	934	4.000	353	888	1084	1329	1566	2.461
STIR	#3- 43	#3-114	#3-128	#3-141	#3-153		#3- 70	#3-119	#3-116	#3-140	#3-146	
33'- 0"	66	413	539	697	851	4.523	304	808	992	1222	1445	2.784
STIR	#3- 38	#3-114	#3-129	#3-143	#3-137		#3- 68	#3-121	#3-124	#3-142	#3-149	
34'- 0"	36	362	482	630	775	5.097	260	735	908	1125	1335	3.137
STIR	#3- 34	#3-114	#3-130	#3-144	#3-145		#3- 66	#3-122	#3-131	#3-145	#3-152	
35'- 0"	8	316	429	569	705	5.724	220	667	831	1036	1234	3.522
STIR	#3- 28	#3-114	#3-130	#3-146	#3-154		#3- 64	#3-123	#3-134	#3-147	#3-155	
36'- 0"		274	380	513	642	6.407	183	606	761	954	1141	3.942
STIR		#3-113	#3-131	#3-147	#3-159		#3- 61	#3-124	#3-136	#3-149	#3-157	
37'- 0"		235	336	461	583	7.149	148	549	696	879	1056	4.399
STIR		#3-112	#3-131	#3-148	#3-161		#3- 59	#3-124	#3-137	#3-133	#3-160	
38'- 0"		199	294	413	529	7.953	117	497	636	809	977	4.894
STIR		#3-111	#3-131	#3-149	#3-163		#3- 55	#3-125	#3-138	#3-141	#3-162	
39'- 0"		166	256	369	479	8.824	88	449	581	745	905	5.430
STIR		#3-110	#3-131	#3-150	#3-164		#3- 52	#3-125	#3-139	#3-148	#3-164	
40'- 0"		135	221	329	433	9.765	61	404	529	686	838	6.009
STIR		#3-109	#3-131	#3-151	#3-166		#3- 49	#3-126	#3-140	#3-155	#3-167	
PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.96	1.28	1.49	1.75	1.98		1.01	1.75	1.98	2.35	4.22	
ACTUAL STEEL %	0.548	0.731	0.853	1.004	1.137		0.577	1.004	1.137	1.351	2.431	
EFF. DEPTH, IN.	18.38	18.38	18.31	18.31	18.31		18.38	18.31	18.31	18.25	18.25	
$-I_{cr}/I_{gr}$	0.135	0.170	0.189	0.214	0.235		0.141	0.214	0.235	0.263	0.391	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	1.04	1.19	1.39	1.58		0.62	1.04	1.19	1.39	1.58	
ACTUAL STEEL %	0.337	0.567	0.647	0.760	0.865		0.337	0.567	0.647	0.760	0.865	
EFF. DEPTH, IN.	18.69	18.59	18.64	18.53	18.50		18.69	18.59	18.64	18.53	18.50	
$+I_{cr}/I_{gr}$	0.118	0.188	0.214	0.243	0.272		0.118	0.188	0.214	0.243	0.272	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	10	9.5	7.5	9.5		8.5	5	4.5	8	6	
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.74	1.18	1.31	1.64	1.85		1.07	1.77	1.99	2.50	3.73	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	351	902	1050	1334	1568	2.344	730	1531	1746	2160	2500	1.443
STIR	#3- 62	#3-115	#3-123	#3-136	#3-143		#3- 78	#3- 99	#3-121	#4-130	#4-128	
29'- 0"	294	808	946	1211	1429	2.698	647	1395	1595	1981	2297	1.660
STIR	#3- 59	#3-116	#3-124	#3-138	#3-146		#3- 78	#3-106	#3-124	#4-132	#4-133	
30'- 0"	243	723	852	1100	1303	3.090	573	1271	1459	1820	2115	1.901
STIR	#3- 56	#3-117	#3-126	#3-125	#3-149		#3- 77	#3-113	#3-127	#3-136	#4-140	
31'- 0"	197	647	767	1000	1190	3.523	506	1160	1336	1673	1950	2.168
STIR	#3- 53	#3-118	#3-127	#3-133	#3-152		#3- 76	#3-120	#3-109	#3-139	#4-144	
32'- 0"	155	577	690	908	1087	4.000	445	1059	1224	1541	1801	2.461
STIR	#3- 49	#3-118	#3-128	#3-142	#3-155		#3- 74	#3-122	#3-117	#3-141	#4-147	
33'- 0"	117	514	620	825	993	4.523	390	967	1122	1420	1664	2.784
STIR	#3- 45	#3-119	#3-129	#3-145	#3-157		#3- 73	#3-123	#3-124	#3-144	#4-151	
34'- 0"	83	456	557	750	908	5.097	340	883	1029	1310	1540	3.137
STIR	#3- 41	#3-119	#3-130	#3-147	#3-142		#3- 71	#3-124	#3-131	#3-146	#4-153	
35'- 0"	51	403	498	680	829	5.724	293	806	944	1209	1426	3.522
STIR	#3- 36	#3-119	#3-131	#3-148	#3-150		#3- 69	#3-126	#3-134	#3-149	#3-156	
36'- 0"	21	355	444	616	758	6.407	251	735	866	1116	1321	3.942
STIR	#3- 31	#3-118	#3-131	#3-150	#3-159		#3- 67	#3-127	#3-135	#3-150	#3-159	
37'- 0"		310	395	558	691	7.149	212	670	794	1031	1225	4.399
STIR		#3-118	#3-131	#3-151	#3-163		#3- 64	#3-128	#3-137	#3-153	#3-161	
38'- 0"		269	349	504	630	7.953	175	611	727	952	1136	4.894
STIR		#3-117	#3-131	#3-152	#3-165		#3- 62	#3-128	#3-138	#3-137	#3-163	
39'- 0"		231	307	454	574	8.824	142	555	666	880	1054	5.430
STIR		#3-116	#3-131	#3-153	#3-167		#3- 59	#3-129	#3-139	#3-145	#3-166	
40'- 0"		196	268	408	522	9.765	111	504	609	812	979	6.009
STIR		#3-115	#3-131	#3-154	#3-168		#3- 56	#3-129	#3-140	#3-152	#3-168	
PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.98	1.52	1.60	2.03	2.27		1.15	1.96	2.18	2.69	4.90	
ACTUAL STEEL %	0.506	0.788	0.830	1.051	1.182		0.596	1.013	1.125	1.404	2.562	
EFF. DEPTH, IN.	18.38	18.31	18.31	18.31	18.25		18.38	18.38	18.38	18.25	18.19	
$-I_{cr}/I_{gr}$	0.130	0.182	0.190	0.227	0.245		0.148	0.223	0.241	0.277	0.410	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.349	0.588	0.652	0.785	0.891		0.349	0.588	0.652	0.785	0.891	
EFF. DEPTH, IN.	18.72	18.64	18.62	18.50	18.46		18.72	18.64	18.62	18.50	18.46	
$+I_{cr}/I_{gr}$	0.124	0.198	0.217	0.251	0.280		0.124	0.198	0.217	0.251	0.280	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	7	8.5	7.5	6		8.5	8	6	8	4	
BOTTOM BARS NO	3# 3	1# 5	2# 6	1# 6	2# 7		3# 3	1# 5	2# 6	1# 6	2# 7	
BARS NO	2# 4	2# 6	1# 7	2# 7	1# 8		2# 4	2# 6	1# 7	2# 7	1# 8	
STEEL (PSF)	0.75	1.13	1.47	1.60	2.00		1.08	1.73	2.28	2.45	4.08	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	351	876	1205	1385	1777	2.344	742	1506	1984	2246	2815	1.443
STIR	#3- 54	#3-107	#3-124	#3-115	#4-144		#3- 73	#3-108	#3-123	#4-128	#4-128	
29'- 0"	293	783	1089	1257	1622	2.698	657	1369	1815	2060	2590	1.660
STIR	#3- 51	#3-108	#3-126	#3-123	#3-147		#3- 72	#3-111	#3-126	#4-130	#4-133	
30'- 0"	240	698	984	1141	1482	3.090	581	1246	1663	1891	2387	1.901
STIR	#3- 47	#3-108	#3-128	#3-131	#3-150		#3- 70	#3-113	#3-128	#3-133	#4-139	
31'- 0"	193	621	890	1037	1356	3.523	512	1135	1525	1739	2203	2.168
STIR	#3- 43	#3-108	#3-129	#3-137	#3-152		#3- 69	#3-114	#3-130	#3-135	#4-145	
32'- 0"	150	552	804	942	1241	4.000	449	1034	1400	1601	2036	2.461
STIR	#3- 39	#3-108	#3-130	#3-139	#3-155		#3- 67	#3-115	#3-114	#3-139	#4-148	
33'- 0"	110	489	725	855	1137	4.523	392	942	1286	1475	1884	2.784
STIR	#3- 34	#3-108	#3-131	#3-141	#3-158		#3- 65	#3-116	#3-121	#3-141	#4-151	
34'- 0"	75	431	654	776	1041	5.097	340	858	1182	1360	1746	3.137
STIR	#3- 29	#3-107	#3-132	#3-142	#3-160		#3- 63	#3-117	#3-128	#3-143	#4-154	
35'- 0"	42	378	588	704	954	5.724	292	781	1087	1255	1619	3.522
STIR	#3- 23	#3-106	#3-133	#3-143	#3-148		#3- 60	#3-118	#3-136	#3-145	#4-157	
36'- 0"	12	329	528	637	874	6.407	248	710	999	1158	1502	3.942
STIR		#3-105	#3-134	#3-145	#3-157		#3- 58	#3-118	#3-137	#3-130	#4-160	
37'- 0"		285	473	576	800	7.149	208	645	919	1069	1395	4.399
STIR		#3-104	#3-134	#3-146	#3-165		#3- 55	#3-119	#3-139	#3-137	#3-163	
38'- 0"		243	422	520	732	7.953	170	585	845	987	1296	4.894
STIR		#3-103	#3-134	#3-146	#3-166		#3- 51	#3-119	#3-140	#3-144	#3-165	
39'- 0"		205	375	468	669	8.824	136	530	776	911	1205	5.430
STIR		#3-101	#3-134	#3-147	#3-168		#3- 48	#3-119	#3-142	#3-151	#3-167	
40'- 0"		170	331	420	611	9.765	104	479	713	841	1120	6.009
STIR		#3- 99	#3-134	#3-148	#3-170		#3- 44	#3-119	#3-143	#3-152	#3-170	
PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.00	1.43	1.82	2.07	2.58		1.18	1.94	2.58	2.75	5.50	
ACTUAL STEEL %	0.472	0.674	0.864	0.979	1.224		0.555	0.918	1.224	1.308	2.616	
EFF. DEPTH, IN.	18.38	18.38	18.31	18.31	18.31		18.38	18.31	18.31	18.25	18.25	
$-I_{cr}/I_{gr}$	0.125	0.166	0.200	0.220	0.259		0.143	0.209	0.259	0.269	0.429	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.73	1.19	1.48	1.64	1.99		0.73	1.19	1.48	1.64	1.99	
ACTUAL STEEL %	0.328	0.538	0.671	0.744	0.904		0.328	0.538	0.671	0.744	0.904	
EFF. DEPTH, IN.	18.78	18.64	18.60	18.58	18.54		18.78	18.64	18.60	18.58	18.54	
$+I_{cr}/I_{gr}$	0.119	0.184	0.223	0.244	0.289		0.119	0.184	0.223	0.244	0.289	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 18″ Deep Rib + 4.5″ Top Slab = 22.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	10	10	9	7.5	9.5		8.5	7.5	9.5	10	6	
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.75	1.20	1.36	1.67	1.87		1.08	1.83	2.08	2.64	3.76	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	223	691	816	1059	1258	4.000	544	1225	1407	1761	2050	2.461
STIR	#3- 63	#3-126	#3-136	#3-131	#3-160		#3- 84	#3-118	#3-136	#4-146	#4-149	
33'- 0"	180	620	739	967	1154	4.523	482	1123	1295	1627	1899	2.784
STIR	#3- 60	#3-127	#3-137	#3-139	#3-163		#3- 83	#3-126	#3-138	#3-148	#4-155	
34'- 0"	142	556	668	883	1059	5.097	426	1029	1191	1505	1761	3.137
STIR	#3- 56	#3-128	#3-138	#3-148	#3-165		#3- 82	#3-131	#3-120	#3-151	#4-158	
35'- 0"	107	498	603	806	972	5.724	375	944	1097	1393	1634	3.522
STIR	#3- 52	#3-128	#3-140	#3-156	#3-168		#3- 80	#3-133	#3-127	#3-154	#4-161	
36'- 0"	74	444	543	735	892	6.407	328	866	1010	1290	1518	3.942
STIR	#3- 48	#3-129	#3-140	#3-158	#3-170		#3- 79	#3-134	#3-135	#3-156	#4-163	
37'- 0"	44	394	489	670	819	7.149	285	794	931	1195	1411	4.399
STIR	#3- 44	#3-129	#3-141	#3-159	#3-154		#3- 77	#3-135	#3-142	#3-159	#3-166	
38'- 0"	17	349	438	610	751	7.953	245	728	857	1108	1313	4.894
STIR	#3- 39	#3-129	#3-142	#3-161	#3-163		#3- 75	#3-137	#3-146	#3-161	#3-169	
39'- 0"		307	391	555	689	8.824	208	666	789	1027	1222	5.430
STIR		#3-129	#3-142	#3-162	#3-171		#3- 73	#3-138	#3-147	#3-164	#3-172	
40'- 0"		268	348	504	631	9.765	174	609	726	953	1138	6.009
STIR		#3-128	#3-142	#3-164	#3-177		#3- 70	#3-139	#3-149	#3-166	#3-175	
41'- 0"		231	308	456	577	10.778	142	557	668	883	1059	6.633
STIR		#3-127	#3-143	#3-165	#3-179		#3- 68	#3-139	#3-150	#3-147	#3-177	
42'- 0"		198	271	412	527	11.869	113	508	614	819	987	7.304
STIR		#3-127	#3-142	#3-166	#3-180		#3- 65	#3-140	#3-151	#3-154	#3-179	
43'- 0"		166	236	371	481	13.040	85	462	563	759	919	8.025
STIR		#3-126	#3-142	#3-167	#3-182		#3- 62	#3-141	#3-153	#3-161	#3-182	
44'- 0"		137	204	332	437	14.296	59	420	516	703	856	8.798
STIR		#3-124	#3-142	#3-167	#3-184		#3- 58	#3-141	#3-153	#3-169	#3-185	
PROPERTIES FOR DESIGN (CONCRETE 0.67 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.96	1.49	1.65	1.98	2.22		1.13	1.98	2.22	2.88	4.80	
ACTUAL STEEL %	0.486	0.756	0.840	1.008	1.133		0.572	1.008	1.133	1.473	2.456	
EFF. DEPTH, IN.	20.38	20.31	20.31	20.31	20.25		20.38	20.31	20.25	20.19	20.19	
$-I_{cr}/I_{gr}$	0.128	0.181	0.196	0.225	0.243		0.146	0.225	0.243	0.291	0.408	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.342	0.575	0.638	0.768	0.871		0.342	0.575	0.638	0.768	0.871	
EFF. DEPTH, IN.	20.72	20.64	20.62	20.50	20.46		20.72	20.64	20.62	20.50	20.46	
$+I_{cr}/I_{gr}$	0.125	0.200	0.220	0.255	0.284		0.125	0.200	0.220	0.255	0.284	
SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 18″ Deep Rib + 4.5″ Top Slab = 22.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	8.5	9.5	8.5		8	5	4	7	4	
BOTTOM BARS NO	1# 5	1# 7	2# 6	1# 8	2# 7		1# 5	1# 7	2# 6	1# 8	2# 7	
BARS NO	1# 6	1# 7	1# 7	1# 9	1# 8		1# 6	1# 7	1# 7	1# 9	1# 8	
STEEL (PSF)	0.77	1.25	1.49	1.85	2.04		1.13	1.84	2.25	2.82	4.11	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	231	668	942	1230	1429	4.000	570	1204	1604	2023	2311	2.461
STIR	#3- 55	#3-117	#3-137	#3-153	#3-161		#3- 78	#3-121	#3-136	#4-146	#4-148	
33'- 0"	187	597	855	1126	1313	4.523	505	1102	1477	1871	2143	2.784
STIR	#3- 51	#3-117	#3-138	#3-136	#3-163		#3- 77	#3-122	#3-139	#4-149	#4-154	
34'- 0"	146	533	776	1031	1207	5.097	446	1008	1362	1733	1989	3.137
STIR	#3- 47	#3-117	#3-140	#3-144	#3-166		#3- 76	#3-123	#3-119	#4-152	#4-158	
35'- 0"	109	474	704	945	1110	5.724	392	923	1256	1607	1848	3.522
STIR	#3- 43	#3-117	#3-141	#3-152	#3-169		#3- 74	#3-125	#3-127	#3-155	#4-160	
36'- 0"	75	420	637	865	1021	6.407	342	844	1159	1491	1719	3.942
STIR	#3- 38	#3-117	#3-142	#3-160	#3-171		#3- 72	#3-126	#3-134	#3-157	#4-164	
37'- 0"	44	370	576	791	940	7.149	297	772	1070	1384	1600	4.399
STIR	#3- 33	#3-116	#3-143	#3-162	#3-153		#3- 70	#3-126	#3-141	#3-160	#4-166	
38'- 0"	15	325	519	724	864	7.953	255	705	988	1285	1490	4.894
STIR	#3- 28	#3-116	#3-143	#3-164	#3-161		#3- 67	#3-127	#3-146	#3-163	#4-169	
39'- 0"		282	467	661	795	8.824	216	643	912	1194	1389	5.430
STIR		#3-115	#3-144	#3-165	#3-170		#3- 65	#3-128	#3-148	#3-165	#4-172	
40'- 0"		243	419	603	730	9.765	180	586	842	1110	1295	6.009
STIR		#3-113	#3-144	#3-167	#3-178		#3- 62	#3-128	#3-149	#3-167	#3-175	
41'- 0"		207	374	549	670	10.778	147	533	777	1032	1208	6.633
STIR		#3-112	#3-144	#3-168	#3-180		#3- 59	#3-128	#3-151	#3-170	#3-177	
42'- 0"		173	332	499	614	11.869	116	484	716	959	1127	7.304
STIR		#3-110	#3-144	#3-169	#3-182		#3- 56	#3-129	#3-152	#3-151	#3-179	
43'- 0"		141	293	453	563	13.040	87	438	659	892	1051	8.025
STIR		#3-109	#3-144	#3-170	#3-183		#3- 52	#3-129	#3-153	#3-158	#3-182	
44'- 0"		112	257	409	514	14.296	60	396	607	828	981	8.798
STIR		#3-107	#3-144	#3-171	#3-185		#3- 48	#3-128	#3-154	#3-165	#3-185	
PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.98	1.52	1.79	2.27	2.54		1.23	1.96	2.45	3.08	5.39	
ACTUAL STEEL %	0.450	0.699	0.823	1.049	1.172		0.562	0.899	1.124	1.423	2.491	
EFF. DEPTH, IN.	20.38	20.31	20.31	20.25	20.25		20.38	20.38	20.38	20.25	20.25	
$-I_{cr}/I_{gr}$	0.123	0.174	0.197	0.235	0.255		0.148	0.213	0.252	0.293	0.426	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.75	1.20	1.48	1.79	1.99		0.75	1.20	1.48	1.79	1.99	
ACTUAL STEEL %	0.329	0.529	0.651	0.792	0.878		0.329	0.529	0.651	0.792	0.878	
EFF. DEPTH, IN.	20.65	20.56	20.60	20.46	20.54		20.65	20.56	20.60	20.46	20.54	
$+I_{cr}/I_{gr}$	0.121	0.185	0.225	0.263	0.291		0.121	0.185	0.225	0.263	0.291	
SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 18″ Deep Rib + 4.5″ Top Slab = 22.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	9.5	8	9	8		7.5	7	6	6.5	4	
BOTTOM BARS NO	1# 4	2# 6	1# 8	2# 7	1# 7		1# 4	2# 6	1# 8	2# 7	1# 7	
BARS NO	2# 5	1# 6	1# 8	1# 8	2# 8		2# 5	1# 6	1# 8	1# 8	2# 8	
STEEL (PSF)	0.78	1.30	1.59	1.98	2.13		1.18	1.97	2.37	3.04	4.16	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	274	761	1004	1401	1581	4.000	645	1352	1706	2284	2545	2.461
STIR	#3- 55	#3-118	#3-134	#3-154	#4-161		#3- 79	#3-122	#3-135	#4-147	#4-149	
33'- 0"	226	683	912	1285	1454	4.523	574	1239	1572	2115	2361	2.784
STIR	#3- 52	#3-118	#3-136	#3-157	#3-163		#3- 77	#3-123	#3-138	#4-151	#4-155	
34'- 0"	181	612	828	1180	1339	5.097	509	1136	1449	1962	2193	3.137
STIR	#3- 48	#3-118	#3-137	#3-141	#3-166		#3- 76	#3-124	#3-123	#4-153	#4-158	
35'- 0"	141	547	751	1083	1233	5.724	450	1042	1337	1821	2039	3.522
STIR	#3- 43	#3-118	#3-138	#3-150	#3-169		#3- 74	#3-126	#3-130	#4-156	#4-160	
36'- 0"	103	488	680	994	1136	6.407	396	955	1234	1691	1898	3.942
STIR	#3- 39	#3-118	#3-139	#3-158	#3-171		#3- 72	#3-127	#3-137	#4-159	#4-164	
37'- 0"	69	433	615	912	1046	7.149	346	875	1140	1572	1768	4.399
STIR	#3- 34	#3-117	#3-139	#3-164	#3-153		#3- 70	#3-128	#3-143	#4-161	#4-166	
38'- 0"	37	382	555	837	964	7.953	300	802	1053	1462	1648	4.894
STIR	#3- 29	#3-117	#3-140	#3-165	#3-161		#3- 68	#3-128	#3-144	#3-163	#4-169	
39'- 0"	8	336	499	767	888	8.824	257	734	972	1361	1537	5.430
STIR	#3- 23	#3-116	#3-140	#3-167	#3-170		#3- 65	#3-129	#3-146	#3-166	#4-172	
40'- 0"		292	448	702	817	9.765	218	671	897	1267	1434	6.009
STIR		#3-115	#3-140	#3-169	#3-178		#3- 62	#3-129	#3-147	#3-168	#4-175	
41'- 0"		252	400	642	752	10.778	182	612	828	1180	1339	6.633
STIR		#3-113	#3-140	#3-170	#3-180		#3- 59	#3-130	#3-148	#3-171	#3-177	
42'- 0"		215	356	587	691	11.869	148	558	764	1099	1251	7.304
STIR		#3-112	#3-140	#3-171	#3-181		#3- 56	#3-130	#3-149	#3-173	#3-180	
43'- 0"		180	315	535	634	13.040	116	508	704	1024	1169	8.025
STIR		#3-110	#3-140	#3-173	#3-183		#3- 52	#3-130	#3-150	#3-155	#3-182	
44'- 0"		148	276	487	582	14.296	86	461	648	953	1092	8.798
STIR		#3-108	#3-139	#3-174	#3-185		#3- 49	#3-130	#3-151	#3-162	#3-185	
PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.00	1.63	1.94	2.44	2.75		1.33	2.21	2.58	3.38	5.50	
ACTUAL STEEL %	0.420	0.687	0.816	1.033	1.162		0.559	0.932	1.088	1.430	2.324	
EFF. DEPTH, IN.	20.38	20.31	20.31	20.25	20.25		20.38	20.31	20.31	20.25	20.25	
$-I_{cr}/I_{gr}$	0.119	0.175	0.200	0.237	0.259		0.150	0.222	0.249	0.300	0.417	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.82	1.32	1.58	1.99	2.18		0.82	1.32	1.58	1.99	2.18	
ACTUAL STEEL %	0.329	0.532	0.640	0.805	0.882		0.329	0.532	0.640	0.805	0.882	
EFF. DEPTH, IN.	20.70	20.62	20.50	20.54	20.52		20.70	20.62	20.50	20.54	20.52	
$+I_{cr}/I_{gr}$	0.123	0.190	0.220	0.272	0.294		0.123	0.190	0.220	0.272	0.294	
SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 6	# 8	Int. Span Defl. Coeff. (2)
AT	10	9	8	9.5	8.5		7	4	6	6.5	7	
BOTTOM BARS NO	1# 4	2# 6	2# 6	1# 8	1# 9		1# 4	2# 6	2# 6	1# 8	1# 9	
BARS NO	2# 5	1# 6	1# 7	1# 9	1# 9		2# 5	1# 6	1# 7	1# 9	1# 9	
STEEL (PSF)	0.80	1.36	1.54	1.87	2.12		1.25	2.14	2.33	2.97	4.23	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
34'- 0" (3)	280	753	903	1184	1378	5.097	640	1328	1546	1956	2237	3.137
STIR	#3- 77	#3-137	#3-147	#3-165	#3-171		#3- 96	#3-123	#3-146	#4-156	#4-157	
35'- 0"	235	682	823	1089	1271	5.724	575	1224	1430	1817	2082	3.522
STIR	#3- 75	#3-138	#3-149	#3-166	#3-174		#3- 96	#3-130	#3-148	#4-160	#4-161	
36'- 0"	194	616	750	1001	1174	6.407	515	1129	1324	1689	1940	3.942
STIR	#3- 72	#3-139	#3-150	#3-149	#3-177		#3- 95	#3-138	#3-151	#4-162	#4-167	
37'- 0"	156	556	683	920	1084	7.149	460	1042	1226	1572	1809	4.399
STIR	#3- 69	#3-139	#3-152	#3-157	#3-180		#3- 94	#3-142	#3-130	#4-165	#4-172	
38'- 0"	122	501	621	846	1001	7.953	410	961	1135	1463	1689	4.894
STIR	#3- 65	#3-140	#3-153	#3-165	#3-183		#3- 93	#3-144	#3-137	#3-168	#4-175	
39'- 0"	90	449	563	777	924	8.824	363	886	1052	1363	1577	5.430
STIR	#3- 62	#3-140	#3-154	#3-173	#3-185		#3- 92	#3-145	#3-144	#3-170	#4-178	
40'- 0"	60	402	510	714	853	9.765	320	817	975	1271	1474	6.009
STIR	#3- 58	#3-140	#3-155	#3-175	#3-165		#3- 90	#3-147	#3-152	#3-173	#4-181	
41'- 0"	32	358	461	655	788	10.778	280	753	903	1185	1378	6.633
STIR	#3- 53	#3-140	#3-155	#3-177	#3-173		#3- 89	#3-148	#3-159	#3-176	#4-183	
42'- 0"	7	317	415	600	726	11.869	243	694	837	1105	1289	7.304
STIR	#3- 49	#3-140	#3-156	#3-179	#3-181		#3- 87	#3-149	#3-160	#3-178	#4-186	
43'- 0"		279	372	549	669	13.040	208	638	775	1031	1207	8.025
STIR		#3-140	#3-156	#3-180	#3-190		#3- 85	#3-150	#3-162	#3-180	#3-189	
44'- 0"		243	333	501	616	14.296	176	587	717	961	1129	8.798
STIR		#3-139	#3-157	#3-182	#3-194		#3- 82	#3-151	#3-163	#3-183	#3-191	
45'- 0"		210	296	456	567	15.641	145	538	663	897	1057	9.625
STIR		#3-138	#3-157	#3-183	#3-196		#3- 80	#3-152	#3-165	#3-184	#3-194	
46'- 0"		179	261	415	520	17.078	117	493	612	836	990	10.510
STIR		#3-137	#3-157	#3-184	#3-198		#3- 78	#3-152	#3-166	#3-167	#3-197	
PROPERTIES FOR DESIGN (CONCRETE 0.71 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.96	1.65	1.86	2.22	2.48		1.37	2.40	2.48	3.25	5.42	
ACTUAL STEEL %	0.435	0.752	0.846	1.014	1.133		0.621	1.087	1.127	1.482	2.487	
EFF. DEPTH, IN.	22.38	22.31	22.31	22.25	22.25		22.38	22.38	22.31	22.25	22.12	
$-I_{cr}/I_{gr}$	0.122	0.188	0.206	0.234	0.254		0.163	0.250	0.255	0.307	0.426	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.82	1.32	1.48	1.79	2.00		0.82	1.32	1.48	1.79	2.00	
ACTUAL STEEL %	0.354	0.572	0.642	0.780	0.873		0.354	0.572	0.642	0.780	0.873	
EFF. DEPTH, IN.	22.70	22.62	22.60	22.46	22.44		22.70	22.62	22.60	22.46	22.44	
$+I_{cr}/I_{gr}$	0.134	0.207	0.229	0.269	0.296		0.134	0.207	0.229	0.269	0.296	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 6	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	9.5	9	7.5	6	8		7	4	7.5	8.5	5	
BOTTOM BARS NO	1# 6	1# 7	1# 6	2# 7	1# 7		1# 6	1# 7	1# 6	2# 7	1# 7	
BARS NO	1# 6	1# 8	2# 7	1# 8	2# 8		1# 6	1# 8	2# 7	1# 8	2# 8	
STEEL (PSF)	0.90	1.41	1.62	2.03	2.16		1.33	2.19	2.56	3.14	4.42	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
34'- 0" (3)	304	783	1022	1347	1522	5.097	689	1386	1733	2206	2461	3.137
STIR	#3- 72	#3-132	#3-148	#3-165	#4-171		#3- 93	#3-129	#3-147	#4-157	#4-157	
35'- 0"	256	708	934	1241	1406	5.724	619	1277	1605	2051	2292	3.522
STIR	#3- 69	#3-132	#3-149	#3-167	#3-174		#3- 92	#3-135	#3-150	#4-160	#4-162	
36'- 0"	212	640	853	1143	1299	6.407	556	1177	1488	1909	2137	3.942
STIR	#3- 66	#3-133	#3-151	#3-147	#3-177		#3- 91	#3-137	#3-151	#4-163	#4-167	
37'- 0"	172	577	779	1053	1201	7.149	497	1086	1379	1779	1994	4.399
STIR	#3- 63	#3-133	#3-152	#3-156	#3-180		#3- 90	#3-138	#3-154	#4-166	#4-171	
38'- 0"	135	519	710	970	1111	7.953	443	1001	1279	1658	1862	4.894
STIR	#3- 59	#3-133	#3-153	#3-164	#3-182		#3- 89	#3-139	#3-136	#4-168	#4-174	
39'- 0"	101	465	647	894	1027	8.824	393	923	1187	1547	1740	5.430
STIR	#3- 55	#3-133	#3-154	#3-173	#3-185		#3- 87	#3-141	#3-143	#4-171	#4-177	
40'- 0"	69	415	588	823	949	9.765	347	851	1102	1443	1628	6.009
STIR	#3- 51	#3-133	#3-155	#3-176	#3-166		#3- 86	#3-142	#3-151	#4-174	#4-180	
41'- 0"	39	369	533	757	877	10.778	304	783	1023	1348	1523	6.633
STIR	#3- 46	#3-133	#3-156	#3-178	#3-174		#3- 84	#3-143	#3-158	#3-177	#4-183	
42'- 0"	12	326	483	696	811	11.869	264	721	949	1259	1426	7.304
STIR	#3- 42	#3-132	#3-156	#3-180	#3-183		#3- 82	#3-144	#3-161	#3-179	#4-186	
43'- 0"		286	436	639	748	13.040	227	663	880	1176	1335	8.025
STIR		#3-131	#3-157	#3-181	#3-191		#3- 79	#3-144	#3-162	#3-182	#4-189	
44'- 0"		249	392	586	690	14.296	192	609	816	1099	1251	8.798
STIR		#3-131	#3-157	#3-182	#3-193		#3- 77	#3-145	#3-164	#3-183	#4-191	
45'- 0"		214	351	536	636	15.641	160	558	757	1027	1172	9.625
STIR		#3-129	#3-157	#3-184	#3-195		#3- 74	#3-145	#3-165	#3-186	#3-193	
46'- 0"		182	312	490	586	17.078	130	511	701	959	1098	10.510
STIR		#3-128	#3-157	#3-185	#3-197		#3- 71	#3-146	#3-167	#3-188	#3-195	
PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.03	1.69	2.03	2.53	2.69		1.40	2.45	2.87	3.46	5.88	
ACTUAL STEEL %	0.424	0.697	0.836	1.045	1.116		0.576	1.008	1.190	1.437	2.443	
EFF. DEPTH, IN.	22.38	22.31	22.31	22.31	22.25		22.38	22.38	22.25	22.19	22.19	
$-I_{cr}/I_{gr}$	0.122	0.181	0.208	0.246	0.256		0.157	0.242	0.269	0.305	0.435	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.88	1.39	1.64	1.99	2.18		0.88	1.39	1.64	1.99	2.18	
ACTUAL STEEL %	0.347	0.551	0.648	0.788	0.864		0.347	0.551	0.648	0.788	0.864	
EFF. DEPTH, IN.	22.62	22.53	22.58	22.54	22.52		22.62	22.53	22.58	22.54	22.52	
$+I_{cr}/I_{gr}$	0.132	0.199	0.232	0.275	0.298		0.132	0.199	0.232	0.275	0.298	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	9	8.5	7	6	7.5		10	9	10	8.5	6	
BOTTOM BARS NO	2# 5	2# 6	2# 6	2# 6	2# 8		2# 5	2# 6	2# 6	2# 6	2# 8	
BARS NO	1# 5	1# 7	2# 6	2# 7	1# 8		1# 5	1# 7	2# 6	2# 7	1# 8	
STEEL (PSF)	0.89	1.47	1.80	2.08	2.32		1.38	2.23	2.73	3.19	4.05	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
34'- 0" (3)	324	842	1108	1406	1668	5.097	731	1486	1873	2305	2686	3.137
STIR	#3- 67	#3-129	#3-146	#3-161	#4-171		#3- 90	#3-131	#3-145	#4-155	#5-161	
35'- 0"	273	763	1014	1294	1541	5.724	658	1370	1735	2143	2503	3.522
STIR	#3- 64	#3-130	#3-148	#3-145	#4-174		#3- 89	#3-134	#3-148	#4-158	#4-164	
36'- 0"	227	689	927	1192	1425	6.407	590	1263	1608	1994	2334	3.942
STIR	#3- 61	#3-130	#3-149	#3-154	#3-176		#3- 88	#3-135	#3-151	#4-160	#4-167	
37'- 0"	184	622	847	1098	1319	7.149	528	1165	1492	1858	2179	4.399
STIR	#3- 57	#3-130	#3-150	#3-162	#3-179		#3- 86	#3-137	#3-131	#4-163	#4-170	
38'- 0"	145	560	773	1011	1221	7.953	471	1075	1385	1731	2036	4.894
STIR	#3- 53	#3-130	#3-151	#3-168	#3-182		#3- 85	#3-138	#3-138	#4-166	#4-174	
39'- 0"	108	503	705	931	1130	8.824	418	992	1286	1615	1904	5.430
STIR	#3- 49	#3-130	#3-152	#3-170	#3-184		#3- 83	#3-139	#3-145	#4-168	#4-177	
40'- 0"	75	449	642	857	1046	9.765	369	914	1194	1507	1782	6.009
STIR	#3- 44	#3-130	#3-153	#3-172	#3-167		#3- 81	#3-140	#3-153	#3-171	#4-180	
41'- 0"	43	400	583	788	968	10.778	324	843	1109	1406	1668	6.633
STIR	#3- 39	#3-129	#3-154	#3-173	#3-175		#3- 79	#3-141	#3-158	#3-173	#4-182	
42'- 0"	14	354	529	724	895	11.869	282	776	1030	1313	1563	7.304
STIR	#3- 34	#3-129	#3-154	#3-175	#3-184		#3- 77	#3-142	#3-160	#3-176	#4-185	
43'- 0"		312	478	664	828	13.040	242	714	956	1226	1464	8.025
STIR		#3-128	#3-155	#3-176	#3-191		#3- 74	#3-142	#3-161	#3-178	#4-187	
44'- 0"		272	431	608	765	14.296	206	656	887	1146	1373	8.798
STIR		#3-127	#3-155	#3-177	#3-192		#3- 72	#3-143	#3-163	#3-157	#4-191	
45'- 0"		235	387	556	706	15.641	171	602	823	1070	1287	9.625
STIR		#3-125	#3-155	#3-178	#3-194		#3- 69	#3-143	#3-164	#3-164	#4-193	
46'- 0"		200	345	508	651	17.078	139	552	763	999	1207	10.510
STIR		#3-124	#3-155	#3-179	#3-196		#3- 66	#3-144	#3-165	#3-171	#3-195	
PROPERTIES FOR DESIGN (CONCRETE 0.76 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.11	1.82	2.21	2.58	2.93		1.55	2.44	3.00	3.53	5.00	
ACTUAL STEEL %	0.419	0.689	0.837	0.976	1.112		0.586	0.927	1.141	1.342	1.902	
EFF. DEPTH, IN.	22.38	22.31	22.31	22.31	22.25		22.31	22.25	22.19	22.19	22.19	
$-I_{cr}/I_{gr}$	0.123	0.183	0.213	0.239	0.261		0.161	0.228	0.264	0.297	0.378	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.48	1.76	2.08	2.37		0.93	1.48	1.76	2.08	2.37	
ACTUAL STEEL %	0.336	0.537	0.638	0.755	0.863		0.336	0.537	0.638	0.755	0.863	
EFF. DEPTH, IN.	22.69	22.60	22.62	22.59	22.50		22.69	22.60	22.62	22.59	22.50	
$+I_{cr}/I_{gr}$	0.130	0.198	0.232	0.269	0.299		0.130	0.198	0.232	0.269	0.299	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 22″ Deep Rib + 4.5″ Top Slab = 26.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 6	# 7	# 8	Int. Span Defl. Coeff. (2)
AT	9	9	7.5	6	7.5		7	4	7.5	8	6	
BOTTOM BARS NO	1# 6	1# 7	1# 6	1# 9	1# 9		1# 6	1# 7	1# 6	1# 9	1# 9	
BARS NO	1# 6	1# 8	2# 7	1# 9	1#10		1# 6	1# 8	2# 7	1# 9	1#10	
STEEL (PSF)	0.92	1.43	1.64	2.11	2.38		1.34	2.21	2.58	3.33	4.86	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	237	679	899	1200	1427	7.149	591	1233	1553	1991	2322	4.399
STIR	#3- 78	#3-143	#3-160	#3-179	#4-188		#3-100	#3-141	#3-159	#4-170	#4-169	
38'- 0"	197	616	824	1109	1325	7.953	532	1141	1444	1859	2173	4.894
STIR	#3- 75	#3-143	#3-162	#3-181	#4-192		#3- 99	#3-146	#3-162	#4-174	#4-174	
39'- 0"	160	557	755	1026	1231	8.824	478	1056	1344	1738	2036	5.430
STIR	#3- 72	#3-144	#3-163	#3-159	#3-194		#3- 99	#3-148	#3-163	#4-176	#4-179	
40'- 0"	125	503	691	948	1143	9.765	428	977	1251	1625	1909	6.009
STIR	#3- 68	#3-144	#3-164	#3-168	#3-197		#3- 97	#3-149	#3-166	#4-180	#4-185	
41'- 0"	93	453	632	877	1062	10.778	381	904	1164	1521	1791	6.633
STIR	#3- 65	#3-144	#3-166	#3-176	#3-199		#3- 96	#3-151	#3-146	#4-183	#4-190	
42'- 0"	63	406	576	810	987	11.869	338	836	1084	1424	1681	7.304
STIR	#3- 61	#3-144	#3-167	#3-185	#3-202		#3- 95	#3-152	#3-153	#4-185	#4-194	
43'- 0"	35	362	525	748	916	13.040	297	773	1010	1334	1579	8.025
STIR	#3- 56	#3-144	#3-168	#3-190	#3-205		#3- 93	#3-153	#3-161	#3-188	#4-196	
44'- 0"	10	322	477	690	851	14.296	260	714	940	1249	1483	8.798
STIR	#3- 52	#3-144	#3-168	#3-192	#3-208		#3- 91	#3-154	#3-168	#3-190	#4-199	
45'- 0"		284	432	636	790	15.641	225	659	875	1171	1394	9.625
STIR		#3-143	#3-169	#3-194	#3-187		#3- 89	#3-155	#3-173	#3-192	#4-202	
46'- 0"		248	390	585	732	17.078	192	607	814	1097	1311	10.510
STIR		#3-143	#3-170	#3-195	#3-195		#3- 87	#3-156	#3-175	#3-195	#4-205	
47'- 0"		215	351	538	679	18.613	161	559	757	1028	1233	11.454
STIR		#3-142	#3-170	#3-197	#3-204		#3- 85	#3-157	#3-177	#3-197	#4-208	
48'- 0"		184	314	493	629	20.248	132	513	703	963	1160	12.460
STIR		#3-141	#3-170	#3-198	#3-213		#3- 82	#3-157	#3-178	#3-199	#4-211	
49'- 0"		155	280	451	581	21.989	105	471	653	903	1091	13.532
STIR		#3-140	#3-170	#3-199	#3-216		#3- 80	#3-158	#3-179	#3-202	#4-213	
PROPERTIES FOR DESIGN (CONCRETE 0.75 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.07	1.65	1.98	2.48	2.82		1.37	2.40	2.82	3.60	6.32	
ACTUAL STEEL %	0.436	0.678	0.814	1.017	1.159		0.561	0.982	1.159	1.486	2.617	
EFF. DEPTH, IN.	24.38	24.31	24.31	24.31	24.25		24.38	24.38	24.25	24.19	24.12	
$-I_{cr}/I_{gr}$	0.127	0.180	0.208	0.246	0.268		0.156	0.241	0.268	0.317	0.457	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.88	1.39	1.64	2.00	2.27		0.88	1.39	1.64	2.00	2.27	
ACTUAL STEEL %	0.345	0.546	0.644	0.788	0.896		0.345	0.546	0.644	0.788	0.896	
EFF. DEPTH, IN.	24.62	24.53	24.58	24.44	24.40		24.62	24.53	24.58	24.44	24.40	
$+I_{cr}/I_{gr}$	0.135	0.204	0.238	0.281	0.313		0.135	0.204	0.238	0.281	0.313	
SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 22″ Deep Rib + 4.5″ Top Slab = 26.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 5	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 8	# 8	Int. Span Defl. Coeff. (2)
AT	9	8.5	7	8	10		10	9	10	10	6	
BOTTOM BARS NO	2# 5	2# 6	1# 8	1# 7	2# 8		2# 5	2# 6	1# 8	1# 7	2# 8	
BARS NO	1# 5	1# 7	1# 9	2# 8	1# 8		1# 5	1# 7	1# 9	2# 8	1# 8	
STEEL (PSF)	0.91	1.49	1.81	2.16	2.37		1.39	2.25	2.75	3.40	4.84	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	250	728	988	1328	1489	7.149	625	1320	1699	2192	2427	4.399
STIR	#3- 71	#3-139	#3-159	#3-178	#4-185		#3- 96	#3-143	#3-158	#4-171	#5-170	
38'- 0"	208	660	907	1229	1382	7.953	563	1222	1581	2048	2271	4.894
STIR	#3- 68	#3-140	#3-160	#3-181	#4-188		#3- 95	#3-144	#3-161	#4-173	#4-176	
39'- 0"	168	598	832	1138	1283	8.824	505	1131	1472	1916	2127	5.430
STIR	#3- 64	#3-140	#3-162	#3-160	#3-190		#3- 94	#3-146	#3-163	#4-177	#4-181	
40'- 0"	131	540	763	1053	1191	9.765	452	1047	1371	1793	1993	6.009
STIR	#3- 60	#3-140	#3-163	#3-168	#3-193		#3- 92	#3-147	#3-141	#4-179	#4-184	
41'- 0"	97	486	698	975	1106	10.778	403	968	1277	1679	1870	6.633
STIR	#3- 56	#3-140	#3-164	#3-177	#3-195		#3- 91	#3-148	#3-148	#4-182	#4-187	
42'- 0"	66	437	639	902	1027	11.869	357	896	1190	1573	1755	7.304
STIR	#3- 52	#3-140	#3-165	#3-185	#3-198		#3- 89	#3-150	#3-155	#4-185	#4-190	
43'- 0"	36	390	583	834	953	13.040	314	828	1109	1474	1648	8.025
STIR	#3- 47	#3-140	#3-166	#3-190	#3-179		#3- 87	#3-151	#3-162	#4-187	#4-193	
44'- 0"	9	347	531	771	885	14.296	274	765	1033	1382	1548	8.798
STIR	#3- 42	#3-139	#3-167	#3-192	#3-187		#3- 85	#3-152	#3-170	#4-189	#4-195	
45'- 0"		306	482	712	821	15.641	237	706	962	1296	1455	9.625
STIR		#3-138	#3-167	#3-193	#3-196		#3- 83	#3-152	#3-172	#3-193	#4-198	
46'- 0"		268	437	656	761	17.078	202	651	896	1215	1367	10.510
STIR		#3-137	#3-168	#3-195	#3-204		#3- 81	#3-153	#3-174	#3-194	#4-201	
47'- 0"		233	394	604	704	18.613	169	600	834	1140	1286	11.454
STIR		#3-136	#3-168	#3-196	#3-207		#3- 78	#3-154	#3-175	#3-197	#4-203	
48'- 0"		200	354	556	652	20.248	139	551	776	1069	1209	12.460
STIR		#3-135	#3-168	#3-198	#3-209		#3- 75	#3-154	#3-177	#3-200	#4-207	
49'- 0"		168	317	510	602	21.989	110	506	722	1003	1137	13.532
STIR		#3-134	#3-168	#3-199	#3-210		#3- 72	#3-154	#3-178	#3-202	#4-209	
PROPERTIES FOR DESIGN (CONCRETE 0.78 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.09	1.79	2.17	2.69	2.94		1.52	2.40	2.94	3.87	6.45	
ACTUAL STEEL %	0.405	0.667	0.809	1.008	1.103		0.567	0.896	1.103	1.457	2.429	
EFF. DEPTH, IN.	24.38	24.31	24.31	24.25	24.19		24.31	24.25	24.19	24.12	24.12	
$-I_{cr}/I_{gr}$	0.122	0.182	0.211	0.247	0.262		0.160	0.226	0.262	0.318	0.447	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.93	1.48	1.79	2.18	2.37		0.93	1.48	1.79	2.18	2.37	
ACTUAL STEEL %	0.332	0.529	0.643	0.782	0.850		0.332	0.529	0.643	0.782	0.850	
EFF. DEPTH, IN.	24.69	24.60	24.46	24.52	24.50		24.69	24.60	24.46	24.52	24.50	
$+I_{cr}/I_{gr}$	0.132	0.201	0.236	0.283	0.305		0.132	0.201	0.236	0.283	0.305	
SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 22″ Deep Rib + 4.5″ Top Slab = 26.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 6	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 8	# 8	Int. Span Defl. Coeff. (2)
AT	8	8	9	8	9		9.5	8	9	10	7.5	
BOTTOM BARS NO	2# 4	1# 6	2# 7	1# 9	2# 8		2# 4	1# 6	2# 7	1# 9	2# 8	
BARS NO	2# 5	2# 7	1# 8	1#10	1# 9		2# 5	2# 7	1# 8	1#10	1# 9	
STEEL (PSF)	1.00	1.57	1.98	2.27	2.59		1.49	2.45	3.01	3.51	4.34	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	298	833	1133	1362	1634	7.149	709	1488	1924	2258	2652	4.399
STIR	#3- 72	#3-141	#3-161	#3-152	#4-184		#3- 97	#3-143	#4-160	#4-167	#5-175	
38'- 0"	251	758	1043	1260	1517	7.953	640	1379	1793	2109	2483	4.894
STIR	#3- 69	#3-141	#3-163	#3-160	#4-187		#3- 96	#3-146	#4-162	#4-171	#5-178	
39'- 0"	207	689	959	1166	1410	8.824	577	1279	1671	1971	2326	5.430
STIR	#3- 65	#3-142	#3-164	#3-168	#4-190		#3- 95	#3-147	#3-165	#4-173	#5-181	
40'- 0"	167	625	882	1078	1310	9.765	519	1185	1559	1844	2182	6.009
STIR	#3- 62	#3-142	#3-166	#3-177	#3-192		#3- 93	#3-149	#3-167	#4-175	#4-184	
41'- 0"	130	566	810	997	1218	10.778	465	1099	1454	1726	2047	6.633
STIR	#3- 58	#3-142	#3-167	#3-181	#3-195		#3- 92	#3-150	#3-145	#4-178	#4-187	
42'- 0"	95	511	743	921	1132	11.869	414	1019	1357	1616	1922	7.304
STIR	#3- 53	#3-142	#3-168	#3-182	#3-198		#3- 90	#3-151	#3-152	#4-181	#4-190	
43'- 0"	63	459	681	851	1052	13.040	367	944	1267	1514	1806	8.025
STIR	#3- 49	#3-142	#3-169	#3-184	#3-179		#3- 88	#3-152	#3-159	#4-183	#4-192	
44'- 0"	33	411	623	786	977	14.296	323	874	1183	1419	1698	8.798
STIR	#3- 44	#3-141	#3-170	#3-186	#3-188		#3- 86	#3-153	#3-166	#3-186	#4-195	
45'- 0"	4	367	569	724	908	15.641	283	809	1104	1330	1596	9.625
STIR	#3- 39	#3-141	#3-171	#3-187	#3-196		#3- 84	#3-154	#3-174	#3-188	#4-198	
46'- 0"		325	519	667	843	17.078	244	748	1031	1246	1501	10.510
STIR		#3-140	#3-171	#3-188	#3-204		#3- 82	#3-155	#3-176	#3-190	#4-201	
47'- 0"		285	471	613	782	18.613	208	691	962	1168	1413	11.454
STIR		#3-139	#3-172	#3-189	#3-206		#3- 79	#3-155	#3-178	#3-167	#4-203	
48'- 0"		249	427	563	724	20.248	175	638	897	1095	1329	12.460
STIR		#3-138	#3-172	#3-191	#3-208		#3- 76	#3-156	#3-179	#3-174	#4-206	
49'- 0"		214	385	516	670	21.989	143	587	836	1026	1251	13.532
STIR		#3-137	#3-172	#3-191	#3-210		#3- 73	#3-156	#3-180	#3-182	#4-209	
PROPERTIES FOR DESIGN (CONCRETE 0.81 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.25	1.94	2.44	2.75	3.33		1.63	2.75	3.33	3.95	5.27	
ACTUAL STEEL %	0.426	0.663	0.839	0.943	1.147		0.558	0.943	1.147	1.363	1.818	
EFF. DEPTH, IN.	24.38	24.31	24.25	24.25	24.19		24.31	24.25	24.19	24.12	24.12	
$-I_{cr}/I_{gr}$	0.130	0.184	0.220	0.240	0.275		0.161	0.240	0.275	0.310	0.378	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.27	2.58		1.02	1.64	1.99	2.27	2.58	
ACTUAL STEEL %	0.334	0.539	0.656	0.751	0.852		0.334	0.539	0.656	0.751	0.852	
EFF. DEPTH, IN.	24.71	24.58	24.54	24.40	24.48		24.71	24.58	24.54	24.40	24.48	
$+I_{cr}/I_{gr}$	0.135	0.206	0.244	0.271	0.306		0.135	0.206	0.244	0.271	0.306	
SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 6	# 6	# 8	Int. Span Defl. Coeff. (2)
AT	8.5	5	4	7.5	9		10	8	7	4.5	5	
BOTTOM BARS NO	2# 5	1# 8	1# 8	1# 9	1#10		2# 5	1# 8	1# 8	1# 9	1#10	
BARS NO	1# 5	1# 8	1# 9	1#10	1#10		1# 5	1# 8	1# 9	1#10	1#10	
STEEL (PSF)	0.93	1.65	1.91	2.38	2.70		1.40	2.52	2.85	4.06	5.73	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	321	927	1121	1562	1808	7.149	726	1607	1890	2531	2889	4.399
STIR	#3- 85	#3-154	#3-163	#4-187	#4-194		#3-105	#3-155	#4-164	#5-176	#5-169	
38'- 0"	275	849	1033	1451	1684	7.953	659	1494	1762	2370	2709	4.894
STIR	#3- 82	#3-155	#3-168	#4-190	#4-198		#3-105	#3-133	#4-166	#4-180	#5-173	
39'- 0"	232	777	952	1349	1570	8.824	597	1390	1644	2221	2543	5.430
STIR	#3- 80	#3-157	#3-170	#3-193	#4-201		#3-104	#3-140	#3-168	#4-183	#5-176	
40'- 0"	192	711	877	1254	1465	9.765	539	1293	1535	2083	2390	6.009
STIR	#3- 77	#3-158	#3-171	#3-195	#4-204		#3-104	#3-147	#3-170	#4-186	#5-178	
41'- 0"	156	649	807	1166	1367	10.778	486	1203	1433	1955	2247	6.633
STIR	#3- 73	#3-159	#3-173	#3-199	#4-208		#3-103	#3-154	#3-173	#4-189	#5-184	
42'- 0"	122	592	742	1084	1275	11.869	436	1120	1339	1837	2114	7.304
STIR	#3- 70	#3-159	#3-174	#3-201	#4-211		#3-102	#3-162	#3-176	#4-192	#5-191	
43'- 0"	90	538	682	1008	1191	13.040	390	1042	1251	1726	1991	8.025
STIR	#3- 66	#3-160	#3-176	#3-203	#4-213		#3-100	#3-165	#3-150	#4-195	#4-197	
44'- 0"	60	488	626	937	1111	14.296	347	970	1169	1623	1876	8.798
STIR	#3- 62	#3-160	#3-177	#3-182	#3-216		#3- 99	#3-166	#3-157	#4-198	#4-203	
45'- 0"	32	442	573	871	1037	15.641	306	902	1093	1526	1768	9.625
STIR	#3- 58	#3-160	#3-178	#3-190	#3-219		#3- 97	#3-168	#3-165	#4-201	#4-209	
46'- 0"	6	398	524	809	968	17.078	269	839	1021	1436	1668	10.510
STIR	#3- 53	#3-161	#3-179	#3-198	#3-221		#3- 95	#3-169	#3-172	#4-204	#4-212	
47'- 0"		357	478	751	904	18.613	233	779	954	1352	1574	11.454
STIR		#3-161	#3-179	#3-207	#3-224		#3- 93	#3-170	#3-180	#4-206	#4-214	
48'- 0"		319	435	696	843	20.248	200	724	891	1272	1485	12.460
STIR		#3-160	#3-180	#3-212	#3-227		#3- 91	#3-172	#3-185	#4-209	#4-218	
49'- 0"		283	394	645	786	21.989	169	671	832	1198	1402	13.532
STIR		#3-160	#3-181	#3-214	#3-229		#3- 89	#3-173	#3-187	#4-211	#4-220	
PROPERTIES FOR DESIGN (CONCRETE 0.79 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.13	1.92	2.40	2.82	3.20		1.49	2.64	3.02	4.69	7.58	
ACTUAL STEEL %	0.420	0.714	0.892	1.053	1.200		0.555	0.987	1.128	1.755	2.852	
EFF. DEPTH, IN.	26.38	26.38	26.38	26.25	26.19		26.31	26.25	26.25	26.25	26.12	
$-I_{cr}/I_{gr}$	0.128	0.196	0.232	0.259	0.283		0.159	0.247	0.273	0.372	0.500	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.58	1.79	2.27	2.54		0.93	1.58	1.79	2.27	2.54	
ACTUAL STEEL %	0.331	0.566	0.641	0.815	0.913		0.331	0.566	0.641	0.815	0.913	
EFF. DEPTH, IN.	26.69	26.50	26.46	26.40	26.36		26.69	26.50	26.46	26.40	26.36	
$+I_{cr}/I_{gr}$	0.135	0.217	0.242	0.298	0.329		0.135	0.217	0.242	0.298	0.329	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 8	# 8	Int. Span Defl. Coeff. (2)
AT	8	5	4	7	8		9.5	8	8.5	9.5	5	
BOTTOM BARS NO	2# 4	1# 6	2# 7	2# 8	1# 8		2# 4	1# 6	2# 7	2# 8	1# 8	
BARS NO	2# 5	2# 7	1# 8	1# 8	2# 9		2# 5	2# 7	1# 8	1# 8	2# 9	
STEEL (PSF)	1.01	1.60	2.01	2.41	2.82		1.50	2.47	3.14	3.66	5.75	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	372	952	1278	1628	2012	7.149	817	1661	2134	2644	3202	4.399
STIR	#3- 85	#3-149	#3-161	#4-184	#4-195		#3-105	#3-133	#4-164	#5-173	#5-173	
38'- 0"	321	872	1180	1512	1876	7.953	743	1543	1992	2475	3004	4.894
STIR	#3- 82	#3-150	#3-169	#4-186	#4-198		#3-105	#3-140	#4-167	#4-177	#5-176	
39'- 0"	274	797	1089	1405	1750	8.824	675	1434	1860	2319	2821	5.430
STIR	#3- 79	#3-150	#3-171	#3-189	#4-202		#3-104	#3-148	#4-170	#4-181	#5-180	
40'- 0"	231	727	1006	1306	1634	9.765	612	1334	1738	2175	2652	6.009
STIR	#3- 76	#3-151	#3-173	#3-191	#4-205		#3-103	#3-155	#4-172	#4-183	#5-182	
41'- 0"	191	663	928	1213	1526	10.778	553	1240	1625	2041	2495	6.633
STIR	#3- 73	#3-152	#3-174	#3-194	#4-208		#3-103	#3-157	#3-175	#4-186	#5-186	
42'- 0"	153	603	856	1128	1426	11.869	498	1153	1520	1916	2349	7.304
STIR	#3- 70	#3-152	#3-176	#3-173	#4-211		#3-101	#3-158	#3-176	#4-189	#5-192	
43'- 0"	118	548	789	1048	1332	13.040	448	1072	1423	1800	2213	8.025
STIR	#3- 66	#3-152	#3-177	#3-182	#4-214		#3-100	#3-160	#3-179	#4-192	#5-197	
44'- 0"	86	496	726	974	1245	14.296	400	997	1331	1692	2087	8.798
STIR	#3- 62	#3-152	#3-179	#3-190	#4-217		#3- 99	#3-161	#3-155	#4-194	#5-203	
45'- 0"	55	448	667	904	1164	15.641	356	927	1246	1591	1968	9.625
STIR	#3- 58	#3-152	#3-180	#3-199	#4-219		#3- 97	#3-162	#3-162	#4-197	#5-208	
46'- 0"	27	402	613	839	1088	17.078	315	861	1167	1496	1858	10.510
STIR	#3- 53	#3-152	#3-181	#3-203	#3-222		#3- 95	#3-163	#3-169	#4-200	#4-212	
47'- 0"		360	561	779	1016	18.613	276	799	1092	1408	1754	11.454
STIR		#3-151	#3-181	#3-205	#3-225		#3- 93	#3-164	#3-177	#4-203	#4-215	
48'- 0"		320	513	721	949	20.248	239	741	1022	1325	1657	12.460
STIR		#3-151	#3-182	#3-206	#3-227		#3- 91	#3-165	#3-184	#4-205	#4-217	
49'- 0"		283	468	668	887	21.989	205	687	956	1247	1565	13.532
STIR		#3-150	#3-183	#3-208	#3-230		#3- 89	#3-166	#3-188	#4-207	#4-221	
PROPERTIES FOR DESIGN (CONCRETE 0.82 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.23	1.96	2.45	3.08	3.68		1.60	2.69	3.46	4.07	7.74	
ACTUAL STEEL %	0.415	0.664	0.830	1.049	1.255		0.543	0.918	1.181	1.395	2.651	
EFF. DEPTH, IN.	26.38	26.38	26.38	26.25	26.19		26.31	26.25	26.19	26.12	26.12	
$-I_{cr}/I_{gr}$	0.129	0.189	0.225	0.264	0.299		0.160	0.239	0.286	0.320	0.489	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.37	2.79		1.02	1.64	1.99	2.37	2.79	
ACTUAL STEEL %	0.331	0.535	0.650	0.775	0.913		0.331	0.535	0.650	0.775	0.913	
EFF. DEPTH, IN.	26.71	26.58	26.54	26.50	26.45		26.71	26.58	26.54	26.50	26.45	
$+I_{cr}/I_{gr}$	0.137	0.209	0.249	0.290	0.334		0.137	0.209	0.249	0.290	0.334	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 10″ Ribs @ 50″ c.-c.
24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 5	# 6	# 6	# 7	End Span	# 5	# 6	# 7	# 8	# 8	Int. Span
AT	7	7	8	7	8.5	Defl. Coeff. (2)	8	7.5	8	9	6	Defl. Coeff. (2)
BOTTOM BARS NO	1# 5	1# 8	1# 7	1#10	1#10		1# 5	1# 8	1# 7	1#10	1#10	
BARS NO	2# 6	1# 9	2# 8	1#10	1#11		2# 6	1# 9	2# 8	1#10	1#11	
STEEL (PSF)	1.13	1.79	2.13	2.58	2.85		1.73	2.69	3.29	3.94	5.19	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	496	1051	1418	1738	2001	7.149	1012	1820	2354	2820	3202	4.399
STIR	#3- 95	#3-148	#3-159	#4-182	#4-190		#3-113	#3-133	#4-164	#5-173	#5-178	
38'- 0"	436	963	1311	1615	1864	7.953	927	1692	2199	2641	3003	4.894
STIR	#3- 94	#3-149	#3-168	#4-184	#4-193		#3-113	#3-141	#4-167	#5-176	#5-181	
39'- 0"	382	882	1212	1501	1737	8.824	847	1574	2055	2474	2818	5.430
STIR	#3- 91	#3-150	#3-172	#3-187	#4-196		#3-112	#3-148	#4-169	#4-179	#5-185	
40'- 0"	331	806	1121	1395	1619	9.765	774	1465	1922	2321	2647	6.009
STIR	#3- 89	#3-151	#3-174	#3-190	#4-199		#3-112	#3-155	#4-173	#4-182	#5-187	
41'- 0"	284	737	1036	1297	1511	10.778	705	1363	1798	2178	2489	6.633
STIR	#3- 86	#3-152	#3-175	#3-169	#4-202		#3-112	#3-156	#4-175	#4-185	#5-191	
42'- 0"	241	672	957	1205	1409	11.869	642	1269	1684	2045	2342	7.304
STIR	#3- 83	#3-152	#3-177	#3-177	#4-204		#3-111	#3-158	#4-177	#4-188	#5-195	
43'- 0"	200	611	883	1121	1315	13.040	583	1181	1577	1922	2204	8.025
STIR	#3- 80	#3-152	#3-178	#3-186	#4-207		#3-110	#3-159	#3-179	#4-190	#5-198	
44'- 0"	162	555	815	1041	1227	14.296	528	1099	1477	1806	2076	8.798
STIR	#3- 77	#3-152	#3-180	#3-195	#3-210		#3-109	#3-160	#3-154	#4-193	#4-200	
45'- 0"	127	502	751	967	1145	15.641	477	1022	1384	1699	1957	9.625
STIR	#3- 74	#3-152	#3-181	#3-198	#3-212		#3-108	#3-162	#3-161	#4-195	#4-204	
46'- 0"	94	453	691	898	1068	17.078	428	951	1297	1598	1845	10.510
STIR	#3- 70	#3-152	#3-182	#3-200	#3-191		#3-107	#3-163	#3-169	#4-199	#4-206	
47'- 0"	63	407	635	833	996	18.613	383	884	1215	1504	1741	11.454
STIR	#3- 66	#3-151	#3-183	#3-202	#3-199		#3-105	#3-164	#3-176	#4-201	#4-209	
48'- 0"	34	364	582	773	929	20.248	341	821	1139	1415	1642	12.460
STIR	#3- 61	#3-151	#3-184	#3-204	#3-208		#3-103	#3-165	#3-183	#4-203	#4-212	
49'- 0"	7	323	533	715	865	21.989	301	762	1067	1332	1550	13.532
STIR	#3- 57	#3-150	#3-184	#3-205	#3-217		#3-102	#3-165	#3-189	#4-205	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.86 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.43	2.21	2.75	3.14	3.53		1.94	2.93	3.75	4.39	6.58	
ACTUAL STEEL %	0.444	0.690	0.860	0.982	1.106		0.604	0.917	1.175	1.380	2.069	
EFF. DEPTH, IN.	26.38	26.31	26.25	26.25	26.19		26.31	26.25	26.19	26.12	26.12	
$-I_{cr}/I_{gr}$	0.139	0.197	0.232	0.257	0.278		0.177	0.244	0.291	0.324	0.427	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	1.19	1.79	2.18	2.54	2.83		1.19	1.79	2.18	2.54	2.83	
ACTUAL STEEL %	0.356	0.539	0.656	0.767	0.856		0.356	0.539	0.656	0.767	0.856	
EFF. DEPTH, IN.	26.64	26.46	26.52	26.36	26.33		26.64	26.46	26.52	26.36	26.33	
$+I_{cr}/I_{gr}$	0.147	0.210	0.252	0.285	0.313		0.147	0.210	0.252	0.285	0.313	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

53″ Forms + 7″ Ribs @ 60″ c.-c.
16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span	# 4	# 4	# 5	# 6	# 7	Int. Span
AT	10	10	8	10	9	Defl. Coeff. (2)	10	8	9	7	8	Defl. Coeff. (2)
BOTTOM BARS NO	2# 4	1# 6	1# 7	1# 7	1# 8		2# 4	1# 6	1# 7	1# 7	1# 8	
BARS NO	1# 4	1# 6	1# 7	1# 8	1# 8		1# 4	1# 6	1# 7	1# 8	1# 8	
STEEL (PSF)	0.57	0.77	1.02	1.18	1.35		0.81	1.13	1.55	2.35	2.77	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	202	523	888	1103	1318	2.344	524	990	1522	1834	2146	1.443
STIR	#3- 68	#3-107	#3-116	#3-141	#3-147		#3- 82	#3-108	#3-127	#4-130	#4-128	
29'- 0"	154	453	794	994	1194	2.698	454	889	1384	1676	1966	1.660
STIR	#3- 66	#3-108	#3-124	#3-144	#3-151		#3- 82	#3-111	#3-130	#3-136	#4-131	
30'- 0"	111	391	709	896	1083	3.090	391	797	1260	1533	1804	1.901
STIR	#3- 63	#3-108	#3-133	#3-147	#3-154		#3- 81	#3-113	#3-133	#3-140	#4-135	
31'- 0"	72	334	632	807	982	3.523	334	715	1148	1403	1658	2.168
STIR	#3- 60	#3-109	#3-136	#3-149	#3-157		#3- 81	#3-114	#3-135	#3-143	#4-141	
32'- 0"	37	282	562	726	891	4.000	283	640	1047	1286	1525	2.461
STIR	#3- 57	#3-108	#3-138	#3-152	#3-160		#3- 80	#3-115	#3-137	#3-145	#4-147	
33'- 0"	4	235	498	653	807	4.523	236	571	954	1179	1404	2.784
STIR	#3- 54	#3-108	#3-140	#3-138	#3-163		#3- 79	#3-116	#3-140	#3-148	#4-153	
34'- 0"		192	440	586	731	5.097	193	509	870	1082	1293	3.137
STIR		#3-108	#3-141	#3-147	#3-166		#3- 77	#3-117	#3-143	#3-151	#3-158	
35'- 0"		153	387	524	662	5.724	153	452	792	992	1192	3.522
STIR		#3-107	#3-142	#3-155	#3-168		#3- 76	#3-118	#3-145	#3-154	#3-161	
36'- 0"		117	338	468	598	6.407	117	400	721	910	1099	3.942
STIR		#3-106	#3-144	#3-158	#3-171		#3- 74	#3-118	#3-131	#3-157	#3-164	
37'- 0"		84	293	416	539	7.149	84	351	656	835	1013	4.399
STIR		#3-105	#3-145	#3-160	#3-173		#3- 72	#3-119	#3-138	#3-159	#3-167	
38'- 0"		53	252	368	485	7.953	54	307	595	765	934	4.894
STIR		#3-103	#3-145	#3-161	#3-162		#3- 69	#3-119	#3-146	#3-162	#3-170	
39'- 0"		25	213	324	435	8.824	25	266	540	701	862	5.430
STIR		#3-102	#3-146	#3-163	#3-170		#3- 67	#3-119	#3-150	#3-163	#3-172	
40'- 0"			178	283	388	9.765		228	488	641	794	6.009
STIR			#3-146	#3-164	#3-178			#3-119	#3-152	#3-166	#3-175	
PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.20	1.20	1.50	1.86	2.07		1.20	1.50	2.07	3.77	4.50	
ACTUAL STEEL %	0.765	0.765	0.957	1.191	1.324		0.765	0.957	1.324	2.425	2.906	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.31	18.31		18.38	18.38	18.31	18.25	18.19	
$-I_{cr}/I_{gr}$	0.160	0.160	0.190	0.221	0.238		0.160	0.190	0.238	0.355	0.392	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.60	0.88	1.20	1.39	1.58		0.60	0.88	1.20	1.39	1.58	
ACTUAL STEEL %	0.361	0.533	0.729	0.846	0.962		0.361	0.533	0.729	0.846	0.962	
EFF. DEPTH, IN.	18.75	18.62	18.56	18.53	18.50		18.75	18.62	18.56	18.53	18.50	
$+I_{cr}/I_{gr}$	0.119	0.168	0.222	0.253	0.284		0.119	0.168	0.222	0.253	0.284	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 8″ Ribs @ 61″ c.-c. 16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	9.5	8	7	9.5		10	7	9.5	8	6	
BOTTOM BARS NO	1# 5	1# 6	1# 5	1# 7	1# 8		1# 5	1# 6	1# 5	1# 7	1# 8	
BARS NO	1# 5	1# 7	2# 6	1# 8	1# 8		1# 5	1# 7	2# 6	1# 8	1# 8	
STEEL (PSF)	0.60	0.85	0.95	1.14	1.31		0.84	1.28	1.44	1.73	2.72	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	198	680	857	1078	1292	2.344	529	1231	1488	1809	2121	1.443
STIR	#3- 57	#3-112	#3-122	#3-134	#3-141		#3- 75	#3-102	#3-122	#3-129	#4-128	
29'- 0"	148	598	763	969	1169	2.698	457	1111	1351	1651	1941	1.660
STIR	#3- 54	#3-113	#3-124	#3-120	#3-145		#3- 74	#3-110	#3-124	#3-131	#4-134	
30'- 0"	104	524	679	871	1057	3.090	392	1004	1228	1508	1779	1.901
STIR	#3- 51	#3-114	#3-126	#3-128	#3-148		#3- 73	#3-116	#3-127	#3-134	#4-140	
31'- 0"	64	457	602	782	957	3.523	334	906	1116	1378	1633	2.168
STIR	#3- 47	#3-114	#3-127	#3-137	#3-150		#3- 72	#3-118	#3-129	#3-137	#4-143	
32'- 0"	27	397	532	701	865	4.000	280	818	1015	1261	1500	2.461
STIR	#3- 43	#3-114	#3-128	#3-141	#3-152		#3- 70	#3-119	#3-116	#3-139	#3-146	
33'- 0"		341	469	628	782	4.523	232	738	923	1154	1378	2.784
STIR		#3-114	#3-129	#3-143	#3-136		#3- 68	#3-120	#3-123	#3-142	#3-149	
34'- 0"		291	411	560	706	5.097	188	664	839	1056	1268	3.137
STIR		#3-114	#3-130	#3-144	#3-145		#3- 66	#3-122	#3-131	#3-144	#3-152	
35'- 0"		245	358	499	636	5.724	147	597	761	967	1166	3.522
STIR		#3-114	#3-130	#3-146	#3-153		#3- 64	#3-123	#3-134	#3-147	#3-154	
36'- 0"		202	309	443	572	6.407	110	535	691	885	1074	3.942
STIR		#3-113	#3-131	#3-147	#3-159		#3- 61	#3-123	#3-136	#3-149	#3-157	
37'- 0"		163	264	391	514	7.149	76	478	626	809	988	4.399
STIR		#3-113	#3-131	#3-148	#3-161		#3- 59	#3-124	#3-137	#3-134	#3-160	
38'- 0"		127	223	343	459	7.953	45	426	566	740	909	4.894
STIR		#3-112	#3-131	#3-149	#3-163		#3- 56	#3-125	#3-138	#3-141	#3-162	
39'- 0"		94	185	299	409	8.824	16	377	510	676	836	5.430
STIR		#3-110	#3-131	#3-150	#3-164		#3- 52	#3-125	#3-140	#3-148	#3-165	
40'- 0"		63	150	258	363	9.765		333	459	616	769	6.009
STIR		#3-109	#3-130	#3-151	#3-166			#3-126	#3-141	#3-154	#3-167	
PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.22	1.28	1.52	1.74	1.99		1.22	1.74	1.99	2.36	4.47	
ACTUAL STEEL %	0.697	0.733	0.871	0.995	1.141		0.697	0.995	1.141	1.355	2.575	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.31		18.38	18.38	18.31	18.31	18.25	
$-I_{cr}/I_{gr}$	0.152	0.158	0.181	0.200	0.219		0.152	0.200	0.219	0.248	0.377	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	1.04	1.19	1.39	1.58		0.62	1.04	1.19	1.39	1.58	
ACTUAL STEEL %	0.337	0.567	0.647	0.760	0.865		0.337	0.567	0.647	0.760	0.865	
EFF. DEPTH, IN.	18.69	18.59	18.64	18.53	18.50		18.69	18.59	18.64	18.53	18.50	
$+I_{cr}/I_{gr}$	0.111	0.178	0.203	0.231	0.259		0.111	0.178	0.203	0.231	0.259	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 9″ Ribs @ 62″ c.-c. 16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	8.5	7.5	9.5	8.5		10	9.5	8.5	7	4	
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.64	0.92	1.05	1.30	1.45		0.88	1.43	1.61	1.98	2.89	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	279	832	981	1267	1502	2.344	658	1463	1679	2096	2438	1.443
STIR	#3- 62	#3-115	#3-123	#3-136	#3-143		#3- 78	#3- 98	#3-122	#4-130	#4-130	
29'- 0"	222	738	877	1144	1363	2.698	576	1326	1528	1916	2235	1.660
STIR	#3- 60	#3-116	#3-124	#3-139	#3-146		#3- 78	#3-105	#3-124	#4-132	#4-134	
30'- 0"	171	653	783	1032	1237	3.090	502	1203	1391	1754	2052	1.901
STIR	#3- 57	#3-117	#3-126	#3-125	#3-149		#3- 77	#3-113	#3-127	#3-136	#4-140	
31'- 0"	125	576	698	931	1123	3.523	435	1091	1267	1607	1886	2.168
STIR	#3- 53	#3-118	#3-127	#3-133	#3-152		#3- 76	#3-120	#3-129	#3-139	#4-144	
32'- 0"	83	507	621	840	1020	4.000	374	990	1155	1474	1736	2.461
STIR	#3- 50	#3-118	#3-128	#3-142	#3-155		#3- 75	#3-122	#3-116	#3-141	#4-147	
33'- 0"	45	443	550	757	926	4.523	318	897	1053	1353	1599	2.784
STIR	#3- 46	#3-119	#3-129	#3-145	#3-157		#3- 73	#3-124	#3-123	#3-144	#4-150	
34'- 0"	10	385	486	681	840	5.097	268	813	960	1243	1474	3.137
STIR	#3- 41	#3-119	#3-130	#3-147	#3-142		#3- 71	#3-125	#3-131	#3-146	#3-153	
35'- 0"		332	427	611	761	5.724	221	736	875	1141	1360	3.522
STIR		#3-119	#3-131	#3-149	#3-150		#3- 69	#3-126	#3-134	#3-149	#3-155	
36'- 0"		284	374	547	689	6.407	179	665	796	1048	1255	3.942
STIR		#3-118	#3-131	#3-150	#3-159		#3- 67	#3-127	#3-136	#3-150	#3-158	
37'- 0"		239	324	488	623	7.149	139	600	724	963	1158	4.399
STIR		#3-118	#3-131	#3-151	#3-163		#3- 65	#3-128	#3-137	#3-152	#3-161	
38'- 0"		198	278	434	561	7.953	103	540	658	884	1069	4.894
STIR		#3-117	#3-131	#3-152	#3-165		#3- 62	#3-129	#3-139	#3-137	#3-164	
39'- 0"		159	236	384	505	8.824	70	485	596	811	987	5.430
STIR		#3-116	#3-131	#3-153	#3-167		#3- 59	#3-130	#3-140	#3-145	#3-166	
40'- 0"		124	197	337	452	9.765	39	433	539	743	911	6.009
STIR		#3-115	#3-131	#3-154	#3-168		#3- 56	#3-130	#3-141	#3-152	#3-168	
PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.24	1.46	1.65	2.02	2.26		1.24	2.02	2.26	2.75	4.80	
ACTUAL STEEL %	0.641	0.754	0.854	1.050	1.173		0.641	1.050	1.173	1.424	2.493	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.31	18.31		18.38	18.31	18.31	18.31	18.31	
$-I_{cr}/I_{gr}$	0.145	0.165	0.182	0.210	0.228		0.145	0.210	0.228	0.263	0.382	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.349	0.588	0.652	0.785	0.891		0.349	0.588	0.652	0.785	0.891	
EFF. DEPTH, IN.	18.72	18.64	18.62	18.50	18.46		18.72	18.64	18.62	18.50	18.46	
$+I_{cr}/I_{gr}$	0.117	0.187	0.206	0.239	0.266		0.117	0.187	0.206	0.239	0.266	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

53″ Forms + 10″ Ribs @ 63″ c.-c.
16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span	# 4	# 5	# 5	# 5	# 7	Int. Span
AT	10	8.5	7	9.5	7.5	Defl. Coeff. (2)	10	10	7.5	7	7	Defl. Coeff. (2)
BOTTOM BARS NO	3# 3	1# 5	2# 6	1# 6	2# 7		3# 3	1# 5	2# 6	1# 6	2# 7	
BARS NO	2# 4	2# 6	1# 7	2# 7	1# 8		2# 4	2# 6	1# 7	2# 7	1# 8	
STEEL (PSF)	0.65	0.91	1.16	1.27	1.59		0.89	1.38	1.82	1.94	3.19	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	279	807	1137	1318	1713	2.344	671	1437	1918	2182	2755	1.443
STIR	#3- 54	#3-107	#3-124	#3-114	#4-144		#3- 73	#3-108	#3-123	#4-128	#4-129	
29'- 0"	221	712	1021	1190	1557	2.698	586	1301	1749	1995	2529	1.660
STIR	#3- 51	#3-108	#3-126	#3-122	#3-147		#3- 72	#3-111	#3-125	#4-130	#4-133	
30'- 0"	168	628	916	1074	1417	3.090	509	1177	1596	1826	2325	1.901
STIR	#3- 47	#3-108	#3-127	#3-131	#3-150		#3- 70	#3-113	#3-128	#3-133	#4-138	
31'- 0"	121	551	821	969	1290	3.523	440	1066	1458	1673	2141	2.168
STIR	#3- 43	#3-108	#3-129	#3-137	#3-153		#3- 69	#3-114	#3-130	#3-135	#4-145	
32'- 0"	77	481	734	873	1175	4.000	377	964	1332	1534	1973	2.461
STIR	#3- 39	#3-108	#3-130	#3-139	#3-155		#3- 67	#3-115	#3-113	#3-139	#4-149	
33'- 0"	38	418	656	786	1070	4.523	320	872	1218	1408	1821	2.784
STIR	#3- 34	#3-108	#3-131	#3-141	#3-158		#3- 65	#3-116	#3-120	#3-141	#4-152	
34'- 0"	2	360	584	707	974	5.097	268	788	1114	1293	1682	3.137
STIR	#3- 29	#3-108	#3-132	#3-142	#3-160		#3- 63	#3-117	#3-128	#3-143	#4-154	
35'- 0"		307	518	634	887	5.724	220	711	1018	1187	1554	3.522
STIR		#3-107	#3-133	#3-144	#3-147		#3- 61	#3-118	#3-135	#3-146	#4-157	
36'- 0"		258	458	568	806	6.407	176	640	931	1090	1437	3.942
STIR		#3-106	#3-133	#3-145	#3-156		#3- 58	#3-119	#3-138	#3-130	#4-160	
37'- 0"		213	403	507	732	7.149	135	575	850	1001	1329	4.399
STIR		#3-105	#3-134	#3-146	#3-165		#3- 55	#3-119	#3-139	#3-137	#3-163	
38'- 0"		172	352	450	664	7.953	98	515	776	919	1230	4.894
STIR		#3-103	#3-134	#3-147	#3-167		#3- 52	#3-119	#3-141	#3-144	#3-165	
39'- 0"		134	304	398	601	8.824	64	459	707	843	1138	5.430
STIR		#3-102	#3-134	#3-147	#3-169		#3- 48	#3-120	#3-142	#3-151	#3-168	
40'- 0"		99	261	349	543	9.765	32	408	643	773	1054	6.009
STIR		#3-100	#3-134	#3-148	#3-170		#3- 45	#3-120	#3-143	#3-152	#3-170	
PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.26	1.48	1.80	2.06	2.60		1.26	1.95	2.60	2.79	5.40	
ACTUAL STEEL %	0.595	0.700	0.850	0.974	1.234		0.595	0.925	1.234	1.322	2.578	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.31	18.31		18.38	18.31	18.31	18.31	18.19	
$-I_{cr}/I_{gr}$	0.140	0.159	0.185	0.203	0.242		0.140	0.195	0.242	0.254	0.390	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.73	1.19	1.48	1.64	1.99		0.73	1.19	1.48	1.64	1.99	
ACTUAL STEEL %	0.328	0.538	0.671	0.744	0.904		0.328	0.538	0.671	0.744	0.904	
EFF. DEPTH, IN.	18.78	18.64	18.60	18.58	18.54		18.78	18.64	18.60	18.58	18.54	
$+I_{cr}/I_{gr}$	0.112	0.174	0.212	0.232	0.275		0.112	0.174	0.212	0.232	0.275	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

53″ Forms + 7″ Ribs @ 60″ c.-c.
20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span	# 4	# 5	# 5	# 6	# 7	Int. Span
AT	10	8	7	9.5	8	Defl. Coeff. (2)	10	9	8	9.5	7	Defl. Coeff. (2)
BOTTOM BARS NO	2# 4	1# 7	1# 7	1# 8	1# 8		2# 4	1# 7	1# 7	1# 8	1# 8	
BARS NO	1# 5	1# 7	1# 8	1# 8	1# 9		1# 5	1# 7	1# 8	1# 8	1# 9	
STEEL (PSF)	0.65	1.02	1.15	1.33	1.51		0.89	1.55	1.75	2.07	3.15	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	222	744	945	1146	1366	4.000	574	1334	1627	1919	2240	2.461
STIR	#3- 77	#3-135	#3-136	#3-157	#3-166		#3- 93	#3-136	#3-143	#4-150	#4-148	
33'- 0"	175	666	856	1045	1252	4.523	507	1221	1497	1771	2073	2.784
STIR	#3- 74	#3-136	#3-144	#3-161	#3-168		#3- 93	#3-114	#3-146	#4-153	#4-151	
34'- 0"	133	596	774	952	1147	5.097	446	1118	1378	1637	1920	3.137
STIR	#3- 72	#3-138	#3-151	#3-163	#3-171		#3- 92	#3-121	#3-149	#4-156	#4-155	
35'- 0"	94	531	699	867	1051	5.724	389	1024	1269	1513	1781	3.522
STIR	#3- 69	#3-139	#3-153	#3-143	#3-174		#3- 92	#3-128	#3-151	#3-159	#4-161	
36'- 0"	59	471	630	789	963	6.407	337	938	1169	1400	1653	3.942
STIR	#3- 66	#3-139	#3-154	#3-151	#3-178		#3- 91	#3-136	#3-154	#3-162	#4-167	
37'- 0"	26	417	567	717	882	7.149	290	858	1077	1296	1535	4.399
STIR	#3- 62	#3-140	#3-156	#3-159	#3-180		#3- 89	#3-143	#3-156	#3-164	#4-172	
38'- 0"		366	509	651	808	7.953	246	785	992	1200	1427	4.894
STIR		#3-141	#3-157	#3-168	#3-183		#3- 88	#3-145	#3-158	#3-167	#4-175	
39'- 0"		320	455	590	739	8.824	206	717	914	1111	1327	5.430
STIR		#3-141	#3-158	#3-172	#3-186		#3- 87	#3-147	#3-138	#3-169	#4-177	
40'- 0"		276	405	534	675	9.765	168	654	842	1029	1234	6.009
STIR		#3-141	#3-160	#3-174	#3-165		#3- 85	#3-148	#3-145	#3-173	#3-181	
41'- 0"		236	359	481	616	10.778	133	596	774	952	1147	6.633
STIR		#3-141	#3-160	#3-175	#3-173		#3- 83	#3-149	#3-152	#3-175	#3-183	
42'- 0"		199	316	433	560	11.869	101	542	712	881	1067	7.304
STIR		#3-141	#3-161	#3-177	#3-181		#3- 81	#3-150	#3-160	#3-177	#3-186	
43'- 0"		164	276	387	509	13.040	71	491	654	815	993	8.025
STIR		#3-141	#3-162	#3-178	#3-190		#3- 79	#3-152	#3-166	#3-179	#3-189	
44'- 0"		132	239	345	461	14.296	43	444	599	754	923	8.798
STIR		#3-140	#3-162	#3-180	#3-194		#3- 76	#3-153	#3-168	#3-181	#3-191	
PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.20	1.50	1.71	1.96	2.33		1.20	2.07	2.33	2.78	5.14	
ACTUAL STEEL %	0.605	0.756	0.864	0.990	1.176		0.605	1.045	1.176	1.411	2.619	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.31	22.31		22.38	22.31	22.31	22.25	22.19	
$-I_{cr}/I_{gr}$	0.145	0.172	0.191	0.210	0.238		0.145	0.218	0.238	0.269	0.401	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.71	1.20	1.39	1.58	1.79		0.71	1.20	1.39	1.58	1.79	
ACTUAL STEEL %	0.340	0.578	0.670	0.763	0.865		0.340	0.578	0.670	0.763	0.865	
EFF. DEPTH, IN.	22.72	22.56	22.53	22.50	22.46		22.72	22.56	22.53	22.50	22.46	
$+I_{cr}/I_{gr}$	0.121	0.194	0.222	0.249	0.278		0.121	0.194	0.222	0.249	0.278	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 8″ Ribs @ 61″ c.-c. 20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	7.5	10	8.5	7.5		9.5	8.5	7.5	6	5	
BOTTOM BARS NO	1# 4	2# 6	2# 6	1# 8	1# 9		1# 4	2# 6	2# 6	1# 8	1# 9	
BARS NO	2# 5	1# 6	1# 7	1# 9	1# 9		2# 5	1# 6	1# 7	1# 9	1# 9	
STEEL (PSF)	0.68	1.06	1.22	1.47	1.67		0.95	1.62	1.85	2.28	3.33	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	310	846	1016	1336	1556	4.000	717	1497	1744	2209	2529	2.461
STIR	#3- 82	#3-134	#3-141	#3-159	#4-166		#3- 97	#3-135	#3-141	#4-150	#4-151	
33'- 0"	256	761	921	1221	1428	4.523	639	1373	1605	2043	2343	2.784
STIR	#3- 80	#3-135	#3-146	#3-161	#4-168		#3- 96	#3-115	#3-144	#4-153	#4-153	
34'- 0"	208	683	833	1117	1311	5.097	568	1259	1478	1890	2173	3.137
STIR	#3- 77	#3-137	#3-147	#3-164	#3-172		#3- 96	#3-122	#3-147	#4-156	#4-157	
35'- 0"	163	611	753	1021	1205	5.724	503	1155	1362	1751	2018	3.522
STIR	#3- 75	#3-138	#3-149	#3-166	#3-174		#3- 96	#3-130	#3-149	#4-160	#4-162	
36'- 0"	122	546	680	933	1106	6.407	444	1060	1255	1623	1875	3.942
STIR	#3- 72	#3-138	#3-151	#3-149	#3-177		#3- 95	#3-137	#3-151	#4-162	#4-168	
37'- 0"	84	485	613	852	1016	7.149	389	972	1157	1505	1744	4.399
STIR	#3- 69	#3-139	#3-152	#3-157	#3-180		#3- 94	#3-143	#3-154	#4-165	#4-172	
38'- 0"	50	430	550	777	933	7.953	338	891	1067	1397	1623	4.894
STIR	#3- 65	#3-140	#3-153	#3-165	#3-183		#3- 93	#3-144	#3-137	#3-168	#4-174	
39'- 0"	17	378	493	708	856	8.824	291	817	983	1296	1511	5.430
STIR	#3- 62	#3-140	#3-154	#3-173	#3-185		#3- 92	#3-146	#3-144	#3-170	#4-177	
40'- 0"		331	440	644	785	9.765	248	747	906	1203	1408	6.009
STIR		#3-140	#3-155	#3-175	#3-164		#3- 90	#3-147	#3-151	#3-173	#4-180	
41'- 0"		287	390	585	719	10.778	208	683	834	1117	1312	6.633
STIR		#3-140	#3-156	#3-177	#3-173		#3- 89	#3-148	#3-159	#3-176	#4-184	
42'- 0"		246	344	530	658	11.869	171	623	767	1037	1223	7.304
STIR		#3-140	#3-156	#3-179	#3-181		#3- 87	#3-149	#3-160	#3-178	#4-186	
43'- 0"		207	302	479	600	13.040	136	568	705	962	1139	8.025
STIR		#3-139	#3-157	#3-180	#3-190		#3- 85	#3-151	#3-162	#3-180	#3-188	
44'- 0"		172	262	431	547	14.296	103	516	647	893	1062	8.798
STIR		#3-139	#3-157	#3-182	#3-194		#3- 83	#3-151	#3-163	#3-183	#3-192	
PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.22	1.63	1.89	2.22	2.52		1.28	2.22	2.52	3.15	5.37	
ACTUAL STEEL %	0.553	0.737	0.860	1.011	1.146		0.582	1.011	1.146	1.433	2.448	
EFF. DEPTH, IN.	22.38	22.38	22.31	22.31	22.31		22.38	22.31	22.31	22.31	22.25	
$-I_{cr}/I_{gr}$	0.138	0.173	0.193	0.218	0.239		0.143	0.218	0.239	0.280	0.397	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.82	1.32	1.48	1.79	2.00		0.82	1.32	1.48	1.79	2.00	
ACTUAL STEEL %	0.354	0.572	0.642	0.780	0.873		0.354	0.572	0.642	0.780	0.873	
EFF. DEPTH, IN.	22.70	22.62	22.60	22.46	22.44		22.70	22.62	22.60	22.46	22.44	
$+I_{cr}/I_{gr}$	0.126	0.195	0.217	0.255	0.281		0.126	0.195	0.217	0.255	0.281	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 9″ Ribs @ 62″ c.-c. 20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	7.5	9.5	7.5	7		9	8.5	7	8	6	
BOTTOM BARS NO	1# 6	1# 7	1# 6	2# 7	1# 7		1# 6	1# 7	1# 6	2# 7	1# 7	
BARS NO	1# 6	1# 8	2# 7	1# 8	2# 8		1# 6	1# 8	2# 7	1# 8	2# 8	
STEEL (PSF)	0.75	1.10	1.28	1.61	1.71		1.04	1.67	1.96	2.46	3.62	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	341	884	1156	1525	1724	4.000	776	1566	1961	2498	2788	2.461
STIR	#3- 77	#3-130	#3-140	#3-159	#4-164		#3- 94	#3-114	#4-142	#4-151	#5-148	
33'- 0"	284	795	1050	1397	1585	4.523	693	1436	1807	2312	2585	2.784
STIR	#3- 75	#3-131	#3-146	#3-163	#4-168		#3- 93	#3-121	#3-144	#4-154	#5-152	
34'- 0"	232	713	953	1280	1457	5.097	617	1317	1667	2142	2399	3.137
STIR	#3- 73	#3-132	#3-148	#3-165	#4-171		#3- 93	#3-129	#3-147	#4-157	#4-155	
35'- 0"	184	638	865	1174	1340	5.724	548	1208	1538	1987	2229	3.522
STIR	#3- 70	#3-132	#3-149	#3-168	#3-174		#3- 92	#3-135	#3-149	#4-160	#4-161	
36'- 0"	140	570	784	1076	1233	6.407	484	1108	1420	1844	2074	3.942
STIR	#3- 67	#3-133	#3-151	#3-147	#3-176		#3- 91	#3-137	#3-151	#4-163	#4-167	
37'- 0"	100	506	709	985	1135	7.149	425	1016	1311	1713	1930	4.399
STIR	#3- 63	#3-133	#3-152	#3-155	#3-180		#3- 90	#3-139	#3-153	#4-166	#4-171	
38'- 0"	63	448	640	902	1044	7.953	371	932	1211	1592	1798	4.894
STIR	#3- 59	#3-133	#3-153	#3-164	#3-182		#3- 89	#3-140	#3-136	#4-168	#4-175	
39'- 0"	28	394	577	825	960	8.824	321	853	1119	1480	1676	5.430
STIR	#3- 56	#3-133	#3-155	#3-172	#3-185		#3- 87	#3-141	#3-143	#4-171	#4-177	
40'- 0"		344	518	754	882	9.765	275	781	1033	1377	1563	6.009
STIR		#3-133	#3-155	#3-176	#3-166		#3- 86	#3-142	#3-151	#3-174	#4-181	
41'- 0"		298	463	688	810	10.778	232	713	954	1281	1458	6.633
STIR		#3-133	#3-156	#3-178	#3-174		#3- 84	#3-143	#3-158	#3-177	#4-183	
42'- 0"		255	412	627	743	11.869	192	651	880	1192	1360	7.304
STIR		#3-132	#3-157	#3-180	#3-183		#3- 82	#3-144	#3-161	#3-179	#4-186	
43'- 0"		215	365	570	680	13.040	155	593	811	1109	1269	8.025
STIR		#3-131	#3-157	#3-181	#3-191		#3- 80	#3-145	#3-162	#3-182	#4-188	
44'- 0"		178	321	516	622	14.296	120	538	747	1031	1184	8.798
STIR		#3-130	#3-158	#3-183	#3-193		#3- 77	#3-146	#3-164	#3-183	#4-191	
PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.24	1.65	2.02	2.56	2.75		1.38	2.26	2.75	3.41	6.20	
ACTUAL STEEL %	0.510	0.680	0.835	1.058	1.133		0.567	0.933	1.133	1.412	2.576	
EFF. DEPTH, IN.	22.38	22.38	22.31	22.31	22.31		22.38	22.31	22.31	22.25	22.19	
$-I_{cr}/I_{gr}$	0.132	0.166	0.193	0.230	0.242		0.143	0.209	0.242	0.281	0.416	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.88	1.39	1.64	1.99	2.18		0.88	1.39	1.64	1.99	2.18	
ACTUAL STEEL %	0.347	0.551	0.648	0.788	0.864		0.347	0.551	0.648	0.788	0.864	
EFF. DEPTH, IN.	22.62	22.53	22.58	22.54	22.52		22.62	22.53	22.58	22.54	22.52	
$+I_{cr}/I_{gr}$	0.124	0.188	0.220	0.261	0.283		0.124	0.188	0.220	0.261	0.283	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

53″ Forms + 10″ Ribs @ 63″ c.-c.
20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	10	7	9	7.5	9		8.5	8	9.5	10	7	
BOTTOM BARS NO	2# 5	2# 6	2# 6	2# 6	2# 8		2# 5	2# 6	2# 6	2# 6	2# 8	
BARS NO	1# 5	1# 7	2# 6	2# 7	1# 8		1# 5	1# 7	2# 6	2# 7	1# 8	
STEEL (PSF)	0.74	1.16	1.42	1.66	1.87		1.06	1.76	2.14	2.63	3.37	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	368	955	1257	1595	1893	4.000	828	1684	2123	2614	3048	2.461
STIR	#3- 73	#3-128	#3-143	#3-156	#4-165		#3- 91	#3-117	#4-141	#4-149	#5-154	
33'- 0"	307	860	1144	1462	1742	4.523	740	1545	1958	2420	2827	2.784
STIR	#3- 70	#3-128	#3-145	#3-159	#4-167		#3- 90	#3-124	#4-143	#4-152	#5-158	
34'- 0"	252	773	1040	1339	1603	5.097	660	1418	1807	2242	2626	3.137
STIR	#3- 67	#3-129	#3-146	#3-162	#4-170		#3- 89	#3-132	#3-146	#4-156	#5-161	
35'- 0"	201	693	945	1228	1476	5.724	586	1301	1668	2079	2441	3.522
STIR	#3- 64	#3-130	#3-148	#3-145	#4-174		#3- 89	#3-134	#3-148	#4-158	#4-165	
36'- 0"	155	619	858	1125	1360	6.407	519	1195	1542	1930	2272	3.942
STIR	#3- 61	#3-130	#3-149	#3-153	#3-177		#3- 87	#3-135	#3-151	#4-161	#4-168	
37'- 0"	112	552	778	1030	1253	7.149	457	1096	1425	1793	2117	4.399
STIR	#3- 57	#3-130	#3-151	#3-162	#3-179		#3- 86	#3-137	#3-131	#4-164	#4-171	
38'- 0"	73	490	704	943	1154	7.953	399	1006	1317	1666	1973	4.894
STIR	#3- 53	#3-130	#3-152	#3-169	#3-182		#3- 85	#3-138	#3-138	#4-167	#4-174	
39'- 0"	36	432	635	863	1063	8.824	347	922	1218	1549	1840	5.430
STIR	#3- 49	#3-130	#3-153	#3-170	#3-184		#3- 83	#3-139	#3-145	#4-169	#4-177	
40'- 0"	2	379	572	788	979	9.765	297	845	1126	1441	1718	6.009
STIR	#3- 44	#3-130	#3-153	#3-172	#3-166		#3- 81	#3-140	#3-153	#3-171	#4-179	
41'- 0"		329	513	719	901	10.778	252	773	1040	1340	1604	6.633
STIR		#3-129	#3-154	#3-174	#3-175		#3- 79	#3-141	#3-158	#3-174	#4-183	
42'- 0"		283	459	655	828	11.869	210	706	961	1246	1498	7.304
STIR		#3-128	#3-155	#3-175	#3-183		#3- 77	#3-142	#3-160	#3-176	#4-185	
43'- 0"		241	408	595	760	13.040	170	644	887	1159	1399	8.025
STIR		#3-127	#3-155	#3-176	#3-191		#3- 74	#3-142	#3-161	#3-178	#4-188	
44'- 0"		201	360	539	697	14.296	134	586	818	1078	1307	8.798
STIR		#3-126	#3-155	#3-178	#3-193		#3- 71	#3-143	#3-163	#3-180	#4-190	
PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.26	1.80	2.17	2.60	3.08		1.48	2.44	2.92	3.78	5.40	
ACTUAL STEEL %	0.475	0.678	0.820	0.984	1.168		0.558	0.923	1.106	1.438	2.054	
EFF. DEPTH, IN.	22.38	22.38	22.31	22.31	22.25		22.38	22.31	22.25	22.19	22.19	
$-I_{cr}/I_{gr}$	0.126	0.168	0.194	0.222	0.250		0.144	0.212	0.241	0.288	0.367	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.93	1.48	1.76	2.08	2.37		0.93	1.48	1.76	2.08	2.37	
ACTUAL STEEL %	0.336	0.537	0.638	0.755	0.863		0.336	0.537	0.638	0.755	0.863	
EFF. DEPTH, IN.	22.69	22.60	22.62	22.59	22.50		22.69	22.60	22.62	22.59	22.50	
$+I_{cr}/I_{gr}$	0.122	0.187	0.219	0.254	0.284		0.122	0.187	0.219	0.254	0.284	

SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

53″ Forms + 7″ Ribs @ 60″ c.-c.
24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	7	8.5	7.5		8.5	8	6	4	
BOTTOM BARS NO	1# 6	1# 7	1# 8	1# 9		1# 6	1# 7	1# 8	1# 9	
BARS NO	1# 6	1# 8	1# 9	1# 9		1# 6	1# 8	1# 9	1# 9	
STEEL (PSF)	0.77	1.15	1.49	1.69		1.09	1.75	2.30	3.07	
CLEAR SPAN	END SPAN					INTERIOR SPAN				
37'- 0" (3)	235	715	1088	1282	7.149	618	1316	1859	2142	4.399
STIR	#3- 93	#3-152	#3-177	#3-185		#3-111	#3-129	#4-169	#4-175	
38'- 0"	191	646	1000	1184	7.953	555	1216	1730	1999	4.894
STIR	#3- 91	#3-153	#3-154	#3-188		#3-110	#3-136	#4-172	#4-178	
39'- 0"	151	583	918	1094	8.824	496	1124	1612	1867	5.430
STIR	#3- 88	#3-154	#3-162	#3-192		#3-110	#3-143	#4-175	#4-181	
40'- 0"	113	524	843	1010	9.765	441	1038	1502	1745	6.009
STIR	#3- 86	#3-155	#3-171	#3-194		#3-110	#3-151	#4-178	#4-185	
41'- 0"	79	469	773	932	10.778	391	959	1401	1631	6.633
STIR	#3- 83	#3-156	#3-179	#3-197		#3-109	#3-158	#3-181	#4-188	
42'- 0"	46	419	708	859	11.869	344	885	1306	1526	7.304
STIR	#3- 80	#3-157	#3-186	#3-199		#3-108	#3-161	#3-184	#4-190	
43'- 0"	16	372	648	792	13.040	300	817	1218	1428	8.025
STIR	#3- 77	#3-157	#3-188	#3-177		#3-107	#3-163	#3-186	#4-194	
44'- 0"		327	591	729	14.296	259	753	1136	1336	8.798
STIR		#3-157	#3-190	#3-185		#3-106	#3-164	#3-188	#4-197	
45'- 0"		286	538	670	15.641	221	693	1060	1251	9.625
STIR		#3-157	#3-192	#3-194		#3-105	#3-165	#3-191	#4-199	
46'- 0"		248	489	615	17.078	185	637	988	1171	10.510
STIR		#3-157	#3-193	#3-202		#3-103	#3-167	#3-193	#3-201	
47'- 0"		212	443	564	18.613	152	585	921	1096	11.454
STIR		#3-157	#3-194	#3-208		#3-102	#3-168	#3-195	#3-204	
48'- 0"		178	400	515	20.248	121	535	858	1026	12.460
STIR		#3-157	#3-196	#3-210		#3-100	#3-169	#3-197	#3-207	
49'- 0"		146	359	470	21.989	91	489	798	960	13.532
STIR		#3-156	#3-197	#3-212		#3- 98	#3-170	#3-176	#3-209	
PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF)										
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.20	1.71	2.19	2.48		1.41	2.33	3.10	4.65	
ACTUAL STEEL %	0.495	0.707	0.905	1.025		0.582	0.961	1.282	1.922	
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31		26.38	26.31	26.31	26.31	
$-I_{cr}/I_{gr}$	0.132	0.176	0.210	0.231		0.151	0.220	0.272	0.359	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.88	1.39	1.79	2.00		0.88	1.39	1.79	2.00	
ACTUAL STEEL %	0.347	0.549	0.709	0.792		0.347	0.549	0.709	0.792	
EFF. DEPTH, IN.	26.62	26.53	26.46	26.44		26.62	26.53	26.46	26.44	
$+I_{cr}/I_{gr}$	0.130	0.198	0.249	0.275		0.130	0.198	0.249	0.275	

SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 8″ Ribs @ 61″ c.-c. 24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	10	8.5	9.5	8		8	7	9	5	5	
BOTTOM BARS NO	2# 5	1# 8	1# 8	1# 9	1#10		2# 5	1# 8	1# 8	1# 9	1#10	
BARS NO	1# 5	1# 8	1# 9	1#10	1#10		1# 5	1# 8	1# 9	1#10	1#10	
STEEL (PSF)	0.75	1.29	1.47	1.87	2.16		1.11	1.99	2.23	3.47	4.42	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	249	857	1052	1496	1744	7.149	655	1539	1823	2469	2829	4.399
STIR	#3- 85	#3-155	#3-162	#4-187	#4-195		#3-105	#3-155	#4-163	#5-176	#5-171	
38'- 0"	203	779	964	1385	1620	7.953	588	1426	1695	2307	2649	4.894
STIR	#3- 83	#3-156	#3-168	#4-190	#4-198		#3-105	#3-133	#4-166	#4-179	#5-174	
39'- 0"	160	707	883	1282	1505	8.824	525	1321	1577	2158	2482	5.430
STIR	#3- 80	#3-157	#3-170	#3-193	#4-202		#3-104	#3-140	#3-169	#4-183	#5-178	
40'- 0"	120	641	808	1187	1399	9.765	468	1224	1467	2019	2328	6.009
STIR	#3- 77	#3-158	#3-172	#3-196	#4-204		#3-103	#3-147	#3-171	#4-186	#5-180	
41'- 0"	84	579	738	1099	1301	10.778	414	1134	1366	1891	2185	6.633
STIR	#3- 74	#3-159	#3-174	#3-198	#4-208		#3-102	#3-155	#3-173	#4-189	#5-185	
42'- 0"	49	521	673	1017	1209	11.869	364	1051	1271	1772	2052	7.304
STIR	#3- 70	#3-160	#3-175	#3-201	#4-211		#3-101	#3-162	#3-175	#4-192	#5-191	
43'- 0"	17	468	612	941	1124	13.040	318	973	1183	1661	1928	8.025
STIR	#3- 66	#3-160	#3-176	#3-204	#4-214		#3-100	#3-165	#3-178	#4-195	#4-198	
44'- 0"		418	556	869	1045	14.296	275	900	1101	1557	1812	8.798
STIR		#3-161	#3-177	#3-181	#3-216		#3- 98	#3-166	#3-157	#4-198	#4-204	
45'- 0"		371	503	803	971	15.641	234	832	1024	1460	1704	9.625
STIR		#3-161	#3-179	#3-189	#3-220		#3- 97	#3-168	#3-164	#4-200	#4-209	
46'- 0"		327	454	741	901	17.078	197	769	952	1370	1603	10.510
STIR		#3-161	#3-179	#3-198	#3-222		#3- 95	#3-169	#3-172	#4-203	#4-212	
47'- 0"		287	407	682	836	18.613	161	709	885	1285	1509	11.454
STIR		#3-161	#3-180	#3-206	#3-225		#3- 93	#3-170	#3-179	#4-206	#4-214	
48'- 0"		248	364	628	775	20.248	128	654	822	1206	1420	12.460
STIR		#3-161	#3-181	#3-213	#3-227		#3- 91	#3-171	#3-185	#4-209	#4-218	
49'- 0"		212	323	576	718	21.989	97	601	763	1131	1337	13.532
STIR		#3-161	#3-181	#3-214	#3-229		#3- 89	#3-173	#3-187	#4-211	#4-220	
PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.22	1.89	2.22	2.83	3.36		1.52	2.70	2.98	5.37	7.32	
ACTUAL STEEL %	0.454	0.705	0.830	1.056	1.255		0.567	1.007	1.115	2.007	2.745	
EFF. DEPTH, IN.	26.38	26.31	26.31	26.25	26.25		26.38	26.31	26.25	26.25	26.19	
$-I_{cr}/I_{gr}$	0.126	0.178	0.201	0.240	0.272		0.151	0.233	0.249	0.375	0.454	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.58	1.79	2.27	2.54		0.93	1.58	1.79	2.27	2.54	
ACTUAL STEEL %	0.331	0.566	0.641	0.815	0.913		0.331	0.566	0.641	0.815	0.913	
EFF. DEPTH, IN.	26.69	26.50	26.46	26.40	26.36		26.69	26.50	26.46	26.40	26.36	
$+I_{cr}/I_{gr}$	0.127	0.204	0.228	0.282	0.311		0.127	0.204	0.228	0.282	0.311	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 9″ Ribs @ 62″ c.-c. 24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 5	# 6	# 7	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 7	# 8	Int. Span Defl. Coeff. (2)
AT	10	9.5	8	9	10		7.5	7	8	9	6	
BOTTOM BARS NO	2# 4	1# 6	2# 7	2# 8	1# 8		2# 4	1# 6	2# 7	2# 8	1# 8	
BARS NO	2# 5	2# 7	1# 8	1# 8	2# 9		2# 5	2# 7	1# 8	1# 8	2# 9	
STEEL (PSF)	0.80	1.28	1.58	1.89	2.24		1.20	1.96	2.46	2.93	4.71	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	301	883	1210	1563	1949	7.149	746	1593	2069	2582	3144	4.399
STIR	#3- 85	#3-149	#3-160	#4-183	#4-195		#3-105	#3-133	#4-164	#5-174	#5-171	
38'- 0"	250	802	1112	1446	1813	7.953	672	1475	1926	2412	2946	4.894
STIR	#3- 82	#3-150	#3-168	#4-187	#4-199		#3-105	#3-140	#4-167	#4-177	#5-174	
39'- 0"	203	727	1021	1339	1687	8.824	604	1366	1794	2256	2762	5.430
STIR	#3- 80	#3-151	#3-172	#3-189	#4-202		#3-104	#3-148	#4-170	#4-181	#5-177	
40'- 0"	159	657	937	1239	1570	9.765	540	1265	1672	2111	2592	6.009
STIR	#3- 77	#3-152	#3-173	#3-192	#4-205		#3-103	#3-155	#4-172	#4-183	#5-180	
41'- 0"	119	593	859	1147	1462	10.778	481	1171	1559	1977	2435	6.633
STIR	#3- 73	#3-152	#3-175	#3-195	#4-208		#3-102	#3-157	#3-175	#4-186	#5-184	
42'- 0"	81	533	787	1061	1361	11.869	427	1084	1453	1852	2288	7.304
STIR	#3- 70	#3-153	#3-177	#3-173	#4-211		#3-101	#3-158	#3-176	#4-189	#5-190	
43'- 0"	46	477	719	981	1267	13.040	376	1003	1355	1735	2152	8.025
STIR	#3- 66	#3-153	#3-178	#3-181	#4-214		#3-100	#3-159	#3-179	#4-192	#5-197	
44'- 0"	14	425	657	906	1180	14.296	329	928	1264	1627	2024	8.798
STIR	#3- 62	#3-153	#3-179	#3-190	#4-217		#3- 98	#3-161	#3-155	#4-194	#5-203	
45'- 0"		377	598	836	1098	15.641	284	857	1178	1525	1906	9.625
STIR		#3-153	#3-180	#3-198	#4-220		#3- 97	#3-162	#3-162	#4-197	#5-209	
46'- 0"		332	543	771	1021	17.078	243	791	1099	1431	1794	10.510
STIR		#3-153	#3-181	#3-203	#4-222		#3- 95	#3-163	#3-169	#4-200	#4-212	
47'- 0"		289	492	710	950	18.613	204	729	1024	1342	1690	11.454
STIR		#3-152	#3-182	#3-205	#3-225		#3- 93	#3-164	#3-177	#4-203	#4-214	
48'- 0"		249	443	653	883	20.248	168	671	953	1258	1593	12.460
STIR		#3-152	#3-183	#3-207	#3-228		#3- 91	#3-165	#3-184	#4-205	#4-218	
49'- 0"		212	398	599	820	21.989	133	616	887	1180	1501	13.532
STIR		#3-151	#3-184	#3-208	#3-230		#3- 88	#3-166	#3-188	#4-207	#4-220	
PROPERTIES FOR DESIGN (CONCRETE 0.73 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.24	2.02	2.40	3.03	3.72		1.65	2.75	3.41	4.13	8.16	
ACTUAL STEEL %	0.420	0.687	0.816	1.032	1.270		0.560	0.932	1.161	1.411	2.796	
EFF. DEPTH, IN.	26.38	26.31	26.31	26.25	26.19		26.38	26.31	26.25	26.19	26.12	
$-I_{cr}/I_{gr}$	0.120	0.178	0.203	0.241	0.278		0.152	0.225	0.262	0.300	0.466	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.37	2.79		1.02	1.64	1.99	2.37	2.79	
ACTUAL STEEL %	0.331	0.535	0.650	0.775	0.913		0.331	0.535	0.650	0.775	0.913	
EFF. DEPTH, IN.	26.71	26.58	26.54	26.50	26.45		26.71	26.58	26.54	26.50	26.45	
$+I_{cr}/I_{gr}$	0.128	0.197	0.235	0.274	0.316		0.128	0.197	0.235	0.274	0.316	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 10″ Ribs @ 63″ c.-c. 24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 5	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	9	9	7	9	10		10	9.5	10	8.5	6	
BOTTOM BARS NO	1# 5	1# 8	1# 7	1#10	1#10		1# 5	1# 8	1# 7	1#10	1#10	
BARS NO	2# 6	1# 9	2# 8	1#10	1#11		2# 6	1# 9	2# 8	1#10	1#11	
STEEL (PSF)	0.90	1.41	1.69	2.04	2.31		1.38	2.13	2.62	3.17	4.03	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	424	982	1351	1674	1938	7.149	942	1753	2290	2760	3145	4.399
STIR	#3- 96	#3-149	#3-159	#4-182	#4-189		#3-113	#3-133	#4-165	#5-173	#5-178	
38'- 0"	365	894	1244	1550	1801	7.953	856	1625	2134	2579	2944	4.894
STIR	#3- 94	#3-150	#3-168	#4-185	#4-193		#3-113	#3-140	#4-167	#5-176	#5-182	
39'- 0"	310	812	1145	1435	1673	8.824	776	1506	1990	2412	2759	5.430
STIR	#3- 92	#3-151	#3-172	#4-188	#4-196		#3-113	#3-148	#4-170	#5-179	#5-185	
40'- 0"	260	737	1053	1329	1555	9.765	703	1397	1857	2258	2587	6.009
STIR	#3- 89	#3-151	#3-174	#3-190	#4-199		#3-112	#3-155	#4-172	#4-182	#5-188	
41'- 0"	213	667	968	1230	1446	10.778	635	1295	1733	2115	2428	6.633
STIR	#3- 87	#3-152	#3-175	#3-168	#4-202		#3-112	#3-156	#4-175	#4-185	#5-191	
42'- 0"	169	602	889	1139	1344	11.869	571	1200	1617	1982	2280	7.304
STIR	#3- 84	#3-152	#3-177	#3-177	#4-205		#3-111	#3-158	#4-177	#4-187	#5-194	
43'- 0"	129	541	815	1054	1250	13.040	512	1112	1510	1858	2143	8.025
STIR	#3- 81	#3-152	#3-178	#3-185	#4-207		#3-110	#3-159	#3-179	#4-190	#5-198	
44'- 0"	91	485	746	974	1161	14.296	457	1030	1410	1742	2014	8.798
STIR	#3- 77	#3-153	#3-180	#3-194	#3-210		#3-109	#3-161	#3-182	#4-193	#4-200	
45'- 0"	55	432	682	900	1079	15.641	405	953	1317	1634	1894	9.625
STIR	#3- 74	#3-152	#3-181	#3-199	#3-212		#3-108	#3-162	#3-161	#4-195	#4-204	
46'- 0"	22	383	622	831	1002	17.078	357	882	1229	1533	1782	10.510
STIR	#3- 70	#3-152	#3-182	#3-201	#3-190		#3-107	#3-163	#3-168	#4-199	#4-206	
47'- 0"		337	566	765	929	18.613	312	815	1148	1438	1677	11.454
STIR		#3-152	#3-183	#3-202	#3-199		#3-105	#3-164	#3-175	#4-201	#4-209	
48'- 0"		293	513	704	862	20.248	270	751	1071	1350	1578	12.460
STIR		#3-151	#3-184	#3-204	#3-207		#3-104	#3-165	#3-183	#4-203	#4-212	
49'- 0"		252	463	647	798	21.989	230	692	999	1266	1486	13.532
STIR		#3-150	#3-184	#3-206	#3-216		#3-102	#3-166	#3-189	#4-205	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.76 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)												
ACTUAL STEEL %	1.40	2.17	2.79	3.08	3.78		1.95	2.92	3.78	4.45	6.30	
EFF. DEPTH, IN.	0.435	0.676	0.870	0.963	1.185		0.609	0.912	1.185	1.394	1.975	
$-I_{cr}/I_{gr}$	26.38	26.31	26.31	26.25	26.19		26.31	26.25	26.19	26.19	26.19	
	0.126	0.179	0.217	0.233	0.270		0.165	0.224	0.270	0.303	0.385	
POSITIVE MOMENT STEEL AREA (SQ. IN.)												
ACTUAL STEEL %	1.19	1.79	2.18	2.54	2.83		1.19	1.79	2.18	2.54	2.83	
EFF. DEPTH, IN.	0.356	0.539	0.656	0.767	0.856		0.356	0.539	0.656	0.767	0.856	
$+I_{cr}/I_{gr}$	26.64	26.46	26.52	26.36	26.33		26.64	26.46	26.52	26.36	26.33	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 6″ Ribs @ 72″ c.-c. 14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4		End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 5		Int. Span Defl. Coeff. (2)
AT	10	10	10	10			10	10	9.5	9.5		
BOTTOM BARS NO	1# 4	1# 5	1# 6	1# 6			1# 4	1# 5	1# 6	1# 6		
BARS NO	1# 5	1# 6	1# 6	1# 7			1# 5	1# 6	1# 6	1# 7		
STEEL (PSF)	0.48	0.60	0.68	0.75			0.72	0.84	0.94	1.30		
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	199	536	718	940		1.265	530	1021	1286	1609		0.779
STIR	#3- 73	#3-102	#3- 99	#3-122			#3- 80	#3-103	#3-110	#3-115		
25'- 0"	142	453	620	825		1.490	447	900	1144	1441		0.917
STIR	#3- 72	#3-104	#3-108	#3-125			#3- 81	#3-105	#3-112	#3-118		
26'- 0"	91	378	533	723		1.743	373	792	1017	1293		1.073
STIR	#3- 70	#3-105	#3-116	#3-128			#3- 81	#3- 94	#3-114	#3-122		
27'- 0"	46	312	456	632		2.027	308	696	905	1160		1.247
STIR	#3- 68	#3-106	#3-118	#3-131			#3- 81	#3-101	#3-118	#3-124		
28'- 0"	5	253	387	550		2.344	249	610	804	1041		1.443
STIR	#3- 66	#3-107	#3-119	#3-133			#3- 81	#3-109	#3-120	#3-128		
29'- 0"		200	325	477		2.698	196	532	713	935		1.660
STIR		#3-107	#3-121	#3-123			#3- 81	#3-110	#3-122	#3-130		
30'- 0"		152	269	411		3.090	148	463	632	839		1.901
STIR		#3-108	#3-122	#3-131			#3- 80	#3-112	#3-107	#3-133		
31'- 0"		109	218	351		3.523	105	400	558	752		2.168
STIR		#3-108	#3-123	#3-137			#3- 79	#3-113	#3-114	#3-135		
32'- 0"		69	172	297		4.000	66	342	491	673		2.461
STIR		#3-108	#3-124	#3-139			#3- 78	#3-114	#3-121	#3-139		
33'- 0"		34	130	247		4.523	30	290	430	601		2.784
STIR		#3-107	#3-125	#3-141			#3- 77	#3-115	#3-128	#3-141		
34'- 0"		1	91	202		5.097		243	374	535		3.137
STIR		#3-107	#3-125	#3-142				#3-116	#3-129	#3-143		
35'- 0"			56	161		5.724		199	323	475		3.522
STIR			#3-126	#3-143				#3-117	#3-131	#3-145		
36'- 0"			24	123		6.407		159	277	420		3.942
STIR			#3-126	#3-145				#3-118	#3-132	#3-148		
PROPERTIES FOR DESIGN (CONCRETE 0.49 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.44	1.44	1.44	1.44			1.44	1.44	1.52	2.35		
ACTUAL STEEL %	1.194	1.194	1.194	1.194			1.194	1.194	1.257	1.957		
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38			16.38	16.38	16.38	16.31		
$-I_{cr}/I_{gr}$	0.198	0.198	0.198	0.198			0.198	0.198	0.205	0.276		
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.51	0.75	0.88	1.04			0.51	0.75	0.88	1.04		
ACTUAL STEEL %	0.397	0.585	0.688	0.814			0.397	0.585	0.688	0.814		
EFF. DEPTH, IN.	16.71	16.65	16.62	16.59			16.71	16.65	16.62	16.59		
$+I_{cr}/I_{gr}$	0.118	0.169	0.195	0.227			0.118	0.169	0.195	0.227		
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 4	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	10	9.5	8		10	10	8	7	8	
BOTTOM BARS NO	1# 4	1# 6	1# 6	1# 7	1# 7		1# 4	1# 6	1# 6	1# 7	1# 7	
BARS NO	1# 5	1# 6	1# 7	1# 7	1# 8		1# 5	1# 6	1# 7	1# 7	1# 8	
STEEL (PSF)	0.48	0.67	0.74	0.84	0.97		0.72	0.91	1.10	1.28	2.02	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	176	695	917	1139	1400	1.265	507	1263	1586	1909	2288	0.779
STIR	#3- 60	#3-104	#3-116	#3-122	#3-128		#3- 72	#3-104	#3-110	#3-116	#4-120	
25'- 0"	118	597	802	1006	1247	1.490	424	1121	1418	1716	2065	0.917
STIR	#3- 58	#3-106	#3-104	#3-125	#3-132		#3- 71	#3-106	#3-114	#3-118	#4-114	
26'- 0"	68	510	700	889	1111	1.743	350	994	1270	1544	1868	1.073
STIR	#3- 55	#3-107	#3-112	#3-129	#3-136		#3- 71	#3-109	#3-116	#3-121	#4-117	
27'- 0"	23	433	609	784	990	2.027	285	882	1137	1392	1692	1.247
STIR	#3- 52	#3-108	#3-120	#3-131	#3-138		#3- 70	#3- 98	#3-118	#3-125	#4-122	
28'- 0"		364	527	690	882	2.344	226	781	1018	1255	1534	1.443
STIR		#3-109	#3-122	#3-133	#3-142		#3- 69	#3-105	#3-122	#3-128	#3-127	
29'- 0"		302	454	606	784	2.698	173	690	912	1133	1393	1.660
STIR		#3-110	#3-124	#3-121	#3-145		#3- 68	#3-112	#3-124	#3-131	#3-133	
30'- 0"		245	388	530	697	3.090	125	609	816	1022	1265	1.901
STIR		#3-111	#3-125	#3-130	#3-148		#3- 66	#3-114	#3-126	#3-134	#3-139	
31'- 0"		195	328	461	617	3.523	82	535	729	922	1150	2.168
STIR		#3-111	#3-127	#3-138	#3-150		#3- 65	#3-115	#3-129	#3-137	#3-144	
32'- 0"		149	274	398	545	4.000	43	468	650	831	1045	2.461
STIR		#3-111	#3-128	#3-140	#3-153		#3- 63	#3-117	#3-117	#3-139	#3-146	
33'- 0"		107	224	341	480	4.523	7	407	578	749	949	2.784
STIR		#3-111	#3-129	#3-142	#3-155		#3- 60	#3-118	#3-124	#3-141	#3-150	
34'- 0"		68	179	290	420	5.097		351	512	673	862	3.137
STIR		#3-110	#3-129	#3-143	#3-144			#3-119	#3-132	#3-144	#3-153	
35'- 0"		33	138	242	365	5.724		300	452	604	782	3.522
STIR		#3-110	#3-130	#3-145	#3-153			#3-120	#3-134	#3-145	#3-155	
36'- 0"		1	100	198	314	6.407		254	397	540	709	3.942
STIR		#3-109	#3-130	#3-146	#3-160			#3-121	#3-135	#3-147	#3-157	
PROPERTIES FOR DESIGN (CONCRETE 0.51 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.46	1.46	1.46	1.54	1.83		1.46	1.46	1.83	2.09	4.01	
ACTUAL STEEL %	1.066	1.066	1.066	1.122	1.332		1.066	1.066	1.332	1.523	2.958	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38	16.38		16.38	16.38	16.38	16.38	16.25	
$-I_{cr}/I_{gr}$	0.186	0.186	0.186	0.193	0.219		0.186	0.186	0.219	0.241	0.362	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.88	1.04	1.20	1.39		0.51	0.88	1.04	1.20	1.39	
ACTUAL STEEL %	0.351	0.609	0.721	0.832	0.966		0.351	0.609	0.721	0.832	0.966	
EFF. DEPTH, IN.	16.71	16.62	16.59	16.56	16.53		16.71	16.62	16.59	16.56	16.53	
$+I_{cr}/I_{gr}$	0.106	0.175	0.203	0.231	0.264		0.106	0.175	0.203	0.231	0.264	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 8″ Ribs @ 74″ c.-c. 14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 4	# 4	Int. Span Defl. Coeff. (2)
AT	10	10	10	10	8.5		10	10	8.5	7	5	
BOTTOM BARS NO	2# 4	1# 6	1# 6	1# 5	1# 7		2# 4	1# 6	1# 6	1# 5	1# 7	
BARS NO	1# 4	1# 6	1# 7	2# 6	1# 8		1# 4	1# 6	1# 7	2# 6	1# 8	
STEEL (PSF)	0.51	0.67	0.73	0.77	0.94		0.75	0.91	1.06	1.22	1.62	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	283	672	894	1110	1377	1.265	674	1240	1563	1877	2266	0.779
STIR	#3- 65	#3- 97	#3-107	#3-117	#3-124		#3- 75	#3- 87	#3-106	#3-112	#4-116	
25'- 0"	215	574	779	978	1224	1.490	576	1098	1395	1685	2043	0.917
STIR	#3- 63	#3- 98	#3-109	#3-119	#3-127		#3- 75	#3- 94	#3-109	#3-114	#4-120	
26'- 0"	156	487	677	861	1088	1.743	489	971	1247	1514	1845	1.073
STIR	#3- 61	#3- 98	#3-111	#3-110	#3-130		#3- 75	#3-101	#3-112	#3-118	#4-122	
27'- 0"	102	410	586	756	967	2.027	411	859	1114	1362	1669	1.247
STIR	#3- 59	#3- 99	#3-112	#3-118	#3-133		#3- 75	#3-102	#3-113	#3-120	#3-127	
28'- 0"	55	341	504	662	859	2.344	342	758	995	1226	1511	1.443
STIR	#3- 56	#3- 99	#3-114	#3-124	#3-136		#3- 74	#3-104	#3-100	#3-123	#3-129	
29'- 0"	12	278	431	578	761	2.698	280	667	889	1104	1370	1.660
STIR	#3- 53	#3- 99	#3-115	#3-126	#3-138		#3- 73	#3-105	#3-108	#3-125	#3-132	
30'- 0"		222	365	503	674	3.090	223	586	793	994	1242	1.901
STIR		#3- 99	#3-115	#3-127	#3-126		#3- 72	#3-106	#3-115	#3-127	#3-135	
31'- 0"		172	305	434	594	3.523	173	512	706	894	1127	2.168
STIR		#3- 98	#3-116	#3-129	#3-134		#3- 71	#3-107	#3-119	#3-130	#3-138	
32'- 0"		126	251	372	522	4.000	126	445	627	803	1022	2.461
STIR		#3- 98	#3-116	#3-130	#3-142		#3- 69	#3-108	#3-121	#3-132	#3-141	
33'- 0"		84	201	315	457	4.523	84	384	555	721	926	2.784
STIR		#3- 97	#3-117	#3-131	#3-144		#3- 67	#3-108	#3-122	#3-121	#3-143	
34'- 0"		45	156	264	397	5.097	46	328	489	646	839	3.137
STIR		#3- 95	#3-117	#3-132	#3-146		#3- 65	#3-109	#3-123	#3-129	#3-145	
35'- 0"		10	115	216	342	5.724	11	277	429	577	760	3.522
STIR		#3- 94	#3-116	#3-133	#3-148		#3- 63	#3-109	#3-124	#3-135	#3-148	
36'- 0"			77	173	291	6.407		230	374	514	686	3.942
STIR			#3-116	#3-133	#3-149			#3-109	#3-125	#3-137	#3-150	
PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.48	1.48	1.48	1.74		1.48	1.48	1.74	2.11	2.96	
ACTUAL STEEL %	0.965	0.965	0.965	0.965	1.135		0.965	0.965	1.135	1.379	1.930	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38	16.38		16.38	16.38	16.38	16.38	16.38	
$-I_{cr}/I_{gr}$	0.177	0.177	0.177	0.177	0.199		0.177	0.177	0.199	0.230	0.289	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.88	1.04	1.19	1.39		0.60	0.88	1.04	1.19	1.39	
ACTUAL STEEL %	0.370	0.546	0.646	0.737	0.867		0.370	0.546	0.646	0.737	0.867	
EFF. DEPTH, IN.	16.75	16.62	16.59	16.64	16.53		16.75	16.62	16.59	16.64	16.53	
$+I_{cr}/I_{gr}$	0.113	0.159	0.185	0.211	0.240		0.113	0.159	0.185	0.211	0.240	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 9″ Ribs @ 75″ c.-c. 14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End	# 4	# 4	# 4	# 5	# 6	Int.
AT	10	10	10	9	7.5	Span	10	9	7.5	10	7.5	Span
BOTTOM BARS NO	2# 4	2# 4	1# 5	2# 6	1# 8	Defl.	2# 4	2# 4	1# 5	2# 6	1# 8	Defl.
BARS NO	1# 4	2# 5	2# 6	1# 6	1# 8	Coeff.	1# 4	2# 5	2# 6	1# 6	1# 8	Coeff.
STEEL (PSF)	0.51	0.70	0.77	0.87	1.07	(2)	0.75	1.00	1.17	1.35	2.19	(2)
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	260	854	1087	1268	1615	1.265	651	1515	1854	2117	2622	0.779
STIR	#3- 54	#3-100	#3-103	#3-117	#3-125		#3- 68	#3-102	#3-107	#3-111	#4-111	
25'- 0"	192	740	955	1122	1441	1.490	553	1349	1662	1904	2369	0.917
STIR	#3- 52	#3-101	#3-111	#3-119	#3-129		#3- 67	#3- 90	#3-110	#3-115	#4-115	
26'- 0"	133	639	838	992	1287	1.743	466	1202	1491	1715	2145	1.073
STIR	#3- 49	#3-102	#3-113	#3-110	#3-132		#3- 66	#3- 97	#3-113	#3-117	#4-119	
27'- 0"	79	549	733	876	1150	2.027	388	1071	1339	1547	1946	1.247
STIR	#3- 45	#3-103	#3-115	#3-118	#3-134		#3- 65	#3-104	#3-115	#3-120	#4-125	
28'- 0"	32	468	640	772	1027	2.344	319	954	1203	1396	1767	1.443
STIR	#3- 41	#3-104	#3-116	#3-124	#3-137		#3- 64	#3-107	#3-118	#3-123	#4-130	
29'- 0"		396	555	679	917	2.698	256	849	1081	1261	1606	1.660
STIR		#3-104	#3-118	#3-126	#3-139		#3- 62	#3-108	#3-104	#3-125	#3-134	
30'- 0"		331	480	595	817	3.090	200	754	971	1139	1462	1.901
STIR		#3-104	#3-119	#3-127	#3-142		#3- 60	#3-110	#3-111	#3-128	#3-136	
31'- 0"		271	411	520	727	3.523	150	668	871	1029	1331	2.168
STIR		#3-104	#3-119	#3-129	#3-131		#3- 58	#3-111	#3-119	#3-130	#3-140	
32'- 0"		218	349	451	646	4.000	103	590	780	928	1212	2.461
STIR		#3-104	#3-120	#3-130	#3-140		#3- 56	#3-112	#3-123	#3-132	#3-143	
33'- 0"		169	292	388	571	4.523	61	519	698	837	1104	2.784
STIR		#3-103	#3-121	#3-131	#3-146		#3- 53	#3-113	#3-125	#3-121	#3-145	
34'- 0"		124	241	331	503	5.097	23	454	623	754	1005	3.137
STIR		#3-102	#3-121	#3-132	#3-148		#3- 50	#3-113	#3-126	#3-128	#3-148	
35'- 0"		84	193	278	441	5.724		394	554	677	915	3.522
STIR		#3-101	#3-121	#3-133	#3-150			#3-114	#3-127	#3-136	#3-150	
36'- 0"		46	150	230	384	6.407		340	491	607	832	3.942
STIR		#3-100	#3-121	#3-133	#3-151			#3-114	#3-128	#3-137	#3-152	
PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.50	1.50	1.50	1.67	2.00		1.50	1.67	2.00	2.33	4.40	
ACTUAL STEEL %	0.884	0.884	0.884	0.982	1.178		0.884	0.982	1.178	1.376	2.615	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38	16.38		16.38	16.38	16.38	16.31	16.25	
$-I_{cr}/I_{gr}$	0.169	0.169	0.169	0.183	0.209		0.169	0.183	0.209	0.231	0.351	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	1.02	1.19	1.32	1.58		0.60	1.02	1.19	1.32	1.58	
ACTUAL STEEL %	0.335	0.571	0.669	0.742	0.894		0.335	0.571	0.669	0.742	0.894	
EFF. DEPTH, IN.	16.75	16.71	16.64	16.62	16.50		16.75	16.71	16.64	16.62	16.50	
$+I_{cr}/I_{gr}$	0.104	0.170	0.194	0.213	0.247		0.104	0.170	0.194	0.213	0.247	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 6″ Ribs @ 72″ c.-c. 16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4			End	# 4	# 4	# 4			Int.
AT	10	10	10			Span	10	9.5	8			Span
BOTTOM BARS NO	1# 4	1# 6	1# 6			Defl.	1# 4	1# 6	1# 6			Defl.
BARS NO	1# 5	1# 6	1# 7			Coeff.	1# 5	1# 6	1# 7			Coeff.
STEEL (PSF)	0.48	0.68	0.75			(2)	0.72	0.94	1.11			(2)
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	144	641	854			1.743	461	1183	1493			1.073
STIR	#3- 67	#3-114	#3-126				#3- 79	#3-113	#3-121			
27'- 0"	94	554	752			2.027	387	1057	1344			1.247
STIR	#3- 65	#3-116	#3-129				#3- 79	#3-117	#3-123			
28'- 0"	48	477	660			2.344	321	944	1211			1.443
STIR	#3- 63	#3-118	#3-117				#3- 79	#3-118	#3-126			
29'- 0"	8	407	578			2.698	262	843	1092			1.660
STIR	#3- 61	#3-119	#3-126				#3- 78	#3-102	#3-129			
30'- 0"		344	504			3.090	209	751	984			1.901
STIR		#3-120	#3-133				#3- 78	#3-109	#3-132			
31'- 0"		287	437			3.523	160	669	886			2.168
STIR		#3-121	#3-135				#3- 77	#3-116	#3-134			
32'- 0"		236	376			4.000	117	594	798			2.461
STIR		#3-122	#3-137				#3- 75	#3-124	#3-136			
33'- 0"		189	321			4.523	77	525	717			2.784
STIR		#3-122	#3-139				#3- 74	#3-126	#3-139			
34'- 0"		146	270			5.097	40	463	644			3.137
STIR		#3-123	#3-140				#3- 72	#3-127	#3-141			
35'- 0"		106	224			5.724	7	406	576			3.522
STIR		#3-123	#3-141				#3- 70	#3-129	#3-126			
36'- 0"		70	181			6.407		353	514			3.942
STIR		#3-123	#3-142					#3-130	#3-133			
37'- 0"		37	142			7.149		305	458			4.399
STIR		#3-123	#3-143					#3-131	#3-141			
38'- 0"		6	106			7.953		260	405			4.894
STIR		#3-122	#3-144					#3-132	#3-147			
PROPERTIES FOR DESIGN (CONCRETE 0.51 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.44	1.44	1.44				1.44	1.52	1.80			
ACTUAL STEEL %	1.041	1.041	1.041				1.041	1.095	1.301			
EFF. DEPTH, IN.	18.38	18.38	18.38				18.38	18.38	18.38			
$-I_{cr}/I_{gr}$	0.188	0.188	0.188				0.188	0.195	0.221			
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.88	1.04				0.51	0.88	1.04			
ACTUAL STEEL %	0.347	0.601	0.711				0.347	0.601	0.711			
EFF. DEPTH, IN.	18.71	18.62	18.59				18.71	18.62	18.59			
$+I_{cr}/I_{gr}$	0.109	0.180	0.210				0.109	0.180	0.210			
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 4	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	9.5	8	7		10	10	7	4	7	
BOTTOM BARS NO	2# 4	1# 6	1# 7	1# 7	1# 8		2# 4	1# 6	1# 7	1# 7	1# 8	
BARS NO	1# 4	1# 6	1# 7	1# 8	1# 8		1# 4	1# 6	1# 7	1# 8	1# 8	
STEEL (PSF)	0.52	0.67	0.84	0.97	1.11		0.76	0.91	1.28	1.87	2.31	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	243	616	1041	1291	1540	1.743	616	1158	1776	2140	2503	1.073
STIR	#3- 72	#3-106	#3-128	#3-134	#3-140		#3- 82	#3- 93	#3-121	#4-124	#4-130	
27'- 0"	183	529	923	1155	1386	2.027	529	1032	1605	1943	2279	1.247
STIR	#3- 70	#3-107	#3-130	#3-138	#3-144		#3- 82	#3-100	#3-124	#4-127	#4-124	
28'- 0"	130	451	818	1033	1249	2.344	451	919	1452	1766	2079	1.443
STIR	#3- 68	#3-108	#3-115	#3-141	#3-147		#3- 82	#3-108	#3-127	#4-130	#4-127	
29'- 0"	82	381	723	924	1125	2.698	382	817	1314	1607	1899	1.660
STIR	#3- 66	#3-108	#3-124	#3-143	#3-151		#3- 82	#3-111	#3-130	#3-136	#4-130	
30'- 0"	39	319	638	826	1013	3.090	319	726	1190	1464	1736	1.901
STIR	#3- 63	#3-109	#3-132	#3-147	#3-154		#3- 82	#3-113	#3-132	#3-139	#4-134	
31'- 0"		262	561	737	912	3.523	262	643	1078	1334	1590	2.168
STIR		#3-109	#3-137	#3-149	#3-157		#3- 81	#3-114	#3-135	#3-142	#4-141	
32'- 0"		210	491	656	821	4.000	210	568	976	1217	1456	2.461
STIR		#3-109	#3-138	#3-151	#3-160		#3- 80	#3-115	#3-138	#3-145	#4-147	
33'- 0"		163	427	582	737	4.523	163	500	883	1109	1335	2.784
STIR		#3-108	#3-140	#3-139	#3-162		#3- 79	#3-116	#3-140	#3-149	#4-153	
34'- 0"		120	369	515	661	5.097	120	437	799	1012	1224	3.137
STIR		#3-108	#3-141	#3-147	#3-166		#3- 77	#3-117	#3-142	#3-150	#3-158	
35'- 0"		81	315	453	591	5.724	81	380	721	922	1122	3.522
STIR		#3-107	#3-143	#3-156	#3-169		#3- 76	#3-118	#3-144	#3-153	#3-161	
36'- 0"		45	266	397	527	6.407	45	328	650	840	1029	3.942
STIR		#3-106	#3-144	#3-158	#3-170		#3- 74	#3-119	#3-131	#3-157	#3-164	
37'- 0"		11	221	345	468	7.149	12	279	585	764	944	4.399
STIR		#3-105	#3-145	#3-160	#3-154		#3- 72	#3-119	#3-138	#3-159	#3-167	
38'- 0"			180	297	414	7.953		235	524	695	865	4.894
STIR			#3-146	#3-161	#3-162			#3-119	#3-146	#3-160	#3-170	
PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.46	1.46	1.54	1.83	2.09		1.46	1.46	2.09	3.65	4.59	
ACTUAL STEEL %	0.931	0.931	0.980	1.164	1.330		0.931	0.931	1.330	2.328	2.951	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.38		18.38	18.38	18.38	18.38	18.25	
$-I_{cr}/I_{gr}$	0.177	0.177	0.184	0.208	0.230		0.177	0.177	0.230	0.335	0.380	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.88	1.20	1.39	1.58		0.60	0.88	1.20	1.39	1.58	
ACTUAL STEEL %	0.361	0.533	0.729	0.846	0.962		0.361	0.533	0.729	0.846	0.962	
EFF. DEPTH, IN.	18.75	18.62	18.56	18.53	18.50		18.75	18.62	18.56	18.53	18.50	
$+I_{cr}/I_{gr}$	0.114	0.162	0.214	0.244	0.274		0.114	0.162	0.214	0.244	0.274	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 8″ Ribs @ 74″ c.-c. 16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	10	8.5	7.5		10	8.5	7.5	9.5	7.5	
BOTTOM BARS NO	1# 5	1# 6	1# 5	1# 7	1# 8		1# 5	1# 6	1# 5	1# 7	1# 8	
BARS NO	1# 5	1# 7	2# 6	1# 8	1# 8		1# 5	1# 7	2# 6	1# 8	1# 8	
STEEL (PSF)	0.54	0.73	0.77	0.94	1.08		0.78	1.06	1.18	1.45	2.20	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	242	803	1009	1265	1515	1.743	626	1442	1741	2115	2478	1.073
STIR	#3- 63	#3-110	#3-112	#3-129	#3-135		#3- 76	#3-110	#3-116	#4-122	#4-122	
27'- 0"	180	701	891	1130	1361	2.027	536	1293	1571	1917	2254	1.247
STIR	#3- 60	#3-111	#3-120	#3-132	#3-139		#3- 76	#3- 95	#3-119	#4-125	#4-126	
28'- 0"	125	609	787	1008	1223	2.344	456	1160	1418	1740	2054	1.443
STIR	#3- 57	#3-112	#3-123	#3-135	#3-142		#3- 75	#3-102	#3-121	#3-129	#4-129	
29'- 0"	76	527	692	899	1099	2.698	385	1041	1281	1582	1874	1.660
STIR	#3- 54	#3-113	#3-124	#3-120	#3-145		#3- 74	#3-110	#3-124	#3-131	#4-134	
30'- 0"	31	453	607	800	988	3.090	320	933	1158	1438	1711	1.901
STIR	#3- 51	#3-114	#3-126	#3-128	#3-147		#3- 73	#3-116	#3-126	#3-134	#4-140	
31'- 0"		386	531	711	887	3.523	261	835	1046	1309	1564	2.168
STIR		#3-114	#3-127	#3-137	#3-150		#3- 72	#3-118	#3-109	#3-137	#4-144	
32'- 0"		325	461	630	795	4.000	208	747	944	1191	1431	2.461
STIR		#3-114	#3-128	#3-141	#3-153		#3- 70	#3-119	#3-116	#3-140	#3-146	
33'- 0"		269	397	557	712	4.523	160	666	852	1084	1309	2.784
STIR		#3-115	#3-129	#3-143	#3-137		#3- 68	#3-121	#3-124	#3-142	#3-150	
34'- 0"		219	339	489	635	5.097	115	593	768	986	1199	3.137
STIR		#3-114	#3-130	#3-144	#3-145		#3- 66	#3-122	#3-131	#3-145	#3-152	
35'- 0"		173	286	428	566	5.724	75	525	690	897	1097	3.522
STIR		#3-114	#3-131	#3-146	#3-154		#3- 64	#3-123	#3-134	#3-146	#3-155	
36'- 0"		130	237	371	502	6.407	38	463	620	814	1004	3.942
STIR		#3-114	#3-131	#3-147	#3-159		#3- 62	#3-124	#3-136	#3-149	#3-157	
37'- 0"		91	193	319	443	7.149	4	407	554	739	918	4.399
STIR		#3-113	#3-131	#3-148	#3-161		#3- 59	#3-124	#3-137	#3-133	#3-160	
38'- 0"		55	151	271	388	7.953		354	494	669	839	4.894
STIR		#3-112	#3-131	#3-149	#3-163			#3-125	#3-138	#3-141	#3-163	
PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.48	1.48	1.74	1.97		1.48	1.74	1.97	2.41	4.34	
ACTUAL STEEL %	0.845	0.845	0.845	0.994	1.127		0.845	0.994	1.127	1.384	2.499	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.38		18.38	18.38	18.38	18.31	18.25	
$-I_{cr}/I_{gr}$	0.168	0.168	0.168	0.189	0.208		0.168	0.189	0.208	0.239	0.351	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	1.04	1.19	1.39	1.58		0.62	1.04	1.19	1.39	1.58	
ACTUAL STEEL %	0.337	0.567	0.647	0.760	0.865		0.337	0.567	0.647	0.760	0.865	
EFF. DEPTH, IN.	18.69	18.59	18.64	18.53	18.50		18.69	18.59	18.64	18.53	18.50	
$+I_{cr}/I_{gr}$	0.107	0.171	0.195	0.223	0.250		0.107	0.171	0.195	0.223	0.250	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 9″ Ribs @ 75″ c.-c. 16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span	# 4	# 4	# 5	# 5	# 6	Int. Span
AT	10	10	9	7.5	10	Defl. Coeff. (2)	10	7.5	10	8.5	6.5	Defl. Coeff. (2)
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.57	0.77	0.87	1.07	1.21		0.81	1.17	1.35	1.63	2.50	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	340	983	1156	1490	1764	1.743	780	1716	1968	2453	2851	1.073
STIR	#3- 67	#3-112	#3-111	#3-130	#4-136		#3- 79	#3-112	#3-117	#4-124	#4-121	
27'- 0"	270	866	1026	1336	1590	2.027	678	1545	1779	2229	2598	1.247
STIR	#3- 65	#3-114	#3-120	#3-133	#3-140		#3- 79	#3-115	#3-120	#4-127	#4-125	
28'- 0"	207	761	910	1198	1434	2.344	586	1393	1610	2028	2372	1.443
STIR	#3- 62	#3-115	#3-123	#3-136	#3-143		#3- 78	#3- 98	#3-122	#4-130	#4-127	
29'- 0"	150	667	806	1074	1294	2.698	504	1256	1458	1848	2168	1.660
STIR	#3- 60	#3-116	#3-124	#3-139	#3-146		#3- 78	#3-106	#3-124	#4-132	#4-133	
30'- 0"	99	582	712	962	1168	3.090	430	1132	1321	1686	1985	1.901
STIR	#3- 57	#3-117	#3-126	#3-125	#3-149		#3- 77	#3-113	#3-127	#3-136	#4-139	
31'- 0"	53	505	627	861	1054	3.523	362	1020	1198	1539	1819	2.168
STIR	#3- 53	#3-118	#3-127	#3-133	#3-152		#3- 76	#3-120	#3-128	#3-139	#4-144	
32'- 0"	11	435	549	770	950	4.000	301	919	1085	1406	1668	2.461
STIR	#3- 50	#3-118	#3-128	#3-142	#3-154		#3- 75	#3-122	#3-116	#3-142	#4-147	
33'- 0"		372	479	686	856	4.523	246	827	983	1284	1531	2.784
STIR		#3-119	#3-129	#3-145	#3-157		#3- 73	#3-123	#3-123	#3-144	#4-151	
34'- 0"		314	415	610	770	5.097	195	742	889	1173	1406	3.137
STIR		#3-119	#3-130	#3-147	#3-141		#3- 71	#3-125	#3-130	#3-146	#4-153	
35'- 0"		261	356	540	691	5.724	149	665	804	1072	1291	3.522
STIR		#3-119	#3-131	#3-148	#3-150		#3- 69	#3-126	#3-134	#3-148	#3-156	
36'- 0"		212	302	476	619	6.407	106	594	725	979	1186	3.942
STIR		#3-118	#3-131	#3-150	#3-158		#3- 67	#3-127	#3-136	#3-151	#3-159	
37'- 0"		167	252	417	552	7.149	67	529	653	893	1089	4.399
STIR		#3-118	#3-131	#3-151	#3-163		#3- 65	#3-128	#3-137	#3-153	#3-162	
38'- 0"		126	207	363	491	7.953	31	469	587	814	1000	4.894
STIR		#3-117	#3-131	#3-152	#3-165		#3- 62	#3-129	#3-139	#3-137	#3-164	
PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.50	1.50	1.67	2.00	2.33		1.50	2.00	2.33	2.74	5.08	
ACTUAL STEEL %	0.775	0.775	0.861	1.034	1.206		0.775	1.034	1.206	1.419	2.644	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.31		18.38	18.38	18.31	18.31	18.25	
$-I_{cr}/I_{gr}$	0.160	0.160	0.173	0.199	0.221		0.160	0.199	0.221	0.248	0.371	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.349	0.588	0.652	0.785	0.891		0.349	0.588	0.652	0.785	0.891	
EFF. DEPTH, IN.	18.72	18.64	18.62	18.50	18.46		18.72	18.64	18.62	18.50	18.46	
$+I_{cr}/I_{gr}$	0.112	0.180	0.198	0.230	0.257		0.112	0.180	0.198	0.230	0.257	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 6″ Ribs @ 72″ c.-c. 20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4				End Span	# 4	# 4				Int. Span
AT	10	10				Defl. Coeff. (2)	10	8				Defl. Coeff. (2)
BOTTOM BARS NO	1# 5	1# 6					1# 5	1# 6				
BARS NO	1# 5	1# 7					1# 5	1# 7				
STEEL (PSF)	0.54	0.75					0.79	1.11				
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	288	878				2.344	690	1548				1.443
STIR	#3- 81	#3-122					#3- 91	#3-124				
29'- 0"	228	778				2.698	603	1403				1.660
STIR	#3- 80	#3-128					#3- 92	#3-127				
30'- 0"	174	688				3.090	524	1272				1.901
STIR	#3- 78	#3-130					#3- 92	#3-130				
31'- 0"	125	606				3.523	453	1153				2.168
STIR	#3- 76	#3-132					#3- 92	#3-132				
32'- 0"	81	532				4.000	389	1045				2.461
STIR	#3- 74	#3-133					#3- 92	#3-134				
33'- 0"	40	465				4.523	330	947				2.784
STIR	#3- 72	#3-135					#3- 91	#3-117				
34'- 0"	3	403				5.097	276	858				3.137
STIR	#3- 69	#3-136					#3- 90	#3-124				
35'- 0"		347				5.724	227	776				3.522
STIR		#3-137					#3- 90	#3-131				
36'- 0"		295				6.407	182	701				3.942
STIR		#3-137					#3- 89	#3-139				
37'- 0"		247				7.149	140	631				4.399
STIR		#3-138					#3- 87	#3-142				
38'- 0"		204				7.953	102	568				4.894
STIR		#3-138					#3- 86	#3-143				
39'- 0"		163				8.824	66	509				5.430
STIR		#3-139					#3- 84	#3-145				
40'- 0"		126				9.765	34	454				6.009
STIR		#3-139					#3- 82	#3-146				
PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.44	1.44					1.44	1.80				
ACTUAL STEEL %	0.818	0.818					0.818	1.023				
EFF. DEPTH, IN.	22.38	22.38					22.38	22.38				
$-I_{cr}/I_{gr}$	0.170	0.170					0.170	0.201				
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.62	1.04					0.62	1.04				
ACTUAL STEEL %	0.334	0.561					0.334	0.561				
EFF. DEPTH, IN.	22.69	22.59					22.69	22.59				
$+I_{cr}/I_{gr}$	0.113	0.182					0.113	0.182				
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	8.5	7.5	10		10	7	9.5	8	6.5	
BOTTOM BARS NO	2# 4	1# 7	1# 7	1# 8	1# 8		2# 4	1# 7	1# 7	1# 8	1# 8	
BARS NO	1# 5	1# 7	1# 8	1# 8	1# 9		1# 5	1# 7	1# 8	1# 8	1# 9	
STEEL (PSF)	0.58	0.83	0.95	1.09	1.23		0.82	1.28	1.46	1.71	2.52	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
30'- 0" (3)	256	852	1082	1311	1563	3.090	658	1524	1859	2192	2558	1.901
STIR	#3- 80	#3-132	#3-144	#3-152	#4-159		#3- 93	#3-131	#3-138	#4-143	#4-143	
31'- 0"	200	758	973	1188	1423	3.523	576	1388	1701	2013	2356	2.168
STIR	#3- 79	#3-134	#3-127	#3-155	#4-162		#3- 93	#3-133	#3-140	#4-146	#4-146	
32'- 0"	149	673	875	1076	1297	4.000	502	1264	1557	1851	2172	2.461
STIR	#3- 77	#3-135	#3-135	#3-158	#3-166		#3- 93	#3-136	#3-143	#4-149	#4-150	
33'- 0"	103	595	785	974	1182	4.523	435	1151	1427	1703	2005	2.784
STIR	#3- 74	#3-136	#3-144	#3-160	#3-168		#3- 93	#3-115	#3-146	#4-152	#4-152	
34'- 0"	60	524	703	882	1077	5.097	373	1048	1308	1568	1853	3.137
STIR	#3- 72	#3-138	#3-151	#3-163	#3-172		#3- 92	#3-122	#3-149	#4-156	#4-156	
35'- 0"	22	459	628	797	981	5.724	317	953	1199	1444	1713	3.522
STIR	#3- 69	#3-139	#3-153	#3-143	#3-175		#3- 92	#3-129	#3-151	#3-159	#4-162	
36'- 0"		400	559	718	893	6.407	265	867	1099	1330	1585	3.942
STIR		#3-140	#3-154	#3-151	#3-177		#3- 91	#3-136	#3-154	#3-162	#4-168	
37'- 0"		345	496	647	812	7.149	217	787	1007	1226	1467	4.399
STIR		#3-140	#3-156	#3-159	#3-180		#3- 90	#3-143	#3-156	#3-165	#4-172	
38'- 0"		294	438	581	737	7.953	174	714	922	1130	1358	4.894
STIR		#3-141	#3-157	#3-168	#3-182		#3- 88	#3-145	#3-159	#3-168	#4-175	
39'- 0"		248	384	519	668	8.824	133	646	843	1041	1257	5.430
STIR		#3-141	#3-159	#3-172	#3-185		#3- 87	#3-146	#3-138	#3-170	#4-177	
40'- 0"		204	334	463	604	9.765	95	583	771	958	1164	6.009
STIR		#3-142	#3-160	#3-174	#3-164		#3- 85	#3-148	#3-145	#3-172	#3-181	
41'- 0"		164	287	410	545	10.778	61	524	703	882	1078	6.633
STIR		#3-142	#3-161	#3-175	#3-173		#3- 83	#3-149	#3-152	#3-174	#3-184	
42'- 0"		127	244	361	490	11.869	28	470	641	811	998	7.304
STIR		#3-141	#3-161	#3-177	#3-181		#3- 81	#3-150	#3-160	#3-177	#3-186	
PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.46	1.46	1.72	1.95	2.26		1.46	2.09	2.38	2.83	4.94	
ACTUAL STEEL %	0.736	0.736	0.866	0.981	1.145		0.736	1.052	1.205	1.431	2.508	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.38	22.31		22.38	22.38	22.31	22.31	22.25	
$-I_{cr}/I_{gr}$	0.160	0.160	0.181	0.199	0.221		0.160	0.209	0.229	0.259	0.372	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.20	1.39	1.58	1.79		0.71	1.20	1.39	1.58	1.79	
ACTUAL STEEL %	0.340	0.578	0.670	0.763	0.865		0.340	0.578	0.670	0.763	0.865	
EFF. DEPTH, IN.	22.72	22.56	22.53	22.50	22.46		22.72	22.56	22.53	22.50	22.46	
$+I_{cr}/I_{gr}$	0.116	0.187	0.213	0.239	0.268		0.116	0.187	0.213	0.239	0.268	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 8″ Ribs @ 74″ c.-c. 20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	9	8	10	9		10	10	9	7.5	6	
BOTTOM BARS NO	1# 4	2# 6	2# 6	1# 8	1# 9		1# 4	2# 6	2# 6	1# 8	1# 9	
BARS NO	2# 5	1# 6	1# 7	1# 9	1# 9		2# 5	1# 6	1# 7	1# 9	1# 9	
STEEL (PSF)	0.60	0.88	1.00	1.22	1.38		0.84	1.36	1.53	1.85	2.77	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
30'- 0" (3)	361	973	1167	1532	1783	3.090	824	1714	1996	2528	2893	1.901
STIR	#3- 85	#3-131	#3-124	#3-153	#4-159		#3- 96	#3-130	#4-136	#4-143	#5-143	
31'- 0"	296	869	1051	1393	1628	3.523	730	1564	1828	2326	2668	2.168
STIR	#3- 83	#3-133	#3-132	#3-156	#4-162		#3- 97	#3-133	#3-139	#4-147	#4-147	
32'- 0"	238	775	946	1267	1488	4.000	645	1427	1675	2142	2463	2.461
STIR	#3- 82	#3-134	#3-141	#3-158	#4-165		#3- 97	#3-135	#3-141	#4-150	#4-151	
33'- 0"	184	690	850	1152	1360	4.523	567	1302	1536	1975	2277	2.784
STIR	#3- 80	#3-136	#3-145	#3-162	#4-169		#3- 97	#3-115	#3-144	#4-153	#4-153	
34'- 0"	135	612	763	1047	1243	5.097	496	1189	1409	1822	2107	3.137
STIR	#3- 77	#3-137	#3-147	#3-164	#3-172		#3- 96	#3-122	#3-146	#4-156	#4-157	
35'- 0"	91	540	683	951	1136	5.724	431	1085	1292	1683	1951	3.522
STIR	#3- 75	#3-138	#3-149	#3-167	#3-175		#3- 96	#3-130	#3-149	#4-160	#4-162	
36'- 0"	50	474	609	863	1037	6.407	371	989	1185	1554	1808	3.942
STIR	#3- 72	#3-139	#3-150	#3-148	#3-178		#3- 95	#3-137	#3-151	#4-162	#4-168	
37'- 0"	12	414	542	782	947	7.149	316	901	1087	1436	1676	4.399
STIR	#3- 69	#3-139	#3-152	#3-157	#3-181		#3- 94	#3-143	#3-153	#4-165	#4-172	
38'- 0"		358	479	707	863	7.953	266	820	996	1328	1555	4.894
STIR		#3-140	#3-153	#3-165	#3-183		#3- 93	#3-144	#3-136	#3-168	#4-175	
39'- 0"		307	422	638	786	8.824	219	745	913	1227	1443	5.430
STIR		#3-140	#3-154	#3-174	#3-185		#3- 92	#3-146	#3-144	#3-171	#4-177	
40'- 0"		259	368	574	715	9.765	176	676	835	1134	1339	6.009
STIR		#3-140	#3-155	#3-175	#3-188		#3- 91	#3-147	#3-151	#3-173	#4-181	
41'- 0"		215	319	514	649	10.778	136	612	763	1048	1243	6.633
STIR		#3-140	#3-155	#3-177	#3-172		#3- 89	#3-149	#3-159	#3-175	#4-183	
42'- 0"		174	273	459	587	11.869	98	552	696	967	1154	7.304
STIR		#3-140	#3-156	#3-179	#3-181		#3- 87	#3-150	#3-161	#3-178	#4-186	
PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.64	1.85	2.29	2.55		1.48	2.29	2.55	3.06	5.43	
ACTUAL STEEL %	0.671	0.745	0.838	1.043	1.159		0.671	1.043	1.159	1.390	2.475	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.31	22.31		22.38	22.31	22.31	22.31	22.25	
$-I_{cr}/I_{gr}$	0.152	0.165	0.180	0.210	0.227		0.152	0.210	0.227	0.259	0.378	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.82	1.32	1.48	1.79	2.00		0.82	1.32	1.48	1.79	2.00	
ACTUAL STEEL %	0.354	0.572	0.642	0.780	0.873		0.354	0.572	0.642	0.780	0.873	
EFF. DEPTH, IN.	22.70	22.62	22.60	22.46	22.44		22.70	22.62	22.60	22.46	22.44	
$+I_{cr}/I_{gr}$	0.121	0.187	0.208	0.244	0.270		0.121	0.187	0.208	0.244	0.270	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 9″ Ribs @ 75″ c.-c. 20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	9	7.5	9.5	8.5		10	10	8.5	9.5	7.5	
BOTTOM BARS NO	1# 6	1# 7	1# 6	2# 7	1# 7		1# 6	1# 7	1# 6	2# 7	1# 7	
BARS NO	1# 6	1# 8	2# 7	1# 8	2# 8		1# 6	1# 8	2# 7	1# 8	2# 8	
STEEL (PSF)	0.66	0.91	1.05	1.31	1.41		0.90	1.40	1.61	2.06	2.93	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
30'- 0" (3)	401	1021	1330	1752	1980	3.090	896	1798	2248	2862	3193	1.901
STIR	#3- 81	#3-127	#3-124	#4-153	#4-158		#3- 94	#3-127	#4-136	#4-144	#5-143	
31'- 0"	332	912	1202	1597	1811	3.523	796	1640	2062	2636	2947	2.168
STIR	#3- 79	#3-129	#3-132	#4-157	#4-162		#3- 94	#3-107	#4-139	#4-148	#5-146	
32'- 0"	269	814	1086	1456	1657	4.000	704	1497	1892	2432	2723	2.461
STIR	#3- 77	#3-130	#3-140	#3-160	#4-165		#3- 94	#3-114	#4-142	#4-151	#5-150	
33'- 0"	212	724	980	1328	1517	4.523	621	1366	1738	2245	2519	2.784
STIR	#3- 75	#3-131	#3-146	#3-162	#4-168		#3- 93	#3-121	#3-145	#4-154	#5-152	
34'- 0"	160	642	883	1211	1389	5.097	545	1247	1598	2075	2333	3.137
STIR	#3- 73	#3-132	#3-148	#3-165	#4-172		#3- 93	#3-128	#3-147	#4-157	#4-156	
35'- 0"	112	567	794	1104	1272	5.724	476	1138	1469	1920	2163	3.522
STIR	#3- 70	#3-132	#3-149	#3-168	#3-174		#3- 92	#3-136	#3-149	#4-160	#4-162	
36'- 0"	68	498	713	1006	1164	6.407	412	1038	1351	1777	2007	3.942
STIR	#3- 67	#3-133	#3-151	#3-171	#3-177		#3- 91	#3-137	#3-151	#4-164	#4-168	
37'- 0"	28	435	638	916	1066	7.149	353	946	1242	1645	1863	4.399
STIR	#3- 63	#3-133	#3-152	#3-155	#3-180		#3- 90	#3-139	#3-154	#4-166	#4-171	
38'- 0"		377	569	832	975	7.953	299	861	1142	1524	1731	4.894
STIR		#3-133	#3-153	#3-163	#3-182		#3- 89	#3-140	#3-136	#4-169	#4-174	
39'- 0"		323	506	755	890	8.824	249	782	1049	1412	1608	5.430
STIR		#3-133	#3-154	#3-172	#3-185		#3- 88	#3-141	#3-143	#4-172	#4-178	
40'- 0"		273	447	684	812	9.765	203	710	963	1308	1495	6.009
STIR		#3-133	#3-155	#3-177	#3-165		#3- 86	#3-142	#3-150	#4-174	#4-180	
41'- 0"		226	392	618	740	10.778	160	642	883	1212	1390	6.633
STIR		#3-133	#3-156	#3-178	#3-174		#3- 84	#3-143	#3-158	#3-176	#4-183	
42'- 0"		183	341	556	673	11.869	120	580	809	1123	1292	7.304
STIR		#3-132	#3-157	#3-180	#3-182		#3- 82	#3-144	#3-161	#3-179	#4-186	
PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.50	1.67	2.00	2.45	2.74		1.50	2.33	2.74	3.47	6.00	
ACTUAL STEEL %	0.617	0.686	0.823	1.010	1.129		0.617	0.960	1.129	1.438	2.493	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.31	22.31		22.38	22.31	22.31	22.25	22.19	
$-I_{cr}/I_{gr}$	0.145	0.157	0.181	0.210	0.228		0.145	0.202	0.228	0.269	0.384	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.88	1.39	1.64	1.99	2.18		0.88	1.39	1.64	1.99	2.18	
ACTUAL STEEL %	0.347	0.551	0.648	0.788	0.864		0.347	0.551	0.648	0.788	0.864	
EFF. DEPTH, IN.	22.62	22.53	22.58	22.54	22.52		22.62	22.53	22.58	22.54	22.52	
$+I_{cr}/I_{gr}$	0.118	0.180	0.211	0.250	0.272		0.118	0.180	0.211	0.250	0.272	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 5	# 5		End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6		Int. Span Defl. Coeff. (2)
AT	10	8.5	10	9			10	10	7.5	6		
BOTTOM BARS NO	1# 6	1# 7	1# 8	1# 9			1# 6	1# 7	1# 8	1# 9		
BARS NO	1# 6	1# 8	1# 9	1# 9			1# 6	1# 8	1# 9	1# 9		
STEEL (PSF)	0.67	0.95	1.23	1.40			0.91	1.42	1.86	2.78		
CLEAR SPAN	END SPAN						INTERIOR SPAN					
35'- 0" (3)	262	799	1217	1436		5.724	690	1472	2080	2398		3.522
STIR	#3- 96	#3-149	#3-172	#4-179			#3-110	#3-149	#4-163	#4-168		
36'- 0"	210	718	1113	1320		6.407	615	1354	1929	2229		3.942
STIR	#3- 95	#3-151	#3-175	#3-183			#3-111	#3-152	#4-166	#4-171		
37'- 0"	163	644	1018	1213		7.149	546	1246	1790	2074		4.399
STIR	#3- 93	#3-152	#3-177	#3-186			#3-111	#3-129	#4-170	#4-174		
38'- 0"	119	575	929	1115		7.953	482	1146	1662	1931		4.894
STIR	#3- 91	#3-153	#3-154	#3-189			#3-111	#3-136	#4-172	#4-178		
39'- 0"	78	511	848	1024		8.824	424	1053	1543	1799		5.430
STIR	#3- 89	#3-154	#3-162	#3-191			#3-110	#3-143	#4-176	#4-182		
40'- 0"	41	452	772	940		9.765	369	968	1433	1676		6.009
STIR	#3- 86	#3-155	#3-170	#3-194			#3-110	#3-150	#4-178	#4-185		
41'- 0"	6	398	702	862		10.778	318	888	1331	1563		6.633
STIR	#3- 83	#3-156	#3-179	#3-197			#3-109	#3-158	#3-180	#4-188		
42'- 0"		347	637	789		11.869	271	814	1237	1457		7.304
STIR		#3-157	#3-187	#3-199			#3-108	#3-161	#3-183	#4-191		
43'- 0"		300	577	721		13.040	228	746	1148	1359		8.025
STIR		#3-157	#3-188	#3-177			#3-107	#3-163	#3-186	#4-193		
44'- 0"		256	520	658		14.296	187	681	1066	1267		8.798
STIR		#3-157	#3-190	#3-185			#3-106	#3-164	#3-188	#4-197		
45'- 0"		214	467	599		15.641	149	622	989	1182		9.625
STIR		#3-158	#3-192	#3-193			#3-105	#3-165	#3-190	#4-200		
46'- 0"		176	418	544		17.078	113	566	918	1101		10.510
STIR		#3-158	#3-193	#3-202			#3-103	#3-167	#3-193	#4-202		
47'- 0"		140	372	493		18.613	79	513	850	1026		11.454
STIR		#3-157	#3-195	#3-208			#3-102	#3-168	#3-195	#3-205		
PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.46	1.72	2.26	2.51			1.46	2.26	3.02	5.35		
ACTUAL STEEL %	0.602	0.708	0.936	1.040			0.602	0.936	1.247	2.220		
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31			26.38	26.31	26.31	26.25		
$-I_{cr}/I_{gr}$	0.146	0.166	0.203	0.220			0.146	0.203	0.251	0.369		
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.88	1.39	1.79	2.00			0.88	1.39	1.79	2.00		
ACTUAL STEEL %	0.347	0.549	0.709	0.792			0.347	0.549	0.709	0.792		
EFF. DEPTH, IN.	26.62	26.53	26.46	26.44			26.62	26.53	26.46	26.44		
$+I_{cr}/I_{gr}$	0.124	0.190	0.238	0.263			0.124	0.190	0.238	0.263		
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

66″ Forms + 8″ Ribs @ 74″ c.-c.
24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span	# 4	# 5	# 5	# 6	# 7	Int. Span
AT	10	7.5	10	8	7	Defl. Coeff. (2)	10	8.5	7.5	6	6	Defl. Coeff. (2)
BOTTOM BARS NO	2# 5	1# 8	1# 8	1# 9	1#10		2# 5	1# 8	1# 8	1# 9	1#10	
BARS NO	1# 5	1# 8	1# 9	1#10	1#10		1# 5	1# 8	1# 9	1#10	1#10	
STEEL (PSF)	0.66	1.08	1.22	1.54	1.76		0.90	1.64	1.85	2.88	3.67	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
35'- 0"(3)	282	963	1182	1680	1958	5.724	736	1727	2045	2769	3174	3.522
STIR	#3- 89	#3-151	#3-145	#4-181	#4-187		#3-106	#3-151	#4-158	#5-169	#5-174	
36'- 0"	227	871	1078	1548	1812	6.407	656	1593	1894	2578	2961	3.942
STIR	#3- 87	#3-153	#3-153	#4-185	#4-191		#3-106	#3-153	#4-161	#5-173	#5-168	
37'- 0"	177	786	982	1428	1677	7.149	583	1470	1755	2402	2765	4.399
STIR	#3- 85	#3-153	#3-162	#4-187	#4-195		#3-105	#3-155	#4-163	#5-176	#5-171	
38'- 0"	131	708	894	1316	1552	7.953	516	1356	1626	2240	2584	4.894
STIR	#3- 83	#3-156	#3-169	#4-190	#4-198		#3-105	#3-133	#4-166	#4-180	#5-174	
39'- 0"	88	636	812	1213	1438	8.824	453	1251	1508	2091	2417	5.430
STIR	#3- 80	#3-157	#3-170	#3-193	#4-202		#3-104	#3-140	#3-169	#4-183	#5-178	
40'- 0"	48	569	737	1118	1331	9.765	395	1154	1398	1952	2262	6.009
STIR	#3- 77	#3-158	#3-172	#3-196	#4-204		#3-104	#3-147	#3-171	#4-186	#5-180	
41'- 0"	11	507	667	1030	1233	10.778	342	1064	1296	1823	2119	6.633
STIR	#3- 74	#3-159	#3-174	#3-198	#4-208		#3-103	#3-154	#3-174	#4-189	#5-185	
42'- 0"		450	602	947	1141	11.869	292	980	1201	1704	1985	7.304
STIR		#3-160	#3-175	#3-201	#4-211		#3-101	#3-162	#3-175	#4-192	#5-190	
43'- 0"		396	541	871	1055	13.040	246	902	1113	1593	1861	8.025
STIR		#3-160	#3-176	#3-204	#4-214		#3-100	#3-165	#3-150	#4-195	#4-196	
44'- 0"		346	485	800	976	14.296	202	829	1031	1489	1745	8.798
STIR		#3-161	#3-178	#3-181	#3-216		#3- 99	#3-166	#3-157	#4-198	#4-202	
45'- 0"		299	432	733	901	15.641	162	761	954	1392	1637	9.625
STIR		#3-161	#3-179	#3-189	#3-220		#3- 97	#3-168	#3-164	#4-201	#4-208	
46'- 0"		256	382	671	832	17.078	124	698	882	1301	1536	10.510
STIR		#3-161	#3-180	#3-198	#3-222		#3- 95	#3-169	#3-172	#4-204	#4-212	
47'- 0"		215	336	612	767	18.613	89	638	815	1216	1441	11.454
STIR		#3-161	#3-180	#3-206	#3-224		#3- 93	#3-170	#3-179	#4-207	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.97	2.29	2.87	3.28		1.48	2.70	3.06	5.43	7.40	
ACTUAL STEEL %	0.550	0.734	0.855	1.069	1.222		0.550	1.006	1.140	2.029	2.775	
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31	26.31		26.38	26.31	26.31	26.25	26.19	
$-I_{cr}/I_{gr}$	0.139	0.174	0.194	0.229	0.253		0.139	0.219	0.241	0.356	0.430	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.58	1.79	2.27	2.54		0.93	1.58	1.79	2.27	2.54	
ACTUAL STEEL %	0.331	0.566	0.641	0.815	0.913		0.331	0.566	0.641	0.815	0.913	
EFF. DEPTH, IN.	26.69	26.50	26.46	26.40	26.36		26.69	26.50	26.46	26.40	26.36	
$+I_{cr}/I_{gr}$	0.121	0.195	0.218	0.270	0.299		0.121	0.195	0.218	0.270	0.299	

SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

66″ Forms + 9″ Ribs @ 75″ c.-c.
24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 5	# 5	# 6	End Span	# 4	# 5	# 5	# 6	# 6	Int. Span
AT	10	7.5	9.5	8	9	Defl. Coeff. (2)	9	8.5	7	8	4	Defl. Coeff. (2)
BOTTOM BARS NO	2# 4	1# 6	2# 7	2# 8	1# 8		2# 4	1# 6	2# 7	2# 8	1# 8	
BARS NO	2# 5	2# 7	1# 8	1# 8	2# 9		2# 5	2# 7	1# 8	1# 8	2# 9	
STEEL (PSF)	0.70	1.05	1.31	1.54	1.84		1.00	1.61	1.99	2.42	3.95	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
35'- 0" (3)	344	996	1363	1759	2193	5.724	842	1791	2324	2900	3532	3.522
STIR	#3- 89	#3-146	#3-143	#4-177	#5-188		#3-106	#3-147	#4-158	#5-167	#5-174	
36'- 0"	284	900	1247	1621	2032	6.407	755	1652	2156	2700	3297	3.942
STIR	#3- 87	#3-148	#3-151	#4-181	#4-191		#3-106	#3-126	#4-161	#5-171	#5-167	
37'- 0"	228	812	1140	1495	1883	7.149	674	1524	2001	2516	3081	4.399
STIR	#3- 85	#3-149	#3-159	#4-183	#4-194		#3-105	#3-133	#4-164	#5-173	#5-170	
38'- 0"	177	731	1042	1378	1746	7.953	600	1405	1858	2346	2882	4.894
STIR	#3- 83	#3-150	#3-168	#4-187	#4-199		#3-105	#3-140	#4-167	#4-177	#5-173	
39'- 0"	130	656	951	1270	1620	8.824	532	1296	1725	2189	2698	5.430
STIR	#3- 80	#3-151	#3-172	#3-189	#4-202		#3-104	#3-147	#4-169	#4-181	#5-177	
40'- 0"	87	586	867	1170	1503	9.765	468	1195	1603	2044	2528	6.009
STIR	#3- 77	#3-152	#3-174	#3-192	#4-205		#3-103	#3-155	#4-172	#4-183	#5-179	
41'- 0"	46	522	789	1078	1394	10.778	409	1101	1490	1909	2370	6.633
STIR	#3- 74	#3-152	#3-175	#3-195	#4-208		#3-102	#3-157	#3-175	#4-186	#5-185	
42'- 0"	9	462	716	991	1293	11.869	355	1014	1384	1784	2223	7.304
STIR	#3- 70	#3-152	#3-177	#3-173	#4-211		#3-101	#3-158	#3-176	#4-189	#5-191	
43'- 0"		406	649	911	1199	13.040	304	933	1286	1668	2086	8.025
STIR		#3-153	#3-178	#3-181	#4-214		#3-100	#3-160	#3-179	#4-192	#5-196	
44'- 0"		354	586	837	1111	14.296	256	857	1194	1559	1958	8.798
STIR		#3-153	#3-179	#3-190	#4-217		#3- 99	#3-161	#3-155	#4-194	#5-202	
45'- 0"		305	527	767	1029	15.641	212	786	1109	1457	1839	9.625
STIR		#3-153	#3-181	#3-198	#4-220		#3- 97	#3-162	#3-162	#4-197	#5-208	
46'- 0"		260	472	701	953	17.078	171	720	1029	1362	1728	10.510
STIR		#3-152	#3-182	#3-203	#4-222		#3- 95	#3-163	#3-169	#4-200	#4-212	
47'- 0"		217	421	640	881	18.613	132	658	954	1273	1623	11.454
STIR		#3-152	#3-183	#3-205	#3-225		#3- 93	#3-164	#3-177	#4-203	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.67 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.50	2.00	2.45	2.91	3.67		1.67	2.74	3.32	4.12	8.25	
ACTUAL STEEL %	0.508	0.677	0.831	0.987	1.249		0.564	0.929	1.128	1.405	2.809	
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31	26.25		26.38	26.31	26.31	26.25	26.25	
$-I_{cr}/I_{gr}$	0.132	0.167	0.194	0.221	0.260		0.144	0.211	0.243	0.283	0.446	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.37	2.79		1.02	1.64	1.99	2.37	2.79	
ACTUAL STEEL %	0.331	0.535	0.650	0.775	0.913		0.331	0.535	0.650	0.775	0.913	
EFF. DEPTH, IN.	26.71	26.58	26.54	26.50	26.45		26.71	26.58	26.54	26.50	26.45	
$+I_{cr}/I_{gr}$	0.122	0.188	0.224	0.262	0.303		0.122	0.188	0.224	0.262	0.303	

SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 11″ Deep Rib + 5.0″ Top Slab = 16.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	10	9	7.5	10		10	7.5	10	8	7	
BOTTOM BARS NO	1# 4	1# 5	1# 6	1# 6	1# 5		1# 4	1# 5	1# 6	1# 6	1# 5	
BARS NO	1# 5	1# 6	1# 6	1# 7	2# 6		1# 5	1# 6	1# 6	1# 7	2# 6	
STEEL (PSF)	0.60	0.78	0.92	1.08	1.20		0.84	1.18	1.41	1.70	1.90	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	211	506	665	858	1046	1.265	503	931	1162	1442	1716	0.779
STIR	#3- 49	#3- 86	#3- 98	#3-106	#3-118		#3- 64	#3- 90	#3- 85	#3-107	#3-112	
25'- 0"	161	433	579	757	930	1.490	430	825	1037	1296	1548	0.917
STIR	#3- 46	#3- 86	#3- 99	#3-110	#3-121		#3- 63	#3- 91	#3- 92	#3-110	#3-115	
26'- 0"	117	368	503	667	827	1.743	365	730	926	1166	1399	1.073
STIR	#3- 43	#3- 86	#3-100	#3-112	#3-108		#3- 62	#3- 92	#3-100	#3-112	#3-118	
27'- 0"	77	310	435	587	736	2.027	307	646	828	1050	1266	1.247
STIR	#3- 39	#3- 86	#3-100	#3-113	#3-116		#3- 61	#3- 93	#3-103	#3-115	#3-121	
28'- 0"	41	258	374	516	654	2.344	255	570	740	946	1147	1.443
STIR	#3- 34	#3- 85	#3-101	#3-115	#3-125		#3- 59	#3- 94	#3-105	#3-116	#3-123	
29'- 0"	10	211	320	452	581	2.698	209	503	660	853	1040	1.660
STIR	#3- 30	#3- 84	#3-101	#3-116	#3-127		#3- 57	#3- 94	#3-106	#3-106	#3-126	
30'- 0"		169	271	394	515	3.090	167	442	589	769	944	1.901
STIR		#3- 82	#3-101	#3-117	#3-129		#3- 55	#3- 95	#3-107	#3-113	#3-129	
31'- 0"		131	226	342	455	3.523	129	386	524	693	857	2.168
STIR		#3- 81	#3-100	#3-117	#3-130		#3- 52	#3- 95	#3-108	#3-120	#3-131	
32'- 0"		97	186	295	400	4.000	95	336	466	624	777	2.461
STIR		#3- 79	#3-100	#3-118	#3-132		#3- 49	#3- 95	#3-109	#3-122	#3-133	
33'- 0"		65	149	251	351	4.523	64	290	412	561	705	2.784
STIR		#3- 77	#3- 99	#3-118	#3-133		#3- 46	#3- 94	#3-110	#3-123	#3-135	
34'- 0"		37	116	212	306	5.097	35	249	363	503	640	3.137
STIR		#3- 74	#3- 98	#3-118	#3-134		#3- 43	#3- 94	#3-111	#3-125	#3-126	
35'- 0"		11	85	176	264	5.724	9	210	319	451	579	3.522
STIR		#3- 71	#3- 96	#3-118	#3-135		#3- 39	#3- 93	#3-111	#3-126	#3-134	
36'- 0"			57	143	226	6.407		175	278	403	524	3.942
STIR			#3- 95	#3-118	#3-135			#3- 93	#3-111	#3-127	#3-138	
PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.96	0.96	1.07	1.28	1.49		0.96	1.28	1.49	1.86	2.13	
ACTUAL STEEL %	0.726	0.726	0.807	0.968	1.131		0.726	0.968	1.131	1.414	1.616	
EFF. DEPTH, IN.	14.38	14.38	14.38	14.38	14.31		14.38	14.38	14.31	14.31	14.31	
$-I_{cr}/I_{gr}$	0.151	0.151	0.164	0.189	0.209		0.151	0.189	0.209	0.246	0.270	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.75	0.88	1.04	1.19		0.51	0.75	0.88	1.04	1.19	
ACTUAL STEEL %	0.364	0.537	0.631	0.748	0.853		0.364	0.537	0.631	0.748	0.853	
EFF. DEPTH, IN.	14.71	14.65	14.62	14.59	14.64		14.71	14.65	14.62	14.59	14.64	
$+I_{cr}/I_{gr}$	0.115	0.164	0.189	0.218	0.248		0.115	0.164	0.189	0.218	0.248	
SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 11″ Deep Rib + 5.0″ Top Slab = 16.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	7.5	10	9		10	7	8.5	7.5	9	
BOTTOM BARS NO	1# 4	1# 4	2# 4	1# 5	2# 6		1# 4	1# 4	2# 4	1# 5	2# 6	
BARS NO	1# 5	2# 5	2# 5	2# 6	1# 6		1# 5	2# 5	2# 5	2# 6	1# 6	
STEEL (PSF)	0.60	0.79	1.03	1.18	1.34		0.84	1.23	1.59	1.81	2.12	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	191	576	824	1025	1182	1.265	482	1042	1402	1696	1924	0.779
STIR	#3- 36	#3- 85	#3-101	#3-102	#3-118		#3- 56	#3- 89	#3-102	#3-108	#3-112	
25'- 0"	141	495	724	910	1054	1.490	409	925	1257	1528	1738	0.917
STIR	#3- 32	#3- 85	#3-102	#3-110	#3-120		#3- 54	#3- 90	#3-104	#3-111	#3-116	
26'- 0"	96	424	635	807	941	1.743	344	821	1128	1379	1573	1.073
STIR	#3- 28	#3- 85	#3-104	#3-114	#3-108		#3- 52	#3- 91	#3- 95	#3-113	#3-118	
27'- 0"	56	361	556	716	840	2.027	287	729	1014	1246	1426	1.247
STIR	#3- 23	#3- 84	#3-104	#3-116	#3-116		#3- 50	#3- 92	#3-103	#3-116	#3-121	
28'- 0"	21	304	486	634	749	2.344	235	646	911	1127	1294	1.443
STIR	#3- 17	#3- 84	#3-105	#3-118	#3-125		#3- 47	#3- 93	#3-108	#3-118	#3-124	
29'- 0"		253	422	561	668	2.698	188	572	819	1020	1176	1.660
STIR		#3- 82	#3-105	#3-119	#3-127		#3- 44	#3- 93	#3-110	#3-120	#3-126	
30'- 0"		207	365	494	595	3.090	147	505	736	924	1069	1.901
STIR		#3- 81	#3-106	#3-120	#3-129		#3- 41	#3- 94	#3-111	#3-109	#3-128	
31'- 0"		165	313	434	528	3.523	109	444	660	836	973	2.168
STIR		#3- 79	#3-106	#3-121	#3-130		#3- 38	#3- 94	#3-112	#3-117	#3-131	
32'- 0"		127	266	380	468	4.000	74	389	592	757	885	2.461
STIR		#3- 77	#3-105	#3-122	#3-131		#3- 34	#3- 94	#3-113	#3-124	#3-133	
33'- 0"		93	224	330	413	4.523	43	339	530	685	806	2.784
STIR		#3- 75	#3-105	#3-122	#3-133		#3- 30	#3- 93	#3-114	#3-126	#3-135	
34'- 0"		61	185	285	363	5.097	15	293	473	619	733	3.137
STIR		#3- 72	#3-104	#3-123	#3-134		#3- 25	#3- 93	#3-115	#3-127	#3-126	
35'- 0"		32	149	244	318	5.724		252	421	559	666	3.522
STIR		#3- 70	#3-103	#3-123	#3-134			#3- 92	#3-116	#3-129	#3-134	
36'- 0"		6	116	206	275	6.407		213	373	504	605	3.942
STIR		#3- 66	#3-102	#3-123	#3-135			#3- 91	#3-116	#3-130	#3-139	
PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.98	0.98	1.31	1.52	1.69		0.98	1.40	1.79	2.03	2.40	
ACTUAL STEEL %	0.669	0.669	0.891	1.041	1.157		0.669	0.955	1.225	1.388	1.650	
EFF. DEPTH, IN.	14.38	14.38	14.38	14.31	14.31		14.38	14.38	14.31	14.31	14.25	
$-I_{cr}/I_{gr}$	0.145	0.145	0.182	0.201	0.218		0.145	0.191	0.227	0.248	0.277	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.82	1.02	1.19	1.32		0.51	0.82	1.02	1.19	1.32	
ACTUAL STEEL %	0.329	0.530	0.659	0.772	0.857		0.329	0.530	0.659	0.772	0.857	
EFF. DEPTH, IN.	14.71	14.70	14.71	14.64	14.62		14.71	14.70	14.71	14.64	14.62	
$+I_{cr}/I_{gr}$	0.106	0.165	0.201	0.229	0.251		0.106	0.165	0.201	0.229	0.251	
SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 11″ Deep Rib + 5.0″ Top Slab = 16.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	9	7.5	10	8		10	10	8.5	7	6	
BOTTOM BARS NO	2# 4	2# 5	2# 5	2# 5	2# 6		2# 4	2# 5	2# 5	2# 5	2# 6	
BARS NO	1# 4	1# 5	1# 6	2# 5	1# 7		1# 4	1# 5	1# 6	2# 5	1# 7	
STEEL (PSF)	0.64	0.89	1.06	1.25	1.50		0.88	1.38	1.62	1.95	2.28	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	285	690	848	1071	1353	1.265	628	1218	1447	1772	2182	0.779
STIR	#3- 45	#3- 88	#3- 97	#3-107	#3-119		#3- 62	#3- 91	#3- 86	#3-107	#4-113	
25'- 0"	225	599	745	950	1210	1.490	542	1085	1297	1596	1974	0.917
STIR	#3- 42	#3- 88	#3- 98	#3-109	#3-121		#3- 61	#3- 92	#3- 93	#3-109	#3-116	
26'- 0"	173	519	653	843	1083	1.743	465	968	1164	1440	1790	1.073
STIR	#3- 38	#3- 88	#3- 99	#3-111	#3-124		#3- 59	#3- 94	#3-101	#3-111	#3-118	
27'- 0"	126	447	571	748	970	2.027	397	863	1045	1301	1625	1.247
STIR	#3- 34	#3- 87	#3- 99	#3-112	#3-114		#3- 57	#3- 95	#3-103	#3-113	#3-122	
28'- 0"	84	382	498	662	869	2.344	336	770	939	1177	1478	1.443
STIR	#3- 29	#3- 87	#3-100	#3-114	#3-123		#3- 55	#3- 96	#3-104	#3-116	#3-124	
29'- 0"	47	324	433	585	779	2.698	282	686	843	1065	1346	1.660
STIR	#3- 24	#3- 86	#3-100	#3-115	#3-128		#3- 53	#3- 96	#3-106	#3-107	#3-127	
30'- 0"	13	272	373	516	697	3.090	232	610	757	965	1227	1.901
STIR	#3- 18	#3- 85	#3- 99	#3-116	#3-130		#3- 51	#3- 97	#3-107	#3-115	#3-129	
31'- 0"		225	320	454	623	3.523	188	541	679	874	1119	2.168
STIR		#3- 83	#3- 99	#3-116	#3-132		#3- 48	#3- 97	#3-108	#3-119	#3-132	
32'- 0"		182	271	397	555	4.000	147	479	608	791	1022	2.461
STIR		#3- 82	#3- 98	#3-117	#3-133		#3- 45	#3- 97	#3-109	#3-121	#3-134	
33'- 0"		143	227	345	494	4.523	110	422	544	716	933	2.784
STIR		#3- 80	#3- 97	#3-117	#3-134		#3- 41	#3- 97	#3-109	#3-122	#3-136	
34'- 0"		108	186	298	438	5.097	77	371	485	647	851	3.137
STIR		#3- 77	#3- 96	#3-117	#3-135		#3- 38	#3- 97	#3-110	#3-123	#3-124	
35'- 0"		75	149	254	387	5.724	46	323	431	584	777	3.522
STIR		#3- 75	#3- 95	#3-117	#3-136		#3- 34	#3- 96	#3-110	#3-125	#3-132	
36'- 0"		45	115	215	340	6.407	18	280	382	526	708	3.942
STIR		#3- 72	#3- 93	#3-116	#3-137		#3- 29	#3- 96	#3-110	#3-126	#3-139	
PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.00	1.11	1.33	1.55	1.94		1.00	1.55	1.82	2.21	2.58	
ACTUAL STEEL %	0.621	0.690	0.828	0.968	1.209		0.621	0.968	1.138	1.382	1.613	
EFF. DEPTH, IN.	14.38	14.38	14.38	14.31	14.31		14.38	14.31	14.31	14.31	14.31	
$-I_{cr}/I_{gr}$	0.140	0.152	0.175	0.195	0.230		0.140	0.195	0.220	0.253	0.282	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.93	1.06	1.24	1.48		0.60	0.93	1.06	1.24	1.48	
ACTUAL STEEL %	0.353	0.549	0.627	0.732	0.879		0.353	0.549	0.627	0.732	0.879	
EFF. DEPTH, IN.	14.75	14.69	14.66	14.69	14.60		14.75	14.69	14.66	14.69	14.60	
$+I_{cr}/I_{gr}$	0.116	0.171	0.192	0.222	0.257		0.116	0.171	0.192	0.222	0.257	
SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	9	7.5	10	8.5		10	10	8.5	7	5	
BOTTOM BARS NO	2# 4	1# 6	1# 6	1# 5	1# 7		2# 4	1# 6	1# 6	1# 5	1# 7	
BARS NO	1# 4	1# 6	1# 7	2# 6	1# 8		1# 4	1# 6	1# 7	2# 6	1# 8	
STEEL (PSF)	0.66	0.92	1.08	1.20	1.45		0.90	1.41	1.64	1.90	2.51	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	404	791	1011	1225	1489	1.265	793	1356	1677	1988	2373	0.779
STIR	#3- 65	#3- 97	#3-107	#3-117	#3-124		#3- 75	#3- 87	#3-106	#3-112	#4-116	
25'- 0"	336	693	896	1093	1337	1.490	696	1214	1510	1797	2151	0.917
STIR	#3- 63	#3- 97	#3-109	#3-119	#3-127		#3- 75	#3- 94	#3-109	#3-114	#4-120	
26'- 0"	277	606	794	977	1202	1.743	609	1089	1362	1627	1954	1.073
STIR	#3- 61	#3- 98	#3-111	#3-110	#3-130		#3- 75	#3-101	#3-112	#3-118	#4-123	
27'- 0"	223	529	703	872	1081	2.027	532	976	1230	1476	1779	1.247
STIR	#3- 59	#3- 99	#3-112	#3-118	#3-132		#3- 75	#3-102	#3-113	#3-120	#3-126	
28'- 0"	176	460	622	779	974	2.344	462	876	1112	1340	1623	1.443
STIR	#3- 56	#3- 99	#3-113	#3-124	#3-135		#3- 74	#3-104	#3-100	#3-123	#3-129	
29'- 0"	133	398	549	696	877	2.698	400	786	1006	1219	1482	1.660
STIR	#3- 53	#3- 99	#3-114	#3-126	#3-138		#3- 73	#3-105	#3-108	#3-125	#3-132	
30'- 0"	95	342	483	620	789	3.090	344	705	910	1109	1355	1.901
STIR	#3- 49	#3- 99	#3-115	#3-127	#3-126		#3- 72	#3-106	#3-115	#3-127	#3-135	
31'- 0"	60	292	424	552	711	3.523	294	631	823	1010	1240	2.168
STIR	#3- 45	#3- 98	#3-116	#3-129	#3-134		#3- 70	#3-107	#3-119	#3-129	#3-138	
32'- 0"	28	246	370	490	639	4.000	248	564	745	920	1136	2.461
STIR	#3- 41	#3- 97	#3-116	#3-130	#3-142		#3- 69	#3-108	#3-121	#3-132	#3-141	
33'- 0"		204	321	434	574	4.523	206	503	673	838	1041	2.784
STIR		#3- 96	#3-116	#3-131	#3-144		#3- 67	#3-108	#3-122	#3-121	#3-143	
34'- 0"		166	276	382	514	5.097	167	448	608	763	954	3.137
STIR		#3- 95	#3-116	#3-132	#3-146		#3- 65	#3-109	#3-123	#3-129	#3-145	
35'- 0"		131	235	335	459	5.724	132	397	548	694	875	3.522
STIR		#3- 93	#3-116	#3-133	#3-147		#3- 62	#3-109	#3-124	#3-135	#3-148	
36'- 0"		99	197	292	409	6.407	100	350	493	631	802	3.942
STIR		#3- 92	#3-115	#3-133	#3-149		#3- 60	#3-109	#3-125	#3-137	#3-150	
PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.96	1.07	1.28	1.49	1.75		0.96	1.49	1.75	2.13	2.98	
ACTUAL STEEL %	0.626	0.696	0.835	0.975	1.147		0.626	0.975	1.147	1.392	1.949	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.31	16.31		16.38	16.31	16.31	16.31	16.31	
$-I_{cr}/I_{gr}$	0.143	0.155	0.179	0.199	0.224		0.143	0.199	0.224	0.258	0.325	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.88	1.04	1.19	1.39		0.60	0.88	1.04	1.19	1.39	
ACTUAL STEEL %	0.370	0.546	0.646	0.737	0.867		0.370	0.546	0.646	0.737	0.867	
EFF. DEPTH, IN.	16.75	16.62	16.59	16.64	16.53		16.75	16.62	16.59	16.64	16.53	
$+I_{cr}/I_{gr}$	0.124	0.174	0.202	0.229	0.260		0.124	0.174	0.202	0.229	0.260	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	8	10	9	7.5		10	9	7.5	9.5	5	
BOTTOM BARS NO	2# 4	2# 4	1# 5	2# 6	1# 8		2# 4	2# 4	1# 5	2# 6	1# 8	
BARS NO	1# 4	2# 5	2# 6	1# 6	1# 8		1# 4	2# 5	2# 6	1# 6	1# 8	
STEEL (PSF)	0.65	1.01	1.18	1.34	1.64		0.89	1.54	1.81	2.06	3.31	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	254	757	954	1106	1398	1.743	586	1318	1604	1826	2251	1.073
STIR	#3- 48	#3-102	#3-113	#3-110	#3-131		#3- 66	#3- 97	#3-113	#3-117	#4-120	
27'- 0"	200	667	850	991	1262	2.027	509	1187	1453	1659	2053	1.247
STIR	#3- 45	#3-103	#3-115	#3-118	#3-134		#3- 65	#3-104	#3-115	#3-120	#4-126	
28'- 0"	153	587	757	888	1140	2.344	439	1071	1318	1509	1875	1.443
STIR	#3- 41	#3-103	#3-116	#3-124	#3-136		#3- 64	#3-107	#3-118	#3-123	#4-130	
29'- 0"	110	515	673	796	1030	2.698	377	966	1196	1374	1716	1.660
STIR	#3- 37	#3-104	#3-118	#3-126	#3-139		#3- 62	#3-108	#3-104	#3-126	#3-133	
30'- 0"	72	450	598	712	932	3.090	321	871	1086	1253	1572	1.901
STIR	#3- 32	#3-104	#3-119	#3-127	#3-142		#3- 60	#3-110	#3-111	#3-128	#3-137	
31'- 0"	37	391	529	637	842	3.523	270	785	987	1143	1442	2.168
STIR	#3- 27	#3-104	#3-119	#3-129	#3-131		#3- 58	#3-111	#3-119	#3-130	#3-139	
32'- 0"	5	337	467	568	761	4.000	224	708	897	1043	1324	2.461
STIR	#3- 22	#3-103	#3-120	#3-130	#3-140		#3- 55	#3-112	#3-123	#3-132	#3-142	
33'- 0"		289	411	506	687	4.523	183	637	815	953	1216	2.784
STIR		#3-103	#3-120	#3-131	#3-146		#3- 53	#3-113	#3-125	#3-121	#3-144	
34'- 0"		244	359	449	619	5.097	144	572	740	870	1118	3.137
STIR		#3-102	#3-121	#3-132	#3-148		#3- 50	#3-113	#3-126	#3-128	#3-147	
35'- 0"		204	312	396	558	5.724	109	513	671	794	1028	3.522
STIR		#3-101	#3-121	#3-133	#3-150		#3- 46	#3-114	#3-127	#3-136	#3-150	
36'- 0"		166	269	349	501	6.407	77	459	608	724	946	3.942
STIR		#3- 99	#3-121	#3-133	#3-151		#3- 43	#3-114	#3-128	#3-137	#3-151	
37'- 0"		132	229	305	449	7.149	48	409	550	660	870	4.399
STIR		#3- 98	#3-120	#3-133	#3-153		#3- 39	#3-115	#3-129	#3-139	#3-154	
38'- 0"		100	192	264	401	7.953	20	363	497	601	800	4.894
STIR		#3- 96	#3-120	#3-134	#3-154		#3- 35	#3-115	#3-130	#3-140	#3-156	
PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.98	1.23	1.52	1.69	2.03		0.98	1.69	2.03	2.27	4.31	
ACTUAL STEEL %	0.577	0.722	0.899	0.999	1.199		0.577	0.999	1.199	1.349	2.563	
EFF. DEPTH, IN.	16.38	16.38	16.31	16.31	16.31		16.38	16.31	16.31	16.25	16.25	
$-I_{cr}/I_{gr}$	0.137	0.163	0.191	0.207	0.237		0.137	0.207	0.237	0.255	0.393	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.60	1.02	1.19	1.32	1.58		0.60	1.02	1.19	1.32	1.58	
ACTUAL STEEL %	0.335	0.571	0.669	0.742	0.894		0.335	0.571	0.669	0.742	0.894	
EFF. DEPTH, IN.	16.75	16.71	16.64	16.62	16.50		16.75	16.71	16.64	16.62	16.50	
$+I_{cr}/I_{gr}$	0.114	0.186	0.212	0.232	0.268		0.114	0.186	0.212	0.232	0.268	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	8	10	8.5	7.5		8.5	9	7.5	6	7.5	
BOTTOM BARS NO	2# 4	1# 6	2# 5	2# 6	1# 6		2# 4	1# 6	2# 5	2# 6	1# 6	
BARS NO	1# 5	1# 7	2# 5	1# 7	2# 7		1# 5	1# 7	2# 5	1# 7	2# 7	
STEEL (PSF)	0.73	1.03	1.25	1.47	1.60		1.06	1.56	1.88	2.28	2.54	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	362	749	995	1270	1455	1.743	754	1316	1674	2075	2345	1.073
STIR	#3- 58	#3- 96	#3-110	#3-108	#3-129		#3- 73	#3- 99	#3-111	#3-118	#4-122	
27'- 0"	299	658	886	1141	1313	2.027	663	1184	1516	1888	2138	1.247
STIR	#3- 55	#3- 96	#3-111	#3-116	#3-131		#3- 72	#3-100	#3-113	#3-121	#4-125	
28'- 0"	243	576	789	1026	1186	2.344	581	1066	1375	1720	1953	1.443
STIR	#3- 52	#3- 96	#3-112	#3-125	#3-134		#3- 71	#3-102	#3-102	#3-124	#4-129	
29'- 0"	193	503	701	923	1072	2.698	508	960	1248	1569	1786	1.660
STIR	#3- 48	#3- 96	#3-113	#3-127	#3-121		#3- 70	#3-103	#3-109	#3-126	#3-131	
30'- 0"	147	438	622	829	969	3.090	442	864	1133	1434	1636	1.901
STIR	#3- 45	#3- 95	#3-114	#3-129	#3-129		#3- 69	#3-104	#3-116	#3-129	#3-134	
31'- 0"	106	378	551	745	875	3.523	382	778	1029	1311	1501	2.168
STIR	#3- 40	#3- 94	#3-115	#3-130	#3-138		#3- 67	#3-105	#3-118	#3-131	#3-137	
32'- 0"	69	324	486	668	791	4.000	328	699	935	1199	1378	2.461
STIR	#3- 36	#3- 93	#3-115	#3-132	#3-140		#3- 65	#3-105	#3-120	#3-133	#3-139	
33'- 0"	35	275	428	598	714	4.523	278	627	849	1098	1266	2.784
STIR	#3- 31	#3- 92	#3-115	#3-133	#3-142		#3- 63	#3-106	#3-121	#3-119	#3-141	
34'- 0"	4	230	374	535	643	5.097	233	562	771	1005	1163	3.137
STIR	#3- 26	#3- 91	#3-115	#3-134	#3-143		#3- 61	#3-106	#3-122	#3-126	#3-144	
35'- 0"		189	324	476	579	5.724	192	502	700	921	1069	3.522
STIR		#3- 89	#3-115	#3-135	#3-145		#3- 58	#3-106	#3-123	#3-134	#3-146	
36'- 0"		151	279	423	520	6.407	154	447	634	843	983	3.942
STIR		#3- 87	#3-114	#3-135	#3-146		#3- 55	#3-106	#3-124	#3-139	#3-149	
37'- 0"		116	238	374	465	7.149	119	397	573	771	904	4.399
STIR		#3- 85	#3-114	#3-136	#3-147		#3- 52	#3-106	#3-125	#3-140	#3-135	
38'- 0"		84	199	328	415	7.953	87	350	517	705	831	4.894
STIR		#3- 82	#3-113	#3-136	#3-148		#3- 49	#3-105	#3-125	#3-142	#3-142	
PROPERTIES FOR DESIGN (CONCRETE 0.67 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.00	1.25	1.55	1.82	2.07		1.18	1.72	2.07	2.58	2.93	
ACTUAL STEEL %	0.537	0.672	0.836	0.984	1.115		0.632	0.929	1.115	1.394	1.590	
EFF. DEPTH, IN.	16.38	16.38	16.31	16.31	16.31		16.38	16.31	16.31	16.31	16.25	
$-I_{cr}/I_{gr}$	0.132	0.157	0.185	0.209	0.229		0.150	0.200	0.229	0.270	0.292	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.71	1.04	1.24	1.48	1.64		0.71	1.04	1.24	1.48	1.64	
ACTUAL STEEL %	0.363	0.536	0.635	0.762	0.845		0.363	0.536	0.635	0.762	0.845	
EFF. DEPTH, IN.	16.72	16.59	16.69	16.60	16.58		16.72	16.59	16.69	16.60	16.58	
$+I_{cr}/I_{gr}$	0.124	0.173	0.206	0.238	0.260		0.124	0.173	0.206	0.238	0.260	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 8″ Ribs @ 48″ c.-c.
15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span	# 4	# 5	# 5	# 6	# 6	Int. Span
AT	10	7.5	10	8.5	7.5	Defl. Coeff. (2)	9.5	8.5	7.5	9	5	Defl. Coeff. (2)
BOTTOM BARS NO	1# 5	1# 6	1# 5	1# 7	1# 8		1# 5	1# 6	1# 5	1# 7	1# 8	
BARS NO	1# 5	1# 7	2# 6	1# 8	1# 8		1# 5	1# 7	2# 6	1# 8	1# 8	
STEEL (PSF)	0.70	1.08	1.20	1.45	1.67		0.96	1.64	1.83	2.21	3.33	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	247	728	904	1123	1336	2.344	577	1277	1533	1852	2162	1.443
STIR	#3- 57	#3-112	#3-123	#3-135	#3-142		#3- 75	#3-102	#3-121	#3-129	#4-129	
29'- 0"	197	646	810	1014	1213	2.698	505	1158	1396	1694	1983	1.660
STIR	#3- 54	#3-113	#3-124	#3-120	#3-145		#3- 74	#3-109	#3-124	#3-131	#4-135	
30'- 0"	153	572	725	916	1102	3.090	441	1050	1273	1551	1821	1.901
STIR	#3- 51	#3-113	#3-126	#3-128	#3-147		#3- 73	#3-116	#3-126	#3-134	#4-140	
31'- 0"	113	505	649	828	1001	3.523	382	953	1162	1422	1675	2.168
STIR	#3- 47	#3-114	#3-127	#3-137	#3-150		#3- 72	#3-118	#3-109	#3-137	#4-143	
32'- 0"	76	444	579	747	910	4.000	329	865	1061	1305	1542	2.461
STIR	#3- 43	#3-114	#3-128	#3-141	#3-153		#3- 70	#3-119	#3-116	#3-140	#3-146	
33'- 0"	43	389	516	674	827	4.523	281	785	969	1199	1422	2.784
STIR	#3- 38	#3-114	#3-129	#3-143	#3-137		#3- 68	#3-121	#3-124	#3-142	#3-149	
34'- 0"	13	339	458	607	751	5.097	237	711	885	1101	1311	3.137
STIR	#3- 34	#3-114	#3-130	#3-144	#3-145		#3- 66	#3-122	#3-131	#3-145	#3-152	
35'- 0"		293	405	546	682	5.724	196	644	808	1012	1211	3.522
STIR		#3-114	#3-130	#3-146	#3-154		#3- 64	#3-123	#3-134	#3-147	#3-155	
36'- 0"		250	357	490	618	6.407	159	582	737	930	1118	3.942
STIR		#3-113	#3-131	#3-147	#3-159		#3- 61	#3-124	#3-136	#3-149	#3-157	
37'- 0"		211	312	438	560	7.149	125	526	672	855	1033	4.399
STIR		#3-112	#3-131	#3-148	#3-161		#3- 59	#3-124	#3-137	#3-133	#3-160	
38'- 0"		175	271	390	506	7.953	94	474	613	786	954	4.894
STIR		#3-111	#3-131	#3-149	#3-163		#3- 55	#3-125	#3-138	#3-141	#3-162	
39'- 0"		142	233	346	456	8.824	65	425	557	722	881	5.430
STIR		#3-110	#3-131	#3-150	#3-164		#3- 52	#3-125	#3-139	#3-148	#3-164	
40'- 0"		111	198	305	410	9.765	38	380	506	662	814	6.009
STIR		#3-109	#3-131	#3-151	#3-166		#3- 49	#3-126	#3-140	#3-155	#3-167	
PROPERTIES FOR DESIGN (CONCRETE 0.67 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.96	1.28	1.49	1.75	1.98		1.01	1.75	1.98	2.35	4.22	
ACTUAL STEEL %	0.548	0.731	0.853	1.004	1.137		0.577	1.004	1.137	1.351	2.431	
EFF. DEPTH, IN.	18.38	18.38	18.31	18.31	18.31		18.38	18.31	18.31	18.25	18.25	
$-I_{cr}/I_{gr}$	0.135	0.169	0.189	0.214	0.234		0.140	0.214	0.234	0.262	0.390	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	1.04	1.19	1.39	1.58		0.62	1.04	1.19	1.39	1.58	
ACTUAL STEEL %	0.337	0.567	0.647	0.760	0.865		0.337	0.567	0.647	0.760	0.865	
EFF. DEPTH, IN.	18.69	18.59	18.64	18.53	18.50		18.69	18.59	18.64	18.53	18.50	
$+I_{cr}/I_{gr}$	0.118	0.187	0.213	0.242	0.271		0.118	0.187	0.213	0.242	0.271	

SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 9″ Ribs @ 49″ c.-c.
15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span	# 4	# 4	# 4	# 6	# 7	Int. Span
AT	10	10	9.5	7.5	9.5	Defl. Coeff. (2)	8.5	5	4.5	8	6	Defl. Coeff. (2)
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.74	1.18	1.31	1.64	1.85		1.07	1.77	1.99	2.50	3.73	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	327	878	1026	1311	1544	2.344	706	1508	1723	2137	2476	1.443
STIR	#3- 62	#3-115	#3-123	#3-136	#3-143		#3- 78	#3- 99	#3-121	#4-130	#4-128	
29'- 0"	271	785	922	1188	1405	2.698	624	1371	1572	1958	2274	1.660
STIR	#3- 59	#3-116	#3-124	#3-138	#3-146		#3- 78	#3-106	#3-124	#4-132	#4-133	
30'- 0"	220	700	829	1077	1280	3.090	550	1248	1436	1796	2092	1.901
STIR	#3- 56	#3-117	#3-126	#3-125	#3-149		#3- 77	#3-113	#3-127	#3-136	#4-140	
31'- 0"	174	623	744	976	1167	3.523	483	1137	1312	1650	1927	2.168
STIR	#3- 53	#3-118	#3-127	#3-133	#3-152		#3- 76	#3-120	#3-109	#3-139	#4-144	
32'- 0"	132	554	667	885	1064	4.000	422	1036	1200	1517	1777	2.461
STIR	#3- 49	#3-118	#3-128	#3-142	#3-155		#3- 74	#3-122	#3-117	#3-141	#4-147	
33'- 0"	94	491	597	802	970	4.523	367	944	1099	1397	1641	2.784
STIR	#3- 45	#3-119	#3-129	#3-145	#3-157		#3- 73	#3-123	#3-124	#3-144	#4-151	
34'- 0"	59	433	533	726	884	5.097	316	860	1006	1286	1516	3.137
STIR	#3- 41	#3-119	#3-130	#3-147	#3-142		#3- 71	#3-124	#3-131	#3-146	#4-153	
35'- 0"	27	380	475	657	806	5.724	270	783	920	1185	1403	3.522
STIR	#3- 36	#3-119	#3-131	#3-148	#3-150		#3- 69	#3-126	#3-134	#3-149	#3-156	
36'- 0"		331	421	593	734	6.407	227	712	842	1093	1298	3.942
STIR		#3-118	#3-131	#3-150	#3-159		#3- 67	#3-127	#3-135	#3-150	#3-159	
37'- 0"		287	371	534	668	7.149	188	647	770	1008	1202	4.399
STIR		#3-118	#3-131	#3-151	#3-163		#3- 64	#3-128	#3-137	#3-153	#3-161	
38'- 0"		246	326	480	607	7.953	152	587	704	929	1113	4.894
STIR		#3-117	#3-131	#3-152	#3-165		#3- 62	#3-128	#3-138	#3-137	#3-163	
39'- 0"		207	284	430	551	8.824	119	532	643	856	1031	5.430
STIR		#3-116	#3-131	#3-153	#3-167		#3- 59	#3-129	#3-139	#3-145	#3-166	
40'- 0"		172	245	384	499	9.765	88	481	586	789	955	6.009
STIR		#3-115	#3-131	#3-154	#3-168		#3- 56	#3-129	#3-140	#3-152	#3-168	
PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.98	1.52	1.60	2.03	2.27		1.15	1.96	2.18	2.69	4.90	
ACTUAL STEEL %	0.506	0.788	0.830	1.051	1.182		0.596	1.013	1.125	1.404	2.562	
EFF. DEPTH, IN.	18.38	18.31	18.31	18.31	18.25		18.38	18.38	18.38	18.25	18.19	
$-I_{cr}/I_{gr}$	0.129	0.182	0.189	0.226	0.244		0.147	0.222	0.240	0.276	0.408	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.349	0.588	0.652	0.785	0.891		0.349	0.588	0.652	0.785	0.891	
EFF. DEPTH, IN.	18.72	18.64	18.62	18.50	18.46		18.72	18.64	18.62	18.50	18.46	
$+I_{cr}/I_{gr}$	0.124	0.197	0.216	0.250	0.278		0.124	0.197	0.216	0.250	0.278	

SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 10″ Ribs @ 50″ c.-c.
15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	7	8.5	7.5	6		8.5	8	6	8	4	
BOTTOM BARS NO	3# 3	1# 5	2# 6	1# 6	2# 7		3# 3	1# 5	2# 6	1# 6	2# 7	
BARS NO	2# 4	2# 6	1# 7	2# 7	1# 8		2# 4	2# 6	1# 7	2# 7	1# 8	
STEEL (PSF)	0.75	1.13	1.47	1.60	2.00		1.08	1.73	2.28	2.45	4.08	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	328	853	1182	1362	1753	2.344	718	1482	1961	2223	2792	1.443
STIR	#3- 54	#3-107	#3-124	#3-115	#4-144		#3- 73	#3-108	#3-123	#4-128	#4-128	
29'- 0"	270	759	1066	1234	1598	2.698	634	1346	1792	2036	2567	1.660
STIR	#3- 51	#3-108	#3-126	#3-123	#3-147		#3- 72	#3-111	#3-126	#4-130	#4-133	
30'- 0"	217	675	961	1118	1459	3.090	557	1223	1640	1868	2364	1.901
STIR	#3- 47	#3-108	#3-128	#3-131	#3-150		#3- 70	#3-113	#3-128	#3-133	#4-139	
31'- 0"	169	598	866	1013	1332	3.523	488	1112	1502	1716	2180	2.168
STIR	#3- 43	#3-108	#3-129	#3-137	#3-152		#3- 69	#3-114	#3-130	#3-135	#4-145	
32'- 0"	126	528	780	918	1218	4.000	425	1010	1377	1577	2013	2.461
STIR	#3- 39	#3-108	#3-130	#3-139	#3-155		#3- 67	#3-115	#3-114	#3-139	#4-148	
33'- 0"	87	465	702	832	1113	4.523	368	918	1263	1451	1861	2.784
STIR	#3- 34	#3-108	#3-131	#3-141	#3-158		#3- 65	#3-116	#3-121	#3-141	#4-151	
34'- 0"	51	407	630	753	1018	5.097	316	834	1159	1336	1722	3.137
STIR	#3- 29	#3-107	#3-132	#3-142	#3-160		#3- 63	#3-117	#3-128	#3-143	#4-154	
35'- 0"	18	355	565	680	931	5.724	268	757	1063	1231	1595	3.522
STIR	#3- 23	#3-106	#3-133	#3-143	#3-148		#3- 60	#3-118	#3-136	#3-145	#4-157	
36'- 0"		306	505	614	851	6.407	225	687	976	1135	1479	3.942
STIR		#3-105	#3-134	#3-145	#3-157		#3- 58	#3-118	#3-137	#3-130	#4-160	
37'- 0"		261	450	553	777	7.149	184	622	896	1046	1372	4.399
STIR		#3-104	#3-134	#3-146	#3-165		#3- 55	#3-119	#3-139	#3-137	#3-163	
38'- 0"		220	399	496	709	7.953	147	562	822	964	1273	4.894
STIR		#3-103	#3-134	#3-146	#3-166		#3- 51	#3-119	#3-140	#3-144	#3-165	
39'- 0"		182	352	444	646	8.824	113	506	753	888	1181	5.430
STIR		#3-101	#3-134	#3-147	#3-168		#3- 48	#3-119	#3-142	#3-151	#3-167	
40'- 0"		147	308	396	588	9.765	81	455	690	818	1097	6.009
STIR		#3- 99	#3-134	#3-148	#3-170		#3- 44	#3-119	#3-143	#3-152	#3-170	
PROPERTIES FOR DESIGN (CONCRETE 0.71 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.00	1.43	1.82	2.07	2.58		1.18	1.94	2.58	2.75	5.50	
ACTUAL STEEL %	0.472	0.674	0.864	0.979	1.224		0.555	0.918	1.224	1.308	2.616	
EFF. DEPTH, IN.	18.38	18.38	18.31	18.31	18.31		18.38	18.31	18.31	18.25	18.25	
$-I_{cr}/I_{gr}$	0.124	0.166	0.199	0.219	0.258		0.142	0.208	0.258	0.268	0.427	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.73	1.19	1.48	1.64	1.99		0.73	1.19	1.48	1.64	1.99	
ACTUAL STEEL %	0.328	0.538	0.671	0.744	0.904		0.328	0.538	0.671	0.744	0.904	
EFF. DEPTH, IN.	18.78	18.64	18.60	18.58	18.54		18.78	18.64	18.60	18.58	18.54	
$+I_{cr}/I_{gr}$	0.119	0.183	0.222	0.243	0.287		0.119	0.183	0.222	0.243	0.287	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 8″ Ribs @ 48″ c.-c.
17″ Deep Rib + 5.0″ Top Slab = 22.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	10	10	9	7.5	9.5		8.5	7.5	9.5	10	6	
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.75	1.20	1.36	1.67	1.87		1.08	1.83	2.08	2.64	3.76	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	199	667	793	1036	1235	4.000	521	1201	1384	1738	2027	2.461
STIR	#3- 63	#3-126	#3-136	#3-131	#3-160		#3- 84	#3-118	#3-136	#4-146	#4-149	
33'- 0"	157	597	716	944	1131	4.523	459	1099	1271	1604	1876	2.784
STIR	#3- 60	#3-127	#3-137	#3-139	#3-163		#3- 83	#3-126	#3-138	#3-148	#4-155	
34'- 0"	119	533	645	860	1036	5.097	403	1006	1168	1481	1737	3.137
STIR	#3- 56	#3-128	#3-138	#3-148	#3-165		#3- 82	#3-131	#3-120	#3-151	#4-158	
35'- 0"	83	475	580	783	949	5.724	352	921	1074	1369	1611	3.522
STIR	#3- 52	#3-128	#3-140	#3-156	#3-168		#3- 80	#3-133	#3-127	#3-154	#4-161	
36'- 0"	51	421	520	712	869	6.407	305	843	987	1267	1495	3.942
STIR	#3- 48	#3-129	#3-140	#3-158	#3-170		#3- 79	#3-134	#3-135	#3-156	#4-163	
37'- 0"	21	371	465	647	796	7.149	262	771	908	1172	1388	4.399
STIR	#3- 44	#3-129	#3-141	#3-159	#3-154		#3- 77	#3-135	#3-142	#3-159	#3-166	
38'- 0"		326	415	587	728	7.953	222	704	834	1085	1290	4.894
STIR		#3-129	#3-142	#3-161	#3-163		#3- 75	#3-137	#3-146	#3-161	#3-169	
39'- 0"		284	368	532	666	8.824	185	643	766	1004	1199	5.430
STIR		#3-129	#3-142	#3-162	#3-171		#3- 73	#3-138	#3-147	#3-164	#3-172	
40'- 0"		244	325	480	608	9.765	151	586	703	929	1114	6.009
STIR		#3-128	#3-142	#3-164	#3-177		#3- 70	#3-139	#3-149	#3-166	#3-175	
41'- 0"		208	285	433	554	10.778	119	534	645	860	1036	6.633
STIR		#3-127	#3-143	#3-165	#3-179		#3- 68	#3-139	#3-150	#3-147	#3-177	
42'- 0"		175	248	389	504	11.869	89	485	591	796	964	7.304
STIR		#3-127	#3-142	#3-166	#3-180		#3- 65	#3-140	#3-151	#3-154	#3-179	
43'- 0"		143	213	347	457	13.040	62	439	540	736	896	8.025
STIR		#3-126	#3-142	#3-167	#3-182		#3- 62	#3-141	#3-153	#3-161	#3-182	
44'- 0"		114	181	309	414	14.296	36	396	493	680	833	8.798
STIR		#3-124	#3-142	#3-167	#3-184		#3- 58	#3-141	#3-153	#3-169	#3-185	
PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.96	1.49	1.65	1.98	2.22		1.13	1.98	2.22	2.88	4.80	
ACTUAL STEEL %	0.486	0.756	0.840	1.008	1.133		0.572	1.008	1.133	1.473	2.456	
EFF. DEPTH, IN.	20.38	20.31	20.31	20.31	20.25		20.38	20.31	20.25	20.19	20.19	
$-I_{cr}/I_{gr}$	0.128	0.180	0.195	0.224	0.242		0.146	0.224	0.242	0.289	0.406	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.342	0.575	0.638	0.768	0.871		0.342	0.575	0.638	0.768	0.871	
EFF. DEPTH, IN.	20.72	20.64	20.62	20.50	20.46		20.72	20.64	20.62	20.50	20.46	
$+I_{cr}/I_{gr}$	0.125	0.199	0.219	0.254	0.283		0.125	0.199	0.219	0.254	0.283	
SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 17″ Deep Rib + 5.0″ Top Slab = 22.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	8.5	9.5	8.5		8	5	4	7	4	
BOTTOM BARS NO	1# 5	1# 7	2# 6	1# 8	2# 7		1# 5	1# 7	2# 6	1# 8	2# 7	
BARS NO	1# 6	1# 7	1# 7	1# 9	1# 8		1# 6	1# 7	1# 7	1# 9	1# 8	
STEEL (PSF)	0.77	1.25	1.49	1.85	2.04		1.13	1.84	2.25	2.82	4.11	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	208	645	919	1207	1406	4.000	546	1181	1580	2000	2288	2.461
STIR	#3- 55	#3-117	#3-137	#3-153	#3-161		#3- 78	#3-121	#3-136	#4-146	#4-148	
33'- 0"	164	574	832	1103	1290	4.523	482	1079	1454	1848	2119	2.784
STIR	#3- 51	#3-117	#3-138	#3-136	#3-163		#3- 77	#3-122	#3-139	#4-149	#4-154	
34'- 0"	123	510	753	1008	1184	5.097	423	985	1339	1710	1966	3.137
STIR	#3- 47	#3-117	#3-140	#3-144	#3-166		#3- 76	#3-123	#3-119	#4-152	#4-158	
35'- 0"	86	451	680	921	1087	5.724	369	900	1233	1584	1825	3.522
STIR	#3- 43	#3-117	#3-141	#3-152	#3-169		#3- 74	#3-125	#3-127	#3-155	#4-160	
36'- 0"	52	397	614	842	998	6.407	319	821	1136	1467	1695	3.942
STIR	#3- 38	#3-117	#3-142	#3-160	#3-171		#3- 72	#3-126	#3-134	#3-157	#4-164	
37'- 0"	21	347	553	768	916	7.149	274	749	1047	1361	1576	4.399
STIR	#3- 33	#3-116	#3-143	#3-162	#3-153		#3- 70	#3-126	#3-141	#3-160	#4-166	
38'- 0"		301	496	700	841	7.953	232	682	965	1262	1467	4.894
STIR		#3-116	#3-143	#3-164	#3-161		#3- 67	#3-127	#3-146	#3-163	#4-169	
39'- 0"		259	444	638	771	8.824	193	620	889	1171	1365	5.430
STIR		#3-115	#3-144	#3-165	#3-170		#3- 65	#3-128	#3-148	#3-165	#4-172	
40'- 0"		220	395	580	707	9.765	157	563	819	1087	1272	6.009
STIR		#3-113	#3-144	#3-167	#3-178		#3- 62	#3-128	#3-149	#3-167	#3-175	
41'- 0"		183	351	526	647	10.778	124	510	753	1009	1184	6.633
STIR		#3-112	#3-144	#3-168	#3-180		#3- 59	#3-128	#3-151	#3-170	#3-177	
42'- 0"		150	309	476	591	11.869	93	461	693	936	1104	7.304
STIR		#3-110	#3-144	#3-169	#3-182		#3- 56	#3-129	#3-152	#3-151	#3-179	
43'- 0"		118	270	430	540	13.040	64	415	636	868	1028	8.025
STIR		#3-109	#3-144	#3-170	#3-183		#3- 52	#3-129	#3-153	#3-158	#3-182	
44'- 0"		89	234	386	491	14.296	37	372	584	805	958	8.798
STIR		#3-107	#3-144	#3-171	#3-185		#3- 48	#3-128	#3-154	#3-165	#3-185	
PROPERTIES FOR DESIGN (CONCRETE 0.73 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.98	1.52	1.79	2.27	2.54		1.23	1.96	2.45	3.08	5.39	
ACTUAL STEEL %	0.450	0.699	0.823	1.049	1.172		0.562	0.899	1.124	1.423	2.491	
EFF. DEPTH, IN.	20.38	20.31	20.31	20.25	20.25		20.38	20.38	20.38	20.25	20.25	
$-I_{cr}/I_{gr}$	0.122	0.173	0.196	0.233	0.253		0.147	0.212	0.250	0.291	0.423	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.75	1.20	1.48	1.79	1.99		0.75	1.20	1.48	1.79	1.99	
ACTUAL STEEL %	0.329	0.529	0.651	0.792	0.878		0.329	0.529	0.651	0.792	0.878	
EFF. DEPTH, IN.	20.65	20.56	20.60	20.46	20.54		20.65	20.56	20.60	20.46	20.54	
$+I_{cr}/I_{gr}$	0.120	0.184	0.224	0.262	0.290		0.120	0.184	0.224	0.262	0.290	
SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 17″ Deep Rib + 5.0″ Top Slab = 22.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	9.5	8	9	8		7.5	7	6	6.5	4	
BOTTOM BARS NO	1# 4	2# 6	1# 8	2# 7	1# 7		1# 4	2# 6	1# 8	2# 7	1# 7	
BARS NO	2# 5	1# 6	1# 8	1# 8	2# 8		2# 5	1# 6	1# 8	1# 8	2# 8	
STEEL (PSF)	0.78	1.30	1.59	1.98	2.13		1.18	1.97	2.37	3.04	4.16	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	251	738	981	1378	1558	4.000	622	1329	1683	2261	2522	2.461
STIR	#3- 55	#3-118	#3-134	#3-154	#4-161		#3- 79	#3-122	#3-135	#4-147	#4-149	
33'- 0"	203	660	889	1262	1431	4.523	551	1216	1549	2092	2338	2.784
STIR	#3- 52	#3-118	#3-136	#3-157	#3-163		#3- 77	#3-123	#3-138	#4-151	#4-155	
34'- 0"	158	589	804	1156	1316	5.097	486	1113	1426	1938	2170	3.137
STIR	#3- 48	#3-118	#3-137	#3-141	#3-166		#3- 76	#3-124	#3-123	#4-153	#4-158	
35'- 0"	118	524	727	1060	1210	5.724	427	1018	1314	1797	2016	3.522
STIR	#3- 43	#3-118	#3-138	#3-150	#3-169		#3- 74	#3-126	#3-130	#4-156	#4-160	
36'- 0"	80	464	657	971	1113	6.407	373	932	1211	1668	1875	3.942
STIR	#3- 39	#3-118	#3-139	#3-158	#3-171		#3- 72	#3-127	#3-137	#4-159	#4-164	
37'- 0"	46	410	592	889	1023	7.149	323	852	1117	1549	1745	4.399
STIR	#3- 34	#3-117	#3-139	#3-164	#3-153		#3- 70	#3-128	#3-143	#4-161	#4-166	
38'- 0"	14	359	532	813	941	7.953	277	778	1029	1439	1625	4.894
STIR	#3- 29	#3-117	#3-140	#3-165	#3-161		#3- 68	#3-128	#3-144	#3-163	#4-169	
39'- 0"		312	476	744	865	8.824	234	711	949	1338	1514	5.430
STIR		#3-116	#3-140	#3-167	#3-170		#3- 65	#3-129	#3-146	#3-166	#4-172	
40'- 0"		269	425	679	794	9.765	195	648	874	1244	1411	6.009
STIR		#3-115	#3-140	#3-169	#3-178		#3- 62	#3-129	#3-147	#3-168	#4-175	
41'- 0"		229	377	619	729	10.778	158	589	805	1157	1316	6.633
STIR		#3-113	#3-140	#3-170	#3-180		#3- 59	#3-130	#3-148	#3-171	#3-177	
42'- 0"		192	333	564	668	11.869	124	535	740	1076	1228	7.304
STIR		#3-112	#3-140	#3-171	#3-181		#3- 56	#3-130	#3-149	#3-173	#3-180	
43'- 0"		157	292	512	611	13.040	93	485	680	1001	1145	8.025
STIR		#3-110	#3-140	#3-173	#3-183		#3- 52	#3-130	#3-150	#3-155	#3-182	
44'- 0"		125	253	463	559	14.296	63	437	625	930	1069	8.798
STIR		#3-108	#3-139	#3-174	#3-185		#3- 49	#3-130	#3-151	#3-162	#3-185	
PROPERTIES FOR DESIGN (CONCRETE 0.75 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.00	1.63	1.94	2.44	2.75		1.33	2.21	2.58	3.38	5.50	
ACTUAL STEEL %	0.420	0.687	0.816	1.033	1.162		0.559	0.932	1.088	1.430	2.324	
EFF. DEPTH, IN.	20.38	20.31	20.31	20.25	20.25		20.38	20.31	20.31	20.25	20.25	
$-I_{cr}/I_{gr}$	0.118	0.174	0.199	0.235	0.257		0.149	0.220	0.247	0.298	0.414	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.82	1.32	1.58	1.99	2.18		0.82	1.32	1.58	1.99	2.18	
ACTUAL STEEL %	0.329	0.532	0.640	0.805	0.882		0.329	0.532	0.640	0.805	0.882	
EFF. DEPTH, IN.	20.70	20.62	20.50	20.54	20.52		20.70	20.62	20.50	20.54	20.52	
$+I_{cr}/I_{gr}$	0.122	0.188	0.219	0.270	0.292		0.122	0.188	0.219	0.270	0.292	
SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 6	# 8	Int. Span Defl. Coeff. (2)
AT	10	9	8	9.5	8.5		7	4	6	6.5	7	
BOTTOM BARS NO	1# 4	2# 6	2# 6	1# 8	1# 9		1# 4	2# 6	2# 6	1# 8	1# 9	
BARS NO	2# 5	1# 6	1# 7	1# 9	1# 9		2# 5	1# 6	1# 7	1# 9	1# 9	
STEEL (PSF)	0.80	1.36	1.54	1.87	2.12		1.25	2.14	2.33	2.97	4.23	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
34'- 0" (3)	257	730	880	1162	1355	5.097	617	1305	1523	1933	2214	3.137
STIR	#3- 77	#3-137	#3-147	#3-165	#3-171		#3- 96	#3-123	#3-146	#4-156	#4-157	
35'- 0"	212	659	800	1066	1248	5.724	552	1201	1407	1794	2059	3.522
STIR	#3- 75	#3-138	#3-149	#3-166	#3-174		#3- 96	#3-130	#3-148	#4-160	#4-161	
36'- 0"	171	593	727	978	1151	6.407	492	1106	1301	1666	1917	3.942
STIR	#3- 72	#3-139	#3-150	#3-149	#3-177		#3- 95	#3-138	#3-151	#4-162	#4-167	
37'- 0"	134	533	660	898	1061	7.149	437	1019	1203	1549	1786	4.399
STIR	#3- 69	#3-139	#3-152	#3-157	#3-180		#3- 94	#3-142	#3-130	#4-165	#4-172	
38'- 0"	99	478	598	823	978	7.953	387	938	1113	1441	1666	4.894
STIR	#3- 65	#3-140	#3-153	#3-165	#3-183		#3- 93	#3-144	#3-137	#3-168	#4-175	
39'- 0"	67	426	540	754	901	8.824	340	863	1029	1340	1554	5.430
STIR	#3- 62	#3-140	#3-154	#3-173	#3-185		#3- 92	#3-145	#3-144	#3-170	#4-178	
40'- 0"	37	379	487	691	830	9.765	297	794	952	1248	1451	6.009
STIR	#3- 58	#3-140	#3-155	#3-175	#3-165		#3- 90	#3-147	#3-152	#3-173	#4-181	
41'- 0"	9	335	438	632	765	10.778	257	730	880	1162	1355	6.633
STIR	#3- 53	#3-140	#3-155	#3-177	#3-173		#3- 89	#3-148	#3-159	#3-176	#4-183	
42'- 0"		294	392	577	703	11.869	220	671	814	1082	1266	7.304
STIR		#3-140	#3-156	#3-179	#3-181		#3- 87	#3-149	#3-160	#3-178	#4-186	
43'- 0"		256	350	526	646	13.040	185	615	752	1008	1184	8.025
STIR		#3-140	#3-156	#3-180	#3-190		#3- 85	#3-150	#3-162	#3-180	#3-189	
44'- 0"		220	310	478	593	14.296	153	564	694	938	1106	8.798
STIR		#3-139	#3-157	#3-182	#3-194		#3- 82	#3-151	#3-163	#3-183	#3-191	
45'- 0"		187	273	433	544	15.641	122	515	640	874	1034	9.625
STIR		#3-138	#3-157	#3-183	#3-196		#3- 80	#3-152	#3-165	#3-184	#3-194	
46'- 0"		156	238	392	497	17.078	94	470	589	813	967	10.510
STIR		#3-137	#3-157	#3-184	#3-198		#3- 78	#3-152	#3-166	#3-167	#3-197	
PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.96	1.65	1.86	2.22	2.48		1.37	2.40	2.48	3.25	5.42	
ACTUAL STEEL %	0.435	0.752	0.846	1.014	1.133		0.621	1.087	1.127	1.482	2.487	
EFF. DEPTH, IN.	22.38	22.31	22.31	22.25	22.25		22.38	22.38	22.31	22.25	22.12	
$-I_{cr}/I_{gr}$	0.121	0.186	0.204	0.232	0.252		0.162	0.249	0.253	0.305	0.422	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.82	1.32	1.48	1.79	2.00		0.82	1.32	1.48	1.79	2.00	
ACTUAL STEEL %	0.354	0.572	0.642	0.780	0.873		0.354	0.572	0.642	0.780	0.873	
EFF. DEPTH, IN.	22.70	22.62	22.60	22.46	22.44		22.70	22.62	22.60	22.46	22.44	
$+I_{cr}/I_{gr}$	0.133	0.205	0.227	0.267	0.294		0.133	0.205	0.227	0.267	0.294	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 6	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	9.5	9	7.5	6	8		7	4	7.5	8.5	5	
BOTTOM BARS NO	1# 6	1# 7	1# 6	2# 7	1# 7		1# 6	1# 7	1# 6	2# 7	1# 7	
BARS NO	1# 6	1# 8	2# 7	1# 8	2# 8		1# 6	1# 8	2# 7	1# 8	2# 8	
STEEL (PSF)	0.90	1.41	1.62	2.03	2.16		1.33	2.19	2.56	3.14	4.42	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
34'- 0" (3)	281	760	999	1324	1500	5.097	666	1363	1710	2183	2438	3.137
STIR	#3- 72	#3-132	#3-148	#3-165	#4-171		#3- 93	#3-129	#3-147	#4-157	#4-157	
35'- 0"	233	685	911	1218	1383	5.724	596	1254	1582	2028	2269	3.522
STIR	#3- 69	#3-132	#3-149	#3-167	#3-174		#3- 92	#3-135	#3-150	#4-160	#4-162	
36'- 0"	189	617	830	1120	1276	6.407	533	1155	1465	1886	2114	3.942
STIR	#3- 66	#3-133	#3-151	#3-147	#3-177		#3- 91	#3-137	#3-151	#4-163	#4-167	
37'- 0"	149	554	756	1030	1178	7.149	474	1063	1356	1756	1971	4.399
STIR	#3- 63	#3-133	#3-152	#3-156	#3-180		#3- 90	#3-138	#3-154	#4-166	#4-171	
38'- 0"	112	496	687	947	1088	7.953	420	978	1256	1635	1839	4.894
STIR	#3- 59	#3-133	#3-153	#3-164	#3-182		#3- 89	#3-139	#3-136	#4-168	#4-174	
39'- 0"	78	442	624	871	1004	8.824	370	900	1164	1524	1717	5.430
STIR	#3- 55	#3-133	#3-154	#3-173	#3-185		#3- 87	#3-141	#3-143	#4-171	#4-177	
40'- 0"	46	392	565	800	926	9.765	324	828	1079	1420	1605	6.009
STIR	#3- 51	#3-133	#3-155	#3-176	#3-166		#3- 86	#3-142	#3-151	#4-174	#4-180	
41'- 0"	16	346	510	734	855	10.778	281	761	1000	1325	1500	6.633
STIR	#3- 46	#3-133	#3-156	#3-178	#3-174		#3- 84	#3-143	#3-158	#3-177	#4-183	
42'- 0"		303	460	673	788	11.869	241	698	926	1236	1403	7.304
STIR		#3-132	#3-156	#3-180	#3-183		#3- 82	#3-144	#3-161	#3-179	#4-186	
43'- 0"		263	413	616	725	13.040	204	640	857	1153	1312	8.025
STIR		#3-131	#3-157	#3-181	#3-191		#3- 79	#3-144	#3-162	#3-182	#4-189	
44'- 0"		226	369	563	667	14.296	170	586	793	1076	1228	8.798
STIR		#3-131	#3-157	#3-182	#3-193		#3- 77	#3-145	#3-164	#3-183	#4-191	
45'- 0"		191	328	513	613	15.641	137	535	734	1004	1149	9.625
STIR		#3-129	#3-157	#3-184	#3-195		#3- 74	#3-145	#3-165	#3-186	#3-193	
46'- 0"		159	289	467	563	17.078	107	488	678	936	1075	10.510
STIR		#3-128	#3-157	#3-185	#3-197		#3- 71	#3-146	#3-167	#3-188	#3-195	
PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.03	1.69	2.03	2.53	2.69		1.40	2.45	2.87	3.46	5.88	
ACTUAL STEEL %	0.424	0.697	0.836	1.045	1.116		0.576	1.008	1.190	1.437	2.443	
EFF. DEPTH, IN.	22.38	22.31	22.31	22.31	22.25		22.38	22.38	22.25	22.19	22.19	
$-I_{cr}/I_{gr}$	0.121	0.179	0.207	0.244	0.254		0.156	0.240	0.267	0.302	0.431	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.88	1.39	1.64	1.99	2.18		0.88	1.39	1.64	1.99	2.18	
ACTUAL STEEL %	0.347	0.551	0.648	0.788	0.864		0.347	0.551	0.648	0.788	0.864	
EFF. DEPTH, IN.	22.62	22.53	22.58	22.54	22.52		22.62	22.53	22.58	22.54	22.52	
$+I_{cr}/I_{gr}$	0.131	0.197	0.230	0.273	0.296		0.131	0.197	0.230	0.273	0.296	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	9	8.5	7	6	7.5		10	9	10	8.5	6	
BOTTOM BARS NO	2# 5	2# 6	2# 6	2# 6	2# 8		2# 5	2# 6	2# 6	2# 6	2# 8	
BARS NO	1# 5	1# 7	2# 6	2# 7	1# 8		1# 5	1# 7	2# 6	2# 7	1# 8	
STEEL (PSF)	0.89	1.47	1.80	2.08	2.32		1.38	2.23	2.73	3.19	4.05	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
34'- 0" (3)	301	819	1085	1383	1645	5.097	708	1463	1850	2282	2663	3.137
STIR	#3- 67	#3-129	#3-146	#3-161	#4-171		#3- 90	#3-131	#3-145	#4-155	#5-161	
35'- 0"	250	740	991	1271	1518	5.724	635	1347	1712	2120	2480	3.522
STIR	#3- 64	#3-130	#3-148	#3-145	#4-174		#3- 89	#3-134	#3-148	#4-158	#4-164	
36'- 0"	204	666	904	1169	1403	6.407	567	1240	1585	1972	2311	3.942
STIR	#3- 61	#3-130	#3-149	#3-154	#3-176		#3- 88	#3-135	#3-151	#4-160	#4-167	
37'- 0"	161	599	824	1075	1296	7.149	505	1142	1469	1835	2156	4.399
STIR	#3- 57	#3-130	#3-150	#3-162	#3-179		#3- 86	#3-137	#3-131	#4-163	#4-170	
38'- 0"	122	537	750	988	1198	7.953	448	1052	1362	1708	2013	4.894
STIR	#3- 53	#3-130	#3-151	#3-168	#3-182		#3- 85	#3-138	#3-138	#4-166	#4-174	
39'- 0"	85	480	682	908	1107	8.824	395	969	1263	1592	1881	5.430
STIR	#3- 49	#3-130	#3-152	#3-170	#3-184		#3- 83	#3-139	#3-145	#4-168	#4-177	
40'- 0"	52	426	619	834	1023	9.765	346	891	1171	1484	1759	6.009
STIR	#3- 44	#3-130	#3-153	#3-172	#3-167		#3- 81	#3-140	#3-153	#3-171	#4-180	
41'- 0"	20	377	560	765	945	10.778	301	820	1086	1383	1645	6.633
STIR	#3- 39	#3-129	#3-154	#3-173	#3-175		#3- 79	#3-141	#3-158	#3-173	#4-182	
42'- 0"		331	506	701	872	11.869	259	753	1007	1290	1540	7.304
STIR		#3-129	#3-154	#3-175	#3-184		#3- 77	#3-142	#3-160	#3-176	#4-185	
43'- 0"		289	455	641	805	13.040	219	691	933	1204	1442	8.025
STIR		#3-128	#3-155	#3-176	#3-191		#3- 74	#3-142	#3-161	#3-178	#4-187	
44'- 0"		249	408	585	742	14.296	183	633	864	1123	1350	8.798
STIR		#3-127	#3-155	#3-177	#3-192		#3- 72	#3-143	#3-163	#3-157	#4-191	
45'- 0"		212	364	533	683	15.641	148	579	800	1047	1264	9.625
STIR		#3-125	#3-155	#3-178	#3-194		#3- 69	#3-143	#3-164	#3-164	#4-193	
46'- 0"		177	322	485	628	17.078	116	529	740	976	1184	10.510
STIR		#3-124	#3-155	#3-179	#3-196		#3- 66	#3-144	#3-165	#3-171	#3-195	
PROPERTIES FOR DESIGN (CONCRETE 0.79 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.11	1.82	2.21	2.58	2.93		1.55	2.44	3.00	3.53	5.00	
ACTUAL STEEL %	0.419	0.689	0.837	0.976	1.112		0.586	0.927	1.141	1.342	1.902	
EFF. DEPTH, IN.	22.38	22.31	22.31	22.31	22.25		22.31	22.25	22.19	22.19	22.19	
$-I_{cr}/I_{gr}$	0.122	0.181	0.211	0.237	0.259		0.159	0.226	0.262	0.294	0.374	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.48	1.76	2.08	2.37		0.93	1.48	1.76	2.08	2.37	
ACTUAL STEEL %	0.336	0.537	0.638	0.755	0.863		0.336	0.537	0.638	0.755	0.863	
EFF. DEPTH, IN.	22.69	22.60	22.62	22.59	22.50		22.69	22.60	22.62	22.59	22.50	
$+I_{cr}/I_{gr}$	0.129	0.196	0.230	0.266	0.297		0.129	0.196	0.230	0.266	0.297	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 21″ Deep Rib + 5.0″ Top Slab = 26.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 6	# 7	# 8	Int. Span Defl. Coeff. (2)
AT	9	9	7.5	6	7.5		7	4	7.5	8	6	
BOTTOM BARS NO	1# 6	1# 7	1# 6	1# 9	1# 9		1# 6	1# 7	1# 6	1# 9	1# 9	
BARS NO	1# 6	1# 8	2# 7	1# 9	1#10		1# 6	1# 8	2# 7	1# 9	1#10	
STEEL (PSF)	0.92	1.43	1.64	2.11	2.38		1.34	2.21	2.58	3.33	4.86	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	215	656	876	1177	1405	7.149	569	1211	1530	1968	2299	4.399
STIR	#3- 78	#3-143	#3-160	#3-179	#4-188		#3-100	#3-141	#3-159	#4-170	#4-169	
38'- 0"	174	593	801	1086	1302	7.953	510	1119	1422	1837	2150	4.894
STIR	#3- 75	#3-143	#3-162	#3-181	#4-192		#3- 99	#3-146	#3-162	#4-174	#4-174	
39'- 0"	137	534	732	1003	1208	8.824	455	1033	1321	1715	2013	5.430
STIR	#3- 72	#3-144	#3-163	#3-159	#3-194		#3- 99	#3-148	#3-163	#4-176	#4-179	
40'- 0"	102	480	668	926	1120	9.765	405	955	1228	1603	1886	6.009
STIR	#3- 68	#3-144	#3-164	#3-168	#3-197		#3- 97	#3-149	#3-166	#4-180	#4-185	
41'- 0"	70	430	609	854	1039	10.778	358	881	1142	1498	1768	6.633
STIR	#3- 65	#3-144	#3-166	#3-176	#3-199		#3- 96	#3-151	#3-146	#4-183	#4-190	
42'- 0"	40	383	554	787	964	11.869	315	813	1061	1401	1658	7.304
STIR	#3- 61	#3-144	#3-167	#3-185	#3-202		#3- 95	#3-152	#3-153	#4-185	#4-194	
43'- 0"	13	340	502	725	894	13.040	275	750	987	1311	1556	8.025
STIR	#3- 56	#3-144	#3-168	#3-190	#3-205		#3- 93	#3-153	#3-161	#3-188	#4-196	
44'- 0"		299	454	667	828	14.296	237	691	917	1227	1461	8.798
STIR		#3-144	#3-168	#3-192	#3-208		#3- 91	#3-154	#3-168	#3-190	#4-199	
45'- 0"		261	410	613	767	15.641	202	636	852	1148	1372	9.625
STIR		#3-143	#3-169	#3-194	#3-187		#3- 89	#3-155	#3-173	#3-192	#4-202	
46'- 0"		226	368	562	710	17.078	169	584	791	1074	1288	10.510
STIR		#3-143	#3-170	#3-195	#3-195		#3- 87	#3-156	#3-175	#3-195	#4-205	
47'- 0"		192	329	515	656	18.613	138	536	734	1005	1211	11.454
STIR		#3-142	#3-170	#3-197	#3-204		#3- 85	#3-157	#3-177	#3-197	#4-208	
48'- 0"		161	292	471	606	20.248	109	491	681	941	1137	12.460
STIR		#3-141	#3-170	#3-198	#3-213		#3- 82	#3-157	#3-178	#3-199	#4-211	
49'- 0"		132	257	429	559	21.989	82	448	630	880	1069	13.532
STIR		#3-140	#3-170	#3-199	#3-216		#3- 80	#3-158	#3-179	#3-202	#4-213	
PROPERTIES FOR DESIGN (CONCRETE 0.78 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.07	1.65	1.98	2.48	2.82		1.37	2.40	2.82	3.60	6.32	
ACTUAL STEEL %	0.436	0.678	0.814	1.017	1.159		0.561	0.982	1.159	1.486	2.617	
EFF. DEPTH, IN.	24.38	24.31	24.31	24.31	24.25		24.38	24.38	24.25	24.19	24.12	
$-I_{cr}/I_{gr}$	0.126	0.178	0.206	0.243	0.265		0.155	0.239	0.265	0.314	0.453	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.88	1.39	1.64	2.00	2.27		0.88	1.39	1.64	2.00	2.27	
ACTUAL STEEL %	0.345	0.546	0.644	0.788	0.896		0.345	0.546	0.644	0.788	0.896	
EFF. DEPTH, IN.	24.62	24.53	24.58	24.44	24.40		24.62	24.53	24.58	24.44	24.40	
$+I_{cr}/I_{gr}$	0.133	0.202	0.235	0.278	0.310		0.133	0.202	0.235	0.278	0.310	
SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 21″ Deep Rib + 5.0″ Top Slab = 26.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 5	# 5	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 8	# 8	Int. Span Defl. Coeff. (2)
AT	9	8.5	7	8	10		10	9	10	10	6	
BOTTOM BARS NO	2# 5	2# 6	1# 8	1# 7	2# 8		2# 5	2# 6	1# 8	1# 7	2# 8	
BARS NO	1# 5	1# 7	1# 9	2# 8	1# 8		1# 5	1# 7	1# 9	2# 8	1# 8	
STEEL (PSF)	0.91	1.49	1.81	2.16	2.37		1.39	2.25	2.75	3.40	4.84	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	228	705	966	1305	1466	7.149	603	1297	1676	2169	2404	4.399
STIR	#3- 71	#3-139	#3-159	#3-178	#4-185		#3- 96	#3-143	#3-158	#4-171	#5-170	
38'- 0"	185	638	885	1206	1359	7.953	540	1199	1558	2026	2248	4.894
STIR	#3- 68	#3-140	#3-160	#3-181	#4-188		#3- 95	#3-144	#3-161	#4-173	#4-176	
39'- 0"	145	575	810	1115	1260	8.824	483	1108	1449	1893	2104	5.430
STIR	#3- 64	#3-140	#3-162	#3-160	#3-190		#3- 94	#3-146	#3-163	#4-177	#4-181	
40'- 0"	109	517	740	1030	1168	9.765	429	1024	1348	1770	1971	6.009
STIR	#3- 60	#3-140	#3-163	#3-168	#3-193		#3- 92	#3-147	#3-141	#4-179	#4-184	
41'- 0"	75	464	676	952	1083	10.778	380	946	1254	1656	1847	6.633
STIR	#3- 56	#3-140	#3-164	#3-177	#3-195		#3- 91	#3-148	#3-148	#4-182	#4-187	
42'- 0"	43	414	616	879	1004	11.869	334	873	1167	1550	1732	7.304
STIR	#3- 52	#3-140	#3-165	#3-185	#3-198		#3- 89	#3-150	#3-155	#4-185	#4-190	
43'- 0"	14	367	560	811	931	13.040	291	806	1086	1451	1625	8.025
STIR	#3- 47	#3-140	#3-166	#3-190	#3-179		#3- 87	#3-151	#3-162	#4-187	#4-193	
44'- 0"		324	508	748	862	14.296	251	743	1010	1359	1525	8.798
STIR		#3-139	#3-167	#3-192	#3-187		#3- 85	#3-152	#3-170	#4-189	#4-195	
45'- 0"		284	460	689	798	15.641	214	684	940	1273	1432	9.625
STIR		#3-138	#3-167	#3-193	#3-196		#3- 83	#3-152	#3-172	#3-193	#4-198	
46'- 0"		246	414	634	738	17.078	179	629	874	1193	1345	10.510
STIR		#3-137	#3-168	#3-195	#3-204		#3- 81	#3-153	#3-174	#3-194	#4-201	
47'- 0"		210	372	582	682	18.613	146	577	812	1117	1263	11.454
STIR		#3-136	#3-168	#3-196	#3-207		#3- 78	#3-154	#3-175	#3-197	#4-203	
48'- 0"		177	332	533	629	20.248	116	529	754	1047	1186	12.460
STIR		#3-135	#3-168	#3-198	#3-209		#3- 75	#3-154	#3-177	#3-200	#4-207	
49'- 0"		146	294	487	579	21.989	87	483	699	980	1114	13.532
STIR		#3-134	#3-168	#3-199	#3-210		#3- 72	#3-154	#3-178	#3-202	#4-209	
PROPERTIES FOR DESIGN (CONCRETE 0.81 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.09	1.79	2.17	2.69	2.94		1.52	2.40	2.94	3.87	6.45	
ACTUAL STEEL %	0.405	0.667	0.809	1.008	1.103		0.567	0.896	1.103	1.457	2.429	
EFF. DEPTH, IN.	24.38	24.31	24.31	24.25	24.19		24.31	24.25	24.19	24.12	24.12	
$-I_{cr}/I_{gr}$	0.121	0.180	0.209	0.245	0.260		0.158	0.224	0.260	0.314	0.442	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.93	1.48	1.79	2.18	2.37		0.93	1.48	1.79	2.18	2.37	
ACTUAL STEEL %	0.332	0.529	0.643	0.782	0.850		0.332	0.529	0.643	0.782	0.850	
EFF. DEPTH, IN.	24.69	24.60	24.46	24.52	24.50		24.69	24.60	24.46	24.52	24.50	
$+I_{cr}/I_{gr}$	0.131	0.199	0.234	0.280	0.301		0.131	0.199	0.234	0.280	0.301	
SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 21″ Deep Rib + 5.0″ Top Slab = 26.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 5	# 6	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 8	# 8	Int. Span Defl. Coeff. (2)
AT	8	8	9	8	9		9.5	8	9	10	7.5	
BOTTOM BARS NO	2# 4	1# 6	2# 7	1# 9	2# 8		2# 4	1# 6	2# 7	1# 9	2# 8	
BARS NO	2# 5	2# 7	1# 8	1#10	1# 9		2# 5	2# 7	1# 8	1#10	1# 9	
STEEL (PSF)	1.00	1.57	1.98	2.27	2.59		1.49	2.45	3.01	3.51	4.34	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	275	810	1110	1340	1611	7.149	686	1465	1901	2235	2629	4.399
STIR	#3- 72	#3-141	#3-161	#3-152	#4-184		#3- 97	#3-143	#4-160	#4-167	#5-175	
38'- 0"	228	736	1020	1237	1494	7.953	618	1356	1770	2086	2460	4.894
STIR	#3- 69	#3-141	#3-163	#3-160	#4-187		#3- 96	#3-146	#4-162	#4-171	#5-178	
39'- 0"	184	667	936	1143	1387	8.824	555	1256	1648	1949	2304	5.430
STIR	#3- 65	#3-142	#3-164	#3-168	#4-190		#3- 95	#3-147	#3-165	#4-173	#5-181	
40'- 0"	144	603	859	1055	1287	9.765	496	1163	1536	1821	2159	6.009
STIR	#3- 62	#3-142	#3-166	#3-177	#3-192		#3- 93	#3-149	#3-167	#4-175	#4-184	
41'- 0"	107	543	787	974	1195	10.778	442	1076	1432	1703	2024	6.633
STIR	#3- 58	#3-142	#3-167	#3-181	#3-195		#3- 92	#3-150	#3-145	#4-178	#4-187	
42'- 0"	72	488	721	899	1109	11.869	391	996	1335	1593	1900	7.304
STIR	#3- 53	#3-142	#3-168	#3-182	#3-198		#3- 90	#3-151	#3-152	#4-181	#4-190	
43'- 0"	40	437	659	828	1029	13.040	344	921	1244	1491	1783	8.025
STIR	#3- 49	#3-142	#3-169	#3-184	#3-179		#3- 88	#3-152	#3-159	#4-183	#4-192	
44'- 0"	10	389	601	763	955	14.296	301	852	1160	1396	1675	8.798
STIR	#3- 44	#3-141	#3-170	#3-186	#3-188		#3- 86	#3-153	#3-166	#3-186	#4-195	
45'- 0"		344	547	702	885	15.641	260	786	1081	1307	1574	9.625
STIR		#3-141	#3-171	#3-187	#3-196		#3- 84	#3-154	#3-174	#3-188	#4-198	
46'- 0"		302	496	644	820	17.078	222	726	1008	1224	1479	10.510
STIR		#3-140	#3-171	#3-188	#3-204		#3- 82	#3-155	#3-176	#3-190	#4-201	
47'- 0"		263	449	591	759	18.613	186	668	939	1145	1390	11.454
STIR		#3-139	#3-172	#3-189	#3-206		#3- 79	#3-155	#3-178	#3-167	#4-203	
48'- 0"		226	404	540	702	20.248	152	615	874	1072	1307	12.460
STIR		#3-138	#3-172	#3-191	#3-208		#3- 76	#3-156	#3-179	#3-174	#4-206	
49'- 0"		191	362	493	648	21.989	120	565	813	1004	1228	13.532
STIR		#3-137	#3-172	#3-191	#3-210		#3- 73	#3-156	#3-180	#3-182	#4-209	
PROPERTIES FOR DESIGN (CONCRETE 0.84 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.25	1.94	2.44	2.75	3.33		1.63	2.75	3.33	3.95	5.27	
ACTUAL STEEL %	0.426	0.663	0.839	0.943	1.147		0.558	0.943	1.147	1.363	1.818	
EFF. DEPTH, IN.	24.38	24.31	24.25	24.25	24.19		24.31	24.25	24.19	24.12	24.12	
$-I_{cr}/I_{gr}$	0.129	0.182	0.217	0.238	0.273		0.159	0.238	0.273	0.306	0.374	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.27	2.58		1.02	1.64	1.99	2.27	2.58	
ACTUAL STEEL %	0.334	0.539	0.656	0.751	0.852		0.334	0.539	0.656	0.751	0.852	
EFF. DEPTH, IN.	24.71	24.58	24.54	24.40	24.48		24.71	24.58	24.54	24.40	24.48	
$+I_{cr}/I_{gr}$	0.133	0.204	0.242	0.268	0.303		0.133	0.204	0.242	0.268	0.303	
SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 6	# 6	# 8	Int. Span Defl. Coeff. (2)
AT	8.5	5	4	7.5	9		10	8	7	4.5	5	
BOTTOM BARS NO	2# 5	1# 8	1# 8	1# 9	1#10		2# 5	1# 8	1# 8	1# 9	1#10	
BARS NO	1# 5	1# 8	1# 9	1#10	1#10		1# 5	1# 8	1# 9	1#10	1#10	
STEEL (PSF)	0.93	1.65	1.91	2.38	2.70		1.40	2.52	2.85	4.06	5.73	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	299	904	1099	1539	1785	7.149	704	1585	1867	2509	2867	4.399
STIR	#3- 85	#3-154	#3-163	#4-187	#4-194		#3-105	#3-155	#4-164	#5-176	#5-169	
38'- 0"	252	827	1011	1429	1662	7.953	637	1472	1740	2347	2687	4.894
STIR	#3- 82	#3-155	#3-168	#4-190	#4-198		#3-105	#3-133	#4-166	#4-180	#5-173	
39'- 0"	210	755	929	1326	1548	8.824	574	1367	1622	2199	2521	5.430
STIR	#3- 80	#3-157	#3-170	#3-193	#4-201		#3-104	#3-140	#3-168	#4-183	#5-176	
40'- 0"	170	688	854	1231	1442	9.765	517	1270	1512	2061	2367	6.009
STIR	#3- 77	#3-158	#3-171	#3-195	#4-204		#3-104	#3-147	#3-170	#4-186	#5-178	
41'- 0"	133	626	785	1144	1344	10.778	463	1181	1411	1933	2224	6.633
STIR	#3- 73	#3-159	#3-173	#3-199	#4-208		#3-103	#3-154	#3-173	#4-189	#5-184	
42'- 0"	99	569	720	1062	1253	11.869	414	1097	1316	1814	2092	7.304
STIR	#3- 70	#3-159	#3-174	#3-201	#4-211		#3-102	#3-162	#3-176	#4-192	#5-191	
43'- 0"	67	516	659	986	1168	13.040	367	1020	1229	1703	1968	8.025
STIR	#3- 66	#3-160	#3-176	#3-203	#4-213		#3-100	#3-165	#3-150	#4-195	#4-197	
44'- 0"	37	466	603	915	1089	14.296	324	947	1147	1600	1853	8.798
STIR	#3- 62	#3-160	#3-177	#3-182	#3-216		#3- 99	#3-166	#3-157	#4-198	#4-203	
45'- 0"	10	419	551	849	1015	15.641	284	879	1070	1504	1746	9.625
STIR	#3- 58	#3-160	#3-178	#3-190	#3-219		#3- 97	#3-168	#3-165	#4-201	#4-209	
46'- 0"		376	501	787	946	17.078	246	816	999	1414	1645	10.510
STIR		#3-161	#3-179	#3-198	#3-221		#3- 95	#3-169	#3-172	#4-204	#4-212	
47'- 0"		335	455	728	881	18.613	211	757	932	1329	1551	11.454
STIR		#3-161	#3-179	#3-207	#3-224		#3- 93	#3-170	#3-180	#4-206	#4-214	
48'- 0"		297	412	674	820	20.248	178	701	869	1250	1463	12.460
STIR		#3-160	#3-180	#3-212	#3-227		#3- 91	#3-172	#3-185	#4-209	#4-218	
49'- 0"		261	371	623	763	21.989	146	649	810	1175	1380	13.532
STIR		#3-160	#3-181	#3-214	#3-229		#3- 89	#3-173	#3-187	#4-211	#4-220	
PROPERTIES FOR DESIGN (CONCRETE 0.82 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.13	1.92	2.40	2.82	3.20		1.49	2.64	3.02	4.69	7.58	
ACTUAL STEEL %	0.420	0.714	0.892	1.053	1.200		0.555	0.987	1.128	1.755	2.852	
EFF. DEPTH, IN.	26.38	26.38	26.38	26.25	26.19		26.31	26.25	26.25	26.25	26.12	
$-I_{cr}/I_{gr}$	0.126	0.194	0.230	0.256	0.280		0.157	0.244	0.269	0.368	0.494	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.58	1.79	2.27	2.54		0.93	1.58	1.79	2.27	2.54	
ACTUAL STEEL %	0.331	0.566	0.641	0.815	0.913		0.331	0.566	0.641	0.815	0.913	
EFF. DEPTH, IN.	26.69	26.50	26.46	26.40	26.36		26.69	26.50	26.46	26.40	26.36	
$+I_{cr}/I_{gr}$	0.134	0.214	0.240	0.295	0.325		0.134	0.214	0.240	0.295	0.325	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 8	# 8	Int. Span Defl. Coeff. (2)
AT	8	5	4	7	8		9.5	8	8.5	9.5	5	
BOTTOM BARS NO	2# 4	1# 6	2# 7	2# 8	1# 8		2# 4	1# 6	2# 7	2# 8	1# 8	
BARS NO	2# 5	2# 7	1# 8	1# 8	2# 9		2# 5	2# 7	1# 8	1# 8	2# 9	
STEEL (PSF)	1.01	1.60	2.01	2.41	2.82		1.50	2.47	3.14	3.66	5.75	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	350	930	1255	1606	1989	7.149	794	1638	2111	2621	3179	4.399
STIR	#3- 85	#3-149	#3-161	#4-184	#4-195		#3-105	#3-133	#4-164	#5-173	#5-173	
38'- 0"	299	849	1157	1490	1853	7.953	721	1521	1969	2452	2982	4.894
STIR	#3- 82	#3-150	#3-169	#4-186	#4-198		#3-105	#3-140	#4-167	#4-177	#5-176	
39'- 0"	252	774	1067	1382	1728	8.824	652	1412	1837	2296	2799	5.430
STIR	#3- 79	#3-150	#3-171	#3-189	#4-202		#3-104	#3-148	#4-170	#4-181	#5-180	
40'- 0"	208	705	983	1283	1611	9.765	589	1311	1716	2152	2630	6.009
STIR	#3- 76	#3-151	#3-173	#3-191	#4-205		#3-103	#3-155	#4-172	#4-183	#5-182	
41'- 0"	168	641	905	1191	1503	10.778	530	1218	1603	2018	2473	6.633
STIR	#3- 73	#3-152	#3-174	#3-194	#4-208		#3-103	#3-157	#3-175	#4-186	#5-186	
42'- 0"	131	581	833	1105	1403	11.869	476	1131	1498	1894	2327	7.304
STIR	#3- 70	#3-152	#3-176	#3-173	#4-211		#3-101	#3-158	#3-176	#4-189	#5-192	
43'- 0"	96	525	766	1026	1310	13.040	425	1050	1400	1778	2191	8.025
STIR	#3- 66	#3-152	#3-177	#3-182	#4-214		#3-100	#3-160	#3-179	#4-192	#5-197	
44'- 0"	63	473	703	951	1223	14.296	378	974	1309	1669	2064	8.798
STIR	#3- 62	#3-152	#3-179	#3-190	#4-217		#3- 99	#3-161	#3-155	#4-194	#5-203	
45'- 0"	33	425	645	882	1141	15.641	333	904	1224	1568	1946	9.625
STIR	#3- 58	#3-152	#3-180	#3-199	#4-219		#3- 97	#3-162	#3-162	#4-197	#5-208	
46'- 0"	4	380	590	817	1065	17.078	292	838	1144	1474	1835	10.510
STIR	#3- 53	#3-152	#3-181	#3-203	#3-222		#3- 95	#3-163	#3-169	#4-200	#4-212	
47'- 0"		337	539	756	994	18.613	253	776	1069	1385	1731	11.454
STIR		#3-151	#3-181	#3-205	#3-225		#3- 93	#3-164	#3-177	#4-203	#4-215	
48'- 0"		297	491	699	927	20.248	217	718	999	1302	1634	12.460
STIR		#3-151	#3-182	#3-206	#3-227		#3- 91	#3-165	#3-184	#4-205	#4-217	
49'- 0"		260	445	645	864	21.989	183	664	934	1224	1543	13.532
STIR		#3-150	#3-183	#3-208	#3-230		#3- 89	#3-166	#3-188	#4-207	#4-221	
PROPERTIES FOR DESIGN (CONCRETE 0.85 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.23	1.96	2.45	3.08	3.68		1.60	2.69	3.46	4.07	7.74	
ACTUAL STEEL %	0.415	0.664	0.830	1.049	1.255		0.543	0.918	1.181	1.395	2.651	
EFF. DEPTH, IN.	26.38	26.38	26.38	26.25	26.19		26.31	26.25	26.19	26.12	26.12	
$-I_{cr}/I_{gr}$	0.128	0.187	0.222	0.261	0.295		0.158	0.236	0.283	0.316	0.483	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.37	2.79		1.02	1.64	1.99	2.37	2.79	
ACTUAL STEEL %	0.331	0.535	0.650	0.775	0.913		0.331	0.535	0.650	0.775	0.913	
EFF. DEPTH, IN.	26.71	26.58	26.54	26.50	26.45		26.71	26.58	26.54	26.50	26.45	
$+I_{cr}/I_{gr}$	0.135	0.207	0.246	0.287	0.330		0.135	0.207	0.246	0.287	0.330	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 5	# 6	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 8	# 8	Int. Span Defl. Coeff. (2)
AT	7	7	8	7	8.5		8	7.5	8	9	6	
BOTTOM BARS NO	1# 5	1# 8	1# 7	1#10	1#10		1# 5	1# 8	1# 7	1#10	1#10	
BARS NO	2# 6	1# 9	2# 8	1#10	1#11		2# 6	1# 9	2# 8	1#10	1#11	
STEEL (PSF)	1.13	1.79	2.13	2.58	2.85		1.73	2.69	3.29	3.94	5.19	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	473	1028	1396	1716	1979	7.149	990	1797	2332	2798	3180	4.399
STIR	#3- 95	#3-148	#3-159	#4-182	#4-190		#3-113	#3-133	#4-164	#5-173	#5-178	
38'- 0"	414	940	1289	1592	1841	7.953	904	1670	2176	2618	2980	4.894
STIR	#3- 94	#3-149	#3-168	#4-184	#4-193		#3-113	#3-141	#4-167	#5-176	#5-181	
39'- 0"	359	859	1190	1478	1714	8.824	825	1551	2032	2452	2796	5.430
STIR	#3- 91	#3-150	#3-172	#3-187	#4-196		#3-112	#3-148	#4-169	#4-179	#5-185	
40'- 0"	309	784	1098	1372	1597	9.765	751	1442	1899	2298	2625	6.009
STIR	#3- 89	#3-151	#3-174	#3-190	#4-199		#3-112	#3-155	#4-173	#4-182	#5-187	
41'- 0"	262	714	1013	1274	1488	10.778	683	1340	1776	2155	2466	6.633
STIR	#3- 86	#3-152	#3-175	#3-169	#4-202		#3-112	#3-156	#4-175	#4-185	#5-191	
42'- 0"	218	649	934	1183	1387	11.869	620	1246	1661	2023	2319	7.304
STIR	#3- 83	#3-152	#3-177	#3-177	#4-204		#3-111	#3-158	#4-177	#4-188	#5-195	
43'- 0"	178	589	861	1098	1292	13.040	561	1158	1554	1899	2182	8.025
STIR	#3- 80	#3-152	#3-178	#3-186	#4-207		#3-110	#3-159	#3-179	#4-190	#5-198	
44'- 0"	140	532	792	1019	1205	14.296	505	1076	1454	1784	2054	8.798
STIR	#3- 77	#3-152	#3-180	#3-195	#3-210		#3-109	#3-160	#3-154	#4-193	#4-200	
45'- 0"	105	480	728	945	1122	15.641	454	1000	1361	1676	1934	9.625
STIR	#3- 74	#3-152	#3-181	#3-198	#3-212		#3-108	#3-162	#3-161	#4-195	#4-204	
46'- 0"	72	431	668	876	1046	17.078	406	928	1274	1576	1823	10.510
STIR	#3- 70	#3-152	#3-182	#3-200	#3-191		#3-107	#3-163	#3-169	#4-199	#4-206	
47'- 0"	41	385	612	811	974	18.613	361	861	1193	1481	1718	11.454
STIR	#3- 66	#3-151	#3-183	#3-202	#3-199		#3-105	#3-164	#3-176	#4-201	#4-209	
48'- 0"	11	341	560	750	906	20.248	319	798	1116	1393	1620	12.460
STIR	#3- 61	#3-151	#3-184	#3-204	#3-208		#3-103	#3-165	#3-183	#4-203	#4-212	
49'- 0"		301	510	693	843	21.989	279	739	1044	1310	1528	13.532
STIR		#3-150	#3-184	#3-205	#3-217		#3-102	#3-165	#3-189	#4-205	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.89 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.43	2.21	2.75	3.14	3.53		1.94	2.93	3.75	4.39	6.58	
ACTUAL STEEL %	0.444	0.690	0.860	0.982	1.106		0.604	0.917	1.175	1.380	2.069	
EFF. DEPTH, IN.	26.38	26.31	26.25	26.25	26.19		26.31	26.25	26.19	26.12	26.12	
$-I_{cr}/I_{gr}$	0.138	0.195	0.229	0.254	0.275		0.175	0.241	0.287	0.320	0.422	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.19	1.79	2.18	2.54	2.83		1.19	1.79	2.18	2.54	2.83	
ACTUAL STEEL %	0.356	0.539	0.656	0.767	0.856		0.356	0.539	0.656	0.767	0.856	
EFF. DEPTH, IN.	26.64	26.46	26.52	26.36	26.33		26.64	26.46	26.52	26.36	26.33	
$+I_{cr}/I_{gr}$	0.145	0.208	0.249	0.282	0.309		0.145	0.208	0.249	0.282	0.309	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 7″ Ribs @ 60″ c.-c. 15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	10	8	10	9		10	8	9	7	8	
BOTTOM BARS NO	2# 4	1# 6	1# 7	1# 7	1# 8		2# 4	1# 6	1# 7	1# 7	1# 8	
BARS NO	1# 4	1# 6	1# 7	1# 8	1# 8		1# 4	1# 6	1# 7	1# 8	1# 8	
STEEL (PSF)	0.57	0.77	1.02	1.18	1.35		0.81	1.13	1.55	2.35	2.77	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	171	491	857	1072	1286	2.344	492	959	1490	1803	2115	1.443
STIR	#3- 68	#3-107	#3-116	#3-141	#3-147		#3- 82	#3-108	#3-127	#4-130	#4-128	
29'- 0"	123	422	762	963	1163	2.698	422	857	1353	1644	1935	1.660
STIR	#3- 66	#3-108	#3-124	#3-144	#3-151		#3- 82	#3-111	#3-130	#3-136	#4-131	
30'- 0"	80	359	677	865	1051	3.090	360	766	1229	1501	1773	1.901
STIR	#3- 63	#3-108	#3-133	#3-147	#3-154		#3- 81	#3-113	#3-133	#3-140	#4-135	
31'- 0"	41	302	600	776	951	3.523	303	683	1117	1372	1626	2.168
STIR	#3- 60	#3-109	#3-136	#3-149	#3-157		#3- 81	#3-114	#3-135	#3-143	#4-141	
32'- 0"	5	251	530	695	859	4.000	251	608	1015	1255	1493	2.461
STIR	#3- 57	#3-108	#3-138	#3-152	#3-160		#3- 80	#3-115	#3-137	#3-145	#4-147	
33'- 0"		204	467	622	776	4.523	204	540	923	1148	1372	2.784
STIR		#3-108	#3-140	#3-138	#3-163		#3- 79	#3-116	#3-140	#3-148	#4-153	
34'- 0"		161	409	554	700	5.097	161	478	838	1050	1262	3.137
STIR		#3-108	#3-141	#3-147	#3-166		#3- 77	#3-117	#3-143	#3-151	#3-158	
35'- 0"		122	355	493	630	5.724	122	420	761	961	1160	3.522
STIR		#3-107	#3-142	#3-155	#3-168		#3- 76	#3-118	#3-145	#3-154	#3-161	
36'- 0"		86	307	437	566	6.407	86	368	690	879	1067	3.942
STIR		#3-106	#3-144	#3-158	#3-171		#3- 74	#3-118	#3-131	#3-157	#3-164	
37'- 0"		52	262	385	507	7.149	53	320	624	803	982	4.399
STIR		#3-105	#3-145	#3-160	#3-173		#3- 72	#3-119	#3-138	#3-159	#3-167	
38'- 0"		22	220	337	453	7.953	22	275	564	734	903	4.894
STIR		#3-103	#3-145	#3-161	#3-162		#3- 69	#3-119	#3-146	#3-162	#3-170	
39'- 0"			182	293	403	8.824		234	508	669	830	5.430
STIR			#3-146	#3-163	#3-170			#3-119	#3-150	#3-163	#3-172	
40'- 0"			146	252	357	9.765		196	457	610	763	6.009
STIR			#3-146	#3-164	#3-178			#3-119	#3-152	#3-166	#3-175	
PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.20	1.20	1.50	1.86	2.07		1.20	1.50	2.07	3.77	4.50	
ACTUAL STEEL %	0.765	0.765	0.957	1.191	1.324		0.765	0.957	1.324	2.425	2.906	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.31	18.31		18.38	18.38	18.31	18.25	18.19	
$-I_{cr}/I_{gr}$	0.160	0.160	0.190	0.221	0.238		0.160	0.190	0.238	0.354	0.392	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.88	1.20	1.39	1.58		0.60	0.88	1.20	1.39	1.58	
ACTUAL STEEL %	0.361	0.533	0.729	0.846	0.962		0.361	0.533	0.729	0.846	0.962	
EFF. DEPTH, IN.	18.75	18.62	18.56	18.53	18.50		18.75	18.62	18.56	18.53	18.50	
$+I_{cr}/I_{gr}$	0.119	0.168	0.222	0.253	0.283		0.119	0.168	0.222	0.253	0.283	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 8″ Ribs @ 61″ c.-c. 15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	9.5	8	7	9.5		10	7	9.5	8	6	
BOTTOM BARS NO	1# 5	1# 6	1# 5	1# 7	1# 8		1# 5	1# 6	1# 5	1# 7	1# 8	
BARS NO	1# 5	1# 7	2# 6	1# 8	1# 8		1# 5	1# 7	2# 6	1# 8	1# 8	
STEEL (PSF)	0.60	0.85	0.95	1.14	1.31		0.84	1.28	1.44	1.73	2.72	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	166	649	826	1047	1261	2.344	497	1199	1457	1778	2089	1.443
STIR	#3- 57	#3-112	#3-122	#3-134	#3-141		#3- 75	#3-102	#3-122	#3-129	#4-128	
29'- 0"	117	567	732	938	1137	2.698	425	1080	1320	1619	1910	1.660
STIR	#3- 54	#3-113	#3-124	#3-120	#3-145		#3- 74	#3-110	#3-124	#3-131	#4-134	
30'- 0"	72	493	647	839	1026	3.090	361	972	1196	1476	1748	1.901
STIR	#3- 51	#3-114	#3-126	#3-128	#3-148		#3- 73	#3-116	#3-127	#3-134	#4-140	
31'- 0"	32	426	570	750	925	3.523	302	875	1085	1347	1601	2.168
STIR	#3- 47	#3-114	#3-127	#3-137	#3-150		#3- 72	#3-118	#3-129	#3-137	#4-143	
32'- 0"		365	501	670	834	4.000	249	787	984	1229	1468	2.461
STIR		#3-114	#3-128	#3-141	#3-152		#3- 70	#3-119	#3-116	#3-139	#3-146	
33'- 0"		310	437	596	750	4.523	201	706	891	1122	1347	2.784
STIR		#3-114	#3-129	#3-143	#3-136		#3- 68	#3-120	#3-123	#3-142	#3-149	
34'- 0"		259	379	529	674	5.097	156	633	807	1025	1236	3.137
STIR		#3-114	#3-130	#3-144	#3-145		#3- 66	#3-122	#3-131	#3-144	#3-152	
35'- 0"		213	326	468	605	5.724	116	565	730	935	1135	3.522
STIR		#3-114	#3-130	#3-146	#3-153		#3- 64	#3-123	#3-134	#3-147	#3-154	
36'- 0"		171	278	411	541	6.407	79	504	659	853	1042	3.942
STIR		#3-113	#3-131	#3-147	#3-159		#3- 61	#3-123	#3-136	#3-149	#3-157	
37'- 0"		132	233	359	482	7.149	45	447	594	778	957	4.399
STIR		#3-113	#3-131	#3-148	#3-161		#3- 59	#3-124	#3-137	#3-134	#3-160	
38'- 0"		96	192	311	428	7.953	13	394	534	708	878	4.894
STIR		#3-112	#3-131	#3-149	#3-163		#3- 56	#3-125	#3-138	#3-141	#3-162	
39'- 0"		62	153	267	378	8.824		346	479	644	805	5.430
STIR		#3-110	#3-131	#3-150	#3-164			#3-125	#3-140	#3-148	#3-165	
40'- 0"		31	118	226	331	9.765		301	427	585	737	6.009
STIR		#3-109	#3-130	#3-151	#3-166			#3-126	#3-141	#3-154	#3-167	
PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.22	1.28	1.52	1.74	1.99		1.22	1.74	1.99	2.36	4.47	
ACTUAL STEEL %	0.697	0.733	0.871	0.995	1.141		0.697	0.995	1.141	1.355	2.575	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.31		18.38	18.38	18.31	18.31	18.25	
$-I_{cr}/I_{gr}$	0.152	0.158	0.181	0.200	0.219		0.152	0.200	0.219	0.248	0.377	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	1.04	1.19	1.39	1.58		0.62	1.04	1.19	1.39	1.58	
ACTUAL STEEL %	0.337	0.567	0.647	0.760	0.865		0.337	0.567	0.647	0.760	0.865	
EFF. DEPTH, IN.	18.69	18.59	18.64	18.53	18.50		18.69	18.59	18.64	18.53	18.50	
$+I_{cr}/I_{gr}$	0.111	0.178	0.203	0.231	0.258		0.111	0.178	0.203	0.231	0.258	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 9″ Ribs @ 62″ c.-c. 15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	8.5	7.5	9.5	8.5		10	9.5	8.5	7	4	
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.64	0.92	1.05	1.30	1.45		0.88	1.43	1.61	1.98	2.89	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	247	800	949	1236	1471	2.344	627	1431	1648	2064	2406	1.443
STIR	#3- 62	#3-115	#3-123	#3-136	#3-143		#3- 78	#3- 98	#3-122	#4-130	#4-130	
29'- 0"	191	706	845	1112	1331	2.698	545	1294	1496	1885	2203	1.660
STIR	#3- 60	#3-116	#3-124	#3-139	#3-146		#3- 78	#3-105	#3-124	#4-132	#4-134	
30'- 0"	140	622	751	1001	1205	3.090	470	1171	1360	1723	2020	1.901
STIR	#3- 57	#3-117	#3-126	#3-125	#3-149		#3- 77	#3-113	#3-127	#3-136	#4-140	
31'- 0"	94	545	666	900	1092	3.523	403	1060	1236	1576	1855	2.168
STIR	#3- 53	#3-118	#3-127	#3-133	#3-152		#3- 76	#3-120	#3-129	#3-139	#4-144	
32'- 0"	52	475	589	808	988	4.000	342	958	1124	1443	1704	2.461
STIR	#3- 50	#3-118	#3-128	#3-142	#3-155		#3- 75	#3-122	#3-116	#3-141	#4-147	
33'- 0"	14	412	519	725	894	4.523	287	866	1022	1322	1568	2.784
STIR	#3- 46	#3-119	#3-129	#3-145	#3-157		#3- 73	#3-124	#3-123	#3-144	#4-150	
34'- 0"		354	455	649	808	5.097	236	782	928	1211	1443	3.137
STIR		#3-119	#3-130	#3-147	#3-142		#3- 71	#3-125	#3-131	#3-146	#3-153	
35'- 0"		301	396	579	730	5.724	190	705	843	1110	1328	3.522
STIR		#3-119	#3-131	#3-149	#3-150		#3- 69	#3-126	#3-134	#3-149	#3-155	
36'- 0"		252	342	515	658	6.407	147	634	765	1017	1223	3.942
STIR		#3-118	#3-131	#3-150	#3-159		#3- 67	#3-127	#3-136	#3-150	#3-158	
37'- 0"		207	293	457	591	7.149	108	569	693	931	1127	4.399
STIR		#3-118	#3-131	#3-151	#3-163		#3- 65	#3-128	#3-137	#3-152	#3-161	
38'- 0"		166	247	402	530	7.953	72	509	626	852	1038	4.894
STIR		#3-117	#3-131	#3-152	#3-165		#3- 62	#3-129	#3-139	#3-137	#3-164	
39'- 0"		128	205	352	473	8.824	38	453	565	779	956	5.430
STIR		#3-116	#3-131	#3-153	#3-167		#3- 59	#3-130	#3-140	#3-145	#3-166	
40'- 0"		93	166	306	421	9.765	8	402	508	712	879	6.009
STIR		#3-115	#3-131	#3-154	#3-168		#3- 56	#3-130	#3-141	#3-152	#3-168	
PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.24	1.46	1.65	2.02	2.26		1.24	2.02	2.26	2.75	4.80	
ACTUAL STEEL %	0.641	0.754	0.854	1.050	1.173		0.641	1.050	1.173	1.424	2.493	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.31	18.31		18.38	18.31	18.31	18.31	18.31	
$-I_{cr}/I_{gr}$	0.145	0.165	0.182	0.210	0.228		0.145	0.210	0.228	0.262	0.381	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.349	0.588	0.652	0.785	0.891		0.349	0.588	0.652	0.785	0.891	
EFF. DEPTH, IN.	18.72	18.64	18.62	18.50	18.46		18.72	18.64	18.62	18.50	18.46	
$+I_{cr}/I_{gr}$	0.117	0.187	0.205	0.238	0.266		0.117	0.187	0.205	0.238	0.266	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

53″ Forms + 10″ Ribs @ 63″ c.-c.
15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 7	Int. Span Defl. Coeff. (2)
AT	10	8.5	7	9.5	7.5		10	10	7.5	7	7	
BOTTOM BARS NO	3# 3	1# 5	2# 6	1# 6	2# 7		3# 3	1# 5	2# 6	1# 6	2# 7	
BARS NO	2# 4	2# 6	1# 7	2# 7	1# 8		2# 4	2# 6	1# 7	2# 7	1# 8	
STEEL (PSF)	0.65	0.91	1.16	1.27	1.59		0.89	1.38	1.82	1.94	3.19	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	248	775	1106	1287	1681	2.344	639	1406	1887	2151	2724	1.443
STIR	#3- 54	#3-107	#3-124	#3-114	#4-144		#3- 73	#3-108	#3-123	#4-128	#4-129	
29'- 0"	189	681	989	1158	1526	2.698	554	1269	1717	1963	2498	1.660
STIR	#3- 51	#3-108	#3-126	#3-122	#3-147		#3- 72	#3-111	#3-125	#4-130	#4-133	
30'- 0"	137	596	884	1042	1385	3.090	478	1146	1565	1794	2294	1.901
STIR	#3- 47	#3-108	#3-127	#3-131	#3-150		#3- 70	#3-113	#3-128	#3-133	#4-138	
31'- 0"	89	519	789	937	1259	3.523	408	1034	1426	1642	2109	2.168
STIR	#3- 43	#3-108	#3-129	#3-137	#3-153		#3- 69	#3-114	#3-130	#3-135	#4-145	
32'- 0"	46	450	703	842	1143	4.000	346	933	1301	1503	1942	2.461
STIR	#3- 39	#3-108	#3-130	#3-139	#3-155		#3- 67	#3-115	#3-113	#3-139	#4-149	
33'- 0"	7	386	624	755	1039	4.523	288	841	1187	1377	1789	2.784
STIR	#3- 34	#3-108	#3-131	#3-141	#3-158		#3- 65	#3-116	#3-120	#3-141	#4-152	
34'- 0"		328	553	676	943	5.097	236	756	1082	1261	1650	3.137
STIR		#3-108	#3-132	#3-142	#3-160		#3- 63	#3-117	#3-128	#3-143	#4-154	
35'- 0"		275	487	603	855	5.724	188	679	987	1156	1523	3.522
STIR		#3-107	#3-133	#3-144	#3-147		#3- 61	#3-118	#3-135	#3-146	#4-157	
36'- 0"		227	427	536	775	6.407	144	608	899	1059	1406	3.942
STIR		#3-106	#3-133	#3-145	#3-156		#3- 58	#3-119	#3-138	#3-130	#4-160	
37'- 0"		182	371	475	701	7.149	104	543	819	970	1298	4.399
STIR		#3-105	#3-134	#3-146	#3-165		#3- 55	#3-119	#3-139	#3-137	#3-163	
38'- 0"		141	320	419	633	7.953	67	483	744	887	1199	4.894
STIR		#3-103	#3-134	#3-147	#3-167		#3- 52	#3-119	#3-141	#3-144	#3-165	
39'- 0"		102	273	366	569	8.824	32	428	676	812	1107	5.430
STIR		#3-102	#3-134	#3-147	#3-169		#3- 48	#3-120	#3-142	#3-151	#3-168	
40'- 0"		67	229	318	511	9.765		376	612	741	1022	6.009
STIR		#3-100	#3-134	#3-148	#3-170			#3-120	#3-143	#3-152	#3-170	
PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.26	1.48	1.80	2.06	2.60		1.26	1.95	2.60	2.79	5.40	
ACTUAL STEEL %	0.595	0.700	0.850	0.974	1.234		0.595	0.925	1.234	1.322	2.578	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.31	18.31		18.38	18.31	18.31	18.31	18.19	
$-I_{cr}/I_{gr}$	0.139	0.158	0.184	0.202	0.241		0.139	0.195	0.241	0.253	0.389	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.73	1.19	1.48	1.64	1.99		0.73	1.19	1.48	1.64	1.99	
ACTUAL STEEL %	0.328	0.538	0.671	0.744	0.904		0.328	0.538	0.671	0.744	0.904	
EFF. DEPTH, IN.	18.78	18.64	18.60	18.58	18.54		18.78	18.64	18.60	18.58	18.54	
$+I_{cr}/I_{gr}$	0.112	0.174	0.211	0.231	0.274		0.112	0.174	0.211	0.231	0.274	

SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

53″ Forms + 7″ Ribs @ 60″ c.-c.
19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	8	7	9.5	8		10	9	8	9.5	7	
BOTTOM BARS NO	2# 4	1# 7	1# 7	1# 8	1# 8		2# 4	1# 7	1# 7	1# 8	1# 8	
BARS NO	1# 5	1# 7	1# 8	1# 8	1# 9		1# 5	1# 7	1# 8	1# 8	1# 9	
STEEL (PSF)	0.65	1.02	1.15	1.33	1.51		0.89	1.55	1.75	2.07	3.15	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	191	713	914	1115	1335	4.000	543	1303	1596	1888	2208	2.461
STIR	#3- 77	#3-135	#3-136	#3-157	#3-166		#3- 93	#3-136	#3-143	#4-150	#4-148	
33'- 0"	144	635	825	1013	1221	4.523	476	1190	1466	1740	2042	2.784
STIR	#3- 74	#3-136	#3-144	#3-161	#3-168		#3- 93	#3-114	#3-146	#4-153	#4-151	
34'- 0"	102	565	743	921	1116	5.097	414	1087	1347	1606	1889	3.137
STIR	#3- 72	#3-138	#3-151	#3-163	#3-171		#3- 92	#3-121	#3-149	#4-156	#4-155	
35'- 0"	63	500	668	836	1020	5.724	358	993	1238	1482	1750	3.522
STIR	#3- 69	#3-139	#3-153	#3-143	#3-174		#3- 92	#3-128	#3-151	#3-159	#4-161	
36'- 0"	28	440	599	758	932	6.407	306	907	1138	1369	1622	3.942
STIR	#3- 66	#3-139	#3-154	#3-151	#3-178		#3- 91	#3-136	#3-154	#3-162	#4-167	
37'- 0"		386	536	686	851	7.149	259	827	1046	1265	1504	4.399
STIR		#3-140	#3-156	#3-159	#3-180		#3- 89	#3-143	#3-156	#3-164	#4-172	
38'- 0"		335	478	620	777	7.953	215	754	961	1169	1396	4.894
STIR		#3-141	#3-157	#3-168	#3-183		#3- 88	#3-145	#3-158	#3-167	#4-175	
39'- 0"		289	424	559	708	8.824	174	686	883	1080	1295	5.430
STIR		#3-141	#3-158	#3-172	#3-186		#3- 87	#3-147	#3-138	#3-169	#4-177	
40'- 0"		245	374	503	644	9.765	137	623	811	997	1203	6.009
STIR		#3-141	#3-160	#3-174	#3-165		#3- 85	#3-148	#3-145	#3-173	#3-181	
41'- 0"		205	328	450	584	10.778	102	565	743	921	1116	6.633
STIR		#3-141	#3-160	#3-175	#3-173		#3- 83	#3-149	#3-152	#3-175	#3-183	
42'- 0"		168	285	402	529	11.869	70	511	681	850	1036	7.304
STIR		#3-141	#3-161	#3-177	#3-181		#3- 81	#3-150	#3-160	#3-177	#3-186	
43'- 0"		133	245	356	478	13.040	40	460	623	784	962	8.025
STIR		#3-141	#3-162	#3-178	#3-190		#3- 79	#3-152	#3-166	#3-179	#3-189	
44'- 0"		101	208	314	430	14.296	12	413	568	723	892	8.798
STIR		#3-140	#3-162	#3-180	#3-194		#3- 76	#3-153	#3-168	#3-181	#3-191	
PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.20	1.50	1.71	1.96	2.33		1.20	2.07	2.33	2.78	5.14	
ACTUAL STEEL %	0.605	0.756	0.864	0.990	1.176		0.605	1.045	1.176	1.411	2.619	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.31	22.31		22.38	22.31	22.31	22.25	22.19	
$-I_{cr}/I_{gr}$	0.144	0.172	0.190	0.209	0.237		0.144	0.217	0.237	0.267	0.399	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.71	1.20	1.39	1.58	1.79		0.71	1.20	1.39	1.58	1.79	
ACTUAL STEEL %	0.340	0.578	0.670	0.763	0.865		0.340	0.578	0.670	0.763	0.865	
EFF. DEPTH, IN.	22.72	22.56	22.53	22.50	22.46		22.72	22.56	22.53	22.50	22.46	
$+I_{cr}/I_{gr}$	0.120	0.194	0.221	0.248	0.277		0.120	0.194	0.221	0.248	0.277	

SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 8″ Ribs @ 61″ c.-c. 19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	7.5	10	8.5	7.5		9.5	8.5	7.5	6	5	
BOTTOM BARS NO	1# 4	2# 6	2# 6	1# 8	1# 9		1# 4	2# 6	2# 6	1# 8	1# 9	
BARS NO	2# 5	1# 6	1# 7	1# 9	1# 9		2# 5	1# 6	1# 7	1# 9	1# 9	
STEEL (PSF)	0.68	1.06	1.22	1.47	1.67		0.95	1.62	1.85	2.28	3.33	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	279	815	985	1305	1525	4.000	686	1466	1713	2178	2498	2.461
STIR	#3- 82	#3-134	#3-141	#3-159	#4-166		#3- 97	#3-135	#3-141	#4-150	#4-151	
33'- 0"	225	730	890	1190	1397	4.523	608	1342	1574	2012	2312	2.784
STIR	#3- 80	#3-135	#3-146	#3-161	#4-168		#3- 96	#3-115	#3-144	#4-153	#4-153	
34'- 0"	177	652	802	1086	1280	5.097	537	1228	1447	1859	2142	3.137
STIR	#3- 77	#3-137	#3-147	#3-164	#3-172		#3- 96	#3-122	#3-147	#4-156	#4-157	
35'- 0"	132	580	722	990	1173	5.724	472	1124	1331	1720	1987	3.522
STIR	#3- 75	#3-138	#3-149	#3-166	#3-174		#3- 96	#3-130	#3-149	#4-160	#4-162	
36'- 0"	91	515	649	902	1075	6.407	412	1029	1224	1592	1844	3.942
STIR	#3- 72	#3-138	#3-151	#3-149	#3-177		#3- 95	#3-137	#3-151	#4-162	#4-168	
37'- 0"	53	454	582	821	985	7.149	358	941	1126	1474	1713	4.399
STIR	#3- 69	#3-139	#3-152	#3-157	#3-180		#3- 94	#3-143	#3-154	#4-165	#4-172	
38'- 0"	18	399	519	746	902	7.953	307	860	1036	1366	1592	4.894
STIR	#3- 65	#3-140	#3-153	#3-165	#3-183		#3- 93	#3-144	#3-137	#3-168	#4-174	
39'- 0"		347	462	677	825	8.824	260	785	952	1265	1480	5.430
STIR		#3-140	#3-154	#3-173	#3-185		#3- 92	#3-146	#3-144	#3-170	#4-177	
40'- 0"		300	409	613	754	9.765	217	716	875	1172	1377	6.009
STIR		#3-140	#3-155	#3-175	#3-164		#3- 90	#3-147	#3-151	#3-173	#4-180	
41'- 0"		256	359	554	688	10.778	177	652	803	1086	1281	6.633
STIR		#3-140	#3-156	#3-177	#3-173		#3- 89	#3-148	#3-159	#3-176	#4-184	
42'- 0"		215	313	499	627	11.869	140	592	736	1006	1192	7.304
STIR		#3-140	#3-156	#3-179	#3-181		#3- 87	#3-149	#3-160	#3-178	#4-186	
43'- 0"		176	271	448	569	13.040	105	537	674	931	1108	8.025
STIR		#3-139	#3-157	#3-180	#3-190		#3- 85	#3-151	#3-162	#3-180	#3-188	
44'- 0"		141	231	400	516	14.296	72	485	616	862	1031	8.798
STIR		#3-139	#3-157	#3-182	#3-194		#3- 83	#3-151	#3-163	#3-183	#3-192	
PROPERTIES FOR DESIGN (CONCRETE 0.67 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.22	1.63	1.89	2.22	2.52		1.28	2.22	2.52	3.15	5.37	
ACTUAL STEEL %	0.553	0.737	0.860	1.011	1.146		0.582	1.011	1.146	1.433	2.448	
EFF. DEPTH, IN.	22.38	22.38	22.31	22.31	22.31		22.38	22.31	22.31	22.31	22.25	
$-I_{cr}/I_{gr}$	0.137	0.172	0.192	0.217	0.238		0.143	0.217	0.238	0.279	0.395	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.82	1.32	1.48	1.79	2.00		0.82	1.32	1.48	1.79	2.00	
ACTUAL STEEL %	0.354	0.572	0.642	0.780	0.873		0.354	0.572	0.642	0.780	0.873	
EFF. DEPTH, IN.	22.70	22.62	22.60	22.46	22.44		22.70	22.62	22.60	22.46	22.44	
$+I_{cr}/I_{gr}$	0.126	0.194	0.215	0.253	0.279		0.126	0.194	0.215	0.253	0.279	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 9″ Ribs @ 62″ c.-c. 19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	7.5	9.5	7.5	7		9	8.5	7	8	6	
BOTTOM BARS NO	1# 6	1# 7	1# 6	2# 7	1# 7		1# 6	1# 7	1# 6	2# 7	1# 7	
BARS NO	1# 6	1# 8	2# 7	1# 8	2# 8		1# 6	1# 8	2# 7	1# 8	2# 8	
STEEL (PSF)	0.75	1.10	1.28	1.61	1.71		1.04	1.67	1.96	2.46	3.62	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	310	853	1125	1494	1693	4.000	745	1535	1930	2467	2757	2.461
STIR	#3- 77	#3-130	#3-140	#3-159	#4-164		#3- 94	#3-114	#4-142	#4-151	#5-148	
33'- 0"	253	764	1019	1366	1554	4.523	662	1405	1776	2281	2554	2.784
STIR	#3- 75	#3-131	#3-146	#3-163	#4-168		#3- 93	#3-121	#3-144	#4-154	#5-152	
34'- 0"	201	682	922	1249	1426	5.097	586	1286	1636	2111	2368	3.137
STIR	#3- 73	#3-132	#3-148	#3-165	#4-171		#3- 93	#3-129	#3-147	#4-157	#4-155	
35'- 0"	153	607	834	1143	1309	5.724	517	1177	1507	1956	2198	3.522
STIR	#3- 70	#3-132	#3-149	#3-168	#3-174		#3- 92	#3-135	#3-149	#4-160	#4-161	
36'- 0"	109	538	753	1045	1202	6.407	453	1077	1389	1813	2043	3.942
STIR	#3- 67	#3-133	#3-151	#3-147	#3-176		#3- 91	#3-137	#3-151	#4-163	#4-167	
37'- 0"	69	475	678	954	1103	7.149	394	985	1280	1682	1899	4.399
STIR	#3- 63	#3-133	#3-152	#3-155	#3-180		#3- 90	#3-139	#3-153	#4-166	#4-171	
38'- 0"	32	417	609	871	1013	7.953	340	901	1180	1561	1767	4.894
STIR	#3- 59	#3-133	#3-153	#3-164	#3-182		#3- 89	#3-140	#3-136	#4-168	#4-175	
39'- 0"		363	546	794	929	8.824	290	822	1088	1449	1645	5.430
STIR		#3-133	#3-155	#3-172	#3-185		#3- 87	#3-141	#3-143	#4-171	#4-177	
40'- 0"		313	487	723	851	9.765	244	750	1002	1346	1532	6.009
STIR		#3-133	#3-155	#3-176	#3-166		#3- 86	#3-142	#3-151	#3-174	#4-181	
41'- 0"		267	432	657	779	10.778	201	682	923	1250	1427	6.633
STIR		#3-133	#3-156	#3-178	#3-174		#3- 84	#3-143	#3-158	#3-177	#4-183	
42'- 0"		224	381	596	711	11.869	161	620	849	1161	1329	7.304
STIR		#3-132	#3-157	#3-180	#3-183		#3- 82	#3-144	#3-161	#3-179	#4-186	
43'- 0"		184	334	539	649	13.040	124	562	780	1078	1238	8.025
STIR		#3-131	#3-157	#3-181	#3-191		#3- 80	#3-145	#3-162	#3-182	#4-188	
44'- 0"		147	290	485	591	14.296	89	507	716	1000	1153	8.798
STIR		#3-130	#3-158	#3-183	#3-193		#3- 77	#3-146	#3-164	#3-183	#4-191	
PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.24	1.65	2.02	2.56	2.75		1.38	2.26	2.75	3.41	6.20	
ACTUAL STEEL %	0.510	0.680	0.835	1.058	1.133		0.567	0.933	1.133	1.412	2.576	
EFF. DEPTH, IN.	22.38	22.38	22.31	22.31	22.31		22.38	22.31	22.31	22.25	22.19	
$-I_{cr}/I_{gr}$	0.131	0.165	0.191	0.229	0.240		0.142	0.208	0.240	0.279	0.413	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.88	1.39	1.64	1.99	2.18		0.88	1.39	1.64	1.99	2.18	
ACTUAL STEEL %	0.347	0.551	0.648	0.788	0.864		0.347	0.551	0.648	0.788	0.864	
EFF. DEPTH, IN.	22.62	22.53	22.58	22.54	22.52		22.62	22.53	22.58	22.54	22.52	
$+I_{cr}/I_{gr}$	0.123	0.187	0.218	0.259	0.281		0.123	0.187	0.218	0.259	0.281	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 10″ Ribs @ 63″ c.-c. 19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	10	7	9	7.5	9		8.5	8	9.5	10	7	
BOTTOM BARS NO	2# 5	2# 6	2# 6	2# 6	2# 8		2# 5	2# 6	2# 6	2# 6	2# 8	
BARS NO	1# 5	1# 7	2# 6	2# 7	1# 8		1# 5	1# 7	2# 6	2# 7	1# 8	
STEEL (PSF)	0.74	1.16	1.42	1.66	1.87		1.06	1.76	2.14	2.63	3.37	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	336	924	1226	1564	1862	4.000	797	1653	2092	2583	3016	2.461
STIR	#3- 73	#3-128	#3-143	#3-156	#4-165		#3- 91	#3-117	#4-141	#4-149	#5-154	
33'- 0"	276	829	1113	1431	1710	4.523	709	1514	1926	2389	2796	2.784
STIR	#3- 70	#3-128	#3-145	#3-159	#4-167		#3- 90	#3-124	#4-143	#4-152	#5-158	
34'- 0"	221	741	1009	1308	1572	5.097	629	1387	1776	2211	2595	3.137
STIR	#3- 67	#3-129	#3-146	#3-162	#4-170		#3- 89	#3-132	#3-146	#4-156	#5-161	
35'- 0"	170	662	914	1196	1445	5.724	555	1270	1637	2048	2410	3.522
STIR	#3- 64	#3-130	#3-148	#3-145	#4-174		#3- 89	#3-134	#3-148	#4-158	#4-165	
36'- 0"	124	588	827	1094	1329	6.407	488	1164	1511	1899	2241	3.942
STIR	#3- 61	#3-130	#3-149	#3-153	#3-177		#3- 87	#3-135	#3-151	#4-161	#4-168	
37'- 0"	81	521	747	999	1222	7.149	426	1065	1394	1762	2086	4.399
STIR	#3- 57	#3-130	#3-151	#3-162	#3-179		#3- 86	#3-137	#3-131	#4-164	#4-171	
38'- 0"	42	458	673	912	1123	7.953	368	975	1286	1635	1942	4.894
STIR	#3- 53	#3-130	#3-152	#3-169	#3-182		#3- 85	#3-138	#3-138	#4-167	#4-174	
39'- 0"	5	401	604	832	1032	8.824	315	891	1187	1518	1809	5.430
STIR	#3- 49	#3-130	#3-153	#3-170	#3-184		#3- 83	#3-139	#3-145	#4-169	#4-177	
40'- 0"		348	541	757	948	9.765	266	814	1095	1409	1687	6.009
STIR		#3-130	#3-153	#3-172	#3-166		#3- 81	#3-140	#3-153	#3-171	#4-179	
41'- 0"		298	482	688	869	10.778	221	742	1009	1309	1573	6.633
STIR		#3-129	#3-154	#3-174	#3-175		#3- 79	#3-141	#3-158	#3-174	#4-183	
42'- 0"		252	428	624	797	11.869	179	675	930	1215	1467	7.304
STIR		#3-128	#3-155	#3-175	#3-183		#3- 77	#3-142	#3-160	#3-176	#4-185	
43'- 0"		210	377	564	729	13.040	139	613	856	1128	1368	8.025
STIR		#3-127	#3-155	#3-176	#3-191		#3- 74	#3-142	#3-161	#3-178	#4-188	
44'- 0"		170	329	508	666	14.296	103	555	787	1047	1276	8.798
STIR		#3-126	#3-155	#3-178	#3-193		#3- 71	#3-143	#3-163	#3-180	#4-190	
PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.26	1.80	2.17	2.60	3.08		1.48	2.44	2.92	3.78	5.40	
ACTUAL STEEL %	0.475	0.678	0.820	0.984	1.168		0.558	0.923	1.106	1.438	2.054	
EFF. DEPTH, IN.	22.38	22.38	22.31	22.31	22.25		22.38	22.31	22.25	22.19	22.19	
$-I_{cr}/I_{gr}$	0.126	0.167	0.192	0.221	0.248		0.143	0.210	0.239	0.286	0.365	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.93	1.48	1.76	2.08	2.37		0.93	1.48	1.76	2.08	2.37	
ACTUAL STEEL %	0.336	0.537	0.638	0.755	0.863		0.336	0.537	0.638	0.755	0.863	
EFF. DEPTH, IN.	22.69	22.60	22.62	22.59	22.50		22.69	22.60	22.62	22.59	22.50	
$+I_{cr}/I_{gr}$	0.122	0.185	0.218	0.253	0.282		0.122	0.185	0.218	0.253	0.282	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 7″ Ribs @ 60″ c.-c. 23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 5	# 5		End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5		Int. Span Defl. Coeff. (2)
AT	10	7	8.5	7.5			8.5	8	6	4		
BOTTOM BARS NO	1# 6	1# 7	1# 8	1# 9			1# 6	1# 7	1# 8	1# 9		
BARS NO	1# 6	1# 8	1# 9	1# 9			1# 6	1# 8	1# 9	1# 9		
STEEL (PSF)	0.77	1.15	1.49	1.69			1.09	1.75	2.30	3.07		
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	204	684	1057	1252		7.149	588	1286	1828	2111		4.399
STIR	#3- 93	#3-152	#3-177	#3-185			#3-111	#3-129	#4-169	#4-175		
38'- 0"	161	616	969	1154		7.953	524	1186	1700	1968		4.894
STIR	#3- 91	#3-153	#3-154	#3-188			#3-110	#3-136	#4-172	#4-178		
39'- 0"	120	552	888	1063		8.824	465	1093	1581	1836		5.430
STIR	#3- 88	#3-154	#3-162	#3-192			#3-110	#3-143	#4-175	#4-181		
40'- 0"	83	493	812	979		9.765	411	1008	1472	1714		6.009
STIR	#3- 86	#3-155	#3-171	#3-194			#3-110	#3-151	#4-178	#4-185		
41'- 0"	48	439	742	901		10.778	360	928	1370	1601		6.633
STIR	#3- 83	#3-156	#3-179	#3-197			#3-109	#3-158	#3-181	#4-188		
42'- 0"	16	388	677	828		11.869	313	855	1276	1495		7.304
STIR	#3- 80	#3-157	#3-186	#3-199			#3-108	#3-161	#3-184	#4-190		
43'- 0"		341	617	761		13.040	269	786	1188	1397		8.025
STIR		#3-157	#3-188	#3-177			#3-107	#3-163	#3-186	#4-194		
44'- 0"		297	560	698		14.296	228	722	1106	1306		8.798
STIR		#3-157	#3-190	#3-185			#3-106	#3-164	#3-188	#4-197		
45'- 0"		256	508	639		15.641	190	662	1029	1220		9.625
STIR		#3-157	#3-192	#3-194			#3-105	#3-165	#3-191	#4-199		
46'- 0"		217	458	584		17.078	155	606	957	1140		10.510
STIR		#3-157	#3-193	#3-202			#3-103	#3-167	#3-193	#3-201		
47'- 0"		181	412	533		18.613	121	554	890	1065		11.454
STIR		#3-157	#3-194	#3-208			#3-102	#3-168	#3-195	#3-204		
48'- 0"		147	369	485		20.248	90	505	827	995		12.460
STIR		#3-157	#3-196	#3-210			#3-100	#3-169	#3-197	#3-207		
49'- 0"		116	328	439		21.989	61	459	768	929		13.532
STIR		#3-156	#3-197	#3-212			#3- 98	#3-170	#3-176	#3-209		
PROPERTIES FOR DESIGN (CONCRETE 0.71 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.20	1.71	2.19	2.48			1.41	2.33	3.10	4.65		
ACTUAL STEEL %	0.495	0.707	0.905	1.025			0.582	0.961	1.282	1.922		
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31			26.38	26.31	26.31	26.31		
$-I_{cr}/I_{gr}$	0.131	0.174	0.209	0.229			0.149	0.218	0.269	0.356		
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.88	1.39	1.79	2.00			0.88	1.39	1.79	2.00		
ACTUAL STEEL %	0.347	0.549	0.709	0.792			0.347	0.549	0.709	0.792		
EFF. DEPTH, IN.	26.62	26.53	26.46	26.44			26.62	26.53	26.46	26.44		
$+I_{cr}/I_{gr}$	0.129	0.196	0.247	0.272			0.129	0.196	0.247	0.272		
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 8″ Ribs @ 61″ c.-c. 23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	10	8.5	9.5	8		8	7	9	5	5	
BOTTOM BARS NO	2# 5	1# 8	1# 8	1# 9	1#10		2# 5	1# 8	1# 8	1# 9	1#10	
BARS NO	1# 5	1# 8	1# 9	1#10	1#10		1# 5	1# 8	1# 9	1#10	1#10	
STEEL (PSF)	0.75	1.29	1.47	1.87	2.16		1.11	1.99	2.23	3.47	4.42	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	219	827	1022	1465	1713	7.149	624	1509	1793	2438	2799	4.399
STIR	#3- 85	#3-155	#3-162	#4-187	#4-195		#3-105	#3-155	#4-163	#5-176	#5-171	
38'- 0"	172	749	934	1354	1589	7.953	557	1395	1665	2276	2618	4.894
STIR	#3- 83	#3-156	#3-168	#4-190	#4-198		#3-105	#3-133	#4-166	#4-179	#5-174	
39'- 0"	129	677	852	1252	1475	8.824	495	1291	1546	2127	2452	5.430
STIR	#3- 80	#3-157	#3-170	#3-193	#4-202		#3-104	#3-140	#3-169	#4-183	#5-178	
40'- 0"	90	610	777	1156	1369	9.765	437	1194	1437	1989	2297	6.009
STIR	#3- 77	#3-158	#3-172	#3-196	#4-204		#3-103	#3-147	#3-171	#4-186	#5-180	
41'- 0"	53	548	707	1068	1270	10.778	383	1104	1335	1860	2154	6.633
STIR	#3- 74	#3-159	#3-174	#3-198	#4-208		#3-102	#3-155	#3-173	#4-189	#5-185	
42'- 0"	19	491	642	986	1179	11.869	334	1020	1240	1741	2021	7.304
STIR	#3- 70	#3-160	#3-175	#3-201	#4-211		#3-101	#3-162	#3-175	#4-192	#5-191	
43'- 0"		437	581	910	1094	13.040	287	942	1152	1630	1897	8.025
STIR		#3-160	#3-176	#3-204	#4-214		#3-100	#3-165	#3-178	#4-195	#4-198	
44'- 0"		387	525	839	1014	14.296	244	869	1070	1526	1782	8.798
STIR		#3-161	#3-177	#3-181	#3-216		#3- 98	#3-166	#3-157	#4-198	#4-204	
45'- 0"		340	472	772	940	15.641	204	802	994	1430	1674	9.625
STIR		#3-161	#3-179	#3-189	#3-220		#3- 97	#3-168	#3-164	#4-200	#4-209	
46'- 0"		297	423	710	870	17.078	166	738	922	1339	1573	10.510
STIR		#3-161	#3-179	#3-198	#3-222		#3- 95	#3-169	#3-172	#4-203	#4-212	
47'- 0"		256	377	652	805	18.613	131	679	855	1254	1478	11.454
STIR		#3-161	#3-180	#3-206	#3-225		#3- 93	#3-170	#3-179	#4-206	#4-214	
48'- 0"		218	334	597	744	20.248	97	623	792	1175	1389	12.460
STIR		#3-161	#3-181	#3-213	#3-227		#3- 91	#3-171	#3-185	#4-209	#4-218	
49'- 0"		181	293	546	687	21.989	66	570	732	1100	1306	13.532
STIR		#3-161	#3-181	#3-214	#3-229		#3- 89	#3-173	#3-187	#4-211	#4-220	
PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.22	1.89	2.22	2.83	3.36		1.52	2.70	2.98	5.37	7.32	
ACTUAL STEEL %	0.454	0.705	0.830	1.056	1.255		0.567	1.007	1.115	2.007	2.745	
EFF. DEPTH, IN.	26.38	26.31	26.31	26.25	26.25		26.38	26.31	26.25	26.25	26.19	
$-I_{cr}/I_{gr}$	0.125	0.176	0.200	0.237	0.269		0.149	0.231	0.247	0.372	0.450	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.58	1.79	2.27	2.54		0.93	1.58	1.79	2.27	2.54	
ACTUAL STEEL %	0.331	0.566	0.641	0.815	0.913		0.331	0.566	0.641	0.815	0.913	
EFF. DEPTH, IN.	26.69	26.50	26.46	26.40	26.36		26.69	26.50	26.46	26.40	26.36	
$+I_{cr}/I_{gr}$	0.125	0.202	0.226	0.279	0.308		0.125	0.202	0.226	0.279	0.308	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 9″ Ribs @ 62″ c.-c. 23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 6	# 7	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 7	# 8	Int. Span Defl. Coeff. (2)
AT	10	9.5	8	9	10		7.5	7	8	9	6	
BOTTOM BARS NO	2# 4	1# 6	2# 7	2# 8	1# 8		2# 4	1# 6	2# 7	2# 8	1# 8	
BARS NO	2# 5	2# 7	1# 8	1# 8	2# 9		2# 5	2# 7	1# 8	1# 8	2# 9	
STEEL (PSF)	0.80	1.28	1.58	1.89	2.24		1.20	1.96	2.46	2.93	4.71	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	270	852	1179	1532	1919	7.149	715	1563	2038	2551	3114	4.399
STIR	#3- 85	#3-149	#3-160	#4-183	#4-195		#3-105	#3-133	#4-164	#5-174	#5-171	
38'- 0"	219	771	1081	1416	1782	7.953	641	1444	1895	2382	2915	4.894
STIR	#3- 82	#3-150	#3-168	#4-187	#4-199		#3-105	#3-140	#4-167	#4-177	#5-174	
39'- 0"	172	696	990	1308	1656	8.824	573	1335	1763	2225	2731	5.430
STIR	#3- 80	#3-151	#3-172	#3-189	#4-202		#3-104	#3-148	#4-170	#4-181	#5-177	
40'- 0"	128	627	906	1208	1539	9.765	510	1234	1641	2080	2562	6.009
STIR	#3- 77	#3-152	#3-173	#3-192	#4-205		#3-103	#3-155	#4-172	#4-183	#5-180	
41'- 0"	88	562	829	1116	1431	10.778	451	1141	1528	1946	2404	6.633
STIR	#3- 73	#3-152	#3-175	#3-195	#4-208		#3-102	#3-157	#3-175	#4-186	#5-184	
42'- 0"	51	503	756	1030	1330	11.869	396	1054	1423	1821	2257	7.304
STIR	#3- 70	#3-153	#3-177	#3-173	#4-211		#3-101	#3-158	#3-176	#4-189	#5-190	
43'- 0"	16	447	689	950	1236	13.040	345	973	1325	1705	2121	8.025
STIR	#3- 66	#3-153	#3-178	#3-181	#4-214		#3-100	#3-159	#3-179	#4-192	#5-197	
44'- 0"		395	626	875	1149	14.296	298	897	1233	1596	1994	8.798
STIR		#3-153	#3-179	#3-190	#4-217		#3- 98	#3-161	#3-155	#4-194	#5-203	
45'- 0"		346	567	806	1067	15.641	254	826	1148	1495	1875	9.625
STIR		#3-153	#3-180	#3-198	#4-220		#3- 97	#3-162	#3-162	#4-197	#5-209	
46'- 0"		301	512	741	991	17.078	212	760	1068	1400	1764	10.510
STIR		#3-153	#3-181	#3-203	#4-222		#3- 95	#3-163	#3-169	#4-200	#4-212	
47'- 0"		258	461	680	919	18.613	173	698	993	1311	1660	11.454
STIR		#3-152	#3-182	#3-205	#3-225		#3- 93	#3-164	#3-177	#4-203	#4-214	
48'- 0"		218	413	622	852	20.248	137	640	923	1228	1562	12.460
STIR		#3-152	#3-183	#3-207	#3-228		#3- 91	#3-165	#3-184	#4-205	#4-218	
49'- 0"		181	367	568	789	21.989	103	586	857	1149	1470	13.532
STIR		#3-151	#3-184	#3-208	#3-230		#3- 88	#3-166	#3-188	#4-207	#4-220	
PROPERTIES FOR DESIGN (CONCRETE 0.76 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.24	2.02	2.40	3.03	3.72		1.65	2.75	3.41	4.13	8.16	
ACTUAL STEEL %	0.420	0.687	0.816	1.032	1.270		0.560	0.932	1.161	1.411	2.796	
EFF. DEPTH, IN.	26.38	26.31	26.31	26.25	26.19		26.38	26.31	26.25	26.19	26.12	
$-I_{cr}/I_{gr}$	0.119	0.176	0.201	0.238	0.275		0.151	0.222	0.260	0.296	0.461	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.37	2.79		1.02	1.64	1.99	2.37	2.79	
ACTUAL STEEL %	0.331	0.535	0.650	0.775	0.913		0.331	0.535	0.650	0.775	0.913	
EFF. DEPTH, IN.	26.71	26.58	26.54	26.50	26.45		26.71	26.58	26.54	26.50	26.45	
$+I_{cr}/I_{gr}$	0.127	0.195	0.232	0.271	0.313		0.127	0.195	0.232	0.271	0.313	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 10″ Ribs @ 63″ c.-c. 23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 5	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	9	9	7	9	10		10	9.5	10	8.5	6	
BOTTOM BARS NO	1# 5	1# 8	1# 7	1#10	1#10		1# 5	1# 8	1# 7	1#10	1#10	
BARS NO	2# 6	1# 9	2# 8	1#10	1#11		2# 6	1# 9	2# 8	1#10	1#11	
STEEL (PSF)	0.90	1.41	1.69	2.04	2.31		1.38	2.13	2.62	3.17	4.03	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	394	951	1321	1643	1908	7.149	911	1722	2260	2729	3114	4.399
STIR	#3- 96	#3-149	#3-159	#4-182	#4-189		#3-113	#3-133	#4-165	#5-173	#5-178	
38'- 0"	334	863	1213	1519	1770	7.953	825	1594	2104	2548	2913	4.894
STIR	#3- 94	#3-150	#3-168	#4-185	#4-193		#3-113	#3-140	#4-167	#5-176	#5-182	
39'- 0"	280	782	1114	1404	1643	8.824	746	1476	1959	2382	2728	5.430
STIR	#3- 92	#3-151	#3-172	#4-188	#4-196		#3-113	#3-148	#4-170	#5-179	#5-185	
40'- 0"	229	706	1022	1298	1525	9.765	672	1366	1826	2227	2557	6.009
STIR	#3- 89	#3-151	#3-174	#3-190	#4-199		#3-112	#3-155	#4-172	#4-182	#5-188	
41'- 0"	182	636	937	1200	1415	10.778	604	1264	1702	2084	2398	6.633
STIR	#3- 87	#3-152	#3-175	#3-168	#4-202		#3-112	#3-156	#4-175	#4-185	#5-191	
42'- 0"	139	571	858	1108	1314	11.869	540	1170	1587	1951	2250	7.304
STIR	#3- 84	#3-152	#3-177	#3-177	#4-205		#3-111	#3-158	#4-177	#4-187	#5-194	
43'- 0"	98	511	784	1023	1219	13.040	481	1082	1480	1827	2112	8.025
STIR	#3- 81	#3-152	#3-178	#3-185	#4-207		#3-110	#3-159	#3-179	#4-190	#5-198	
44'- 0"	60	454	715	944	1131	14.296	426	1000	1380	1711	1984	8.798
STIR	#3- 77	#3-153	#3-180	#3-194	#3-210		#3-109	#3-161	#3-182	#4-193	#4-200	
45'- 0"	25	401	651	869	1048	15.641	375	923	1286	1603	1864	9.625
STIR	#3- 74	#3-152	#3-181	#3-199	#3-212		#3-108	#3-162	#3-161	#4-195	#4-204	
46'- 0"		352	591	800	971	17.078	326	851	1199	1502	1751	10.510
STIR		#3-152	#3-182	#3-201	#3-190		#3-107	#3-163	#3-168	#4-199	#4-206	
47'- 0"		306	535	735	899	18.613	281	784	1117	1408	1646	11.454
STIR		#3-152	#3-183	#3-202	#3-199		#3-105	#3-164	#3-175	#4-201	#4-209	
48'- 0"		263	482	674	831	20.248	239	721	1040	1319	1548	12.460
STIR		#3-151	#3-184	#3-204	#3-207		#3-104	#3-165	#3-183	#4-203	#4-212	
49'- 0"		222	433	616	767	21.989	199	662	968	1236	1455	13.532
STIR		#3-150	#3-184	#3-206	#3-216		#3-102	#3-166	#3-189	#4-205	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.79 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.40	2.17	2.79	3.08	3.78		1.95	2.92	3.78	4.45	6.30	
ACTUAL STEEL %	0.435	0.676	0.870	0.963	1.185		0.609	0.912	1.185	1.394	1.975	
EFF. DEPTH, IN.	26.38	26.31	26.31	26.25	26.19		26.31	26.25	26.19	26.19	26.19	
$-I_{cr}/I_{gr}$	0.125	0.177	0.215	0.231	0.267		0.163	0.221	0.267	0.300	0.380	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	1.19	1.79	2.18	2.54	2.83		1.19	1.79	2.18	2.54	2.83	
ACTUAL STEEL %	0.356	0.539	0.656	0.767	0.856		0.356	0.539	0.656	0.767	0.856	
EFF. DEPTH, IN.	26.64	26.46	26.52	26.36	26.33		26.64	26.46	26.52	26.36	26.33	
$+I_{cr}/I_{gr}$	0.136	0.196	0.235	0.267	0.293		0.136	0.196	0.235	0.267	0.293	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 6″ Ribs @ 72″ c.-c. 13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4		End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 5		Int. Span Defl. Coeff. (2)
AT	10	10	10	10			10	10	9.5	9.5		
BOTTOM BARS NO	1# 4	1# 5	1# 6	1# 6			1# 4	1# 5	1# 6	1# 6		
BARS NO	1# 5	1# 6	1# 6	1# 7			1# 5	1# 6	1# 6	1# 7		
STEEL (PSF)	0.48	0.60	0.68	0.75			0.72	0.84	0.94	1.30		
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	159	497	678	901		1.265	491	982	1246	1569		0.779
STIR	#3- 73	#3-102	#3- 99	#3-122			#3- 80	#3-103	#3-110	#3-115		
25'- 0"	102	413	580	785		1.490	407	860	1104	1401		0.917
STIR	#3- 72	#3-104	#3-108	#3-125			#3- 81	#3-105	#3-112	#3-118		
26'- 0"	51	339	494	683		1.743	334	752	977	1253		1.073
STIR	#3- 70	#3-105	#3-116	#3-128			#3- 81	#3- 94	#3-114	#3-122		
27'- 0"	6	273	416	592		2.027	268	656	865	1120		1.247
STIR	#3- 68	#3-106	#3-118	#3-131			#3- 81	#3-101	#3-118	#3-124		
28'- 0"		213	347	510		2.344	209	570	764	1002		1.443
STIR		#3-107	#3-119	#3-133			#3- 81	#3-109	#3-120	#3-128		
29'- 0"		160	285	437		2.698	156	493	674	895		1.660
STIR		#3-107	#3-121	#3-123			#3- 81	#3-110	#3-122	#3-130		
30'- 0"		112	229	371		3.090	109	423	592	799		1.901
STIR		#3-108	#3-122	#3-131			#3- 80	#3-112	#3-107	#3-133		
31'- 0"		69	178	311		3.523	65	360	518	712		2.168
STIR		#3-108	#3-123	#3-137			#3- 79	#3-113	#3-114	#3-135		
32'- 0"		30	132	257		4.000	26	302	451	633		2.461
STIR		#3-108	#3-124	#3-139			#3- 78	#3-114	#3-121	#3-139		
33'- 0"			90	207		4.523		250	390	561		2.784
STIR			#3-125	#3-141				#3-115	#3-128	#3-141		
34'- 0"			52	162		5.097		203	335	496		3.137
STIR			#3-125	#3-142				#3-116	#3-129	#3-143		
35'- 0"			17	121		5.724		159	284	435		3.522
STIR			#3-126	#3-143				#3-117	#3-131	#3-145		
36'- 0"				83		6.407		119	237	380		3.942
STIR				#3-145				#3-118	#3-132	#3-148		
PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.44	1.44	1.44	1.44			1.44	1.44	1.52	2.35		
ACTUAL STEEL %	1.194	1.194	1.194	1.194			1.194	1.194	1.257	1.957		
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38			16.38	16.38	16.38	16.31		
$-I_{cr}/I_{gr}$	0.198	0.198	0.198	0.198			0.198	0.198	0.205	0.275		
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.51	0.75	0.88	1.04			0.51	0.75	0.88	1.04		
ACTUAL STEEL %	0.397	0.585	0.688	0.814			0.397	0.585	0.688	0.814		
EFF. DEPTH, IN.	16.71	16.65	16.62	16.59			16.71	16.65	16.62	16.59		
$+I_{cr}/I_{gr}$	0.118	0.169	0.195	0.227			0.118	0.169	0.195	0.227		
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 4	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	10	9.5	8		10	10	8	7	8	
BOTTOM BARS NO	1# 4	1# 6	1# 6	1# 7	1# 7		1# 4	1# 6	1# 6	1# 7	1# 7	
BARS NO	1# 5	1# 6	1# 7	1# 7	1# 8		1# 5	1# 6	1# 7	1# 7	1# 8	
STEEL (PSF)	0.48	0.67	0.74	0.84	0.97		0.72	0.91	1.10	1.28	2.02	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	136	655	878	1099	1360	1.265	468	1223	1546	1869	2249	0.779
STIR	#3- 60	#3-104	#3-116	#3-122	#3-128		#3- 72	#3-104	#3-110	#3-116	#4-120	
25'- 0"	79	557	762	966	1207	1.490	384	1081	1379	1676	2026	0.917
STIR	#3- 58	#3-106	#3-104	#3-125	#3-132		#3- 71	#3-106	#3-114	#3-118	#4-114	
26'- 0"	28	471	660	849	1071	1.743	311	954	1230	1504	1828	1.073
STIR	#3- 55	#3-107	#3-112	#3-129	#3-136		#3- 71	#3-109	#3-116	#3-121	#4-117	
27'- 0"		393	569	744	950	2.027	245	842	1097	1352	1652	1.247
STIR		#3-108	#3-120	#3-131	#3-138		#3- 70	#3- 98	#3-118	#3-125	#4-122	
28'- 0"		324	487	650	842	2.344	186	741	979	1215	1494	1.443
STIR		#3-109	#3-122	#3-133	#3-142		#3- 69	#3-105	#3-122	#3-128	#3-127	
29'- 0"		262	414	566	745	2.698	133	651	872	1093	1353	1.660
STIR		#3-110	#3-124	#3-121	#3-145		#3- 68	#3-112	#3-124	#3-131	#3-133	
30'- 0"		206	348	490	657	3.090	85	569	776	982	1225	1.901
STIR		#3-111	#3-125	#3-130	#3-148		#3- 66	#3-114	#3-126	#3-134	#3-139	
31'- 0"		155	288	421	577	3.523	42	495	689	882	1110	2.168
STIR		#3-111	#3-127	#3-138	#3-150		#3- 65	#3-115	#3-129	#3-137	#3-144	
32'- 0"		109	234	358	505	4.000	3	428	610	791	1005	2.461
STIR		#3-111	#3-128	#3-140	#3-153		#3- 63	#3-117	#3-117	#3-139	#3-146	
33'- 0"		67	184	302	440	4.523		367	538	709	910	2.784
STIR		#3-111	#3-129	#3-142	#3-155			#3-118	#3-124	#3-141	#3-150	
34'- 0"		29	139	250	380	5.097		312	473	633	822	3.137
STIR		#3-110	#3-129	#3-143	#3-144			#3-119	#3-132	#3-144	#3-153	
35'- 0"			98	202	325	5.724		261	412	564	743	3.522
STIR			#3-130	#3-145	#3-153			#3-120	#3-134	#3-145	#3-155	
36'- 0"			60	159	275	6.407		214	357	501	669	3.942
STIR			#3-130	#3-146	#3-160			#3-121	#3-135	#3-147	#3-157	
PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.46	1.46	1.46	1.54	1.83		1.46	1.46	1.83	2.09	4.01	
ACTUAL STEEL %	1.066	1.066	1.066	1.122	1.332		1.066	1.066	1.332	1.523	2.958	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38	16.38		16.38	16.38	16.38	16.38	16.25	
$-I_{cr}/I_{gr}$	0.186	0.186	0.186	0.193	0.219		0.186	0.186	0.219	0.241	0.362	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.88	1.04	1.20	1.39		0.51	0.88	1.04	1.20	1.39	
ACTUAL STEEL %	0.351	0.609	0.721	0.832	0.966		0.351	0.609	0.721	0.832	0.966	
EFF. DEPTH, IN.	16.71	16.62	16.59	16.56	16.53		16.71	16.62	16.59	16.56	16.53	
$+I_{cr}/I_{gr}$	0.106	0.175	0.203	0.231	0.264		0.106	0.175	0.203	0.231	0.264	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 8″ Ribs @ 74″ c.-c. 13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 4	# 4	Int. Span Defl. Coeff. (2)
AT	10	10	10	10	8.5		10	10	8.5	7	5	
BOTTOM BARS NO	2# 4	1# 6	1# 6	1# 5	1# 7		2# 4	1# 6	1# 6	1# 5	1# 7	
BARS NO	1# 4	1# 6	1# 7	2# 6	1# 8		1# 4	1# 6	1# 7	2# 6	1# 8	
STEEL (PSF)	0.51	0.67	0.73	0.77	0.94		0.75	0.91	1.06	1.22	1.62	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	243	632	855	1070	1337	1.265	634	1200	1523	1837	2226	0.779
STIR	#3- 65	#3- 97	#3-107	#3-117	#3-124		#3- 75	#3- 87	#3-106	#3-112	#4-116	
25'- 0"	176	534	739	938	1184	1.490	536	1058	1356	1645	2003	0.917
STIR	#3- 63	#3- 98	#3-109	#3-119	#3-127		#3- 75	#3- 94	#3-109	#3-114	#4-120	
26'- 0"	116	448	637	821	1048	1.743	449	931	1207	1474	1805	1.073
STIR	#3- 61	#3- 98	#3-111	#3-110	#3-130		#3- 75	#3-101	#3-112	#3-118	#4-122	
27'- 0"	63	370	546	716	927	2.027	371	819	1074	1322	1629	1.247
STIR	#3- 59	#3- 99	#3-112	#3-118	#3-133		#3- 75	#3-102	#3-113	#3-120	#3-127	
28'- 0"	15	301	464	623	819	2.344	302	718	956	1186	1472	1.443
STIR	#3- 56	#3- 99	#3-114	#3-124	#3-136		#3- 74	#3-104	#3-100	#3-123	#3-129	
29'- 0"		239	391	539	722	2.698	240	628	849	1064	1330	1.660
STIR		#3- 99	#3-115	#3-126	#3-138		#3- 73	#3-105	#3-108	#3-125	#3-132	
30'- 0"		183	325	463	634	3.090	184	546	753	954	1202	1.901
STIR		#3- 99	#3-115	#3-127	#3-126		#3- 72	#3-106	#3-115	#3-127	#3-135	
31'- 0"		132	265	394	554	3.523	133	472	666	854	1087	2.168
STIR		#3- 98	#3-116	#3-129	#3-134		#3- 71	#3-107	#3-119	#3-130	#3-138	
32'- 0"		86	211	332	482	4.000	87	405	587	764	982	2.461
STIR		#3- 98	#3-116	#3-130	#3-142		#3- 69	#3-108	#3-121	#3-132	#3-141	
33'- 0"		44	161	275	417	4.523	45	344	515	681	887	2.784
STIR		#3- 97	#3-117	#3-131	#3-144		#3- 67	#3-108	#3-122	#3-121	#3-143	
34'- 0"		6	116	224	357	5.097	6	288	450	606	799	3.137
STIR		#3- 95	#3-117	#3-132	#3-146		#3- 65	#3-109	#3-123	#3-129	#3-145	
35'- 0"			75	176	302	5.724		237	389	537	720	3.522
STIR			#3-116	#3-133	#3-148			#3-109	#3-124	#3-135	#3-148	
36'- 0"			37	133	252	6.407		191	334	474	646	3.942
STIR			#3-116	#3-133	#3-149			#3-109	#3-125	#3-137	#3-150	
PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.48	1.48	1.48	1.74		1.48	1.48	1.74	2.11	2.96	
ACTUAL STEEL %	0.965	0.965	0.965	0.965	1.135		0.965	0.965	1.135	1.379	1.930	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38	16.38		16.38	16.38	16.38	16.38	16.38	
$-I_{cr}/I_{gr}$	0.177	0.177	0.177	0.177	0.199		0.177	0.177	0.199	0.229	0.289	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.88	1.04	1.19	1.39		0.60	0.88	1.04	1.19	1.39	
ACTUAL STEEL %	0.370	0.546	0.646	0.737	0.867		0.370	0.546	0.646	0.737	0.867	
EFF. DEPTH, IN.	16.75	16.62	16.59	16.64	16.53		16.75	16.62	16.59	16.64	16.53	
$+I_{cr}/I_{gr}$	0.113	0.159	0.185	0.211	0.240		0.113	0.159	0.185	0.211	0.240	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 9″ Ribs @ 75″ c.-c. 13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	10	9	7.5		10	9	7.5	10	7.5	
BOTTOM BARS NO	2# 4	2# 4	1# 5	2# 6	1# 8		2# 4	2# 4	1# 5	2# 6	1# 8	
BARS NO	1# 4	2# 5	2# 6	1# 6	1# 8		1# 4	2# 5	2# 6	1# 6	1# 8	
STEEL (PSF)	0.51	0.70	0.77	0.87	1.07		0.75	1.00	1.17	1.35	2.19	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	220	814	1047	1228	1575	1.265	611	1475	1814	2077	2582	0.779
STIR	#3- 54	#3-100	#3-103	#3-117	#3-125		#3- 68	#3-102	#3-107	#3-111	#4-111	
25'- 0"	152	700	915	1082	1401	1.490	513	1310	1622	1864	2329	0.917
STIR	#3- 52	#3-101	#3-111	#3-119	#3-129		#3- 67	#3- 90	#3-110	#3-115	#4-115	
26'- 0"	93	599	798	952	1247	1.743	426	1162	1451	1675	2105	1.073
STIR	#3- 49	#3-102	#3-113	#3-110	#3-132		#3- 66	#3- 97	#3-113	#3-117	#4-119	
27'- 0"	39	509	693	836	1110	2.027	348	1031	1299	1507	1906	1.247
STIR	#3- 45	#3-103	#3-115	#3-118	#3-134		#3- 65	#3-104	#3-115	#3-120	#4-125	
28'- 0"		428	600	733	987	2.344	279	914	1163	1356	1727	1.443
STIR		#3-104	#3-116	#3-124	#3-137		#3- 64	#3-107	#3-118	#3-123	#4-130	
29'- 0"		356	516	639	877	2.698	217	809	1041	1221	1567	1.660
STIR		#3-104	#3-118	#3-126	#3-139		#3- 62	#3-108	#3-104	#3-125	#3-134	
30'- 0"		291	440	556	778	3.090	161	714	931	1099	1422	1.901
STIR		#3-104	#3-119	#3-127	#3-142		#3- 60	#3-110	#3-111	#3-128	#3-136	
31'- 0"		232	371	480	688	3.523	110	628	831	989	1291	2.168
STIR		#3-104	#3-119	#3-129	#3-131		#3- 58	#3-111	#3-119	#3-130	#3-140	
32'- 0"		178	309	411	606	4.000	64	550	741	888	1172	2.461
STIR		#3-104	#3-120	#3-130	#3-140		#3- 56	#3-112	#3-123	#3-132	#3-143	
33'- 0"		129	252	348	532	4.523	22	479	658	797	1064	2.784
STIR		#3-103	#3-121	#3-131	#3-146		#3- 53	#3-113	#3-125	#3-121	#3-145	
34'- 0"		85	201	291	464	5.097		414	583	714	965	3.137
STIR		#3-102	#3-121	#3-132	#3-148			#3-113	#3-126	#3-128	#3-148	
35'- 0"		44	153	238	401	5.724		355	514	638	875	3.522
STIR		#3-101	#3-121	#3-133	#3-150			#3-114	#3-127	#3-136	#3-150	
36'- 0"		6	110	190	344	6.407		300	451	568	792	3.942
STIR		#3-100	#3-121	#3-133	#3-151			#3-114	#3-128	#3-137	#3-152	
PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.50	1.50	1.50	1.67	2.00		1.50	1.67	2.00	2.33	4.40	
ACTUAL STEEL %	0.884	0.884	0.884	0.982	1.178		0.884	0.982	1.178	1.376	2.615	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38	16.38		16.38	16.38	16.38	16.31	16.25	
$-I_{cr}/I_{gr}$	0.169	0.169	0.169	0.183	0.209		0.169	0.183	0.209	0.231	0.351	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	1.02	1.19	1.32	1.58		0.60	1.02	1.19	1.32	1.58	
ACTUAL STEEL %	0.335	0.571	0.669	0.742	0.894		0.335	0.571	0.669	0.742	0.894	
EFF. DEPTH, IN.	16.75	16.71	16.64	16.62	16.50		16.75	16.71	16.64	16.62	16.50	
$+I_{cr}/I_{gr}$	0.104	0.170	0.194	0.213	0.247		0.104	0.170	0.194	0.213	0.247	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 6″ Ribs @ 72″ c.-c. 15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4			End Span Defl. Coeff. (2)	# 4	# 4	# 4			Int. Span Defl. Coeff. (2)
AT	10	10	10				10	9.5	8			
BOTTOM BARS NO	1# 4	1# 6	1# 6				1# 4	1# 6	1# 6			
BARS NO	1# 5	1# 6	1# 7				1# 5	1# 6	1# 7			
STEEL (PSF)	0.48	0.68	0.75				0.72	0.94	1.11			
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	105	601	814			1.743	421	1144	1453			1.073
STIR	#3- 67	#3-114	#3-126				#3- 79	#3-113	#3-121			
27'- 0"	54	515	712			2.027	348	1018	1305			1.247
STIR	#3- 65	#3-116	#3-129				#3- 79	#3-117	#3-123			
28'- 0"	9	437	620			2.344	282	905	1171			1.443
STIR	#3- 63	#3-118	#3-117				#3- 79	#3-118	#3-126			
29'- 0"		367	538			2.698	223	803	1052			1.660
STIR		#3-119	#3-126				#3- 78	#3-102	#3-129			
30'- 0"		304	464			3.090	169	712	944			1.901
STIR		#3-120	#3-133				#3- 78	#3-109	#3-132			
31'- 0"		248	397			3.523	121	629	847			2.168
STIR		#3-121	#3-135				#3- 77	#3-116	#3-134			
32'- 0"		196	336			4.000	77	554	758			2.461
STIR		#3-122	#3-137				#3- 75	#3-124	#3-136			
33'- 0"		149	281			4.523	37	486	678			2.784
STIR		#3-122	#3-139				#3- 74	#3-126	#3-139			
34'- 0"		106	230			5.097	1	423	604			3.137
STIR		#3-123	#3-140				#3- 72	#3-127	#3-141			
35'- 0"		67	184			5.724		366	537			3.522
STIR		#3-123	#3-141					#3-129	#3-126			
36'- 0"		31	142			6.407		314	475			3.942
STIR		#3-123	#3-142					#3-130	#3-133			
37'- 0"			102			7.149		265	418			4.399
STIR			#3-143					#3-131	#3-141			
38'- 0"			66			7.953		221	366			4.894
STIR			#3-144					#3-132	#3-147			
PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.44	1.44	1.44				1.44	1.52	1.80			
ACTUAL STEEL %	1.041	1.041	1.041				1.041	1.095	1.301			
EFF. DEPTH, IN.	18.38	18.38	18.38				18.38	18.38	18.38			
$-I_{cr}/I_{gr}$	0.188	0.188	0.188				0.188	0.195	0.221			
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.88	1.04				0.51	0.88	1.04			
ACTUAL STEEL %	0.347	0.601	0.711				0.347	0.601	0.711			
EFF. DEPTH, IN.	18.71	18.62	18.59				18.71	18.62	18.59			
$+I_{cr}/I_{gr}$	0.109	0.180	0.210				0.109	0.180	0.210			
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 4	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	9.5	8	7		10	10	7	4	7	
BOTTOM BARS NO	2# 4	1# 6	1# 7	1# 7	1# 8		2# 4	1# 6	1# 7	1# 7	1# 8	
BARS NO	1# 4	1# 6	1# 7	1# 8	1# 8		1# 4	1# 6	1# 7	1# 8	1# 8	
STEEL (PSF)	0.52	0.67	0.84	0.97	1.11		0.76	0.91	1.28	1.87	2.31	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	203	576	1001	1251	1501	1.743	576	1118	1737	2101	2464	1.073
STIR	#3- 72	#3-106	#3-128	#3-134	#3-140		#3- 82	#3- 93	#3-121	#4-124	#4-130	
27'- 0"	144	489	883	1115	1347	2.027	489	992	1565	1903	2240	1.247
STIR	#3- 70	#3-107	#3-130	#3-138	#3-144		#3- 82	#3-100	#3-124	#4-127	#4-124	
28'- 0"	90	412	778	994	1209	2.344	412	879	1412	1726	2039	1.443
STIR	#3- 68	#3-108	#3-115	#3-141	#3-147		#3- 82	#3-108	#3-127	#4-130	#4-127	
29'- 0"	42	342	683	885	1085	2.698	342	778	1275	1567	1859	1.660
STIR	#3- 66	#3-108	#3-124	#3-143	#3-151		#3- 82	#3-111	#3-130	#3-136	#4-130	
30'- 0"		279	598	786	974	3.090	279	686	1151	1424	1697	1.901
STIR		#3-109	#3-132	#3-147	#3-154		#3- 82	#3-113	#3-132	#3-139	#4-134	
31'- 0"		222	521	697	873	3.523	222	604	1038	1295	1550	2.168
STIR		#3-109	#3-137	#3-149	#3-157		#3- 81	#3-114	#3-135	#3-142	#4-141	
32'- 0"		170	451	616	781	4.000	171	528	937	1177	1417	2.461
STIR		#3-109	#3-138	#3-151	#3-160		#3- 80	#3-115	#3-138	#3-145	#4-147	
33'- 0"		123	387	543	698	4.523	124	460	844	1070	1295	2.784
STIR		#3-108	#3-140	#3-139	#3-162		#3- 79	#3-116	#3-140	#3-149	#4-153	
34'- 0"		80	329	475	621	5.097	81	398	759	972	1184	3.137
STIR		#3-108	#3-141	#3-147	#3-166		#3- 77	#3-117	#3-142	#3-150	#3-158	
35'- 0"		41	276	414	552	5.724	41	340	682	882	1083	3.522
STIR		#3-107	#3-143	#3-156	#3-169		#3- 76	#3-118	#3-144	#3-153	#3-161	
36'- 0"		5	227	357	487	6.407	5	288	610	800	990	3.942
STIR		#3-106	#3-144	#3-158	#3-170		#3- 74	#3-119	#3-131	#3-157	#3-164	
37'- 0"			182	305	429	7.149		240	545	725	904	4.399
STIR			#3-145	#3-160	#3-154			#3-119	#3-138	#3-159	#3-167	
38'- 0"			140	257	374	7.953		195	485	655	825	4.894
STIR			#3-146	#3-161	#3-162			#3-119	#3-146	#3-160	#3-170	
PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.46	1.46	1.54	1.83	2.09		1.46	1.46	2.09	3.65	4.59	
ACTUAL STEEL %	0.931	0.931	0.980	1.164	1.330		0.931	0.931	1.330	2.328	2.951	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.38		18.38	18.38	18.38	18.38	18.25	
$-I_{cr}/I_{gr}$	0.177	0.177	0.184	0.208	0.229		0.177	0.177	0.229	0.335	0.380	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.88	1.20	1.39	1.58		0.60	0.88	1.20	1.39	1.58	
ACTUAL STEEL %	0.361	0.533	0.729	0.846	0.962		0.361	0.533	0.729	0.846	0.962	
EFF. DEPTH, IN.	18.75	18.62	18.56	18.53	18.50		18.75	18.62	18.56	18.53	18.50	
$+I_{cr}/I_{gr}$	0.114	0.162	0.214	0.244	0.274		0.114	0.162	0.214	0.244	0.274	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 8″ Ribs @ 74″ c.-c. 15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	10	8.5	7.5		10	8.5	7.5	9.5	7.5	
BOTTOM BARS NO	1# 5	1# 6	1# 5	1# 7	1# 8		1# 5	1# 6	1# 5	1# 7	1# 8	
BARS NO	1# 5	1# 7	2# 6	1# 8	1# 8		1# 5	1# 7	2# 6	1# 8	1# 8	
STEEL (PSF)	0.54	0.73	0.77	0.94	1.08		0.78	1.06	1.18	1.45	2.20	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	202	763	969	1226	1476	1.743	586	1402	1702	2075	2439	1.073
STIR	#3- 63	#3-110	#3-112	#3-129	#3-135		#3- 76	#3-110	#3-116	#4-122	#4-122	
27'- 0"	141	661	852	1090	1322	2.027	497	1254	1531	1878	2214	1.247
STIR	#3- 60	#3-111	#3-120	#3-132	#3-139		#3- 76	#3- 95	#3-119	#4-125	#4-126	
28'- 0"	86	569	747	968	1184	2.344	417	1121	1379	1701	2014	1.443
STIR	#3- 57	#3-112	#3-123	#3-135	#3-142		#3- 75	#3-102	#3-121	#3-129	#4-129	
29'- 0"	36	487	653	859	1060	2.698	345	1001	1242	1542	1834	1.660
STIR	#3- 54	#3-113	#3-124	#3-120	#3-145		#3- 74	#3-110	#3-124	#3-131	#4-134	
30'- 0"		413	568	761	948	3.090	280	893	1118	1399	1672	1.901
STIR		#3-114	#3-126	#3-128	#3-147		#3- 73	#3-116	#3-126	#3-134	#4-140	
31'- 0"		346	491	672	847	3.523	222	796	1006	1269	1525	2.168
STIR		#3-114	#3-127	#3-137	#3-150		#3- 72	#3-118	#3-109	#3-137	#4-144	
32'- 0"		285	421	591	756	4.000	168	707	905	1151	1391	2.461
STIR		#3-114	#3-128	#3-141	#3-153		#3- 70	#3-119	#3-116	#3-140	#3-146	
33'- 0"		230	358	517	672	4.523	120	627	812	1044	1270	2.784
STIR		#3-115	#3-129	#3-143	#3-137		#3- 68	#3-121	#3-124	#3-142	#3-150	
34'- 0"		179	300	450	596	5.097	76	553	728	947	1159	3.137
STIR		#3-114	#3-130	#3-144	#3-145		#3- 66	#3-122	#3-131	#3-145	#3-152	
35'- 0"		133	247	388	526	5.724	35	486	651	857	1057	3.522
STIR		#3-114	#3-131	#3-146	#3-154		#3- 64	#3-123	#3-134	#3-146	#3-155	
36'- 0"		90	198	332	462	6.407		424	580	775	964	3.942
STIR		#3-114	#3-131	#3-147	#3-159			#3-124	#3-136	#3-149	#3-157	
37'- 0"		51	153	280	403	7.149		367	515	699	879	4.399
STIR		#3-113	#3-131	#3-148	#3-161			#3-124	#3-137	#3-133	#3-160	
38'- 0"		15	112	232	349	7.953		314	455	630	800	4.894
STIR		#3-112	#3-131	#3-149	#3-163			#3-125	#3-138	#3-141	#3-163	
PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.48	1.48	1.74	1.97		1.48	1.74	1.97	2.41	4.34	
ACTUAL STEEL %	0.845	0.845	0.845	0.994	1.127		0.845	0.994	1.127	1.384	2.499	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.38		18.38	18.38	18.38	18.31	18.25	
$-I_{cr}/I_{gr}$	0.167	0.167	0.167	0.189	0.208		0.167	0.189	0.208	0.238	0.351	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	1.04	1.19	1.39	1.58		0.62	1.04	1.19	1.39	1.58	
ACTUAL STEEL %	0.337	0.567	0.647	0.760	0.865		0.337	0.567	0.647	0.760	0.865	
EFF. DEPTH, IN.	18.69	18.59	18.64	18.53	18.50		18.69	18.59	18.64	18.53	18.50	
$+I_{cr}/I_{gr}$	0.107	0.171	0.195	0.222	0.249		0.107	0.171	0.195	0.222	0.249	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 9″ Ribs @ 75″ c.-c. 15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span	# 4	# 4	# 5	# 5	# 6	Int. Span
AT	10	10	9	7.5	10	Defl. Coeff. (2)	10	7.5	10	8.5	6.5	Defl. Coeff. (2)
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.57	0.77	0.87	1.07	1.21		0.81	1.17	1.35	1.63	2.50	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	300	944	1117	1450	1724	1.743	741	1676	1928	2413	2811	1.073
STIR	#3- 67	#3-112	#3-111	#3-130	#4-136		#3- 79	#3-112	#3-117	#4-124	#4-121	
27'- 0"	230	826	987	1296	1550	2.027	638	1506	1739	2189	2558	1.247
STIR	#3- 65	#3-114	#3-120	#3-133	#3-140		#3- 79	#3-115	#3-120	#4-127	#4-125	
28'- 0"	167	721	871	1158	1394	2.344	547	1353	1570	1989	2332	1.443
STIR	#3- 62	#3-115	#3-123	#3-136	#3-143		#3- 78	#3- 98	#3-122	#4-130	#4-127	
29'- 0"	110	627	766	1034	1254	2.698	464	1216	1419	1809	2129	1.660
STIR	#3- 60	#3-116	#3-124	#3-139	#3-146		#3- 78	#3-106	#3-124	#4-132	#4-133	
30'- 0"	59	542	672	923	1128	3.090	390	1093	1282	1646	1945	1.901
STIR	#3- 57	#3-117	#3-126	#3-125	#3-149		#3- 77	#3-113	#3-127	#3-136	#4-139	
31'- 0"	13	465	587	822	1014	3.523	323	981	1158	1499	1779	2.168
STIR	#3- 53	#3-118	#3-127	#3-133	#3-152		#3- 76	#3-120	#3-128	#3-139	#4-144	
32'- 0"		396	510	730	911	4.000	262	879	1046	1366	1629	2.461
STIR		#3-118	#3-128	#3-142	#3-154		#3- 75	#3-122	#3-116	#3-142	#4-147	
33'- 0"		332	440	647	817	4.523	206	787	943	1244	1492	2.784
STIR		#3-119	#3-129	#3-145	#3-157		#3- 73	#3-123	#3-123	#3-144	#4-151	
34'- 0"		274	375	570	730	5.097	156	703	850	1134	1366	3.137
STIR		#3-119	#3-130	#3-147	#3-141		#3- 71	#3-125	#3-130	#3-146	#4-153	
35'- 0"		221	317	501	652	5.724	109	625	764	1032	1252	3.522
STIR		#3-119	#3-131	#3-148	#3-150		#3- 69	#3-126	#3-134	#3-148	#3-156	
36'- 0"		172	263	437	579	6.407	67	554	686	939	1147	3.942
STIR		#3-118	#3-131	#3-150	#3-158		#3- 67	#3-127	#3-136	#3-151	#3-159	
37'- 0"		127	213	378	513	7.149	27	489	614	853	1050	4.399
STIR		#3-118	#3-131	#3-151	#3-163		#3- 65	#3-128	#3-137	#3-153	#3-162	
38'- 0"		86	167	323	451	7.953		429	547	774	961	4.894
STIR		#3-117	#3-131	#3-152	#3-165			#3-129	#3-139	#3-137	#3-164	
PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.50	1.50	1.67	2.00	2.33		1.50	2.00	2.33	2.74	5.08	
ACTUAL STEEL %	0.775	0.775	0.861	1.034	1.206		0.775	1.034	1.206	1.419	2.644	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.31		18.38	18.38	18.31	18.31	18.25	
$-I_{cr}/I_{gr}$	0.160	0.160	0.173	0.199	0.220		0.160	0.199	0.220	0.248	0.371	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.349	0.588	0.652	0.785	0.891		0.349	0.588	0.652	0.785	0.891	
EFF. DEPTH, IN.	18.72	18.64	18.62	18.50	18.46		18.72	18.64	18.62	18.50	18.46	
$+I_{cr}/I_{gr}$	0.112	0.180	0.197	0.230	0.256		0.112	0.180	0.197	0.230	0.256	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 6″ Ribs @ 72″ c.-c. 19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4				End Span	# 4	# 4				Int. Span
AT	10	10				Defl. Coeff. (2)	10	8				Defl. Coeff. (2)
BOTTOM BARS NO	1# 5	1# 6					1# 5	1# 6				
BARS NO	1# 5	1# 7					1# 5	1# 7				
STEEL (PSF)	0.54	0.75					0.79	1.11				
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	249	839				2.344	651	1509				1.443
STIR	#3- 81	#3-122					#3- 91	#3-124				
29'- 0"	189	739				2.698	564	1364				1.660
STIR	#3- 80	#3-128					#3- 92	#3-127				
30'- 0"	135	648				3.090	485	1232				1.901
STIR	#3- 78	#3-130					#3- 92	#3-130				
31'- 0"	86	567				3.523	414	1114				2.168
STIR	#3- 76	#3-132					#3- 92	#3-132				
32'- 0"	41	493				4.000	349	1006				2.461
STIR	#3- 74	#3-133					#3- 92	#3-134				
33'- 0"	1	425				4.523	291	908				2.784
STIR	#3- 72	#3-135					#3- 91	#3-117				
34'- 0"		364				5.097	237	819				3.137
STIR		#3-136					#3- 90	#3-124				
35'- 0"		308				5.724	188	737				3.522
STIR		#3-137					#3- 90	#3-131				
36'- 0"		256				6.407	142	661				3.942
STIR		#3-137					#3- 89	#3-139				
37'- 0"		208				7.149	101	592				4.399
STIR		#3-138					#3- 87	#3-142				
38'- 0"		164				7.953	63	528				4.894
STIR		#3-138					#3- 86	#3-143				
39'- 0"		124				8.824	27	469				5.430
STIR		#3-139					#3- 84	#3-145				
40'- 0"		86				9.765		415				6.009
STIR		#3-139						#3-146				
PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.44	1.44					1.44	1.80				
ACTUAL STEEL %	0.818	0.818					0.818	1.023				
EFF. DEPTH, IN.	22.38	22.38					22.38	22.38				
$-I_{cr}/I_{gr}$	0.169	0.169					0.169	0.200				
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	1.04					0.62	1.04				
ACTUAL STEEL %	0.334	0.561					0.334	0.561				
EFF. DEPTH, IN.	22.69	22.59					22.69	22.59				
$+I_{cr}/I_{gr}$	0.112	0.181					0.112	0.181				
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	8.5	7.5	10		10	7	9.5	8	6.5	
BOTTOM BARS NO	2# 4	1# 7	1# 7	1# 8	1# 8		2# 4	1# 7	1# 7	1# 8	1# 8	
BARS NO	1# 5	1# 7	1# 8	1# 8	1# 9		1# 5	1# 7	1# 8	1# 8	1# 9	
STEEL (PSF)	0.58	0.83	0.95	1.09	1.23		0.82	1.28	1.46	1.71	2.52	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
30'- 0" (3)	217	813	1042	1272	1523	3.090	619	1485	1819	2153	2519	1.901
STIR	#3- 80	#3-132	#3-144	#3-152	#4-159		#3- 93	#3-131	#3-138	#4-143	#4-143	
31'- 0"	161	719	934	1149	1384	3.523	537	1348	1662	1974	2317	2.168
STIR	#3- 79	#3-134	#3-127	#3-155	#4-162		#3- 93	#3-133	#3-140	#4-146	#4-146	
32'- 0"	110	633	835	1037	1258	4.000	463	1224	1518	1811	2133	2.461
STIR	#3- 77	#3-135	#3-135	#3-158	#3-166		#3- 93	#3-136	#3-143	#4-149	#4-150	
33'- 0"	64	556	746	935	1143	4.523	396	1112	1388	1663	1966	2.784
STIR	#3- 74	#3-136	#3-144	#3-160	#3-168		#3- 93	#3-115	#3-146	#4-152	#4-152	
34'- 0"	21	485	664	842	1038	5.097	334	1009	1269	1528	1813	3.137
STIR	#3- 72	#3-138	#3-151	#3-163	#3-172		#3- 92	#3-122	#3-149	#4-156	#4-156	
35'- 0"		420	589	757	942	5.724	278	914	1160	1405	1674	3.522
STIR		#3-139	#3-153	#3-143	#3-175		#3- 92	#3-129	#3-151	#3-159	#4-162	
36'- 0"		360	520	679	854	6.407	226	828	1060	1291	1545	3.942
STIR		#3-140	#3-154	#3-151	#3-177		#3- 91	#3-136	#3-154	#3-162	#4-168	
37'- 0"		306	457	608	773	7.149	178	748	968	1187	1427	4.399
STIR		#3-140	#3-156	#3-159	#3-180		#3- 90	#3-143	#3-156	#3-165	#4-172	
38'- 0"		255	398	541	698	7.953	134	674	883	1091	1319	4.894
STIR		#3-141	#3-157	#3-168	#3-182		#3- 88	#3-145	#3-159	#3-168	#4-175	
39'- 0"		208	344	480	629	8.824	94	606	804	1002	1218	5.430
STIR		#3-141	#3-159	#3-172	#3-185		#3- 87	#3-146	#3-138	#3-170	#4-177	
40'- 0"		165	295	424	565	9.765	56	544	732	919	1125	6.009
STIR		#3-142	#3-160	#3-174	#3-164		#3- 85	#3-148	#3-145	#3-172	#3-181	
41'- 0"		125	248	371	506	10.778	21	485	664	843	1039	6.633
STIR		#3-142	#3-161	#3-175	#3-173		#3- 83	#3-149	#3-152	#3-174	#3-184	
42'- 0"		88	205	322	451	11.869		431	602	772	958	7.304
STIR		#3-141	#3-161	#3-177	#3-181			#3-150	#3-160	#3-177	#3-186	
PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.46	1.46	1.72	1.95	2.26		1.46	2.09	2.38	2.83	4.94	
ACTUAL STEEL %	0.736	0.736	0.866	0.981	1.145		0.736	1.052	1.205	1.431	2.508	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.38	22.31		22.38	22.38	22.31	22.31	22.25	
$-I_{cr}/I_{gr}$	0.159	0.159	0.180	0.198	0.220		0.159	0.209	0.228	0.258	0.371	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.20	1.39	1.58	1.79		0.71	1.20	1.39	1.58	1.79	
ACTUAL STEEL %	0.340	0.578	0.670	0.763	0.865		0.340	0.578	0.670	0.763	0.865	
EFF. DEPTH, IN.	22.72	22.56	22.53	22.50	22.46		22.72	22.56	22.53	22.50	22.46	
$+I_{cr}/I_{gr}$	0.115	0.186	0.213	0.239	0.267		0.115	0.186	0.213	0.239	0.267	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 8″ Ribs @ 74″ c.-c. 19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	9	8	10	9		10	10	9	7.5	6	
BOTTOM BARS NO	1# 4	2# 6	2# 6	1# 8	1# 9		1# 4	2# 6	2# 6	1# 8	1# 9	
BARS NO	2# 5	1# 6	1# 7	1# 9	1# 9		2# 5	1# 6	1# 7	1# 9	1# 9	
STEEL (PSF)	0.60	0.88	1.00	1.22	1.38		0.84	1.36	1.53	1.85	2.77	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
30'- 0" (3)	322	934	1128	1493	1744	3.090	785	1675	1957	2489	2854	1.901
STIR	#3- 85	#3-131	#3-124	#3-153	#4-159		#3- 96	#3-130	#4-136	#4-143	#5-143	
31'- 0"	257	830	1012	1354	1589	3.523	691	1524	1789	2286	2629	2.168
STIR	#3- 83	#3-133	#3-132	#3-156	#4-162		#3- 97	#3-133	#3-139	#4-147	#4-147	
32'- 0"	198	736	907	1228	1448	4.000	606	1388	1636	2103	2424	2.461
STIR	#3- 82	#3-134	#3-141	#3-158	#4-165		#3- 97	#3-135	#3-141	#4-150	#4-151	
33'- 0"	145	650	811	1113	1320	4.523	528	1263	1497	1936	2238	2.784
STIR	#3- 80	#3-136	#3-145	#3-162	#4-169		#3- 97	#3-115	#3-144	#4-153	#4-153	
34'- 0"	96	572	723	1008	1203	5.097	457	1150	1369	1783	2067	3.137
STIR	#3- 77	#3-137	#3-147	#3-164	#3-172		#3- 96	#3-122	#3-146	#4-156	#4-157	
35'- 0"	51	501	643	912	1096	5.724	392	1046	1253	1643	1912	3.522
STIR	#3- 75	#3-138	#3-149	#3-167	#3-175		#3- 96	#3-130	#3-149	#4-160	#4-162	
36'- 0"	10	435	570	824	998	6.407	332	950	1146	1515	1769	3.942
STIR	#3- 72	#3-139	#3-150	#3-148	#3-178		#3- 95	#3-137	#3-151	#4-162	#4-168	
37'- 0"		375	502	743	908	7.149	277	862	1048	1397	1637	4.399
STIR		#3-139	#3-152	#3-157	#3-181		#3- 94	#3-143	#3-153	#4-165	#4-172	
38'- 0"		319	440	668	824	7.953	227	781	957	1288	1516	4.894
STIR		#3-140	#3-153	#3-165	#3-183		#3- 93	#3-144	#3-136	#3-168	#4-175	
39'- 0"		268	382	599	747	8.824	180	706	873	1188	1404	5.430
STIR		#3-140	#3-154	#3-174	#3-185		#3- 92	#3-146	#3-144	#3-171	#4-177	
40'- 0"		220	329	535	676	9.765	137	637	796	1095	1300	6.009
STIR		#3-140	#3-155	#3-175	#3-188		#3- 91	#3-147	#3-151	#3-173	#4-181	
41'- 0"		176	280	475	610	10.778	96	573	724	1008	1204	6.633
STIR		#3-140	#3-155	#3-177	#3-172		#3- 89	#3-149	#3-159	#3-175	#4-183	
42'- 0"		135	234	420	548	11.869	59	513	657	928	1114	7.304
STIR		#3-140	#3-156	#3-179	#3-181		#3- 87	#3-150	#3-161	#3-178	#4-186	
PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.64	1.85	2.29	2.55		1.48	2.29	2.55	3.06	5.43	
ACTUAL STEEL %	0.671	0.745	0.838	1.043	1.159		0.671	1.043	1.159	1.390	2.475	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.31	22.31		22.38	22.31	22.31	22.31	22.25	
$-I_{cr}/I_{gr}$	0.151	0.164	0.179	0.210	0.227		0.151	0.210	0.227	0.258	0.376	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.82	1.32	1.48	1.79	2.00		0.82	1.32	1.48	1.79	2.00	
ACTUAL STEEL %	0.354	0.572	0.642	0.780	0.873		0.354	0.572	0.642	0.780	0.873	
EFF. DEPTH, IN.	22.70	22.62	22.60	22.46	22.44		22.70	22.62	22.60	22.46	22.44	
$+I_{cr}/I_{gr}$	0.120	0.187	0.207	0.244	0.269		0.120	0.187	0.207	0.244	0.269	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 9″ Ribs @ 75″ c.-c. 19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	9	7.5	9.5	8.5		10	10	8.5	9.5	7.5	
BOTTOM BARS NO	1# 6	1# 7	1# 6	2# 7	1# 7		1# 6	1# 7	1# 6	2# 7	1# 7	
BARS NO	1# 6	1# 8	2# 7	1# 8	2# 8		1# 6	1# 8	2# 7	1# 8	2# 8	
STEEL (PSF)	0.66	0.91	1.05	1.31	1.41		0.90	1.40	1.61	2.06	2.93	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
30'- 0" (3)	362	981	1291	1713	1941	3.090	857	1759	2209	2822	3154	1.901
STIR	#3- 81	#3-127	#3-124	#4-153	#4-158		#3- 94	#3-127	#4-136	#4-144	#5-143	
31'- 0"	293	873	1163	1558	1771	3.523	757	1601	2022	2597	2908	2.168
STIR	#3- 79	#3-129	#3-132	#4-157	#4-162		#3- 94	#3-107	#4-139	#4-148	#5-146	
32'- 0"	230	774	1046	1417	1618	4.000	665	1457	1853	2393	2684	2.461
STIR	#3- 77	#3-130	#3-140	#3-160	#4-165		#3- 94	#3-114	#4-142	#4-151	#5-150	
33'- 0"	173	685	941	1289	1478	4.523	582	1327	1699	2206	2480	2.784
STIR	#3- 75	#3-131	#3-146	#3-162	#4-168		#3- 93	#3-121	#3-145	#4-154	#5-152	
34'- 0"	120	603	844	1172	1350	5.097	506	1208	1558	2036	2294	3.137
STIR	#3- 73	#3-132	#3-148	#3-165	#4-172		#3- 93	#3-128	#3-147	#4-157	#4-156	
35'- 0"	73	528	755	1065	1233	5.724	437	1099	1430	1880	2124	3.522
STIR	#3- 70	#3-132	#3-149	#3-168	#3-174		#3- 92	#3-136	#3-149	#4-160	#4-162	
36'- 0"	29	459	674	967	1125	6.407	373	999	1311	1738	1968	3.942
STIR	#3- 67	#3-133	#3-151	#3-171	#3-177		#3- 91	#3-137	#3-151	#4-164	#4-168	
37'- 0"		396	599	877	1026	7.149	314	907	1203	1606	1824	4.399
STIR		#3-133	#3-152	#3-155	#3-180		#3- 90	#3-139	#3-154	#4-166	#4-171	
38'- 0"		337	530	793	935	7.953	260	822	1102	1485	1691	4.894
STIR		#3-133	#3-153	#3-163	#3-182		#3- 89	#3-140	#3-136	#4-169	#4-174	
39'- 0"		283	467	716	851	8.824	210	743	1010	1373	1569	5.430
STIR		#3-133	#3-154	#3-172	#3-185		#3- 88	#3-141	#3-143	#4-172	#4-178	
40'- 0"		233	408	645	773	9.765	164	671	924	1269	1456	6.009
STIR		#3-133	#3-155	#3-177	#3-165		#3- 86	#3-142	#3-150	#4-174	#4-180	
41'- 0"		187	353	579	701	10.778	121	603	844	1173	1350	6.633
STIR		#3-133	#3-156	#3-178	#3-174		#3- 84	#3-143	#3-158	#3-176	#4-183	
42'- 0"		144	302	517	634	11.869	81	541	770	1083	1253	7.304
STIR		#3-132	#3-157	#3-180	#3-182		#3- 82	#3-144	#3-161	#3-179	#4-186	
PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.50	1.67	2.00	2.45	2.74		1.50	2.33	2.74	3.47	6.00	
ACTUAL STEEL %	0.617	0.686	0.823	1.010	1.129		0.617	0.960	1.129	1.438	2.493	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.31	22.31		22.38	22.31	22.31	22.25	22.19	
$-I_{cr}/I_{gr}$	0.144	0.156	0.180	0.209	0.227		0.144	0.201	0.227	0.267	0.382	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.88	1.39	1.64	1.99	2.18		0.88	1.39	1.64	1.99	2.18	
ACTUAL STEEL %	0.347	0.551	0.648	0.788	0.864		0.347	0.551	0.648	0.788	0.864	
EFF. DEPTH, IN.	22.62	22.53	22.58	22.54	22.52		22.62	22.53	22.58	22.54	22.52	
$+I_{cr}/I_{gr}$	0.118	0.179	0.210	0.249	0.270		0.118	0.179	0.210	0.249	0.270	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5		End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6		Int. Span Defl. Coeff. (2)
AT	10	8.5	10	9			10	10	7.5	6		
BOTTOM BARS NO	1# 6	1# 7	1# 8	1# 9			1# 6	1# 7	1# 8	1# 9		
BARS NO	1# 6	1# 8	1# 9	1# 9			1# 6	1# 8	1# 9	1# 9		
STEEL (PSF)	0.67	0.95	1.23	1.40			0.91	1.42	1.86	2.78		
CLEAR SPAN	END SPAN						INTERIOR SPAN					
35'- 0" (3)	223	761	1179	1397		5.724	652	1434	2042	2359		3.522
STIR	#3- 96	#3-149	#3-172	#4-179			#3-110	#3-149	#4-163	#4-168		
36'- 0"	171	680	1075	1281		6.407	577	1316	1890	2191		3.942
STIR	#3- 95	#3-151	#3-175	#3-183			#3-111	#3-152	#4-166	#4-171		
37'- 0"	124	605	979	1174		7.149	507	1207	1751	2035		4.399
STIR	#3- 93	#3-152	#3-177	#3-186			#3-111	#3-129	#4-170	#4-174		
38'- 0"	80	536	891	1076		7.953	444	1107	1623	1892		4.894
STIR	#3- 91	#3-153	#3-154	#3-189			#3-111	#3-136	#4-172	#4-178		
39'- 0"	40	472	809	985		8.824	385	1014	1504	1760		5.430
STIR	#3- 89	#3-154	#3-162	#3-191			#3-110	#3-143	#4-176	#4-182		
40'- 0"	2	414	734	901		9.765	330	929	1394	1638		6.009
STIR	#3- 86	#3-155	#3-170	#3-194			#3-110	#3-150	#4-178	#4-185		
41'- 0"		359	664	823		10.778	280	849	1292	1524		6.633
STIR		#3-156	#3-179	#3-197			#3-109	#3-158	#3-180	#4-188		
42'- 0"		308	599	750		11.869	233	776	1198	1418		7.304
STIR		#3-157	#3-187	#3-199			#3-108	#3-161	#3-183	#4-191		
43'- 0"		261	538	683		13.040	189	707	1110	1320		8.025
STIR		#3-157	#3-188	#3-177			#3-107	#3-163	#3-186	#4-193		
44'- 0"		217	481	620		14.296	148	643	1027	1228		8.798
STIR		#3-157	#3-190	#3-185			#3-106	#3-164	#3-188	#4-197		
45'- 0"		176	429	561		15.641	110	583	951	1143		9.625
STIR		#3-158	#3-192	#3-193			#3-105	#3-165	#3-190	#4-200		
46'- 0"		137	379	506		17.078	74	527	879	1063		10.510
STIR		#3-158	#3-193	#3-202			#3-103	#3-167	#3-193	#4-202		
47'- 0"		101	333	454		18.613	41	474	811	988		11.454
STIR		#3-157	#3-195	#3-208			#3-102	#3-168	#3-195	#3-205		
PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.46	1.72	2.26	2.51			1.46	2.26	3.02	5.35		
ACTUAL STEEL %	0.602	0.708	0.936	1.040			0.602	0.936	1.247	2.220		
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31			26.38	26.31	26.31	26.25		
$-I_{cr}/I_{gr}$	0.145	0.165	0.202	0.219			0.145	0.202	0.250	0.366		
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.88	1.39	1.79	2.00			0.88	1.39	1.79	2.00		
ACTUAL STEEL %	0.347	0.549	0.709	0.792			0.347	0.549	0.709	0.792		
EFF. DEPTH, IN.	26.62	26.53	26.46	26.44			26.62	26.53	26.46	26.44		
$+I_{cr}/I_{gr}$	0.123	0.188	0.237	0.262			0.123	0.188	0.237	0.262		
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

66″ Forms + 8″ Ribs @ 74″ c.-c.
23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span	# 4	# 5	# 5	# 6	# 7	Int. Span
AT	10	7.5	10	8	7	Defl. Coeff. (2)	10	8.5	7.5	6	6	Defl. Coeff. (2)
BOTTOM BARS NO	2# 5	1# 8	1# 8	1# 9	1#10		2# 5	1# 8	1# 8	1# 9	1#10	
BARS NO	1# 5	1# 8	1# 9	1#10	1#10		1# 5	1# 8	1# 9	1#10	1#10	
STEEL (PSF)	0.66	1.08	1.22	1.54	1.76		0.90	1.64	1.85	2.88	3.67	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
35'- 0" (3)	243	924	1143	1641	1919	5.724	697	1688	2006	2730	3135	3.522
STIR	#3- 89	#3-151	#3-145	#4-181	#4-187		#3-106	#3-151	#4-158	#5-169	#5-174	
36'- 0"	188	832	1039	1510	1773	6.407	618	1554	1855	2539	2922	3.942
STIR	#3- 87	#3-153	#3-153	#4-185	#4-191		#3-106	#3-153	#4-161	#5-173	#5-168	
37'- 0"	138	748	943	1389	1638	7.149	544	1431	1716	2364	2726	4.399
STIR	#3- 85	#3-155	#3-162	#4-187	#4-195		#3-105	#3-155	#4-163	#5-176	#5-171	
38'- 0"	92	670	855	1277	1514	7.953	477	1317	1587	2202	2545	4.894
STIR	#3- 83	#3-156	#3-169	#4-190	#4-198		#3-105	#3-133	#4-166	#4-180	#5-174	
39'- 0"	49	597	774	1175	1399	8.824	414	1212	1469	2052	2378	5.430
STIR	#3- 80	#3-157	#3-170	#3-193	#4-202		#3-104	#3-140	#3-169	#4-183	#5-178	
40'- 0"	9	531	698	1079	1292	9.765	357	1115	1359	1913	2223	6.009
STIR	#3- 77	#3-158	#3-172	#3-196	#4-204		#3-104	#3-147	#3-171	#4-186	#5-180	
41'- 0"		469	628	991	1194	10.778	303	1025	1257	1785	2080	6.633
STIR		#3-159	#3-174	#3-198	#4-208		#3-103	#3-154	#3-174	#4-189	#5-185	
42'- 0"		411	563	909	1102	11.869	253	941	1162	1665	1946	7.304
STIR		#3-160	#3-175	#3-201	#4-211		#3-101	#3-162	#3-175	#4-192	#5-190	
43'- 0"		357	502	832	1017	13.040	207	863	1074	1554	1822	8.025
STIR		#3-160	#3-176	#3-204	#4-214		#3-100	#3-165	#3-150	#4-195	#4-196	
44'- 0"		307	446	761	937	14.296	164	791	992	1450	1706	8.798
STIR		#3-161	#3-178	#3-181	#3-216		#3- 99	#3-166	#3-157	#4-198	#4-202	
45'- 0"		261	393	694	863	15.641	123	723	915	1353	1598	9.625
STIR		#3-161	#3-179	#3-189	#3-220		#3- 97	#3-168	#3-164	#4-201	#4-208	
46'- 0"		217	344	632	793	17.078	85	659	843	1262	1497	10.510
STIR		#3-161	#3-180	#3-198	#3-222		#3- 95	#3-169	#3-172	#4-204	#4-212	
47'- 0"		176	297	573	728	18.613	50	599	776	1177	1402	11.454
STIR		#3-161	#3-180	#3-206	#3-224		#3- 93	#3-170	#3-179	#4-207	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.97	2.29	2.87	3.28		1.48	2.70	3.06	5.43	7.40	
ACTUAL STEEL %	0.550	0.734	0.855	1.069	1.222		0.550	1.006	1.140	2.029	2.775	
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31	26.31		26.38	26.31	26.31	26.25	26.19	
$-I_{cr}/I_{gr}$	0.137	0.173	0.193	0.228	0.251		0.137	0.218	0.239	0.353	0.427	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.58	1.79	2.27	2.54		0.93	1.58	1.79	2.27	2.54	
ACTUAL STEEL %	0.331	0.566	0.641	0.815	0.913		0.331	0.566	0.641	0.815	0.913	
EFF. DEPTH, IN.	26.69	26.50	26.46	26.40	26.36		26.69	26.50	26.46	26.40	26.36	
$+I_{cr}/I_{gr}$	0.120	0.194	0.217	0.268	0.296		0.120	0.194	0.217	0.268	0.296	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

66″ Forms + 9″ Ribs @ 75″ c.-c.
23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 5	# 5	# 6	End Span	# 4	# 5	# 5	# 6	# 6	Int. Span
AT	10	7.5	9.5	8	9	Defl. Coeff. (2)	9	8.5	7	8	4	Defl. Coeff. (2)
BOTTOM BARS NO	2# 4	1# 6	2# 7	2# 8	1# 8		2# 4	1# 6	2# 7	2# 8	1# 8	
BARS NO	2# 5	2# 7	1# 8	1# 8	2# 9		2# 5	2# 7	1# 8	1# 8	2# 9	
STEEL (PSF)	0.70	1.05	1.31	1.54	1.84		1.00	1.61	1.99	2.42	3.95	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
35'- 0" (3)	305	957	1324	1720	2154	5.724	803	1752	2285	2861	3493	3.522
STIR	#3- 89	#3-146	#3-143	#4-177	#5-188		#3-106	#3-147	#4-158	#5-167	#5-174	
36'- 0"	245	862	1208	1582	1993	6.407	716	1613	2117	2661	3258	3.942
STIR	#3- 87	#3-148	#3-151	#4-181	#4-191		#3-106	#3-126	#4-161	#5-171	#5-167	
37'- 0"	190	774	1101	1456	1844	7.149	635	1485	1962	2477	3042	4.399
STIR	#3- 85	#3-149	#3-159	#4-183	#4-194		#3-105	#3-133	#4-164	#5-173	#5-170	
38'- 0"	139	692	1003	1339	1708	7.953	561	1367	1819	2307	2843	4.894
STIR	#3- 83	#3-150	#3-168	#4-187	#4-199		#3-105	#3-140	#4-167	#4-177	#5-173	
39'- 0"	92	617	912	1231	1581	8.824	493	1257	1687	2151	2659	5.430
STIR	#3- 80	#3-151	#3-172	#3-189	#4-202		#3-104	#3-147	#4-169	#4-181	#5-177	
40'- 0"	48	548	828	1131	1464	9.765	429	1156	1564	2005	2489	6.009
STIR	#3- 77	#3-152	#3-174	#3-192	#4-205		#3-103	#3-155	#4-172	#4-183	#5-179	
41'- 0"	8	483	750	1039	1355	10.778	371	1062	1451	1871	2331	6.633
STIR	#3- 74	#3-152	#3-175	#3-195	#4-208		#3-102	#3-157	#3-175	#4-186	#5-185	
42'- 0"		423	678	953	1254	11.869	316	975	1345	1745	2184	7.304
STIR		#3-152	#3-177	#3-173	#4-211		#3-101	#3-158	#3-176	#4-189	#5-191	
43'- 0"		367	610	873	1160	13.040	265	894	1247	1629	2047	8.025
STIR		#3-153	#3-178	#3-181	#4-214		#3-100	#3-160	#3-179	#4-192	#5-196	
44'- 0"		315	547	798	1073	14.296	218	818	1156	1520	1920	8.798
STIR		#3-153	#3-179	#3-190	#4-217		#3- 99	#3-161	#3-155	#4-194	#5-202	
45'- 0"		267	488	728	991	15.641	173	747	1070	1418	1801	9.625
STIR		#3-153	#3-181	#3-198	#4-220		#3- 97	#3-162	#3-162	#4-197	#5-208	
46'- 0"		221	433	663	914	17.078	132	681	990	1323	1689	10.510
STIR		#3-152	#3-182	#3-203	#4-222		#3- 95	#3-163	#3-169	#4-200	#4-212	
47'- 0"		179	382	601	842	18.613	93	619	915	1234	1585	11.454
STIR		#3-152	#3-183	#3-205	#3-225		#3- 93	#3-164	#3-177	#4-203	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.50	2.00	2.45	2.91	3.67		1.67	2.74	3.32	4.12	8.25	
ACTUAL STEEL %	0.508	0.677	0.831	0.987	1.249		0.564	0.929	1.128	1.405	2.809	
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31	26.25		26.38	26.31	26.31	26.25	26.25	
$-I_{cr}/I_{gr}$	0.131	0.165	0.192	0.219	0.258		0.143	0.209	0.241	0.280	0.443	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.37	2.79		1.02	1.64	1.99	2.37	2.79	
ACTUAL STEEL %	0.331	0.535	0.650	0.775	0.913		0.331	0.535	0.650	0.775	0.913	
EFF. DEPTH, IN.	26.71	26.58	26.54	26.50	26.45		26.71	26.58	26.54	26.50	26.45	
$+I_{cr}/I_{gr}$	0.121	0.187	0.222	0.260	0.301		0.121	0.187	0.222	0.260	0.301	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 11″ Deep Rib + 5.5″ Top Slab = 16.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	10	9	7.5	10		10	7.5	10	8	7	
BOTTOM BARS NO	1# 4	1# 5	1# 6	1# 6	1# 5		1# 4	1# 5	1# 6	1# 6	1# 5	
BARS NO	1# 5	1# 6	1# 6	1# 7	2# 6		1# 5	1# 6	1# 6	1# 7	2# 6	
STEEL (PSF)	0.60	0.78	0.92	1.08	1.20		0.84	1.18	1.41	1.70	1.90	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	188	482	641	834	1022	1.265	479	907	1138	1419	1692	0.779
STIR	#3- 49	#3- 86	#3- 98	#3-106	#3-118		#3- 64	#3- 90	#3- 85	#3-107	#3-112	
25'- 0"	137	409	555	733	906	1.490	406	801	1013	1272	1524	0.917
STIR	#3- 46	#3- 86	#3- 99	#3-110	#3-121		#3- 63	#3- 91	#3- 92	#3-110	#3-115	
26'- 0"	93	344	479	643	804	1.743	341	706	903	1142	1375	1.073
STIR	#3- 43	#3- 86	#3-100	#3-112	#3-108		#3- 62	#3- 92	#3-100	#3-112	#3-118	
27'- 0"	53	286	411	564	712	2.027	283	622	804	1026	1242	1.247
STIR	#3- 39	#3- 86	#3-100	#3-113	#3-116		#3- 61	#3- 93	#3-103	#3-115	#3-121	
28'- 0"	18	234	350	492	631	2.344	232	547	716	922	1123	1.443
STIR	#3- 34	#3- 85	#3-101	#3-115	#3-125		#3- 59	#3- 94	#3-105	#3-116	#3-123	
29'- 0"		188	296	428	557	2.698	185	479	637	829	1016	1.660
STIR		#3- 84	#3-101	#3-116	#3-127		#3- 57	#3- 94	#3-106	#3-106	#3-126	
30'- 0"		146	247	370	491	3.090	143	418	565	745	920	1.901
STIR		#3- 82	#3-101	#3-117	#3-129		#3- 55	#3- 95	#3-107	#3-113	#3-129	
31'- 0"		108	202	318	431	3.523	105	362	500	669	833	2.168
STIR		#3- 81	#3-100	#3-117	#3-130		#3- 52	#3- 95	#3-108	#3-120	#3-131	
32'- 0"		73	162	271	377	4.000	71	312	442	600	754	2.461
STIR		#3- 79	#3-100	#3-118	#3-132		#3- 49	#3- 95	#3-109	#3-122	#3-133	
33'- 0"		42	125	228	327	4.523	40	267	388	537	682	2.784
STIR		#3- 77	#3- 99	#3-118	#3-133		#3- 46	#3- 94	#3-110	#3-123	#3-135	
34'- 0"		13	92	188	282	5.097	11	225	340	480	616	3.137
STIR		#3- 74	#3- 98	#3-118	#3-134		#3- 43	#3- 94	#3-111	#3-125	#3-126	
35'- 0"			61	152	240	5.724		187	295	427	556	3.522
STIR			#3- 96	#3-118	#3-135			#3- 93	#3-111	#3-126	#3-134	
36'- 0"			33	119	202	6.407		152	254	379	500	3.942
STIR			#3- 95	#3-118	#3-135			#3- 93	#3-111	#3-127	#3-138	
PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.96	0.96	1.07	1.28	1.49		0.96	1.28	1.49	1.86	2.13	
ACTUAL STEEL %	0.726	0.726	0.807	0.968	1.131		0.726	0.968	1.131	1.414	1.616	
EFF. DEPTH, IN.	14.38	14.38	14.38	14.38	14.31		14.38	14.38	14.31	14.31	14.31	
$-I_{cr}/I_{gr}$	0.151	0.151	0.164	0.189	0.209		0.151	0.189	0.209	0.246	0.270	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.51	0.75	0.88	1.04	1.19		0.51	0.75	0.88	1.04	1.19	
ACTUAL STEEL %	0.364	0.537	0.631	0.748	0.853		0.364	0.537	0.631	0.748	0.853	
EFF. DEPTH, IN.	14.71	14.65	14.62	14.59	14.64		14.71	14.65	14.62	14.59	14.64	
$+I_{cr}/I_{gr}$	0.115	0.164	0.189	0.218	0.248		0.115	0.164	0.189	0.218	0.248	
SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 11″ Deep Rib + 5.5″ Top Slab = 16.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	7.5	10	9		10	7	8.5	7.5	9	
BOTTOM BARS NO	1# 4	1# 4	2# 4	1# 5	2# 6		1# 4	1# 4	2# 4	1# 5	2# 6	
BARS NO	1# 5	2# 5	2# 5	2# 6	1# 6		1# 5	2# 5	2# 5	2# 6	1# 6	
STEEL (PSF)	0.60	0.79	1.03	1.18	1.34		0.84	1.23	1.59	1.81	2.12	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	167	552	800	1002	1158	1.265	458	1018	1379	1672	1900	0.779
STIR	#3- 36	#3- 85	#3-101	#3-102	#3-118		#3- 56	#3- 89	#3-102	#3-108	#3-112	
25'- 0"	117	472	700	886	1030	1.490	385	901	1233	1504	1714	0.917
STIR	#3- 32	#3- 85	#3-102	#3-110	#3-120		#3- 54	#3- 90	#3-104	#3-111	#3-116	
26'- 0"	72	400	611	783	917	1.743	320	797	1105	1355	1549	1.073
STIR	#3- 28	#3- 85	#3-104	#3-114	#3-108		#3- 52	#3- 91	#3- 95	#3-113	#3-118	
27'- 0"	33	337	532	692	816	2.027	263	705	990	1222	1402	1.247
STIR	#3- 23	#3- 84	#3-104	#3-116	#3-116		#3- 50	#3- 92	#3-103	#3-116	#3-121	
28'- 0"		280	462	610	725	2.344	211	622	887	1103	1270	1.443
STIR		#3- 84	#3-105	#3-118	#3-125		#3- 47	#3- 93	#3-108	#3-118	#3-124	
29'- 0"		229	398	537	644	2.698	165	548	795	996	1152	1.660
STIR		#3- 82	#3-105	#3-119	#3-127		#3- 44	#3- 93	#3-110	#3-120	#3-126	
30'- 0"		183	341	471	571	3.090	123	481	712	900	1046	1.901
STIR		#3- 81	#3-106	#3-120	#3-129		#3- 41	#3- 94	#3-111	#3-109	#3-128	
31'- 0"		141	290	411	504	3.523	85	420	637	813	949	2.168
STIR		#3- 79	#3-106	#3-121	#3-130		#3- 38	#3- 94	#3-112	#3-117	#3-131	
32'- 0"		103	243	356	444	4.000	51	365	568	733	862	2.461
STIR		#3- 77	#3-105	#3-122	#3-131		#3- 34	#3- 94	#3-113	#3-124	#3-133	
33'- 0"		69	200	307	390	4.523	19	315	506	661	782	2.784
STIR		#3- 75	#3-105	#3-122	#3-133		#3- 30	#3- 93	#3-114	#3-126	#3-135	
34'- 0"		37	161	261	339	5.097		270	449	596	709	3.137
STIR		#3- 72	#3-104	#3-123	#3-134			#3- 93	#3-115	#3-127	#3-126	
35'- 0"		9	125	220	294	5.724		228	397	535	642	3.522
STIR		#3- 70	#3-103	#3-123	#3-134			#3- 92	#3-116	#3-129	#3-134	
36'- 0"			92	182	252	6.407		189	350	480	581	3.942
STIR			#3-102	#3-123	#3-135			#3- 91	#3-116	#3-130	#3-139	
PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.98	0.98	1.31	1.52	1.69		0.98	1.40	1.79	2.03	2.40	
ACTUAL STEEL %	0.669	0.669	0.891	1.041	1.157		0.669	0.955	1.225	1.388	1.650	
EFF. DEPTH, IN.	14.38	14.38	14.38	14.31	14.31		14.38	14.38	14.31	14.31	14.25	
$-I_{cr}/I_{gr}$	0.145	0.145	0.181	0.201	0.218		0.145	0.191	0.227	0.248	0.277	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.51	0.82	1.02	1.19	1.32		0.51	0.82	1.02	1.19	1.32	
ACTUAL STEEL %	0.329	0.530	0.659	0.772	0.857		0.329	0.530	0.659	0.772	0.857	
EFF. DEPTH, IN.	14.71	14.70	14.71	14.64	14.62		14.71	14.70	14.71	14.64	14.62	
$+I_{cr}/I_{gr}$	0.106	0.165	0.201	0.229	0.250		0.106	0.165	0.201	0.229	0.250	
SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 11″ Deep Rib + 5.5″ Top Slab = 16.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	9	7.5	10	8		10	10	8.5	7	6	
BOTTOM BARS NO	2# 4	2# 5	2# 5	2# 5	2# 6		2# 4	2# 5	2# 5	2# 5	2# 6	
BARS NO	1# 4	1# 5	1# 6	2# 5	1# 7		1# 4	1# 5	1# 6	2# 5	1# 7	
STEEL (PSF)	0.64	0.89	1.06	1.25	1.50		0.88	1.38	1.62	1.95	2.28	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	261	666	824	1047	1329	1.265	604	1194	1424	1748	2158	0.779
STIR	#3- 45	#3- 88	#3- 97	#3-107	#3-119		#3- 62	#3- 91	#3- 86	#3-107	#4-113	
25'- 0"	202	575	721	927	1186	1.490	518	1062	1273	1572	1950	0.917
STIR	#3- 42	#3- 88	#3- 98	#3-109	#3-121		#3- 61	#3- 92	#3- 93	#3-109	#3-116	
26'- 0"	149	495	629	819	1060	1.743	441	944	1140	1417	1766	1.073
STIR	#3- 38	#3- 88	#3- 99	#3-111	#3-124		#3- 59	#3- 94	#3-101	#3-111	#3-118	
27'- 0"	102	423	547	724	947	2.027	373	840	1021	1278	1602	1.247
STIR	#3- 34	#3- 87	#3- 99	#3-112	#3-114		#3- 57	#3- 95	#3-103	#3-113	#3-122	
28'- 0"	60	358	474	638	845	2.344	313	746	915	1153	1455	1.443
STIR	#3- 29	#3- 87	#3-100	#3-114	#3-123		#3- 55	#3- 96	#3-104	#3-116	#3-124	
29'- 0"	23	301	409	562	755	2.698	258	662	819	1042	1322	1.660
STIR	#3- 24	#3- 86	#3-100	#3-115	#3-128		#3- 53	#3- 96	#3-106	#3-107	#3-127	
30'- 0"		249	350	492	673	3.090	209	586	733	941	1203	1.901
STIR		#3- 85	#3- 99	#3-116	#3-130		#3- 51	#3- 97	#3-107	#3-115	#3-129	
31'- 0"		201	296	430	599	3.523	164	518	655	850	1096	2.168
STIR		#3- 83	#3- 99	#3-116	#3-132		#3- 48	#3- 97	#3-108	#3-119	#3-132	
32'- 0"		159	247	373	531	4.000	123	455	584	767	998	2.461
STIR		#3- 82	#3- 98	#3-117	#3-133		#3- 45	#3- 97	#3-109	#3-121	#3-134	
33'- 0"		120	203	321	470	4.523	87	399	520	692	909	2.784
STIR		#3- 80	#3- 97	#3-117	#3-134		#3- 41	#3- 97	#3-109	#3-122	#3-136	
34'- 0"		84	163	274	414	5.097	53	347	461	623	827	3.137
STIR		#3- 77	#3- 96	#3-117	#3-135		#3- 38	#3- 97	#3-110	#3-123	#3-124	
35'- 0"		51	126	231	363	5.724	22	300	407	560	753	3.522
STIR		#3- 75	#3- 95	#3-117	#3-136		#3- 34	#3- 96	#3-110	#3-125	#3-132	
36'- 0"		22	92	191	316	6.407		256	358	502	685	3.942
STIR		#3- 72	#3- 93	#3-116	#3-137			#3- 96	#3-110	#3-126	#3-139	
PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.00	1.11	1.33	1.55	1.94		1.00	1.55	1.82	2.21	2.58	
ACTUAL STEEL %	0.621	0.690	0.828	0.968	1.209		0.621	0.968	1.138	1.382	1.613	
EFF. DEPTH, IN.	14.38	14.38	14.38	14.31	14.31		14.38	14.31	14.31	14.31	14.31	
$-I_{cr}/I_{gr}$	0.140	0.152	0.175	0.195	0.230		0.140	0.195	0.220	0.253	0.282	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.93	1.06	1.24	1.48		0.60	0.93	1.06	1.24	1.48	
ACTUAL STEEL %	0.353	0.549	0.627	0.732	0.879		0.353	0.549	0.627	0.732	0.879	
EFF. DEPTH, IN.	14.75	14.69	14.66	14.69	14.60		14.75	14.69	14.66	14.69	14.60	
$+I_{cr}/I_{gr}$	0.116	0.171	0.192	0.222	0.257		0.116	0.171	0.192	0.222	0.257	
SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	9	7.5	10	8.5		10	10	8.5	7	5	
BOTTOM BARS NO	2# 4	1# 6	1# 6	1# 5	1# 7		2# 4	1# 6	1# 6	1# 5	1# 7	
BARS NO	1# 4	1# 6	1# 7	2# 6	1# 8		1# 4	1# 6	1# 7	2# 6	1# 8	
STEEL (PSF)	0.66	0.92	1.08	1.20	1.45		0.90	1.41	1.64	1.90	2.51	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	380	767	987	1201	1466	1.265	770	1333	1654	1965	2349	0.779
STIR	#3- 65	#3- 97	#3-107	#3-117	#3-124		#3- 75	#3- 87	#3-106	#3-112	#4-116	
25'- 0"	313	669	873	1070	1313	1.490	672	1191	1486	1773	2127	0.917
STIR	#3- 63	#3- 97	#3-109	#3-119	#3-127		#3- 75	#3- 94	#3-109	#3-114	#4-120	
26'- 0"	253	583	771	953	1178	1.743	585	1065	1338	1603	1931	1.073
STIR	#3- 61	#3- 98	#3-111	#3-110	#3-130		#3- 75	#3-101	#3-112	#3-118	#4-123	
27'- 0"	200	506	680	849	1058	2.027	508	953	1206	1452	1756	1.247
STIR	#3- 59	#3- 99	#3-112	#3-118	#3-132		#3- 75	#3-102	#3-113	#3-120	#3-126	
28'- 0"	152	437	599	756	950	2.344	439	852	1088	1317	1599	1.443
STIR	#3- 56	#3- 99	#3-113	#3-124	#3-135		#3- 74	#3-104	#3-100	#3-123	#3-129	
29'- 0"	110	375	526	672	853	2.698	377	762	982	1195	1458	1.660
STIR	#3- 53	#3- 99	#3-114	#3-126	#3-138		#3- 73	#3-105	#3-108	#3-125	#3-132	
30'- 0"	71	319	460	597	766	3.090	321	681	886	1085	1331	1.901
STIR	#3- 49	#3- 99	#3-115	#3-127	#3-126		#3- 72	#3-106	#3-115	#3-127	#3-135	
31'- 0"	36	268	400	529	687	3.523	270	607	800	986	1216	2.168
STIR	#3- 45	#3- 98	#3-116	#3-129	#3-134		#3- 70	#3-107	#3-119	#3-129	#3-138	
32'- 0"	5	222	346	467	615	4.000	224	541	721	896	1112	2.461
STIR	#3- 41	#3- 97	#3-116	#3-130	#3-142		#3- 69	#3-108	#3-121	#3-132	#3-141	
33'- 0"		180	297	410	550	4.523	182	480	649	814	1017	2.784
STIR		#3- 96	#3-116	#3-131	#3-144		#3- 67	#3-108	#3-122	#3-121	#3-143	
34'- 0"		142	252	359	490	5.097	144	424	584	739	931	3.137
STIR		#3- 95	#3-116	#3-132	#3-146		#3- 65	#3-109	#3-123	#3-129	#3-145	
35'- 0"		107	211	312	436	5.724	109	373	524	671	851	3.522
STIR		#3- 93	#3-116	#3-133	#3-147		#3- 62	#3-109	#3-124	#3-135	#3-148	
36'- 0"		75	173	268	386	6.407	77	327	469	608	778	3.942
STIR		#3- 92	#3-115	#3-133	#3-149		#3- 60	#3-109	#3-125	#3-137	#3-150	
PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.96	1.07	1.28	1.49	1.75		0.96	1.49	1.75	2.13	2.98	
ACTUAL STEEL %	0.626	0.696	0.835	0.975	1.147		0.626	0.975	1.147	1.392	1.949	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.31	16.31		16.38	16.31	16.31	16.31	16.31	
$-I_{cr}/I_{gr}$	0.143	0.155	0.179	0.199	0.224		0.143	0.199	0.224	0.258	0.325	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.88	1.04	1.19	1.39		0.60	0.88	1.04	1.19	1.39	
ACTUAL STEEL %	0.370	0.546	0.646	0.737	0.867		0.370	0.546	0.646	0.737	0.867	
EFF. DEPTH, IN.	16.75	16.62	16.59	16.64	16.53		16.75	16.62	16.59	16.64	16.53	
$+I_{cr}/I_{gr}$	0.124	0.174	0.202	0.229	0.260		0.124	0.174	0.202	0.229	0.260	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	8	10	9	7.5		10	9	7.5	9.5	5	
BOTTOM BARS NO	2# 4	2# 4	1# 5	2# 6	1# 8		2# 4	2# 4	1# 5	2# 6	1# 8	
BARS NO	1# 4	2# 5	2# 6	1# 6	1# 8		1# 4	2# 5	2# 6	1# 6	1# 8	
STEEL (PSF)	0.65	1.01	1.18	1.34	1.64		0.89	1.54	1.81	2.06	3.31	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	230	733	930	1083	1375	1.743	562	1294	1581	1803	2228	1.073
STIR	#3- 48	#3-102	#3-113	#3-110	#3-131		#3- 66	#3- 97	#3-113	#3-117	#4-120	
27'- 0"	177	644	826	968	1238	2.027	485	1164	1429	1635	2029	1.247
STIR	#3- 45	#3-103	#3-115	#3-118	#3-134		#3- 65	#3-104	#3-115	#3-120	#4-126	
28'- 0"	129	563	733	865	1116	2.344	416	1047	1294	1485	1852	1.443
STIR	#3- 41	#3-103	#3-116	#3-124	#3-136		#3- 64	#3-107	#3-118	#3-123	#4-130	
29'- 0"	86	491	649	772	1007	2.698	354	942	1172	1351	1692	1.660
STIR	#3- 37	#3-104	#3-118	#3-126	#3-139		#3- 62	#3-108	#3-104	#3-126	#3-133	
30'- 0"	48	426	574	688	908	3.090	298	847	1063	1229	1548	1.901
STIR	#3- 32	#3-104	#3-119	#3-127	#3-142		#3- 60	#3-110	#3-111	#3-128	#3-137	
31'- 0"	13	367	506	613	818	3.523	247	762	963	1119	1418	2.168
STIR	#3- 27	#3-104	#3-119	#3-129	#3-131		#3- 58	#3-111	#3-119	#3-130	#3-139	
32'- 0"		314	444	544	737	4.000	201	684	873	1020	1300	2.461
STIR		#3-103	#3-120	#3-130	#3-140		#3- 55	#3-112	#3-123	#3-132	#3-142	
33'- 0"		265	387	482	663	4.523	159	613	791	929	1193	2.784
STIR		#3-103	#3-120	#3-131	#3-146		#3- 53	#3-113	#3-125	#3-121	#3-144	
34'- 0"		221	336	425	596	5.097	121	549	716	846	1095	3.137
STIR		#3-102	#3-121	#3-132	#3-148		#3- 50	#3-113	#3-126	#3-128	#3-147	
35'- 0"		180	289	373	534	5.724	86	490	648	770	1005	3.522
STIR		#3-101	#3-121	#3-133	#3-150		#3- 46	#3-114	#3-127	#3-136	#3-150	
36'- 0"		143	245	325	477	6.407	54	435	585	701	922	3.942
STIR		#3- 99	#3-121	#3-133	#3-151		#3- 43	#3-114	#3-128	#3-137	#3-151	
37'- 0"		108	206	281	425	7.149	24	385	527	636	846	4.399
STIR		#3- 98	#3-120	#3-133	#3-153		#3- 39	#3-115	#3-129	#3-139	#3-154	
38'- 0"		77	169	240	377	7.953		339	473	577	776	4.894
STIR		#3- 96	#3-120	#3-134	#3-154			#3-115	#3-130	#3-140	#3-156	
PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.98	1.23	1.52	1.69	2.03		0.98	1.69	2.03	2.27	4.31	
ACTUAL STEEL %	0.577	0.722	0.899	0.999	1.199		0.577	0.999	1.199	1.349	2.563	
EFF. DEPTH, IN.	16.38	16.38	16.31	16.31	16.31		16.38	16.31	16.31	16.25	16.25	
$-I_{cr}/I_{gr}$	0.137	0.163	0.191	0.207	0.237		0.137	0.207	0.237	0.255	0.392	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	1.02	1.19	1.32	1.58		0.60	1.02	1.19	1.32	1.58	
ACTUAL STEEL %	0.335	0.571	0.669	0.742	0.894		0.335	0.571	0.669	0.742	0.894	
EFF. DEPTH, IN.	16.75	16.71	16.64	16.62	16.50		16.75	16.71	16.64	16.62	16.50	
$+I_{cr}/I_{gr}$	0.114	0.186	0.212	0.232	0.268		0.114	0.186	0.212	0.232	0.268	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	8	10	8.5	7.5		8.5	9	7.5	6	7.5	
BOTTOM BARS NO	2# 4	1# 6	2# 5	2# 6	1# 6		2# 4	1# 6	2# 5	2# 6	1# 6	
BARS NO	1# 5	1# 7	2# 5	1# 7	2# 7		1# 5	1# 7	2# 5	1# 7	2# 7	
STEEL (PSF)	0.73	1.03	1.25	1.47	1.60		1.06	1.56	1.88	2.28	2.54	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	339	725	971	1246	1432	1.743	731	1293	1651	2051	2321	1.073
STIR	#3- 58	#3- 96	#3-110	#3-108	#3-129		#3- 73	#3- 99	#3-111	#3-118	#4-122	
27'- 0"	276	634	862	1118	1290	2.027	640	1161	1493	1864	2114	1.247
STIR	#3- 55	#3- 96	#3-111	#3-116	#3-131		#3- 72	#3-100	#3-113	#3-121	#4-125	
28'- 0"	220	553	765	1002	1162	2.344	558	1043	1351	1696	1929	1.443
STIR	#3- 52	#3- 96	#3-112	#3-125	#3-134		#3- 71	#3-102	#3-102	#3-124	#4-129	
29'- 0"	169	480	678	899	1048	2.698	485	936	1224	1546	1763	1.660
STIR	#3- 48	#3- 96	#3-113	#3-127	#3-121		#3- 70	#3-103	#3-109	#3-126	#3-131	
30'- 0"	124	414	599	806	945	3.090	418	841	1109	1410	1613	1.901
STIR	#3- 45	#3- 95	#3-114	#3-129	#3-129		#3- 69	#3-104	#3-116	#3-129	#3-134	
31'- 0"	83	354	528	721	852	3.523	359	754	1006	1287	1477	2.168
STIR	#3- 40	#3- 94	#3-115	#3-130	#3-138		#3- 67	#3-105	#3-118	#3-131	#3-137	
32'- 0"	45	300	463	645	767	4.000	304	675	912	1176	1354	2.461
STIR	#3- 36	#3- 93	#3-115	#3-132	#3-140		#3- 65	#3-105	#3-120	#3-133	#3-139	
33'- 0"	11	251	404	575	690	4.523	255	604	826	1074	1242	2.784
STIR	#3- 31	#3- 92	#3-115	#3-133	#3-142		#3- 63	#3-106	#3-121	#3-119	#3-141	
34'- 0"		206	350	511	620	5.097	210	538	748	982	1140	3.137
STIR		#3- 91	#3-115	#3-134	#3-143		#3- 61	#3-106	#3-122	#3-126	#3-144	
35'- 0"		165	301	453	555	5.724	168	478	676	897	1046	3.522
STIR		#3- 89	#3-115	#3-135	#3-145		#3- 58	#3-106	#3-123	#3-134	#3-146	
36'- 0"		127	256	399	496	6.407	130	424	610	819	960	3.942
STIR		#3- 87	#3-114	#3-135	#3-146		#3- 55	#3-106	#3-124	#3-139	#3-149	
37'- 0"		93	214	350	442	7.149	95	373	550	747	881	4.399
STIR		#3- 85	#3-114	#3-136	#3-147		#3- 52	#3-106	#3-125	#3-140	#3-135	
38'- 0"		61	176	305	391	7.953	63	326	494	681	808	4.894
STIR		#3- 82	#3-113	#3-136	#3-148		#3- 49	#3-105	#3-125	#3-142	#3-142	
PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.00	1.25	1.55	1.82	2.07		1.18	1.72	2.07	2.58	2.93	
ACTUAL STEEL %	0.537	0.672	0.836	0.984	1.115		0.632	0.929	1.115	1.394	1.590	
EFF. DEPTH, IN.	16.38	16.38	16.31	16.31	16.31		16.38	16.31	16.31	16.31	16.25	
$-I_{cr}/I_{gr}$	0.131	0.157	0.184	0.209	0.229		0.150	0.200	0.229	0.269	0.292	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.04	1.24	1.48	1.64		0.71	1.04	1.24	1.48	1.64	
ACTUAL STEEL %	0.363	0.536	0.635	0.762	0.845		0.363	0.536	0.635	0.762	0.845	
EFF. DEPTH, IN.	16.72	16.59	16.69	16.60	16.58		16.72	16.59	16.69	16.60	16.58	
$+I_{cr}/I_{gr}$	0.124	0.173	0.205	0.238	0.260		0.124	0.173	0.205	0.238	0.260	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	7.5	10	8.5	7.5		9.5	8.5	7.5	9	5	
BOTTOM BARS NO	1# 5	1# 6	1# 5	1# 7	1# 8		1# 5	1# 6	1# 5	1# 7	1# 8	
BARS NO	1# 5	1# 7	2# 6	1# 8	1# 8		1# 5	1# 7	2# 6	1# 8	1# 8	
STEEL (PSF)	0.70	1.08	1.20	1.45	1.67		0.96	1.64	1.83	2.21	3.33	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	223	704	880	1100	1313	2.344	554	1253	1509	1828	2138	1.443
STIR	#3- 57	#3-112	#3-123	#3-135	#3-142		#3- 75	#3-102	#3-121	#3-129	#4-129	
29'- 0"	174	622	786	991	1189	2.698	482	1134	1373	1670	1959	1.660
STIR	#3- 54	#3-113	#3-124	#3-120	#3-145		#3- 74	#3-109	#3-124	#3-131	#4-135	
30'- 0"	129	548	702	893	1078	3.090	417	1027	1250	1528	1798	1.901
STIR	#3- 51	#3-113	#3-126	#3-128	#3-147		#3- 73	#3-116	#3-126	#3-134	#4-140	
31'- 0"	89	482	625	804	978	3.523	359	930	1139	1399	1652	2.168
STIR	#3- 47	#3-114	#3-127	#3-137	#3-150		#3- 72	#3-118	#3-109	#3-137	#4-143	
32'- 0"	53	421	556	724	887	4.000	306	841	1038	1282	1519	2.461
STIR	#3- 43	#3-114	#3-128	#3-141	#3-153		#3- 70	#3-119	#3-116	#3-140	#3-146	
33'- 0"	19	366	493	650	804	4.523	257	761	946	1175	1398	2.784
STIR	#3- 38	#3-114	#3-129	#3-143	#3-137		#3- 68	#3-121	#3-124	#3-142	#3-149	
34'- 0"		315	435	584	728	5.097	213	688	861	1078	1288	3.137
STIR		#3-114	#3-130	#3-144	#3-145		#3- 66	#3-122	#3-131	#3-145	#3-152	
35'- 0"		269	382	522	659	5.724	173	621	785	989	1187	3.522
STIR		#3-114	#3-130	#3-146	#3-154		#3- 64	#3-123	#3-134	#3-147	#3-155	
36'- 0"		227	333	466	595	6.407	136	559	714	907	1094	3.942
STIR		#3-113	#3-131	#3-147	#3-159		#3- 61	#3-124	#3-136	#3-149	#3-157	
37'- 0"		188	289	414	536	7.149	102	502	649	832	1009	4.399
STIR		#3-112	#3-131	#3-148	#3-161		#3- 59	#3-124	#3-137	#3-133	#3-160	
38'- 0"		152	248	367	482	7.953	70	450	589	762	931	4.894
STIR		#3-111	#3-131	#3-149	#3-163		#3- 55	#3-125	#3-138	#3-141	#3-162	
39'- 0"		119	210	323	432	8.824	41	402	534	698	858	5.430
STIR		#3-110	#3-131	#3-150	#3-164		#3- 52	#3-125	#3-139	#3-148	#3-164	
40'- 0"		88	174	282	386	9.765	14	357	483	639	791	6.009
STIR		#3-109	#3-131	#3-151	#3-166		#3- 49	#3-126	#3-140	#3-155	#3-167	
PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.96	1.28	1.49	1.75	1.98		1.01	1.75	1.98	2.35	4.22	
ACTUAL STEEL %	0.548	0.731	0.853	1.004	1.137		0.577	1.004	1.137	1.351	2.431	
EFF. DEPTH, IN.	18.38	18.38	18.31	18.31	18.31		18.38	18.31	18.31	18.25	18.25	
$-I_{cr}/I_{gr}$	0.135	0.169	0.189	0.213	0.234		0.140	0.213	0.234	0.262	0.390	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	1.04	1.19	1.39	1.58		0.62	1.04	1.19	1.39	1.58	
ACTUAL STEEL %	0.337	0.567	0.647	0.760	0.865		0.337	0.567	0.647	0.760	0.865	
EFF. DEPTH, IN.	18.69	18.59	18.64	18.53	18.50		18.69	18.59	18.64	18.53	18.50	
$+I_{cr}/I_{gr}$	0.117	0.187	0.213	0.242	0.271		0.117	0.187	0.213	0.242	0.271	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	10	9.5	7.5	9.5		8.5	5	4.5	8	6	
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.74	1.18	1.31	1.64	1.85		1.07	1.77	1.99	2.50	3.73	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	304	855	1003	1288	1521	2.344	683	1484	1699	2114	2453	1.443
STIR	#3- 62	#3-115	#3-123	#3-136	#3-143		#3- 78	#3- 99	#3-121	#4-130	#4-128	
29'- 0"	248	761	899	1164	1382	2.698	601	1348	1548	1934	2251	1.660
STIR	#3- 59	#3-116	#3-124	#3-138	#3-146		#3- 78	#3-106	#3-124	#4-132	#4-133	
30'- 0"	197	676	805	1053	1257	3.090	527	1225	1412	1773	2068	1.901
STIR	#3- 56	#3-117	#3-126	#3-125	#3-149		#3- 77	#3-113	#3-127	#3-136	#4-140	
31'- 0"	150	600	721	953	1143	3.523	460	1113	1289	1627	1903	2.168
STIR	#3- 53	#3-118	#3-127	#3-133	#3-152		#3- 76	#3-120	#3-109	#3-139	#4-144	
32'- 0"	109	530	644	862	1040	4.000	399	1012	1177	1494	1754	2.461
STIR	#3- 49	#3-118	#3-128	#3-142	#3-155		#3- 74	#3-122	#3-117	#3-141	#4-147	
33'- 0"	71	467	574	779	947	4.523	343	920	1075	1373	1617	2.784
STIR	#3- 45	#3-119	#3-129	#3-145	#3-157		#3- 73	#3-123	#3-124	#3-144	#4-151	
34'- 0"	36	409	510	703	861	5.097	293	836	982	1263	1493	3.137
STIR	#3- 41	#3-119	#3-130	#3-147	#3-142		#3- 71	#3-124	#3-131	#3-146	#4-153	
35'- 0"	4	357	451	633	783	5.724	246	759	897	1162	1379	3.522
STIR	#3- 36	#3-119	#3-131	#3-148	#3-150		#3- 69	#3-126	#3-134	#3-149	#3-156	
36'- 0"		308	397	570	711	6.407	204	689	819	1069	1275	3.942
STIR		#3-118	#3-131	#3-150	#3-159		#3- 67	#3-127	#3-135	#3-150	#3-159	
37'- 0"		263	348	511	645	7.149	165	624	747	984	1178	4.399
STIR		#3-118	#3-131	#3-151	#3-163		#3- 64	#3-128	#3-137	#3-153	#3-161	
38'- 0"		222	302	457	584	7.953	129	564	681	905	1090	4.894
STIR		#3-117	#3-131	#3-152	#3-165		#3- 62	#3-128	#3-138	#3-137	#3-163	
39'- 0"		184	260	407	527	8.824	95	508	619	833	1008	5.430
STIR		#3-116	#3-131	#3-153	#3-167		#3- 59	#3-129	#3-139	#3-145	#3-166	
40'- 0"		149	221	361	475	9.765	65	457	563	766	932	6.009
STIR		#3-115	#3-131	#3-154	#3-168		#3- 56	#3-129	#3-140	#3-152	#3-168	
PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.98	1.52	1.60	2.03	2.27		1.15	1.96	2.18	2.69	4.90	
ACTUAL STEEL %	0.506	0.788	0.830	1.051	1.182		0.596	1.013	1.125	1.404	2.562	
EFF. DEPTH, IN.	18.38	18.31	18.31	18.31	18.25		18.38	18.38	18.38	18.25	18.19	
$-I_{cr}/I_{gr}$	0.129	0.181	0.189	0.225	0.243		0.147	0.222	0.240	0.275	0.407	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.349	0.588	0.652	0.785	0.891		0.349	0.588	0.652	0.785	0.891	
EFF. DEPTH, IN.	18.72	18.64	18.62	18.50	18.46		18.72	18.64	18.62	18.50	18.46	
$+I_{cr}/I_{gr}$	0.123	0.196	0.215	0.250	0.278		0.123	0.196	0.215	0.250	0.278	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	7	8.5	7.5	6		8.5	8	6	8	4	
BOTTOM BARS NO	3# 3	1# 5	2# 6	1# 6	2# 7		3# 3	1# 5	2# 6	1# 6	2# 7	
BARS NO	2# 4	2# 6	1# 7	2# 7	1# 8		2# 4	2# 6	1# 7	2# 7	1# 8	
STEEL (PSF)	0.75	1.13	1.47	1.60	2.00		1.08	1.73	2.28	2.45	4.08	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	304	830	1158	1339	1730	2.344	695	1459	1937	2199	2768	1.443
STIR	#3- 54	#3-107	#3-124	#3-115	#4-144		#3- 73	#3-108	#3-123	#4-128	#4-128	
29'- 0"	246	736	1042	1210	1575	2.698	610	1323	1768	2013	2543	1.660
STIR	#3- 51	#3-108	#3-126	#3-123	#3-147		#3- 72	#3-111	#3-126	#4-130	#4-133	
30'- 0"	194	651	938	1095	1435	3.090	534	1199	1616	1844	2340	1.901
STIR	#3- 47	#3-108	#3-128	#3-131	#3-150		#3- 70	#3-113	#3-128	#3-133	#4-139	
31'- 0"	146	575	843	990	1309	3.523	465	1088	1478	1692	2156	2.168
STIR	#3- 43	#3-108	#3-129	#3-137	#3-152		#3- 69	#3-114	#3-130	#3-135	#4-145	
32'- 0"	103	505	757	895	1194	4.000	402	987	1353	1554	1990	2.461
STIR	#3- 39	#3-108	#3-130	#3-139	#3-155		#3- 67	#3-115	#3-114	#3-139	#4-148	
33'- 0"	64	442	678	808	1090	4.523	345	895	1239	1428	1838	2.784
STIR	#3- 34	#3-108	#3-131	#3-141	#3-158		#3- 65	#3-116	#3-121	#3-141	#4-151	
34'- 0"	28	384	607	729	995	5.097	293	811	1135	1313	1699	3.137
STIR	#3- 29	#3-107	#3-132	#3-142	#3-160		#3- 63	#3-117	#3-128	#3-143	#4-154	
35'- 0"		331	542	657	907	5.724	245	734	1040	1208	1572	3.522
STIR		#3-106	#3-133	#3-143	#3-148		#3- 60	#3-118	#3-136	#3-145	#4-157	
36'- 0"		283	481	590	827	6.407	201	663	953	1111	1455	3.942
STIR		#3-105	#3-134	#3-145	#3-157		#3- 58	#3-118	#3-137	#3-130	#4-160	
37'- 0"		238	426	529	753	7.149	161	598	872	1022	1348	4.399
STIR		#3-104	#3-134	#3-146	#3-165		#3- 55	#3-119	#3-139	#3-137	#3-163	
38'- 0"		197	375	473	685	7.953	124	538	798	940	1249	4.894
STIR		#3-103	#3-134	#3-146	#3-166		#3- 51	#3-119	#3-140	#3-144	#3-165	
39'- 0"		159	328	421	623	8.824	89	483	730	865	1158	5.430
STIR		#3-101	#3-134	#3-147	#3-168		#3- 48	#3-119	#3-142	#3-151	#3-167	
40'- 0"		123	284	373	564	9.765	57	432	666	795	1073	6.009
STIR		#3- 99	#3-134	#3-148	#3-170		#3- 44	#3-119	#3-143	#3-152	#3-170	
PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.00	1.43	1.82	2.07	2.58		1.18	1.94	2.58	2.75	5.50	
ACTUAL STEEL %	0.472	0.674	0.864	0.979	1.224		0.555	0.918	1.224	1.308	2.616	
EFF. DEPTH, IN.	18.38	18.38	18.31	18.31	18.31		18.38	18.31	18.31	18.25	18.25	
$-I_{cr}/I_{gr}$	0.124	0.165	0.198	0.218	0.257		0.142	0.208	0.257	0.267	0.426	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.73	1.19	1.48	1.64	1.99		0.73	1.19	1.48	1.64	1.99	
ACTUAL STEEL %	0.328	0.538	0.671	0.744	0.904		0.328	0.538	0.671	0.744	0.904	
EFF. DEPTH, IN.	18.78	18.64	18.60	18.58	18.54		18.78	18.64	18.60	18.58	18.54	
$+I_{cr}/I_{gr}$	0.118	0.183	0.222	0.243	0.287		0.118	0.183	0.222	0.243	0.287	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 17″ Deep Rib + 5.5″ Top Slab = 22.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	10	10	9	7.5	9.5		8.5	7.5	9.5	10	6	
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.75	1.20	1.36	1.67	1.87		1.08	1.83	2.08	2.64	3.76	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	176	644	770	1013	1212	4.000	497	1178	1361	1715	2004	2.461
STIR	#3- 63	#3-126	#3-136	#3-131	#3-160		#3- 84	#3-118	#3-136	#4-146	#4-149	
33'- 0"	134	574	692	921	1108	4.523	436	1076	1248	1581	1852	2.784
STIR	#3- 60	#3-127	#3-137	#3-139	#3-163		#3- 83	#3-126	#3-138	#3-148	#4-155	
34'- 0"	95	510	621	837	1013	5.097	380	983	1145	1458	1714	3.137
STIR	#3- 56	#3-128	#3-138	#3-148	#3-165		#3- 82	#3-131	#3-120	#3-151	#4-158	
35'- 0"	60	451	557	760	926	5.724	329	898	1051	1346	1588	3.522
STIR	#3- 52	#3-128	#3-140	#3-156	#3-168		#3- 80	#3-133	#3-127	#3-154	#4-161	
36'- 0"	28	398	497	689	846	6.407	282	820	964	1243	1472	3.942
STIR	#3- 48	#3-129	#3-140	#3-158	#3-170		#3- 79	#3-134	#3-135	#3-156	#4-163	
37'- 0"		348	442	624	773	7.149	238	748	884	1149	1365	4.399
STIR		#3-129	#3-141	#3-159	#3-154		#3- 77	#3-135	#3-142	#3-159	#3-166	
38'- 0"		302	392	564	705	7.953	198	681	811	1062	1267	4.894
STIR		#3-129	#3-142	#3-161	#3-163		#3- 75	#3-137	#3-146	#3-161	#3-169	
39'- 0"		260	345	509	642	8.824	161	620	743	981	1176	5.430
STIR		#3-129	#3-142	#3-162	#3-171		#3- 73	#3-138	#3-147	#3-164	#3-172	
40'- 0"		221	302	457	584	9.765	127	563	680	906	1091	6.009
STIR		#3-128	#3-142	#3-164	#3-177		#3- 70	#3-139	#3-149	#3-166	#3-175	
41'- 0"		185	262	410	531	10.778	96	510	622	837	1013	6.633
STIR		#3-127	#3-143	#3-165	#3-179		#3- 68	#3-139	#3-150	#3-147	#3-177	
42'- 0"		151	224	365	481	11.869	66	461	568	773	940	7.304
STIR		#3-127	#3-142	#3-166	#3-180		#3- 65	#3-140	#3-151	#3-154	#3-179	
43'- 0"		120	190	324	434	13.040	39	416	517	713	873	8.025
STIR		#3-126	#3-142	#3-167	#3-182		#3- 62	#3-141	#3-153	#3-161	#3-182	
44'- 0"		91	157	286	391	14.296	13	373	470	657	810	8.798
STIR		#3-124	#3-142	#3-167	#3-184		#3- 58	#3-141	#3-153	#3-169	#3-185	
PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.96	1.49	1.65	1.98	2.22		1.13	1.98	2.22	2.88	4.80	
ACTUAL STEEL %	0.486	0.756	0.840	1.008	1.133		0.572	1.008	1.133	1.473	2.456	
EFF. DEPTH, IN.	20.38	20.31	20.31	20.31	20.25		20.38	20.31	20.25	20.19	20.19	
$-I_{cr}/I_{gr}$	0.127	0.179	0.194	0.223	0.241		0.145	0.223	0.241	0.288	0.405	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.342	0.575	0.638	0.768	0.871		0.342	0.575	0.638	0.768	0.871	
EFF. DEPTH, IN.	20.72	20.64	20.62	20.50	20.46		20.72	20.64	20.62	20.50	20.46	
$+I_{cr}/I_{gr}$	0.124	0.199	0.218	0.253	0.282		0.124	0.199	0.218	0.253	0.282	
SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 17″ Deep Rib + 5.5″ Top Slab = 22.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	8.5	9.5	8.5		8	5	4	7	4	
BOTTOM BARS NO	1# 5	1# 7	2# 6	1# 8	2# 7		1# 5	1# 7	2# 6	1# 8	2# 7	
BARS NO	1# 6	1# 7	1# 7	1# 9	1# 8		1# 6	1# 7	1# 7	1# 9	1# 8	
STEEL (PSF)	0.77	1.25	1.49	1.85	2.04		1.13	1.84	2.25	2.82	4.11	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	185	622	896	1184	1382	4.000	523	1158	1557	1976	2265	2.461
STIR	#3- 55	#3-117	#3-137	#3-153	#3-161		#3- 78	#3-121	#3-136	#4-146	#4-148	
33'- 0"	141	551	809	1080	1267	4.523	459	1056	1431	1825	2096	2.784
STIR	#3- 51	#3-117	#3-138	#3-136	#3-163		#3- 77	#3-122	#3-139	#4-149	#4-154	
34'- 0"	100	487	730	985	1161	5.097	400	962	1316	1687	1942	3.137
STIR	#3- 47	#3-117	#3-140	#3-144	#3-166		#3- 76	#3-123	#3-119	#4-152	#4-158	
35'- 0"	63	428	657	898	1064	5.724	346	876	1210	1560	1802	3.522
STIR	#3- 43	#3-117	#3-141	#3-152	#3-169		#3- 74	#3-125	#3-127	#3-155	#4-160	
36'- 0"	29	374	591	818	975	6.407	296	798	1113	1444	1672	3.942
STIR	#3- 38	#3-117	#3-142	#3-160	#3-171		#3- 72	#3-126	#3-134	#3-157	#4-164	
37'- 0"		324	529	745	893	7.149	251	725	1024	1337	1553	4.399
STIR		#3-116	#3-143	#3-162	#3-153		#3- 70	#3-126	#3-141	#3-160	#4-166	
38'- 0"		278	473	677	818	7.953	208	659	942	1239	1444	4.894
STIR		#3-116	#3-143	#3-164	#3-161		#3- 67	#3-127	#3-146	#3-163	#4-169	
39'- 0"		236	421	615	748	8.824	170	597	866	1148	1342	5.430
STIR		#3-115	#3-144	#3-165	#3-170		#3- 65	#3-128	#3-148	#3-165	#4-172	
40'- 0"		197	372	557	684	9.765	134	540	795	1064	1248	6.009
STIR		#3-113	#3-144	#3-167	#3-178		#3- 62	#3-128	#3-149	#3-167	#3-175	
41'- 0"		160	327	503	624	10.778	100	487	730	986	1161	6.633
STIR		#3-112	#3-144	#3-168	#3-180		#3- 59	#3-128	#3-151	#3-170	#3-177	
42'- 0"		126	286	453	568	11.869	69	438	670	913	1080	7.304
STIR		#3-110	#3-144	#3-169	#3-182		#3- 56	#3-129	#3-152	#3-151	#3-179	
43'- 0"		95	247	406	516	13.040	40	392	613	845	1005	8.025
STIR		#3-109	#3-144	#3-170	#3-183		#3- 52	#3-129	#3-153	#3-158	#3-182	
44'- 0"		66	211	363	468	14.296	14	349	560	782	935	8.798
STIR		#3-107	#3-144	#3-171	#3-185		#3- 48	#3-128	#3-154	#3-165	#3-185	
PROPERTIES FOR DESIGN (CONCRETE 0.76 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	0.98	1.52	1.79	2.27	2.54		1.23	1.96	2.45	3.08	5.39	
ACTUAL STEEL %	0.450	0.699	0.823	1.049	1.172		0.562	0.899	1.124	1.423	2.491	
EFF. DEPTH, IN.	20.38	20.31	20.31	20.25	20.25		20.38	20.38	20.38	20.25	20.25	
$-I_{cr}/I_{gr}$	0.122	0.172	0.195	0.232	0.252		0.146	0.211	0.249	0.290	0.422	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.75	1.20	1.48	1.79	1.99		0.75	1.20	1.48	1.79	1.99	
ACTUAL STEEL %	0.329	0.529	0.651	0.792	0.878		0.329	0.529	0.651	0.792	0.878	
EFF. DEPTH, IN.	20.65	20.56	20.60	20.46	20.54		20.65	20.56	20.60	20.46	20.54	
$+I_{cr}/I_{gr}$	0.120	0.183	0.223	0.261	0.289		0.120	0.183	0.223	0.261	0.289	
SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 17″ Deep Rib + 5.5″ Top Slab = 22.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	9.5	8	9	8		7.5	7	6	6.5	4	
BOTTOM BARS NO	1# 4	2# 6	1# 8	2# 7	1# 7		1# 4	2# 6	1# 8	2# 7	1# 7	
BARS NO	2# 5	1# 6	1# 8	1# 8	2# 8		2# 5	1# 6	1# 8	1# 8	2# 8	
STEEL (PSF)	0.78	1.30	1.59	1.98	2.13		1.18	1.97	2.37	3.04	4.16	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	228	714	958	1355	1535	4.000	598	1306	1660	2238	2499	2.461
STIR	#3- 55	#3-118	#3-134	#3-154	#4-161		#3- 79	#3-122	#3-135	#4-147	#4-149	
33'- 0"	179	637	865	1239	1408	4.523	528	1193	1526	2069	2315	2.784
STIR	#3- 52	#3-118	#3-136	#3-157	#3-163		#3- 77	#3-123	#3-138	#4-151	#4-155	
34'- 0"	135	566	781	1133	1292	5.097	463	1090	1403	1915	2147	3.137
STIR	#3- 48	#3-118	#3-137	#3-141	#3-166		#3- 76	#3-124	#3-123	#4-153	#4-158	
35'- 0"	94	501	704	1036	1187	5.724	404	995	1291	1774	1993	3.522
STIR	#3- 43	#3-118	#3-138	#3-150	#3-169		#3- 74	#3-126	#3-130	#4-156	#4-160	
36'- 0"	57	441	633	947	1089	6.407	350	909	1188	1645	1851	3.942
STIR	#3- 39	#3-118	#3-139	#3-158	#3-171		#3- 72	#3-127	#3-137	#4-159	#4-164	
37'- 0"	23	386	568	866	1000	7.149	300	829	1093	1526	1721	4.399
STIR	#3- 34	#3-117	#3-139	#3-164	#3-153		#3- 70	#3-128	#3-143	#4-161	#4-166	
38'- 0"		336	508	790	918	7.953	254	755	1006	1416	1602	4.894
STIR		#3-117	#3-140	#3-165	#3-161		#3- 68	#3-128	#3-144	#3-163	#4-169	
39'- 0"		289	453	720	841	8.824	211	687	926	1315	1491	5.430
STIR		#3-116	#3-140	#3-167	#3-170		#3- 65	#3-129	#3-146	#3-166	#4-172	
40'- 0"		246	402	656	771	9.765	172	624	851	1221	1388	6.009
STIR		#3-115	#3-140	#3-169	#3-178		#3- 62	#3-129	#3-147	#3-168	#4-175	
41'- 0"		206	354	596	706	10.778	135	566	782	1134	1293	6.633
STIR		#3-113	#3-140	#3-170	#3-180		#3- 59	#3-130	#3-148	#3-171	#3-177	
42'- 0"		168	310	540	645	11.869	101	512	717	1053	1205	7.304
STIR		#3-112	#3-140	#3-171	#3-181		#3- 56	#3-130	#3-149	#3-173	#3-180	
43'- 0"		134	268	489	588	13.040	70	461	657	977	1122	8.025
STIR		#3-110	#3-140	#3-173	#3-183		#3- 52	#3-130	#3-150	#3-155	#3-182	
44'- 0"		101	230	440	535	14.296	40	414	601	907	1045	8.798
STIR		#3-108	#3-139	#3-174	#3-185		#3- 49	#3-130	#3-151	#3-162	#3-185	
PROPERTIES FOR DESIGN (CONCRETE 0.78 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.00	1.63	1.94	2.44	2.75		1.33	2.21	2.58	3.38	5.50	
ACTUAL STEEL %	0.420	0.687	0.816	1.033	1.162		0.559	0.932	1.088	1.430	2.324	
EFF. DEPTH, IN.	20.38	20.31	20.31	20.25	20.25		20.38	20.31	20.31	20.25	20.25	
$-I_{cr}/I_{gr}$	0.117	0.173	0.198	0.234	0.256		0.148	0.219	0.246	0.297	0.412	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.82	1.32	1.58	1.99	2.18		0.82	1.32	1.58	1.99	2.18	
ACTUAL STEEL %	0.329	0.532	0.640	0.805	0.882		0.329	0.532	0.640	0.805	0.882	
EFF. DEPTH, IN.	20.70	20.62	20.50	20.54	20.52		20.70	20.62	20.50	20.54	20.52	
$+I_{cr}/I_{gr}$	0.122	0.187	0.218	0.269	0.291		0.122	0.187	0.218	0.269	0.291	
SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 6	# 8	Int. Span Defl. Coeff. (2)
AT	10	9	8	9.5	8.5		7	4	6	6.5	7	
BOTTOM BARS NO	1# 4	2# 6	2# 6	1# 8	1# 9		1# 4	2# 6	2# 6	1# 8	1# 9	
BARS NO	2# 5	1# 6	1# 7	1# 9	1# 9		2# 5	1# 6	1# 7	1# 9	1# 9	
STEEL (PSF)	0.80	1.36	1.54	1.87	2.12		1.25	2.14	2.33	2.97	4.23	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
34'- 0" (3)	234	707	857	1139	1332	5.097	594	1282	1500	1910	2191	3.137
STIR	#3- 77	#3-137	#3-147	#3-165	#3-171		#3- 96	#3-123	#3-146	#4-156	#4-157	
35'- 0"	189	636	777	1043	1225	5.724	529	1178	1384	1771	2036	3.522
STIR	#3- 75	#3-138	#3-149	#3-166	#3-174		#3- 96	#3-130	#3-148	#4-160	#4-161	
36'- 0"	148	570	704	955	1128	6.407	469	1083	1278	1643	1894	3.942
STIR	#3- 72	#3-139	#3-150	#3-149	#3-177		#3- 95	#3-138	#3-151	#4-162	#4-167	
37'- 0"	111	510	637	875	1038	7.149	414	996	1180	1526	1763	4.399
STIR	#3- 69	#3-139	#3-152	#3-157	#3-180		#3- 94	#3-142	#3-130	#4-165	#4-172	
38'- 0"	76	455	575	800	955	7.953	364	915	1090	1418	1643	4.894
STIR	#3- 65	#3-140	#3-153	#3-165	#3-183		#3- 93	#3-144	#3-137	#3-168	#4-175	
39'- 0"	44	403	517	731	878	8.824	317	840	1006	1317	1531	5.430
STIR	#3- 62	#3-140	#3-154	#3-173	#3-185		#3- 92	#3-145	#3-144	#3-170	#4-178	
40'- 0"	14	356	464	668	807	9.765	274	771	929	1225	1428	6.009
STIR	#3- 58	#3-140	#3-155	#3-175	#3-165		#3- 90	#3-147	#3-152	#3-173	#4-181	
41'- 0"		312	415	609	742	10.778	234	707	857	1139	1332	6.633
STIR		#3-140	#3-155	#3-177	#3-173		#3- 89	#3-148	#3-159	#3-176	#4-183	
42'- 0"		271	369	554	680	11.869	197	648	791	1059	1243	7.304
STIR		#3-140	#3-156	#3-179	#3-181		#3- 87	#3-149	#3-160	#3-178	#4-186	
43'- 0"		233	327	503	623	13.040	162	592	729	985	1161	8.025
STIR		#3-140	#3-156	#3-180	#3-190		#3- 85	#3-150	#3-162	#3-180	#3-189	
44'- 0"		197	287	455	570	14.296	130	541	671	915	1083	8.798
STIR		#3-139	#3-157	#3-182	#3-194		#3- 82	#3-151	#3-163	#3-183	#3-191	
45'- 0"		164	250	410	521	15.641	99	492	617	851	1011	9.625
STIR		#3-138	#3-157	#3-183	#3-196		#3- 80	#3-152	#3-165	#3-184	#3-194	
46'- 0"		133	215	369	474	17.078	71	447	566	790	944	10.510
STIR		#3-137	#3-157	#3-184	#3-198		#3- 78	#3-152	#3-166	#3-167	#3-197	
PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	0.96	1.65	1.86	2.22	2.48		1.37	2.40	2.48	3.25	5.42	
ACTUAL STEEL %	0.435	0.752	0.846	1.014	1.133		0.621	1.087	1.127	1.482	2.487	
EFF. DEPTH, IN.	22.38	22.31	22.31	22.25	22.25		22.38	22.38	22.31	22.25	22.12	
$-I_{cr}/I_{gr}$	0.121	0.185	0.203	0.231	0.250		0.161	0.247	0.252	0.303	0.420	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.82	1.32	1.48	1.79	2.00		0.82	1.32	1.48	1.79	2.00	
ACTUAL STEEL %	0.354	0.572	0.642	0.780	0.873		0.354	0.572	0.642	0.780	0.873	
EFF. DEPTH, IN.	22.70	22.62	22.60	22.46	22.44		22.70	22.62	22.60	22.46	22.44	
$+I_{cr}/I_{gr}$	0.133	0.204	0.226	0.265	0.292		0.133	0.204	0.226	0.265	0.292	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 4	# 6	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	9.5	9	7.5	6	8		7	4	7.5	8.5	5	
BOTTOM BARS NO	1# 6	1# 7	1# 6	2# 7	1# 7		1# 6	1# 7	1# 6	2# 7	1# 7	
BARS NO	1# 6	1# 8	2# 7	1# 8	2# 8		1# 6	1# 8	2# 7	1# 8	2# 8	
STEEL (PSF)	0.90	1.41	1.62	2.03	2.16		1.33	2.19	2.56	3.14	4.42	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
34'- 0" (3)	258	737	976	1301	1477	5.097	643	1340	1687	2160	2415	3.137
STIR	#3- 72	#3-132	#3-148	#3-165	#4-171		#3- 93	#3-129	#3-147	#4-157	#4-157	
35'- 0"	210	662	888	1195	1360	5.724	573	1231	1559	2005	2246	3.522
STIR	#3- 69	#3-132	#3-149	#3-167	#3-174		#3- 92	#3-135	#3-150	#4-160	#4-162	
36'- 0"	166	594	807	1097	1253	6.407	510	1132	1442	1863	2091	3.942
STIR	#3- 66	#3-133	#3-151	#3-147	#3-177		#3- 91	#3-137	#3-151	#4-163	#4-167	
37'- 0"	126	531	733	1007	1155	7.149	451	1040	1333	1733	1948	4.399
STIR	#3- 63	#3-133	#3-152	#3-156	#3-180		#3- 90	#3-138	#3-154	#4-166	#4-171	
38'- 0"	89	473	664	924	1065	7.953	397	955	1233	1612	1816	4.894
STIR	#3- 59	#3-133	#3-153	#3-164	#3-182		#3- 89	#3-139	#3-136	#4-168	#4-174	
39'- 0"	55	419	601	848	981	8.824	347	877	1141	1501	1694	5.430
STIR	#3- 55	#3-133	#3-154	#3-173	#3-185		#3- 87	#3-141	#3-143	#4-171	#4-177	
40'- 0"	23	369	542	777	903	9.765	301	805	1056	1397	1582	6.009
STIR	#3- 51	#3-133	#3-155	#3-176	#3-166		#3- 86	#3-142	#3-151	#4-174	#4-180	
41'- 0"		323	487	711	832	10.778	258	738	977	1302	1477	6.633
STIR		#3-133	#3-156	#3-178	#3-174		#3- 84	#3-143	#3-158	#3-177	#4-183	
42'- 0"		280	437	650	765	11.869	218	675	903	1213	1380	7.304
STIR		#3-132	#3-156	#3-180	#3-183		#3- 82	#3-144	#3-161	#3-179	#4-186	
43'- 0"		240	390	593	702	13.040	181	617	834	1130	1289	8.025
STIR		#3-131	#3-157	#3-181	#3-191		#3- 79	#3-144	#3-162	#3-182	#4-189	
44'- 0"		203	346	540	644	14.296	147	563	770	1053	1205	8.798
STIR		#3-131	#3-157	#3-182	#3-193		#3- 77	#3-145	#3-164	#3-183	#4-191	
45'- 0"		168	305	490	590	15.641	114	512	711	981	1126	9.625
STIR		#3-129	#3-157	#3-184	#3-195		#3- 74	#3-145	#3-165	#3-186	#3-193	
46'- 0"		136	266	444	540	17.078	84	465	655	913	1052	10.510
STIR		#3-128	#3-157	#3-185	#3-197		#3- 71	#3-146	#3-167	#3-188	#3-195	
PROPERTIES FOR DESIGN (CONCRETE 0.80 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.03	1.69	2.03	2.53	2.69		1.40	2.45	2.87	3.46	5.88	
ACTUAL STEEL %	0.424	0.697	0.836	1.045	1.116		0.576	1.008	1.190	1.437	2.443	
EFF. DEPTH, IN.	22.38	22.31	22.31	22.31	22.25		22.38	22.38	22.25	22.19	22.19	
$-I_{cr}/I_{gr}$	0.121	0.178	0.205	0.243	0.253		0.155	0.239	0.265	0.301	0.429	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.88	1.39	1.64	1.99	2.18		0.88	1.39	1.64	1.99	2.18	
ACTUAL STEEL %	0.347	0.551	0.648	0.788	0.864		0.347	0.551	0.648	0.788	0.864	
EFF. DEPTH, IN.	22.62	22.53	22.58	22.54	22.52		22.62	22.53	22.58	22.54	22.52	
$+I_{cr}/I_{gr}$	0.130	0.196	0.229	0.272	0.294		0.130	0.196	0.229	0.272	0.294	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 10″ Ribs @ 50″ c.-c.
19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span	# 5	# 6	# 7	# 7	# 7	Int. Span
AT	9	8.5	7	6	7.5	Defl. Coeff. (2)	10	9	10	8.5	6	Defl. Coeff. (2)
BOTTOM BARS NO	2# 5	2# 6	2# 6	2# 6	2# 8		2# 5	2# 6	2# 6	2# 6	2# 8	
BARS NO	1# 5	1# 7	2# 6	2# 7	1# 8		1# 5	1# 7	2# 6	2# 7	1# 8	
STEEL (PSF)	0.89	1.47	1.80	2.08	2.32		1.38	2.23	2.73	3.19	4.05	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
34'- 0" (3)	278	796	1062	1360	1622	5.097	685	1440	1827	2259	2640	3.137
STIR	#3- 67	#3-129	#3-146	#3-161	#4-171		#3- 90	#3-131	#3-145	#4-155	#5-161	
35'- 0"	227	717	968	1248	1495	5.724	612	1324	1689	2097	2457	3.522
STIR	#3- 64	#3-130	#3-148	#3-145	#4-174		#3- 89	#3-134	#3-148	#4-158	#4-164	
36'- 0"	181	643	881	1146	1380	6.407	544	1217	1562	1949	2288	3.942
STIR	#3- 61	#3-130	#3-149	#3-154	#3-176		#3- 88	#3-135	#3-151	#4-160	#4-167	
37'- 0"	138	576	801	1052	1273	7.149	482	1119	1446	1812	2133	4.399
STIR	#3- 57	#3-130	#3-150	#3-162	#3-179		#3- 86	#3-137	#3-131	#4-163	#4-170	
38'- 0"	99	514	727	965	1175	7.953	425	1029	1339	1685	1990	4.894
STIR	#3- 53	#3-130	#3-151	#3-168	#3-182		#3- 85	#3-138	#3-138	#4-166	#4-174	
39'- 0"	62	457	659	885	1084	8.824	372	946	1240	1569	1858	5.430
STIR	#3- 49	#3-130	#3-152	#3-170	#3-184		#3- 83	#3-139	#3-145	#4-168	#4-177	
40'- 0"	29	403	596	811	1000	9.765	323	868	1148	1461	1736	6.009
STIR	#3- 44	#3-130	#3-153	#3-172	#3-167		#3- 81	#3-140	#3-153	#3-171	#4-180	
41'- 0"		354	537	742	922	10.778	278	797	1063	1360	1622	6.633
STIR		#3-129	#3-154	#3-173	#3-175		#3- 79	#3-141	#3-158	#3-173	#4-182	
42'- 0"		308	483	678	849	11.869	236	730	984	1267	1517	7.304
STIR		#3-129	#3-154	#3-175	#3-184		#3- 77	#3-142	#3-160	#3-176	#4-185	
43'- 0"		266	432	618	782	13.040	196	668	910	1181	1419	8.025
STIR		#3-128	#3-155	#3-176	#3-191		#3- 74	#3-142	#3-161	#3-178	#4-187	
44'- 0"		226	385	562	719	14.296	160	610	841	1100	1327	8.798
STIR		#3-127	#3-155	#3-177	#3-192		#3- 72	#3-143	#3-163	#3-157	#4-191	
45'- 0"		189	341	511	660	15.641	125	556	777	1024	1241	9.625
STIR		#3-125	#3-155	#3-178	#3-194		#3- 69	#3-143	#3-164	#3-164	#4-193	
46'- 0"		154	299	462	605	17.078	93	506	717	953	1161	10.510
STIR		#3-124	#3-155	#3-179	#3-196		#3- 66	#3-144	#3-165	#3-171	#3-195	
PROPERTIES FOR DESIGN (CONCRETE 0.83 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.11	1.82	2.21	2.58	2.93		1.55	2.44	3.00	3.53	5.00	
ACTUAL STEEL %	0.419	0.689	0.837	0.976	1.112		0.586	0.927	1.141	1.342	1.902	
EFF. DEPTH, IN.	22.38	22.31	22.31	22.31	22.25		22.31	22.25	22.19	22.19	22.19	
$-I_{cr}/I_{gr}$	0.121	0.180	0.210	0.236	0.257		0.158	0.225	0.260	0.292	0.372	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.48	1.76	2.08	2.37		0.93	1.48	1.76	2.08	2.37	
ACTUAL STEEL %	0.336	0.537	0.638	0.755	0.863		0.336	0.537	0.638	0.755	0.863	
EFF. DEPTH, IN.	22.69	22.60	22.62	22.59	22.50		22.69	22.60	22.62	22.59	22.50	
$+I_{cr}/I_{gr}$	0.128	0.195	0.229	0.265	0.295		0.128	0.195	0.229	0.265	0.295	

SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 8″ Ribs @ 48″ c.-c.
21″ Deep Rib + 5.5″ Top Slab = 26.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 5	# 5	# 5	# 6	End Span	# 4	# 4	# 6	# 7	# 8	Int. Span
AT	9	9	7.5	6	7.5	Defl. Coeff. (2)	7	4	7.5	8	6	Defl. Coeff. (2)
BOTTOM BARS NO	1# 6	1# 7	1# 6	1# 9	1# 9		1# 6	1# 7	1# 6	1# 9	1# 9	
BARS NO	1# 6	1# 8	2# 7	1# 9	1#10		1# 6	1# 8	2# 7	1# 9	1#10	
STEEL (PSF)	0.92	1.43	1.64	2.11	2.38		1.34	2.21	2.58	3.33	4.86	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	192	633	853	1154	1382	7.149	546	1188	1508	1945	2276	4.399
STIR	#3- 78	#3-143	#3-160	#3-179	#4-188		#3-100	#3-141	#3-159	#4-170	#4-169	
38'- 0"	152	570	778	1064	1279	7.953	487	1096	1399	1814	2128	4.894
STIR	#3- 75	#3-143	#3-162	#3-181	#4-192		#3- 99	#3-146	#3-162	#4-174	#4-174	
39'- 0"	114	512	709	980	1185	8.824	433	1011	1298	1692	1990	5.430
STIR	#3- 72	#3-144	#3-163	#3-159	#3-194		#3- 99	#3-148	#3-163	#4-176	#4-179	
40'- 0"	80	457	645	903	1098	9.765	382	932	1205	1580	1863	6.009
STIR	#3- 68	#3-144	#3-164	#3-168	#3-197		#3- 97	#3-149	#3-166	#4-180	#4-185	
41'- 0"	47	407	586	831	1016	10.778	336	859	1119	1475	1745	6.633
STIR	#3- 65	#3-144	#3-166	#3-176	#3-199		#3- 96	#3-151	#3-146	#4-183	#4-190	
42'- 0"	18	360	531	764	941	11.869	292	791	1039	1378	1635	7.304
STIR	#3- 61	#3-144	#3-167	#3-185	#3-202		#3- 95	#3-152	#3-153	#4-185	#4-194	
43'- 0"		317	479	702	871	13.040	252	727	964	1288	1533	8.025
STIR		#3-144	#3-168	#3-190	#3-205		#3- 93	#3-153	#3-161	#3-188	#4-196	
44'- 0"		276	432	644	805	14.296	214	668	894	1204	1438	8.798
STIR		#3-144	#3-168	#3-192	#3-208		#3- 91	#3-154	#3-168	#3-190	#4-199	
45'- 0"		238	387	590	744	15.641	179	613	829	1125	1349	9.625
STIR		#3-143	#3-169	#3-194	#3-187		#3- 89	#3-155	#3-173	#3-192	#4-202	
46'- 0"		203	345	540	687	17.078	146	562	768	1051	1266	10.510
STIR		#3-143	#3-170	#3-195	#3-195		#3- 87	#3-156	#3-175	#3-195	#4-205	
47'- 0"		170	306	492	633	18.613	115	513	711	983	1188	11.454
STIR		#3-142	#3-170	#3-197	#3-204		#3- 85	#3-157	#3-177	#3-197	#4-208	
48'- 0"		138	269	448	583	20.248	86	468	658	918	1115	12.460
STIR		#3-141	#3-170	#3-198	#3-213		#3- 82	#3-157	#3-178	#3-199	#4-211	
49'- 0"		109	234	406	536	21.989	59	425	608	857	1046	13.532
STIR		#3-140	#3-170	#3-199	#3-216		#3- 80	#3-158	#3-179	#3-202	#4-213	
PROPERTIES FOR DESIGN (CONCRETE 0.81 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.07	1.65	1.98	2.48	2.82		1.37	2.40	2.82	3.60	6.32	
ACTUAL STEEL %	0.436	0.678	0.814	1.017	1.159		0.561	0.982	1.159	1.486	2.617	
EFF. DEPTH, IN.	24.38	24.31	24.31	24.31	24.25		24.38	24.38	24.25	24.19	24.12	
$-I_{cr}/I_{gr}$	0.125	0.177	0.204	0.242	0.264		0.154	0.237	0.264	0.312	0.450	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.88	1.39	1.64	2.00	2.27		0.88	1.39	1.64	2.00	2.27	
ACTUAL STEEL %	0.345	0.546	0.644	0.788	0.896		0.345	0.546	0.644	0.788	0.896	
EFF. DEPTH, IN.	24.62	24.53	24.58	24.44	24.40		24.62	24.53	24.58	24.44	24.40	
$+I_{cr}/I_{gr}$	0.132	0.200	0.234	0.276	0.308		0.132	0.200	0.234	0.276	0.308	

SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 21″ Deep Rib + 5.5″ Top Slab = 26.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 5	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 8	# 8	Int. Span Defl. Coeff. (2)
AT	9	8.5	7	8	10		10	9	10	10	6	
BOTTOM BARS NO	2# 5	2# 6	1# 8	1# 7	2# 8		2# 5	2# 6	1# 8	1# 7	2# 8	
BARS NO	1# 5	1# 7	1# 9	2# 8	1# 8		1# 5	1# 7	1# 9	2# 8	1# 8	
STEEL (PSF)	0.91	1.49	1.81	2.16	2.37		1.39	2.25	2.75	3.40	4.84	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	205	683	943	1282	1443	7.149	580	1274	1653	2146	2381	4.399
STIR	#3- 71	#3-139	#3-159	#3-178	#4-185		#3- 96	#3-143	#3-158	#4-171	#5-170	
38'- 0"	162	615	862	1183	1336	7.953	517	1176	1535	2003	2225	4.894
STIR	#3- 68	#3-140	#3-160	#3-181	#4-188		#3- 95	#3-144	#3-161	#4-173	#4-176	
39'- 0"	123	552	787	1092	1237	8.824	460	1085	1426	1870	2081	5.430
STIR	#3- 64	#3-140	#3-162	#3-160	#3-190		#3- 94	#3-146	#3-163	#4-177	#4-181	
40'- 0"	86	495	717	1007	1146	9.765	407	1001	1325	1747	1948	6.009
STIR	#3- 60	#3-140	#3-163	#3-168	#3-193		#3- 92	#3-147	#3-141	#4-179	#4-184	
41'- 0"	52	441	653	929	1060	10.778	357	923	1231	1633	1824	6.633
STIR	#3- 56	#3-140	#3-164	#3-177	#3-195		#3- 91	#3-148	#3-148	#4-182	#4-187	
42'- 0"	20	391	593	856	981	11.869	311	850	1144	1527	1709	7.304
STIR	#3- 52	#3-140	#3-165	#3-185	#3-198		#3- 89	#3-150	#3-155	#4-185	#4-190	
43'- 0"		345	537	788	908	13.040	268	783	1063	1428	1602	8.025
STIR		#3-140	#3-166	#3-190	#3-179		#3- 87	#3-151	#3-162	#4-187	#4-193	
44'- 0"		301	485	725	839	14.296	229	720	988	1336	1502	8.798
STIR		#3-139	#3-167	#3-192	#3-187		#3- 85	#3-152	#3-170	#4-189	#4-195	
45'- 0"		261	437	666	775	15.641	191	661	917	1250	1409	9.625
STIR		#3-138	#3-167	#3-193	#3-196		#3- 83	#3-152	#3-172	#3-193	#4-198	
46'- 0"		223	391	611	715	17.078	156	606	851	1170	1322	10.510
STIR		#3-137	#3-168	#3-195	#3-204		#3- 81	#3-153	#3-174	#3-194	#4-201	
47'- 0"		187	349	559	659	18.613	124	554	789	1095	1240	11.454
STIR		#3-136	#3-168	#3-196	#3-207		#3- 78	#3-154	#3-175	#3-197	#4-203	
48'- 0"		154	309	510	606	20.248	93	506	731	1024	1163	12.460
STIR		#3-135	#3-168	#3-198	#3-209		#3- 75	#3-154	#3-177	#3-200	#4-207	
49'- 0"		123	271	465	557	21.989	64	460	676	958	1091	13.532
STIR		#3-134	#3-168	#3-199	#3-210		#3- 72	#3-154	#3-178	#3-202	#4-209	
PROPERTIES FOR DESIGN (CONCRETE 0.84 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.09	1.79	2.17	2.69	2.94		1.52	2.40	2.94	3.87	6.45	
ACTUAL STEEL %	0.405	0.667	0.809	1.008	1.103		0.567	0.896	1.103	1.457	2.429	
EFF. DEPTH, IN.	24.38	24.31	24.31	24.25	24.19		24.31	24.25	24.19	24.12	24.12	
$-I_{cr}/I_{gr}$	0.120	0.178	0.208	0.243	0.258		0.157	0.223	0.258	0.312	0.439	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.48	1.79	2.18	2.37		0.93	1.48	1.79	2.18	2.37	
ACTUAL STEEL %	0.332	0.529	0.643	0.782	0.850		0.332	0.529	0.643	0.782	0.850	
EFF. DEPTH, IN.	24.69	24.60	24.46	24.52	24.50		24.69	24.60	24.46	24.52	24.50	
$+I_{cr}/I_{gr}$	0.130	0.198	0.232	0.278	0.299		0.130	0.198	0.232	0.278	0.299	
SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 10″ Ribs @ 50″ c.-c. 21″ Deep Rib + 5.5″ Top Slab = 26.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 5	# 6	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 8	# 8	Int. Span Defl. Coeff. (2)
AT	8	8	9	8	9		9.5	8	9	10	7.5	
BOTTOM BARS NO	2# 4	1# 6	2# 7	1# 9	2# 8		2# 4	1# 6	2# 7	1# 9	2# 8	
BARS NO	2# 5	2# 7	1# 8	1#10	1# 9		2# 5	2# 7	1# 8	1#10	1# 9	
STEEL (PSF)	1.00	1.57	1.98	2.27	2.59		1.49	2.45	3.01	3.51	4.34	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	252	788	1088	1317	1588	7.149	663	1442	1879	2212	2607	4.399
STIR	#3- 72	#3-141	#3-161	#3-152	#4-184		#3- 97	#3-143	#4-160	#4-167	#5-175	
38'- 0"	205	713	997	1215	1472	7.953	595	1334	1747	2063	2437	4.894
STIR	#3- 69	#3-141	#3-163	#3-160	#4-187		#3- 96	#3-146	#4-162	#4-171	#5-178	
39'- 0"	162	644	914	1120	1364	8.824	532	1233	1626	1926	2281	5.430
STIR	#3- 65	#3-142	#3-164	#3-168	#4-190		#3- 95	#3-147	#3-165	#4-173	#5-181	
40'- 0"	121	580	836	1032	1265	9.765	473	1140	1513	1798	2136	6.009
STIR	#3- 62	#3-142	#3-166	#3-177	#3-192		#3- 93	#3-149	#3-167	#4-175	#4-184	
41'- 0"	84	520	765	951	1172	10.778	419	1054	1409	1680	2002	6.633
STIR	#3- 58	#3-142	#3-167	#3-181	#3-195		#3- 92	#3-150	#3-145	#4-178	#4-187	
42'- 0"	49	465	698	876	1086	11.869	369	973	1312	1571	1877	7.304
STIR	#3- 53	#3-142	#3-168	#3-182	#3-198		#3- 90	#3-151	#3-152	#4-181	#4-190	
43'- 0"	17	414	636	806	1006	13.040	322	899	1222	1468	1760	8.025
STIR	#3- 49	#3-142	#3-169	#3-184	#3-179		#3- 88	#3-152	#3-159	#4-183	#4-192	
44'- 0"		366	578	740	932	14.296	278	829	1137	1373	1652	8.798
STIR		#3-141	#3-170	#3-186	#3-188		#3- 86	#3-153	#3-166	#3-186	#4-195	
45'- 0"		321	524	679	862	15.641	237	764	1059	1284	1551	9.625
STIR		#3-141	#3-171	#3-187	#3-196		#3- 84	#3-154	#3-174	#3-188	#4-198	
46'- 0"		279	473	622	797	17.078	199	703	985	1201	1456	10.510
STIR		#3-140	#3-171	#3-188	#3-204		#3- 82	#3-155	#3-176	#3-190	#4-201	
47'- 0"		240	426	568	736	18.613	163	646	916	1123	1367	11.454
STIR		#3-139	#3-172	#3-189	#3-206		#3- 79	#3-155	#3-178	#3-167	#4-203	
48'- 0"		203	381	518	679	20.248	129	592	851	1050	1284	12.460
STIR		#3-138	#3-172	#3-191	#3-208		#3- 76	#3-156	#3-179	#3-174	#4-206	
49'- 0"		169	340	470	625	21.989	98	542	791	981	1206	13.532
STIR		#3-137	#3-172	#3-191	#3-210		#3- 73	#3-156	#3-180	#3-182	#4-209	
PROPERTIES FOR DESIGN (CONCRETE 0.87 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.25	1.94	2.44	2.75	3.33		1.63	2.75	3.33	3.95	5.27	
ACTUAL STEEL %	0.426	0.663	0.839	0.943	1.147		0.558	0.943	1.147	1.363	1.818	
EFF. DEPTH, IN.	24.38	24.31	24.25	24.25	24.19		24.31	24.25	24.19	24.12	24.12	
$-I_{cr}/I_{gr}$	0.128	0.181	0.216	0.236	0.270		0.158	0.236	0.270	0.304	0.371	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.27	2.58		1.02	1.64	1.99	2.27	2.58	
ACTUAL STEEL %	0.334	0.539	0.656	0.751	0.852		0.334	0.539	0.656	0.751	0.852	
EFF. DEPTH, IN.	24.71	24.58	24.54	24.40	24.48		24.71	24.58	24.54	24.40	24.48	
$+I_{cr}/I_{gr}$	0.132	0.202	0.240	0.266	0.301		0.132	0.202	0.240	0.266	0.301	
SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 8″ Ribs @ 48″ c.-c. 23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 6	# 6	# 8	Int. Span Defl. Coeff. (2)
AT	8.5	5	4	7.5	9		10	8	7	4.5	5	
BOTTOM BARS NO	2# 5	1# 8	1# 8	1# 9	1#10		2# 5	1# 8	1# 8	1# 9	1#10	
BARS NO	1# 5	1# 8	1# 9	1#10	1#10		1# 5	1# 8	1# 9	1#10	1#10	
STEEL (PSF)	0.93	1.65	1.91	2.38	2.70		1.40	2.52	2.85	4.06	5.73	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	276	882	1076	1517	1763	7.149	681	1562	1845	2486	2844	4.399
STIR	#3- 85	#3-154	#3-163	#4-187	#4-194		#3-105	#3-155	#4-164	#5-176	#5-169	
38'- 0"	230	804	988	1406	1639	7.953	614	1449	1717	2325	2664	4.894
STIR	#3- 82	#3-155	#3-168	#4-190	#4-198		#3-105	#3-133	#4-166	#4-180	#5-173	
39'- 0"	187	732	907	1304	1525	8.824	552	1345	1599	2176	2498	5.430
STIR	#3- 80	#3-157	#3-170	#3-193	#4-201		#3-104	#3-140	#3-168	#4-183	#5-176	
40'- 0"	147	666	832	1209	1419	9.765	494	1248	1490	2038	2345	6.009
STIR	#3- 77	#3-158	#3-171	#3-195	#4-204		#3-104	#3-147	#3-170	#4-186	#5-178	
41'- 0"	111	604	762	1121	1321	10.778	441	1158	1388	1910	2202	6.633
STIR	#3- 73	#3-159	#3-173	#3-199	#4-208		#3-103	#3-154	#3-173	#4-189	#5-184	
42'- 0"	76	546	697	1039	1230	11.869	391	1075	1294	1791	2069	7.304
STIR	#3- 70	#3-159	#3-174	#3-201	#4-211		#3-102	#3-162	#3-176	#4-192	#5-191	
43'- 0"	45	493	637	963	1145	13.040	345	997	1206	1681	1946	8.025
STIR	#3- 66	#3-160	#3-176	#3-203	#4-213		#3-100	#3-165	#3-150	#4-195	#4-197	
44'- 0"	15	443	581	892	1066	14.296	302	924	1124	1578	1831	8.798
STIR	#3- 62	#3-160	#3-177	#3-182	#3-216		#3- 99	#3-166	#3-157	#4-198	#4-203	
45'- 0"		397	528	826	992	15.641	261	857	1048	1481	1723	9.625
STIR		#3-160	#3-178	#3-190	#3-219		#3- 97	#3-168	#3-165	#4-201	#4-209	
46'- 0"		353	479	764	923	17.078	224	793	976	1391	1623	10.510
STIR		#3-161	#3-179	#3-198	#3-221		#3- 95	#3-169	#3-172	#4-204	#4-212	
47'- 0"		312	433	706	858	18.613	188	734	909	1307	1528	11.454
STIR		#3-161	#3-179	#3-207	#3-224		#3- 93	#3-170	#3-180	#4-206	#4-214	
48'- 0"		274	389	651	798	20.248	155	678	846	1227	1440	12.460
STIR		#3-160	#3-180	#3-212	#3-227		#3- 91	#3-172	#3-185	#4-209	#4-218	
49'- 0"		238	349	600	741	21.989	124	626	787	1153	1357	13.532
STIR		#3-160	#3-181	#3-214	#3-229		#3- 89	#3-173	#3-187	#4-211	#4-220	
PROPERTIES FOR DESIGN (CONCRETE 0.85 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.13	1.92	2.40	2.82	3.20		1.49	2.64	3.02	4.69	7.58	
ACTUAL STEEL %	0.420	0.714	0.892	1.053	1.200		0.555	0.987	1.128	1.755	2.852	
EFF. DEPTH, IN.	26.38	26.38	26.38	26.25	26.19		26.31	26.25	26.25	26.25	26.12	
$-I_{cr}/I_{gr}$	0.125	0.192	0.228	0.254	0.277		0.156	0.242	0.267	0.365	0.490	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.58	1.79	2.27	2.54		0.93	1.58	1.79	2.27	2.54	
ACTUAL STEEL %	0.331	0.566	0.641	0.815	0.913		0.331	0.566	0.641	0.815	0.913	
EFF. DEPTH, IN.	26.69	26.50	26.46	26.40	26.36		26.69	26.50	26.46	26.40	26.36	
$+I_{cr}/I_{gr}$	0.132	0.213	0.238	0.293	0.323		0.132	0.213	0.238	0.293	0.323	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	40″ Forms + 9″ Ribs @ 49″ c.-c. 23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 8	# 8	Int. Span Defl. Coeff. (2)
AT	8	5	4	7	8		9.5	8	8.5	9.5	5	
BOTTOM BARS NO	2# 4	1# 6	2# 7	2# 8	1# 8		2# 4	1# 6	2# 7	2# 8	1# 8	
BARS NO	2# 5	2# 7	1# 8	1# 8	2# 9		2# 5	2# 7	1# 8	1# 8	2# 9	
STEEL (PSF)	1.01	1.60	2.01	2.41	2.82		1.50	2.47	3.14	3.66	5.75	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	327	907	1232	1583	1967	7.149	772	1616	2089	2599	3157	4.399
STIR	#3- 85	#3-149	#3-161	#4-184	#4-195		#3-105	#3-133	#4-164	#5-173	#5-173	
38'- 0"	276	826	1135	1467	1831	7.953	698	1498	1946	2430	2959	4.894
STIR	#3- 82	#3-150	#3-169	#4-186	#4-198		#3-105	#3-140	#4-167	#4-177	#5-176	
39'- 0"	229	752	1044	1360	1705	8.824	630	1389	1815	2274	2776	5.430
STIR	#3- 79	#3-150	#3-171	#3-189	#4-202		#3-104	#3-148	#4-170	#4-181	#5-180	
40'- 0"	186	682	961	1261	1589	9.765	566	1289	1693	2129	2607	6.009
STIR	#3- 76	#3-151	#3-173	#3-191	#4-205		#3-103	#3-155	#4-172	#4-183	#5-182	
41'- 0"	146	618	883	1168	1481	10.778	508	1195	1580	1995	2450	6.633
STIR	#3- 73	#3-152	#3-174	#3-194	#4-208		#3-103	#3-157	#3-175	#4-186	#5-186	
42'- 0"	108	558	811	1083	1381	11.869	453	1108	1475	1871	2304	7.304
STIR	#3- 70	#3-152	#3-176	#3-173	#4-211		#3-101	#3-158	#3-176	#4-189	#5-192	
43'- 0"	73	503	743	1003	1287	13.040	402	1027	1377	1755	2168	8.025
STIR	#3- 66	#3-152	#3-177	#3-182	#4-214		#3-100	#3-160	#3-179	#4-192	#5-197	
44'- 0"	41	451	681	929	1200	14.296	355	952	1286	1647	2042	8.798
STIR	#3- 62	#3-152	#3-179	#3-190	#4-217		#3- 99	#3-161	#3-155	#4-194	#5-203	
45'- 0"	10	402	622	859	1119	15.641	311	881	1201	1546	1923	9.625
STIR	#3- 58	#3-152	#3-180	#3-199	#4-219		#3- 97	#3-162	#3-162	#4-197	#5-208	
46'- 0"		357	567	794	1043	17.078	269	816	1121	1451	1812	10.510
STIR		#3-152	#3-181	#3-203	#3-222		#3- 95	#3-163	#3-169	#4-200	#4-212	
47'- 0"		315	516	733	971	18.613	231	754	1047	1363	1709	11.454
STIR		#3-151	#3-181	#3-205	#3-225		#3- 93	#3-164	#3-177	#4-203	#4-215	
48'- 0"		275	468	676	904	20.248	194	696	977	1280	1611	12.460
STIR		#3-151	#3-182	#3-206	#3-227		#3- 91	#3-165	#3-184	#4-205	#4-217	
49'- 0"		237	423	623	842	21.989	160	641	911	1202	1520	13.532
STIR		#3-150	#3-183	#3-208	#3-230		#3- 89	#3-166	#3-188	#4-207	#4-221	
PROPERTIES FOR DESIGN (CONCRETE 0.89 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.23	1.96	2.45	3.08	3.68		1.60	2.69	3.46	4.07	7.74	
ACTUAL STEEL %	0.415	0.664	0.830	1.049	1.255		0.543	0.918	1.181	1.395	2.651	
EFF. DEPTH, IN.	26.38	26.38	26.38	26.25	26.19		26.31	26.25	26.19	26.12	26.12	
$-I_{cr}/I_{gr}$	0.127	0.185	0.220	0.259	0.293		0.157	0.234	0.280	0.313	0.479	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.37	2.79		1.02	1.64	1.99	2.37	2.79	
ACTUAL STEEL %	0.331	0.535	0.650	0.775	0.913		0.331	0.535	0.650	0.775	0.913	
EFF. DEPTH, IN.	26.71	26.58	26.54	26.50	26.45		26.71	26.58	26.54	26.50	26.45	
$+I_{cr}/I_{gr}$	0.134	0.205	0.244	0.284	0.327		0.134	0.205	0.244	0.284	0.327	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

40″ Forms + 10″ Ribs @ 50″ c.-c.
23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 5	# 6	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 8	# 8	Int. Span Defl. Coeff. (2)
AT	7	7	8	7	8.5		8	7.5	8	9	6	
BOTTOM BARS NO	1# 5	1# 8	1# 7	1#10	1#10		1# 5	1# 8	1# 7	1#10	1#10	
BARS NO	2# 6	1# 9	2# 8	1#10	1#11		2# 6	1# 9	2# 8	1#10	1#11	
STEEL (PSF)	1.13	1.79	2.13	2.58	2.85		1.73	2.69	3.29	3.94	5.19	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	450	1006	1373	1693	1956	7.149	967	1775	2309	2775	3157	4.399
STIR	#3- 95	#3-148	#3-159	#4-182	#4-190		#3-113	#3-133	#4-164	#5-173	#5-178	
38'- 0"	391	918	1266	1570	1819	7.953	881	1647	2154	2595	2958	4.894
STIR	#3- 94	#3-149	#3-168	#4-184	#4-193		#3-113	#3-141	#4-167	#5-176	#5-181	
39'- 0"	337	836	1167	1455	1692	8.824	802	1529	2010	2429	2773	5.430
STIR	#3- 91	#3-150	#3-172	#3-187	#4-196		#3-112	#3-148	#4-169	#4-179	#5-185	
40'- 0"	286	761	1076	1350	1574	9.765	729	1419	1877	2275	2602	6.009
STIR	#3- 89	#3-151	#3-174	#3-190	#4-199		#3-112	#3-155	#4-173	#4-182	#5-187	
41'- 0"	239	691	991	1252	1465	10.778	660	1318	1753	2133	2444	6.633
STIR	#3- 86	#3-152	#3-175	#3-169	#4-202		#3-112	#3-156	#4-175	#4-185	#5-191	
42'- 0"	196	627	912	1160	1364	11.869	597	1224	1638	2000	2296	7.304
STIR	#3- 83	#3-152	#3-177	#3-177	#4-204		#3-111	#3-158	#4-177	#4-188	#5-195	
43'- 0"	155	566	838	1075	1270	13.040	538	1136	1532	1877	2159	8.025
STIR	#3- 80	#3-152	#3-178	#3-186	#4-207		#3-110	#3-159	#3-179	#4-190	#5-198	
44'- 0"	117	510	770	996	1182	14.296	483	1054	1432	1761	2031	8.798
STIR	#3- 77	#3-152	#3-180	#3-195	#3-210		#3-109	#3-160	#3-154	#4-193	#4-200	
45'- 0"	82	457	706	922	1100	15.641	431	977	1339	1654	1912	9.625
STIR	#3- 74	#3-152	#3-181	#3-198	#3-212		#3-108	#3-162	#3-161	#4-195	#4-204	
46'- 0"	49	408	646	853	1023	17.078	383	906	1252	1553	1800	10.510
STIR	#3- 70	#3-152	#3-182	#3-200	#3-191		#3-107	#3-163	#3-169	#4-199	#4-206	
47'- 0"	18	362	590	788	951	18.613	338	839	1170	1459	1695	11.454
STIR	#3- 66	#3-151	#3-183	#3-202	#3-199		#3-105	#3-164	#3-176	#4-201	#4-209	
48'- 0"		319	537	727	883	20.248	296	776	1093	1370	1597	12.460
STIR		#3-151	#3-184	#3-204	#3-208		#3-103	#3-165	#3-183	#4-203	#4-212	
49'- 0"		278	488	670	820	21.989	256	717	1021	1287	1505	13.532
STIR		#3-150	#3-184	#3-205	#3-217		#3-102	#3-165	#3-189	#4-205	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.92 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.43	2.21	2.75	3.14	3.53		1.94	2.93	3.75	4.39	6.58	
ACTUAL STEEL %	0.444	0.690	0.860	0.982	1.106		0.604	0.917	1.175	1.380	2.069	
EFF. DEPTH, IN.	26.38	26.31	26.25	26.25	26.19		26.31	26.25	26.19	26.12	26.12	
$-I_{cr}/I_{gr}$	0.136	0.193	0.227	0.251	0.272		0.174	0.239	0.285	0.317	0.418	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.19	1.79	2.18	2.54	2.83		1.19	1.79	2.18	2.54	2.83	
ACTUAL STEEL %	0.356	0.539	0.656	0.767	0.856		0.356	0.539	0.656	0.767	0.856	
EFF. DEPTH, IN.	26.64	26.46	26.52	26.36	26.33		26.64	26.46	26.52	26.36	26.33	
$+I_{cr}/I_{gr}$	0.143	0.206	0.247	0.279	0.307		0.143	0.206	0.247	0.279	0.307	

SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

53″ Forms + 7″ Ribs @ 60″ c.-c.
15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	10	8	10	9		10	8	9	7	8	
BOTTOM BARS NO	2# 4	1# 6	1# 7	1# 7	1# 8		2# 4	1# 6	1# 7	1# 7	1# 8	
BARS NO	1# 4	1# 6	1# 7	1# 8	1# 8		1# 4	1# 6	1# 7	1# 8	1# 8	
STEEL (PSF)	0.57	0.77	1.02	1.18	1.35		0.81	1.13	1.55	2.35	2.77	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	139	460	825	1040	1255	2.344	461	927	1459	1771	2083	1.443
STIR	#3- 68	#3-107	#3-116	#3-141	#3-147		#3- 82	#3-108	#3-127	#4-130	#4-128	
29'- 0"	91	390	731	931	1131	2.698	391	826	1321	1613	1903	1.660
STIR	#3- 66	#3-108	#3-124	#3-144	#3-151		#3- 82	#3-111	#3-130	#3-136	#4-131	
30'- 0"	48	327	646	833	1020	3.090	328	734	1197	1470	1741	1.901
STIR	#3- 63	#3-108	#3-133	#3-147	#3-154		#3- 81	#3-113	#3-133	#3-140	#4-135	
31'- 0"	9	271	569	744	919	3.523	271	652	1085	1340	1595	2.168
STIR	#3- 60	#3-109	#3-136	#3-149	#3-157		#3- 81	#3-114	#3-135	#3-143	#4-141	
32'- 0"		219	499	663	828	4.000	220	577	984	1223	1462	2.461
STIR		#3-108	#3-138	#3-152	#3-160		#3- 80	#3-115	#3-137	#3-145	#4-147	
33'- 0"		172	435	590	744	4.523	173	508	891	1116	1341	2.784
STIR		#3-108	#3-140	#3-138	#3-163		#3- 79	#3-116	#3-140	#3-148	#4-153	
34'- 0"		129	377	523	668	5.097	130	446	806	1019	1230	3.137
STIR		#3-108	#3-141	#3-147	#3-166		#3- 77	#3-117	#3-143	#3-151	#3-158	
35'- 0"		90	324	461	599	5.724	90	389	729	929	1129	3.522
STIR		#3-107	#3-142	#3-155	#3-168		#3- 76	#3-118	#3-145	#3-154	#3-161	
36'- 0"		54	275	405	535	6.407	54	337	658	847	1036	3.942
STIR		#3-106	#3-144	#3-158	#3-171		#3- 74	#3-118	#3-131	#3-157	#3-164	
37'- 0"		21	230	353	476	7.149	21	288	593	772	950	4.399
STIR		#3-105	#3-145	#3-160	#3-173		#3- 72	#3-119	#3-138	#3-159	#3-167	
38'- 0"			189	305	422	7.953		244	532	702	871	4.894
STIR			#3-145	#3-161	#3-162			#3-119	#3-146	#3-162	#3-170	
39'- 0"			150	261	372	8.824		203	477	638	799	5.430
STIR			#3-146	#3-163	#3-170			#3-119	#3-150	#3-163	#3-172	
40'- 0"			115	220	325	9.765		165	425	578	731	6.009
STIR			#3-146	#3-164	#3-178			#3-119	#3-152	#3-166	#3-175	
PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.20	1.20	1.50	1.86	2.07		1.20	1.50	2.07	3.77	4.50	
ACTUAL STEEL %	0.765	0.765	0.957	1.191	1.324		0.765	0.957	1.324	2.425	2.906	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.31	18.31		18.38	18.38	18.31	18.25	18.19	
$-I_{cr}/I_{gr}$	0.160	0.160	0.190	0.221	0.238		0.160	0.190	0.238	0.354	0.392	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.88	1.20	1.39	1.58		0.60	0.88	1.20	1.39	1.58	
ACTUAL STEEL %	0.361	0.533	0.729	0.846	0.962		0.361	0.533	0.729	0.846	0.962	
EFF. DEPTH, IN.	18.75	18.62	18.56	18.53	18.50		18.75	18.62	18.56	18.53	18.50	
$+I_{cr}/I_{gr}$	0.119	0.168	0.222	0.253	0.283		0.119	0.168	0.222	0.253	0.283	

SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 8″ Ribs @ 61″ c.-c. 15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	9.5	8	7	9.5		10	7	9.5	8	6	
BOTTOM BARS NO	1# 5	1# 6	1# 5	1# 7	1# 8		1# 5	1# 6	1# 5	1# 7	1# 8	
BARS NO	1# 5	1# 7	2# 6	1# 8	1# 8		1# 5	1# 7	2# 6	1# 8	1# 8	
STEEL (PSF)	0.60	0.85	0.95	1.14	1.31		0.84	1.28	1.44	1.73	2.72	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	135	617	794	1015	1229	2.344	466	1168	1425	1746	2058	1.443
STIR	#3- 57	#3-112	#3-122	#3-134	#3-141		#3- 75	#3-102	#3-122	#3-129	#4-128	
29'- 0"	85	535	700	906	1106	2.698	394	1048	1288	1587	1878	1.660
STIR	#3- 54	#3-113	#3-124	#3-120	#3-145		#3- 74	#3-110	#3-124	#3-131	#4-134	
30'- 0"	41	461	615	808	994	3.090	329	941	1165	1445	1716	1.901
STIR	#3- 51	#3-114	#3-126	#3-128	#3-148		#3- 73	#3-116	#3-127	#3-134	#4-140	
31'- 0"	1	394	539	719	894	3.523	271	843	1053	1315	1570	2.168
STIR	#3- 47	#3-114	#3-127	#3-137	#3-150		#3- 72	#3-118	#3-129	#3-137	#4-143	
32'- 0"		334	469	638	802	4.000	217	755	952	1198	1437	2.461
STIR		#3-114	#3-128	#3-141	#3-152		#3- 70	#3-119	#3-116	#3-139	#3-146	
33'- 0"		278	406	565	719	4.523	169	675	860	1091	1315	2.784
STIR		#3-114	#3-129	#3-143	#3-136		#3- 68	#3-120	#3-123	#3-142	#3-149	
34'- 0"		228	348	497	643	5.097	125	601	776	993	1205	3.137
STIR		#3-114	#3-130	#3-144	#3-145		#3- 66	#3-122	#3-131	#3-144	#3-152	
35'- 0"		182	295	436	573	5.724	84	534	698	904	1103	3.522
STIR		#3-114	#3-130	#3-146	#3-153		#3- 64	#3-123	#3-134	#3-147	#3-154	
36'- 0"		139	246	380	509	6.407	47	472	628	822	1011	3.942
STIR		#3-113	#3-131	#3-147	#3-159		#3- 61	#3-123	#3-136	#3-149	#3-157	
37'- 0"		100	201	328	451	7.149	13	415	563	746	925	4.399
STIR		#3-113	#3-131	#3-148	#3-161		#3- 59	#3-124	#3-137	#3-134	#3-160	
38'- 0"		64	160	280	396	7.953		363	503	677	846	4.894
STIR		#3-112	#3-131	#3-149	#3-163			#3-125	#3-138	#3-141	#3-162	
39'- 0"		31	122	236	346	8.824		314	447	613	773	5.430
STIR		#3-110	#3-131	#3-150	#3-164			#3-125	#3-140	#3-148	#3-165	
40'- 0"			87	195	300	9.765		270	396	553	706	6.009
STIR			#3-130	#3-151	#3-166			#3-126	#3-141	#3-154	#3-167	
PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.22	1.28	1.52	1.74	1.99		1.22	1.74	1.99	2.36	4.47	
ACTUAL STEEL %	0.697	0.733	0.871	0.995	1.141		0.697	0.995	1.141	1.355	2.575	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.31		18.38	18.38	18.31	18.31	18.25	
$-I_{cr}/I_{gr}$	0.152	0.158	0.180	0.200	0.219		0.152	0.200	0.219	0.247	0.376	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	1.04	1.19	1.39	1.58		0.62	1.04	1.19	1.39	1.58	
ACTUAL STEEL %	0.337	0.567	0.647	0.760	0.865		0.337	0.567	0.647	0.760	0.865	
EFF. DEPTH, IN.	18.69	18.59	18.64	18.53	18.50		18.69	18.59	18.64	18.53	18.50	
$+I_{cr}/I_{gr}$	0.111	0.178	0.203	0.231	0.258		0.111	0.178	0.203	0.231	0.258	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 9″ Ribs @ 62″ c.-c. 15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 5	Int. Span Defl. Coeff. (2)
AT	10	8.5	7.5	9.5	8.5		10	9.5	8.5	7	4	
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.64	0.92	1.05	1.30	1.45		0.88	1.43	1.61	1.98	2.89	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	216	769	918	1204	1439	2.344	595	1400	1616	2033	2374	1.443
STIR	#3- 62	#3-115	#3-123	#3-136	#3-143		#3- 78	#3- 98	#3-122	#4-130	#4-130	
29'- 0"	159	675	814	1081	1300	2.698	513	1263	1465	1853	2172	1.660
STIR	#3- 60	#3-116	#3-124	#3-139	#3-146		#3- 78	#3-105	#3-124	#4-132	#4-134	
30'- 0"	108	590	720	969	1174	3.090	439	1140	1328	1691	1989	1.901
STIR	#3- 57	#3-117	#3-126	#3-125	#3-149		#3- 77	#3-113	#3-127	#3-136	#4-140	
31'- 0"	62	513	635	868	1060	3.523	372	1028	1204	1544	1823	2.168
STIR	#3- 53	#3-118	#3-127	#3-133	#3-152		#3- 76	#3-120	#3-129	#3-139	#4-144	
32'- 0"	20	444	558	777	957	4.000	311	927	1092	1411	1673	2.461
STIR	#3- 50	#3-118	#3-128	#3-142	#3-155		#3- 75	#3-122	#3-116	#3-141	#4-147	
33'- 0"		380	487	694	863	4.523	255	834	990	1290	1536	2.784
STIR		#3-119	#3-129	#3-145	#3-157		#3- 73	#3-124	#3-123	#3-144	#4-150	
34'- 0"		322	423	617	777	5.097	205	750	897	1179	1411	3.137
STIR		#3-119	#3-130	#3-147	#3-142		#3- 71	#3-125	#3-131	#3-146	#3-153	
35'- 0"		269	364	548	698	5.724	158	673	811	1078	1297	3.522
STIR		#3-119	#3-131	#3-149	#3-150		#3- 69	#3-126	#3-134	#3-149	#3-155	
36'- 0"		221	311	484	626	6.407	116	602	733	985	1192	3.942
STIR		#3-118	#3-131	#3-150	#3-159		#3- 67	#3-127	#3-136	#3-150	#3-158	
37'- 0"		176	261	425	560	7.149	76	537	661	900	1095	4.399
STIR		#3-118	#3-131	#3-151	#3-163		#3- 65	#3-128	#3-137	#3-152	#3-161	
38'- 0"		135	215	371	498	7.953	40	477	595	821	1006	4.894
STIR		#3-117	#3-131	#3-152	#3-165		#3- 62	#3-129	#3-139	#3-137	#3-164	
39'- 0"		96	173	321	442	8.824	7	422	533	748	924	5.430
STIR		#3-116	#3-131	#3-153	#3-167		#3- 59	#3-130	#3-140	#3-145	#3-166	
40'- 0"		61	134	274	389	9.765		370	476	680	848	6.009
STIR		#3-115	#3-131	#3-154	#3-168			#3-130	#3-141	#3-152	#3-168	
PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.24	1.46	1.65	2.02	2.26		1.24	2.02	2.26	2.75	4.80	
ACTUAL STEEL %	0.641	0.754	0.854	1.050	1.173		0.641	1.050	1.173	1.424	2.493	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.31	18.31		18.38	18.31	18.31	18.31	18.31	
$-I_{cr}/I_{gr}$	0.145	0.165	0.181	0.210	0.228		0.145	0.210	0.228	0.262	0.381	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.349	0.588	0.652	0.785	0.891		0.349	0.588	0.652	0.785	0.891	
EFF. DEPTH, IN.	18.72	18.64	18.62	18.50	18.46		18.72	18.64	18.62	18.50	18.46	
$+I_{cr}/I_{gr}$	0.117	0.187	0.205	0.238	0.265		0.117	0.187	0.205	0.238	0.265	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 10″ Ribs @ 63″ c.-c. 15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 7	Int. Span Defl. Coeff. (2)
AT	10	8.5	7	9.5	7.5		10	10	7.5	7	7	
BOTTOM BARS NO	3# 3	1# 5	2# 6	1# 6	2# 7		3# 3	1# 5	2# 6	1# 6	2# 7	
BARS NO	2# 4	2# 6	1# 7	2# 7	1# 8		2# 4	2# 6	1# 7	2# 7	1# 8	
STEEL (PSF)	0.65	0.91	1.16	1.27	1.59		0.89	1.38	1.82	1.94	3.19	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	216	744	1074	1255	1650	2.344	607	1374	1855	2119	2692	1.443
STIR	#3- 54	#3-107	#3-124	#3-114	#4-144		#3- 73	#3-108	#3-123	#4-128	#4-129	
29'- 0"	158	649	958	1127	1494	2.698	523	1238	1686	1932	2466	1.660
STIR	#3- 51	#3-108	#3-126	#3-122	#3-147		#3- 72	#3-111	#3-125	#4-130	#4-133	
30'- 0"	105	565	853	1011	1354	3.090	446	1114	1533	1763	2262	1.901
STIR	#3- 47	#3-108	#3-127	#3-131	#3-150		#3- 70	#3-113	#3-128	#3-133	#4-138	
31'- 0"	58	488	758	906	1227	3.523	377	1003	1395	1610	2078	2.168
STIR	#3- 43	#3-108	#3-129	#3-137	#3-153		#3- 69	#3-114	#3-130	#3-135	#4-145	
32'- 0"	14	418	671	810	1112	4.000	314	901	1269	1471	1910	2.461
STIR	#3- 39	#3-108	#3-130	#3-139	#3-155		#3- 67	#3-115	#3-113	#3-139	#4-149	
33'- 0"		355	593	723	1007	4.523	257	809	1155	1345	1758	2.784
STIR		#3-108	#3-131	#3-141	#3-158		#3- 65	#3-116	#3-120	#3-141	#4-152	
34'- 0"		297	521	644	911	5.097	205	725	1051	1230	1619	3.137
STIR		#3-108	#3-132	#3-142	#3-160		#3- 63	#3-117	#3-128	#3-143	#4-154	
35'- 0"		244	455	571	824	5.724	157	648	955	1124	1491	3.522
STIR		#3-107	#3-133	#3-144	#3-147		#3- 61	#3-118	#3-135	#3-146	#4-157	
36'- 0"		195	395	505	743	6.407	113	577	868	1027	1374	3.942
STIR		#3-106	#3-133	#3-145	#3-156		#3- 58	#3-119	#3-138	#3-130	#4-160	
37'- 0"		150	340	444	669	7.149	72	512	787	938	1266	4.399
STIR		#3-105	#3-134	#3-146	#3-165		#3- 55	#3-119	#3-139	#3-137	#3-163	
38'- 0"		109	289	387	601	7.953	35	452	713	856	1167	4.894
STIR		#3-103	#3-134	#3-147	#3-167		#3- 52	#3-119	#3-141	#3-144	#3-165	
39'- 0"		71	241	335	538	8.824	1	396	644	780	1075	5.430
STIR		#3-102	#3-134	#3-147	#3-169		#3- 48	#3-120	#3-142	#3-151	#3-168	
40'- 0"		36	198	286	480	9.765		345	580	710	991	6.009
STIR		#3-100	#3-134	#3-148	#3-170			#3-120	#3-143	#3-152	#3-170	
PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.26	1.48	1.80	2.06	2.60		1.26	1.95	2.60	2.79	5.40	
ACTUAL STEEL %	0.595	0.700	0.850	0.974	1.234		0.595	0.925	1.234	1.322	2.578	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.31	18.31		18.38	18.31	18.31	18.31	18.19	
$-I_{cr}/I_{gr}$	0.139	0.158	0.184	0.202	0.241		0.139	0.194	0.241	0.253	0.389	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.73	1.19	1.48	1.64	1.99		0.73	1.19	1.48	1.64	1.99	
ACTUAL STEEL %	0.328	0.538	0.671	0.744	0.904		0.328	0.538	0.671	0.744	0.904	
EFF. DEPTH, IN.	18.78	18.64	18.60	18.58	18.54		18.78	18.64	18.60	18.58	18.54	
$+I_{cr}/I_{gr}$	0.112	0.174	0.211	0.231	0.274		0.112	0.174	0.211	0.231	0.274	

SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 7″ Ribs @ 60″ c.-c. 19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	8	7	9.5	8		10	9	8	9.5	7	
BOTTOM BARS NO	2# 4	1# 7	1# 7	1# 8	1# 8		2# 4	1# 7	1# 7	1# 8	1# 8	
BARS NO	1# 5	1# 7	1# 8	1# 8	1# 9		1# 5	1# 7	1# 8	1# 8	1# 9	
STEEL (PSF)	0.65	1.02	1.15	1.33	1.51		0.89	1.55	1.75	2.07	3.15	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	159	682	883	1084	1304	4.000	512	1272	1565	1857	2177	2.461
STIR	#3- 77	#3-135	#3-136	#3-157	#3-166		#3- 93	#3-136	#3-143	#4-150	#4-148	
33'- 0"	113	604	794	982	1190	4.523	445	1159	1435	1709	2011	2.784
STIR	#3- 74	#3-136	#3-144	#3-161	#3-168		#3- 93	#3-114	#3-146	#4-153	#4-151	
34'- 0"	71	533	712	890	1085	5.097	383	1056	1316	1574	1858	3.137
STIR	#3- 72	#3-138	#3-151	#3-163	#3-171		#3- 92	#3-121	#3-149	#4-156	#4-155	
35'- 0"	32	469	637	805	989	5.724	327	962	1207	1451	1719	3.522
STIR	#3- 69	#3-139	#3-153	#3-143	#3-174		#3- 92	#3-128	#3-151	#3-159	#4-161	
36'- 0"		409	568	727	901	6.407	275	876	1107	1338	1591	3.942
STIR		#3-139	#3-154	#3-151	#3-178		#3- 91	#3-136	#3-154	#3-162	#4-167	
37'- 0"		354	505	655	820	7.149	228	796	1015	1234	1473	4.399
STIR		#3-140	#3-156	#3-159	#3-180		#3- 89	#3-143	#3-156	#3-164	#4-172	
38'- 0"		304	447	589	745	7.953	184	723	930	1137	1365	4.894
STIR		#3-141	#3-157	#3-168	#3-183		#3- 88	#3-145	#3-158	#3-167	#4-175	
39'- 0"		257	393	528	676	8.824	143	655	852	1049	1264	5.430
STIR		#3-141	#3-158	#3-172	#3-186		#3- 87	#3-147	#3-138	#3-169	#4-177	
40'- 0"		214	343	472	613	9.765	106	592	779	966	1171	6.009
STIR		#3-141	#3-160	#3-174	#3-165		#3- 85	#3-148	#3-145	#3-173	#3-181	
41'- 0"		174	297	419	553	10.778	71	534	712	890	1085	6.633
STIR		#3-141	#3-160	#3-175	#3-173		#3- 83	#3-149	#3-152	#3-175	#3-183	
42'- 0"		137	254	370	498	11.869	39	480	650	819	1005	7.304
STIR		#3-141	#3-161	#3-177	#3-181		#3- 81	#3-150	#3-160	#3-177	#3-186	
43'- 0"		102	214	325	447	13.040	8	429	591	753	931	8.025
STIR		#3-141	#3-162	#3-178	#3-190		#3- 79	#3-152	#3-166	#3-179	#3-189	
44'- 0"		70	176	283	399	14.296		382	537	692	861	8.798
STIR		#3-140	#3-162	#3-180	#3-194			#3-153	#3-168	#3-181	#3-191	
PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.20	1.50	1.71	1.96	2.33		1.20	2.07	2.33	2.78	5.14	
ACTUAL STEEL %	0.605	0.756	0.864	0.990	1.176		0.605	1.045	1.176	1.411	2.619	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.31	22.31		22.38	22.31	22.31	22.25	22.19	
$-I_{cr}/I_{gr}$	0.144	0.171	0.190	0.208	0.236		0.144	0.217	0.236	0.267	0.398	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.20	1.39	1.58	1.79		0.71	1.20	1.39	1.58	1.79	
ACTUAL STEEL %	0.340	0.578	0.670	0.763	0.865		0.340	0.578	0.670	0.763	0.865	
EFF. DEPTH, IN.	22.72	22.56	22.53	22.50	22.46		22.72	22.56	22.53	22.50	22.46	
$+I_{cr}/I_{gr}$	0.120	0.193	0.220	0.247	0.276		0.120	0.193	0.220	0.247	0.276	

SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 8″ Ribs @ 61″ c.-c. 19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	7.5	10	8.5	7.5		9.5	8.5	7.5	6	5	
BOTTOM BARS NO	1# 4	2# 6	2# 6	1# 8	1# 9		1# 4	2# 6	2# 6	1# 8	1# 9	
BARS NO	2# 5	1# 6	1# 7	1# 9	1# 9		2# 5	1# 6	1# 7	1# 9	1# 9	
STEEL (PSF)	0.68	1.06	1.22	1.47	1.67		0.95	1.62	1.85	2.28	3.33	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	248	784	954	1274	1494	4.000	655	1435	1682	2147	2467	2.461
STIR	#3- 82	#3-134	#3-141	#3-159	#4-166		#3- 97	#3-135	#3-141	#4-150	#4-151	
33'- 0"	194	699	858	1159	1366	4.523	577	1310	1543	1980	2281	2.784
STIR	#3- 80	#3-135	#3-146	#3-161	#4-168		#3- 96	#3-115	#3-144	#4-153	#4-153	
34'- 0"	146	621	771	1055	1249	5.097	506	1197	1416	1828	2111	3.137
STIR	#3- 77	#3-137	#3-147	#3-164	#3-172		#3- 96	#3-122	#3-147	#4-156	#4-157	
35'- 0"	101	549	691	959	1142	5.724	441	1093	1300	1689	1956	3.522
STIR	#3- 75	#3-138	#3-149	#3-166	#3-174		#3- 96	#3-130	#3-149	#4-160	#4-162	
36'- 0"	60	484	618	871	1044	6.407	381	998	1193	1561	1813	3.942
STIR	#3- 72	#3-138	#3-151	#3-149	#3-177		#3- 95	#3-137	#3-151	#4-162	#4-168	
37'- 0"	22	423	550	790	954	7.149	326	910	1095	1443	1682	4.399
STIR	#3- 69	#3-139	#3-152	#3-157	#3-180		#3- 94	#3-143	#3-154	#4-165	#4-172	
38'- 0"		368	488	715	871	7.953	276	829	1004	1334	1561	4.894
STIR		#3-140	#3-153	#3-165	#3-183		#3- 93	#3-144	#3-137	#3-168	#4-174	
39'- 0"		316	431	646	794	8.824	229	754	921	1234	1449	5.430
STIR		#3-140	#3-154	#3-173	#3-185		#3- 92	#3-146	#3-144	#3-170	#4-177	
40'- 0"		269	378	582	723	9.765	186	685	843	1141	1346	6.009
STIR		#3-140	#3-155	#3-175	#3-164		#3- 90	#3-147	#3-151	#3-173	#4-180	
41'- 0"		225	328	523	657	10.778	146	621	772	1055	1250	6.633
STIR		#3-140	#3-156	#3-177	#3-173		#3- 89	#3-148	#3-159	#3-176	#4-184	
42'- 0"		183	282	468	595	11.869	108	561	705	975	1160	7.304
STIR		#3-140	#3-156	#3-179	#3-181		#3- 87	#3-149	#3-160	#3-178	#4-186	
43'- 0"		145	239	417	538	13.040	74	506	643	900	1077	8.025
STIR		#3-139	#3-157	#3-180	#3-190		#3- 85	#3-151	#3-162	#3-180	#3-188	
44'- 0"		110	200	369	485	14.296	41	454	585	831	1000	8.798
STIR		#3-139	#3-157	#3-182	#3-194		#3- 83	#3-151	#3-163	#3-183	#3-192	
PROPERTIES FOR DESIGN (CONCRETE 0.71 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.22	1.63	1.89	2.22	2.52		1.28	2.22	2.52	3.15	5.37	
ACTUAL STEEL %	0.553	0.737	0.860	1.011	1.146		0.582	1.011	1.146	1.433	2.448	
EFF. DEPTH, IN.	22.38	22.38	22.31	22.31	22.31		22.38	22.31	22.31	22.31	22.25	
$-I_{cr}/I_{gr}$	0.136	0.171	0.191	0.216	0.237		0.142	0.216	0.237	0.278	0.394	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.82	1.32	1.48	1.79	2.00		0.82	1.32	1.48	1.79	2.00	
ACTUAL STEEL %	0.354	0.572	0.642	0.780	0.873		0.354	0.572	0.642	0.780	0.873	
EFF. DEPTH, IN.	22.70	22.62	22.60	22.46	22.44		22.70	22.62	22.60	22.46	22.44	
$+I_{cr}/I_{gr}$	0.125	0.194	0.215	0.252	0.278		0.125	0.194	0.215	0.252	0.278	

SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 9″ Ribs @ 62″ c.-c. 19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	7.5	9.5	7.5	7		9	8.5	7	8	6	
BOTTOM BARS NO	1# 6	1# 7	1# 6	2# 7	1# 7		1# 6	1# 7	1# 6	2# 7	1# 7	
BARS NO	1# 6	1# 8	2# 7	1# 8	2# 8		1# 6	1# 8	2# 7	1# 8	2# 8	
STEEL (PSF)	0.75	1.10	1.28	1.61	1.71		1.04	1.67	1.96	2.46	3.62	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	279	822	1093	1463	1662	4.000	714	1504	1899	2436	2726	2.461
STIR	#3- 77	#3-130	#3-140	#3-159	#4-164		#3- 94	#3-114	#4-142	#4-151	#5-148	
33'- 0"	222	733	988	1335	1522	4.523	631	1374	1745	2250	2523	2.784
STIR	#3- 75	#3-131	#3-146	#3-163	#4-168		#3- 93	#3-121	#3-144	#4-154	#5-152	
34'- 0"	170	651	891	1218	1395	5.097	555	1255	1604	2080	2337	3.137
STIR	#3- 73	#3-132	#3-148	#3-165	#4-171		#3- 93	#3-129	#3-147	#4-157	#4-155	
35'- 0"	122	576	803	1111	1278	5.724	486	1146	1476	1925	2167	3.522
STIR	#3- 70	#3-132	#3-149	#3-168	#3-174		#3- 92	#3-135	#3-149	#4-160	#4-161	
36'- 0"	78	507	722	1013	1171	6.407	422	1046	1358	1782	2011	3.942
STIR	#3- 67	#3-133	#3-151	#3-147	#3-176		#3- 91	#3-137	#3-151	#4-163	#4-167	
37'- 0"	38	444	647	923	1072	7.149	363	954	1249	1651	1868	4.399
STIR	#3- 63	#3-133	#3-152	#3-155	#3-180		#3- 90	#3-139	#3-153	#4-166	#4-171	
38'- 0"	1	386	578	840	981	7.953	309	869	1149	1530	1736	4.894
STIR	#3- 59	#3-133	#3-153	#3-164	#3-182		#3- 89	#3-140	#3-136	#4-168	#4-175	
39'- 0"		332	515	763	897	8.824	259	791	1057	1418	1614	5.430
STIR		#3-133	#3-155	#3-172	#3-185		#3- 87	#3-141	#3-143	#4-171	#4-177	
40'- 0"		282	456	692	820	9.765	213	719	971	1315	1500	6.009
STIR		#3-133	#3-155	#3-176	#3-166		#3- 86	#3-142	#3-151	#3-174	#4-181	
41'- 0"		236	401	626	747	10.778	170	651	892	1219	1395	6.633
STIR		#3-133	#3-156	#3-178	#3-174		#3- 84	#3-143	#3-158	#3-177	#4-183	
42'- 0"		193	350	565	680	11.869	130	589	818	1130	1298	7.304
STIR		#3-132	#3-157	#3-180	#3-183		#3- 82	#3-144	#3-161	#3-179	#4-186	
43'- 0"		153	303	507	618	13.040	93	530	749	1046	1207	8.025
STIR		#3-131	#3-157	#3-181	#3-191		#3- 80	#3-145	#3-162	#3-182	#4-188	
44'- 0"		115	259	454	560	14.296	58	476	685	969	1122	8.798
STIR		#3-130	#3-158	#3-183	#3-193		#3- 77	#3-146	#3-164	#3-183	#4-191	
PROPERTIES FOR DESIGN (CONCRETE 0.73 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.24	1.65	2.02	2.56	2.75		1.38	2.26	2.75	3.41	6.20	
ACTUAL STEEL %	0.510	0.680	0.835	1.058	1.133		0.567	0.933	1.133	1.412	2.576	
EFF. DEPTH, IN.	22.38	22.38	22.31	22.31	22.31		22.38	22.31	22.31	22.25	22.19	
$-I_{cr}/I_{gr}$	0.130	0.164	0.191	0.228	0.240		0.142	0.207	0.240	0.278	0.412	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.88	1.39	1.64	1.99	2.18		0.88	1.39	1.64	1.99	2.18	
ACTUAL STEEL %	0.347	0.551	0.648	0.788	0.864		0.347	0.551	0.648	0.788	0.864	
EFF. DEPTH, IN.	22.62	22.53	22.58	22.54	22.52		22.62	22.53	22.58	22.54	22.52	
$+I_{cr}/I_{gr}$	0.123	0.186	0.217	0.258	0.280		0.123	0.186	0.217	0.258	0.280	

SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 10″ Ribs @ 63″ c.-c. 19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	10	7	9	7.5	9		8.5	8	9.5	10	7	
BOTTOM BARS NO	2# 5	2# 6	2# 6	2# 6	2# 8		2# 5	2# 6	2# 6	2# 6	2# 8	
BARS NO	1# 5	1# 7	2# 6	2# 7	1# 8		1# 5	1# 7	2# 6	2# 7	1# 8	
STEEL (PSF)	0.74	1.16	1.42	1.66	1.87		1.06	1.76	2.14	2.63	3.37	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
32'- 0" (3)	305	893	1195	1533	1831	4.000	766	1621	2061	2552	2985	2.461
STIR	#3- 73	#3-128	#3-143	#3-156	#4-165		#3- 91	#3-117	#4-141	#4-149	#5-154	
33'- 0"	245	798	1082	1399	1679	4.523	678	1482	1895	2358	2765	2.784
STIR	#3- 70	#3-128	#3-145	#3-159	#4-167		#3- 90	#3-124	#4-143	#4-152	#5-158	
34'- 0"	190	710	978	1277	1541	5.097	598	1355	1744	2180	2564	3.137
STIR	#3- 67	#3-129	#3-146	#3-162	#4-170		#3- 89	#3-132	#3-146	#4-156	#5-161	
35'- 0"	139	630	883	1165	1414	5.724	524	1239	1606	2017	2379	3.522
STIR	#3- 64	#3-130	#3-148	#3-145	#4-174		#3- 89	#3-134	#3-148	#4-158	#4-165	
36'- 0"	93	557	796	1063	1298	6.407	457	1132	1479	1868	2210	3.942
STIR	#3- 61	#3-130	#3-149	#3-153	#3-177		#3- 87	#3-135	#3-151	#4-161	#4-168	
37'- 0"	50	490	715	968	1191	7.149	395	1034	1363	1730	2054	4.399
STIR	#3- 57	#3-130	#3-151	#3-162	#3-179		#3- 86	#3-137	#3-131	#4-164	#4-171	
38'- 0"	10	427	641	881	1092	7.953	337	944	1255	1604	1911	4.894
STIR	#3- 53	#3-130	#3-152	#3-169	#3-182		#3- 85	#3-138	#3-138	#4-167	#4-174	
39'- 0"		370	573	801	1001	8.824	284	860	1156	1487	1778	5.430
STIR		#3-130	#3-153	#3-170	#3-184		#3- 83	#3-139	#3-145	#4-169	#4-177	
40'- 0"		317	510	726	917	9.765	235	783	1064	1378	1655	6.009
STIR		#3-130	#3-153	#3-172	#3-166		#3- 81	#3-140	#3-153	#3-171	#4-179	
41'- 0"		267	451	657	838	10.778	190	711	978	1278	1542	6.633
STIR		#3-129	#3-154	#3-174	#3-175		#3- 79	#3-141	#3-158	#3-174	#4-183	
42'- 0"		221	396	593	766	11.869	148	644	899	1184	1436	7.304
STIR		#3-128	#3-155	#3-175	#3-183		#3- 77	#3-142	#3-160	#3-176	#4-185	
43'- 0"		178	346	533	698	13.040	108	582	825	1097	1337	8.025
STIR		#3-127	#3-155	#3-176	#3-191		#3- 74	#3-142	#3-161	#3-178	#4-188	
44'- 0"		139	298	477	635	14.296	71	524	756	1016	1245	8.798
STIR		#3-126	#3-155	#3-178	#3-193		#3- 71	#3-143	#3-163	#3-180	#4-190	
PROPERTIES FOR DESIGN (CONCRETE 0.75 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.26	1.80	2.17	2.60	3.08		1.48	2.44	2.92	3.78	5.40	
ACTUAL STEEL %	0.475	0.678	0.820	0.984	1.168		0.558	0.923	1.106	1.438	2.054	
EFF. DEPTH, IN.	22.38	22.38	22.31	22.31	22.25		22.38	22.31	22.25	22.19	22.19	
$-I_{cr}/I_{gr}$	0.125	0.167	0.191	0.220	0.247		0.143	0.209	0.238	0.285	0.363	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.48	1.76	2.08	2.37		0.93	1.48	1.76	2.08	2.37	
ACTUAL STEEL %	0.336	0.537	0.638	0.755	0.863		0.336	0.537	0.638	0.755	0.863	
EFF. DEPTH, IN.	22.69	22.60	22.62	22.59	22.50		22.69	22.60	22.62	22.59	22.50	
$+I_{cr}/I_{gr}$	0.121	0.185	0.217	0.251	0.280		0.121	0.185	0.217	0.251	0.280	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 7″ Ribs @ 60″ c.-c. 23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 5	# 5		End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5		Int. Span Defl. Coeff. (2)
AT	10	7	8.5	7.5			8.5	8	6	4		
BOTTOM BARS NO	1# 6	1# 7	1# 8	1# 9			1# 6	1# 7	1# 8	1# 9		
BARS NO	1# 6	1# 8	1# 9	1# 9			1# 6	1# 8	1# 9	1# 9		
STEEL (PSF)	0.77	1.15	1.49	1.69			1.09	1.75	2.30	3.07		
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	174	654	1026	1221		7.149	557	1255	1797	2080		4.399
STIR	#3- 93	#3-152	#3-177	#3-185			#3-111	#3-129	#4-169	#4-175		
38'- 0"	130	585	938	1123		7.953	493	1155	1669	1938		4.894
STIR	#3- 91	#3-153	#3-154	#3-188			#3-110	#3-136	#4-172	#4-178		
39'- 0"	89	521	857	1032		8.824	434	1063	1551	1806		5.430
STIR	#3- 88	#3-154	#3-162	#3-192			#3-110	#3-143	#4-175	#4-181		
40'- 0"	52	463	782	948		9.765	380	977	1441	1683		6.009
STIR	#3- 86	#3-155	#3-171	#3-194			#3-110	#3-151	#4-178	#4-185		
41'- 0"	17	408	712	870		10.778	329	898	1339	1570		6.633
STIR	#3- 83	#3-156	#3-179	#3-197			#3-109	#3-158	#3-181	#4-188		
42'- 0"		357	647	798		11.869	282	824	1245	1465		7.304
STIR		#3-157	#3-186	#3-199			#3-108	#3-161	#3-184	#4-190		
43'- 0"		310	586	730		13.040	239	755	1157	1367		8.025
STIR		#3-157	#3-188	#3-177			#3-107	#3-163	#3-186	#4-194		
44'- 0"		266	530	667		14.296	198	691	1075	1275		8.798
STIR		#3-157	#3-190	#3-185			#3-106	#3-164	#3-188	#4-197		
45'- 0"		225	477	609		15.641	160	632	998	1190		9.625
STIR		#3-157	#3-192	#3-194			#3-105	#3-165	#3-191	#4-199		
46'- 0"		187	428	554		17.078	124	576	926	1110		10.510
STIR		#3-157	#3-193	#3-202			#3-103	#3-167	#3-193	#3-201		
47'- 0"		151	382	502		18.613	91	523	859	1035		11.454
STIR		#3-157	#3-194	#3-208			#3-102	#3-168	#3-195	#3-204		
48'- 0"		117	338	454		20.248	59	474	796	965		12.460
STIR		#3-157	#3-196	#3-210			#3-100	#3-169	#3-197	#3-207		
49'- 0"		85	298	409		21.989	30	428	737	899		13.532
STIR		#3-156	#3-197	#3-212			#3- 98	#3-170	#3-176	#3-209		
PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.20	1.71	2.19	2.48			1.41	2.33	3.10	4.65		
ACTUAL STEEL %	0.495	0.707	0.905	1.025			0.582	0.961	1.282	1.922		
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31			26.38	26.31	26.31	26.31		
$-I_{cr}/I_{gr}$	0.130	0.173	0.207	0.228			0.149	0.217	0.268	0.354		
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.88	1.39	1.79	2.00			0.88	1.39	1.79	2.00		
ACTUAL STEEL %	0.347	0.549	0.709	0.792			0.347	0.549	0.709	0.792		
EFF. DEPTH, IN.	26.62	26.53	26.46	26.44			26.62	26.53	26.46	26.44		
$+I_{cr}/I_{gr}$	0.129	0.195	0.245	0.271			0.129	0.195	0.245	0.271		
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 8″ Ribs @ 61″ c.-c. 23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 6	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	10	8.5	9.5	8		8	7	9	5	5	
BOTTOM BARS NO	2# 5	1# 8	1# 8	1# 9	1#10		2# 5	1# 8	1# 8	1# 9	1#10	
BARS NO	1# 5	1# 8	1# 9	1#10	1#10		1# 5	1# 8	1# 9	1#10	1#10	
STEEL (PSF)	0.75	1.29	1.47	1.87	2.16		1.11	1.99	2.23	3.47	4.42	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	188	796	991	1435	1683	7.149	594	1478	1762	2407	2768	4.399
STIR	#3- 85	#3-155	#3-162	#4-187	#4-195		#3-105	#3-155	#4-163	#5-176	#5-171	
38'- 0"	142	718	903	1323	1559	7.953	526	1365	1634	2246	2588	4.894
STIR	#3- 83	#3-156	#3-168	#4-190	#4-198		#3-105	#3-133	#4-166	#4-179	#5-174	
39'- 0"	99	646	822	1221	1444	8.824	464	1260	1515	2096	2421	5.430
STIR	#3- 80	#3-157	#3-170	#3-193	#4-202		#3-104	#3-140	#3-169	#4-183	#5-178	
40'- 0"	59	579	746	1126	1338	9.765	406	1163	1406	1958	2267	6.009
STIR	#3- 77	#3-158	#3-172	#3-196	#4-204		#3-103	#3-147	#3-171	#4-186	#5-180	
41'- 0"	22	517	676	1038	1240	10.778	353	1073	1304	1830	2123	6.633
STIR	#3- 74	#3-159	#3-174	#3-198	#4-208		#3-102	#3-155	#3-173	#4-189	#5-185	
42'- 0"		460	611	956	1148	11.869	303	989	1210	1710	1990	7.304
STIR		#3-160	#3-175	#3-201	#4-211		#3-101	#3-162	#3-175	#4-192	#5-191	
43'- 0"		406	551	879	1063	13.040	257	911	1122	1599	1866	8.025
STIR		#3-160	#3-176	#3-204	#4-214		#3-100	#3-165	#3-178	#4-195	#4-198	
44'- 0"		356	494	808	983	14.296	213	839	1040	1496	1751	8.798
STIR		#3-161	#3-177	#3-181	#3-216		#3- 98	#3-166	#3-157	#4-198	#4-204	
45'- 0"		310	442	742	909	15.641	173	771	963	1399	1643	9.625
STIR		#3-161	#3-179	#3-189	#3-220		#3- 97	#3-168	#3-164	#4-200	#4-209	
46'- 0"		266	392	679	840	17.078	135	707	891	1309	1542	10.510
STIR		#3-161	#3-179	#3-198	#3-222		#3- 95	#3-169	#3-172	#4-203	#4-212	
47'- 0"		225	346	621	775	18.613	100	648	824	1224	1447	11.454
STIR		#3-161	#3-180	#3-206	#3-225		#3- 93	#3-170	#3-179	#4-206	#4-214	
48'- 0"		187	303	566	714	20.248	67	592	761	1144	1359	12.460
STIR		#3-161	#3-181	#3-213	#3-227		#3- 91	#3-171	#3-185	#4-209	#4-218	
49'- 0"		151	262	515	656	21.989	36	540	702	1070	1275	13.532
STIR		#3-161	#3-181	#3-214	#3-229		#3- 89	#3-173	#3-187	#4-211	#4-220	
PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.22	1.89	2.22	2.83	3.36		1.52	2.70	2.98	5.37	7.32	
ACTUAL STEEL %	0.454	0.705	0.830	1.056	1.255		0.567	1.007	1.115	2.007	2.745	
EFF. DEPTH, IN.	26.38	26.31	26.31	26.25	26.25		26.38	26.31	26.25	26.25	26.19	
$-I_{cr}/I_{gr}$	0.124	0.175	0.198	0.236	0.267		0.148	0.229	0.245	0.369	0.447	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.58	1.79	2.27	2.54		0.93	1.58	1.79	2.27	2.54	
ACTUAL STEEL %	0.331	0.566	0.641	0.815	0.913		0.331	0.566	0.641	0.815	0.913	
EFF. DEPTH, IN.	26.69	26.50	26.46	26.40	26.36		26.69	26.50	26.46	26.40	26.36	
$+I_{cr}/I_{gr}$	0.125	0.201	0.225	0.278	0.307		0.125	0.201	0.225	0.278	0.307	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	53″ Forms + 9″ Ribs @ 62″ c.-c. 23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 5	# 5	# 6	# 7	End Span Defl. Coeff. (2)	# 4	# 5	# 6	# 7	# 8	Int. Span Defl. Coeff. (2)
AT	10	9.5	8	9	10		7.5	7	8	9	6	
BOTTOM BARS NO	2# 4	1# 6	2# 7	2# 8	1# 8		2# 4	1# 6	2# 7	2# 8	1# 8	
BARS NO	2# 5	2# 7	1# 8	1# 8	2# 9		2# 5	2# 7	1# 8	1# 8	2# 9	
STEEL (PSF)	0.80	1.28	1.58	1.89	2.24		1.20	1.96	2.46	2.93	4.71	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	239	822	1149	1501	1888	7.149	685	1532	2007	2520	3083	4.399
STIR	#3- 85	#3-149	#3-160	#4-183	#4-195		#3-105	#3-133	#4-164	#5-174	#5-171	
38'- 0"	188	741	1050	1385	1752	7.953	611	1414	1864	2351	2884	4.894
STIR	#3- 82	#3-150	#3-168	#4-187	#4-199		#3-105	#3-140	#4-167	#4-177	#5-174	
39'- 0"	141	666	960	1277	1625	8.824	542	1305	1733	2195	2701	5.430
STIR	#3- 80	#3-151	#3-172	#3-189	#4-202		#3-104	#3-148	#4-170	#4-181	#5-177	
40'- 0"	98	596	876	1178	1509	9.765	479	1204	1610	2050	2531	6.009
STIR	#3- 77	#3-152	#3-173	#3-192	#4-205		#3-103	#3-155	#4-172	#4-183	#5-180	
41'- 0"	57	532	798	1085	1400	10.778	420	1110	1497	1915	2373	6.633
STIR	#3- 73	#3-152	#3-175	#3-195	#4-208		#3-102	#3-157	#3-175	#4-186	#5-184	
42'- 0"	20	472	725	999	1299	11.869	365	1023	1392	1790	2227	7.304
STIR	#3- 70	#3-153	#3-177	#3-173	#4-211		#3-101	#3-158	#3-176	#4-189	#5-190	
43'- 0"		416	658	919	1206	13.040	315	942	1294	1674	2090	8.025
STIR		#3-153	#3-178	#3-181	#4-214		#3-100	#3-159	#3-179	#4-192	#5-197	
44'- 0"		364	595	845	1118	14.296	267	866	1202	1565	1963	8.798
STIR		#3-153	#3-179	#3-190	#4-217		#3- 98	#3-161	#3-155	#4-194	#5-203	
45'- 0"		316	537	775	1036	15.641	223	796	1117	1464	1844	9.625
STIR		#3-153	#3-180	#3-198	#4-220		#3- 97	#3-162	#3-162	#4-197	#5-209	
46'- 0"		270	482	710	960	17.078	181	730	1037	1369	1733	10.510
STIR		#3-153	#3-181	#3-203	#4-222		#3- 95	#3-163	#3-169	#4-200	#4-212	
47'- 0"		228	430	649	888	18.613	143	668	962	1280	1629	11.454
STIR		#3-152	#3-182	#3-205	#3-225		#3- 93	#3-164	#3-177	#4-203	#4-214	
48'- 0"		188	382	592	821	20.248	106	610	892	1197	1531	12.460
STIR		#3-152	#3-183	#3-207	#3-228		#3- 91	#3-165	#3-184	#4-205	#4-218	
49'- 0"		150	337	538	758	21.989	72	555	826	1119	1439	13.532
STIR		#3-151	#3-184	#3-208	#3-230		#3- 88	#3-166	#3-188	#4-207	#4-220	
PROPERTIES FOR DESIGN (CONCRETE 0.80 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.24	2.02	2.40	3.03	3.72		1.65	2.75	3.41	4.13	8.16	
ACTUAL STEEL %	0.420	0.687	0.816	1.032	1.270		0.560	0.932	1.161	1.411	2.796	
EFF. DEPTH, IN.	26.38	26.31	26.31	26.25	26.19		26.38	26.31	26.25	26.19	26.12	
$-I_{cr}/I_{gr}$	0.118	0.175	0.200	0.237	0.273		0.150	0.221	0.258	0.294	0.458	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.37	2.79		1.02	1.64	1.99	2.37	2.79	
ACTUAL STEEL %	0.331	0.535	0.650	0.775	0.913		0.331	0.535	0.650	0.775	0.913	
EFF. DEPTH, IN.	26.71	26.58	26.54	26.50	26.45		26.71	26.58	26.54	26.50	26.45	
$+I_{cr}/I_{gr}$	0.126	0.194	0.231	0.269	0.311		0.126	0.194	0.231	0.269	0.311	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

53″ Forms + 10″ Ribs @ 63″ c.-c.
23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 5	# 5	# 6	# 7	End Span Defl. Coeff. (2)	# 5	# 6	# 7	# 7	# 7	Int. Span Defl. Coeff. (2)
AT	9	9	7	9	10		10	9.5	10	8.5	6	
BOTTOM BARS NO	1# 5	1# 8	1# 7	1#10	1#10		1# 5	1# 8	1# 7	1#10	1#10	
BARS NO	2# 6	1# 9	2# 8	1#10	1#11		2# 6	1# 9	2# 8	1#10	1#11	
STEEL (PSF)	0.90	1.41	1.69	2.04	2.31		1.38	2.13	2.62	3.17	4.03	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
37'- 0" (3)	363	920	1290	1612	1877	7.149	881	1692	2229	2698	3083	4.399
STIR	#3- 96	#3-149	#3-159	#4-182	#4-189		#3-113	#3-133	#4-165	#5-173	#5-178	
38'- 0"	304	832	1183	1488	1739	7.953	795	1563	2073	2518	2883	4.894
STIR	#3- 94	#3-150	#3-168	#4-185	#4-193		#3-113	#3-140	#4-167	#5-176	#5-182	
39'- 0"	249	751	1083	1374	1612	8.824	715	1445	1929	2351	2697	5.430
STIR	#3- 92	#3-151	#3-172	#4-188	#4-196		#3-113	#3-148	#4-170	#5-179	#5-185	
40'- 0"	198	675	992	1268	1494	9.765	641	1335	1795	2197	2526	6.009
STIR	#3- 89	#3-151	#3-174	#3-190	#4-199		#3-112	#3-155	#4-172	#4-182	#5-188	
41'- 0"	151	605	906	1169	1385	10.778	573	1234	1671	2053	2367	6.633
STIR	#3- 87	#3-152	#3-175	#3-168	#4-202		#3-112	#3-156	#4-175	#4-185	#5-191	
42'- 0"	108	540	827	1078	1283	11.869	510	1139	1556	1920	2219	7.304
STIR	#3- 84	#3-152	#3-177	#3-177	#4-205		#3-111	#3-158	#4-177	#4-187	#5-194	
43'- 0"	67	480	754	992	1188	13.040	451	1051	1449	1796	2081	8.025
STIR	#3- 81	#3-152	#3-178	#3-185	#4-207		#3-110	#3-159	#3-179	#4-190	#5-198	
44'- 0"	29	423	685	913	1100	14.296	395	969	1349	1681	1953	8.798
STIR	#3- 77	#3-153	#3-180	#3-194	#3-210		#3-109	#3-161	#3-182	#4-193	#4-200	
45'- 0"		371	621	839	1018	15.641	344	892	1255	1573	1833	9.625
STIR		#3-152	#3-181	#3-199	#3-212		#3-108	#3-162	#3-161	#4-195	#4-204	
46'- 0"		321	561	769	940	17.078	296	820	1168	1472	1721	10.510
STIR		#3-152	#3-182	#3-201	#3-190		#3-107	#3-163	#3-168	#4-199	#4-206	
47'- 0"		275	504	704	868	18.613	251	753	1086	1377	1616	11.454
STIR		#3-152	#3-183	#3-202	#3-199		#3-105	#3-164	#3-175	#4-201	#4-209	
48'- 0"		232	451	643	800	20.248	208	690	1009	1288	1517	12.460
STIR		#3-151	#3-184	#3-204	#3-207		#3-104	#3-165	#3-183	#4-203	#4-212	
49'- 0"		191	402	586	737	21.989	169	631	937	1205	1424	13.532
STIR		#3-150	#3-184	#3-206	#3-216		#3-102	#3-166	#3-189	#4-205	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.82 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.40	2.17	2.79	3.08	3.78		1.95	2.92	3.78	4.45	6.30	
ACTUAL STEEL %	0.435	0.676	0.870	0.963	1.185		0.609	0.912	1.185	1.394	1.975	
EFF. DEPTH, IN.	26.38	26.31	26.31	26.25	26.19		26.31	26.25	26.19	26.19	26.19	
$-I_{cr}/I_{gr}$	0.124	0.176	0.213	0.229	0.265		0.162	0.220	0.265	0.297	0.378	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	1.19	1.79	2.18	2.54	2.83		1.19	1.79	2.18	2.54	2.83	
ACTUAL STEEL %	0.356	0.539	0.656	0.767	0.856		0.356	0.539	0.656	0.767	0.856	
EFF. DEPTH, IN.	26.64	26.46	26.52	26.36	26.33		26.64	26.46	26.52	26.36	26.33	
$+I_{cr}/I_{gr}$	0.135	0.194	0.233	0.265	0.291		0.135	0.194	0.233	0.265	0.291	

SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

66″ Forms + 6″ Ribs @ 72″ c.-c.
13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

f'_c = 4,000 psi
f_y = 60,000 psi

TOP BARS NO	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 5	Int. Span Defl. Coeff. (2)
AT	10	10	10	10		10	10	9.5	9.5	
BOTTOM BARS NO	1# 4	1# 5	1# 6	1# 6		1# 4	1# 5	1# 6	1# 6	
BARS NO	1# 5	1# 6	1# 6	1# 7		1# 5	1# 6	1# 6	1# 7	
STEEL (PSF)	0.48	0.60	0.68	0.75		0.72	0.84	0.94	1.30	
CLEAR SPAN	END SPAN					INTERIOR SPAN				
24'- 0" (3)	119	457	639	861	1.265	451	942	1206	1529	0.779
STIR	#3- 73	#3-102	#3- 99	#3-122		#3- 80	#3-103	#3-110	#3-115	
25'- 0"	62	373	541	745	1.490	368	820	1064	1362	0.917
STIR	#3- 72	#3-104	#3-108	#3-125		#3- 81	#3-105	#3-112	#3-118	
26'- 0"	11	299	454	643	1.743	294	712	938	1213	1.073
STIR	#3- 70	#3-105	#3-116	#3-128		#3- 81	#3- 94	#3-114	#3-122	
27'- 0"		233	376	552	2.027	228	616	825	1080	1.247
STIR		#3-106	#3-118	#3-131		#3- 81	#3-101	#3-118	#3-124	
28'- 0"		174	307	470	2.344	169	530	724	962	1.443
STIR		#3-107	#3-119	#3-133		#3- 81	#3-109	#3-120	#3-128	
29'- 0"		120	245	397	2.698	116	453	634	855	1.660
STIR		#3-107	#3-121	#3-123		#3- 81	#3-110	#3-122	#3-130	
30'- 0"		72	189	331	3.090	69	383	552	759	1.901
STIR		#3-108	#3-122	#3-131		#3- 80	#3-112	#3-107	#3-133	
31'- 0"		29	138	271	3.523	26	320	478	672	2.168
STIR		#3-108	#3-123	#3-137		#3- 79	#3-113	#3-114	#3-135	
32'- 0"			92	217	4.000		263	411	593	2.461
STIR			#3-124	#3-139			#3-114	#3-121	#3-139	
33'- 0"			50	168	4.523		210	350	521	2.784
STIR			#3-125	#3-141			#3-115	#3-128	#3-141	
34'- 0"			12	122	5.097		163	295	456	3.137
STIR			#3-125	#3-142			#3-116	#3-129	#3-143	
35'- 0"				81	5.724		119	244	396	3.522
STIR				#3-143			#3-117	#3-131	#3-145	
36'- 0"				43	6.407		79	197	341	3.942
STIR				#3-145			#3-118	#3-132	#3-148	
PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF)										
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.44	1.44	1.44	1.44		1.44	1.44	1.52	2.35	
ACTUAL STEEL %	1.194	1.194	1.194	1.194		1.194	1.194	1.257	1.957	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38		16.38	16.38	16.38	16.31	
$-I_{cr}/I_{gr}$	0.197	0.197	0.197	0.197		0.197	0.197	0.205	0.275	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.51	0.75	0.88	1.04		0.51	0.75	0.88	1.04	
ACTUAL STEEL %	0.397	0.585	0.688	0.814		0.397	0.585	0.688	0.814	
EFF. DEPTH, IN.	16.71	16.65	16.62	16.59		16.71	16.65	16.62	16.59	
$+I_{cr}/I_{gr}$	0.118	0.168	0.195	0.226		0.118	0.168	0.195	0.226	

SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 4	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	10	9.5	8		10	10	8	7	8	
BOTTOM BARS NO	1# 4	1# 6	1# 6	1# 7	1# 7		1# 4	1# 6	1# 6	1# 7	1# 7	
BARS NO	1# 5	1# 6	1# 7	1# 7	1# 8		1# 5	1# 6	1# 7	1# 7	1# 8	
STEEL (PSF)	0.48	0.67	0.74	0.84	0.97		0.72	0.91	1.10	1.28	2.02	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	96	615	838	1059	1320	1.265	428	1183	1506	1829	2209	0.779
STIR	#3- 60	#3-104	#3-116	#3-122	#3-128		#3- 72	#3-104	#3-110	#3-116	#4-120	
25'- 0"	39	518	722	927	1167	1.490	345	1041	1339	1636	1986	0.917
STIR	#3- 58	#3-106	#3-104	#3-125	#3-132		#3- 71	#3-106	#3-114	#3-118	#4-114	
26'- 0"		431	620	809	1031	1.743	271	915	1190	1465	1788	1.073
STIR		#3-107	#3-112	#3-129	#3-136		#3- 71	#3-109	#3-116	#3-121	#4-117	
27'- 0"		353	529	704	910	2.027	205	802	1057	1312	1612	1.247
STIR		#3-108	#3-120	#3-131	#3-138		#3- 70	#3- 98	#3-118	#3-125	#4-122	
28'- 0"		284	447	610	802	2.344	146	701	939	1176	1455	1.443
STIR		#3-109	#3-122	#3-133	#3-142		#3- 69	#3-105	#3-122	#3-128	#3-127	
29'- 0"		222	374	526	705	2.698	93	611	832	1053	1313	1.660
STIR		#3-110	#3-124	#3-121	#3-145		#3- 68	#3-112	#3-124	#3-131	#3-133	
30'- 0"		166	308	450	617	3.090	46	529	736	942	1185	1.901
STIR		#3-111	#3-125	#3-130	#3-148		#3- 66	#3-114	#3-126	#3-134	#3-139	
31'- 0"		115	248	381	538	3.523	2	455	649	842	1070	2.168
STIR		#3-111	#3-127	#3-138	#3-150		#3- 65	#3-115	#3-129	#3-137	#3-144	
32'- 0"		69	194	319	465	4.000		388	570	751	965	2.461
STIR		#3-111	#3-128	#3-140	#3-153			#3-117	#3-117	#3-139	#3-146	
33'- 0"		27	145	262	400	4.523		327	498	669	870	2.784
STIR		#3-111	#3-129	#3-142	#3-155			#3-118	#3-124	#3-141	#3-150	
34'- 0"			99	210	340	5.097		272	433	593	783	3.137
STIR			#3-129	#3-143	#3-144			#3-119	#3-132	#3-144	#3-153	
35'- 0"			58	162	285	5.724		221	373	524	703	3.522
STIR			#3-130	#3-145	#3-153			#3-120	#3-134	#3-145	#3-155	
36'- 0"			20	119	235	6.407		174	317	461	630	3.942
STIR			#3-130	#3-146	#3-160			#3-121	#3-135	#3-147	#3-157	
PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.46	1.46	1.46	1.54	1.83		1.46	1.46	1.83	2.09	4.01	
ACTUAL STEEL %	1.066	1.066	1.066	1.122	1.332		1.066	1.066	1.332	1.523	2.958	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38	16.38		16.38	16.38	16.38	16.38	16.25	
$-I_{cr}/I_{gr}$	0.186	0.186	0.186	0.193	0.219		0.186	0.186	0.219	0.240	0.362	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.88	1.04	1.20	1.39		0.51	0.88	1.04	1.20	1.39	
ACTUAL STEEL %	0.351	0.609	0.721	0.832	0.966		0.351	0.609	0.721	0.832	0.966	
EFF. DEPTH, IN.	16.71	16.62	16.59	16.56	16.53		16.71	16.62	16.59	16.56	16.53	
$+I_{cr}/I_{gr}$	0.106	0.175	0.203	0.231	0.263		0.106	0.175	0.203	0.231	0.263	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 8″ Ribs @ 74″ c.-c. 13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 4	# 4	Int. Span Defl. Coeff. (2)
AT	10	10	10	10	8.5		10	10	8.5	7	5	
BOTTOM BARS NO	2# 4	1# 6	1# 6	1# 5	1# 7		2# 4	1# 6	1# 6	1# 5	1# 7	
BARS NO	1# 4	1# 6	1# 7	2# 6	1# 8		1# 4	1# 6	1# 7	2# 6	1# 8	
STEEL (PSF)	0.51	0.67	0.73	0.77	0.94		0.75	0.91	1.06	1.22	1.62	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	203	592	815	1030	1298	1.265	594	1160	1484	1797	2186	0.779
STIR	#3- 65	#3- 97	#3-107	#3-117	#3-124		#3- 75	#3- 87	#3-106	#3-112	#4-116	
25'- 0"	136	495	699	898	1144	1.490	496	1018	1316	1605	1963	0.917
STIR	#3- 63	#3- 98	#3-109	#3-119	#3-127		#3- 75	#3- 94	#3-109	#3-114	#4-120	
26'- 0"	76	408	597	781	1008	1.743	409	892	1167	1434	1765	1.073
STIR	#3- 61	#3- 98	#3-111	#3-110	#3-130		#3- 75	#3-101	#3-112	#3-118	#4-122	
27'- 0"	23	330	506	676	887	2.027	331	779	1034	1282	1589	1.247
STIR	#3- 59	#3- 99	#3-112	#3-118	#3-133		#3- 75	#3-102	#3-113	#3-120	#3-127	
28'- 0"		261	424	583	779	2.344	262	678	916	1146	1432	1.443
STIR		#3- 99	#3-114	#3-124	#3-136		#3- 74	#3-104	#3-100	#3-123	#3-129	
29'- 0"		199	351	499	682	2.698	200	588	809	1024	1290	1.660
STIR		#3- 99	#3-115	#3-126	#3-138		#3- 73	#3-105	#3-108	#3-125	#3-132	
30'- 0"		143	285	423	594	3.090	144	506	713	914	1163	1.901
STIR		#3- 99	#3-115	#3-127	#3-126		#3- 72	#3-106	#3-115	#3-127	#3-135	
31'- 0"		92	225	354	515	3.523	93	432	626	814	1047	2.168
STIR		#3- 98	#3-116	#3-129	#3-134		#3- 71	#3-107	#3-119	#3-130	#3-138	
32'- 0"		46	171	292	442	4.000	47	365	547	724	942	2.461
STIR		#3- 98	#3-116	#3-130	#3-142		#3- 69	#3-108	#3-121	#3-132	#3-141	
33'- 0"		4	121	236	377	4.523	5	304	475	641	847	2.784
STIR		#3- 97	#3-117	#3-131	#3-144		#3- 67	#3-108	#3-122	#3-121	#3-143	
34'- 0"			76	184	317	5.097		249	410	566	760	3.137
STIR			#3-117	#3-132	#3-146			#3-109	#3-123	#3-129	#3-145	
35'- 0"			35	137	262	5.724		198	350	497	680	3.522
STIR			#3-116	#3-133	#3-148			#3-109	#3-124	#3-135	#3-148	
36'- 0"				93	212	6.407		151	294	434	607	3.942
STIR				#3-133	#3-149			#3-109	#3-125	#3-137	#3-150	
PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.48	1.48	1.48	1.74		1.48	1.48	1.74	2.11	2.96	
ACTUAL STEEL %	0.965	0.965	0.965	0.965	1.135		0.965	0.965	1.135	1.379	1.930	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38	16.38		16.38	16.38	16.38	16.38	16.38	
$-I_{cr}/I_{gr}$	0.177	0.177	0.177	0.177	0.199		0.177	0.177	0.199	0.229	0.289	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.88	1.04	1.19	1.39		0.60	0.88	1.04	1.19	1.39	
ACTUAL STEEL %	0.370	0.546	0.646	0.737	0.867		0.370	0.546	0.646	0.737	0.867	
EFF. DEPTH, IN.	16.75	16.62	16.59	16.64	16.53		16.75	16.62	16.59	16.64	16.53	
$+I_{cr}/I_{gr}$	0.113	0.159	0.185	0.211	0.240		0.113	0.159	0.185	0.211	0.240	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 9″ Ribs @ 75″ c.-c. 13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	10	9	7.5		10	9	7.5	10	7.5	
BOTTOM BARS NO	2# 4	2# 4	1# 5	2# 6	1# 8		2# 4	2# 4	1# 5	2# 6	1# 8	
BARS NO	1# 4	2# 5	2# 6	1# 6	1# 8		1# 4	2# 5	2# 6	1# 6	1# 8	
STEEL (PSF)	0.51	0.70	0.77	0.87	1.07		0.75	1.00	1.17	1.35	2.19	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
24'- 0" (3)	180	774	1008	1188	1535	1.265	571	1436	1775	2038	2542	0.779
STIR	#3- 54	#3-100	#3-103	#3-117	#3-125		#3- 68	#3-102	#3-107	#3-111	#4-111	
25'- 0"	113	660	875	1042	1362	1.490	473	1270	1582	1824	2289	0.917
STIR	#3- 52	#3-101	#3-111	#3-119	#3-129		#3- 67	#3- 90	#3-110	#3-115	#4-115	
26'- 0"	53	559	758	912	1207	1.743	386	1123	1411	1636	2065	1.073
STIR	#3- 49	#3-102	#3-113	#3-110	#3-132		#3- 66	#3- 97	#3-113	#3-117	#4-119	
27'- 0"		469	653	796	1070	2.027	308	992	1259	1467	1866	1.247
STIR		#3-103	#3-115	#3-118	#3-134		#3- 65	#3-104	#3-115	#3-120	#4-125	
28'- 0"		389	560	693	947	2.344	239	874	1123	1317	1687	1.443
STIR		#3-104	#3-116	#3-124	#3-137		#3- 64	#3-107	#3-118	#3-123	#4-130	
29'- 0"		316	476	600	837	2.698	177	769	1001	1181	1527	1.660
STIR		#3-104	#3-118	#3-126	#3-139		#3- 62	#3-108	#3-104	#3-125	#3-134	
30'- 0"		251	400	516	738	3.090	121	674	891	1059	1382	1.901
STIR		#3-104	#3-119	#3-127	#3-142		#3- 60	#3-110	#3-111	#3-128	#3-136	
31'- 0"		192	331	440	648	3.523	70	588	791	949	1251	2.168
STIR		#3-104	#3-119	#3-129	#3-131		#3- 58	#3-111	#3-119	#3-130	#3-140	
32'- 0"		138	269	371	566	4.000	24	510	701	849	1132	2.461
STIR		#3-104	#3-120	#3-130	#3-140		#3- 56	#3-112	#3-123	#3-132	#3-143	
33'- 0"		89	213	308	492	4.523		439	618	757	1024	2.784
STIR		#3-103	#3-121	#3-131	#3-146			#3-113	#3-125	#3-121	#3-145	
34'- 0"		45	161	251	424	5.097		374	543	674	925	3.137
STIR		#3-102	#3-121	#3-132	#3-148			#3-113	#3-126	#3-128	#3-148	
35'- 0"		4	113	198	362	5.724		315	474	598	835	3.522
STIR		#3-101	#3-121	#3-133	#3-150			#3-114	#3-127	#3-136	#3-150	
36'- 0"			70	150	305	6.407		260	411	528	752	3.942
STIR			#3-121	#3-133	#3-151			#3-114	#3-128	#3-137	#3-152	
PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.50	1.50	1.50	1.67	2.00		1.50	1.67	2.00	2.33	4.40	
ACTUAL STEEL %	0.884	0.884	0.884	0.982	1.178		0.884	0.982	1.178	1.376	2.615	
EFF. DEPTH, IN.	16.38	16.38	16.38	16.38	16.38		16.38	16.38	16.38	16.31	16.25	
$-I_{cr}/I_{gr}$	0.169	0.169	0.169	0.183	0.209		0.169	0.183	0.209	0.231	0.351	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	1.02	1.19	1.32	1.58		0.60	1.02	1.19	1.32	1.58	
ACTUAL STEEL %	0.335	0.571	0.669	0.742	0.894		0.335	0.571	0.669	0.742	0.894	
EFF. DEPTH, IN.	16.75	16.71	16.64	16.62	16.50		16.75	16.71	16.64	16.62	16.50	
$+I_{cr}/I_{gr}$	0.104	0.170	0.194	0.213	0.247		0.104	0.170	0.194	0.213	0.247	
SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 6″ Ribs @ 72″ c.-c. 15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)											f'_c = 4,000 psi f_y = 60,000 psi
TOP BARS NO	# 4	# 4	# 4			End Span Defl. Coeff. (2)	# 4	# 4	# 4			Int. Span Defl. Coeff. (2)
AT	10	10	10				10	9.5	8			
BOTTOM BARS NO	1# 4	1# 6	1# 6				1# 4	1# 6	1# 6			
BARS NO	1# 5	1# 6	1# 7				1# 5	1# 6	1# 7			
STEEL (PSF)	0.48	0.68	0.75				0.72	0.94	1.11			
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	65	562	774			1.743	382	1104	1414			1.073
STIR	#3- 67	#3-114	#3-126				#3- 79	#3-113	#3-121			
27'- 0"	14	475	672			2.027	308	978	1265			1.247
STIR	#3- 65	#3-116	#3-129				#3- 79	#3-117	#3-123			
28'- 0"		397	581			2.344	242	865	1132			1.443
STIR		#3-118	#3-117				#3- 79	#3-118	#3-126			
29'- 0"		328	499			2.698	183	764	1012			1.660
STIR		#3-119	#3-126				#3- 78	#3-102	#3-129			
30'- 0"		265	425			3.090	129	672	905			1.901
STIR		#3-120	#3-133				#3- 78	#3-109	#3-132			
31'- 0"		208	358			3.523	81	589	807			2.168
STIR		#3-121	#3-135				#3- 77	#3-116	#3-134			
32'- 0"		156	297			4.000	37	514	719			2.461
STIR		#3-122	#3-137				#3- 75	#3-124	#3-136			
33'- 0"		109	241			4.523		446	638			2.784
STIR		#3-122	#3-139					#3-126	#3-139			
34'- 0"		66	191			5.097		383	564			3.137
STIR		#3-123	#3-140					#3-127	#3-141			
35'- 0"		27	144			5.724		326	497			3.522
STIR		#3-123	#3-141					#3-129	#3-126			
36'- 0"			102			6.407		274	435			3.942
STIR			#3-142					#3-130	#3-133			
37'- 0"			63			7.149		226	378			4.399
STIR			#3-143					#3-131	#3-141			
38'- 0"			27			7.953		181	326			4.894
STIR			#3-144					#3-132	#3-147			
PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.44	1.44	1.44				1.44	1.52	1.80			
ACTUAL STEEL %	1.041	1.041	1.041				1.041	1.095	1.301			
EFF. DEPTH, IN.	18.38	18.38	18.38				18.38	18.38	18.38			
$-I_{cr}/I_{gr}$	0.188	0.188	0.188				0.188	0.195	0.221			
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.51	0.88	1.04				0.51	0.88	1.04			
ACTUAL STEEL %	0.347	0.601	0.711				0.347	0.601	0.711			
EFF. DEPTH, IN.	18.71	18.62	18.59				18.71	18.62	18.59			
$+I_{cr}/I_{gr}$	0.109	0.180	0.210				0.109	0.180	0.210			
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 4	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	9.5	8	7		10	10	7	4	7	
BOTTOM BARS NO	2# 4	1# 6	1# 7	1# 7	1# 8		2# 4	1# 6	1# 7	1# 7	1# 8	
BARS NO	1# 4	1# 6	1# 7	1# 8	1# 8		1# 4	1# 6	1# 7	1# 8	1# 8	
STEEL (PSF)	0.52	0.67	0.84	0.97	1.11		0.76	0.91	1.28	1.87	2.31	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	164	536	961	1212	1461	1.743	537	1079	1697	2061	2424	1.073
STIR	#3- 72	#3-106	#3-128	#3-134	#3-140		#3- 82	#3- 93	#3-121	#4-124	#4-130	
27'- 0"	104	449	844	1076	1307	2.027	450	952	1526	1863	2200	1.247
STIR	#3- 70	#3-107	#3-130	#3-138	#3-144		#3- 82	#3-100	#3-124	#4-127	#4-124	
28'- 0"	50	372	738	954	1169	2.344	372	840	1373	1687	2000	1.443
STIR	#3- 68	#3-108	#3-115	#3-141	#3-147		#3- 82	#3-108	#3-127	#4-130	#4-127	
29'- 0"	3	302	644	845	1046	2.698	302	738	1235	1528	1820	1.660
STIR	#3- 66	#3-108	#3-124	#3-143	#3-151		#3- 82	#3-111	#3-130	#3-136	#4-130	
30'- 0"		239	558	746	934	3.090	239	647	1111	1384	1657	1.901
STIR		#3-109	#3-132	#3-147	#3-154		#3- 82	#3-113	#3-132	#3-139	#4-134	
31'- 0"		182	481	657	833	3.523	183	564	999	1255	1510	2.168
STIR		#3-109	#3-137	#3-149	#3-157		#3- 81	#3-114	#3-135	#3-142	#4-141	
32'- 0"		131	411	577	741	4.000	131	489	897	1137	1377	2.461
STIR		#3-109	#3-138	#3-151	#3-160		#3- 80	#3-115	#3-138	#3-145	#4-147	
33'- 0"		84	348	503	658	4.523	84	420	804	1030	1256	2.784
STIR		#3-108	#3-140	#3-139	#3-162		#3- 79	#3-116	#3-140	#3-149	#4-153	
34'- 0"		41	289	436	582	5.097	41	358	719	932	1145	3.137
STIR		#3-108	#3-141	#3-147	#3-166		#3- 77	#3-117	#3-142	#3-150	#3-158	
35'- 0"		1	236	374	512	5.724	2	301	642	843	1043	3.522
STIR		#3-107	#3-143	#3-156	#3-169		#3- 76	#3-118	#3-144	#3-153	#3-161	
36'- 0"			187	318	448	6.407		248	571	761	950	3.942
STIR			#3-144	#3-158	#3-170			#3-119	#3-131	#3-157	#3-164	
37'- 0"			142	266	389	7.149		200	505	685	864	4.399
STIR			#3-145	#3-160	#3-154			#3-119	#3-138	#3-159	#3-167	
38'- 0"			101	218	335	7.953		156	445	615	785	4.894
STIR			#3-146	#3-161	#3-162			#3-119	#3-146	#3-160	#3-170	
PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.46	1.46	1.54	1.83	2.09		1.46	1.46	2.09	3.65	4.59	
ACTUAL STEEL %	0.931	0.931	0.980	1.164	1.330		0.931	0.931	1.330	2.328	2.951	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.38		18.38	18.38	18.38	18.38	18.25	
$-I_{cr}/I_{gr}$	0.177	0.177	0.183	0.208	0.229		0.177	0.177	0.229	0.335	0.380	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.60	0.88	1.20	1.39	1.58		0.60	0.88	1.20	1.39	1.58	
ACTUAL STEEL %	0.361	0.533	0.729	0.846	0.962		0.361	0.533	0.729	0.846	0.962	
EFF. DEPTH, IN.	18.75	18.62	18.56	18.53	18.50		18.75	18.62	18.56	18.53	18.50	
$+I_{cr}/I_{gr}$	0.114	0.162	0.214	0.244	0.274		0.114	0.162	0.214	0.244	0.274	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 8″ Ribs @ 74″ c.-c. 15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 4	# 4	End Span Defl. Coeff. (2)	# 4	# 4	# 4	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	10	8.5	7.5		10	8.5	7.5	9.5	7.5	
BOTTOM BARS NO	1# 5	1# 6	1# 5	1# 7	1# 8		1# 5	1# 6	1# 5	1# 7	1# 8	
BARS NO	1# 5	1# 7	2# 6	1# 8	1# 8		1# 5	1# 7	2# 6	1# 8	1# 8	
STEEL (PSF)	0.54	0.73	0.77	0.94	1.08		0.78	1.06	1.18	1.45	2.20	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	162	723	929	1186	1436	1.743	546	1363	1662	2036	2399	1.073
STIR	#3- 63	#3-110	#3-112	#3-129	#3-135		#3- 76	#3-110	#3-116	#4-122	#4-122	
27'- 0"	101	621	812	1050	1282	2.027	457	1214	1492	1838	2175	1.247
STIR	#3- 60	#3-111	#3-120	#3-132	#3-139		#3- 76	#3- 95	#3-119	#4-125	#4-126	
28'- 0"	46	530	707	929	1144	2.344	377	1081	1339	1661	1974	1.443
STIR	#3- 57	#3-112	#3-123	#3-135	#3-142		#3- 75	#3-102	#3-121	#3-129	#4-129	
29'- 0"		448	613	820	1020	2.698	305	961	1202	1502	1794	1.660
STIR		#3-113	#3-124	#3-120	#3-145		#3- 74	#3-110	#3-124	#3-131	#4-134	
30'- 0"		374	528	721	909	3.090	241	854	1078	1359	1632	1.901
STIR		#3-114	#3-126	#3-128	#3-147		#3- 73	#3-116	#3-126	#3-134	#4-140	
31'- 0"		306	451	632	808	3.523	182	756	967	1229	1485	2.168
STIR		#3-114	#3-127	#3-137	#3-150		#3- 72	#3-118	#3-109	#3-137	#4-144	
32'- 0"		246	381	551	716	4.000	129	668	865	1112	1352	2.461
STIR		#3-114	#3-128	#3-141	#3-153		#3- 70	#3-119	#3-116	#3-140	#3-146	
33'- 0"		190	318	477	632	4.523	80	587	773	1005	1230	2.784
STIR		#3-115	#3-129	#3-143	#3-137		#3- 68	#3-121	#3-124	#3-142	#3-150	
34'- 0"		140	260	410	556	5.097	36	513	688	907	1119	3.137
STIR		#3-114	#3-130	#3-144	#3-145		#3- 66	#3-122	#3-131	#3-145	#3-152	
35'- 0"		93	207	349	486	5.724		446	611	817	1018	3.522
STIR		#3-114	#3-131	#3-146	#3-154			#3-123	#3-134	#3-146	#3-155	
36'- 0"		51	158	292	422	6.407		384	540	735	925	3.942
STIR		#3-114	#3-131	#3-147	#3-159			#3-124	#3-136	#3-149	#3-157	
37'- 0"		12	113	240	363	7.149		327	475	660	839	4.399
STIR		#3-113	#3-131	#3-148	#3-161			#3-124	#3-137	#3-133	#3-160	
38'- 0"			72	192	309	7.953		275	415	590	760	4.894
STIR			#3-131	#3-149	#3-163			#3-125	#3-138	#3-141	#3-163	
PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.48	1.48	1.74	1.97		1.48	1.74	1.97	2.41	4.34	
ACTUAL STEEL %	0.845	0.845	0.845	0.994	1.127		0.845	0.994	1.127	1.384	2.499	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.38		18.38	18.38	18.38	18.31	18.25	
$-I_{cr}/I_{gr}$	0.167	0.167	0.167	0.189	0.208		0.167	0.189	0.208	0.238	0.351	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	1.04	1.19	1.39	1.58		0.62	1.04	1.19	1.39	1.58	
ACTUAL STEEL %	0.337	0.567	0.647	0.760	0.865		0.337	0.567	0.647	0.760	0.865	
EFF. DEPTH, IN.	18.69	18.59	18.64	18.53	18.50		18.69	18.59	18.64	18.53	18.50	
$+I_{cr}/I_{gr}$	0.107	0.171	0.195	0.222	0.249		0.107	0.171	0.195	0.222	0.249	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 9″ Ribs @ 75″ c.-c. 15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	9	7.5	10		10	7.5	10	8.5	6.5	
BOTTOM BARS NO	2# 4	1# 5	2# 6	1# 8	1# 8		2# 4	1# 5	2# 6	1# 8	1# 8	
BARS NO	1# 5	2# 6	1# 6	1# 8	1# 9		1# 5	2# 6	1# 6	1# 8	1# 9	
STEEL (PSF)	0.57	0.77	0.87	1.07	1.21		0.81	1.17	1.35	1.63	2.50	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
26'- 0" (3)	261	904	1077	1411	1684	1.743	701	1637	1888	2374	2772	1.073
STIR	#3- 67	#3-112	#3-111	#3-130	#4-136		#3- 79	#3-112	#3-117	#4-124	#4-121	
27'- 0"	190	787	947	1256	1510	2.027	599	1466	1700	2150	2519	1.247
STIR	#3- 65	#3-114	#3-120	#3-133	#3-140		#3- 79	#3-115	#3-120	#4-127	#4-125	
28'- 0"	127	682	831	1119	1355	2.344	507	1314	1531	1949	2292	1.443
STIR	#3- 62	#3-115	#3-123	#3-136	#3-143		#3- 78	#3- 98	#3-122	#4-130	#4-127	
29'- 0"	71	588	727	995	1215	2.698	425	1177	1379	1769	2089	1.660
STIR	#3- 60	#3-116	#3-124	#3-139	#3-146		#3- 78	#3-106	#3-124	#4-132	#4-133	
30'- 0"	20	503	633	883	1089	3.090	350	1053	1242	1607	1906	1.901
STIR	#3- 57	#3-117	#3-126	#3-125	#3-149		#3- 77	#3-113	#3-127	#3-136	#4-139	
31'- 0"		426	547	782	975	3.523	283	941	1118	1460	1740	2.168
STIR		#3-118	#3-127	#3-133	#3-152		#3- 76	#3-120	#3-128	#3-139	#4-144	
32'- 0"		356	470	690	871	4.000	222	840	1006	1326	1589	2.461
STIR		#3-118	#3-128	#3-142	#3-154		#3- 75	#3-122	#3-116	#3-142	#4-147	
33'- 0"		292	400	607	777	4.523	167	747	904	1205	1452	2.784
STIR		#3-119	#3-129	#3-145	#3-157		#3- 73	#3-123	#3-123	#3-144	#4-151	
34'- 0"		234	336	531	691	5.097	116	663	810	1094	1327	3.137
STIR		#3-119	#3-130	#3-147	#3-141		#3- 71	#3-125	#3-130	#3-146	#4-153	
35'- 0"		181	277	461	612	5.724	70	586	725	992	1212	3.522
STIR		#3-119	#3-131	#3-148	#3-150		#3- 69	#3-126	#3-134	#3-148	#3-156	
36'- 0"		133	223	397	540	6.407	27	515	646	899	1107	3.942
STIR		#3-118	#3-131	#3-150	#3-158		#3- 67	#3-127	#3-136	#3-151	#3-159	
37'- 0"		88	173	338	473	7.149		450	574	814	1010	4.399
STIR		#3-118	#3-131	#3-151	#3-163			#3-128	#3-137	#3-153	#3-162	
38'- 0"		46	127	284	412	7.953		389	507	734	921	4.894
STIR		#3-117	#3-131	#3-152	#3-165			#3-129	#3-139	#3-137	#3-164	
PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.50	1.50	1.67	2.00	2.33		1.50	2.00	2.33	2.74	5.08	
ACTUAL STEEL %	0.775	0.775	0.861	1.034	1.206		0.775	1.034	1.206	1.419	2.644	
EFF. DEPTH, IN.	18.38	18.38	18.38	18.38	18.31		18.38	18.38	18.31	18.31	18.25	
$-I_{cr}/I_{gr}$	0.160	0.160	0.173	0.199	0.220		0.160	0.199	0.220	0.248	0.371	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.19	1.32	1.58	1.79		0.71	1.19	1.32	1.58	1.79	
ACTUAL STEEL %	0.349	0.588	0.652	0.785	0.891		0.349	0.588	0.652	0.785	0.891	
EFF. DEPTH, IN.	18.72	18.64	18.62	18.50	18.46		18.72	18.64	18.62	18.50	18.46	
$+I_{cr}/I_{gr}$	0.112	0.180	0.197	0.230	0.256		0.112	0.180	0.197	0.230	0.256	
SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 6″ Ribs @ 72″ c.-c. 19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4				End Span Defl. Coeff. (2)	# 4	# 4				Int. Span Defl. Coeff. (2)
AT	10	10					10	8				
BOTTOM BARS NO	1# 5	1# 6					1# 5	1# 6				
BARS NO	1# 5	1# 7					1# 5	1# 7				
STEEL (PSF)	0.54	0.75					0.79	1.11				
CLEAR SPAN	END SPAN						INTERIOR SPAN					
28'- 0" (3)	210	799				2.344	612	1470				1.443
STIR	#3- 81	#3-122					#3- 91	#3-124				
29'- 0"	150	699				2.698	525	1324				1.660
STIR	#3- 80	#3-128					#3- 92	#3-127				
30'- 0"	95	609				3.090	446	1193				1.901
STIR	#3- 78	#3-130					#3- 92	#3-130				
31'- 0"	47	528				3.523	375	1075				2.168
STIR	#3- 76	#3-132					#3- 92	#3-132				
32'- 0"	2	454				4.000	310	967				2.461
STIR	#3- 74	#3-133					#3- 92	#3-134				
33'- 0"		386				4.523	251	869				2.784
STIR		#3-135					#3- 91	#3-117				
34'- 0"		325				5.097	198	779				3.137
STIR		#3-136					#3- 90	#3-124				
35'- 0"		268				5.724	148	697				3.522
STIR		#3-137					#3- 90	#3-131				
36'- 0"		217				6.407	103	622				3.942
STIR		#3-137					#3- 89	#3-139				
37'- 0"		169				7.149	62	553				4.399
STIR		#3-138					#3- 87	#3-142				
38'- 0"		125				7.953	23	489				4.894
STIR		#3-138					#3- 86	#3-143				
39'- 0"		85				8.824		430				5.430
STIR		#3-139						#3-145				
40'- 0"		47				9.765		376				6.009
STIR		#3-139						#3-146				
PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.44	1.44					1.44	1.80				
ACTUAL STEEL %	0.818	0.818					0.818	1.023				
EFF. DEPTH, IN.	22.38	22.38					22.38	22.38				
$-I_{cr}/I_{gr}$	0.169	0.169					0.169	0.200				
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.62	1.04					0.62	1.04				
ACTUAL STEEL %	0.334	0.561					0.334	0.561				
EFF. DEPTH, IN.	22.69	22.59					22.69	22.59				
$+I_{cr}/I_{gr}$	0.112	0.181					0.112	0.181				
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 4	# 5	End Span Defl. Coeff. (2)	# 4	# 4	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	10	8.5	7.5	10		10	7	9.5	8	6.5	
BOTTOM BARS NO	2# 4	1# 7	1# 7	1# 8	1# 8		2# 4	1# 7	1# 7	1# 8	1# 8	
BARS NO	1# 5	1# 7	1# 8	1# 8	1# 9		1# 5	1# 7	1# 8	1# 8	1# 9	
STEEL (PSF)	0.58	0.83	0.95	1.09	1.23		0.82	1.28	1.46	1.71	2.52	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
30'- 0" (3)	178	773	1003	1232	1484	3.090	580	1446	1780	2114	2480	1.901
STIR	#3- 80	#3-132	#3-144	#3-152	#4-159		#3- 93	#3-131	#3-138	#4-143	#4-143	
31'- 0"	122	679	895	1109	1345	3.523	498	1309	1622	1935	2277	2.168
STIR	#3- 79	#3-134	#3-127	#3-155	#4-162		#3- 93	#3-133	#3-140	#4-146	#4-146	
32'- 0"	71	594	796	998	1219	4.000	424	1185	1479	1772	2094	2.461
STIR	#3- 77	#3-135	#3-135	#3-158	#3-166		#3- 93	#3-136	#3-143	#4-149	#4-150	
33'- 0"	24	517	706	896	1104	4.523	356	1072	1349	1624	1927	2.784
STIR	#3- 74	#3-136	#3-144	#3-160	#3-168		#3- 93	#3-115	#3-146	#4-152	#4-152	
34'- 0"		446	625	803	999	5.097	295	969	1229	1489	1774	3.137
STIR		#3-138	#3-151	#3-163	#3-172		#3- 92	#3-122	#3-149	#4-156	#4-156	
35'- 0"		381	550	718	903	5.724	238	875	1120	1366	1634	3.522
STIR		#3-139	#3-153	#3-143	#3-175		#3- 92	#3-129	#3-151	#3-159	#4-162	
36'- 0"		321	481	640	815	6.407	187	788	1020	1252	1506	3.942
STIR		#3-140	#3-154	#3-151	#3-177		#3- 91	#3-136	#3-154	#3-162	#4-168	
37'- 0"		266	418	568	734	7.149	139	709	928	1148	1388	4.399
STIR		#3-140	#3-156	#3-159	#3-180		#3- 90	#3-143	#3-156	#3-165	#4-172	
38'- 0"		216	359	502	659	7.953	95	635	843	1051	1279	4.894
STIR		#3-141	#3-157	#3-168	#3-182		#3- 88	#3-145	#3-159	#3-168	#4-175	
39'- 0"		169	305	441	590	8.824	55	567	765	962	1179	5.430
STIR		#3-141	#3-159	#3-172	#3-185		#3- 87	#3-146	#3-138	#3-170	#4-177	
40'- 0"		126	255	384	526	9.765	17	504	692	880	1086	6.009
STIR		#3-142	#3-160	#3-174	#3-164		#3- 85	#3-148	#3-145	#3-172	#3-181	
41'- 0"		86	209	332	466	10.778		446	625	804	999	6.633
STIR		#3-142	#3-161	#3-175	#3-173			#3-149	#3-152	#3-174	#3-184	
42'- 0"		49	166	283	411	11.869		392	562	732	919	7.304
STIR		#3-141	#3-161	#3-177	#3-181			#3-150	#3-160	#3-177	#3-186	
PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.46	1.46	1.72	1.95	2.26		1.46	2.09	2.38	2.83	4.94	
ACTUAL STEEL %	0.736	0.736	0.866	0.981	1.145		0.736	1.052	1.205	1.431	2.508	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.38	22.31		22.38	22.38	22.31	22.31	22.25	
$-I_{cr}/I_{gr}$	0.159	0.159	0.180	0.198	0.220		0.159	0.208	0.228	0.258	0.371	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.71	1.20	1.39	1.58	1.79		0.71	1.20	1.39	1.58	1.79	
ACTUAL STEEL %	0.340	0.578	0.670	0.763	0.865		0.340	0.578	0.670	0.763	0.865	
EFF. DEPTH, IN.	22.72	22.56	22.53	22.50	22.46		22.72	22.56	22.53	22.50	22.46	
$+I_{cr}/I_{gr}$	0.115	0.186	0.212	0.238	0.266		0.115	0.186	0.212	0.238	0.266	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 8″ Ribs @ 74″ c.-c. 19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)						f'_c = 4,000 psi f_y = 60,000 psi					
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 5	# 6	Int. Span Defl. Coeff. (2)
AT	10	9	8	10	9		10	10	9	7.5	6	
BOTTOM BARS NO	1# 4	2# 6	2# 6	1# 8	1# 9		1# 4	2# 6	2# 6	1# 8	1# 9	
BARS NO	2# 5	1# 6	1# 7	1# 9	1# 9		2# 5	1# 6	1# 7	1# 9	1# 9	
STEEL (PSF)	0.60	0.88	1.00	1.22	1.38		0.84	1.36	1.53	1.85	2.77	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
30'- 0" (3)	283	894	1088	1454	1705	3.090	746	1636	1918	2449	2815	1.901
STIR	#3- 85	#3-131	#3-124	#3-153	#4-159		#3- 96	#3-130	#4-136	#4-143	#5-143	
31'- 0"	218	791	973	1315	1550	3.523	652	1485	1750	2247	2589	2.168
STIR	#3- 83	#3-133	#3-132	#3-156	#4-162		#3- 97	#3-133	#3-139	#4-147	#4-147	
32'- 0"	159	697	867	1188	1409	4.000	566	1348	1597	2064	2385	2.461
STIR	#3- 82	#3-134	#3-141	#3-158	#4-165		#3- 97	#3-135	#3-141	#4-150	#4-151	
33'- 0"	106	611	772	1074	1281	4.523	489	1224	1457	1896	2198	2.784
STIR	#3- 80	#3-136	#3-145	#3-162	#4-169		#3- 97	#3-115	#3-144	#4-153	#4-153	
34'- 0"	57	533	684	969	1164	5.097	418	1110	1330	1744	2028	3.137
STIR	#3- 77	#3-137	#3-147	#3-164	#3-172		#3- 96	#3-122	#3-146	#4-156	#4-157	
35'- 0"	12	462	604	873	1057	5.724	353	1006	1214	1604	1872	3.522
STIR	#3- 75	#3-138	#3-149	#3-167	#3-175		#3- 96	#3-130	#3-149	#4-160	#4-162	
36'- 0"		396	531	784	959	6.407	293	911	1107	1476	1730	3.942
STIR		#3-139	#3-150	#3-148	#3-178		#3- 95	#3-137	#3-151	#4-162	#4-168	
37'- 0"		335	463	703	868	7.149	238	823	1009	1358	1598	4.399
STIR		#3-139	#3-152	#3-157	#3-181		#3- 94	#3-143	#3-153	#4-165	#4-172	
38'- 0"		280	401	628	785	7.953	187	742	918	1249	1477	4.894
STIR		#3-140	#3-153	#3-165	#3-183		#3- 93	#3-144	#3-136	#3-168	#4-175	
39'- 0"		228	343	559	708	8.824	141	667	834	1149	1365	5.430
STIR		#3-140	#3-154	#3-174	#3-185		#3- 92	#3-146	#3-144	#3-171	#4-177	
40'- 0"		181	290	495	637	9.765	97	598	757	1055	1261	6.009
STIR		#3-140	#3-155	#3-175	#3-188		#3- 91	#3-147	#3-151	#3-173	#4-181	
41'- 0"		136	240	436	570	10.778	57	533	685	969	1165	6.633
STIR		#3-140	#3-155	#3-177	#3-172		#3- 89	#3-149	#3-159	#3-175	#4-183	
42'- 0"		95	194	381	509	11.869	20	474	618	889	1075	7.304
STIR		#3-140	#3-156	#3-179	#3-181		#3- 87	#3-150	#3-161	#3-178	#4-186	
PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.64	1.85	2.29	2.55		1.48	2.29	2.55	3.06	5.43	
ACTUAL STEEL %	0.671	0.745	0.838	1.043	1.159		0.671	1.043	1.159	1.390	2.475	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.31	22.31		22.38	22.31	22.31	22.31	22.25	
$-I_{cr}/I_{gr}$	0.151	0.164	0.179	0.209	0.226		0.151	0.209	0.226	0.258	0.376	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.82	1.32	1.48	1.79	2.00		0.82	1.32	1.48	1.79	2.00	
ACTUAL STEEL %	0.354	0.572	0.642	0.780	0.873		0.354	0.572	0.642	0.780	0.873	
EFF. DEPTH, IN.	22.70	22.62	22.60	22.46	22.44		22.70	22.62	22.60	22.46	22.44	
$+I_{cr}/I_{gr}$	0.120	0.186	0.207	0.243	0.268		0.120	0.186	0.207	0.243	0.268	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 9″ Ribs @ 75″ c.-c. 19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 4	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	9	7.5	9.5	8.5		10	10	8.5	9.5	7.5	
BOTTOM BARS NO	1# 6	1# 7	1# 6	2# 7	1# 7		1# 6	1# 7	1# 6	2# 7	1# 7	
BARS NO	1# 6	1# 8	2# 7	1# 8	2# 8		1# 6	1# 8	2# 7	1# 8	2# 8	
STEEL (PSF)	0.66	0.91	1.05	1.31	1.41		0.90	1.40	1.61	2.06	2.93	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
30'- 0" (3)	323	942	1252	1674	1902	3.090	818	1719	2170	2783	3115	1.901
STIR	#3- 81	#3-127	#3-124	#4-153	#4-158		#3- 94	#3-127	#4-136	#4-144	#5-143	
31'- 0"	253	834	1124	1519	1732	3.523	717	1561	1983	2558	2868	2.168
STIR	#3- 79	#3-129	#3-132	#4-157	#4-162		#3- 94	#3-107	#4-139	#4-148	#5-146	
32'- 0"	191	735	1007	1378	1578	4.000	626	1418	1814	2353	2645	2.461
STIR	#3- 77	#3-130	#3-140	#3-160	#4-165		#3- 94	#3-114	#4-142	#4-151	#5-150	
33'- 0"	133	645	901	1250	1438	4.523	543	1288	1660	2167	2441	2.784
STIR	#3- 75	#3-131	#3-146	#3-162	#4-168		#3- 93	#3-121	#3-145	#4-154	#5-152	
34'- 0"	81	564	805	1133	1311	5.097	467	1169	1519	1997	2255	3.137
STIR	#3- 73	#3-132	#3-148	#3-165	#4-172		#3- 93	#3-128	#3-147	#4-157	#4-156	
35'- 0"	33	489	716	1026	1193	5.724	397	1060	1390	1841	2085	3.522
STIR	#3- 70	#3-132	#3-149	#3-168	#3-174		#3- 92	#3-136	#3-149	#4-160	#4-162	
36'- 0"		420	635	928	1086	6.407	334	959	1272	1698	1929	3.942
STIR		#3-133	#3-151	#3-171	#3-177		#3- 91	#3-137	#3-151	#4-164	#4-168	
37'- 0"		356	560	837	987	7.149	275	867	1163	1567	1785	4.399
STIR		#3-133	#3-152	#3-155	#3-180		#3- 90	#3-139	#3-154	#4-166	#4-171	
38'- 0"		298	491	754	896	7.953	221	782	1063	1446	1652	4.894
STIR		#3-133	#3-153	#3-163	#3-182		#3- 89	#3-140	#3-136	#4-169	#4-174	
39'- 0"		244	427	677	812	8.824	171	704	970	1334	1530	5.430
STIR		#3-133	#3-154	#3-172	#3-185		#3- 88	#3-141	#3-143	#4-172	#4-178	
40'- 0"		194	368	606	734	9.765	124	631	885	1230	1416	6.009
STIR		#3-133	#3-155	#3-177	#3-165		#3- 86	#3-142	#3-150	#4-174	#4-180	
41'- 0"		148	314	539	662	10.778	81	564	805	1134	1311	6.633
STIR		#3-133	#3-156	#3-178	#3-174		#3- 84	#3-143	#3-158	#3-176	#4-183	
42'- 0"		105	263	478	594	11.869	41	501	731	1044	1213	7.304
STIR		#3-132	#3-157	#3-180	#3-182		#3- 82	#3-144	#3-161	#3-179	#4-186	
PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.50	1.67	2.00	2.45	2.74		1.50	2.33	2.74	3.47	6.00	
ACTUAL STEEL %	0.617	0.686	0.823	1.010	1.129		0.617	0.960	1.129	1.438	2.493	
EFF. DEPTH, IN.	22.38	22.38	22.38	22.31	22.31		22.38	22.31	22.31	22.25	22.19	
$-I_{cr}/I_{gr}$	0.144	0.156	0.180	0.208	0.226		0.144	0.200	0.226	0.267	0.382	
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.88	1.39	1.64	1.99	2.18		0.88	1.39	1.64	1.99	2.18	
ACTUAL STEEL %	0.347	0.551	0.648	0.788	0.864		0.347	0.551	0.648	0.788	0.864	
EFF. DEPTH, IN.	22.62	22.53	22.58	22.54	22.52		22.62	22.53	22.58	22.54	22.52	
$+I_{cr}/I_{gr}$	0.117	0.179	0.209	0.249	0.270		0.117	0.179	0.209	0.249	0.270	
SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 7″ Ribs @ 73″ c.-c. 23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 5	# 5		End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6		Int. Span Defl. Coeff. (2)
AT	10	8.5	10	9			10	10	7.5	6		
BOTTOM BARS NO	1# 6	1# 7	1# 8	1# 9			1# 6	1# 7	1# 8	1# 9		
BARS NO	1# 6	1# 8	1# 9	1# 9			1# 6	1# 8	1# 9	1# 9		
STEEL (PSF)	0.67	0.95	1.23	1.40			0.91	1.42	1.86	2.78		
CLEAR SPAN	END SPAN						INTERIOR SPAN					
35'- 0" (3)	184	722	1140	1358		5.724	613	1395	2003	2320		3.522
STIR	#3- 96	#3-149	#3-172	#4-179			#3-110	#3-149	#4-163	#4-168		
36'- 0"	133	641	1036	1242		6.407	538	1277	1851	2152		3.942
STIR	#3- 95	#3-151	#3-175	#3-183			#3-111	#3-152	#4-166	#4-171		
37'- 0"	85	566	940	1136		7.149	469	1168	1712	1997		4.399
STIR	#3- 93	#3-152	#3-177	#3-186			#3-111	#3-129	#4-170	#4-174		
38'- 0"	41	497	852	1037		7.953	405	1068	1584	1853		4.894
STIR	#3- 91	#3-153	#3-154	#3-189			#3-111	#3-136	#4-172	#4-178		
39'- 0"	1	434	770	946		8.824	346	976	1465	1721		5.430
STIR	#3- 89	#3-154	#3-162	#3-191			#3-110	#3-143	#4-176	#4-182		
40'- 0"		375	695	862		9.765	291	890	1356	1599		6.009
STIR		#3-155	#3-170	#3-194			#3-110	#3-150	#4-178	#4-185		
41'- 0"		320	625	784		10.778	241	811	1254	1485		6.633
STIR		#3-156	#3-179	#3-197			#3-109	#3-158	#3-180	#4-188		
42'- 0"		269	560	711		11.869	194	737	1159	1380		7.304
STIR		#3-157	#3-187	#3-199			#3-108	#3-161	#3-183	#4-191		
43'- 0"		222	499	644		13.040	150	668	1071	1281		8.025
STIR		#3-157	#3-188	#3-177			#3-107	#3-163	#3-186	#4-193		
44'- 0"		178	443	581		14.296	109	604	989	1190		8.798
STIR		#3-157	#3-190	#3-185			#3-106	#3-164	#3-188	#4-197		
45'- 0"		137	390	522		15.641	71	544	912	1104		9.625
STIR		#3-158	#3-192	#3-193			#3-105	#3-165	#3-190	#4-200		
46'- 0"		98	340	467		17.078	35	488	840	1024		10.510
STIR		#3-158	#3-193	#3-202			#3-103	#3-167	#3-193	#4-202		
47'- 0"		62	294	415		18.613	2	435	773	949		11.454
STIR		#3-157	#3-195	#3-208			#3-102	#3-168	#3-195	#3-205		
PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF)												
NEGATIVE MOMENT STEEL AREA (SQ. IN.)	1.46	1.72	2.26	2.51			1.46	2.26	3.02	5.35		
ACTUAL STEEL %	0.602	0.708	0.936	1.040			0.602	0.936	1.247	2.220		
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31			26.38	26.31	26.31	26.25		
$-I_{cr}/I_{gr}$	0.144	0.164	0.201	0.218			0.144	0.201	0.249	0.365		
POSITIVE MOMENT STEEL AREA (SQ. IN.)	0.88	1.39	1.79	2.00			0.88	1.39	1.79	2.00		
ACTUAL STEEL %	0.347	0.549	0.709	0.792			0.347	0.549	0.709	0.792		
EFF. DEPTH, IN.	26.62	26.53	26.46	26.44			26.62	26.53	26.46	26.44		
$+I_{cr}/I_{gr}$	0.123	0.187	0.236	0.261			0.123	0.187	0.236	0.261		
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ ℓ_n/18.5 for end spans, ℓ_n/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 8″ Ribs @ 74″ c.-c. 23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 5	# 5	# 5	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 7	Int. Span Defl. Coeff. (2)
AT	10	7.5	10	8	7		10	8.5	7.5	6	6	
BOTTOM BARS NO	2# 5	1# 8	1# 8	1# 9	1#10		2# 5	1# 8	1# 8	1# 9	1#10	
BARS NO	1# 5	1# 8	1# 9	1#10	1#10		1# 5	1# 8	1# 9	1#10	1#10	
STEEL (PSF)	0.66	1.08	1.22	1.54	1.76		0.90	1.64	1.85	2.88	3.67	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
35'- 0" (3)	204	886	1104	1602	1881	5.724	658	1649	1967	2691	3096	3.522
STIR	#3- 89	#3-151	#3-145	#4-181	#4-187		#3-106	#3-151	#4-158	#5-169	#5-174	
36'- 0"	150	793	1000	1471	1734	6.407	579	1515	1816	2500	2883	3.942
STIR	#3- 87	#3-153	#3-153	#4-185	#4-191		#3-106	#3-153	#4-161	#5-173	#5-168	
37'- 0"	99	709	905	1350	1599	7.149	506	1392	1677	2325	2687	4.399
STIR	#3- 85	#3-155	#3-162	#4-187	#4-195		#3-105	#3-155	#4-163	#5-176	#5-171	
38'- 0"	53	631	816	1239	1475	7.953	438	1279	1549	2163	2506	4.894
STIR	#3- 83	#3-156	#3-169	#4-190	#4-198		#3-105	#3-133	#4-166	#4-180	#5-174	
39'- 0"	10	559	735	1136	1360	8.824	376	1174	1430	2013	2339	5.430
STIR	#3- 80	#3-157	#3-170	#3-193	#4-202		#3-104	#3-140	#3-169	#4-183	#5-178	
40'- 0"		492	659	1040	1254	9.765	318	1076	1320	1874	2185	6.009
STIR		#3-158	#3-172	#3-196	#4-204		#3-104	#3-147	#3-171	#4-186	#5-180	
41'- 0"		430	589	952	1155	10.778	264	986	1218	1746	2041	6.633
STIR		#3-159	#3-174	#3-198	#4-208		#3-103	#3-154	#3-174	#4-189	#5-185	
42'- 0"		372	524	870	1063	11.869	214	902	1124	1626	1908	7.304
STIR		#3-160	#3-175	#3-201	#4-211		#3-101	#3-162	#3-175	#4-192	#5-190	
43'- 0"		319	464	793	978	13.040	168	824	1035	1515	1783	8.025
STIR		#3-160	#3-176	#3-204	#4-214		#3-100	#3-165	#3-150	#4-195	#4-196	
44'- 0"		269	407	722	898	14.296	125	752	953	1411	1668	8.798
STIR		#3-161	#3-178	#3-181	#3-216		#3- 99	#3-166	#3-157	#4-198	#4-202	
45'- 0"		222	354	655	824	15.641	84	684	876	1314	1559	9.625
STIR		#3-161	#3-179	#3-189	#3-220		#3- 97	#3-168	#3-164	#4-201	#4-208	
46'- 0"		178	305	593	754	17.078	47	620	805	1224	1458	10.510
STIR		#3-161	#3-180	#3-198	#3-222		#3- 95	#3-169	#3-172	#4-204	#4-212	
47'- 0"		137	259	535	689	18.613	11	561	737	1139	1363	11.454
STIR		#3-161	#3-180	#3-206	#3-224		#3- 93	#3-170	#3-179	#4-207	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.48	1.97	2.29	2.87	3.28		1.48	2.70	3.06	5.43	7.40	
ACTUAL STEEL %	0.550	0.734	0.855	1.069	1.222		0.550	1.006	1.140	2.029	2.775	
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31	26.31		26.38	26.31	26.31	26.25	26.19	
$-I_{cr}/I_{gr}$	0.137	0.172	0.192	0.227	0.250		0.137	0.217	0.238	0.351	0.425	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	0.93	1.58	1.79	2.27	2.54		0.93	1.58	1.79	2.27	2.54	
ACTUAL STEEL %	0.331	0.566	0.641	0.815	0.913		0.331	0.566	0.641	0.815	0.913	
EFF. DEPTH, IN.	26.69	26.50	26.46	26.40	26.36		26.69	26.50	26.46	26.40	26.36	
$+I_{cr}/I_{gr}$	0.119	0.193	0.216	0.267	0.295		0.119	0.193	0.216	0.267	0.295	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS	66″ Forms + 9″ Ribs @ 75″ c.-c. 23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF)					f'_c = 4,000 psi f_y = 60,000 psi						
TOP BARS NO	# 4	# 4	# 5	# 5	# 6	End Span Defl. Coeff. (2)	# 4	# 5	# 5	# 6	# 6	Int. Span Defl. Coeff. (2)
AT	10	7.5	9.5	8	9		9	8.5	7	8	4	
BOTTOM BARS NO	2# 4	1# 6	2# 7	2# 8	1# 8		2# 4	1# 6	2# 7	2# 8	1# 8	
BARS NO	2# 5	2# 7	1# 8	1# 8	2# 9		2# 5	2# 7	1# 8	1# 8	2# 9	
STEEL (PSF)	0.70	1.05	1.31	1.54	1.84		1.00	1.61	1.99	2.42	3.95	
CLEAR SPAN	END SPAN						INTERIOR SPAN					
35'- 0" (3)	266	919	1285	1681	2115	5.724	764	1713	2247	2823	3454	3.522
STIR	#3- 89	#3-146	#3-143	#4-177	#5-188		#3-106	#3-147	#4-158	#5-167	#5-174	
36'- 0"	206	823	1169	1544	1954	6.407	677	1574	2078	2622	3220	3.942
STIR	#3- 87	#3-148	#3-151	#4-181	#4-191		#3-106	#3-126	#4-161	#5-171	#5-167	
37'- 0"	151	735	1063	1417	1806	7.149	597	1446	1923	2438	3004	4.399
STIR	#3- 85	#3-149	#3-159	#4-183	#4-194		#3-105	#3-133	#4-164	#5-173	#5-170	
38'- 0"	100	653	964	1300	1669	7.953	522	1328	1780	2269	2804	4.894
STIR	#3- 83	#3-150	#3-168	#4-187	#4-199		#3-105	#3-140	#4-167	#4-177	#5-173	
39'- 0"	53	578	874	1192	1542	8.824	454	1218	1648	2112	2620	5.430
STIR	#3- 80	#3-151	#3-172	#3-189	#4-202		#3-104	#3-147	#4-169	#4-181	#5-177	
40'- 0"	9	509	789	1093	1425	9.765	391	1117	1526	1967	2450	6.009
STIR	#3- 77	#3-152	#3-174	#3-192	#4-205		#3-103	#3-155	#4-172	#4-183	#5-179	
41'- 0"		444	711	1000	1316	10.778	332	1023	1412	1832	2292	6.633
STIR		#3-152	#3-175	#3-195	#4-208		#3-102	#3-157	#3-175	#4-186	#5-185	
42'- 0"		384	639	914	1215	11.869	277	936	1307	1707	2145	7.304
STIR		#3-152	#3-177	#3-173	#4-211		#3-101	#3-158	#3-176	#4-189	#5-191	
43'- 0"		329	571	834	1121	13.040	226	855	1208	1590	2008	8.025
STIR		#3-153	#3-178	#3-181	#4-214		#3-100	#3-160	#3-179	#4-192	#5-196	
44'- 0"		276	508	759	1034	14.296	179	779	1117	1481	1881	8.798
STIR		#3-153	#3-179	#3-190	#4-217		#3- 99	#3-161	#3-155	#4-194	#5-202	
45'- 0"		228	450	689	952	15.641	134	709	1031	1380	1762	9.625
STIR		#3-153	#3-181	#3-198	#4-220		#3- 97	#3-162	#3-162	#4-197	#5-208	
46'- 0"		182	395	624	875	17.078	93	642	951	1285	1650	10.510
STIR		#3-152	#3-182	#3-203	#4-222		#3- 95	#3-163	#3-169	#4-200	#4-212	
47'- 0"		140	343	563	803	18.613	54	580	876	1196	1546	11.454
STIR		#3-152	#3-183	#3-205	#3-225		#3- 93	#3-164	#3-177	#4-203	#4-215	
PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF)												
NEGATIVE MOMENT												
STEEL AREA (SQ. IN.)	1.50	2.00	2.45	2.91	3.67		1.67	2.74	3.32	4.12	8.25	
ACTUAL STEEL %	0.508	0.677	0.831	0.987	1.249		0.564	0.929	1.128	1.405	2.809	
EFF. DEPTH, IN.	26.38	26.38	26.31	26.31	26.25		26.38	26.31	26.31	26.25	26.25	
$-I_{cr}/I_{gr}$	0.130	0.164	0.191	0.217	0.256		0.142	0.208	0.240	0.279	0.440	
POSITIVE MOMENT												
STEEL AREA (SQ. IN.)	1.02	1.64	1.99	2.37	2.79		1.02	1.64	1.99	2.37	2.79	
ACTUAL STEEL %	0.331	0.535	0.650	0.775	0.913		0.331	0.535	0.650	0.775	0.913	
EFF. DEPTH, IN.	26.71	26.58	26.54	26.50	26.45		26.71	26.58	26.54	26.50	26.45	
$+I_{cr}/I_{gr}$	0.120	0.186	0.221	0.259	0.299		0.120	0.186	0.221	0.259	0.299	
SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)												

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

CHAPTER 9 – SOLID TWO-WAY FLAT PLATES — SQUARE PANELS

General. The tabulated designs presented in this Chapter are for flat plates defined as solid uniform depth concrete slabs, reinforced in two directions to transfer loads directly to supporting columns without capitals, beams, or drop panels. Spandrel edges of the flat plate are assumed to extend at least to the outer face of the edge and corner columns. Where architectural or construction considerations permit cantilevered edges, this modification can be performed for moderate span cantilevers with minor adjustments of the reinforcement tabulated, and will improve the structural performance of the flat plate.

Flat Plate Advantages. The two-way flat plate is one of the most efficient structural systems for economy. Flat plates can be constructed in minimum time with minimum field labor because the flat plate utilizes the simplest possible formwork and reinforcing steel layout. Flat plates result in minimum story height for required clear headroom, and provide for greatest flexibility in layout of columns, partitions, small openings, etc. Where requirements of the project permit direct application of the ceiling finish to the flat plate soffit, elimination of ceiling construction permits additional substantial cost and construction time savings compared to other structural systems.

Flat plates have become increasingly economical and widely used as the cost of field labor has increased relative to materials. They have been applied with particular advantage to multi-story motel, hotel, hospital, dormitory, and apartment buildings. The principal limitation on use of flat plate construction is imposed by the shear area, the perimeter about the column-plus-plate depth, times the plate depth available. For industrial loads or longer spans, the solid flat slab (with capitals or drop panels or both) may be preferable. See Chapter 10. For long spans, the reduced dead load and increased stiffness of the waffle flat slab will usually result in overall economy. See Chapter 11.

Since the span and load limits for maximum economy vary with local costs and may depend upon other requirements of the project, the tabulated designs in this Handbook cover the partly overlapping practicable ranges of span and load for each of the three principal two-way structural systems.

Design Considerations. In Chapter 13 of the ACI Building Code, design requirements are combined for all types of two-way slab construction, since the fundamental behavior is the same for all. Chapter 13 applies to flat plates; flat slabs with capitals, drop panels, or both; waffle flat slabs; and two-way slabs supported on monolithic beams. The requirements for distribution of reinforcement are made dependent by elastic analysis upon the relative stiffness of all participating structural elements. Rather complex provisions for calculation of stiffness include for flat plates assumption of infinite column stiffness at the joints within the depth of the plate, increased slab stiffness within the column at the joints, and torsional stiffness of the portion of the plate within and at right angles to the width of the column. Even the *Direct Design Method* provides for adjustment of moments based on the results of three-dimensional stiffness calculations.

The most critical problem in the design, however, is not the distribution of reinforcement in the flat plate for elastic analysis. If the proper total area of reinforcement (based on M_o, the total static moment for a span) is provided, redistribution before failure load is reached will usually ensure its effectiveness. The Code permits a 10 percent adjustment of negative and positive factored moments, provided the total static moment, M_o, for a panel in the direction considered is not less than $q_u \ell_2 \ell_n^2/8$ (ACI 13.6.7). Shear transfer of gravity load and moment, however, is not capable of such redistribution. The Code requires that shear developed by transfer of balanced gravity loads be combined with shear created by transfer of a portion of the moment due to unbalanced gravity loads and horizontal forces. This shear and the transmission of remaining moment through flexure to the columns by properly anchored flexural reinforcement are the critical elements for a safe design.

All prescribed design methods, including the Direct Design Method, the Equivalent Frame Method, and the provision for use of any rational method, including limit design, consist essentially of reviewing a trial design. If additional trials are necessary due to a change in any dimension (stiffness) of any participating structural element, the entire process must be repeated. The time required for a completely manual design, probably through several trials, makes use of a computer or a computer-produced set of design tables the logical procedure for any routine structure.

Scope of Flat Plate Tabulated Designs. In this Chapter, tabulated designs for flat plates are presented for typical square exterior edge and interior floor panels. (Types E and I in location diagram, Fig. 9-1).

Corner panels (C) and first interior panels (IC, EC, IE) require combinations of appropriate exterior panel reinforcement. To present the entire range considered practicable for flat plates, complete designs are tabulated for spans from 12′-0″ to 31′-0″; factored superimposed loads from 50 psf to 350 psf; plate (slab) thicknesses from 5 to 10 inches. Minimum size square columns satisfying Code requirements for shear transfer are included with each load and span combination.

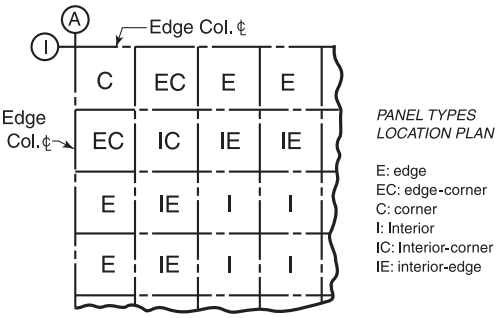
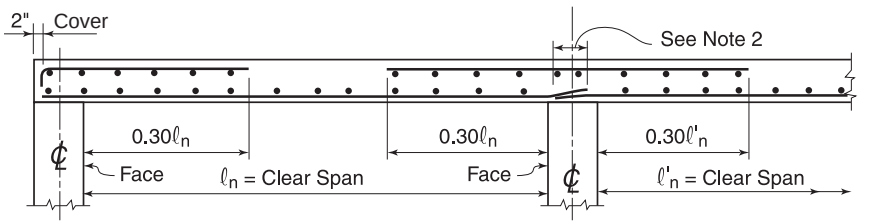


Figure 9-1 Panel Nomenclature

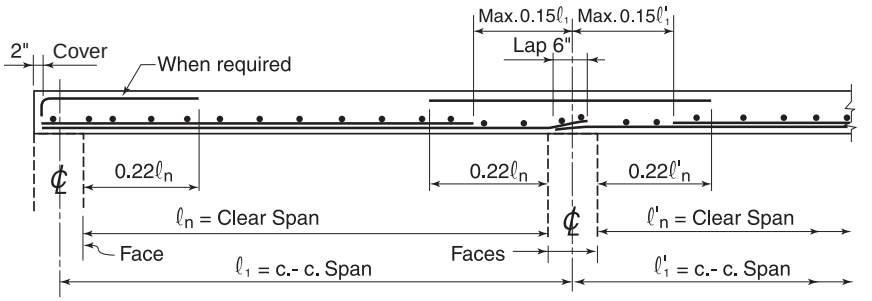
All tabulated designs conform to ACI 318 minimum requirements for shear without use of shearhead reinforcement.

To aid in quantity estimates for cost comparisons of alternative designs, concrete and reinforcing steel average quantities per square foot are given in the tabulated designs for the six panel types identified in Fig. 9-1. Reinforcing steel quantities include all reinforcement in the flat plate, except integrity steel (ACI 13.3.8.5).

Basis of Tabulated Designs. All tabulated designs are prepared for normal-weight concrete, f'_c = 4,000 psi, and Grade 60 reinforcing bars with f_y = 60,000 psi. The tabulated designs use load factors (1.2*D* and 1.6*L*) and ϕ-factors as prescribed in the 2008 Code, and follow the "Direct Design Method" of ACI 13.6. All designs tabulated satisfy the minimum thickness requirements of ACI 9.5.3.2 so that deflection calculations are not required by the Code. Crack control requirements of ACI 13.3.2 have been satisfied by the spacing of reinforcing bars. Anchorage and development requirements were applied to select bar sizes for full development when anchored and cut-off per the recommended reinforcement details. See Fig. 9-2.



(a) Column Strip



(b) Middle Strip

Notes:

1. Top bars must be concentrated within width of the column plus 1.5*h* on each side of the column (ACI 13.5.3.2 and 13.5.3.4).
2. Integrity reinforcement is required (ACI 13.3.8.5). All bottom bars in the column strip must be continuous or spliced over the support with Class B tension lap splices. At least two of the column strip bottom bars in each direction must pass within the column core and be anchored at exterior supports.

Figure 9-2 Typical Bar Length Details

The tabulated designs are applicable within the following limitations established for the Direct Design Method, Section 13.6.1:

1. Minimum of three spans continuous in each direction.
2. Ratio of panel length to width not to exceed 2.0.
3. Successive span lengths (in the same direction) to differ not more than one-third the longer span.
4. Individual column centers not to be offset more than 10 percent of the span in the direction of the offset, in either direction from the grid of lines connecting centers of successive columns.
5. Service live load cannot exceed two times service dead load (i.e., Actual loads before application of load factors).

USE OF FLAT PLATE TABULATED DESIGNS

Direct Applications Within Dimensional Limitations of Tabulated Designs. Limitations within the tables are:

1. Square column sizes as tabulated
2. Square panels
3. Minimum three panels continuous
4. Equal spans
5. Edge of slab flush with outer face of edge column
6. Live load $\leq 2 \times$ dead load (unfactored loads)
7. Uniformly distributed gravity loads only. See Section 13.6.1.5 (Code and Commentary). For lateral load analyses, see "Equivalent Frame Method," Sections 13.5.1, 13.5.3, 13.7, and Commentary Section R13.7.

Example 1: *Preliminary Selection.* Compare alternate designs in order to make a preliminary selection for a flat plate intermediate floor, which is subjected to a 100 psf superimposed factored load on square panels 20 feet center-to-center of columns. Lay out the reinforcement for the design selected.

Solution: Read "Square Edge Panel" only since minimum required size of interior columns here is less than exterior columns.

Slab Thickness, h (inches)	Min. Edge Col., $c_1 = c_2$ (inches)	Reinforcing Steel Edge Panel, E
7	20	2.04 psf
7½	18	2.08 psf
8	17	2.08 psf
8½	16	2.09 psf

If the 16-in. square column is inadequate for vertical loads from upper floors, the next choice would be the 8-in. plate with 17 in. $\times$ 17 in. square columns. If this column size proves adequate for loads from above, and the size fits architectural requirements, the tabulated designs can be used directly. Note that total reinforcing steel quantities are given for three types of exterior and interior panels. See Fig. 9-1, Panel Nomenclature. Not only should these data make preliminary estimates more accurate, but it should serve as a reminder that tabulated reinforcement for exterior panels runs both ways in corner panels and that the first interior column top bars tabulated under "Edge" panels will be used at both ends of the center panel in a three-bay frame, etc.

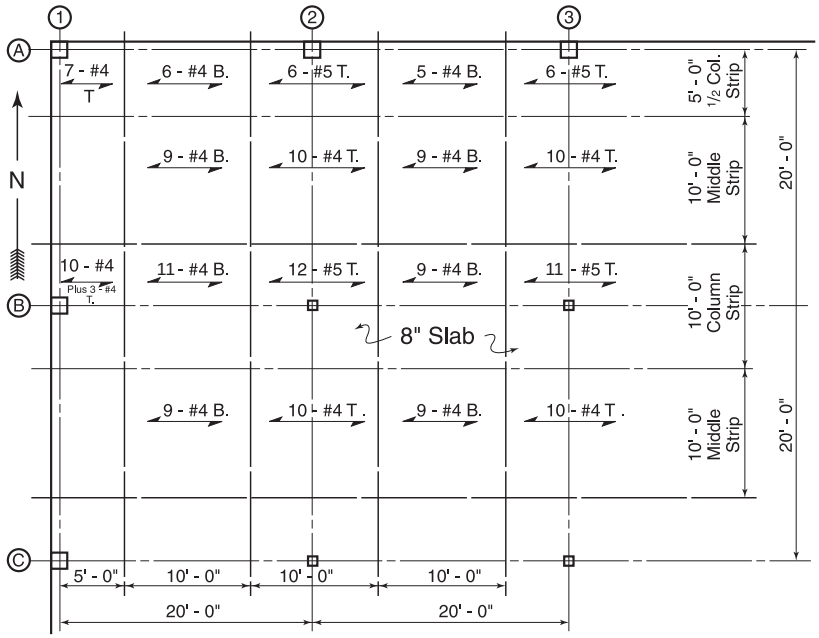


Figure 9-3 Plan – East-West Bars (North-South Bars Same) – Example 1

The reinforcement required for the 8-in. slab is listed in the tabulated design on Page 9-26. The layout of the required reinforcement is shown in Fig. 9-3. Concentration of top reinforcement over edge columns may be achieved by closer spacing within width of the column plus 1.5*h* on each side of the column (ACI 13.5.3.2). See Fig. 9-3.

Adjustment of Tabulated Designs to Project Conditions. In practice, the usual variations from the limitations of the tabulated designs will occur in one or more of the following areas:

1. Non-square panels
2. Non-equal consecutive spans
3. Minor cantilevers
4. Major cantilevers

Moment. Adjustments up to 10 percent are permitted by the Code in negative and positive factored moments, provided the total factored static moment for a span in each direction, M_o, is not reduced.

Shear. Adjustments to accomodate a number of the usual variations should not require a new shear analysis at the exterior column. Non-square panels, non-equal consecutive spans, cantilevers of any type, will generally reduce critical shear. Use of larger than minimum size square columns (where $v_c = 4\sqrt{f'_c}$), may require a new shear analysis if ACI Eq. 11-32 controls shear strength, i.e., when $(\alpha_s d/b_o + 2) < 4$. With major cantilevers, a new shear analysis will be desirable as it will usually allow use of smaller exterior columns, and facilitate use of straight bar embedment to satisfy "structural integrity" requirements of the ACI Building Code. See the "Manual Example" for the complete shear analysis required. A cantilever sufficiently loaded to develop a minimum (dead load) moment at the exterior column centerline equal to that at interior column centerlines will generally permit use of the interior span design, including the minimum size interior column.

Example 2: *Non-square Panels.* Consider the same conditions as in Example 1 (100 psf superimposed load on an intermediate floor) except with $\ell_1 = 20'\text{-}0''$; $\ell_2 = 18'\text{-}0''$. As the ratio of spans in opposite directions, ℓ_2/ℓ_1, varies from 1.0 for square panels, the ACI Building Code provides for varying distribution of moment to the column and middle strips only where beams are used.

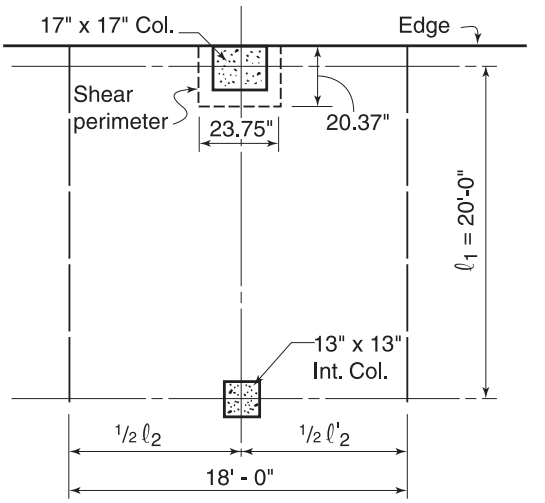
For ratios ℓ_2/ℓ_1 close to 1.0, the simplest adjustment is to provide reinforcing steel and minimum column size as tabulated for the larger span in both directions in the flat plate.

Moment – Compare tabulated reinforcing steel for $\ell_1 = 20'\text{-}0''$ and $\ell_2 = 18'\text{-}0''$ assuming square panels in both directions:

Location		$\ell_1 = 20'\text{-}0''$	$\ell_2 = 18'\text{-}0''$
End Panel			
Col. strip	Top Ext.	10-#4 plus 3-#4	9-#4 plus 3-#4
	Bot.	11-#4	8-#4
	Top Int.	12-#5	13-#4
Middle strip	Bot.	9-#4	8-#4
	Top Int.	10-#4	9-#4
Interior Panel			
Col. strip	Top	11-#5	12-#4
	Bot.	9-#4	8-#4
Middle strip	Top	10-#4	9-#4
	Bot.	9-#4	8-#4

Note that changes in reinforcement are too minor to justify making two designs for less than about this ratio of $\ell_2/\ell_1 = 18/20$. At this ratio, the reinforcing steel in the short span direction could be reduced in the bottom of the column strip in the end span; in the top of the column strip at the first interior column and at other interior columns; and by one bar at other locations. See Fig. 9-4.

Possible reduction of the size of the interior column would be too slight to justify the attempt by inspection. The exterior column dimension in the ℓ_2 direction could be reduced slightly without a new shear analysis. The



Read "Minimum Square Column"

Minimum Column	$\ell_1 = \ell_2 =$ 20′-0″	$\ell_1 = \ell_2 =$ 18′-0″
Exterior	17 in.	13 in.
Interior	13 in.	11 in.

Figure 9-4 Non-Square Panel (Example 2)

total shear and the total exterior panel moment are now reduced 18/20. It will be possible to reduce the column to 17 in. × 15 in. (c_1 = 17 in. and c_2 = 15 in.) which reduces the critical shear section area and the moment of inertia of same less than 10 percent.

Example 3: *Non-equal consecutive spans.* Exterior span ℓ_1 = 20′-0″; first interior span ℓ_1 = 18′-0″, both panels, ℓ_2 = 20′-0″. Tabulated bottom reinforcing steel does not need to be changed. Top reinforcing steel at the centerline of a common (interior) support must be that required for the larger span (ACI 13.6.3.4). Thus, top reinforcement for both column and middle strip must be provided as tabulated for the larger span. From the comparison in Example 2, provide 12-#5 bars Top in the column strip and 10-#4 bars Top in the middle strip over the first interior column centerline.

Example 4: *Minor cantilevers.* On the flat plate in Example 1, a small "eyebrow" cantilever for shade is desired, extending 4′-0″ outside the building edge which is flush with the outer face of the edge columns. The overall depth of this cantilever is 8 inches. Any cantilever will reduce the unbalanced moment to be transferred to the exterior column. For small cantilevers of this type, re-calculation of the entire column shear analysis is seldom justifiable in terms of reduced column size, savings in reinforcing steel, etc. It will usually be sufficiently accurate and always safe merely to extend all top bars from the exterior column strip straight into the cantilever and as near to the edge as concrete cover requirements permit (2 inches for exposed edges). The hooked ends of the top bars required for flush edges, see Fig. 9-2, will be eliminated as the cantilever extension gives ample development length for anchorage.

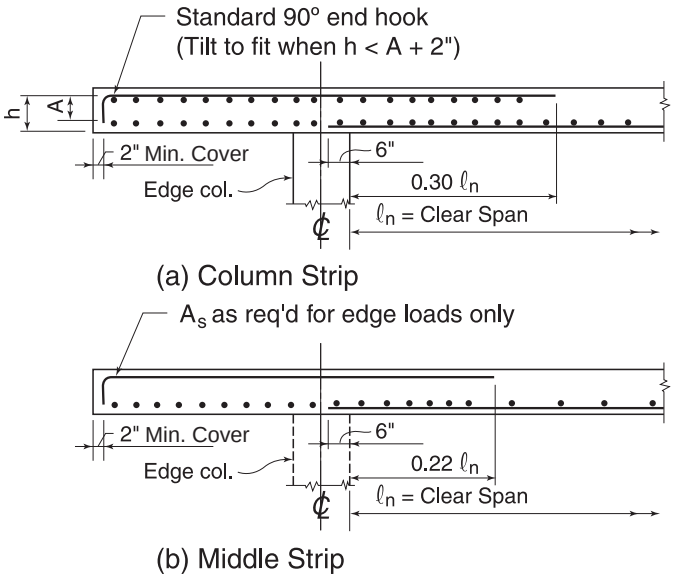


Figure 9-5 Cantilever Details

The one addition to tabulated reinforcement will be top bars into the cantilever from the middle strip. The dead load of the slab (h = 8 inches) is 100 psf. The factored dead load D = 1.2 × 100 = 120 psf. Assume the specified service live load equals 30 psf. The factored live load L = 1.6 × 30 = 48 psf. The total factored load = 120 + 48 = 168 psf. The factored moment:

$$M_u = \frac{168(4)^2}{2}(12/1000)/(10) = 161 \text{ in.-kips for the } 10'\text{-}0'' \text{ wide middle strip}$$

$$\text{Req'd } A_s = \frac{1.7 f_c' bd}{2 f_y} - \frac{1}{2}\sqrt{\frac{2.89(f_c' bd)^2}{(f_y)^2} - \frac{6.8 f_c' b M_u}{\phi (f_y)^2}}^{*}$$

$$= \frac{1.7(4)(120)(6.5)}{2(60)} - \frac{1}{2}\sqrt{\frac{2.89((4)(120)(6.5))^2}{(60)^2} - \frac{6.8(4)(120)(161)}{0.90(60)^2}}$$

$$= 0.46 \text{ in.}^2$$

Min. $A_s = 0.0018bh = (0.0018)(8)(10)(12) = 1.73$ in.^{2} at maximum spacing 5h or 18 inches.

Use 10-#4 bars spaced at 12 inches on center. These bars must extend inward beyond the outer face of the edge column only 19 inches for full development at the face of the cantilever (see Chapter 5, Table 5-2(b)), but should extend 0.22 ℓ_n into the span past the inner face of the column to ensure anchorage past the negative moment area. See Fig. 9-5. Note that these bars are marked "When required," as in this example. The Code does not require top bars at the edge of the middle strip unless cantilever, spandrel wall loads, etc., are present. Note that top and bottom bars in the ℓ_2 span half column strip are merely repeated (same size and spacing) in the cantilever.

Example 5: *Major cantilevers.* A major cantilever is defined for purposes of these examples as one that will justify a complete new shear analysis to reduce the size of the exterior column. The simplest illustration is a cantilever just sufficient to produce the same dead load moment at the edge column centerline as the minimum negative moment at an interior column. For this condition, the shear analysis at the interior column will apply and all columns, edge and interior.

* The expression is from Chapter 5.

For the design in Example 1, $\ell_1 = \ell_2 = 20'\text{-}0''$; the factored live load q_{Lu} = 100 psf; h = 8 inches; the minimum cantilever to create interior column conditions is easily calculated. See "Edge Panel" load table on Page 9-26. Read "$-M$ at 1st Interior Column"; $-M_{int}$ = 135 ft-kips. The dead load fraction of this factored moment cannot exceed

$$\frac{100 \times 1.2}{100 + 100 \times 1.2} = \frac{120}{220} \times \text{the total factored panel moment.}$$

The cantilever moment cannot exceed:

$$-M = \frac{120}{220} \times 135 = -74 \text{ ft-kips}$$

Assume the 8-in. plate thickness is unchanged in the cantilever and a light spandrel beam weighing 125 plf (factored dead load = 150 plf) is present.

$$-M_{\text{cant}} = \frac{(20)(0.120)}{2} \ell_c^2 + (20)(0.150)\,\ell_c = -74 \text{ ft-kips}$$

where ℓ_c = clear cantilever span

Solving for ℓ_c: $-M_{\text{cant}} = 1.2(\ell_c)^2 + 3.0\,\ell_c = -74$ ft-kips; ℓ_c = 6.7 feet

Caution:

The design shear strength of the concrete for two-way action is the smallest of the values computed from ACI Eqs. 11-31 to 11-33:

$$\phi V_c = \phi(2 + 4/\beta)\sqrt{f'_c}\, b_o d \quad \text{(ACI Eq. 11-31)}$$

$$\phi V_c = \phi(\alpha_s d/b_o + 2)\sqrt{f'_c}\, b_o d \quad \text{(ACI Eq. 11-32)}$$

$$\phi V_c = \phi 4\sqrt{f'_c}\, b_o d \quad \text{(ACI Eq. 11-33)}$$

Since all tabulated designs in this Chapter use square columns, the governing ϕV_c is the smaller of the values computed from Eq. 11-32 and Eq. 11-33. For two-way slab systems with rectangular columns, Eq. 11-31 must also be included in the determination of the governing value of ϕV_c. Design shear strength will be sharply reduced by Eq. 11-31, for example, in two-way slabs at long narrow (wall-like) rectangular columns. In Eq. 11-31, β = ratio of long/short sides of column. Note that nominal unit shear strength, $v_c = 4\sqrt{f'_c}$ applies up to $\beta = 2$, and that the equation gradually reduces shear strength until about equal (at section d/2 from face of support) to that for one-way shear (at section d from face of support).

ACI Eq. 11-32 accounts for a reduction in shear strength where the ratio b_o/d increases. Design shear strength, ϕV_c, of two-way slabs will be controlled by Eq. 11-32, particularly for combinations of relatively shallow slabs and large columns.

DIRECT DESIGN OF FLAT PLATES

The procedure presented in the 2008 ACI Building Code and Commentary has been used in the preparation of the tabulated designs in this Chapter. The following outline presents the major steps in this procedure:

1. Select slab thicknesses within minimum prescribed thicknesses to avoid deflection calculations. See Fig. 9-6.
2. Compute factored load $U = 1.2D + 1.6L$.
3. Select first trial square column size. A minimum of 10 inches, or previously tabulated size in table, whichever is greater.
4. Calculate the total factored static moment,

$$M_o = \frac{q_u \ell_2 (\ell_n)^2}{8} \quad \text{(ACI Eq. 13-4)}$$

5. Calculate the exterior panel moments: $-M_{int} = k_1 M_o$ and $+M = k_2 M_o$; and $-M_{ext} = k_3 M_o$.

Calculate interior panel moments: $-M = 0.65 M_o$ and $+M = 0.35 M_o$.

6. Select flexural reinforcement. Use largest size (minimum number) of reinforcing bars which will satisfy steel areas required for flexure and minimum reinforcement (for temperature and shrinkage) within maximum spacing limits. See Fig. 9-2 "Typical Bar Length Details."
7. Compute shear constants for moment transferred by eccentricity of shear at exterior and interior columns (A_c, J, C_{AB} and C_{CD}).

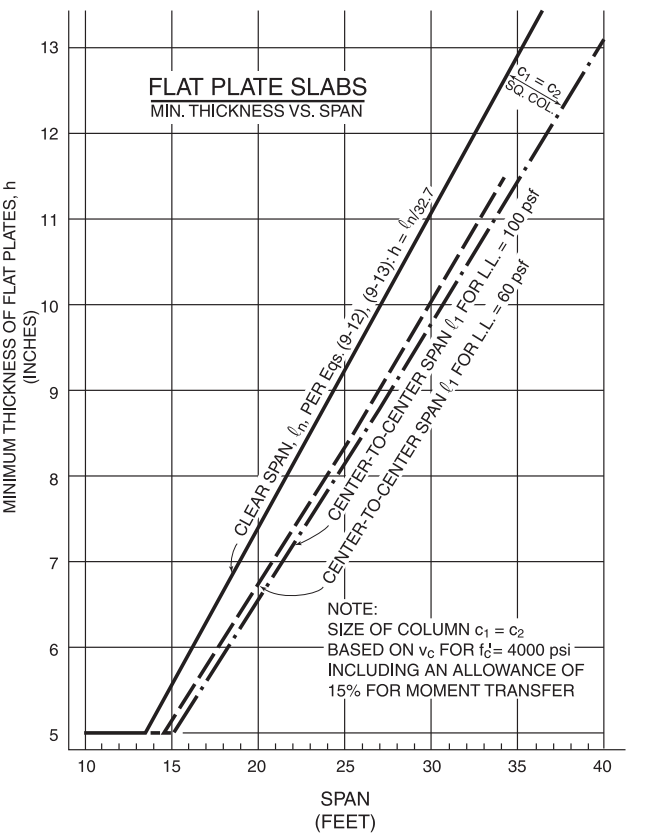


Figure 9-6 Minimum Thickness

8. Compute shear and unbalanced moment at centroid of column shear area, A_c.

9. Compute fraction of unbalanced moment transferred to column by shear, γ_v, for interior and edge columns. At edge columns, the unbalanced moment transferred by eccentricity of shear between the slab and edge column is $0.3M_o$ (ACI 13.6.3.6). At interior columns, the unbalanced moment is determined from ACI Eq. 13-7.

At interior columns, compute the maximum shear stress, v_u, for two conditions: (1) full load, and (2) maximum unbalanced moment plus load causing same. Repeat Steps 3 through 8 if necessary until $v_u \leqq v_c$ in Step 9, where v_c is based on $(\alpha_s d/b_o + 2)\sqrt{f'_c}$ or $4\sqrt{f'_c}$, whichever is smaller.

10. At exterior columns, compute the additional top reinforcement required to resist the fraction at the unbalanced moment within the "effective width" ($1.5h + C_2$) in the column strip.

11. Compute average weights of reinforcing steel (psf) for various panels.

Note on Computation Procedure. Minimum sizes of edge and interior columns were calculated separately.

ACI 318 MOMENT COEFFICIENTS FOR DISTRIBUTING M_o IN END SPAN

Coefficients for distributing M_o in an end span are given in ACI 13.6.3.3 for five conditions:

Condition / Negative and Positive Factored Moments	Exterior edge unrestrained	Slab with beams between all supports	Slab without beams between Interior supports		Exterior edge fully restrained
			Without edge beam	With edge beam	
Interior negative factored moment, k_1	0.75	0.70	0.70	0.70	0.65
Positive factored moment, k_2	0.63	0.57	0.52	0.50	0.35
Exterior negative factored moment, k_3	0.00	0.16	0.26	0.30	0.65

MANUAL EXAMPLE

Review the tabulated design for an intermediate flat plate floor, which is subjected to a superimposed factored live load of 200 psf on an 8-in. thick slab in a square panel: $\ell_1 = \ell_2 = 22'\text{-}0''$. Specified strengths of the concrete and reinforcing bars are f'_c = 4,000 psi (150 pcf) and f_y = 60,000 psi. The minimum columns shown are 30-in. square (exterior) and 26-in. square (interior).

End Span

From table on Page 9-27:

Column Strip Reinforcement:
- Top Ext = 16 - #4 bars (with 5 additional bars)
- Bottom = 12 - #5 bars
- Top 1st Int = 15 - #6 bars

Middle Strip Reinforcement:
- Bottom = 12 - #4 bars
- Top 1st Int = 11 - #4 bars

$q_u = q_{Du} + q_{Lu} = 1.2\,(100) + 200 = 320$ psf $= 0.320$ ksf

$\ell_n = 22 - (30/2 + 26/2)/12 = 19.667$ ft

$M_o = q_u \ell_2 (\ell_n)^2/8 = 0.320(22)(19.667)^2/8$
$= 340.376$ ft-kips

Factored Moments (ACI 13.6.3.3):
- Ext Col = 0.26 (340.376) = –88.498 ft-kips (tabulated: 88)
- Bottom = 0.52 (340.376) = +176.996 ft-kips (tabulated: 177)
- 1st Int Col = 0.70 (340.376) = –238.263 ft-kips (tabulated: 238)

Required Flexural Reinforcement in End Span:

$$\text{Required } A_s = \frac{1.7 f'_c bd}{2 f_y} - \frac{1}{2}\sqrt{\frac{2.89(f'_c bd)^2}{(f_y)^2} - \frac{6.8 f'_c b M_u}{\phi (f_y)^2}}$$

For f'_c = 4,000 psi, f_y = 60,000 psi, and ϕ = 0.90:

$A_s = 0.680\,d - \sqrt{0.462d^2 - 0.0252\,M_u}$

where M_u is in units of in.-kips/ft and A_s is in units of in.^{2}/ft

Slab thickness, h = 8 in.

$d = h$ – (concrete cover + d_b) = 8 – 1.5 = 6.5 in.

Exterior Column (Top Bars):

$M_u = 12\,(88.498)/11 = 96.543$ in.-kips/ft

$A_s = 0.680\,(6.5) - \sqrt{0.462\,(6.5)^2 - 0.0252\,(96.543)}$
$= 0.286$ in.^{2}/ft

$A_{s(total)} = 0.286\,(11) = 3.146$ in.^{2}

All reinforcement in column strip = 3.146 in.^{2} (tabulated: 16 - #4 bars; A_s = 3.20 in.^{2})

Verify section is tension-controlled so that $\phi = 0.90$:
From Page 5-4 with f'_c = 4,000 psi and f_y = 60,000 psi, max $\rho = 0.0181$ for $\varepsilon_t = 0.005$.

Actual $\rho = A_s/bd = \dfrac{3.20}{11(12)(6.5)} = 0.0037 < \rho_{max}$; $\phi = 0.90$

Bottom Bars:

Column strip $M_u = 0.60\ (176.996) = 106.198$ ft-kips

$M_u = 12\ (106.198)/11 = 115.852$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(115.852)}$

$= 0.346$ in.^{2}/ft

$A_{s(total)} = 0.346(11) = 3.806$ in.^{2}

(tabulated: 12 - #5 bars; $A_s = 3.72$ in.^{2})

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{3.72}{11(12)(6.5)} = 0.0043 < \rho_{max}$; $\phi = 0.90$

Middle strip $M_u = 0.40\ (176.996) = 70.798$ ft-kips

$M_u = 12(70.798)/11 = 77.234$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(77.234)}$

$= 0.228$ in.^{2}/ft

$A_{s(total)} = 0.228(11) = 2.508$ in.^{2}

(tabulated: 12 - #4 bars; $A_s = 2.40$ in.^{2})

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{2.40}{11(12)(6.5)} = 0.0028 < \rho_{max}$; $\phi = 0.90$

First Interior Column (Top Bars):

Column strip $M_u = 0.75\ (238.263) = 178.697$ ft-kips

$M_u = 12(178.697)/11 = 194.942$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(194.942)}$

$= 0.598$ in.^{2}/ft

$A_{s(total)} = 0.598(11) = 6.578$ in.^{2}

(tabulated: 15 - #6 bars; $A_s = 6.60$ in.^{2})

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{6.60}{11(12)(6.5)} = 0.0077 < \rho_{max}$; $\phi = 0.90$

Middle strip $M_u = (1–0.75)(238.263) = 59.566$ ft-kips

$M_u = 12(59.566)/11 = 64.981$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(64.981)}$

$= 0.191$ in.^{2}/ft

$A_{s(total)} = 0.191(11) = 2.101$ in.^{2}

(tabulated: 11 - #4 bars; $A_s = 2.20$ in.^{2})

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{2.20}{11(12)(6.5)} = 0.0026 < \rho_{max}$; $\phi = 0.90$

Shear Constants at Exterior Column (ACI R11.11.7.2):

$b_1 = 30 + 6.5/2 = 33.25$ in.

$b_2 = 30 + 6.5 = 36.5$ in.

$A_c = (2 \times 33.25 + 36.5)\ 6.5 = 669.5$ in.^{2}

$C_{AB} = (33.25)^2(6.5/669.5) = 10.734$ in.

$C_{CD} = 33.25 - 10.734 = 22.516$ in.

$$J = \frac{b_1 d^3}{6} + \frac{2d\,(C_{AB}^3 + C_{CD}^3)}{3} + b_2 d\, C_{AB}^2$$

$$J = \frac{33.25(6.5)^3}{6} + \frac{2(6.5)(10.734^3 + 22.516^3)}{3} + 36.5(6.5)(10.734)^2$$

$= 1{,}522 + 54{,}824 + 27{,}336$

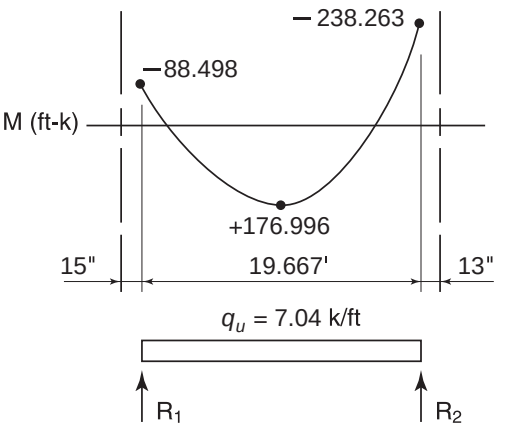
$= 83{,}682$ in.^{4}

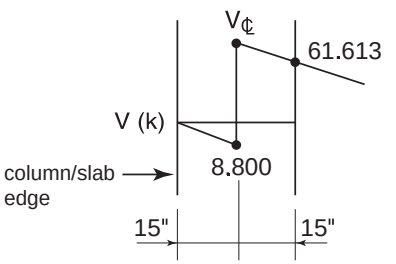
Factored Moments and Shears at Column Centerline

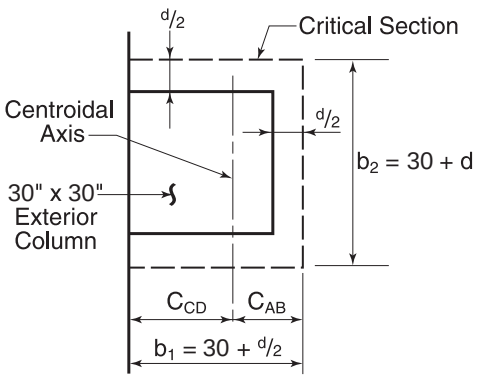
$$R_1 = \frac{7.04(19.667)}{2} - \frac{(238.263 - 88.498)}{19.667}$$

$= 69.228 - 7.615 = 61.613$ kips

$R_2 = 69.228 + 7.615 = 76.843$ kips







$V_{ext} = 61.613 + 7.04\ (30)/12 = 79.213$ kips

Unbalanced moment transferred by shear is $0.3M_o$ (ACI 13.6.3.6).

$M_{unb} = 0.3\ (340.376) = 102.113$ ft kips

$\gamma_f = 1/(1 + (2/3)\sqrt{b_1/b_2})$

$= 1/(1 + (2/3)\sqrt{33.25/36.5}) = 0.611$

$\gamma_v = 1 - \gamma_f = 1 - 0.611 = 0.389$

Maximum shear stress, v_u:

$$v_u = \frac{V_{ext}}{A_c} + \frac{\gamma_v M_{unb} C_{AB}}{J}$$

$$= \frac{79.213}{669.5} + \frac{0.389(102.113 \times 12)(10.734)}{83{,}682}$$

$= 0.118 + 0.061 = 0.179$ ksi

$b_o = 2b_1 + b_2 = 2(33.25) + 36.5 = 103.0$ in.

For square columns:

$v_c = (\alpha_s d/b_o + 2)\sqrt{f'_c} \le 4\sqrt{f'_c}$

$= [(30)(6.5)/103.0 + 2]\sqrt{f'_c} = 3.893\sqrt{f'_c} < 4\sqrt{f'_c}$

$\phi v_c = 0.75(3.893)\sqrt{4000}/1000 = 0.185$ ksi

$v_u < \phi v_c$, Okay

Determine the Number of Extra Bars Required in Column Strip at Exterior Column:

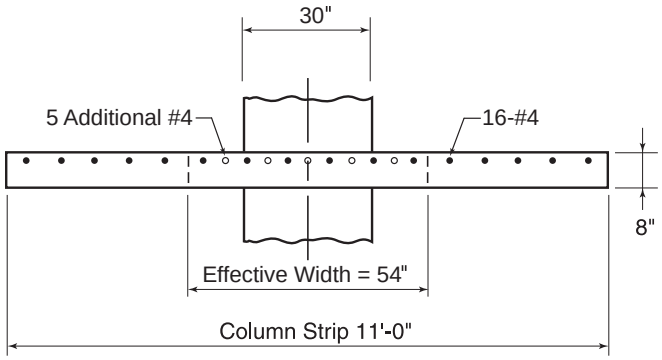
$M_{unb} = 88.498$ ft-kips

$M_u = \gamma_f M_{unb}$

$= 0.611(88.498) = 54.072$ ft-kips

"Effective Width" $= 30 + 1.5\ (8)2 = 54$ in.

Bar Layout:



Bar spacing $= 11 \times 12/16 = 8.25$ in.

Try 5 additional bars (as per tabulated design on Page 9-27) for a total of 11-#4 bars in "effective width"

$A_s = 2.20$ in.^{2} for 11-#4 bars

$a = A_s f_y/(0.85 f'_c b) = 2.20(60)/(0.85)(4)(54)$

$= 0.719$ in.

$\phi M_n = \phi A_s f_y (d - a/2)$

$= 0.90(2.20)(60)(6.5 - \frac{0.719}{2})/12$

$= 60.791$ ft-kips

$\phi M_n > \gamma_f M_{unb}$, Okay

Actual $\rho = \frac{A_s}{bd} = \frac{2.20}{54(6.5)} = 0.0063 < \rho_{max}$; $\phi = 0.90$

Interior Span

From table on Page 9-27:

Column Strip Reinforcement:
Bottom = 13-#4 bars
Top = 11-#7 bars
Middle Strip Reinforcement:
Bottom = 10-#4 bars
Top = 11-#4 bars

$q_u = 0.320$ ksf

$\ell_n = 22 - (26)/12 = 19.833$ ft

$M_o = 0.320(22)(19.833)^2/8 = 346.146$ ft-kips

Factored Moments (ACI 13.6.3.2):
Bottom $= 0.35(346.146) = 121.151$ ft-kips
Top $= 0.65(346.146) = 224.994$ ft-kips

Required Flexural Reinforcement:
$d = 6.5$ in.

Bottom Bars:
Column Strip: $M_u = 0.60(121.151)$
$= 72.691$ ft-kips

$M_u = 12(72.691)/11 = 79.299$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(79.299)}$

$= 0.232$ in.^{2}/ft

$A_{s(total)} = 0.232(11) = 2.552$ in.^{2}

(tabulated: 13-#4 bars; $A_s = 2.60$ in.^{2})

Actual $\rho = \frac{A_s}{bd} = \frac{2.60}{11(12)(6.5)} = 0.0030 < \rho_{max}$;
$\phi = 0.90$

Middle Strip: $M_u = 0.40(121.151) = 48.460$ ft-kips

$M_u = 12(48.460)/11 = 52.866$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(52.866)}$

$= 0.155$ in.^{2}/ft

$A_{s(total)} = 0.155(11) = 1.705$ in.^{2}

(tabulated: 10-#4 bars; $A_s = 2.00$ in.^{2})

Min $A_s = 0.0018\ bh = 0.0018\ (11 \times 12)(8)$

$= 1.90$ in.^{2}

Top Bars:

Column Strip: $M_u = 0.75(224.994) = 168.746$ ft-kips

$M_u = 12(168.746)/11 = 184.087$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(184.087)}$

$= 0.563$ in.^{2}/ft

$A_{s(total)} = 0.563(11) = 6.193$ in.^{2}

(tabulated: 11-#7 bars; $A_s = 6.60$ in.^{2})

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{6.60}{11(12)(6.5)} = 0.0077 < \rho_{max}$;

$\phi = 0.90$

Middle Strip: $M_u = 0.25\ (224.994) = 56.249$ ft-kips

$M_u = 12(56.249)/11 = 61.363$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(61.363)}$

$= 0.181$ in.^{2}/ft

$A_{s(total)} = 0.181(11) = 1.991$ in.^{2}

(tabulated: 11-#4 bars; $A_s = 2.20$ in.^{2})

By inspection, actual $\rho < \rho_{max}$; $\phi = 0.90$

Shear Constants:

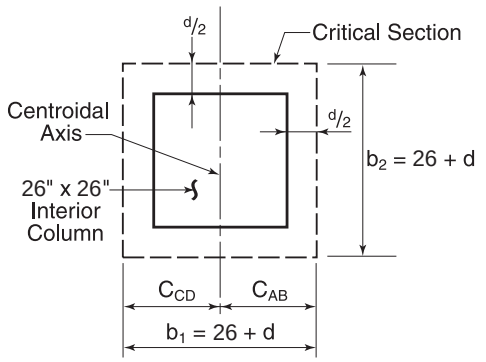
$b_1 = b_2 = 26 + 6.5 = 32.5$ in.

$A_c = 4\ (32.5)\ 6.5 = 845.0$ in.^{2}

$C_{AB} = C_{CD} = 32.5/2 = 16.25$ in.

$$J = \frac{b_1 d^3}{6} + \frac{d(b_1)^3}{6} + \frac{d(b_1)^3}{2} = \frac{d\,b_1}{6}\,(d^2 + 4\,b_1^2)$$

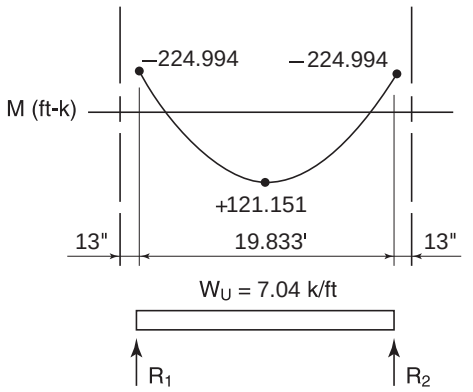
$$J = \frac{6.5\,(32.5)}{6}\,(6.5^2 + 4\,(32.5)^2) = 150{,}243 \text{ in.}^4$$



Factored Moments and Shears at Column Centerline:

$$R_1 = R_2 = 76.843 + \frac{7.04(19.833)}{2} + \frac{7.04(26)}{12}$$

$= 76.843 + 69.812 + 15.253 = 161.908$ kips



$M_{int} = 0.07\ [(q_{Du} + 0.5\ q_{Lu})\ \ell_2\ (\ell_n)^2 - q'_{Du}\ \ell'_2\ (\ell'_n)^2]$... (ACI Eq. 13-4)

Where q'_{Du}, ℓ'_2 and ℓ'_n refer to the shorter span

$M_{int} = 0.07\ [(0.120 + 0.100)(22)(19.833)^2$

$- 0.120\ (22)\ (19.833)^2]$

$= 0.07\,[1{,}903.804 - 1{,}038.438] = 60.576$ ft-kips

Maximum Shear Stress:

$b_o = 4b_1 = 4\,(32.5) = 130.0$ in.

$V_{int} = 161.908$ kips,

$M_{int} = 60.576$ ft-kips (i.e., full load on one side, dead load only on other side)

With moment, $V = q_u\ \ell/2 + q_{Du}\ \ell/2$

$= 7.04(22)/2 + 2.64(22)/2 = 106.480$ kips

$\gamma_f = 1/(1 + (2/3)\sqrt{b_1/b_2}) = 0.600$

$\gamma_v = 1 - \gamma_f = 0.400$

$$v_u = \frac{V}{A_c} + \frac{\gamma_v MC_{AB}}{J}$$

$$v_u = \frac{106.480}{845.0} + \frac{0.400\,(12 \times 60.576)\,16.25}{150{,}243}$$

$= 0.126 + 0.032 = 0.158$ ksi

$$v_c = (\alpha_s d/b_o + 2)\sqrt{f'_c} \le 4\sqrt{f'_c}$$

$$v_c = [40\ (6.5)/130.0 + 2]\sqrt{f'_c} \le 4\sqrt{f'_c}$$

$= 4\sqrt{f'_c}$

Use $v_c = 4\sqrt{f'_c}$

$\phi v_c = 0.75(4)\sqrt{4000}/1000 = 0.190$ ksi

$\phi v_c > v_u$, Okay

With $V_{int} = 161.908$ kips and $M = 0$ (i.e., full load on both sides of column)

$$v_u = \frac{V_{int}}{A_c} = \frac{161.908}{845.0} = 0.192 \text{ ksi}$$

$\phi v_c = 0.190$ ksi $\approx v_u$, Okay within 15%

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
10	5	2.94	82	1,200	3.73	130	2,100	6.75	189	5,800
	6	3.06	110	1,800	3.85	176	3,100	7.25	261	9,400
	7	3.19	140	2,600	3.96	226	4,400	7.75	341	14,100
	8	3.31	172	3,500	4.08	280	6,000	8.25	429	20,200
	9	3.44	206	4,500	4.20	338	8,000	8.75	525	28,000
	10	3.56	242	5,900	4.32	400	10,400	9.25	629	37,800
	11	3.69	280	7,400	4.44	466	13,300	9.75	741	49,700
	12	3.81	320	9,200	4.56	536	16,600	10.25	861	64,300
	13	3.94	362	11,400	4.68	610	20,600	10.75	989	81,600
	14	4.06	406	13,800	4.80	688	25,200	11.25	1,125	102,200
	15	4.19	452	16,700	4.92	770	30,500	11.75	1,269	126,400
	16	4.31	500	19,900	5.04	856	36,600	12.25	1,421	154,600
	17	4.44	550	23,600	5.16	946	43,600	12.75	1,581	187,200
	18	4.56	602	27,700	5.29	1,040	51,500	13.25	1,749	224,500
	19	4.69	656	32,400	5.41	1,138	60,400	13.75	1,925	267,200
	20	4.81	712	37,700	5.53	1,240	70,400	14.25	2,109	315,600
	21	4.94	770	43,500	5.65	1,346	81,600	14.75	2,301	370,200
	22	5.06	830	50,000	5.78	1,456	94,000	15.25	2,501	431,600
	23	5.19	892	57,200	5.90	1,570	107,800	15.75	2,709	500,200
	24	5.31	956	65,200	6.02	1,688	123,100	16.25	2,925	576,600
12	5	3.44	96	1,900	4.40	151	3,300	7.75	217	8,800
	6	3.56	128	2,800	4.51	203	4,800	8.25	297	13,700
	7	3.69	162	3,900	4.63	259	6,600	8.75	385	20,100
	8	3.81	198	5,200	4.75	319	8,900	9.25	481	28,300
	9	3.94	236	6,700	4.86	383	11,600	9.75	585	38,400
	10	4.06	276	8,400	4.98	451	14,800	10.25	697	50,900
	11	4.19	318	10,500	5.10	523	18,600	10.75	817	66,000
	12	4.31	362	12,900	5.22	599	22,900	11.25	945	84,100
	13	4.44	408	15,600	5.34	679	28,000	11.75	1,081	105,500
	14	4.56	456	18,800	5.46	763	33,900	12.25	1,225	130,500
	15	4.69	506	22,400	5.58	851	40,500	12.75	1,377	159,700
	16	4.81	558	26,400	5.70	943	48,100	13.25	1,537	193,400
	17	4.94	612	31,000	5.82	1,039	56,700	13.75	1,705	232,000
	18	5.06	668	36,100	5.94	1,139	66,300	14.25	1,881	276,000
	19	5.19	726	41,800	6.06	1,243	77,100	14.75	2,065	325,900
	20	5.31	786	48,200	6.19	1,351	89,100	15.25	2,257	382,100
	21	5.44	848	55,200	6.31	1,463	102,500	15.75	2,457	445,300
	22	5.56	912	63,000	6.43	1,579	117,200	16.25	2,665	515,800
	23	5.69	978	71,600	6.55	1,699	133,500	16.75	2,881	594,400
	24	5.81	1,046	81,000	6.67	1,823	151,500	17.25	3,105	681,500

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
14	5	3.94	110	2,900	5.06	172	4,800	8.75	245	12,600
	6	4.06	146	4,100	5.18	230	7,000	9.25	333	19,300
	7	4.19	184	5,600	5.29	292	9,500	9.75	429	27,700
	8	4.31	224	7,300	5.41	358	12,600	10.25	533	38,300
	9	4.44	266	9,400	5.53	428	16,100	10.75	645	51,200
	10	4.56	310	11,700	5.65	502	20,300	11.25	765	66,800
	11	4.69	356	14,400	5.76	580	25,200	11.75	893	85,600
	12	4.81	404	17,500	5.88	662	30,800	12.25	1,029	107,700
	13	4.94	454	21,000	6.00	748	37,100	12.75	1,173	133,600
	14	5.06	506	24,900	6.12	838	44,400	13.25	1,325	163,700
	15	5.19	560	29,400	6.24	932	52,600	13.75	1,485	198,400
	16	5.31	616	34,400	6.36	1,030	61,900	14.25	1,653	238,300
	17	5.44	674	40,000	6.48	1,132	72,300	14.75	1,829	283,600
	18	5.56	734	46,200	6.60	1,238	83,900	15.25	2,013	334,900
	19	5.69	796	53,100	6.72	1,348	96,800	15.75	2,205	392,800
	20	5.81	860	60,700	6.84	1,462	111,100	16.25	2,405	457,700
	21	5.94	926	69,100	6.96	1,580	126,900	16.75	2,613	530,100
	22	6.06	994	78,300	7.09	1,702	144,300	17.25	2,829	610,700
	23	6.19	1,064	88,400	7.21	1,828	163,400	17.75	3,053	700,100
	24	6.31	1,136	99,400	7.33	1,958	184,300	18.25	3,285	798,700
16	5	4.44	124	4,100	5.73	193	6,900	9.75	273	17,400
	6	4.56	164	5,800	5.84	257	9,800	10.25	369	26,200
	7	4.69	206	7,800	5.96	325	13,200	10.75	473	37,000
	8	4.81	250	10,100	6.07	397	17,200	11.25	585	50,400
	9	4.94	296	12,700	6.19	473	21,800	11.75	705	66,500
	10	5.06	344	15,700	6.31	553	27,100	12.25	833	85,800
	11	5.19	394	19,200	6.43	637	33,300	12.75	969	108,700
	12	5.31	446	23,000	6.54	725	40,200	13.25	1,113	135,400
	13	5.44	500	27,400	6.66	817	48,100	13.75	1,265	166,400
	14	5.56	556	32,300	6.78	913	57,100	14.25	1,425	202,200
	15	5.69	614	37,800	6.90	1,013	67,100	14.75	1,593	243,100
	16	5.81	674	43,900	7.02	1,117	78,300	15.25	1,769	289,800
	17	5.94	736	50,600	7.14	1,225	90,700	15.75	1,953	342,500
	18	6.06	800	58,100	7.26	1,337	104,600	16.25	2,145	401,900
	19	6.19	866	66,300	7.38	1,453	119,900	16.75	2,345	468,500
	20	6.31	934	75,400	7.50	1,573	136,700	17.25	2,553	542,900
	21	6.44	1,004	85,300	7.62	1,697	155,200	17.75	2,769	625,500
	22	6.56	1,076	96,100	7.74	1,825	175,500	18.25	2,993	717,000
	23	6.69	1,150	107,900	7.86	1,957	197,700	18.75	3,225	818,000
	24	6.81	1,226	120,700	7.98	2,093	221,900	19.25	3,465	929,100

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
18	5	4.94	138	5,700	6.39	214	9,400	10.75	301	23,300
	6	5.06	182	7,900	6.51	284	13,200	11.25	405	34,500
	7	5.19	228	10,500	6.62	358	17,600	11.75	517	48,200
	8	5.31	276	13,500	6.74	436	22,800	12.25	637	64,800
	9	5.44	326	16,800	6.86	518	28,700	12.75	765	84,700
	10	5.56	378	20,600	6.97	604	35,400	13.25	901	108,200
	11	5.69	432	24,900	7.09	694	43,000	13.75	1,045	135,600
	12	5.81	488	29,700	7.21	788	51,600	14.25	1,197	167,500
	13	5.94	546	35,100	7.33	886	61,200	14.75	1,357	204,300
	14	6.06	606	41,100	7.44	988	72,000	15.25	1,525	246,400
	15	6.19	668	47,700	7.56	1,094	84,100	15.75	1,701	294,200
	16	6.31	732	55,000	7.68	1,204	97,400	16.25	1,885	348,400
	17	6.44	798	63,100	7.80	1,318	112,200	16.75	2,077	409,300
	18	6.56	866	72,000	7.92	1,436	128,600	17.25	2,277	477,500
	19	6.69	936	81,700	8.04	1,558	146,500	17.75	2,485	553,700
	20	6.81	1,008	92,400	8.16	1,684	166,200	18.25	2,701	638,300
	21	6.94	1,082	104,000	8.28	1,814	187,800	18.75	2,925	731,900
	22	7.06	1,158	116,600	8.40	1,948	211,200	19.25	3,157	835,200
	23	7.19	1,236	130,300	8.52	2,086	236,800	19.75	3,397	948,800
	24	7.31	1,316	145,100	8.64	2,228	264,500	20.25	3,645	1,073,300
20	5	5.44	152	7,600	7.06	235	12,500	11.75	329	30,400
	6	5.56	200	10,500	7.17	311	17,400	12.25	441	44,500
	7	5.69	250	13,800	7.29	391	23,100	12.75	561	61,500
	8	5.81	302	17,600	7.40	475	29,500	13.25	689	81,900
	9	5.94	356	21,800	7.52	563	36,800	13.75	825	105,900
	10	6.06	412	26,500	7.64	655	45,100	14.25	969	134,100
	11	6.19	470	31,800	7.75	751	54,400	14.75	1,121	166,800
	12	6.31	530	37,700	7.87	851	64,900	15.25	1,281	204,500
	13	6.44	592	44,200	7.99	955	76,500	15.75	1,449	247,600
	14	6.56	656	51,400	8.11	1,063	89,500	16.25	1,625	296,600
	15	6.69	722	59,300	8.22	1,175	103,800	16.75	1,809	352,100
	16	6.81	790	68,000	8.34	1,291	119,600	17.25	2,001	414,500
	17	6.94	860	77,600	8.46	1,411	137,000	17.75	2,201	484,300
	18	7.06	932	88,100	8.58	1,535	156,100	18.25	2,409	562,200
	19	7.19	1,006	99,500	8.70	1,663	177,100	18.75	2,625	648,700
	20	7.31	1,082	111,900	8.82	1,795	199,900	19.25	2,849	744,400
	21	7.44	1,160	125,400	8.94	1,931	224,800	19.75	3,081	850,000
	22	7.56	1,240	139,900	9.06	2,071	251,800	20.25	3,321	966,000
	23	7.69	1,322	155,700	9.18	2,215	281,100	20.75	3,569	1,093,200
	24	7.81	1,406	172,700	9.30	2,363	312,700	21.25	3,825	1,232,200

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
22	5	5.94	166	9,900	7.73	256	16,200	12.75	357	38,900
	6	6.06	218	13,600	7.84	338	22,400	13.25	477	56,200
	7	6.19	272	17,700	7.96	424	29,500	13.75	605	77,000
	8	6.31	328	22,400	8.07	514	37,500	14.25	741	101,600
	9	6.44	386	27,600	8.19	608	46,500	14.75	885	130,400
	10	6.56	446	33,400	8.30	706	56,600	15.25	1,037	163,900
	11	6.69	508	39,800	8.42	808	67,800	15.75	1,197	202,500
	12	6.81	572	46,900	8.54	914	80,400	16.25	1,365	246,600
	13	6.94	638	54,700	8.65	1,024	94,200	16.75	1,541	296,700
	14	7.06	706	63,300	8.77	1,138	109,600	17.25	1,725	353,400
	15	7.19	776	72,700	8.89	1,256	126,500	17.75	1,917	417,200
	16	7.31	848	83,000	9.01	1,378	145,000	18.25	2,117	488,600
	17	7.44	922	94,300	9.12	1,504	165,400	18.75	2,325	568,200
	18	7.56	998	106,500	9.24	1,634	187,600	19.25	2,541	656,600
	19	7.69	1,076	119,700	9.36	1,768	211,800	19.75	2,765	754,300
	20	7.81	1,156	134,100	9.48	1,906	238,100	20.25	2,997	862,000
	21	7.94	1,238	149,600	9.60	2,048	266,600	20.75	3,237	980,400
	22	8.06	1,322	166,400	9.72	2,194	297,500	21.25	3,485	1,110,200
	23	8.19	1,408	184,500	9.84	2,344	330,800	21.75	3,741	1,251,900
	24	8.31	1,496	203,900	9.96	2,498	366,800	22.25	4,005	1,406,300
24	5	6.44	180	12,500	8.39	277	20,500	13.75	385	48,700
	6	6.56	236	17,200	8.51	365	28,300	14.25	513	69,900
	7	6.69	294	22,300	8.62	457	37,000	14.75	649	95,000
	8	6.81	354	28,000	8.74	553	46,800	15.25	793	124,300
	9	6.94	416	34,400	8.85	653	57,700	15.75	945	158,500
	10	7.06	480	41,400	8.97	757	69,800	16.25	1,105	197,900
	11	7.19	546	49,100	9.08	865	83,300	16.75	1,273	242,900
	12	7.31	614	57,600	9.20	977	98,200	17.25	1,449	294,100
	13	7.44	684	66,900	9.32	1,093	114,600	17.75	1,633	352,000
	14	7.56	756	77,000	9.43	1,213	132,600	18.25	1,825	417,100
	15	7.69	830	88,100	9.55	1,337	152,400	18.75	2,025	490,000
	16	7.81	906	100,100	9.67	1,465	174,000	19.25	2,233	571,200
	17	7.94	984	113,200	9.79	1,597	197,500	19.75	2,449	661,400
	18	8.06	1,064	127,400	9.91	1,733	223,100	20.25	2,673	761,100
	19	8.19	1,146	142,700	10.02	1,873	250,900	20.75	2,905	870,900
	20	8.31	1,230	159,200	10.14	2,017	281,000	21.25	3,145	991,600
	21	8.44	1,316	177,000	10.26	2,165	313,500	21.75	3,393	1,123,800
	22	8.56	1,404	196,200	10.38	2,317	348,600	22.25	3,649	1,268,200
	23	8.69	1,494	216,700	10.50	2,473	386,400	22.75	3,913	1,425,500
	24	8.81	1,586	238,800	10.62	2,633	427,000	23.25	4,185	1,596,400

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
26	5	6.94	194	15,700	9.06	298	25,600	14.75	413	60,100
	6	7.06	254	21,400	9.17	392	35,100	15.25	549	85,600
	7	7.19	316	27,600	9.29	490	45,700	15.75	693	115,500
	8	7.31	380	34,600	9.40	592	57,500	16.25	845	150,200
	9	7.44	446	42,200	9.52	698	70,600	16.75	1,005	190,300
	10	7.56	514	50,600	9.63	808	85,000	17.25	1,173	236,200
	11	7.69	584	59,700	9.75	922	101,000	17.75	1,349	288,400
	12	7.81	656	69,800	9.86	1,040	118,500	18.25	1,533	347,400
	13	7.94	730	80,700	9.98	1,162	137,700	18.75	1,725	413,800
	14	8.06	806	92,600	10.10	1,288	158,700	19.25	1,925	488,100
	15	8.19	884	105,500	10.21	1,418	181,700	19.75	2,133	570,900
	16	8.31	964	119,500	10.33	1,552	206,600	20.25	2,349	662,700
	17	8.44	1,046	134,600	10.45	1,690	233,700	20.75	2,573	764,300
	18	8.56	1,130	150,900	10.57	1,832	263,000	21.25	2,805	876,200
	19	8.69	1,216	168,500	10.69	1,978	294,800	21.75	3,045	999,200
	20	8.81	1,304	187,400	10.80	2,128	329,000	22.25	3,293	1,133,800
	21	8.94	1,394	207,700	10.92	2,282	365,900	22.75	3,549	1,280,800
	22	9.06	1,486	229,500	11.04	2,440	405,600	23.25	3,813	1,440,900
	23	9.19	1,580	252,800	11.16	2,602	448,200	23.75	4,085	1,614,800
	24	9.31	1,676	277,600	11.28	2,768	493,800	24.25	4,365	1,803,300
28	5	7.44	208	19,300	9.73	319	31,500	15.75	441	73,200
	6	7.56	272	26,200	9.84	419	43,000	16.25	585	103,500
	7	7.69	338	33,700	9.95	523	55,700	16.75	737	138,800
	8	7.81	406	42,000	10.07	631	69,800	17.25	897	179,500
	9	7.94	476	51,100	10.18	743	85,300	17.75	1,065	226,200
	10	8.06	548	61,000	10.30	859	102,300	18.25	1,241	279,300
	11	8.19	622	71,900	10.41	979	121,000	18.75	1,425	339,300
	12	8.31	698	83,600	10.53	1,103	141,500	19.25	1,617	406,900
	13	8.44	776	96,400	10.65	1,231	163,800	19.75	1,817	482,500
	14	8.56	856	110,200	10.76	1,363	188,200	20.25	2,025	566,800
	15	8.69	938	125,100	10.88	1,499	214,600	20.75	2,241	660,300
	16	8.81	1,022	141,300	11.00	1,639	243,200	21.25	2,465	763,700
	17	8.94	1,108	158,600	11.11	1,783	274,200	21.75	2,697	877,600
	18	9.06	1,196	177,300	11.23	1,931	307,600	22.25	2,937	1,002,600
	19	9.19	1,286	197,400	11.35	2,083	343,600	22.75	3,185	1,139,600
	20	9.31	1,378	218,900	11.47	2,239	382,400	23.25	3,441	1,289,100
	21	9.44	1,472	241,900	11.59	2,399	424,000	23.75	3,705	1,451,900
	22	9.56	1,568	266,500	11.70	2,563	468,700	24.25	3,977	1,628,800
	23	9.69	1,666	292,700	11.82	2,731	516,500	24.75	4,257	1,820,400
	24	9.81	1,766	320,700	11.94	2,903	567,600	25.25	4,545	2,027,700

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
30	5	7.94	222	23,500	10.39	340	38,200	16.75	469	88,000
	6	8.06	290	31,700	10.51	446	51,900	17.25	621	123,700
	7	8.19	360	40,700	10.62	556	67,100	17.75	781	165,000
	8	8.31	432	50,500	10.73	670	83,700	18.25	949	212,400
	9	8.44	506	61,300	10.85	788	101,900	18.75	1,125	266,300
	10	8.56	582	72,900	10.96	910	121,900	19.25	1,309	327,300
	11	8.69	660	85,500	11.08	1,036	143,600	19.75	1,501	396,000
	12	8.81	740	99,200	11.19	1,166	167,400	20.25	1,701	472,800
	13	8.94	822	114,000	11.31	1,300	193,100	20.75	1,909	558,500
	14	9.06	906	129,900	11.43	1,438	221,100	21.25	2,125	653,500
	15	9.19	992	147,100	11.54	1,580	251,300	21.75	2,349	758,700
	16	9.31	1,080	165,600	11.66	1,726	284,000	22.25	2,581	874,400
	17	9.44	1,170	185,400	11.78	1,876	319,200	22.75	2,821	1,001,600
	18	9.56	1,262	206,700	11.89	2,030	357,100	23.25	3,069	1,140,800
	19	9.69	1,356	229,400	12.01	2,188	397,800	23.75	3,325	1,292,800
	20	9.81	1,452	253,800	12.13	2,350	441,500	24.25	3,589	1,458,200
	21	9.94	1,550	279,700	12.25	2,516	488,200	24.75	3,861	1,637,900
	22	10.06	1,650	307,400	12.37	2,686	538,200	25.25	4,141	1,832,600
	23	10.19	1,752	336,800	12.49	2,860	591,600	25.75	4,429	2,043,100
	24	10.31	1,856	368,200	12.60	3,038	648,600	26.25	4,725	2,270,200
32	5	8.44	236	28,200	11.06	361	45,900	17.75	497	104,600
	6	8.56	308	37,900	11.17	473	62,100	18.25	657	146,400
	7	8.69	382	48,600	11.29	589	79,900	18.75	825	194,400
	8	8.81	458	60,100	11.40	709	99,300	19.25	1,001	249,100
	9	8.94	536	72,600	11.51	833	120,600	19.75	1,185	310,900
	10	9.06	616	86,200	11.63	961	143,800	20.25	1,377	380,600
	11	9.19	698	100,900	11.74	1,093	168,900	20.75	1,577	458,600
	12	9.31	782	116,700	11.86	1,229	196,200	21.25	1,785	545,600
	13	9.44	868	133,700	11.98	1,369	225,800	21.75	2,001	642,100
	14	9.56	956	152,000	12.09	1,513	257,700	22.25	2,225	748,800
	15	9.69	1,046	171,600	12.21	1,661	292,100	22.75	2,457	866,400
	16	9.81	1,138	192,600	12.32	1,813	329,200	23.25	2,697	995,600
	17	9.94	1,232	215,200	12.44	1,969	369,000	23.75	2,945	1,136,900
	18	10.06	1,328	239,200	12.56	2,129	411,700	24.25	3,201	1,291,200
	19	10.19	1,426	264,900	12.68	2,293	457,500	24.75	3,465	1,459,200
	20	10.31	1,526	292,300	12.79	2,461	506,500	25.25	3,737	1,641,700
	21	10.44	1,628	321,400	12.91	2,633	558,800	25.75	4,017	1,839,300
	22	10.56	1,732	352,400	13.03	2,809	614,600	26.25	4,305	2,053,000
	23	10.69	1,838	385,400	13.15	2,989	674,000	26.75	4,601	2,283,500
	24	10.81	1,946	420,300	13.27	3,173	737,300	27.25	4,905	2,531,600

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
34	5	8.94	250	33,400	11.73	382	54,400	18.75	525	123,300
	6	9.06	326	44,900	11.84	500	73,500	19.25	693	171,800
	7	9.19	404	57,400	11.95	622	94,200	19.75	869	227,100
	8	9.31	484	70,800	12.07	748	116,900	20.25	1,053	289,700
	9	9.44	566	85,400	12.18	878	141,500	20.75	1,245	360,300
	10	9.56	650	101,100	12.29	1,012	168,100	21.25	1,445	439,400
	11	9.69	736	117,900	12.41	1,150	197,000	21.75	1,653	527,500
	12	9.81	824	136,100	12.52	1,292	228,200	22.25	1,869	625,400
	13	9.94	914	155,500	12.64	1,438	261,900	22.75	2,093	733,700
	14	10.06	1,006	176,400	12.76	1,588	298,200	23.25	2,325	853,000
	15	10.19	1,100	198,700	12.87	1,742	337,100	23.75	2,565	984,000
	16	10.31	1,196	222,500	12.99	1,900	379,000	24.25	2,813	1,127,500
	17	10.44	1,294	248,000	13.11	2,062	423,800	24.75	3,069	1,284,000
	18	10.56	1,394	275,100	13.22	2,228	471,800	25.25	3,333	1,454,500
	19	10.69	1,496	303,900	13.34	2,398	523,000	25.75	3,605	1,639,600
	20	10.81	1,600	334,600	13.46	2,572	577,700	26.25	3,885	1,840,100
	21	10.94	1,706	367,200	13.57	2,750	636,000	26.75	4,173	2,056,800
	22	11.06	1,814	401,800	13.69	2,932	698,000	27.25	4,469	2,290,600
	23	11.19	1,924	438,500	13.81	3,118	764,000	27.75	4,773	2,542,300
	24	11.31	2,036	477,300	13.93	3,308	834,000	28.25	5,085	2,812,700
36	5	9.44	264	39,400	12.39	403	64,000	19.75	553	144,100
	6	9.56	344	52,800	12.50	527	86,100	20.25	729	199,900
	7	9.69	426	67,200	12.62	655	110,200	20.75	913	263,200
	8	9.81	510	82,800	12.73	787	136,300	21.25	1,105	334,600
	9	9.94	596	99,500	12.85	923	164,600	21.75	1,305	414,600
	10	10.06	684	117,500	12.96	1,063	195,200	22.25	1,513	503,900
	11	10.19	774	136,800	13.08	1,207	228,100	22.75	1,729	603,100
	12	10.31	866	157,500	13.19	1,355	263,600	23.25	1,953	712,800
	13	10.44	960	179,600	13.31	1,507	301,800	23.75	2,185	833,700
	14	10.56	1,056	203,300	13.42	1,663	342,800	24.25	2,425	966,500
	15	10.69	1,154	228,500	13.54	1,823	386,700	24.75	2,673	1,111,900
	16	10.81	1,254	255,400	13.65	1,987	433,700	25.25	2,929	1,270,600
	17	10.94	1,356	284,000	13.77	2,155	483,900	25.75	3,193	1,443,400
	18	11.06	1,460	314,400	13.89	2,327	537,600	26.25	3,465	1,631,000
	19	11.19	1,566	346,700	14.00	2,503	594,700	26.75	3,745	1,834,300
	20	11.31	1,674	381,000	14.12	2,683	655,600	27.25	4,033	2,054,000
	21	11.44	1,784	417,300	14.24	2,867	720,200	27.75	4,329	2,291,000
	22	11.56	1,896	455,700	14.36	3,055	788,900	28.25	4,633	2,546,100
	23	11.69	2,010	496,400	14.47	3,247	861,800	28.75	4,945	2,820,100
	24	11.81	2,126	539,300	14.59	3,443	939,000	29.25	5,265	3,114,100

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
38	5	9.94	278	45,900	13.06	424	74,600	20.75	581	167,100
	6	10.06	362	61,400	13.17	554	100,200	21.25	765	230,900
	7	10.19	448	78,100	13.28	688	127,900	21.75	957	303,000
	8	10.31	536	96,000	13.40	826	157,900	22.25	1,157	383,900
	9	10.44	626	115,200	13.51	968	190,200	22.75	1,365	474,200
	10	10.56	718	135,700	13.63	1,114	224,900	23.25	1,581	574,500
	11	10.69	812	157,700	13.74	1,264	262,400	23.75	1,805	685,500
	12	10.81	908	181,100	13.86	1,418	302,500	24.25	2,037	807,900
	13	10.94	1,006	206,200	13.97	1,576	345,600	24.75	2,277	942,400
	14	11.06	1,106	232,800	14.09	1,738	391,700	25.25	2,525	1,089,700
	15	11.19	1,208	261,200	14.20	1,904	440,900	25.75	2,781	1,250,400
	16	11.31	1,312	291,400	14.32	2,074	493,500	26.25	3,045	1,425,500
	17	11.44	1,418	323,400	14.43	2,248	549,600	26.75	3,317	1,615,600
	18	11.56	1,526	357,400	14.55	2,426	609,300	27.25	3,597	1,821,500
	19	11.69	1,636	393,400	14.67	2,608	672,800	27.75	3,885	2,044,000
	20	11.81	1,748	431,500	14.79	2,794	740,200	28.25	4,181	2,284,100
	21	11.94	1,862	471,800	14.90	2,984	811,800	28.75	4,485	2,542,500
	22	12.06	1,978	514,400	15.02	3,178	887,600	29.25	4,797	2,820,100
	23	12.19	2,096	559,300	15.14	3,376	967,900	29.75	5,117	3,117,800
	24	12.31	2,216	606,700	15.26	3,578	1,052,800	30.25	5,445	3,436,500
40	5	10.44	292	53,200	13.72	445	86,400	21.75	609	192,400
	6	10.56	380	71,000	13.84	581	115,700	22.25	801	265,000
	7	10.69	470	90,100	13.95	721	147,400	22.75	1,001	346,600
	8	10.81	562	110,500	14.06	865	181,600	23.25	1,209	437,800
	9	10.94	656	132,400	14.18	1,013	218,200	23.75	1,425	539,200
	10	11.06	752	155,700	14.29	1,165	257,600	24.25	1,649	651,400
	11	11.19	850	180,600	14.41	1,321	299,900	24.75	1,881	775,200
	12	11.31	950	207,000	14.52	1,481	345,100	25.25	2,121	911,300
	13	11.44	1,052	235,200	14.64	1,645	393,400	25.75	2,369	1,060,300
	14	11.56	1,156	265,200	14.75	1,813	445,000	26.25	2,625	1,222,900
	15	11.69	1,262	297,000	14.87	1,985	500,100	26.75	2,889	1,400,100
	16	11.81	1,370	330,700	14.98	2,161	558,700	27.25	3,161	1,592,500
	17	11.94	1,480	366,400	15.10	2,341	621,000	27.75	3,441	1,801,000
	18	12.06	1,592	404,200	15.22	2,525	687,200	28.25	3,729	2,026,300
	19	12.19	1,706	444,200	15.33	2,713	757,500	28.75	4,025	2,269,300
	20	12.31	1,822	486,400	15.45	2,905	832,000	29.25	4,329	2,530,900
	21	12.44	1,940	531,000	15.57	3,101	910,900	29.75	4,641	2,811,900
	22	12.56	2,060	578,000	15.68	3,301	994,400	30.25	4,961	3,113,300
	23	12.69	2,182	627,500	15.80	3,505	1,082,600	30.75	5,289	3,435,900
	24	12.81	2,306	679,600	15.92	3,713	1,175,700	31.25	5,625	3,780,800

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
42	5	10.94	306	61,200	14.39	466	99,300	22.75	637	220,100
	6	11.06	398	81,600	14.50	608	132,800	23.25	837	302,300
	7	11.19	492	103,300	14.62	754	168,800	23.75	1,045	394,300
	8	11.31	588	126,500	14.73	904	207,500	24.25	1,261	496,600
	9	11.44	686	151,200	14.84	1,058	249,000	24.75	1,485	609,900
	10	11.56	786	177,600	14.96	1,216	293,400	25.25	1,717	735,000
	11	11.69	888	205,600	15.07	1,378	340,800	25.75	1,957	872,400
	12	11.81	992	235,300	15.19	1,544	391,500	26.25	2,205	1,023,100
	13	11.94	1,098	266,900	15.30	1,714	445,600	26.75	2,461	1,187,600
	14	12.06	1,206	300,400	15.42	1,888	503,100	27.25	2,725	1,366,700
	15	12.19	1,316	335,800	15.53	2,066	564,400	27.75	2,997	1,561,300
	16	12.31	1,428	373,400	15.65	2,248	629,400	28.25	3,277	1,772,200
	17	12.44	1,542	413,100	15.76	2,434	698,500	28.75	3,565	2,000,200
	18	12.56	1,658	455,000	15.88	2,624	771,700	29.25	3,861	2,246,000
	19	12.69	1,776	499,200	16.00	2,818	849,200	29.75	4,165	2,510,700
	20	12.81	1,896	545,900	16.11	3,016	931,300	30.25	4,477	2,795,000
	21	12.94	2,018	595,000	16.23	3,218	1,018,000	30.75	4,797	3,099,900
	22	13.06	2,142	646,700	16.35	3,424	1,109,600	31.25	5,125	3,426,300
	23	13.19	2,268	701,100	16.46	3,634	1,206,200	31.75	5,461	3,775,200
	24	13.31	2,396	758,300	16.58	3,848	1,308,000	32.25	5,805	4,147,500
44	5	11.44	320	70,000	15.06	487	113,500	23.75	665	250,400
	6	11.56	416	93,100	15.17	635	151,500	24.25	873	343,000
	7	11.69	514	117,700	15.28	787	192,200	24.75	1,089	446,100
	8	11.81	614	143,900	15.40	943	235,800	25.25	1,313	560,400
	9	11.94	716	171,800	15.51	1,103	282,500	25.75	1,545	686,600
	10	12.06	820	201,400	15.62	1,267	332,300	26.25	1,785	825,400
	11	12.19	926	232,800	15.74	1,435	385,400	26.75	2,033	977,500
	12	12.31	1,034	266,100	15.85	1,607	442,000	27.25	2,289	1,143,700
	13	12.44	1,144	301,300	15.97	1,783	502,100	27.75	2,553	1,324,700
	14	12.56	1,256	338,600	16.08	1,963	566,100	28.25	2,825	1,521,400
	15	12.69	1,370	378,000	16.20	2,147	634,000	28.75	3,105	1,734,600
	16	12.81	1,486	419,700	16.31	2,335	706,000	29.25	3,393	1,965,000
	17	12.94	1,604	463,600	16.43	2,527	782,200	29.75	3,689	2,213,600
	18	13.06	1,724	509,900	16.55	2,723	862,900	30.25	3,993	2,481,200
	19	13.19	1,846	558,700	16.66	2,923	948,200	30.75	4,305	2,768,700
	20	13.31	1,970	610,100	16.78	3,127	1,038,300	31.25	4,625	3,077,000
	21	13.44	2,096	664,100	16.90	3,335	1,133,300	31.75	4,953	3,407,100
	22	13.56	2,224	720,800	17.01	3,547	1,233,600	32.25	5,289	3,759,900
	23	13.69	2,354	780,400	17.13	3,763	1,339,100	32.75	5,633	4,136,300
	24	13.81	2,486	843,000	17.25	3,983	1,450,200	33.25	5,985	4,537,400

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
46	5	11.94	334	79,600	15.72	508	128,900	24.75	693	283,400
	6	12.06	434	105,700	15.84	662	171,800	25.25	909	387,100
	7	12.19	536	133,400	15.95	820	217,700	25.75	1,133	502,300
	8	12.31	640	162,900	16.06	982	266,700	26.25	1,365	629,400
	9	12.44	746	194,100	16.18	1,148	318,900	26.75	1,605	769,400
	10	12.56	854	227,300	16.29	1,318	374,500	27.25	1,853	922,900
	11	12.69	964	262,300	16.40	1,492	433,700	27.75	2,109	1,090,600
	12	12.81	1,076	299,400	16.52	1,670	496,600	28.25	2,373	1,273,400
	13	12.94	1,190	338,600	16.63	1,852	563,400	28.75	2,645	1,472,100
	14	13.06	1,306	380,000	16.75	2,038	634,200	29.25	2,925	1,687,400
	15	13.19	1,424	423,600	16.86	2,228	709,200	29.75	3,213	1,920,200
	16	13.31	1,544	469,700	16.98	2,422	788,500	30.25	3,509	2,171,400
	17	13.44	1,666	518,100	17.10	2,620	872,500	30.75	3,813	2,441,800
	18	13.56	1,790	569,100	17.21	2,822	961,100	31.25	4,125	2,732,300
	19	13.69	1,916	622,800	17.33	3,028	1,054,700	31.75	4,445	3,043,900
	20	13.81	2,044	679,200	17.44	3,238	1,153,300	32.25	4,773	3,377,500
	21	13.94	2,174	738,400	17.56	3,452	1,257,200	32.75	5,109	3,734,100
	22	14.06	2,306	800,500	17.68	3,670	1,366,600	33.25	5,453	4,114,600
	23	14.19	2,440	865,600	17.79	3,892	1,481,600	33.75	5,805	4,520,000
	24	14.31	2,576	933,900	17.91	4,118	1,602,500	34.25	6,165	4,951,300
48	5	12.44	348	90,000	16.39	529	145,700	25.75	721	319,100
	6	12.56	452	119,300	16.50	689	193,900	26.25	945	434,900
	7	12.69	558	150,500	16.62	853	245,300	26.75	1,177	563,000
	8	12.81	666	183,500	16.73	1,021	300,000	27.25	1,417	704,000
	9	12.94	776	218,400	16.84	1,193	358,300	27.75	1,665	858,700
	10	13.06	888	255,300	16.96	1,369	420,200	28.25	1,921	1,027,800
	11	13.19	1,002	294,300	17.07	1,549	485,900	28.75	2,185	1,212,200
	12	13.31	1,118	335,400	17.19	1,733	555,600	29.25	2,457	1,412,700
	13	13.44	1,236	378,900	17.30	1,921	629,400	29.75	2,737	1,630,000
	14	13.56	1,356	424,600	17.41	2,113	707,500	30.25	3,025	1,865,100
	15	13.69	1,478	472,800	17.53	2,309	790,100	30.75	3,321	2,118,700
	16	13.81	1,602	523,500	17.64	2,509	877,400	31.25	3,625	2,391,800
	17	13.94	1,728	576,800	17.76	2,713	969,500	31.75	3,937	2,685,200
	18	14.06	1,856	632,900	17.88	2,921	1,066,600	32.25	4,257	3,000,000
	19	14.19	1,986	691,700	17.99	3,133	1,168,900	32.75	4,585	3,337,000
	20	14.31	2,118	753,400	18.11	3,349	1,276,700	33.25	4,921	3,697,200
	21	14.44	2,252	818,100	18.22	3,569	1,390,000	33.75	5,265	4,081,500
	22	14.56	2,388	885,900	18.34	3,793	1,509,000	34.25	5,617	4,491,100
	23	14.69	2,526	956,900	18.46	4,021	1,634,100	34.75	5,977	4,926,900
	24	14.81	2,666	1,031,200	18.57	4,253	1,765,300	35.25	6,345	5,389,900

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL															SQUARE INTERIOR PANEL									
SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superimposed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2) Span c.-c.	(3)	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf)		
							Each Column Strip			Each Middle Strip		Steel (psf)						Column Strip		Middle Strip		Location of Panel		
				–M Ext.	+M Int.	–M 1st int.	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Location of Panel						Top	Bottom	Top	Bottom			
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)						E	EC	C	(ft)	(psf)	(in.)					I	IE	IC
5 in. = TOTAL THICKNESS OF SLAB														0.417 c.f./s.f.	5 in. = TOTAL THICKNESS OF SLAB									0.417 c.f./s.f.
12	50	10	0.831	6	12	16	10-#4 0	8-#3	10-#4	8-#3	8-#4	1.96	1.96	1.94	12	50	10	10-#4	8-#3	8-#4	8-#3	1.99	1.99	1.99
12	100	10	0.870	8	17	23	10-#4 0	8-#3	10-#4	8-#3	8-#4	1.97	1.97	1.95	12	100	11	10-#4	8-#3	8-#4	8-#3	2.00	2.00	2.00
12	150	12	0.845	11	21	29	10-#4 0	8-#3	10-#4	8-#3	8-#4	1.97	1.97	1.94	12	150	12	10-#4	8-#3	8-#4	8-#3	2.00	2.00	2.00
12	200	15	0.778	13	25	34	10-#4 0	9-#3	10-#4	8-#3	8-#4	2.00	2.00	1.97	12	200	13	10-#4	8-#3	8-#4	8-#3	2.01	2.01	2.01
12	250	17	0.778	14	29	39	10-#4 0	10-#3	10-#4	8-#3	8-#4	2.04	2.04	2.04	12	250	16	10-#4	8-#3	8-#4	8-#3	2.03	2.03	2.03
12	300	21	0.725	15	31	41	10-#4 0	11-#3	10-#4	8-#3	8-#4	2.11	2.11	2.14	12	300	21	10-#4	8-#3	8-#4	8-#3	2.06	2.06	2.06
13	50	10	0.861	8	16	21	11-#4 0	8-#3	11-#4	8-#3	8-#4	1.86	1.86	1.83	13	50	10	11-#4	8-#3	8-#4	8-#3	1.90	1.90	1.90
13	100	12	0.855	11	21	29	11-#4 1	8-#3	11-#4	8-#3	8-#4	1.86	1.86	1.82	13	100	11	11-#4	8-#3	8-#4	8-#3	1.90	1.90	1.90
13	150	14	0.825	13	27	36	11-#4 0	9-#3	11-#4	8-#3	8-#4	1.92	1.92	1.92	13	150	12	11-#4	8-#3	8-#4	8-#3	1.91	1.91	1.91
13	200	18	0.769	16	31	42	11-#4 0	11-#3	11-#4	8-#3	8-#4	1.99	1.99	2.01	13	200	16	11-#4	8-#3	8-#4	8-#3	1.93	1.93	1.93
13	250	22	0.730	17	34	46	11-#4 0	12-#3	12-#4	8-#3	8-#4	2.04	2.05	2.15	13	250	22	11-#4	8-#3	8-#4	8-#3	1.97	1.98	2.00
13	300	27	0.657	18	36	49	11-#4 0	12-#3	12-#4	8-#3	8-#4	2.08	2.08	2.19	13	300	28	11-#4	8-#3	8-#4	8-#3	2.00	2.02	2.04
14	50	10	0.888	10	20	27	12-#4 0	9-#3	12-#4	9-#3	9-#4	1.95	1.95	1.92	14	50	10	12-#4	9-#3	9-#4	9-#3	1.97	1.97	1.97
14	100	14	0.818	13	27	36	12-#4 0	9-#3	12-#4	9-#3	9-#4	1.95	1.95	1.92	14	100	11	12-#4	9-#3	9-#4	9-#3	1.98	1.97	1.97
14	150	18	0.787	16	33	44	12-#4 1	11-#3	12-#4	9-#3	9-#4	2.03	2.03	2.01	14	150	14	12-#4	9-#3	9-#4	9-#3	1.99	1.99	1.99
14	200	23	0.714	19	37	50	12-#4 0	13-#3	13-#4	9-#3	9-#4	2.14	2.14	2.17	14	200	21	12-#4	9-#3	9-#4	9-#3	2.03	2.05	2.06
14	250	28	0.657	20	40	54	12-#4 0	14-#3	14-#4	9-#3	9-#4	2.20	2.21	2.29	14	250	28	13-#4	9-#3	9-#4	9-#3	2.13	2.15	2.17
14	300	32	0.634	21	43	58	12-#4 0	9-#4	15-#4	10-#3	9-#4	2.32	2.35	2.44	14	300	35	13-#4	10-#3	9-#4	9-#3	2.21	2.25	2.28
15	50	12	0.849	12	24	33	12-#4 0	9-#3	12-#4	9-#3	9-#4	1.83	1.83	1.83	15	50	10	12-#4	9-#3	9-#4	9-#3	1.83	1.83	1.83
15	100	16	0.804	16	33	44	12-#4 1	11-#3	12-#4	9-#3	9-#4	1.91	1.91	1.93	15	100	12	12-#4	9-#3	9-#4	9-#3	1.84	1.84	1.84
15	150	22	0.736	19	39	52	12-#4 1	13-#3	13-#4	9-#3	9-#4	1.99	1.99	2.03	15	150	19	12-#4	9-#3	9-#4	9-#3	1.88	1.89	1.91
15	200	27	0.671	22	44	59	12-#4 0	9-#4	15-#4	10-#3	9-#4	2.16	2.18	2.29	15	200	27	14-#4	10-#3	9-#4	9-#3	2.07	2.09	2.10
15	250	33	0.606	23	47	63	12-#4 0	9-#4	16-#4	11-#3	9-#4	2.29	2.31	2.46	15	250	35	15-#4	11-#3	9-#4	9-#3	2.22	2.24	2.26
15	300	39	0.605	25	49	67	12-#4 0	10-#4	17-#4	11-#3	9-#4	2.38	2.41	2.57	15	300	42	15-#4	11-#3	9-#4	9-#3	2.26	2.29	2.33
16	50	14	0.842	15	29	39	13-#4 2	10-#3	13-#4	10-#3	10-#4	1.86	1.86	1.84	16	50	10	13-#4	10-#3	10-#4	10-#3	1.88	1.88	1.87
16	100	19	0.785	19	39	52	13-#4 1	13-#3	13-#4	10-#3	10-#4	1.94	1.93	1.95	16	100	15	13-#4	10-#3	10-#4	10-#3	1.90	1.90	1.90
16	150	26	0.706	23	45	61	13-#4 1	15-#3	15-#4	10-#3	10-#4	2.08	2.09	2.18	16	150	24	14-#4	10-#3	10-#4	10-#3	2.00	2.01	2.02
16	200	33	0.606	25	50	68	13-#4 0	10-#4	17-#4	11-#3	10-#4	2.24	2.26	2.38	16	200	33	16-#4	11-#3	10-#4	10-#3	2.20	2.21	2.23
16	250	39	0.605	27	54	73	13-#4 0	18-#3	18-#4	12-#3	10-#4	2.36	2.38	2.51	16	250	42	17-#4	12-#3	10-#4	10-#3	2.34	2.35	2.37
16	300	45	0.604	28	57	76	13-#4 0	11-#4	13-#5	13-#3	10-#4	2.51	2.54	2.67	16	300	50	17-#4	12-#3	10-#4	10-#3	2.38	2.43	2.48

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL															SQUARE INTERIOR PANEL									
SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2)	(3)	(1)	Reinforcing Bars				Steel (psf)		
							Each Column Strip			Each Middle Strip		Steel (psf)						Column Strip		Middle Strip		Location of Panel		
				–M Ext.	+M Int.	–M 1st int.						Location of Panel												
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C	Span c.-c. (ft)	Load (psf)	Min. Sq. Col. (in.)	Top	Bottom	Top	Bottom	I	IE	IC
5.5 in. = TOTAL THICKNESS OF SLAB											0.458 c.f./s.f.				5.5 in. = TOTAL THICKNESS OF SLAB									0.458 c.f./s.f.
12	50	10	0.791	6	13	17	9-#4 0	7-#3	9-#4	7-#3	7-#4	1.74	1.74	1.71	12	50	10	9-#4	7-#3	7-#4	7-#3	1.78	1.78	1.78
12	100	10	0.830	9	18	24	9-#4 0	7-#3	9-#4	7-#3	7-#4	1.75	1.75	1.71	12	100	11	9-#4	7-#3	7-#4	7-#3	1.78	1.78	1.78
12	150	11	0.833	11	22	30	9-#4 0	7-#3	9-#4	7-#3	7-#4	1.79	1.79	1.79	12	150	13	9-#4	7-#3	7-#4	7-#3	1.79	1.79	1.80
12	200	13	0.817	13	26	35	9-#4 1	8-#3	9-#4	7-#3	7-#4	1.82	1.82	1.87	12	200	14	9-#4	7-#3	7-#4	7-#3	1.80	1.80	1.80
12	250	15	0.782	15	30	40	9-#4 1	9-#3	9-#4	7-#3	7-#4	1.85	1.85	1.89	12	250	15	9-#4	7-#3	7-#4	7-#3	1.81	1.81	1.81
12	300	17	0.718	17	34	46	9-#4 0	10-#3	10-#4	7-#3	7-#4	1.92	1.93	1.98	12	300	15	9-#4	7-#3	7-#4	7-#3	1.81	1.82	1.84
13	50	10	0.827	8	17	22	10-#4 0	8-#3	10-#4	8-#3	8-#4	1.78	1.78	1.74	13	50	10	10-#4	8-#3	8-#4	8-#3	1.83	1.83	1.83
13	100	10	0.869	11	23	31	10-#4 0	8-#3	10-#4	8-#3	8-#4	1.79	1.79	1.74	13	100	11	10-#4	8-#3	8-#4	8-#3	1.84	1.84	1.84
13	150	13	0.810	14	28	38	10-#4 0	8-#3	10-#4	8-#3	8-#4	1.82	1.82	1.79	13	150	13	10-#4	8-#3	8-#4	8-#3	1.85	1.85	1.85
13	200	15	0.782	17	33	45	10-#4 0	10-#3	10-#4	8-#3	8-#4	1.87	1.87	1.89	13	200	14	10-#4	8-#3	8-#4	8-#3	1.85	1.85	1.85
13	250	17	0.775	19	38	51	10-#4 1	11-#3	11-#4	8-#3	8-#4	1.92	1.93	1.93	13	250	16	10-#4	8-#3	8-#4	8-#3	1.87	1.88	1.90
13	300	21	0.720	21	41	55	10-#4 1	12-#3	12-#4	8-#3	8-#4	2.02	2.02	2.10	13	300	20	11-#4	8-#3	8-#4	8-#3	1.96	1.97	1.99
14	50	10	0.859	10	21	28	11-#4 0	8-#3	11-#4	8-#3	8-#4	1.72	1.72	1.70	14	50	10	11-#4	8-#3	8-#4	8-#3	1.76	1.76	1.76
14	100	12	0.855	14	28	38	11-#4 1	9-#3	11-#4	8-#3	8-#4	1.75	1.75	1.72	14	100	11	11-#4	8-#3	8-#4	8-#3	1.76	1.76	1.76
14	150	15	0.789	17	35	47	11-#4 0	10-#3	11-#4	8-#3	8-#4	1.78	1.78	1.78	14	150	13	11-#4	8-#3	8-#4	8-#3	1.77	1.77	1.77
14	200	18	0.738	20	41	55	11-#4 0	12-#3	12-#4	8-#3	8-#4	1.88	1.88	2.00	14	200	15	11-#4	8-#3	8-#4	8-#3	1.78	1.80	1.81
14	250	22	0.695	23	45	61	11-#4 0	8-#4	13-#4	9-#3	8-#4	2.01	2.03	2.16	14	250	21	12-#4	9-#3	8-#4	8-#3	1.93	1.94	1.96
14	300	26	0.653	24	48	65	11-#4 0	8-#4	14-#4	10-#3	8-#4	2.13	2.14	2.28	14	300	27	13-#4	10-#3	8-#4	8-#3	2.06	2.08	2.09
15	50	11	0.858	13	26	35	11-#4 1	9-#3	11-#4	9-#3	9-#4	1.77	1.77	1.76	15	50	10	11-#4	9-#3	9-#4	9-#3	1.78	1.78	1.78
15	100	14	0.830	17	35	47	11-#4 2	10-#3	11-#4	9-#3	9-#4	1.80	1.80	1.82	15	100	11	11-#4	9-#3	9-#4	9-#3	1.78	1.78	1.78
15	150	17	0.751	21	43	57	11-#4 0	13-#3	12-#4	9-#3	9-#4	1.90	1.90	1.95	15	150	14	12-#4	9-#3	9-#4	9-#3	1.85	1.85	1.85
15	200	22	0.683	24	48	65	11-#4 0	14-#3	14-#4	10-#3	9-#4	2.02	2.04	2.12	15	200	20	13-#4	10-#3	9-#4	9-#3	1.98	1.99	2.01
15	250	27	0.618	26	53	71	11-#4 0	9-#4	16-#4	11-#3	9-#4	2.19	2.22	2.31	15	250	27	14-#4	11-#3	9-#4	9-#3	2.12	2.15	2.18
15	300	32	0.607	28	56	76	11-#4 0	10-#4	11-#5	11-#3	9-#4	2.32	2.35	2.49	15	300	33	15-#4	11-#3	9-#4	9-#3	2.21	2.25	2.28
16	50	12	0.848	16	31	42	12-#4 0	9-#3	12-#4	9-#3	9-#4	1.70	1.70	1.68	16	50	10	12-#4	9-#3	9-#4	9-#3	1.72	1.72	1.72
16	100	16	0.793	21	42	56	12-#4 1	12-#3	12-#4	9-#3	9-#4	1.79	1.79	1.82	16	100	13	12-#4	9-#3	9-#4	9-#3	1.73	1.73	1.73
16	150	21	0.747	25	50	68	12-#4 2	9-#4	15-#4	10-#3	9-#4	2.00	2.00	2.09	16	150	17	14-#4	10-#3	9-#4	9-#3	1.89	1.90	1.91
16	200	27	0.627	28	56	76	12-#4 0	10-#4	17-#4	11-#3	9-#4	2.18	2.19	2.34	16	200	25	16-#4	11-#3	9-#4	9-#3	2.08	2.09	2.11
16	250	32	0.607	31	61	82	12-#4 0	18-#3	12-#5	12-#3	9-#4	2.29	2.32	2.42	16	250	33	17-#4	12-#3	9-#4	9-#3	2.21	2.24	2.26
16	300	38	0.606	32	64	86	12-#4 0	11-#4	13-#5	13-#3	9-#4	2.45	2.49	2.65	16	300	41	17-#4	13-#3	9-#4	9-#3	2.30	2.35	2.39
17	50	14	0.841	19	37	50	13-#4 2	11-#3	13-#4	10-#3	10-#4	1.77	1.77	1.76	17	50	10	13-#4	10-#3	10-#4	10-#3	1.76	1.76	1.76
17	100	18	0.779	25	49	66	13-#4 1	15-#3	14-#4	10-#3	10-#4	1.88	1.88	1.92	17	100	15	14-#4	10-#3	10-#4	10-#3	1.83	1.83	1.83
17	150	25	0.696	29	58	78	13-#4 1	10-#4	17-#4	12-#3	10-#4	2.11	2.13	2.27	17	150	22	16-#4	12-#3	10-#4	10-#3	2.04	2.05	2.06
17	200	31	0.611	32	65	87	13-#4 0	11-#4	13-#5	13-#3	10-#4	2.30	2.33	2.45	17	200	31	18-#4	13-#3	10-#4	10-#3	2.23	2.26	2.29
17	250	38	0.606	35	69	94	13-#4 0	12-#4	14-#5	14-#3	10-#4	2.51	2.52	2.63	17	250	40	13-#5	14-#3	10-#4	10-#3	2.43	2.45	2.47
17	300	44	0.605	37	73	99	13-#4 0	13-#4	15-#5	15-#3	10-#4	2.63	2.66	2.79	17	300	48	13-#5	14-#3	10-#4	10-#3	2.47	2.52	2.56

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

SQUARE EDGE PANEL

SQUARE INTERIOR PANEL

f'_c = 4,000 psi
Grade 60 Bars

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superimposed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2)	(3)	(1)	Reinforcing Bars				Steel (psf)		
				–M Ext.	+M Int.	–M 1st int.	Each Column Strip			Each Middle Strip		Steel (psf)						Column Strip		Middle Strip		Location of Panel		
							Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Location of Panel												
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)						E	EC	C	Span c.-c. (ft)	Load (psf)	Min. Sq. Col. (in.)	Top	Bottom	Top	Bottom	I	IE	IC
6 in. = TOTAL THICKNESS OF SLAB														0.500 c.f./s.f.	6 in. = TOTAL THICKNESS OF SLAB									0.500 c.f./s.f.
12	50	10	0.742	7	14	18	8-#4 0	8-#3	8-#4	8-#3	7-#4	1.79	1.79	1.79	12	50	10	8-#4	8-#3	7-#4	8-#3	1.80	1.80	1.80
12	100	10	0.782	9	18	25	8-#4 0	8-#3	8-#4	8-#3	7-#4	1.80	1.80	1.79	12	100	11	8-#4	8-#3	7-#4	8-#3	1.80	1.80	1.80
12	150	11	0.780	11	23	30	8-#4 0	8-#3	8-#4	8-#3	7-#4	1.78	1.78	1.76	12	150	13	8-#4	8-#3	7-#4	8-#3	1.81	1.81	1.82
12	200	12	0.778	13	27	36	8-#4 0	7-#3	8-#4	8-#3	7-#4	1.78	1.78	1.76	12	200	14	8-#4	8-#3	7-#4	8-#3	1.82	1.82	1.82
12	250	13	0.779	16	31	42	8-#4 0	8-#3	8-#4	8-#3	7-#4	1.81	1.81	1.79	12	250	15	8-#4	8-#3	7-#4	8-#3	1.82	1.83	1.83
12	300	15	0.731	17	35	47	8-#4 0	9-#3	9-#4	8-#3	7-#4	1.85	1.86	1.83	12	300	16	8-#4	8-#3	7-#4	8-#3	1.83	1.85	1.87
12	350	16	0.733	19	39	52	8-#4 0	6-#4	10-#4	7-#3	7-#4	1.90	1.93	1.94	12	350	17	9-#4	7-#3	7-#4	8-#3	1.86	1.88	1.90
13	50	10	0.788	9	18	24	9-#4 0	8-#3	9-#4	8-#3	7-#4	1.70	1.70	1.68	13	50	10	9-#4	8-#3	7-#4	8-#3	1.72	1.72	1.72
13	100	10	0.830	12	24	32	9-#4 0	8-#3	9-#4	8-#3	7-#4	1.71	1.71	1.68	13	100	11	9-#4	8-#3	7-#4	8-#3	1.72	1.72	1.72
13	150	11	0.852	15	29	39	9-#4 1	8-#3	9-#4	8-#3	7-#4	1.71	1.71	1.68	13	150	13	9-#4	8-#3	7-#4	8-#3	1.73	1.73	1.74
13	200	13	0.822	17	35	47	9-#4 1	9-#3	9-#4	8-#3	7-#4	1.77	1.77	1.78	13	200	14	9-#4	8-#3	7-#4	8-#3	1.74	1.74	1.74
13	250	15	0.809	20	40	53	9-#4 2	11-#3	10-#4	8-#3	7-#4	1.86	1.86	1.89	13	250	15	10-#4	8-#3	7-#4	8-#3	1.81	1.81	1.81
13	300	18	0.680	22	44	60	9-#4 0	7-#4	12-#4	8-#3	7-#4	1.94	1.97	2.09	13	300	16	11-#4	8-#3	7-#4	8-#3	1.88	1.90	1.91
13	350	20	0.646	24	48	65	9-#4 0	13-#3	13-#4	9-#3	7-#4	2.07	2.07	2.14	13	350	18	12-#4	9-#3	7-#4	8-#3	2.01	2.03	2.05
14	50	10	0.826	11	22	30	10-#4 0	9-#3	10-#4	9-#3	7-#4	1.76	1.76	1.76	14	50	10	10-#4	9-#3	7-#4	9-#3	1.76	1.76	1.76
14	100	11	0.836	15	30	40	10-#4 0	9-#3	10-#4	9-#3	7-#4	1.76	1.76	1.76	14	100	11	10-#4	9-#3	7-#4	9-#3	1.76	1.76	1.76
14	150	13	0.812	18	36	49	10-#4 0	10-#3	10-#4	9-#3	7-#4	1.79	1.79	1.82	14	150	13	10-#4	9-#3	7-#4	9-#3	1.77	1.77	1.77
14	200	16	0.767	21	43	58	10-#4 1	7-#4	11-#4	9-#3	7-#4	1.88	1.88	1.84	14	200	14	11-#4	9-#3	7-#4	9-#3	1.84	1.84	1.84
14	250	18	0.741	24	49	66	10-#4 1	13-#3	13-#4	9-#3	7-#4	1.99	2.00	2.01	14	250	16	12-#4	9-#3	7-#4	9-#3	1.91	1.92	1.94
14	300	21	0.692	27	54	72	10-#4 1	8-#4	14-#4	10-#3	7-#4	2.09	2.11	2.18	14	300	20	13-#4	10-#3	7-#4	9-#3	2.03	2.05	2.06
14	350	25	0.609	28	57	77	10-#4 0	9-#4	10-#5	10-#3	7-#4	2.21	2.24	2.34	14	350	25	14-#4	10-#3	7-#4	9-#3	2.12	2.15	2.17
15	50	10	0.844	14	27	37	10-#4 0	9-#3	10-#4	9-#3	8-#4	1.66	1.66	1.65	15	50	10	10-#4	9-#3	8-#4	9-#3	1.68	1.68	1.68
15	100	13	0.790	18	36	49	10-#4 0	10-#3	10-#4	9-#3	8-#4	1.70	1.70	1.67	15	100	11	10-#4	9-#3	8-#4	9-#3	1.69	1.69	1.69
15	150	16	0.751	22	45	60	10-#4 1	12-#3	12-#4	9-#3	8-#4	1.79	1.80	1.82	15	150	13	11-#4	9-#3	8-#4	9-#3	1.75	1.76	1.78
15	200	18	0.733	26	52	70	10-#4 1	8-#4	14-#4	9-#3	8-#4	1.94	1.96	1.99	15	200	16	13-#4	10-#3	8-#4	9-#3	1.91	1.93	1.94
15	250	22	0.690	29	58	78	10-#4 2	9-#4	10-#5	10-#3	8-#4	2.08	2.11	2.20	15	250	20	14-#4	11-#3	8-#4	9-#3	2.04	2.06	2.08
15	300	26	0.649	31	63	84	10-#4 2	10-#4	16-#4	11-#3	8-#4	2.24	2.25	2.41	15	300	26	10-#5	11-#3	8-#4	9-#3	2.16	2.17	2.18
15	350	30	0.608	33	66	89	10-#4 0	10-#4	17-#4	12-#3	8-#4	2.32	2.33	2.43	15	350	32	16-#4	12-#3	8-#4	9-#3	2.26	2.27	2.29
16	50	11	0.858	17	33	45	11-#4 1	10-#3	11-#4	10-#3	8-#4	1.69	1.69	1.67	16	50	10	11-#4	10-#3	8-#4	10-#3	1.69	1.69	1.69
16	100	15	0.798	22	44	59	11-#4 2	12-#3	11-#4	10-#3	8-#4	1.74	1.74	1.74	16	100	11	11-#4	10-#3	8-#4	10-#3	1.70	1.70	1.70
16	150	18	0.710	27	53	72	11-#4 0	8-#4	14-#4	10-#3	8-#4	1.86	1.88	1.93	16	150	15	13-#4	10-#3	8-#4	10-#3	1.82	1.83	1.84
16	200	22	0.675	31	62	83	11-#4 1	9-#4	16-#4	11-#3	8-#4	2.02	2.03	2.11	16	200	19	15-#4	11-#3	8-#4	10-#3	1.99	2.00	2.01
16	250	26	0.644	34	68	91	11-#4 1	10-#4	12-#5	12-#3	8-#4	2.21	2.24	2.35	16	250	26	16-#4	12-#3	8-#4	10-#3	2.11	2.15	2.18
16	300	32	0.608	36	72	96	11-#4 1	11-#4	13-#5	13-#3	8-#4	2.37	2.40	2.52	16	300	33	17-#4	13-#3	8-#4	10-#3	2.24	2.29	2.34
16	350	36	0.607	38	76	102	11-#4 0	8-#5	13-#5	13-#3	8-#4	2.48	2.51	2.64	16	350	39	12-#5	13-#3	8-#4	10-#3	2.37	2.40	2.42

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel		
							Each Column Strip			Each Middle Strip		Steel (psf) Location of Panel		
				–M Ext.	+M Int.	–M 1st int.	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)								
6 in. = TOTAL THICKNESS OF SLAB											0.500 c.f./s.f.			
17	50	13	0.828	20	40	54	12-#4 1	11-#3	12-#4	11-#3	9-#4	1.75	1.75	1.73
17	100	17	0.773	26	52	70	12-#4 2	14-#3	13-#4	11-#3	9-#4	1.84	1.84	1.84
17	150	20	0.760	32	63	85	12-#4 3	10-#4	17-#4	11-#3	9-#4	2.04	2.05	2.08
17	200	26	0.620	36	71	96	12-#4 0	11-#4	13-#5	13-#3	9-#4	2.26	2.29	2.36
17	250	32	0.608	39	77	104	12-#4 1	12-#4	20-#4	14-#3	9-#4	2.41	2.42	2.53
17	300	37	0.607	41	82	110	12-#4 1	13-#4	15-#5	9-#4	9-#4	2.60	2.63	2.71
17	350	43	0.606	43	85	115	12-#4 0	13-#4	15-#5	9-#4	9-#4	2.65	2.69	2.85
18	50	14	0.830	24	47	64	12-#4 2	13-#3	12-#4	11-#3	9-#4	1.69	1.69	1.71
18	100	19	0.734	31	61	82	12-#4 2	9-#4	16-#4	11-#3	9-#4	1.87	1.89	1.95
18	150	24	0.709	37	73	98	12-#4 3	11-#4	13-#5	13-#3	9-#4	2.14	2.16	2.23
18	200	31	0.608	41	81	109	12-#4 1	12-#4	14-#5	14-#3	9-#4	2.30	2.32	2.42
18	250	37	0.607	44	88	118	12-#4 1	13-#4	15-#5	9-#4	9-#4	2.48	2.50	2.66
18	300	43	0.606	46	93	125	12-#4 2	14-#4	16-#5	9-#4	9-#4	2.64	2.66	2.84
18	350	50	0.605	48	96	129	12-#4 0	10-#5	12-#6	10-#4	9-#4	2.82	2.85	2.93
19	50	16	0.814	27	55	74	13-#4 3	15-#3	14-#4	12-#3	10-#4	1.77	1.77	1.79
19	100	21	0.733	36	71	96	13-#4 2	11-#4	18-#4	13-#3	10-#4	1.99	2.01	2.10
19	150	29	0.629	41	83	111	13-#4 2	13-#4	15-#5	15-#3	10-#4	2.27	2.31	2.38
19	200	36	0.607	46	92	123	13-#4 1	14-#4	16-#5	16-#3	10-#4	2.48	2.50	2.64
19	250	43	0.606	49	99	133	13-#4 1	10-#5	13-#6	10-#4	10-#4	2.74	2.77	2.85
19	300	50	0.605	52	104	139	13-#4 2	16-#4	18-#5	18-#3	10-#4	2.82	2.85	3.01
19	350	57	0.604	53	107	143	14-#4 0	16-#4	14-#6	11-#4	10-#4	2.95	3.00	3.17

SQUARE INTERIOR PANEL

(2) Span c.-c.	(3) Load	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf) Location of Panel		
			Column Strip		Middle Strip				
(ft)	(psf)	(in.)	Top	Bottom	Top	Bottom	I	IE	IC
6 in. = TOTAL THICKNESS OF SLAB							0.500 c.f./s.f.		
17	50	10	12-#4	11-#3	9-#4	11-#3	1.77	1.77	1.76
17	100	13	13-#4	11-#3	9-#4	11-#3	1.83	1.83	1.82
17	150	17	16-#4	12-#3	9-#4	11-#3	2.03	2.04	2.05
17	200	24	17-#4	13-#3	9-#4	11-#3	2.15	2.19	2.23
17	250	32	13-#5	14-#3	9-#4	11-#3	2.39	2.39	2.38
17	300	40	13-#5	14-#3	9-#4	11-#3	2.43	2.47	2.52
17	350	47	20-#4	15-#3	9-#4	10-#3	2.45	2.50	2.55
18	50	10	12-#4	11-#3	9-#4	11-#3	1.67	1.67	1.66
18	100	15	15-#4	11-#3	9-#4	11-#3	1.82	1.83	1.84
18	150	21	12-#5	13-#3	9-#4	11-#3	2.09	2.11	2.13
18	200	30	13-#5	15-#3	9-#4	11-#3	2.28	2.30	2.32
18	250	39	14-#5	15-#3	9-#4	10-#3	2.36	2.38	2.40
18	300	47	15-#5	9-#4	9-#4	11-#3	2.56	2.58	2.60
18	350	55	15-#5	10-#4	9-#4	11-#3	2.65	2.70	2.75
19	50	12	13-#4	12-#3	10-#4	12-#3	1.72	1.73	1.74
19	100	17	17-#4	13-#3	10-#4	12-#3	1.95	1.96	1.97
19	150	26	20-#4	15-#3	10-#4	12-#3	2.19	2.23	2.26
19	200	36	15-#5	16-#3	10-#4	11-#3	2.39	2.41	2.43
19	250	45	16-#5	10-#4	10-#4	12-#3	2.60	2.65	2.70
19	300	54	17-#5	10-#4	10-#4	12-#3	2.72	2.74	2.76
19	350	63	17-#5	18-#3	10-#4	12-#3	2.77	2.83	2.90

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL															SQUARE INTERIOR PANEL									
SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2) Span c.-c.	(3)	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf)		
							Each Column Strip			Each Middle Strip		Steel (psf)						Column Strip		Middle Strip		Location of Panel		
				–M Ext.	+M Int.	–M 1st int.						Location of Panel												
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C	(ft)	(psf)	(in.)	Top	Bottom	Top	Bottom	I	IE	IC
6.5 in. = TOTAL THICKNESS OF SLAB														0.542 c.f./s.f.	6.5 in. = TOTAL THICKNESS OF SLAB									0.542 c.f./s.f.
13	50	10	0.739	9	18	25	8-#4 0	9-#3	8-#4	9-#3	7-#4	1.77	1.77	1.76	13	50	10	8-#4	9-#3	7-#4	9-#3	1.77	1.77	1.77
13	100	10	0.782	12	25	33	8-#4 0	9-#3	8-#4	9-#3	7-#4	1.77	1.77	1.76	13	100	11	8-#4	9-#3	7-#4	9-#3	1.78	1.78	1.78
13	150	12	0.736	15	30	40	8-#4 0	9-#3	8-#4	9-#3	7-#4	1.78	1.78	1.76	13	150	14	8-#4	9-#3	7-#4	9-#3	1.79	1.79	1.79
13	200	13	0.738	18	35	47	8-#4 0	9-#3	8-#4	9-#3	7-#4	1.78	1.78	1.76	13	200	15	8-#4	9-#3	7-#4	9-#3	1.79	1.79	1.80
13	250	14	0.741	20	41	55	8-#4 0	6-#4	10-#4	9-#3	7-#4	1.87	1.88	1.88	13	250	16	9-#4	9-#3	7-#4	9-#3	1.86	1.88	1.90
13	300	16	0.692	23	45	61	8-#4 0	6-#4	11-#4	9-#3	7-#4	1.93	1.94	1.86	13	300	17	10-#4	9-#3	7-#4	9-#3	1.94	1.95	1.97
13	350	17	0.730	25	51	68	8-#4 1	7-#4	8-#5	8-#3	7-#4	2.00	2.03	2.04	13	350	17	11-#4	8-#3	7-#4	9-#3	1.95	1.97	2.00
14	50	10	0.786	12	23	31	9-#4 0	9-#3	9-#4	9-#3	7-#4	1.69	1.69	1.67	14	50	10	9-#4	9-#3	7-#4	9-#3	1.70	1.70	1.70
14	100	10	0.830	15	31	42	9-#4 0	9-#3	9-#4	9-#3	7-#4	1.69	1.69	1.67	14	100	11	9-#4	9-#3	7-#4	9-#3	1.70	1.71	1.71
14	150	12	0.819	19	38	51	9-#4 1	9-#3	9-#4	9-#3	7-#4	1.71	1.71	1.71	14	150	14	9-#4	9-#3	7-#4	9-#3	1.72	1.72	1.72
14	200	14	0.808	22	44	60	9-#4 2	11-#3	10-#4	9-#3	7-#4	1.82	1.82	1.83	14	200	15	10-#4	9-#3	7-#4	9-#3	1.78	1.78	1.78
14	250	16	0.779	25	51	68	9-#4 2	7-#4	12-#4	9-#3	7-#4	1.90	1.93	1.97	14	250	16	11-#4	9-#3	7-#4	9-#3	1.85	1.86	1.88
14	300	18	0.695	28	57	77	9-#4 0	8-#4	13-#4	9-#3	7-#4	2.00	2.03	2.09	14	300	17	12-#4	9-#3	7-#4	9-#3	1.91	1.93	1.94
14	350	21	0.612	31	62	83	9-#4 0	9-#4	10-#5	10-#3	7-#4	2.18	2.19	2.27	14	350	19	9-#5	10-#3	7-#4	9-#3	2.09	2.11	2.14
15	50	10	0.824	14	29	39	10-#4 0	10-#3	10-#4	10-#3	8-#4	1.74	1.74	1.73	15	50	10	10-#4	10-#3	8-#4	10-#3	1.75	1.75	1.75
15	100	11	0.837	19	38	51	10-#4 0	10-#3	10-#4	10-#3	8-#4	1.74	1.74	1.73	15	100	11	10-#4	10-#3	8-#4	10-#3	1.76	1.76	1.76
15	150	14	0.796	23	46	62	10-#4 1	11-#3	11-#4	10-#3	8-#4	1.79	1.79	1.77	15	150	14	10-#4	10-#3	8-#4	10-#3	1.77	1.79	1.80
15	200	17	0.730	27	54	73	10-#4 1	13-#3	13-#4	10-#3	8-#4	1.91	1.92	1.90	15	200	15	12-#4	10-#3	8-#4	10-#3	1.89	1.90	1.92
15	250	19	0.728	31	62	83	10-#4 2	9-#4	10-#5	10-#3	8-#4	2.08	2.09	2.11	15	250	17	14-#4	10-#3	8-#4	10-#3	2.01	2.03	2.06
15	300	21	0.704	34	68	92	10-#4 2	10-#4	16-#4	11-#3	8-#4	2.18	2.21	2.25	15	300	20	10-#5	11-#3	8-#4	10-#3	2.17	2.17	2.18
15	350	25	0.643	36	73	98	10-#4 2	10-#4	17-#4	7-#4	8-#4	2.32	2.34	2.42	15	350	25	16-#4	7-#4	8-#4	10-#3	2.28	2.30	2.31
16	50	10	0.844	18	35	48	10-#4 0	11-#3	10-#4	11-#3	8-#4	1.72	1.72	1.71	16	50	10	10-#4	11-#3	8-#4	11-#3	1.74	1.74	1.74
16	100	13	0.810	23	46	62	10-#4 1	11-#3	11-#4	11-#3	8-#4	1.73	1.74	1.72	16	100	11	10-#4	11-#3	8-#4	11-#3	1.74	1.75	1.77
16	150	16	0.755	28	56	75	10-#4 1	13-#3	13-#4	11-#3	8-#4	1.85	1.86	1.85	16	150	14	12-#4	11-#3	8-#4	11-#3	1.86	1.87	1.88
16	200	19	0.718	33	65	88	10-#4 2	9-#4	10-#5	11-#3	8-#4	2.03	2.04	2.04	16	200	16	14-#4	11-#3	8-#4	11-#3	1.97	1.99	2.01
16	250	22	0.661	37	73	99	10-#4 2	10-#4	17-#4	12-#3	8-#4	2.17	2.18	2.30	16	250	20	16-#4	12-#3	8-#4	11-#3	2.13	2.14	2.16
16	300	26	0.620	40	80	107	10-#4 2	11-#4	13-#5	13-#3	8-#4	2.37	2.39	2.43	16	300	25	12-#5	13-#3	8-#4	11-#3	2.35	2.37	2.39
16	350	30	0.609	42	84	113	10-#4 0	8-#5	13-#5	13-#3	8-#4	2.46	2.49	2.61	16	350	32	12-#5	13-#3	8-#4	11-#3	2.38	2.41	2.43
17	50	12	0.839	21	42	57	11-#4 2	11-#3	11-#4	11-#3	9-#4	1.71	1.71	1.70	17	50	10	11-#4	11-#3	9-#4	11-#3	1.72	1.72	1.72
17	100	15	0.813	28	55	74	11-#4 3	13-#3	13-#4	11-#3	9-#4	1.79	1.80	1.78	17	100	11	12-#4	11-#3	9-#4	11-#3	1.77	1.78	1.79
17	150	18	0.737	33	67	90	11-#4 1	9-#4	16-#4	11-#3	9-#4	1.97	1.99	2.02	17	150	15	15-#4	11-#3	9-#4	11-#3	1.93	1.95	1.96
17	200	22	0.644	38	77	103	11-#4 1	18-#3	12-#5	12-#3	9-#4	2.14	2.16	2.23	17	200	19	11-#5	13-#3	9-#4	11-#3	2.14	2.15	2.17
17	250	26	0.640	42	85	114	11-#4 2	8-#5	13-#5	8-#4	9-#4	2.39	2.40	2.50	17	250	25	12-#5	8-#4	9-#4	11-#3	2.28	2.30	2.32
17	300	31	0.609	45	91	122	11-#4 2	8-#5	14-#5	8-#4	9-#4	2.49	2.50	2.58	17	300	32	13-#5	8-#4	9-#4	11-#3	2.40	2.42	2.44
17	350	36	0.608	48	95	128	11-#4 2	13-#4	11-#6	9-#4	9-#4	2.63	2.66	2.78	17	350	39	14-#5	15-#3	9-#4	11-#3	2.55	2.59	2.63

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel		
							Each Column Strip			Each Middle Strip		Steel (psf) Location of Panel		
				–M Ext.	+M Int.	–M 1st int.	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)								
6.5 in. = TOTAL THICKNESS OF SLAB														0.542 c.f./s.f.
18	50	13	0.828	25	50	67	12-#4 1	12-#3	12-#4	12-#3	9-#4	1.72	1.72	1.71
18	100	17	0.775	32	65	87	12-#4 2	9-#4	15-#4	12-#3	9-#4	1.88	1.89	1.87
18	150	21	0.718	39	78	105	12-#4 3	11-#4	12-#5	13-#3	9-#4	2.08	2.10	2.17
18	200	26	0.614	44	89	119	12-#4 1	12-#4	14-#5	14-#3	9-#4	2.29	2.32	2.40
18	250	31	0.609	48	97	130	12-#4 1	13-#4	15-#5	9-#4	9-#4	2.48	2.50	2.58
18	300	37	0.607	51	102	138	12-#4 2	14-#4	16-#5	9-#4	9-#4	2.62	2.64	2.82
18	350	43	0.606	53	107	144	12-#4 2	10-#5	12-#6	10-#4	9-#4	2.77	2.81	2.93
19	50	15	0.799	29	59	79	12-#4 2	14-#3	14-#4	13-#3	10-#4	1.77	1.78	1.77
19	100	19	0.752	38	75	102	12-#4 3	10-#4	12-#5	12-#3	10-#4	1.97	1.99	2.02
19	150	24	0.698	45	90	121	12-#4 4	12-#4	14-#5	14-#3	10-#4	2.21	2.23	2.31
19	200	30	0.609	50	101	135	12-#4 2	9-#5	16-#5	9-#4	10-#4	2.44	2.45	2.54
19	250	37	0.607	54	109	146	12-#4 2	10-#5	17-#5	10-#4	10-#4	2.65	2.68	2.80
19	300	43	0.606	57	115	155	13-#4 2	16-#4	13-#6	18-#3	10-#4	2.79	2.83	2.97
19	350	49	0.606	60	120	161	14-#4 1	11-#5	14-#6	11-#4	10-#4	2.99	3.05	3.14
20	50	17	0.796	34	68	91	13-#4 4	16-#3	16-#4	13-#3	10-#4	1.82	1.83	1.84
20	100	21	0.731	44	87	117	13-#4 3	12-#4	20-#4	14-#3	10-#4	2.06	2.07	2.12
20	150	28	0.646	51	102	138	13-#4 3	14-#4	16-#5	16-#3	10-#4	2.34	2.36	2.42
20	200	35	0.608	56	113	152	13-#4 4	10-#5	13-#6	10-#4	10-#4	2.57	2.61	2.73
20	250	42	0.607	61	122	164	14-#4 1	11-#5	14-#6	11-#4	10-#4	2.80	2.84	2.97
20	300	49	0.606	64	128	173	15-#4 1	12-#5	20-#5	12-#4	10-#4	2.99	3.04	3.15
20	350	56	0.605	66	132	178	15-#4 1	12-#5	15-#6	12-#4	10-#4	3.12	3.16	3.33

SQUARE INTERIOR PANEL

(2) Span c.-c.	(3) Load	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf) Location of Panel		
			Column Strip		Middle Strip				
			Top	Bottom	Top	Bottom	I	IE	IC
(ft)	(psf)	(in.)							
6.5 in. = TOTAL THICKNESS OF SLAB									0.542 c.f./s.f.
18	50	10	12-#4	12-#3	9-#4	12-#3	1.73	1.73	1.73
18	100	13	14-#4	12-#3	9-#4	12-#3	1.83	1.84	1.85
18	150	17	17-#4	13-#3	9-#4	12-#3	2.03	2.04	2.06
18	200	23	13-#5	15-#3	9-#4	12-#3	2.28	2.30	2.31
18	250	31	14-#5	9-#4	9-#4	12-#3	2.43	2.45	2.47
18	300	39	15-#5	9-#4	9-#4	12-#3	2.55	2.57	2.59
18	350	46	15-#5	10-#4	9-#4	11-#3	2.61	2.65	2.70
19	50	10	13-#4	13-#3	10-#4	13-#3	1.79	1.80	1.81
19	100	15	17-#4	12-#3	10-#4	13-#3	1.94	1.96	1.98
19	150	20	13-#5	15-#3	10-#4	13-#3	2.22	2.23	2.25
19	200	29	15-#5	9-#4	10-#4	13-#3	2.44	2.45	2.47
19	250	37	16-#5	10-#4	10-#4	13-#3	2.60	2.62	2.63
19	300	46	12-#6	10-#4	10-#4	12-#3	2.70	2.72	2.75
19	350	54	12-#6	11-#4	10-#4	13-#3	2.85	2.90	2.96
20	50	12	15-#4	13-#3	10-#4	13-#3	1.79	1.80	1.81
20	100	17	13-#5	14-#3	10-#4	13-#3	2.05	2.05	2.05
20	150	24	15-#5	10-#4	10-#4	13-#3	2.34	2.35	2.37
20	200	35	16-#5	10-#4	10-#4	13-#3	2.45	2.50	2.54
20	250	44	26-#4	11-#4	10-#4	13-#3	2.60	2.66	2.73
20	300	53	13-#6	12-#4	10-#4	13-#3	2.84	2.86	2.89
20	350	62	14-#6	12-#4	10-#4	14-#3	3.01	3.04	3.07

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

SQUARE EDGE PANEL

SQUARE INTERIOR PANEL

f'_c = 4,000 psi
Grade 60 Bars

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2) Span c.-c.	(3) Load	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf)		
				–M Ext.	+M Int.	–M 1st int.	Each Column Strip			Each Middle Strip		Steel (psf) Location of Panel						Column Strip		Middle Strip		Location of Panel		
							Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C				Top	Bottom	Top	Bottom	I	IE	IC
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)									(ft)	(psf)	(in.)							
7 in. = TOTAL THICKNESS OF SLAB														0.583 c.f./s.f.	7 in. = TOTAL THICKNESS OF SLAB									0.583 c.f./s.f.
14	50	10	0.734	12	24	33	8-#4 0	6-#4	8-#4	6-#4	7-#4	1.77	1.77	1.76	14	50	10	8-#4	6-#4	7-#4	6-#4	1.78	1.78	1.78
14	100	10	0.805	16	32	43	8-#4 1	6-#4	8-#4	6-#4	7-#4	1.78	1.78	1.76	14	100	11	8-#4	6-#4	7-#4	6-#4	1.78	1.78	1.78
14	150	12	0.740	19	39	52	8-#4 0	6-#4	8-#4	6-#4	7-#4	1.78	1.78	1.76	14	150	14	8-#4	6-#4	7-#4	6-#4	1.80	1.80	1.80
14	200	13	0.745	23	46	62	8-#4 0	6-#4	10-#4	6-#4	7-#4	1.82	1.85	1.81	14	200	15	9-#4	6-#4	7-#4	6-#4	1.86	1.88	1.89
14	250	15	0.700	26	52	70	8-#4 0	7-#4	11-#4	6-#4	7-#4	1.93	1.94	1.92	14	250	16	10-#4	6-#4	7-#4	6-#4	1.93	1.94	1.96
14	300	17	0.653	29	58	79	8-#4 0	7-#4	8-#5	6-#4	7-#4	2.02	2.02	1.96	14	300	17	8-#5	6-#4	7-#4	6-#4	2.08	2.08	2.08
14	350	19	0.643	32	64	87	8-#4 1	8-#4	9-#5	6-#4	7-#4	2.09	2.11	2.08	14	350	18	13-#4	6-#4	7-#4	6-#4	2.12	2.13	2.15
15	50	10	0.783	15	30	41	9-#4 0	11-#3	9-#4	11-#3	8-#4	1.76	1.76	1.74	15	50	10	9-#4	11-#3	8-#4	11-#3	1.80	1.80	1.80
15	100	10	0.848	20	40	54	9-#4 1	11-#3	9-#4	11-#3	8-#4	1.77	1.77	1.74	15	100	11	9-#4	11-#3	8-#4	11-#3	1.80	1.80	1.80
15	150	13	0.784	24	48	64	9-#4 1	11-#3	10-#4	11-#3	8-#4	1.78	1.80	1.77	15	150	14	9-#4	11-#3	8-#4	11-#3	1.82	1.83	1.84
15	200	15	0.776	28	56	76	9-#4 2	7-#4	12-#4	11-#3	8-#4	1.92	1.94	1.90	15	200	15	11-#4	11-#3	8-#4	11-#3	1.93	1.95	1.96
15	250	17	0.768	32	64	86	9-#4 3	8-#4	9-#5	11-#3	8-#4	2.04	2.06	2.02	15	250	16	13-#4	11-#3	8-#4	11-#3	2.05	2.06	2.08
15	300	19	0.657	36	72	96	9-#4 0	9-#4	10-#5	11-#3	8-#4	2.15	2.18	2.20	15	300	18	14-#4	11-#3	8-#4	11-#3	2.12	2.14	2.16
15	350	22	0.613	39	78	105	9-#4 1	10-#4	11-#5	11-#3	8-#4	2.29	2.30	2.39	15	350	20	10-#5	7-#4	8-#4	11-#3	2.29	2.31	2.33
16	50	10	0.823	19	37	50	10-#4 0	11-#3	10-#4	11-#3	8-#4	1.74	1.74	1.76	16	50	10	10-#4	11-#3	8-#4	11-#3	1.74	1.74	1.74
16	100	12	0.819	24	48	65	10-#4 1	11-#3	10-#4	11-#3	8-#4	1.74	1.74	1.75	16	100	11	10-#4	11-#3	8-#4	11-#3	1.74	1.74	1.74
16	150	15	0.761	29	58	78	10-#4 1	7-#4	12-#4	11-#3	8-#4	1.81	1.83	1.83	16	150	14	11-#4	11-#3	8-#4	11-#3	1.80	1.82	1.83
16	200	17	0.760	34	68	92	10-#4 2	9-#4	14-#4	11-#3	8-#4	2.00	2.01	2.00	16	200	15	14-#4	11-#3	8-#4	11-#3	1.97	1.97	1.96
16	250	20	0.696	38	77	103	10-#4 2	10-#4	16-#4	11-#3	8-#4	2.13	2.15	2.13	16	250	18	10-#5	7-#4	8-#4	11-#3	2.13	2.13	2.14
16	300	22	0.697	43	85	114	10-#4 3	7-#5	12-#5	7-#4	8-#4	2.27	2.29	2.34	16	300	21	11-#5	7-#4	8-#4	11-#3	2.22	2.25	2.27
16	350	25	0.620	46	92	123	10-#4 2	8-#5	13-#5	13-#3	8-#4	2.43	2.46	2.55	16	350	25	12-#5	8-#4	8-#4	11-#3	2.39	2.41	2.43
17	50	10	0.843	22	45	60	10-#4 0	12-#3	10-#4	12-#3	9-#4	1.73	1.73	1.72	17	50	10	10-#4	12-#3	9-#4	12-#3	1.73	1.73	1.73
17	100	14	0.774	29	58	78	10-#4 1	13-#3	12-#4	12-#3	9-#4	1.79	1.81	1.78	17	100	11	12-#4	12-#3	9-#4	12-#3	1.83	1.83	1.83
17	150	17	0.740	35	70	94	10-#4 2	9-#4	10-#5	12-#3	9-#4	1.95	1.97	1.93	17	150	14	14-#4	12-#3	9-#4	12-#3	1.94	1.96	1.98
17	200	20	0.682	40	81	108	10-#4 2	10-#4	11-#5	12-#3	9-#4	2.09	2.09	2.16	17	200	17	16-#4	12-#3	9-#4	12-#3	2.06	2.07	2.08
17	250	23	0.617	45	91	122	10-#4 2	11-#4	13-#5	13-#3	9-#4	2.27	2.29	2.28	17	250	20	12-#5	8-#4	9-#4	12-#3	2.29	2.31	2.33
17	300	26	0.622	50	99	133	10-#4 3	8-#5	10-#6	8-#4	9-#4	2.42	2.46	2.54	17	300	25	13-#5	8-#4	9-#4	12-#3	2.39	2.42	2.45
17	350	31	0.609	52	104	141	11-#4 2	13-#4	11-#6	9-#4	9-#4	2.63	2.65	2.69	17	350	31	10-#6	15-#3	9-#4	12-#3	2.57	2.60	2.63
18	50	12	0.839	26	53	71	11-#4 2	13-#3	11-#4	13-#3	9-#4	1.75	1.75	1.72	18	50	10	11-#4	13-#3	9-#4	13-#3	1.76	1.76	1.76
18	100	16	0.782	34	68	91	11-#4 3	9-#4	14-#4	13-#3	9-#4	1.91	1.92	1.88	18	100	12	14-#4	13-#3	9-#4	13-#3	1.91	1.91	1.91
18	150	19	0.721	41	82	110	11-#4 2	10-#4	17-#4	13-#3	9-#4	2.04	2.04	2.09	18	150	16	16-#4	12-#3	9-#4	13-#3	1.98	1.99	2.00
18	200	22	0.673	47	94	127	11-#4 2	8-#5	13-#5	8-#4	9-#4	2.28	2.29	2.31	18	200	20	13-#5	8-#4	9-#4	13-#3	2.28	2.27	2.27
18	250	26	0.611	53	105	142	11-#4 2	13-#4	11-#6	9-#4	9-#4	2.50	2.51	2.55	18	250	24	14-#5	9-#4	9-#4	13-#3	2.44	2.47	2.51
18	300	31	0.609	56	112	151	12-#4 2	9-#5	16-#5	9-#4	9-#4	2.64	2.65	2.74	18	300	32	11-#6	9-#4	9-#4	13-#3	2.62	2.62	2.63
18	350	37	0.608	59	117	158	12-#4 2	10-#5	12-#6	10-#4	9-#4	2.79	2.82	2.94	18	350	39	11-#6	10-#4	9-#4	13-#3	2.71	2.74	2.77

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2)	(3)	(1)	Reinforcing Bars				Steel (psf)		
				–M Ext.	+M Int.	–M 1st int.	Each Column Strip			Each Middle Strip		Steel (psf)						Column Strip		Middle Strip		Location of Panel		
							Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Location of Panel												
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)						E	EC	C	Span c.-c. (ft)	Load (psf)	Min. Sq. Col. (in.)	Top	Bottom	Top	Bottom	I	IE	IC
7 in. = TOTAL THICKNESS OF SLAB														0.583 c.f./s.f.	7 in. = TOTAL THICKNESS OF SLAB									0.583 c.f./s.f.
19	50	14	0.810	31	62	83	11-#4 3	14-#3	13-#4	14-#3	10-#4	1.78	1.79	1.77	19	50	10	12-#4	14-#3	10-#4	14-#3	1.80	1.81	1.82
19	100	18	0.758	40	79	106	11-#4 4	10-#4	11-#5	14-#3	10-#4	1.96	1.98	1.95	19	100	14	16-#4	14-#3	10-#4	14-#3	1.99	2.00	2.02
19	150	21	0.683	48	95	128	11-#4 2	12-#4	13-#5	14-#3	10-#4	2.16	2.17	2.18	19	150	18	13-#5	14-#3	10-#4	14-#3	2.20	2.20	2.20
19	200	26	0.611	54	109	147	11-#4 3	9-#5	23-#4	9-#4	10-#4	2.43	2.43	2.45	19	200	22	11-#6	9-#4	10-#4	14-#3	2.49	2.47	2.45
19	250	31	0.609	59	119	160	12-#4 2	10-#5	12-#6	10-#4	10-#4	2.63	2.67	2.80	19	250	30	16-#5	10-#4	10-#4	14-#3	2.59	2.61	2.64
19	300	37	0.608	63	126	170	13-#4 2	16-#4	13-#6	18-#3	10-#4	2.78	2.79	2.87	19	300	38	12-#6	18-#3	10-#4	14-#3	2.73	2.76	2.79
19	350	43	0.607	66	131	177	14-#4 1	16-#4	11-#7	11-#4	10-#4	2.95	3.02	3.10	19	350	46	17-#5	11-#4	10-#4	14-#3	2.81	2.90	2.99
20	50	16	0.766	36	72	97	12-#4 2	9-#4	15-#4	14-#3	10-#4	1.80	1.81	1.76	20	50	11	14-#4	14-#3	10-#4	14-#3	1.80	1.81	1.82
20	100	20	0.736	46	91	123	12-#4 4	11-#4	13-#5	14-#3	10-#4	2.04	2.05	2.01	20	100	16	12-#5	14-#3	10-#4	14-#3	2.01	2.03	2.04
20	150	24	0.672	55	109	147	12-#4 4	9-#5	23-#4	9-#4	10-#4	2.31	2.31	2.35	20	150	20	15-#5	9-#4	10-#4	14-#3	2.30	2.29	2.28
20	200	30	0.610	61	123	165	13-#4 3	10-#5	17-#5	10-#4	10-#4	2.52	2.55	2.70	20	200	28	16-#5	10-#4	10-#4	14-#3	2.45	2.46	2.48
20	250	36	0.608	66	133	179	14-#4 3	11-#5	14-#6	11-#4	10-#4	2.76	2.82	2.93	20	250	37	26-#4	11-#4	10-#4	14-#3	2.60	2.66	2.72
20	300	43	0.607	70	140	189	15-#4 1	12-#5	20-#5	12-#4	10-#4	2.99	3.01	3.14	20	300	45	13-#6	12-#4	10-#4	14-#3	2.83	2.85	2.87
20	350	49	0.606	73	146	196	15-#4 1	12-#5	15-#6	12-#4	10-#4	3.10	3.13	3.24	20	350	54	14-#6	12-#4	10-#4	14-#3	2.97	3.00	3.03
21	50	17	0.772	41	83	112	12-#4 3	10-#4	17-#4	9-#4	11-#4	1.92	1.92	1.91	21	50	12	17-#4	15-#3	11-#4	15-#3	1.93	1.93	1.93
21	100	22	0.697	52	105	141	12-#4 4	13-#4	15-#5	9-#4	11-#4	2.17	2.20	2.20	21	100	18	14-#5	9-#4	11-#4	15-#3	2.18	2.19	2.21
21	150	28	0.637	62	124	167	13-#4 4	10-#5	26-#4	10-#4	11-#4	2.45	2.46	2.56	21	150	23	12-#6	11-#4	11-#4	15-#3	2.52	2.50	2.49
21	200	35	0.608	68	137	184	14-#4 3	11-#5	14-#6	11-#4	11-#4	2.73	2.76	2.85	21	200	34	13-#6	12-#4	11-#4	15-#3	2.70	2.73	2.75
21	250	42	0.607	74	148	199	15-#4 3	12-#5	15-#6	12-#4	11-#4	2.92	2.96	3.05	21	250	43	14-#6	12-#4	11-#4	14-#3	2.80	2.83	2.85
21	300	49	0.606	78	155	209	16-#4 2	9-#6	12-#7	13-#4	11-#4	3.15	3.20	3.36	21	300	53	20-#5	13-#4	11-#4	15-#3	2.94	3.00	3.06
21	350	56	0.605	81	161	217	17-#4 0	20-#4	13-#7	13-#4	11-#4	3.26	3.34	3.53	21	350	61	15-#6	13-#4	11-#4	15-#3	3.09	3.16	3.23
22	50	19	0.771	47	94	127	13-#4 5	12-#4	13-#5	16-#3	11-#4	1.99	2.00	1.97	22	50	14	13-#5	16-#3	11-#4	16-#3	2.02	2.02	2.02
22	100	24	0.680	60	119	160	13-#4 4	10-#5	17-#5	10-#4	11-#4	2.32	2.33	2.39	22	100	20	16-#5	10-#4	11-#4	16-#3	2.27	2.29	2.30
22	150	32	0.609	69	138	186	14-#4 3	17-#4	14-#6	11-#4	11-#4	2.57	2.59	2.65	22	150	29	13-#6	12-#4	11-#4	16-#3	2.58	2.60	2.62
22	200	40	0.607	76	152	205	16-#4 2	13-#5	16-#6	13-#4	11-#4	2.90	2.95	3.04	22	200	40	20-#5	13-#4	11-#4	15-#3	2.74	2.79	2.83
22	250	48	0.606	81	163	219	17-#4 2	20-#4	13-#7	14-#4	11-#4	3.12	3.17	3.26	22	250	50	21-#5	14-#4	11-#4	16-#3	2.92	2.99	3.06
22	300	55	0.606	86	172	231	18-#4 2	10-#6	14-#7	14-#4	12-#4	3.35	3.42	3.53	22	300	60	16-#6	14-#4	11-#4	16-#3	3.09	3.18	3.26
22	350	63	0.605	88	176	237	18-#4 0	11-#6	14-#7	10-#5	12-#4	3.61	3.63	3.72	22	350	70	13-#7	14-#4	11-#4	10-#4	3.36	3.40	3.45

SQUARE INTERIOR PANEL

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

SQUARE EDGE PANEL

SQUARE INTERIOR PANEL

f'_c = 4,000 psi
Grade 60 Bars

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2)	(3)	(1)	Reinforcing Bars				Steel (psf)		
				–M Ext.	+M Int.	–M 1st int.	Each Column Strip			Each Middle Strip		Steel (psf)						Column Strip		Middle Strip		Location of Panel		
							Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Location of Panel												
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)						E	EC	C	Span c.-c. (ft)	Load (psf)	Min. Sq. Col. (in.)	Top	Bottom	Top	Bottom	I	IE	IC
7.5 in. = TOTAL THICKNESS OF SLAB														0.625 c.f./s.f.	7.5 in. = TOTAL THICKNESS OF SLAB									0.625 c.f./s.f.
15	50	10	0.761	16	32	43	8-#4 1	7-#4	8-#4	7-#4	8-#4	1.87	1.87	1.88	15	50	10	8-#4	7-#4	8-#4	7-#4	1.88	1.88	1.88
15	100	10	0.826	21	41	56	8-#4 2	7-#4	8-#4	7-#4	8-#4	1.87	1.87	1.88	15	100	11	8-#4	7-#4	8-#4	7-#4	1.88	1.88	1.88
15	150	12	0.745	25	50	67	8-#4 0	7-#4	10-#4	7-#4	8-#4	1.92	1.92	1.90	15	150	14	9-#4	7-#4	8-#4	7-#4	1.95	1.97	1.98
15	200	13	0.781	29	58	78	8-#4 1	7-#4	11-#4	7-#4	8-#4	1.97	1.98	1.94	15	200	16	10-#4	7-#4	8-#4	7-#4	2.02	2.03	2.05
15	250	16	0.695	33	66	88	8-#4 1	8-#4	13-#4	7-#4	8-#4	2.10	2.10	2.02	15	250	17	8-#5	7-#4	8-#4	7-#4	2.16	2.17	2.18
15	300	18	0.653	37	73	99	8-#4 1	6-#5	14-#4	7-#4	8-#4	2.17	2.19	2.11	15	300	18	13-#4	7-#4	8-#4	7-#4	2.19	2.21	2.22
15	350	20	0.615	41	81	109	8-#4 1	6-#5	16-#4	6-#4	8-#4	2.22	2.24	2.20	15	350	18	10-#5	7-#4	8-#4	7-#4	2.34	2.35	2.35
16	50	10	0.782	19	39	52	9-#4 0	7-#4	9-#4	7-#4	8-#4	1.79	1.79	1.79	16	50	10	9-#4	7-#4	8-#4	7-#4	1.81	1.81	1.81
16	100	11	0.814	25	50	68	9-#4 1	7-#4	10-#4	7-#4	8-#4	1.82	1.83	1.82	16	100	11	9-#4	7-#4	8-#4	7-#4	1.81	1.83	1.84
16	150	13	0.808	30	60	81	9-#4 2	7-#4	12-#4	7-#4	8-#4	1.89	1.90	1.87	16	150	14	11-#4	7-#4	8-#4	7-#4	1.93	1.94	1.96
16	200	16	0.742	35	70	94	9-#4 2	8-#4	9-#5	7-#4	8-#4	2.00	2.02	2.02	16	200	16	13-#4	7-#4	8-#4	7-#4	2.04	2.06	2.07
16	250	18	0.738	40	80	107	9-#4 3	9-#4	10-#5	7-#4	8-#4	2.10	2.13	2.14	16	250	17	14-#4	7-#4	8-#4	7-#4	2.10	2.12	2.14
16	300	21	0.614	44	89	119	9-#4 1	10-#4	17-#4	7-#4	8-#4	2.21	2.22	2.27	16	300	18	16-#4	7-#4	8-#4	7-#4	2.21	2.22	2.24
16	350	23	0.613	48	97	130	9-#4 1	11-#4	9-#6	8-#4	8-#4	2.42	2.44	2.43	16	350	21	12-#5	8-#4	8-#4	7-#4	2.44	2.46	2.47
17	50	10	0.823	23	47	63	10-#4 0	7-#4	10-#4	7-#4	9-#4	1.76	1.76	1.73	17	50	10	10-#4	7-#4	9-#4	7-#4	1.79	1.79	1.79
17	100	13	0.785	30	60	81	10-#4 1	7-#4	12-#4	7-#4	9-#4	1.82	1.82	1.80	17	100	11	11-#4	7-#4	9-#4	7-#4	1.84	1.85	1.86
17	150	15	0.785	36	72	97	10-#4 2	8-#4	14-#4	7-#4	9-#4	1.93	1.95	1.98	17	150	14	13-#4	7-#4	9-#4	7-#4	1.95	1.96	1.97
17	200	18	0.727	42	84	113	10-#4 2	10-#4	16-#4	7-#4	9-#4	2.12	2.14	2.09	17	200	16	10-#5	7-#4	9-#4	7-#4	2.09	2.09	2.10
17	250	21	0.687	47	95	127	10-#4 3	7-#5	12-#5	7-#4	9-#4	2.25	2.27	2.23	17	250	18	17-#4	8-#4	9-#4	7-#4	2.22	2.24	2.27
17	300	23	0.667	52	104	140	10-#4 3	8-#5	20-#4	8-#4	9-#4	2.44	2.44	2.50	17	300	22	13-#5	8-#4	9-#4	7-#4	2.41	2.41	2.40
17	350	26	0.612	57	113	152	11-#4 2	13-#4	11-#6	9-#4	9-#4	2.65	2.67	2.65	17	350	25	10-#6	9-#4	9-#4	7-#4	2.61	2.64	2.67
18	50	11	0.825	28	56	75	10-#4 1	8-#4	11-#4	8-#4	9-#4	1.82	1.82	1.83	18	50	10	10-#4	8-#4	9-#4	8-#4	1.79	1.81	1.82
18	100	14	0.795	36	72	96	10-#4 2	8-#4	14-#4	8-#4	9-#4	1.91	1.91	1.88	18	100	11	13-#4	8-#4	9-#4	8-#4	1.94	1.95	1.96
18	150	18	0.704	43	85	115	10-#4 2	10-#4	11-#5	8-#4	9-#4	2.07	2.09	2.02	18	150	14	10-#5	8-#4	9-#4	8-#4	2.07	2.08	2.10
18	200	21	0.671	49	98	132	10-#4 3	11-#4	13-#5	8-#4	9-#4	2.22	2.23	2.16	18	200	18	12-#5	8-#4	9-#4	8-#4	2.23	2.25	2.26
18	250	24	0.613	55	110	148	11-#4 2	13-#4	10-#6	9-#4	9-#4	2.42	2.45	2.48	18	250	21	20-#4	9-#4	9-#4	8-#4	2.38	2.40	2.43
18	300	26	0.626	61	122	164	12-#4 2	9-#5	16-#5	9-#4	9-#4	2.61	2.62	2.65	18	300	25	11-#6	10-#4	9-#4	8-#4	2.68	2.68	2.68
18	350	31	0.610	64	129	173	12-#4 2	10-#5	12-#6	10-#4	9-#4	2.77	2.81	2.96	18	350	31	23-#4	10-#4	9-#4	8-#4	2.62	2.67	2.72
19	50	13	0.822	33	65	88	11-#4 3	8-#4	13-#4	8-#4	10-#4	1.79	1.81	1.79	19	50	10	12-#4	8-#4	10-#4	8-#4	1.82	1.83	1.84
19	100	16	0.799	42	83	112	11-#4 4	10-#4	16-#4	8-#4	10-#4	1.96	1.98	1.93	19	100	12	15-#4	8-#4	10-#4	8-#4	1.96	1.97	1.98
19	150	20	0.686	50	99	134	11-#4 2	11-#4	13-#5	8-#4	10-#4	2.13	2.14	2.07	19	150	16	12-#5	8-#4	10-#4	8-#4	2.13	2.15	2.17
19	200	23	0.661	57	114	154	11-#4 3	13-#4	11-#6	9-#4	10-#4	2.35	2.38	2.41	19	200	20	14-#5	9-#4	10-#4	8-#4	2.36	2.39	2.42
19	250	26	0.612	64	128	172	12-#4 2	10-#5	12-#6	10-#4	10-#4	2.60	2.63	2.71	19	250	24	23-#4	10-#4	10-#4	8-#4	2.48	2.53	2.57
19	300	32	0.610	68	137	184	13-#4 2	16-#4	13-#6	10-#4	10-#4	2.74	2.77	2.88	19	300	31	12-#6	11-#4	10-#4	8-#4	2.76	2.79	2.82
19	350	37	0.609	72	143	193	14-#4 1	16-#4	11-#7	11-#4	10-#4	2.95	3.03	3.12	19	350	39	12-#6	11-#4	10-#4	8-#4	2.80	2.88	2.96

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel		
							Each Column Strip			Each Middle Strip		Steel (psf) Location of Panel		
				–M Ext.	+M Int.	–M 1st int.	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)								
7.5 in. = TOTAL THICKNESS OF SLAB														0.625 c.f./s.f.
20	50	14	0.824	38	76	103	11-#4 4	9-#4	15-#4	9-#4	10-#4	1.91	1.93	1.88
20	100	18	0.776	48	96	130	11-#4 5	11-#4	12-#5	9-#4	10-#4	2.08	2.09	2.07
20	150	22	0.669	57	114	154	11-#4 3	13-#4	11-#6	9-#4	10-#4	2.28	2.31	2.30
20	200	26	0.653	66	131	176	13-#4 4	10-#5	12-#6	10-#4	10-#4	2.57	2.59	2.61
20	250	31	0.612	72	144	193	14-#4 3	16-#4	11-#7	11-#4	10-#4	2.74	2.78	2.84
20	300	37	0.609	76	153	206	15-#4 3	12-#5	20-#5	8-#5	10-#4	3.00	3.04	3.11
20	350	43	0.608	80	160	215	15-#4 1	12-#5	15-#6	8-#5	10-#4	3.17	3.18	3.26
21	50	16	0.783	44	88	118	12-#4 3	10-#4	17-#4	9-#4	11-#4	1.93	1.94	1.89
21	100	21	0.703	55	110	148	12-#4 4	13-#4	14-#5	9-#4	11-#4	2.17	2.17	2.17
21	150	25	0.655	65	130	176	12-#4 5	10-#5	12-#6	10-#4	11-#4	2.44	2.46	2.47
21	200	30	0.610	74	148	199	14-#4 3	11-#5	14-#6	11-#4	11-#4	2.75	2.76	2.73
21	250	36	0.609	80	160	216	15-#4 3	12-#5	15-#6	12-#4	11-#4	2.93	2.95	3.04
21	300	43	0.608	85	169	228	16-#4 2	9-#6	12-#7	13-#4	11-#4	3.11	3.16	3.33
21	350	49	0.607	89	177	238	17-#4 2	20-#4	13-#7	9-#5	11-#4	3.28	3.33	3.42
22	50	18	0.755	50	100	134	12-#4 4	11-#4	13-#5	9-#4	11-#4	1.99	1.99	1.93
22	100	23	0.681	63	125	168	12-#4 5	14-#4	16-#5	10-#4	11-#4	2.24	2.25	2.23
22	150	28	0.611	74	148	200	14-#4 3	11-#5	14-#6	11-#4	11-#4	2.58	2.60	2.61
22	200	35	0.609	82	164	221	16-#4 4	9-#6	21-#5	13-#4	11-#4	2.88	2.90	2.98
22	250	42	0.608	88	177	238	17-#4 2	13-#5	13-#7	13-#4	11-#4	3.09	3.15	3.26
22	300	49	0.607	93	187	251	12-#5 2	10-#6	13-#7	14-#4	12-#4	3.34	3.38	3.52
22	350	56	0.606	97	194	261	12-#5 0	11-#6	14-#7	10-#5	12-#4	3.59	3.61	3.72
23	50	20	0.712	57	113	152	13-#4 3	13-#4	15-#5	10-#4	12-#4	2.09	2.11	2.08
23	100	25	0.642	71	142	191	13-#4 4	16-#4	13-#6	11-#4	12-#4	2.37	2.39	2.45
23	150	32	0.619	82	165	222	16-#4 4	13-#5	21-#5	13-#4	12-#4	2.77	2.78	2.87
23	200	40	0.608	91	181	244	17-#4 4	10-#6	13-#7	14-#4	12-#4	3.07	3.12	3.21
23	250	47	0.607	98	196	263	19-#4 3	11-#6	14-#7	10-#5	13-#4	3.39	3.43	3.52
23	300	55	0.606	102	204	275	19-#4 2	23-#4	15-#7	10-#5	13-#4	3.48	3.54	3.72
23	350	63	0.605	106	212	285	13-#5 0	16-#5	15-#7	16-#4	14-#4	3.63	3.72	3.85

SQUARE INTERIOR PANEL

(2) Span c.-c.	(3) Load	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf) Location of Panel		
			Column Strip		Middle Strip				
			Top	Bottom	Top	Bottom	I	IE	IC
(ft)	(psf)	(in.)							
7.5 in. = TOTAL THICKNESS OF SLAB									0.625 c.f./s.f.
20	50	10	14-#4	9-#4	10-#4	9-#4	1.94	1.95	1.96
20	100	14	12-#5	9-#4	10-#4	9-#4	2.15	2.15	2.15
20	150	19	14-#5	9-#4	10-#4	9-#4	2.30	2.33	2.36
20	200	23	16-#5	10-#4	10-#4	9-#4	2.50	2.52	2.54
20	250	30	17-#5	11-#4	10-#4	9-#4	2.66	2.74	2.82
20	300	38	13-#6	8-#5	10-#4	9-#4	2.90	2.92	2.94
20	350	46	11-#7	8-#5	10-#4	9-#4	3.14	3.14	3.14
21	50	11	16-#4	9-#4	11-#4	9-#4	1.96	1.97	1.98
21	100	16	13-#5	9-#4	11-#4	9-#4	2.15	2.16	2.17
21	150	21	16-#5	10-#4	11-#4	9-#4	2.40	2.42	2.44
21	200	27	13-#6	12-#4	11-#4	9-#4	2.71	2.73	2.75
21	250	36	14-#6	12-#4	11-#4	9-#4	2.84	2.87	2.89
21	300	45	20-#5	13-#4	11-#4	9-#4	2.94	3.00	3.06
21	350	53	15-#6	13-#4	11-#4	9-#4	3.08	3.15	3.22
22	50	13	12-#5	9-#4	11-#4	9-#4	1.98	1.99	2.00
22	100	18	15-#5	10-#4	11-#4	9-#4	2.22	2.23	2.24
22	150	23	13-#6	12-#4	11-#4	9-#4	2.56	2.58	2.60
22	200	33	20-#5	13-#4	11-#4	9-#4	2.74	2.76	2.77
22	250	43	15-#6	9-#5	11-#4	9-#4	2.95	3.01	3.07
22	300	52	12-#7	9-#5	11-#4	9-#4	3.11	3.15	3.19
22	350	61	13-#7	10-#5	11-#4	10-#4	3.39	3.44	3.48
23	50	14	14-#5	10-#4	12-#4	10-#4	2.12	2.13	2.14
23	100	20	17-#5	11-#4	12-#4	10-#4	2.36	2.39	2.41
23	150	28	20-#5	13-#4	12-#4	10-#4	2.67	2.68	2.69
23	200	39	16-#6	14-#4	12-#4	10-#4	2.94	2.97	3.01
23	250	49	13-#7	10-#5	12-#4	10-#4	3.21	3.25	3.29
23	300	60	13-#7	10-#5	12-#4	10-#4	3.26	3.33	3.41
23	350	69	14-#7	16-#4	12-#4	11-#4	3.51	3.56	3.61

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superimposed Load	(1) Min. Square Column		Total Panel Moments			SQUARE EDGE PANEL Reinforcing Bars					End Panel			(2)	(3)	(1)	SQUARE INTERIOR PANEL Reinforcing Bars				Steel (psf)		
				−M Ext.	+M Int.	−M 1st int.	Each Column Strip			Each Middle Strip		Steel (psf) Location of Panel			Span c.-c.	Load	Min. Sq. Col.	Column Strip		Middle Strip		Location of Panel		
							Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C				Top	Bottom	Top	Bottom	I	IE	IC
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)									(ft)	(psf)	(in.)							
8 in. = TOTAL THICKNESS OF SLAB														0.667 c.f./s.f.	8 in. = TOTAL THICKNESS OF SLAB									0.667 c.f./s.f.
16	50	10	0.759	20	41	55	8-#4 1	7-#4	8-#4	7-#4	8-#4	1.75	1.75	1.76	16	50	10	8-#4	7-#4	8-#4	7-#4	1.76	1.76	1.76
16	100	10	0.827	26	52	70	8-#4 2	7-#4	9-#4	7-#4	8-#4	1.78	1.78	1.77	16	100	11	9-#4	7-#4	8-#4	7-#4	1.81	1.81	1.82
16	150	12	0.778	31	62	84	8-#4 1	7-#4	11-#4	7-#4	8-#4	1.85	1.85	1.82	16	150	15	10-#4	7-#4	8-#4	7-#4	1.88	1.90	1.91
16	200	14	0.746	36	72	97	8-#4 1	8-#4	13-#4	7-#4	8-#4	1.99	1.99	1.92	16	200	16	8-#5	7-#4	8-#4	7-#4	2.02	2.02	2.03
16	250	17	0.657	41	82	110	8-#4 1	6-#5	10-#5	7-#4	8-#4	2.15	2.16	2.10	16	250	17	9-#5	7-#4	8-#4	7-#4	2.10	2.12	2.15
16	300	19	0.616	46	91	123	8-#4 1	10-#4	16-#4	7-#4	8-#4	2.22	2.22	2.22	16	300	18	10-#5	7-#4	8-#4	7-#4	2.19	2.20	2.20
16	350	21	0.615	50	100	135	9-#4 1	7-#5	12-#5	7-#4	8-#4	2.34	2.35	2.31	16	350	19	8-#6	7-#4	8-#4	7-#4	2.32	2.33	2.34
17	50	10	0.802	25	49	66	9-#4 1	8-#4	9-#4	8-#4	9-#4	1.85	1.85	1.85	17	50	10	9-#4	8-#4	9-#4	8-#4	1.85	1.85	1.85
17	100	11	0.833	31	63	85	9-#4 2	8-#4	11-#4	8-#4	9-#4	1.91	1.92	1.89	17	100	11	10-#4	8-#4	9-#4	8-#4	1.91	1.92	1.93
17	150	14	0.794	37	74	100	9-#4 3	8-#4	13-#4	8-#4	9-#4	1.99	2.00	1.94	17	150	15	12-#4	8-#4	9-#4	8-#4	2.02	2.03	2.04
17	200	17	0.732	43	86	116	9-#4 3	9-#4	10-#5	8-#4	9-#4	2.10	2.13	2.05	17	200	16	14-#4	8-#4	9-#4	8-#4	2.12	2.14	2.16
17	250	19	0.729	49	98	132	9-#4 4	10-#4	12-#5	8-#4	9-#4	2.25	2.26	2.24	17	250	17	11-#5	8-#4	9-#4	8-#4	2.28	2.30	2.32
17	300	22	0.661	54	109	146	10-#4 3	8-#5	9-#6	8-#4	9-#4	2.41	2.42	2.37	17	300	19	12-#5	8-#4	9-#4	8-#4	2.37	2.39	2.41
17	350	24	0.635	59	118	159	11-#4 2	8-#5	10-#6	8-#4	9-#4	2.51	2.54	2.57	17	350	22	13-#5	9-#4	9-#4	8-#4	2.54	2.57	2.59
18	50	10	0.839	29	59	79	9-#4 2	8-#4	11-#4	8-#4	9-#4	1.78	1.80	1.79	18	50	10	10-#4	8-#4	9-#4	8-#4	1.79	1.81	1.82
18	100	13	0.807	37	74	100	9-#4 3	8-#4	13-#4	8-#4	9-#4	1.87	1.88	1.85	18	100	11	12-#4	8-#4	9-#4	8-#4	1.89	1.90	1.91
18	150	16	0.754	44	88	119	9-#4 3	9-#4	16-#4	8-#4	9-#4	2.01	2.03	1.97	18	150	15	10-#5	8-#4	9-#4	8-#4	2.07	2.08	2.08
18	200	19	0.716	51	102	138	9-#4 4	7-#5	12-#5	8-#4	9-#4	2.15	2.17	2.15	18	200	16	17-#4	8-#4	9-#4	8-#4	2.14	2.16	2.18
18	250	22	0.654	57	115	155	10-#4 3	8-#5	10-#6	8-#4	9-#4	2.33	2.35	2.39	18	250	19	9-#6	8-#4	9-#4	8-#4	2.31	2.33	2.36
18	300	25	0.613	63	126	170	11-#4 2	13-#4	11-#6	9-#4	9-#4	2.51	2.52	2.56	18	300	22	10-#6	9-#4	9-#4	8-#4	2.50	2.52	2.55
18	350	27	0.612	69	137	185	12-#4 2	7-#6	16-#5	10-#4	9-#4	2.75	2.76	2.83	18	350	26	11-#6	10-#4	9-#4	8-#4	2.68	2.68	2.69
19	50	12	0.791	34	69	92	10-#4 1	9-#4	12-#4	9-#4	10-#4	1.90	1.91	1.90	19	50	10	11-#4	9-#4	10-#4	9-#4	1.92	1.93	1.94
19	100	15	0.762	44	87	117	10-#4 2	9-#4	10-#5	9-#4	10-#4	2.03	2.03	1.96	19	100	11	10-#5	9-#4	10-#4	9-#4	2.12	2.12	2.12
19	150	18	0.733	52	104	139	10-#4 3	11-#4	12-#5	9-#4	10-#4	2.17	2.19	2.15	19	150	15	17-#4	9-#4	10-#4	9-#4	2.19	2.21	2.23
19	200	22	0.635	59	119	160	11-#4 2	8-#5	10-#6	8-#4	10-#4	2.31	2.33	2.31	19	200	18	13-#5	9-#4	10-#4	9-#4	2.35	2.38	2.40
19	250	25	0.613	66	133	179	12-#4 2	9-#5	16-#5	9-#4	10-#4	2.53	2.54	2.52	19	250	22	11-#6	10-#4	10-#4	9-#4	2.62	2.62	2.63
19	300	28	0.612	73	146	196	13-#4 3	10-#5	17-#5	10-#4	10-#4	2.72	2.75	2.83	19	300	26	16-#5	11-#4	10-#4	9-#4	2.72	2.74	2.75
19	350	31	0.618	78	156	210	14-#4 3	8-#6	10-#7	11-#4	10-#4	2.99	3.03	3.04	19	350	32	17-#5	11-#4	10-#4	9-#4	2.82	2.87	2.92
20	50	13	0.796	40	80	108	10-#4 2	9-#4	14-#4	9-#4	10-#4	1.86	1.88	1.85	20	50	10	13-#4	9-#4	10-#4	9-#4	1.90	1.91	1.92
20	100	17	0.737	50	101	135	10-#4 3	11-#4	12-#5	9-#4	10-#4	2.08	2.10	2.06	20	100	13	11-#5	9-#4	10-#4	9-#4	2.08	2.10	2.11
20	150	21	0.649	60	119	160	11-#4 2	8-#5	10-#6	9-#4	10-#4	2.25	2.27	2.24	20	150	17	13-#5	9-#4	10-#4	9-#4	2.23	2.25	2.27
20	200	24	0.690	68	137	184	12-#4 5	14-#4	16-#5	10-#4	10-#4	2.45	2.46	2.42	20	200	21	11-#6	10-#4	10-#4	9-#4	2.48	2.48	2.48
20	250	27	0.650	76	153	206	13-#4 4	16-#4	10-#7	11-#4	10-#4	2.69	2.73	2.80	20	250	25	12-#6	11-#4	10-#4	9-#4	2.66	2.70	2.74
20	300	32	0.617	82	165	222	10-#5 2	17-#4	11-#7	8-#5	10-#4	2.96	3.01	3.07	20	300	31	10-#7	8-#5	10-#4	9-#4	2.92	2.96	2.99
20	350	37	0.609	87	173	233	10-#5 1	12-#5	11-#7	8-#5	10-#4	3.13	3.14	3.23	20	350	39	11-#7	8-#5	10-#4	9-#4	3.10	3.10	3.10

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel		
							Each Column Strip			Each Middle Strip		Steel (psf)		
												Location of Panel		
(ft)	(psf)	(in.)	γ_f	–M Ext. (ft-kip)	+M Int. (ft-kip)	–M 1st int. (ft-kip)	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C
8 in. = TOTAL THICKNESS OF SLAB														0.667 c.f./s.f.
21	50	15	0.795	46	92	124	11-#4 4	10-#4	16-#4	10-#4	11-#4	1.98	2.00	1.94
21	100	19	0.747	58	115	155	11-#4 5	8-#5	14-#5	10-#4	11-#4	2.20	2.21	2.17
21	150	23	0.696	68	137	184	12-#4 5	14-#4	16-#5	10-#4	11-#4	2.38	2.38	2.33
21	200	27	0.622	78	156	209	14-#4 3	16-#4	11-#7	11-#4	11-#4	2.64	2.69	2.73
21	250	31	0.611	86	172	232	15-#4 3	12-#5	11-#7	8-#5	11-#4	2.94	2.97	3.01
21	300	37	0.609	92	183	247	16-#4 2	9-#6	12-#7	13-#4	11-#4	3.12	3.17	3.26
21	350	43	0.608	96	192	258	11-#5 2	20-#4	13-#7	9-#5	11-#4	3.28	3.34	3.44
22	50	17	0.768	53	106	142	11-#4 5	11-#4	12-#5	10-#4	11-#4	1.99	2.00	1.93
22	100	21	0.725	66	131	177	12-#4 5	9-#5	23-#4	10-#4	11-#4	2.25	2.24	2.21
22	150	25	0.681	78	155	209	14-#4 4	16-#4	13-#6	11-#4	11-#4	2.48	2.50	2.56
22	200	30	0.657	88	177	238	16-#4 5	12-#5	15-#6	12-#4	11-#4	2.80	2.82	2.88
22	250	36	0.610	96	191	257	11-#5 2	13-#5	13-#7	13-#4	11-#4	3.05	3.11	3.27
22	300	43	0.608	101	202	272	12-#5 2	10-#6	13-#7	14-#4	12-#4	3.30	3.34	3.52
22	350	49	0.607	106	212	285	12-#5 2	11-#6	11-#8	10-#5	13-#4	3.56	3.61	3.73
23	50	19	0.724	60	119	161	12-#4 4	13-#4	14-#5	10-#4	12-#4	2.04	2.05	2.01
23	100	23	0.704	74	149	200	13-#4 5	10-#5	13-#6	10-#4	12-#4	2.31	2.33	2.37
23	150	28	0.663	88	175	236	15-#4 6	12-#5	15-#6	12-#4	12-#4	2.66	2.69	2.74
23	200	35	0.610	98	195	263	17-#4 4	10-#6	13-#7	9-#5	12-#4	3.03	3.06	3.19
23	250	42	0.608	105	210	283	12-#5 2	11-#6	14-#7	10-#5	12-#4	3.33	3.38	3.53
23	300	49	0.607	111	222	298	19-#4 2	23-#4	19-#6	10-#5	13-#4	3.42	3.44	3.56
23	350	56	0.606	115	231	311	20-#4 1	16-#5	12-#8	16-#4	9-#5	3.63	3.70	3.85
24	50	20	0.771	67	135	181	13-#4 7	9-#5	16-#5	11-#4	13-#4	2.18	2.20	2.16
24	100	26	0.664	83	167	224	15-#4 5	12-#5	14-#6	12-#4	13-#4	2.56	2.57	2.55
24	150	32	0.613	98	195	263	17-#4 4	10-#6	13-#7	9-#5	13-#4	2.95	2.98	3.00
24	200	40	0.609	107	215	289	19-#4 3	11-#6	14-#7	10-#5	13-#4	3.21	3.26	3.40
24	250	47	0.607	115	231	311	13-#5 2	16-#5	12-#8	16-#4	9-#5	3.47	3.50	3.57
24	300	55	0.606	121	243	327	14-#5 1	9-#7	13-#8	11-#5	14-#4	3.73	3.81	3.95
24	350	63	0.606	125	251	338	22-#4 0	10-#7	13-#8	12-#5	10-#5	4.01	4.04	4.15
25	50	22	0.746	75	151	203	13-#4 8	16-#4	13-#6	11-#4	13-#4	2.24	2.26	2.25
25	100	28	0.646	94	187	252	16-#4 5	13-#5	16-#6	13-#4	13-#4	2.64	2.66	2.70
25	150	36	0.633	108	216	290	19-#4 6	11-#6	14-#7	10-#5	13-#4	3.08	3.11	3.24
25	200	44	0.608	118	237	319	14-#5 3	12-#6	13-#8	11-#5	14-#4	3.47	3.51	3.54
25	250	53	0.607	126	252	339	22-#4 2	10-#7	13-#8	12-#5	10-#5	3.75	3.81	3.93
25	300	61	0.606	132	264	355	15-#5 1	10-#7	14-#8	12-#5	10-#5	3.98	4.05	4.20
25	350	69	0.605	137	273	368	16-#5 0	14-#6	14-#8	19-#4	16-#4	4.10	4.14	4.27

SQUARE INTERIOR PANEL

(2) Span c.-c. (ft)	(3) Load (psf)	(1) Min. Sq. Col. (in.)	Reinforcing Bars				Steel (psf)		
			Column Strip		Middle Strip		Location of Panel		
			Top	Bottom	Top	Bottom	I	IE	IC
8 in. = TOTAL THICKNESS OF SLAB									0.667 c.f./s.f.
21	50	10	16-#4	10-#4	11-#4	10-#4	2.05	2.05	2.05
21	100	15	13-#5	10-#4	11-#4	10-#4	2.23	2.25	2.26
21	150	19	11-#6	10-#4	11-#4	10-#4	2.43	2.43	2.43
21	200	24	17-#5	11-#4	11-#4	10-#4	2.58	2.65	2.72
21	250	30	11-#7	8-#5	11-#4	10-#4	2.98	2.98	2.97
21	300	38	20-#5	13-#4	11-#4	10-#4	2.95	3.01	3.06
21	350	46	15-#6	13-#4	11-#4	10-#4	3.09	3.16	3.23
22	50	11	12-#5	10-#4	11-#4	10-#4	2.06	2.06	2.06
22	100	17	11-#6	10-#4	11-#4	10-#4	2.31	2.29	2.27
22	150	22	17-#5	11-#4	11-#4	10-#4	2.45	2.48	2.50
22	200	26	11-#7	13-#4	11-#4	10-#4	2.85	2.85	2.85
22	250	36	15-#6	9-#5	11-#4	10-#4	2.96	3.02	3.08
22	300	45	12-#7	14-#4	11-#4	10-#4	3.10	3.14	3.18
22	350	53	13-#7	10-#5	11-#4	10-#4	3.35	3.42	3.48
23	50	13	13-#5	10-#4	12-#4	10-#4	2.06	2.07	2.08
23	100	19	12-#6	11-#4	12-#4	10-#4	2.38	2.40	2.41
23	150	24	14-#6	13-#4	12-#4	10-#4	2.66	2.68	2.70
23	200	32	12-#7	9-#5	12-#4	10-#4	2.95	2.97	3.00
23	250	42	13-#7	10-#5	12-#4	10-#4	3.18	3.21	3.24
23	300	52	13-#7	10-#5	12-#4	10-#4	3.22	3.26	3.30
23	350	61	14-#7	16-#4	12-#4	11-#4	3.47	3.54	3.61
24	50	15	15-#5	11-#4	13-#4	11-#4	2.22	2.23	2.24
24	100	21	14-#6	12-#4	13-#4	11-#4	2.56	2.56	2.56
24	150	27	12-#7	9-#5	13-#4	11-#4	2.88	2.91	2.93
24	200	38	13-#7	10-#5	13-#4	11-#4	3.10	3.13	3.16
24	250	49	14-#7	16-#4	13-#4	11-#4	3.29	3.34	3.40
24	300	59	19-#6	11-#5	13-#4	11-#4	3.40	3.49	3.59
24	350	69	12-#8	17-#4	13-#4	12-#4	3.67	3.74	3.80
25	50	17	17-#5	11-#4	13-#4	11-#4	2.24	2.26	2.28
25	100	23	15-#6	13-#4	13-#4	11-#4	2.59	2.61	2.63
25	150	32	13-#7	10-#5	13-#4	11-#4	2.95	2.97	3.00
25	200	44	14-#7	11-#5	13-#4	11-#4	3.19	3.28	3.36
25	250	56	15-#7	12-#5	14-#4	12-#4	3.48	3.55	3.62
25	300	67	13-#8	12-#5	14-#4	12-#4	3.75	3.81	3.86
25	350	77	13-#8	12-#5	14-#4	12-#4	3.81	3.86	3.92

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL															SQUARE INTERIOR PANEL									
SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2) Span c.-c.	(3) Load	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf)		
							Each Column Strip			Each Middle Strip		Steel (psf)						Column Strip		Middle Strip		Location of Panel		
				–M Ext.	+M Int.	–M 1st int.						Location of Panel												
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C	(ft)	(psf)	(in.)	Top	Bottom	Top	Bottom	I	IE	IC
8.5 in. = TOTAL THICKNESS OF SLAB														0.708 c.f./s.f.	8.5 in. = TOTAL THICKNESS OF SLAB									0.708 c.f./s.f.
17	50	10	0.782	26	51	69	9-#4 1	8-#4	9-#4	8-#4	6-#5	1.86	1.86	1.85	17	50	10	9-#4	8-#4	6-#5	8-#4	1.87	1.87	1.87
17	100	10	0.845	33	66	88	9-#4 2	8-#4	11-#4	8-#4	6-#5	1.91	1.92	1.89	17	100	10	10-#4	8-#4	6-#5	8-#4	1.92	1.93	1.94
17	150	13	0.786	38	77	103	9-#4 2	8-#4	13-#4	8-#4	6-#5	2.00	2.00	1.94	17	150	15	8-#5	8-#4	6-#5	8-#4	2.06	2.06	2.07
17	200	15	0.780	44	89	120	9-#4 3	6-#5	10-#5	8-#4	6-#5	2.12	2.13	2.03	17	200	17	9-#5	8-#4	6-#5	8-#4	2.14	2.16	2.18
17	250	18	0.711	50	100	135	9-#4 3	10-#4	8-#6	8-#4	6-#5	2.22	2.24	2.19	17	250	18	10-#5	8-#4	6-#5	8-#4	2.22	2.25	2.28
17	300	20	0.620	56	112	150	9-#4 1	7-#5	12-#5	8-#4	6-#5	2.30	2.32	2.27	17	300	19	8-#6	8-#4	6-#5	8-#4	2.35	2.36	2.37
17	350	22	0.676	61	123	165	10-#4 3	8-#5	10-#6	8-#4	6-#5	2.48	2.49	2.51	17	350	20	9-#6	8-#4	6-#5	8-#4	2.47	2.49	2.52
18	50	10	0.820	31	61	82	9-#4 2	9-#4	10-#4	9-#4	9-#4	1.91	1.93	1.92	18	50	10	9-#4	9-#4	9-#4	9-#4	1.90	1.91	1.92
18	100	12	0.818	39	78	105	9-#4 3	9-#4	13-#4	9-#4	9-#4	2.00	2.01	1.97	18	100	10	12-#4	9-#4	9-#4	9-#4	2.03	2.05	2.06
18	150	15	0.763	46	91	123	9-#4 3	9-#4	10-#5	9-#4	9-#4	2.09	2.11	2.05	18	150	15	9-#5	9-#4	9-#4	9-#4	2.15	2.17	2.18
18	200	18	0.722	52	105	141	9-#4 4	10-#4	17-#4	9-#4	9-#4	2.20	2.21	2.19	18	200	17	16-#4	9-#4	9-#4	9-#4	2.25	2.26	2.27
18	250	20	0.701	60	119	160	10-#4 3	8-#5	13-#5	9-#4	9-#4	2.38	2.40	2.35	18	250	18	12-#5	9-#4	9-#4	9-#4	2.38	2.40	2.41
18	300	23	0.632	66	131	177	11-#4 2	13-#4	11-#6	9-#4	9-#4	2.56	2.59	2.51	18	300	20	10-#6	9-#4	9-#4	9-#4	2.56	2.59	2.62
18	350	25	0.636	72	143	193	12-#4 2	9-#5	16-#5	9-#4	9-#4	2.66	2.67	2.65	18	350	23	11-#6	10-#4	9-#4	9-#4	2.74	2.74	2.75
19	50	11	0.807	36	72	97	10-#4 1	9-#4	12-#4	9-#4	10-#4	1.90	1.90	1.89	19	50	10	11-#4	9-#4	10-#4	9-#4	1.92	1.93	1.94
19	100	14	0.775	46	91	123	10-#4 2	9-#4	10-#5	9-#4	10-#4	2.01	2.02	1.96	19	100	10	14-#4	9-#4	10-#4	9-#4	2.05	2.06	2.08
19	150	17	0.741	53	107	144	10-#4 3	7-#5	12-#5	9-#4	10-#4	2.21	2.22	2.16	19	150	15	11-#5	9-#4	10-#4	9-#4	2.20	2.22	2.24
19	200	20	0.685	62	123	166	10-#4 3	8-#5	20-#4	9-#4	10-#4	2.31	2.32	2.29	19	200	17	9-#6	9-#4	10-#4	9-#4	2.35	2.34	2.34
19	250	23	0.649	69	138	186	11-#4 3	9-#5	11-#6	9-#4	10-#4	2.50	2.52	2.47	19	250	20	10-#6	9-#4	10-#4	9-#4	2.46	2.48	2.51
19	300	26	0.613	76	152	204	12-#4 2	7-#6	9-#7	10-#4	10-#4	2.70	2.72	2.72	19	300	23	16-#5	10-#4	10-#4	9-#4	2.64	2.67	2.69
19	350	28	0.613	82	165	222	9-#5 1	16-#4	10-#7	7-#5	10-#4	2.86	2.89	2.96	19	350	27	9-#7	7-#5	10-#4	9-#4	2.84	2.88	2.91
20	50	12	0.810	42	84	113	10-#4 2	10-#4	14-#4	10-#4	10-#4	1.98	1.98	1.96	20	50	10	13-#4	10-#4	10-#4	10-#4	2.00	2.01	2.02
20	100	16	0.748	53	105	142	10-#4 3	10-#4	17-#4	10-#4	10-#4	2.09	2.09	2.02	20	100	11	11-#5	10-#4	10-#4	10-#4	2.17	2.17	2.17
20	150	19	0.720	62	125	168	10-#4 4	8-#5	10-#6	10-#4	10-#4	2.27	2.29	2.22	20	150	15	13-#5	10-#4	10-#4	10-#4	2.32	2.34	2.36
20	200	23	0.673	71	142	191	12-#4 4	9-#5	11-#6	9-#4	10-#4	2.45	2.46	2.40	20	200	19	11-#6	10-#4	10-#4	10-#4	2.52	2.52	2.52
20	250	26	0.645	79	158	213	13-#4 4	10-#5	26-#4	10-#4	10-#4	2.61	2.63	2.71	20	250	23	16-#5	11-#4	10-#4	10-#4	2.61	2.62	2.63
20	300	29	0.612	87	173	233	14-#4 3	8-#6	11-#7	11-#4	10-#4	2.95	2.97	2.96	20	300	27	10-#7	8-#5	10-#4	10-#4	2.95	2.98	3.01
20	350	32	0.637	93	187	251	10-#5 3	12-#5	11-#7	8-#5	10-#4	3.14	3.14	3.25	20	350	32	11-#7	8-#5	10-#4	10-#4	3.11	3.11	3.11
21	50	14	0.809	48	97	130	11-#4 4	10-#4	16-#4	10-#4	11-#4	1.98	1.99	1.94	21	50	10	10-#5	10-#4	11-#4	10-#4	2.03	2.04	2.04
21	100	18	0.756	60	121	162	11-#4 5	8-#5	13-#5	10-#4	11-#4	2.18	2.19	2.10	21	100	13	13-#5	10-#4	11-#4	10-#4	2.23	2.23	2.22
21	150	22	0.700	71	142	191	12-#4 5	9-#5	11-#6	10-#4	11-#4	2.38	2.39	2.35	21	150	18	11-#6	10-#4	11-#4	10-#4	2.42	2.42	2.42
21	200	25	0.662	81	162	218	13-#4 4	16-#4	10-#7	11-#4	11-#4	2.60	2.64	2.68	21	200	22	12-#6	11-#4	11-#4	10-#4	2.59	2.63	2.66
21	250	28	0.679	91	181	244	10-#5 3	12-#5	20-#5	8-#5	11-#4	2.88	2.91	2.97	21	250	26	10-#7	8-#5	11-#4	10-#4	2.83	2.84	2.84
21	300	32	0.611	99	197	265	16-#4 2	9-#6	12-#7	13-#4	11-#4	3.09	3.13	3.19	21	300	31	20-#5	13-#4	11-#4	10-#4	2.92	2.97	3.03
21	350	38	0.610	103	206	278	11-#5 2	13-#5	10-#8	13-#4	11-#4	3.24	3.30	3.41	21	350	39	15-#6	9-#5	11-#4	10-#4	3.12	3.19	3.25

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel		
							Each Column Strip			Each Middle Strip		Steel (psf) Location of Panel		
				–M Ext.	+M Int.	–M 1st int.	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)								
8.5 in. = TOTAL THICKNESS OF SLAB														0.708 c.f./s.f.
22	50	16	0.781	56	111	149	11-#4 5	11-#4	12-#5	11-#4	11-#4	2.07	2.08	2.03
22	100	20	0.733	69	137	185	11-#4 6	13-#4	11-#6	11-#4	11-#4	2.26	2.28	2.23
22	150	24	0.665	81	161	217	13-#4 4	16-#4	13-#6	11-#4	11-#4	2.51	2.54	2.55
22	200	28	0.613	92	184	248	15-#4 3	12-#5	20-#5	8-#5	11-#4	2.81	2.82	2.83
22	250	32	0.611	102	204	275	11-#5 2	13-#5	12-#7	13-#4	11-#4	3.06	3.09	3.14
22	300	38	0.610	108	217	292	12-#5 2	10-#6	13-#7	9-#5	8-#5	3.29	3.33	3.39
22	350	44	0.609	114	227	306	12-#5 2	8-#7	11-#8	10-#5	8-#5	3.56	3.61	3.65
23	50	18	0.737	63	126	169	12-#4 4	12-#4	14-#5	11-#4	12-#4	2.08	2.10	2.06
23	100	22	0.694	78	155	209	13-#4 4	10-#5	12-#6	11-#4	12-#4	2.36	2.38	2.31
23	150	26	0.699	91	183	246	15-#4 6	12-#5	20-#5	12-#4	12-#4	2.67	2.68	2.70
23	200	30	0.654	104	208	280	11-#5 3	20-#4	13-#7	9-#5	12-#4	3.00	3.04	3.07
23	250	37	0.610	112	225	303	12-#5 2	11-#6	11-#8	10-#5	12-#4	3.37	3.40	3.47
23	300	43	0.609	119	239	322	19-#4 4	23-#4	11-#8	10-#5	13-#4	3.35	3.40	3.58
23	350	50	0.608	124	249	335	20-#4 3	16-#5	12-#8	16-#4	9-#5	3.63	3.68	3.84
24	50	19	0.744	71	142	191	13-#4 4	9-#5	23-#4	12-#4	13-#4	2.22	2.22	2.10
24	100	24	0.718	88	175	236	14-#4 7	11-#5	14-#6	11-#4	13-#4	2.45	2.47	2.43
24	150	29	0.635	102	205	276	17-#4 4	13-#5	12-#7	13-#4	13-#4	2.82	2.83	2.81
24	200	35	0.610	115	230	309	12-#5 2	11-#6	14-#7	10-#5	13-#4	3.22	3.25	3.33
24	250	42	0.609	124	247	333	13-#5 2	16-#5	12-#8	16-#4	9-#5	3.41	3.45	3.55
24	300	49	0.608	131	261	352	14-#5 1	9-#7	12-#8	11-#5	14-#4	3.62	3.67	3.81
24	350	56	0.607	136	272	367	22-#4 2	10-#7	13-#8	12-#5	10-#5	3.97	4.03	4.12
25	50	21	0.717	80	159	214	13-#4 5	10-#5	17-#5	12-#4	13-#4	2.25	2.25	2.18
25	100	26	0.699	98	196	264	16-#4 6	9-#6	12-#7	13-#4	13-#4	2.60	2.65	2.66
25	150	32	0.671	115	229	308	12-#5 5	11-#6	14-#7	10-#5	13-#4	3.05	3.08	3.12
25	200	40	0.609	126	252	339	20-#4 5	16-#5	12-#8	16-#4	9-#5	3.28	3.31	3.41
25	250	47	0.608	135	271	364	22-#4 4	10-#7	13-#8	12-#5	10-#5	3.71	3.80	3.95
25	300	55	0.607	142	285	383	15-#5 1	10-#7	17-#7	12-#5	10-#5	3.88	3.94	4.12
25	350	63	0.606	148	295	397	16-#5 0	14-#6	14-#8	9-#6	16-#4	4.09	4.16	4.34
26	50	23	0.720	89	178	239	14-#4 7	17-#4	14-#6	12-#4	13-#4	2.28	2.30	2.26
26	100	29	0.675	109	218	293	18-#4 7	10-#6	13-#7	14-#4	13-#4	2.75	2.77	2.85
26	150	36	0.612	126	252	339	20-#4 5	16-#5	15-#7	16-#4	14-#4	3.09	3.13	3.24
26	200	44	0.609	138	276	372	22-#4 5	10-#7	13-#8	12-#5	10-#5	3.59	3.66	3.74
26	250	53	0.607	147	295	397	16-#5 2	14-#6	14-#8	19-#4	16-#4	3.88	3.95	4.11
26	300	61	0.606	154	309	415	25-#4 3	20-#5	15-#8	13-#5	11-#5	4.10	4.14	4.23
26	350	70	0.606	159	319	429	17-#5 0	11-#7	15-#8	10-#6	17-#4	4.29	4.32	4.48

SQUARE INTERIOR PANEL

(2) Span c.-c.	(3) Load	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf) Location of Panel		
			Column Strip		Middle Strip				
			Top	Bottom	Top	Bottom	I	IE	IC
(ft)	(psf)	(in.)							
8.5 in. = TOTAL THICKNESS OF SLAB									0.708 c.f./s.f.
22	50	10	17-#4	11-#4	11-#4	11-#4	2.11	2.13	2.14
22	100	15	14-#5	11-#4	11-#4	11-#4	2.31	2.34	2.36
22	150	20	12-#6	11-#4	11-#4	11-#4	2.52	2.54	2.56
22	200	24	11-#7	8-#5	11-#4	11-#4	2.87	2.84	2.82
22	250	29	15-#6	9-#5	11-#4	11-#4	2.99	3.01	3.04
22	300	38	12-#7	14-#4	11-#4	11-#4	3.13	3.18	3.22
22	350	46	13-#7	10-#5	8-#5	11-#4	3.43	3.47	3.52
23	50	12	13-#5	11-#4	12-#4	11-#4	2.17	2.18	2.19
23	100	17	16-#5	11-#4	12-#4	11-#4	2.36	2.37	2.39
23	150	22	11-#7	12-#4	12-#4	11-#4	2.73	2.71	2.69
23	200	27	12-#7	9-#5	12-#4	11-#4	2.98	3.01	3.04
23	250	36	13-#7	10-#5	12-#4	11-#4	3.21	3.25	3.29
23	300	45	13-#7	10-#5	12-#4	11-#4	3.25	3.30	3.35
23	350	54	11-#8	16-#4	12-#4	11-#4	3.48	3.54	3.59
24	50	14	15-#5	12-#4	13-#4	12-#4	2.30	2.29	2.29
24	100	19	13-#6	12-#4	13-#4	12-#4	2.52	2.53	2.55
24	150	25	15-#6	9-#5	13-#4	12-#4	2.81	2.83	2.86
24	200	32	13-#7	10-#5	13-#4	12-#4	3.12	3.14	3.17
24	250	42	14-#7	16-#4	13-#4	12-#4	3.29	3.35	3.40
24	300	52	19-#6	11-#5	13-#4	11-#4	3.36	3.42	3.48
24	350	61	12-#8	12-#5	9-#5	12-#4	3.74	3.79	3.85
25	50	15	12-#6	12-#4	13-#4	12-#4	2.33	2.32	2.32
25	100	21	20-#5	13-#4	13-#4	12-#4	2.54	2.58	2.63
25	150	27	13-#7	10-#5	13-#4	12-#4	2.97	2.99	3.01
25	200	38	14-#7	11-#5	13-#4	12-#4	3.20	3.25	3.30
25	250	49	12-#8	12-#5	9-#5	12-#4	3.52	3.57	3.62
25	300	59	12-#8	12-#5	14-#4	12-#4	3.57	3.62	3.67
25	350	69	13-#8	19-#4	10-#5	13-#4	3.89	3.93	3.97
26	50	17	13-#6	12-#4	13-#4	12-#4	2.31	2.33	2.34
26	100	24	16-#6	10-#5	13-#4	12-#4	2.71	2.74	2.77
26	150	32	14-#7	11-#5	13-#4	12-#4	3.05	3.08	3.11
26	200	44	13-#8	12-#5	14-#4	12-#4	3.49	3.50	3.51
26	250	55	13-#8	19-#4	10-#5	13-#4	3.66	3.69	3.73
26	300	67	13-#8	13-#5	10-#5	13-#4	3.78	3.86	3.94
26	350	77	14-#8	20-#4	10-#5	14-#4	3.98	4.03	4.08

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

SQUARE EDGE PANEL

SQUARE INTERIOR PANEL

f'_c = 4,000 psi
Grade 60 Bars

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2) Span c.-c.	(3) Load	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf)		
				–M Ext.	+M Int.	–M 1st int.	Each Column Strip			Each Middle Strip		Steel (psf)						Column Strip		Middle Strip		Location of Panel		
							Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Location of Panel												
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)						E	EC	C	(ft)	(psf)	(in.)	Top	Bottom	Top	Bottom	I	IE	IC
9 in. = TOTAL THICKNESS OF SLAB														0.750 c.f./s.f.	9 in. = TOTAL THICKNESS OF SLAB									0.750 c.f./s.f.
18	50	10	0.782	32	64	86	9-#4 1	6-#5	10-#4	6-#5	6-#5	1.93	1.94	1.90	18	50	10	9-#4	6-#5	6-#5	6-#5	1.94	1.95	1.96
18	100	11	0.830	40	81	109	9-#4 3	6-#5	8-#5	6-#5	6-#5	2.03	2.04	1.99	18	100	10	8-#5	6-#5	6-#5	6-#5	2.10	2.10	2.10
18	150	14	0.774	47	94	127	9-#4 3	6-#5	10-#5	6-#5	6-#5	2.10	2.12	2.07	18	150	15	13-#4	6-#5	6-#5	6-#5	2.14	2.17	2.20
18	200	16	0.769	54	108	146	9-#4 4	10-#4	8-#6	6-#5	6-#5	2.25	2.27	2.20	18	200	17	10-#5	6-#5	6-#5	6-#5	2.27	2.30	2.32
18	250	19	0.704	61	122	164	9-#4 4	11-#4	9-#6	6-#5	6-#5	2.36	2.37	2.26	18	250	18	12-#5	6-#5	6-#5	6-#5	2.42	2.44	2.45
18	300	21	0.701	68	136	183	10-#4 4	8-#5	10-#6	6-#5	6-#5	2.50	2.52	2.45	18	300	19	13-#5	6-#5	6-#5	6-#5	2.50	2.52	2.55
18	350	24	0.615	74	148	199	11-#4 2	9-#5	8-#7	6-#5	6-#5	2.64	2.66	2.62	18	350	21	10-#6	6-#5	6-#5	6-#5	2.61	2.63	2.65
19	50	10	0.822	38	75	102	10-#4 1	10-#4	12-#4	10-#4	10-#4	2.02	2.02	2.02	19	50	10	11-#4	10-#4	10-#4	10-#4	2.02	2.03	2.04
19	100	13	0.787	47	94	127	10-#4 2	10-#4	10-#5	10-#4	10-#4	2.11	2.12	2.09	19	100	10	9-#5	10-#4	10-#4	10-#4	2.15	2.17	2.18
19	150	16	0.751	55	110	149	10-#4 3	10-#4	11-#5	10-#4	10-#4	2.20	2.21	2.13	19	150	15	16-#4	10-#4	10-#4	10-#4	2.25	2.27	2.28
19	200	19	0.691	63	127	171	10-#4 3	8-#5	9-#6	10-#4	10-#4	2.36	2.38	2.27	19	200	17	12-#5	10-#4	10-#4	10-#4	2.38	2.40	2.41
19	250	21	0.695	72	144	193	11-#4 3	13-#4	11-#6	10-#4	10-#4	2.50	2.52	2.42	19	250	18	10-#6	10-#4	10-#4	10-#4	2.55	2.58	2.60
19	300	24	0.631	78	157	211	12-#4 2	14-#4	16-#5	10-#4	10-#4	2.60	2.62	2.64	19	300	22	11-#6	10-#4	10-#4	10-#4	2.67	2.67	2.68
19	350	26	0.636	85	171	230	13-#4 2	10-#5	10-#7	10-#4	10-#4	2.79	2.83	2.86	19	350	25	16-#5	7-#5	10-#4	10-#4	2.77	2.83	2.89
20	50	11	0.824	44	88	118	10-#4 2	10-#4	9-#5	10-#4	10-#4	2.00	2.00	1.98	20	50	10	13-#4	10-#4	10-#4	10-#4	2.00	2.01	2.02
20	100	15	0.760	55	110	148	10-#4 3	10-#4	11-#5	10-#4	10-#4	2.05	2.07	2.03	20	100	10	16-#4	10-#4	10-#4	10-#4	2.12	2.13	2.14
20	150	18	0.729	64	129	173	10-#4 4	8-#5	13-#5	10-#4	10-#4	2.24	2.25	2.16	20	150	15	12-#5	10-#4	10-#4	10-#4	2.25	2.27	2.28
20	200	21	0.677	74	148	199	11-#4 3	9-#5	11-#6	10-#4	10-#4	2.43	2.44	2.33	20	200	17	10-#6	10-#4	10-#4	10-#4	2.42	2.44	2.46
20	250	24	0.684	82	164	221	13-#4 4	7-#6	9-#7	10-#4	10-#4	2.59	2.61	2.61	20	250	21	16-#5	10-#4	10-#4	10-#4	2.54	2.56	2.59
20	300	27	0.614	90	180	242	9-#5 1	16-#4	10-#7	7-#5	10-#4	2.71	2.75	2.82	20	300	25	17-#5	11-#4	10-#4	10-#4	2.69	2.73	2.77
20	350	30	0.613	97	195	262	10-#5 2	12-#5	20-#5	8-#5	10-#4	3.00	3.04	3.11	20	350	28	10-#7	8-#5	10-#4	10-#4	2.96	2.96	2.97
21	50	13	0.821	51	101	137	11-#4 4	7-#5	10-#5	7-#5	7-#5	2.10	2.10	2.06	21	50	10	10-#5	7-#5	7-#5	7-#5	2.16	2.16	2.16
21	100	17	0.767	63	126	169	11-#4 5	8-#5	13-#5	7-#5	7-#5	2.25	2.26	2.17	21	100	12	12-#5	7-#5	7-#5	7-#5	2.29	2.30	2.32
21	150	20	0.689	74	148	199	11-#4 3	9-#5	11-#6	7-#5	7-#5	2.40	2.43	2.37	21	150	16	10-#6	7-#5	7-#5	7-#5	2.45	2.47	2.49
21	200	24	0.664	84	168	226	13-#4 4	7-#6	17-#5	7-#5	7-#5	2.60	2.61	2.53	21	200	20	16-#5	7-#5	7-#5	7-#5	2.57	2.58	2.60
21	250	27	0.618	94	187	252	14-#4 3	8-#6	11-#7	11-#4	7-#5	2.86	2.88	2.80	21	250	24	10-#7	8-#5	7-#5	7-#5	2.89	2.92	2.95
21	300	30	0.635	103	205	276	10-#5 3	12-#5	15-#6	8-#5	7-#5	3.04	3.05	3.11	21	300	28	11-#7	13-#4	7-#5	7-#5	3.07	3.07	3.07
21	350	33	0.612	111	222	298	11-#5 2	7-#7	10-#8	9-#5	11-#4	3.31	3.37	3.49	21	350	32	15-#6	9-#5	7-#5	7-#5	3.15	3.21	3.28
22	50	15	0.780	58	116	156	11-#4 4	11-#4	12-#5	11-#4	11-#4	2.07	2.08	2.02	22	50	10	11-#5	11-#4	11-#4	11-#4	2.12	2.13	2.15
22	100	19	0.743	71	143	192	11-#4 6	13-#4	11-#6	11-#4	11-#4	2.29	2.31	2.24	22	100	14	10-#6	11-#4	11-#4	11-#4	2.33	2.35	2.37
22	150	23	0.671	84	168	226	13-#4 4	10-#5	12-#6	11-#4	11-#4	2.48	2.49	2.42	22	150	18	16-#5	11-#4	11-#4	11-#4	2.44	2.46	2.48
22	200	26	0.689	95	191	257	10-#5 3	8-#6	11-#7	8-#5	11-#4	2.79	2.81	2.77	22	200	23	10-#7	8-#5	11-#4	11-#4	2.75	2.77	2.80
22	250	30	0.632	106	212	285	16-#4 5	9-#6	12-#7	13-#4	11-#4	2.99	3.01	3.06	22	250	27	11-#7	13-#4	11-#4	11-#4	2.92	2.94	2.97
22	300	33	0.617	116	233	313	12-#5 2	10-#6	10-#8	9-#5	8-#5	3.28	3.31	3.39	22	300	31	12-#7	14-#4	11-#4	11-#4	3.10	3.14	3.18
22	350	38	0.610	122	245	330	12-#5 2	8-#7	11-#8	10-#5	8-#5	3.56	3.59	3.69	22	350	39	10-#8	10-#5	8-#5	11-#4	3.40	3.44	3.48

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

SQUARE EDGE PANEL

SQUARE INTERIOR PANEL

f'_c = 4,000 psi
Grade 60 Bars

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2)	(3)	(1)	Reinforcing Bars				Steel (psf)		
				–M Ext.	+M Int.	–M 1st int.	Each Column Strip			Each Middle Strip		Steel (psf)						Column Strip		Middle Strip		Location of Panel		
							Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Location of Panel												
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)						E	EC	C	Span c.-c. (ft)	Load (psf)	Min. Sq. Col. (in.)	Top	Bottom	Top	Bottom	I	IE	IC
9 in. = TOTAL THICKNESS OF SLAB														0.750 c.f./s.f.	9 in. = TOTAL THICKNESS OF SLAB									0.750 c.f./s.f.
23	50	17	0.751	66	132	177	12-#4 4	8-#5	13-#5	8-#5	8-#5	2.20	2.20	2.12	23	50	11	13-#5	8-#5	8-#5	8-#5	2.31	2.31	2.31
23	100	21	0.704	81	162	218	12-#4 5	10-#5	12-#6	8-#5	8-#5	2.43	2.44	2.33	23	100	16	11-#6	8-#5	8-#5	8-#5	2.49	2.51	2.53
23	150	25	0.655	95	189	255	14-#4 4	8-#6	11-#7	8-#5	8-#5	2.67	2.69	2.61	23	150	21	13-#6	8-#5	8-#5	8-#5	2.67	2.71	2.75
23	200	29	0.641	108	216	290	16-#4 5	13-#5	12-#7	13-#4	8-#5	2.89	2.91	2.93	23	200	25	11-#7	13-#4	8-#5	8-#5	2.88	2.91	2.94
23	250	33	0.612	119	239	322	12-#5 2	8-#7	13-#7	10-#5	8-#5	3.30	3.31	3.35	23	250	30	13-#7	10-#5	8-#5	8-#5	3.26	3.26	3.26
23	300	38	0.610	128	256	344	19-#4 4	23-#4	11-#8	10-#5	13-#4	3.38	3.42	3.50	23	300	38	13-#7	10-#5	8-#5	8-#5	3.30	3.34	3.38
23	350	44	0.609	134	268	360	20-#4 3	16-#5	12-#8	16-#4	9-#5	3.63	3.66	3.82	23	350	47	11-#8	16-#4	8-#5	8-#5	3.52	3.57	3.63
24	50	18	0.757	74	149	200	13-#4 4	9-#5	11-#6	8-#5	8-#5	2.23	2.25	2.14	24	50	13	14-#5	8-#5	8-#5	8-#5	2.28	2.30	2.32
24	100	23	0.726	91	182	245	14-#4 7	8-#6	13-#6	8-#5	8-#5	2.49	2.50	2.46	24	100	18	13-#6	8-#5	8-#5	8-#5	2.55	2.55	2.54
24	150	27	0.688	107	214	287	16-#4 6	9-#6	12-#7	13-#4	8-#5	2.77	2.78	2.82	24	150	23	11-#7	13-#4	8-#5	8-#5	2.75	2.78	2.80
24	200	31	0.691	121	243	326	12-#5 5	8-#7	11-#8	10-#5	8-#5	3.19	3.22	3.25	24	200	28	13-#7	10-#5	8-#5	8-#5	3.11	3.14	3.18
24	250	37	0.633	132	265	357	13-#5 4	16-#5	12-#8	16-#4	9-#5	3.39	3.43	3.53	24	250	35	11-#8	16-#4	13-#4	8-#5	3.32	3.37	3.41
24	300	44	0.609	140	279	376	14-#5 3	9-#7	12-#8	8-#6	14-#4	3.65	3.71	3.85	24	300	45	11-#8	8-#6	13-#4	8-#5	3.47	3.51	3.56
24	350	50	0.608	146	293	394	22-#4 2	8-#8	13-#8	12-#5	10-#5	3.98	4.04	4.15	24	350	54	12-#8	12-#5	9-#5	8-#5	3.73	3.78	3.83
25	50	20	0.729	84	167	225	13-#4 5	10-#5	12-#6	13-#4	13-#4	2.31	2.33	2.26	25	50	14	16-#5	13-#4	13-#4	13-#4	2.36	2.38	2.39
25	100	25	0.706	102	204	275	16-#4 6	12-#5	15-#6	12-#4	13-#4	2.57	2.59	2.54	25	100	20	14-#6	13-#4	13-#4	13-#4	2.60	2.62	2.63
25	150	30	0.665	119	238	320	12-#5 4	10-#6	13-#7	14-#4	13-#4	2.94	2.96	2.99	25	150	26	13-#7	10-#5	13-#4	13-#4	3.02	3.01	3.01
25	200	35	0.619	135	269	363	20-#4 5	16-#5	12-#8	16-#4	9-#5	3.27	3.32	3.38	25	200	31	14-#7	11-#5	13-#4	13-#4	3.22	3.27	3.32
25	250	42	0.609	145	289	389	22-#4 4	26-#4	13-#8	12-#5	10-#5	3.57	3.63	3.72	25	250	42	12-#8	12-#5	9-#5	13-#4	3.54	3.59	3.63
25	300	50	0.608	152	304	410	15-#5 3	10-#7	13-#8	12-#5	10-#5	3.81	3.87	4.10	25	300	52	12-#8	12-#5	14-#4	12-#4	3.54	3.58	3.63
25	350	57	0.607	158	317	426	16-#5 2	14-#6	14-#8	9-#6	16-#4	4.11	4.13	4.29	25	350	62	13-#8	19-#4	10-#5	13-#4	3.85	3.89	3.93
26	50	22	0.731	93	186	251	14-#4 7	11-#5	14-#6	13-#4	13-#4	2.38	2.40	2.34	26	50	16	13-#6	13-#4	13-#4	13-#4	2.41	2.43	2.44
26	100	27	0.711	114	228	307	17-#4 8	10-#6	13-#7	9-#5	13-#4	2.77	2.80	2.79	26	100	22	12-#7	9-#5	13-#4	13-#4	2.72	2.75	2.77
26	150	32	0.660	133	266	358	13-#5 4	16-#5	12-#8	16-#4	9-#5	3.15	3.19	3.22	26	150	28	14-#7	11-#5	13-#4	13-#4	3.08	3.13	3.18
26	200	40	0.610	147	294	396	22-#4 4	10-#7	13-#8	12-#5	10-#5	3.53	3.58	3.69	26	200	37	12-#8	12-#5	9-#5	13-#4	3.38	3.42	3.46
26	250	48	0.608	157	315	424	16-#5 2	10-#7	14-#8	19-#4	16-#4	3.84	3.86	3.99	26	250	48	13-#8	19-#4	10-#5	13-#4	3.62	3.66	3.69
26	300	56	0.607	165	331	445	25-#4 3	20-#5	15-#8	13-#5	11-#5	3.98	4.06	4.23	26	300	59	13-#8	13-#5	10-#5	13-#4	3.74	3.82	3.90
26	350	63	0.607	172	344	464	17-#5 2	9-#8	15-#8	10-#6	12-#5	4.38	4.41	4.57	26	350	69	14-#8	10-#6	16-#4	9-#5	4.08	4.13	4.19
27	50	24	0.707	104	207	279	16-#4 6	9-#6	15-#6	9-#5	9-#5	2.50	2.52	2.45	27	50	18	14-#6	9-#5	9-#5	9-#5	2.52	2.53	2.55
27	100	30	0.650	126	253	340	19-#4 6	11-#6	14-#7	10-#5	9-#5	2.88	2.91	2.91	27	100	24	13-#7	16-#4	9-#5	9-#5	2.87	2.89	2.91
27	150	36	0.647	147	293	395	22-#4 7	10-#7	13-#8	12-#5	10-#5	3.40	3.44	3.55	27	150	31	12-#8	12-#5	9-#5	9-#5	3.27	3.31	3.35
27	200	45	0.609	160	320	431	16-#5 2	14-#6	14-#8	19-#4	16-#4	3.65	3.71	3.88	27	200	43	13-#8	13-#5	10-#5	9-#5	3.56	3.60	3.63
27	250	53	0.608	171	342	460	12-#6 2	9-#8	15-#8	10-#6	17-#4	4.09	4.14	4.26	27	250	55	14-#8	10-#6	16-#4	9-#5	3.85	3.89	3.93
27	300	62	0.607	179	358	482	13-#6 1	9-#8	16-#8	10-#6	12-#5	4.29	4.33	4.48	27	300	66	14-#8	10-#6	11-#5	14-#4	3.92	4.00	4.08
27	350	70	0.606	185	371	499	28-#4 2	12-#7	16-#8	22-#4	9-#6	4.37	4.43	4.62	27	350	77	15-#8	22-#4	11-#5	10-#5	4.16	4.21	4.27
28	50	26	0.707	115	229	308	17-#4 8	10-#6	13-#7	14-#4	14-#4	2.56	2.59	2.58	28	50	20	16-#6	14-#4	14-#4	14-#4	2.54	2.57	2.59
28	100	32	0.690	140	279	376	14-#5 6	12-#6	13-#8	11-#5	14-#4	3.06	3.11	3.18	28	100	27	15-#7	17-#4	14-#4	14-#4	2.99	3.03	3.08
28	150	41	0.614	159	318	428	16-#5 4	10-#7	14-#8	19-#4	16-#4	3.49	3.54	3.63	28	150	37	13-#8	13-#5	10-#5	14-#4	3.39	3.42	3.45
28	200	50	0.608	173	346	466	17-#5 4	11-#7	15-#8	10-#6	12-#5	3.94	3.96	4.07	28	200	50	14-#8	10-#6	16-#4	14-#4	3.66	3.71	3.76
28	250	59	0.607	185	369	497	13-#6 1	12-#7	16-#8	22-#4	13-#5	4.20	4.25	4.44	28	250	62	15-#8	22-#4	11-#5	10-#5	3.92	3.98	4.03
28	300	68	0.606	193	386	520	19-#5 1	10-#8	17-#8	23-#4	13-#5	4.48	4.55	4.80	28	300	74	15-#8	11-#6	12-#5	10-#5	4.15	4.23	4.30
28	350	77	0.605	199	399	537	20-#5 1	10-#8	18-#8	16-#5	13-#5	4.65	4.73	4.86	28	350	85	16-#8	11-#6	12-#5	10-#5	4.33	4.42	4.50

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL															SQUARE INTERIOR PANEL									
SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2) Span c.-c.	(3) Load	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf)		
							Each Column Strip			Each Middle Strip		Steel (psf)						Column Strip		Middle Strip		Location of Panel		
				–M Ext.	+M Int.	–M 1st int.	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Location of Panel						Top	Bottom	Top	Bottom			
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)						E	EC	C	(ft)	(psf)	(in.)					I	IE	IC
9.5 in. = TOTAL THICKNESS OF SLAB														0.792 c.f./s.f.	9.5 in. = TOTAL THICKNESS OF SLAB									0.792 c.f./s.f.
19	50	10	0.859	39	78	106	9-#5 1	7-#5	9-#5	7-#5	7-#5	2.33	2.33	2.35	19	50	10	9-#5	7-#5	7-#5	7-#5	2.32	2.32	2.32
19	100	12	0.844	49	98	132	9-#5 1	7-#5	9-#5	7-#5	7-#5	2.33	2.33	2.34	19	100	10	9-#5	7-#5	7-#5	7-#5	2.32	2.32	2.32
19	150	15	0.817	57	114	153	9-#5 2	7-#5	11-#5	7-#5	7-#5	2.42	2.43	2.40	19	150	15	10-#5	7-#5	7-#5	7-#5	2.41	2.43	2.44
19	200	17	0.801	65	131	176	9-#5 2	8-#5	9-#6	7-#5	7-#5	2.58	2.58	2.51	19	200	17	12-#5	7-#5	7-#5	7-#5	2.56	2.57	2.59
19	250	20	0.771	73	146	197	9-#5 3	8-#5	10-#6	7-#5	7-#5	2.62	2.64	2.66	19	250	19	13-#5	7-#5	7-#5	7-#5	2.63	2.66	2.68
19	300	22	0.754	81	163	219	9-#5 3	9-#5	11-#6	7-#5	7-#5	2.77	2.78	2.79	19	300	20	11-#6	7-#5	7-#5	7-#5	2.84	2.84	2.83
19	350	25	0.643	88	176	237	9-#5 1	7-#6	9-#7	7-#5	7-#5	2.88	2.92	2.98	19	350	23	16-#5	7-#5	7-#5	7-#5	2.86	2.89	2.92
20	50	11	0.849	46	92	123	9-#5 1	7-#5	9-#5	7-#5	7-#5	2.21	2.21	2.23	20	50	10	9-#5	7-#5	7-#5	7-#5	2.21	2.21	2.20
20	100	14	0.826	57	114	153	9-#5 2	7-#5	11-#5	7-#5	7-#5	2.29	2.30	2.28	20	100	10	10-#5	7-#5	7-#5	7-#5	2.27	2.28	2.30
20	150	17	0.785	66	132	178	9-#5 2	8-#5	9-#6	7-#5	7-#5	2.40	2.43	2.42	20	150	15	12-#5	7-#5	7-#5	7-#5	2.42	2.43	2.45
20	200	20	0.759	76	152	204	9-#5 3	9-#5	11-#6	7-#5	7-#5	2.57	2.60	2.63	20	200	17	10-#6	7-#5	7-#5	7-#5	2.58	2.60	2.63
20	250	23	0.712	85	170	229	9-#5 3	7-#6	16-#5	7-#5	7-#5	2.68	2.70	2.71	20	250	19	11-#6	7-#5	7-#5	7-#5	2.69	2.69	2.69
20	300	25	0.641	93	186	251	9-#5 1	8-#6	10-#7	7-#5	7-#5	2.92	2.95	2.94	20	300	23	9-#7	7-#5	7-#5	7-#5	2.82	2.85	2.89
20	350	28	0.674	101	202	272	10-#5 3	8-#6	9-#8	8-#5	7-#5	3.13	3.18	3.31	20	350	26	10-#7	8-#5	7-#5	7-#5	3.05	3.10	3.16
21	50	12	0.853	53	106	143	10-#5 1	7-#5	10-#5	7-#5	7-#5	2.18	2.18	2.21	21	50	10	10-#5	7-#5	7-#5	7-#5	2.16	2.16	2.16
21	100	16	0.791	65	131	176	10-#5 1	8-#5	13-#5	7-#5	7-#5	2.30	2.32	2.32	21	100	11	12-#5	7-#5	7-#5	7-#5	2.29	2.30	2.31
21	150	19	0.771	77	153	206	10-#5 2	9-#5	11-#6	7-#5	7-#5	2.51	2.53	2.53	21	150	15	10-#6	7-#5	7-#5	7-#5	2.45	2.47	2.49
21	200	22	0.731	87	175	235	10-#5 2	7-#6	12-#6	7-#5	7-#5	2.66	2.67	2.70	21	200	18	11-#6	7-#5	7-#5	7-#5	2.55	2.57	2.59
21	250	25	0.711	97	194	262	10-#5 3	8-#6	10-#7	7-#5	7-#5	2.88	2.87	2.82	21	250	22	10-#7	8-#5	7-#5	7-#5	2.88	2.88	2.87
21	300	28	0.668	106	212	286	10-#5 3	12-#5	11-#7	8-#5	7-#5	3.03	3.04	3.16	21	300	26	10-#7	8-#5	7-#5	7-#5	2.90	2.93	2.96
21	350	31	0.623	115	230	310	11-#5 2	7-#7	12-#7	9-#5	7-#5	3.26	3.31	3.36	21	350	29	11-#7	9-#5	7-#5	7-#5	3.13	3.16	3.19
22	50	14	0.818	61	121	163	10-#5 1	8-#5	12-#5	8-#5	8-#5	2.31	2.31	2.32	22	50	10	11-#5	8-#5	8-#5	8-#5	2.30	2.31	2.33
22	100	18	0.774	74	149	200	10-#5 2	9-#5	10-#6	8-#5	8-#5	2.45	2.47	2.44	22	100	13	13-#5	8-#5	8-#5	8-#5	2.43	2.45	2.47
22	150	21	0.760	87	174	235	10-#5 3	10-#5	12-#6	8-#5	8-#5	2.60	2.63	2.63	22	150	17	11-#6	8-#5	8-#5	8-#5	2.61	2.63	2.65
22	200	25	0.691	99	198	266	10-#5 3	8-#6	10-#7	8-#5	8-#5	2.82	2.82	2.74	22	200	21	10-#7	8-#5	8-#5	8-#5	2.85	2.85	2.85
22	250	28	0.653	110	220	296	10-#5 3	9-#6	15-#6	8-#5	8-#5	3.02	3.02	3.07	22	250	25	11-#7	9-#5	8-#5	8-#5	3.08	3.08	3.08
22	300	31	0.613	120	241	324	11-#5 2	10-#6	10-#8	9-#5	8-#5	3.24	3.29	3.41	22	300	29	12-#7	9-#5	8-#5	8-#5	3.22	3.25	3.28
22	350	34	0.612	130	260	350	12-#5 2	8-#7	11-#8	10-#5	8-#5	3.55	3.58	3.62	22	350	33	10-#8	10-#5	8-#5	8-#5	3.44	3.48	3.51
23	50	16	0.826	69	138	186	11-#5 3	8-#5	13-#5	8-#5	8-#5	2.29	2.29	2.27	23	50	10	13-#5	8-#5	8-#5	8-#5	2.31	2.31	2.31
23	100	20	0.789	84	168	226	11-#5 4	10-#5	16-#5	8-#5	8-#5	2.49	2.49	2.43	23	100	15	11-#6	8-#5	8-#5	8-#5	2.49	2.49	2.49
23	150	23	0.729	99	197	266	11-#5 2	8-#6	11-#7	8-#5	8-#5	2.73	2.74	2.67	23	150	19	13-#6	8-#5	8-#5	8-#5	2.66	2.70	2.74
23	200	27	0.664	112	224	302	11-#5 2	9-#6	12-#7	9-#5	8-#5	2.94	2.97	3.07	23	200	23	20-#5	9-#5	8-#5	8-#5	2.84	2.89	2.94
23	250	31	0.621	124	248	333	12-#5 2	10-#6	13-#7	9-#5	8-#5	3.13	3.18	3.28	23	250	28	12-#7	10-#5	8-#5	8-#5	3.14	3.16	3.19
23	300	34	0.658	136	271	365	13-#5 4	8-#7	11-#8	10-#5	9-#5	3.44	3.48	3.58	23	300	32	13-#7	10-#5	8-#5	8-#5	3.27	3.32	3.37
23	350	39	0.618	143	286	385	14-#5 3	16-#5	12-#8	8-#6	9-#5	3.70	3.72	3.78	23	350	40	11-#8	8-#6	9-#5	8-#5	3.63	3.67	3.71

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel		
							Each Column Strip			Each Middle Strip		Steel (psf)		
												Location of Panel		
(ft)	(psf)	(in.)	γ_f	–M Ext. (ft-kip)	+M Int. (ft-kip)	–M 1st int. (ft-kip)	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C
9.5 in. = TOTAL THICKNESS OF SLAB														0.792 c.f./s.f.
24	50	17	0.819	78	156	210	11-#5 3	9-#5	11-#6	8-#5	8-#5	2.29	2.31	2.28
24	100	22	0.759	95	189	255	11-#5 4	8-#6	13-#6	8-#5	8-#5	2.52	2.55	2.56
24	150	26	0.664	111	222	298	11-#5 2	9-#6	15-#6	8-#5	8-#5	2.75	2.76	2.87
24	200	30	0.672	125	251	338	12-#5 4	10-#6	13-#7	10-#5	8-#5	3.03	3.08	3.18
24	250	34	0.615	139	278	374	13-#5 3	11-#6	11-#8	8-#6	9-#5	3.43	3.45	3.53
24	300	39	0.611	149	298	402	14-#5 3	9-#7	12-#8	8-#6	10-#5	3.70	3.76	3.95
24	350	45	0.609	156	312	421	15-#5 2	8-#8	13-#8	12-#5	10-#5	4.01	4.07	4.31
25	50	19	0.800	88	175	236	12-#5 3	10-#5	12-#6	9-#5	9-#5	2.48	2.50	2.45
25	100	24	0.745	106	212	286	12-#5 4	12-#5	20-#5	9-#5	9-#5	2.70	2.72	2.78
25	150	28	0.717	124	248	334	12-#5 5	10-#6	13-#7	9-#5	9-#5	2.97	3.01	3.04
25	200	33	0.638	140	280	376	13-#5 4	11-#6	19-#6	11-#5	9-#5	3.31	3.33	3.35
25	250	38	0.611	153	306	412	14-#5 3	9-#7	13-#8	12-#5	10-#5	3.66	3.72	3.85
25	300	44	0.610	163	326	439	15-#5 3	10-#7	13-#8	12-#5	10-#5	3.84	3.89	4.12
25	350	51	0.608	170	340	458	16-#5 2	14-#6	14-#8	9-#6	11-#5	4.13	4.17	4.32
26	50	21	0.782	98	195	263	12-#5 4	11-#5	13-#6	9-#5	9-#5	2.50	2.51	2.51
26	100	26	0.716	118	237	319	12-#5 4	13-#5	12-#7	9-#5	9-#5	2.76	2.78	2.75
26	150	31	0.662	138	276	371	13-#5 4	11-#6	14-#7	10-#5	9-#5	3.12	3.13	3.15
26	200	35	0.643	156	312	420	15-#5 3	10-#7	13-#8	12-#5	10-#5	3.59	3.65	3.78
26	250	43	0.610	167	335	450	16-#5 2	10-#7	14-#8	9-#6	11-#5	3.83	3.89	4.06
26	300	50	0.609	177	354	476	12-#6 2	20-#5	15-#8	13-#5	11-#5	4.04	4.08	4.21
26	350	57	0.608	184	369	496	17-#5 2	9-#8	15-#8	10-#6	12-#5	4.32	4.38	4.64
27	50	23	0.749	108	217	292	12-#5 4	12-#5	15-#6	9-#5	9-#5	2.54	2.57	2.58
27	100	28	0.703	132	263	354	12-#5 5	11-#6	14-#7	10-#5	9-#5	2.93	2.96	3.03
27	150	33	0.656	153	306	412	14-#5 4	9-#7	12-#8	12-#5	10-#5	3.35	3.36	3.51
27	200	40	0.643	170	340	458	16-#5 5	14-#6	14-#8	9-#6	11-#5	3.70	3.75	3.94
27	250	48	0.609	182	364	491	12-#6 2	11-#7	15-#8	10-#6	12-#5	4.06	4.08	4.17
27	300	56	0.608	192	383	516	13-#6 1	9-#8	16-#8	10-#6	12-#5	4.31	4.35	4.51
27	350	64	0.607	198	396	534	19-#5 1	12-#7	16-#8	11-#6	9-#6	4.47	4.53	4.73
28	50	25	0.732	120	240	323	13-#5 4	10-#6	13-#7	10-#5	10-#5	2.73	2.75	2.70
28	100	31	0.695	145	291	391	14-#5 6	16-#5	15-#7	11-#5	10-#5	3.02	3.04	3.10
28	150	36	0.669	169	337	454	16-#5 5	10-#7	14-#8	13-#5	11-#5	3.55	3.60	3.79
28	200	45	0.609	185	369	497	17-#5 4	11-#7	15-#8	10-#6	12-#5	3.91	3.93	4.03
28	250	54	0.608	197	393	529	13-#6 1	12-#7	16-#8	11-#6	12-#5	4.28	4.31	4.45
28	300	62	0.607	206	412	555	19-#5 1	10-#8	17-#8	11-#6	13-#5	4.51	4.57	4.72
28	350	70	0.606	214	427	575	20-#5 1	10-#8	18-#8	16-#5	10-#6	4.68	4.76	4.93
29	50	27	0.699	133	265	357	13-#5 4	11-#6	14-#7	10-#5	10-#5	2.77	2.79	2.84
29	100	33	0.684	161	321	432	15-#5 6	10-#7	13-#8	12-#5	10-#5	3.26	3.29	3.40
29	150	41	0.616	183	367	494	17-#5 4	11-#7	15-#8	10-#6	12-#5	3.74	3.77	3.90
29	200	50	0.609	200	399	538	19-#5 3	12-#7	16-#8	11-#6	13-#5	4.13	4.15	4.29
29	250	59	0.607	212	425	572	14-#6 1	10-#8	17-#8	16-#5	13-#5	4.41	4.46	4.59
29	300	68	0.606	222	444	598	15-#6 0	11-#8	18-#8	12-#6	10-#6	4.72	4.78	4.93
29	350	77	0.606	229	458	616	16-#6 0	11-#8	19-#8	12-#6	14-#5	4.91	4.98	5.28

SQUARE INTERIOR PANEL

(2) Span c.-c. (ft)	(3) Load (psf)	(1) Min. Sq. Col. (in.)	Reinforcing Bars				Steel (psf)		
			Column Strip		Middle Strip		Location of Panel		
			Top	Bottom	Top	Bottom	I	IE	IC
9.5 in. = TOTAL THICKNESS OF SLAB									0.792 c.f./s.f.
24	50	12	14-#5	8-#5	8-#5	8-#5	2.27	2.30	2.32
24	100	17	12-#6	8-#5	8-#5	8-#5	2.47	2.48	2.50
24	150	21	20-#5	9-#5	8-#5	8-#5	2.71	2.73	2.75
24	200	26	12-#7	10-#5	8-#5	8-#5	2.99	3.02	3.04
24	250	31	11-#8	8-#6	8-#5	8-#5	3.39	3.40	3.41
24	300	38	11-#8	8-#6	9-#5	8-#5	3.46	3.51	3.56
24	350	47	12-#8	12-#5	9-#5	8-#5	3.69	3.74	3.79
25	50	13	16-#5	9-#5	9-#5	9-#5	2.49	2.51	2.52
25	100	19	14-#6	9-#5	9-#5	9-#5	2.73	2.72	2.72
25	150	24	12-#7	10-#5	9-#5	9-#5	2.99	3.01	3.03
25	200	29	14-#7	11-#5	9-#5	9-#5	3.30	3.29	3.29
25	250	36	12-#8	12-#5	9-#5	9-#5	3.57	3.61	3.66
25	300	45	12-#8	12-#5	10-#5	9-#5	3.65	3.69	3.73
25	350	54	13-#8	9-#6	10-#5	9-#5	3.93	3.97	4.02
26	50	15	13-#6	9-#5	9-#5	9-#5	2.53	2.53	2.53
26	100	21	15-#6	9-#5	9-#5	9-#5	2.70	2.72	2.74
26	150	26	14-#7	11-#5	9-#5	9-#5	3.15	3.15	3.15
26	200	32	12-#8	12-#5	9-#5	9-#5	3.41	3.45	3.49
26	250	42	13-#8	9-#6	10-#5	9-#5	3.71	3.75	3.79
26	300	52	13-#8	13-#5	10-#5	9-#5	3.75	3.83	3.91
26	350	62	14-#8	10-#6	11-#5	9-#5	4.07	4.12	4.17
27	50	17	14-#6	9-#5	9-#5	9-#5	2.51	2.53	2.55
27	100	23	13-#7	10-#5	9-#5	9-#5	2.85	2.87	2.89
27	150	29	12-#8	12-#5	9-#5	9-#5	3.26	3.27	3.28
27	200	37	13-#8	13-#5	10-#5	9-#5	3.54	3.58	3.62
27	250	48	14-#8	10-#6	11-#5	9-#5	3.84	3.89	3.93
27	300	59	14-#8	10-#6	11-#5	10-#5	3.95	4.03	4.11
27	350	70	15-#8	11-#6	11-#5	10-#5	4.25	4.31	4.37
28	50	19	16-#6	10-#5	10-#5	10-#5	2.71	2.73	2.76
28	100	25	14-#7	11-#5	10-#5	10-#5	3.00	3.03	3.05
28	150	32	13-#8	13-#5	10-#5	10-#5	3.44	3.48	3.51
28	200	43	14-#8	10-#6	11-#5	10-#5	3.73	3.77	3.81
28	250	55	15-#8	11-#6	12-#5	10-#5	4.05	4.09	4.12
28	300	67	15-#8	11-#6	12-#5	10-#5	4.11	4.19	4.27
28	350	78	16-#8	11-#6	12-#5	11-#5	4.37	4.47	4.56
29	50	20	13-#7	10-#5	10-#5	10-#5	2.72	2.74	2.76
29	100	27	13-#8	12-#5	10-#5	10-#5	3.22	3.22	3.22
29	150	36	14-#8	10-#6	11-#5	10-#5	3.56	3.60	3.64
29	200	49	15-#8	11-#6	12-#5	10-#5	3.88	3.92	3.96
29	250	62	16-#8	16-#5	12-#5	11-#5	4.13	4.17	4.22
29	300	74	17-#8	12-#6	13-#5	11-#5	4.43	4.48	4.53
29	350	86	17-#8	12-#6	13-#5	11-#5	4.50	4.58	4.65

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL															SQUARE INTERIOR PANEL									
SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel			(2) Span c.-c.	(3) Load	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf)		
							Each Column Strip			Each Middle Strip		Steel (psf) Location of Panel						Column Strip		Middle Strip		Location of Panel		
				–M Ext.	+M Int.	–M 1st int.	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C				Top	Bottom	Top	Bottom	I	IE	IC
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)									(ft)	(psf)	(in.)							
10 in. = TOTAL THICKNESS OF SLAB														0.833 c.f./s.f.	10 in. = TOTAL THICKNESS OF SLAB									0.833 c.f./s.f.
20	50	10	0.860	48	96	129	9-#5 1	7-#5	9-#5	7-#5	7-#5	2.22	2.22	2.23	20	50	10	9-#5	7-#5	7-#5	7-#5	2.21	2.21	2.21
20	100	13	0.836	59	118	159	9-#5 2	7-#5	11-#5	7-#5	7-#5	2.26	2.28	2.28	20	100	10	10-#5	7-#5	7-#5	7-#5	2.27	2.28	2.30
20	150	16	0.794	68	137	184	9-#5 2	7-#5	12-#5	7-#5	7-#5	2.34	2.36	2.36	20	150	15	12-#5	7-#5	7-#5	7-#5	2.42	2.42	2.42
20	200	18	0.797	78	156	210	9-#5 3	8-#5	10-#6	7-#5	7-#5	2.53	2.55	2.57	20	200	18	9-#6	7-#5	7-#5	7-#5	2.49	2.52	2.54
20	250	21	0.752	87	175	235	9-#5 3	9-#5	11-#6	7-#5	7-#5	2.68	2.69	2.65	20	250	19	11-#6	7-#5	7-#5	7-#5	2.69	2.68	2.68
20	300	24	0.643	96	192	259	9-#5 1	10-#5	9-#7	7-#5	7-#5	2.79	2.82	2.82	20	300	21	16-#5	7-#5	7-#5	7-#5	2.70	2.73	2.76
20	350	26	0.623	104	209	281	9-#5 1	8-#6	10-#7	8-#5	7-#5	3.05	3.07	3.03	20	350	24	10-#7	8-#5	7-#5	7-#5	3.04	3.04	3.04
21	50	11	0.864	55	111	149	10-#5 1	8-#5	10-#5	8-#5	8-#5	2.33	2.33	2.31	21	50	10	10-#5	8-#5	8-#5	8-#5	2.35	2.35	2.35
21	100	15	0.802	68	136	183	10-#5 1	8-#5	12-#5	8-#5	8-#5	2.43	2.45	2.45	21	100	10	12-#5	8-#5	8-#5	8-#5	2.47	2.47	2.47
21	150	18	0.780	79	158	212	10-#5 2	9-#5	10-#6	8-#5	8-#5	2.57	2.59	2.56	21	150	15	13-#5	8-#5	8-#5	8-#5	2.55	2.57	2.59
21	200	21	0.738	90	179	241	10-#5 2	7-#6	16-#5	8-#5	8-#5	2.72	2.73	2.65	21	200	18	11-#6	8-#5	8-#5	8-#5	2.74	2.74	2.74
21	250	24	0.714	100	201	270	10-#5 3	8-#6	10-#7	8-#5	8-#5	2.89	2.92	2.87	21	250	20	12-#6	8-#5	8-#5	8-#5	2.84	2.88	2.91
21	300	26	0.704	110	220	296	10-#5 3	12-#5	11-#7	8-#5	8-#5	3.01	3.05	3.18	21	300	24	10-#7	8-#5	8-#5	8-#5	3.00	3.04	3.07
21	350	29	0.656	119	238	320	11-#5 2	7-#7	12-#7	9-#5	8-#5	3.28	3.31	3.35	21	350	27	20-#5	9-#5	8-#5	8-#5	3.14	3.20	3.25
22	50	13	0.830	63	127	170	10-#5 1	8-#5	11-#5	8-#5	8-#5	2.29	2.29	2.31	22	50	10	11-#5	8-#5	8-#5	8-#5	2.30	2.30	2.30
22	100	17	0.785	77	155	208	10-#5 2	8-#5	10-#6	8-#5	8-#5	2.40	2.41	2.37	22	100	12	13-#5	8-#5	8-#5	8-#5	2.42	2.44	2.46
22	150	20	0.747	91	181	244	10-#5 2	10-#5	16-#5	8-#5	8-#5	2.58	2.59	2.52	22	150	15	11-#6	8-#5	8-#5	8-#5	2.60	2.60	2.60
22	200	23	0.730	103	205	276	10-#5 3	8-#6	10-#7	8-#5	8-#5	2.75	2.78	2.75	22	200	19	17-#5	8-#5	8-#5	8-#5	2.69	2.72	2.76
22	250	26	0.691	114	228	307	10-#5 3	12-#5	11-#7	8-#5	8-#5	2.95	2.95	3.03	22	250	23	11-#7	8-#5	8-#5	8-#5	2.98	2.98	2.97
22	300	29	0.673	124	249	335	11-#5 3	13-#5	12-#7	9-#5	8-#5	3.12	3.16	3.27	22	300	27	11-#7	9-#5	8-#5	8-#5	3.09	3.12	3.15
22	350	32	0.632	134	268	361	12-#5 2	10-#6	10-#8	10-#5	8-#5	3.41	3.44	3.54	22	350	31	12-#7	10-#5	8-#5	8-#5	3.30	3.33	3.36
23	50	15	0.836	72	144	194	11-#5 3	9-#5	13-#5	9-#5	9-#5	2.47	2.49	2.48	23	50	10	12-#5	9-#5	9-#5	9-#5	2.48	2.49	2.50
23	100	19	0.798	88	175	236	11-#5 4	9-#5	11-#6	9-#5	9-#5	2.62	2.62	2.53	23	100	13	11-#6	9-#5	9-#5	9-#5	2.70	2.70	2.70
23	150	22	0.737	102	204	275	11-#5 2	8-#6	13-#6	9-#5	9-#5	2.81	2.83	2.80	23	150	18	17-#5	9-#5	9-#5	9-#5	2.79	2.81	2.83
23	200	26	0.668	115	231	311	11-#5 2	12-#5	11-#7	9-#5	9-#5	3.00	3.00	3.02	23	200	22	11-#7	9-#5	9-#5	9-#5	3.06	3.06	3.06
23	250	29	0.656	128	256	345	11-#5 3	10-#6	13-#7	9-#5	9-#5	3.20	3.23	3.26	23	250	26	12-#7	9-#5	9-#5	9-#5	3.20	3.22	3.25
23	300	32	0.620	140	280	378	12-#5 2	8-#7	11-#8	10-#5	8-#5	3.47	3.49	3.47	23	300	30	13-#7	10-#5	9-#5	9-#5	3.40	3.42	3.45
23	350	36	0.612	151	301	406	13-#5 2	16-#5	12-#8	8-#6	9-#5	3.70	3.73	3.76	23	350	34	11-#8	8-#6	9-#5	9-#5	3.69	3.73	3.77
24	50	17	0.804	81	163	219	11-#5 3	9-#5	11-#6	9-#5	9-#5	2.46	2.48	2.43	24	50	11	14-#5	9-#5	9-#5	9-#5	2.48	2.51	2.53
24	100	21	0.769	99	197	266	11-#5 4	8-#6	13-#6	9-#5	9-#5	2.69	2.71	2.71	24	100	15	12-#6	9-#5	9-#5	9-#5	2.67	2.69	2.71
24	150	24	0.727	115	230	310	11-#5 3	12-#5	11-#7	9-#5	9-#5	2.84	2.85	2.90	24	150	20	11-#7	9-#5	9-#5	9-#5	2.92	2.92	2.92
24	200	28	0.723	130	260	350	12-#5 5	10-#6	13-#7	9-#5	9-#5	3.10	3.13	3.16	24	200	24	12-#7	10-#5	9-#5	9-#5	3.11	3.14	3.16
24	250	32	0.667	144	287	387	13-#5 4	8-#7	11-#8	10-#5	9-#5	3.35	3.37	3.40	24	250	29	13-#7	10-#5	9-#5	9-#5	3.24	3.28	3.32
24	300	35	0.641	157	315	423	14-#5 3	9-#7	12-#8	8-#6	9-#5	3.71	3.74	3.78	24	300	33	11-#8	8-#6	9-#5	9-#5	3.53	3.56	3.60
24	350	40	0.611	167	333	448	15-#5 2	8-#8	13-#8	12-#5	10-#5	3.97	4.02	4.13	24	350	40	12-#8	12-#5	9-#5	9-#5	3.74	3.79	3.84
25	50	18	0.810	92	183	247	12-#5 3	10-#5	16-#5	9-#5	9-#5	2.46	2.47	2.44	25	50	12	16-#5	9-#5	9-#5	9-#5	2.49	2.49	2.49
25	100	23	0.753	111	221	298	12-#5 4	12-#5	14-#6	9-#5	9-#5	2.73	2.75	2.69	25	100	17	14-#6	9-#5	9-#5	9-#5	2.72	2.72	2.72
25	150	27	0.704	128	257	346	12-#5 4	10-#6	13-#7	9-#5	9-#5	2.97	3.01	3.04	25	150	22	12-#7	9-#5	9-#5	9-#5	2.91	2.94	2.96
25	200	31	0.671	145	290	390	13-#5 4	11-#6	14-#7	10-#5	9-#5	3.23	3.25	3.29	25	200	27	13-#7	11-#5	9-#5	9-#5	3.18	3.21	3.23
25	250	35	0.617	160	321	432	14-#5 3	9-#7	12-#8	11-#5	10-#5	3.58	3.60	3.75	25	250	32	12-#8	12-#5	9-#5	9-#5	3.55	3.56	3.57
25	300	39	0.611	173	346	466	15-#5 3	10-#7	13-#8	12-#5	10-#5	3.84	3.89	4.14	25	300	39	12-#8	12-#5	10-#5	9-#5	3.62	3.66	3.69
25	350	46	0.610	181	361	486	16-#5 2	10-#7	14-#8	9-#6	11-#5	4.10	4.13	4.28	25	350	48	13-#8	9-#6	10-#5	9-#5	3.89	3.94	3.99

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

FLAT PLATE SYSTEM
(WITHOUT SHEARHEADS)

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANEL

SPAN c.-c. Cols. $\ell_1 = \ell_2$	Factored Superim-posed Load	(1) Min. Square Column		Total Panel Moments			Reinforcing Bars					End Panel		
							Each Column Strip			Each Middle Strip		Steel (psf) Location of Panel		
				–M Ext.	+M Int.	–M 1st int.	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	E	EC	C
(ft)	(psf)	(in.)	γ_f	(ft-kip)	(ft-kip)	(ft-kip)								
10 in. = TOTAL THICKNESS OF SLAB														0.833 c.f./s.f.
26	50	20	0.791	102	204	275	12-#5 4	11-#5	13-#6	10-#5	10-#5	2.59	2.61	2.55
26	100	25	0.723	123	247	332	12-#5 4	13-#5	12-#7	10-#5	10-#5	2.84	2.85	2.79
26	150	29	0.696	143	286	385	13-#5 4	11-#6	14-#7	10-#5	10-#5	3.11	3.13	3.13
26	200	34	0.617	161	322	434	14-#5 3	9-#7	12-#8	11-#5	10-#5	3.46	3.48	3.61
26	250	38	0.658	178	355	478	16-#5 5	10-#7	17-#7	9-#6	11-#5	3.81	3.84	4.05
26	300	45	0.610	188	376	507	12-#6 2	14-#6	14-#8	13-#5	11-#5	3.99	4.02	4.20
26	350	52	0.609	196	392	528	17-#5 2	9-#8	15-#8	10-#6	12-#5	4.32	4.37	4.43
27	50	22	0.760	113	227	305	12-#5 4	12-#5	20-#5	10-#5	10-#5	2.60	2.62	2.61
27	100	27	0.710	137	274	369	12-#5 5	11-#6	13-#7	10-#5	10-#5	2.92	2.93	2.91
27	150	32	0.639	159	317	427	14-#5 3	9-#7	12-#8	11-#5	10-#5	3.26	3.28	3.29
27	200	36	0.671	179	358	481	16-#5 5	10-#7	14-#8	9-#6	11-#5	3.69	3.74	3.93
27	250	43	0.610	193	386	520	12-#6 2	11-#7	15-#8	10-#6	12-#5	4.04	4.10	4.26
27	300	51	0.609	204	407	548	13-#6 1	9-#8	16-#8	10-#6	12-#5	4.24	4.31	4.55
27	350	58	0.608	212	423	570	19-#5 1	12-#7	16-#8	11-#6	9-#6	4.47	4.52	4.72
28	50	24	0.743	126	252	339	13-#5 4	13-#5	16-#6	10-#5	10-#5	2.64	2.65	2.63
28	100	29	0.698	151	303	407	13-#5 5	16-#5	15-#7	11-#5	10-#5	3.01	3.03	3.07
28	150	34	0.686	175	350	472	15-#5 6	10-#7	13-#8	12-#5	10-#5	3.42	3.44	3.54
28	200	41	0.611	195	390	525	17-#5 4	11-#7	15-#8	10-#6	12-#5	3.88	3.90	4.03
28	250	48	0.609	209	418	563	13-#6 1	12-#7	16-#8	11-#6	12-#5	4.19	4.24	4.46
28	300	56	0.608	220	440	592	19-#5 3	10-#8	17-#8	11-#6	13-#5	4.40	4.47	4.68
28	350	64	0.607	229	457	616	20-#5 1	10-#8	18-#8	16-#5	10-#6	4.67	4.75	4.93
29	50	26	0.711	139	277	373	13-#5 4	11-#6	13-#7	11-#5	11-#5	2.85	2.86	2.85
29	100	32	0.674	167	333	448	15-#5 5	10-#7	13-#8	12-#5	11-#5	3.29	3.32	3.38
29	150	37	0.638	192	385	518	17-#5 4	20-#5	15-#8	10-#6	11-#5	3.71	3.74	3.82
29	200	45	0.610	212	423	570	19-#5 3	12-#7	16-#8	11-#6	13-#5	4.07	4.12	4.31
29	250	54	0.608	226	451	607	14-#6 3	10-#8	17-#8	16-#5	13-#5	4.34	4.39	4.55
29	300	63	0.607	236	472	635	15-#6 0	11-#8	18-#8	12-#6	10-#6	4.72	4.77	4.94
29	350	71	0.607	245	490	659	16-#6 0	11-#8	19-#8	17-#5	11-#6	4.90	4.97	5.18
30	50	28	0.724	152	305	410	14-#5 6	16-#5	15-#7	11-#5	11-#5	2.92	2.94	2.90
30	100	34	0.665	183	366	493	16-#5 5	14-#6	14-#8	13-#5	11-#5	3.37	3.42	3.55
30	150	41	0.663	210	420	565	19-#5 6	12-#7	16-#8	11-#6	13-#5	3.96	3.97	4.00
30	200	50	0.609	228	457	615	20-#5 5	10-#8	18-#8	16-#5	10-#6	4.19	4.26	4.44
30	250	60	0.608	242	484	652	15-#6 3	11-#8	19-#8	12-#6	10-#6	4.57	4.64	4.81
30	300	69	0.607	254	507	683	16-#6 2	11-#8	20-#8	10-#7	11-#6	4.93	4.99	5.25
30	350	78	0.606	262	523	704	23-#5 1	10-#9	20-#8	10-#7	11-#6	5.16	5.23	5.60
31	50	30	0.708	167	334	450	15-#5 6	13-#6	16-#7	12-#5	11-#5	3.03	3.04	3.11
31	100	36	0.695	200	401	540	18-#5 7	15-#6	15-#8	14-#5	12-#5	3.51	3.57	3.70
31	150	46	0.610	226	452	608	14-#6 3	13-#7	17-#8	16-#5	13-#5	4.01	4.03	4.18
31	200	56	0.608	245	489	658	16-#6 2	11-#8	19-#8	12-#6	11-#6	4.45	4.52	4.71
31	250	66	0.607	259	519	699	23-#5 3	12-#8	20-#8	13-#6	11-#6	4.79	4.86	5.13
31	300	75	0.606	271	542	730	17-#6 2	12-#8	21-#8	14-#6	16-#5	5.05	5.12	5.45
31	350	85	0.606	279	558	752	18-#6 0	13-#8	22-#8	14-#6	12-#6	5.33	5.42	5.72

SQUARE INTERIOR PANEL

(2) Span c.-c.	(3) Load	(1) Min. Sq. Col.	Reinforcing Bars				Steel (psf) Location of Panel		
			Column Strip		Middle Strip				
			Top	Bottom	Top	Bottom	I	IE	IC
(ft)	(psf)	(in.)							
10 in. = TOTAL THICKNESS OF SLAB									0.833 c.f./s.f.
26	50	14	17-#5	10-#5	10-#5	10-#5	2.60	2.62	2.64
26	100	19	15-#6	10-#5	10-#5	10-#5	2.85	2.87	2.89
26	150	25	13-#7	10-#5	10-#5	10-#5	3.06	3.09	3.11
26	200	30	12-#8	12-#5	10-#5	10-#5	3.49	3.49	3.49
26	250	36	13-#8	9-#6	10-#5	10-#5	3.73	3.74	3.75
26	300	45	13-#8	13-#5	10-#5	10-#5	3.78	3.82	3.86
26	350	55	14-#8	10-#6	11-#5	10-#5	4.09	4.14	4.19
27	50	16	14-#6	10-#5	10-#5	10-#5	2.66	2.66	2.65
27	100	21	13-#7	10-#5	10-#5	10-#5	2.93	2.93	2.93
27	150	27	19-#6	12-#5	10-#5	10-#5	3.18	3.22	3.26
27	200	33	13-#8	9-#6	10-#5	10-#5	3.58	3.62	3.66
27	250	42	14-#8	10-#6	11-#5	10-#5	3.87	3.91	3.95
27	300	52	14-#8	11-#6	11-#5	10-#5	4.03	4.10	4.18
27	350	63	15-#8	11-#6	12-#5	10-#5	4.26	4.30	4.35
28	50	17	15-#6	10-#5	10-#5	10-#5	2.63	2.65	2.66
28	100	24	14-#7	11-#5	10-#5	10-#5	3.00	3.02	3.04
28	150	30	13-#8	13-#5	10-#5	10-#5	3.43	3.43	3.43
28	200	37	14-#8	10-#6	11-#5	10-#5	3.70	3.74	3.78
28	250	49	15-#8	11-#6	12-#5	10-#5	4.02	4.06	4.09
28	300	60	15-#8	11-#6	12-#5	10-#5	4.08	4.15	4.23
28	350	70	16-#8	16-#5	12-#5	11-#5	4.33	4.42	4.52
29	50	19	13-#7	11-#5	11-#5	11-#5	2.90	2.89	2.89
29	100	26	15-#7	12-#5	11-#5	11-#5	3.15	3.19	3.24
29	150	33	14-#8	10-#6	11-#5	11-#5	3.62	3.65	3.68
29	200	43	15-#8	11-#6	12-#5	11-#5	3.92	3.96	4.00
29	250	55	16-#8	16-#5	12-#5	11-#5	4.10	4.14	4.18
29	300	67	17-#8	12-#6	13-#5	11-#5	4.40	4.45	4.49
29	350	78	17-#8	12-#6	13-#5	11-#5	4.46	4.55	4.65
30	50	21	14-#7	11-#5	11-#5	11-#5	2.89	2.91	2.93
30	100	28	17-#7	13-#5	11-#5	11-#5	3.29	3.32	3.34
30	150	36	15-#8	11-#6	12-#5	11-#5	3.76	3.79	3.83
30	200	49	16-#8	16-#5	13-#5	11-#5	3.96	4.03	4.10
30	250	62	17-#8	12-#6	13-#5	11-#5	4.22	4.29	4.36
30	300	74	18-#8	10-#7	10-#6	12-#5	4.64	4.72	4.79
30	350	86	18-#8	10-#7	10-#6	12-#5	4.70	4.78	4.86
31	50	23	15-#7	12-#5	11-#5	11-#5	2.93	2.95	2.97
31	100	31	14-#8	14-#5	11-#5	11-#5	3.35	3.38	3.42
31	150	42	16-#8	16-#5	13-#5	11-#5	3.80	3.82	3.85
31	200	56	17-#8	17-#5	13-#5	12-#5	4.08	4.17	4.25
31	250	69	18-#8	13-#6	14-#5	12-#5	4.40	4.48	4.55
31	300	82	19-#8	14-#6	11-#6	13-#5	4.79	4.85	4.92
31	350	94	19-#8	14-#6	11-#6	13-#5	4.85	4.96	5.07

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

CHAPTER 10 – TWO-WAY SOLID FLAT SLABS – SQUARE PANELS WITH DROPS

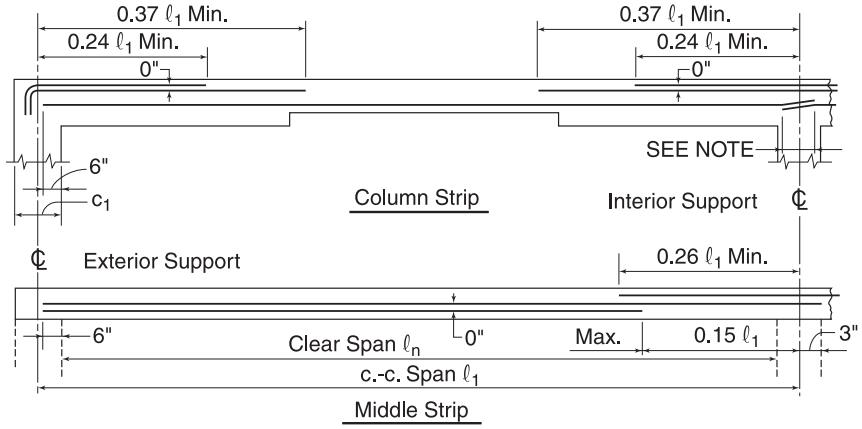
General. Two-way solid flat slabs under the provisions of Chapter 13 in the ACI 318 Building Code, include two-way reinforced slabs with capitals or brackets, drop panels, or both. The use of both capitals and drop panels, commonly used in the early years of two-way slab construction, is less favored today because of the higher formwork costs. In this Chapter, therefore, the tabulated designs presented are for two-way reinforced solid slabs with drop panels only. Capitals and brackets could also be used to provide the necessary critical shear section for transfer of heavy loads from slab to column, but the entire structural analysis and subsequent determination of the required flexural reinforcement would have to be revised. For the tabulated designs in this Chapter, required column sizes were kept to a maximum of $0.083\ell_n$ by increasing the depth of the drop panel for simpler forming and maximum economy for the negative reinforcement. Normal-weight concrete, with f'_c = 4,000 psi, and Grade 60 (f_y = 60,000 psi) reinforcing bars are used in the tabulated designs.

Flat Slab Advantages. The two-way flat slab designs in this Chapter are heavy duty designs, compared to the flat plates of Chapter 9. For the combination of heavier loads and longer spans, the flat slab with adjustment of drop panel depth will require less concrete and reinforcement and can utilize smaller columns than the flat plate for the slight added cost of forming drop panels. These designs are most efficient for square or nearly square panels. For parking garages, storage buildings, or industrial structures, the drop panel soffit is usually an acceptable exposed ceiling. For longer spans, the waffle flat slab (Chapter 11) will provide increased stiffness with less dead weight for overall economy. The choice of a two-way system, however, usually depends upon varying conditions of the structure and other requirements. For this reason, the tabulated designs in Chapters 9, 10, and 11 cover the practicable range of load and span combinations for each, overlapping somewhat.

Design Considerations. All design requirements for flat plates apply equally to flat slabs. Only the design considerations in addition to those described in Chapter 9, applicable because of the drop panels, will be presented in this Chapter.

Column Sizes. The minimum column size for the flat slab designs in this Chapter was taken as 12 inches square. Only square columns are included in the tabulated designs. The Code permits conversion of round columns to square columns of equivalent area for calculation of clear span, but actual round column cross-sections should be used for the critical shear sections. Minimum size interior and exterior columns are established separately.

Drop Panels. The tabulated designs presented begin with the minimum size drop panel (ACI 13.3.7) extending one-third of the span length from the column centerline and projecting 2-1/4 in. below for slab thicknesses of 9 in. or less; for slab thicknesses greater than 9 in., the projection below starts at 4-1/4 in. As shear on the critical section around the column becomes critical with heavier loads, column size is increased up to the maximum considered practical, $0.083\ell_n$. With further



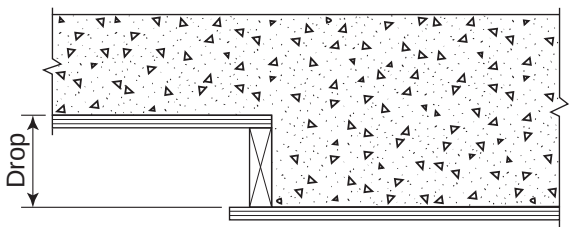
NOTE: Integrity reinforcement is required (ACI 13.3.8.5). All bottom bars in the column strip must be continuous or spliced over the support with Class B tension lap splices. At least two of the column strip bottom bars in each direction must pass within the column core and be anchored at exterior supports.

Figure 10-1 Recommeded Bar Details for Two-Way Solid Flat Slabs

increases in load, shear around the column ("punching" shear $v_c = \left(\frac{\alpha_s d}{b_o} + 2\right)\sqrt{f'_c}$ governed by ACI Eq. 11-32 or $v_c = 4\sqrt{f'_c}$ governed by ACI Eq. 11-33) becomes larger and drop panel depth is increased. Simultaneously, shear around the edge of the drop panel ("beam" shear, $v_c = 2\sqrt{f'_c}$) increases, and drop panel extension into the span is increased in one increment to forty percent of the span, when $v_u > v_c$. Note: The modification factor, λ, for lightweight concrete is excluded from the expressions for v_c, because the tabulated designs in this Chapter are based on normal-weight concrete.

Drop Panels—Projections Below Slab Based on Standard Nominal Lumber Dimensions.

Nominal Size	Actual Size (in.)	Add for Thickness of Plywood (in.)	Total Drop Panel Projection
2x	1 ½	¾	2 ¼
4x	3 ½	¾	4 ¼
6x	5 ½	¾	6 ¼



Control of Deflections (or Minimum Slab Thickness). Minimum thickness/span ratios were observed in preparation of the tabulated designs so that extremely complex deflection calculations in routine designs can be avoided. See Table 10-1, "Minimum Thickness of Two-Way Slabs," for which no deflection calculations are required (ACI 9.5.3).

Flexural Reinforcement. Flexural reinforcement has been selected with the limitations of maximum $\rho < 0.75\rho_b$ and maximum spacing $s \le 2h$, based on overall slab thickness, h (ACI 13.3.2). Bar sizes have been selected for the area of steel required so that the spacing of bars is not less than 3 inches: nor greater than the maximum permitted. For top reinforcement, CRSI recommends a minimum of #4 bars spaced at 12 inches on center for rigidity under construction for traffic. The tabulated reinforcing steel weight per square foot is based on the bar lengths shown in Fig. 10-1. The bar lengths suggested in Fig. 10-1 as standard details are applicable to ratios of adjoining spans up to 1.50 under uniform load. "Integrity reinforcement" is required by ACI 318 (ACI 13.3.8.5). The tabulated reinforcing steel weights do not include "integrity reinforcement."

Table 10-1 Minimum Thickness, *h*, of Two-Way Slabs*

(Expressed as fraction of longer clear span, ℓ_n)

1. Slabs without Interior Beams or with Interior Beams with $\alpha_{fm} \le 0.2$

   a. Flat Plates+ (no drop panels) Min. h = 5 inches
   Interior panels . . . . . $\ell_n/33$
   Exterior panels, no edge beams. . . . . $\ell_n/33$
   Exterior panels, with edge beams*** . . . . $\ell_n/33$

   b. Flat Slab+ (with drop panels) Min. h = 4 inches
   Interior panels . . . . . $\ell_n/36$
   Exterior panels, no edge beams. . . . . $\ell_n/33$
   Exterior panels, with edge beams*** . . . . $\ell_n/36$

2. Slabs with Interior Beams with $\alpha_{fm} > 0.2$**

   a. $\alpha_{fm} \le 2.0$ Min. h = 5 inches

   $h = \left(\frac{1.1}{36 + 5\beta(\alpha_{fm} - 0.2)}\right)\ell_n$ ACI Equation 9-12 with f_y = 60,000 psi

   b. $\alpha_{fm} > 2.0$ Min. h = 3.5 inches

   $h = \left(\frac{1.1}{36 + 9\beta}\right)\ell_n$ ACI Equation 9-13 with f_y = 60,000 psi

where β = ratio of clear spans in long to short direction

Minimum h expressions for different values of α_{fm} and β are as follows:

	Minimum h for different β					
α_{fm}	1.0	1.2	1.4	1.6	1.8	2.0
0.3	$\ell_n/33.2$	$\ell_n/33.3$	$\ell_n/33.4$	$\ell_n/33.5$	$\ell_n/33.5$	$\ell_n/33.6$
0.4	$\ell_n/33.6$	$\ell_n/33.8$	$\ell_n/34.0$	$\ell_n/34.2$	$\ell_n/34.4$	$\ell_n/34.5$
0.6	$\ell_n/34.5$	$\ell_n/34.9$	$\ell_n/35.3$	$\ell_n/35.6$	$\ell_n/36.02$	$\ell_n/36.4$
0.8	$\ell_n/35.5$	$\ell_n/36.0$	$\ell_n/36.5$	$\ell_n/37.1$	$\ell_n/37.6$	$\ell_n/38.2$
1.0	$\ell_n/36.4$	$\ell_n/37.1$	$\ell_n/37.8$	$\ell_n/38.5$	$\ell_n/39.3$	$\ell_n/40.0$
1.2	$\ell_n/37.3$	$\ell_n/38.2$	$\ell_n/39.1$	$\ell_n/40.0$	$\ell_n/40.9$	$\ell_n/41.8$
1.4	$\ell_n/38.2$	$\ell_n/39.3$	$\ell_n/40.4$	$\ell_n/41.5$	$\ell_n/42.5$	$\ell_n/43.6$
1.6	$\ell_n/39.1$	$\ell_n/40.4$	$\ell_n/41.6$	$\ell_n/42.9$	$\ell_n/44.2$	$\ell_n/45.5$
1.8	$\ell_n/40.0$	$\ell_n/41.5$	$\ell_n/42.9$	$\ell_n/44.4$	$\ell_n/45.8$	$\ell_n/47.3$
2.0	$\ell_n/40.9$	$\ell_n/42.5$	$\ell_n/44.2$	$\ell_n/45.8$	$\ell_n/47.5$	$\ell_n/49.1$
>2.0	$\ell_n/40.9$	$\ell_n/42.5$	$\ell_n/44.2$	$\ell_n/45.8$	$\ell_n/47.5$	$\ell_n/49.1$

* Minimum thickness unless deflection is computed, and is within maximim allowable computed deflection (ACI 9.5.3). Grade 60 reinforcing bars assumed.

** For exterior panel, α_f for edge beams not less than 0.8. Otherwise, minimum h must be increased at least 10 percent.

\+ Ratio of long to short span not greater than 2.

*** Slabs with beams along exterior edges. Value of α_f for edge beams not less than 0.8.

USE OF FLAT SLAB TABULATED DESIGNS

Direct Applications Within Dimensional Limitations of Tables

These limitations are:

1. Square column sizes as tabulated
2. Square panels
3. Minimum three panels continuous
4. Equal spans
5. Edge of slab flush with outer face of edge column
6. Live load $\leq 2 \times$ dead load (unfactored loads)
7. Concrete in slab, f'_c = 4,000 psi: normal-weight, w = 150 pcf
8. No edge beams
9. Uniformly distributed gravity loads only

Example 1. ***Preliminary Selection.*** Compare alternate designs to make a preliminary selection of a flat slab intermediate floor with square panels 20 feet center-to-center of columns; the superimposed factored load is 400 psf.

Slab Thickness	Drop Panel	Min Square Column $c_1 = c_2$		Concrete c.f. per s.f.	Reinforcing Steel	
		Edge	Interior		Edge Panel	Interior Panel
8″	6¼″x 6′-8″	18″	20″	0.725	3.24 psf	2.78 psf
8½″	4¼″x 6′-8″	18″	20″	0.748	3.06 psf	2.71 psf
9″	4¼″x 6′-8″	19″	20″	0.789	3.03 psf	2.68 psf

No meaningful reduction in the required amount of reinforcing steel is gained by increasing the slab thickness beyond 8 inches. Concrete quantities, of course, increase. Column and drop panel sizes are essentially the same. Use the 8-inch slab design.

For direct applications within the limitations of the tabulated designs, the tabulated reinforcement can be transferred directly from the tables to the design drawings. Concentration of top reinforcement over edge columns may be achieved by closer spacing, up to 50 percent of the column strip top bars, within the center third of the width of the column strip. Note that one special detail must be developed for the top bars at flush corner columns to ensure that a critical section cannot develop diagonal to the grid. Concentration of reinforcement over the corner column is achieved by addition of bars, top and bottom, in each direction, within the width of the column.

Preliminary Estimates

Preliminary estimates of reinforcing steel and concrete quantities for various structural systems are often required to make a selection. The tabulated designs in this Handbook permit rapid estimates of reinforcing steel and concrete quantities for various systems to support a required load.

Adjustment of Tabulated Designs to Project Conditions

In practice, the usual variations from the limitations of the tabulated designs will occur in one of the following areas:

Variations *within* limitations of the Direct Design Method:

1. Non-square panels where $\ell_2/\ell_1 > 2.0$
2. Non-equal consecutive spans where $\ell'_1/\ell_1 < 1.50$
3. Cantilevers
4. Use of edge beams

Variation *outside* limitations of the Direct Design Method:

5. Entire superimposed load is a movable type of live load (warehouse, storage, etc.) and the service live load, $L >$ two times the service dead load, D, i.e., $L > 2D$.
6. Consecutive spans or non-square panels exceed the limits of 1.50 or 2.0, respectively.

Variations of the first three types listed are illustrated by the examples in Chapter 9 for flat plate design and will require similar treatment for flat slab design.

MANUAL EXAMPLE

To illustrate the design assumptions, applicable Code requirements, and the procedures used in the preparation of the flat slab tabulated designs, one of the designs will be reviewed with detailed calculations performed.This review will assist or guide any user wishing to extend the scope of the designs to longer spans or heavier loads.

Review the tabulated design (Page 10-18) for an intermediate flat slab floor with square panels; $\ell_1 = \ell_2 = 20'\text{-}0''$; the floor has an 8-in. slab plus 4.25-in. drop panels; factored live load = 300 psf; normal-weight concrete, f'_c = 4,000 psi; Grade 60 reinforcing bars, f_y = 60,000 psi. The spans and the dimensions of the columns and drop panels are shown in Fig. 10-2.

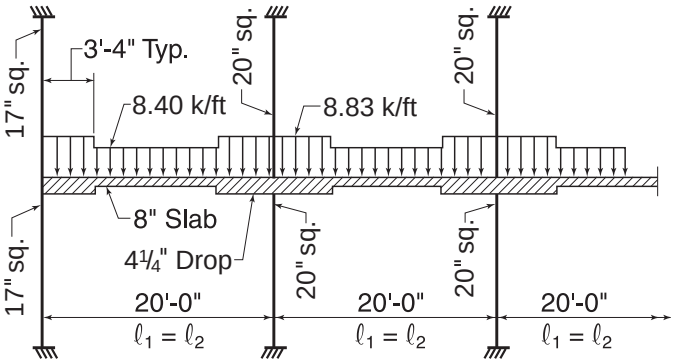


Figure 10-2 Factored Loads and Dimensions of Frame

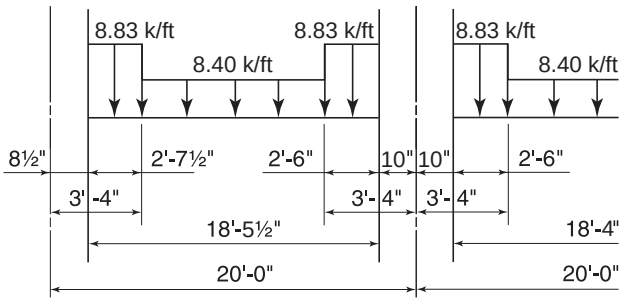
Ratio of Service Live Load to Service Dead Load:

$$L/D = \frac{300/1.6}{100} = 1.875 < 2.0, \text{ Okay}$$

Factored Loads

q_{Du} = 1.2(8/12)(150) = 120 psf = 0.120 ksf (slab)
q_{Du} = 1.2(4.25/12)(150) = 64 psf
= 0.064 ksf (drop panel)
Total q_{Du} = 20(0.120) + (20/3) (0.064)
= 2.40 + 0.43 = 2.83 kips/ft (floor)
q_{Lu} = 20(0.300) = 6.00 kips/ft (floor)
q_u = 2.83 + 6.00 = 8.83 kips/ft (drop panel)
q_u = 2.40 + 6.00 = 8.40 kips/ft (slab)

End Span



Total Static Moment, M_o :
M_o = 8.40(18.458)^2/8 = 357.746 ft-kips (slab)
M_o = (8.83 – 8.40)(2.6)^2/2
= 1.453 ft-kips (drop panel)
M_o = 357.746 + 1.453 = 359.199 ft-kips

Panel Moments (ACI 13.6.3.3)

Exterior Column (Negative Factored Moment)
M_u = 0.26(359.199) = 93.392 ft-kips
Column strip resists 100% of M_u; 1.00(93.392)
= 93.392 ft-kips
(tabulated: 93.4) (ACI 13.6.4.2)
Bottom (Positive Factored Moment)
M_u = 0.52(359.199) = 186.783 ft-kips
(tabulated: 186.8)
Column strip resists 60% of M_u; 0.60(186.783)
= 112.070 ft-kips (ACI 13.6.4.4)
Middle strip resists 40% of M_u; 0.40(186.783)
= 74.713 ft-kips
First Interior Column (Negative Factored Moment)
M_u = 0.70(359.199) = 251.439 ft-kips
(tabulated: 251.4)
Column strip resists 75% of M_u; 0.75(251.439)
= 188.579 ft-kips (ACI 13.6.4.1)
Middle strip resists 25% of M_u; 0.25(251.439)
= 62.860 ft-kips

Flexural Reinforcement

For f'_c = 4,000 psi and f_y = 60,000 psi:
Required $A_s = 0.680\, d - \sqrt{0.462d^2 - 0.0252\, M_u}$
where M_u is in units of in.-kips/ft and A_s is in units of in.^{2}/ft. See Chapter 5.
At support, h = 8 + 4.25 = 12.25 in.
d = 12.25 – 0.75 (concrete cover) – 0.75 (avg. d_b)
= 10.75 in. (drop panel)
Slab thickness, h = 8 in.
d = 8 – 0.75 (concrete cover) – 0.75 (avg. d_b)
= 6.5 in. (slab)

Exterior Column

Column Strip Top Bars (d = 10.75 in.)

M_u = 12(93.392)/10 = 112.070 in.-kips/ft

$A_s = 0.680(10.75) - \sqrt{0.462(10.75)^2 - 0.0252(112.070)}$

$= 0.199$ in.^{2}/ft

Total $A_s = 0.199(10) = 1.99$ in.^{2}

(tabulated: 10–#4 bars; $A_s = 2.00$ in.^{2})

Column Strip Bottom Bars (d = 6.5 in.)

M_u = 12(112.070)/10 = 134.484 in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(134.484)}$

$= 0.404$ in.^{2}/ft

Total $A_s = 0.404(10) = 4.04$ in.^{2}

(tabulated: 13–#5 bars; $A_s = 4.03$ in.^{2})

Middle Strip Bottom Bars (d = 6.5 in.)

M_u = 12(74.713)/10 = 89.656 in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(89.656)}$

$= 0.265$ in.^{2}/ft

Total $A_s = 0.265(10) = 2.65$ in.^{2}

(tabulated: 13–#4 bars ; $A_s = 2.60$ in.^{2})

First Interior Column

Column Strip Top Bars (d = 10.75 in.)

M_u = 12(188.579)/10 = 226.295 in.-kips/ft

$A_s = 0.680(10.75) - \sqrt{0.462(10.75)^2 - 0.0252(226.295)}$

$= 0.404$ in.^{2}/ft

Total $A_s = 0.404(10) = 4.04$ in.^{2}

(tabulated: 13–#5 bars; $A_s = 4.03$ in.^{2})

Middle Strip Top Bars (d = 6.5 in.)

M_u = 12(62.860)/10 = 75.432 in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(75.432)}$

$= 0.223$ in.^{2}/ft

Total $A_s = 0.223(10) = 2.23$ in.^{2}

(tabulated: 11–#4 bars; $A_s = 2.22$ in.^{2})

Summary – Flexural Reinforcement – End Span

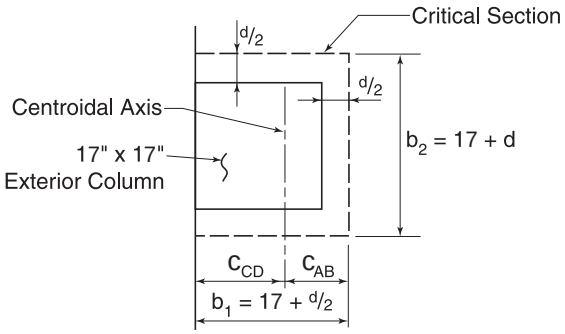
Location	Size-No.	A_s	d	b	$\rho = A_s/bd$	Max. ρ	ϕ = 0.90	Min. A_s
Column Strip								
Exterior Top Bars	10-#4	2.00	10.75	120	0.0016	0.0181	Yes	2.65
Bottom Bars	13-#5	4.03	6.50	120	0.0052	0.0181	Yes	1.73
Interior Top Bars	13-#5	4.03	10.75	120	0.0031	0.0181	Yes	2.65
Middle Strip								
Bottom Bars	13-#4	2.60	6.50	120	0.0033	0.0181	Yes	1.73
Interior Top Bars	11-#4	2.22	6.50	120	0.0029	0.0181	Yes	1.73

Min. $A_s = 0.0018bh$ { For h = 12.25 in., Min. $A_s = 0.0018(120)(12.25) = 2.65$ in.^{2} ; For h = 8.00 in., Min. $A_s = 0.0018(120)(8.00) = 1.73$ in.^{2}

For transfer of unbalanced moment by flexure, 3-#4 bars are required within effective width; hence, A_s in column strip is 2.60 in.^{2}, which is ≈ Min. A_s of 2.65 in.^{2}

With f'_c = 4,000 psi and f_y = 60,000 psi, Max. ρ = 0.0181 for ϵ_t = 0.005 (Page 5-4).

Shear Constants at Exterior Column (ACI R11.11.7.2):



b_1 = 17 + 10.75/2 = 22.38 in.

b_2 = 17 + 10.75 = 27.75 in.

b_o = 2(22.38) + 27.75 = 72.5 in.

A_c = 72.5(10.75) = 779.38 in.^{2}

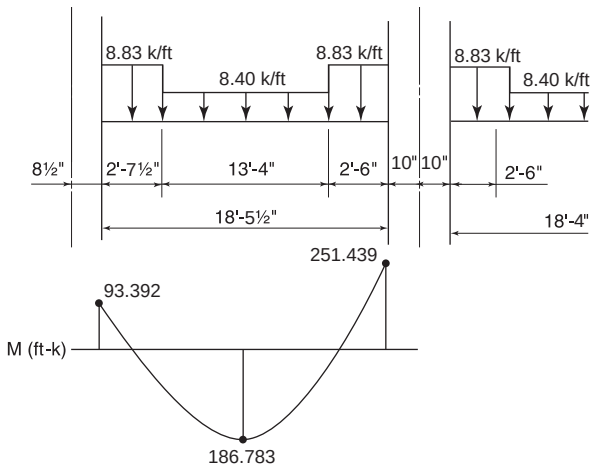
$c_{AB} = (22.38)^2 (10.75/779.38) = 6.91$ in.

c_{CD} = 22.38 – 6.91 = 15.47 in.

$J = 22.38(10.75)^3/6 + 2(10.75)(6.91^3 + 15.47^3)/3 + 27.75(10.75)(6.91)^2$

$= 4{,}634 + 28{,}898 + 14{,}244 = 47{,}776$ in.^{4}

Factored Moments and Shears at Face of Exterior Column



V_u (at ext col face) = 8.40(18.458)/2

+ (8.83 – 8.40)(5.125)/2

– (251.439 – 93.392)/18.458

= 77.524 + 1.102 – 8.562

= 70.064 kips

V_u (at C.L. ext col) = 70.064 + 8.83(8.5/12)

= 76.319 kips

V_{ext} = 70.064 + 8.83(17/12) = 82.573 kips

Shear Check at Exterior Column

$v_c = (\alpha_s d/b_o + 2)\sqrt{f'_c} \le 4\sqrt{f'_c}$

$v_c = (30 \times 10.75/72.5 + 2)\sqrt{f'_c} = 6.45\sqrt{f'_c}$

Use $v_c = 4\sqrt{f'_c}$

$\gamma_f = 1/[1 + (2/3)\sqrt{b_1/b_2}]$

$= 1/[1 + (2/3)\sqrt{22.38/27.75}] = 0.626$

(tabulated: 0.626)

$\gamma_v = 1 - \gamma_f = 1 - 0.626 = 0.374$

$v_u = V_{ext}/A_c + \gamma_v Mc_{AB}/J$

Where $M = 0.3M_o$ (ACI 13.6.3.6)

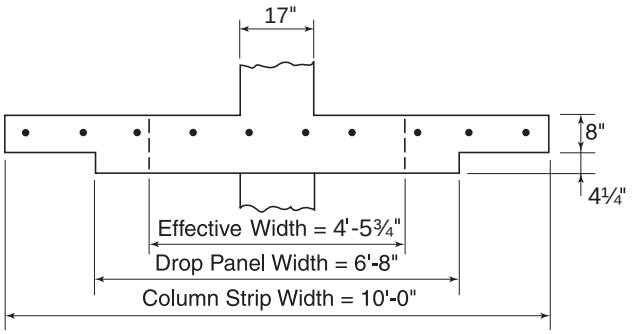
$= 0.3(359.199) = 107.760$ ft-kips

$v_u = 82.573/779.38 + 0.374(107.760 \times 12 \times 6.91)/47{,}776$

$v_u = 0.106 + 0.070 = 0.176$ ksi or 176 psi

$\phi v_c = 0.75\ (4)\sqrt{4000} = 190$ psi $> v_u$, Okay

Determine the Number of Extra Bars Required in Column Strip at Exterior Column



$\gamma_f M_u = 0.626(93.392) = 58.463$ ft-kips

"Effective Width" = 17 + 1.5(12.25)2 = 53.75 in.

10–#4 bars are required to resist exterior $-M_u$ in column strip

Note: 4 bars are located where d = 6.5 in. and 6 bars are located where d = 10.75 in.

Try 3 additional bars (as per tabulated design) for a total of 7 bars in the effective width

$A_s = 7(0.20) = 1.40$ in.^{2} for 7–#4 bars

$a = A_s f_y/0.85 f'_c\ b = 1.40(60)/0.85(4)(54)$

$= 0.458$ in.

$$\phi M_n = \phi A_s f_y \left(d - \frac{a}{2}\right)$$

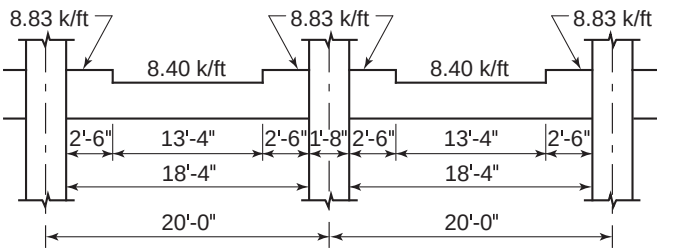
$\phi M_n = 0.90(1.40)(60)(10.75 - 0.458/2)/12$

$\phi M_n = 66.282$ ft-kips $> \gamma_f M_u$, Okay

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{1.40}{(53.75)(10.75)}$

$\rho = 0.0024 < \rho_{max}$; $\phi = 0.90$

Interior Span



Total Static Moment, M_o:

$M_o = 8.40(18.333)^2/8 = 352.904$ ft-kips (slab)

$M_o = (8.83 - 8.40)(2.5)^2/2$

$= 1.344$ ft-kips (drop panel)

$M_o = 352.904 + 1.344 = 354.248$ ft-kips

Panel Moments

Bottom (Positive Factored Moment)

$M_u = 0.35(354.248) = 123.987$ ft-kips

Column strip resists 60% of M_u; 0.60(123.987)

$= 74.392$ ft-kips (ACI 13.6.4.4)

Middle strip resists 40% of M_u; 0.40(123.987)

$= 49.595$ ft-kips

Top (Negative Factored Moment)

$M_u = 0.65(354.248) = 230.261$ ft-kips

Column strip resists 75% of M_u; 0.75(230.261)

$= 172.696$ ft-kips (ACI 13.6.4.1)

Middle strip resists 25% of M_u; 0.25(230.261)

$= 57.565$ ft-kips

Flexural Reinforcement

Column Strip Bottom Bars (d = 6.5 in.)

$M_u = 12(74.392)/10 = 89.270$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(89.270)}$

$= 0.264$ in.^{2}/ft

Total $A_s = 0.264(10) = 2.64$ in.^{2}

(tabulated: 13–#4 bars; $A_s = 2.60$ in.^{2})

Middle Strip Bottom Bars (d = 6.5 in.)

$M_u = 12(49.595)/10 = 59.514$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(59.514)}$

$= 0.175$ in.^{2}/ft

Total $A_s = 0.175(10) = 1.75$ in.^{2}

(tabulated: 9–#4 bars ; $A_s = 1.80$ in.^{2})

Column Strip Top Bars (d = 10.75 in.)

$M_u = 12(172.696)/10 = 207.235$ in.-kips/ft

$A_s = 0.680(10.75) - \sqrt{0.462(10.75)^2 - 0.0252(207.235)}$

$= 0.370$ in.^{2}/ft

Total $A_s = 0.370(10) = 3.70$ in.^{2}

(tabulated: 12–#5 bars; $A_s = 3.72$ in.^{2})

Middle Strip Top Bars (d = 6.5 in.)

$M_u = 12(57.565)/10 = 69.078$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(69.078)}$

$= 0.204$ in.^{2}/ft

Total $A_s = 0.204(10) = 2.04$ in.^{2}

(tabulated: 10–#4 bars; $A_s = 2.00$ in.^{2})

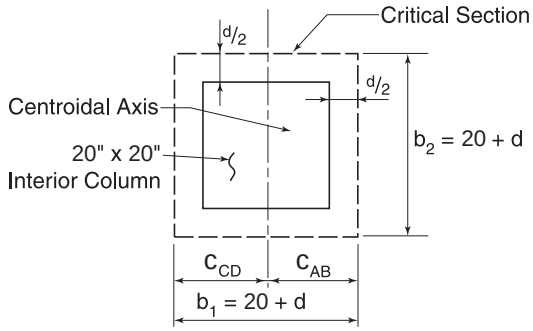
Summary – Flexural Reinforcement – Interior Span

Location	Size-No.	A_s	d	b	$\rho = A_s/bd$	Max. ρ	$\phi = 0.90$	Min. A_s
Column Strip								
Top Bars	12-#5	3.72	10.75	120	0.0029	0.0181	Yes	2.65
Bottom Bars	13-#4	2.60	6.50	120	0.0033	0.0181	Yes	1.73
Middle Strip								
Top Bars	10-#4	2.00	6.50	120	0.0026	0.0181	Yes	1.73
Bottom Bars	9-#4	1.80	6.50	120	0.0023	0.0181	Yes	1.73

Min. $A_s = 0.0018bh$ { For h = 12.25 in., Min. A_s = 0.0018(120)(12.25) = 2.65 in.^{2} ; For h = 8.00 in., Min. A_s = 0.0018(120)(8.00) = 1.73 in.^{2}

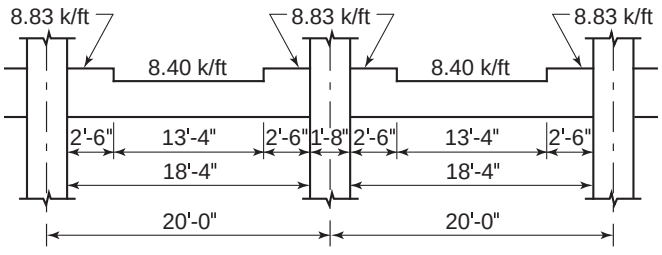
With f'_c = 4,000 psi and f_y = 60,000 psi, Max. ρ = 0.0181 for ϵ_t = 0.005 (Page 5-4).

Shear Constants



$b_1 = b_2 = 20 + 10.75 = 30.75$ in.
$b_o = 4(30.75) = 123$ in.
$A_c = 123(10.75) = 1{,}322$ in.^{2}
$c_{AB} = c_{CD} = 30.75/2 = 15.38$ in.
$J = d b_1 (d^2 + 4b_1^2)/6$
$= 10.75(30.75)((10.75)^2 + 4(30.75)^2)/6$
$= 214{,}745$ in.^{4}

Factored Moments and Shears at Centerline of Interior Column



Maximum factored shear, V_u, and no unbalanced moment (full factored load on adjacent spans)

$V_u = 8.40(18.33) + (8.83 - 8.40)(2.5 + 2.5 + 20/12)$
$V_u = 153.972 + 2.867 = 156.839$ kips

For checking shear due to combined effects (i.e., direct shear plus transfer of unbalanced moment) the factored moment:

$M_{int} = 0.07\,[(q_{Du} + 0.5q_{Lu})\,\ell_2\,\ell_n^2 - q'_{Du}\,\ell'_2(\ell'_n)^2]$ . . . . (ACI Eq. 13-7)

where q'_{Du}, ℓ'_2 and ℓ'_n refer to the shorter span

$M_{int} = 0.07[(0.120 + 0.150)(20)(18.333)^2 - 0.120(20)(18.333)^2]$
$= 0.07[1{,}814.934 - 806.637] = 70.581$ ft-kips

With factored moment M_{int} = 70.581 ft-kips, the factored shear is:

$V_u = q_u\,\ell/2 + q_{Du}\,\ell/2$ (i.e., full factored load on one span and factored dead load only on other span)
$V_u = 8.40(20)/2 + (8.83 - 8.40)(2.5) + 2.40(20)/2 + 0.43(2.5)$
$= 84.0 + 1.075 + 24.0 + 1.075 = 110.150$ kips

Shear Check at Interior Column

$v_c = (\alpha_s\, d/b_o + 2)\sqrt{f'_c} \le 4\sqrt{f'_c}$
$v_c = (40 \times 10.75/123 + 2)\sqrt{f'_c} = 5.496\sqrt{f'_c}$
Use $v_c = 4\sqrt{f'_c}$

For factored shear V_{int} = 156.839 kips and no unbalanced moment

$v_u = V_u/A_c$
$v_u = 156.839/1{,}322 = 0.119$ ksi or 119 psi
$\phi v_c = 0.75(4)\sqrt{4000} = 190$ psi > v_u, Okay

For factored shear V_u = 110.150 kips and factored moment M_{int} = 70.581 ft-kips

$\gamma_f = 1/[1 + (2/3)\sqrt{b_1/b_2}]$
$= 1/[1 + (2/3)\sqrt{30.75/30.75}] = 0.60$
$\gamma_v = 1 - \gamma_f = 1 - 0.60 = 0.40$
$v_u = V_u/A_c + \gamma_v\, M_{int}\, c_{AB}/J$
$= 110.150/1{,}322 + 0.40(70.581 \times 12)(15.38)/(214{,}745)$
$v_u = 0.083 + 0.024 = 0.107$ ksi or 107 psi
$\phi v_c = 190$ psi > v_u, Okay

Check one-way shear at distance d beyond edge of drop panel. The section for checking one-way shear is located 2.500 + 6.5/12 = 3.042 ft from the face of the left or right column.

$V_u = (18.333/2 - 3.042)(8.40) = 51.446$ kips
$\phi V_n = \phi 2\sqrt{f'_c}\, b_w d$
$= 0.75(2)\sqrt{4000}(20 \times 12)(6.5)/1{,}000$
$= 147.994$ kips
$\phi V_n > V_u$, Okay

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
10	8.25	3.34	181	3,700	4.11	294	6,500	8.38	452	22,000
	9.25	3.47	215	4,900	4.23	353	8,600	8.88	550	30,300
	10.25	3.59	252	6,200	4.35	416	11,100	9.38	656	40,500
	11.25	3.72	290	7,800	4.47	483	14,000	9.88	770	53,100
	12.25	3.84	331	9,700	4.59	554	17,600	10.38	892	68,300
	13.25	3.97	373	11,900	4.71	629	21,700	10.88	1,022	86,500
	14.25	4.09	418	14,500	4.83	708	26,500	11.38	1,160	107,900
	15.25	4.22	464	17,400	4.95	791	32,000	11.88	1,306	133,100
	16.25	4.34	513	20,800	5.07	878	38,300	12.38	1,460	162,300
	17.25	4.47	563	24,600	5.20	969	45,500	12.88	1,622	196,000
	18.25	4.59	616	28,800	5.32	1,064	53,600	13.38	1,792	234,700
	19.25	4.72	670	33,700	5.44	1,163	62,800	13.88	1,970	278,700
	20.25	4.84	727	39,100	5.56	1,266	73,100	14.38	2,156	328,600
	21.25	4.97	785	45,100	5.68	1,373	84,500	14.88	2,350	384,900
	22.25	5.09	846	51,700	5.81	1,484	97,300	15.38	2,552	448,000
	23.25	5.22	908	59,100	5.93	1,599	111,500	15.88	2,762	518,500
	24.25	5.34	973	67,300	6.05	1,718	127,200	16.38	2,980	597,000
	25.25	5.47	1,039	76,200	6.17	1,841	144,400	16.88	3,206	684,000
	26.25	5.59	1,108	86,000	6.30	1,968	163,300	17.38	3,440	780,200
12	8.25	3.84	208	5,500	4.78	334	9,500	9.38	506	30,600
	9.25	3.97	246	7,100	4.89	399	12,300	9.88	612	41,300
	10.25	4.09	287	8,900	5.01	468	15,700	10.38	726	54,400
	11.25	4.22	329	11,100	5.13	541	19,600	10.88	848	70,200
	12.25	4.34	374	13,500	5.25	618	24,200	11.38	978	89,100
	13.25	4.47	420	16,400	5.37	699	29,400	11.88	1,116	111,400
	14.25	4.59	469	19,700	5.49	784	35,400	12.38	1,262	137,400
	15.25	4.72	519	23,400	5.61	873	42,300	12.88	1,416	167,700
	16.25	4.84	572	27,500	5.73	966	50,100	13.38	1,578	202,500
	17.25	4.97	626	32,200	5.85	1,063	59,000	13.88	1,748	242,400
	18.25	5.09	683	37,500	5.97	1,164	68,900	14.38	1,926	287,900
	19.25	5.22	741	43,400	6.09	1,269	80,000	14.88	2,112	339,300
	20.25	5.34	802	49,900	6.22	1,378	92,300	15.38	2,306	397,200
	21.25	5.47	864	57,100	6.34	1,491	106,000	15.88	2,508	462,200
	22.25	5.59	929	65,100	6.46	1,608	121,200	16.38	2,718	534,700
	23.25	5.72	995	73,900	6.58	1,729	137,900	16.88	2,936	615,300
	24.25	5.84	1,064	83,500	6.70	1,854	156,200	17.38	3,162	704,600
	25.25	5.97	1,134	94,000	6.83	1,983	176,400	17.88	3,396	803,300
	26.25	6.09	1,207	105,500	6.95	2,116	198,400	18.38	3,638	911,800

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
14	8.25	4.34	235	7,800	5.44	375	13,400	10.38	560	41,300
	9.25	4.47	277	9,900	5.56	446	17,100	10.88	674	54,800
	10.25	4.59	322	12,300	5.67	521	21,500	11.38	796	71,200
	11.25	4.72	368	15,100	5.79	600	26,500	11.88	926	90,700
	12.25	4.84	417	18,300	5.91	683	32,300	12.38	1,064	113,800
	13.25	4.97	467	21,900	6.03	770	38,900	12.88	1,210	140,700
	14.25	5.09	520	26,000	6.15	861	46,400	13.38	1,364	171,900
	15.25	5.22	574	30,600	6.27	956	54,900	13.88	1,526	207,900
	16.25	5.34	631	35,700	6.39	1,055	64,400	14.38	1,696	249,100
	17.25	5.47	689	41,500	6.51	1,158	75,100	14.88	1,874	295,800
	18.25	5.59	750	47,900	6.63	1,265	87,000	15.38	2,060	348,800
	19.25	5.72	812	54,900	6.75	1,376	100,300	15.88	2,254	408,300
	20.25	5.84	877	62,700	6.87	1,491	114,900	16.38	2,456	475,100
	21.25	5.97	943	71,300	6.99	1,610	131,100	16.88	2,666	549,500
	22.25	6.09	1,012	80,800	7.12	1,733	148,900	17.38	2,884	632,200
	23.25	6.22	1,082	91,100	7.24	1,860	168,400	17.88	3,110	723,800
	24.25	6.34	1,155	102,300	7.36	1,991	189,800	18.38	3,344	824,900
	25.25	6.47	1,229	114,600	7.48	2,126	213,100	18.88	3,586	936,100
	26.25	6.59	1,306	127,900	7.60	2,265	238,500	19.38	3,836	1,058,000
16	8.25	4.84	262	10,700	6.10	415	18,300	11.38	614	54,200
	9.25	4.97	308	13,400	6.22	492	23,100	11.88	736	71,100
	10.25	5.09	357	16,600	6.34	573	28,600	12.38	866	91,200
	11.25	5.22	407	20,100	6.46	658	34,900	12.88	1,004	115,000
	12.25	5.34	460	24,100	6.57	747	42,100	13.38	1,150	142,700
	13.25	5.47	514	28,600	6.69	840	50,300	13.88	1,304	174,900
	14.25	5.59	571	33,600	6.81	937	59,500	14.38	1,466	211,900
	15.25	5.72	629	39,200	6.93	1,038	69,800	14.88	1,636	254,300
	16.25	5.84	690	45,500	7.05	1,143	81,300	15.38	1,814	302,400
	17.25	5.97	752	52,400	7.17	1,252	94,100	15.88	2,000	356,700
	18.25	6.09	817	60,100	7.29	1,365	108,300	16.38	2,194	417,900
	19.25	6.22	883	68,500	7.41	1,482	123,900	16.88	2,396	486,400
	20.25	6.34	952	77,800	7.53	1,603	141,200	17.38	2,606	562,700
	21.25	6.47	1,022	87,900	7.65	1,728	160,100	17.88	2,824	647,500
	22.25	6.59	1,095	99,000	7.77	1,857	180,900	18.38	3,050	741,300
	23.25	6.72	1,169	111,000	7.89	1,990	203,500	18.88	3,284	844,800
	24.25	6.84	1,246	124,100	8.01	2,127	228,200	19.38	3,526	958,500
	25.25	6.97	1,324	138,300	8.14	2,268	255,000	19.88	3,776	1,083,200
	26.25	7.09	1,405	153,600	8.26	2,413	284,100	20.38	4,034	1,219,500

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
18	8.25	5.34	289	14,300	6.77	456	24,200	12.38	668	69,500
	9.25	5.47	339	17,700	6.89	539	30,200	12.88	798	90,200
	10.25	5.59	392	21,700	7.00	626	37,200	13.38	936	114,600
	11.25	5.72	446	26,100	7.12	717	45,000	13.88	1,082	143,200
	12.25	5.84	503	31,000	7.24	812	53,900	14.38	1,236	176,300
	13.25	5.97	561	36,500	7.36	911	63,800	14.88	1,398	214,300
	14.25	6.09	622	42,700	7.47	1,014	74,900	15.38	1,568	257,800
	15.25	6.22	684	49,500	7.59	1,121	87,300	15.88	1,746	307,100
	16.25	6.34	749	57,000	7.71	1,232	101,000	16.38	1,932	362,900
	17.25	6.47	815	65,300	7.83	1,347	116,200	16.88	2,126	425,600
	18.25	6.59	884	74,400	7.95	1,466	132,900	17.38	2,328	495,800
	19.25	6.72	954	84,300	8.07	1,589	151,300	17.88	2,538	574,000
	20.25	6.84	1,027	95,200	8.19	1,716	171,400	18.38	2,756	660,800
	21.25	6.97	1,101	107,000	8.31	1,847	193,400	18.88	2,982	756,800
	22.25	7.09	1,178	119,900	8.43	1,982	217,400	19.38	3,216	862,600
	23.25	7.22	1,256	133,800	8.55	2,121	243,500	19.88	3,458	978,900
	24.25	7.34	1,337	149,000	8.67	2,264	271,800	20.38	3,708	1,106,300
	25.25	7.47	1,419	165,300	8.79	2,411	302,500	20.88	3,966	1,245,500
	26.25	7.59	1,504	182,900	8.91	2,562	335,600	21.38	4,232	1,397,100
20	8.25	5.84	316	18,600	7.43	496	31,300	13.38	722	87,500
	9.25	5.97	370	22,900	7.55	585	38,800	13.88	860	112,600
	10.25	6.09	427	27,800	7.67	678	47,300	14.38	1,006	141,800
	11.25	6.22	485	33,200	7.78	775	56,900	14.88	1,160	175,700
	12.25	6.34	546	39,200	7.90	876	67,700	15.38	1,322	214,700
	13.25	6.47	608	45,900	8.02	981	79,600	15.88	1,492	259,300
	14.25	6.59	673	53,300	8.14	1,090	92,900	16.38	1,670	309,900
	15.25	6.72	739	61,400	8.25	1,203	107,600	16.88	1,856	367,000
	16.25	6.84	808	70,400	8.37	1,320	123,800	17.38	2,050	431,200
	17.25	6.97	878	80,100	8.49	1,441	141,600	17.88	2,252	503,000
	18.25	7.09	951	90,800	8.61	1,566	161,200	18.38	2,462	583,000
	19.25	7.22	1,025	102,500	8.73	1,695	182,600	18.88	2,680	671,800
	20.25	7.34	1,102	115,100	8.85	1,828	205,900	19.38	2,906	769,900
	21.25	7.47	1,180	128,900	8.97	1,965	231,300	19.88	3,140	878,000
	22.25	7.59	1,261	143,800	9.09	2,106	258,900	20.38	3,382	996,800
	23.25	7.72	1,343	159,800	9.21	2,251	288,700	20.88	3,632	1,126,800
	24.25	7.84	1,428	177,200	9.33	2,400	321,000	21.38	3,890	1,268,800
	25.25	7.97	1,514	195,800	9.45	2,553	355,900	21.88	4,156	1,423,600
	26.25	8.09	1,603	215,900	9.57	2,710	393,400	22.38	4,430	1,591,700

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
22	8.25	6.34	343	23,600	8.10	537	39,600	14.38	776	108,400
	9.25	6.47	401	29,000	8.21	632	48,900	14.88	922	138,300
	10.25	6.59	462	34,900	8.33	731	59,300	15.38	1,076	173,000
	11.25	6.72	524	41,500	8.45	834	70,800	15.88	1,238	212,900
	12.25	6.84	589	48,800	8.56	941	83,700	16.38	1,408	258,500
	13.25	6.97	655	56,800	8.68	1,052	97,900	16.88	1,586	310,300
	14.25	7.09	724	65,600	8.80	1,167	113,700	17.38	1,772	368,700
	15.25	7.22	794	75,200	8.92	1,286	131,000	17.88	1,966	434,300
	16.25	7.34	867	85,700	9.04	1,409	150,000	18.38	2,168	507,700
	17.25	7.47	941	97,200	9.15	1,536	170,700	18.88	2,378	589,400
	18.25	7.59	1,018	109,700	9.27	1,667	193,400	19.38	2,596	680,100
	19.25	7.72	1,096	123,200	9.39	1,802	218,100	19.88	2,822	780,300
	20.25	7.84	1,177	137,900	9.51	1,941	245,000	20.38	3,056	890,600
	21.25	7.97	1,259	153,700	9.63	2,084	274,100	20.88	3,298	1,011,800
	22.25	8.09	1,344	170,800	9.75	2,231	305,600	21.38	3,548	1,144,400
	23.25	8.22	1,430	189,200	9.87	2,382	339,600	21.88	3,806	1,289,300
	24.25	8.34	1,519	208,900	9.99	2,537	376,200	22.38	4,072	1,447,000
	25.25	8.47	1,609	230,200	10.11	2,696	415,600	22.88	4,346	1,618,300
	26.25	8.59	1,702	252,900	10.23	2,859	457,900	23.38	4,628	1,804,000
24	8.25	6.84	370	29,600	8.76	577	49,400	15.38	830	132,400
	9.25	6.97	432	36,100	8.88	678	60,600	15.88	984	167,800
	10.25	7.09	497	43,200	9.00	783	73,100	16.38	1,146	208,600
	11.25	7.22	563	51,100	9.11	892	86,900	16.88	1,316	255,100
	12.25	7.34	632	59,800	9.23	1,005	102,100	17.38	1,494	307,900
	13.25	7.47	702	69,300	9.35	1,122	118,900	17.88	1,680	367,600
	14.25	7.59	775	79,700	9.46	1,243	137,400	18.38	1,874	434,600
	15.25	7.72	849	91,000	9.58	1,368	157,600	18.88	2,076	509,500
	16.25	7.84	926	103,300	9.70	1,497	179,700	19.38	2,286	592,900
	17.25	7.97	1,004	116,600	9.82	1,630	203,700	19.88	2,504	685,400
	18.25	8.09	1,085	131,100	9.93	1,767	229,900	20.38	2,730	787,500
	19.25	8.22	1,167	146,700	10.05	1,908	258,200	20.88	2,964	900,100
	20.25	8.34	1,252	163,600	10.17	2,053	288,900	21.38	3,206	1,023,600
	21.25	8.47	1,338	181,700	10.29	2,202	322,100	21.88	3,456	1,158,800
	22.25	8.59	1,427	201,200	10.41	2,355	357,800	22.38	3,714	1,306,300
	23.25	8.72	1,517	222,100	10.53	2,512	396,300	22.88	3,980	1,466,900
	24.25	8.84	1,610	244,500	10.65	2,673	437,600	23.38	4,254	1,641,400
	25.25	8.97	1,704	268,500	10.77	2,838	481,900	23.88	4,536	1,830,400
	26.25	9.09	1,801	294,100	10.89	3,007	529,400	24.38	4,826	2,034,800

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
26	8.25	7.34	397	36,400	9.43	618	60,600	16.38	884	159,700
	9.25	7.47	463	44,200	9.55	725	74,100	16.88	1,046	201,200
	10.25	7.59	532	52,800	9.66	836	88,900	17.38	1,216	248,700
	11.25	7.72	602	62,200	9.78	951	105,200	17.88	1,394	302,500
	12.25	7.84	675	72,400	9.89	1,070	123,100	18.38	1,580	363,300
	13.25	7.97	749	83,600	10.01	1,193	142,800	18.88	1,774	431,600
	14.25	8.09	826	95,700	10.13	1,320	164,300	19.38	1,976	508,000
	15.25	8.22	904	108,900	10.24	1,451	187,700	19.88	2,186	593,000
	16.25	8.34	985	123,200	10.36	1,586	213,200	20.38	2,404	687,200
	17.25	8.47	1,067	138,600	10.48	1,725	240,800	20.88	2,630	791,300
	18.25	8.59	1,152	155,200	10.60	1,868	270,700	21.38	2,864	905,900
	19.25	8.72	1,238	173,100	10.72	2,015	303,100	21.88	3,106	1,031,700
	20.25	8.84	1,327	192,400	10.83	2,166	338,000	22.38	3,356	1,169,300
	21.25	8.97	1,417	213,000	10.95	2,321	375,600	22.88	3,614	1,319,500
	22.25	9.09	1,510	235,100	11.07	2,480	416,000	23.38	3,880	1,483,000
	23.25	9.22	1,604	258,800	11.19	2,643	459,300	23.88	4,154	1,660,500
	24.25	9.34	1,701	284,100	11.31	2,810	505,700	24.38	4,436	1,852,800
	25.25	9.47	1,799	311,100	11.43	2,981	555,400	24.88	4,726	2,060,700
	26.25	9.59	1,900	339,900	11.55	3,156	608,400	25.38	5,024	2,284,900
28	8.25	7.84	424	44,200	10.10	658	73,500	17.38	938	190,600
	9.25	7.97	494	53,500	10.21	771	89,400	17.88	1,108	238,800
	10.25	8.09	567	63,700	10.33	888	106,900	18.38	1,286	293,600
	11.25	8.22	641	74,700	10.44	1,009	126,000	18.88	1,472	355,500
	12.25	8.34	718	86,700	10.56	1,134	146,900	19.38	1,666	425,000
	13.25	8.47	796	99,700	10.67	1,263	169,700	19.88	1,868	502,700
	14.25	8.59	877	113,800	10.79	1,396	194,600	20.38	2,078	589,300
	15.25	8.72	959	129,100	10.91	1,533	221,500	20.88	2,296	685,200
	16.25	8.84	1,044	145,500	11.03	1,674	250,700	21.38	2,522	791,100
	17.25	8.97	1,130	163,200	11.14	1,819	282,300	21.88	2,756	907,800
	18.25	9.09	1,219	182,200	11.26	1,968	316,400	22.38	2,998	1,035,700
	19.25	9.22	1,309	202,600	11.38	2,121	353,100	22.88	3,248	1,175,800
	20.25	9.34	1,402	224,500	11.50	2,278	392,500	23.38	3,506	1,328,500
	21.25	9.47	1,496	247,900	11.62	2,439	434,900	23.88	3,772	1,494,800
	22.25	9.59	1,593	272,900	11.73	2,604	480,300	24.38	4,046	1,675,300
	23.25	9.72	1,691	299,500	11.85	2,773	528,900	24.88	4,328	1,870,800
	24.25	9.84	1,792	328,000	11.97	2,946	580,900	25.38	4,618	2,082,000
	25.25	9.97	1,894	358,200	12.09	3,123	636,300	25.88	4,916	2,309,900
	26.25	10.09	1,999	390,400	12.21	3,304	695,300	26.38	5,222	2,555,200

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
30	8.25	8.34	451	53,100	10.76	699	88,100	18.38	992	225,200
	9.25	8.47	525	64,100	10.88	818	106,700	18.88	1,170	280,900
	10.25	8.59	602	76,000	10.99	941	127,100	19.38	1,356	343,700
	11.25	8.72	680	88,900	11.11	1,068	149,400	19.88	1,550	414,400
	12.25	8.84	761	102,800	11.22	1,199	173,600	20.38	1,752	493,400
	13.25	8.97	843	117,900	11.34	1,334	199,900	20.88	1,962	581,300
	14.25	9.09	928	134,100	11.46	1,473	228,400	21.38	2,180	678,900
	15.25	9.22	1,014	151,600	11.57	1,616	259,200	21.88	2,406	786,600
	16.25	9.34	1,103	170,400	11.69	1,763	292,500	22.38	2,640	905,100
	17.25	9.47	1,193	190,600	11.81	1,914	328,400	22.88	2,882	1,035,200
	18.25	9.59	1,286	212,200	11.92	2,069	367,000	23.38	3,132	1,177,600
	19.25	9.72	1,380	235,400	12.04	2,228	408,400	23.88	3,390	1,332,800
	20.25	9.84	1,477	260,100	12.16	2,391	452,900	24.38	3,656	1,501,800
	21.25	9.97	1,575	286,500	12.28	2,558	500,400	24.88	3,930	1,685,100
	22.25	10.09	1,676	314,600	12.40	2,729	551,300	25.38	4,212	1,883,700
	23.25	10.22	1,778	344,500	12.52	2,904	605,500	25.88	4,502	2,098,300
	24.25	10.34	1,883	376,300	12.63	3,083	663,400	26.38	4,800	2,329,700
	25.25	10.47	1,989	410,100	12.75	3,266	725,000	26.88	5,106	2,578,700
	26.25	10.59	2,098	445,900	12.87	3,453	790,500	27.38	5,420	2,846,300
32	8.25	8.84	478	63,200	11.43	739	104,500	19.38	1,046	263,800
	9.25	8.97	556	75,900	11.54	864	126,200	19.88	1,232	327,600
	10.25	9.09	637	89,800	11.66	993	149,800	20.38	1,426	399,300
	11.25	9.22	719	104,700	11.77	1,126	175,500	20.88	1,628	479,500
	12.25	9.34	804	120,800	11.89	1,263	203,400	21.38	1,838	568,800
	13.25	9.47	890	138,100	12.00	1,404	233,500	21.88	2,056	667,800
	14.25	9.59	979	156,700	12.12	1,549	266,000	22.38	2,282	777,200
	15.25	9.72	1,069	176,700	12.24	1,698	301,100	22.88	2,516	897,600
	16.25	9.84	1,162	198,100	12.35	1,851	338,800	23.38	2,758	1,029,700
	17.25	9.97	1,256	221,000	12.47	2,008	379,400	23.88	3,008	1,174,300
	18.25	10.09	1,353	245,500	12.59	2,169	422,900	24.38	3,266	1,331,900
	19.25	10.22	1,451	271,600	12.71	2,334	469,400	24.88	3,532	1,503,500
	20.25	10.34	1,552	299,400	12.82	2,503	519,200	25.38	3,806	1,689,600
	21.25	10.47	1,654	329,000	12.94	2,676	572,400	25.88	4,088	1,891,200
	22.25	10.59	1,759	360,500	13.06	2,853	629,100	26.38	4,378	2,109,000
	23.25	10.72	1,865	393,900	13.18	3,034	689,500	26.88	4,676	2,343,800
	24.25	10.84	1,974	429,300	13.30	3,219	753,700	27.38	4,982	2,596,500
	25.25	10.97	2,084	466,900	13.41	3,408	821,900	27.88	5,296	2,868,000
	26.25	11.09	2,197	506,600	13.53	3,601	894,300	28.38	5,618	3,159,100

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
34	8.25	9.34	505	74,400	12.09	780	122,800	20.38	1,100	306,600
	9.25	9.47	587	89,200	12.21	911	147,900	20.88	1,294	379,200
	10.25	9.59	672	105,200	12.32	1,046	175,100	21.38	1,496	460,500
	11.25	9.72	758	122,300	12.44	1,185	204,600	21.88	1,706	551,100
	12.25	9.84	847	140,800	12.55	1,328	236,400	22.38	1,924	651,500
	13.25	9.97	937	160,600	12.67	1,475	270,700	22.88	2,150	762,500
	14.25	10.09	1,030	181,800	12.79	1,626	307,700	23.38	2,384	884,600
	15.25	10.22	1,124	204,500	12.90	1,781	347,300	23.88	2,626	1,018,700
	16.25	10.34	1,221	228,700	13.02	1,940	389,900	24.38	2,876	1,165,300
	17.25	10.47	1,319	254,600	13.13	2,103	435,500	24.88	3,134	1,325,300
	18.25	10.59	1,420	282,100	13.25	2,270	484,300	25.38	3,400	1,499,300
	19.25	10.72	1,522	311,400	13.37	2,441	536,400	25.88	3,674	1,688,200
	20.25	10.84	1,627	342,600	13.49	2,616	592,000	26.38	3,956	1,892,700
	21.25	10.97	1,733	375,700	13.60	2,795	651,200	26.88	4,246	2,113,600
	22.25	11.09	1,842	410,800	13.72	2,978	714,200	27.38	4,544	2,351,800
	23.25	11.22	1,952	448,000	13.84	3,165	781,100	27.88	4,850	2,608,100
	24.25	11.34	2,065	487,300	13.96	3,356	852,100	28.38	5,164	2,883,300
	25.25	11.47	2,179	528,900	14.08	3,551	927,400	28.88	5,486	3,178,400
	26.25	11.59	2,296	572,900	14.20	3,750	1,007,200	29.38	5,816	3,494,300
36	8.25	9.84	532	86,900	12.76	820	143,200	21.38	1,154	353,800
	9.25	9.97	618	103,900	12.87	957	172,000	21.88	1,356	436,100
	10.25	10.09	707	122,200	12.99	1,098	203,200	22.38	1,566	527,700
	11.25	10.22	797	141,900	13.10	1,243	236,800	22.88	1,784	629,500
	12.25	10.34	890	162,900	13.22	1,392	272,900	23.38	2,010	741,900
	13.25	10.47	984	185,400	13.33	1,545	311,800	23.88	2,244	865,700
	14.25	10.59	1,081	209,400	13.45	1,702	353,500	24.38	2,486	1,001,600
	15.25	10.72	1,179	235,100	13.57	1,863	398,100	24.88	2,736	1,150,300
	16.25	10.84	1,280	262,400	13.68	2,028	445,900	25.38	2,994	1,312,500
	17.25	10.97	1,382	291,400	13.80	2,197	497,000	25.88	3,260	1,488,900
	18.25	11.09	1,487	322,300	13.92	2,370	551,500	26.38	3,534	1,680,400
	19.25	11.22	1,593	355,100	14.03	2,547	609,600	26.88	3,816	1,887,700
	20.25	11.34	1,702	389,900	14.15	2,728	671,400	27.38	4,106	2,111,600
	21.25	11.47	1,812	426,700	14.27	2,913	737,000	27.88	4,404	2,353,000
	22.25	11.59	1,925	465,700	14.39	3,102	806,800	28.38	4,710	2,612,800
	23.25	11.72	2,039	506,900	14.50	3,295	880,700	28.88	5,024	2,891,700
	24.25	11.84	2,156	550,400	14.62	3,492	959,000	29.38	5,346	3,190,800
	25.25	11.97	2,274	596,400	14.74	3,693	1,041,900	29.88	5,676	3,510,800
	26.25	12.09	2,395	644,800	14.86	3,898	1,129,600	30.38	6,014	3,852,800

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
38	8.25	10.34	559	100,700	13.43	861	165,700	22.38	1,208	405,600
	9.25	10.47	649	120,200	13.54	1,004	198,600	22.88	1,418	498,300
	10.25	10.59	742	141,100	13.66	1,151	234,000	23.38	1,636	601,200
	11.25	10.72	836	163,400	13.77	1,302	272,100	23.88	1,862	715,100
	12.25	10.84	933	187,300	13.88	1,457	313,000	24.38	2,096	840,400
	13.25	10.97	1,031	212,700	14.00	1,616	356,800	24.88	2,338	978,000
	14.25	11.09	1,132	239,800	14.12	1,779	403,700	25.38	2,588	1,128,600
	15.25	11.22	1,234	268,600	14.23	1,946	453,800	25.88	2,846	1,292,800
	16.25	11.34	1,339	299,200	14.35	2,117	507,200	26.38	3,112	1,471,600
	17.25	11.47	1,445	331,700	14.46	2,292	564,200	26.88	3,386	1,665,500
	18.25	11.59	1,554	366,200	14.58	2,471	624,800	27.38	3,668	1,875,500
	19.25	11.72	1,664	402,700	14.70	2,654	689,300	27.88	3,958	2,102,400
	20.25	11.84	1,777	441,400	14.81	2,841	757,700	28.38	4,256	2,346,900
	21.25	11.97	1,891	482,200	14.93	3,032	830,300	28.88	4,562	2,610,000
	22.25	12.09	2,008	525,400	15.05	3,227	907,300	29.38	4,876	2,892,600
	23.25	12.22	2,126	570,900	15.17	3,426	988,700	29.88	5,198	3,195,500
	24.25	12.34	2,247	619,000	15.28	3,629	1,074,800	30.38	5,528	3,519,600
	25.25	12.47	2,369	669,500	15.40	3,836	1,165,800	30.88	5,866	3,865,900
	26.25	12.59	2,494	722,800	15.52	4,047	1,261,700	31.38	6,212	4,235,400
40	8.25	10.84	586	115,900	14.09	901	190,500	23.38	1,262	462,200
	9.25	10.97	680	138,100	14.21	1,050	227,800	23.88	1,480	566,200
	10.25	11.09	777	161,800	14.32	1,203	267,900	24.38	1,706	681,300
	11.25	11.22	875	187,000	14.44	1,360	310,900	24.88	1,940	808,100
	12.25	11.34	976	213,900	14.55	1,521	356,900	25.38	2,182	947,300
	13.25	11.47	1,078	242,500	14.67	1,686	406,000	25.88	2,432	1,099,600
	14.25	11.59	1,183	272,900	14.78	1,855	458,500	26.38	2,690	1,265,900
	15.25	11.72	1,289	305,200	14.90	2,028	514,400	26.88	2,956	1,446,800
	16.25	11.84	1,398	339,400	15.01	2,205	573,900	27.38	3,230	1,643,100
	17.25	11.97	1,508	375,600	15.13	2,386	637,200	27.88	3,512	1,855,700
	18.25	12.09	1,621	414,000	15.25	2,571	704,400	28.38	3,802	2,085,300
	19.25	12.22	1,735	454,500	15.36	2,760	775,800	28.88	4,100	2,332,900
	20.25	12.34	1,852	497,300	15.48	2,953	851,300	29.38	4,406	2,599,300
	21.25	12.47	1,970	542,500	15.60	3,150	931,400	29.88	4,720	2,885,300
	22.25	12.59	2,091	590,100	15.71	3,351	1,016,000	30.38	5,042	3,191,900
	23.25	12.72	2,213	640,300	15.83	3,556	1,105,400	30.88	5,372	3,520,000
	24.25	12.84	2,338	693,100	15.95	3,765	1,199,800	31.38	5,710	3,870,600
	25.25	12.97	2,464	748,600	16.07	3,978	1,299,300	31.88	6,056	4,244,500
	26.25	13.09	2,593	807,000	16.18	4,195	1,404,200	32.38	6,410	4,642,800

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
42	8.25	11.34	613	132,500	14.76	942	217,600	24.38	1,316	523,900
	9.25	11.47	711	157,700	14.87	1,097	259,800	24.88	1,542	640,100
	10.25	11.59	812	184,400	14.99	1,256	304,900	25.38	1,776	768,100
	11.25	11.72	914	212,800	15.10	1,419	353,200	25.88	2,018	908,800
	12.25	11.84	1,019	243,000	15.22	1,586	404,700	26.38	2,268	1,062,800
	13.25	11.97	1,125	275,100	15.33	1,757	459,600	26.88	2,526	1,230,900
	14.25	12.09	1,234	309,100	15.45	1,932	518,100	27.38	2,792	1,413,900
	15.25	12.22	1,344	345,000	15.56	2,111	580,300	27.88	3,066	1,612,500
	16.25	12.34	1,457	383,100	15.68	2,294	646,300	28.38	3,348	1,827,600
	17.25	12.47	1,571	423,300	15.79	2,481	716,400	28.88	3,638	2,059,900
	18.25	12.59	1,688	465,800	15.91	2,672	790,700	29.38	3,936	2,310,400
	19.25	12.72	1,806	510,600	16.03	2,867	869,300	29.88	4,242	2,579,900
	20.25	12.84	1,927	557,900	16.14	3,066	952,500	30.38	4,556	2,869,300
	21.25	12.97	2,049	607,700	16.26	3,269	1,040,500	30.88	4,878	3,179,500
	22.25	13.09	2,174	660,100	16.38	3,476	1,133,300	31.38	5,208	3,511,400
	23.25	13.22	2,300	715,200	16.49	3,687	1,231,200	31.88	5,546	3,866,000
	24.25	13.34	2,429	773,100	16.61	3,902	1,334,300	32.38	5,892	4,244,300
	25.25	13.47	2,559	833,900	16.73	4,121	1,443,000	32.88	6,246	4,647,300
	26.25	13.59	2,692	897,700	16.85	4,344	1,557,200	33.38	6,608	5,075,900
44	8.25	11.84	640	150,700	15.43	982	247,200	25.38	1,370	590,800
	9.25	11.97	742	179,000	15.54	1,143	294,600	25.88	1,604	720,100
	10.25	12.09	847	209,100	15.65	1,308	345,200	26.38	1,846	862,100
	11.25	12.22	953	240,900	15.77	1,477	399,200	26.88	2,096	1,017,700
	12.25	12.34	1,062	274,700	15.88	1,650	456,700	27.38	2,354	1,187,500
	13.25	12.47	1,172	310,400	16.00	1,827	517,800	27.88	2,620	1,372,400
	14.25	12.59	1,285	348,300	16.11	2,008	582,700	28.38	2,894	1,573,100
	15.25	12.72	1,399	388,200	16.23	2,193	651,600	28.88	3,176	1,790,500
	16.25	12.84	1,516	430,400	16.34	2,382	724,600	29.38	3,466	2,025,400
	17.25	12.97	1,634	474,900	16.46	2,575	802,000	29.88	3,764	2,278,700
	18.25	13.09	1,755	521,900	16.57	2,772	883,800	30.38	4,070	2,551,200
	19.25	13.22	1,877	571,300	16.69	2,973	970,300	30.88	4,384	2,843,800
	20.25	13.34	2,002	623,300	16.81	3,178	1,061,600	31.38	4,706	3,157,500
	21.25	13.47	2,128	678,000	16.92	3,387	1,157,900	31.88	5,036	3,493,100
	22.25	13.59	2,257	735,500	17.04	3,600	1,259,400	32.38	5,374	3,851,700
	23.25	13.72	2,387	795,800	17.16	3,817	1,366,400	32.88	5,720	4,234,300
	24.25	13.84	2,520	859,100	17.28	4,038	1,478,800	33.38	6,074	4,641,700
	25.25	13.97	2,654	925,500	17.39	4,263	1,597,100	33.88	6,436	5,075,100
	26.25	14.09	2,791	995,100	17.51	4,492	1,721,400	34.38	6,806	5,535,400

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$C_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
46	8.25	12.34	667	170,500	16.09	1,023	279,400	26.38	1,424	663,200
	9.25	12.47	773	202,200	16.21	1,190	332,500	26.88	1,666	806,500
	10.25	12.59	882	235,800	16.32	1,361	389,000	27.38	1,916	963,500
	11.25	12.72	992	271,400	16.43	1,536	449,100	27.88	2,174	1,134,900
	12.25	12.84	1,105	309,000	16.55	1,715	512,900	28.38	2,440	1,321,600
	13.25	12.97	1,219	348,700	16.66	1,898	580,700	28.88	2,714	1,524,300
	14.25	13.09	1,336	390,700	16.78	2,085	652,500	29.38	2,996	1,743,900
	15.25	13.22	1,454	434,900	16.89	2,276	728,600	29.88	3,286	1,981,200
	16.25	13.34	1,575	481,500	17.01	2,471	809,100	30.38	3,584	2,237,100
	17.25	13.47	1,697	530,600	17.12	2,670	894,200	30.88	3,890	2,512,500
	18.25	13.59	1,822	582,300	17.24	2,873	984,000	31.38	4,204	2,808,200
	19.25	13.72	1,948	636,600	17.36	3,080	1,078,800	31.88	4,526	3,125,200
	20.25	13.84	2,077	693,700	17.47	3,291	1,178,800	32.38	4,856	3,464,500
	21.25	13.97	2,207	753,600	17.59	3,506	1,284,000	32.88	5,194	3,826,900
	22.25	14.09	2,340	816,500	17.71	3,725	1,394,800	33.38	5,540	4,213,500
	23.25	14.22	2,474	882,400	17.82	3,948	1,511,300	33.88	5,894	4,625,300
	24.25	14.34	2,611	951,500	17.94	4,175	1,633,700	34.38	6,256	5,063,300
	25.25	14.47	2,749	1,023,800	18.06	4,406	1,762,100	34.88	6,626	5,528,600
	26.25	14.59	2,890	1,099,400	18.17	4,641	1,896,900	35.38	7,004	6,022,100
48	8.25	12.84	694	192,000	16.76	1,063	314,300	27.38	1,478	741,300
	9.25	12.97	804	227,400	16.87	1,236	373,400	27.88	1,728	899,600
	10.25	13.09	917	264,800	16.99	1,413	436,200	28.38	1,986	1,072,500
	11.25	13.22	1,031	304,400	17.10	1,594	502,900	28.88	2,252	1,260,800
	12.25	13.34	1,148	346,100	17.21	1,779	573,600	29.38	2,526	1,465,400
	13.25	13.47	1,266	390,100	17.33	1,968	648,500	29.88	2,808	1,687,100
	14.25	13.59	1,387	436,400	17.44	2,161	727,700	30.38	3,098	1,926,700
	15.25	13.72	1,509	485,200	17.56	2,358	811,500	30.88	3,396	2,185,100
	16.25	13.84	1,634	536,600	17.67	2,559	900,000	31.38	3,702	2,463,200
	17.25	13.97	1,760	590,600	17.79	2,764	993,300	31.88	4,016	2,761,900
	18.25	14.09	1,889	647,300	17.91	2,973	1,091,700	32.38	4,338	3,082,100
	19.25	14.22	2,019	706,800	18.02	3,186	1,195,400	32.88	4,668	3,424,800
	20.25	14.34	2,152	769,300	18.14	3,403	1,304,500	33.38	5,006	3,790,900
	21.25	14.47	2,286	834,800	18.25	3,624	1,419,200	33.88	5,352	4,181,500
	22.25	14.59	2,423	903,400	18.37	3,849	1,539,700	34.38	5,706	4,597,500
	23.25	14.72	2,561	975,200	18.49	4,078	1,666,300	34.88	6,068	5,040,000
	24.25	14.84	2,702	1,050,300	18.60	4,311	1,799,100	35.38	6,438	5,510,000
	25.25	14.97	2,844	1,128,900	18.72	4,548	1,938,400	35.88	6,816	6,008,600
	26.25	15.09	2,989	1,211,000	18.84	4,789	2,084,300	36.38	7,202	6,536,900

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels(2)
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superim-posed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superim-posed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$
h = 6 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 6 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
15	100	2.25	5.00	12	0.634	10-#4 0	10-#3	10-#4	9-#3	8-#4	1.60	18.2	36.5	49.1	100	12	10-#4	9-#3	8-#4	9-#3	1.60	0.521
15	200	2.25	5.00	13	0.700	10-#4 0	8-#4	10-#4	10-#3	8-#4	1.75	27.1	54.3	73.1	200	15	10-#4	10-#3	8-#4	9-#3	1.65	0.521
15	300	2.25	5.00	14	0.799	10-#4 1	8-#5	13-#4	8-#4	8-#4	2.23	36.2	81.0	97.6	300	15	12-#4	8-#4	8-#4	10-#3	1.96	0.521
15	400	4.25	5.00	15	0.624	10-#4 0	17-#4	12-#4	11-#4	8-#4	2.66	45.3	109.6	122.0	400	15	11-#4	11-#4	8-#4	13-#3	2.27	0.539
16	100	2.25	5.33	12	0.695	11-#4 0	12-#3	11-#4	10-#3	8-#4	1.65	22.3	44.7	60.1	100	12	11-#4	10-#3	8-#4	10-#3	1.62	0.521
16	200	2.25	5.33	13	0.769	11-#4 0	10-#4	12-#4	12-#3	8-#4	1.87	33.3	66.6	89.6	200	15	11-#4	12-#3	8-#4	10-#3	1.71	0.521
16	300	4.25	5.33	15	0.624	11-#4 0	15-#4	12-#4	10-#4	8-#4	2.33	44.1	97.1	118.6	300	16	11-#4	10-#4	8-#4	12-#3	2.01	0.539
16	400	4.25	5.33	16	0.623	11-#4 0	13-#5	15-#4	13-#4	10-#4	2.97	55.0	126.9	148.0	400	16	14-#4	13-#4	9-#4	15-#3	2.51	0.539
17	100	2.25	5.67	12	0.746	12-#4 0	14-#3	12-#4	11-#3	9-#4	1.71	27.0	54.0	72.7	100	12	12-#4	11-#3	9-#4	11-#3	1.67	0.521
17	200	2.25	5.67	14	0.833	12-#4 2	12-#4	14-#4	14-#3	9-#4	2.03	39.9	79.7	107.3	200	16	13-#4	14-#3	9-#4	11-#3	1.84	0.521
17	300	4.25	5.67	15	0.651	12-#4 0	11-#5	14-#4	11-#4	9-#4	2.47	53.1	109.4	143.0	300	17	13-#4	11-#4	9-#4	13-#3	2.12	0.539
17	400	4.25	6.80	17	0.742	12-#4 1	16-#5	12-#5	10-#5	11-#4	3.26	66.2	149.3	178.1	400	17	16-#4	10-#5	11-#4	10-#4	2.74	0.557
18	100	2.25	6.00	12	0.790	12-#4 1	10-#4	12-#4	11-#3	9-#4	1.70	32.3	64.6	86.9	100	12	12-#4	12-#3	9-#4	11-#3	1.60	0.521
18	200	4.25	6.00	14	0.634	12-#4 0	15-#4	13-#4	10-#4	9-#4	2.11	47.9	95.8	128.9	200	16	12-#4	10-#4	9-#4	11-#3	1.81	0.539
18	300	4.25	6.00	15	0.701	12-#4 0	13-#5	17-#4	13-#4	11-#4	2.71	63.3	126.6	170.5	300	18	15-#4	13-#4	10-#4	15-#3	2.30	0.539
18	400	6.25	7.20	17	0.626	12-#4 0	19-#5	17-#4	12-#5	9-#5	3.53	79.2	176.2	213.1	400	18	16-#4	12-#5	13-#4	12-#4	2.96	0.583

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f_c' = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels

No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)
h = 6.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS														
15	100	2.25	5.00	12	0.625	10-#4 0	10-#3	10-#4	10-#3	8-#4	1.66	19.0	37.9	51.0
15	200	2.25	5.00	13	0.655	10-#4 0	8-#4	10-#4	10-#3	8-#4	1.77	27.8	57.2	74.9
15	300	2.25	5.00	15	0.690	10-#4 0	12-#4	12-#4	8-#4	8-#4	2.16	36.7	84.1	98.8
15	400	4.25	5.00	15	0.625	10-#4 0	16-#4	12-#4	18-#3	8-#4	2.57	46.0	113.8	123.8
16	100	2.25	5.33	12	0.634	10-#4 0	11-#3	10-#4	11-#3	8-#4	1.64	23.2	46.4	62.5
16	200	2.25	5.33	13	0.696	10-#4 0	9-#4	11-#4	11-#3	8-#4	1.77	33.9	67.9	91.4
16	300	2.25	5.33	15	0.795	10-#4 2	13-#4	14-#4	9-#4	8-#4	2.20	44.8	97.1	120.6
16	400	4.25	5.33	16	0.624	10-#4 0	19-#4	14-#4	8-#5	9-#4	2.75	55.8	133.2	150.3
17	100	2.25	5.67	12	0.696	11-#4 0	8-#4	11-#4	11-#3	9-#4	1.68	28.1	56.1	75.6
17	200	2.25	5.67	13	0.766	11-#4 0	11-#4	13-#4	13-#3	9-#4	1.91	41.1	82.2	110.7
17	300	4.25	5.67	16	0.624	11-#4 0	16-#4	14-#4	18-#3	9-#4	2.35	53.8	114.9	144.9
17	400	4.25	5.67	16	0.672	11-#4 1	14-#5	11-#5	14-#4	10-#4	3.02	67.3	153.5	181.3
18	100	2.25	6.00	12	0.747	12-#4 0	9-#4	12-#4	12-#3	9-#4	1.70	33.6	67.1	90.3
18	200	4.25	6.00	14	0.626	12-#4 0	13-#4	12-#4	9-#4	9-#4	1.99	48.9	97.7	131.6
18	300	4.25	6.00	16	0.624	12-#4 0	18-#4	16-#4	12-#4	10-#4	2.49	64.2	128.4	172.9
18	400	6.25	6.00	17	0.626	12-#4 0	9-#7	16-#4	16-#4	12-#4	3.31	80.0	178.3	215.4
19	100	2.25	6.33	12	0.791	12-#4 1	11-#4	13-#4	13-#3	10-#4	1.76	39.7	79.4	106.9
19	200	4.25	6.33	14	0.676	12-#4 1	16-#4	15-#4	11-#4	10-#4	2.15	57.9	115.9	156.0
19	300	4.25	6.33	16	0.701	12-#4 1	21-#4	19-#4	9-#5	12-#4	2.78	76.2	152.4	205.2
19	400	6.25	7.60	18	0.625	12-#4 0	14-#6	19-#4	19-#4	10-#5	3.52	94.5	208.3	254.4

SQUARE INTERIOR PANEL

With Drop Panels(2)

No Beams

Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 6.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
100	12	10-#4	10-#3	8-#4	10-#3	1.68	0.562
200	15	10-#4	10-#3	8-#4	10-#3	1.69	0.562
300	15	11-#4	8-#4	8-#4	10-#3	1.92	0.562
400	15	11-#4	7-#5	8-#4	12-#3	2.25	0.581
100	12	10-#4	11-#3	8-#4	11-#3	1.65	0.562
200	16	10-#4	11-#3	8-#4	11-#3	1.66	0.562
300	16	13-#4	9-#4	8-#4	10-#3	1.95	0.562
400	16	13-#4	12-#4	8-#4	8-#4	2.32	0.581
100	12	11-#4	11-#3	9-#4	11-#3	1.64	0.562
200	16	12-#4	13-#3	9-#4	11-#3	1.76	0.562
300	17	13-#4	11-#4	9-#4	12-#3	2.07	0.581
400	17	16-#4	14-#4	10-#4	9-#4	2.59	0.581
100	12	12-#4	12-#3	9-#4	12-#3	1.63	0.562
200	17	12-#4	9-#4	9-#4	12-#3	1.78	0.581
300	18	15-#4	12-#4	9-#4	14-#3	2.17	0.581
400	18	15-#4	11-#5	11-#4	11-#4	2.78	0.600
100	12	12-#4	13-#3	10-#4	13-#3	1.65	0.562
200	17	13-#4	18-#3	10-#4	12-#3	1.82	0.581
300	18	12-#5	9-#5	11-#4	9-#4	2.47	0.581
400	19	12-#5	19-#4	13-#4	22-#3	2.95	0.625

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip [1] Top Ext. +	Column Strip [1] Bottom	Column Strip [1] Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 7 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 7 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
15	100	2.25	5.00	12	0.626	9-#4 0	11-#3	9-#4	11-#3	8-#4	1.71	19.7	39.4	53.0	100	12	9-#4	11-#3	8-#4	11-#3	1.73	0.604
15	200	2.25	5.00	14	0.623	9-#4 0	13-#3	9-#4	11-#3	8-#4	1.77	28.4	59.6	76.4	200	15	9-#4	11-#3	8-#4	11-#3	1.74	0.604
15	300	2.25	5.00	15	0.622	9-#4 0	7-#5	11-#4	7-#4	8-#4	2.06	37.4	87.2	100.7	300	15	11-#4	7-#4	8-#4	11-#3	1.90	0.604
15	400	2.25	5.00	15	0.725	9-#4 0	14-#4	9-#5	10-#4	8-#4	2.49	46.6	114.4	125.5	400	15	13-#4	10-#4	8-#4	11-#3	2.22	0.604
15	500	4.25	5.00	15	0.626	9-#4 0	12-#5	13-#4	8-#5	8-#4	2.89	55.9	142.3	150.5	500	15	12-#4	12-#4	8-#4	8-#4	2.43	0.623
16	100	2.25	5.33	12	0.626	10-#4 0	11-#3	10-#4	11-#3	8-#4	1.64	24.1	48.2	64.9	100	12	10-#4	11-#3	8-#4	11-#3	1.65	0.604
16	200	2.25	5.33	14	0.623	10-#4 0	15-#3	10-#4	11-#3	8-#4	1.73	34.6	69.2	93.2	200	16	10-#4	11-#3	8-#4	11-#3	1.66	0.604
16	300	2.25	5.33	15	0.723	10-#4 1	13-#4	14-#4	15-#3	8-#4	2.19	45.7	101.6	122.9	300	16	13-#4	15-#3	8-#4	11-#3	1.97	0.604
16	400	4.25	5.33	16	0.625	10-#4 0	17-#4	14-#4	8-#5	8-#4	2.67	56.7	137.5	152.6	400	16	13-#4	12-#4	8-#4	8-#4	2.32	0.623
16	500	4.25	5.33	16	0.625	10-#4 0	10-#6	16-#4	9-#5	10-#4	3.20	67.9	167.5	182.7	500	16	10-#5	14-#4	9-#4	9-#4	2.70	0.623
17	100	2.25	5.67	12	0.637	10-#4 0	13-#3	10-#4	12-#3	9-#4	1.65	29.1	58.3	78.4	100	12	10-#4	12-#3	9-#4	12-#3	1.65	0.604
17	200	2.25	5.67	14	0.693	10-#4 1	18-#3	13-#4	12-#3	9-#4	1.84	41.9	83.8	112.9	200	16	12-#4	12-#3	9-#4	12-#3	1.75	0.604
17	300	2.25	5.67	16	0.791	10-#4 3	14-#4	16-#4	10-#4	9-#4	2.31	54.7	114.9	147.4	300	17	10-#5	10-#4	9-#4	12-#3	2.12	0.604
17	400	4.25	5.67	17	0.624	10-#4 1	13-#5	16-#4	13-#4	10-#4	2.83	68.0	158.8	183.0	400	17	10-#5	13-#4	9-#4	9-#4	2.47	0.623
17	500	4.25	6.80	17	0.755	10-#4 4	9-#7	19-#4	8-#6	8-#5	3.60	81.6	197.9	219.6	500	17	12-#5	11-#5	11-#4	11-#4	3.03	0.640
18	100	2.25	6.00	12	0.699	11-#4 0	15-#3	11-#4	13-#3	9-#4	1.70	34.8	69.6	93.8	100	12	11-#4	13-#3	9-#4	13-#3	1.68	0.604
18	200	2.25	6.00	14	0.759	11-#4 1	8-#5	15-#4	8-#4	9-#4	1.99	50.2	100.4	135.2	200	16	14-#4	8-#4	9-#4	13-#3	1.85	0.604
18	300	4.25	6.00	16	0.625	11-#4 0	11-#5	16-#4	11-#4	9-#4	2.36	65.4	135.1	176.1	300	18	14-#4	11-#4	9-#4	13-#3	2.03	0.623
18	400	4.25	6.00	17	0.678	11-#4 2	15-#5	19-#4	10-#5	11-#4	3.10	81.1	180.7	218.3	400	18	12-#5	15-#4	11-#4	10-#4	2.70	0.623
18	500	6.25	7.20	18	0.626	11-#4 1	20-#5	19-#4	13-#5	9-#5	3.79	97.1	233.2	261.3	500	18	12-#5	13-#5	13-#4	13-#4	3.24	0.667
19	100	2.25	6.33	12	0.772	11-#4 2	10-#4	12-#4	14-#3	10-#4	1.73	41.2	82.4	111.0	100	12	11-#4	14-#3	10-#4	14-#3	1.67	0.604
19	200	4.25	6.33	14	0.627	11-#4 0	15-#4	14-#4	10-#4	10-#4	2.09	59.4	118.8	159.9	200	17	13-#4	10-#4	10-#4	14-#3	1.88	0.623
19	300	4.25	6.33	16	0.638	11-#4 1	19-#4	12-#5	13-#4	11-#4	2.56	77.3	154.5	208.0	300	19	11-#5	13-#4	10-#4	15-#3	2.27	0.623
19	400	6.25	6.33	18	0.626	11-#4 1	18-#5	12-#5	17-#4	13-#4	3.24	95.5	208.1	257.1	400	19	17-#4	18-#4	12-#4	20-#3	2.76	0.641
19	500	6.25	7.60	18	0.661	11-#4 3	17-#6	15-#5	15-#5	16-#4	4.23	114.7	264.5	308.9	500	19	14-#5	15-#5	10-#5	10-#5	3.59	0.667
20	100	2.25	6.67	12	0.811	12-#4 2	12-#4	14-#4	14-#3	10-#4	1.77	48.3	96.7	130.1	100	12	13-#4	14-#3	10-#4	14-#3	1.66	0.604
20	200	4.25	6.67	14	0.712	12-#4 2	17-#4	17-#4	20-#3	10-#4	2.18	69.8	139.6	187.9	200	17	15-#4	20-#3	10-#4	14-#3	1.92	0.623
20	300	4.25	6.67	17	0.700	12-#4 2	15-#5	14-#5	10-#5	13-#4	2.88	90.1	180.1	242.5	300	20	13-#5	15-#4	12-#4	10-#4	2.52	0.623
20	400	6.25	8.00	18	0.626	12-#4 1	11-#7	22-#4	20-#4	16-#4	3.57	112.3	242.0	302.4	400	20	13-#5	20-#4	14-#4	13-#4	3.00	0.667
20	500	8.25	8.00	19	0.628	12-#4 1	19-#6	15-#5	9-#7	19-#4	4.46	134.1	302.4	361.0	500	20	14-#5	17-#5	17-#4	11-#5	3.72	0.693
21	100	4.25	7.00	12	0.686	12-#4 1	9-#5	13-#4	9-#4	11-#4	1.84	56.5	113.0	152.1	100	12	12-#4	10-#4	11-#4	15-#3	1.70	0.623
21	200	4.25	7.00	14	0.782	12-#4 4	20-#4	19-#4	9-#5	11-#4	2.43	81.3	162.7	219.0	200	17	12-#5	13-#4	11-#4	9-#4	2.14	0.623
21	300	6.25	7.00	17	0.627	12-#4 1	18-#5	14-#5	12-#5	10-#5	3.07	105.3	210.6	283.5	300	20	19-#4	17-#4	9-#5	20-#3	2.57	0.641
21	400	6.25	8.40	18	0.749	13-#4 5	16-#6	12-#6	22-#4	12-#5	3.83	130.6	264.3	351.5	400	21	16-#5	22-#4	11-#5	10-#5	3.34	0.667

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f_c' = 4{,}000$ psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels(2)
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 7.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 7.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
15	100	2.25	5.00	12	0.627	8-#4 0	7-#4	8-#4	7-#4	8-#4	1.78	20.4	40.8	54.9	100	12	8-#4	7-#4	8-#4	7-#4	1.79	0.646
15	200	2.25	5.00	14	0.624	8-#4 0	7-#4	8-#4	7-#4	8-#4	1.79	29.1	62.1	78.2	200	15	8-#4	7-#4	8-#4	7-#4	1.81	0.646
15	300	2.25	5.00	15	0.623	8-#4 0	10-#4	11-#4	7-#4	8-#4	2.00	38.1	89.9	102.6	300	15	10-#4	7-#4	8-#4	7-#4	1.91	0.646
15	400	2.25	5.00	15	0.662	8-#4 1	9-#5	13-#4	6-#5	8-#4	2.42	47.3	117.2	127.4	400	15	8-#5	9-#4	8-#4	7-#4	2.18	0.646
15	500	4.25	5.00	15	0.627	8-#4 0	11-#5	13-#4	11-#4	8-#4	2.72	56.6	145.8	152.4	500	15	8-#5	11-#4	8-#4	8-#4	2.38	0.664
16	100	2.25	5.33	12	0.627	9-#4 0	7-#4	9-#4	7-#4	8-#4	1.72	25.0	49.9	67.2	100	12	9-#4	7-#4	8-#4	7-#4	1.73	0.646
16	200	2.25	5.33	14	0.624	9-#4 0	8-#4	10-#4	7-#4	8-#4	1.78	35.5	71.7	95.4	200	16	9-#4	7-#4	8-#4	7-#4	1.75	0.646
16	300	2.25	5.33	16	0.622	9-#4 0	12-#4	13-#4	8-#4	8-#4	2.10	46.2	104.9	124.5	300	16	12-#4	8-#4	8-#4	7-#4	1.94	0.646
16	400	2.25	5.33	16	0.732	9-#4 1	16-#4	16-#4	7-#5	8-#4	2.59	57.4	137.8	154.6	400	16	10-#5	7-#5	8-#4	7-#4	2.34	0.646
16	500	4.25	5.33	16	0.626	9-#4 0	13-#5	10-#5	13-#4	9-#4	2.94	68.7	172.5	184.9	500	16	14-#4	13-#4	8-#4	9-#4	2.51	0.664
17	100	2.25	5.67	12	0.627	10-#4 0	7-#4	10-#4	7-#4	9-#4	1.68	30.2	60.4	81.3	100	12	10-#4	7-#4	9-#4	7-#4	1.69	0.646
17	200	2.25	5.67	14	0.624	10-#4 0	10-#4	12-#4	7-#4	9-#4	1.84	42.7	85.4	115.0	200	17	11-#4	7-#4	9-#4	7-#4	1.77	0.646
17	300	2.25	5.67	16	0.723	10-#4 2	9-#5	10-#5	9-#4	9-#4	2.27	55.8	120.4	150.1	300	17	10-#5	9-#4	9-#4	7-#4	2.09	0.646
17	400	4.25	5.67	17	0.625	10-#4 0	9-#6	10-#5	8-#5	9-#4	2.81	69.0	163.6	185.7	400	17	10-#5	13-#4	9-#4	9-#4	2.47	0.664
17	500	4.25	5.67	17	0.625	10-#4 0	11-#6	12-#5	10-#5	7-#5	3.32	82.4	200.7	221.8	500	17	11-#5	10-#5	10-#4	10-#4	2.84	0.664
18	100	2.25	6.00	12	0.640	10-#4 0	8-#4	10-#4	8-#4	9-#4	1.70	36.1	72.2	97.2	100	12	10-#4	8-#4	9-#4	8-#4	1.70	0.646
18	200	2.25	6.00	14	0.697	10-#4 1	12-#4	14-#4	8-#4	9-#4	1.95	51.2	102.4	137.8	200	17	13-#4	8-#4	9-#4	8-#4	1.85	0.646
18	300	4.25	6.00	16	0.626	10-#4 1	16-#4	10-#5	11-#4	9-#4	2.31	66.6	141.6	179.4	300	18	14-#4	11-#4	9-#4	8-#4	2.06	0.664
18	400	4.25	6.00	17	0.625	10-#4 2	14-#5	12-#5	14-#4	11-#4	2.90	82.3	187.3	221.6	400	18	11-#5	14-#4	10-#4	10-#4	2.55	0.664
18	500	6.25	6.00	18	0.627	10-#4 0	18-#5	12-#5	12-#5	8-#5	3.52	97.9	234.7	263.6	500	18	11-#5	18-#4	8-#5	8-#5	3.03	0.683
19	100	2.25	6.33	12	0.752	11-#4 2	10-#4	12-#4	8-#4	10-#4	1.75	42.7	85.4	115.0	100	12	11-#4	8-#4	10-#4	8-#4	1.69	0.646
19	200	2.25	6.33	15	0.752	11-#4 2	9-#5	11-#5	9-#4	10-#4	2.10	60.4	120.8	162.6	200	17	16-#4	9-#4	10-#4	8-#4	1.95	0.646
19	300	4.25	6.33	16	0.626	11-#4 1	18-#4	12-#5	8-#5	10-#4	2.43	78.7	157.4	211.9	300	19	16-#4	12-#4	10-#4	8-#4	2.12	0.664
19	400	4.25	6.33	18	0.684	11-#4 3	16-#5	14-#5	16-#4	8-#5	3.16	96.8	209.3	260.5	400	19	13-#5	16-#4	8-#5	11-#4	2.80	0.664
19	500	6.25	7.60	19	0.626	11-#4 2	12-#7	14-#5	10-#6	10-#5	4.03	115.6	274.2	311.1	500	19	13-#5	10-#6	9-#5	9-#5	3.38	0.708

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip [1] Top Ext. +	Column Strip Bottom	Column Strip Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)
h = 7.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS														
20	100	2.25	6.67	12	0.793	11-#4 3	11-#4	14-#4	9-#4	10-#4	1.83	50.1	100.2	134.9
20	200	4.25	6.67	15	0.627	11-#4 0	16-#4	16-#4	11-#4	10-#4	2.16	71.2	142.3	191.6
20	300	4.25	6.67	16	0.714	11-#4 3	21-#4	14-#5	9-#5	8-#5	2.66	92.6	185.1	249.2
20	400	6.25	6.67	18	0.627	11-#4 2	19-#5	14-#5	12-#5	10-#5	3.34	113.5	240.1	305.6
20	500	6.25	8.00	19	0.668	13-#4 2	13-#7	12-#6	16-#5	17-#4	4.30	135.4	308.4	364.6
21	100	4.25	7.00	12	0.666	12-#4 1	13-#4	13-#4	9-#4	11-#4	1.80	58.5	117.1	157.6
21	200	4.25	7.00	15	0.705	12-#4 3	19-#4	12-#5	13-#4	11-#4	2.33	83.0	165.9	223.3
21	300	6.25	7.00	17	0.628	12-#4 1	9-#7	13-#5	16-#4	9-#5	2.92	107.2	214.5	288.7
21	400	6.25	7.00	18	0.627	12-#4 2	11-#7	16-#5	13-#5	11-#5	3.60	131.9	263.8	355.2
21	500	8.25	8.40	20	0.628	13-#4 1	15-#7	25-#4	10-#7	13-#5	4.62	157.1	350.7	422.9
22	100	4.25	7.33	12	0.715	12-#4 2	15-#4	15-#4	10-#4	11-#4	1.86	67.6	135.2	182.0
22	200	4.25	7.33	15	0.772	12-#4 5	22-#4	14-#5	10-#5	12-#4	2.53	96.0	192.0	258.4
22	300	6.25	7.33	17	0.628	12-#4 2	19-#5	15-#5	19-#4	16-#4	3.16	124.2	248.4	334.4
22	400	8.25	8.80	19	0.629	12-#4 2	13-#7	16-#5	16-#5	13-#5	3.91	152.7	311.4	411.0
22	500	8.25	8.80	20	0.646	15-#4 3	22-#6	14-#6	14-#6	23-#4	4.84	181.3	384.1	488.2

Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$
h = 7.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
100	12	13-#4	9-#4	10-#4	9-#4	1.79	0.646
200	17	15-#4	11-#4	10-#4	9-#4	1.99	0.664
300	19	19-#4	9-#5	11-#4	9-#4	2.36	0.664
400	20	13-#5	18-#4	13-#4	8-#5	2.85	0.683
500	20	11-#6	16-#5	16-#4	16-#4	3.65	0.708
100	12	12-#4	9-#4	11-#4	9-#4	1.69	0.664
200	17	17-#4	13-#4	11-#4	9-#4	2.08	0.664
300	20	12-#5	16-#4	13-#4	11-#4	2.47	0.683
400	21	15-#5	13-#5	10-#5	13-#4	3.08	0.683
500	21	15-#5	13-#6	12-#5	12-#5	3.86	0.735
100	12	14-#4	10-#4	11-#4	9-#4	1.72	0.664
200	17	13-#5	15-#4	11-#4	10-#4	2.23	0.664
300	20	14-#5	19-#4	10-#5	13-#4	2.77	0.683
400	22	15-#5	16-#5	12-#5	16-#4	3.35	0.735
500	22	18-#5	14-#6	10-#6	13-#5	4.15	0.735

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f_c' = 4{,}000$ psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels(2)
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 8 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 8 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
16	100	2.25	5.33	12	0.628	8-#4 0	7-#4	8-#4	7-#4	8-#4	1.66	25.8	51.7	69.6	100	12	8-#4	7-#4	8-#4	7-#4	1.67	0.688
16	200	2.25	5.33	14	0.625	8-#4 0	8-#4	10-#4	7-#4	8-#4	1.76	36.3	74.9	97.7	200	16	9-#4	7-#4	8-#4	7-#4	1.75	0.688
16	300	2.25	5.33	16	0.623	8-#4 0	12-#4	8-#5	8-#4	8-#4	2.08	47.1	108.1	126.7	300	16	8-#5	8-#4	8-#4	7-#4	1.97	0.688
16	400	2.25	5.33	16	0.635	8-#4 1	15-#4	10-#5	10-#4	8-#4	2.41	58.3	141.4	156.9	400	16	14-#4	10-#4	8-#4	7-#4	2.17	0.688
16	500	4.25	5.33	16	0.627	8-#4 1	9-#6	10-#5	8-#5	8-#4	2.91	69.5	176.9	187.2	500	16	9-#5	13-#4	8-#4	6-#5	2.54	0.706
17	100	2.25	5.67	12	0.628	9-#4 0	8-#4	9-#4	8-#4	9-#4	1.77	31.3	62.5	84.1	100	12	9-#4	8-#4	9-#4	8-#4	1.78	0.688
17	200	2.25	5.67	14	0.625	9-#4 1	9-#4	12-#4	8-#4	9-#4	1.89	43.7	87.5	117.8	200	17	11-#4	8-#4	9-#4	8-#4	1.88	0.688
17	300	2.25	5.67	16	0.623	9-#4 0	13-#4	10-#5	9-#4	9-#4	2.21	56.8	124.9	152.8	300	17	9-#5	9-#4	9-#4	8-#4	2.09	0.688
17	400	4.25	5.67	17	0.626	9-#4 0	12-#5	10-#5	8-#5	9-#4	2.63	70.0	167.8	188.4	400	17	9-#5	12-#4	9-#4	8-#4	2.27	0.706
17	500	4.25	5.67	17	0.626	9-#4 1	15-#5	12-#5	7-#6	10-#4	3.20	83.4	206.8	224.5	500	17	11-#5	15-#4	9-#4	10-#4	2.73	0.706
18	100	2.25	6.00	12	0.636	9-#4 1	8-#4	10-#4	8-#4	9-#4	1.67	37.4	74.7	100.6	100	12	9-#4	8-#4	9-#4	8-#4	1.67	0.688
18	200	2.25	6.00	14	0.683	9-#4 2	7-#5	9-#5	8-#4	9-#4	1.91	52.4	104.8	141.1	200	17	13-#4	8-#4	9-#4	8-#4	1.85	0.688
18	300	2.25	6.00	16	0.759	9-#4 4	15-#4	12-#5	10-#4	9-#4	2.31	67.7	141.2	182.3	300	18	11-#5	10-#4	9-#4	8-#4	2.15	0.688
18	400	4.25	6.00	18	0.625	9-#4 1	10-#6	12-#5	9-#5	10-#4	2.89	83.1	192.2	223.7	400	18	11-#5	9-#5	9-#4	9-#4	2.49	0.706
18	500	4.25	6.00	18	0.660	11-#4 2	7-#8	10-#6	8-#6	8-#5	3.58	99.0	237.9	266.5	500	18	9-#6	11-#5	7-#5	11-#4	3.01	0.706
19	100	2.25	6.33	12	0.645	10-#4 0	9-#4	12-#4	9-#4	10-#4	1.80	44.2	88.4	119.0	100	12	11-#4	9-#4	10-#4	9-#4	1.81	0.688
19	200	2.25	6.33	14	0.735	10-#4 2	13-#4	16-#4	9-#4	10-#4	2.06	62.1	124.3	167.3	200	17	10-#5	9-#4	10-#4	9-#4	2.01	0.688
19	300	4.25	6.33	17	0.626	10-#4 2	17-#4	11-#5	8-#5	10-#4	2.40	79.7	163.3	214.7	300	19	10-#5	12-#4	10-#4	9-#4	2.18	0.706
19	400	4.25	6.33	18	0.625	11-#4 2	15-#5	10-#6	10-#5	8-#5	3.01	98.2	217.4	264.3	400	19	13-#5	15-#4	11-#4	10-#4	2.62	0.706
19	500	6.25	6.33	19	0.627	11-#4 2	14-#6	10-#6	9-#6	9-#5	3.74	116.6	275.8	313.8	500	19	13-#5	13-#5	13-#4	13-#4	3.21	0.725
20	100	2.25	6.67	12	0.708	10-#4 1	11-#4	14-#4	9-#4	10-#4	1.82	51.9	103.7	139.6	100	12	13-#4	9-#4	10-#4	9-#4	1.79	0.688
20	200	4.25	6.67	15	0.628	10-#4 1	15-#4	10-#5	10-#4	10-#4	2.03	72.5	145.1	195.3	200	18	14-#4	10-#4	10-#4	9-#4	1.89	0.706
20	300	4.25	6.67	17	0.626	10-#4 3	13-#5	13-#5	13-#4	11-#4	2.52	93.4	186.8	251.4	300	20	12-#5	13-#4	10-#4	9-#4	2.23	0.706
20	400	6.25	6.67	18	0.628	10-#4 1	18-#5	10-#6	12-#5	9-#5	3.24	115.2	249.8	310.1	400	20	19-#4	18-#4	8-#5	8-#5	2.78	0.725
20	500	6.25	8.00	20	0.626	12-#4 2	17-#6	16-#5	8-#7	16-#4	4.09	136.4	319.6	367.3	500	20	15-#5	15-#5	10-#5	10-#5	3.48	0.750
21	100	2.25	7.00	12	0.812	11-#4 4	13-#4	16-#4	10-#4	11-#4	1.94	60.3	120.7	162.4	100	12	15-#4	10-#4	11-#4	10-#4	1.89	0.688
21	200	4.25	7.00	15	0.628	11-#4 1	18-#4	12-#5	8-#5	11-#4	2.28	84.6	169.1	227.7	200	18	11-#5	12-#4	11-#4	10-#4	2.09	0.706
21	300	4.25	7.00	17	0.688	12-#4 2	15-#5	15-#5	10-#5	13-#4	2.78	109.0	217.9	293.4	300	20	14-#5	15-#4	8-#5	10-#4	2.45	0.706
21	400	6.25	7.00	18	0.628	12-#4 2	8-#8	11-#6	19-#4	16-#4	3.43	133.8	274.2	360.3	400	21	22-#4	19-#4	10-#5	13-#4	2.92	0.725
21	500	6.25	8.40	20	0.728	14-#4 5	11-#8	14-#6	9-#7	19-#4	4.54	158.6	356.7	427.1	500	21	17-#5	9-#7	17-#4	8-#6	3.83	0.750

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip [1] Top Ext. +	Column Strip Bottom	Column Strip Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 8 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 8 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
22	100	4.25	7.33	12	0.632	11-#4 0	15-#4	15-#4	10-#4	11-#4	1.88	70.0	140.0	188.4	100	12	14-#4	10-#4	11-#4	10-#4	1.76	0.706
22	200	4.25	7.33	15	0.667	11-#4 2	21-#4	14-#5	9-#5	12-#4	2.42	97.9	195.7	263.5	200	18	19-#4	9-#5	11-#4	10-#4	2.16	0.706
22	300	6.25	7.33	17	0.629	11-#4 3	18-#5	15-#5	12-#5	10-#5	3.02	126.4	252.9	340.4	300	20	14-#5	18-#4	9-#5	12-#4	2.62	0.725
22	400	6.25	7.33	18	0.743	14-#4 5	22-#5	18-#5	22-#4	12-#5	3.66	154.4	308.9	415.8	400	22	12-#6	14-#5	11-#5	14-#4	3.21	0.725
22	500	8.25	8.80	20	0.628	14-#4 1	16-#7	14-#6	19-#5	22-#4	4.64	183.5	405.2	494.1	500	22	12-#6	19-#5	13-#5	19-#4	3.89	0.777
23	100	4.25	7.67	12	0.741	12-#4 3	11-#5	17-#4	11-#4	12-#4	1.98	80.3	160.6	216.2	100	12	16-#4	11-#4	12-#4	10-#4	1.82	0.706
23	200	6.25	7.67	15	0.631	12-#4 1	16-#5	13-#5	16-#4	13-#4	2.54	112.8	225.6	303.7	200	18	12-#5	16-#4	12-#4	11-#4	2.20	0.725
23	300	6.25	7.67	17	0.686	13-#4 4	11-#7	12-#6	20-#4	11-#5	3.31	145.4	290.9	391.6	300	20	16-#5	20-#4	16-#4	9-#5	2.86	0.725
23	400	8.25	9.20	20	0.628	14-#4 3	18-#6	18-#5	9-#7	10-#6	4.00	176.9	353.7	476.2	400	23	25-#4	9-#7	19-#4	11-#5	3.45	0.777
23	500	8.25	9.20	20	0.668	16-#4 3	23-#6	15-#6	11-#7	9-#7	4.98	210.5	441.4	566.7	500	23	14-#6	11-#7	15-#5	10-#6	4.30	0.777
24	100	4.25	8.00	12	0.780	13-#4 3	19-#4	13-#5	13-#4	13-#4	2.15	91.6	183.2	246.6	100	12	12-#5	13-#4	13-#4	11-#4	1.99	0.706
24	200	6.25	8.00	15	0.665	13-#4 3	18-#5	15-#5	12-#5	10-#5	2.77	128.8	257.7	346.9	200	18	14-#5	18-#4	9-#5	12-#4	2.38	0.725
24	300	6.25	8.00	18	0.724	15-#4 4	23-#5	14-#6	15-#5	19-#4	3.56	165.0	330.0	444.2	300	21	18-#5	15-#5	12-#5	10-#5	3.14	0.725
24	400	8.25	9.60	20	0.628	16-#4 2	12-#8	15-#6	10-#7	16-#5	4.42	202.4	404.8	544.9	400	23	14-#6	10-#7	22-#4	19-#4	3.78	0.777

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f_c' = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels(2)
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 8.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 8.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
17	100	2.25	5.67	12	0.629	9-#4 0	8-#4	9-#4	8-#4	6-#5	1.78	32.3	64.6	87.0	100	12	9-#4	8-#4	6-#5	8-#4	1.79	0.729
17	200	2.25	5.67	15	0.625	9-#4 0	9-#4	11-#4	8-#4	6-#5	1.86	44.5	89.1	119.9	200	17	10-#4	8-#4	6-#5	8-#4	1.84	0.729
17	300	2.25	5.67	17	0.623	9-#4 0	8-#5	14-#4	6-#5	6-#5	2.17	57.5	128.3	154.7	300	17	13-#4	9-#4	6-#5	8-#4	2.05	0.729
17	400	2.25	5.67	17	0.648	9-#4 1	11-#5	12-#5	7-#5	6-#5	2.62	70.9	168.3	190.8	400	17	8-#6	11-#4	6-#5	8-#4	2.38	0.729
17	500	4.25	5.67	17	0.626	9-#4 1	10-#6	8-#6	9-#5	6-#5	3.04	84.4	211.7	227.2	500	17	16-#4	9-#5	6-#5	6-#5	2.61	0.748
17	600	4.25	5.67	17	0.627	10-#4 1	16-#5	13-#5	16-#4	7-#5	3.47	97.8	248.2	263.4	600	17	12-#5	11-#5	10-#4	7-#5	3.08	0.748
18	100	2.25	6.00	12	0.629	9-#4 0	9-#4	10-#4	9-#4	9-#4	1.81	38.6	77.3	104.0	100	12	9-#4	9-#4	9-#4	9-#4	1.80	0.729
18	200	2.25	6.00	15	0.625	9-#4 2	7-#5	13-#4	9-#4	9-#4	1.98	53.4	106.7	143.7	200	17	12-#4	9-#4	9-#4	9-#4	1.94	0.729
18	300	2.25	6.00	17	0.623	9-#4 1	14-#4	11-#5	10-#4	9-#4	2.27	68.6	146.0	184.6	300	18	16-#4	10-#4	9-#4	9-#4	2.17	0.729
18	400	4.25	6.00	18	0.625	9-#4 1	9-#6	11-#5	13-#4	9-#4	2.68	84.3	197.5	226.9	400	18	16-#4	13-#4	9-#4	9-#4	2.34	0.748
18	500	4.25	6.00	18	0.625	10-#4 1	16-#5	10-#6	16-#4	7-#5	3.24	100.2	244.6	269.7	500	18	19-#4	16-#4	10-#4	7-#5	2.82	0.748
18	600	6.25	6.00	18	0.628	10-#4 1	8-#8	13-#5	9-#6	13-#4	3.94	116.2	291.3	312.9	600	18	12-#5	9-#6	8-#5	13-#4	3.34	0.766
19	100	2.25	6.33	12	0.629	10-#4 0	9-#4	12-#4	9-#4	10-#4	1.80	45.7	91.4	123.1	100	12	11-#4	9-#4	10-#4	9-#4	1.81	0.729
19	200	2.25	6.33	15	0.629	10-#4 1	12-#4	16-#4	9-#4	10-#4	2.03	63.3	126.6	170.4	200	17	10-#5	9-#4	10-#4	9-#4	2.01	0.729
19	300	2.25	6.33	17	0.747	10-#4 4	16-#4	13-#5	7-#5	10-#4	2.39	81.0	162.8	218.1	300	19	12-#5	7-#5	10-#4	9-#4	2.26	0.729
19	400	4.25	6.33	18	0.625	10-#4 3	15-#5	20-#4	7-#6	7-#5	2.93	99.6	224.6	268.1	400	19	19-#4	15-#4	10-#4	10-#4	2.53	0.748
19	500	4.25	6.33	19	0.670	12-#4 2	13-#6	16-#5	12-#5	13-#4	3.63	117.8	278.5	317.2	500	19	15-#5	12-#5	8-#5	8-#5	3.19	0.748
19	600	6.25	7.60	19	0.627	12-#4 2	12-#7	11-#6	8-#7	7-#6	4.24	137.1	340.5	369.1	600	19	22-#4	15-#5	9-#5	7-#6	3.58	0.792
20	100	2.25	6.67	12	0.685	10-#4 1	11-#4	13-#4	10-#4	10-#4	1.87	53.6	107.2	144.4	100	12	12-#4	10-#4	10-#4	10-#4	1.84	0.729
20	200	2.25	6.67	15	0.728	10-#4 3	15-#4	12-#5	10-#4	10-#4	2.15	74.4	148.8	200.3	200	17	11-#5	10-#4	10-#4	10-#4	2.07	0.729
20	300	4.25	6.67	17	0.626	10-#4 2	12-#5	13-#5	8-#5	11-#4	2.45	95.0	190.1	255.9	300	20	12-#5	12-#4	10-#4	10-#4	2.23	0.748
20	400	4.25	6.67	18	0.673	12-#4 2	16-#5	11-#6	16-#4	13-#4	3.06	116.7	250.9	314.1	400	20	22-#4	16-#4	8-#5	11-#4	2.71	0.748
20	500	6.25	6.67	20	0.626	12-#4 2	15-#6	11-#6	10-#6	10-#5	3.84	137.6	320.2	370.5	500	20	22-#4	14-#5	9-#5	9-#5	3.28	0.766
20	600	6.25	8.00	20	0.651	14-#4 1	11-#8	18-#5	9-#7	12-#5	4.70	159.9	385.6	430.5	600	20	12-#6	12-#6	16-#4	8-#6	3.93	0.792
21	100	2.25	7.00	12	0.779	11-#4 3	12-#4	10-#5	10-#4	11-#4	1.89	62.4	124.8	168.0	100	12	14-#4	10-#4	11-#4	10-#4	1.85	0.729
21	200	4.25	7.00	15	0.629	11-#4 1	11-#5	12-#5	11-#4	11-#4	2.18	86.5	173.1	233.0	200	18	16-#4	11-#4	11-#4	10-#4	1.99	0.748
21	300	4.25	7.00	17	0.657	11-#4 3	15-#5	15-#5	10-#5	8-#5	2.73	110.9	221.8	298.6	300	20	10-#6	14-#4	11-#4	10-#4	2.38	0.748
21	400	6.25	7.00	19	0.627	12-#4 2	19-#5	11-#6	12-#5	10-#5	3.29	135.2	284.6	363.9	400	21	10-#6	12-#5	9-#5	8-#5	2.87	0.766
21	500	6.25	8.40	21	0.625	14-#4 1	10-#8	18-#5	16-#5	12-#5	4.17	159.8	368.2	430.3	500	21	12-#6	16-#5	16-#4	16-#4	3.54	0.792
21	600	8.25	8.40	21	0.628	14-#4 1	16-#7	18-#5	19-#5	10-#6	4.86	185.5	441.0	499.4	600	21	12-#6	14-#6	19-#4	19-#4	4.12	0.818

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel		(3) Square Column		REINFORCING BARS (E. W.)						MOMENTS			Factored Superimposed Load (psf)	(3) Square Column	REINFORCING BARS (E. W.)					Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$
						Column Strip [1]			Middle Strip								Column Strip		Middle Strip			
		Depth (in.)	Width (ft)	Size (in.)	γ_f	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Total Steel (psf)	Edge (–) (ft-k)	Bot. (+) (ft-k)	Int. (–) (ft-k)		Size (in.)	Top	Bottom	Top	Bottom	Total Steel (psf)	
h = 8.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															*h* = 8.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
22	100	4.25	7.33	12	0.633	11-#4 0	9-#5	15-#4	11-#4	11-#4	1.94	72.3	144.7	194.8	100	12	14-#4	11-#4	11-#4	11-#4	1.87	0.748
22	200	4.25	7.33	15	0.641	11-#4 2	13-#5	14-#5	13-#4	11-#4	2.36	100.2	200.3	269.6	200	18	12-#5	13-#4	11-#4	11-#4	2.14	0.748
22	300	4.25	7.33	18	0.743	13-#4 5	9-#7	12-#6	8-#6	9-#5	3.05	127.4	254.8	343.0	300	21	11-#6	11-#5	13-#4	11-#4	2.65	0.748
22	400	6.25	7.33	19	0.638	14-#4 3	11-#7	18-#5	20-#4	8-#6	3.49	156.0	312.0	420.0	400	22	16-#5	20-#4	10-#5	9-#5	3.00	0.766
22	500	6.25	8.80	21	0.716	16-#4 4	15-#7	11-#7	8-#8	20-#4	4.68	184.5	407.7	496.8	500	22	14-#6	13-#6	12-#5	12-#5	3.95	0.792
22	600	8.25	8.80	21	0.628	16-#4 2	14-#8	11-#7	9-#8	11-#6	5.49	214.2	490.5	576.6	600	22	14-#6	9-#8	8-#7	10-#6	4.70	0.818
23	100	4.25	7.67	12	0.702	12-#4 2	16-#4	11-#5	11-#4	12-#4	1.98	83.0	166.0	223.5	100	12	16-#4	11-#4	12-#4	11-#4	1.88	0.748
23	200	4.25	7.67	15	0.763	12-#4 5	15-#5	11-#6	10-#5	13-#4	2.56	115.1	230.2	309.9	200	18	14-#5	15-#4	12-#4	11-#4	2.26	0.748
23	300	6.25	7.67	18	0.628	13-#4 3	19-#5	12-#6	19-#4	16-#4	3.08	146.9	293.7	395.4	300	21	15-#5	19-#4	10-#5	13-#4	2.71	0.766
23	400	8.25	7.67	19	0.630	13-#4 2	17-#6	18-#5	11-#6	13-#5	3.75	179.1	358.3	482.3	400	23	16-#5	15-#5	12-#5	10-#5	3.19	0.785
23	500	8.25	9.20	21	0.628	16-#4 2	13-#8	11-#7	20-#5	11-#6	4.79	212.2	460.7	571.2	500	23	14-#6	20-#5	10-#6	13-#5	4.07	0.818
24	100	4.25	8.00	12	0.764	13-#4 3	12-#5	19-#4	12-#4	13-#4	2.11	94.7	189.4	254.9	100	12	12-#5	12-#4	13-#4	12-#4	1.98	0.748
24	200	6.25	8.00	16	0.630	13-#4 3	9-#7	15-#5	11-#5	14-#4	2.68	130.8	261.7	352.3	200	19	14-#5	11-#5	13-#4	11-#4	2.30	0.766
24	300	6.25	8.00	18	0.682	15-#4 3	22-#5	14-#6	22-#4	12-#5	3.42	167.9	335.9	452.1	300	21	18-#5	22-#4	11-#5	10-#5	3.01	0.766
24	400	8.25	8.00	19	0.630	15-#4 3	15-#7	20-#5	10-#7	15-#5	4.27	205.0	409.9	551.8	400	23	28-#4	18-#5	10-#6	12-#5	3.59	0.785
24	500	8.25	9.60	21	0.720	18-#4 5	14-#8	13-#7	9-#8	10-#7	5.20	241.9	498.6	651.3	500	24	12-#7	9-#8	16-#5	10-#6	4.45	0.818
25	100	6.25	8.33	12	0.636	13-#4 1	21-#4	12-#5	9-#5	13-#4	2.15	107.8	215.7	290.3	100	12	17-#4	9-#5	13-#4	12-#4	1.95	0.766
25	200	6.25	8.33	16	0.658	13-#4 4	19-#5	12-#6	19-#4	16-#4	2.84	148.7	297.3	400.3	200	19	16-#5	19-#4	10-#5	13-#4	2.51	0.766
25	300	8.25	8.33	18	0.631	14-#4 3	18-#6	14-#6	9-#7	10-#6	3.79	191.3	382.6	515.0	300	21	12-#6	9-#7	19-#4	11-#5	3.29	0.785
25	400	8.25	10.00	20	0.690	17-#4 5	22-#6	12-#7	20-#5	9-#7	4.43	232.7	465.4	626.5	400	24	15-#6	20-#5	23-#4	13-#5	3.83	0.818
25	500	10.25	10.00	21	0.630	18-#4 2	20-#7	13-#7	10-#8	20-#5	5.40	274.9	549.9	740.2	500	25	12-#7	10-#8	10-#7	11-#6	4.69	0.845

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f_c' = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels

No Beams

SQUARE INTERIOR PANEL

With Drop Panels(2)

No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel		(3) Square Column		REINFORCING BARS (E. W.)						MOMENTS			Factored Superimposed Load (psf)	(3) Square Column	REINFORCING BARS (E. W.)					Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$
						Column Strip (1)			Middle Strip								Column Strip		Middle Strip			
		Depth (in.)	Width (ft)	Size (in.)	γ_f	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Total Steel (psf)	Edge (–) (ft-k)	Bot. (+) (ft-k)	Int. (–) (ft-k)		Size (in.)	Top	Bottom	Top	Bottom	Total Steel (psf)	
h = 9 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 9 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
18	100	2.25	6.00	12	0.630	9-#4 0	9-#4	10-#4	6-#5	6-#5	1.83	39.9	79.8	107.4	100	12	9-#4	9-#4	6-#5	6-#5	1.83	0.771
18	200	2.25	6.00	15	0.626	9-#4 0	10-#4	13-#4	6-#5	6-#5	1.98	54.3	108.6	146.2	200	18	8-#5	9-#4	6-#5	6-#5	1.99	0.771
18	300	2.25	6.00	17	0.624	9-#4 1	9-#5	8-#6	6-#5	6-#5	2.24	69.8	151.1	187.8	300	18	10-#5	9-#4	6-#5	6-#5	2.12	0.771
18	400	2.25	6.00	18	0.701	10-#4 3	12-#5	13-#5	8-#5	6-#5	2.69	85.3	198.1	229.8	400	18	12-#5	12-#4	6-#5	6-#5	2.42	0.771
18	500	4.25	6.00	18	0.626	10-#4 1	15-#5	13-#5	7-#6	7-#5	3.09	101.4	249.6	273.0	500	18	12-#5	15-#4	10-#4	10-#4	2.66	0.789
18	600	4.25	6.00	18	0.705	12-#4 2	13-#6	8-#7	12-#5	8-#5	3.78	117.3	294.0	315.8	600	18	10-#6	12-#5	11-#4	8-#5	3.27	0.789
19	100	2.25	6.33	12	0.630	10-#4 0	10-#4	11-#4	10-#4	10-#4	1.88	47.2	94.4	127.1	100	12	10-#4	10-#4	10-#4	10-#4	1.87	0.771
19	200	2.25	6.33	15	0.626	10-#4 1	12-#4	10-#5	10-#4	10-#4	2.09	64.4	128.9	173.5	200	18	9-#5	10-#4	10-#4	10-#4	2.06	0.771
19	300	2.25	6.33	17	0.681	10-#4 3	10-#5	9-#6	10-#4	10-#4	2.35	82.4	169.6	221.9	300	19	12-#5	10-#4	10-#4	10-#4	2.24	0.771
19	400	4.25	6.33	19	0.625	10-#4 1	10-#6	9-#6	9-#5	10-#4	2.83	100.5	230.0	270.6	400	19	12-#5	9-#5	10-#4	10-#4	2.49	0.789
19	500	4.25	6.33	19	0.633	12-#4 2	13-#6	15-#5	8-#6	8-#5	3.54	119.2	285.2	321.0	500	19	10-#6	12-#5	11-#4	8-#5	3.09	0.789
19	600	6.25	6.33	19	0.628	12-#4 2	15-#6	15-#5	10-#6	14-#4	4.01	138.1	341.8	371.8	600	19	10-#6	14-#5	13-#4	9-#5	3.44	0.808
20	100	2.25	6.67	12	0.661	10-#4 1	10-#4	13-#4	10-#4	10-#4	1.84	55.4	110.8	149.1	100	12	12-#4	10-#4	10-#4	10-#4	1.84	0.771
20	200	2.25	6.67	15	0.674	10-#4 2	9-#5	12-#5	10-#4	10-#4	2.10	75.7	151.5	203.9	200	18	16-#4	10-#4	10-#4	10-#4	2.01	0.771
20	300	4.25	6.67	17	0.627	10-#4 2	12-#5	19-#4	8-#5	10-#4	2.40	96.7	195.0	260.3	300	20	17-#4	12-#4	10-#4	10-#4	2.17	0.789
20	400	4.25	6.67	19	0.625	12-#4 2	11-#6	15-#5	16-#4	8-#5	3.03	117.8	258.5	317.1	400	20	10-#6	16-#4	11-#4	7-#5	2.68	0.789
20	500	6.25	6.67	20	0.627	12-#4 2	11-#7	15-#5	13-#5	14-#4	3.71	139.2	328.1	374.9	500	20	10-#6	13-#5	13-#4	9-#5	3.18	0.808
20	600	6.25	8.00	20	0.627	9-#5 1	10-#8	18-#5	16-#5	8-#6	4.35	161.6	396.2	435.0	600	20	25-#4	16-#5	10-#5	16-#4	3.64	0.833
21	100	2.25	7.00	12	0.761	11-#4 3	12-#4	10-#5	7-#5	7-#5	1.99	64.4	128.9	173.5	100	12	14-#4	7-#5	7-#5	7-#5	1.98	0.771
21	200	4.25	7.00	15	0.629	11-#4 1	16-#4	17-#4	7-#5	7-#5	2.16	88.5	177.0	238.3	200	18	16-#4	7-#5	7-#5	7-#5	2.07	0.789
21	300	4.25	7.00	17	0.627	11-#4 2	10-#6	22-#4	9-#5	8-#5	2.67	112.4	224.7	302.5	300	21	13-#5	9-#5	7-#5	7-#5	2.40	0.789
21	400	4.25	7.00	19	0.678	13-#4 2	17-#5	18-#5	17-#4	9-#5	3.16	136.9	285.7	368.6	400	21	16-#5	17-#4	13-#4	8-#5	2.82	0.789
21	500	6.25	7.00	20	0.627	14-#4 1	12-#7	18-#5	8-#7	8-#6	4.04	161.9	367.7	435.9	500	21	25-#4	15-#5	7-#6	7-#6	3.46	0.808
21	600	6.25	8.40	21	0.675	10-#5 1	15-#7	11-#7	8-#8	9-#6	4.89	187.0	445.1	503.5	600	21	10-#7	13-#6	12-#5	12-#5	4.11	0.833
22	100	2.25	7.33	12	0.800	11-#4 4	9-#5	12-#5	11-#4	11-#4	2.00	74.4	148.8	200.4	100	12	16-#4	11-#4	11-#4	11-#4	1.94	0.771
22	200	4.25	7.33	15	0.629	11-#4 2	12-#5	13-#5	8-#5	11-#4	2.27	102.4	204.9	275.8	200	18	12-#5	12-#4	11-#4	11-#4	2.10	0.789
22	300	4.25	7.33	17	0.754	13-#4 5	11-#6	12-#6	16-#4	13-#4	2.83	130.2	260.3	350.4	300	21	15-#5	16-#4	8-#5	11-#4	2.51	0.789
22	400	6.25	7.33	19	0.628	13-#4 2	8-#8	17-#5	13-#5	16-#4	3.44	158.2	322.9	426.0	400	22	16-#5	9-#6	10-#5	13-#4	3.00	0.808
22	500	6.25	8.80	21	0.638	10-#5 1	11-#8	11-#7	9-#7	19-#4	4.45	186.7	419.6	502.7	500	22	10-#7	9-#7	12-#5	8-#6	3.82	0.833
22	600	8.25	8.80	22	0.628	10-#5 1	13-#8	11-#7	11-#7	8-#7	5.18	215.4	505.9	580.0	600	22	10-#7	11-#7	10-#6	10-#6	4.45	0.860

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superim-posed Load (psf)	Square Drop Panel		(3) Square Column		REINFORCING BARS (E. W.)						MOMENTS			Factored Superim-posed Load (psf)	(3) Square Column	REINFORCING BARS (E. W.)					Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$
						Column Strip [1]			Middle Strip								Column Strip		Middle Strip			
		Depth (in.)	Width (ft)	Size (in.)	γ_f	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Total Steel (psf)	Edge (–) (ft-k)	Bot. (+) (ft-k)	Int. (–) (ft-k)		Size (in.)	Top	Bottom	Top	Bottom	Total Steel (psf)	
h = 9 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															*h* = 9 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
23	100	4.25	7.67	12	0.683	12-#4 2	10-#5	11-#5	8-#5	8-#5	2.07	85.7	171.5	230.8	100	12	16-#4	12-#4	8-#5	8-#5	2.00	0.789
23	200	4.25	7.67	15	0.742	12-#4 5	10-#6	15-#5	14-#4	8-#5	2.50	117.7	235.5	317.0	200	18	14-#5	14-#4	8-#5	8-#5	2.30	0.789
23	300	6.25	7.67	18	0.629	12-#4 2	18-#5	16-#5	12-#5	10-#5	2.94	149.4	298.8	402.3	300	21	15-#5	18-#4	9-#5	8-#5	2.59	0.808
23	400	6.25	7.67	19	0.701	15-#4 4	9-#8	14-#6	8-#7	12-#5	3.78	181.4	362.8	488.4	400	23	18-#5	15-#5	8-#6	10-#5	3.27	0.808
23	500	8.25	9.20	22	0.628	16-#4 2	12-#8	11-#7	19-#5	8-#7	4.55	213.8	473.1	575.6	500	23	14-#6	19-#5	13-#5	19-#4	3.87	0.860
23	600	8.25	9.20	22	0.646	18-#4 2	15-#8	13-#7	12-#7	9-#7	5.66	247.2	559.0	665.5	600	23	12-#7	10-#8	11-#6	8-#7	4.93	0.860
24	100	4.25	8.00	12	0.730	13-#4 2	18-#4	19-#4	8-#5	8-#5	2.10	97.8	195.6	263.2	100	12	12-#5	12-#4	8-#5	8-#5	1.99	0.789
24	200	4.25	8.00	16	0.754	13-#4 5	16-#5	12-#6	16-#4	9-#5	2.64	133.5	267.0	359.4	200	19	11-#6	16-#4	8-#5	8-#5	2.39	0.789
24	300	6.25	8.00	18	0.636	14-#4 3	11-#7	14-#6	10-#6	17-#4	3.32	170.9	341.7	460.0	300	21	12-#6	21-#4	16-#4	9-#5	2.84	0.808
24	400	8.25	8.00	20	0.629	15-#4 3	18-#6	14-#6	9-#7	10-#6	4.00	207.1	414.1	557.5	400	23	18-#5	9-#7	19-#4	8-#6	3.51	0.826
24	500	8.25	9.60	21	0.646	18-#4 2	17-#7	23-#5	11-#7	9-#7	4.87	244.8	516.9	659.0	500	24	15-#6	11-#7	8-#7	10-#6	4.23	0.860
25	100	4.25	8.33	12	0.785	13-#4 4	13-#5	14-#5	13-#4	13-#4	2.21	110.9	221.8	298.6	100	12	13-#5	9-#5	13-#4	13-#4	2.11	0.789
25	200	6.25	8.33	16	0.631	13-#4 3	18-#5	25-#4	12-#5	10-#5	2.69	152.0	304.1	409.4	200	19	15-#5	18-#4	14-#4	12-#4	2.34	0.808
25	300	6.25	8.33	18	0.760	16-#4 7	17-#6	15-#6	11-#6	13-#5	3.63	194.3	388.5	523.0	300	21	14-#6	11-#6	12-#5	10-#5	3.18	0.808
25	400	8.25	8.33	20	0.629	17-#4 2	12-#8	12-#7	10-#7	16-#5	4.34	235.6	471.1	634.2	400	23	15-#6	19-#5	22-#4	19-#4	3.70	0.826
25	500	10.25	10.00	22	0.630	18-#4 2	15-#8	23-#5	10-#8	10-#7	5.23	277.2	569.2	746.2	500	25	15-#6	10-#8	9-#7	15-#5	4.47	0.887
26	100	6.25	8.67	12	0.653	13-#4 2	15-#5	14-#5	10-#5	13-#4	2.26	125.7	251.3	338.3	100	12	13-#5	15-#4	13-#4	13-#4	2.05	0.808
26	200	6.25	8.67	16	0.691	14-#4 4	11-#7	14-#6	10-#6	12-#5	3.07	171.9	343.7	462.7	200	19	12-#6	21-#4	16-#4	9-#5	2.61	0.808
26	300	8.25	8.67	18	0.631	16-#4 2	19-#6	15-#6	10-#7	22-#4	3.90	219.4	438.7	590.6	300	22	14-#6	18-#5	10-#6	12-#5	3.39	0.826
26	400	8.25	10.40	21	0.704	19-#4 5	14-#8	18-#6	21-#5	10-#7	4.66	265.2	530.4	714.0	400	25	12-#7	15-#6	16-#5	10-#6	3.99	0.860
26	500	10.25	10.40	22	0.636	13-#5 2	21-#7	26-#5	18-#6	15-#6	5.42	312.7	625.5	842.0	500	26	13-#7	18-#6	19-#5	9-#7	4.73	0.887
27	100	6.25	9.00	12	0.753	14-#4 5	9-#7	16-#5	11-#5	14-#4	2.45	141.2	282.3	380.0	100	12	14-#5	11-#5	9-#5	9-#5	2.17	0.808
27	200	8.25	9.00	16	0.634	14-#4 3	17-#6	28-#4	11-#6	13-#5	3.20	193.8	387.7	521.9	200	19	12-#6	24-#4	12-#5	10-#5	2.74	0.826
27	300	8.25	9.00	18	0.710	18-#4 5	16-#7	13-#7	14-#6	9-#7	4.18	246.9	493.8	664.8	300	22	15-#6	14-#6	15-#5	13-#5	3.59	0.826
27	400	10.25	10.80	21	0.631	19-#4 4	16-#8	18-#6	24-#5	20-#5	4.99	299.6	599.3	806.7	400	25	12-#7	10-#8	10-#7	16-#5	4.31	0.887

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f_c' = 4{,}000$ psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip [1] Top Ext. +	Column Strip [1] Bottom	Column Strip [1] Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 9.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 9.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
19	100	2.25	6.33	12	0.700	9-#5 0	7-#5	9-#5	7-#5	7-#5	2.22	48.7	97.4	131.2	100	12	9-#5	7-#5	7-#5	7-#5	2.22	0.812
19	200	2.25	6.33	15	0.701	9-#5 1	8-#5	10-#5	7-#5	7-#5	2.29	65.9	131.7	177.3	200	18	9-#5	7-#5	7-#5	7-#5	2.24	0.812
19	300	2.25	6.33	17	0.678	9-#5 0	7-#6	9-#6	7-#5	7-#5	2.54	83.8	175.8	225.7	300	19	12-#5	7-#5	7-#5	7-#5	2.42	0.812
19	400	2.25	6.33	19	0.740	9-#5 1	13-#5	15-#5	9-#5	7-#5	2.97	101.8	230.7	274.0	400	19	10-#6	9-#5	7-#5	7-#5	2.74	0.812
19	500	4.25	6.33	19	0.626	9-#5 0	7-#8	15-#5	8-#6	8-#5	3.51	120.6	291.2	324.8	500	19	10-#6	11-#5	7-#5	8-#5	3.00	0.831
19	600	6.25	6.33	19	0.629	9-#5 0	11-#7	15-#5	13-#5	9-#5	3.94	139.5	349.6	375.6	600	19	10-#6	13-#5	8-#5	9-#5	3.34	0.850
20	100	2.25	6.67	12	0.722	9-#5 0	7-#5	9-#5	7-#5	7-#5	2.10	57.1	114.3	153.8	100	12	9-#5	7-#5	7-#5	7-#5	2.10	0.812
20	200	2.25	6.67	15	0.757	9-#5 2	9-#5	12-#5	7-#5	7-#5	2.31	77.4	154.9	208.5	200	18	11-#5	7-#5	7-#5	7-#5	2.24	0.812
20	300	2.25	6.67	17	0.795	9-#5 3	11-#5	15-#5	8-#5	7-#5	2.60	98.2	196.4	264.4	300	20	13-#5	8-#5	7-#5	7-#5	2.45	0.812
20	400	4.25	6.67	19	0.626	9-#5 0	15-#5	15-#5	7-#6	8-#5	3.03	119.4	266.5	321.5	400	20	10-#6	7-#6	7-#5	7-#5	2.72	0.831
20	500	4.25	6.67	20	0.663	9-#5 1	10-#7	9-#7	9-#6	9-#5	3.74	140.7	329.2	378.8	500	20	16-#5	9-#6	8-#5	9-#5	3.29	0.831
20	600	6.25	6.67	20	0.628	9-#5 1	10-#8	9-#7	8-#7	10-#5	4.35	162.7	397.6	438.1	600	20	16-#5	15-#5	7-#6	7-#6	3.63	0.850
21	100	2.25	7.00	12	0.760	10-#5 0	8-#5	10-#5	7-#5	7-#5	2.08	66.5	133.0	179.0	100	12	10-#5	7-#5	7-#5	7-#5	2.03	0.812
21	200	2.25	7.00	15	0.797	10-#5 2	10-#5	13-#5	7-#5	7-#5	2.29	90.3	180.5	243.0	200	18	12-#5	7-#5	7-#5	7-#5	2.17	0.812
21	300	4.25	7.00	18	0.627	10-#5 1	9-#6	10-#6	9-#5	7-#5	2.65	113.8	227.6	306.4	300	21	13-#5	9-#5	7-#5	7-#5	2.40	0.831
21	400	4.25	7.00	19	0.705	10-#5 2	7-#8	12-#6	8-#6	9-#5	3.29	138.8	296.3	373.7	400	21	11-#6	11-#5	8-#5	8-#5	2.84	0.831
21	500	6.25	7.00	21	0.627	10-#5 0	9-#8	12-#6	10-#6	10-#5	3.92	163.1	375.6	439.1	500	21	16-#5	14-#5	7-#6	7-#6	3.37	0.850
21	600	6.25	8.40	21	0.642	10-#5 1	11-#8	14-#6	17-#5	12-#5	4.65	188.9	457.5	508.6	600	21	10-#7	13-#6	8-#6	12-#5	4.09	0.875
22	100	2.25	7.33	12	0.803	10-#5 1	9-#5	11-#5	8-#5	8-#5	2.21	76.8	153.6	206.7	100	12	11-#5	8-#5	8-#5	8-#5	2.19	0.812
22	200	4.25	7.33	16	0.629	10-#5 0	12-#5	13-#5	8-#5	8-#5	2.40	103.9	207.7	279.6	200	19	12-#5	8-#5	8-#5	8-#5	2.25	0.831
22	300	4.25	7.33	18	0.691	10-#5 2	15-#5	16-#5	10-#5	8-#5	2.82	131.8	263.7	355.0	300	21	15-#5	10-#5	8-#5	8-#5	2.58	0.831
22	400	6.25	7.33	20	0.628	10-#5 0	10-#7	12-#6	9-#6	10-#5	3.43	159.8	333.9	430.1	400	22	11-#6	9-#6	9-#5	9-#5	3.02	0.850
22	500	6.25	7.33	21	0.627	10-#5 1	17-#6	14-#6	11-#6	12-#5	4.15	188.3	416.8	506.9	500	22	10-#7	16-#5	8-#6	8-#6	3.71	0.850
22	600	8.25	8.80	22	0.628	10-#5 1	16-#7	20-#5	8-#8	10-#6	4.91	217.6	520.9	585.9	600	22	10-#7	11-#7	9-#6	13-#5	4.28	0.902
23	100	4.25	7.67	12	0.714	11-#5 0	10-#5	11-#5	8-#5	8-#5	2.17	88.4	176.9	238.1	100	12	11-#5	8-#5	8-#5	8-#5	2.08	0.831
23	200	4.25	7.67	16	0.669	11-#5 0	10-#6	15-#5	9-#5	8-#5	2.57	119.4	238.8	321.5	200	19	14-#5	9-#5	8-#5	8-#5	2.32	0.831
23	300	4.25	7.67	18	0.755	11-#5 2	9-#7	14-#6	8-#6	10-#5	3.08	151.7	303.4	408.4	300	21	12-#6	11-#5	9-#5	8-#5	2.68	0.831
23	400	6.25	7.67	20	0.628	11-#5 1	11-#7	14-#6	10-#6	12-#5	3.61	183.2	366.4	493.2	400	23	18-#5	14-#5	8-#6	9-#5	3.14	0.850
23	500	8.25	7.67	21	0.629	11-#5 2	19-#6	14-#6	8-#8	10-#6	4.42	216.2	467.1	582.1	500	23	13-#6	18-#5	9-#6	12-#5	3.76	0.868
23	600	8.25	9.20	23	0.627	12-#5 1	14-#8	12-#7	9-#8	11-#6	5.37	248.7	576.5	669.5	600	23	11-#7	9-#8	8-#7	8-#7	4.67	0.902

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 9.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 9.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
24	100	4.25	8.00	12	0.735	11-#5 0	11-#5	13-#5	8-#5	8-#5	2.16	100.9	201.7	271.6	100	12	12-#5	8-#5	8-#5	8-#5	2.03	0.831
24	200	4.25	8.00	16	0.731	11-#5 1	15-#5	12-#6	10-#5	9-#5	2.63	136.5	272.9	367.4	200	19	11-#6	10-#5	8-#5	8-#5	2.39	0.831
24	300	6.25	8.00	18	0.630	11-#5 1	8-#8	18-#5	13-#5	8-#6	3.26	173.1	346.3	466.1	300	22	12-#6	9-#6	10-#5	9-#5	2.85	0.850
24	400	6.25	8.00	20	0.713	11-#5 3	17-#6	12-#7	11-#6	13-#5	3.89	209.6	419.3	564.4	400	23	20-#5	11-#6	12-#5	8-#6	3.44	0.850
24	500	8.25	9.60	22	0.628	11-#5 2	13-#8	12-#7	20-#5	11-#6	4.66	246.7	531.5	664.1	500	24	11-#7	20-#5	10-#6	13-#5	3.99	0.902
24	600	8.25	9.60	23	0.698	13-#5 2	20-#7	26-#5	10-#8	8-#8	5.67	283.6	633.2	763.6	600	24	13-#7	10-#8	9-#7	16-#5	4.93	0.902
25	100	4.25	8.33	12	0.815	12-#5 2	9-#6	14-#5	9-#5	9-#5	2.34	114.4	228.8	308.0	100	12	13-#5	9-#5	9-#5	9-#5	2.19	0.831
25	200	6.25	8.33	16	0.632	12-#5 0	18-#5	16-#5	12-#5	10-#5	2.82	155.4	310.9	418.5	200	19	15-#5	12-#5	9-#5	9-#5	2.49	0.850
25	300	6.25	8.33	18	0.722	12-#5 2	12-#7	15-#6	15-#5	9-#6	3.54	196.9	393.7	530.0	300	22	14-#6	15-#5	11-#5	10-#5	3.07	0.850
25	400	8.25	8.33	20	0.630	12-#5 1	15-#7	12-#7	10-#7	15-#5	4.22	238.0	476.0	640.7	400	24	14-#6	18-#5	10-#6	12-#5	3.55	0.868
25	500	8.25	10.00	22	0.694	13-#5 2	14-#8	26-#5	9-#8	10-#7	5.06	279.8	573.7	753.2	500	25	13-#7	9-#8	16-#5	10-#6	4.37	0.902
26	100	6.25	8.67	12	0.721	12-#5 1	15-#5	14-#5	10-#5	9-#5	2.37	129.6	259.2	349.0	100	12	13-#5	10-#5	9-#5	9-#5	2.16	0.850
26	200	6.25	8.67	16	0.739	12-#5 3	14-#6	13-#6	13-#5	11-#5	2.97	175.7	351.4	473.0	200	19	12-#6	13-#5	10-#5	9-#5	2.58	0.850
26	300	8.25	8.67	19	0.631	12-#5 1	18-#6	15-#6	9-#7	10-#6	3.77	222.3	444.7	598.6	300	22	14-#6	9-#7	9-#6	11-#5	3.31	0.868
26	400	8.25	8.67	20	0.689	12-#5 3	13-#8	13-#7	20-#5	9-#7	4.47	269.4	538.7	725.2	400	24	12-#7	20-#5	11-#6	13-#5	3.82	0.868
26	500	10.25	10.40	22	0.630	13-#5 1	15-#8	26-#5	10-#8	20-#5	5.24	316.4	632.8	851.8	500	26	13-#7	10-#8	10-#7	11-#6	4.61	0.928
27	100	6.25	9.00	12	0.761	12-#5 2	16-#5	15-#5	11-#5	9-#5	2.41	145.6	291.2	392.0	100	12	14-#5	11-#5	9-#5	9-#5	2.17	0.850
27	200	6.25	9.00	16	0.781	12-#5 4	22-#5	15-#6	15-#5	9-#6	3.21	197.6	395.3	532.1	200	19	14-#6	15-#5	12-#5	10-#5	2.85	0.850
27	300	8.25	9.00	19	0.631	12-#5 2	12-#8	12-#7	10-#7	11-#6	4.06	250.3	500.6	673.9	300	22	15-#6	19-#5	15-#5	9-#6	3.50	0.868
27	400	10.25	10.80	21	0.631	12-#5 2	15-#8	13-#7	10-#8	19-#5	4.86	303.8	607.5	817.9	400	25	12-#7	12-#7	10-#7	15-#5	4.13	0.928
27	500	10.25	10.80	22	0.735	15-#5 4	18-#8	12-#8	11-#8	12-#7	5.71	356.6	713.1	959.9	500	26	14-#7	11-#8	11-#7	18-#5	4.84	0.928
28	100	6.25	9.33	12	0.796	13-#5 2	18-#5	17-#5	12-#5	10-#5	2.57	162.8	325.7	438.4	100	12	16-#5	12-#5	10-#5	10-#5	2.31	0.850
28	200	8.25	9.33	16	0.684	13-#5 2	18-#6	15-#6	12-#6	10-#6	3.46	221.9	443.8	597.4	200	19	14-#6	12-#6	13-#5	11-#5	3.00	0.868
28	300	8.25	9.33	19	0.751	13-#5 5	17-#7	26-#5	15-#6	10-#7	4.33	280.5	561.1	755.3	300	22	13-#7	21-#5	16-#5	10-#6	3.75	0.868
28	400	10.25	11.20	21	0.700	14-#5 4	21-#7	15-#7	11-#8	12-#7	5.23	340.7	681.4	917.2	400	25	18-#6	11-#8	14-#6	12-#6	4.49	0.928
28	500	12.25	11.20	23	0.632	15-#5 3	20-#8	16-#7	16-#7	18-#6	5.98	398.3	796.5	1072.3	500	27	14-#7	16-#7	23-#5	14-#6	5.03	0.955

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f_c' = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL

With Drop Panels(2)
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 10 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 10 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
20	100	2.25	6.67	12	0.703	9-#5 0	7-#5	9-#5	7-#5	7-#5	2.10	58.9	117.8	158.6	100	12	9-#5	7-#5	7-#5	7-#5	2.10	0.854
20	200	2.25	6.67	16	0.672	9-#5 1	9-#5	11-#5	7-#5	7-#5	2.26	78.8	157.5	212.1	200	18	10-#5	7-#5	7-#5	7-#5	2.17	0.854
20	300	2.25	6.67	18	0.652	9-#5 0	11-#5	10-#6	7-#5	7-#5	2.50	99.4	201.6	267.6	300	20	9-#6	7-#5	7-#5	7-#5	2.37	0.854
20	400	2.25	6.67	20	0.725	9-#5 1	10-#6	9-#7	7-#6	7-#5	3.09	120.3	266.1	324.0	400	20	11-#6	7-#6	7-#5	7-#5	2.82	0.854
20	500	4.25	6.67	20	0.630	9-#5 1	13-#6	9-#7	12-#5	9-#5	3.53	142.4	336.6	383.3	500	20	11-#6	12-#5	8-#5	8-#5	3.07	0.873
20	600	6.25	6.67	20	0.628	9-#5 1	9-#8	9-#7	8-#7	7-#6	4.21	164.4	406.9	442.5	600	20	11-#6	15-#5	9-#5	7-#6	3.58	0.891
20	700	6.25	8.00	20	0.635	10-#5 0	11-#8	10-#7	7-#8	8-#6	4.77	186.7	472.5	502.6	700	20	18-#5	12-#6	10-#5	8-#6	3.96	0.917
21	100	2.25	7.00	12	0.742	10-#5 0	8-#5	10-#5	8-#5	8-#5	2.23	68.5	137.1	184.5	100	12	10-#5	8-#5	8-#5	8-#5	2.23	0.854
21	200	2.25	7.00	15	0.756	10-#5 1	7-#6	13-#5	8-#5	8-#5	2.45	92.2	184.5	248.3	200	18	12-#5	8-#5	8-#5	8-#5	2.36	0.854
21	300	2.25	7.00	18	0.788	10-#5 3	12-#5	16-#5	8-#5	8-#5	2.66	115.5	231.0	311.0	300	21	15-#5	8-#5	8-#5	8-#5	2.56	0.854
21	400	4.25	7.00	20	0.638	10-#5 2	16-#5	12-#6	8-#6	9-#5	3.14	140.1	304.6	377.2	400	21	15-#5	11-#5	8-#5	8-#5	2.79	0.873
21	500	4.25	7.00	21	0.625	10-#5 0	11-#7	14-#6	13-#5	7-#6	3.83	164.8	376.7	443.7	500	21	18-#5	7-#7	9-#5	9-#5	3.37	0.873
21	600	6.25	7.00	21	0.627	10-#5 0	11-#8	14-#6	16-#5	8-#6	4.57	190.3	459.0	512.3	600	21	18-#5	12-#6	8-#6	8-#6	3.95	0.891
21	700	8.25	8.40	21	0.630	10-#5 0	16-#7	10-#7	8-#8	9-#6	5.00	216.5	542.6	582.8	700	21	18-#5	14-#6	12-#5	9-#6	4.23	0.943
22	100	2.25	7.33	12	0.788	10-#5 1	9-#5	11-#5	8-#5	8-#5	2.18	79.2	158.3	213.1	100	12	10-#5	8-#5	8-#5	8-#5	2.12	0.854
22	200	2.25	7.33	16	0.776	10-#5 2	11-#5	15-#5	8-#5	8-#5	2.45	105.9	211.7	285.0	200	19	10-#6	8-#5	8-#5	8-#5	2.38	0.854
22	300	4.25	7.33	18	0.634	10-#5 1	10-#6	16-#5	10-#5	8-#5	2.80	134.1	268.1	360.9	300	21	15-#5	10-#5	8-#5	8-#5	2.58	0.873
22	400	4.25	7.33	20	0.715	10-#5 3	13-#6	10-#7	12-#5	10-#5	3.32	161.7	335.2	435.4	400	22	18-#5	12-#5	9-#5	8-#5	2.93	0.873
22	500	6.25	7.33	21	0.627	10-#5 0	17-#6	14-#6	8-#7	8-#6	3.99	190.5	428.2	512.8	500	22	18-#5	15-#5	8-#6	10-#5	3.43	0.891
22	600	6.25	8.80	22	0.715	11-#5 3	15-#7	12-#7	8-#8	13-#5	4.85	219.4	524.5	590.7	600	22	11-#7	10-#7	12-#5	9-#6	4.23	0.917
22	700	8.25	8.80	22	0.629	11-#5 0	11-#9	12-#7	9-#8	8-#7	5.61	248.9	609.0	670.1	700	22	11-#7	9-#8	10-#6	8-#7	4.84	0.943
23	100	2.25	7.67	12	0.852	11-#5 3	10-#5	13-#5	9-#5	9-#5	2.37	90.8	181.6	244.5	100	12	12-#5	9-#5	9-#5	9-#5	2.33	0.854
23	200	4.25	7.67	16	0.648	11-#5 0	9-#6	15-#5	9-#5	9-#5	2.57	122.0	244.0	328.5	200	19	13-#5	9-#5	9-#5	9-#5	2.41	0.873
23	300	4.25	7.67	18	0.733	11-#5 2	16-#5	18-#5	8-#6	9-#5	3.00	154.3	308.5	415.3	300	21	12-#6	11-#5	9-#5	9-#5	2.77	0.873
23	400	6.25	7.67	20	0.628	11-#5 1	11-#7	14-#6	13-#5	8-#6	3.46	185.7	376.4	500.0	400	23	17-#5	13-#5	10-#5	9-#5	2.96	0.891
23	500	6.25	7.67	21	0.698	11-#5 3	18-#6	12-#7	9-#7	13-#5	4.33	218.5	470.7	588.2	500	23	11-#7	9-#7	12-#5	8-#6	3.87	0.891
23	600	8.25	9.20	23	0.628	11-#5 0	11-#9	12-#7	15-#6	8-#7	5.16	251.2	593.6	676.2	600	23	11-#7	15-#6	10-#6	10-#6	4.36	0.943
23	700	8.25	9.20	23	0.699	13-#5 2	13-#9	18-#6	8-#9	9-#7	6.09	284.4	676.3	765.7	700	23	13-#7	8-#9	11-#6	16-#5	5.17	0.943
24	100	4.25	8.00	12	0.719	11-#5 0	11-#5	12-#5	9-#5	9-#5	2.29	104.0	207.9	279.9	100	12	12-#5	9-#5	9-#5	9-#5	2.23	0.873
24	200	4.25	8.00	16	0.711	11-#5 1	15-#5	12-#6	10-#5	9-#5	2.67	139.4	278.9	375.4	200	19	15-#5	10-#5	9-#5	9-#5	2.47	0.873
24	300	6.25	8.00	18	0.630	11-#5 1	19-#5	18-#5	9-#6	8-#6	3.13	176.0	352.1	474.0	300	22	12-#6	12-#5	10-#5	9-#5	2.76	0.891
24	400	6.25	8.00	20	0.661	11-#5 2	12-#7	12-#7	8-#7	9-#6	3.75	211.7	423.4	570.0	400	24	14-#6	15-#5	8-#6	10-#5	3.24	0.891
24	500	8.25	8.00	21	0.630	11-#5 2	15-#7	12-#7	8-#8	8-#7	4.52	249.4	523.7	671.4	500	24	11-#7	13-#6	10-#6	12-#5	3.88	0.910
24	600	8.25	9.60	23	0.673	13-#5 2	12-#9	18-#6	8-#9	9-#7	5.70	286.5	655.4	771.3	600	24	13-#7	8-#9	11-#6	11-#6	4.94	0.943

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superim-posed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip [1] Top Ext. +	Column Strip Bottom	Column Strip Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superim-posed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 10 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															*h* = 10 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
25	100	4.25	8.33	12	0.802	12-#5 2	9-#6	14-#5	9-#5	9-#5	2.34	117.9	235.9	317.5	100	12	13-#5	9-#5	9-#5	9-#5	2.19	0.873
25	200	4.25	8.33	16	0.813	12-#5 4	9-#7	14-#6	11-#5	10-#5	2.85	158.4	316.8	426.5	200	19	12-#6	11-#5	9-#5	9-#5	2.53	0.873
25	300	6.25	8.33	18	0.675	12-#5 1	15-#6	20-#5	10-#6	12-#5	3.35	200.2	400.4	539.0	300	22	13-#6	14-#5	11-#5	10-#5	2.95	0.891
25	400	8.25	8.33	20	0.631	12-#5 1	11-#8	12-#7	9-#7	10-#6	4.07	241.3	482.5	649.5	400	24	14-#6	9-#7	13-#5	11-#5	3.47	0.910
25	500	8.25	10.00	22	0.646	13-#5 1	17-#7	18-#6	11-#7	9-#7	4.77	283.0	592.9	761.9	500	25	12-#7	11-#7	11-#6	10-#6	4.14	0.943
25	600	10.25	10.00	24	0.629	13-#5 1	17-#8	26-#5	9-#9	19-#5	5.93	324.4	728.2	873.3	600	25	13-#7	11-#8	10-#7	9-#7	5.10	0.970
26	100	4.25	8.67	12	0.833	12-#5 3	10-#6	16-#5	10-#5	10-#5	2.48	133.1	266.2	358.3	100	12	15-#5	10-#5	10-#5	10-#5	2.34	0.873
26	200	6.25	8.67	16	0.722	12-#5 3	19-#5	18-#5	9-#6	11-#5	2.94	179.5	359.0	483.3	200	19	12-#6	9-#6	10-#5	10-#5	2.66	0.891
26	300	6.25	8.67	19	0.704	12-#5 2	17-#6	12-#7	16-#5	13-#5	3.61	225.7	451.3	607.5	300	22	15-#6	16-#5	12-#5	11-#5	3.20	0.891
26	400	8.25	8.67	20	0.640	12-#5 2	12-#8	13-#7	19-#5	16-#5	4.28	273.1	546.1	735.1	400	24	12-#7	19-#5	15-#5	9-#6	3.72	0.910
26	500	8.25	10.40	23	0.753	14-#5 5	12-#9	12-#8	12-#7	10-#7	5.12	318.2	636.4	856.7	500	26	26-#5	12-#7	17-#5	15-#5	4.31	0.943
26	600	10.25	10.40	24	0.629	15-#5 0	18-#8	12-#8	12-#8	9-#8	6.07	366.1	789.3	985.7	600	26	14-#7	15-#7	20-#5	10-#7	5.15	0.970
27	100	6.25	9.00	12	0.749	12-#5 2	16-#5	15-#5	11-#5	10-#5	2.47	150.1	300.1	404.0	100	12	14-#5	11-#5	10-#5	10-#5	2.26	0.891
27	200	6.25	9.00	16	0.766	12-#5 4	9-#8	15-#6	10-#6	12-#5	3.19	201.9	403.8	543.6	200	19	14-#6	14-#5	11-#5	10-#5	2.76	0.891
27	300	8.25	9.00	19	0.632	12-#5 1	9-#9	12-#7	10-#7	15-#5	3.94	254.5	509.0	685.2	300	22	15-#6	18-#5	10-#6	12-#5	3.34	0.910
27	400	8.25	9.00	21	0.735	14-#5 4	11-#9	27-#5	9-#8	10-#7	4.83	305.5	610.9	822.4	400	25	13-#7	9-#8	9-#7	10-#6	4.20	0.910
27	500	10.25	10.80	23	0.630	14-#5 1	13-#9	12-#8	18-#6	15-#6	5.36	358.2	716.4	964.4	500	27	26-#5	18-#6	14-#6	9-#7	4.60	0.970
28	100	6.25	9.33	12	0.785	13-#5 2	18-#5	17-#5	12-#5	10-#5	2.57	167.8	335.6	451.8	100	12	16-#5	12-#5	10-#5	10-#5	2.31	0.891
28	200	6.25	9.33	17	0.778	13-#5 4	17-#6	16-#6	16-#5	13-#5	3.34	224.7	449.4	604.9	200	20	15-#6	16-#5	12-#5	11-#5	2.95	0.891
28	300	8.25	9.33	19	0.718	13-#5 4	22-#6	18-#6	20-#5	12-#6	4.11	285.3	570.5	768.0	300	22	13-#7	20-#5	11-#6	13-#5	3.61	0.910
28	400	10.25	9.33	21	0.637	14-#5 3	20-#7	27-#5	10-#8	20-#5	4.98	343.1	686.2	923.7	400	25	13-#7	10-#8	10-#7	16-#5	4.36	0.928
28	500	10.25	11.20	23	0.724	16-#5 4	18-#8	13-#8	12-#8	10-#8	5.88	401.9	803.9	1082.2	500	27	16-#7	12-#8	12-#7	10-#7	5.15	0.970
29	100	6.25	9.67	12	0.816	13-#5 3	14-#6	14-#6	13-#5	11-#5	2.75	186.9	373.9	503.3	100	12	18-#5	13-#5	11-#5	11-#5	2.47	0.891
29	200	8.25	9.67	17	0.686	13-#5 3	11-#8	16-#6	10-#7	15-#5	3.61	251.3	502.6	676.5	200	20	15-#6	18-#5	10-#6	12-#5	3.08	0.910
29	300	10.25	9.67	19	0.634	13-#5 3	14-#8	18-#6	12-#7	10-#7	4.34	318.0	635.9	856.1	300	23	23-#5	22-#5	17-#5	15-#5	3.65	0.928
29	400	10.25	11.60	22	0.704	15-#5 4	14-#9	16-#7	12-#8	12-#7	5.43	383.2	766.5	1031.8	400	26	15-#7	11-#8	11-#7	18-#5	4.59	0.970
29	500	12.25	11.60	23	0.632	16-#5 2	17-#9	13-#8	17-#7	11-#8	6.26	450.1	900.3	1211.9	500	27	16-#7	17-#7	10-#8	15-#6	5.32	0.997
30	100	8.25	10.00	12	0.732	14-#5 1	22-#5	14-#6	15-#5	12-#5	2.84	208.3	416.5	560.7	100	12	17-#5	15-#5	12-#5	11-#5	2.49	0.910
30	200	8.25	10.00	17	0.732	14-#5 3	16-#7	18-#6	14-#6	12-#6	3.78	279.2	558.5	751.8	200	20	16-#6	14-#6	15-#5	13-#5	3.24	0.910
30	300	10.25	10.00	19	0.693	14-#5 4	13-#9	15-#7	18-#6	11-#7	4.82	353.6	707.1	951.9	300	23	26-#5	18-#6	10-#7	12-#6	4.07	0.928
30	400	12.25	12.00	22	0.633	15-#5 3	16-#9	16-#7	10-#9	18-#6	5.71	427.6	855.2	1151.2	400	26	15-#7	10-#9	23-#5	20-#5	4.83	0.997

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f_c' = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel		(3) Square Column		REINFORCING BARS (E. W.)						MOMENTS			Factored Superimposed Load (psf)	(3) Square Column	REINFORCING BARS (E. W.)					Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$
						Column Strip [1]			Middle Strip								Column Strip		Middle Strip			
		Depth (in.)	Width (ft)	Size (in.)	γ_f	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Total Steel (psf)	Edge (–) (ft-k)	Bot. (+) (ft-k)	Int. (–) (ft-k)		Size (in.)	Top	Bottom	Top	Bottom	Total Steel (psf)	
h = 10.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 10.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
21	100	2.25	7.00	12	0.725	10-#5 0	8-#5	10-#5	8-#5	8-#5	2.23	70.6	141.1	190.0	100	12	10-#5	8-#5	8-#5	8-#5	2.23	0.896
21	200	2.25	7.00	16	0.699	10-#5 1	7-#6	13-#5	8-#5	8-#5	2.45	93.8	187.6	252.6	200	18	12-#5	8-#5	8-#5	8-#5	2.36	0.896
21	300	2.25	7.00	18	0.745	10-#5 2	12-#5	11-#6	8-#5	8-#5	2.66	117.4	234.9	316.2	300	21	15-#5	8-#5	8-#5	8-#5	2.56	0.896
21	400	4.25	7.00	20	0.626	10-#5 0	11-#6	16-#5	8-#6	8-#5	3.12	142.0	312.5	382.3	400	21	15-#5	11-#5	8-#5	8-#5	2.79	0.914
21	500	4.25	7.00	21	0.625	10-#5 0	8-#8	10-#7	9-#6	7-#6	3.72	166.7	385.6	448.8	500	21	18-#5	13-#5	9-#5	9-#5	3.25	0.914
21	600	6.25	7.00	21	0.628	10-#5 0	8-#9	10-#7	11-#6	8-#6	4.38	192.2	467.2	517.4	600	21	18-#5	16-#5	7-#6	8-#6	3.74	0.933
21	700	6.25	8.40	21	0.666	11-#5 0	15-#7	12-#7	8-#8	12-#5	4.93	218.0	545.4	586.9	700	21	14-#6	13-#6	8-#6	12-#5	4.12	0.958
22	100	2.25	7.33	12	0.747	10-#5 0	9-#5	11-#5	9-#5	9-#5	2.35	81.5	163.0	219.5	100	12	10-#5	9-#5	9-#5	9-#5	2.34	0.896
22	200	2.25	7.33	16	0.755	10-#5 2	11-#5	15-#5	9-#5	9-#5	2.62	108.6	217.2	292.3	200	18	10-#6	9-#5	9-#5	9-#5	2.59	0.896
22	300	4.25	7.33	18	0.628	10-#5 1	10-#6	11-#6	9-#5	9-#5	2.79	135.7	271.5	365.4	300	22	10-#6	9-#5	9-#5	9-#5	2.61	0.914
22	400	4.25	7.33	20	0.660	10-#5 2	13-#6	10-#7	8-#6	9-#5	3.31	163.9	345.6	441.3	400	22	12-#6	8-#6	9-#5	9-#5	2.98	0.914
22	500	6.25	7.33	21	0.628	10-#5 0	9-#8	10-#7	8-#7	8-#6	3.91	192.7	438.7	518.7	500	22	18-#5	15-#5	10-#5	10-#5	3.36	0.933
22	600	6.25	7.33	22	0.627	11-#5 0	11-#8	12-#7	8-#8	9-#6	4.76	220.9	522.4	594.9	600	22	20-#5	13-#6	8-#6	12-#5	4.02	0.933
22	700	8.25	8.80	22	0.629	11-#5 0	13-#8	12-#7	11-#7	10-#6	5.18	251.1	622.1	676.0	700	22	20-#5	15-#6	13-#5	10-#6	4.39	0.985
23	100	2.25	7.67	12	0.793	11-#5 0	9-#5	13-#5	9-#5	9-#5	2.33	93.5	187.1	251.8	100	12	12-#5	9-#5	9-#5	9-#5	2.33	0.896
23	200	4.25	7.67	16	0.630	11-#5 0	9-#6	14-#5	9-#5	9-#5	2.56	124.6	249.2	335.5	200	19	13-#5	9-#5	9-#5	9-#5	2.41	0.914
23	300	4.25	7.67	18	0.684	11-#5 1	11-#6	18-#5	8-#6	9-#5	2.94	156.2	312.4	420.6	300	22	16-#5	10-#5	9-#5	9-#5	2.64	0.914
23	400	6.25	7.67	20	0.629	11-#5 1	8-#8	13-#6	9-#6	8-#6	3.43	188.2	388.4	506.8	400	23	12-#6	9-#6	10-#5	9-#5	2.99	0.933
23	500	6.25	7.67	21	0.644	11-#5 2	8-#9	12-#7	16-#5	9-#6	4.15	221.0	484.3	595.0	500	23	14-#6	16-#5	8-#6	8-#6	3.57	0.933
23	600	6.25	9.20	23	0.728	12-#5 3	16-#7	13-#7	8-#8	10-#6	4.89	253.2	592.8	681.6	600	23	12-#7	11-#7	13-#5	13-#5	4.29	0.958
23	700	8.25	9.20	23	0.647	13-#5 1	12-#9	13-#7	8-#9	16-#5	5.88	286.9	693.3	772.4	700	23	12-#7	8-#9	8-#7	11-#6	5.05	0.985
24	100	4.25	8.00	12	0.703	11-#5 0	11-#5	12-#5	9-#5	9-#5	2.27	107.1	214.1	288.2	100	12	11-#5	9-#5	9-#5	9-#5	2.19	0.914
24	200	4.25	8.00	16	0.691	11-#5 1	10-#6	16-#5	10-#5	9-#5	2.64	142.4	284.8	383.4	200	19	15-#5	10-#5	9-#5	9-#5	2.47	0.914
24	300	4.25	8.00	19	0.736	11-#5 3	18-#5	20-#5	12-#5	10-#5	3.08	178.0	356.0	479.2	300	22	13-#6	12-#5	9-#5	9-#5	2.80	0.914
24	400	6.25	8.00	20	0.636	11-#5 2	9-#8	11-#7	10-#6	12-#5	3.63	214.6	429.2	577.8	400	24	14-#6	14-#5	8-#6	10-#5	3.17	0.933
24	500	6.25	8.00	22	0.710	12-#5 3	11-#8	13-#7	8-#8	10-#6	4.47	251.0	525.7	675.8	500	24	12-#7	18-#5	9-#6	12-#5	3.81	0.933
24	600	8.25	9.60	24	0.628	13-#5 1	14-#8	13-#7	9-#8	16-#5	5.22	288.2	666.9	775.9	600	24	12-#7	12-#7	8-#7	8-#7	4.53	0.985
24	700	8.25	9.60	24	0.716	14-#5 2	13-#9	12-#8	9-#9	8-#8	6.22	326.0	765.1	877.6	700	24	26-#5	11-#8	9-#7	9-#7	5.26	0.985
25	100	4.25	8.33	12	0.790	12-#5 2	12-#5	14-#5	10-#5	10-#5	2.42	121.4	242.9	326.9	100	12	13-#5	10-#5	10-#5	10-#5	2.35	0.914
25	200	4.25	8.33	16	0.797	12-#5 4	16-#5	18-#5	11-#5	10-#5	2.80	161.8	323.6	435.6	200	19	12-#6	11-#5	10-#5	10-#5	2.63	0.914
25	300	6.25	8.33	19	0.630	12-#5 1	11-#7	14-#6	10-#6	11-#5	3.32	202.8	405.5	545.9	300	22	18-#5	14-#5	11-#5	10-#5	2.90	0.933
25	400	6.25	8.33	20	0.732	12-#5 3	10-#8	13-#7	16-#5	10-#6	3.93	244.2	488.4	657.4	400	24	12-#7	16-#5	9-#6	11-#5	3.46	0.933
25	500	8.25	8.33	22	0.629	12-#5 2	12-#8	13-#7	19-#5	16-#5	4.46	285.0	581.0	767.3	500	25	12-#7	19-#5	15-#5	9-#6	3.89	0.951
25	600	8.25	10.00	24	0.687	14-#5 2	13-#9	12-#8	10-#8	10-#7	5.64	327.0	730.7	880.3	600	25	26-#5	10-#8	9-#7	16-#5	4.72	0.985

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels No Beams

SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$
h = 10.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 10.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
26	100	4.25	8.67	12	0.822	12-#5 3	10-#6	16-#5	10-#5	10-#5	2.48	137.0	274.1	369.0	100	12	15-#5	10-#5	10-#5	10-#5	2.34	0.914
26	200	6.25	8.67	16	0.633	12-#5 0	18-#5	18-#5	12-#5	10-#5	2.82	183.3	366.6	493.5	200	19	12-#6	12-#5	10-#5	10-#5	2.58	0.933
26	300	6.25	8.67	19	0.683	12-#5 2	17-#6	12-#7	15-#5	9-#6	3.50	229.4	458.8	617.6	300	22	15-#6	15-#5	12-#5	10-#5	3.06	0.933
26	400	8.25	8.67	21	0.630	12-#5 2	9-#9	13-#7	10-#7	15-#5	4.17	274.8	549.6	739.9	400	25	12-#7	18-#5	10-#6	12-#5	3.56	0.951
26	500	8.25	10.40	23	0.659	14-#5 1	11-#9	12-#8	9-#8	10-#7	4.99	321.8	654.6	866.5	500	26	18-#6	9-#8	9-#7	15-#5	4.31	0.985
26	600	10.25	10.40	24	0.630	14-#5 1	14-#9	12-#8	9-#9	11-#7	5.97	369.7	810.3	995.4	600	26	14-#7	9-#9	10-#7	18-#5	5.08	1.012
27	100	6.25	9.00	12	0.736	12-#5 2	15-#5	15-#5	10-#5	10-#5	2.36	154.5	309.0	416.0	100	12	14-#5	10-#5	10-#5	10-#5	2.20	0.933
27	200	6.25	9.00	16	0.751	12-#5 4	11-#7	20-#5	10-#6	12-#5	3.08	206.2	412.4	555.2	200	19	13-#6	14-#5	11-#5	10-#5	2.71	0.933
27	300	8.25	9.00	19	0.632	12-#5 1	11-#8	12-#7	9-#7	15-#5	3.79	257.9	515.7	694.2	300	23	15-#6	9-#7	13-#5	11-#5	3.26	0.951
27	400	8.25	9.00	21	0.651	13-#5 2	13-#8	14-#7	11-#7	9-#7	4.56	309.6	619.2	833.6	400	25	13-#7	11-#7	16-#5	10-#6	4.01	0.951
27	500	10.25	10.80	23	0.631	14-#5 1	13-#9	12-#8	10-#8	20-#5	5.24	362.3	724.6	975.4	500	27	18-#6	10-#8	10-#7	16-#5	4.42	1.012
27	600	10.25	10.80	24	0.716	16-#5 4	15-#9	13-#8	12-#8	10-#8	6.17	415.4	871.9	1118.3	600	27	12-#8	12-#8	9-#8	19-#5	5.27	1.012
28	100	6.25	9.33	12	0.773	13-#5 2	17-#5	17-#5	12-#5	11-#5	2.60	172.8	345.6	465.2	100	12	16-#5	12-#5	11-#5	11-#5	2.42	0.933
28	200	6.25	9.33	16	0.791	13-#5 4	17-#6	16-#6	15-#5	13-#5	3.28	230.9	461.9	621.8	200	19	15-#6	15-#5	12-#5	11-#5	2.89	0.933
28	300	8.25	9.33	19	0.700	13-#5 4	12-#8	13-#7	10-#7	16-#5	3.98	289.0	578.1	778.2	300	23	23-#5	19-#5	15-#5	13-#5	3.42	0.951
28	400	10.25	9.33	21	0.632	14-#5 3	12-#9	14-#7	10-#8	14-#6	4.92	347.7	695.4	936.2	400	25	13-#7	17-#6	10-#7	15-#5	4.18	0.970
28	500	10.25	11.20	23	0.688	16-#5 3	17-#8	13-#8	11-#8	12-#7	5.51	406.5	813.1	1094.5	500	27	15-#7	11-#8	11-#7	18-#5	4.76	1.012
29	100	6.25	9.67	12	0.806	13-#5 3	19-#5	14-#6	13-#5	11-#5	2.71	192.5	385.0	518.2	100	12	18-#5	13-#5	11-#5	11-#5	2.47	0.933
29	200	8.25	9.67	17	0.645	13-#5 2	11-#8	16-#6	12-#6	10-#6	3.47	256.6	513.2	690.9	200	20	15-#6	12-#6	13-#5	11-#5	2.97	0.951
29	300	8.25	9.67	19	0.764	14-#5 5	11-#9	15-#7	12-#7	10-#7	4.41	322.6	645.3	868.6	300	23	18-#6	21-#5	12-#6	10-#6	3.67	0.951
29	400	10.25	9.67	21	0.678	15-#5 3	21-#7	16-#7	11-#8	12-#7	5.24	388.3	776.6	1045.5	400	25	15-#7	11-#8	14-#6	12-#6	4.60	0.970
29	500	12.25	11.60	23	0.632	16-#5 2	16-#9	13-#8	10-#9	18-#6	6.05	453.8	907.6	1221.8	500	28	16-#7	10-#9	10-#8	14-#6	5.19	1.038
30	100	8.25	10.00	12	0.719	14-#5 1	15-#6	14-#6	10-#6	12-#5	2.77	214.4	428.8	577.2	100	12	17-#5	14-#5	11-#5	11-#5	2.40	0.951
30	200	8.25	10.00	17	0.717	14-#5 3	12-#8	18-#6	10-#7	16-#5	3.70	285.2	570.3	767.8	200	20	16-#6	19-#5	15-#5	13-#5	3.16	0.951
30	300	10.25	10.00	19	0.655	14-#5 3	12-#9	15-#7	10-#8	20-#5	4.61	359.4	718.8	967.6	300	23	18-#6	17-#6	10-#7	16-#5	3.92	0.970
30	400	10.25	12.00	22	0.760	17-#5 6	15-#9	14-#8	12-#8	10-#8	5.60	432.2	864.3	1163.5	400	26	16-#7	12-#8	12-#7	10-#7	4.79	1.012
30	500	12.25	12.00	23	0.676	18-#5 2	18-#9	15-#8	14-#8	12-#8	6.52	505.1	1010.2	1359.9	500	28	17-#7	11-#9	11-#8	12-#7	5.55	1.038
31	100	8.25	10.33	12	0.757	14-#5 2	17-#6	15-#6	11-#6	13-#5	2.98	237.1	474.2	638.4	100	12	14-#6	16-#5	12-#5	12-#5	2.61	0.951
31	200	8.25	10.33	17	0.772	14-#5 5	13-#8	27-#5	11-#7	13-#6	3.93	315.8	631.6	850.2	200	20	18-#6	11-#7	16-#5	14-#5	3.41	0.951
31	300	10.25	10.33	19	0.725	15-#5 4	17-#8	16-#7	11-#8	12-#7	4.98	398.2	796.3	1072.0	300	23	15-#7	11-#8	20-#5	18-#5	4.31	0.970
31	400	12.25	12.40	22	0.633	17-#5 2	17-#9	14-#8	17-#7	11-#8	5.87	480.4	960.8	1293.3	400	26	16-#7	17-#7	13-#7	15-#6	4.95	1.038
31	500	12.25	12.40	24	0.756	19-#5 6	20-#9	16-#8	13-#9	13-#8	7.12	558.5	1117.0	1503.6	500	28	15-#8	13-#9	12-#8	13-#7	6.11	1.038

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f_c' = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels

No Beams

SQUARE INTERIOR PANEL

With Drop Panels(2)

No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel		(3) Square Column		REINFORCING BARS (E. W.)						MOMENTS			Factored Superimposed Load (psf)	(3) Square Column	REINFORCING BARS (E. W.)					Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$
						Column Strip (1)			Middle Strip								Column Strip		Middle Strip			
		Depth (in.)	Width (ft)	Size (in.)	γ_f	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Total Steel (psf)	Edge (–) (ft-k)	Bot. (+) (ft-k)	Int. (–) (ft-k)		Size (in.)	Top	Bottom	Top	Bottom	Total Steel (psf)	
h = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
22	100	2.25	7.33	12	0.730	10-#5 0	9-#5	11-#5	9-#5	9-#5	2.35	83.9	167.8	225.8	100	12	10-#5	9-#5	9-#5	9-#5	2.34	0.938
22	200	2.25	7.33	16	0.710	10-#5 1	11-#5	10-#6	9-#5	9-#5	2.58	110.4	220.8	297.2	200	19	13-#5	9-#5	9-#5	9-#5	2.53	0.938
22	300	2.25	7.33	18	0.780	10-#5 3	13-#5	18-#5	9-#5	9-#5	2.79	138.3	276.6	372.3	300	21	16-#5	9-#5	9-#5	9-#5	2.69	0.938
22	400	4.25	7.33	20	0.633	10-#5 2	9-#7	18-#5	8-#6	9-#5	3.22	166.1	355.2	447.3	400	22	12-#6	11-#5	9-#5	9-#5	2.91	0.956
22	500	4.25	7.33	21	0.738	11-#5 3	11-#7	15-#6	10-#6	10-#5	3.80	194.6	440.1	524.0	500	22	14-#6	14-#5	10-#5	9-#5	3.34	0.956
22	600	6.25	7.33	22	0.628	11-#5 0	11-#8	11-#7	9-#7	12-#5	4.57	223.1	532.1	600.7	600	22	14-#6	9-#7	8-#6	8-#6	3.94	0.975
22	700	8.25	8.80	22	0.630	11-#5 0	10-#9	15-#6	11-#7	10-#6	5.16	253.2	633.8	681.8	700	22	14-#6	11-#7	9-#6	10-#6	4.41	1.027
23	100	2.25	7.67	12	0.777	11-#5 0	9-#5	12-#5	9-#5	9-#5	2.32	96.2	192.5	259.1	100	12	12-#5	9-#5	9-#5	9-#5	2.33	0.938
23	200	2.25	7.67	16	0.785	11-#5 2	12-#5	16-#5	9-#5	9-#5	2.59	126.9	253.9	341.7	200	19	15-#5	9-#5	9-#5	9-#5	2.52	0.938
23	300	4.25	7.67	19	0.628	11-#5 1	15-#5	17-#5	10-#5	9-#5	2.82	158.1	316.3	425.8	300	22	16-#5	10-#5	9-#5	9-#5	2.64	0.956
23	400	4.25	7.67	20	0.733	11-#5 3	13-#6	11-#7	12-#5	10-#5	3.32	190.5	388.8	512.9	400	23	14-#6	12-#5	9-#5	9-#5	3.00	0.956
23	500	6.25	7.67	22	0.628	11-#5 2	8-#9	11-#7	11-#6	12-#5	4.13	222.6	494.8	599.4	500	23	14-#6	11-#6	8-#6	8-#6	3.59	0.975
23	600	6.25	7.67	23	0.659	12-#5 2	15-#7	24-#5	8-#8	10-#6	4.83	255.0	590.0	686.4	600	23	12-#7	10-#7	9-#6	9-#6	4.27	0.975
23	700	8.25	9.20	23	0.629	12-#5 0	14-#8	13-#7	12-#7	8-#7	5.42	289.4	708.5	779.1	700	23	12-#7	12-#7	10-#6	8-#7	4.68	1.027
24	100	2.25	8.00	12	0.845	11-#5 3	11-#5	14-#5	10-#5	10-#5	2.48	109.8	219.5	295.5	100	12	13-#5	10-#5	10-#5	10-#5	2.45	0.938
24	200	4.25	8.00	16	0.637	11-#5 0	10-#6	16-#5	10-#5	10-#5	2.70	145.4	290.7	391.4	200	19	15-#5	10-#5	10-#5	10-#5	2.57	0.956
24	300	4.25	8.00	19	0.691	11-#5 2	9-#7	14-#6	8-#6	10-#5	3.08	180.9	361.8	487.0	300	22	18-#5	8-#6	10-#5	10-#5	2.85	0.956
24	400	6.25	8.00	21	0.629	11-#5 2	11-#7	11-#7	10-#6	8-#6	3.55	216.6	433.3	583.3	400	24	14-#6	14-#5	8-#6	10-#5	3.17	0.975
24	500	6.25	8.00	22	0.661	12-#5 2	11-#8	13-#7	9-#7	10-#6	4.37	253.9	541.6	683.5	500	24	12-#7	9-#7	9-#6	8-#6	3.82	0.975
24	600	8.25	9.60	24	0.628	12-#5 2	11-#9	13-#7	9-#8	8-#7	5.19	291.0	679.8	783.6	600	24	12-#7	9-#8	10-#6	8-#7	4.48	1.027
24	700	8.25	9.60	24	0.689	14-#5 2	13-#9	11-#8	9-#9	8-#8	6.16	328.8	784.6	885.2	700	24	26-#5	11-#8	16-#5	9-#7	5.19	1.027
25	100	4.25	8.33	12	0.777	12-#5 2	12-#5	14-#5	10-#5	10-#5	2.42	124.9	249.9	336.4	100	12	13-#5	10-#5	10-#5	10-#5	2.35	0.956
25	200	4.25	8.33	16	0.767	12-#5 3	11-#6	18-#5	11-#5	10-#5	2.80	165.2	330.3	444.7	200	19	12-#6	11-#5	10-#5	10-#5	2.63	0.956
25	300	6.25	8.33	19	0.630	12-#5 1	14-#6	14-#6	9-#6	11-#5	3.17	206.1	412.2	554.8	300	22	18-#5	9-#6	10-#5	10-#5	2.82	0.975
25	400	6.25	8.33	21	0.649	12-#5 2	17-#6	13-#7	11-#6	13-#5	3.79	246.6	493.1	663.8	400	24	12-#7	11-#6	12-#5	10-#5	3.36	0.975
25	500	8.25	8.33	22	0.630	12-#5 2	12-#8	13-#7	10-#7	15-#5	4.51	288.2	599.8	776.0	500	25	12-#7	10-#7	10-#6	9-#6	3.97	0.993
25	600	8.25	10.00	24	0.638	14-#5 1	12-#9	12-#8	10-#8	10-#7	5.49	330.2	747.0	888.9	600	25	26-#5	10-#8	16-#5	11-#6	4.66	1.027
25	700	10.25	10.00	25	0.630	14-#5 1	14-#9	12-#8	12-#8	14-#6	6.23	372.2	875.1	1002.2	700	25	26-#5	15-#7	10-#7	10-#7	5.28	1.053
26	100	4.25	8.67	12	0.795	12-#5 2	13-#5	15-#5	10-#5	10-#5	2.39	141.0	282.0	379.6	100	12	14-#5	10-#5	10-#5	10-#5	2.29	0.956
26	200	6.25	8.67	16	0.634	12-#5 0	18-#5	18-#5	12-#5	10-#5	2.79	187.1	374.3	503.8	200	19	16-#5	12-#5	10-#5	10-#5	2.52	0.975
26	300	6.25	8.67	19	0.632	12-#5 1	9-#8	12-#7	15-#5	12-#5	3.40	233.1	466.3	627.7	300	22	20-#5	15-#5	11-#5	10-#5	2.93	0.975
26	400	8.25	8.67	21	0.631	12-#5 2	11-#8	13-#7	10-#7	15-#5	4.08	278.5	557.0	749.8	400	25	15-#6	18-#5	10-#6	12-#5	3.49	0.993
26	500	8.25	8.67	22	0.647	14-#5 1	13-#8	12-#8	11-#7	9-#7	4.79	325.2	650.4	875.6	500	26	13-#7	11-#7	11-#6	10-#6	4.18	0.993
26	600	10.25	10.40	24	0.630	14-#5 1	17-#8	12-#8	9-#9	14-#6	5.77	373.4	829.7	1005.2	600	26	26-#5	11-#8	10-#7	18-#5	4.90	1.053

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superim-posed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip [1] Top Ext. +	Column Strip Bottom	Column Strip Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)
						h = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS								
27	100	4.25	9.00	12	0.839	12-#5 4	15-#5	12-#6	11-#5	11-#5	2.56	158.4	316.8	426.4
27	200	6.25	9.00	16	0.668	12-#5 1	14-#6	14-#6	13-#5	11-#5	2.96	210.5	421.0	566.8
27	300	6.25	9.00	19	0.772	13-#5 5	18-#6	13-#7	9-#7	10-#6	3.76	262.5	524.9	706.6
27	400	8.25	9.00	21	0.631	13-#5 2	16-#7	14-#7	14-#6	9-#7	4.31	313.8	627.5	844.7
27	500	8.25	10.80	23	0.766	15-#5 5	12-#9	16-#7	10-#8	19-#5	5.16	365.6	731.2	984.3
27	600	10.25	10.80	24	0.677	16-#5 3	18-#8	13-#8	12-#8	9-#8	6.03	419.4	896.1	1129.2
28	100	6.25	9.33	12	0.760	13-#5 2	12-#6	17-#5	11-#5	11-#5	2.56	177.8	355.5	478.6
28	200	6.25	9.33	16	0.777	13-#5 4	12-#7	16-#6	15-#5	13-#5	3.25	235.8	471.5	634.7
28	300	8.25	9.33	19	0.661	13-#5 3	15-#7	13-#7	10-#7	11-#6	3.88	293.7	587.5	790.8
28	400	8.25	9.33	21	0.750	15-#5 4	11-#9	16-#7	12-#7	10-#7	4.77	351.9	703.7	947.3
28	500	10.25	11.20	23	0.687	15-#5 4	13-#9	22-#6	11-#8	12-#7	5.41	409.8	819.5	1103.2
28	600	10.25	11.20	25	0.726	18-#5 3	19-#8	15-#8	10-#9	10-#8	6.19	467.6	954.2	1259.0
29	100	6.25	9.67	12	0.794	13-#5 3	19-#5	14-#6	13-#5	12-#5	2.76	198.0	396.1	533.1
29	200	8.25	9.67	17	0.635	13-#5 2	10-#8	16-#6	12-#6	10-#6	3.37	261.9	523.9	705.2
29	300	8.25	9.67	19	0.733	14-#5 4	13-#8	15-#7	11-#7	17-#5	4.21	327.9	655.8	882.7
29	400	10.25	9.67	21	0.660	15-#5 3	20-#7	16-#7	10-#8	11-#7	4.93	393.5	787.0	1059.4
29	500	10.25	11.60	23	0.741	17-#5 4	15-#9	14-#8	12-#8	10-#8	5.86	457.9	915.8	1232.8
30	100	8.25	10.00	12	0.707	14-#5 1	11-#7	14-#6	10-#6	12-#5	2.81	220.6	441.1	593.8
30	200	8.25	10.00	17	0.702	14-#5 3	15-#7	18-#6	10-#7	15-#5	3.57	291.1	582.2	783.7
30	300	10.25	10.00	20	0.634	14-#5 3	12-#9	15-#7	12-#7	10-#7	4.50	364.1	728.2	980.3
30	400	10.25	10.00	21	0.715	16-#5 4	14-#9	14-#8	12-#8	10-#8	5.46	437.7	875.5	1178.5
30	500	12.25	12.00	24	0.632	17-#5 2	17-#9	14-#8	17-#7	11-#8	6.12	509.2	1018.4	1371.0

Factored Superim-posed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
		h = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS					
100	12	16-#5	11-#5	11-#5	11-#5	2.46	0.956
200	19	18-#5	13-#5	11-#5	11-#5	2.68	0.975
300	22	12-#7	9-#7	9-#6	11-#5	3.33	0.975
400	25	13-#7	14-#6	15-#5	13-#5	3.78	0.993
500	27	12-#8	12-#7	10-#7	15-#5	4.46	1.027
600	27	12-#8	12-#8	11-#7	10-#7	5.24	1.053
100	12	16-#5	11-#5	11-#5	11-#5	2.36	0.975
200	19	15-#6	15-#5	12-#5	11-#5	2.89	0.975
300	23	16-#6	13-#6	10-#6	12-#5	3.33	0.993
400	25	19-#6	12-#7	12-#6	15-#5	4.14	0.993
500	28	15-#7	11-#8	14-#6	12-#6	4.67	1.053
600	28	13-#8	16-#7	12-#7	20-#5	5.32	1.053
100	12	18-#5	13-#5	12-#5	12-#5	2.55	0.975
200	20	20-#5	12-#6	13-#5	12-#5	2.94	0.993
300	23	18-#6	21-#5	16-#5	10-#6	3.62	0.993
400	25	27-#5	10-#8	10-#7	12-#6	4.33	1.012
500	28	13-#8	12-#8	12-#7	10-#7	5.07	1.053
100	12	17-#5	14-#5	12-#5	12-#5	2.48	0.993
200	20	16-#6	18-#5	10-#6	12-#5	3.02	0.993
300	23	18-#6	12-#7	10-#7	15-#5	3.84	1.012
400	25	16-#7	15-#7	15-#6	18-#5	4.62	1.012
500	28	17-#7	17-#7	10-#8	15-#6	5.23	1.080

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f_c' = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels

No Beams

SQUARE INTERIOR PANEL

With Drop Panels(2)

No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel		(3) Square Column		REINFORCING BARS (E. W.)						MOMENTS			Factored Superimposed Load (psf)	(3) Square Column	REINFORCING BARS (E. W.)					Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$
						Column Strip (1)			Middle Strip								Column Strip		Middle Strip			
		Depth (in.)	Width (ft)	Size (in.)	γ_f	Top Ext. +	Bottom	Top Int.	Bottom	Top Int.	Total Steel (psf)	Edge (–) (ft-k)	Bot. (+) (ft-k)	Int. (–) (ft-k)		Size (in.)	Top	Bottom	Top	Bottom	Total Steel (psf)	
h = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
31	100	8.25	10.33	12	0.746	14-#5 2	12-#7	15-#6	15-#5	13-#5	2.93	243.9	487.8	656.7	100	12	14-#6	11-#6	12-#5	12-#5	2.62	0.993
31	200	8.25	10.33	17	0.745	14-#5 4	22-#6	14-#7	20-#5	12-#6	3.74	322.3	644.7	867.8	200	20	18-#6	20-#5	11-#6	14-#5	3.29	0.993
31	300	10.25	10.33	20	0.660	15-#5 3	13-#9	16-#7	18-#6	15-#6	4.76	403.4	806.9	1086.2	300	23	15-#7	18-#6	14-#6	12-#6	4.10	1.012
31	400	12.25	12.40	22	0.634	17-#5 2	16-#9	14-#8	22-#6	11-#8	5.63	485.3	970.6	1306.6	400	27	16-#7	22-#6	13-#7	20-#5	4.77	1.080
31	500	12.25	12.40	24	0.728	19-#5 5	19-#9	16-#8	12-#9	16-#7	6.82	564.8	1129.5	1520.5	500	28	15-#8	12-#9	12-#8	13-#7	5.94	1.080
32	100	8.25	10.67	12	0.794	15-#5 4	18-#6	16-#6	12-#6	14-#5	3.11	268.9	537.7	723.9	100	12	15-#6	12-#6	13-#5	13-#5	2.76	0.993
32	200	10.25	10.67	17	0.637	15-#5 2	11-#9	19-#6	12-#7	19-#5	4.06	356.6	713.2	960.1	200	20	18-#6	12-#7	17-#5	15-#5	3.50	1.012
32	300	10.25	10.67	20	0.754	17-#5 6	14-#9	18-#7	12-#8	13-#7	5.16	445.5	891.0	1199.4	300	23	16-#7	15-#7	12-#7	19-#5	4.43	1.012
32	400	12.25	12.80	22	0.716	18-#5 5	18-#9	15-#8	14-#8	12-#8	6.13	536.2	1072.4	1443.7	400	27	18-#7	11-#9	11-#8	12-#7	5.24	1.080
32	500	12.25	12.80	26	0.765	15-#6 5	21-#9	17-#8	13-#9	11-#9	7.19	620.6	1241.2	1670.9	500	28	16-#8	13-#9	16-#7	11-#8	6.16	1.080
33	100	10.25	11.00	12	0.731	15-#5 3	15-#7	16-#6	13-#6	11-#6	3.24	296.5	593.1	798.4	100	12	15-#6	19-#5	15-#5	13-#5	2.80	1.012
33	200	10.25	11.00	17	0.717	15-#5 4	20-#7	16-#7	13-#7	11-#7	4.24	392.3	784.6	1056.2	200	20	27-#5	13-#7	19-#5	16-#5	3.63	1.012
33	300	12.25	11.00	20	0.656	17-#5 4	16-#9	18-#7	22-#6	11-#8	5.37	491.3	982.6	1322.7	300	23	16-#7	22-#6	13-#7	11-#7	4.57	1.030
33	400	12.25	13.20	23	0.746	20-#5 5	19-#9	16-#8	13-#9	13-#8	6.60	588.9	1177.9	1585.6	400	27	15-#8	13-#9	12-#8	13-#7	5.72	1.080

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip [1] Top Ext. +	Column Strip Bottom	Column Strip Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
23	100	2.25	7.67	12	0.760	11-#5 0	10-#5	12-#5	10-#5	10-#5	2.48	99.0	197.9	266.4	100	12	11-#5	10-#5	10-#5	10-#5	2.47	0.979
23	200	2.25	7.67	16	0.746	11-#5 1	12-#5	16-#5	10-#5	10-#5	2.73	129.5	259.1	348.7	200	19	15-#5	10-#5	10-#5	10-#5	2.69	0.979
23	300	4.25	7.67	19	0.629	11-#5 1	15-#5	12-#6	10-#5	10-#5	2.89	160.7	321.4	432.6	300	22	11-#6	10-#5	10-#5	10-#5	2.75	0.998
23	400	4.25	7.67	20	0.685	11-#5 2	13-#6	20-#5	12-#5	10-#5	3.35	193.0	400.2	519.7	400	23	14-#6	12-#5	10-#5	10-#5	3.11	0.998
23	500	6.25	7.67	22	0.628	11-#5 2	12-#7	11-#7	8-#7	8-#6	3.88	225.1	506.3	606.1	500	23	14-#6	15-#5	8-#6	10-#5	3.38	1.016
23	600	6.25	7.67	23	0.629	12-#5 2	9-#9	13-#7	8-#8	9-#6	4.74	257.5	601.7	693.1	600	23	12-#7	13-#6	12-#5	12-#5	4.03	1.016
23	700	8.25	9.20	23	0.630	12-#5 0	11-#9	13-#7	9-#8	8-#7	5.43	291.9	722.1	785.8	700	23	12-#7	9-#8	10-#6	8-#7	4.69	1.068
24	100	2.25	8.00	12	0.802	11-#5 1	10-#5	14-#5	10-#5	10-#5	2.44	112.9	225.7	303.9	100	12	13-#5	10-#5	10-#5	10-#5	2.45	0.979
24	200	4.25	8.00	16	0.632	11-#5 0	13-#5	11-#6	10-#5	10-#5	2.62	148.3	296.7	399.4	200	19	14-#5	10-#5	10-#5	10-#5	2.52	0.998
24	300	4.25	8.00	19	0.638	11-#5 1	9-#7	14-#6	8-#6	10-#5	3.06	183.8	367.6	494.8	300	22	18-#5	11-#5	10-#5	10-#5	2.79	0.998
24	400	4.25	8.00	21	0.740	12-#5 3	8-#8	12-#7	13-#5	8-#6	3.48	219.2	438.4	590.2	400	24	11-#7	13-#5	10-#5	10-#5	3.13	0.998
24	500	6.25	8.00	22	0.633	12-#5 2	11-#8	13-#7	9-#7	9-#6	4.33	256.7	556.3	691.1	500	24	12-#7	9-#7	12-#5	8-#6	3.78	1.016
24	600	8.25	8.00	23	0.630	12-#5 2	10-#9	13-#7	11-#7	8-#7	5.00	293.9	674.9	791.3	600	24	12-#7	11-#7	10-#6	10-#6	4.37	1.035
24	700	8.25	9.60	24	0.640	14-#5 1	12-#9	27-#5	8-#9	9-#7	5.72	331.6	802.1	892.8	700	24	18-#6	8-#9	11-#6	16-#5	4.94	1.068
25	100	4.25	8.33	12	0.743	12-#5 1	12-#5	14-#5	11-#5	11-#5	2.57	128.5	256.9	345.8	100	12	13-#5	11-#5	11-#5	11-#5	2.54	0.998
25	200	4.25	8.33	16	0.683	12-#5 0	15-#5	18-#5	11-#5	11-#5	2.80	168.6	337.1	453.8	200	19	16-#5	11-#5	11-#5	11-#5	2.69	0.998
25	300	4.25	8.33	19	0.732	12-#5 2	10-#7	12-#7	9-#6	11-#5	3.30	209.0	418.1	562.8	300	22	20-#5	9-#6	11-#5	11-#5	3.04	0.998
25	400	6.25	8.33	21	0.629	12-#5 2	9-#8	12-#7	15-#5	9-#6	3.67	248.9	497.8	670.1	400	25	15-#6	15-#5	12-#5	11-#5	3.29	1.016
25	500	6.25	8.33	22	0.731	13-#5 3	9-#9	14-#7	10-#7	15-#5	4.48	291.1	603.8	783.8	500	25	13-#7	13-#6	10-#6	12-#5	3.90	1.016
25	600	8.25	10.00	24	0.629	14-#5 1	12-#9	27-#5	12-#7	9-#7	5.31	333.4	762.1	897.5	600	25	18-#6	10-#8	11-#6	15-#5	4.59	1.068
25	700	8.25	10.00	25	0.706	15-#5 2	17-#8	16-#7	9-#9	10-#7	6.20	374.8	883.0	1009.1	700	25	12-#8	11-#8	10-#7	10-#7	5.45	1.068
26	100	4.25	8.67	12	0.782	12-#5 2	9-#6	15-#5	11-#5	11-#5	2.53	145.0	289.9	390.3	100	12	14-#5	11-#5	11-#5	11-#5	2.47	0.998
26	200	4.25	8.67	16	0.792	12-#5 4	9-#7	14-#6	12-#5	11-#5	2.92	190.5	381.0	512.9	200	19	13-#6	11-#5	11-#5	11-#5	2.72	0.998
26	300	6.25	8.67	19	0.631	12-#5 1	15-#6	12-#7	10-#6	12-#5	3.32	236.1	472.1	635.5	300	23	14-#6	14-#5	11-#5	11-#5	2.97	1.016
26	400	6.25	8.67	21	0.696	13-#5 2	18-#6	26-#5	9-#7	10-#6	3.97	281.8	563.6	758.7	400	25	13-#7	9-#7	9-#6	11-#5	3.59	1.016
26	500	8.25	8.67	23	0.630	13-#5 2	16-#7	14-#7	14-#6	9-#7	4.49	327.7	662.1	882.3	500	26	13-#7	14-#6	15-#5	13-#5	3.94	1.035
26	600	8.25	10.40	24	0.709	15-#5 2	13-#9	16-#7	18-#6	10-#7	5.67	376.3	831.3	1013.1	600	26	12-#8	18-#6	10-#7	9-#7	4.97	1.068
26	700	10.25	10.40	26	0.629	16-#5 0	15-#9	22-#6	12-#8	15-#6	6.34	422.3	980.2	1137.0	700	26	12-#8	16-#7	14-#6	14-#6	5.47	1.095

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f_c' = 4{,}000$ psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL

With Drop Panels(2)
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
27	100	4.25	9.00	12	0.815	12-#5 3	15-#5	12-#6	11-#5	11-#5	2.56	162.8	325.7	438.4	100	12	16-#5	11-#5	11-#5	11-#5	2.46	0.998
27	200	6.25	9.00	16	0.648	12-#5 1	10-#7	14-#6	9-#6	11-#5	2.96	214.8	429.6	578.3	200	19	18-#5	9-#6	11-#5	11-#5	2.70	1.016
27	300	6.25	9.00	19	0.702	12-#5 3	17-#6	13-#7	16-#5	13-#5	3.54	265.8	531.6	715.6	300	23	12-#7	11-#6	12-#5	11-#5	3.16	1.016
27	400	8.25	9.00	21	0.631	13-#5 2	12-#8	26-#5	10-#7	16-#5	4.25	317.9	635.8	855.9	400	25	13-#7	10-#7	15-#5	9-#6	3.78	1.035
27	500	8.25	9.00	23	0.720	15-#5 4	11-#9	12-#8	9-#8	10-#7	5.02	368.1	736.2	991.0	500	27	12-#8	9-#8	9-#7	15-#5	4.47	1.035
27	600	10.25	10.80	25	0.630	16-#5 2	14-#9	22-#6	9-#9	15-#6	5.85	422.1	915.3	1136.3	600	27	12-#8	9-#9	14-#6	18-#5	5.04	1.095
27	700	10.25	10.80	25	0.737	17-#5 4	17-#9	14-#8	17-#7	10-#8	6.85	476.2	1070.2	1282.0	700	27	13-#8	11-#9	9-#8	15-#6	5.93	1.095
28	100	6.25	9.33	12	0.728	13-#5 1	16-#5	17-#5	12-#5	12-#5	2.62	182.7	365.5	492.0	100	12	16-#5	12-#5	12-#5	12-#5	2.51	1.016
28	200	6.25	9.33	16	0.762	13-#5 4	12-#7	16-#6	10-#6	12-#5	3.18	240.6	481.1	647.7	200	19	20-#5	14-#5	12-#5	12-#5	2.81	1.016
28	300	6.25	9.33	20	0.773	14-#5 5	11-#8	27-#5	10-#7	15-#5	3.89	297.0	593.9	799.5	300	23	13-#7	18-#5	10-#6	12-#5	3.38	1.016
28	400	8.25	9.33	21	0.731	15-#5 4	17-#7	16-#7	15-#6	10-#7	4.48	356.5	713.0	959.8	400	25	14-#7	15-#6	16-#5	10-#6	3.90	1.035
28	500	10.25	11.20	24	0.631	15-#5 3	13-#9	16-#7	10-#8	11-#7	5.16	413.0	826.0	1111.9	500	28	15-#7	10-#8	10-#7	16-#5	4.43	1.095
28	600	10.25	11.20	25	0.689	17-#5 3	15-#9	14-#8	12-#8	10-#8	6.09	472.2	981.8	1271.2	600	28	13-#8	12-#8	12-#7	14-#6	5.29	1.095
29	100	6.25	9.67	12	0.783	13-#5 3	18-#5	14-#6	12-#5	12-#5	2.65	203.6	407.1	548.1	100	12	17-#5	12-#5	12-#5	12-#5	2.46	1.016
29	200	6.25	9.67	17	0.774	13-#5 5	17-#6	13-#7	16-#5	13-#5	3.30	266.6	533.3	717.9	200	20	16-#6	16-#5	12-#5	12-#5	2.94	1.016
29	300	8.25	9.67	20	0.665	14-#5 3	16-#7	19-#6	14-#6	12-#6	4.00	332.1	664.2	894.1	300	23	13-#7	14-#6	15-#5	13-#5	3.49	1.035
29	400	10.25	9.67	22	0.632	15-#5 2	12-#9	16-#7	10-#8	14-#6	4.85	396.2	792.4	1066.7	400	26	14-#7	17-#6	10-#7	11-#6	4.15	1.053
29	500	10.25	11.60	24	0.658	17-#5 2	14-#9	14-#8	12-#8	10-#8	5.63	461.5	923.1	1242.6	500	28	22-#6	12-#8	15-#6	18-#5	4.82	1.095
29	600	12.25	11.60	25	0.632	18-#5 1	20-#8	14-#8	13-#8	11-#8	6.22	527.0	1064.6	1419.0	600	29	13-#8	13-#8	10-#8	11-#7	5.43	1.122
30	100	6.25	10.00	12	0.813	14-#5 3	20-#5	15-#6	10-#6	13-#5	2.88	225.9	451.8	608.2	100	12	14-#6	14-#5	13-#5	13-#5	2.70	1.016
30	200	8.25	10.00	17	0.665	14-#5 2	11-#8	17-#6	10-#7	15-#5	3.56	297.0	594.0	799.7	200	20	16-#6	18-#5	10-#6	13-#5	3.09	1.035
30	300	8.25	10.00	20	0.734	15-#5 4	11-#9	16-#7	12-#7	10-#7	4.47	369.3	738.6	994.2	300	23	15-#7	12-#7	12-#6	15-#5	3.92	1.035
30	400	10.25	10.00	22	0.645	16-#5 3	17-#8	17-#7	11-#8	12-#7	5.22	440.8	881.6	1186.8	400	26	16-#7	11-#8	20-#5	18-#5	4.54	1.053
30	500	12.25	12.00	24	0.633	17-#5 2	16-#9	14-#8	10-#9	11-#8	5.89	513.3	1026.6	1382.0	500	29	22-#6	10-#9	10-#8	20-#5	5.01	1.122
30	600	12.25	12.00	25	0.700	19-#5 3	18-#9	16-#8	12-#9	12-#8	6.91	585.0	1170.0	1575.0	600	30	15-#8	12-#9	11-#8	10-#8	6.06	1.122
31	100	8.25	10.33	12	0.733	14-#5 2	12-#7	15-#6	15-#5	13-#5	2.95	250.7	501.4	675.0	100	12	14-#6	15-#5	13-#5	13-#5	2.66	1.035
31	200	8.25	10.33	17	0.731	14-#5 4	12-#8	14-#7	14-#6	12-#6	3.71	328.9	657.8	885.5	200	20	18-#6	14-#6	15-#5	13-#5	3.24	1.035
31	300	10.25	10.33	20	0.642	15-#5 3	20-#7	16-#7	13-#7	11-#7	4.58	409.9	819.8	1103.6	300	23	15-#7	13-#7	19-#5	16-#5	3.99	1.053
31	400	10.25	10.33	22	0.760	18-#5 6	15-#9	15-#8	12-#8	13-#7	5.58	488.7	977.3	1315.7	400	26	14-#8	21-#6	12-#7	19-#5	4.78	1.053
31	500	12.25	12.40	24	0.712	19-#5 5	18-#9	16-#8	14-#8	12-#8	6.38	569.4	1138.7	1532.9	500	29	14-#8	14-#8	11-#8	12-#7	5.45	1.122

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip [1] Top Ext. +	Column Strip Bottom	Column Strip Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)
h = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS														
32	100	8.25	10.67	12	0.784	15-#5 4	13-#7	16-#6	12-#6	14-#5	3.10	276.4	552.7	744.0
32	200	10.25	10.67	17	0.637	15-#5 2	11-#9	19-#6	12-#7	13-#6	4.00	363.8	727.7	979.6
32	300	10.25	10.67	20	0.726	17-#5 5	17-#8	18-#7	11-#8	12-#7	4.92	452.6	905.2	1218.6
32	400	12.25	12.80	23	0.656	18-#5 4	17-#9	15-#8	11-#9	11-#8	5.99	541.7	1083.3	1458.3
32	500	12.25	12.80	25	0.773	15-#6 5	19-#9	17-#8	13-#9	13-#8	6.90	627.5	1255.0	1689.5
33	100	8.25	11.00	12	0.831	15-#5 6	11-#8	18-#6	13-#6	15-#5	3.23	303.7	607.4	817.6
33	200	10.25	11.00	17	0.685	15-#5 3	12-#9	16-#7	13-#7	14-#6	4.21	400.3	800.6	1077.7
33	300	12.25	11.00	20	0.640	17-#5 4	15-#9	18-#7	12-#8	18-#6	5.13	497.8	995.5	1340.1
33	400	12.25	13.20	23	0.731	20-#5 5	18-#9	16-#8	12-#9	16-#7	6.32	596.6	1193.3	1606.3
33	500	12.25	13.20	28	0.721	16-#6 4	21-#9	15-#9	14-#9	14-#8	7.33	685.7	1371.4	1846.1
34	100	10.25	11.33	12	0.737	16-#5 3	16-#7	18-#6	14-#6	12-#6	3.36	334.0	667.9	899.1
34	200	10.25	11.33	17	0.756	16-#5 6	13-#9	17-#7	14-#7	12-#7	4.47	439.1	878.2	1182.1
34	300	12.25	11.33	20	0.704	18-#5 5	17-#9	19-#7	14-#8	12-#8	5.70	546.3	1092.7	1470.9
34	400	12.25	13.60	25	0.745	22-#5 6	20-#9	18-#8	13-#9	14-#8	6.65	651.7	1303.4	1754.5
34	500	12.25	13.60	31	0.680	18-#6 2	23-#9	16-#9	15-#9	13-#9	7.74	745.3	1490.7	2006.7

Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
100	12	15-#6	12-#6	13-#5	13-#5	2.76	1.035
200	20	18-#6	22-#5	12-#6	15-#5	3.39	1.053
300	23	16-#7	11-#8	11-#7	18-#5	4.27	1.053
400	27	18-#7	11-#9	18-#6	12-#7	5.17	1.122
500	29	16-#8	13-#9	12-#8	13-#7	5.99	1.122
100	12	23-#5	18-#5	14-#5	14-#5	2.82	1.035
200	20	19-#6	17-#6	13-#6	16-#5	3.56	1.053
300	24	16-#7	21-#6	12-#7	14-#6	4.35	1.072
400	27	15-#8	12-#9	12-#8	13-#7	5.57	1.122
500	29	17-#8	14-#9	13-#8	12-#8	6.41	1.122
100	12	16-#6	14-#6	16-#5	14-#5	2.89	1.053
200	20	16-#7	14-#7	20-#5	17-#5	3.84	1.053
300	24	18-#7	14-#8	18-#6	12-#7	4.92	1.072
400	27	16-#8	13-#9	16-#7	14-#7	5.72	1.122
500	30	19-#8	15-#9	12-#9	16-#7	6.76	1.122

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f_c' = 4{,}000$ psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL — With Drop Panels — No Beams

SQUARE INTERIOR PANEL

With Drop Panels(2)
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
24	100	2.25	8.00	12	0.787	11-#5 1	11-#5	14-#5	8-#6	8-#6	2.67	116.0	231.9	312.2	100	12	13-#5	11-#5	8-#6	8-#6	2.69	1.021
24	200	2.25	8.00	16	0.778	11-#5 2	9-#6	18-#5	8-#6	8-#6	2.89	151.0	302.0	406.5	200	19	16-#5	11-#5	8-#6	8-#6	2.86	1.021
24	300	4.25	8.00	19	0.629	11-#5 1	16-#5	14-#6	8-#6	8-#6	3.07	186.0	372.0	500.8	300	23	17-#5	11-#5	8-#6	8-#6	2.93	1.039
24	400	4.25	8.00	21	0.695	11-#5 3	10-#7	12-#7	9-#6	8-#6	3.52	222.1	445.7	597.9	400	24	11-#7	9-#6	8-#6	8-#6	3.33	1.039
24	500	6.25	8.00	22	0.629	12-#5 2	8-#9	12-#7	16-#5	9-#6	4.03	259.6	570.0	698.8	500	24	15-#6	16-#5	8-#6	8-#6	3.50	1.058
24	600	6.25	8.00	23	0.687	13-#5 2	12-#8	11-#8	8-#8	10-#6	4.82	296.5	678.2	798.2	600	24	13-#7	14-#6	13-#5	9-#6	4.21	1.058
24	700	8.25	9.60	24	0.629	13-#5 2	12-#9	11-#8	8-#9	16-#5	5.71	334.4	815.0	900.4	700	24	13-#7	8-#9	8-#7	11-#6	4.93	1.110
25	100	2.25	8.33	12	0.848	12-#5 3	11-#5	16-#5	11-#5	11-#5	2.60	131.5	263.1	354.1	100	12	15-#5	11-#5	11-#5	11-#5	2.63	1.021
25	200	4.25	8.33	16	0.662	12-#5 0	15-#5	18-#5	11-#5	11-#5	2.80	171.9	343.9	462.9	200	19	16-#5	11-#5	11-#5	11-#5	2.69	1.039
25	300	4.25	8.33	19	0.710	12-#5 2	13-#6	12-#7	12-#5	11-#5	3.19	211.6	423.1	569.6	300	23	14-#6	12-#5	11-#5	11-#5	2.97	1.039
25	400	6.25	8.33	21	0.630	12-#5 1	9-#8	12-#7	10-#6	12-#5	3.58	252.1	504.3	678.9	400	25	15-#6	14-#5	11-#5	11-#5	3.19	1.058
25	500	6.25	8.33	22	0.686	13-#5 2	11-#8	26-#5	10-#7	10-#6	4.37	294.4	621.2	792.5	500	25	13-#7	13-#6	9-#6	12-#5	3.85	1.058
25	600	8.25	8.33	24	0.629	13-#5 2	9-#10	14-#7	9-#8	16-#5	5.21	335.4	752.9	902.9	600	25	13-#7	9-#8	15-#5	10-#6	4.46	1.076
25	700	8.25	10.00	25	0.660	15-#5 1	13-#9	12-#8	9-#9	10-#7	6.07	378.0	899.3	1017.7	700	25	12-#8	11-#8	9-#7	9-#7	5.25	1.110
26	100	4.25	8.67	12	0.768	12-#5 2	9-#6	15-#5	11-#5	11-#5	2.53	148.9	297.9	401.0	100	12	14-#5	11-#5	11-#5	11-#5	2.47	1.039
26	200	4.25	8.67	16	0.776	12-#5 4	9-#7	14-#6	11-#5	11-#5	2.87	194.3	388.7	523.2	200	19	18-#5	11-#5	11-#5	11-#5	2.67	1.039
26	300	6.25	8.67	19	0.632	12-#5 1	11-#7	15-#6	10-#6	12-#5	3.31	239.8	479.6	645.6	300	23	14-#6	14-#5	11-#5	11-#5	2.97	1.058
26	400	6.25	8.67	21	0.673	13-#5 2	10-#8	18-#6	16-#5	10-#6	3.78	285.5	570.9	768.6	400	25	23-#5	16-#5	9-#6	11-#5	3.31	1.058
26	500	8.25	8.67	23	0.630	13-#5 2	12-#8	14-#7	14-#6	16-#5	4.46	331.4	682.3	892.1	500	26	13-#7	14-#6	15-#5	9-#6	3.95	1.076
26	600	8.25	10.40	25	0.629	15-#5 1	12-#9	12-#8	10-#8	10-#7	5.42	378.6	846.0	1019.2	600	26	12-#8	10-#8	9-#7	16-#5	4.74	1.110
26	700	10.25	10.40	26	0.630	15-#5 1	12-#10	16-#7	12-#8	11-#7	6.33	425.9	999.4	1146.7	700	26	12-#8	12-#8	10-#7	10-#7	5.38	1.137
27	100	4.25	9.00	12	0.803	12-#5 3	10-#6	12-#6	12-#5	12-#5	2.66	167.3	334.6	450.4	100	12	16-#5	12-#5	12-#5	12-#5	2.60	1.039
27	200	6.25	9.00	16	0.635	12-#5 1	10-#7	14-#6	9-#6	12-#5	3.01	219.1	438.2	589.9	200	19	18-#5	9-#6	12-#5	12-#5	2.79	1.058
27	300	6.25	9.00	19	0.658	12-#5 2	17-#6	13-#7	15-#5	9-#6	3.49	270.0	540.0	726.9	300	23	12-#7	15-#5	12-#5	12-#5	3.14	1.058
27	400	6.25	9.00	22	0.755	14-#5 5	9-#9	12-#8	10-#7	15-#5	4.14	319.4	638.9	860.0	400	26	26-#5	18-#5	10-#6	12-#5	3.53	1.058
27	500	8.25	9.00	23	0.681	15-#5 3	13-#8	12-#8	15-#6	10-#7	4.67	372.2	744.4	1002.0	500	27	27-#5	11-#7	16-#5	10-#6	4.08	1.076
27	600	10.25	10.80	25	0.630	15-#5 1	17-#8	16-#7	9-#9	11-#7	5.68	426.1	935.9	1147.2	600	27	12-#8	11-#8	10-#7	18-#5	4.91	1.137
27	700	10.25	10.80	26	0.700	12-#6 3	13-#10	14-#8	13-#8	12-#7	6.67	478.6	1090.5	1288.5	700	27	13-#8	13-#8	15-#6	11-#7	5.68	1.137

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

f'_c = 4,000 psi
Grade 60 Bars

FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

SQUARE INTERIOR PANEL
With Drop Panels(2)
No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)	Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$
h = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS															h = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
28	100	6.25	9.33	12	0.714	13-#5 1	16-#5	17-#5	12-#5	12-#5	2.62	187.7	375.4	505.4	100	12	16-#5	12-#5	12-#5	12-#5	2.51	1.058
28	200	6.25	9.33	16	0.731	13-#5 3	11-#7	16-#6	10-#6	12-#5	3.12	245.4	490.7	660.6	200	19	20-#5	14-#5	12-#5	12-#5	2.81	1.058
28	300	6.25	9.33	19	0.783	14-#5 5	11-#8	14-#7	12-#6	15-#5	3.78	302.6	605.2	814.7	300	23	13-#7	12-#6	13-#5	12-#5	3.31	1.058
28	400	8.25	9.33	22	0.643	14-#5 3	10-#9	15-#7	11-#7	12-#6	4.41	358.8	717.6	966.0	400	26	26-#5	11-#7	11-#6	10-#6	3.86	1.076
28	500	10.25	9.33	23	0.632	15-#5 1	12-#9	16-#7	10-#8	14-#6	5.09	418.1	836.2	1125.6	500	27	15-#7	17-#6	10-#7	11-#6	4.41	1.095
28	600	10.25	11.20	25	0.648	17-#5 2	18-#8	14-#8	12-#8	12-#7	5.91	476.7	1007.3	1283.4	600	28	13-#8	12-#8	11-#7	10-#7	5.19	1.137
28	700	12.25	11.20	26	0.631	18-#5 1	14-#10	14-#8	14-#8	11-#8	6.88	536.3	1197.3	1444.0	700	28	13-#8	14-#8	10-#8	12-#7	5.87	1.163
29	100	6.25	9.67	12	0.754	13-#5 2	18-#5	13-#6	13-#5	13-#5	2.76	209.1	418.2	563.0	100	12	17-#5	13-#5	13-#5	13-#5	2.62	1.058
29	200	6.25	9.67	16	0.787	13-#5 5	17-#6	13-#7	11-#6	13-#5	3.35	273.7	547.3	736.8	200	19	16-#6	11-#6	13-#5	13-#5	3.05	1.058
29	300	8.25	9.67	20	0.633	13-#5 2	12-#8	14-#7	10-#7	16-#5	3.90	337.3	674.6	908.2	300	23	13-#7	19-#5	15-#5	13-#5	3.40	1.076
29	400	8.25	9.67	22	0.723	16-#5 4	14-#8	13-#8	12-#7	10-#7	4.73	402.0	804.1	1082.4	400	25	16-#7	12-#7	10-#7	15-#5	4.22	1.076
29	500	10.25	11.60	24	0.637	17-#5 2	17-#8	14-#8	11-#8	12-#7	5.39	465.1	930.3	1252.3	500	29	16-#7	11-#8	11-#7	18-#5	4.67	1.137
29	600	12.25	11.60	25	0.632	17-#5 2	13-#10	14-#8	13-#8	18-#6	6.29	532.1	1095.0	1432.6	600	29	13-#8	13-#8	10-#8	11-#7	5.43	1.163
30	100	6.25	10.00	12	0.790	14-#5 2	14-#6	15-#6	13-#5	13-#5	2.83	232.1	464.1	624.8	100	12	14-#6	13-#5	13-#5	13-#5	2.64	1.058
30	200	8.25	10.00	17	0.649	14-#5 2	11-#8	17-#6	12-#6	15-#5	3.46	302.9	605.9	815.6	200	20	16-#6	12-#6	13-#5	13-#5	3.02	1.076
30	300	8.25	10.00	20	0.719	15-#5 4	13-#8	16-#7	15-#6	10-#7	4.23	375.1	750.2	1009.9	300	23	15-#7	15-#6	12-#6	10-#6	3.74	1.076
30	400	10.25	10.00	22	0.633	16-#5 2	10-#10	17-#7	18-#6	15-#6	4.97	446.6	893.1	1202.3	400	26	16-#7	18-#6	14-#6	12-#6	4.32	1.095
30	500	10.25	12.00	24	0.754	19-#5 5	12-#10	15-#8	12-#8	10-#8	5.80	517.8	1035.7	1394.2	500	29	14-#8	12-#8	12-#7	14-#6	5.01	1.137
30	600	12.25	12.00	25	0.663	19-#5 2	17-#9	16-#8	11-#9	12-#8	6.51	590.6	1181.3	1590.2	600	30	14-#8	11-#9	11-#8	12-#7	5.65	1.163
31	100	8.25	10.33	12	0.700	14-#5 1	12-#7	15-#6	15-#5	13-#5	2.95	257.5	515.0	693.3	100	12	14-#6	15-#5	13-#5	13-#5	2.66	1.076
31	200	8.25	10.33	17	0.717	14-#5 4	15-#7	14-#7	19-#5	16-#5	3.58	335.4	670.9	903.1	200	20	18-#6	19-#5	15-#5	13-#5	3.16	1.076
31	300	10.25	10.33	20	0.635	15-#5 3	12-#9	16-#7	13-#7	14-#6	4.50	415.1	830.3	1117.7	300	24	27-#5	17-#6	13-#6	11-#6	3.81	1.095
31	400	10.25	10.33	22	0.733	18-#5 5	14-#9	15-#8	12-#8	13-#7	5.43	495.0	990.1	1332.8	400	26	17-#7	15-#7	12-#7	19-#5	4.69	1.095
31	500	12.25	12.40	24	0.681	19-#5 4	17-#9	15-#8	11-#9	12-#8	6.24	575.6	1151.2	1549.7	500	29	14-#8	11-#9	18-#6	12-#7	5.38	1.163
31	600	12.25	12.40	26	0.774	15-#6 5	15-#10	14-#9	13-#9	13-#8	7.16	653.3	1306.6	1758.9	600	30	16-#8	13-#9	12-#8	13-#7	6.20	1.163
32	100	8.25	10.67	12	0.774	15-#5 4	13-#7	16-#6	16-#5	14-#5	3.06	283.9	567.7	764.2	100	12	15-#6	16-#5	14-#5	14-#5	2.76	1.076
32	200	8.25	10.67	17	0.745	15-#5 4	13-#8	16-#7	11-#7	13-#6	3.88	370.2	740.4	996.7	200	20	19-#6	11-#7	16-#5	14-#5	3.36	1.076
32	300	10.25	10.67	20	0.659	16-#5 3	13-#9	18-#7	11-#8	12-#7	4.84	458.4	916.9	1234.3	300	24	16-#7	11-#8	20-#5	17-#5	4.18	1.095
32	400	12.25	10.67	22	0.651	18-#5 4	13-#10	15-#8	13-#8	11-#8	5.83	547.7	1095.3	1474.5	400	26	17-#7	13-#8	13-#7	11-#7	4.97	1.113
32	500	12.25	12.80	24	0.781	15-#6 5	15-#10	17-#8	12-#9	16-#7	6.71	636.2	1272.5	1713.0	500	29	16-#8	12-#9	12-#8	13-#7	5.83	1.163

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f_c' = 4{,}000$ psi
Grade 60 Bars

FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels

No Beams

SPAN c.-c. $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	Square Drop Panel Depth (in.)	Square Drop Panel Width (ft)	(3) Square Column Size (in.)	(3) Square Column γ_f	REINFORCING BARS (E. W.) Column Strip (1) Top Ext. +	Column Strip (1) Bottom	Column Strip (1) Top Int.	Middle Strip Bottom	Middle Strip Top Int.	Total Steel (psf)	MOMENTS Edge (–) (ft-k)	MOMENTS Bot. (+) (ft-k)	MOMENTS Int. (–) (ft-k)
h = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS														
33	100	8.25	11.00	12	0.813	15-#5 5	11-#8	18-#6	13-#6	15-#5	3.23	311.9	623.9	839.8
33	200	10.25	11.00	17	0.671	15-#5 3	12-#9	16-#7	13-#7	14-#6	4.21	408.2	816.5	1099.1
33	300	10.25	11.00	20	0.766	18-#5 6	18-#8	15-#8	12-#8	13-#7	5.11	504.7	1009.4	1358.7
33	400	12.25	11.00	22	0.716	20-#5 4	14-#10	16-#8	14-#8	12-#8	6.12	603.1	1206.2	1623.8
33	500	12.25	13.20	27	0.730	16-#6 4	16-#10	15-#9	13-#9	11-#9	7.03	695.2	1390.4	1871.6
34	100	10.25	11.33	12	0.727	16-#5 3	12-#8	18-#6	19-#5	16-#5	3.32	343.0	686.0	923.4
34	200	10.25	11.33	17	0.745	16-#5 6	13-#9	17-#7	18-#6	15-#6	4.37	447.8	895.6	1205.7
34	300	12.25	11.33	20	0.674	18-#5 4	13-#10	19-#7	13-#8	14-#7	5.47	554.9	1109.8	1494.0
34	400	12.25	13.60	24	0.763	22-#5 7	19-#9	18-#8	13-#9	13-#8	6.50	661.9	1323.7	1781.9
34	500	12.25	13.60	30	0.690	18-#6 2	18-#10	16-#9	18-#8	12-#9	7.48	757.6	1515.3	2039.8
35	100	10.25	11.67	12	0.773	16-#5 5	13-#8	19-#6	15-#6	13-#6	3.51	374.8	749.6	1009.1
35	200	12.25	11.67	17	0.663	16-#5 5	14-#9	17-#7	12-#8	23-#5	4.64	491.0	982.1	1322.0
35	300	12.25	11.67	20	0.766	20-#5 7	14-#10	16-#8	14-#8	12-#8	5.72	607.4	1214.7	1635.2
35	400	12.25	14.00	27	0.724	23-#5 6	17-#10	19-#8	14-#9	14-#8	6.97	719.2	1438.3	1936.2
35	500	12.25	14.00	33	0.667	26-#5 4	19-#10	17-#9	13-#10	13-#9	7.98	817.2	1634.5	2200.2
36	100	10.25	12.00	12	0.801	16-#5 6	12-#9	16-#7	23-#5	19-#5	3.73	408.6	817.1	1100.0
36	200	12.25	12.00	17	0.719	17-#5 6	12-#10	19-#7	16-#7	18-#6	4.83	535.7	1071.5	1442.4
36	300	12.25	12.00	22	0.744	21-#5 7	15-#10	18-#8	13-#9	13-#8	6.12	659.7	1319.4	1776.1
36	400	12.25	14.40	29	0.732	18-#6 5	18-#10	17-#9	12-#10	13-#9	7.33	781.7	1563.4	2104.5

SQUARE INTERIOR PANEL

With Drop Panels(2)

No Beams

Factored Superimposed Load (psf)	(3) Square Column Size (in.)	REINFORCING BARS (E. W.) Column Strip Top	Column Strip Bottom	Middle Strip Top	Middle Strip Bottom	Total Steel (psf)	Concrete (cu. ft / sq. ft)
h = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS							
100	12	23-#5	18-#5	14-#5	14-#5	2.82	1.076
200	20	19-#6	17-#6	13-#6	11-#6	3.57	1.095
300	24	18-#7	15-#7	12-#7	19-#5	4.43	1.095
400	26	15-#8	14-#8	11-#8	12-#7	5.29	1.113
500	29	17-#8	13-#9	22-#6	11-#8	6.10	1.163
100	12	16-#6	14-#6	15-#5	15-#5	2.92	1.095
200	20	16-#7	18-#6	14-#6	12-#6	3.75	1.095
300	24	18-#7	13-#8	13-#7	15-#6	4.70	1.113
400	27	16-#8	13-#9	12-#8	18-#6	5.62	1.163
500	29	19-#8	18-#8	14-#8	12-#8	6.49	1.163
100	12	18-#6	15-#6	12-#6	15-#5	3.05	1.095
200	20	16-#7	15-#7	12-#7	13-#6	4.00	1.113
300	24	19-#7	14-#8	14-#7	12-#7	4.89	1.113
400	27	18-#8	14-#9	13-#8	12-#8	6.09	1.163
500	32	16-#9	13-#10	12-#9	13-#8	7.01	1.163
100	12	19-#6	23-#5	13-#6	16-#5	3.16	1.095
200	20	17-#7	16-#7	13-#7	20-#5	4.15	1.113
300	24	16-#8	20-#7	12-#8	18-#6	5.18	1.113
400	27	19-#8	12-#10	12-#9	16-#7	6.38	1.163

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

CHAPTER 11 – WAFFLE FLAT SLABS — SQUARE PANELS

GENERAL CONSIDERATIONS

Description. Waffle flat slabs, as illustrated in Fig. 11-1, consist of rows of concrete joists at right angles to each other with solid heads at the columns. The joists are commonly formed by using standard square "dome" forms of the sizes described in the following section on "Standard Dome Data," and the domes are omitted around the columns to form the "solid heads." The top slab over the dome forms is usually reinforced with welded wire reinforcement and can be of various thicknesses. Standard dome forms provide waffle panels in modules of either 2 feet, 2.5 feet, or 3 feet. Depending on required size of solid head, there will either be a joist or a row of domes on the column centerline according to whether the number of joists framing into the solid head is odd or even. The column size selected must be of sufficient size to keep factored shear in the solid head within design strength values or supplemental shear capacity must be provided. Alternatives are headed shear stud reinforcement (ACI 11.11.5), shear reinforcement consisting of bars or wires and single-leg or multiple-leg stirrups (ACI 11.11.3), or structural steel shearheads (ACI 11.11.4).

For design purposes, waffle slabs are considered as flat slabs, with the solid heads acting as drop panels. Joists in each direction are divided into two bands or strips—a column strip including all joists that frame into the solid head, and a middle strip filling in between consecutive column strips. A second set of similar strips of joists runs at right angles to the first. Each joist rib typically contains two bottom bars. Straight bars are provided over column centerlines for negative factored moment.

Stirrups can be used in the joist ribs, as necessary.

Advantages of Waffle Flat Slabs. Waffle flat slabs allow a considerable reduction in dead load as compared to conventional solid flat slabs. See Table 11-1. Thus, it is particularly advantageous where the use of longer spans and/or heavier loads are desired without the use of deepened drop panels or support beams. The geometrical shape formed by the joist ribs is often architecturally desirable, as is the resulting flush soffit. Also, waffle flat slabs provide for relatively easy accommodation of electrical and mechanical utilities. See Fig.11-1.

Standard Dome Data. The square "dome" forms used for the waffle slabs designs tabulated in this Handbook are designed to meet the recommendations of the "Concrete Joist Construction — Recommended Industry Practice", CRSI *Manual of Standard Practice* for domes up to 20-inch depths. The standard domes are:

(1) 30-inch × 30-inch square domes with 3-inch flanges; from which 6-inch wide joist ribs at 36-inch centers are formed: These are available in standard depths of 8, 10, 12, 14, 16 and 20 inches.

(2) 24-inch × 24-inch square domes with 3-inch flanges; from which 6-inch wide joist ribs at 30-inch centers are formed. These are available in standard depths of 8, 10, 12, 14, 16 and 20 inches.

(3) 19-inch × 19-inch square domes with 2½-inch flanges, from which 5-inch wide joist ribs at 24-inch centers are formed. These are available in standard depths of 8, 10, 12 , 14 and 16 inches.

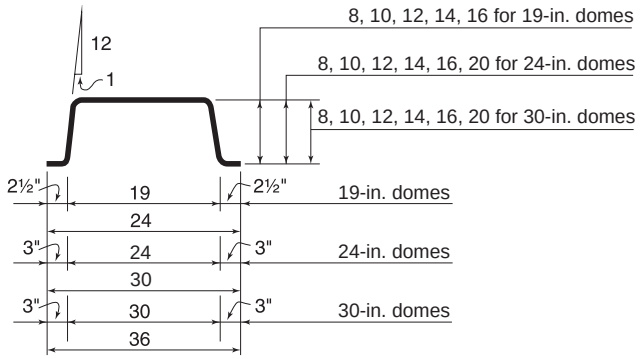
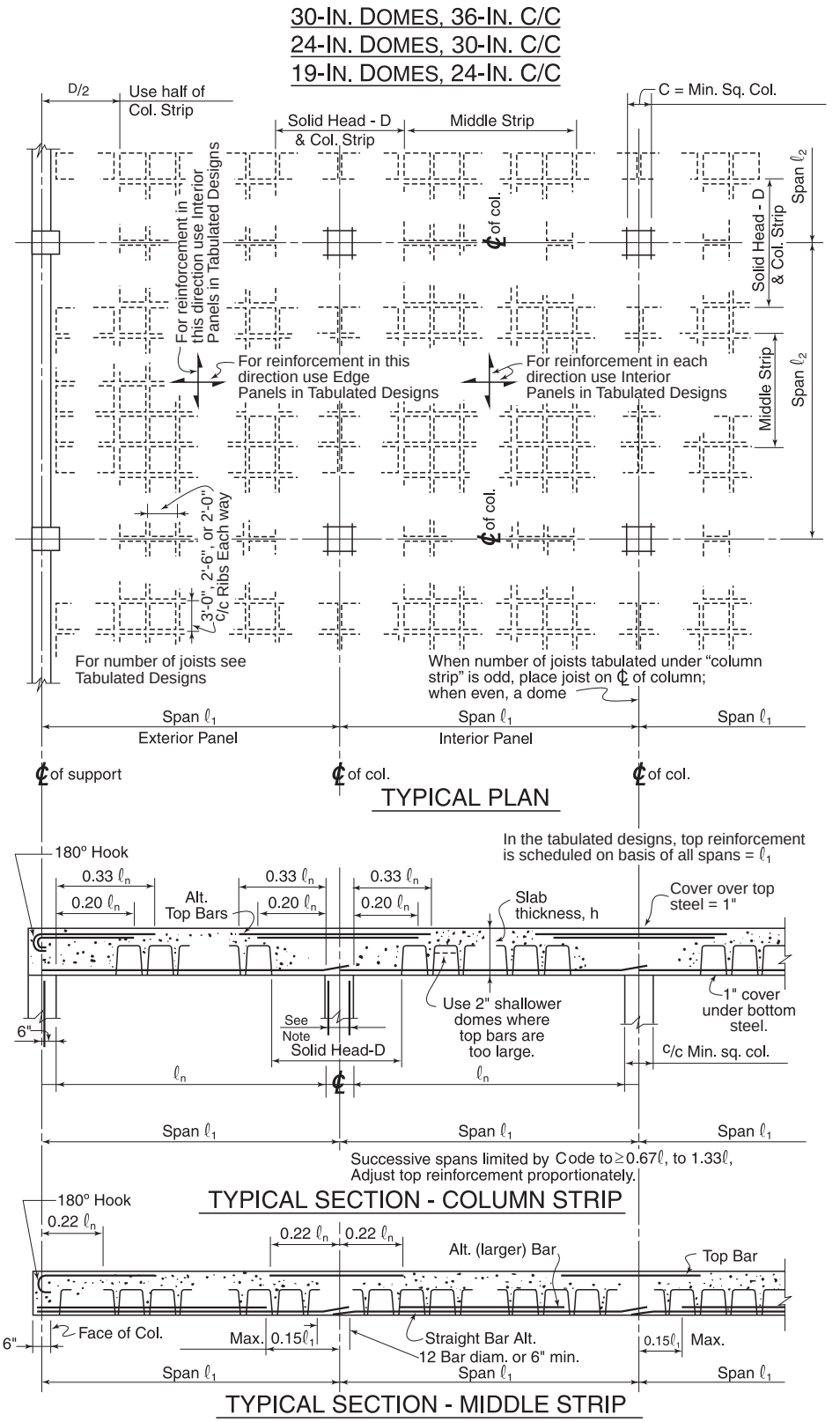


Table 11-1 Standard Dome Dimensions and Other Data

Dome Size	Dome Depth (in.)	Volume of Dome (ft^3)	Floor Dead Load (psf) per Slab Thickness			
			3 in.	4 in.	4.5 in.	5 in.
19-in.	8	1.56	79	92	98	104
	10	1.91	91	103	110	116
	12	2.25	103	116	122	128
	14	2.58	116	128	134	141
	16	2.90	129	141	148	154
24-in.	8	2.52	77	89	96	102
	10	3.11	88	100	107	113
	12	3.68	99	112	118	124
	14	4.23	111	124	130	136
	16	4.76	123	136	142	148
	20	5.78	149	161	167	174
30-in.	8	3.98	71	84	90	96
	10	4.92	80	93	99	105
	12	5.84	90	103	109	115
	14	6.74	100	113	119	125
	16	7.61	111	123	129	136
	20	9.30	132	145	151	157



NOTE: Integrity reinforcement is required (ACI 13.3.8.5). All bottom bars in the column strip must be continuous or spliced over the support with Class B tension lap splices. At least two of the column strip bottom bars in each direction must pass within the column core and be anchored at exterior supports. For other end support conditions; see Figs. 11-2 and 11-3.

Figure 11-1 Reinforcing Bar Details and Layout of Joists and Domes

DESIGN CONSIDERATIONS IN WAFFLE FLAT SLAB CONSTRUCTION

Economy. In order to maintain maximum economy, it is important that a uniform depth and the same size dome forms be used throughout a floor system, or structure, if possible. Construction costs will also be reduced by selecting a floor system that has sufficient design shear strength to resist the required factored loads without using joist stirrups and with the smallest size solid head. The amount of flexural reinforcement and, if necessary, the top slab thickness can be changed to provide the required design moment strengths for different spans, areas, or floors of a structure.

Alternate Dome Layouts.

1. For layouts that do not meet the standard 2-foot, 2.5-foot, or 3-foot modules, it is preferable that the required additional width be obtained by increasing the width of the ribs framing into the solid column head. If the off-modular amount is small (less than 6 inches), the forms for one rib only can be spaced farther apart to make up the necessary bay width. Special filler size domes are also available on a limited basis to fill out column spacings that are not multiples of 3 feet, 2.5 feet, or 2 feet. Sketching the spacings for a typical panel, correlated with the column spacings, should be a part of the early planning.

2. In some designs, large size top bars are required. To obtain sufficient concrete cover, shallower standard domes may be used around the solid head.

Service Load Deflections. The tabulated designs of waffle flat slabs are based on strength (safety) requirements for superimposed factored loads ranging from 50 psf to 500 psf. All waffle flat slab tabulated designs are within a maximum span-depth ratio of 33 for exterior panels and 36 for interior panels (ACI 9.5.3.2). In this range, the Code does not require deflection computations. Waffle flat slabs, due to their lighter dead weight, provide considerably more depth and stiffness than economically comparable solid flat slabs. Where conditions of the structure impose limitations on acceptable deflection, the deflection should be estimated to determine if it is acceptable for the conditions of the structure under consideration. For relatively high ratios of permanent load to total load, calculated creep deflections may be reduced by extending the top straight bars sufficiently to act in compression.

An example of calculating approximate deflections for waffle flat slabs is given in Chapter 6. The term "t_e", (average equivalent thickness) represents the thickness of a solid flat plate having the computed equivalent stiffness of the waffle slab; "t_e" can be computed as the average of the gross moments of inertia of the solid head area and ribbed area. Since all solid head areas tabulated are within one rib module of $L/3$, the area of solid head can be taken as 1/9 the total bay area. Assume the solid head area twice as effective, as it is in the area of maximum moment. "t_e" required for the deflection formula can then be calculated from:

$$(t_e)^3 = \frac{1}{10}\left[\, 2(t_s)^3 + 8(t_r)^3 \right]$$

where:

t_s = thickness of the solid head

t_r = equivalent thickness of ribbed area

Values of t_e for various standard dome sizes and top slab thicknesses calculated as above, are tabulated in Tables 11-2 through 11-4.

Tables 11-2 through 11-4 also give the maximum span and load for various rib and top slab combinations within the limit of $\Delta = L/360$. The maximum span and load values based on the gross moment of inertia, I_g, were calculated using the equation for slab deflection given in Chapter 6, which is in terms of $wL^4/(t_e)^3$.

Code deflection limits are also expressed as fractions of the span, L.

It is, therefore, possible to solve for a limiting unit load, w, at any given L/t_e ratio which results in a deflection of $L/360$.

Setting Δ_{max} = the deflection limit $= \dfrac{L}{360} = \dfrac{kqL^4}{E_c(t_e)^3}$

where $k = 0.1028$ (see Chapter 6)

$w = 144q$, load in psf

q = load in psi

$E_c = 3.5 \times 10^6$ psi

and solving for w_{max}:

$$w_{max} = \frac{(3.5 \times 10^6)(144)}{(0.1028)(L/t_e)^3(360)}$$

$$w_{max} = 13.6 \times 10^6\ (t_e/L)^3 \text{ for } \Delta = L/360$$

Direct comparison by inspection of the required service live load versus the maximum load for $L/360$ or $L/180$ deflection limits should aid in the selection of tabulated designs meeting deflection criteria applicable to the structure under consideration. If creep deflection must be limited to $L/360$, the sum of service live load plus two times the estimated long-term service loads should be used for this comparison. (Creep factor = 2.0, ACI 9.5.2.5) If detailed estimates are required, such as for camber, for construction loads, or when E_c is lower, the tabulated equivalent thicknesses will save computations.

For heavily reinforced waffle slabs, more refined calculations are required. The Code requires using the transformed (cracked) section moment of inertia and the gross section moment of inertia to determine the *effective* moment of inertia. Usually $I_e \approx I_g$ except in ribbed areas in which case the transformed section moment of inertia of the ribbed area must be combined with the gross moment of inertia to determine equivalent thickness.

Caution: All deflection serviceability criteria are based upon *service*, not *factored* loads. Actual loads are to be used except in computing long-term deflection where a creep factor, *not a load factor*, is required for long-term loads.

The effective moment of inertia, I_e, is computed as:

$I_e = (M_{cr}/M_a)^3 I_g + [1 - (M_{cr}/M_a)^3] I_{cr}$ . . (ACI Eq. 9-8)

in which:

Cracking moment, $M_{cr} = f_r I_g / y_t$

Modulus of rupture, $f_r = 7.5\sqrt{f'_c}$ for normal-weight concrete

Actual moment, $M_a =$ maximum moment of service load $(D + L)$

and $y_t =$ distance from centroid to extreme tension fiber of gross section.

Table 11-2 Waffle Flat Slabs (19″ x 19″ Domes at 2′-0″)—Equivalent Thickness and Maximum Load Based on *L*/360 Deflection

Rib+Slab Depths (in.)	Equiv. Thickness t_e* (in.)	Max. Span in Tables (ft.)	Maximum Span Limited by *L*/360 Deflection for Load Shown Below						
			L/t_e=30	L/t_e=31	L/t_e=32	L/t_e=33	L/t_e=34	L/t_e=35	L/t_e=36
8 + 3	8.89	30	22′-2″	22′-11″	23′-8″	24′-5″	25′-2″	25′-11″	26′-7″
8 + 4	9.70	32	24′-3″	25′-0″	25′-10″	26′-8″	27′-5″	28′-3″	29′-1″
8 + 4½	10.11	34	25′-3″	26′-1″	26′-11″	27′-9″	28′-7″	29′-5″	30′-4″
8 + 5	10.52	36	26′-3″	27′-2″	28′-0″	28′-11″	29′-9″	30′-8″	31′-6″
10 + 3	10.51	36	26′-3″	27′-1″	28′-0″	28′-10″	29′-9″	30′-7″	31′-6″
10 + 4	11.34	38	28′-4″	29′-3″	30′-2″	31′-2″	32′-1″	33′-0″	34′-0″
10 + 4½	11.75	38	29′-4″	30′-4″	31′-3″	32′-3″	33′-3″	34′-3″	35′-2″
10 + 5	12.16	38	30′-4″	31′-4″	32′-4″	33′-5″	34′-5″	35′-5″	36′-5″
12 + 3	12.12	38	30′-3″	31′-3″	32′-3″	33′-3″	34′-3″	35′-4″	36′-4″
12 + 4	12.97	38	32′-4″	33′-5″	34′-6″	35′-7″	36′-8″	37′-9″	38′-10″
12 + 4½	13.38	38	33′-5″	34′-6″	35′-8″	36′-9″	37′-11″	39′-0″	40′-1″
12 + 5	13.80	38	34′-5″	35′-7″	36′-9″	37′-11″	39′-1″	40′-2″	41′-4″
14 + 3	13.72	38	34′-3″	35′-5″	36′-6″	37′-8″	38′-10″	40′-0″	41′-1″
14 + 4	14.59	38	36′-5″	37′-8″	38′-10″	40′-1″	41′-4″	42′-6″	43′-9″
14 + 4½	15.02	38	37′-6″	38′-9″	40′-0″	41′-3″	42′-6″	43′-9″	45′-0″
14 + 5	15.43	38	38′-7″	39′-10″	41′-1″	42′-5″	43′-8″	45′-0″	46′-3″
16 + 3	15.31	38	38′-3″	39′-6″	40′-10″	42′-1″	43′-4″	44′-7″	45′-11″
16 + 4	16.21	38	40′-6″	41′-10″	43′-2″	44′-6″	45′-11″	47′-3″	48′-7″
16 + 4½	16.64	38	41′-7″	42′-11″	44′-4″	45′-9″	47′-1″	48′-6″	49′-11″
16 + 5	17.07	38	42′-8″	44′-1″	45′-6″	46′-11″	48′-4″	49′-9″	51′-2″
Maximum Load (psf) for Immediate (Elastic) Deflection of *L*/360**			504	457	416	379	346	318	292

* Based on gross moment of inertia.

** For long-term (creep) deflection limited to *L*/360, multiply the long-term loads, including the waffle slab weight, times 2; deduct from loads shown above. Result is maximum superimposed service live load.

Bar Spacing. For crack control in two-way slabs, the spacing of reinforcing bars is limited to 2*h* (ACI 13.3.2). This limit does not apply to waffle slabs (ACI Commentary R13.3.2). Spacing of top bars cannot exceed 5*h* nor 18 inches (ACI 7.12). In the tabulated designs, bar sizes have been selected for the area of steel required so that their spacing is not less than 3 inches nor greater than the maximum permitted.

CRSI recommends a minimum of #4 bars spaced at 12 inches on center for rigidity under construction traffic.

Openings. Outside the solid head in waffle flat slabs, small openings may be located anywhere through the thin top slab between joists. The space available in one such dome will usually accommodate most service openings for electrical, plumbing, etc., needs. The Code

Table 11-3 Waffle Flat Slabs (24″ x 24″ Domes at 2′- 6″)—Equivalent Thickness and Maximum Load Based on *L*/360 Deflection

Rib+Slab Depths (in.)	Equiv. Thickness t_e* (in.)	Max. Span in Tables (ft.)	Maximum Span Limited by *L*/360 Deflection for Load Shown Below						
			L/t_e=30	L/t_e=31	L/t_e=32	L/t_e=33	L/t_e=34	L/t_e=35	L/t_e=36
8 + 3	8.82	30	22′-2″	22′-9″	23′-6″	24′-3″	25′-0″	25′-8″	26′-5″
8 + 4	9.63	32.5	24′-1″	24′-10″	25′-8″	26′-5″	27′-3″	28′-1″	28′-10″
8 + 4½	10.04	35	25′-1″	25′-11″	26′-9″	27′-7″	28′-5″	29′-3″	30′-1″
8 + 5	10.45	35	26′-1″	26′-11″	27′-10″	28′-8″	29′-7″	30′-5″	31′-4″
10 + 3	10.43	35	26′-0″	26′-11″	27′-9″	28′-8″	29′-6″	30′-5″	31′-3″
10 + 4	11.25	37.5	28′-1″	29′-0″	30′-0″	30′-11″	31′-10″	32′-9″	33′-9″
10 + 4½	11.66	40	29′-1″	30′-1″	31′-1″	32′-0″	33′-0″	34′-0″	34′-11″
10 + 5	12.06	40	30′-1″	31′-2″	32′-2″	33′-2″	34′-2″	35′-2″	36′-2″
12 + 3	12.03	40	30′-0″	31′-0″	32′-0″	33′-0″	34′-0″	35′-1″	36′-1″
12 + 4	12.87	42.5	32′-2″	33′-2″	34′-3″	35′-4″	36′-5″	37′-6″	38′-7″
12 + 4½	13.28	45	33′-2″	34′-3″	35′-5″	36′-6″	37′-7″	38′-8″	39′-10″
12 + 5	13.69	45	34′-2″	35′-4″	36′-6″	37′-7″	38′-9″	39′-11″	41′-0″
14 + 3	13.62	45	34′-0″	35′-2″	36′-3″	37′-5″	38′-6″	39′-8″	40′-10″
14 + 4	14.48	47.5	36′-2″	37′-4″	38′-7″	39′-9″	41′-0″	42′-2″	43′-5″
14 + 4½	14.90	47.5	37′-3″	38′-5″	39′-8″	40′-11″	42′-2″	43′-5″	44′-8″
14 + 5	15.31	47.5	38′-3″	39′-6″	40′-10″	42′-1″	43′-4″	44′-8″	45′-11″
16 + 3	15.20	47.5	37′-11″	39′-3″	40′-6″	41′-9″	43′-0″	44′-3″	45′-7″
16 + 4	16.09	47.5	40′-2″	41′-6″	42′-10″	44′-2″	45′-6″	46′-10″	48′-3″
16 + 4½	16.51	47.5	41′-3″	42′-7″	44′-0″	45′-4″	46′-9″	48′-1″	49′-6″
16 + 5	16.94	47.5	42′-4″	43′-9″	45′-1″	46′-6″	47′-11″	49′-4″	50′-9″
20 + 3	18.34	47.5	45′-10″	47′-4″	48′-10″	50′-5″	51′-11″	53′-6″	55′-0″
20 + 4	19.28	47.5	48′-2″	49′-9″	51′-4″	53′-0″	54′-7″	56′-2″	57′-10″
20 + 4½	19.73	47.5	49′-3″	50′-11″	52′-7″	54′-2″	55′-10″	57′-6″	59′-2″
20 + 5	20.16	47.5	50′-4″	52′-1″	53′-9″	55′-5″	57′-1″	58′-9″	60′-5″
Maximum Load (psf) for Immediate (Elastic) Deflection of *L*/360**			504	457	416	379	346	318	292

* Based on gross moment of inertia.

** For long-term (creep) deflection limited to *L*/360, multiply the long-term loads, including the waffle slab weight, times 2; deduct from loads shown above. Result is maximum superimposed service live load.

requirement for total area of flexural reinforcement is maintained by the reinforcement in the joists. Larger openings must be treated as provided in the Code (ACI 13.4).

Edge Conditions. Joists parallel to the discontinuous edge may be selected from the tabulated designs for interior panels as these joists are continuous. For the design strips perpendicular to the discontinuous edge, joists may be selected from the tabulated designs for exterior panels, provided that the exterior edge frames integrally into columns as shown in the tabulated designs.

For corner panels, joists in the design strips in both directions may be selected from the tabulated designs for end panels under the same edge conditions as for other discontinuous joists. See Fig. 11-2.

Table 11-4 Waffle Flat Slabs (30″ x 30″ Domes at 3′- 0″)—Equivalent Thickness and Maximum Load Based on *L*/360 Deflection

Rib+Slab Depths (in.)	Equiv. Thickness t_e* (in.)	Max. Span in Tables (ft.)	Maximum Span Limited by *L*/360 Deflection for Load Shown Below						
			L/t_e=30	L/t_e=31	L/t_e=32	L/t_e=33	L/t_e=34	L/t_e=35	L/t_e=36
8 + 3	8.61	30	21′-6″	22′-2″	22′-11″	23′-8″	24′-4″	25′-1″	25′-9″
8 + 4	9.40	33	23′-5″	24′-3″	25′-0″	25′-10″	26′-7″	27′-4″	28′-2″
8 + 4½	9.79	33	24′-5″	25′-3″	26′-1″	26′-11″	27′-8″	28′-6″	29′-4″
8 + 5	10.20	36	25′-5″	26′-4″	27′-2″	28′-0″	28′-10″	29′-8″	30′-7″
10 + 3	10.18	36	25′-5″	26′-3″	27′-1″	27′-11″	28′-10″	29′-8″	30′-6″
10 + 4	10.98	39	27′-5″	28′-4″	29′-3″	30′-2″	31′-1″	32′-0″	32′-11″
10 + 4½	11.37	39	28′-5″	29′-4″	30′-3″	31′-3″	32′-2″	33′-1″	34′-1″
10 + 5	11.77	39	29′-5″	30′-4″	31′-4″	32′-4″	33′-4″	34′-3″	35′-3″
12 + 3	11.74	39	29′-4″	30′-4″	31′-3″	32′-3″	33′-3″	34′-3″	35′-2″
12 + 4	12.56	42	31′-4″	32′-5″	33′-5″	34′-6″	35′-6″	36′-7″	37′-8″
12 + 4½	12.95	45	32′-4″	33′-5″	34′-6″	35′-7″	36′-8″	37′-9″	38′-10″
12 + 5	13.35	45	33′-4″	34′-5″	35′-7″	36′-8″	37′-9″	38′-11″	40′-0″
14 + 3	13.30	45	33′-2″	34′-4″	35′-5″	36′-6″	37′-8″	38′-9″	39′-10″
14 + 4	14.13	48	35′-3″	36′-6″	37′-8″	38′-10″	40′-0″	41′-2″	42′-4″
14 + 4½	14.54	51	36′-4″	37′-6″	38′-9″	39′-11″	41′-2″	42′-4″	43′-7″
14 + 5	14.94	51	37′-4″	38′-7″	39′-10″	41′-0″	42′-3″	43′-6″	44′-9″
16 + 3	14.85	51	37′-1″	38′-4″	39′-7″	40′-9″	42′-0″	43′-3″	44′-6″
16 + 4	15.70	54	39′-3″	40′-6″	41′-10″	43′-2″	44′-5″	45′-9″	47′-1″
16 + 4½	16.12	54	40′-3″	41′-7″	42′-11″	44′-3″	45′-7″	47′-0″	48′-4″
16 + 5	16.52	57	41′-3″	42′-8″	44′-0″	45′-5″	46′-9″	48′-2″	49′-6″
20 + 3	17.92	57	44′-9″	46′-3″	47′-9″	49′-3″	50′-9″	52′-3″	53′-9″
20 + 4	18.83	57	47′-0″	48′-7″	50′-2″	51′-9″	53′-4″	54′-11″	56′-5″
20 + 4½	19.26	57	48′-1″	49′-9″	51′-4″	52′-11″	54′-6″	56′-2″	57′-9″
20 + 5	19.69	57	49′-2″	50′-10″	52′-5″	54′-1″	55′-9″	57′-4″	59′-0″
Maximum Load (psf) for Immediate (Elastic) Deflection of *L*/360**			504	457	416	379	346	318	292

* Based on gross moment of inertia.

** For long-term (creep) deflection limited to *L*/360, multiply the long-term loads, including the waffle slab weight, times 2; deduct from loads shown above. Result is maximum superimposed service live load.

Cantilever Edges. Architectural or construction requirements frequently make cantilevered edges necessary. "Balanced" negative edge moments under full uniform load are often advantageous for: (1) many architectural exterior conditions require that exterior columns be set back from light outer cladding of other materials; and (2) often continuous "eyebrow" canopies are used to block direct sunlight. The variation in loads, spans, and thicknesses encountered in such cantilevered edge conditions precludes any standard detail or design recommendation. Reinforcement for these negative cantilever moments can be combined with top reinforcement from exterior panel strips and will usually improve performance of the waffle flat slab. Gravity loads on the exterior columns are nearly balanced, reducing gravity moments in the columns and positive moments and deflections in the exterior panel. See Fig. 11-3.

The simplest detail for full-depth waffle slab cantilevered edges is to extend top bars, anchored at the edge with end hooks, and add top bars similarly anchored to meet area of steel required for negative factored moment. For cantilever spans long enough to involve deflection limits, bottom bars may be extended as compression reinforcement to reduce creep deflections, and to ensure development of at least two bars past the edge column centerline.

Stirrups. When factored shears exceed the relatively low values prescribed for the concrete shear strength, stirrups are required as indicated in the tabulated designs. The notation used to describe the stirrups required for rib depths to 20 inches is explained in the notes on Page 11-24. Regarding the last character in the stirrup notation, a "one" indicates that single vertical bars properly anchored at spacing < 0.5*d* are necessary in the joist ribs from the face of the solid head area to the first cross rib. This distance is equal to the length of one dome form. For convenience in placing, stirrups are assembled in units. When the last character in the stirrup notation is a "two," it indicates that stirrups are required in the joist ribs to the second cross rib from the face of the solid head. Sizes and spacings of stirrup legs are: #3 bars spaced at 4 inches (see Fig. 11-4) for joist ribs 8 inches and 10 inches deep; and #4 bars spaced at 6 inches for ribs 12, 14, and 16 inches deep. For the 20-inch rib depths, the size, spacing, and arrangement of the stirrups must be specified.

DESCRIPTION OF TABULATED DESIGNS

Scope. Tabulated designs are presented for waffle flat slab floor construction using the standard 19-inch × 19-inch, 24-inch × 24-inch, and 30-inch × 30-inch domes as described on Page 11-1. For each of the standard dome depths, tabulated designs are given for 3-inch, 4-inch, 4.5-inch, and 5-inch top slabs. Spans range from 15 feet to 57 feet for 30-inch domes, 15 feet to 47.5 feet for 24-inch domes, and 14 feet to 38 feet for 19-inch domes, for superimposed factored loads up to the maximum (shear) strength, for both typical square interior panels and for strips perpendicular to the wall in square edge panels that are built integrally with exterior columns.

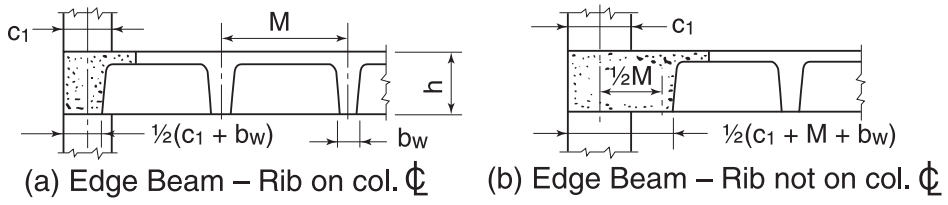


Figure 11-2 Edge Conditions for Tabulated Designs

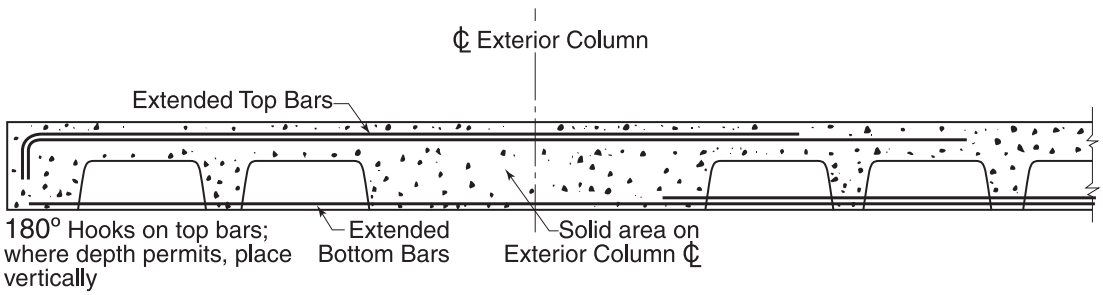


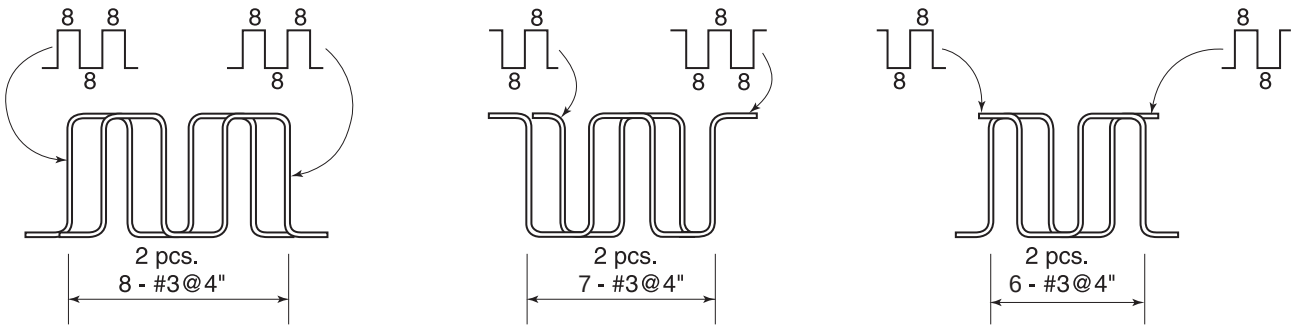
Figure 11-3 Cantilever Edge Reinforcement

The tabulated designs are based on the use of square columns, with the exterior columns located flush with the edge. Total slab thickness, size of solid head (drop panel), minimum size of column, reinforcing bars required, and average weight of reinforcing steel and volume of concrete per square foot of floor area are given in the tabulated designs. The Code requires "integrity reinforcement" (ACI 13.3.8.5). The tabulated values of reinforcing steel weight do not include integrity reinforcement. Under "Edge Panels," all total factored panel moments are given to serve as an aid in modifying the flush column design to any location of edge columns.

Organization. The tabulated designs are presented in three parts; first, 19-inch × 19-inch domes for a 24-inch module, then, 24-inch × 24-inch domes for a 30-inch module, and last, 30-inch × 30-inch domes for a 36-inch module. In each part, the 3-inch top slab designs are given first, followed by 4-inch, 4.5-inch, and 5-inch top slab designs, each in order of total depth, beginning with the shallowest.

Explanation. For a sample preliminary design and comparisons of material quantities for cost estimating, see Fig. 11-5. The data "Total Weight of Reinforcing Steel" (psf) and "Concrete" (cf/sf) are given for each separate tabulated design (one line across the page) for convenient plotting, as in Fig. 11-5. See Fig. 11-1 for the bar lengths and bending details, which are used as a basis for the tabulated weight of reinforcing steel. The tabulated design shows reinforcing bars in one direction. "Total Weight of Reinforcing Steel" includes identical bars both ways for square interior panels, and includes one set of interior bars, plus one set of edge panel bars, for the square edge panel. Integrity reinforcement is not included in the reinforcing steel quantity. Stirrups, shear reinforcement at columns, and any welded wire reinforcement used in the top slab are not included as these items are usually estimated separately. The concrete quantities are for the waffle slab and solid head only. They do not include concrete in columns or any added beams.

The tabulated designs give the "Square Column" side dimensions in inches which is the minimum size of support that will keep punching shear stress equal to or less than $4\sqrt{f'_c}$ (ACI 11.11.2.1, Eq. 11-33) and $(\alpha_s d/b_o + 2)\sqrt{f'_c}$ (ACI Eq. 11-32) for use without shear reinforcement. For moderate loads and spans, the column sizes tabulated are not excessive, but for heavier loads or longer spans, maximum column size was limited to $\ell/15$. These sizes, marked by an asterisk, "*", require



Alternate detail: Plain or deformed welded wire reinforcement "ladder style" stirrups. Size and spacing of vertical legs to provide equivalent areas to reinforcing bar stirrups. Welded wire reinforcement ladders must include two longitudinal anchor wires top and bottom. (ACI 12.13.2.4)

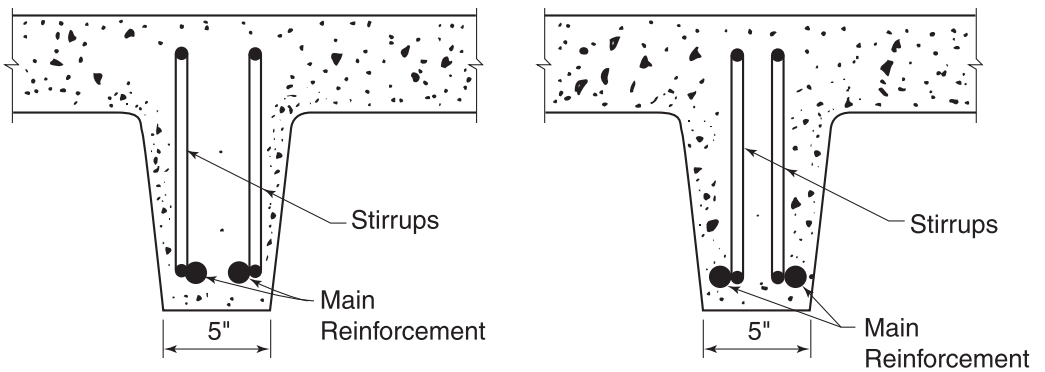


Figure 11-4 Typical Stirrups for Tabulated Designs (Minimum Width Rib Shown)

the use of headed shear stud reinforcement (ACI 11.11.5), or other types of shear reinforcement, or concrete caps or brackets to reduce column size. If equivalent stiffness round columns are used and caps are desirable, standard conical cap forms are available with diameters in multiples of 6 inches. Columns are shown square as they are usually more easily fitted into wall construction. See Fig. 11-6. If square shear caps are used, the minimum effective angle of slope with the horizontal is 45 degrees (ACI 13.1.2), and so the depth below the solid head should be equal or larger than the projection beyond the faces of the column on all sides.

The tabulated designs are for square panels only. For the design of rectangular panels (with the ℓ_1/ℓ_2 limitation of 2.0), the factored superimposed load values tabulated for the longer span may be used, and tabulated reinforcement adjusted in both directions. All loads tabulated are factored superimposed loads. "Factored superimposed load" consists of live load, floor finishes, partition allowance, and everything except the weight of the structural concrete, multiplied by the appropriate load factors.

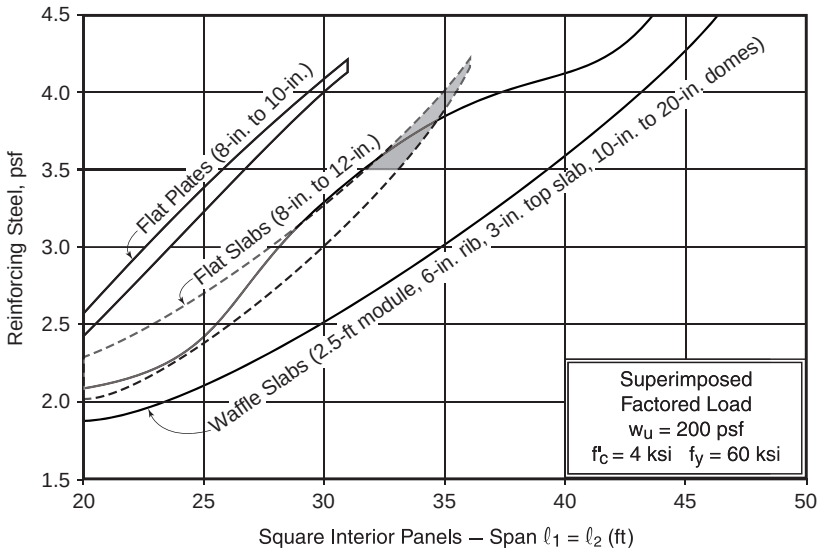


Figure 11-5 Preliminary Design and Material Quantity Estimates for Flat Plates, Flat Slabs, and Waffle Flat Slabs from Tabulated Designs

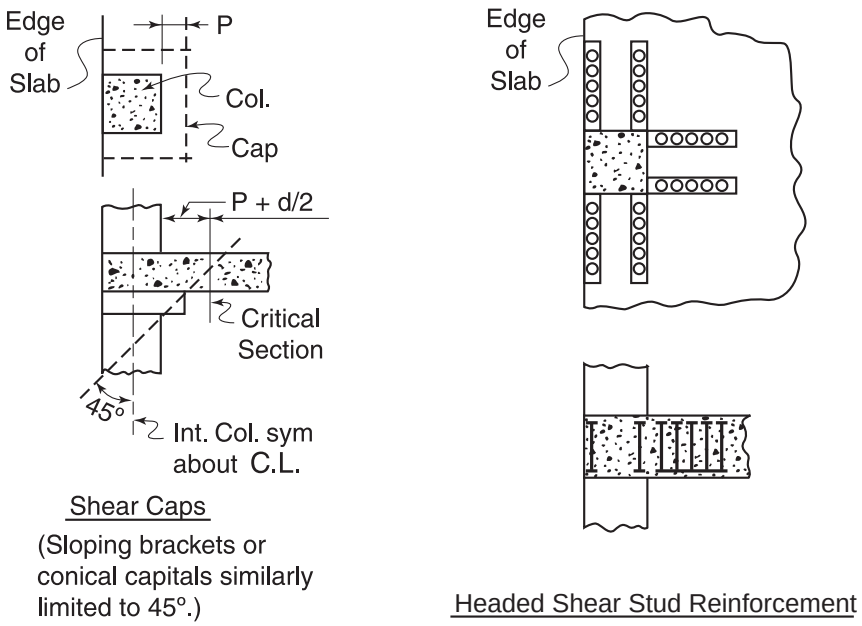


Figure 11-6 Alternate Punching Shear Designs at Columns Marked "*"

Dead weight of the waffle flat slab (based on 150 pounds per cubic foot) has been deducted. Strength-reduction factors, "ϕ-factors" (ACI 9.3), have been applied. Total load to be distributed to supporting columns, beams, and walls will consist of superimposed factored load, plus the factored dead load of the waffle slab itself (1.2 × actual weight).

BASIS OF TABULATED DESIGNS

General. All waffle flat slab tabulated designs presented in this Chapter are based on the "Strength Design" method and the "Direct Design Method" of analysis (ACI 13.6). Limitations of the Direct Design Method and the tabulated designs are: (1) at least three continuous panels in each direction, (2) ratio of length to width of panels not to exceed 2.0, (3) successive span lengths cannot vary more than 33 percent of the longer span, (4) ratio of live to dead (actual) load not to exceed two, and (5) uniformly distributed gravity loads only (ACI 13.6.1).

Design Assumptions. In applying the Direct Design Method, it is assumed that a waffle slab panel is composed of column strips and a middle strip, similar to those used in ordinary flat slab design. The column strip consists of the joist ribs and adjacent top slab framing directly into the solid head section. The remaining ribs and top slab comprise the middle strip of the panel. The solid head over columns is treated as if it were a drop panel in conventional flat slab construction. The individual ribs are designed as joists. Each rib contains two straight bottom bars. In the middle strips, one of the bottom bars, the larger if two sizes are used, is cut off and the other is extended, as shown in Fig. 11-1. Straight top bars are used and are generally of two lengths in the column strips to provide the negative moment reinforcement (ACI 13.3.8).

A layer of 6 × 6 – W3 × W3 welded wire reinforcement is assumed to be placed in the top slab over the domes in all cases.

The effective depth, *d*, of the waffle flat slab is computed on the basis of 1 inch of concrete cover for both the top and bottom reinforcement, plus an allowance of one bar diameter because the bars cross each other; thus, *d* equals the total depth minus 1.75 inches. For square panels, therefore, it is not necessary to specify the placing sequence as it is immaterial in which direction bars are at the greater depth as long as the design is based on the smaller effective depth.

The recommended reinforcing bar details shown in Fig. 11-1 conform to minimum lengths required by the Code (ACI 13.3.8). Based on practice, some minimum anchorages were increased to be practicable for usual conditions. For unusually high ratios of movable live load to dead-plus-fixed-live load, moving loads, concentrated loads, or openings, special analyses should be made and bar lengths increased as required. Integrity reinforcement has to be provided (ACI 13.3.8.5). If moment reversals are anticipated (due to moving live load or unfavorable ratios of adjacent spans), some bars should be continuous in both top and bottom. For waffle flat slabs with only two continuous spans, the amount, distribution, and lengths of reinforcing bars will require adjustment determined by a special analysis.

USE OF TABULATED DESIGNS

The first step is to select the module, 2-feet, 2.5-feet, or 3-feet, best suited to the span and depth within span ranges given in the *Scope* (Page 11-7). Requirements for fire resistance in the legally adopted building code or project requirements for embedded conduits may require the 5-inch top slab; if not, a thinner top slab will be slightly more economical. The next step is to enter the appropriate tabulated design with the center-to-center span of columns and factored superimposed loads. See Chapter 5 for load factors and load combinations.

For preliminary design and material quantity estimates, see Fig. 11-5.

For the same span and loads, end span positive factored moments and negative factored moment (at first interior column) are larger. The basic design can be selected from either the edge or interior panel tablulated designs, depending on which type predominates in the actual building layout. The preliminary selection of sizes should be adequate for the required superimposed factored load with minimum use of stirrups in the ribs or shear reinforcement at columns. If a special long span or heavy load condition exists in a small area of the total layout, the shear reinforcement may be used to advantage in this area to avoid increasing depth in the entire layout. The same size forms should be used throughout a building for maximum economy.

If the basic design is selected from the interior span (interior panel) tabulated design, the corresponding tabulated design of the end span (edge panel) should also be checked to ensure that the end span will provide the required strength.

The tabulated designs furnish pertinent design and estimating data, including the sizes and the number of

reinforcing bars, weight of reinforcing steel per square foot, and average quantity of concrete per square foot. If reinforcing bar detailing information for a particular tabulated design is desired, Fig. 11-1 should be useful.

Adaptation of Tabulated Designs to Non-Standard Situations. For tabulated designs requiring modification, necessary additional data are presented for convenience in making adjustments. Factored moments for the exterior panel are tabulated for use in adjusting designs requiring top slab thicknesses other than the standard thicknesses tabulated, concrete compressive strengths, f_c', other than 4,000 psi, or in deflection calculations.

See Chapters 9 and 10 for examples illustrating some of these adjustments. Chapter 9, "Flat Plates," presents the fundamental approach to "Direct Design" of two-way slabs under the ACI Building Code for the simplest application. Chapter 10, "Flat Slabs with Drop Panels," illustrates the additional computations required by the presence of the drop panels. This Chapter emphasizes solution of requirements to accommodate the two-way joists. To avoid duplication, the various design aids and explanations are not repeated in each Chapter. The three Chapters should be studied as a unit for full utilization of the tabulated designs, explanations for adjustment to project conditions, and use of the various design aids.

Other special conditions outside the range of the tabulated design include: (1) lateral load analysis on unbraced waffle slab-column frames and (2) rectanglar columns where ratio $c_1/c_2 = \beta_c > 2$. For two-way slabs that are required to resist moments due to lateral loads in frames not braced against side-sway, factored moments and required bar lengths must be determined by special analyses rather than those for gravity load alone (ACI 13.3.8.4). For rectangular columns where $\beta_c > 2$, or for square or rectangular columns where $\alpha_s d/b_o < 2$, the nominal shear strength of concrete, v_c, in two-way slabs is reduced, i.e., less than $4\sqrt{f_c'}$ (ACI 11.11.2).

For unbraced frames otherwise within limitations for the Direct Design Method (ACI 13.6), gravity load moments in the tabulated designs may be combined with lateral load moments from a separate analysis with suitable load factors applied (ACI 9.2).

TABULATED DESIGNS—EXAMPLES

The following examples will illustrate use of the tabulated designs.

Example 1. Select a tabulated design of a waffle flat slab floor system with center-to-center spans of columns $\ell_1 = \ell_2 = 30'\text{-}0''$ for a service live load of 100 psf plus ceiling and floor finish of 20 psf. Maximum column size preferred is 16-in. square. Normal-weight concrete with $f_c' = 4{,}000$ psi will be used with Grade 60 ($f_y = 60{,}000$ psi) reinforcing bars. A 3-in. thick top slab will satisfy fire rating requirements. Factored superimposed load $w_u = 1.2D + 1.6L = 1.2 \times 20 + 1.6 \times 100 = 184$ psf. Use 30 in. × 30 in. dome forms for a $3'\text{-}0''$ module.

From the tabulated designs on Page 11-84 for the span and dome size, select the 12 + 3 waffle flat slab with solid head $12'\text{-}6''$ square. Stirrups are required for a distance of one module to the first cross rib from the solid head. (Where depth is available, maximum economy is usually achieved with depth adequate to enable use of the solid head tabulated without stirrups.) The factored superimposed load = 200 psf > 184 psf, okay.

To complete the final design, see Page 11-84 for the reinforcement, minimum column sizes required, and average quantities of reinforcing steel and concrete per square foot. Minimum column sizes are: exterior 15 in.* square and interior 15 in.* square. Reinforcing steel: 3.07 pounds per square foot (psf), exterior panels; and 2.79 pounds per square foot (psf), interior panels. Concrete: 0.705 cubic feet per square foot (cf/sf).

Note that this design will provide a floor system with a total depth of 15 in. (which is a reasonable minimum) and the (square) column sizes are within the preliminary limit established of 16 in. square. To achieve these limits, however, shear reinforcement (*) is noted around the exterior and interior columns, and stirrups are required in the ribs around the drop head at interior columns.

Minimum size columns are part of the architectural requirements and so provisions for shear reinforcement are required. The last character in the stirrup notation, i.e., the "one" indicates that such stirrups extend from the face of the solid head to the first cross rib (36 in.). See Fig. 11-4 for details and note that the vertical legs of stirrups are #4 bars spaced at 6 in.

Providing a shear cap is one option for satisfying the two-way shear requirements ($v_u \le v_c$) at the exterior columns. Assume that it satisfies architectural requirements here. The asterisk (*) after minimum size square exterior column ($c_1 = c_2 = 15$ in.*) indicates that $4\sqrt{f_c'} < v_u \le 6\sqrt{f_c'}$.

Proportioning shear cap. A shear cap will stiffen the exterior column, very slightly increasing $-M_{ext}$. It will reduce clear span very slightly, reducing $-M_{ext}$. It will usually be within acceptable limits of accuracy to neglect these minor effects as though the increases were equal to the decreases since the shear cap will be proportioned to the next higher dimension in integral inch-units. A direct solution for the minimum size shear cap is difficult, but trial solutions with the benefit of the peripheral shear constants in Table 11-5 are relatively simple.

Total factored load = superimposed factored load
+ (1.2) (0.705 × 150)
= 184 + 127
w_u = 311 psf

Take (conservatively) $V_u = (0.311)(30 \times ½ \times 30) = 140$ kips

Try a shear cap projecting 11 in. (11-in. depth) which will add 11 in. to column dimensions. Use $c'_1 = c'_2 = 26$ in. The peripheral shear constraints, from Table 11-5, for $c'_1 = c'_2 = 26$ in. and $h = 15$ in., are:

$c_{AB} = 10.19$ in.; $A_c = 1{,}385$ in.^{2} and $J_c = 175{,}700$ in.^{4}

Read on Page 11-84: $M_{edge} = -254$ ft-kips; $M_{bot} = +611$ ft-kips and $M_{int} = -683$ ft-kips

$M_o = (254 + 683)/2 + 611 = 1{,}080$ ft-kips

Unbalanced gravity load moment transferred by shear = $0.3M_o$ (ACI 13.6.3.6).
$0.3M_o = 0.3(1{,}080) = 324$ ft-kips

Take shear transfer coefficient (conservatively), $\gamma_v = 0.40$ (ACI 11.11.7.1).

$$v_u = \frac{V_u}{A_c} + \frac{\gamma_v M c_{AB}}{J_c}$$

$$v_u = \frac{140{,}000}{1{,}385} + \frac{(0.40)(324)(12)(1{,}000)(10.19)}{(175{,}700)}$$

$v_u = 101 + 90 = 191$ psi

$\phi v_c = (0.75)(4)\sqrt{4{,}000}$

$\phi v_c = 190$ psi $\approx v_u$, okay

Nominal shear strength of concrete ($v_c = 4\sqrt{f'_c}$) is controlled by ACI Eq. 11-33, because in ACI Eq. 11-32, $(\alpha_s d/b_o + 2) = (30 \times 14)/109 + 2 = 5.85 > 4$.

An 11-in. deep shear cap projecting 11 in. from the column will be adequate. Note that the shear analysis was actually made for a square column head 26 × 26 in., whereas the face of the shear cap will be at $c_1 + 11$ in. = 26 in. deep and $c_2 + (2)(11) = 37$ in. wide. See Fig. 11-7.

Complete Example 1 by reading the required flexural reinforcement from the tabulated design on Page 11-84:

Edge panel

Strips parallel to edge same as interior panels.
Strips at right angles to edge,

Column strip
13-#5 plus 4-#5 in 60-in. effective width; Top bars at edge
1-#7, 1-#8 } Bottom bars per rib in 5 ribs
20-#6 Top bars at first interior column

Middle strip
No top bars required at edge (ACI 13.6.6.1)
2-#6 Bottom bars per rib in 5 ribs
14-#5 Top bars at first interior column centerline

Interior panels

Column strip – 18-#6 Top bars at other interior columns
2-#6 Bottom bars per rib in 5 ribs

Middle strip – 14-#5 Top bars on other column centerlines
2-#5 Bottom bars per rib in 5 ribs

Stirrups #4 bars spaced at 6 in. extending 36 in. in (20) ribs at all interior column solid heads.

Example 2. Select a waffle flat slab floor system with square panels and center-to-center spans of columns $\ell_1 = \ell_2 = 36'\text{-}0''$ for a superimposed factored load $w_u = 150$ psf.

In the tabulated designs on Page 11-84, read for $\ell_1 = \ell_2 = 36'\text{-}0''$ and $w_u = 150$ psf:

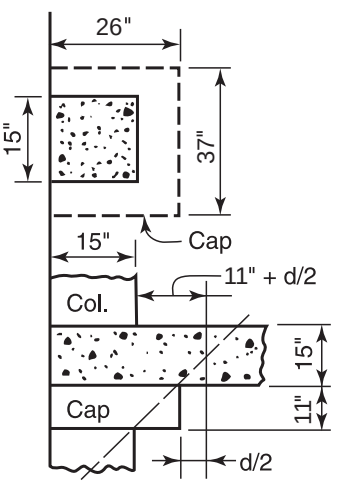


Figure 11-7 Shear Cap

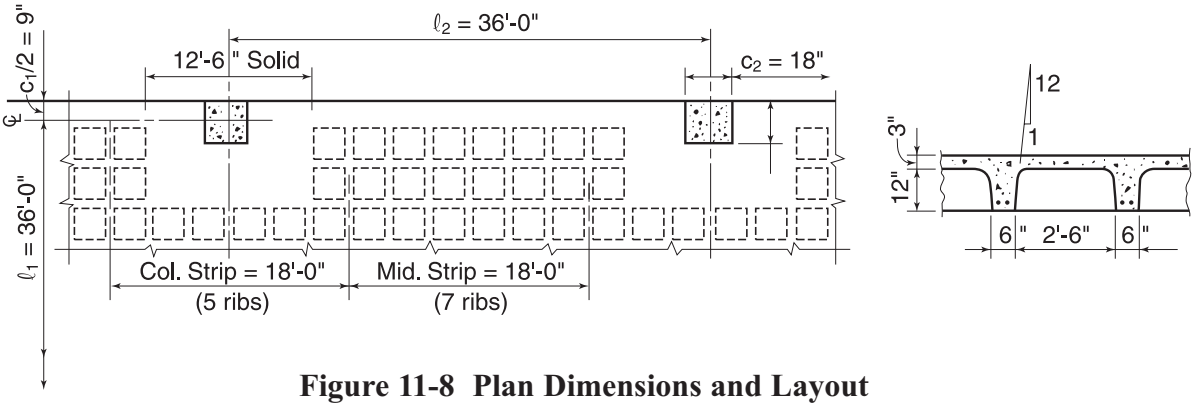


Figure 11-8 Plan Dimensions and Layout

12″ + 3″, 6-in. ribs @ 36 in. This design requires square exterior columns $c_1 = c_2 = 20$ in.*

Shear reinforcement is required at exterior columns. Interior columns are 18 in. square. Stirrups are required at interior columns. If these column dimensions are satisfactory, this design should suffice.

SPECIAL DETAILS

Examples 1 and 2 illustrate the various adjustments required for designs outside the conditions tabulated. For these and similar adjustments, the design aids (tables, curves, etc.) of this Chapter and Chapters 9 and 10 should reduce design time to a minimum.

Special details will have to be developed to complete the design of an actual project. It is impossible to tabulate designs for the variety of edge conditions which may be required. As noted, cantilever edges are structurally desirable and will simplify design. Minimum solid sections as flush depth edge beams are shown in Fig. 11-2. These beams must be investigated for torsion, as well as flexure and vertical shear. Whenever architectural requirements preclude cantilever edges and permit spandrel edge beams projecting below the slab, the use of such spandrel beams will stiffen edges for better structural performance.

Where use of headed shear stud reinforcement is desirable to maintain uniform floor depth or column size for a few panels with longer spans or heavier loads than the remainder of a floor system, a special design will be required. Design of headed shear stud reinforcement is prescribed by the Code (ACI 11.11.5 and Commentary). Other types of shear reinforcement are stirrups (ACI 11.11.3) and structural steel shearheads (ACI 11.11.4). For total depth of solid head less than 12 inches, the feasibility of fabricating and placing shear reinforcement, other than headed shear stud reinforcement, should be investigated.

MANUAL EXAMPLE

To illustrate the design assumptions, applicable Code requirements, and the procedures used in the preparation of the waffle flat slab tabulated designs, one of the tabulated designs will be reviewed with all calculations performed longhand. This review should also provide guidance to extend the scope of the tabulated designs to longer spans or heaver loads; to use other compressive strengths of concrete; or conditions of support other than the tabulated size square colums.

Review the tabulated design, on Page 11-84, for an intermediate waffle flat slab floor with square panels; $\ell_1 = \ell_2 = 36'\text{-}0''$; 12-in. deep ribs plus 3-in. top slab depth; 6-in. wide ribs at a 3′-0″ module; superimposed factored live load = 100 psf; normal-weight concrete; f'_c = 4,000 psi; Grade 60 reinforcing bars, f_y = 60,000 psi; 18-in. square columns (exterior and interior). For plan dimensions and layout, see Fig 11-8.

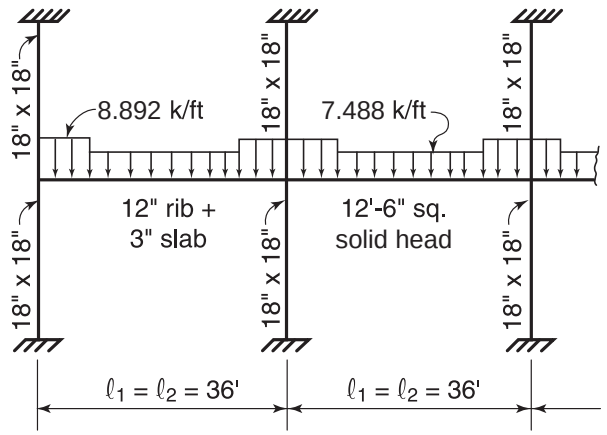


Figure 11-9 Schematic of Waffle Flat Slab Frame and Factored Loads

Factored Loads

Floor (joist) dead load = 90 psf (Table 11-1)

Joist w_D = 1.2 (90) = 108 psf = 0.108 ksf

Solid head w_D = 1.2 (15/12) 150 = 225 psf = 0.225 ksf

w_L = 100 psf = 0.100 ksf

Floor w_D = 36 (0.108) + (1/3)(36)(0.225 – 0.108)
= 3.888 + 1.404 = 5.292 kips/ft

Floor w_L = 36(0.100) = 3.6 kips/ft

$w_D + w_L$ = 5.292 + 3.6 = 8.892 kips/ft (solid head)

$w_D + w_L$ = 3.888 + 3.6 = 7.488 kips/ft (outside head)

Ratio of Service Live Load to Service Dead Load:

L/D = [100/1.6]/90 = 0.69 < 2, Okay... (ACI 13.6.1.5)

End Span

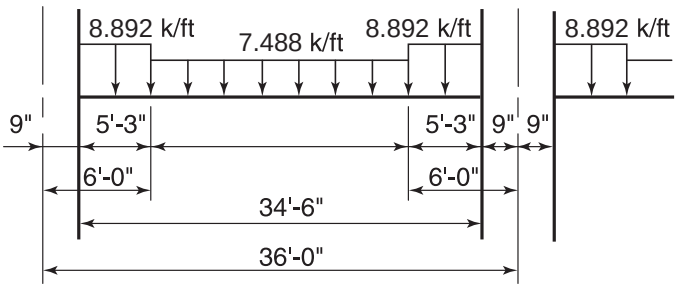
Total Static Moment, M_o:

M_o (outside head) = $7.488(34.5)^2/8$ = 1,114.074 ft-kips

M_o (head) = $(8.892 - 7.488)(5.25)^2/2$ = 19.349 ft-kips

M_o = 1,114.074 + 19.349 = 1,133.423 ft-kips

Panel Moments (ACI 13.6.3.3)



Exterior Column (Negative Factored Moment)

M_u = 0.26(1,133.423) = 294.690 ft-kips
(tabulated: 295)

Column strip resists 100% of M_u; 1.00(294.690) = 294.690 ft-kips (ACI 13.6.4.2)

Bottom (Positive Factored Moment)

M_u = 0.52(1,133.423) = 589.380 ft-kips
(tabulated: 590)

Column strip resists 60% of M_u; 0.60(589.380) = 353.628 ft-kips (ACI 13.6.4.4)

Middle strip resists 40% of M_u; 0.40(589.380) = 235.752 ft-kips

First Interior Column (Negative Factored Moment)

M_u = 0.70(1,133.423) = 793.396 ft-kips
(tabulated: 794)

Column strip resists 75% of M_u; 0.75(793.396) = 595.047 ft-kips (ACI 13.6.4.1)

Middle strip resists 25% of M_u; 0.25(793.396) = 198.349 ft-kips

Flexural Reinforcement

$$\text{Required } A_s = \frac{1.7 f_c' bd}{2 f_y} - \frac{1}{2}\sqrt{\frac{2.89(f_c' bd)^2}{(f_y)^2} - \frac{6.8 f_c' b M_u}{\phi (f_y)^2}}$$

For f_c' = 4,000 psi, f_y = 60,000 psi and ϕ = 0.90:

Required $A_s = 0.680d - \sqrt{0.462d^2 - 0.0252M_u}$ where M_u is in units of in.-kips/ft and A_s is in units of in.^{2}/ft

d = (3 + 12) – 1 (concrete cover) – 0.75 (avg. d_b)
= 13.25 in.

Exterior Column (Column Strip Top Bars)

M_u = 12(294.690)/12 = 294.690 in.-kips/ft

$A_s = 0.680(13.25)^2 - \sqrt{0.462(13.25)^2 - 0.0252(294.690)}$
= 0.426 in.^{2}/ft

Total A_s = 0.426(12) = 5.11 in.^{2}

(tabulated: 11–#6 bars; A_s = 4.84 in.^{2})

Column Strip Bottom Bars

M_u = 12(353.628)/12 = 353.628 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(353.628)}$
= 0.513 in.^{2}/ft

Total A_s = 0.513(12) = 6.16 in.^{2}

(tabulated: 5–#7 bars and 5-#8 bars;
A_s = 6.95 in.^{2})

Middle Strip Bottom Bars

M_u = 12(235.752)/24 = 117.876 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(117.876)}$
= 0.170 in.^{2}/ft

Total A_s = 0.170(24) = 4.08 in.^{2}

(tabulated: 14–#5 bars; A_s = 4.34 in.^{2})

First Interior Column (Column Strip Top Bars)

M_u = 12(595.047)/12 = 595.047 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(595.047)}$
= 0.879 in.^{2}/ft

Total A_s = 0.879(12) = 10.55 in.^{2}

(tabulated: 23–#6 bars; A_s = 10.12 in.^{2})

First Interior Column (Middle Strip Top Bars)

$M_u = 12(198.349)/24 = 99.175$ in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(99.175)}$
$= 0.144$ in.^{2}/ft

Total $A_s = 0.144(24) = 3.46$ in.^{2}

(tabulated: 19–#5 bars; $A_s = 5.89$ in.^{2})

The maximum spacing of the top bars in the middle strip is limited to 18 in. (ACI 13.3.2). The calculated total required $A_s = 3.46$ in.^{2}; 12-#5 bars would provide an $A_s = 3.72$ in.^{2} But the spacing of the 12-#5 bars in the 24′-0″ wide middle strip would be 288/11 = 26 in. > 18 in., which exceeds the Code limit.

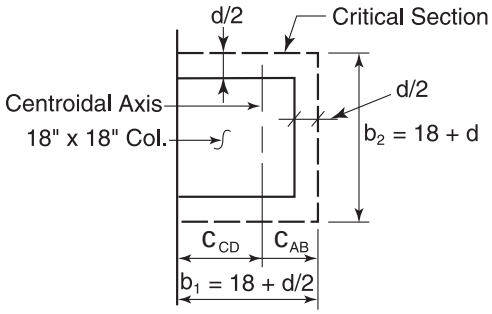
The computer program prescribes 19-#5 bars whose spacing is 288/19 = 15 in. < 18 in., Okay

Verify $\phi = 0.90$ for flexure; for $f'_c = 4{,}000$ psi and $f_y = 60{,}000$ psi, maximum $\rho = 0.0181$ for $\varepsilon_t = 0.005$ and $\phi = 0.90$.

Location	Tabulated Design	A_s, in.^{2}	b, in.	d, in.	ρ
Column strip top bars at exterior column	11-#6	4.84	144	13.25	0.0025
Column strip bottom bars	5-#7 and 5-#8	6.95	144	13.25	0.0036
Middle strip bottom bars	14-#5	4.34	288	13.25	0.0011
First Interior Column strip top bars	23-#6	10.12	144	13.25	0.0053
Middle strip top bars	19-#5	5.89	42	13.25	0.0106

In all cases, actual $\rho <$ maximum ρ, so $\phi = 0.90$.

Shear Constants at Exterior Column (ACI R11.12.6.2):



$b_1 = 18 + 13.25/2 = 24.625$ in.

$b_2 = 18 + 13.25 = 31.25$ in.

$b_0 = 2 \times 24.625 + 31.25 = 80.50$ in.^{2}

$A_c = 80.50 \times 13.25 = 1{,}066.625$ in.^{2}

(tabulated in Table 11-5; $A_c = 1{,}067$ in.^{2})

$c_{AB} = (2)(13.25)(24.625)^2/2 = 7.533$ in.

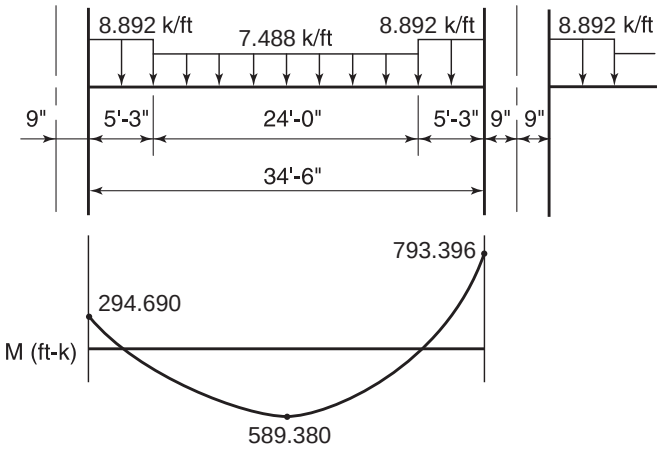
(tabulated in Table 11-5; $c_{AB} = 7.53$ in.)

$c_{CD} = 24.625 - 7.533 = 17.092$ in.

$J_c = b_1 d^3/6 + 2d[(c_{AB})^3 + (c_{CD})^3]/3 + b_2 d c_{AB}$
$= 24.625(13.25)^3/6 + 2(13.25)[(7.533)^3 + 17.092^3)]/3$
$+ 31.25(13.25)(7.533)^3$
$= 9{,}547.125 + 47{,}882.539 + 23{,}496.428$
$= 80{,}926$ in.^{4}

(tabulated in Table 11-5; $J_c = 80{,}900$ in.^{4})

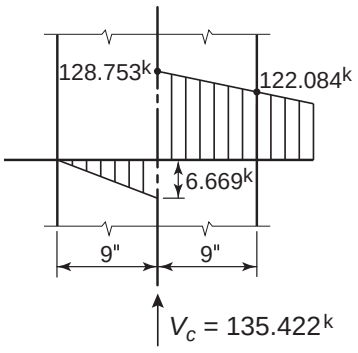
Factored Moments in End Span:



Calculate Factored Shear, V_u, at Centerline of Exterior Column

V_u (at exterior column face)
$= 7.488(34.5)/2 + (8.892 - 7.488)(5.25)$
$- (793.396 - 294.690)/34.5$
$= 122.084$ kips

V_u (at centerline exterior column)
$= 122.084 + 8.892(18/12)$
$= 135.422$ kips



Exterior Column

Shear Check at Exterior Column:

$v_c = (\alpha_s d/b_0 + 2)\sqrt{f'_c} \le 4\sqrt{f'_c}$ (ACI Eq. 11-32)
$= (30 \times 13.25/80.50 + 2)\sqrt{f'_c} = 6.94\sqrt{f'_c}$

ACI Eq. 11-35 governs: use $v_c = 4\sqrt{f'_c} = 4\sqrt{4{,}000} = 253$ psi

$\phi v_c = 0.75(253) = 190$ psi or 0.191 ksi

$$v_u = \frac{V_u}{A_c} + \frac{\gamma_v M_u c_{AB}}{J_c} \quad \text{(ACI R11.11.7.2)}$$

where:

$\gamma_v = (1 - \gamma_f)$ (ACI Eq. 11-37)

$\gamma_f = 1/(1 + (2/3)\sqrt{b_1/b_2})$ (ACI Eq. 13-1)

$= 1/(1 + (2/3)\sqrt{24.625/31.25} = 0.628$

$\gamma_v = 1 - \gamma_f = 1 - 0.628 = 0.372$

Where $M_u = 0.3M_o$ (ACI 13.6.3.6)

$M_u = 0.3(1{,}133.423) = 340.027$ ft-kips

$v_u = 135.422/1{,}066.625 + 0.372(12 \times 340.027) \times (7.533/80{,}926) = 0.127 + 0.141$

$= 0.268$ ksi, $> \phi v_c$, N.G.

An option would be to use headed shear stud reinforcement to provide the required design shear strength (ACI 11.11.5).

Another option is to use the provisions in ACI 13.5.3.3: If $0.75V_c > V_u$, γ_f can be adjusted up to 1.0.

$0.75\phi V_c = 0.75\phi(4\sqrt{f'_c})b_o d$

$= 0.75(0.75)(4\sqrt{4{,}000})(80.50)(13.25)/1{,}000$

$0.75\phi V_c = 151.783$ kips $> V_u$, so γ_f can be adjusted up to 1.0

For $\gamma_v = 0.372$, total $v_u = 0.268$ ksi > 0.190 ksi, N.G.

Therefore, limit total v_u to 0.190 ksi and solving for required γ_v.

$0.190 = 135.422/1{,}066.625 + \gamma_v(12 \times 340.027)(7.533)/80{,}926$

$\gamma_v = 0.166$

$\gamma_f = 1 - \gamma_v = 1 - 0.166 = 0.834$

The computer program optimizes γ_f to 0.882; thus, $\gamma_v = 1 - 0.882 = 0.118$

Shear check for $\gamma_v = 0.118$

$v_u = 135.422/1{,}066.625 + 0.118(12 \times 340.027)(7.533)/80{,}926$

$v_u = 0.127 + 0.045$

$v_u = 0.172$ ksi $< \phi v_c$, Okay

Determine Number of Extra Top Bars Required in Column Strip at Exterior Column:

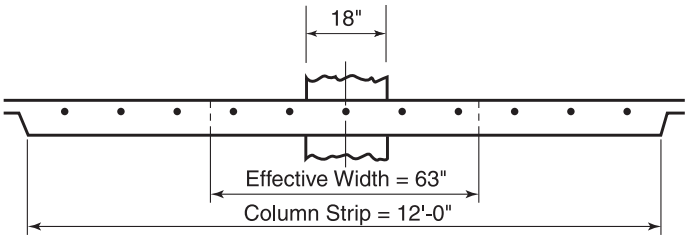
Unbalanced $M_u = 0.26M_o = 0.26(1{,}133.423) = 294.690$ ft-kips

$\gamma_f M_u = 0.882(294.690) = 259.917$ ft-kips

Effective Width = 18 + 1.5(15)2 = 63 in.

Bar Layout: 11 – #6 top bars are required to resist exterior $-M_u$ in column strip

Bar spacing = 12 × 12/11 ≈ 13 in.



Try 6-#6 additional top bars (as per tabulated design) for a total of 11 – #6 reinforcing bars in the effective width

Calculate design moment strength, ϕM_n

$A_s = (11)(0.44) = 4.84$ in.^{2} for 11–#6 top bars

$a = A_s f_y/(0.85 f'_c b) = 4.84(60)/(0.85(4)63) = 1.356$ in.

$\phi M_n = \phi A_s f_y(d - a/2)$

$= 0.90(4.84)(60)(13.25 - 1.356/2)/12$

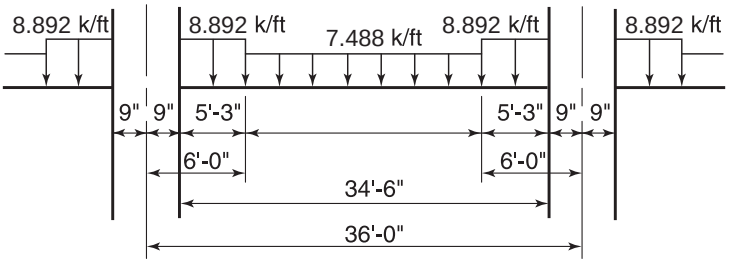
$\phi M_n = 273.818$ ft-kips $> \gamma_f M_u$, Okay

ACI 13.5.3.3 limits the amount of flexural reinforcement in the effective width so that $\varepsilon_t \geq 0.010$. For $f'_c = 4{,}000$ psi and $f_y = 60{,}000$ psi, a value of $\varepsilon_t = 0.010$ corresponds to $\rho_{max} = 0.011$. For the 11-#6 top bars in the effective width:

$$\rho = \frac{A_s}{bd} = \frac{4.84}{63(13.25)} = 0.0058$$

$\rho < \rho_{max}$, Okay

Interior Span



Total Static Moment, M_o:

$M_o = 1{,}133.423$ ft-kips (the same value as in the end span)

Panel Moments

Bottom (Positive Factored Moment)

M_u = 0.35(1,133.423) = 396.698 ft-kips

Column strip resists 60% of M_u;
0.60(396.698) = 238.019 ft-kips (ACI 13.6.4.4)

Middle strip resists 40% of M_u;
0.40(396.698) = 158.679 ft-kips

Top (Negative Factored Moment)

M_u = 0.65(1,133.423) = 736.725 ft-kips

Column strip resists 75% of M_u;
0.75(736.725) = 552.544 ft-kips (ACI 13.6.4.1)

Middle strip resists 25% of M_u;
0.25(736.725) = 184.181 ft-kips

Flexural Reinforcement

Column Strip Bottom Bars

M_u = 12(238.019)/12 = 238.019 in-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(238.019)}$
= 0.343 in.^{2}/ft

Total A_s = 0.343(12) = 4.12 in.^{2}
(tabulated: 10–#6 bars; A_s = 4.40 in.^{2})

Middle Strip Bottom Bars

M_u = 12(158.679)/24 = 79.340 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(79.340)}$
= 0.116 in.^{2}/ft

Total A_s = 0.116(24) = 2.78 in.^{2}
(tabulated: 14–#4 bars; A_s = 2.80 in.^{2})

Column Strip Top Bars

M_u = 12(552.544)/12 = 552.544 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(552.544)}$
= 0.813 in.^{2}/ft

Total A_s = 0.813(12) = 9.76 in.^{2}
(tabulated: 30–#5 bars; A_s = 9.30 in.^{2})

Middle Strip Top Bars

M_u = 12(184.181)/24 = 92.091 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(92.091)}$
= 0.134 in.^{2}/ft

Total A_s = 0.134(24) = 3.22 in.^{2}
(tabulated: 19–#5 bars; A_s = 5.89 in.^{2})

Verify ϕ = 0.90 for flexure; for f'_c = 4,000 psi and f_y = 60,000 psi, maximum ρ = 0.0181 for ε_t = 0.005 and ϕ = 0.90.

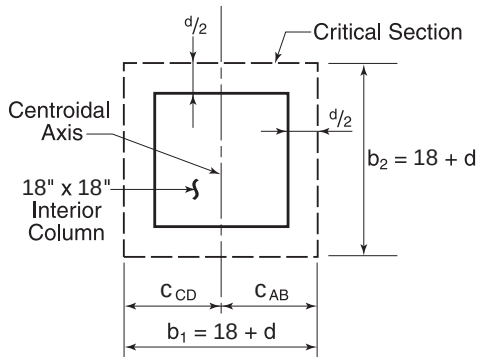
Location	Tabulated Design	A_s, in.^{2}	b, in.	d, in.	ρ
Column strip bottom bars	10-#6	4.40	144	13.25	0.0023
Middle strip bottom bars	14-#4	2.80	288	13.25	0.0007
Column strip top bars	30-#5	9.30	144	13.25	0.0049
Middle strip top bars	19-#5	5.89	42	13.25	0.0106

In all cases, actual ρ < maximum ρ, so ϕ = 0.90.

The maximum spacing of the top bars in the middle strip is limited to 18 in. (ACI 13.3.2). The calculated total required A_s = 3.22 in.^{2}; 11-#5 bars would provide an A_s = 3.41 in.^{2} But the spacing of the 11-#5 bars in the 24'-0" wide middle strip would be 288/11 = 26 in. > 18 in., which exceeds the Code limit.

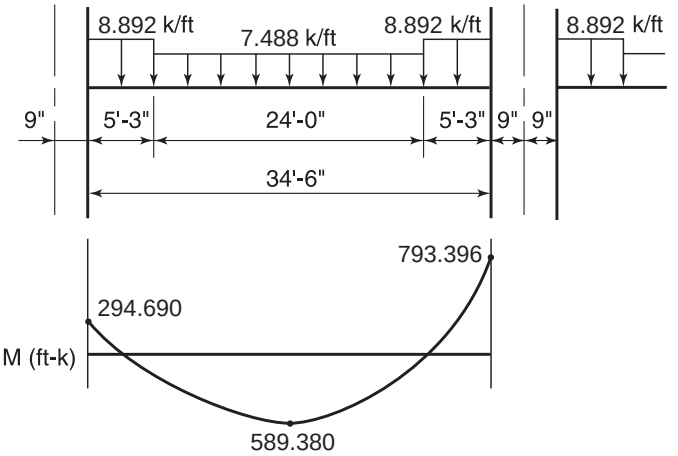
The computer program prescribes 19-#5 bars whose spacing is 288/19 = 15 in. < 18 in., Okay

Shear Constants at Interior Column (ACI R11.12.6.2):



b_1 = b_2 = 18 + 13.25 = 31.25 in.
b_0 = 4 × 31.25 = 125 in.
A_s = 125 × 13.25 = 1,656.250 in.^{2}
(tabulated in Table 11-5; A_c = 1,656 in.^{2})
c_{AB} = c_{CD} = 31.25/2 = 15.625 in.
(tabulated in Table 11-5; c_{AB} = 15.63 in.)
J_c = $(db_1/6)[d^2 + 4b_1^2]$
J_c = (13.25(31.25)/6)[(13.25)^2 + 4(31.25)^2]
= 281,688 in.^{4}
(tabulated in Table 11-5; J_c = 281,700 in.^{4})

Factored Moments in End Span



Calculate Factored Shear, V_u at Centerline of First Interior Column:

V_u (at first interior column face) = 7.488(34.5)/2
+ (8.892 – 7.488)(5.25) + (793.396 – 294.690)/34.5
= 150.994 kips

V_u (at centerline first interior column)

= 150.994 + 7.488(34.5)/2
+ (8.892 – 7.488)(5.25) + 8.892(18/12)
= 300.871 kips

For checking shear due to combined effects (i.e., direct shear plus transfer of unbalanced moment), the factored moment is:

$M_{int} = 0.07[(w_D + 0.5\,w_L)\,\ell_2\,\ell_n^2 - w_D'\ell_2'(\ell_n')^2]$. . . . . (ACI Eq. 13-7)

where w_D', ℓ_2' and ℓ_n' refer to the shorter span

$M_{int} = 0.07\,[(0.126 + 0.050)36(34.5)^2 - 0.126(36)(34.5)^2]$
= 0.07 [7,541.424 – 5,398.974]
= 149.972 ft-kips

Shear Check:

With factored moment M_{int} = 149.972 ft-kips, the factored shear, V_u, is:

$V_u = w_u\ell/2 + w_D\ell/2$ (i.e., full factored load on one span and factored dead load only on other span)

V_u = 7.488(36)/2 + (8.892 – 7.488)5.25
+ 3.888(36)/2 + 1.404(5.25)
= 134.784 + 7.371 + 69.984 + 7.371
V_u = 219.510 kips

Shear Check at First Interior Column

$v_c = (\alpha_s d/b_o + 2)\sqrt{f_c'} \le 4\sqrt{f_c'}$ (ACI Eq. 11-32)

$v_c = (40 \times 13.25/125 + 2)\sqrt{f_c'} = 6.24\sqrt{f_c'}$

ACI Eq. 11-33 governs: use $v_c = 4\sqrt{f_c'} = 4\sqrt{4{,}000} = 253$ psi

$\phi v_c = 0.75(253) = 190$ psi

Case 1: For factored shear V_{int} = 300.871 kips and no unbalanced moment

v_u = 300.871/1,656.250 = 0.182 ksi or 182 psi

ϕv_c = 190 psi > v_u, Okay

Case 2: For factored shear V_u = 219.510 kips and factored moment M_{int} = 149.972 ft-kips

$\gamma_f = 1/(1 + 2/3\sqrt{b_1/b_2})$ (ACI Eq. 13-1)
$= 1/(1 + 2/3\sqrt{31.25/31.25}) = 0.60$

$\gamma_v = 1 - \gamma_f = 1 - 0.60 = 0.40$

$v_u = V_u/A_c + \gamma_v\,M_{int}\,c_{AB}/J_c$

v_u = 219.510/1,656.250 + 0.40(149.972 × 12) ×
15.625/281,668 = 0.133 + 0.040
= 0.173 ksi or 173 psi

ϕv_c = 190 psi > v_u, Okay

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
10	6	3.03	103	1,700	3.82	164	2,800	7.13	242	8,400
	7	3.16	133	2,400	3.94	213	4,100	7.63	320	12,800
	8	3.28	164	3,200	4.05	266	5,600	8.13	406	18,500
	9	3.41	198	4,300	4.17	323	7,500	8.63	500	25,900
	10	3.53	233	5,500	4.29	384	9,800	9.13	602	35,100
	11	3.66	271	7,000	4.41	449	12,500	9.63	712	46,500
	12	3.78	310	8,700	4.53	518	15,700	10.13	830	60,400
	13	3.91	352	10,800	4.65	591	19,500	10.63	956	77,000
	14	4.03	395	13,200	4.77	668	24,000	11.13	1,090	96,800
	15	4.16	441	15,900	4.89	749	29,100	11.63	1,232	120,000
	16	4.28	488	19,000	5.01	834	35,000	12.13	1,382	147,200
	17	4.41	538	22,600	5.13	923	41,800	12.63	1,540	178,600
	18	4.53	589	26,600	5.26	1,016	49,400	13.13	1,706	214,700
	19	4.66	643	31,200	5.38	1,113	58,100	13.63	1,880	256,000
	20	4.78	698	36,300	5.50	1,214	67,800	14.13	2,062	302,900
	21	4.91	756	42,000	5.62	1,319	78,600	14.63	2,252	355,900
	22	5.03	815	48,300	5.74	1,428	90,800	15.13	2,450	415,600
	23	5.16	877	55,300	5.87	1,541	104,200	15.63	2,656	482,300
	24	5.28	940	63,100	5.99	1,658	119,100	16.13	2,870	556,700
12	6	3.53	120	2,600	4.48	189	4,400	8.13	276	12,400
	7	3.66	154	3,600	4.60	244	6,100	8.63	362	18,400
	8	3.78	189	4,800	4.72	303	8,300	9.13	456	26,100
	9	3.91	227	6,300	4.83	366	10,900	9.63	558	35,700
	10	4.03	266	8,000	4.95	433	13,900	10.13	668	47,600
	11	4.16	308	10,000	5.07	504	17,600	10.63	786	62,000
	12	4.28	351	12,300	5.19	579	21,800	11.13	912	79,300
	13	4.41	397	14,900	5.31	658	26,700	11.63	1,046	99,800
	14	4.53	444	18,000	5.43	741	32,300	12.13	1,188	123,900
	15	4.66	494	21,400	5.55	828	38,800	12.63	1,338	152,000
	16	4.78	545	25,400	5.67	919	46,100	13.13	1,496	184,500
	17	4.91	599	29,800	5.79	1,014	54,400	13.63	1,662	221,800
	18	5.03	654	34,800	5.91	1,113	63,800	14.13	1,836	264,400
	19	5.16	712	40,400	6.03	1,216	74,300	14.63	2,018	312,800
	20	5.28	771	46,500	6.16	1,323	86,000	15.13	2,208	367,400
	21	5.41	833	53,400	6.28	1,434	99,000	15.63	2,406	428,800
	22	5.53	896	61,000	6.40	1,549	113,400	16.13	2,612	497,400
	23	5.66	962	69,400	6.52	1,668	129,300	16.63	2,826	573,900
	24	5.78	1,029	78,600	6.64	1,791	146,800	17.13	3,048	658,800

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
14	6	4.03	137	3,800	5.15	215	6,400	9.13	310	17,500
	7	4.16	175	5,200	5.26	276	8,800	9.63	404	25,400
	8	4.28	214	6,900	5.38	341	11,800	10.13	506	35,400
	9	4.41	256	8,800	5.50	410	15,200	10.63	616	47,700
	10	4.53	299	11,100	5.62	483	19,200	11.13	734	62,700
	11	4.66	345	13,700	5.73	560	23,900	11.63	860	80,600
	12	4.78	392	16,700	5.85	641	29,300	12.13	994	101,800
	13	4.91	442	20,000	5.97	726	35,500	12.63	1,136	126,700
	14	5.03	493	23,900	6.09	815	42,500	13.13	1,286	155,800
	15	5.16	547	28,200	6.21	908	50,500	13.63	1,444	189,300
	16	5.28	602	33,100	6.33	1,005	59,500	14.13	1,610	227,800
	17	5.41	660	38,500	6.45	1,106	69,600	14.63	1,784	271,700
	18	5.53	719	44,600	6.57	1,211	80,900	15.13	1,966	321,500
	19	5.66	781	51,300	6.69	1,320	93,500	15.63	2,156	377,700
	20	5.78	844	58,700	6.81	1,433	107,400	16.13	2,354	440,800
	21	5.91	910	66,900	6.93	1,550	122,800	16.63	2,560	511,300
	22	6.03	977	75,900	7.05	1,671	139,800	17.13	2,774	589,800
	23	6.16	1,047	85,800	7.18	1,796	158,500	17.63	2,996	676,900
	24	6.28	1,118	96,600	7.30	1,925	178,900	18.13	3,226	773,100
16	6	4.53	154	5,400	5.81	240	9,000	10.13	344	23,800
	7	4.66	196	7,300	5.93	307	12,300	10.63	446	34,100
	8	4.78	239	9,500	6.05	378	16,100	11.13	556	46,800
	9	4.91	285	12,000	6.16	453	20,600	11.63	674	62,200
	10	5.03	332	15,000	6.28	532	25,700	12.13	800	80,700
	11	5.16	382	18,300	6.40	615	31,700	12.63	934	102,600
	12	5.28	433	22,000	6.51	702	38,400	13.13	1,076	128,300
	13	5.41	487	26,300	6.63	793	46,100	13.63	1,226	158,200
	14	5.53	542	31,000	6.75	888	54,700	14.13	1,384	192,800
	15	5.66	600	36,400	6.87	987	64,500	14.63	1,550	232,400
	16	5.78	659	42,300	6.99	1,090	75,400	15.13	1,724	277,600
	17	5.91	721	48,900	7.11	1,197	87,500	15.63	1,906	328,700
	18	6.03	784	56,200	7.23	1,308	101,000	16.13	2,096	386,400
	19	6.16	850	64,200	7.35	1,423	115,900	16.63	2,294	451,200
	20	6.28	917	73,000	7.47	1,542	132,400	17.13	2,500	523,500
	21	6.41	987	82,700	7.59	1,665	150,400	17.63	2,714	604,000
	22	6.53	1,058	93,300	7.71	1,792	170,300	18.13	2,936	693,200
	23	6.66	1,132	104,800	7.83	1,923	192,000	18.63	3,166	791,800
	24	6.78	1,207	117,400	7.95	2,058	215,600	19.13	3,404	900,300

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
18	6	5.03	171	7,300	6.48	266	12,200	11.13	378	31,500
	7	5.16	217	9,800	6.60	339	16,500	11.63	488	44,500
	8	5.28	264	12,700	6.71	416	21,400	12.13	606	60,400
	9	5.41	314	16,000	6.83	497	27,100	12.63	732	79,400
	10	5.53	365	19,700	6.94	582	33,600	13.13	866	101,900
	11	5.66	419	23,800	7.06	671	41,000	13.63	1,008	128,400
	12	5.78	474	28,500	7.18	764	49,300	14.13	1,158	159,100
	13	5.91	532	33,700	7.30	861	58,700	14.63	1,316	194,600
	14	6.03	591	39,500	7.41	962	69,200	15.13	1,482	235,300
	15	6.16	653	46,000	7.53	1,067	80,900	15.63	1,656	281,700
	16	6.28	716	53,100	7.65	1,176	94,000	16.13	1,838	334,200
	17	6.41	782	61,000	7.77	1,289	108,400	16.63	2,028	393,400
	18	6.53	849	69,700	7.89	1,406	124,300	17.13	2,226	459,700
	19	6.66	919	79,200	8.01	1,527	141,900	17.63	2,432	533,900
	20	6.78	990	89,600	8.13	1,652	161,100	18.13	2,646	616,300
	21	6.91	1,064	101,000	8.25	1,781	182,200	18.63	2,868	707,600
	22	7.03	1,139	113,300	8.37	1,914	205,200	19.13	3,098	808,400
	23	7.16	1,217	126,700	8.49	2,051	230,200	19.63	3,336	919,400
	24	7.28	1,296	141,300	8.61	2,192	257,400	20.13	3,582	1,041,100
20	6	5.53	188	9,700	7.15	291	16,100	12.13	412	40,700
	7	5.66	238	12,900	7.26	370	21,600	12.63	530	57,000
	8	5.78	289	16,600	7.38	453	27,800	13.13	656	76,400
	9	5.91	343	20,700	7.49	540	34,900	13.63	790	99,500
	10	6.03	398	25,300	7.61	631	43,000	14.13	932	126,600
	11	6.16	456	30,400	7.72	726	52,000	14.63	1,082	158,200
	12	6.28	515	36,100	7.84	825	62,100	15.13	1,240	194,600
	13	6.41	577	42,500	7.96	928	73,500	15.63	1,406	236,300
	14	6.53	640	49,500	8.08	1,035	86,100	16.13	1,580	283,800
	15	6.66	706	57,300	8.20	1,146	100,100	16.63	1,762	337,600
	16	6.78	773	65,800	8.31	1,261	115,500	17.13	1,952	398,200
	17	6.91	843	75,100	8.43	1,380	132,500	17.63	2,150	466,100
	18	7.03	914	85,400	8.55	1,503	151,200	18.13	2,356	542,000
	19	7.16	988	96,500	8.67	1,630	171,700	18.63	2,570	626,300
	20	7.28	1,063	108,700	8.79	1,761	194,000	19.13	2,792	719,600
	21	7.41	1,141	121,900	8.91	1,896	218,400	19.63	3,022	822,700
	22	7.53	1,220	136,200	9.03	2,035	244,800	20.13	3,260	936,000
	23	7.66	1,302	151,600	9.15	2,178	273,500	20.63	3,506	1,060,300
	24	7.78	1,385	168,300	9.27	2,325	304,600	21.13	3,760	1,196,300

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
22	6	6.03	205	12,600	7.81	317	20,800	13.13	446	51,600
	7	6.16	259	16,600	7.93	402	27,600	13.63	572	71,500
	8	6.28	314	21,200	8.04	491	35,400	14.13	706	95,100
	9	6.41	372	26,200	8.16	584	44,100	14.63	848	122,800
	10	6.53	431	31,900	8.27	681	53,900	15.13	998	155,100
	11	6.66	493	38,100	8.39	782	64,900	15.63	1,156	192,300
	12	6.78	556	45,100	8.51	887	77,100	16.13	1,322	235,000
	13	6.91	622	52,700	8.62	996	90,600	16.63	1,496	283,600
	14	7.03	689	61,100	8.74	1,109	105,600	17.13	1,678	338,600
	15	7.16	759	70,300	8.86	1,226	122,100	17.63	1,868	400,600
	16	7.28	830	80,400	8.98	1,347	140,200	18.13	2,066	470,000
	17	7.41	904	91,400	9.09	1,472	160,100	18.63	2,272	547,500
	18	7.53	979	103,300	9.21	1,601	181,800	19.13	2,486	633,600
	19	7.66	1,057	116,300	9.33	1,734	205,500	19.63	2,708	728,900
	20	7.78	1,136	130,400	9.45	1,871	231,300	20.13	2,938	834,100
	21	7.91	1,218	145,600	9.57	2,012	259,200	20.63	3,176	949,800
	22	8.03	1,301	162,100	9.69	2,157	289,500	21.13	3,422	1,076,600
	23	8.16	1,387	179,800	9.81	2,306	322,200	21.63	3,676	1,215,300
	24	8.28	1,474	198,900	9.93	2,459	357,500	22.13	3,938	1,366,500
24	6	6.53	222	16,000	8.48	342	26,300	14.13	480	64,200
	7	6.66	280	21,000	8.59	433	34,700	14.63	614	88,300
	8	6.78	339	26,500	8.71	528	44,200	15.13	756	116,600
	9	6.91	401	32,700	8.82	627	54,800	15.63	906	149,500
	10	7.03	464	39,600	8.94	730	66,700	16.13	1,064	187,500
	11	7.16	530	47,100	9.05	837	79,800	16.63	1,230	231,100
	12	7.28	597	55,400	9.17	948	94,300	17.13	1,404	280,700
	13	7.41	667	64,500	9.29	1,063	110,300	17.63	1,586	336,900
	14	7.53	738	74,400	9.40	1,182	127,900	18.13	1,776	400,100
	15	7.66	812	85,200	9.52	1,305	147,300	18.63	1,974	471,000
	16	7.78	887	97,000	9.64	1,432	168,400	19.13	2,180	550,100
	17	7.91	965	109,800	9.76	1,563	191,400	19.63	2,394	637,900
	18	8.03	1,044	123,700	9.88	1,698	216,500	20.13	2,616	735,200
	19	8.16	1,126	138,800	9.99	1,837	243,800	20.63	2,846	842,500
	20	8.28	1,209	155,000	10.11	1,980	273,300	21.13	3,084	960,400
	21	8.41	1,295	172,500	10.23	2,127	305,200	21.63	3,330	1,089,700
	22	8.53	1,382	191,300	10.35	2,278	339,600	22.13	3,584	1,230,900
	23	8.66	1,472	211,500	10.47	2,433	376,700	22.63	3,846	1,384,900
	24	8.78	1,563	233,100	10.59	2,592	416,600	23.13	4,116	1,552,400

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
26	6	7.03	239	19,900	9.14	368	32,700	15.13	514	78,800
	7	7.16	301	26,000	9.26	465	43,000	15.63	656	107,600
	8	7.28	364	32,800	9.37	566	54,400	16.13	806	141,100
	9	7.41	430	40,200	9.49	671	67,200	16.63	964	179,800
	10	7.53	497	48,400	9.60	780	81,300	17.13	1,130	224,200
	11	7.66	567	57,400	9.72	893	96,800	17.63	1,304	274,800
	12	7.78	638	67,200	9.84	1,010	114,000	18.13	1,486	332,000
	13	7.91	712	77,900	9.95	1,131	132,800	18.63	1,676	396,500
	14	8.03	787	89,500	10.07	1,256	153,300	19.13	1,874	468,700
	15	8.16	865	102,200	10.19	1,385	175,700	19.63	2,080	549,300
	16	8.28	944	115,900	10.30	1,518	200,200	20.13	2,294	638,900
	17	8.41	1,026	130,700	10.42	1,655	226,700	20.63	2,516	738,000
	18	8.53	1,109	146,700	10.54	1,796	255,500	21.13	2,746	847,300
	19	8.66	1,195	164,000	10.66	1,941	286,600	21.63	2,984	967,400
	20	8.78	1,282	182,600	10.78	2,090	320,200	22.13	3,230	1,099,000
	21	8.91	1,372	202,500	10.89	2,243	356,400	22.63	3,484	1,242,800
	22	9.03	1,463	223,900	11.01	2,400	395,400	23.13	3,746	1,399,600
	23	9.16	1,557	246,800	11.13	2,561	437,300	23.63	4,016	1,570,000
	24	9.28	1,652	271,300	11.25	2,726	482,100	24.13	4,294	1,754,800
28	6	7.53	256	24,400	9.81	393	40,000	16.13	548	95,400
	7	7.66	322	31,800	9.92	496	52,400	16.63	698	129,500
	8	7.78	389	39,900	10.04	603	66,100	17.13	856	168,800
	9	7.91	459	48,800	10.15	714	81,300	17.63	1,022	213,900
	10	8.03	530	58,500	10.27	829	97,900	18.13	1,196	265,400
	11	8.16	604	69,100	10.38	948	116,200	18.63	1,378	323,600
	12	8.28	679	80,600	10.50	1,071	136,200	19.13	1,568	389,300
	13	8.41	757	93,100	10.62	1,198	158,100	19.63	1,766	462,800
	14	8.53	836	106,600	10.73	1,329	181,900	20.13	1,972	544,900
	15	8.66	918	121,300	10.85	1,464	207,800	20.63	2,186	636,000
	16	8.78	1,001	137,100	10.97	1,603	235,800	21.13	2,408	736,900
	17	8.91	1,087	154,200	11.08	1,746	266,200	21.63	2,638	848,100
	18	9.03	1,174	172,500	11.20	1,893	299,000	22.13	2,876	970,300
	19	9.16	1,264	192,200	11.32	2,044	334,400	22.63	3,122	1,104,200
	20	9.28	1,355	213,400	11.44	2,199	372,500	23.13	3,376	1,250,500
	21	9.41	1,449	236,000	11.56	2,358	413,400	23.63	3,638	1,409,900
	22	9.53	1,544	260,200	11.67	2,521	457,200	24.13	3,908	1,583,200
	23	9.66	1,642	286,000	11.79	2,688	504,200	24.63	4,186	1,771,100
	24	9.78	1,741	313,500	11.91	2,859	554,500	25.13	4,472	1,974,400

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
30	6	8.03	273	29,600	10.48	419	48,400	17.13	582	114,300
	7	8.16	343	38,400	10.59	528	63,100	17.63	740	154,200
	8	8.28	414	48,000	10.71	641	79,400	18.13	906	200,000
	9	8.41	488	58,500	10.82	758	97,200	18.63	1,080	252,200
	10	8.53	563	69,900	10.93	879	116,700	19.13	1,262	311,400
	11	8.66	641	82,300	11.05	1,004	138,000	19.63	1,452	378,100
	12	8.78	720	95,700	11.17	1,133	161,200	20.13	1,650	452,800
	13	8.91	802	110,200	11.28	1,266	186,500	20.63	1,856	536,200
	14	9.03	885	125,800	11.40	1,403	213,900	21.13	2,070	628,900
	15	9.16	971	142,700	11.51	1,544	243,500	21.63	2,292	731,400
	16	9.28	1,058	160,900	11.63	1,689	275,600	22.13	2,522	844,500
	17	9.41	1,148	180,300	11.75	1,838	310,100	22.63	2,760	968,700
	18	9.53	1,239	201,200	11.87	1,991	347,300	23.13	3,006	1,104,800
	19	9.66	1,333	223,600	11.98	2,148	387,300	23.63	3,260	1,253,500
	20	9.78	1,428	247,500	12.10	2,309	430,300	24.13	3,522	1,415,600
	21	9.91	1,526	273,100	12.22	2,474	476,200	24.63	3,792	1,591,600
	22	10.03	1,625	300,300	12.34	2,643	525,400	25.13	4,070	1,782,500
	23	10.16	1,727	329,300	12.46	2,816	578,000	25.63	4,356	1,989,000
	24	10.28	1,830	360,200	12.57	2,993	634,000	26.13	4,650	2,211,800
32	6	8.53	290	35,400	11.14	444	57,900	18.13	616	135,400
	7	8.66	364	45,800	11.26	559	75,300	18.63	782	181,800
	8	8.78	439	57,100	11.37	678	94,300	19.13	956	234,700
	9	8.91	517	69,400	11.49	801	115,100	19.63	1,138	294,800
	10	9.03	596	82,700	11.60	928	137,800	20.13	1,328	362,400
	11	9.16	678	97,100	11.72	1,059	162,400	20.63	1,526	438,300
	12	9.28	761	112,600	11.83	1,194	189,200	21.13	1,732	522,900
	13	9.41	847	129,300	11.95	1,333	218,100	21.63	1,946	617,000
	14	9.53	934	147,300	12.06	1,476	249,500	22.13	2,168	721,200
	15	9.66	1,024	166,600	12.18	1,623	283,200	22.63	2,398	836,000
	16	9.78	1,115	187,200	12.30	1,774	319,600	23.13	2,636	962,200
	17	9.91	1,209	209,400	12.41	1,929	358,800	23.63	2,882	1,100,400
	18	10.03	1,304	233,100	12.53	2,088	400,700	24.13	3,136	1,251,400
	19	10.16	1,402	258,300	12.65	2,251	445,800	24.63	3,398	1,415,900
	20	10.28	1,501	285,300	12.76	2,418	493,900	25.13	3,668	1,594,700
	21	10.41	1,603	314,000	12.88	2,589	545,400	25.63	3,946	1,788,400
	22	10.53	1,706	344,500	13.00	2,764	600,300	26.13	4,232	1,998,000
	23	10.66	1,812	376,900	13.12	2,943	658,800	26.63	4,526	2,224,200
	24	10.78	1,919	411,400	13.24	3,126	721,100	27.13	4,828	2,467,900

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
34	6	9.03	307	42,000	11.81	470	68,500	19.13	650	159,000
	7	9.16	385	54,200	11.92	591	88,900	19.63	824	212,600
	8	9.28	464	67,400	12.04	716	111,000	20.13	1,006	273,300
	9	9.41	546	81,600	12.15	845	135,100	20.63	1,196	341,900
	10	9.53	629	97,000	12.27	978	161,300	21.13	1,394	418,800
	11	9.66	715	113,600	12.38	1,115	189,600	21.63	1,600	504,600
	12	9.78	802	131,400	12.50	1,256	220,200	22.13	1,814	600,000
	13	9.91	892	150,500	12.61	1,401	253,300	22.63	2,036	705,600
	14	10.03	983	171,000	12.73	1,550	288,900	23.13	2,266	822,100
	15	10.16	1,077	193,000	12.84	1,703	327,100	23.63	2,504	950,100
	16	10.28	1,172	216,400	12.96	1,860	368,200	24.13	2,750	1,090,400
	17	10.41	1,270	241,400	13.08	2,021	412,300	24.63	3,004	1,243,600
	18	10.53	1,369	268,100	13.19	2,186	459,500	25.13	3,266	1,410,500
	19	10.66	1,471	296,600	13.31	2,355	509,900	25.63	3,536	1,591,900
	20	10.78	1,574	326,800	13.43	2,528	563,700	26.13	3,814	1,788,500
	21	10.91	1,680	358,900	13.55	2,705	621,100	26.63	4,100	2,001,100
	22	11.03	1,787	393,000	13.66	2,886	682,200	27.13	4,394	2,230,500
	23	11.16	1,897	429,100	13.78	3,071	747,100	27.63	4,696	2,477,600
	24	11.28	2,008	467,400	13.90	3,260	816,100	28.13	5,006	2,743,300
36	6	9.53	324	49,300	12.48	495	80,400	20.13	684	185,300
	7	9.66	406	63,500	12.59	622	104,000	20.63	866	246,700
	8	9.78	489	78,800	12.70	753	129,600	21.13	1,056	316,000
	9	9.91	575	95,200	12.82	888	157,300	21.63	1,254	393,800
	10	10.03	662	112,900	12.93	1,027	187,300	22.13	1,460	480,700
	11	10.16	752	131,900	13.05	1,170	219,600	22.63	1,674	577,300
	12	10.28	843	152,200	13.16	1,317	254,500	23.13	1,896	684,300
	13	10.41	937	174,000	13.28	1,468	292,000	23.63	2,126	802,400
	14	10.53	1,032	197,200	13.39	1,623	332,300	24.13	2,364	932,100
	15	10.66	1,130	222,000	13.51	1,782	375,400	24.63	2,610	1,074,300
	16	10.78	1,229	248,500	13.62	1,945	421,600	25.13	2,864	1,229,600
	17	10.91	1,331	276,700	13.74	2,112	471,100	25.63	3,126	1,398,800
	18	11.03	1,434	306,600	13.86	2,283	523,800	26.13	3,396	1,582,700
	19	11.16	1,540	338,400	13.97	2,458	580,100	26.63	3,674	1,782,000
	20	11.28	1,647	372,200	14.09	2,637	640,000	27.13	3,960	1,997,500
	21	11.41	1,757	408,000	14.21	2,820	703,700	27.63	4,254	2,230,100
	22	11.53	1,868	445,900	14.33	3,007	771,400	28.13	4,556	2,480,600
	23	11.66	1,982	486,000	14.44	3,198	843,200	28.63	4,866	2,749,800
	24	11.78	2,097	528,400	14.56	3,393	919,300	29.13	5,184	3,038,700

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
38	6	10.03	341	57,500	13.14	521	93,600	21.13	718	214,200
	7	10.16	427	73,800	13.26	654	120,800	21.63	908	284,200
	8	10.28	514	91,400	13.37	791	150,200	22.13	1,106	362,800
	9	10.41	604	110,300	13.48	932	181,900	22.63	1,312	450,700
	10	10.53	695	130,500	13.60	1,077	216,000	23.13	1,526	548,500
	11	10.66	789	152,100	13.71	1,226	252,700	23.63	1,748	656,700
	12	10.78	884	175,100	13.83	1,379	292,200	24.13	1,978	776,200
	13	10.91	982	199,800	13.94	1,536	334,500	24.63	2,216	907,600
	14	11.03	1,081	226,000	14.06	1,697	379,800	25.13	2,462	1,051,600
	15	11.16	1,183	254,000	14.17	1,862	428,300	25.63	2,716	1,208,900
	16	11.28	1,286	283,700	14.29	2,031	480,000	26.13	2,978	1,380,300
	17	11.41	1,392	315,200	14.41	2,204	535,200	26.63	3,248	1,566,600
	18	11.53	1,499	348,700	14.52	2,381	594,000	27.13	3,526	1,768,500
	19	11.66	1,609	384,200	14.64	2,562	656,500	27.63	3,812	1,986,800
	20	11.78	1,720	421,800	14.76	2,747	723,000	28.13	4,106	2,222,400
	21	11.91	1,834	461,500	14.87	2,936	793,500	28.63	4,408	2,476,100
	22	12.03	1,949	503,500	14.99	3,129	868,300	29.13	4,718	2,748,800
	23	12.16	2,067	547,900	15.11	3,326	947,400	29.63	5,036	3,041,400
	24	12.28	2,186	594,600	15.23	3,527	1,031,200	30.13	5,362	3,354,800
40	6	10.53	358	66,500	13.81	546	108,200	22.13	752	246,100
	7	10.66	448	85,200	13.92	685	139,300	22.63	950	325,400
	8	10.78	539	105,300	14.04	828	172,800	23.13	1,156	414,100
	9	10.91	633	126,800	14.15	975	208,800	23.63	1,370	512,900
	10	11.03	728	149,700	14.26	1,126	247,500	24.13	1,592	622,300
	11	11.16	826	174,200	14.38	1,281	289,000	24.63	1,822	743,200
	12	11.28	925	200,300	14.49	1,440	333,500	25.13	2,060	876,100
	13	11.41	1,027	228,000	14.61	1,603	381,000	25.63	2,306	1,021,700
	14	11.53	1,130	257,500	14.72	1,770	431,800	26.13	2,560	1,180,900
	15	11.66	1,236	288,800	14.84	1,941	486,000	26.63	2,822	1,354,400
	16	11.78	1,343	322,100	14.95	2,116	543,700	27.13	3,092	1,542,900
	17	11.91	1,453	357,300	15.07	2,295	605,100	27.63	3,370	1,747,300
	18	12.03	1,564	394,500	15.19	2,478	670,300	28.13	3,656	1,968,300
	19	12.16	1,678	434,000	15.30	2,665	739,600	28.63	3,950	2,206,800
	20	12.28	1,793	475,600	15.42	2,856	813,000	29.13	4,252	2,463,700
	21	12.41	1,911	519,600	15.54	3,051	890,800	29.63	4,562	2,739,800
	22	12.53	2,030	566,000	15.65	3,250	973,100	30.13	4,880	3,036,000
	23	12.66	2,152	614,900	15.77	3,453	1,060,100	30.63	5,206	3,353,200
	24	12.78	2,275	666,400	15.89	3,660	1,152,000	31.13	5,540	3,692,400

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
42	6	11.03	375	76,400	14.48	572	124,200	23.13	786	280,900
	7	11.16	469	97,700	14.59	717	159,600	23.63	992	370,300
	8	11.28	564	120,600	14.70	866	197,600	24.13	1,206	470,000
	9	11.41	662	144,900	14.82	1,019	238,300	24.63	1,428	580,500
	10	11.53	761	170,800	14.93	1,176	282,000	25.13	1,658	702,600
	11	11.66	863	198,400	15.04	1,337	328,700	25.63	1,896	836,900
	12	11.78	966	227,700	15.16	1,502	378,500	26.13	2,142	984,100
	13	11.91	1,072	258,800	15.27	1,671	431,700	26.63	2,396	1,145,100
	14	12.03	1,179	291,800	15.39	1,844	488,400	27.13	2,658	1,320,500
	15	12.16	1,289	326,800	15.50	2,021	548,700	27.63	2,928	1,511,200
	16	12.28	1,400	363,800	15.62	2,202	612,800	28.13	3,206	1,717,900
	17	12.41	1,514	402,900	15.74	2,387	680,800	28.63	3,492	1,941,500
	18	12.53	1,629	444,300	15.85	2,576	753,000	29.13	3,786	2,182,800
	19	12.66	1,747	487,900	15.97	2,769	829,400	29.63	4,088	2,442,700
	20	12.78	1,866	534,000	16.08	2,966	910,300	30.13	4,398	2,722,000
	21	12.91	1,988	582,500	16.20	3,167	995,900	30.63	4,716	3,021,700
	22	13.03	2,111	633,500	16.32	3,372	1,086,200	31.13	5,042	3,342,700
	23	13.16	2,237	687,300	16.44	3,581	1,181,600	31.63	5,376	3,685,800
	24	13.28	2,364	743,800	16.55	3,794	1,282,100	32.13	5,718	4,052,200
44	6	11.53	392	87,200	15.14	597	141,700	24.13	820	318,900
	7	11.66	490	111,400	15.26	748	181,800	24.63	1,034	419,300
	8	11.78	589	137,200	15.37	903	224,700	25.13	1,256	530,700
	9	11.91	691	164,700	15.48	1,062	270,500	25.63	1,486	653,900
	10	12.03	794	193,800	15.60	1,225	319,500	26.13	1,724	789,400
	11	12.16	900	224,800	15.71	1,392	371,800	26.63	1,970	938,200
	12	12.28	1,007	257,600	15.82	1,563	427,500	27.13	2,224	1,100,800
	13	12.41	1,117	292,300	15.94	1,738	486,700	27.63	2,486	1,278,000
	14	12.53	1,228	329,100	16.05	1,917	549,700	28.13	2,756	1,470,700
	15	12.66	1,342	368,000	16.17	2,100	616,600	28.63	3,034	1,679,700
	16	12.78	1,457	409,000	16.29	2,287	687,600	29.13	3,320	1,905,700
	17	12.91	1,575	452,400	16.40	2,478	762,700	29.63	3,614	2,149,700
	18	13.03	1,694	498,100	16.52	2,673	842,300	30.13	3,916	2,412,500
	19	13.16	1,816	546,300	16.63	2,872	926,400	30.63	4,226	2,694,900
	20	13.28	1,939	597,000	16.75	3,075	1,015,300	31.13	4,544	2,997,900
	21	13.41	2,065	650,300	16.87	3,282	1,109,100	31.63	4,870	3,322,500
	22	13.53	2,192	706,400	16.98	3,493	1,208,000	32.13	5,204	3,669,500
	23	13.66	2,322	765,300	17.10	3,708	1,312,200	32.63	5,546	4,039,900
	24	13.78	2,453	827,100	17.22	3,927	1,421,900	33.13	5,896	4,434,800

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

		Corner Column			Edge Column			Interior Column		
Square Column (in.)	Slab or Drop* (in.)	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})	$c_{AB} = y_t$ (in.)	$A_c = b_o d$ (in.^{2})	J_c (in.^{4})
46	6	12.03	409	99,000	15.81	623	160,800	25.13	854	360,100
	7	12.16	511	126,300	15.92	780	205,900	25.63	1,076	472,400
	8	12.28	614	155,400	16.03	941	254,100	26.13	1,306	596,500
	9	12.41	720	186,200	16.15	1,106	305,500	26.63	1,544	733,200
	10	12.53	827	218,800	16.26	1,275	360,300	27.13	1,790	883,200
	11	12.66	937	253,400	16.38	1,448	418,600	27.63	2,044	1,047,300
	12	12.78	1,048	289,900	16.49	1,625	480,500	28.13	2,306	1,226,300
	13	12.91	1,162	328,600	16.61	1,806	546,300	28.63	2,576	1,420,900
	14	13.03	1,277	369,400	16.72	1,991	616,100	29.13	2,854	1,632,000
	15	13.16	1,395	412,500	16.84	2,180	690,000	29.63	3,140	1,860,300
	16	13.28	1,514	457,900	16.95	2,373	768,300	30.13	3,434	2,106,800
	17	13.41	1,636	505,800	17.07	2,570	851,100	30.63	3,736	2,372,300
	18	13.53	1,759	556,100	17.18	2,771	938,500	31.13	4,046	2,657,800
	19	13.66	1,885	609,100	17.30	2,976	1,030,800	31.63	4,364	2,964,000
	20	13.78	2,012	664,800	17.41	3,185	1,128,200	32.13	4,690	3,292,000
	21	13.91	2,142	723,300	17.53	3,398	1,230,700	32.63	5,024	3,642,800
	22	14.03	2,273	784,700	17.65	3,615	1,338,700	33.13	5,366	4,017,200
	23	14.16	2,407	849,100	17.76	3,836	1,452,300	33.63	5,716	4,416,200
	24	14.28	2,542	916,500	17.88	4,061	1,571,700	34.13	6,074	4,841,000
48	6	12.53	426	111,800	16.48	648	181,500	26.13	888	404,800
	7	12.66	532	142,500	16.59	811	232,100	26.63	1,118	529,800
	8	12.78	639	175,000	16.70	978	286,000	27.13	1,356	667,500
	9	12.91	749	209,500	16.81	1,149	343,400	27.63	1,602	818,700
	10	13.03	860	245,900	16.93	1,324	404,400	28.13	1,856	984,100
	11	13.16	974	284,300	17.04	1,503	469,100	28.63	2,118	1,164,700
	12	13.28	1,089	324,900	17.16	1,686	537,800	29.13	2,388	1,361,000
	13	13.41	1,207	367,800	17.27	1,873	610,500	29.63	2,666	1,574,100
	14	13.53	1,326	412,900	17.39	2,064	687,600	30.13	2,952	1,804,600
	15	13.66	1,448	460,500	17.50	2,259	769,000	30.63	3,246	2,053,500
	16	13.78	1,571	510,600	17.62	2,458	855,100	31.13	3,548	2,321,600
	17	13.91	1,697	563,300	17.73	2,661	946,000	31.63	3,858	2,609,900
	18	14.03	1,824	618,600	17.85	2,868	1,041,900	32.13	4,176	2,919,300
	19	14.16	1,954	676,700	17.96	3,079	1,142,900	32.63	4,502	3,250,600
	20	14.28	2,085	737,700	18.08	3,294	1,249,200	33.13	4,836	3,604,900
	21	14.41	2,219	801,700	18.20	3,513	1,361,100	33.63	5,178	3,983,100
	22	14.53	2,354	868,700	18.31	3,736	1,478,700	34.13	5,528	4,386,300
	23	14.66	2,492	938,900	18.43	3,963	1,602,300	34.63	5,886	4,815,400
	24	14.78	2,631	1,012,400	18.55	4,194	1,731,900	35.13	6,252	5,271,500

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 11 in.	Rib Depth = 8 in.		Total Slab Depth = 3 in.														
14'-0"	50	2.05	12	0.629		6-#5+ 0	4	#4	#4	6-#5	3	#4	#4	7-#5	11	23	31
D = 6.417	100	2.05	12	0.629		6-#5+ 0	4	#4	#4	6-#5	3	#4	#4	7-#5	15	33	41
RIB NOT ON	150	2.05	12	0.629		6-#5+ 0	4	#4	#4	6-#5	3	#4	#4	7-#5	19	45	52
COLUMN LINE	200	2.05	12	0.629		6-#5+ 0	4	#4	#4	6-#5	3	#4	#4	7-#5	23	57	62
0.599 CF/SF	300	2.05	12	0.629		6-#5+ 0	4	#4	#4	6-#5	3	#4	#4	7-#5	31	81	83
	400	2.05	12	0.679		6-#5+ 0	4	#4	#4	6-#5	3	#4	#4	7-#5	38	104	103
16'-0"	50	2.07	12	0.629		7-#5+ 0	4	#4	#4	7-#5	4	#4	#4	8-#5	17	35	47
D = 6.417	100	2.07	12	0.629		7-#5+ 0	4	#4	#4	7-#5	4	#4	#4	8-#5	23	49	62
RIB NOT ON	150	2.07	12	0.629		7-#5+ 0	4	#4	#4	7-#5	4	#4	#4	8-#5	29	68	78
COLUMN LINE	200	2.07	12	0.661		7-#5+ 0	4	#4	#4	7-#5	4	#4	#4	8-#5	35	86	94
0.582 CF/SF	300	2.16	12	0.736		7-#5+ 0	4	#4	#5	7-#5	4	#4	#4	8-#5	47	122	125
	400	2.29	12 *	0.811		7-#5+ 0	4	#5	#5	6-#6	4	#4	#4	8-#5	58	157	157
18'-0"	50	2.10	12	0.629		8-#5+ 0	4	#4	#4	8-#5	5	#4	#4	10-#5	25	50	67
D = 6.417	100	2.10	12	0.671		8-#5+ 0	4	#4	#4	8-#5	5	#4	#4	10-#5	33	70	90
RIB NOT ON	150	2.10	12	0.712		8-#5+ 0	4	#4	#4	8-#5	5	#4	#4	10-#5	42	98	112
COLUMN LINE	200	2.18	12	0.754		8-#5+ 0	4	#4	#5	8-#5	5	#4	#4	10-#5	50	124	135
0.571 CF/SF	300	2.54	12 *	0.855		8-#5+ 1	4	#5	#6	7-#6	5	#4	#4	10-#5	67	176	181
	400	2.89	12 *	0.630		8-#5+ 1	4	#6	#6	9-#6	5	#4	#5	10-#5	84	227	226
20'-0"	50	1.99	12	0.660		8-#5+ 0	5	#4	#4	8-#5	5	#4	#4	10-#5	35	70	94
D = 8.417	100	1.99	12	0.711		8-#5+ 0	5	#4	#4	8-#5	5	#4	#4	10-#5	47	99	126
RIB ON	150	2.01	12	0.762		8-#5+ 0	5	#4	#4	9-#5	5	#4	#4	10-#5	58	137	157
COLUMN LINE	200	2.18	12 *	0.833		8-#5+ 1	5	#4	#5	7-#6	5	#4	#4	10-#5	70	174	189
0.590 CF/SF	300	2.65	12 *	0.630		8-#5+ 1	5	#5	#6	10-#6	5	#4	#5	10-#5	94	246	252
	400	3.22	15 *	0.626		9-#5+ 1	5	#6	#7	18-#5	5	#5	#5	10-#5	115	308	310
22'-0"	50	2.01	12	0.724		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	11-#5	47	93	125
D = 8.417	100	2.01	12	0.780		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	11-#5	62	132	168
RIB ON	150	2.25	12 *	0.851		9-#5+ 1	5	#5	#5	8-#6	6	#4	#4	11-#5	78	183	210
COLUMN LINE	200	2.52	12 *	0.909		9-#5+ 2	5	#5	#6	10-#6	6	#4	#4	11-#5	94	233	253
0.579 CF/SF	300	3.25	16 *	0.625		9-#5+ 2	5	#6	#7	14-#6	6	#5	#5	11-#5	123	324	332
24'-0"	50	2.05	12	0.779		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	13-#5	61	121	163
D = 8.417	100	2.18	12 *	0.864		10-#5+ 2	5	#4	#5	9-#6	7	#4	#4	13-#5	81	172	219
RIB ON	150	2.51	12 *	0.926		10-#5+ 4	5	#5	#6	11-#6	7	#4	#4	13-#5	102	239	275
COLUMN LINE	200	2.98	14 *	0.627		10-#5+ 3	5	#6	#7	14-#6	7	#4	#5	13-#5	122	301	328
0.571 CF/SF																	
26'-0"	50	2.03	13	0.799		11-#5+ 0	6	#4	#4	12-#5	7	#4	#4	13-#5	78	156	210
D = 10.417	100	2.31	13 *	0.893		11-#5+ 3	6	#5	#5	11-#6	7	#4	#4	13-#5	104	215	280
RIB NOT ON	150	2.70	15 *	0.917		11-#5+ 5	6	#5	#6	15-#6	7	#4	#5	13-#5	129	298	348
COLUMN LINE	200	3.10	19 *	0.622		12-#5+ 4	6	#6	#7	17-#6	7	#4	#5	13-#5	153	364	411
0.585 CF/SF																	
28'-0"	50	2.20	14 *	0.852		12-#5+ 3	6	#4	#5	15-#5	8	#4	#4	15-#5	97	193	260
D = 10.417	100	2.58	14 *	0.925		12-#5+ 6	6	#5	#6	15-#6	8	#4	#4	15-#5	130	259	349
RIB NOT ON	150	3.07	19 *	0.622		12-#5+ 5	6	#6	#7	18-#6	8	#4	#5	15-#5	160	357	430
COLUMN LINE																	
0.577 CF/SF																	
30'-0"	50	2.32	15 *	0.873		9-#6+ 3	6	#5	#5	13-#6	9	#4	#4	16-#5	119	237	319
D = 10.417	100	2.81	17 *	0.923		9-#6+ 6	6	#6	#6	18-#6	9	#4	#4	16-#5	158	316	425
RIB NOT ON																	
COLUMN LINE																	
0.571 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 11 in.			Rib Depth = 8 in.				Total Slab Depth = 3 in.			
2.07	12		4	#4	#4	6-#5	3	#4	#4	7-#5
2.07	12		4	#4	#4	6-#5	3	#4	#4	7-#5
2.07	12		4	#4	#4	6-#5	3	#4	#4	7-#5
2.07	12		4	#4	#4	6-#5	3	#4	#4	7-#5
2.07	12		4	#4	#4	6-#5	3	#4	#4	7-#5
2.07	12		4	#4	#4	6-#5	3	#4	#4	7-#5
2.10	12		4	#4	#4	7-#5	4	#4	#4	8-#5
2.10	12		4	#4	#4	7-#5	4	#4	#4	8-#5
2.10	12		4	#4	#4	7-#5	4	#4	#4	8-#5
2.10	12		4	#4	#4	7-#5	4	#4	#4	8-#5
2.10	12		4	#4	#4	7-#5	4	#4	#4	8-#5
2.16	12	3 S 4 1	4	#4	#4	8-#5	4	#4	#4	8-#5
2.15	12		4	#4	#4	8-#5	5	#4	#4	10-#5
2.15	12		4	#4	#4	8-#5	5	#4	#4	10-#5
2.15	12		4	#4	#4	8-#5	5	#4	#4	10-#5
2.15	12		4	#4	#4	8-#5	5	#4	#4	10-#5
2.45	12	3 S 4 1	4	#4	#5	7-#6	5	#4	#4	10-#5
2.69	12 *	3 S 4 1	4	#5	#5	12-#5	5	#4	#4	10-#5
2.03	12		5	#4	#4	8-#5	5	#4	#4	10-#5
2.03	12		5	#4	#4	8-#5	5	#4	#4	10-#5
2.03	12		5	#4	#4	8-#5	5	#4	#4	10-#5
2.17	12		5	#4	#4	7-#6	5	#4	#4	10-#5
2.47	12 *	3 S 4 1	5	#4	#5	9-#6	5	#4	#4	10-#5
2.85	13 *	3 S 4 1	5	#5	#5	12-#6	5	#4	#4	10-#5
2.05	12		5	#4	#4	9-#5	6	#4	#4	11-#5
2.05	12		5	#4	#4	9-#5	6	#4	#4	11-#5
2.17	12		5	#4	#4	8-#6	6	#4	#4	11-#5
2.45	12 *	3 S 4 1	5	#4	#5	10-#6	6	#4	#4	11-#5
2.98	12 *	3 S 4 1	5	#5	#6	13-#6	6	#4	#4	11-#5
2.11	12		5	#4	#4	7-#6	7	#4	#4	13-#5
2.16	12		5	#4	#4	8-#6	7	#4	#4	13-#5
2.42	12 *	3 S 4 1	5	#4	#5	10-#6	7	#4	#4	13-#5
2.71	12 *	3 S 4 1	5	#5	#5	18-#5	7	#4	#4	13-#5
2.06	13		6	#4	#4	11-#5	7	#4	#4	13-#5
2.24	13 *		6	#4	#4	15-#5	7	#4	#4	13-#5
2.53	13 *	3 S 4 1	6	#4	#5	13-#6	7	#4	#4	13-#5
2.84	14*	3 S 4 1	6	#5	#5	16-#6	7	#4	#4	13-#5
2.19	14		6	#4	#4	10-#6	8	#4	#4	15-#5
2.50	14 *	3 S 4 1	6	#4	#5	13-#6	8	#4	#4	15-#5
2.86	14 *	3 S 4 1	6	#5	#5	17-#6	8	#4	#4	15-#5
2.26	15		6	#4	#4	12-#6	9	#4	#4	16-#5
2.78	15 *	3 S 4 1	6	#5	#5	17-#6	9	#4	#4	16-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 6″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 13 in.	Rib Depth = 10 in.	Total Slab Depth = 3 in.																Total Depth = 13 in.	Rib Depth = 10 in.	Total Slab Depth = 3 in.								
18'-0"	50	2.10	12	0.633		8-#5+ 0	4	#4	#4	8-#5	5	#4	#4	10-#5	27	55	73	2.15	12		4	#4	#4	8-#5	5	#4	#4	10-#5
D = 6.417	100	2.10	12	0.633		8-#5+ 0	4	#4	#4	8-#5	5	#4	#4	10-#5	36	74	96	2.15	12		4	#4	#4	8-#5	5	#4	#4	10-#5
RIB NOT ON	150	2.10	12	0.633		8-#5+ 0	4	#4	#4	8-#5	5	#4	#4	10-#5	44	103	119	2.15	12		4	#4	#4	8-#5	5	#4	#4	10-#5
COLUMN LINE	200	2.10	12	0.651		8-#5+ 0	4	#4	#4	8-#5	5	#4	#4	10-#5	53	130	142	2.15	12		4	#4	#4	8-#5	5	#4	#4	10-#5
0.659 CF/SF	300	2.27	12	0.726		8-#5+ 0	4	#5	#5	6-#6	5	#4	#4	10-#5	70	182	187	2.15	12	3 S 4 1	4	#4	#4	8-#5	5	#4	#4	10-#5
	400	2.56	12 *	0.802		8-#5+ 0	4	#5	#6	8-#6	5	#4	#4	10-#5	86	233	233	2.45	12	3 S 4 1	4	#4	#5	7-#6	5	#4	#4	10-#5
	500	2.89	12 *	0.634		8-#5+ 0	4	#6	#6	9-#6	5	#4	#5	10-#5	103	284	278	2.69	12 *	3 S 4 1	4	#5	#5	12-#5	5	#4	#4	10-#5
20'-0"	50	2.07	12	0.633		9-#5+ 0	5	#4	#4	9-#5	5	#4	#4	10-#5	38	77	103	2.10	12		5	#4	#4	9-#5	5	#4	#4	10-#5
D = 8.417	100	2.07	12	0.656		9-#5+ 0	5	#4	#4	9-#5	5	#4	#4	10-#5	50	105	135	2.10	12		5	#4	#4	9-#5	5	#4	#4	10-#5
RIB ON	150	2.07	12	0.698		9-#5+ 0	5	#4	#4	9-#5	5	#4	#4	10-#5	62	144	167	2.10	12		5	#4	#4	9-#5	5	#4	#4	10-#5
COLUMN LINE	200	2.15	12	0.739		9-#5+ 0	5	#4	#5	9-#5	5	#4	#4	10-#5	74	181	198	2.10	12		5	#4	#4	9-#5	5	#4	#4	10-#5
0.682 CF/SF	300	2.41	12 *	0.840		9-#5+ 1	5	#5	#5	12-#5	5	#4	#4	10-#5	97	254	261	2.37	12		5	#4	#5	8-#6	5	#4	#4	10-#5
	400	2.98	12 *	0.634		9-#5+ 0	5	#6	#6	15-#5	5	#5	#5	10-#5	121	325	325	2.68	12 *	3 S 4 1	5	#5	#5	10-#6	5	#4	#4	10-#5
	500	3.49	13 *	0.632		9-#5+ 1	5	#6	#7	13-#6	5	#5	#6	10-#5	143	394	386	3.15	12 *	3 S 4 1	5	#5	#6	12-#6	5	#4	#5	10-#5
22'-0"	50	2.01	12	0.643		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	11-#5	51	102	138	2.05	12		5	#4	#4	9-#5	6	#4	#4	11-#5
D = 8.417	100	2.01	12	0.693		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	11-#5	67	140	180	2.05	12		5	#4	#4	9-#5	6	#4	#4	11-#5
RIB ON	150	2.13	12	0.743		9-#5+ 0	5	#4	#5	7-#6	6	#4	#4	11-#5	83	193	223	2.11	12		5	#4	#4	7-#6	6	#4	#4	11-#5
COLUMN LINE	200	2.26	12 *	0.813		9-#5+ 1	5	#5	#5	12-#5	6	#4	#4	11-#5	99	243	265	2.17	12		5	#4	#4	8-#6	6	#4	#4	11-#5
0.669 CF/SF	300	2.82	12 *	0.634		9-#5+ 1	5	#6	#6	12-#6	6	#4	#5	11-#5	130	340	350	2.62	12 *	3 S 4 1	5	#5	#5	15-#5	6	#4	#4	11-#5
	400	3.43	14 *	0.631	3 S 4 1	10-#5+ 1	5	#7	#7	15-#6	6	#5	#5	11-#5	160	432	432	3.04	12 *	3 S 4 1	5	#5	#6	14-#6	6	#4	#4	11-#5
	500	3.98	18 *	0.626	3 S 4 1	8-#6+ 2	5	#7	#8	17-#6	6	#5	#6	11-#5	185	489	499	3.51	16 *	3 S 4 2	5	#6	#6	16-#6	6	#4	#5	11-#5
24'-0"	50	2.05	12	0.705		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	13-#5	67	133	180	2.11	12		5	#4	#4	7-#6	7	#4	#4	13-#5
D = 8.417	100	2.14	12	0.759		10-#5+ 0	5	#4	#5	8-#6	7	#4	#4	13-#5	87	182	235	2.11	12		5	#4	#4	7-#6	7	#4	#4	13-#5
RIB ON	150	2.31	12 *	0.813		10-#5+ 0	5	#5	#5	10-#6	7	#4	#4	13-#5	108	251	291	2.25	12		5	#4	#4	9-#6	7	#4	#4	13-#5
COLUMN LINE	200	2.62	12 *	0.888		10-#5+ 2	5	#6	#6	12-#6	7	#4	#4	13-#5	129	316	346	2.46	12 *	3 S 4 1	5	#4	#5	15-#5	7	#4	#4	13-#5
0.659 CF/SF	300	3.29	14 *	0.631	3 S 4 1	10-#5+ 1	5	#7	#7	16-#6	7	#4	#5	13-#5	169	441	454	3.06	12 *	3 S 4 2	5	#5	#6	15-#6	7	#4	#4	13-#5
	400	3.82	18 *	0.626	3 S 4 1	9-#6+ 1	5	#7	#8	19-#6	7	#5	#5	13-#5	203	525	548	3.42	16 *	3 S 4 2	5	#6	#6	18-#6	7	#4	#4	13-#5
26'-0"	50	2.02	13	0.728		11-#5+ 0	6	#4	#4	11-#5	7	#4	#4	13-#5	86	171	231	2.06	13		6	#4	#4	11-#5	7	#4	#4	13-#5
D = 10.417	100	2.18	13 *	0.805		11-#5+ 1	6	#4	#5	10-#6	7	#4	#4	13-#5	112	229	301	2.15	13		6	#4	#4	9-#6	7	#4	#4	13-#5
RIB NOT ON	150	2.50	13 *	0.887		11-#5+ 4	6	#5	#6	12-#6	7	#4	#4	13-#5	138	318	372	2.40	13 *		6	#4	#5	16-#5	7	#4	#4	13-#5
COLUMN LINE	200	2.89	13 *	0.632		11-#5+ 2	6	#6	#6	15-#6	7	#4	#5	13-#5	164	400	442	2.71	13 *	3 S 4 1	6	#5	#5	14-#6	7	#4	#4	13-#5
0.676 CF/SF	300	3.59	18 *	0.626		9-#6+ 2	6	#7	#7	20-#6	7	#5	#5	13-#5	212	536	570	3.28	15 *	3 S 4 1	6	#5	#6	18-#6	7	#4	#5	13-#5

(Continued on next page)

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 6″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	Square Edge Column γ_f	Square Edge Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 13 in.	Rib Depth = 10 in.	Total Slab Depth = 3 in.																Total Depth = 13 in.	Rib Depth = 10 in.	Total Slab Depth = 3 in.								
28'-0"	50	2.13	14	0.749		12-#5+ 0	6	#4	#5	9-#6	8	#4	#4	15-#5	106	213	286	2.09	14		6	#4	#4	12-#5	8	#4	#4	15-#5
D = 10.417	100	2.35	14 *	0.841		12-#5+ 2	6	#5	#5	18-#5	8	#4	#4	15-#5	139	278	375	2.31	14		6	#4	#4	12-#6	8	#4	#4	15-#5
RIB NOT ON	150	2.79	14 *	0.915		12-#5+ 5	6	#6	#6	16-#6	8	#4	#4	15-#5	172	388	463	2.74	14 *	3 S 4 1	6	#5	#5	15-#6	8	#4	#4	15-#5
COLUMN LINE	200	3.20	16 *	0.628		9-#6+ 3	6	#6	#7	19-#6	8	#4	#5	15-#5	203	487	547	3.05	14 *	3 S 4 1	6	#5	#6	18-#6	8	#4	#4	15-#5
0.666 CF/SF	300	3.78	23 *	0.622		11-#6+ 3	6	#7	#7	25-#6	8	#5	#5	15-#5	258	567	693	3.54	20 *	3 S 4 2	6	#6	#6	23-#6	8	#4	#4	15-#5
30'-0"	50	2.27	15	0.807		9-#6+ 2	6	#5	#5	12-#6	9	#4	#4	16-#5	130	261	351	2.19	15		6	#4	#4	15-#5	9	#4	#4	16-#5
D = 10.417	100	2.55	15 *	0.895		9-#6+ 5	6	#5	#6	16-#6	9	#4	#4	16-#5	171	341	459	2.49	15 *	3 S 4 1	6	#4	#5	14-#6	9	#4	#4	16-#5
RIB NOT ON	150	3.12	16 *	0.628		9-#6+ 4	6	#6	#7	20-#6	9	#4	#5	16-#5	210	463	566	2.96	15 *	3 S 4 1	6	#5	#6	18-#6	9	#4	#4	16-#5
COLUMN LINE	200	3.59	20 *	0.625		11-#6+ 3	6	#7	#7	24-#6	9	#5	#5	16-#5	247	580	666	3.32	15 *	3 S 4 2	6	#6	#6	22-#6	9	#4	#4	16-#5
0.659 CF/SF																												
32'-0"	50	2.32	16 *	0.839		10-#6+ 3	7	#5	#5	14-#6	9	#4	#4	16-#5	159	319	429	2.25	16		7	#4	#4	13-#6	9	#4	#4	16-#5
D = 12.417	100	2.66	16 *	0.917		10-#6+ 6	7	#5	#6	19-#6	9	#4	#4	16-#5	208	416	561	2.62	16 *		7	#4	#5	18-#6	9	#4	#4	16-#5
RIB ON	150	3.25	20 *	0.625		11-#6+ 3	7	#6	#7	24-#6	9	#4	#5	16-#5	254	547	685	3.10	16 *	3 S 4 1	7	#5	#6	22-#6	9	#4	#4	16-#5
COLUMN LINE	200	3.56	26 *	0.620		13-#6+ 4	7	#6	#7	28-#6	9	#5	#5	16-#5	293	587	790	3.33	21 *	3 S 4 2	7	#5	#6	26-#6	9	#4	#4	16-#5
0.673 CF/SF																												
34'-0"	50	2.54	17 *	0.854		10-#6+ 4	7	#5	#6	17-#6	10	#4	#4	18-#5	190	381	512	2.49	17		7	#4	#5	16-#6	10	#4	#4	18-#5
D = 12.417	100	2.91	18 *	0.918		11-#6+ 6	7	#6	#6	23-#6	10	#4	#4	18-#5	248	497	668	2.90	17 *	3 S 4 1	7	#5	#5	22-#6	10	#4	#4	18-#5
RIB ON	150	3.49	25 *	0.621		13-#6+ 4	7	#7	#7	29-#6	10	#4	#5	18-#5	301	623	811	3.29	17 *	3 S 4 2	7	#5	#6	27-#6	10	#4	#4	18-#5
COLUMN LINE																												
0.665 CF/SF																												
36'-0"	50	2.75	18 *	0.877		11-#6+ 5	7	#6	#6	21-#6	11	#4	#4	19-#5	225	450	606	2.70	18 *	3 S 4 1	7	#5	#5	19-#6	11	#4	#4	19-#5
D = 12.417	100	3.25	22 *	0.916		18-#5+11	7	#6	#7	28-#6	11	#4	#5	19-#5	292	584	786	3.14	18 *	3 S 4 1	7	#5	#6	26-#6	11	#4	#4	19-#5
RIB ON																												
COLUMN LINE																												
0.659 CF/SF																												

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 15 in.	Rib Depth = 12 in.		Total Slab Depth = 3 in.															Total Depth = 15 in.	Rib Depth = 12 in.		Total Slab Depth = 3 in.							
20'-0"	50	2.07	12	0.636		9-#5+ 0	5	#4	#4	9-#5	5	#4	#4	10-#5	42	84	113	2.10	12		5	#4	#4	9-#5	5	#4	#4	10-#5
D = 8.417	100	2.07	12	0.636		9-#5+ 0	5	#4	#4	9-#5	5	#4	#4	10-#5	54	110	145	2.10	12		5	#4	#4	9-#5	5	#4	#4	10-#5
RIB ON	150	2.07	12	0.636		9-#5+ 0	5	#4	#4	9-#5	5	#4	#4	10-#5	66	150	176	2.10	12		5	#4	#4	9-#5	5	#4	#4	10-#5
COLUMN LINE	200	2.07	12	0.643		9-#5+ 0	5	#4	#4	9-#5	5	#4	#4	10-#5	77	188	208	2.10	12		5	#4	#4	9-#5	5	#4	#4	10-#5
0.777 CF/SF	300	2.28	12	0.720		9-#5+ 0	5	#5	#5	7-#6	5	#4	#4	10-#5	101	261	271	2.17	12		5	#4	#4	7-#6	5	#4	#4	10-#5
	400	2.62	12 *	0.817		9-#5+ 1	5	#5	#6	9-#6	5	#4	#5	10-#5	124	333	334	2.40	12	4 S 6 1	5	#4	#5	12-#5	5	#4	#4	10-#5
	500	3.00	12 *	0.637		9-#5+ 1	5	#6	#6	11-#6	5	#5	#5	10-#5	148	404	397	2.68	12 *	4 S 6 1	5	#5	#5	10-#6	5	#4	#4	10-#5
22'-0"	50	2.01	12	0.636		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	11-#5	56	112	151	2.05	12		5	#4	#4	9-#5	6	#4	#4	11-#5
D = 8.417	100	2.01	12	0.636		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	11-#5	72	146	193	2.05	12		5	#4	#4	9-#5	6	#4	#4	11-#5
RIB ON	150	2.09	12	0.648		9-#5+ 0	5	#4	#5	9-#5	6	#4	#4	11-#5	88	201	236	2.05	12		5	#4	#4	9-#5	6	#4	#4	11-#5
COLUMN LINE	200	2.15	12	0.695		9-#5+ 0	5	#4	#5	8-#6	6	#4	#4	11-#5	103	251	278	2.11	12		5	#4	#4	7-#6	6	#4	#4	11-#5
0.761 CF/SF	300	2.49	12 *	0.827		9-#5+ 2	5	#5	#6	10-#6	6	#4	#4	11-#5	135	350	363	2.39	12	4 S 6 1	5	#4	#5	9-#6	6	#4	#4	11-#5
	400	3.00	12 *	0.637		9-#5+ 1	5	#6	#7	18-#5	6	#4	#5	11-#5	166	446	448	2.73	12 *	4 S 6 1	5	#5	#5	12-#6	6	#4	#4	11-#5
	500	3.51	13 *	0.635	4 S 6 1	10-#5+ 1	5	#7	#7	15-#6	6	#5	#5	11-#5	197	540	531	3.18	12 *	4 S 62	5	#5	#6	14-#6	6	#4	#5	11-#5
24'-0"	50	2.05	12	0.636		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	13-#5	73	146	196	2.11	12		5	#4	#4	7-#6	7	#4	#4	13-#5
D = 8.417	100	2.05	12	0.677		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	13-#5	94	191	252	2.11	12		5	#4	#4	7-#6	7	#4	#4	13-#5
RIB ON	150	2.24	12	0.727		10-#5+ 0	5	#5	#5	12-#5	7	#4	#4	13-#5	114	261	307	2.16	12		5	#4	#4	8-#6	7	#4	#4	13-#5
COLUMN LINE	200	2.46	12	0.777		10-#5+ 0	5	#5	#6	10-#6	7	#4	#4	13-#5	135	328	363	2.37	12	4 S 6 1	5	#4	#5	9-#6	7	#4	#4	13-#5
0.749 CF/SF	300	3.07	12 *	0.637		10-#5+ 1	5	#6	#7	14-#6	7	#4	#5	13-#5	176	456	474	2.87	12 *	4 S 6 1	5	#5	#6	18-#5	7	#4	#4	13-#5
	400	3.68	13 *	0.635	4 S 6 1	8-#6+ 2	5	#7	#8	17-#6	7	#5	#5	13-#5	217	580	583	3.26	12 *	4 S 6 2	5	#6	#6	16-#6	7	#4	#4	13-#5
	500	4.27	17 *	0.630	4 S 6 1	9-#6+ 2	5	#8	#8	20-#6	7	#5	#6	13-#5	252	682	679	3.86	14 *	4 S 6 2	5	#6	#7	19-#6	7	#4	#5	13-#5
26'-0"	50	2.02	13	0.654		11-#5+ 0	6	#4	#4	11-#5	7	#4	#4	13-#5	94	187	252	2.06	13		6	#4	#4	11-#5	7	#4	#4	13-#5
D = 10.417	100	2.14	13	0.709		11-#5+ 0	6	#4	#5	9-#6	7	#4	#4	13-#5	120	241	323	2.09	13		6	#4	#4	12-#5	7	#4	#4	13-#5
RIB NOT ON	150	2.30	13	0.800		11-#5+ 2	6	#5	#5	11-#6	7	#4	#4	13-#5	146	332	394	2.20	13		6	#4	#4	10-#6	7	#4	#4	13-#5
COLUMN LINE	200	2.55	13 *	0.867		11-#5+ 4	6	#5	#6	13-#6	7	#4	#4	13-#5	172	416	464	2.46	13		6	#4	#5	12-#6	7	#4	#4	13-#5
0.770 CF/SF	300	3.29	13 *	0.635		12-#5+ 2	6	#6	#7	18-#6	7	#5	#5	13-#5	225	579	605	3.00	13 *	4 S 6 1	6	#5	#6	16-#6	7	#4	#4	13-#5
	400	4.00	18 *	0.629		10-#6+ 1	6	#7	#8	21-#6	7	#5	#6	13-#5	271	712	729	3.56	15 *	4 S 6 2	6	#6	#6	20-#6	7	#4	#5	13-#5
28'-0"	50	2.04	14	0.679		12-#5+ 0	6	#4	#4	12-#5	8	#4	#4	15-#5	116	233	313	2.09	14		6	#4	#4	12-#5	8	#4	#4	15-#5
D = 10.417	100	2.21	14	0.759		12-#5+ 1	6	#4	#5	11-#6	8	#4	#4	15-#5	149	298	401	2.19	14		6	#4	#4	10-#6	8	#4	#4	15-#5
RIB NOT ON	150	2.54	14 *	0.839		12-#5+ 3	6	#5	#6	14-#6	8	#4	#4	15-#5	182	407	490	2.46	14		6	#4	#5	18-#5	8	#4	#4	15-#5
COLUMN LINE	200	2.90	14 *	0.901		12-#5+ 5	6	#6	#6	17-#6	8	#4	#5	15-#5	215	512	578	2.74	14 *	4 S 6 1	6	#5	#5	15-#6	8	#4	#4	15-#5
0.759 CF/SF	300	3.84	17 *	0.630		10-#6+ 3	6	#7	#8	22-#6	8	#5	#5	15-#5	278	709	747	3.54	14 *	4 S 6 2	6	#6	#6	21-#6	8	#4	#5	15-#5
	400	4.40	22 *	0.626		18-#5+ 2	6	#8	#8	27-#6	8	#5	#6	15-#5	332	822	893	3.98	19 *	4 S 6 2	6	#6	#7	25-#6	8	#4	#5	15-#5

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WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 15 in.	Rib Depth = 12 in.	Total Slab Depth = 3 in.															
30'-0"	50	2.17	15	0.697		9-#6+ 0	6	#4	#5	15-#5	9	#4	#4	16-#5	142	285	384
D = 10.417	100	2.40	15 *	0.787		9-#6+ 1	6	#5	#5	14-#6	9	#4	#4	16-#5	183	366	492
RIB NOT ON	150	2.76	15 *	0.873		9-#6+ 3	6	#6	#6	17-#6	9	#4	#4	16-#5	223	490	601
COLUMN LINE	200	3.28	15 *	0.633		10-#6+ 3	6	#7	#7	21-#6	9	#4	#5	16-#5	263	618	709
0.749 CF/SF	300	4.26	21 *	0.626		18-#5+ 2	6	#8	#8	27-#6	9	#5	#6	16-#5	336	823	904
32'-0"	50	2.21	16	0.772		10-#6+ 2	7	#4	#5	13-#6	9	#4	#4	16-#5	174	349	469
D = 12.417	100	2.58	16 *	0.855		10-#6+ 4	7	#5	#6	17-#6	9	#4	#4	16-#5	223	446	601
RIB ON	150	2.97	16 *	0.917		10-#6+ 6	7	#6	#6	21-#6	9	#4	#5	16-#5	272	587	733
COLUMN LINE	200	3.54	19 *	0.628		12-#6+ 2	7	#7	#7	25-#6	9	#5	#5	16-#5	318	737	857
0.766 CF/SF	300	4.24	25 *	0.624	4 S 6 1	15-#6+ 3	7	#7	#8	33-#6	9	#5	#6	16-#5	402	859	1081
34'-0"	50	2.37	17 *	0.792		10-#6+ 3	7	#5	#5	16-#6	10	#4	#4	18-#5	208	416	560
D = 12.417	100	2.81	17 *	0.882		10-#6+ 6	7	#6	#6	21-#6	10	#4	#4	18-#5	267	534	718
RIB ON	150	3.27	18 *	0.629		12-#6+ 3	7	#6	#7	26-#6	10	#4	#5	18-#5	325	681	874
COLUMN LINE	200	3.84	22 *	0.626		14-#6+ 4	7	#7	#8	31-#6	10	#5	#5	18-#5	379	857	1021
0.757 CF/SF																	
36'-0"	50	2.57	18 *	0.810		11-#6+ 3	7	#5	#6	19-#6	11	#4	#4	19-#5	246	492	663
D = 12.417	100	2.99	18 *	0.905		12-#6+ 6	7	#6	#7	25-#6	11	#4	#4	19-#5	316	632	850
RIB ON	150	3.56	21 *	0.626		15-#6+ 3	7	#7	#7	31-#6	11	#4	#5	19-#5	383	775	1030
COLUMN LINE	200	4.06	27 *	0.622	4 S 6 1	17-#6+ 2	7	#7	#8	36-#6	11	#5	#5	19-#5	443	906	1192
0.749 CF/SF																	
38'-0"	50	2.65	19 *	0.857		12-#6+ 6	8	#5	#6	23-#6	11	#4	#4	19- #5	292	583	785
D = 14.417	100	3.30	20 *	0.920		14-#6+ 8	8	#6	#7	30-#6	11	#4	#5	19-#5	373	745	1003
RIB NOT ON	150	3.81	26 *	0.623		17-#6+ 5	8	#7	#7	36-#6	11	#5	#5	19-#5	448	896	1206
COLUMN LINE																	
0.763 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 15 in.	Rib Depth = 12 in.	Total Slab Depth = 3 in.								
2.15	15		6	#4	#4	10-#6	9	#4	#4	16-#5
2.40	15		6	#4	#5	18-#5	9	#4	#4	16-#5
2.71	15 *	4 S 6 1	6	#5	#5	16-#6	9	#4	#4	16-#5
3.03	15 *	4 S 6 1	6	#5	#6	19-#6	9	#4	#4	16-#5
3.85	17 *	4 S 6 2	6	#6	#7	25-#6	9	#4	#5	16-#5
2.19	16		7	#4	#4	12-#6	9	#4	#4	16-#5
2.51	16		7	#4	#5	16-#6	9	#4	#4	16-#5
2.84	16 *	4 S 6 1	7	#5	#5	20-#6	9	#4	#4	16-#5
3.20	16 *	4 S 6 1	7	#5	#6	24-#6	9	#4	#4	16-#5
3.84	22 *	4 S 6 2	7	#6	#6	30-#6	9	#4	#5	16-#5
2.34	17		7	#4	#4	15-#6	10	#4	#4	18-#5
2.76	17 *	4 S 6 1	7	#5	#5	19-#6	10	#4	#4	18-#5
3.14	17 *	4 S 6 1	7	#5	#6	24-#6	10	#4	#4	18-#5
3.46	17 *	4 S 6 2	7	#6	#6	40-#5	10	#4	#4	18-#5
2.53	18		7	#4	#5	18-#6	11	#4	#4	19-#5
2.88	18 *	4 S 6 1	7	#5	#5	23-#6	11	#4	#4	19-#5
3.43	18 *	4 S 6 2	7	#6	#6	29-#6	11	#4	#4	19-#5
3.82	20 *	4 S 6 2	7	#6	#7	34-#6	11	#4	#4	19-#5
2.61	19		8	#4	#5	21-#6	11	#4	#4	19-#5
3.17	19 *	4 S 6 1	8	#5	#6	28-#6	11	#4	#4	19-#5
3.57	19 *	4 S 6 2	8	#6	#6	34-#6	11	#4	#4	19-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 17 in.	Rib Depth = 14 in.	Total Slab Depth = 3 in.																Total Depth = 17 in.	Rib Depth = 14 in.	Total Slab Depth = 3 in.								
22'-0"	50	2.01	12	0.639		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	11-#5	61	122	164	2.05	12		5	#4	#4	9-#5	6	#4	#4	11-#5
D = 8.417	100	2.01	12	0.639		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	11-#5	77	154	207	2.05	12		5	#4	#4	9-#5	6	#4	#4	11-#5
RIB ON	150	2.01	12	0.639		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	11-#5	93	208	249	2.05	12		5	#4	#4	9-#5	6	#4	#4	11-#5
COLUMN LINE	200	2.10	12	0.639		9-#5+ 0	5	#4	#5	7-#6	6	#4	#4	11-#5	108	259	292	2.05	12		5	#4	#4	9-#5	6	#4	#4	11-#5
0.857 CF/SF	300	2.43	12	0.683		9-#5+ 0	5	#5	#6	9-#6	6	#4	#4	11-#5	140	359	377	2.30	12		5	#4	#5	8-#6	6	#4	#4	11-#5
	400	2.79	12 *	0.813		9-#5+ 2	5	#6	#6	11-#6	6	#4	#5	11-#5	171	456	461	2.58	12	4 S 6 1	5	#5	#5	10-#6	6	#4	#4	11-#5
	500	3.23	12 *	0.640		9-#5+ 2	5	#6	#7	14-#6	6	#5	#5	11-#5	203	552	546	2.93	12 *	4 S 6 1	5	#5	#6	18-#5	6	#4	#4	11-#5
24'-0"	50	2.05	12	0.639		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	13-#5	79	159	214	2.11	12		5	#4	#4	7-#6	7	#4	#4	13-#5
D = 8.417	100	2.05	12	0.639		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	13-#5	100	200	269	2.11	12		5	#4	#4	7-#6	7	#4	#4	13-#5
RIB ON	150	2.14	12	0.639		10-#5+ 0	5	#4	#5	8-#6	7	#4	#4	13-#5	121	270	325	2.11	12		5	#4	#4	7-#6	7	#4	#4	13-#5
COLUMN LINE	200	2.25	12	0.685		10-#5+ 0	5	#5	#5	9-#6	7	#4	#4	13-#5	141	338	380	2.16	12		5	#4	#4	8-#6	7	#4	#4	13-#5
0.843 CF/SF	300	2.70	12 *	0.817		10-#5+ 2	5	#6	#6	12-#6	7	#4	#4	13-#5	183	468	492	2.62	12	4 S 6 1	5	#5	#5	11-#6	7	#4	#4	13-#5
	400	3.24	12 *	0.640		10-#5+ 1	5	#7	#7	15-#6	7	#4	#5	13-#5	224	595	603	2.98	12 *	4 S 6 1	5	#5	#6	14-#6	7	#4	#4	13-#5
	500	3.81	12 *	0.640	4 S 6 1	8-#6+ 2	5	#7	#8	18-#6	7	#5	#5	13-#5	265	721	714	3.50	12 *	4 S 6 2	5	#6	#6	17-#6	7	#4	#5	13-#5
26'-0"	50	2.02	13	0.637		11-#5+ 0	6	#4	#4	11-#5	7	#4	#4	13-#5	102	204	275	2.06	13		6	#4	#4	11-#5	7	#4	#4	13-#5
D = 10.417	100	2.03	13	0.637		11-#5+ 0	6	#4	#4	12-#5	7	#4	#4	13-#5	128	257	345	2.06	13		6	#4	#4	11-#5	7	#4	#4	13-#5
RIB NOT ON	150	2.18	13	0.706		11-#5+ 1	6	#4	#5	10-#6	7	#4	#4	13-#5	155	344	416	2.15	13		6	#4	#4	9-#6	7	#4	#4	13-#5
COLUMN LINE	200	2.50	13	0.773		11-#5+ 2	6	#5	#6	12-#6	7	#4	#4	13-#5	181	430	487	2.41	13		6	#4	#5	11-#6	7	#4	#4	13-#5
0.867 CF/SF	300	3.01	13 *	0.894		11-#5+ 6	6	#6	#7	16-#6	7	#4	#5	13-#5	233	595	628	2.71	13 *	4 S 6 1	6	#5	#5	14-#6	7	#4	#4	13-#5
	400	3.76	13 *	0.638		9-#6+ 2	6	#7	#7	19-#6	7	#5	#6	13-#5	286	757	769	3.43	13 *	4 S 6 1	6	#6	#6	18-#6	7	#4	#5	13-#5
	500	4.39	17 *	0.633		15-#5+ 2	6	#7	#8	23-#6	7	#6	#6	13-#5	332	897	895	4.03	14 *	4 S 6 2	6	#6	#7	21-#6	7	#5	#5	13-#5
28'-0"	50	2.04	14	0.636		12-#5+ 0	6	#4	#4	12-#5	8	#4	#4	15-#5	127	253	341	2.09	14		6	#4	#4	12-#5	8	#4	#4	15-#5
D = 10.417	100	2.19	14	0.662		12-#5+ 0	6	#4	#5	10-#6	8	#4	#4	15-#5	159	319	429	2.19	14		6	#4	#4	10-#6	8	#4	#4	15-#5
RIB NOT ON	150	2.41	14	0.741		12-#5+ 1	6	#5	#5	18-#5	8	#4	#4	15-#5	192	423	518	2.43	14		6	#4	#5	12-#6	8	#4	#4	15-#5
COLUMN LINE	200	2.74	14 *	0.821		12-#5+ 3	6	#6	#6	15-#6	8	#4	#4	15-#5	225	531	606	2.67	14		6	#5	#5	14-#6	8	#4	#4	15-#5
0.854 CF/SF	300	3.43	14 *	0.637		9-#6+ 2	6	#7	#7	20-#6	8	#5	#5	15-#5	291	736	782	3.05	14 *	4 S 6 1	6	#5	#6	18-#6	8	#4	#4	15-#5
	400	4.26	17 *	0.633		11-#6+ 3	6	#8	#8	24-#6	8	#5	#6	15-#5	353	929	950	3.84	14 *	4 S 6 2	6	#6	#7	23-#6	8	#4	#5	15-#5
30'-0"	50	2.14	15	0.634		9-#6+ 0	6	#4	#5	10-#6	9	#4	#4	16-#5	155	310	418	2.11	15		6	#4	#4	9-#6	9	#4	#4	16-#5
D = 10.417	100	2.31	15	0.688		9-#6+ 0	6	#5	#5	18-#5	9	#4	#4	16-#5	195	391	526	2.26	15		6	#4	#4	12-#6	9	#4	#4	16-#5
RIB NOT ON	150	2.67	15 *	0.796		9-#6+ 2	6	#6	#6	16-#6	9	#4	#4	16-#5	236	511	635	2.55	15		6	#4	#5	15-#6	9	#4	#4	16-#5
COLUMN LINE	200	3.09	15 *	0.871		9-#6+ 4	6	#6	#7	19-#6	9	#4	#5	16-#5	276	644	743	2.92	15 *	4 S 6 1	6	#5	#6	17-#6	9	#4	#4	16-#5
0.843 CF/SF	300	3.85	16 *	0.634		16-#5+ 3	6	#7	#8	25-#6	9	#5	#5	16-#5	356	893	957	3.57	15 *	4 S 6 2	6	#6	#7	23-#6	9	#4	#4	16-#5
32'-0"	50	2.17	16	0.692		10-#6+ 1	7	#4	#5	12-#6	9	#4	#4	16-#5	190	380	511	2.14	16		7	#4	#4	16-#5	9	#4	#4	16-#5
D = 12.417	100	2.40	16	0.790		10-#6+ 3	7	#5	#5	16-#6	9	#4	#4	16-#5	239	478	643	2.35	16		7	#4	#4	15-#6	9	#4	#4	16-#5
RIB ON	150	2.81	16 *	0.862		10-#6+ 5	7	#6	#6	19-#6	9	#4	#4	16-#5	288	615	775	2.74	16		7	#5	#5	18-#6	9	#4	#4	16-#5
COLUMN LINE	200	3.23	16 *	0.634		11-#6+ 3	7	#6	#7	23-#6	9	#4	#5	16-#5	337	777	906	3.06	16 *	4 S 6 1	7	#5	#6	21-#6	9	#4	#4	16-#5
0.862 CF/SF	300	4.32	20 *	0.630		14-#6+ 4	7	#8	#8	30-#6	9	#5	#6	16-#5	430	1070	1157	3.88	16 *	4 S 6 2	7	#6	#7	28-#6	9	#4	#5	16-#5
34'-0"	50	2.33	17	0.718		10-#6+ 2	7	#5	#5	15-#6	10	#4	#4	18-#5	227	453	610	2.28	17		7	#4	#4	14-#6	10	#4	#4	18-#5
D = 12.417	100	2.61	17 *	0.813		10-#6+ 4	7	#5	#6	19-#6	10	#4	#4	18-#5	285	571	768	2.59	17		7	#4	#5	18-#6	10	#4	#4	18-#5
RIB ON	150	3.11	17 *	0.891		11-#6+ 6	7	#6	#7	23-#6	10	#4	#5	18-#5	344	719	926	2.90	17 *	4 S 6 1	7	#5	#5	22-#6	10	#4	#4	18-#5
COLUMN LINE	200	3.64	17 *	0.633		13-#6+ 4	7	#7	#7	28-#6	10	#5	#5	18-#5	403	913	1084	3.38	17 *	4 S 6 1	7	#6	#6	26-#6	10	#4	#4	18-#5
0.852 CF/SF																												
36'-0"	50	2.54	18	0.742		11-#6+ 2	7	#5	#6	18-#6	11	#4	#4	19-#5	268	536	722	2.50	18		7	#4	#5	17-#6	11	#4	#4	19-#5
D = 12.417	100	2.82	18 *	0.846		11-#6+ 5	7	#6	#6	23-#6	11	#4	#4	19-#5	338	675	909	2.79	18	4 S 6 1	7	#5	#5	21-#6	11	#4	#4	19-#5
RIB ON	150	3.36	18 *	0.632		13-#6+ 2	7	#7	#7	28-#6	11	#4	#5	19-#5	407	828	1097	3.14	18 *	4 S 6 1	7	#5	#6	26-#6	11	#4	#4	19-#5
COLUMN LINE	200	3.93	21 *	0.629		22-#5+ 5	7	#7	#8	33-#6	11	#5	#5	19-#5	473	1051	1275	3.68	18 *	4 S 6 2	7	#6	#7	31-#6	11	#4	#4	19-#5
0.843 CF/SF																												
38'-0"	50	2.60	19 *	0.806		12-#6+ 5	8	#5	#6	21-#6	11	#4	#4	19-#5	318	635	855	2.56	19		8	#4	#5	20-#6	11	#4	#4	19-#5
D = 14.417	100	3.12	19 *	0.884		18-#5+10	8	#6	#7	27-#6	11	#4	#5	19-#5	399	799	1075	2.90	19 *		8	#5	#5	25-#6	11	#4	#4	19-#5
RIB NOT ON	150	3.62	21 *	0.629		22-#5+ 5	8	#7	#7	33-#6	11	#5	#5	19-#5	479	958	1290	3.31	19 *	4 S 6 1	8	#5	#6	31-#6	11	#4	#4	19-#5
COLUMN LINE	200	4.28	25 *	0.626		18-#6+ 4	8	#7	#8	39-#6	11	#5	#6	19-#5	555	1209	1495	3.98	19 *	4 S 6 2	8	#6	#7	36-#6	11	#4	#5	19-#5
0.859 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 19 in.	Rib Depth = 16 in.	Total Slab Depth = 3 in.																Total Depth = 19 in.	Rib Depth = 16 in.	Total Slab Depth = 3 in.								
26'-0"	50	2.02	13	0.640		11-#5+ 0	6	#4	#4	11-#5	7	#4	#4	13-#5	111	222	298	2.06	13		6	#4	#4	11-#5	7	#4	#4	13-#5
D = 10.417	100	2.02	13	0.640		11-#5+ 0	6	#4	#4	11-#5	7	#4	#4	13-#5	137	274	369	2.06	13		6	#4	#4	11-#5	7	#4	#4	13-#5
RIB NOT ON	150	2.14	13	0.640		11-#5+ 0	6	#4	#5	9-#6	7	#4	#4	13-#5	163	356	439	2.09	13		6	#4	#4	12-#5	7	#4	#4	13-#5
COLUMN LINE	200	2.30	13	0.642		11-#5+ 0	6	#5	#5	11-#6	7	#4	#4	13-#5	189	444	510	2.20	13		6	#4	#4	10-#6	7	#4	#4	13-#5
0.967 CF/SF	300	2.84	13	0.764		11-#5+ 1	6	#6	#6	14-#6	7	#4	#5	13-#5	242	610	651	2.66	13		6	#5	#5	13-#6	7	#4	#4	13-#5
	400	3.28	13 *	0.641		12-#5+ 2	6	#6	#7	17-#6	7	#5	#5	13-#5	294	773	793	3.00	13 *	4 S 6 1	6	#5	#6	16-#6	7	#4	#4	13-#5
	500	3.97	13 *	0.641		10-#6+ 1	6	#7	#8	21-#6	7	#5	#6	13-#5	347	933	934	3.50	13 *	4 S 6 1	6	#6	#6	19-#6	7	#4	#5	13-#5
28'-0"	50	2.04	14	0.638		12-#5+ 0	6	#4	#4	12-#5	8	#4	#4	15-#5	137	275	370	2.09	14		6	#4	#4	12-#5	8	#4	#4	15-#5
D = 10.417	100	2.17	14	0.638		12-#5+ 0	6	#4	#5	10-#6	8	#4	#4	15-#5	170	340	458	2.15	14		6	#4	#4	9-#6	8	#4	#4	15-#5
RIB NOT ON	150	2.32	14	0.638		12-#5+ 0	6	#5	#5	12-#6	8	#4	#4	15-#5	203	438	546	2.26	14		6	#4	#4	11-#6	8	#4	#4	15-#5
COLUMN LINE	200	2.54	14	0.733		12-#5+ 2	6	#5	#6	14-#6	8	#4	#4	15-#5	236	548	635	2.46	14		6	#4	#5	18-#5	8	#4	#4	15-#5
0.952 CF/SF	300	3.15	14 *	0.857		12-#5+ 5	6	#6	#7	18-#6	8	#4	#5	15-#5	301	756	811	3.01	14 *	4 S 6 1	6	#5	#6	17-#6	8	#4	#4	15-#5
	400	3.91	14 *	0.639		10-#6+ 2	6	#7	#8	22-#6	8	#5	#6	15-#5	367	959	987	3.47	14 *	4 S 6 1	6	#6	#6	20-#6	8	#4	#5	15-#5
	500	4.46	16 *	0.636		12-#6+ 1	6	#8	#8	26-#6	8	#6	#6	15-#5	430	1151	1157	3.88	14 *	4 S 6 2	6	#6	#7	24-#6	8	#4	#5	15-#5
30'-0"	50	2.14	15	0.637		9-#6+ 0	6	#4	#5	10-#6	9	#4	#4	16-#5	168	336	453	2.11	15		6	#4	#4	9-#6	9	#4	#4	16-#5
D = 10.417	100	2.29	15	0.637		9-#6+ 0	6	#5	#5	12-#6	9	#4	#4	16-#5	209	417	561	2.22	15		6	#4	#4	11-#6	9	#4	#4	16-#5
RIB NOT ON	150	2.54	15	0.670		9-#6+ 0	6	#5	#6	15-#6	9	#4	#4	16-#5	249	530	670	2.49	15		6	#4	#5	14-#6	9	#4	#4	16-#5
COLUMN LINE	200	2.76	15 *	0.779		9-#6+ 2	6	#6	#6	17-#6	9	#4	#4	16-#5	289	666	778	2.71	15	4 S 6 1	6	#5	#5	16-#6	9	#4	#4	16-#5
0.940 CF/SF	300	3.65	15 *	0.638		15-#5+ 2	6	#7	#8	22-#6	9	#5	#5	16-#5	370	920	995	3.28	15 *	4 S 6 1	6	#6	#6	21-#6	9	#4	#4	16-#5
	400	4.35	16 *	0.636		18-#5+ 3	6	#8	#8	27-#6	9	#5	#6	16-#5	449	1166	1209	4.01	15 *	4 S 6 2	6	#7	#7	25-#6	9	#4	#5	16-#5
32'-0"	50	2.17	16	0.635		10-#6+ 0	7	#4	#5	12-#6	9	#4	#4	16-#5	206	412	555	2.15	16		7	#4	#4	11-#6	9	#4	#4	16-#5
D = 12.417	100	2.35	16	0.712		10-#6+ 2	7	#5	#5	15-#6	9	#4	#4	16-#5	255	510	686	2.29	16		7	#4	#4	14-#6	9	#4	#4	16-#5
RIB ON	150	2.62	16	0.798		10-#6+ 4	7	#5	#6	18-#6	9	#4	#4	16-#5	304	640	818	2.58	16		7	#4	#5	17-#6	9	#4	#4	16-#5
COLUMN LINE	200	3.06	16 *	0.862		10-#6+ 6	7	#6	#7	21-#6	9	#4	#5	16-#5	353	806	950	2.80	16		7	#5	#5	19-#6	9	#4	#4	16-#5
0.961 CF/SF	300	3.99	16 *	0.636		18-#5+ 5	7	#7	#8	27-#6	9	#5	#6	16-#5	451	1114	1213	3.56	16 *	4 S 6 1	7	#6	#6	25-#6	9	#4	#5	16-#5
34'-0"	50	2.29	17	0.634		10-#6+ 1	7	#5	#5	14-#6	10	#4	#4	18-#5	246	492	662	2.24	17		7	#4	#4	13-#6	10	#4	#4	18-#5
D = 12.417	100	2.58	17	0.741		10-#6+ 3	7	#5	#6	18-#6	10	#4	#4	18-#5	305	609	820	2.55	17		7	#4	#5	17-#6	10	#4	#4	18-#5
RIB ON	150	2.84	17 *	0.835		10-#6+ 6	7	#6	#6	22-#6	10	#4	#4	18-#5	363	751	978	2.80	17		7	#5	#5	20-#6	10	#4	#4	18-#5
COLUMN LINE	200	3.36	17 *	0.894		12-#6+ 6	7	#7	#7	25-#6	10	#4	#5	18-#5	422	951	1136	3.14	17 *	4 S 6 1	7	#5	#6	24-#6	10	#4	#4	18-#5
0.950 CF/SF	300	4.35	19 *	0.633		22-#5+ 3	7	#8	#8	33-#6	10	#5	#6	18-#5	536	1312	1444	3.95	17 *	4 S 6 2	7	#6	#7	31-#6	10	#4	#5	18-#5
36'-0"	50	2.50	18	0.661		11-#6+ 1	7	#5	#6	17-#6	11	#4	#4	19-#5	291	581	783	2.44	18		7	#4	#5	16-#6	11	#4	#4	19-#5
D = 12.417	100	2.78	18 *	0.784		11-#6+ 4	7	#6	#6	22-#6	11	#4	#4	19-#5	360	721	970	2.74	18		7	#5	#5	20-#6	11	#4	#4	19-#5
RIB ON	150	3.18	18 *	0.866		12-#6+ 6	7	#6	#7	26-#6	11	#4	#5	19-#5	430	869	1158	3.05	18 *	4 S 6 1	7	#5	#6	24-#6	11	#4	#4	19-#5
COLUMN LINE	200	3.73	18 *	0.634		14-#6+ 2	7	#7	#8	30-#6	11	#5	#5	19-#5	500	1107	1345	3.37	18 *	4 S 6 1	7	#6	#6	28-#6	11	#4	#4	19-#5
0.940 CF/SF																												
38'-0"	50	2.57	19	0.713		12-#6+ 2	8	#5	#6	20-#6	11	#4	#4	19-#5	344	689	927	2.52	19		8	#4	#5	19-#6	11	#4	#4	19-#5
D = 14.417	100	2.88	19 *	0.819		12-#6+ 5	8	#6	#6	26-#6	11	#4	#4	19-#5	426	853	1148	2.85	19		8	#5	#5	24-#6	11	#4	#4	19-#5
RIB NOT ON	150	3.33	19 *	0.908		15-#6+ 8	8	#6	#7	31-#6	11	#4	#5	19-#5	508	1016	1368	3.17	19 *	4 S 6 1	8	#5	#6	28-#6	11	#4	#4	19-#5
COLUMN LINE	200	3.99	20 *	0.632		17-#6+ 5	8	#7	#8	36-#6	11	#5	#5	19-#5	589	1285	1585	3.69	19 *	4 S 6 1	8	#6	#6	33-#6	11	#4	#5	19-#5
0.958 CF/SF																												

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 12 in.	Rib Depth = 8 in.	Total Slab Depth = 4 in.																Total Depth = 12 in.	Rib Depth = 8 in.	Total Slab Depth = 4 in.								
16'-0"	50	2.04	12	0.631		7-#5+ 0	4	#4	#4	5-#6	4	#4	#4	7-#5	19	38	51	2.06	12		4	#4	#4	5-#6	4	#4	#4	7-#5
D = 6.417	100	2.04	12	0.631		7-#5+ 0	4	#4	#4	5-#6	4	#4	#4	7-#5	25	51	67	2.06	12		4	#4	#4	5-#6	4	#4	#4	7-#5
RIB NOT ON	150	2.04	12	0.631		7-#5+ 0	4	#4	#4	5-#6	4	#4	#4	7-#5	31	71	83	2.06	12		4	#4	#4	5-#6	4	#4	#4	7-#5
COLUMN LINE	200	2.04	12	0.631		7-#5+ 0	4	#4	#4	5-#6	4	#4	#4	7-#5	37	89	99	2.06	12		4	#4	#4	5-#6	4	#4	#4	7-#5
0.666 CF/SF	300	2.13	12	0.681		7-#5+ 0	4	#4	#5	5-#6	4	#4	#4	7-#5	48	126	130	2.06	12		4	#4	#4	5-#6	4	#4	#4	7-#5
	400	2.22	12	0.752		7-#5+ 0	4	#5	#5	8-#5	4	#4	#4	7-#5	60	161	162	2.06	12	3 S 4 1	4	#4	#4	5-#6	4	#4	#4	7-#5
	500	2.56	12 *	0.823		7-#5+ 0	4	#5	#6	5-#7	4	#4	#5	7-#5	72	196	193	2.29	12 *	3 S 4 1	4	#4	#5	6-#6	4	#4	#4	7-#5
18'-0"	50	1.99	12	0.631		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	27	55	74	2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
D = 6.417	100	1.99	12	0.631		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	36	73	96	2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
RIB NOT ON	150	1.99	12	0.631		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	44	102	119	2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
COLUMN LINE	200	2.07	12	0.673		5-#6+ 0	4	#4	#5	5-#6	5	#4	#4	8-#5	53	129	142	2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
0.654 CF/SF	300	2.22	12	0.762		5-#6+ 0	4	#5	#5	5-#7	5	#4	#4	8-#5	70	181	188	2.08	12	3 S 4 1	4	#4	#4	6-#6	5	#4	#4	8-#5
	400	2.68	12 *	0.632		5-#6+ 0	4	#6	#6	6-#7	5	#4	#4	8-#5	87	232	233	2.56	12 *	3 S 4 1	4	#5	#5	6-#7	5	#4	#4	8-#5
	500	3.08	12 *	0.632		5-#6+ 1	4	#6	#7	10-#6	5	#4	#5	8-#5	103	282	279	2.86	12 *	3 S 4 2	4	#5	#6	5-#8	5	#4	#4	8-#5
20'-0"	50	1.92	12	0.631		8-#5+ 0	5	#4	#4	8-#5	5	#4	#4	8-#5	38	77	103	1.93	12		5	#4	#4	8-#5	5	#4	#4	8-#5
D = 8.417	100	1.92	12	0.671		8-#5+ 0	5	#4	#4	8-#5	5	#4	#4	8-#5	50	103	135	1.93	12		5	#4	#4	8-#5	5	#4	#4	8-#5
RIB ON	150	1.92	12	0.719		8-#5+ 0	5	#4	#4	8-#5	5	#4	#4	8-#5	62	143	167	1.93	12		5	#4	#4	8-#5	5	#4	#4	8-#5
COLUMN LINE	200	2.05	12	0.793		8-#5+ 1	5	#4	#5	7-#6	5	#4	#4	8-#5	74	180	198	1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
0.673 CF/SF	300	2.53	12 *	0.901		8-#5+ 3	5	#5	#6	7-#7	5	#4	#5	8-#5	97	253	261	2.29	12 *	3 S 4 1	5	#4	#5	6-#7	5	#4	#4	8-#5
	400	2.96	13 *	0.630		8-#5+ 2	5	#6	#6	7-#8	5	#5	#5	8-#5	120	322	323	2.64	12 *	3 S 4 1	5	#5	#5	6-#8	5	#4	#4	8-#5
	500	3.46	16 *	0.627	3 S 4 1	9-#5+ 2	5	#6	#7	6-#9	5	#5	#6	8-#5	140	376	377	3.13	14 *	3 S 4 1	5	#5	#6	7-#8	5	#4	#5	8-#5
22'-0"	50	1.98	12	0.693		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	51	103	138	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
D = 8.417	100	1.98	12	0.745		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	67	138	181	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
RIB ON	150	2.12	12 *	0.797		9-#5+ 0	5	#4	#5	6-#7	6	#4	#4	10-#5	83	191	223	2.07	12		5	#4	#4	7-#6	6	#4	#4	10-#5
COLUMN LINE	200	2.46	12 *	0.876		9-#5+ 2	5	#5	#6	7-#7	6	#4	#4	10-#5	99	241	266	2.35	12 *	3 S 4 1	5	#4	#5	9-#6	6	#4	#4	10-#5
0.662 CF/SF	300	3.01	13 *	0.630		9-#5+ 1	5	#6	#7	7-#8	6	#4	#5	10-#5	130	337	349	2.75	12 *	3 S 4 1	5	#5	#5	7-#8	6	#4	#4	10-#5
	400	3.45	17 *	0.626	3 S 4 1	7-#6+ 2	5	#7	#7	7-#9	6	#5	#5	10-#5	157	405	421	3.03	15 *	3 S 4 2	5	#5	#6	8-#8	6	#4	#4	10-#5
24'-0"	50	1.99	12	0.751		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	67	134	180	2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
D = 8.417	100	2.11	12 *	0.839		10-#5+ 2	5	#4	#5	6-#7	7	#4	#4	11-#5	88	179	236	2.09	12		5	#4	#4	6-#7	7	#4	#4	11-#5
RIB ON	150	2.43	12 *	0.902		10-#5+ 4	5	#5	#6	6-#8	7	#4	#4	11-#5	108	249	291	2.33	12 *	3 S 4 1	5	#4	#5	7-#7	7	#4	#4	11-#5
COLUMN LINE	200	2.71	12 *	0.632		10-#5+ 2	5	#6	#6	7-#8	7	#4	#4	11-#5	129	314	347	2.65	12 *	3 S 4 1	5	#5	#5	7-#8	7	#4	#4	11-#5
0.654 CF/SF	300	3.53	17 *	0.626	3 S 4 1	6-#7+ 0	5	#7	#7	8-#9	7	#5	#5	11-#5	166	419	446	3.22	14 *	3 S 4 2	5	#6	#6	7-#9	7	#4	#4	11-#5
26'-0"	50	1.98	13	0.780		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	86	171	231	2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
D = 10.417	100	2.16	13 *	0.858		8-#6+ 1	6	#4	#5	8-#7	7	#4	#4	11-#5	112	225	301	2.11	13		6	#4	#4	7-#7	7	#4	#4	11-#5
RIB NOT ON	150	2.54	13 *	0.630		8-#6+ 1	6	#5	#6	8-#8	7	#4	#4	11-#5	138	314	372	2.44	13 *	3 S 4 1	6	#4	#5	7-#8	7	#4	#4	11-#5
COLUMN LINE	200	2.89	16 *	0.627		8-#6+ 2	6	#6	#6	7-#9	7	#4	#5	11-#5	163	392	438	2.72	13 *	3 S 4 1	6	#5	#5	11-#7	7	#4	#4	11-#5
0.668 CF/SF																												
28'-0"	50	2.10	14 *	0.806		8-#6+ 1	6	#4	#5	10-#6	8	#4	#4	12-#5	107	213	287	2.08	14		6	#4	#4	7-#7	8	#4	#4	12-#5
D = 10.417	100	2.38	14 *	0.894		8-#6+ 3	6	#5	#5	8-#8	8	#4	#4	12-#5	139	279	375	2.38	14 *	3 S 4 1	6	#4	#5	7-#8	8	#4	#4	12-#5
RIB NOT ON	150	2.86	16 *	0.627		8-#6+ 2	6	#6	#6	8-#9	8	#4	#5	12-#5	171	379	460	2.70	14 *	3 S 4 1	6	#5	#5	7-#9	8	#4	#4	12-#5
COLUMN LINE	200	3.35	19 *	0.624		7-#7+ 2	6	#7	#7	9-#9	8	#4	#5	12-#5	201	462	541	3.12	15 *	3 S 4 2	6	#5	#6	9-#9	8	#4	#4	12-#5
0.660 CF/SF																												
30'-0"	50	2.29	15 *	0.857		9-#6+ 3	6	#5	#5	7-#8	9	#4	#4	14-#5	131	261	352	2.25	15		6	#4	#4	7-#8	9	#4	#4	14-#5
D = 10.417	100	2.68	15 *	0.932		9-#6+ 6	6	#6	#6	8-#9	9	#4	#4	14-#5	171	342	460	2.55	15 *	3 S 4 1	6	#4	#5	7-#9	9	#4	#4	14-#5
RIB NOT ON	150	3.18	19 *	0.624		7-#7+ 2	6	#6	#7	12-#8	9	#4	#5	14-#5	209	448	562	3.05	15 *	3 S 4 2	6	#5	#6	9-#9	9	#4	#4	14-#5
COLUMN LINE																												
0.654 CF/SF																												
32'-0"	50	2.36	16 *	0.883		10-#6+ 4	7	#5	#5	9-#8	9	#4	#4	14-#5	160	319	430	2.29	16		7	#4	#4	11-#7	9	#4	#4	14-#5
D = 12.417	100	2.86	18 *	0.925		10-#6+ 7	7	#6	#6	9-#9	9	#4	#4	14-#5	207	415	558	2.83	16 *	3 S 4 1	7	#5	#5	9-#9	9	#4	#4	14-#5
RIB ON																												
COLUMN LINE																												
0.666 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 14 in.	Rib Depth = 10 in.	Total Slab Depth = 4 in.															
18'-0"	50	1.99	12	0.634		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	30	60	80
D = 6.417	100	1.99	12	0.634		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	38	77	103
RIB NOT ON	150	1.99	12	0.634		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	47	106	126
COLUMN LINE	200	1.99	12	0.634		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	55	133	149
0.742 CF/SF	300	2.08	12	0.635		5-#6+ 0	4	#4	#5	8-#5	5	#4	#4	8-#5	72	186	194
	400	2.41	12	0.717		5-#6+ 0	4	#5	#6	5-#7	5	#4	#4	8-#5	89	238	240
	500	2.77	12 *	0.832		5-#6+ 1	4	#6	#6	6-#7	5	#4	#5	8-#5	106	289	285
20'-0"	50	1.96	12	0.634		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	42	84	113
D = 8.417	100	1.96	12	0.634		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	54	109	144
RIB ON	150	1.96	12	0.638		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	65	149	176
COLUMN LINE	200	2.04	12	0.680		6-#6+ 0	5	#4	#5	6-#6	5	#4	#4	8-#5	77	187	208
0.765 CF/SF	300	2.22	12	0.765		6-#6+ 0	5	#5	#5	6-#7	5	#4	#4	8-#5	101	260	271
	400	2.59	12 *	0.870		6-#6+ 1	5	#5	#6	7-#7	5	#4	#5	8-#5	124	332	334
	500	3.10	12 *	0.635		6-#6+ 0	5	#6	#7	7-#8	5	#5	#5	8-#5	148	403	397
22'-0"	50	1.98	12	0.634		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	56	112	151
D = 8.417	100	1.98	12	0.655		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	72	145	193
RIB ON	150	2.07	12	0.703		9-#5+ 0	5	#4	#5	7-#6	6	#4	#4	10-#5	87	199	236
COLUMN LINE	200	2.23	12	0.751		9-#5+ 0	5	#5	#5	6-#7	6	#4	#4	10-#5	103	250	278
0.752 CF/SF	300	2.74	12 *	0.885		9-#5+ 3	5	#6	#6	6-#8	6	#4	#5	10-#5	135	348	363
	400	3.21	12 *	0.635		9-#5+ 2	5	#6	#7	6-#9	6	#5	#5	10-#5	166	445	448
	500	3.90	15 *	0.631	3 S 4 1	6-#7+ 0	5	#7	#8	7-#9	6	#5	#6	10-#5	195	529	524
24'-0"	50	1.99	12	0.674		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	73	146	196
D = 8.417	100	2.06	12	0.726		10-#5+ 0	5	#4	#5	7-#6	7	#4	#4	11-#5	94	189	252
RIB ON	150	2.20	12	0.778		10-#5+ 0	5	#5	#5	9-#6	7	#4	#4	11-#5	114	260	307
COLUMN LINE	200	2.43	12 *	0.845		10-#5+ 1	5	#5	#6	6-#8	7	#4	#4	11-#5	135	326	363
0.742 CF/SF	300	3.04	12 *	0.635		10-#5+ 1	5	#6	#7	6-#9	7	#4	#5	11-#5	176	454	474
	400	3.71	16 *	0.630	3 S 4 1	6-#7+ 1	5	#7	#8	8-#9	7	#5	#5	11-#5	213	566	574
	500	4.31	20 *	0.626	3 S 4 1	7-#7+ 0	5	#8	#8	9-#9	7	#5	#6	11-#5	245	629	661
26'-0"	50	1.98	13	0.710		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	94	187	252
D = 10.417	100	2.12	13	0.765		8-#6+ 0	6	#4	#5	7-#7	7	#4	#4	11-#5	120	239	322
RIB NOT ON	150	2.30	13 *	0.856		8-#6+ 2	6	#5	#5	7-#8	7	#4	#4	11-#5	146	329	393
COLUMN LINE	200	2.72	13 *	0.909		8-#6+ 3	6	#6	#6	8-#8	7	#4	#5	11-#5	172	413	464
0.760 CF/SF	300	3.43	16 *	0.630		9-#6+ 1	6	#7	#7	8-#9	7	#5	#5	11-#5	222	570	599
	400	4.01	20 *	0.626		15-#5+ 4	6	#7	#8	10-#9	7	#5	#6	11-#5	266	663	716
28'-0"	50	2.05	14	0.708		8-#6+ 0	6	#4	#5	9-#6	8	#4	#4	12-#5	116	232	313
D = 10.417	100	2.24	14 *	0.819		8-#6+ 2	6	#5	#5	7-#8	8	#4	#4	12-#5	149	298	401
RIB NOT ON	150	2.51	14 *	0.883		8-#6+ 3	6	#5	#6	8-#8	8	#4	#4	12-#5	182	402	489
COLUMN LINE	200	3.05	14 *	0.632		12-#5+ 3	6	#6	#7	8-#9	8	#4	#5	12-#5	214	507	577
0.750 CF/SF	300	3.79	20 *	0.626		8-#7+ 2	6	#7	#8	10-#9	8	#5	#5	12-#5	273	673	735

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 14 in.			Rib Depth = 10 in.				Total Slab Depth = 4 in.			
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.27	12	3 S 4 1	4	#4	#5	9-#5	5	#4	#4	8-#5
2.56	12 *	3 S 4 1	4	#5	#5	6-#7	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
2.07	12		5	#4	#4	7-#6	5	#4	#4	8-#5
2.38	12 *	3 S 4 1	5	#4	#5	9-#6	5	#4	#4	8-#5
2.64	12 *	3 S 4 1	5	#5	#5	6-#8	5	#4	#4	8-#5
2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
2.14	12		5	#4	#4	6-#7	6	#4	#4	10-#5
2.52	12 *	3 S 4 1	5	#5	#5	7-#7	6	#4	#4	10-#5
2.91	12 *	3 S 4 1	5	#5	#6	7-#8	6	#4	#4	10-#5
3.40	13 *	3 S 4 2	5	#6	#6	11-#7	6	#4	#5	10-#5
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.09	12		5	#4	#4	6-#7	7	#4	#4	11-#5
2.33	12	3 S 4 1	5	#4	#5	7-#7	7	#4	#4	11-#5
2.87	12 *	3 S 4 1	5	#5	#6	6-#9	7	#4	#4	11-#5
3.33	13 *	3 S 4 2	5	#6	#6	8-#9	7	#4	#4	11-#5
3.91	18 *	3 S 4 2	5	#6	#7	9-#9	7	#4	#5	11-#5
2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
2.08	13		6	#4	#4	9-#6	7	#4	#4	11-#5
2.18	13		6	#4	#4	8-#7	7	#4	#4	11-#5
2.44	13 *	3 S 4 1	6	#4	#5	7-#8	7	#4	#4	11-#5
3.06	13 *	3 S 4 1	6	#5	#6	8-#9	7	#4	#4	11-#5
3.56	18 *	3 S 4 2	6	#6	#6	9-#9	7	#4	#5	11-#5
1.99	14		6	#4	#4	12-#5	8	#4	#4	12-#5
2.14	14		6	#4	#4	8-#7	8	#4	#4	12-#5
2.46	14 *	3 S 4 1	6	#4	#5	8-#8	8	#4	#4	12-#5
2.85	14 *	3 S 4 1	6	#5	#6	7-#9	8	#4	#4	12-#5
3.45	16 *	3 S 4 2	6	#6	#6	12-#8	8	#4	#5	12-#5

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 14 in.	Rib Depth = 10 in.	Total Slab Depth = 4 in.																Total Depth = 14 in.	Rib Depth = 10 in.	Total Slab Depth = 4 in.								
30'-0"	50	2.24	15	0.741		9-#6+ 0	6	#5	#5	7-#8	9	#4	#4	14-#5	142	285	383	2.14	15		6	#4	#4	8-#7	9	#4	#4	14-#5
D = 10.417	100	2.50	15 *	0.845		9-#6+ 2	6	#5	#6	11-#7	9	#4	#4	14-#5	183	365	492	2.43	15	3 S 4 1	6	#4	#5	8-#8	9	#4	#4	14-#5
RIB NOT ON	150	2.88	15 *	0.631		9-#6+ 1	6	#6	#7	8-#9	9	#4	#4	14-#5	223	483	600	2.76	15 *	3 S 4 1	6	#5	#5	8-#9	9	#4	#4	14-#5
COLUMN LINE	200	3.37	18 *	0.628		15-#5+ 3	6	#7	#7	10-#9	9	#4	#5	14-#5	261	605	702	3.19	15 *	3 S 4 2	6	#6	#6	9-#9	9	#4	#4	14-#5
0.742 CF/SF																												
32'-0"	50	2.28	16 *	0.809		10-#6+ 2	7	#5	#5	14-#6	9	#4	#4	14-#5	174	348	468	2.21	16		7	#4	#4	10-#7	9	#4	#4	14-#5
D = 12.417	100	2.63	16 *	0.896		10-#6+ 5	7	#5	#6	9-#9	9	#4	#4	14-#5	223	446	600	2.55	16 *		7	#4	#5	10-#8	9	#4	#4	14-#5
RIB ON	150	3.10	18 *	0.628		11-#6+ 3	7	#6	#7	10-#9	9	#4	#5	14-#5	270	573	728	2.85	16 *	3 S 4 1	7	#5	#5	12-#8	9	#4	#4	14-#5
COLUMN LINE	200	3.64	21 *	0.625		9-#7+ 4	7	#7	#7	12-#9	9	#5	#5	14-#5	315	702	849	3.37	17 *	3 S 4 2	7	#6	#6	11-#9	9	#4	#4	14-#5
0.756 CF/SF																												
34'-0"	50	2.49	17 *	0.840		10-#6+ 4	7	#5	#6	10-#8	10	#4	#4	15-#5	208	416	560	2.42	17		7	#4	#5	9-#8	10	#4	#4	15-#5
D = 12.417	100	2.81	17 *	0.925		15-#5+11	7	#6	#6	10-#9	10	#4	#4	15-#5	267	533	718	2.76	17 *	3 S 4 1	7	#5	#5	9-#9	10	#4	#4	15-#5
RIB ON	150	3.42	21 *	0.625		10-#7+ 3	7	#7	#7	12-#9	10	#4	#5	15-#5	322	659	866	3.21	17 *	3 S 4 1	7	#5	#6	12-#9	10	#4	#4	15-#5
COLUMN LINE	200	3.80	27 *	0.621	3 S 4 1	11-#7+ 3	7	#7	#7	18-#8	10	#5	#5	15-#5	369	738	993	3.59	22 *	3 S 4 2	7	#6	#6	14-#9	10	#4	#4	15-#5
0.748 CF/SF																												
36'-0"	50	2.73	18 *	0.865		11-#6+ 5	7	#6	#6	9-#9	11	#4	#4	16-#5	246	492	662	2.70	18		7	#5	#5	9-#9	11	#4	#4	16-#5
D = 12.417	100	3.17	20 *	0.922		9-#7+ 7	7	#6	#7	12-#9	11	#4	#5	16-#5	314	628	846	3.04	18 *	3 S 4 1	7	#5	#6	11-#9	11	#4	#4	16-#5
RIB ON	150	3.71	26 *	0.622		11-#7+ 3	7	#7	#8	15-#9	11	#4	#5	16-#5	377	754	1014	3.46	19 *	3 S 4 2	7	#6	#6	14-#9	11	#4	#4	16-#5
COLUMN LINE																												
0.742 CF/SF																												
38'-0"	50	2.79	19 *	0.898		12-#6+ 8	8	#6	#6	11-#9	11	#4	#4	16-#5	291	582	783	2.71	19 *		8	#5	#5	10-#9	11	#4	#4	16-#5
D = 14.417	100	3.42	23 *	0.624		11-#7+ 3	8	#7	#7	14-#9	11	#4	#5	16-#5	369	739	995	3.17	19 *	3 S 4 1	8	#5	#6	13-#9	11	#4	#4	16-#5
RIB NOT ON																												
COLUMN LINE																												
0.754 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 16 in.	Rib Depth = 12 in.		Total Slab Depth = 4 in.														
22'-0"	50	1.98	12	0.637		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	61	122	164
D = 8.417	100	1.98	12	0.637		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	77	153	206
RIB ON	150	1.98	12	0.637		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	92	206	249
COLUMN LINE	200	2.10	12	0.651		9-#5+ 0	5	#4	#5	7-#6	6	#4	#4	10-#5	108	258	291
0.845 CF/SF	300	2.46	12	0.768		9-#5+ 1	5	#5	#6	7-#7	6	#4	#4	10-#5	140	357	376
	400	2.81	12 *	0.875		9-#5+ 3	5	#6	#6	7-#8	6	#4	#5	10-#5	171	454	461
	500	3.33	12 *	0.638		10-#5+ 1	5	#7	#7	6-#9	6	#5	#5	10-#5	203	550	546
24'-0"	50	1.99	12	0.637		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	79	158	213
D = 8.417	100	1.99	12	0.641		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	100	200	269
RIB ON	150	2.11	12	0.690		10-#5+ 0	5	#4	#5	6-#7	7	#4	#4	11-# 5	120	269	324
COLUMN LINE	200	2.39	12	0.739		10-#5+ 0	5	#5	#6	7-#7	7	#4	#4	11-#5	141	337	380
0.833 CF/SF	300	2.92	12 *	0.874		10-#5+ 3	5	#6	#7	7-#8	7	#4	#5	11-#5	182	466	491
	400	3.42	12 *	0.638	4 S 6 1	6-#7+ 0	5	#7	#7	7-#9	7	#5	#5	11-#5	224	593	602
	500	4.14	15 *	0.634	4 S 6 1	9-#6+ 2	5	#8	#8	8-#9	7	#5	#6	11-#5	262	711	705
26'-0"	50	1.98	13	0.636		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	102	203	273
D = 10.417	100	2.00	13	0.687		8-#6+ 0	6	#4	#4	9-#6	7	#4	#4	11-#5	128	256	344
RIB NOT ON	150	2.24	13	0.768		8-#6+ 1	6	#5	#5	8-#7	7	#4	#4	11-#5	154	342	415
COLUMN LINE	200	2.52	13 *	0.833		8-#6+ 2	6	#5	#6	7-#8	7	#4	#4	11-#5	180	428	485
0.854 CF/SF	300	3.19	13 *	0.637		8-#6+ 2	6	#6	#7	7-#9	7	#5	#5	11-#5	233	593	627
	400	3.87	16 *	0.633		7-#7+ 2	6	#7	#8	9-#9	7	#5	#6	11-#5	282	746	760
	500	4.54	19 *	0.630		8-#7+ 2	6	#8	#8	13-#8	7	#6	#6	11-#5	326	858	879
28'-0"	50	1.95	14	0.634		8-#6+ 0	6	#4	#4	12-#5	8	#4	#4	12-#5	126	252	340
D = 10.417	100	2.12	14	0.693		8-#6+ 0	6	#4	#5	8-#7	8	#4	#4	12-#5	159	318	428
RIB NOT ON	150	2.47	14 *	0.803		8-#6+ 2	6	#5	#6	8-#8	8	#4	#4	12-#5	192	419	516
COLUMN LINE	200	2.78	14 *	0.877		8-#6+ 4	6	#6	#6	7-#9	8	#4	#5	12-#5	224	527	604
0.842 CF/SF	300	3.53	15 *	0.634		7-#7+ 2	6	#7	#7	9-#9	8	#5	#5	12-#5	289	730	778
	400	4.23	20 *	0.629		12-#6+ 2	6	#8	#8	11-#9	8	#5	#6	12-#5	347	895	933
30'-0"	50	2.12	15	0.671		9-#6+ 0	6	#4	#5	8-#7	9	#4	#4	14-#5	155	309	416
D = 10.417	100	2.37	15	0.762		9-#6+ 1	6	#5	#5	8-#8	9	#4	#4	14-#5	195	390	525
RIB NOT ON	150	2.68	15 *	0.850		9-#6+ 3	6	#6	#6	7-#9	9	#4	#4	14-#5	235	506	633
COLUMN LINE	200	3.09	15 *	0.634		9-#6+ 2	6	#6	#7	9-#9	9	#4	#5	14-#5	275	638	742
0.833 CF/SF	300	4.09	19 *	0.630		12-#6+ 3	6	#8	#8	12-#9	9	#5	#5	14-#5	352	879	947
32'-0"	50	2.18	16	0.754		10-#6+ 2	7	#4	#5	10-#7	9	#4	#4	14-#5	189	378	509
D = 12.417	100	2.54	16 *	0.838		10-#6+ 4	7	#5	#6	9-#8	9	#4	#4	14-#5	238	476	641
RIB ON	150	2.95	16 *	0.901		10-#6+ 6	7	#6	#6	9-#9	9	#4	#5	14-#5	287	607	772
COLUMN LINE	200	3.47	17 *	0.632		12-#6+ 2	7	#7	#7	11-#9	9	#5	#5	14-#5	335	766	901
0.849 CF/SF	300	4.34	23 *	0.626	4 S 6 1	11-#7+ 3	7	#8	#8	14-#9	9	#5	#6	14-#5	422	992	1135
34'-0"	50	2.37	17	0.775		10-#6+ 3	7	#5	#5	9-#8	10	#4	#4	15-#5	226	451	608
D = 12.417	100	2.78	17 *	0.858		10-#6+ 5	7	#6	#6	9-#9	10	#4	#4	15-#5	284	569	766
RIB ON	150	3.17	17 *	0.632		12-#6+ 2	7	#6	#7	11-#9	10	#4	#5	15-#5	343	708	924
COLUMN LINE	200	3.74	20 *	0.629		10-#7+ 3	7	#7	#8	13-#9	10	#5	#5	15-#5	399	894	1073
0.840 CF/SF	300	4.57	27 *	0.624	4 S 6 1	10-#8+ 1	7	#8	#8	17-#9	10	#5	#6	17-#5	496	993	1336
36'-0"	50	2.52	18 *	0.796		11-#6+ 3	7	#5	#6	9-#9	11	#4	#4	16-#5	267	534	719
D = 12.417	100	2.92	18 *	0.892		12-#6+ 6	7	#6	#7	11-#9	11	#4	#4	16-#5	337	673	906
RIB ON	150	3.35	20 *	0.629		10-#7+ 3	7	#7	#7	13-#9	11	#4	#5	16-#5	404	809	1089
COLUMN LINE	200	4.11	24 *	0.625	4 S 6 1	9-#8+ 2	7	#8	#8	16-#9	11	#5	#5	16-#5	469	1026	1263
0.833 CF/SF																	
38'-0"	50	2.67	19 *	0.846		12-#6+ 6	8	#6	#6	10-#9	11	#4	#4	16-#5	316	632	851
D = 14.417	100	3.20	19 *	0.926		10-#7+ 7	8	#6	#7	16-#8	11	#4	#5	16-#5	398	796	1071
RIB NOT ON	150	3.76	23 *	0.626		12-#7+ 5	8	#7	#7	16-#9	11	#5	#5	16-#5	475	951	1280
COLUMN LINE	200	4.38	29 *	0.622		14-#7+ 4	8	#7	#8	18-#9	11	#5	#6	19-#5	545	1090	1467
0.847 CF/SF																	

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 16 in.	Rib Depth = 12 in.		Total Slab Depth = 4 in.									
22'-0"	50	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
D = 8.417	100	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
RIB ON	150	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
COLUMN LINE	200	2.07	12		5	#4	#4	7-#6	6	#4	#4	10-#5
0.845 CF/SF	300	2.35	12		5	#4	#5	9-#6	6	#4	#4	10-#5
	400	2.58	12 *	4 S 6 1	5	#5	#5	6-#8	6	#4	#4	10-#5
	500	2.91	12 *	4 S 6 1	5	#5	#6	7-#8	6	#4	#4	10-#5
24'-0"	50	2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
D = 8.417	100	2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
RIB ON	150	2.09	12		5	#4	#4	6-#7	7	#4	#4	11-#5
COLUMN LINE	200	2.29	12		5	#4	#5	9-#6	7	#4	#4	11-#5
0.833 CF/SF	300	2.65	12 *	4 S 6 1	5	#5	#5	7-#8	7	#4	#4	11-#5
	400	3.06	12 *	4 S 6 2	5	#6	#6	8-#8	7	#4	#4	11-#5
	500	3.69	12 *	4 S 6 2	5	#6	#7	8-#9	7	#4	#5	11-#5
26'-0"	50	2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
D = 10.417	100	2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
RIB NOT ON	150	2.11	13		6	#4	#4	7-#7	7	#4	#4	11-#5
COLUMN LINE	200	2.44	13		6	#4	#5	7-#8	7	#4	#4	11-#5
0.854 CF/SF	300	2.88	13 *	4 S 6 1	6	#5	#6	11-#7	7	#4	#4	11-#5
	400	3.36	13 *	4 S 6 1	6	#6	#6	8-#9	7	#4	#5	11-#5
	500	4.06	17 *	4 S 6 2	6	#6	#7	10-#9	7	#5	#5	11-#5
28'-0"	50	1.97	14		6	#4	#4	8-#6	8	#4	#4	12-#5
D = 10.417	100	2.09	14		6	#4	#4	10-#6	8	#4	#4	12-#5
RIB NOT ON	150	2.38	14		6	#4	#5	7-#8	8	#4	#4	12-#5
COLUMN LINE	200	2.58	14 *	4 S 6 1	6	#5	#5	8-#8	8	#4	#4	12-#5
0.842 CF/SF	300	3.27	14 *	4 S 6 1	6	#6	#6	9-#9	8	#4	#4	12-#5
	400	3.76	16 *	4 S 6 2	6	#6	#7	13-#8	8	#4	#5	12-#5
30'-0"	50	2.08	15		6	#4	#4	7-#7	9	#4	#4	14-#5
D = 10.417	100	2.36	15		6	#4	#5	7-#8	9	#4	#4	14-#5
RIB NOT ON	150	2.61	15	4 S 6 1	6	#5	#5	11-#7	9	#4	#4	14-#5
COLUMN LINE	200	2.90	15 *	4 S 6 1	6	#5	#6	8-#9	9	#4	#4	14-#5
0.833 CF/SF	300	3.79	15 *	4 S 6 2	6	#6	#7	11-#9	9	#4	#5	14-#5
32'-0"	50	2.15	16		7	#4	#4	9-#7	9	#4	#4	14-#5
D = 12.417	100	2.48	16		7	#4	#5	9-#8	9	#4	#4	14-#5
RIB ON	150	2.83	16 *	4 S 6 1	7	#5	#5	9-#9	9	#4	#4	14-#5
COLUMN LINE	200	3.07	16*	4 S 6 1	7	#5	#6	10-#9	9	#4	#4	14-#5
0.849 CF/SF	300	3.86	19 *	4 S 6 2	7	#6	#7	16-#8	9	#4	#5	14-#5
34'-0"	50	2.37	17		7	#4	#5	11-#7	10	#4	#4	15-#5
D = 12.417	100	2.76	17		7	#5	#5	9-#9	10	#4	#4	15-#5
RIB ON	150	2.99	17 *	4 S 6 1	7	#5	#6	10-#9	10	#4	#4	15-#5
COLUMN LINE	200	3.35	17 *	4 S 6 2	7	#6	#6	12-#9	10	#4	#4	15-#5
0.840 CF/SF	300	4.17	24 *	4 S 6 2	7	#6	#7	16-#9	10	#4	#5	16-#5
36'-0"	50	2.44	18		7	#4	#5	10-#8	11	#4	#4	16-#5
D = 12.417	100	2.78	18 *	4 S 6 1	7	#5	#5	10-#9	11	#4	#4	16-#5
RIB ON	150	3.12	18 *	4 S 6 2	7	#5	#6	12-#9	11	#4	#4	16-#5
COLUMN LINE	200	3.75	18 *	4 S 6 2	7	#6	#7	15-#9	11	#4	#4	16-#5
0.833 CF/SF												
38'-0"	50	2.54	19		8	#4	#5	12-#8	11	#4	#4	16-#5
D = 14.417	100	3.05	19 *	4 S 6 1	8	#5	#6	12-#9	11	#4	#4	16-#5
RIB NOT ON	150	3.52	19 *	4 S 6 1	8	#6	#6	15-#9	11	#4	#4	16-#5
COLUMN LINE	200	4.10	22 *	4 S 6 2	8	#6	#7	17-#9	11	#4	#5	18-#5
0.847 CF/SF												

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 18 in.	Rib Depth = 14 in.	Total Slab Depth = 4 in.															
24'-0"	50	1.99	12	0.640		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	86	171	230
D = 8.417	100	1.99	12	0.640		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	106	212	286
RIB ON	150	2.08	12	0.640		10-#5+ 0	5	#4	#5	6-#7	7	#4	#4	11-#5	127	278	342
COLUMN LINE	200	2.18	12	0.644		10-#5+ 0	5	#5	#5	6-#7	7	#4	#4	11-#5	148	347	397
0.927 CF/SF	300	2.60	12	0.762		10-#5+ 1	5	#6	#6	6-#8	7	#4	#4	11-#5	189	478	508
	400	3.01	12 *	0.641		10-#5+ 1	5	#6	#7	6-#9	7	#4	#5	11-#5	230	605	619
	500	3.65	12 *	0.641	4 S 6 1	6-#7+ 1	5	#7	#8	8-#9	7	#5	#5	11-#5	271	732	730
26'-0"	50	1.98	13	0.638		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	110	220	296
D = 10.417	100	1.98	13	0.638		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	136	272	367
RIB NOT ON	150	2.12	13	0.654		8-#6+ 0	6	#4	#5	7-#7	7	#4	#4	11-#5	162	353	437
COLUMN LINE	200	2.33	13	0.736		8-#6+ 1	6	#5	#5	8-#7	7	#4	#4	11-#5	189	441	508
0.950 CF/SF	300	2.83	13 *	0.856		8-#6+ 3	6	#6	#6	8-#8	7	#4	#5	11-#5	241	608	649
	400	3.45	13 *	0.639		9-#6+ 1	6	#7	#7	8-#9	7	#5	#5	11-#5	294	770	790
	500	3.97	14 *	0.638		10-#6+ 1	6	#7	#8	12-#8	7	#5	#6	11-#5	345	928	928
28'-0"	50	1.95	14	0.637		8-#6+ 0	6	#4	#4	8-#6	8	#4	#4	12-#5	137	273	368
D = 10.417	100	2.10	14	0.637		8-#6+ 0	6	#4	#5	10-#6	8	#4	#4	12-#5	169	339	456
RIB NOT ON	150	2.24	14	0.704		8-#6+ 1	6	#5	#5	7-#8	8	#4	#4	12-#5	202	435	544
COLUMN LINE	200	2.55	14	0.781		8-#6+ 2	6	#6	#6	8-#8	8	#4	#4	12-#5	235	545	632
0.937 CF/SF	300	3.32	14 *	0.638		9-#6+ 2	6	#7	#7	8-#9	8	#5	#5	12-#5	300	752	809
	400	3.99	15 *	0.637		8-#7+ 2	6	#7	#8	10-#9	8	#5	#6	12-#5	365	952	982
30'-0"	50	2.09	15	0.636		9-#6+ 0	6	#4	#5	7-#7	9	#4	#4	14-#5	167	334	450
D = 10.417	100	2.29	15	0.659		9-#6+ 0	6	#5	#5	7-#8	9	#4	#4	14-#5	207	415	559
RIB NOT ON	150	2.50	15	0.748		9-#6+ 1	6	#5	#6	11-#7	9	#4	#4	14-#5	248	526	667
COLUMN LINE	200	2.93	15 *	0.836		9-#6+ 3	6	#6	#7	8-#9	9	#4	#5	14-#5	288	662	776
0.927 CF/SF	300	3.63	15 *	0.637		8-#7+ 2	6	#7	#8	10-#9	9	#5	#5	14-#5	369	916	993
32'-0"	50	2.17	16	0.669		10-#6+ 1	7	#4	#5	9-#7	9	#4	#4	14-#5	205	409	551
D = 12.417	100	2.36	16	0.769		10-#6+ 3	7	#5	#5	9-#8	9	#4	#4	14-#5	253	507	682
RIB ON	150	2.72	16 *	0.843		10-#6+ 5	7	#6	#6	9-#9	9	#4	#4	14-#5	302	634	814
COLUMN LINE	200	3.14	16 *	0.895		15-#5+ 8	7	#6	#7	12-#8	9	#4	#5	14-#5	351	799	946
0.946 CF/SF	300	4.11	18 *	0.633		10-#7+ 3	7	#7	#8	16-#8	9	#5	#6	14-#5	447	1101	1202
34'-0"	50	2.25	17	0.698		10-#6+ 2	7	#5	#5	11-#7	10	#4	#4	15-#5	244	489	658
D = 12.417	100	2.56	17 *	0.794		10-#6+ 4	7	#5	#6	9-#9	10	#4	#4	15-#5	303	606	816
RIB ON	150	3.01	17 *	0.874		11-#6+ 6	7	#6	#7	10-#9	10	#4	#5	15-#5	362	742	973
COLUMN LINE	200	3.54	17 *	0.634		9-#7+ 2	7	#7	#7	12-#9	10	#5	#5	15-#5	420	942	1131
0.935 CF/SF	300	4.43	22 *	0.629	4 S 6 1	9-#8+ 1	7	#8	#8	15-#9	10	#5	#6	16-#5	529	1272	1425
36'-0"	50	2.45	18	0.724		11-#6+ 2	7	#5	#6	10-#8	11	#4	#4	16-#5	289	578	778
D = 12.417	100	2.75	18 *	0.829		11-#6+ 5	7	#6	#6	10-#9	11	#4	#4	16-#5	359	717	965
RIB ON	150	3.19	18 *	0.914		10-#7+ 6	7	#6	#7	12-#9	11	#4	#5	16-#5	428	857	1153
COLUMN LINE	200	3.75	19 *	0.632		11-#7+ 3	7	#7	#8	14-#9	11	#5	#5	16-#5	497	1092	1337
0.927 CF/SF																	
38'-0"	50	2.54	19 *	0.766		12-#6+ 3	8	#5	#6	12-#8	11	#4	#4	16-#5	342	684	921
D = 14.417	100	3.06	19 *	0.867		18-#5+ 9	8	#6	#7	12-#9	11	#4	#5	16-#5	424	848	1141
RIB NOT ON	150	3.42	19 *	0.632		11-#7+ 3	8	#7	#7	14-#9	11	#4	#5	16-#5	506	1012	1362
COLUMN LINE	200	4.24	23 *	0.628		10-#8+ 3	8	#7	#8	17-#9	11	#5	#6	17-#5	582	1259	1568
0.942 CF/SF	300	4.81	30 *	0.624		32-#5+ 5	8	#8	#8	21-#9	11	#5	#6	16-#6	719	1437	1935

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 18 in.	Rib Depth = 14 in.	Total Slab Depth = 4 in.								
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.09	12		5	#4	#4	6-#7	7	#4	#4	11-#5
2.50	12	4 S 6 1	5	#5	#5	6-#8	7	#4	#4	11-#5
2.82	12 *	4 S 6 1	5	#5	#6	7-#8	7	#4	#4	11-#5
3.21	12 *	4 S 6 2	5	#6	#6	7-#9	7	#4	#4	11-#5
2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
2.08	13		6	#4	#4	9-#6	7	#4	#4	11-#5
2.31	13		6	#4	#5	8-#7	7	#4	#4	11-#5
2.65	13	4 S 6 1	6	#5	#5	8-#8	7	#4	#4	11-#5
3.09	13 *	4 S 6 1	6	#5	#6	7-#9	7	#4	#5	11-#5
3.53	13 *	4 S 6 2	6	#6	#6	9-#9	7	#4	#5	11-#5
1.97	14		6	#4	#4	8-#6	8	#4	#4	12-#5
2.08	14		6	#4	#4	7-#7	8	#4	#4	12-#5
2.14	14		6	#4	#4	8-#7	8	#4	#4	12-#5
2.38	14		6	#4	#5	7-#8	8	#4	#4	12-#5
2.96	14 *	4 S 6 1	6	#5	#6	8-#9	8	#4	#4	12-#5
3.62	14 *	4 S 6 2	6	#6	#7	12-#8	8	#4	#5	12-#5
2.05	15		6	#4	#4	9-#6	9	#4	#4	14-#5
2.25	15		6	#4	#4	7-#8	9	#4	#4	14-#5
2.43	15		6	#4	#5	8-#8	9	#4	#4	14-#5
2.67	15	4 S 6 1	6	#5	#5	7-#9	9	#4	#4	14-#5
3.22	15 *	4 S 6 2	6	#6	#6	12-#8	9	#4	#4	14-#5
2.15	16		7	#4	#4	9-#7	9	#4	#4	14-#5
2.29	16		7	#4	#4	11-#7	9	#4	#4	14-#5
2.55	16		7	#4	#5	10-#8	9	#4	#4	14-#5
2.98	16 *	4 S 6 1	7	#5	#6	9-#9	9	#4	#4	14-#5
3.78	16 *	4 S 6 2	7	#6	#7	12-#9	9	#4	#5	14-#5
2.17	17		7	#4	#4	10-#7	10	#4	#4	15-#5
2.49	17		7	#4	#5	10-#8	10	#4	#4	15-#5
2.76	17 *	4 S 6 1	7	#5	#5	9-#9	10	#4	#4	15-#5
3.26	17 *	4 S 6 1	7	#6	#6	11-#9	10	#4	#4	15-#5
4.06	18 *	4 S 6 2	7	#7	#7	14-#9	10	#4	#5	15-#5
2.38	18		7	#4	#5	9-#8	11	#4	#4	16-#5
2.70	18	4 S 6 1	7	#5	#5	9-#9	11	#4	#4	16-#5
3.04	18 *	4 S 6 1	7	#5	#6	11-#9	11	#4	#4	16-#5
3.38	18 *	4 S 6 2	7	#6	#6	13-#9	11	#4	#4	16-#5
2.48	19		8	#4	#5	11-#8	11	#4	#4	16-#5
2.83	19 *		8	#5	#5	11-#9	11	#4	#4	16-#5
3.17	19 *	4 S 6 1	8	#5	#6	13-#9	11	#4	#4	16-#5
3.91	19 *	4 S 6 2	8	#6	#7	16-#9	11	#4	#5	16-#5
4.45	27 *	4 S 6 2	8	#6	#7	20-#9	11	#4	#5	20-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 20 in.	Rib Depth = 16 in.	Total Slab Depth = 4 in.															
26'-0"	50	1.98	13	0.641		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	119	237	319
D = 10.417	100	1.98	13	0.641		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	145	290	390
RIB NOT ON	150	2.09	13	0.641		8-#6+ 0	6	#4	#5	9-#6	7	#4	#4	11-#5	171	364	461
COLUMN LINE	200	2.24	13	0.641		8-#6+ 0	6	#5	#5	8-#7	7	#4	#4	11-#5	197	454	531
1.050 CF/SF	300	2.78	13	0.767		8-#6+ 2	6	#6	#6	8-#8	7	#4	#5	11-#5	250	622	672
	400	3.19	13 *	0.870		8-#6+ 4	6	#6	#7	7-#9	7	#5	#5	11-#5	302	786	814
	500	3.73	13 *	0.642		9-#6+ 2	6	#7	#7	9-#9	7	#5	#6	11-#5	355	947	955
28'-0"	50	1.95	14	0.639		8-#6+ 0	6	#4	#4	8-#6	8	#4	#4	12-#5	147	295	396
D = 10.417	100	2.08	14	0.639		8-#6+ 0	6	#4	#5	7-#7	8	#4	#4	12-#5	180	360	485
RIB NOT ON	150	2.22	14	0.639		8-#6+ 0	6	#5	#5	8-#7	8	#4	#4	12-#5	213	449	573
COLUMN LINE	200	2.45	14	0.673		8-#6+ 1	6	#5	#6	7-#8	8	#4	#4	12-#5	246	561	661
1.035 CF/SF	300	3.04	14 *	0.830		8-#6+ 4	6	#6	#7	8-#9	8	#4	#5	12-#5	311	771	837
	400	3.66	14 *	0.640		7-#7+ 0	6	#7	#8	9-#9	8	#5	#5	12-#5	377	975	1014
	500	4.21	14 *	0.640		12-#6+ 1	6	#8	#8	11-#9	8	#5	#6	12-#5	442	1176	1190
30'-0"	50	2.09	15	0.638		9-#6+ 0	6	#4	#5	7-#7	9	#4	#4	14-#5	180	361	485
D = 10.417	100	2.24	15	0.638		9-#6+ 0	6	#5	#5	7-#8	9	#4	#4	14-#5	221	441	594
RIB NOT ON	150	2.45	15	0.638		9-#6+ 0	6	#5	#6	8-#8	9	#4	#4	14-#5	261	544	702
COLUMN LINE	200	2.68	15	0.750		9-#6+ 2	6	#6	#6	7-#9	9	#4	#4	14-#5	301	682	811
1.023 CF/SF	300	3.45	15 *	0.863		7-#7+ 2	6	#7	#7	9-#9	9	#5	#5	14-#5	382	940	1028
	400	4.23	15 *	0.639		7-#8+ 0	6	#8	#8	12-#9	9	#5	#6	14-#5	462	1190	1245
32'-0"	50	2.13	16	0.637		10-#6+ 0	7	#4	#5	9-#7	9	#4	#4	14-#5	221	441	594
D = 12.417	100	2.30	16	0.637		10-#6+ 0	7	#5	#5	11-#7	9	#4	#4	14-#5	270	539	726
RIB ON	150	2.55	16	0.717		10-#6+ 1	7	#5	#6	10-#8	9	#4	#4	14-#5	318	657	857
COLUMN LINE	200	2.95	16 *	0.808		10-#6+ 3	7	#6	#6	9-#9	9	#4	#5	14-#5	367	825	989
1.045 CF/SF	300	3.95	16 *	0.638		9-#7+ 2	7	#7	#8	12-#9	9	#5	#6	14-#5	465	1138	1252
	400	4.61	19 *	0.634		11-#7+ 3	7	#8	#8	14-#9	9	#6	#6	15-#5	558	1430	1503
34'-0"	50	2.25	17	0.635		10-#6+ 0	7	#5	#5	11-#7	10	#4	#4	15-#5	263	527	709
D = 12.417	100	2.49	17	0.636		10-#6+ 0	7	#5	#6	10-#8	10	#4	#4	15-#5	322	644	867
RIB ON	150	2.78	17 *	0.774		10-#6+ 3	7	#6	#6	9-#9	10	#4	#4	15-#5	381	772	1025
COLUMN LINE	200	3.26	17 *	0.869		12-#6+ 5	7	#7	#7	11-#9	10	#4	#5	15-#5	439	975	1183
1.033 CF/SF	300	4.25	17 *	0.636		11-#7+ 3	7	#8	#8	14-#9	10	#5	#6	15-#5	557	1349	1499
36'-0"	50	2.45	18	0.639		11-#6+ 1	7	#5	#6	10-#8	11	#4	#4	16-#5	312	623	839
D = 12.417	100	2.73	18	0.765		11-#6+ 4	7	#6	#6	9-#9	11	#4	#4	16-#5	381	762	1026
RIB ON	150	2.99	18 *	0.841		12-#6+ 5	7	#6	#7	11-#9	11	#4	#4	16-#5	451	902	1214
COLUMN LINE	200	3.53	18 *	0.635		10-#7+ 1	7	#7	#8	13-#9	11	#4	#5	16-#5	520	1136	1401
1.023 CF/SF																	
38'-0"	50	2.53	19	0.672		12-#6+ 1	8	#5	#6	11-#8	11	#4	#4	16-#5	369	738	993
D = 14.417	100	2.79	19 *	0.803		12-#6+ 5	8	#6	#6	11-#9	11	#4	#4	16-#5	451	902	1214
RIB NOT ON	150	3.24	19 *	0.889		11-#7+ 5	8	#6	#7	13-#9	11	#4	#5	16-#5	533	1066	1434
COLUMN LINE	200	3.81	19 *	0.634		12-#7+ 3	8	#7	#8	16-#9	11	#5	#5	16-#5	615	1324	1655
1.041 CF/SF																	

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 20 in.	Rib Depth = 16 in.	Total Slab Depth = 4 in.									
26'-0"	2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
D = 10.417	2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
RIB NOT ON	2.02	13		6	#4	#4	12-#5	7	#4	#4	11-#5
COLUMN LINE	2.11	13		6	#4	#4	7-#7	7	#4	#4	11-#5
1.050 CF/SF	2.57	13		6	#5	#5	7-#8	7	#4	#4	11-#5
	2.88	13 *	4 S 6 1	6	#5	#6	11-#7	7	#4	#4	11-#5
	3.36	13 *	4 S 6 1	6	#6	#6	8-#9	7	#4	#5	11-#5
28'-0"	1.97	14		6	#4	#4	8-#6	8	#4	#4	12-#5
D = 10.417	2.04	14		6	#4	#4	9-#6	8	#4	#4	12-#5
RIB NOT ON	2.14	14		6	#4	#4	8-#7	8	#4	#4	12-#5
COLUMN LINE	2.38	14		6	#4	#5	7-#8	8	#4	#4	12-#5
1.035 CF/SF	2.85	14	4 S 6 1	6	#5	#6	7-#9	8	#4	#4	12-#5
	3.27	14 *	4 S 6 1	6	#6	#6	9-#9	8	#4	#4	12-#5
	3.70	14 *	4 S 6 2	6	#6	#7	10-#9	8	#4	#5	12-#5
30'-0"	2.05	15		6	#4	#4	9-#6	9	#4	#4	14-#5
D = 10.417	2.14	15		6	#4	#4	8-#7	9	#4	#4	14-#5
RIB NOT ON	2.36	15		6	#4	#5	7-#8	9	#4	#4	14-#5
COLUMN LINE	2.61	15	4 S 6 1	6	#5	#5	11-#7	9	#4	#4	14-#5
1.023 CF/SF	3.19	15 *	4 S 6 1	6	#6	#6	9-#9	9	#4	#4	14-#5
	3.79	15 *	4 S 6 2	6	#6	#7	11-#9	9	#4	#5	14-#5
32'-0"	2.09	16		7	#4	#4	11-#6	9	#4	#4	14-#5
D = 12.417	2.21	16		7	#4	#4	10-#7	9	#4	#4	14-#5
RIB ON	2.48	16		7	#4	#5	9-#8	9	#4	#4	14-#5
COLUMN LINE	2.83	16		7	#5	#5	9-#9	9	#4	#4	14-#5
1.045 CF/SF	3.51	16 *	4 S 6 1	7	#6	#6	11-#9	9	#4	#5	14-#5
	4.14	16 *	4 S 6 2	7	#6	#7	13-#9	9	#5	#5	14-#5
34'-0"	2.17	17		7	#4	#4	10-#7	10	#4	#4	15-#5
D = 12.417	2.42	17		7	#4	#5	9-#8	10	#4	#4	15-#5
RIB ON	2.76	17		7	#5	#5	9-#9	10	#4	#4	15-#5
COLUMN LINE	2.99	17 *	4 S 6 1	7	#5	#6	10-#9	10	#4	#4	15-#5
1.033 CF/SF	3.80	17 *	4 S 6 2	7	#6	#7	13-#9	10	#4	#5	15-#5
36'-0"	2.38	18		7	#4	#5	9-#8	11	#4	#4	16-#5
D = 12.417	2.70	18		7	#5	#5	9-#9	11	#4	#4	16-#5
RIB ON	2.91	18	4 S 6 1	7	#5	#6	10-#9	11	#4	#4	16-#5
COLUMN LINE	3.25	18 *	4 S 6 1	7	#6	#6	12-#9	11	#4	#4	16-#5
1.023 CF/SF											
38'-0"	2.48	19		8	#4	#5	11-#8	11	#4	#4	16-#5
D = 14.417	2.71	19		8	#5	#5	10-#9	11	#4	#4	16-#5
RIB NOT ON	3.05	19 *	4 S 6 1	8	#5	#6	12-#9	11	#4	#4	16-#5
COLUMN LINE	3.39	19 *	4 S 6 1	8	#6	#6	14-#9	11	#4	#4	16-#5
1.041 CF/SF											

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 12 ½ in.	Rib Depth = 8 in.	Total Slab Depth = 4 ½ in.															
16'-0"	50	2.04	12	0.632		7-#5+ 0	4	#4	#4	5-#6	4	#4	#4	7-#5	20	40	54
D = 6.417	100	2.04	12	0.632		7-#5+ 0	4	#4	#4	5-#6	4	#4	#4	7-#5	26	52	69
RIB NOT ON	150	2.04	12	0.632		7-#5+ 0	4	#4	#4	5-#6	4	#4	#4	7-#5	32	72	85
COLUMN LINE	200	2.04	12	0.632		7-#5+ 0	4	#4	#4	5-#6	4	#4	#4	7-#5	37	91	101
0.707 CF/SF	300	2.04	12	0.653		7-#5+ 0	4	#4	#4	5-#6	4	#4	#4	7-#5	49	127	132
	400	2.13	12	0.723		7-#5+ 0	4	#4	#5	5-#6	4	#4	#4	7-#5	61	163	164
	500	2.54	12	0.792		7-#5+ 0	4	#5	#6	9-#5	4	#4	#5	7-#5	73	198	195
18'-0"	50	1.99	12	0.632		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	29	57	77
D = 6.417	100	1.99	12	0.632		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	37	75	100
RIB NOT ON	150	1.99	12	0.632		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	46	104	123
COLUMN LINE	200	2.07	12	0.647		5-#6+ 0	4	#4	#5	5-#6	5	#4	#4	8-#5	54	131	145
0.696 CF/SF	300	2.20	12	0.734		5-#6+ 0	4	#5	#5	6-#6	5	#4	#4	8-#5	71	183	191
	400	2.47	12 *	0.850		5-#6+ 1	4	#5	#6	6-#7	5	#4	#4	8-#5	88	235	236
	500	2.96	12 *	0.633		5-#6+ 1	4	#6	#7	5-#8	5	#4	#5	8-#5	105	285	282
20'-0"	50	1.96	12	0.632		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	40	80	108
D = 8.417	100	1.96	12	0.671		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	52	105	140
RIB ON	150	1.96	12	0.756		6-#6+ 1	5	#4	#4	6-#6	5	#4	#4	8-#5	64	146	171
COLUMN LINE	200	2.07	12	0.794		6-#6+ 1	5	#4	#5	7-#6	5	#4	#4	8-#5	75	183	203
0.715 CF/SF	300	2.53	12 *	0.899		6-#6+ 3	5	#5	#6	9-#6	5	#4	#5	8-#5	99	256	266
	400	2.93	12 *	0.633		6-#6+ 2	5	#6	#6	6-#8	5	#5	#5	8-#5	122	327	329
	500	3.45	15 *	0.629	3 S 4 1	6-#6+ 1	5	#6	#7	6-#9	5	#5	#6	8-#5	143	388	386
22'-0"	50	1.98	12	0.676		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	54	107	145
D = 8.417	100	1.98	12	0.727		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	69	141	187
RIB ON	150	2.12	12	0.778		9-#5+ 0	5	#4	#5	6-#7	6	#4	#4	10-#5	85	194	229
COLUMN LINE	200	2.31	12 *	0.846		9-#5+ 1	5	#5	#5	9-#6	6	#4	#4	10-#5	101	244	272
0.704 CF/SF	300	2.81	12 *	0.633		9-#5+ 1	5	#6	#6	7-#8	6	#4	#5	10-#5	133	342	357
	400	3.41	16 *	0.628	3 S 4 1	10-#5+ 1	5	#7	#7	7-#9	6	#5	#5	10-#5	161	426	433
24'-0"	50	1.99	12	0.737		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	70	140	188
D = 8.417	100	2.11	12	0.826		10-#5+ 2	5	#4	#5	6-#7	7	#4	#4	11-#5	91	183	244
RIB ON	150	2.42	12 *	0.881		10-#5+ 3	5	#5	#6	10-#6	7	#4	#4	11-#5	111	253	300
COLUMN LINE	200	2.64	12 *	0.633		10-#5+ 2	5	#6	#6	7-#8	7	#4	#4	11-#5	132	319	355
0.696 CF/SF	300	3.38	16 *	0.628	3 S 4 1	6-#7+ 0	5	#7	#7	7-#9	7	#5	#5	11-#5	170	434	458
	400	3.80	20 *	0.624	3 S 4 1	9-#6+ 2	5	#7	#8	9-#9	7	#5	#5	11-#5	203	475	546

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 12 ½ in.	Rib Depth = 8 in.	Total Slab Depth = 4 ½ in.								
2.06	12		4	#4	#4	5-#6	4	#4	#4	7-#5
2.06	12		4	#4	#4	5-#6	4	#4	#4	7-#5
2.06	12		4	#4	#4	5-#6	4	#4	#4	7-#5
2.06	12		4	#4	#4	5-#6	4	#4	#4	7-#5
2.06	12		4	#4	#4	5-#6	4	#4	#4	7-#5
2.06	12	3 S 4 1	4	#4	#4	5-#6	4	#4	#4	7-#5
2.29	12	3 S 4 1	4	#4	#5	6-#6	4	#4	#4	7-#5
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.08	12	3 S 4 1	4	#4	#4	6-#6	5	#4	#4	8-#5
2.33	12 *	3 S 4 1	4	#4	#5	5-#7	5	#4	#4	8-#5
2.66	12 *	3 S 4 1	4	#5	#5	5-#8	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
2.29	12 *	3 S 4 1	5	#4	#5	6-#7	5	#4	#4	8-#5
2.64	12 *	3 S 4 1	5	#5	#5	6-#8	5	#4	#4	8-#5
3.13	13 *	3 S 4 1	5	#5	#6	7-#8	5	#4	#5	8-#5
2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
2.07	12		5	#4	#4	7-#6	6	#4	#4	10-#5
2.27	12	3 S 4 1	5	#4	#5	6-#7	6	#4	#4	10-#5
2.58	12 *	3 S 4 1	5	#5	#5	6-#8	6	#4	#4	10-#5
2.97	13 *	3 S 4 2	5	#5	#6	6-#9	6	#4	#4	10-#5
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.09	12		5	#4	#4	6-#7	7	#4	#4	11-#5
2.33	12	3 S 4 1	5	#4	#5	7-#7	7	#4	#4	11-#5
2.50	12 *	3 S 4 1	5	#5	#5	6-#8	7	#4	#4	11-#5
2.99	13 *	3 S 4 2	5	#5	#6	11-#7	7	#4	#4	11-#5
3.37	19 *	3 S 4 2	5	#6	#6	8-#9	7	#4	#4	11-#5

(Continued on next page)

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 12 ½ in.		Rib Depth = 8 in.		Total Slab Depth = 4 ½ in.													
26'-0"	50	1.98	13	0.768		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	90	179	241
D = 10.417	100	2.16	13 *	0.845		8-#6+ 1	6	#4	#5	8-#7	7	#4	#4	11-#5	116	232	312
RIB NOT ON	150	2.54	13 *	0.916		8-#6+ 3	6	#5	#6	8-#8	7	#4	#4	11-#5	142	320	383
COLUMN LINE	200	2.86	15 *	0.629		8-#6+ 2	6	#6	#6	7-#9	7	#4	#5	11-#5	167	400	450
0.710 CF/SF	300	3.66	20 *	0.624		7-#7+ 2	6	#7	#7	9-#9	7	#5	#5	11-#5	213	506	573
28'-0"	50	2.10	14	0.795		8-#6+ 1	6	#4	#5	10-#6	8	#4	#4	12-#5	111	223	300
D = 10.417	100	2.32	14 *	0.883		8-#6+ 3	6	#5	#5	8-#8	8	#4	#4	12-#5	144	289	388
RIB NOT ON	150	2.77	15 *	0.629		8-#6+ 2	6	#6	#6	8-#9	8	#4	#4	12-#5	176	388	475
COLUMN LINE	200	3.26	18 *	0.626		7-#7+ 2	6	#7	#7	9-#9	8	#4	#5	12-#5	207	486	558
0.702 CF/SF																	
30'-0"	50	2.29	15 *	0.849		9-#6+ 3	6	#5	#5	7-#8	9	#4	#4	14-#5	137	273	368
D = 10.417	100	2.60	15 *	0.924		9-#6+ 6	6	#5	#6	8-#9	9	#4	#4	14-#5	177	354	476
RIB NOT ON	150	3.17	18 *	0.626		7-#7+ 2	6	#6	#7	9-#9	9	#4	#5	14-#5	215	460	580
COLUMN LINE	200	3.40	24 *	0.621		8-#7+ 2	6	#7	#7	11-#9	9	#4	#5	14-#5	249	509	669
0.696 CF/SF																	
32'-0"	50	2.36	16 *	0.876		10-#6+ 4	7	#5	#5	9-#8	9	#4	#4	14-#5	167	334	449
D = 12.417	100	2.86	18 *	0.911		10-#6+ 6	7	#6	#6	9-#9	9	#4	#4	14-#5	215	429	578
RIB ON	150	3.33	23 *	0.622		12-#6+ 4	7	#6	#7	11-#9	9	#4	#5	14-#5	259	518	697
COLUMN LINE																	
0.707 CF/SF																	
34'-0"	50	2.56	17 *	0.890		10-#6+ 5	7	#5	#6	9-#9	10	#4	#4	15-#5	199	399	537
D = 12.417	100	3.11	21 *	0.623		12-#6+ 4	7	#6	#7	11-#9	10	#4	#5	15-#5	255	511	688
RIB ON																	
COLUMN LINE																	
0.701 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 12 ½ in.			Rib Depth = 8 in.				Total Slab Depth = 4 ½ in.			
2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
2.11	13		6	#4	#4	7-#7	7	#4	#4	11-#5
2.44	13 *	3 S 4 1	6	#4	#5	7-#8	7	#4	#4	11-#5
2.65	13 *	3 S 4 1	6	#5	#5	8-#8	7	#4	#4	11-#5
3.40	17 *	3 S 4 2	6	#5	#6	9-#9	7	#4	#5	11-#5
2.08	14		6	#4	#4	7-#7	8	#4	#4	12-#5
2.26	14 *		6	#4	#4	7-#8	8	#4	#4	12-#5
2.70	14 *	3 S 4 1	6	#5	#5	7-#9	8	#4	#4	12-#5
2.96	14 *	3 S 4 1	6	#5	#6	8-#9	8	#4	#4	12-#5
2.25	15		6	#4	#4	7-#8	9	#4	#4	14-#5
2.55	15 *	3 S 4 1	6	#4	#5	7-#9	9	#4	#4	14-#5
3.05	15 *	3 S 4 1	6	#5	#6	9-#9	9	#4	#4	14-#5
3.16	18 *	3 S 4 2	6	#5	#6	10-#9	9	#4	#4	14-#5
2.29	16		7	#4	#4	11-#7	9	#4	#4	14-#5
2.83	16 *	3 S 4 1	7	#5	#5	9-#9	9	#4	#4	14-#5
3.22	17 *	3 S 4 1	7	#5	#6	11-#9	9	#4	#4	14-#5
2.49	17 *		7	#4	#5	10-#8	10	#4	#4	15-#5
2.89	17 *	3 S 4 1	7	#5	#5	13-#8	10	#4	#4	15-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 24″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 14 ½ in.	Rib Depth = 10 in.	Total Slab Depth = 4 ½ in.																Total Depth = 14 ½ in.	Rib Depth = 10 in.	Total Slab Depth = 4 ½ in.								
20'-0"	50	1.96	12	0.635		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	44	87	118	1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
D = 8.417	100	1.96	12	0.635		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	55	111	149	1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
RIB ON	150	1.96	12	0.635		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	67	151	181	1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
COLUMN LINE	200	1.96	12	0.658		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	79	190	212	1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
0.807 CF/SF	300	2.22	12	0.741		6-#6+ 0	5	#5	#5	6-#7	5	#4	#4	8-#5	102	263	276	2.07	12		5	#4	#4	7-#6	5	#4	#4	8-#5
	400	2.59	12 *	0.849		6-#6+ 1	5	#5	#6	7-#7	5	#4	#5	8-#5	126	335	339	2.38	12 *	3 S 4 1	5	#4	#5	9-#6	5	#4	#4	8-#5
	500	2.98	12 *	0.636		6-#6+ 0	5	#6	#6	7-#8	5	#5	#5	8-#5	149	406	402	2.64	12 *	3 S 4 1	5	#5	#5	6-#8	5	#4	#4	8-#5
22'-0"	50	1.98	12	0.635		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	58	117	157	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
D = 8 .417	100	1.98	12	0.636		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	74	148	199	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
RIB ON	150	2.07	12	0.683		9-#5+ 0	5	#4	#5	7-#6	6	#4	#4	10-#5	90	202	242	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
COLUMN LINE	200	2.23	12	0.731		9-#5+ 0	5	#5	#5	6-#7	6	#4	#4	10-#5	106	253	284	2.14	12		5	#4	#4	6-#7	6	#4	#4	10-#5
0.794 CF/SF	300	2.67	12 *	0.857		9-#5+ 2	5	#6	#6	6-#8	6	#4	#5	10-#5	137	352	369	2.39	12 *	3 S 4 1	5	#4	#5	7-#7	6	#4	#4	10-#5
	400	3.21	12 *	0.636		9-#5+ 2	5	#6	#7	6-#9	6	#5	#5	10-#5	169	449	454	2.91	12 *	3 S 4 1	5	#5	#6	7-#8	6	#4	#4	10-#5
	500	3.72	14 *	0.633	3 S 4 1	6-#7+ 0	5	#7	#7	7-#9	6	#5	#6	10-#5	199	540	535	3.31	12 *	3 S 4 2	5	#6	#6	8-#8	6	#4	#5	10-#5
24'-0"	50	1.99	12	0.658		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	76	152	205	2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
D = 8.417	100	2.06	12	0.709		10-#5+ 0	5	#4	#5	7-#6	7	#4	#4	11-#5	97	193	260	2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
RIB ON	150	2.20	12	0.760		10-#5+ 0	5	#5	#5	9-#6	7	#4	#4	11-#5	117	264	316	2.09	12		5	#4	#4	6-#7	7	#4	#4	11-#5
COLUMN LINE	200	2.43	12 *	0.828		10-#5+ 1	5	#5	#6	6-#8	7	#4	#4	11-#5	138	331	371	2.33	12	3 S 4 1	5	#4	#5	7-#7	7	#4	#4	11-#5
0.784 CF/SF	300	3.01	12 *	0.636		10-#5+ 1	5	#6	#7	6-#9	7	#4	#5	11-#5	179	460	482	2.82	12 *	3 S 4 1	5	#5	#6	7-#8	7	#4	#4	11-#5
	400	3.65	15 *	0.632	3 S 4 1	6-#7+ 1	5	#7	#8	8-#9	7	#5	#5	11-#5	218	580	587	3.21	12 *	3 S 4 2	5	#6	#6	7-#9	7	#4	#4	11-#5
	500	4.31	19 *	0.628	3 S 4 1	7-#7+ 0	5	#8	#8	9-#9	7	#5	#6	11-#5	251	662	676	3.90	16 *	3 S 4 2	5	#6	#7	9-#9	7	#4	#5	11-#5
26'-0"	50	1.98	13	0.696		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	97	195	262	2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
D = 10.417	100	2.12	13	0.751		8-#6+ 0	6	#4	#5	7-#7	7	#4	#4	11-#5	124	247	333	2.08	13		6	#4	#4	9-#6	7	#4	#4	11-#5
RIB NOT ON	150	2.30	13 *	0.843		8-#6+ 2	6	#5	#5	7-#8	7	#4	#4	11-#5	150	334	404	2.18	13		6	#4	#4	8-#7	7	#4	#4	11-#5
COLUMN LINE	200	2.63	13 *	0.897		8-#6+ 3	6	#5	#6	8-#8	7	#4	#5	11-#5	176	419	474	2.44	13 *	3 S 4 1	6	#4	#5	7-#8	7	#4	#4	11-#5
0.801 CF/SF	300	3.41	15 *	0.632		12-#5+ 3	6	#7	#7	8-#9	7	#5	#5	11-#5	227	579	611	3.06	13 *	3 S 4 1	6	#5	#6	8-#9	7	#4	#4	11-#5
	400	4.00	19 *	0.628		15-#5+ 3	6	#7	#8	10-#9	7	#5	#6	11-#5	273	701	734	3.55	16 *	3 S 4 2	6	#6	#6	9-#9	7	#4	#5	11-#5
28'-0"	50	2.05	14	0.695		8-#6+ 0	6	#4	#5	9-#6	8	#4	#4	12-#5	121	242	326	1.99	14		6	#4	#4	12-#5	8	#4	#4	12-#5
D = 10.417	100	2.24	14 *	0.786		8-#6+ 1	6	#5	#5	7-#8	8	#4	#4	12-#5	154	308	414	2.14	14		6	#4	#4	8-#7	8	#4	#4	12-#5
RIB NOT ON	150	2.51	14 *	0.872		8-#6+ 3	6	#5	#6	8-#8	8	#4	#4	12-#5	187	409	502	2.46	14 *	3 S 4 1	6	#4	#5	8-#8	8	#4	#4	12-#5
COLUMN LINE	200	2.97	14 *	0.633		8-#6+ 2	6	#6	#7	8-#9	8	#4	#5	12-#5	219	515	591	2.70	14 *	3 S 4 1	6	#5	#5	7-#9	8	#4	#4	12-#5
0.791 CF/SF	300	3.79	19 *	0.628		8-#7+ 2	6	#7	#8	10-#9	8	#5	#5	12-#5	280	697	753	3.45	15 *	3 S 4 2	6	#6	#6	12-#8	8	#4	#5	12-#5

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WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 24″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 14 ½ in.		Rib Depth = 10 in.		Total Slab Depth = 4 ½ in.													
30'-0"	50	2.24	15	0.730		9-#6+ 0	6	#5	#5	7-#8	9	#4	#4	14-#5	148	297	400
D = 10.417	100	2.49	15 *	0.834		9-#6+ 2	6	#5	#6	8-#8	9	#4	#4	14-#5	189	377	508
RIB NOT ON	150	2.78	15 *	0.907		9-#6+ 4	6	#6	#6	8-#9	9	#4	#4	14-#5	229	491	617
COLUMN LINE	200	3.28	17 *	0.630		10-#6+ 3	6	#7	#7	12-#8	9	#4	#5	14-#5	268	618	721
0.784 CF/SF	300	4.19	23 *	0.624		7-#8+ 2	6	#8	#8	16-#8	9	#5	#5	14-#5	338	774	909
32'-0"	50	2.28	16 *	0.800		10-#6+ 2	7	#5	#5	14-#6	9	#4	#4	14-#5	181	363	488
D = 12.417	100	2.59	16 *	0.888		10-#6+ 5	7	#5	#6	10-#8	9	#4	#4	14-#5	230	460	620
RIB ON	150	3.08	17 *	0.630		15-#5+ 4	7	#6	#7	10-#9	9	#4	#5	14-#5	278	585	749
COLUMN LINE	200	3.64	21 *	0.626		9-#7+ 4	7	#7	#7	12-#9	9	#5	#5	14-#5	324	735	871
0.798 CF/SF																	
34'-0"	50	2.49	17 *	0.833		10-#6+ 4	7	#5	#6	10-#8	10	#4	#4	15-#5	217	433	583
D = 12.417	100	2.81	17 *	0.908		15-#5+ 8	7	#6	#6	10-#9	10	#4	#4	15-#5	275	551	741
RIB ON	150	3.36	20 *	0.627		9-#7+ 4	7	#7	#7	12-#9	10	#4	#5	15-#5	331	674	892
COLUMN LINE	200	3.86	24 *	0.624	3 S 4 1	11-#7+ 3	7	#7	#8	14-#9	10	#5	#5	15-#5	383	796	1032
0.790 CF/SF																	
36'-0"	50	2.73	18 *	0.859		11-#6+ 5	7	#6	#6	9-#9	11	#4	#4	16-#5	256	513	690
D = 12.417	100	3.18	19 *	0.628		9-#7+ 4	7	#6	#7	12-#9	11	#4	#5	16-#5	325	651	876
RIB ON	150	3.71	24 *	0.624		11-#7+ 3	7	#7	#8	15-#9	11	#4	#5	16-#5	390	780	1050
COLUMN LINE																	
0.784 CF/SF																	
38'-0"	50	2.79	19 *	0.894		12-#6+ 8	8	#6	#6	11-#9	11	#4	#4	16-#5	303	607	817
D = 14.417	100	3.32	22 *	0.625		11-#7+ 3	8	#6	#7	14-#9	11	#4	#5	16-#5	382	765	1030
RIB NOT ON	150	3.98	31 *	0.620		10-#8+ 3	8	#7	#8	17-#9	11	#5	#5	17-#5	449	897	1208
COLUMN LINE																	
0.795 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 14 ½ in.			Rib Depth = 10 in.				Total Slab Depth = 4 ½ in.			
2.14	15		6	#4	#4	8-#7	9	#4	#4	14-#5
2.43	15	3 S 4 1	6	#4	#5	8-#8	9	#4	#4	14-#5
2.76	15 *	3 S 4 1	6	#5	#5	8-#9	9	#4	#4	14-#5
3.05	15 *	3 S 4 2	6	#5	#6	9-#9	9	#4	#4	14-#5
3.90	19 *	3 S 4 2	6	#6	#7	12-#9	9	#4	#5	14-#5
2.21	16		7	#4	#4	10-#7	9	#4	#4	14-#5
2.55	16 *		7	#4	#5	10-#8	9	#4	#4	14-#5
2.83	16 *	3 S 4 1	7	#5	#5	9-#9	9	#4	#4	14-#5
3.36	16*	3 S 4 1	7	#6	#6	11-#9	9	#4	#4	14-#5
2.42	17		7	#4	#5	9-#8	10	#4	#4	15-#5
2.76	17 *	3 S 4 1	7	#5	#5	9-#9	10	#4	#4	15-#5
3.12	17 *	3 S 4 1	7	#5	#6	11-#9	10	#4	#4	15-#5
3.49	19 *	3 S 4 2	7	#6	#6	13-#9	10	#4	#4	15-#5
2.70	18		7	#5	#5	9-#9	11	#4	#4	16-#5
3.04	18 *	3 S 4 1	7	#5	#6	11-#9	11	#4	#4	16-#5
3.46	18 *	3 S 4 2	7	#6	#6	14-#9	11	#4	#4	16-#5
2.71	19 *		8	#5	#5	10-#9	11	#4	#4	16-#5
3.17	19 *	3 S 4 1	8	#5	#6	13-#9	11	#4	#4	16-#5
3.61	24 *	3 S 4 2	8	#6	#6	16-#9	11	#4	#4	16-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 16 ½ in.			Rib Depth = 12 in.		Total Slab Depth = 4 ½ in.												
22'-0"	50	1.98	12	0.638		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	63	126	170
D = 8.417	100	1.98	12	0.638		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	79	158	212
RIB ON	150	1.98	12	0.638		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	95	209	255
COLUMN LINE	200	2.10	12	0.638		9-#5+ 0	5	#4	#5	7-#6	6	#4	#4	10-#5	110	262	297
0.886 CF/SF	300	2.42	12	0.747		9-#5+ 1	5	#5	#6	7-#7	6	#4	#4	10-#5	142	361	382
	400	2.81	12 *	0.857		9-#5+ 3	5	#6	#6	7-#8	6	#4	#5	10-#5	173	458	467
	500	3.22	12 *	0.639		10-#5+ 1	5	#6	#7	6-#9	6	#5	#5	10-#5	205	555	552
24'-0"	50	1.99	12	0.638		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	82	164	221
D = 8.417	100	1.99	12	0.638		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	103	206	277
RIB ON	150	2.11	12	0.671		10-#5+ 0	5	#4	#5	6-#7	7	#4	#4	11-#5	123	273	332
COLUMN LINE	200	2.30	12	0.719		10-#5+ 0	5	#5	#5	7-#7	7	#4	#4	11-#5	144	341	388
0.874 CF/SF	300	2.73	12 *	0.846		10-#5+ 2	5	#6	#6	7-#8	7	#4	#5	11-#5	185	471	499
	400	3.30	12 *	0.639		7-#6+ 1	5	#7	#7	7-#9	7	#5	#5	11-#5	227	599	610
	500	4.00	14 *	0.636	4 S 6 1	6-#7+ 1	5	#7	#8	8-#9	7	#5	#6	11-#5	266	719	716
26'-0"	50	1.98	13	0.636		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	106	211	284
D = 10.417	100	2.00	13	0.670		8-#6+ 0	6	#4	#4	9-#6	7	#4	#4	11-#5	132	263	355
RIB NOT ON	150	2.24	13	0.722		8-#6+ 0	6	#5	#5	8-#7	7	#4	#4	11-#5	158	346	425
COLUMN LINE	200	2.46	13 *	0.818		8-#6+ 2	6	#5	#6	7-#8	7	#4	#4	11-#5	184	434	496
0.895 CF/SF	300	3.07	13 *	0.637		8-#6+ 2	6	#6	#7	7-#9	7	#5	#5	11-#5	237	599	637
	400	3.75	14 *	0.636		7-#7+ 2	6	#7	#7	9-#9	7	#5	#6	11-#5	288	758	776
	500	4.48	18 *	0.631		8-#7+ 2	6	#8	#8	10-#9	7	#6	#6	11-#5	332	880	895
28'-0"	50	1.97	14	0.635		8-#6+ 0	6	#4	#4	9-#6	8	#4	#4	12-#5	131	262	353
D = 10.417	100	2.11	14	0.677		8-#6+ 0	6	#4	#5	8-#7	8	#4	#4	12-#5	164	328	441
RIB NOT ON	150	2.45	14	0.790		8-#6+ 2	6	#5	#6	7-#8	8	#4	#4	12-#5	197	425	529
COLUMN LINE	200	2.78	14 *	0.853		8-#6+ 3	6	#6	#6	7-#9	8	#4	#5	12-#5	229	535	618
0.884 CF/SF	300	3.45	14 *	0.636		7-#7+ 2	6	#7	#7	9-#9	8	#5	#5	12-#5	295	740	794
	400	4.20	19 *	0.630		12-#6+ 2	6	#8	#8	11-#9	8	#5	#6	12-#5	354	918	952
30'-0"	50	2.12	15	0.658		9-#6+ 0	6	#4	#5	8-#7	9	#4	#4	14-#5	161	321	432
D = 10.417	100	2.37	15	0.749		9-#6+ 1	6	#5	#5	8-#8	9	#4	#4	14-#5	201	402	541
RIB NOT ON	150	2.68	15 *	0.839		9-#6+ 3	6	#6	#6	7-#9	9	#4	#4	14-#5	241	513	649
COLUMN LINE	200	3.09	15 *	0.896		9-#6+ 4	6	#6	#7	9-#9	9	#4	#5	14-#5	281	648	758
0.874 CF/SF	300	4.02	18 *	0.631		12-#6+ 2	6	#8	#8	11-#9	9	#5	#5	14-#5	359	892	966
32'-0"	50	2.18	16	0.720		10-#6+ 1	7	#4	#5	10-#7	9	#4	#4	14-#5	196	393	529
D = 12.417	100	2.51	16 *	0.828		10-#6+ 4	7	#5	#6	9-#8	9	#4	#4	14-#5	245	490	660
RIB ON	150	2.95	16 *	0.891		10-#6+ 6	7	#6	#6	9-#9	9	#4	#5	14-#5	294	617	792
COLUMN LINE	200	3.45	16 *	0.633		16-#5+ 3	7	#7	#7	11-#9	9	#5	#5	14-#5	343	781	924
0.891 CF/SF	300	4.33	22 *	0.628		11-#7+ 3	7	#8	#8	14-#9	9	#5	#6	14-#5	431	1032	1161
34'-0"	50	2.37	17	0.766		10-#6+ 3	7	#5	#5	9-#8	10	#4	#4	15-#5	235	469	631
D = 12.417	100	2.78	17 *	0.849		10-#6+ 5	7	#6	#6	9-#9	10	#4	#4	15-#5	293	586	789
RIB ON	150	3.17	17 *	0.632		12-#6+ 2	7	#6	#7	11-#9	10	#4	#5	15-#5	352	719	947
COLUMN LINE	200	3.73	19 *	0.630		10-#7+ 3	7	#7	#8	16-#8	10	#5	#5	15-#5	408	912	1099
0.882 CF/SF	300	4.52	26 *	0.625	4 S 6 1	10-#8+ 1	7	#8	#8	17-#9	10	#5	#6	17-#5	510	1135	1373
36'-0"	50	2.52	18 *	0.787		11-#6+ 3	7	#5	#6	9-#9	11	#4	#4	16-#5	278	555	747
D = 12.417	100	2.92	18 *	0.877		12-#6+ 5	7	#6	#7	11-#9	11	#4	#4	16-#5	347	694	935
RIB ON	150	3.35	19 *	0.630		10-#7+ 3	7	#7	#7	13-#9	11	#4	#5	16-#5	416	831	1119
COLUMN LINE	200	4.04	23 *	0.627	4 S 6 1	9-#8+ 1	7	#8	#8	16-#9	11	#5	#5	16-#5	480	1049	1293
0.874 CF/SF																	
38'-0"	50	2.67	19 *	0.839		12-#6+ 6	8	#6	#6	10-#9	11	#4	#4	16-#5	328	657	884
D = 14.417	100	3.20	19 *	0.915		10-#7+ 6	8	#6	#7	16-#8	11	#4	#5	16-#5	410	821	1105
RIB NOT ON	150	3.70	23 *	0.627		12-#7+ 2	8	#7	#7	16-#9	11	#5	#5	16-#5	488	975	1313
COLUMN LINE	200	4.37	27 *	0.624		14-#7+ 4	8	#7	#8	18-#9	11	#5	#6	19-#5	561	1123	1509
0.888 CF/SF																	

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 16 ½ in.				Rib Depth = 12 in.				Total Slab Depth = 4 ½ in.			
22'-0"	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
D = 8.417	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
RIB ON	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
COLUMN LINE	2.07	12		5	#4	#4	7-#6	6	#4	#4	10-#5
0.886 CF/SF	2.27	12		5	#4	#5	6-#7	6	#4	#4	10-#5
	2.58	12 *	4 S 6 1	5	#5	#5	6-#8	6	#4	#4	10-#5
	2.91	12 *	4 S 6 1	5	#5	#6	7-#8	6	#4	#4	10-#5
24'-0"	2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
D = 8.417	2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
RIB ON	2.09	12		5	#4	#4	6-#7	7	#4	#4	11-#5
COLUMN LINE	2.29	12		5	#4	#5	9-#6	7	#4	#4	11-#5
0.874 CF/SF	2.50	12	4 S 6 1	5	#5	#5	6-#8	7	#4	#4	11-#5
	2.87	12 *	4 S 6 1	5	#5	#6	6-#9	7	#4	#4	11-#5
	3.69	12 *	4 S 6 2	5	#6	#7	8-#9	7	#4	#5	11-#5
26'-0"	2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
D = 10.417	2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
RIB NOT ON	2.11	13		6	#4	#4	7-#7	7	#4	#4	11-#5
COLUMN LINE	2.31	13		6	#4	#5	8-#7	7	#4	#4	11-#5
0.895 CF/SF	2.65	13 *	4 S 6 1	6	#5	#5	8-#8	7	#4	#4	11-#5
	3.36	13 *	4 S 6 1	6	#6	#6	8-#9	7	#4	#5	11-#5
	3.97	16 *	4 S 6 2	6	#6	#7	12-#8	7	#5	#5	11-#5
28'-0"	1.97	14		6	#4	#4	8-#6	8	#4	#4	12-#5
D = 10.417	2.08	14		6	#4	#4	7-#7	8	#4	#4	12-#5
RIB NOT ON	2.38	14		6	#4	#5	7-#8	8	#4	#4	12-#5
COLUMN LINE	2.58	14	4 S 6 1	6	#5	#5	8-#8	8	#4	#4	12-#5
0.884 CF/SF	3.10	14 *	4 S 6 1	6	#6	#6	8-#9	8	#4	#4	12-#5
	3.70	15 *	4 S 6 2	6	#6	#7	10-#9	8	#4	#5	12-#5
30'-0"	2.08	15		6	#4	#4	7-#7	9	#4	#4	14-#5
D = 10.417	2.36	15		6	#4	#5	7-#8	9	#4	#4	14-#5
RIB NOT ON	2.61	15	4 S 6 1	6	#5	#5	11-#7	9	#4	#4	14-#5
COLUMN LINE	2.90	15 *	4 S 6 1	6	#5	#6	8-#9	9	#4	#4	14-#5
0.874 CF/SF	3.68	15 *	4 S 6 2	6	#6	#7	13-#8	9	#4	#5	14-#5
32'-0"	2.15	16		7	#4	#4	9-#7	9	#4	#4	14-#5
D = 12.417	2.42	16		7	#4	#5	11-#7	9	#4	#4	14-#5
RIB ON	2.83	16 *	4 S 6 1	7	#5	#5	9-#9	9	#4	#4	14-#5
COLUMN LINE	3.07	16 *	4 S 6 1	7	#5	#6	10-#9	9	#4	#4	14-#5
0.891 CF/SF	3.86	18 *	4 S 6 2	7	#6	#7	16-#8	9	#4	#5	14-#5
34'-0"	2.37	17		7	#4	#5	11-#7	10	#4	#4	15-#5
D = 12.417	2.76	17		7	#5	#5	9-#9	10	#4	#4	15-#5
RIB ON	2.99	17 *	4 S 6 1	7	#5	#6	10-#9	10	#4	#4	15-#5
COLUMN LINE	3.35	17 *	4 S 6 2	7	#6	#6	12-#9	10	#4	#4	15-#5
0.882 CF/SF	4.07	21 *	4 S 6 2	7	#6	#7	15-#9	10	#4	#5	16-#5
36'-0"	2.44	18		7	#4	#5	10-#8	11	#4	#4	16-#5
D = 12.417	2.78	18 *	4 S 6 1	7	#5	#5	10-#9	11	#4	#4	16-#5
RIB ON	3.12	18 *	4 S 6 1	7	#5	#6	12-#9	11	#4	#4	16-#5
COLUMN LINE	3.62	18 *	4 S 6 2	7	#6	#7	14-#9	11	#4	#4	16-#5
0.874 CF/SF											
38'-0"	2.54	19		8	#4	#5	12-#8	11	#4	#4	16-#5
D = 14.417	3.05	19 *	4 S 6 1	8	#5	#6	12-#9	11	#4	#4	16-#5
RIB NOT ON	3.41	19 *	4 S 6 1	8	#6	#6	18-#8	11	#4	#4	16-#5
COLUMN LINE	4.09	21 *	4 S 6 2	8	#6	#7	17-#9	11	#4	#5	18-#5
0.888 CF/SF											

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 18 ½ in.		Rib Depth = 14 in.		Total Slab Depth = 4 ½ in.													
24'-0"	50	1.99	12	0.641		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	89	177	239
D = 8.417	100	1.99	12	0.641		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	109	219	294
RIB ON	150	2.08	12	0.641		10-#5+ 0	5	#4	#5	6-#7	7	#4	#4	11-#5	130	281	350
COLUMN LINE	200	2.18	12	0.641		10-#5+ 0	5	#5	#5	6-#7	7	#4	#4	11-#5	151	351	405
0.968 CF/SF	300	2.60	12	0.717		10-#5+ 0	5	#6	#6	6-#8	7	#4	#4	11-#5	192	482	517
	400	3.01	12 *	0.853		10-#5+ 3	5	#6	#7	6-#9	7	#4	#5	11-#5	233	610	628
	500	3.59	12 *	0.642	4 S 6 1	6-#7+ 0	5	#7	#8	7-#9	7	#5	#5	11-#5	274	737	739
26'-0"	50	1.98	13	0.639		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	114	228	307
D = 10.417	100	1.98	13	0.639		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	140	280	377
RIB NOT ON	150	2.12	13	0.639		8-#6+ 0	6	#4	#5	7-#7	7	#4	#4	11-#5	166	358	448
COLUMN LINE	200	2.27	13	0.720		8-#6+ 1	6	#5	#5	8-#7	7	#4	#4	11-#5	193	446	519
0.992 CF/SF	300	2.83	13 *	0.842		8-#6+ 3	6	#6	#6	8-#8	7	#4	#5	11-#5	245	614	660
	400	3.36	13 *	0.640		12-#5+ 3	6	#7	#7	8-#9	7	#5	#5	11-#5	298	777	801
	500	3.97	13 *	0.640		7-#7+ 3	6	#7	#8	12-#8	7	#5	#6	11-#5	350	938	942
28'-0"	50	1.95	14	0.637		8-#6+ 0	6	#4	#4	8-#6	8	#4	#4	12-#5	141	283	381
D = 10.417	100	2.10	14	0.637		8-#6+ 0	6	#4	#5	7-#7	8	#4	#4	12-#5	174	348	469
RIB NOT ON	150	2.24	14	0.687		8-#6+ 1	6	#5	#5	7-#8	8	#4	#4	12-#5	207	440	557
COLUMN LINE	200	2.47	14	0.765		8-#6+ 2	6	#5	#6	8-#8	8	#4	#4	12-#5	240	551	645
0.979 CF/SF	300	3.11	14 *	0.638		9-#6+ 1	6	#6	#7	8-#9	8	#4	#5	12-#5	305	760	822
	400	3.89	14 *	0.638		8-#7+ 2	6	#7	#8	10-#9	8	#5	#6	12-#5	371	963	998
30'-0"	50	2.09	15	0.636		9-#6+ 0	6	#4	#5	7-#7	9	#4	#4	14-#5	173	346	466
D = 10.417	100	2.29	15	0.642		9-#6+ 0	6	#5	#5	7-#8	9	#4	#4	14-#5	214	427	575
RIB NOT ON	150	2.50	15	0.733		9-#6+ 1	6	#5	#6	11-#7	9	#4	#4	14-#5	254	533	683
COLUMN LINE	200	2.84	15 *	0.823		9-#6+ 3	6	#6	#7	8-#9	9	#4	#4	14-#5	294	670	792
0.968 CF/SF	300	3.61	15 *	0.637		8-#7+ 2	6	#7	#8	10-#9	9	#5	#5	14-#5	375	925	1009
32'-0"	50	2.17	16	0.658		10-#6+ 1	7	#4	#5	9-#7	9	#4	#4	14-#5	212	424	571
D = 12.417	100	2.36	16	0.739		10-#6+ 2	7	#5	#5	9-#8	9	#4	#4	14-#5	261	522	702
RIB ON	150	2.59	16 *	0.822		10-#6+ 4	7	#5	#6	10-#8	9	#4	#4	14-#5	310	642	834
COLUMN LINE	200	3.14	16 *	0.880		15-#5+ 7	7	#6	#7	12-#8	9	#4	#5	14-#5	359	809	965
0.987 CF/SF	300	4.03	17 *	0.635		10-#7+ 3	7	#7	#8	16-#8	9	#5	#6	14-#5	455	1116	1225
34'-0"	50	2.25	17	0.688		10-#6+ 2	7	#5	#5	11-#7	10	#4	#4	15-#5	253	506	681
D = 12.417	100	2.56	17	0.785		10-#6+ 4	7	#5	#6	9-#9	10	#4	#4	15-#5	312	623	839
RIB ON	150	2.82	17 *	0.858		11-#6+ 5	7	#6	#6	10-#9	10	#4	#4	15-#5	370	753	997
COLUMN LINE	200	3.36	17 *	0.635		9-#7+ 2	7	#7	#7	12-#9	10	#4	#5	15-#5	429	954	1155
0.977 CF/SF	300	4.43	21 *	0.631	4 S 6 1	9-#8+ 1	7	#8	#8	15-#9	10	#5	#6	16-#5	541	1311	1456
36'-0"	50	2.45	18	0.715		11-#6+ 2	7	#5	#6	10-#8	11	#4	#4	16-#5	299	599	806
D = 12.417	100	2.75	18 *	0.821		11-#6+ 5	7	#6	#6	10-#9	11	#4	#4	16-#5	369	738	993
RIB ON	150	3.18	18 *	0.887		9-#7+ 4	7	#6	#7	12-#9	11	#4	#5	16-#5	439	877	1181
COLUMN LINE	200	3.75	18 *	0.634		11-#7+ 3	7	#7	#8	14-#9	11	#5	#5	16-#5	508	1110	1368
0.968 CF/SF																	
38'-0"	50	2.54	19	0.758		12-#6+ 3	8	#5	#6	12-#8	11	#4	#4	16-#5	354	709	954
D = 14.417	100	3.06	19 *	0.860		18-#5+ 9	8	#6	#7	12-#9	11	#4	#5	16-#5	436	873	1175
RIB NOT ON	150	3.42	19 *	0.633		11-#7+ 3	8	#7	#7	14-#9	11	#4	#5	16-#5	518	1036	1395
COLUMN LINE	200	4.15	22 *	0.630		10-#8+ 3	8	#7	#8	17-#9	11	#5	#6	17-#5	596	1280	1604
0.984 CF/SF	300	4.80	29 *	0.625		12-#8+ 3	8	#8	#8	21-#9	11	#5	#6	16-#6	736	1471	1980

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 18 ½ in.			Rib Depth = 14 in.				Total Slab Depth = 4 ½ in.			
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.09	12		5	#4	#4	6-#7	7	#4	#4	11-#5
2.50	12	4 S 6 1	5	#5	#5	6-#8	7	#4	#4	11-#5
2.82	12 *	4 S 6 1	5	#5	#6	7-#8	7	#4	#4	11-#5
3.13	12 *	4 S 6 2	5	#6	#6	11-#7	7	#4	#4	11-#5
2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
2.08	13		6	#4	#4	9-#6	7	#4	#4	11-#5
2.18	13		6	#4	#4	8-#7	7	#4	#4	11-#5
2.65	13		6	#5	#5	8-#8	7	#4	#4	11-#5
2.95	13 *	4 S 6 1	6	#5	#6	7-#9	7	#4	#4	11-#5
3.53	13 *	4 S 6 1	6	#6	#6	9-#9	7	#4	#5	11-#5
1.97	14		6	#4	#4	8-#6	8	#4	#4	12-#5
2.08	14		6	#4	#4	7-#7	8	#4	#4	12-#5
2.14	14		6	#4	#4	8-#7	8	#4	#4	12-#5
2.38	14		6	#4	#5	7-#8	8	#4	#4	12-#5
2.96	14 *	4 S 6 1	6	#5	#6	8-#9	8	#4	#4	12-#5
3.42	14 *	4 S 6 2	6	#6	#6	9-#9	8	#4	#5	12-#5
2.05	15		6	#4	#4	9-#6	9	#4	#4	14-#5
2.25	15		6	#4	#4	7-#8	9	#4	#4	14-#5
2.43	15		6	#4	#5	8-#8	9	#4	#4	14-#5
2.67	15	4 S 6 1	6	#5	#5	7-#9	9	#4	#4	14-#5
3.19	15 *	4 S 6 2	6	#6	#6	9-#9	9	#4	#4	14-#5
2.15	16		7	#4	#4	9-#7	9	#4	#4	14-#5
2.29	16		7	#4	#4	11-#7	9	#4	#4	14-#5
2.55	16		7	#4	#5	10-#8	9	#4	#4	14-#5
2.98	16 *	4 S 6 1	7	#5	#6	9-#9	9	#4	#4	14-#5
3.60	16 *	4 S 6 1	7	#6	#6	12-#9	9	#4	#5	14-#5
2.17	17		7	#4	#4	10-#7	10	#4	#4	15-#5
2.49	17		7	#4	#5	10-#8	10	#4	#4	15-#5
2.76	17	4 S 6 1	7	#5	#5	9-#9	10	#4	#4	15-#5
3.12	17 *	4 S 6 1	7	#5	#6	11-#9	10	#4	#4	15-#5
4.06	17 *	4 S 6 2	7	#7	#7	14-#9	10	#4	#5	15-#5
2.38	18		7	#4	#5	9-#8	11	#4	#4	16-#5
2.70	18	4 S 6 1	7	#5	#5	9-#9	11	#4	#4	16-#5
3.04	18 *	4 S 6 1	7	#5	#6	11-#9	11	#4	#4	16-#5
3.38	18 *	4 S 6 2	7	#6	#6	13-#9	11	#4	#4	16-#5
2.48	19		8	#4	#5	11-#8	11	#4	#4	16-#5
2.83	19 *		8	#5	#5	11-#9	11	#4	#4	16-#5
3.17	19 *	4 S 6 1	8	#5	#6	13-#9	11	#4	#4	16-#5
3.74	19 *	4 S 6 2	8	#6	#6	16-#9	11	#4	#5	16-#5
4.44	25 *	4 S 6 2	8	#6	#7	20-#9	11	#4	#5	20-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column			Reinforcing Bars—Each Direction									Moments		
						Column Strip					Middle Strip						
						Top	Bottom			Top	Bottom			Top	–M	+M	–M
			$c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Edge No.-size +	No. Ribs	Long Bars	Short Bars	Interior No.-size	No. Ribs	Long Bars	Short Bars	Interior No.-size	Edge (ft-k)	Bot. (ft-k)	Int. (ft-k)
Total Depth = 20 ½ in.		Rib Depth = 16 in.		Total Slab Depth = 4 ½ in.													
28'-0"	50	1.95	14	0.640		8-#6+ 0	6	#4	#4	8-#6	8	#4	#4	12-#5	152	304	410
D = 10.417	100	2.08	14	0.640		8-#6+ 0	6	#4	#5	7-#7	8	#4	#4	12-#5	185	370	498
RIB NOT ON	150	2.22	14	0.640		8-#6+ 0	6	#5	#5	8-#7	8	#4	#4	12-#5	218	454	586
COLUMN LINE	200	2.45	14	0.656		8-#6+ 1	6	#5	#6	7-#8	8	#4	#4	12-#5	250	567	674
1.077 CF/SF	300	3.02	14 *	0.800		8-#6+ 3	6	#6	#7	7-#9	8	#4	#5	12-#5	316	778	851
	400	3.45	14 *	0.641		7-#7+ 0	6	#7	#7	9-#9	8	#5	#5	12-#5	382	983	1027
	500	4.21	14 *	0.641		12-#6+ 0	6	#8	#8	11-#9	8	#5	#6	12-#5	447	1185	1204
30'-0"	50	2.09	15	0.638		9-#6+ 0	6	#4	#5	7-#7	9	#4	#4	14-#5	186	373	502
D = 10.417	100	2.24	15	0.638		9-#6+ 0	6	#5	#5	7-#8	9	#4	#4	14-#5	227	453	610
RIB NOT ON	150	2.45	15	0.638		9-#6+ 0	6	#5	#6	8-#8	9	#4	#4	14-#5	267	551	719
COLUMN LINE	200	2.65	15	0.709		9-#6+ 1	6	#6	#6	7-#9	9	#4	#4	14-#5	307	689	827
1.065 CF/SF	300	3.34	15 *	0.849		7-#7+ 2	6	#7	#7	9-#9	9	#4	#5	14-#5	388	949	1044
	400	4.14	15 *	0.639		12-#6+ 1	6	#8	#8	11-#9	9	#5	#6	14-#5	468	1200	1261
32'-0"	50	2.13	16	0.637		10-#6+ 0	7	#4	#5	9-#7	9	#4	#4	14-#5	228	456	614
D = 12.417	100	2.30	16	0.637		10-#6+ 0	7	#5	#5	11-#7	9	#4	#4	14-#5	277	554	746
RIB ON	150	2.55	16	0.702		10-#6+ 1	7	#5	#6	10-#8	9	#4	#4	14-#5	326	665	877
COLUMN LINE	200	2.87	16 *	0.795		10-#6+ 3	7	#6	#6	9-#9	9	#4	#5	14-#5	375	834	1009
1.086 CF/SF	300	3.76	16 *	0.638		12-#6+ 3	7	#7	#8	11-#9	9	#5	#5	14-#5	473	1150	1272
	400	4.58	18 *	0.636		11-#7+ 3	7	#8	#8	14-#9	9	#6	#6	15-#5	567	1447	1527
34'-0"	50	2.25	17	0.636		10-#6+ 0	7	#5	#5	11-#7	10	#4	#4	15-#5	272	544	733
D = 12.417	100	2.49	17	0.636		10-#6+ 0	7	#5	#6	10-#8	10	#4	#4	15-#5	331	662	891
RIB ON	150	2.78	17 *	0.744		10-#6+ 2	7	#6	#6	9-#9	10	#4	#4	15-#5	390	782	1049
COLUMN LINE	200	3.17	17 *	0.860		12-#6+ 5	7	#6	#7	11-#9	10	#4	#5	15-#5	448	986	1207
1.075 CF/SF	300	4.21	17 *	0.637		11-#7+ 3	7	#8	#8	14-#9	10	#5	#6	15-#5	566	1363	1523
36'-0"	50	2.45	18	0.635		11-#6+ 1	7	#5	#6	10-#8	11	#4	#4	16-#5	322	644	867
D = 12.417	100	2.73	18	0.739		11-#6+ 3	7	#6	#6	9-#9	11	#4	#4	16-#5	392	783	1054
RIB ON	150	2.99	18 *	0.832		12-#6+ 5	7	#6	#7	11-#9	11	#4	#4	16-#5	461	923	1242
COLUMN LINE	200	3.42	18 *	0.636		10-#7+ 1	7	#7	#7	13-#9	11	#4	#5	16-#5	531	1150	1429
1.065 CF/SF																	
38'-0"	50	2.54	19	0.662		12-#6+ 1	8	#5	#6	12-#8	11	#4	#4	16-#5	381	763	1026
D = 14.417	100	2.79	19 *	0.795		12-#6+ 5	8	#6	#6	11-#9	11	#4	#4	16-#5	463	926	1247
RIB NOT ON	150	3.22	19 *	0.883		14-#6+ 8	8	#6	#7	13-#9	11	#4	#5	16-#5	545	1090	1467
COLUMN LINE	200	3.80	19 *	0.635		12-#7+ 3	8	#7	#8	15-#9	11	#5	#5	16-#5	627	1340	1688
1.083 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column		Reinforcing Bars—Each Direction							
			Column Strip				Middle Strip			
			Bottom			Top	Bottom			Top
	$c_1 = c_2$ (in.)	(2) Stirrups	No. Ribs	Long Bars	Short Bars	Interior No.-size	No. Ribs	Long Bars	Short Bars	Interior No.-size
Total Depth = 20 ½ in.			Rib Depth = 16 in.				Total Slab Depth = 4 ½ in.			
1.97	14		6	#4	#4	8-#6	8	#4	#4	12-#5
2.04	14		6	#4	#4	9-#6	8	#4	#4	12-#5
2.14	14		6	#4	#4	8-#7	8	#4	#4	12-#5
2.38	14		6	#4	#5	7-#8	8	#4	#4	12-#5
2.85	14	4 S 6 1	6	#5	#6	7-#9	8	#4	#4	12-#5
3.10	14 *	4 S 6 1	6	#6	#6	8-#9	8	#4	#4	12-#5
3.70	14 *	4 S 6 2	6	#6	#7	10-#9	8	#4	#5	12-#5
2.05	15		6	#4	#4	9-#6	9	#4	#4	14-#5
2.14	15		6	#4	#4	8-#7	9	#4	#4	14-#5
2.36	15		6	#4	#5	7-#8	9	#4	#4	14-#5
2.55	15		6	#5	#5	8-#8	9	#4	#4	14-#5
3.19	15 *	4 S 6 1	6	#6	#6	9-#9	9	#4	#4	14-#5
3.68	15 *	4 S 6 2	6	#6	#7	13-#8	9	#4	#5	14-#5
2.09	16		7	#4	#4	11-#6	9	#4	#4	14-#5
2.21	16		7	#4	#4	10-#7	9	#4	#4	14-#5
2.48	16		7	#4	#5	9-#8	9	#4	#4	14-#5
2.67	16		7	#5	#5	10-#8	9	#4	#4	14-#5
3.41	16 *	4 S 6 1	7	#6	#6	13-#8	9	#4	#5	14-#5
4.06	16 *	4 S 6 2	7	#6	#7	16-#8	9	#5	#5	14-#5
2.17	17		7	#4	#4	10-#7	10	#4	#4	15-#5
2.42	17		7	#4	#5	9-#8	10	#4	#4	15-#5
2.76	17		7	#5	#5	9-#9	10	#4	#4	15-#5
2.99	17 *	4 S 6 1	7	#5	#6	10-#9	10	#4	#4	15-#5
3.73	17 *	4 S 6 2	7	#6	#7	16-#8	10	#4	#5	15-#5
2.38	18		7	#4	#5	9-#8	11	#4	#4	16-#5
2.70	18		7	#5	#5	9-#9	11	#4	#4	16-#5
2.91	18	4 S 6 1	7	#5	#6	10-#9	11	#4	#4	16-#5
3.25	18 *	4 S 6 1	7	#6	#6	12-#9	11	#4	#4	16-#5
2.48	19		8	#4	#5	11-#8	11	#4	#4	16-#5
2.71	19		8	#5	#5	10-#9	11	#4	#4	16-#5
3.05	19 *	4 S 6 1	8	#5	#6	12-#9	11	#4	#4	16-#5
3.39	19 *	4 S 6 1	8	#6	#6	14-#9	11	#4	#4	16-#5

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 13 in.	Rib Depth = 8 in.	Total Slab Depth = 5 in.															
18'-0"	50	1.99	12	0.633		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	30	60	81
D = 6.417	100	1.99	12	0.633		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	38	77	103
RIB NOT ON	150	1.99	12	0.633		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	47	106	126
COLUMN LINE	200	1.99	12	0.633		5-#6+ 0	4	#4	#4	5-#6	5	#4	#4	8-#5	55	133	149
0.737 CF/SF	300	2.18	12	0.706		5-#6+ 0	4	#5	#5	6-#6	5	#4	#4	8-#5	72	185	194
	400	2.47	12 *	0.825		5-#6+ 1	4	#5	#6	6-#7	5	#4	#4	8-#5	89	237	240
	500	2.79	12 *	0.634		5-#6+ 1	4	#6	#6	5-#8	5	#4	#5	8-#5	106	288	285
20'-0"	50	1.96	12	0.633		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	42	84	113
D = 8.417	100	1.96	12	0.651		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	54	107	145
RIB ON	150	1.96	12	0.695		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	65	148	176
COLUMN LINE	200	2.07	12	0.739		6-#6+ 0	5	#4	#5	7-#6	5	#4	#4	8-#5	77	186	208
0.756 CF/SF	300	2.41	12 *	0.826		6-#6+ 0	5	#5	#5	6-#7	5	#4	#5	8-#5	101	259	271
	400	2.90	12 *	0.634		6-#6+ 0	5	#6	#6	6-#8	5	#5	#5	8-#5	124	330	334
	500	3.43	14 *	0.631		6-#6+ 1	5	#6	#7	7-#8	5	#5	#6	8-#5	146	398	394
22'-0"	50	1.98	12	0.659		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	56	112	151
D = 8.417	100	1.98	12	0.709		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	72	144	193
RIB ON	150	2.12	12	0.759		9-#5+ 0	5	#4	#5	6-#7	6	#4	#4	10-#5	88	198	236
COLUMN LINE	200	2.25	12 *	0.828		9-#5+ 1	5	#5	#5	9-#6	6	#4	#4	10-#5	103	248	278
0.746 CF/SF	300	2.81	12 *	0.634		9-#5+ 1	5	#6	#6	7-#8	6	#4	#5	10-#5	135	346	363
	400	3.36	15 *	0.630	3 S 4 1	10-#5+ 1	5	#7	#7	8-#8	6	#5	#5	10-#5	164	438	443
	500	3.98	18 *	0.626	3 S 4 1	6-#7+ 1	5	#7	#8	8-#9	6	#5	#6	10-#5	190	497	512
24'-0"	50	1.99	12	0.722		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	73	146	197
D = 8.417	100	2.11	12	0.776		10-#5+ 0	5	#4	#5	6-#7	7	#4	#4	11-#5	94	187	252
RIB ON	150	2.30	12 *	0.845		10-#5+ 1	5	#5	#5	7-#7	7	#4	#4	11-#5	114	258	308
COLUMN LINE	200	2.64	12 *	0.910		10-#5+ 3	5	#6	#6	7-#8	7	#4	#4	11-#5	135	324	363
0.737 CF/SF	300	3.23	15 *	0.630	3 S 4 1	6-#7+ 0	5	#7	#7	7-#9	7	#4	#5	11-#5	174	447	469
	400	3.86	19 *	0.625	3 S 4 1	9-#6+ 2	5	#7	#8	9-#9	7	#5	#5	11-#5	209	529	562
26'-0"	50	1.98	13	0.755		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	94	187	252
D = 10.417	100	2.16	13 *	0.833		8-#6+ 1	6	#4	#5	8-#7	7	#4	#4	11-#5	120	240	323
RIB NOT ON	150	2.52	13 *	0.905		8-#6+ 3	6	#5	#6	7-#8	7	#4	#4	11-#5	146	325	393
COLUMN LINE	200	2.86	14 *	0.631		8-#6+ 2	6	#6	#6	7-#9	7	#4	#5	11-#5	172	408	462
0.752 CF/SF	300	3.56	19 *	0.625		7-#7+ 2	6	#7	#7	9-#9	7	#5	#5	11-#5	219	542	589

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 13 in.	Rib Depth = 8 in.	Total Slab Depth = 5 in.								
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.01	12		4	#4	#4	5-#6	5	#4	#4	8-#5
2.04	12	3 S 4 1	4	#4	#4	8-#5	5	#4	#4	8-#5
2.33	12	3 S 4 1	4	#4	#5	5-#7	5	#4	#4	8-#5
2.56	12 *	3 S 4 1	4	#5	#5	6-#7	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
2.29	12	3 S 4 1	5	#4	#5	6-#7	5	#4	#4	8-#5
2.58	12 *	3 S 4 1	5	#5	#5	10-#6	5	#4	#4	8-#5
3.12	12 *	3 S 4 1	5	#5	#6	7-#8	5	#4	#5	8-#5
2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
2.07	12		5	#4	#4	7-#6	6	#4	#4	10-#5
2.14	12	3 S 4 1	5	#4	#4	6-#7	6	#4	#4	10-#5
2.58	12 *	3 S 4 1	5	#5	#5	6-#8	6	#4	#4	10-#5
2.96	12 *	3 S 4 2	5	#5	#6	6-#9	6	#4	#4	10-#5
3.50	16 *	3 S 4 2	5	#6	#6	7-#9	6	#4	#5	10-#5
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.09	12		5	#4	#4	6-#7	7	#4	#4	11-#5
2.29	12	3 S 4 1	5	#4	#5	9-#6	7	#4	#4	11-#5
2.50	12 *	3 S 4 1	5	#5	#5	6-#8	7	#4	#4	11-#5
2.91	12 *	3 S 4 2	5	#5	#6	8-#8	7	#4	#4	11-#5
3.50	16 *	3 S 4 2	5	#6	#6	8-#9	7	#4	#5	11-#5
2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
2.11	13		6	#4	#4	7-#7	7	#4	#4	11-#5
2.44	13 *		6	#4	#5	7-#8	7	#4	#4	11-#5
2.65	13 *	3 S 4 1	6	#5	#5	8-#8	7	#4	#4	11-#5
3.21	15 *	3 S 4 2	6	#5	#6	8-#9	7	#4	#5	11-#5

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	(1) Steel (psf)	Square Edge Column			Reinforcing Bars—Each Direction									Moments			(1) Steel (psf)	Square Interior Column		Reinforcing Bars—Each Direction							
						Column Strip					Middle Strip										Column Strip				Middle Strip			
						Top	Bottom			Top	Bottom			Top							Bottom			Top	Bottom			Top
			$c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Edge No.-size +	No. Ribs	Long Bars	Short Bars	Interior No.-size	No. Ribs	Long Bars	Short Bars	Interior No.-size	$-M$ Edge (ft-k)	$+M$ Bot. (ft-k)	$-M$ Int. (ft-k)		$c_1 = c_2$ (in.)	(2) Stirrups	No. Ribs	Long Bars	Short Bars	Interior No.-size	No. Ribs	Long Bars	Short Bars	Interior No.-size
Total Depth = 13 in.	Rib Depth = 8 in.	Total Slab Depth = 5 in.																Total Depth = 13 in.	Rib Depth = 8 in.	Total Slab Depth = 5 in.								
28'-0"	50	2.10	14	0.784		8-#6+ 1	6	#4	#5	10-#6	8	#4	#4	12-#5	116	233	313	2.08	14		6	#4	#4	7-#7	8	#4	#4	12-#5
D = 10.417	100	2.32	14 *	0.860		8-#6+ 2	6	#5	#5	8-#8	8	#4	#4	12-#5	149	298	402	2.26	14		6	#4	#4	7-#8	8	#4	#4	12-#5
RIB NOT ON	150	2.72	14 *	0.631		8-#6+ 2	6	#6	#6	7-#9	8	#4	#4	12-#5	182	396	490	2.64	14 *	3 S 4 1	6	#5	#5	11-#7	8	#4	#4	12-#5
COLUMN LINE	200	3.15	17 *	0.627		9-#6+ 2	6	#6	#7	9-#9	8	#4	#5	12-#5	213	496	573	2.96	14 *	3 S 4 1	6	#5	#6	8-#9	8	#4	#4	12-#5
0.744 CF/SF																												
30'-0"	50	2.29	15 *	0.840		9-#6+ 3	6	#5	#5	7-#8	9	#4	#4	14-#5	143	285	384	2.25	15		6	#4	#4	7-#8	9	#4	#4	14-#5
D = 10.417	100	2.55	15 *	0.910		9-#6+ 5	6	#5	#6	7-#9	9	#4	#4	14-#5	183	366	493	2.49	15 *	3 S 4 1	6	#4	#5	11-#7	9	#4	#4	14-#5
RIB NOT ON	150	3.17	17 *	0.627		7-#7+ 2	6	#6	#7	9-#9	9	#4	#5	14-#5	222	470	598	3.05	15 *	3 S 4 1	6	#5	#6	9-#9	9	#4	#4	14-#5
COLUMN LINE	200	3.47	21 *	0.624		8-#7+ 2	6	#7	#7	11-#9	9	#4	#5	14-#5	258	573	695	3.29	16 *	3 S 4 2	6	#6	#6	10-#9	9	#4	#4	14-#5
0.737 CF/SF																												
32'-0"	50	2.36	16 *	0.867		10-#6+ 4	7	#5	#5	9-#8	9	#4	#4	14-#5	174	348	469	2.29	16		7	#4	#4	11-#7	9	#4	#4	14-#5
D = 12.417	100	2.86	17 *	0.918		10-#6+ 6	7	#6	#6	9-#9	9	#4	#4	14-#5	222	445	599	2.83	16 *	3 S 4 1	7	#5	#5	9-#9	9	#4	#4	14-#5
RIB ON	150	3.28	21 *	0.624		12-#6+ 4	7	#6	#7	11-#9	9	#4	#5	14-#5	268	554	722	3.12	16 *	3 S 4 1	7	#5	#6	13-#8	9	#4	#4	14-#5
COLUMN LINE																												
0.749 CF/SF																												
34'-0"	50	2.56	17 *	0.883		10-#6+ 5	7	#5	#6	9-#9	10	#4	#4	15-#5	208	417	561	2.49	17 *		7	#4	#5	10-#8	10	#4	#4	15-#5
D = 12.417	100	3.09	20 *	0.922		12-#6+ 8	7	#6	#7	11-#9	10	#4	#5	15-#5	265	530	713	2.84	17 *	3 S 4 1	7	#5	#5	10-#9	10	#4	#4	15-#5
RIB ON	150	3.49	28 *	0.619		10-#7+ 3	7	#7	#7	13-#9	10	#4	#5	15-#5	313	626	843	3.28	21 *	3 S 4 2	7	#5	#6	16-#8	10	#4	#4	15-#5
COLUMN LINE																												
0.743 CF/SF																												
36'-0"	50	2.75	18 *	0.904		11-#6+ 6	7	#6	#6	10-#9	11	#4	#4	16-#5	247	493	664	2.70	18 *	3 S 4 1	7	#5	#5	9-#9	11	#4	#4	16-#5
D = 12.417	100	3.35	25 *	0.621		10-#7+ 3	7	#7	#7	13-#9	11	#4	#5	16-#5	311	622	837	3.12	18 *	3 S 4 2	7	#5	#6	12-#9	11	#4	#4	16-#5
RIB ON																												
COLUMN LINE																												
0.737 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 15 in.	Rib Depth = 10 in.	Total Slab Depth = 5 in.																Total Depth = 15 in.	Rib Depth = 10 in.	Total Slab Depth = 5 in.								
20'-0"	50	1.96	12	0.636		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	45	91	122	1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
D = 8.417	100	1.96	12	0.636		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	57	114	154	1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
RIB ON	150	1.96	12	0.636		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	69	154	186	1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
COLUMN LINE	200	1.96	12	0.636		6-#6+ 0	5	#4	#4	6-#6	5	#4	#4	8-#5	81	192	217	1.97	12		5	#4	#4	6-#6	5	#4	#4	8-#5
0.849 CF/SF	300	2.22	12	0.717		6-#6+ 0	5	#5	#5	6-#7	5	#4	#4	8-#5	104	266	280	2.07	12		5	#4	#4	7-#6	5	#4	#4	8-#5
	400	2.55	12 *	0.799		6-#6+ 0	5	#5	#6	7-#7	5	#4	#5	8-#5	128	338	343	2.29	12	3 S 4 1	5	#4	#5	6-#7	5	#4	#4	8-#5
	500	2.93	12 *	0.637		6-#6+ 0	5	#6	#6	6-#8	5	#5	#5	8-#5	151	410	407	2.64	12 *	3 S 4 1	5	#5	#5	6-#8	5	#4	#4	8-#5
22'-0"	50	1.98	12	0.636		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	61	121	163	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
D = 8.417	100	1.98	12	0.636		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	76	153	206	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
RIB ON	150	2.07	12	0.663		9-#5+ 0	5	#4	#5	7-#6	6	#4	#4	10-#5	92	205	248	2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
COLUMN LINE	200	2.19	12	0.710		9-#5+ 0	5	#5	#5	6-#7	6	#4	#4	10-#5	108	257	291	2.07	12		5	#4	#4	7-#6	6	#4	#4	10-#5
0.835 CF/SF	300	2.50	12 *	0.839		9-#5+ 2	5	#5	#6	6-#8	6	#4	#4	10-#5	140	356	376	2.39	12	3 S 4 1	5	#4	#5	7-#7	6	#4	#4	10-#5
	400	3.01	12 *	0.637		9-#5+ 2	5	#6	#7	7-#8	6	#4	#5	10-#5	171	453	461	2.75	12 *	3 S 4 1	5	#5	#5	7-#8	6	#4	#4	10-#5
	500	3.57	13 *	0.635	3 S 4 1	7-#6+ 1	5	#7	#7	7-#9	6	#5	#5	10-#5	202	547	543	3.26	12 *	3 S 4 2	5	#6	#6	6-#9	6	#4	#5	10-#5
24'-0"	50	1.99	12	0.642		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	79	158	213	2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
D = 8.417	100	1.99	12	0.692		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	100	199	268	2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
RIB ON	150	2.20	12	0.742		10-#5+ 0	5	#5	#5	9-#6	7	#4	#4	11-#5	120	267	324	2.09	12		5	#4	#4	6-#7	7	#4	#4	11-#5
COLUMN LINE	200	2.43	12 *	0.811		10-#5+ 1	5	#5	#6	6-#8	7	#4	#4	11-#5	141	335	380	2.33	12	3 S 4 1	5	#4	#5	7-#7	7	#4	#4	11-#5
0.825 CF/SF	300	3.01	12 *	0.637		10-#5+ 1	5	#6	#7	6-#9	7	#4	#5	11-#5	182	465	491	2.82	12*	3 S 4 1	5	#5	#6	7-#8	7	#4	#4	11-#5
	400	3.65	14 *	0.634	3 S 4 1	6-#7+ 1	5	#7	#8	8-#9	7	#5	#5	11-#5	222	587	597	3.21	12 *	3 S 4 2	5	#6	#6	7-#9	7	#4	#4	11-#5
	500	4.21	17 *	0.630	3 S 4 1	7-#7+ 0	5	#8	#8	9-#9	7	#5	#6	11-#5	257	683	692	3.70	15 *	3 S 4 2	5	#6	#7	8-#9	7	#4	#5	11-#5
26'-0"	50	1.98	13	0.681		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	101	203	273	2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
D = 10.417	100	2.12	13	0.735		8-#6+ 0	6	#4	#5	7-#7	7	#4	#4	11-#5	128	255	344	2.08	13		6	#4	#4	9-#6	7	#4	#4	11-#5
RIB NOT ON	150	2.30	13 *	0.811		8-#6+ 1	6	#5	#5	7-#8	7	#4	#4	11-#5	154	339	414	2.18	13		6	#4	#4	8-#7	7	#4	#4	11-#5
COLUMN LINE	200	2.63	13 *	0.884		8-#6+ 3	6	#5	#6	8-#8	7	#4	#5	11-#5	180	425	485	2.44	13 *		6	#4	#5	7-#8	7	#4	#4	11-#5
0.843 CF/SF	300	3.25	14 *	0.634		12-#5+ 3	6	#6	#7	8-#9	7	#5	#5	11-#5	232	587	624	2.95	13 *	3 S 4 1	6	#5	#6	7-#9	7	#4	#4	11-#5
	400	3.97	18 *	0.629		10-#6+ 1	6	#7	#8	12-#8	7	#5	#6	11-#5	278	722	749	3.54	15 *	3 S 4 2	6	#6	#6	9-#9	7	#4	#5	11-#5
28'-0"	50	2.05	14	0.680		8-#6+ 0	6	#4	#5	9-#6	8	#4	#4	12-#5	126	252	339	1.99	14		6	#4	#4	12-#5	8	#4	#4	12-#5
D = 10.417	100	2.24	14	0.772		8-#6+ 1	6	#5	#5	7-#8	8	#4	#4	12-#5	159	318	427	2.14	14		6	#4	#4	8-#7	8	#4	#4	12-#5
RIB NOT ON	150	2.51	14 *	0.860		8-#6+ 3	6	#5	#6	8-#8	8	#4	#4	12-#5	192	415	516	2.46	14	3 S 4 1	6	#4	#5	8-#8	8	#4	#4	12-#5
COLUMN LINE	200	2.97	14 *	0.634		8-#6+ 2	6	#6	#7	8-#9	8	#4	#5	12-#5	224	523	604	2.70	14 *	3 S 4 1	6	#5	#5	7-#9	8	#4	#4	12-#5
0.833 CF/SF	300	3.76	18 *	0.629		15-#5+ 4	6	#7	#8	10-#9	8	#5	#5	12-#5	286	718	770	3.42	14 *	3 S 4 2	6	#6	#6	9-#9	8	#4	#5	12-#5
	400	4.34	23 *	0.625	3 S 4 1	7-#8+ 2	6	#8	#8	12-#9	8	#5	#6	12-#5	340	828	915	3.89	19 *	3 S 4 2	6	#6	#7	11-#9	8	#4	#5	12-#5

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 15 in.	Rib Depth = 10 in.	Total Slab Depth = 5 in.															
30'-0"	50	2.24	15	0.717		9-#6+ 0	6	#5	#5	7-#8	9	#4	#4	14-#5	154	309	416
D = 10.417	100	2.49	15 *	0.823		9-#6+ 2	6	#5	#6	8-#8	9	#4	#4	14-#5	195	389	524
RIB NOT ON	150	2.74	15 *	0.897		9-#6+ 4	6	#6	#6	8-#9	9	#4	#4	14-#5	235	499	633
COLUMN LINE	200	3.28	16 *	0.631		7-#7+ 3	6	#7	#7	12-#8	9	#4	#5	14-#5	275	630	739
0.825 CF/SF	300	4.17	22 *	0.626		7-#8+ 2	6	#8	#8	12-#9	9	#5	#5	14-#5	346	813	930
32'-0"	50	2.28	16	0.790		10-#6+ 2	7	#5	#5	14-#6	9	#4	#4	14-#5	189	377	508
D = 12.417	100	2.55	16 *	0.879		10-#6+ 5	7	#5	#6	10-#8	9	#4	#4	14-#5	238	475	640
RIB ON	150	2.98	16 *	0.631		15-#5+ 4	7	#6	#6	10-#9	9	#4	#5	14-#5	286	597	771
COLUMN LINE	200	3.56	20 *	0.627		12-#6+ 3	7	#7	#7	12-#9	9	#5	#5	14-#5	332	750	893
0.839 CF/SF																	
34'-0"	50	2.49	17 *	0.824		10-#6+ 4	7	#5	#6	10-#8	10	#4	#4	15-#5	225	451	607
D = 12.417	100	2.79	17 *	0.899		15-#5+ 8	7	#6	#6	12-#8	10	#4	#4	15-#5	284	568	765
RIB ON	150	3.26	19 *	0.628		9-#7+ 4	7	#6	#7	12-#9	10	#4	#5	15-#5	341	688	918
COLUMN LINE	200	3.86	23 *	0.625		11-#7+ 3	7	#7	#8	14-#9	10	#5	#5	15-#5	394	847	1061
0.832 CF/SF																	
36'-0"	50	2.73	18 *	0.842		11-#6+ 4	7	#6	#6	9-#9	11	#4	#4	16-#5	267	534	719
D = 12.417	100	3.18	18 *	0.629		9-#7+ 4	7	#6	#7	12-#9	11	#4	#5	16-#5	337	673	906
RIB ON	150	3.52	23 *	0.625		11-#7+ 3	7	#7	#7	14-#9	11	#4	#5	16-#5	401	802	1080
COLUMN LINE	200	4.11	29 *	0.621	3 S 4 1	10-#8+ 3	7	#7	#8	17-#9	11	#5	#5	17-#5	457	915	1231
0.825 CF/SF																	
38'-0"	50	2.79	19 *	0.888		12-#6+ 8	8	#6	#6	11-#9	11	#4	#4	16-#5	316	631	850
D = 14.417	100	3.28	22 *	0.914		11-#7+ 6	8	#6	#7	14-#9	11	#4	#5	16-#5	395	789	1063
RIB NOT ON	150	3.96	28 *	0.622		10-#8+ 3	8	#7	#8	17-#9	11	#5	#5	17-#5	468	936	1261
COLUMN LINE																	
0.837 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 15 in.	Rib Depth = 10 in.	Total Slab Depth = 5 in.								
2.14	15		6	#4	#4	8-#7	9	#4	#4	14-#5
2.43	15		6	#4	#5	8-#8	9	#4	#4	14-#5
2.67	15 *	3 S 4 1	6	#5	#5	7-#9	9	#4	#4	14-#5
3.05	15 *	3 S 4 1	6	#5	#6	9-#9	9	#4	#4	14-#5
3.90	18 *	3 S 4 2	6	#6	#7	12-#9	9	#4	#5	14-#5
2.21	16		7	#4	#4	10-#7	9	#4	#4	14-#5
2.48	16		7	#4	#5	9-#8	9	#4	#4	14-#5
2.83	16 *	3 S 4 1	7	#5	#5	9-#9	9	#4	#4	14-#5
3.21	16 *	3 S 4 1	7	#5	#6	11-#9	9	#4	#4	14-#5
2.42	17		7	#4	#5	9-#8	10	#4	#4	15-#5
2.76	17 *	3 S 4 1	7	#5	#5	9-#9	10	#4	#4	15-#5
3.12	17 *	3 S 4 1	7	#5	#6	11-#9	10	#4	#4	15-#5
3.49	18 *	3 S 4 2	7	#6	#6	13-#9	10	#4	#4	15-#5
2.70	18		7	#5	#5	9-#9	11	#4	#4	16-#5
3.04	18 *	3 S 4 1	7	#5	#6	11-#9	11	#4	#4	16-#5
3.38	18 *	3 S 4 2	7	#6	#6	13-#9	11	#4	#4	16-#5
3.85	23 *	3 S 4 2	7	#6	#7	16-#9	11	#4	#4	16-#5
2.71	19 *		8	#5	#5	10-#9	11	#4	#4	16-#5
3.11	19 *	3 S 4 1	8	#5	#6	16-#8	11	#4	#4	16-#5
3.60	20 *	3 S 4 2	8	#6	#6	16-#9	11	#4	#4	16-#5

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 17 in.	Rib Depth = 12 in.		Total Slab Depth = 5 in.														
22'-0"	50	1.98	12	0.639		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	66	131	176
D = 8.417	100	1.98	12	0.639		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	81	163	219
RIB ON	150	1.98	12	0.639		9-#5+ 0	5	#4	#4	9-#5	6	#4	#4	10-#5	97	212	261
COLUMN LINE	200	2.10	12	0.639		9-#5+ 0	5	#4	#5	7-#6	6	#4	#4	10-#5	113	265	304
0.928 CF/SF	300	2.41	12	0.696		9-#5+ 0	5	#5	#6	9-#6	6	#4	#4	10-#5	144	365	389
	400	2.77	12 *	0.824		9-#5+ 2	5	#6	#6	6-#8	6	#4	#5	10-#5	176	462	473
	500	3.21	12 *	0.640		9-#5+ 2	5	#6	#7	6-#9	6	#5	#5	10-#5	207	559	558
24'-0"	50	1.99	12	0.639		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	85	171	230
D = 8.417	100	1.99	12	0.639		10-#5+ 0	5	#4	#4	7-#6	7	#4	#4	11-#5	106	212	285
RIB ON	150	2.11	12	0.652		10-#5+ 0	5	#4	#5	6-#7	7	#4	#4	11-#5	127	276	341
COLUMN LINE	200	2.27	12	0.700		10-#5+ 0	5	#5	#5	7-#7	7	#4	#4	11-#5	147	345	396
0.916 CF/SF	300	2.64	12 *	0.829		10-#5+ 2	5	#6	#6	7-#8	7	#4	#4	11-#5	188	476	507
	400	3.17	12 *	0.640		10-#5+ 2	5	#7	#7	11-#7	7	#4	#5	11-#5	230	604	619
	500	3.73	12 *	0.640	4 S 6 1	6-#7+ 1	5	#7	#8	8-#9	7	#5	#5	11-#5	271	730	730
26'-0"	50	1.98	13	0.637		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	109	219	295
D = 10.417	100	2.00	13	0.654		8-#6+ 0	6	#4	#4	9-#6	7	#4	#4	11-#5	136	271	365
RIB NOT ON	150	2.24	13	0.705		8-#6+ 0	6	#5	#5	8-#7	7	#4	#4	11-#5	162	351	436
COLUMN LINE	200	2.46	13	0.782		8-#6+ 1	6	#5	#6	7-#8	7	#4	#4	11-#5	188	439	507
0.937 CF/SF	300	2.97	13 *	0.638		8-#6+ 2	6	#6	#7	7-#9	7	#4	#5	11-#5	241	605	648
	400	3.73	13 *	0.638		9-#6+ 2	6	#7	#7	9-#9	7	#5	#6	11-#5	293	768	789
	500	4.35	17 *	0.633		8-#7+ 2	6	#7	#8	10-#9	7	#6	#6	11-#5	340	908	915
28'-0"	50	1.97	14	0.636		8-#6+ 0	6	#4	#4	9-#6	8	#4	#4	12-#5	136	272	366
D = 10.417	100	2.11	14	0.661		8-#6+ 0	6	#4	#5	8-#7	8	#4	#4	12-#5	169	338	454
RIB NOT ON	150	2.45	14	0.776		8-#6+ 2	6	#5	#6	7-#8	8	#4	#4	12-#5	202	431	543
COLUMN LINE	200	2.67	14 *	0.840		8-#6+ 3	6	#6	#6	11-#7	8	#4	#4	12-#5	234	542	631
0.925 CF/SF	300	3.38	14 *	0.637		7-#7+ 2	6	#7	#7	9-#9	8	#5	#5	12-#5	300	748	807
	400	4.20	18 *	0.632		12-#6+ 2	6	#8	#8	11-#9	8	#5	#6	12-#5	361	939	971
30'-0"	50	2.12	15	0.643		9-#6+ 0	6	#4	#5	8-#7	9	#4	#4	14-#5	167	333	449
D = 10.417	100	2.37	15	0.706		9-#6+ 0	6	#5	#5	8-#8	9	#4	#4	14-#5	207	414	557
RIB NOT ON	150	2.65	15 *	0.811		9-#6+ 2	6	#6	#6	7-#9	9	#4	#4	14-#5	247	521	666
COLUMN LINE	200	3.09	15 *	0.884		9-#6+ 4	6	#6	#7	9-#9	9	#4	#5	14-#5	288	657	774
0.916 CF/SF	300	3.81	17 *	0.633		12-#6+ 2	6	#7	#8	11-#9	9	#5	#5	14-#5	366	905	985
32'-0"	50	2.25	16	0.710		10-#6+ 1	7	#5	#5	10-#7	9	#4	#4	14-#5	204	407	548
D = 12.417	100	2.51	16 *	0.805		10-#6+ 3	7	#5	#6	9-#8	9	#4	#4	14-#5	253	505	680
RIB ON	150	2.87	16 *	0.883		10-#6+ 6	7	#6	#6	9-#9	9	#4	#5	14-#5	301	626	812
COLUMN LINE	200	3.29	16 *	0.634		11-#6+ 3	7	#6	#7	13-#8	9	#5	#5	14-#5	350	792	943
0.933 CF/SF	300	4.31	21 *	0.629		14-#6+ 4	7	#8	#8	14-#9	9	#5	#6	14-#5	441	1067	1187
	400	4.88	26 *	0.625	4 S 6 1	17-#6+ 3	7	#8	#8	16-#9	9	#6	#6	17-#5	521	1178	1402
34'-0"	50	2.37	17	0.757		10-#6+ 3	7	#5	#5	9-#8	10	#4	#4	15-#5	243	487	655
D = 12.417	100	2.65	17 *	0.841		10-#6+ 5	7	#6	#6	9-#9	10	#4	#4	15-#5	302	604	813
RIB ON	150	3.09	17 *	0.910		12-#6+ 6	7	#6	#7	11-#9	10	#4	#5	15-#5	361	731	971
COLUMN LINE	200	3.61	18 *	0.632		10-#7+ 3	7	#7	#7	16-#8	10	#5	#5	15-#5	418	928	1126
0.924 CF/SF	300	4.55	25 *	0.626	4 S 6 1	17-#6+ 3	7	#8	#8	16-#9	10	#5	#6	17-#5	521	1191	1404
36'-0"	50	2.52	18 *	0.779		11-#6+ 3	7	#5	#6	9-#9	11	#4	#4	16-#5	288	576	775
D = 12.417	100	2.92	18 *	0.870		12-#6+ 5	7	#6	#7	11-#9	11	#4	#4	16-#5	358	715	963
RIB ON	150	3.35	18 *	0.632		10-#7+ 3	7	#7	#7	13-#9	11	#4	#5	16-#5	427	854	1150
COLUMN LINE	200	4.03	22 *	0.628	4 S 6 1	9-#8+ 1	7	#8	#8	15-#9	11	#5	#5	16-#5	492	1069	1325
0.916 CF/SF																	
38'-0"	50	2.67	19 *	0.834		12-#6+ 6	8	#6	#6	10-#9	11	#4	#4	16-#5	341	681	917
D = 14.417	100	3.20	19 *	0.909		10-#7+ 6	8	#6	#7	16-#8	11	#4	#5	16-#5	423	845	1138
RIB NOT ON	150	3.68	22 *	0.628		12-#7+ 2	8	#7	#7	15-#9	11	#5	#5	16-#5	501	1002	1349
COLUMN LINE	200	4.36	26 *	0.625		14-#7+ 4	8	#7	#8	18-#9	11	#5	#6	19-#5	575	1192	1549
0.930 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 17 in.			Rib Depth = 12 in.				Total Slab Depth = 5 in.			
2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
2.01	12		5	#4	#4	9-#5	6	#4	#4	10-#5
2.07	12		5	#4	#4	7-#6	6	#4	#4	10-#5
2.27	12		5	#4	#5	6-#7	6	#4	#4	10-#5
2.58	12	4 S 6 1	5	#5	#5	6-#8	6	#4	#4	10-#5
2.91	12 *	4 S 6 1	5	#5	#6	7-#8	6	#4	#4	10-#5
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.03	12		5	#4	#4	7-#6	7	#4	#4	11-#5
2.09	12		5	#4	#4	6-#7	7	#4	#4	11-#5
2.21	12		5	#4	#5	6-#7	7	#4	#4	11-#5
2.50	12	4 S 6 1	5	#5	#5	6-#8	7	#4	#4	11-#5
2.87	12 *	4 S 6 1	5	#5	#6	6-#9	7	#4	#4	11-#5
3.36	12 *	4 S 6 2	5	#6	#6	7-#9	7	#4	#5	11-#5
2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
2.11	13		6	#4	#4	7-#7	7	#4	#4	11-#5
2.31	13		6	#4	#5	8-#7	7	#4	#4	11-#5
2.65	13 *	4 S 6 1	6	#5	#5	8-#8	7	#4	#4	11-#5
3.36	13 *	4 S 6 1	6	#6	#6	8-#9	7	#4	#5	11-#5
3.96	14 *	4 S 6 2	6	#6	#7	12-#8	7	#5	#5	11-#5
1.97	14		6	#4	#4	8-#6	8	#4	#4	12-#5
2.08	14		6	#4	#4	7-#7	8	#4	#4	12-#5
2.38	14		6	#4	#5	7-#8	8	#4	#4	12-#5
2.58	14	4 S 6 1	6	#5	#5	8-#8	8	#4	#4	12-#5
2.96	14 *	4 S 6 1	6	#5	#6	8-#9	8	#4	#4	12-#5
3.70	14 *	4 S 6 2	6	#6	#7	10-#9	8	#4	#5	12-#5
2.08	15		6	#4	#4	7-#7	9	#4	#4	14-#5
2.36	15		6	#4	#5	7-#8	9	#4	#4	14-#5
2.55	15	4 S 6 1	6	#5	#5	8-#8	9	#4	#4	14-#5
2.90	15 *	4 S 6 1	6	#5	#6	8-#9	9	#4	#4	14-#5
3.48	15 *	4 S 6 2	6	#6	#7	10-#9	9	#4	#4	14-#5
2.15	16		7	#4	#4	9-#7	9	#4	#4	14-#5
2.42	16		7	#4	#5	11-#7	9	#4	#4	14-#5
2.67	16 *		7	#5	#5	10-#8	9	#4	#4	14-#5
3.00	16 *	4 S 6 1	7	#5	#6	12-#8	9	#4	#4	14-#5
3.85	17 *	4 S 6 2	7	#6	#7	16-#8	9	#4	#5	14-#5
4.47	23 *	4 S 6 2	7	#6	#7	15-#9	9	#5	#5	16-#5
2.37	17		7	#4	#5	11-#7	10	#4	#4	15-#5
2.49	17		7	#4	#5	10-#8	10	#4	#4	15-#5
2.84	17 *	4 S 6 1	7	#5	#5	10-#9	10	#4	#4	15-#5
3.35	17 *	4 S 6 1	7	#6	#6	12-#9	10	#4	#4	15-#5
4.23	20 *	4 S 6 2	7	#7	#7	15-#9	10	#4	#5	16-#5
2.44	18		7	#4	#5	10-#8	11	#4	#4	16-#5
2.78	18 *	4 S 6 1	7	#5	#5	10-#9	11	#4	#4	16-#5
3.12	18 *	4 S 6 1	7	#5	#6	12-#9	11	#4	#4	16-#5
3.62	18 *	4 S 6 2	7	#6	#7	14-#9	11	#4	#4	16-#5
2.54	19		8	#4	#5	12-#8	11	#4	#4	16-#5
3.05	19 *	4 S 6 1	8	#5	#6	12-#9	11	#4	#4	16-#5
3.39	19 *	4 S 6 1	8	#6	#6	14-#9	11	#4	#4	16-#5
4.07	20 *	4 S 6 2	8	#6	#7	17-#9	11	#4	#5	17-#5

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 19 in.	Rib Depth = 14 in.	Total Slab Depth = 5 in.															
26'-0"	50	1.98	13	0.640		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	118	236	317
D = 10.417	100	1.98	13	0.640		8-#6+ 0	6	#4	#4	8-#6	7	#4	#4	11-#5	144	288	388
RIB NOT ON	150	2.12	13	0.640		8-#6+ 0	6	#4	#5	7-#7	7	#4	#4	11-#5	170	362	458
COLUMN LINE	200	2.27	13	0.667		8-#6+ 0	6	#5	#5	8-#7	7	#4	#4	11-#5	197	451	529
1.034 CF/SF	300	2.78	13 *	0.828		8-#6+ 3	6	#6	#6	8-#8	7	#4	#5	11-#5	249	620	670
	400	3.25	13 *	0.641		8-#6+ 2	6	#6	#7	8-#9	7	#5	#5	11-#5	301	783	812
	500	3.96	13 *	0.641		7-#7+ 2	6	#7	#8	9-#9	7	#5	#6	11-#5	354	944	953
28'-0"	50	1.95	14	0.638		8-#6+ 0	6	#4	#4	8-#6	8	#4	#4	12-#5	146	293	394
D = 10.417	100	2.10	14	0.638		8-#6+ 0	6	#4	#5	7-#7	8	#4	#4	12-#5	179	358	482
RIB NOT ON	150	2.24	14	0.671		8-#6+ 1	6	#5	#5	7-#8	8	#4	#4	12-#5	212	446	570
COLUMN LINE	200	2.47	14	0.750		8-#6+ 2	6	#5	#6	8-#8	8	#4	#4	12-#5	245	558	659
1.021 CF/SF	300	3.06	14 *	0.879		9-#6+ 4	6	#6	#7	8-#9	8	#4	#5	12-#5	310	767	835
	400	3.88	14 *	0.639		15-#5+ 2	6	#7	#8	10-#9	8	#5	#6	12-#5	376	971	1011
	500	4.66	17 *	0.635		7-#8+ 0	6	#8	#8	12-#9	8	#6	#6	12-#5	437	1161	1177
30'-0"	50	2.10	15	0.637		9-#6+ 0	6	#4	#5	7-#7	9	#4	#4	14-#5	179	359	483
D = 10.417	100	2.29	15	0.637		9-#6+ 0	6	#5	#5	7-#8	9	#4	#4	14-#5	220	439	591
RIB NOT ON	150	2.49	15	0.718		9-#6+ 1	6	#5	#6	8-#8	9	#4	#4	14-#5	260	540	700
COLUMN LINE	200	2.84	15 *	0.810		9-#6+ 3	6	#6	#7	8-#9	9	#4	#4	14-#5	300	678	808
1.010 CF/SF	300	3.61	15 *	0.638		8-#7+ 2	6	#7	#8	10-#9	9	#5	#5	14-#5	381	935	1025
32'-0"	50	2.17	16	0.645		10-#6+ 1	7	#4	#5	9-#7	9	#4	#4	14-#5	219	438	590
D = 12.417	100	2.36	16	0.727		10-#6+ 2	7	#5	#5	9-#8	9	#4	#4	14-#5	268	536	722
RIB ON	150	2.59	16 *	0.811		10-#6+ 4	7	#5	#6	10-#8	9	#4	#4	14-#5	317	651	854
COLUMN LINE	200	3.06	16 *	0.874		10-#6+ 6	7	#6	#7	12-#8	9	#4	#5	14-#5	366	819	985
1.029 CF/SF	300	3.97	16 *	0.636		10-#7+ 3	7	#7	#8	12-#9	9	#5	#6	14-#5	464	1131	1249
34'-0"	50	2.25	17	0.676		10-#6+ 2	7	#5	#5	11-#7	10	#4	#4	15-#5	262	524	705
D = 12.417	100	2.56	17	0.774		10-#6+ 4	7	#5	#6	9-#9	10	#4	#4	15-#5	321	641	863
RIB ON	150	2.81	17 *	0.843		15-#5+ 7	7	#6	#6	10-#9	10	#4	#4	15-#5	379	763	1021
COLUMN LINE	200	3.36	17 *	0.635		9-#7+ 2	7	#7	#7	12-#9	10	#4	#5	15-#5	438	966	1179
1.019 CF/SF	300	4.34	20 *	0.632		9-#8+ 1	7	#8	#8	15-#9	10	#5	#6	15-#5	551	1329	1483
36'-0"	50	2.45	18	0.705		11-#6+ 2	7	#5	#6	10-#8	11	#4	#4	16-#5	310	620	834
D = 12.417	100	2.75	18 *	0.812		11-#6+ 5	7	#6	#6	10-#9	11	#4	#4	16-#5	379	759	1022
RIB ON	150	3.18	18 *	0.878		9-#7+ 4	7	#6	#7	12-#9	11	#4	#5	16-#5	449	898	1209
COLUMN LINE	200	3.72	18 *	0.634		11-#7+ 3	7	#7	#8	14-#9	11	#5	#5	16-#5	519	1124	1397
1.010 CF/SF																	
38'-0"	50	2.54	19	0.750		12-#6+ 3	8	#5	#6	12-#8	11	#4	#4	16-#5	367	733	987
D = 14.417	100	3.06	19 *	0.852		18-#5+ 9	8	#6	#7	12-#9	11	#4	#5	16-#5	449	897	1208
RIB NOT ON	150	3.42	19 *	0.633		11-#7+ 3	8	#7	#7	14-#9	11	#4	#5	16-#5	530	1061	1428
COLUMN LINE	200	4.01	21 *	0.631		10-#8+ 3	8	#7	#8	17-#9	11	#5	#5	17-#5	609	1300	1641
1.026 CF/SF	300	4.83	28 *	0.626		12-#8+ 2	8	#8	#8	21-#9	11	#5	#6	21-#5	751	1565	2022

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 19 in.	Rib Depth = 14 in.	Total Slab Depth = 5 in.								
2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
2.00	13		6	#4	#4	8-#6	7	#4	#4	11-#5
2.08	13		6	#4	#4	9-#6	7	#4	#4	11-#5
2.18	13		6	#4	#4	8-#7	7	#4	#4	11-#5
2.57	13		6	#5	#5	7-#8	7	#4	#4	11-#5
2.95	13 *	4 S 6 1	6	#5	#6	7-#9	7	#4	#4	11-#5
3.53	13 *	4 S 6 1	6	#6	#6	9-#9	7	#4	#5	11-#5
1.97	14		6	#4	#4	8-#6	8	#4	#4	12-#5
2.08	14		6	#4	#4	7-#7	8	#4	#4	12-#5
2.14	14		6	#4	#4	8-#7	8	#4	#4	12-#5
2.38	14		6	#4	#5	7-#8	8	#4	#4	12-#5
2.85	14 *	4 S 6 1	6	#5	#6	7-#9	8	#4	#4	12-#5
3.42	14 *	4 S 6 2	6	#6	#6	9-#9	8	#4	#5	12-#5
4.26	14 *	4 S 6 2	6	#7	#7	11-#9	8	#5	#5	12-#5
2.08	15		6	#4	#4	7-#7	9	#4	#4	14-#5
2.25	15		6	#4	#4	7-#8	9	#4	#4	14-#5
2.43	15		6	#4	#5	8-#8	9	#4	#4	14-#5
2.67	15	4 S 6 1	6	#5	#5	7-#9	9	#4	#4	14-#5
3.19	15 *	4 S 6 1	6	#6	#6	9-#9	9	#4	#4	14-#5
2.15	16		7	#4	#4	9-#7	9	#4	#4	14-#5
2.29	16		7	#4	#4	11-#7	9	#4	#4	14-#5
2.55	16		7	#4	#5	10-#8	9	#4	#4	14-#5
2.83	16 *	4 S 6 1	7	#5	#5	9-#9	9	#4	#4	14-#5
3.51	16 *	4 S 6 1	7	#6	#6	11-#9	9	#4	#5	14-#5
2.17	17		7	#4	#4	10-#7	10	#4	#4	15-#5
2.49	17		7	#4	#5	10-#8	10	#4	#4	15-#5
2.76	17	4 S 6 1	7	#5	#5	9-#9	10	#4	#4	15-#5
3.12	17 *	4 S 6 1	7	#5	#6	11-#9	10	#4	#4	15-#5
3.89	17 *	4 S 6 2	7	#6	#7	14-#9	10	#4	#5	15-#5
2.38	18		7	#4	#5	9-#8	11	#4	#4	16-#5
2.70	18		7	#5	#5	9-#9	11	#4	#4	16-#5
3.04	18 *	4 S 6 1	7	#5	#6	11-#9	11	#4	#4	16-#5
3.31	18 *	4 S 6 2	7	#6	#6	16-#8	11	#4	#4	16-#5
2.48	19		8	#4	#5	11-#8	11	#4	#4	16-#5
2.83	19		8	#5	#5	11-#9	11	#4	#4	16-#5
3.17	19 *	4 S 6 1	8	#5	#6	13-#9	11	#4	#4	16-#5
3.67	19 *	4 S 6 1	8	#6	#6	15-#9	11	#4	#5	16-#5
4.53	24 *	4 S 6 2	8	#7	#7	19-#9	11	#4	#5	20-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 21 in.		Rib Depth = 16 in.		Total Slab Depth = 5 in.													
28'-0"	50	2.24	14	0.640		8-#6+ 0	6	#4	#5	8-#6	8	#4	#5	12-#5	157	314	423
D = 10.417	100	2.31	14	0.640		8-#6+ 0	6	#4	#5	7-#7	8	#4	#5	12-#5	190	380	511
RIB NOT ON	150	2.44	14	0.640		8-#6+ 0	6	#5	#5	8-#7	8	#4	#5	12-#5	223	459	599
COLUMN LINE	200	2.61	14	0.640		8-#6+ 1	6	#5	#6	7-#8	8	#4	#5	12-#5	255	573	688
1.118 CF/SF	300	2.99	14	0.784		8-#6+ 3	6	#6	#7	7-#9	8	#4	#5	12-#5	321	785	864
	400	3.53	14 *	0.641		7-#7+ 0	6	#7	#7	9-#9	8	#5	#5	12-#5	386	991	1040
	500	4.19	14 *	0.641		8-#7+ 2	6	#8	#8	11-#9	8	#5	#6	12-#5	452	1193	1217
30'-0"	50	2.32	15	0.639		9-#6+ 0	6	#4	#5	7-#7	9	#4	#5	14-#5	192	385	518
D = 10.417	100	2.47	15	0.639		9-#6+ 0	6	#5	#5	7-#8	9	#4	#5	14-#5	233	465	626
RIB NOT ON	150	2.62	15	0.639		9-#6+ 0	6	#5	#6	8-#8	9	#4	#5	14-#5	273	557	735
COLUMN LINE	200	2.83	15	0.693		9-#6+ 1	6	#6	#6	7-#9	9	#4	#5	14-#5	313	697	843
1.107 CF/SF	300	3.34	15 *	0.835		7-#7+ 2	6	#7	#7	9-#9	9	#4	#5	14-#5	394	958	1060
	400	4.12	15 *	0.640		12-#6+ 1	6	#8	#8	11-#9	9	#5	#6	14-#5	474	1210	1277
32'-0"	50	2.36	16	0.638		10-#6+ 0	7	#4	#5	9-#7	9	#4	#5	14-#5	235	471	634
D = 12.417	100	2.52	16	0.638		10-#6+ 0	7	#5	#5	11-#7	9	#4	#5	14-#5	284	568	765
RIB ON	150	2.72	16	0.658		10-#6+ 0	7	#5	#6	10-#8	9	#4	#5	14-#5	333	673	897
COLUMN LINE	200	2.94	16 *	0.765		10-#6+ 2	7	#6	#6	9-#9	9	#4	#5	14-#5	382	844	1029
1.128 CF/SF	300	3.62	16 *	0.639		12-#6+ 3	7	#7	#7	11-#9	9	#5	#5	14-#5	480	1161	1292
	400	4.46	17 *	0.637		11-#7+ 3	7	#8	#8	14-#9	9	#6	#6	14-#5	576	1463	1551
34'-0"	50	2.48	17	0.636		10-#6+ 0	7	#5	#5	11-#7	10	#4	#5	15-#5	281	562	757
D = 12.417	100	2.66	17	0.636		10-#6+ 0	7	#5	#6	10-#8	10	#4	#5	15-#5	340	679	915
RIB ON	150	2.95	17	0.730		10-#6+ 2	7	#6	#6	9-#9	10	#4	#5	15-#5	398	797	1072
COLUMN LINE	200	3.24	17 *	0.850		12-#6+ 5	7	#6	#7	11-#9	10	#4	#5	15-#5	457	997	1230
1.116 CF/SF	300	4.21	17 *	0.637		11-#7+ 3	7	#8	#8	14-#9	10	#5	#6	15-#5	574	1377	1546
36'-0"	50	2.63	18	0.635		11-#6+ 1	7	#5	#6	10-#8	11	#4	#5	16-#5	332	665	895
D = 12.417	100	2.90	18	0.728		11-#6+ 3	7	#6	#6	9-#9	11	#4	#5	16-#5	402	804	1083
RIB ON	150	3.16	18 *	0.822		12-#6+ 5	7	#6	#7	11-#9	11	#4	#5	16-#5	472	943	1270
COLUMN LINE	200	3.48	18 *	0.884		10-#7+ 4	7	#7	#7	16-#8	11	#4	#5	16-#5	541	1164	1457
1.107 CF/SF																	
38'-0"	50	2.71	19	0.651		12-#6+ 1	8	#5	#6	12-#8	11	#4	#5	16-#5	394	787	1060
D = 14.417	100	2.95	19 *	0.773		12-#6+ 4	8	#6	#6	11-#9	11	#4	#5	16-#5	475	951	1280
RIB NOT ON	150	3.30	19 *	0.875		10-#7+ 6	8	#6	#7	13-#9	11	#4	#5	16-#5	557	1115	1501
COLUMN LINE	200	3.87	19 *	0.635		12-#7+ 3	8	#7	#8	15-#9	11	#5	#5	16-#5	639	1356	1721
1.124 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 21 in.			Rib Depth = 16 in.				Total Slab Depth = 5 in.			
2.24	14		6	#4	#5	8-#6	8	#4	#5	12-#5
2.31	14		6	#4	#5	9-#6	8	#4	#5	12-#5
2.41	14		6	#4	#5	8-#7	8	#4	#5	12-#5
2.53	14		6	#4	#5	7-#8	8	#4	#5	12-#5
2.79	14	4 S 6 1	6	#5	#5	11-#7	8	#4	#5	12-#5
3.25	14 *	4 S 6 1	6	#6	#6	8-#9	8	#4	#5	12-#5
3.70	14 *	4 S 6 2	6	#6	#7	10-#9	8	#4	#5	12-#5
2.32	15		6	#4	#5	9-#6	9	#4	#5	14-#5
2.41	15		6	#4	#5	8-#7	9	#4	#5	14-#5
2.52	15		6	#4	#5	7-#8	9	#4	#5	14-#5
2.70	15		6	#5	#5	8-#8	9	#4	#5	14-#5
3.20	15 *	4 S 6 1	6	#6	#6	8-#9	9	#4	#5	14-#5
3.63	15 *	4 S 6 2	6	#6	#7	10-#9	9	#4	#5	14-#5
2.36	16		7	#4	#5	11-#6	9	#4	#5	14-#5
2.48	16		7	#4	#5	10-#7	9	#4	#5	14-#5
2.62	16		7	#4	#5	9-#8	9	#4	#5	14-#5
2.82	16		7	#5	#5	10-#8	9	#4	#5	14-#5
3.37	16 *	4 S 6 1	7	#6	#6	10-#9	9	#4	#5	14-#5
3.85	16 *	4 S 6 2	7	#6	#7	16-#8	9	#4	#5	14-#5
2.44	17		7	#4	#5	10-#7	10	#4	#5	15-#5
2.58	17		7	#4	#5	9-#8	10	#4	#5	15-#5
2.91	17		7	#5	#5	9-#9	10	#4	#5	15-#5
3.14	17	4 S 6 1	7	#5	#6	10-#9	10	#4	#5	15-#5
3.73	17 *	4 S 6 2	7	#6	#7	16-#8	10	#4	#5	15-#5
2.54	18		7	#4	#5	9-#8	11	#4	#5	16-#5
2.86	18		7	#5	#5	9-#9	11	#4	#5	16-#5
3.07	18	4 S 6 1	7	#5	#6	10-#9	11	#4	#5	16-#5
3.41	18 *	4 S 6 1	7	#6	#6	12-#9	11	#4	#5	16-#5
2.63	19		8	#4	#5	11-#8	11	#4	#5	16-#5
2.86	19		8	#5	#5	10-#9	11	#4	#5	16-#5
3.21	19 *	4 S 6 1	8	#5	#6	12-#9	11	#4	#5	16-#5
3.55	19 *	4 S 6 1	8	#6	#6	14-#9	11	#4	#5	16-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 11 in.	Rib Depth = 8 in.	Total Slab Depth = 3 in.															
15'-0"	50	1.82	12	0.629		6-#5+ 0	3	#4	#4	6-#5	3	#4	#4	8-#5	14	28	37
D = 5.500	100	1.82	12	0.629		6-#5+ 0	3	#4	#4	6-#5	3	#4	#4	8-#5	19	40	50
RIB ON	150	1.82	12	0.629		6-#5+ 0	3	#4	#4	6-#5	3	#4	#4	8-#5	23	55	63
COLUMN LINE	200	1.82	12	0.629		6-#5+ 0	3	#4	#4	6-#5	3	#4	#4	8-#5	28	70	76
0.558 CF/SF	300	1.89	12	0.648		6-#5+ 0	3	#4	#5	6-#5	3	#4	#4	8-#5	38	99	101
	400	2.12	12	0.725		6-#5+ 0	3	#5	#5	5-#6	3	#4	#5	8-#5	47	128	127
17'-6"	50	1.75	12	0.629		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	8-#5	23	46	61
D = 8.000	100	1.75	12	0.629		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	8-#5	31	65	82
RIB NOT ON	150	1.75	12	0.659		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	8-#5	38	91	103
COLUMN LINE	200	1.83	12	0.704		7-#5+ 0	4	#4	#5	7-#5	3	#4	#4	8-#5	46	115	124
0.587 CF/SF	300	2.12	12 *	0.838		7-#5+ 2	4	#5	#5	9-#5	3	#5	#5	8-#5	62	162	166
	400	2.59	12 *	0.630		7-#5+ 1	4	#6	#6	8-#6	3	#5	#6	8-#5	77	209	207
20'-0"	50	1.76	12	0.657		8-#5+ 0	4	#4	#4	8-#5	4	#4	#4	10-#5	34	68	92
D = 8.000	100	1.76	12	0.708		8-#5+ 0	4	#4	#4	8-#5	4	#4	#4	10-#5	46	98	124
RIB NOT ON	150	1.85	12	0.759		8-#5+ 0	4	#4	#5	9-#5	4	#4	#4	10-#5	58	136	155
COLUMN LINE	200	2.20	12 *	0.831		8-#5+ 1	4	#5	#6	7-#6	4	#4	#5	10-#5	69	173	187
0.570 CF/SF	300	2.66	12 *	0.630		8-#5+ 1	4	#6	#7	10-#6	4	#5	#5	10-#5	93	244	250
	400	3.28	15 *	0.626		8-#5+ 2	4	#7	#7	18-#5	4	#6	#6	10-#5	114	306	308
22'-6"	50	1.85	12	0.755		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	12-#5	49	98	132
D = 8.000	100	1.91	12	0.824		10-#5+ 1	4	#4	#5	7-#6	5	#4	#4	12-#5	66	140	177
RIB NOT ON	150	2.17	12 *	0.882		10-#5+ 2	4	#5	#6	9-#6	5	#4	#4	12-#5	83	195	223
COLUMN LINE	200	2.56	12 *	0.630		10-#5+ 2	4	#6	#7	11-#6	5	#4	#5	12-#5	100	247	268
0.558 CF/SF	300	3.34	16 *	0.625		10-#5+ 1	4	#7	#8	15-#6	5	#5	#6	12-#5	131	339	352
25'-0"	50	1.79	12	0.838		11-#5+ 2	5	#4	#4	11-#5	5	#4	#4	12-#5	69	137	185
D = 10.500	100	2.01	12 *	0.902		11-#5+ 4	5	#5	#5	10-#6	5	#4	#4	12-#5	92	197	248
RIB ON	150	2.55	13 *	0.629		11-#5+ 1	5	#6	#6	18-#5	5	#5	#5	12-#5	115	272	309
COLUMN LINE	200	2.95	16 *	0.625		11-#5+ 2	5	#6	#7	15-#6	5	#5	#6	12-#5	137	341	368
0.578 CF/SF																	
27'-6"	50	1.97	13 *	0.866		12-#5+ 3	5	#5	#5	10-#6	6	#4	#4	14-#5	91	181	244
D = 10.500	100	2.25	13 *	0.933		12-#5+ 6	5	#5	#6	14-#6	6	#4	#4	14-#5	122	252	328
RIB ON	150	2.91	17 *	0.624		12-#5+ 4	5	#7	#7	17-#6	6	#5	#5	14-#5	151	349	407
COLUMN LINE																	
0.567 CF/SF																	
30'-0"	50	2.18	15 *	0.870		9-#6+ 3	5	#5	#6	18-#5	7	#4	#4	16-#5	117	233	314
D = 10.500	100	2.63	17 *	0.921		9-#6+ 6	5	#6	#7	18-#6	7	#4	#5	16-#5	156	312	420
RIB ON																	
COLUMN LINE																	
0.558 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 11 in.	Rib Depth = 8 in.	Total Slab Depth = 3 in.								
1.87	12		3	#4	#4	6-#5	3	#4	#4	8-#5
1.87	12		3	#4	#4	6-#5	3	#4	#4	8-#5
1.87	12		3	#4	#4	6-#5	3	#4	#4	8-#5
1.87	12		3	#4	#4	6-#5	3	#4	#4	8-#5
1.87	12		3	#4	#4	6-#5	3	#4	#4	8-#5
2.01	12	3 S 4 1	3	#4	#5	6-#5	3	#4	#4	8-#5
1.78	12		4	#4	#4	7-#5	3	#4	#4	8-#5
1.78	12		4	#4	#4	7-#5	3	#4	#4	8-#5
1.78	12		4	#4	#4	7-#5	3	#4	#4	8-#5
1.78	12		4	#4	#4	7-#5	3	#4	#4	8-#5
1.92	12		4	#4	#4	9-#5	3	#4	#4	8-#5
2.29	12 *	3 S 4 1	4	#4	#5	8-#6	3	#4	#5	8-#5
1.81	12		4	#4	#4	8-#5	4	#4	#4	10-#5
1.81	12		4	#4	#4	8-#5	4	#4	#4	10-#5
1.81	12		4	#4	#4	8-#5	4	#4	#4	10-#5
2.06	12		4	#4	#5	7-#6	4	#4	#4	10-#5
2.34	12 *	3 S 4 1	4	#5	#5	9-#6	4	#4	#4	10-#5
2.96	13 *	3 S 4 1	4	#6	#6	12-#6	4	#4	#5	10-#5
1.92	12		4	#4	#4	7-#6	5	#4	#4	12-#5
1.92	12		4	#4	#4	7-#6	5	#4	#4	12-#5
2.08	12	3 S 4 1	4	#4	#5	8-#6	5	#4	#4	12-#5
2.32	12 *	3 S 4 1	4	#5	#5	10-#6	5	#4	#4	12-#5
3.01	13 *	3 S 4 1	4	#6	#6	14-#6	5	#4	#5	12-#5
1.84	12		5	#4	#4	11-#5	5	#4	#4	12-#5
1.93	12		5	#4	#4	9-#6	5	#4	#4	12-#5
2.34	12 *	3 S 4 1	5	#5	#5	12-#6	5	#4	#4	12-#5
2.71	12 *	3 S 4 1	5	#5	#6	14-#6	5	#4	#5	12-#5
1.91	13		5	#4	#4	9-#6	6	#4	#4	14-#5
2.21	13 *	3 S 4 1	5	#4	#5	18-#5	6	#4	#4	14-#5
2.64	13 *	3 S 4 1	5	#5	#6	16-#6	6	#4	#4	14-#5
2.14	15		5	#4	#5	12-#6	7	#4	#4	16-#5
2.46	15 *	3 S 4 1	5	#5	#5	23-#5	7	#4	#4	16-#5

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 13 in.	Rib Depth = 10 in.	Total Slab Depth = 3 in.															
17'-6"	50	1.75	12	0.633		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	8-#5	25	50	67
D = 8.000	100	1.75	12	0.633		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	8-#5	33	69	88
RIB NOT ON	150	1.75	12	0.633		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	8-#5	40	95	109
COLUMN LINE	200	1.75	12	0.633		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	8-#5	48	120	130
0.677 CF/SF	300	1.89	12	0.668		7-#5+ 0	4	#4	#5	8-#5	3	#4	#5	8-#5	64	167	172
	400	2.30	12	0.804		7-#5+ 2	4	#5	#6	7-#6	3	#5	#5	8-#5	79	215	213
	500	2.66	12 *	0.880		7-#5+ 3	4	#6	#6	8-#6	3	#5	#6	8-#5	95	261	255
20'-0"	50	1.84	12	0.633		9-#5+ 0	4	#4	#4	9-#5	4	#4	#4	10-#5	37	75	101
D = 8.000	100	1.84	12	0.653		9-#5+ 0	4	#4	#4	9-#5	4	#4	#4	10-#5	49	104	132
RIB NOT ON	150	1.90	12	0.695		9-#5+ 0	4	#4	#5	9-#5	4	#4	#4	10-#5	61	143	164
COLUMN LINE	200	1.97	12	0.736		9-#5+ 0	4	#5	#5	9-#5	4	#4	#4	10-#5	73	180	195
0.656 CF/SF	300	2.36	12 *	0.837		9-#5+ 1	4	#6	#6	12-#5	4	#4	#5	10-#5	96	252	259
	400	2.92	12 *	0.634		9-#5+ 0	4	#6	#7	15-#5	4	#5	#6	10-#5	120	323	322
	500	3.51	13 *	0.632		9-#5+ 1	4	#7	#8	13-#6	4	#6	#6	10-#5	142	392	383
22'-6"	50	1.85	12	0.681		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	12-#5	53	107	144
D = 8.000	100	1.91	12	0.728		10-#5+ 0	4	#4	#5	7-#6	5	#4	#4	12-#5	70	148	190
RIB NOT ON	150	2.04	12	0.775		10-#5+ 0	4	#5	#5	8-#6	5	#4	#4	12-#5	87	204	235
COLUMN LINE	200	2.37	12 *	0.823		10-#5+ 0	4	#6	#6	9-#6	5	#4	#5	12-#5	104	257	281
0.641 CF/SF	300	2.90	12 *	0.634		10-#5+ 0	4	#7	#7	18-#5	5	#5	#5	12-#5	138	362	372
	400	3.60	15 *	0.630		7-#6+ 2	4	#8	#8	16-#6	5	#5	#6	12-#5	170	459	457
25'-0"	50	1.79	12	0.742		11-#5+ 0	5	#4	#4	11-#5	5	#4	#4	12-#5	75	150	202
D = 10.500	100	1.87	12	0.812		11-#5+ 1	5	#4	#5	12-#5	5	#4	#4	12-#5	99	208	265
RIB ON	150	2.25	12 *	0.871		11-#5+ 2	5	#5	#6	11-#6	5	#4	#5	12-#5	122	286	328
COLUMN LINE	200	2.57	12 *	0.634		11-#5+ 2	5	#6	#6	13-#6	5	#5	#5	12-#5	145	360	391
0.666 CF/SF	300	3.51	16 *	0.628		12-#5+ 2	5	#7	#8	17-#6	5	#6	#6	12-#5	189	492	508
27'-6"	50	1.86	13	0.799		12-#5+ 2	5	#4	#5	12-#5	6	#4	#4	14-#5	99	199	267
D = 10.500	100	2.17	13 *	0.870		12-#5+ 4	5	#5	#6	12-#6	6	#4	#4	14-#5	130	269	351
RIB ON	150	2.60	13 *	0.925		12-#5+ 6	5	#6	#7	15-#6	6	#4	#5	14-#5	162	374	435
COLUMN LINE	200	3.14	15 *	0.630		12-#5+ 2	5	#7	#7	18-#6	6	#5	#6	14-#5	192	468	516
0.652 CF/SF	300	3.90	21 *	0.624	3 S 4 1	15-#5+ 4	5	#8	#8	23-#6	6	#6	#6	14-#5	245	599	661
30'-0"	50	2.05	15	0.803		9-#6+ 2	5	#5	#5	11-#6	7	#4	#4	16-#5	128	255	343
D = 10.500	100	2.38	15 *	0.884		9-#6+ 4	5	#6	#6	15-#6	7	#4	#4	16-#5	168	336	452
RIB ON	150	2.93	16 *	0.628		9-#6+ 4	5	#7	#7	19-#6	7	#5	#5	16-#5	208	459	559
COLUMN LINE	200	3.58	20 *	0.625	3 S 4 1	15-#5+ 4	5	#8	#8	23-#6	7	#5	#6	16-#5	245	576	659
0.641 CF/SF																	
32'-6"	50	2.20	16 *	0.852		14-#5+ 6	6	#5	#6	15-#6	7	#4	#4	16-#5	164	328	442
D = 13.000	100	2.56	16 *	0.924		14-#5+10	6	#6	#6	20-#6	7	#4	#5	16-#5	215	431	580
RIB NOT ON	150	3.31	20 *	0.625		12-#6+ 4	6	#7	#7	25-#6	7	#5	#6	16-#5	264	571	710
COLUMN LINE																	
0.660 CF/SF																	
35'-0"	50	2.40	17 *	0.880		15-#5+ 8	6	#6	#6	19-#6	8	#4	#4	18-#5	204	408	549
D = 13.000	100	3.01	20 *	0.915		12-#6+ 8	6	#7	#7	25-#6	8	#5	#5	18-#5	266	532	716
RIB NOT ON	150	3.63	28 *	0.619		14-#6+ 4	6	#7	#8	31-#6	8	#5	#6	18-#5	320	639	861
COLUMN LINE																	
0.650 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 13 in.	Rib Depth = 10 in.	Total Slab Depth = 3 in.								
1.78	12		4	#4	#4	7-#5	3	#4	#4	8-#5
1.78	12		4	#4	#4	7-#5	3	#4	#4	8-#5
1.78	12		4	#4	#4	7-#5	3	#4	#4	8-#5
1.78	12		4	#4	#4	7-#5	3	#4	#4	8-#5
1.78	12		4	#4	#4	7-#5	3	#4	#4	8-#5
2.04	12		4	#4	#5	9-#5	3	#4	#4	8-#5
2.42	12 *	3 S 4 1	4	#5	#5	8-#6	3	#4	#5	8-#5
1.88	12		4	#4	#4	9-#5	4	#4	#4	10-#5
1.88	12		4	#4	#4	9-#5	4	#4	#4	10-#5
1.88	12		4	#4	#4	9-#5	4	#4	#4	10-#5
1.88	12		4	#4	#4	9-#5	4	#4	#4	10-#5
2.13	12	3 S 4 1	4	#4	#5	8-#6	4	#4	#4	10-#5
2.65	12 *	3 S 4 1	4	#5	#6	10-#6	4	#4	#5	10-#5
3.11	12 *	3 S 4 1	4	#6	#6	12-#6	4	#5	#5	10-#5
1.92	12		4	#4	#4	7-#6	5	#4	#4	12-#5
1.92	12		4	#4	#4	7-#6	5	#4	#4	12-#5
2.02	12		4	#4	#5	7-#6	5	#4	#4	12-#5
2.20	12	3 S 4 1	4	#5	#5	12-#5	5	#4	#4	12-#5
2.61	12 *	3 S 4 1	4	#5	#6	12-#6	5	#4	#4	12-#5
3.27	12 *	3 S 4 2	4	#6	#7	15-#6	5	#4	#5	12-#5
1.84	12		5	#4	#4	11-#5	5	#4	#4	12-#5
1.84	12		5	#4	#4	11-#5	5	#4	#4	12-#5
2.10	12		5	#4	#5	10-#6	5	#4	#4	12-#5
2.34	12 *	3 S 4 1	5	#5	#5	12-#6	5	#4	#4	12-#5
3.14	13 *	3 S 4 1	5	#6	#6	16-#6	5	#5	#5	12-#5
1.86	13		5	#4	#4	12-#5	6	#4	#4	14-#5
2.09	13		5	#4	#5	15-#5	6	#4	#4	14-#5
2.40	13 *	3 S 4 1	5	#5	#5	14-#6	6	#4	#4	14-#5
2.89	13 *	3 S 4 1	5	#6	#6	23-#5	6	#4	#5	14-#5
3.58	17 *	3 S 4 2	5	#6	#7	22-#6	6	#5	#5	14-#5
2.06	15		5	#4	#5	15-#5	7	#4	#4	16-#5
2.34	15	3 S 4 1	5	#5	#5	14-#6	7	#4	#4	16-#5
2.68	15 *	3 S 4 1	5	#5	#6	18-#6	7	#4	#4	16-#5
3.29	15 *	3 S 4 2	5	#6	#7	22-#6	7	#4	#5	16-#5
2.15	16		6	#4	#5	14-#6	7	#4	#4	16-#5
2.46	16 *		6	#5	#5	18-#6	7	#4	#4	16-#5
3.09	16 *	3 S 4 1	6	#6	#6	23-#6	7	#4	#5	16-#5
2.37	17		6	#5	#5	17-#6	8	#4	#4	18-#5
2.77	17 *	3 S 4 1	6	#5	#6	23-#6	8	#4	#4	18-#5
3.45	21 *	3 S 4 1	6	#6	#7	29-#6	8	#4	#5	18-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 15 in.	Rib Depth = 12 in.	Total Slab Depth = 3 in.																Total Depth = 15 in.	Rib Depth = 12 in.	Total Slab Depth = 3 in.								
20'-0"	50	1.84	12	0.636		9-#5+ 0	4	#4	#4	9-#5	4	#4	#4	10-#5	41	82	110	1.88	12		4	#4	#4	9-#5	4	#4	#4	10-#5
D = 8.000	100	1.84	12	0.636		9-#5+ 0	4	#4	#4	9-#5	4	#4	#4	10-#5	53	108	141	1.88	12		4	#4	#4	9-#5	4	#4	#4	10-#5
RIB NOT ON	150	1.84	12	0.636		9-#5+ 0	4	#4	#4	9-#5	4	#4	#4	10-#5	64	148	173	1.88	12		4	#4	#4	9-#5	4	#4	#4	10-#5
COLUMN LINE	200	1.90	12	0.639		9-#5+ 0	4	#4	#5	9-#5	4	#4	#4	10-#5	76	186	205	1.88	12		4	#4	#4	9-#5	4	#4	#4	10-#5
0.745 CF/SF	300	2.22	12	0.716		9-#5+ 0	4	#5	#6	7-#6	4	#4	#5	10-#5	99	259	268	2.06	12		4	#4	#5	7-#6	4	#4	#4	10-#5
	400	2.52	12 *	0.814		9-#5+ 1	4	#6	#6	9-#6	4	#5	#5	10-#5	123	331	331	2.27	12	4 S 6 1	4	#5	#5	12-#5	4	#4	#4	10-#5
	500	3.03	12 *	0.637		9-#5+ 1	4	#7	#7	11-#6	4	#5	#6	10-#5	146	402	394	2.65	12 *	4 S 6 1	4	#5	#6	10-#6	4	#4	#5	10-#5
22'-6"	50	1.85	12	0.636		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	12-#5	58	117	157	1.92	12		4	#4	#4	7-#6	5	#4	#4	12-#5
D = 8.000	100	1.85	12	0.645		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	12-#5	75	155	202	1.92	12		4	#4	#4	7-#6	5	#4	#4	12-#5
RIB NOT ON	150	1.97	12	0.689		10-#5+ 0	4	#5	#5	7-#6	5	#4	#4	12-#5	92	212	248	1.92	12		4	#4	#4	7-#6	5	#4	#4	12-#5
COLUMN LINE	200	2.11	12	0.733		10-#5+ 0	4	#5	#6	8-#6	5	#4	#4	12-#5	109	266	293	2.02	12		4	#4	#5	7-#6	5	#4	#4	12-#5
0.727 CF/SF	300	2.63	12 *	0.838		10-#5+ 1	4	#6	#7	11-#6	5	#4	#5	12-#5	143	372	384	2.47	12	4 S 6 1	4	#5	#6	10-#6	5	#4	#4	12-#5
	400	3.27	12 *	0.637		10-#5+ 1	4	#7	#8	14-#6	5	#5	#6	12-#5	177	475	475	2.90	12 *	4 S 6 1	4	#6	#6	18-#5	5	#4	#5	12-#5
	500	3.80	14 *	0.634		8-#6+ 2	4	#8	#8	16-#6	5	#6	#6	12-#5	209	573	562	3.44	12 *	4 S 6 2	4	#6	#7	15-#6	5	#5	#5	12-#5
25'-0"	50	1.79	12	0.670		11-#5+ 0	5	#4	#4	11-#5	5	#4	#4	12-#5	82	164	221	1.84	12		5	#4	#4	11-#5	5	#4	#4	12-#5
D = 10.500	100	1.86	12	0.720		11-#5+ 0	5	#4	#5	11-#5	5	#4	#4	12-#5	105	218	284	1.84	12		5	#4	#4	11-#5	5	#4	#4	12-#5
RIB ON	150	2.01	12	0.788		11-#5+ 1	5	#5	#5	10-#6	5	#4	#4	12-#5	129	298	347	1.93	12		5	#4	#4	9-#6	5	#4	#4	12-#5
COLUMN LINE	200	2.35	12 *	0.857		11-#5+ 3	5	#6	#6	16-#5	5	#4	#5	12-#5	152	373	410	2.13	12		5	#4	#5	15-#5	5	#4	#4	12-#5
0.756 CF/SF	300	3.05	12 *	0.637		11-#5+ 3	5	#7	#7	15-#6	5	#5	#6	12-#5	199	518	536	2.71	12 *	4 S 6 1	5	#5	#6	14-#6	5	#4	#5	12-#5
	400	3.80	15 *	0.633		9-#6+ 2	5	#7	#8	19-#6	5	#6	#7	12-#5	243	655	655	3.43	12 *	4 S 6 1	5	#6	#7	18-#6	5	#5	#5	12-#5
	500	4.24	19 *	0.628	4 S 6 1	10-#6+ 1	5	#8	#8	22-#6	5	#6	#7	12-#5	280	741	755	3.96	17 *	4 S 6 2	5	#7	#7	21-#6	5	#5	#6	12-#5
27'-6"	50	1.86	13	0.698		12-#5+ 0	5	#4	#5	12-#5	6	#4	#4	14-#5	108	216	291	1.86	13		5	#4	#4	12-#5	6	#4	#4	14-#5
D = 10.500	100	2.00	13	0.755		12-#5+ 0	5	#5	#5	15-#5	6	#4	#4	14-#5	139	283	375	1.96	13		5	#4	#4	10-#6	6	#4	#4	14-#5
RIB ON	150	2.42	13 *	0.838		12-#5+ 2	5	#6	#6	13-#6	6	#4	#5	14-#5	171	390	459	2.28	13		5	#5	#5	12-#6	6	#4	#4	14-#5
COLUMN LINE	200	2.75	13 *	0.906		12-#5+ 5	5	#6	#7	16-#6	6	#5	#5	14-#5	202	489	543	2.52	13 *	4 S 6 1	5	#5	#6	14-#6	6	#4	#4	14-#5
0.740 CF/SF	300	3.77	16 *	0.631		10-#6+ 3	5	#8	#8	21-#6	6	#6	#6	14-#5	262	677	704	3.39	13 *	4 S 6 1	5	#6	#7	19-#6	6	#5	#5	14-#5
	400	4.39	21 *	0.626	4 S 6 1	12-#6+ 2	5	#8	#9	25-#6	6	#6	#7	14-#5	314	809	846	3.99	17 *	4 S 6 2	5	#7	#7	24-#6	6	#5	#6	14-#5
30'-0"	50	1.97	15	0.691		9-#6+ 0	5	#5	#5	10-#6	7	#4	#4	16-#5	139	278	374	1.93	15		5	#4	#4	10-#6	7	#4	#4	16-#5
D = 10.500	100	2.21	15 *	0.782		9-#6+ 1	5	#5	#6	14-#6	7	#4	#4	16-#5	179	358	483	2.17	15		5	#4	#5	18-#5	7	#4	#4	16-#5
RIB ON	150	2.68	15 *	0.868		9-#6+ 3	5	#6	#7	17-#6	7	#4	#5	16-#5	220	486	591	2.57	15 *	4 S 6 1	5	#5	#6	16-#6	7	#4	#4	16-#5
COLUMN LINE	200	3.16	15 *	0.633		10-#6+ 3	5	#7	#8	21-#6	7	#5	#5	16-#5	260	614	700	2.86	15 *	4 S 6 1	5	#6	#6	19-#6	7	#4	#4	16-#5
0.727 CF/SF	300	4.15	21 *	0.626	4 S 6 1	18-#5+ 2	5	#8	#9	27-#6	7	#6	#6	16-#5	332	819	895	3.79	17 *	4 S 6 2	5	#7	#7	25-#6	7	#5	#5	16-#5
32'-6"	50	2.02	16	0.759		14-#5+ 2	6	#5	#5	14-#6	7	#4	#4	16-#5	179	358	482	1.97	16		6	#4	#4	18-#5	7	#4	#4	16-#5
D = 13.000	100	2.48	16 *	0.858		14-#5+ 6	6	#6	#6	18-#6	7	#4	#5	16-#5	230	460	620	2.36	16		6	#5	#5	16-#6	7	#4	#4	16-#5
RIB NOT ON	150	2.97	16 *	0.631		15-#5+ 5	6	#7	#7	22-#6	7	#5	#5	16-#5	281	614	758	2.69	16 *	4 S 6 1	6	#5	#6	20-#6	7	#4	#4	16-#5
COLUMN LINE	200	3.62	19 *	0.628		12-#6+ 5	6	#7	#8	26-#6	7	#6	#6	16-#5	330	769	889	3.28	16 *	4 S 6 1	6	#6	#7	24-#6	7	#4	#5	16-#5
0.749 CF/SF																												
35'-0"	50	2.30	17 *	0.823		15-#5+ 6	6	#6	#6	17-#6	8	#4	#4	18-#5	222	445	598	2.21	17		6	#4	#5	16-#6	8	#4	#4	18-#5
D = 13.000	100	2.76	17 *	0.901		15-#5+10	6	#6	#7	23-#6	8	#4	#5	18-#5	286	573	771	2.67	17 *	4 S 6 1	6	#5	#6	21-#6	8	#4	#4	18-#5
RIB NOT ON	150	3.43	20 *	0.627		13-#6+ 4	6	#7	#8	28-#6	8	#5	#6	18-#5	348	738	937	3.14	17 *	4 S 6 1	6	#6	#6	26-#6	8	#4	#5	18-#5
COLUMN LINE	200	4.18	24 *	0.624		15-#6+ 4	6	#8	#9	33-#6	8	#6	#6	18-#5	406	901	1094	3.84	18 *	4 S 6 2	6	#7	#7	31-#6	8	#5	#5	18-#5
0.737 CF/SF																												
37'-6"	50	2.59	18 *	0.854		16-#5+ 8	6	#6	#7	21-#6	9	#4	#5	20-#5	272	545	733	2.44	18		6	#5	#5	20-#6	9	#4	#4	20-#5
D = 13.000	100	3.19	19 *	0.922		13-#6+ 9	6	#7	#8	28-#6	9	#5	#5	20-#5	350	701	944	2.93	18 *	4 S 6 1	6	#6	#6	26-#6	9	#4	#4	20-#5
RIB NOT ON	150	3.72	24 *	0.624		16-#6+ 3	6	#8	#8	34-#6	9	#5	#6	20-#5	424	868	1142	3.45	18 *	4 S 6 2	6	#6	#7	32-#6	9	#4	#5	20-#5
COLUMN LINE																												
0.727 CF/SF																												
40'-0"	50	2.75	20 *	0.874		18-#5+11	7	#6	#7	26-#6	9	#4	#5	20-#5	332	665	895	2.66	20 *		7	#5	#6	24-#6	9	#4	#4	20-#5
D = 15.500	100	3.50	23 *	0.915		16-#6+10	7	#7	#8	34-#6	9	#5	#6	20-#5	425	850	1144	3.23	20 *	4 S 6 1	7	#6	#6	32-#6	9	#4	#5	20-#5
RIB ON	150	4.12	32 *	0.620		19-#6+ 6	7	#8	#8	41-#6	9	#6	#6	20-#5	505	1009	1359	3.85	24 *	4 S 6 2	7	#6	#7	39-#6	9	#5	#5	20-#5
COLUMN LINE																												
0.745 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	Square Edge Column γ_f	Square Edge Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 17 in.	Rib Depth = 14 in.	Total Slab Depth = 3 in.																Total Depth = 17 in.	Rib Depth = 14 in.	Total Slab Depth = 3 in.								
22'-6"	50	1.85	12	0.639		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	12-#5	63	126	170	1.92	12		4	#4	#4	7-#6	5	#4	#4	12-#5
D = 8.000	100	1.85	12	0.639		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	12-#5	80	161	216	1.92	12		4	#4	#4	7-#6	5	#4	#4	12-#5
RIB NOT ON	150	1.91	12	0.639		10-#5+ 0	4	#4	#5	7-#6	5	#4	#4	12-#5	97	220	261	1.92	12		4	#4	#4	7-#6	5	#4	#4	12-#5
COLUMN LINE	200	2.02	12	0.641		10-#5+ 0	4	#5	#5	7-#6	5	#4	#4	12-#5	114	275	307	2.02	12		4	#4	#5	7-#6	5	#4	#4	12-#5
0.815 CF/SF	300	2.42	12	0.725		10-#5+ 0	4	#6	#6	10-#6	5	#4	#5	12-#5	148	381	398	2.27	12	4 S 6 1	4	#5	#5	9-#6	5	#4	#4	12-#5
	400	2.86	12 *	0.841		10-#5+ 2	4	#7	#7	12-#6	5	#5	#5	12-#5	182	485	489	2.56	12	4 S 6 1	4	#5	#6	11-#6	5	#4	#4	12-#5
	500	3.29	12 *	0.640		10-#5+ 1	4	#7	#8	14-#6	5	#5	#6	12-#5	215	587	580	2.95	12 *	4 S 6 1	4	#6	#6	13-#6	5	#4	#5	12-#5
25'-0"	50	1.79	12	0.639		11-#5+ 0	5	#4	#4	11-#5	5	#4	#4	12-#5	89	178	240	1.84	12		5	#4	#4	11-#5	5	#4	#4	12-#5
D = 10.500	100	1.79	12	0.640		11-#5+ 0	5	#4	#4	11-#5	5	#4	#4	12-#5	112	226	303	1.84	12		5	#4	#4	11-#5	5	#4	#4	12-#5
RIB ON	150	1.97	12	0.687		11-#5+ 0	5	#5	#5	9-#6	5	#4	#4	12-#5	136	308	366	1.87	12		5	#4	#4	12-#5	5	#4	#4	12-#5
COLUMN LINE	200	2.23	12	0.756		11-#5+ 1	5	#5	#6	10-#6	5	#4	#5	12-#5	159	384	429	2.10	12		5	#4	#5	10-#6	5	#4	#4	12-#5
0.848 CF/SF	300	2.89	12 *	0.874		11-#5+ 4	5	#6	#7	14-#6	5	#5	#6	12-#5	206	531	555	2.62	12 *		5	#5	#6	18-#5	5	#4	#5	12-#5
	400	3.50	12 *	0.640		11-#5+ 3	5	#7	#8	17-#6	5	#6	#6	12-#5	253	675	681	3.14	12 *	4 S 6 1	5	#6	#6	16-#6	5	#5	#5	12-#5
	500	4.04	14 *	0.637		10-#6+ 1	5	#8	#8	20-#6	5	#6	#7	12-#5	297	812	801	3.64	12 *	4 S 6 1	5	#6	#7	19-#6	5	#5	#6	12-#5
27'-6"	50	1.86	13	0.637		12-#5+ 0	5	#4	#5	12-#5	6	#4	#4	14-#5	117	235	316	1.86	13		5	#4	#4	12-#5	6	#4	#4	14-#5
D = 10.500	100	1.97	13	0.680		12-#5+ 0	5	#5	#5	10-#6	6	#4	#4	14-#5	149	297	400	1.91	13		5	#4	#4	9-#6	6	#4	#4	14-#5
RIB ON	150	2.19	13	0.753		12-#5+ 1	5	#5	#6	12-#6	6	#4	#4	14-#5	180	404	484	2.13	13		5	#4	#5	11-#6	6	#4	#4	14-#5
COLUMN LINE	200	2.53	13 *	0.829		12-#5+ 3	5	#6	#7	14-#6	6	#4	#5	14-#5	211	506	568	2.31	13		5	#5	#5	18-#5	6	#4	#4	14-#5
0.830 CF/SF	300	3.28	13 *	0.638		12-#5+ 3	5	#7	#8	26-#5	6	#5	#6	14-#5	273	701	736	2.96	13 *	4 S 6 1	5	#6	#6	17-#6	6	#4	#5	14-#5
	400	4.07	16 *	0.634	4 S 6 1	15-#5+ 4	5	#8	#9	23-#6	6	#6	#6	14-#5	333	884	895	3.66	13 *	4 S 6 1	5	#7	#7	21-#6	6	#5	#5	14-#5
	500	4.68	20 *	0.630	4 S 6 1	18-#5+ 2	5	#9	#9	27-#6	6	#6	#7	14-#5	384	1018	1034	4.26	17 *	4 S 6 2	5	#7	#8	25-#6	6	#5	#6	14-#5
30'-0"	50	1.95	15	0.634		9-#6+ 0	5	#5	#5	10-#6	7	#4	#4	16-#5	151	301	406	1.89	15		5	#4	#4	9-#6	7	#4	#4	16-#5
D = 10.500	100	2.18	15	0.681		9-#6+ 0	5	#5	#6	18-#5	7	#4	#4	16-#5	191	382	514	2.14	15		5	#4	#5	12-#6	7	#4	#4	16-#5
RIB ON	150	2.54	15 *	0.790		9-#6+ 2	5	#6	#7	15-#6	7	#4	#5	16-#5	231	507	623	2.34	15	4 S 6 1	5	#5	#5	14-#6	7	#4	#4	16-#5
COLUMN LINE	200	2.95	15 *	0.855		9-#6+ 3	5	#7	#7	18-#6	7	#5	#5	16-#5	272	638	731	2.75	15 *	4 S 6 1	5	#6	#6	17-#6	7	#4	#4	16-#5
0.815 CF/SF	300	3.91	16 *	0.634	4 S 6 1	11-#6+ 3	5	#8	#9	24-#6	7	#6	#6	16-#5	351	887	945	3.43	15 *	4 S 6 2	5	#7	#7	22-#6	7	#4	#5	16-#5
	400	4.82	21 *	0.629	4 S 6 1	14-#6+ 2	5	#9	#10	30-#6	7	#6	#7	16-#5	423	1089	1138	4.28	17 *	4 S 6 2	5	#7	#8	28-#6	7	#5	#6	16-#5
32'-6"	50	1.99	16	0.680		14-#5+ 1	6	#5	#5	18-#5	7	#4	#4	16-#5	194	388	523	1.95	16		6	#4	#4	12-#6	7	#4	#4	16-#5
D = 13.000	100	2.31	16	0.787		14-#5+ 4	6	#5	#6	16-#6	7	#4	#5	16-#5	245	491	661	2.22	16		6	#4	#5	15-#6	7	#4	#4	16-#5
RIB NOT ON	150	2.79	16 *	0.863		14-#5+ 7	6	#6	#7	20-#6	7	#5	#5	16-#5	297	642	799	2.59	16		6	#5	#6	26-#5	7	#4	#4	16-#5
COLUMN LINE	200	3.36	16 *	0.634		11-#6+ 3	6	#7	#8	24-#6	7	#5	#6	16-#5	348	810	937	3.03	16 *	4 S 6 1	6	#6	#6	22-#6	7	#4	#5	16-#5
0.840 CF/SF	300	4.40	21 *	0.629		15-#6+ 3	6	#8	#9	31-#6	7	#6	#7	16-#5	445	1114	1197	4.00	16 *	4 S 6 1	6	#7	#7	29-#6	7	#5	#6	16-#5
	400	5.02	26 *	0.625		18-#6+ 4	6	#9	#9	37-#6	7	#7	#7	17-#5	528	1222	1421	4.52	23 *	4 S 6 2	6	#7	#8	35-#6	7	#5	#6	16-#5

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 17 in.	Rib Depth = 14 in.	Total Slab Depth = 3 in.																Total Depth = 17 in.	Rib Depth = 14 in.	Total Slab Depth = 3 in.								
35'-0"	50	2.20	17	0.725		15-#5+ 2	6	#5	#6	16-#6	8	#4	#4	18-#5	241	482	649	2.18	17		6	#4	#5	15-#6	8	#4	#4	18-#5
D = 13.000	100	2.63	17 *	0.832		15-#5+ 6	6	#6	#7	21-#6	8	#4	#5	18-#5	305	611	822	2.46	17		6	#5	#5	19-#6	8	#4	#4	18-#5
RIB NOT ON	150	3.08	17 *	0.907		12-#6+ 6	6	#7	#7	25-#6	8	#5	#5	18-#5	369	782	995	2.89	17 *	4 S 6 1	6	#6	#6	23-#6	8	#4	#4	18-#5
COLUMN LINE	200	3.67	19 *	0.631		14-#6+ 4	6	#8	#8	30-#6	8	#5	#6	18-#5	431	986	1161	3.37	17 *	4 S 6 1	6	#6	#7	28-#6	8	#4	#5	18-#5
0.827 CF/SF	300	4.76	26 *	0.625		18-#6+ 4	6	#9	#9	38-#6	8	#6	#7	18-#5	544	1242	1463	4.39	21 *	4 S 6 2	6	#7	#8	36-#6	8	#5	#6	18-#5
37'-6"	50	2.38	18 *	0.763		16-#5+ 3	6	#6	#6	20-#6	9	#4	#4	20-#5	295	591	795	2.36	18		6	#5	#5	18-#6	9	#4	#4	20-#5
D = 13.000	100	2.87	18 *	0.877		12-#6+ 6	6	#7	#7	26-#6	9	#4	#5	20-#5	374	749	1008	2.73	18 *	4 S 6 1	6	#5	#6	24-#6	9	#4	#4	20-#5
RIB NOT ON	150	3.53	19 *	0.631		15-#6+ 3	6	#8	#8	31-#6	9	#5	#5	20-#5	452	931	1218	3.33	18 *	4 S 6 1	6	#6	#7	29-#6	9	#4	#5	20-#5
COLUMN LINE	200	4.32	23 *	0.627		17-#6+ 3	6	#9	#9	37-#6	9	#6	#6	20-#5	526	1176	1416	3.90	18 *	4 S 6 2	6	#7	#7	35-#6	9	#5	#5	20-#5
0.815 CF/SF																												
40'-0"	50	2.65	20 *	0.825		18-#5+ 9	7	#6	#7	24-#6	9	#4	#5	20-#5	361	721	971	2.50	20		7	#5	#5	23-#6	9	#4	#4	20-#5
D = 15.500	100	3.17	20 *	0.912		15-#6+10	7	#7	#7	31-#6	9	#5	#5	20-#5	456	912	1228	2.99	20 *	4 S 6 1	7	#6	#6	29-#6	9	#4	#4	20-#5
RIB ON	150	3.82	24 *	0.627		18-#6+ 4	7	#8	#8	38-#6	9	#5	#6	20-#5	547	1093	1472	3.53	20 *	4 S 6 1	7	#6	#7	36-#6	9	#4	#5	20-#5
COLUMN LINE	200	4.43	28 *	0.624		21-#6+ 5	7	#8	#9	45-#6	9	#6	#6	21-#5	633	1265	1704	4.10	22 *	4 S 6 2	7	#7	#7	42-#6	9	#5	#5	20-#5
0.835 CF/SF																												
42'-6"	50	2.88	21 *	0.851		14-#6+ 7	7	#7	#7	30-#6	10	#4	#5	22-#5	431	861	1160	2.72	21		7	#5	#6	27-#6	10	#4	#4	22-#5
D = 15.500	100	3.70	22 *	0.628		18-#6+ 4	7	#8	#8	38-#6	10	#5	#6	22-#5	544	1088	1465	3.41	21 *	4 S 6 1	7	#6	#7	35-#6	10	#4	#5	22-#5
RIB ON	150	4.34	28 *	0.624		22-#6+ 5	7	#8	#9	46-#6	10	#6	#6	22-#5	650	1301	1751	4.03	21 *	4 S 6 2	7	#7	#7	43-#6	10	#5	#5	22-#5
COLUMN LINE																												
0.825 CF/SF																												
45'-0"	50	3.23	22 *	0.889		17-#6+ 9	7	#7	#8	35-#6	11	#5	#5	24-#5	510	1019	1372	2.99	22 *	4 S 6 1	7	#6	#6	33-#6	11	#4	#4	24-#5
D = 15.500	100	3.99	26 *	0.625		21-#6+ 5	7	#8	#9	45-#6	11	#5	#6	24-#5	641	1282	1725	3.70	22 *	4 S 6 2	7	#7	#7	42-#6	11	#4	#5	24-#5
RIB ON	150	4.65	36 *	0.620	4 S 6 1	25-#6+ 6	7	#9	#9	54-#6	11	#6	#6	24-#5	751	1503	2023	4.34	28 *	4 S 6 2	7	#7	#8	50-#6	11	#5	#5	24-#5
COLUMN LINE																												
0.815 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 19 in.	Rib Depth = 16 in.	Total Slab Depth = 3 in.															
25'-0"	50	2.03	12	0.641		11-#5+ 0	5	#4	#5	11-#5	5	#4	#5	12-#5	96	192	259
D = 10.500	100	2.03	12	0.641		11-#5+ 0	5	#4	#5	11-#5	5	#4	#5	12-#5	120	239	322
RIB ON	150	2.04	12	0.641		11-#5+ 0	5	#4	#5	12-#5	5	#4	#5	12-#5	143	317	385
COLUMN LINE	200	2.18	12	0.646		11-#5+ 0	5	#5	#5	10-#6	5	#4	#5	12-#5	166	395	448
0.943 CF/SF	300	2.57	12	0.736		11-#5+ 0	5	#6	#6	12-#6	5	#5	#5	12-#5	213	544	574
	400	3.05	12 *	0.864		11-#5+ 3	5	#7	#7	15-#6	5	#5	#6	12-#5	260	689	700
	500	3.56	12 *	0.642		12-#5+ 3	5	#7	#8	18-#6	5	#6	#6	12-#5	307	832	826
27'-6"	50	2.04	13	0.640		12-#5+ 0	5	#4	#5	12-#5	6	#4	#5	14-#5	127	254	342
D = 10 .500	100	2.05	13	0.640		12-#5+ 0	5	#4	#5	9-#6	6	#4	#5	14-#5	158	316	426
RIB ON	150	2.26	13	0.652		12-#5+ 0	5	#5	#6	11-#6	6	#4	#5	14-#5	189	417	510
COLUMN LINE	200	2.47	13	0.726		12-#5+ 1	5	#6	#6	18-#5	6	#4	#5	14-#5	220	521	594
0.922 CF/SF	300	3.01	13 *	0.863		12-#5+ 5	5	#7	#7	17-#6	6	#5	#5	14-#5	283	718	762
	400	3.77	13 *	0.641		10-#6+ 1	5	#8	#8	21-#6	6	#6	#6	14-#5	345	911	929
	500	4.36	15 *	0.638	4 S 6 1	12-#6+ 2	5	#8	#9	25-#6	6	#6	#7	14-#5	405	1094	1090
30'-0"	50	2.07	15	0.637		9-# 6+ 0	5	#4	#5	9-#6	7	#4	#5	16-#5	163	326	438
D = 10.500	100	2.28	15	0.637		9-#6+ 0	5	#5	#6	12-#6	7	#4	#5	16-#5	203	406	547
RIB ON	150	2.48	15	0.662		9-#6+ 0	5	#6	#6	14-#6	7	#4	#5	16-#5	243	525	655
COLUMN LINE	200	2.82	15	0.772		9-#6+ 2	5	#7	#7	17-#6	7	#4	#5	16-#5	284	660	764
0.906 CF/SF	300	3.51	15 *	0.638		10-#6+ 1	5	#8	#8	22-#6	7	#5	#6	16-#5	364	913	981
	400	4.35	16 *	0.636	4 S 6 1	18-#5+ 3	5	#9	#9	27-#6	7	#6	#6	16-#5	444	1159	1194
	500	5.00	20 *	0.632	4 S 6 1	15-#6+ 1	5	#9	#10	32-#6	7	#6	#7	16-#5	515	1361	1386
32'-6"	50	2.14	16	0.635		14-#5+ 0	6	#5	#5	12-#6	7	#4	#5	16-#5	210	420	565
D = 13.000	100	2.33	16	0.695		14-#5+ 2	6	#5	#6	15-#6	7	#4	#5	16-#5	261	522	703
RIB NOT ON	150	2.57	16 *	0.791		14-#5+ 5	6	#6	#6	18-#6	7	#4	#5	16-#5	313	667	841
COLUMN LINE	200	3.11	16 *	0.861		15-#5+ 7	6	#7	#7	22-#6	7	#5	#6	16-#5	364	840	980
0.934 CF/SF	300	3.90	16 *	0.636		13-#6+ 2	6	#8	#8	28-#6	7	#6	#6	16-#5	466	1162	1256
	400	4.85	22 *	0.630		16-#6+ 3	6	#9	#9	34-#6	7	#7	#7	16-#5	557	1423	1499
	500	5.49	26 *	0.627		19-#6+ 2	6	#9	#10	40-#6	7	#7	#7	18-#5	641	1576	1726
35'-0"	50	2.30	17	0.634		15-#5+ 0	6	#5	#6	15-#6	8	#4	#5	18-#5	261	521	702
D = 13.000	100	2.56	17	0.757		15-#5+ 4	6	#6	#6	19-#6	8	#4	#5	18-#5	325	650	874
RIB NOT ON	150	3.01	17 *	0.845		11-#6+ 5	6	#7	#7	23-#6	8	#5	#5	18-#5	389	815	1047
COLUMN LINE	200	3.47	17 *	0.635		13-#6+ 2	6	#7	#8	27-#6	8	#5	#6	18-#5	453	1031	1220
0.919 CF/SF	300	4.64	21 *	0.631		17-#6+ 2	6	#9	#9	35-#6	8	#6	#7	18-#5	575	1418	1549
	400	5.29	27 *	0.627	4 S 6 1	20-#6+ 3	6	#9	#10	42-#6	8	#7	#7	19-#5	681	1605	1834

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 19 in.	Rib Depth = 16 in.	Total Slab Depth = 3 in.								
2.05	12		5	#4	#5	11-#5	5	#4	#5	12-#5
2.05	12		5	#4	#5	11-#5	5	#4	#5	12-#5
2.05	12		5	#4	#5	11-#5	5	#4	#5	12-#5
2.15	12		5	#4	#5	9-#6	5	#4	#5	12-#5
2.39	12		5	#5	#5	11-#6	5	#4	#5	12-#5
2.71	12 *	4 S 6 1	5	#5	#6	14-#6	5	#4	#5	12-#5
3.22	12 *	4 S 6 1	5	#6	#6	17-#6	5	#5	#5	12-#5
2.07	13		5	#4	#5	12-#5	6	#4	#5	14-#5
2.07	13		5	#4	#5	12-#5	6	#4	#5	14-#5
2.17	13		5	#4	#5	10-#6	6	#4	#5	14-#5
2.39	13		5	#5	#5	12-#6	6	#4	#5	14-#5
2.84	13	4 S 6 1	5	#6	#6	15-#6	6	#4	#5	14-#5
3.39	13 *	4 S 6 1	5	#6	#7	19-#6	6	#5	#5	14-#5
3.92	13 *	4 S 6 2	5	#7	#7	23-#6	6	#5	#6	14-#5
2.11	15		5	#4	#5	9-#6	7	#4	#5	16-#5
2.22	15		5	#4	#5	11-#6	7	#4	#5	16-#5
2.42	15		5	#5	#5	13-#6	7	#4	#5	16-#5
2.69	15	4 S 6 1	5	#5	#6	16-#6	7	#4	#5	16-#5
3.18	15 *	4 S 6 1	5	#6	#7	20-#6	7	#4	#5	16-#5
3.97	15 *	4 S 6 2	5	#7	#8	25-#6	7	#5	#5	16-#5
4.56	17 *	4 S 6 2	5	#8	#8	30-#6	7	#5	#6	16-#5
2.13	16		6	#4	#5	11-#6	7	#4	#5	16-#5
2.27	16		6	#4	#5	14-#6	7	#4	#5	16-#5
2.53	16		6	#5	#5	17-#6	7	#4	#5	16-#5
2.80	16 *		6	#5	#6	20-#6	7	#4	#5	16-#5
3.55	16 *	4 S 6 1	6	#6	#7	26-#6	7	#5	#5	16-#5
4.32	18 *	4 S 6 2	6	#7	#8	32-#6	7	#5	#6	16-#5
5.02	23 *	4 S 6 2	6	#8	#8	37-#6	7	#6	#6	17-#5
2.24	17		6	#4	#5	14-#6	8	#4	#5	18-#5
2.52	17		6	#5	#5	18-#6	8	#4	#5	18-#5
2.83	17	4 S 6 1	6	#5	#6	22-#6	8	#4	#5	18-#5
3.24	17 *	4 S 6 1	6	#6	#7	25-#6	8	#4	#5	18-#5
4.24	17 *	4 S 6 2	6	#7	#8	33-#6	8	#5	#6	18-#5
4.75	23 *	4 S 6 2	6	#8	#8	40-#6	8	#5	#6	18-#5

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 19 in.	Rib Depth = 16 in.	Total Slab Depth = 3 in.															
37'-6"	50	2.49	18	0.692		16-#5+ 2	6	#6	#6	19-#6	9	#4	#5	20-#5	319	638	859
D = 13.000	100	2.85	18 *	0.806		16-#5+ 6	6	#7	#7	24-#6	9	#4	#5	20-#5	398	796	1072
RIB NOT ON	150	3.30	18 *	0.904		14-#6+ 8	6	#7	#8	29-#6	9	#5	#5	20-#5	477	978	1285
COLUMN LINE	200	3.90	19 *	0.633		16-#6+ 3	6	#8	#9	34-#6	9	#5	#6	20-#5	555	1242	1494
0.906 CF/SF	300	5.04	26 *	0.627		29-#5+ 4	6	#9	#10	43-#6	9	#6	#7	20-#5	696	1605	1873
40'-0"	50	2.58	20	0.747		18-#5+ 5	7	#6	#6	23-#6	9	#4	#5	20-#5	390	780	1049
D = 15.500	100	3.09	20 *	0.856		14-#6+ 7	7	#7	#7	29-#6	9	#5	#5	20-#5	485	971	1307
RIB ON	150	3.56	20 *	0.632		17-#6+ 5	7	#7	#8	35-#6	9	#5	#6	20-#5	581	1162	1564
COLUMN LINE	200	4.29	23 *	0.630		20-#6+ 5	7	#8	#9	41-#6	9	#6	#6	20-#5	672	1453	1809
0.928 CF/SF	300	5.13	31 *	0.624	4 S 6 1	25-#6+ 5	7	#9	#9	52-#6	9	#6	#7	24-#5	835	1670	2248
42'-6"	50	2.89	21 *	0.804		13-#6+ 7	7	#7	#7	28-#6	10	#4	#5	22-#5	466	931	1253
D = 15.500	100	3.38	21 *	0.897		17-#6+ 9	7	#7	#8	35-#6	10	#5	#5	22-#5	580	1160	1562
RIB ON	150	4.03	23 *	0.630		20-#6+ 6	7	#8	#9	43-#6	10	#5	#6	22-#5	692	1384	1863
COLUMN LINE	200	4.63	28 *	0.626		33-#5+ 7	7	#9	#9	50-#6	10	#6	#6	23-#5	796	1624	2143
0.916 CF/SF																	
45'-0"	50	3.23	22 *	0.852		16-#6+ 9	7	#7	#8	33-#6	11	#5	#5	24-#5	551	1101	1483
D = 15.500	100	3.80	22 *	0.630		20-#6+ 6	7	#8	#8	42-#6	11	#5	#6	24-#5	687	1374	1850
RIB ON	150	4.54	28 *	0.626		24-#6+ 6	7	#9	#9	51-#6	11	#6	#6	24-#5	813	1627	2190
COLUMN LINE	200	5.16	33 *	0.623	4 S 6 1	28-#6+ 4	7	#9	#10	59-#6	11	#6	#7	27-#5	931	1862	2507
0.906 CF/SF																	
47'-6"	50	3.38	23 *	0.888		19-#6+11	8	#7	#8	40-#6	11	#5	#5	24-#5	654	1307	1760
D = 18.000	100	4.28	27 *	0.917		24-#6+14	8	#8	#9	50-#6	11	#6	#6	24-#5	808	1615	2175
RIB NOT ON	150	4.91	33 *	0.623		28-#6+ 7	8	#9	#9	60-#6	11	#6	#7	27-#5	952	1905	2564
COLUMN LINE																	
0.925 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 19 in.	Rib Depth = 16 in.	Total Slab Depth = 3 in.								
2.45	18		6	#5	#5	17-#6	9	#4	#5	20-#5
2.77	18	4 S 6 1	6	#5	#6	22-#6	9	#4	#5	20-#5
3.11	18 *	4 S 6 1	6	#6	#6	27-#6	9	#4	#5	20-#5
3.58	18 *	4 S 6 1	6	#7	#7	32-#6	9	#4	#5	20-#5
4.65	21 *	4 S 6 2	6	#8	#8	41-#6	9	#5	#6	20-#5
2.54	20		7	#5	#5	21-#6	9	#4	#5	20-#5
2.91	20		7	#5	#6	27-#6	9	#4	#5	20-#5
3.28	20 *	4 S 6 1	7	#6	#6	33-#6	9	#4	#5	20-#5
3.93	20*	4 S 6 1	7	#7	#7	38-#6	9	#5	#5	20-#5
4.80	26 *	4 S 6 2	7	#7	#8	49-#6	9	#5	#6	23-#5
2.80	21		7	#5	#6	26-#6	10	#4	#5	22-#5
3.19	21 *	4 S 6 1	7	#6	#6	33-#6	10	#4	#5	22-#5
3.72	21 *	4 S 6 1	7	#7	#7	40-#6	10	#4	#5	22-#5
4.30	22 *	4 S 6 2	7	#7	#8	46-#6	10	#5	#5	22-#5
3.05	22	4 S 6 1	7	#6	#6	31-#6	11	#4	#5	24-#5
3.59	22 *	4 S 6 1	7	#7	#7	39-#6	11	#4	#5	24-#5
4.22	22 *	4 S 6 2	7	#7	#8	47-#6	11	#5	#5	24-#5
4.70	26 *	4 S 6 2	7	#8	#8	55-#6	11	#5	#5	25-#5
3.19	23 *		8	#6	#6	37-#6	11	#4	#5	24-#5
3.94	23 *	4 S 6 1	8	#7	#7	46-#6	11	#5	#5	24-#5
4.50	25 *	4 S 6 2	8	#7	#8	56-#6	11	#5	#5	26-#5

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 23 in.		Rib Depth = 20 in.		Total Slab Depth = 3 in.													
30'-0"	50	2.35	15	0.641		9-#6+ 0	5	#5	#5	9-#6	7	#5	#5	16-#5	188	376	507
D = 10.500	100	2.39	15	0.641		9-#6+ 0	5	#5	#5	15-#5	7	#5	#5	16-#5	229	457	615
RIB ON	150	2.53	15	0.641		9-#6+ 0	5	#5	#6	18-#5	7	#5	#5	16-#5	269	558	724
COLUMN LINE	200	2.78	15	0.641		9-#6+ 0	5	#6	#7	15-#6	7	#5	#5	16-#5	309	697	832
1.094 CF/SF	300	3.21	15	0.655		9-#6+ 0	5	#7	#8	19-#6	7	#5	#5	16-#5	390	957	1049
	400	3.67	15 *	0.850		11-#6+ 3	5	#8	#8	23-#6	7	#5	#6	16-#5	470	1209	1266
	500	4.46	15 *	0.642	5 S 8 1	18-#5+ 1	5	#9	#9	27-#6	7	#6	#7	16-#5	551	1457	1483
32'-6"	50	2.33	16	0.640		14-#5+ 0	6	#5	#5	11-#6	7	#5	#5	16-#5	243	486	654
D = 13.000	100	2.42	16	0.640		14-#5+ 0	6	#5	#5	14-#6	7	#5	#5	16-#5	294	588	792
RIB NOT ON	150	2.66	16	0.640		14-#5+ 0	6	#6	#6	16-#6	7	#5	#5	16-#5	345	712	930
COLUMN LINE	200	2.92	16	0.642		14-#5+ 1	6	#6	#7	19-#6	7	#5	#5	16-#5	397	889	1068
1.128 CF/SF	300	3.44	16 *	0.841		16-#5+ 7	6	#7	#8	24-#6	7	#5	#6	16-#5	499	1221	1344
	400	4.32	16 *	0.641		14-#6+ 2	6	#8	#9	29-#6	7	#6	#7	16-#5	602	1542	1621
	500	5.13	17 *	0.639		17-#6+ 2	6	#9	#10	35-#6	7	#7	#7	16-#5	703	1853	1892
35'-0"	50	2.49	17	0.638		15-#5+ 0	6	#5	#6	14-#6	8	#5	#5	18-#5	301	603	811
D = 13.000	100	2.66	17	0.638		15-#5+ 0	6	#6	#6	17-#6	8	#5	#5	18-#5	366	731	984
RIB NOT ON	150	2.86	17	0.638		15-#5+ 1	6	#6	#7	21-#6	8	#5	#5	18-#5	430	873	1157
COLUMN LINE	200	3.17	17	0.738		11-#6+ 2	6	#7	#7	24-#6	8	#5	#5	18-#5	494	1096	1329
1.109 CF/SF	300	4.07	17 *	0.639		15-#6+ 1	6	#8	#9	30-#6	8	#6	#6	18-#5	622	1510	1675
	400	4.84	17 *	0.639		18-#6+ 2	6	#9	#10	37-#6	8	#6	#7	18-#5	750	1910	2020
	500	5.65	22 *	0.634		29-#5+ 2	6	#10	#10	43-#6	8	#7	#7	20-#5	863	2236	2324
37'-6"	50	2.63	18	0.637		16-#5+ 1	6	#6	#6	18-#6	9	#5	#5	20-#5	369	738	993
D = 13.000	100	2.89	18	0.637		16-#5+ 2	6	#6	#7	22-#6	9	#5	#5	20-#5	448	896	1206
RIB NOT ON	150	3.11	18	0.763		12-#6+ 4	6	#7	#7	26-#6	9	#5	#5	20-#5	527	1054	1419
COLUMN LINE	200	3.64	18 *	0.844		14-#6+ 5	6	#8	#8	30-#6	9	#5	#6	20-#5	606	1328	1631
1.094 CF/SF	300	4.43	18 *	0.638		18-#6+ 2	6	#9	#9	38-#6	9	#6	#6	20-#5	764	1837	2057
	400	5.50	23 *	0.633		22-#6+ 3	6	#10	#10	46-#6	9	#7	#7	21-#5	911	2301	2453
40'-0"	50	2.71	20	0.635		18-#5+ 2	7	#6	#6	22-#6	9	#5	#5	20-#5	451	902	1214
D = 15.500	100	2.98	20	0.720		18-#5+ 6	7	#6	#7	26-#6	9	#5	#5	20-#5	546	1093	1471
RIB ON	150	3.31	20 *	0.821		15-#6+ 6	7	#7	#7	31-#6	9	#5	#5	20-#5	642	1284	1728
COLUMN LINE	200	3.82	20 *	0.889		17-#6+ 8	7	#8	#8	36-#6	9	#5	#6	20-#5	737	1576	1985
1.121 CF/SF	300	4.98	22 *	0.634		22-#6+ 5	7	#9	#10	46-#6	9	#6	#7	21-#5	924	2181	2488
	400	6.02	28 *	0.630	5 S 8 1	26-#6+ 3	7	#10	#10	55-#6	9	#7	#8	25-#5	1090	2566	2934
42'-6"	50	2.93	21	0.634		13-#6+ 2	7	#6	#7	26-#6	10	#5	#5	22-#5	538	1076	1449
D = 15.500	100	3.25	21 *	0.790		15-#6+ 6	7	#7	#7	32-#6	10	#5	#5	22-#5	653	1306	1758
RIB ON	150	3.79	21 *	0.878		18-#6+ 9	7	#8	#8	38-#6	10	#5	#6	22-#5	768	1535	2067
COLUMN LINE	200	4.25	21 *	0.635		21-#6+ 3	7	#8	#9	44-#6	10	#6	#6	22-#5	882	1847	2375
1.107 CF/SF	300	5.60	27 *	0.630	5 S 8 1	26-#6+ 3	7	#10	#10	55-#6	10	#7	#7	25-#5	1098	2551	2955
45'-0"	50	3.17	22	0.733		15-#6+ 5	7	#7	#7	31-#6	11	#5	#5	24-#5	637	1273	1714
D = 15.500	100	3.60	22 *	0.850		18-#6+ 9	7	#8	#8	38-#6	11	#5	#5	24-#5	773	1546	2081
RIB ON	150	4.09	22 *	0.634		22-#6+ 5	7	#8	#9	45-#6	11	#5	#6	24-#5	909	1818	2448
COLUMN LINE	200	4.58	24 *	0.633		25-#6+ 4	7	#9	#9	52-#6	11	#6	#6	24-#5	1041	2127	2803
1.094 CF/SF																	
47'-6"	50	3.38	23 *	0.797		18-#6+ 7	8	#7	#8	37-#6	11	#5	#5	24-#5	756	1511	2035
D = 18.000	100	3.87	23 *	0.891		22-#6+11	8	#8	#8	45-#6	11	#5	#6	24-#5	916	1832	2466
RIB NOT ON	150	4.40	24 *	0.633		36-#5+ 8	8	#8	#9	54-#6	11	#6	#6	25-#5	1074	2149	2893
COLUMN LINE	200	5.17	29 *	0.629		29-#6+ 6	8	#9	#10	61-#6	11	#6	#7	28-#5	1223	2450	3292
1.117 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 23 in.			Rib Depth = 20 in.				Total Slab Depth = 3 in.			
2.38	15		5	#5	#5	9-#6	7	#5	#5	16-#5
2.42	15		5	#5	#5	10-#6	7	#5	#5	16-#5
2.53	15		5	#5	#5	12-#6	7	#5	#5	16-#5
2.64	15		5	#5	#5	14-#6	7	#5	#5	16-#5
3.05	15	5 S 8 1	5	#6	#6	17-#6	7	#5	#5	16-#5
3.43	15 *	5 S 8 1	5	#6	#7	21-#6	7	#5	#5	16-#5
3.97	15 *	5 S 8 2	5	#7	#8	25-#6	7	#5	#5	16-#5
2.36	16		6	#5	#5	15-#5	7	#5	#5	16-#5
2.46	16		6	#5	#5	18-#5	7	#5	#5	16-#5
2.60	16		6	#5	#5	15-#6	7	#5	#5	16-#5
2.86	16		6	#5	#6	18-#6	7	#5	#5	16-#5
3.19	16	5 S 8 1	6	#6	#6	22-#6	7	#5	#5	16-#5
3.90	16 *	5 S 8 1	6	#7	#7	27-#6	7	#5	#6	16-#5
4.52	16 *	5 S 8 2	6	#7	#8	32-#6	7	#6	#6	16-#5
2.47	17		6	#5	#5	13-#6	8	#5	#5	18-#5
2.60	17		6	#5	#5	16-#6	8	#5	#5	18-#5
2.76	17		6	#5	#5	19-#6	8	#5	#5	18-#5
3.12	17		6	#6	#6	22-#6	8	#5	#5	18-#5
3.68	17 *	5 S 8 1	6	#7	#7	28-#6	8	#5	#5	18-#5
4.27	17 *	5 S 8 2	6	#7	#8	34-#6	8	#5	#6	18-#5
5.15	19 *	5 S 8 2	6	#8	#9	40-#6	8	#6	#6	18-#5
2.58	18		6	#5	#5	16-#6	9	#5	#5	20-#5
2.86	18		6	#5	#6	20-#6	9	#5	#5	20-#5
3.04	18	5 S 8 1	6	#5	#6	24-#6	9	#5	#5	20-#5
3.42	18	5 S 8 1	6	#6	#7	27-#6	9	#5	#5	20-#5
4.07	18 *	5 S 8 2	6	#7	#8	35-#6	9	#5	#5	20-#5
4.93	18 *	5 S 8 2	6	#8	#9	43-#6	9	#5	#6	20-#5
2.66	20		7	#5	#5	20-#6	9	#5	#5	20-#5
2.95	20		7	#5	#6	24-#6	9	#5	#5	20-#5
3.28	20		7	#6	#6	29-#6	9	#5	#5	20-#5
3.59	20 *	5 S 8 1	7	#6	#7	33-#6	9	#5	#5	20-#5
4.45	20 *	5 S 8 2	7	#7	#8	43-#6	9	#5	#6	20-#5
5.47	24 *	5 S 8 2	7	#8	#9	51-#6	9	#6	#6	24-#5
2.90	21		7	#5	#6	24-#6	10	#5	#5	22-#5
3.22	21		7	#6	#6	29-#6	10	#5	#5	22-#5
3.58	21 *	5 S 8 1	7	#6	#7	35-#6	10	#5	#5	22-#5
3.90	21 *	5 S 8 1	7	#7	#7	40-#6	10	#5	#5	22-#5
5.06	21 *	5 S 8 2	7	#8	#9	52-#6	10	#5	#6	24-#5
3.16	22		7	#6	#6	29-#6	11	#5	#5	24-#5
3.51	22	5 S 8 1	7	#6	#7	35-#6	11	#5	#5	24-#5
3.88	22 *	5 S 8 1	7	#7	#7	42-#6	11	#5	#5	24-#5
4.25	22 *	5 S 8 2	7	#7	#8	48-#6	11	#5	#5	24-#5
3.25	23		8	#6	#6	34-#6	11	#5	#5	24-#5
3.67	23 *	5 S 8 1	8	#6	#7	42-#6	11	#5	#5	24-#5
4.08	23 *	5 S 8 1	8	#7	#7	50-#6	11	#5	#5	24-#5
4.70	23 *	5 S 8 2	8	#7	#8	57-#6	11	#5	#6	27-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 12 in.	Rib Depth = 8 in.	Total Slab Depth = 4 in.															
17'-6"	50	1.71	12	0.631		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	25	50	68
D = 8.000	100	1.71	12	0.631		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	33	68	88
RIB NOT ON	150	1.71	12	0.631		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	41	94	109
COLUMN LINE	200	1.71	12	0.653		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	48	119	130
0.671 CF/SF	300	1.96	12	0.770		7-#5+ 1	4	#5	#5	6-#6	3	#4	#5	7-#5	64	167	172
	400	2.36	12 *	0.861		7-#5+ 2	4	#5	#6	6-#7	3	#5	#5	7-#5	79	214	214
	500	2.73	12 *	0.632		7-#5+ 2	4	#6	#6	9-#6	3	#6	#6	7-#5	95	260	255
20'-0"	50	1.69	12	0.631		8-#5+ 0	4	#4	#4	8-#5	4	#4	#4	8-#5	38	75	101
D = 8.000	100	1.69	12	0.668		8-#5+ 0	4	#4	#4	8-#5	4	#4	#4	8-#5	49	102	133
RIB NOT ON	150	1.76	12	0.717		8-#5+ 0	4	#4	#5	8-#5	4	#4	#4	8-#5	61	142	165
COLUMN LINE	200	1.88	12	0.765		8-#5+ 0	4	#5	#5	7-#6	4	#4	#4	8-#5	73	179	196
0.653 CF/SF	300	2.42	12 *	0.899		8-#5+ 3	4	#6	#6	9-#6	4	#5	#5	8-#5	96	251	259
	400	3.00	13 *	0.630		8-#5+ 2	4	#7	#7	7-#8	4	#5	#6	8-#5	119	321	321
	500	3.49	16 *	0.627		9-#5+ 2	4	#7	#8	6-#9	4	#6	#6	8-#5	139	374	376
22'-6"	50	1.79	12	0.727		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	54	108	145
D = 8.000	100	1.85	12	0.776		10-#5+ 0	4	#4	#5	7-#6	5	#4	#4	10-#5	71	146	191
RIB NOT ON	150	2.09	12 *	0.826		10-#5+ 0	4	#5	#6	6-#7	5	#4	#4	10-#5	88	203	236
COLUMN LINE	200	2.38	12 *	0.886		10-#5+ 1	4	#6	#6	10-#6	5	#4	#5	10-#5	105	256	282
0.641 CF/SF	300	3.20	14 *	0.629		10-#5+ 1	4	#7	#8	6-#9	5	#5	#6	10-#5	137	357	370
	400	3.83	18 *	0.625		6-#7+ 0	4	#8	#8	8-#9	5	#6	#6	10-#5	166	430	448
25'-0"	50	1.75	12	0.792		8-#6+ 0	5	#4	#4	8-#6	5	#4	#4	10-#5	76	151	203
D = 10.500	100	1.95	12 *	0.863		8-#6+ 1	5	#5	#5	7-#7	5	#4	#4	10-#5	99	205	266
RIB ON	150	2.34	12 *	0.919		8-#6+ 2	5	#6	#6	7-#8	5	#4	#5	10-#5	122	284	329
COLUMN LINE	200	2.82	14 *	0.629		8-#6+ 1	5	#6	#7	8-#8	5	#5	#5	10-#5	145	355	390
0.661 CF/SF	300	3.56	19 *	0.624		9-#6+ 3	5	#7	#8	8-#9	5	#6	#6	10-#5	185	454	499
27'-6"	50	1.91	13 *	0.821		8-#6+ 1	5	#5	#5	7-#7	6	#4	#4	12-#5	100	200	269
D = 10.500	100	2.19	13 *	0.902		8-#6+ 3	5	#5	#6	7-#8	6	#4	#4	12-#5	131	264	353
RIB ON	150	2.71	15 *	0.628		8-#6+ 2	5	#6	#7	7-#9	6	#5	#5	12-#5	161	367	434
COLUMN LINE	200	3.31	18 *	0.625		9-#6+ 4	5	#7	#8	9-#9	6	#5	#6	12-#5	190	449	511
0.650 CF/SF																	
30'-0"	50	2.13	15 *	0.854		9-#6+ 3	5	#5	#6	7-#8	7	#4	#4	13-#5	129	257	346
D = 10.500	100	2.57	15 *	0.929		9-#6+ 6	5	#6	#7	8-#9	7	#4	#5	13-#5	169	338	455
RIB ON	150	3.13	19 *	0.624		7-#7+ 2	5	#7	#8	12-#8	7	#5	#5	13-#5	207	445	557
COLUMN LINE																	
0.641 CF/SF																	
32'-6"	50	2.26	16 *	0.886		10-#6+ 4	6	#5	#6	9-#8	7	#4	#5	13-#5	165	330	445
D = 13.000	100	2.82	19 *	0.920		10-#6+ 7	6	#6	#7	12-#8	7	#5	#5	13-#5	215	429	578
RIB NOT ON																	
COLUMN LINE																	
0.656 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 12 in.			Rib Depth = 8 in.				Total Slab Depth = 4 in.			
1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
1.78	12		4	#4	#4	8-#5	3	#4	#4	7-#5
2.16	12 *	3 S 4 1	4	#4	#5	7-#6	3	#4	#5	7-#5
2.38	12 *	3 S 4 1	4	#5	#5	6-#7	3	#4	#5	7-#5
1.71	12		4	#4	#4	8-#5	4	#4	#4	8-#5
1.71	12		4	#4	#4	8-#5	4	#4	#4	8-#5
1.71	12		4	#4	#4	8-#5	4	#4	#4	8-#5
1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
2.16	12 *	3 S 4 1	4	#5	#5	6-#7	4	#4	#4	8-#5
2.61	12 *	3 S 4 1	4	#5	#6	6-#8	4	#4	#5	8-#5
3.09	14 *	3 S 4 1	4	#6	#6	7-#8	4	#5	#5	8-#5
1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
2.00	12	3 S 4 1	4	#4	#5	6-#7	5	#4	#4	10-#5
2.23	12 *	3 S 4 1	4	#5	#5	7-#7	5	#4	#4	10-#5
2.83	12 *	3 S 4 1	4	#6	#6	7-#8	5	#4	#5	10-#5
3.46	15 *	3 S 4 2	4	#6	#7	7-#9	5	#5	#5	10-#5
1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
1.85	12		5	#4	#4	9-#6	5	#4	#4	10-#5
2.08	12 *		5	#4	#5	8-#7	5	#4	#4	10-#5
2.65	12 *	3 S 4 1	5	#5	#6	8-#8	5	#4	#5	10-#5
3.22	16 *	3 S 4 1	5	#6	#6	8-#9	5	#5	#5	10-#5
1.84	13		5	#4	#4	9-#6	6	#4	#4	12-#5
2.16	13 *		5	#4	#5	7-#8	6	#4	#4	12-#5
2.47	13 *	3 S 4 1	5	#5	#6	8-#8	6	#4	#4	12-#5
2.94	14 *	3 S 4 1	5	#6	#6	8-#9	6	#4	#5	12-#5
2.09	15		5	#4	#5	7-#8	7	#4	#4	13-#5
2.38	15 *	3 S 4 1	5	#5	#5	7-#9	7	#4	#4	13-#5
2.85	15 *	3 S 4 1	5	#6	#6	9-#9	7	#4	#4	13-#5
2.13	16 *		6	#4	#5	11-#7	7	#4	#4	13-#5
2.65	16 *	3 S 4 1	6	#5	#6	9-#9	7	#4	#4	13-#5

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 14 in.	Rib Depth = 10 in.	Total Slab Depth = 4 in.																Total Depth = 14 in.	Rib Depth = 10 in.	Total Slab Depth = 4 in.								
20'-0"	50	1.73	12	0.634		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	41	82	110	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
D = 8.000	100	1.73	12	0.634		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	53	108	142	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
RIB NOT ON	150	1.73	12	0.635		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	64	148	173	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
COLUMN LINE	200	1.80	12	0.677		6-#6+ 0	4	#4	#5	6-#6	4	#4	#4	8-#5	76	185	205	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
0.739 CF/SF	300	2.16	12	0.761		6-#6+ 0	4	#5	#6	6-#7	4	#4	#5	8-#5	100	258	268	1.97	12		4	#4	#5	7-#6	4	#4	#4	8-#5
	400	2.59	12 *	0.867		6-#6+ 1	4	#6	#7	7-#7	4	#5	#5	8-#5	123	330	331	2.24	12 *	3 S 4 1	4	#5	#5	9-#6	4	#4	#4	8-#5
	500	3.01	12 *	0.635		6-#6+ 0	4	#7	#7	7-#8	4	#5	#6	8-#5	147	401	394	2.61	12 *	3 S 4 1	4	#5	#6	6-#8	4	#4	#5	8-#5
22'-6"	50	1.79	12	0.648		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	59	117	158	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
D = 8.000	100	1.85	12	0.694		10-#5+ 0	4	#4	#5	7-#6	5	#4	#4	10-#5	75	154	203	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
RIB NOT ON	150	1.91	12	0.740		10-#5+ 0	4	#5	#5	7-#6	5	#4	#4	10-#5	92	211	249	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
COLUMN LINE	200	2.09	12	0.785		10-#5+ 0	4	#5	#6	6-#7	5	#4	#4	10-#5	109	265	294	2.00	12	3 S 4 1	4	#4	#5	6-#7	5	#4	#4	10-#5
0.725 CF/SF	300	2.79	12 *	0.635		10-#5+ 0	4	#7	#7	7-#8	5	#5	#5	10-#5	143	371	385	2.43	12 *	3 S 4 1	4	#5	#6	6-#8	5	#4	#4	10-#5
	400	3.33	13 *	0.634		10-#5+ 1	4	#7	#8	8-#8	5	#5	#6	10-#5	176	472	474	3.07	12 *	3 S 4 1	4	#6	#7	6-#9	5	#4	#5	10-#5
	500	4.04	16 *	0.630		6-#7+ 1	4	#8	#9	8-#9	5	#6	#6	10-#5	206	555	554	3.61	14 *	3 S 4 2	4	#7	#7	7-#9	5	#5	#5	10-#5
25'-0"	50	1.75	12	0.723		8-#6+ 0	5	#4	#4	8-#6	5	#4	#4	10-#5	82	164	221	1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
D = 10.500	100	1.82	12	0.773		8-#6+ 0	5	#4	#5	8-#6	5	#4	#4	10-#5	106	216	284	1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
RIB ON	150	2.19	12 *	0.842		8-#6+ 1	5	#5	#6	8-#7	5	#4	#5	10-#5	129	296	347	2.01	12		5	#4	#5	7-#7	5	#4	#4	10-#5
COLUMN LINE	200	2.54	12 *	0.897		8-#6+ 2	5	#6	#6	7-#8	5	#5	#5	10-#5	152	371	410	2.32	12 *		5	#5	#5	7-#8	5	#4	#4	10-#5
0.749 CF/SF	300	3.22	14 *	0.632		8-#6+ 2	5	#7	#7	7-#9	5	#6	#6	10-#5	198	513	532	2.86	12 *	3 S 4 1	5	#6	#6	11-#7	5	#4	#5	10-#5
	400	3.90	18 *	0.628		7-#7+ 2	5	#8	#8	9-#9	5	#6	#7	10-#5	238	624	641	3.38	15 *	3 S 4 1	5	#6	#7	8-#9	5	#5	#5	10-#5
27'-6"	50	1.81	13	0.729		8-#6+ 0	5	#4	#5	9-#6	6	#4	#4	12-#5	109	217	293	1.77	13		5	#4	#4	8-#6	6	#4	#4	12-#5
D = 10.500	100	2.03	13 *	0.813		8-#6+ 1	5	#5	#5	8-#7	6	#4	#4	12-#5	140	280	377	2.04	13		5	#4	#5	8-#7	6	#4	#4	12-#5
RIB ON	150	2.41	13 *	0.892		8-#6+ 3	5	#6	#6	8-#8	6	#4	#5	12-#5	171	387	460	2.26	13 *	3 S 4 1	5	#5	#5	7-#8	6	#4	#4	12-#5
COLUMN LINE	200	2.86	13 *	0.634		8-#6+ 2	5	#7	#7	7-#9	6	#5	#5	12-#5	202	487	544	2.60	13 *	3 S 4 1	5	#5	#6	7-#9	6	#4	#4	12-#5
0.735 CF/SF	300	3.77	19 *	0.627	3 S 4 1	10-#6+ 3	5	#8	#8	12-#8	6	#6	#6	12-#5	258	648	694	3.43	15 *	3 S 4 1	5	#6	#7	9-#9	6	#5	#5	12-#5
30'-0"	50	1.98	15	0.737		9-#6+ 0	5	#5	#5	8-#7	7	#4	#4	13-#5	140	279	376	1.98	15		5	#4	#5	8-#7	7	#4	#4	13-#5
D = 10.500	100	2.30	15 *	0.841		9-#6+ 2	5	#6	#6	8-#8	7	#4	#4	13-#5	180	360	484	2.26	15	3 S 4 1	5	#5	#5	8-#8	7	#4	#4	13-#5
RIB ON	150	2.76	15 *	0.631		9-#6+ 1	5	#7	#7	8-#9	7	#4	#5	13-#5	220	480	593	2.59	15 *	3 S 4 1	5	#5	#6	8-#9	7	#4	#4	13-#5
COLUMN LINE	200	3.36	18 *	0.628		10-#6+ 3	5	#7	#8	12-#8	7	#5	#6	13-#5	258	602	695	3.13	15 *	3 S 4 1	5	#6	#7	9-#9	7	#4	#5	13-#5
0.725 CF/SF	300	3.97	24 *	0.623	3 S 4 1	7-#8+ 2	5	#8	#9	16-#8	7	#5	#6	13-#5	326	694	878	3.65	21 *	3 S 4 2	5	#7	#7	12-#9	7	#4	#5	13-#5
32'-6"	50	2.13	16 *	0.826		10-#6+ 3	6	#5	#6	11-#7	7	#4	#4	13-#5	179	359	483	2.04	16		6	#4	#5	10-#7	7	#4	#4	13-#5
D = 13.000	100	2.50	16 *	0.906		10-#6+ 6	6	#6	#6	9-#9	7	#4	#5	13-#5	231	462	621	2.36	16 *		6	#5	#5	10-#8	7	#4	#4	13-#5
RIB NOT ON	150	3.13	19 *	0.627		11-#6+ 3	6	#7	#7	13-#8	7	#5	#6	13-#5	280	598	753	2.85	16 *	3 S 4 1	6	#5	#6	10-#9	7	#4	#5	13-#5
COLUMN LINE	200	3.87	22 *	0.624		10-#7+ 3	6	#8	#8	16-#8	7	#6	#6	13-#5	327	732	880	3.52	17 *	3 S 4 1	6	#6	#7	12-#9	7	#5	#5	13-#5
0.743 CF/SF																												
35'-0"	50	2.41	17 *	0.863		15-#5+ 7	6	#6	#6	10-#8	8	#4	#5	15-#5	223	446	601	2.31	17		6	#5	#5	10-#8	8	#4	#4	15-#5
D = 13.000	100	2.94	18 *	0.927		12-#6+ 8	6	#7	#7	11-#9	8	#5	#5	15-#5	287	573	772	2.66	17 *	3 S 4 1	6	#5	#6	10-#9	8	#4	#4	15-#5
RIB NOT ON	150	3.52	23 *	0.624		10-#7+ 3	6	#7	#8	13-#9	8	#5	#6	15-#5	346	715	932	3.31	17 *	3 S 4 1	6	#6	#7	16-#8	8	#4	#5	15-#5
COLUMN LINE																												
0.733 CF/SF																												
37'-6"	50	2.63	18 *	0.894		16-#5+10	6	#6	#7	10-#9	9	#4	#5	17-#5	274	547	737	2.54	18 *	3 S 4 1	6	#5	#6	12-#8	9	#4	#4	17-#5
D = 13.000	100	3.23	22 *	0.918		14-#6+ 9	6	#7	#8	14-#9	9	#5	#5	17-#5	349	699	941	2.96	18 *	3 S 4 1	6	#6	#6	16-#8	9	#4	#4	17-#5
RIB NOT ON																												
COLUMN LINE																												
0.725 CF/SF																												

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 16 in.	Rib Depth = 12 in.	Total Slab Depth = 4 in.															
22'-6"	50	1.79	12	0.637		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	63	127	171
D = 8.000	100	1.79	12	0.637		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	80	160	216
RIB NOT ON	150	1.91	12	0.651		10-#5+ 0	4	#5	#5	7-#6	5	#4	#4	10-#5	97	219	262
COLUMN LINE	200	2.05	12	0.694		10-#5+ 0	4	#5	#6	6-#7	5	#4	#4	10-#5	114	274	307
0.811 CF/SF	300	2.47	12	0.780		10-#5+ 0	4	#6	#7	10-#6	5	#4	#5	10-#5	148	380	398
	400	3.00	12 *	0.638		10-#5+ 0	4	#7	#7	7-#8	5	#5	#5	10-#5	182	484	489
	500	3.45	12 *	0.638		10-#5+ 2	4	#8	#8	11-#7	5	#5	#6	10-#5	215	587	580
25'-0"	50	1.75	12	0.651		8-#6+ 0	5	#4	#4	8-#6	5	#4	#4	10-#5	89	178	240
D = 10.500	100	1.82	12	0.697		8-#6+ 0	5	#4	#5	8-#6	5	#4	#4	10-#5	112	225	303
RIB ON	150	1.92	12	0.744		8-#6+ 0	5	#5	#5	9-#6	5	#4	#4	10-#5	136	306	366
COLUMN LINE	200	2.20	12	0.814		8-#6+ 1	5	#5	#6	8-#7	5	#4	#5	10-#5	159	383	429
0.839 CF/SF	300	2.90	12 *	0.638		8-#6+ 1	5	#6	#7	8-#8	5	#5	#6	10-#5	206	530	555
	400	3.48	13 *	0.637		12-#5+ 3	5	#7	#8	8-#9	5	#6	#6	10-#5	252	671	678
	500	4.05	17 *	0.632		7-#7+ 2	5	#8	#8	9-#9	5	#6	#7	10-#5	292	789	787
27'-6"	50	1.79	13	0.654		8-#6+ 0	5	#4	#5	8-#6	6	#4	#4	12-#5	118	235	317
D = 10.500	100	1.93	13	0.712		8-#6+ 0	5	#5	#5	10-#6	6	#4	#4	12-#5	149	298	401
RIB ON	150	2.33	13 *	0.815		8-#6+ 2	5	#6	#6	7-#8	6	#4	#5	12-#5	180	402	484
COLUMN LINE	200	2.68	13 *	0.874		8-#6+ 3	5	#6	#7	8-#8	6	#5	#5	12-#5	211	504	568
0.823 CF/SF	300	3.38	14 *	0.635		9-#6+ 2	5	#7	#8	9-#9	6	#5	#6	12-#5	273	697	734
	400	4.21	18 *	0.631	4 S 6 1	8-#7+ 2	5	#8	#9	11-#9	6	#6	#7	12-#5	328	859	884
30'-0"	50	1.91	15	0.665		9-#6+ 0	5	#5	#5	8-#7	7	#4	#4	13-#5	151	302	407
D = 10.500	100	2.15	15	0.756		9-#6+ 1	5	#5	#6	8-#8	7	#4	#4	13-#5	191	383	515
RIB ON	150	2.57	15 *	0.845		9-#6+ 3	5	#6	#7	7-#9	7	#4	#5	13-#5	232	502	624
COLUMN LINE	200	3.04	15 *	0.634		9-#6+ 2	5	#7	#8	9-#9	7	#5	#5	13-#5	272	634	732
0.811 CF/SF	300	4.04	19 *	0.630	4 S 6 1	12-#6+ 3	5	#8	#9	11-#9	7	#6	#6	13-#5	348	874	938
	400	4.73	24 *	0.625	4 S 6 1	8-#8+ 2	5	#9	#10	14-#9	7	#6	#7	14-#5	415	1009	1119
32'-6"	50	2.01	16	0.756		10-#6+ 2	6	#5	#5	10-#7	7	#4	#4	13-#5	194	389	523
D = 13.000	100	2.43	16 *	0.841		10-#6+ 4	6	#6	#6	10-#8	7	#4	#5	13-#5	246	491	661
RIB NOT ON	150	2.82	16 *	0.905		10-#6+ 6	6	#6	#7	9-#9	7	#5	#5	13-#5	297	635	799
COLUMN LINE	200	3.34	18 *	0.631		12-#6+ 2	6	#7	#8	11-#9	7	#5	#6	13-#5	346	798	932
0.832 CF/SF	300	4.45	24 *	0.625		11-#7+ 3	6	#8	#9	18-#8	7	#6	#7	15-#5	437	1035	1177
35'-0"	50	2.26	17 *	0.778		15-#5+ 3	6	#6	#6	10-#8	8	#4	#4	15-#5	242	483	650
D = 13.000	100	2.67	17 *	0.873		15-#5+ 7	6	#6	#7	12-#8	8	#4	#5	15-#5	306	611	823
RIB NOT ON	150	3.25	18 *	0.631		9-#7+ 4	6	#7	#8	12-#9	8	#5	#5	15-#5	369	768	993
COLUMN LINE	200	3.96	22 *	0.627		11-#7+ 3	6	#8	#8	14-#9	8	#6	#6	15-#5	428	967	1154
0.820 CF/SF																	
37'-6"	50	2.60	18 *	0.836		16-#5+ 7	6	#6	#7	9-#9	9	#4	#5	17-#5	296	592	797
D = 13.000	100	3.11	18 *	0.924		10-#7+ 6	6	#7	#8	12-#9	9	#5	#5	17-#5	375	750	1010
RIB NOT ON	150	3.67	22 *	0.627		9-#8+ 1	6	#8	#8	15-#9	9	#5	#6	17-#5	450	907	1211
COLUMN LINE	200	4.05	26 *	0.624		10-#8+ 3	6	#8	#9	18-#9	9	#5	#6	18-#5	519	1038	1398
0.811 CF/SF																	
40'-0"	50	2.74	20 *	0.865		18-#5+11	7	#6	#7	12-#9	9	#4	#5	17-#5	361	722	972
D = 15.500	100	3.45	22 *	0.920		12-#7+ 8	7	#7	#8	15-#9	9	#5	#6	17-#5	454	909	1223
RIB ON	150	4.08	27 *	0.624		14-#7+ 4	7	#8	#8	18-#9	9	#6	#6	19-#5	543	1087	1463
COLUMN LINE																	
0.828 CF/SF																	
42'-6"	50	3.01	21 *	0.892		11-#7+ 6	7	#7	#7	14-#9	10	#5	#5	18-#5	431	863	1161
D = 15.500	100	3.75	25 *	0.625		14-#7+ 4	7	#8	#8	18-#9	10	#5	#6	19-#5	541	1083	1458
RIB ON																	
COLUMN LINE																	
0.818 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 16 in.			Rib Depth = 12 in.				Total Slab Depth = 4 in.			
1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
1.93	12		4	#4	#5	7-#6	5	#4	#4	10-#5
2.23	12	4 S 6 1	4	#5	#5	7-#7	5	#4	#4	10-#5
2.83	12 *	4 S 6 1	4	#6	#6	7-#8	5	#4	#5	10-#5
3.07	12 *	4 S 6 1	4	#6	#7	6-#9	5	#4	#5	10-#5
1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
1.80	12		5	#4	#4	12-#5	5	#4	#4	10-#5
2.02	12		5	#4	#5	10-#6	5	#4	#4	10-#5
2.65	12*	4 S 6 1	5	#5	#6	8-#8	5	#4	#5	10-#5
3.08	12 *	4 S 6 1	5	#6	#6	7-#9	5	#5	#5	10-#5
3.68	14 *	4 S 6 1	5	#6	#7	9-#9	5	#5	#6	10-#5
1.77	13		5	#4	#4	8-#6	6	#4	#4	12-#5
1.88	13		5	#4	#4	7-#7	6	#4	#4	12-#5
2.16	13		5	#4	#5	7-#8	6	#4	#4	12-#5
2.47	13 *	4 S 6 1	5	#5	#6	8-#8	6	#4	#4	12-#5
3.09	13 *	4 S 6 1	5	#6	#7	8-#9	6	#4	#5	12-#5
3.68	15 *	4 S 6 2	5	#7	#7	10-#9	6	#5	#5	12-#5
1.83	15		5	#4	#4	7-#7	7	#4	#4	13-#5
2.09	15		5	#4	#5	7-#8	7	#4	#4	13-#5
2.43	15	4 S 6 1	5	#5	#6	11-#7	7	#4	#4	13-#5
2.70	15 *	4 S 6 1	5	#6	#6	8-#9	7	#4	#4	13-#5
3.70	15 *	4 S 6 2	5	#7	#7	11-#9	7	#5	#5	13-#5
4.08	20 *	4 S 6 2	5	#7	#8	16-#8	7	#5	#5	13-#5
1.99	16		6	#4	#5	9-#7	7	#4	#4	13-#5
2.29	16		6	#5	#5	9-#8	7	#4	#4	13-#5
2.65	16 *	4 S 6 1	6	#5	#6	9-#9	7	#4	#4	13-#5
2.97	16 *	4 S 6 1	6	#6	#6	10-#9	7	#4	#5	13-#5
4.08	19 *	4 S 6 2	6	#7	#7	14-#9	7	#5	#6	14-#5
2.15	17		6	#4	#5	9-#8	8	#4	#4	15-#5
2.58	17 *	4 S 6 1	6	#5	#6	9-#9	8	#4	#4	15-#5
3.03	17 *	4 S 6 1	6	#6	#6	11-#9	8	#4	#5	15-#5
3.69	17 *	4 S 6 1	6	#7	#7	13-#9	8	#5	#5	15-#5
2.52	18		6	#5	#6	9-#9	9	#4	#4	17-#5
2.82	18 *	4 S 6 1	6	#6	#6	11-#9	9	#4	#4	17-#5
3.36	18 *	4 S 6 2	6	#6	#7	14-#9	9	#4	#5	17-#5
3.70	21 *	4 S 6 2	6	#7	#7	16-#9	9	#4	#5	17-#5
2.64	20		7	#5	#6	11-#9	9	#4	#4	17-#5
3.14	20 *	4 S 6 1	7	#6	#6	14-#9	9	#4	#5	17-#5
3.78	20 *	4 S 6 1	7	#6	#7	17-#9	9	#5	#5	18-#5
2.79	21 *	4 S 6 1	7	#6	#6	16-#8	10	#4	#4	18-#5
3.46	21 *	4 S 6 1	7	#6	#7	17-#9	10	#4	#5	18-#5

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 18 in.		Rib Depth = 14 in.		Total Slab Depth = 4 in.													
25'-0"	50	1.75	12	0.640		8-#6+ 0	5	#4	#4	8-#6	5	#4	#4	10-#5	96	192	258
D = 10.500	100	1.75	12	0.640		8-#6+ 0	5	#4	#4	8-#6	5	#4	#4	10-#5	119	239	321
RIB ON	150	1.89	12	0.662		8-#6+ 0	5	#5	#5	12-#5	5	#4	#4	10-#5	143	316	384
COLUMN LINE	200	2.16	12	0.707		8-#6+ 0	5	#5	#6	7-#7	5	#4	#5	10-#5	166	394	447
0.932 CF/SF	300	2.63	12 *	0.837		8-#6+ 2	5	#6	#7	7-#8	5	#5	#5	10-#5	213	542	573
	400	3.19	12 *	0.641		8-#6+ 2	5	#7	#7	7-#9	5	#6	#6	10-#5	260	687	699
	500	3.89	12 *	0.641		9-#6+ 2	5	#8	#8	9-#9	5	#6	#7	10-#5	307	830	825
27'-6"	50	1.79	13	0.638		8-#6+ 0	5	#4	#5	8-#6	6	#4	#4	12-#5	127	254	341
D = 10.500	100	1.91	13	0.638		8-#6+ 0	5	#5	#5	7-#7	6	#4	#4	12-#5	158	316	425
RIB ON	150	2.10	13	0.719		8-#6+ 1	5	#5	#6	8-#7	6	#4	#4	12-#5	189	415	509
COLUMN LINE	200	2.41	13	0.791		8-#6+ 2	5	#6	#6	8-#8	6	#4	#5	12-#5	220	519	593
0.913 CF/SF	300	3.20	13 *	0.639		8-#6+ 2	5	#7	#8	8-#9	6	#5	#6	12-#5	283	716	761
	400	3.77	14 *	0.638		10-#6+ 1	5	#8	#8	12-#8	6	#6	#6	12-#5	344	906	926
	500	4.53	17 *	0.634	4 S 6 1	12-#6+ 3	5	#9	#9	11-#9	6	#6	#7	12-#5	400	1068	1076
30'-0"	50	1.88	15	0.636		9-#6+ 0	5	#5	#5	7-#7	7	#4	#4	13-#5	163	326	438
D = 10.500	100	2.08	15	0.652		9-#6+ 0	5	#5	#6	7-#8	7	#4	#4	13-#5	203	406	547
RIB ON	150	2.37	15	0.742		9-#6+ 1	5	#6	#6	8-#8	7	#4	#5	13-#5	243	522	655
COLUMN LINE	200	2.80	15 *	0.831		9-#6+ 3	5	#7	#7	8-#9	7	#5	#5	13-#5	284	657	764
0.899 CF/SF	300	3.49	15 *	0.637		8-#7+ 2	5	#8	#8	10-#9	7	#5	#6	13-#5	364	910	981
	400	4.46	19 *	0.632	4 S 6 1	7-#8+ 0	5	#9	#9	16-#8	7	#6	#7	13-#5	440	1145	1184
	500	5.06	23 *	0.628	4 S 6 1	11-#7+ 1	5	#9	#10	15-#9	7	#6	#7	15-#5	506	1287	1361
32'-6"	50	1.95	16	0.670		10-#6+ 1	6	#5	#5	9-#7	7	#4	#4	13-#5	210	419	564
D = 13.000	100	2.26	16	0.771		10-#6+ 3	6	#5	#6	9-#8	7	#4	#5	13-#5	261	522	702
RIB NOT ON	150	2.67	16 *	0.846		10-#6+ 5	6	#6	#7	9-#9	7	#5	#5	13-#5	312	661	840
COLUMN LINE	200	3.15	16 *	0.904		11-#6+ 6	6	#7	#7	10-#9	7	#5	#6	13-#5	363	834	979
0.924 CF/SF	300	4.19	19 *	0.632		10-#7+ 3	6	#8	#9	13-#9	7	#6	#7	14-#5	462	1146	1245
	400	4.95	24 *	0.628		9-#8+ 2	6	#9	#9	16-#9	7	#7	#7	17-#5	549	1335	1477
35'-0"	50	2.15	17	0.705		15-#5+ 2	6	#5	#6	9-#8	8	#4	#4	15-#5	260	521	701
D = 13.000	100	2.60	17 *	0.805		15-#5+ 5	6	#6	#7	9-#9	8	#4	#5	15-#5	325	649	874
RIB NOT ON	150	3.00	17 *	0.891		12-#6+ 6	6	#7	#7	11-#9	8	#5	#5	15-#5	389	807	1046
COLUMN LINE	200	3.57	17 *	0.634		10-#7+ 3	6	#8	#8	16-#8	8	#5	#6	15-#5	453	1023	1219
0.910 CF/SF	300	4.70	24 *	0.628		10-#8+ 1	6	#9	#9	17-#9	8	#6	#7	17-#5	568	1351	1529

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 18 in.			Rib Depth = 14 in.				Total Slab Depth = 4 in.			
1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
1.97	12		5	#4	#5	9-#6	5	#4	#4	10-#5
2.32	12		5	#5	#5	7-#8	5	#4	#4	10-#5
2.79	12 *	4 S 6 1	5	#6	#6	8-#8	5	#4	#5	10-#5
3.36	12 *	4 S 6 1	5	#6	#7	8-#9	5	#5	#5	10-#5
1.77	13		5	#4	#4	8-#6	6	#4	#4	12-#5
1.84	13		5	#4	#4	9-#6	6	#4	#4	12-#5
2.04	13		5	#4	#5	8-#7	6	#4	#4	12-#5
2.26	13		5	#5	#5	7-#8	6	#4	#4	12-#5
2.84	13 *	4 S 6 1	5	#6	#6	7-#9	6	#4	#5	12-#5
3.42	13 *	4 S 6 1	5	#6	#7	9-#9	6	#5	#5	12-#5
4.07	15 *	4 S 6 2	5	#7	#8	13-#8	6	#5	#6	12-#5
1.80	15		5	#4	#4	9-#6	7	#4	#4	13-#5
1.98	15		5	#4	#5	8-#7	7	#4	#4	13-#5
2.26	15		5	#5	#5	8-#8	7	#4	#4	13-#5
2.49	15	4 S 6 1	5	#5	#6	7-#9	7	#4	#4	13-#5
3.13	15 *	4 S 6 1	5	#6	#7	9-#9	7	#4	#5	13-#5
3.98	15 *	4 S 6 2	5	#7	#8	12-#9	7	#5	#5	13-#5
4.60	20 *	4 S 6 2	5	#8	#8	14-#9	7	#5	#6	14-#5
1.89	16		6	#4	#4	9-#7	7	#4	#4	13-#5
2.13	16		6	#4	#5	11-#7	7	#4	#4	13-#5
2.36	16		6	#5	#5	10-#8	7	#4	#4	13-#5
2.89	16 *	4 S 6 1	6	#6	#6	9-#9	7	#4	#5	13-#5
3.67	16 *	4 S 6 1	6	#7	#7	12-#9	7	#5	#5	13-#5
4.44	21 *	4 S 6 2	6	#7	#8	15-#9	7	#5	#6	15-#5
2.10	17		6	#4	#5	11-#7	8	#4	#4	15-#5
2.46	17		6	#5	#5	9-#9	8	#4	#4	15-#5
2.78	17 *	4 S 6 1	6	#6	#6	10-#9	8	#4	#4	15-#5
3.25	17 *	4 S 6 1	6	#6	#7	12-#9	8	#4	#5	15-#5
4.25	19 *	4 S 6 2	6	#7	#8	15-#9	8	#5	#6	16-#5

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 18 in.	Rib Depth = 14 in.	Total Slab Depth = 4 in.															
37'-6"	50	2.40	18	0.747		16-#5+ 3	6	#6	#7	9-#9	9	#4	#4	17-#5	319	638	859
D = 13.000	100	2.78	18 *	0.855		12-#6+ 5	6	#7	#7	11-#9	9	#4	#5	17-#5	398	796	1072
RIB NOT ON	150	3.32	18 *	0.633		11-#7+ 3	6	#7	#8	14-#9	9	#5	#5	17-#5	477	965	1284
COLUMN LINE	200	4.04	22 *	0.629		9-#8+ 2	6	#8	#9	16-#9	9	#6	#6	17-#5	551	1221	1483
0.899 CF/SF	300	4.89	29 *	0.624	4 S 6 1	9-#9+ 2	6	#9	#10	20-#9	9	#6	#6	21-#5	686	1415	1846
40'-0"	50	2.61	20 *	0.813		12-#6+ 7	7	#6	#7	11-#9	9	#4	#5	17-#5	389	779	1048
D = 15.500	100	3.11	20 *	0.895		11-#7+ 6	7	#7	#7	14-#9	9	#5	#5	17-#5	485	970	1305
RIB ON	150	3.74	22 *	0.629		13-#7+ 4	7	#8	#8	17-#9	9	#5	#6	17-#5	578	1155	1555
COLUMN LINE	200	4.37	26 *	0.626		12-#8+ 2	7	#8	#9	19-#9	9	#6	#6	20-#5	667	1422	1795
0.919 CF/SF																	
42'-6"	50	2.90	21 *	0.842		14-#6+ 7	7	#7	#7	13-#9	10	#5	#5	18-#5	465	930	1252
D = 15.500	100	3.63	21 *	0.630		13-#7+ 4	7	#8	#8	17-#9	10	#5	#6	18-#5	580	1160	1561
RIB ON	150	4.30	26 *	0.626		12-#8+ 2	7	#8	#9	20-#9	10	#6	#6	21-#5	687	1374	1850
COLUMN LINE	200	4.78	32 *	0.623	4 S 6 1	11-#9+ 2	7	#9	#9	23-#9	10	#6	#6	24-#5	784	1568	2111
0.908 CF/SF																	
45'-0"	50	3.14	22 *	0.888		12-#7+ 8	7	#7	#8	16-#9	11	#5	#5	20-#5	551	1101	1482
D = 15.500	100	3.93	25 *	0.627		12-#8+ 2	7	#8	#9	20-#9	11	#5	#6	21-#5	683	1365	1838
RIB ON	150	4.64	31 *	0.623	4 S 6 1	11-#9+ 3	7	#9	#9	24-#9	11	#6	#6	25-#5	807	1614	2172
COLUMN LINE																	
0.899 CF/SF																	
47'-6"	50	3.57	23 *	0.924		12-#8+ 8	8	#7	#8	19-#9	11	#5	#6	20-#5	653	1305	1757
D = 18.000	100	4.39	30 *	0.624		14-#8+ 4	8	#8	#9	24-#9	11	#6	#6	24-#5	802	1605	2160
RIB NOT ON																	
COLUMN LINE																	
0.915 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 18 in.	Rib Depth = 14 in.	Total Slab Depth = 4 in.								
2.27	18		6	#5	#5	10-#8	9	#4	#4	17-#5
2.59	18	4 S 6 1	6	#5	#6	10-#9	9	#4	#4	17-#5
3.09	18 *	4 S 6 1	6	#6	#7	16-#8	9	#4	#4	17-#5
3.61	18 *	4 S 6 2	6	#7	#7	15-#9	9	#4	#5	17-#5
4.46	24 *	4 S 6 2	6	#7	#8	19-#9	9	#5	#5	20-#5
2.44	20		7	#5	#5	13-#8	9	#4	#4	17-#5
2.89	20 *	4 S 6 1	7	#6	#6	16-#8	9	#4	#4	17-#5
3.40	20 *	4 S 6 1	7	#6	#7	15-#9	9	#4	#5	17-#5
4.02	20 *	4 S 6 2	7	#7	#7	18-#9	9	#5	#5	19-#5
2.63	21		7	#5	#6	12-#9	10	#4	#4	18-#5
3.29	21 *	4 S 6 1	7	#6	#7	15-#9	10	#4	#5	18-#5
3.97	21 *	4 S 6 2	7	#7	#7	19-#9	10	#5	#5	19-#5
4.46	25 *	4 S 6 2	7	#7	#8	22-#9	10	#5	#5	22-#5
2.86	22 *	4 S 6 1	7	#6	#6	18-#8	11	#4	#4	20-#5
3.58	22 *	4 S 6 2	7	#7	#7	23-#8	11	#4	#5	20-#5
4.29	23 *	4 S 6 2	7	#7	#8	28-#8	11	#5	#5	23-#5
3.31	23 *	4 S 6 1	8	#6	#7	17-#9	11	#4	#5	20-#5
4.06	23 *	4 S 6 1	8	#7	#7	22-#9	11	#5	#5	23-#5

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 20 in.	Rib Depth = 16 in.		Total Slab Depth = 4 in.														
27'-6"	50	1.97	13	0.641		8-#6+ 0	5	#4	#5	8-#6	6	#4	#5	12-#5	136	273	367
D = 10.500	100	1.99	13	0.641		8-#6+ 0	5	#4	#5	9-#6	6	#4	#5	12-#5	167	335	451
RIB ON	150	2.20	13	0.641		8-#6+ 0	5	#5	#6	8-#7	6	#4	#5	12-#5	199	428	535
COLUMN LINE	200	2.38	13	0.687		8-#6+ 1	5	#6	#6	7-#8	6	#4	#5	12-#5	230	533	619
1.005 CF/SF	300	2.85	13 *	0.822		8-#6+ 3	5	#7	#7	7-#9	6	#5	#5	12-#5	292	732	787
	400	3.59	13 *	0.642		9-#6+ 2	5	#8	#8	9-#9	6	#6	#6	12-#5	355	926	955
	500	4.13	13 *	0.642	4 S 6 1	8-#7+ 2	5	#8	#9	10-#9	6	#6	#7	12-#5	417	1118	1123
30'-0"	50	2.05	15	0.638		9-#6+ 0	5	#5	#5	9-#6	7	#4	#5	13-#5	175	350	471
D = 10 .500	100	2.21	15	0.638		9-#6+ 0	5	#5	#6	7-#8	7	#4	#5	13-#5	215	430	579
RIB ON	150	2.40	15	0.638		9-#6+ 0	5	#6	#6	8-#8	7	#4	#5	13-#5	256	539	688
COLUMN LINE	200	2.61	15	0.718		9-#6+ 1	5	#6	#7	7-#9	7	#4	#5	13-#5	296	676	796
0.989 CF/SF	300	3.45	15 *	0.857		7-#7+ 2	5	#8	#8	9-#9	7	#5	#6	13-#5	376	933	1013
	400	4.13	15 *	0.639	4 S 6 1	12-#6+ 1	5	#9	#9	12-#9	7	#6	#6	13-#5	457	1183	1230
	500	4.88	18 *	0.635	4 S 6 1	8-#8+ 2	5	#9	#10	14-#9	7	#6	#7	14-#5	533	1417	1435
32'-6"	50	2.09	16	0.637		10-# 6+ 1	6	#5	#5	9-#7	7	#4	#5	13-#5	225	451	607
D = 13.000	100	2.26	16	0.690		10-#6+ 2	6	#5	#6	11-#7	7	#4	#5	13-#5	277	553	745
RIB NOT ON	150	2.49	16	0.780		10-#6+ 4	6	#6	#6	10-#8	7	#4	#5	13-#5	328	685	883
COLUMN LINE	200	2.96	16 *	0.847		10-#6+ 6	6	#7	#7	9-#9	7	#5	#5	13-#5	379	861	1021
1.017 CF/SF	300	3.81	16 *	0.638		10-#7+ 3	6	#8	#8	12-#9	7	#6	#6	13-#5	482	1187	1297
	400	4.81	20 *	0.633		9-#8+ 1	6	#9	#9	15-#9	7	#7	#7	15-#5	578	1489	1556
	500	5.54	24 *	0.630		10-#8+ 1	6	#9	#10	17-#9	7	#7	#8	13-#6	663	1681	1785
35'-0"	50	2.23	17	0.635		15-#5+ 1	6	#5	#6	11-#7	8	#4	#5	15-#5	280	560	754
D = 13.000	100	2.51	17	0.722		15-#5+ 3	6	#6	#6	9-#9	8	#4	#5	15-#5	344	688	926
RIB NOT ON	150	2.92	17 *	0.827		11-#6+ 5	6	#7	#7	10-#9	8	#5	#5	15-#5	408	839	1099
COLUMN LINE	200	3.34	17 *	0.886		9-#7+ 4	6	#7	#8	12-#9	8	#5	#6	15-#5	472	1058	1272
1.002 CF/SF	300	4.46	19 *	0.634		9-#8+ 2	6	#9	#9	15-#9	8	#6	#7	16-#5	598	1458	1609
	400	5.24	25 *	0.629		14-#7+ 2	6	#9	#10	18-#9	8	#7	#7	19-#5	707	1727	1903
37'-6"	50	2.46	18	0.654		16-#5+ 1	6	#6	#6	9-#9	9	#4	#5	17-#5	343	686	923
D = 13.000	100	2.77	18 *	0.789		16-#5+ 6	6	#7	#7	10-#9	9	#4	#5	17-#5	422	844	1136
RIB NOT ON	150	3.23	18 *	0.875		10-#7+ 4	6	#7	#8	16-#8	9	#5	#5	17-#5	501	1007	1348
COLUMN LINE	200	3.85	18 *	0.635		9-#8+ 1	6	#8	#9	15-#9	9	#5	#6	17-#5	580	1279	1561
0.989 CF/SF	300	5.00	24 *	0.630		11-#8+ 3	6	#9	#10	19-#9	9	#6	#7	19-#5	726	1726	1954
	400	5.60	30 *	0.626	4 S 6 1	10-#9+ 1	6	#10	#10	28-#8	9	#6	#7	23-#5	854	1847	2299
40'-0"	50	2.61	20	0.711		12-#6+ 3	7	#6	#7	13-#8	9	#4	#5	17-#5	418	837	1127
D = 15.500	100	3.03	20 *	0.843		14-#6+ 7	7	#7	#7	16-#8	9	#5	#5	17-#5	514	1028	1384
RIB ON	150	3.46	20 *	0.909		12-#7+ 6	7	#7	#8	15-#9	9	#5	#6	17-#5	609	1219	1641
COLUMN LINE	200	4.25	22 *	0.631		14-#7+ 4	7	#8	#9	18-#9	9	#6	#6	19-#5	702	1499	1890
1.012 CF/SF	300	5.22	29 *	0.626	4 S 6 1	13-#8+ 2	7	#9	#10	23-#9	9	#6	#7	17-#6	870	1870	2343
42'-6"	50	2.84	21 *	0.774		19-#5+ 7	7	#7	#7	12-#9	10	#4	#5	18-#5	500	1000	1346
D = 15.500	100	3.28	21 *	0.881		12-#7+ 6	7	#7	#8	16-#9	10	#5	#5	18-#5	615	1229	1655
RIB ON	150	3.86	22 *	0.631		11-#8+ 3	7	#8	#8	19-#9	10	#5	#6	19-#5	728	1455	1959
COLUMN LINE	200	4.61	26 *	0.628		13-#8+ 2	7	#9	#9	22-#9	10	#6	#6	22-#5	835	1738	2248
1.000 CF/SF																	
45'-0"	50	3.19	22 *	0.832		12-#7+ 5	7	#7	#8	15-#9	11	#5	#5	20-#5	592	1183	1593
D = 15.500	100	3.75	22 *	0.918		11-#8+ 6	7	#8	#8	19-#9	11	#5	#6	20-#5	728	1456	1960
RIB ON	150	4.51	26 *	0.628		13-#8+ 2	7	#9	#9	22-#9	11	#6	#6	23-#5	857	1715	2308
COLUMN LINE	200	5.13	31 *	0.625	4 S 6 1	12-#9+ 2	7	#9	#10	26-#9	11	#6	#7	27-#5	979	1957	2635
0.989 CF/SF																	
47'-6"	50	3.40	23 *	0.882		14-#7+ 8	8	#7	#8	18-#9	11	#5	#6	20-#5	702	1403	1889
D = 18.000	100	4.28	26 *	0.919		13-#8+ 8	8	#8	#9	22-#9	11	#6	#6	23-#5	857	1714	2308
RIB NOT ON	150	4.92	31 *	0.625		12-#9+ 2	8	#9	#9	26-#9	11	#6	#7	27-#5	1005	2010	2706
COLUMN LINE	200	5.51	38 *	0.622		14-#9+ 3	8	#9	#10	30-#9	11	#6	#7	22-#6	1130	2260	3042
1.008 CF/SF																	

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 20 in.		Rib Depth = 16 in.		Total Slab Depth = 4 in.							
27'-6"	1.98	13		5	#4	#5	8-#6	6	#4	#5	12-#5
D = 10.500	1.98	13		5	#4	#5	8-#6	6	#4	#5	12-#5
RIB ON	2.09	13		5	#4	#5	7-#7	6	#4	#5	12-#5
COLUMN LINE	2.26	13		5	#5	#5	8-#7	6	#4	#5	12-#5
1.005 CF/SF	2.58	13	4 S 6 1	5	#5	#6	8-#8	6	#4	#5	12-#5
	3.09	13 *	4 S 6 1	5	#6	#7	8-#9	6	#4	#5	12-#5
	3.60	13 *	4 S 6 1	5	#7	#7	12-#8	6	#5	#5	12-#5
30'-0"	2.01	15		5	#4	#5	9-#6	7	#4	#5	13-#5
D = 10 .500	2.10	15		5	#4	#5	8-#7	7	#4	#5	13-#5
RIB ON	2.30	15		5	#5	#5	7-#8	7	#4	#5	13-#5
COLUMN LINE	2.50	15	4 S 6 1	5	#5	#6	8-#8	7	#4	#5	13-#5
0.989 CF/SF	3.13	15 *	4 S 6 1	5	#6	#7	9-#9	7	#4	#5	13-#5
	3.59	15 *	4 S 6 2	5	#7	#7	13-#8	7	#5	#5	13-#5
	4.36	15 *	4 S 6 2	5	#8	#8	16-#8	7	#5	#6	13-#5
32'-6"	2.04	16		6	#4	#5	11-#6	7	#4	#5	13-#5
D = 13.000	2.16	16		6	#4	#5	10-#7	7	#4	#5	13-#5
RIB NOT ON	2.40	16		6	#5	#5	9-#8	7	#4	#5	13-#5
COLUMN LINE	2.76	16		6	#5	#6	9-#9	7	#4	#5	13-#5
1.017 CF/SF	3.43	16 *	4 S 6 1	6	#6	#7	11-#9	7	#5	#5	13-#5
	4.24	16 *	4 S 6 2	6	#7	#8	14-#9	7	#5	#6	14-#5
	4.96	21 *	4 S 6 2	6	#8	#8	16-#9	7	#6	#6	17-#5
35'-0"	2.14	17		6	#4	#5	10-#7	8	#4	#5	15-#5
D = 13.000	2.43	17		6	#5	#5	10-#8	8	#4	#5	15-#5
RIB NOT ON	2.70	17	4 S 6 1	6	#5	#6	9-#9	8	#4	#5	15-#5
COLUMN LINE	3.03	17 *	4 S 6 1	6	#6	#6	11-#9	8	#4	#5	15-#5
1.002 CF/SF	3.94	17 *	4 S 6 2	6	#7	#8	14-#9	8	#5	#5	15-#5
	4.69	21 *	4 S 6 2	6	#8	#8	17-#9	8	#5	#6	18-#5
37'-6"	2.39	18		6	#5	#5	10-#8	9	#4	#5	17-#5
D = 13.000	2.66	18		6	#5	#6	12-#8	9	#4	#5	17-#5
RIB NOT ON	3.03	18 *	4 S 6 1	6	#6	#6	12-#9	9	#4	#5	17-#5
COLUMN LINE	3.49	18 *	4 S 6 1	6	#7	#7	14-#9	9	#4	#5	17-#5
0.989 CF/SF	4.57	19 *	4 S 6 2	6	#8	#8	18-#9	9	#5	#6	18-#5
	5.24	26 *	4 S 6 2	6	#8	#9	21-#9	9	#5	#6	22-#5
40'-0"	2.47	20		7	#5	#5	12-#8	9	#4	#5	17-#5
D = 15.500	2.83	20		7	#5	#6	12-#9	9	#4	#5	17-#5
RIB ON	3.14	20 *	4 S 6 1	7	#6	#6	14-#9	9	#4	#5	17-#5
COLUMN LINE	3.90	20 *	4 S 6 1	7	#7	#7	17-#9	9	#5	#5	17-#5
1.012 CF/SF	4.72	24 *	4 S 6 2	7	#7	#8	21-#9	9	#5	#6	22-#5
42'-6"	2.75	21		7	#5	#6	12-#9	10	#4	#5	18-#5
D = 15.500	3.04	21 *	4 S 6 1	7	#6	#6	14-#9	10	#4	#5	18-#5
RIB ON	3.59	21 *	4 S 6 1	7	#7	#7	17-#9	10	#4	#5	18-#5
COLUMN LINE	4.24	21 *	4 S 6 2	7	#7	#8	20-#9	10	#5	#5	21-#5
1.000 CF/SF											
45'-0"	2.98	22	4 S 6 1	7	#6	#6	14-#9	11	#4	#5	20-#5
D = 15.500	3.50	22 *	4 S 6 1	7	#7	#7	17-#9	11	#4	#5	20-#5
RIB ON	4.18	22 *	4 S 6 2	7	#7	#8	21-#9	11	#5	#5	21-#5
COLUMN LINE	4.66	24 *	4 S 6 2	7	#8	#8	24-#9	11	#5	#5	25-#5
0.989 CF/SF											
47'-6"	3.07	23 *		8	#6	#6	16-#9	11	#4	#5	20-#5
D = 18.000	3.95	23 *	4 S 6 1	8	#7	#7	21-#9	11	#5	#5	21-#5
RIB NOT ON	4.53	24 *	4 S 6 2	8	#7	#8	25-#9	11	#5	#5	26-#5
COLUMN LINE	5.15	32 *	4 S 6 2	8	#8	#8	28-#9	11	#5	#6	20-#6
1.008 CF/SF											

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 24 in.	Rib Depth = 20 in.	Total Slab Depth = 4 in.															
32'-6"	50	2.27	16	0.640		10-#6+ 0	6	#5	#5	11-#6	7	#5	#5	13-#5	258	516	695
D = 13.000	100	2.35	16	0.640		10-#6+ 0	6	#5	#5	10-#7	7	#5	#5	13-#5	309	619	833
RIB NOT ON	150	2.53	16	0.640		10-#6+ 0	6	#5	#6	9-#8	7	#5	#5	13-#5	361	728	971
COLUMN LINE	200	2.77	16	0.640		10-#6+ 1	6	#6	#7	10-#8	7	#5	#5	13-#5	412	908	1109
1.212 CF/SF	300	3.34	16 *	0.789		11-#6+ 3	6	#7	#8	10-#9	7	#5	#6	13-#5	515	1244	1386
	400	4.17	16 *	0.641		10-#7+ 1	6	#8	#9	16-#8	7	#6	#7	13-#5	617	1566	1662
	500	4.83	16 *	0.641		9-#8+ 1	6	#9	#9	15-#9	7	#7	#7	16-#5	720	1884	1938
35'-0"	50	2.43	17	0.639		15-#5+ 0	6	#5	#6	14-#6	8	#5	#5	15-#5	321	641	863
D = 13.000	100	2.61	17	0.639		15-#5+ 0	6	#6	#6	10-#8	8	#5	#5	15-#5	385	770	1036
RIB NOT ON	150	2.83	17	0.639		15-#5+ 1	6	#6	#7	9-#9	8	#5	#5	15-#5	449	898	1209
COLUMN LINE	200	3.07	17	0.711		11-#6+ 2	6	#7	#7	10-#9	8	#5	#5	15-#5	513	1119	1381
1.193 CF/SF	300	3.97	17 *	0.877		10-#7+ 4	6	#8	#9	13-#9	8	#6	#6	15-#5	641	1539	1727
	400	4.79	17 *	0.640		17-#6+ 3	6	#9	#10	16-#9	8	#6	#7	17-#5	770	1942	2072
	500	5.63	20 *	0.637		11-#8+ 1	6	#10	#10	19-#9	8	#7	#7	20-#5	891	2321	2399
37'-6"	50	2.58	18	0.638		16-#5+ 0	6	#6	#6	10-#8	9	#5	#5	17-#5	393	785	1057
D = 13.000	100	2.84	18	0.638		16-#5+ 0	6	#6	#7	9-#9	9	#5	#5	17-#5	472	943	1270
RIB NOT ON	150	3.02	18	0.743		12-#6+ 4	6	#7	#7	11-#9	9	#5	#5	17-#5	551	1101	1482
COLUMN LINE	200	3.47	18 *	0.814		10-#7+ 3	6	#8	#8	16-#8	9	#5	#5	17-#5	630	1358	1695
1.177 CF/SF	300	4.34	18 *	0.639		10-#8+ 1	6	#9	#9	16-#9	9	#6	#6	17-#5	788	1875	2120
	400	5.42	21 *	0.636		9-#9+ 2	6	#10	#10	20-#9	9	#7	#7	21-#5	939	2352	2528
40'-0"	50	2.64	20	0.636		12-#6+ 2	7	#6	#6	12-#8	9	#5	#5	17-#5	479	959	1291
D = 15.500	100	2.96	20	0.689		18-#5+ 5	7	#6	#7	12-#9	9	#5	#5	17-#5	575	1150	1548
RIB ON	150	3.25	20 *	0.813		11-#7+ 5	7	#7	#7	14-#9	9	#5	#5	17-#5	670	1341	1805
COLUMN LINE	200	3.74	20 *	0.871		17-#6+ 7	7	#8	#8	16-#9	9	#5	#6	17-#5	766	1613	2062
1.205 CF/SF	300	4.77	20 *	0.637		12-#8+ 2	7	#9	#9	20-#9	9	#6	#7	21-#5	957	2239	2577
	400	5.98	26 *	0.632	5 S 8 1	11-#9+ 3	7	#10	#10	24-#9	9	#7	#8	18-#6	1128	2726	3036
42'-6"	50	2.90	21	0.635		13-#6+ 2	7	#6	#7	12-#9	10	#5	#5	18-#5	573	1145	1542
D = 15.500	100	3.16	21 *	0.784		11-#7+ 5	7	#7	#7	14-#9	10	#5	#5	18-#5	687	1375	1850
RIB ON	150	3.72	21 *	0.854		13-#7+ 5	7	#8	#8	17-#9	10	#5	#6	18-#5	802	1604	2159
COLUMN LINE	200	4.20	21 *	0.636		11-#8+ 3	7	#8	#9	19-#9	10	#6	#6	20-#5	917	1894	2468
1.190 CF/SF	300	5.46	25 *	0.633	5 S 8 1	11-#9+ 3	7	#10	#10	24-#9	10	#7	#7	18-#6	1136	2623	3060
45'-0"	50	3.10	22	0.727		11-#7+ 4	7	#7	#7	14-#9	11	#5	#5	20-#5	677	1355	1824
D = 15.500	100	3.57	22 *	0.824		13-#7+ 5	7	#8	#8	17-#9	11	#5	#5	20-#5	814	1627	2191
RIB ON	150	4.01	22 *	0.906		12-#8+ 6	7	#8	#9	20-#9	11	#5	#6	21-#5	950	1900	2558
COLUMN LINE	200	4.58	22 *	0.635		11-#9+ 3	7	#9	#9	23-#9	11	#6	#6	24-#5	1086	2193	2925
1.177 CF/SF																	
47'-6"	50	3.34	23 *	0.796		13-#7+ 6	8	#7	#8	17-#9	11	#5	#5	20-#5	804	1608	2164
D = 18.000	100	3.80	23 *	0.881		12-#8+ 6	8	#8	#8	20-#9	11	#5	#6	21-#5	964	1928	2596
RIB NOT ON	150	4.40	23 *	0.634		14-#8+ 4	8	#8	#9	24-#9	11	#6	#6	25-#5	1125	2249	3028
COLUMN LINE	200	5.03	27 *	0.631		16-#8+ 3	8	#9	#9	27-#9	11	#6	#7	20-#6	1275	2551	3434
1.200 CF/SF	300	6.26	36 *	0.626		16-#9+ 3	8	#10	#10	33-#9	11	#7	#7	24-#6	1546	3092	4162

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 24 in.	Rib Depth = 20 in.	Total Slab Depth = 4 in.								
2.27	16		6	#5	#5	15-#5	7	#5	#5	13-#5
2.37	16		6	#5	#5	9-#7	7	#5	#5	13-#5
2.51	16		6	#5	#5	11-#7	7	#5	#5	13-#5
2.64	16		6	#5	#5	10-#8	7	#5	#5	13-#5
3.07	16	5 S 8 1	6	#6	#6	12-#8	7	#5	#5	13-#5
3.67	16 *	5 S 8 1	6	#7	#7	12-#9	7	#5	#5	13-#5
4.24	16 *	5 S 8 2	6	#7	#8	14-#9	7	#5	#6	14-#5
2.41	17		6	#5	#5	10-#7	8	#5	#5	15-#5
2.54	17		6	#5	#5	9-#8	8	#5	#5	15-#5
2.75	17		6	#5	#5	9-#9	8	#5	#5	15-#5
3.01	17		6	#6	#6	12-#8	8	#5	#5	15-#5
3.56	17 *	5 S 8 1	6	#7	#7	12-#9	8	#5	#5	15-#5
4.21	17 *	5 S 8 2	6	#7	#8	15-#9	8	#5	#6	15-#5
5.09	17 *	5 S 8 2	6	#8	#9	17-#9	8	#6	#6	18-#5
2.52	18		6	#5	#5	9-#8	9	#5	#5	17-#5
2.82	18		6	#5	#6	9-#9	9	#5	#5	17-#5
2.90	18	5 S 8 1	6	#5	#6	10-#9	9	#5	#5	17-#5
3.34	18	5 S 8 1	6	#6	#7	12-#9	9	#5	#5	17-#5
3.96	18 *	5 S 8 2	6	#7	#8	15-#9	9	#5	#5	17-#5
4.79	18 *	5 S 8 2	6	#8	#9	18-#9	9	#5	#6	19-#5
2.59	20		7	#5	#5	11-#8	9	#5	#5	17-#5
2.93	20		7	#5	#6	11-#9	9	#5	#5	17-#5
3.18	20		7	#6	#6	16-#8	9	#5	#5	17-#5
3.47	20 *	5 S 8 1	7	#6	#7	18-#8	9	#5	#5	17-#5
4.33	20 *	5 S 8 2	7	#7	#8	18-#9	9	#5	#6	19-#5
5.37	22 *	5 S 8 2	7	#8	#9	22-#9	9	#6	#6	23-#5
2.86	21		7	#5	#6	11-#9	10	#5	#5	18-#5
3.10	21		7	#6	#6	16-#8	10	#5	#5	18-#5
3.46	21 *	5 S 8 1	7	#6	#7	15-#9	10	#5	#5	18-#5
3.84	21 *	5 S 8 1	7	#7	#7	18-#9	10	#5	#5	18-#5
4.77	21 *	5 S 8 2	7	#8	#8	22-#9	10	#5	#6	23-#5
3.05	22		7	#6	#6	16-#8	11	#5	#5	20-#5
3.46	22	5 S 8 1	7	#6	#7	16-#9	11	#5	#5	20-#5
3.75	22 *	5 S 8 1	7	#7	#7	18-#9	11	#5	#5	20-#5
4.21	22 *	5 S 8 2	7	#7	#8	21-#9	11	#5	#5	22-#5
3.19	23		8	#6	#6	15-#9	11	#5	#5	20-#5
3.56	23 *	5 S 8 1	8	#6	#7	23-#8	11	#5	#5	20-#5
4.06	23 *	5 S 8 1	8	#7	#7	22-#9	11	#5	#5	23-#5
4.68	23 *	5 S 8 2	8	#7	#8	25-#9	11	#5	#6	26-#5
5.89	30 *	5 S 8 2	8	#8	#9	31-#9	11	#6	#6	23-#6

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 12 ½ in.	Rib Depth = 8 in.	Total Slab Depth = 4 ½ in.																Total Depth = 12 ½ in.	Rib Depth = 8 in.	Total Slab Depth = 4 ½ in.								
17'-6"	50	1.71	12	0.632		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	26	53	71	1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
D = 8.000	100	1.71	12	0.632		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	34	70	92	1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
RIB NOT ON	150	1.71	12	0.632		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	42	96	112	1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
COLUMN LINE	200	1.71	12	0.632		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	50	121	133	1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
0.712 CF/SF	300	1.95	12	0.745		7-#5+ 1	4	#5	#5	8-#5	3	#4	#5	7-#5	65	169	175	1.78	12		4	#4	#4	8-#5	3	#4	#4	7-#5
	400	2.29	12 *	0.838		7-#5+ 2	4	#5	#6	7-#6	3	#5	#5	7-#5	80	216	217	2.07	12	3 S 4 1	4	#4	#5	7-#6	3	#4	#4	7-#5
	500	2.65	12 *	0.633		7-#5+ 2	4	#6	#6	9-#6	3	#5	#6	7-#5	96	262	258	2.38	12 *	3 S 4 1	4	#5	#5	6-#7	3	#4	#5	7-#5
20'-0"	50	1.73	12	0.632		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	39	79	106	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
D = 8.000	100	1.73	12	0.668		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	51	104	138	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
RIB NOT ON	150	1.80	12	0.713		6-#6+ 0	4	#4	#5	6-#6	4	#4	#4	8-#5	63	144	169	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
COLUMN LINE	200	1.89	12	0.758		6-#6+ 0	4	#5	#5	7-#6	4	#4	#4	8-#5	75	181	201	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
0.695 CF/SF	300	2.43	12 *	0.869		6-#6+ 1	4	#6	#6	9-#6	4	#5	#5	8-#5	98	254	264	2.16	12 *	3 S 4 1	4	#5	#5	6-#7	4	#4	#4	8-#5
	400	2.97	12 *	0.633		6-#6+ 0	4	#7	#7	6-#8	4	#5	#6	8-#5	122	326	327	2.61	12 *	3 S 4 1	4	#5	#6	6-#8	4	#4	#5	8-#5
	500	3.48	15 *	0.629		6-#6+ 1	4	#7	#8	6-#9	4	#6	#6	8-#5	142	386	384	3.08	13 *	3 S 4 1	4	#6	#6	7-#8	4	#5	#5	8-#5
22'-6"	50	1.79	12	0.712		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	56	113	152	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
D = 8.000	100	1.85	12	0.760		10-#5+ 0	4	#4	#5	7-#6	5	#4	#4	10-#5	73	149	198	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
RIB NOT ON	150	2.09	12	0.809		10-#5+ 0	4	#5	#6	6-#7	5	#4	#4	10-#5	90	207	243	2.00	12		4	#4	#5	6-#7	5	#4	#4	10-#5
COLUMN LINE	200	2.35	12 *	0.870		10-#5+ 1	4	#6	#6	7-#7	5	#4	#5	10-#5	107	260	289	2.18	12	3 S 4 1	4	#5	#5	9-#6	5	#4	#4	10-#5
0.683 CF/SF	300	3.01	13 *	0.631		10-#5+ 1	4	#7	#7	6-#9	5	#5	#5	10-#5	140	363	378	2.83	12 *	3 S 4 1	4	#6	#6	7-#8	5	#4	#5	10-#5
	400	3.67	17 *	0.627		6-#7+ 0	4	#8	#8	7-#9	5	#6	#6	10-#5	170	446	458	3.20	14 *	3 S 4 2	4	#6	#7	11-#7	5	#4	#5	10-#5
25'-0"	50	1.75	12	0.780		8-#6+ 0	5	#4	#4	8-#6	5	#4	#4	10-#5	79	158	213	1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
D = 10.500	100	1.95	12 *	0.851		8-#6+ 1	5	#5	#5	7-#7	5	#4	#4	10-#5	102	209	276	1.85	12		5	#4	#4	9-#6	5	#4	#4	10-#5
RIB ON	150	2.26	12 *	0.907		8-#6+ 2	5	#5	#6	7-#8	5	#4	#5	10-#5	126	289	339	2.08	12 *		5	#4	#5	8-#7	5	#4	#4	10-#5
COLUMN LINE	200	2.65	13 *	0.631		8-#6+ 1	5	#6	#7	8-#8	5	#5	#5	10-#5	149	362	400	2.32	12 *	3 S 4 1	5	#5	#5	7-#8	5	#4	#4	10-#5
0.703 CF/SF	300	3.54	18 *	0.626		12-#5+ 3	5	#7	#8	8-#9	5	#6	#6	10-#5	190	474	511	3.21	15 *	3 S 4 1	5	#6	#6	8-#9	5	#5	#5	10-#5
27'-6"	50	1.91	13	0.788		8-#6+ 0	5	#5	#5	7-#7	6	#4	#4	12-#5	105	209	282	1.84	13		5	#4	#4	9-#6	6	#4	#4	12-#5
D = 10.500	100	2.19	13 *	0.882		8-#6+ 2	5	#5	#6	7-#8	6	#4	#4	12-#5	136	272	366	2.16	13 *		5	#4	#5	7-#8	6	#4	#4	12-#5
RIB ON	150	2.71	14 *	0.630		8-#6+ 2	5	#6	#7	7-#9	6	#5	#5	12-#5	167	376	448	2.47	13 *	3 S 4 1	5	#5	#6	8-#8	6	#4	#4	12-#5
COLUMN LINE	200	3.26	17 *	0.627		9-#6+ 3	5	#7	#8	8-#9	6	#5	#6	12-#5	196	469	527	2.94	13 *	3 S 4 1	5	#6	#6	8-#9	6	#4	#5	12-#5
0.692 CF/SF																												
30'-0"	50	2.13	15 *	0.846		9-#6+ 3	5	#5	#6	7-#8	7	#4	#4	13-#5	135	269	363	2.09	15		5	#4	#5	7-#8	7	#4	#4	13-#5
D = 10.500	100	2.52	15 *	0.916		9-#6+ 5	5	#6	#7	7-#9	7	#4	#5	13-#5	175	350	471	2.32	15 *	3 S 4 1	5	#5	#5	11-#7	7	#4	#4	13-#5
RIB ON	150	3.02	18 *	0.626		7-#7+ 2	5	#7	#7	9-#9	7	#5	#5	13-#5	213	457	574	2.85	15 *	3 S 4 1	5	#6	#6	9-#9	7	#4	#4	13-#5
COLUMN LINE	200	3.32	23 *	0.622	3 S 4 1	8-#7+ 2	5	#7	#8	11-#9	7	#5	#5	13-#5	247	508	666	3.09	18 *	3 S 4 2	5	#6	#6	10-#9	7	#4	#5	13-#5
0.683 CF/SF																												
32'-6"	50	2.26	16 *	0.879		10-#6+ 4	6	#5	#6	9-#8	7	#4	#5	13-#5	173	346	465	2.13	16		6	#4	#5	11-#7	7	#4	#4	13-#5
D = 13.000	100	2.82	18 *	0.921		10-#6+ 7	6	#6	#7	12-#8	7	#5	#5	13-#5	223	446	600	2.65	16 *	3 S 4 1	6	#5	#6	9-#9	7	#4	#4	13-#5
RIB NOT ON	150	3.33	25 *	0.620		12-#6+ 5	6	#7	#7	12-#9	7	#5	#6	13-#5	267	534	719	3.12	18 *	3 S 4 1	6	#6	#6	11-#9	7	#4	#5	13-#5
COLUMN LINE																												
0.698 CF/SF																												
35'-0"	50	2.60	17 *	0.911		15-#5+ 9	6	#6	#7	9-#9	8	#4	#5	15-#5	215	430	579	2.46	17 *	3 S 4 1	6	#5	#5	9-#9	8	#4	#4	15-#5
D = 13.000	100	3.09	24 *	0.621		9-#7+ 4	6	#7	#7	12-#9	8	#5	#5	15-#5	274	549	739	2.91	17 *	3 S 4 1	6	#6	#6	11-#9	8	#4	#4	15-#5
RIB NOT ON																												
COLUMN LINE																												
0.690 CF/SF																												

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 14 ½ in.	Rib Depth = 10 in.	Total Slab Depth = 4 ½ in.															
20'-0"	50	1.73	12	0.635		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	43	85	115
D = 8.000	100	1.73	12	0.635		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	54	109	147
RIB NOT ON	150	1.73	12	0.635		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	66	150	178
COLUMN LINE	200	1.80	12	0.655		6-#6+ 0	4	#4	#5	6-#6	4	#4	#4	8-#5	78	188	210
0.781 CF/SF	300	2.16	12	0.738		6-#6+ 0	4	#5	#6	6-#7	4	#4	#5	8-#5	101	261	273
	400	2.59	12 *	0.846		6-#6+ 1	4	#6	#7	7-#7	4	#5	#5	8-#5	125	333	336
	500	3.01	12 *	0.636		6-#6+ 0	4	#7	#7	7-#8	4	#5	#6	8-#5	148	404	399
22'-6"	50	1.79	12	0.635		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	61	122	164
D = 8.000	100	1.85	12	0.677		10-#5+ 0	4	#4	#5	7-#6	5	#4	#4	10-#5	78	156	210
RIB NOT ON	150	1.91	12	0.722		10-#5+ 0	4	#5	#5	7-#6	5	#4	#4	10-#5	95	215	255
COLUMN LINE	200	2.09	12	0.767		10-#5+ 0	4	#5	#6	6-#7	5	#4	#4	10-#5	112	269	301
0.766 CF/SF	300	2.67	12 *	0.880		10-#5+ 2	4	#6	#7	6-#8	5	#5	#5	10-#5	146	375	392
	400	3.21	12 *	0.636		10-#5+ 1	4	#7	#8	6-#9	5	#5	#6	10-#5	179	478	483
	500	3.91	15 *	0.632		6-#7+ 0	4	#8	#8	8-#9	5	#6	#6	10-#5	210	569	565
25'-0"	50	1.75	12	0.710		8-#6+ 0	5	#4	#4	8-#6	5	#4	#4	10-#5	86	171	231
D = 10.500	100	1.82	12	0.759		8-#6+ 0	5	#4	#5	8-#6	5	#4	#4	10-#5	109	219	294
RIB ON	150	2.18	12 *	0.828		8-#6+ 1	5	#5	#6	10-#6	5	#4	#5	10-#5	132	300	357
COLUMN LINE	200	2.47	12 *	0.884		8-#6+ 2	5	#6	#6	7-#8	5	#5	#5	10-#5	156	376	420
0.791 CF/SF	300	3.03	13 *	0.635		8-#6+ 2	5	#7	#7	7-#9	5	#5	#6	10-#5	202	521	544
	400	3.88	17 *	0.630		9-#6+ 2	5	#8	#8	9-#9	5	#6	#7	10-#5	243	641	655
27'-6"	50	1.81	13	0.715		8-#6+ 0	5	#4	#5	9-#6	6	#4	#4	12-#5	113	227	305
D = 10.500	100	2.03	13	0.801		8-#6+ 1	5	#5	#5	8-#7	6	#4	#4	12-#5	145	289	389
RIB ON	150	2.41	13 *	0.881		8-#6+ 3	5	#6	#6	8-#8	6	#4	#5	12-#5	176	393	473
COLUMN LINE	200	2.83	13 *	0.635		8-#6+ 2	5	#7	#7	7-#9	6	#5	#5	12-#5	207	494	557
0.777 CF/SF	300	3.77	18 *	0.629		7-#7+ 2	5	#8	#8	12-#8	6	#6	#6	12-#5	264	669	711
	400	4.34	22 *	0.625	3 S 4 1	12-#6+ 3	5	#8	#9	12-#9	6	#6	#7	12-#5	316	772	851
30'-0"	50	1.98	15	0.725		9-#6+ 0	5	#5	#5	8-#7	7	#4	#4	13-#5	146	291	392
D = 10.500	100	2.30	15 *	0.830		9-#6+ 2	5	#6	#6	8-#8	7	#4	#4	13-#5	186	372	501
RIB ON	150	2.71	15 *	0.904		9-#6+ 4	5	#7	#7	8-#9	7	#4	#5	13-#5	226	488	609
COLUMN LINE	200	3.27	17 *	0.630		7-#7+ 3	5	#7	#8	12-#8	7	#5	#5	13-#5	265	614	713
0.766 CF/SF	300	4.16	22 *	0.625	3 S 4 1	7-#8+ 2	5	#8	#9	16-#8	7	#6	#6	13-#5	336	773	905
32'-6"	50	2.13	16 *	0.818		10-#6+ 3	6	#5	#6	11-#7	7	#4	#4	13-#5	187	374	504
D = 13.000	100	2.50	16 *	0.892		10-#6+ 5	6	#6	#6	9-#9	7	#4	#5	13-#5	238	477	642
RIB NOT ON	150	3.01	18 *	0.629		11-#6+ 3	6	#7	#7	10-#9	7	#5	#5	13-#5	288	610	776
COLUMN LINE	200	3.85	21 *	0.626		10-#7+ 3	6	#8	#8	12-#9	7	#6	#6	13-#5	336	768	906
0.785 CF/SF																	
35'-0"	50	2.41	17 *	0.857		15-#5+ 7	6	#6	#6	10-#8	8	#4	#5	15-#5	233	466	627
D = 13.000	100	2.93	17 *	0.630		16-#5+ 5	6	#7	#7	11-#9	8	#5	#5	15-#5	297	594	800
RIB NOT ON	150	3.49	22 *	0.625		10-#7+ 3	6	#7	#8	13-#9	8	#5	#6	15-#5	357	731	960
COLUMN LINE	200	3.81	28 *	0.621		9-#8+ 1	6	#8	#8	15-#9	8	#5	#6	16-#5	408	816	1099
0.775 CF/SF																	
37'-6"	50	2.63	18 *	0.885		16-#5+ 9	6	#6	#7	10-#9	9	#4	#5	17-#5	286	571	769
D = 13.000	100	3.21	21 *	0.923		10-#7+ 7	6	#7	#8	13-#9	9	#5	#5	17-#5	362	724	974
RIB NOT ON	150	3.83	29 *	0.621		17-#6+ 5	6	#8	#8	16-#9	9	#5	#6	17-#5	430	860	1158
COLUMN LINE																	
0.766 CF/SF																	
40'-0"	50	2.96	20 *	0.906		19-#5+12	7	#7	#7	16-#8	9	#5	#5	17-#5	348	696	936
D = 15.500	100	3.61	27 *	0.622		17-#6+ 5	7	#7	#8	16-#9	9	#5	#6	17-#5	436	873	1175
RIB ON																	
COLUMN LINE																	
0.781 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 14 ½ in.	Rib Depth = 10 in.	Total Slab Depth = 4 ½ in.								
1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
1.97	12		4	#4	#5	7-#6	4	#4	#4	8-#5
2.24	12 *	3 S 4 1	4	#5	#5	9-#6	4	#4	#4	8-#5
2.61	12 *	3 S 4 1	4	#5	#6	6-#8	4	#4	#5	8-#5
1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
2.00	12		4	#4	#5	6-#7	5	#4	#4	10-#5
2.43	12 *	3 S 4 1	4	#5	#6	6-#8	5	#4	#4	10-#5
2.83	12 *	3 S 4 1	4	#6	#6	7-#8	5	#4	#5	10-#5
3.60	13 *	3 S 4 2	4	#7	#7	7-#9	5	#5	#5	10-#5
1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
2.01	12		5	#4	#5	7-#7	5	#4	#4	10-#5
2.19	12 *		5	#5	#5	8-#7	5	#4	#4	10-#5
2.65	12 *	3 S 4 1	5	#5	#6	8-#8	5	#4	#5	10-#5
3.37	14 *	3 S 4 1	5	#6	#7	8-#9	5	#5	#5	10-#5
1.77	13		5	#4	#4	8-#6	6	#4	#4	12-#5
2.04	13		5	#4	#5	8-#7	6	#4	#4	12-#5
2.26	13 *	3 S 4 1	5	#5	#5	7-#8	6	#4	#4	12-#5
2.53	13 *	3 S 4 1	5	#5	#6	11-#7	6	#4	#4	12-#5
3.43	14 *	3 S 4 1	5	#6	#7	9-#9	6	#5	#5	12-#5
3.87	19 *	3 S 4 2	5	#7	#7	11-#9	6	#5	#5	12-#5
1.98	15		5	#4	#5	8-#7	7	#4	#4	13-#5
2.26	15	3 S 4 1	5	#5	#5	8-#8	7	#4	#4	13-#5
2.49	15 *	3 S 4 1	5	#5	#6	7-#9	7	#4	#4	13-#5
3.13	15 *	3 S 4 1	5	#6	#7	9-#9	7	#4	#5	13-#5
3.81	19 *	3 S 4 2	5	#7	#7	12-#9	7	#5	#5	13-#5
2.04	16		6	#4	#5	10-#7	7	#4	#4	13-#5
2.36	16 *		6	#5	#5	10-#8	7	#4	#4	13-#5
2.78	16 *	3 S 4 1	6	#5	#6	12-#8	7	#4	#5	13-#5
3.52	16 *	3 S 4 1	6	#6	#7	12-#9	7	#5	#5	13-#5
2.31	17		6	#5	#5	10-#8	8	#4	#4	15-#5
2.66	17 *	3 S 4 1	6	#5	#6	10-#9	8	#4	#4	15-#5
3.25	17 *	3 S 4 1	6	#6	#7	12-#9	8	#4	#5	15-#5
3.48	22 *	3 S 4 2	6	#6	#7	14-#9	8	#4	#5	15-#5
2.54	18 *	3 S 4 1	6	#5	#6	12-#8	9	#4	#4	17-#5
2.96	18 *	3 S 4 1	6	#6	#6	16-#8	9	#4	#4	17-#5
3.62	20 *	3 S 4 2	6	#7	#7	15-#9	9	#4	#5	17-#5
2.71	20 *		7	#5	#6	12-#9	9	#4	#4	17-#5
3.40	20 *	3 S 4 1	7	#6	#7	15-#9	9	#4	#5	17-#5

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 16 ½ in.	Rib Depth = 12 in.	Total Slab Depth = 4 ½ in.																Total Depth = 16 ½ in.	Rib Depth = 12 in.	Total Slab Depth = 4 ½ in.								
22'-6"	50	1.79	12	0.638		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	66	132	177	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
D = 8.000	100	1.79	12	0.638		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	83	166	223	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
RIB NOT ON	150	1.85	12	0.638		10-#5+ 0	4	#4	#5	7-#6	5	#4	#4	10-#5	100	222	268	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
COLUMN LINE	200	2.05	12	0.675		10-#5+ 0	4	#5	#6	6-#7	5	#4	#4	10-#5	117	278	314	1.93	12		4	#4	#5	7-#6	5	#4	#4	10-#5
0.852 CF/SF	300	2.44	12	0.760		10-#5+ 0	4	#6	#7	7-#7	5	#4	#5	10-#5	150	384	405	2.18	12	4 S 6 1	4	#5	#5	9-#6	5	#4	#4	10-#5
	400	2.86	12 *	0.870		10-#5+ 2	4	#7	#7	7-#8	5	#5	#5	10-#5	184	488	496	2.56	12 *	4 S 6 1	4	#6	#6	6-#8	5	#4	#4	10-#5
	500	3.44	12 *	0.639		10-#5+ 1	4	#8	#8	8-#8	5	#5	#6	10-#5	218	591	587	3.07	12 *	4 S 6 1	4	#6	#7	6-#9	5	#4	#5	10-#5
25'-0"	50	1.75	12	0.638		8-#6+ 0	5	#4	#4	8-#6	5	#4	#4	10-#5	92	185	249	1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
D = 10.500	100	1.82	12	0.682		8-#6+ 0	5	#4	#5	8-#6	5	#4	#4	10-#5	116	232	312	1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
RIB ON	150	1.92	12	0.728		8-#6+ 0	5	#5	#5	9-#6	5	#4	#4	10-#5	139	311	375	1.80	12		5	#4	#4	12-#5	5	#4	#4	10-#5
COLUMN LINE	200	2.19	12	0.799		8-#6+ 1	5	#5	#6	8-#7	5	#4	#5	10-#5	163	388	438	2.01	12		5	#4	#5	7-#7	5	#4	#4	10-#5
0.881 CF/SF	300	2.85	12 *	0.639		8-#6+ 1	5	#6	#7	8-#8	5	#5	#6	10-#5	209	535	564	2.56	12 *	4 S 6 1	5	#5	#6	7-#8	5	#4	#5	10-#5
	400	3.48	12 *	0.639		8-#6+ 2	5	#7	#8	8-#9	5	#6	#6	10-#5	256	680	690	3.08	12 *	4 S 6 1	5	#6	#6	7-#9	5	#5	#5	10-#5
	500	4.05	16 *	0.633		7-#7+ 2	5	#8	#8	9-#9	5	#6	#7	10-#5	298	805	802	3.68	13 *	4 S 6 1	5	#6	#7	9-#9	5	#5	#6	10-#5
27'-6"	50	1.79	13	0.638		8-#6+ 0	5	#4	#5	8-#6	6	#4	#4	12-#5	122	245	329	1.77	13		5	#4	#4	8-#6	6	#4	#4	12-#5
D = 10.500	100	1.93	13	0.695		8-#6+ 0	5	#5	#5	10-#6	6	#4	#4	12-#5	153	307	413	1.88	13		5	#4	#4	7-#7	6	#4	#4	12-#5
RIB ON	150	2.20	13	0.801		8-#6+ 2	5	#5	#6	7-#8	6	#4	#5	12-#5	185	408	497	2.04	13		5	#4	#5	8-#7	6	#4	#4	12-#5
COLUMN LINE	200	2.68	13 *	0.861		8-#6+ 3	5	#6	#7	8-#8	6	#5	#5	12-#5	216	511	581	2.47	13	4 S 6 1	5	#5	#6	8-#8	6	#4	#4	12-#5
0.865 CF/SF	300	3.31	13 *	0.637		9-#6+ 2	5	#7	#8	9-#9	6	#5	#6	12-#5	278	707	749	2.94	13 *	4 S 6 1	5	#6	#6	8-#9	6	#4	#5	12-#5
	400	4.14	17 *	0.632	4 S 6 1	8-#7+ 2	5	#8	#9	13-#8	6	#6	#7	12-#5	335	879	902	3.60	14 *	4 S 6 2	5	#7	#7	12-#8	6	#5	#5	12-#5
	500	4.66	21 *	0.628	4 S 6 1	7-#8+ 2	5	#9	#9	12-#9	6	#6	#7	13-#5	385	987	1037	4.21	19 *	4 S 6 2	5	#7	#8	11-#9	6	#5	#6	12-#5
30'-0"	50	1.91	15	0.652		9-#6+ 0	5	#5	#5	8-#7	7	#4	#4	13-#5	157	314	423	1.83	15		5	#4	#4	7-#7	7	#4	#4	13-#5
D = 10.500	100	2.13	15	0.716		9-#6+ 0	5	#5	#6	7-#8	7	#4	#4	13-#5	197	395	531	2.09	15		5	#4	#5	7-#8	7	#4	#4	13-#5
RIB ON	150	2.55	15 *	0.820		9-#6+ 2	5	#6	#7	7-#9	7	#4	#5	13-#5	238	510	640	2.37	15	4 S 6 1	5	#5	#6	8-#8	7	#4	#4	13-#5
COLUMN LINE	200	2.94	15 *	0.892		9-#6+ 4	5	#7	#7	9-#9	7	#5	#5	13-#5	278	643	748	2.70	15 *	4 S 6 1	5	#6	#6	8-#9	7	#4	#4	13-#5
0.852 CF/SF	300	3.97	18 *	0.631	4 S 6 1	12-#6+ 2	5	#8	#9	11-#9	7	#6	#6	13-#5	355	887	957	3.54	15 *	4 S 6 2	5	#7	#7	10-#9	7	#5	#5	13-#5
	400	4.73	23 *	0.627	4 S 6 1	8-#8+ 2	5	#9	#10	14-#9	7	#6	#7	14-#5	424	1049	1141	4.07	19 *	4 S 6 2	5	#7	#8	16-#8	7	#5	#5	13-#5
32'-6"	50	2.01	16	0.745		10-#6+ 2	6	#5	#5	10-#7	7	#4	#4	13-#5	202	404	544	1.99	16		6	#4	#5	9-#7	7	#4	#4	13-#5
D = 13.000	100	2.43	16 *	0.831		10-#6+ 4	6	#6	#6	10-#8	7	#4	#5	13-#5	253	507	682	2.29	16		6	#5	#5	9-#8	7	#4	#4	13-#5
RIB NOT ON	150	2.82	16 *	0.895		10-#6+ 6	6	#6	#7	9-#9	7	#5	#5	13-#5	305	644	820	2.65	16 *	4 S 6 1	6	#5	#6	9-#9	7	#4	#4	13-#5
COLUMN LINE	200	3.34	17 *	0.632		12-#6+ 2	6	#7	#8	11-#9	7	#5	#6	13-#5	355	813	956	2.97	16 *	4 S 6 1	6	#6	#6	10-#9	7	#4	#5	13-#5
0.874 CF/SF	300	4.40	23 *	0.627		11-#7+ 3	6	#8	#9	14-#9	7	#6	#7	15-#5	447	1076	1204	3.99	18 *	4 S 6 2	6	#7	#7	13-#9	7	#5	#6	14-#5

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 16 ½ in.	Rib Depth = 12 in.	Total Slab Depth = 4 ½ in.																Total Depth = 16 ½ in.	Rib Depth = 12 in.	Total Slab Depth = 4 ½ in.								
35'-0"	50	2.26	17	0.769		15-#5+ 3	6	#6	#6	10-#8	8	#4	#4	15-#5	251	502	676	2.15	17		6	#4	#5	9-#8	8	#4	#4	15-#5
D = 13.000	100	2.67	17 *	0.864		15-#5+ 7	6	#6	#7	12-#8	8	#4	#5	15-#5	315	631	849	2.58	17 *	4 S 6 1	6	#5	#6	9-#9	8	#4	#4	15-#5
RIB NOT ON	150	3.19	17 *	0.632		9-#7+ 4	6	#7	#8	12-#9	8	#5	#5	15-#5	379	783	1022	2.91	17 *	4 S 6 1	6	#6	#6	11-#9	8	#4	#4	15-#5
COLUMN LINE	200	3.76	21 *	0.628		11-#7+ 3	6	#8	#8	14-#9	8	#6	#6	15-#5	439	986	1182	3.31	17 *	4 S 6 1	6	#6	#7	16-#8	8	#4	#5	15-#5
0.862 CF/SF	300	4.50	28 *	0.623		10-#8+ 3	6	#8	#9	18-#9	8	#6	#6	18-#5	546	1092	1470	4.21	24 *	4 S 6 2	6	#7	#7	17-#9	8	#5	#5	17-#5
37'-6"	50	2.60	18 *	0.829		16-#5+ 7	6	#6	#7	9-#9	9	#4	#5	17-#5	308	616	829	2.52	18		6	#5	#6	9-#9	9	#4	#4	17-#5
D = 13.000	100	3.02	18 *	0.917		10-#7+ 6	6	#7	#7	12-#9	9	#5	#5	17-#5	387	774	1042	2.82	18 *	4 S 6 1	6	#6	#6	11-#9	9	#4	#4	17-#5
RIB NOT ON	150	3.65	21 *	0.628		22-#5+ 5	6	#8	#8	15-#9	9	#5	#6	17-#5	463	925	1245	3.36	18 *	4 S 6 2	6	#6	#7	14-#9	9	#4	#5	17-#5
COLUMN LINE	200	4.13	25 *	0.625		10-#8+ 3	6	#8	#9	17-#9	9	#6	#6	18-#5	533	1104	1436	3.69	20 *	4 S 6 2	6	#7	#7	16-#9	9	#4	#5	17-#5
0.852 CF/SF																												
40'-0"	50	2.74	20 *	0.859		18-#5+11	7	#6	#7	12-#9	9	#4	#5	17-#5	375	750	1010	2.64	20		7	#5	#6	11-#9	9	#4	#4	17-#5
D = 15.500	100	3.46	21 *	0.926		12-#7+ 8	7	#7	#8	15-#9	9	#5	#6	17-#5	470	939	1265	3.14	20 *	4 S 6 1	7	#6	#6	14-#9	9	#4	#5	17-#5
RIB ON	150	4.07	26 *	0.625		14-#7+ 4	7	#8	#8	18-#9	9	#6	#6	19-#5	559	1117	1504	3.75	20 *	4 S 6 1	7	#6	#7	17-#9	9	#5	#5	17-#5
COLUMN LINE																												
0.870 CF/SF																												
42'-6"	50	3.04	21 *	0.887		11-#7+ 6	7	#7	#7	14-#9	10	#5	#5	18-#5	449	897	1208	2.85	21 *	4 S 6 1	7	#6	#6	13-#9	10	#4	#4	18-#5
D = 15.500	100	3.75	25 *	0.916		14-#7+ 8	7	#8	#8	18-#9	10	#5	#6	19-#5	559	1117	1504	3.46	21 *	4 S 6 1	7	#6	#7	17-#9	10	#4	#5	18-#5
RIB ON	150	4.40	33 *	0.621		32-#5+ 7	7	#8	#9	21-#9	10	#6	#6	22-#5	655	1311	1764	4.10	25 *	4 S 6 2	7	#7	#7	20-#9	10	#5	#5	21-#5
COLUMN LINE																												
0.860 CF/SF																												
45'-0"	50	3.41	22 *	0.924		13-#7+ 9	7	#8	#8	17-#9	11	#5	#5	20-#5	531	1062	1430	3.14	22 *	4 S 6 1	7	#6	#7	16-#9	11	#4	#4	20-#5
D = 15.500	100	4.06	30 *	0.622		32-#5+ 7	7	#8	#9	22-#9	11	#5	#6	22-#5	657	1314	1768	3.75	22 *	4 S 6 2	7	#7	#7	20-#9	11	#4	#5	21-#5
RIB ON																												
COLUMN LINE																												
0.852 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 18 ½ in.		Rib Depth = 14 in.		Total Slab Depth = 4 ½ in.													
25'-0"	50	1.99	12	0.641		8-#6+ 0	5	#4	#5	8-#6	5	#4	#5	10-#5	99	199	268
D = 10.500	100	1.99	12	0.641		8-#6+ 0	5	#4	#5	8-#6	5	#4	#5	10-#5	123	246	331
RIB ON	150	2.06	12	0.645		8-#6+ 0	5	#5	#5	12-#5	5	#4	#5	10-#5	146	320	394
COLUMN LINE	200	2.21	12	0.689		8-#6+ 0	5	#5	#6	7-#7	5	#4	#5	10-#5	170	399	457
0.973 CF/SF	300	2.68	12	0.822		8-#6+ 2	5	#6	#7	7-#8	5	#5	#5	10-#5	216	548	583
	400	3.10	12 *	0.642		8-#6+ 2	5	#7	#7	7-#9	5	#5	#6	10-#5	263	693	709
	500	3.73	12 *	0.642		9-#6+ 2	5	#7	#8	8-#9	5	#6	#7	10-#5	310	836	835
27'-6"	50	1.97	13	0.639		8-#6+ 0	5	#4	#5	8-#6	6	#4	#5	12-#5	131	263	354
D = 10 .500	100	2.09	13	0.639		8-#6+ 0	5	#5	#5	7-#7	6	#4	#5	12-#5	163	325	438
RIB ON	150	2.23	13	0.667		8-#6+ 0	5	#5	#6	8-#7	6	#4	#5	12-#5	194	421	522
COLUMN LINE	200	2.44	13	0.777		8-#6+ 2	5	#6	#6	7-#8	6	#4	#5	12-#5	225	525	606
0.955 CF/SF	300	3.09	13 *	0.887		8-#6+ 4	5	#7	#7	8-#9	6	#5	#6	12-#5	287	723	774
	400	3.77	13 *	0.640		7-#7+ 3	5	#8	#8	9-#9	6	#6	#6	12-#5	350	917	942
	500	4.51	16 *	0.636	4 S 6 1	12-#6+ 2	5	#9	#9	11-#9	6	#6	#7	12-#5	407	1089	1095
30'-0"	50	2.06	15	0.636		9-# 6+ 0	5	#5	#5	7-#7	7	#4	#5	13-#5	169	338	455
D = 10.500	100	2.21	15	0.636		9-#6+ 0	5	#5	#6	7-#8	7	#4	#5	13-#5	209	418	563
RIB ON	150	2.44	15	0.727		9-#6+ 1	5	#6	#6	8-#8	7	#4	#5	13-#5	249	529	672
COLUMN LINE	200	2.77	15 *	0.817		9-#6+ 3	5	#7	#7	8-#9	7	#4	#5	13-#5	290	665	780
0.940 CF/SF	300	3.49	15 *	0.637		8-#7+ 2	5	#8	#8	10-#9	7	#5	#6	13-#5	370	919	997
	400	4.44	18 *	0.634	4 S 6 1	7-#8+ 0	5	#9	#9	12-#9	7	#6	#7	13-#5	447	1159	1203
	500	5.02	22 *	0.630	4 S 6 1	11-#7+ 1	5	#9	#10	18-#8	7	#6	#7	15-#5	514	1324	1385
32'-6"	50	2.12	16	0.659		10-#6+ 1	6	#5	#5	9-#7	7	#4	#5	13-#5	217	435	585
D = 13.000	100	2.32	16	0.761		10-#6+ 3	6	#5	#6	9-#8	7	#4	#5	13-#5	269	537	723
RIB NOT ON	150	2.65	16 *	0.837		10-#6+ 5	6	#6	#7	9-#9	7	#4	#5	13-#5	320	671	861
COLUMN LINE	200	3.15	16 *	0.895		11-#6+ 6	6	#7	#7	10-#9	7	#5	#6	13-#5	371	845	999
0.965 CF/SF	300	4.17	18 *	0.634		10-#7+ 3	6	#8	#9	16-#8	7	#6	#7	14-#5	471	1162	1269
	400	4.88	23 *	0.629		9-#8+ 2	6	#9	#9	16-#9	7	#7	#7	16-#5	559	1381	1506
35'-0"	50	2.28	17	0.677		15-#5+ 1	6	#5	#6	9-#8	8	#4	#5	15-#5	270	540	727
D = 13.000	100	2.59	17 *	0.796		15-#5+ 5	6	#6	#7	9-#9	8	#4	#5	15-#5	334	668	900
RIB NOT ON	150	3.00	17 *	0.877		12-#6+ 5	6	#7	#7	11-#9	8	#5	#5	15-#5	398	819	1072
COLUMN LINE	200	3.57	17 *	0.635		10-#7+ 3	6	#8	#8	16-#8	8	#5	#6	15-#5	462	1037	1245
0.952 CF/SF	300	4.65	23 *	0.629		17-#6+ 3	6	#9	#9	16-#9	8	#6	#7	17-#5	580	1397	1562

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 18 ½ in.		Rib Depth = 14 in.		Total Slab Depth = 4 ½ in.						
1.99	12		5	#4	#5	8-#6	5	#4	#5	10-#5
1.99	12		5	#4	#5	8-#6	5	#4	#5	10-#5
1.99	12		5	#4	#5	8-#6	5	#4	#5	10-#5
2.07	12		5	#4	#5	9-#6	5	#4	#5	10-#5
2.42	12		5	#5	#5	7-#8	5	#4	#5	10-#5
2.79	12 *	4 S 6 1	5	#6	#6	8-#8	5	#4	#5	10-#5
3.36	12 *	4 S 6 1	5	#6	#7	8-#9	5	#5	#5	10-#5
1.98	13		5	#4	#5	8-#6	6	#4	#5	12-#5
2.06	13		5	#4	#5	9-#6	6	#4	#5	12-#5
2.15	13		5	#4	#5	8-#7	6	#4	#5	12-#5
2.37	13		5	#5	#5	7-#8	6	#4	#5	12-#5
2.84	13 *	4 S 6 1	5	#6	#6	7-#9	6	#4	#5	12-#5
3.42	13 *	4 S 6 1	5	#6	#7	9-#9	6	#5	#5	12-#5
4.01	14 *	4 S 6 2	5	#7	#8	10-#9	6	#5	#6	12-#5
2.01	15		5	#4	#5	9-#6	7	#4	#5	13-#5
2.10	15		5	#4	#5	8-#7	7	#4	#5	13-#5
2.38	15		5	#5	#5	8-#8	7	#4	#5	13-#5
2.61	15	4 S 6 1	5	#5	#6	7-#9	7	#4	#5	13-#5
3.13	15 *	4 S 6 1	5	#6	#7	9-#9	7	#4	#5	13-#5
3.98	15 *	4 S 6 2	5	#7	#8	12-#9	7	#5	#5	13-#5
4.60	19 *	4 S 6 2	5	#8	#8	14-#9	7	#5	#6	14-#5
2.10	16		6	#4	#5	9-#7	7	#4	#5	13-#5
2.24	16		6	#4	#5	11-#7	7	#4	#5	13-#5
2.47	16		6	#5	#5	10-#8	7	#4	#5	13-#5
2.89	16 *	4 S 6 1	6	#6	#6	9-#9	7	#4	#5	13-#5
3.67	16 *	4 S 6 1	6	#7	#7	12-#9	7	#5	#5	13-#5
4.30	20 *	4 S 6 2	6	#7	#8	18-#8	7	#5	#6	15-#5
2.22	17		6	#4	#5	11-#7	8	#4	#5	15-#5
2.43	17		6	#5	#5	10-#8	8	#4	#5	15-#5
2.78	17 *	4 S 6 1	6	#5	#6	10-#9	8	#4	#5	15-#5
3.25	17 *	4 S 6 1	6	#6	#7	12-#9	8	#4	#5	15-#5
4.25	18 *	4 S 6 2	6	#7	#8	15-#9	8	#5	#6	16-#5

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 18 ½ in.	Rib Depth = 14 in.	Total Slab Depth = 4 ½ in.															
37'-6"	50	2.54	18	0.739		16-#5+ 3	6	#6	#7	9-#9	9	#4	#5	17-#5	331	662	891
D = 13.000	100	2.84	18 *	0.848		12-#6+ 5	6	#7	#7	11-#9	9	#4	#5	17-#5	410	820	1104
RIB NOT ON	150	3.38	18 *	0.634		11-#7+ 3	6	#7	#8	14-#9	9	#5	#5	17-#5	489	980	1316
COLUMN LINE	200	3.93	21 *	0.631		9-#8+ 2	6	#8	#9	16-#9	9	#5	#6	17-#5	564	1242	1518
0.940 CF/SF	300	5.06	28 *	0.626	4 S 6 1	9-#9+ 2	6	#9	#10	20-#9	9	#6	#7	21-#5	700	1504	1886
40'-0"	50	2.67	20 *	0.808		12-#6+ 7	7	#6	#7	11-#9	9	#4	#5	17-#5	404	807	1087
D = 15.500	100	3.17	20 *	0.890		11-#7+ 6	7	#7	#7	14-#9	9	#5	#5	17-#5	499	998	1344
RIB ON	150	3.75	21 *	0.631		13-#7+ 4	7	#8	#8	17-#9	9	#5	#6	17-#5	593	1187	1597
COLUMN LINE	200	4.36	25 *	0.628		11-#8+ 3	7	#8	#9	19-#9	9	#6	#6	20-#5	682	1447	1837
0.960 CF/SF																	
42'-6"	50	2.96	21 *	0.837		14-#6+ 7	7	#7	#7	13-#9	10	#5	#5	18-#5	482	965	1299
D = 15.500	100	3.63	21 *	0.631		13-#7+ 4	7	#8	#8	17-#9	10	#5	#6	18-#5	597	1194	1607
RIB ON	150	4.30	25 *	0.628		12-#8+ 2	7	#8	#9	20-#9	10	#6	#6	21-#5	706	1411	1900
COLUMN LINE	200	4.78	30 *	0.624	4 S 6 1	11-#9+ 2	7	#9	#9	23-#9	10	#6	#6	24-#5	806	1611	2169
0.950 CF/SF																	
45'-0"	50	3.32	22 *	0.879		17-#6+ 9	7	#7	#8	16-#9	11	#5	#5	20-#5	571	1142	1537
D = 15.500	100	3.92	24 *	0.628		12-#8+ 2	7	#8	#9	20-#9	11	#5	#6	21-#5	704	1409	1897
RIB ON	150	4.63	30 *	0.624	4 S 6 1	11-#9+ 3	7	#9	#9	24-#9	11	#6	#6	24-#5	829	1657	2231
COLUMN LINE																	
0.940 CF/SF																	
47'-6"	50	3.66	23 *	0.922		12-#8+ 8	8	#8	#8	19-#9	11	#5	#6	20-#5	677	1354	1822
D = 18.000	100	4.39	29 *	0.625		14-#8+ 4	8	#8	#9	24-#9	11	#6	#6	24-#5	828	1655	2228
RIB NOT ON																	
COLUMN LINE																	
0.957 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 18 ½ in.	Rib Depth = 14 in.	Total Slab Depth = 4 ½ in.								
2.39	18		6	#5	#5	10-#8	9	#4	#5	17-#5
2.72	18	4 S 6 1	6	#5	#6	10-#9	9	#4	#5	17-#5
3.21	18 *	4 S 6 1	6	#6	#7	16-#8	9	#4	#5	17-#5
3.61	18 *	4 S 6 2	6	#7	#7	15-#9	9	#4	#5	17-#5
4.58	23 *	4 S 6 2	6	#8	#8	19-#9	9	#5	#5	19-#5
2.56	20		7	#5	#5	13-#8	9	#4	#5	17-#5
3.01	20 *	4 S 6 1	7	#6	#6	16-#8	9	#4	#5	17-#5
3.40	20 *	4 S 6 1	7	#6	#7	15-#9	9	#4	#5	17-#5
4.02	20*	4 S 6 2	7	#7	#7	18-#9	9	#5	#5	19-#5
2.75	21		7	#5	#6	12-#9	10	#4	#5	18-#5
3.29	21 *	4 S 6 1	7	#6	#7	15-#9	10	#4	#5	18-#5
3.97	21 *	4 S 6 2	7	#7	#7	19-#9	10	#5	#5	19-#5
4.45	24 *	4 S 6 2	7	#7	#8	22-#9	10	#5	#5	22-#5
3.21	22 *	4 S 6 1	7	#6	#7	15-#9	11	#4	#5	20-#5
3.56	22 *	4 S 6 1	7	#7	#7	18-#9	11	#4	#5	20-#5
4.30	23 *	4 S 6 2	7	#7	#8	22-#9	11	#5	#5	23-#5
3.31	23 *	4 S 6 1	8	#6	#7	17-#9	11	#4	#5	20-#5
4.06	23 *	4 S 6 1	8	#7	#7	22-#9	11	#5	#5	23-#5

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 20 ½ in.		Rib Depth = 16 in.		Total Slab Depth = 4 ½ in.													
27'-6"	50	1.97	13	0.641		8-#6+ 0	5	#4	#5	8-#6	6	#4	#5	12-#5	141	282	380
D = 10.500	100	1.99	13	0.641		8-#6+ 0	5	#4	#5	9-#6	6	#4	#5	12-#5	172	344	463
RIB ON	150	2.13	13	0.641		8-#6+ 0	5	#5	#5	8-#7	6	#4	#5	12-#5	203	433	547
COLUMN LINE	200	2.38	13	0.669		8-#6+ 1	5	#6	#6	7-#8	6	#4	#5	12-#5	235	539	631
1.047 CF/SF	300	2.85	13	0.806		8-#6+ 3	5	#7	#7	7-#9	6	#5	#5	12-#5	297	739	799
	400	3.38	13 *	0.642		9-#6+ 2	5	#7	#8	9-#9	6	#5	#6	12-#5	359	934	967
	500	4.11	13 *	0.642		8-#7+ 2	5	#8	#9	10-#9	6	#6	#7	12-#5	422	1126	1135
30'-0"	50	2.06	15	0.638		9-#6+ 0	5	#5	#5	7-#7	7	#4	#5	13-#5	181	362	487
D = 10.500	100	2.21	15	0.638		9-#6+ 0	5	#5	#6	7-#8	7	#4	#5	13-#5	221	443	596
RIB ON	150	2.40	15	0.638		9-#6+ 0	5	#6	#6	8-#8	7	#4	#5	13-#5	262	546	704
COLUMN LINE	200	2.61	15	0.702		9-#6+ 1	5	#6	#7	7-#9	7	#4	#5	13-#5	302	684	813
1.031 CF/SF	300	3.28	15 *	0.843		7-#7+ 2	5	#7	#8	9-#9	7	#5	#6	13-#5	382	942	1030
	400	3.97	15 *	0.639	4 S 6 1	12-#6+ 1	5	#8	#9	11-#9	7	#6	#6	13-#5	463	1193	1247
	500	4.82	17 *	0.637	4 S 6 1	8-#8+ 2	5	#9	#10	13-#9	7	#6	#7	14-#5	540	1432	1455
32'-6"	50	2.09	16	0.637		10-#6+ 1	6	#5	#5	9-#7	7	#4	#5	13-#5	233	466	627
D = 13.000	100	2.26	16	0.678		10-#6+ 2	6	#5	#6	11-#7	7	#4	#5	13-#5	284	569	765
RIB NOT ON	150	2.49	16	0.751		10-#6+ 3	6	#6	#6	10-#8	7	#4	#5	13-#5	336	694	904
COLUMN LINE	200	2.96	16 *	0.826		10-#6+ 5	6	#7	#7	9-#9	7	#5	#5	13-#5	387	870	1042
1.059 CF/SF	300	3.80	16 *	0.638		9-#7+ 2	6	#8	#8	12-#9	7	#6	#6	13-#5	490	1199	1318
	400	4.76	19 *	0.635		11-#7+ 3	6	#9	#9	18-#8	7	#7	#7	15-#5	587	1506	1581
	500	5.53	23 *	0.631		10-#8+ 1	6	#9	#10	17-#9	7	#7	#8	13-#6	674	1726	1815
35'-0"	50	2.24	17	0.636		15-#5+ 1	6	#5	#6	11-#7	8	#4	#5	15-#5	290	579	779
D = 13.000	100	2.51	17	0.712		15-#5+ 3	6	#6	#6	9-#9	8	#4	#5	15-#5	354	707	952
RIB NOT ON	150	2.75	17 *	0.818		11-#6+ 5	6	#6	#7	10-#9	8	#4	#5	15-#5	418	850	1125
COLUMN LINE	200	3.34	17 *	0.878		9-#7+ 4	6	#7	#8	12-#9	8	#5	#6	15-#5	482	1071	1298
1.044 CF/SF	300	4.47	18 *	0.636		9-#8+ 1	6	#9	#9	15-#9	8	#6	#7	16-#5	609	1477	1639
	400	5.23	24 *	0.630		14-#7+ 2	6	#9	#10	18-#9	8	#7	#7	19-#5	720	1778	1938
37'-6"	50	2.46	18	0.644		16-#5+ 1	6	#6	#6	9-#9	9	#4	#5	17-#5	355	710	955
D = 13.000	100	2.77	18 *	0.781		16-#5+ 6	6	#7	#7	10-#9	9	#4	#5	17-#5	434	867	1168
RIB NOT ON	150	3.23	18 *	0.858		10-#7+ 3	6	#7	#8	16-#8	9	#5	#5	17-#5	513	1025	1380
COLUMN LINE	200	3.79	18 *	0.636		22-#5+ 3	6	#8	#9	15-#9	9	#5	#6	17-#5	592	1295	1593
1.031 CF/SF	300	4.96	23 *	0.631		11-#8+ 3	6	#9	#10	19-#9	9	#6	#7	19-#5	741	1777	1994
	400	5.72	29 *	0.627	4 S 6 1	10-#9+ 1	6	#10	#10	22-#9	9	#7	#7	23-#5	870	1943	2341
40'-0"	50	2.61	20	0.703		12-#6+ 3	7	#6	#7	13-#8	9	#4	#5	17-#5	433	866	1165
D = 15.500	100	3.03	20 *	0.837		14-#6+ 7	7	#7	#7	16-#8	9	#5	#5	17-#5	528	1057	1422
RIB ON	150	3.46	20 *	0.903		12-#7+ 6	7	#7	#8	15-#9	9	#5	#6	17-#5	624	1248	1680
COLUMN LINE	200	4.25	21 *	0.633		14-#7+ 4	7	#8	#9	18-#9	9	#6	#6	19-#5	718	1522	1932
1.053 CF/SF	300	5.38	28 *	0.628	4 S 6 1	13-#8+ 2	7	#9	#10	28-#8	9	#7	#7	23-#5	888	1961	2391
42'-6"	50	2.85	21 *	0.769		19-#5+ 7	7	#7	#7	16-#8	10	#4	#5	18-#5	517	1034	1392
D = 15.500	100	3.28	21 *	0.876		12-#7+ 6	7	#7	#8	16-#9	10	#5	#5	18-#5	632	1264	1701
RIB ON	150	3.86	21 *	0.633		11-#8+ 3	7	#8	#8	19-#9	10	#5	#6	19-#5	746	1493	2010
COLUMN LINE	200	4.61	25 *	0.630		13-#8+ 2	7	#9	#9	22-#9	10	#6	#6	22-#5	854	1766	2299
1.041 CF/SF	300	5.52	33 *	0.625	4 S 6 1	16-#8+ 3	7	#9	#10	27-#9	10	#6	#7	20-#6	1048	2095	2821
45'-0"	50	3.19	22 *	0.828		12-#7+ 5	7	#7	#8	15-#9	11	#5	#5	20-#5	612	1224	1648
D = 15.500	100	3.75	22 *	0.915		11-#8+ 6	7	#8	#8	19-#9	11	#5	#6	20-#5	748	1497	2015
RIB ON	150	4.51	25 *	0.630		13-#8+ 2	7	#9	#9	22-#9	11	#6	#6	23-#5	879	1759	2367
COLUMN LINE	200	5.02	30 *	0.626	4 S 6 1	12-#9+ 2	7	#9	#10	26-#9	11	#6	#6	26-#5	1001	2001	2694
1.031 CF/SF																	
47'-6"	50	3.45	23 *	0.878		14-#7+ 8	8	#7	#8	18-#9	11	#5	#6	20-#5	726	1451	1954
D = 18.000	100	4.28	25 *	0.630		13-#8+ 4	8	#8	#9	22-#9	11	#6	#6	23-#5	883	1765	2377
RIB NOT ON	150	4.92	30 *	0.626		12-#9+ 2	8	#9	#9	26-#9	11	#6	#7	27-#5	1033	2065	2780
COLUMN LINE	200	5.51	36 *	0.623		14-#9+ 3	8	#9	#10	30-#9	11	#6	#7	22-#6	1166	2333	3140
1.050 CF/SF																	

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 20 ½ in.		Rib Depth = 16 in.		Total Slab Depth = 4 ½ in.							
27'-6"	1.98	13		5	#4	#5	8-#6	6	#4	#5	12-#5
D = 10.500	1.98	13		5	#4	#5	8-#6	6	#4	#5	12-#5
RIB ON	2.09	13		5	#4	#5	7-#7	6	#4	#5	12-#5
COLUMN LINE	2.26	13		5	#5	#5	8-#7	6	#4	#5	12-#5
1.047 CF/SF	2.58	13	4 S 6 1	5	#5	#6	8-#8	6	#4	#5	12-#5
	3.09	13 *	4 S 6 1	5	#6	#7	8-#9	6	#4	#5	12-#5
	3.57	13 *	4 S 6 1	5	#7	#7	9-#9	6	#5	#5	12-#5
30'-0"	2.01	15		5	#4	#5	9-#6	7	#4	#5	13-#5
D = 10.500	2.10	15		5	#4	#5	8-#7	7	#4	#5	13-#5
RIB ON	2.30	15		5	#5	#5	7-#8	7	#4	#5	13-#5
COLUMN LINE	2.50	15	4 S 6 1	5	#5	#6	8-#8	7	#4	#5	13-#5
1.031 CF/SF	2.98	15*	4 S 6 1	5	#6	#7	8-#9	7	#4	#5	13-#5
	3.54	15 *	4 S 6 2	5	#7	#7	10-#9	7	#5	#5	13-#5
	4.29	15 *	4 S 6 2	5	#8	#8	12-#9	7	#5	#6	13-#5
32'-6"	2.04	16		6	#4	#5	11-#6	7	#4	#5	13-#5
D = 13.000	2.16	16		6	#4	#5	10-#7	7	#4	#5	13-#5
RIB NOT ON	2.40	16		6	#5	#5	9-#8	7	#4	#5	13-#5
COLUMN LINE	2.76	16		6	#5	#6	9-#9	7	#4	#5	13-#5
1.059 CF/SF	3.43	16 *	4 S 6 1	6	#6	#7	11-#9	7	#5	#5	13-#5
	4.24	16 *	4 S 6 2	6	#7	#8	14-#9	7	#5	#6	14-#5
	4.92	20 *	4 S 6 2	6	#8	#8	16-#9	7	#6	#6	16-#5
35'-0"	2.16	17		6	#4	#5	14-#6	8	#4	#5	15-#5
D = 13.000	2.43	17		6	#5	#5	10-#8	8	#4	#5	15-#5
RIB NOT ON	2.70	17		6	#5	#6	9-#9	8	#4	#5	15-#5
COLUMN LINE	3.03	17 *	4 S 6 1	6	#6	#6	11-#9	8	#4	#5	15-#5
1.044 CF/SF	3.94	17 *	4 S 6 2	6	#7	#8	14-#9	8	#5	#5	15-#5
	4.69	20 *	4 S 6 2	6	#8	#8	17-#9	8	#5	#6	18-#5
37'-6"	2.39	18		6	#5	#5	10-#8	9	#4	#5	17-#5
D = 13.000	2.66	18		6	#5	#6	12-#8	9	#4	#5	17-#5
RIB NOT ON	3.03	18 *	4 S 6 1	6	#6	#6	12-#9	9	#4	#5	17-#5
COLUMN LINE	3.41	18 *	4 S 6 1	6	#7	#7	13-#9	9	#4	#5	17-#5
1.031 CF/SF	4.49	18 *	4 S 6 2	6	#8	#8	17-#9	9	#5	#6	18-#5
	5.20	25 *	4 S 6 2	6	#8	#9	21-#9	9	#5	#6	21-#5
40'-0"	2.47	20		7	#5	#5	12-#8	9	#4	#5	17-#5
D = 15.500	2.83	20		7	#5	#6	12-#9	9	#4	#5	17-#5
RIB ON	3.14	20 *	4 S 6 1	7	#6	#6	14-#9	9	#4	#5	17-#5
COLUMN LINE	3.90	20 *	4 S 6 1	7	#7	#7	17-#9	9	#5	#5	17-#5
1.053 CF/SF	4.88	23 *	4 S 6 2	7	#8	#8	21-#9	9	#5	#6	22-#5
42'-6"	2.75	21		7	#5	#6	12-#9	10	#4	#5	18-#5
D = 15.500	3.04	21 *	4 S 6 1	7	#6	#6	14-#9	10	#4	#5	18-#5
RIB ON	3.59	21 *	4 S 6 1	7	#7	#7	17-#9	10	#4	#5	18-#5
COLUMN LINE	4.24	21 *	4 S 6 2	7	#7	#8	20-#9	10	#5	#5	21-#5
1.041 CF/SF	5.15	28 *	4 S 6 2	7	#8	#8	25-#9	10	#5	#6	18-#6
45'-0"	2.98	22	4 S 6 1	7	#6	#6	14-#9	11	#4	#5	20-#5
D = 15.500	3.50	22 *	4 S 6 1	7	#7	#7	17-#9	11	#4	#5	20-#5
RIB ON	4.18	22 *	4 S 6 2	7	#7	#8	21-#9	11	#5	#5	21-#5
COLUMN LINE	4.66	24 *	4 S 6 2	7	#8	#8	24-#9	11	#5	#5	25-#5
1.031 CF/SF											
47'-6"	3.17	23 *		8	#6	#6	17-#9	11	#4	#5	20-#5
D = 18.000	3.95	23 *	4 S 6 1	8	#7	#7	21-#9	11	#5	#5	21-#5
RIB NOT ON	4.53	23 *	4 S 6 2	8	#7	#8	25-#9	11	#5	#5	26-#5
COLUMN LINE	5.16	28 *	4 S 6 2	8	#8	#8	28-#9	11	#5	#6	21-#6
1.050 CF/SF											

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments –M Edge (ft-k)	Moments +M Bot. (ft-k)	Moments –M Int. (ft-k)
Total Depth = 24 ½ in.		Rib Depth = 20 in.		Total Slab Depth = 4 ½ in.													
32'-6"	50	2.29	16	0.641		10-#6+ 0	6	#5	#5	9-#7	7	#5	#5	13-#5	266	532	716
D = 13.000	100	2.43	16	0.641		10-#6+ 0	6	#5	#6	10-#7	7	#5	#5	13-#5	317	634	854
RIB NOT ON	150	2.53	16	0.641		10-#6+ 0	6	#5	#6	9-#8	7	#5	#5	13-#5	368	737	992
COLUMN LINE	200	2.77	16	0.641		10-#6+ 1	6	#6	#7	10-#8	7	#5	#5	13-#5	420	917	1130
1.253 CF/SF	300	3.33	16	0.759		11-#6+ 2	6	#7	#8	10-#9	7	#5	#6	13-#5	522	1255	1406
	400	4.10	16 *	0.642		10-#7+ 1	6	#8	#9	12-#9	7	#6	#7	13-#5	625	1578	1683
	500	4.82	16 *	0.642		9-#8+ 1	6	#9	#9	15-#9	7	#7	#7	15-#5	728	1897	1959
35'-0"	50	2.45	17	0.640		15-#5+ 0	6	#5	#6	11-#7	8	#5	#5	15-#5	330	660	889
D = 13.000	100	2.61	17	0.640		15-#5+ 0	6	#6	#6	10-#8	8	#5	#5	15-#5	394	789	1062
RIB NOT ON	150	2.76	17	0.640		15-#5+ 1	6	#6	#7	9-#9	8	#5	#5	15-#5	459	917	1235
COLUMN LINE	200	3.01	17	0.674		11-#6+ 1	6	#7	#7	10-#9	8	#5	#5	15-#5	523	1131	1407
1.234 CF/SF	300	3.77	17 *	0.868		10-#7+ 4	6	#8	#8	16-#8	8	#6	#6	15-#5	651	1554	1753
	400	4.57	17 *	0.641		9-#8+ 2	6	#9	#9	16-#9	8	#6	#7	16-#5	779	1957	2098
	500	5.59	19 *	0.638		11-#8+ 1	6	#10	#10	18-#9	8	#7	#7	19-#5	903	2343	2431
37'-6"	50	2.58	18	0.639		16-#5+ 0	6	#6	#6	10-#8	9	#5	#5	17-#5	405	809	1089
D = 13.000	100	2.84	18	0.639		16-#5+ 0	6	#6	#7	9-#9	9	#5	#5	17-#5	484	967	1302
RIB NOT ON	150	3.02	18	0.672		12-#6+ 1	6	#7	#7	11-#9	9	#5	#5	17-#5	562	1125	1514
COLUMN LINE	200	3.39	18 *	0.805		10-#7+ 3	6	#7	#8	16-#8	9	#5	#5	17-#5	641	1372	1727
1.219 CF/SF	300	4.34	18 *	0.640		10-#8+ 1	6	#9	#9	16-#9	9	#6	#6	17-#5	799	1893	2152
	400	5.42	20 *	0.637		9-#9+ 2	6	#10	#10	20-#9	9	#7	#7	20-#5	953	2377	2565
40'-0"	50	2.64	20	0.636		12-#6+ 2	7	#6	#6	12-#8	9	#5	#5	17-#5	494	988	1329
D = 15.500	100	2.96	20	0.649		18-#5+ 3	7	#6	#7	12-#9	9	#5	#5	17-#5	589	1179	1587
RIB ON	150	3.25	20 *	0.805		11-#7+ 5	7	#7	#7	14-#9	9	#5	#5	17-#5	685	1370	1844
COLUMN LINE	200	3.73	20 *	0.866		12-#7+ 6	7	#8	#8	16-#9	9	#5	#6	17-#5	780	1631	2101
1.246 CF/SF	300	4.77	20 *	0.637		12-#8+ 2	7	#9	#9	20-#9	9	#6	#7	21-#5	971	2263	2615
	400	5.96	25 *	0.633	5 S 8 1	11-#9+ 3	7	#10	#10	24-#9	9	#7	#8	17-#6	1147	2795	3088
42'-6"	50	2.90	21	0.636		13-#6+ 2	7	#6	#7	12-#9	10	#5	#5	18-#5	590	1180	1588
D = 15.500	100	3.25	21	0.763		11-#7+ 4	7	#7	#8	14-#9	10	#5	#5	18-#5	704	1409	1897
RIB ON	150	3.72	21 *	0.848		13-#7+ 5	7	#8	#8	17-#9	10	#5	#6	18-#5	819	1638	2205
COLUMN LINE	200	4.20	21 *	0.637		11-#8+ 3	7	#8	#9	19-#9	10	#6	#6	20-#5	934	1916	2514
1.232 CF/SF	300	5.46	24 *	0.634	5 S 8 1	11-#9+ 3	7	#10	#10	24-#9	10	#7	#7	18-#6	1156	2658	3112
45'-0"	50	3.10	22	0.721		11-#7+ 4	7	#7	#7	14-#9	11	#5	#5	20-#5	698	1396	1879
D = 15.500	100	3.57	22 *	0.819		13-#7+ 5	7	#8	#8	17-#9	11	#5	#5	20-#5	834	1668	2246
RIB ON	150	4.01	22 *	0.902		12-#8+ 6	7	#8	#9	20-#9	11	#5	#6	21-#5	970	1941	2613
COLUMN LINE	200	4.58	22 *	0.636		11-#9+ 3	7	#9	#9	23-#9	11	#6	#6	24-#5	1107	2220	2980
1.219 CF/SF																	
47'-6"	50	3.34	23 *	0.791		13-#7+ 6	8	#7	#8	17-#9	11	#5	#5	20-#5	828	1656	2229
D = 18.000	100	3.80	23 *	0.877		12-#8+ 6	8	#8	#8	20-#9	11	#5	#6	21-#5	988	1977	2661
RIB NOT ON	150	4.40	23 *	0.635		14-#8+ 4	8	#8	#9	24-#9	11	#6	#6	25-#5	1149	2297	3093
COLUMN LINE	200	5.03	27 *	0.632		16-#8+ 3	8	#9	#9	27-#9	11	#6	#7	20-#6	1299	2598	3498
1.242 CF/SF	300	6.26	35 *	0.627		16-#9+ 2	8	#10	#10	33-#9	11	#7	#7	24-#6	1575	3150	4241

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 24 ½ in.		Rib Depth = 20 in.		Total Slab Depth = 4 ½ in.						
2.27	16		6	#5	#5	15-#5	7	#5	#5	13-#5
2.37	16		6	#5	#5	9-#7	7	#5	#5	13-#5
2.51	16		6	#5	#5	11-#7	7	#5	#5	13-#5
2.64	16		6	#5	#5	10-#8	7	#5	#5	13-#5
3.05	16		6	#6	#6	9-#9	7	#5	#5	13-#5
3.58	16 *	5 S 8 1	6	#7	#7	11-#9	7	#5	#5	13-#5
4.24	16 *	5 S 8 1	6	#7	#8	14-#9	7	#5	#6	14-#5
2.41	17		6	#5	#5	10-#7	8	#5	#5	15-#5
2.54	17		6	#5	#5	9-#8	8	#5	#5	15-#5
2.61	17		6	#5	#5	10-#8	8	#5	#5	15-#5
2.87	17		6	#5	#6	9-#9	8	#5	#5	15-#5
3.42	17 *	5 S 8 1	6	#6	#7	12-#9	8	#5	#5	15-#5
4.10	17 *	5 S 8 2	6	#7	#8	18-#8	8	#5	#6	15-#5
5.09	17 *	5 S 8 2	6	#8	#9	17-#9	8	#6	#6	18-#5
2.52	18		6	#5	#5	9-#8	9	#5	#5	17-#5
2.82	18		6	#5	#6	9-#9	9	#5	#5	17-#5
2.90	18		6	#5	#6	10-#9	9	#5	#5	17-#5
3.34	18	5 S 8 1	6	#6	#7	12-#9	9	#5	#5	17-#5
3.96	18 *	5 S 8 2	6	#7	#8	15-#9	9	#5	#5	17-#5
4.79	18 *	5 S 8 2	6	#8	#9	18-#9	9	#5	#6	19-#5
2.59	20		7	#5	#5	11-#8	9	#5	#5	17-#5
2.93	20		7	#5	#6	11-#9	9	#5	#5	17-#5
3.18	20		7	#6	#6	16-#8	9	#5	#5	17-#5
3.45	20 *	5 S 8 1	7	#6	#7	14-#9	9	#5	#5	17-#5
4.33	20 *	5 S 8 2	7	#7	#8	18-#9	9	#5	#6	19-#5
5.37	21 *	5 S 8 2	7	#8	#9	22-#9	9	#6	#6	23-#5
2.86	21		7	#5	#6	11-#9	10	#5	#5	18-#5
3.10	21		7	#6	#6	16-#8	10	#5	#5	18-#5
3.46	21 *	5 S 8 1	7	#6	#7	15-#9	10	#5	#5	18-#5
3.84	21 *	5 S 8 1	7	#7	#7	18-#9	10	#5	#5	18-#5
4.77	21 *	5 S 8 2	7	#8	#8	22-#9	10	#5	#6	23-#5
3.05	22		7	#6	#6	16-#8	11	#5	#5	20-#5
3.46	22	5 S 8 1	7	#6	#7	16-#9	11	#5	#5	20-#5
3.75	22 *	5 S 8 1	7	#7	#7	18-#9	11	#5	#5	20-#5
4.21	22 *	5 S 8 2	7	#7	#8	21-#9	11	#5	#5	22-#5
3.19	23		8	#6	#6	15-#9	11	#5	#5	20-#5
3.56	23 *	5 S 8 1	8	#6	#7	23-#8	11	#5	#5	20-#5
4.06	23 *	5 S 8 1	8	#7	#7	22-#9	11	#5	#5	23-#5
4.68	23 *	5 S 8 2	8	#7	#8	25-#9	11	#5	#6	26-#5
5.88	29 *	5 S 8 2	8	#8	#9	31-#9	11	#6	#6	23-#6

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 13 in.	Rib Depth = 8 in.	Total Slab Depth = 5 in.																Total Depth = 13 in.	Rib Depth = 8 in.	Total Slab Depth = 5 in.								
17′-6″	50	1.71	12	0.633		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	27	55	74	1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
D = 8.000	100	1.71	12	0.633		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	35	71	95	1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
RIB NOT ON	150	1.71	12	0.633		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	43	98	116	1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
COLUMN LINE	200	1.71	12	0.633		7-#5+ 0	4	#4	#4	7-#5	3	#4	#4	7-#5	51	122	136	1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
0.754 CF/SF	300	1.85	12	0.681		7-#5+ 0	4	#4	#5	8-#5	3	#4	#5	7-#5	66	171	178	1.73	12		4	#4	#4	7-#5	3	#4	#4	7-#5
	400	2.25	12	0.815		7-#5+ 2	4	#5	#6	7-#6	3	#5	#5	7-#5	82	218	220	1.99	12		4	#4	#5	9-#5	3	#4	#4	7-#5
	500	2.63	12 *	0.634		7-#5+ 1	4	#6	#6	6-#7	3	#5	#6	7-#5	97	265	261	2.38	12 *	3 S 4 1	4	#5	#5	6-#7	3	#4	#5	7-#5
20′-0″	50	1.73	12	0.633		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	41	82	111	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
D = 8.000	100	1.73	12	0.649		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	53	106	143	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
RIB NOT ON	150	1.80	12	0.692		6-#6+ 0	4	#4	#5	6-#6	4	#4	#4	8-#5	65	147	174	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
COLUMN LINE	200	1.87	12	0.736		6-#6+ 0	4	#5	#5	9-#5	4	#4	#4	8-#5	76	184	206	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
0.737 CF/SF	300	2.34	12 *	0.824		6-#6+ 0	4	#6	#6	6-#7	4	#4	#5	8-#5	100	257	269	2.16	12	3 S 4 1	4	#5	#5	6-#7	4	#4	#4	8-#5
	400	2.84	12 *	0.634		6-#6+ 0	4	#6	#7	6-#8	4	#5	#6	8-#5	123	329	332	2.55	12 *	3 S 4 1	4	#5	#6	10-#6	4	#4	#5	8-#5
	500	3.46	14 *	0.631		6-#6+ 1	4	#7	#8	7-#8	4	#6	#6	8-#5	145	396	392	3.08	12 *	3 S 4 1	4	#6	#6	7-#8	4	#5	#5	8-#5
22′-6″	50	1.79	12	0.697		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	59	118	159	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
D = 8.000	100	1.85	12	0.744		10-#5+ 0	4	#4	#5	7-#6	5	#4	#4	10-#5	76	152	204	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
RIB NOT ON	150	2.09	12	0.791		10-#5+ 0	4	#5	#6	6-#7	5	#4	#4	10-#5	93	210	250	2.00	12		4	#4	#5	6-#7	5	#4	#4	10-#5
COLUMN LINE	200	2.35	12 *	0.853		10-#5+ 1	4	#6	#6	7-#7	5	#4	#5	10-#5	110	264	295	2.18	12	3 S 4 1	4	#5	#5	9-#6	5	#4	#4	10-#5
0.725 CF/SF	300	2.87	12 *	0.634		10-#5+ 0	4	#7	#7	7-#8	5	#5	#5	10-#5	144	369	386	2.59	12 *	3 S 4 1	4	#5	#6	7-#8	5	#4	#4	10-#5
	400	3.53	16 *	0.628		6-#7+ 0	4	#8	#8	7-#9	5	#5	#6	10-#5	174	459	468	3.12	13 *	3 S 4 2	4	#6	#7	8-#8	5	#4	#5	10-#5
25′-0″	50	1.75	12	0.767		8-#6+ 0	5	#4	#4	8-#6	5	#4	#4	10-#5	83	165	222	1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
D = 10.500	100	1.85	12 *	0.839		8-#6+ 1	5	#4	#5	9-#6	5	#4	#4	10-#5	106	213	285	1.80	12		5	#4	#4	12-#5	5	#4	#4	10-#5
RIB ON	150	2.23	12 *	0.896		8-#6+ 2	5	#5	#6	8-#7	5	#4	#5	10-#5	129	294	348	2.08	12 *		5	#4	#5	8-#7	5	#4	#4	10-#5
COLUMN LINE	200	2.65	12 *	0.634		8-#6+ 1	5	#6	#7	8-#8	5	#5	#5	10-#5	153	369	411	2.32	12 *	3 S 4 1	5	#5	#5	7-#8	5	#4	#4	10-#5
0.744 CF/SF	300	3.47	17 *	0.627		8-#6+ 2	5	#7	#8	8-#9	5	#6	#6	10-#5	195	499	526	3.09	13 *	3 S 4 1	5	#6	#6	7-#9	5	#5	#5	10-#5
27′-6″	50	1.91	13	0.775		8-#6+ 0	5	#5	#5	7-#7	6	#4	#4	12-#5	109	219	295	1.84	13		5	#4	#4	9-#6	6	#4	#4	12-#5
D = 10.500	100	2.19	13 *	0.871		8-#6+ 2	5	#5	#6	7-#8	6	#4	#4	12-#5	141	281	378	2.16	13		5	#4	#5	7-#8	6	#4	#4	12-#5
RIB ON	150	2.56	13 *	0.632		8-#6+ 2	5	#6	#7	7-#9	6	#4	#5	12-#5	172	383	462	2.34	13 *	3 S 4 1	5	#5	#5	8-#8	6	#4	#4	12-#5
COLUMN LINE	200	3.14	16 *	0.628		12-#5+ 3	5	#7	#7	8-#9	6	#5	#6	12-#5	201	478	541	2.94	13 *	3 S 4 1	5	#6	#6	8-#9	6	#4	#5	12-#5
0.733 CF/SF	300	3.80	22 *	0.623	3 S 4 1	8-#7+ 2	5	#8	#8	13-#8	6	#6	#6	12-#5	253	563	680	3.39	19 *	3 S 4 2	5	#6	#7	10-#9	6	#4	#5	12-#5
30′-0″	50	2.13	15 *	0.837		9-#6+ 3	5	#5	#6	7-#8	7	#4	#4	13-#5	141	281	379	2.09	15		5	#4	#5	7-#8	7	#4	#4	13-#5
D = 10.500	100	2.43	15 *	0.908		9-#6+ 5	5	#6	#6	7-#9	7	#4	#5	13-#5	181	362	487	2.32	15 *	3 S 4 1	5	#5	#5	11-#7	7	#4	#4	13-#5
RIB ON	150	2.95	17 *	0.627		7-#7+ 2	5	#7	#7	9-#9	7	#5	#5	13-#5	220	468	592	2.70	15 *	3 S 4 1	5	#6	#6	8-#9	7	#4	#4	13-#5
COLUMN LINE	200	3.57	21 *	0.624	3 S 4 1	8-#7+ 2	5	#8	#8	11-#9	7	#5	#6	13-#5	256	570	690	3.23	16 *	3 S 4 2	5	#6	#7	10-#9	7	#4	#5	13-#5
0.725 CF/SF																												
32′-6″	50	2.26	16 *	0.871		10-#6+ 4	6	#5	#6	9-#8	7	#4	#5	13-#5	181	361	486	2.13	16		6	#4	#5	11-#7	7	#4	#4	13-#5
D = 13.000	100	2.76	17 *	0.927		10-#6+ 7	6	#6	#7	12-#8	7	#5	#5	13-#5	231	462	622	2.52	16 *	3 S 4 1	6	#5	#5	9-#9	7	#4	#4	13-#5
RIB NOT ON	150	3.32	22 *	0.623		12-#6+ 5	6	#7	#7	12-#9	7	#5	#6	13-#5	279	578	750	3.12	16 *	3 S 4 1	6	#6	#6	11-#9	7	#4	#5	13-#5
COLUMN LINE																												
0.740 CF/SF																												
35′-0″	50	2.60	17 *	0.904		15-#5+ 9	6	#6	#7	9-#9	8	#4	#5	15-#5	225	450	605	2.46	17 *	3 S 4 1	6	#5	#5	9-#9	8	#4	#4	15-#5
D = 13.000	100	3.09	21 *	0.624		9-#7+ 4	6	#7	#7	12-#9	8	#5	#5	15-#5	286	572	770	2.91	17 *	3 S 4 1	6	#6	#6	11-#9	8	#4	#4	15-#5
RIB NOT ON																												
COLUMN LINE																												
0.731 CF/SF																												

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 15 in.	Rib Depth = 10 in.	Total Slab Depth = 5 in.																Total Depth = 15 in.	Rib Depth = 10 in.	Total Slab Depth = 5 in.								
20'-0"	50	1.73	12	0.636		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	44	89	120	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
D = 8.000	100	1.73	12	0.636		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	56	112	151	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
RIB NOT ON	150	1.73	12	0.636		6-#6+ 0	4	#4	#4	6-#6	4	#4	#4	8-#5	68	152	183	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
COLUMN LINE	200	1.80	12	0.636		6-#6+ 0	4	#4	#5	6-#6	4	#4	#4	8-#5	80	190	214	1.75	12		4	#4	#4	6-#6	4	#4	#4	8-#5
0.823 CF/SF	300	2.16	12	0.714		6-#6+ 0	4	#5	#6	6-#7	4	#4	#5	8-#5	103	264	278	1.97	12		4	#4	#5	7-#6	4	#4	#4	8-#5
	400	2.45	12 *	0.796		6-#6+ 0	4	#6	#6	7-#7	4	#5	#5	8-#5	127	336	341	2.16	12	3 S 4 1	4	#5	#5	6-#7	4	#4	#4	8-#5
	500	2.97	12 *	0.637		6-#6+ 0	4	#7	#7	6-#8	4	#5	#6	8-#5	150	408	404	2.61	12 *	3 S 4 1	4	#5	#6	6-#8	4	#4	#5	8-#5
22'-6"	50	1.79	12	0.636		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	64	127	171	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
D = 8.000	100	1.85	12	0.659		10-#5+ 0	4	#4	#5	7-#6	5	#4	#4	10-#5	81	161	217	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
RIB NOT ON	150	1.91	12	0.704		10-#5+ 0	4	#5	#5	7-#6	5	#4	#4	10-#5	97	218	262	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
COLUMN LINE	200	2.09	12	0.748		10-#5+ 0	4	#5	#6	6-#7	5	#4	#4	10-#5	114	273	308	2.00	12		4	#4	#5	6-#7	5	#4	#4	10-#5
0.808 CF/SF	300	2.64	12 *	0.851		10-#5+ 1	4	#6	#7	6-#8	5	#5	#5	10-#5	148	379	399	2.38	12	3 S 4 1	4	#5	#6	10-#6	5	#4	#4	10-#5
	400	3.21	12 *	0.637		10-#5+ 1	4	#7	#8	6-#9	5	#5	#6	10-#5	182	483	490	2.83	12 *	3 S 4 1	4	#6	#6	7-#8	5	#4	#5	10-#5
	500	3.79	14 *	0.634		6-#7+ 0	4	#8	#8	7-#9	5	#6	#6	10-#5	214	581	576	3.44	12 *	3 S 4 2	4	#6	#7	7-#9	5	#5	#5	10-#5
25'-0"	50	1.75	12	0.696		8-#6+ 0	5	#4	#4	8-#6	5	#4	#4	10-#5	89	178	240	1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
D = 10.500	100	1.82	12	0.744		8-#6+ 0	5	#4	#5	8-#6	5	#4	#4	10-#5	113	225	303	1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
RIB ON	150	2.07	12	0.815		8-#6+ 1	5	#5	#5	7-#7	5	#4	#5	10-#5	136	305	366	1.97	12		5	#4	#5	9-#6	5	#4	#4	10-#5
COLUMN LINE	200	2.47	12 *	0.871		8-#6+ 2	5	#6	#6	7-#8	5	#5	#5	10-#5	159	381	429	2.19	12		5	#5	#5	8-#7	5	#4	#4	10-#5
0.832 CF/SF	300	3.03	12 *	0.637		8-#6+ 2	5	#7	#7	7-#9	5	#5	#6	10-#5	206	528	555	2.65	12 *	3 S 4 1	5	#5	#6	8-#8	5	#4	#5	10-#5
	400	3.77	16 *	0.631		9-#6+ 2	5	#7	#8	9-#9	5	#6	#7	10-#5	249	657	669	3.37	13 *	3 S 4 1	5	#6	#7	8-#9	5	#5	#5	10-#5
	500	4.32	20 *	0.627	3 S 4 1	15-#5+ 4	5	#8	#9	10-#9	5	#6	#7	11-#5	286	748	771	3.86	17 *	3 S 4 2	5	#7	#7	9-#9	5	#5	#6	10-#5
27'-6"	50	1.81	13	0.701		8-#6+ 0	5	#4	#5	9-#6	6	#4	#4	12-#5	118	236	318	1.77	13		5	#4	#4	8-#6	6	#4	#4	12-#5
D = 10.500	100	2.00	13	0.787		8-#6+ 1	5	#5	#5	8-#7	6	#4	#4	12-#5	149	298	402	1.99	13		5	#4	#5	10-#6	6	#4	#4	12-#5
RIB ON	150	2.41	13 *	0.869		8-#6+ 3	5	#6	#6	8-#8	6	#4	#5	12-#5	180	399	486	2.26	13		5	#5	#5	7-#8	6	#4	#4	12-#5
COLUMN LINE	200	2.71	13 *	0.635		8-#6+ 2	5	#6	#7	7-#9	6	#5	#5	12-#5	212	501	570	2.47	13 *	3 S 4 1	5	#5	#6	8-#8	6	#4	#4	12-#5
0.819 CF/SF	300	3.76	17 *	0.630		7-#7+ 2	5	#8	#8	9-#9	6	#6	#6	12-#5	270	687	728	3.42	13 *	3 S 4 1	5	#6	#7	9-#9	6	#5	#5	12-#5
	400	4.31	21 *	0.626	3 S 4 1	12-#6+ 2	5	#8	#9	11-#9	6	#6	#7	12-#5	322	804	868	3.87	18 *	3 S 4 2	5	#7	#7	11-#9	6	#5	#5	12-#5
30'-0"	50	1.98	15	0.713		9-#6+ 0	5	#5	#5	8-#7	7	#4	#4	13-#5	152	303	409	1.98	15		5	#4	#5	8-#7	7	#4	#4	13-#5
D = 10.500	100	2.30	15 *	0.819		9-#6+ 2	5	#6	#6	8-#8	7	#4	#4	13-#5	192	384	517	2.26	15	3 S 4 1	5	#5	#5	8-#8	7	#4	#4	13-#5
RIB ON	150	2.63	15 *	0.894		9-#6+ 4	5	#6	#7	8-#9	7	#4	#5	13-#5	232	496	625	2.49	15 *	3 S 4 1	5	#5	#6	7-#9	7	#4	#4	13-#5
COLUMN LINE	200	3.19	16 *	0.631		7-#7+ 2	5	#7	#8	9-#9	7	#5	#5	13-#5	272	626	732	2.98	15 *	3 S 4 1	5	#6	#6	9-#9	7	#4	#5	13-#5
0.808 CF/SF	300	4.14	21 *	0.626	3 S 4 1	7-#8+ 2	5	#8	#9	12-#9	7	#6	#6	13-#5	345	831	929	3.80	17 *	3 S 4 2	5	#7	#7	12-#9	7	#5	#5	13-#5
32'-6"	50	2.13	16 *	0.809		10-#6+ 3	6	#5	#6	11-#7	7	#4	#4	13-#5	195	390	525	2.04	16		6	#4	#5	10-#7	7	#4	#4	13-#5
D = 13.000	100	2.50	16 *	0.883		10-#6+ 5	6	#6	#6	9-#9	7	#4	#5	13-#5	246	492	663	2.36	16 *		6	#5	#5	10-#8	7	#4	#4	13-#5
RIB NOT ON	150	2.95	17 *	0.630		11-#6+ 3	6	#7	#7	10-#9	7	#5	#5	13-#5	297	623	799	2.67	16 *	3 S 4 1	6	#5	#6	12-#8	7	#4	#4	13-#5
COLUMN LINE	200	3.69	20 *	0.627		9-#7+ 4	6	#7	#8	12-#9	7	#6	#6	13-#5	345	784	929	3.43	16 *	3 S 4 1	6	#6	#7	11-#9	7	#5	#5	13-#5
0.826 CF/SF																												
35'-0"	50	2.41	17 *	0.849		15-#5+ 7	6	#6	#6	10-#8	8	#4	#5	15-#5	242	485	653	2.31	17		6	#5	#5	10-#8	8	#4	#4	15-#5
D = 13.000	100	2.90	17 *	0.919		11-#6+ 7	6	#7	#7	11-#9	8	#5	#5	15-#5	307	613	825	2.60	17 *	3 S 4 1	6	#5	#6	12-#8	8	#4	#4	15-#5
RIB NOT ON	150	3.41	21 *	0.626		10-#7+ 3	6	#7	#8	16-#8	8	#5	#6	15-#5	367	746	988	3.11	17 *	3 S 4 1	6	#6	#6	12-#9	8	#4	#5	15-#5
COLUMN LINE	200	3.80	25 *	0.624		9-#8+ 1	6	#8	#8	15-#9	8	#5	#6	16-#5	423	848	1139	3.47	20 *	3 S 4 2	6	#6	#7	14-#9	8	#4	#5	15-#5
0.816 CF/SF																												
37'-6"	50	2.63	18 *	0.879		16-#5+ 9	6	#6	#7	10-#9	9	#4	#5	17-#5	297	595	801	2.54	18 *	3 S 4 1	6	#5	#6	12-#8	9	#4	#4	17-#5
D = 13.000	100	3.18	20 *	0.627		10-#7+ 3	6	#7	#8	13-#9	9	#5	#5	17-#5	375	749	1009	2.90	18 *	3 S 4 1	6	#6	#6	12-#9	9	#4	#4	17-#5
RIB NOT ON	150	3.82	26 *	0.623		9-#8+ 2	6	#8	#8	16-#9	9	#5	#6	17-#5	446	891	1200	3.61	19 *	3 S 4 2	6	#7	#7	15-#9	9	#4	#5	17-#5
COLUMN LINE																												
0.808 CF/SF																												
40'-0"	50	2.96	20 *	0.900		19-#5+12	7	#7	#7	16-#8	9	#5	#5	17-#5	362	724	975	2.71	20 *		7	#5	#6	12-#9	9	#4	#4	17-#5
D = 15.500	100	3.61	25 *	0.624		17-#6+ 5	7	#7	#8	16-#9	9	#5	#6	17-#5	453	905	1218	3.40	20 *	3 S 4 1	7	#6	#7	15-#9	9	#4	#5	17-#5
RIB ON																												
COLUMN LINE																												
0.823 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	$+M$ Bot. (ft-k)	$-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 17 in.	Rib Depth = 12 in.	Total Slab Depth = 5 in.																Total Depth = 17 in.	Rib Depth = 12 in.	Total Slab Depth = 5 in.								
22′-6″	50	1.79	12	0.639		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	68	137	184	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
D = 8.000	100	1.79	12	0.639		10-#5+ 0	4	#4	#4	7-#6	5	#4	#4	10-#5	85	171	230	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
RIB NOT ON	150	1.85	12	0.639		10-#5+ 0	4	#4	#5	7-#6	5	#4	#4	10-#5	102	225	275	1.83	12		4	#4	#4	7-#6	5	#4	#4	10-#5
COLUMN LINE	200	1.98	12	0.654		10-#5+ 0	4	#5	#5	6-#7	5	#4	#4	10-#5	119	281	321	1.93	12		4	#4	#5	7-#6	5	#4	#4	10-#5
0.894 CF/SF	300	2.35	12	0.739		10-#5+ 0	4	#6	#6	7-#7	5	#4	#5	10-#5	153	388	412	2.18	12	4 S 6 1	4	#5	#5	9-#6	5	#4	#4	10-#5
	400	2.79	12 *	0.852		10-#5+ 2	4	#7	#7	7-#8	5	#5	#5	10-#5	187	492	503	2.43	12 *	4 S 6 1	4	#5	#6	6-#8	5	#4	#4	10-#5
	500	3.32	12 *	0.640		10-#5+ 1	4	#7	#8	6-#9	5	#5	#6	10-#5	221	596	594	3.07	12 *	4 S 6 1	4	#6	#7	6-#9	5	#4	#5	10-#5
25′-0″	50	1.75	12	0.639		8-#6+ 0	5	#4	#4	8-#6	5	#4	#4	10-#5	96	192	258	1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
D = 10.500	100	1.82	12	0.666		8-#6+ 0	5	#4	#5	8-#6	5	#4	#4	10-#5	119	239	321	1.77	12		5	#4	#4	8-#6	5	#4	#4	10-#5
RIB ON	150	1.92	12	0.711		8-#6+ 0	5	#5	#5	9-#6	5	#4	#4	10-#5	143	315	384	1.80	12		5	#4	#4	12-#5	5	#4	#4	10-#5
COLUMN LINE	200	2.19	12	0.784		8-#6+ 1	5	#5	#6	8-#7	5	#4	#5	10-#5	166	393	447	2.01	12		5	#4	#5	7-#7	5	#4	#4	10-#5
0.923 CF/SF	300	2.85	12 *	0.889		8-#6+ 3	5	#6	#7	8-#8	5	#5	#6	10-#5	213	541	573	2.56	12 *	4 S 6 1	5	#5	#6	7-#8	5	#4	#5	10-#5
	400	3.48	12 *	0.640		8-#6+ 2	5	#7	#8	8-#9	5	#6	#6	10-#5	260	686	699	3.08	12 *	4 S 6 1	5	#6	#6	7-#9	5	#5	#5	10-#5
	500	3.96	15 *	0.635		7-#7+ 2	5	#8	#8	9-#9	5	#6	#7	10-#5	303	820	817	3.49	12 *	4 S 6 1	5	#6	#7	8-#9	5	#5	#6	10-#5
27′-6″	50	1.79	13	0.637		8-#6+ 0	5	#4	#5	8-#6	6	#4	#4	12-#5	127	254	342	1.77	13		5	#4	#4	8-#6	6	#4	#4	12-#5
D = 10.500	100	1.93	13	0.680		8-#6+ 0	5	#5	#5	7-#7	6	#4	#4	12-#5	158	316	426	1.88	13		5	#4	#4	7-#7	6	#4	#4	12-#5
RIB ON	150	2.13	13	0.765		8-#6+ 1	5	#5	#6	7-#8	6	#4	#4	12-#5	189	413	510	2.04	13		5	#4	#5	8-#7	6	#4	#4	12-#5
COLUMN LINE	200	2.49	13 *	0.849		8-#6+ 3	5	#6	#7	8-#8	6	#4	#5	12-#5	220	517	594	2.26	13	4 S 6 1	5	#5	#5	7-#8	6	#4	#4	12-#5
0.906 CF/SF	300	3.27	13 *	0.638		9-#6+ 2	5	#7	#8	8-#9	6	#5	#6	12-#5	283	714	762	2.94	13 *	4 S 6 1	5	#6	#6	8-#9	6	#4	#5	12-#5
	400	4.12	16 *	0.634	4 S 6 1	8-#7+ 2	5	#8	#9	10-#9	6	#6	#7	12-#5	342	898	921	3.60	13 *	4 S 6 2	5	#7	#7	12-#8	6	#5	#5	12-#5
	500	4.66	20 *	0.630	4 S 6 1	7-#8+ 2	5	#9	#9	12-#9	6	#6	#7	13-#5	392	1017	1056	4.20	18 *	4 S 6 2	5	#7	#8	11-#9	6	#5	#6	12-#5
30′-0″	50	1.91	15	0.637		9-#6+ 0	5	#5	#5	8-#7	7	#4	#4	13-#5	163	326	439	1.83	15		5	#4	#4	7-#7	7	#4	#4	13-#5
D = 10.500	100	2.13	15	0.701		9-#6+ 0	5	#5	#6	7-#8	7	#4	#4	13-#5	203	407	548	2.09	15		5	#4	#5	7-#8	7	#4	#4	13-#5
RIB ON	150	2.49	15 *	0.806		9-#6+ 2	5	#6	#7	7-#9	7	#4	#5	13-#5	244	517	656	2.26	15	4 S 6 1	5	#5	#5	8-#8	7	#4	#4	13-#5
COLUMN LINE	200	2.90	15 *	0.880		9-#6+ 4	5	#7	#7	8-#9	7	#5	#5	13-#5	284	653	765	2.70	15 *	4 S 6 1	5	#6	#6	8-#9	7	#4	#4	13-#5
0.894 CF/SF	300	3.88	17 *	0.633	4 S 6 1	12-#6+ 2	5	#8	#9	11-#9	7	#6	#6	13-#5	362	900	976	3.37	15 *	4 S 6 2	5	#7	#7	10-#9	7	#4	#5	13-#5
	400	4.69	21 *	0.629	4 S 6 1	10-#7+ 1	5	#9	#10	13-#9	7	#6	#7	14-#5	433	1088	1167	4.07	18 *	4 S 6 2	5	#7	#8	16-#8	7	#5	#5	13-#5
32′-6″	50	2.01	16	0.736		10-#6+ 2	6	#5	#5	10-#7	7	#4	#4	13-#5	210	419	565	1.99	16		6	#4	#5	9-#7	7	#4	#4	13-#5
D = 13.000	100	2.43	16 *	0.822		10-#6+ 4	6	#6	#6	10-#8	7	#4	#5	13-#5	261	522	703	2.29	16		6	#5	#5	9-#8	7	#4	#4	13-#5
RIB NOT ON	150	2.82	16 *	0.887		10-#6+ 6	6	#6	#7	9-#9	7	#5	#5	13-#5	312	654	841	2.65	16 *		6	#5	#6	9-#9	7	#4	#4	13-#5
COLUMN LINE	200	3.34	16 *	0.634		12-#6+ 2	6	#7	#8	11-#9	7	#5	#6	13-#5	364	827	979	2.97	16 *	4 S 6 1	6	#6	#6	10-#9	7	#4	#5	13-#5
0.916 CF/SF	300	4.39	22 *	0.628		11-#7+ 3	6	#8	#9	14-#9	7	#6	#7	15-#5	457	1112	1231	3.98	17 *	4 S 6 2	6	#7	#7	13-#9	7	#5	#6	14-#5

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 17 in.	Rib Depth = 12 in.	Total Slab Depth = 5 in.																Total Depth = 17 in.	Rib Depth = 12 in.	Total Slab Depth = 5 in.								
35'-0"	50	2.31	17	0.760		15-#5+ 3	6	#6	#6	10-#8	8	#4	#4	15-#5	261	522	702	2.25	17		6	#5	#5	9-#8	8	#4	#4	15-#5
D = 13.000	100	2.67	17 *	0.856		15-#5+ 7	6	#6	#7	12-#8	8	#4	#5	15-#5	325	650	875	2.58	17	4 S 6 1	6	#5	#6	9-#9	8	#4	#4	15-#5
RIB NOT ON	150	3.10	17 *	0.633		9-#7+ 4	6	#7	#7	12-#9	8	#5	#5	15-#5	389	795	1047	2.91	17 *	4 S 6 1	6	#6	#6	11-#9	8	#4	#4	15-#5
COLUMN LINE	200	3.66	20 *	0.630		11-#7+ 3	6	#8	#8	14-#9	8	#5	#6	15-#5	450	1005	1211	3.31	17 *	4 S 6 1	6	#6	#7	16-#8	8	#4	#5	15-#5
0.904 CF/SF	300	4.72	27 *	0.625		10-#8+ 1	6	#9	#9	18-#9	8	#6	#7	18-#5	560	1213	1507	4.23	22 *	4 S 6 2	6	#7	#8	16-#9	8	#5	#5	17-#5
37'-6"	50	2.60	18 *	0.806		16-#5+ 5	6	#6	#7	12-#8	9	#4	#5	17-#5	320	639	861	2.52	18		6	#5	#6	9-#9	9	#4	#4	17-#5
D = 13.000	100	3.01	18 *	0.912		9-#7+ 7	6	#7	#7	12-#9	9	#5	#5	17-#5	399	797	1073	2.82	18 *	4 S 6 1	6	#6	#6	11-#9	9	#4	#4	17-#5
RIB NOT ON	150	3.57	20 *	0.630		11-#7+ 3	6	#8	#8	15-#9	9	#5	#5	17-#5	475	951	1280	3.36	18 *	4 S 6 1	6	#6	#7	14-#9	9	#4	#5	17-#5
COLUMN LINE	200	4.22	25 *	0.626		10-#8+ 3	6	#8	#9	17-#9	9	#6	#6	18-#5	546	1165	1471	3.87	19 *	4 S 6 2	6	#7	#7	16-#9	9	#5	#5	17-#5
0.894 CF/SF																												
40'-0"	50	2.74	20 *	0.855		18-#5+11	7	#6	#7	12-#9	9	#4	#5	17-#5	390	779	1049	2.64	20		7	#5	#6	11-#9	9	#4	#4	17-#5
D = 15.500	100	3.46	20 *	0.630		12-#7+ 4	7	#7	#8	15-#9	9	#5	#6	17-#5	485	970	1306	3.14	20 *	4 S 6 1	7	#6	#6	14-#9	9	#4	#5	17-#5
RIB ON	150	3.98	25 *	0.626		14-#7+ 4	7	#8	#8	18-#9	9	#6	#6	19-#5	574	1148	1546	3.58	20 *	4 S 6 1	7	#6	#7	17-#9	9	#4	#5	17-#5
COLUMN LINE	200	4.51	30 *	0.623		12-#8+ 2	7	#8	#9	21-#9	9	#6	#6	21-#5	655	1310	1764	4.17	24 *	4 S 6 2	7	#7	#7	19-#9	9	#5	#5	20-#5
0.911 CF/SF																												
42'-6"	50	3.04	21 *	0.883		11-#7+ 6	7	#7	#7	14-#9	10	#5	#5	18-#5	466	932	1254	2.85	21 *	4 S 6 1	7	#6	#6	13-#9	10	#4	#4	18-#5
D = 15.500	100	3.74	24 *	0.627		14-#7+ 4	7	#8	#8	18-#9	10	#5	#6	18-#5	577	1154	1553	3.46	21 *	4 S 6 1	7	#6	#7	17-#9	10	#4	#5	18-#5
RIB ON	150	4.39	30 *	0.623		32-#5+ 7	7	#8	#9	21-#9	10	#6	#6	22-#5	679	1358	1829	4.09	23 *	4 S 6 2	7	#7	#7	20-#9	10	#5	#5	21-#5
COLUMN LINE																												
0.902 CF/SF																												
45'-0"	50	3.41	22 *	0.920		13-#7+ 9	7	#8	#8	17-#9	11	#5	#5	20-#5	552	1103	1485	3.14	22 *	4 S 6 1	7	#6	#7	16-#9	11	#4	#4	20-#5
D = 15.500	100	4.04	28 *	0.624		32-#5+ 7	7	#8	#9	21-#9	11	#5	#6	22-#5	680	1359	1830	3.75	22 *	4 S 6 2	7	#7	#7	20-#9	11	#4	#5	21-#5
RIB ON																												
COLUMN LINE																												
0.894 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 19 in.	Rib Depth = 14 in.	Total Slab Depth = 5 in.																Total Depth = 19 in.	Rib Depth = 14 in.	Total Slab Depth = 5 in.								
25'-0"	50	1.99	12	0.641		8-#6+ 0	5	#4	#5	8-#6	5	#4	#5	10-#5	103	206	277	1.99	12		5	#4	#5	8-#6	5	#4	#5	10-#5
D = 10.500	100	1.99	12	0.641		8-#6+ 0	5	#4	#5	8-#6	5	#4	#5	10-#5	126	253	340	1.99	12		5	#4	#5	8-#6	5	#4	#5	10-#5
RIB ON	150	2.00	12	0.641		8-#6+ 0	5	#4	#5	12-#5	5	#4	#5	10-#5	150	324	403	1.99	12		5	#4	#5	8-#6	5	#4	#5	10-#5
COLUMN LINE	200	2.21	12	0.670		8-#6+ 0	5	#5	#6	7-#7	5	#4	#5	10-#5	173	403	466	2.07	12		5	#4	#5	9-#6	5	#4	#5	10-#5
1.015 CF/SF	300	2.59	12	0.806		8-#6+ 2	5	#6	#6	7-#8	5	#5	#5	10-#5	220	553	592	2.42	12		5	#5	#5	7-#8	5	#4	#5	10-#5
	400	3.01	12 *	0.642		8-#6+ 2	5	#7	#7	11-#7	5	#5	#6	10-#5	267	698	718	2.65	12 *	4 S 6 1	5	#5	#6	8-#8	5	#4	#5	10-#5
	500	3.67	12 *	0.642		9-#6+ 2	5	#7	#8	8-#9	5	#6	#7	10-#5	314	842	844	3.25	12 *	4 S 6 1	5	#6	#7	7-#9	5	#5	#5	10-#5
27'-6"	50	1.97	13	0.640		8-#6+ 0	5	#4	#5	8-#6	6	#4	#5	12-#5	136	272	367	1.98	13		5	#4	#5	8-#6	6	#4	#5	12-#5
D = 10 .500	100	2.09	13	0.640		8-#6+ 0	5	#5	#5	7-#7	6	#4	#5	12-#5	167	335	451	2.06	13		5	#4	#5	9-#6	6	#4	#5	12-#5
RIB ON	150	2.23	13	0.649		8-#6+ 0	5	#5	#6	8-#7	6	#4	#5	12-#5	199	426	534	2.15	13		5	#4	#5	8-#7	6	#4	#5	12-#5
COLUMN LINE	200	2.44	13	0.762		8-#6+ 2	5	#6	#6	7-#8	6	#4	#5	12-#5	230	531	618	2.37	13		5	#5	#5	7-#8	6	#4	#5	12-#5
0.996 CF/SF	300	3.09	13 *	0.874		8-#6+ 4	5	#7	#7	8-#9	6	#5	#6	12-#5	292	730	786	2.84	13 *	4 S 6 1	5	#6	#6	7-#9	6	#4	#5	12-#5
	400	3.77	13 *	0.641		7-#7+ 2	5	#8	#8	9-#9	6	#6	#6	12-#5	354	924	954	3.42	13 *	4 S 6 1	5	#6	#7	9-#9	6	#5	#5	12-#5
	500	4.41	15 *	0.638	4 S 6 1	12-#6+ 2	5	#9	#9	11-#9	6	#6	#7	12-#5	414	1108	1115	3.81	13 *	4 S 6 2	5	#7	#7	10-#9	6	#5	#6	12-#5
30'-0"	50	2.06	15	0.637		9-# 6+ 0	5	#5	#5	7-#7	7	#4	#5	13-#5	175	350	471	2.01	15		5	#4	#5	9-#6	7	#4	#5	13-#5
D = 10.500	100	2.21	15	0.637		9-#6+ 0	5	#5	#6	7-#8	7	#4	#5	13-#5	215	430	579	2.10	15		5	#4	#5	8-#7	7	#4	#5	13-#5
RIB ON	150	2.44	15	0.712		9-#6+ 1	5	#6	#6	8-#8	7	#4	#5	13-#5	255	536	688	2.38	15		5	#5	#5	8-#8	7	#4	#5	13-#5
COLUMN LINE	200	2.77	15 *	0.787		9-#6+ 2	5	#7	#7	8-#9	7	#4	#5	13-#5	296	673	796	2.61	15	4 S 6 1	5	#5	#6	7-#9	7	#4	#5	13-#5
0.982 CF/SF	300	3.48	15 *	0.638		15-#5+ 2	5	#8	#8	10-#9	7	#5	#6	13-#5	376	929	1013	3.13	15 *	4 S 6 1	5	#6	#7	9-#9	7	#4	#5	13-#5
	400	4.29	17 *	0.635	4 S 6 1	7-#8+ 0	5	#9	#9	12-#9	7	#6	#6	13-#5	454	1172	1223	3.88	15 *	4 S 6 2	5	#7	#8	11-#9	7	#5	#5	13-#5
	500	4.95	21 *	0.631	4 S 6 1	8-#8+ 2	5	#9	#10	14-#9	7	#6	#7	15-#5	523	1358	1409	4.49	18 *	4 S 6 2	5	#8	#8	13-#9	7	#5	#6	14-#5
32'-6"	50	2.14	16	0.646		10-#6+ 1	6	#5	#5	10-#7	7	#4	#5	13-#5	225	450	606	2.10	16		6	#4	#5	9-#7	7	#4	#5	13-#5
D = 13.000	100	2.32	16	0.750		10-#6+ 3	6	#5	#6	9-#8	7	#4	#5	13-#5	276	553	744	2.24	16		6	#4	#5	11-#7	7	#4	#5	13-#5
RIB NOT ON	150	2.65	16 *	0.827		10-#6+ 5	6	#6	#7	9-#9	7	#4	#5	13-#5	328	680	882	2.47	16		6	#5	#5	10-#8	7	#4	#5	13-#5
COLUMN LINE	200	3.13	16 *	0.880		15-#5+ 8	6	#7	#7	10-#9	7	#5	#6	13-#5	379	855	1020	2.89	16 *	4 S 6 1	6	#6	#6	9-#9	7	#4	#5	13-#5
1.007 CF/SF	300	4.05	17 *	0.635		10-#7+ 3	6	#8	#8	16-#8	7	#6	#7	13-#5	480	1178	1293	3.67	16 *	4 S 6 1	6	#7	#7	12-#9	7	#5	#5	13-#5
	400	4.86	22 *	0.630		9-#8+ 2	6	#9	#9	16-#9	7	#7	#7	16-#5	571	1442	1538	4.28	18 *	4 S 6 2	6	#7	#8	14-#9	7	#5	#6	15-#5
35'-0"	50	2.28	17	0.665		15-#5+ 1	6	#5	#6	9-#8	8	#4	#5	15-#5	280	559	753	2.22	17		6	#4	#5	11-#7	8	#4	#5	15-#5
D = 13.000	100	2.59	17 *	0.786		15-#5+ 5	6	#6	#7	9-#9	8	#4	#5	15-#5	344	688	926	2.43	17		6	#5	#5	10-#8	8	#4	#5	15-#5
RIB NOT ON	150	3.00	17 *	0.868		12-#6+ 5	6	#7	#7	11-#9	8	#5	#5	15-#5	408	830	1098	2.78	17 *	4 S 6 1	6	#5	#6	10-#9	8	#4	#5	15-#5
COLUMN LINE	200	3.57	17 *	0.635		10-#7+ 3	6	#8	#8	16-#8	8	#5	#6	15-#5	472	1050	1271	3.25	17 *	4 S 6 1	6	#6	#7	12-#9	8	#4	#5	15-#5
0.993 CF/SF	300	4.65	22 *	0.630		17-#6+ 3	6	#9	#9	16-#9	8	#6	#7	17-#5	593	1438	1596	4.24	17 *	4 S 6 2	6	#7	#8	15-#9	8	#5	#6	16-#5
	400	5.36	28 *	0.626	4 S 6 1	11-#8+ 3	6	#9	#10	19-#9	8	#7	#7	20-#5	696	1572	1874	4.82	24 *	4 S 6 2	6	#8	#8	18-#9	8	#5	#6	19-#5

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 19 in.	Rib Depth = 14 in.	Total Slab Depth = 5 in.																Total Depth = 19 in.	Rib Depth = 14 in.	Total Slab Depth = 5 in.								
37'-6"	50	2.54	18	0.729		16-#5+ 3	6	#6	#7	9-#9	9	#4	#5	17-#5	343	686	923	2.39	18		6	#5	#5	10-#8	9	#4	#5	17-#5
D = 13.000	100	2.84	18 *	0.840		12-#6+ 5	6	#7	#7	11-#9	9	#4	#5	17-#5	422	844	1136	2.72	18	4 S 6 1	6	#5	#6	10-#9	9	#4	#5	17-#5
RIB NOT ON	150	3.25	18 *	0.634		14-#6+ 4	6	#7	#8	13-#9	9	#5	#5	17-#5	501	1002	1348	3.03	18 *	4 S 6 1	6	#6	#6	12-#9	9	#4	#5	17-#5
COLUMN LINE	200	3.87	20 *	0.632		9-#8+ 2	6	#8	#9	16-#9	9	#5	#6	17-#5	577	1261	1553	3.50	18 *	4 S 6 2	6	#7	#7	18-#8	9	#4	#5	17-#5
0.982 CF/SF	300	5.08	27 *	0.627	4 S 6 1	9-#9+ 1	6	#9	#10	20-#9	9	#6	#7	20-#5	715	1582	1926	4.63	22 *	4 S 6 2	6	#8	#8	23-#8	9	#5	#6	19-#5
40'-0"	50	2.73	20 *	0.790		12-#6+ 6	7	#6	#7	11-#9	9	#4	#5	17-#5	418	836	1125	2.68	20		7	#5	#6	13-#8	9	#4	#5	17-#5
D = 15.500	100	3.17	20 *	0.884		11-#7+ 6	7	#7	#7	14-#9	9	#5	#5	17-#5	513	1027	1382	3.01	20 *	4 S 6 1	7	#6	#6	16-#8	9	#4	#5	17-#5
RIB ON	150	3.72	20 *	0.632		13-#7+ 4	7	#8	#8	16-#9	9	#5	#6	17-#5	609	1218	1639	3.40	20 *	4 S 6 1	7	#6	#7	15-#9	9	#4	#5	17-#5
COLUMN LINE	200	4.36	25 *	0.628		11-#8+ 3	7	#8	#9	19-#9	9	#6	#6	20-#5	697	1468	1875	4.02	20 *	4 S 6 2	7	#7	#7	18-#9	9	#5	#5	19-#5
1.002 CF/SF	300	5.20	32 *	0.624	4 S 6 1	11-#9+ 3	7	#9	#9	24-#9	9	#6	#7	17-#6	854	1708	2300	4.84	29 *	4 S 6 2	7	#7	#8	22-#9	9	#5	#6	23-#5
42'-6"	50	3.02	21 *	0.832		14-#6+ 7	7	#7	#7	13-#9	10	#5	#5	18-#5	500	999	1345	2.87	21		7	#6	#6	12-#9	10	#4	#5	18-#5
D = 15.500	100	3.63	21 *	0.920		13-#7+ 8	7	#8	#8	17-#9	10	#5	#6	18-#5	614	1228	1654	3.29	21 *	4 S 6 1	7	#6	#7	15-#9	10	#4	#5	18-#5
RIB ON	150	4.15	25 *	0.628		12-#8+ 2	7	#8	#9	20-#9	10	#6	#6	21-#5	723	1446	1946	3.69	21 *	4 S 6 2	7	#7	#7	18-#9	10	#4	#5	19-#5
COLUMN LINE	200	4.74	29 *	0.625	4 S 6 1	11-#9+ 2	7	#9	#9	23-#9	10	#6	#6	24-#5	826	1652	2224	4.38	23 *	4 S 6 2	7	#7	#8	21-#9	10	#5	#5	22-#5
0.991 CF/SF																												
45'-0"	50	3.32	22 *	0.875		17-#6+ 9	7	#7	#8	16-#9	11	#5	#5	20-#5	591	1183	1592	3.21	22 *	4 S 6 1	7	#6	#7	15-#9	11	#4	#5	20-#5
D = 15.500	100	3.91	24 *	0.629		12-#8+ 2	7	#8	#9	20-#9	11	#5	#6	20-#5	725	1450	1951	3.56	22 *	4 S 6 1	7	#7	#7	18-#9	11	#4	#5	20-#5
RIB ON	150	4.63	29 *	0.625	4 S 6 1	11-#9+ 3	7	#9	#9	24-#9	11	#6	#6	24-#5	852	1704	2294	4.29	22 *	4 S 6 2	7	#7	#8	22-#9	11	#5	#5	23-#5
COLUMN LINE	200	5.25	36 *	0.622	4 S 6 1	16-#8+ 3	7	#9	#10	27-#9	11	#6	#7	20-#6	959	1918	2582	4.80	29 *	4 S 6 2	7	#8	#8	25-#9	11	#5	#5	26-#5
0.982 CF/SF																												
47'-6"	50	3.69	23 *	0.920		12-#8+ 8	8	#8	#8	19-#9	11	#5	#6	20-#5	701	1402	1887	3.37	23 *	4 S 6 1	8	#6	#7	18-#9	11	#4	#5	20-#5
D = 18.000	100	4.39	28 *	0.626		14-#8+ 4	8	#8	#9	24-#9	11	#6	#6	24-#5	853	1706	2297	4.06	23 *	4 S 6 1	8	#7	#7	22-#9	11	#5	#5	23-#5
RIB NOT ON	150	5.23	36 *	0.622		16-#8+ 5	8	#9	#10	28-#9	11	#6	#7	20-#6	989	1978	2663	4.77	27 *	4 S 6 2	8	#7	#8	26-#9	11	#5	#6	27-#5
COLUMN LINE																												
0.999 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 21 in.	Rib Depth = 16 in.	Total Slab Depth = 5 in.															
30'-0"	50	2.06	15	0.639		9-#6+ 0	5	#5	#5	7-#7	7	#4	#5	13-#5	187	374	504
D = 10.500	100	2.21	15	0.639		9-#6+ 0	5	#5	#6	7-#8	7	#4	#5	13-#5	227	455	612
RIB ON	150	2.40	15	0.639		9-#6+ 0	5	#6	#6	8-#8	7	#4	#5	13-#5	268	553	721
COLUMN LINE	200	2.61	15	0.686		9-#6+ 1	5	#6	#7	7-#9	7	#4	#5	13-#5	308	691	829
1.073 CF/SF	300	3.28	15 *	0.829		7-#7+ 2	5	#7	#8	9-#9	7	#5	#6	13-#5	388	951	1046
	400	3.97	15 *	0.640	4 S 6 1	12-#6+ 1	5	#8	#9	11-#9	7	#6	#6	13-#5	469	1203	1263
	500	4.81	16 *	0.639	4 S 6 1	10-#7+ 1	5	#9	#10	13-#9	7	#6	#7	14-#5	548	1446	1476
32'-6"	50	2.09	16	0.638		10-#6+ 0	6	#5	#5	9-#7	7	#4	#5	13-#5	241	481	648
D = 13.000	100	2.26	16	0.638		10-#6+ 0	6	#5	#6	11-#7	7	#4	#5	13-#5	292	584	786
RIB NOT ON	150	2.49	16	0.692		10-#6+ 1	6	#6	#6	10-#8	7	#4	#5	13-#5	343	702	924
COLUMN LINE	200	2.87	16 *	0.788		10-#6+ 3	6	#6	#7	9-#9	7	#5	#5	13-#5	395	880	1062
1.101 CF/SF	300	3.80	16 *	0.639		9-#7+ 2	6	#8	#8	12-#9	7	#6	#6	13-#5	497	1211	1339
	400	4.60	17 *	0.637		11-#7+ 3	6	#9	#9	14-#9	7	#6	#7	15-#5	598	1527	1610
	500	5.35	22 *	0.632		10-#8+ 1	6	#9	#10	17-#9	7	#7	#7	17-#5	685	1767	1845
35'-0"	50	2.27	17	0.636		15-#5+ 1	6	#5	#6	11-#7	8	#4	#5	15-#5	299	598	805
D = 13.000	100	2.51	17	0.700		15-#5+ 3	6	#6	#6	9-#9	8	#4	#5	15-#5	363	727	978
RIB NOT ON	150	2.75	17 *	0.808		11-#6+ 5	6	#6	#7	10-#9	8	#4	#5	15-#5	427	860	1151
COLUMN LINE	200	3.34	17 *	0.868		9-#7+ 4	6	#7	#8	12-#9	8	#5	#6	15-#5	492	1083	1323
1.085 CF/SF	300	4.28	17 *	0.637		9-#8+ 1	6	#9	#9	15-#9	8	#6	#6	16-#5	620	1496	1669
	400	5.22	23 *	0.632		14-#7+ 2	6	#9	#10	18-#9	8	#7	#7	19-#5	733	1825	1974
	500	5.87	28 *	0.628	4 S 6 1	12-#8+ 0	6	#10	#10	21-#9	8	#7	#7	15-#6	835	1972	2248
37' -6"	50	2.46	18	0.635		16-#5+ 1	6	#6	#6	9-#9	9	#4	#5	17-#5	367	733	987
D = 13.000	100	2.77	18 *	0.761		16-#5+ 5	6	#7	#7	10-#9	9	#4	#5	17-#5	446	891	1200
RIB NOT ON	150	3.18	18 *	0.849		10-#7+ 3	6	#7	#8	12-#9	9	#5	#5	17-#5	525	1049	1412
COLUMN LINE	200	3.59	18 *	0.636		11-#7+ 3	6	#8	#8	14-#9	9	#5	#6	17-#5	604	1310	1625
1.073 CF/SF	300	4.93	22 *	0.632		11-#8+ 3	6	#9	#10	18-#9	9	#6	#7	19-#5	754	1801	2031
	400	5.71	28 *	0.628	4 S 6 1	10-#9+ 1	6	#10	#10	22-#9	9	#7	#7	23-#5	885	2029	2383
40'-0"	50	2.61	20	0.694		12-#6+ 3	7	#6	#7	13-#8	9	#4	#5	17-#5	447	894	1204
D = 15.500	100	3.03	20 *	0.830		14-#6+ 7	7	#7	#7	16-#8	9	#5	#5	17-#5	543	1085	1461
RIB ON	150	3.46	20 *	0.896		12-#7+ 6	7	#7	#8	15-#9	9	#5	#6	17-#5	638	1276	1718
COLUMN LINE	200	4.20	20 *	0.634		14-#7+ 4	7	#8	#9	18-#9	9	#6	#6	19-#5	734	1545	1975
1.095 CF/SF	300	5.38	27 *	0.629	4 S 6 1	13-#8+ 2	7	#9	#10	22-#9	9	#7	#7	23-#5	906	2043	2440
42'-6"	50	2.86	21 *	0.781		14-#6+ 6	7	#7	#7	16-#8	10	#4	#5	18-#5	534	1069	1439
D = 15.500	100	3.28	21 *	0.870		12-#7+ 6	7	#7	#8	16-#9	10	#5	#5	18-#5	649	1298	1747
RIB ON	150	3.77	21 *	0.633		11-#8+ 3	7	#8	#8	23-#8	10	#5	#6	19-#5	764	1527	2056
COLUMN LINE	200	4.59	25 *	0.630		13-#8+ 2	7	#9	#9	21-#9	10	#6	#6	22-#5	871	1790	2345
1.083 CF/SF	300	5.50	32 *	0.626	4 S 6 1	12-#9+ 3	7	#9	#10	27-#9	10	#6	#7	19-#6	1069	2137	2877
45'-0"	50	3.19	22 *	0.823		12-#7+ 5	7	#7	#8	15-#9	11	#5	#5	20-#5	632	1265	1703
D = 15.500	100	3.75	22 *	0.910		11-#8+ 6	7	#8	#8	19-#9	11	#5	#6	20-#5	769	1537	2070
RIB ON	150	4.51	25 *	0.630		13-#8+ 2	7	#9	#9	22-#9	11	#6	#6	23-#5	900	1799	2422
COLUMN LINE	200	5.01	29 *	0.627	4 S 6 1	12-#9+ 2	7	#9	#10	26-#9	11	#6	#6	26-#5	1025	2050	2759
1.073 CF/SF																	
47'-6"	50	3.52	23 *	0.875		14-#7+ 8	8	#7	#8	18-#9	11	#5	#6	20-#5	750	1500	2019
D = 18.000	100	4.28	24 *	0.631		13-#8+ 4	8	#8	#9	22-#9	11	#6	#6	23-#5	908	1817	2446
RIB NOT ON	150	4.86	30 *	0.627		12-#9+ 2	8	#9	#9	26-#9	11	#6	#7	27-#5	1056	2113	2844
COLUMN LINE	200	5.50	34 *	0.625		14-#9+ 3	8	#9	#10	30-#9	11	#6	#7	22-#6	1194	2388	3215
1.091 CF/SF																	

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 21 in.		Rib Depth = 16 in.		Total Slab Depth = 5 in.							
30'-0"	2.01	15		5	#4	#5	9-#6	7	#4	#5	13-#5
D = 10.500	2.10	15		5	#4	#5	8-#7	7	#4	#5	13-#5
RIB ON	2.30	15		5	#5	#5	7-#8	7	#4	#5	13-#5
COLUMN LINE	2.50	15		5	#5	#6	8-#8	7	#4	#5	13-#5
1.073 CF/SF	2.98	15	4 S 6 1	5	#6	#7	8-#9	7	#4	#5	13-#5
	3.54	15 *	4 S 6 2	5	#7	#7	10-#9	7	#5	#5	13-#5
	4.29	15 *	4 S 6 2	5	#8	#8	12-#9	7	#5	#6	13-#5
32'-6"	2.03	16		6	#4	#5	16-#5	7	#4	#5	13-#5
D = 13.000	2.16	16		6	#4	#5	10-#7	7	#4	#5	13-#5
RIB NOT ON	2.40	16		6	#5	#5	9-#8	7	#4	#5	13-#5
COLUMN LINE	2.76	16		6	#5	#6	9-#9	7	#4	#5	13-#5
1.101 CF/SF	3.43	16 *	4 S 6 1	6	#6	#7	11-#9	7	#5	#5	13-#5
	4.15	16 *	4 S 6 1	6	#7	#8	13-#9	7	#5	#6	14-#5
	4.83	19 *	4 S 6 2	6	#8	#8	15-#9	7	#6	#6	16-#5
35'-0"	2.22	17		6	#4	#5	11-#7	8	#4	#5	15-#5
D = 13.000	2.43	17		6	#5	#5	10-#8	8	#4	#5	15-#5
RIB NOT ON	2.70	17		6	#5	#6	9-#9	8	#4	#5	15-#5
COLUMN LINE	3.03	17 *	4 S 6 1	6	#6	#6	11-#9	8	#4	#5	15-#5
1.085 CF/SF	3.78	17 *	4 S 6 2	6	#7	#7	14-#9	8	#5	#5	15-#5
	4.65	19 *	4 S 6 2	6	#8	#8	17-#9	8	#5	#6	17-#5
	5.40	25 *	4 S 6 2	6	#8	#9	19-#9	8	#6	#6	20-#5
37' -6"	2.39	18		6	#5	#5	10-#8	9	#4	#5	17-#5
D = 13.000	2.66	18		6	#5	#6	12-#8	9	#4	#5	17-#5
RIB NOT ON	2.95	18 *	4 S 6 1	6	#6	#6	11-#9	9	#4	#5	17-#5
COLUMN LINE	3.28	18 *	4 S 6 1	6	#6	#7	13-#9	9	#4	#5	17-#5
1.073 CF/SF	4.49	18 *	4 S 6 2	6	#8	#8	17-#9	9	#5	#6	18-#5
	5.20	24 *	4 S 6 2	6	#8	#9	21-#9	9	#5	#6	21-#5
40'-0"	2.47	20		7	#5	#5	12-#8	9	#4	#5	17-#5
D = 15.500	2.83	20		7	#5	#6	12-#9	9	#4	#5	17-#5
RIB ON	3.14	20 *	4 S 6 1	7	#6	#6	14-#9	9	#4	#5	17-#5
COLUMN LINE	3.78	20 *	4 S 6 1	7	#7	#7	16-#9	9	#5	#5	17-#5
1.095 CF/SF	4.87	22 *	4 S 6 2	7	#8	#8	21-#9	9	#5	#6	22-#5
42'-6"	2.75	21		7	#5	#6	12-#9	10	#4	#5	18-#5
D = 15.500	3.04	21 *	4 S 6 1	7	#6	#6	14-#9	10	#4	#5	18-#5
RIB ON	3.46	21 *	4 S 6 1	7	#6	#7	17-#9	10	#4	#5	18-#5
COLUMN LINE	4.24	21 *	4 S 6 2	7	#7	#8	20-#9	10	#5	#5	21-#5
1.083 CF/SF	5.15	27 *	4 S 6 2	7	#8	#8	25-#9	10	#5	#6	18-#6
45'-0"	2.98	22	4 S 6 1	7	#6	#6	14-#9	11	#4	#5	20-#5
D = 15.500	3.50	22 *	4 S 6 1	7	#7	#7	17-#9	11	#4	#5	20-#5
RIB ON	4.18	22 *	4 S 6 2	7	#7	#8	21-#9	11	#5	#5	21-#5
COLUMN LINE	4.65	23 *	4 S 6 2	7	#8	#8	24-#9	11	#5	#5	25-#5
1.073 CF/SF											
47'-6"	3.31	23 *		8	#6	#7	17-#9	11	#4	#5	20-#5
D = 18.000	3.95	23 *	4 S 6 1	8	#7	#7	21-#9	11	#5	#5	21-#5
RIB NOT ON	4.41	23 *	4 S 6 2	8	#7	#8	24-#9	11	#5	#5	25-#5
COLUMN LINE	5.13	28 *	4 S 6 2	8	#8	#8	28-#9	11	#5	#6	20-#6
1.091 CF/SF											

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 25 in.	Rib Depth = 20 in.	Total Slab Depth = 5 in.															
35'-0"	50	2.45	17	0.640		15-#5+ 0	6	#5	#6	11-#7	8	#5	#5	15-#5	340	680	915
D = 13.000	100	2.61	17	0.640		15-#5+ 0	6	#6	#6	10-#8	8	#5	#5	15-#5	404	808	1088
RIB NOT ON	150	2.76	17	0.640		15-#5+ 1	6	#6	#7	9-#9	8	#5	#5	15-#5	468	936	1260
COLUMN LINE	200	3.01	17	0.658		11-#6+ 1	6	#7	#7	10-#9	8	#5	#5	15-#5	532	1142	1433
1.276 CF/SF	300	3.77	17 *	0.857		10-#7+ 4	6	#8	#8	16-#8	8	#6	#6	15-#5	661	1568	1779
	400	4.56	17 *	0.641		9-#8+ 2	6	#9	#9	16-#9	8	#6	#7	16-#5	789	1972	2124
	500	5.47	18 *	0.640		14-#7+ 2	6	#10	#10	18-#9	8	#7	#7	19-#5	915	2365	2463
37'-6"	50	2.58	18	0.639		16-#5+ 0	6	#6	#6	10-#8	9	#5	#5	17-#5	416	833	1121
D = 13.000	100	2.84	18	0.639		16-#5+ 0	6	#6	#7	9-#9	9	#5	#5	17-#5	495	991	1334
RIB NOT ON	150	3.02	18	0.659		12-#6+ 1	6	#7	#7	11-#9	9	#5	#5	17-#5	574	1149	1546
COLUMN LINE	200	3.39	18 *	0.795		10-#7+ 3	6	#7	#8	16-#8	9	#5	#5	17-#5	653	1386	1759
1.261 CF/SF	300	4.32	18 *	0.640		17-#6+ 1	6	#9	#9	16-#9	9	#6	#6	17-#5	811	1911	2184
	400	5.40	19 *	0.639		9-#9+ 2	6	#10	#10	19-#9	9	#7	#7	20-#5	967	2402	2603
40'-0"	50	2.64	20	0.637		12-#6+ 2	7	#6	#6	12-#8	9	#5	#5	17-#5	508	1016	1368
D = 15.500	100	2.96	20	0.639		18-#5+ 3	7	#6	#7	12-#9	9	#5	#5	17-#5	604	1207	1625
RIB ON	150	3.25	20 *	0.785		11-#7+ 4	7	#7	#7	14-#9	9	#5	#5	17-#5	699	1398	1882
COLUMN LINE	200	3.63	20 *	0.859		12-#7+ 6	7	#7	#8	16-#9	9	#5	#6	17-#5	795	1648	2139
1.288 CF/SF	300	4.77	20 *	0.638		12-#8+ 2	7	#9	#9	20-#9	9	#6	#7	21-#5	986	2286	2654
	400	5.96	24 *	0.634	5 S 8 1	11-#9+ 3	7	#10	#10	24-#9	9	#7	#8	17-#6	1166	2858	3140
42'-6"	50	2.90	21	0.636		13-#6+ 2	7	#6	#7	12-#9	10	#5	#5	18-#5	607	1214	1634
D = 15.500	100	3.28	21	0.755		11-#7+ 4	7	#7	#8	14-#9	10	#5	#5	18-#5	722	1443	1943
RIB ON	150	3.69	21 *	0.841		13-#7+ 5	7	#8	#8	16-#9	10	#5	#6	18-#5	836	1673	2252
COLUMN LINE	200	4.06	21 *	0.637		11-#8+ 3	7	#8	#9	19-#9	10	#5	#6	20-#5	951	1937	2561
1.273 CF/SF	300	5.46	23 *	0.635	5 S 8 1	11-#9+ 3	7	#10	#10	24-#9	10	#7	#7	18-#6	1175	2692	3165
45'-0"	50	3.10	22	0.714		11-#7+ 4	7	#7	#7	14-#9	11	#5	#5	20-#5	718	1437	1934
D = 15.500	100	3.57	22 *	0.813		13-#7+ 5	7	#8	#8	17-#9	11	#5	#5	20-#5	855	1709	2301
RIB ON	150	4.01	22 *	0.896		12-#8+ 6	7	#8	#9	20-#9	11	#5	#6	21-#5	991	1982	2668
COLUMN LINE	200	4.58	22 *	0.636		11-#9+ 3	7	#9	#9	23-#9	11	#6	#6	24-#5	1127	2254	3035
1.261 CF/SF																	
47'-6"	50	3.34	23 *	0.786		13-#7+ 6	8	#7	#8	17-#9	11	#5	#5	20-#5	852	1704	2294
D = 18.000	100	3.84	23 *	0.865		12-#8+ 5	8	#8	#8	20-#9	11	#5	#6	21-#5	1012	2025	2726
RIB NOT ON	150	4.40	23 *	0.635		14-#8+ 4	8	#8	#9	24-#9	11	#6	#6	25-#5	1173	2345	3157
COLUMN LINE	200	5.04	26 *	0.633		16-#8+ 3	8	#9	#9	27-#9	11	#6	#7	20-#6	1326	2651	3569
1.284 CF/SF	300	6.25	34 *	0.628		16-#9+ 2	8	#10	#10	33-#9	11	#7	#7	24-#6	1605	3209	4320

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 25 in.	Rib Depth = 20 in.	Total Slab Depth = 5 in.								
2.41	17		6	#5	#5	10-#7	8	#5	#5	15-#5
2.54	17		6	#5	#5	9-#8	8	#5	#5	15-#5
2.61	17		6	#5	#5	10-#8	8	#5	#5	15-#5
2.87	17		6	#5	#6	9-#9	8	#5	#5	15-#5
3.42	17 *	5 S 8 1	6	#6	#7	12-#9	8	#5	#5	15-#5
4.08	17 *	5 S 8 2	6	#7	#8	14-#9	8	#5	#6	15-#5
4.88	17 *	5 S 8 2	6	#8	#8	17-#9	8	#6	#6	18-#5
2.52	18		6	#5	#5	9-#8	9	#5	#5	17-#5
2.82	18		6	#5	#6	9-#9	9	#5	#5	17-#5
2.90	18		6	#5	#6	10-#9	9	#5	#5	17-#5
3.34	18	5 S 8 1	6	#6	#7	12-#9	9	#5	#5	17-#5
3.96	18 *	5 S 8 2	6	#7	#8	15-#9	9	#5	#5	17-#5
4.79	18 *	5 S 8 2	6	#8	#9	18-#9	9	#5	#6	19-#5
2.59	20		7	#5	#5	11-#8	9	#5	#5	17-#5
2.93	20		7	#5	#6	11-#9	9	#5	#5	17-#5
3.18	20		7	#6	#6	16-#8	9	#5	#5	17-#5
3.45	20 *	5 S 8 1	7	#6	#7	14-#9	9	#5	#5	17-#5
4.33	20 *	5 S 8 1	7	#7	#8	18-#9	9	#5	#6	19-#5
5.36	20 *	5 S 8 2	7	#8	#9	22-#9	9	#6	#6	23-#5
2.86	21		7	#5	#6	11-#9	10	#5	#5	18-#5
3.15	21		7	#6	#6	13-#9	10	#5	#5	18-#5
3.46	21	5 S 8 1	7	#6	#7	15-#9	10	#5	#5	18-#5
3.77	21 *	5 S 8 1	7	#7	#7	17-#9	10	#5	#5	18-#5
4.77	21 *	5 S 8 2	7	#8	#8	22-#9	10	#5	#6	23-#5
3.05	22		7	#6	#6	16-#8	11	#5	#5	20-#5
3.46	22	5 S 8 1	7	#6	#7	16-#9	11	#5	#5	20-#5
3.75	22 *	5 S 8 1	7	#7	#7	18-#9	11	#5	#5	20-#5
4.21	22 *	5 S 8 2	7	#7	#8	21-#9	11	#5	#5	22-#5
3.19	23		8	#6	#6	15-#9	11	#5	#5	20-#5
3.64	23 *	5 S 8 1	8	#6	#7	19-#9	11	#5	#5	20-#5
4.06	23 *	5 S 8 1	8	#7	#7	22-#9	11	#5	#5	23-#5
4.68	23 *	5 S 8 2	8	#7	#8	25-#9	11	#5	#6	26-#5
5.88	28 *	5 S 8 2	8	#8	#9	31-#9	11	#6	#6	23-#6

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 11 in.	Rib Depth = 8 in.		Total Slab Depth = 3 in.														
15'-0"	50	1.60	12	0.629		6-#5+ 0	3	#4	#4	6-#5	2	#4	#4	7-#5	13	27	36
D = 6.500	100	1.60	12	0.629		6-#5+ 0	3	#4	#4	6-#5	2	#4	#4	7-#5	18	39	49
RIB ON	150	1.60	12	0.629		6-#5+ 0	3	#4	#4	6-#5	2	#4	#4	7-#5	23	55	62
COLUMN LINE	200	1.60	12	0.629		6-#5+ 0	3	#4	#4	6-#5	2	#4	#4	7-#5	28	70	74
0.545 CF/SF	300	1.71	12	0.644		6-#5+ 0	3	#4	#5	6-#5	2	#4	#5	7-#5	37	99	100
	400	1.94	12	0.721		6-#5+ 0	3	#5	#5	7-#5	2	#5	#5	7-#5	47	127	126
18'-0"	50	1.71	12	0.629		8-#5+ 0	3	#4	#4	8-#5	3	#4	#4	10-#5	23	47	63
D = 6.500	100	1.71	12	0.663		8-#5+ 0	3	#4	#4	8-#5	3	#4	#4	10-#5	32	69	85
RIB ON	150	1.77	12	0.704		8-#5+ 0	3	#4	#5	8-#5	3	#4	#4	10-#5	40	96	108
COLUMN LINE	200	1.83	12	0.746		8-#5+ 0	3	#5	#5	8-#5	3	#4	#4	10-#5	49	122	131
0.523 CF/SF	300	2.25	12 *	0.848		8-#5+ 1	3	#6	#6	7-#6	3	#5	#5	10-#5	66	173	176
	400	2.74	12 *	0.630	3 S 4 1	8-#5+ 1	3	#7	#7	9-#6	3	#5	#6	10-#5	82	223	222
21'-0"	50	1.63	12	0.701		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	10-#5	38	77	103
D = 9.500	100	1.69	12	0.776		9-#5+ 1	4	#4	#5	9-#5	3	#4	#4	10-#5	52	114	140
RIB NOT ON	150	1.81	12	0.837		9-#5+ 2	4	#5	#5	10-#5	3	#4	#5	10-#5	66	158	177
COLUMN LINE	200	2.18	12 *	0.888		9-#5+ 3	4	#5	#6	12-#5	3	#5	#6	10-#5	79	200	214
0.555 CF/SF	300	2.92	13 *	0.629		9-#5+ 3	4	#7	#7	12-#6	3	#6	#7	10-#5	106	282	286
	400	3.40	17 *	0.624		10-#5+ 3	4	#7	#8	15-#6	3	#7	#7	10-#5	129	328	347
24'-0"	50	1.67	12	0.768		10-#5+ 0	4	#4	#5	10-#5	4	#4	#4	12-#5	57	115	154
D = 9.500	100	1.88	12 *	0.855		10-#5+ 2	4	#5	#5	8-#6	4	#4	#5	12-#5	78	170	210
RIB NOT ON	150	2.24	12 *	0.918		10-#5+ 4	4	#6	#6	15-#5	4	#5	#5	12-#5	99	235	265
COLUMN LINE	200	2.68	14 *	0.627		10-#5+ 2	4	#7	#7	13-#6	4	#5	#6	12-#5	118	297	319
0.536 CF/SF																	
27'-0"	50	1.75	13 *	0.806		8-#6+ 0	4	#5	#5	12-#5	5	#4	#4	14-#5	81	162	219
D = 9.500	100	2.17	13 *	0.899		8-#6+ 2	4	#6	#6	12-#6	5	#4	#5	14-#5	111	233	298
RIB NOT ON	150	2.88	16 *	0.912		8-#6+ 4	4	#7	#8	16-#6	5	#5	#6	14-#5	139	323	374
COLUMN LINE	200	3.26	21 *	0.621		12-#5+ 3	4	#8	#8	19-#6	5	#6	#6	14-#5	164	382	442
0.523 CF/SF																	
30'-0"	50	1.99	15 *	0.854		13-#5+ 3	5	#5	#6	12-#6	5	#4	#5	14-#5	113	225	303
D = 12.500	100	2.45	16 *	0.919		13-#5+ 7	5	#6	#7	17-#6	5	#5	#5	14-#5	152	305	411
RIB ON	150	2.93	24 *	0.619		10-#6+ 3	5	#7	#7	21-#6	5	#5	#6	14-#5	186	373	502
COLUMN LINE																	
0.545 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 11 in.			Rib Depth = 8 in.				Total Slab Depth = 3 in.			
1.64	12		3	#4	#4	6-#5	2	#4	#4	7-#5
1.64	12		3	#4	#4	6-#5	2	#4	#4	7-#5
1.64	12		3	#4	#4	6-#5	2	#4	#4	7-#5
1.64	12		3	#4	#4	6-#5	2	#4	#4	7-#5
1.64	12		3	#4	#4	6-#5	2	#4	#4	7-#5
1.83	12	3 S 4 1	3	#4	#5	6-#5	2	#4	#5	7-#5
1.78	12		3	#4	#4	8-#5	3	#4	#4	10-#5
1.78	12		3	#4	#4	8-#5	3	#4	#4	10-#5
1.78	12		3	#4	#4	8-#5	3	#4	#4	10-#5
1.78	12	3 S 4 1	3	#4	#4	8-#5	3	#4	#4	10-#5
2.03	12	3 S 4 1	3	#5	#5	6-#6	3	#4	#4	10-#5
2.44	12 *	3 S 4 1	3	#5	#6	8-#6	3	#4	#5	10-#5
1.68	12		4	#4	#4	9-#5	3	#4	#4	10-#5
1.68	12		4	#4	#4	9-#5	3	#4	#4	10-#5
1.68	12		4	#4	#4	9-#5	3	#4	#4	10-#5
1.99	12 *		4	#4	#5	8-#6	3	#4	#5	10-#5
2.54	12 *	3 S 4 1	4	#5	#6	15-#5	3	#5	#5	10-#5
2.99	16 *	3 S 4 1	4	#6	#6	13-#6	3	#5	#6	10-#5
1.68	12		4	#4	#4	10-#5	4	#4	#4	12-#5
1.84	12		4	#4	#5	8-#6	4	#4	#4	12-#5
2.08	12 *	3 S 4 1	4	#5	#5	10-#6	4	#4	#4	12-#5
2.42	12 *	3 S 4 1	4	#5	#6	12-#6	4	#4	#5	12-#5
1.71	13		4	#4	#4	8-#6	5	#4	#4	14-#5
2.07	13 *	3 S 4 1	4	#5	#5	11-#6	5	#4	#4	14-#5
2.63	13 *	3 S 4 1	4	#6	#6	15-#6	5	#4	#5	14-#5
2.95	15 *	3 S 4 2	4	#6	#7	18-#6	5	#4	#5	14-#5
1.88	15		5	#4	#5	11-#6	5	#4	#4	14-#5
2.24	15 *	3 S 4 1	5	#5	#5	16-#6	5	#4	#4	14-#5
2.78	18 *	3 S 4 1	5	#6	#6	20-#6	5	#4	#5	14-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 13 in.	Rib Depth = 10 in.	Total Slab Depth = 3 in.															
18'-0"	50	1.71	12	0.633		8-#5+ 0	3	#4	#4	8-#5	3	#4	#4	10-#5	25	51	68
D = 6.500	100	1.71	12	0.633		8-#5+ 0	3	#4	#4	8-#5	3	#4	#4	10-#5	34	73	91
RIB ON	150	1.71	12	0.633		8-#5+ 0	3	#4	#4	8-#5	3	#4	#4	10-#5	42	100	113
COLUMN LINE	200	1.77	12	0.641		8-#5+ 0	3	#4	#5	8-#5	3	#4	#4	10-#5	51	127	136
0.597 CF/SF	300	2.01	12	0.717		8-#5+ 0	3	#5	#6	8-#5	3	#4	#5	10-#5	68	179	182
	400	2.44	12	0.793		8-#5+ 0	3	#6	#7	7-#6	3	#5	#5	10-#5	84	230	227
21'-0"	50	1.63	12	0.633		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	10-#5	42	84	113
D = 9.500	100	1.63	12	0.664		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	10-#5	55	120	149
RIB NOT ON	150	1.74	12	0.709		9-#5+ 0	4	#4	#5	9-#5	3	#4	#5	10-#5	69	165	186
COLUMN LINE	200	1.92	12	0.755		9-#5+ 0	4	#5	#5	10-#5	3	#5	#5	10-#5	83	208	223
0.637 CF/SF	300	2.60	12 *	0.874		9-#5+ 2	4	#6	#7	10-#6	3	#6	#6	10-#5	110	292	296
	400	3.05	12 *	0.634		9-#5+ 1	4	#7	#7	12-#6	3	#6	#7	10-#5	137	375	370
24'-0"	50	1.62	12	0.692		10-#5+ 0	4	#4	#4	10-#5	4	#4	#4	12-#5	62	125	168
D = 9.500	100	1.73	12	0.769		10-#5+ 1	4	#5	#5	10-#5	4	#4	#4	12-#5	83	179	223
RIB NOT ON	150	1.97	12 *	0.833		10-#5+ 2	4	#5	#6	9-#6	4	#4	#5	12-#5	104	247	279
COLUMN LINE	200	2.43	12 *	0.895		10-#5+ 4	4	#6	#7	11-#6	4	#5	#5	12-#5	124	311	334
0.613 CF/SF	300	3.15	14 *	0.631		10-#5+ 3	4	#7	#8	15-#6	4	#6	#6	12-#5	164	435	442
	400	3.86	18 *	0.626		12-#5+ 3	4	#8	#9	19-#6	4	#7	#7	12-#5	200	529	538
27'-0"	50	1.75	13	0.735		8-#6+ 0	4	#5	#5	8-#6	5	#4	#4	14-#5	88	176	237
D = 9.500	100	1.95	13 *	0.819		8-#6+ 1	4	#5	#6	15-#5	5	#4	#4	14-#5	118	248	317
RIB NOT ON	150	2.48	13 *	0.897		8-#6+ 3	4	#7	#7	13-#6	5	#5	#5	14-#5	147	344	396
COLUMN LINE	200	2.95	14 *	0.631		8-#6+ 2	4	#7	#8	16-#6	5	#5	#6	14-#5	176	435	474
0.597 CF/SF	300	3.82	20 *	0.625		10-#6+ 1	4	#9	#9	22-#6	5	#6	#7	14-#5	228	570	613
30'-0"	50	1.78	15	0.785		13-#5+ 2	5	#5	#5	11-#6	5	#4	#4	14-#5	123	245	330
D = 12.500	100	2.29	15 *	0.872		13-#5+ 5	5	#6	#6	15-#6	5	#5	#5	14-#5	163	327	438
RIB ON	150	2.74	16 *	0.918		13-#5+ 8	5	#7	#7	26-#5	5	#5	#6	14-#5	202	458	545
COLUMN LINE	200	3.51	19 *	0.625		15-#5+ 5	5	#8	#8	23-#6	5	#6	#7	14-#5	241	577	648
0.624 CF/SF																	
33'-0"	50	2.18	16 *	0.835		10-#6+ 3	5	#6	#6	15-#6	6	#4	#5	17-#5	162	324	436
D = 12.500	100	2.60	16 *	0.917		10-#6+ 6	5	#7	#7	20-#6	6	#5	#5	17-#5	216	431	581
RIB ON	150	3.39	20 *	0.625		12-#6+ 4	5	#8	#8	25-#6	6	#6	#6	17-#5	267	582	718
COLUMN LINE																	
0.609 CF/SF																	
36'-0"	50	2.38	18 *	0.852		11-#6+ 4	5	#6	#7	19-#6	7	#4	#5	19-#5	208	417	561
D = 12.500	100	3.05	20 *	0.921		12-#6+ 9	5	#7	#8	26-#6	7	#5	#6	19-#5	277	553	744
RIB ON																	
COLUMN LINE																	
0.597 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 13 in.	Rib Depth = 10 in.	Total Slab Depth = 3 in.								
1.78	12		3	#4	#4	8-#5	3	#4	#4	10-#5
1.78	12		3	#4	#4	8-#5	3	#4	#4	10-#5
1.78	12		3	#4	#4	8-#5	3	#4	#4	10-#5
1.78	12		3	#4	#4	8-#5	3	#4	#4	10-#5
1.89	12	3 S 4 1	3	#4	#5	8-#5	3	#4	#4	10-#5
2.23	12	3 S 4 1	3	#5	#5	7-#6	3	#4	#5	10-#5
1.68	12		4	#4	#4	9-#5	3	#4	#4	10-#5
1.68	12		4	#4	#4	9-#5	3	#4	#4	10-#5
1.68	12		4	#4	#4	9-#5	3	#4	#4	10-#5
1.79	12		4	#4	#5	9-#5	3	#4	#4	10-#5
2.30	12 *	3 S 4 1	4	#5	#5	9-#6	3	#5	#5	10-#5
2.81	12 *	3 S 4 1	4	#6	#6	16-#5	3	#5	#6	10-#5
1.68	12		4	#4	#4	10-#5	4	#4	#4	12-#5
1.68	12		4	#4	#4	10-#5	4	#4	#4	12-#5
1.84	12		4	#4	#5	8-#6	4	#4	#4	12-#5
2.28	12 *	3 S 4 1	4	#5	#6	10-#6	4	#4	#5	12-#5
2.93	12 *	3 S 4 1	4	#6	#7	14-#6	4	#5	#5	12-#5
3.41	15 *	3 S 4 1	4	#7	#7	17-#6	4	#5	#6	12-#5
1.71	13		4	#4	#4	8-#6	5	#4	#4	14-#5
1.92	13	3 S 4 1	4	#4	#5	10-#6	5	#4	#4	14-#5
2.23	13 *	3 S 4 1	4	#5	#6	12-#6	5	#4	#4	14-#5
2.77	13 *	3 S 4 1	4	#6	#7	15-#6	5	#4	#5	14-#5
3.34	16 *	3 S 4 2	4	#7	#7	20-#6	5	#5	#5	14-#5
1.72	15		5	#4	#4	10-#6	5	#4	#4	14-#5
2.13	15		5	#5	#5	14-#6	5	#4	#4	14-#5
2.51	15 *	3 S 4 1	5	#5	#6	17-#6	5	#4	#5	14-#5
3.21	15 *	3 S 4 1	5	#6	#7	21-#6	5	#5	#6	14-#5
2.09	16		5	#5	#5	14-#6	6	#4	#4	17-#5
2.39	16 *	3 S 4 1	5	#5	#6	18-#6	6	#4	#4	17-#5
3.15	16 *	3 S 4 1	5	#6	#7	24-#6	6	#5	#5	17-#5
2.31	18	3 S 4 1	5	#5	#6	18-#6	7	#4	#4	19-#5
2.90	18 *	3 S 4 1	5	#6	#7	24-#6	7	#4	#5	19-#5

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 15 in.	Rib Depth = 12 in.	Total Slab Depth = 3 in.															
21'-0"	50	1.63	12	0.636		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	10-#5	45	91	122
D = 9.500	100	1.63	12	0.636		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	10-#5	59	126	159
RIB NOT ON	150	1.69	12	0.636		9-#5+ 0	4	#4	#5	9-#5	3	#4	#4	10-#5	73	172	196
COLUMN LINE	200	1.80	12	0.656		9-#5+ 0	4	#5	#5	9-#5	3	#4	#5	10-#5	86	215	232
0.720 CF/SF	300	2.25	12	0.741		9-#5+ 0	4	#6	#6	8-#6	3	#5	#6	10-#5	114	300	306
	400	2.71	12 *	0.857		9-#5+ 2	4	#6	#7	15-#5	3	#6	#6	10-#5	141	383	379
	500	3.28	12 *	0.637		9-#5+ 1	4	#7	#8	18-#5	3	#7	#7	10-#5	168	465	453
24'-0"	50	1.62	12	0.636		10-#5+ 0	4	#4	#4	10-#5	4	#4	#4	12-#5	67	135	182
D = 9.500	100	1.67	12	0.662		10-#5+ 0	4	#4	#5	10-#5	4	#4	#4	12-#5	88	187	237
RIB NOT ON	150	1.95	12	0.712		10-#5+ 0	4	#5	#6	8-#6	4	#4	#5	12-#5	109	256	293
COLUMN LINE	200	2.20	12	0.762		10-#5+ 0	4	#6	#6	10-#6	4	#5	#5	12-#5	129	321	348
0.692 CF/SF	300	2.81	12 *	0.894		10-#5+ 3	4	#7	#7	13-#6	4	#6	#6	12-#5	171	449	459
	400	3.45	13 *	0.635		8-#6+ 2	4	#8	#8	16-#6	4	#6	#7	12-#5	211	573	568
	500	4.10	17 *	0.630		9-#6+ 2	4	#9	#9	20-#6	4	#7	#7	12-#5	247	673	664
27'-0"	50	1.70	13	0.661		8-#6+ 0	4	#4	#5	8-#6	5	#4	#4	14-#5	95	191	257
D = 9.500	100	1.88	13	0.718		8-#6+ 0	4	#5	#6	9-#6	5	#4	#4	14-#5	125	260	336
RIB NOT ON	150	2.22	13 *	0.801		8-#6+ 1	4	#6	#7	12-#6	5	#4	#5	14-#5	154	359	415
COLUMN LINE	200	2.63	13 *	0.878		8-#6+ 3	4	#7	#7	14-#6	5	#5	#5	14-#5	184	452	495
0.673 CF/SF	300	3.51	15 *	0.633		9-#6+ 1	4	#8	#9	19-#6	5	#6	#6	14-#5	241	630	649
	400	4.31	19 *	0.628		11-#6+ 1	4	#9	#10	24-#6	5	#7	#7	14-#5	293	768	788
30'-0"	50	1.74	15	0.682		13-#5+ 0	5	#5	#5	10-#6	5	#4	#4	14-#5	133	265	357
D = 12.500	100	2.03	15	0.795		13-#5+ 3	5	#5	#6	13-#6	5	#4	#5	14-#5	173	348	466
RIB ON	150	2.58	15 *	0.872		13-#5+ 6	5	#6	#7	16-#6	5	#5	#6	14-#5	213	485	574
COLUMN LINE	200	3.07	15 *	0.633		13-#5+ 4	5	#7	#8	20-#6	5	#6	#6	14-#5	254	611	683
0.705 CF/SF	300	4.00	20 *	0.627	4 S 6 1	12-#6+ 3	5	#8	#9	26-#6	5	#7	#7	14-#5	328	834	884
33'-0"	50	1.94	16	0.765		10-#6+ 2	5	#5	#6	13-#6	6	#4	#4	17-#5	175	351	472
D = 12.500	100	2.46	16 *	0.853		10-#6+ 4	5	#6	#7	18-#6	6	#5	#5	17-#5	229	458	617
RIB ON	150	2.97	16 *	0.631		15-#5+ 3	5	#7	#8	22-#6	6	#5	#6	17-#5	283	627	761
COLUMN LINE	200	3.70	19 *	0.628		18-#5+ 4	5	#8	#9	27-#6	6	#6	#7	17-#5	334	788	899
0.687 CF/SF																	
36'-0"	50	2.26	18 *	0.773		11-#6+ 2	5	#6	#7	17-#6	7	#4	#5	19-#5	225	451	606
D = 12.500	100	2.76	18 *	0.882		11-#6+ 6	5	#7	#8	23-#6	7	#5	#5	19-#5	295	590	794
RIB ON	150	3.41	20 *	0.627	4 S 6 1	19-#5+ 4	5	#8	#9	29-#6	7	#5	#6	19-#5	363	756	977
COLUMN LINE	200	4.06	25 *	0.624	4 S 6 1	16-#6+ 3	5	#9	#9	35-#6	7	#6	#7	19-#5	426	922	1146
0.673 CF/SF																	
39'-0"	50	2.51	19 *	0.856		17-#5+10	6	#6	#7	23-#6	7	#5	#5	19-#5	291	582	783
D = 15.500	100	3.07	21 *	0.910		14-#6+10	6	#7	#8	30-#6	7	#5	#6	19-#5	378	756	1017
RIB NOT ON	150	3.88	27 *	0.622		18-#6+ 6	6	#8	#9	37-#6	7	#6	#7	19-#5	460	934	1238
COLUMN LINE																	
0.697 CF/SF																	

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 15 in.	Rib Depth = 12 in.	Total Slab Depth = 3 in.									
21'-0"	1.68	12		4	#4	#4	9-#5	3	#4	#4	10-#5
D = 9.500	1.68	12		4	#4	#4	9-#5	3	#4	#4	10-#5
RIB NOT ON	1.68	12		4	#4	#4	9-#5	3	#4	#4	10-#5
COLUMN LINE	1.68	12		4	#4	#4	9-#5	3	#4	#4	10-#5
0.720 CF/SF	1.99	12		4	#4	#5	8-#6	3	#4	#5	10-#5
	2.49	12 *	4 S 6 1	4	#5	#6	10-#6	3	#5	#5	10-#5
	2.88	12 *	4 S 6 1	4	#6	#6	12-#6	3	#5	#6	10-#5
24'-0"	1.68	12		4	#4	#4	10-#5	4	#4	#4	12-#5
D = 9.500	1.68	12		4	#4	#4	10-#5	4	#4	#4	12-#5
RIB NOT ON	1.84	12		4	#4	#5	8-#6	4	#4	#4	12-#5
COLUMN LINE	2.02	12		4	#5	#5	9-#6	4	#4	#4	12-#5
0.692 CF/SF	2.53	12 *	4 S 6 1	4	#6	#6	12-#6	4	#4	#5	12-#5
	3.12	12 *	4 S 6 1	4	#6	#7	15-#6	4	#5	#6	12-#5
	3.62	14 *	4 S 6 2	4	#7	#7	18-#6	4	#6	#6	12-#5
27'-0"	1.71	13		4	#4	#4	8-#6	5	#4	#4	14-#5
D = 9.500	1.81	13		4	#4	#5	12-#5	5	#4	#4	14-#5
RIB NOT ON	2.03	13	4 S 6 1	4	#5	#5	15-#5	5	#4	#4	14-#5
COLUMN LINE	2.51	13 *	4 S 6 1	4	#6	#6	13-#6	5	#4	#5	14-#5
0.673 CF/SF	3.21	13 *	4 S 6 1	4	#7	#7	18-#6	5	#5	#5	14-#5
	3.75	16 *	4 S 6 2	4	#7	#8	22-#6	5	#5	#6	14-#5
30'-0"	1.67	15		5	#4	#4	13-#5	5	#4	#4	14-#5
D = 12.500	1.92	15		5	#4	#5	12-#6	5	#4	#4	14-#5
RIB ON	2.39	15	4 S 6 1	5	#5	#6	15-#6	5	#4	#5	14-#5
COLUMN LINE	2.79	15 *	4 S 6 1	5	#6	#6	18-#6	5	#5	#5	14-#5
0.705 CF/SF	3.66	16 *	4 S 6 1	5	#7	#7	24-#6	5	#6	#6	14-#5
33'-0"	1.90	16		5	#4	#5	12-#6	6	#4	#4	17-#5
D = 12.500	2.29	16	4 S 6 1	5	#5	#6	16-#6	6	#4	#4	17-#5
RIB ON	2.75	16 *	4 S 6 1	5	#6	#6	21-#6	6	#4	#5	17-#5
COLUMN LINE	3.34	16 *	4 S 6 1	5	#7	#7	25-#6	6	#5	#5	17-#5
0.687 CF/SF											
36'-0"	2.12	18		5	#5	#5	16-#6	7	#4	#4	19-#5
D = 12.500	2.54	18 *	4 S 6 1	5	#6	#6	30-#5	7	#4	#4	19-#5
RIB ON	3.16	18 *	4 S 6 2	5	#7	#7	27-#6	7	#4	#5	19-#5
COLUMN LINE	3.73	19 *	4 S 6 2	5	#7	#8	33-#6	7	#5	#5	19-#5
0.673 CF/SF											
39'-0"	2.37	19		6	#5	#6	21-#6	7	#4	#4	19-#5
D = 15.500	2.85	19 *	4 S 6 1	6	#6	#6	28-#6	7	#4	#5	19-#5
RIB NOT ON	3.54	19 *	4 S 6 1	6	#7	#7	35-#6	7	#5	#5	19-#5
COLUMN LINE											
0.697 CF/SF											

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 17 in.	Rib Depth = 14 in.	Total Slab Depth = 3 in.																Total Depth = 17 in.	Rib Depth = 14 in.	Total Slab Depth = 3 in.								
24'-0"	50	1.62	12	0.639		10-#5+ 0	4	#4	#4	10-#5	4	#4	#4	12-#5	73	146	196	1.68	12		4	#4	#4	10-#5	4	#4	#4	12-#5
D = 9.500	100	1.67	12	0.639		10-#5+ 0	4	#4	#5	10-#5	4	#4	#4	12-#5	93	194	251	1.68	12		4	#4	#4	10-#5	4	#4	#4	12-#5
RIB NOT ON	150	1.73	12	0.639		10-#5+ 0	4	#5	#5	10-#5	4	#4	#4	12-#5	114	265	307	1.68	12		4	#4	#4	10-#5	4	#4	#4	12-#5
COLUMN LINE	200	1.96	12	0.668		10-#5+ 0	4	#5	#6	12-#5	4	#4	#5	12-#5	135	331	363	1.84	12		4	#4	#5	8-#6	4	#4	#4	12-#5
0.773 CF/SF	300	2.53	12	0.785		10-#5+ 1	4	#6	#7	12-#6	4	#5	#6	12-#5	176	459	474	2.32	12	4 S 6 1	4	#5	#6	15-#5	4	#4	#5	12-#5
	400	3.05	12 *	0.640		10-#5+ 1	4	#7	#8	15-#6	4	#6	#6	12-#5	217	586	585	2.74	12 *	4 S 6 1	4	#6	#6	13-#6	4	#5	#5	12-#5
	500	3.79	12 *	0.640		8-#6+ 2	4	#8	#9	18-#6	4	#7	#7	12-#5	258	711	696	3.31	12 *	4 S 6 1	4	#7	#7	16-#6	4	#5	#6	12-#5
27'-0"	50	1.70	13	0.637		8-#6+ 0	4	#4	#5	8-#6	5	#4	#4	14-#5	103	206	277	1.71	13		4	#4	#4	8-#6	5	#4	#4	14-#5
D = 9.500	100	1.75	13	0.637		8-#6+ 0	4	#5	#5	12-#5	5	#4	#4	14-#5	132	271	356	1.71	13		4	#4	#4	8-#6	5	#4	#4	14-#5
RIB NOT ON	150	2.11	13	0.692		8-#6+ 0	4	#6	#6	15-#5	5	#4	#5	14-#5	162	372	435	2.00	13		4	#5	#5	10-#6	5	#4	#4	14-#5
COLUMN LINE	200	2.47	13	0.797		8-#6+ 2	4	#7	#7	18-#5	5	#5	#5	14-#5	191	466	515	2.23	13	4 S 6 1	4	#5	#6	12-#6	5	#4	#4	14-#5
0.751 CF/SF	300	3.24	13 *	0.638		8-#6+ 2	4	#8	#8	17-#6	5	#6	#6	14-#5	250	649	673	2.96	13 *	4 S 6 1	4	#6	#7	16-#6	5	#5	#5	14-#5
	400	3.95	14 *	0.637		10-#6+ 1	4	#9	#9	21-#6	5	#6	#7	14-#5	308	827	829	3.62	13 *	4 S 6 2	4	#7	#8	20-#6	5	#5	#6	14-#5
	500	4.66	18 *	0.632	4 S 6 1	12-#6+ 0	4	#10	#10	25-#6	5	#7	#7	14-#5	360	974	968	4.15	15 *	4 S 6 2	4	#8	#8	23-#6	5	#6	#6	14-#5
30'-0"	50	1.67	15	0.634		13-#5+ 0	5	#4	#5	13-#5	5	#4	#4	14-#5	143	287	386	1.67	15		5	#4	#4	13-#5	5	#4	#4	14-#5
D = 12.500	100	1.99	15	0.714		13-#5+ 2	5	#5	#6	12-#6	5	#4	#5	14-#5	184	367	494	1.88	15		5	#4	#5	11-#6	5	#4	#4	14-#5
RIB ON	150	2.37	15	0.795		13-#5+ 4	5	#6	#7	15-#6	5	#5	#5	14-#5	224	505	603	2.13	15		5	#5	#5	14-#6	5	#4	#4	14-#5
COLUMN LINE	200	2.76	15 *	0.859		13-#5+ 6	5	#7	#7	18-#6	5	#5	#6	14-#5	264	633	711	2.55	15	4 S 6 1	5	#6	#6	16-#6	5	#4	#5	14-#5
0.788 CF/SF	300	3.83	15 *	0.635		11-#6+ 3	5	#8	#9	24-#6	5	#7	#7	14-#5	345	884	928	3.39	15 *	4 S 6 1	5	#7	#7	22-#6	5	#5	#6	14-#5
	400	4.56	20 *	0.630	4 S 6 1	19-#5+ 4	5	#9	#10	29-#6	5	#7	#8	14-#5	417	1088	1121	4.00	17 *	4 S 6 2	5	#7	#8	27-#6	5	#6	#6	14-#5
33'-0"	50	1.91	16	0.682		10-#6+ 1	5	#5	#6	12-#6	6	#4	#4	17-#5	189	378	509	1.86	16		5	#4	#5	11-#6	6	#4	#4	17-#5
D = 12.500	100	2.22	16	0.785		10-#6+ 3	5	#6	#6	16-#6	6	#4	#5	17-#5	243	486	654	2.15	16		5	#5	#5	15-#6	6	#4	#4	17-#5
RIB ON	150	2.78	16 *	0.861		10-#6+ 5	5	#7	#7	20-#6	6	#5	#6	17-#5	297	657	799	2.59	16	4 S 6 1	5	#6	#6	26-#5	6	#4	#5	17-#5
COLUMN LINE	200	3.32	16 *	0.634		11-#6+ 3	5	#8	#8	24-#6	6	#6	#6	17-#5	350	828	943	3.05	16 *	4 S 6 1	5	#6	#7	22-#6	6	#5	#5	17-#5
0.767 CF/SF	300	4.50	21 *	0.629	4 S 6 1	15-#6+ 3	5	#9	#10	31-#6	6	#7	#7	17-#5	451	1129	1213	4.11	17 *	4 S 6 2	5	#8	#8	29-#6	6	#6	#6	17-#5
	400	5.04	27 *	0.625	4 S 6 1	18-#6+ 2	5	#10	#10	38-#6	6	#7	#8	18-#5	538	1252	1450	4.48	23 *	4 S 6 2	5	#8	#8	36-#6	6	#6	#6	17-#5
36'-0"	50	2.17	18	0.694		11-#6+ 1	5	#6	#6	16-#6	7	#4	#5	19-#5	243	486	654	2.09	18		5	#5	#5	15-#6	7	#4	#4	19-#5
D = 12.500	100	2.59	18 *	0.813		11-#6+ 4	5	#7	#7	21-#6	7	#5	#5	19-#5	312	625	841	2.40	18	4 S 6 1	5	#5	#6	20-#6	7	#4	#4	19-#5
RIB ON	150	3.13	18 *	0.894		12-#6+ 6	5	#8	#8	26-#6	7	#5	#6	19-#5	382	807	1029	2.90	18 *	4 S 6 1	5	#6	#7	24-#6	7	#4	#5	19-#5
COLUMN LINE	200	3.83	20 *	0.630	4 S 6 1	15-#6+ 3	5	#9	#9	31-#6	7	#6	#6	19-#5	449	1021	1210	3.55	18 *	4 S 6 2	5	#7	#8	29-#6	7	#5	#5	19-#5
0.751 CF/SF	300	4.85	27 *	0.625	4 S 6 1	19-#6+ 4	5	#10	#10	41-#6	7	#7	#7	19-#5	572	1280	1540	4.40	22 *	4 S 6 2	5	#8	#9	38-#6	7	#5	#6	19-#5
39'-0"	50	2.41	19 *	0.776		17-#5+ 5	6	#6	#7	21-#6	7	#5	#5	19-#5	314	628	845	2.21	19		6	#5	#5	20-#6	7	#4	#4	19-#5
D = 15.500	100	2.98	19 *	0.885		13-#6+ 8	6	#7	#8	27-#6	7	#5	#6	19-#5	403	805	1084	2.74	19 *	4 S 6 1	6	#6	#6	25-#6	7	#4	#5	19-#5
RIB NOT ON	150	3.50	21 *	0.629		16-#6+ 5	6	#8	#8	34-#6	7	#6	#6	19-#5	489	1013	1317	3.25	19 *	4 S 6 1	6	#6	#7	31-#6	7	#5	#5	19-#5
COLUMN LINE	200	4.29	26 *	0.625		19-#6+ 6	6	#9	#9	40-#6	7	#7	#7	19-#5	571	1275	1537	3.89	19 *	4 S 6 2	6	#7	#8	37-#6	7	#5	#6	19-#5
0.779 CF/SF																												
42'-0"	50	2.66	21 *	0.819		18-#5+10	6	#7	#7	26-#6	8	#5	#5	22-#5	388	776	1044	2.53	21		6	#6	#6	24-#6	8	#4	#4	22-#5
D = 15.500	100	3.28	21 *	0.912		16-#6+10	6	#8	#8	35-#6	8	#5	#6	22-#5	499	997	1342	3.06	21 *	4 S 6 1	6	#6	#7	32-#6	8	#4	#5	22-#5
RIB NOT ON	150	4.10	26 *	0.625		20-#6+ 6	6	#9	#9	42-#6	8	#6	#7	22-#5	603	1205	1622	3.77	21 *	4 S 6 2	6	#7	#8	40-#6	8	#5	#5	22-#5
COLUMN LINE	200	4.58	34 *	0.621		23-#6+ 4	6	#9	#10	49-#6	8	#6	#7	23-#5	692	1384	1864	4.28	26 *	4 S 6 2	6	#8	#8	46-#6	8	#5	#6	22-#5
0.763 CF/SF																												
45'-0"	50	3.03	22 *	0.867		22-#5+13	6	#8	#8	33-#6	9	#5	#5	24-#5	475	951	1280	2.89	22	4 S 6 1	6	#6	#7	30-#6	9	#4	#5	24-#5
D = 15.500	100	3.89	25 *	0.915		20-#6+12	6	#9	#9	43-#6	9	#6	#6	24-#5	608	1216	1636	3.64	22 *	4 S 6 2	6	#7	#8	40-#6	9	#5	#5	24-#5
RIB NOT ON	150	4.51	34 *	0.621		24-#6+ 6	6	#9	#10	52-#6	9	#6	#7	24-#5	727	1454	1957	4.24	24 *	4 S 6 2	6	#8	#8	49-#6	9	#5	#6	24-#5
COLUMN LINE																												
0.751 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 19 in.	Rib Depth = 16 in.	Total Slab Depth = 3 in.															
27'-0"	50	1.85	13	0.640		8-#6+ 0	4	#4	#5	8-#6	5	#4	#5	14-#5	110	221	297
D = 9.500	100	1.89	13	0.640		8-#6+ 0	4	#5	#5	8-#6	5	#4	#5	14-#5	140	280	377
RIB NOT ON	150	2.02	13	0.640		8-#6+ 0	4	#5	#6	10-#6	5	#4	#5	14-#5	169	383	456
COLUMN LINE	200	2.31	13	0.657		8-#6+ 0	4	#6	#7	16-#5	5	#4	#5	14-#5	199	479	535
0.831 CF/SF	300	2.83	13 *	0.826		8-#6+ 3	4	#7	#8	15-#6	5	#5	#6	14-#5	258	664	694
	400	3.60	13 *	0.641		9-#6+ 2	4	#8	#9	19-#6	5	#6	#7	14-#5	317	845	853
	500	4.26	13 *	0.641		15-#5+ 2	4	#9	#10	23-#6	5	#7	#7	14-#5	376	1024	1012
30'-0"	50	1.82	15	0.637		13-#5+ 0	5	#4	#5	13-#5	5	#4	#5	14-#5	154	308	415
D = 12.500	100	1.92	15	0.637		13-#5+ 0	5	#5	#5	11-#6	5	#4	#5	14-#5	194	389	523
RIB ON	150	2.27	15	0.651		13-#5+ 0	5	#6	#6	14-#6	5	#5	#5	14-#5	235	522	632
COLUMN LINE	200	2.58	15	0.748		13-#5+ 2	5	#6	#7	16-#6	5	#5	#6	14-#5	275	654	740
0.873 CF/SF	300	3.45	15 *	0.901		10-#6+ 6	5	#8	#8	21-#6	5	#6	#7	14-#5	356	907	957
	400	4.27	16 *	0.636		12-#6+ 3	5	#9	#9	26-#6	5	#7	#8	14-#5	435	1151	1171
	500	4.93	20 *	0.632	4 S 6 1	15-#6+ 3	5	#9	#10	31-#6	5	#8	#8	15-#5	506	1354	1363
33'-0"	50	2.00	16	0.635		10-#6+ 0	5	#5	#6	12-#6	6	#4	#5	17-#5	203	407	547
D = 12.500	100	2.23	16	0.704		10-#6+ 2	5	#6	#6	15-#6	6	#4	#5	17-#5	257	514	692
RIB ON	150	2.61	16	0.794		10-#6+ 4	5	#7	#7	18-#6	6	#5	#5	17-#5	311	681	837
COLUMN LINE	200	2.99	16 *	0.862		10-#6+ 6	5	#7	#8	22-#6	6	#5	#6	17-#5	365	857	982
0.849 CF/SF	300	4.11	16 *	0.636	4 S 6 1	19-#5+ 4	5	#9	#9	29-#6	6	#7	#7	17-#5	472	1193	1271
	400	4.99	22 *	0.630	4 S 6 1	17-#6+ 2	5	#10	#10	35-#6	6	#7	#8	17-#5	567	1464	1527
36'-0"	50	2.18	18	0.633		11-#6+ 0	5	#6	#6	15-#6	7	#4	#5	19-#5	261	522	703
D = 12.500	100	2.50	18	0.742		11-#6+ 3	5	#7	#7	20-#6	7	#4	#5	19-#5	331	661	890
RIB ON	150	2.97	18 *	0.827		11-#6+ 5	5	#7	#8	24-#6	7	#5	#6	19-#5	400	844	1078
COLUMN LINE	200	3.53	18 *	0.905		19-#5+10	5	#8	#9	40-#5	7	#6	#6	19-#5	470	1071	1265
0.831 CF/SF	300	4.80	22 *	0.630	4 S 6 1	18-#6+ 2	5	#10	#10	37-#6	7	#7	#7	19-#5	603	1488	1624
39'-0"	50	2.26	19	0.712		17-#5+ 4	6	#6	#6	20-#6	7	#4	#5	19-#5	338	675	909
D = 15.500	100	2.78	19 *	0.815		17-#5+ 8	6	#7	#7	26-#6	7	#5	#6	19-#5	426	853	1148
RIB NOT ON	150	3.42	19 *	0.902		15-#6+ 8	6	#8	#8	31-#6	7	#6	#6	19-#5	515	1069	1387
COLUMN LINE	200	4.08	21 *	0.631		17-#6+ 5	6	#9	#9	37-#6	7	#6	#7	19-#5	601	1352	1618
0.862 CF/SF	300	5.09	28 *	0.626		22-#6+ 5	6	#10	#10	47-#6	7	#7	#8	22-#5	758	1704	2041
42'-0"	50	2.63	21	0.729		18-#5+ 5	6	#7	#7	25-#6	8	#5	#5	22-#5	417	834	1123
D = 15.500	100	3.20	21 *	0.855		15-#6+ 7	6	#8	#8	32-#6	8	#5	#6	22-#5	528	1055	1421
RIB NOT ON	150	3.73	21 *	0.631		26-#5+ 8	6	#8	#9	39-#6	8	#6	#6	22-#5	638	1276	1718
COLUMN LINE	200	4.57	26 *	0.627		22-#6+ 5	6	#9	#10	46-#6	8	#7	#7	22-#5	741	1583	1994
0.845 CF/SF																	
45'-0"	50	2.90	22 *	0.804		15-#6+ 6	6	#7	#8	31-#6	9	#5	#5	24-#5	511	1022	1375
D = 15.500	100	3.58	22 *	0.907		19-#6+10	6	#8	#9	40-#6	9	#6	#6	24-#5	647	1294	1742
RIB NOT ON	150	4.31	26 *	0.627		32-#5+ 8	6	#9	#10	48-#6	9	#6	#7	24-#5	777	1554	2092
COLUMN LINE	200	4.98	31 *	0.624	4 S 6 1	27-#6+ 5	6	#10	#10	57-#6	9	#7	#7	26-#5	900	1799	2422
0.831 CF/SF																	
48'-0"	50	3.23	24 *	0.858		18-#6+11	7	#8	#8	38-#6	9	#5	#6	24-#5	626	1252	1685
D = 18.500	100	4.10	26 *	0.915		23-#6+14	7	#9	#9	49-#6	9	#6	#7	24-#5	788	1576	2121
RIB ON	150	4.78	32 *	0.624		28-#6+ 6	7	#9	#10	59-#6	9	#7	#7	28-#5	942	1883	2535
COLUMN LINE																	
0.856 CF/SF																	
51'-0"	50	3.65	25 *	0.894		22-#6+13	7	#8	#9	46-#6	10	#6	#6	26-#5	747	1494	2012
D = 18.500	100	4.47	30 *	0.922		28-#6+18	7	#9	#10	58-#6	10	#6	#7	27-#5	937	1874	2523
RIB ON																	
COLUMN LINE																	
0.843 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 19 in.	Rib Depth = 16 in.	Total Slab Depth = 3 in.								
1.89	13		4	#4	#5	8-#6	5	#4	#5	14-#5
1.89	13		4	#4	#5	8-#6	5	#4	#5	14-#5
1.97	13		4	#4	#5	9-#6	5	#4	#5	14-#5
2.24	13	4 S 6 1	4	#5	#6	15-#5	5	#4	#5	14-#5
2.55	13	4 S 6 1	4	#6	#6	14-#6	5	#4	#5	14-#5
3.21	13 *	4 S 6 1	4	#7	#7	18-#6	5	#5	#5	14-#5
3.69	13 *	4 S 6 2	4	#7	#8	21-#6	5	#5	#6	14-#5
1.85	15		5	#4	#5	13-#5	5	#4	#5	14-#5
1.90	15		5	#4	#5	10-#6	5	#4	#5	14-#5
2.13	15		5	#5	#5	18-#5	5	#4	#5	14-#5
2.39	15		5	#5	#6	15-#6	5	#4	#5	14-#5
3.14	15 *	4 S 6 1	5	#6	#7	20-#6	5	#5	#6	14-#5
3.81	15 *	4 S 6 1	5	#7	#8	24-#6	5	#6	#6	14-#5
4.39	17 *	4 S 6 2	5	#8	#8	29-#6	5	#6	#7	14-#5
1.93	16		5	#4	#5	15-#5	6	#4	#5	17-#5
2.18	16		5	#5	#5	14-#6	6	#4	#5	17-#5
2.45	16	4 S 6 1	5	#5	#6	17-#6	6	#4	#5	17-#5
2.81	16	4 S 6 1	5	#6	#7	20-#6	6	#4	#5	17-#5
3.70	16 *	4 S 6 1	5	#7	#8	27-#6	6	#5	#6	17-#5
4.50	18 *	4 S 6 2	5	#8	#9	33-#6	6	#6	#6	17-#5
2.13	18		5	#5	#5	14-#6	7	#4	#5	19-#5
2.41	18	4 S 6 1	5	#5	#6	18-#6	7	#4	#5	19-#5
2.81	18	4 S 6 1	5	#6	#7	22-#6	7	#4	#5	19-#5
3.25	18 *	4 S 6 1	5	#7	#7	26-#6	7	#5	#5	19-#5
4.44	18 *	4 S 6 2	5	#8	#9	35-#6	7	#6	#6	19-#5
2.22	19		6	#5	#5	18-#6	7	#4	#5	19-#5
2.58	19		6	#5	#6	24-#6	7	#4	#5	19-#5
3.17	19 *	4 S 6 1	6	#6	#7	29-#6	7	#5	#5	19-#5
3.75	19 *	4 S 6 1	6	#7	#8	34-#6	7	#5	#6	19-#5
4.56	23 *	4 S 6 2	6	#8	#8	44-#6	7	#6	#6	21-#5
2.50	21		6	#5	#6	23-#6	8	#4	#5	22-#5
2.98	21 *	4 S 6 1	6	#6	#7	30-#6	8	#4	#5	22-#5
3.48	21 *	4 S 6 1	6	#7	#7	36-#6	8	#5	#5	22-#5
4.15	21 *	4 S 6 2	6	#8	#8	43-#6	8	#5	#6	22-#5
2.80	22	4 S 6 1	6	#6	#7	40-#5	9	#4	#5	24-#5
3.26	22 *	4 S 6 1	6	#7	#7	37-#6	9	#4	#5	24-#5
3.95	22 *	4 S 6 2	6	#8	#8	45-#6	9	#5	#5	24-#5
4.56	24 *	4 S 6 2	6	#8	#9	53-#6	9	#5	#6	25-#5
3.00	24	4 S 6 1	7	#6	#7	35-#6	9	#4	#5	24-#5
3.74	24 *	4 S 6 1	7	#7	#8	45-#6	9	#5	#5	24-#5
4.38	24 *	4 S 6 2	7	#8	#8	55-#6	9	#5	#6	26-#5
3.39	25 *	4 S 6 1	7	#7	#7	42-#6	10	#5	#5	26-#5
4.16	25 *	4 S 6 2	7	#8	#8	54-#6	10	#5	#6	26-#5

See the notes on Page 11-84.

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 23 in.	Rib Depth = 20 in.	Total Slab Depth = 3 in.															
30'-0"	50	2.05	15	0.641		13-#5+ 0	5	#5	#5	13-#5	5	#5	#5	14-#5	177	354	476
D = 12.500	100	2.06	15	0.641		13-#5+ 0	5	#5	#5	10-#6	5	#5	#5	14-#5	217	434	584
RIB ON	150	2.21	15	0.641		13-#5+ 0	5	#5	#6	12-#6	5	#5	#5	14-#5	257	554	693
COLUMN LINE	200	2.36	15	0.641		13-#5+ 0	5	#6	#6	14-#6	5	#5	#5	14-#5	298	690	801
1.048 CF/SF	300	3.03	15	0.688		13-#5+ 2	5	#7	#8	18-#6	5	#6	#6	14-#5	378	947	1018
	400	3.47	15 *	0.838		15-#5+ 5	5	#8	#8	22-#6	5	#6	#7	14-#5	459	1198	1235
	500	4.28	15 *	0.642		18-#5+ 2	5	#9	#9	26-#6	5	#7	#8	14-#5	539	1445	1452
33'-0"	50	2.09	16	0.640		10-#6+ 0	5	#5	#5	15-#5	6	#5	#5	17-#5	233	466	627
D = 12.500	100	2.24	16	0.640		10-#6+ 0	5	#5	#6	14-#6	6	#5	#5	17-#5	287	574	772
RIB ON	150	2.48	16	0.640		10-#6+ 0	5	#6	#7	16-#6	6	#5	#5	17-#5	341	725	917
COLUMN LINE	200	2.81	16	0.646		10-#6+ 1	5	#7	#7	19-#6	6	#5	#6	17-#5	394	907	1062
1.020 CF/SF	300	3.61	16 *	0.844		12-#6+ 5	5	#8	#9	24-#6	6	#6	#7	17-#5	502	1249	1351
	400	4.28	16 *	0.641	5 S 8 1	14-#6+ 2	5	#9	#10	30-#6	6	#7	#7	17-#5	609	1583	1641
	500	5.06	17 *	0.639	5 S 8 1	17-#6+ 3	5	#10	#10	35-#6	6	#7	#8	17-#5	715	1907	1925
36'-0"	50	2.29	18	0.637		11-#6+ 0	5	#6	#6	14-#6	7	#5	#5	19-#5	299	598	805
D = 12.500	100	2.52	18	0.637		11-#6+ 0	5	#6	#7	18-#6	7	#5	#5	19-#5	369	737	992
RIB ON	150	2.76	18	0.637		11-#6+ 0	5	#7	#7	21-#6	7	#5	#5	19-#5	438	907	1180
COLUMN LINE	200	3.18	18	0.765		12-#6+ 4	5	#8	#8	25-#6	7	#5	#6	19-#5	508	1144	1367
0.998 CF/SF	300	4.11	18 *	0.638	5 S 8 1	15-#6+ 2	5	#9	#10	32-#6	7	#6	#7	19-#5	647	1584	1742
39'-0"	50	2.36	19	0.636		17-#5+ 0	6	#6	#6	18-#6	7	#5	#5	19-#5	387	774	1042
D = 15.500	100	2.62	19	0.636		17-#5+ 2	6	#6	#7	23-#6	7	#5	#5	19-#5	476	952	1281
RIB NOT ON	150	3.04	19 *	0.762		13-#6+ 4	6	#7	#8	27-#6	7	#5	#6	19-#5	565	1155	1520
COLUMN LINE	200	3.58	19 *	0.857		15-#6+ 7	6	#8	#8	32-#6	7	#6	#7	19-#5	653	1459	1759
1.036 CF/SF	300	4.71	19 *	0.637		20-#6+ 3	6	#9	#10	41-#6	7	#7	#8	19-#5	831	2020	2237
42'-0"	50	2.59	21	0.634		13-#6+ 1	6	#6	#7	23-#6	8	#5	#5	22-#5	478	956	1287
D = 15.500	100	2.94	21	0.737		14-#6+ 5	6	#7	#8	29-#6	8	#5	#5	22-#5	589	1177	1585
RIB NOT ON	150	3.34	21 *	0.831		16-#6+ 7	6	#8	#8	34-#6	8	#5	#6	22-#5	699	1398	1882
COLUMN LINE	200	4.02	21 *	0.904		19-#6+10	6	#9	#9	40-#6	8	#6	#7	22-#5	810	1748	2180
1.015 CF/SF																	
45'-0"	50	2.85	22	0.676		14-#6+ 4	6	#7	#8	28-#6	9	#5	#5	24-#5	585	1170	1575
D = 15.500	100	3.28	22 *	0.793		17-#6+ 5	6	#8	#8	35-#6	9	#5	#6	24-#5	721	1443	1942
RIB NOT ON	150	3.87	22 *	0.888		20-#6+ 9	6	#9	#9	42-#6	9	#6	#6	24-#5	858	1715	2309
COLUMN LINE	200	4.54	23 *	0.633		24-#6+ 4	6	#10	#10	50-#6	9	#6	#7	24-#5	992	2090	2671
0.998 CF/SF																	
48'-0"	50	3.07	24 *	0.743		17-#6+ 6	7	#7	#8	35-#6	9	#5	#6	24-#5	718	1435	1932
D = 18.500	100	3.69	24 *	0.858		21-#6+10	7	#8	#9	43-#6	9	#6	#6	24-#5	883	1765	2376
RIB ON	150	4.25	24 *	0.633		25-#6+ 6	7	#9	#9	52-#6	9	#6	#7	24-#5	1048	2095	2821
COLUMN LINE	200	5.02	28 *	0.630		29-#6+ 6	7	#10	#10	60-#6	9	#7	#7	28-#5	1204	2427	3241
1.028 CF/SF																	
51'-0"	50	3.38	25 *	0.815		20-#6+10	7	#8	#8	42-#6	10	#5	#6	26-#5	856	1713	2305
D = 18.500	100	4.07	25 *	0.901		25-#6+13	7	#9	#9	52-#6	10	#6	#7	26-#5	1055	2109	2839
RIB ON	150	4.83	28 *	0.630		30-#6+ 6	7	#10	#10	63-#6	10	#7	#7	29-#5	1246	2493	3355
COLUMN LINE																	
1.012 CF/SF																	
54'-0"	50	3.82	27 *	0.846		24-#6+12	7	#9	#9	50-#6	11	#6	#6	29-#5	1009	2018	2717
D = 18.500	100	4.57	27 *	0.630		30-#6+ 8	7	#10	#10	62-#6	11	#6	#7	29-#5	1244	2488	3349
RIB ON																	
COLUMN LINE																	
0.998 CF/SF																	
57'-0"	50	4.12	28 *	0.890		29-#6+16	8	#9	#9	60-#6	11	#6	#7	29-#5	1201	2402	3234
D =21.500	100	5.13	33 *	0.914		35-#6+21	8	#10	#10	74-#6	11	#7	#7	34-#5	1466	2932	3947
RIB NOT ON																	
COLUMN LINE																	
1.023 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 23 in.	Rib Depth = 20 in.	Total Slab Depth = 3 in.								
2.07	15		5	#5	#5	13-#5	5	#5	#5	14-#5
2.07	15		5	#5	#5	13-#5	5	#5	#5	14-#5
2.19	15		5	#5	#5	11-#6	5	#5	#5	14-#5
2.30	15		5	#5	#5	13-#6	5	#5	#5	14-#5
2.75	15		5	#6	#6	17-#6	5	#5	#5	14-#5
3.14	15 *	5 S 8 1	5	#6	#7	20-#6	5	#5	#6	14-#5
3.81	15 *	5 S 8 1	5	#7	#8	24-#6	5	#6	#6	14-#5
2.12	16		5	#5	#5	10-#6	6	#5	#5	17-#5
2.22	16		5	#5	#5	12-#6	6	#5	#5	17-#5
2.38	16		5	#5	#5	15-#6	6	#5	#5	17-#5
2.69	16		5	#6	#6	17-#6	6	#5	#5	17-#5
3.24	16	5 S 8 1	5	#7	#7	23-#6	6	#5	#5	17-#5
3.74	16 *	5 S 8 2	5	#7	#8	28-#6	6	#5	#6	17-#5
4.63	16 *	5 S 8 2	5	#8	#9	33-#6	6	#6	#7	17-#5
2.25	18		5	#5	#5	13-#6	7	#5	#5	19-#5
2.47	18		5	#5	#6	16-#6	7	#5	#5	19-#5
2.75	18	5 S 8 1	5	#6	#6	20-#6	7	#5	#5	19-#5
3.01	18	5 S 8 1	5	#6	#7	23-#6	7	#5	#5	19-#5
3.67	18 *	5 S 8 2	5	#7	#8	29-#6	7	#5	#6	19-#5
2.32	19		6	#5	#5	17-#6	7	#5	#5	19-#5
2.60	19		6	#5	#6	21-#6	7	#5	#5	19-#5
2.87	19		6	#6	#6	25-#6	7	#5	#5	19-#5
3.29	19 *	5 S 8 1	6	#7	#7	29-#6	7	#5	#5	19-#5
4.23	19 *	5 S 8 2	6	#8	#8	38-#6	7	#6	#6	19-#5
2.57	21		6	#5	#6	21-#6	8	#5	#5	22-#5
2.85	21		6	#6	#6	26-#6	8	#5	#5	22-#5
3.20	21	5 S 8 1	6	#6	#7	32-#6	8	#5	#5	22-#5
3.66	21 *	5 S 8 1	6	#7	#8	37-#6	8	#5	#5	22-#5
2.78	22		6	#6	#6	26-#6	9	#5	#5	24-#5
3.16	22	5 S 8 1	6	#6	#7	33-#6	9	#5	#5	24-#5
3.61	22 *	5 S 8 1	6	#7	#8	39-#6	9	#5	#5	24-#5
4.11	22 *	5 S 8 2	6	#8	#8	46-#6	9	#5	#6	24-#5
2.91	24		7	#6	#6	32-#6	9	#5	#5	24-#5
3.42	24 *	5 S 8 1	7	#7	#7	40-#6	9	#5	#5	24-#5
3.95	24 *	5 S 8 1	7	#7	#8	48-#6	9	#5	#6	24-#5
4.58	24 *	5 S 8 2	7	#8	#8	56-#6	9	#6	#6	26-#5
3.30	25	5 S 8 1	7	#7	#7	39-#6	10	#5	#5	26-#5
3.71	25 *	5 S 8 1	7	#7	#8	48-#6	10	#5	#5	26-#5
4.31	25 *	5 S 8 2	7	#8	#8	58-#6	10	#5	#6	27-#5
3.57	27	5 S 8 1	7	#7	#8	46-#6	11	#5	#5	29-#5
4.19	27 *	5 S 8 2	7	#8	#8	58-#6	11	#5	#6	29-#5
3.77	28 *	5 S 8 1	8	#7	#8	55-#6	11	#5	#5	29-#5
4.81	28 *	5 S 8 2	8	#8	#9	69-#6	11	#6	#6	32-#5

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 12 in.	Rib Depth = 8 in.	Total Slab Depth = 4 in.															
18'-0"	50	1.60	12	0.631		5-#6+ 0	3	#4	#4	5-#6	3	#4	#4	8-#5	26	52	69
D = 6.500	100	1.60	12	0.631		5-#6+ 0	3	#4	#4	5-#6	3	#4	#4	8-#5	34	72	92
RIB ON	150	1.66	12	0.631		5-#6+ 0	3	#4	#5	5-#6	3	#4	#4	8-#5	43	100	115
COLUMN LINE	200	1.72	12	0.664		5-#6+ 0	3	#5	#5	5-#6	3	#4	#4	8-#5	51	126	138
0.606 CF/SF	300	2.14	12	0.753		5-#6+ 0	3	#6	#6	9-#5	3	#5	#5	8-#5	68	178	183
	400	2.55	12 *	0.868	3 S 4 1	5-#6+ 1	3	#6	#7	6-#7	3	#5	#6	8-#5	85	229	229
21'-0"	50	1.56	12	0.669		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	43	85	114
D = 9 .500	100	1.56	12	0.717		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	56	119	151
RIB NOT ON	150	1.73	12	0.788		9-#5+ 1	4	#5	#5	9-#5	3	#4	#5	8-#5	70	164	188
COLUMN LINE	200	1.98	12 *	0.858		9-#5+ 3	4	#5	#6	8-#6	3	#5	#5	8-#5	83	207	225
0.639 CF/SF	300	2.64	12 *	0.632		9-#5+ 3	4	#6	#7	8-#7	3	#6	#6	8-#5	111	291	298
	400	3.27	15 *	0.628		9-#5+ 2	4	#7	#8	8-#8	3	#7	#7	8-#5	136	369	367
24'-0"	50	1.63	12	0.741		10-# 5+ 0	4	#4	#5	7-#6	4	#4	#4	10-#5	64	127	171
D = 9.500	100	1.70	12	0.815		10-#5+ 1	4	#5	#5	8-#6	4	#4	#4	10-#5	84	177	227
RIB NOT ON	150	2.17	12 *	0.887		10-#5+ 3	4	#6	#6	10-#6	4	#5	#5	10-#5	105	245	282
COLUMN LINE	200	2.57	12 *	0.632		10-#5+ 2	4	#7	#7	7-#8	4	#5	#6	10-#5	125	310	338
0.620 CF/SF	300	3.39	17 *	0.626		8-#6+ 2	4	#8	#8	7-#9	4	#6	#7	10-#5	163	422	439
27'-0"	50	1.70	13	0.782		8-#6+ 0	4	#5	#5	12-#5	5	#4	#4	12-#5	90	180	242
D = 9.500	100	2.12	13 *	0.877		8-#6+ 2	4	#6	#6	7-#8	5	#4	#5	12-#5	120	244	322
RIB NOT ON	150	2.56	14 *	0.629		8-#6+ 1	4	#7	#7	8-#8	5	#5	#5	12-#5	149	340	400
COLUMN LINE	200	3.13	17 *	0.626		8-#6+ 2	4	#8	#8	8-#9	5	#6	#6	12-#5	176	427	474
0.606 CF/SF																	
30'-0"	50	1.95	15 *	0.847		9-#6+ 3	5	#5	#6	9-#7	5	#4	#5	12-#5	125	249	336
D = 12.500	100	2.29	15 *	0.918		9-#6+ 5	5	#6	#6	9-#8	5	#5	#5	12-#5	165	330	444
RIB ON	150	3.13	19 *	0.624		10-#6+ 3	5	#7	#8	9-#9	5	#6	#6	12-#5	203	444	546
COLUMN LINE																	
0.628 CF/SF																	
33'-0"	50	2.16	16 *	0.883		10-#6+ 4	5	#6	#6	9-#8	6	#4	#5	14-#5	165	330	445
D = 12.500	100	2.82	19 *	0.925		15-#5+11	5	#7	#7	10-#9	6	#5	#6	14-#5	217	434	585
RIB ON																	
COLUMN LINE																	
0.616 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 12 in.			Rib Depth = 8 in.				Total Slab Depth = 4 in.			
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.92	12	3 S 4 1	3	#5	#5	6-#6	3	#4	#4	8-#5
2.35	12 *	3 S 4 1	3	#5	#6	6-#7	3	#4	#5	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.76	12		4	#4	#5	7-#6	3	#4	#4	8-#5
2.39	12 *	3 S 4 1	4	#5	#6	7-#7	3	#5	#5	8-#5
2.85	12 *	3 S 4 1	4	#6	#6	7-#8	3	#5	#6	8-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.98	12	3 S 4 1	4	#5	#5	7-#7	4	#4	#4	10-#5
2.26	12 *	3 S 4 1	4	#5	#6	8-#7	4	#4	#5	10-#5
3.05	13 *	3 S 4 1	4	#6	#7	11-#7	4	#5	#6	10-#5
1.64	13		4	#4	#4	8-#6	5	#4	#4	12-#5
1.98	13	3 S 4 1	4	#5	#5	8-#7	5	#4	#4	12-#5
2.40	13 *	3 S 4 1	4	#6	#6	8-#8	5	#4	#4	12-#5
2.77	13 *	3 S 4 1	4	#6	#7	7-#9	5	#4	#5	12-#5
1.81	15		5	#4	#5	11-#6	5	#4	#4	12-#5
2.13	15 *	3 S 4 1	5	#5	#5	11-#7	5	#4	#4	12-#5
2.88	15 *	3 S 4 1	5	#6	#6	9-#9	5	#5	#5	12-#5
2.06	16	3 S 4 1	5	#5	#5	11-#7	6	#4	#4	14-#5
2.65	16 *	3 S 4 1	5	#6	#6	9-#9	6	#4	#5	14-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 14 in.	Rib Depth = 10 in.	Total Slab Depth = 4 in.															
18'-0"	50	1.60	12	0.634		5-#6+ 0	3	#4	#4	5-#6	3	#4	#4	8-#5	28	56	75
D = 6.500	100	1.60	12	0.634		5-#6+ 0	3	#4	#4	5-#6	3	#4	#4	8-#5	36	75	98
RIB ON	150	1.60	12	0.634		5-#6+ 0	3	#4	#4	5-#6	3	#4	#4	8-#5	45	104	120
COLUMN LINE	200	1.66	12	0.634		5-#6+ 0	3	#4	#5	5-#6	3	#4	#4	8-#5	53	131	143
0.680 CF/SF	300	1.90	12	0.634		5-#6+ 0	3	#5	#6	5-#6	3	#4	#5	8-#5	70	183	189
	400	2.16	12	0.707		5-#6+ 0	3	#6	#6	5-#7	3	#5	#5	8-#5	87	234	234
	500	2.64	12 *	0.824	3 S 4 1	5-#6+ 1	3	#7	#7	6-#7	3	#5	#6	8-#5	104	285	280
21'-0"	50	1.56	12	0.634		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	46	92	124
D = 9.500	100	1.56	12	0.634		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	60	125	160
RIB NOT ON	150	1.67	12	0.669		9-#5+ 0	4	#4	#5	9-#5	3	#4	#5	8-#5	73	171	197
COLUMN LINE	200	1.80	12	0.713		9-#5+ 0	4	#5	#5	7-#6	3	#5	#5	8-#5	87	214	234
0.720 CF/SF	300	2.27	12 *	0.821		9-#5+ 1	4	#6	#6	9-#6	3	#5	#6	8-#5	114	299	307
	400	2.92	12 *	0.635		9-#5+ 1	4	#7	#7	7-#8	3	#6	#7	8-#5	141	382	381
	500	3.34	13 *	0.634		9-#5+ 2	4	#7	#8	8-#8	3	#7	#7	8-#5	168	462	453
24'-0"	50	1.57	12	0.662		10-#5+ 0	4	#4	#4	7-#6	4	#4	#4	10-#5	68	137	184
D = 9.500	100	1.63	12	0.714		10-#5+ 0	4	#4	#5	7-#6	4	#4	#4	10-#5	89	186	240
RIB NOT ON	150	1.91	12	0.804		10-#5+ 2	4	#5	#6	9-#6	4	#4	#5	10-#5	110	256	295
COLUMN LINE	200	2.26	12 *	0.858		10-#5+ 3	4	#6	#7	8-#7	4	#5	#5	10-#5	130	321	351
0.696 CF/SF	300	2.96	12 *	0.635		10-#5+ 3	4	#7	#8	8-#8	4	#6	#6	10-#5	172	449	462
	400	3.74	16 *	0.630		8-#6+ 2	4	#8	#9	8-#9	4	#7	#7	10-#5	209	560	563
	500	4.28	20 *	0.626		7-#7+ 2	4	#9	#9	9-#9	4	#7	#7	10-#5	242	633	652
27'-0"	50	1.69	13	0.710		8-#6+ 0	4	#5	#5	8-#6	5	#4	#4	12-#5	97	194	261
D = 9.500	100	1.88	13	0.795		8-#6+ 1	4	#5	#6	10-#6	5	#4	#4	12-#5	126	258	340
RIB NOT ON	150	2.38	13 *	0.863		8-#6+ 2	4	#6	#7	7-#8	5	#5	#5	12-#5	156	358	420
COLUMN LINE	200	2.79	13 *	0.634		8-#6+ 1	4	#7	#8	11-#7	5	#5	#6	12-#5	185	451	499
0.680 CF/SF	300	3.83	17 *	0.629		7-#7+ 2	4	#9	#9	9-#9	5	#6	#7	12-#5	241	625	649
	400	4.32	22 *	0.624	3 S 4 1	12-#6+ 2	4	#9	#10	11-#9	5	#7	#7	12-#5	289	704	777
30'-0"	50	1.73	15	0.774		9-#6+ 2	5	#5	#5	11-#6	5	#4	#4	12-#5	135	269	362
D = 12.500	100	2.17	15 *	0.857		9-#6+ 4	5	#6	#6	11-#7	5	#4	#5	12-#5	175	350	471
RIB ON	150	2.67	15 *	0.918		9-#6+ 6	5	#7	#7	10-#8	5	#5	#6	12-#5	215	480	579
COLUMN LINE	200	3.28	17 *	0.629		10-#6+ 3	5	#7	#8	12-#8	5	#6	#7	12-#5	254	602	684
0.707 CF/SF	300	4.02	24 *	0.623	3 S 4 1	10-#7+ 3	5	#8	#9	12-#9	5	#7	#7	13-#5	322	731	868
33'-0"	50	2.11	16 *	0.821		10-#6+ 3	5	#6	#6	11-#7	6	#4	#5	14-#5	178	356	479
D = 12.500	100	2.47	16 *	0.903		10-#6+ 6	5	#6	#7	9-#9	6	#5	#5	14-#5	232	464	624
RIB ON	150	3.22	19 *	0.627		11-#6+ 3	5	#8	#8	11-#9	6	#6	#6	14-#5	283	614	763
COLUMN LINE	200	3.78	22 *	0.624	3 S 4 1	10-#7+ 3	5	#8	#9	16-#8	6	#6	#7	14-#5	333	750	897
0.692 CF/SF																	
36'-0"	50	2.33	18 *	0.840		11-#6+ 4	5	#6	#7	9-#9	7	#4	#5	16-#5	229	458	617
D = 12.500	100	2.97	19 *	0.920		12-#6+ 9	5	#7	#8	11-#9	7	#5	#6	16-#5	298	596	802
RIB ON	150	3.62	24 *	0.623	3 S 4 1	11-#7+ 3	5	#8	#9	14-#9	7	#6	#6	16-#5	363	728	977
COLUMN LINE																	
0.680 CF/SF																	
39'-0"	50	2.64	19 *	0.894		12-#6+ 8	6	#7	#7	11-#9	7	#5	#5	16-#5	295	590	795
D = 15.500	100	3.45	25 *	0.918		11-#7+ 9	6	#8	#8	15-#9	7	#6	#6	16-#5	379	757	1019
RIB NOT ON																	
COLUMN LINE																	
0.700 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 14 in.	Rib Depth = 10 in.	Total Slab Depth = 4 in.								
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.75	12	3 S 4 1	3	#4	#5	5-#6	3	#4	#4	8-#5
1.92	12	3 S 4 1	3	#5	#5	6-#6	3	#4	#4	8-#5
2.35	12	3 S 4 1	3	#5	#6	6-#7	3	#4	#5	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
2.03	12	3 S 4 1	4	#5	#5	12-#5	3	#4	#5	8-#5
2.56	12 *	3 S 4 1	4	#5	#6	8-#7	3	#5	#6	8-#5
2.98	12 *	3 S 4 1	4	#6	#6	7-#8	3	#6	#6	8-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.76	12		4	#4	#5	8-#6	4	#4	#4	10-#5
1.98	12	3 S 4 1	4	#5	#5	7-#7	4	#4	#4	10-#5
2.64	12 *	3 S 4 1	4	#6	#6	7-#8	4	#5	#5	10-#5
3.26	13 *	3 S 4 1	4	#7	#7	7-#9	4	#5	#6	10-#5
3.94	17 *	3 S 4 2	4	#7	#8	9-#9	4	#6	#6	10-#5
1.64	13		4	#4	#4	8-#6	5	#4	#4	12-#5
1.83	13		4	#4	#5	7-#7	5	#4	#4	12-#5
2.21	13	3 S 4 1	4	#5	#6	7-#8	5	#4	#4	12-#5
2.50	13 *	3 S 4 1	4	#6	#6	8-#8	5	#4	#5	12-#5
3.43	13 *	3 S 4 2	4	#7	#7	9-#9	5	#5	#6	12-#5
3.74	19 *	3 S 4 2	4	#7	#8	10-#9	5	#5	#6	12-#5
1.65	15		5	#4	#4	10-#6	5	#4	#4	12-#5
2.04	15		5	#5	#5	10-#7	5	#4	#4	12-#5
2.40	15 *	3 S 4 1	5	#5	#6	9-#8	5	#4	#5	12-#5
3.02	15 *	3 S 4 1	5	#6	#7	9-#9	5	#5	#5	12-#5
3.63	20 *	3 S 4 2	5	#7	#7	12-#9	5	#5	#6	12-#5
1.98	16		5	#5	#5	10-#7	6	#4	#4	14-#5
2.29	16 *	3 S 4 1	5	#5	#6	10-#8	6	#4	#4	14-#5
2.86	16 *	3 S 4 1	5	#6	#7	10-#9	6	#4	#5	14-#5
3.47	17 *	3 S 4 2	5	#7	#7	12-#9	6	#5	#6	14-#5
2.22	18	3 S 4 1	5	#5	#6	10-#8	7	#4	#4	16-#5
2.79	18 *	3 S 4 1	5	#6	#7	13-#8	7	#4	#5	16-#5
3.35	18 *	3 S 4 2	5	#7	#7	13-#9	7	#5	#5	16-#5
2.48	19 *	3 S 4 1	6	#5	#6	13-#8	7	#4	#5	16-#5
3.20	19 *	3 S 4 1	6	#6	#7	14-#9	7	#5	#5	16-#5

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 16 in.	Rib Depth = 12 in.	Total Slab Depth = 4 in.															
21'-0"	50	1.56	12	0.637		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	49	99	133
D = 9.500	100	1.56	12	0.637		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	63	130	170
RIB NOT ON	150	1.63	12	0.637		9-#5+ 0	4	#4	#5	9-#5	3	#4	#4	8-#5	77	177	207
COLUMN LINE	200	1.73	12	0.637		9-#5+ 0	4	#5	#5	9-#5	3	#4	#5	8-#5	90	221	243
0.803 CF/SF	300	2.07	12	0.695		9-#5+ 0	4	#5	#6	8-#6	3	#5	#6	8-#5	118	306	317
	400	2.53	12 *	0.800		9-#5+ 1	4	#6	#7	7-#7	3	#6	#6	8-#5	145	390	390
	500	2.99	12 *	0.638		9-#5+ 1	4	#7	#7	7-#8	3	#6	#7	8-#5	172	473	464
24'-0"	50	1.57	12	0.637		10-#5+ 0	4	#4	#4	7-#6	4	#4	#4	10-#5	74	147	198
D = 9.500	100	1.63	12	0.637		10-#5+ 0	4	#4	#5	7-#6	4	#4	#4	10-#5	94	193	254
RIB NOT ON	150	1.80	12	0.675		10-#5+ 0	4	#5	#5	8-#6	4	#4	#5	10-#5	115	264	309
COLUMN LINE	200	2.10	12	0.724		10-#5+ 0	4	#6	#6	9-#6	4	#5	#5	10-#5	136	331	365
0.775 CF/SF	300	2.57	12 *	0.851		10-#5+ 2	4	#7	#7	7-#8	4	#5	#6	10-#5	177	459	476
	400	3.29	12 *	0.638		7-#6+ 3	4	#8	#8	7-#9	4	#6	#7	10-#5	218	586	587
	500	3.90	14 *	0.635		9-#6+ 1	4	#8	#9	8-#9	4	#7	#7	10-#5	257	706	693
27'-0"	50	1.64	13	0.636		8-#6+ 0	4	#4	#5	8-#6	5	#4	#4	12-#5	104	208	281
D = 9.500	100	1.82	13	0.689		8-#6+ 0	4	#5	#6	9-#6	5	#4	#4	12-#5	134	270	360
RIB NOT ON	150	2.09	13	0.773		8-#6+ 1	4	#6	#6	8-#7	5	#4	#5	12-#5	163	371	439
COLUMN LINE	200	2.47	13 *	0.840		8-#6+ 2	4	#7	#7	8-#8	5	#5	#5	12-#5	193	466	519
0.756 CF/SF	300	3.38	13 *	0.637		12-#5+ 3	4	#8	#9	8-#9	5	#6	#6	12-#5	252	649	677
	400	4.18	17 *	0.632		15-#5+ 1	4	#9	#10	10-#9	5	#7	#7	12-#5	305	811	822
	500	4.71	21 *	0.628	4 S 6 1	12-#6+ 1	4	#10	#10	12-#9	5	#7	#7	12-#5	354	924	953
30'-0"	50	1.70	15	0.686		9-#6+ 1	5	#5	#5	10-#6	5	#4	#4	12-#5	145	290	390
D = 12.500	100	2.00	15	0.786		9-#6+ 3	5	#5	#6	10-#7	5	#4	#5	12-#5	185	370	498
RIB ON	150	2.54	15 *	0.848		9-#6+ 4	5	#6	#7	9-#8	5	#5	#6	12-#5	225	501	607
COLUMN LINE	200	3.03	15 *	0.907		9-#6+ 6	5	#7	#8	9-#9	5	#6	#6	12-#5	266	630	715
0.788 CF/SF	300	3.82	18 *	0.631		12-#6+ 2	5	#8	#9	11-#9	5	#7	#7	12-#5	343	873	924
	400	4.63	23 *	0.626	4 S 6 1	14-#6+ 4	5	#9	#10	14-#9	5	#7	#8	14-#5	411	1013	1106
33'-0"	50	1.90	16	0.749		10-#6+ 2	5	#5	#6	10-#7	6	#4	#4	14-#5	191	383	515
D = 12.500	100	2.35	16 *	0.836		10-#6+ 4	5	#6	#7	10-#8	6	#5	#5	14-#5	245	490	660
RIB ON	150	2.88	16 *	0.902		10-#6+ 6	5	#7	#8	12-#8	6	#5	#6	14-#5	299	651	805
COLUMN LINE	200	3.48	18 *	0.631		12-#6+ 3	5	#8	#9	11-#9	6	#6	#6	14-#5	351	817	945
0.770 CF/SF	300	4.42	24 *	0.625	4 S 6 1	22-#5+ 5	5	#9	#10	15-#9	6	#7	#7	16-#5	446	1036	1200
36'-0"	50	2.27	18	0.758		11-#6+ 2	5	#6	#7	10-#8	7	#4	#5	16-#5	246	492	663
D = 12.500	100	2.69	18 *	0.869		11-#6+ 6	5	#7	#8	10-#9	7	#5	#5	16-#5	316	632	850
RIB ON	150	3.19	19 *	0.630		10-#7+ 3	5	#8	#8	16-#8	7	#5	#6	16-#5	384	791	1035
COLUMN LINE	200	3.97	23 *	0.626	4 S 6 1	9-#8+ 1	5	#9	#9	15-#9	7	#6	#7	16-#5	449	1000	1210
0.756 CF/SF																	
39'-0"	50	2.46	19 *	0.839		12-#6+ 6	6	#6	#7	13-#8	7	#5	#5	16-#5	318	635	855
D = 15.500	100	3.00	19 *	0.922		14-#6+ 9	6	#7	#8	13-#9	7	#5	#6	16-#5	406	812	1094
RIB NOT ON	150	3.80	24 *	0.625		17-#6+ 5	6	#8	#9	16-#9	7	#6	#7	17-#5	489	983	1317
COLUMN LINE	200	4.34	31 *	0.621		11-#8+ 3	6	#9	#9	19-#9	7	#6	#7	20-#5	561	1122	1511
0.780 CF/SF																	
42'-0"	50	2.82	21 *	0.861		14-#6+ 7	6	#7	#8	16-#8	8	#5	#5	18-#5	393	786	1058
D = 15.500	100	3.63	24 *	0.912		13-#7+ 8	6	#8	#9	17-#9	8	#6	#6	18-#5	500	1000	1347
RIB NOT ON	150	4.25	32 *	0.621		12-#8+ 2	6	#9	#9	20-#9	8	#6	#7	21-#5	597	1194	1608
COLUMN LINE																	
0.767 CF/SF																	

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 16 in.	Rib Depth = 12 in.	Total Slab Depth = 4 in.									
21'-0"	1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
D = 9.500	1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
RIB NOT ON	1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
COLUMN LINE	1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
0.803 CF/SF	1.83	12		4	#4	#5	7-#6	3	#4	#5	8-#5
	2.21	12	4 S 6 1	4	#5	#5	9-#6	3	#5	#5	8-#5
	2.69	12 *	4 S 6 1	4	#6	#6	8-#7	3	#5	#6	8-#5
24'-0"	1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
D = 9.500	1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
RIB NOT ON	1.71	12		4	#4	#5	7-#6	4	#4	#4	10-#5
COLUMN LINE	1.88	12		4	#5	#5	12-#5	4	#4	#4	10-#5
0.775 CF/SF	2.26	12 *	4 S 6 1	4	#5	#6	8-#7	4	#4	#5	10-#5
	2.87	12 *	4 S 6 1	4	#6	#7	8-#8	4	#5	#5	10-#5
	3.53	12 *	4 S 6 1	4	#7	#7	8-#9	4	#6	#6	10-#5
27'-0"	1.64	13		4	#4	#4	8-#6	5	#4	#4	12-#5
D = 9.500	1.74	13		4	#4	#5	12-#5	5	#4	#4	12-#5
RIB NOT ON	1.98	13	4 S 6 1	4	#5	#5	8-#7	5	#4	#4	12-#5
COLUMN LINE	2.21	13	4 S 6 1	4	#5	#6	7-#8	5	#4	#4	12-#5
0.756 CF/SF	3.03	13 *	4 S 6 1	4	#7	#7	7-#9	5	#5	#5	12-#5
	3.60	14 *	4 S 6 2	4	#7	#8	9-#9	5	#5	#6	12-#5
	4.22	18 *	4 S 6 2	4	#8	#8	11-#9	5	#6	#6	12-#5
30'-0"	1.61	15		5	#4	#4	9-#6	5	#4	#4	12-#5
D = 12.500	1.89	15		5	#4	#5	9-#7	5	#4	#4	12-#5
RIB ON	2.33	15		5	#5	#6	11-#7	5	#4	#5	12-#5
COLUMN LINE	2.71	15 *	4 S 6 1	5	#6	#6	10-#8	5	#5	#5	12-#5
0.788 CF/SF	3.36	15 *	4 S 6 1	5	#7	#7	10-#9	5	#5	#6	12-#5
	4.05	20 *	4 S 6 2	5	#7	#8	16-#8	5	#6	#6	13-#5
33'-0"	1.84	16		5	#4	#5	9-#7	6	#4	#4	14-#5
D = 12.500	2.12	16	4 S 6 1	5	#5	#5	9-#8	6	#4	#4	14-#5
RIB ON	2.65	16 *	4 S 6 1	5	#6	#6	9-#9	6	#4	#5	14-#5
COLUMN LINE	3.16	16 *	4 S 6 1	5	#7	#7	13-#8	6	#5	#5	14-#5
0.770 CF/SF	3.88	20 *	4 S 6 2	5	#7	#8	14-#9	6	#5	#6	15-#5
36'-0"	2.16	18		5	#5	#6	9-#8	7	#4	#4	16-#5
D = 12.500	2.46	18 *	4 S 6 1	5	#6	#6	9-#9	7	#4	#4	16-#5
RIB ON	2.96	18 *	4 S 6 1	5	#6	#7	12-#9	7	#4	#5	16-#5
COLUMN LINE	3.58	18 *	4 S 6 2	5	#7	#8	14-#9	7	#5	#5	16-#5
0.756 CF/SF											
39'-0"	2.30	19		6	#5	#6	12-#8	7	#4	#4	16-#5
D = 15.500	2.74	19 *	4 S 6 1	6	#6	#6	12-#9	7	#4	#5	16-#5
RIB NOT ON	3.44	19 *	4 S 6 1	6	#7	#7	15-#9	7	#5	#5	16-#5
COLUMN LINE	4.06	24 *	4 S 6 2	6	#7	#8	18-#9	7	#5	#6	19-#5
0.780 CF/SF											
42'-0"	2.66	21	4 S 6 1	6	#6	#6	12-#9	8	#4	#5	18-#5
D = 15.500	3.33	21 *	4 S 6 1	6	#7	#7	15-#9	8	#5	#5	18-#5
RIB NOT ON	3.99	23 *	4 S 6 2	6	#7	#8	19-#9	8	#5	#6	20-#5
COLUMN LINE											
0.767 CF/SF											

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 18 in.	Rib Depth = 14 in.	Total Slab Depth = 4 in.															
24'-0"	50	1.57	12	0.640		10-#5+ 0	4	#4	#4	7-#6	4	#4	#4	10-#5	79	158	213
D = 9.500	100	1.63	12	0.640		10-#5+ 0	4	#4	#5	7-#6	4	#4	#4	10-#5	100	200	268
RIB NOT ON	150	1.68	12	0.640		10-#5+ 0	4	#5	#5	7-#6	4	#4	#4	10-#5	120	272	324
COLUMN LINE	200	1.90	12	0.640		10-#5+ 0	4	#5	#6	12-#5	4	#4	#5	10-#5	141	340	379
0.856 CF/SF	300	2.43	12	0.721		10-#5+ 0	4	#6	#7	8-#7	4	#5	#6	10-#5	182	469	490
	400	2.96	12 *	0.857		10-#5+ 3	4	#7	#8	8-#8	4	#6	#6	10-#5	223	596	601
	500	3.40	12 *	0.641		8-#6+ 2	4	#8	#8	7-#9	4	#6	#7	10-#5	265	722	712
27'-0"	50	1.64	13	0.638		8-#6+ 0	4	#4	#5	8-#6	5	#4	#4	12-#5	112	223	301
D = 9.500	100	1.70	13	0.638		8-#6+ 0	4	#5	#5	12-#5	5	#4	#4	12-#5	141	282	380
RIB NOT ON	150	2.04	13	0.658		8-#6+ 0	4	#6	#6	10-#6	5	#4	#5	12-#5	171	383	459
COLUMN LINE	200	2.32	13	0.743		8-#6+ 1	4	#6	#7	7-#8	5	#5	#5	12-#5	200	479	539
0.834 CF/SF	300	2.96	13 *	0.878		8-#6+ 4	4	#8	#8	7-#9	5	#5	#6	12-#5	259	664	697
	400	3.75	13 *	0.639		7-#7+ 0	4	#9	#9	9-#9	5	#6	#7	12-#5	318	845	856
	500	4.42	16 *	0.635		8-#7+ 2	4	#9	#10	13-#8	5	#7	#7	12-#5	373	1014	1005
30'-0"	50	1.63	15	0.636		9-#6+ 0	5	#4	#5	9-#6	5	#4	#4	12-#5	155	311	418
D = 12.500	100	1.95	15	0.637		9-#6+ 0	5	#5	#6	9-#7	5	#4	#5	12-#5	196	391	527
RIB ON	150	2.23	15	0.728		9-#6+ 1	5	#6	#6	11-#7	5	#5	#5	12-#5	236	520	635
COLUMN LINE	200	2.67	15 *	0.819		9-#6+ 3	5	#7	#7	10-#8	5	#5	#6	12-#5	276	652	744
0.871 CF/SF	300	3.45	15 *	0.637		15-#5+ 4	5	#8	#8	10-#9	5	#6	#7	12-#5	357	904	961
	400	4.31	18 *	0.633	4 S 6 1	10-#7+ 3	5	#9	#9	12-#9	5	#7	#8	13-#5	434	1142	1167
	500	4.96	23 *	0.628	4 S 6 1	11-#7+ 3	5	#9	#10	14-#9	5	#8	#8	15-#5	498	1285	1342
33'-0"	50	1.88	16	0.661		10-#6+ 1	5	#5	#6	9-#7	6	#4	#4	14-#5	205	410	552
D = 12.500	100	2.16	16	0.765		10-#6+ 3	5	#6	#6	9-#8	6	#4	#5	14-#5	259	518	697
RIB ON	150	2.64	16 *	0.842		10-#6+ 5	5	#7	#7	9-#9	6	#5	#5	14-#5	313	677	842
COLUMN LINE	200	3.21	16 *	0.901		11-#6+ 6	5	#8	#8	10-#9	6	#6	#6	14-#5	366	853	987
0.850 CF/SF	300	4.22	19 *	0.632	4 S 6 1	14-#6+ 4	5	#9	#10	13-#9	6	#7	#7	14-#5	470	1179	1266
	400	5.02	25 *	0.627	4 S 6 1	17-#6+ 3	5	#10	#10	16-#9	6	#7	#8	17-#5	560	1369	1508
36'-0"	50	2.11	18	0.675		11-#6+ 1	5	#6	#6	9-#8	7	#4	#5	16-#5	264	527	710
D = 12.500	100	2.54	18 *	0.797		11-#6+ 4	5	#7	#7	9-#9	7	#5	#5	16-#5	333	667	897
RIB ON	150	3.05	18 *	0.878		12-#6+ 6	5	#8	#8	11-#9	7	#5	#6	16-#5	403	835	1085
COLUMN LINE	200	3.76	18 *	0.633	4 S 6 1	11-#7+ 3	5	#9	#9	14-#9	7	#6	#6	16-#5	473	1063	1272
0.834 CF/SF	300	4.84	25 *	0.627	4 S 6 1	10-#8+ 1	5	#10	#10	18-#9	7	#7	#7	18-#5	598	1409	1611
39'-0"	50	2.41	19 *	0.783		12-#6+ 5	6	#6	#7	12-#8	7	#5	#5	16-#5	340	681	917
D = 15.500	100	2.92	19 *	0.873		13-#6+ 8	6	#7	#8	12-#9	7	#5	#6	16-#5	429	858	1156
RIB NOT ON	150	3.47	20 *	0.631		12-#7+ 4	6	#8	#8	15-#9	7	#6	#6	16-#5	517	1051	1391
COLUMN LINE	200	4.21	24 *	0.628		26-#5+ 8	6	#9	#9	17-#9	7	#7	#7	18-#5	600	1329	1615
0.862 CF/SF																	
42'-0"	50	2.63	21 *	0.795		18-#5+ 8	6	#7	#7	12-#9	8	#5	#5	18-#5	421	842	1134
D = 15.500	100	3.20	21 *	0.908		12-#7+ 8	6	#8	#8	15-#9	8	#5	#6	18-#5	532	1063	1431
RIB NOT ON	150	4.01	24 *	0.628		11-#8+ 3	6	#9	#9	23-#8	8	#6	#7	19-#5	638	1276	1718
COLUMN LINE	200	4.56	29 *	0.624		13-#8+ 4	6	#9	#10	22-#9	8	#6	#7	23-#5	737	1474	1984
0.847 CF/SF																	
45'-0"	50	3.10	22 *	0.867		12-#7+ 7	6	#8	#8	15-#9	9	#5	#6	20-#5	516	1032	1390
D = 15.500	100	3.84	24 *	0.915		11-#8+ 6	6	#9	#9	19-#9	9	#6	#6	20-#5	650	1300	1749
RIB NOT ON	150	4.52	29 *	0.624		11-#9+ 2	6	#9	#10	23-#9	9	#6	#7	24-#5	778	1555	2094
COLUMN LINE																	
0.834 CF/SF																	
48'-0"	50	3.42	24 *	0.897		14-#7+10	7	#8	#8	18-#9	9	#6	#6	20-#5	632	1263	1700
D = 18.500	100	4.27	29 *	0.916		14-#8+ 8	7	#9	#9	23-#9	9	#6	#7	24-#5	789	1578	2124
RIB ON																	
COLUMN LINE																	
0.856 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 18 in.	Rib Depth = 14 in.	Total Slab Depth = 4 in.								
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.76	12		4	#4	#5	8-#6	4	#4	#4	10-#5
2.20	12	4 S 6 1	4	#5	#6	10-#6	4	#4	#5	10-#5
2.64	12 *	4 S 6 1	4	#6	#6	7-#8	4	#5	#5	10-#5
3.05	12 *	4 S 6 1	4	#6	#7	11-#7	4	#5	#6	10-#5
1.64	13		4	#4	#4	8-#6	5	#4	#4	12-#5
1.64	13		4	#4	#4	8-#6	5	#4	#4	12-#5
1.92	13		4	#5	#5	7-#7	5	#4	#4	12-#5
2.09	13	4 S 6 1	4	#5	#6	8-#7	5	#4	#4	12-#5
2.64	13 *	4 S 6 1	4	#6	#7	8-#8	5	#4	#5	12-#5
3.26	13 *	4 S 6 2	4	#7	#7	8-#9	5	#5	#6	12-#5
4.03	13 *	4 S 6 2	4	#8	#8	10-#9	5	#6	#6	12-#5
1.61	15		5	#4	#4	9-#6	5	#4	#4	12-#5
1.81	15		5	#4	#5	11-#6	5	#4	#4	12-#5
2.04	15		5	#5	#5	10-#7	5	#4	#4	12-#5
2.40	15	4 S 6 1	5	#5	#6	9-#8	5	#4	#5	12-#5
3.13	15 *	4 S 6 1	5	#6	#7	9-#9	5	#5	#6	12-#5
3.82	15 *	4 S 6 1	5	#7	#8	11-#9	5	#6	#6	12-#5
4.45	20 *	4 S 6 2	5	#8	#8	13-#9	5	#6	#7	14-#5
1.84	16		5	#4	#5	9-#7	6	#4	#4	14-#5
2.06	16		5	#5	#5	11-#7	6	#4	#4	14-#5
2.49	16	4 S 6 1	5	#6	#6	10-#8	6	#4	#5	14-#5
2.91	16 *	4 S 6 1	5	#6	#7	9-#9	6	#5	#5	14-#5
3.67	16 *	4 S 6 2	5	#7	#8	16-#8	6	#5	#6	14-#5
4.55	21 *	4 S 6 2	5	#8	#9	15-#9	6	#6	#6	16-#5
2.01	18		5	#5	#5	11-#7	7	#4	#4	16-#5
2.36	18	4 S 6 1	5	#5	#6	9-#9	7	#4	#4	16-#5
2.79	18 *	4 S 6 1	5	#6	#7	13-#8	7	#4	#5	16-#5
3.43	18 *	4 S 6 2	5	#7	#8	16-#8	7	#5	#5	16-#5
4.44	20 *	4 S 6 2	5	#8	#9	16-#9	7	#6	#6	17-#5
2.24	19		6	#5	#6	11-#8	7	#4	#4	16-#5
2.67	19 *	4 S 6 1	6	#6	#6	11-#9	7	#4	#5	16-#5
3.20	19 *	4 S 6 1	6	#6	#7	14-#9	7	#5	#5	16-#5
3.80	19 *	4 S 6 2	6	#7	#8	16-#9	7	#5	#6	17-#5
2.49	21	4 S 6 1	6	#6	#6	11-#9	8	#4	#4	18-#5
2.96	21 *	4 S 6 1	6	#6	#7	14-#9	8	#4	#5	18-#5
3.64	21 *	4 S 6 2	6	#7	#8	17-#9	8	#5	#5	18-#5
4.22	23 *	4 S 6 2	6	#8	#8	20-#9	8	#5	#6	21-#5
2.86	22	4 S 6 1	6	#6	#7	14-#9	9	#4	#5	20-#5
3.58	22 *	4 S 6 2	6	#7	#8	18-#9	9	#5	#5	20-#5
4.21	22 *	4 S 6 2	6	#8	#8	22-#9	9	#5	#6	22-#5
3.19	24 *	4 S 6 1	7	#6	#7	17-#9	9	#5	#5	20-#5
4.00	24 *	4 S 6 2	7	#7	#8	22-#9	9	#5	#6	23-#5

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 20 in.	Rib Depth = 16 in.		Total Slab Depth = 4 in.														
27'-0"	50	1.79	13	0.641		8-#6+ 0	4	#4	#5	8-#6	5	#4	#5	12-#5	119	239	321
D = 9.500	100	1.84	13	0.641		8-#6+ 0	4	#5	#5	8-#6	5	#4	#5	12-#5	149	298	401
RIB NOT ON	150	1.97	13	0.641		8-#6+ 0	4	#5	#6	7-#7	5	#4	#5	12-#5	178	393	480
COLUMN LINE	200	2.21	13	0.641		8-#6+ 0	4	#6	#7	8-#7	5	#4	#5	12-#5	208	491	559
0.915 CF/SF	300	2.77	13	0.722		8-#6+ 0	4	#7	#8	8-#8	5	#5	#6	12-#5	267	678	718
	400	3.38	13 *	0.642		12-#5+ 1	4	#8	#9	8-#9	5	#6	#6	12-#5	326	860	877
	500	3.93	13 *	0.642		10-#6+ 1	4	#9	#9	12-#8	5	#6	#7	12-#5	385	1040	1035
30'-0"	50	1.77	15	0.638		9-#6+ 0	5	#4	#5	9-#6	5	#4	#5	12-#5	166	332	447
D = 12.500	100	1.88	15	0.638		9-#6+ 0	5	#5	#5	11-#6	5	#4	#5	12-#5	206	413	556
RIB ON	150	2.22	15	0.638		9-#6+ 0	5	#6	#6	10-#7	5	#5	#5	12-#5	247	536	664
COLUMN LINE	200	2.54	15	0.703		9-#6+ 1	5	#6	#7	9-#8	5	#5	#6	12-#5	287	671	773
0.956 CF/SF	300	3.37	15 *	0.853		10-#6+ 3	5	#8	#8	9-#9	5	#6	#7	12-#5	368	926	990
	400	4.01	15 *	0.639		12-#6+ 3	5	#9	#9	11-#9	5	#7	#7	12-#5	448	1175	1207
	500	4.80	18 *	0.635	4 S 6 1	10-#7+ 1	5	#9	#10	13-#9	5	#8	#8	14-#5	524	1408	1411
33'-0"	50	1.96	16	0.637		10-#6+ 0	5	#5	#6	9-#7	6	#4	#5	14-#5	219	439	591
D = 12.500	100	2.15	16	0.637		10-#6+ 0	5	#6	#6	11-#7	6	#4	#5	14-#5	273	546	735
RIB ON	150	2.52	16	0.714		10-#6+ 1	5	#7	#7	10-#8	6	#5	#5	14-#5	327	701	880
COLUMN LINE	200	2.87	16 *	0.808		10-#6+ 3	5	#7	#8	9-#9	6	#5	#6	14-#5	381	881	1025
0.932 CF/SF	300	3.89	16 *	0.638		10-#7+ 1	5	#9	#9	12-#9	6	#6	#7	14-#5	488	1219	1315
	400	4.80	20 *	0.633	4 S 6 1	9-#8+ 1	5	#10	#10	15-#9	6	#7	#8	16-#5	589	1535	1587
36'-0"	50	2.12	18	0.634		11-#6+ 1	5	#6	#6	11-#7	7	#4	#5	16-#5	282	564	759
D = 12.500	100	2.45	18	0.702		11-#6+ 2	5	#7	#7	9-#9	7	#4	#5	16-#5	352	703	946
RIB ON	150	2.75	18 *	0.808		11-#6+ 5	5	#7	#8	10-#9	7	#5	#5	16-#5	421	870	1134
COLUMN LINE	200	3.45	18 *	0.873		10-#7+ 3	5	#8	#9	12-#9	7	#6	#6	16-#5	491	1105	1321
0.915 CF/SF	300	4.53	20 *	0.633	4 S 6 1	17-#6+ 3	5	#10	#10	16-#9	7	#7	#7	17-#5	627	1532	1688
39'-0"	50	2.32	19	0.656		12-#6+ 1	6	#6	#7	11-#8	7	#4	#5	16-#5	364	728	981
D = 15.500	100	2.71	19 *	0.794		12-#6+ 5	6	#7	#7	11-#9	7	#5	#6	16-#5	453	906	1219
RIB NOT ON	150	3.27	19 *	0.890		11-#7+ 6	6	#7	#8	14-#9	7	#6	#6	16-#5	542	1103	1458
COLUMN LINE	200	3.86	19 *	0.634		17-#6+ 5	6	#8	#9	16-#9	7	#6	#7	17-#5	630	1404	1697
0.946 CF/SF	300	5.20	26 *	0.628		12-#8+ 2	6	#10	#10	20-#9	7	#7	#8	16-#6	791	1856	2130
42'-0"	50	2.57	21	0.716		18-#5+ 5	6	#7	#7	11-#9	8	#5	#5	18-#5	450	900	1212
D = 15.500	100	3.13	21 *	0.843		11-#7+ 5	6	#8	#8	14-#9	8	#5	#6	18-#5	561	1122	1510
RIB NOT ON	150	3.66	21 *	0.632		18-#6+ 5	6	#8	#9	17-#9	8	#6	#6	18-#5	671	1343	1808
COLUMN LINE	200	4.43	24 *	0.630		12-#8+ 2	6	#9	#10	20-#9	8	#6	#7	21-#5	777	1654	2092
0.929 CF/SF	300	5.45	32 *	0.625	4 S 6 1	12-#9+ 2	6	#10	#10	26-#9	8	#7	#8	19-#6	967	1934	2604
45'-0"	50	2.86	22 *	0.803		11-#7+ 5	6	#7	#8	14-#9	9	#5	#5	20-#5	552	1103	1485
D = 15.500	100	3.50	22 *	0.902		14-#7+ 8	6	#8	#9	18-#9	9	#6	#6	20-#5	688	1376	1852
RIB NOT ON	150	4.27	25 *	0.629		32-#5+ 7	6	#9	#10	21-#9	9	#6	#7	22-#5	819	1638	2206
COLUMN LINE	200	4.96	30 *	0.626		12-#9+ 2	6	#10	#10	25-#9	9	#7	#7	26-#5	943	1887	2540
0.915 CF/SF																	
48'-0"	50	3.19	24 *	0.848		26-#5+14	7	#8	#8	17-#9	9	#5	#6	20-#5	675	1351	1818
D = 18.500	100	4.07	25 *	0.920		13-#8+ 8	7	#9	#9	22-#9	9	#6	#7	23-#5	839	1678	2259
RIB ON	150	4.75	30 *	0.626		15-#8+ 3	7	#9	#10	26-#9	9	#7	#7	27-#5	994	1988	2677
COLUMN LINE	200	5.50	37 *	0.622	4 S 6 1	14-#9+ 3	7	#10	#10	30-#9	9	#7	#8	22-#6	1129	2258	3040
0.940 CF/SF																	
51'-0"	50	3.64	25 *	0.892		16-#7+10	7	#8	#9	21-#9	10	#6	#6	22-#5	807	1613	2172
D = 18.500	100	4.47	29 *	0.626		20-#7+ 6	7	#9	#10	26-#9	10	#6	#7	27-#5	998	1996	2687
RIB ON																	
COLUMN LINE																	
0.926 CF/SF																	
54'-0"	50	4.05	27 *	0.918		15-#8+10	7	#9	#10	25-#9	11	#6	#6	26-#5	951	1903	2561
D = 18.500																	
RIB ON																	
COLUMN LINE																	
0.915 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 20 in.	Rib Depth = 16 in.	Total Slab Depth = 4 in.								
1.82	13		4	#4	#5	8-#6	5	#4	#5	12-#5
1.82	13		4	#4	#5	8-#6	5	#4	#5	12-#5
1.89	13		4	#4	#5	9-#6	5	#4	#5	12-#5
2.08	13		4	#5	#5	8-#7	5	#4	#5	12-#5
2.50	13	4 S 6 1	4	#6	#6	8-#8	5	#4	#5	12-#5
3.03	13 *	4 S 6 1	4	#7	#7	7-#9	5	#5	#5	12-#5
3.60	13 *	4 S 6 2	4	#7	#8	9-#9	5	#5	#6	12-#5
1.79	15		5	#4	#5	9-#6	5	#4	#5	12-#5
1.83	15		5	#4	#5	10-#6	5	#4	#5	12-#5
2.07	15		5	#5	#5	9-#7	5	#4	#5	12-#5
2.33	15		5	#5	#6	11-#7	5	#4	#5	12-#5
3.02	15 *	4 S 6 1	5	#6	#7	9-#9	5	#5	#5	12-#5
3.51	15 *	4 S 6 1	5	#7	#7	10-#9	5	#6	#6	12-#5
4.23	15 *	4 S 6 2	5	#8	#8	12-#9	5	#6	#7	13-#5
1.87	16		5	#4	#5	11-#6	6	#4	#5	14-#5
2.08	16		5	#5	#5	10-#7	6	#4	#5	14-#5
2.32	16	4 S 6 1	5	#5	#6	9-#8	6	#4	#5	14-#5
2.65	16	4 S 6 1	5	#6	#6	9-#9	6	#4	#5	14-#5
3.52	16 *	4 S 6 1	5	#7	#8	11-#9	6	#5	#6	14-#5
4.17	16 *	4 S 6 2	5	#8	#8	14-#9	6	#6	#6	15-#5
2.05	18		5	#5	#5	14-#6	7	#4	#5	16-#5
2.32	18	4 S 6 1	5	#5	#6	10-#8	7	#4	#5	16-#5
2.58	18	4 S 6 1	5	#6	#6	12-#8	7	#4	#5	16-#5
3.14	18 *	4 S 6 1	5	#7	#7	11-#9	7	#5	#5	16-#5
3.96	18 *	4 S 6 2	5	#8	#8	15-#9	7	#5	#6	16-#5
2.23	19		6	#5	#5	11-#8	7	#4	#5	16-#5
2.48	19		6	#5	#6	13-#8	7	#4	#5	16-#5
3.06	19 *	4 S 6 1	6	#6	#7	16-#8	7	#5	#5	16-#5
3.55	19 *	4 S 6 1	6	#7	#7	15-#9	7	#5	#6	16-#5
4.81	21 *	4 S 6 2	6	#8	#9	19-#9	7	#6	#7	20-#5
2.42	21		6	#5	#6	13-#8	8	#4	#5	18-#5
2.89	21	4 S 6 1	6	#6	#7	13-#9	8	#4	#5	18-#5
3.39	21 *	4 S 6 1	6	#7	#7	16-#9	8	#5	#5	18-#5
4.12	21 *	4 S 6 2	6	#8	#8	19-#9	8	#5	#6	20-#5
5.04	27 *	4 S 6 2	6	#8	#9	24-#9	8	#6	#6	18-#6
2.74	22	4 S 6 1	6	#6	#7	16-#8	9	#4	#5	20-#5
3.14	22 *	4 S 6 1	6	#7	#7	16-#9	9	#4	#5	20-#5
3.89	22 *	4 S 6 2	6	#8	#8	20-#9	9	#5	#5	21-#5
4.51	23 *	4 S 6 2	6	#8	#9	23-#9	9	#5	#6	24-#5
2.95	24	4 S 6 1	7	#6	#7	16-#9	9	#4	#5	20-#5
3.68	24 *	4 S 6 1	7	#7	#8	20-#9	9	#5	#5	21-#5
4.35	24 *	4 S 6 2	7	#8	#8	24-#9	9	#5	#6	26-#5
5.11	30 *	4 S 6 2	7	#8	#9	28-#9	9	#6	#6	21-#6
3.37	25 *	4 S 6 1	7	#7	#7	19-#9	10	#5	#5	22-#5
4.16	25 *	4 S 6 2	7	#8	#8	24-#9	10	#5	#6	25-#5
3.68	27 *	4 S 6 2	7	#7	#8	23-#9	11	#5	#5	24-#5

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments –M Edge (ft-k)	Moments +M Bot. (ft-k)	Moments –M Int. (ft-k)
Total Depth = 24 in.	Rib Depth = 20 in.		Total Slab Depth = 4 in.														
33'-0"	50	2.03	16	0.640		10-#6+ 0	5	#5	#5	11-#6	6	#5	#5	14-#5	249	498	671
D = 12.500	100	2.18	16	0.640		10-#6+ 0	5	#5	#6	10-#7	6	#5	#5	14-#5	303	606	815
RIB ON	150	2.42	16	0.640		10-#6+ 0	5	#6	#7	9-#8	6	#5	#5	14-#5	357	742	960
COLUMN LINE	200	2.67	16	0.640		10-#6+ 1	5	#7	#7	10-#8	6	#5	#5	14-#5	410	927	1105
1.103 CF/SF	300	3.28	16 *	0.784		11-#6+ 3	5	#8	#8	10-#9	6	#6	#6	14-#5	518	1274	1395
	400	4.18	16 *	0.641		10-#7+ 1	5	#9	#10	16-#8	6	#7	#7	14-#5	626	1609	1684
	500	4.90	16 *	0.641	5 S 8 1	9-#8+ 2	5	#10	#10	15-#9	6	#7	#8	16-#5	733	1940	1974
36'-0"	50	2.24	18	0.638		11-#6+ 0	5	#6	#6	14-#6	7	#5	#5	16-#5	320	640	861
D = 12.500	100	2.46	18	0.638		11-#6+ 0	5	#6	#7	10-#8	7	#5	#5	16-#5	390	779	1049
RIB ON	150	2.72	18	0.638		11-#6+ 0	5	#7	#7	9-#9	7	#5	#5	16-#5	459	930	1236
COLUMN LINE	200	3.11	18	0.686		12-#6+ 1	5	#8	#8	11-#9	7	#5	#6	16-#5	529	1171	1424
1.081 CF/SF	300	4.03	18 *	0.865		11-#7+ 3	5	#9	#10	14-#9	7	#6	#7	16-#5	668	1618	1799
39'-0"	50	2.34	19	0.637		12-#6+ 1	6	#6	#6	11-#8	7	#5	#5	16-#5	414	827	1114
D = 15.500	100	2.57	19	0.637		12-#6+ 2	6	#6	#7	13-#8	7	#5	#5	16-#5	502	1005	1353
RIB NOT ON	150	2.99	19	0.727		13-#6+ 3	6	#7	#8	12-#9	7	#5	#6	16-#5	591	1184	1592
COLUMN LINE	200	3.36	19 *	0.841		11-#7+ 5	6	#8	#8	14-#9	7	#6	#6	16-#5	680	1494	1831
1.119 CF/SF	300	4.63	19 *	0.638		14-#7+ 4	6	#9	#10	18-#9	7	#7	#8	19-#5	857	2064	2308
42'-0"	50	2.53	21	0.635		13-#6+ 1	6	#6	#7	13-#8	8	#5	#5	18-#5	511	1022	1376
D = 15.500	100	2.96	21	0.671		14-#6+ 2	6	#7	#8	16-#8	8	#5	#6	18-#5	622	1243	1674
RIB NOT ON	150	3.28	21 *	0.819		12-#7+ 5	6	#8	#8	15-#9	8	#5	#6	18-#5	732	1465	1972
COLUMN LINE	200	3.92	21 *	0.880		14-#7+ 5	6	#9	#9	17-#9	8	#6	#7	18-#5	843	1792	2269
1.098 CF/SF																	
45'-0"	50	2.81	22	0.634		14-#6+ 2	6	#7	#8	16-#8	9	#5	#5	20-#5	626	1252	1686
D = 15.500	100	3.25	22 *	0.792		12-#7+ 5	6	#8	#8	16-#9	9	#5	#6	20-#5	762	1525	2052
RIB NOT ON	150	3.81	22 *	0.884		11-#8+ 6	6	#9	#9	19-#9	9	#6	#6	20-#5	899	1797	2419
COLUMN LINE	200	4.38	22 *	0.635		13-#8+ 2	6	#9	#10	22-#9	9	#6	#7	23-#5	1035	2150	2786
1.081 CF/SF																	
48'-0"	50	3.08	24	0.744		17-#6+ 7	7	#7	#8	16-#9	9	#5	#6	20-#5	767	1534	2065
D = 18.500	100	3.64	24 *	0.846		15-#7+ 7	7	#8	#9	19-#9	9	#6	#6	20-#5	932	1864	2510
RIB ON	150	4.24	24 *	0.634		14-#8+ 4	7	#9	#9	23-#9	9	#6	#7	24-#5	1097	2194	2954
COLUMN LINE	200	4.94	27 *	0.631		16-#8+ 3	7	#9	#10	27-#9	9	#7	#7	20-#6	1255	2510	3379
1.112 CF/SF																	
51'-0"	50	3.45	25 *	0.800		15-#7+ 6	7	#8	#9	19-#9	10	#5	#6	22-#5	916	1832	2466
D = 18.500	100	4.07	25 *	0.899		14-#8+ 8	7	#9	#9	23-#9	10	#6	#7	25-#5	1114	2228	3000
RIB ON	150	4.85	27 *	0.631		13-#9+ 4	7	#10	#10	28-#9	10	#7	#7	29-#5	1308	2616	3521
COLUMN LINE																	
1.095 CF/SF																	
54'-0"	50	3.82	27 *	0.842		14-#8+ 6	7	#9	#9	23-#9	11	#6	#6	24-#5	1080	2159	2907
D = 18.500	100	4.58	27 *	0.631		13-#9+ 4	7	#10	#10	28-#9	11	#6	#7	29-#5	1315	2629	3539
RIB ON																	
COLUMN LINE																	
1.081 CF/SF																	
57'-0"	50	4.19	28 *	0.891		16-#8+10	8	#9	#9	27-#9	11	#6	#7	28-#5	1284	2568	3457
D =21.500	100	5.18	32 *	0.628		16-#9+ 5	8	#10	#10	33-#9	11	#7	#7	24-#6	1551	3102	4175
RIB NOT ON																	
COLUMN LINE																	
1.107 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 24 in.	Rib Depth = 20 in.	Total Slab Depth = 4 in.								
2.03	16		5	#5	#5	10-#6	6	#5	#5	14-#5
2.16	16		5	#5	#5	9-#7	6	#5	#5	14-#5
2.30	16		5	#5	#5	11-#7	6	#5	#5	14-#5
2.63	16		5	#6	#6	10-#8	6	#5	#5	14-#5
3.06	16	5 S 8 1	5	#7	#7	12-#8	6	#5	#5	14-#5
3.61	16 *	5 S 8 1	5	#7	#8	12-#9	6	#5	#6	14-#5
4.35	16 *	5 S 8 2	5	#8	#9	14-#9	6	#6	#6	15-#5
2.18	18		5	#5	#5	10-#7	7	#5	#5	16-#5
2.41	18		5	#5	#6	9-#8	7	#5	#5	16-#5
2.71	18	5 S 8 1	5	#6	#6	9-#9	7	#5	#5	16-#5
2.90	18	5 S 8 1	5	#6	#7	10-#9	7	#5	#5	16-#5
3.55	18*	5 S 8 2	5	#7	#8	16-#8	7	#5	#6	16-#5
2.28	19		6	#5	#5	13-#7	7	#5	#5	16-#5
2.53	19		6	#5	#6	12-#8	7	#5	#5	16-#5
2.81	19		6	#6	#6	11-#9	7	#5	#5	16-#5
3.06	19	5 S 8 1	6	#6	#7	16-#8	7	#5	#5	16-#5
4.11	19 *	5 S 8 1	6	#8	#8	16-#9	7	#6	#6	17-#5
2.48	21		6	#5	#6	12-#8	8	#5	#5	18-#5
2.81	21		6	#6	#6	12-#9	8	#5	#5	18-#5
3.10	21	5 S 8 1	6	#6	#7	14-#9	8	#5	#5	18-#5
3.53	21 *	5 S 8 1	6	#7	#8	16-#9	8	#5	#5	18-#5
2.74	22		6	#6	#6	12-#9	9	#5	#5	20-#5
3.12	22	5 S 8 1	6	#7	#7	14-#9	9	#5	#5	20-#5
3.52	22 *	5 S 8 1	6	#7	#8	17-#9	9	#5	#5	20-#5
4.02	22 *	5 S 8 2	6	#8	#8	20-#9	9	#5	#6	21-#5
2.95	24		7	#6	#7	18-#8	9	#5	#5	20-#5
3.37	24 *	5 S 8 1	7	#7	#7	18-#9	9	#5	#5	20-#5
3.92	24 *	5 S 8 1	7	#7	#8	21-#9	9	#5	#6	22-#5
4.62	24 *	5 S 8 2	7	#8	#8	25-#9	9	#6	#6	26-#5
3.28	25	5 S 8 1	7	#7	#7	18-#9	10	#5	#5	22-#5
3.72	25 *	5 S 8 1	7	#7	#8	22-#9	10	#5	#5	23-#5
4.34	25 *	5 S 8 2	7	#8	#8	26-#9	10	#5	#6	27-#5
3.54	27	5 S 8 1	7	#7	#8	21-#9	11	#5	#5	24-#5
4.18	27 *	5 S 8 2	7	#8	#8	26-#9	11	#5	#6	27-#5
3.90	28 *	5 S 8 1	8	#7	#8	25-#9	11	#5	#6	26-#5
4.86	28 *	5 S 8 2	8	#8	#9	31-#9	11	#6	#6	32-#5

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f_c' = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 12 ½ in.		Rib Depth = 8 in.		Total Slab Depth = 4 ½ in.													
18'-0"	50	1.60	12	0.632		5-#6+ 0	3	#4	#4	5-#6	3	#4	#4	8-#5	27	54	73
D = 6.500	100	1.60	12	0.632		5-#6+ 0	3	#4	#4	5-#6	3	#4	#4	8-#5	36	73	96
RIB ON	150	1.66	12	0.632		5-#6+ 0	3	#4	#5	5-#6	3	#4	#4	8-#5	44	102	118
COLUMN LINE	200	1.72	12	0.639		5-#6+ 0	3	#5	#5	5-#6	3	#4	#4	8-#5	52	128	141
0.648 CF/SF	300	2.00	12	0.726		5-#6+ 0	3	#6	#6	6-#6	3	#4	#5	8-#5	69	180	187
	400	2.50	12 *	0.843		5-#6+ 1	3	#6	#7	6-#7	3	#5	#6	8-#5	86	232	232
	500	3.02	12 *	0.633	3 S 4 1	5-#6+ 1	3	#7	#8	5-#8	3	#6	#6	8-#5	103	282	278
21'-0"	50	1.56	12	0.653		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	45	89	120
D = 9.500	100	1.56	12	0.699		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	58	121	157
RIB NOT ON	150	1.73	12	0.771		9-#5+ 1	4	#5	#5	9-#5	3	#4	#5	8-#5	72	167	194
COLUMN LINE	200	1.98	12	0.829		9-#5+ 2	4	#5	#6	8-#6	3	#5	#5	8-#5	86	210	230
0.680 CF/SF	300	2.58	12 *	0.633		9-#5+ 2	4	#6	#7	8-#7	3	#6	#6	8-#5	113	295	304
	400	3.25	14 *	0.630		9-#5+ 2	4	#7	#8	7-#8	3	#7	#7	8-#5	139	374	374
	500	3.71	17 *	0.627		10-#5+ 3	4	#8	#8	7-#9	3	#7	#8	8-#5	162	430	436
24'-0"	50	1.63	12	0.727		10-#5+ 0	4	#4	#5	7-#6	4	#4	#4	10-#5	67	133	179
D = 9.500	100	1.70	12	0.801		10-#5+ 1	4	#5	#5	8-#6	4	#4	#4	10-#5	87	181	235
RIB NOT ON	150	2.14	12 *	0.874		10-#5+ 3	4	#6	#6	7-#7	4	#5	#5	10-#5	108	250	290
COLUMN LINE	200	2.50	12 *	0.633		10-#5+ 2	4	#6	#7	7-#8	4	#5	#6	10-#5	129	315	346
0.661 CF/SF	300	3.30	16 *	0.628		8-#6+ 2	4	#8	#8	7-#9	4	#6	#7	10-#5	167	436	450
	400	3.89	20 *	0.624		9-#6+ 2	4	#8	#9	9-#9	4	#7	#7	10-#5	200	489	539
27'-0"	50	1.70	13	0.770		8-#6+ 0	4	#5	#5	12-#5	5	#4	#4	12-#5	94	189	254
D = 9.500	100	2.12	13 *	0.866		8-#6+ 2	4	#6	#6	7-#8	5	#4	#5	12-#5	124	249	334
RIB NOT ON	150	2.51	13 *	0.631		8-#6+ 1	4	#7	#7	8-#8	5	#5	#5	12-#5	153	349	413
COLUMN LINE	200	3.05	16 *	0.628		8-#6+ 2	4	#8	#8	8-#9	5	#5	#6	12-#5	181	436	488
0.648 CF/SF																	
30'-0"	50	1.95	15 *	0.839		9-#6+ 3	5	#5	#6	9-#7	5	#4	#5	12-#5	131	262	352
D = 12.500	100	2.29	15 *	0.910		9-#6+ 5	5	#6	#6	9-#8	5	#5	#5	12-#5	171	342	461
RIB ON	150	3.04	18 *	0.626		10-#6+ 3	5	#7	#7	9-#9	5	#6	#6	12-#5	209	457	564
COLUMN LINE	200	3.49	23 *	0.622		11-#6+ 3	5	#8	#8	11-#9	5	#6	#7	12-#5	244	534	658
0.670 CF/SF																	
33'-0"	50	2.16	16 *	0.876		10-#6+ 4	5	#6	#6	9-#8	6	#4	#5	14-#5	173	347	466
D = 12.500	100	2.80	18 *	0.920		10-#6+ 7	5	#7	#7	12-#8	6	#5	#6	14-#5	226	452	608
RIB ON	150	3.40	26 *	0.620	3 S 4 1	9-#7+ 4	5	#8	#8	12-#9	6	#6	#6	14-#5	272	544	732
COLUMN LINE																	
0.658 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 12 ½ in.			Rib Depth = 8 in.				Total Slab Depth = 4 ½ in.			
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
1.78	12	3 S 4 1	3	#4	#5	8-#5	3	#4	#4	8-#5
2.25	12 *	3 S 4 1	3	#5	#6	5-#7	3	#4	#5	8-#5
2.71	12 *	3 S 4 1	3	#6	#6	5-#8	3	#5	#5	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.76	12		4	#4	#5	7-#6	3	#4	#4	8-#5
2.26	12 *	3 S 4 1	4	#5	#5	7-#7	3	#5	#5	8-#5
2.85	12 *	3 S 4 1	4	#6	#6	7-#8	3	#5	#6	8-#5
3.26	15 *	3 S 4 1	4	#6	#7	8-#8	3	#6	#6	8-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.94	12	3 S 4 1	4	#5	#5	9-#6	4	#4	#4	10-#5
2.26	12 *	3 S 4 1	4	#5	#6	8-#7	4	#4	#5	10-#5
2.87	12 *	3 S 4 1	4	#6	#7	8-#8	4	#5	#5	10-#5
3.41	18 *	3 S 4 2	4	#7	#7	8-#9	4	#5	#6	10-#5
1.64	13		4	#4	#4	8-#6	5	#4	#4	12-#5
1.98	13	3 S 4 1	4	#5	#5	8-#7	5	#4	#4	12-#5
2.29	13 *	3 S 4 1	4	#5	#6	8-#8	5	#4	#4	12-#5
2.77	13 *	3 S 4 1	4	#6	#7	7-#9	5	#4	#5	12-#5
1.81	15		5	#4	#5	11-#6	5	#4	#4	12-#5
2.13	15 *	3 S 4 1	5	#5	#5	11-#7	5	#4	#4	12-#5
2.88	15 *	3 S 4 1	5	#6	#6	9-#9	5	#5	#5	12-#5
3.12	17 *	3 S 4 1	5	#6	#7	10-#9	5	#5	#5	12-#5
2.06	16	3 S 4 1	5	#5	#5	11-#7	6	#4	#4	14-#5
2.65	16 *	3 S 4 1	5	#6	#6	9-#9	6	#4	#5	14-#5
3.14	18 *	3 S 4 2	5	#6	#7	11-#9	6	#5	#5	14-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f_c'}$ but less than $6\sqrt{f_c'}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column			Reinforcing Bars—Each Direction									Moments		
						Column Strip					Middle Strip						
						Top	Bottom			Top	Bottom			Top			
			$c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Edge No.-size +	No. Ribs	Long Bars	Short Bars	Interior No.-size	No. Ribs	Long Bars	Short Bars	Interior No.-size	–M Edge (ft-k)	+M Bot. (ft-k)	–M Int. (ft-k)
Total Depth = 14 ½ in.		Rib Depth = 10 in.		Total Slab Depth = 4 ½ in.													
21'-0"	50	1.56	12	0.635		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	48	96	129
D = 9.500	100	1.56	12	0.635		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	62	127	166
RIB NOT ON	150	1.63	12	0.649		9-#5+ 0	4	#4	#5	9-#5	3	#4	#4	8-#5	75	174	203
COLUMN LINE	200	1.75	12	0.693		9-#5+ 0	4	#5	#5	7-#6	3	#4	#5	8-#5	89	217	239
0.762 CF/SF	300	2.26	12	0.801		9-#5+ 1	4	#6	#6	9-#6	3	#5	#6	8-#5	116	302	313
	400	2.80	12 *	0.636		9-#5+ 1	4	#7	#7	8-#7	3	#6	#7	8-#5	144	386	386
	500	3.28	12 *	0.636		9-#5+ 2	4	#7	#8	8-#8	3	#7	#7	8-#5	171	468	460
24'-0"	50	1.57	12	0.646		10-#5+ 0	4	#4	#4	7-#6	4	#4	#4	10-#5	72	143	193
D = 9.500	100	1.63	12	0.697		10-#5+ 0	4	#4	#5	7-#6	4	#4	#4	10-#5	92	189	248
RIB NOT ON	150	1.91	12	0.771		10-#5+ 1	4	#5	#6	9-#6	4	#4	#5	10-#5	113	260	304
COLUMN LINE	200	2.17	12 *	0.845		10-#5+ 3	4	#6	#6	10-#6	4	#5	#5	10-#5	133	326	359
0.738 CF/SF	300	2.96	12 *	0.636		10-#5+ 3	4	#7	#8	8-#8	4	#6	#6	10-#5	175	454	470
	400	3.53	15 *	0.632		8-#6+ 2	4	#8	#8	8-#9	4	#6	#7	10-#5	214	574	575
	500	4.18	18 *	0.629		7-#7+ 2	4	#9	#9	9-#9	4	#7	#7	10-#5	248	658	667
27'-0"	50	1.69	13	0.696		8-#6+ 0	4	#5	#5	8-#6	5	#4	#4	12-#5	101	203	273
D = 9.500	100	1.86	13	0.755		8-#6+ 0	4	#5	#6	7-#7	5	#4	#4	12-#5	131	263	352
RIB NOT ON	150	2.31	13 *	0.851		8-#6+ 2	4	#6	#7	7-#8	5	#4	#5	12-#5	160	364	432
COLUMN LINE	200	2.79	13 *	0.915		8-#6+ 4	4	#7	#8	11-#7	5	#5	#6	12-#5	190	458	511
0.722 CF/SF	300	3.59	16 *	0.631		7-#7+ 2	4	#8	#9	9-#9	5	#6	#7	12-#5	246	634	663
	400	4.30	21 *	0.626	3 S 4 1	8-#7+ 2	4	#9	#10	11-#9	5	#7	#7	12-#5	295	736	794
30'-0"	50	1.73	15	0.765		9-#6+ 2	5	#5	#5	11-#6	5	#4	#4	12-#5	141	281	379
D = 12.500	100	2.10	15 *	0.848		9-#6+ 4	5	#6	#6	14-#6	5	#4	#5	12-#5	181	362	487
RIB ON	150	2.67	15 *	0.909		9-#6+ 6	5	#7	#7	10-#8	5	#5	#6	12-#5	221	488	596
COLUMN LINE	200	3.20	16 *	0.631		10-#6+ 3	5	#7	#8	9-#9	5	#6	#6	12-#5	261	614	702
0.749 CF/SF	300	4.05	22 *	0.625	3 S 4 1	10-#7+ 3	5	#8	#9	12-#9	5	#7	#7	13-#5	332	797	894
33'-0"	50	2.11	16 *	0.813		10-#6+ 3	5	#6	#6	11-#7	6	#4	#5	14-#5	186	372	501
D = 12.500	100	2.47	16 *	0.889		10-#6+ 5	5	#6	#7	9-#9	6	#5	#5	14-#5	240	480	646
RIB ON	150	2.99	18 *	0.629		11-#6+ 3	5	#7	#8	13-#8	6	#5	#6	14-#5	292	627	786
COLUMN LINE	200	3.77	22 *	0.625	3 S 4 1	10-#7+ 3	5	#8	#9	16-#8	6	#6	#7	14-#5	342	786	920
0.734 CF/SF																	
36'-0"	50	2.33	18 *	0.834		11-#6+ 4	5	#6	#7	9-#9	7	#4	#5	16-#5	240	479	645
D = 12.500	100	2.88	18 *	0.927		12-#6+ 9	5	#7	#8	11-#9	7	#5	#5	16-#5	309	618	833
RIB ON	150	3.55	23 *	0.624	3 S 4 1	11-#7+ 3	5	#8	#9	14-#9	7	#6	#6	16-#5	374	748	1007
COLUMN LINE																	
0.722 CF/SF																	
39'-0"	50	2.64	19 *	0.890		12-#6+ 8	6	#7	#7	11-#9	7	#5	#5	16-#5	309	617	831
D = 15.500	100	3.43	23 *	0.923		11-#7+ 9	6	#8	#8	18-#8	7	#6	#6	16-#5	394	787	1060
RIB NOT ON																	
COLUMN LINE																	
0.742 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column		Reinforcing Bars—Each Direction							
			Column Strip				Middle Strip			
			Bottom			Top	Bottom			Top
	$c_1 = c_2$ (in.)	(2) Stirrups	No. Ribs	Long Bars	Short Bars	Interior No.-size	No. Ribs	Long Bars	Short Bars	Interior No.-size
Total Depth = 14 ½ in.			Rib Depth = 10 in.				Total Slab Depth = 4 ½ in.			
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
2.00	12		4	#5	#5	8-#6	3	#4	#5	8-#5
2.40	12 *	3 S 4 1	4	#5	#6	10-#6	3	#5	#5	8-#5
2.85	12 *	3 S 4 1	4	#6	#6	7-#8	3	#5	#6	8-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.76	12		4	#4	#5	8-#6	4	#4	#4	10-#5
1.98	12	3 S 4 1	4	#5	#5	7-#7	4	#4	#4	10-#5
2.64	12 *	3 S 4 1	4	#6	#6	7-#8	4	#5	#5	10-#5
3.26	12 *	3 S 4 1	4	#7	#7	7-#9	4	#5	#6	10-#5
3.74	16 *	3 S 4 2	4	#7	#8	8-#9	4	#6	#6	10-#5
1.64	13		4	#4	#4	8-#6	5	#4	#4	12-#5
1.80	13		4	#4	#5	9-#6	5	#4	#4	12-#5
2.21	13	3 S 4 1	4	#5	#6	7-#8	5	#4	#4	12-#5
2.50	13 *	3 S 4 1	4	#6	#6	8-#8	5	#4	#5	12-#5
3.14	13 *	3 S 4 2	4	#7	#7	8-#9	5	#5	#5	12-#5
3.73	18 *	3 S 4 2	4	#7	#8	10-#9	5	#5	#6	12-#5
1.65	15		5	#4	#4	10-#6	5	#4	#4	12-#5
1.95	15		5	#4	#5	10-#7	5	#4	#4	12-#5
2.40	15 *	3 S 4 1	5	#5	#6	9-#8	5	#4	#5	12-#5
3.02	15 *	3 S 4 1	5	#6	#7	9-#9	5	#5	#5	12-#5
3.68	18 *	3 S 4 2	5	#7	#7	11-#9	5	#6	#6	12-#5
1.98	16		5	#5	#5	10-#7	6	#4	#4	14-#5
2.29	16 *	3 S 4 1	5	#5	#6	10-#8	6	#4	#4	14-#5
2.79	16 *	3 S 4 1	5	#6	#7	12-#8	6	#4	#5	14-#5
3.46	16 *	3 S 4 2	5	#7	#7	12-#9	6	#5	#6	14-#5
2.22	18	3 S 4 1	5	#5	#6	10-#8	7	#4	#4	16-#5
2.75	18 *	3 S 4 1	5	#6	#7	10-#9	7	#4	#5	16-#5
3.20	18 *	3 S 4 2	5	#7	#7	13-#9	7	#4	#5	16-#5
2.48	19 *	3 S 4 1	6	#5	#6	13-#8	7	#4	#5	16-#5
3.20	19 *	3 S 4 1	6	#6	#7	14-#9	7	#5	#5	16-#5

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 16 ½ in.	Rib Depth = 12 in.	Total Slab Depth = 4 ½ in.																Total Depth = 16 ½ in.	Rib Depth = 12 in.	Total Slab Depth = 4 ½ in.								
24'-0"	50	1.57	12	0.638		10-#5+ 0	4	#4	#4	7-#6	4	#4	#4	10-#5	77	153	207	1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
D = 9.500	100	1.63	12	0.638		10-#5+ 0	4	#4	#5	7-#6	4	#4	#4	10-#5	97	196	262	1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
RIB NOT ON	150	1.74	12	0.657		10-#5+ 0	4	#5	#5	8-#6	4	#4	#4	10-#5	118	268	318	1.71	12		4	#4	#5	7-#6	4	#4	#4	10-#5
COLUMN LINE	200	1.99	12	0.705		10-#5+ 0	4	#6	#6	9-#6	4	#4	#5	10-#5	139	335	373	1.79	12		4	#4	#5	12-#5	4	#4	#4	10-#5
0.817 CF/SF	300	2.57	12 *	0.834		10-#5+ 2	4	#7	#7	7-#8	4	#5	#6	10-#5	180	464	484	2.26	12	4 S 6 1	4	#5	#6	8-#7	4	#4	#5	10-#5
	400	3.25	12 *	0.639		10-#5+ 2	4	#8	#8	8-#8	4	#6	#7	10-#5	221	591	595	2.87	12 *	4 S 6 1	4	#6	#7	8-#8	4	#5	#5	10-#5
	500	3.74	13 *	0.637		12-#5+ 3	4	#8	#9	8-#9	4	#7	#7	10-#5	261	714	704	3.26	12 *	4 S 6 1	4	#7	#7	7-#9	4	#5	#6	10-#5
27'-0"	50	1.64	13	0.636		8-#6+ 0	4	#4	#5	8-#6	5	#4	#4	12-#5	109	217	292	1.64	13		4	#4	#4	8-#6	5	#4	#4	12-#5
D = 9.500	100	1.82	13	0.673		8-#6+ 0	4	#5	#6	9-#6	5	#4	#4	12-#5	138	276	372	1.74	13		4	#4	#5	12-#5	5	#4	#4	12-#5
RIB NOT ON	150	2.09	13	0.758		8-#6+ 1	4	#6	#6	8-#7	5	#4	#5	12-#5	168	376	451	1.98	13	4 S 6 1	4	#5	#5	8-#7	5	#4	#4	12-#5
COLUMN LINE	200	2.45	13 *	0.826		8-#6+ 2	4	#7	#7	7-#8	5	#5	#5	12-#5	197	472	530	2.21	13	4 S 6 1	4	#5	#6	7-#8	5	#4	#4	12-#5
0.798 CF/SF	300	3.21	13 *	0.637		8-#6+ 2	4	#8	#8	8-#9	5	#6	#6	12-#5	256	656	689	2.91	13 *	4 S 6 1	4	#6	#7	7-#9	5	#5	#5	12-#5
	400	3.92	16 *	0.633		10-#6+ 1	4	#9	#9	12-#8	5	#6	#7	12-#5	312	829	840	3.60	13 *	4 S 6 2	4	#7	#8	9-#9	5	#5	#6	12-#5
	500	4.68	20 *	0.629	4 S 6 1	12-#6+ 0	4	#10	#10	11-#9	5	#7	#7	12-#5	361	951	971	4.22	17 *	4 S 6 2	4	#8	#8	11-#9	5	#6	#6	12-#5
30'-0"	50	1.70	15	0.674		9-#6+ 1	5	#5	#5	10-#6	5	#4	#4	12-#5	151	302	406	1.61	15		5	#4	#4	9-#6	5	#4	#4	12-#5
D = 12.500	100	2.00	15	0.776		9-#6+ 3	5	#5	#6	10-#7	5	#4	#5	12-#5	191	382	515	1.89	15		5	#4	#5	9-#7	5	#4	#4	12-#5
RIB ON	150	2.47	15 *	0.838		9-#6+ 4	5	#6	#7	9-#8	5	#5	#5	12-#5	231	509	623	2.33	15		5	#5	#6	11-#7	5	#4	#5	12-#5
COLUMN LINE	200	2.94	15 *	0.898		9-#6+ 6	5	#7	#7	9-#9	5	#6	#6	12-#5	272	640	732	2.71	15 *	4 S 6 1	5	#6	#6	10-#8	5	#5	#5	12-#5
0.830 CF/SF	300	3.83	17 *	0.632		12-#6+ 2	5	#8	#9	11-#9	5	#7	#7	12-#5	350	886	943	3.36	15 *	4 S 6 1	5	#7	#7	10-#9	5	#5	#6	12-#5
	400	4.56	22 *	0.628	4 S 6 1	10-#7+ 3	5	#9	#10	13-#9	5	#7	#8	14-#5	419	1051	1128	3.97	19 *	4 S 6 2	5	#7	#8	12-#9	5	#6	#6	13-#5
33'-0"	50	1.90	16	0.716		10-#6+ 1	5	#5	#6	10-#7	6	#4	#4	14-#5	199	399	537	1.84	16		5	#4	#5	9-#7	6	#4	#4	14-#5
D = 12.500	100	2.28	16 *	0.827		10-#6+ 4	5	#6	#7	10-#8	6	#4	#5	14-#5	253	506	682	2.12	16	4 S 6 1	5	#5	#5	9-#8	6	#4	#4	14-#5
RIB ON	150	2.87	16 *	0.893		10-#6+ 6	5	#7	#8	9-#9	6	#5	#6	14-#5	307	661	827	2.65	16 *	4 S 6 1	5	#6	#6	9-#9	6	#4	#5	14-#5
COLUMN LINE	200	3.36	17 *	0.632		12-#6+ 3	5	#8	#8	11-#9	6	#6	#6	14-#5	360	833	969	3.12	16 *	4 S 6 1	5	#7	#7	10-#9	6	#5	#5	14-#5
0.812 CF/SF	300	4.45	23 *	0.627	4 S 6 1	11-#7+ 3	5	#9	#10	18-#8	6	#7	#7	15-#5	456	1083	1227	4.02	19 *	4 S 6 2	5	#7	#8	14-#9	6	#6	#6	14-#5
36'-0"	50	2.27	18	0.750		11-#6+ 2	5	#6	#7	10-#8	7	#4	#5	16-#5	257	513	691	2.16	18		5	#5	#6	9-#8	7	#4	#4	16-#5
D = 12.500	100	2.69	18 *	0.852		11-#6+ 5	5	#7	#8	10-#9	7	#5	#5	16-#5	326	652	878	2.46	18	4 S 6 1	5	#6	#6	9-#9	7	#4	#4	16-#5
RIB ON	150	3.19	18 *	0.631		10-#7+ 3	5	#8	#8	16-#8	7	#5	#6	16-#5	396	807	1066	2.96	18 *	4 S 6 1	5	#6	#7	12-#9	7	#4	#5	16-#5
COLUMN LINE	200	3.95	22 *	0.628	4 S 6 1	22-#5+ 5	5	#9	#9	15-#9	7	#6	#7	16-#5	461	1021	1241	3.58	18 *	4 S 6 2	5	#7	#8	14-#9	7	#5	#5	16-#5
0.798 CF/SF																												
39'-0"	50	2.46	19 *	0.833		12-#6+ 6	6	#6	#7	13-#8	7	#5	#5	16-#5	331	662	891	2.30	19		6	#5	#6	12-#8	7	#4	#4	16-#5
D = 15.500	100	3.00	19 *	0.913		14-#6+ 8	6	#7	#8	13-#9	7	#5	#6	16-#5	420	839	1130	2.74	19 *	4 S 6 1	6	#6	#6	12-#9	7	#4	#5	16-#5
RIB NOT ON	150	3.80	23 *	0.627		17-#6+ 5	6	#8	#9	16-#9	7	#6	#7	17-#5	504	1007	1356	3.44	19 *	4 S 6 1	6	#7	#7	15-#9	7	#5	#5	16-#5
COLUMN LINE	200	4.34	28 *	0.623		11-#8+ 3	6	#9	#9	19-#9	7	#6	#7	20-#5	581	1161	1563	4.05	22 *	4 S 6 2	6	#7	#8	18-#9	7	#5	#6	19-#5
0.822 CF/SF																												
42'-0"	50	2.82	21 *	0.856		14-#6+ 7	6	#7	#8	16-#8	8	#5	#5	18-#5	409	819	1102	2.66	21	4 S 6 1	6	#6	#6	12-#9	8	#4	#5	18-#5
D = 15.500	100	3.63	23 *	0.919		13-#7+ 8	6	#8	#9	17-#9	8	#6	#6	18-#5	518	1036	1394	3.33	21 *	4 S 6 1	6	#7	#7	15-#9	8	#5	#5	18-#5
RIB NOT ON	150	4.25	29 *	0.623		12-#8+ 2	6	#9	#9	20-#9	8	#6	#7	21-#5	620	1240	1669	3.98	21 *	4 S 6 2	6	#7	#8	19-#9	8	#5	#6	20-#5
COLUMN LINE																												
0.809 CF/SF																												
45'-0"	50	3.23	22 *	0.903		17-#6+10	6	#8	#8	16-#9	9	#5	#6	20-#5	502	1004	1352	3.07	22 *	4 S 6 1	6	#7	#7	15-#9	9	#4	#5	20-#5
D = 15.500	100	4.06	28 *	0.623		12-#8+ 2	6	#9	#10	21-#9	9	#6	#6	21-#5	631	1262	1698	3.68	22 *	4 S 6 2	6	#7	#8	19-#9	9	#5	#5	20-#5
RIB NOT ON																												
COLUMN LINE																												
0.798 CF/SF																												

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 18 ½ in.	Rib Depth = 14 in.	Total Slab Depth = 4 ½ in.															
24'-0"	50	1.77	12	0.641		10-#5+ 0	4	#4	#5	7-#6	4	#4	#5	10-#5	82	164	221
D = 9.500	100	1.77	12	0.641		10-#5+ 0	4	#4	#5	7-#6	4	#4	#5	10-#5	103	205	276
RIB NOT ON	150	1.83	12	0.641		10-#5+ 0	4	#5	#5	7-#6	4	#4	#5	10-#5	123	276	332
COLUMN LINE	200	1.93	12	0.641		10-#5+ 0	4	#5	#6	8-#6	4	#4	#5	10-#5	144	344	388
0.898 CF/SF	300	2.43	12	0.700		10-#5+ 0	4	#6	#7	8-#7	4	#5	#6	10-#5	185	474	499
	400	2.96	12 *	0.840		10-#5+ 3	4	#7	#8	8-#8	4	#6	#6	10-#5	226	601	610
	500	3.36	12 *	0.642		8-#6+ 2	4	#8	#8	7-#9	4	#6	#7	10-#5	268	727	721
27'-0"	50	1.79	13	0.639		8-#6+ 0	4	#4	#5	8-#6	5	#4	#5	12-#5	116	232	312
D = 9.500	100	1.85	13	0.639		8-#6+ 0	4	#5	#5	12-#5	5	#4	#5	12-#5	146	291	392
RIB NOT ON	150	2.09	13	0.640		8-#6+ 0	4	#6	#6	10-#6	5	#4	#5	12-#5	175	388	471
COLUMN LINE	200	2.37	13	0.727		8-#6+ 1	4	#6	#7	7-#8	5	#5	#5	12-#5	204	485	550
0.876 CF/SF	300	2.88	13 *	0.853		8-#6+ 3	4	#7	#8	7-#9	5	#5	#6	12-#5	263	671	709
	400	3.58	13 *	0.640		9-#6+ 2	4	#8	#9	9-#9	5	#6	#7	12-#5	322	852	868
	500	4.28	15 *	0.637		8-#7+ 2	4	#9	#10	10-#9	5	#7	#7	12-#5	379	1025	1020
30'-0"	50	1.83	15	0.636		9-#6+ 0	5	#5	#5	9-#6	5	#4	#5	12-#5	161	323	434
D = 12.500	100	2.00	15	0.636		9-#6+ 0	5	#5	#6	9-#7	5	#4	#5	12-#5	202	403	543
RIB ON	150	2.27	15	0.713		9-#6+ 1	5	#6	#6	11-#7	5	#5	#5	12-#5	242	527	651
COLUMN LINE	200	2.65	15 *	0.789		9-#6+ 2	5	#7	#7	9-#8	5	#5	#6	12-#5	282	661	760
0.913 CF/SF	300	3.43	15 *	0.637		15-#5+ 4	5	#8	#8	12-#8	5	#6	#7	12-#5	363	914	977
	400	4.31	17 *	0.635	4 S 6 1	10-#7+ 3	5	#9	#9	12-#9	5	#7	#8	13-#5	441	1156	1187
	500	4.96	22 *	0.630	4 S 6 1	11-#7+ 3	5	#9	#10	14-#9	5	#8	#8	15-#5	507	1321	1365
33'-0"	50	1.99	16	0.650		10-#6+ 1	5	#5	#6	9-#7	6	#4	#5	14-#5	213	426	574
D = 12.500	100	2.21	16	0.756		10-#6+ 3	5	#6	#6	9-#8	6	#4	#5	14-#5	267	534	719
RIB ON	150	2.59	16 *	0.833		10-#6+ 5	5	#7	#7	9-#9	6	#5	#5	14-#5	321	687	864
COLUMN LINE	200	3.21	16 *	0.893		11-#6+ 6	5	#8	#8	10-#9	6	#6	#6	14-#5	375	866	1008
0.892 CF/SF	300	4.06	18 *	0.634	4 S 6 1	10-#7+ 3	5	#9	#9	13-#9	6	#7	#7	14-#5	480	1196	1291
	400	5.02	24 *	0.628	4 S 6 1	17-#6+ 3	5	#10	#10	16-#9	6	#7	#8	17-#5	571	1419	1537
36'-0"	50	2.23	18	0.665		11-#6+ 1	5	#6	#7	9-#8	7	#4	#5	16-#5	274	548	738
D = 12.500	100	2.59	18 *	0.788		11-#6+ 4	5	#7	#7	9-#9	7	#5	#5	16-#5	344	688	926
RIB ON	150	3.03	18 *	0.871		12-#6+ 6	5	#8	#8	11-#9	7	#5	#6	16-#5	413	848	1113
COLUMN LINE	200	3.62	18 *	0.634	4 S 6 1	14-#6+ 4	5	#9	#9	13-#9	7	#6	#6	16-#5	483	1080	1301
0.876 CF/SF	300	4.81	24 *	0.628	4 S 6 1	10-#8+ 1	5	#10	#10	17-#9	7	#7	#7	18-#5	612	1463	1647

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 18 ½ in.	Rib Depth = 14 in.	Total Slab Depth = 4 ½ in.								
1.80	12		4	#4	#5	7-#6	4	#4	#5	10-#5
1.80	12		4	#4	#5	7-#6	4	#4	#5	10-#5
1.80	12		4	#4	#5	7-#6	4	#4	#5	10-#5
1.85	12		4	#4	#5	8-#6	4	#4	#5	10-#5
2.19	12	4 S 6 1	4	#5	#6	7-#7	4	#4	#5	10-#5
2.64	12	4 S 6 1	4	#6	#6	7-#8	4	#5	#5	10-#5
2.97	12 *	4 S 6 1	4	#6	#7	8-#8	4	#5	#6	10-#5
1.82	13		4	#4	#5	8-#6	5	#4	#5	12-#5
1.82	13		4	#4	#5	8-#6	5	#4	#5	12-#5
2.02	13		4	#5	#5	7-#7	5	#4	#5	12-#5
2.19	13	4 S 6 1	4	#5	#6	8-#7	5	#4	#5	12-#5
2.64	13	4 S 6 1	4	#6	#7	8-#8	5	#4	#5	12-#5
3.14	13 *	4 S 6 1	4	#7	#7	8-#9	5	#5	#5	12-#5
3.77	13 *	4 S 6 2	4	#8	#8	12-#8	5	#5	#6	12-#5
1.79	15		5	#4	#5	9-#6	5	#4	#5	12-#5
1.90	15		5	#4	#5	11-#6	5	#4	#5	12-#5
2.13	15		5	#5	#5	10-#7	5	#4	#5	12-#5
2.40	15	4 S 6 1	5	#5	#6	9-#8	5	#4	#5	12-#5
3.13	15 *	4 S 6 1	5	#6	#7	9-#9	5	#5	#6	12-#5
3.82	15 *	4 S 6 1	5	#7	#8	11-#9	5	#6	#6	12-#5
4.44	19 *	4 S 6 2	5	#8	#8	13-#9	5	#6	#7	14-#5
1.94	16		5	#4	#5	9-#7	6	#4	#5	14-#5
2.16	16		5	#5	#5	11-#7	6	#4	#5	14-#5
2.39	16	4 S 6 1	5	#5	#6	10-#8	6	#4	#5	14-#5
2.91	16 *	4 S 6 1	5	#6	#7	9-#9	6	#5	#5	14-#5
3.61	16 *	4 S 6 2	5	#7	#8	12-#9	6	#5	#6	14-#5
4.54	20 *	4 S 6 2	5	#8	#9	15-#9	6	#6	#6	16-#5
2.11	18		5	#5	#5	11-#7	7	#4	#5	16-#5
2.46	18	4 S 6 1	5	#5	#6	9-#9	7	#4	#5	16-#5
2.75	18 *	4 S 6 1	5	#6	#7	10-#9	7	#4	#5	16-#5
3.22	18 *	4 S 6 2	5	#7	#7	12-#9	7	#5	#5	16-#5
4.44	19 *	4 S 6 2	5	#8	#9	16-#9	7	#6	#6	17-#5

(Continued on next page)

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f_c' = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 18 ½ in.	Rib Depth = 14 in.	Total Slab Depth = 4 ½ in.																Total Depth = 18 ½ in.	Rib Depth = 14 in.	Total Slab Depth = 4 ½ in.								
39'-0"	50	2.45	19	0.777		12-#6+ 5	6	#6	#7	12-#8	7	#5	#5	16-#5	354	708	953	2.33	19		6	#5	#6	11-#8	7	#4	#5	16-#5
D = 15.500	100	2.92	19 *	0.861		13-#6+ 7	6	#7	#8	12-#9	7	#5	#6	16-#5	443	885	1191	2.67	19 *	4 S 6 1	6	#6	#6	11-#9	7	#4	#5	16-#5
RIB NOT ON	150	3.47	19 *	0.633		12-#7+ 4	6	#8	#8	15-#9	7	#6	#6	16-#5	531	1070	1430	3.20	19 *	4 S 6 1	6	#6	#7	14-#9	7	#5	#5	16-#5
COLUMN LINE	200	4.22	23 *	0.629		18-#6+ 5	6	#9	#9	17-#9	7	#7	#7	18-#5	614	1355	1654	3.80	19 *	4 S 6 2	6	#7	#8	16-#9	7	#5	#6	17-#5
0.904 CF/SF	300	5.09	30 *	0.624		13-#8+ 4	6	#9	#10	22-#9	7	#7	#8	16-#6	767	1563	2064	4.67	25 *	4 S 6 2	6	#8	#8	20-#9	7	#6	#6	16-#6
42'-0"	50	2.68	21 *	0.790		18-#5+ 8	6	#7	#7	12-#9	8	#5	#5	18-#5	438	875	1178	2.59	21	4 S 6 1	6	#6	#6	11-#9	8	#4	#5	18-#5
D = 15.500	100	3.20	21 *	0.904		12-#7+ 8	6	#8	#8	15-#9	8	#5	#6	18-#5	548	1097	1476	2.96	21 *	4 S 6 1	6	#6	#7	14-#9	8	#4	#5	18-#5
RIB NOT ON	150	3.99	24 *	0.628		14-#7+ 4	6	#9	#9	18-#9	8	#6	#7	19-#5	655	1309	1762	3.64	21 *	4 S 6 2	6	#7	#8	17-#9	8	#5	#5	18-#5
COLUMN LINE	200	4.56	28 *	0.626		13-#8+ 4	6	#9	#10	22-#9	8	#6	#7	23-#5	756	1527	2036	4.21	22 *	4 S 6 2	6	#8	#8	20-#9	8	#5	#6	21-#5
0.888 CF/SF																												
45'-0"	50	3.10	22 *	0.848		12-#7+ 5	6	#8	#8	15-#9	9	#5	#6	20-#5	537	1073	1445	2.86	22	4 S 6 1	6	#6	#7	14-#9	9	#4	#5	20-#5
D = 15.500	100	3.85	23 *	0.629		11-#8+ 3	6	#9	#9	19-#9	9	#6	#6	20-#5	671	1343	1808	3.58	22 *	4 S 6 2	6	#7	#8	18-#9	9	#5	#5	20-#5
RIB NOT ON	150	4.49	29 *	0.625		11-#9+ 2	6	#9	#10	23-#9	9	#6	#7	24-#5	798	1596	2148	4.14	22 *	4 S 6 2	6	#8	#8	21-#9	9	#5	#6	22-#5
COLUMN LINE																												
0.876 CF/SF																												
48'-0"	50	3.42	24 *	0.885		14-#7+ 8	7	#8	#8	18-#9	9	#6	#6	20-#5	656	1313	1767	3.19	24 *	4 S 6 1	7	#6	#7	17-#9	9	#5	#5	20-#5
D = 18.500	100	4.27	28 *	0.921		14-#8+ 8	7	#9	#9	23-#9	9	#6	#7	24-#5	815	1630	2195	4.00	24 *	4 S 6 2	7	#7	#8	22-#9	9	#5	#6	23-#5
RIB ON	150	5.10	38 *	0.621	4 S 6 1	16-#8+ 5	7	#10	#10	27-#9	9	#7	#7	20-#6	952	1903	2562	4.72	29 *	4 S 6 2	7	#8	#8	26-#9	9	#6	#6	27-#5
COLUMN LINE																												
0.898 CF/SF																												
51'-0"	50	3.85	26 *	0.912		13-#8+ 8	7	#9	#9	22-#9	10	#6	#6	23-#5	783	1566	2108	3.55	25 *	4 S 6 1	7	#7	#8	20-#9	10	#5	#5	22-#5
D = 18.500	100	4.83	35 *	0.622	4 S 6 1	16-#8+ 5	7	#10	#10	28-#9	10	#7	#7	29-#5	965	1931	2599	4.34	25 *	4 S 6 2	7	#8	#8	26-#9	10	#5	#6	27-#5
RIB ON																												
COLUMN LINE																												
0.886 CF/SF																												

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f_c'}$ but less than $6\sqrt{f_c'}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 20 ½ in.	Rib Depth = 16 in.	Total Slab Depth = 4 ½ in.															
27'-0"	50	1.79	13	0.641		8-#6+ 0	4	#4	#5	8-#6	5	#4	#5	12-#5	124	247	333
D = 9.500	100	1.84	13	0.641		8-#6+ 0	4	#5	#5	8-#6	5	#4	#5	12-#5	153	306	412
RIB NOT ON	150	1.97	13	0.641		8-#6+ 0	4	#5	#6	7-#7	5	#4	#5	12-#5	183	398	492
COLUMN LINE	200	2.18	13	0.641		8-#6+ 0	4	#6	#7	8-#7	5	#4	#5	12-#5	212	497	571
0.956 CF/SF	300	2.73	13	0.701		8-#6+ 0	4	#7	#8	8-#8	5	#5	#6	12-#5	271	684	730
	400	3.38	13 *	0.851		12-#5+ 3	4	#8	#9	8-#9	5	#6	#6	12-#5	330	867	889
	500	3.92	13 *	0.642		7-#7+ 1	4	#9	#9	9-#9	5	#6	#7	12-#5	389	1047	1047
30'-0"	50	1.77	15	0.638		9-#6+ 0	5	#4	#5	9-#6	5	#4	#5	12-#5	172	344	464
D = 12 .500	100	1.88	15	0.638		9-#6+ 0	5	#5	#5	11-#6	5	#4	#5	12-#5	213	425	572
RIB ON	150	2.22	15	0.638		9-#6+ 0	5	#6	#6	10-#7	5	#5	#5	12-#5	253	543	681
COLUMN LINE	200	2.54	15	0.687		9-#6+ 1	5	#6	#7	9-#8	5	#5	#6	12-#5	293	679	789
0.998 CF/SF	300	3.19	15 *	0.839		10-#6+ 3	5	#7	#8	9-#9	5	#6	#7	12-#5	374	935	1006
	400	3.91	15 *	0.639		12-#6+ 2	5	#8	#9	11-#9	5	#7	#7	12-#5	454	1185	1223
	500	4.80	17 *	0.637	4 S 6 1	10-#7+ 1	5	#9	#10	13-#9	5	#8	#8	14-#5	532	1423	1432
33'-0"	50	1.96	16	0.637		10-# 6+ 0	5	#5	#6	9-#7	6	#4	#5	14-#5	227	455	612
D = 12.500	100	2.15	16	0.637		10-#6+ 0	5	#6	#6	11-#7	6	#4	#5	14-#5	281	562	757
RIB ON	150	2.45	16	0.699		10-#6+ 1	5	#6	#7	10-#8	6	#5	#5	14-#5	335	710	902
COLUMN LINE	200	2.87	16 *	0.795		10-#6+ 3	5	#7	#8	9-#9	6	#5	#6	14-#5	389	892	1047
0.974 CF/SF	300	3.89	16 *	0.638		10-#7+ 1	5	#9	#9	12-#9	6	#6	#7	14-#5	496	1232	1336
	400	4.80	19 *	0.635	4 S 6 1	9-#8+ 1	5	#10	#10	15-#9	6	#7	#8	16-#5	599	1552	1613
36'-0"	50	2.16	18	0.635		11-#6+ 1	5	#6	#6	9-#8	7	#4	#5	16-#5	292	585	787
D = 12.500	100	2.45	18	0.692		11-#6+ 2	5	#7	#7	9-#9	7	#4	#5	16-#5	362	724	974
RIB ON	150	2.75	18 *	0.800		11-#6+ 5	5	#7	#8	10-#9	7	#5	#5	16-#5	432	883	1162
COLUMN LINE	200	3.45	18 *	0.865		10-#7+ 3	5	#8	#9	12-#9	7	#6	#6	16-#5	501	1120	1349
0.956 CF/SF	300	4.53	19 *	0.635	4 S 6 1	9-#8+ 2	5	#10	#10	16-#9	7	#7	#7	17-#5	639	1553	1720
39'-0"	50	2.39	19	0.647		12-#6+ 1	6	#6	#7	11-#8	7	#5	#5	16-#5	378	755	1016
D = 15.500	100	2.77	19 *	0.773		12-#6+ 4	6	#7	#7	11-#9	7	#5	#6	16-#5	466	932	1255
RIB NOT ON	150	3.27	19 *	0.878		11-#7+ 5	6	#7	#8	14-#9	7	#6	#6	16-#5	555	1118	1494
COLUMN LINE	200	3.86	19 *	0.635		17-#6+ 5	6	#8	#9	16-#9	7	#6	#7	17-#5	644	1423	1733
0.987 CF/SF	300	5.18	26 *	0.629		12-#8+ 2	6	#10	#10	20-#9	7	#7	#8	21-#5	806	1916	2170
	400	5.58	32 *	0.625	4 S 6 1	11-#9+ 3	6	#10	#10	24-#9	7	#7	#8	18-#6	949	1965	2555

(Continued on next page)

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 20 ½ in.	Rib Depth = 16 in.	Total Slab Depth = 4 ½ in.								
1.82	13		4	#4	#5	8-#6	5	#4	#5	12-#5
1.82	13		4	#4	#5	8-#6	5	#4	#5	12-#5
1.89	13		4	#4	#5	9-#6	5	#4	#5	12-#5
2.03	13		4	#5	#5	10-#6	5	#4	#5	12-#5
2.41	13	4 S 6 1	4	#6	#6	7-#8	5	#4	#5	12-#5
3.03	13 *	4 S 6 1	4	#7	#7	7-#9	5	#5	#5	12-#5
3.60	13 *	4 S 6 2	4	#7	#8	9-#9	5	#5	#6	12-#5
1.79	15		5	#4	#5	9-#6	5	#4	#5	12-#5
1.83	15		5	#4	#5	10-#6	5	#4	#5	12-#5
2.07	15		5	#5	#5	9-#7	5	#4	#5	12-#5
2.33	15		5	#5	#6	11-#7	5	#4	#5	12-#5
2.85	15 *	4 S 6 1	5	#6	#7	10-#8	5	#5	#5	12-#5
3.51	15 *	4 S 6 1	5	#7	#7	10-#9	5	#6	#6	12-#5
4.23	15 *	4 S 6 2	5	#8	#8	12-#9	5	#6	#7	13-#5
1.87	16		5	#4	#5	11-#6	6	#4	#5	14-#5
2.08	16		5	#5	#5	10-#7	6	#4	#5	14-#5
2.32	16		5	#5	#6	9-#8	6	#4	#5	14-#5
2.65	16	4 S 6 1	5	#6	#6	9-#9	6	#4	#5	14-#5
3.52	16 *	4 S 6 1	5	#7	#8	11-#9	6	#5	#6	14-#5
4.17	16 *	4 S 6 2	5	#8	#8	14-#9	6	#6	#6	15-#5
2.11	18		5	#5	#5	11-#7	7	#4	#5	16-#5
2.32	18	4 S 6 1	5	#5	#6	10-#8	7	#4	#5	16-#5
2.58	18	4 S 6 1	5	#6	#6	12-#8	7	#4	#5	16-#5
3.14	18 *	4 S 6 1	5	#7	#7	11-#9	7	#5	#5	16-#5
3.96	18 *	4 S 6 2	5	#8	#8	15-#9	7	#5	#6	16-#5
2.23	19		6	#5	#5	11-#8	7	#4	#5	16-#5
2.59	19		6	#6	#6	13-#8	7	#4	#5	16-#5
3.06	19 *	4 S 6 1	6	#6	#7	16-#8	7	#5	#5	16-#5
3.55	19 *	4 S 6 1	6	#7	#7	15-#9	7	#5	#6	16-#5
4.80	20 *	4 S 6 2	6	#8	#9	19-#9	7	#6	#7	20-#5
5.22	28 *	4 S 6 2	6	#8	#9	28-#8	7	#6	#7	17-#6

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 20 ½ in.	Rib Depth = 16 in.	Total Slab Depth = 4 ½ in.															
42'-0"	50	2.63	21	0.738		13-#6+ 5	6	#7	#7	11-#9	8	#5	#5	18-#5	467	934	1257
D = 15.500	100	3.13	21 *	0.837		11-#7+ 5	6	#8	#8	14-#9	8	#5	#6	18-#5	577	1155	1555
RIB NOT ON	150	3.66	21 *	0.633		13-#7+ 4	6	#8	#9	17-#9	8	#6	#6	18-#5	688	1376	1852
COLUMN LINE	200	4.31	24 *	0.630		12-#8+ 2	6	#9	#10	20-#9	8	#6	#7	21-#5	793	1679	2136
0.970 CF/SF	300	5.43	31 *	0.626	4 S 6 1	12-#9+ 2	6	#10	#10	25-#9	8	#7	#8	19-#6	987	1996	2659
45'-0"	50	2.93	22 *	0.798		11-#7+ 5	6	#8	#8	14-#9	9	#5	#5	20-#5	572	1144	1540
D = 15.500	100	3.50	22 *	0.899		14-#7+ 8	6	#8	#9	18-#9	9	#6	#6	20-#5	708	1417	1907
RIB NOT ON	150	4.20	24 *	0.630		32-#5+ 7	6	#9	#10	21-#9	9	#6	#7	22-#5	841	1682	2265
COLUMN LINE	200	4.96	29 *	0.627		12-#9+ 2	6	#10	#10	25-#9	9	#7	#7	26-#5	967	1985	2604
0.956 CF/SF																	
48'-0"	50	3.20	24 *	0.847		14-#7+ 7	7	#8	#8	17-#9	9	#5	#6	20-#5	700	1400	1885
D = 18.500	100	4.08	24 *	0.630		13-#8+ 4	7	#9	#9	22-#9	9	#6	#7	23-#5	865	1730	2329
RIB ON	150	4.74	30 *	0.626		15-#8+ 3	7	#9	#10	26-#9	9	#7	#7	27-#5	1019	2037	2743
COLUMN LINE	200	5.49	35 *	0.624	4 S 6 1	14-#9+ 3	7	#10	#10	30-#9	9	#7	#8	22-#6	1162	2324	3128
0.981 CF/SF																	
51'-0"	50	3.64	25 *	0.890		16-#7+10	7	#8	#9	21-#9	10	#6	#6	22-#5	836	1673	2252
D = 18.500	100	4.47	29 *	0.919		20-#7+12	7	#9	#10	26-#9	10	#6	#7	27-#5	1027	2055	2766
RIB ON																	
COLUMN LINE																	
0.968 CF/SF																	
54'-0"	50	4.05	27 *	0.916		15-#8+10	7	#9	#10	25-#9	11	#6	#6	26-#5	987	1973	2656
D = 18.500																	
RIB ON																	
0.956 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	Square Interior Column (2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 20 ½ in.	Rib Depth = 16 in.	Total Slab Depth = 4 ½ in.								
2.52	21		6	#6	#6	13-#8	8	#4	#5	18-#5
2.89	21	4 S 6 1	6	#6	#7	13-#9	8	#4	#5	18-#5
3.39	21 *	4 S 6 1	6	#7	#7	16-#9	8	#5	#5	18-#5
3.87	21 *	4 S 6 2	6	#7	#8	23-#8	8	#5	#6	19-#5
5.04	26 *	4 S 6 2	6	#8	#9	24-#9	8	#6	#6	18-#6
2.74	22	4 S 6 1	6	#6	#7	16-#8	9	#4	#5	20-#5
3.14	22 *	4 S 6 1	6	#7	#7	16-#9	9	#4	#5	20-#5
3.75	22 *	4 S 6 2	6	#7	#8	20-#9	9	#5	#5	20-#5
4.51	22*	4 S 6 2	6	#8	#9	23-#9	9	#5	#6	24-#5
2.95	24	4 S 6 1	7	#6	#7	16-#9	9	#4	#5	20-#5
3.68	24 *	4 S 6 1	7	#7	#8	20-#9	9	#5	#5	21-#5
4.33	24 *	4 S 6 2	7	#8	#8	24-#9	9	#5	#6	25-#5
5.10	28 *	4 S 6 2	7	#8	#9	28-#9	9	#6	#6	21-#6
3.37	25 *	4 S 6 1	7	#7	#7	19-#9	10	#5	#5	22-#5
4.16	25 *	4 S 6 2	7	#8	#8	24-#9	10	#5	#6	25-#5
3.68	27 *	4 S 6 2	7	#7	#8	23-#9	11	#5	#5	24-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 24 ½ in.	Rib Depth = 20 in.	Total Slab Depth = 4 ½ in.																Total Depth = 24 ½ in.	Rib Depth = 20 in.	Total Slab Depth = 4 ½ in.								
33'-0"	50	2.03	16	0.641		10-#6+ 0	5	#5	#5	11-#6	6	#5	#5	14-#5	257	514	692	2.03	16		5	#5	#5	10-#6	6	#5	#5	14-#5
D = 12.500	100	2.18	16	0.641		10-#6+ 0	5	#5	#6	10-#7	6	#5	#5	14-#5	311	622	837	2.16	16		5	#5	#5	9-#7	6	#5	#5	14-#5
RIB ON	150	2.42	16	0.641		10-#6+ 0	5	#6	#7	9-#8	6	#5	#5	14-#5	365	751	982	2.30	16		5	#5	#5	11-#7	6	#5	#5	14-#5
COLUMN LINE	200	2.62	16	0.641		10-#6+ 1	5	#7	#7	10-#8	6	#5	#5	14-#5	419	937	1127	2.53	16		5	#5	#6	10-#8	6	#5	#5	14-#5
1.145 CF/SF	300	3.22	16	0.754		11-#6+ 2	5	#8	#8	10-#9	6	#6	#6	14-#5	526	1286	1416	2.93	16	5 S 8 1	5	#6	#7	12-#8	6	#5	#5	14-#5
	400	4.05	16 *	0.642		10-#7+ 1	5	#9	#9	16-#8	6	#7	#7	14-#5	634	1622	1706	3.61	16 *	5 S 8 1	5	#7	#8	12-#9	6	#5	#6	14-#5
	500	4.90	16 *	0.642	5 S 8 1	9-#8+ 1	5	#10	#10	15-#9	6	#7	#8	16-#5	741	1954	1995	4.35	16 *	5 S 8 2	5	#8	#9	14-#9	6	#6	#6	15-#5
36'-0"	50	2.26	18	0.639		11-#6+ 0	5	#6	#6	11-#7	7	#5	#5	16-#5	330	661	889	2.18	18		5	#5	#5	10-#7	7	#5	#5	16-#5
D = 12.500	100	2.46	18	0.639		11-#6+ 0	5	#6	#7	10-#8	7	#5	#5	16-#5	400	800	1077	2.41	18		5	#5	#6	9-#8	7	#5	#5	16-#5
RIB ON	150	2.67	18	0.639		11-#6+ 0	5	#7	#7	9-#9	7	#5	#5	16-#5	470	941	1264	2.61	18	5 S 8 1	5	#5	#6	9-#9	7	#5	#5	16-#5
COLUMN LINE	200	3.08	18	0.646		12-#6+ 0	5	#8	#8	11-#9	7	#5	#6	16-#5	539	1184	1452	2.84	18	5 S 8 1	5	#6	#7	12-#8	7	#5	#5	16-#5
1.123 CF/SF	300	3.85	18 *	0.856		11-#7+ 3	5	#9	#9	14-#9	7	#6	#7	16-#5	678	1634	1827	3.43	18 *	5 S 8 2	5	#7	#8	16-#8	7	#5	#5	16-#5
	400	4.76	18 *	0.640	5 S 8 1	10-#8+ 1	5	#10	#10	17-#9	7	#7	#7	17-#5	818	2068	2202	4.32	18 *	5 S 8 2	5	#8	#9	15-#9	7	#6	#6	16-#5
39'-0"	50	2.34	19	0.637		12-#6+ 1	6	#6	#6	11-#8	7	#5	#5	16-#5	427	854	1150	2.28	19		6	#5	#5	13-#7	7	#5	#5	16-#5
D = 15.500	100	2.57	19	0.637		12-#6+ 2	6	#6	#7	13-#8	7	#5	#5	16-#5	516	1032	1389	2.53	19		6	#5	#6	12-#8	7	#5	#5	16-#5
RIB NOT ON	150	2.99	19	0.717		13-#6+ 3	6	#7	#8	12-#9	7	#5	#6	16-#5	605	1209	1628	2.81	19		6	#6	#6	11-#9	7	#5	#5	16-#5
COLUMN LINE	200	3.36	19 *	0.833		11-#7+ 5	6	#8	#8	14-#9	7	#6	#6	16-#5	693	1510	1866	3.06	19	5 S 8 1	6	#6	#7	16-#8	7	#5	#5	16-#5
1.161 CF/SF	300	4.54	19 *	0.638		14-#7+ 4	6	#9	#10	18-#9	7	#7	#7	19-#5	871	2085	2344	4.11	19 *	5 S 8 1	6	#8	#8	16-#9	7	#6	#6	17-#5
42'-0"	50	2.59	21	0.636		13-#6+ 1	6	#7	#7	13-#8	8	#5	#5	18-#5	528	1056	1421	2.48	21		6	#5	#6	12-#8	8	#5	#5	18-#5
D = 15.500	100	2.96	21	0.662		14-#6+ 2	6	#7	#8	16-#8	8	#5	#6	18-#5	638	1277	1719	2.81	21		6	#6	#6	12-#9	8	#5	#5	18-#5
RIB NOT ON	150	3.28	21 *	0.813		12-#7+ 5	6	#8	#8	15-#9	8	#5	#6	18-#5	749	1498	2016	3.10	21	5 S 8 1	6	#6	#7	14-#9	8	#5	#5	18-#5
COLUMN LINE	200	3.92	21 *	0.874		14-#7+ 5	6	#9	#9	17-#9	8	#6	#7	18-#5	859	1813	2314	3.53	21 *	5 S 8 1	6	#7	#8	16-#9	8	#5	#5	18-#5
1.140 CF/SF																												
45'-0"	50	2.81	22	0.635		14-#6+ 2	6	#7	#8	16-#8	9	#5	#5	20-#5	646	1293	1741	2.74	22		6	#6	#6	12-#9	9	#5	#5	20-#5
D = 15.500	100	3.26	22 *	0.776		17-#6+ 5	6	#8	#8	16-#9	9	#5	#6	20-#5	783	1565	2107	3.13	22	5 S 8 1	6	#7	#7	18-#8	9	#5	#5	20-#5
RIB NOT ON	150	3.81	22 *	0.880		11-#8+ 6	6	#9	#9	19-#9	9	#6	#6	20-#5	919	1838	2474	3.52	22 *	5 S 8 1	6	#7	#8	17-#9	9	#5	#5	20-#5
COLUMN LINE	200	4.38	22 *	0.636		13-#8+ 2	6	#9	#10	22-#9	9	#6	#7	23-#5	1055	2177	2841	4.02	22 *	5 S 8 2	6	#8	#8	20-#9	9	#5	#6	21-#5
1.123 CF/SF																												
48'-0"	50	3.12	24	0.739		17-#6+ 7	7	#7	#8	16-#9	9	#5	#6	20-#5	792	1584	2132	3.03	24		7	#6	#7	15-#9	9	#5	#5	20-#5
D = 18.500	100	3.64	24 *	0.841		15-#7+ 7	7	#8	#9	19-#9	9	#6	#6	20-#5	957	1914	2576	3.37	24	5 S 8 1	7	#7	#7	18-#9	9	#5	#5	20-#5
RIB ON	150	4.24	24 *	0.634		14-#8+ 4	7	#9	#9	23-#9	9	#6	#7	24-#5	1122	2244	3021	3.92	24 *	5 S 8 1	7	#7	#8	21-#9	9	#5	#6	22-#5
COLUMN LINE	200	4.91	26 *	0.632		16-#8+ 3	7	#9	#10	26-#9	9	#7	#7	20-#6	1282	2564	3452	4.62	24 *	5 S 8 2	7	#8	#8	25-#9	9	#6	#6	26-#5
1.153 CF/SF																												
51'-0"	50	3.45	25 *	0.797		15-#7+ 6	7	#8	#9	19-#9	10	#5	#6	22-#5	946	1891	2546	3.28	25	5 S 8 1	7	#7	#7	18-#9	10	#5	#5	22-#5
D = 18.500	100	4.07	25 *	0.896		14-#8+ 8	7	#9	#9	23-#9	10	#6	#7	25-#5	1144	2288	3080	3.72	25 *	5 S 8 1	7	#7	#8	22-#9	10	#5	#5	23-#5
RIB ON	150	4.85	26 *	0.632		13-#9+ 4	7	#10	#10	28-#9	10	#7	#7	29-#5	1340	2680	3607	4.34	25 *	5 S 8 2	7	#8	#8	26-#9	10	#5	#6	27-#5
COLUMN LINE																												
1.137 CF/SF																												
54'-0"	50	3.82	27 *	0.847		14-#8+ 7	7	#9	#9	23-#9	11	#6	#6	24-#5	1115	2230	3002	3.54	27	5 S 8 1	7	#7	#8	21-#9	11	#5	#5	24-#5
D = 18.500	100	4.58	27 *	0.632		13-#9+ 4	7	#10	#10	28-#9	11	#6	#7	29-#5	1350	2700	3634	4.18	27 *	5 S 8 2	7	#8	#8	26-#9	11	#5	#6	27-#5
RIB ON																												
COLUMN LINE																												
1.123 CF/SF																												
57'-0"	50	4.30	28 *	0.890		16-#8+10	8	#9	#10	27-#9	11	#6	#7	29-#5	1326	2651	3569	3.90	28 *	5 S 8 1	8	#7	#8	25-#9	11	#5	#6	26-#5
D =21.500	100	5.19	31 *	0.629		16-#9+ 5	8	#10	#10	33-#9	11	#7	#7	25-#6	1595	3189	4293	4.86	28 *	5 S 8 2	8	#8	#9	31-#9	11	#6	#6	32-#5
RIB NOT ON																												
COLUMN LINE																												
1.148 CF/SF																												

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f_c' = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Superimposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 13 in.	Rib Depth = 8 in.	Total Slab Depth = 5 in.																Total Depth = 13 in.	Rib Depth = 8 in.	Total Slab Depth = 5 in.								
18'-0"	50	1.60	12	0.633		5-#6+ 0	3	#4	#4	5-#6	3	#4	#4	8-#5	28	57	76	1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
D = 6.500	100	1.60	12	0.633		5-#6+ 0	3	#4	#4	5-#6	3	#4	#4	8-#5	37	75	99	1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
RIB ON	150	1.66	12	0.633		5-#6+ 0	3	#4	#5	5-#6	3	#4	#4	8-#5	45	104	122	1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
COLUMN LINE	200	1.72	12	0.633		5-#6+ 0	3	#5	#5	5-#6	3	#4	#4	8-#5	54	130	145	1.64	12		3	#4	#4	5-#6	3	#4	#4	8-#5
0.690 CF/SF	300	1.93	12	0.698		5-#6+ 0	3	#5	#6	6-#6	3	#4	#5	8-#5	71	183	190	1.78	12	3 S 4 1	3	#4	#5	8-#5	3	#4	#4	8-#5
	400	2.44	12 *	0.819		5-#6+ 1	3	#6	#7	6-#7	3	#5	#5	8-#5	88	234	236	2.25	12	3 S 4 1	3	#5	#6	5-#7	3	#4	#5	8-#5
	500	2.80	12 *	0.634	3 S 4 1	5-#6+ 1	3	#7	#7	5-#8	3	#6	#6	8-#5	104	285	281	2.47	12 *	3 S 4 1	3	#6	#6	6-#7	3	#4	#5	8-#5
21'-0"	50	1.56	12	0.635		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	47	93	126	1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
D = 9.500	100	1.56	12	0.681		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	60	124	162	1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
RIB NOT ON	150	1.67	12	0.726		9-#5+ 0	4	#4	#5	9-#5	3	#4	#5	8-#5	74	170	199	1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
COLUMN LINE	200	1.98	12	0.772		9-#5+ 0	4	#5	#6	8-#6	3	#5	#5	8-#5	88	214	236	1.76	12		4	#4	#5	7-#6	3	#4	#4	8-#5
0.722 CF/SF	300	2.53	12 *	0.888		9-#5+ 2	4	#6	#7	7-#7	3	#6	#6	8-#5	115	298	309	2.21	12 *	3 S 4 1	4	#5	#5	9-#6	3	#5	#5	8-#5
	400	3.07	13 *	0.632		9-#5+ 1	4	#7	#7	7-#8	3	#6	#7	8-#5	142	380	381	2.85	12 *	3 S 4 1	4	#6	#6	7-#8	3	#5	#6	8-#5
	500	3.67	16 *	0.628		10-#5+ 3	4	#8	#8	8-#8	3	#7	#8	8-#5	165	445	445	3.26	14 *	3 S 4 1	4	#6	#7	8-#8	3	#6	#6	8-#5
24'-0"	50	1.63	12	0.713		10-#5+ 0	4	#4	#5	7-#6	4	#4	#4	10-#5	70	139	188	1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
D = 9.500	100	1.70	12	0.787		10-#5+ 1	4	#5	#5	8-#6	4	#4	#4	10-#5	90	184	243	1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
RIB NOT ON	150	2.03	12 *	0.861		10-#5+ 3	4	#6	#6	7-#7	4	#4	#5	10-#5	111	255	299	1.85	12	3 S 4 1	4	#4	#5	9-#6	4	#4	#4	10-#5
COLUMN LINE	200	2.50	12 *	0.909		10-#5+ 4	4	#6	#7	7-#8	4	#5	#6	10-#5	132	320	354	2.26	12 *	3 S 4 1	4	#5	#6	8-#7	4	#4	#5	10-#5
0.703 CF/SF	300	3.19	15 *	0.630		7-#6+ 2	4	#7	#8	7-#9	4	#6	#7	10-#5	171	443	460	2.87	12 *	3 S 4 1	4	#6	#7	8-#8	4	#5	#5	10-#5
	400	3.88	19 *	0.625		9-#6+ 1	4	#8	#9	9-#9	4	#7	#7	10-#5	206	525	553	3.40	16 *	3 S 4 2	4	#7	#7	8-#9	4	#5	#6	10-#5
27'-0"	50	1.70	13	0.758		8-#6+ 0	4	#5	#5	12-#5	5	#4	#4	12-#5	99	198	266	1.64	13		4	#4	#4	8-#6	5	#4	#4	12-#5
D = 9.500	100	2.09	13 *	0.855		8-#6+ 2	4	#6	#6	8-#7	5	#4	#5	12-#5	128	257	346	1.98	13	3 S 4 1	4	#5	#5	8-#7	5	#4	#4	12-#5
RIB NOT ON	150	2.47	13 *	0.914		8-#6+ 3	4	#7	#7	8-#8	5	#5	#5	12-#5	158	356	425	2.21	13 *	3 S 4 1	4	#5	#6	7-#8	5	#4	#4	12-#5
COLUMN LINE	200	2.96	15 *	0.630		8-#6+ 2	4	#7	#8	8-#9	5	#5	#6	12-#5	186	445	501	2.77	13 *	3 S 4 1	4	#6	#7	7-#9	5	#4	#5	12-#5
0.690 CF/SF	300	3.72	20 *	0.625		15-#5+ 3	4	#8	#9	10-#9	5	#6	#7	12-#5	237	564	639	3.33	17 *	3 S 4 2	4	#7	#7	9-#9	5	#5	#5	12-#5
30'-0"	50	1.95	15 *	0.831		9-#6+ 3	5	#5	#6	9-#7	5	#4	#5	12-#5	137	274	368	1.81	15		5	#4	#5	11-#6	5	#4	#4	12-#5
D = 12.500	100	2.29	15 *	0.902		9-#6+ 5	5	#6	#6	9-#8	5	#5	#5	12-#5	177	354	477	2.13	15 *	3 S 4 1	5	#5	#5	11-#7	5	#4	#4	12-#5
RIB ON	150	2.88	17 *	0.627		9-#6+ 4	5	#7	#7	9-#9	5	#6	#6	12-#5	216	469	582	2.59	15 *	3 S 4 1	5	#6	#6	10-#8	5	#4	#5	12-#5
COLUMN LINE	200	3.43	20 *	0.625		11-#6+ 3	5	#8	#8	13-#8	5	#6	#7	12-#5	253	572	682	3.05	16 *	3 S 4 1	5	#6	#7	12-#8	5	#5	#5	12-#5
0.711 CF/SF																												
33'-0"	50	2.16	16 *	0.868		10-#6+ 4	5	#6	#6	9-#8	6	#4	#5	14-#5	181	363	488	2.06	16	3 S 4 1	5	#5	#5	11-#7	6	#4	#4	14-#5
D = 12.500	100	2.73	17 *	0.926		10-#6+ 7	5	#7	#7	12-#8	6	#5	#5	14-#5	234	469	631	2.65	16 *	3 S 4 1	5	#6	#6	9-#9	6	#4	#5	14-#5
RIB ON	150	3.39	23 *	0.622	3 S 4 1	9-#7+ 4	5	#8	#8	12-#9	6	#6	#6	14-#5	283	593	763	3.14	16 *	3 S 4 1	5	#6	#7	11-#9	6	#5	#5	14-#5
COLUMN LINE																												
0.699 CF/SF																												
36'-0"	50	2.60	18 *	0.885		11-#6+ 5	5	#7	#7	12-#8	7	#5	#5	16-#5	234	467	629	2.46	18 *	3 S 4 1	5	#6	#6	9-#9	7	#4	#4	16-#5
D = 12.500	100	3.19	23 *	0.622	3 S 4 1	10-#7+ 3	5	#8	#8	16-#8	7	#5	#6	16-#5	300	599	806	2.96	18 *	3 S 4 2	5	#6	#7	12-#9	7	#4	#5	16-#5
RIB ON																												
COLUMN LINE																												
0.690 CF/SF																												

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f_c'}$ but less than $6\sqrt{f_c'}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments –M Edge (ft-k)	Moments +M Bot. (ft-k)	Moments –M Int. (ft-k)
Total Depth = 15 in.	Rib Depth = 10 in.		Total Slab Depth = 5 in.														
21'-0"	50	1.56	12	0.636		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	50	100	135
D = 9.500	100	1.56	12	0.636		9-#5+ 0	4	#4	#4	9-#5	3	#4	#4	8-#5	64	129	171
RIB NOT ON	150	1.63	12	0.636		9-#5+ 0	4	#4	#5	9-#5	3	#4	#4	8-#5	77	176	208
COLUMN LINE	200	1.75	12	0.671		9-#5+ 0	4	#5	#5	7-#6	3	#4	#5	8-#5	91	220	245
0.803 CF/SF	300	2.26	12	0.757		9-#5+ 0	4	#6	#6	9-#6	3	#5	#6	8-#5	118	306	318
	400	2.71	12 *	0.881		9-#5+ 3	4	#6	#7	8-#7	3	#6	#7	8-#5	146	390	392
	500	3.25	12 *	0.637		9-#5+ 2	4	#7	#8	7-#8	3	#7	#7	8-#5	173	472	465
24'-0"	50	1.57	12	0.636		10-#5+ 0	4	#4	#4	7-#6	4	#4	#4	10-#5	75	149	201
D = 9.500	100	1.63	12	0.680		10-#5+ 0	4	#4	#5	7-#6	4	#4	#4	10-#5	95	192	257
RIB NOT ON	150	1.90	12	0.730		10-#5+ 0	4	#5	#6	12-#5	4	#4	#5	10-#5	116	264	312
COLUMN LINE	200	2.17	12 *	0.781		10-#5+ 0	4	#6	#6	10-#6	4	#5	#5	10-#5	137	330	368
0.780 CF/SF	300	2.86	12 *	0.637		10-#5+ 1	4	#7	#7	8-#8	4	#6	#6	10-#5	178	459	479
	400	3.43	14 *	0.634		8-#6+ 2	4	#8	#8	7-#9	4	#6	#7	10-#5	217	581	586
	500	4.07	17 *	0.630		9-#6+ 2	4	#9	#9	9-#9	4	#7	#7	10-#5	253	677	681
27'-0"	50	1.69	13	0.682		8-#6+ 0	4	#5	#5	8-#6	5	#4	#4	12-#5	106	212	285
D = 9.500	100	1.86	13	0.740		8-#6+ 0	4	#5	#6	7-#7	5	#4	#4	12-#5	135	271	364
RIB NOT ON	150	2.25	13 *	0.837		8-#6+ 2	4	#6	#7	7-#8	5	#4	#5	12-#5	165	370	444
COLUMN LINE	200	2.77	13 *	0.894		8-#6+ 3	4	#7	#8	8-#8	5	#5	#6	12-#5	194	465	523
0.764 CF/SF	300	3.49	15 *	0.633		9-#6+ 2	4	#8	#9	9-#9	5	#6	#6	12-#5	252	644	677
	400	4.30	20 *	0.627	3 S 4 1	8-#7+ 2	4	#9	#10	11-#9	5	#7	#7	12-#5	301	764	811
30'-0"	50	1.73	15	0.755		9-#6+ 2	5	#5	#5	11-#6	5	#4	#4	12-#5	147	293	395
D = 12.500	100	2.10	15 *	0.839		9-#6+ 4	5	#6	#6	10-#7	5	#4	#5	12-#5	187	374	503
RIB ON	150	2.59	15 *	0.901		9-#6+ 6	5	#6	#7	10-#8	5	#5	#6	12-#5	227	496	612
COLUMN LINE	200	3.13	15 *	0.633		10-#6+ 3	5	#7	#8	9-#9	5	#6	#6	12-#5	268	626	720
0.790 CF/SF	300	4.02	21 *	0.626	3 S 4 1	9-#7+ 4	5	#8	#9	12-#9	5	#7	#7	13-#5	340	830	915
33'-0"	50	2.11	16	0.805		10-#6+ 3	5	#6	#6	11-#7	6	#4	#5	14-#5	194	388	523
D = 12.500	100	2.47	16 *	0.881		10-#6+ 5	5	#6	#7	9-#9	6	#5	#5	14-#5	248	496	668
RIB ON	150	3.00	17 *	0.630		11-#6+ 3	5	#7	#8	13-#8	6	#5	#6	14-#5	301	640	810
COLUMN LINE	200	3.70	21 *	0.626	3 S 4 1	10-#7+ 3	5	#8	#9	12-#9	6	#6	#7	14-#5	351	802	944
0.775 CF/SF																	
36'-0"	50	2.33	18 *	0.826		11-#6+ 4	5	#6	#7	9-#9	7	#4	#5	16-#5	250	500	673
D = 12.500	100	2.82	18 *	0.908		12-#6+ 6	5	#7	#8	11-#9	7	#5	#5	16-#5	320	639	861
RIB ON	150	3.52	22 *	0.626	3 S 4 1	11-#7+ 3	5	#8	#9	14-#9	7	#6	#6	16-#5	385	771	1038
COLUMN LINE	200	3.98	27 *	0.622	3 S 4 1	9-#8+ 2	5	#9	#9	16-#9	7	#6	#6	17-#5	445	891	1199
0.764 CF/SF																	
39'-0"	50	2.64	19 *	0.885		12-#6+ 8	6	#7	#7	11-#9	7	#5	#5	16-#5	322	644	867
D = 15.500	100	3.39	22 *	0.927		11-#7+ 9	6	#8	#8	14-#9	7	#6	#6	16-#5	408	816	1098
RIB NOT ON	150	3.96	30 *	0.621		18-#6+ 4	6	#8	#9	17-#9	7	#6	#7	18-#5	483	967	1301
COLUMN LINE																	
0.784 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 15 in.	Rib Depth = 10 in.	Total Slab Depth = 5 in.								
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
1.59	12		4	#4	#4	9-#5	3	#4	#4	8-#5
2.00	12		4	#5	#5	8-#6	3	#4	#5	8-#5
2.39	12 *	3 S 4 1	4	#5	#6	7-#7	3	#5	#5	8-#5
2.85	12 *	3 S 4 1	4	#6	#6	7-#8	3	#5	#6	8-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
1.76	12		4	#4	#5	8-#6	4	#4	#4	10-#5
1.98	12	3 S 4 1	4	#5	#5	7-#7	4	#4	#4	10-#5
2.64	12 *	3 S 4 1	4	#6	#6	7-#8	4	#5	#5	10-#5
3.12	12 *	3 S 4 1	4	#6	#7	7-#9	4	#5	#6	10-#5
3.55	15 *	3 S 4 2	4	#7	#7	8-#9	4	#6	#6	10-#5
1.64	13		4	#4	#4	8-#6	5	#4	#4	12-#5
1.80	13		4	#4	#5	9-#6	5	#4	#4	12-#5
2.09	13	3 S 4 1	4	#5	#6	8-#7	5	#4	#4	12-#5
2.50	13 *	3 S 4 1	4	#6	#6	8-#8	5	#4	#5	12-#5
3.14	13 *	3 S 4 2	4	#7	#7	8-#9	5	#5	#5	12-#5
3.73	17 *	3 S 4 2	4	#7	#8	10-#9	5	#5	#6	12-#5
1.65	15		5	#4	#4	10-#6	5	#4	#4	12-#5
1.95	15		5	#4	#5	10-#7	5	#4	#4	12-#5
2.40	15 *	3 S 4 1	5	#5	#6	9-#8	5	#4	#5	12-#5
2.88	15 *	3 S 4 1	5	#6	#6	9-#9	5	#5	#5	12-#5
3.68	17 *	3 S 4 2	5	#7	#7	11-#9	5	#6	#6	12-#5
1.98	16		5	#5	#5	10-#7	6	#4	#4	14-#5
2.29	16 *	3 S 4 1	5	#5	#6	10-#8	6	#4	#4	14-#5
2.79	16 *	3 S 4 1	5	#6	#7	12-#8	6	#4	#5	14-#5
3.35	16 *	3 S 4 2	5	#7	#7	12-#9	6	#5	#5	14-#5
2.22	18	3 S 4 1	5	#5	#6	10-#8	7	#4	#4	16-#5
2.64	18 *	3 S 4 1	5	#6	#6	10-#9	7	#4	#5	16-#5
3.13	18 *	3 S 4 2	5	#7	#7	16-#8	7	#4	#5	16-#5
3.72	21 *	3 S 4 2	5	#7	#8	15-#9	7	#5	#5	16-#5
2.48	19 *	3 S 4 1	6	#5	#6	13-#8	7	#4	#5	16-#5
3.12	19 *	3 S 4 1	6	#6	#7	13-#9	7	#5	#5	16-#5
3.66	22 *	3 S 4 2	6	#7	#7	16-#9	7	#5	#6	17-#5

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 17 in.	Rib Depth = 12 in.	Total Slab Depth = 5 in.															
24'-0"	50	1.57	12	0.639		10-#5+ 0	4	#4	#4	7-#6	4	#4	#4	10-#5	80	160	215
D = 9.500	100	1.63	12	0.639		10-#5+ 0	4	#4	#5	7-#6	4	#4	#4	10-#5	100	201	270
RIB NOT ON	150	1.70	12	0.639		10-#5+ 0	4	#5	#5	8-#6	4	#4	#4	10-#5	121	272	326
COLUMN LINE	200	1.98	12	0.685		10-#5+ 0	4	#6	#6	9-#6	4	#4	#5	10-#5	142	339	382
0.859 CF/SF	300	2.57	12 *	0.817		10-#5+ 2	4	#7	#7	7-#8	4	#5	#6	10-#5	183	469	493
	400	3.16	12 *	0.640		10-#5+ 1	4	#7	#8	8-#8	4	#6	#7	10-#5	224	596	604
	500	3.74	12 *	0.640		8-#6+ 2	4	#8	#9	8-#9	4	#7	#7	10-#5	266	722	715
27'-0"	50	1.64	13	0.637		8-#6+ 0	4	#4	#5	8-#6	5	#4	#4	12-#5	113	226	304
D = 9.500	100	1.82	13	0.657		8-#6+ 0	4	#5	#6	9-#6	5	#4	#4	12-#5	143	285	384
RIB NOT ON	150	2.06	13	0.743		8-#6+ 1	4	#6	#6	8-#7	5	#4	#5	12-#5	172	382	463
COLUMN LINE	200	2.45	13 *	0.812		8-#6+ 2	4	#7	#7	7-#8	5	#5	#5	12-#5	201	479	542
0.840 CF/SF	300	3.21	13 *	0.638		8-#6+ 2	4	#8	#8	8-#9	5	#6	#6	12-#5	260	663	701
	400	3.92	15 *	0.635		7-#7+ 1	4	#9	#9	12-#8	5	#6	#7	12-#5	317	839	854
	500	4.60	19 *	0.631	4 S 6 1	12-#6+ 0	4	#10	#10	11-#9	5	#7	#7	12-#5	367	975	989
30'-0"	50	1.70	15	0.662		9-#6+ 1	5	#5	#5	10-#6	5	#4	#4	12-#5	157	314	422
D = 12.500	100	1.99	15	0.744		9-#6+ 2	5	#5	#6	9-#7	5	#4	#5	12-#5	197	394	531
RIB ON	150	2.41	15 *	0.826		9-#6+ 4	5	#6	#7	9-#8	5	#5	#5	12-#5	237	516	639
COLUMN LINE	200	2.84	15 *	0.887		9-#6+ 6	5	#7	#7	10-#8	5	#6	#6	12-#5	278	649	748
0.871 CF/SF	300	3.83	16 *	0.634		12-#6+ 2	5	#8	#9	11-#9	5	#7	#7	12-#5	357	899	962
	400	4.56	21 *	0.629	4 S 6 1	10-#7+ 3	5	#9	#10	13-#9	5	#7	#8	14-#5	427	1086	1151
33'-0"	50	1.90	16	0.705		10-#6+ 1	5	#5	#6	10-#7	6	#4	#4	14-#5	208	415	559
D = 12.500	100	2.28	16 *	0.818		10-#6+ 4	5	#6	#7	10-#8	6	#4	#5	14-#5	261	523	704
RIB ON	150	2.87	16 *	0.885		10-#6+ 6	5	#7	#8	9-#9	6	#5	#6	14-#5	315	671	848
COLUMN LINE	200	3.30	16 *	0.634		12-#6+ 2	5	#8	#8	11-#9	6	#6	#6	14-#5	369	848	993
0.853 CF/SF	300	4.40	22 *	0.628	4 S 6 1	11-#7+ 3	5	#9	#10	14-#9	6	#7	#7	15-#5	466	1125	1255
36'-0"	50	2.27	18	0.741		11-#6+ 2	5	#6	#7	10-#8	7	#4	#5	16-#5	267	534	719
D = 12.500	100	2.69	18 *	0.845		11-#6+ 5	5	#7	#8	10-#9	7	#5	#5	16-#5	337	673	906
RIB ON	150	3.14	18 *	0.632		10-#7+ 3	5	#8	#8	12-#9	7	#5	#6	16-#5	406	821	1094
COLUMN LINE	200	3.92	21 *	0.629	4 S 6 1	11-#7+ 3	5	#9	#9	18-#8	7	#6	#7	16-#5	472	1043	1272
0.840 CF/SF	300	4.86	28 *	0.624	4 S 6 1	11-#8+ 3	5	#10	#10	19-#9	7	#7	#7	20-#5	593	1235	1596
39'-0"	50	2.46	19 *	0.828		12-#6+ 6	6	#6	#7	13-#8	7	#5	#5	16-#5	344	688	926
D = 15.500	100	3.00	19 *	0.908		14-#6+ 8	6	#7	#8	13-#9	7	#5	#6	16-#5	433	866	1165
RIB NOT ON	150	3.61	22 *	0.628		12-#7+ 5	6	#8	#8	16-#9	7	#6	#6	17-#5	518	1036	1395
COLUMN LINE	200	4.26	27 *	0.625		11-#8+ 3	6	#9	#9	23-#8	7	#6	#7	20-#5	596	1216	1606
0.864 CF/SF																	
42'-0"	50	2.89	21 *	0.852		14-#6+ 7	6	#7	#8	16-#8	8	#5	#6	18-#5	426	852	1147
D = 15.500	100	3.63	22 *	0.628		13-#7+ 4	6	#8	#9	17-#9	8	#6	#6	18-#5	535	1071	1442
RIB NOT ON	150	4.25	28 *	0.624		12-#8+ 2	6	#9	#9	20-#9	8	#6	#7	21-#5	638	1275	1717
COLUMN LINE																	
0.850 CF/SF																	
45'-0"	50	3.32	22 *	0.899		17-#6+10	6	#8	#9	16-#9	9	#5	#6	20-#5	523	1045	1407
D = 15.500	100	3.96	27 *	0.625		12-#8+ 2	6	#9	#9	21-#9	9	#6	#6	21-#5	652	1305	1756
RIB NOT ON																	
COLUMN LINE																	
0.840 CF/SF																	

SQUARE INTERIOR PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 17 in.	Rib Depth = 12 in.	Total Slab Depth = 5 in.									
24'-0"	1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
D = 9.500	1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
RIB NOT ON	1.62	12		4	#4	#4	7-#6	4	#4	#4	10-#5
COLUMN LINE	1.76	12		4	#4	#5	8-#6	4	#4	#4	10-#5
0.859 CF/SF	2.26	12	4 S 6 1	4	#5	#6	8-#7	4	#4	#5	10-#5
	2.87	12 *	4 S 6 1	4	#6	#7	8-#8	4	#5	#5	10-#5
	3.26	12 *	4 S 6 1	4	#7	#7	7-#9	4	#5	#6	10-#5
27'-0"	1.64	13		4	#4	#4	8-#6	5	#4	#4	12-#5
D = 9.500	1.74	13		4	#4	#5	12-#5	5	#4	#4	12-#5
RIB NOT ON	1.93	13	4 S 6 1	4	#5	#5	10-#6	5	#4	#4	12-#5
COLUMN LINE	2.21	13	4 S 6 1	4	#5	#6	7-#8	5	#4	#4	12-#5
0.840 CF/SF	2.91	13 *	4 S 6 1	4	#6	#7	7-#9	5	#5	#5	12-#5
	3.60	13 *	4 S 6 2	4	#7	#8	9-#9	5	#5	#6	12-#5
	4.04	16 *	4 S 6 2	4	#8	#8	10-#9	5	#6	#6	12-#5
30'-0"	1.61	15		5	#4	#4	9-#6	5	#4	#4	12-#5
D = 12.500	1.89	15		5	#4	#5	9-#7	5	#4	#4	12-#5
RIB ON	2.22	15		5	#5	#5	11-#7	5	#4	#5	12-#5
COLUMN LINE	2.59	15 *	4 S 6 1	5	#6	#6	10-#8	5	#4	#5	12-#5
0.871 CF/SF	3.36	15 *	4 S 6 1	5	#7	#7	10-#9	5	#5	#6	12-#5
	3.97	18 *	4 S 6 2	5	#7	#8	12-#9	5	#6	#6	13-#5
33'-0"	1.84	16		5	#4	#5	9-#7	6	#4	#4	14-#5
D = 12.500	2.12	16	4 S 6 1	5	#5	#5	9-#8	6	#4	#4	14-#5
RIB ON	2.65	16 *	4 S 6 1	5	#6	#6	9-#9	6	#4	#5	14-#5
COLUMN LINE	3.00	16 *	4 S 6 1	5	#6	#7	10-#9	6	#5	#5	14-#5
0.853 CF/SF	3.92	18 *	4 S 6 2	5	#7	#8	13-#9	6	#6	#6	14-#5
36'-0"	2.16	18		5	#5	#6	9-#8	7	#4	#4	16-#5
D = 12.500	2.46	18	4 S 6 1	5	#6	#6	9-#9	7	#4	#4	16-#5
RIB ON	2.88	18 *	4 S 6 1	5	#6	#7	11-#9	7	#4	#5	16-#5
COLUMN LINE	3.58	18 *	4 S 6 2	5	#7	#8	14-#9	7	#5	#5	16-#5
0.840 CF/SF	4.33	23 *	4 S 6 2	5	#8	#8	18-#9	7	#5	#6	18-#5
39'-0"	2.30	19		6	#5	#6	12-#8	7	#4	#4	16-#5
D = 15.500	2.74	19 *	4 S 6 1	6	#6	#6	12-#9	7	#4	#5	16-#5
RIB NOT ON	3.44	19 *	4 S 6 1	6	#7	#7	15-#9	7	#5	#5	16-#5
COLUMN LINE	3.95	21 *	4 S 6 2	6	#7	#8	17-#9	7	#5	#6	18-#5
0.864 CF/SF											
42'-0"	2.66	21	4 S 6 1	6	#6	#6	12-#9	8	#4	#5	18-#5
D = 15.500	3.33	21 *	4 S 6 1	6	#7	#7	15-#9	8	#5	#5	18-#5
RIB NOT ON	3.98	21 *	4 S 6 2	6	#7	#8	19-#9	8	#5	#6	20-#5
COLUMN LINE											
0.850 CF/SF											
45'-0"	3.07	22 *	4 S 6 1	6	#7	#7	15-#9	9	#4	#5	20-#5
D = 15.500	3.68	22 *	4 S 6 2	6	#7	#8	19-#9	9	#5	#5	20-#5
RIB NOT ON											
COLUMN LINE											
0.840 CF/SF											

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 19 in.	Rib Depth = 14 in.	Total Slab Depth = 5 in.															
27'-0"	50	1.79	13	0.640		8-#6+ 0	4	#4	#5	8-#6	5	#4	#5	12-#5	120	241	324
D = 9.500	100	1.85	13	0.640		8-#6+ 0	4	#5	#5	12-#5	5	#4	#5	12-#5	150	300	404
RIB NOT ON	150	2.09	13	0.640		8-#6+ 0	4	#6	#6	10-#6	5	#4	#5	12-#5	179	393	483
COLUMN LINE	200	2.30	13	0.711		8-#6+ 1	4	#6	#7	7-#8	5	#4	#5	12-#5	209	491	562
0.918 CF/SF	300	2.88	13 *	0.840		8-#6+ 3	4	#7	#8	7-#9	5	#5	#6	12-#5	268	677	721
	400	3.58	13 *	0.641		9-#6+ 2	4	#8	#9	9-#9	5	#6	#7	12-#5	327	860	880
	500	4.27	14 *	0.639		8-#7+ 2	4	#9	#10	10-#9	5	#7	#7	12-#5	384	1036	1035
30'-0"	50	1.84	15	0.637		9-#6+ 0	5	#5	#5	10-#6	5	#4	#5	12-#5	167	335	451
D = 12.500	100	2.00	15	0.637		9-#6+ 0	5	#5	#6	9-#7	5	#4	#5	12-#5	208	415	559
RIB ON	150	2.27	15	0.666		9-#6+ 0	5	#6	#6	11-#7	5	#5	#5	12-#5	248	534	668
COLUMN LINE	200	2.62	15 *	0.775		9-#6+ 2	5	#7	#7	9-#8	5	#5	#6	12-#5	288	669	776
0.954 CF/SF	300	3.43	15 *	0.638		10-#6+ 4	5	#8	#8	12-#8	5	#6	#7	12-#5	369	924	993
	400	4.30	16 *	0.636	4 S 6 1	9-#7+ 2	5	#9	#9	12-#9	5	#7	#8	13-#5	448	1170	1207
	500	4.92	21 *	0.631	4 S 6 1	11-#7+ 3	5	#9	#10	14-#9	5	#8	#8	15-#5	516	1354	1389
33'-0"	50	1.99	16	0.638		10-#6+ 1	5	#5	#6	9-#7	6	#4	#5	14-#5	221	443	596
D = 12.500	100	2.21	16	0.724		10-#6+ 2	5	#6	#6	9-#8	6	#4	#5	14-#5	275	550	741
RIB ON	150	2.59	16 *	0.823		10-#6+ 5	5	#7	#7	9-#9	6	#5	#5	14-#5	329	696	885
COLUMN LINE	200	3.14	16 *	0.884		11-#6+ 6	5	#8	#8	10-#9	6	#6	#6	14-#5	383	878	1030
0.934 CF/SF	300	4.06	17 *	0.635	4 S 6 1	10-#7+ 3	5	#9	#9	13-#9	6	#7	#7	14-#5	489	1212	1316
	400	5.01	22 *	0.630	4 S 6 1	9-#8+ 2	5	#10	#10	16-#9	6	#7	#8	17-#5	583	1467	1571
36'-0"	50	2.23	18	0.655		11-#6+ 1	5	#6	#7	9-#8	7	#4	#5	16-#5	285	569	766
D = 12.500	100	2.59	18	0.779		11-#6+ 4	5	#7	#7	9-#9	7	#5	#5	16-#5	354	708	954
RIB ON	150	2.96	18 *	0.854		12-#6+ 5	5	#7	#8	11-#9	7	#5	#6	16-#5	424	861	1141
COLUMN LINE	200	3.53	18 *	0.634	4 S 6 1	10-#7+ 1	5	#8	#9	13-#9	7	#6	#6	16-#5	494	1098	1329
0.918 CF/SF	300	4.81	23 *	0.630	4 S 6 1	10-#8+ 1	5	#10	#10	17-#9	7	#7	#7	18-#5	625	1512	1683
39'-0"	50	2.45	19	0.770		12-#6+ 5	6	#6	#7	12-#8	7	#5	#5	16-#5	367	734	988
D = 15.500	100	2.92	19 *	0.855		13-#6+ 7	6	#7	#8	12-#9	7	#5	#6	16-#5	456	912	1227
RIB NOT ON	150	3.39	19 *	0.633		22-#5+ 7	6	#8	#8	18-#8	7	#6	#6	16-#5	545	1089	1466
COLUMN LINE	200	4.22	22 *	0.630		13-#7+ 4	6	#9	#9	17-#9	7	#7	#7	18-#5	629	1381	1693
0.945 CF/SF	300	5.18	29 *	0.625		13-#8+ 2	6	#10	#10	22-#9	7	#7	#8	16-#6	783	1663	2109
42'-0"	50	2.69	21 *	0.791		13-#6+ 6	6	#7	#7	12-#9	8	#5	#5	18-#5	454	909	1223
D = 15.500	100	3.20	21 *	0.888		12-#7+ 6	6	#8	#8	15-#9	8	#5	#6	18-#5	565	1130	1521
RIB NOT ON	150	3.84	23 *	0.630		14-#7+ 4	6	#9	#9	18-#9	8	#6	#6	19-#5	673	1345	1811
COLUMN LINE	200	4.61	27 *	0.627		32-#5+ 8	6	#9	#10	21-#9	8	#7	#7	22-#5	776	1618	2089
0.930 CF/SF																	
45'-0"	50	3.10	22 *	0.844		12-#7+ 5	6	#8	#8	15-#9	9	#5	#6	20-#5	557	1114	1500
D = 15.500	100	3.81	23 *	0.918		11-#8+ 6	6	#9	#9	19-#9	9	#6	#6	20-#5	692	1384	1863
RIB NOT ON	150	4.47	28 *	0.626		13-#8+ 4	6	#9	#10	23-#9	9	#6	#7	24-#5	820	1639	2207
COLUMN LINE																	
0.918 CF/SF																	
48'-0"	50	3.44	24 *	0.892		15-#7+ 9	7	#8	#8	18-#9	9	#6	#6	20-#5	681	1362	1834
D = 18.500	100	4.24	28 *	0.917		14-#8+ 8	7	#9	#9	23-#9	9	#6	#7	24-#5	840	1679	2261
RIB ON	150	5.11	35 *	0.622	4 S 6 1	16-#8+ 5	7	#10	#10	28-#9	9	#7	#7	20-#6	987	1973	2656
COLUMN LINE																	
0.940 CF/SF																	
51'-0"	50	3.90	26 *	0.910		13-#8+ 8	7	#9	#9	22-#9	10	#6	#6	23-#5	813	1625	2188
D = 18.500	100	4.85	33 *	0.623	4 S 6 1	13-#9+ 4	7	#10	#10	28-#9	10	#7	#7	29-#5	998	1996	2687
RIB ON																	
COLUMN LINE																	
0.928 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 19 in.	Rib Depth = 14 in.	Total Slab Depth = 5 in.								
1.82	13		4	#4	#5	8-#6	5	#4	#5	12-#5
1.82	13		4	#4	#5	8-#6	5	#4	#5	12-#5
2.02	13		4	#5	#5	7-#7	5	#4	#5	12-#5
2.19	13	4 S 6 1	4	#5	#6	8-#7	5	#4	#5	12-#5
2.64	13	4 S 6 1	4	#6	#7	8-#8	5	#4	#5	12-#5
3.14	13 *	4 S 6 1	4	#7	#7	8-#9	5	#5	#5	12-#5
3.75	13 *	4 S 6 2	4	#8	#8	9-#9	5	#5	#6	12-#5
1.79	15		5	#4	#5	9-#6	5	#4	#5	12-#5
1.90	15		5	#4	#5	11-#6	5	#4	#5	12-#5
2.13	15		5	#5	#5	10-#7	5	#4	#5	12-#5
2.33	15		5	#5	#6	11-#7	5	#4	#5	12-#5
3.13	15 *	4 S 6 1	5	#6	#7	9-#9	5	#5	#6	12-#5
3.82	15 *	4 S 6 1	5	#7	#8	11-#9	5	#6	#6	12-#5
4.35	18 *	4 S 6 2	5	#8	#8	16-#8	5	#6	#7	14-#5
1.94	16		5	#4	#5	9-#7	6	#4	#5	14-#5
2.16	16		5	#5	#5	11-#7	6	#4	#5	14-#5
2.39	16	4 S 6 1	5	#5	#6	10-#8	6	#4	#5	14-#5
2.77	16 *	4 S 6 1	5	#6	#7	9-#9	6	#4	#5	14-#5
3.61	16 *	4 S 6 2	5	#7	#8	12-#9	6	#5	#6	14-#5
4.54	19 *	4 S 6 2	5	#8	#9	15-#9	6	#6	#6	16-#5
2.11	18		5	#5	#5	11-#7	7	#4	#5	16-#5
2.46	18	4 S 6 1	5	#5	#6	9-#9	7	#4	#5	16-#5
2.75	18 *	4 S 6 1	5	#6	#7	10-#9	7	#4	#5	16-#5
3.22	18 *	4 S 6 2	5	#7	#7	12-#9	7	#5	#5	16-#5
4.43	18 *	4 S 6 2	5	#8	#9	16-#9	7	#6	#6	17-#5
2.33	19		6	#5	#6	11-#8	7	#4	#5	16-#5
2.67	19	4 S 6 1	6	#6	#6	11-#9	7	#4	#5	16-#5
3.12	19 *	4 S 6 1	6	#6	#7	13-#9	7	#5	#5	16-#5
3.80	19 *	4 S 6 1	6	#7	#8	16-#9	7	#5	#6	17-#5
4.61	24 *	4 S 6 2	6	#8	#8	20-#9	7	#6	#6	21-#5
2.59	21	4 S 6 1	6	#6	#6	11-#9	8	#4	#5	18-#5
2.96	21 *	4 S 6 1	6	#6	#7	14-#9	8	#4	#5	18-#5
3.50	21 *	4 S 6 2	6	#7	#7	17-#9	8	#5	#5	18-#5
4.21	21 *	4 S 6 2	6	#8	#8	20-#9	8	#5	#6	21-#5
2.86	22	4 S 6 1	6	#6	#7	14-#9	9	#4	#5	20-#5
3.52	22 *	4 S 6 2	6	#7	#8	17-#9	9	#5	#5	20-#5
4.14	22 *	4 S 6 2	6	#8	#8	21-#9	9	#5	#6	22-#5
3.19	24 *	4 S 6 1	7	#6	#7	17-#9	9	#5	#5	20-#5
3.94	24 *	4 S 6 2	7	#7	#8	21-#9	9	#5	#6	23-#5
4.71	26 *	4 S 6 2	7	#8	#8	26-#9	9	#6	#6	27-#5
3.64	25 *	4 S 6 1	7	#7	#8	21-#9	10	#5	#5	22-#5
4.34	25 *	4 S 6 2	7	#8	#8	26-#9	10	#5	#6	27-#5

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 21 in.	Rib Depth = 16 in.	Total Slab Depth = 5 in.															
30'-0"	50	1.77	15	0.639		9-#6+ 0	5	#4	#5	9-#6	5	#4	#5	12-#5	178	357	480
D = 12.500	100	1.88	15	0.639		9-#6+ 0	5	#5	#5	11-#6	5	#4	#5	12-#5	219	437	588
RIB ON	150	2.16	15	0.639		9-#6+ 0	5	#6	#6	10-#7	5	#4	#5	12-#5	259	550	697
COLUMN LINE	200	2.52	15	0.671		9-#6+ 1	5	#6	#7	11-#7	5	#5	#6	12-#5	299	687	805
1.039 CF/SF	300	3.19	15 *	0.827		10-#6+ 3	5	#7	#8	9-#9	5	#6	#7	12-#5	380	944	1022
	400	3.83	15 *	0.640		12-#6+ 2	5	#8	#9	11-#9	5	#7	#7	12-#5	460	1195	1239
	500	4.60	16 *	0.639	4 S 6 1	10-#7+ 1	5	#9	#10	16-#8	5	#7	#8	14-#5	539	1438	1452
33'-0"	50	1.96	16	0.638		10-#6+ 0	5	#5	#6	9-#7	6	#4	#5	14-#5	236	471	634
D = 12.500	100	2.15	16	0.638		10-#6+ 0	5	#6	#6	11-#7	6	#4	#5	14-#5	289	579	779
RIB ON	150	2.45	16	0.655		10-#6+ 0	5	#6	#7	10-#8	6	#5	#5	14-#5	343	719	924
COLUMN LINE	200	2.87	16 *	0.784		10-#6+ 3	5	#7	#8	9-#9	6	#5	#6	14-#5	397	902	1068
1.016 CF/SF	300	3.80	16 *	0.639		9-#7+ 2	5	#9	#9	12-#9	6	#6	#7	14-#5	504	1244	1358
	400	4.78	18 *	0.636	4 S 6 1	9-#8+ 1	5	#10	#10	15-#9	6	#7	#8	15-#5	609	1570	1639
36'-0"	50	2.16	18	0.635		11-#6+ 1	5	#6	#6	9-#8	7	#4	#5	16-#5	303	606	815
D = 12.500	100	2.45	18	0.680		11-#6+ 2	5	#7	#7	9-#9	7	#4	#5	16-#5	372	745	1003
RIB ON	150	2.75	18 *	0.789		11-#6+ 5	5	#7	#8	10-#9	7	#5	#5	16-#5	442	895	1190
COLUMN LINE	200	3.38	18 *	0.855		10-#7+ 3	5	#8	#9	12-#9	7	#6	#6	16-#5	512	1134	1378
0.998 CF/SF	300	4.46	18 *	0.636	4 S 6 1	9-#8+ 2	5	#10	#10	16-#9	7	#7	#7	16-#5	651	1574	1752
39'-0"	50	2.39	19	0.637		12-#6+ 1	6	#6	#7	11-#8	7	#5	#5	16-#5	391	782	1052
D = 15.500	100	2.77	19 *	0.764		12-#6+ 4	6	#7	#7	11-#9	7	#5	#6	16-#5	480	959	1291
RIB NOT ON	150	3.16	19 *	0.870		11-#7+ 5	6	#7	#8	13-#9	7	#6	#6	16-#5	568	1137	1530
COLUMN LINE	200	3.80	19 *	0.635		12-#7+ 3	6	#8	#9	16-#9	7	#6	#7	17-#5	657	1441	1769
1.029 CF/SF	300	5.18	25 *	0.630		12-#8+ 2	6	#10	#10	20-#9	7	#7	#8	21-#5	823	1974	2216
42'-0"	50	2.63	21	0.731		13-#6+ 5	6	#7	#7	11-#9	8	#5	#5	18-#5	483	967	1302
D = 15.500	100	3.13	21 *	0.831		11-#7+ 5	6	#8	#8	14-#9	8	#5	#6	18-#5	594	1188	1599
RIB NOT ON	150	3.66	21 *	0.911		13-#7+ 8	6	#8	#9	17-#9	8	#6	#6	18-#5	705	1409	1897
COLUMN LINE	200	4.30	23 *	0.632		12-#8+ 2	6	#9	#10	20-#9	8	#6	#7	21-#5	812	1705	2185
1.012 CF/SF																	
45'-0"	50	2.96	22 *	0.793		11-#7+ 5	6	#8	#8	14-#9	9	#5	#5	20-#5	593	1185	1595
D = 15.500	100	3.50	22 *	0.894		14-#7+ 8	6	#8	#9	18-#9	9	#6	#6	20-#5	729	1458	1962
RIB NOT ON	150	4.20	24 *	0.631		32-#5+ 7	6	#9	#10	21-#9	9	#6	#7	22-#5	862	1723	2320
COLUMN LINE	200	4.94	28 *	0.628		11-#9+ 3	6	#10	#10	25-#9	9	#7	#7	26-#5	989	2017	2664
0.998 CF/SF																	
48'-0"	50	3.29	24 *	0.844		14-#7+ 7	7	#8	#8	17-#9	9	#6	#6	20-#5	725	1450	1952
D = 18.500	100	4.08	24 *	0.924		13-#8+ 8	7	#9	#9	22-#9	9	#6	#7	23-#5	890	1780	2396
RIB ON	150	4.74	29 *	0.627		15-#8+ 3	7	#9	#10	26-#9	9	#7	#7	27-#5	1045	2090	2814
COLUMN LINE	200	5.49	34 *	0.625	4 S 6 1	14-#9+ 3	7	#10	#10	30-#9	9	#7	#8	22-#6	1191	2381	3205
1.023 CF/SF																	
51'-0"	50	3.64	25 *	0.889		32-#5+19	7	#8	#9	21-#9	10	#6	#6	22-#5	866	1732	2332
D = 18.500	100	4.49	28 *	0.628		16-#8+ 5	7	#9	#10	26-#9	10	#6	#7	27-#5	1059	2118	2851
RIB ON																	
COLUMN LINE																	
1.009 CF/SF																	
54'-0"	50	4.11	27 *	0.908		15-#8+ 8	7	#9	#10	25-#9	11	#6	#6	26-#5	1022	2044	2751
D = 18.500																	
RIB ON																	
COLUMN LINE																	
0.998 CF/SF																	
57'-0"	50	4.57	31 *	0.918		18-#8+12	8	#9	#10	30-#9	11	#6	#7	31-#5	1208	2416	3252
D =21.500																	
RIB NOT ON																	
COLUMN LINE																	
1.019 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 21 in.			Rib Depth = 16 in.				Total Slab Depth = 5 in.			
1.79	15		5	#4	#5	9-#6	5	#4	#5	12-#5
1.83	15		5	#4	#5	10-#6	5	#4	#5	12-#5
2.07	15		5	#5	#5	9-#7	5	#4	#5	12-#5
2.33	15		5	#5	#6	11-#7	5	#4	#5	12-#5
2.85	15	4 S 6 1	5	#6	#7	10-#8	5	#5	#5	12-#5
3.36	15 *	4 S 6 1	5	#7	#7	10-#9	5	#5	#6	12-#5
4.08	15 *	4 S 6 2	5	#7	#8	12-#9	5	#6	#7	13-#5
1.87	16		5	#4	#5	11-#6	6	#4	#5	14-#5
2.08	16		5	#5	#5	10-#7	6	#4	#5	14-#5
2.32	16		5	#5	#6	9-#8	6	#4	#5	14-#5
2.65	16	4 S 6 1	5	#6	#6	9-#9	6	#4	#5	14-#5
3.38	16 *	4 S 6 1	5	#7	#7	11-#9	6	#5	#6	14-#5
4.14	16 *	4 S 6 2	5	#8	#8	14-#9	6	#6	#6	14-#5
2.11	18		5	#5	#5	11-#7	7	#4	#5	16-#5
2.32	18	4 S 6 1	5	#5	#6	10-#8	7	#4	#5	16-#5
2.58	18	4 S 6 1	5	#6	#6	12-#8	7	#4	#5	16-#5
2.99	18 *	4 S 6 1	5	#7	#7	11-#9	7	#4	#5	16-#5
3.85	18 *	4 S 6 2	5	#8	#8	18-#8	7	#5	#6	16-#5
2.23	19		6	#5	#5	11-#8	7	#4	#5	16-#5
2.59	19		6	#6	#6	13-#8	7	#4	#5	16-#5
2.87	19 *	4 S 6 1	6	#6	#7	12-#9	7	#4	#5	16-#5
3.45	19 *	4 S 6 1	6	#7	#7	18-#8	7	#5	#6	16-#5
4.80	19 *	4 S 6 2	6	#8	#9	19-#9	7	#6	#7	20-#5
2.52	21		6	#6	#6	13-#8	8	#4	#5	18-#5
2.89	21	4 S 6 1	6	#6	#7	13-#9	8	#4	#5	18-#5
3.39	21 *	4 S 6 1	6	#7	#7	16-#9	8	#5	#5	18-#5
3.85	21 *	4 S 6 2	6	#7	#8	18-#9	8	#5	#6	19-#5
2.80	22	4 S 6 1	6	#6	#7	13-#9	9	#4	#5	20-#5
3.14	22 *	4 S 6 1	6	#7	#7	16-#9	9	#4	#5	20-#5
3.75	22 *	4 S 6 2	6	#7	#8	20-#9	9	#5	#5	20-#5
4.51	22 *	4 S 6 2	6	#8	#9	23-#9	9	#5	#6	24-#5
2.95	24	4 S 6 1	7	#6	#7	16-#9	9	#4	#5	20-#5
3.68	24 *	4 S 6 1	7	#7	#8	20-#9	9	#5	#5	21-#5
4.33	24 *	4 S 6 2	7	#8	#8	24-#9	9	#5	#6	25-#5
5.09	27 *	4 S 6 2	7	#8	#9	28-#9	9	#6	#6	21-#6
3.37	25 *	4 S 6 1	7	#7	#7	19-#9	10	#5	#5	22-#5
4.16	25 *	4 S 6 2	7	#8	#8	24-#9	10	#5	#6	25-#5
3.80	27 *	4 S 6 2	7	#8	#8	23-#9	11	#5	#5	24-#5
4.26	28 *	4 S 6 1	8	#8	#8	28-#9	11	#5	#6	29-#5

WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

f'_c = 4,000 psi
Grade 60 Bars

SQUARE EDGE PANELS

Span c.-c. Columns $\ell_1 = \ell_2$ (ft)	Factored Super-imposed Load (psf)	(1) Steel (psf)	Square Edge Column $c_1 = c_2$ (in.)	γ_f	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size +	Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size	Moments $-M$ Edge (ft-k)	Moments $+M$ Bot. (ft-k)	Moments $-M$ Int. (ft-k)
Total Depth = 25 in.	Rib Depth = 20 in.	Total Slab Depth = 5 in.															
33'-0"	50	2.03	16	0.641		10-#6+ 0	5	#5	#5	11-#6	6	#5	#5	14-#5	265	530	714
D = 12.500	100	2.18	16	0.641		10-#6+ 0	5	#5	#6	10-#7	6	#5	#5	14-#5	319	638	859
RIB ON	150	2.35	16	0.641		10-#6+ 0	5	#6	#6	9-#8	6	#5	#5	14-#5	373	759	1004
COLUMN LINE	200	2.59	16	0.641		10-#6+ 1	5	#7	#7	10-#8	6	#5	#5	14-#5	427	946	1148
1.186 CF/SF	300	3.21	16	0.740		11-#6+ 2	5	#8	#8	10-#9	6	#6	#6	14-#5	534	1297	1438
	400	4.05	16 *	0.642		10-#7+ 1	5	#9	#9	16-#8	6	#7	#7	14-#5	642	1635	1728
	500	4.79	16 *	0.642	5 S 8 1	9-#8+ 1	5	#10	#10	15-#9	6	#7	#8	16-#5	749	1967	2017
36'-0"	50	2.26	18	0.639		11-#6+ 0	5	#6	#6	11-#7	7	#5	#5	16-#5	341	682	917
D = 12 .500	100	2.46	18	0.639		11-#6+ 0	5	#6	#7	10-#8	7	#5	#5	16-#5	410	821	1105
RIB ON	150	2.67	18	0.639		11-#6+ 0	5	#7	#7	9-#9	7	#5	#5	16-#5	480	960	1292
COLUMN LINE	200	3.05	18	0.639		12-#6+ 0	5	#8	#8	13-#8	7	#5	#6	16-#5	550	1196	1480
1.165 CF/SF	300	3.82	18 *	0.845		11-#7+ 3	5	#9	#9	14-#9	7	#6	#7	16-#5	689	1650	1855
	400	4.73	18 *	0.640	5 S 8 1	10-#8+ 1	5	#10	#10	16-#9	7	#7	#7	17-#5	828	2085	2230
39'-0"	50	2.34	19	0.638		12-# 6+ 1	6	#6	#6	11-#8	7	#5	#5	16-#5	440	881	1186
D = 15.500	100	2.57	19	0.638		12-#6+ 2	6	#6	#7	13-#8	7	#5	#5	16-#5	529	1058	1424
RIB NOT ON	150	2.99	19	0.707		13-#6+ 3	6	#7	#8	12-#9	7	#5	#6	16-#5	618	1236	1663
COLUMN LINE	200	3.36	19 *	0.826		11-#7+ 5	6	#8	#8	14-#9	7	#6	#6	16-#5	707	1526	1902
1.203 CF/SF	300	4.45	19 *	0.639		14-#7+ 2	6	#9	#10	17-#9	7	#7	#7	19-#5	884	2105	2380
42'-0"	50	2.59	21	0.636		13-#6+ 1	6	#7	#7	13-#8	8	#5	#5	18-#5	544	1089	1466
D = 15.500	100	2.96	21	0.652		14-#6+ 2	6	#7	#8	16-#8	8	#5	#6	18-#5	655	1310	1763
RIB NOT ON	150	3.28	21 *	0.793		12-#7+ 4	6	#8	#8	15-#9	8	#5	#6	18-#5	765	1531	2061
COLUMN LINE	200	3.85	21 *	0.867		14-#7+ 5	6	#9	#9	17-#9	8	#6	#7	18-#5	876	1833	2359
1.182 CF/SF																	
45'-0"	50	2.81	22	0.635		14-#6+ 2	6	#7	#8	16-#8	9	#5	#5	20-#5	667	1334	1796
D = 15.500	100	3.26	22 *	0.769		17-#6+ 5	6	#8	#8	16-#9	9	#5	#6	20-#5	803	1606	2162
RIB NOT ON	150	3.81	22 *	0.874		11-#8+ 6	6	#9	#9	19-#9	9	#6	#6	20-#5	939	1879	2529
COLUMN LINE	200	4.38	22 *	0.636		13-#8+ 2	6	#9	#10	22-#9	9	#6	#7	23-#5	1076	2202	2896
1.165 CF/SF																	
48'-0"	50	3.12	24	0.734		17-#6+ 7	7	#7	#8	16-#9	9	#5	#6	20-#5	817	1633	2199
D = 18.500	100	3.64	24 *	0.836		15-#7+ 7	7	#8	#9	19-#9	9	#6	#6	20-#5	982	1963	2643
RIB ON	150	4.24	24 *	0.913		14-#8+ 8	7	#9	#9	23-#9	9	#6	#7	24-#5	1147	2293	3087
COLUMN LINE	200	4.87	25 *	0.634		16-#8+ 3	7	#9	#10	26-#9	9	#7	#7	20-#6	1309	2619	3525
1.195 CF/SF																	
51'-0"	50	3.54	25 *	0.794		15-#7+ 6	7	#8	#9	19-#9	10	#6	#6	22-#5	975	1951	2626
D = 18.500	100	4.07	25 *	0.893		14-#8+ 8	7	#9	#9	23-#9	10	#6	#7	25-#5	1174	2347	3160
RIB ON	150	4.85	26 *	0.633		13-#9+ 4	7	#10	#10	28-#9	10	#7	#7	29-#5	1369	2739	3687
COLUMN LINE																	
1.179 CF/SF																	
54'-0"	50	3.82	27 *	0.844		14-#8+ 7	7	#9	#9	23-#9	11	#6	#6	24-#5	1150	2300	3096
D = 18.500	100	4.58	27 *	0.919		13-#9+ 8	7	#10	#10	28-#9	11	#6	#7	29-#5	1385	2770	3729
RIB ON																	
COLUMN LINE																	
1.165 CF/SF																	
57'-0"	50	4.33	28 *	0.888		17-#8+ 9	8	#9	#10	27-#9	11	#6	#7	29-#5	1367	2734	3681
D =21.500	100	5.19	31 *	0.630		16-#9+ 5	8	#10	#10	33-#9	11	#7	#7	25-#6	1636	3272	4405
RIB NOT ON																	
COLUMN LINE																	
1.190 CF/SF																	

SQUARE INTERIOR PANELS

(1) Steel (psf)	Square Interior Column $c_1 = c_2$ (in.)	(2) Stirrups	Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs	Column Strip Bottom Long Bars	Column Strip Bottom Short Bars	Column Strip Top Interior No.-size	Middle Strip Bottom No. Ribs	Middle Strip Bottom Long Bars	Middle Strip Bottom Short Bars	Middle Strip Top Interior No.-size
Total Depth = 25 in.	Rib Depth = 20 in.	Total Slab Depth = 5 in.								
2.03	16		5	#5	#5	10-#6	6	#5	#5	14-#5
2.16	16		5	#5	#5	9-#7	6	#5	#5	14-#5
2.30	16		5	#5	#5	11-#7	6	#5	#5	14-#5
2.46	16		5	#5	#6	9-#8	6	#5	#5	14-#5
2.91	16	5 S 8 1	5	#6	#7	9-#9	6	#5	#5	14-#5
3.61	16 *	5 S 8 1	5	#7	#8	12-#9	6	#5	#6	14-#5
4.14	16 *	5 S 8 2	5	#8	#8	14-#9	6	#6	#6	14-#5
2.18	18		5	#5	#5	10-#7	7	#5	#5	16-#5
2.41	18		5	#5	#6	9-#8	7	#5	#5	16-#5
2.61	18	5 S 8 1	5	#5	#6	9-#9	7	#5	#5	16-#5
2.84	18	5 S 8 1	5	#6	#7	12-#8	7	#5	#5	16-#5
3.37	18 *	5 S 8 1	5	#7	#8	12-#9	7	#5	#5	16-#5
4.32	18 *	5 S 8 2	5	#8	#9	15-#9	7	#6	#6	16-#5
2.28	19		6	#5	#5	13-#7	7	#5	#5	16-#5
2.53	19		6	#5	#6	12-#8	7	#5	#5	16-#5
2.81	19		6	#6	#6	11-#9	7	#5	#5	16-#5
3.06	19	5 S 8 1	6	#6	#7	16-#8	7	#5	#5	16-#5
3.96	19 *	5 S 8 1	6	#7	#8	16-#9	7	#6	#6	17-#5
2.48	21		6	#5	#6	12-#8	8	#5	#5	18-#5
2.81	21		6	#6	#6	12-#9	8	#5	#5	18-#5
3.10	21	5 S 8 1	6	#6	#7	14-#9	8	#5	#5	18-#5
3.39	21 *	5 S 8 1	6	#7	#7	16-#9	8	#5	#5	18-#5
2.74	22		6	#6	#6	12-#9	9	#5	#5	20-#5
3.13	22	5 S 8 1	6	#7	#7	18-#8	9	#5	#5	20-#5
3.52	22 *	5 S 8 1	6	#7	#8	17-#9	9	#5	#5	20-#5
4.02	22 *	5 S 8 2	6	#8	#8	20-#9	9	#5	#6	21-#5
3.03	24		7	#6	#7	15-#9	9	#5	#5	20-#5
3.37	24	5 S 8 1	7	#7	#7	18-#9	9	#5	#5	20-#5
3.92	24 *	5 S 8 1	7	#7	#8	21-#9	9	#5	#6	22-#5
4.52	24 *	5 S 8 2	7	#8	#8	24-#9	9	#6	#6	26-#5
3.28	25	5 S 8 1	7	#7	#7	18-#9	10	#5	#5	22-#5
3.72	25 *	5 S 8 1	7	#7	#8	22-#9	10	#5	#5	23-#5
4.34	25 *	5 S 8 2	7	#8	#8	26-#9	10	#5	#6	27-#5
3.54	27	5 S 8 1	7	#7	#8	21-#9	11	#5	#5	24-#5
4.18	27 *	5 S 8 2	7	#8	#8	26-#9	11	#5	#6	27-#5
3.91	28 *	5 S 8 1	8	#7	#8	25-#9	11	#5	#6	27-#5
4.86	28 *	5 S 8 2	8	#8	#9	31-#9	11	#6	#6	32-#5

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

CHAPTER 12 – BEAMS

INTRODUCTION

General. The tabulated designs of rectangular beams in this Chapter are based on the Strength Design Method in the ACI Building Code. Appropriate load factors must be applied to service dead and live loads before using the tabulated designs. In the tabulated designs, the nominal design strength has been reduced to a usable factored load capacity by the prescribed strength-reduction ϕ-factors.

The tabulated designs are based on $f'_c = 4{,}000$ psi and $f_y = 60{,}000$ psi (Grade 60 reinforcing bars). Variations in f'_c between 3,000 psi and 5,000 psi will not significantly affect load capacity for flexural design strength nor the flexural reinforcement required. For $f'_c > 4{,}000$ psi, the minor reductions in stirrup requirements can usually be neglected since the potential reduction, $(2\sqrt{f'_c} - 63)$ psi, is sharply limited by the maximum spacing requirements (ACI 11.4.5) and minimum stirrup requirements (ACI 11.4.6).

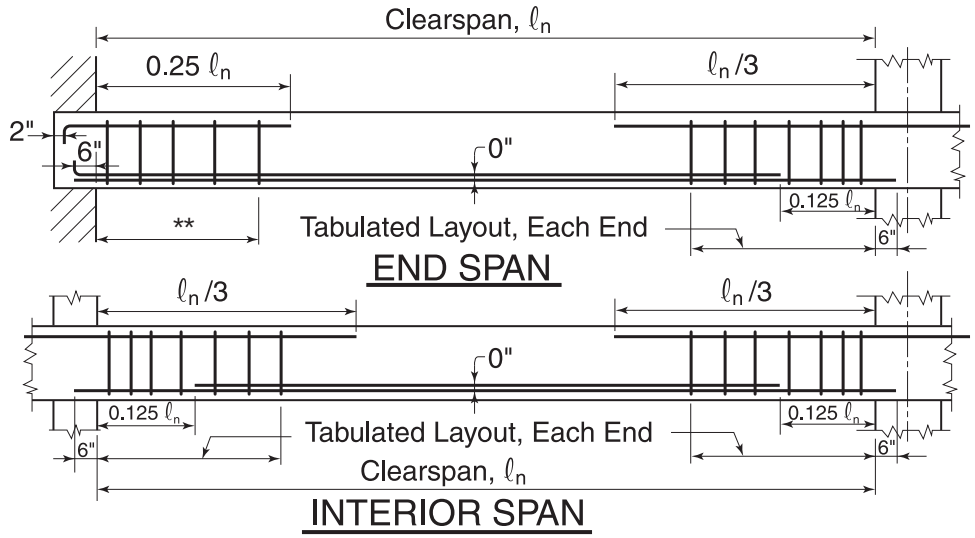
Unlike the other tabulated designs in this Handbook, the factored dead weight of the beam has not been deducted. The total load capacities have been reduced by strength-reduction or ϕ-factors with no deduction for dead weight of the beam. Most of the dead weight of a floor system is in the tributary slabs or joists; therefore, selfweight of a beam is typically only a small part of the dead load it must support.

Complete beam designs for uniformly distributed loads are presented on two lines in the tabulated designs. The first line is for open U-stirrups where torsion is negligible. The second line is for closed stirrups required to resist combined torsion and shear. Load capacity, torsional moment strength with open stirrups, and torsional moment strength with closed stirrups are tabulated for the usual range of suitable spans. Deflection for all tabulated loads meets the ACI Code general limit, $\ell/360$, (ACI 9.5.2.6).*

Scope. Two sets of beam designs are tabulated. One set utilizes "normal" proportions. See Pages 12-22 to 12-81. The other set matches the depths of standard joist construction but considers the wide beam widths commonly required for uniform depth joist-beam floor or roof construction. See Pages 12-82 to 12-109.

Both sets of tabulated designs, beams of normal proportions and joist-band (wide) beams for joist construction, are further subdivided into "Exterior Span" and "Interior Span" beams for the different moment conditions present. See Fig. 12-1 "Recommended Bar Details for Beams." Figs. 12-2 and 12-3 "Typical Beam Section at Support" and "Typical Girder Section at Support" show adjustments required to apply the beam designs tabulated for use as girders where effective depth is reduced so that the girder reinforcing steel fits under crossing beam bars. For stirrup details, see Fig. 12-4.

*Exceptions are noted *, X, or Y. See footnotes on tables.



** See Note 5 in tabulated designs.

Figure 12-1 Recommended Bar Details for Beams

Spans range from 12 to 54 feet, utilizing widths approximately one-half to two-thirds the depth, for the beams of normal proportions. For the joist-band (wide) beams for use with joists, depths range from 12.5 inches in increments the same as those for standard joists with 4.5-inch top slabs to 28.5 inches, utilizing widths from 24 to 48 inches.

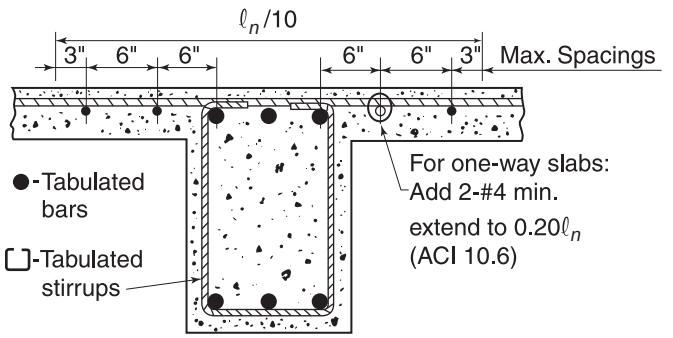
Note that eight different clear span lengths are provided for each combination of beam depth and width and that the tabulated designs are divided into two pages. The first page is for the first four spans and the second page is for the last four spans. The specific beam overall depths, widths, and clear spans used in the tabulated designs are as follows:

BEAMS OF NORMAL PROPORTIONS

Depth, h, (in.)	*Widths, b, (in)*	*Clear Spans (ft)*
12	8, 10, 12	12, 14, 16, 18, 20, 22, 24, 26
14	8, 10, 12, 14	12, 14, 16, 18, 20, 22, 24, 26
16	10, 12, 14, 16	16, 18, 20, 22, 24, 26, 28, 30
18	10, 12, 14, 16	16, 18, 20, 22, 24, 26, 28, 30
20	10, 12, 14, 16	20, 22, 24, 26, 28, 30, 32, 34
22	12, 14, 16, 18	20, 22, 24, 26, 28, 30, 32, 34
24	12, 14, 16, 18	24, 26, 28, 30, 32, 34, 36, 38
26	14, 16, 18, 20	24, 26, 28, 30, 32, 34, 36, 38
28	14, 16, 18, 20	26, 28, 30, 32, 34, 36, 38, 40
30	14, 16, 18, 20	26, 28, 30, 32, 34, 36, 38, 40
32	16, 18, 20, 24	32, 34, 36, 38, 40, 42, 44, 46
34	16, 18, 20, 24	32, 34, 36, 38, 40, 42, 44, 46
36	16, 18, 20, 24	36, 38, 40, 42, 44, 46, 48, 50
42	20, 24, 30, 36	36, 38, 40, 42, 44, 46, 48, 50
48	24, 30, 36, 42	40, 42, 44, 46, 48, 50, 52, 54

JOIST-BAND (WIDE) BEAMS

Depth, h, (in.)	*Widths, b, (in.)*	*Clear Spans (ft)*
12.5	24, 36, 48	12, 14, 16, 18, 20, 22, 24, 26
14.5	24, 36, 48	12, 14, 16, 18, 20, 22, 24, 26
16.5	24, 36, 48	16, 18, 20, 22, 24, 26 ,28, 30
18.5	24, 36, 48	16, 18, 20, 22, 24, 26 ,28, 30
20.5	24, 36, 48	20, 22, 24, 26, 28, 30, 32, 34
24.5	24, 36, 48	20, 22, 24, 26, 28, 30, 32, 34
28.5	24, 36, 48	22, 24, 26, 28, 30, 32, 34, 36



(Bot. and shrinkage-temperature bars in slab not shown.)

Figure 12-2 Typical Beam Section at Support

Selection of Beam Sizes. One of the main advantages of reinforced concrete construction is the wide range of possible sizes for the structural members. Reinforced concrete beams may be wide and shallow or narrow and deep. For uniform depth joist-beam construction, using a single flat bottom form for a level ceiling that facilitates construction, the beams will be shallow and require more flexural reinforcement. Ordinarily, these shallow beams are proportioned to a width that eliminates or minimizes shear reinforcement, which is costlier per pound than the larger flexural reinforcing bars. For minimum flexural reinforcement, the Code requires that $A_s = 3\sqrt{f'_c}\, b_w d/f_y \geq 200\, b_w d/f_y$ (ACI 10.5.1). With shallow beams, deflections are more critical and must be carefully controlled.

Criteria for Selection of Flexural Reinforcement Area. The ratio of flexural steel, $\rho = A_s/bd$, used in these designs lies between minimum and maximum limits set by the Code (ACI 10.5.1) and (ACI 10.3.4), respectively. The ratio, ρ, is based on the web width, b_w, of the rectangular section so that the tabulated designs are conservative for the positive design moment strength when slabs are on one or both sides, and slabs may be of any depth.

The values of ρ used to develop the tables for the designs of each beam cross section (h by b_w) are:

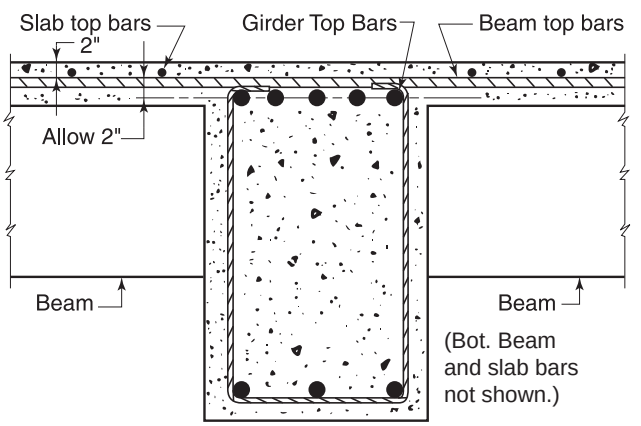
a. Minimum $\rho = 0.0033$ (ACI 10.5.1)

b. $\rho = 0.21\rho_b = 0.0060$

c. $\rho = 0.42\rho_b = 0.0120$

d. Maximum $\rho = 0.63\ \rho_b = 0.0181$ (ACI 10.3.4)

Where ρ_b is the balanced ratio ($\rho_b = 0.0285$ for f'_c = 4,000 psi and f_y = 60,000 psi).



Note: Top bars of beam and slab form two-way mat for crack control (ACI 10.6).

Figure 12-3 Typical Girder Section at Support

Stirrups. The ACI Building Code provides an upper limit on the factored torsional moment, T_u, due to the continuity of the slab and spandrel beam, where open stirrups are permitted (ACI 11.5.2.2). This upper limit on the factored torsional moment is:

$$T_u \leq \phi 4\sqrt{f_c'}\left(\frac{A^2_{cp}}{p_{cp}}\right)$$

The stress $4\sqrt{f_c'}$ is equal to the assumed cracking stress. When T_u is more than:

$$T_u > \phi \sqrt{f_c'}\left(\frac{A^2_{cp}}{p_{cp}}\right)$$

Closed stirrups are required to resist combined shear and torsion.

Beams are exempt from the minimum stirrup requirements if total depth, h, does not exceed 10 in. (ACI 11.4.6.1-d); and for beams monolithic with slabs if h does not exceed 24 in. and h is not greater than the larger of 2.5 times thickness of flange, or one-half the width of the web (ACI 11.4.6.1-e). This latter provision greatly reduces stirrup requirements in the shallow joist-band (wide) beam sizes.

Special Design Data. In addition to the load capacity and stirrup (open or closed) requirements for the usual range of spans, the tabulated designs include design data for making short-cut design adjustments for: (1) spans outside the ranges tabulated, (2) design of girders with concentrated load patterns, (3) adjustment of flexural reinforcement for unusual end restraint conditions, and (4) actual deflection predictions where necessary for fit of other materials, and camber. The tabulated designs include values of:

$+\phi M_n$ = positive design moment strength as individual beams

$-\phi M_n$ = negative design moment strength as individual beams

C = deflection coefficient such that $\Delta = (C \times 10^{-9})(w\ell_n^4)$

The tabulated designs also include the total weight of the steel reinforcement (flexural reinforcement and stirrups).

BASIS FOR DESIGN

Load Capacities. The tabulated designs are based on uniformly distributed loads. Moments and shears are calculated using simplified coefficients (ACI 8.3.3). Materials are normal-weight concrete, $w_c \simeq 150$ pcf, with f_c' = 4,000 psi, and reinforcing bars with f_y = 60,000 psi. The design moment strengths were computed using the rectangular stress block specified in the Code (ACI 10.2.7).

Flexure. See Chapter 5 for a general explanation of moment coefficient analyses. The general limitations of the moment coefficients are of particular interest in the design of beams. The tabulated designs in this Chapter will require adjustments when the particular project conditions of adjacent span lengths exceed the limit 1.20 for long/short span; live load, L, exceeds three times dead load, 3D, unfactored; or where concentrated loads occur as in girder design.

Concentrated Loads. Girder design can be simplified by use of the tabulated beam designs, but the concentrated beam loads must be combined for flexure with the uniform load moments. Both positive and negative design moment strengths are listed (in the second-to-last column) for each tabulated beam design. In using the tabulated designs to select a girder design, use (h – 2 inches) to allow for lowered top bars; that is, for a girder with overall depth 30 inches, select a tabulated design for h = 28 inches. This adjustment should result in the correct negative design moment strength. Positive moment strength should be based on the overall depth of h = 30 inches. See the girder design (Example 2) under "Beam Tables–Examples of Use." See Fig. 12-3.

Variable Span Lengths. At the ends of beams, continuous over interior supports, the total area of top reinforcement, used as a basis for computing negative moment design strength, is shown as straight top bars. When designs selected for adjoining spans do not provide the same area of top bars, adjustment of the total top reinforcement should be made by varying the size or number of top bars in proportion to the average of the two spans. End span reinforcement governs at the first interior support where spans are equal.

Shear. Shear has been computed assuming the load capacity shown is uniformly distributed along the entire length of the beam. For concentrated loads or partial loadings (uniform distribution on part of the beam), the shear capacity should be checked even though these loads may produce bending moments equivalent to those for the tabulated uniform load capacity.

The quickest solution to take into account concentrated loads, as on girders, is to compute the sum of the concentrated load shear and the uniform load shear, and select a tabulated stirrup pattern for the same size beam under uniform load generating shear equal to this sum.

For girders supporting a single beam at the center, flexural design will control. The tabulated stirrup design for an equivalent uniform load moment will suffice at the support, and a stirrup pattern for a lower uniform load may be selected and extended from the support throughout the span. For girders resisting loads from two or more beam loads, the stirrup pattern for a heavier load (than equivalent for moment) will be required. In either case, the design time to determine a tabulated stirrup size and spacing at the support for the combined shear will be less than for complete manual computation of the required stirrups. See the girder design (Example 2) under "How to Use Tabulated Designs." Concentrated loads may require an essentially uniform stirrup spacing between face of the support and the load point.

Partial loadings in particular may require stirrups beyond the pattern required for full uniform load. In many cases, it will suffice to provide an arbitrary extension of stirrup reinforcement across the span between the points where shear calculations based on only full uniform load indicate stirrups are no longer required.

All of these adjustments can usually be made without separate calculations, by visual selection of tabulated stirrup patterns as illustrated in the examples.

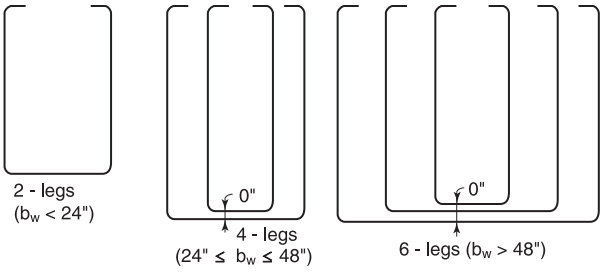
The first line of each tabulated design shows open U-stirrups required with negligible torsion. See Fig. 12-4, "Typical Open Stirrups and Closed Stirrups." These designs suffice for vertical shear due to tabulated load capacity, including a factored torsional moment

$T_u \le \phi\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right)$ (ACI 11.5.1a).

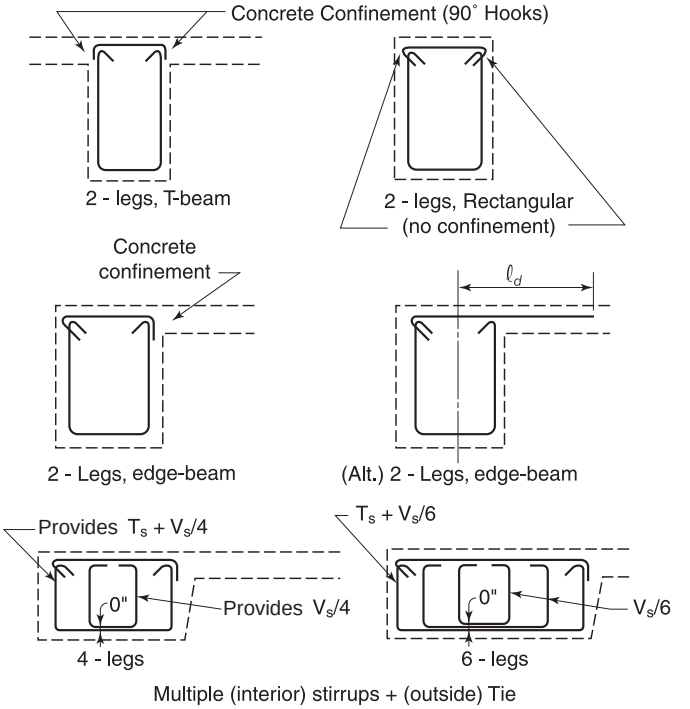
Torsion. Closed stirrups for shear plus maximum torsion are shown on the second line of each tabulated design. See Fig. 12-4 for details appropriate for *two-piece* closed stirrups, necessary for practicable field assembly. These designs are for $T_u \le \phi 4\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right)$

This torsional moment is the maximum required for the common case where torsion (as in a spandrel) results from the interior of the (statically indeterminate) structure (ACI 11.5.2.2). It is assumed that minor cracking at this stress with stirrups yielding will reduce torsional stiffness, like a hinge, precluding any increase in torsion load. Statically determinate torsion effects requiring torsional moment strength for stability to maintain equilibrium, as in cantilever supports, where the required torsional resistance is equal to the factored torsional moment (ACI 11.5.2.1). Such designs must be "custom made" if T_u required exceeds $\phi 4\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right)$.

For such designs, where multiple closed stirrups are required, note that only the outer two legs are proportioned for torsion. All interior legs resist only vertical shear. See Fig. 12-4.



(a) Open stirrups for shear plus torsion; $T_u \le \phi\sqrt{f'c}\,(A^2_{cp}/p_{cp})$



(b) Various closed two-piece "stirrups"; required only with torsion where; $\phi\sqrt{f'c}\,(A^2_{cp}/p_{cp}) < T_u \le \phi\ 4\sqrt{f'c}\,(A^2_{cp}/p_{cp})$. For $b_w \ge 24$", add interior open stirrups as required above.

NOTE: In the absence of specific ACI Code limitations on maximum beam widths for 2-leg, 4-leg, or 6-leg stirrup combinations, the limits shown above were applied by CRSI. Users of this Handbook should apply their best judgment to set maximum width limits for their designs. Also see ACI R11.4.7.

Figure 12-4 Typical Open Stirrups and Closed Stirrups

Development of Flexural Reinforcement. See Fig. 12-1. The recommended detail at free ends in the end spans of beams consists of straight extension of all bottom bars and properly anchored top bars. The recommended details and bar sizes are compatible for uniform loads and spans that vary by no more than 20 percent, the limitation of coefficients for design (ACI 8.3.3). Where a short span is located between two long spans at or near $\ell_{n1} = 1.2\ \ell_{n2}$ and the expected live load varies from zero to 100 percent, approximately 20 percent of the top reinforcement should be made continuous across the shorter span because a negative bending moment can develop across the entire shorter span. At other cases of long-short spans near the limit 1.20, it will suffice to extend top bars in the shorter span to $0.40\ \ell_{n2}$ where ℓ_{n2} is the short span.

The tabulated designs were prepared with optimum bar sizes selected for the recommended details in Fig. 12-1. The computer program computes the "exact" steel area required for flexure. Steel areas furnished are by the least number of largest bars that could be developed, as well as steel areas for the next lower sizes, down to #4. The number of bars required in each size was then compared to the minimum number required for crack control and to the maximum number allowed for fit. Unsuitable sizes were rejected. The bar size selected was the largest size whose area did not exceed the area of the smaller usable size by more than 5 percent, for economy in placing.

Thus, for project conditions within the stated limitations, the tabulated beam designs herein can be used as the basis for a tentative design. Commonly, however, it may be expected that conditions special or even unique to a particular project will occur. In these cases, the tabulated designs must be appropriately adjusted. Adjustments may or may not require a change in the required steel areas. If so, these adjustments for moment conditions other than those used for the tables (see "Flexure" on Page 12-3) are straightforward arithmetic.

The "art" of design in reinforced concrete begins after this straightforward arithmetic. The selection of bar sizes and detail arrangements is a vital part of this art. The most frequent adjustment of tabulated designs (or converting theoretically required steel areas to actual bars) occurs when said bars must fit *between* other bars. If column bars are spaced to provide four spaces through which beam bars must pass, and tabulated beam designs show numbers higher than four, an adjustment is required. In some cases, column bar sizes may be revised or column bars may be bundled to provide clearances. (Bundling of beam bars is also permitted, but may be counterproductive as bundled bars in flexural tension areas involve further Code restrictions.) In cases where only the top bars tabulated cause fitting problems, the excess above those fitting through the column may be located outside the column in the beam flange. See "Crack Control" on Page 12-11.

In remaining cases, a change in tabulated number of bars will be required. If a larger bar size is necessary, the development length of the larger bars must be checked. Conformance to development requirements in the Code may require longer extensions.

The "Recommended Bar Details for Beams" (Fig. 12-1) are for general use (by CRSI). They satisfy Code requirements for development with uniform beam loading, common girder loadings combining some uniform load and one or more concentrated beam loads (excepting the case of "pure" third point concentrated loads).

HOW TO USE TABULATED DESIGNS

Steps in selecting a tabulated design and adjusting it to special conditions of a project are reviewed below:

Beam Dimensions

Step 1. Consider an entire floor building layout, comparing conditions along the entire length of continuous beams in one direction. Decide whether conditions are similar enough to justify one width for all interior beams and one for all spandrel beams. A width for minimum stirrups will be most economical. Depth of all beams should normally be held uniform for practical reasons (head room and formwork economy). Take the controlling span conditions (highest shear); with equal spans, it is usually the first interior support on the end span side.

Enter END SPAN beam tables with controlling load (kips/foot) and clear span (feet) for the interior beam lines for cases where spans are not equal. Select width-depth combination within established architectural limits for near-to-minimum stirrups. If possible for the controlling condition, use width-depth combination adequate on second or third line in tables, since all other spans will require less than the controlling condition. Record flexural reinforcement bar sizes as tentative choices, and stirrup pattern designation number.

Step 2. Continue selections in INTERIOR SPAN tables for remainder of the continuous line of beams. Enter for same width/depth combination with load and span data for each (the span, and often load, may be same as for end span). Record flexural reinforcement bottom bar sizes and number as tentative choices, as

well as stirrup designation number for each span. For top bars, if adjacent spans vary, average spans on both sides of support and enter tables with average span and load for each end of the span considered.

Step 3. Reconcile tentative design. Check size and location of spaces between the column vertical bars and the space outside same in beam if the beam is wider than the column for bottom bars, and possible location outside the column vertical bars in slab adjacent to the column for top bars. Be sure bars selected will fit in these spaces. If possible use the same size bars throughout as bottom bars; then, similarly for top bars. If two bar sizes are tabulated for bottom bars for say, END SPAN, try to use the same two sizes throughout.

Step 4. Adjust the basic design as necessary where project conditions lie outside Code limits on moment coefficients and shears. Adjust factored moments and shears, adjust bar lengths and sizes, and note conditions where factored shear is higher or non-uniform. For higher factored shear, select stirrup pattern from other beam designs having required design shear strength instead of stirrup pattern tabulated for beam selected. Be sure space is available for bars selected. Record flexural reinforcement, and stirrup patterns for design drawings.

Step 5. Consider torsion. Closed stirrups for torsion are seldom necessary for beams supporting slabs on both sides. If slab loading is unequal, or if interior openings are present only on one side, compute factored torsional moment, T_u, as the difference in end moments from the slabs with live load on one side only. If $T_u \le \phi\sqrt{f'_c}(A^2_{cp}/p_{cp})$, neglect torsion. Where larger T_u exists, beam has to be designed for combined shear and torsion.

Step 6. Structurally detail the reinforcement to comply with the requirements for structural integrity (ACI 7.13).

Exterior Line Spandrel Beams

Same steps as for interior lines of beams except:

Step 1. In addition to factored gravity loads and spans, design data to enter the tabulated designs should include factored torsional moment, T_u. Factored torsional moment may be actual factored end moments from continuity or $T_u \le \phi\, 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$, whichever is less; or actual cantilever type factored torsional moment required for equilibrium if larger than the lesser of $\phi 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$ or continuity end moment torsion. Two values of design torsional moment strength, ϕT_n, are given in the tabulated designs. The value on the first line corresponds to $\phi T_n = \phi\sqrt{f'_c}(A^2_{cp}/p_{cp})$. The value of ϕT_n on the second line corresponds to $\phi\, 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$.

Where $T_u > \phi\, 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$, use a larger beam section if possible; otherwise a special design is required, and torsional reinforcement could be very costly. For $\phi\sqrt{f'_c}(A^2_{cp}/p_{cp}) < T_u \le \phi\, 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$, use the tabulated designs. Try to select beam dimensions where $T_u \le \phi\sqrt{f'_c}(A^2_{cp}/p_{cp})$ so that no (closed) stirrups are required for torsion, except perhaps where only one span in a long series of spandrel spans has to resist a special factored torsional moment, and it would require a disproportionately large beam section.

Step 2, 3, and 4. Same as for interior beams, unless factored torsional moment, $T_u > \phi\, 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$. In this case, record T-designations for closed stirrups.

Step 5. Sketch cross-sections of the spandrel beams and fit flexural reinforcement inside an appropriate closed stirrup shape. Each closed stirrup should be formed in two pieces for facilitating field assembly. See suggested shapes, Fig. 12-4. Finally, add tabulated additional longitudinal face reinforcement (A_ℓ) bars inside the closed stirrups. These bars, with a nominal diameter at least 1/24 of the stirrup spacing, must be distributed around the perimeter of the beam spaced not more than 12 inches apart (around the perimeter) with at least one bar, principal or added, in each corner of the stirrups (ACI 11.5.6.2).

Step 6. Structurally detail the reinforcement to comply with the requirements for structural integrity (ACI 7.13).

Girders

All steps listed for beams apply to girders. One additional consideration here is that the effective depth of the girder should be taken as 2 inches less than the actual depth, *h*, to allow space for beam bars to cross above top girder bars.

The main difference between beams and girders is in the variable load patterns commonly associated with girders. To apply the tabulated uniformly loaded beam designs herein to girders with one or more concentrated loads, equivalent uniform beam loadings must be selected separately for factored shear and moment. Alternatively, total factored moment may be used as a basis for design. See next to last column of tables for design moment strengths, $-\phi M_n$ and $+\phi M_n$. If width/depth dimensions are selected for factored moment requiring flexural reinforcement on the fourth

line (heaviest) for each size, the stirrup pattern from one of the preceding lines will often suffice for the girder shear.

BEAM TABLES–EXAMPLES OF USE

Example 1. Design Beam B1. See Fig. 12-5 for plan dimensions. Service live load = 150 psf. In addition to floor loads, make allowance for a future partition; a service line load of 200 plf. f'_c = 4,000 psi. f_y = 60,000 psi. Conditions permit use of total depth, h = 30 in. Clear span, ℓ_n = 30 ft.

Actual Loads

Slab: (6/12)(150)	=	75 psf
Ceiling and floor finish	=	10 psf
		85 psf

Estimate weight of beam stem:
(18 × 24)(150)/(144) = 450 plf

Factored Loads

Contributory area *DL* = 1.2(85)(14)	=	1,428 plf
Contributory area *LL* = 1.6(150)(14)	=	3,360
		4,788 plf
Beam stem *DL* = 1.2(450)	=	540
Future partition = 1.2(200)	=	240
	w_u =	5,568 plf

Step 1. Enter End Span tables for Beam B1 (end span) on Page 12-40. Enter tables for $h = 30''$ and $\ell_n = 30'$.
Read: • 14 × 30, capacity = 5.70 kips/ft > 5.57
Top: 3-#11 bars; Bottom: 2-#14 bars; #5 stirrups
• 16 × 30, capacity = 6.36 kips/ft > 5.57
Top: 4-#11 bars; Bottom: 3-#11 bars; #5 stirrups
• 18 × 30, capacity = 8.05 kips/ft > 5.57
Top: 3-#14 bars; Bottom: 3-#14 bars; #5 stirrups
• 20 × 30, capacity = 5.90 kips/ft > 5.57
Top: 3-#11 bars; Bottom: 3-#11 bars; #4 stirrups

Compare designs:

Any one of the designs can be selected.

16 × 30 design avoids use of #14 bars required in 18 × 30 design.

Both the 16 × 30 and the 20 × 30 designs use #11 flexural reinforcement, but the 20 × 30 design uses #4 open stirrups while the 16 × 30 design uses #5 open stirrups.

The 14 × 30 design is selected for this example.

Flexural reinforcement is tabulated for load capacity = 5.70 kips/ft and factored load is 5.568 kips/ft. Reduction is possible in the ratio (5.57/5.70) = 0.98, but 2% is insignificant.

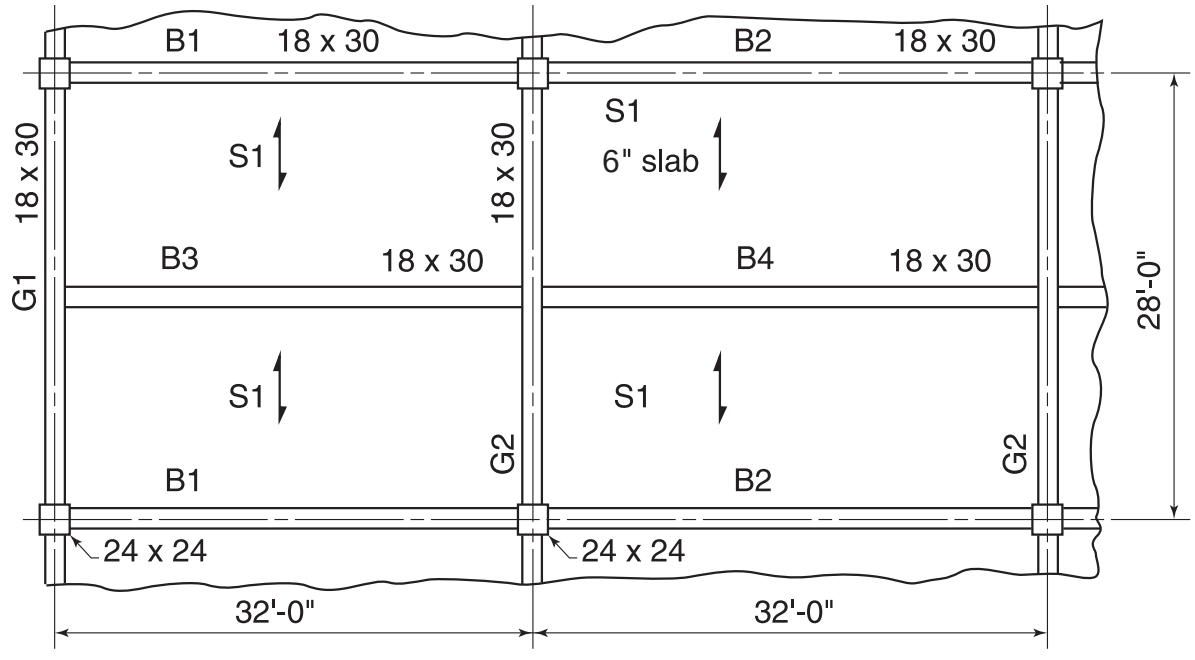


Figure 12-5 Plan Dimensions – Examples 1 and 2

At discontinuous end, $-M_u$ = (11/16) ($-M_u$ for interior column).

Bottom bars: 2-#14

Top bars: 3-#11. (Over first interior column, A_s = 4.68 in.^{2})

At discontinuous end, required A_s = (11/16)(4.68) = 3.22 in.^{2} Use 4-#8 bars with standard 90° end hooks.

Adjustment of open stirrup quantities or pattern by 98% is not feasible since stirrups are nearly spaced at max s; d = 27.2″; max $s = d/2$ = 13.6″ ≈ 13″. Stirrup pattern is 145K; see Page 12-14; 14-#5: 1 @ 2″ and 13 at each end (EE).

Example 2. See Fig. 12-5. Design interior girder, G2. In addition to loads from beams, a line load (partition) of 200 plf is supported by the girder. Clear span, ℓ_n = 26 ft. Assume overall depth, h, not to exceed 30 in.

Step 1. Convert to uniform loads.

Concentrated load at center = 5.568 kips/ft (32 ft) = 178.2 kips. Assume stem width = 18″:

Uniform Loads:

Stem	(18 × 24)(150/144) = 450 plf	× 1.2 = 540 plf
Partition	= 200	× 1.2 = 240 plf
	Factored total load =	780 plf

Concentrated load factored moment, M = (178.2 × 26)/8 = 579 ft-kips. Equivalent uniform load, $w = (11 \times M)/\ell_n^2$ for end moment, $w = 11(579)/(26)^2$ = 9.42 kips/ft

Total equivalent factored uniform load (for $-M_u$), w_u = 9.42 + 0.78 = 10.20 kips/ft

Factored positive moment, $+M_u = 579 + 0.78(26)^2/16$ = 612 ft-kips

Or total equivalent uniform load (for $+M_u$), $w_u = (16 \times 579)/(26)^2 + 0.78$ = 14.48 kips/ft

Step 2. Enter Interior Span Tables. See Page 12-68. Enter tables for h = 28″ under "Interior Spans." Read for ℓ_n = 26 ft:

18 × 28, capacity = 10.80 kips/ft > 10.20, Okay

Bottom bars: 3-#11

Top bars: 3-#14

Stirrup designations: 145GeJ and 315C

Torsional design moment strength (with open stirrups) = 13 ft-kips

Estimate T_u for G2 with live load on one side only:

w_u (live load) = 1.6(0.150)(14) = 3.36 kips/ft

$$T_u = \frac{1}{11}(3.36)(30.5)^2 = 284 \text{ ft-kips}$$

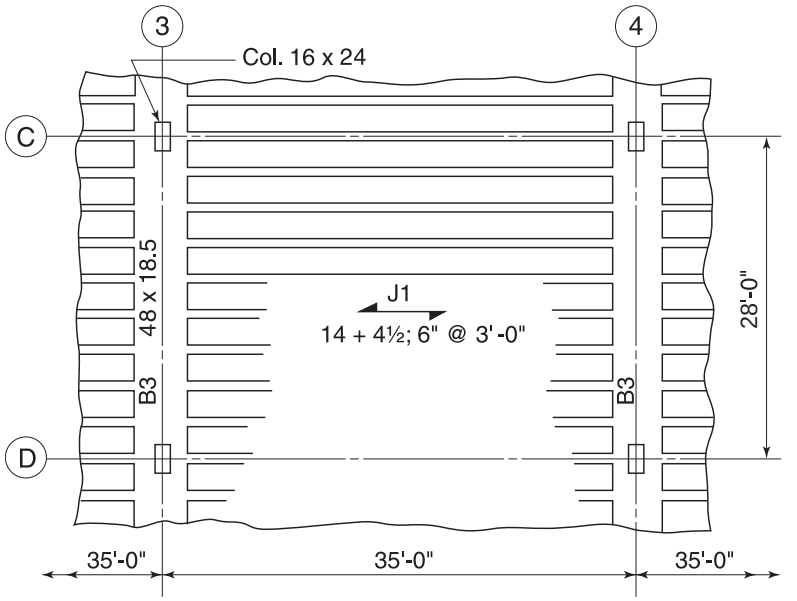


Figure 12-6 Plan Dimensions Joist-Band Beam Floor

This total unbalanced torsional moment will be distributed (see Fig. 12-5) among the B3-B4 tee-beams, which have an estimated flexural stiffness, $2K_b$ = $1{,}700E_c$; and to two sides of girder G2, which have an estimated torsional stiffness $(60E_c)2 = 120E_c$.

$$T_u \text{ in G2} = \frac{K_t}{2K_t + 2K_b}(284)$$
$$= \frac{60}{1820}(284) = 9 \text{ ft-kips} < 13$$

Closed stirrups and additional longitudinal bars for torsion are not required.

Check shear: Max $V_u = (178.2/2) + (0.78 \times 13) = 99.2$ kips

Equivalent w_u for shear = (99.2/13) = 7.63 kips/ft < 10.80. Initial stirrup spacing — Okay

Step 3. Bottom bars; equivalent w_u = 14.48 kips/ft and $+M_u$ = 612 ft-kips. See Page 12-70; use h = 30″. For ℓ_n = 26′-0″, a beam 20″ × 30″ with 3-#14 (A_s = 6.75 in.^{2}) bottom bars capacity = 15.28 kips/ft and $+\phi M_u$ = 734 ft-kips. Reduction in A_s is possible in the ratio (734–612)/734 = 0.17, but is not pursued. Use 3-#14.

Step 4. Adjust initial stirrup spacing for equivalent w_u = 7.63 kips/ft for full span. For the tabulated design above the one selected for negative design moment strength, the shear strength = 7.88 kips/ft, stirrup pattern 125J. See Page 12-68: 12-#5, 1 @ 2″, 10 @ 12″ each end (EE).

Example 3. See Fig. 12-6. Design a joist-band beam, B3, for typical interior clear spans, ℓ_n, = 26′-0″, with f'_c = 4,000 psi and f_y = 60,000 psi for the following loads: partitions 20 psf, floor plus ceiling finish, 5 psf, and a specified service live load = 50 psf. Overall depth, h = 18.5″.

Step 1. Compute factored loads:

Joist-slab system		
(0.61 c.f.)(150)	=	92
Partitions	=	20
Floor and ceiling finishes	=	5
Factored dead load (total)	=	117 psf × 1.2 = 141 psf
Factored live load	=	50 psf × 1.6 = 80 psf
		Area factored load, q_u = 221 psf

Step 2.

For beam width b = 48″. Added line load for beam stem:

(1.2) [18.5 – (0.61)(12)](48)(150/144) = 671 plf

$w_u = (0.221 \times 35) + 0.671 = 8.41$ kips/ft

Step 3. Enter Interior Span tables for joist-band beams, Page 12-103, for ℓ_n = 26 ft., h = 18 in. and b = 48 in.

Read for third design: capacity = 11.02 kips/ft > 8.41. Okay

Open stirrups: 184E

See Fig. 12-4: 4 stirrup legs are required.

See Page 12-14. “184E” is 18-#4, 1 @ 2″, 17 @ 7″ at each end (E.E.)

Spacing of 7″ ≈ 0.5d so no real reduction in stirrups is possible.

Flexural reinforcement:

Top: 7-#11 bars; Bottom: 6-#10 bars

It is possible to reduce the top flexural reinforcement by 8.41/11.02 = 0.76, but the 24% reduction is not made here.

Top: use 7-#11 bars
Bottom: use 6-#10 bars
} See Fig. 12-7

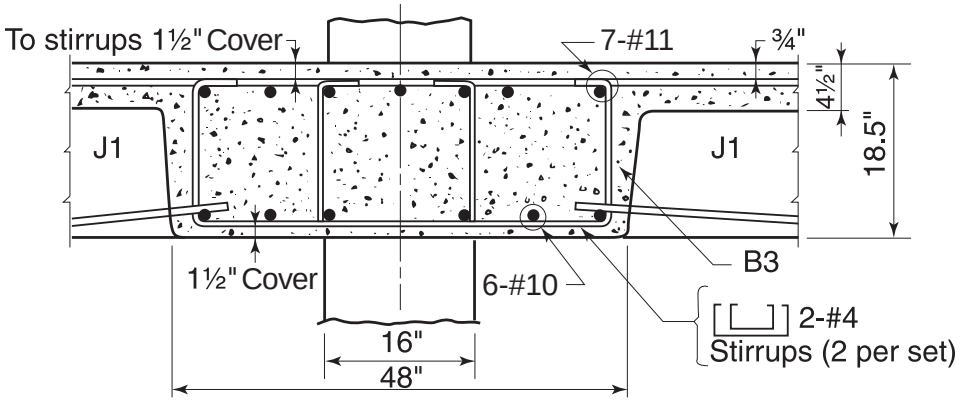


Figure 12-7 Joist-Band Beam B3

Table 12-1 Moments of Inertia, in.^{4} per 12 in. Width*

t for I_g / d for I_{cr}	$I_g = t^3$	I_{cr} – Moment of Inertia, in.^{4} per foot of width, Cracked Transformed Section									
		Reinforcement ratio, ρ (Average top and bottom ρ for end and interior span)									
		0.009	0.010	0.011	0.012	0.013	0.014	0.015	0.016	0.017	0.018
10”	1,000	530	574	617	658	697	735	772	808	843	877
12”	1,728	916	993	1,066	1,137	1,205	1,271	1,335	1,397	1,457	1,515
14”	2,744	1,455	1,576	1,693	1,806	1,914	2,019	2,120	2,219	2,314	2,406
16”	4,096	2,172	2,353	2,528	2,695	2,857	3,014	3,165	3,312	3,454	3,592
18”	5,832	3,093	3,351	3,599	3,838	4,069	4,291	4,507	4,716	4,919	5,115
20”	8,000	4,243	4,597	4,937	5,265	5,581	5,887	6,183	6,469	6,747	7,017
22”	10,648	5,648	6,119	6,572	7,008	7,429	7,836	8,229	8,611	8,981	9,340
24”	13,824	7,332	7,944	8,532	9,098	9,645	10,173	10,684	11,179	11,660	12,126
26”	17,576	9,322	10,100	10,848	11,568	12,263	12,934	13,584	14,214	14,824	15,417
28”	21,952	11,644	12,615	13,548	14,448	15,316	16,155	16,966	17,753	18,515	19,255
30”	27,000	14,321	15,516	16,664	17,770	18,838	19,870	20,868	21,835	22,773	23,683
32”	32,768	17,381	18,830	20,224	21,567	22,863	24,115	25,326	26,500	27,638	28,743
34”	39,304	20,848	22,586	24,258	25,869	27,423	28,925	30,378	31,786	33,151	34,476
36”	46,656	24,747	26,811	28,796	30,708	32,553	34,335	36,060	37,731	39,352	40,925
38”	54,872	29,105	31,533	33,867	36,115	38,285	40,382	42,411	44,376	46,282	48,132
40”	64,000	33,947	36,778	39,501	42,123	44,654	47,099	49,466	51,758	53,981	56,139
42”	74,088	39,298	42,576	45,727	48,763	51,693	54,523	57,263	59,916	62,490	64,988
	C	0.530	0.575	0.617	0.658	0.698	0.736	0.773	0.809	0.843	0.877
	k	0.314	0.328	0.341	0.353	0.364	0.374	0.384	0.394	0.403	0.412

$k = \sqrt{2\rho n + (\rho n)^2} - \rho n$ $\quad C = [4k^3 + 12n\rho\,(1-k)^2]$ $\quad I_{cr} = Cd^3$

*These coefficients are based on E = 3,605,000 psi for normal-weight concrete with f'_c = 4,000 psi. They are applicable, however, for most purposes for 3000 psi < f'_c < 5,000 psi.

DESIGN FOR SERVICEABILITY

Control of Deflections. For routine use of the tabulated beam designs, it should not be necessary to compute live load deflection. Unless marked with an *, X, or Y, to footnote references, all the tabulated load capacities with 100 percent of the live load cause deflection less than ℓ/360. Thus, live load deflection automatically conforms to the usual limit required (ACI 9.5.2.6). Where necessary, the coefficients tabulated for each beam design should be helpful in computing the deflection for any special requirements such as stricter deflection limits, or to subtract superimposed dead loads. When long-term (creep) deflections must be determined, it will be necessary to compute the sum of the service dead load and long-term portion of the service live load, as well as the proper coefficient for creep since these values vary with type of loading considered. Where conditions require that an estimated deflection for a particular beam be prepared, the coefficients in Table 12-1 will be convenient for determination of gross and cracked moments of inertia required.

COEFFICIENTS FOR DEFLECTION COMPUTATIONS

If live load is limited by the requirement that immediate deflection is not to exceed 1/360 times the span, the following formulas may be used to determine maximum load:

Single Span $\quad W = 5{,}250\, I/L^3$
End Span $\quad W = 8{,}050\, I/L^3$
Interior Span $\quad W = 13{,}050\, I/L^3$

in which W = actual load(not multiplied by load factors) in plf
L = span in feet
I = average effective moment of inertia in in.^{4}

Moment of inertia for a reinforced concrete member can involve complex manual computations. The Code permits use of the *average* of positive and negative moment sections, that is, midspan and face of support (ACI 9.5.2.4).

The *effective* moment of inertia, I_e, is

$$I_e = \left(\frac{M_{cr}}{M_a}\right)^3 I_g + \left[1 - \left(\frac{M_{cr}}{M_a}\right)^3\right] I_{cr} \qquad \text{(ACI Eq. 9-8)}$$

in which the cracking moment for normal-weight concrete, $M_{cr} = 7.5\sqrt{f_c'}\, I_g/y_t$ and M_a = actual service load moment. Values of I_g per foot of width are equal to t^3, where t is the overall depth of the member. The transformed moment of inertia:

$$I_{cr} = d^3\,[4k^3 + 12\,n\rho\,(1-k)^2]$$

where: $n = E_s/E_c$

$$k = \sqrt{2\rho n + (\rho n)^2} - \rho n$$

is tabulated in Table 12-1 for $0.009 \le \rho \le 0.018$. For $\rho < 0.009$, a conservative solution is to use I_{cr} for $\rho = 0.009$ and (M_{cr}/M_a) = 0.5.

Note: For intermediate values of depth or reinforcement ratio, straight line interpolation is sufficiently accurate. For depths beyond the range tabulated, use value of *C* (bottom line) for computation of I_{cr}.

Crack Control. Chapter 6 in this Handbook includes a discussion of Code requirements for crack control. All tabulated designs here comply with crack control requirements for beam stems (ACI 10.6).

Top bars in beams, and also in girders, must be physically located above the beam stem in usual situations where the beam supports the slab and girders support the beams. Crack control at the top surface is mainly dependent upon the one or two layers of slab bars above the top beam bars, and both slab and beam bars above top girder bars. Tabulated designs provide number of top bars accordingly.

For isolated T-beams, I-beams, or other flanged shapes, top bars must be spaced across the width of flanges in tension (ACI 10.6.6).

The Code requirements for crack control with Grade 60 reinforcing bars (distribution of flexural reinforcement in beams—ACI 10.6) are:

1. Only deformed bars may be used.
2. Tension reinforcement must be well distributed in zones of **maximum** concrete tension.
3. Where flanges are in tension, part of the main tension reinforcement shall be distributed in the effective flange width or a width equal to 1/10 of the span, whichever is smaller.
4. Spacing of reinforcing bars must not exceed

$$s = 15\left(\frac{40{,}000}{f_s}\right) - 2.5c_c \quad \text{(ACI Eq. 10-4)}$$

but not greater than

$$12\left(\frac{40{,}000}{f_s}\right)$$

where $f_s = (2/3)\ f_y$, psi (assumed)

c_c = concrete cover, in.

Maximum spacing of reinforcing bars, computed by ACI Eq. 10-4 and assuming f_y = 60,000 psi (Grade 60 reinforcing bars) and 1½ inches concrete cover, is as follows:

#3 stirrups - 10¼ in.
#4 stirrups - 10 in.
#5 stirrups - 9½ in.

When the effective depth, *d*, of a beam exceeds 36 inches, skin reinforcement is also required for crack control (ACI 10.6.7). In the tabulated designs in this Chapter, only the beams with overall depths, *h*, of 42 inches and 48 inches will require skin reinforcement, A_{sk}. For *h* = 42 inches or 48 inches, 3-#3 reinforcing bars in each face of the web would provide the required A_{sk}. Skin reinforcement is not listed in the tabulated designs. For beams with rather large cross sections, as in these cases for *h* = 42 inches or 48 inches, the recommended minimum longitudinal bar size is a #5.

MAXIMUM NUMBER OF BARS IN BEAM STEMS

The practical problem of physically fitting the reinforcing bars into the width of stem available between stirrups at Code-required concrete cover and clear spacings between bars limits the *maximum* number of given size bars in a single layer. These Code requirements, for minimum concrete cover and spacing, are based on practical problems of placing concrete, weather, and fire resistance (ACI 7.6.1, 7.6.2, and 7.7.1). The ACI Building Code concrete cover requirements and the concrete cover used in the tabulated designs are shown in Fig. 12-8. Maximum number of bars in beam stems are based on concrete cover and clear spacings (Fig. 12-9) and overall (not nominal) bar diameter.

Tables 12-2(a) and 12-2(b) give the minimum and maximum number of reinforcing bars in a single layer in beam stems. The values in the tables are based on combining the Code requirements for crack control and the provisions for clear spacings. An "N.A." in the tables indicates that the maximum number of reinforcing bars, based on the required clear spacing including aggregate size and concrete cover, is less than the minimum number of bars which are required for crack control.

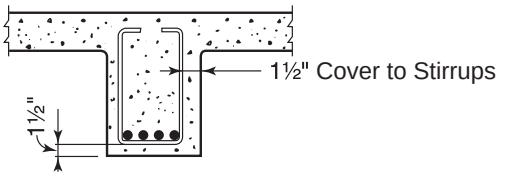


Figure 12-8 Concrete Cover Requirements for Cast-in-Place Beams

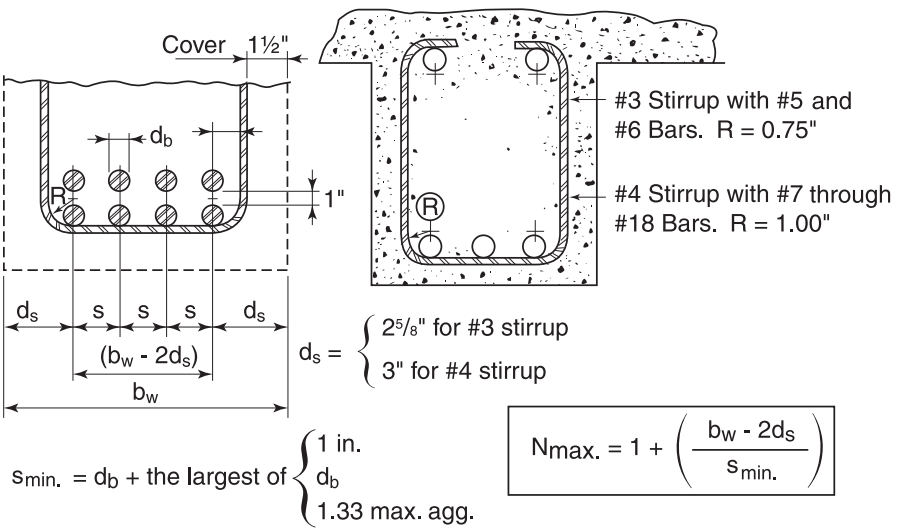


Figure 12-9 Maximum Number of Bars in Beam Stems

Table 12-2(a) – Minimum and Maximum Number of Bars in a Beam (Single Layer)
Concrete Cover = 1.5 in. #4 Stirrups Maximum Size Coarse Aggregate = ¾ in.

Beam Width, in.	Minimum, Maximum Number of Bars Per Bar Size																	
	#5		#6		#7		#8		#9		#10		#11		#14		#18	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
8	2	2	2	2	2	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	2	3	2	3	2	4	2	2	2	2	2	2	2	2	2	2	N/A	N/A
12	2	4	2	4	2	5	2	3	2	3	2	3	2	2	2	2	2	2
14	2	5	2	5	2	6	2	4	2	4	2	3	2	3	2	3	2	2
16	2	6	2	6	2	7	3	5	2	5	2	4	2	4	2	3	2	2
18	3	8	3	7	3	8	3	6	3	5	3	5	3	4	3	4	3	3
20	3	9	3	8	3	9	3	7	3	6	3	5	3	5	3	4	3	3
22	3	10	3	9	3	10	3	8	3	7	3	6	3	5	3	5	3	4
24	3	11	3	10	3	11	3	9	3	8	3	7	3	6	3	5	3	4
26	3	12	3	11	3	12	4	9	3	9	3	7	3	7	3	6	3	4
28	4	14	4	12	4	13	4	10	4	9	4	8	4	7	4	6	4	5
30	4	15	4	13	4	14	4	11	4	10	4	9	4	8	4	7	4	5
32	4	16	4	14	4	15	4	12	4	11	4	10	4	9	4	7	4	6
34	4	17	4	15	4	16	4	13	4	12	4	10	4	9	4	8	4	6
36	4	18	4	17	4	17	5	14	4	13	4	11	4	10	4	9	4	6
38	5	19	5	18	5	18	5	15	5	13	5	12	5	10	5	9	5	7
40	5	21	5	19	5	19	5	16	5	14	5	12	5	11	5	10	5	7
42	5	22	5	20	5	20	5	17	5	15	5	13	5	12	5	10	5	8
44	5	23	5	21	5	21	5	17	5	16	5	14	5	12	5	11	5	8
46	5	24	5	22	5	22	6	18	5	17	5	14	5	13	5	11	5	8
48	6	25	6	23	6	23	6	19	6	17	6	15	6	13	6	12	6	9

1. Minimum number of bars is based on crack control requirements of ACI 10.6.
2. Maximum mumber of bars is based on clear spacing requirements of ACI 3.3.2(c) and ACI 7.6.1.
3. Overall bar diameter, rather than nominal bar diameter, was used in calculating the maximum number of bars.

Table 12-2(b) – Minimum and Maximum Number of Bars in a Beam (Single Layer)
Concrete Cover = 1.5 in. #4 Stirrups Maximum Size Coarse Aggregate = 1 in.

Beam Width, in.	Minimum, Maximum Number of Bars Per Bar Size																	
	#5		#6		#7		#8		#9		#10		#11		#14		#18	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	N/A	N/A
12	2	3	2	3	2	4	2	3	2	3	2	3	2	2	2	2	2	2
14	2	4	2	4	2	5	2	4	2	4	2	3	2	3	2	3	2	2
16	2	5	2	5	2	6	3	5	2	4	2	4	2	4	2	3	2	2
18	3	6	3	6	3	7	3	5	3	5	3	5	3	4	3	4	3	3
20	3	7	3	7	3	7	3	6	3	6	3	5	3	5	3	4	3	3
22	3	8	3	8	3	8	3	7	3	7	3	6	3	5	3	5	3	4
24	3	9	3	9	3	9	3	8	3	7	3	7	3	6	3	5	3	4
26	3	10	3	10	3	10	4	9	3	8	3	7	3	7	3	6	3	4
28	4	11	4	10	4	11	4	9	4	9	4	8	4	7	4	6	4	5
30	4	12	4	11	4	12	4	10	4	10	4	9	4	8	4	7	4	5
32	4	13	4	12	4	13	4	11	4	11	4	10	4	9	4	7	4	6
34	4	14	4	13	4	13	4	12	4	11	4	10	4	9	4	8	4	6
36	4	15	4	14	4	14	5	13	4	12	4	11	4	10	4	9	4	6
38	5	16	5	15	5	15	5	14	5	13	5	12	5	10	5	9	5	7
40	5	17	5	16	5	16	5	14	5	14	5	12	5	11	5	10	5	7
42	5	18	5	17	5	17	5	15	5	14	5	13	5	12	5	10	5	8
44	5	19	5	18	5	18	5	16	5	15	5	14	5	12	5	11	5	8
46	5	20	5	19	5	19	6	17	5	16	5	14	5	13	5	11	5	8
48	6	21	6	20	6	19	6	18	6	17	6	15	6	13	6	12	6	9

1. Minimum number of bars is based on crack control requirements of ACI 10.6.
2. Maximum mumber of bars is based on clear spacing requirements of ACI 3.3.2(c) and ACI 7.6.1.
3. Overall bar diameter, rather than nominal bar diameter, was used in calculating the maximum number of bars.

STIRRUP DESIGNATION NOTATION

Stirrup layout pattern is in the following format:

N1 N2 S3 S4 S5 where:

N1 is a two digit number denoting the number of stirrups at each end of the beam.

N2 is a one digit number representing the size designation of the reinforcing bar.

S3 definition depends on whether S4 and S5 are also listed. If S4 and S5 are not listed, then S3 is the symbol for the maximum spacing of the stirrups (inches).

If S4 and S5 are listed, then S3 is the symbol for the intermediate spacing of the stirrups, required at a distance *d* from the face of the support (inches).

S4 is the symbol for the number of stirrups at the intermediate spacing.

S5 is the symbol for the spacing of the remainder of the stirrups (inches).

Note that first stirrup is always 2 inches from the face of the support.

The physical meaning of symbols S3, S4 and S5 are as follows:

S3, S5 (Stirrup Spacings)

Symbol	Spacing	Symbol	Spacing
A	3″	0	16″
B	4″	P	17″
C	5″	Q	18″
D	6″	R	19″
E	7″	S	20″
F	8″	T	21″
G	9″	U	22″
H	10″	V	23″
I	11″	W	24″
J	12″	X	25″
K	13″	Y	26″
M	14″	Z	27″
N	15″		

S4 (Stirrup Number)

Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.
a	1	n	14	A	27	N	40
b	2	o	15	B	28	0	41
c	3	p	16	C	29	P	42
d	4	q	17	D	30	Q	43
e	5	r	18	E	31	R	44
f	6	s	19	F	32	S	45
g	7	t	20	G	33	T	46
h	8	u	21	H	34	U	47
i	9	v	22	I	35	V	48
j	10	w	23	J	36	W	49
k	11	x	24	K	37	X	50
l	12	y	25	L	38	Y	51
m	13	z	26	M	39	Z	52

Examples:

294B means 29-#4: 1 @ 2″, 28 @ 4″ Each End

175K means 17-#5: 1 @ 2″, 16 @ 13″ Each End

275CgF means 27-#5: 1 @ 2″, 7 @ 5″, 19 @ 8″ Each End

305CqH means 30-#5: 1 @ 2″, 17 @ 5″, 12 @ 10″ Each End

SPECIAL STIRRUP LAYOUT REQUIREMENTS

For deep, narrow beam cross sections, closed stirrup requirements for full design torsional moment strength, $\phi T_n \geq T_u \geq \phi 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$, plus high shear may become impracticable for placing reinforcement. Similarly, in shallow beams heavily reinforced for flexure in cases of short spans and high vertical shear, the limited depth precludes use of larger sizes for closed stirrups and the full $\phi T_n \geq T_u$ cannot be developed. These situations indicate that a larger section should be used or that a special design is required (perhaps full $\phi T_n \geq T_u$ is more than required, etc.).

Some intermediate situations may also arise, particularly where a large number of closed stirrups for full $\phi T_n \geq T_u$ are required at a very small intermediate spacing. These layouts are outside the range of the standardized notation in this Chapter for stirrup patterns and must be considered a special case design.

SELECTION OF OPEN STIRRUPS/CLOSED STIRRUPS FOR FLEXURAL MEMBERS UNDER SHEAR OR COMBINED SHEAR AND TORSION

Three principal points that should be kept in mind are:
(1) For structural safety, adequate shear and torsion reinforcement is very important, since the failure mode is brittle. The Code provisions are, properly, conservative to avoid failure with no warning signs as in the ductile flexural mode, that is, cracking, deflection, etc.
(2) For economy in construction, the selection of shear-torsion reinforcement is also important. Per pound, the small pieces of small bars require disproportionately large amounts of high cost shop labor and field labor in placing.
(3) For economy in design time, a complete step-by-step procedure to meet each applicable Code requirement is prohibitive—design aids to avoid all the Code calculations are essential.

Structural analysis can usually be done quickly to establish maximum shear and torsion at the section located a distance, d, from face of supports. The coefficients (ACI 8.3.3) for shear are generally applicable for uniform loads, and are reasonable even where a triangular loaded slab area contributes shear load to the beam. The former assumption results in a linear decrease in shear from face of the support toward midspan. Similarly, torsion from slabs under uniform load is also generally assumed to decrease linearly from the same critical section, d, from face of support.

A refinement used only with heavy live loads (warehouse loads, etc.) when a real probability of partial load exists is to consider a minimum live load shear at interior midspans equal to $w_{v\ell}\,\ell/8$. Usually, shear at midspan is taken as zero.

A corollary of the three points made is that design time is more cost-effective applied to a quick, conservative analysis than a meticulous "minimum weight" layout of an intricate pattern of stirrup spacings. An "exact" minimum weight solution for stirrups with an intricate layout pattern closely following the linear decrease in total shear can be run off from a computer. It is merely a valuable time-saving start in the design process. Adjustment into a simpler pattern can be performed. If necessary to use the maximum spacing, $d/2$, larger size stirrup substitutions may be made, e.g., #4 for #3 at double spacing, #5 for #4 at 1.5 times spacing.

The stirrup layout patterns shown in this Handbook are "minimum cost" solutions. Minimum cost solutions for simple placing of reinforcement were limited to three spacings: the first stirrup located 2 inches from face of support as a minimum clearance, an intermediate spacing, and finally a maximum spacing, usually $d/2$ for open stirrups, and $d/4$ for closed stirrups.

In all cases, the largest practical reinforcing bar size as limited by width or depth of the beam was used. See the following tabulation for minimum width of beam to allow for bend radii at corners of stirrups.

Stirrup	Minimum Width of Beam
#3	10 in.
#4	12 in. – 14 in.
#5	14 in.

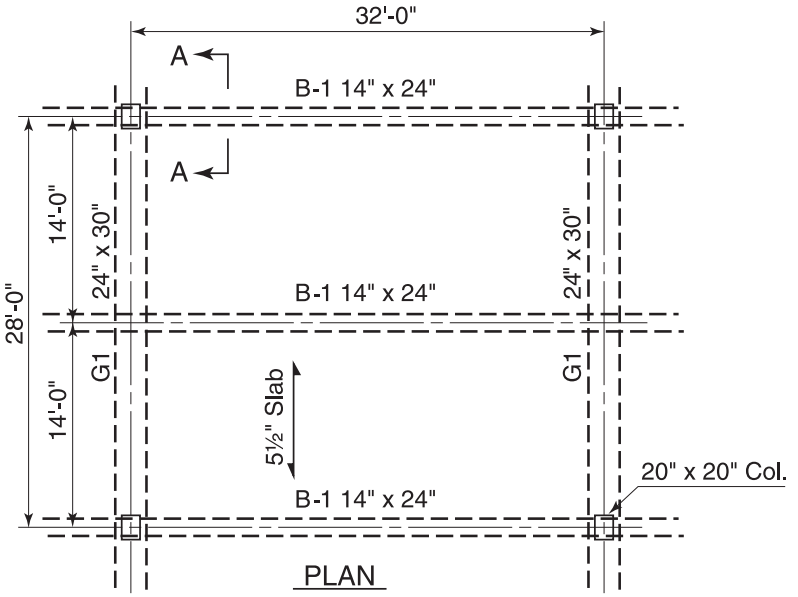
The applicable Code provisions were considered in stirrup selections presented in this Chapter. These requirements affecting both size and *layout* (spacings) of stirrup patterns are listed as follows:

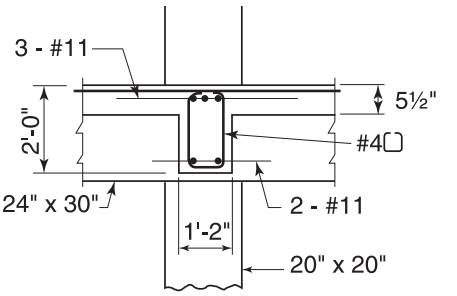
Code Requirements for Stirrup Size and Layout

11.4.4	Extend $(d - d')$ and anchor per 12.13.
11.4.5.1	Maximum spacing, $s = 0.5d$.
11.4.5.3	When $V_s > 4\sqrt{f'_c}\ b_w d$, maximum $s = 0.25d$.
11.5.6.1	Closed stirrups – maximum spacing is $p_h/8 < 12$ in.
12.13.2.1	For #5 or smaller, a standard hook (90° or 135°) enclosing a longitudinal bar. Stirrups used in tabulated designs are #3, #4, or #5. (Anchorage of #6, #7, and #8 stirrups must conform to 12.13.2.2.)

Figs. 12-1 and 12-4 show typical details recommended for flexural reinforcement and shear/torsion, respectively.

MANUAL EXAMPLE – BEAM B-1
(TORSION NEGLIGIBLE)





MATERIALS
f'_c = 4,000 psi
f_y = 60,000 psi

FLOOR LOAD
5½″ slab = 69 psf
Ceilings = 4
Partitions = 20
93 psf
Service live load = 125 psf
q_u = 1.2(93) + 1.6(125) = 312 psf

BEAM B-1 (Spanning between girders, G1)

Loads
Floor (0.312) (14) = 4.37
Beam Stem ((18.5 (14)/144) (0.15) (1.2) = 0.32
w_u = 4.69 kips/ft

See tables on Page 12-64: For ℓ_n = 30′-0″, h = 24 in. and b_w = 14 in.; select third tabulated design with load capacity = 4.72 kips/ft – Okay

Review tabulated design

Flexure
$+M_u = w_u \ell_n^2/16$
$+M_u$ = (4.69) $(30)^2/16$ = 263.8 ft-kips
d = 24 – (1.5 + 0.5[#4 stirrup] + 1.41/2) = 21.3 in.

$$\text{Required } A_s = \frac{1.7 f'_c b_w d}{2 f_y} - \frac{1}{2}\sqrt{\frac{2.89(f'_c b_w d)^2}{(f_y)^2} - \frac{6.8 f'_c b_w M_u}{\phi (f_y)^2}}$$

$$= \frac{1.7\,(4)\,(14)\,(21.3)}{2(60)} - \frac{1}{2}\sqrt{\frac{2.89(4 \times 14 \times 21.3)^2}{(60)^2} - \frac{6.8(4)\,(14)\,(263.8 \times 12)}{(0.90)\,(60)^2}}$$

Required A_s = 3.02 in.^{2}

Bottom bars tabulated: 2-#11
A_s provided = 2(1.56) = 3.12 in.^{2} > 3.02 - Okay

Confirm section is tension-controlled so ϕ = 0.90

$$\text{Actual } \rho = \frac{A_s}{b_w d} = \frac{3.12}{(14)(21.3)} = 0.0105$$

From Chapter 5; for f'_c = 4,000 psi and f_y = 60,000 psi:

Max ρ = 0.0181 for ϕ = 0.90
Actual ρ = 0.0105 < max ρ ; hence, ϕ = 0.90

$-M_u = w_u \ell_n^2/11$

$-M_u$ = (4.69) $(30)^2/11$ = 383.7 ft-kips

d = 24 – (1.5 + 0.5 + 1.41/2) = 21.3 in.

$$\text{Required } A_s = \frac{1.7\,(4)\,(14)\,(21.3)}{2(60)} - \frac{1}{2}\sqrt{\frac{2.89\,(4 \times 14 \times 21.3)^2}{(60)^2} - \frac{6.8\,(4)\,(14)\,(383.7 \times 12)}{(0.90)\,(60)^2}}$$

Required A_s = 4.64 in.^{2}

Top bars tabulated: 3-#11

A_s provided = 3(1.56) = 4.68 in.^{2} > 4.64 – Okay

Confirm section is tension-controlled so ϕ = 0.90

$$\text{Actual } \rho = \frac{A_s}{b_w d} = \frac{4.68}{(14)(21.3)} = 0.0157$$

Max ρ = 0.0181 for ϕ = 0.90
Actual ρ = 0.0157 < max ρ ; hence, ϕ = 0.90

Torsion

Assume Beam B-1 fixed at both ends. Conservatively, slab width = 30 ft.

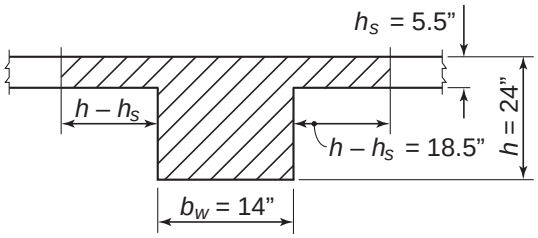
Gross moment of inertia of slab,

$I_g = 360\ (5.5)^3/12 = 4{,}990\ \text{in.}^4$

Flexural stiffness of slab,

$$K_s = \frac{4I_gE_c}{\ell} = \frac{4(4{,}990)\ E_c}{(14)\ (12)} = 118.8\ E_c$$

Torsional moment of inertia, J, of Beam B-1,



Beam Section for Calculating *J*

$J = (b_w)^3(h)/3 - (b_w)^4/5 + 2\ [(h_s)^3(h - h_s)/3 - (h_s)^4/5]$

$J = (14)^3\ (24)/3 - (14)^4/5 + 2[(5.5)^3(18.5)/3 - (5.5)^4/5]$
$= 15{,}955\ \text{in.}^4$

Torsional stiffness of Beam B-1,

$$K_t = \frac{GJ}{\ell} = \frac{(0.45E_c)\ (15{,}955)}{(30)(12)} = 19.9E_c$$

Assume slab live loads and partitions in alternate panels.

Fixed-end moment:

$-M_u = w_u(\ell_n)^2/12$

$-M_u = (1.6 \times 0.125 + 1.2 \times 0.020)\ (14)^2/12 = 3.66$ ft-kips/ft

$\Sigma K_s = (118.8\ E_c)\ (2) = 237.6\ E_c$ Slabs = 92%

$K_t =$ $19.9\ E_c$ Beam = 8%

$257.5\ E_c$ Total = 100%

$T_u = (3.66)\ (15 - 21.3/12)\ (0.08) = 3.87$ ft-kips at each end of B-1

Compare T_u vs. $\phi\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right)$

$A_{cp} = 14 \times 24 = 336\ \text{in.}^2$

$p_{cp} = 2(14 + 24) = 76$ in.

$$\phi\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right) = 0.75\ \sqrt{4{,}000}\ (336)^2/76$$
$$= 70{,}462\ \text{in.-lb}$$
$$= 5.87\ \text{ft-kips}$$

$T_u = 3.87$ ft-kips < 5.87 ft-kips, so torsion is resisted by concrete and no torsion reinforcement is required.

Shear

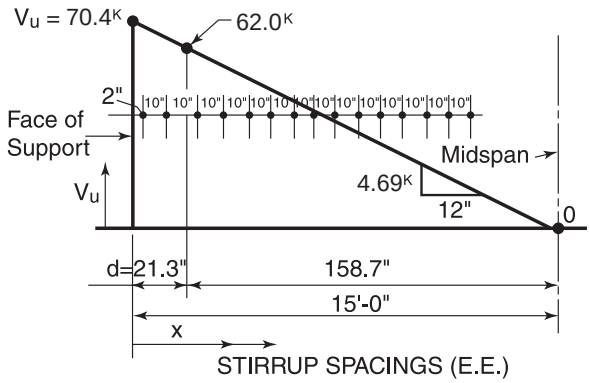
$\phi V_c = \phi\, 2\sqrt{f'_c}\, b_w d = 0.75(2)\sqrt{4{,}000}\ (14)\ (21.3)/1{,}000$
$= 28.3$ kips

At $d = 21.3$ in. from face of support

$V_u = 4.69\ (15 - 21.3/12) = 62.0$ kips

Maximum size stirrups, see Page 12-15.

For $b = 14$ in., #4 stirrups



Use #4 U-shaped stirrups; determine required spacing:

$$s = \frac{\phi A_v f_y d}{(V_u - \phi V_c)} = \frac{(0.75)(0.40)(60)(21.3)}{(62.0 - 28.3)} = 11.4'' > d/2 = 10''$$

Extend stirrups until $V_u = 0.5\ \phi V_c = 0.5(28.3) = 14.2$ k

Extend to (14.2 kips/4.69 kips/ft) = 3.03 ft from midspan

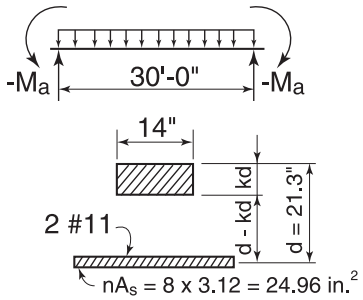
Spaced at 10″, (15 – 3.03)12/10 = 15 spaces are required

Use: 16-#4; 1 @ 2″, 15 @ 10″ at each end of beam

See Page 12-64; read "164H". See Page 12-14 for pattern.

Deflection

Calculate I_{cr} for positive moment section



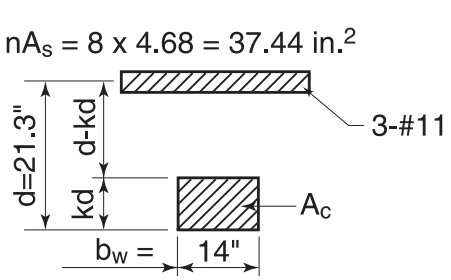
$n = E_s/E_c = 29 \times 10^6/57{,}000\ \sqrt{4{,}000} = 8$

$14(kd)^2/2 = 24.96(21.3 - kd)$

Solving: $kd = 7.11$ in.

$I_{cr} = 14(7.11)^3/3 + 24.96(21.3 - 7.11)^2 = 6{,}703\ \text{in.}^4$

Calculate I_{cr} for negative moment section



$14(kd)^2/2 = 37.44\ (21.3 - kd)$

Solving: $kd = 8.33$ in.

$I_{cr} = 14(8.33)^3/3 + 37.44\ (21.3 - 8.33)^2 = 8{,}996$ in.^{4}

$I_g = b_w h^3/12 = 14(24)^3/12 = 16{,}128$ in.^{4}

Take average service load as (1.2D + 1.6L)/1.4, conservatively.

Average service load = 4.69/1.4 = 3.35 kips/ft

$\pm M_a = w(\ell_n)^2/16 = 3.35(30)^2/16 = 188.4$ ft-kips

$$I_e = \left(\frac{M_{cr}}{M_a}\right)^3 I_g + \left[1 - \left(\frac{M_{cr}}{M_a}\right)^3\right] I_{cr} \quad \text{(ACI Eq. 9-8)}$$

Where:

$$M_{cr} = 7.5\sqrt{f'_c}\, I_g/y_t = \frac{7.5\sqrt{4{,}000}\,(16{,}128)}{12(12{,}000)} = 53.1 \text{ ft-kips}$$

$$I_e = \left(\frac{53.1}{188.4}\right)^3 (16{,}128) + \left[1 - \left(\frac{53.1}{188.4}\right)^3\right]\left(\frac{6{,}703 + 8{,}996}{2}\right)$$
$$= 8{,}035 \text{ in.}^4$$

Deflection

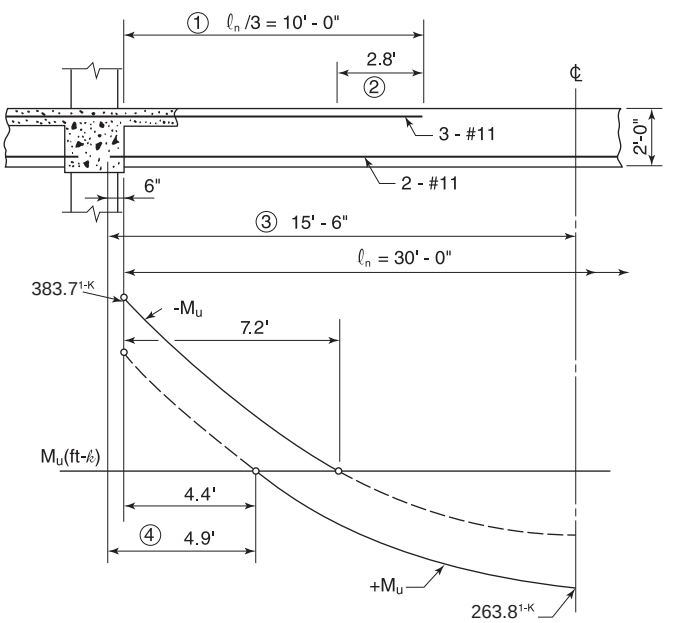
$$\Delta = \frac{2w\,(\ell_n)^4}{384 E_c I_e} = \frac{2(3{,}350/12)\,(360)^4}{(384)(57{,}000\sqrt{4{,}000})(8{,}035)} = 0.84 \text{ in.}$$

Compare calculated $\Delta = 0.84$ in. with tabulated deflection coefficient, $C = 311$.

Deflection based on $C = \Delta_c$
$= (C \times 10^{-9})$ (w in kips/ft) (ℓ_n in ft)^4

Thus, C corresponding to calculated $\Delta = 0.84$ in. is:

$$C = \frac{0.84 \times 10^9}{(3.35)\,(30)^4} = 310 \text{ (tabulated } C = 311)$$



Development

Top bars: 3-#11

Concrete cover = 1.5 + 0.5 (#4 stirrups) = 2 in. = 2/1.41 or $1.4d_b$;

Chapter 5; from Table 5-2(b), Case 1;
$\ell_d = 87$ in. $= 7.25$ ft

Dimension ① = $10.0' > \ell_d = 7.25'$, okay

Dimension ② = $2.8' > 12d_b = 1.41'$, okay
$> d = 1.78'$, okay
$> \ell_n/16 = 1.88'$, okay
} (ACI 12.10.3 and 12.12.3)

Bottom bars: 2-#11

Concrete cover = 2 in. or $1.4d_b$ as for the #11 top bars

Chapter 5; from Table 5-2(b), Case 1;
$\ell_d = 67$ in. $= 5.58$ ft

At inflection point, check $\ell_d \le M_n/V_u + \ell_a$ (ACI Eq. 12-5)

$a = A_s f_y/0.85 f'_c b_w$

$a = 3.12\ (60)/0.85(4)\ (14) = 3.93$ in.

$M_n = A_s f_y(d - a/2)$

$M_n = 3.12\ (60)\ (21.3 - 3.93/2)/12 = 301.6$ ft-kips

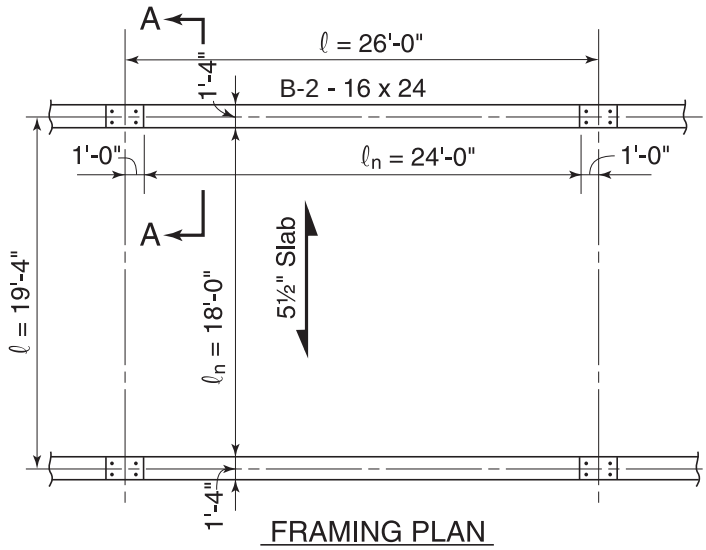
$V_u = 70.4 - 4.69\ (4.4) = 49.8$ kips

ℓ_a is larger of $12d_b = 16.9''$ or $d = 21.3''$

$M_n/V_u + \ell_a = 301.6(12)/49.8 + 21.3 = 94.0''$
$> \ell_d = 67''$, okay.

Dimension ③ = $15.5' > \ell_d = 5.58'$, okay
Dimension ④ = $4.9' > 12d_b = 1.41'$, okay
$> d = 1.77'$, okay
} (ACI 12.10.3)

Since closed stirrups are not provided, structural integrity (ACI 7.13.2.5) would require lap splicing (Class B) of at least 25 percent of the bottom A_s required at midspan to the bottom bars in the adjacent spans. Hence, the above check on Dimension ④ would be affected.



FRAMING PLAN

Review the tabulated design of an interior span of a continuous beam, designated as Beam B-2 in this example, for combined shear and torsion only. Beam B-2, a spandrel beam, is subjected to uniformly distributed factored gravity loads, and a uniformly distributed factored torsional moment over its clear span, $\ell_n = 24'\text{-}0''$.

Assume Beam B-2 with b_w = 16 in. and h = 24 in. This is the first tabulated design on Page 12-64 with a load capacity = 4.07 kips/ft.

Reinforcement tabulated:

Top bars: 3-#8, A_s = 2.37 in.^{2}

Bottom bars: 2-#8, A_s = 1.58 in.^{2}

Stirrup pattern for shear and negligible torsion: 113H

Stirrup pattern for combined shear and maximum torsion: 184F

Torsion

The effects of torsion can be neglected when

$$T_u < \phi\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right) \text{ (ACI 11.5.1-a)}$$

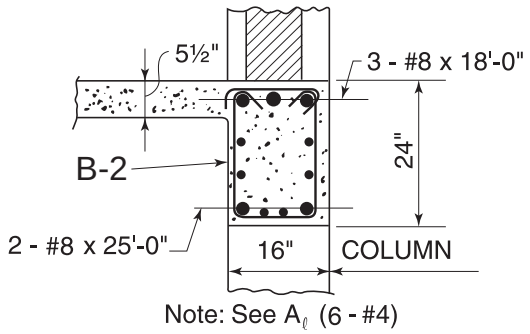
For Beam B-2:

$A_{cp} = 16 \times 24 = 384$ in.^{2}

$p_{cp} = 2(16 + 24) = 80$ in.

$T_u = 0.75\sqrt{(4000)}(384)^2/(80)(12{,}000) = 7.3$ ft-kips

For a uniformly distributed factored torsional moment applied over the 24-ft clear span, the computed value, T_u = 7.3 ft-kips, would be the (total) factored torsional moment at a distance, d, from the face of the support where open stirrups could be used.



SECTION A-A

The effective depth, d, for the 3-#8 top bars and #4 stirrups:

$d = 24 - (1.5 + 0.500 + 1.000/2) = 21.5$ in. or 1.79 ft

The tabulated value of T_u is the (total) factored torsional moment at the face of the support.

For Beam B-2 (at face of support):
$T_u = 12/(12 - 1.79)(7.3) = 8.6$ ft-kips (tabulated = 9), okay

Closed stirrup capacity:

When a beam uses closed stirrups, the beam can be designed for:

$$\text{Max } T_u = \phi 4\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right) \text{ (ACI 11.5.2.2-a)}$$

For Beam B-2 (at a distance d from face of support):

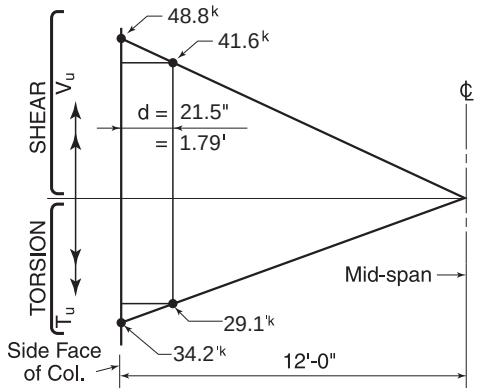
Max $T_u = (0.75)(4)\sqrt{4{,}000}(384)^2/(80)(12{,}000) = 29.1$ ft-kips

For Beam B-2 (at face of support):

Max T_u = 12/10.21 (29.1) = 34.2 ft-kips (tabulated = 34), okay

Combined shear and torsion considerations:

Reinforcement required for combined shear and torsion:



At distance d from face of support:
$V_u = 4.07\ (12 - 1.79) = 41.6$ kips
$T_u = 29.1$ ft-kips (previously calculated)

Check adequacy of cross-sectional dimensions

$$\sqrt{\left(\frac{V_u}{b_w d}\right)^2 + \left(\frac{T_u p_h}{1.7 A_{oh}^2}\right)^2} \le \phi\left(\frac{V_c}{b_w d} + 8\sqrt{f_c'}\right) \text{(ACI Eq. 11-18)}$$

Where:

$p_h = 2(x_1 + y_1) = 2(12.500 + 20.500)$

$p_h = 66.0$ in.

$A_{oh} = (x_1)(y_1) = (12.500)(20.500)$

$A_{oh} = 256$ in.^{2}

$$\sqrt{\left(\frac{41{,}600}{16(21.5)}\right)^2 + \left(\frac{29.1 \times 12{,}000(66.0)}{1.7\ (256)^2}\right)^2} = 240 \text{ psi}$$

Compute maximum shear and torsion capacity for this cross section:

$0.75\ (2\sqrt{4{,}000} + 8\sqrt{4{,}000}) = 474$ psi

$240 < 474$, okay

Stirrups required for shear.
$\phi V_s = V_u - \phi V_c$

Where:
$\phi V_c = \phi 2\sqrt{f_c'}\, bd = 0.75(2)\sqrt{4{,}000}(16)(21.5)/1000$
$= 32.6$ kips
$\phi V_s = 41.6 - 32.6 = 9.0$ kips

$$\text{Required } A_v = \left(\frac{V_s s}{\phi f_{yt} d}\right) \text{ (ACI Eq. 11-15)}$$

For shear, max $s = d/2 \approx 10$ in.

For combined shear and torsion, max $s = p_h/8$ or 12 in.

Max $s = 66.0/8 = 8.25$ in. < 12 in., use 8 in.

For $s = 8$ in., required $A_v = \dfrac{(9.0)(8)}{(0.75)(60)(21.5)} = 0.074$ in.^{2}

Vertical stirrups required for torsion:

$$T_n = \frac{2A_o A_t f_{yt}}{s} \cot\theta \text{ (ACI Eq. 11-21)}$$

$A_o = 0.85\ A_{oh} = 0.85\ (256) = 218$ in.^{2}

$$A_t = \frac{T_n s}{\phi 2\ A_o\ f_{yt} \cot\theta}$$

$$\text{Required } A_t = \frac{29{,}100\ (12)\ (8)}{0.75(2)\ (218)\ (60{,}000)\ (1)} = 0.142 \text{ in.}^2$$

For combined shear and torsion, the required area of stirrups spaced at 8 in.:

$A_v/2 + A_t = 0.074/2 + 0.142$
$= 0.18$ in.$^2 <$ #4 (0.20 in.^{2}), okay

Min area of closed stirrups,

$$A_v + 2A_t = 0.75\sqrt{f_c'}\ \frac{b_w s}{f_{yt}} \ge \frac{50 b_w s}{f_{yv}} \text{ (ACI Eq. 11-23)}$$

$$\frac{50 b_w s}{f_{yt}} = \frac{50\,(16)\,(8)}{60{,}000} = 0.11 \text{ in.}^2 < 0.20 \text{ in.}^2\text{, okay}$$

Longitudinal bar area required for torsion:

$$A_\ell = \frac{A_t}{s}\, p_h\, \frac{f_{yt}}{f_y} \cot^2\theta \text{ (ACI Eq. 11-22)}$$

$$A_\ell = \left(\frac{0.142}{8}\right)(66.0)(1)(1)$$
$= 1.17$ in.^{2} (tabulated = 1.3), okay

$$\text{Min } A_\ell = \frac{5\sqrt{f_c'}\ A_{cp}}{f_y} - \frac{A_t}{s}\, p_h\, \frac{f_{yt}}{f_{y\ell}} \text{ (ACI Eq. 11-24)}$$

where $A_t/s \ge 25\ b_w/f_{yt}$

$25\ b_w/f_{yt} = 25\ (16)/60{,}000 = 0.007$

$A_t/s = (0.142/8) = 0.018 > 0.007$, Okay

$$\text{Min } A_\ell = \frac{5\sqrt{4{,}000}\,(384)}{60{,}000} - \left(\frac{0.142}{8}\right)(66.0)\frac{60{,}000}{60{,}000} = 0.85 \text{ in.}^2$$

Torsion reinforcement must be provided for a distance (b_t + d) past the point where theoretically required (ACI 11.5.6.3):

$b_t + d = 16 + 21.5 = 37.5$ in. or 3.13 ft

Torsion reinforcement is not required where $T_u \leq 7.3$ ft-kips. The point where $T_u = 7.3$ ft-kips is 9.44′ from face of support. Since 9.44 + 3.13 = 12.57′ > 12.0′, torsion reinforcement is required over the entire span of Beam B-2.

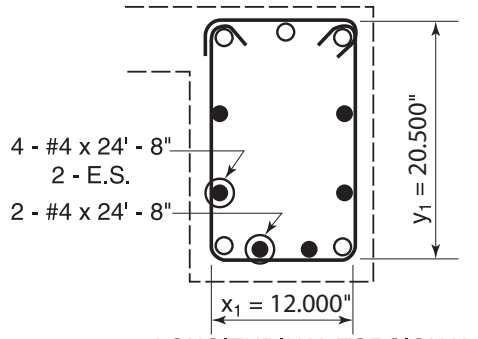
Stirrup pattern tabulated is 184F, stirrups extend 2″ + 17(8) = 138″ each side of midspan (within 6″ of midspan), okay.

6-#4 = 6 × 0.20 = 1.20 in.^{2} > 1.17 okay

Auxiliary longitudinal reinforcement for torsion, A_ℓ: ●

Main flexural reinforcement, A_s: ○

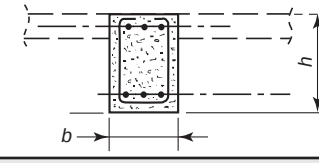
A_ℓ length – 2[136″ (extension into span)
+ 24″ (column)] = 296″ = 24′–8″

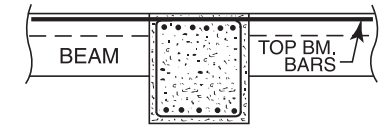


LONGITUDINAL TORSIONAL REINFORCEMENT, A_ℓ

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																						
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 12 ft					SPAN, ℓ_n = 14 ft.					SPAN, ℓ_n = 16 ft.					SPAN, ℓ_n = 18 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
12	8	2# 4		1	2# 4	1.16	123B	1	-	56	0.85	123B	1	-	60	0.65	123B	1	-	65	0.52	113B	1	-	67	16	7661
				1			243A	4	0.4	108		283A	4	0.4	125		323A	4	0.4	143		363A	4	0.4	160	16	
		2# 3	2# 3	2	2# 5	1.31	143B	1	-	67	0.96	143B	1	-	72	0.74	143B	1	-	78	0.58	143B	1	-	83	17	8777
				1			243A	4	0.4	115		283A	4	0.4	133		323A	4	0.4	151		363A	4	0.4	170	25	
		2# 4	2# 4	2	2# 6	2.23	173B	1	-	97	1.64*	193B	1	-	110	1.26*	203B	1	-	121	0.99*	223B	1	-	134	29	10707
				1			243A	4	0.4	138		283A	4	0.4	160		323A	4	0.4	182		363A	4	0.4	203	34	
		2# 4	2# 4	2	3# 5	2.23	173B	1	-	98	1.64*	193B	1	-	111	1.26*	203B	1	-	122	0.99*	223B	1	-	135	29	11089
				2			243A	4	0.4	139		283A	4	0.4	161		323A	4	0.4	183		363A	4	0.4	204	33	
	10	2# 4		1	2# 4	1.17	103B	1	-	53	0.86	093B	1	-	55	0.66	083B	1	-	57	0.52	053B	1	-	54	16	4035
				1			183B	6	0.4	93		213B	6	0.4	108		243B	6	0.4	123		273B	6	0.4	138	16	
		2# 5		1	2# 5	1.77	143B	1	-	78	1.30	153B	1	-	87	1.00	153B	1	-	94	0.79	153B	1	-	100	25	7792
				1			183B	6	0.4	109		213B	6	0.4	126		243B	6	0.4	143		273B	6	0.4	160	25	
		2# 6		1	3# 5	2.58	163B	1	-	104	1.89	183B	1	-	118	1.45*	193B	1	-	130	1.15*	203B	1	-	142	35	8570
				1			183B	6	0.4	130		213B	6	0.4	150		243B	6	0.4	170		273B	6	0.4	190	37	
		3# 4	2# 4	2	2# 7	2.84	173B	1	-	119	2.09*	193B	1	-	135	1.60*	203B	1	-	148	1.26*	223B	1	-	164	37	8293
				1			183B	6	0.4	143		213B	6	0.4	164		243B	6	0.4	186		273B	6	0.4	208	45	
	12	2# 5		1	2# 5	1.79	123B	2	-	75	1.31	133B	2	-	84	1.01	123B	2	-	88	0.79	113B	2	-	92	25	5316
				1			183B	8	0.5	113		213B	8	0.5	131		243B	7	0.5	149		273B	7	0.5	167	25	
		2# 6		1	2# 6	2.47	153B	2	-	103	1.81	163B	2	-	115	1.39	173B	2	-	127	1.10	173B	2	-	136	35	7079
				1			183B	8	0.5	134		213B	8	0.5	155		243B	7	0.5	175		273B	7	0.5	196	35	
		2# 5	2# 5	1	2# 7	3.26	173B	2	-	129	2.39	183B	2	-	144	1.83*	203B	2	-	162	1.45*	213B	2	-	177	48	6800
				1			183B	8	0.5	155		213B	8	0.5	179		243B	7	0.5	203		273B	7	0.5	227	46	
		2# 6	1# 6	1	2# 8	3.93	183B	2	-	149	2.89*	193B	2	-	167	2.21*	213B	2	-	186	1.75*	233B	2	-	206	51	6439
				1			184B	8	0.5	246		213B	8	0.5	199		243B	7	0.5	225		273B	7	0.5	252	59	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b - 2''$).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360 <$ deflection $< \ell_n/240$
X – $\ell_n/240 <$ deflection $< \ell_n/180$
Y – deflection $> \ell_n/180$

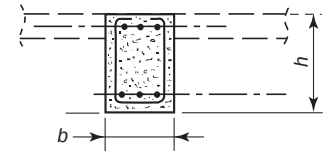
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b > 24$ in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

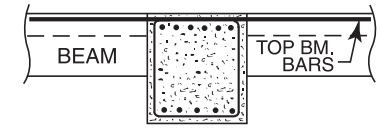
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as $w/1.4$.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
12	8	2# 4		1	2# 4	0.42	093B	1	-	67	0.35	073B	1	-	67	0.29	043B	1	-	65	0.25	N/A	1	-	60	16	7661
				1			403A	4	0.4	178		443A	4	0.4	195		483A	4	0.4	212		523A	4	0.4	230	16	
		2# 5		1	2# 5	0.63*	183B	1	-	111	0.52*	183B	1	-	118	0.44*	173B	1	-	122	0.37*	163B	1	-	127	25	10675
				1			403A	4	0.4	202		443A	4	0.4	222		483A	4	0.4	242		523A	4	0.4	261	25	
		2# 6		1	3# 5	0.85*	233B	1	-	156	0.70X	233B	1	-	165	0.59X	243B	1	-	177	0.50X	243B	1	-	187	34	10248
				2			403A	4	0.4	236		443A	4	0.4	258		483A	4	0.4	281		523A	4	0.4	304	33	
		2# 5	2# 5	2	2# 7	1.11X	263B	1	-	195	0.92X	283B	1	-	212	0.77Y	293B	1	-	227	0.66Y	303B	1	-	241	41	9101
				1			403A	4	0.4	268		443A	4	0.4	294		483A	4	0.4	320		523A	4	0.4	345	44	
	10	2# 5		1	2# 5	0.64	143B	1	-	104	0.53	133B	1	-	109	0.44*	113B	1	-	111	0.38*	093B	1	-	113	25	7792
				1			303B	6	0.4	177		333B	6	0.4	194		363B	5	0.4	212		393B	5	0.4	229	25	
		2# 6		1	2# 6	0.88*	203B	1	-	151	0.72*	203B	1	-	160	0.61X	203B	1	-	170	0.52X	193B	1	-	177	35	8551
				1			303B	6	0.4	209		333B	6	0.4	229		363B	5	0.4	250		393B	5	0.4	270	35	
		2# 7		1	2# 7	1.15X	243B	1	-	198	0.95X	253B	1	-	213	0.80X	253B	1	-	226	0.68X	263B	1	-	242	45	7713
				1			303B	6	0.4	248		333B	6	0.4	271		363B	5	0.4	295		393B	5	0.4	318	45	
		2# 6	1# 6	1	2# 8	1.38X	263B	1	-	225	1.14X	273B	1	-	242	0.96X	283B	1	-	260	0.82Y	293B	1	-	277	50	6966
				1			303B	6	0.4	270		333B	6	0.4	296		363B	5	0.4	321		393B	5	0.4	346	57	
	12	2# 5		1	2# 5	0.64	103B	2	-	96	0.53	083B	2	-	98	0.45	053B	2	-	97	0.38	N/A	2	-	92	25	5316
				1			303B	7	0.5	185		333B	7	0.5	203		363B	7	0.5	221		393B	7	0.5	238	25	
		2# 6		1	2# 6	0.89*	173B	2	-	146	0.73*	173B	2	-	155	0.62*	163B	2	-	162	0.53*	153B	2	-	169	35	7079
				1			303B	7	0.5	217		333B	7	0.5	238		363B	7	0.5	259		393B	7	0.5	279	35	
		2# 7		1	2# 8	1.29*	233B	2	-	217	1.07X	243B	2	-	234	0.90X	243B	2	-	248	0.76X	243B	2	-	262	46	6559
				1			303B	7	0.5	273		333B	7	0.5	299		363B	7	0.5	325		393B	7	0.5	350	59	
		2# 8		1	2# 9	1.63X	263B	2	-	272	1.35X	273B	2	-	293	1.13X	283B	2	-	314	0.96Y	293B	2	-	335	59	5817
				1			303B	7	0.5	321		333B	7	0.5	351		363B	7	0.5	381		393B	7	0.5	411	71	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
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X – $\ell_n/240$ < deflection < $\ell_n/180$
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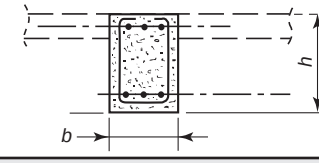
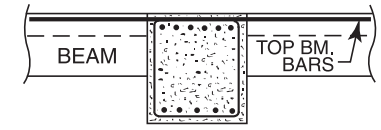
RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																						
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 12 ft					SPAN, ℓ_n = 14 ft.					SPAN, ℓ_n = 16 ft.					SPAN, ℓ_n = 18 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
14	8	2# 4		1	2# 4	1.41	103C	1	-	54	1.04	103C	1	-	59	0.80	103C	1	-	63	0.63	093C	1	-	65	20	3909
				1			183B	5	0.5	93		213B	5	0.4	108		243B	5	0.4	123		273B	5	0.4	138	20	
		2# 4	1# 4	2	2# 5	2.13	133C	1	-	76	1.57	143C	1	-	84	1.20	153C	1	-	93	0.95	153C	1	-	100	28	6571
				1			183B	5	0.4	107		213B	5	0.4	124		243B	5	0.4	141		273B	5	0.4	158	30	
		2# 4	2# 4	2	2# 6	2.78	143C	1	-	94	2.04	163C	1	-	108	1.57	173C	1	-	119	1.24*	183C	1	-	130	36	6679
				1			183B	5	0.4	123		213B	5	0.4	142		243B	5	0.4	162		273B	5	0.4	181	42	
		2# 4	2# 4	2	3# 5	2.78	143C	1	-	95	2.04	163C	1	-	109	1.57	173C	1	-	120	1.24*	183C	1	-	131	36	6836
				2			183B	5	0.4	124		213B	5	0.4	143		243B	5	0.4	163		273B	5	0.4	182	42	
	10	2# 4		1	2# 5	1.57	093C	2	-	59	1.15	093C	2	-	65	0.88	083C	2	-	67	0.70	073C	2	-	70	20	2401
				1			183B	8	0.5	104		213B	7	0.5	120		243B	7	0.5	137		273B	7	0.5	153	31	
		2# 5		1	2# 5	2.16	113C	2	-	74	1.59	123C	2	-	83	1.21	123C	2	-	90	0.96	123C	2	-	96	31	4309
				1			183B	8	0.5	113		213B	7	0.5	131		243B	7	0.5	149		273B	7	0.5	167	31	
		2# 6		1	3# 5	3.16	133C	2	-	100	2.32	153C	2	-	115	1.78	163C	2	-	127	1.40	173C	2	-	139	42	5314
				1			183B	8	0.5	134		213B	7	0.5	155		243B	7	0.5	176		273B	7	0.5	197	45	
		3# 4	2# 4	2	2# 7	3.53	143C	2	-	115	2.59	163C	2	-	132	1.99	173C	2	-	146	1.57*	183C	2	-	160	46	5187
				1			183B	7	0.5	147		213B	7	0.5	170		243B	7	0.5	192		273B	7	0.5	215	56	
	12	2# 5		1	2# 5	2.18	103C	2	-	72	1.60	103C	2	-	79	1.22	103C	2	-	86	0.97	093C	2	-	90	31	2742
				1			143C	10	0.6	102		173C	10	0.6	120		193C	10	0.6	135		223C	9	0.6	154	31	
		2# 6		1	2# 6	3.02	123C	2	-	98	2.22	133C	2	-	111	1.70	143C	2	-	123	1.34	143C	2	-	132	43	4138
				1			143C	10	0.6	122		173C	10	0.6	144		193C	10	0.6	161		223C	9	0.6	183	43	
		2# 5	2# 5	1	2# 7	4.01	143C	2	-	125	2.94	153C	2	-	141	2.25	163C	2	-	156	1.78	173C	2	-	171	60	4261
				1			144C	10	0.6	203		173C	10	0.6	168		193C	10	0.6	189		223C	9	0.6	214	57	
		2# 6	1# 6	1	2# 8	4.83	143C	2	-	143	3.55	163C	2	-	163	2.72	173C	2	-	181	2.15*	193C	2	-	201	63	4097
				1			144C	10	0.6	221		174C	10	0.6	261		194C	10	0.6	292		223C	9	0.6	238	73	
	14	2# 5		1	3# 4	2.13	093C	3	-	70	1.57	093C	3	-	77	1.20	083C	3	-	81	0.95	063C	3	-	82	31	1615
				1			143C	13	0.7	105		173C	12	0.7	124		193C	12	0.7	139		223C	12	0.7	158	30	
		2# 6		1	3# 5	3.23	123C	3	-	101	2.37	133C	3	-	113	1.81	133C	3	-	123	1.43	133C	3	-	132	43	3343
				1			143C	13	0.7	126		173C	12	0.7	149		193C	12	0.7	167		223C	12	0.7	189	46	
		2# 6	1# 6	1	3# 6	4.45	133C	3	-	133	3.27	153C	3	-	152	2.50	163C	3	-	169	1.98	173C	3	-	186	64	3736
				1			144C	13	0.7	218		174C	12	0.7	258		193C	12	0.7	205		223C	12	0.7	232	64	
		3# 5	2# 5	1	3# 7	5.71	143C	3	-	159	4.19	163C	3	-	182	3.21	173C	3	-	202	2.54*	193C	3	-	225	74	3505
				1			144C	13	0.7	242		174C	12	0.7	285		194C	12	0.7	320		224C	12	0.7	363	84	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

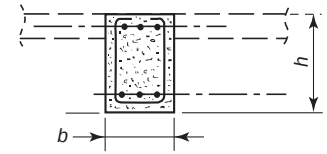
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

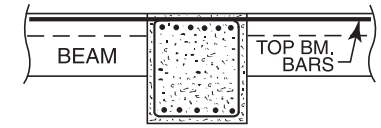
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
14	8	2# 4		1	2# 5	0.56	103C	1	-	81	0.46	083C	1	-	82	0.39	073C	1	-	85	0.33	053C	1	-	85	20	4510
				1			303B	5	0.4	162		333B	5	0.4	178		363B	5	0.4	194		393B	5	0.4	209	30	
		2# 5		1	2# 6	0.84	163C	1	-	124	0.70	163C	1	-	132	0.59*	163C	1	-	139	0.50*	163C	1	-	147	30	6253
				1			303B	5	0.4	190		333B	5	0.4	208		363B	5	0.4	227		393B	5	0.4	245	42	
		2# 5	2# 5	2	2# 7	1.38*	223C	1	-	192	1.14*	233C	1	-	207	0.96X	243C	1	-	222	0.82X	253C	1	-	237	53	5746
				1			303B	5	0.4	243		333B	5	0.4	266		363B	5	0.4	289		393B	5	0.4	313	55	
		2# 6	1# 6	2	2# 8	1.57*	223C	1	-	219	1.29X	243C	1	-	238	1.09X	253C	1	-	256	0.93X	263C	1	-	273	56	5110
				1			303B	5	0.4	270		333B	5	0.4	296		363B	5	0.4	321		393B	5	0.4	346	69	
	10	2# 5		1	2# 5	0.78	123C	2	-	103	0.64	113C	2	-	107	0.54	103C	2	-	111	0.46	083C	2	-	112	31	4309
				1			303B	7	0.5	185		333B	7	0.5	203		363B	7	0.5	221		393B	7	0.5	238	31	
		2# 6		1	2# 6	1.07	163C	2	-	145	0.89*	173C	2	-	157	0.75*	163C	2	-	164	0.64*	163C	2	-	174	42	5242
				1			303B	7	0.5	217		333B	7	0.5	238		363B	7	0.5	259		393B	7	0.5	279	42	
		2# 7		1	2# 8	1.56*	203C	2	-	212	1.29*	213C	2	-	229	1.08*	223C	2	-	246	0.92X	233C	2	-	263	56	4570
				1			303B	7	0.5	273		333B	7	0.5	299		363B	7	0.5	325		393B	7	0.5	350	71	
		2# 8		1	2# 9	1.98*	223C	2	-	265	1.63*	233C	2	-	286	1.37X	253C	2	-	310	1.17X	263C	2	-	331	71	3990
				1			303B	7	0.5	321		333B	7	0.5	351		363B	7	0.5	381		393B	7	0.5	411	87	
	12	2# 6		1	2# 6	1.09	143C	2	-	142	0.90	143C	2	-	151	0.75	133C	2	-	158	0.64*	123C	2	-	165	43	4138
				1			243C	9	0.6	200		263C	9	0.6	218		293C	9	0.6	239		313C	9	0.6	257	43	
		2# 7		1	2# 7	1.44*	183C	2	-	191	1.19*	183C	2	-	204	1.00*	183C	2	-	217	0.85*	183C	2	-	230	57	4346
				1			243C	9	0.6	239		263C	9	0.6	260		293C	9	0.6	285		313C	9	0.6	306	57	
		2# 8		1	2# 9	2.02*	213C	2	-	265	1.67*	223C	2	-	286	1.40X	233C	2	-	308	1.20X	243C	2	-	329	73	3710
				1			243C	9	0.6	305		263C	9	0.6	331		293C	9	0.6	362		313C	9	0.6	389	89	
		2# 9		1	2#10	2.47*	223C	2	-	326	2.04X	243C	2	-	355	1.71X	253C	2	-	381	1.46X	263C	2	-	407	89	3254
				1			244C	9	0.6	465		264C	9	0.6	505		294C	9	0.6	553		313C	9	0.6	462	106	
	14	2# 6		1	3# 5	1.16	133C	3	-	142	0.96	123C	3	-	149	0.81	113C	3	-	156	0.69	103C	3	-	163	43	3343
				1			243C	12	0.7	208		263C	12	0.6	226		293C	12	0.6	248		313C	12	0.6	266	46	
		2# 7		1	3# 6	1.60*	173C	3	-	195	1.32*	183C	3	-	212	1.11*	183C	3	-	225	0.95*	183C	3	-	238	58	3857
				1			243C	12	0.7	250		263C	12	0.6	272		293C	12	0.6	298		313C	12	0.6	320	64	
		2# 9		1	3# 8	2.52*	213C	3	-	314	2.08*	233C	3	-	343	1.75X	243C	3	-	369	1.49X	253C	3	-	394	91	3099
				1			244C	12	0.7	464		264C	12	0.6	504		293C	12	0.6	424		313C	12	0.6	456	106	
		2#10		1	3# 8	2.67*	223C	3	-	355	2.20*	233C	3	-	384	1.85X	243C	3	-	414	1.58X	263C	3	-	446	111	2896
				1			244C	12	0.7	502		264C	12	0.6	546		294C	12	0.6	599		313C	12	0.6	505	106	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

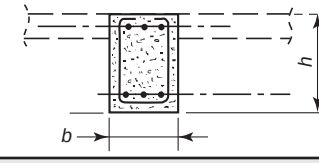
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

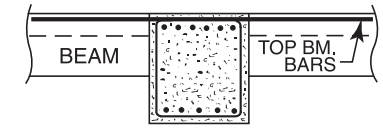
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 16 ft					SPAN, ℓ_n = 18 ft.					SPAN, ℓ_n = 20 ft.					SPAN, ℓ_n = 22 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
16	10	2# 6		1	2# 6	1.99	133D	2	-	122	1.57	143D	2	-	134	1.27	143D	2	-	144	1.05	143D	2	-	153	50	3376
				1			193C	9	0.6	161		223C	9	0.6	183		243C	9	0.6	200		263C	9	0.6	218	50	
		2# 7		1	2# 7	2.64	153D	2	-	159	2.08	163D	2	-	175	1.69	173D	2	-	190	1.40*	173D	2	-	203	67	3323
				1			193C	9	0.6	193		223C	9	0.6	218		243C	9	0.6	239		263C	9	0.6	260	67	
		2# 8		1	2# 9	3.70	163D	2	-	216	2.92*	173D	2	-	238	2.37*	193D	2	-	262	1.96*	203D	2	-	284	86	2740
				1			323A	9	0.6	300		363A	9	0.6	334		403A	9	0.6	369		263C	9	0.6	331	105	
		3# 5	3# 5	2	2# 9	4.04	163D	2	-	224	3.19*	183D	2	-	249	2.59*	193D	2	-	272	2.14*	213D	2	-	297	94	2746
				1			323A	9	0.6	307		363A	9	0.6	343		403A	9	0.6	379		443A	9	0.6	415	105	
	12	2# 6		1	2# 6	2.01	123D	3	-	120	1.59	123D	3	-	130	1.28	123D	3	-	139	1.06	123D	3	-	149	51	2523
				1			193C	12	0.7	166		223C	12	0.7	188		243C	12	0.7	206		263C	11	0.7	224	51	
		2# 7		1	2# 8	2.94	143D	3	-	173	2.32	153D	3	-	190	1.88	163D	3	-	208	1.56	173D	3	-	225	68	2776
				1			193C	12	0.7	213		223C	12	0.7	240		243C	12	0.7	263		263C	11	0.7	286	87	
		3# 5	3# 5	2	2# 9	4.14	163D	3	-	226	3.27*	173D	3	-	249	2.65*	193D	3	-	274	2.19*	203D	3	-	297	96	2555
				1			194C	12	0.7	345		224C	12	0.7	390		244C	11	0.7	428		264C	11	0.6	465	107	
		4# 5	3# 5	2	2#10	4.78	164D	3	-	313	3.78*	183D	3	-	297	3.06*	193D	3	-	323	2.53*	213D	3	-	353	111	2253
				1			194C	12	0.7	385		224C	12	0.7	435		244C	11	0.7	477		264C	11	0.6	518	131	
	14	2# 7		1	3# 6	2.97	133D	4	-	160	2.35	143D	4	-	177	1.90	153D	4	-	193	1.57	153D	4	-	207	69	2516
				1			164D	15	0.8	267		183D	15	0.8	215		203D	15	0.7	238		223D	15	0.7	260	75	
		2# 8		1	3# 7	3.82	153D	4	-	207	3.02	163D	4	-	228	2.44*	173D	4	-	249	2.02*	183D	4	-	270	88	2400
				1			164D	15	0.8	308		184D	15	0.8	344		204D	15	0.7	380		224D	15	0.7	417	100	
		2# 8	1# 8	1	3# 8	5.00	164D	4	-	320	3.95	173D	4	-	300	3.20*	193D	4	-	331	2.65*	203D	4	-	358	128	2012
				1			165D	15	0.8	468		184D	15	0.7	413		204D	15	0.7	456		224D	15	0.7	499	128	
		5# 5	4# 5	2	3# 9	6.05	164D	4	-	367	4.78*	184D	4	-	409	3.87*	204D	4	-	451	3.20*	213D	4	-	423	140	1864
				1			165D	15	0.8	515		185D	15	0.7	575		205D	15	0.7	635		224D	14	0.7	561	155	
	16	2# 7		1	3# 6	2.99	133D	5	-	162	2.36	133D	5	-	176	1.92	133D	4	-	189	1.58	133D	4	-	202	69	2105
				1			164D	18	0.9	275		183D	18	0.9	220		203D	18	0.8	243		223D	18	0.8	266	76	
		2# 8		1	3# 7	3.86	143D	5	-	206	3.05	153D	5	-	227	2.47	163D	4	-	248	2.04*	163D	4	-	266	89	2182
				1			164D	18	0.9	315		184D	18	0.9	353		204D	18	0.8	390		223D	18	0.8	320	101	
		2# 8	1# 8	1	3# 9	5.59	164D	5	-	351	4.41	173D	5	-	332	3.58*	183D	4	-	362	2.96*	203D	4	-	396	130	1781
				1			165D	18	0.9	506		184D	18	0.8	451		204D	18	0.8	497		224D	18	0.8	544	159	
		5# 5	5# 5	2	3#10	6.69	164D	5	-	420	5.29*	184D	5	-	468	4.28*	204D	4	-	515	3.54*	214D	4	-	556	155	1602
				1			165D	18	0.8	575		185D	18	0.8	642		205D	18	0.8	709		225D	18	0.8	775	193	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

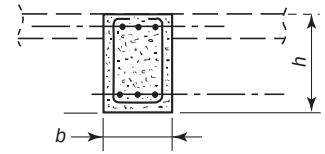
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

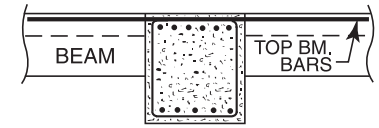
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																		$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
16	10	2# 6		1	2# 6	0.88	143D	2	-	163	0.75	143D	2	-	172	0.65*	133D	2	-	179	0.57*	133D	2	-	188	50	3376
				1			293C	8	0.6	239		313C	8	0.6	257		343C	8	0.6	279		363C	8	0.5	296	50	
		2# 7		1	2# 7	1.17*	183D	2	-	219	1.00*	183D	2	-	232	0.86*	183D	2	-	245	0.75*	193D	2	-	261	67	3323
				1			293C	8	0.6	285		313C	8	0.6	306		343C	8	0.6	331		363C	8	0.5	352	67	
		2# 8		1	2# 9	1.64*	213D	2	-	305	1.40*	223D	2	-	326	1.21X	233D	2	-	348	1.05X	233D	2	-	366	86	2740
				1			293C	8	0.6	362		313C	8	0.6	389		343C	8	0.6	419		363C	8	0.5	446	105	
		2# 9		1	2# 9	1.82*	223D	2	-	344	1.55X	233D	2	-	369	1.34X	243D	2	-	393	1.17X	253D	2	-	417	105	2564
				1			483A	8	0.6	475		313C	8	0.6	428		343C	8	0.6	462		363C	8	0.5	491	105	
	12	2# 6		1	2# 6	0.89	113D	3	-	156	0.76	113D	3	-	165	0.66	103D	3	-	172	0.57	093D	3	-	178	51	2523
				1			293C	11	0.6	247		313C	11	0.6	265		343C	11	0.6	287		363C	11	0.6	305	51	
		2# 7		1	2# 8	1.31*	173D	3	-	239	1.11*	173D	3	-	254	0.96*	173D	3	-	268	0.84*	173D	3	-	283	68	2776
				1			293C	11	0.6	313		313C	11	0.6	336		343C	11	0.6	363		363C	11	0.6	386	87	
		2# 9		1	2# 9	1.87*	213D	3	-	344	1.59*	213D	3	-	366	1.37X	223D	3	-	390	1.20X	233D	3	-	415	107	2393
				1			293C	11	0.6	406		313C	11	0.6	436		343C	11	0.6	470		363C	11	0.6	500	107	
		2#10		1	2#10	2.28*	223D	3	-	424	1.94X	233D	3	-	454	1.68X	243D	3	-	484	1.46X	253D	3	-	514	131	2084
				1			294C	11	0.6	612		314C	11	0.6	656		344C	11	0.6	710		363C	11	0.6	594	131	
	14	2# 7		1	3# 6	1.32	153D	4	-	220	1.12*	153D	4	-	234	0.97*	153D	4	-	247	0.84*	143D	4	-	258	69	2516
				1			243D	14	0.7	283		263D	14	0.7	305		283D	14	0.7	327		303D	14	0.7	350	75	
		2# 8		1	3# 7	1.70*	183D	4	-	288	1.45*	193D	4	-	309	1.25*	193D	4	-	327	1.09X	193D	4	-	344	88	2400
				1			243D	14	0.7	341		263D	14	0.7	368		283D	14	0.7	395		303D	14	0.7	421	100	
		2#10		1	3# 8	2.22*	213D	4	-	410	1.89*	223D	4	-	440	1.63X	223D	4	-	467	1.42X	233D	4	-	496	134	1986
				1			244D	14	0.7	566		264D	14	0.7	611		284D	14	0.7	656		304D	14	0.7	701	128	
		2#10		1	3# 9	2.57*	223D	4	-	451	2.19X	233D	4	-	483	1.89X	243D	4	-	515	1.64X	253D	4	-	548	134	1858
				1			244D	14	0.7	604		264D	14	0.7	651		284D	14	0.7	699		304D	14	0.7	746	155	
	16	2# 7		1	3# 6	1.33	133D	4	-	216	1.13	133D	4	-	229	0.98	123D	4	-	240	0.85*	113D	4	-	250	69	2105
				1			243D	18	0.8	289		263D	18	0.8	312		283D	17	0.8	335		303D	17	0.8	357	76	
		2# 9		1	3# 7	1.77*	173D	4	-	323	1.51*	183D	4	-	347	1.30*	183D	4	-	368	1.13*	183D	4	-	389	110	2066
				1			243D	18	0.8	383		263D	18	0.8	414		283D	17	0.8	444		303D	17	0.8	474	101	
		2#10		1	3# 9	2.61*	213D	4	-	451	2.23*	223D	4	-	483	1.92X	233D	4	-	515	1.67X	243D	4	-	548	136	1767
				1			244D	18	0.8	615		264D	17	0.8	663		284D	17	0.8	711		304D	17	0.8	760	159	
		2#11		1	3#10	3.10*	223D	4	-	551	2.64X	233D	4	-	591	2.28X	253D	4	-	634	1.99X	263D	4	-	673	162	1551
				1			244D	18	0.8	712		264D	17	0.8	768		284D	17	0.8	823		304D	17	0.8	879	193	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
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*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
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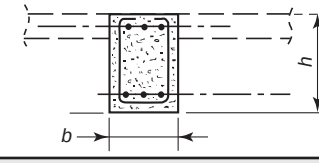
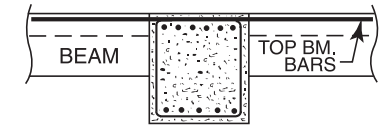
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																			
						SPAN, ℓ_n = 16 ft					SPAN, ℓ_n = 18 ft.					SPAN, ℓ_n = 20 ft.					SPAN, ℓ_n = 22 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h	b	BOTTOM		Layers	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)																							
18	10	2# 6		1	2# 6	2.30	113E	3	-	119	1.81	123E	3	-	131	1.47	123E	3	-	141	1.21	123E	3	-	150	58	2240
				1			193C	11	0.7	166		223C	10	0.7	188		243C	10	0.6	206		263C	10	0.6	224	58	
		2# 7		1	2# 7	3.06	133E	3	-	156	2.42	143E	3	-	172	1.96	143E	3	-	185	1.62	153E	3	-	201	78	2347
				1			193C	11	0.7	197		223C	10	0.7	223		243C	10	0.6	245		263C	10	0.6	266	78	
		2# 8		1	2# 9	4.31	143E	3	-	214	3.41	153E	3	-	236	2.76	163E	3	-	258	2.28*	173E	3	-	279	100	1981
				1			323A	11	0.7	308		363A	10	0.7	343		403A	10	0.6	379		443A	10	0.6	415	123	
		3# 5	3# 5	2	2#10	4.76	163BeE	3	-	251	3.76	163E	3	-	273	3.05	173E	3	-	298	2.52*	183E	3	-	323	110	1816
				1			323A	11	0.7	338		363A	10	0.7	377		403A	10	0.6	416		443A	10	0.6	455	150	
	12	2# 6		1	2# 7	2.55	113E	4	-	133	2.01	113E	4	-	144	1.63	123E	3	-	158	1.35	123E	3	-	169	59	1722
				1			163D	14	0.8	170		183D	14	0.8	190		203D	14	0.7	210		223D	14	0.7	230	79	
		2# 8		1	2# 8	3.98	133E	4	-	195	3.15	143E	4	-	215	2.55	153E	3	-	235	2.11	163E	3	-	255	101	1915
				1			164D	14	0.8	300		184D	14	0.8	335		204D	14	0.7	370		224D	14	0.7	406	101	
		3# 5	3# 5	2	2#10	4.86	144E	4	-	290	3.84	153E	3	-	272	3.11	163E	3	-	297	2.57	173E	3	-	322	113	1684
				1			164D	14	0.8	349		184D	14	0.8	389		204D	14	0.7	429		224D	14	0.7	469	154	
		4# 5	4# 5	2	2#10	6.03	144E	4	-	323	4.76	164E	3	-	362	3.86*	174E	3	-	394	3.19*	183E	3	-	370	145	1572
				1			324A	14	0.8	528		364A	14	0.7	591		204D	14	0.7	470		224D	14	0.7	514	154	
	14	2# 7		1	3# 6	3.43	123E	5	-	160	2.71	123E	4	-	174	2.20	133E	4	-	191	1.82	133E	4	-	204	79	1695
				1			164D	18	0.9	275		184D	18	0.9	307		203D	18	0.8	243		223D	17	0.8	266	87	
		2# 8		1	3# 7	4.43	133E	5	-	204	3.50	143E	4	-	226	2.84	153E	4	-	247	2.34	153E	4	-	265	103	1700
				1			164D	18	0.9	315		184D	18	0.9	353		204D	18	0.8	390		224D	17	0.8	427	116	
		2# 8	1# 8	1	3# 9	6.42	144E	5	-	342	5.07	154E	4	-	376	4.11	173E	4	-	361	3.39*	183E	4	-	392	149	1357
				1			165D	18	0.9	506		185D	18	0.9	565		204D	18	0.8	497		224D	17	0.8	544	182	
		5# 5	4# 5	2	3# 9	7.12	144E	5	-	361	5.63	164E	4	-	404	4.56*	174E	4	-	440	3.77*	184E	4	-	476	165	1343
				1			165D	18	0.9	526		185D	18	0.8	587		205D	18	0.8	649		224D	17	0.8	571	182	
	16	2# 7		1	3# 6	3.46	113E	6	-	158	2.73	123E	6	-	175	2.21	123E	5	-	189	1.83	123E	5	-	202	80	1365
				1			144E	22	1.0	262		164E	22	1.0	295		174E	22	1.0	319		193E	21	0.9	256	88	
		2# 8		1	3# 8	4.47	123E	6	-	226	3.53	133E	6	-	249	2.86	143E	5	-	273	2.36	143E	5	-	293	104	1395
				1			144E	22	1.0	325		164E	22	1.0	366		174E	22	1.0	396		194E	21	0.9	436	151	
		2# 7	2# 7	1	3# 9	6.61	144E	6	-	344	5.22	154E	6	-	378	4.23	163E	5	-	359	3.50*	173E	5	-	390	153	1277
				1			145E	22	1.0	483		165E	22	1.0	544		175E	22	0.9	588		194E	21	0.9	523	186	
		5# 5	5# 5	2	3#10	7.89	145E	6	-	473	6.24	164E	5	-	462	5.05	174E	5	-	504	4.17*	184E	5	-	545	183	1151
				1			245B	22	1.0	720		165E	22	0.9	621		175E	22	0.9	672		195E	21	0.9	740	227	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360 <$ deflection $< \ell_n/240$
X – $\ell_n/240 <$ deflection $< \ell_n/180$
Y – deflection $> \ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b > 24$ in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
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(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as $w/1.4$.

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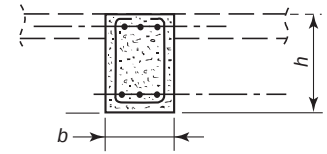
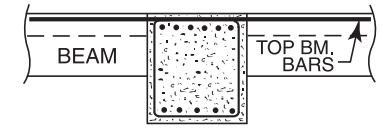
RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																		$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
18	10	2# 6		1	2# 6	1.02	123E	3	-	160	0.87	123E	3	-	170	0.75	123E	2	-	179	0.65	113E	2	-	185	58	2240
				1			293C	10	0.6	247		313C	10	0.6	265		343C	10	0.6	287		363C	10	0.6	305	58	
		2# 7		1	2# 8	1.50	163E	3	-	239	1.27*	173E	3	-	256	1.10*	173E	2	-	270	0.96*	183E	2	-	288	78	2226
				1			293C	10	0.6	313		313C	10	0.6	336		343C	10	0.6	363		363C	10	0.6	386	100	
		2# 9		1	2# 9	2.14*	193E	3	-	341	1.82*	203E	3	-	365	1.57*	213E	2	-	390	1.37*	223E	2	-	414	123	1856
				1			483A	10	0.6	487		313C	10	0.6	436		343C	10	0.6	470		363C	10	0.6	500	123	
		2#10		1	2#10	2.60*	203E	3	-	420	2.22*	213E	3	-	451	1.91*	223E	2	-	481	1.67X	233E	2	-	511	150	1606
				1			483A	10	0.6	563		523A	10	0.6	608		563A	10	0.6	652		603A	10	0.6	696	150	
	12	2# 7		1	2# 7	1.38	143E	3	-	213	1.17	143E	3	-	226	1.01	143E	3	-	239	0.88*	143E	3	-	252	79	1964
				1			243D	14	0.7	277		263D	13	0.7	299		283D	13	0.7	321		303D	13	0.7	342	79	
		2# 8		1	2# 8	1.77*	163E	3	-	272	1.51*	173E	3	-	292	1.30*	173E	3	-	309	1.13*	173E	3	-	326	101	1915
				1			243D	14	0.7	329		263D	13	0.7	355		283D	13	0.7	381		303D	13	0.7	407	101	
		2#10		1	2#10	2.68*	193E	3	-	420	2.28*	203E	3	-	450	1.97*	213E	3	-	480	1.71*	223E	3	-	511	154	1506
				1			244D	14	0.7	579		264D	13	0.7	625		284D	13	0.7	670		304D	13	0.7	716	154	
		2#10		1	2#11	2.95*	203E	3	-	458	2.51*	213E	3	-	491	2.16*	223E	3	-	524	1.89X	233E	3	-	557	154	1415
				1			244D	14	0.7	615		264D	13	0.7	663		284D	13	0.7	711		304D	13	0.7	759	182	
	14	2# 7		1	3# 6	1.53	133E	4	-	217	1.30	133E	4	-	231	1.12	133E	4	-	244	0.98	133E	4	-	258	79	1695
				1			243D	17	0.8	289		263D	17	0.8	312		283D	17	0.8	335		303D	17	0.8	357	87	
		2# 9		1	3# 7	2.03	163E	4	-	322	1.73*	173E	4	-	346	1.49*	173E	4	-	367	1.30*	173E	4	-	388	127	1602
				1			244D	17	0.8	500		263D	17	0.8	414		283D	17	0.8	444		303D	17	0.8	474	116	
		2#10		1	3# 9	3.00*	193E	4	-	447	2.56*	203E	4	-	479	2.21*	213E	4	-	511	1.92*	223E	4	-	544	157	1344
				1			244D	17	0.8	615		264D	17	0.8	663		284D	17	0.8	711		304D	17	0.8	760	182	
		2#11		1	3#10	3.57*	204E	4	-	612	3.05*	213E	4	-	587	2.63*	223E	4	-	627	2.29X	233E	4	-	666	187	1174
				1			244D	17	0.8	712		264D	17	0.8	768		284D	17	0.8	823		304D	17	0.8	879	222	
	16	2# 8		1	3# 7	1.99	153E	5	-	284	1.69	153E	5	-	302	1.46*	153E	5	-	320	1.27*	153E	5	-	338	104	1515
				1			214E	21	0.9	445		224E	21	0.9	472		243E	21	0.9	389		263E	21	0.9	416	118	
		2# 9		1	3# 8	2.46*	173E	5	-	359	2.10*	173E	5	-	382	1.81*	183E	5	-	409	1.58*	183E	5	-	432	128	1427
				1			214E	21	0.9	513		224E	21	0.9	546		244E	21	0.9	589		264E	21	0.9	632	151	
		2#11		1	3# 9	3.23*	193E	5	-	499	2.75*	203E	5	-	536	2.37*	203E	5	-	569	2.07*	213E	5	-	606	190	1203
				1			214E	21	0.9	646		224E	21	0.9	689		244E	21	0.9	742		264E	21	0.9	796	186	
		2#10	1#10	1	3#10	3.95*	204E	5	-	658	3.36*	214E	5	-	705	2.90*	223E	5	-	679	2.53X	233E	5	-	722	227	1047
				1			215E	21	0.9	874		225E	21	0.9	930		245E	21	0.9	1003		264E	21	0.9	905	227	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

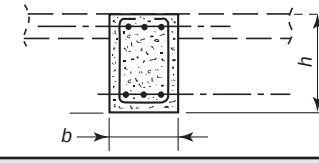
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

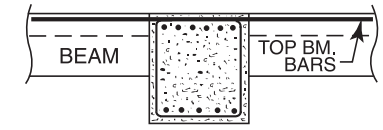
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																		
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
20	10	2# 6		1	2# 7	1.83	123F	3	-	159	1.52	123F	3	-	170	1.27	123F	3	-	181	1.09	123F	3	-	192	66	1585
				1			203D	12	0.7	210		223D	12	0.7	230		243D	12	0.7	249		263D	12	0.7	269	89	
		2# 8		1	2# 8	2.86	143F	3	-	233	2.37	153F	3	-	254	1.99	163F	3	-	274	1.69*	163F	3	-	291	114	1581
				1			403A	12	0.7	367		443A	12	0.7	402		483A	12	0.7	437		263D	12	0.7	355	114	
		2# 9		1	2#10	3.88	173CdF	3	-	323	3.21	163F	3	-	343	2.69*	173F	3	-	370	2.30*	183F	3	-	397	141	1297
				1			403A	12	0.7	447		443A	12	0.7	489		483A	12	0.7	530		523A	12	0.7	572	172	
		2#10		1	2#11	4.75	193CiF	3	-	398	3.93*	193CgF	3	-	428	3.30*	203CfF	3	-	461	2.81*	213CdF	3	-	494	172	1133
				1			403A	12	0.7	516		443A	12	0.7	563		483A	12	0.7	611		523A	12	0.7	659	204	
	12	2# 7		1	2# 7	2.25	123F	4	-	184	1.86	123F	4	-	197	1.56	123F	4	-	210	1.33	123F	4	-	223	90	1375
				1			203D	16	0.8	238		223D	16	0.8	260		243D	16	0.8	283		263D	16	0.8	305	90	
		2# 8		1	2# 9	3.19	143F	4	-	257	2.64	153F	4	-	279	2.22	153F	4	-	297	1.89	163F	4	-	319	116	1351
				1			204D	16	0.8	401		224D	16	0.8	439		244D	16	0.8	477		264D	16	0.8	515	143	
		2#10		1	2#11	4.87	154F	4	-	437	4.03	174F	4	-	480	3.38*	184F	4	-	516	2.88*	193F	4	-	490	177	1064
				1			404A	16	0.8	721		224D	16	0.8	577		244D	16	0.8	626		264D	16	0.8	675	210	
		4# 6	3# 6	2	2#11	5.27	154F	4	-	463	4.35*	174F	4	-	509	3.66*	184F	4	-	548	3.12*	194F	4	-	587	202	1032
				1			404A	16	0.8	747		444A	16	0.8	818		244D	16	0.8	658		264D	16	0.8	709	210	
	14	2# 8		1	3# 6	2.49	123F	5	-	217	2.06	123F	5	-	233	1.73	123F	5	-	248	1.48	123F	5	-	264	117	1102
				1			174E	21	1.0	345		194E	21	0.9	381		213E	20	0.9	311		223E	20	0.9	332	99	
		2# 9		1	3# 8	4.00	143F	5	-	305	3.31	153F	5	-	331	2.78	163F	5	-	358	2.37*	163F	5	-	381	145	1143
				1			174E	21	0.9	426		194E	21	0.9	470		214E	20	0.9	513		224E	20	0.9	546	170	
		2# 9	1# 9	1	3# 9	5.25	154F	5	-	453	4.34	164F	5	-	492	3.64*	174F	5	-	530	3.10*	183F	5	-	507	209	955
				1			175E	21	0.9	632		195E	21	0.9	697		215E	20	0.9	762		224E	20	0.9	665	209	
		2#10	1#10	1	3#10	6.41	155F	5	-	613	5.30	174F	5	-	602	4.45*	184F	5	-	649	3.80*	194F	5	-	696	256	824
				1			175E	21	0.9	727		195E	21	0.9	800		215E	20	0.9	874		225E	20	0.9	930	256	
	16	2# 8		1	3# 7	3.25	123F	6	-	241	2.69	133F	6	-	263	2.26	133F	6	-	281	1.92	133F	6	-	299	118	1078
				1			174E	26	1.1	376		194E	25	1.1	415		214E	25	1.0	454		224E	25	1.0	483	134	
		2#10		1	3# 8	4.32	143F	6	-	345	3.57	153F	6	-	375	3.00	153F	6	-	401	2.55	163F	6	-	432	182	1000
				1			174E	26	1.1	472		194E	25	1.0	520		214E	25	1.0	568		224E	25	1.0	605	172	
		2#10	1#10	1	3#10	6.54	155F	6	-	618	5.41	174F	6	-	606	4.54*	184F	6	-	653	3.87*	194F	6	-	700	261	788
				1			175E	26	1.1	739		195E	25	1.0	814		215E	25	1.0	888		225E	25	1.0	945	261	
		2#10	1#10	1	3#11	7.20	155F	6	-	665	5.95*	175F	6	-	731	5.00*	184F	6	-	707	4.26*	194F	6	-	757	261	738
				1			305B	26	1.1	1012		195E	25	1.0	864		215E	25	1.0	942		225E	25	1.0	1002	309	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
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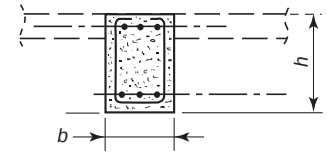
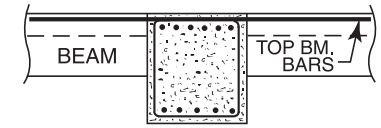
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																		$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 28 ft					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.					SPAN, ℓ_n = 34 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
20	10	2# 6		1	2# 7	0.94	123F	3	-	203	0.82	123F	3	-	213	0.72	113F	3	-	221	0.63	113F	3	-	232	66	1585
				1			283D	12	0.7	289		303D	12	0.7	309		323D	11	0.7	329		343D	11	0.7	348	89	
		2# 8		1	2# 8	1.46*	173F	3	-	311	1.27*	173F	3	-	328	1.12*	183F	3	-	348	0.99*	183F	3	-	365	114	1581
				1			283D	12	0.7	381		303D	12	0.7	407		323D	11	0.7	433		343D	11	0.7	459	114	
		2# 9		1	2#10	1.98*	193F	3	-	424	1.72*	203F	3	-	451	1.52*	213F	3	-	478	1.34*	213F	3	-	502	141	1297
				1			563A	12	0.7	614		603A	12	0.7	655		643A	11	0.7	697		683A	11	0.7	739	172	
		2#10		1	2#11	2.43*	203F	3	-	520	2.11*	213F	3	-	553	1.86*	223F	3	-	586	1.64X	233F	3	-	619	172	1133
				1			563A	12	0.7	706		603A	12	0.7	754		643A	11	0.7	802		683A	11	0.7	849	204	
	12	2# 7		1	2# 7	1.15	123F	4	-	236	1.00	123F	4	-	248	0.88	123F	4	-	261	0.78	113F	4	-	271	90	1375
				1			283D	16	0.8	328		303D	16	0.8	350		323D	15	0.8	372		343D	15	0.8	395	90	
		2# 8		1	2# 9	1.63*	163F	4	-	338	1.42*	173F	4	-	360	1.25*	173F	4	-	379	1.11*	173F	4	-	397	116	1351
				1			283D	16	0.8	416		303D	16	0.8	444		323D	15	0.8	473		343D	15	0.8	501	143	
		2#10		1	2#11	2.49*	193F	4	-	519	2.16*	203F	4	-	552	1.90*	213F	4	-	585	1.69X	223F	4	-	618	177	1064
				1			284D	16	0.8	723		304D	16	0.8	772		324D	15	0.8	821		344D	15	0.8	870	210	
		2#11		1	2#11	2.69*	203F	4	-	581	2.34*	213F	4	-	618	2.06*	223F	4	-	655	1.82X	223F	4	-	689	210	1000
				1			284D	16	0.8	782		304D	16	0.8	835		324D	15	0.8	888		344D	15	0.8	941	210	
	14	2# 8		1	3# 6	1.27	123F	5	-	280	1.11	113F	5	-	293	0.97	113F	5	-	309	0.86	103F	5	-	321	117	1102
				1			243E	20	0.9	358		263E	20	0.9	384		283E	20	0.9	410		293E	20	0.9	431	99	
		2# 9		1	3# 8	2.04*	173F	5	-	407	1.78*	173F	5	-	430	1.56*	183F	5	-	457	1.39*	183F	5	-	480	145	1143
				1			244E	20	0.9	589		264E	20	0.9	632		284E	20	0.9	675		294E	20	0.9	708	170	
		2#11		1	3# 9	2.68*	193F	5	-	568	2.33*	203F	5	-	605	2.05*	203F	5	-	638	1.82*	213F	5	-	675	215	951
				1			244E	20	0.9	742		264E	20	0.9	796		284E	20	0.9	849		294E	20	0.9	892	209	
		2#10	1#10	1	3#10	3.27*	204F	5	-	743	2.85*	214F	5	-	789	2.51*	223F	5	-	761	2.22X	233F	5	-	804	256	824
				1			245E	20	0.9	1003		265E	20	0.9	1076		284E	20	0.9	965		294E	20	0.9	1015	256	
	16	2# 8		1	3# 7	1.66	133F	6	-	316	1.45	133F	6	-	334	1.27	133F	6	-	352	1.13*	133F	6	-	370	118	1078
				1			243E	25	1.0	395		263E	25	1.0	423		283E	24	1.0	451		293E	24	1.0	474	134	
		2#10		1	3# 8	2.20*	163F	6	-	458	1.92*	173F	6	-	489	1.69*	173F	6	-	515	1.49*	173F	6	-	542	182	1000
				1			244E	25	1.0	652		264E	25	1.0	700		284E	24	1.0	748		294E	24	1.0	785	172	
		2#11		1	3#10	3.07*	193F	6	-	624	2.67*	203F	6	-	664	2.35*	203F	6	-	700	2.08*	213F	6	-	740	218	842
				1			244E	25	1.0	807		264E	25	1.0	864		284E	24	1.0	922		294E	24	1.0	969	261	
		2#14		1	3#11	3.95*	204F	6	-	894	3.44*	214F	6	-	951	3.03X	224F	6	-	1007	2.68X	234F	6	-	1064	297	710
				1			245E	25	1.0	1167		265E	25	1.0	1251		285E	24	1.0	1335		295E	24	1.0	1402	309	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

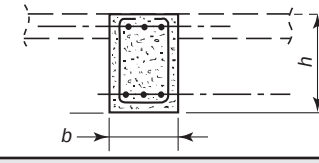
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

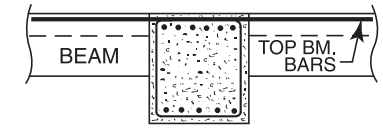
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
22	12	2# 7		1	2# 8	2.77	113G	5	-	201	2.29	123G	5	-	219	1.93	123G	5	-	234	1.64	123G	5	-	248	100	1012
				1			174E	19	0.9	332		194E	19	0.9	367		214E	18	0.9	401		223E	18	0.9	314	130	
		2# 9		1	2# 9	4.04	133G	5	-	287	3.34	143G	5	-	312	2.81	143G	5	-	334	2.39	153G	5	-	359	161	992
				1			174E	19	0.9	411		194E	19	0.9	452		214E	18	0.9	494		224E	18	0.9	526	161	
		2#10		1	2#11	5.50	144G	5	-	436	4.55	154G	5	-	473	3.82	164G	5	-	510	3.25*	174G	5	-	547	199	825
				1			304B	19	0.9	638		334B	19	0.9	698		364B	18	0.9	758		224E	18	0.9	646	238	
		4# 6	3# 6	2	3#10	6.33	154DdG	5	-	501	5.23	154G	5	-	536	4.40	164G	5	-	578	3.75*	174G	5	-	620	230	740
				1			304B	19	0.9	695		334B	19	0.9	761		364B	18	0.9	826		394B	18	0.9	891	283	
	14	2# 8		1	3# 7	3.62	123G	6	-	243	2.99	123G	6	-	261	2.51	133G	6	-	282	2.14	133G	6	-	300	131	922
				1			174E	24	1.1	376		194E	24	1.0	415		214E	24	1.0	454		224E	23	1.0	483	149	
		2#10		1	3# 8	4.80	134G	6	-	390	3.97	143G	6	-	373	3.33	153G	6	-	403	2.84	153G	6	-	430	203	826
				1			175E	24	1.1	588		194E	24	1.0	520		214E	24	1.0	568		224E	23	1.0	605	192	
		2# 9	1# 9	1	3#10	6.51	144G	6	-	494	5.38	154G	6	-	536	4.52	164G	6	-	578	3.85	174G	6	-	620	236	688
				1			175E	24	1.1	685		195E	24	1.0	754		215E	24	1.0	824		225E	23	1.0	876	290	
		2#10	1#10	1	3#11	8.00	304B	6	-	714	6.61	155G	6	-	713	5.55	165G	6	-	769	4.73*	184G	6	-	754	290	599
				1			304B	24	1.1	807		195E	24	1.0	864		215E	24	1.0	942		225E	23	1.0	1002	344	
	16	2# 9		1	3# 7	3.76	113G	8	-	271	3.11	123G	7	-	296	2.61	123G	7	-	317	2.23	123G	7	-	337	164	761
				1			154F	30	1.2	393		174F	30	1.2	436		184F	29	1.2	467		204F	29	1.1	510	150	
		2#10		1	3# 9	5.65	134G	7	-	425	4.67	144G	7	-	462	3.92	153G	7	-	443	3.34	153G	7	-	472	205	736
				1			155F	30	1.2	596		175F	30	1.2	662		185F	29	1.1	709		205F	29	1.1	774	240	
		2#10	1#10	1	3#11	8.14	145G	7	-	663	6.73	155G	7	-	719	5.65	165G	7	-	774	4.82*	174G	7	-	751	295	573
				1			245C	30	1.2	924		265C	30	1.2	1003		295C	29	1.1	1101		205F	29	1.1	982	351	
		5# 6	5# 6	2	3#11	8.80	304B	7	-	755	7.27	155G	7	-	757	6.11*	165G	7	-	816	5.21*	185G	7	-	887	323	567
				1			305B	30	1.2	1067		265C	29	1.1	1042		295C	29	1.1	1143		315C	29	1.1	1225	351	
	18	2# 7	1# 7	1	3# 8	4.16	113G	9	-	280	3.44	123G	9	-	305	2.89	123G	9	-	326	2.46	123G	9	-	347	151	674
				1			154F	36	1.3	407		194E	36	1.3	474		214E	35	1.3	518		224E	35	1.3	550	195	
		2# 9	1# 9	1	3# 9	6.06	134G	9	-	451	5.01	144G	9	-	491	4.21	143G	9	-	468	3.59	153G	9	-	504	242	661
				1			155F	36	1.3	630		175F	36	1.3	699		185F	35	1.3	749		205F	35	1.3	818	242	
		2#10	1#10	1	3#11	8.25	145G	9	-	668	6.82	155G	9	-	724	5.73	164G	9	-	703	4.88*	174G	9	-	755	299	550
				1			245C	36	1.3	941		265C	36	1.3	1022		295C	35	1.3	1121		205F	35	1.3	996	358	
		2#10	2#10	1	4#11	10.61	304B	9	-	882	8.77	165DdG	9	-	905	7.37	165G	9	-	962	6.28*	185G	9	-	1044	385	455
				1			305B	36	1.3	1208		265C	36	1.3	1190		295C	35	1.3	1303		315C	35	1.3	1398	455	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
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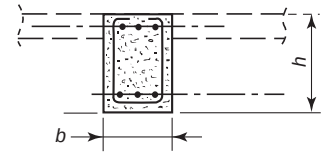
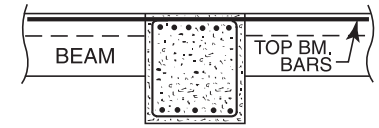
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

f_c' = 4,000 psi
f_y = 60,000 psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 28 ft					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.					SPAN, ℓ_n = 34 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
22	12	2# 7		1	2# 8	1.42	123G	5	-	263	1.23	123G	4	-	277	1.08	123G	4	-	291	0.96	123G	4	-	306	100	1012
				1			243E	18	0.9	339		263E	18	0.9	363		283E	18	0.9	387		293E	18	0.9	407	130	
		2# 9		1	2# 9	2.06	163G	5	-	384	1.80*	163G	4	-	406	1.58*	163G	4	-	428	1.40*	173G	4	-	453	161	992
				1			244E	18	0.9	567		264E	18	0.9	609		284E	18	0.9	651		294E	18	0.9	683	161	
		2#11		1	2#11	3.04*	184G	5	-	642	2.65*	193G	4	-	616	2.33*	203G	4	-	654	2.06*	203G	4	-	687	238	776
				1			244E	18	0.9	754		264E	18	0.9	808		284E	18	0.9	862		294E	18	0.9	906	238	
		2#11		1	3#10	3.35*	184G	5	-	684	2.92*	194G	4	-	727	2.56*	203G	4	-	700	2.27*	213G	4	-	740	238	722
				1			424B	18	0.9	978		454B	18	0.9	1044		284E	18	0.9	909		294E	18	0.9	955	283	
	14	2# 8		1	3# 7	1.85	133G	6	-	318	1.61	143G	6	-	340	1.41	143G	6	-	357	1.25	143G	6	-	375	131	922
				1			244E	23	1.0	521		264E	23	1.0	560		283E	23	1.0	451		293E	23	1.0	474	149	
		2#10		1	3# 8	2.45	163G	6	-	460	2.13*	163G	6	-	487	1.88*	173G	6	-	517	1.66*	173G	6	-	544	203	826
				1			244E	23	1.0	652		264E	23	1.0	700		284E	23	1.0	748		294E	23	1.0	785	192	
		2#11		1	3#10	3.41*	184G	6	-	688	2.97*	193G	6	-	663	2.61*	193G	6	-	699	2.32*	203G	6	-	739	243	685
				1			245E	23	1.0	971		264E	23	1.0	864		284E	23	1.0	922		294E	23	1.0	969	290	
		2#10	1#10	1	3#11	4.08*	194G	6	-	805	3.55*	194G	6	-	848	3.12*	204G	6	-	899	2.77*	214G	6	-	950	290	599
				1			245E	23	1.0	1081		265E	23	1.0	1159		285E	23	1.0	1237		295E	23	1.0	1298	344	
	16	2# 9		1	3# 7	1.92	123G	7	-	358	1.67	133G	7	-	383	1.47	123G	7	-	400	1.30	123G	7	-	420	164	761
				1			214F	29	1.1	542		234F	28	1.1	585		244F	28	1.1	616		263F	28	1.1	516	150	
		2#10		1	3# 9	2.88	163G	7	-	505	2.51*	163G	7	-	534	2.21*	173G	7	-	567	1.95*	173G	7	-	596	205	736
				1			214F	29	1.1	673		234F	28	1.1	724		244F	28	1.1	764		264F	28	1.1	815	240	
		2#10	1#10	1	3#11	4.15*	184G	7	-	802	3.62*	194G	7	-	853	3.18*	204G	7	-	904	2.82*	203G	7	-	872	295	573
				1			215F	29	1.1	1043		235F	28	1.1	1123		245F	28	1.1	1184		265F	28	1.1	1263	351	
		2#14		1	3#11	4.49*	184G	7	-	888	3.91*	194G	7	-	945	3.44*	204G	7	-	1002	3.04*	214G	7	-	1059	337	550
				1			215F	29	1.1	1130		235F	28	1.1	1215		245F	28	1.1	1282		265F	28	1.1	1368	351	
	18	2# 7	1# 7	1	3# 8	2.12	123G	9	-	368	1.85	123G	9	-	389	1.63	123G	9	-	410	1.44	123G	8	-	431	151	674
				1			244E	34	1.3	594		263E	34	1.3	490		283E	34	1.2	523		293E	34	1.2	550	195	
		2# 9	1# 9	1	3# 9	3.09	163G	9	-	540	2.69*	163G	9	-	571	2.37*	163G	8	-	602	2.10*	173G	8	-	638	242	661
				1			214F	34	1.3	715		234F	34	1.2	770		284E	34	1.2	858		294E	34	1.2	901	242	
		2#11	1#11	1	3#11	4.57*	184G	9	-	890	3.98*	194G	9	-	947	3.50*	204G	8	-	1004	3.10*	204G	8	-	1053	358	517
				1			215F	34	1.2	1141		235F	34	1.2	1228		245F	34	1.2	1296		265F	34	1.2	1383	358	
		2#11	1#11	1	4#11	5.02*	185G	9	-	1078	4.38*	194G	9	-	1055	3.85*	204G	8	-	1118	3.41*	214G	8	-	1181	358	468
				1			345C	34	1.2	1488		235F	34	1.2	1336		245F	34	1.2	1411		265F	34	1.2	1503	455	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

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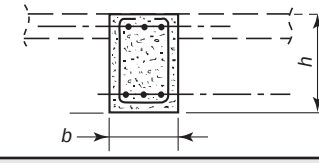
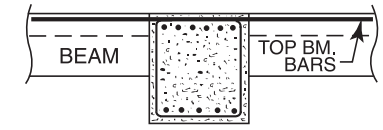
RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																		
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
24	12	2# 8		1	2# 8	2.51	123H	5	-	268	2.14	123H	5	-	285	1.84	133H	5	-	306	1.61	133H	5	-	323	144	806
				1			214E	21	1.0	442		224E	21	1.0	470		244E	20	1.0	508		264E	20	1.0	546	144	
		2# 9		1	2#10	3.43	143H	5	-	369	2.92	143H	5	-	393	2.52	153H	5	-	420	2.20	153H	5	-	444	179	737
				1			214E	21	1.0	535		224E	21	1.0	569		244E	20	1.0	614		264E	20	1.0	659	222	
		2#11		1	2#11	4.63	154H	5	-	560	3.95	164H	5	-	602	3.40	164H	5	-	635	2.96*	174H	5	-	677	266	617
				1			364B	21	1.0	825		394B	21	1.0	890		244E	20	1.0	765		264E	20	1.0	820	266	
		4# 6	4# 6	2	2#14	5.49	164EeH	5	-	666	4.68	174EdH	5	-	714	4.04*	174H	5	-	755	3.52*	184H	5	-	803	287	541
				1			364B	21	1.0	923		394B	21	1.0	995		424B	20	1.0	1067		454B	20	1.0	1139	361	
	14	2# 8		1	3# 7	2.78	123H	7	-	282	2.37	123H	7	-	299	2.05	123H	7	-	317	1.78	123H	7	-	335	145	696
				1			184F	27	1.1	431		204F	27	1.1	471		214F	26	1.1	499		234F	26	1.1	539	165	
		2#10		1	3# 9	4.31	144H	7	-	494	3.68	153H	7	-	474	3.17	153H	7	-	503	2.76	163H	7	-	536	225	620
				1			185F	27	1.1	709		205F	27	1.1	774		215F	26	1.1	821		234F	26	1.1	724	263	
		2#10	1#10	1	3#10	5.64	155H	7	-	714	4.81	164H	7	-	690	4.15	174H	7	-	737	3.61*	174H	7	-	777	325	510
				1			185F	27	1.1	849		205F	27	1.1	925		215F	26	1.1	982		235F	26	1.1	1058	325	
		2#11	1#11	1	3#11	6.71	155H	7	-	839	5.72	165H	7	-	901	4.93*	175H	7	-	963	4.29*	184H	7	-	939	386	447
				1			295C	27	1.1	1173		315C	27	1.1	1259		215F	26	1.1	1127		235F	26	1.1	1212	386	
	16	2# 9		1	3# 8	3.49	123H	8	-	351	2.98	133H	8	-	378	2.57	133H	8	-	401	2.24	133H	8	-	424	182	610
				1			184F	33	1.3	507		204F	33	1.3	553		214F	33	1.3	588		234F	33	1.2	633	215	
		2#11		1	3# 9	4.64	144H	8	-	548	3.95	143H	8	-	526	3.41	153H	8	-	563	2.97	153H	8	-	596	274	550
				1			185F	33	1.3	772		205F	33	1.3	843		215F	33	1.2	895		234F	32	1.2	797	267	
		2#11	1#11	1	3#11	6.84	155H	8	-	844	5.83	165H	8	-	907	5.03*	175H	8	-	969	4.38*	184H	8	-	943	394	428
				1			295C	33	1.3	1193		315C	33	1.2	1280		215F	33	1.2	1141		235F	32	1.2	1228	394	
		2#11	1#11	1	4#11	7.53	155H	8	-	934	6.41	165H	8	-	1003	5.53*	175H	8	-	1071	4.82*	185H	8	-	1139	394	387
				1			295C	33	1.3	1283		315C	33	1.2	1376		345C	33	1.2	1488		365C	32	1.2	1581	496	
	18	2# 8	1# 8	1	3# 8	3.77	123H	10	-	374	3.21	123H	10	-	398	2.77	133H	10	-	427	2.41	133H	10	-	452	216	537
				1			165G	40	1.4	633		184G	40	1.4	561		194G	40	1.4	598		264E	39	1.4	706	216	
		2# 9	1# 9	1	3#10	5.15	144H	10	-	576	4.39	143H	10	-	554	3.78	153H	10	-	593	3.29	153H	10	-	627	269	491
				1			165G	40	1.4	770		185G	40	1.4	844		195G	40	1.4	898		205G	39	1.4	952	334	
		2#11	1#11	1	3#11	6.95	155H	10	-	850	5.92	165H	10	-	912	5.10	164H	10	-	881	4.45*	174H	10	-	939	400	411
				1			245D	40	1.4	1116		265D	40	1.4	1204		285D	39	1.4	1292		305D	39	1.4	1380	400	
		2#11	2#11	1	3#14	9.41	295C	10	-	1278	8.02*	175EeH	10	-	1184	6.91*	185EdH	10	-	1264	6.02*	185H	10	-	1331	512	333
				1			295C	40	1.4	1455		315C	40	1.4	1560		285D	39	1.4	1569		305D	39	1.4	1674	542	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

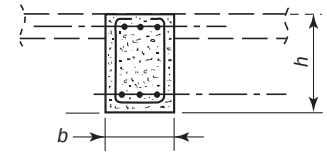
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

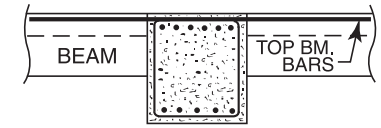
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				DEFL (C)
						SPAN, ℓ_n = 32 ft					SPAN, ℓ_n = 34 ft.					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.					$+\phi M_n$ $-\phi M_n$	
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	$\times 10^{-9}$
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	in.
24	12	2# 8		1	2# 8	1.41	133H	5	-	340	1.25	133H	5	-	357	1.12	133H	5	-	374	1.00	133H	5	-	390	144	806
				1			283E	20	1.0	436		293E	20	1.0	458		313E	20	1.0	485		333E	20	1.0	513	144	
		2# 9		1	2#10	1.93	163H	5	-	471	1.71*	163H	5	-	495	1.53*	173H	5	-	523	1.37*	173H	5	-	546	179	737
				1			284E	20	1.0	704		294E	20	1.0	738		314E	20	1.0	783		334E	20	1.0	827	222	
		2#11		1	2#11	2.61*	183H	5	-	651	2.31*	183H	5	-	684	2.06*	193H	5	-	722	1.85*	203H	5	-	760	266	617
				1			284E	20	1.0	875		294E	20	1.0	919		314E	20	1.0	974		334E	20	1.0	1029	266	
		2#10	1#10	1	2#14	3.42*	194H	5	-	888	3.03*	204H	5	-	938	2.70*	214H	5	-	989	2.42*	224H	5	-	1039	318	513
				1			484B	20	1.0	1248		514B	20	1.0	1323		544B	20	0.9	1397		334E	20	0.9	1218	361	
	14	2# 8		1	3# 7	1.57	123H	7	-	353	1.39	123H	6	-	371	1.24	123H	6	-	389	1.11	123H	6	-	406	145	696
				1			244F	26	1.1	568		264F	26	1.1	608		274F	26	1.1	637		293F	26	1.1	517	165	
		2#10		1	3# 9	2.43*	163H	7	-	565	2.15*	173H	6	-	598	1.92*	173H	6	-	627	1.72*	183H	6	-	661	225	620
				1			244F	26	1.1	764		264F	26	1.1	815		274F	26	1.1	855		294F	26	1.1	907	263	
		2#10	1#10	1	3#10	3.18*	184H	7	-	825	2.81*	194H	6	-	873	2.51*	193H	6	-	839	2.25*	203H	6	-	883	325	510
				1			245F	26	1.1	1116		265F	26	1.1	1192		275F	26	1.1	1250		294F	26	1.1	1121	325	
		2#14		1	3#11	3.77*	194H	6	-	999	3.34*	204H	6	-	1056	2.98*	204H	6	-	1105	2.68*	214H	6	-	1162	370	457
				1			245F	26	1.1	1282		265F	26	1.1	1368		275F	26	1.1	1435		295F	26	1.1	1520	386	
	16	2# 9		1	3# 8	1.97	133H	8	-	447	1.74	143H	8	-	474	1.55	143H	8	-	497	1.39*	143H	8	-	520	182	610
				1			244F	32	1.2	668		264F	32	1.2	714		274F	32	1.2	748		294F	32	1.2	794	215	
		2#11		1	3# 9	2.61*	163H	8	-	634	2.31*	163H	8	-	667	2.06*	173H	8	-	704	1.85*	173H	8	-	737	274	550
				1			244F	32	1.2	842		264F	32	1.2	898		274F	32	1.2	943		294F	32	1.2	999	267	
		2#14		1	3#11	3.85*	184H	8	-	995	3.41*	194H	8	-	1052	3.04*	204H	8	-	1110	2.73*	204H	8	-	1159	378	437
				1			245F	32	1.2	1299		265F	32	1.2	1386		275F	32	1.2	1454		295F	32	1.2	1540	394	
		2#11	1#11	1	4#11	4.23*	194H	8	-	1115	3.75*	204H	8	-	1178	3.35*	204H	8	-	1234	3.00*	214H	8	-	1297	394	387
				1			245F	32	1.2	1411		265F	32	1.2	1503		275F	32	1.2	1578		295F	32	1.2	1670	496	
	18	2# 8	1# 8	1	3# 8	2.12	133H	10	-	477	1.88	133H	10	-	501	1.67	133H	10	-	526	1.50	133H	10	-	551	216	537
				1			284E	39	1.4	754		294E	39	1.4	791		314E	38	1.3	840		333E	38	1.3	693	216	
		2# 9	1# 9	1	3#10	2.90	163H	10	-	666	2.56*	163H	10	-	701	2.29*	173H	10	-	740	2.05*	173H	10	-	774	269	491
				1			225G	39	1.4	1025		235G	39	1.3	1079		244G	38	1.3	952		264G	38	1.3	1011	334	
		2#11	1#11	1	3#11	3.91*	184H	10	-	996	3.46*	184H	10	-	1045	3.09*	194H	10	-	1103	2.77*	203H	10	-	1079	400	411
				1			225G	39	1.3	1274		235G	39	1.3	1342		245G	38	1.3	1411		265G	38	1.3	1499	400	
		2#11	2#11	1	3#14	5.29*	195H	10	-	1411	4.69*	205H	10	-	1491	4.18*	215H	10	-	1571	3.75*	225H	10	-	1651	512	333
				1			325D	39	1.3	1780		345D	39	1.3	1885		365D	38	1.3	1991		385D	38	1.3	2096	542	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

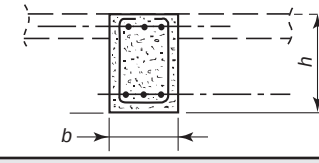
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

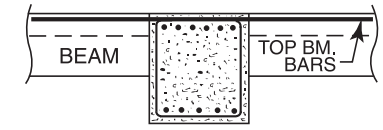
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
26	14	2# 9		1	3# 8	3.81	123I	8	-	353	3.25	123I	8	-	376	2.80	133I	7	-	403	2.44	133I	7	-	426	199	541
				1			184F	31	1.2	507		204F	30	1.2	553		214F	30	1.2	588		234F	30	1.2	633	234	
		2#10		1	3# 9	4.75	134I	8	-	492	4.05	134I	8	-	521	3.49	143I	7	-	502	3.04	153I	7	-	536	248	500
				1			185F	30	1.2	721		205F	30	1.2	788		215F	30	1.2	836		234F	30	1.2	735	290	
		2#10	1#10	1	3#11	6.86	135I	8	-	751	5.85	145I	8	-	807	5.04	165I	7	-	878	4.39	164I	7	-	841	359	387
				1			295C	30	1.2	1121		205F	30	1.2	996		215F	30	1.2	1058		235F	30	1.2	1139	428	
		2#11	1#11	1	4#10	8.00	294C	8	-	910	6.82	145I	8	-	905	5.88	165I	7	-	983	5.12*	175I	7	-	1047	428	352
				1			295C	30	1.2	1212		315C	30	1.2	1300		345C	30	1.2	1407		365C	30	1.2	1495	460	
	16	2# 9		1	3# 8	3.84	113I	9	-	350	3.27	123I	9	-	377	2.82	123I	9	-	400	2.46	123I	9	-	423	200	474
				1			165G	38	1.4	612		184G	37	1.4	538		194G	37	1.4	573		234F	37	1.4	644	236	
		2#11		1	3#10	5.78	134I	9	-	593	4.93	144I	9	-	638	4.25	144I	9	-	674	3.70	154I	9	-	719	302	418
				1			165G	38	1.4	793		185G	37	1.4	868		195G	37	1.4	924		205G	37	1.3	979	364	
		2#11	1#11	1	3#11	7.57	135I	9	-	827	6.45	145I	9	-	890	5.56	155I	9	-	953	4.85	165I	9	-	1016	436	347
				1			245D	38	1.4	1116		265D	37	1.4	1204		285D	37	1.3	1292		305D	37	1.3	1380	436	
		2#10	2#10	1	3#14	8.98	294C	9	-	1046	7.65	165FdI	9	-	1075	6.60	165I	9	-	1134	5.75	175I	9	-	1207	470	299
				1			295C	38	1.4	1361		265D	37	1.4	1361		285D	37	1.3	1459		305D	37	1.3	1557	586	
	18	2# 8	1# 8	1	3# 9	4.55	123I	11	-	414	3.88	123I	11	-	441	3.34	123I	11	-	469	2.91	133I	11	-	500	238	415
				1			165G	46	1.5	682		185G	45	1.5	749		195G	45	1.5	797		204G	44	1.5	689	296	
		2#10	1#10	1	3#10	6.40	134I	11	-	638	5.45	144I	11	-	687	4.70	144I	11	-	726	4.10	154I	11	-	775	368	375
				1			245D	46	1.5	1007		185G	45	1.5	926		195G	45	1.5	986		205G	44	1.5	1046	368	
		2#11	1#11	1	4#11	8.45	145FcI	11	-	936	7.20	145I	11	-	991	6.21	155I	11	-	1061	5.41	165I	11	-	1130	442	302
				1			245D	46	1.5	1223		265D	45	1.5	1318		285D	45	1.5	1414		305D	44	1.5	1510	568	
		2#11	2#11	1	3#14	10.46	295C	11	-	1298	8.92	165FfI	11	-	1182	7.69	175FeI	11	-	1263	6.70*	185FdI	11	-	1343	568	270
				1			295C	46	1.5	1475		315C	45	1.5	1582		345C	45	1.5	1709		305D	44	1.5	1695	602	
	20	2# 9	1# 9	1	3# 9	5.18	123I	14	-	468	4.42	123I	13	-	499	3.81	133I	13	-	535	3.32	133I	13	-	567	298	378
				1			155H	54	1.7	724		165H	53	1.7	777		175H	53	1.7	829		185H	52	1.6	881	298	
		2#10	1#10	1	3#11	7.10	135I	14	-	764	6.05	144I	13	-	747	5.22	144I	13	-	790	4.54	154I	13	-	843	371	338
				1			215E	54	1.7	1015		225E	53	1.7	1079		245E	53	1.6	1164		265E	52	1.6	1249	447	
		2#11	2#11	1	3#14	10.64	165EgI	14	-	1121	9.07	165FfI	13	-	1188	7.82	175FeI	13	-	1269	6.81*	175FcI	13	-	1335	576	261
				1			295C	54	1.7	1495		315C	53	1.7	1603		285D	53	1.6	1607		305D	52	1.6	1716	612	
		2#11	2#11	1	5#11	11.02	165EhI	14	-	1173	9.39	165FfI	13	-	1244	8.09	175FeI	13	-	1329	7.05*	185FdI	13	-	1415	576	246
				1			295C	54	1.7	1547		315C	53	1.7	1660		345C	53	1.6	1793		305D	52	1.6	1781	696	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

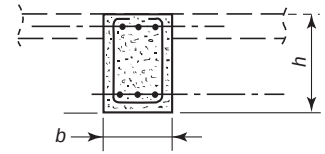
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

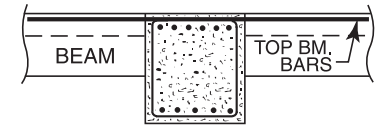
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

f_c' = 4,000 psi
f_y = 60,000 psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
						SPAN, ℓ_n = 32 ft					SPAN, ℓ_n = 34 ft.					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7) $\times 10^{-9}$
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	in.
26	14	2# 9		1	3# 8	2.14	133I	7	-	449	1.90	143I	7	-	476	1.69	143I	7	-	499	1.52	143I	7	-	522	199	541
				1			244F	29	1.2	668		264F	29	1.2	714		274F	29	1.2	748		294F	29	1.2	794	234	
		2#10		1	3# 9	2.67	153I	7	-	565	2.37	153I	7	-	594	2.11*	163I	7	-	627	1.90*	163I	7	-	656	248	500
				1			244F	29	1.2	775		264F	29	1.2	827		274F	29	1.2	868		294F	29	1.2	920	290	
		2#14		1	3#11	4.18*	175I	7	-	1076	3.71*	184I	7	-	1048	3.31*	194I	7	-	1106	2.97*	204I	7	-	1163	411	371
				1			245F	29	1.2	1299		265F	29	1.2	1386		275F	29	1.2	1454		295F	29	1.2	1540	428	
		2#14		1	4#10	4.42*	185I	7	-	1113	3.91*	185I	7	-	1164	3.49*	194I	7	-	1133	3.13*	204I	7	-	1192	411	359
				1			245F	29	1.2	1323		265F	29	1.2	1411		275F	29	1.2	1481		295F	29	1.2	1569	460	
	16	2# 9		1	3# 8	2.16	123I	9	-	446	1.91	133I	9	-	473	1.71	133I	9	-	496	1.53	123I	9	-	515	200	474
				1			244F	36	1.3	679		264F	36	1.3	726		274F	36	1.3	760		294F	36	1.3	807	236	
		2#11		1	3#10	3.25	153I	9	-	693	2.88*	163I	9	-	734	2.57*	163I	9	-	770	2.31*	173I	9	-	811	302	418
				1			225G	36	1.3	1055		235G	36	1.3	1111		245G	36	1.3	1166		265G	36	1.3	1242	364	
		2#14		1	3#11	4.26*	174I	9	-	995	3.77*	184I	9	-	1052	3.37*	184I	9	-	1102	3.02*	194I	9	-	1159	418	355
				1			325D	36	1.3	1471		235G	36	1.3	1345		245G	36	1.3	1414		265G	36	1.3	1502	436	
		2#10	2#10	1	3#14	5.05*	185I	9	-	1280	4.47*	185I	9	-	1339	3.99*	195I	9	-	1411	3.58*	204I	9	-	1382	470	299
				1			325D	36	1.3	1655		345D	36	1.3	1753		365D	36	1.3	1851		385D	36	1.3	1949	586	
	18	2# 8	1# 8	1	3# 9	2.56	133I	11	-	528	2.27	133I	11	-	555	2.02	133I	11	-	582	1.81	133I	11	-	609	238	415
				1			284E	44	1.5	815		294E	44	1.5	855		314E	43	1.5	907		334E	43	1.5	959	296	
		2#10	1#10	1	3#10	3.60	153I	11	-	751	3.19*	163I	11	-	795	2.84*	163I	11	-	835	2.55*	173I	11	-	880	368	375
				1			225G	44	1.5	1126		235G	44	1.5	1186		245G	43	1.5	1246		265G	43	1.5	1326	368	
		2#11	1#11	1	4#11	4.75*	175I	11	-	1199	4.21*	174I	11	-	1165	3.75*	184I	11	-	1230	3.37*	194I	11	-	1294	442	302
				1			325D	44	1.5	1605		345D	44	1.5	1701		245G	43	1.4	1555		265G	43	1.4	1650	568	
		2#14	1#14	1	3#14	5.89*	185I	11	-	1480	5.21*	195I	11	-	1564	4.65*	195I	11	-	1635	4.17*	205I	11	-	1720	602	265
				1			325D	44	1.5	1871		345D	44	1.5	1982		365D	43	1.4	2094		385D	43	1.4	2205	602	
	20	2# 9	1# 9	1	3# 9	2.92	133I	13	-	598	2.58	133I	13	-	630	2.30	133I	13	-	661	2.07	133I	13	-	693	298	378
				1			195H	52	1.6	934		215H	52	1.6	1007		224H	51	1.6	883		383D	51	1.6	879	298	
		2#10	1#10	1	3#11	3.99	154I	13	-	886	3.54*	163I	13	-	869	3.16*	163I	13	-	912	2.83*	173I	13	-	960	371	338
				1			195H	52	1.6	1146		215H	52	1.6	1231		225H	51	1.6	1296		235H	51	1.6	1360	447	
		2#11	2#11	1	3#14	5.98*	175I	13	-	1402	5.30*	185I	13	-	1483	4.73*	195I	13	-	1564	4.24*	195I	13	-	1631	576	261
				1			325D	52	1.6	1824		295E	52	1.6	1828		315E	51	1.6	1937		335E	51	1.6	2045	612	
		2#14	1#14	1	5#11	6.58*	195FdI	13	-	1569	5.83*	195FcI	13	-	1644	5.20*	195I	13	-	1719	4.67*	205I	13	-	1809	612	242
				1			325D	52	1.6	1963		345D	52	1.6	2080		365D	51	1.6	2196		335E	51	1.6	2209	696	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
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*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
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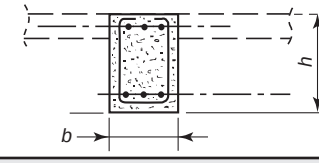
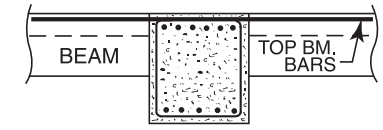
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																		
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 26 ft					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
28	14	2# 9		1	3# 8	3.54	123J	8	-	379	3.05	123J	8	-	402	2.66	123J	8	-	425	2.34	133J	8	-	452	217	432
				1			185G	34	1.3	674		194G	33	1.3	573		204G	33	1.3	608		224G	33	1.3	655	256	
		2#11		1	3# 9	4.70	134J	8	-	582	4.05	134J	8	-	615	3.53	143J	8	-	597	3.10	143J	8	-	631	327	388
				1			185G	34	1.3	818		195G	33	1.3	870		205G	33	1.3	923		225G	33	1.3	995	317	
		2#14		1	3#11	6.96	135J	8	-	884	6.00	145J	8	-	947	5.23	155J	8	-	1010	4.60	165J	8	-	1074	451	306
				1			265D	34	1.3	1207		285D	33	1.3	1295		305D	33	1.3	1383		325D	33	1.3	1471	470	
		4# 7	4# 7	2	4#11	7.59	145GdJ	8	-	991	6.55	155GcJ	8	-	1061	5.70	155J	8	-	1116	5.01*	165J	8	-	1186	466	297
				2			265D	34	1.3	1301		285D	33	1.3	1395		305D	33	1.3	1489		325D	33	1.3	1584	560	
	16	2#10		1	3# 8	3.82	113J	10	-	424	3.29	123J	10	-	455	2.87	123J	10	-	482	2.52	123J	10	-	509	273	369
				1			185G	42	1.5	736		194G	42	1.5	634		204G	41	1.5	673		244F	41	1.5	749	258	
		2#11		1	3#10	5.39	134J	10	-	635	4.64	134J	10	-	672	4.05	144J	10	-	717	3.56	143J	10	-	692	330	343
				1			185G	42	1.5	880		195G	41	1.5	937		205G	41	1.5	993		225G	41	1.4	1070	398	
		2#14		1	4#11	7.47	135J	10	-	984	6.44	145J	10	-	1054	5.61	155J	10	-	1124	4.93	165J	10	-	1194	459	264
				1			265D	42	1.5	1321		285D	41	1.5	1417		305D	41	1.4	1512		325D	41	1.4	1608	613	
		2#11	2#11	1	3#14	9.63	265D	10	-	1332	8.30	285D	10	-	1427	7.23	175GeJ	10	-	1335	6.36*	175GdJ	10	-	1402	613	232
				1			525A	42	1.5	2005		565A	41	1.5	2153		305D	41	1.4	1695		325D	41	1.4	1802	650	
	18	2# 9	1# 9	1	3# 9	4.79	123J	13	-	501	4.13	123J	13	-	532	3.59	133J	12	-	569	3.16	133J	12	-	600	323	332
				1			165H	51	1.7	777		175H	50	1.6	829		185H	50	1.6	881		195H	49	1.6	934	323	
		2#10	1#10	1	3#11	6.56	135J	13	-	812	5.65	144J	13	-	793	4.92	144J	12	-	837	4.33	154J	12	-	889	402	291
				1			225E	51	1.6	1079		245E	50	1.6	1164		265E	50	1.6	1249		285E	49	1.6	1334	484	
		2#11	2#11	1	3#14	9.82	165FgJ	13	-	1193	8.46	165GfJ	13	-	1260	7.37	175GeJ	12	-	1341	6.48*	175GdJ	12	-	1408	624	223
				1			315C	51	1.6	1603		345C	50	1.6	1733		305D	50	1.6	1716		325D	49	1.6	1824	663	
		2#14	1#14	1	3#14	9.82	165FgJ	13	-	1250	8.46	165GfJ	13	-	1321	7.37	175GeJ	12	-	1407	6.48	175GdJ	12	-	1477	663	219
				1			315C	51	1.6	1660		345C	50	1.6	1794		305D	50	1.6	1781		325D	49	1.6	1894	663	
	20	2# 9	1# 9	1	3# 9	4.82	113J	15	-	497	4.15	123J	15	-	534	3.62	123J	15	-	565	3.18	123J	15	-	597	325	300
				1			165H	60	1.8	788		175H	59	1.8	841		185H	59	1.8	894		195H	58	1.8	947	325	
		2#11	1#11	1	3#11	7.24	135J	15	-	895	6.24	145J	15	-	959	5.44	144J	15	-	930	4.78	154J	15	-	988	489	263
				1			225E	60	1.8	1172		245E	59	1.8	1265		265E	59	1.8	1357		285E	58	1.8	1449	489	
		2#14	1#14	1	3#14	9.96	165FgJ	15	-	1256	8.59	165GeJ	15	-	1327	7.48	165GdJ	15	-	1397	6.58	175GcJ	15	-	1483	673	211
				1			315C	60	1.8	1682		345C	59	1.8	1817		305D	59	1.8	1802		325D	58	1.8	1916	673	
		2#14	1#14	1	4#14	10.96	175EiJ	15	-	1412	9.45	175FhJ	15	-	1492	8.23	175GfJ	15	-	1571	7.24	185GeJ	15	-	1666	673	191
				1			395B	60	1.8	1995		345C	59	1.8	1967		365C	59	1.8	2090		325D	58	1.8	2084	857	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

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(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
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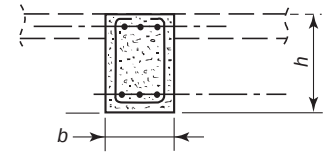
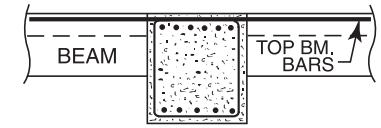
RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
						SPAN, ℓ_n = 34 ft					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.					SPAN, ℓ_n = 40 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h	b	BOTTOM		Lay-ers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
28	14	2# 9		1	3# 8	2.07	133J	8	-	475	1.85	133J	8	-	498	1.66	133J	8	-	521	1.50	133J	8	-	544	217	432
				1			234G	32	1.3	690		244G	32	1.3	725		264G	32	1.3	772		274G	32	1.3	806	256	
		2#11		1	3# 9	2.75	153J	8	-	668	2.45	153J	8	-	702	2.20*	163J	8	-	739	1.99*	163J	8	-	772	327	388
				1			235G	32	1.3	1048		245G	32	1.3	1100		264G	32	1.3	976		274G	32	1.3	1021	317	
		2#14		1	3#11	4.07*	174J	8	-	1048	3.63*	174J	8	-	1097	3.26*	184J	8	-	1155	2.94*	194J	8	-	1213	451	306
				1			235G	32	1.3	1345		245G	32	1.3	1414		265G	32	1.3	1502		275G	32	1.3	1571	470	
		2#10	2#10	1	4#11	4.82*	175J	8	-	1284	4.30*	185J	8	-	1355	3.86*	195J	8	-	1426	3.48*	195J	8	-	1483	506	282
				2			345D	32	1.3	1706		365D	32	1.3	1802		385D	32	1.3	1898		275G	32	1.2	1741	560	
	16	2#10		1	3# 8	2.23	123J	10	-	535	1.99	123J	10	-	562	1.79	123J	10	-	588	1.61	123J	10	-	615	273	369
				1			264F	40	1.4	801		274F	40	1.4	840		294F	40	1.4	891		304F	40	1.4	930	258	
		2#11		1	3#10	3.15	153J	10	-	733	2.81	153J	10	-	770	2.52*	163J	10	-	811	2.28*	163J	10	-	847	330	343
				1			235G	40	1.4	1126		245G	40	1.4	1183		265G	40	1.4	1260		274G	40	1.4	1106	398	
		2#14		1	4#11	4.37	175J	10	-	1263	3.90*	174J	10	-	1228	3.50*	184J	10	-	1292	3.16*	184J	10	-	1347	459	264
				1			345D	40	1.4	1704		245G	40	1.4	1558		265G	40	1.4	1653		275G	40	1.4	1729	613	
		2#11	2#11	1	3#14	5.63*	185GcJ	10	-	1483	5.02*	185J	10	-	1550	4.51*	195J	10	-	1631	4.07*	205J	10	-	1712	613	232
				1			345D	40	1.4	1909		365D	40	1.4	2016		385D	40	1.4	2123		405D	40	1.4	2230	650	
	18	2# 9	1# 9	1	3# 9	2.80	133J	12	-	631	2.50	133J	12	-	663	2.24	133J	12	-	694	2.02	143J	12	-	731	323	332
				1			215H	49	1.6	1007		225H	49	1.6	1059		234H	48	1.6	927		244H	48	1.6	971	323	
		2#10	1#10	1	3#11	3.83	154J	12	-	933	3.42	163J	12	-	914	3.07*	163J	12	-	957	2.77*	173J	12	-	1005	402	291
				1			215H	49	1.6	1231		225H	49	1.6	1296		235H	48	1.6	1360		245H	48	1.6	1424	484	
		2#11	2#11	1	3#14	5.74*	175J	12	-	1474	5.12*	185J	12	-	1556	4.60*	185J	12	-	1622	4.15*	195J	12	-	1704	624	223
				1			295E	49	1.6	1828		315E	49	1.6	1937		335E	48	1.6	2045		345E	48	1.6	2132	663	
		2#14	1#14	1	3#14	5.74*	175J	12	-	1548	5.12*	185J	12	-	1634	4.60*	195J	12	-	1719	4.15*	195J	12	-	1790	663	219
				1			345D	49	1.6	2006		315E	49	1.6	2014		335E	48	1.6	2127		345E	48	1.6	2218	663	
	20	2# 9	1# 9	1	3# 9	2.82	123J	14	-	628	2.51	123J	14	-	660	2.25	123J	14	-	691	2.03	123J	14	-	722	325	300
				1			215H	58	1.8	1021		224H	58	1.7	893		234H	57	1.7	938		403D	57	1.7	934	325	
		2#11	1#11	1	3#11	4.23	154J	14	-	1037	3.77	164J	14	-	1096	3.39*	163J	14	-	1072	3.06*	163J	14	-	1121	489	263
				1			295E	58	1.7	1520		225H	58	1.7	1418		235H	57	1.7	1489		245H	57	1.7	1559	489	
		2#14	1#14	1	3#14	5.83*	175J	14	-	1554	5.20*	175J	14	-	1625	4.66*	185J	14	-	1711	4.21*	195J	14	-	1796	673	211
				1			295E	58	1.7	1922		315E	57	1.7	2036		335E	57	1.7	2150		345E	57	1.7	2242	673	
		2#14	1#14	1	4#14	6.41*	185GdJ	14	-	1746	5.72*	195GcJ	14	-	1841	5.13*	195J	14	-	1920	4.63*	195J	14	-	2000	673	191
				1			345D	58	1.7	2206		365D	57	1.7	2329		335E	57	1.7	2344		345E	57	1.7	2445	857	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

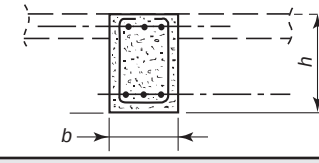
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

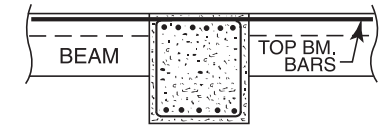
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 26 ft					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
30	14	2#10		1	3# 8	4.10	113K	9	-	426	3.54	113K	9	-	452	3.08	123K	9	-	484	2.71	123K	9	-	510	294	341
				1			185G	37	1.4	736		195G	37	1.4	782		204G	37	1.4	673		224G	36	1.4	725	277	
		2#11		1	3#10	5.79	124K	9	-	629	4.99	134K	9	-	675	4.35	134K	9	-	711	3.82	144K	9	-	756	355	304
				1			185G	37	1.4	880		195G	37	1.4	937		205G	37	1.4	993		225G	36	1.4	1070	428	
		2#14		1	3#11	7.58	135HcK	9	-	893	6.54	135K	9	-	942	5.70	145K	9	-	1006	5.01	155K	9	-	1070	492	257
				1			265D	37	1.4	1225		285D	37	1.4	1315		305D	36	1.4	1404		325D	36	1.4	1494	512	
		2#14	1#11	1	3#14	10.29	265D	9	-	1344	8.87	285D	9	-	1440	7.73	304D	9	-	1371	6.79	324D	9	-	1457	638	205
				1			525A	37	1.4	2008		565A	37	1.4	2155		305D	36	1.4	1698		325D	36	1.4	1805	695	
	16	2#10		1	3# 9	4.83	113K	12	-	467	4.16	123K	12	-	501	3.63	123K	11	-	530	3.19	123K	11	-	559	296	306
				1			165H	47	1.6	746		175H	46	1.6	796		185H	46	1.6	846		195H	45	1.6	896	348	
		2#11		1	3#10	5.84	124K	12	-	632	5.04	124K	12	-	668	4.39	134K	11	-	714	3.86	133K	11	-	691	359	285
				1			225E	47	1.6	976		175H	46	1.6	908		185H	46	1.6	966		195H	45	1.6	1023	433	
		2#11	1#11	1	4#11	8.47	135HdK	12	-	991	7.30	145HcK	12	-	1061	6.36	145K	11	-	1116	5.59	155K	11	-	1187	520	217
				1			265D	47	1.6	1336		245E	46	1.6	1350		265E	46	1.6	1447		285E	45	1.6	1544	669	
		2#14	1#14	1	3#14	10.53	265D	12	-	1407	9.08	285D	12	-	1508	7.91	165GgK	11	-	1397	6.95	165HeK	11	-	1468	711	190
				1			525A	47	1.6	2099		565A	46	1.6	2253		305D	46	1.6	1781		325D	45	1.6	1894	711	
	18	2# 9	1# 9	1	3# 9	5.19	113K	14	-	499	4.47	113K	14	-	530	3.89	123K	14	-	567	3.42	123K	14	-	598	350	270
				1			165H	57	1.8	788		175H	56	1.8	841		185H	55	1.8	894		195H	55	1.7	947	350	
		2#10	1#10	1	3#11	7.11	125K	14	-	806	6.13	135K	14	-	865	5.34	134K	14	-	833	4.70	144K	14	-	887	437	243
				1			225E	57	1.8	1094		245E	56	1.8	1181		265E	55	1.7	1267		285E	55	1.7	1354	526	
		2#14	1#14	1	3#14	10.71	155FhK	14	-	1246	9.24	155GgK	14	-	1317	8.05	155HeK	14	-	1387	7.07	165HeK	14	-	1474	724	183
				1			315C	57	1.8	1682		345C	56	1.8	1817		305D	55	1.7	1802		325D	55	1.7	1916	724	
		2#14	1#14	1	4#14	11.79	265D	14	-	1557	10.16	285D	14	-	1668	8.85	175FhK	14	-	1577	7.78	175GgK	14	-	1657	724	165
				1			525A	57	1.8	2276		565A	56	1.8	2442		365C	55	1.7	2090		385C	55	1.7	2213	907	
	20	2# 9	1# 9	1	3#10	5.74	113K	17	-	550	4.95	113K	17	-	585	4.31	123K	16	-	625	3.79	123K	16	-	659	352	240
				1			205F	67	2.0	938		165I	66	1.9	884		175I	66	1.9	941		185I	65	1.9	998	440	
		2#11	1#11	1	3#11	7.86	125K	17	-	888	6.78	135K	17	-	953	5.90	134K	16	-	926	5.19	144K	16	-	985	531	219
				1			225E	67	2.0	1188		215F	66	1.9	1214		235F	66	1.9	1308		245F	65	1.9	1380	531	
		2#14	1#14	1	3#14	10.86	155FhK	17	-	1251	9.37	155GfK	17	-	1322	8.16	155HeK	16	-	1393	7.17	165HdK	16	-	1479	734	177
				1			315C	67	2.0	1704		345C	66	1.9	1841		305D	66	1.9	1823		325D	65	1.9	1938	734	
		2#14	2#14	1	4#14	13.89	265D	17	-	1744	11.98	285D	17	-	1869	10.43	305D	16	-	1993	9.17	205EkK	16	-	1928	938	146
				1			525A	67	2.0	2490		565A	66	1.9	2672		605A	66	1.9	2854		385C	65	1.9	2457	938	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
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(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
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$f_c' = 4{,}000$ psi
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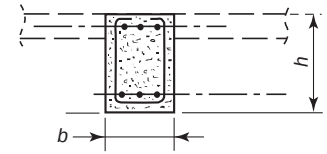
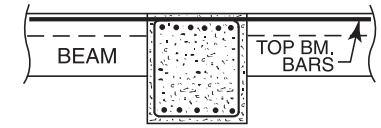
RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
						SPAN, ℓ_n = 34 ft					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.					SPAN, ℓ_n = 40 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7) $\times 10^{-9}$
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	in.
30	14	2#10		1	3# 8	2.40	123K	9	-	537	2.14	133K	9	-	568	1.92	133K	9	-	595	1.73	133K	9	-	621	294	341
				1			234G	36	1.4	764		244G	36	1.4	803		264G	35	1.4	854		274G	35	1.4	893	277	
		2#11		1	3#10	3.38	144K	9	-	793	3.02	153K	9	-	771	2.71	153K	9	-	808	2.44*	163K	9	-	849	355	304
				1			235G	36	1.4	1126		245G	36	1.4	1183		265G	35	1.4	1260		275G	35	1.4	1316	428	
		2#14		1	3#11	4.44	165K	9	-	1134	3.96*	164K	9	-	1095	3.55*	174K	9	-	1154	3.20*	174K	9	-	1203	492	257
				1			235G	36	1.4	1361		245G	36	1.4	1431		265G	35	1.4	1520		275G	35	1.4	1590	512	
		2#10	2#10	1	3#14	5.26	165K	9	-	1328	4.69*	175K	9	-	1402	4.21*	185K	9	-	1476	3.80*	185K	9	-	1535	552	216
				1			345D	36	1.4	1777		365D	36	1.4	1876		385D	35	1.4	1976		275G	35	1.3	1813	695	
	16	2#10		1	3# 9	2.82	133K	11	-	593	2.52	133K	11	-	623	2.26	133K	11	-	652	2.04	133K	11	-	681	296	306
				1			215H	45	1.6	967		225H	44	1.5	1017		234H	44	1.5	883		244H	44	1.5	925	348	
		2#11		1	3#10	3.42	143K	11	-	732	3.05	143K	11	-	768	2.74	153K	11	-	810	2.47	153K	11	-	846	359	285
				1			215H	45	1.6	1101		225H	44	1.5	1158		235H	44	1.5	1215		245H	44	1.5	1272	433	
		2#11	1#11	1	4#11	4.95	165K	11	-	1257	4.42	165K	11	-	1313	3.96*	174K	11	-	1288	3.58*	174K	11	-	1343	520	217
				1			295E	45	1.5	1620		315E	44	1.5	1717		335E	44	1.5	1814		345E	44	1.5	1891	669	
		2#14	1#14	1	3#14	6.16	175HdK	11	-	1554	5.49*	185HcK	11	-	1640	4.93*	185K	11	-	1711	4.45*	185K	11	-	1781	711	190
				1			345D	45	1.5	2006		315E	44	1.5	2014		335E	44	1.5	2127		345E	44	1.5	2218	711	
	18	2# 9	1# 9	1	3# 9	3.03	123K	14	-	630	2.70	123K	13	-	661	2.43	133K	13	-	698	2.19	133K	13	-	729	350	270
				1			215H	54	1.7	1021		225H	54	1.7	1074		234H	54	1.7	938		244H	53	1.7	982	350	
		2#10	1#10	1	3#11	4.16	144K	14	-	930	3.71	154K	13	-	983	3.33	153K	13	-	956	3.01*	153K	13	-	1000	437	243
				1			215H	54	1.7	1246		225H	54	1.7	1311		235H	54	1.7	1376		245H	53	1.7	1441	526	
		2#14	1#14	1	3#14	6.27	175HdK	14	-	1560	5.59*	175K	13	-	1631	5.02*	175K	13	-	1701	4.53*	185K	13	-	1788	724	183
				1			345D	54	1.7	2030		315E	54	1.7	2036		335E	54	1.7	2150		345E	53	1.7	2242	724	
		2#14	1#14	1	4#14	6.89	175HfK	14	-	1736	6.15*	185HeK	13	-	1832	5.52*	195HdK	13	-	1927	4.98*	185K	13	-	1991	724	165
				1			345D	54	1.7	2206		365D	54	1.7	2329		385D	54	1.7	2452		345E	53	1.7	2445	907	
	20	2# 9	1# 9	1	3#10	3.35	123K	16	-	694	2.99	123K	16	-	729	2.69	133K	16	-	768	2.42	133K	16	-	803	352	240
				1			195I	64	1.9	1054		205I	64	1.9	1111		215I	64	1.9	1168		225I	63	1.9	1225	440	
		2#11	1#11	1	3#11	4.60	144K	16	-	1034	4.10	154K	16	-	1093	3.68	153K	16	-	1071	3.32*	153K	16	-	1120	531	219
				1			265F	64	1.9	1473		275F	64	1.9	1545		295F	64	1.9	1638		225I	63	1.8	1532	531	
		2#14	1#14	1	3#14	6.35	165HcK	16	-	1550	5.67*	165K	16	-	1621	5.09*	175K	16	-	1707	4.59*	175K	16	-	1778	734	177
				1			345D	64	1.9	2053		315E	64	1.9	2057		335E	63	1.9	2173		305F	63	1.8	2177	734	
		2#14	2#14	1	4#14	8.12	195FiK	16	-	2005	7.24*	195GhK	16	-	2099	6.50*	205GgK	16	-	2207	5.87*	205HeK	16	-	2301	938	146
				1			415C	64	1.9	2617		435C	64	1.9	2755		385D	63	1.9	2737		405D	63	1.8	2874	938	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

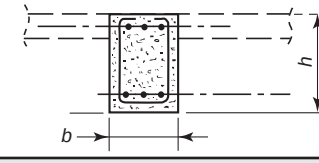
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

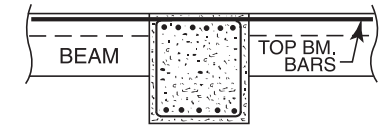
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																			
		BOTTOM		Lay-ers	TOP	SPAN, ℓ_n = 32 ft					SPAN, ℓ_n = 34 ft.					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
32	16	2#10		1	3# 9	3.43	123M	12	-	562	3.04	123M	12	-	591	2.71	123M	12	-	621	2.43	123M	12	-	650	319	251
				1			195H	50	1.7	909		215H	49	1.7	982		225H	49	1.7	1032		235H	49	1.6	1083	375	
		2#11		1	3#11	4.16	134M	12	-	824	3.68	133M	12	-	802	3.29	133M	12	-	841	2.95	143M	12	-	886	387	222
				1			195H	50	1.7	1104		215H	49	1.7	1187		225H	49	1.7	1248		235H	49	1.6	1309	562	
		2#11	2#11	1	3#14	7.54	165HfM	12	-	1410	6.68	165IeM	12	-	1476	5.96	175IdM	12	-	1559	5.35*	175IcM	12	-	1625	725	165
				1			325D	50	1.7	1846		345D	49	1.7	1956		315E	49	1.6	1958		335E	49	1.6	2068	772	
		2#14	1#14	1	5#11	8.18	175GhM	12	-	1564	7.25	175HgM	12	-	1639	6.46*	175IfM	12	-	1714	5.80*	185IeM	12	-	1805	772	160
				2			385C	50	1.7	2114		345D	49	1.7	2103		365D	49	1.6	2221		385D	49	1.6	2339	837	
	18	2# 9	1# 9	1	3#10	4.06	123M	15	-	661	3.59	123M	15	-	696	3.20	123M	15	-	730	2.88	133M	15	-	770	377	218
				1			185I	61	1.9	998		195I	60	1.9	1054		205I	60	1.8	1111		215I	59	1.8	1168	471	
		2#11	1#11	1	3#11	5.55	135M	15	-	1056	4.92	144M	15	-	1038	4.39	144M	15	-	1087	3.94	154M	15	-	1146	568	194
				1			245F	60	1.9	1380		265F	60	1.8	1473		275F	59	1.8	1545		295F	59	1.8	1638	568	
		2#14	1#14	1	3#14	7.67	155IeM	15	-	1469	6.79	165IdM	15	-	1556	6.06	165IcM	15	-	1626	5.44	165M	15	-	1697	785	155
				1			325D	60	1.9	1938		345D	60	1.8	2053		315E	59	1.8	2057		335E	59	1.8	2173	785	
		3#11	2#11	1	4#14	9.60	285E	15	-	1952	8.51	195FjM	15	-	1893	7.59*	195GiM	15	-	1979	6.81*	195GhM	15	-	2065	894	133
				1			485B	60	1.9	2568		415C	60	1.8	2498		435C	59	1.8	2629		385D	59	1.8	2604	1002	
	20	2#10	1#10	1	3#10	4.64	124M	18	-	808	4.11	124M	18	-	847	3.66	134M	18	-	898	3.29	134M	18	-	937	474	198
				1			245F	72	2.0	1233		195I	71	2.0	1158		205I	71	2.0	1221		215I	70	2.0	1284	474	
		2#11	1#11	1	3#11	5.60	134M	18	-	981	4.96	134M	18	-	1030	4.42	144M	18	-	1090	3.97	144M	18	-	1139	573	185
				1			245F	72	2.0	1396		265F	71	2.0	1491		275F	71	2.0	1563		295F	70	2.0	1658	573	
		2#14	1#14	1	4#14	8.54	165HfM	18	-	1658	7.57	175HfM	18	-	1754	6.75	175IeM	18	-	1834	6.06	175IdM	18	-	1914	795	135
				1			385C	72	2.0	2266		345D	71	2.0	2254		365D	71	2.0	2379		385D	70	2.0	2505	1019	
		2#14	2#14	1	4#14	9.96	205EIM	18	-	1942	8.82	195FjM	18	-	2019	7.87	195GiM	18	-	2112	7.06*	195GhM	18	-	2205	1019	123
				1			385C	72	2.0	2484		415C	71	2.0	2646		435C	71	2.0	2785		465C	70	2.0	2947	1019	
	24	2#10	1#10	1	4#10	5.15	123M	24	-	901	4.56	123M	24	-	945	4.07	123M	24	-	990	3.65	123M	23	-	1035	479	161
				1			225G	96	2.4	1635		175J	95	2.4	1484		185J	94	2.4	1568		235H	94	2.4	1808	628	
		2#11	1#11	1	4#11	6.24	133M	24	-	1097	5.53	133M	24	-	1152	4.93	133M	24	-	1208	4.42	143M	23	-	1273	580	154
				1			225G	96	2.4	1820		235G	95	2.4	1915		245G	94	2.4	2009		265G	94	2.4	2143	758	
		2#14	2#14	1	4#14	10.22	145M	24	-	2060	9.05	155M	24	-	2185	8.08	165M	24	-	2310	7.25	164M	23	-	2214	1046	116
				1			285E	96	2.4	2707		295E	95	2.4	2839		275F	94	2.4	2854		295F	94	2.4	3025	1046	
		3#14	2#14	1	5#14	12.37	155IdM	24	-	2512	10.96	165IcM	24	-	2661	9.77	165M	24	-	2778	8.77*	175M	23	-	2928	1266	100
				1			325D	96	2.4	3284		345D	95	2.4	3479		365D	94	2.4	3675		335E	94	2.4	3675	1266	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

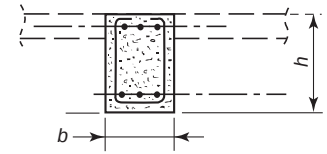
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

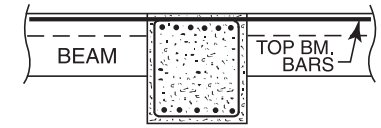
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
						SPAN, ℓ_n = 40 ft					SPAN, ℓ_n = 42 ft.					SPAN, ℓ_n = 44 ft.					SPAN, ℓ_n = 46 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
32	16	2#10		1	3# 9	2.20	123M	12	-	679	1.99	123M	12	-	708	1.82	133M	12	-	742	1.66	133M	12	-	771	319	251
				1			244H	48	1.6	936		254H	48	1.6	978		334F	48	1.6	1114		354F	48	1.6	1169	375	
		2#11		1	3#11	2.66	143M	12	-	926	2.41	143M	12	-	966	2.20	143M	12	-	1006	2.01	153M	12	-	1051	387	222
				1			245H	48	1.6	1371		255H	48	1.6	1432		275H	48	1.6	1515		285H	48	1.6	1577	562	
		2#11	2#11	1	3#14	4.83*	175M	12	-	1692	4.38*	185M	12	-	1775	3.99*	185M	12	-	1841	3.65*	195M	12	-	1924	725	165
				1			345E	48	1.6	2156		365E	48	1.6	2266		385E	48	1.6	2375		405E	48	1.6	2485	772	
		2#14	1#14	1	5#11	5.24*	185ldM	12	-	1880	4.75*	195lcM	12	-	1971	4.33*	195M	12	-	2046	3.96*	195M	12	-	2121	772	160
				2			345E	48	1.6	2328		365E	48	1.6	2446		385E	48	1.6	2564		405E	48	1.6	2682	837	
	18	2# 9	1# 9	1	3#10	2.60	133M	15	-	805	2.35	133M	15	-	839	2.15	133M	15	-	874	1.96	133M	14	-	909	377	218
				1			225I	59	1.8	1225		235I	58	1.8	1282		245I	58	1.8	1339		255I	58	1.8	1396	471	
		2#11	1#11	1	3#11	3.55	154M	15	-	1195	3.22	153M	15	-	1171	2.94*	163M	15	-	1226	2.69*	163M	14	-	1275	568	194
				1			305F	59	1.8	1710		235I	58	1.8	1603		245I	58	1.8	1674		255I	58	1.8	1746	568	
		2#14	1#14	1	3#14	4.91*	175M	15	-	1784	4.45*	175M	15	-	1855	4.05*	185M	15	-	1942	3.71*	185M	14	-	2012	785	155
				1			345E	59	1.8	2266		325F	58	1.8	2292		335F	58	1.8	2385		355F	58	1.8	2500	785	
		3#11	2#11	1	4#14	6.15*	195HgM	15	-	2152	5.58*	195leM	15	-	2238	5.08*	205leM	15	-	2340	4.65*	205ldM	14	-	2426	894	133
				1			405D	59	1.8	2734		425D	58	1.8	2865		445D	58	1.8	2996		405E	58	1.8	2993	1002	
	20	2#10	1#10	1	3#10	2.97	134M	17	-	977	2.69	134M	17	-	1017	2.45	134M	17	-	1057	2.24	134M	17	-	1097	474	198
				1			225I	70	2.0	1346		235I	69	2.0	1409		245I	69	2.0	1472		255I	69	2.0	1535	474	
		2#11	1#11	1	3#11	3.58	144M	17	-	1188	3.25	154M	17	-	1248	2.96*	154M	17	-	1297	2.71*	154M	17	-	1346	573	185
				1			225I	70	2.0	1547		235I	69	2.0	1619		245I	69	2.0	1691		255I	69	2.0	1763	573	
		2#14	1#14	1	4#14	5.47*	175M	17	-	1993	4.96*	175M	17	-	2073	4.52*	185M	17	-	2169	4.13*	185M	17	-	2249	795	135
				1			345E	70	2.0	2493		365E	69	2.0	2618		385E	69	2.0	2744		355F	69	1.9	2755	1019	
		2#14	2#14	1	4#14	6.37*	195HgM	17	-	2298	5.78*	195leM	17	-	2391	5.27*	195ldM	17	-	2484	4.82*	205ldM	17	-	2594	1019	123
				1			405D	70	2.0	2902		425D	69	2.0	3041		445D	69	2.0	3180		405E	69	1.9	3181	1019	
	24	2#10	1#10	1	4#10	3.30	123M	23	-	1080	2.99	123M	23	-	1125	2.72	133M	23	-	1180	2.49	133M	23	-	1225	479	161
				1			245H	93	2.4	1892		255H	93	2.3	1976		275H	92	2.3	2099		285H	92	2.3	2183	628	
		2#11	1#11	1	4#11	3.99	143M	23	-	1329	3.62	143M	23	-	1384	3.30	143M	23	-	1439	3.02	153M	23	-	1505	580	154
				1			205J	93	2.3	1964		215J	93	2.3	2058		225J	92	2.3	2153		285H	92	2.3	2443	758	
		2#14	2#14	1	4#14	6.54*	174M	23	-	2327	5.93*	174M	23	-	2420	5.41*	184M	23	-	2534	4.95*	184M	23	-	2627	1046	116
				1			305F	93	2.3	3157		325F	93	2.3	3329		305G	92	2.3	3344		315G	92	2.3	3476	1046	
		3#14	2#14	1	5#14	7.92*	175M	23	-	3045	7.18*	185M	23	-	3194	6.54*	195M	23	-	3344	5.99*	195M	23	-	3461	1266	100
				1			345E	93	2.3	3831		365E	93	2.3	4027		335F	92	2.3	4027		355F	92	2.3	4222	1266	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

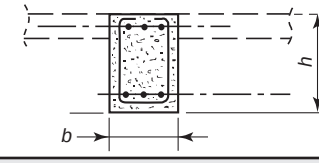
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

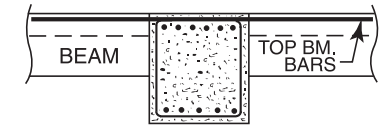
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 32 ft					SPAN, ℓ_n = 34 ft.					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
34	16	2#11		1	3# 9	3.93	113N	14	-	627	3.48	123N	13	-	665	3.10	123N	13	-	698	2.78	123N	13	-	731	415	205
				1			185I	55	1.8	967		195I	54	1.8	1023		205I	54	1.8	1078		215I	53	1.8	1133	402	
		2#14		1	3#11	5.91	135N	14	-	1063	5.23	135N	13	-	1112	4.67	144N	13	-	1093	4.19	144N	13	-	1142	580	178
				1			245F	54	1.8	1382		265F	54	1.8	1476		275F	54	1.8	1547		295F	53	1.7	1641	604	
		2#14	1#14	1	3#14	8.14	155HgN	14	-	1474	7.21	165IfN	13	-	1561	6.43	165JeN	13	-	1632	5.77	165JdN	13	-	1703	833	138
				1			325D	54	1.8	1938		345D	54	1.8	2053		315E	54	1.8	2057		335E	53	1.7	2173	833	
		2#14	1#14	1	4#14	8.95	175GiN	14	-	1675	7.93	185GiN	13	-	1771	7.07	175HgN	13	-	1834	6.35*	175IfN	13	-	1914	833	134
				2			385C	54	1.8	2239		345D	54	1.8	2230		365D	54	1.8	2354		385D	53	1.7	2478	992	
	18	2# 9	1# 9	1	3#10	4.35	114N	17	-	714	3.85	114N	16	-	749	3.43	124N	16	-	794	3.08	124N	16	-	829	404	181
				1			185I	66	2.0	1010		195I	66	2.0	1068		205I	65	2.0	1125		215I	65	2.0	1183	505	
		2#11	1#11	1	3#11	5.96	135N	17	-	1065	5.28	134N	16	-	1033	4.71	134N	16	-	1082	4.23	144N	16	-	1142	610	166
				1			245F	66	2.0	1396		265F	66	2.0	1491		275F	65	2.0	1563		295F	65	1.9	1658	610	
		2#14	1#14	1	3#14	8.26	155IfN	17	-	1479	7.32	155JeN	16	-	1550	6.53	155JdN	16	-	1621	5.86	165JcN	16	-	1708	845	133
				1			325D	66	2.0	1960		345D	66	2.0	2077		315E	65	2.0	2079		335E	65	1.9	2196	845	
		2#14	2#14	1	4#14	10.58	285E	17	-	2084	9.37	205FlN	16	-	2042	8.36	205FkN	16	-	2135	7.50	205GjN	16	-	2228	1083	109
				1			485B	66	2.0	2713		415C	66	2.0	2646		435C	65	2.0	2785		465C	65	1.9	2947	1083	
	20	2#10	1#10	1	3#10	4.97	114N	20	-	802	4.40	124N	20	-	853	3.93	124N	19	-	893	3.52	124N	19	-	932	508	165
				1			225G	79	2.2	1202		235G	78	2.2	1266		245G	77	2.1	1329		195J	77	2.1	1251	508	
		2#11	1#11	1	3#11	6.01	124N	20	-	976	5.33	134N	20	-	1036	4.75	134N	19	-	1085	4.26	134N	19	-	1135	615	157
				1			245F	79	2.2	1413		235G	78	2.2	1438		245G	77	2.1	1511		265G	77	2.1	1608	615	
		2#14	1#14	1	4#14	9.19	155HgN	20	-	1652	8.14	165IfN	20	-	1749	7.26	165JeN	19	-	1829	6.52	165JdN	19	-	1908	855	116
				1			385C	79	2.2	2292		345D	78	2.2	2277		365D	77	2.1	2404		385D	77	2.1	2531	1100	
		2#14	2#14	1	5#14	11.83	315BiE	20	-	2313	10.48	295E	20	-	2381	9.34	225EnN	19	-	2362	8.39	215FlN	19	-	2447	1100	98
				1			485B	79	2.2	2914		515B	78	2.2	3087		435C	77	2.1	3000		465C	77	2.1	3173	1325	
	24	2#11	1#11	1	4#10	6.59	123N	26	-	1002	5.83	123N	26	-	1053	5.20	123N	26	-	1103	4.67	133N	26	-	1165	622	139
				1			225G	106	2.6	1761		235G	105	2.6	1852		245G	104	2.5	1943		265G	103	2.5	2075	674	
		2#14	1#14	1	4#11	7.95	134N	26	-	1455	7.04	134N	26	-	1524	6.28	134N	26	-	1593	5.64	143N	26	-	1542	870	121
				1			225G	106	2.6	2072		235G	105	2.6	2181		245G	104	2.5	2290		265G	103	2.5	2440	814	
		2#14	2#14	1	4#14	11.01	135N	26	-	2046	9.76	145N	26	-	2172	8.70	155N	26	-	2299	7.81	155N	26	-	2392	1127	100
				1			285E	106	2.6	2746		295E	105	2.6	2879		315E	104	2.5	3054		295F	103	2.5	3066	1127	
		3#14	2#14	1	5#14	13.36	145JeN	26	-	2499	11.83	155JdN	26	-	2650	10.55	155JcN	26	-	2767	9.47	165N	26	-	2918	1367	86
				1			325D	106	2.6	3328		345D	105	2.6	3526		365D	104	2.5	3725		335E	103	2.5	3720	1367	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

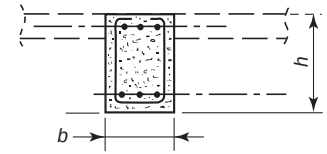
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

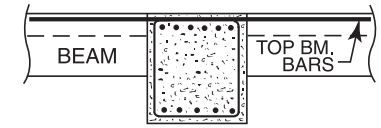
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

f_c' = 4,000 psi
f_y = 60,000 psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 40 ft					SPAN, ℓ_n = 42 ft.					SPAN, ℓ_n = 44 ft.					SPAN, ℓ_n = 46 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
34	16	2#11		1	3# 9	2.51	123N	13	-	765	2.28	123N	13	-	798	2.08	123N	13	-	831	1.90	133N	13	-	870	415	205
				1			225I	53	1.8	1189		235I	52	1.7	1244		245I	52	1.7	1300		255I	52	1.7	1355	402	
		2#14		1	3#11	3.78	154N	13	-	1202	3.43	154N	13	-	1251	3.12*	164N	13	-	1310	2.86*	164N	13	-	1360	580	178
				1			305F	53	1.7	1713		325F	52	1.7	1806		245I	52	1.7	1678		255I	52	1.7	1749	604	
		2#14	1#14	1	3#14	5.21	175JcN	13	-	1790	4.72*	175N	13	-	1861	4.30*	175N	13	-	1931	3.94*	185N	13	-	2019	833	138
				1			345E	53	1.7	2266		325F	52	1.7	2292		335F	52	1.7	2385		355F	52	1.7	2500	833	
		2#14	1#14	1	4#14	5.73*	175JeN	13	-	1993	5.20*	185JdN	13	-	2089	4.73*	185JcN	13	-	2169	4.33*	185N	13	-	2249	833	134
				2			345E	53	1.7	2469		365E	52	1.7	2593		385E	52	1.7	2717		405E	52	1.7	2842	992	
	18	2# 9	1# 9	1	3#10	2.78	124N	16	-	863	2.52	124N	16	-	898	2.30	124N	16	-	933	2.10	124N	16	-	967	404	181
				1			225I	64	1.9	1240		235I	64	1.9	1298		245I	64	1.9	1355		255I	63	1.9	1413	505	
		2#11	1#11	1	3#11	3.82	144N	16	-	1191	3.46	154N	16	-	1251	3.15	154N	16	-	1300	2.89*	154N	16	-	1349	610	166
				1			305F	64	1.9	1730		235I	64	1.9	1619		245I	63	1.9	1691		255I	63	1.9	1763	610	
		2#14	1#14	1	3#14	5.29	165N	16	-	1779	4.79*	165N	16	-	1850	4.37*	175N	16	-	1937	4.00*	175N	16	-	2008	845	133
				1			345E	64	1.9	2289		325F	64	1.9	2314		335F	63	1.9	2408		355F	63	1.9	2525	845	
		2#14	2#14	1	4#14	6.77*	195HhN	16	-	2304	6.14*	205HhN	16	-	2414	5.59*	195IfN	16	-	2491	5.12*	195JeN	16	-	2584	1083	109
				1			405D	64	1.9	2902		425D	64	1.9	3041		445D	63	1.9	3180		465D	63	1.9	3319	1083	
	20	2#10	1#10	1	3#10	3.18	124N	19	-	972	2.89	124N	19	-	1012	2.63	134N	19	-	1063	2.41	134N	19	-	1103	508	165
				1			205J	76	2.1	1314		215J	76	2.1	1378		225J	75	2.1	1441		235J	75	2.1	1505	508	
		2#11	1#11	1	3#11	3.85	144N	19	-	1195	3.49	144N	19	-	1244	3.18	144N	19	-	1293	2.91	144N	19	-	1342	615	157
				1			275G	76	2.1	1680		285G	76	2.1	1753		225J	75	2.1	1660		235J	75	2.1	1733	615	
		2#14	1#14	1	4#14	5.88	165JcN	19	-	1988	5.34	165N	19	-	2068	4.86*	175N	19	-	2164	4.45*	175N	19	-	2244	855	116
				1			345E	76	2.1	2516		365E	76	2.1	2643		385E	75	2.1	2770		355F	75	2.1	2779	1100	
		2#14	2#14	1	5#14	7.57*	205GjN	19	-	2532	6.87*	215GjN	19	-	2651	6.26*	205HhN	19	-	2736	5.72*	205IgN	19	-	2838	1100	98
				1			485C	76	2.1	3322		505C	76	2.1	3472		445D	75	2.1	3432		465D	75	2.1	3581	1325	
	24	2#11	1#11	1	4#10	4.21	133N	26	-	1216	3.82	133N	25	-	1266	3.48	133N	25	-	1317	3.19	143N	25	-	1379	622	139
				1			275G	102	2.5	2166		215J	102	2.5	1973		225J	101	2.5	2065		235J	101	2.5	2156	674	
		2#14	1#14	1	4#11	5.09	143N	26	-	1610	4.62	153N	25	-	1690	4.21	153N	25	-	1759	3.85	153N	25	-	1828	870	121
				1			275G	102	2.5	2550		285G	102	2.5	2659		305G	101	2.5	2809		315G	101	2.5	2918	814	
		2#14	2#14	1	4#14	7.05	164N	26	-	2322	6.39*	164N	25	-	2415	5.82*	174N	25	-	2529	5.33*	174N	25	-	2622	1127	100
				1			305F	102	2.5	3199		325F	102	2.5	3373		305G	101	2.5	3385		315G	101	2.5	3519	1127	
		3#14	2#14	1	5#14	8.55*	165N	26	-	3035	7.75*	175N	25	-	3186	7.06*	185N	25	-	3337	6.46*	185N	25	-	3454	1367	86
				1			345E	102	2.5	3878		365E	102	2.5	4077		385E	101	2.5	4275		355F	101	2.5	4271	1367	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

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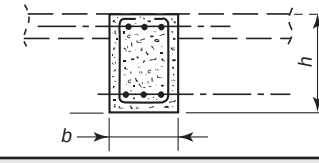
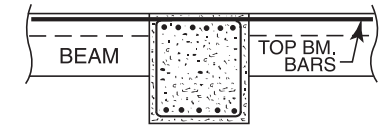
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																		
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 36 ft					SPAN, ℓ_n = 38 ft.					SPAN, ℓ_n = 40 ft.					SPAN, ℓ_n = 42 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
36	16	2#11		1	3#10	3.76	123O	15	-	767	3.38	123O	14	-	804	3.05	123O	14	-	840	2.76	133O	14	-	882	443	171
				1			205I	58	1.9	1158		215I	58	1.9	1217		225I	57	1.9	1276		235I	57	1.9	1336	536	
		2#14		1	3#11	4.99	135O	15	-	1170	4.48	144O	14	-	1148	4.04	144O	14	-	1198	3.67	144O	14	-	1247	621	153
				1			275F	58	1.9	1566		295F	58	1.9	1661		305F	57	1.9	1733		325F	57	1.8	1829	646	
		2#14	1#14	1	3#14	6.90	155JeO	15	-	1626	6.19	155KdO	14	-	1697	5.59	165KdO	14	-	1784	5.07	165KcO	14	-	1855	893	120
				1			365D	58	1.9	2194		335E	58	1.9	2196		345E	57	1.9	2289		365E	57	1.8	2406	893	
		3#11	2#11	2	4#14	8.28	275F	14	-	2137	7.43	195GkO	14	-	2085	6.71*	195HiO	14	-	2171	6.08*	195HiO	14	-	2258	978	113
				2			435C	58	1.9	2659		465C	57	1.9	2814		405D	57	1.8	2762		425D	57	1.8	2894	1073	
	18	2#10	1#10	1	3#10	4.17	124O	18	-	895	3.74	124O	18	-	935	3.38	124O	17	-	975	3.06	134O	17	-	1026	540	153
				1			245G	71	2.1	1329		195J	70	2.1	1251		205J	70	2.1	1314		215J	69	2.1	1378	540	
		2#11	1#11	1	3#11	5.04	134O	18	-	1088	4.52	134O	18	-	1138	4.08	134O	17	-	1187	3.70	144O	17	-	1247	652	142
				1			245G	71	2.1	1511		265G	70	2.1	1608		275G	70	2.1	1680		285G	69	2.0	1753	652	
		2#14	1#14	1	4#14	7.69	165IgO	18	-	1834	6.91	165JfO	18	-	1914	6.23	165KeO	17	-	1993	5.65	165KdO	17	-	2073	906	104
				1			365D	71	2.1	2404		385D	70	2.1	2531		345E	70	2.1	2516		365E	69	2.0	2643	1164	
		2#14	2#14	1	4#14	8.98	205FlO	18	-	2149	8.06	195GjO	18	-	2225	7.28	195HiO	17	-	2318	6.60	195HhO	17	-	2411	1164	95
				1			435C	71	2.1	2815		465C	70	2.1	2979		405D	70	2.1	2930		425D	69	2.0	3070	1164	
	20	2#10	1#10	1	3#11	4.61	124O	21	-	973	4.14	124O	21	-	1016	3.73	124O	21	-	1060	3.39	124O	21	-	1103	543	137
				1			245G	85	2.3	1421		265G	84	2.3	1513		275G	83	2.3	1581		215J	83	2.2	1478	657	
		2#11	1#11	1	3#14	5.58	134O	21	-	1267	5.01	134O	21	-	1325	4.52	134O	21	-	1382	4.10	144O	21	-	1451	657	121
				1			275F	85	2.3	1777		265G	84	2.3	1810		275G	83	2.3	1892		285G	83	2.2	1973	916	
		2#14	2#14	1	4#14	9.12	185GjO	21	-	2120	8.18	195GjO	21	-	2231	7.39	185HhO	21	-	2306	6.70	185IgO	21	-	2399	1181	92
				1			435C	84	2.3	2844		465C	84	2.3	3011		405D	83	2.3	2958		425D	83	2.2	3099	1181	
		2#14	2#14	1	5#14	10.03	225EoO	21	-	2377	9.00	215FmO	21	-	2462	8.13	205GkO	21	-	2546	7.37	215GkO	21	-	2666	1181	85
				1			435C	84	2.3	3030		465C	84	2.3	3205		485C	83	2.3	3356		505C	83	2.2	3506	1427	
	24	2#11	1#11	1	4#10	5.56	123O	28	-	1109	4.99	123O	28	-	1160	4.50	123O	28	-	1211	4.08	133O	28	-	1273	664	118
				1			245G	114	2.7	1976		265G	113	2.7	2111		275G	112	2.7	2203		285G	111	2.6	2296	720	
		2#14	1#14	1	4#11	6.72	134O	28	-	1605	6.03	133O	28	-	1537	5.44	133O	28	-	1606	4.93	143O	28	-	1686	931	104
				1			245G	114	2.7	2324		265G	113	2.7	2476		275G	112	2.7	2587		285G	111	2.6	2698	870	
		2#14	2#14	1	5#14	10.26	145O	28	-	2470	9.21	155O	28	-	2607	8.31	155O	28	-	2709	7.54	165O	28	-	2846	1208	80
				1			315E	114	2.7	3282		335E	113	2.7	3468		345E	112	2.7	3612		325F	111	2.6	3630	1469	
		3#14	2#14	1	6#14	12.47	155JfO	28	-	2974	11.19	165KeO	28	-	3135	10.10	165KdO	28	-	3261	9.16*	175KcO	28	-	3422	1469	69
				1			365D	114	2.7	3960		385D	113	2.7	4170		405D	112	2.7	4380		365E	111	2.6	4339	1712	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

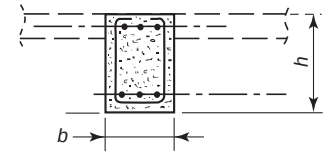
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

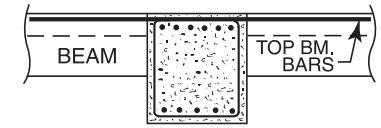
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

f_c' = 4,000 psi
f_y = 60,000 psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS(1)				TOTAL CAPACITY $U = 1.2D + 1.6L$(3)																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 44 ft					SPAN, ℓ_n = 46 ft.					SPAN, ℓ_n = 48 ft.					SPAN, ℓ_n = 50 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	(6)	(7) $\times 10^{-9}$
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft.-kips	sq. in.	lb.	ft.-kip	in.
36	16	2#11		1	3#10	2.52	133O	14	-	918	2.30	133O	14	-	955	2.12	133O	14	-	991	1.95	133O	14	-	1027	443	171
				1			245I	57	1.8	1395		255I	56	1.8	1454		265I	56	1.8	1513		285I	56	1.8	1596	536	
		2#14		1	3#11	3.34	154O	14	-	1307	3.06	154O	14	-	1356	2.81*	153O	14	-	1327	2.59*	163O	14	-	1382	621	153
				1			245I	57	1.8	1694		255I	56	1.8	1766		265I	56	1.8	1838		285I	56	1.8	1934	646	
		2#14	1#14	1	3#14	4.62*	165O	14	-	1926	4.22*	175O	14	-	2014	3.88*	175O	14	-	2085	3.58*	185O	14	-	2173	893	120
				1			335F	57	1.8	2408		355F	56	1.8	2525		365F	56	1.8	2618		385F	56	1.8	2735	893	
		3#11	2#11	2	4#14	5.54*	195lgO	14	-	2344	5.07*	195JfO	14	-	2430	4.66*	195KeO	14	-	2516	4.29*	195KdO	14	-	2602	978	113
				2			445D	56	1.8	3026		405E	56	1.8	3021		415E	56	1.8	3130		435E	56	1.8	3262	1073	
	18	2#10	1#10	1	3#10	2.79	134O	17	-	1066	2.55	134O	17	-	1106	2.34	134O	17	-	1145	2.16	134O	17	-	1185	540	153
				1			225J	69	2.0	1441		235J	69	2.0	1505		245J	68	2.0	1568		255J	68	2.0	1632	540	
		2#11	1#11	1	3#11	3.37	144O	17	-	1296	3.09	144O	17	-	1345	2.83	154O	17	-	1406	2.61	154O	17	-	1455	652	142
				1			305G	69	2.0	1850		315G	69	2.0	1922		245J	68	2.0	1806		255J	68	2.0	1879	652	
		2#14	1#14	1	4#14	5.15	175KcO	17	-	2170	4.71*	175O	17	-	2250	4.33*	175O	17	-	2330	3.99*	185O	17	-	2427	906	104
				1			385E	69	2.0	2770		405E	69	2.0	2897		365F	68	2.0	2882		385F	68	2.0	3009	1164	
		2#14	2#14	1	4#14	6.01*	195lgO	17	-	2504	5.50*	195JfO	17	-	2597	5.05*	195KeO	17	-	2690	4.66*	195KdO	17	-	2783	1164	95
				1			445D	69	2.0	3210		465D	69	2.0	3351		415E	68	2.0	3326		435E	68	2.0	3466	1164	
	20	2#10	1#10	1	3#11	3.09	134O	21	-	1158	2.82	134O	20	-	1201	2.59	134O	20	-	1244	2.39	134O	20	-	1288	543	137
				1			225J	82	2.2	1545		235J	82	2.2	1613		245J	81	2.2	1681		255J	81	2.2	1749	657	
		2#11	1#11	1	3#14	3.74	144O	21	-	1508	3.42	144O	20	-	1565	3.14	154O	20	-	1634	2.89	154O	20	-	1691	657	121
				1			305G	82	2.2	2079		315G	82	2.2	2161		325G	81	2.2	2243		255J	81	2.2	2130	916	
		2#14	2#14	1	4#14	6.10*	185JfO	21	-	2493	5.59*	185KeO	20	-	2586	5.13*	185KdO	20	-	2679	4.73*	195KcO	20	-	2790	1181	92
				1			445D	82	2.2	3241		465D	82	2.2	3383		415E	81	2.2	3354		435E	81	2.2	3496	1181	
		2#14	2#14	1	5#14	6.72*	205HiO	21	-	2750	6.14*	205IhO	20	-	2852	5.64*	205IgO	20	-	2954	5.20*	205JfO	20	-	3056	1181	85
				1			445D	82	2.2	3462		465D	82	2.2	3613		485D	81	2.2	3764		505D	81	2.2	3914	1427	
	24	2#11	1#11	1	4#10	3.72	133O	28	-	1323	3.40	133O	27	-	1374	3.13	133O	27	-	1425	2.88	133O	27	-	1475	664	118
				1			225J	110	2.6	2095		235J	110	2.6	2188		245J	109	2.6	2280		305H	109	2.6	2582	720	
		2#14	1#14	1	4#11	4.50	143O	28	-	1755	4.11	143O	27	-	1824	3.78	153O	27	-	1904	3.48	153O	27	-	1973	931	104
				1			305G	110	2.6	2850		315G	110	2.6	2961		325G	109	2.6	3072		345G	109	2.6	3224	870	
		2#14	2#14	1	5#14	6.87*	165O	28	-	2948	6.28*	174O	27	-	2868	5.77*	174O	27	-	2970	5.32*	184O	27	-	3094	1208	80
				1			335F	110	2.6	3774		355F	110	2.6	3960		365F	109	2.6	4104		345G	109	2.6	4122	1469	
		3#14	2#14	1	6#14	8.35*	175O	28	-	3548	7.64*	185O	27	-	3709	7.01*	185O	27	-	3835	6.46*	195O	27	-	3996	1469	69
				1			385E	110	2.6	4549		405E	110	2.6	4759		415E	109	2.6	4927		435E	109	2.6	5137	1712	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

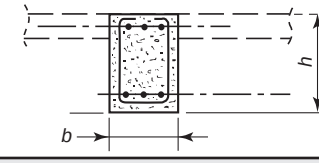
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

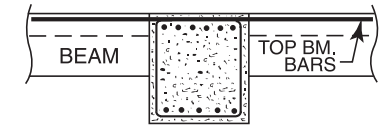
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 36 ft					SPAN, ℓ_n = 38 ft.					SPAN, ℓ_n = 40 ft.					SPAN, ℓ_n = 42 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
42	20	2#11	1#11	1	3#11	6.05	114R	27	-	1084	5.43	114R	26	-	1133	4.90	114R	26	-	1182	4.44	114R	26	-	1231	784	86
				1			245G	107	2.7	1578		265G	106	2.7	1680		275G	105	2.7	1756		285G	104	2.7	1831	784	
		2#14	1#14	1	3#14	8.48	135MeR	27	-	1627	7.61	135OdR	26	-	1698	6.87	135OcR	26	-	1769	6.23	135R	26	-	1840	1098	75
				1			365D	107	2.7	2319		335E	106	2.7	2310		345E	105	2.7	2408		365E	104	2.7	2531	1098	
		2#14	2#14	1	5#14	12.09	225EqR	27	-	2423	10.85	215FoR	26	-	2505	9.80	205GmR	26	-	2587	8.89	205GmR	26	-	2689	1424	57
				1			545B	107	2.7	3410		465C	106	2.7	3301		485C	105	2.7	3456		505C	104	2.7	3611	1730	
		3#14	2#14	1	6#14	14.69	295DoG	27	-	3032	13.19	305DnG	26	-	3178	11.90	315DmG	26	-	3324	10.79	325DlG	26	-	3471	1730	53
				2			545B	107	2.7	3879		575B	106	2.7	4084		605B	105	2.7	4290		635B	104	2.7	4495	1913	
	24	2#11	1#11	1	4#11	6.72	103R	36	-	1201	6.03	113R	36	-	1269	5.44	113R	35	-	1325	4.93	113R	35	-	1380	791	70
				1			245G	145	3.2	2176		265G	143	3.2	2324		275G	142	3.2	2425		285G	141	3.2	2527	1038	
		2#14	1#14	1	4#14	9.45	115R	36	-	1981	8.49	124R	36	-	1930	7.66	124R	35	-	2010	6.95	134R	35	-	2114	1113	63
				1			275F	144	3.2	2797		295F	143	3.2	2969		305F	142	3.2	3095		285G	141	3.2	3082	1451	
		3#14	2#14	1	5#14	13.68	135MeR	36	-	2773	12.28	135NeR	36	-	2890	11.08	145OdR	35	-	3046	10.05	145OcR	35	-	3164	1772	50
				1			365D	144	3.2	3925		385D	143	3.2	4134		405D	142	3.2	4344		365E	141	3.2	4277	1772	
		3#14	3#14	1	7#14	17.45	245G	36	-	3817	15.66	265G	36	-	4043	14.14	275G	35	-	4231	12.82	285G	35	-	4418	2077	44
				2			435C	144	3.2	4863		465C	143	3.2	5150		485C	142	3.2	5391		425D	141	3.2	5263	2261	
	30	2#11	2#11	1	4#11	8.12	104R	52	-	1498	7.28	104R	51	-	1562	6.57	114R	51	-	1653	5.96	114R	50	-	1717	1051	57
				1			245G	207	4.0	2405		265G	205	4.0	2566		275G	203	3.9	2679		285G	202	3.9	2793	1051	
		2#14	2#14	1	4#14	11.41	115R	52	-	2242	10.24	125R	51	-	2375	9.24	124R	51	-	2292	8.38	124R	50	-	2385	1478	53
				1			315E	207	4.0	3301		335E	205	3.9	3492		345E	203	3.9	3633		325F	202	3.9	3629	1478	
		3#14	3#14	1	7#14	18.14	165HjR	52	-	3528	16.28	165IiR	51	-	3676	14.69	165JhR	51	-	3825	13.33	165KgR	50	-	3973	2137	39
				1			435C	207	4.0	4968		465C	205	3.9	5262		485C	203	3.9	5508		505C	202	3.9	5753	2446	
		4#14	3#14	1	8#14	20.77	275DgG	52	-	4440	18.64	265G	51	-	4572	16.82	205GmR	51	-	4503	15.26	195HkR	50	-	4636	2446	35
				1			545B	207	4.0	5970		575B	205	3.9	6288		485C	203	3.9	6025		505C	202	3.9	6294	2742	
	36	2#14	2#14	1	5#11	10.12	104R	69	-	1956	9.09	114R	68	-	2071	8.20	114R	68	-	2159	7.44	114R	67	-	2248	1496	46
				1			315E	275	4.7	3269		335E	272	4.7	3459		345E	270	4.7	3599		365E	268	4.6	3789	1312	
		2#14	2#14	1	5#14	12.70	115R	69	-	2442	11.40	115R	68	-	2544	10.29	124R	68	-	2507	9.33	124R	67	-	2609	1496	45
				1			365D	275	4.7	3817		335E	272	4.7	3766		345E	270	4.7	3919		365E	268	4.6	4123	1842	
		4#14	3#14	1	8#14	21.23	185GlR	69	-	4102	19.06	195GlR	68	-	4317	17.20	185HkR	68	-	4448	15.60	175IiR	67	-	4579	2501	33
				1			545B	275	4.7	6102		575B	272	4.7	6427		485C	270	4.7	6141		505C	268	4.6	6416	2814	
		5#14	4#14	1	10#14	24.96	285DkG	69	-	5418	22.40	295DjG	68	-	5679	20.22	225FpR	68	-	5607	18.34	235FpR	67	-	5868	3115	30
				2			545B	275	4.7	7001		575B	272	4.7	7373		605B	270	4.7	7745		635B	268	4.6	8117	3234	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).

(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.

(3) For superimposed factored load capacity, deduct 1.2 × stem weight.

(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

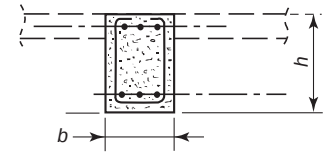
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

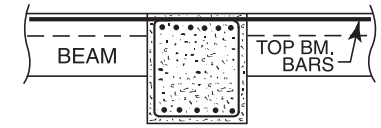
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$

(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 44 ft					SPAN, ℓ_n = 46 ft.					SPAN, ℓ_n = 48 ft.					SPAN, ℓ_n = 50 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
42	20	2#11	1#11	1	3#11	4.05	124R	26	-	1293	3.71	124R	26	-	1342	3.40	124R	26	-	1391	3.14	124R	25	-	1441	784	86
				1			305G	103	2.7	1933		315G	103	2.6	2009		245J	102	2.6	1873		255J	102	2.6	1948	784	
		2#14	1#14	1	3#14	5.68	135R	26	-	1911	5.19	145R	26	-	2001	4.77	145R	26	-	2072	4.40	145R	25	-	2143	1098	75
				1			335F	103	2.7	2523		355F	103	2.6	2646		365F	102	2.6	2743		345G	101	2.6	2761	1098	
		2#14	2#14	1	5#14	8.10	195HkR	26	-	2771	7.41	195IjR	26	-	2873	6.80	195IiR	26	-	2975	6.27	195JhR	25	-	3077	1424	57
				1			535C	103	2.7	3792		465D	103	2.6	3709		485D	102	2.6	3864		505D	101	2.6	4019	1730	
		3#14	2#14	1	6#14	9.83	285EuR	26	-	3517	9.00	255FrR	26	-	3583	8.26*	265FrR	26	-	3729	7.62*	255GpR	25	-	3836	1730	53
				2			665B	103	2.7	4701		555C	103	2.6	4537		585C	102	2.6	4742		605C	101	2.6	4921	1913	
	24	2#11	1#11	1	4#11	4.50	113R	35	-	1435	4.11	113R	35	-	1491	3.78	113R	35	-	1546	3.48	113R	34	-	1601	791	70
				1			305G	140	3.1	2674		315G	139	3.1	2775		245J	138	3.1	2508		255J	137	3.1	2610	1038	
		2#14	1#14	1	4#14	6.33	134R	35	-	2194	5.79	134R	35	-	2274	5.32	143R	35	-	2214	4.90	143R	34	-	2293	1113	63
				1			305G	140	3.1	3254		315G	139	3.1	3380		325G	138	3.1	3505		345G	137	3.1	3677	1451	
		3#14	2#14	1	5#14	9.16	145R	35	-	3281	8.38	155R	35	-	3437	7.69	155R	35	-	3554	7.09	165R	34	-	3711	1772	50
				1			385E	140	3.1	4486		405E	139	3.1	4696		415E	138	3.1	4859		385F	137	3.1	4838	1772	
		3#14	3#14	1	7#14	11.68	175JhR	35	-	4139	10.69	175KgR	35	-	4287	9.82*	175MfR	35	-	4436	9.05*	175NeR	34	-	4584	2077	44
				2			445D	140	3.1	5504		465D	139	3.1	5744		485D	138	3.1	5985		505D	137	3.1	6226	2261	
	30	2#11	2#11	1	4#11	5.43	114R	50	-	1782	4.97	114R	50	-	1846	4.57	114R	49	-	1911	4.21	114R	49	-	1976	1051	57
				1			305G	200	3.9	2954		315G	199	3.8	3067		325G	198	3.8	3181		345G	197	3.8	3342	1051	
		2#14	2#14	1	4#14	7.64	134R	50	-	2504	6.99	134R	50	-	2597	6.42	134R	49	-	2690	5.91	144R	49	-	2809	1478	53
				1			335F	200	3.9	3771		355F	199	3.8	3961		365F	198	3.8	4102		345G	197	3.8	4098	1478	
		3#14	3#14	1	7#14	12.14	165KfR	50	-	4122	11.11	165MfR	50	-	4270	10.20	165NeR	49	-	4419	9.40	165OdR	49	-	4568	2137	39
				1			445D	200	3.9	5611		465D	199	3.8	5856		485D	198	3.8	6102		505D	197	3.8	6347	2446	
		4#14	3#14	1	8#14	13.90	185IjR	50	-	4768	12.72	195IjR	50	-	4981	11.68	195JiR	49	-	5154	10.77*	185KgR	49	-	5286	2446	35
				1			535C	200	3.9	6613		555C	199	3.8	6882		585C	198	3.8	7201		505D	197	3.8	6985	2742	
	36	2#14	2#14	1	5#11	6.78	114R	67	-	2336	6.20	114R	66	-	2425	5.70	114R	66	-	2513	5.25	124R	65	-	2628	1496	46
				1			385E	266	4.6	3979		405E	264	4.6	4169		415E	263	4.5	4309		305H	261	4.5	3837	1312	
		2#14	2#14	1	5#14	8.50	124R	67	-	2711	7.78	134R	66	-	2839	7.14	134R	66	-	2941	6.58	134R	65	-	3043	1496	45
				1			385E	266	4.6	4327		405E	264	4.6	4531		415E	263	4.5	4684		435E	261	4.5	4888	1842	
		4#14	3#14	1	8#14	14.21	175JhR	67	-	4751	13.00	175KgR	66	-	4924	11.94	185KgR	66	-	5139	11.01*	175MfR	65	-	5270	2501	33
				1			535C	266	4.6	6742		555C	264	4.6	7016		585C	263	4.5	7342		505D	261	4.5	7107	2814	
		5#14	4#14	1	10#14	16.71	225GnR	67	-	6045	15.29	225GnR	66	-	6264	14.04*	215HlR	66	-	6442	12.94*	215IkR	65	-	6661	3115	30
				2			665B	266	4.6	8489		695B	264	4.6	8861		585C	263	4.5	8520		605C	261	4.5	8841	3234	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
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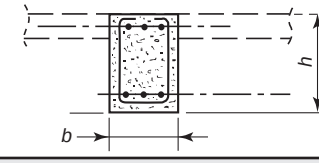
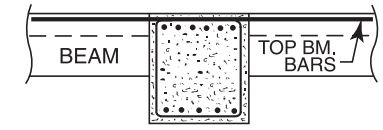
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 40 ft					SPAN, ℓ_n = 42 ft.					SPAN, ℓ_n = 44 ft.					SPAN, ℓ_n = 46 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
48	24	2#14	1#14	1	4#11	7.55	104U	44	-	1731	6.85	104U	43	-	1800	6.24	114U	43	-	1896	5.71	114U	42	-	1965	1296	47
				1			275G	174	3.7	2812		285G	173	3.7	2931		305G	171	3.7	3101		315G	170	3.6	3220	1207	
		2#14	1#14	1	4#14	8.91	114U	44	-	2015	8.08	114U	43	-	2095	7.36	114U	43	-	2175	6.74	124U	42	-	2282	1296	44
				1			305F	174	3.7	3220		325F	173	3.7	3400		305G	171	3.7	3379		315G	170	3.6	3509	1694	
		3#14	3#14	1	6#14	15.26	155KhU	44	-	3623	13.84	155MhU	43	-	3762	12.61	155MgU	43	-	3902	11.54	155NfU	42	-	4042	2441	32
				1			405D	174	3.7	4986		425D	173	3.7	5226		445D	171	3.7	5466		465D	170	3.6	5706	2441	
		4#14	3#14	2	8#14	18.47	275EhH	43	-	4861	16.76	275EfH	43	-	5033	15.27	275H	43	-	5206	13.97	285H	42	-	5422	2687	30
				2			485C	173	3.7	6108		505C	172	3.7	6381		535C	170	3.6	6705		555C	169	3.6	6978	2984	
	30	2#14	2#14	1	4#14	10.76	115U	63	-	2474	9.76	114U	62	-	2390	8.89	114U	62	-	2483	8.14	124U	61	-	2605	1721	37
				1			345E	251	4.6	3775		365E	249	4.5	3973		335F	247	4.5	3908		355F	245	4.5	4107	1721	
		2#14	2#14	1	5#14	11.84	115U	63	-	2677	10.74	115U	62	-	2779	9.78	125U	62	-	2926	8.95	125U	61	-	3028	1721	35
				1			345E	251	4.6	3978		365E	249	4.5	4186		385E	247	4.5	4393		405E	245	4.5	4600	2118	
		4#14	3#14	1	8#14	19.74	185HmU	63	-	4498	17.91	195HmU	62	-	4715	16.32	185llU	62	-	4843	14.93	185lkU	61	-	5016	2871	25
				1			605B	251	4.6	6857		505C	249	4.5	6503		535C	247	4.5	6834		555C	245	4.5	7112	3228	
		4#14	4#14	1	9#14	21.47	255FjI	63	-	5284	19.47	265FiI	62	-	5524	17.74	225GpU	62	-	5541	16.23	215HnU	61	-	5691	3228	24
				2			605B	251	4.6	7332		635B	249	4.5	7685		535C	247	4.5	7353		555C	245	4.5	7654	3434	
	36	2#14	2#14	1	5#14	11.96	105U	84	-	2646	10.85	114U	83	-	2612	9.88	114U	83	-	2714	9.04	114U	82	-	2816	1739	31
				1			345E	336	5.4	4061		365E	333	5.4	4273		385E	330	5.4	4486		405E	328	5.3	4698	2146	
		3#14	2#14	1	5#14	13.41	115U	84	-	3006	12.17	115U	83	-	3123	11.09	115U	83	-	3241	10.14	125U	82	-	3404	2146	30
				1			405D	336	5.4	4705		425D	333	5.4	4933		385E	330	5.4	4830		405E	328	5.3	5057	2146	
		4#14	4#14	1	9#14	22.69	225FqU	84	-	5181	20.58	215GoU	83	-	5330	18.75	195HmU	83	-	5434	17.16	205HmU	82	-	5675	3300	22
				1			605B	336	5.4	7478		635B	333	5.4	7838		665B	330	5.4	8199		695B	328	5.3	8559	3662	
		5#14	5#14	2	11#14	26.14	315DpH	83	-	6586	23.71	295EmH	83	-	6736	21.60	315EmH	82	-	7070	19.76	315ElH	81	-	7311	3842	21
				2			805A	334	5.4	9572		635B	331	5.4	8877		665B	328	5.3	9284		695B	326	5.3	9691	4181	
	42	3#14	2#14	1	5#14	13.54	105U	107	-	2974	12.28	114U	106	-	2951	11.19	114U	105	-	3069	10.24	114U	104	-	3186	2166	27
				1			485C	427	6.3	5263		505C	423	6.3	5495		535C	419	6.2	5785		555C	416	6.2	6018	2166	
		3#14	3#14	1	6#14	16.07	115RcU	107	-	3496	14.57	125RcU	106	-	3683	13.28	125U	105	-	3823	12.15	125U	104	-	3962	2570	26
				1			485C	427	6.3	5738		505C	423	6.3	5993		535C	419	6.2	6305		555C	416	6.2	6560	2570	
		5#14	4#14	1	10#14	25.58	225FqU	107	-	5729	23.20	235FqU	106	-	5996	21.14	215GoU	105	-	6120	19.34	225GoU	104	-	6387	3726	19
				1			605B	427	6.3	8141		635B	423	6.3	8533		665B	419	6.2	8925		695B	416	6.2	9317	4093	
		6#14	6#14	2	13#14	30.81	365CwH	106	-	7858	27.94	335DsH	105	-	8004	25.46	345DrH	104	-	8340	23.29	355DqH	103	-	8675	4591	17
				2			805A	424	6.3	10759		845A	420	6.2	11277		885A	417	6.2	11796		925A	414	6.1	12314	4928	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

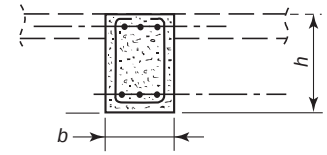
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

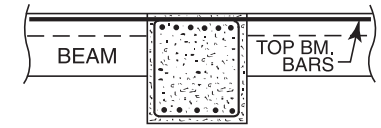
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
						SPAN, ℓ_n = 48 ft					SPAN, ℓ_n = 50 ft.					SPAN, ℓ_n = 52 ft.					SPAN, ℓ_n = 54 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7) $\times 10^{-9}$
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	in.
48	24	2#14	1#14	1	4#11	5.24	114U	42	-	2034	4.83	114U	42	-	2103	4.47	114U	42	-	2171	4.14	124U	41	-	2268	1296	47
				1			325G	169	3.6	3339		345G	168	3.6	3508		355G	167	3.6	3627		365G	166	3.5	3746	1207	
		2#14	1#14	1	4#14	6.19	124U	42	-	2362	5.70	124U	42	-	2441	5.27	124U	42	-	2521	4.89	134U	41	-	2628	1296	44
				1			325G	169	3.6	3639		345G	168	3.6	3819		355G	167	3.6	3949		365G	166	3.5	4079	1694	
		3#14	3#14	1	6#14	10.60	155OfU	42	-	4181	9.77	155PeU	42	-	4321	9.03	155QdU	42	-	4461	8.37	165RdU	41	-	4643	2441	32
				1			485D	169	3.6	5946		435E	168	3.6	5834		455E	167	3.6	6075		465E	166	3.5	6264	2441	
		4#14	3#14	2	8#14	12.83	295H	42	-	5638	11.82	195JkT	42	-	5380	10.93	195KjT	41	-	5552	10.14*	195KiT	41	-	5725	2687	30
				2			585C	168	3.6	7302		505D	167	3.6	7072		525D	166	3.5	7346		545D	165	3.5	7619	2984	
	30	2#14	2#14	1	4#14	7.47	124U	61	-	2698	6.89	124U	60	-	2791	6.37	124U	60	-	2884	5.90	124U	60	-	2977	1721	37
				1			365F	243	4.4	4253		385F	242	4.4	4451		395F	240	4.4	4597		365G	239	4.4	4532	1721	
		2#14	2#14	1	5#14	8.22	124U	61	-	2937	7.57	124U	60	-	3039	7.00	134U	60	-	3169	6.49	134U	60	-	3271	1721	35
				1			365F	243	4.4	4492		385F	242	4.4	4699		395F	240	4.4	4854		415F	239	4.4	5061	2118	
		4#14	3#14	1	8#14	13.71	185JjU	61	-	5189	12.64	185KiU	60	-	5362	11.68	175MhU	60	-	5490	10.83	175NgU	60	-	5663	2871	25
				1			585C	243	4.4	7443		605C	242	4.4	7721		625C	240	4.4	7999		545D	239	4.4	7750	3228	
		4#14	4#14	1	9#14	14.91	205lmU	61	-	5842	13.74	205llU	60	-	6037	12.70	205JkU	60	-	6232	11.78	195KjU	60	-	6383	3228	24
				2			585C	243	4.4	8007		605C	242	4.4	8307		625C	240	4.4	8608		655C	239	4.4	8961	3434	
	36	2#14	2#14	1	5#14	8.30	114U	81	-	2918	7.65	124U	81	-	3050	7.08	124U	80	-	3152	6.56	124U	80	-	3254	1739	31
				1			415E	325	5.3	4855		435E	323	5.2	5067		455E	321	5.2	5279		465E	320	5.2	5436	2146	
		3#14	2#14	1	5#14	9.32	124U	81	-	3323	8.59	124U	81	-	3440	7.94	124U	80	-	3557	7.36	134U	80	-	3704	2146	30
				1			415E	325	5.3	5230		435E	323	5.2	5457		455E	321	5.2	5685		465E	320	5.2	5857	2146	
		4#14	4#14	1	9#14	15.76	195llU	81	-	5824	14.52	195JkU	81	-	6019	13.42	195JjU	80	-	6214	12.45	195KiU	80	-	6409	3300	22
				1			585C	325	5.3	8148		605C	323	5.2	8453		625C	321	5.2	8759		655C	320	5.2	9119	3662	
		5#14	5#14	2	11#14	18.15	265FtT	81	-	7323	16.73	275FtT	80	-	7611	15.47	255GqT	80	-	7761	14.34*	265GqT	80	-	8048	3842	21
				2			725B	323	5.2	10098		755B	322	5.2	10505		785B	320	5.2	10912		815B	318	5.2	11319	4181	
	42	3#14	2#14	1	5#14	9.40	114U	103	-	3303	8.66	114U	103	-	3421	8.01	124U	102	-	3568	7.43	124U	102	-	3686	2166	27
				1			585C	413	6.1	6308		605C	411	6.1	6540		625C	408	6.0	6772		415F	406	6.0	5681	2166	
		3#14	3#14	1	6#14	11.16	125U	103	-	4102	10.28	125U	103	-	4242	9.51	134U	102	-	4207	8.82	134U	102	-	4347	2570	26
				1			585C	413	6.1	6872		605C	411	6.1	7127		625C	408	6.0	7381		655C	406	6.0	7693	2570	
		5#14	4#14	1	10#14	17.77	215HnU	103	-	6559	16.37	215HmU	103	-	6778	15.14	205llU	102	-	6950	14.04	195JjU	102	-	7122	3726	19
				1			725B	413	6.1	9709		755B	411	6.1	10101		625C	408	6.0	9572		655C	406	6.0	9964	4093	
		6#14	6#14	2	13#14	21.39	305ExT	103	-	8727	19.72	315ExT	102	-	9062	18.23	315ExT	102	-	9350	16.90*	295FuT	101	-	9544	4591	17
				2			965A	411	6.1	12832		755B	408	6.0	11912		785B	406	6.0	12373		815B	404	6.0	12833	4928	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

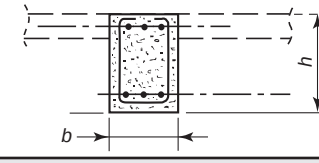
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

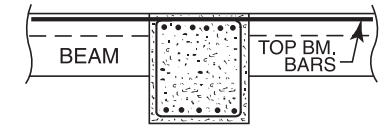
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 12 ft					SPAN, ℓ_n = 14 ft.					SPAN, ℓ_n = 16 ft.					SPAN, ℓ_n = 18 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
12	8	2# 4		1	2# 5	1.86	133B	1	-	63	1.37	143B	1	-	71	1.05	143B	1	-	76	0.83	153B	1	-	84	16	5187
				1			243A	4	0.4	113		283A	4	0.4	131		323A	4	0.4	150		353A	4	0.4	165	25	
		2# 4		1	2# 5	1.86	133B	1	-	63	1.37	143B	1	-	71	1.05	143B	1	-	76	0.83	153B	1	-	84	16	5187
				1			243A	4	0.4	113		283A	4	0.4	131		323A	4	0.4	150		353A	4	0.4	165	25	
		2# 5		1	2# 7	2.79	153B	1	-	93	2.05	173B	1	-	107	1.57	183B	1	-	119	1.24	193B	1	-	130	25	5703
				1			243A	4	0.4	138		283A	4	0.4	161		323A	4	0.4	183		353A	4	0.4	203	44	
		2# 4	2# 4	2	2# 7	3.25	163B	1	-	98	2.39	183B	1	-	113	1.83	193B	1	-	125	1.44*	213B	1	-	140	29	5936
				1			243A	4	0.4	141		283A	4	0.4	164		313A	4	0.4	185		343A	4	0.4	205	44	
	10	2# 4		1	2# 5	1.88	123B	1	-	62	1.38	123B	1	-	68	1.06	123B	1	-	73	0.84	113B	1	-	77	16	2998
				1			183B	6	0.5	98		213B	6	0.4	114		243B	6	0.4	130		273B	6	0.4	146	25	
		2# 5		1	2# 6	2.68	143B	1	-	84	1.97	153B	1	-	94	1.51	163B	1	-	105	1.19	163B	1	-	113	25	4662
				1			183B	6	0.5	114		213B	6	0.4	133		243B	6	0.4	152		273B	6	0.4	170	35	
		2# 6		1	2# 7	3.51	153B	1	-	107	2.58	173B	1	-	123	1.97	183B	1	-	136	1.56	193B	1	-	150	35	4790
				1			183B	6	0.5	135		213B	6	0.4	157		243B	6	0.4	179		273B	6	0.4	201	45	
		3# 4	2# 4	2	2# 8	4.13	163B	1	-	119	3.04	183B	1	-	137	2.33	193B	1	-	153	1.84*	213B	1	-	171	37	4658
				1			243A	6	0.5	166		213B	6	0.4	169		243B	6	0.4	193		273B	6	0.4	217	57	
	12	2# 5		1	2# 6	2.72	133B	2	-	83	2.00	143B	2	-	94	1.53	143B	2	-	102	1.21	143B	2	-	110	25	3353
				1			183B	8	0.5	119		213B	8	0.5	138		243B	8	0.5	158		273B	8	0.5	177	35	
		2# 5		1	2# 7	2.86	133B	2	-	92	2.10	143B	2	-	104	1.61	153B	2	-	116	1.27	153B	2	-	125	25	3423
				1			183B	8	0.5	128		213B	8	0.5	148		243B	8	0.5	169		273B	8	0.5	190	46	
		2# 5	1# 5	1	2# 8	4.19	153B	2	-	116	3.08	173B	2	-	134	2.36	183B	2	-	149	1.86	193B	2	-	164	37	4002
				1			183B	8	0.5	147		213B	8	0.5	171		243B	8	0.5	195		273B	8	0.5	219	59	
		2# 6	1# 6	1	2# 9	5.48	163B	2	-	146	4.02	183B	2	-	168	3.08	203B	2	-	191	2.43*	213B	2	-	210	51	3653
				1			184B	8	0.5	247		214B	8	0.5	288		243B	8	0.5	232		273B	7	0.5	260	71	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360 <$ deflection $< \ell_n/240$
X – $\ell_n/240 <$ deflection $< \ell_n/180$
Y – deflection $> \ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b > 24$ in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
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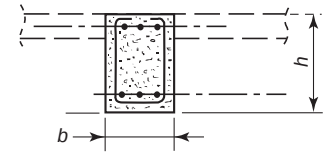
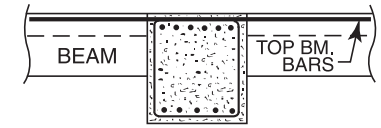
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as $w/1.4$.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
12	8	2# 4		1	2# 5	0.67	143B	1	-	87	0.55	143B	1	-	93	0.47	133B	1	-	96	0.40	123B	1	-	100	16	5187
				1			383A	4	0.4	181		413A	4	0.4	196		443A	4	0.4	211		473A	4	0.4	226	25	
		2# 4		1	2# 5	0.67	143B	1	-	87	0.55	143B	1	-	93	0.47	133B	1	-	96	0.40	123B	1	-	100	16	5187
				1			383A	4	0.4	181		413A	4	0.4	196		443A	4	0.4	211		473A	4	0.4	226	25	
		2# 5		1	2# 7	1.00	203B	1	-	142	0.83*	213B	1	-	154	0.70*	213B	1	-	164	0.59*	213B	1	-	173	25	5703
				1			383A	4	0.4	222		413A	4	0.4	242		443A	4	0.4	261		473A	4	0.4	280	44	
		2# 6		1	2# 7	1.22*	223B	1	-	166	1.01*	233B	1	-	179	0.85*	243B	1	-	193	0.72X	253B	1	-	207	34	5525
				1			383A	4	0.4	241		413A	4	0.4	263		443A	4	0.4	284		473A	4	0.4	305	44	
	10	2# 4		1	2# 5	0.68	103B	1	-	80	0.56	093B	1	-	83	0.47	073B	1	-	84	0.40	053B	1	-	85	16	2998
				1			293B	6	0.4	158		313B	6	0.4	171		343B	6	0.4	187		363B	6	0.4	200	25	
		2# 5		1	2# 6	0.96	173B	1	-	123	0.80	173B	1	-	131	0.67	163B	1	-	137	0.57*	163B	1	-	145	25	4662
				1			293B	6	0.4	186		313B	6	0.4	201		343B	6	0.4	220		363B	6	0.4	235	35	
		2# 6		1	2# 7	1.26*	203B	1	-	164	1.04*	213B	1	-	178	0.88*	213B	1	-	189	0.75*	223B	1	-	203	35	4790
				1			293B	6	0.4	219		313B	6	0.4	238		343B	6	0.4	260		363B	6	0.4	278	45	
		3# 4	2# 4	2	2# 8	1.49*	223B	1	-	186	1.23*	233B	1	-	202	1.03*	243B	1	-	217	0.88X	253B	1	-	233	37	4658
				1			293B	6	0.4	237		313B	6	0.4	257		333B	6	0.4	278		363B	5	0.4	301	57	
	12	2# 5		1	2# 6	0.98	143B	2	-	118	0.81	143B	2	-	126	0.68	133B	2	-	132	0.58	113B	2	-	135	25	3353
				1			303B	7	0.5	197		323B	7	0.5	212		343B	7	0.5	228		363B	7	0.5	244	35	
		2# 5		1	2# 7	1.03	153B	2	-	135	0.85	153B	2	-	145	0.72	143B	2	-	152	0.61	133B	2	-	159	25	3423
				1			303B	7	0.5	211		323B	7	0.5	228		343B	7	0.5	245		363B	7	0.5	263	46	
		2# 5	1# 5	1	2# 8	1.51*	203B	2	-	180	1.25*	213B	2	-	195	1.05*	213B	2	-	208	0.89*	213B	2	-	221	37	4002
				1			303B	7	0.5	243		323B	7	0.5	264		343B	7	0.5	284		363B	7	0.5	305	59	
		2# 7		1	2# 9	1.87*	223B	2	-	230	1.55*	233B	2	-	250	1.30*	243B	2	-	270	1.11X	253B	2	-	289	46	3742
				1			293B	7	0.5	286		323B	7	0.5	314		343B	7	0.5	339		363B	7	0.5	364	71	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

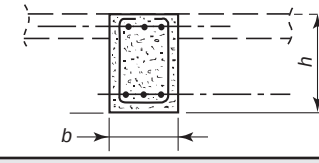
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

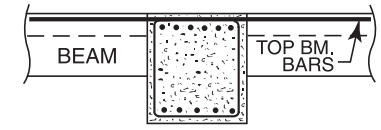
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																						
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 12 ft					SPAN, ℓ_n = 14 ft.					SPAN, ℓ_n = 16 ft.					SPAN, ℓ_n = 18 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
14	8	2# 4		1	2# 5	2.26	113C	1	-	61	1.66	113C	1	-	67	1.27	123C	1	-	75	1.01	123C	1	-	81	20	2775
				1			183B	5	0.5	98		213B	5	0.5	114		243B	5	0.4	130		273B	5	0.4	146	30	
		2# 4	1# 4	2	2# 6	3.18	123C	1	-	77	2.33	143C	1	-	90	1.79	153C	1	-	100	1.41	153C	1	-	108	28	3774
				1			183B	5	0.5	111		213B	5	0.4	130		243B	5	0.4	148		273B	5	0.4	166	42	
		2# 4	2# 4	2	2# 7	4.05	133C	1	-	95	2.97	153C	1	-	110	2.28	163C	1	-	123	1.80	173C	1	-	135	36	3707
				1			183B	5	0.5	126		213B	5	0.4	147		243B	5	0.4	168		273B	5	0.4	189	55	
		2# 4	2# 4	2	3# 6	4.05	133C	1	-	98	2.97	153C	1	-	114	2.28	163C	1	-	127	1.80	173C	1	-	140	36	3776
				2			183B	5	0.5	129		213B	5	0.4	151		243B	5	0.4	172		273B	5	0.4	194	56	
	10	2# 4		1	2# 5	2.28	103C	2	-	60	1.67	103C	2	-	66	1.28	103C	2	-	71	1.01	093C	2	-	74	20	1477
				1			183B	8	0.5	102		213B	8	0.5	119		243B	7	0.5	136		273B	7	0.5	153	31	
		2# 5		1	2# 6	3.28	113C	2	-	79	2.41	123C	2	-	90	1.85	133C	2	-	101	1.46	143C	2	-	112	31	2663
				1			183B	8	0.5	119		213B	7	0.5	138		243B	7	0.5	158		273B	7	0.5	177	42	
		2# 6		1	3# 6	4.75	133C	2	-	109	3.49	143C	2	-	123	2.67	153C	2	-	138	2.11	163C	2	-	152	42	2985
				1			183B	8	0.5	143		213B	7	0.5	166		243B	7	0.5	189		273B	7	0.5	213	62	
		3# 4	2# 4	2	2# 8	5.13	133C	2	-	115	3.77	153C	2	-	134	2.89	163C	2	-	150	2.28	173C	2	-	166	46	2913
				1			243A	8	0.5	172		213B	7	0.5	174		243B	7	0.5	199		273B	7	0.5	223	71	
	12	2# 5		1	2# 6	3.32	113C	3	-	81	2.44	113C	2	-	89	1.87	123C	2	-	100	1.48	123C	2	-	108	31	1793
				1			143C	10	0.6	107		173C	10	0.6	128		193C	10	0.6	144		223C	10	0.6	164	43	
		2# 6		1	2# 7	4.41	123C	3	-	104	3.24	133C	2	-	118	2.48	143C	2	-	132	1.96	153C	2	-	147	43	2387
				1			144C	10	0.6	187		173C	10	0.6	151		193C	10	0.6	171		223C	10	0.6	194	57	
		2# 5	2# 5	1	2# 8	5.61	133C	3	-	124	4.13	143C	2	-	141	3.16	153C	2	-	158	2.50	163C	2	-	175	60	2384
				1			144C	10	0.6	204		174C	10	0.6	243		194C	10	0.6	274		223C	10	0.6	220	73	
		2# 6	1# 6	1	2# 9	6.85	133C	3	-	142	5.03	153C	2	-	165	3.85	163C	2	-	185	3.04	173C	2	-	205	63	2321
				1			144C	10	0.6	223		174C	10	0.6	265		194C	10	0.6	298		224C	10	0.6	341	89	
	14	2# 5		1	3# 5	3.50	103C	3	-	80	2.57	113C	3	-	92	1.97	113C	3	-	100	1.56	113C	3	-	108	31	1285
				1			143C	13	0.7	112		173C	13	0.7	133		193C	12	0.7	150		223C	12	0.7	171	46	
		2# 6		1	3# 6	4.87	123C	3	-	109	3.58	133C	3	-	124	2.74	143C	3	-	139	2.16	143C	3	-	151	43	2012
				1			144C	13	0.7	197		173C	13	0.7	160		193C	12	0.7	180		223C	12	0.7	205	64	
		2# 6	1# 6	1	3# 7	6.45	133C	3	-	138	4.74	143C	3	-	158	3.63	153C	3	-	177	2.87	163C	3	-	196	64	2096
				1			144C	13	0.7	224		174C	13	0.7	266		194C	12	0.7	300		223C	12	0.7	245	84	
		3# 5	2# 5	1	3# 8	8.15	134C	3	-	197	5.99	153C	3	-	186	4.59	163C	3	-	209	3.62	183C	3	-	234	74	1961
				1			144C	13	0.7	246		174C	13	0.7	292		194C	12	0.7	329		224C	12	0.7	375	106	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360 <$ deflection $< \ell_n/240$
X – $\ell_n/240 <$ deflection $< \ell_n/180$
Y – deflection $> \ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b > 24$ in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
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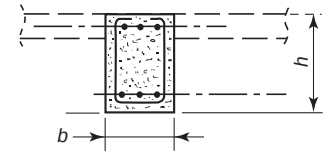
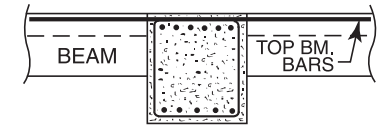
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as $w/1.4$.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																		$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	(6)	(7) $\times 10^{-9}$
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft.-kips	sq. in.	lb.	ft.-kip	in.
14	8	2# 4		1	2# 5	0.81	123C	1	-	86	0.67	123C	1	-	92	0.57	113C	1	-	95	0.48	103C	1	-	98	20	2775
				1			293B	5	0.4	158		313B	5	0.4	171		343B	5	0.4	187		363B	5	0.4	200	30	
		2# 5		1	2# 6	1.16	163C	1	-	123	0.96	163C	1	-	131	0.81	173C	1	-	142	0.69	173C	1	-	150	30	3702
				1			293B	5	0.4	186		313B	5	0.4	201		343B	5	0.4	220		363B	5	0.4	235	42	
		2# 6		1	2# 7	1.52	183C	1	-	162	1.26*	193C	1	-	175	1.06*	203C	1	-	189	0.90*	213C	1	-	203	42	3503
				1			293B	5	0.4	219		313B	5	0.4	238		343B	5	0.4	260		363B	5	0.4	278	55	
		2# 5	2# 4	2	2# 8	1.83*	203C	1	-	185	1.51*	213C	1	-	200	1.27*	223C	1	-	216	1.08*	233C	1	-	232	45	3307
				1			293B	5	0.4	237		313B	5	0.4	258		333B	5	0.4	278		363B	5	0.4	302	69	
	10	2# 5		1	2# 6	1.18	143C	2	-	120	0.98	143C	2	-	128	0.82	143C	2	-	136	0.70	133C	2	-	142	31	2663
				1			303B	7	0.5	197		323B	7	0.5	212		343B	7	0.5	228		363B	7	0.5	244	42	
		2# 5		1	2# 7	1.24	143C	2	-	134	1.03	153C	2	-	146	0.86	143C	2	-	154	0.74	143C	2	-	163	31	2650
				1			303B	7	0.5	211		323B	7	0.5	228		343B	7	0.5	245		363B	7	0.5	263	56	
		2# 7		1	2# 8	1.98	183C	2	-	203	1.63*	193C	2	-	221	1.37*	203C	2	-	239	1.17*	213C	2	-	257	56	2738
				1			303B	7	0.5	270		323B	7	0.5	293		343B	7	0.5	315		363B	7	0.5	338	71	
		2# 7		1	2# 9	2.27*	193C	2	-	225	1.88*	203C	2	-	245	1.58*	223C	2	-	268	1.34*	223C	2	-	285	56	2597
				1			303B	7	0.5	289		323B	7	0.5	314		343B	7	0.5	339		363B	7	0.5	364	87	
	12	2# 5		1	2# 6	1.20	123C	2	-	116	0.99	113C	2	-	122	0.83	113C	2	-	130	0.71	103C	2	-	135	31	1793
				1			243C	10	0.6	180		263C	9	0.6	196		283C	9	0.6	213		303C	9	0.6	229	43	
		2# 6		1	2# 7	1.59	153C	2	-	158	1.31	153C	2	-	169	1.10	153C	2	-	181	0.94	153C	2	-	192	43	2387
				1			243C	10	0.6	214		263C	9	0.6	233		283C	9	0.6	253		303C	9	0.6	272	57	
		2# 7		1	2# 9	2.31	183C	2	-	225	1.91*	193C	2	-	245	1.60*	203C	2	-	265	1.37*	213C	2	-	285	57	2358
				1			243C	9	0.6	273		263C	9	0.6	298		283C	9	0.6	323		303C	9	0.6	349	89	
		2# 8		1	2#10	2.92*	203C	2	-	281	2.41*	213C	2	-	306	2.03*	223C	2	-	330	1.73*	233C	2	-	355	73	2107
				1			244C	9	0.6	425		264C	9	0.6	464		284C	9	0.6	502		303C	9	0.6	414	106	
	14	2# 6		1	3# 6	1.75	153C	3	-	165	1.45	153C	3	-	177	1.22	153C	3	-	189	1.04	143C	3	-	199	43	2012
				1			243C	12	0.7	225		263C	12	0.7	246		283C	12	0.7	267		303C	12	0.6	287	64	
		2# 7		1	3# 7	2.32	173C	3	-	216	1.92	183C	3	-	235	1.61*	183C	3	-	251	1.37*	193C	3	-	270	58	2157
				1			243C	12	0.7	270		263C	12	0.7	295		283C	12	0.7	320		303C	12	0.6	345	84	
		2# 8		1	3# 8	2.93	193C	3	-	273	2.43*	203C	3	-	297	2.04*	213C	3	-	321	1.74*	223C	3	-	345	74	1977
				1			244C	12	0.7	428		264C	12	0.7	467		283C	12	0.7	381		303C	12	0.6	411	106	
		2# 7	1# 7	1	3# 9	3.38*	203C	3	-	309	2.79*	213C	3	-	337	2.35*	223C	3	-	364	2.00*	233C	3	-	392	84	1786
				1			244C	12	0.7	462		264C	12	0.7	504		284C	12	0.7	546		304C	12	0.6	588	125	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

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(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
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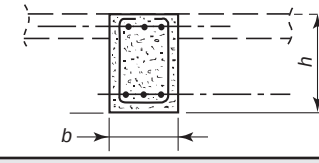
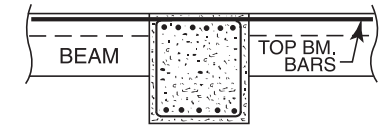
RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 16 ft					SPAN, ℓ_n = 18 ft.					SPAN, ℓ_n = 20 ft.					SPAN, ℓ_n = 22 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
16	10	2# 5		1	2# 6	2.19	113D	2	-	99	1.73	123D	2	-	110	1.40	123D	2	-	118	1.16	123D	2	-	126	36	1585
				1			193C	9	0.6	144		223C	9	0.6	164		243C	9	0.6	180		263C	9	0.6	196	50	
		2# 6		1	2# 7	2.90	133D	2	-	131	2.29	143D	2	-	146	1.86	143D	2	-	157	1.53	153D	2	-	171	50	1926
				1			193C	9	0.6	171		223C	9	0.6	194		243C	9	0.6	214		263C	9	0.6	233	67	
		2# 7		1	2# 9	4.22	143D	2	-	182	3.33	153D	2	-	202	2.70	163D	2	-	222	2.23	173D	2	-	242	67	1769
				1			323A	9	0.6	270		363A	9	0.6	304		403A	9	0.6	337		263C	9	0.6	298	105	
		2# 8		1	2#10	5.26	173AeD	2	-	231	4.15	163D	2	-	250	3.37	173D	2	-	275	2.78	193D	2	-	303	86	1552
				1			323A	9	0.6	311		363A	9	0.6	349		403A	9	0.6	387		433A	9	0.6	422	122	
	12	2# 6		1	2# 7	2.94	123D	3	-	130	2.32	123D	3	-	141	1.88	133D	3	-	156	1.56	133D	3	-	167	51	1481
				1			193C	12	0.7	176		223C	12	0.7	200		243C	12	0.7	220		263C	12	0.7	240	68	
		2# 7		1	2# 8	3.77	133D	3	-	165	2.98	143D	3	-	183	2.41	153D	3	-	201	1.99	153D	3	-	217	68	1606
				1			194C	12	0.7	292		223C	12	0.7	236		243C	12	0.7	259		263C	12	0.7	283	87	
		2# 8		1	2#10	5.48	144D	3	-	264	4.33	163D	3	-	252	3.51	173D	3	-	277	2.90	183D	3	-	302	87	1439
				1			194C	12	0.7	348		224C	12	0.7	396		244C	12	0.7	436		264C	12	0.7	476	131	
		2# 9		1	2#11	6.25	154D	3	-	317	4.94	164D	3	-	350	4.00	173D	3	-	335	3.31	193D	3	-	368	107	1275
				1			194C	12	0.7	395		224C	12	0.7	448		244C	12	0.7	494		264C	12	0.7	539	145	
	14	2# 6		1	3# 6	3.23	123D	4	-	136	2.56	123D	4	-	148	2.07	123D	4	-	160	1.71	133D	4	-	175	51	1214
				1			164D	15	0.8	246		183D	15	0.8	192		203D	15	0.8	213		223D	15	0.8	234	75	
		2# 7		1	3# 7	4.32	133D	4	-	175	3.41	143D	4	-	194	2.77	153D	4	-	214	2.29	153D	4	-	230	69	1419
				1			164D	15	0.8	282		184D	15	0.8	316		204D	15	0.8	351		224D	15	0.8	386	100	
		2# 8		1	3# 9	5.56	143D	4	-	243	4.39	153D	4	-	270	3.56	163D	4	-	297	2.94	173D	4	-	325	88	1241
				1			164D	15	0.8	346		184D	15	0.8	389		204D	15	0.8	432		224D	15	0.8	474	155	
		2# 9		1	3# 9	6.70	154D	4	-	316	5.29	164D	4	-	349	4.29	173D	4	-	331	3.54	183D	4	-	361	109	1203
				1			165D	15	0.8	469		185D	15	0.8	527		204D	15	0.8	462		224D	15	0.7	508	155	
	16	2# 7		1	3# 7	4.35	123D	5	-	173	3.44	133D	5	-	193	2.79	143D	5	-	212	2.30	143D	5	-	229	69	1204
				1			164D	19	0.9	289		184D	19	0.9	325		204D	18	0.9	360		223D	18	0.8	289	101	
		2# 8		1	3# 8	5.59	133D	5	-	218	4.41	153D	5	-	246	3.58	153D	5	-	267	2.96	163D	5	-	291	89	1229
				1			164D	19	0.9	330		184D	19	0.9	371		204D	18	0.9	412		224D	18	0.8	452	130	
		2# 9		1	3# 9	6.83	144D	5	-	313	5.40	153D	5	-	300	4.37	173D	5	-	333	3.61	183D	5	-	364	110	1131
				1			165D	19	0.9	480		185D	18	0.9	539		204D	18	0.8	471		224D	18	0.8	518	159	
		2# 8	1# 8	1	3#10	8.13	154D	5	-	355	6.42	164D	5	-	393	5.20	174D	5	-	432	4.30	183D	5	-	414	130	1009
				1			165D	19	0.9	516		185D	19	0.9	580		205D	18	0.8	644		225D	18	0.8	708	193	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

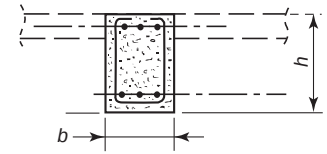
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

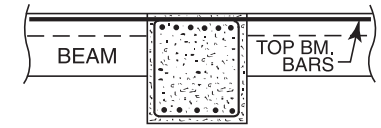
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
16	10	2# 5		1	2# 6	0.97	123D	2	-	134	0.83	113D	2	-	139	0.71	113D	2	-	148	0.62	103D	2	-	153	36	1585
				1			283C	9	0.6	213		303C	9	0.6	229		323C	8	0.6	245		343C	8	0.6	261	50	
		2# 6		1	2# 7	1.29	153D	2	-	183	1.10	153D	2	-	194	0.95	163D	2	-	209	0.83	163D	2	-	220	50	1926
				1			283C	9	0.6	253		303C	9	0.6	272		323C	8	0.6	292		343C	8	0.6	311	67	
		2# 7		1	2# 9	1.88	183D	2	-	262	1.60*	193D	2	-	282	1.38*	203D	2	-	302	1.20*	203D	2	-	319	67	1769
				1			283C	9	0.6	323		303C	9	0.6	349		323C	8	0.6	374		333C	8	0.6	395	105	
		2# 8		1	2#10	2.34*	203D	2	-	328	1.99*	213D	2	-	353	1.72*	223D	2	-	378	1.50*	233D	2	-	403	86	1552
				1			463A	9	0.6	456		493A	9	0.6	490		323C	8	0.6	444		333C	8	0.6	470	122	
	12	2# 6		1	2# 7	1.31	133D	3	-	179	1.11	133D	3	-	190	0.96	133D	3	-	202	0.84	133D	3	-	213	51	1481
				1			293C	11	0.7	264		303C	11	0.6	280		323C	11	0.6	300		343C	11	0.6	320	68	
		2# 7		1	2# 8	1.68	163D	3	-	235	1.43	163D	3	-	250	1.23	173D	3	-	268	1.07	173D	3	-	284	68	1606
				1			283C	11	0.7	307		303C	11	0.6	331		323C	11	0.6	355		343C	11	0.6	378	87	
		2# 8		1	2#10	2.44*	193D	3	-	327	2.08*	203D	3	-	352	1.79*	213D	3	-	377	1.56*	213D	3	-	400	87	1439
				1			284C	11	0.7	515		303C	11	0.6	421		323C	11	0.6	452		343C	11	0.6	483	131	
		2# 9		1	2#11	2.78*	203D	3	-	399	2.37*	213D	3	-	430	2.04*	223D	3	-	460	1.78*	233D	3	-	491	107	1275
				1			284C	11	0.7	584		304C	11	0.6	629		324C	11	0.6	674		343C	11	0.6	568	145	
	14	2# 6		1	3# 6	1.44	133D	4	-	187	1.23	123D	4	-	196	1.06	123D	4	-	208	0.92	123D	4	-	220	51	1214
				1			243D	15	0.7	255		263D	14	0.7	277		273D	14	0.7	293		293D	14	0.7	314	75	
		2# 7		1	3# 7	1.92	163D	4	-	249	1.64	163D	4	-	266	1.41	163D	4	-	282	1.23*	173D	4	-	302	69	1419
				1			243D	15	0.7	309		263D	14	0.7	334		273D	14	0.7	355		293D	14	0.7	380	100	
		2# 8		1	3# 9	2.47	183D	4	-	352	2.10	193D	4	-	379	1.81*	193D	4	-	404	1.58*	203D	4	-	431	88	1241
				1			244D	15	0.7	517		264D	14	0.7	559		274D	14	0.7	593		293D	14	0.7	500	155	
		2# 9		1	3# 9	2.98*	193D	4	-	392	2.54*	203D	4	-	422	2.19*	213D	4	-	452	1.90*	223D	4	-	482	109	1203
				1			244D	15	0.7	553		264D	14	0.7	599		274D	14	0.7	635		294D	14	0.7	681	155	
	16	2# 7		1	3# 7	1.94	153D	4	-	248	1.65	153D	4	-	265	1.42	153D	4	-	281	1.24	153D	4	-	297	69	1204
				1			243D	18	0.8	315		263D	18	0.8	340		283D	18	0.8	366		293D	18	0.8	387	101	
		2# 8		1	3# 8	2.48	173D	4	-	316	2.12	173D	4	-	337	1.82*	183D	4	-	362	1.59*	183D	4	-	383	89	1229
				1			244D	18	0.8	493		264D	18	0.8	533		283D	18	0.8	438		293D	18	0.8	464	130	
		2# 9		1	3# 9	3.04*	183D	4	-	391	2.59*	193D	4	-	421	2.23*	203D	4	-	452	1.94*	213D	4	-	482	110	1131
				1			244D	18	0.8	564		264D	18	0.8	611		284D	18	0.8	657		294D	17	0.8	694	159	
		2#10		1	3#10	3.69*	203D	4	-	486	3.14*	213D	4	-	523	2.71*	223D	4	-	561	2.36*	233D	4	-	598	136	1000
				1			244D	18	0.8	653		264D	18	0.8	707		284D	18	0.8	760		294D	17	0.8	804	193	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
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X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
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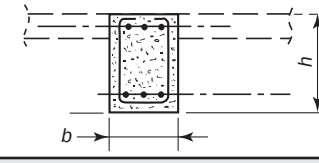
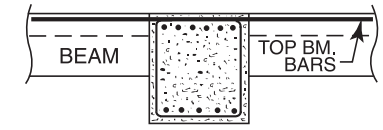
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 16 ft					SPAN, ℓ_n = 18 ft.					SPAN, ℓ_n = 20 ft.					SPAN, ℓ_n = 22 ft.						
h	b	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
18	10	2# 5		1	2# 7	2.64	103E	3	-	110	2.09	113E	3	-	122	1.69	113E	3	-	132	1.40	113E	3	-	142	42	1005
				1			193C	11	0.7	160		223C	11	0.7	182		243C	11	0.7	201		263C	10	0.7	219	78	
		2# 6		1	2# 8	3.68	113E	3	-	142	2.90	123E	3	-	158	2.35	133E	3	-	174	1.94	143E	3	-	190	58	1293
				1			323A	11	0.7	244		223C	11	0.7	215		243C	11	0.7	237		263C	10	0.7	258	100	
		2# 8		1	2# 9	5.29	133E	3	-	203	4.18	143E	3	-	226	3.38	153E	3	-	249	2.80	163E	3	-	272	100	1189
				1			323A	11	0.7	300		363A	11	0.7	336		403A	11	0.7	373		443A	10	0.7	410	123	
		2# 8		1	2#10	6.27	153BfE	3	-	229	4.95	163BeE	3	-	254	4.01	153E	3	-	273	3.32	163E	3	-	298	100	1121
				1			323A	11	0.7	319		363A	11	0.7	358		403A	11	0.7	397		443A	10	0.7	437	150	
	12	2# 6		1	2# 7	3.41	103E	4	-	127	2.69	113E	4	-	141	2.18	113E	4	-	153	1.80	123E	3	-	167	59	945
				1			164D	15	0.8	241		183D	14	0.8	187		203D	14	0.8	208		223D	14	0.8	228	79	
		2# 7		1	2# 9	4.95	123E	4	-	180	3.91	133E	4	-	201	3.17	143E	4	-	221	2.62	143E	3	-	239	79	1108
				1			164D	15	0.8	289		184D	14	0.8	324		204D	14	0.8	360		224D	14	0.8	396	125	
		2# 8		1	2#10	6.37	134E	4	-	265	5.03	143E	4	-	249	4.08	153E	4	-	275	3.37	163E	3	-	300	101	1031
				1			324A	15	0.8	476		184D	14	0.8	370		204D	14	0.8	410		224D	14	0.8	451	154	
		2# 9		1	2#11	7.84	134E	4	-	311	6.20	144E	4	-	345	5.02	154E	4	-	379	4.15	164E	3	-	413	125	923
				1			324A	15	0.8	522		364A	14	0.8	587		404A	14	0.8	651		224D	14	0.7	514	182	
	14	2# 7		1	3# 7	5.00	113E	5	-	171	3.95	123E	5	-	191	3.20	133E	5	-	211	2.64	133E	4	-	227	79	964
				1			164D	19	0.9	289		184D	18	0.9	325		204D	18	0.9	360		224D	18	0.9	396	116	
		2# 8		1	3# 8	6.42	124E	5	-	255	5.07	133E	5	-	241	4.11	143E	5	-	265	3.39	153E	4	-	290	103	954
				1			164D	19	0.9	330		184D	18	0.9	371		204D	18	0.9	412		224D	18	0.9	452	149	
		2# 9		1	3# 9	7.86	134E	5	-	309	6.21	144E	5	-	343	5.03	154E	5	-	377	4.16	163E	4	-	359	127	866
				1			165D	19	0.9	480		185D	18	0.9	539		204D	18	0.9	471		224D	18	0.8	518	182	
		2# 8	1# 8	1	3#10	9.34	283A	5	-	354	7.38	144E	5	-	384	5.98	154E	5	-	422	4.94	164E	4	-	461	149	768
				1			324A	19	0.9	569		185D	18	0.9	580		205D	18	0.9	644		225D	18	0.8	708	222	
	16	2# 7		1	3# 7	5.03	113E	6	-	173	3.97	123E	6	-	193	3.22	123E	6	-	209	2.66	123E	5	-	225	80	790
				1			144E	23	1.0	276		164E	23	1.0	313		174E	22	1.0	339		194E	22	1.0	376	118	
		2# 8		1	3# 8	6.50	123E	6	-	218	5.14	133E	6	-	242	4.16	143E	6	-	267	3.44	143E	5	-	289	104	858
				1			145E	23	1.0	410		164E	23	1.0	359		174E	22	1.0	390		194E	22	1.0	432	151	
		2# 8	1# 8	1	3#10	9.46	135E	6	-	403	7.47	144E	6	-	387	6.05	154E	6	-	426	5.00	164E	5	-	464	151	727
				1			245B	23	1.0	661		165E	23	1.0	559		175E	22	1.0	608		195E	22	1.0	673	227	
		2# 9	1# 9	1	3#11	11.02	293A	6	-	426	8.71	145E	6	-	520	7.05	164E	6	-	515	5.83	174E	5	-	561	186	642
				1			324A	23	1.0	649		275B	23	1.0	817		175E	22	1.0	690		195E	22	0.9	763	256	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

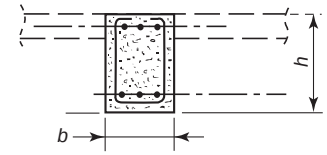
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

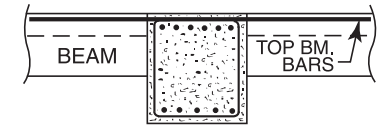
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
18	10	2# 5		1	2# 7	1.17	113E	3	-	151	1.00	113E	3	-	161	0.86	103E	3	-	168	0.75	103E	3	-	177	42	1005
				1			293C	10	0.6	241		303C	10	0.6	255		323C	10	0.6	273		343C	10	0.6	291	78	
		2# 6		1	2# 8	1.63	143E	3	-	204	1.39	143E	3	-	217	1.20	153E	3	-	233	1.05	153E	3	-	246	58	1293
				1			293C	10	0.6	284		303C	10	0.6	302		323C	10	0.6	323		343C	10	0.6	345	100	
		2# 8		1	2# 9	2.35	163E	3	-	291	2.00	173E	3	-	314	1.73	183E	3	-	337	1.50*	193E	3	-	360	100	1189
				1			293C	10	0.6	366		303C	10	0.6	390		323C	10	0.6	418		343C	10	0.6	446	123	
		2# 8		1	2#10	2.79	173E	3	-	323	2.37*	183E	3	-	349	2.05*	193E	3	-	374	1.78*	203E	3	-	399	100	1121
				1			473A	10	0.6	471		503A	10	0.6	506		533A	10	0.6	541		343C	10	0.6	483	150	
	12	2# 6		1	2# 7	1.51	123E	3	-	179	1.29	123E	3	-	190	1.11	123E	3	-	202	0.97	113E	3	-	210	59	945
				1			243D	14	0.7	249		263D	14	0.7	269		273D	14	0.7	285		293D	13	0.7	306	79	
		2# 7		1	2# 9	2.20	153E	3	-	259	1.88	153E	3	-	276	1.62	163E	3	-	297	1.41	163E	3	-	314	79	1108
				1			244D	14	0.7	431		263D	14	0.7	346		273D	14	0.7	367		293D	13	0.7	394	125	
		2# 8		1	2#10	2.83	163E	3	-	322	2.41	173E	3	-	348	2.08*	183E	3	-	373	1.81*	193E	3	-	398	101	1031
				1			244D	14	0.7	491		264D	14	0.7	532		274D	14	0.7	563		294D	13	0.7	604	154	
		2# 9		1	2#11	3.49	173E	3	-	394	2.97*	183E	3	-	425	2.56*	193E	3	-	456	2.23*	203E	3	-	487	125	923
				1			244D	14	0.7	560		264D	14	0.7	606		274D	14	0.7	643		294D	13	0.7	689	182	
	14	2# 7		1	3# 7	2.22	143E	4	-	247	1.89	143E	4	-	263	1.63	143E	4	-	280	1.42	143E	4	-	296	79	964
				1			243D	18	0.8	315		263D	17	0.8	340		283D	17	0.8	366		293D	17	0.8	387	116	
		2# 8		1	3# 8	2.85	163E	4	-	315	2.43	163E	4	-	336	2.10	173E	4	-	361	1.83*	173E	4	-	382	103	954
				1			244D	18	0.8	493		264D	17	0.8	533		284D	17	0.8	574		294D	17	0.8	605	149	
		2# 9		1	3# 9	3.49	173E	4	-	390	2.98	183E	4	-	420	2.57*	183E	4	-	447	2.23*	193E	4	-	478	127	866
				1			244D	18	0.8	564		264D	17	0.8	611		284D	17	0.8	657		294D	17	0.8	694	182	
		2#10		1	3#10	4.24	184E	4	-	539	3.62*	194E	4	-	580	3.12*	203E	4	-	557	2.72*	203E	4	-	591	157	759
				1			245D	18	0.8	806		264D	17	0.8	707		284D	17	0.8	760		294D	17	0.8	804	222	
	16	2# 7		1	3# 7	2.24	133E	5	-	245	1.90	133E	5	-	261	1.64	133E	5	-	278	1.43	133E	5	-	294	80	790
				1			214E	22	0.9	412		223E	21	0.9	327		243E	21	0.9	353		263E	21	0.9	380	118	
		2# 8		1	3# 8	2.89	153E	5	-	313	2.46	153E	5	-	335	2.12	163E	5	-	360	1.85	163E	5	-	381	104	858
				1			214E	22	0.9	474		224E	21	0.9	505		244E	21	0.9	547		264E	21	0.9	588	151	
		2#10		1	3#10	4.34	174E	5	-	537	3.70*	183E	5	-	518	3.19*	193E	5	-	556	2.78*	203E	5	-	594	159	720
				1			215E	22	0.9	772		225E	21	0.9	823		244E	21	0.9	733		264E	21	0.9	787	227	
		2#10		1	3#11	4.43	174E	5	-	585	3.78	183E	5	-	571	3.26*	193E	5	-	613	2.84*	203E	5	-	654	159	671
				1			215E	22	0.9	821		225E	21	0.9	876		245E	21	0.9	948		264E	21	0.9	848	256	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

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(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
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$f_c' = 4{,}000$ psi
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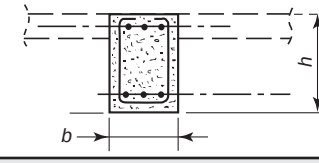
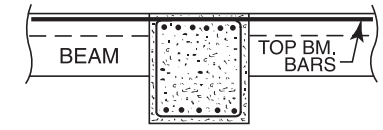
RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
20	10	2# 6		1	2# 7	2.45	113F	3	-	154	2.03	123F	3	-	169	1.70	123F	3	-	180	1.45	123F	3	-	192	66	890
				1			203D	12	0.7	208		223D	12	0.7	228		243D	12	0.7	249		263D	12	0.7	269	89	
		2# 7		1	2# 8	3.15	123F	3	-	197	2.60	133F	3	-	216	2.19	143F	3	-	234	1.86	143F	3	-	249	89	953
				1			403A	12	0.7	338		443A	12	0.7	371		473A	12	0.7	400		263D	12	0.7	320	114	
		2# 8		1	2#10	4.58	153CdF	3	-	277	3.79	143F	3	-	296	3.18	153F	3	-	321	2.71	163F	3	-	346	114	840
				1			403A	12	0.7	407		443A	12	0.7	448		473A	12	0.7	483		503A	12	0.7	519	172	
		2# 9		1	2#11	5.61	173ChF	3	-	341	4.64	183CgF	3	-	372	3.90	183CeF	3	-	400	3.32	193CdF	3	-	431	141	742
				1			403A	12	0.7	465		443A	12	0.7	511		473A	12	0.7	552		503A	12	0.7	593	204	
	12	2# 6		1	2# 8	2.69	113F	4	-	172	2.22	113F	4	-	185	1.87	113F	4	-	198	1.59	113F	4	-	212	67	669
				1			203D	17	0.9	230		223D	16	0.8	252		243D	16	0.8	275		263D	16	0.8	297	116	
		2# 7		1	2# 9	3.60	123F	4	-	218	2.98	133F	4	-	239	2.50	133F	4	-	256	2.13	143F	4	-	276	90	797
				1			204D	17	0.9	369		224D	16	0.8	406		244D	16	0.8	442		264D	16	0.8	479	143	
		2# 9		1	2#11	5.75	144F	4	-	379	4.75	154F	4	-	414	3.99	164F	4	-	448	3.40	163F	4	-	423	143	692
				1			404A	17	0.8	670		224D	16	0.8	524		244D	16	0.8	571		264D	16	0.8	618	210	
		2#10		1	3#10	6.80	144F	4	-	448	5.62	154F	4	-	489	4.72	164F	4	-	530	4.03	174F	4	-	571	177	603
				1			404A	17	0.8	738		444A	16	0.8	811		484A	16	0.8	884		264D	16	0.8	707	247	
	14	2# 7		1	3# 7	3.63	113F	5	-	207	3.00	123F	5	-	227	2.52	123F	5	-	243	2.15	133F	5	-	263	90	670
				1			174E	21	1.0	339		194E	21	1.0	376		214E	21	0.9	412		224E	21	0.9	439	133	
		2# 8		1	3# 8	4.69	133F	5	-	265	3.88	133F	5	-	287	3.26	143F	5	-	312	2.78	143F	5	-	333	117	699
				1			174E	21	1.0	390		194E	21	1.0	432		214E	21	0.9	474		224E	21	0.9	505	170	
		2#10		1	3#10	7.06	144F	5	-	451	5.83	154F	5	-	492	4.90	164F	5	-	534	4.17	174F	5	-	575	180	570
				1			175E	21	1.0	637		195E	21	0.9	704		215E	21	0.9	772		225E	21	0.9	823	256	
		2#10		1	3#11	7.21	144F	5	-	491	5.96	154F	5	-	537	5.01	164F	5	-	582	4.26	174F	5	-	628	180	530
				1			175E	21	1.0	677		195E	21	0.9	749		215E	21	0.9	821		225E	21	0.9	876	287	
	16	2# 7		1	3# 7	3.65	113F	7	-	208	3.02	113F	6	-	225	2.54	113F	6	-	241	2.16	113F	6	-	257	91	528
				1			174E	26	1.1	347		194E	26	1.1	384		214E	26	1.1	422		224E	25	1.1	449	134	
		2# 9		1	3# 9	5.86	134F	7	-	373	4.84	143F	6	-	358	4.07	143F	6	-	385	3.47	153F	6	-	416	146	598
				1			175E	26	1.1	574		195E	26	1.1	636		214E	26	1.1	555		224E	25	1.0	592	213	
		2#10		1	3#10	7.20	144F	7	-	454	5.95	144F	6	-	488	5.00	154F	6	-	530	4.26	164F	6	-	572	182	539
				1			175E	26	1.1	648		195E	26	1.1	718		215E	26	1.1	787		225E	25	1.0	839	261	
		2#11		1	3#11	8.52	145F	7	-	599	7.04	155F	6	-	653	5.92	164F	6	-	636	5.04	174F	6	-	686	218	481
				1			305B	26	1.1	957		195E	26	1.1	808		215E	26	1.0	886		225E	25	1.0	946	309	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360 <$ deflection $< \ell_n/240$
X – $\ell_n/240 <$ deflection $< \ell_n/180$
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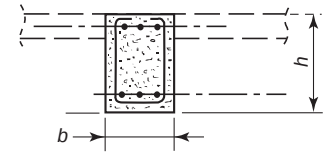
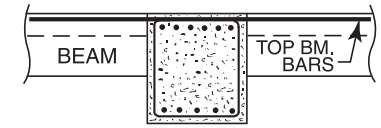
RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 28 ft					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.					SPAN, ℓ_n = 34 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
20	10	2# 6		1	2# 7	1.25	123F	3	-	203	1.09	123F	3	-	215	0.96	123F	3	-	226	0.85	123F	3	-	238	66	890
				1			283D	12	0.7	290		293D	12	0.7	306		313D	12	0.7	326		323D	12	0.7	342	89	
		2# 7		1	2# 8	1.61	143F	3	-	265	1.40	153F	3	-	283	1.23	153F	3	-	299	1.09	153F	3	-	314	89	953
				1			273D	12	0.7	340		293D	12	0.7	364		303D	12	0.7	384		323D	12	0.7	409	114	
		2# 8		1	2#10	2.34	173F	3	-	372	2.04	183F	3	-	397	1.79*	183F	3	-	420	1.58*	193F	3	-	445	114	840
				1			533A	12	0.7	555		563A	12	0.7	590		593A	12	0.7	626		623A	12	0.7	662	172	
		2# 9		1	2#11	2.86*	183F	3	-	455	2.50*	193F	3	-	486	2.19*	203F	3	-	518	1.94*	203F	3	-	545	141	742
				1			533A	12	0.7	635		563A	12	0.7	676		593A	12	0.7	717		623A	12	0.7	759	204	
	12	2# 6		1	2# 8	1.37	113F	4	-	225	1.20	113F	4	-	238	1.05	113F	4	-	251	0.93	113F	4	-	264	67	669
				1			283D	16	0.8	320		293D	16	0.8	338		313D	16	0.8	361		323D	16	0.8	379	116	
		2# 7		1	2# 9	1.84	143F	4	-	294	1.60	143F	4	-	311	1.41	153F	4	-	332	1.25	153F	4	-	349	90	797
				1			283D	16	0.8	379		293D	16	0.8	401		313D	16	0.8	428		323D	16	0.8	450	143	
		2# 9		1	2#11	2.93	173F	4	-	454	2.55*	183F	4	-	485	2.25*	193F	4	-	517	1.99*	193F	4	-	544	143	692
				1			284D	16	0.8	665		294D	16	0.8	703		314D	16	0.8	750		324D	16	0.8	787	210	
		2#10		1	3#10	3.47	184F	4	-	612	3.02*	193F	4	-	590	2.66*	203F	4	-	628	2.35*	203F	4	-	663	177	603
				1			284D	16	0.8	760		294D	16	0.8	804		314D	16	0.8	858		324D	16	0.8	902	247	
	14	2# 7		1	3# 7	1.85	133F	5	-	279	1.61	133F	5	-	296	1.42	133F	5	-	312	1.26	133F	5	-	329	90	670
				1			244E	20	0.9	475		263E	20	0.9	380		273E	20	0.9	401		283E	20	0.9	422	133	
		2# 8		1	3# 8	2.39	153F	5	-	358	2.09	153F	5	-	379	1.83	163F	5	-	404	1.62	163F	5	-	426	117	699
				1			244E	20	0.9	547		264E	20	0.9	588		274E	20	0.9	620		284E	20	0.9	651	170	
		2#10		1	3#10	3.60	174F	5	-	609	3.14*	183F	5	-	589	2.76*	193F	5	-	627	2.44*	203F	5	-	665	180	570
				1			245E	20	0.9	891		264E	20	0.9	787		274E	20	0.9	832		284E	20	0.9	876	256	
		2#10		1	3#11	3.68	184F	5	-	673	3.20	183F	5	-	650	2.82*	193F	5	-	692	2.49*	203F	5	-	734	180	530
				1			245E	20	0.9	948		265E	20	0.9	1019		274E	20	0.9	896		284E	20	0.9	945	287	
	16	2# 7		1	3# 7	1.86	123F	6	-	277	1.62	113F	6	-	290	1.43	113F	6	-	306	1.26	113F	6	-	323	91	528
				1			243E	25	1.0	359		263E	25	1.0	386		273E	25	1.0	408		283E	25	1.0	429	134	
		2# 9		1	3# 9	2.99	163F	6	-	447	2.60	163F	6	-	474	2.29	173F	6	-	505	2.03*	173F	6	-	532	146	598
				1			244E	25	1.0	641		264E	25	1.0	689		274E	25	1.0	727		284E	25	1.0	765	213	
		2#10		1	3#10	3.67	173F	6	-	553	3.20	183F	6	-	592	2.81*	183F	6	-	626	2.49*	193F	6	-	664	182	539
				1			245E	25	1.0	908		264E	25	1.0	799		274E	25	1.0	844		284E	25	1.0	889	261	
		2#11		1	3#11	4.35	184F	6	-	736	3.79*	194F	6	-	785	3.33*	194F	6	-	828	2.95*	203F	6	-	807	218	481
				1			245E	25	1.0	1023		265E	25	1.0	1100		275E	25	1.0	1160		285E	25	1.0	1220	309	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

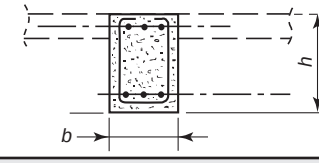
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

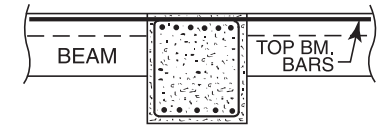
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
22	12	2# 7		1	2# 8	3.59	103G	5	-	194	2.96	113G	5	-	213	2.49	113G	5	-	228	2.12	123G	5	-	247	100	554
				1			174E	19	1.0	329		194E	19	0.9	364		214E	19	0.9	400		224E	19	0.9	425	130	
		2# 8		1	2#10	5.22	124G	5	-	314	4.31	133G	5	-	297	3.62	133G	5	-	319	3.09	143G	5	-	345	130	583
				1			304B	19	1.0	530		194E	19	0.9	441		214E	19	0.9	483		224E	19	0.9	515	199	
		2# 9		1	2#11	6.47	124G	5	-	371	5.35	134G	5	-	406	4.49	144G	5	-	441	3.83	154G	5	-	476	161	534
				1			304B	19	0.9	587		334B	19	0.9	645		364B	19	0.9	703		224E	19	0.9	590	238	
		2#10		1	2#14	8.00	273B	5	-	485	6.61	154DdG	5	-	531	5.56	154G	5	-	568	4.73	164G	5	-	613	199	446
				1			304B	19	0.9	687		334B	19	0.9	755		364B	19	0.9	823		394B	19	0.9	891	302	
	14	2# 7		1	3# 7	4.06	103G	6	-	206	3.36	113G	6	-	226	2.82	113G	6	-	242	2.40	113G	6	-	259	101	472
				1			174E	25	1.1	347		194E	24	1.1	384		214E	24	1.1	422		224E	24	1.0	449	149	
		2# 9		1	3# 9	6.51	124G	6	-	368	5.38	134G	6	-	403	4.52	133G	6	-	383	3.85	143G	6	-	414	163	496
				1			175E	25	1.1	574		195E	24	1.1	636		215E	24	1.0	698		224E	24	1.0	592	236	
		2#10		1	3#10	8.00	125G	6	-	497	6.61	134G	6	-	484	5.55	144G	6	-	526	4.73	154G	6	-	568	203	441
				1			175E	25	1.1	648		195E	24	1.1	718		215E	24	1.0	787		225E	24	1.0	839	290	
		2#11		1	3#11	9.47	274B	6	-	637	7.82	145G	6	-	646	6.57	155G	6	-	701	5.60	164G	6	-	682	243	391
				1			304B	25	1.1	752		335B	24	1.0	1052		215E	24	1.0	886		225E	24	1.0	946	344	
	16	2# 8		1	3# 8	5.30	113G	8	-	262	4.38	113G	8	-	284	3.68	123G	7	-	309	3.13	123G	7	-	330	132	448
				1			155F	31	1.2	490		174F	30	1.2	427		184F	30	1.2	460		204F	29	1.2	503	194	
		2# 9		1	3# 9	6.60	124G	8	-	371	5.45	124G	8	-	398	4.58	133G	7	-	385	3.91	143G	7	-	416	164	453
				1			155F	31	1.2	550		175F	30	1.2	613		185F	30	1.2	659		205F	29	1.2	722	240	
		2#11		1	3#11	9.68	135G	8	-	596	8.00	145G	8	-	651	6.72	145G	7	-	693	5.73	154G	7	-	678	246	372
				1			245C	31	1.2	870		265C	30	1.2	948		295C	30	1.2	1045		205F	29	1.1	925	351	
		2#10	1#10	1	4#10	10.41	135G	8	-	635	8.61	145G	8	-	694	7.23	155G	7	-	753	6.16	155G	7	-	800	295	338
				1			245C	31	1.2	909		265C	30	1.2	991		295C	30	1.2	1092		315C	29	1.1	1175	378	
	18	2# 7	1# 7	1	3# 8	5.38	103G	9	-	264	4.44	113G	9	-	290	3.73	113G	9	-	312	3.18	123G	9	-	338	151	369
				1			155F	37	1.3	505		174F	36	1.3	440		214E	36	1.3	508		224E	35	1.3	541	195	
		2# 8	1# 8	1	3#10	7.82	124G	9	-	419	6.47	134G	9	-	459	5.43	134G	9	-	491	4.63	143G	9	-	477	195	389
				1			155F	37	1.3	606		175F	36	1.3	675		185F	36	1.3	726		205F	35	1.3	795	299	
		2# 9	1# 9	1	3#11	9.70	125G	9	-	559	8.02	135G	9	-	611	6.74	144G	9	-	597	5.74	154G	9	-	645	242	356
				1			245C	37	1.3	857		265C	36	1.3	934		295C	36	1.3	1031		205F	35	1.3	902	358	
		2#10	1#10	1	3#14	12.00	274B	9	-	765	9.92	145G	9	-	783	8.33	155G	9	-	850	7.10	165G	9	-	917	299	297
				1			305B	37	1.3	1114		265C	36	1.3	1094		295C	36	1.3	1204		315C	35	1.3	1296	453	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
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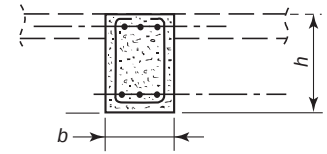
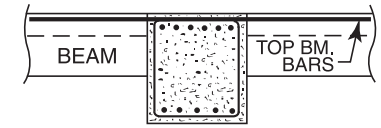
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 28 ft					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.					SPAN, ℓ_n = 34 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
22	12	2# 7		1	2# 8	1.83	123G	5	-	263	1.59	123G	5	-	278	1.40	123G	5	-	293	1.24	123G	4	-	308	100	554
				1			244E	18	0.9	460		263E	18	0.9	364		273E	18	0.9	384		283E	18	0.9	404	130	
		2# 8		1	2#10	2.66	143G	5	-	367	2.32	153G	5	-	393	2.04	153G	5	-	415	1.80	163G	4	-	441	130	583
				1			244E	18	0.9	558		264E	18	0.9	600		274E	18	0.9	632		284E	18	0.9	665	199	
		2# 9		1	2#11	3.30	153G	5	-	451	2.87	163G	5	-	482	2.53	173G	5	-	514	2.24*	173G	4	-	542	161	534
				1			244E	18	0.9	638		264E	18	0.9	686		274E	18	0.9	724		284E	18	0.9	761	238	
		2#10		1	2#14	4.08	164G	5	-	651	3.56	174G	5	-	696	3.12	184G	5	-	740	2.77*	193G	4	-	718	199	446
				1			424B	18	0.9	959		444B	18	0.9	1017		274E	18	0.9	883		284E	18	0.9	931	302	
	14	2# 7		1	3# 7	2.07	123G	6	-	279	1.81	123G	6	-	295	1.59	123G	6	-	312	1.41	123G	6	-	328	101	472
				1			244E	24	1.0	486		263E	23	1.0	386		273E	23	1.0	408		293E	23	1.0	435	149	
		2# 9		1	3# 9	3.32	153G	6	-	445	2.89	153G	6	-	472	2.54	163G	6	-	503	2.25	163G	6	-	530	163	496
				1			244E	24	1.0	641		264E	23	1.0	689		274E	23	1.0	727		294E	23	1.0	775	236	
		2#10		1	3#10	4.08	164G	6	-	610	3.55	164G	6	-	644	3.12	173G	6	-	624	2.77*	183G	6	-	663	203	441
				1			245E	24	1.0	908		265E	23	1.0	977		274E	23	1.0	844		294E	23	1.0	900	290	
		2#11		1	3#11	4.83	164G	6	-	725	4.21	174G	6	-	775	3.70*	184G	6	-	825	3.28*	194G	6	-	875	243	391
				1			245E	24	1.0	1023		265E	23	1.0	1100		275E	23	1.0	1160		295E	23	1.0	1237	344	
	16	2# 8		1	3# 8	2.70	133G	7	-	356	2.35	133G	7	-	377	2.07	133G	7	-	398	1.83	133G	7	-	420	132	448
				1			214F	29	1.2	536		234F	29	1.1	579		244F	29	1.1	611		254F	29	1.1	644	194	
		2# 9		1	3# 9	3.37	143G	7	-	443	2.93	153G	7	-	474	2.58	153G	7	-	501	2.28	153G	7	-	528	164	453
				1			214F	29	1.1	619		234F	29	1.1	668		244F	29	1.1	706		254F	28	1.1	744	240	
		2#11		1	3#11	4.94	164G	7	-	729	4.30	174G	7	-	779	3.78	174G	7	-	821	3.35*	184G	7	-	871	246	372
				1			215F	29	1.1	985		235F	29	1.1	1064		245F	29	1.1	1125		255F	28	1.1	1185	351	
		2#10	1#10	1	4#10	5.31	164G	7	-	784	4.63	174G	7	-	838	4.07	184G	7	-	893	3.60*	194G	7	-	947	295	338
				1			215F	29	1.1	1041		235F	29	1.1	1124		245F	29	1.1	1188		255F	28	1.1	1253	378	
	18	2# 7	1# 7	1	3# 8	2.74	123G	9	-	360	2.39	123G	9	-	382	2.10	123G	9	-	404	1.86	123G	9	-	426	151	369
				1			244E	35	1.3	586		264E	35	1.3	631		284E	35	1.3	676		293E	34	1.3	544	195	
		2# 8	1# 8	1	3#10	3.99	143G	9	-	509	3.48	153G	9	-	545	3.06	153G	9	-	577	2.71	163G	9	-	613	195	389
				1			215F	35	1.3	846		235F	35	1.3	916		244F	34	1.3	791		264F	34	1.2	846	299	
		2# 9	1# 9	1	3#11	4.95	154G	9	-	685	4.31	164G	9	-	733	3.79	173G	9	-	715	3.36*	173G	9	-	755	242	356
				1			215F	35	1.3	960		235F	35	1.3	1038		245F	34	1.3	1097		265F	34	1.2	1174	358	
		2#10	1#10	1	3#14	6.12	165G	9	-	971	5.33	174G	9	-	957	4.69	184G	9	-	1019	4.15*	194G	9	-	1081	299	297
				1			345C	35	1.3	1407		365C	35	1.3	1498		245F	34	1.2	1327		265F	34	1.2	1419	453	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
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X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

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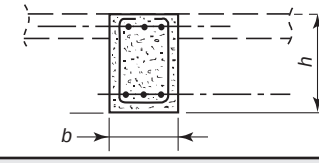
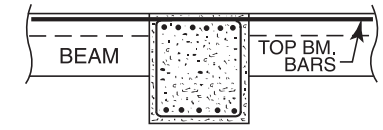
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																						
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
24	12	2# 7		1	2# 9	3.10	113H	5	-	254	2.64	113H	5	-	272	2.28	123H	5	-	293	1.99	123H	5	-	310	111	434
				1			214E	21	1.0	433		224E	21	1.0	460		244E	21	1.0	499		264E	21	1.0	537	179	
		2# 8		1	2#10	4.02	123H	5	-	319	3.42	133H	5	-	345	2.95	133H	5	-	367	2.57	143H	5	-	393	144	453
				1			214E	21	1.0	493		224E	21	1.0	525		244E	21	1.0	569		264E	21	1.0	612	222	
		2#10		1	3#10	6.08	134H	5	-	522	5.18	144H	5	-	564	4.47	154H	5	-	606	3.89	164H	5	-	648	222	372
				1			364B	21	1.0	801		394B	21	1.0	868		424B	21	1.0	934		444B	21	1.0	989	318	
		2#11		1	2#14	6.90	154EeH	5	-	626	5.88	164EdH	5	-	675	5.07	154H	5	-	709	4.42	164H	5	-	758	266	335
				1			364B	21	1.0	890		394B	21	1.0	964		424B	21	1.0	1037		444B	21	1.0	1100	361	
	14	2# 8		1	3# 8	4.05	113H	7	-	306	3.45	123H	7	-	332	2.98	123H	7	-	353	2.59	133H	7	-	379	145	397
				1			184F	28	1.2	460		204F	27	1.1	503		214F	27	1.1	536		234F	27	1.1	579	213	
		2# 9		1	3# 9	5.04	124H	7	-	428	4.29	133H	7	-	413	3.70	133H	7	-	441	3.22	143H	7	-	472	181	388
				1			185F	28	1.2	659		205F	27	1.1	722		215F	27	1.1	767		234F	27	1.1	668	263	
		2#11		1	3#11	7.38	135H	7	-	686	6.29	145H	7	-	741	5.42	154H	7	-	724	4.72	164H	7	-	775	271	311
				1			295C	28	1.1	1045		315C	27	1.1	1124		215F	27	1.1	985		235F	27	1.1	1064	386	
		2#11		1	4#10	7.54	135H	7	-	706	6.42	145H	7	-	763	5.54	155H	7	-	820	4.82	164H	7	-	800	271	300
				1			295C	28	1.1	1065		315C	27	1.1	1146		215F	27	1.1	1009		235F	27	1.1	1089	415	
	16	2# 8		1	3# 8	4.07	113H	9	-	308	3.47	113H	8	-	329	2.99	123H	8	-	355	2.61	123H	8	-	376	146	331
				1			184F	34	1.3	468		204F	34	1.3	512		214F	33	1.3	545		234F	33	1.3	589	215	
		2#10		1	3#10	6.31	134H	9	-	528	5.37	134H	8	-	562	4.63	144H	8	-	605	4.04	143H	8	-	584	228	327
				1			185F	34	1.3	760		205F	34	1.3	832		215F	33	1.3	885		235F	33	1.3	957	330	
		2#11		1	3#11	7.53	135H	9	-	690	6.41	145H	8	-	746	5.53	154H	8	-	728	4.82	154H	8	-	770	274	295
				1			295C	34	1.3	1065		205F	34	1.3	939		215F	33	1.3	1000		235F	33	1.3	1080	394	
		2#10	1#10	1	4#11	9.17	155EdH	9	-	828	7.82	145H	8	-	867	6.74	155H	8	-	932	5.87	165H	8	-	997	330	251
				1			295C	34	1.3	1177		315C	34	1.3	1267		345C	33	1.3	1375		365C	33	1.2	1465	496	
	18	2# 7	1# 7	1	3# 9	4.65	113H	10	-	350	3.96	113H	10	-	375	3.42	123H	10	-	404	2.98	123H	10	-	429	167	289
				1			165G	41	1.4	614		185G	41	1.4	677		194G	40	1.4	578		204G	40	1.4	615	269	
		2# 8	1# 8	1	3#10	6.03	124H	10	-	489	5.13	133H	10	-	476	4.43	133H	10	-	508	3.86	143H	10	-	544	216	302
				1			165G	41	1.4	700		185G	41	1.4	770		195G	40	1.4	822		205G	40	1.4	873	334	
		2#10	1#10	1	4#11	9.29	135H	10	-	807	7.91	145H	10	-	872	6.82	155H	10	-	937	5.94	165H	10	-	1003	334	241
				1			245D	41	1.4	1100		265D	41	1.4	1191		285D	40	1.4	1282		305D	40	1.4	1373	512	
		2#11	1#11	1	3#14	10.35	155EeH	10	-	929	8.82	165EdH	10	-	1002	7.61	155H	10	-	1049	6.62	165H	10	-	1122	400	223
				1			295C	41	1.4	1293		265D	41	1.4	1295		285D	40	1.4	1393		305D	40	1.4	1492	542	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
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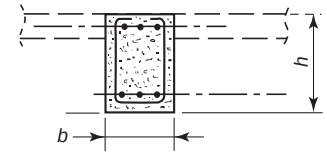
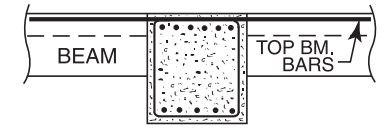
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 32 ft					SPAN, ℓ_n = 34 ft.					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
24	12	2# 7		1	2# 9	1.74	123H	5	-	327	1.55	123H	5	-	345	1.38	123H	5	-	362	1.24	123H	5	-	379	111	434
				1			274E	21	1.0	565		293E	20	1.0	450		303E	20	1.0	472		313E	20	1.0	495	179	
		2# 8		1	2#10	2.26	143H	5	-	415	2.00	143H	5	-	437	1.79	153H	5	-	463	1.60	153H	5	-	485	144	453
				1			274E	21	1.0	645		294E	20	1.0	688		304E	20	1.0	721		314E	20	1.0	753	222	
		2#10		1	3#10	3.42	164H	5	-	682	3.03	174H	5	-	724	2.70*	173H	5	-	695	2.42*	183H	5	-	734	222	372
				1			274E	20	1.0	844		294E	20	1.0	900		304E	20	1.0	945		314E	20	1.0	990	318	
		2#11		1	2#14	3.88	174H	5	-	808	3.44	174H	5	-	849	3.07*	184H	5	-	899	2.75*	194H	5	-	948	266	335
				1			474B	20	1.0	1173		494B	20	1.0	1236		514B	20	1.0	1298		314E	20	1.0	1129	361	
	14	2# 8		1	3# 8	2.28	133H	7	-	400	2.02	133H	7	-	421	1.80	133H	7	-	443	1.62	133H	6	-	464	145	397
				1			244F	26	1.1	611		254F	26	1.1	644		274F	26	1.1	687		284F	26	1.1	719	213	
		2# 9		1	3# 9	2.83	143H	7	-	499	2.51	153H	7	-	530	2.24	153H	7	-	558	2.01	163H	6	-	589	181	388
				1			244F	26	1.1	706		254F	26	1.1	744		274F	26	1.1	794		284F	26	1.1	832	263	
		2#11		1	3#11	4.15	164H	7	-	817	3.68	174H	7	-	868	3.28*	184H	7	-	918	2.94*	184H	6	-	961	271	311
				1			245F	26	1.1	1125		255F	26	1.1	1185		275F	26	1.1	1264		285F	26	1.1	1324	386	
		2#11		1	4#10	4.24	164H	7	-	844	3.76	174H	7	-	897	3.35*	184H	7	-	949	3.01*	184H	6	-	993	271	300
				1			245F	26	1.1	1152		255F	26	1.1	1214		275F	26	1.1	1294		285F	26	1.1	1357	415	
	16	2# 8		1	3# 8	2.29	123H	8	-	397	2.03	123H	8	-	419	1.81	123H	8	-	440	1.63	123H	8	-	462	146	331
				1			244F	33	1.3	622		264F	33	1.2	667		274F	32	1.2	699		284F	32	1.2	732	215	
		2#10		1	3#10	3.55	153H	8	-	622	3.14	163H	8	-	661	2.80	163H	8	-	695	2.52	163H	8	-	730	228	327
				1			245F	33	1.2	1010		265F	33	1.2	1082		274F	32	1.2	938		284F	32	1.2	984	330	
		2#11		1	3#11	4.23	164H	8	-	821	3.75	174H	8	-	872	3.35	174H	8	-	914	3.00*	183H	8	-	894	274	295
				1			245F	33	1.2	1141		265F	33	1.2	1221		275F	32	1.2	1283		285F	32	1.2	1344	394	
		2#10	1#10	1	4#11	5.16	175H	8	-	1062	4.57	174H	8	-	1031	4.08*	184H	8	-	1091	3.66*	194H	8	-	1151	330	251
				1			385C	33	1.2	1554		265F	33	1.2	1381		275F	32	1.2	1452		285F	32	1.2	1522	496	
	18	2# 7	1# 7	1	3# 9	2.62	123H	10	-	453	2.32	123H	10	-	478	2.07	123H	10	-	503	1.86	123H	10	-	528	167	289
				1			284E	40	1.4	735		294E	39	1.4	772		314E	39	1.4	821		324E	39	1.4	858	269	
		2# 8	1# 8	1	3#10	3.39	143H	10	-	576	3.00	143H	10	-	608	2.68	153H	10	-	644	2.40	153H	10	-	676	216	302
				1			225G	40	1.4	944		235G	39	1.4	995		244G	39	1.4	866		254G	39	1.4	910	334	
		2#10	1#10	1	4#11	5.22	164H	10	-	975	4.63	174H	10	-	1035	4.13	184H	10	-	1095	3.70*	184H	10	-	1147	334	241
				1			325D	40	1.4	1464		345D	39	1.4	1555		245G	39	1.3	1412		255G	39	1.3	1483	512	
		2#11	1#11	1	3#14	5.82	175H	10	-	1195	5.16	175H	10	-	1255	4.60*	184H	10	-	1238	4.13*	194H	10	-	1306	400	223
				1			325D	40	1.4	1591		345D	39	1.4	1690		365D	39	1.3	1788		375D	39	1.3	1868	542	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

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$f_c' = 4{,}000$ psi
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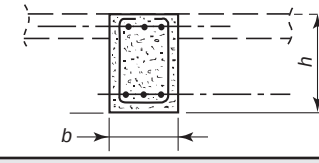
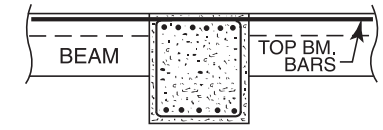
RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
26	14	2# 8		1	3# 8	4.44	113I	8	-	309	3.79	113I	8	-	331	3.27	113I	8	-	352	2.84	123I	8	-	378	160	304
				1			184F	31	1.3	468		204F	31	1.3	512		214F	30	1.2	545		234F	30	1.2	589	234	
		2# 9		1	3# 9	5.54	114I	8	-	425	4.72	123I	8	-	412	4.07	123I	8	-	439	3.55	133I	8	-	471	199	308
				1			185F	31	1.3	671		205F	31	1.3	736		215F	30	1.2	782		234F	30	1.2	679	290	
		2#11		1	3#11	8.18	125I	8	-	681	6.97	135I	8	-	737	6.01	145I	8	-	793	5.24	144I	8	-	765	299	252
				1			295C	31	1.3	1065		315C	31	1.2	1145		215F	30	1.2	1000		235F	30	1.2	1080	428	
		2#10	1#10	1	4#11	9.22	145FdI	8	-	820	7.85	135I	8	-	859	6.77	145I	8	-	924	5.90	155I	8	-	989	359	231
				2			295C	31	1.3	1177		315C	31	1.2	1267		345C	30	1.2	1375		365C	30	1.2	1465	482	
	16	2# 9		1	3# 9	5.58	113I	10	-	382	4.76	113I	10	-	409	4.10	123I	9	-	441	3.57	123I	9	-	468	200	272
				1			165G	39	1.4	645		185G	38	1.4	711		195G	38	1.4	758		205G	37	1.4	804	294	
		2#10		1	3#10	6.96	124I	10	-	525	5.93	124I	10	-	559	5.12	134I	9	-	602	4.46	134I	9	-	637	251	262
				1			245D	39	1.4	889		185G	38	1.4	807		195G	38	1.4	860		205G	37	1.4	914	364	
		2#11		1	4#10	8.41	125I	10	-	706	7.17	135I	10	-	764	6.18	135I	9	-	808	5.38	144I	9	-	794	302	230
				1			245D	39	1.4	1008		265D	38	1.4	1091		285D	38	1.4	1175		305D	37	1.4	1258	470	
		2#14		1	3#14	11.20	264C	10	-	973	9.54	284C	10	-	1052	8.23	155FdI	9	-	1078	7.17	155I	9	-	1139	418	192
				1			295C	39	1.4	1314		315C	38	1.4	1414		285D	38	1.4	1417		305D	37	1.4	1517	586	
	18	2# 8	1# 8	1	3# 9	5.66	113I	12	-	395	4.83	113I	12	-	423	4.16	113I	11	-	452	3.62	123I	11	-	485	238	228
				1			165G	47	1.6	667		185G	46	1.6	736		195G	46	1.5	784		205G	45	1.5	833	296	
		2# 9	1# 9	1	3#11	8.24	125I	12	-	655	7.02	124I	12	-	632	6.05	134I	11	-	681	5.27	144I	11	-	730	296	225
				1			245D	47	1.6	970		265D	46	1.5	1050		285D	46	1.5	1131		205G	45	1.5	1009	442	
		2#10	1#10	1	3#14	10.24	135FdI	12	-	843	8.72	135I	12	-	897	7.52	145I	11	-	965	6.55	145I	11	-	1020	368	190
				1			245D	47	1.6	1144		265D	46	1.5	1238		285D	46	1.5	1333		305D	45	1.5	1428	602	
		2#11	1#11	1	3#14	11.51	145FeI	12	-	926	9.81	155FeI	12	-	1000	8.46	155FdI	11	-	1059	7.37	155I	11	-	1119	442	181
				1			295C	47	1.6	1313		315C	46	1.5	1413		285D	46	1.5	1413		305D	45	1.5	1513	602	
	20	2# 8	1# 8	1	3#10	6.65	114I	14	-	488	5.67	113I	14	-	472	4.89	123I	14	-	508	4.26	123I	13	-	540	239	212
				1			215E	56	1.7	826		165H	55	1.7	754		175H	54	1.7	807		185H	53	1.7	859	371	
		2# 9	1# 9	1	3#11	8.29	115I	14	-	645	7.07	124I	14	-	635	6.09	134I	14	-	684	5.31	134I	13	-	724	298	211
				1			215E	56	1.7	924		225E	55	1.7	985		245E	54	1.7	1067		265E	53	1.7	1148	447	
		2#11	1#11	1	3#14	11.70	145FeI	14	-	930	9.97	145FdI	14	-	990	8.60	155FcI	13	-	1065	7.49	145I	13	-	1110	447	174
				1			295C	55	1.7	1333		315C	55	1.7	1435		285D	54	1.7	1432		305D	53	1.7	1534	612	
		2#10	2#10	1	4#14	13.41	265C	14	-	1235	11.43	165EgI	14	-	1161	9.85	165FeI	13	-	1232	8.58	165FeI	13	-	1303	482	153
				1			485A	55	1.7	1861		315C	55	1.7	1577		345C	54	1.7	1711		365C	53	1.7	1823	735	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
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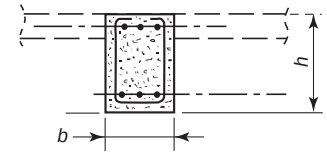
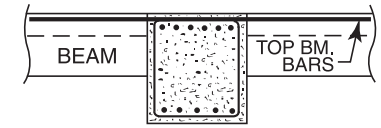
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 32 ft					SPAN, ℓ_n = 34 ft.					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
26	14	2# 8		1	3# 8	2.50	123I	7	-	399	2.21	123I	7	-	420	1.98	123I	7	-	442	1.77	123I	7	-	463	160	304
				1			244F	30	1.2	622		264F	30	1.2	667		274F	29	1.2	699		284F	29	1.2	732	234	
		2# 9		1	3# 9	3.12	133I	7	-	498	2.76	143I	7	-	530	2.46	143I	7	-	557	2.21	143I	7	-	584	199	308
				1			244F	30	1.2	717		264F	30	1.2	767		274F	29	1.2	806		284F	29	1.2	845	290	
		2#11		1	3#11	4.60	154I	7	-	816	4.08	164I	7	-	867	3.64	164I	7	-	910	3.26	174I	7	-	961	299	252
				1			245F	30	1.2	1141		265F	30	1.2	1221		275F	29	1.2	1283		285F	29	1.2	1344	428	
		2#10	1#10	1	4#11	5.19	165I	7	-	1055	4.59	164I	7	-	1027	4.10	174I	7	-	1087	3.68	174I	7	-	1139	359	231
				2			245F	30	1.2	1291		265F	30	1.2	1381		275F	29	1.2	1452		285F	29	1.2	1522	482	
	16	2# 9		1	3# 9	3.14	133I	9	-	500	2.78	133I	9	-	527	2.48	133I	9	-	554	2.23	133I	9	-	581	200	272
				1			225G	37	1.4	870		234G	37	1.3	743		244G	37	1.3	783		284F	36	1.3	858	294	
		2#10		1	3#10	3.92	143I	9	-	622	3.47	143I	9	-	656	3.09	153I	9	-	695	2.78	153I	9	-	729	251	262
				1			225G	37	1.4	988		235G	37	1.3	1042		245G	37	1.3	1096		255G	36	1.3	1149	364	
		2#11		1	4#10	4.73	154I	9	-	847	4.19	154I	9	-	891	3.74	164I	9	-	944	3.36	164I	9	-	988	302	230
				1			225G	37	1.3	1146		235G	37	1.3	1210		245G	37	1.3	1274		255G	36	1.3	1337	470	
		2#14		1	3#14	6.30	165I	9	-	1214	5.58	165I	9	-	1275	4.98	175I	9	-	1350	4.47*	185I	9	-	1425	418	192
				1			325D	37	1.3	1618		345D	37	1.3	1718		365D	36	1.3	1818		375D	36	1.3	1898	586	
	18	2# 8	1# 8	1	3# 9	3.19	123I	11	-	513	2.82	123I	11	-	541	2.52	123I	11	-	569	2.26	123I	11	-	598	238	228
				1			224G	45	1.5	730		234G	44	1.5	771		314E	44	1.5	898		324E	44	1.5	939	296	
		2# 9	1# 9	1	3#11	4.63	144I	11	-	770	4.10	154I	11	-	818	3.66	153I	11	-	795	3.29	153I	11	-	835	296	225
				1			225G	45	1.5	1090		235G	44	1.5	1150		245G	44	1.5	1210		265G	44	1.5	1290	442	
		2#10	1#10	1	3#14	5.76	155I	11	-	1088	5.10	164I	11	-	1072	4.55	164I	11	-	1127	4.08	174I	11	-	1190	368	190
				1			325D	45	1.5	1522		345D	44	1.5	1617		365D	44	1.5	1711		265G	44	1.5	1564	602	
		2#11	1#11	1	3#14	6.48	155I	11	-	1179	5.74	165I	11	-	1253	5.12	175I	11	-	1327	4.59	175I	11	-	1387	442	181
				1			325D	45	1.5	1613		345D	44	1.5	1713		365D	44	1.5	1813		385D	44	1.5	1913	602	
	20	2# 8	1# 8	1	3#10	3.74	123I	13	-	572	3.31	133I	13	-	609	2.96	133I	13	-	641	2.65	133I	13	-	672	239	212
				1			195H	53	1.7	912		215H	53	1.6	986		225H	52	1.6	1038		235H	52	1.6	1091	371	
		2# 9	1# 9	1	3#11	4.66	143I	13	-	712	4.13	143I	13	-	752	3.69	143I	13	-	792	3.31	153I	13	-	836	298	211
				1			195H	53	1.6	1042		215H	53	1.6	1124		225H	52	1.6	1185		235H	52	1.6	1246	447	
		2#11	1#11	1	3#14	6.58	155I	13	-	1184	5.83	165I	13	-	1258	5.20	165I	13	-	1318	4.67	174I	13	-	1301	447	174
				1			285E	53	1.6	1552		295E	52	1.6	1633		315E	52	1.6	1734		335E	52	1.6	1836	612	
		2#10	2#10	1	4#14	7.55	175Fdl	13	-	1389	6.68	165I	13	-	1445	5.96	175I	13	-	1530	5.35	185I	13	-	1616	482	153
				1			325D	53	1.6	1811		345D	52	1.6	1924		315E	52	1.6	1932		335E	52	1.6	2044	735	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
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(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

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(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

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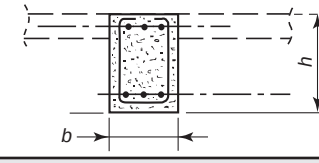
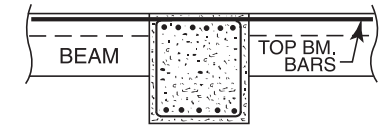
RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 26 ft					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
28	14	2# 9		1	3# 8	4.17	103J	9	-	368	3.59	113J	9	-	397	3.13	113J	8	-	421	2.75	113J	8	-	446	217	227
				1			185G	35	1.4	673		194G	34	1.3	573		204G	34	1.3	610		224G	33	1.3	658	256	
		2#10		1	3#10	6.41	124J	9	-	562	5.52	124J	9	-	596	4.81	134J	8	-	640	4.23	134J	8	-	674	271	230
				1			185G	35	1.4	807		195G	34	1.3	860		205G	34	1.3	914		225G	33	1.3	988	393	
		2#11		1	3#11	7.66	125J	9	-	732	6.60	135J	9	-	789	5.75	135J	8	-	831	5.06	144J	8	-	814	327	207
				1			265D	35	1.4	1069		285D	34	1.3	1151		305D	34	1.3	1232		225G	33	1.3	1119	470	
		2#10	1#10	1	3#14	9.32	244D	9	-	926	8.03	145GdJ	9	-	965	7.00	145J	8	-	1020	6.15	155J	8	-	1088	393	172
				1			265D	35	1.4	1220		285D	34	1.3	1313		305D	34	1.3	1407		325D	33	1.3	1500	607	
	16	2# 9		1	3# 9	5.18	113J	11	-	412	4.47	113J	11	-	439	3.89	113J	10	-	466	3.42	123J	10	-	498	218	214
				1			185G	43	1.5	723		195G	42	1.5	771		205G	42	1.5	818		225G	42	1.5	886	321	
		2#10		1	3#10	6.48	114J	11	-	556	5.59	124J	11	-	599	4.87	124J	10	-	634	4.28	134J	10	-	677	273	212
				1			185G	43	1.5	819		195G	42	1.5	874		205G	42	1.5	928		225G	42	1.5	1003	398	
		2#10	1#10	1	4#11	9.44	135GdJ	11	-	872	8.14	135J	11	-	924	7.09	145J	10	-	991	6.23	145J	10	-	1043	398	168
				1			265D	43	1.5	1209		285D	42	1.5	1301		305D	42	1.5	1394		325D	42	1.5	1486	613	
		2#14		1	3#14	10.59	245D	11	-	1157	9.13	145GeJ	11	-	1074	7.96	155GdJ	10	-	1150	6.99	155GcJ	10	-	1211	459	158
				1			525A	43	1.5	1859		285D	42	1.5	1437		305D	42	1.5	1538		325D	41	1.5	1640	650	
	18	2# 8	1# 8	1	3#10	6.14	114J	13	-	522	5.30	113J	13	-	505	4.61	123J	13	-	542	4.06	123J	13	-	574	259	188
				1			165H	52	1.7	754		175H	51	1.7	807		185H	51	1.7	859		195H	50	1.6	912	402	
		2# 9	1# 9	1	3#11	7.66	115J	13	-	689	6.60	124J	13	-	678	5.75	134J	13	-	727	5.06	134J	13	-	767	323	183
				1			225E	52	1.7	985		245E	51	1.7	1067		265E	51	1.6	1148		285E	50	1.6	1230	484	
		2#11	1#11	1	3#14	10.80	145GeJ	13	-	995	9.31	145GdJ	13	-	1055	8.11	155GdJ	13	-	1130	7.13	145J	13	-	1175	484	149
				1			315C	52	1.7	1435		285D	51	1.7	1432		305D	51	1.6	1534		285E	50	1.6	1552	663	
		2#11	1#11	1	5#11	11.47	145FfJ	13	-	1058	9.89	145GeJ	13	-	1122	8.61	155GdJ	13	-	1202	7.57	155GdJ	13	-	1267	484	140
				1			315C	52	1.7	1498		345C	51	1.7	1625		305D	51	1.6	1606		325D	50	1.6	1712	753	
	20	2# 8	1# 8	1	3#10	6.17	103J	15	-	470	5.32	113J	15	-	506	4.64	113J	15	-	538	4.08	113J	15	-	570	260	166
				1			165H	62	1.9	765		175H	61	1.8	818		185H	60	1.8	872		195H	60	1.8	925	406	
		2#10	1#10	1	3#11	7.96	115J	15	-	759	6.86	124J	15	-	752	5.98	124J	15	-	797	5.26	134J	15	-	851	406	162
				1			225E	62	1.9	1067		245E	61	1.8	1155		265E	60	1.8	1243		285E	60	1.8	1331	489	
		2#11	1#11	1	3#14	10.96	135GeJ	15	-	985	9.45	145GdJ	15	-	1060	8.23	135J	15	-	1105	7.24	145J	15	-	1179	489	143
				1			315C	62	1.9	1457		285D	61	1.8	1452		305D	60	1.8	1555		285E	59	1.8	1571	673	
		2#11	2#11	1	4#14	13.96	245D	15	-	1387	12.04	175EiJ	15	-	1360	10.49	165FgJ	15	-	1422	9.22	175FgJ	15	-	1516	632	119
				1			525A	62	1.9	2145		425B	61	1.8	2008		365C	60	1.8	1956		385C	59	1.8	2078	857	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
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(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

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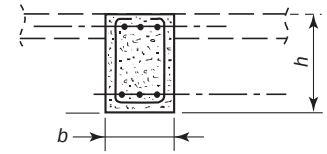
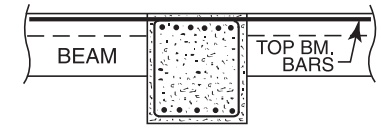
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

f_c' = 4,000 psi
f_y = 60,000 psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 34 ft					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.					SPAN, ℓ_n = 40 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
28	14	2# 9		1	3# 8	2.44	113J	8	-	470	2.17	123J	8	-	499	1.95	123J	8	-	523	1.76	123J	8	-	547	217	227
				1			234G	33	1.3	694		244G	33	1.3	730		254G	33	1.3	766		264G	32	1.3	802	256	
		2#10		1	3#10	3.75	144J	8	-	717	3.34	143J	8	-	692	3.00	153J	8	-	731	2.71	153J	8	-	766	271	230
				1			235G	33	1.3	1042		245G	33	1.3	1096		255G	33	1.3	1149		265G	32	1.3	1203	393	
		2#11		1	3#11	4.48	154J	8	-	866	3.99	154J	8	-	908	3.58	164J	8	-	959	3.24	164J	8	-	1002	327	207
				1			235G	33	1.3	1181		245G	33	1.3	1243		255G	33	1.3	1305		265G	32	1.3	1367	470	
		2#10	1#10	1	3#14	5.45	155J	8	-	1142	4.86	165J	8	-	1211	4.36	165J	8	-	1265	3.94	174J	8	-	1244	393	172
				1			345D	33	1.3	1593		365D	33	1.3	1686		375D	33	1.3	1760		265G	32	1.3	1600	607	
	16	2# 9		1	3# 9	3.03	123J	10	-	526	2.70	123J	10	-	553	2.43	123J	10	-	580	2.19	133J	10	-	612	218	214
				1			234G	41	1.5	754		244G	41	1.5	794		294F	41	1.5	883		304F	40	1.4	922	321	
		2#10		1	3#10	3.79	133J	10	-	655	3.38	143J	10	-	694	3.04	143J	10	-	728	2.74	143J	10	-	763	273	212
				1			235G	41	1.5	1058		245G	41	1.5	1112		265G	41	1.4	1187		275G	40	1.4	1242	398	
		2#10	1#10	1	4#11	5.52	155J	10	-	1109	4.92	155J	10	-	1161	4.42	164J	10	-	1142	3.99	174J	10	-	1203	398	168
				1			345D	41	1.5	1578		365D	41	1.4	1671		265G	41	1.4	1521		275G	40	1.4	1593	613	
		2#14		1	3#14	6.19	155J	10	-	1272	5.53	165J	10	-	1348	4.96	165J	10	-	1409	4.48	175J	10	-	1485	459	158
				1			345D	41	1.5	1741		365D	41	1.4	1843		385D	41	1.4	1944		395D	40	1.4	2026	650	
	18	2# 8	1# 8	1	3#10	3.59	123J	12	-	605	3.20	133J	12	-	642	2.88	133J	12	-	674	2.60	133J	12	-	706	259	188
				1			215H	50	1.6	986		225H	49	1.6	1038		235H	49	1.6	1091		245H	49	1.6	1144	402	
		2# 9	1# 9	1	3#11	4.48	134J	12	-	807	3.99	143J	12	-	793	3.58	143J	12	-	833	3.24	153J	12	-	878	323	183
				1			215H	50	1.6	1124		225H	49	1.6	1185		235H	49	1.6	1246		245H	49	1.6	1306	484	
		2#11	1#11	1	3#14	6.31	155J	12	-	1249	5.63	155J	12	-	1309	5.05	165J	12	-	1384	4.56	175J	12	-	1458	484	149
				1			295E	50	1.6	1633		315E	49	1.6	1734		335E	49	1.6	1836		345E	49	1.6	1916	663	
		2#11	1#11	1	5#11	6.70	155J	12	-	1331	5.98	165J	12	-	1411	5.37	165J	12	-	1475	4.84	175J	12	-	1555	484	140
				1			345D	50	1.6	1819		315E	49	1.6	1821		335E	49	1.6	1927		345E	49	1.6	2013	753	
	20	2# 8	1# 8	1	3#10	3.61	123J	15	-	607	3.22	123J	15	-	639	2.89	123J	15	-	671	2.61	123J	14	-	703	260	166
				1			215H	59	1.8	1000		225H	59	1.8	1054		235H	58	1.8	1107		244H	58	1.7	963	406	
		2#10	1#10	1	3#11	4.66	134J	15	-	896	4.15	143J	15	-	886	3.73	143J	15	-	931	3.36	143J	14	-	976	406	162
				1			215H	59	1.8	1225		225H	59	1.8	1291		235H	58	1.8	1358		245H	58	1.7	1424	489	
		2#11	1#11	1	3#14	6.41	155J	15	-	1254	5.72	155J	15	-	1314	5.13	165J	15	-	1389	4.63	164J	14	-	1359	489	143
				1			295E	59	1.8	1653		315E	59	1.8	1756		335E	58	1.7	1859		345E	58	1.7	1940	673	
		2#11	2#11	1	4#14	8.16	175GfJ	15	-	1594	7.28	175GeJ	15	-	1672	6.54	185GdJ	15	-	1765	5.90	175J	14	-	1828	632	119
				1			415C	59	1.8	2220		365D	59	1.8	2190		385D	58	1.7	2312		405D	58	1.7	2433	857	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

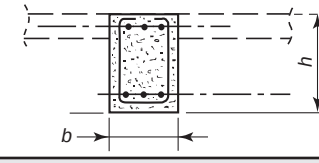
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

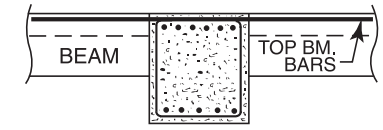
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 26 ft					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
30	14	2# 9		1	3# 9	5.58	104K	10	-	453	4.81	113K	9	-	441	4.19	113K	9	-	468	3.68	123K	9	-	500	235	200
				1			185G	38	1.5	723		195G	38	1.5	771		205G	37	1.4	818		225G	37	1.4	886	344	
		2#10		1	3#10	6.96	115K	10	-	619	6.01	114K	9	-	593	5.23	124K	9	-	636	4.60	124K	9	-	671	294	191
				1			185G	38	1.5	819		195G	38	1.5	874		205G	37	1.4	928		225G	37	1.4	1003	428	
		2#10	1#10	1	4#10	8.99	125HcK	10	-	792	7.75	125K	9	-	839	6.75	135K	9	-	900	5.93	135K	9	-	947	428	158
				1			265D	38	1.5	1139		285D	38	1.5	1226		305D	37	1.4	1313		325D	37	1.4	1400	552	
		2#14		1	3#14	11.32	245D	10	-	1166	9.76	254D	9	-	1104	8.50	274D	9	-	1184	7.47	155HdK	9	-	1216	492	139
				1			525A	38	1.5	1859		285D	38	1.4	1437		305D	37	1.4	1538		325D	37	1.4	1640	695	
	16	2# 9		1	3# 9	5.61	103K	12	-	410	4.84	103K	12	-	437	4.21	113K	12	-	469	3.70	113K	12	-	496	236	170
				1			165H	48	1.7	694		175H	47	1.6	742		185H	47	1.6	790		195H	46	1.6	838	348	
		2#11		1	3#11	8.47	115K	12	-	730	7.30	125K	12	-	787	6.36	125K	12	-	830	5.59	134K	12	-	814	359	162
				1			225E	48	1.7	1022		245E	47	1.6	1106		265E	47	1.6	1191		285E	46	1.6	1275	520	
		2#14		1	3#14	11.58	245D	12	-	1174	9.99	145GfK	12	-	1084	8.70	145HeK	12	-	1145	7.65	155HdK	12	-	1221	499	132
				1			525A	48	1.6	1896		285D	47	1.6	1456		305D	47	1.6	1559		325D	46	1.6	1662	711	
		2#14		1	5#11	11.82	245D	12	-	1237	10.20	145GfK	12	-	1151	8.88	145HeK	12	-	1217	7.81	155HdK	12	-	1298	499	131
				2			525A	48	1.6	1958		345C	47	1.6	1649		305D	47	1.6	1631		325D	46	1.6	1739	767	
	18	2# 8	1# 8	1	3#10	6.65	104K	15	-	517	5.73	103K	14	-	503	4.99	113K	14	-	540	4.39	113K	14	-	572	280	151
				1			165H	58	1.8	765		175H	57	1.8	818		185H	57	1.8	872		195H	56	1.8	925	437	
		2# 9	1# 9	1	3#11	8.30	115K	15	-	696	7.15	114K	14	-	673	6.23	124K	14	-	723	5.48	124K	14	-	763	350	151
				1			225E	58	1.8	1000		245E	57	1.8	1083		265E	57	1.8	1167		285E	56	1.8	1250	526	
		2#11	1#11	1	3#14	11.79	135GfK	15	-	989	10.16	135HeK	14	-	1049	8.85	145HdK	14	-	1125	7.78	145HcK	14	-	1184	526	125
				1			315C	58	1.8	1457		285D	57	1.8	1452		305D	57	1.8	1555		325D	56	1.8	1658	724	
		2#10	2#10	1	4#14	13.46	245D	15	-	1302	11.60	155FhK	14	-	1234	10.11	155GfK	14	-	1304	8.88	155HeK	14	-	1375	568	109
				1			525A	58	1.8	2051		345C	57	1.8	1734		365C	57	1.8	1848		325D	56	1.8	1833	907	
	20	2# 9	1# 9	1	3#10	7.17	104K	17	-	573	6.18	103K	17	-	562	5.38	113K	17	-	603	4.73	113K	17	-	639	352	133
				1			205F	69	2.0	919		215F	68	2.0	977		235F	67	2.0	1057		185I	66	1.9	982	440	
		2#10	1#10	1	3#11	8.65	115K	17	-	767	7.46	114K	17	-	747	6.49	124K	17	-	802	5.71	124K	17	-	847	440	132
				1			225E	69	2.0	1082		215F	68	2.0	1105		235F	67	2.0	1194		245F	66	1.9	1261	531	
		2#11	1#11	1	5#11	12.58	135GfK	17	-	1057	10.84	135HeK	17	-	1121	9.45	145HdK	17	-	1202	8.30	145HdK	17	-	1266	531	113
				1			315C	69	2.0	1541		345C	68	2.0	1672		305D	67	2.0	1648		325D	66	1.9	1757	837	
		2#14	1#14	1	4#14	15.28	245D	17	-	1472	13.17	255D	17	-	1571	11.48	165FhK	17	-	1512	10.09	175FhK	17	-	1610	734	98
				1			525A	69	2.0	2250		565A	68	2.0	2422		365C	67	2.0	2059		385C	66	1.9	2187	938	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
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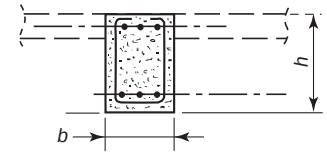
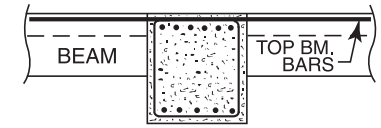
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																		$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 34 ft					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.					SPAN, ℓ_n = 40 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
30	14	2# 9		1	3# 9	3.26	123K	9	-	527	2.91	123K	9	-	554	2.61	123K	9	-	582	2.36	133K	9	-	614	235	200
				1			235G	37	1.4	933		244G	36	1.4	794		264G	36	1.4	846		274G	36	1.4	885	344	
		2#10		1	3#10	4.07	134K	9	-	715	3.63	133K	9	-	691	3.26	143K	9	-	730	2.94	143K	9	-	765	294	191
				1			235G	37	1.4	1058		245G	36	1.4	1112		265G	36	1.4	1187		275G	36	1.4	1242	428	
		2#10	1#10	1	4#10	5.26	145K	9	-	1008	4.69	144K	9	-	978	4.21	154K	9	-	1034	3.80	154K	9	-	1080	428	158
				1			345D	37	1.4	1487		245G	36	1.4	1332		265G	36	1.4	1419		275G	36	1.4	1485	552	
		2#14		1	3#14	6.62	155HdK	9	-	1277	5.90	155K	9	-	1339	5.30	165K	9	-	1415	4.78	165K	9	-	1476	492	139
				1			345D	37	1.4	1741		365D	36	1.4	1843		385D	36	1.4	1944		395D	36	1.4	2026	695	
	16	2# 9		1	3# 9	3.28	113K	11	-	524	2.93	113K	11	-	551	2.63	123K	11	-	583	2.37	123K	11	-	610	236	170
				1			215H	46	1.6	907		225H	45	1.6	955		234H	45	1.6	819		244H	45	1.5	859	348	
		2#11		1	3#11	4.95	134K	11	-	857	4.42	144K	11	-	909	3.96	144K	11	-	951	3.58	144K	11	-	994	359	162
				1			295E	46	1.6	1338		225H	45	1.6	1235		235H	45	1.5	1298		245H	45	1.5	1361	520	
		2#14		1	3#14	6.77	155HcK	11	-	1283	6.04	155K	11	-	1344	5.42	155K	11	-	1405	4.89	165K	11	-	1481	499	132
				1			295E	46	1.6	1661		315E	45	1.6	1764		335E	45	1.5	1866		345E	45	1.5	1949	711	
		2#14		1	5#11	6.91	155HcK	11	-	1364	6.17	155K	11	-	1431	5.54	155K	11	-	1497	5.00	165K	11	-	1578	499	131
				2			295E	46	1.6	1743		315E	45	1.6	1850		335E	45	1.5	1958		345E	45	1.5	2045	767	
	18	2# 8	1# 8	1	3#10	3.89	113K	14	-	603	3.47	123K	14	-	640	3.11	123K	14	-	672	2.81	123K	14	-	704	280	151
				1			215H	56	1.8	1000		225H	55	1.7	1054		235H	55	1.7	1107		245H	54	1.7	1161	437	
		2# 9	1# 9	1	3#11	4.85	134K	14	-	813	4.33	134K	14	-	853	3.88	133K	14	-	832	3.51	143K	14	-	877	350	151
				1			215H	55	1.7	1139		225H	55	1.7	1200		235H	55	1.7	1262		245H	54	1.7	1323	526	
		2#11	1#11	1	3#14	6.89	145K	14	-	1244	6.15	145K	14	-	1304	5.52	155K	14	-	1379	4.98	155K	14	-	1439	526	125
				1			295E	55	1.7	1653		315E	55	1.7	1756		335E	55	1.7	1859		345E	54	1.7	1940	724	
		2#10	2#10	1	4#14	7.87	155HeK	14	-	1446	7.02	165HdK	14	-	1533	6.30	155K	14	-	1588	5.69	165K	14	-	1675	568	109
				1			345D	55	1.7	1947		365D	55	1.7	2061		335E	55	1.7	2067		345E	54	1.7	2160	907	
	20	2# 9	1# 9	1	3#10	4.19	113K	16	-	675	3.74	123K	16	-	716	3.35	123K	16	-	752	3.03	123K	16	-	787	352	133
				1			195I	66	1.9	1040		205I	65	1.9	1098		215I	65	1.9	1156		225I	64	1.9	1215	440	
		2#10	1#10	1	3#11	5.06	124K	16	-	892	4.51	133K	16	-	885	4.05	133K	16	-	930	3.65	133K	16	-	975	440	132
				1			265F	66	1.9	1351		275F	65	1.9	1418		215I	65	1.9	1329		225I	64	1.9	1396	531	
		2#11	1#11	1	5#11	7.35	145K	16	-	1331	6.56	145K	16	-	1396	5.89	155K	16	-	1476	5.31	155K	16	-	1541	531	113
				1			295E	66	1.9	1755		315E	65	1.9	1864		335E	65	1.9	1973		305F	64	1.9	1971	837	
		2#14	1#14	1	4#14	8.93	175GgK	16	-	1693	7.97	165HeK	16	-	1760	7.15	175HeK	16	-	1859	6.45	175HdK	16	-	1942	734	98
				1			415C	66	1.9	2336		365D	65	1.9	2308		385D	65	1.9	2435		405D	64	1.9	2563	938	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

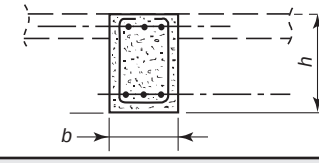
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

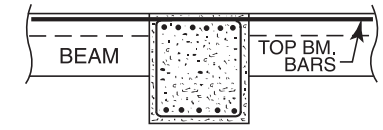
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 32 ft					SPAN, ℓ_n = 34 ft.					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
32	16	2#10		1	3#10	4.99	114M	13	-	669	4.42	123M	13	-	656	3.95	123M	12	-	691	3.54	123M	12	-	725	319	143
				1			195H	51	1.7	969		215H	50	1.7	1046		225H	50	1.7	1102		235H	50	1.7	1158	467	
		2#11		1	3#11	6.04	124M	13	-	810	5.35	124M	13	-	853	4.78	134M	12	-	905	4.29	134M	12	-	948	387	136
				1			285E	51	1.7	1294		295E	50	1.7	1358		225H	50	1.7	1250		235H	50	1.7	1314	562	
		2#14		1	3#14	8.30	145ldM	13	-	1216	7.35	145ldM	13	-	1277	6.56	145M	12	-	1338	5.88	145M	12	-	1400	540	112
				1			325D	51	1.7	1684		295E	50	1.7	1681		315E	50	1.7	1785		335E	50	1.7	1889	772	
		2#10	2#10	1	4#14	9.31	155HfM	13	-	1381	8.25	155HfM	13	-	1452	7.36	155leM	12	-	1522	6.60	165ldM	12	-	1609	607	104
				2			325D	51	1.7	1833		345D	50	1.7	1947		365D	50	1.7	2061		335E	50	1.7	2067	867	
	18	2# 8	1# 8	1	3#10	4.72	103M	15	-	569	4.18	113M	15	-	606	3.73	113M	15	-	638	3.35	113M	15	-	670	302	121
				1			185l	62	1.9	916		195l	61	1.9	970		205l	61	1.9	1024		215l	60	1.9	1079	471	
		2#10	1#10	1	3#11	6.11	124M	15	-	850	5.41	124M	15	-	895	4.83	124M	15	-	940	4.33	134M	15	-	995	471	119
				1			245F	62	1.9	1261		265F	61	1.9	1351		275F	61	1.9	1418		295F	60	1.8	1507	568	
		2#11	1#11	1	3#14	8.43	135ldM	15	-	1178	7.47	145lcM	15	-	1254	6.66	145M	15	-	1314	5.98	145M	15	-	1374	568	105
				1			325D	62	1.9	1680		295E	61	1.9	1673		315E	61	1.9	1777		335E	60	1.8	1882	785	
		2#11	2#11	1	4#14	10.76	175FiM	15	-	1533	9.53	175GhM	15	-	1611	8.50	175GgM	15	-	1689	7.63	175HfM	15	-	1767	736	87
				1			385C	62	1.9	2104		415C	61	1.9	2249		435C	61	1.9	2371		385D	60	1.8	2338	1002	
	20	2# 9	1# 9	1	3#11	5.93	114M	18	-	761	5.25	114M	18	-	801	4.69	124M	18	-	851	4.21	124M	18	-	891	379	113
				1			245F	74	2.1	1197		265F	73	2.1	1283		205l	72	2.0	1185		215l	72	2.0	1248	573	
		2#10	1#10	1	3#11	6.16	114M	18	-	842	5.46	124M	18	-	897	4.87	124M	18	-	942	4.37	124M	18	-	987	474	109
				1			245F	74	2.1	1278		265F	73	2.1	1369		275F	72	2.0	1437		215l	71	2.0	1344	573	
		2#10	2#10	1	4#14	9.69	145HeM	18	-	1375	8.58	145ldM	18	-	1445	7.65	155ldM	18	-	1533	6.87	145M	18	-	1587	620	89
				1			325D	74	2.1	1878		345D	73	2.1	1994		365D	72	2.0	2111		335E	71	2.0	2113	1019	
		2#14	1#14	1	5#14	12.42	255E	18	-	1917	11.00	205ElM	18	-	1928	9.82	195FjM	18	-	2004	8.81	195FiM	18	-	2097	795	76
				1			485B	73	2.1	2606		415C	73	2.1	2538		435C	72	2.0	2677		465C	71	2.0	2839	1165	
	24	2#10	1#10	1	4#10	6.75	113M	25	-	870	5.98	113M	24	-	917	5.34	113M	24	-	963	4.79	123M	24	-	1021	479	93
				1			225G	98	2.5	1615		235G	97	2.4	1701		245G	96	2.4	1786		195J	96	2.4	1637	628	
		2#11	1#11	1	4#11	8.14	124M	25	-	1174	7.21	123M	24	-	1115	6.44	123M	24	-	1173	5.78	133M	24	-	1241	580	91
				1			225G	98	2.5	1792		235G	97	2.4	1889		245G	96	2.4	1985		265G	96	2.4	2121	758	
		2#14	1#14	1	4#14	11.24	135M	25	-	1757	9.96	135M	24	-	1840	8.88	144M	24	-	1790	7.97	144M	24	-	1872	810	77
				1			285E	98	2.5	2436		295E	97	2.4	2558		275F	96	2.4	2563		295F	95	2.4	2724	1046	
		3#11	2#11	1	5#14	13.61	145lcM	25	-	2045	12.05	145M	24	-	2144	10.75	145M	24	-	2242	9.65	155M	24	-	2373	927	68
				1			325D	98	2.5	2849		345D	97	2.4	3026		315E	96	2.4	3007		335E	96	2.4	3184	1266	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

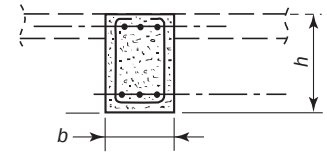
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

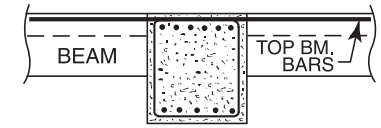
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 40 ft					SPAN, ℓ_n = 42 ft.					SPAN, ℓ_n = 44 ft.					SPAN, ℓ_n = 46 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
32	16	2#10		1	3#10	3.20	133M	12	-	765	2.90	133M	12	-	799	2.64	133M	12	-	834	2.42	133M	12	-	868	319	143
				1			245H	49	1.7	1214		255H	49	1.7	1270		265H	49	1.6	1326		275H	48	1.6	1382	467	
		2#11		1	3#11	3.87	144M	12	-	1000	3.51	143M	12	-	976	3.20	143M	12	-	1019	2.92	153M	12	-	1066	387	136
				1			245H	49	1.7	1378		255H	49	1.7	1442		265H	49	1.6	1506		275H	48	1.6	1570	562	
		2#14		1	3#14	5.31	155M	12	-	1477	4.82	155M	12	-	1538	4.39	165M	12	-	1615	4.02	165M	12	-	1676	540	112
				1			345E	49	1.7	1972		365E	49	1.6	2076		375E	49	1.6	2159		385E	48	1.6	2242	772	
		2#10	2#10	1	4#14	5.96	165lcM	12	-	1680	5.41	165M	12	-	1751	4.93	165M	12	-	1822	4.51	175M	12	-	1909	607	104
				2			345E	49	1.7	2160		365E	49	1.6	2274		375E	49	1.6	2366		385E	48	1.6	2459	867	
	18	2# 8	1# 8	1	3#10	3.02	113M	15	-	702	2.74	113M	15	-	734	2.50	123M	15	-	771	2.29	123M	15	-	803	302	121
				1			225I	60	1.8	1133		235I	59	1.8	1187		245I	59	1.8	1241		255I	59	1.8	1295	471	
		2#10	1#10	1	3#11	3.91	133M	15	-	976	3.55	133M	15	-	1021	3.23	143M	15	-	1071	2.96	143M	15	-	1116	471	119
				1			225I	60	1.8	1396		235I	59	1.8	1464		245I	59	1.8	1531		255I	59	1.8	1598	568	
		2#11	1#11	1	3#14	5.40	155M	15	-	1450	4.90	155M	15	-	1509	4.46	154M	15	-	1480	4.08	164M	15	-	1550	568	105
				1			305F	60	1.8	1875		325F	59	1.8	1979		335F	59	1.8	2061		345F	59	1.8	2143	785	
		2#11	2#11	1	4#14	6.89	165leM	15	-	1829	6.25	175ldM	15	-	1923	5.69	175ldM	15	-	2001	5.21	175M	15	-	2079	736	87
				1			405D	60	1.8	2460		425D	59	1.8	2583		375E	59	1.8	2550		395E	59	1.8	2672	1002	
	20	2# 9	1# 9	1	3#11	3.80	124M	18	-	931	3.44	124M	18	-	971	3.14	134M	18	-	1021	2.87	134M	17	-	1061	379	113
				1			225I	71	2.0	1311		235I	71	2.0	1374		245I	70	2.0	1436		255I	70	2.0	1499	573	
		2#10	1#10	1	3#11	3.94	124M	18	-	1032	3.58	134M	18	-	1088	3.26	134M	18	-	1132	2.98	134M	17	-	1177	474	109
				1			225I	71	2.0	1412		235I	70	2.0	1480		245I	70	2.0	1548		255I	70	2.0	1615	573	
		2#10	2#10	1	4#14	6.20	155M	18	-	1675	5.62	155M	18	-	1746	5.12	165M	18	-	1833	4.69	165M	17	-	1904	620	89
				1			345E	71	2.0	2207		365E	70	2.0	2324		335F	70	2.0	2326		345F	70	2.0	2420	1019	
		2#14	1#14	1	5#14	7.95	185GhM	18	-	2174	7.21	185HgM	18	-	2267	6.57	185leM	18	-	2360	6.01	185leM	17	-	2453	795	76
				1			485C	71	2.0	2978		425D	70	2.0	2934		445D	70	2.0	3073		455D	70	2.0	3189	1165	
	24	2#10	1#10	1	4#10	4.32	123M	24	-	1067	3.92	123M	24	-	1114	3.57	123M	23	-	1160	3.27	123M	23	-	1207	479	93
				1			205J	95	2.4	1723		215J	94	2.4	1809		275H	94	2.4	2090		285H	93	2.4	2176	628	
		2#11	1#11	1	4#11	5.21	133M	24	-	1299	4.73	133M	24	-	1356	4.31	143M	23	-	1424	3.94	143M	23	-	1482	580	91
				1			275G	95	2.4	2218		285G	94	2.4	2314		305G	94	2.4	2450		235J	93	2.3	2234	758	
		2#14	1#14	1	4#14	7.20	154M	24	-	1976	6.53	154M	24	-	2058	5.95	154M	23	-	2141	5.44	164M	23	-	2244	810	77
				1			305F	95	2.4	2846		285G	94	2.4	2851		305G	94	2.3	3012		315G	93	2.3	3134	1046	
		3#11	2#11	1	5#14	8.71	155M	24	-	2472	7.90	165M	24	-	2603	7.20	164M	23	-	2513	6.58	174M	23	-	2632	927	68
				1			345E	95	2.4	3322		325F	94	2.4	3343		335F	94	2.4	3481		355F	93	2.3	3658	1266	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

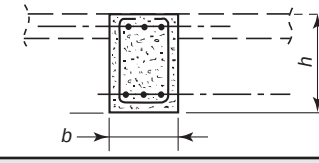
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

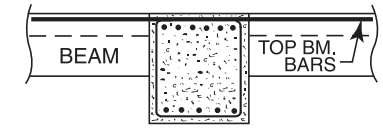
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 32 ft					SPAN, ℓ_n = 34 ft.					SPAN, ℓ_n = 36 ft.					SPAN, ℓ_n = 38 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
34	16	2#10		1	3#10	5.35	114N	14	-	674	4.74	113N	14	-	654	4.23	113N	14	-	688	3.79	123N	14	-	728	342	119
				1			245F	56	1.8	1093		195I	55	1.8	1017		205I	55	1.8	1073		215I	54	1.8	1130	501	
		2#11		1	3#11	6.49	115N	14	-	872	5.75	124N	14	-	858	5.13	124N	14	-	901	4.60	124N	14	-	943	415	115
				1			245F	56	1.8	1225		265F	55	1.8	1312		275F	55	1.8	1376		295F	54	1.8	1463	604	
		2#14		1	3#14	8.95	135IeN	14	-	1209	7.93	135JdN	14	-	1270	7.07	145JcN	14	-	1348	6.35	145N	14	-	1409	580	96
				1			325D	56	1.8	1707		295E	55	1.8	1701		315E	55	1.8	1807		335E	54	1.8	1912	833	
		2#11	2#11	1	4#14	10.66	255E	14	-	1671	9.44	165GhN	14	-	1601	8.42	165HgN	14	-	1679	7.56	165IfN	14	-	1757	782	83
				2			485B	56	1.8	2327		345D	55	1.8	2093		365D	55	1.8	2215		385D	54	1.8	2338	992	
	18	2# 9	1# 9	1	3#11	6.32	114N	17	-	763	5.60	114N	17	-	803	4.99	114N	17	-	843	4.48	124N	17	-	894	404	104
				1			245F	68	2.0	1197		265F	67	2.0	1283		275F	67	2.0	1345		215I	66	2.0	1248	610	
		2#10	1#10	1	3#11	6.56	114N	17	-	845	5.81	114N	17	-	890	5.18	124N	17	-	945	4.65	124N	17	-	990	505	100
				1			245F	68	2.0	1278		265F	67	2.0	1369		275F	67	2.0	1437		295F	66	2.0	1527	610	
		2#10	2#10	1	4#14	10.31	145HfN	17	-	1379	9.14	145IfN	17	-	1450	8.15	145JeN	17	-	1521	7.31	145JdN	17	-	1592	660	79
				1			325D	68	2.0	1878		345D	67	2.0	1994		365D	67	2.0	2111		385D	66	2.0	2228	1083	
		2#14	1#14	1	4#14	11.63	175FjN	17	-	1628	10.31	175GiN	17	-	1711	9.19	175GhN	17	-	1794	8.25	165HgN	16	-	1860	845	73
				1			385C	68	2.0	2213		415C	67	2.0	2365		435C	67	2.0	2494		385D	66	2.0	2462	1083	
	20	2# 9	1# 9	1	3#11	6.35	104N	20	-	755	5.63	114N	20	-	806	5.02	114N	20	-	846	4.50	114N	20	-	886	406	93
				1			225G	81	2.2	1166		235G	80	2.2	1230		245G	79	2.2	1293		265G	79	2.2	1381	615	
		2#11	1#11	1	3#14	9.19	125JdN	20	-	1174	8.14	125N	20	-	1234	7.26	125N	20	-	1294	6.52	135N	20	-	1371	615	86
				1			325D	81	2.2	1724		295E	80	2.2	1713		315E	79	2.2	1820		335E	78	2.2	1927	855	
		2#11	2#11	1	4#14	11.83	165FiN	20	-	1534	10.48	165GhN	20	-	1612	9.34	165HgN	20	-	1690	8.39	155IfN	20	-	1751	801	72
				1			385C	81	2.2	2157		415C	80	2.2	2306		435C	79	2.2	2431		385D	78	2.2	2391	1100	
		2#14	1#14	1	5#14	13.37	255E	20	-	1935	11.85	195ElN	20	-	1925	10.57	195FkN	20	-	2018	9.48	185GiN	20	-	2093	855	65
				1			485B	81	2.2	2639		515B	80	2.2	2803		435C	79	2.2	2707		465C	78	2.2	2871	1325	
	24	2#10	1#10	1	4#11	8.03	113N	27	-	962	7.11	113N	27	-	1014	6.34	113N	27	-	1066	5.69	123N	26	-	1129	513	77
				1			225G	108	2.6	1732		235G	107	2.6	1824		245G	106	2.6	1917		265G	105	2.6	2050	814	
		2#11	1#11	1	4#11	8.75	114N	27	-	1164	7.75	113N	27	-	1110	6.91	123N	27	-	1179	6.20	123N	26	-	1237	622	77
				1			225G	108	2.6	1823		235G	107	2.6	1921		245G	106	2.6	2019		265G	105	2.6	2157	814	
		2#14	1#14	1	5#14	13.61	125N	27	-	1905	12.05	135N	27	-	2031	10.75	135N	27	-	2125	9.65	145N	26	-	2251	870	61
				1			325D	108	2.6	2801		295E	107	2.6	2772		315E	106	2.6	2946		335E	105	2.6	3120	1367	
		2#14	2#14	1	6#14	17.09	254E	27	-	2379	15.14	264E	27	-	2515	13.50	145JdN	27	-	2548	12.12	155JdN	26	-	2696	1127	53
				1			485B	108	2.6	3795		515B	107	2.6	4032		365D	106	2.6	3539		385D	105	2.6	3735	1591	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

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*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
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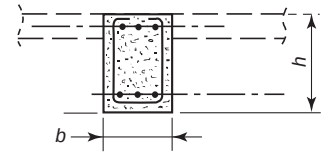
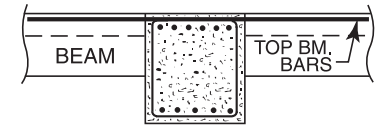
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

f_c' = 4,000 psi
f_y = 60,000 psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS(1)				TOTAL CAPACITY $U = 1.2D + 1.6L$(3)																$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 40 ft					SPAN, ℓ_n = 42 ft.					SPAN, ℓ_n = 44 ft.					SPAN, ℓ_n = 46 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
34	16	2#10		1	3#10	3.42	123N	13	-	763	3.11	123N	13	-	797	2.83	123N	13	-	831	2.59	123N	13	-	866	342	119
				1			225I	54	1.8	1187		235I	53	1.8	1243		245I	53	1.8	1300		255I	53	1.8	1357	501	
		2#11		1	3#11	4.15	134N	13	-	996	3.77	134N	13	-	1039	3.43	133N	13	-	1017	3.14	143N	13	-	1065	415	115
				1			305F	54	1.8	1528		235I	53	1.8	1415		245I	53	1.7	1480		255I	53	1.8	1544	604	
		2#14		1	3#14	5.73	145N	13	-	1470	5.20	155N	13	-	1548	4.73	155N	13	-	1609	4.33	155N	13	-	1671	580	96
				1			305F	54	1.8	1907		325F	53	1.8	2013		335F	53	1.7	2096		345F	53	1.7	2179	833	
		2#11	2#11	1	4#14	6.82	165JeN	13	-	1835	6.19	165JdN	13	-	1913	5.64	165JdN	13	-	1991	5.16	165N	13	-	2069	782	83
				2			405D	54	1.8	2460		365E	53	1.8	2449		375E	53	1.7	2550		395E	53	1.7	2672	992	
	18	2# 9	1# 9	1	3#11	4.05	124N	16	-	934	3.67	124N	16	-	974	3.34	134N	16	-	1024	3.06	134N	16	-	1064	404	104
				1			225I	66	2.0	1311		235I	65	2.0	1374		245I	65	2.0	1436		255I	64	1.9	1499	610	
		2#10	1#10	1	3#11	4.20	124N	16	-	1035	3.81	134N	16	-	1091	3.47	134N	16	-	1135	3.18	134N	16	-	1180	505	100
				1			225I	66	2.0	1412		235I	65	2.0	1480		245I	65	2.0	1548		255I	64	1.9	1615	610	
		2#10	2#10	1	4#14	6.60	155JcN	16	-	1680	5.99	155N	16	-	1751	5.46	155N	16	-	1822	4.99	155N	16	-	1893	660	79
				1			345E	66	2.0	2207		365E	65	2.0	2324		385E	65	1.9	2441		345F	64	1.9	2420	1083	
		2#14	1#14	1	4#14	7.45	165IfN	16	-	1943	6.75	165JeN	16	-	2025	6.15	165JdN	16	-	2108	5.63	175JdN	16	-	2208	845	73
				1			405D	65	2.0	2591		425D	65	1.9	2719		385E	65	1.9	2710		395E	64	1.9	2816	1083	
	20	2# 9	1# 9	1	3#11	4.07	114N	19	-	926	3.69	124N	19	-	977	3.36	124N	19	-	1016	3.07	124N	19	-	1056	406	93
				1			205J	78	2.2	1279		215J	77	2.1	1342		225J	77	2.1	1406		235J	76	2.1	1469	615	
		2#11	1#11	1	3#14	5.88	135N	19	-	1431	5.34	145N	19	-	1508	4.86	144N	19	-	1479	4.45	144N	19	-	1539	615	86
				1			305F	78	2.2	1916		325F	77	2.1	2023		305G	77	2.1	2036		315G	76	2.1	2119	855	
		2#11	2#11	1	4#14	7.57	155JeN	19	-	1829	6.87	165JdN	19	-	1924	6.26	165JdN	19	-	2002	5.72	165N	19	-	2080	801	72
				1			405D	78	2.2	2516		425D	77	2.1	2641		385E	77	2.1	2625		395E	76	2.1	2726	1100	
		2#14	1#14	1	5#14	8.56	185GiN	19	-	2187	7.76	175HgN	19	-	2262	7.07	175IfN	19	-	2356	6.47	185IfN	19	-	2466	855	65
				1			485C	78	2.2	3012		425D	77	2.1	2963		445D	77	2.1	3103		455D	76	2.1	3220	1325	
	24	2#10	1#10	1	4#11	5.14	123N	26	-	1181	4.66	123N	26	-	1233	4.25	123N	26	-	1285	3.88	123N	26	-	1337	513	77
				1			275G	104	2.6	2142		285G	104	2.5	2235		225J	103	2.5	2044		235J	102	2.5	2136	814	
		2#11	1#11	1	4#11	5.60	123N	26	-	1294	5.08	133N	26	-	1363	4.63	133N	26	-	1420	4.23	133N	26	-	1478	622	77
				1			275G	104	2.5	2255		285G	104	2.5	2353		305G	103	2.5	2492		315G	102	2.5	2590	814	
		2#14	1#14	1	5#14	8.71	145N	26	-	2344	7.90	154N	26	-	2286	7.20	154N	26	-	2379	6.59	154N	26	-	2473	870	61
				1			305F	104	2.5	3092		325F	104	2.5	3266		335F	103	2.5	3400		355F	102	2.5	3574	1367	
		2#14	2#14	1	6#14	10.94	155JcN	26	-	2811	9.92	155N	26	-	2926	9.04	165N	26	-	3074	8.27	165N	26	-	3189	1127	53
				1			405D	104	2.5	3930		365E	104	2.5	3883		385E	103	2.5	4079		405E	102	2.5	4275	1591	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
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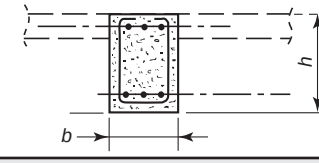
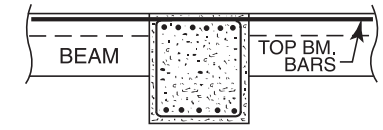
$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 36 ft					SPAN, ℓ_n = 38 ft.					SPAN, ℓ_n = 40 ft.					SPAN, ℓ_n = 42 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
36	16	2#10		1	3#10	4.51	113O	15	-	691	4.05	113O	15	-	725	3.65	113O	15	-	760	3.31	113O	15	-	794	365	99
				1			205I	60	1.9	1087		215I	59	1.9	1145		225I	59	1.9	1202		235I	58	1.9	1259	536	
		2#11		1	3#11	5.47	114O	15	-	896	4.91	124O	15	-	949	4.43	124O	15	-	991	4.02	124O	15	-	1034	443	98
				1			275F	60	1.9	1395		295F	59	1.9	1484		305F	59	1.9	1549		235I	58	1.9	1431	646	
		2#14		1	3#14	7.59	135KdO	15	-	1341	6.81	135KcO	15	-	1402	6.15	135O	15	-	1463	5.57	145O	15	-	1541	621	83
				1			315E	60	1.9	1828		335E	59	1.9	1935		305F	59	1.9	1928		325F	58	1.9	2035	893	
		2#11	2#11	1	4#14	9.11	165HhO	15	-	1690	8.17	155IgO	15	-	1751	7.38	155JfO	15	-	1829	6.69	155KeO	15	-	1907	838	72
				2			365D	60	1.9	2241		385D	59	1.9	2364		405D	59	1.9	2488		365E	58	1.9	2474	1073	
	18	2# 9	1# 9	1	3#11	5.33	114O	18	-	848	4.78	114O	18	-	888	4.32	114O	18	-	928	3.91	124O	18	-	979	431	88
				1			245G	73	2.1	1293		265G	72	2.1	1381		275G	71	2.1	1444		285G	71	2.1	1508	652	
		2#10	1#10	1	3#14	6.67	125O	18	-	1196	5.98	125O	18	-	1250	5.40	124O	18	-	1227	4.90	134O	18	-	1293	540	80
				1			275F	73	2.1	1624		295F	72	2.1	1725		275G	71	2.1	1732		285G	71	2.1	1810	906	
		2#11	2#11	1	4#14	9.88	175GiO	18	-	1713	8.87	165HhO	18	-	1773	8.00	165IfO	18	-	1851	7.26	165JfO	18	-	1929	849	65
				1			435C	73	2.1	2431		385D	72	2.1	2391		405D	71	2.1	2516		425D	71	2.1	2641	1164	
		2#14	1#14	1	5#14	10.94	195FlO	18	-	2024	9.81	185GjO	18	-	2100	8.86	185GjO	18	-	2193	8.03	175HhO	18	-	2268	906	62
				2			435C	73	2.1	2707		465C	72	2.1	2871		485C	71	2.1	3012		425D	71	2.1	2963	1288	
	20	2# 9	1# 9	1	3#11	5.35	104O	22	-	839	4.80	114O	21	-	891	4.34	114O	21	-	931	3.93	114O	21	-	971	433	77
				1			245G	87	2.3	1310		265G	86	2.3	1399		275G	85	2.3	1463		215J	84	2.3	1357	657	
		2#11	1#11	1	3#14	7.78	125O	22	-	1302	6.98	125O	21	-	1362	6.30	135O	21	-	1440	5.72	135O	21	-	1500	657	74
				1			315E	87	2.3	1842		335E	86	2.3	1950		305F	85	2.3	1937		325F	84	2.3	2046	916	
		2#14	1#14	1	4#14	10.03	155HgO	22	-	1776	9.00	155IfO	21	-	1858	8.13	155IfO	21	-	1941	7.37	155JeO	21	-	2024	916	61
				1			435C	86	2.3	2554		385D	86	2.3	2515		405D	85	2.3	2646		425D	84	2.3	2778	1181	
		3#11	2#11	1	5#14	12.11	215EnO	22	-	2171	10.87	195FlO	21	-	2234	9.81	205FlO	21	-	2350	8.90	195GjO	21	-	2431	1047	54
				1			545B	87	2.3	3109		465C	86	2.3	3013		485C	85	2.3	3160		505C	84	2.3	3308	1427	
	24	2#10	1#10	1	4#11	6.77	113O	29	-	1071	6.07	113O	29	-	1123	5.48	113O	29	-	1175	4.97	113O	28	-	1227	548	64
				1			245G	116	2.8	1950		265G	115	2.7	2086		275G	114	2.7	2180		285G	113	2.7	2274	870	
		2#11	1#11	1	4#14	8.21	114O	29	-	1513	7.37	124O	29	-	1605	6.65	123O	29	-	1549	6.03	123O	28	-	1619	664	60
				1			245G	116	2.8	2276		265G	115	2.7	2430		275G	114	2.7	2542		285G	113	2.7	2654	1208	
		2#14	1#14	1	5#14	11.50	125O	29	-	2108	10.32	135O	29	-	2236	9.32	135O	29	-	2329	8.45	145O	28	-	2457	931	53
				1			315E	116	2.8	2989		335E	115	2.7	3166		345E	114	2.7	3301		325F	113	2.7	3310	1469	
		2#14	2#14	1	6#14	14.54	145JeO	29	-	2568	13.05	145KdO	29	-	2682	11.77	155KdO	29	-	2832	10.68	155KcO	28	-	2947	1208	46
				1			365D	116	2.8	3589		385D	115	2.7	3788		405D	114	2.7	3986		425D	113	2.7	4185	1712	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

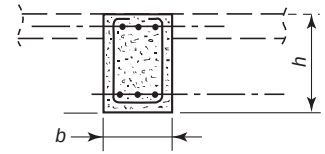
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

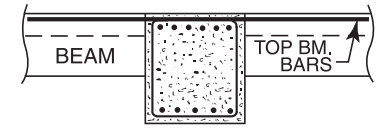
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

f_c' = 4,000 psi
f_y = 60,000 psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 44 ft					SPAN, ℓ_n = 46 ft.					SPAN, ℓ_n = 48 ft.					SPAN, ℓ_n = 50 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
36	16	2#10		1	3#10	3.02	123O	14	-	834	2.76	123O	14	-	869	2.54	123O	14	-	903	2.34	123O	14	-	938	365	99
				1			245I	58	1.9	1317		255I	57	1.9	1374		265I	57	1.9	1431		275I	57	1.9	1489	536	
		2#11		1	3#11	3.66	133O	14	-	1020	3.35	133O	14	-	1062	3.08	133O	14	-	1105	2.84	133O	14	-	1147	443	98
				1			245I	58	1.9	1496		255I	57	1.9	1562		265I	57	1.9	1627		275I	57	1.8	1693	646	
		2#14		1	3#14	5.08	145O	14	-	1603	4.65	155O	14	-	1681	4.27	155O	14	-	1742	3.93	154O	14	-	1709	621	83
				1			335F	58	1.9	2119		345F	57	1.9	2203		355F	57	1.8	2287		375F	57	1.8	2394	893	
		2#11	2#11	1	4#14	6.10	165KdO	14	-	2002	5.58	165KdO	14	-	2080	5.12	165KcO	14	-	2158	4.72	165O	14	-	2236	838	72
				2			385E	58	1.9	2598		395E	57	1.9	2699		405E	57	1.8	2800		375F	57	1.8	2809	1073	
	18	2# 9	1# 9	1	3#11	3.57	124O	18	-	1019	3.26	124O	17	-	1059	3.00	124O	17	-	1099	2.76	124O	17	-	1139	431	88
				1			225J	70	2.1	1406		235J	70	2.1	1469		245J	70	2.1	1533		255J	69	2.0	1597	652	
		2#10	1#10	1	3#14	4.46	134O	18	-	1347	4.08	134O	17	-	1401	3.75	144O	17	-	1467	3.46	144O	17	-	1521	540	80
				1			305G	70	2.1	1912		315G	70	2.1	1990		325G	70	2.0	2068		335G	69	2.0	2145	906	
		2#11	2#11	1	4#14	6.61	165KeO	18	-	2007	6.05	165KdO	17	-	2085	5.56	165KcO	17	-	2163	5.12	165O	17	-	2241	849	65
				1			445D	70	2.1	2767		395E	70	2.1	2726		415E	70	2.0	2852		425E	69	2.0	2953	1164	
		2#14	1#14	1	5#14	7.32	185HhO	18	-	2379	6.70	185IgO	17	-	2472	6.15	175JfO	17	-	2548	5.67	175KeO	17	-	2641	906	62
				2			445D	70	2.1	3103		465D	70	2.1	3244		475D	69	2.0	3360		425E	69	2.0	3335	1288	
	20	2# 9	1# 9	1	3#11	3.58	114O	21	-	1011	3.28	114O	21	-	1051	3.01	114O	21	-	1091	2.77	124O	21	-	1142	433	77
				1			225J	84	2.3	1421		235J	83	2.3	1485		245J	83	2.3	1550		255J	82	2.2	1614	657	
		2#11	1#11	1	3#14	5.21	134O	21	-	1474	4.76	144O	21	-	1545	4.38	144O	21	-	1605	4.03	144O	21	-	1665	657	74
				1			335F	84	2.3	2130		315G	83	2.3	2141		325G	83	2.2	2225		335G	82	2.2	2309	916	
		2#14	1#14	1	4#14	6.72	155KdO	21	-	2107	6.14	155KcO	21	-	2190	5.64	155O	21	-	2273	5.20	165O	21	-	2374	916	61
				1			445D	84	2.3	2909		405E	83	2.3	2895		415E	83	2.2	3002		425E	82	2.2	3109	1181	
		3#11	2#11	1	5#14	8.11	185HiO	21	-	2512	7.42	185HhO	21	-	2611	6.81	185IgO	21	-	2710	6.28	185JfO	21	-	2809	1047	54
				1			535C	84	2.3	3480		465D	83	2.3	3408		475D	83	2.2	3531		495D	82	2.2	3679	1427	
	24	2#10	1#10	1	4#11	4.53	123O	28	-	1291	4.14	123O	28	-	1343	3.81	123O	28	-	1395	3.51	123O	28	-	1447	548	64
				1			305G	113	2.7	2409		235J	112	2.7	2168		245J	111	2.7	2262		255J	111	2.6	2356	870	
		2#11	1#11	1	4#14	5.50	133O	28	-	1701	5.03	133O	28	-	1771	4.62	133O	28	-	1841	4.26	133O	28	-	1911	664	60
				1			305G	113	2.7	2808		315G	112	2.7	2920		325G	111	2.7	3032		345G	111	2.6	3186	1208	
		2#14	1#14	1	5#14	7.70	144O	28	-	2371	7.04	154O	28	-	2486	6.47	154O	28	-	2579	5.96	154O	28	-	2672	931	53
				1			335F	112	2.7	3445		355F	112	2.7	3622		325G	111	2.6	3590		345G	111	2.6	3767	1469	
		2#14	2#14	1	6#14	9.73	155O	28	-	3061	8.90	155O	28	-	3176	8.18	165O	28	-	3326	7.54	165O	28	-	3440	1208	46
				1			385E	112	2.7	4132		405E	112	2.7	4330		415E	111	2.6	4487		435E	111	2.6	4685	1712	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

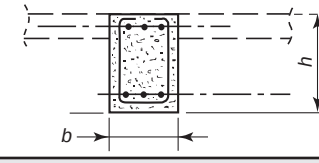
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

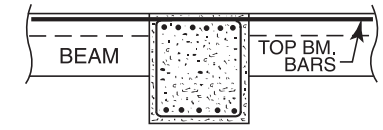
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 36 ft					SPAN, ℓ_n = 38 ft.					SPAN, ℓ_n = 40 ft.					SPAN, ℓ_n = 42 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
42	20	2#10	1#10	1	3#11	6.65	094R	28	-	932	5.97	094R	27	-	977	5.39	104R	27	-	1034	4.89	104R	27	-	1079	646	45
				1			245G	110	2.8	1451		265G	109	2.8	1549		275G	108	2.8	1620		285G	107	2.7	1692	784	
		2#11	1#11	1	3#14	9.33	115OcR	27	-	1307	8.37	115R	27	-	1367	7.55	115R	27	-	1427	6.85	115R	27	-	1487	784	48
				1			315E	110	2.8	1907		335E	109	2.8	2019		345E	108	2.8	2105		325F	107	2.7	2112	1098	
		2#14	1#14	1	5#14	13.57	195FmR	27	-	2070	12.18	175GkR	27	-	2124	10.99	185GkR	27	-	2237	9.97	175HjR	27	-	2310	1098	38
				1			435C	110	2.8	2827		465C	109	2.8	2999		485C	108	2.8	3145		505C	107	2.7	3291	1730	
		2#14	2#14	1	6#14	16.24	265DlG	27	-	2601	14.58	275DkG	27	-	2735	13.16	235EqR	27	-	2770	11.93	235EqR	27	-	2885	1424	35
				2			545B	110	2.8	3508		575B	109	2.8	3702		605B	108	2.8	3896		635B	107	2.7	4090	1913	
	24	2#11	1#11	1	4#11	8.82	103R	37	-	1177	7.91	103R	37	-	1235	7.14	103R	36	-	1292	6.48	103R	36	-	1350	791	40
				1			245G	149	3.3	2152		265G	147	3.3	2302		275G	146	3.3	2406		285G	144	3.2	2509	1038	
		2#14	1#14	1	4#14	12.32	105R	37	-	1896	11.06	115R	37	-	2018	9.98	115R	36	-	2101	9.05	124R	36	-	2053	1113	38
				1			315E	149	3.3	2935		335E	147	3.3	3110		305F	145	3.3	3055		325F	144	3.2	3230	1451	
		2#14	2#14	1	6#14	17.63	145JgR	37	-	2626	15.82	145KfR	37	-	2741	14.28	135MeR	36	-	2817	12.95	145NeR	36	-	2970	1451	31
				1			365D	149	3.3	3739		385D	147	3.3	3946		405D	145	3.3	4153		425D	144	3.2	4360	2077	
		3#14	2#14	1	7#14	19.20	225G	37	-	3404	17.23	235G	37	-	3583	15.55	155JgR	36	-	3412	14.10	155KfR	36	-	3552	1772	28
				2			435C	149	3.3	4528		465C	147	3.3	4807		405D	145	3.3	4671		425D	144	3.2	4903	2261	
	30	2#11	2#11	1	4#14	12.55	104R	53	-	1671	11.26	104R	53	-	1749	10.16	114R	52	-	1853	9.22	114R	52	-	1931	1051	33
				1			315E	213	4.1	2918		335E	211	4.1	3093		305F	208	4.0	3025		325F	207	4.0	3200	1478	
		2#11	2#11	1	5#14	12.99	105R	53	-	2001	11.66	104R	53	-	1943	10.52	114R	52	-	2057	9.54	114R	52	-	2145	1051	31
				1			315E	213	4.1	3102		335E	211	4.1	3287		345E	208	4.0	3423		325F	207	4.0	3415	1814	
		3#14	2#14	1	7#14	20.77	145IhR	53	-	3112	18.64	145JgR	53	-	3252	16.82	155JgR	52	-	3433	15.26	145KfR	52	-	3533	1814	25
				1			435C	213	4.1	4633		465C	210	4.1	4919		485C	208	4.0	5156		505C	206	4.0	5393	2446	
		3#14	3#14	1	9#14	24.51	255DgG	53	-	4129	22.00	235G	53	-	4221	19.85	195GlR	52	-	4232	18.01	175HjR	52	-	4323	2137	23
				2			545B	213	4.1	5740		575B	210	4.1	6058		485C	208	4.0	5793		505C	206	4.0	6063	2888	
	36	2#11	2#11	1	5#14	13.09	104R	71	-	1864	11.75	104R	70	-	1952	10.60	104R	69	-	2040	9.62	104R	69	-	2129	1060	25
				1			315E	283	4.9	3177		335E	280	4.8	3367		345E	277	4.8	3506		365E	275	4.7	3696	1842	
		2#14	2#14	1	5#14	15.64	105R	71	-	2314	14.04	105R	70	-	2419	12.67	115R	69	-	2565	11.49	114R	69	-	2503	1496	26
				1			365D	283	4.9	3731		385D	280	4.8	3937		345E	277	4.8	3838		365E	274	4.7	4044	1842	
		3#14	3#14	1	8#14	23.88	155HiR	71	-	3563	21.44	165HiR	70	-	3767	19.35	155IhR	69	-	3887	17.55	155JgR	69	-	4049	2177	21
				1			545B	283	4.9	5688		465C	280	4.8	5442		485C	277	4.8	5706		505C	274	4.7	5970	2814	
		4#14	3#14	1	10#14	27.45	255DiG	71	-	4631	24.64	205FnR	70	-	4620	22.24	185GlR	69	-	4734	20.17	195GlR	69	-	4973	2501	20
				2			545B	283	4.9	6338		575B	280	4.8	6689		605B	277	4.8	7039		635B	274	4.7	7390	3234	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

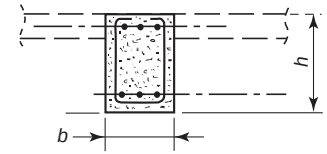
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

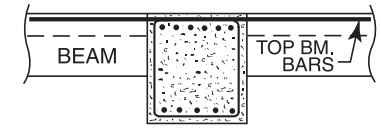
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																		$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 44 ft					SPAN, ℓ_n = 46 ft.					SPAN, ℓ_n = 48 ft.					SPAN, ℓ_n = 50 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
42	20	2#10	1#10	1	3#11	4.45	104R	26	-	1124	4.08	104R	26	-	1169	3.74	104R	26	-	1214	3.45	104R	26	-	1259	646	45
				1			305G	106	2.7	1789		235J	105	2.7	1649		245J	104	2.7	1721		255J	104	2.7	1792	784	
		2#11	1#11	1	3#14	6.24	125R	26	-	1567	5.71	125R	26	-	1626	5.25	124R	26	-	1599	4.83	124R	26	-	1659	784	48
				1			335F	106	2.7	2199		315G	105	2.7	2206		325G	104	2.7	2292		345G	104	2.7	2405	1098	
		2#14	1#14	1	5#14	9.08	165lhR	26	-	2383	8.31	165JgR	26	-	2476	7.63	165KgR	26	-	2569	7.03	165KfR	26	-	2662	1098	38
				1			445D	106	2.7	3226		465D	105	2.7	3371		485D	104	2.7	3517		505D	103	2.7	3663	1730	
		2#14	2#14	1	6#14	10.87	225FoR	26	-	2980	9.95	225FoR	26	-	3094	9.14	215GmR	26	-	3189	8.42	205HlR	26	-	3284	1424	35
				2			535C	106	2.7	3940		555C	105	2.7	4108		585C	104	2.7	4302		605C	103	2.7	4469	1913	
	24	2#11	1#11	1	4#11	5.90	113R	36	-	1420	5.40	113R	35	-	1478	4.96	113R	35	-	1535	4.57	113R	35	-	1593	791	40
				1			305G	143	3.2	2659		315G	142	3.2	2762		325G	141	3.2	2866		345G	140	3.1	3016	1038	
		2#14	1#14	1	4#14	8.25	124R	36	-	2136	7.55	124R	35	-	2219	6.93	124R	35	-	2302	6.39	134R	35	-	2409	1113	38
				1			335F	143	3.2	3359		355F	142	3.2	3534		325G	141	3.2	3478		345G	140	3.1	3653	1451	
		2#14	2#14	1	6#14	11.80	145OdR	36	-	3085	10.80	145OcR	35	-	3200	9.92	145OcR	35	-	3314	9.14	145R	35	-	3429	1451	31
				1			445D	143	3.2	4567		405E	142	3.2	4497		415E	141	3.2	4658		435E	140	3.1	4865	2077	
		3#14	2#14	1	7#14	12.85	155MfR	36	-	3693	11.76	155NeR	35	-	3833	10.80	155OdR	35	-	3973	9.95	155OdR	35	-	4113	1772	28
				2			445D	143	3.2	5135		465D	142	3.2	5368		485D	141	3.2	5600		435E	140	3.1	5510	2261	
	30	2#11	2#11	1	4#14	8.40	114R	51	-	2009	7.69	114R	51	-	2087	7.06	124R	50	-	2191	6.51	124R	50	-	2269	1051	33
				1			335F	205	3.9	3327		355F	203	3.9	3502		325G	202	3.9	3434		345G	201	3.9	3609	1478	
		2#11	2#11	1	5#14	8.69	114R	51	-	2233	7.95	114R	51	-	2322	7.30	124R	50	-	2435	6.73	124R	50	-	2524	1051	31
				1			335F	205	3.9	3551		355F	203	3.9	3737		365F	202	3.9	3873		345G	201	3.9	3864	1814	
		3#14	2#14	1	7#14	13.90	145MeR	51	-	3673	12.72	145NeR	51	-	3813	11.68	145OdR	50	-	3954	10.77	145OcR	50	-	4094	1814	25
				1			445D	205	3.9	5242		465D	203	3.9	5480		485D	202	3.9	5717		505D	200	3.9	5954	2446	
		3#14	3#14	1	9#14	16.41	175liR	51	-	4495	15.01	175liR	51	-	4667	13.79	175JhR	50	-	4840	12.71	175KgR	50	-	5012	2137	23
				2			535C	205	3.9	6380		555C	203	3.9	6649		585C	202	3.9	6967		605C	200	3.9	7236	2888	
	36	2#11	2#11	1	5#14	8.76	104R	68	-	2217	8.02	114R	68	-	2332	7.36	114R	67	-	2420	6.79	114R	67	-	2508	1060	25
				1			385E	272	4.7	3886		405E	270	4.7	4076		415E	268	4.6	4215		435E	267	4.6	4406	1842	
		2#14	2#14	1	5#14	10.47	114R	68	-	2608	9.58	124R	68	-	2739	8.80	124R	67	-	2844	8.11	124R	67	-	2948	1496	26
				1			385E	272	4.7	4251		405E	270	4.7	4457		415E	268	4.6	4613		435E	266	4.6	4819	1842	
		3#14	3#14	1	8#14	15.99	155KfR	68	-	4211	14.63	145MeR	68	-	4331	13.44	145NeR	67	-	4493	12.38	145OdR	67	-	4655	2177	21
				1			535C	272	4.7	6285		555C	270	4.7	6549		585C	268	4.6	6863		505D	266	4.6	6618	2814	
		4#14	3#14	1	10#14	18.38	185HjR	68	-	5129	16.81	175liR	68	-	5285	15.44	185liR	67	-	5525	14.23	175JhR	67	-	5680	2501	20
				2			535C	272	4.7	7078		555C	270	4.7	7377		585C	268	4.6	7728		605C	266	4.6	8027	3234	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

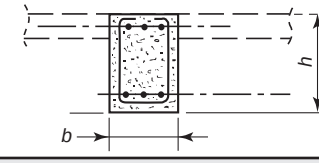
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

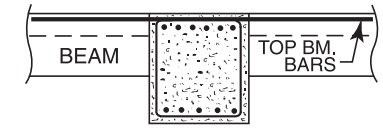
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 40 ft					SPAN, ℓ_n = 42 ft.					SPAN, ℓ_n = 44 ft.					SPAN, ℓ_n = 46 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
48	24	2#11	1#11	1	4#14	9.18	094U	45	-	1659	8.32	094U	44	-	1729	7.58	104U	44	-	1826	6.94	104U	44	-	1896	917	25
				1			275G	180	3.8	2767		285G	178	3.8	2888		305G	176	3.8	3058		315G	174	3.7	3178	1694	
		2#14	1#14	1	4#14	11.65	105U	45	-	2104	10.57	105U	44	-	2187	9.63	104U	44	-	2114	8.81	114U	44	-	2224	1296	26
				1			345E	179	3.8	3381		325F	178	3.8	3363		335F	176	3.8	3496		355F	174	3.7	3680	1694	
		3#14	2#14	1	7#14	18.47	155JiU	45	-	3475	16.76	145KhU	44	-	3572	15.27	145MgU	44	-	3712	13.97	145NfU	44	-	3852	2076	20
				2			485C	179	3.8	5239		425D	178	3.8	5078		445D	176	3.8	5319		465D	174	3.7	5560	2687	
		3#14	2#14	1	8#14	20.52	225Ffl	45	-	3980	18.61	215l	44	-	4088	16.96	225l	44	-	4281	15.51	165JiU	44	-	4173	2076	19
				2			485C	179	3.8	5443		505C	178	3.8	5694		535C	176	3.8	5995		555C	174	3.7	6246	2984	
	30	2#11	2#11	1	4#14	11.84	094U	65	-	1826	10.74	104U	64	-	1933	9.78	104U	63	-	2011	8.95	104U	63	-	2089	1220	21
				1			345E	259	4.7	3361		365E	256	4.7	3545		335F	254	4.6	3465		355F	251	4.6	3648	1721	
		2#14	2#14	1	5#14	14.56	105U	65	-	2551	13.21	105U	64	-	2656	12.04	105U	63	-	2760	11.01	115U	63	-	2909	1721	20
				1			405D	259	4.7	4213		365E	256	4.7	4107		385E	254	4.6	4317		405E	251	4.6	4527	2118	
		3#14	3#14	1	8#14	22.20	175HkU	65	-	4018	20.13	165ljU	64	-	4135	18.34	165JiU	63	-	4297	16.78	165JiU	63	-	4459	2501	16
				1			485C	259	4.7	5790		505C	256	4.7	6057		535C	254	4.6	6377		555C	251	4.6	6644	3228	
		4#14	3#14	1	10#14	25.65	235Fil	65	-	5007	23.26	245Fil	64	-	5249	21.20	245Fhl	63	-	5446	19.39	195HmU	63	-	5422	2871	15
				2			605B	259	4.7	7143		635B	256	4.7	7499		665B	254	4.6	7855		555C	251	4.6	7473	3730	
	36	2#14	2#14	1	5#14	14.76	095U	87	-	2519	13.38	105U	86	-	2670	12.19	104U	85	-	2609	11.16	104U	84	-	2713	1739	17
				1			405D	346	5.6	4311		425D	342	5.5	4525		385E	339	5.5	4409		405E	336	5.4	4624	2146	
		2#14	2#14	1	6#14	17.39	105RcU	87	-	2769	15.78	115RcU	86	-	2930	14.38	105U	85	-	2999	13.15	115U	84	-	3159	1739	18
				1			405D	346	5.6	4515		425D	342	5.5	4739		445D	339	5.5	4964		465D	336	5.4	5189	2542	
		4#14	3#14	1	10#14	26.41	185GmU	87	-	4809	23.96	195GmU	86	-	5053	21.83	185HlU	85	-	5204	19.97	185HlU	84	-	5402	2926	14
				2			605B	346	5.6	7289		635B	342	5.5	7652		665B	339	5.5	8015		695B	336	5.4	8378	3842	
		4#14	4#14	1	12#14	30.78	255Eml	87	-	5768	27.91	265Eml	86	-	6043	25.43	255Fkl	85	-	6227	23.27	235FqU	84	-	6365	3300	12
				2			805A	346	5.6	9029		635B	342	5.5	8322		665B	339	5.5	8717		695B	336	5.4	9111	4476	
	42	3#11	2#11	1	5#14	14.89	094U	110	-	2265	13.51	094U	109	-	2364	12.31	094U	108	-	2462	11.26	104U	107	-	2591	1532	14
				1			485C	440	6.5	4754		505C	435	6.4	4968		535C	431	6.4	5239		555C	427	6.3	5453	2166	
		3#14	2#14	1	7#14	20.39	115OeU	110	-	3348	18.49	115QdU	109	-	3488	16.85	115RcU	108	-	3629	15.42	115RcU	107	-	3769	2166	15
				1			485C	440	6.5	5590		505C	435	6.4	5845		535C	431	6.4	6158		555C	427	6.3	6413	2965	
		4#14	4#14	1	11#14	30.59	235ErU	110	-	5504	27.75	215FpU	109	-	5629	25.28	225FpU	108	-	5895	23.13	205GnU	107	-	6020	3351	12
				1			605B	440	6.5	7869		635B	435	6.4	8261		665B	431	6.4	8653		695B	427	6.3	9045	4449	
		5#14	4#14	1	14#14	35.90	285DqI	110	-	6666	32.57	295DqI	109	-	6979	29.67	305DqI	108	-	7291	27.15	265EuU	107	-	7367	3726	11
				2			805A	440	6.5	9945		845A	435	6.4	10441		885A	431	6.4	10936		925A	427	6.3	11431	5222	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
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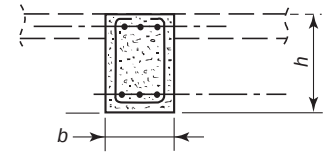
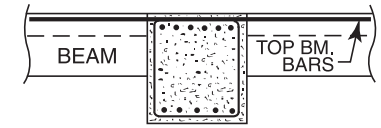
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

RECTANGULAR BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																			
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 48 ft					SPAN, ℓ_n = 50 ft.					SPAN, ℓ_n = 52 ft.					SPAN, ℓ_n = 54 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
48	24	2#11	1#11	1	4#14	6.37	104U	43	-	1966	5.87	104U	43	-	2036	5.43	104U	43	-	2106	5.04	114U	42	-	2204	917	25
				1			325G	173	3.7	3299		345G	172	3.7	3469		355G	170	3.6	3590		365G	169	3.6	3710	1694	
		2#14	1#14	1	4#14	8.09	114U	43	-	2307	7.46	114U	43	-	2390	6.89	124U	43	-	2500	6.39	124U	42	-	2583	1296	26
				1			365F	173	3.7	3813		345G	172	3.7	3795		355G	170	3.6	3928		365G	169	3.6	4061	1694	
		3#14	2#14	1	7#14	12.83	145OfU	43	-	3992	11.82	145OeU	43	-	4133	10.93	145PeU	43	-	4273	10.14	145QdU	42	-	4413	2076	20
				2			485D	173	3.7	5800		505D	172	3.7	6041		525D	170	3.6	6282		465E	169	3.6	6121	2687	
		3#14	2#14	1	8#14	14.25	165KhU	43	-	4324	13.13	165MhU	43	-	4474	12.14	165NgU	43	-	4624	11.26	165NgU	42	-	4775	2076	19
				2			485D	173	3.7	6045		505D	172	3.7	6296		525D	170	3.6	6547		545D	169	3.6	6798	2984	
	30	2#11	2#11	1	4#14	8.22	104U	62	-	2167	7.57	104U	62	-	2245	7.00	114U	61	-	2351	6.49	114U	61	-	2429	1220	21
				1			365F	249	4.5	3779		385F	248	4.5	3962		355G	246	4.5	3882		365G	244	4.5	4013	1721	
		2#14	2#14	1	5#14	10.11	115U	62	-	3014	9.32	114U	62	-	2942	8.62	124U	61	-	3075	7.99	124U	61	-	3179	1721	20
				1			415E	249	4.5	4684		435E	247	4.5	4894		395F	246	4.5	4788		415F	244	4.5	4998	2118	
		3#14	3#14	1	8#14	15.41	155KhU	62	-	4577	14.21	155MgU	62	-	4739	13.13	155NfU	61	-	4901	12.18	155OfU	61	-	5062	2501	16
				1			585C	249	4.5	6964		605C	247	4.5	7231		525D	246	4.5	6972		545D	244	4.5	7239	3228	
		4#14	3#14	1	10#14	17.81	205HmU	62	-	5664	16.41	185lkU	62	-	5772	15.18	185JjU	61	-	5970	14.07	185JjU	61	-	6167	2871	15
				2			585C	249	4.5	7829		605C	247	4.5	8132		625C	246	4.5	8434		655C	244	4.5	8790	3730	
	36	2#14	2#14	1	5#14	10.25	104U	83	-	2818	9.44	114U	83	-	2952	8.73	114U	82	-	3057	8.10	114U	82	-	3161	1739	17
				1			415E	333	5.4	4784		435E	331	5.4	4999		455E	329	5.3	5213		465E	327	5.3	5373	2146	
		2#14	2#14	1	6#14	12.08	115U	83	-	3274	11.13	115U	83	-	3389	10.29	125U	82	-	3550	9.54	124U	82	-	3466	1739	18
				1			485D	333	5.4	5414		435E	331	5.4	5254		455E	329	5.3	5479		465E	327	5.3	5648	2542	
		4#14	3#14	1	10#14	18.34	185lkU	83	-	5600	16.90	175JiU	83	-	5751	15.63	165KhU	82	-	5903	14.49	175KhU	82	-	6147	2926	14
				2			585C	333	5.4	7970		605C	331	5.4	8278		625C	329	5.3	8585		655C	327	5.3	8948	3842	
		4#14	4#14	1	12#14	21.37	225GpU	83	-	6548	19.70	225GoU	83	-	6778	18.21	215HnU	82	-	6961	16.89	215HnU	82	-	7191	3300	12
				2			725B	333	5.4	9506		755B	331	5.4	9901		785B	329	5.3	10296		815B	327	5.3	10691	4476	
	42	3#11	2#11	1	5#14	10.34	104U	106	-	2690	9.53	104U	105	-	2789	8.81	104U	104	-	2888	8.17	104U	104	-	2987	1532	14
				1			585C	424	6.3	5725		605C	420	6.2	5939		395F	418	6.2	4829		415F	415	6.1	5043	2166	
		3#14	2#14	1	7#14	14.16	115U	106	-	3909	13.05	115U	105	-	4049	12.06	125U	104	-	4237	11.19	125U	104	-	4377	2166	15
				1			585C	423	6.3	6726		605C	420	6.2	6982		625C	417	6.2	7237		655C	415	6.1	7550	2965	
		4#14	4#14	1	11#14	21.25	195HlU	106	-	6192	19.58	195HlU	105	-	6411	18.10	185lkU	104	-	6583	16.79	195lkU	104	-	6850	3351	12
				1			725B	423	6.3	9437		755B	420	6.2	9829		785B	417	6.2	10220		655C	415	6.1	9692	4449	
		5#14	4#14	1	14#14	24.93	275EuU	106	-	7680	22.98	255FsU	105	-	7850	21.25	255FrU	104	-	8116	19.70	235GpU	104	-	8286	3726	11
				2			725B	423	6.3	10546		755B	420	6.2	10984		785B	417	6.2	11421		815B	415	6.1	11859	5222	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

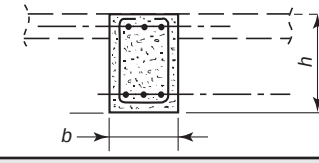
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

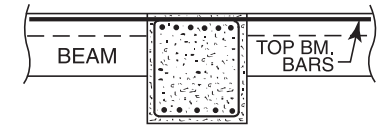
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																						
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 12 ft					SPAN, ℓ_n = 14 ft.					SPAN, ℓ_n = 16 ft.					SPAN, ℓ_n = 18 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
12.5	24	2# 6	1# 6	1	4# 5	3.77	103C	6	-	149	2.77	103C	5	-	162	2.12	103C	5	-	176	1.68	093C	5	-	184	57	2230
				1			143C	22	1.0	200		173C	22	1.0	237		193C	21	1.0	266		223C	21	1.0	303	54	
		2# 6	2# 6	1	4# 7	5.73	133C	6	-	220	4.21	143C	5	-	247	3.23	153C	5	-	273	2.55	153C	5	-	294	75	3056
				1			144C	22	1.0	364		173C	22	1.0	299		193C	21	1.0	335		223C	21	1.0	379	99	
		3# 6	3# 6	1	4# 8	8.31	143C	6	-	287	6.10*	163C	5	-	327	4.67*	173C	5	-	362	3.69*	183C	5	-	397	108	2853
				1			144C	22	1.0	425		174C	22	1.0	500		194C	21	1.0	561		224C	21	1.0	636	125	
		4# 6	4# 6	1	4# 9	10.58	144C	6	-	431	7.77*	173C	5	-	408	5.95*	193C	5	-	457	4.70*	203C	5	-	501	139	2476
				1			144C	22	1.0	490		174C	22	1.0	575		194C	21	1.0	644		224C	21	1.0	729	152	
	36	2# 6	2# 6	1	5# 6	5.86	113C	9	-	213	4.31	N/A	9	-	160	3.30	N/A	9	-	180	2.61	N/A	9	-	200	76	1576
				1			243A	38	1.5	367		283A	37	1.5	425		323A	36	1.5	483		363A	36	1.5	540	94	
		3# 6	2# 6	1	5# 7	7.25	123C	9	-	265	5.33	133C	9	-	298	4.08	N/A	9	-	238	3.22	N/A	9	-	264	94	1933
				1			243A	38	1.5	412		283A	37	1.5	476		323A	36	1.5	540		363A	36	1.5	605	125	
		5# 6	4# 6	1	5# 9	12.46	144C	9	-	508	9.16*	163C	9	-	477	7.01*	173C	9	-	529	5.54*	183C	9	-	581	163	1880
				1			244A	38	1.5	774		174C	37	1.5	688		323A	36	1.5	719		363A	36	1.5	802	195	
		6# 6	5# 6	1	5#10	14.87	144C	9	-	591	10.93*	174C	9	-	687	8.37*	183C	9	-	640	6.61*	203C	9	-	710	194	1671
				1			244A	38	1.5	857		284A	37	1.5	988		194C	36	1.5	876		363A	36	1.5	918	237	
	48	3# 6	3# 6	1	6# 6	7.95	113C	13	-	273	5.84	N/A	13	-	217	4.47	N/A	13	-	244	3.53	N/A	13	-	271	114	1216
				1			**	54	5.4	189		**	53	5.4	217		**	52	5.3	244		**	51	5.3	271	114	
		4# 6	3# 6	1	6# 8	10.12	123C	13	-	369	7.44	133C	13	-	415	5.69	133C	13	-	454	4.50	N/A	13	-	393	132	1445
				1			**	54	5.4	277		**	53	5.4	316		**	52	5.3	354		**	51	5.3	393	194	
		6# 6	6# 6	1	6# 9	16.56	144C	13	-	619	12.17*	164C	13	-	706	9.32*	173C	13	-	655	7.36*	183C	13	-	721	217	1461
				1			244A	54	2.1	936		284A	53	2.0	1081		194C	52	2.0	941		**	51	5.3	583	238	
		8# 6	7# 6	1	6#10	20.16	164AdC	13	-	761	14.81*	174C	13	-	848	11.34*	184C	13	-	936	8.96*	203C	13	-	893	264	1292
				1			244A	54	2.1	1048		284A	53	2.0	1208		324A	52	2.0	1368		224C	51	2.0	1222	290	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

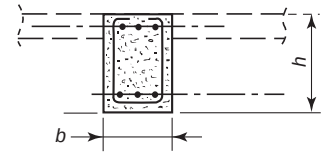
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

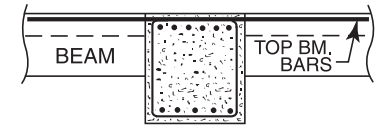
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, END SPANS





STEM		BARS(1)				TOTAL CAPACITY $U = 1.2D + 1.6L$(3)																$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	(6)	(7) $\times 10^{-9}$
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft.-kips	sq. in.	lb.	ft.-kip	in.
12.5	24	2# 6	1# 6	1	4# 5	1.36	083C	5	-	192	1.12	073C	5	-	199	0.94	053C	5	-	202	0.80	N/A	5	-	187	57	2230
				1			243C	21	1.0	331		263C	21	1.0	360		293C	21	1.0	397		313C	21	1.0	426	54	
		2# 7	1# 7	1	4# 7	2.09*	163C	5	-	326	1.73*	163C	5	-	347	1.45*	153C	5	-	363	1.24*	153C	5	-	384	76	3079
				1			243C	21	1.0	421		263C	21	1.0	457		293C	21	1.0	502		313C	21	1.0	539	99	
		2# 9	1# 9	1	4# 8	3.14X	253B	5	-	495	2.60X	263B	5	-	532	2.18X	273B	5	-	570	1.86X	283B	5	-	607	119	2811
				1			303B	21	1.0	585		333B	21	1.0	640		363B	21	1.0	695		393B	21	1.0	750	125	
		2#10	1#10	1	4# 9	3.81X	273B	5	-	603	3.15X	283B	5	-	649	2.65X	303B	5	-	701	2.25Y	313B	5	-	748	145	2480
				1			303B	21	1.0	682		333B	21	1.0	746		363B	21	1.0	810		393B	21	1.0	873	152	
	36	2# 6	2# 6	1	5# 6	2.11	N/A	9	-	220	1.74	N/A	9	-	240	1.47	N/A	9	-	260	1.25	N/A	9	-	280	76	1576
				1			403A	36	1.5	598		443A	35	1.5	656		**	35	0.0	260		**	35	0.0	280	94	
		2# 8	2# 8	1	5# 7	3.15*	N/A	9	-	350	2.60*	N/A	9	-	382	2.19*	N/A	9	-	414	1.86*	N/A	9	-	445	131	2088
				1			403A	36	1.5	728		443A	35	1.5	798		483A	35	1.4	868		523A	35	1.4	938	125	
		2# 9	2# 9	1	5# 9	4.43*	243B	9	-	666	3.66X	253B	9	-	718	3.08X	263B	9	-	769	2.62X	263B	9	-	815	161	1904
				1			403A	36	1.5	885		443A	35	1.5	968		483A	35	1.4	1051		523A	35	1.4	1134	195	
		2#10	2#10	1	5#10	5.42X	263B	9	-	817	4.48X	283B	9	-	888	3.76X	293B	9	-	952	3.21Y	303B	9	-	1016	197	1691
				1			403A	36	1.5	1023		443A	35	1.5	1118		483A	35	1.4	1214		523A	35	1.4	1309	237	
	48	3# 6	3# 6	1	6# 6	2.86	N/A	13	-	299	2.37	N/A	13	-	326	1.99	N/A	13	-	354	1.69	N/A	12	-	381	114	1216
				1			**	51	5.4	299		**	50	0.0	326		**	50	0.0	354		**	50	0.0	381	114	
		3# 7	3# 7	1	6# 8	4.19*	N/A	13	-	463	3.46*	N/A	13	-	505	2.91*	N/A	13	-	547	2.48*	N/A	12	-	588	152	1554
				1			**	51	5.4	463		**	50	5.4	505		**	50	5.3	547		**	50	5.3	588	194	
		3# 9	3# 9	1	6# 9	5.96*	243B	13	-	870	4.93X	253B	13	-	940	4.14X	263B	13	-	1010	3.53X	273B	12	-	1079	238	1428
				1			**	51	2.1	687		**	50	2.0	749		**	50	2.0	811		**	50	5.3	873	238	
		3#10	3#10	1	6#10	7.26X	263B	13	-	1073	6.00X	283B	13	-	1167	5.04X	293B	13	-	1253	4.29Y	303B	12	-	1339	290	1266
				1			**	51	2.1	874		**	50	2.0	953		**	50	2.0	1031		**	50	2.0	1110	290	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

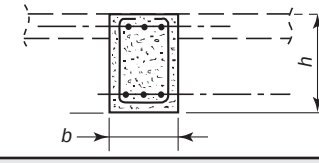
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

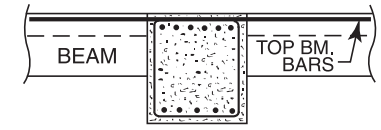
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 12 ft					SPAN, ℓ_n = 14 ft.					SPAN, ℓ_n = 16 ft.					SPAN, ℓ_n = 18 ft.					(6)	(7)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	ft.-kip	$\times 10^{-9}$ in.
14.5	24	2# 6	1# 6	1	4# 6	5.28	103D	7	-	171	3.88	103D	7	-	187	2.97	103D	7	-	202	2.35	103D	7	-	218	69	1491
				1			143C	29	1.2	225		173C	28	1.2	265		193C	28	1.1	297		223C	28	1.1	337	90	
		2# 6	2# 6	1	4# 7	6.94	113D	7	-	215	5.10	123D	7	-	242	3.91	123D	7	-	262	3.09	133D	7	-	289	90	1866
				1			144C	29	1.2	377		173C	28	1.2	307		193C	28	1.1	345		223C	28	1.1	390	120	
		4# 6	3# 6	1	4# 9	11.64	124D	7	-	403	8.55	143D	7	-	379	6.55	153D	7	-	421	5.17*	173D	7	-	469	152	1672
				1			125D	29	1.2	580		144D	28	1.2	522		164D	28	1.1	591		224C	28	1.1	725	188	
		10# 4	9# 4	2	4#10	13.25	144C	7	-	495	9.73	173C	7	-	473	7.45*	193C	7	-	530	5.89*	213C	7	-	587	173	1537
				1			145C	29	1.2	702		174C	28	1.2	648		194C	28	1.1	725		224C	27	1.1	819	228	
	36	2# 6	2# 6	1	5# 7	7.07	093D	12	-	230	5.20	N/A	12	-	189	3.98	N/A	12	-	212	3.14	N/A	12	-	235	92	812
				1			243A	50	1.8	405		283A	49	1.7	468		323A	48	1.7	531		363A	47	1.7	594	152	
		3# 6	3# 6	1	5# 8	10.42	113D	12	-	311	7.65	123D	12	-	351	5.86	123D	12	-	383	4.63	133D	12	-	423	136	1218
				1			124D	50	1.8	468		283A	49	1.7	544		323A	48	1.7	617		363A	47	1.7	689	196	
		6# 6	5# 6	1	5#10	18.20	124D	12	-	576	13.37	144D	12	-	660	10.24	164D	12	-	745	8.09*	173D	12	-	699	238	1089
				1			125D	50	1.8	790		145D	49	1.7	910		165D	48	1.7	1030		185D	47	1.7	1150	294	
		7# 6	6# 6	1	5#11	21.08	125D	12	-	769	15.49	144D	12	-	762	11.86*	164D	12	-	858	9.37*	174D	12	-	939	276	978
				1			245A	50	1.8	1262		145D	49	1.7	1011		165D	48	1.7	1143		185D	47	1.7	1274	342	
	48	3# 6	3# 6	1	6# 7	10.56	103D	18	-	302	7.76	N/A	18	-	252	5.94	N/A	17	-	283	4.69	N/A	17	-	314	138	744
				1			**	72	5.4	221		**	70	0.0	252		**	69	0.0	283		**	68	0.0	314	184	
		4# 6	4# 6	1	6# 8	13.89	113D	18	-	383	10.20	123D	18	-	433	7.81	123D	17	-	474	6.17	133D	17	-	523	181	940
				1			**	72	5.4	294		**	70	5.4	335		**	69	5.3	376		**	68	5.3	417	237	
		7# 6	7# 6	1	6#10	23.28	125D	18	-	807	17.10	144D	18	-	794	13.09	154D	17	-	879	10.35*	174D	17	-	980	304	856
				1			245A	72	2.4	1383		145D	70	2.3	1086		195C	69	2.3	1339		224C	68	2.2	1213	358	
		9# 6	9# 6	1	6#11	29.05	244A	18	-	1019	21.34	145D	18	-	1083	16.34*	165D	17	-	1221	12.91*	184D	17	-	1188	380	753
				1			245A	72	2.4	1520		285A	70	2.3	1754		325A	69	2.3	1989		185D	68	2.2	1563	424	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b - 2''$).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360 <$ deflection $< \ell_n/240$
X – $\ell_n/240 <$ deflection $< \ell_n/180$
Y – deflection $> \ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b > 24$ in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
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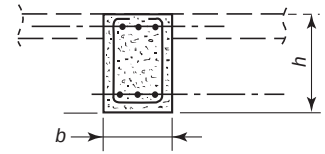
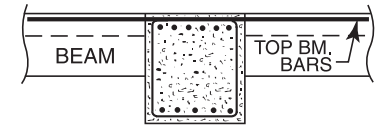
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as $w/1.4$.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
14.5	24	2# 7	1# 7	1	4# 6	2.27	123D	7	-	278	1.88	123D	7	-	297	1.58	113D	7	-	310	1.34	113D	7	-	329	92	1819
				1			243C	27	1.1	402		263C	27	1.1	437		293C	27	1.1	480		313C	27	1.1	516	90	
		2# 8	1# 8	1	4# 7	3.02*	153D	7	-	365	2.49*	163D	7	-	396	2.10*	163D	7	-	421	1.79*	163D	7	-	446	118	1967
				1			243C	27	1.1	470		263C	27	1.1	512		293C	27	1.1	561		313C	27	1.1	602	120	
		2#10	1#10	1	4# 9	4.71*	223C	7	-	586	3.89*	233C	7	-	633	3.27X	243C	7	-	680	2.79X	253C	7	-	726	179	1614
				1			244C	27	1.1	844		264C	27	1.1	918		294C	27	1.1	1008		314C	27	1.1	1081	188	
		2#10	1#10	1	4#10	4.93*	223C	7	-	640	4.08*	243C	7	-	698	3.43X	253C	7	-	749	2.92X	263C	7	-	799	179	1498
				1			244C	27	1.1	899		264C	27	1.1	976		294C	27	1.1	1071		314C	27	1.1	1148	228	
	36	2# 7	2# 7	1	5# 7	3.41	N/A	12	-	301	2.82	N/A	12	-	328	2.37	N/A	12	-	355	2.02	N/A	11	-	383	123	1211
				1			403A	47	1.7	699		443A	46	1.7	766		483A	46	1.6	834		523A	46	1.6	901	152	
		2# 9	2# 9	1	5# 8	4.90*	193C	12	-	588	4.05*	193C	12	-	629	3.40*	203C	11	-	677	2.90*	N/A	11	-	575	197	1282
				1			403A	47	1.7	851		443A	46	1.7	932		483A	46	1.6	1013		523A	46	1.6	1093	196	
		2#10	2#10	1	5#10	6.68*	213C	12	-	795	5.52*	233C	12	-	866	4.64X	243C	11	-	931	3.95X	253C	11	-	995	242	1097
				1			403A	47	1.7	1043		443A	46	1.7	1140		483A	46	1.6	1238		523A	46	1.6	1335	294	
		3#10	2#10	1	5#11	8.10*	233C	12	-	977	6.69*	243C	12	-	1056	5.63X	263C	11	-	1142	4.79X	273C	11	-	1221	294	970
				1			244C	47	1.7	1283		264C	46	1.6	1394		483A	46	1.6	1434		523A	46	1.6	1546	342	
	48	3# 7	3# 7	1	6# 7	4.62	N/A	17	-	409	3.82	N/A	17	-	446	3.21	N/A	17	-	483	2.73	N/A	16	-	521	184	924
				1			**	67	5.4	409		**	67	0.0	446		**	66	0.0	483		**	66	0.0	521	184	
		3# 8	3# 8	1	6# 8	5.93*	153D	17	-	659	4.90*	153D	17	-	708	4.12*	N/A	17	-	634	3.51*	N/A	16	-	683	237	983
				1			**	67	5.4	537		**	67	5.4	585		**	66	5.3	634		**	66	5.3	683	237	
		3#10	3#10	1	6#10	8.97*	213C	17	-	1045	7.41*	233C	17	-	1140	6.23X	243C	17	-	1227	5.31X	253C	16	-	1313	358	822
				1			244C	67	2.2	1422		264C	66	2.2	1546		**	66	2.3	1031		**	66	2.2	1110	358	
		3#10	3#10	1	6#11	9.87*	224C	17	-	1315	8.15*	243C	17	-	1248	6.85X	253C	17	-	1342	5.84X	263C	16	-	1436	358	777
				1			245C	67	2.2	1847		264C	66	2.2	1646		294C	66	2.2	1800		**	66	2.2	1224	424	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

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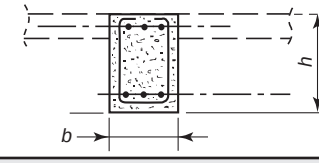
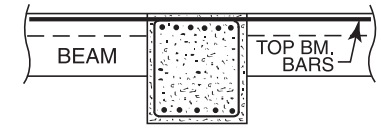
JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 16 ft					SPAN, ℓ_n = 18 ft.					SPAN, ℓ_n = 20 ft.					SPAN, ℓ_n = 22 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
16.5	24	2# 7	1# 7	1	4# 7	4.66	113E	9	-	266	3.69	123E	9	-	294	2.99	123E	9	-	315	2.47	123E	8	-	337	108	1206
				1			193C	35	1.3	359		223C	35	1.3	406		243C	34	1.3	445		263C	34	1.3	484	142	
		2# 8	1# 8	1	4# 8	6.02	123E	9	-	334	4.75	133E	9	-	368	3.85	143E	9	-	403	3.18	143E	8	-	431	140	1263
				1			194C	35	1.3	583		224C	34	1.3	663		243C	34	1.3	519		263C	34	1.3	564	182	
		3# 8	2# 8	1	4#10	9.58	144E	9	-	604	7.57	153E	9	-	566	6.13*	163E	9	-	618	5.07*	183E	8	-	677	223	1022
				1			145E	35	1.3	817		165E	34	1.3	919		175E	34	1.3	993		194E	34	1.2	886	274	
		8# 5	7# 5	2	4#10	10.54	164D	9	-	664	8.33*	184D	9	-	740	6.74*	203D	8	-	687	5.57*	213D	8	-	743	245	1018
				1			165D	35	1.3	908		185D	34	1.3	1014		205D	34	1.3	1121		224D	34	1.2	984	274	
	36	2# 8	2# 8	1	5# 7	7.03	113E	15	-	370	5.55	123E	15	-	409	4.50	N/A	15	-	350	3.72	N/A	15	-	382	188	817
				1			323A	61	1.9	621		363A	60	1.9	694		403A	59	1.9	768		443A	59	1.9	842	179	
		2# 8	2# 8	1	5# 9	8.08	123E	15	-	461	6.38	133E	15	-	509	5.17	133E	15	-	549	4.27	133E	15	-	588	188	807
				1			323A	61	1.9	704		363A	60	1.9	786		403A	59	1.9	868		443A	59	1.9	949	285	
		4# 8	3# 8	1	5#10	13.52	144E	15	-	765	10.68	154E	15	-	841	8.65*	164E	15	-	916	7.15*	173E	15	-	868	314	740
				1			145E	61	1.9	1021		165E	60	1.9	1148		205D	59	1.9	1341		224D	59	1.9	1189	351	
		5# 8	4# 8	1	5#11	16.29	145E	15	-	1042	12.87*	164E	15	-	1021	10.43*	174E	15	-	1112	8.62*	184E	15	-	1204	392	645
				1			245B	61	1.9	1503		275B	60	1.9	1679		175E	59	1.9	1423		195E	59	1.8	1566	417	
	48	3# 7	3# 7	1	6# 8	9.33	113E	22	-	475	7.37	123E	22	-	526	5.97	N/A	21	-	463	4.93	N/A	21	-	505	217	606
				1			**	88	5.4	380		**	87	0.0	422		**	86	0.0	463		**	85	0.0	505	280	
		3# 8	3# 8	1	6# 9	12.03	123E	22	-	598	9.51	133E	22	-	660	7.70	143E	21	-	723	6.36	143E	21	-	776	280	645
				1			194C	88	2.6	945		**	87	5.4	548		**	86	5.3	601		**	85	5.3	655	346	
		5# 8	4# 8	1	6#11	17.45	145E	22	-	1146	13.79	154E	22	-	1105	11.17*	164E	21	-	1204	9.23*	174E	21	-	1303	406	543
				1			245B	88	2.6	1685		275B	87	2.5	1882		175E	86	2.5	1583		264C	85	2.5	1636	508	
		6# 8	6# 8	1	7#11	22.47	165BdE	22	-	1387	17.75*	165E	22	-	1491	14.38*	175E	21	-	1621	11.88*	185E	21	-	1751	522	476
				1			245B	88	2.6	1873		275B	87	2.5	2090		305B	86	2.5	2308		335B	85	2.5	2526	579	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b - 2''$).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360 <$ deflection $< \ell_n/240$
X – $\ell_n/240 <$ deflection $< \ell_n/180$
Y – deflection $> \ell_n/180$

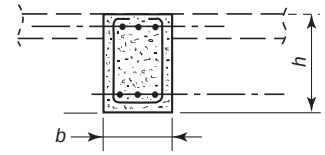
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b > 24$ in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

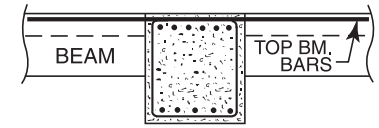
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as $w/1.4$.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
16.5	24	2# 7	1# 7	1	4# 7	2.07	123E	8	-	358	1.77	113E	8	-	373	1.52	113E	8	-	394	1.33	103E	8	-	409	108	1206
				1			293C	33	1.2	531		313C	33	1.2	570		343C	33	1.2	617		363C	33	1.2	656	142	
		2# 9	1# 9	1	4# 8	3.17*	193D	8	-	544	2.70*	193D	8	-	576	2.33*	203D	8	-	614	2.03*	203D	8	-	646	173	1257
				1			293C	33	1.2	670		313C	33	1.2	720		343C	33	1.2	778		363C	33	1.2	827	182	
		2#10	1#10	1	4#10	4.08*	213D	8	-	734	3.48*	223D	8	-	786	3.00*	233D	8	-	837	2.61X	243D	8	-	889	213	1040
				1			294C	33	1.2	1097		314C	33	1.2	1177		344C	33	1.2	1273		363C	33	1.2	1043	274	
		2#11	1#11	1	4#10	4.76*	223D	8	-	813	4.06X	233D	8	-	871	3.50X	243D	8	-	928	3.05X	253D	8	-	985	254	989
				1			244D	33	1.2	1083		314C	33	1.2	1255		344C	33	1.2	1357		364C	33	1.2	1442	274	
	36	2# 8	2# 8	1	5# 7	3.12	N/A	15	-	414	2.66	N/A	14	-	445	2.29	N/A	14	-	477	2.00	N/A	14	-	509	188	817
				1			483A	58	1.9	916		523A	58	1.8	990		563A	57	1.8	1063		603A	57	1.8	1137	179	
		2# 9	2# 9	1	5# 9	4.45*	183D	15	-	734	3.79*	193D	14	-	787	3.27*	193D	14	-	833	2.85*	N/A	14	-	733	233	841
				1			483A	58	1.9	1099		523A	58	1.8	1186		563A	57	1.8	1273		603A	57	1.8	1361	285	
		2#11	2#11	1	5#10	6.11*	213D	14	-	1014	5.20*	223D	14	-	1086	4.49X	233D	14	-	1159	3.91X	243D	14	-	1232	344	723
				1			244D	58	1.8	1346		264D	58	1.8	1452		563A	57	1.8	1569		603A	57	1.8	1676	351	
		3#11	2#11	1	5#11	7.24*	223D	14	-	1244	6.17*	233D	14	-	1333	5.32X	253D	14	-	1429	4.63X	263D	14	-	1519	417	635
				1			245D	58	1.8	1872		265D	58	1.8	2020		284D	57	1.8	1813		304D	57	1.8	1936	417	
	48	3# 7	3# 7	1	6# 8	4.15	N/A	21	-	547	3.53	N/A	21	-	588	3.05	N/A	21	-	630	2.65	N/A	21	-	672	217	606
				1			**	84	5.4	547		**	83	0.0	588		**	83	0.0	630		**	82	0.0	672	280	
		3# 9	3# 9	1	6# 9	6.02*	183D	21	-	967	5.13*	193D	21	-	1037	4.42*	193D	21	-	1099	3.85*	N/A	21	-	997	346	632
				1			**	84	2.6	811		**	83	5.4	873		**	83	5.3	935		**	82	5.3	997	346	
		3#10	3#10	1	6#11	8.16*	213D	21	-	1320	6.95*	223D	21	-	1414	6.00X	233D	21	-	1508	5.22X	243D	21	-	1603	427	539
				1			294C	84	2.5	1827		314C	83	2.4	1960		**	83	2.5	1310		**	82	2.5	1395	508	
		3#11	3#11	1	7#11	9.71*	224D	21	-	1737	8.28X	234D	21	-	1857	7.14X	253D	21	-	1791	6.22X	263D	21	-	1903	508	485
				1			245D	84	2.4	2283		315C	83	2.4	2652		344C	83	2.4	2382		364C	82	2.4	2533	579	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation: N/A – STIRRUPS ARE NOT REQUIRED
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(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
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$f_c' = 4{,}000$ psi
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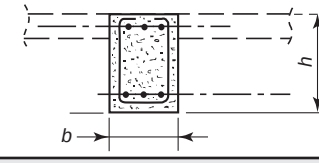
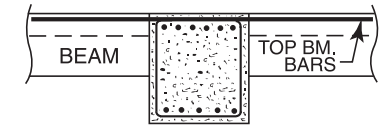
JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 16 ft					SPAN, ℓ_n = 18 ft.					SPAN, ℓ_n = 20 ft.					SPAN, ℓ_n = 22 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
18.5	24	2# 8	1# 8	1	4# 7	6.40	113F	11	-	302	5.06	113F	11	-	327	4.10	123F	10	-	359	3.39	123F	10	-	384	161	902
				1			124F	43	1.5	442		144F	42	1.4	504		243C	41	1.4	494		263C	41	1.4	538	163	
		2# 8	1# 8	1	4# 8	6.93	113F	11	-	333	5.48	123F	11	-	368	4.44	123F	10	-	395	3.67	133F	10	-	430	161	886
				1			125F	43	1.5	611		144F	42	1.4	537		244C	41	1.4	747		263C	41	1.4	577	210	
		7# 5	6# 5	2	4#10	10.87	144E	11	-	618	8.59	153E	10	-	575	6.96	173E	10	-	635	5.75*	183E	10	-	687	253	766
				1			145E	43	1.5	838		165E	42	1.4	943		175E	41	1.4	1018		195E	41	1.4	1124	319	
		9# 5	8# 5	2	4#11	13.74	323A	11	-	769	10.86	164E	10	-	822	8.79*	174E	10	-	894	7.27*	194E	10	-	980	319	668
				1			324A	43	1.5	1124		165E	42	1.4	1074		175E	41	1.4	1162		195E	41	1.4	1279	379	
	36	2# 8	2# 8	1	5# 8	9.30	113F	19	-	414	7.35	113F	18	-	449	5.95	123F	18	-	493	4.92	123F	18	-	529	216	589
				1			323A	75	2.2	675		363A	74	2.2	754		403A	73	2.1	834		443A	72	2.1	913	267	
		3# 8	2# 8	1	5# 9	11.48	113F	19	-	504	9.07	123F	18	-	558	7.35	133F	18	-	611	6.07	133F	18	-	656	267	597
				1			165D	75	2.2	968		184D	74	2.1	846		403A	73	2.1	944		443A	72	2.1	1033	330	
		4# 8	4# 8	1	5#11	17.66	125F	19	-	965	13.95	144F	18	-	953	11.30	154F	18	-	1040	9.34*	164F	18	-	1127	410	488
				1			195C	75	2.2	1318		225C	74	2.1	1493		245C	73	2.1	1633		175F	72	2.1	1462	487	
		13# 5	12# 5	2	6#11	20.24	324A	19	-	1308	15.99	165E	18	-	1294	12.96	175E	18	-	1405	10.71*	194E	18	-	1361	471	448
				1			324A	75	2.2	1487		275B	73	2.1	1822		305B	72	2.1	2012		335B	72	2.1	2202	568	
	48	3# 8	3# 8	1	6# 8	12.61	113F	27	-	540	9.96	113F	27	-	589	8.07	123F	27	-	646	6.67	123F	26	-	695	322	447
				1			**	110	5.4	439		**	108	0.0	488		**	106	0.0	537		**	105	0.0	585	322	
		3# 8	3# 8	1	6#10	13.87	113F	27	-	663	10.96	123F	27	-	733	8.87	123F	27	-	793	7.33	133F	26	-	862	322	421
				1			194C	110	2.9	1031		**	108	5.4	623		**	106	5.3	683		**	105	5.3	743	495	
		6# 8	5# 8	1	6#11	23.16	125F	27	-	1193	18.30	145F	27	-	1342	14.82	155F	27	-	1463	12.25*	164F	26	-	1416	563	375
				1			245B	110	2.9	1802		275B	108	2.8	2013		305B	106	2.8	2224		335B	105	2.8	2435	592	
		17# 5	16# 5	2	6#14	26.74	324A	27	-	1686	21.13	165E	27	-	1690	17.11	175E	26	-	1836	14.14*	195E	26	-	2011	622	331
				1			325A	109	2.9	2384		275B	107	2.8	2305		305B	106	2.8	2542		335B	104	2.7	2778	800	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
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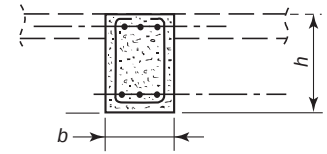
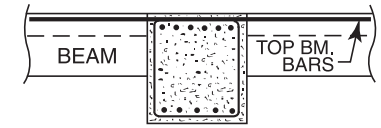
JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES (5)	ϕT_n	$A\ell$	STEEL WGT	(6)	(7) $\times 10^{-9}$
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft-kips	sq. in.	lb.	k/ft		ft.-kips	sq. in.	lb.	ft.-kip	in.
18.5	24	2# 8	1# 8	1	4# 7	2.85	123F	10	-	409	2.43	123F	10	-	434	2.09	123F	10	-	459	1.82	123F	10	-	483	161	902
				1			293C	41	1.4	590		313C	40	1.4	634		343C	40	1.4	686		363C	40	1.4	729	163	
		2# 9	1# 9	1	4# 8	3.66	163E	10	-	532	3.12*	173E	10	-	571	2.69*	173E	10	-	603	2.34*	183E	10	-	642	200	902
				1			294C	41	1.4	946		313C	40	1.4	735		343C	40	1.4	795		363C	40	1.4	845	210	
		2#11	1#11	1	4#10	5.56*	193E	10	-	803	4.73*	203E	10	-	861	4.08*	213E	10	-	918	3.56*	223E	10	-	976	296	722
				1			215E	41	1.4	1291		224E	40	1.4	1119		244E	40	1.4	1206		264E	40	1.4	1293	319	
		2#11	2#11	1	4#11	6.58*	204E	10	-	1133	5.61*	213E	10	-	1068	4.84*	223E	10	-	1139	4.21X	233E	10	-	1211	379	617
				1			215E	41	1.4	1477		225E	40	1.4	1571		245E	40	1.4	1696		265E	40	1.4	1820	379	
	36	2# 8	2# 8	1	5# 8	4.13	123F	18	-	564	3.52	123F	18	-	600	3.04	123F	18	-	635	2.65	123F	17	-	671	216	589
				1			483A	71	2.1	993		523A	71	2.1	1072		563A	70	2.0	1152		603A	70	2.0	1231	267	
		2#10	2#10	1	5# 9	5.75	173E	18	-	819	4.90*	173E	18	-	871	4.22*	183E	18	-	932	3.68*	183E	17	-	984	334	581
				1			483A	71	2.1	1207		523A	71	2.1	1303		563A	70	2.0	1399		603A	70	2.0	1495	330	
		2#11	2#11	1	5#11	7.65*	193E	18	-	1097	6.52*	203E	18	-	1176	5.62*	213E	18	-	1255	4.90*	213E	17	-	1326	400	495
				1			245D	71	2.1	1773		264D	71	2.0	1571		284D	70	2.0	1685		304D	70	2.0	1798	487	
		3#11	2#11	1	6#11	9.31*	204E	18	-	1482	7.93*	214E	18	-	1585	6.84*	224E	18	-	1688	5.96X	233E	17	-	1615	487	436
				1			215E	71	2.0	1891		225E	71	2.0	2014		285D	70	2.0	2309		305D	70	2.0	2466	568	
	48	3# 8	3# 8	1	6# 8	5.60	N/A	26	-	634	4.77	N/A	26	-	683	4.12	N/A	26	-	732	3.59	N/A	25	-	780	322	447
				1			**	104	5.4	634		**	103	0.0	683		**	102	0.0	732		**	102	0.0	780	322	
		3# 9	3# 9	1	6#10	7.65	173E	26	-	1061	6.52*	173E	26	-	1129	5.62*	183E	26	-	1207	4.89*	183E	25	-	1275	400	433
				1			**	104	2.9	905		**	103	5.4	974		**	102	5.3	1042		**	102	5.3	1110	495	
		3#11	3#11	1	6#11	10.29*	194E	26	-	1615	8.77*	204E	26	-	1729	7.56*	213E	26	-	1665	6.59*	213E	25	-	1762	592	371
				1			215E	104	2.7	2108		314C	103	2.7	2140		344C	102	2.7	2311		364C	101	2.7	2458	592	
		4#11	3#11	1	6#14	12.94*	205E	26	-	2229	11.02*	214E	26	-	2161	9.51*	224E	26	-	2302	8.28X	234E	25	-	2444	677	317
				1			365B	104	2.7	3087		395B	103	2.7	3329		425B	102	2.7	3571		265E	101	2.7	3064	800	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

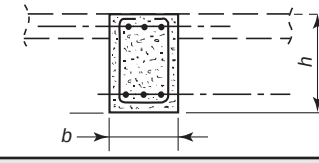
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

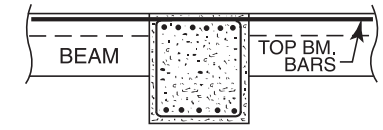
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.					(6)	(7)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	ft.-kip	$\times 10^{-9}$ in.
20.5	24	2# 8	1# 8	1	4# 7	4.64	113G	12	-	357	3.83	113G	12	-	382	3.22	113G	12	-	407	2.74	113G	12	-	432	182	633
				1			144G	49	1.6	541		154G	49	1.6	585		293C	48	1.6	605		313C	48	1.5	649	185	
		2#10	1#10	1	4# 9	7.41	143F	12	-	558	6.12	153F	12	-	606	5.15	163F	12	-	654	4.38*	173F	12	-	703	282	615
				1			155F	49	1.6	918		175F	49	1.6	1020		185F	48	1.5	1092		205F	48	1.5	1195	296	
		2#10	2#10	1	4#11	10.06	154F	12	-	868	8.31	174F	12	-	955	6.98*	184F	12	-	1027	5.95*	193F	12	-	961	365	498
				1			155F	49	1.6	1112		175F	49	1.6	1231		185F	48	1.5	1319		205F	48	1.5	1438	435	
		3#10	2#10	1	5#11	12.20	303B	12	-	1042	10.09	174F	12	-	1138	8.48*	184F	12	-	1224	7.22*	194F	12	-	1311	443	430
				1			304B	49	1.6	1387		265C	49	1.6	1693		295C	48	1.5	1859		205F	48	1.5	1650	519	
	36	2# 9	2# 9	1	5# 8	7.57	123F	22	-	556	6.25	133F	22	-	606	5.26	133F	21	-	647	4.48	133F	21	-	688	305	435
				1			403A	88	2.4	911		443A	86	2.3	998		483A	85	2.3	1085		523A	85	2.3	1172	302	
		2#10	2#10	1	5#10	10.45	143F	22	-	766	8.63	153F	22	-	832	7.26	163F	21	-	898	6.18	163F	21	-	955	379	413
				1			155F	88	2.3	1184		225D	86	2.3	1494		244D	85	2.3	1296		264D	85	2.3	1398	466	
		3#10	3#10	1	5#11	13.94	154F	22	-	1141	11.52	164F	22	-	1237	9.68*	174F	21	-	1333	8.25*	184F	21	-	1429	548	352
				1			245C	88	2.3	1753		265C	86	2.3	1905		295C	85	2.3	2092		205F	85	2.3	1848	557	
		4#10	3#10	1	5#14	17.26	155F	22	-	1566	14.26	175F	22	-	1721	11.98*	185F	21	-	1850	10.21*	194F	21	-	1788	627	299
				1			245C	88	2.3	2028		265C	86	2.3	2202		295C	85	2.3	2411		315C	85	2.3	2585	754	
	48	3# 8	3# 8	1	6# 9	10.05	113G	32	-	708	8.30	123G	32	-	771	6.98	123G	31	-	825	5.95	N/A	31	-	763	365	323
				1			**	129	5.4	601		**	127	0.0	655		**	125	0.0	709		**	124	0.0	763	454	
		3#10	3#10	1	6#10	14.11	144F	32	-	1134	11.66	154F	32	-	1231	9.80	163F	31	-	1186	8.35	163F	31	-	1264	564	310
				1			175E	128	3.1	1569		195E	127	3.1	1729		294C	125	3.0	1773		314C	124	3.0	1902	564	
		4#10	4#10	1	7#11	19.40	155F	32	-	1656	16.03	165F	32	-	1793	13.47*	175F	31	-	1931	11.48*	184F	31	-	1870	731	260
				1			305B	128	3.1	2438		335B	127	3.1	2668		365B	125	3.0	2899		395B	124	3.0	3129	775	
		5#10	4#10	1	6#14	22.30	175CfF	32	-	1949	18.43	175F	32	-	2076	15.48*	185F	31	-	2232	13.19*	195F	31	-	2388	810	236
				1			305B	128	3.1	2672		335B	127	3.1	2921		365B	125	3.0	3171		395B	124	3.0	3420	921	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b - 2''$).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360 <$ deflection $< \ell_n/240$
X – $\ell_n/240 <$ deflection $< \ell_n/180$
Y – deflection $> \ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b > 24$ in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
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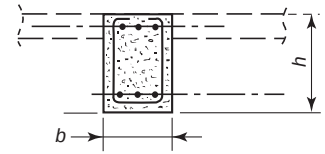
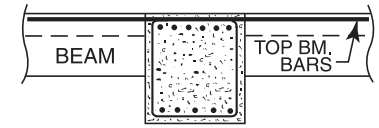
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as $w/1.4$.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 28 ft					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.					SPAN, ℓ_n = 34 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7) $\times 10^{-9}$
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	in.
20.5	24	2# 8	1# 8	1	4# 7	2.37	113G	12	-	457	2.06	113G	12	-	482	1.81	113G	12	-	507	1.61	103G	12	-	524	182	633
				1			343C	47	1.5	703		363C	47	1.5	747		383C	47	1.5	792		413C	47	1.5	846	185	
		2#10	1#10	1	4# 9	3.78*	173F	12	-	743	3.29*	183F	12	-	792	2.89*	183F	12	-	832	2.56*	193F	12	-	880	282	615
				1			214F	47	1.5	1015		234F	47	1.5	1094		383C	47	1.5	1064		413C	47	1.5	1133	296	
		2#11	1#11	1	4#11	4.75*	193F	12	-	995	4.14*	203F	12	-	1058	3.64*	203F	12	-	1113	3.22*	213F	12	-	1176	338	510
				1			215F	47	1.5	1503		235F	47	1.5	1620		245F	47	1.5	1707		264F	47	1.5	1513	435	
		2#14	1#14	1	5#11	6.47*	214F	12	-	1458	5.63*	224F	12	-	1548	4.95*	233F	12	-	1471	4.39X	243F	12	-	1554	460	427
				1			215F	47	1.5	1799		235F	47	1.5	1936		245F	47	1.5	2042		265F	47	1.5	2179	519	
	36	2# 9	2# 9	1	5# 8	3.86	143F	21	-	737	3.36	133F	21	-	770	2.96	133F	21	-	811	2.62	133F	21	-	852	305	435
				1			563A	84	2.3	1259		603A	83	2.2	1346		643A	83	2.2	1433		683A	83	2.2	1519	302	
		2#10	2#10	1	5#10	5.33*	173F	21	-	1021	4.64*	173F	21	-	1078	4.08*	183F	21	-	1144	3.62*	183F	21	-	1202	379	413
				1			563A	84	2.3	1516		603A	83	2.2	1620		643A	83	2.2	1723		683A	82	2.2	1826	466	
		3#11	2#11	1	5#11	7.11*	193F	21	-	1403	6.19*	203F	21	-	1493	5.44*	203F	21	-	1574	4.82*	213F	21	-	1664	557	351
				1			215F	84	2.2	1994		304D	83	2.2	1991		324D	83	2.2	2117		344D	82	2.2	2243	557	
		2#14	2#14	1	5#14	8.78*	204F	21	-	1910	7.65*	214F	21	-	2029	6.72*	224F	21	-	2148	5.95X	234F	21	-	2267	625	302
				1			345C	84	2.2	2799		365C	83	2.2	2973		245F	83	2.2	2643		265F	82	2.2	2817	754	
	48	3# 8	3# 8	1	6# 9	5.13	N/A	31	-	817	4.47	N/A	31	-	871	3.92	N/A	30	-	924	3.48	N/A	30	-	978	365	323
				1			**	123	5.4	817		**	122	0.0	871		**	122	0.0	924		**	121	0.0	978	454	
		3#10	3#10	1	6#10	7.20*	173F	31	-	1352	6.27*	173F	31	-	1431	5.51*	183F	30	-	1519	4.88*	183F	30	-	1598	564	310
				1			**	123	3.1	1188		**	122	3.1	1267		**	122	3.0	1345		**	121	3.0	1424	564	
		3#11	3#11	1	7#11	9.50*	194F	31	-	1928	8.28*	204F	31	-	2050	7.27*	203F	30	-	1975	6.44*	213F	30	-	2087	677	268
				1			245E	123	3.0	2556		364C	122	3.0	2599		384C	122	3.0	2753		414C	121	2.9	2933	775	
		3#14	3#14	1	6#14	11.76*	205F	31	-	2730	10.24*	215F	31	-	2899	9.00*	224F	30	-	2826	7.97X	234F	30	-	2985	921	226
				1			425B	123	3.0	3854		455B	122	3.0	4116		485B	121	2.9	4379		295E	121	2.9	3742	921	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
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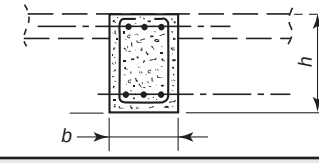
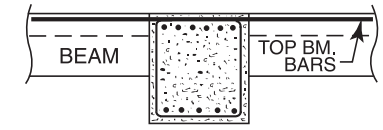
JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
24.5	24	2# 9	1# 9	1	4# 8	7.41	113H	17	-	449	6.12	123H	16	-	489	5.14	123H	16	-	521	4.38	123H	16	-	553	281	383
				1			125H	67	1.9	760		135H	66	1.9	826		155H	65	1.9	926		165H	64	1.9	992	296	
		2#10	1#10	1	4#10	9.65	124H	17	-	706	7.97	133H	16	-	663	6.70	133H	16	-	707	5.71	143H	16	-	761	350	350
				1			175E	67	1.9	1082		135H	66	1.9	991		155H	65	1.9	1103		165H	64	1.9	1182	457	
		3#10	2#10	1	4#11	13.69	125H	17	-	1056	11.31	134H	16	-	1018	9.51	154H	16	-	1118	8.10	164H	16	-	1200	558	289
				1			175E	67	1.9	1311		195E	66	1.9	1445		215E	65	1.9	1578		225E	64	1.8	1678	547	
		8# 6	8# 6	2	4#14	16.26	244C	17	-	1327	13.44	264C	16	-	1441	11.29	155H	16	-	1488	9.62	165H	16	-	1596	591	256
				1			245C	67	1.9	1739		265C	66	1.9	1887		215E	65	1.9	1799		225E	64	1.8	1913	742	
	36	2#10	2#10	1	5# 9	11.65	113H	30	-	683	9.63	123H	30	-	744	8.09	123H	29	-	797	6.89	133H	29	-	858	471	252
				1			175E	121	2.8	1236		195E	119	2.8	1365		155H	117	2.8	1262		165H	116	2.7	1353	465	
		2#10	2#10	1	5#11	12.96	124H	30	-	945	10.71	123H	30	-	901	9.00	133H	29	-	974	7.67	133H	29	-	1037	471	232
				1			175E	121	2.8	1381		195E	119	2.8	1522		215E	117	2.8	1663		225E	116	2.7	1765	697	
		4#10	3#10	1	5#14	21.66	135EdH	30	-	1549	17.90	135H	30	-	1650	15.04	155H	29	-	1811	12.82	165H	29	-	1942	787	187
				1			245C	121	2.8	2095		265C	119	2.8	2274		245D	117	2.8	2298		265D	116	2.7	2477	956	
		5#10	4#10	1	6#14	26.96	245C	30	-	2156	22.28	265C	30	-	2342	18.73	294C	29	-	2239	15.96	175EeH	29	-	2329	980	162
				1			405A	121	2.8	2997		445A	119	2.8	3279		485A	117	2.8	3561		315C	116	2.7	3028	1114	
	48	3# 9	3# 9	1	6#10	15.47	114H	45	-	993	12.78	123H	44	-	965	10.74	123H	43	-	1033	9.15	133H	43	-	1112	562	187
				1			175E	179	3.8	1510		264C	176	3.7	1549		294C	174	3.7	1700		**	172	0.0	974	701	
		3#10	3#10	1	6#11	19.30	125H	45	-	1355	15.95	134H	44	-	1318	13.40	134H	43	-	1404	11.42	144H	43	-	1510	701	181
				1			305B	179	3.8	2276		335B	176	3.7	2493		215E	174	3.7	2055		225E	172	3.6	2184	845	
		5#10	4#10	1	6#14	27.96	145EfH	45	-	1899	23.10	155EeH	44	-	2058	19.41	165EdH	43	-	2217	16.54	165H	43	-	2344	1016	147
				1			305B	179	3.8	2756		335B	176	3.7	3013		365B	174	3.7	3271		395B	172	3.6	3528	1164	
		6#10	5#10	1	7#14	33.24	245C	45	-	2505	27.47	175DiH	44	-	2430	23.08	185DiH	43	-	2614	19.67	185EgH	43	-	2766	1213	131
				1			405A	179	3.8	3474		445A	176	3.7	3800		365B	174	3.7	3603		395B	172	3.6	3886	1329	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

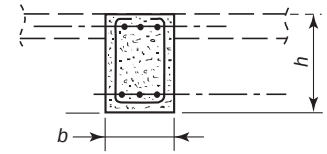
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

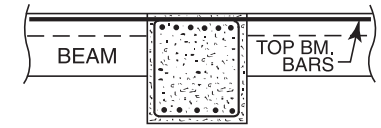
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 28 ft					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.					SPAN, ℓ_n = 34 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
24.5	24	2# 9	1# 9	1	4# 8	3.78	133H	16	-	594	3.29	133H	16	-	626	2.89	133H	16	-	658	2.56	133H	16	-	690	281	383
				1			175H	64	1.8	1058		185H	63	1.8	1124		195H	63	1.8	1190		214H	62	1.8	1018	296	
		2#11	1#11	1	4#10	5.83	163H	16	-	907	5.08*	163H	16	-	957	4.46*	173H	16	-	1017	3.95*	173H	16	-	1067	422	340
				1			175H	64	1.8	1345		185H	63	1.8	1429		195H	63	1.8	1514		215H	62	1.8	1632	457	
		2#14	1#14	1	4#11	6.98	164H	16	-	1311	6.08*	174H	16	-	1397	5.35*	183H	16	-	1336	4.74*	193H	16	-	1414	582	286
				1			245E	63	1.8	1857		265E	63	1.8	1993		195H	62	1.8	1825		215H	62	1.8	1961	547	
		3#11	2#11	1	4#14	9.32*	175H	16	-	1782	8.12*	184H	16	-	1715	7.14*	194H	16	-	1818	6.32*	204H	16	-	1921	664	242
				1			245E	64	1.8	2141		265E	63	1.8	2295		285E	63	1.8	2449		295E	62	1.8	2569	742	
	36	2#10	2#10	1	5# 9	5.94	133H	29	-	910	5.18	133H	28	-	963	4.55	143H	28	-	1024	4.03	143H	28	-	1076	471	252
				1			563A	115	2.7	1483		603A	114	2.7	1585		643A	113	2.7	1687		683A	112	2.7	1789	465	
		2#11	2#11	1	5#11	7.98	153H	29	-	1229	6.96	163H	28	-	1309	6.11	163H	28	-	1380	5.41*	173H	28	-	1461	569	230
				1			245E	115	2.7	2015		265E	114	2.7	2163		195H	113	2.7	1962		215H	112	2.6	2111	697	
		2#14	2#14	1	5#14	11.05	175H	29	-	2078	9.63*	174H	28	-	1993	8.46*	184H	28	-	2114	7.49*	194H	28	-	2234	787	188
				1			285D	114	2.7	2661		265E	114	2.7	2685		285E	113	2.6	2865		295E	112	2.6	3006	956	
		3#14	2#14	1	6#14	13.42*	175H	29	-	2450	11.69*	185H	28	-	2605	10.28*	195H	28	-	2761	9.10*	205H	28	-	2917	956	164
				1			345C	114	2.7	3265		305D	114	2.7	3236		325D	113	2.6	3440		345D	112	2.6	3644	1114	
	48	3# 9	3# 9	1	6#10	7.89	133H	43	-	1181	6.87	133H	42	-	1249	6.04	133H	42	-	1317	5.35	143H	42	-	1396	562	187
				1			**	170	3.8	1042		**	169	3.7	1110		**	167	3.7	1179		**	166	0.0	1247	701	
		3#11	3#11	1	6#11	10.78	154H	42	-	1779	9.39	164H	42	-	1897	8.26*	163H	42	-	1838	7.31*	173H	42	-	1945	845	173
				1			245E	170	3.6	2520		364C	169	3.6	2557		384C	167	3.5	2709		414C	166	3.5	2888	845	
		3#14	3#14	1	6#14	14.86	175H	42	-	2688	12.94*	175H	42	-	2828	11.37*	185H	42	-	3000	10.08*	195H	42	-	3172	1164	140
				1			425B	170	3.6	3971		455B	168	3.5	4242		485B	167	3.5	4512		515B	166	3.5	4783	1164	
		4#14	3#14	1	7#14	16.96*	195EfH	42	-	3125	14.77*	195EdH	42	-	3288	12.98*	195H	42	-	3452	11.50*	205H	42	-	3648	1329	127
				1			425B	170	3.6	4343		455B	168	3.5	4638		485B	167	3.5	4932		515B	166	3.5	5227	1329	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

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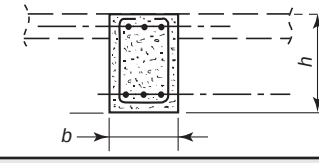
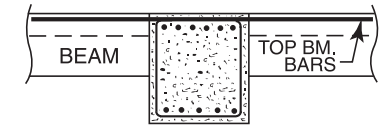
JOIST-BAND BEAMS, END SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 22 ft					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					(6)	(7)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	ft.-kip	$\times 10^{-9}$ in.
28.5	24	2#10	1#10	1	4# 9	9.10	113J	21	-	598	7.65	113J	21	-	638	6.51	123J	21	-	689	5.62	123J	20	-	729	419	240
				1			175F	85	2.3	1115		185F	83	2.2	1192		145I	82	2.2	1086		165I	81	2.2	1200	440	
		2#11	1#11	1	4#11	11.52	114J	21	-	888	9.68	124J	21	-	962	8.25	134J	21	-	1035	7.11	133J	20	-	975	507	211
				1			175F	85	2.3	1307		185F	83	2.2	1399		205F	82	2.2	1528		215F	81	2.2	1620	659	
		3#11	2#11	1	4#14	18.29	224D	21	-	1478	15.37	244D	21	-	1601	13.10	135J	21	-	1625	11.29	145J	20	-	1741	804	163
				1			445A	85	2.3	2683		245D	83	2.2	2035		265D	82	2.2	2195		245E	81	2.2	2208	904	
		10# 6	9# 6	2	5#14	19.00	224D	21	-	1637	15.97	244D	21	-	1772	13.60	264D	21	-	1908	11.73	145J	20	-	1937	836	150
				1			445A	85	2.2	2842		245D	83	2.2	2207		265D	82	2.2	2378		285D	81	2.1	2550	1079	
	36	2#10	2#10	1	5#10	12.79	114J	39	-	926	10.75	113J	38	-	877	9.16	113J	38	-	934	7.90	123J	37	-	1002	562	157
				1			195E	156	3.3	1491		215E	153	3.3	1632		225E	151	3.2	1731		245E	149	3.2	1871	694	
		2#11	2#11	1	5#11	15.49	114J	39	-	1096	13.01	124J	38	-	1187	11.09	124J	38	-	1258	9.56	134J	37	-	1350	681	152
				1			195E	155	3.3	1661		215E	153	3.3	1815		225E	151	3.2	1927		245E	149	3.2	2081	838	
		4#11	3#11	1	5#14	23.95	135FfJ	39	-	1839	20.12	145GeJ	38	-	1987	17.15	145GdJ	38	-	2102	14.78	145J	37	-	2217	1136	118
				1			335B	155	3.3	2790		295C	153	3.3	2739		315C	151	3.2	2937		345C	149	3.2	3177	1159	
		4#11	4#11	1	7#14	29.02	225D	39	-	2482	24.38	245D	38	-	2688	20.78	265D	38	-	2895	17.92	175FgJ	37	-	2746	1276	101
				1			445A	155	3.3	3598		485A	153	3.3	3907		525A	151	3.2	4215		345C	149	3.2	3609	1544	
	48	3#10	3#10	1	6#10	17.33	114J	58	-	1197	14.56	114J	57	-	1276	12.41	124J	56	-	1377	10.70	124J	56	-	1455	838	119
				1			335B	233	4.4	2484		215E	229	4.3	2006		314C	226	4.3	2016		344C	223	4.2	2182	838	
		3#11	3#11	1	6#11	20.95	115J	58	-	1569	17.60	125J	57	-	1701	15.00	124J	56	-	1643	12.93	134J	56	-	1762	1014	114
				1			335B	233	4.4	2714		365B	229	4.3	2950		395B	226	4.3	3186		245E	223	4.2	2587	1014	
		5#11	4#11	1	7#14	33.33	175DkJ	58	-	2489	28.00	185DkJ	57	-	2677	23.86	175EiJ	56	-	2795	20.57	175FgJ	56	-	2948	1466	88
				1			445A	233	4.4	3935		365B	229	4.3	3716		395B	226	4.3	4008		425B	223	4.2	4300	1612	
		6#11	5#11	1	9#14	39.73	295AnD	58	-	3384	33.39	305AlD	57	-	3610	28.45	315AiD	56	-	3835	24.53	215DmJ	56	-	3675	1748	76
				1			445A	233	4.4	4408		485A	229	4.3	4784		525A	226	4.3	5160		565A	223	4.2	5537	1998	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
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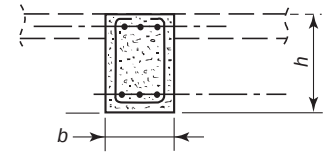
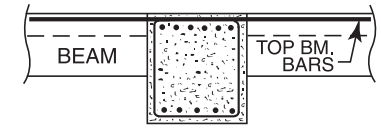




STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 30 ft					SPAN, ℓ_n = 32 ft.					SPAN, ℓ_n = 34 ft.					SPAN, ℓ_n = 36 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
28.5	24	2#10	1#10	1	4# 9	4.89	133J	20	-	779	4.30	133J	20	-	820	3.81	133J	20	-	861	3.40	133J	20	-	901	419	240
				1			185H	81	2.1	1314		195H	80	2.1	1391		215H	79	2.1	1505		225H	79	2.1	1583	440	
		2#11	1#11	1	4#11	6.20	143J	20	-	1040	5.45	143J	20	-	1095	4.82	153J	20	-	1160	4.30	153J	20	-	1215	507	211
				1			235F	80	2.1	1748		245F	80	2.1	1840		195I	79	2.1	1712		205I	79	2.1	1804	659	
		2#14	1#14	1	4#14	8.60	154J	20	-	1593	7.56	164J	20	-	1691	6.70	174J	20	-	1789	5.97*	174J	20	-	1869	703	171
				1			235F	80	2.1	2158		245F	80	2.1	2274		265F	79	2.1	2427		275F	79	2.1	2544	904	
		2#14	2#14	1	5#14	11.06	155J	20	-	2121	9.72	165J	20	-	2252	8.61*	175J	20	-	2384	7.68*	185J	20	-	2515	904	145
				1			305D	80	2.1	2778		285E	80	2.1	2807		295E	79	2.1	2945		315E	79	2.1	3121	1079	
	26	2#10	1#10	1	4# 9	4.92	123J	23	-	772	4.32	123J	23	-	812	3.83	133J	22	-	863	3.41	133J	22	-	903	421	222
				1			155J	91	2.3	1216		165J	90	2.3	1294		235G	90	2.3	1597		245G	89	2.3	1676	442	
		2#11	1#11	1	4#11	6.23	133J	23	-	1032	5.48	143J	23	-	1097	4.85	143J	22	-	1153	4.33	153J	22	-	1218	509	202
				1			205G	91	2.3	1654		225G	90	2.3	1785		235G	89	2.3	1878		245G	89	2.2	1970	664	
		2#14	2#14	1	4#14	10.17	155J	23	-	1969	8.94	165J	23	-	2092	7.92*	174J	22	-	2026	7.06*	184J	22	-	2138	915	152
				1			265E	91	2.3	2493		285E	90	2.3	2662		295E	89	2.3	2792		275F	89	2.2	2810	915	
		2#14	2#14	1	5#14	11.19	155J	23	-	2128	9.83	165J	23	-	2260	8.71*	175J	22	-	2392	7.77*	185J	22	-	2524	915	141
				1			305D	91	2.3	2802		285E	90	2.3	2829		295E	89	2.3	2969		315E	89	2.2	3146	1105	
	48	3#10	3#10	1	6#10	9.32	124J	55	-	1534	8.19	134J	55	-	1635	7.26	134J	54	-	1713	6.47	134J	54	-	1792	838	119
				1			364C	221	4.2	2319		**	219	4.3	1345		**	217	4.3	1424		**	216	4.2	1502	838	
		3#11	3#11	1	6#11	11.27	134J	55	-	1859	9.90	144J	55	-	1979	8.77	144J	54	-	2076	7.82	154J	54	-	2195	1014	114
				1			265E	221	4.2	2777		384C	219	4.2	2778		414C	217	4.1	2963		434C	216	4.1	3118	1014	
		3#14	3#14	1	7#14	17.21	165GeJ	55	-	2999	15.12	175GdJ	55	-	3182	13.39*	175J	54	-	3331	11.95*	175J	54	-	3479	1407	90
				1			455B	221	4.2	4526		485B	219	4.1	4813		515B	217	4.1	5101		545B	216	4.1	5389	1612	
		4#14	4#14	1	9#14	22.12	225DmJ	55	-	3969	19.44*	215EkJ	55	-	4129	17.22*	215EjJ	54	-	4324	15.36*	215FhJ	54	-	4519	1809	75
				1			455B	221	4.2	5285		485B	219	4.1	5619		515B	217	4.1	5954		545B	216	4.1	6288	1998	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

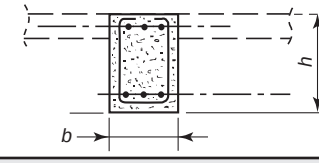
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

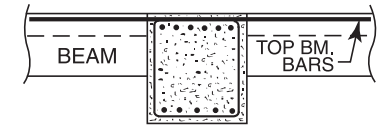
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 12 ft					SPAN, ℓ_n = 14 ft.					SPAN, ℓ_n = 16 ft.					SPAN, ℓ_n = 18 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
12.5	24	2# 6	1# 6	1	4# 6	5.73	113C	6	-	163	4.21	113C	6	-	179	3.23	123C	5	-	201	2.55	123C	5	-	217	57	1419
				1			143C	23	1.1	209		173C	22	1.0	248		193C	22	1.0	280		223C	22	1.0	319	75	
		2# 6	1# 6	1	4# 7	6.36	113C	6	-	180	4.67	123C	6	-	205	3.58	133C	5	-	230	2.83	133C	5	-	249	57	1557
				1			144C	23	1.1	335		173C	22	1.0	268		193C	22	1.0	303		223C	22	1.0	345	99	
		3# 6	2# 6	1	4# 8	9.60	133C	6	-	244	7.05	143C	6	-	278	5.40	153C	5	-	311	4.27	163C	5	-	345	92	1749
				1			144C	23	1.1	388		174C	22	1.0	462		194C	22	1.0	521		224C	22	1.0	595	125	
		3# 6	3# 6	1	4# 9	11.64	133C	6	-	281	8.55	153C	6	-	326	6.55	163C	5	-	366	5.17*	173C	5	-	406	108	1618
				1			144C	23	1.0	425		174C	22	1.0	505		194C	22	1.0	570		224C	22	1.0	650	152	
	36	2# 6	2# 6	1	5# 7	8.53	113C	10	-	221	6.27	113C	9	-	245	4.80	N/A	9	-	196	3.79	N/A	9	-	220	76	930
				1			243A	38	1.6	375		283A	38	1.5	437		323A	37	1.5	499		363A	36	1.5	561	125	
		3# 6	2# 6	1	5# 8	10.54	123C	10	-	272	7.75	133C	9	-	310	5.93	133C	9	-	341	4.69	143C	9	-	379	94	1116
				1			243A	38	1.6	420		283A	38	1.5	489		323A	37	1.5	558		363A	36	1.5	627	160	
		4# 6	3# 6	1	5# 9	14.43	133C	10	-	341	10.60	143C	9	-	389	8.12	153C	9	-	437	6.41	163C	9	-	485	129	1176
				1			144C	38	1.6	516		174C	38	1.5	614		323A	37	1.5	640		363A	36	1.5	720	195	
		5# 6	4# 6	1	5#10	18.13	134C	10	-	494	13.32	154C	9	-	573	10.20	163C	9	-	536	8.06*	183C	9	-	602	163	1072
				1			244A	38	1.6	772		284A	38	1.5	900		194C	37	1.5	784		224C	36	1.5	893	237	
	48	3# 6	3# 6	1	6# 7	11.63	113C	14	-	281	8.55	113C	13	-	313	6.54	123C	13	-	353	5.17	N/A	13	-	294	114	725
				1			**	55	4.2	197		**	53	4.3	229		**	53	4.3	261		**	52	4.2	294	152	
		3# 6	3# 6	1	6# 8	12.72	113C	14	-	311	9.35	123C	13	-	356	7.16	133C	13	-	401	5.66	133C	13	-	438	114	783
				1			**	55	4.2	227		**	53	4.2	264		**	53	4.1	302		**	52	4.1	339	194	
		5# 6	5# 6	1	6#10	20.50	134C	14	-	566	15.06	144C	13	-	641	11.53	163C	13	-	616	9.11	173C	13	-	684	184	850
				1			244A	55	2.1	897		284A	53	2.0	1046		194C	53	2.0	909		224C	52	2.0	1036	290	
		6# 6	6# 6	1	6#10	22.17	134C	14	-	599	16.29	154C	13	-	694	12.47	164C	13	-	775	9.85*	173C	13	-	733	217	822
				1			244A	55	2.1	930		284A	53	2.0	1084		324A	53	2.0	1238		224C	52	2.0	1085	290	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
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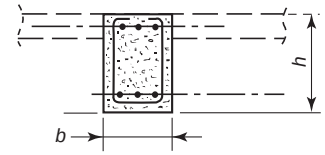
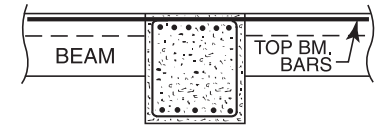
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS(1)				TOTAL CAPACITY $U = 1.2D + 1.6L$(3)																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
12.5	24	2# 6	1# 6	1	4# 6	2.06	123C	5	-	233	1.71	113C	5	-	244	1.43	113C	5	-	260	1.22	103C	5	-	271	57	1419
				1			243C	21	1.0	351		263C	21	1.0	382		293C	21	1.0	422		313C	21	1.0	453	75	
		2# 6	1# 6	1	4# 7	2.29	133C	5	-	268	1.89	133C	5	-	287	1.59	133C	5	-	306	1.36	123C	5	-	320	57	1557
				1			243C	21	1.0	380		263C	21	1.0	414		293C	21	1.0	456		313C	21	1.0	491	99	
		2# 8	1# 8	1	4# 8	3.46*	173C	5	-	390	2.86*	183C	5	-	425	2.40*	193C	5	-	460	2.05*	193C	5	-	489	97	1730
				1			243C	21	1.0	480		263C	21	1.0	524		293C	21	1.0	576		313C	21	1.0	620	125	
		3# 6	3# 6	1	4# 9	4.19*	183C	5	-	445	3.46*	203C	5	-	490	2.91*	203C	5	-	524	2.48X	213C	5	-	564	108	1618
				1			244C	21	1.0	715		264C	21	1.0	780		293C	21	1.0	635		313C	21	1.0	684	152	
	36	2# 6	2# 6	1	5# 7	3.07	N/A	9	-	244	2.54	N/A	9	-	269	2.13	N/A	9	-	293	1.82	N/A	9	-	317	76	930
				1			403A	36	1.5	623		443A	36	1.5	685		483A	36	1.5	747		523A	35	1.5	809	125	
		2# 7	2# 7	1	5# 8	4.09	153C	9	-	425	3.38	153C	9	-	457	2.84	N/A	9	-	389	2.42*	N/A	9	-	421	102	1176
				1			403A	36	1.5	704		443A	36	1.5	774		483A	35	1.5	844		523A	35	1.5	914	160	
		2# 8	2# 8	1	5# 9	5.25*	173C	9	-	532	4.34*	183C	9	-	580	3.64*	193C	9	-	628	3.11*	193C	9	-	669	131	1183
				1			403A	36	1.5	797		443A	36	1.5	877		483A	35	1.5	956		523A	35	1.5	1035	195	
		2# 9	2# 9	1	5#10	6.45*	233B	9	-	684	5.33*	243B	9	-	744	4.48*	263B	9	-	809	3.82X	273B	9	-	868	161	1085
				1			403A	36	1.5	910		443A	36	1.5	1001		483A	35	1.5	1091		523A	35	1.5	1181	237	
	48	3# 6	3# 6	1	6# 7	4.19	N/A	13	-	326	3.46	N/A	13	-	358	2.91	N/A	13	-	390	2.48	N/A	13	-	422	114	725
				1			**	51	4.2	326		**	51	4.3	358		**	51	4.3	390		**	50	0.0	422	152	
		3# 6	3# 6	1	6# 8	4.58	N/A	13	-	376	3.79	N/A	13	-	413	3.18	N/A	13	-	450	2.71	N/A	13	-	487	114	783
				1			**	51	4.2	376		**	51	4.2	413		**	51	4.1	450		**	50	4.1	487	194	
		3# 8	3# 8	1	6#10	7.79*	183C	13	-	770	6.44*	193C	13	-	840	5.41*	203C	13	-	910	4.61*	203C	13	-	973	194	852
				1			**	51	2.1	633		**	51	2.0	695		**	51	2.0	758		**	50	2.0	820	290	
		4# 8	3# 8	1	6#10	7.98*	183C	13	-	826	6.60*	193C	13	-	902	5.54*	203C	13	-	977	4.72*	213C	13	-	1053	223	820
				1			**	51	2.1	689		**	51	2.0	756		**	51	2.0	824		**	50	2.0	892	290	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

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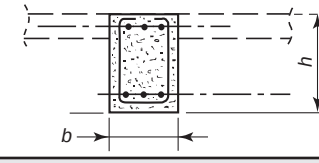
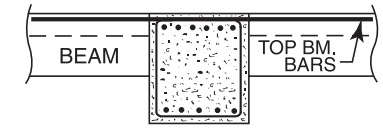
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 12 ft					SPAN, ℓ_n = 14 ft.					SPAN, ℓ_n = 16 ft.					SPAN, ℓ_n = 18 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
14.5	24	2# 6	1# 6	1	4# 7	7.68	103D	7	-	179	5.64	103D	7	-	199	4.32	113D	7	-	224	3.41	113D	7	-	243	69	876
				1			144C	30	1.2	348		173C	29	1.2	277		193C	28	1.2	312		223C	28	1.2	356	120	
		2# 6	2# 6	1	4# 8	10.10	103D	7	-	213	7.42	113D	7	-	244	5.68	123D	7	-	275	4.49	133D	7	-	306	90	1067
				1			124D	30	1.2	348		174C	29	1.2	455		194C	28	1.2	513		223C	28	1.2	406	154	
		3# 6	3# 6	1	4# 9	14.39	114D	7	-	342	10.57	133D	7	-	322	8.09	143D	7	-	362	6.40	153D	7	-	402	132	1048
				1			125D	30	1.2	531		145D	29	1.2	619		164D	28	1.2	538		224C	28	1.2	670	188	
		4# 6	3# 6	1	4#10	16.93	223A	7	-	391	12.44	134D	7	-	456	9.52	143D	7	-	426	7.52	153D	7	-	474	152	950
				1			244A	30	1.2	650		145D	29	1.2	675		165D	28	1.2	771		184D	28	1.1	677	228	
	36	2# 6	2# 6	1	5# 7	10.29	093D	13	-	212	7.56	103D	12	-	243	5.79	N/A	12	-	196	4.57	N/A	12	-	220	92	500
				1			243A	51	1.8	387		283A	50	1.8	451		323A	49	1.7	515		363A	48	1.7	579	152	
		3# 6	3# 6	1	5# 8	14.98	103D	13	-	277	11.01	113D	12	-	318	8.43	123D	12	-	359	6.66	133D	12	-	400	136	742
				1			125D	51	1.8	588		144D	50	1.8	514		323A	49	1.7	592		363A	48	1.7	665	196	
		5# 6	4# 6	1	5#10	22.09	114D	13	-	478	16.23	134D	12	-	558	12.42	144D	12	-	625	9.82	153D	12	-	589	198	693
				1			125D	51	1.8	706		145D	50	1.8	822		165D	49	1.7	938		185D	48	1.7	1055	294	
		5# 6	5# 6	1	5#11	24.30	115D	13	-	626	17.85	134D	12	-	621	13.67	144D	12	-	697	10.80	154D	12	-	773	218	638
				1			245A	51	1.8	1141		145D	50	1.8	885		165D	49	1.7	1010		185D	48	1.7	1135	342	
	48	3# 6	3# 6	1	6# 8	15.36	103D	18	-	309	11.29	103D	18	-	346	8.64	113D	18	-	391	6.83	N/A	17	-	339	138	440
				1			**	74	4.2	227		**	72	4.3	264		**	70	4.3	302		**	69	0.0	339	237	
		4# 6	3# 6	1	6# 9	17.80	103D	18	-	363	13.08	113D	18	-	417	10.01	123D	18	-	472	7.91	123D	17	-	518	160	497
				1			144C	74	2.4	601		**	72	4.2	328		**	70	4.1	374		**	69	4.1	420	292	
		6# 6	5# 6	1	6#10	27.19	115D	18	-	670	19.98	124D	18	-	645	15.29	144D	18	-	740	12.08	154D	17	-	820	244	542
				1			245A	74	2.4	1272		145D	72	2.3	969		195C	70	2.3	1216		224C	69	2.3	1084	358	
		7# 6	7# 6	1	6#11	32.41	115D	18	-	766	23.81	135D	18	-	896	18.23	144D	18	-	866	14.41	154D	17	-	962	304	490
				1			245A	74	2.4	1367		285A	72	2.3	1593		325A	70	2.3	1819		185D	69	2.3	1384	424	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360 <$ deflection $< \ell_n/240$
X – $\ell_n/240 <$ deflection $< \ell_n/180$
Y – deflection $> \ell_n/180$

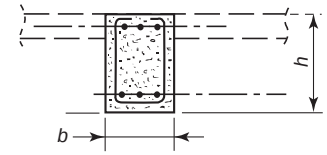
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b > 24$ in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

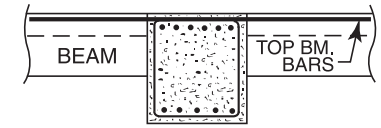
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as $w/1.4$.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																		$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
14.5	24	2# 6	1# 6	1	4# 7	2.77	113D	7	-	262	2.29	113D	7	-	281	1.92	113D	7	-	301	1.64	103D	7	-	314	69	876
				1			243C	28	1.1	392		263C	27	1.1	427		293C	27	1.1	471		313C	27	1.1	507	120	
		2# 7	1# 7	1	4# 8	3.69	143D	7	-	345	3.05	143D	7	-	370	2.57	143D	7	-	396	2.19	153D	7	-	427	92	1077
				1			243C	28	1.1	456		263C	27	1.1	498		293C	27	1.1	548		313C	27	1.1	590	154	
		2# 9	1# 9	1	4# 9	5.18	193C	7	-	492	4.28	203C	7	-	535	3.60*	213C	7	-	578	3.07*	223C	7	-	621	146	1023
				1			244C	28	1.1	769		264C	27	1.1	838		294C	27	1.1	924		313C	27	1.1	740	188	
		2# 9	1# 9	1	4#10	5.85	203C	7	-	546	4.83*	213C	7	-	594	4.06*	223C	7	-	642	3.46*	233C	7	-	689	146	965
				1			244C	28	1.1	817		264C	27	1.1	891		294C	27	1.1	982		314C	27	1.1	1057	228	
	36	2# 7	2# 7	1	5# 7	4.21	N/A	12	-	283	3.48	N/A	12	-	311	2.92	N/A	12	-	339	2.49	N/A	12	-	367	123	601
				1			403A	47	1.7	682		443A	47	1.7	750		483A	47	1.7	818		523A	46	1.7	885	152	
		2# 8	2# 8	1	5# 8	5.39	143D	12	-	470	4.46	143D	12	-	507	3.74	143D	12	-	543	3.19	N/A	12	-	480	159	718
				1			403A	47	1.7	769		443A	47	1.7	845		483A	47	1.7	921		523A	46	1.7	998	196	
		2# 9	2# 9	1	5#10	7.89	193C	12	-	667	6.52*	203C	12	-	727	5.48*	213C	12	-	787	4.67*	223C	12	-	846	197	699
				1			403A	47	1.7	930		443A	47	1.7	1023		483A	47	1.7	1115		523A	46	1.7	1207	294	
		2#10	2#10	1	5#11	9.42*	203C	12	-	807	7.78*	213C	12	-	880	6.54*	223C	12	-	952	5.57*	243C	12	-	1032	242	629
				1			244C	47	1.7	1135		264C	47	1.7	1239		483A	46	1.7	1273		523A	46	1.7	1379	342	
	48	3# 6	3# 6	1	6# 8	5.53	N/A	17	-	376	4.57	N/A	17	-	413	3.84	N/A	17	-	450	3.27	N/A	17	-	487	138	440
				1			**	68	4.2	376		**	67	4.3	413		**	67	4.3	450		**	66	0.0	487	237	
		3# 7	3# 7	1	6# 9	7.39	143D	17	-	607	6.11	143D	17	-	655	5.13	143D	17	-	704	4.37	N/A	17	-	639	184	549
				1			**	68	2.4	493		**	67	4.2	541		**	67	4.1	590		**	66	4.1	639	292	
		3# 9	3# 9	1	6#10	9.87	183C	17	-	858	8.15	203C	17	-	944	6.85*	203C	17	-	1015	5.84*	213C	17	-	1093	292	517
				1			244C	68	2.2	1259		**	67	2.3	782		**	67	2.3	852		**	66	2.3	922	358	
		3# 9	3# 9	1	6#11	11.67*	204C	17	-	1109	9.64*	213C	17	-	1042	8.10*	223C	17	-	1128	6.90*	233C	17	-	1214	292	501
				1			245C	68	2.2	1673		264C	67	2.2	1464		294C	67	2.2	1610		**	66	2.3	1027	424	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation: N/A – STIRRUPS ARE NOT REQUIRED
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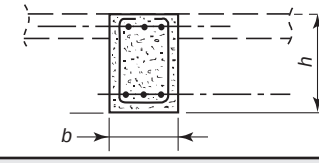
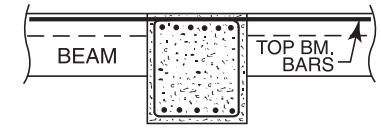
(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																			
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 16 ft					SPAN, ℓ_n = 18 ft.					SPAN, ℓ_n = 20 ft.					SPAN, ℓ_n = 22 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
16.5	24	2# 7	1# 7	1	4# 7	6.12	103E	9	-	248	4.83	113E	9	-	276	3.91	113E	9	-	299	3.24	123E	9	-	327	108	659
				1			194C	36	1.3	510		223C	35	1.3	395		243C	35	1.3	435		263C	34	1.3	474	142	
		2# 8	1# 8	1	4# 8	7.84	113E	9	-	310	6.20	123E	9	-	345	5.02	133E	9	-	381	4.15	133E	9	-	410	140	733
				1			144E	36	1.3	479		224C	35	1.3	647		244C	35	1.3	710		263C	34	1.3	550	182	
		2# 9	1# 9	1	4#10	10.83	143D	9	-	433	8.56	153D	9	-	481	6.93	173D	9	-	536	5.73	183D	9	-	585	173	666
				1			165D	36	1.3	793		184D	35	1.3	693		204D	35	1.3	770		264C	34	1.3	915	274	
		2# 9	2# 9	1	4#11	13.44	154D	9	-	620	10.62	164D	9	-	685	8.60	173D	9	-	641	7.11	193D	9	-	707	224	586
				1			165D	36	1.3	877		185D	35	1.3	986		205D	35	1.3	1095		224D	34	1.3	961	312	
	36	2# 7	2# 7	1	5# 8	9.10	103E	16	-	337	7.19	113E	15	-	377	5.82	113E	15	-	409	4.81	N/A	15	-	357	145	435
				1			323A	62	2.0	596		363A	61	2.0	670		403A	60	1.9	744		443A	59	1.9	818	231	
		2# 8	2# 8	1	5# 9	11.75	113E	16	-	420	9.29	123E	15	-	469	7.52	133E	15	-	518	6.22	133E	15	-	560	188	496
				1			165D	62	2.0	867		184D	61	1.9	747		403A	60	1.9	838		443A	59	1.9	921	285	
		3# 9	2# 9	1	5#11	17.87	154D	16	-	762	14.12	164D	15	-	843	11.44	174D	15	-	924	9.45	183D	15	-	874	285	436
				1			165D	62	2.0	1070		185D	61	1.9	1202		205D	60	1.9	1334		225D	59	1.9	1467	417	
		3# 9	3# 9	1	6#11	20.16	155D	16	-	996	15.93	164D	15	-	953	12.90	174D	15	-	1046	10.66	194D	15	-	1154	336	390
				1			325A	62	2.0	1698		185D	61	1.9	1312		205D	60	1.9	1456		225D	59	1.9	1601	469	
	48	3# 7	3# 7	1	6# 8	12.03	103E	23	-	435	9.51	113E	22	-	487	7.70	113E	22	-	529	6.36	N/A	22	-	477	217	324
				1			**	90	4.2	349		**	88	4.3	392		**	87	4.3	434		**	86	0.0	477	280	
		3# 8	3# 8	1	6# 9	14.89	113E	23	-	545	11.76	123E	22	-	609	9.53	133E	22	-	673	7.87	133E	22	-	728	280	360
				1			194C	90	2.6	901		**	88	4.2	505		**	87	4.1	560		**	86	4.1	616	346	
		3# 9	3# 9	1	6#11	21.66	145D	22	-	1011	17.11	154D	22	-	965	13.86	174D	22	-	1077	11.45	184D	21	-	1172	346	345
				1			325A	90	2.6	1854		185D	88	2.6	1399		205D	87	2.5	1554		265C	86	2.5	1860	508	
		4# 9	3# 9	1	7#11	24.89	155D	22	-	1152	19.67	165D	22	-	1271	15.93	174D	22	-	1219	13.16	184D	21	-	1328	398	318
				1			325A	90	2.6	1969		365A	88	2.6	2213		405A	87	2.5	2457		225D	86	2.5	1864	579	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
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(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b > 24$ in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

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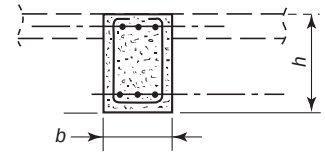
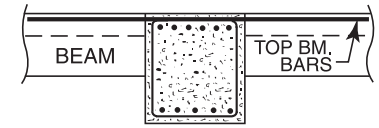
"Average service load" is taken as $w/1.4$.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
16.5	24	2# 7	1# 7	1	4# 7	2.72	123E	8	-	350	2.32	123E	8	-	372	2.00	113E	8	-	387	1.74	113E	8	-	409	108	659
				1			293C	34	1.3	522		313C	34	1.3	562		343C	33	1.2	610		363C	33	1.2	650	142	
		2# 8	1# 8	1	4# 8	3.49	143E	8	-	445	2.97	143E	8	-	474	2.56	153E	8	-	510	2.23	153E	8	-	539	140	733
				1			293C	34	1.3	605		313C	34	1.3	651		343C	33	1.2	706		363C	33	1.2	753	182	
		2# 9	1# 9	1	4#10	4.81	193D	8	-	633	4.10*	193D	8	-	674	3.54*	203D	8	-	723	3.08*	213D	8	-	771	173	666
				1			294C	34	1.3	1009		314C	34	1.3	1085		344C	33	1.2	1179		363C	33	1.2	945	274	
		2#10	1#10	1	4#11	5.94*	203D	8	-	765	5.06*	213D	8	-	824	4.36*	223D	8	-	883	3.80*	233D	8	-	941	213	597
				1			244D	34	1.3	1048		264D	34	1.2	1135		344C	33	1.2	1325		364C	33	1.2	1412	312	
	36	2# 7	2# 7	1	5# 8	4.04	N/A	15	-	389	3.44	N/A	15	-	421	2.97	N/A	14	-	454	2.59	N/A	14	-	486	145	435
				1			483A	59	1.9	892		523A	58	1.9	966		563A	58	1.9	1040		603A	58	1.8	1114	231	
		2# 8	2# 8	1	5# 9	5.22	143E	15	-	609	4.45	143E	15	-	650	3.84	153E	14	-	699	3.34	N/A	14	-	626	188	496
				1			483A	59	1.9	1004		523A	58	1.9	1087		563A	58	1.9	1170		603A	58	1.8	1254	285	
		2#10	2#10	1	5#11	7.97*	193D	15	-	940	6.79*	203D	15	-	1014	5.85*	213D	14	-	1087	5.10*	223D	14	-	1160	288	436
				1			245D	59	1.9	1592		264D	58	1.9	1394		284D	58	1.8	1501		603A	58	1.8	1620	417	
		2#11	2#11	1	6#11	8.96*	204D	15	-	1265	7.63*	213D	15	-	1207	6.58*	223D	14	-	1295	5.73*	233D	14	-	1382	344	389
				1			245D	59	1.9	1764		265D	58	1.9	1910		285D	58	1.8	2056		304D	58	1.8	1822	469	
	48	3# 7	3# 7	1	6# 8	5.35	N/A	21	-	520	4.56	N/A	21	-	563	3.93	N/A	21	-	606	3.42	N/A	21	-	648	217	324
				1			**	85	4.2	520		**	85	4.3	563		**	84	4.3	606		**	83	0.0	648	280	
		3# 8	3# 8	1	6# 9	6.62	143E	21	-	792	5.64	143E	21	-	847	4.86	N/A	21	-	781	4.23	N/A	21	-	837	280	360
				1			**	85	2.6	671		**	84	4.2	726		**	84	4.1	781		**	83	4.1	837	346	
		3# 9	3# 9	1	6#11	9.62	193D	21	-	1113	8.20*	193D	21	-	1191	7.07*	203D	21	-	1278	6.16*	213D	21	-	1365	346	345
				1			294C	85	2.5	1637		314C	84	2.5	1763		**	84	2.5	1105		**	83	2.5	1183	508	
		3#10	3#10	1	7#11	11.06*	194D	21	-	1468	9.43*	204D	21	-	1580	8.13*	213D	21	-	1521	7.08*	223D	21	-	1625	427	311
				1			295C	85	2.5	2254		315C	84	2.5	2425		344C	84	2.5	2147		364C	83	2.4	2289	579	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

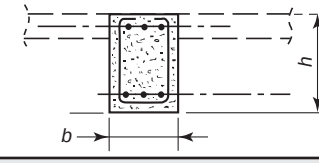
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

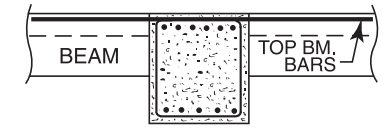
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 16 ft					SPAN, ℓ_n = 18 ft.					SPAN, ℓ_n = 20 ft.					SPAN, ℓ_n = 22 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
18.5	24	2# 7	1# 7	1	4# 8	7.80	103F	11	-	279	6.16	103F	11	-	305	4.99	113F	11	-	337	4.12	113F	10	-	363	124	460
				1			125F	44	1.5	565		144F	43	1.5	489		243C	42	1.5	480		263C	42	1.4	524	210	
		2# 8	1# 8	1	4# 9	10.08	113F	11	-	346	7.97	113F	11	-	379	6.45	123F	11	-	419	5.33	133F	10	-	459	161	507
				1			125F	44	1.5	625		145F	43	1.5	717		155F	42	1.4	779		174F	42	1.4	676	260	
		2# 9	2# 9	1	4#10	13.75	134E	11	-	563	10.86	144E	11	-	623	8.80	153E	11	-	581	7.27	163E	10	-	635	260	450
				1			145E	44	1.5	797		165E	43	1.5	903		175E	42	1.4	980		195E	42	1.4	1086	319	
		2# 9	2# 9	1	4#11	16.27	134E	11	-	606	12.86	144E	11	-	672	10.42	154E	11	-	738	8.61	164E	10	-	804	260	428
				1			245B	44	1.5	1137		165E	43	1.5	952		175E	42	1.4	1033		195E	42	1.4	1145	379	
	36	2# 8	2# 8	1	5# 8	11.48	103F	19	-	379	9.07	103F	19	-	415	7.35	113F	19	-	460	6.07	113F	18	-	496	216	304
				1			164D	77	2.2	640		363A	76	2.2	729		403A	74	2.2	809		443A	73	2.1	889	267	
		2# 9	2# 9	1	5#10	16.83	124E	19	-	617	13.29	134E	19	-	685	10.77	143E	19	-	646	8.90	153E	18	-	706	269	341
				1			145E	77	2.2	911		185D	75	2.2	1102		205D	74	2.1	1224		224D	73	2.1	1056	408	
		3# 9	2# 9	1	5#11	20.69	135E	19	-	868	16.35	144E	19	-	826	13.24	154E	19	-	908	10.94	164E	18	-	990	330	316
				1			245B	77	2.2	1369		275B	75	2.2	1538		175E	74	2.1	1258		195E	73	2.1	1394	487	
		3# 9	3# 9	1	6#11	24.41	135E	19	-	966	19.29	145E	19	-	1069	15.62	154E	19	-	1030	12.91	164E	18	-	1124	390	285
				1			245B	77	2.2	1466		275B	75	2.2	1648		305B	74	2.1	1830		335B	73	2.1	2012	568	
	48	3# 7	3# 7	1	6# 9	15.59	103F	28	-	487	12.32	103F	28	-	536	9.98	113F	27	-	593	8.25	113F	27	-	642	249	233
				1			194C	113	3.0	864		**	110	4.3	444		**	108	4.3	493		**	107	0.0	541	400	
		3# 8	3# 8	1	6#10	20.17	114F	28	-	702	15.94	114F	28	-	764	12.91	123F	27	-	742	10.67	133F	27	-	814	322	259
				1			245B	112	3.0	1455		165E	110	2.9	1202		244C	108	2.9	1224		264C	107	2.8	1336	495	
		4# 9	3# 9	1	7#11	28.84	135E	28	-	1116	22.79	145E	27	-	1237	18.46	155E	27	-	1357	15.25	164E	27	-	1309	461	231
				1			245B	112	3.0	1697		275B	110	2.9	1908		305B	108	2.8	2118		335B	107	2.8	2329	677	
		4# 9	4# 9	1	6#14	32.55	165BfE	28	-	1335	25.72	145E	27	-	1387	20.83	155E	27	-	1524	17.22	165E	27	-	1661	520	210
				1			245B	112	3.0	1831		275B	110	2.9	2058		305B	108	2.8	2285		335B	107	2.8	2513	800	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
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(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
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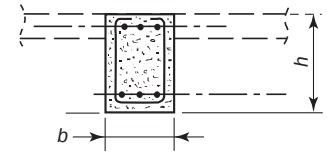
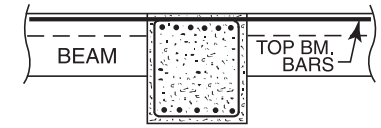
JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS(1)				TOTAL CAPACITY $U = 1.2D + 1.6L$(3)																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 24 ft					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					SPAN, ℓ_n = 30 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
18.5	24	2# 7	1# 7	1	4# 8	3.47	113F	10	-	388	2.95	113F	10	-	414	2.55	113F	10	-	439	2.22	113F	10	-	465	124	460
				1			293C	41	1.4	577		313C	41	1.4	621		343C	41	1.4	674		363C	40	1.4	718	210	
		2# 8	1# 8	1	4# 9	4.48	133F	10	-	492	3.82	143F	10	-	532	3.29	143F	10	-	565	2.87	143F	10	-	598	161	507
				1			184F	41	1.4	727		313C	41	1.4	718		343C	41	1.4	778		363C	40	1.4	829	260	
		2#10	1#10	1	4#10	6.11	173E	10	-	689	5.21	183E	10	-	743	4.49	183E	10	-	790	3.91*	193E	10	-	844	247	458
				1			215E	41	1.4	1192		224E	41	1.4	1016		244E	40	1.4	1099		364C	40	1.4	1364	319	
		2#11	1#11	1	4#11	7.24	183E	10	-	830	6.17	193E	10	-	895	5.32*	193E	10	-	952	4.63*	203E	10	-	1017	296	411
				1			215E	41	1.4	1326		225E	41	1.4	1413		245E	40	1.4	1530		264E	40	1.4	1348	379	
	36	2# 8	2# 8	1	5# 8	5.10	113F	18	-	533	4.35	113F	18	-	569	3.75	113F	18	-	606	3.27	113F	18	-	642	216	304
				1			483A	72	2.1	970		523A	72	2.1	1050		563A	71	2.1	1130		603A	71	2.1	1211	267	
		2# 9	2# 9	1	5#10	7.48	163E	18	-	767	6.37	163E	18	-	819	5.49	173E	18	-	880	4.79	173E	18	-	933	269	341
				1			244D	72	2.1	1151		523A	72	2.1	1259		563A	71	2.1	1356		603A	71	2.1	1452	408	
		2#10	2#10	1	5#11	9.28	174E	18	-	1064	7.91	183E	18	-	1007	6.82*	183E	18	-	1073	5.94*	193E	18	-	1147	334	316
				1			245D	72	2.1	1625		265D	72	2.1	1760		284D	71	2.1	1527		304D	71	2.0	1635	487	
		2#11	2#11	1	6#11	10.86	184E	18	-	1252	9.25	194E	18	-	1347	7.98*	194E	18	-	1427	6.95*	203E	18	-	1369	400	284
				1			215E	72	2.1	1693		225E	72	2.1	1808		285D	71	2.1	2095		305D	71	2.0	2244	568	
	48	3# 7	3# 7	1	6# 9	6.93	113F	26	-	691	5.91	N/A	26	-	639	5.09	N/A	26	-	687	4.44	N/A	26	-	736	249	233
				1			**	106	3.0	590		**	105	4.3	639		**	104	4.3	687		**	103	0.0	736	400	
		3# 8	3# 8	1	6#10	8.96	133F	26	-	876	7.64	143F	26	-	948	6.59	143F	26	-	1011	5.74	143F	26	-	1073	322	259
				1			**	105	3.0	758		**	104	2.9	820		**	104	2.9	882		**	103	2.8	945	495	
		3#10	3#10	1	7#11	12.94	174E	26	-	1450	11.02	184E	26	-	1563	9.51*	194E	26	-	1675	8.28*	193E	26	-	1608	495	226
				1			365B	105	2.8	2571		225E	104	2.7	2113		245E	104	2.7	2287		364C	103	2.7	2322	677	
		3#11	3#11	1	6#14	15.28	185E	26	-	1927	13.02	194E	26	-	1872	11.23*	204E	26	-	2007	9.78*	214E	26	-	2142	592	203
				1			365B	105	2.8	2840		395B	104	2.7	3076		425B	103	2.7	3311		265E	103	2.7	2797	800	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
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X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

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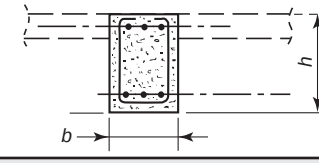
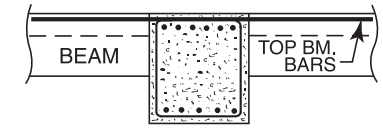
$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
20.5	24	2# 8	1# 8	1	4# 8	6.58	103G	13	-	371	5.44	113G	12	-	408	4.57	113G	12	-	437	3.90	123G	12	-	473	182	357
				1			145G	51	1.6	730		155G	50	1.6	790		164G	49	1.6	659		184G	49	1.6	726	239	
		2# 9	1# 9	1	4# 9	8.15	123F	13	-	467	6.74	133F	12	-	511	5.66	143F	12	-	556	4.82	143F	12	-	593	227	370
				1			155F	51	1.6	842		175F	50	1.6	941		185F	49	1.6	1009		204F	49	1.6	869	296	
		2#10	1#10	1	4#11	11.29	144F	13	-	737	9.33	144F	12	-	789	7.84	153F	12	-	747	6.68	163F	12	-	807	282	327
				1			155F	51	1.6	995		175F	50	1.6	1110		185F	49	1.6	1193		205F	49	1.6	1307	435	
		2#11	1#11	1	5#11	13.54	144F	13	-	866	11.19	154F	12	-	945	9.40	164F	12	-	1025	8.01	174F	12	-	1104	338	288
				1			245C	50	1.6	1404		265C	50	1.6	1531		185F	49	1.6	1346		205F	49	1.5	1473	519	
	36	2# 8	2# 8	1	5# 9	9.80	103G	22	-	505	8.10	113G	22	-	555	6.80	113G	22	-	597	5.80	123G	22	-	647	244	239
				1			204D	90	2.4	866		443A	88	2.4	965		483A	87	2.3	1052		523A	86	2.3	1139	375	
		2# 9	2# 9	1	5#10	12.21	123F	22	-	635	10.09	133F	22	-	697	8.48	143F	22	-	758	7.22	143F	22	-	810	305	250
				1			155F	90	2.4	1071		225D	88	2.4	1376		244D	87	2.3	1173		264D	86	2.3	1270	466	
		2#11	2#11	1	6#11	17.95	145F	22	-	1182	14.84	155F	22	-	1289	12.47	164F	22	-	1235	10.62	164F	22	-	1315	456	214
				1			245C	89	2.4	1671		265C	88	2.3	1823		295C	87	2.3	2010		315C	86	2.3	2162	652	
		3#11	2#11	1	5#14	20.74	145F	22	-	1379	17.14	155F	22	-	1504	14.40	165F	22	-	1630	12.27	175F	22	-	1756	557	191
				1			245C	89	2.4	1868		265C	88	2.3	2038		295C	87	2.3	2245		315C	86	2.3	2416	754	
	48	3# 8	3# 8	1	6# 9	12.50	103G	33	-	657	10.33	113G	32	-	722	8.68	113G	32	-	777	7.40	113G	32	-	832	365	171
				1			**	131	3.0	560		**	129	4.3	616		**	128	4.3	671		**	126	0.0	726	454	
		3# 9	3# 9	1	6#11	18.18	134F	33	-	1034	15.02	144F	32	-	1131	12.62	144F	32	-	1209	10.76	153F	32	-	1172	454	184
				1			305B	131	3.2	2018		195E	129	3.1	1647		215E	128	3.1	1807		314C	126	3.1	1820	677	
		3#10	3#10	1	6#14	22.58	145F	33	-	1490	18.66	145F	32	-	1597	15.68	155F	32	-	1733	13.36	164F	32	-	1693	564	160
				1			305B	131	3.2	2302		335B	129	3.1	2531		365B	128	3.1	2760		395B	126	3.1	2989	921	
		3#11	3#11	1	6#14	25.35	165CeF	33	-	1659	20.95	155F	32	-	1746	17.60	165F	32	-	1893	15.00	175F	32	-	2039	677	153
				1			305B	131	3.2	2411		335B	129	3.1	2651		365B	128	3.1	2890		395B	126	3.1	3130	921	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

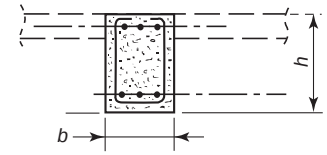
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

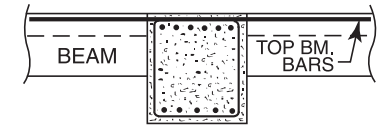
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS(1)				TOTAL CAPACITY $U = 1.2D + 1.6L$(3)																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 28 ft					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.					SPAN, ℓ_n = 34 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
20.5	24	2# 8	1# 8	1	4# 8	3.36	123G	12	-	502	2.93	123G	12	-	531	2.57	123G	12	-	560	2.28	123G	12	-	589	182	357
				1			343C	48	1.6	741		363C	48	1.5	789		383C	47	1.5	837		413C	47	1.5	895	239	
		2# 9	1# 9	1	4# 9	4.16	153F	12	-	637	3.62	153F	12	-	674	3.18	163F	12	-	718	2.82	163F	12	-	755	227	370
				1			214F	48	1.5	925		364C	48	1.5	1249		383C	47	1.5	965		413C	47	1.5	1031	296	
		2#10	1#10	1	4#11	5.76	173F	12	-	867	5.02	183F	12	-	926	4.41*	183F	12	-	978	3.91*	193F	12	-	1038	282	327
				1			215F	48	1.5	1390		235F	48	1.5	1504		245F	47	1.5	1587		265F	47	1.5	1702	435	
		2#11	1#11	1	5#11	6.91	184F	12	-	1184	6.02*	193F	12	-	1126	5.29*	203F	12	-	1198	4.69*	203F	12	-	1262	338	288
				1			215F	48	1.5	1569		235F	48	1.5	1696		245F	47	1.5	1792		265F	47	1.5	1919	519	
	36	2# 8	2# 8	1	5# 9	5.00	123G	21	-	688	4.35	123G	21	-	729	3.83	123G	21	-	771	3.39	123G	21	-	812	244	239
				1			563A	85	2.3	1227		603A	85	2.3	1314		643A	84	2.3	1401		683A	84	2.3	1488	375	
		2# 9	2# 9	1	5#10	6.23	153F	21	-	871	5.43	153F	21	-	924	4.77	163F	21	-	985	4.22	163F	21	-	1037	305	250
				1			563A	85	2.3	1384		603A	85	2.3	1482		643A	84	2.3	1581		683A	84	2.3	1679	466	
		2#11	2#11	1	6#11	9.16	174F	21	-	1411	7.98	184F	21	-	1507	7.01*	193F	21	-	1450	6.21*	193F	21	-	1530	456	214
				1			345C	85	2.3	2350		235F	85	2.3	2034		325D	84	2.3	2437		344D	83	2.2	2126	652	
		3#11	2#11	1	5#14	10.58	184F	21	-	1701	9.22*	194F	21	-	1816	8.10*	204F	21	-	1932	7.18*	204F	21	-	2031	557	191
				1			345C	85	2.3	2623		365C	85	2.3	2794		385C	84	2.2	2964		265F	83	2.2	2631	754	
	48	3# 8	3# 8	1	6# 9	6.38	N/A	31	-	781	5.55	N/A	31	-	837	4.88	N/A	31	-	892	4.32	N/A	31	-	947	365	171
				1			**	125	3.0	781		**	124	4.3	837		**	123	4.3	892		**	123	0.0	947	454	
		3# 9	3# 9	1	6#11	9.28	163F	31	-	1259	8.08	163F	31	-	1338	7.10	173F	31	-	1426	6.29	173F	31	-	1504	454	184
				1			344C	125	3.0	1974		**	124	3.1	1183		**	123	3.1	1261		**	123	3.1	1340	677	
		3#10	3#10	1	6#14	11.52	174F	31	-	1818	10.04	184F	31	-	1943	8.82	184F	31	-	2049	7.81*	193F	31	-	2005	564	160
				1			245E	125	3.0	2483		265E	124	3.0	2671		384C	123	3.0	2687		414C	122	3.0	2870	921	
		3#11	3#11	1	6#14	12.93	185F	31	-	2186	11.27	184F	31	-	2105	9.90*	194F	31	-	2241	8.77*	204F	31	-	2376	677	153
				1			425B	125	3.0	3369		455B	124	3.0	3609		285E	123	3.0	3032		295E	122	3.0	3189	921	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation: N/A – STIRRUPS ARE NOT REQUIRED
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(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
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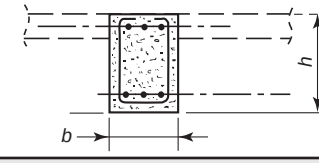
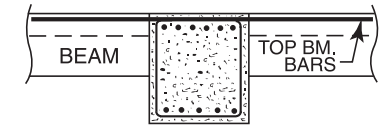
JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 20 ft					SPAN, ℓ_n = 22 ft.					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.						
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
24.5	24	2# 8	1# 8	1	4# 9	9.01	093I	17	-	411	7.45	103I	17	-	453	6.26	103I	17	-	486	5.33	103I	16	-	518	225	199
				1			125H	69	2.0	740		135H	68	2.0	807		155H	67	1.9	908		165H	66	1.9	974	368	
		2#10	1#10	1	4#10	12.57	114H	17	-	659	10.39	124H	17	-	722	8.73	123H	17	-	672	7.44	133H	16	-	727	350	208
				1			175E	69	2.0	1051		195E	68	1.9	1165		215E	66	1.9	1280		165H	66	1.9	1157	457	
		2#11	1#11	1	5#11	16.91	125H	17	-	978	13.98	125H	17	-	1043	11.74	134H	17	-	1004	10.01	144H	16	-	1085	422	179
				1			205D	69	2.0	1335		195E	68	1.9	1366		215E	66	1.9	1498		225E	66	1.9	1597	664	
		2#11	2#11	1	4#14	20.43	224C	17	-	1159	16.89	244C	17	-	1270	14.19	145H	17	-	1321	12.09	145H	16	-	1399	547	158
				1			245C	69	2.0	1604		265C	68	1.9	1750		245D	66	1.9	1760		225E	66	1.9	1770	742	
	36	2# 9	2# 9	1	5#10	15.09	104H	31	-	717	12.47	113H	30	-	690	10.48	113H	30	-	743	8.93	123H	30	-	805	377	142
				1			175E	124	2.9	1191		195E	122	2.9	1321		215E	120	2.8	1451		225E	118	2.8	1542	580	
		2#10	2#10	1	5#11	18.85	115H	31	-	989	15.58	124H	30	-	952	13.09	124H	30	-	1018	11.16	134H	30	-	1102	471	142
				1			205D	124	2.9	1439		195E	122	2.9	1466		215E	120	2.8	1609		225E	118	2.8	1713	697	
		3#11	2#11	1	5#14	26.31	135EeH	31	-	1388	21.74	145EdH	30	-	1517	18.27	135H	30	-	1586	15.57	145H	30	-	1714	697	118
				1			305B	124	2.9	2167		265C	122	2.9	2111		295C	120	2.8	2326		265D	118	2.8	2308	956	
		3#11	3#11	1	6#14	30.65	225C	31	-	1836	25.33	245C	30	-	2012	21.28	155EeH	30	-	1863	18.13	165EdH	30	-	2010	821	105
				1			405A	124	2.9	2736		445A	122	2.9	3008		295C	120	2.8	2544		315C	118	2.8	2738	1114	
	48	3# 8	3# 8	1	6#10	18.03	094I	46	-	816	14.90	104I	45	-	899	12.52	104I	44	-	962	10.67	104I	44	-	1024	450	101
				1			175E	185	3.9	1374		264C	181	3.8	1408		294C	178	3.8	1552		**	176	0.0	820	701	
		3#10	3#10	1	6#11	23.25	115H	46	-	1245	19.22	114H	45	-	1202	16.15	124H	44	-	1310	13.76	134H	44	-	1418	701	104
				1			305B	184	3.9	2199		335B	181	3.8	2417		215E	178	3.7	1981		225E	175	3.7	2113	845	
		3#11	3#11	1	6#14	32.03	135EfH	46	-	1606	26.47	145EeH	45	-	1755	22.24	145EdH	44	-	1872	18.95	145H	44	-	1989	845	94
				1			305B	184	3.9	2495		335B	181	3.8	2743		365B	178	3.7	2991		395B	175	3.7	3238	1164	
		4#11	3#11	1	8#14	38.89	225C	46	-	2213	32.14	165DhH	45	-	2167	27.01	175DhH	44	-	2347	23.01	165EfH	44	-	2463	972	82
				1			405A	184	3.9	3247		445A	181	3.8	3569		365B	178	3.7	3368		395B	175	3.7	3647	1485	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b - 2''$).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360 <$ deflection $< \ell_n/240$
X – $\ell_n/240 <$ deflection $< \ell_n/180$
Y – deflection $> \ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b > 24$ in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

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(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
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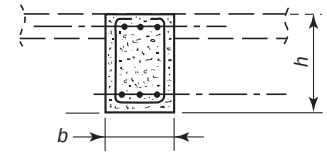
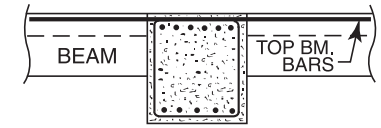
$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS(1)				TOTAL CAPACITY $U = 1.2D + 1.6L$(3)																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 28 ft					SPAN, ℓ_n = 30 ft.					SPAN, ℓ_n = 32 ft.					SPAN, ℓ_n = 34 ft.						
h in.	b in.	BOTTOM ℓ_n + 12 in.	BOTTOM 0.875 ℓ_n	Layers (2)	TOP	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
24.5	24	2# 8	1# 8	1	4# 9	4.60	113I	16	-	560	4.01	113I	16	-	593	3.52	113I	16	-	626	3.12	113I	16	-	658	225	199
				1			175H	65	1.9	1041		185H	64	1.9	1108		195H	64	1.8	1174		215H	63	1.8	1275	368	
		2#10	1#10	1	4#10	6.41	133H	16	-	774	5.59	143H	16	-	829	4.91	143H	16	-	876	4.35	153H	16	-	931	350	208
				1			175H	65	1.9	1237		185H	64	1.9	1318		195H	64	1.8	1399		215H	63	1.8	1513	457	
		2#11	1#11	1	5#11	8.63	154H	16	-	1167	7.52	154H	16	-	1231	6.61	164H	16	-	1313	5.85	173H	16	-	1257	422	179
				1			245E	65	1.9	1729		265E	64	1.8	1862		285E	64	1.8	1994		215H	63	1.8	1821	664	
		2#11	2#11	1	4#14	10.42	154H	16	-	1354	9.08	164H	16	-	1448	7.98	174H	16	-	1543	7.07	174H	16	-	1621	547	158
				1			245E	65	1.9	1916		265E	64	1.8	2062		285E	64	1.8	2208		295E	63	1.8	2320	742	
	36	2# 9	2# 9	1	5#10	7.70	123H	29	-	857	6.71	133H	29	-	920	5.89	133H	29	-	972	5.22	133H	28	-	1025	377	142
				1			175H	117	2.7	1401		603A	116	2.7	1542		643A	115	2.7	1645		683A	114	2.7	1747	580	
		2#10	2#10	1	5#11	9.62	133H	29	-	1052	8.38	143H	29	-	1127	7.37	143H	29	-	1192	6.52	153H	28	-	1268	471	142
				1			245E	117	2.7	1857		265E	116	2.7	2000		285E	115	2.7	2143		215H	114	2.7	1937	697	
		3#11	2#11	1	5#14	13.42	155H	29	-	1843	11.69	155H	29	-	1941	10.28	164H	29	-	1894	9.10	174H	28	-	2012	697	118
				1			285D	117	2.7	2485		305D	116	2.7	2661		285E	115	2.7	2682		295E	114	2.7	2820	956	
		2#14	2#14	1	6#14	15.64	155H	29	-	2065	13.62	165H	29	-	2209	11.97	175H	29	-	2354	10.60	185H	28	-	2498	787	107
				1			345C	117	2.7	2940		305D	116	2.7	2899		325D	115	2.7	3092		345D	114	2.7	3284	1114	
	48	3# 8	3# 8	1	6#10	9.20	114I	43	-	1107	8.01	114I	43	-	1169	7.04	114I	43	-	1232	6.24	114I	42	-	1294	450	101
				1			**	174	3.9	882		**	172	3.8	945		**	170	3.8	1007		**	169	0.0	1070	701	
		3#10	3#10	1	6#11	11.86	134H	43	-	1506	10.33	143H	43	-	1477	9.08	143H	43	-	1565	8.05	143H	42	-	1653	701	104
				1			344C	173	3.7	2172		364C	172	3.6	2315		384C	170	3.6	2457		**	169	3.7	1504	845	
		3#11	3#11	1	6#14	16.34	145H	43	-	2106	14.24	155H	43	-	2256	12.51	164H	43	-	2214	11.08	164H	42	-	2331	845	94
				1			425B	173	3.6	3486		455B	172	3.6	3734		485B	170	3.6	3982		295E	169	3.6	3270	1164	
		4#11	3#11	1	8#14	19.84	175EeH	43	-	2643	17.29	175EdH	43	-	2791	15.19	175H	43	-	2939	13.46	175H	42	-	3087	972	82
				1			425B	173	3.6	3926		455B	172	3.6	4205		485B	170	3.6	4484		515B	169	3.6	4763	1485	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

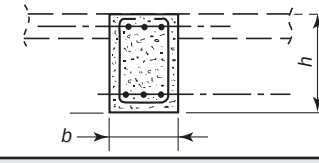
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

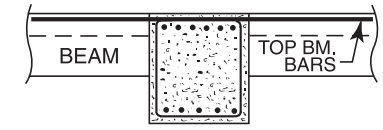
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS[1]				TOTAL CAPACITY $U = 1.2D + 1.6L$[3]																				
		BOTTOM		Layers	TOP	SPAN, ℓ_n = 22 ft					SPAN, ℓ_n = 24 ft.					SPAN, ℓ_n = 26 ft.					SPAN, ℓ_n = 28 ft.					$+\phi M_n$ $-\phi M_n$	DEFL (C)
h in.	b in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft-kips	$A\ell$ sq. in.	STEEL WGT lb.	LOAD (4) k/ft	STIR. TIES (5)	ϕT_n ft.-kips	$A\ell$ sq. in.	STEEL WGT lb.	(6) ft.-kip	(7) $\times 10^{-9}$ in.
28.5	24	2# 9	1# 9	1	4#10	11.08	103J	22	-	561	9.31	103J	21	-	603	7.93	113J	21	-	654	6.84	113J	21	-	696	335	130
				1			175F	88	2.3	1088		185F	86	2.3	1167		205F	85	2.2	1282		165I	83	2.2	1177	548	
		2#10	1#10	1	4#11	13.87	104J	22	-	766	11.65	114J	21	-	837	9.93	114J	21	-	889	8.56	123J	21	-	852	419	131
				1			175F	88	2.3	1204		185F	86	2.3	1293		205F	84	2.2	1418		215F	83	2.2	1507	659	
		2#11	2#11	1	4#14	20.57	204D	22	-	1240	17.28	125J	21	-	1301	14.73	125J	21	-	1379	12.70	135J	21	-	1487	659	107
				1			225D	88	2.3	1675		245D	86	2.3	1827		265D	84	2.2	1978		245E	83	2.2	1983	904	
		3#10	2#10	1	5#14	22.23	214D	22	-	1390	18.68	224D	21	-	1498	15.91	125J	21	-	1534	13.72	135J	21	-	1653	672	97
				1			445A	88	2.3	2614		245D	86	2.3	1970		265D	84	2.2	2133		285D	83	2.2	2296	1079	
	36	2#10	2#10	1	5#11	18.61	104J	40	-	934	15.63	114J	39	-	1020	13.32	114J	39	-	1085	11.49	114J	38	-	1151	562	91
				1			225D	160	3.4	1644		215E	157	3.4	1668		225E	155	3.3	1775		245E	153	3.3	1923	838	
		2#11	2#11	1	5#11	19.05	105J	40	-	1133	16.01	114J	39	-	1106	13.64	114J	39	-	1179	11.76	124J	38	-	1272	681	87
				1			225D	160	3.4	1723		215E	157	3.4	1754		225E	155	3.3	1869		245E	152	3.3	2024	838	
		3#11	2#11	1	6#14	27.71	125GeJ	40	-	1603	23.29	125GdJ	39	-	1712	19.84	135GdJ	39	-	1853	17.11	135J	38	-	1963	838	74
				1			335B	160	3.4	2586		295C	157	3.4	2529		315C	155	3.3	2721		345C	152	3.3	2955	1357	
		4#11	3#11	1	7#14	35.10	215D	40	-	2216	29.50	225D	39	-	2386	25.13	245D	39	-	2589	21.67	165FgJ	38	-	2468	1136	64
				1			445A	160	3.4	3365		485A	157	3.4	3669		525A	155	3.3	3973		425B	152	3.3	3696	1544	
	48	3# 9	3# 9	1	6#11	22.17	104J	60	-	1093	18.62	104J	59	-	1171	15.87	114J	58	-	1272	13.68	114J	57	-	1350	670	67
				1			335B	241	4.5	2402		365B	236	4.5	2620		225E	232	4.4	2048		245E	229	4.3	2219	1014	
		3#10	3#10	1	6#14	27.73	115GcJ	60	-	1569	23.30	115J	59	-	1676	19.86	115J	58	-	1782	17.12	125J	57	-	1924	838	64
				1			335B	241	4.5	2715		365B	236	4.5	2960		395B	232	4.4	3206		425B	229	4.3	3452	1407	
		4#11	3#11	1	7#14	36.66	155DiJ	60	-	2064	30.80	155EhJ	59	-	2202	26.25	145FfJ	58	-	2304	22.63	145GeJ	57	-	2442	1168	58
				1			335B	240	4.5	3069		365B	236	4.4	3346		395B	232	4.4	3623		425B	228	4.3	3900	1612	
		5#11	4#11	1	9#14	45.42	275AlD	60	-	2920	38.17	275AjD	59	-	3096	32.52	245D	58	-	3168	28.04	195DkJ	57	-	3169	1466	49
				1			445A	240	4.5	4014		485A	236	4.4	4376		525A	232	4.4	4739		425B	228	4.3	4451	1998	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

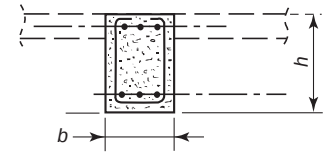
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

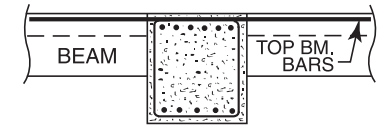
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

JOIST-BAND BEAMS, INTERIOR SPANS





STEM		BARS(1)				TOTAL CAPACITY $U = 1.2D + 1.6L$(3)																	$+\phi M_n$ $-\phi M_n$	DEFL (C)
						SPAN, ℓ_n = 30 ft					SPAN, ℓ_n = 32 ft.					SPAN, ℓ_n = 34 ft.					SPAN, ℓ_n = 36 ft.						
h	b	BOTTOM		Layers	TOP	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	LOAD (4)	STIR. TIES	ϕT_n	$A\ell$	STEEL WGT	(6)	(7)
in.	in.	ℓ_n + 12 in.	0.875 ℓ_n	(2)		k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft-kips	sq. in.	lb.	k/ft	(5)	ft.-kips	sq. in.	lb.	ft.-kip	$\times 10^{-9}$ in.
28.5	24	2# 9	1# 9	1	4#10	5.96	113J	21	-	738	5.24	123J	20	-	789	4.64	123J	20	-	831	4.14	123J	20	-	872	335	130
				1			175I	82	2.2	1255		195H	81	2.2	1370		215H	81	2.2	1485		225H	80	2.1	1563	548	
		2#10	1#10	1	4#11	7.46	123J	21	-	904	6.55	133J	20	-	966	5.81	133J	20	-	1018	5.18	143J	20	-	1080	419	131
				1			235F	82	2.2	1632		245F	81	2.2	1721		265F	81	2.1	1846		205I	80	2.1	1678	659	
		2#11	2#11	1	4#14	11.06	145J	21	-	1594	9.72	144J	20	-	1519	8.61	154J	20	-	1615	7.68	164J	20	-	1712	659	107
				1			265E	82	2.2	2134		285E	81	2.2	2285		265F	81	2.1	2290		275F	80	2.1	2405	904	
		2#14	1#14	1	5#14	12.51	145J	21	-	1825	11.00	155J	20	-	1948	9.74	155J	20	-	2041	8.69	165J	20	-	2163	703	97
				1			305D	82	2.2	2512		285E	81	2.2	2532		295E	81	2.1	2661		315E	80	2.1	2828	1079	
	36	2#10	2#10	1	5#11	10.01	123J	38	-	1120	8.79	123J	37	-	1185	7.79	133J	37	-	1261	6.95	133J	37	-	1327	562	91
				1			265E	151	3.2	2072		285E	149	3.2	2221		295E	148	3.2	2328		225H	147	3.1	2102	838	
		2#11	2#11	1	5#11	10.25	124J	38	-	1345	9.01	123J	37	-	1300	7.98	133J	37	-	1384	7.12	133J	37	-	1456	681	87
				1			265E	151	3.2	2180		285E	149	3.2	2336		295E	148	3.2	2450		315E	147	3.1	2606	838	
		2#14	2#14	1	6#14	16.59	155GdJ	38	-	2222	14.58	145J	37	-	2304	12.92	155J	37	-	2451	11.52	165J	37	-	2598	949	72
				1			365C	150	3.2	3232		325D	149	3.2	3181		345D	148	3.1	3379		365D	146	3.1	3576	1357	
		3#14	2#14	1	7#14	18.88	165GfJ	38	-	2644	16.59	165GeJ	37	-	2784	14.70	165GdJ	37	-	2925	13.11	175GcJ	37	-	3097	1159	64
				1			365C	150	3.2	3622		385C	149	3.2	3846		415C	148	3.1	4111		435C	146	3.1	4334	1544	
	48	3# 9	3# 9	1	6#11	11.92	114J	56	-	1428	10.48	124J	56	-	1528	9.28	124J	55	-	1607	8.28	124J	55	-	1685	670	67
				1			364C	226	4.3	2236		384C	224	4.2	2373		414C	222	4.2	2539		**	220	4.3	1418	1014	
		3#10	3#10	1	6#14	14.91	124J	56	-	1876	13.11	134J	56	-	2004	11.61	134J	55	-	2111	10.36	144J	55	-	2239	838	64
				1			455B	226	4.3	3697		285E	224	4.2	3015		295E	221	4.2	3167		315E	220	4.1	3367	1407	
		4#11	3#11	1	7#14	19.71	145GdJ	56	-	2580	17.33	155GcJ	56	-	2753	15.35	155J	55	-	2891	13.69	155J	55	-	3029	1168	58
				1			455B	226	4.3	4177		485B	223	4.2	4454		515B	221	4.2	4731		545B	220	4.1	5008	1612	
		3#14	3#14	1	9#14	24.43	185EiJ	56	-	3237	21.47	185EiJ	56	-	3409	19.02	185FgJ	55	-	3581	16.96	175GfJ	55	-	3718	1407	50
				1			455B	226	4.3	4693		485B	223	4.2	5005		515B	221	4.2	5316		545B	219	4.1	5628	1998	

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches (b – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For b > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where w = tabulated load (k/ft.), ℓ_n in ft.
"Average service load" is taken as w/1.4.

CHAPTER 13 – SQUARE SPREAD FOOTINGS, PILE CAPS AND DRILLED PIERS

This Chapter covers square spread footings for individual columns, pile caps for individual columns, and drilled pier (caisson) foundations.

SQUARE SPREAD FOOTINGS FOR INDIVIDUAL COLUMNS

The function of a spread footing is to distribute the total downward load of a column, pier or wall (including the weight of the footing itself) over a sufficient area of soil to keep the bearing pressure within that allowable for the soil encountered. Also, the centroid of the downward load should coincide with that of the soil pressure prism to avoid eccentricities and overturning.

Net factored axial load capacities for columns bearing on individual square spread footings are included in the tabulated designs in this Chapter. The footing designs are based on concrete with a compressive strength f'_c = 3,000 psi and reinforcing bars with f_y = 60,000 psi. In the tabulated designs, 1.2 times the weight of the footing has been deducted from the total factored load on the footing.

Allowable soil pressures are usually recommended by a geotechnical engineer, or set by the statutory building code as safe bearing capacities per square foot, where "safe" means for "service loads." The service load from column to footing is the computed dead load plus live load. For strength design, the total factored load becomes 1.2 × dead load plus 1.6 × live load (or other combinations as in ACI 9.2). A load factor of 1.4 times the "safe soil bearing capacity" will provide about the same "safety factor" on soil for 1.2 dead plus 1.6 live load from the column. Therefore, the tabulated designs are arranged for factored capacities of 1,400, 2,800, 4,200... psf, corresponding to the safe bearing capacities of 1,000, 2,000, 3,000... psf.

Usually, in design practice, and invariably throughout these tabulated designs, soil pressures are assumed uniformly distributed across the bottom of the footing. If the distribution pressure is high directly underneath the column and decreasing toward the edges of the footing, the footing bending moment would be reduced. If the distribution pressure is high around the edges of the footing and low in the center, the footing bending moment would be increased.

To meet the first functional requirement of a footing, all downward loads in the column from the floors above are accumulated. All dead loads will be multiplied by a factor of 1.2, as required by ACI 9.2.l. Included under this load factor are all floor finishes, ceilings, piping, ducts, partitions, cases, storage racks, fixed mechanical equipment, or any similar permanent, known, unvarying loads. Similarly, all live loads are augmented by a factor of 1.6 as required by ACI 9.2.l. Live loads are only the specified superimposed live loads, suitable values for which are specified in all statutory building codes with allowable reductions for column design. The effects of all wind, earthquake and other loads that should be used in the design of the column are similarly computed and properly augmented.

The effects of these various loadings will be combined into a required column strength, *U,* which is the largest from the equations in ACI 9.2:

$U = 1.4D$
$U = 1.2D + 1.6L$
$U = 1.2D + 1.0L + 1.6W$ (whichever is larger)

This maximum column required strength is the one to be used in entering the tabulated designs in this Chapter.

The strength-reduction factors, ϕ (ACI 9.3) have already been incorporated into the tabulated designs.

A footing can usually be made square, centered under the column it supports, and of size such as those tabulated. Rectangular footings can be substituted when space is restricted in one direction and not in the other. Round, octagonal, and other footing shapes can be used. Approximations are possible for such shapes from tabulated designs.

A word of caution: No tables or methods of computation can replace sound engineering judgment, especially in dealing with soil conditions. Selection of the footing design for an appropriate soil bearing capacity must be based on knowledge of the soil's characteristics.

Design Considerations

The general design considerations leading to the footing tabulated designs involve both code requirements and normal design and construction practices. Some of these considerations are listed below:

(1) Choice of materials. Normal-weight concrete with a specified compressive strength of 3,000 psi is usually the most economical choice. Higher strength concrete can be used where the depth or the weight of the footing is very critical and must be minimized, but usually savings in concrete volume do not offset

higher unit price. Lower strength concretes will reduce shear and increase development lengths. Grade 60 reinforcing bars (f_y = 60,000 psi) are the standard grade recommended for overall economy.

(2) Design for concentric load. Only special designs consider moment transfer from column to footing, which are outside the scope of the tabulated designs.

(3) Size of column. Again, conservatively, the smallest practicable reinforced concrete square tied column was assumed for design of the footings. Normally, for the loads shown, a larger column will be used with consequent reduction of factored shears and moments. For much larger columns on small footings with high soil bearing capacity, it may be worthwhile to reduce the reinforcement in proportion to the square of the ratio of reduced cantilever span to the tabulated dimension (except when minimum reinforcement controls).

(4) Effective depth. Average effective depth was used to compute both design shear strength and the required flexural reinforcement. For square footings, it is normal to require equal flexural reinforcement each way.

(5), Shear. Both two-way and one-way shear have been considered.

(6) Length of reinforcing bars. As is common practice, all reinforcing bars are shown as equal length. For each tabulated design, the bar size is the maximum for the available development length and minimum spacing. For very large footings, alternate length bars may be used, but an additional step in design is required to satisfy the stringent code requirements for bars cut off in tension zones (ACI 12.10.5).

(7) Minimum area of shrinkage and temperature reinforcement, A_s = 0.0018bh (ACI 10.5.4 and ACI 7.12)

Scope of Load Tables

The scope of the tabulated designs provide a range of safe bearing capacity from 1,000 psf to 15,500 psf in increments of 500 psf, which was considered adequate to include the poorest soil normally encountered to high quality bearing clays. Footing sizes offered cover the range 4′-0″ to 20′-0″ square, considered adequate for most structures using individual footings.

Basis of Tabulated Designs

See Fig. 13-1 for the material strengths, concrete cover, effective depth d, arrangement of reinforcing bars, and design shear strengths used in the preparation of the tabulated designs.

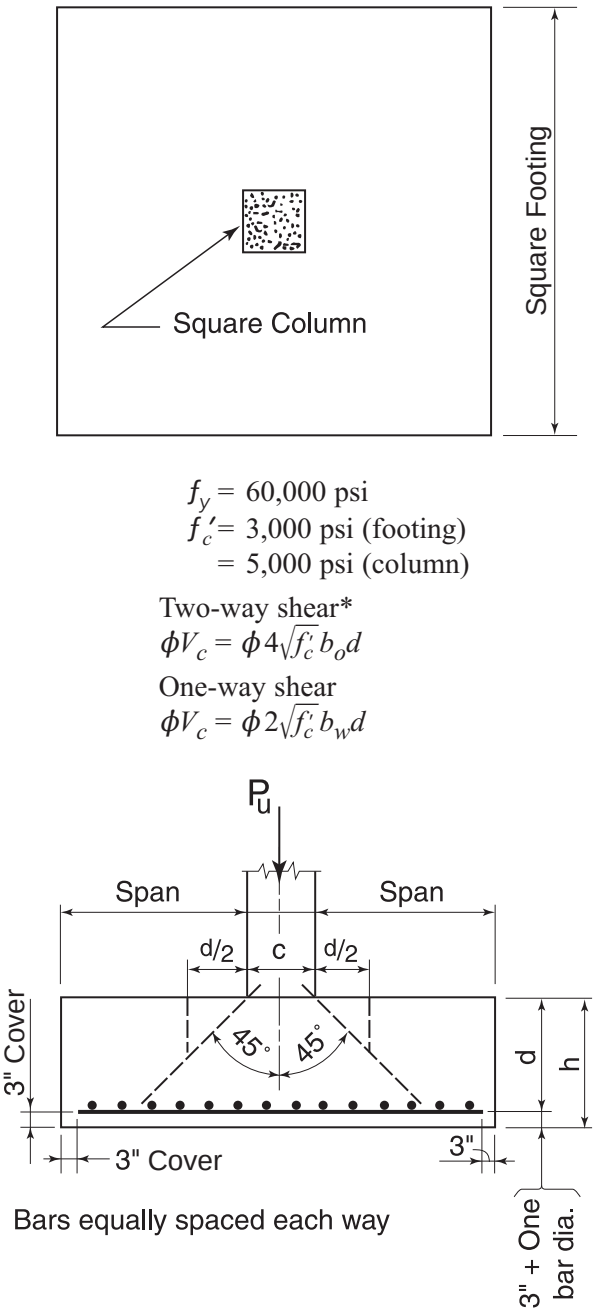


Figure 13-1 Footing Dimensions

*ACI Eq. 11-31 is not applicable for square columns. For the column sizes and footing thicknesses in the tabulated designs, ACI Eq. 11-32 does not control design shear strength.

Use of Tabulated Designs

The tabulated designs plus details of Fig. 13-1 are arranged to provide a complete design for square spread footings. Select the table for the appropriate safe soil bearing capacity and enter the table with the maximum column factored load, $P_u = 1.2D + 1.6L$, proceed down the last column of the table, and select the first design with a column design capacity larger than the factored load. For quick estimates, the volume of concrete, the size and the number of bars, and the total weight of reinforcing bars are included in the tabulated designs.

The Manual Example on Page 13-4 illustrates the computations of the computer program used to prepare the tabulated designs. It will be noted that the process of preparing tabulated designs reverses the normal design procedure. Beginning with a selected increment of footing size and safe soil bearing capacity, the minimum column size, depth, and required reinforcement are determined. Since the weight of the footing must be deducted from the total load on the soil, the computer program uses a convergent system of trial depths to select the tabulated depth which is determined by shear for the net load.

DEVELOPMENT OF DOWELS IN FOOTINGS

Table 13-1 gives the minimum compression development lengths, ℓ_d, for Grade 60 (f_y = 60,000 psi) reinforcing bars in concrete with $f'_c \geq$ 3,000 psi. For minimum footing thickness, add 3 inches of bottom concrete cover.

Table 13-1 Compression ℓ_d for Grade 60 Reinforcing Bars with $f'_c \geq$ 3,000 psi

Compression ℓ_d (inches)								
#5	#6	#7	#8	#9	#10	#11	#14	#18
14	17	19	22	25	28	31	38	50

When the dowel compression development length exceeds the available length for a given footing thickness, three possibilities are:

(1) Add a monolithic concrete cap suffciently thick to provide the required embedment length.

(2) Use a greater number of smaller diameter dowels to provide the required area of dowels and embedment length within the thickness selected.

(3) Thicken the footing to provide necessary embedment length.

This discussion considers dowels in compression only. Dowels in tension are excluded here.

Dowels are required to transfer only the *excess* compression above bearing allowed on the footing or on the gross area of column (ACI 15.8.1.2). The column dowels must provide a minimum area of 0.5 percent times the gross area of the column. (ACI 15.8.2.1).

The strength-reduction factor, $\phi = 0.65$, is identical to that for compression in tied columns (ACI 9.3.2.2-b). Design bearing strength on full sections (as on the base of the column) is $\phi(0.85 f'_c A_1)$ (ACI 10.14.1). If the load bearing, A_1, is one half or less than the area resisting the bearing load, A_2, the design bearing strength is $2\phi(0.85 f'_c A_1)$.

Example 1. Dowels for Minimum Size Columns

From the Manual Example of a footing design on Page 13-4, take an 18 in. × 18 in. column with P_u = 1,345 kips on a footing 38-in. deep. Column concrete f'_c = 5,000 psi; longitudinal column bars are 8 percent of gross area of column; f_y = 60,000 psi. Footing concrete f'_c = 3,000 psi.

Design bearing strength of column concrete
$= 0.85\phi f'_c = (0.85)(0.65)(5{,}000) = 2{,}763$ psi

Design bearing strength of footing concrete
$= 2(0.85)\phi f'_c = 2(0.85)(0.65)(3{,}000) = 3{,}315$ psi

Note that the design bearing strength is always critical on the column until the compressive strength of the column concrete is twice that of the footing.

Column compression is transferred by a combination of concrete bearing and steel bearing. The design bearing strength of the column is then (2,763)(18 × 18) = 895 kips

Excess compression to be transferred by dowels,
$P_u - 895 = 1{,}345 - 895 = 450$ kips

Area of dowels required = 450/60 = 7.50 in.^{2}, which is greater than the minimum area of dowels = $0.005A_g$ = 0.005(18)(18) = 1.62 in.^{2}

Embedment depth available = 38 – 3 = 35 in.
Maximum size bar (see Table 13-1):

For #11 bar, compression ℓ_d = 31 in. < 35 in.

Area of #11 bar = 1.56 in.^{2}

Number of bars required: 7.50/1.56 = 5 – #11 bars

Total length of dowel = embedment (compression ℓ_d) in footing plus compression lap splice in column. Compression lap splice in column with f'_c = 5,000 psi; see Table 5-1; for a #11 bar, the lap length = 0.83(43) = 36 in. if column tie area ≥ 0.0015*hs* or 43 in. with lesser ties. With vertical bars equal to 8 percent of the column area, ties will usually satisfy these requirements (ACI 12.17.2.4). Dowel length is 31 + 36 = 67 in.

Example 2. Dowels for Columns with Minimum Longitudinal Reinforcement

Select dowels for a 26 in. × 26 in. column with 8-#9 longitudinal bars (1.18 percent); f_y = 60,000 psi; column concrete f'_c = 5,000 psi. Same factored load as in Example 1, P_u = 1,345 kips. Footing concrete f'_c = 3,000 psi.

Design concrete bearing strength of footing
= $2(0.85)\phi f'_c = 2(0.85)(0.65)(3{,}000) = 3{,}315$ psi

Design concrete bearing strength of column
= $0.85\phi f'_c = 0.85(0.65)(5{,}000) = 2{,}763$ psi (controls)

Total compression = 1,345(1,000)/(26 × 26)

= 1,990 psi < 2,763 psi

There is no excess compression since the total compression load is less than the controlling design bearing strength. The Code nevertheless requires dowels with a total minimum area = 0.005(26)(26) = 3.38 in.^{2} (ACI 15.8.2.1).

Try: 4 – #9 dowels (A_s = 4.00 in.^{2}).

From Table 13-1, for a #9 bar, compression ℓ_d = 25 in.

From Table 5-1, the compression lap length of the #9 dowels = 34 in. (the required length would be less than 34 in. if the reduction for column ties was considered (ACI 12.17.2.4).) Dowel length is 34 + 25 = 59 in.

Use: 4 – #9 × 4′-11″ dowels

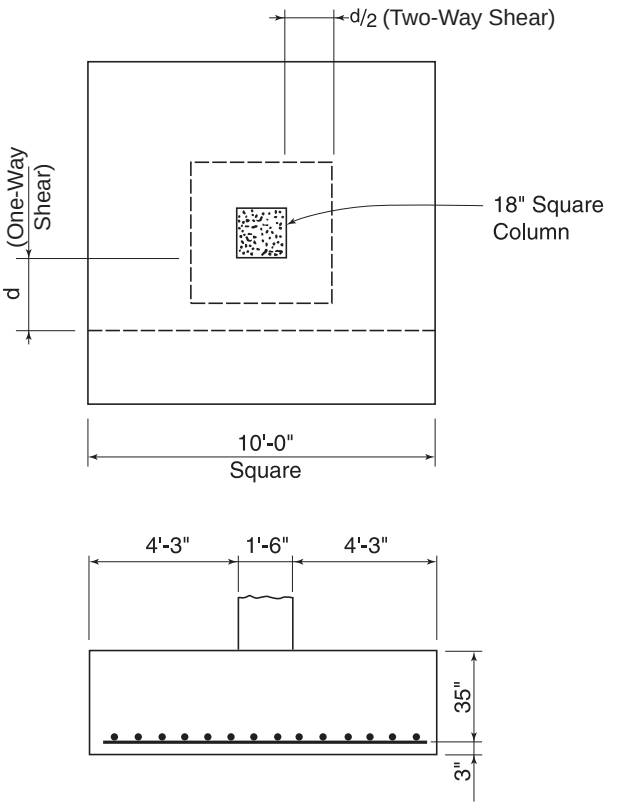
Manual Example

For a safe allowable soil bearing capacity of 10,000 psf, determine the maximum column capacity, and the minimum depth and required reinforcement for a 10′-0″ square footing. Use f'_c = 3,000 psi and f_y = 60,000 psi for the footing. The design should be adequate for any square column *larger* than that required for a tied column with f'_c = 5,000 psi, and 8 percent Grade 60 vertical reinforcement. See Fig. 13-1, and the following plan view and elevation of the footing. Compare results to tabulated designs on Page 13-15.

Soil Calculations:

Safe allowable bearing capacity, q_a = 10,000 psf (given)
Total factored bearing capacity, q_t = 14,000 psf
For first trial, assume footing thickness 3′-2″ (38”)
Net factored soil pressure = q_s

$q_s = q_t = 14{,}000 - 1.2(38/12)(150) = 13{,}430$ psf



Factored column load, P_u:

$$P_u = \frac{(10 \times 10)(13{,}430)}{1000} = 1{,}343 \text{ kips}$$

Minimum size square tied column:

f'_c = 5,000 psi; f_y = 60,000 psi; ρ = 0.08;

Maximum axial design strength (ACI Eq. 10-2):
$\phi P_{n(max)} = 0.80\phi\,[0.85 f'_c\,(A_g - A_{st}) + f_y\,A_{st}]$

Substituting $A_{st} = \rho A_g$ and ϕ = 0.65 and solving for:
$\phi P_{n(max)}/A_g = 0.442 f'_c(1 - \rho) + 0.520 f_y \rho = 4.53$ ksi

Min. size of square column, $c = \sqrt{\frac{P_u}{4.53}} = \sqrt{\frac{1{,}343}{4.53}}$
= 17.22 = 18 in.
Min. size of square column = 18 in. × 18 in.

Two-way shear

Design shear strength, $\phi V_c = \phi 4\sqrt{f'_c} b_o d$ on a critical section located at a distance $d/2$ from the face of the column (ACI 11.11.2). See plan view of the footing.

Compute the minimum effective depth for the maximum size bar that can be developed in the span length. Embedment length available for tension development = 51 – 3 = 48 in. Assume #9 bars per tabulated design. See Chapter 5 for required tension ℓ_d. From Table 5-2(a), Case 1, ℓ_d = 62 in.; from Table 5-3(a), ℓ_d = 41 in.

for 2 in. or 3 in. of concrete cover, provided the c.-c. spacing of the bars > twice the concrete cover plus one bar diameter (Note 3 under Table 5-3(a)). If the applicable ℓ_d is 41 in., the available embedment length of 48 in. > 41 in. From the tabulated design on Page 13-15, the c.-c. spacing of #9 bars = $(12 \times 10 - 3 - 3 - 1.128)/(9 - 1) = 14.11$ in. which is greater than 2(3) + 1 = 7 in.; hence, ℓ_d = 41 in.

$d = 38 - 3 - 1.128 = 33.87$ in.

For two-way shear, $b_o = 4(18 + 33.87) = 207.5$ in.

Total factored shear V_u

$$V_u = \frac{(13{,}430)}{1000}\left(10 \times 10 - \frac{51.87}{12} \times \frac{51.87}{12}\right)$$
$$= 1{,}092 \text{ kips}$$

$\phi V_c = 0.75(4)\sqrt{3{,}000}(207.5)(33.87)/1{,}000$
$\phi V_c = 1{,}154$ kips > V_u, okay

One-way (beam) shear

Design shear strength, $\phi V_c = \phi 2\sqrt{f'_c} b_w d$ on a critical section located at a distance d from the face of the column. See plan view of the footing.

$$V_u = \frac{(51 - 33.87)}{12}(10)(13{,}430)/1{,}000 = 192 \text{ kips}$$

$\phi V_c = 0.75(2)\sqrt{3{,}000}(120)(33.87)/1{,}000$
$\phi V_c = 334$ kips > V_u, okay

Selection of bar size – The bar size and number of bars are selected by the following process:

1. Compute the required number of each bar size that would satisfy the total required A_s.
2. Reject bar sizes that are too large to be fully developed by anchorage (as straight bars).
3. Reject bar sizes for which the required number results in A_s more than 10 percent higher than A_s required (to save tonnage).
4. Reject bar sizes that require spacing at more than 18 in.
5. Reject bar sizes that require a total number of bars 25 percent more than the minimum number for bar sizes passing criteria 1 through 4 (to avoid high placing cost).
6. If more than one choice remains, select from the remaining choices the same bar size used for the preceding smaller footing if this bar size is one of those remaining. If not, select the bar size remaining that gives the least weight of reinforcing bars.

Required flexural reinforcement

Factored moment is computed at the face of the column at the critical section prescribed (ACI 15.4.2.-a).

$$M_u = \frac{1}{2}(13{,}430)(10)(4.25)^2/1{,}000$$
$$= 1{,}213 \text{ ft.-kips}$$
$$= 1{,}213(12/10) = 1{,}455 \text{ in.-kips/ft.}$$

From Chapter 5 with f'_c = 3,000 psi and b = 12 in.:

$$A_s = 0.510(d) - \sqrt{0.260d^2 - 0.0189M_u}$$
$$= 0.510(33.87) - \sqrt{0.260(33.87)^2 - 0.0189(1{,}455)}$$
$$= 0.815 \text{ in.}^2\text{/ft.} = 8.15 \text{ in.}^2$$

∴Use 9-#9 bars (#9 bars used in 9'-6" footing)

Need to check that $\varepsilon_t \geq 0.005$, which is required in the ACI Building Code for ϕ =0.90.

From Chapter 5, $\rho_{max} = 0.01355$

$$\rho = \frac{A_s}{bd} = \frac{9.00}{12(10)33.87} = 0.01329 < 0.01355, \text{ OK}$$

Quantities of materials

Weight of reinforcing bars:

Weight = (2)(9)(3.40)(9.5) = 581 pounds

$$\text{Volume of Concrete} = \frac{(10 \times 10)(38/12)}{27}$$
$$= 11.7 \text{ cubic yards}$$

CONCRETELY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 1,400 psf (SAFE BEARING CAPACITY 1,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	12	10	4-#4 *	0.73	19	0.6	20
4'-6"	12	10	5-#4	0.83	27	0.8	25
5'-0"	12	10	4-#5	0.90	38	0.9	31
5'-6"	12	10	5-#5	0.99	52	1.1	37
6'-0"	12	10	5-#5	1.09	57	1.3	44
6'-6"	12	10	6-#5	1.18	75	1.6	52
7'-0"	12	10	6-#5	1.27	81	1.8	60
7'-6"	12	10	6-#5	1.38	88	2.1	69
8'-0"	12	10	6-#5	1.71	94	2.4	78
8'-6"	12	10	7-#5	2.08	117	2.7	88
9'-0"	13	10	8-#5	2.20	142	3.3	98
9'-6"	14	10	8-#5	2.33	150	3.9	107
10'-0"	14	10	9-#5	2.75	178	4.3	119
10'-6"	15	10	10-#5	2.88	209	5.1	130
11'-0"	15	10	11-#5	3.35	241	5.6	142
11'-6"	16	10	12-#5	3.49	275	6.5	153
12'-0"	16	10	13-#5	4.00	312	7.1	167
12'-6"	17	10	14-#5	4.15	350	8.2	179
13'-0"	18	10	14-#5	4.30	365	9.4	191
13'-6"	18	10	16-#5	4.85	434	10.1	206
14'-0"	19	10	17-#5	5.00	479	11.5	219
14'-6"	19	10	13-#6	5.64	547	12.3	234
15'-0"	20	10	14-#6	5.80	610	13.9	248
15'-6"	20	10	15-#6	6.43	676	14.8	264
16'-0"	21	10	15-#6	6.58	698	16.6	278
16'-6"	22	10	16-#6	6.74	769	18.5	291
17'-0"	22	10	17-#6	7.41	843	19.6	309
17'-6"	23	10	13-#7	7.62	903	21.7	323
18'-0"	23	10	14-#7	8.33	1002	23.0	342
18'-6"	24	10	15-#7	8.48	1104	25.4	356
19'-0"	24	10	16-#7	9.22	1210	26.7	375
19'-6"	25	10	16-#7	9.37	1243	29.3	390
20'-0"	25	10	17-#7	10.14	1355	30.9	410

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCRETELY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 2,100 psf (SAFE BEARING CAPACITY 1,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	12	10	4-#4 *	0.73	19	0.6	31
4'-6"	12	10	5-#4	0.83	27	0.8	39
5'-0"	12	10	4-#5	0.90	38	0.9	48
5'-6"	12	10	5-#5	0.99	52	1.1	58
6'-0"	12	10	5-#5	1.09	57	1.3	69
6'-6"	12	10	6-#5	1.36	75	1.6	81
7'-0"	13	10	6-#5	1.54	81	2.0	93
7'-6"	13	10	7-#5	1.93	102	2.3	107
8'-0"	14	10	7-#5	2.13	110	2.8	121
8'-6"	15	10	8-#5	2.34	134	3.3	135
9'-0"	16	10	9-#5	2.56	160	4.0	151
9'-6"	16	10	10-#5	3.06	188	4.5	168
10'-0"	17	10	11-#5	3.30	218	5.2	185
10'-6"	18	10	12-#5	3.55	250	6.1	202
11'-0"	19	10	9-#6	3.85	284	7.1	220
11'-6"	19	10	11-#6	4.44	363	7.8	240
12'-0"	20	10	11-#6	4.72	380	8.9	259
12'-6"	21	10	12-#6	5.00	433	10.1	279
13'-0"	22	10	13-#6	5.30	488	11.5	299
13'-6"	22	10	14-#6	5.98	547	12.4	323
14'-0"	23	10	15-#6	6.29	608	13.9	344
14'-6"	24	10	16-#6	6.61	673	15.6	366
15'-0"	24	10	17-#6	7.36	740	16.7	392
15'-6"	25	10	13-#7	7.74	797	18.5	414
16'-0"	26	10	14-#7	8.08	887	20.5	438
16'-6"	26	11	15-#7	8.81	981	21.8	466
17'-0"	27	11	12-#8	9.21	1057	24.1	490
17'-6"	28	11	13-#8	9.57	1180	26.5	515
18'-0"	28	11	14-#8	10.46	1308	28.0	544
18'-6"	29	12	14-#8	10.73	1346	30.6	570
19'-0"	29	12	15-#8	11.67	1482	32.3	601
19'-6"	30	12	16-#8	12.05	1623	35.2	627
20'-0"	30	13	17-#8	12.93	1770	37.0	660

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 2,800 psf (SAFE BEARING CAPACITY 2,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	12	10	4-#4 *	0.73	19	0.6	42
4'-6"	12	10	5-#4	0.83	27	0.8	53
5'-0"	12	10	4-#5	0.90	38	0.9	66
5'-6"	12	10	5-#5	1.06	52	1.1	79
6'-0"	13	10	5-#5	1.26	57	1.4	94
6'-6"	13	10	6-#5	1.66	75	1.7	110
7'-0"	14	10	7-#5	1.89	95	2.1	127
7'-6"	15	10	7-#5	2.15	102	2.6	145
8'-0"	16	10	8-#5	2.42	125	3.2	164
8'-6"	17	10	9-#5	2.70	150	3.8	184
9'-0"	18	10	7-#6	3.03	179	4.5	205
9'-6"	19	10	8-#6	3.34	216	5.3	227
10'-0"	20	10	9-#6	3.67	257	6.2	250
10'-6"	21	10	10-#6	4.01	300	7.1	274
11'-0"	21	10	8-#7	4.70	343	7.8	301
11'-6"	22	10	9-#7	5.07	405	9.0	327
12'-0"	23	10	10-#7	5.46	470	10.2	354
12'-6"	24	10	10-#7	5.86	491	11.6	381
13'-0"	25	10	11-#7	6.28	562	13.0	410
13'-6"	26	10	12-#7	6.70	638	14.6	439
14'-0"	26	11	13-#7	7.43	717	15.7	472
14'-6"	27	11	14-#7	7.88	801	17.5	504
15'-0"	28	11	14-#7	8.34	830	19.4	536
15'-6"	28	12	12-#8	9.20	961	20.8	572
16'-0"	29	12	13-#8	9.69	1076	22.9	605
16'-6"	30	12	13-#8	10.19	1111	25.2	640
17'-0"	31	13	14-#8	10.59	1234	27.7	675
17'-6"	31	13	15-#8	11.61	1362	29.3	715
18'-0"	32	13	16-#8	12.14	1495	32.0	752
18'-6"	33	14	16-#8	12.56	1538	34.9	789
19'-0"	34	14	17-#8	13.11	1679	37.9	827
19'-6"	34	14	15-#9	14.30	1938	39.9	871
20'-0"	35	15	15-#9	14.74	1989	43.2	910

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 3,500 psf (SAFE BEARING CAPACITY 2,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	12	10	4-#4 *	0.73	19	0.6	53
4'-6"	12	10	5-#4	0.83	27	0.8	67
5'-0"	12	10	4-#5	0.98	38	0.9	83
5'-6"	13	10	5-#5	1.20	52	1.2	100
6'-0"	14	10	5-#5	1.44	57	1.6	118
6'-6"	15	10	6-#5	1.71	75	2.0	138
7'-0"	16	10	7-#5	1.99	95	2.4	160
7'-6"	17	10	8-#5	2.30	117	3.0	183
8'-0"	18	10	9-#5	2.62	141	3.6	207
8'-6"	19	10	7-#6	2.99	168	4.2	232
9'-0"	20	10	8-#6	3.36	204	5.0	259
9'-6"	21	10	9-#6	3.74	243	5.8	287
10'-0"	22	10	10-#6	4.15	285	6.8	317
10'-6"	23	10	8-#7	4.60	327	7.8	348
11'-0"	24	10	9-#7	5.04	386	9.0	380
11'-6"	25	10	10-#7	5.50	450	10.2	413
12'-0"	26	10	10-#7	5.97	470	11.6	448
12'-6"	27	11	11-#7	6.37	540	13.0	484
13'-0"	28	11	12-#7	6.88	613	14.6	521
13'-6"	28	12	13-#7	7.66	691	15.8	561
14'-0"	29	12	14-#7	8.21	773	17.5	601
14'-6"	30	12	15-#7	8.77	858	19.5	641
15'-0"	31	13	12-#8	9.28	929	21.5	683
15'-6"	32	13	13-#8	9.87	1041	23.7	726
16'-0"	32	14	14-#8	10.80	1159	25.3	773
16'-6"	33	14	15-#8	11.43	1282	27.7	818
17'-0"	34	14	16-#8	12.08	1410	30.3	864
17'-6"	35	15	16-#8	12.61	1452	33.1	911
18'-0"	36	15	17-#8	13.28	1589	36.0	959
18'-6"	37	15	18-#8	13.96	1730	39.1	1008
19'-0"	37	16	20-#8	15.05	1976	41.2	1063
19'-6"	38	16	20-#8	15.77	2029	44.6	1114
20'-0"	39	17	21-#8	16.35	2187	48.1	1166

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 4,200 psf (SAFE BEARING CAPACITY 3,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	12	10	4-#4 *	0.73	19	0.6	64
4'-6"	12	10	5-#4	0.83	27	0.8	81
5'-0"	13	10	4-#5	1.05	38	1.0	100
5'-6"	14	10	5-#5	1.31	52	1.3	121
6'-0"	15	10	6-#5	1.59	69	1.7	143
6'-6"	16	10	7-#5	1.90	88	2.1	167
7'-0"	17	10	8-#5	2.23	108	2.6	193
7'-6"	18	10	6-#6	2.62	126	3.1	221
8'-0"	19	10	7-#6	3.00	158	3.8	251
8'-6"	21	10	8-#6	3.19	192	4.7	281
9'-0"	22	10	9-#6	3.61	230	5.5	313
9'-6"	23	10	10-#6	4.06	270	6.4	348
10'-0"	24	10	8-#7	4.55	311	7.4	384
10'-6"	25	10	9-#7	5.05	368	8.5	422
11'-0"	26	11	10-#7	5.47	429	9.7	461
11'-6"	27	11	11-#7	6.00	495	11.0	502
12'-0"	28	11	11-#7	6.56	517	12.4	544
12'-6"	29	12	12-#7	7.04	589	14.0	588
13'-0"	30	12	13-#7	7.63	664	15.6	634
13'-6"	30	13	11-#8	8.54	764	16.9	683
14'-0"	31	13	12-#8	9.19	865	18.8	732
14'-6"	32	14	13-#8	9.74	972	20.8	782
15'-0"	33	14	11-#9	10.48	1085	22.9	834
15'-6"	34	14	12-#9	11.19	1224	25.2	887
16'-0"	35	15	12-#9	11.79	1265	27.7	941
16'-6"	36	15	13-#9	12.53	1414	30.3	996
17'-0"	37	16	14-#9	13.16	1571	33.0	1053
17'-6"	38	16	14-#9	13.94	1618	35.9	1112
18'-0"	38	17	16-#9	15.10	1904	38.0	1176
18'-6"	39	17	16-#9	15.93	1958	41.2	1237
19'-0"	41	17	17-#9	16.23	2139	45.7	1294
19'-6"	41	18	14-#10	17.55	2289	48.1	1363
20'-0"	42	18	15-#10	18.43	2517	51.9	1428

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 4,900 psf (SAFE BEARING CAPACITY 3,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	12	10	4-#4 *	0.73	19	0.6	76
4'-6"	12	10	5-#4	0.96	27	0.8	96
5'-0"	14	10	4-#5	1.12	38	1.1	117
5'-6"	15	10	5-#5	1.40	52	1.4	141
6'-0"	16	10	6-#5	1.71	69	1.8	168
6'-6"	17	10	7-#5	2.06	88	2.2	196
7'-0"	18	10	8-#5	2.44	108	2.7	227
7'-6"	20	10	9-#5	2.66	131	3.5	259
8'-0"	21	10	10-#5	3.08	156	4.1	293
8'-6"	22	10	12-#5	3.53	200	4.9	330
9'-0"	23	10	13-#5	4.01	231	5.8	369
9'-6"	25	10	10-#6	4.36	270	7.0	408
10'-0"	26	10	11-#6	4.83	314	8.0	451
10'-6"	27	11	9-#7	5.32	368	9.2	496
11'-0"	28	11	10-#7	5.90	429	10.5	542
11'-6"	29	12	11-#7	6.40	495	11.8	590
12'-0"	30	12	9-#8	7.06	553	13.3	641
12'-6"	31	13	10-#8	7.60	641	14.9	693
13'-0"	32	13	11-#8	8.28	734	16.7	747
13'-6"	32	14	12-#8	9.23	833	18.0	806
14'-0"	34	14	10-#9	9.63	918	20.6	860
14'-6"	34	15	11-#9	10.65	1047	22.1	923
15'-0"	36	15	12-#9	11.03	1183	25.0	981
15'-6"	36	16	13-#9	12.11	1326	26.7	1047
16'-0"	38	16	13-#9	12.50	1370	30.0	1108
16'-6"	38	17	14-#9	13.66	1523	31.9	1179
17'-0"	39	17	15-#9	14.54	1683	34.8	1247
17'-6"	40	18	16-#9	15.28	1850	37.8	1317
18'-0"	41	18	13-#10	16.27	1958	41.0	1388
18'-6"	42	18	14-#10	17.22	2169	44.4	1461
19'-0"	43	19	15-#10	18.02	2388	47.9	1536
19'-6"	44	19	15-#10	19.01	2453	51.6	1612
20'-0"	45	20	16-#10	19.84	2685	55.6	1690

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 5,600 psf (SAFE BEARING CAPACITY 4,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	12	10	4-#4 *	0.73	19	0.6	87
4'-6"	13	10	5-#4	0.98	27	0.8	109
5'-0"	14	10	5-#5	1.28	47	1.1	135
5'-6"	16	10	5-#5	1.47	52	1.5	162
6'-0"	17	10	6-#5	1.82	69	1.9	192
6'-6"	18	10	8-#5	2.20	100	2.3	225
7'-0"	20	10	8-#5	2.48	108	3.0	260
7'-6"	21	10	7-#6	2.90	147	3.6	297
8'-0"	22	10	8-#6	3.37	180	4.3	337
8'-6"	24	10	9-#6	3.72	216	5.4	379
9'-0"	25	10	10-#6	4.19	255	6.3	423
9'-6"	26	11	8-#7	4.68	294	7.2	470
10'-0"	27	11	9-#7	5.27	350	8.3	520
10'-6"	28	12	10-#7	5.78	409	9.5	571
11'-0"	29	12	11-#7	6.43	472	10.8	625
11'-6"	30	13	9-#8	7.03	529	12.2	681
12'-0"	31	13	10-#8	7.74	614	13.8	739
12'-6"	32	14	11-#8	8.35	705	15.4	800
13'-0"	33	14	12-#8	9.12	801	17.2	863
13'-6"	34	15	10-#9	9.82	884	19.1	928
14'-0"	36	15	11-#9	10.27	1010	21.8	992
14'-6"	36	16	12-#9	11.36	1142	23.4	1064
15'-0"	38	16	12-#9	11.83	1183	26.4	1132
15'-6"	39	17	13-#9	12.57	1326	28.9	1205
16'-0"	40	17	14-#9	13.49	1476	31.6	1280
16'-6"	41	18	15-#9	14.27	1632	34.5	1357
17'-0"	42	18	16-#9	15.24	1795	37.5	1436
17'-6"	43	19	13-#10	16.13	1902	40.6	1517
18'-0"	44	19	14-#10	17.16	2108	44.0	1601
18'-6"	45	20	15-#10	18.03	2324	47.5	1686
19'-0"	46	20	16-#10	19.11	2547	51.3	1773
19'-6"	47	21	16-#10	20.02	2616	55.2	1861
20'-0"	48	21	17-#10	21.15	2853	59.3	1952

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 6,300 psf (SAFE BEARING CAPACITY 4,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	12	10	5-#4 *	0.82	23	0.6	98
4'-6"	14	10	6-#4	1.02	32	0.9	123
5'-0"	15	10	5-#5	1.32	47	1.2	152
5'-6"	16	10	6-#5	1.67	63	1.5	183
6'-0"	18	10	7-#5	1.91	80	2.0	217
6'-6"	19	10	8-#5	2.32	100	2.5	254
7'-0"	21	10	6-#6	2.62	117	3.2	293
7'-6"	22	10	8-#6	3.10	168	3.8	336
8'-0"	23	10	9-#6	3.61	203	4.5	381
8'-6"	25	10	9-#6	3.95	216	5.6	428
9'-0"	26	11	8-#7	4.46	278	6.5	479
9'-6"	27	11	9-#7	5.07	331	7.5	532
10'-0"	28	12	10-#7	5.61	388	8.6	588
10'-6"	30	12	8-#8	6.05	427	10.2	645
11'-0"	30	13	9-#8	6.93	505	11.2	708
11'-6"	31	14	10-#8	7.55	587	12.7	772
12'-0"	33	14	11-#8	8.01	676	14.7	836
12'-6"	34	15	11-#8	8.68	705	16.4	905
13'-0"	35	15	10-#9	9.55	850	18.3	976
13'-6"	36	16	11-#9	10.27	972	20.3	1050
14'-0"	37	16	12-#9	11.17	1102	22.4	1126
14'-6"	38	17	12-#9	11.95	1142	24.7	1205
15'-0"	40	17	13-#9	12.50	1282	27.8	1283
15'-6"	41	18	14-#9	13.32	1428	30.4	1366
16'-0"	42	18	15-#9	14.32	1581	33.2	1452
16'-6"	43	19	16-#9	15.19	1741	36.1	1540
17'-0"	44	19	13-#10	16.32	1846	39.2	1630
17'-6"	45	20	14-#10	17.24	2048	42.5	1723
18'-0"	46	21	15-#10	18.18	2259	46.0	1818
18'-6"	47	21	16-#10	19.34	2479	49.6	1915
19'-0"	48	22	17-#10	20.33	2707	53.5	2014
19'-6"	49	22	17-#10	21.56	2780	57.5	2116
20'-0"	50	23	18-#10	22.60	3021	61.7	2220

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 7,000 psf (SAFE BEARING CAPACITY 5,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	13	10	5-#4 *	0.82	23	0.6	109
4'-6"	14	10	6-#4	1.11	32	0.9	137
5'-0"	16	10	5-#5	1.35	47	1.2	169
5'-6"	17	10	6-#5	1.72	63	1.6	204
6'-0"	19	10	7-#5	1.99	80	2.1	242
6'-6"	20	10	8-#5	2.43	100	2.6	283
7'-0"	22	10	9-#5	2.78	122	3.3	327
7'-6"	23	10	11-#5	3.25	161	4.0	374
8'-0"	25	10	12-#5	3.69	188	4.9	424
8'-6"	26	11	7-#7	4.15	229	5.8	478
9'-0"	27	11	8-#7	4.77	278	6.8	534
9'-6"	28	12	9-#7	5.32	331	7.8	594
10'-0"	29	13	10-#7	5.91	388	9.0	657
10'-6"	31	13	11-#7	6.37	450	10.5	720
11'-0"	32	14	9-#8	7.04	505	12.0	789
11'-6"	33	14	10-#8	7.83	587	13.5	860
12'-0"	34	15	11-#8	8.53	676	15.1	935
12'-6"	36	15	12-#8	9.07	769	17.4	1009
13'-0"	37	16	10-#9	9.86	850	19.3	1089
13'-6"	38	17	11-#9	10.64	972	21.4	1172
14'-0"	39	17	12-#9	11.60	1102	23.6	1257
14'-6"	40	18	13-#9	12.44	1238	26.0	1346
15'-0"	41	18	11-#10	13.53	1373	28.5	1437
15'-6"	42	19	12-#10	14.43	1549	31.1	1530
16'-0"	44	19	12-#10	15.09	1601	34.8	1623
16'-6"	45	20	13-#10	16.04	1790	37.8	1722
17'-0"	46	21	14-#10	17.01	1988	41.0	1824
17'-6"	47	21	15-#10	18.20	2195	44.4	1928
18'-0"	48	22	13-#11	19.29	2417	48.0	2035
18'-6"	49	22	14-#11	20.56	2678	51.8	2144
19'-0"	50	23	14-#11	21.65	2752	55.7	2256
19'-6"	52	23	15-#11	22.42	3028	61.0	2365
20'-0"	53	24	16-#11	23.55	3315	65.4	2482

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 7,700 psf (SAFE BEARING CAPACITY 5,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	13	10	5-#4 *	0.90	23	0.6	120
4'-6"	15	10	6-#4	1.12	32	0.9	151
5'-0"	16	10	5-#5	1.49	47	1.2	187
5'-6"	18	10	6-#5	1.76	63	1.7	225
6'-0"	19	10	8-#5	2.20	92	2.1	267
6'-6"	21	10	6-#6	2.54	108	2.7	312
7'-0"	23	10	7-#6	2.91	137	3.5	360
7'-6"	24	10	8-#6	3.43	168	4.2	413
8'-0"	25	11	9-#6	3.93	203	4.9	469
8'-6"	27	11	10-#6	4.35	240	6.0	527
9'-0"	28	12	12-#6	4.91	306	7.0	590
9'-6"	29	13	13-#6	5.50	351	8.1	656
10'-0"	31	13	14-#6	5.99	400	9.6	724
10'-6"	32	14	16-#6	6.64	481	10.9	796
11'-0"	33	14	17-#6	7.45	536	12.3	872
11'-6"	34	15	19-#6	8.17	628	13.9	951
12'-0"	35	16	15-#7	8.95	705	15.6	1033
12'-6"	37	16	16-#7	9.56	785	17.8	1116
13'-0"	38	17	18-#7	10.36	920	19.8	1205
13'-6"	39	17	19-#7	11.36	1010	21.9	1297
14'-0"	40	18	21-#7	12.23	1159	24.2	1392
14'-6"	42	19	13-#9	12.84	1238	27.3	1486
15'-0"	43	19	14-#9	13.94	1380	29.9	1587
15'-6"	44	20	15-#9	14.90	1530	32.6	1691
16'-0"	46	20	16-#9	15.64	1686	36.3	1795
16'-6"	47	21	17-#9	16.65	1850	39.5	1904
17'-0"	48	22	14-#10	17.75	1988	42.8	2017
17'-6"	49	22	15-#10	19.03	2195	46.3	2133
18'-0"	50	23	13-#11	20.20	2417	50.0	2252
18'-6"	52	23	14-#11	21.04	2678	54.9	2368
19'-0"	53	24	15-#11	22.20	2949	59.1	2493
19'-6"	54	25	15-#11	23.38	3028	63.4	2620
20'-0"	55	25	16-#11	24.83	3315	67.9	2750

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 8,400 psf (SAFE BEARING CAPACITY 6,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	14	10	5-#4 *	0.91	23	0.7	131
4'-6"	15	10	4-#5 *	1.24	33	0.9	166
5'-0"	17	10	5-#5	1.50	47	1.3	204
5'-6"	19	10	6-#5	1.83	63	1.8	245
6'-0"	20	10	8-#5	2.25	92	2.2	292
6'-6"	22	10	6-#6	2.62	108	2.9	341
7'-0"	23	10	8-#6	3.17	156	3.5	395
7'-6"	25	10	6-#7	3.60	172	4.3	451
8'-0"	26	11	7-#7	4.13	215	5.1	513
8'-6"	27	12	8-#7	4.70	262	6.0	578
9'-0"	29	12	9-#7	5.19	313	7.3	645
9'-6"	30	13	10-#7	5.82	368	8.4	717
10'-0"	31	14	11-#7	6.49	427	9.6	794
10'-6"	33	14	9-#8	7.09	481	11.2	872
11'-0"	34	15	10-#8	7.82	561	12.7	955
11'-6"	35	16	11-#8	8.59	646	14.3	1041
12'-0"	37	16	12-#8	9.23	737	16.4	1130
12'-6"	38	17	13-#8	10.06	833	18.3	1223
13'-0"	39	18	11-#9	10.96	935	20.3	1321
13'-6"	41	18	12-#9	11.67	1061	23.1	1419
14'-0"	42	19	10-#10	12.64	1162	25.4	1523
14'-6"	43	19	11-#10	13.79	1325	27.9	1630
15'-0"	45	20	12-#10	14.38	1497	31.3	1738
15'-6"	46	21	13-#10	15.40	1678	34.1	1852
16'-0"	47	21	14-#10	16.65	1868	37.1	1970
16'-6"	48	22	14-#10	17.74	1928	40.3	2091
17'-0"	49	23	15-#10	18.87	2130	43.7	2215
17'-6"	51	23	13-#11	19.82	2348	48.2	2338
18'-0"	52	24	14-#11	21.00	2603	52.0	2469
18'-6"	54	24	15-#11	21.93	2869	57.0	2598
19'-0"	55	25	15-#11	23.16	2949	61.3	2735
19'-6"	56	26	16-#11	24.43	3230	65.7	2875
20'-0"	57	26	17-#11	25.98	3523	70.4	3018

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 9,100 psf (SAFE BEARING CAPACITY 6,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	14	10	5-#4 *	0.97	23	0.7	142
4'-6"	16	10	4-#5 *	1.23	33	1.0	179
5'-0"	18	10	4-#6 *	1.54	54	1.4	221
5'-6"	19	10	5-#6 *	1.97	75	1.8	267
6'-0"	21	10	6-#6	2.32	99	2.3	316
6'-6"	23	10	7-#6	2.70	126	3.0	370
7'-0"	24	10	8-#6	3.27	156	3.6	428
7'-6"	26	11	9-#6	3.61	189	4.5	490
8'-0"	27	12	7-#7	4.19	215	5.3	556
8'-6"	28	12	9-#7	4.89	294	6.2	627
9'-0"	30	13	9-#7	5.31	313	7.5	701
9'-6"	31	14	10-#7	5.97	368	8.6	779
10'-0"	33	14	11-#7	6.55	427	10.2	861
10'-6"	34	15	13-#7	7.28	531	11.6	947
11'-0"	35	16	14-#7	8.05	601	13.1	1038
11'-6"	37	16	9-#9	8.78	673	15.1	1130
12'-0"	38	17	10-#9	9.63	782	16.9	1228
12'-6"	39	18	11-#9	10.51	898	18.8	1330
13'-0"	41	18	12-#9	11.25	1020	21.4	1434
13'-6"	42	19	10-#10	12.24	1119	23.6	1544
14'-0"	43	20	11-#10	13.23	1278	26.0	1657
14'-6"	45	20	12-#10	14.05	1446	29.2	1771
15'-0"	46	21	12-#10	15.10	1497	31.9	1892
15'-6"	47	22	13-#10	16.19	1678	34.9	2017
16'-0"	49	22	14-#10	17.08	1868	38.7	2141
16'-6"	50	23	12-#11	18.29	2040	42.0	2273
17'-0"	51	24	13-#11	19.48	2279	45.5	2409
17'-6"	53	24	14-#11	20.44	2529	50.1	2543
18'-0"	54	25	14-#11	21.69	2603	54.0	2686
18'-6"	55	26	15-#11	22.98	2869	58.1	2832
19'-0"	57	26	16-#11	24.01	3145	63.5	2976
19'-6"	58	27	17-#11	25.36	3432	68.1	3129
20'-0"	59	27	18-#11	26.99	3730	72.8	3286

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 9,800 psf (SAFE BEARING CAPACITY 7,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	15	10	5-#4 *	0.99	23	0.7	153
4'-6"	16	10	7-#4	1.32	37	1.0	194
5'-0"	18	10	4-#6 *	1.65	54	1.4	238
5'-6"	20	10	5-#6 *	1.99	75	1.9	287
6'-0"	22	10	6-#6	2.37	99	2.4	341
6'-6"	23	10	7-#6	2.91	126	3.0	399
7'-0"	25	11	8-#6	3.26	156	3.8	462
7'-6"	26	11	9-#6	3.91	189	4.5	529
8'-0"	28	12	10-#6	4.31	225	5.5	600
8'-6"	29	13	12-#6	4.93	288	6.5	677
9'-0"	31	13	13-#6	5.49	332	7.8	756
9'-6"	32	14	8-#8	6.24	384	8.9	841
10'-0"	33	15	9-#8	6.99	457	10.2	931
10'-6"	35	16	10-#8	7.50	534	11.9	1023
11'-0"	36	16	11-#8	8.46	617	13.4	1120
11'-6"	38	17	12-#8	9.02	705	15.5	1221
12'-0"	39	18	10-#9	9.94	782	17.3	1327
12'-6"	41	18	11-#9	10.71	898	19.8	1435
13'-0"	42	19	12-#9	11.67	1020	21.9	1550
13'-6"	43	20	13-#9	12.67	1149	24.2	1668
14'-0"	45	20	11-#10	13.57	1278	27.2	1789
14'-6"	46	21	12-#10	14.64	1446	29.9	1915
15'-0"	47	22	13-#10	15.75	1622	32.6	2046
15'-6"	49	22	14-#10	16.69	1807	36.3	2178
16'-0"	50	23	12-#11	17.93	1976	39.5	2317
16'-6"	51	24	13-#11	19.16	2210	42.9	2460
17'-0"	53	24	13-#11	20.17	2279	47.3	2602
17'-6"	54	25	14-#11	21.47	2529	51.0	2753
18'-0"	55	26	15-#11	22.80	2789	55.0	2908
18'-6"	57	26	16-#11	23.89	3060	60.2	3061
19'-0"	58	27	17-#11	25.29	3342	64.6	3224
19'-6"	60	28	17-#11	26.18	3432	70.4	3384
20'-0"	61	29	18-#11	27.63	3730	75.3	3554

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 10,500 psf (SAFE BEARING CAPACITY 7,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	15	10	6-#4 *	1.02	28	0.7	164
4'-6"	17	10	7-#4	1.31	37	1.1	207
5'-0"	19	10	4-#6 *	1.65	54	1.5	255
5'-6"	20	10	5-#6 *	2.14	75	1.9	309
6'-0"	22	10	6-#6	2.54	99	2.4	366
6'-6"	24	10	7-#6	2.97	126	3.1	428
7'-0"	25	11	8-#6	3.51	156	3.8	496
7'-6"	27	12	9-#6	3.91	189	4.7	568
8'-0"	29	12	6-#8 *	4.48	240	5.7	644
8'-6"	30	13	7-#8	5.14	299	6.7	726
9'-0"	31	14	8-#8	5.84	363	7.8	813
9'-6"	33	15	9-#8	6.34	433	9.2	903
10'-0"	34	15	10-#8	7.25	507	10.5	999
10'-6"	36	16	10-#8	7.81	534	12.3	1098
11'-0"	37	17	11-#8	8.66	617	13.8	1203
11'-6"	38	18	10-#9	9.60	748	15.5	1313
12'-0"	40	18	11-#9	10.39	860	17.8	1426
12'-6"	41	19	12-#9	11.37	979	19.8	1545
13'-0"	43	20	10-#10	12.09	1076	22.4	1665
13'-6"	45	20	11-#10	12.97	1231	25.3	1791
14'-0"	46	21	12-#10	14.05	1394	27.8	1923
14'-6"	47	22	12-#10	15.18	1446	30.5	2059
15'-0"	48	23	13-#10	16.35	1622	33.3	2201
15'-6"	50	23	14-#10	17.35	1807	37.1	2342
16'-0"	51	24	12-#11	18.66	1976	40.3	2492
16'-6"	53	25	13-#11	19.49	2210	44.5	2642
17'-0"	54	25	14-#11	21.05	2455	48.2	2800
17'-6"	56	26	15-#11	21.92	2710	52.9	2958
18'-0"	57	27	15-#11	23.31	2789	57.0	3125
18'-6"	59	27	16-#11	24.48	3060	62.3	3291
19'-0"	60	28	17-#11	25.94	3342	66.9	3466
19'-6"	61	29	18-#11	27.44	3634	71.6	3645
20'-0"	63	30	19-#11	28.42	3937	77.8	3822

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 11,200 psf (SAFE BEARING CAPACITY 8,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	15	10	6-#4 *	1.09	28	0.7	176
4'-6"	17	10	7-#4	1.39	37	1.1	222
5'-0"	19	10	6-#5	1.75	56	1.5	273
5'-6"	21	10	7-#5	2.13	73	2.0	329
6'-0"	23	10	6-#6	2.56	99	2.6	391
6'-6"	24	11	8-#6	3.08	144	3.1	458
7'-0"	26	11	6-#7 *	3.60	159	3.9	530
7'-6"	28	12	7-#7	4.02	200	4.9	606
8'-0"	29	13	6-#8 *	4.69	240	5.7	689
8'-6"	30	14	7-#8	5.38	299	6.7	777
9'-0"	32	14	8-#8	6.01	363	8.0	868
9'-6"	34	15	9-#8	6.55	433	9.5	965
10'-0"	35	16	10-#8	7.36	507	10.8	1068
10'-6"	36	17	11-#8	8.21	587	12.3	1175
11'-0"	38	17	12-#8	8.99	673	14.2	1286
11'-6"	40	18	10-#9	9.66	748	16.3	1402
12'-0"	41	19	11-#9	10.63	860	18.2	1524
12'-6"	42	20	12-#9	11.65	979	20.3	1652
13'-0"	44	20	10-#10	12.61	1076	23.0	1781
13'-6"	45	21	11-#10	13.71	1231	25.3	1918
14'-0"	47	22	12-#10	14.48	1394	28.4	2057
14'-6"	48	23	13-#10	15.66	1566	31.1	2203
15'-0"	50	23	11-#11	16.75	1695	34.7	2351
15'-6"	51	24	12-#11	18.02	1913	37.8	2507
16'-0"	53	25	13-#11	18.88	2141	41.9	2664
16'-6"	54	25	14-#11	20.46	2380	45.4	2829
17'-0"	56	26	14-#11	21.38	2455	50.0	2994
17'-6"	57	27	15-#11	22.79	2710	53.9	3168
18'-0"	58	28	16-#11	24.25	2975	58.0	3347
18'-6"	60	28	17-#11	25.51	3252	63.4	3525
19'-0"	62	29	17-#11	26.51	3342	69.1	3707
19'-6"	63	30	18-#11	28.08	3634	73.9	3899
20'-0"	64	31	20-#11	29.68	4144	79.0	4096

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 11,900 psf (SAFE BEARING CAPACITY 8,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	16	10	6-#4 *	1.08	28	0.8	187
4'-6"	18	10	5-#5 *	1.40	42	1.1	236
5'-0"	20	10	4-#6 *	1.76	54	1.5	290
5'-6"	22	10	5-#6 *	2.17	75	2.1	350
6'-0"	24	10	6-#6	2.62	99	2.7	415
6'-6"	25	11	8-#6	3.12	144	3.3	487
7'-0"	26	12	9-#6	3.71	176	3.9	564
7'-6"	28	12	10-#6	4.26	210	4.9	646
8'-0"	30	13	8-#7	4.77	245	5.9	733
8'-6"	31	14	7-#8	5.51	299	6.9	826
9'-0"	33	15	8-#8	6.04	363	8.3	924
9'-6"	34	16	9-#8	6.84	433	9.5	1028
10'-0"	36	16	10-#8	7.58	507	11.1	1136
10'-6"	37	17	11-#8	8.48	587	12.6	1251
11'-0"	39	18	12-#8	9.13	673	14.6	1369
11'-6"	40	19	13-#8	10.10	764	16.3	1494
12'-0"	42	19	14-#8	10.99	860	18.7	1623
12'-6"	44	20	15-#8	11.72	961	21.2	1756
13'-0"	45	21	13-#9	12.86	1105	23.5	1897
13'-6"	46	22	15-#9	14.01	1326	25.9	2043
14'-0"	48	22	12-#10	15.08	1394	29.0	2191
14'-6"	50	23	13-#10	15.92	1566	32.4	2344
15'-0"	51	24	14-#10	17.19	1747	35.4	2505
15'-6"	52	25	12-#11	18.57	1913	38.6	2672
16'-0"	54	26	13-#11	19.49	2141	42.7	2839
16'-6"	56	26	14-#11	20.68	2380	47.1	3011
17'-0"	57	27	15-#11	22.11	2630	50.8	3192
17'-6"	58	28	16-#11	23.60	2890	54.8	3378
18'-0"	60	29	16-#11	24.62	2975	60.0	3564
18'-6"	62	29	17-#11	25.94	3252	65.5	3754
19'-0"	63	30	18-#11	27.53	3538	70.2	3955
19'-6"	64	31	19-#11	29.18	3836	75.1	4160
20'-0"	66	32	20-#11	30.30	4144	81.5	4364

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

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CONCRETE REINFORCING STEEL INSTITUTE

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 12,600 psf (SAFE BEARING CAPACITY 9,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	16	10	6-#4 *	1.13	28	0.8	198
4'-6"	18	10	5-#5 *	1.47	42	1.1	250
5'-0"	20	10	6-#5	1.85	56	1.5	308
5'-6"	22	10	8-#5	2.27	83	2.1	371
6'-0"	24	10	9-#5	2.73	103	2.7	441
6'-6"	26	11	11-#5	3.14	138	3.4	516
7'-0"	27	12	9-#6	3.76	176	4.1	598
7'-6"	29	13	10-#6	4.23	210	5.0	684
8'-0"	30	14	12-#6	4.92	270	5.9	778
8'-6"	32	14	13-#6	5.57	312	7.1	876
9'-0"	34	15	14-#6	6.14	357	8.5	979
9'-6"	35	16	16-#6	6.96	433	9.7	1090
10'-0"	36	17	18-#6	7.84	514	11.1	1206
10'-6"	38	18	11-#8	8.56	587	12.9	1326
11'-0"	40	18	12-#8	9.41	673	14.9	1452
11'-6"	41	19	11-#9 *	10.46	823	16.7	1585
12'-0"	43	20	9-#10 *	11.25	891	19.1	1722
12'-6"	44	21	10-#10 *	12.36	1033	21.2	1866
13'-0"	46	22	11-#10 *	13.16	1183	24.0	2013
13'-6"	48	22	12-#10	14.20	1343	27.0	2165
14'-0"	49	23	10-#11 *	15.49	1435	29.6	2326
14'-6"	51	24	11-#11	16.38	1636	33.1	2488
15'-0"	52	25	12-#11	17.70	1849	36.1	2660
15'-6"	53	26	13-#11	19.07	2072	39.3	2836
16'-0"	55	26	14-#11	20.29	2306	43.5	3014
16'-6"	57	27	14-#11	21.30	2380	47.9	3198
17'-0"	58	28	15-#11	22.79	2630	51.7	3390
17'-6"	60	29	16-#11	23.85	2890	56.7	3583
18'-0"	62	29	17-#11	25.21	3161	62.0	3781
18'-6"	63	30	18-#11	26.82	3443	66.5	3989
19'-0"	64	31	19-#11	28.49	3735	71.3	4202
19'-6"	66	32	20-#11	29.65	4038	77.5	4415
20'-0"	67	33	21-#11	31.40	4351	82.7	4638

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 13,300 psf (SAFE BEARING CAPACITY 9,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	17	10	6-#4 *	1.17	28	0.8	209
4'-6"	19	10	5-#5 *	1.49	42	1.2	264
5'-0"	21	10	7-#5	1.88	66	1.6	325
5'-6"	23	10	8-#5	2.30	83	2.1	392
6'-0"	24	11	7-#6	2.82	116	2.7	466
6'-6"	26	11	8-#6	3.34	144	3.4	545
7'-0"	28	12	9-#6	3.80	176	4.2	631
7'-6"	29	13	6-#8 *	4.52	224	5.0	724
8'-0"	31	14	7-#8 *	5.05	280	6.1	821
8'-6"	32	15	8-#8 *	5.82	342	7.1	926
9'-0"	34	16	7-#9 *	6.44	405	8.5	1036
9'-6"	36	16	8-#9 *	7.21	490	10.0	1152
10'-0"	37	17	9-#9 *	8.13	581	11.4	1275
10'-6"	39	18	9-#9 *	8.82	612	13.3	1402
11'-0"	40	19	10-#9 *	9.83	714	14.9	1537
11'-6"	42	20	11-#9 *	10.59	823	17.1	1676
12'-0"	43	21	12-#9	11.69	938	19.1	1822
12'-6"	45	21	13-#9	12.70	1061	21.7	1973
13'-0"	47	22	11-#10 *	13.60	1183	24.5	2129
13'-6"	48	23	12-#10	14.84	1343	27.0	2293
14'-0"	50	24	13-#10	15.75	1510	30.2	2460
14'-6"	51	25	11-#11	17.13	1636	33.1	2635
15'-0"	53	25	12-#11	18.34	1849	36.8	2814
15'-6"	55	26	13-#11	19.34	2072	40.8	2997
16'-0"	56	27	14-#11	20.81	2306	44.2	3190
16'-6"	58	28	15-#11	21.87	2550	48.7	3384
17'-0"	59	29	16-#11	23.42	2805	52.6	3588
17'-6"	61	29	16-#11	24.81	2890	57.7	3793
18'-0"	63	30	17-#11	25.96	3161	63.0	4003
18'-6"	64	31	18-#11	27.64	3443	67.6	4223
19'-0"	66	32	19-#11	28.84	3735	73.5	4444
19'-6"	67	33	20-#11	30.61	4038	78.6	4675
20'-0"	69	33	21-#11	32.18	4351	85.2	4906

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 14,000 psf (SAFE BEARING CAPACITY 10,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	17	10	6-#4 *	1.17	28	0.8	220
4'-6"	19	10	5-#5 *	1.53	42	1.2	278
5'-0"	21	10	7-#5	1.94	66	1.6	342
5'-6"	23	10	8-#5	2.40	83	2.1	413
6'-0"	25	11	7-#6	2.82	116	2.8	491
6'-6"	26	12	8-#6	3.42	144	3.4	575
7'-0"	28	13	9-#6	3.90	176	4.2	665
7'-6"	30	13	6-#8 *	4.58	224	5.2	762
8'-0"	32	14	7-#8 *	5.13	280	6.3	865
8'-6"	33	15	8-#8 *	5.92	342	7.4	976
9'-0"	35	16	7-#9 *	6.57	405	8.8	1091
9'-6"	36	17	8-#9 *	7.46	490	10.0	1215
10'-0"	38	18	9-#9 *	8.15	581	11.7	1343
10'-6"	39	19	10-#9 *	9.14	680	13.3	1479
11'-0"	41	19	8-#10 *	10.12	723	15.3	1620
11'-6"	43	20	9-#10 *	10.91	852	17.6	1766
12'-0"	45	21	10-#10 *	11.73	990	20.0	1919
12'-6"	46	22	11-#10 *	12.91	1136	22.2	2080
13'-0"	48	23	11-#10 *	13.80	1183	25.0	2244
13'-6"	49	24	12-#10	15.08	1343	27.6	2418
14'-0"	51	24	13-#10	16.26	1510	30.9	2594
14'-6"	53	25	14-#10	17.24	1687	34.4	2776
15'-0"	54	26	12-#11	18.71	1849	37.5	2968
15'-6"	56	27	13-#11	19.76	2072	41.5	3162
16'-0"	57	28	14-#11	21.28	2306	45.0	3365
16'-6"	59	29	15-#11	22.39	2550	49.6	3571
17'-0"	61	29	16-#11	23.80	2805	54.4	3782
17'-6"	62	30	17-#11	25.45	3071	58.6	4003
18'-0"	64	31	18-#11	26.65	3347	64.0	4225
18'-6"	65	32	19-#11	28.40	3634	68.7	4458
19'-0"	67	33	20-#11	29.66	3932	74.7	4691
19'-6"	68	34	21-#11	31.50	4240	79.8	4936
20'-0"	70	34	22-#11	33.15	4559	86.4	5180

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 14,700 psf (SAFE BEARING CAPACITY 10,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-0"	17	10	7-#4 *	1.22	33	0.8	231
4'-6"	19	10	6-#5 *	1.61	50	1.2	292
5'-0"	21	10	7-#5	2.04	66	1.6	360
5'-6"	24	10	8-#5	2.42	83	2.2	434
6'-0"	25	11	7-#6	2.97	116	2.8	516
6'-6"	27	12	8-#6	3.43	144	3.5	604
7'-0"	28	13	7-#7 *	4.13	186	4.2	700
7'-6"	30	14	6-#8 *	4.69	224	5.2	802
8'-0"	32	15	7-#8 *	5.26	280	6.3	910
8'-6"	33	16	8-#8 *	6.09	342	7.4	1026
9'-0"	35	16	7-#9 *	6.92	405	8.8	1148
9'-6"	37	17	8-#9 *	7.60	490	10.3	1277
10'-0"	39	18	9-#9 *	8.32	581	12.0	1412
10'-6"	40	19	10-#9 *	9.34	680	13.6	1555
11'-0"	42	20	11-#9 *	10.13	785	15.7	1702
11'-6"	44	21	11-#9 *	10.95	823	18.0	1857
12'-0"	45	22	10-#10 *	12.16	990	20.0	2020
12'-6"	47	22	11-#10 *	13.26	1136	22.7	2187
13'-0"	49	23	12-#10 *	14.19	1291	25.6	2360
13'-6"	50	24	10-#11 *	15.56	1381	28.1	2542
14'-0"	52	25	11-#11 *	16.56	1578	31.5	2728
14'-6"	54	26	12-#11	17.58	1785	35.0	2920
15'-0"	55	27	13-#11	19.05	2003	38.2	3122
15'-6"	57	28	13-#11	20.14	2072	42.3	3326
16'-0"	59	28	14-#11	21.53	2306	46.6	3537
16'-6"	60	29	15-#11	23.14	2550	50.4	3757
17'-0"	62	30	16-#11	24.33	2805	55.3	3980
17'-6"	63	31	17-#11	26.04	3071	59.5	4212
18'-0"	65	32	18-#11	27.30	3347	65.0	4447
18'-6"	67	33	19-#11	28.58	3634	70.8	4687
19'-0"	68	34	20-#11	30.43	3932	75.8	4938
19'-6"	70	34	21-#11	32.10	4240	82.2	5190
20'-0"	72	35	22-#11	33.48	4559	88.9	5448

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCRETELY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 15,400 psf (SAFE BEARING CAPACITY 11,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-6"	20	10	6-#5 *	1.59	50	1.3	306
5'-0"	22	10	7-#5	2.02	66	1.7	377
5'-6"	24	11	8-#5	2.42	83	2.2	455
6'-0"	26	11	7-#6	2.97	116	2.9	540
6'-6"	27	12	9-#6	3.61	162	3.5	634
7'-0"	29	13	7-#7 *	4.15	186	4.4	733
7'-6"	31	14	6-#8 *	4.73	224	5.4	840
8'-0"	32	15	7-#8 *	5.53	280	6.3	955
8'-6"	34	16	8-#8 *	6.17	342	7.6	1076
9'-0"	36	17	7-#9 *	6.86	405	9.0	1204
9'-6"	37	18	8-#9 *	7.82	490	10.3	1340
10'-0"	39	19	9-#9 *	8.57	581	12.0	1482
10'-6"	41	19	10-#9 *	9.53	680	14.0	1630
11'-0"	43	20	11-#9 *	10.35	785	16.1	1785
11'-6"	44	21	12-#9 *	11.51	898	18.0	1949
12'-0"	46	22	10-#10 *	12.45	990	20.4	2118
12'-6"	48	23	11-#10 *	13.38	1136	23.1	2294
13'-0"	49	24	12-#10 *	14.69	1291	25.6	2478
13'-6"	51	25	13-#10	15.69	1454	28.7	2667
14'-0"	53	26	11-#11 *	16.77	1578	32.1	2863
14'-6"	54	27	12-#11	18.24	1785	35.0	3068
15'-0"	56	27	13-#11	19.60	2003	38.9	3276
15'-6"	58	28	14-#11	20.75	2231	43.0	3491
16'-0"	60	29	15-#11	21.92	2471	47.4	3712
16'-6"	61	30	16-#11	23.58	2720	51.3	3944
17'-0"	63	31	16-#11	24.82	2805	56.2	4177
17'-6"	64	32	18-#11	26.58	3252	60.5	4422
18'-0"	66	33	18-#11	27.89	3347	66.0	4669
18'-6"	68	33	19-#11	29.56	3634	71.8	4922
19'-0"	70	34	20-#11	30.93	3932	78.0	5180
19'-6"	71	35	22-#11	32.88	4442	83.3	5451
20'-0"	73	36	23-#11	34.33	4766	90.1	5722

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCRETELY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 16,100 psf (SAFE BEARING CAPACITY 11,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-6"	20	10	6-#5 *	1.66	50	1.3	320
5'-0"	22	10	7-#5	2.12	66	1.7	394
5'-6"	24	11	6-#6 *	2.55	90	2.2	476
6'-0"	26	12	7-#6	3.01	116	2.9	566
6'-6"	27	13	9-#6	3.66	162	3.5	663
7'-0"	29	14	10-#6	4.20	195	4.4	768
7'-6"	31	14	12-#6	4.91	252	5.4	879
8'-0"	33	15	13-#6	5.53	293	6.5	999
8'-6"	35	16	8-#8 *	6.24	342	7.8	1125
9'-0"	36	17	10-#8	7.17	454	9.0	1260
9'-6"	38	18	8-#9 *	7.94	490	10.6	1402
10'-0"	40	19	9-#9 *	8.71	581	12.3	1550
10'-6"	42	20	10-#9 *	9.52	680	14.3	1706
11'-0"	43	21	11-#9 *	10.65	785	16.1	1870
11'-6"	45	22	12-#9 *	11.54	898	18.4	2040
12'-0"	47	23	10-#10 *	12.51	990	20.9	2217
12'-6"	48	24	11-#10 *	13.81	1136	23.1	2403
13'-0"	50	24	12-#10 *	15.04	1291	26.1	2594
13'-6"	52	25	13-#10	16.08	1454	29.3	2792
14'-0"	54	26	14-#10	17.16	1627	32.7	2997
14'-6"	55	27	12-#11	18.72	1785	35.7	3212
15'-0"	57	28	13-#11	19.87	2003	39.6	3430
15'-6"	59	29	14-#11	21.05	2231	43.7	3655
16'-0"	60	30	15-#11	22.72	2471	47.4	3891
16'-6"	62	31	16-#11	23.98	2720	52.1	4130
17'-0"	64	32	17-#11	25.27	2981	57.1	4375
17'-6"	66	32	18-#11	26.90	3252	62.4	4627
18'-0"	68	33	19-#11	28.26	3533	68.0	4886
18'-6"	69	34	20-#11	30.17	3825	72.9	5156
19'-0"	71	35	21-#11	31.60	4128	79.1	5428
19'-6"	72	36	22-#11	33.61	4442	84.5	5711
20'-0"	74	37	23-#11	35.11	4766	91.4	5996

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 16,800 psf (SAFE BEARING CAPACITY 12,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-6"	20	10	6-#5 *	1.73	50	1.3	334
5'-0"	23	10	7-#5	2.09	66	1.8	411
5'-6"	24	11	9-#5	2.65	94	2.2	497
6'-0"	26	12	11-#5	3.13	126	2.9	591
6'-6"	28	13	12-#5	3.64	150	3.7	692
7'-0"	30	14	14-#5	4.20	190	4.5	801
7'-6"	31	15	12-#6	5.00	252	5.4	919
8'-0"	33	16	13-#6	5.64	293	6.5	1044
8'-6"	35	17	15-#6	6.32	360	7.8	1176
9'-0"	37	18	16-#6	7.03	409	9.3	1316
9'-6"	39	18	19-#6	7.95	514	10.9	1463
10'-0"	41	19	20-#6	8.75	571	12.7	1619
10'-6"	42	20	10-#9 *	9.96	680	14.3	1783
11'-0"	44	21	11-#9 *	10.85	785	16.4	1953
11'-6"	46	22	12-#9 *	11.77	898	18.8	2131
12'-0"	48	23	13-#9	12.72	1017	21.3	2316
12'-6"	49	24	15-#9	14.05	1224	23.6	2510
13'-0"	51	25	12-#10 *	15.14	1291	26.6	2710
13'-6"	53	26	13-#10	16.21	1454	29.8	2917
14'-0"	54	27	14-#10	17.71	1627	32.7	3134
14'-6"	56	28	15-#10	18.86	1807	36.3	3356
15'-0"	58	29	13-#11	20.10	2003	40.3	3584
15'-6"	59	30	14-#11	21.76	2231	43.7	3824
16'-0"	62	30	15-#11	22.88	2471	49.0	4063
16'-6"	63	31	16-#11	24.64	2720	52.9	4317
17'-0"	65	32	17-#11	25.98	2981	58.0	4573
17'-6"	67	33	18-#11	27.36	3252	63.3	4837
18'-0"	68	34	19-#11	29.28	3533	68.0	5113
18'-6"	70	35	20-#11	30.73	3825	73.9	5390
19'-0"	72	36	21-#11	32.22	4128	80.2	5675
19'-6"	73	37	22-#11	34.29	4442	85.7	5972
20'-0"	75	38	23-#11	35.85	4766	92.6	6270

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 17,500 psf (SAFE BEARING CAPACITY 12,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-6"	21	10	6-#5 *	1.70	50	1.3	348
5'-0"	23	10	5-#6 *	2.20	68	1.8	429
5'-6"	25	11	7-#6 *	2.65	105	2.3	518
6'-0"	27	12	8-#6	3.13	132	3.0	615
6'-6"	28	13	9-#6	3.82	162	3.7	722
7'-0"	30	14	8-#7 *	4.42	213	4.5	835
7'-6"	32	15	9-#7 *	5.04	258	5.6	957
8'-0"	34	16	10-#7	5.70	307	6.7	1087
8'-6"	36	17	11-#7	6.40	360	8.0	1225
9'-0"	37	18	13-#7	7.37	452	9.3	1373
9'-6"	39	19	14-#7	8.16	515	10.9	1527
10'-0"	41	20	15-#7	8.99	583	12.7	1689
10'-6"	43	21	10-#9 *	9.92	680	14.6	1858
11'-0"	44	22	9-#10 *	11.16	813	16.4	2038
11'-6"	46	23	10-#10 *	12.12	947	18.8	2223
12'-0"	48	24	11-#10 *	13.11	1089	21.3	2416
12'-6"	50	25	12-#10 *	14.14	1239	24.1	2617
13'-0"	52	25	10-#11 *	15.50	1328	27.1	2826
13'-6"	54	26	11-#11 *	16.62	1520	30.4	3042
14'-0"	55	27	12-#11 *	18.15	1721	33.3	3268
14'-6"	57	28	13-#11 *	19.35	1934	37.0	3500
15'-0"	59	29	14-#11	20.59	2157	41.0	3738
15'-6"	61	30	15-#11	21.86	2391	45.2	3985
16'-0"	62	31	16-#11	23.61	2635	49.0	4242
16'-6"	64	32	17-#11	24.97	2890	53.8	4503
17'-0"	66	33	17-#11	26.36	2981	58.9	4771
17'-6"	68	34	18-#11	27.78	3252	64.3	5047
18'-0"	69	35	20-#11	29.74	3719	69.0	5335
18'-6"	71	36	21-#11	31.25	4017	75.0	5625
19'-0"	73	37	22-#11	32.79	4325	81.3	5922
19'-6"	74	38	23-#11	34.91	4644	86.8	6232
20'-0"	76	39	24-#11	36.53	4973	93.8	6544

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCRETELY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 18,200 psf (SAFE BEARING CAPACITY 13,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-6"	21	10	6-#5 *	1.77	50	1.3	362
5'-0"	23	10	8-#5	2.27	75	1.8	446
5'-6"	25	11	9-#5	2.74	94	2.3	539
6'-0"	27	12	11-#5	3.25	126	3.0	641
6'-6"	29	13	9-#6	3.81	162	3.8	751
7'-0"	31	14	8-#7 *	4.43	213	4.7	869
7'-6"	33	15	9-#7 *	5.06	258	5.7	996
8'-0"	34	16	10-#7	5.94	307	6.7	1132
8'-6"	36	17	7-#9 *	6.73	381	8.0	1276
9'-0"	38	18	8-#9 *	7.50	462	9.5	1428
9'-6"	40	19	9-#9 *	8.31	551	11.1	1588
10'-0"	42	20	10-#9 *	9.17	646	13.0	1757
10'-6"	43	21	11-#9 *	10.34	748	14.6	1935
11'-0"	45	22	9-#10 *	11.33	813	16.8	2121
11'-6"	47	23	10-#10 *	12.31	947	19.2	2314
12'-0"	49	24	11-#10 *	13.34	1089	21.8	2515
12'-6"	51	25	12-#10 *	14.41	1239	24.6	2724
13'-0"	52	26	13-#10 *	15.87	1398	27.1	2944
13'-6"	54	27	11-#11 *	17.07	1520	30.4	3169
14'-0"	56	28	12-#11 *	18.26	1721	33.9	3403
14'-6"	58	29	13-#11 *	19.50	1934	37.6	3644
15'-0"	60	30	14-#11	20.77	2157	41.7	3893
15'-6"	61	31	15-#11	22.51	2391	45.2	4153
16'-0"	63	32	16-#11	23.87	2635	49.8	4417
16'-6"	65	33	17-#11	25.26	2890	54.6	4690
17'-0"	67	34	18-#11	26.69	3156	59.8	4969
17'-6"	68	35	19-#11	28.65	3432	64.3	5261
18'-0"	70	36	20-#11	30.17	3719	70.0	5557
18'-6"	72	36	21-#11	32.08	4017	76.1	5859
19'-0"	74	37	22-#11	33.68	4325	82.5	6169
19'-6"	76	38	23-#11	35.31	4644	89.2	6487
20'-0"	78	39	24-#11	36.98	4973	96.3	6812

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 18,900 psf (SAFE BEARING CAPACITY 13,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-6"	21	10	6-#5 *	1.84	50	1.3	376
5'-0"	23	11	8-#5	2.27	75	1.8	464
5'-6"	25	12	9-#5	2.74	94	2.3	560
6'-0"	27	13	11-#5	3.26	126	3.0	666
6'-6"	29	14	9-#6	3.84	162	3.8	780
7'-0"	31	15	8-#7 *	4.47	213	4.7	903
7'-6"	33	16	9-#7 *	5.12	258	5.7	1035
8'-0"	34	17	8-#8 *	6.05	320	6.7	1177
8'-6"	36	18	7-#9 *	6.83	381	8.0	1327
9'-0"	38	19	8-#9 *	7.63	462	9.5	1485
9'-6"	40	20	9-#9 *	8.47	551	11.1	1652
10'-0"	42	21	10-#9 *	9.35	646	13.0	1827
10'-6"	44	22	11-#9 *	10.27	748	15.0	2011
11'-0"	45	23	12-#9 *	11.53	857	16.8	2205
11'-6"	47	24	10-#10 *	12.59	947	19.2	2406
12'-0"	49	25	11-#10 *	13.65	1089	21.8	2616
12'-6"	51	26	12-#10 *	14.75	1239	24.6	2834
13'-0"	53	26	13-#10 *	16.15	1398	27.6	3060
13'-6"	55	27	14-#10	17.34	1566	30.9	3294
14'-0"	57	28	12-#11 *	18.62	1721	34.5	3537
14'-6"	59	29	13-#11 *	19.90	1934	38.3	3788
15'-0"	61	30	14-#11	21.21	2157	42.4	4047
15'-6"	62	31	15-#11	23.00	2391	46.0	4317
16'-0"	64	32	16-#11	24.40	2635	50.6	4593
16'-6"	66	33	17-#11	25.84	2890	55.5	4876
17'-0"	68	34	18-#11	27.32	3156	60.7	5167
17'-6"	70	35	19-#11	28.85	3432	66.2	5467
18'-0"	71	36	20-#11	30.91	3719	71.0	5779
18'-6"	73	37	21-#11	32.52	4017	77.1	6094
19'-0"	75	38	22-#11	34.17	4325	83.6	6417
19'-6"	77	39	23-#11	35.86	4644	90.4	6748
20'-0"	79	40	25-#11	37.58	5180	97.5	7086

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f_c', or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 19,600 psf (SAFE BEARING CAPACITY 14,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-6"	22	10	6-#5 *	1.80	50	1.4	390
5'-0"	24	11	8-#5	2.23	75	1.9	481
5'-6"	25	12	7-#6 *	2.87	105	2.3	582
6'-0"	27	13	8-#6	3.41	132	3.0	691
6'-6"	29	14	10-#6	3.99	180	3.8	810
7'-0"	31	15	8-#7 *	4.65	213	4.7	938
7'-6"	33	16	9-#7 *	5.32	258	5.7	1075
8'-0"	35	17	8-#8 *	6.07	320	6.9	1221
8'-6"	37	18	7-#9 *	6.87	381	8.3	1376
9'-0"	39	19	8-#9 *	7.68	462	9.8	1540
9'-6"	41	20	9-#9 *	8.54	551	11.4	1713
10'-0"	42	21	10-#9 *	9.71	646	13.0	1897
10'-6"	44	22	11-#9 *	10.67	748	15.0	2088
11'-0"	46	23	12-#9 *	11.68	857	17.2	2288
11'-6"	48	24	13-#9 *	12.72	972	19.6	2497
12'-0"	50	25	11-#10 *	13.85	1089	22.2	2714
12'-6"	52	26	12-#10 *	14.99	1239	25.1	2941
13'-0"	54	27	13-#10 *	16.16	1398	28.2	3176
13'-6"	56	28	14-#10 *	17.38	1566	31.5	3419
14'-0"	57	29	15-#10	19.03	1743	34.5	3674
14'-6"	59	30	17-#10	20.34	2048	38.3	3935
15'-0"	61	31	14-#11	21.76	2157	42.4	4204
15'-6"	63	32	15-#11	23.16	2391	46.7	4482
16'-0"	65	33	16-#11	24.60	2635	51.4	4768
16'-6"	67	34	17-#11	26.08	2890	56.3	5062
17'-0"	68	35	19-#11	28.08	3331	60.7	5370
17'-6"	70	36	20-#11	29.66	3613	66.2	5681
18'-0"	72	37	21-#11	31.27	3905	72.0	6000
18'-6"	74	38	22-#11	32.93	4208	78.2	6328
19'-0"	76	39	23-#11	34.62	4521	84.7	6664
19'-6"	78	40	24-#11	36.36	4845	91.5	7008
20'-0"	79	41	25-#11	38.70	5180	97.5	7366

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 20,300 psf (SAFE BEARING CAPACITY 14,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-6"	22	10	7-#5 *	1.87	58	1.4	404
5'-0"	24	11	8-#5	2.32	75	1.9	499
5'-6"	26	12	7-#6 *	2.83	105	2.4	602
6'-0"	28	13	8-#6	3.38	132	3.1	716
6'-6"	30	14	10-#6	3.97	180	3.9	839
7'-0"	32	15	8-#7 *	4.64	213	4.8	971
7'-6"	34	16	9-#7 *	5.33	258	5.9	1113
8'-0"	35	17	8-#8 *	6.30	320	6.9	1266
8'-6"	37	18	9-#8 *	7.10	384	8.3	1427
9'-0"	39	19	8-#9 *	7.97	462	9.8	1597
9'-6"	41	20	9-#9 *	8.86	551	11.4	1777
10'-0"	43	21	10-#9 *	9.80	646	13.3	1966
10'-6"	45	22	11-#9 *	10.78	748	15.3	2164
11'-0"	47	23	12-#9 *	11.81	857	17.6	2371
11'-6"	49	24	13-#9 *	12.89	972	20.0	2587
12'-0"	51	25	15-#9 *	14.00	1173	22.7	2813
12'-6"	53	26	12-#10 *	15.21	1239	25.6	3048
13'-0"	55	27	13-#10 *	16.42	1398	28.7	3291
13'-6"	56	28	12-#11 *	18.10	1658	31.5	3547
14'-0"	58	29	13-#11 *	19.41	1865	35.1	3808
14'-6"	60	31	14-#11 *	20.47	2083	38.9	4079
15'-0"	62	32	15-#11	21.86	2311	43.1	4358
15'-6"	63	33	16-#11	23.73	2550	46.7	4650
16'-0"	65	34	17-#11	25.22	2800	51.4	4947
16'-6"	67	35	18-#11	26.75	3060	56.3	5253
17'-0"	69	36	19-#11	28.32	3331	61.5	5568
17'-6"	71	37	20-#11	29.94	3613	67.1	5891
18'-0"	73	38	21-#11	31.60	3905	73.0	6222
18'-6"	75	39	22-#11	33.30	4208	79.2	6563
19'-0"	77	40	23-#11	35.04	4521	85.8	6911
19'-6"	78	41	24-#11	37.38	4845	91.5	7274
20'-0"	80	42	26-#11	39.21	5387	98.8	7640

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 21,000 psf (SAFE BEARING CAPACITY 15,000 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-6"	22	10	7-#5 *	1.93	58	1.4	419
5'-0"	24	11	8-#5	2.40	75	1.9	516
5'-6"	26	12	7-#6 *	2.93	105	2.4	623
6'-0"	28	13	8-#6	3.50	132	3.1	741
6'-6"	30	14	10-#6	4.12	180	3.9	868
7'-0"	32	15	11-#6	4.78	215	4.8	1005
7'-6"	34	16	13-#6	5.50	273	5.9	1153
8'-0"	35	18	15-#6	6.31	338	6.9	1310
8'-6"	37	19	12-#7	7.15	392	8.3	1477
9'-0"	39	20	14-#7	8.01	486	9.8	1654
9'-6"	41	21	9-#9 *	8.99	551	11.4	1840
10'-0"	43	22	10-#9 *	9.95	646	13.3	2036
10'-6"	45	23	11-#9 *	10.96	748	15.3	2241
11'-0"	47	24	8-#11 *	12.10	893	17.6	2456
11'-6"	49	25	9-#11 *	13.21	1052	20.0	2680
12'-0"	51	26	10-#11 *	14.36	1222	22.7	2914
12'-6"	53	27	10-#11 *	15.56	1275	25.6	3157
13'-0"	55	28	11-#11 *	16.81	1461	28.7	3410
13'-6"	57	29	12-#11 *	18.10	1658	32.1	3671
14'-0"	59	30	13-#11 *	19.44	1865	35.7	3943
14'-6"	61	31	14-#11 *	20.82	2083	39.6	4223
15'-0"	63	32	15-#11	22.25	2311	43.8	4512
15'-6"	64	33	16-#11	24.16	2550	47.5	4815
16'-0"	66	34	17-#11	25.69	2800	52.1	5123
16'-6"	68	35	18-#11	27.27	3060	57.1	5440
17'-0"	70	36	19-#11	28.89	3331	62.4	5766
17'-6"	72	37	20-#11	30.55	3613	68.1	6101
18'-0"	74	38	21-#11	32.26	3905	74.0	6444
18'-6"	76	39	22-#11	34.01	4208	80.3	6797
19'-0"	78	40	23-#11	35.81	4521	86.9	7159
19'-6"	80	41	25-#11	37.64	5047	93.9	7529
20'-0"	82	42	26-#11	39.53	5387	101.2	7908

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

f'_c = 3,000 psi f_y = 60,000 psi

FACTORED SOIL BEARING CAPACITY 21,700 psf (SAFE BEARING CAPACITY 15,500 psf)

Size B	Thick-ness (in.)	Min. Col. Size (in.)	Bars Each Way (No.-Size)	Required Steel Area (sq.-in.)	Weight of Bars (pounds)	Volume of Concrete (cu. yd.)	Factored Column Capacity (kips)
4'-6"	23	10	7-#5 *	1.89	58	1.4	432
5'-0"	25	11	8-#5	2.36	75	1.9	533
5'-6"	27	12	7-#6 *	2.90	105	2.5	644
6'-0"	28	14	8-#6	3.50	132	3.1	766
6'-6"	30	15	10-#6	4.13	180	3.9	898
7'-0"	32	16	11-#6	4.80	215	4.8	1040
7'-6"	34	17	13-#6	5.53	273	5.9	1192
8'-0"	36	18	15-#6	6.31	338	7.1	1354
8'-6"	38	19	12-#7	7.17	392	8.5	1527
9'-0"	40	20	14-#7	8.05	486	10.0	1709
9'-6"	42	21	15-#7	8.98	552	11.7	1902
10'-0"	44	22	8-#10 *	10.06	654	13.6	2104
10'-6"	46	23	9-#10 *	11.09	775	15.7	2316
11'-0"	48	24	8-#11 *	12.22	893	17.9	2539
11'-6"	50	25	9-#11 *	13.35	1052	20.4	2771
12'-0"	52	26	10-#11 *	14.53	1222	23.1	3012
12'-6"	54	27	11-#11 *	15.76	1403	26.0	3264
13'-0"	56	28	11-#11 *	17.04	1461	29.2	3525
13'-6"	58	29	12-#11 *	18.36	1658	32.6	3796
14'-0"	59	31	13-#11 *	19.83	1865	35.7	4080
14'-6"	61	32	14-#11 *	21.26	2083	39.6	4370
15'-0"	63	33	15-#11	22.73	2311	43.8	4670
15'-6"	65	34	16-#11	24.24	2550	48.2	4979
16'-0"	67	35	17-#11	25.81	2800	52.9	5298
16'-6"	69	36	18-#11	27.42	3060	58.0	5626
17'-0"	71	37	19-#11	29.07	3331	63.3	5964
17'-6"	73	38	20-#11	30.77	3613	69.0	6310
18'-0"	75	39	21-#11	32.52	3905	75.0	6666
18'-6"	77	40	22-#11	34.32	4208	81.3	7032
19'-0"	78	41	24-#11	36.70	4718	86.9	7411
19'-6"	80	42	25-#11	38.60	5047	93.9	7795
20'-0"	82	43	26-#11	40.54	5387	101.2	8188

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased f'_c, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

PILE CAPS FOR INDIVIDUAL COLUMNS

General

In this Chapter, a pile cap is considered to be a reinforced concrete structural slab which distributes a column load to a group of individual piles. The tabulated designs are based upon use of a square reinforced concrete column of at least the minimum size indicated or a structural steel column on a square steel base plate such that the section half-way between the column face and the edge of the base plate is equivalent to the size of the column. The tabulated designs are adequate (and conservative) for rectangular columns or steel base plates if the short side or section is equal to the minimum tabulated column size. Columns are located at the centroid of the pile groups.

Pile caps are an important structure, however, somewhat neglected in handbooks on structural steel because they are reinforced concrete or in handbooks on reinforced concrete in the range where steel piles are used. Since pile caps are basic to safety of the structure and usually not open to visual inspection under service, a conservative design is justified. Complete analyses are complex, usually involving strut and tie design models and allowable values for use in design are not available for certain modes of failure. As a result, most pile caps are designed in practice by various short-cut rule-of-thumb procedures using what are hoped to be conservative allowable stresses. Since practical limits on pile capacity and pile spacing exist, a set of tabulated designs can be offered for the usual range of column loads in which the complex analyses are performed by computer.

Basis of Tabulated Designs

(See also Figs. 13-2 and 13-3)

a. *ACI 318 Building Code*. The tabulated designs for pile caps in this Chapter are based on the ACI 318-99 Code. However, headed bars, which first appeared in the ACI 318-08 Code, are recognized as a viable alternative to hooked bars and are referenced in the tabulated designs.

b. *Concrete strengths.* Due to space limitations, tabulated designs are shown for only the two most commonly used concrete compressive strengths, f'_c = 3,000 psi and f'_c = 4,000 psi. Since shear strength controls depth, and $v_c = k\sqrt{f'_c}$, the saving in concrete and formwork for higher values of f'_c would not ordinarily offset the higher concrete cost and added reinforcing steel required for lesser depth. If minimum depth is itself an important cost consideration, then higher strength concrete, or specifying f'_c at periods later than 28 days, or both may be desirable. Such designs could not be adapted from tabulated design. (See "Manual Example.")

c. *Pile embedment*. A minimum embedment of 6 inches has been established as good practice with structural steel shapes to avoid use of cover plates for bearing.

If precast concrete piles are to be used in the tabulated designs, a minimum embedment of 4 inches is usually sufficient. Design depth is unaffected so only 4 inches of embedment needs to be shown, deduct 2 inches from tabulated thickness, and reduce tabulated concrete volume appropriately.

d. *Concrete cover.* The tabulated designs are based on a concrete cover (between the top of a steel pile and the reinforcing bars) of 3 inches.

e. *Pile spacing.* A minimum pile spacing of 3′-0″ c.-c. and a minimum clear distance of 2′-0″ between piles were established as generally conservative for piles up to 12 inches in diameter. For larger piles, the minimum clear distance controls, and larger spacings are required, as shown in the tabulated designs. See Fig. 13-3. If a closer spacing is used, the tabulated designs for thickness and reinforcing bars are generally conservative. The condition of overlapping critical shear sections for a pair of piles should be investigated, but should not be critical as the allowable v_c will increase if the angle of the potential crack to the vertical, $a < 45°$ . . . (ACI Commentary R11.8.7).

f. *Patterns.* Patterns for 2-pile to 30-pile pile cap layouts are included. To prevent vertical edge splitting, the minimum edge distance, E, to the center of piles is 15 inches for pile capacity $P \leq 60$ tons, 21 inches for $60 < P \leq 120$, 27 inches for $120 < P \leq 200$, and 30 inches for $P > 200$ tons. A minimum clear edge distance, $E' = E - 3$ inches ≥ 9 inches, is required for (hooked or headed) end anchorage. Where the pile diameter, d_p, exceeds 12 inches, the edge distance, E, should be increased to maintain the minimum clear edge distance. See Fig. 13-3.

Note that some tabulated designs show dimensions on the line below. These dimensions are for use with "clipped corners" to save concrete as an option. For example, the 3-pile cap shown in Fig. 13-2 would be dimensioned in the tabulated designs as:

Long A	*Short B*	
5'-6"	5'-2"	(first line)
1'-6"	1'-7"	(second line)

In other words, the "clipped corner" dimensions are the truncated dimensions of the pile cap with the corners removed.

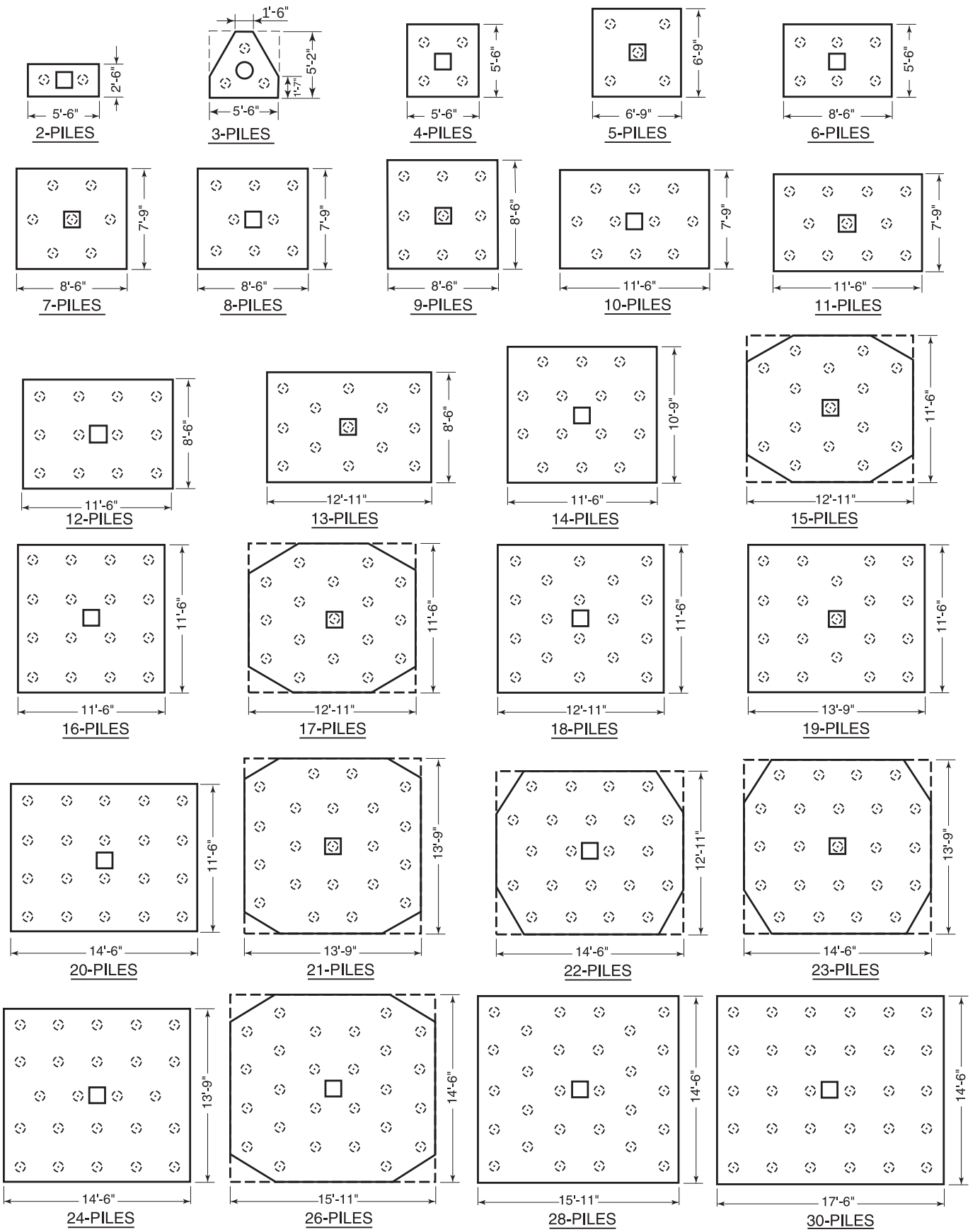


Figure 13-2 Arrangements of Piles and Plan Dimensions* of Pile Caps

*Minimum dimensions shown. See tabulated designs for dimensions used.

g. *Pile capacity.* Pile capacity is tabulated in tons, ($D + L$), as is usually done in accepted practice. The range shown, 40 tons to 200 tons, covers the usual range for precast concrete or structural steel piles. *Net* column loads, P_u, are shown (weight of pile cap has been deducted). Column load is shown in kips for strength design as $P_u = 1.6(D + L)$ where the average load factor is assumed to be 1.6.

h. *Flexural reinforcement*. All tabulated designs are based on the use of Grade 60 (f_y = 60,000 psi) reinforcing bars. Areas of required flexural reinforcement are conservatively based on an average effective depth, $d = D - d_c$, where D = total depth, and d_c = 10 inches for structural steel piles, or d_c = 8 inches for concrete piles. The requirements for minimum areas of flexural reinforcement (ACI 10.5 and 7.12) are satisfied by the following conservative interpretation, where A_s is the calculated area of reinforcement required for flexure (ACI 7.12 and 10.5):

(1) if $A_s > 0.0033bd$, use A_s (where $200/f_y = 0.0033$)
(2) if $A_s < 0.0033bd < 4/3A_s$, use $0.0033bd$
(3) if $0.0018bD < 4/3A_s < 0.0033bd$, use $4/3A_s$
(4) if $4/3A_s < 0.0018bD < 0.0033bd$, use $0.0018bD$

For 2-pile pile caps only, use (1), (2), or (3) for the required flexural (long) bars. Flexural reinforcement areas in the short direction for rectangular pile caps have been increased to permit use of uniform bar spacings to avoid errors in field placing and still conform to ACI 15.4.4.2.

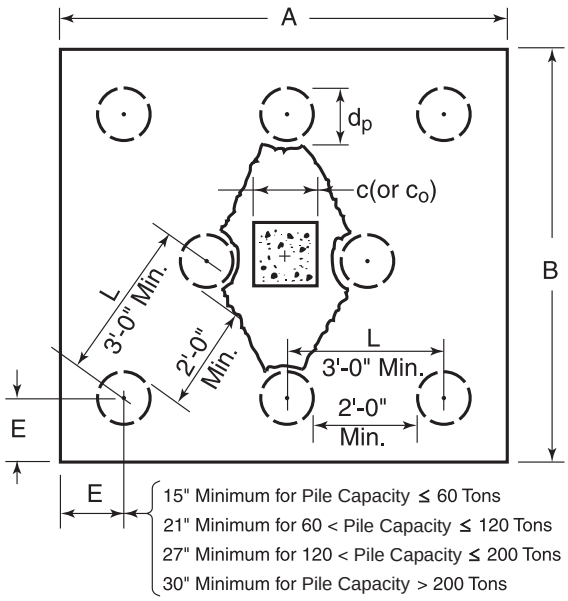
i. *Anchorage.* For pile caps with 2, 3, 4, 5, 6, 7, or 9 piles, all reinforcing bars must be provided with standard end hooks. For pile caps with 8, 10, 11, or 12 piles, only the short reinforcing bars must be provided with end hooks, and should be placed as the lower layer. As an alternative to hooked bars, the bar ends can instead be headed. See Figs. 13-12 and 13-13.

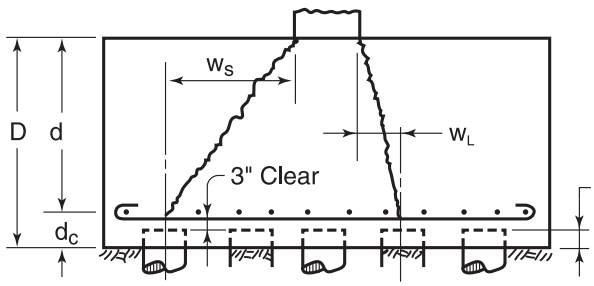
j. *Column size.* The column sizes shown are derived from square column sizes for a bearing stress of 4,000 psi on the gross column area. Tabulated designs are conservative if the column is larger than the minimum column size tabulated.

Design Procedure

a. Flexure. The design strength of the critical section for flexure and the required area of flexural reinforcement at f_y = 60,000 psi is determined by the ACI strength design method for factored pile loads equal to $1.6(D + L)$. Since the depth of the pile cap required is usually established by shear, the flexural reinforcement ratio is usually near or controlled by the minimum ratios required by ACI 10.5 and ACI 7.12.

b. Shear. Due to the variety of conditions resulting from the 26 pile cap patterns, a variable number of critical sections for shear must be investigated. See Fig. 13-4. The possibilities of shear failures at $d/2$ about a single pile or at an "overlapping" section $d/2$ about a pair of piles are most conveniently related to the footing depth using f'_c = 3,000 psi with solutions for the full range of pile loads (12-inch pile diameter and 36-inch pile spacing). See Fig. 13-5. Fig. 13-5 also includes solutions for a "corner" failure at 45° as a beam, in one-way shear with $v_c = 2\sqrt{f'_c}$. This latter condition with one (or three) pile loads on the critical section is generally precluded by the dimensions of pile diameter, pile spacing, and pile cap depths.





NOTATION

D = total depth = d + d_c
d = effective depth
d_c = average to ctr. of bars
c (or c_o) = col. side (dia.)
d_p = diameter of pile
E = edge to ℄ piles
L = spacing, c-c. piles
A = long side
B = short side
P = pile capacity (D + L) in tons
w = horizontal component col. face-to-bot. crack (sub "S" short side "L" long side)

Figure 13-3 Pile Cap Nomenclature, Dimensions, and Plan and Section Details

In addition to these possible critical sections, shear is investigated as prescribed in the Code for a "punching" failure about the column at a section located at a distance $d/2$ from the column face ($v_c = 4\sqrt{f'_c}$), and for a "beam" failure straight across the width of the pile cap in either direction at a section located at a distance d from the column face ($v_c = 2\sqrt{f'_c}$) . . . (ACI 11.12). See Fig. 13-4. Both of these Code-required investigations become inappropriate as the depth of the footing increases so that the sections at distance d (or $d/2$) exclude all or part of the pile loads causing shear or even fall outside the footing.

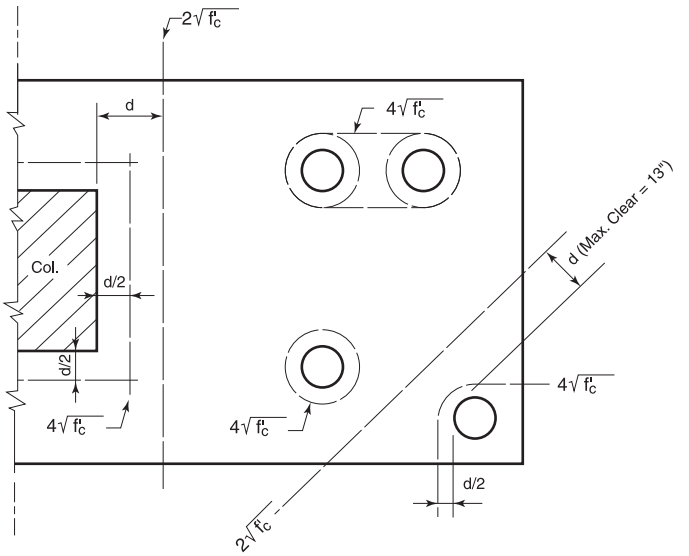


Figure 13-4 Plan of Critical Shear Sections for Code-Prescribed Allowable Shear on Concrete (One-Way, $v_c = 2\sqrt{f'_c}$; Two-Way, $v_c = 4\sqrt{f'_c}$)

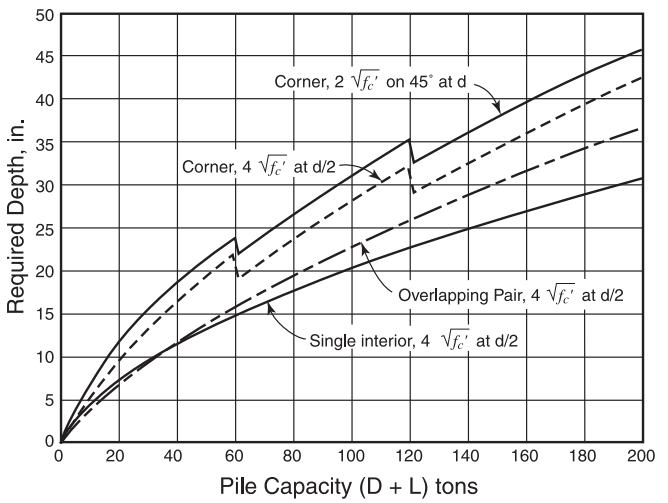


Figure 13-5 Solutions for Design Depth Required at Code-Prescribed Allowable Shear on Concrete at Critical Sections Around Piles versus Pile Capacity, Tons ($D + L$)

SPECIAL INVESTIGATIONS

As the previous Code-prescribed assumptions are not satisfied, two special investigations for possible shear failure are necessary. The investigation of a beam shear failure, cracking across the width of a footing, when footing depth creates "deep beam" shear, and a column punching failure when the nearest piles cause such failure to occur in a manner approaching "pure shear" will establish two additional rational basis for selecting the depth when "normal" shear investigations do not apply. See Figs. 13-6 and 13-7. Limiting values for v_c under these special conditions, based on research, become very high.*

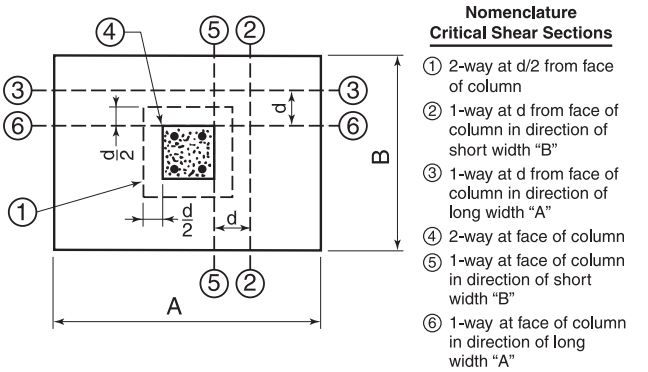


Figure 13-6 Critical Sections and Notation for Special Investigations of Deep Beam (One-Way) Shear

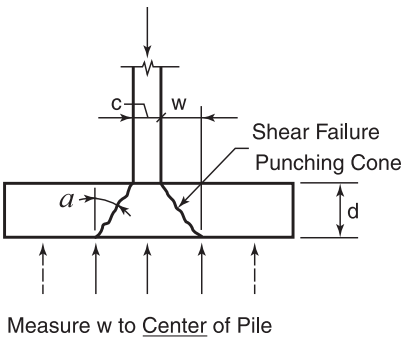


Figure 13-7 Two-Way Shear at Columns; Code-Prescribed Investigation, $v_c = 4\sqrt{f'_c}$ for $a = 45^o$; Special Deep Two-Way Corbel Investigation for $a < 45^o$**

*Joint ASCE-ACI Committee 426, "The Shear Strength of Reinforced Concrete," Journal of the Structural Division, ASCE, Part I — Beams and Special Members, June 1973 and Part II — Slabs, Aug. 1974.

**Tabulated designs reflect $w' = w + 3$ in. in all calculations for shear and flexure to include adverse tolerance effects.

SPECIAL INVESTIGATION – Two-Way Deep Corbel

For square (or equivalent round) columns. The shear failure section is a pyramidal frustrum with slope angle to the vertical, $\alpha \approx 45^o$, and $w \approx d$. This condition is part of the explicitly Code-prescribed investigation. The allowable shear stress on concrete is: $v_c = 4\sqrt{f'_c}$, at a section, which is located at a distance of $d/2$ from the perimeter of the column for all piles outside this section. The shear section perimeter is: $b_o = 4(c + d)$.

When $w < d$, and $45^o > \alpha \geq 0$, the explicit Code provisions do not apply. The condition is an inverted "deep" two-way cantilever slab with concentrated loads (pile loads, 1.6P). Providing horizontal shear-friction reinforcement distributed through 2/3 of the depth as for small one-way corbels is impracticable (ACI 11.9.4, 11.9.5). Failure when $\alpha < 45^o$ can occur, but only at increasingly higher values of v_c, approaching a theoretical strength $v_c = 0.5f'_c \approx 32\sqrt{f'_c}$ at $\alpha = 0$ ("pure" shear). The "deep" beam formulas of the Code for one-way shear omit limits for cantilever spans and are not applicable for this condition (ACI 11.8). See Figures 5.1 and 5.9 in the reference noted on Page 13-24.

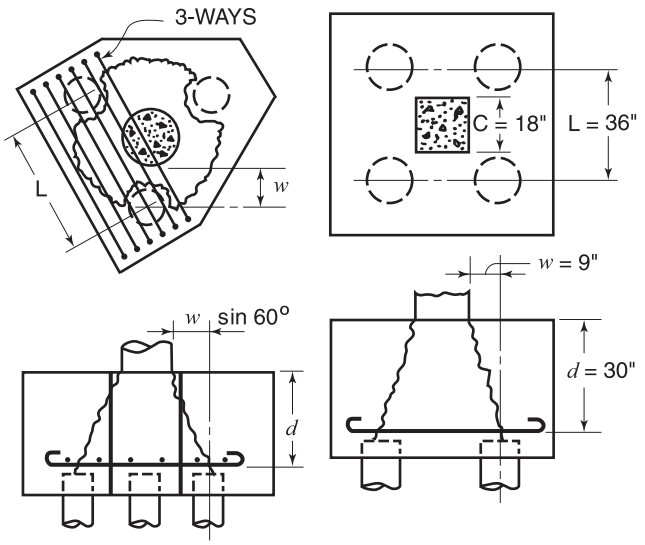


Figure 13-8 Deep Two-Way Pile Cap Slabs

Since the various pile arrangements in Fig. 13-2 include all variations of distance w from face of column to centers of first piles and w can approach zero, it is most convenient to make this special investigation on the perimeter at the **face** of the column with the special critical section $b_s = 4c$. This special investigation will be made only when $w < d/2$ since the ACI-prescribed procedure can be applied when $w \geq d/2$. Converting the ACI-prescribed v_c from $v_c = 4\sqrt{f'_c}$, at the section perimeter at $d/2$, $b_o = 4(c + d)$ to the perimeter at the column (b_s), v_c becomes

$$v_c\,(4\sqrt{f'_c}) = b_o/b_s = (1 + d/c)$$

For the special investigation then, on a section at the face of the column, when $w = d/2$ the allowable shear stress, $v_c = (1 + d/c)(4\sqrt{f'_c})$ with $b_s = 4c$. A simple conservative linear variation for v_c between the value $v_c = (1 + d/c)4\sqrt{f'_c}$ at $w = d/2$ and $v_c = 32\sqrt{f'_c}$ at $w = 0$ is used. See Fig. 13-9.

$$v_c = (d/w)(1 + d/c)(2\sqrt{f'_c}) \quad \text{(ACI Eq. 13-1)}$$

For the determination of the shear strength for design, Eq. 13-1 becomes

$$\phi V_c = 0.85\left(\frac{d}{w}\right)\left(1 + \frac{d}{c}\right)(2\sqrt{f'_c})(b_s d)$$

SPECIAL INVESTIGATION – One-Way Deep Beam

A similar special investigation is required for possible failure in one-way shear as a deep beam. See Fig. 13-6. Possible failure sections (cracks) in both directions are shown in Fig. 13-10 for a 6-pile cap arrangement. Under Code prescribed procedures, shear is investigated at a distance d from the face of the column with an allowable value, $v_c = 2\sqrt{f'_c}$, for shear on concrete. Note that for a value of $d \geq 7.25$ inches, Section S2 is outside all piles. Similarly, for $d \geq 26.5$ inches, Section S1 is outside all piles.

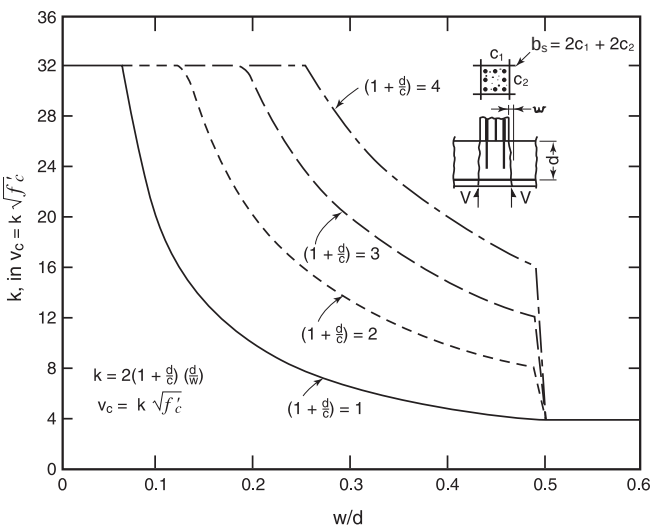


Figure 13-9 Derivation of Allowable Shear, v_c, for Two-Way Deep Corbels, $w/d < 0.5$

As for the two-way deep corbels, a one-way shear section is investigated at the *face* of the column. In this case, the width of the critical section is unchanged. No correction factor, based upon column size or ratio (d/c),

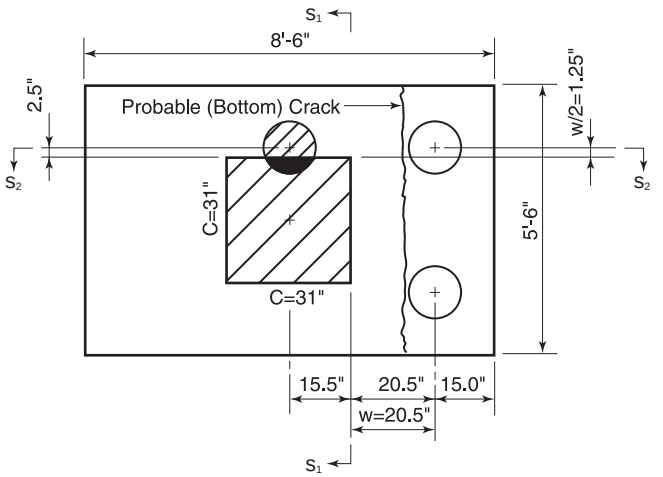


Figure 13-10 Critical Sections through 6-Pile Cap with 200-Ton Piles for One-Way Deep Beam Shear

is required. Research reports, including tests for shear with (w/d) as low as 0.5, show shear strengths of approximately 1,200 to 1,300 psi and show an exponential increase in shear strength as (w/d) decreases. These very favorable strengths develop in confined situations (at the face of a support), and the support here (upside down) is the column, the width of which involves a variable (c/A) or (c/B). No test results are available to evaluate the precise effect of the (column width/footing width) ratios nor to evaluate the precise upper value for v_c at $w = 0$, at the column. Under these conditions, no further refinement than an average value for v_c applied across the full footing width is justifiable. A conservative upper limit for the value, v_c, as w approaches zero is $10\sqrt{f'_c}$.* In order to include the effect (M_u/V_ud) for several lines of piles at varying spans, the initial value beginning at (w/d) = 1.0 will be that from ACI Eq. 11-5, and a simple linear function for the effect of (d/w) will be used for the transition.

For (w/d) ≥ 1.0, a one-way (normal) shear investigation with loads outside the critical section (located at a distance d from the face of the column, b = footing width) and

$$v_c = 1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_ud}{M_u}\right) \geq 2\sqrt{f'_c} \quad \text{(ACI Eq. 11-5)}$$

which reduces for $\rho_w \approx 0.002$ and 3,000 psi ≤ f'_c ≤ 4,000 psi to $v_c = 1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\,(V_ud/M_u) \geq 2\sqrt{f'_c}$.

For (w/d) < 1.0, $1.0 > M_u/V_ud > 0$; $\infty > V_ud/M_u \geq 1.0$ (no limits on M_u, V_ud, other than above)

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_ud}\right)\right]\left[1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_ud}{M_u}\right)\right] \leq 10\sqrt{f'_c}$$

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_ud}\right)\right]\left[1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\left(\frac{V_ud}{M_u}\right)\right] \leq 10\sqrt{f'_c} \quad \text{(ACI Eq. 13-2)}$$

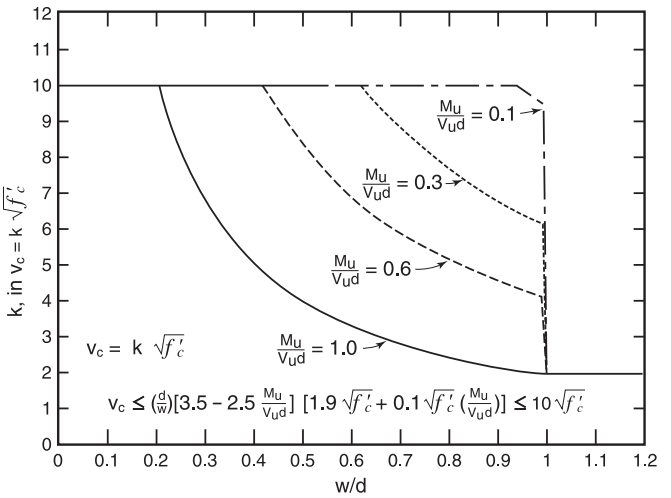


Figure 13-11 Derivation of Allowable Shear, v_c, for One-Way Deep Beam Sections, $w/d < 1.0$

For visual representation of Eq. 11-5, see Fig. 13-11. Note again that the equation permits reaching the maximum shear value in a short finite length of w, the distance from the column face to the center of the pile, which allows for the finite size of piles.

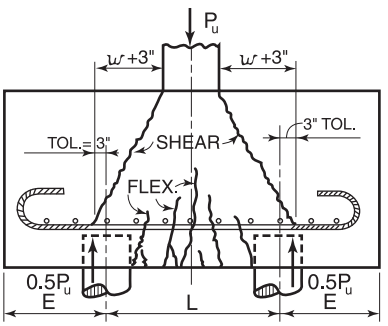


Figure 13-12 Shear Failure Model

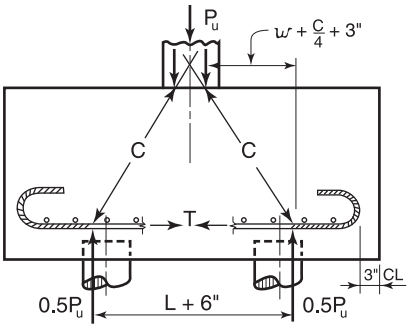


Figure 13-13 Tied-Arch Model

*Reference: footnote, Page 13-24. Also Rogowsky and MacGregor, "Shear Strength of Deep Reinforced Concrete Continuous Beams," Struct. Eng. Report No. 110, Univ. of Alberta, Nov. 1983.

"Tied-Arch" Behavior

The provision to include a 180º end hooks or heads on all reinforcing bars in pile caps with single lines of piles around the column is a prudent precaution against a premature "tied-arch" shear failure mode. See Fig. 13-13. In addition, however, the maximum bar size should be related to the embedment length available. The ACI Code establishes required development lengths required for full development of hooks and headed bars. The Code permits a 30 percent reduction in hook development where confining reinforcement and at least 2½ inches of concrete cover are present. Crossing bars provide a degree of confinement and the compressive reactions of the piles contribute also to confinement. See Chapter 5 for hook and headed bar development lengths.

Special Anchorage Requirements

High-capacity piles, up to the limits set by supporting soil strata, minimize the number of piles required as well as the area of the pile cap for a given column load. An obvious potential economy results in more "deep beam" or "deep slab" pile caps. Theoretical analyses indicating a "tied-arch" mode of failure as depth/span ratios become larger have been confirmed to some extent by model tests and reports of field behavior. See Fig. 13-13. When $w << d$ in one-way shear or flexure, and $w << 0.5d$ in two-way shear or flexure, the ordinary requirement for tension development length at simple supports is:

$$\ell_d \le (M_n/V_u) + \ell_a \quad \text{(ACI Eq. 12-2)}$$

and may not be adequate, even with the increase of 30 percent allowed in M_n/V_u.

Ordinarily, with all tension reinforcement extended to the support, the requirement can be expressed as

$$\left[\frac{M_n}{V_u}\right] = \left[\frac{(P_u L/4)}{\phi P_u/2}\right] = \frac{L}{2\phi}$$

where P_u = factored column load
$\ell_a = E - 3$ inches
$\ell_d \le (L/2\phi) + E - 3$ inches

The "tied-arch" model at failure (Fig. 13-13) indicates that full development of the bars at the **center** of the support is desirable, particularly with an adverse 3-inch tolerance.

Shear at Critical Sections Around Piles (Fig. 13-4)

Compare the graphic solutions (Fig. 13-5) for the four conditions of Fig. 13-4 to the thicknesses of pile caps tabulated. Read from Fig. 13-5 the following minimum thicknesses for 3,000 psi concrete:

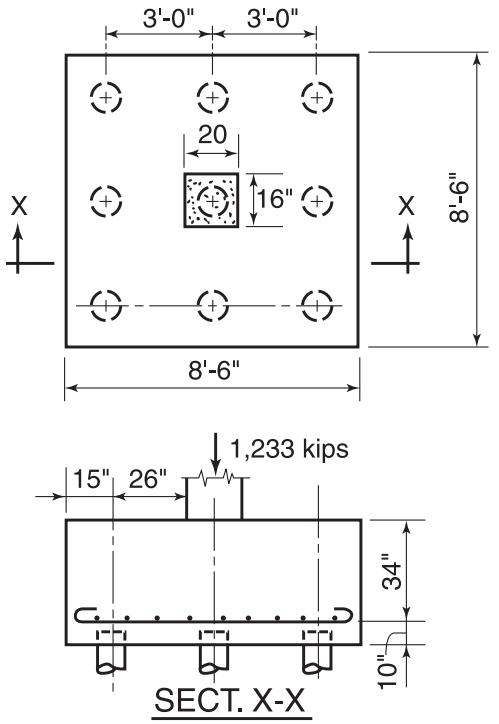
Pile Capacity (Tons)	Corner d at 45º (in.)	Corner $d/2$ Circle (in.)	Overlapping Pair (in.)	Single Interior (in.)
40	19	17	12	12
50	22	20	14	14
60	25	23	16	15
70	25	22	18	17
80	27	24	20	18
90	30	27	22	20
100	32	29	23	21
110	34	31	25	22
120	36	33	27	23
130	35	31	28	24
140	37	33	30	26
150	39	35	31	27
160	40	37	32	28
170	42	39	34	29
180	44	40	35	30
190	45	42	36	31
200	47	43	37	31

In order to check conformance with the above analyses, it is necessary to study the pile arrangement and various sections at $d/2$ and d. Take $d = (D - 10$ inches) for this purpose. See tabulated designs, Pages 13-31 to 13-37.

It will be noted that the "single interior pile punching failure" never controlled the arrangements used. The 3-pile corner failure at 45º in beam (one-way) shear cannot occur with the CRSI arrangements. Where "overlaps" exist for pairs of piles, the perimeter is usually incomplete and would not control. The single pile corner "beam" or "punching" shear failure alone of the criteria in Figs. 13-4 and 13-5 approaches critical shear for some combinations. These criteria and solutions (Figs. 13-4 and 13-5) are presented, however, for specifying piles at larger spacings than assumed for the tabulated designs (3′-0″). Smaller spacings will require even less than the thicknesses shown in Fig. 13-5 and will often make these possible failure sections inapplicable, or applicable at higher allowable stresses (v_c). Consideration of these cases is advised where pile arrangement is based on larger spacings.

USE OF TABLES

Example 1. Select a pile cap, using piles with a 50-ton capacity for the multi-story column of Example 1, Chapter 3. P_u = 1,036 kips. M_u = 0 ft-kips (calculated). Column size is 16 in. × 20 in.; f'_c = 3,000 psi.



9-Pile Pile Cap Design (Example 1)

Enter pile cap table, Page 13-31, for 50-ton piles. Try 9-pile pile cap. From the tabulated designs, P_u = 1,376 kips. Note that minimum column size tabulated is 19 in. In the 16-in. direction of the column, the pile loads will have an additional 1.5 in. moment arm distance. This effect should be negligible, but will be checked here for illustrative purposes. See Figs. 13-2 and 13-3. Note that the reaction of these 50-ton piles is located 3′-0″ from the column center. Cantilever span for the tabulated design, $\ell_c = 36 - 0.5 \times 19 = 26.5$ in. The column size of Example 1 will increase the footing moment (1.5/26.5 = 5.6 percent. The ratio of tabulated to required capacity is (1,376/1,036) = 1.33, approximately 33 percent above that required, and the listed capacity includes adverse 3 in. tolerances. No change in tabulated reinforcement nor thickness is required. Use tabulated design.

Shear. Again for illustrative purposes, note slab shear on section ① controlled. See Fig. 13-6. For this condition, the allowable shear is v_c = 219 psi. The ratios of computed/allowable shears are: 0.919 controlling slab shear on (ACI) section ①; and 0.911 controlling beam shear on both (CRSI) sections ⑤ and ⑥ due to two-way symmetry.

"Tied Arch." Note also that the tabulated design requires the same number and size of reinforcing bars in each direction, all with hooked or headed bar ends. Bar size for hooked bars is limited to #6 for which ℓ_{dh} = 0.7 (17) = 12 in. See Table 5-5(a) in Chapter 5. The edge distance, E = 15 in., provides a net hook embedment of 15 – 3 (end concrete cover) = 12 in. (For this purpose, the 3-in. tolerance was not considered.) Also note that the average effective depth, d = 44 – 10 = 34 in., and that w = 26.5 in., which definitely is within the range of proportions where tied-arch behavior should be considered in the design.

MANUAL EXAMPLE

To illustrate the design assumptions, applicable Code requirements and procedures used in the preparation of the pile cap tabulated designs, one of the designs will be reviewed with all calculations performed longhand. This review will also assist or guide anyone wishing to extend the scope of the tabulated designs to longer spans or heavier loads; to use other concrete compressive strengths or yield strengths of reinforcing bars; conditions of concrete cover other than those used (shown in Fig. 13-3); or columns smaller than the tabulated sizes.

From the table on Page 13-31, review the 12-pile pile cap with 50-ton piles.

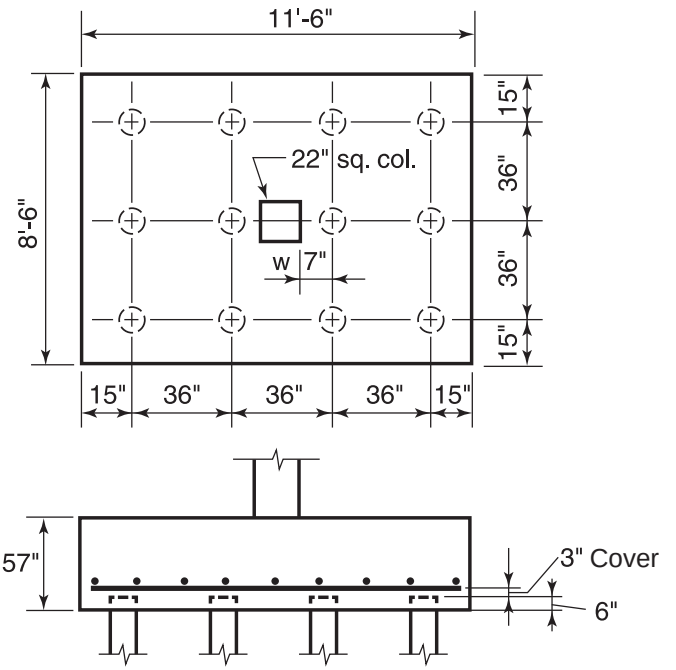


Fig. 13-14 Manual Example

12-Pile Pile Cap

Piles : Service load = 50 tons
Pile Cap: f'_c = 3,000 psi
f_y = 60,000 psi

Column : P_u/A_g = 4,000 psi

with a 1.6 load factor; a 36-in. pile spacing; and a 15-in. edge distance

1. Minimum Square Column Size

$$h = \sqrt{\frac{[12 \times 100 - 11.5 \times 8.5 \times (57/12) \times 0.15]\ 1.6}{4}}$$

= 21.26, use 22 in.

2. Required Flexural Reinforcement—Short Bars

The moment arm of M_u is taken from a point, which is located between the column center and the column face $c/4$, and includes the placing tolerance of 3 inches but neglects the pile cap dead load.

$M_u = 4 \times 1.6 \times 100\ (36 + 3 - 22/4) = 21{,}440$ in.-kips

$M_u = 21{,}440/11.5 = 1{,}864$ in.-kips/ft

$d = 57 - 9 - 1.128 - 0.375 = 46.497$ in.

For f'_c = 3,000 psi and f_y = 60,000 psi, the required area of flexural reinforcement,

$A_s = 0.51d - \sqrt{0.26d^2 - 0.0189M_u}$ (See Chapter 5)

$= 0.51(46.5) - \sqrt{0.26(46.5)^2 - 0.0189(1{,}864)}$

$= 0.759$ in.^{2}/ft

Calculated total required $A_s = 0.759 \times 11.5 = 8.73$ in.^{2}

$(4/3)\ A_s = (4/3)(8.73) = 11.64$ in.^{2}

$(200/f_y) \times 11.5 \times 12 \times 46.497 = 21.39$ in.^{2}

$0.0018 \times 11.5 \times 12 \times 57 = 14.16$ in.^{2}

Increase the calculated area in order to maintain uniform spacing of the short bars (ACI 15.4.4).

$\beta = 11.5/8.5 = 1.353$, ratio of long-to-short sides

$A_s = 8.73(2\beta)/(1 + \beta) = 10.04$ in.^{2}

Thus, use $A_s = 14.16$ in.^{2} (14.16 in.^{2} tabulated)

$E' = E - 3$ in. (concrete cover)
$E = 15 - 3 = 12$ in. for hook embedment

Maximum bar size is #6 (ℓ_{dh} = 0.7 (17) = 12 in., see Table 5-5(a) in Chapter 5)

Thus, use 32 – #6 bars with standard hooks at ends; A_s provided is 14.08 in.^{2}

3. Required Flexural Reinforcement – Long Bars

3 piles at 18 in.; 3 piles at 54 in., plus a 3-in. tolerance

$M_u = 1.6 \times 100[3 \times (18 + 3) + 3 \times (54 + 3) - 6 \times 22/4]$
$= 32{,}160$ in.-kips

$M_u = 32{,}160/8.5 = 3{,}784$ in.-kips/ft

$d = 57 - 9 - 1.128/2 = 47.44$ in.

$A_s = 0.51(47.44) - \sqrt{0.26(47.44)^2 - 0.0189(3{,}784)}$
$= 1.53$ in.^{2}/ft

Calculated total required $A_s = 1.53 \times 8.5 = 13.01$ in.^{2}

$(4/3)\ A_s = (4/3)(13.01) = 17.34$ in.^{2}

$(200/f_y)\ 8.5 \times 12 \times 47.44 = 16.13$ in.^{2}

$0.0018 \times 8.5 \times 12 \times 57 = 10.46$ in.^{2}

Thus, use $A_s = 16.13$ in.^{2} (16.13 tabulated)

Embedment length available for tension development
$= (11.5 \times 12)/2 - 3 - 11 = 55$ in.

13 – #10 bars; $A_s = 16.51$ in.^{2}
16 – #9 bars; $A_s = 16.00$ in.^{2}
Hence, use 16 - #9 bars

Check tension development length of #9 bars vs. available embedment length; c.-c. spacing of #9 bars = $((8.5 \times 12) - (4.31 \times 2))/15 = 6.23$ in. or $6.23/1.128 = 5.5d_b$; concrete cover = 3.75 in. or $3.75/1.128 = 3.3d_b$; from Table 5-3(a) for "Other Bars", $\ell_d = 41$ in. < 55 in., okay.

4. Check Shear at a distance *d*/2 from Column: Case ①

Centers of 10 piles lie outside section at $d/2$ from face of column

$V_u = 10 \times 1.6 \times 100 = 1{,}600$ kips

$d = 57 - 9 - 1 = 47$ in.

$b_o = 4\ (22 + 47) = 276$ in.

$\phi V_c = 0.85 \times 4 \times \sqrt{3000} \times 276 \times 47/1000$
$= 2{,}416$ kips > 1,600 kips

$V_u/\phi V_c = 0.662$ (0.632 tabulated, using long formula for shear strength)

5. Check One-Way Beam Shear at a distance *d* from Column: Case ② (Short Direction)

No check is necessary, because all piles are within this section.

6. Check Deep Beam (One-Way) Shear at Face of Column (When $w/d < 1.0$): Case ⑤

$w' = 7 + 3 = 10$ in.

$V_u = 6 \times 1.6 \times 100 = 960$ kips

$M_u = 1.6 \times 100\ [3 \times 10 + 3 \times 46] = 26{,}880$ in.-kips

$V_u d/M_u = 1.679$

$M_u/V_u d = 0.596$

$k = [3.5 - 2.5\ (0.596)][1.9 + 0.1\ (1.679)] \times 47/11$
$= 17.76 > 10$, use 10

$\phi V_c = 0.85 \times 10 \times \sqrt{3000} \times 8.5 \times 12 \times 47/1000$
$= 2{,}232$ kips $> V_u$

$V_u/\phi V_c = 0.430$ (0.409 tabulated, due to round-off)

7. Quantities of Concrete and Reinforcing Bars

Concrete:

8.5(11.5)(57/12)/27 = 17.197 cubic yards
(17.2 cubic yards tabulated)

Reinforcing bars:

16 – #9 bars × 11′-0″; 16(3.400)(11) =	598 pounds
32 – #6 bars × 8′-0″; 32 (1.502)(8) =	385 pounds
32 – #6 bars with standard end hooks at each end; 64 hooks at 8″; 64(64(1.502)(0.67) =	64 pounds
Total weight =	1,047 pounds

Total weight = 1,047/2,000 = 0.524 tons
(0.523 tons tabulated)

8. Compute Net Design Capacity of Pile Cap

Total design capacity = $12 \times 1.6 \times 100 = 1{,}920$ kips

Pile cap weight = $17.197 \times 27 \times 0.15 = 69.6$ kips

Factored pile cap weight = $1.4 \times 69.6 = 97.4$ kips

Net design capacity = 1,920 – 97.4 = 1,823 kips

(1,808 kips tabulated. Computer program conservatively uses the combined load factor 1.6 for the dead load of the pile cap.)

f_c' = 3,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

40-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 15″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Concrete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	246	10	5- 6	2- 6	34	1.4	8 H# 5	2.37	5 H# 4	N/A	0.031	0.956	N/A
3	370	11	5- 6	5- 2	31	2.0	4 H# 6	1.78	3-WAYS		0.057	0.775	0.952
			1- 6	1- 7									
4	493	12	5- 6	5- 6	31	2.9	11 H# 6	4.76	11 H# 6	4.76	0.105	0.762	0.965
5	608	13	6- 9	6- 9	35	4.9	14 H# 6	6.31	14 H# 6	6.31	0.159	0.859	0.688
6	726	14	8- 6	5- 6	44	6.3	14 H# 6	6.31	18 H# 6	8.08	0.184	0.968	0.399
7	845	17	8- 6	7- 9	38	7.7	16 H# 6	7.25	16 H# 6	6.98	0.215	0.707	0.985
8	972	16	8- 6	7- 9	39	7.9	21 H# 6	9.08	22 H# 6	9.77	0.289	0.967	0.748
9	1089	17	8- 6	8- 6	43	9.6	22 H# 6	9.77	22 H# 6	9.77	0.308	0.909	0.795
10	1206	18	11- 6	7- 9	41	11.3	8 #10	10.20	23 H# 6	10.18	0.338	0.621	0.852
11	1331	19	11- 6	7- 9	43	11.8	12 # 9	12.06	25 H# 6	11.15	0.386	0.813	0.954
12	1442	19	11- 6	8- 6	48	14.5	10 #10	13.04	27 H# 6	11.92	0.426	0.997	0.881
13	1549	20	12-11	8- 6	52	17.6	14 # 9	14.43	18 # 8	14.51	0.488	0.923	0.747
14	1690	21	11- 6	10- 9	41	15.6	12 #10	15.08	16 # 9	16.41	0.563	0.883	0.994
15	1790	22	12-11	11- 6	48	19.9	14 #10	17.65	19 # 9	19.20	0.729	0.673	0.993
			5-11	7- 6									
16	1921	22	11- 6	11- 6	48	19.6	18 # 9	17.68	18 # 9	17.68	0.673	0.985	0.844
17	2038	23	12-11	11- 6	51	21.2	15 #10	19.03	18 # 9	17.65	0.737	0.787	0.992
			5-11	7- 6									
18	2152	24	12-11	11- 6	51	23.4	15 #10	19.03	20 # 9	20.00	0.775	0.903	0.970
19	2261	24	13- 9	11- 6	54	26.4	16 #10	20.41	21 # 9	20.88	0.849	0.835	0.973
20	2376	25	14- 6	11- 6	55	28.3	13 #11	20.84	22 # 9	22.63	0.895	0.944	0.920
21	2492	25	13- 9	13- 9	56	30.2	19 #10	24.80	19 #10	24.80	1.083	0.764	0.988
			11- 0	3- 5									
22	2632	26	14- 6	12-11	53	28.3	14 #11	22.37	19 #10	24.33	1.028	0.961	0.975
			10- 6	5-11									
23	2728	27	14- 6	13- 9	58	33.2	17 #11	26.56	21 #10	26.86	1.231	0.711	0.987
			10- 6	6- 9									
24	2852	27	14- 6	13- 9	55	33.8	16 #11	24.91	20 #10	25.49	1.165	0.813	0.986
26	3080	28	15-11	14- 6	57	38.1	18 #11	28.74	19 #11	29.21	1.444	0.633	0.995
			8-11	10- 6									
28	3307	29	15-11	14- 6	60	42.7	19 #11	29.17	20 #11	31.12	1.522	0.716	0.881
30	3540	30	17- 6	14- 6	59	46.2	22 #11	34.82	21 #11	33.52	1.775	0.741	0.979

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 3,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

50-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 15″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Concrete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	309	10	5- 6	2- 6	39	1.7	8 H# 5	2.46	5 H# 4	N/A	0.031	0.853	N/A
3	466	13	5- 6	5- 2	33	2.2	7 H# 5	1.99	3-WAYS		0.068	0.627	0.972
			1- 6	1- 7									
4	619	13	5- 6	5- 6	34	3.2	12 H# 6	5.42	12 H# 6	5.42	0.114	0.598	0.946
5	767	14	6- 9	6- 9	36	5.1	16 H# 6	7.19	16 H# 6	7.19	0.182	0.874	0.794
6	917	16	8- 6	5- 6	45	6.5	17 H# 6	7.67	19 H# 6	8.26	0.210	0.968	0.462
7	1064	19	8- 6	7- 9	42	8.5	18 H# 6	7.82	17 H# 6	7.71	0.236	0.491	0.960
8	1225	18	8- 6	7- 9	41	8.3	22 H# 6	9.80	24 H# 6	10.50	0.309	0.839	0.813
9	1376	19	8- 6	8- 6	44	9.8	26 H# 6	11.58	26 H# 6	11.58	0.364	0.911	0.919
10	1525	20	11- 6	7- 9	42	11.6	10 #10	12.42	24 H# 6	10.72	0.391	0.579	0.985
11	1676	21	11- 6	7- 9	47	12.9	13 # 9	13.35	28 H# 6	12.27	0.424	0.923	0.962
12	1808	22	11- 6	8- 6	57	17.2	16 # 9	16.13	32 H# 6	14.16	0.523	0.409	0.632
13	1952	23	12-11	8- 6	58	19.7	13 #10	16.44	20 # 8	16.18	0.561	0.995	0.474
14	2128	24	11- 6	10- 9	45	17.2	16 # 9	16.41	18 # 9	17.65	0.613	0.999	0.982
15	2257	24	12-11	11- 6	53	22.0	16 #10	19.95	21 # 9	21.16	0.820	0.637	0.993
			5-11	7- 6									
16	2414	25	11- 6	11- 6	55	22.4	21 # 9	20.90	21 # 9	20.90	0.785	0.422	0.772
17	2577	26	12-11	11- 6	53	22.0	16 #10	19.95	21 # 9	20.83	0.820	0.985	0.820
			5-11	7- 6									
18	2707	27	12-11	11- 6	58	26.6	17 #10	22.25	21 # 9	20.87	0.847	0.983	0.788
19	2859	27	13- 9	11- 6	57	27.8	18 #10	22.41	24 # 9	24.16	0.962	0.992	0.812
20	3003	28	14- 6	11- 6	59	30.4	15 #11	23.65	25 # 9	25.61	1.025	0.946	0.972
21	3150	29	13- 9	13- 9	60	32.4	21 #10	27.00	21 #10	27.00	1.197	0.916	0.599
			11- 0	3- 5									
22	3318	29	14- 6	12-11	58	31.0	16 #11	24.95	21 #10	27.23	1.156	0.950	0.990
			10- 6	5-11									
23	3450	30	14- 6	13- 9	62	35.5	18 #11	28.76	23 #10	29.55	1.325	0.871	0.958
			10- 6	6- 9									
24	3608	31	14- 6	13- 9	58	35.7	18 #11	27.52	22 #10	28.32	1.297	0.966	0.842
26	3886	32	15-11	14- 6	63	42.2	20 #11	31.38	21 #11	32.57	1.600	0.767	0.986
			8-11	10- 6									
28	4189	33	15-11	14- 6	63	44.9	21 #11	33.61	26 #10	33.08	1.643	0.858	0.970
30	4470	34	17- 6	14- 6	65	50.9	24 #11	38.33	29 #10	37.77	1.957	0.844	0.982

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 3,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

60-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 15″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Con-crete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	372	10	5- 6	2- 6	43	1.8	6 H# 6	2.61	5 H# 4	N/A	0.034	0.829	N/A
3	561	14	5- 6	5- 2	35	2.3	5 H# 6	2.18	3-WAYS		0.071	0.549	0.994
			1- 6	1- 7									
4	746	14	5- 6	5- 6	36	3.4	13 H# 6	5.86	13 H# 6	5.86	0.124	0.539	0.974
5	927	16	6- 9	6- 9	36	5.1	16 H# 6	7.19	16 H# 6	7.19	0.182	0.937	0.915
6	1109	17	8- 6	5- 6	46	6.6	18 H# 6	8.06	19 H# 6	8.45	0.217	1.000	0.523
7	1284	21	8- 6	7- 9	45	9.1	19 H# 6	8.45	19 H# 6	8.26	0.256	0.408	0.966
8	1481	20	8- 6	7- 9	41	8.3	22 H# 6	9.80	24 H# 6	10.64	0.309	0.915	0.945
9	1661	21	8- 6	8- 6	46	10.3	28 H# 6	12.45	28 H# 6	12.45	0.393	0.816	0.975
10	1834	22	11- 6	7- 9	48	13.2	12 # 9	12.29	27 H# 6	11.92	0.398	0.531	0.945
11	2019	23	11- 6	7- 9	52	14.3	14 # 9	13.92	29 H# 6	12.92	0.449	0.997	0.914
12	2194	24	11- 6	8- 6	56	16.9	16 # 9	15.79	31 H# 6	13.91	0.516	0.507	0.771
13	2357	25	12-11	8- 6	63	21.3	14 #10	18.14	22 # 8	17.58	0.609	0.445	0.471
14	2564	26	11- 6	10- 9	50	19.1	17 # 9	17.39	18 # 9	18.14	0.632	0.750	0.929
15	2740	27	12-11	11- 6	52	21.6	15 #10	19.49	21 # 9	21.27	0.793	0.796	0.841
			5-11	7- 6									
16	2929	28	11- 6	11- 6	54	22.0	21 # 9	21.04	21 # 9	21.04	0.785	0.523	0.932
17	3097	28	12-11	11- 6	62	25.7	19 #10	24.09	20 # 9	20.20	0.882	0.382	0.584
			5-11	7- 6									
18	3274	29	12-11	11- 6	61	28.0	19 #10	23.63	23 # 9	23.39	0.938	0.432	0.590
19	3439	30	13- 9	11- 6	66	32.2	20 #10	25.93	23 # 9	23.62	1.000	0.403	0.603
20	3616	31	14- 6	11- 6	67	34.5	17 #11	26.36	25 # 9	25.70	1.100	0.997	0.679
21	3804	31	13- 9	13- 9	65	35.1	23 #10	29.75	23 #10	29.75	1.311	0.388	0.608
			11- 0	3- 5									
22	4016	32	14- 6	12-11	60	32.1	17 #11	26.83	22 #10	28.39	1.220	0.528	0.830
			10- 6	5-11									
23	4178	33	14- 6	13- 9	64	36.6	23 #10	29.90	24 #10	30.80	1.377	0.782	0.952
			10- 6	6- 9									
24	4352	33	14- 6	13- 9	64	39.4	23 #10	29.90	24 #10	30.80	1.377	0.874	0.824
26	4697	35	15-11	14- 6	68	45.5	22 #11	34.03	27 #10	35.10	1.714	0.899	0.998
			8-11	10- 6									
28	5062	36	15-11	14- 6	68	48.4	23 #11	36.46	28 #10	36.26	1.785	0.957	0.983
30	5399	37	17- 6	14- 6	71	55.6	26 #11	41.03	33 #10	41.97	2.168	0.893	0.975

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.

** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.

(1) "H"—Use hooked or headed bars.

(2) Based on calculation of A_s; $(4/3)A_s$; 0.0033 bd; 0.0018 bh.

(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 3,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 10 in.
spaced at 3′-0″

80-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 21″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Con-crete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	494	12	6- 6	3- 6	38	2.7	4 H# 9	3.98	5 H# 4	N/A	0.064	0.960	N/A
3	743	16	6- 6	6- 2	39	3.8	3 H# 9	2.41	3-WAYS		0.130	0.477	0.985
			2- 1	2- 3									
4	991	16	6- 6	6- 6	39	5.1	10 H# 8	7.41	10 H# 8	7.41	0.209	0.474	0.915
5	1233	18	7- 9	7- 9	39	7.2	9 H# 9	9.13	9 H# 9	9.13	0.298	0.681	0.974
6	1479	20	9- 6	6- 6	46	8.8	12 H# 8	9.49	12 H# 8	9.44	0.299	0.983	0.657
7	1708	24	9- 6	8- 9	50	12.8	12 H# 8	9.45	10 H# 9	10.26	0.356	0.376	0.985
8	1968	23	9- 6	8- 9	48	12.3	13 H# 9	13.24	14 H# 9	14.18	0.510	0.506	0.967
9	2210	24	9- 6	9- 6	52	14.5	15 H# 9	14.88	15 H# 9	14.88	0.586	0.529	0.962
10	2448	25	12- 6	8- 9	51	17.2	12 #10	14.82	14 H# 9	13.77	0.566	0.583	0.976
11	2695	26	12- 6	8- 9	55	18.6	13 #10	16.92	19 H# 8	15.46	0.591	0.559	0.666
12	2939	28	12- 6	9- 6	56	20.5	20 # 9	19.64	17 H# 9	17.46	0.740	0.607	0.974
13	3166	29	13-11	9- 6	61	24.9	16 #10	20.93	23 # 8	18.34	0.738	0.508	0.493
14	3422	30	12- 6	11- 9	55	24.9	17 #10	21.32	22 # 9	22.08	0.860	0.550	0.971
15	3670	31	13-11	12- 6	54	26.1	18 #10	23.47	20 #10	25.31	1.036	0.937	0.990
			6- 2	8- 1									
16	3911	32	12- 6	12- 6	59	28.5	19 #10	24.68	19 #10	24.68	0.981	0.577	0.995
17	4166	33	13-11	12- 6	59	28.6	21 #10	26.44	21 #10	26.77	1.148	0.503	0.812
			6- 2	8- 1									
18	4402	34	13-11	12- 6	59	31.7	23 #10	29.30	27 # 9	26.81	1.215	0.517	0.796
19	4631	35	14- 9	12- 6	63	35.9	20 #11	30.85	30 # 9	30.70	1.369	0.528	0.837
20	4856	35	15- 6	12- 6	68	40.7	20 #11	31.09	32 # 9	32.75	1.450	0.490	0.847
21	5122	36	14- 9	14- 9	63	39.0	25 #10	32.46	25 #10	32.46	1.533	0.505	0.822
			11- 9	3- 7									
22	5385	37	15- 6	13-11	62	38.0	21 #11	33.50	27 #10	34.14	1.616	0.638	0.988
			11- 1	6- 2									
23	5608	38	15- 6	14- 9	66	43.1	21 #11	33.69	27 #10	34.22	1.665	0.950	0.977
			11- 1	7- 0									
24	5842	39	15- 6	14- 9	66	46.6	23 #11	36.48	29 #10	37.24	1.806	0.529	0.978

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.

** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.

(1) "H"—Use hooked or headed bars.

(2) Based on calculation of A_s; $(4/3)A_s$; 0.0033 bd; 0.0018 bh.

(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 3,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 10 in.
spaced at 3′-0″

100-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 21″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Con-crete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	621	13	6- 6	3- 6	41	2.9	6 H# 8	4.41	5 H# 4	N/A	0.069	0.991	N/A
3	933	18	6- 6 2- 1	6- 2 2- 3	42	4.1	6 H# 9	2.67	3-WAYS		0.130	0.542	0.923
4	1246	18	6- 6	6- 6	40	5.2	8 H# 9	7.91	8 H# 9	7.91	0.231	0.576	0.931
5	1548	20	7- 9	7- 9	43	8.0	13 H# 8	10.39	13 H# 8	10.39	0.315	0.532	0.956
6	1860	22	9- 6	6- 6	48	9.1	13 H# 8	10.41	10 H# 9	9.85	0.333	0.946	0.994
7	2148	27	9- 6	8- 9	55	14.1	13 H# 8	10.39	11 H# 9	11.29	0.389	0.421	0.981
8	2476	25	9- 6	8- 9	50	12.8	14 H# 9	14.15	15 H# 9	14.94	0.548	0.508	0.967
9	2778	27	9- 6	9- 6	56	15.6	17 H# 9	16.74	17 H# 9	16.74	0.665	0.459	1.000
10	3088	28	12- 6	8- 9	51	17.2	18 # 9	18.46	16 H# 9	15.67	0.660	0.727	0.973
11	3404	30	12- 6	8- 9	53	17.9	17 #10	22.02	20 H# 9	19.89	0.804	0.739	0.788
12	3702	31	12- 6	9- 6	58	21.3	18 #10	23.34	21 H# 9	20.71	0.875	0.732	0.695
13	4001	32	13-11	9- 6	60	24.5	21 #10	26.89	23 # 8	18.63	0.883	0.583	0.595
14	4303	33	12- 6	11- 9	60	27.2	19 #10	23.67	24 # 9	24.58	0.950	0.622	0.997
15	4614	34	13-11 6- 2	12- 6 8- 1	59	28.6	20 #10	25.98	27 # 9	27.76	1.128	0.570	0.803
16	4916	36	12- 6	12- 6	65	31.3	27 # 9	27.72	27 # 9	27.72	1.102	0.646	0.996
17	5254	37	13-11 6- 2	12- 6 8- 1	59	28.6	26 #10	32.84	27 # 9	27.05	1.301	0.634	0.980
18	5558	38	13-11	12- 6	58	31.1	29 #10	37.45	31 # 9	31.45	1.470	0.666	0.994
19	5844	39	14- 9	12- 6	64	36.4	29 #10	37.63	31 # 9	31.66	1.522	0.654	0.984
20	6132	40	15- 6	12- 6	69	41.3	24 #11	37.93	35 # 9	35.98	1.670	0.607	0.990

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 3,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 12 in.
spaced at 3′-1″

120-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 21″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Con-crete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	747	14	6- 7	3- 6	45	3.2	6 H# 8	4.83	5 H# 4	N/A	0.070	0.985	N/A
3	1123	19	6- 7 2- 1	6- 3 2- 2	44	4.3	3 H# 9	3.07	3-WAYS		0.131	0.606	0.933
4	1500	20	6- 7	6- 7	41	5.5	11 H# 8	8.30	11 H# 8	8.30	0.233	0.662	0.947
5	1862	22	7-11	7-11	46	8.9	15 H# 8	11.56	15 H# 8	11.56	0.370	0.479	0.964
6	2240	24	9- 8	6- 7	50	9.8	12 H# 9	12.16	11 H# 9	11.17	0.399	0.946	0.995
7	2584	29	9- 8	8-11	60	16.0	15 H# 8	11.56	16 H# 8	12.53	0.439	0.447	0.970
8	2980	28	9- 8	8-11	53	14.1	20 H# 8	15.52	16 H# 9	16.41	0.591	0.522	0.872
9	3342	29	9- 8	9- 8	61	17.6	18 H# 9	18.41	18 H# 9	18.41	0.714	0.411	0.991
10	3721	31	12- 9	8-11	52	18.2	17 #10	22.13	19 H# 9	18.65	0.801	0.832	0.993
11	4103	33	12- 9	8-11	53	18.6	21 #10	27.11	21 H# 9	21.50	0.943	0.874	0.914
12	4467	34	12- 9	9- 8	57	21.7	23 #10	29.40	23 H# 9	23.54	1.062	0.886	0.799
13	4826	35	14- 3	9- 8	60	25.5	26 #10	33.32	28 # 8	22.64	1.112	0.687	0.695
14	5177	36	12- 9	12- 0	65	30.7	21 #10	26.58	27 # 9	27.62	1.081	0.667	0.997
15	5566	38	14- 3 6- 5	12- 9 8- 3	59	29.9	25 #10	31.76	33 # 9	33.78	1.427	0.671	0.926
16	5913	39	12- 9	12- 9	71	35.6	31 # 9	31.33	31 # 9	31.33	1.291	0.687	0.985

Minimum Pile Diameter = 12 in.
spaced at 3′-1″

140-TON STEEL PILES

Edge E = 27″

2	867	15	7- 7	4- 6	42	4.4	4 H#11	5.83	6 H# 4	N/A	0.119	0.996	N/A
3	1304	21	7- 7 2- 7	7- 2 2-11	44	6.0	3 H#10	3.45	3-WAYS		0.192	0.612	0.974
4	1743	21	7- 7	7- 7	42	7.5	8 H#10	9.82	8 H#10	9.82	0.341	0.647	0.950
5	2165	24	8-11	8-11	47	11.5	11 H#10	13.33	11 H#10	13.33	0.532	0.470	0.950
6	2605	26	10- 8	7- 7	51	12.7	11 H#10	13.53	8 H#11	12.27	0.525	0.823	0.989
7	3009	31	10- 8	9-11	60	19.6	8 H#11	12.85	9 H#11	13.82	0.584	0.468	0.554
8	3474	30	10- 8	9-11	52	17.0	11 H#11	16.78	11 H#11	17.45	0.757	0.559	0.976
9	3890	32	10- 8	10- 8	62	21.8	13 H#11	20.61	13 H#11	20.61	0.921	0.417	0.979
10	4330	33	13- 9	9-11	55	23.1	18 #10	23.40	13 H#11	19.74	0.948	0.695	0.988
11	4780	35	13- 9	9-11	54	22.7	24 #10	30.24	15 H#11	23.66	1.186	0.895	0.999
12	5214	37	13- 9	10- 8	55	24.9	27 #10	35.18	17 H#11	26.20	1.372	0.979	0.938
13	5632	38	15- 3	10- 8	59	29.6	25 #11	39.22	33 # 8	26.11	1.427	0.741	0.806
14	6021	39	13- 9	13- 0	70	38.6	24 #10	31.39	25 #10	32.50	1.357	0.660	0.977

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 3,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 15 in.
spaced at 3′-3″

160-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 27″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Concrete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	991	16	7- 9	4- 6	46	5.0	4 H#11	6.42	6 H# 4	N/A	0.121	0.969	N/A
3	1493	22	7- 9	7- 4	46	6.5	3 H#11	3.91	3-WAYS		0.249	0.647	0.988
			2- 7	2-11									
4	1996	23	7- 9	7- 9	43	8.0	8 H#10	10.34	8 H#10	10.34	0.347	0.703	0.968
5	2477	25	9- 2	9- 2	49	12.7	9 H#11	14.41	9 H#11	14.41	0.566	0.497	0.982
6	2981	28	11- 0	7- 9	53	13.9	10 H#11	15.52	9 H#11	13.90	0.612	0.853	0.996
7	3447	34	11- 0	10- 2	61	21.1	12 H#10	14.62	12 H#10	14.49	0.667	0.513	0.575
8	3975	32	11- 0	10- 2	54	18.6	14 H#10	18.04	13 H#11	19.94	0.845	0.596	0.991
9	4450	34	11- 0	11- 0	65	24.3	15 H#11	23.35	15 H#11	23.35	1.089	0.437	0.985
10	4951	36	14- 3	10- 2	58	25.9	20 #10	26.14	14 H#11	21.95	1.069	0.727	0.986
11	5463	37	14- 3	10- 2	58	25.9	26 #10	33.21	17 H#11	26.80	1.349	0.915	0.758
12	5959	39	14- 3	11- 0	59	28.5	30 #10	38.71	18 H#11	28.84	1.541	0.996	0.919

Minimum Pile Diameter = 15 in.
spaced at 3′-3″

180-TON STEEL PILES

Edge E = 27″

2	1117	17	7- 9	4- 6	49	5.3	6 H#10	6.57	6 H# 4	N/A	0.140	0.999	N/A
3	1684	24	7- 9	7- 4	47	6.6	3 H#11	4.18	3-WAYS		0.249	0.710	0.934
			2- 7	2-11									
4	2251	24	7- 9	7- 9	44	8.2	7 H#11	10.90	7 H#11	10.90	0.387	0.769	0.948
5	2795	27	9- 2	9- 2	50	13.0	12 H#10	14.80	12 H#10	14.80	0.594	0.547	0.952
6	3362	29	11- 0	7- 9	55	14.5	13 H#10	16.61	12 H#10	14.65	0.633	0.810	0.954
7	3900	36	11- 0	10- 2	59	20.4	11 H#11	16.92	13 H#10	16.08	0.749	0.604	0.650
8	4484	34	11- 0	10- 2	55	19.0	12 H#11	19.23	14 H#11	21.74	0.913	0.658	0.953
9	5024	36	11- 0	11- 0	66	24.6	16 H#11	24.77	16 H#11	24.77	1.162	0.485	0.996
10	5594	38	14- 3	10- 2	57	25.5	23 #10	30.02	16 H#11	25.02	1.226	0.839	0.853
11	6162	40	14- 3	10- 2	60	26.8	27 #10	35.19	18 H#11	27.94	1.412	0.991	0.656

Minimum Pile Diameter = 15 in.
spaced at 3′-3″

200-TON STEEL PILES

Edge E = 27″

2	1242	18	7- 9	4- 6	54	5.8	4 H#11	6.37	6 H# 4	N/A	0.121	0.982	N/A
3	1876	25	7- 9	7- 4	47	6.6	3 H#11	4.61	3-WAYS		0.249	0.790	0.986
			2- 7	2-11									
4	2508	26	7- 9	7- 9	43	8.0	8 H#11	12.17	8 H#11	12.17	0.443	0.883	0.997
5	3114	28	9- 2	9- 2	51	13.2	12 H#10	15.17	12 H#10	15.17	0.594	0.594	0.952
6	3746	31	11- 0	7- 9	55	14.5	12 H#11	18.37	10 H#11	15.89	0.712	0.830	0.985
7	4352	38	11- 0	10- 2	57	19.7	12 H#11	19.23	12 H#11	18.54	0.845	0.702	0.721
8	4996	36	11- 0	10- 2	55	19.0	17 H#10	21.10	15 H#11	23.82	0.999	0.734	0.954
9	5597	38	11- 0	11- 0	67	25.0	16 H#11	25.21	16 H#11	25.21	1.162	0.532	0.995
10	6240	40	14- 3	10- 2	55	24.6	27 #10	34.95	16 H#11	25.26	1.344	0.978	0.940

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 4,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

40-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 15″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Concrete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	246	10	5- 6	2- 6	33	1.4	4 H# 7	2.36	5 H# 4	N/A	0.032	0.914	N/A
3	371	11	5- 6	5- 2	30	2.0	3 H# 7	1.75	3-WAYS		0.061	0.817	0.894
			1- 6	1- 7									
4	494	12	5- 6	5- 6	29	2.7	8 H# 7	4.55	8 H# 7	4.55	0.109	0.920	0.984
5	609	13	6- 9	6- 9	34	4.8	11 H# 7	6.43	11 H# 7	6.43	0.178	0.879	0.638
6	727	14	8- 6	5- 6	43	6.2	11 H# 7	6.48	13 H# 7	7.89	0.197	0.960	0.364
7	848	17	8- 6	7- 9	36	7.3	13 H# 7	7.81	12 H# 7	7.05	0.238	0.830	0.964
8	973	16	8- 6	7- 9	38	7.7	15 H# 7	8.85	16 H# 7	9.41	0.294	0.962	0.687
9	1091	17	8- 6	8- 6	42	9.4	17 H# 7	10.10	17 H# 7	10.10	0.336	0.902	0.725
10	1206	18	11- 6	7- 9	41	11.3	8 #10	10.09	17 H# 7	10.18	0.344	0.544	0.738
11	1336	19	11- 6	7- 9	40	11.0	13 # 9	13.23	20 H# 7	12.33	0.425	0.770	0.966
12	1451	20	11- 6	8- 6	43	13.0	11 #10	14.33	21 H# 7	12.89	0.468	0.985	0.806
13	1552	20	12-11	8- 6	51	17.3	9 #11	14.04	14 # 9	14.23	0.487	0.913	0.674
14	1695	21	11- 6	10- 9	39	14.9	13 #10	16.05	14 #10	17.56	0.616	0.817	0.986
15	1798	22	12-11	11- 6	45	18.7	13 #10	16.27	14 #10	17.62	0.679	0.825	0.986
			5-11	7- 6									
16	1936	23	11- 6	11- 6	42	17.1	16 #10	20.15	16 #10	20.15	0.757	0.993	0.953
17	2046	23	12-11	11- 6	48	19.9	11 #11	17.67	15 #10	19.09	0.718	0.791	0.975
			5-11	7- 6									
18	2158	24	12-11	11- 6	49	22.5	12 #11	18.87	15 #10	19.61	0.751	0.894	0.913
19	2273	24	13- 9	11- 6	50	24.4	17 #10	21.11	17 #10	21.50	0.887	0.902	0.987
20	2379	25	14- 6	11- 6	54	27.8	16 #10	20.91	18 #10	23.01	0.908	0.917	0.827
21	2506	26	13- 9	13- 9	52	28.1	15 #11	23.26	15 #11	23.26	1.056	0.720	0.982
			11- 0	3- 5									
22	2635	26	14- 6	12-11	52	27.8	14 #11	21.85	15 #11	23.71	1.015	0.860	0.982
			10- 6	5-11									
23	2743	27	14- 6	13- 9	54	30.9	16 #11	24.36	16 #11	24.87	1.158	0.654	0.988
			10- 6	6- 9									
24	2864	27	14- 6	13- 9	52	32.0	16 #11	25.27	17 #11	26.19	1.193	0.791	0.958
26	3098	28	15-11	14- 6	53	35.5	20 #11	31.40	17 #11	26.67	1.451	0.817	0.999
			8-11	10- 6									
28	3316	29	15-11	14- 6	58	41.3	19 #11	29.70	19 #11	29.85	1.485	0.648	0.978
30	3540	30	17- 6	14- 6	59	46.2	15 #14	34.48	21 #11	33.32	1.756	0.648	0.848

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 4,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

50-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 15″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Concrete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	310	10	5- 6	2- 6	35	1.5	6 H# 6	2.56	5 H# 4	N/A	0.034	0.969	N/A
3	466	13	5- 6	5- 2	31	2.0	3 H# 7	1.83	3-WAYS		0.061	0.747	0.976
			1- 6	1- 7									
4	620	13	5- 6	5- 6	32	3.0	11 H# 6	4.98	11 H# 6	4.98	0.105	0.679	0.945
5	768	14	6- 9	6- 9	35	4.9	16 H# 6	6.92	16 H# 6	6.92	0.182	0.883	0.734
6	918	16	8- 6	5- 6	44	6.3	13 H# 7	7.60	18 H# 6	8.08	0.214	0.949	0.420
7	1068	19	8- 6	7- 9	39	7.9	14 H# 7	8.65	13 H# 7	7.83	0.257	0.593	0.977
8	1225	18	8- 6	7- 9	41	8.3	16 H# 7	9.78	17 H# 7	10.43	0.313	0.735	0.704
9	1377	19	8- 6	8- 6	43	9.6	19 H# 7	11.41	19 H# 7	11.41	0.375	0.894	0.836
10	1528	20	11- 6	7- 9	40	11.0	13 # 9	13.13	19 H# 7	11.41	0.416	0.657	0.948
11	1681	21	11- 6	7- 9	44	12.1	15 # 9	14.48	22 H# 7	13.40	0.481	0.866	0.957
12	1816	22	11- 6	8- 6	53	16.0	15 # 9	14.77	22 H# 7	13.17	0.498	0.978	0.635
13	1968	23	12-11	8- 6	51	17.3	13 #10	16.63	18 # 8	14.23	0.540	0.999	0.814
14	2136	24	11- 6	10- 9	42	16.0	14 #10	17.95	15 #10	19.46	0.662	0.939	0.983
15	2265	24	12-11	11- 6	50	20.8	12 #11	18.54	16 #10	20.13	0.774	0.579	0.969
			5-11	7- 6									
16	2422	25	11- 6	11- 6	52	21.2	15 #10	19.49	15 #10	19.49	0.710	0.988	0.750
17	2580	26	12-11	11- 6	52	21.6	13 #11	19.80	17 #10	21.16	0.831	0.872	0.999
			5-11	7- 6									
18	2725	27	12-11	11- 6	52	23.8	14 #11	21.81	17 #10	21.16	0.864	0.969	0.850
19	2875	27	13- 9	11- 6	52	25.4	16 #11	25.16	18 #10	22.53	0.989	0.950	0.846
20	3016	28	14- 6	11- 6	55	28.3	16 #11	25.72	20 #10	25.49	1.068	0.890	0.969
21	3160	29	13- 9	13- 9	57	30.8	17 #11	26.01	17 #11	26.01	1.197	0.840	0.992
			11- 0	3- 5									
22	3332	29	14- 6	12-11	54	28.9	16 #11	25.58	17 #11	26.32	1.156	0.871	0.989
			10- 6	5-11									
23	3461	30	14- 6	13- 9	59	33.8	17 #11	27.11	18 #11	27.77	1.266	0.786	0.973
			10- 6	6- 9									
24	3616	31	14- 6	13- 9	56	34.5	18 #11	28.55	19 #11	29.46	1.338	0.875	0.992
26	3904	32	15-11	14- 6	59	39.5	22 #11	33.88	19 #11	30.49	1.608	0.693	0.972
			8-11	10- 6									
28	4212	33	15-11	14- 6	58	41.3	24 #11	37.13	21 #11	32.98	1.764	0.812	0.988
30	4495	34	17- 6	14- 6	60	47.0	19 #14	42.30	24 #11	37.68	2.128	0.801	0.995

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 4,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

60-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 15″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Concrete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	373	10	5- 6	2- 6	40	1.7	5 H# 7	2.86	5 H# 4	N/A	0.039	0.841	N/A
3	562	14	5- 6	5- 2	33	2.2	5 H# 6	2.01	3-WAYS		0.071	0.625	0.986
			1- 6	1- 7									
4	747	14	5- 6	5- 6	34	3.2	9 H# 7	5.40	9 H# 7	5.40	0.123	0.594	0.962
5	928	16	6- 9	6- 9	35	4.9	12 H# 7	7.03	12 H# 7	7.03	0.194	0.937	0.844
6	1109	17	8- 6	5- 6	45	6.5	13 H# 7	7.82	14 H# 7	8.26	0.224	0.973	0.475
7	1288	21	8- 6	7- 9	42	8.5	15 H# 7	9.26	14 H# 7	8.41	0.276	0.462	0.968
8	1483	20	8- 6	7- 9	40	8.1	16 H# 7	9.74	18 H# 7	10.98	0.322	0.893	0.863
9	1665	21	8- 6	8- 6	43	9.6	19 H# 7	11.41	19 H# 7	11.41	0.375	0.977	0.973
10	1845	22	11- 6	7- 9	42	11.6	15 # 9	14.70	21 H# 7	12.69	0.472	0.531	0.994
11	2028	23	11- 6	7- 9	47	12.9	16 # 9	15.82	24 H# 7	14.57	0.518	0.966	0.974
12	2194	24	11- 6	8- 6	56	16.9	16 # 9	15.79	23 H# 7	13.91	0.526	0.439	0.667
13	2362	25	12-11	8- 6	61	20.7	11 #11	17.44	21 # 8	17.02	0.587	0.992	0.435
14	2571	26	11- 6	10- 9	47	17.9	18 # 9	18.32	20 # 9	19.60	0.685	0.998	0.913
15	2740	27	12-11	11- 6	52	21.6	15 #10	19.49	17 #10	21.23	0.803	0.696	0.728
			5-11	7- 6									
16	2929	28	11- 6	11- 6	54	22.0	16 #10	20.92	16 #10	20.92	0.757	0.453	0.807
17	3107	28	12-11	11- 6	58	24.1	14 #11	22.22	17 #10	22.03	0.864	0.998	0.699
			5-11	7- 6									
18	3277	29	12-11	11- 6	60	27.5	15 #11	23.14	19 #10	23.85	0.944	0.999	0.528
19	3458	30	13- 9	11- 6	60	29.3	16 #11	24.86	21 #10	26.73	1.060	0.988	0.630
20	3643	31	14- 6	11- 6	59	30.4	18 #11	28.11	22 #10	27.81	1.190	0.990	0.754
21	3829	31	13- 9	13- 9	58	31.3	18 #11	27.64	18 #11	27.64	1.267	0.998	0.660
			11- 0	3- 5									
22	4016	32	14- 6	12-11	60	32.1	17 #11	26.54	22 #10	28.39	1.220	0.462	0.719
			10- 6	5-11									
23	4189	33	14- 6	13- 9	61	34.9	18 #11	28.29	18 #11	28.93	1.303	0.942	0.960
			10- 6	6- 9									
24	4372	34	14- 6	13- 9	59	36.3	20 #11	31.93	21 #11	32.86	1.483	0.994	0.827
26	4714	35	15-11	14- 6	64	42.8	23 #11	36.45	21 #11	33.67	1.723	0.807	0.972
			8-11	10- 6									
28	5085	36	15-11	14- 6	63	44.9	25 #11	39.86	22 #11	35.31	1.842	0.899	0.987
30	5425	37	17- 6	14- 6	66	51.7	20 #14	44.75	25 #11	39.76	2.230	0.876	0.972

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 4,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 10 in.
spaced at 3′-0″

80-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 21″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Concrete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	495	12	6- 6	3- 6	36	2.5	3 H#10	3.70	5 H# 4	N/A	0.064	0.967	N/A
3	744	16	6- 6 2- 1	6- 2 2- 3	37	3.6	3 H# 9	2.58	3-WAYS		0.130	0.444	0.959
4	992	16	6- 6	6- 6	37	4.8	7 H# 9	7.13	7 H# 9	7.13	0.202	0.441	0.959
5	1235	18	7- 9	7- 9	37	6.9	7 H#10	8.68	7 H#10	8.68	0.304	0.742	0.947
6	1480	20	9- 6	6- 6	45	8.6	9 H# 9	9.21	9 H# 9	9.23	0.306	0.952	0.596
7	1713	24	9- 6	8- 9	47	12.1	8 H#10	10.25	10 H# 9	9.64	0.386	0.353	0.969
8	1978	23	9- 6	8- 9	42	10.8	12 H# 9	11.85	11 H#10	13.42	0.497	0.737	0.980
9	2217	24	9- 6	9- 6	48	13.4	15 H# 9	14.61	15 H# 9	14.61	0.586	0.628	0.981
10	2455	25	12- 6	8- 9	48	16.2	10 #11	15.98	11 H#10	13.84	0.581	0.541	0.956
11	2700	26	12- 6	8- 9	53	17.9	11 #11	17.62	13 H#10	16.27	0.661	0.998	0.651
12	2943	28	12- 6	9- 6	54	19.8	16 #10	20.42	14 H#10	18.31	0.770	0.550	0.907
13	3166	29	13-11	9- 6	61	24.9	13 #11	20.72	18 # 9	18.34	0.739	0.447	0.427
14	3434	30	12- 6	11- 9	51	23.1	17 #10	21.33	18 #10	22.65	0.875	0.776	0.977
15	3683	31	13-11 6- 2	12- 6 8- 1	50	24.2	17 #11	25.83	22 #10	27.99	1.174	0.854	0.998
16	3924	32	12- 6	12- 6	55	26.5	21 #10	26.52	21 #10	26.52	1.084	0.546	0.988
17	4166	33	13-11 6- 2	12- 6 8- 1	59	28.6	17 #11	26.19	21 #10	26.69	1.148	0.435	0.703
18	4402	34	13-11	12- 6	59	31.7	19 #11	28.98	21 #10	26.69	1.219	0.448	0.689
19	4631	35	14- 9	12- 6	63	35.9	19 #11	30.48	24 #10	30.65	1.339	0.457	0.725
20	4856	35	15- 6	12- 6	68	40.7	20 #11	30.75	25 #10	32.56	1.442	0.424	0.733
21	5122	36	14- 9 11- 9	14- 9 3- 7	63	39.0	21 #11	32.24	21 #11	32.24	1.590	0.437	0.712
22	5401	37	15- 6 11- 1	13-11 6- 2	58	35.6	23 #11	36.18	24 #11	37.03	1.772	0.573	0.972
23	5621	38	15- 6 11- 1	14- 9 7- 0	63	41.1	23 #11	35.43	23 #11	36.09	1.787	0.810	0.978
24	5865	39	15- 6	14- 9	61	43.0	25 #11	40.02	26 #11	41.02	1.980	0.984	0.984

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.

** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.

(1) "H"—Use hooked or headed bars.

(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.

(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 4,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 10 in.
spaced at 3′-0″

100-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 21″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Concrete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	622	13	6- 6	3- 6	39	2.7	4 H# 9	4.12	5 H# 4	N/A	0.064	0.979	N/A
3	934	18	6- 6 2- 1	6- 2 2- 3	40	3.9	3 H# 9	2.84	3-WAYS		0.130	0.501	0.949
4	1247	18	6- 6	6- 6	38	5.0	6 H#10	7.39	6 H#10	7.39	0.228	0.535	0.967
5	1551	20	7- 9	7- 9	40	7.4	10 H# 9	9.50	10 H# 9	9.50	0.331	0.612	0.966
6	1863	22	9- 6	6- 6	46	8.8	11 H# 9	10.93	8 H#10	10.32	0.367	0.984	0.993
7	2155	27	9- 6	8- 9	51	13.1	9 H#10	11.24	8 H#10	10.47	0.420	0.401	0.988
8	2480	25	9- 6	8- 9	48	12.3	11 H#10	13.45	11 H#10	14.10	0.542	0.516	0.958
9	2784	27	9- 6	9- 6	53	14.8	13 H#10	16.48	13 H#10	16.48	0.662	0.488	0.966
10	3088	28	12- 6	8- 9	51	17.2	14 #10	18.24	12 H#10	15.66	0.648	0.638	0.843
11	3404	30	12- 6	8- 9	53	17.9	17 #10	21.68	16 H#10	19.78	0.820	0.640	0.683
12	3704	31	12- 6	9- 6	57	20.9	19 #10	23.57	17 H#10	21.08	0.923	0.648	0.987
13	4001	32	13-11	9- 6	60	24.5	17 #11	26.53	19 # 9	18.62	0.897	0.515	0.515
14	4315	33	12- 6	11- 9	56	25.4	18 #10	23.34	19 #10	24.57	0.925	0.587	0.987
15	4614	34	13-11 6- 2	12- 6 8- 1	59	28.6	20 #10	25.69	22 #10	27.51	1.145	0.493	0.695
16	4929	36	12- 6	12- 6	61	29.4	22 #10	28.31	22 #10	28.31	1.136	0.605	0.973
17	5261	37	13-11 6- 2	12- 6 8- 1	57	27.6	22 #11	33.96	22 #10	28.18	1.352	0.575	0.906
18	5561	38	13-11	12- 6	57	30.6	24 #11	37.77	25 #10	31.98	1.501	0.589	0.890
19	5855	39	14- 9	12- 6	61	34.7	25 #11	39.59	26 #10	33.56	1.618	0.601	0.933
20	6144	40	15- 6	12- 6	66	39.5	25 #11	39.67	27 #10	34.19	1.693	0.555	0.932

Minimum Pile Diameter = 12 in.
spaced at 3′-1″

120-TON STEEL PILES

Edge E = 21″

2	748	14	6- 7	3- 6	43	3.1	5 H# 9	4.68	5 H# 4	N/A	0.080	0.953	N/A
3	1125	19	6- 7 2- 1	6- 3 2- 2	42	4.1	3 H#10	3.25	3-WAYS		0.173	0.558	0.949
4	1502	20	6- 7	6- 7	39	5.2	7 H#10	8.40	7 H#10	8.40	0.269	0.613	0.976
5	1866	22	7-11	7-11	43	8.3	11 H# 9	10.59	11 H# 9	10.59	0.371	0.537	0.961
6	2242	24	9- 8	6- 7	48	9.4	10 H#10	12.73	12 H# 9	11.79	0.433	0.971	0.986
7	2593	29	9- 8	8-11	55	14.6	10 H#10	12.44	9 H#10	11.60	0.476	0.431	0.997
8	2985	28	9- 8	8-11	50	13.3	11 H#10	14.40	16 H# 9	15.94	0.581	0.500	0.962
9	3349	29	9- 8	9- 8	57	16.4	14 H#10	18.31	14 H#10	18.31	0.723	0.450	0.980
10	3726	31	12- 9	8-11	50	17.5	18 #10	23.00	15 H#10	19.58	0.837	0.759	0.976
11	4103	33	12- 9	8-11	53	18.6	21 #10	26.59	17 H#10	21.47	0.965	0.757	0.792
12	4467	34	12- 9	9- 8	57	21.7	23 #10	28.89	18 H#10	23.51	1.071	0.767	0.692
13	4826	35	14- 3	9- 8	60	25.5	21 #11	32.75	28 # 8	22.56	1.110	0.595	0.602
14	5192	37	12- 9	12- 0	60	28.3	20 #10	25.87	21 #10	27.00	1.047	0.637	0.994
15	5566	38	14- 3 6- 5	12- 9 8- 3	59	29.9	20 #11	31.38	26 #10	33.53	1.416	0.581	0.802
16	5929	39	12- 9	12- 9	66	33.1	24 #10	31.20	24 #10	31.20	1.265	0.650	0.978

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.

** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.

(1) "H"—Use hooked or headed bars.

(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.

(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 4,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 12 in.
spaced at 3′-1″

140-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 27″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Con-crete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	868	15	7- 7	4- 6	40	4.2	4 H#11	5.47	6 H# 4	N/A	0.119	0.979	N/A
3	1306	21	7- 7 2- 7	7- 2 2-11	42	5.7	3 H#10	3.65	3-WAYS		0.192	0.564	0.990
4	1746	21	7- 7	7- 7	40	7.1	6 H#11	9.37	6 H#11	9.37	0.327	0.598	0.974
5	2168	24	8-11	8-11	45	11.0	8 H#11	12.59	8 H#11	12.59	0.492	0.431	0.952
6	2608	26	10- 8	7- 7	49	12.2	9 H#11	14.16	10 H#10	12.91	0.532	0.836	0.977
7	3011	31	10- 8	9-11	59	19.3	8 H#11	12.82	11 H#10	13.59	0.573	0.414	0.983
8	3476	30	10- 8	9-11	51	16.7	11 H#11	16.38	8 H#14	17.82	0.678	0.497	0.900
9	3897	32	10- 8	10- 8	59	20.7	14 H#11	21.03	14 H#11	21.03	0.992	0.384	0.992
10	4340	33	13- 9	9-11	51	21.5	16 #11	25.65	10 H#14	21.86	0.923	0.773	0.992
11	4786	35	13- 9	9-11	52	21.9	20 #11	31.35	11 H#14	24.77	1.100	0.813	0.931
12	5217	37	13- 9	10- 8	54	24.4	23 #11	35.43	12 H#14	26.78	1.276	0.868	0.841
13	5632	38	15- 3	10- 8	59	29.6	24 #11	38.41	26 # 9	25.97	1.390	0.642	0.698
14	6039	39	13- 9	13- 0	65	35.9	18 #11	28.75	23 #10	29.68	1.252	0.625	0.973

Minimum Pile Diameter = 15 in.
spaced at 3′-3″

160-TON STEEL PILES

Edge E = 27″

2	994	16	7- 9	4- 6	43	4.6	4 H#11	6.01	6 H# 4	N/A	0.121	0.982	N/A
3	1495	22	7- 9 2- 7	7- 4 2-11	44	6.2	3 H#11	4.13	3-WAYS		0.249	0.594	0.994
4	1998	23	7- 9	7- 9	41	7.6	7 H#11	10.67	7 H#11	10.67	0.387	0.649	0.987
5	2481	25	9- 2	9- 2	47	12.2	9 H#11	13.67	9 H#11	13.67	0.566	0.454	0.977
6	2985	28	11- 0	7- 9	51	13.4	7 H#14	16.22	12 H#10	14.63	0.541	0.860	0.977
7	3447	34	11- 0	10- 2	61	21.1	12 H#10	14.54	12 H#10	14.49	0.667	0.444	0.498
8	3979	32	11- 0	10- 2	52	17.9	8 H#14	18.49	14 H#11	21.02	0.799	0.542	0.969
9	4457	34	11- 0	11- 0	62	23.2	10 H#14	22.95	10 H#14	22.95	0.803	0.401	0.989
10	4963	36	14- 3	10- 2	54	24.1	18 #11	28.46	11 H#14	24.17	1.064	0.688	0.979
11	5478	38	14- 3	10- 2	53	23.7	23 #11	36.73	13 H#14	28.95	1.321	0.887	0.990
12	5968	39	14- 3	11- 0	56	27.1	26 #11	40.86	14 H#14	30.84	1.512	0.920	0.878

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

f_c' = 4,000 psi; w = 150 pcf
f_y = 60 ksi
Minimum Pile Diameter = 15 in.
spaced at 3′-3″

180-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
d_c = 10″
Edge E = 27″
See Fig. 13-3

PILES	COLUMN		PILE CAP				REINFORCING BARS					SHEAR	
												$V_u/\phi V_n$	
No. of Piles per cap	Max. Load P_u (net) (kips)	Min. Size * (in.)	Long A ** (ft-in.)	Short B ** (ft-in.)	D (in.)	Con-crete ** (c.y.)	Long A-Bars (1) No.-Size	Min. A_s (2) (in.²)	Short B-Bars (1) No.-Size	Min. A_s (2) (in.²)	Steel Wt. (3) (tons)	Beam One-Way Ratio	Slab Two-Way Ratio
2	1120	17	7- 9	4- 6	45	4.8	4 H#11	6.35	6 H# 4	N/A	0.121	0.993	N/A
3	1686	24	7- 9 2- 7	7- 4 2-11	45	6.3	3 H#11	4.40	3-WAYS		0.249	0.650	0.935
4	2253	24	7- 9	7- 9	42	7.8	9 H#10	11.51	9 H#10	11.51	0.390	0.708	0.961
5	2799	27	9- 2	9- 2	48	12.4	9 H#11	14.04	9 H#11	14.04	0.566	0.499	0.943
6	3367	30	11- 0	7- 9	52	13.7	8 H#14	17.66	10 H#11	15.62	0.598	0.832	0.945
7	3900	36	11- 0	10- 2	59	20.4	11 H#11	16.81	10 H#11	16.01	0.740	0.523	0.563
8	4491	34	11- 0	10- 2	52	17.9	9 H#14	20.58	15 H#11	23.41	0.873	0.612	0.986
9	5031	36	11- 0	11- 0	63	23.5	15 H#11	23.45	15 H#11	23.45	1.089	0.445	0.997
10	5594	38	14- 3	10- 2	57	25.5	19 #11	29.56	11 H#14	25.00	1.101	0.727	0.739
11	6176	40	14- 3	10- 2	55	24.6	25 #11	39.02	14 H#14	30.59	1.431	0.955	0.731

Minimum Pile Diameter = 15 in.
spaced at 3′-3″

200-TON STEEL PILES

Edge E = 27″

2	1246	18	7- 9	4- 6	48	5.2	6 H#10	6.91	6 H# 4	N/A	0.140	0.999	N/A
3	1878	25	7- 9 2- 7	7- 4 2-11	45	6.3	3 H#11	4.54	3-WAYS		0.249	0.723	0.987
4	2509	26	7- 9	7- 9	42	7.8	8 H#11	12.50	8 H#11	12.50	0.443	0.789	0.935
5	3117	28	9- 2	9- 2	49	12.7	10 H#11	14.79	10 H#11	14.79	0.629	0.542	0.939
6	3749	31	11- 0	7- 9	53	13.9	12 H#11	19.05	11 H#11	16.59	0.740	0.828	0.945
7	4352	38	11- 0	10- 2	57	19.7	12 H#11	19.16	8 H#14	18.47	0.731	0.608	0.624
8	5003	36	11- 0	10- 2	52	17.9	10 H#14	22.60	16 H#11	25.72	0.947	0.682	0.986
9	5605	38	11- 0	11- 0	64	23.9	15 H#11	23.89	15 H#11	23.89	1.089	0.487	0.992
10	6240	40	14- 3	10- 2	55	24.6	22 #11	34.28	11 H#14	25.21	1.210	0.847	0.814

* Concrete columns—side dimension of square column. Structural steel columns, b or t + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of A_s; (4/3)A_s; 0.0033 bd; 0.0018 bh.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

SUMMARY OF DERIVATIONS AND DESIGN PROCEDURES FOR DRILLED PIER (CAISSON) LOAD TABLES

ACI 318-08

Section 22.8.3 Maximum stress (due to factored axial load) on unreinforced pedestals ≤ permissible bearing stress (design bearing strength of ACI 22.5.5).

Section 15.8.1.1 Bearing stress ≤ permissible bearing stress (design bearing strength of ACI 10.14).

Section 9.3.2.2 Strength-reduction factor, $\phi = 0.65$

Section 10.14.1 Permissible (design) bearing stress ≤ $0.85\phi f'_c A_1\sqrt{A_2/A_1} \le (2)(0.85\phi f'_c)$ where $\sqrt{A_2/A_1} \le 2$, A_1 = loaded area, and supporting surface area, $A_2 \ge 4$ times (concentric) A_1.

Section 15.8.1.1 Permissible (design) bearing stress on pedestal = $0.85\phi f'_c = (0.85)(0.65)f'_c = 0.553f'_c$ assuming column or effective size of structural steel base plate is the same as shaft size.

International Building Code (Section 1810.1.2)

1. Minimum longitudinal reinforcement for axial loads: 0.0025 (Seismic Design Category C); 0.0050 (SDC D, E, or F).

2. Maximum allowable axial stress in concrete, f_c: $0.25f'_c$ for enlarged base piles and driven uncased piles; $0.33f'_c$ for drilled or augered uncased piles, caisson piles and micropiles. Both maximum limits are presented so that either may be selected ($0.33f'_c$ was conservatively rounded down to $0.30f'_c$).

3. Minimum of four longitudinal bars.

4. Maximum tie spacing: 16 longitudinal bar diameters (SDC C), 12 longitudinal bar diameters or one-half pile diameter or 12 inches, whichever is smallest (SDC D, E, or F).

Dimensional Proportions Recommended

1. Extend longitudinal reinforcement at minimum 10′-0″ ≥ 3*d*,* to provide for disturbed soil causing reduced lateral resistance at top.

2. Minimum edge of bell thickness = 12 in.

3. Minimum angle for slope of bell to horizontal = 60º.

4. Specified concrete cover to lateral ties = 3 in. (ACI 7.7.1-a).

*d is the diameter of the shaft (see Fig. 13-16).

USE OF DRILLED PIER (CAISSON) TABLES

Example 1

An interior column resists a factored load, P_u, of 2,000 kips. A rock stratum approximately 75 feet below the surface has been permitted a service load bearing value of 20,000 psf under the local building code (which has been verified by load tests). Test borings indicate feasibility of belled bottom, unlined holes, and the presence of lateral support for the full depth. Select from the tabulated designs and provide a quantity estimate of materials. Assume that $f_c = 0.30f'_c$.

Solution.

Service load, $P = \frac{P_u}{1.6} = \frac{2{,}000}{1.6} = 1{,}250$ kips

Enter "Shaft Maximum Allowable Axial Load" table with 1,250 kips and read under "$f_c = 0.30f'_c$:"

for f'_c = 3000 psi, the diameter required = 3′-6″
for f'_c = 4000 psi, the diameter required = 3′-6″
for f'_c = 5000 psi, the diameter required = 3′-0″
for f'_c = 6000 psi, the diameter required = 2′-6″

Enter "Bell Safe Bearing Load" table with P = 1,250 kips and p = 20,000 psf and read; bell diameter required = 9′-0″.

In the tabulated designs, note that the minimum shaft size recommended with a 9′-0″ bell is 3′-0″ diameter. Compare quantities for concrete with f'_c = 3,000 psi and f'_c = 5,000 psi. See table of Concrete Quantities. Read:

9′-0″ Bell + 3′-0″ Shaft: 179 + (7.07 × 75) = 709 cubic feet

9′-0″ Bell + 3′-6″ Shaft: 164 + (9.62 × 75) = 886 cubic feet

See table of minimum reinforcement:

Shaft dia. = 3′-0″: 215 pounds

Shaft dia. = 3′-6″: 278 pounds

Example 2

Same as Example 1, but assume that an intermediate stratum of soil does not provide lateral support. This stratum begins approximately 20 feet below the surface and extends 10 feet deeper (total depth to bottom = 30 feet). This soil stratum will also require a casing (which will not be considered in design calculations) (Section 3.7.3, Reference 2). The shaft must be designed for an unbraced length of 10 feet plus 2*d* (Section 3.7.5, Reference 2). Since this length will exceed 3*d* (plain concrete pedestals), the shaft will be designed as a rein-

forced concrete column with minimum longitudinal reinforcement (percentage of reinforcement ≥ 0.01). Use f'_c = 5,000 psi. See round-tied column tabulated designs, Page 4-24. Select a column at least 3 inches less in diameter than the drilled shaft (even multiples of 6 inches) to allow for 3 inches of concrete cover instead of 1½ inches in portion below casing. For P_u = 2,000 kips, read for a 32-inch diameter column, with 6-#11 bars; maximum design axial strength is 2,049 kips (percentage of reinforcement = 1.16). Check for slenderness effects. See Fig. 13-15.

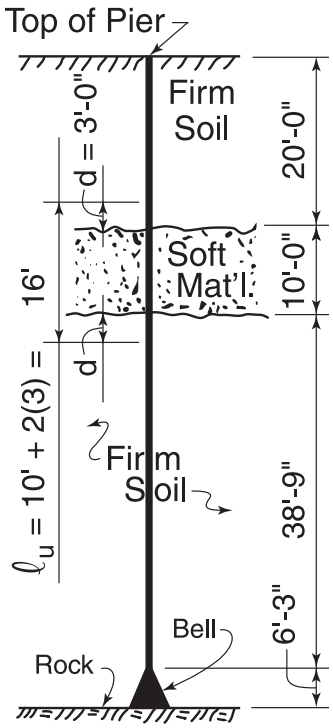


Figure 13-15 Example 3

For a 32-inch shaft diameter, slenderness effects will have to be considered. Thus, try a 36-inch shaft diameter:

Unbraced length, ℓ_u = (10 × 12) + 2(36) = 192 in.

For columns braced against sidesway, take k = 1.0 (ACI 10.10.6.3).

Compute $\frac{k\ell_u}{r} = \frac{1.0(192)}{0.25(36)} = 21.3$

Compare $\frac{k\ell_u}{r}$ vs. 34 – 12 M_1/M_2 (ACI 10.10.1)

34 – 12 M_1/M_2 = 34 – 12 (0)/(0) = 22

$\frac{k\ell_u}{r}$ = 21.3 < 22, neglect slenderness

Use a shaft diameter of 3′-0″ with a bell diameter of 9′-0″; 6-#11 bars × 36′-0″ and #4 ties spaced at 18 in.; with f'_c = 5,000 psi specified.

Quantities: See tabulated designs.

5,000 psi concrete: [(7.07)(75) + 179]/27 = 26 cubic yards

Reinforcing steel:

Longitudinal bars: (6)(5.313)(36) = 1,148 pounds
Ties: (24)(0.668)(π 32 + 24)/12 = 166 pounds
Total = 1,314 pounds

References

(1) 2006 International Building Code, International Code Council, Washington, D.C.
(2) "Design and Construction of Drilled Piers (ACI 336.3R-93, Reapproved 2006)" American Concrete Institute, Farmington Hills, Michigan.

Shaft Diameter (ft-in.)	Shaft Area (in.²)	SHAFT MAXIMUM ALLOWABLE AXIAL LOAD—KIPS*							
		$f_c = 0.25f'_c$				$f_c = 0.30f'_c$			
		f'_c = 3,000 psi	f'_c = 4,000 psi	f'_c = 5,000 psi	f'_c = 6,000 psi	f'_c = 3,000 psi	f'_c = 4,000 psi	f'_c = 5,000 psi	f'_c = 6,000 psi
1-6	254	191	254	318	382	229	305	382	458
2-0	452	339	452	565	679	407	543	679	814
2-6	707	530	707	884	1060	636	848	1060	1272
3-0	1018	763	1018	1272	1527	916	1221	1527	1832
3-6	1385	1039	1385	1732	2078	1247	1663	2078	2494
4-0	1810	1357	1810	2262	2714	1629	2171	2714	3257
4-6	2290	1718	2290	2863	3435	2061	2748	3435	4122
5-0	2827	2121	2827	3534	4241	2545	3393	4241	5089
5-6	3421	2566	3421	4276	5132	3079	4105	5132	6158
6-0	4072	3054	4072	5089	6107	3664	4886	6107	7329
6-6	4778	3584	4778	5973	7168	4301	5734	7168	8601
7-0	5542	4156	5542	6927	8313	4988	6650	8313	9975

* For shafts designed as plain concrete piers, laterally braced by soil.

Bell Diameter (ft-in)	Bearing Area (ft²)	BELL SAFE BEARING LOAD—KIPS**					
		10,000 psf**	12,000 psf**	15,000 psf**	20,000 psf**	25,000 psf**	30,000 psf**
1-6	1.77	18	21	27	35	44	53
2-0	3.14	31	38	47	63	79	94
2-6	4.91	49	59	74	98	123	147
3-0	7.07	71	85	106	141	177	212
3-6	9.62	96	115	144	192	241	289
4-0	12.57	126	151	188	251	314	377
4-6	15.90	159	191	239	318	398	477
5-0	19.63	196	236	295	393	491	589
5-6	23.76	238	285	356	475	594	713
6-0	28.27	283	339	424	565	707	848
6-6	33.18	332	398	498	664	830	995
7-0	38.48	385	462	557	770	962	1155
7-6	44.18	442	530	663	884	1104	1325
8-0	50.27	503	603	754	1005	1257	1508
8-6	56.75	567	681	851	1135	1419	1702
9-0	63.62	636	763	954	1272	1590	1909
9-6	70.88	709	851	1063	1418	1772	2126
10-0	78.54	785	942	1178	1571	1963	2356
10-6	86.59	866	1039	1299	1732	2165	2598
11-0	95.03	950	1140	1425	1901	2376	2851
11-6	103.87	1039	1246	1558	2077	2597	3116
12-0	113.10	1131	1357	1696	2262	2827	3393
12-6	122.72	1227	1473	1841	2454	3068	3682
13-0	132.73	1327	1593	1991	2655	3318	3982
13-6	143.14	1431	1718	2147	2863	3578	4294
14-0	153.94	1539	1847	2309	3079	3848	4618
14-6	165.13	1651	1982	2477	3303	4128	4954
15-0	176.71	1767	2121	2651	3534	4418	5301
15-6	188.69	1887	2264	2830	3774	4717	5661
16-0	201.06	2011	2413	3016	4021	5027	6032
16-6	213.82	2138	2566	3207	4276	5346	6415
17-0	226.98	2270	2724	3405	4540	5675	6809
17-6	240.53	2405	2886	3608	4811	6013	7216
18-0	254.47	2545	3054	3817	5089	6362	7634
18-6	268.80	2688	3226	4032	5376	6720	8064
19-0	283.53	2835	3402	4253	5671	7088	8506
19-6	298.65	2986	3584	4480	5973	7466	8959
20-0	314.16	3142	3770	4712	6283	7854	9425
20-6	330.06	3301	3961	4951	6601	8252	9902
21-0	346.36	3464	4156	5195	6927	8659	10391

** As permitted by statutory building code or established by accepted tests.

DRILLED PIER—SHAFT & BELL—CONCRETE QUANTITIES

Bell			Bell			Bell		
Diameter (ft-in.)	Volume (c.f.)	Height (ft)	Diameter (ft-in.)	Volume (c.f.)	Height (ft)	Diameter (ft-in.)	Volume (c.f.)	Height (ft)
Shaft	Diameter d = 1′-6″ Volume = 1.77 cf/ft		Shaft	Diameter d = 4′-0″ Volume = 12.57 cf/ft		Shaft	Diameter d = 5′-6″ Volume = 23.76 cf/ft	
2-0	2	1.43	4-6	4	1.43	6-0	5	1.43
2-6	4	1.87	5-0	10	1.87	6-6	13	1.87
3-0	8	2.30	5-6	18	2.30	7-0	24	2.30
3-6	14	2.73	6-0	28	2.73	7-6	37	2.73
4-0	21	3.17	6-6	41	3.17	8-0	53	3.17
4-6	29	3.60	7-0	57	3.60	8-6	73	3.60
Shaft	Diameter d = 2′-0″ Volume = 3.14 cf/ft		7-6	75	4.03	9-0	95	4.03
2-6	2	1.43	8-0	96	4.46	9-6	121	4.46
3-0	6	1.87	8-6	120	4.90	10-0	151	4.90
3-6	10	2.30	9-0	147	5.33	10-6	185	5.33
4-0	17	2.73	9-6	178	5.76	11-0	222	5.76
4-6	25	3.17	10-0	213	6.20	11-6	264	6.20
5-0	35	3.60	10-6	251	6.63	12-0	310	6.63
5-6	47	4.03	11-0	294	7.06	12-6	360	7.06
6-0	61	4.46	11-6	340	7.50	13-0	415	7.50
Shaft	Diameter d = 2′-6″ Volume = 4.91 cf/ft		12-0	391	7.93	13-6	475	7.93
3-0	3	1.43	Shaft	Diameter d = 4′-6″ Volume = 15.90 cf/ft		14-0	540	8.36
3-6	7	1.87	5-0	5	1.43	14-6	610	8.79
4-0	12	2.30	5-6	11	1.87	15-0	685	9.23
4-6	20	2.73	6-0	20	2.30	15-6	766	9.66
5-0	29	3.17	6-6	31	2.73	16-0	852	10.09
5-6	40	3.60	7-0	45	3.17	16-6	944	10.53
6-0	54	4.03	7-6	62	3.60	Shaft	Diameter d = 6′-0″ Volume = 28.27 cf/ft	
6-6	70	4.46	8-0	82	4.03	6-5	6	1.43
7-0	89	4.90	8-6	104	4.46	7-0	15	1.87
7-6	110	5.33	9-0	130	4.90	7-6	26	2.30
Shaft	Diameter d = 3′-0″ Volume = 7.07 cf/ft		9-6	160	5.33	8-0	40	2.73
4-0	8	1.87	10-0	193	5.76	8-6	58	3.17
4-6	14	2.30	10-6	230	6.20	9-0	78	3.60
5-0	23	2.73	11-0	271	6.63	9-6	102	4.03
5-6	33	3.17	11-6	316	7.06	10-0	130	4.46
6-0	46	3.60	12-0	365	7.50	10-6	162	4.90
6-6	61	4.03	12-6	419	7.93	11-0	197	5.33
7-0	79	4.46	13-0	477	8.36	11-6	237	5.76
7-6	99	4.90	13-6	540	8.79	12-0	281	6.20
8-0	123	5.33	Shaft	Diameter d = 5′-0″ Volume = 19.63 cf/ft		12-6	329	6.63
8-6	149	5.76	5-5	5	1.43	13-0	382	7.06
9-0	179	6.20	6-0	12	1.87	13-6	440	7.50
Shaft	Diameter d = 3′-6″ Volume = 9.62 cf/ft		6-6	22	2.30	14-0	503	7.93
4-6	9	1.87	7-0	34	2.73	14-6	571	8.36
5-0	16	2.30	7-6	49	3.17	15-0	644	8.79
5-6	25	2.73	8-0	67	3.60	15-6	723	9.23
6-0	37	3.17	8-6	88	4.03	16-0	808	9.66
6-6	51	3.60	9-0	113	4.46	16-6	898	10.09
7-0	68	4.03	9-6	141	4.90	17-0	994	10.53
7-6	87	4.46	10-0	172	5.33	17-6	1097	10.96
8-0	110	4.90	10-6	208	5.76	18-0	1206	11.39
8-6	135	5.33	11-0	247	6.20			
9-0	164	5.76	11-6	290	6.63			
9-6	196	6.20	12-0	338	7.06			
10-0	232	6.63	12-6	390	7.50			
10-6	271	7.06	13-0	447	7.93			
			13-6	508	8.36			
			14-0	575	8.79			
			14-6	647	9.23			
			15-0	724	9.66			

DRILLED PIER—SHAFT & BELL—CONCRETE QUANTITIES . . . (CONT.)

Bell		
Diameter (ft-in.)	Volume (c.f.)	Height (ft)
Shaft	Diameter d = 6′-6″ Volume = 33.18 cf/ft	
7-0	6	1.43
7-6	16	1.87
8-0	28	2.30
8-6	43	2.73
9-0	62	3.17
9-6	84	3.60
10-0	109	4.03
10-6	139	4.46
11-0	172	4.90
11-6	210	5.33
12-0	251	5.76
12-6	298	6.20
13-0	349	6.63
13-6	404	7.06
14-0	465	7.50
14-6	531	7.93
15-0	602	8.36
15-6	679	8.79
16-0	761	9.23
16-6	849	9.66
17-0	944	10.09
17-6	1044	10.53
18-0	1151	10.96
18-6	1264	11.39
19-0	1384	11.83
19-6	1511	12.26
Shaft	Diameter d = 7′-0″ Volume = 38.48 cf/ft	
7-6	7	1.43
8-0	17	1.87
8-6	30	2.30
9-0	46	2.73
9-6	66	3.17
10-0	89	3.60
10-6	116	4.03
11-0	147	4.46
11-6	182	4.90
12-0	222	5.33
12-6	266	5.76
13-0	315	6.20
13-6	368	6.63
14-0	427	7.06
14-6	490	7.50
15-0	559	7.93
15-6	633	8.36
16-0	714	8.79
16-6	799	9.23
17-0	891	9.66
17-6	989	10.09
18-0	1094	10.53
18-6	1205	10.96
19-0	1322	11.39
19-6	1447	11.83
20-0	1578	12.26
20-6	1717	12.69
21-0	1863	13.12

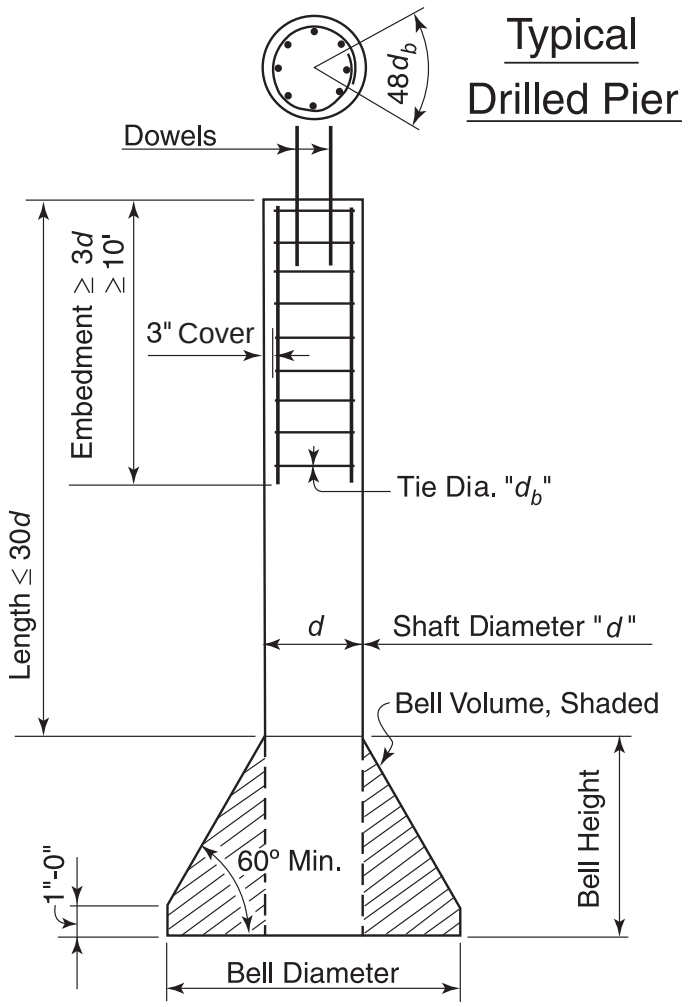


Figure 13-16 Recommended Minimum Proportions and Reinforcement Details (Percentage of Reinforcement ≈ 0.005) for Unlined Drilled Piers Designed as Plain Concrete

DRILLED PIER—REINFORCEMENT

Shaft Diameter (ft-in.)	Number, Sizes, Spacing		Total Weight (lbs) per Pier*		
d	Vertical	Ties**	Vertical	Ties**	Total
1′-6″	6-#5	#3 @ 10″	63	20	83
2′-0″	6-#6	#3 @ 12″	90	23	113
2′-6″	6-#7	#3 @ 14″	123	26	149
3′-0″	7-#8	#3 @ 16″	187	28	215
3′-6″	7-#9	#3 @ 18″	250	28	278
4′-0″	7-#10	#4 @ 18″	361	69	430
4′-6″	9-#10	#4 @ 18″	523	87	610
5′-0″	9-#11	#4 @ 18″	717	107	824
5′-6″	11-#11	#4 @ 18″	964	129	1093
6′-0″	13-#11	#4 @ 18″	1243	153	1397
6′-6″	16-#11	#4 @ 18″	1658	180	1838
7′-0″	18-#11	#4 @ 18″	2008	208	2217

* Total weights for minimum embedment. See Fig. 13-16.
** Begin first tie 2 inches below top.

CHAPTER 14 – CANTILEVERED RETAINING WALLS

INTRODUCTION

General. The tabulated designs in this Chapter give complete dimensions and reinforcement details for cantilevered retaining walls varying from 3 to 22 feet in height above the top of footing, for two backfill conditions: level backfill and no surcharge,† and backfill sloping upward. The tabulated designs show base pressures on the earth at the heel and toe, factors of safety against sliding and overturning and calculated deflection at the top. Various soil properties and backfill conditions considered are listed in Table 14-1.

† Instead of a fixed surcharge, AASHTO recommends 2 feet of added depth of fill for walls as the equivalent loading for a normal highway surcharge. It should usually be satisfactory to select a design tabulated for 2 feet added to actual height, and to reduce reinforcement and concrete quantities for the amounts that would have been required in the top 2 feet.

The backfill material actually used in retaining wall construction will often differ from that assumed for purposes of design. The resulting differences in forces can be considerable and as a result the retaining wall could be under-designed. The determination of pressures for the actual soil conditions, allowable soil pressures, influence of foundation on under lying strata, and similar matters of judgement require consideration by an engineer familiar with soil mechanics.

TABLE 14-1 SOIL PROPERTIES AND BACKFILL CONDITIONS USED IN TABULATED DESIGNS

Backfill Condition	Internal Friction Angle, ϕ	Backfill Density, γ	Sliding Friction Coefficient, μ
Level	30°, 35°, 40°	115, 130 pcf	0.45, 0.55
Sloping*	30°, 35°, 40°,	115, 130 pcf	0.45, 0.55

*Backfill slope, β, set equal to soil angle of internal friction, ϕ

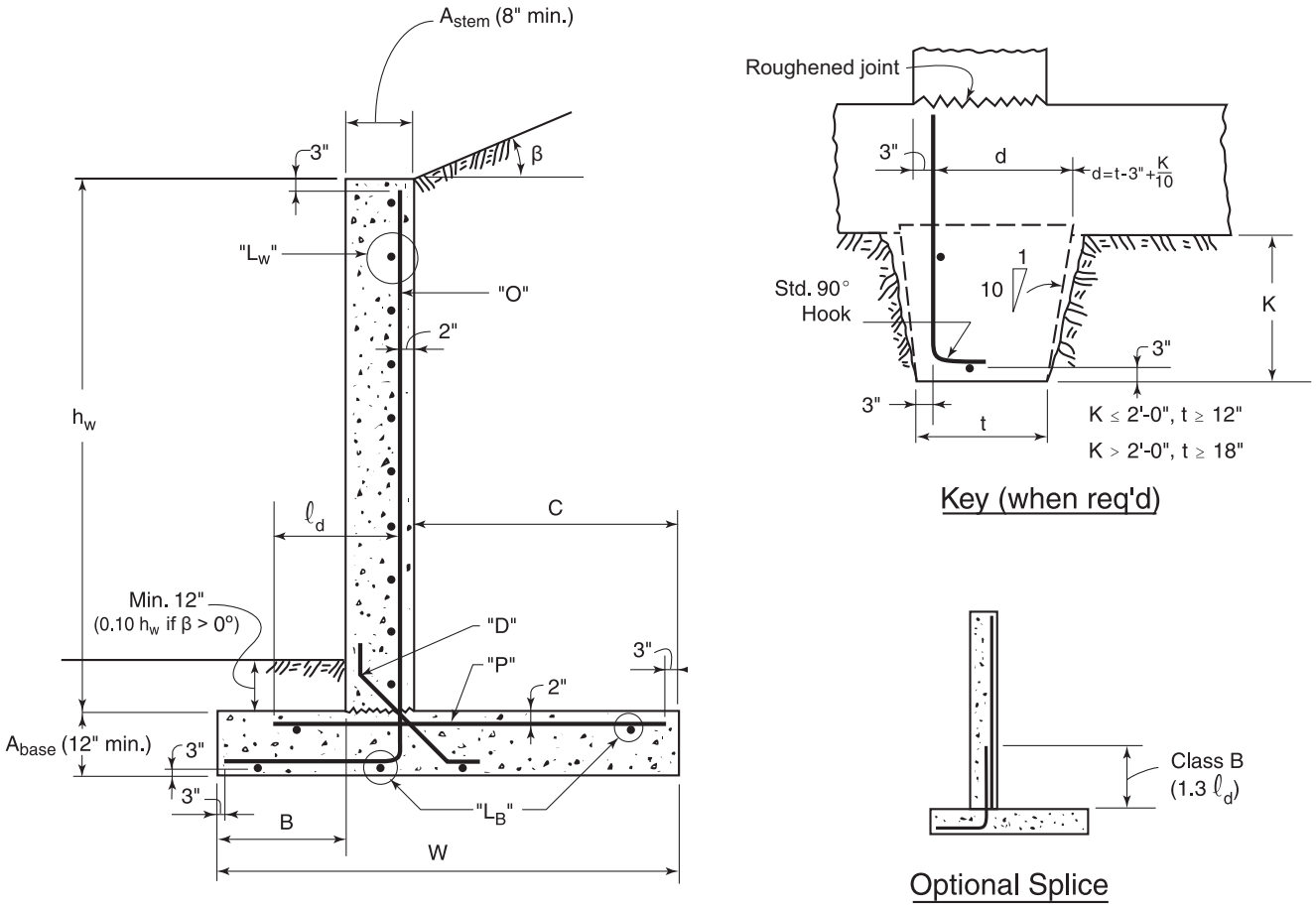


Figure 14-1 Notation for Dimensions and Reinforcement for Wall Heights ≤ 10′

The importance of drainage behind a wall cannot be overemphasized. Weep holes through the vertical stem at intervals of about 10 feet, located near the base of the wall at the exterior grade level, and a French drain of gravel, crushed stone, or equivalent, a foot or so thick, for most of the height at the back of the wall are desirable. It is also usually desirable to provide weakened plane contraction joints at intervals of about 25 feet and keyed expansion joints about every fourth contraction joint. The exact spacing will depend upon the climate, exposure, and similar factors. Weakened plane joints are made either with suitable rubber strips placed vertically full height in each face of the wall and left there or with wood strips similarly placed but eventually removed and the resulting slot filled with mastic caulking. Alternate longitudinal bars, at least, should be cut exactly opposite such weakened plane joints.

The tabulated designs in this Chapter provide for stability under service loads against overturning about a point at the toe of the footing. The minimum factor of safety against overturning under service loads is 2.0. The minimum factor of safety against horizontal sliding is 1.5. See Figs. 14-1, 14-2 and 14-3. For tall walls, it is recommended that the user provide for stability against a sliding circle failure based upon properties of the underlying soil and the actual backfill material. When keys are not feasible or where the sliding circle analysis requires additional precautions for soil-loading combinations outside the scope of the tabulated designs, some alternate wall geometries are suggested. See Fig. 14-4.

The use of a key usually adds costs for separate excavation, formwork, or concreting operations—sometimes all three. Some engineers question the effectiveness of keys unless they are cast against near-vertical undisturbed soil.

The tabulated designs were proportioned to obtain the most economical design. Three different wall configurations were investigated:

1. Length of base was varied from 0.40 h_w to 1.0 h_w while the stem and base thicknesses were varied up to 24 inches with no key.

2. Length of base was varied from 0.67 h_w to 1.0 h_w while key depth was varied from 16 to 60 inches and the stem and base thicknesses were varied up to 50 inches.

3. Key depth was varied from 16 to 60 inches while the base length was varied from 1.0 h_w to 1.5 h_w and the base and stem thicknesses were varied up to 60 inches.

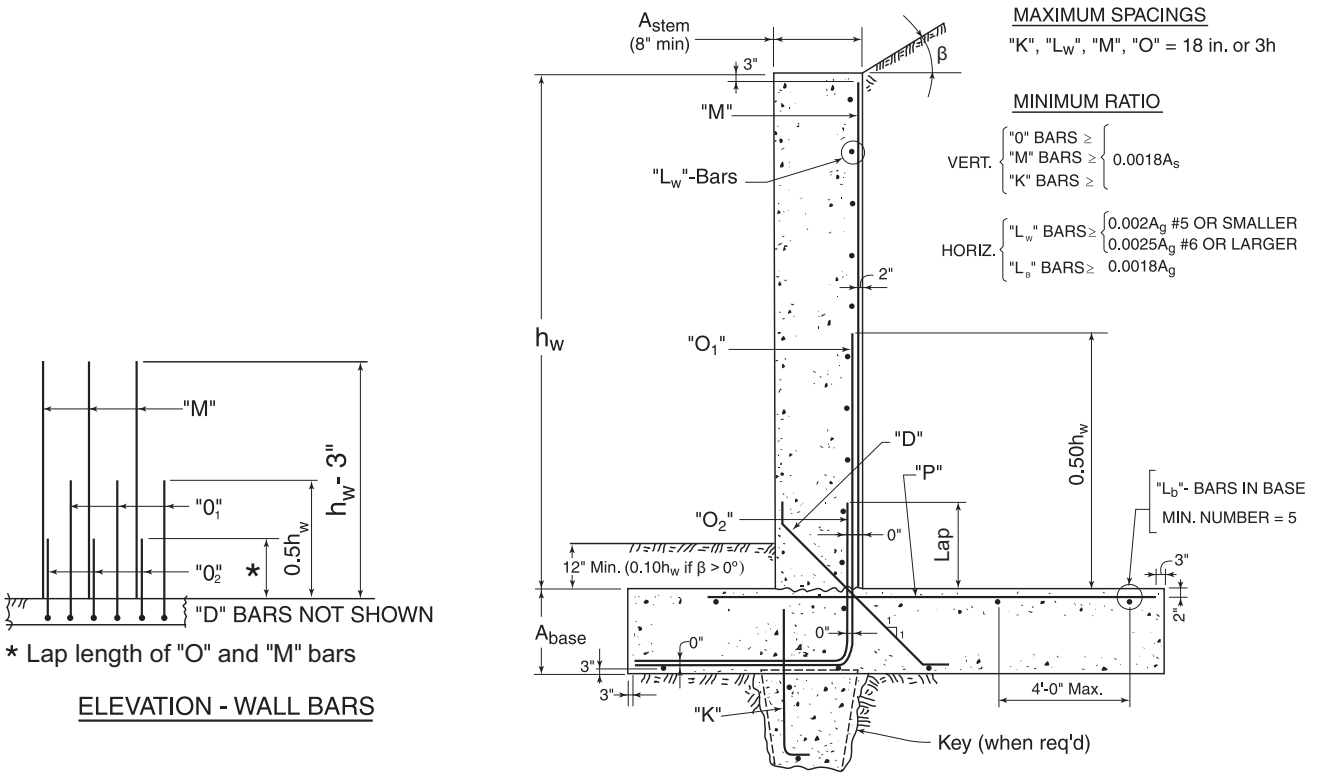


Figure 14-2 Notation for Dimensions and Reinforcement for Wall Heights > 10'

In the case where, for a specific wall height, any of the design requirements (i.e., factor of safety against sliding or overturning, deflection at the top of the wall) could not be met regardless what dimensions were tried, the computer program used to develop the tabulated designs skipped this wall height and stops. For example, on Page 14-35 for a sloping backfill with γ = 115 pcf, ϕ = 30°, and μ = 0.45, the tabulated designs stop at 18 feet. This stoppage occurs because, for any wall height greater than 18 feet with these soil properties, no dimensions for wall, base, and key could be found to satisfy all design requirements.

When the subsoil conditions are too unstable to permit trenching to the tabulated depths for keys with near-vertical sides which would serve as forms, the sides should be formed or the retaining wall should be redesigned. It may also be necessary to redesign when the actual soil can not be relied upon to develop the coefficient of friction used. Conversely, local conditions may require additional depth of front fill to protect the base against frost.

Based on local conditions, there are at least three options:

1. When frost protection is not required, the base slab and heel may be widened (to increase weight above and friction resistance). A key may be added or deepened. See Fig. 14-4 (a).

2. When the base is to be located below a frost line, the key may be eliminated or a shallower key may suffice because of the passive resistance of the soil at the toe. See Fig. 14-4 (b) and (c).

3. When the soil has a very low friction coefficient, or for some clay subsoils where cohesion is low or unreliable, and the required depth of key is impracticable, the base may be supported on battered piles.

Soil Data and Assumed Properties. Three different soil internal friction angles, two soil densities, and two sliding friction coefficients were used in the tabulated designs. See Table 14-1.

Rankine formulas were used to determine the soil pressures on the retaining wall. At a depth *h*, the active and passive earth pressures are, respectively:

$$P_a = K_a\,(h)\,\gamma$$
$$P_p = K_p\,(h)\,\gamma$$

where $K_a = \cos\beta\left[\dfrac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}\right] (\beta \neq 0^\circ)$

$= \tan^2(45^\circ - \phi/2)\ (\beta = 0^\circ)$

$K_p = \tan^2(45^\circ + \phi/2)$

To facilitate manual calculations, Table 14-2a lists various active and passive pressure coefficients, based on the Rankine formulas. Note that frontfill is conservatively assumed to be level.

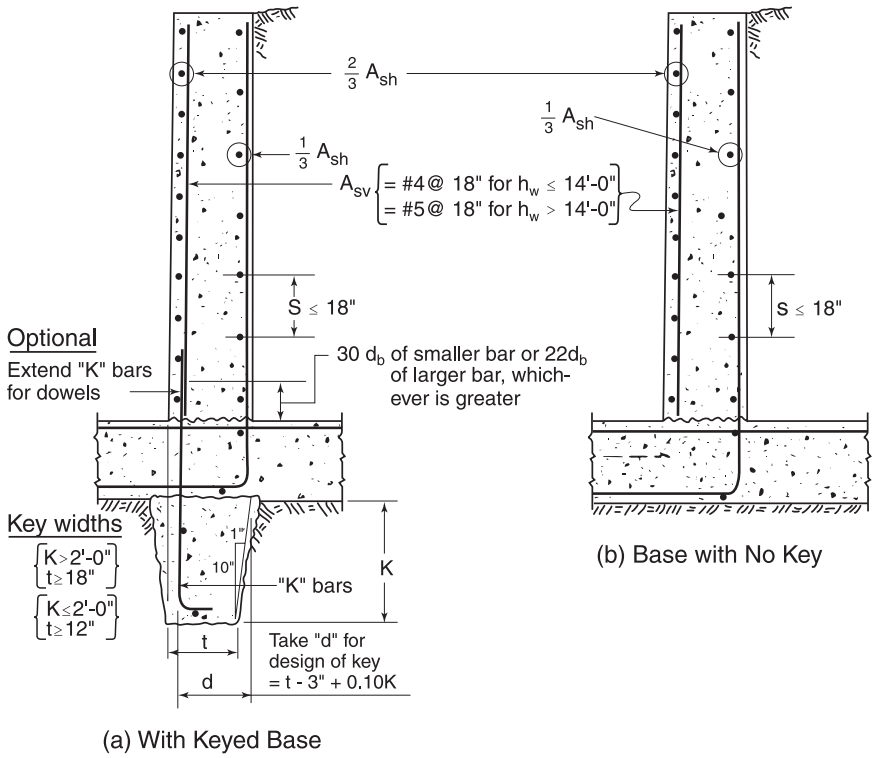


Figure 14-3 Shrinkage and Temperature Bars in Exposed Face (When Used)

TABLE 14-2a ACTIVE AND PASSIVE PRESSURE COEFFICIENTS (RANKINE)

Internal Friction Angle, ϕ (deg)	Active pressure Coefficient, K_a, for Various Backfill Angles (deg)										Passive Pressure Coefficient, K_p
	0	5	10	15	20	25	30	35	40	45	
5	0.8397	0.9962	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.1910
10	0.7041	0.7352	0.9848	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.4203
15	0.5888	0.6046	0.6636	0.9659	N/A	N/A	N/A	N/A	N/A	N/A	1.6984
20	0.4903	0.4996	0.5312	0.6028	0.9397	N/A	N/A	N/A	N/A	N/A	2.0396
25	0.4059	0.4117	0.4309	0.4695	0.5469	0.9063	N/A	N/A	N/A	N/A	2.4639
30	0.3333	0.3372	0.3495	0.3729	0.4142	0.4936	0.8660	N/A	N/A	N/A	3.0000
35	0.2710	0.2736	0.2818	0.2968	0.3216	0.3631	0.4416	0.8192	N/A	N/A	3.6902
40	0.2174	0.2192	0.2247	0.2346	0.2504	0.2750	0.3151	0.3906	0.7660	N/A	4.5989
45	0.1716	0.1716	0.1765	0.1831	0.1934	0.2088	0.2321	0.2695	0.3404	0.7071	5.8284

TABLE 14-2b EQUIVALENT ACTIVE AND PASSIVE FLUID PRESSURES FOR SOILS IN THE TABULATED DESIGNS

Unit Density, γ (pcf)	Internal Friction Angle, ϕ	Active Fluid Pressure, γ_a (pcf)				Passive Fluid Pressure γ_p (pcf)
		$\beta = 0°$	$\beta = \phi$			
			γ_a	$\gamma_a \cos\phi$	$\gamma_a \sin\phi$	
115	30°	38	100	87	50	345
115	35°	31	94	77	54	424
115	40°	25	88	67	57	529
130	30°	43	113	98	56	390
130	35°	35	106	87	61	480
130	40°	28	100	77	64	598

In some cases, the equivalent fluid pressure of the soil can be determined, but the soil's internal angle of friction, ϕ, and its unit density, γ, will be unknown. The equivalent soil fluid pressures are defined as:

γ_a = Active fluid pressure = $K_a\,\gamma$
γ_p = Passive fluid pressure = $K_p\,\gamma$

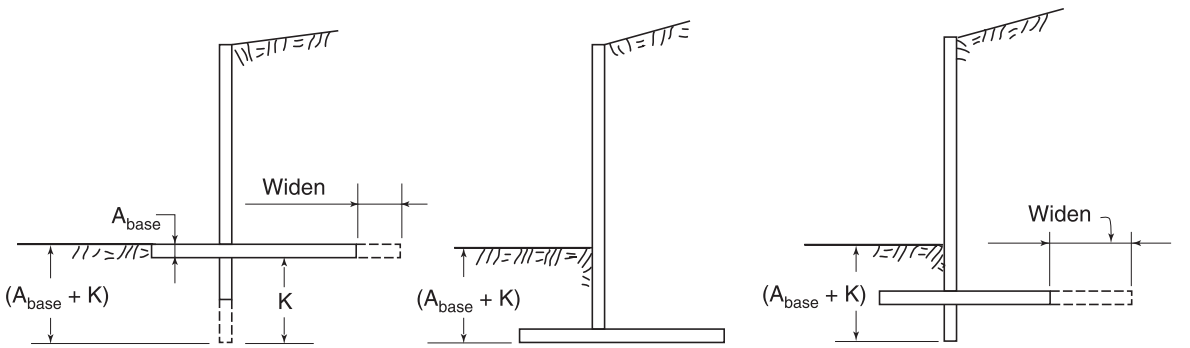
Table 14-2b shows the equivalent active and passive fluid pressures for the soil properties assumed in the tabulated designs.

Note, for the case of a sloping backfill with $\beta = \phi$, the horizontal and vertical component of the active equivalent soil pressure ($\gamma_a \cos(\phi)$ and $\gamma_a \sin(\phi)$, respectively) are also listed in Table 14-2b.

To use the tabulated designs in this Chapter, the angle of internal friction (ϕ) and unit soil density (γ) must be known. If these factors are not known, but the active and passive fluid pressures (γ_a and γ_p, respectively) are known, then for the case of a level backfill, it is possible to solve for ϕ and γ, given γ_a and γ_p:

$$\phi = 2\tan^{-1}\left[\frac{1-\sqrt[4]{\gamma_a/\gamma_p}}{1+\sqrt[4]{\gamma_a/\gamma_p}}\right]$$

$$\gamma = \gamma_a / \tan^2(45° - \phi/2)$$



(a) No Frost (b) Frost depth ≈ $(A_{base} + K)$ (c) Intermediate

Figure 14-4 Alternative Designs to Resist Horizontal Sliding

COST CONSIDERATIONS IN DESIGN

Less Thickness – More Flexural Reinforcement. Use of the minimum thickness possible for walls, principally reinforced for bending in one direction, seldom achieves overall economy. The cost of reinforcing steel is a major item in the total cost. When larger concrete cover is required and even with single curtains of reinforcing steel in both directions, wall thicknesses less than 8 inches are likely to make concrete placing and consolidation difficult. Tabulated designs in this Chapter are, therefore, based on an 8 in. minimum wall thickness. As walls become taller or more heavily loaded, greater thickness becomes economical. Reduction in weight of flexural reinforcement is directly proportional to an increase in effective depth, *d*, approximately 15 percent for the first added inch of thickness. Note, however, that horizontal (shrinkage and temperature) reinforcing steel weight *increases* approximately 15 percent for the same added inch.

More Thickness – More Horizontal Reinforcement. For taller walls, for doubly reinforced walls where lateral force may be applied from either side, or where two curtains of horizontal shrinkage and temperature bars are desired, a minimum wall thickness of 12 inches is required to provide adequate clearance for concreting.

In general, wall and base thicknesses in the tabulated designs provide a reasonably effective balance between flexural and horizontal reinforcing steel areas for overall economy. Some savings in concrete (and lesser amounts in horizontal reinforcement) may be achieved by use of tapered walls for heights above 10 feet. Since the tapered walls complicate concrete placing slightly and form construction considerably, use of tapered walls will seldom achieve overall economy without several form reuses, as on long walls.

Crack Control. Wide vertical cracks are objectionable, but the width of vertical cracks can be controlled by more horizontal reinforcing steel (increasing reinforcing steel cost) or closer spacing of control or construction joints (increasing construction time). With such joints at very close spacing (10 to 15 feet) that may happen to match the natural shrinkage crack interval, theoretically, horizontal reinforcing steel for crack control would not be necessary. Unfortunately, this "natural crack interval" is a function of the unpredictable concrete tensile strength during early curing. Cracks often occur during the first night after casting, particularly, if a large temperature drop occurs at this most crucial period. Figure 14-5 shows a general relationship developed in ACI Committee 350, Environmental Engineering Concrete Structures, between joint spacing and horizontal reinforcement for walls intended to be watertight.

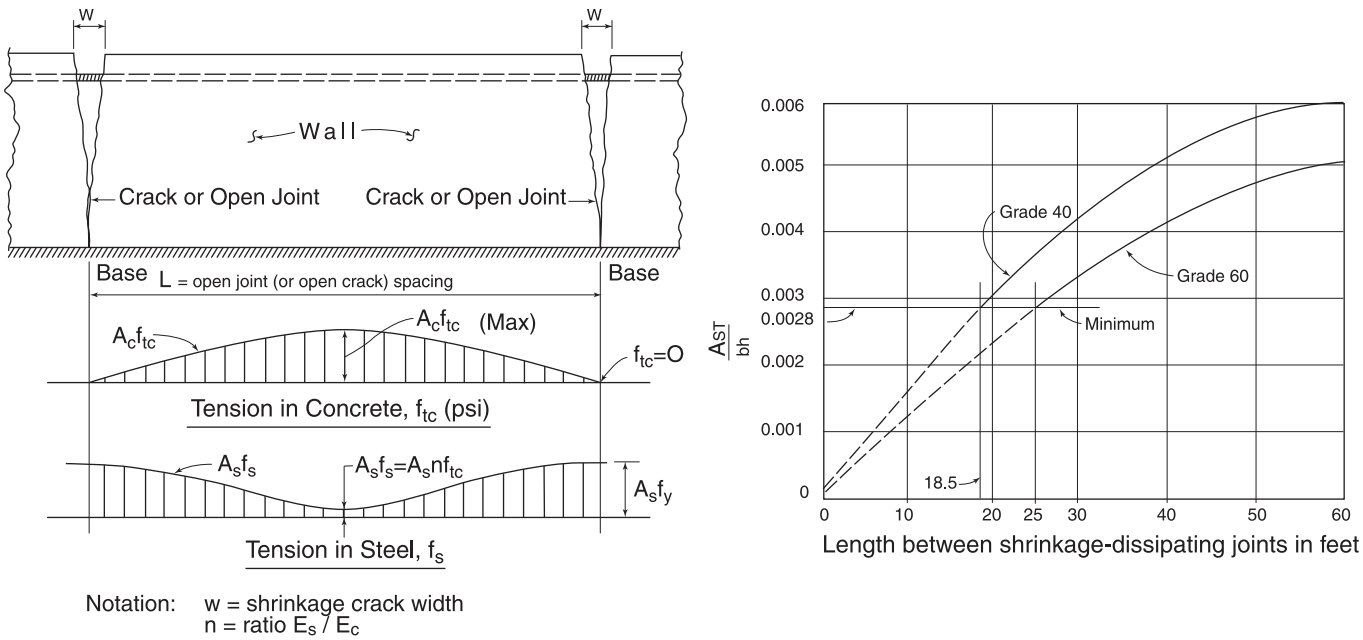


Figure 14-5 Joint Spacing Related to Reinforcing Steel for Shrinkage and Temperature

Project requirements affecting acceptable width of vertical cracks vary considerably. ACI Building Code requirements for horizontal reinforcing steel are minimum values. These minimal quantities of crack control steel are still required even with such close joints as to theoretically remove any need of reinforcing steel. The use of such minimal steel ratios could reasonably be extended also to building walls with longer joint spacings or even with no joints. Vertical cracks may not be objectionable for covered walls, retaining walls in well-drained locations well above the water table, and some interior walls.

Horizontal (Longitudinal) Reinforcement. Cantilevered retaining walls will usually require some horizontal steel. The amount required for serviceability can vary from a minimum for walls under 10 feet in length to 0.005 (for Grade 60) times the gross area for walls without contraction joints (or construction joints serving to accommodate some contraction) (see Fig. 14-5). Exposure conditions and appearance requirements for "no cracks" or minimum crack widths will also add to horizontal reinforcing steel requirements and may require both horizontal crack control steel and vertical bars for its support in the exposed face.

Horizontal reinforcement in cantilevered retaining wall designs conforming to the ACI Building Code must meet the following requirements for minimum ratios of Grade 60 reinforcing bars to gross area:

horizontally (ACI 14.3.3)
- #3, #4, and #5 bars 0.0020
- other bars 0.0025

For the base, temperature and shrinkage exposure is ordinarily less severe than for walls. Appearance and watertightness are ordinarily not design requirements. Longitudinal bars spaced no greater than approximately 4 feet are recommended, top and bottom, as practical support bars and spacers to hold the flexural and diagonal corner bars in place during construction. As shown in Figs. 14-1, 14-2, and 14-3, the tabulated designs provide for a minimum of five longitudinal bars. The longitudinal bars in the stem will provide a minimum steel ratio of 0.002, with spacing, *s*, equal to about one average wall thickness but not to exceed 18 inches in one layer as shown, which will also serve to hold the vertical flexural bars in proper position.

It would be impossible to tabulate longitudinal bars designed for each special service condition encountered. The longitudinal reinforcement in the tabulated designs is the minimum to satisfy the various Code requirements, as well as practical placing requirements. The tabulated designs are suitable for moderate exposures, with provision for shrinkage control (contraction joints) at short intervals, and where adequate drainage is provided. More longitudinal reinforcement may be needed for any special condition. For extreme exposure or watertight cracks, both vertical and horizontal crack control reinforcement near the exposed face will be desirable.

CRACK CONTROL IN CANTILEVERED WALLS

General. Observations of retaining walls in service generally show that objectionable horizontal cracks are rare and usually associated with a structural deficiency, while vertical cracks are common. As noted previously, vertical cracking is related to joint interval, for relief of tension stresses due to shrinkage, and total longitudinal reinforcing steel capacity ($A_s f_y$). See Fig. 14-5. The tension in the concrete has been relieved (to zero) at each crack. Between cracks, tensile stress in the concrete increases as shrinkage, temperature drop, or both occur. The tensile stress increases from zero at each vertical crack to a maximum at the midpoint between the vertical cracks. If tensile stresses in the concrete exceed the concrete tensile strength, a new vertical crack occurs. If this process is repeated often enough, the result will be closely spaced, *tight* vertical cracks. When the maximum force in the horizontal reinforcing steel ($A_s f_y$) is *less* than the tensile force carried by the concrete, the process of forming new cracks at closer spacings stops. Instead, the reinforcing steel yields at existing cracks which *widen* to provide needed strain relief in the concrete between them. This process provides the relationship between (relief) joint spacing and ratio of shrinkage and temperature reinforcing steel to crack width. Precise predictions of crack widths are not feasible, because early curing conditions control the tensile strength of the concrete. These same conditions vary the tensile force caused by drying and possible sudden temperature drops even during the first 24 hours. The curves in Fig. 14-5 should, therefore, be regarded merely as a guide, effective for usual applications.

Vertical Reinforcement (Flexure). Note that walls have been classified as "low" ($h_w \leq 10$ ft) and "high" ($h_w > 10$ ft) with different arrangements of vertical reinforcing steel. In low walls, lap splices of vertical reinforcement can be avoided entirely. The vertical bars are L-shaped and serve as vertical, dowel, and footing reinforcement. Temporary bracing must be provided for all dowels to ensure proper position (plumb) and location. For high walls, only 50 percent of the main flexural reinforcing steel is lap spliced at the base, using Class "B" lap splices to the short dowels.

Dimensions of the wall, base, and key (if required), as shown in Figs. 14-1, 14-2 and 14-3, are included in the tabulated designs. Note that the minimum wall thickness, 8 inches, is shown in Fig. 14-2. Sometimes, the front (exposed) face of the wall is cambered for expected lateral deflection-plus-tilt at the top. A variable thickness wall may be used, tapered from the top (8 inches) to the base, with the slope located on either face. Camber on the front face is desirable, even if a sloping back face is used.

Vertical Reinforcement (Front Face). When horizontal bars for shrinkage and temperature are used in both faces, the vertical reinforcement in the front face serves the practical purpose of spacing and supporting the longitudinal bars.*

Code Requirements for Crack Control. The Code requirements for "Distribution of Flexural Reinforcement" (ACI 10.6) provide crack control for the tensile zone in one-way beams or slabs under ordinary exposure. If desired, these provisions may be applied to cantilevered walls (designed as one-way slabs) at points of maximum flexural stress for the vertical bars in the back face. Since the tensile zone is in the back face where the horizontal flexural cracks are not objectionable for appearance, special crack control requirements on the spacing of the bars are not necessary. Tests have shown a 76 percent reduction of the crack width at the base of the cantilever stem when diagonal bars were present.**

All arbitrary maximum bar spacing requirements applicable to walls were observed in developing the tabulated designs. These include: for temperature and shrinkage (longitudinal) bars five times wall thickness, 5*h*, or 18 in. (ACI 7.12.2.2); for main bars, 3*h* or 18 in. (ACI 10.5.4 and ACI 14.3.5).

*The back face is somewhat protected from the direct effect of temperature changes, which cause warping stresses. To allow for this effect, two-thirds of the total horizontal reinforcing steel in the walls may be located in the front face.

**"Reinforced Corners and Joints Subjected to Bending Moment," I. Nilson and A. Losberg, ASCE ST 6, June, 1976.

TABULATED DESIGNS FOR RETAINING WALLS

Complete designs are presented for walls ranging from = 3 to 22 feet high, for the various soil conditions; under two backfill conditions, Level Backfill, No Surcharge; and Sloping Backfill (backfill angle $\beta = \phi$). The tabulated designs show; "Low" walls $h_w \leq 10$ feet, and "High" walls $h_w > 10$ feet. Fig 14-2 shows two bar arrangements for walls: (a) where dowels are at full height to serve as both footing and wall reinforcement, and (b) with dowels and straight bars. With the second arrangement, the full-height vertical bars are lap spliced, (Class B) to the dowels. Figures 14-2 and 14-3 show bar designations as tabulated for high walls.

The tabulated designs present the following data:

- Concrete Dimensions & Volume. Dimensions of the stem, base and key (if needed), and concrete quantity.
- Service Load Analysis. Base soil pressures at the toe and heel, safety factors against sliding and overturning, and calculated deflection at the top of the wall.
- Stem Reinforcement. Bar size and spacing for the "O", "M", "D" and "L_w" bars.
- Base Reinforcement. Bar size and spacing for the "P", "L_b" and "K" (if needed) bars.
- Total steel weight.

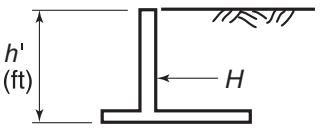
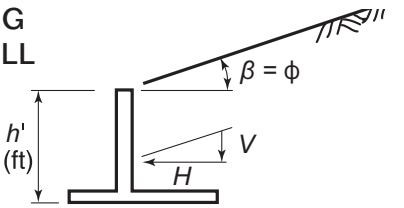
An analysis of on site soil conditions must be made in order to design against an overturning shear failure (sliding on a circular arc), as well as determine the actual coefficient of friction between concrete and soil.

The critical starting dimension is the height of the wall from the top to the base (h_w). The tabulated designs were prepared for a 12 in. minimum depth of soil above the base at the toe (frontfill). Note that for Sloping Backfill, the tabulated designs are based upon a minimum frontfill of $0.10h_w \geq 12$ in. Frost conditions may require greater frontfill in some areas. Consideration should be given whether to use a small camber to offset tilt and deflection or to use a tapered wall to save concrete or both.

ANALYSIS AND DESIGN PROCEDURES

Analysis. Service load analyses were used to establish concrete dimensions that control deflection at the top of the cantilever wall, limit soil stresses and tilting of the base, and provide the minimum safety factors of 1.5 against (horizontal) sliding and 2.0 against overturning about the toe.

TABLE 14-3 SERVICE LOAD BACKFILL PRESSURES, LOADS AND MOMENTS

	LEVEL BACKFILL 	SLOPING BACKFILL 
Soil Properties γ(pcf) / ϕ	$H = (½)\ K_a\ \gamma(h')^2$ $M = H(h'/3) = (1/6)\ K_a\ \gamma(h')^3$	$H = (½)\ K_a\ \gamma \cos(\beta)\ (h')^2$ $V = (½)\ K_a\ \gamma \sin(\beta)\ (h')^2$ $M = H\ (h'/3) = (1/6)\ K_a\ \gamma \cos(\beta)\ (h')^3$
115 / 30°	$H = 19.2\ (h')^2$ (lbs) $M = 6.39\ (h')^3$ (ft-lbs)	$H = 43.1\ (h')^2$ (lbs) $V = 24.9\ (h')^2$ (lbs) $M = 14.4\ (h')^3$ (ft-lbs)
115 / 35°	$H = 15.6\ (h')^2$ (lbs) $M = 5.19\ (h')^3$ (ft-lbs)	$H = 38.6\ (h')^2$ (lbs) $V = 27.0\ (h')^2$ (lbs) $M = 12.9\ (h')^3$ (ft-lbs)
115 / 40°	$H = 12.5\ (h')^2$ (lbs) $M = 4.17\ (h')^3$ (ft-lbs)	$H = 33.7\ (h')^2$ (lbs) $V = 28.3\ (h')^2$ (lbs) $M = 11.2\ (h')^3$ (ft-lbs)
130 / 30°	$H = 21.7\ (h')^2$ (lbs) $M = 7.22\ (h')^3$ (ft-lbs)	$H = 48.8\ (h')^2$ (lbs) $V = 28.1\ (h')^2$ (lbs) $M = 16.3\ (h')^3$ (ft-lbs)
130 / 35°	$H = 17.6\ (h')^2$ (lbs) $M = 5.87\ (h')^3$ (ft-lbs)	$H = 43.6\ (h')^2$ (lbs) $V = 30.5\ (h')^2$ (lbs) $M = 14.5\ (h')^3$ (ft-lbs)
130 / 40°	$H = 14.1\ (h')^2$ (lbs) $M = 4.71\ (h')^3$ (ft-lbs)	$H = 38.1\ (h')^2$ (lbs) $V = 32.0\ (h')^2$ (lbs) $M = 12.7\ (h')^3$ (ft-lbs)

1. Service Load Shear and Moment (See Table 14-3)

2. Service Load Analyses for Stem Deflection Control

Determination of E_cI_e:

$f_c' = 3{,}000$ psi

$E_c = 57{,}000\sqrt{f_c'} = 3{,}122{,}000$ psi

No creep factors used. Elastic deflection under full load, considering loss of stiffness in cracked section, neglecting effects of batter, and tilt:

t = Average wall thickness (in.)

Δ = Maximum lateral deflection at top of wall (in.)

H = Total lateral force (pounds)

$$I_e = \left(\frac{M_{cr}}{M_a}\right)^3 I_g + \left[1 - \left(\frac{M_{cr}}{M_a}\right)^3\right] I_{cr}$$

I_{cr}/I_g, ratio is between 0.28 and 0.38

$$\frac{M_a}{M_{cr}} = (0.266)\left(\frac{t}{t - 3''}\right)^2$$

Within limits
$\rho \cong 0.008$
10 ft < h < 22 ft

$I_e \cong 0.32t^3$

$E_cI_e \cong 1{,}000{,}000t^3$

$\Delta = W\ (h_w)^4/30EI$

$H = K_a\ (h_w)\ \gamma \cos\beta$

substituting:

$$\Delta = \frac{K_a\ (h_w)^5\ \gamma \cos\beta}{30 \times 10^6 t^3}$$

A minimum uniform wall thickness of 8 inches is used. This arbitrary minimum allows for 2 inches specified concrete cover plus two layers of reinforcing steel in the back face, say 3.5 inches, which provides a 4.5 inch space for placing and vibrating concrete to avoid honeycomb areas.

One of the criteria used in the tabulated designs to determine the stem thickness is to limit cantilever deflection of non-tapered walls (neglecting rotation) to $h_w/240$. Deflection was calculated for service load, cracked section, effective I_e, per ACI 318, with no creep (load reduces from passive to active as wall deflects) and calculated for non-tapered wall. For

Computed deflections of the stem have been tabulated. Total lateral displacement will be the sum of deflection plus tilt. See Fig. 14-6. Differential settlement of the base, $\Delta_s = \Delta_{toe} - \Delta_{heel}$. Settlement must be calculated, since it will be a function of the soil properties. Consolidation of the soil below the base slab is a function of loading on the soil or the soil pressure. For estimates, it may usually be assumed that Δ_s per 1,000 psf differential pressure ($P_{toe} - P_{heel}$) is approximately $^1/_{16}$ inch for compaction equivalent to good highway practice or $^1/_8$ inch for ordinary building construction practice. Tilt will equal $h_w \sin \theta$ where $\tan \theta = \Delta_s/W$. If such displacement is considered unsightly, some camber of the exposed face formwork is suggested where the exposed face is intended to appear vertical. Where the sloping face is the exposed face, no further precaution is required, since this slope is much larger than the small camber to offset $h_w/240$ plus tilt.

3. Service Load Analyses for Proportions of Base

The depth of the base, A_b, can vary from 12 inches to the thickness of the stem, which provides a practical, efficient connection. For large projects where potential savings in concrete quantity justify refinements in design and construction, the base may be tapered in the outer two-thirds of the heel portion to a (recommended) minimum of 12 in. See Fig. 14-7. This refinement will require complete investigation of development for top bars in the base ("P" bars), and may necessitate adjusting the size and spacing. Alternatively, with a full depth base, alternate top bars ("P" bars) may be cut-off at $0.5C$ (half-span) plus $12d_b$ or $C/16$, whichever is greater, from the back face of the wall.

SERVICE LOAD ANALYSES FOR SLIDING AND OVERTURNING

Resistance against sliding and overturning is investigated by analyzing a particular retaining wall configuration (stem thickness, base thickness, base width, and no key or with key). To investigate overturning, forces and resulting moments (about the toe) are determined, due to the soil pushing against the retaining wall and due to the stabilizing effect of the retaining wall itself and the soil backfill, and are compared. To investigate sliding, the static frictional force due to the weight of the soil above the base and the weight of the wall itself is calculated and added to the passive resisting force from the soil at the front face. This is compared to the horizontal force from the soil acting on the back face. A factor of safety of at least 2.0 against overturning and at least 1.5 against sliding is sought. If necessary, the retaining wall configuration is adjusted until both safety factors are satisfied.

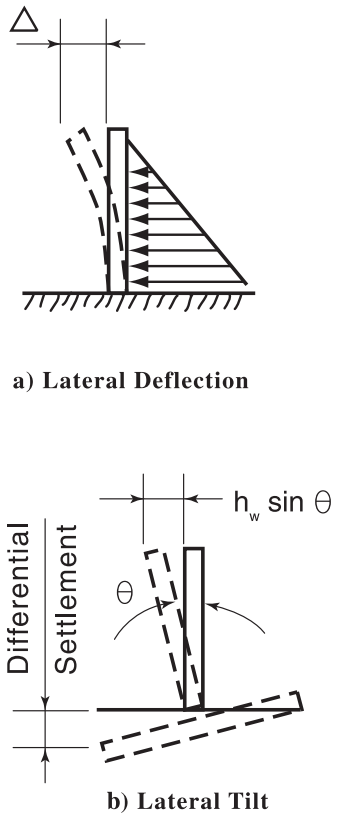


Figure 14-6 Deflection and Tilt

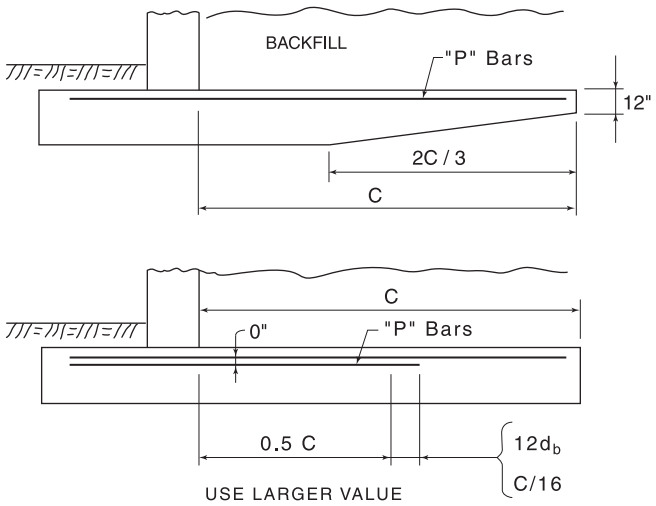


Figure 14-7 Modifications for Base Slab (Heel)

Centerline moments under elastic loads are used to calculate soil pressures for use in estimating settlement and angle of rotation ("tilt"). See Fig. 14-9.

General Notes and Assumptions on Service Load Analyses

1. Determine the safe service load bearing pressure for the in-place subbase system, q_a, and compare it to the tabulated maximum for the soil, loading condition, and wall height of design. It will be noted that the range of tabulated wall heights should be acceptable for most soils. If the bearing pressure is too large, the design of the base must be modified or the subbase improved. Battered pile supports may be required. The stem design can be utilized without redesign if the redesigned base provides the proper shear and moment resistance.

2. Sliding resistance calculations were based upon coefficients of friction, μ, concrete-to-soil in Table 14-1. Some soils with properties other than those assumed in Table 14-1 may not develop the assumed coefficient of friction. Where such soils consist of cohesive soils, calculate sliding based on tests or assume some conservative (1000 lbs/SF max) cohesion resistance. If more exact values of μ are available, and those used here are not conservative with any particular soil used, the tabulated designs must be modified to maintain the factor of safety against sliding ≥ 1.5.

3. A minimum depth of fill of 12 inches is assumed above the top of the toe. For sloping backfill designs, a depth of fill of $0.10h_w$ (minimum 12 inches) above the top of the toe was included in calculating passive pressures on toe and heel. The local Code requirement for depth below the frost line will determine whether the elevation at the bottom of the base requires more than these minimum depths above the top of the base.

4. Length of base, W, is selected such that positive pressure is provided in both the toe and the heel.

5. Length of the toe was assumed equal to $0.20h_w$ (minimum 12 inches).

6. Maximum key depth was set to $0.25h_w$ or 60 in.

FACTORED LOAD DESIGN PROCEDURES

The retaining wall tabulated designs in Chapter 14 differ from other tabulated designs in this book in one important aspect. All other design tabulations are for single *structural elements* while retaining walls are complete *structures*. Even the two-way slab *systems* tabulated in Chapter 9, 10, and 11 are not complete as structures — only the slab element is designed. The cantilevered retaining wall is actually a structure comprising three distinct connected structural elements, four if a key is required. Under ACI 318, several loading conditions must be considered, but the controling combination is assumed to be $1.2D + 1.6H$. For the tabulations herein, each element has been designed conservatively for the load condition critical for that element. Under any given load condition, static equilibrium must be satisfied for all moments of all loads taken about a common point.

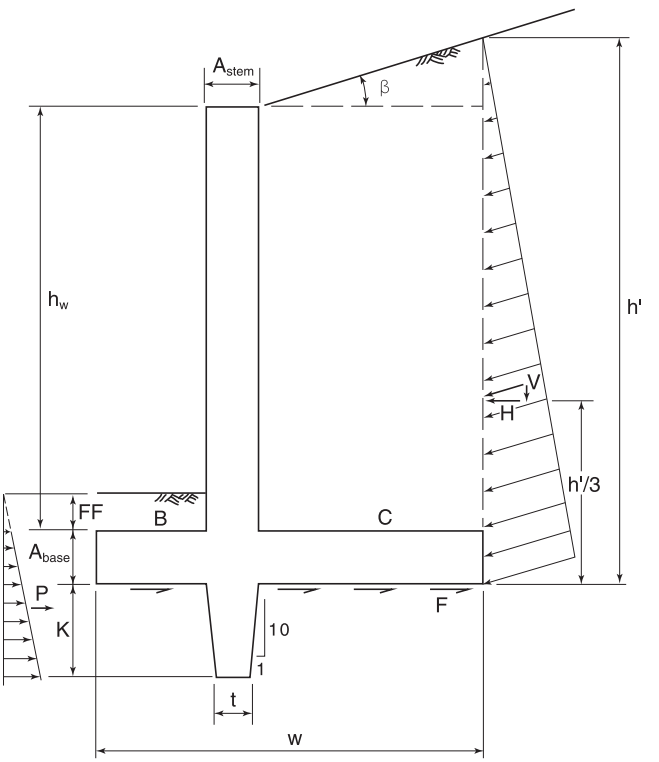


Figure 14-8 Proportioning Base Dimensions for Service Load Conditions

There is the requirement that the moments M_{us}, M_{ut}, M_{uh}, and M_{uk}, (about stem, toe, heel, and key, respectively) must be in equilibrium, that is, $M_{us}+M_{ut}+M_{uh}+M_{uk}=0$.The stem factored moment, M_{us}, is a direct function of load with a simple (1.6) load factor. The stem is the primary element directly resisting the external load. Its reaction to this load indirectly creates the moments in the other elements. The toe factored moment, M_{ut}, is based upon a loading of 1.6 times the soil service load reaction under the toe. The heel factored moment, M_{uh}, is calculated from the weight of the backfill above (with a 1.6 load factor), plus the dead load of the heel itself, minus 1.6 times the force of the soil service pressure underneath, which is also conservatively reduced by 25 percent (i.e. soil reaction is 0.75). This factored heel moment is then compared to the "global" M_{uh} of $M_{us} + M_{uk} - M_{ut}$ and the larger value is used for determining the required reinforcement in the heel. Finally, an upper limit of $M_{uh} \leq M_{us}$ is enforced. The objective is to ensure against premature failure of toe, heel, or key before the stem develops its full factored load at $1.6H$, so that the prescribed overload ($1.6/\phi$) is satisfied for the structure as a whole.

"D" bars in the stem/base were designed for shear at the base of the stem and at the face of the heel.

Stem. Stem design is straightforward with a factor of 1.6 for moment at critical section located at the top of the base. See Fig. 14-10a. Reinforcement ratio of the "O" bars must be limited to ≤ 0.0135 for 3,000 psi concrete (see Chapter 5).

Toe. Soil pressures calculated during the service load analysis are used to determine the upward soil pressures beneath the toe. Downward force of the frontfill and the dead load of the toe itself is conservatively ignored. The soil reaction is multiplied by a 1.6 load factor. See Fig. 14-10d.

The adequacy of the "O" bars in the toe must also be investigated. If the "O" bars, as detailed in Figs. 14-1 or 14-2, do not have enough available embedment length for the tension development of the bar (i.e., available length $< \ell_d$), then the bars must be hooked or headed. Where the tension development length of the "O" bars is longer than the available embedment length, an "H" flag is printed prior to the size and spacing of the "O" bars in the tabulated designs.

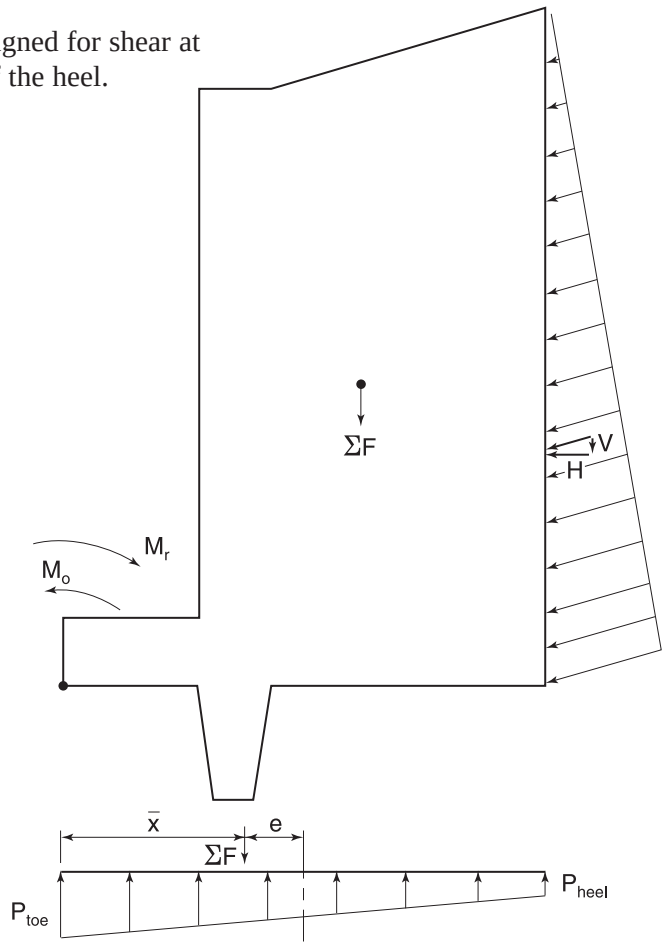


Fig. 14-9 Determination of Base Service Load Pressures

Key. The key is designed to resist the passive force of the soil at the frontface, utilizing a conservative 1.6 load factor. See Fig. 14-10e.

Heel. The heel is designed for the downward load of the soil above, plus the dead load of the heel itself, minus the upward force of the soil reaction underneath. As a conservative measure, the upward soil reaction is reduced 25 percent and a 1.6 load factor is used. The resulting factored moment is then compared to the "global" moment of $M_{us} + M_{uk} - M_{ut}$ and the larger value is selected for designing the heel. Finally, the maximum limit of M_{us} is applied. See Figs. 14-10f and 14-10g.

An "H" flag is printed prior to (indicating that a hook or headed bar is necessary in the toe) or after (hook or headed bar needed in heel) the "P" bars when the tension development length is greater than the available embedment length.

DESIGN

With all dimensions established to provide proper stiffnesses required to control deflection and to provide stability under service load without exceeding soil properties available, the strength design method is used to select Grade 60 reinforcement required under factored loads. See Figs. 14-10 and 14-11.

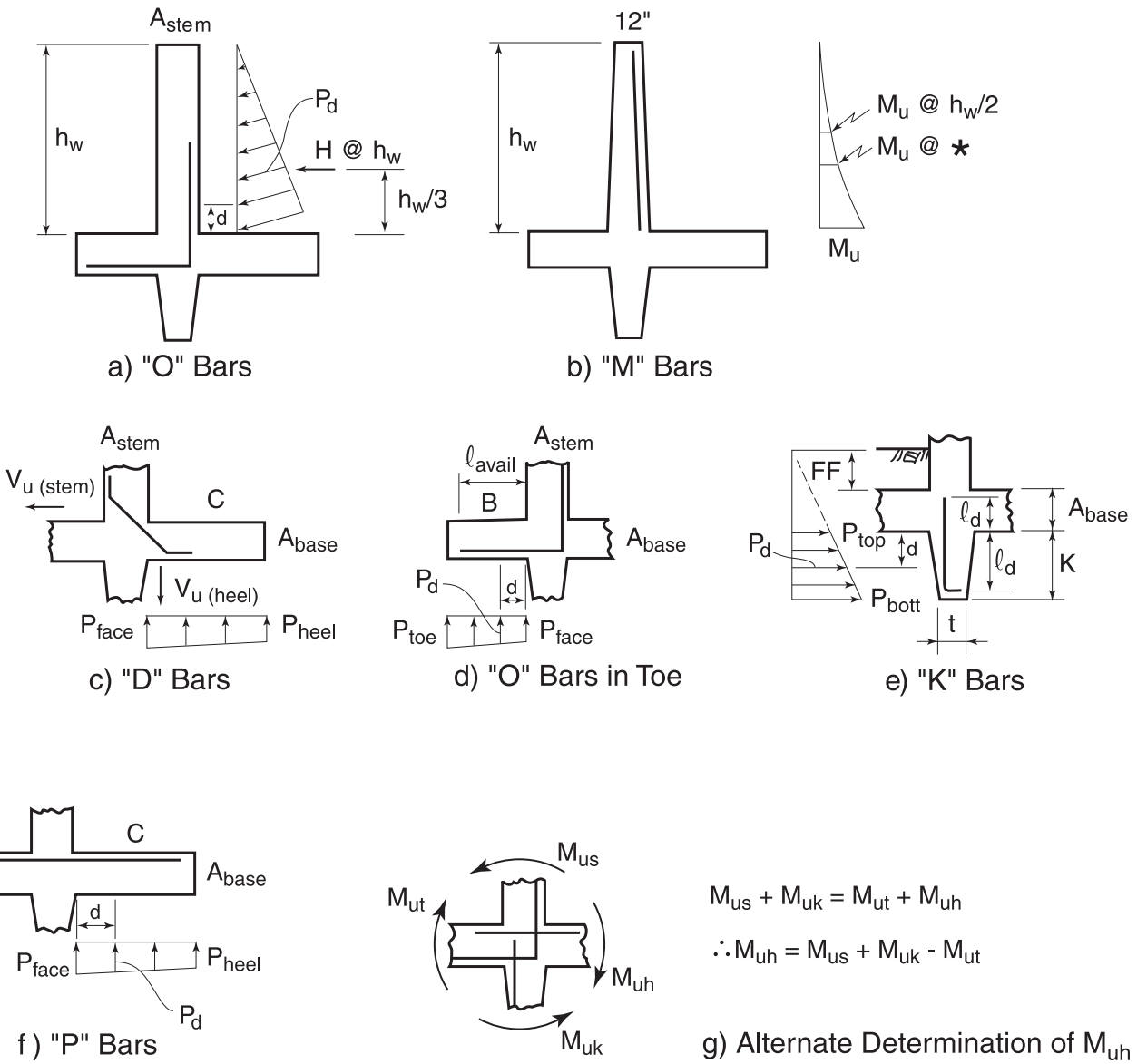


Figure 14-10 Design Loads

I. Strength Design – for Stem (See Fig. 14-10a)

V_{us} at "d" from base = $1.6H\ (h_w - \mathrm{d})^2/h_w{}^2$
$M_{us} = 1.6H\ (h_w/3)$

The quadratic equation for required area of tensile steel in strength design is $M_u = \phi M_n = \phi f_y\, A_s\, (d - a/2)$ where $a = A_s f_y / 0.85 f_c'\, b$. The general solution is,

$$A_s = \frac{1.7 f_c'\, bd}{2 f_y} - \frac{1}{2}\sqrt{\frac{2.89\,(f_c'\, bd)^2}{f_y{}^2} - \frac{6.8 f_c'\, b M_u}{\phi f_y{}^2}}$$

For $f_c' = 3$ ksi, $f_y = 60$ ksi, $b = 12''$ width, and M_u, in kip-in., the solution becomes

$A_s = 0.51\, d - \sqrt{0.26\, d^2 - 0.0189\, M_u}$ in.^{2}/ft.

The "O" bar size is based on a spacing of 15, 12, 9, or 6 inches for walls not over 10 feet high. When the wall height is over 10 feet, the spacing is 9 or 6 inches. For walls not over 10 feet high, the "O" bars extend to the height of the wall less 3 inches. Cut-off locations of the "O" bars for walls over 10 feet high alternates between 0.5 h_w and *, where * is the lap splice length of the "O" and "M" bars, which is the larger of the development length of the larger bar and the lap splice length of the smaller bar.

For walls over 10 feet in height, selection of the "M" bar size is based on the larger amount of required flexural reinforcement at two critical sections: at a distance "*" from the base where half of the "O" bars are assumed effective in flexure (along with all the "M" bars), and at a distance of 0.5 h_w, where only the "M" bars are assumed effective. Factored moments in the wall are based on a function of the cube of the depth below the top of the wall. See Fig. 14-10b. Moments at these two critical sections are calculated as:

M_u at $0.50\ h_w = 0.125\ M_{us}$
M_u at * $= M_{us}\ ((h_w - *)/h_w)^3$

Spacing of the "M" bars is set equal to twice the spacing of the "O" bars for walls over 10 feet high.

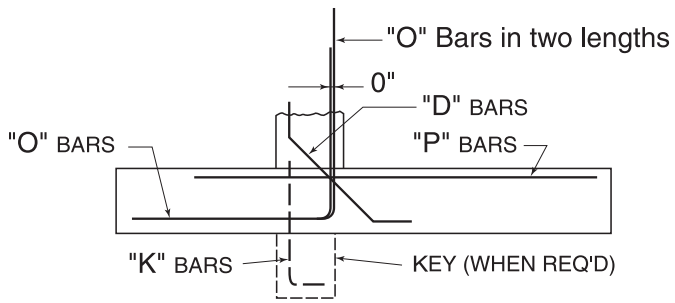


Figure 14-11 Flexural Bar Designations

II. Strength Design for Toe (See Fig. 14-10d)

V_{ut} at "d" from face = $1.6\ [P_d + P_{toe}]\ ((B - d)/2)$
$M_{ut} = 1.6\ [P_{face} + 2P_{toe}]\ (B^2/6)$

Calculate M_{ut} of factored loads on critical section at face of stem and provide A_s required in bottom of toe. Check that "O" bars in toe will be properly developed in the length between the critical section and a point 3 inches from the front of the toe.

III. Strength Design for Heel (See Figs. 14-10f and 14-10g)

V_{uh} at "d" from face
$= [1.2A_{base}(C - d)150 + 1.6(w_3 + w_4)](C - d)/C$
$- 0.75(1.6)[P_d + P_{heel}]((C - d)/2)$
$M_{uh} = [1.2A_{base}(C)150(C/2) + 1.6(w_3(C/2) + w_4(2C/3)]$
$- 0.75(1.6)[P_{face} + 2P_{heel}](C^2/6)$

Standard specifications (AREMA, etc.) require that the heel be designed to meet either of two criteria:

(1) The heel must be capable of resisting *all* vertical loads above it (as a cantilever) minus the upward soil pressure below it. Or,

(2) "More exact analyses" may be applied.

Note that criterion (1) is generally conservative, except for the reduction for upward soil pressure from below. To allow for a partial reduction of soil support under the heel, the upward soil pressure is reduced by 25 percent. Factored load moment for heel *need not be larger* than factored moment for stem: $M_{uh} \le M_{us}$. Factored load moment for the heel *must be equal or*

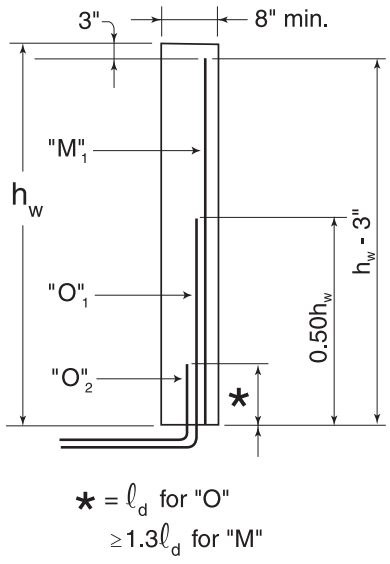


Figure 14-12 Stem Bar Designations and Cut-off Points for $h_w > 10'$

larger than the difference between factored load moments of stem, key, and toe: $M_{uh} \geq M_{us} + M_{uk} - M_{ut}$.

Development of "P" bars on both sides of the stem must be checked.

IV. Strength Design for Key (See Fig. 14-10e)

Passive soil pressures:

$P_{top} = K_p\,(FF + A_{base})\,\gamma$

$P_d = K_p\,(FF + A_{base} + d)\,\gamma$

$P_{bott} = K_p\,(FF + A_{base} + K)\,\gamma$

Factored moment:

$M_{uk} = 1.6\,[P_{top} + 2P_{bott}](K^2/6)$

Factored shear at d from face:

$V_{uk} = 1.6\,[P_d + 2P_{bott}]((K - d)/2)$

Development of "K" bars is determined and checked against the depth of the key.

Selected References

(1) Vetter, C. P., Assoc. M. AM. Soc. C. E., "Stresses in Reinforced Concrete Due to Volume Changes." In Transactions of the American Society of Civil Engineers, Volume 98. New York, 1933.

(2) "Application of Strength Design Methods to Sanitary Structures," Klein, Hoffman, and Rice, *Concrete International*, April, 1981, pp. 35-40.

(3) "Control of Cracking in Concrete Structures," ACI Committee 224, *Concrete International*, October, 1980, pp. 35-76.

Example 1

This example shows how a surcharge load can be accommodated using the tabulated designs.

Given conditions:

1. f'_c = 3,000 psi; f_y = 60,000 psi
2. 11-ft wall, level backfill, 2-ft surcharge
3. Soil properties: γ = 115 pcf, ϕ = 30°, μ = 0.45

Solution:

From Page 14-23, for a 13′ (i.e., 11′ + 2′) wall, see Fig. 14-13. Calculated deflection (0.616 in.) must be adjusted for an 11-ft wall:

$\Delta \approx 0.616\ (11/13) = 0.521$ in.

Concrete quantity (0.78 cy/lf) must also be adjusted:

0.78 – 2 * 11/12 * 1/27 = 0.78 – 0.07 = 0.71 cy/lf

Total weight of reinforcing steel (70.09 lbs/lf) must be adjusted:

"M" Bars: #5 @ 12 × 2′-0″ = 1.043 (2) 12/12 = 2.09 lbs/lf
"L_w" Bars: 2 - #5 = 2 (1.043) 1 = 2.09 lbs/lf
4.18 lbs/lf

Total weight of reinforcing steel
= 70.09 – 4.18 = 65.91 lbs/lf

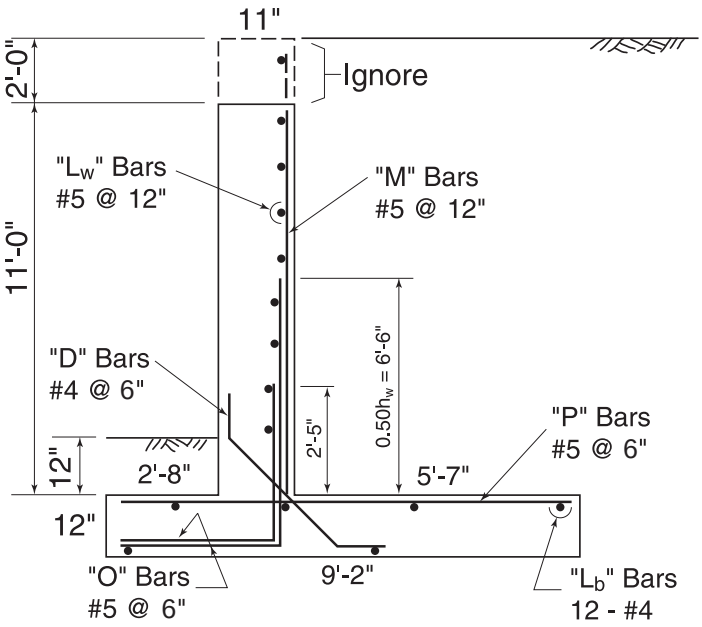


Figure 14-13 Example 1

Example 2

This example shows how a tabulated design is adjusted for contraction joints.

Given conditions:

1. f'_c = 3,000 psi; f_y = 60,000 psi
2. 18-ft wall, sloping backfill ($\beta = \phi$)
3. Soil properties: γ = 130 pcf, ϕ = 35°, μ = 0.55
4. Assume vertical shrinkage-dissipating joints in the wall at 40-ft spacing

Solution:

From Page 14-44:

Deflection = 0.892 in., Concrete quantity = 2.52 cy/lf

See Fig. 14-14. For joints spaced at 40 ft, steel ratio of 0.0041 is suggested, of which two-thirds will be placed in the front face. Resulting areas of shrinkage and temperature bars:

Front face = 0.0027 (12) 22 = 0.71 in.^{2}/ft = #8 @ 12″
Back face = 0.0014 (12) 22 = 0.37 in.^{2}/ft = #6 @ 12″

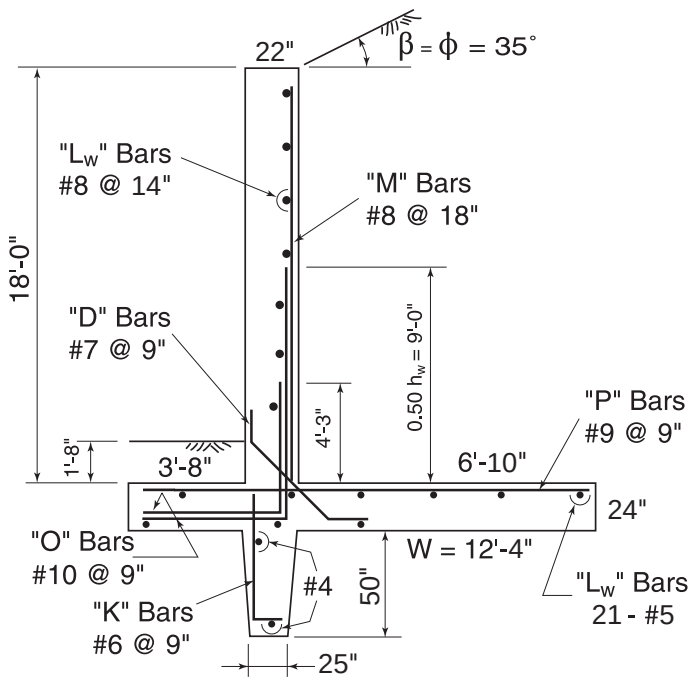


Figure 14-14 Example 2

Note that this reinforcement will replace the tabulated "L_w" bars (#8 @ 14″). Details for this reinforcement is shown in Figure 14-15.

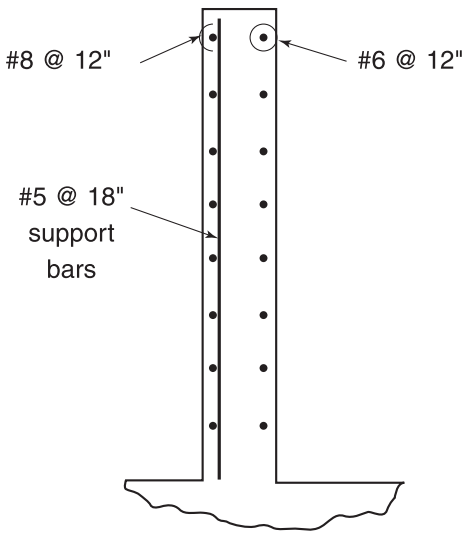


Figure 14-15 Shrinkage & Temperature Steel in Stem of Example 2

Reinforcement quantity (251.16 lbs/lf) must be adjusted:

Original "L_W" Bars: #8 @ 14″ = 1′ × 2.67 × $\frac{(18 \times 12)}{14}$
= 41.19 lbs/lf

#8 Front Face: #8 @ 12″ = 1′ × 2.67(18)
= 48.06 lbs/lf
#6 Back Face: #6 @ 12″ = 1′ × 1.502(18)
= 27.04 lbs/lf
#5 Support bars: #5 @ 18″ = 18′ × 1.043 (12/18)
= 12.52 lbs/lf
Total weight of reinforcing steel
= 251.16 – 41.19 + 48.06 + 27.04 + 12.52
= 297.59 lbs/lf

MANUAL REVIEWS

MANUAL EXAMPLE 1—LEVEL BACKFILL

f_c' = 3,000 psi; f_y = 60,000 psi, 9-ft wall
Soil: γ = 115 pcf; ϕ = 35º; μ = 0.45
Minimum safety factors:
1.50 (sliding), 2.0 (overturning)
SR = Soil Reaction = 0.75

From tabulated design on Page 14-25:

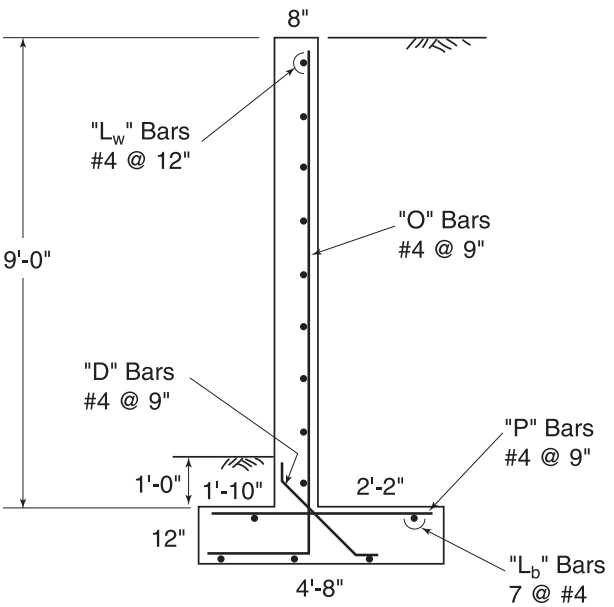


Figure 14-16 Manual Example 1

Stability (See Figure 14-8)
Weights:

Wall = $A_{stem}\ h_w\ \gamma_c$ = (8/12) 9 (150)	=	900 lbs
Base = $A_{base}\ W\ \gamma_c$ = (12/12)4.667(150)	=	700 lbs
Backfill = $C\ (h_w)\ \gamma_s$ = 2.167 (9) 115	=	2,243 lbs
W_T	=	3,843 lbs

$K_a = \tan^2 (45^o - \phi/2) = \tan^2 (45 - 35/2) = 0.271$
$h' = h_w + A_{base} = 9 + (12/12) = 10$ ft
$H = (1/2)\ Ka\ (h')^2\ \gamma_s = 0.5\ (0.271)\ 10^2\ (115) = 1{,}558$ lbs
$K_p = \tan^2 (45^o + \phi/2) = \tan^2 (45 + 35/2) = 3.690$
$P = (1/2)\ Kp\ [(FF + A_{base})^2 - FF^2]\ \gamma_s$
= 0.5 (3.690) $[(1 + 12/12)^2 - 1^2]$ 115 = 637 lbs
$F = \mu W_T$ = 0.45 (3,843) = 1,729 lbs
Safety Factor (sliding)
= $(F + P)/H$
= (1,729 + 637)/1,558
= 1.519 > 1.50, Okay (1.52 printed)

Moments about Toe:

Wall = $W_w(B + A_{stem}/2)$
= 900 (1.833 + 8/24) = 1,950 ft-lbs

Base = $W_B\,(W)/2$ = 700 (4.667)/2 = 1,633 ft-lbs

Backfill = $W_{BA}\ (W - C/2)$
= 2,243(4.667 – 2.167/2) = 8,038 ft-lbs

M_T = 11,621 ft-lbs

$M_o = H\,(h')/3$ = 1,558 (10) /3 = 5,193 ft-lbs

Safety Factor (overturning) = M_T/M_o = 11,621/5,193
= 2.238 > 2.0, Okay (2.24 printed)

Deflection

$\Delta = K_a\,(h_w)^5\gamma_c \cos\beta/(30 \times 10^6\, t^3)$
= $0.271(9)^5\,115(1)/(30 \times 10^6 8^3)1728$
= 0.207 in. (0.207 printed)

$\Delta_{max} = h_w/240$ = 12(9) / 240 = 0.450 in. > 0.207, Okay

Soil Service Pressures (See Figure 14-9)

$\Sigma F = W_T$ = 3,843 lbs, $\Sigma M_r = M_t$ = 11,621 ft-lbs

M_o = 5,193 ft-lbs

$\bar{x} = (M_r - M_o)/\Sigma F$ = (11,621 – 5,193)/3,843
= 1.673 ft

$e = W/2 - \bar{x}$ = 4.667/2 – 1.673 = 0.661 ft

$e_{max} = W/6$ = 4.667/6 = 0.778 > e, Okay

$P_{toe} = (\Sigma F/W)\,[1 + 6e/W]$
= (3,843/4.667) [1 + 6(0.661)/4.667]
= 823 + 700 = 1,523 psf (1,523 printed)

$P_{hee1} = (\Sigma F/W)\,[1 - 6e/W]$
= 823 – 700 = 123 psf (123 printed)

Reinforcement in Stem, "O" Bars (See Figure 14-10a)

$H\ @\ h_w = (1/2)\,K_a\,(h_w)^2\,\gamma_s$
= 0.5 (0.271) 9^2 (115) = 1,262 lbs

$V_u = 1.6\,(H\ @\ h_w)$ = 1.6 (1,262) = 2,019 lbs

$M_u = V_u(h_w)$ / 3 = 2,019 (9)/3
= 6,057 ft-lbs = 72.68 in.-k

$d = A_{stem} - 2'' - 0.25''$ = 8-2.25 = 5.75 in.

$C_1 = 1.7 f_c'\ bd/(2\,f_y)$ = 1.7(3)12(5.75) / (2(60))
= 2.933 in.^{2}

$C_2 = 6.8\,f_c'\,bM_u\,/(4(0.9)\,f_y{}^2)$
= $6.8(3)12\,(72.68)/(4(0.9)60^2)$ = 1.373 in.^{4}

$A_s = C_1 - \sqrt{C_1{}^2 - C_2} = 2.933 - \sqrt{2.933^2 - 1.373}$
= 0.244 in.^{2}/ft

S & T: 0.0018bt = 0.0018 (12) 8 = 0.173 in.^{2}/ft

Required A_s in toe = 0.259 in.^{2}/ft (see calculations for toe reinforcement)

$\therefore A_s$ = 0.259 in.^{2}/ft

"*O*" Bars: #4 @ 9″ = 0.20 (12/9)
= 0.267 in.^{2}/ft > 0.259, Okay

Confirm section is tension-controlled, so ϕ = 0.90

$$\rho = \frac{A_s}{bd} = \frac{0.267}{8(12)} = 0.00278$$

From Chapter 5 for f_c' = 3,000 psi and f_y = 60,000 psi:
Max ρ = 0.0135 > 0.00278
Hence, ϕ = 0.90

Shear check:

$H\ @\ (h_w - d) = H\ @\ h_w\,(h_w - d)^2/h_w{}^2$
= $1{,}262\,(9 - 5.75/12)^2/9^2$
= 1,131 lbs

$V_u = 1.6H\ @\ (h_w - d)$ = 1.6 (1,131)
= 1,810 lbs

$\phi V_c = \phi\ 2\sqrt{f_c'}\ 12(d)$
= $0.75\ (2)\sqrt{3{,}000}\ 12(5.75)$
= 5,669 lbs > 1,810 lbs, Okay

Reinforcement in Stem & Base, "D" Bars (See Figure 14-10c)

$V_{u\ (stem)}$ = 2,019 lbs

$V_{u\ (heel)}$: Backfill = $1.6W_{BA}$ = 1.6(2,243) = 3,589 lbs

Heel = $1.2A_{base}\ (C)\ \gamma_c$
= 1.2(12/12)(2.167)(150) = 390 lbs

$V_{u\ (down)}$ = 3,979 lbs

$P_{face} = P_{heel} + (P_{toe} - P_{heel})\ C/W$
= 123 + (1,523 – 123) 2.167/4.667
= 773 psf

$V_{u\ (up)} = SR\ (1.6)\ [P_{face} + P_{heel}]\ C/2$
= 0.75 (1.6) [773 + 123] 2.167/2 = 1,165 lbs

$\therefore V_{u\ (heel)} = V_{u\ (down)} - V_{u\ (up)}$ = 3,979 – 1,165
= 2,814 lbs

V_u = maximum of $V_{u\ (stem)}$ and $V_{u\ (heel)}$
= 2,814 lbs

$A_s = V_u / (0.75\ (0.707)\ f_y)$
= 2,814 / (0.75 (0.707) 60,000)
= 0.088 in.^{2}/ft

"*D*" Bars: #4 @ 9″ = 0.20 (12/9)
= 0.267 in.^{2}/ft > 0.088, Okay

Reinforcement in Stem, "L_w" Bars

For #4 bars, $A_s = 0.002bt$ = 0.002 (12) 8 = 0.192 in.^{2}/ft

"L_w" Bars: #4 @ 12″ = 0.20 in.^{2}/ft > 0.192, Okay

Reinforcement in Base (Toe), "O" Bars (See Figure 14-10d)

$P_{face} = P_{toe} - (P_{toe} - P_{heel})\,B/W$
= 1,523 – (1,523 – 123) 1.833/4.667
= 973 psf

$M_u = 1.6\ [P_{face} + 2P_{toe}]B^2/6$
= $1.6\ [973 + 2\,(1{,}523)]\ (1.833)^2/6$
= 3,601 ft-lbs = 43.21 in.-k

$d = A_{base} - 3'' - 0.5'' - 0.25''$ = 12 – 3.75 = 8.25 in.

C_1 = 1.7 (3) 12 (8.25) / (2(60)) = 4.208 in.^{2}

C_2 = 6.8 (3) 12 (43.21) / (4(0.9) 60^2) = 0.816 in.^{4}

$A_s = 4.208 - \sqrt{4.208^2 - 0.816}$ = 0.098 in.^{2}/ft

S & *T*: 0.0018bt = 0.0018 (12) 12
= 0.259 in.^{2}/ft

$\therefore A_s = 0.259$ in.^{2}/ft

$\rho = \dfrac{0.259}{12(12)} = 0.00180 < 0.0135$

Hence, $\phi = 0.90$

"*O*" Bars: #4 @ 9″ = 0.20 (12/9)
= 0.267 in.^{2}/ft > 0.259, Okay

Check development of "*O*" bars in toe:

ℓ_{avail} = B – 3″ = 22 – 3 = 19 in.

ℓ_d for #4 @ 9″ with 3″ cover = 13 in. (Table 5-3(a))

$\ell_{avail} > \ell_d$, Okay

Shear check:

P at "*d*" from face
$= P_{toe} - (P_{toe} - P_{heel})(B - d)/W$
$= 1{,}523 - (1{,}523 - 123)(22 - 8.25)/56$
= 1,180 psf

$V = (P_{toe} + P_d)(B - d)/2$
$= (1{,}523 + 1{,}180)(22 - 8.25)/12/2$
= 1,549 lbs

$V_u = 1.6V = 1.6(1{,}549) = 2{,}478$ lbs

$\phi V_c = \phi\, 2\sqrt{f'_c}\,(12)d$
$= 0.75\,(2)\sqrt{3{,}000}\,(12)8.25$
= 8,134 lbs > 2,478 lbs, Okay

Reinforcement in Base (Heel), "P" Bars (See Figures 14-10f and 14-10g)

V_u = 2,814 lbs (from "*D*" Bar calcs)

Downward Moment (from "*D*" Bar calcs):

Backfill = $W_{BA}\,(C)/2 = 3{,}589\,(2.167/2) = 3{,}888$ ft-lbs

Heel = $W_{UH}\,(C)/2 = 390\,(2.167/2) =$ 423 ft-lbs

$M_{u\,(down)} = 4{,}311$ ft-lbs

Upward Moment (from "*D*" Bar calcs):

$M_{u\,(up)}$ = SR (1.6) $[P_{face} + 2\,P_{heel}]\,C^2/6$
$= 0.75\,(1.6)\,[773 + 2(123)]\,2.167^2/6$
= 957 ft-lbs

$\therefore M_u = M_{u\,(down)} - M_{u\,(up)} = 4{,}311 - 957 = 3{,}354$ ft-lbs

$M_{u\,(global)} = M_{u\,(stem)} - M_{u\,(toe)} = 6{,}057 - 3{,}601$
= 2,456 ft-lbs

$\therefore M_u = 3{,}354$ ft-lbs $< M_{u\,(stem)}$, Okay

M_u = 3,354 ft-lbs = 40.25 in.-k

$d = A_{base} - 2'' - 0.25'' = 12 - 2.25 = 9.75$ in.

$C_1 = 1.7\,(3)\,12\,(9.75)\,/\,(2(60)) = 4.973$ in.^{2}

$C_2 = 6.8\,(3)\,12\,(40.25)\,/\,(4(0.9)\,60^2) = 0.760$ in.^{4}

$A_S = 4.973 - \sqrt{4.973^2 - 0.760} = 0.077$ in.^{2}/ft

S & *T*: 0.0018*bt* = 0.0018 (12) 12 = 0.259 in.^{2}/ft

$\therefore A_S = 0.259$ in.^{2}/ft

"*P*" Bars: #4 @ 9″ = 0.20 (12/9)
= 0.267 in.^{2}/ft > 0.259, Okay

$\rho_{act} = A_S/(bd) = 0.267/(12(9.75))$
= 0.00228 < 0.0135, $\phi = 0.90$

Check development of "*P*" Bars at critical section:

ℓ_d for #4 @ 9″ with 2″ cover = 13 in. (Table 5-3(a)).

$\ell_{avail\ (toward\ toe)} = B + A_{stem} - 3'' = 22 + 8 - 3$
= 27 in. > 13, Okay

$\ell_{avail\ (toward\ heel)} = C - 3'' = 26 - 3$
= 23 in. > 13, Okay

Shear check:

$V_{u\,(down)}$ = 3,979 lbs (from "*D*" Bar calcs)

V_u @ *d* from face = $V_{u\,(down)}\,(C - d)/C$
$= 3{,}979$ lbs $(26 - 9.75)/26$
= 2,487 lbs

P at "*d*" from face = $P_{heel} + (P_{toe} - P_{heel})(C - d)/W$
$= 123 + (1{,}523 - 123)(26 - 9.75)/56$
= 529 psf

$V_{u\,(up)} = SR(1.6)(P_d + P_{heel})(C - d)/2$
$= 0.75(1.6)(529 + 123)(26 - 9.75)/12/2$
= 530 lbs

$V_u = V_{u\,(down)} - V_{u\,(up)}$
$= 2{,}487 - 530 = 1{,}957$ lbs

$\phi V_c = \phi 2\sqrt{f'_c}\,(12)d$
$= 0.75\,(2)\sqrt{3{,}000}\,(12)\,9.75$
= 9,613 lbs > 1,957 lbs, Okay

Reinforcement in Base, "L_b" Bars

S & *T*: 0.0018*bt* = 0.0018 (12) 4.667 (12)
= 1.210 in.^{2}/ft

"L_b" Bars: 7 - #4 = 7 (0.20) = 1.40 in.^{2} > 1.210, Okay

Concrete Volume

Stem = $A_{stem}\,(h_w)$ = (8/12) 9/27 = 0.222 cy/ft

Base = $A_{base}\,(W)$ = (12/12) 4.667/27 = 0.173 cy/ft

0.395 cy/ft
(0.40 printed)

Weight of Reinforcing Steel

Lengths:

"*O*" Bars $= B + A_{stem} - 3'' - 2'' + A_{base} + h_w - 3'' - 3''$
$= 1.833 + 8/12 - 5/12 + 12/12 + 9 - 6/12$
= 11.583 ft

"*D*" Bars $= \sqrt{2}\,[A_{stem} + 2'' + A_{base} - 4'' - 5''] + 6'' + 6''$
$= \sqrt{2}\,[8 + 2 + 12 - 9]\,/\,12 + 1$
= 2.532 ft

"*P*" Bars $= C - 3'' + 2'' + \ell_d$
$= 2.167 - 3/12 + 2/12 + 13/12$
= 3.167 ft

Number "L_w" Bars = h_w/spacing = 9(12) / 12 = 9

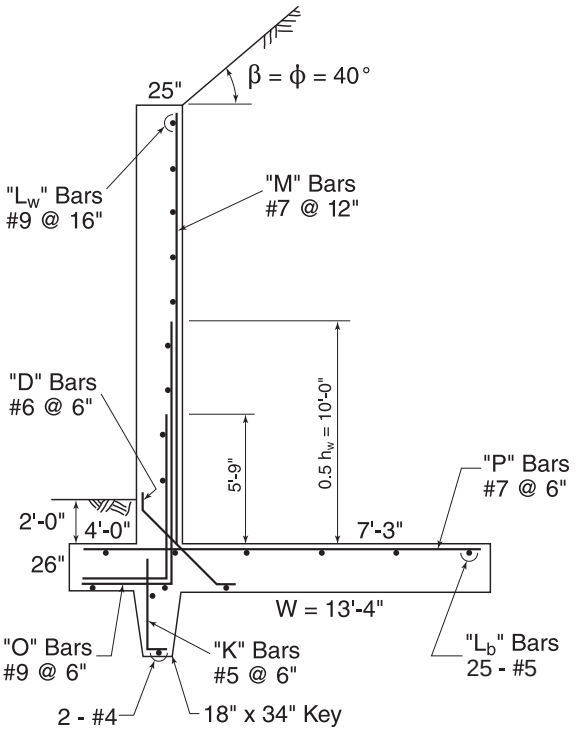
Weights:

"*O*" Bars	= 11.583(0.668)(12/9)	= 10.32 lbs/ft
"*D*" Bars	= 2.532 (0.668)(12/9)	= 2.26 lbs/ft
"*P*" Bars	= 3.167 (0.668)(12/9)	= 2.82 lbs/ft
"L_w" Bars	= 9(1)(0.668)	= 6.01 lbs/ft
"L_b" Bars	= 7 (1) (0.668)	= 4.68 lbs/ft
		26.09 lbs/ft
		(26.08 printed)

MANUAL EXAMPLE 2—SLOPED BACKFILL

f'_c = 3,000 psi; f_y = 60,000 psi; 20-ft wall
Soil: γ = 130 pcf; ϕ = 40°; μ = 0.55
Minimum safety factors:
1.50 (sliding); 2.0 (overturning)
SR = Soil Reaction = 0.75

From tabulated design on Page 14-46:



Stability (See Figure 14-8)

Weights:

Wall = $A_{stem}\ h_w\ \gamma_c$ = (25/12) 20 (150) = 6,250 lbs
Base = $A_{base}\ W\ \gamma_c$ = (26/12) 13.333 (150)
= 4,333 lbs
Key = $K\ (t + K/10)\ \gamma_c$
= 34 (18 + 34/10) 150/144 = 758 lbs
Backfill-A = $C\ (h_w)\ \gamma_s$ = 7.25 (20) 130 = 18,850 lbs
Backfill-B = C^2 (0.5) tan (β) γ_s
= 7.25^2 (0.5) tan 40 (130) = 2,867 lbs
W_T = 33,058 lbs

K_a = cos (ϕ) (for $\beta = \phi$)
= cos (40) = 0.766

h' = $h_w + A_{base} + C$ tan (β)
= 20 + 26/12 + 7.25 tan (40) = 28.25 ft
H_T = (1/2) K_a (h')^2 γ_s = 0.5 (0.766) 28.25^2 (130)
= 39,736 lbs
H = H_T cos (β) = 39,736 cos (40) = 30,440 lbs
V = H_T sin (β) = 39,736 sin (40) = 25,542 lbs
K_p = tan^2 (45 + ϕ/2) = tan^2 (45 + 40/2) = 4.599
P = (1/2) K_p [($FF + A_{base} + K$)^2 – FF^2] γ_s
= 0.5 (4.599) [(2 + 26/12 + 34/12)^2 – 2^2] 130
= 13,452 lbs
F = μ ($W_T + V$) = 0.55 (33,058 + 25,542)
= 32,230 lbs
Safety Factor (sliding) = ($F + P$)/H
= (32,320 + 13,452) / 30,440
= 1.501 > 1.5, Okay (1.50 printed)

Moments about Toe:

Wall = $W_w\ (B + A_{stem}/2)$
= 6,250 (4 + 25/24) = 31,510 ft-lbs
Base = $W_B\ (W)/2$
= 4,333 (13,333)/2 = 28,886 ft-lbs
Key = $W_K\ (B + A_{stem}/2)$
= 758 (4 + 25/24) = 3,822 ft-lbs
Backfill-A = $W_{BA}\ (W - C/2)$
= 18,850 (13,333 – 7.25/2) = 182,996 ft-lbs
Backfill-B $\ell_d = W_{BB}\ (W - C/3)$
= 2,867 (13,333 – 7.25/3) = 31,297 ft-lbs
M_t = 278,511 ft-lbs

M_o = $H(h')/3$ = 30,440(28.25)/3 = 286,643 ft/lbs
Safety Factor (overturning) = [$M_t + V(W)$] / M_o
= [278,511 + 25,542 (13.333)] / 286,643
= 2.160 > 2.0, Okay (2.16 printed)

Deflection

Δ = $K_a(h_w)^5\ \gamma_c$ cos β /(30 × $10^6\ t^3$)
= 0.766 (20)^5 130 cos (40) /(30 × 10^6 25^3) 1728
= 0.900 in. (0.900 printed)
Δ_{max} = h_w/240 = 12 (20) / 240 = 1.0 in. > 0.900, Okay

Soil Service Pressures (See Figure 14-9)

ΣF = $W_T + V$ = 33,058 + 25,542 = 58,600 lbs
M_r = $M_t + V\ (W)$ = 278,511 + 25,542 (13.333)
= 619,062 ft-lbs
M_o = $H(h')/3$
= 30,440 (28.25)/3 = 286,643 ft-lbs
$\bar{x}$ = [$M_r - M_o$] / ΣF
= [619,062 – 286,643] / 58,600 = 5.673 ft
e = $W/2 - \bar{x}$ = 13.333/2 – 5.673 = 0.994 ft
e_{max} = $W/6$ = 13.333/6 = 2.222 > e, Okay
P_{toe} = ($\Sigma F/W$) [1 + 6e/W]
= 58,600/13.333 [1 + 6(0.994)/13.333]
= 4,395 + 1,966 = 6,361 psf (6,361 printed)
P_{heel} = ($\Sigma F/W$)[1 – 6e/W] = 4,395 – 1,966
= 2,429 psf (2,430 printed)

Reinforcement in Stem, "O" Bars (See Figure 14-10a)

$H_T @ h_w = (1/2) K_a (h_w)^2 \gamma_s$
$= 0.5 (0.766) 20^2 (130) = 19{,}916$ lbs

$H @ h_w = H_T @ h_w \cos \beta = 19{,}916 \cos (40)$
$= 15{,}257$ lbs

$V @ h_w = H_T @ h_w \sin \beta = 19{,}916 \sin (40)$
$= 12{,}802$ lbs

$V_u = 1.6H @ h_w = 1.6(15{,}257) = 24{,}411$ lbs

$M_u = V_u (h_w)/3 = 24{,}411(20)/3$
$= 162{,}740$ ft-lbs $= 1{,}953$ in.-k

$d = A_{stem} - 2'' - 0.25'' = 25 - 2.25 = 22.75$ in.

$C_1 = 1.7 f'_c bd/ (2 f_y) = 1.7(3)12(22.75)/(2 (60))$
$= 11.603$ in.^{2}

$C_2 = 6.8 f'_c bM_u/(4(0.9) f_y^2)$
$= 6.8 (3) 12 (1{,}953) / (4 (0.9) 60^2)$
$= 36.890$ in.^{4}

$A_s = C_1 - \sqrt{C_1^2 - C_2} = 11.603 - \sqrt{11.603^2 - 36.890}$
$= 1.717$ in.^{2}/ft

S & T: $0.0018bt = 0.0018 (12) 25 = 0.540$ in.^{2}/ft

$\therefore A_s = 1.717$ in.^{2}/ft

"O" Bars: #9 @ 6 = 1.00 (12/6)
$= 2.00$ in.^{2}/ft > 1.717, Okay

$$\rho = \frac{2.00}{25(12)} = 0.0067 < 0.0135, \phi = 0.90$$

Shear check:

$H @ (h_w - d) = H @ h_w (h_w - d)^2/h_w^2$
$= 15{,}257 (20 - 22.75/12)^2/20^2$
$= 12{,}502$ lbs

$V_u = 1.6H @ (h_w - d) = 1.6(12{,}502)$
$= 20{,}003$ lbs

$\phi V_c = \phi 2 \sqrt{f'_c} (12)d$
$= 0.75 (2) \sqrt{3{,}000} (12) 22.75$
$= 22{,}429$ lbs $> 20{,}003$ lbs, Okay

Reinforcement in Stem, "M" Bars (See Figure 14-10b)

$M_{u\,(base)} = 1{,}953$ in.-k (from "O" Bars calcs)

$d = A_{stem} - 2'' - 0.25'' = 25 - 2.25 = 22.75$ in.

At $hw/2$: $M_u = M_{u\,(base)}/8 = 1{,}953/8 = 244.1$ in.-k

$C_1 = 1.7 f'_c bd/(2 f_y) = 1.7(3)12(22.75)/2(60)$
$= 11.603$ in.^{2}

$C_2 = 6.8 f'_c b M_u/4(0.9) f_y^2$
$= 6.8(3)12(244.1)/4(0.9)60^2 = 4.611$ in.^{4}

$A_s = C_1 - \sqrt{C_1^2 - C_2}$
$= 11.603 - \sqrt{11.603^2 - 4.611}$
$= 0.200$ in.^{2}/ft

S&T: $0.0018bt = 0.0018(12)25 = 0.540$ in.^{2}/ft

$\therefore A_s = 0.540$ in.^{2}/ft

"M" Bars: #7 @ 12″
$= 0.600$ in.^{2}/ft > 0.540, Okay

At *: ℓ_d of "O" Bars = 41 in. (Table 5-3(a))
$1.3\ell_d$ of "M" Bars = $1.3 \times 29 = 38$ in. (Table 5-3(a))

$\therefore$ * = 41 in.

$M_u = M_{u\,(base)} (h_w - *)^3/h_w^3$
$= 1{,}953 (20 - 41/12)^3/20^3 = 1{,}113$ in.-k

$C_1 = 11.603$ in.^{2}

$C_2 = 6.8(3)12(1{,}113)/4(0.9)60^2 = 21.023$ in.^{4}

$A_s = 11.603 - \sqrt{11.603^2 - 21.023}$
$= 0.994$ in.^{2}/ft

S&T = 0.540 in.^{2}/ft

$\therefore A_s = 0.994$ in.^{2}/ft

(½) "O" Bars = (½) #9 @ 6″ = 1.000 in.^{2}/ft

"M" Bars = 0.600 in.^{2}/ft

Total $A_s = 1.000 + 0.600 = 1.600 > 0.994$, Okay

Reinforcement in Stem & Base, "D" Bars (See Figure 14-10c)

V_u (*stem*) = 24,411 lbs

V_u (*heel*):

Backfill-A = $1.6 W_{BA} = 1.6 (18{,}850) = 30{,}160$ lbs

Backfill-B = $1.6 W_{BB} = 1.6 (2{,}867) = 4{,}587$ lbs

Heel $= 1.2 A_{base} (C) \gamma_c$
$= 1.2 (26/12) 7.25 (150) = 2{,}828$ lbs

$V_{u\,(down)} = 37{,}575$ lbs

$P_{face} = P_{heel} + (P_{toe} - P_{heel}) C/W$
$= 2{,}429 + (6{,}361 - 2{,}429) 7.25/13.333$
$= 4{,}567$ psf

$V_{u\,(up)} = SR(1.6) [P_{face} + P_{heel}] C/2$
$= 0.75 (1.6) [4{,}567 + 2{,}429] (7.25/2)$
$= 30{,}433$ lbs

$\therefore V_u = V_{u\,(down)} - V_{u\,(up)} = 37{,}575 - 30{,}433$
$= 7{,}142$ lbs

$\therefore V_u = 24{,}411$ lbs

$A_s = V_u / (0.75 (0.707) f_y)$
$= 24{,}411/(0.75 (0.707) 60{,}000) = 0.767$ in.^{2}/ft

"D" Bars: #6 @ 6″ = 0.44 (12/6)
$= 0.88$ in.^{2}/ft > 0.767, Okay

Reinforcement in Stem, "L_w" Bars

For #9 bars, $A_s = 0.0025bt = 0.0025 (12) 25$
$= 0.75$ in.^{2}/ft

"L_w" Bars: #9 @ 16″ = 1.00 (12/16) = 0.75 in.^{2}/ft, Okay

Reinforcement in Base (Toe), "O" Bars (See Figure 14-10d)

$P_{face} = P_{toe} - (P_{toe} - P_{heel}) B/W$
$= 6{,}361 - (6{,}361 - 2{,}429) 4/13.333$
$= 5{,}181$ psf

$M_u = 1.6 [P_{face} + 2P_{toe}] B^2/6$
$= 1.6 [5{,}181 + 2(6{,}361)] 4^2/6$
$= 76{,}386$ ft-lbs $= 916.6$ in.-k

$d = A_{base} - 3'' - 0.5'' - 0.25'' = 26 - 3.75 = 22.25$ in.

$C_1 = 1.7(3)12(22.25)/(2(60)) = 11.348$ in.^{2}

$C_2 = 6.8(3)12(916.6)/(4(0.9) 60^2) = 17.314$ in.^{4}

$A_s = 11.348 - \sqrt{11.348^2 - 17.314} = 0.790$ in.^{2}/ft

S & T = $0.0018bt$ = 0.0018(12)26
= 0.562 in.^{2}/ft

$\therefore A_s$ = 0.790 in.^{2}/ft

"O" Bars: #9 @ 6″ = 1.00 (12/6) = 2.00 in.^{2}/ft

$\rho = \dfrac{2.00}{26(12)} = 0.0064 < 0.0135$, $\phi = 0.90$

Check development of "O" bars in toe:

ℓ_{avail} = B – 3″ = 48 – 3 = 45 in.

ℓ_d for #9 @ 6″ with 3″ cover = 41 in. (Table 5-3(a))

$\ell_{avail} > \ell_d$, okay

A_s = 2.00 in.^{2}/ft > 0.790, Okay

Shear check:

P at "d" from face
= $P_{toe} - (P_{toe} - P_{heel})(B - d)/W$
= 6,361 – (6,361 – 2,430)(48 – 22.25)/12/13.333
= 5,728 psf

V = $(P_{toe} + P_d)(B - d)/2$
= (6,361 + 5,728)(48 – 22.25)/12/2
= 12,970 lbs

V_u = 1.6V = 1.6(12,970) = 20,752 lbs

ϕV_c = $\phi\, 2\sqrt{f'_c}\ bd$
= 0.75(2)$\sqrt{3{,}000}$ (12)22.25
= 21,936 lbs > 20,752 lbs, Okay

Reinforcement in Key, "K" Bars (See Figure14-10e)

d of Key at d from bottom of base:

$d = \dfrac{(t - 3.25)10}{11} + \dfrac{K}{11}$
$= \dfrac{(18 - 3.25)10}{11} + \dfrac{34}{11}$
= 16.50 in.

P_{top} = $K_p\,(FF + A_{base})\,\gamma_s$ 4.599 (2 + 26/12) 130
= 2,491 psf

P_{bott} = $K_p\,(FF + A_{base} + K)\,\gamma_s$
= 4.599 (2 + 26/12 + 34/12) 130 = 4,185 psf

P at "d" from face
= $P_{top} + (P_{bott} - P_{top})\,d/K$
= 2,491 + (4,185 – 2,491)16.50/34
= 3,313 psf

$V_{u(d)}$ = 1.6$[P_d + P_{bott}](K - d)/2/12$
= 1.6[3,313 + 4,185](34 – 16.50)/2/12
= 8,748 lbs

ϕV_c = 0.75 (2)$\sqrt{f'_c}\ bd$ = 0.75(2)$\sqrt{3{,}000}$ (12)16.50
= 16,267 lbs > 8,748, Okay

M_u = 1.6 $[P_{top} + 2P_{bott}]\,K^2/6$
= 1.6 [2,491 + 2 (4,185)] (34/12)^2/6
= 23,250 ft-lbs = 279.0 in.-k

C_1 = 1.7(3)12(16.50)/(2(60)) = 8.415 in.^{2}

C_2 = 6.8(3)12(279.0)/(4(0.9)60^2) = 5.270 in.^{4}

A_s = $8.415 - \sqrt{8.415^2 - 5.270}$ = 0.319 in.^{2}/ft

S & T: $0.0018b\,(t + 2K/10)$
= 0.0018 (12) (18 + 2 (34)/10) = 0.536 in.^{2}/ft

$\therefore A_s$ = 0.536 in.^{2}/ft

"K" Bars: #5 @ 6″
= 0.31 (12/6) = 0.62 in.^{2}/ft > 0.536, Okay

$\rho = \dfrac{0.62}{16.50(12)} = 0.00313 < 0.0135$, $\phi = 0.90$

Reinforcement in Base (Heel), "P" Bars
(See Figures 14-10f and 14-10g)

V_u = 7,142 lbs (from "D" Bar calcs)

Downward Moment (from "D" Bar calcs):

Backfill-A = $W_{u(BA)}\,(C/2)$
= 30,160 (7.25)/2 = 109,330 ft-lbs

Backfill-B = $W_{u(BB)}\,(2C/3)$
= 4,587(2)7.25/3 = 22,170 ft-lbs

Heel = $W_{u(H)}(C/2)$ = 2,828(7.25)/2 = 10,252 ft-lbs

$M_{u\ (down)}$ = 141,752 ft-lbs

Upward Moment (from "D" Bar calcs):

$M_{u\ (up)}$ = SR (1.6) $[P_{face} + 2P_{heel}]\ C^2/6$
= 0.75 (1.6) [4,567 + 2(2,429)] 7.25^2/6
= 99,080 ft-lbs

$\therefore M_u$ = $M_{u\ (down)} - M_{u\ (up)}$ = 141,752 – 99,080
= 42,672 ft-lbs

$M_{u(global)}$ = $M_{u\ (stem)} + M_{u\ (key)} - M_{u\ (toe)}$
= 162,740 + 23,250 – 76,386 = 109,604 ft-lbs

$\therefore M_u$ = 109,604 ft-lbs < $M_{u\ (stem)}$, Okay

M_u = 1,315.2 in.-k

d = A_{base} – 2″ – 0.25″ = 26 – 2.25 = 23.75 in.

C_1 = 1.7 (3) 12 (23.75) / (2(60)) = 12.113 in.^{2}

C_2 = 6.8 (3) 12 (1,315.2) / (4(0.9) 60^2) = 24.846 in.^{4}

$A_s = 12.113 - \sqrt{12.113^2 - 24.846}$ = 1.073 in.^{2}/ft

S & T: 0.0018bt = 0.0018(12)26 = 0.562 in.^{2}/ft

$\therefore A_s$ = 1.073 in.^{2}/ft

"P" Bars: #7 @ 6″ = 0.60 (12/6)
= 1.20 in.^{2}/ft > 1.073, Okay

$\rho_{act} = A_s/(bd)$ = 1.20 / (12(23.75))
= 0.00421 < 0.0135, ϕ = 0.90

Check development of "P" Bars at critical section:

ℓ_d for #7 @ 6″ with 2″ cover = 38 in. (Table 5-3(a))

$\ell_{avail\ (toward\ toe)}$ = $B + A_{stem} - 3''$
= 48 + 25 – 3 = 70 in. > 38, Okay

$\ell_{avail\ (toward\ heel)}$ = $C - 3''$ = 87 – 3
= 84 in. > 38, Okay

Shear check:

$V_{u\ (down)}$ = 37,575 lbs (from "*D*" Bar calcs)

V_u @ "*d*" from face (down)

$= V_u\ (C - d)/C$

$= 37{,}575\ (87 - 23.75)/87$

= 27,317 lbs

P @ "*d*" from face

$= P_{heel} + (P_{toe} - P_{heel})(C - d)/W$

$= 2{,}430 + (6{,}361 - 2{,}430)(87 - 23.75)/160$

= 3,984 psf

V_u @ "*d*" from face (up)

$= SR(1.6)(P_d + P_{heel})(C - d)/2$

$= 0.75(1.6)(3{,}984 + 2{,}430)(87 - 23.75)/12/2$

= 20,284 lbs

V_u @ "*d*" = V_u @ "*d*" (down) – V_u @ "*d*" (up)

= 27,317 – 20,284 = 7,033 lbs

$\phi V_c = \phi\ (2)\ \sqrt{f'_c}\ (12)\ d$

$= 0.75(2)\sqrt{3{,}000}\ (12)23.75$

= 23,415 lbs > 7,033 lbs, Okay

Reinforcement in Base, "L_b" Bars

S & *T*: $0.0018bt$ = 0.0018 (12) 13.333 (26)

= 7.488 in.^{2}/ft

"L_b" Bars: 25 - #5 = 25(0.31)

= 7.75 in.^{2}/ft > 7.488, Okay

Concrete Volume

Stem = $A_{stem}\ h_w$ = (25/12) 20/27 = 1.543 cy/ft

Base = $A_{base}\ W$ = (26/12) 13.333/27 = 1.070 cy/ft

Key = $K\ (t + K/10)$

= 34(18 + 34/10) / 144/27 = 0.187 cy/ft

2.800 cy/ft

(2.80 printed)

Weight of Reinforcing Steel

Lengths:

"*O*" Bars: $= B + A_{stem} - 3'' - 2'' + A_{base} + 0.5\,h_w - 3''$

(long) = 4 + 25/12 – 5/12 + 26/12 + 0.5 (20) – 3/12

= 17.583 ft

"*O*" Bars: *x* = max (ℓ_d for "*O*", 1.3 ℓ_d for "*M*")

(short) = max (ℓ_d for #9, 1.3 ℓ_d for #7)

= max (41″, 38″)

= 41 in. = 3.417 ft

L $= B + A_{stem} - 3'' - 2'' + A_{base} + x - 3''$

= 4 + (25/12) – 5/12 + (26/12) + 3.417 – 3/12

= 11.000 ft

"*M*" Bar: $= h_w - 3''$ = 20 – 3/12 = 19.75 ft

"*D*" Bar: $= \sqrt{2}\,[A_{stem} + 2'' + A_{base} - 4'' - 5''] + 6'' + 6''$

$= \sqrt{2}\,[25 + 2 + 26 - 9]/12 + 1 = 6.185$ ft

"*P*" Bars: *x* = min (ℓ_d for "*P*", $B + A_{stem} - 2'' - 3''$)

= min (38″, 48″ + 25″ – 5″)

= min (38″, 68″) = 38 in.

L $= x + C + 2'' - 3''$

= 38″ + 87″ – 1″

= 124 in. = 10.333 ft

"*K*" Bars: $= K - 3'' + \ell_d + 16d_b$

= 34/12 – 3/12 + 17/12 + 16 (5/8) / 12

= 4.833 ft

Number "L_w" Bars = h_w /spacing = 20 (12) / 16 = 15

Weights:

"*O*" Bars(long)	= 17.583 (3.400) (12/12)	= 59.78 lbs
"*O*" Bars(short)	= 11.000 (3.400) (12/12)	= 37.40 lbs
"*M*" Bars	= 19.75 (2.044) (12/12)	= 40.37 lbs
"*D*" Bars	= 6.185 (1.502) (12/6)	= 18.58 lbs
"*P*" Bars	= 10.333 (2.044) (12/6)	= 42.24 lbs
"*K*" Bars	= 4.833 (1.043) (12/6)	= 10.08 lbs
"L_w" Bars	= 15 (1) (3.400)	= 51.00 lbs
"L_b" Bars	= 25 (1) (1.043)	= 26.08 lbs
2 - #4 in key	= 2 (1) (0.668)	= 1.34 lbs
		286.87 lbs

(286.87 printed)

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 30°, μ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	494	289	3.22	4.11	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	823	122	2.26	2.58	0.004	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 6	3 - 2	12	None	0.24	1051	110	1.95	2.54	0.013	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	17.17
6	8	1 - 8	3 - 7	12	None	0.28	1206	71	1.65	2.32	0.034	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	19.10
7	8	2 - 2	4 - 3	12	None	0.33	1295	155	1.55	2.48	0.072	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	21.92
8	8	2 -10	5 - 2	12	None	0.39	1278	341	1.55	2.87	0.141	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	7 # 4	None	24.97
9	8	3 - 6	6 - 0	12	None	0.44	1339	469	1.54	3.14	0.255	# 5@12	None	None	# 4@12	# 4@12	# 5@12	8 # 4	None	30.17
10	8	4 - 0	6 - 8	12	None	0.49	1445	535	1.50	3.19	0.431	# 6@12	None	None	# 4@12	# 4@12	# 5@12	9 # 4	None	39.10
11	9	4 - 7	7 - 7	12	None	0.59	1476	678	1.52	3.45	0.488	# 6@ 9	1 -10	# 5@18	# 4@ 9	# 5@12	# 5@ 9	10 # 4	None	50.21
12	10	5 - 1	8 - 4	12	None	0.68	1579	762	1.51	3.54	0.549	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 5@ 9	7 # 5	None	58.28
13	11	5 - 7	9 - 2	12	None	0.78	1620	894	1.52	3.74	0.616	# 5@ 6	1 -10	# 5@12	# 4@ 6	# 5@12	# 5@ 6	12 # 4	None	70.09
14	12	6 - 1	9 -11	12	None	0.89	1725	975	1.52	3.80	0.687	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 5@12	# 7@ 9	13 # 4	None	86.90
15	14	6 - 4	10 - 6	14	None	1.10	1934	997	1.51	3.67	0.611	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 7@ 9	16 # 4	None	109.02
16	15	6 - 9	11 - 3	16	None	1.30	2075	1065	1.51	3.66	0.686	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@11	# 7@ 9	5 # 8	None	121.72
17	16	7 - 3	12 - 0	16	None	1.43	2179	1147	1.51	3.71	0.765	# 6@ 6	2 - 2	# 6@12	# 4@ 6	# 7@15	# 6@ 6	7 # 7	None	133.58
18	17	7 - 7	12 - 8	18	None	1.65	2320	1215	1.51	3.70	0.849	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 7@14	# 8@ 9	16 # 5	None	159.81
19	18	8 - 1	13 - 5	18	None	1.80	2425	1297	1.51	3.74	0.937	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@17	# 7@ 6	17 # 5	None	185.10
20	20	8 - 4	14 - 0	20	None	2.10	2635	1318	1.50	3.65	0.883	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@15	# 7@ 6	14 # 6	None	202.92
21	21	8 - 9	14 - 9	22	None	2.36	2776	1386	1.50	3.64	0.974	# 7@ 6	3 - 2	# 7@12	# 5@ 6	# 8@15	# 7@ 6	16 # 6	None	228.31
22	22	7 - 7	13 -10	22	12x20	2.50	3276	961	1.51	2.91	1.069	# 9@ 9	3 - 7	# 8@18	# 6@ 9	# 8@14	# 8@ 9	15 # 6	# 4@ 9	232.88

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 30°, μ = 0.55

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	494	289	3.56	4.11	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	823	122	2.53	2.58	0.004	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 6	3 - 2	12	None	0.24	1051	110	2.21	2.54	0.013	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	17.17
6	8	1 - 8	3 - 7	12	None	0.28	1206	71	1.89	2.32	0.034	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	19.10
7	8	2 - 0	4 - 1	12	None	0.32	1363	69	1.73	2.27	0.072	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	21.78
8	8	2 - 2	4 - 6	12	None	0.36	1521	21	1.56	2.13	0.141	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	23.71
9	8	2 - 8	5 - 2	12	None	0.41	1603	114	1.54	2.27	0.255	# 5@12	None	None	# 4@12	# 4@12	# 5@12	7 # 4	None	28.63
10	8	3 - 2	5 -10	12	None	0.46	1692	200	1.53	2.39	0.431	# 6@12	None	None	# 4@12	# 4@12	# 5@12	5 # 5	None	37.43
11	9	3 - 7	6 - 7	12	None	0.55	1733	318	1.53	2.54	0.488	# 6@ 9	1 -10	# 5@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	45.41
12	10	3 -11	7 - 2	12	None	0.63	1869	354	1.51	2.56	0.549	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 5@ 9	6 # 5	None	55.61
13	11	4 - 3	7 -10	12	None	0.73	1919	464	1.51	2.67	0.616	# 5@ 6	1 -10	# 5@12	# 4@ 6	# 5@12	# 4@ 6	7 # 5	None	61.93
14	12	4 - 9	8 - 7	12	None	0.84	2007	566	1.53	2.79	0.687	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 5@12	# 6@ 9	12 # 4	None	75.97
15	14	4 -10	9 - 0	14	None	1.04	2284	502	1.50	2.64	0.611	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 6@ 9	9 # 5	None	96.95
16	15	5 - 3	9 - 9	16	None	1.22	2421	574	1.53	2.69	0.686	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@11	# 6@ 9	17 # 4	None	107.63
17	16	5 - 7	10 - 4	16	None	1.35	2558	609	1.51	2.70	0.765	# 6@ 6	2 - 2	# 6@12	# 4@ 6	# 7@15	# 5@ 6	6 # 7	None	118.83
18	17	5 - 9	10 -10	18	None	1.55	2745	612	1.50	2.65	0.849	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 7@14	# 6@ 9	14 # 5	None	133.90
19	18	6 - 3	11 - 7	18	None	1.70	2832	716	1.52	2.74	0.937	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@17	# 6@ 6	23 # 4	None	162.10
20	20	6 - 6	12 - 2	20	None	1.99	3060	719	1.52	2.71	0.883	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@15	# 6@ 6	17 # 5	None	178.73
21	21	6 - 9	12 - 9	22	None	2.23	3248	722	1.51	2.67	0.974	# 7@ 6	3 - 2	# 7@12	# 5@ 6	# 8@15	# 6@ 6	14 # 6	None	203.48
22	22	7 - 1	13 - 4	22	None	2.40	3384	758	1.50	2.67	1.069	# 9@ 9	3 - 7	# 8@18	# 6@ 9	# 8@14	# 8@ 9	21 # 5	None	226.32

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \leq$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 35°, μ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	430	354	4.44	5.06	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	697	248	3.09	3.18	0.004	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 0	2 - 8	12	None	0.22	1095	11	2.32	2.18	0.011	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	16.73
6	8	1 - 6	3 - 5	12	None	0.27	1073	184	2.10	2.57	0.027	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	18.96
7	8	1 - 6	3 - 7	12	None	0.31	1351	14	1.74	2.11	0.059	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	20.66
8	8	1 -10	4 - 2	12	None	0.35	1398	95	1.61	2.21	0.115	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	23.41
9	8	2 - 2	4 - 8	12	None	0.40	1523	123	1.52	2.24	0.207	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	7 # 4	None	26.08
10	8	2 -10	5 - 6	12	None	0.45	1516	332	1.55	2.59	0.351	# 6@15	None	None	# 4@15	# 4@12	# 6@15	5 # 5	None	33.88
11	9	3 - 3	6 - 3	12	None	0.54	1537	472	1.54	2.79	0.397	# 5@ 9	1 -10	# 5@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	40.83
12	10	3 - 7	6 -10	12	None	0.62	1649	533	1.51	2.83	0.447	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	52.17
13	11	3 -11	7 - 6	12	None	0.72	1681	662	1.51	2.99	0.501	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 5@ 9	10 # 4	None	59.45
14	12	4 - 5	8 - 3	12	None	0.82	1753	782	1.53	3.16	0.559	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 5@ 9	7 # 5	None	63.89
15	13	4 - 7	8 - 8	14	None	0.98	1986	751	1.50	2.99	0.620	# 5@ 6	1 -10	# 5@12	# 4@ 6	# 6@12	# 4@ 6	6 # 6	None	78.17
16	14	5 - 0	9 - 5	14	None	1.10	2022	874	1.50	3.11	0.686	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 6@ 9	5 # 7	None	102.31
17	15	5 - 4	10 - 0	16	None	1.28	2214	905	1.52	3.08	0.755	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@11	# 6@ 9	8 # 6	None	113.92
18	16	5 - 8	10 - 8	16	None	1.42	2252	1026	1.52	3.19	0.828	# 6@ 6	2 - 2	# 6@12	# 4@ 6	# 7@15	# 5@ 6	12 # 5	None	122.40
19	17	6 - 0	11 - 3	18	None	1.62	2442	1058	1.53	3.16	0.905	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 7@14	# 6@ 9	10 # 6	None	139.68
20	18	6 - 4	11 -10	18	None	1.77	2557	1116	1.51	3.16	0.985	# 8@ 9	3 - 2	# 7@18	# 6@ 9	# 8@17	# 7@ 9	15 # 5	None	160.43
21	20	6 - 6	12 - 5	20	None	2.06	2718	1154	1.51	3.13	0.916	# 8@ 9	3 - 7	# 8@18	# 6@ 9	# 8@15	# 7@ 9	9 # 7	None	186.28
22	21	6 -10	13 - 0	22	None	2.31	2909	1185	1.52	3.10	0.999	# 7@ 6	3 - 2	# 7@12	# 5@ 6	# 8@15	# 6@ 6	20 # 5	None	209.93

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 35°, μ = 0.55

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	430	354	4.86	5.06	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	697	248	3.41	3.18	0.004	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 0	2 - 8	12	None	0.22	1095	11	2.58	2.18	0.011	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	16.73
6	8	1 - 6	3 - 5	12	None	0.27	1073	184	2.38	2.57	0.027	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	18.96
7	8	1 - 6	3 - 7	12	None	0.31	1351	14	1.99	2.11	0.059	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	20.66
8	8	1 -10	4 - 2	12	None	0.35	1398	95	1.86	2.21	0.115	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	23.41
9	8	2 - 0	4 - 6	12	None	0.39	1605	15	1.70	2.06	0.207	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	25.26
10	8	2 - 4	5 - 0	12	None	0.43	1727	46	1.63	2.10	0.351	# 6@15	None	None	# 4@15	# 4@12	# 6@15	7 # 4	None	32.74
11	9	2 - 5	5 - 5	12	None	0.51	1870	13	1.53	2.03	0.397	# 5@ 9	1 -10	# 5@18	# 4@ 9	# 5@12	# 4@ 9	7 # 4	None	38.75
12	10	2 - 9	6 - 0	12	None	0.59	1964	95	1.52	2.12	0.447	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	5 # 5	None	50.63
13	11	2 -11	6 - 6	12	None	0.68	2027	170	1.50	2.18	0.501	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	54.95
14	12	3 - 3	7 - 1	12	None	0.78	2127	246	1.50	2.26	0.559	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	6 # 5	None	58.63
15	13	3 - 7	7 - 8	14	None	0.93	2324	275	1.54	2.28	0.620	# 5@ 6	1 -10	# 5@12	# 4@ 6	# 6@12	# 4@ 6	12 # 4	None	75.83
16	14	3 -10	8 - 3	14	None	1.05	2391	345	1.52	2.32	0.686	# 7@ 9	3 - 2	# 7@18	# 4@ 9	# 6@12	# 5@ 9	13 # 4	None	93.05
17	15	4 - 0	8 - 8	16	None	1.21	2658	277	1.51	2.25	0.755	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@11	# 5@ 9	5 # 7	None	105.29
18	16	4 - 4	9 - 4	16	None	1.35	2657	442	1.53	2.38	0.828	# 6@ 6	2 - 2	# 6@12	# 4@ 6	# 7@15	# 5@ 6	17 # 4	None	118.46
19	17	4 - 6	9 - 9	18	None	1.54	2921	377	1.52	2.31	0.905	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 7@14	# 6@ 9	19 # 4	None	134.35
20	18	4 -10	10 - 4	18	None	1.69	3024	448	1.52	2.35	0.985	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 8@17	# 6@ 9	13 # 5	None	143.83
21	20	4 -10	10 - 9	20	None	1.96	3258	387	1.51	2.28	0.916	# 8@ 9	3 - 7	# 8@18	# 6@ 9	# 8@15	# 6@ 9	15 # 5	None	171.27
22	21	5 - 2	11 - 4	22	None	2.19	3455	416	1.53	2.30	0.999	# 7@ 6	3 - 2	# 7@12	# 5@ 6	# 8@15	# 5@ 6	9 # 7	None	195.14

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 40°, μ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	374	409	6.32	6.30	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	589	356	4.35	3.96	0.003	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 0	2 - 8	12	None	0.22	908	198	3.24	2.72	0.009	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	16.73
6	8	1 - 0	2 -11	12	None	0.26	1081	103	2.56	2.28	0.022	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	18.51
7	8	1 - 6	3 - 7	12	None	0.31	1105	259	2.37	2.63	0.047	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	20.66
8	8	1 - 6	3 -10	12	None	0.34	1275	163	2.01	2.29	0.092	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	22.44
9	8	1 - 8	4 - 2	12	None	0.38	1449	111	1.80	2.16	0.166	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	24.97
10	8	1 -10	4 - 6	12	None	0.41	1627	55	1.65	2.06	0.281	# 6@18	None	None	# 4@18	# 4@12	# 6@18	6 # 4	None	28.00
11	8	2 - 0	4 -11	12	None	0.45	1735	38	1.53	2.01	0.453	# 5@ 9	1 -10	# 5@18	# 4@ 9	# 4@12	# 4@ 9	7 # 4	None	34.03
12	9	2 - 4	5 - 6	12	None	0.54	1791	164	1.51	2.15	0.492	# 5@ 9	1 -10	# 5@18	# 4@ 9	# 5@12	# 4@ 9	5 # 5	None	41.51
13	10	2 - 8	6 - 2	12	None	0.63	1750	376	1.53	2.40	0.535	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	54.45
14	11	3 - 0	6 - 9	12	None	0.73	1825	479	1.53	2.51	0.582	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	57.89
15	12	3 - 4	7 - 4	12	None	0.83	1904	578	1.53	2.61	0.633	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	10 # 4	None	61.99
16	13	3 - 5	7 - 9	14	None	0.98	2095	545	1.51	2.51	0.687	# 5@ 6	1 -10	# 5@12	# 4@ 6	# 6@12	# 4@ 6	12 # 4	None	79.18
17	14	3 - 9	8 - 4	14	None	1.09	2174	644	1.51	2.59	0.745	# 7@ 9	3 - 2	# 7@18	# 4@ 9	# 6@12	# 5@ 9	13 # 4	None	96.91
18	15	3 -11	8 -10	16	None	1.27	2304	702	1.53	2.61	0.806	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@11	# 5@ 9	7 # 6	None	109.79
19	16	4 - 3	9 - 5	16	None	1.40	2385	797	1.53	2.68	0.871	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 7@15	# 5@ 9	17 # 4	None	114.58
20	17	4 - 3	9 - 8	18	None	1.59	2670	682	1.50	2.52	0.938	# 6@ 6	2 - 2	# 6@12	# 4@ 6	# 7@14	# 4@ 6	19 # 4	None	127.36
21	18	4 - 8	10 - 5	18	None	1.74	2654	864	1.52	2.66	1.009	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 8@17	# 6@ 9	7 # 7	None	150.02
22	19	4 -10	10 -10	20	None	1.96	2878	839	1.52	2.60	1.082	# 8@ 9	3 - 7	# 8@18	# 6@ 9	# 8@16	# 6@ 9	6 # 8	None	174.34

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 40°, μ = 0.55

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	374	409	6.84	6.30	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	589	356	4.76	3.96	0.003	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 0	2 - 8	12	None	0.22	908	198	3.56	2.72	0.009	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	16.73
6	8	1 - 0	2 -11	12	None	0.26	1081	103	2.85	2.28	0.022	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	18.51
7	8	1 - 6	3 - 7	12	None	0.31	1105	259	2.67	2.63	0.047	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	20.66
8	8	1 - 6	3 -10	12	None	0.34	1275	163	2.28	2.29	0.092	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	22.44
9	8	1 - 8	4 - 2	12	None	0.38	1449	111	2.06	2.16	0.166	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	24.97
10	8	1 -10	4 - 6	12	None	0.41	1627	55	1.90	2.06	0.281	# 6@18	None	None	# 4@18	# 4@12	# 6@18	6 # 4	None	28.00
11	8	2 - 0	4 -11	12	None	0.45	1735	38	1.77	2.01	0.453	# 5@ 9	1 -10	# 5@18	# 4@ 9	# 4@12	# 4@ 9	7 # 4	None	34.03
12	9	2 - 2	5 - 4	12	None	0.53	1879	41	1.70	2.00	0.492	# 5@ 9	1 -10	# 5@18	# 4@ 9	# 5@12	# 4@ 9	7 # 4	None	40.83
13	10	2 - 4	5 -10	12	None	0.62	1902	158	1.68	2.11	0.535	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	5 # 5	None	53.36
14	11	2 - 6	6 - 3	12	None	0.71	2045	162	1.63	2.10	0.582	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	57.44
15	12	2 - 8	6 - 8	12	None	0.80	2189	166	1.60	2.09	0.633	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	60.73
16	13	2 - 9	7 - 1	14	None	0.95	2398	111	1.59	2.03	0.687	# 5@ 6	1 -10	# 5@12	# 4@ 6	# 6@12	# 4@ 6	7 # 5	None	77.57
17	14	2 -11	7 - 6	14	None	1.06	2542	115	1.56	2.03	0.745	# 7@ 9	3 - 2	# 7@18	# 4@ 9	# 6@12	# 5@ 9	12 # 4	None	95.09
18	15	3 - 1	8 - 0	16	None	1.23	2662	184	1.60	2.08	0.806	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@11	# 5@ 9	9 # 5	None	107.50
19	16	3 - 3	8 - 5	16	None	1.35	2806	188	1.57	2.08	0.871	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 7@15	# 5@ 9	5 # 7	None	112.05
20	17	3 - 5	8 -10	18	None	1.54	3049	143	1.58	2.05	0.938	# 6@ 6	2 - 2	# 6@12	# 4@ 6	# 7@14	# 4@ 6	8 # 6	None	125.57
21	18	3 - 6	9 - 3	18	None	1.68	3159	136	1.54	2.03	1.009	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 8@17	# 5@ 9	6 # 7	None	141.77
22	19	3 - 8	9 - 8	20	None	1.88	3403	90	1.55	2.00	1.082	# 8@ 9	3 - 7	# 8@18	# 5@ 9	# 8@16	# 6@ 9	7 # 7	None	167.38

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \leq$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 30°, μ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	525	293	3.10	3.85	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	891	99	2.18	2.43	0.005	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 6	3 - 2	12	None	0.24	1138	94	1.88	2.42	0.015	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	17.17
6	8	1 - 8	3 - 7	12	None	0.28	1314	46	1.58	2.22	0.038	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	19.10
7	8	2 - 4	4 - 5	12	None	0.34	1345	234	1.55	2.59	0.082	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	22.07
8	8	3 - 0	5 - 4	12	None	0.40	1340	430	1.54	2.98	0.160	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	7 # 4	None	25.12
9	8	3 - 8	6 - 2	12	None	0.45	1415	568	1.54	3.24	0.288	# 6@15	None	None	# 4@15	# 4@12	# 6@15	8 # 4	None	32.94
10	8	4 - 2	6 -10	12	None	0.50	1535	643	1.50	3.28	0.488	# 8@18	None	None	# 5@18	# 4@12	# 6@18	9 # 4	None	42.91
11	10	4 - 8	7 - 9	12	None	0.63	1577	799	1.51	3.53	0.402	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 5@ 9	7 # 5	None	54.84
12	11	5 - 2	8 - 6	12	None	0.72	1689	892	1.50	3.62	0.467	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 6@ 9	5 # 6	None	63.33
13	12	5 - 8	9 - 4	12	None	0.83	1736	1037	1.51	3.81	0.536	# 5@ 6	1 -10	# 5@12	# 4@ 6	# 5@12	# 5@ 6	8 # 5	None	70.92
14	13	6 - 2	10 - 1	14	None	1.00	1924	1105	1.53	3.79	0.611	# 7@ 9	2 - 5	# 6@18	# 5@ 9	# 6@12	# 7@ 9	7 # 6	None	98.06
15	14	6 - 8	10 -10	14	None	1.12	2039	1196	1.52	3.84	0.691	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 7@ 9	17 # 4	None	110.60
16	15	7 - 1	11 - 7	16	None	1.31	2190	1270	1.52	3.80	0.775	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 6@11	# 7@ 9	20 # 4	None	131.61
17	17	7 - 4	12 - 2	18	None	1.57	2413	1292	1.50	3.68	0.721	# 8@ 9	3 - 2	# 7@18	# 6@ 9	# 7@14	# 7@ 9	6 # 8	None	147.35
18	18	7 -10	13 - 0	18	None	1.72	2460	1436	1.51	3.82	0.809	# 8@ 9	3 - 2	# 7@18	# 6@ 9	# 8@17	# 8@ 9	26 # 4	None	168.59
19	19	8 - 4	13 - 9	20	None	1.96	2648	1503	1.52	3.80	0.901	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@16	# 7@ 6	10 # 7	None	193.26
20	20	7 - 2	12 -10	20	12x18	2.09	3168	1056	1.51	2.97	0.998	# 9@ 9	3 - 7	# 8@18	# 6@ 9	# 8@15	# 8@ 9	18 # 5	# 4@ 9	209.43
21	22	7 - 6	13 - 7	22	12x18	2.41	3321	1131	1.51	2.99	0.957	# 9@ 9	3 - 7	# 8@18	# 7@ 9	# 8@14	# 8@ 9	21 # 5	# 4@ 9	229.40
22	23	7 - 8	14 - 0	24	12x20	2.67	3609	1065	1.50	2.87	1.057	# 8@ 6	3 - 2	# 7@12	# 6@ 6	# 9@17	# 7@ 6	24 # 5	# 4@ 6	269.20

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 30°, μ = 0.55

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	525	293	3.42	3.85	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	891	99	2.42	2.43	0.005	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 6	3 - 2	12	None	0.24	1138	94	2.13	2.42	0.015	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	17.17
6	8	1 - 8	3 - 7	12	None	0.28	1314	46	1.81	2.22	0.038	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	19.10
7	8	2 - 0	4 - 1	12	None	0.32	1489	45	1.66	2.19	0.082	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	21.78
8	8	2 - 4	4 - 8	12	None	0.37	1585	97	1.56	2.23	0.160	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	7 # 4	None	24.52
9	8	2 -10	5 - 4	12	None	0.42	1685	196	1.54	2.36	0.288	# 6@15	None	None	# 4@15	# 4@12	# 6@15	7 # 4	None	31.27
10	8	3 - 4	6 - 0	12	None	0.47	1789	289	1.53	2.48	0.488	# 8@18	None	None	# 5@18	# 4@12	# 6@18	8 # 4	None	41.40
11	10	3 - 8	6 - 9	12	None	0.59	1843	415	1.53	2.62	0.402	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	49.38
12	11	4 - 0	7 - 4	12	None	0.68	1993	454	1.50	2.62	0.467	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 5@ 9	10 # 4	None	56.42
13	12	4 - 4	8 - 0	12	None	0.78	2050	573	1.50	2.73	0.536	# 5@ 6	1 -10	# 5@12	# 4@ 6	# 5@12	# 5@ 6	7 # 5	None	67.10
14	13	4 - 8	8 - 7	14	None	0.93	2291	570	1.50	2.68	0.611	# 7@ 9	2 - 5	# 6@18	# 5@ 9	# 6@12	# 6@ 9	6 # 6	None	85.90
15	14	5 - 2	9 - 4	14	None	1.05	2388	684	1.52	2.79	0.691	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 6@ 9	5 # 7	None	98.45
16	15	5 - 5	9 -11	16	None	1.23	2590	685	1.50	2.72	0.775	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 6@11	# 6@ 9	8 # 6	None	117.59
17	17	5 - 8	10 - 6	18	None	1.47	2836	684	1.50	2.68	0.721	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 7@14	# 6@ 9	7 # 7	None	130.17
18	18	6 - 0	11 - 2	18	None	1.62	2893	801	1.51	2.75	0.809	# 8@ 9	3 - 2	# 7@18	# 6@ 9	# 8@17	# 7@ 9	10 # 6	None	150.63
19	19	6 - 4	11 - 9	20	None	1.84	3134	799	1.50	2.71	0.901	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@16	# 6@ 6	17 # 5	None	169.15
20	20	6 -10	12 - 6	20	None	2.01	3231	912	1.52	2.79	0.998	# 9@ 9	3 - 7	# 8@18	# 6@ 9	# 8@15	# 8@ 9	7 # 8	None	204.15
21	22	7 - 0	13 - 1	22	None	2.31	3437	915	1.51	2.74	0.957	# 9@ 9	3 - 7	# 8@18	# 7@ 9	# 8@14	# 8@ 9	8 # 8	None	223.07
22	23	7 - 4	13 - 8	24	None	2.57	3678	912	1.50	2.71	1.057	# 8@ 6	3 - 2	# 7@12	# 6@ 6	# 9@17	# 7@ 6	9 # 8	None	261.26

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 35°, μ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	452	366	4.29	4.73	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	749	241	2.98	2.99	0.004	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 6	3 - 2	12	None	0.24	963	268	2.52	2.98	0.012	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	17.17
6	8	1 - 6	3 - 5	12	None	0.27	1165	171	2.02	2.46	0.031	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	18.96
7	8	1 - 8	3 - 9	12	None	0.31	1387	95	1.75	2.23	0.067	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	20.81
8	8	1 -10	4 - 2	12	None	0.35	1533	66	1.56	2.13	0.130	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	23.41
9	8	2 - 4	4 -10	12	None	0.40	1590	212	1.52	2.34	0.234	# 6@18	None	None	# 4@18	# 4@12	# 6@18	7 # 4	None	27.34
10	8	2 -10	5 - 6	12	None	0.45	1660	343	1.50	2.51	0.396	# 7@18	None	None	# 4@18	# 4@12	# 6@18	5 # 5	None	34.82
11	9	3 - 5	6 - 5	12	None	0.54	1625	581	1.54	2.88	0.448	# 6@ 9	1 -10	# 5@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	45.26
12	10	3 - 9	7 - 0	12	None	0.63	1748	647	1.50	2.91	0.505	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 5@ 9	6 # 5	None	55.38
13	11	4 - 3	7 -10	12	None	0.73	1742	853	1.54	3.21	0.566	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 5@ 9	7 # 5	None	60.53
14	12	4 - 7	8 - 5	12	None	0.83	1866	917	1.51	3.21	0.632	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 5@12	# 6@ 9	5 # 6	None	75.13
15	13	4 -11	9 - 0	14	None	0.99	2072	950	1.52	3.16	0.701	# 7@ 9	2 - 5	# 6@18	# 5@ 9	# 6@12	# 6@ 9	9 # 5	None	90.38
16	14	5 - 4	9 - 9	14	None	1.11	2117	1081	1.52	3.27	0.775	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 6@ 9	5 # 7	None	102.98
17	16	5 - 7	10 - 4	16	None	1.35	2325	1117	1.53	3.23	0.703	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 7@15	# 6@ 9	6 # 7	None	115.14
18	17	5 - 9	10 -10	18	None	1.55	2492	1152	1.52	3.17	0.780	# 6@ 6	2 - 2	# 6@12	# 5@ 6	# 7@14	# 5@ 6	14 # 5	None	131.15
19	18	6 - 1	11 - 5	18	None	1.69	2617	1217	1.50	3.18	0.862	# 8@ 9	3 - 2	# 7@18	# 6@ 9	# 8@17	# 7@ 9	15 # 5	None	154.28
20	19	6 - 5	12 - 0	20	None	1.91	2823	1249	1.51	3.14	0.947	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@16	# 6@ 6	17 # 5	None	175.22
21	20	6 -10	12 - 9	20	None	2.08	2866	1381	1.51	3.22	1.036	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@15	# 6@ 6	7 # 8	None	186.86
22	22	7 - 1	13 - 4	22	None	2.40	3075	1417	1.51	3.19	0.982	# 7@ 6	3 - 2	# 7@12	# 5@ 6	# 8@14	# 6@ 6	21 # 5	None	214.98

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 35°, μ = 0.55

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	452	366	4.68	4.73	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	749	241	3.28	2.99	0.004	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 6	3 - 2	12	None	0.24	963	268	2.83	2.98	0.012	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	17.17
6	8	1 - 6	3 - 5	12	None	0.27	1165	171	2.29	2.46	0.031	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	18.96
7	8	1 - 8	3 - 9	12	None	0.31	1387	95	1.99	2.23	0.067	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	20.81
8	8	1 -10	4 - 2	12	None	0.35	1533	66	1.79	2.13	0.130	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	23.41
9	8	2 - 2	4 - 8	12	None	0.40	1672	100	1.70	2.16	0.234	# 6@18	None	None	# 4@18	# 4@12	# 6@18	7 # 4	None	27.17
10	8	2 - 4	5 - 0	12	None	0.43	1902	12	1.57	2.03	0.396	# 7@18	None	None	# 4@18	# 4@12	# 6@18	7 # 4	None	33.78
11	9	2 - 7	5 - 7	12	None	0.51	1968	95	1.53	2.10	0.448	# 6@ 9	1 -10	# 5@18	# 4@ 9	# 5@12	# 4@ 9	5 # 5	None	43.72
12	10	2 -11	6 - 2	12	None	0.60	2075	180	1.52	2.18	0.505	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	8 # 4	None	50.90
13	11	3 - 3	6 -10	12	None	0.70	2074	363	1.54	2.37	0.566	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 5@ 9	9 # 4	None	57.85
14	12	3 - 7	7 - 5	12	None	0.79	2190	438	1.54	2.42	0.632	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 5@12	# 5@ 9	10 # 4	None	68.77
15	13	3 - 9	7 -10	14	None	0.94	2475	364	1.52	2.32	0.701	# 7@ 9	2 - 5	# 6@18	# 5@ 9	# 6@12	# 5@ 9	12 # 4	None	83.06
16	14	4 - 0	8 - 5	14	None	1.05	2552	437	1.50	2.36	0.775	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 5@ 9	13 # 4	None	95.02
17	16	4 - 3	9 - 0	16	None	1.28	2768	469	1.53	2.37	0.703	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 7@15	# 5@ 9	10 # 5	None	106.32
18	17	4 - 5	9 - 6	18	None	1.47	2944	493	1.53	2.37	0.780	# 6@ 6	2 - 2	# 6@12	# 4@ 6	# 7@14	# 5@ 6	12 # 5	None	123.06
19	18	4 - 9	10 - 1	18	None	1.62	3060	568	1.53	2.41	0.862	# 8@ 9	3 - 2	# 7@18	# 6@ 9	# 8@17	# 6@ 9	5 # 8	None	140.68
20	19	4 -11	10 - 6	20	None	1.82	3346	493	1.52	2.33	0.947	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@16	# 5@ 6	15 # 5	None	161.51
21	20	5 - 2	11 - 1	20	None	1.98	3423	567	1.50	2.36	1.036	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@15	# 5@ 6	8 # 7	None	172.18
22	22	5 - 5	11 - 8	22	None	2.28	3639	598	1.52	2.37	0.982	# 7@ 6	3 - 2	# 7@12	# 5@ 6	# 8@14	# 5@ 6	7 # 8	None	199.22

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 40°, μ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	389	429	6.13	5.90	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	626	364	4.22	3.72	0.003	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 0	2 - 8	12	None	0.22	983	180	3.13	2.56	0.010	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	16.73
6	8	1 - 0	2 -11	12	None	0.26	1183	64	2.48	2.15	0.025	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	18.51
7	8	1 - 6	3 - 7	12	None	0.31	1203	250	2.29	2.51	0.053	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	20.66
8	8	1 - 6	3 -10	12	None	0.34	1398	134	1.94	2.19	0.104	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	22.44
9	8	1 - 8	4 - 2	12	None	0.38	1594	74	1.74	2.07	0.188	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	24.97
10	8	2 - 0	4 - 8	12	None	0.42	1694	149	1.66	2.15	0.318	# 5@12	None	None	# 4@12	# 4@12	# 5@12	7 # 4	None	29.82
11	8	2 - 2	5 - 1	12	None	0.46	1816	132	1.53	2.09	0.512	# 6@ 9	1 -10	# 5@18	# 4@ 9	# 4@12	# 4@ 9	7 # 4	None	38.41
12	9	2 - 6	5 - 8	12	None	0.54	1884	261	1.51	2.23	0.556	# 6@ 9	1 -10	# 5@18	# 4@ 9	# 5@12	# 4@ 9	5 # 5	None	46.20
13	10	2 -10	6 - 4	12	None	0.64	1849	483	1.53	2.47	0.605	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	54.60
14	11	3 - 2	6 -11	12	None	0.73	1934	592	1.52	2.57	0.658	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	58.03
15	12	3 - 6	7 - 6	12	None	0.83	2022	698	1.52	2.66	0.716	# 5@ 6	1 -10	# 5@12	# 4@ 6	# 5@12	# 4@ 6	10 # 4	None	66.51
16	13	3 - 9	8 - 1	14	None	0.99	2164	756	1.54	2.67	0.777	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 6@12	# 5@ 9	8 # 5	None	85.55
17	14	4 - 1	8 - 8	14	None	1.11	2255	858	1.53	2.75	0.843	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 5@ 9	6 # 6	None	99.44
18	16	4 - 0	9 - 0	16	None	1.33	2460	826	1.52	2.64	0.751	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 7@15	# 5@ 9	16 # 4	None	109.04
19	17	4 - 2	9 - 5	18	None	1.52	2704	793	1.51	2.57	0.821	# 6@ 6	2 - 2	# 6@12	# 4@ 6	# 7@14	# 4@ 6	12 # 5	None	122.30
20	18	4 - 6	10 - 0	18	None	1.67	2791	899	1.51	2.63	0.893	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 8@17	# 6@ 9	5 # 8	None	142.95
21	19	4 - 9	10 - 7	20	None	1.88	2933	957	1.53	2.64	0.969	# 8@ 9	3 - 7	# 8@18	# 6@ 9	# 8@16	# 6@ 9	15 # 5	None	167.90
22	20	5 - 1	11 - 2	20	None	2.05	3022	1060	1.52	2.70	1.049	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@15	# 5@ 6	11 # 6	None	178.01

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 40°, μ = 0.55

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	389	429	6.62	5.90	0.001	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	626	364	4.59	3.72	0.003	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 0	2 - 8	12	None	0.22	983	180	3.44	2.56	0.010	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	16.73
6	8	1 - 0	2 -11	12	None	0.26	1183	64	2.74	2.15	0.025	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	18.51
7	8	1 - 6	3 - 7	12	None	0.31	1203	250	2.57	2.51	0.053	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	20.66
8	8	1 - 6	3 -10	12	None	0.34	1398	134	2.19	2.19	0.104	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	22.44
9	8	1 - 8	4 - 2	12	None	0.38	1594	74	1.99	2.07	0.188	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	None	24.97
10	8	2 - 0	4 - 8	12	None	0.42	1694	149	1.91	2.15	0.318	# 5@12	None	None	# 4@12	# 4@12	# 5@12	7 # 4	None	29.82
11	8	2 - 2	5 - 1	12	None	0.46	1816	132	1.77	2.09	0.512	# 6@ 9	1 -10	# 5@18	# 4@ 9	# 4@12	# 4@ 9	7 # 4	None	38.41
12	9	2 - 4	5 - 6	12	None	0.54	1975	132	1.70	2.08	0.556	# 6@ 9	1 -10	# 5@18	# 4@ 9	# 5@12	# 4@ 9	5 # 5	None	46.05
13	10	2 - 4	5 -10	12	None	0.62	2100	118	1.62	2.04	0.605	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	5 # 5	None	53.36
14	11	2 - 6	6 - 3	12	None	0.71	2259	117	1.57	2.03	0.658	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 4@ 9	9 # 4	None	57.44
15	12	2 - 8	6 - 8	12	None	0.80	2418	117	1.53	2.02	0.716	# 5@ 6	1 -10	# 5@12	# 4@ 6	# 5@12	# 4@ 6	9 # 4	None	64.73
16	13	2 -11	7 - 3	14	None	0.95	2551	186	1.57	2.07	0.777	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 6@12	# 5@ 9	5 # 6	None	83.56
17	14	3 - 1	7 - 8	14	None	1.06	2710	186	1.54	2.06	0.843	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 5@ 9	12 # 4	None	97.05
18	16	3 - 0	8 - 0	16	None	1.29	2941	122	1.53	2.01	0.751	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 7@15	# 5@ 9	9 # 5	None	106.35
19	17	3 - 4	8 - 7	18	None	1.47	3108	205	1.58	2.07	0.821	# 6@ 6	2 - 2	# 6@12	# 4@ 6	# 7@14	# 4@ 6	17 # 4	None	120.02
20	18	3 - 6	9 - 0	18	None	1.61	3267	205	1.56	2.06	0.893	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 8@17	# 5@ 9	8 # 6	None	135.74
21	19	3 - 7	9 - 5	20	None	1.81	3498	135	1.54	2.01	0.969	# 8@ 9	3 - 7	# 8@18	# 6@ 9	# 8@16	# 6@ 9	7 # 7	None	164.23
22	20	3 - 9	9 -10	20	None	1.96	3657	134	1.52	2.01	1.049	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@15	# 5@ 6	14 # 5	None	173.31

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 30°, μ = 0.45

BACKFILL SLOPE: 30°

$f_c' =$ 3,000 psi

$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	12x18	0.24	1003	391	3.07	2.53	0.002	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	# 4@ 9	17.62
4	8	1 - 6	3 - 2	12	12x18	0.28	1501	240	2.14	2.14	0.010	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	# 4@ 9	19.62
5	8	2 - 2	3 -10	12	12x18	0.33	1949	161	1.66	2.02	0.030	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	# 4@ 9	21.78
6	8	2 - 8	4 - 7	12	12x22	0.40	2158	244	1.54	2.03	0.075	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	# 5@ 9	27.33
7	10	3 - 4	5 - 7	18	12x24	0.62	2685	270	1.50	2.03	0.083	H# 7@18	None	None	# 4@18	# 5@12	H# 7@18	5 # 6	# 6@18	44.26
8	11	3 - 3	5 -10	14	18x32	0.70	2888	268	1.52	2.00	0.122	# 5@12	None	None	# 4@12	# 5@12	# 5@12	9 # 4	# 6@12	41.49
9	19	3 - 3	6 - 8	20	18x32	1.11	3278	365	1.50	2.05	0.043	H# 6@12	None	None	# 4@12	# 8@16	# 6@12	5 # 7	# 6@12	68.86
10	29	2 -11	7 - 4	30	18x30	1.74	3973	303	1.51	2.00	0.020	H# 9@18	None	None	# 6@18	# 9@13	H# 9@18H	8 # 7	# 7@18	116.07
11	33	3 - 2	8 - 2	34	18x32	2.15	4295	397	1.51	2.02	0.022	H# 7@ 9	5 - 6	#10@18	# 4@ 9	# 9@12	# 7@ 9	10 # 7	# 5@ 9	155.25
12	35	3 - 6	8 -10	36	18x36	2.48	4707	384	1.51	2.00	0.029	H# 7@ 9	5 - 6	#10@18	# 5@ 9	# 9@11	# 7@ 9	16 # 6	# 5@ 9	176.61
13	39	3 - 9	9 - 8	40	19x38	2.98	5037	481	1.50	2.03	0.031	# 6@ 6	4 - 5	# 9@12	# 4@ 6	# 9@10	# 6@ 6	19 # 6	# 5@ 6	210.78
14	40	4 - 2	10 - 4	42	21x42	3.34	5495	443	1.50	2.00	0.042	# 8@ 9	6 - 7	#11@18	# 6@ 9	# 9@10	# 8@ 9	12 # 8	# 6@ 9	254.94
15	43	4 - 9	11 - 4	48	22x44	3.97	6008	483	1.50	2.01	0.047	# 8@ 9	6 - 7	#11@18	# 6@ 9	# 9@ 9	# 8@ 9	15 # 8	# 6@ 9	285.38
16	46	4 - 9	11 -10	48	24x48	4.38	6246	532	1.50	2.01	0.054	# 8@ 9	6 - 7	#11@18	# 6@ 9	# 9@ 8	# 8@ 9	21 # 7	# 6@ 9	309.44
17	54	9 - 1	17 - 0	54	25x50	6.05	5258	2133	1.50	2.67	0.045	# 7@ 6	5 - 6	#10@12	# 6@ 6	# 9@ 7	# 7@ 6	34 # 7	# 5@ 6	419.52
18	56	9 - 8	18 - 0	56	27x54	6.67	5503	2275	1.50	2.68	0.053	# 9@ 9	5 - 6	#10@18	# 7@ 9	# 9@ 7	# 9@ 9	28 # 8	# 7@ 9	442.46

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 30°, μ = 0.55

BACKFILL SLOPE: 30°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	906	294	1.55	2.28	0.002	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	9	2 - 2	3 -11	12	12x16	0.31	1808	221	1.73	2.05	0.007	H# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9	6 # 4	# 4@ 9	22.42
5	8	2 - 2	3 -10	12	12x16	0.32	1933	160	1.74	2.01	0.030	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	# 4@ 9	21.63
6	8	2 - 9	4 - 8	12	12x16	0.38	2081	281	1.50	2.05	0.075	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	7 # 4	# 4@ 9	25.26
7	10	3 - 1	5 - 4	14	12x20	0.52	2486	275	1.50	2.02	0.083	H# 5@12	None	None	# 4@12	# 5@12	# 5@12	9 # 4	# 5@12	34.99
8	12	3 - 6	6 - 2	16	12x24	0.69	2745	378	1.50	2.05	0.094	H# 6@15	None	None	# 4@15	# 5@12	# 6@15	7 # 5	# 6@15	44.17
9	15	3 - 9	6 -10	20	18x26	0.98	3295	334	1.50	2.02	0.087	H# 6@12	None	None	# 4@12	# 6@11	# 6@12	5 # 7	# 6@12	64.37
10	19	4 - 1	7 - 8	20	18x30	1.22	3424	514	1.50	2.10	0.072	# 6@12	None	None	# 5@12	# 8@16	# 6@12	11 # 5	# 6@12	77.32
11	21	4 - 6	8 - 6	24	18x32	1.52	3813	555	1.50	2.09	0.086	# 6@ 9	3 - 7	# 8@18	# 4@ 9	# 8@15	# 6@ 9	15 # 5	# 5@ 9	104.48
12	21	5 - 2	9 - 4	26	18x36	1.73	4205	580	1.50	2.07	0.133	# 6@ 9	3 - 7	# 8@18	# 5@ 9	# 8@15	# 6@ 9	17 # 5	# 5@ 9	117.05
13	26	4 -10	9 - 8	28	19x38	2.10	4586	522	1.50	2.02	0.105	# 5@ 6	3 - 2	# 7@12	# 4@ 6	# 9@15	# 5@ 6	19 # 5	# 5@ 6	138.10
14	28	5 - 2	10 - 4	28	21x42	2.38	4860	582	1.50	2.03	0.122	# 5@ 6	3 - 7	# 8@12	# 5@ 6	# 9@14	# 5@ 6	8 # 8	# 5@ 6	165.53
15	28	6 - 0	11 - 4	34	22x44	2.78	5466	554	1.50	2.01	0.172	# 7@ 9	4 - 5	# 9@18	# 6@ 9	# 9@14	# 7@ 9	19 # 6	# 6@ 9	196.11
16	30	6 - 1	11 -10	34	24x48	3.08	5743	565	1.50	2.00	0.193	# 7@ 9	4 - 5	# 9@18	# 6@ 9	# 9@13	# 7@ 9	20 # 6	# 6@ 9	209.86
17	32	6 - 9	12 -10	38	25x50	3.57	6139	653	1.50	2.02	0.215	# 6@ 6	3 - 7	# 8@12	# 6@ 6	# 9@12	# 6@ 6	24 # 6	# 5@ 6	248.55
18	36	6 - 6	13 - 2	36	27x54	3.91	6280	701	1.50	2.02	0.201	# 8@ 9	5 - 6	#10@18	# 7@ 9	# 9@11	# 7@ 9	13 # 8	# 7@ 9	283.88
19	38	7 - 0	14 - 0	40	28x56	4.44	6754	707	1.50	2.01	0.224	# 8@ 9	5 - 6	#10@18	# 7@ 9	# 9@10	# 8@ 9	21 # 7	# 7@ 9	322.07
20	40	7 - 4	14 - 8	40	30x60	4.84	7028	766	1.50	2.02	0.248	# 7@ 6	4 - 5	# 9@12	# 6@ 6	# 9@10	# 7@ 6	29 # 6	# 6@ 6	357.70
21	42	7 -11	15 - 8	48	30x60	5.60	7627	753	1.50	2.01	0.274	# 9@ 9	6 - 7	#11@18	# 8@ 9	# 9@ 9	# 8@ 9	21 # 8	# 7@ 9	416.81
22	50	8 - 5	17 - 0	50	30x60	6.57	7540	1194	1.50	2.11	0.205	# 7@ 6	5 - 6	#10@12	# 7@ 6	# 9@ 8	# 7@ 6	31 # 7	# 6@ 6	471.80

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 35°, μ = 0.45

BACKFILL SLOPE: 35°

$f_c' =$ 3,000 psi

$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	810	452	1.63	2.52	0.002	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	2 - 0	3 - 8	12	12x16	0.29	1826	338	1.86	2.08	0.009	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	# 4@ 9	19.92
5	8	1 -10	3 - 6	12	12x16	0.31	1955	259	1.90	2.02	0.027	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	# 4@ 9	21.33
6	8	2 - 3	4 - 2	12	12x16	0.36	2154	339	1.58	2.01	0.068	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	# 4@ 9	24.15
7	9	2 - 8	4 -10	12	12x20	0.45	2425	417	1.53	2.03	0.102	# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9	7 # 4	# 4@ 9	30.00
8	12	2 - 8	5 - 4	12	12x24	0.58	2609	500	1.52	2.04	0.084	# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9	7 # 4	# 5@ 9	35.43
9	14	3 - 4	6 - 4	20	12x24	0.87	3262	522	1.50	2.02	0.096	H# 6@12	None	None	# 4@12	# 6@12	# 6@12	9 # 5	# 5@12	58.49
10	15	3 - 7	6 -10	18	18x30	1.00	3515	585	1.51	2.03	0.132	H# 7@18	None	None	# 5@18	# 6@11	H# 7@18	9 # 5	# 7@18	65.95
11	16	4 - 1	7 - 8	22	18x32	1.24	3911	655	1.50	2.03	0.175	# 6@ 9	3 - 2	# 7@18	# 4@ 9	# 7@15	# 6@ 9	12 # 5	# 5@ 9	88.07
12	18	4 - 3	8 - 2	22	18x36	1.42	4220	674	1.51	2.01	0.190	# 6@ 9	3 - 2	# 7@18	# 5@ 9	# 8@17	# 6@ 9	5 # 8	# 5@ 9	97.85
13	21	4 - 5	8 -10	24	19x38	1.72	4471	781	1.50	2.03	0.178	# 6@ 9	3 - 7	# 8@18	# 5@ 9	# 8@15	# 6@ 9	15 # 5	# 6@ 9	119.81
14	21	4 -11	9 - 6	26	21x42	1.94	4947	767	1.51	2.01	0.258	# 7@ 9	3 - 7	# 8@18	# 5@ 9	# 8@15	# 6@ 9	9 # 7	# 6@ 9	138.39
15	24	5 - 2	10 - 2	28	22x44	2.29	5283	838	1.50	2.01	0.244	# 7@ 9	3 - 7	# 8@18	# 6@ 9	# 9@16	# 7@ 9	14 # 6	# 6@ 9	166.58
16	25	5 - 4	10 - 8	28	24x48	2.51	5562	867	1.50	2.00	0.298	# 6@ 6	3 - 2	# 7@12	# 5@ 6	# 9@16	# 6@ 6	21 # 5	# 5@ 6	182.22
17	27	5 -10	11 - 6	32	25x50	2.94	6011	931	1.51	2.01	0.321	# 8@ 9	4 - 5	# 9@18	# 6@ 9	# 9@14	# 7@ 9	19 # 6	# 6@ 9	220.89
18	28	6 - 2	12 - 2	32	27x54	3.21	6210	1047	1.50	2.02	0.383	# 7@ 6	3 - 7	# 8@12	# 6@ 6	# 9@14	# 6@ 6	11 # 8	# 5@ 6	247.63
19	30	6 - 6	12 -10	36	28x56	3.67	6739	1024	1.51	2.00	0.408	# 7@ 6	3 - 7	# 8@12	# 6@ 6	# 9@13	# 6@ 6	23 # 6	# 6@ 6	280.27
20	30	7 - 0	13 - 6	36	30x60	3.91	7064	1074	1.50	2.00	0.527	# 8@ 6	3 - 7	# 8@12	# 6@ 6	# 9@13	# 7@ 6	24 # 6	# 6@ 6	322.15
21	36	6 -11	14 - 2	40	30x60	4.64	7325	1204	1.50	2.02	0.389	# 9@ 9	5 - 6	#10@18	# 8@ 9	# 9@11	# 8@ 9	28 # 6	# 7@ 9	354.64
22	42	6 - 9	14 - 8	44	30x60	5.40	7752	1212	1.50	2.01	0.309	# 9@ 9	6 - 7	#11@18	# 8@ 9	# 9@ 9	# 8@ 9	18 # 8	# 7@ 9	410.28

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 35°, μ = 0.55

BACKFILL SLOPE: 35°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	810	452	1.83	2.52	0.002	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	10	1 - 0	2 -10	12	None	0.23	1316	310	1.52	2.09	0.005	H# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9H	5 # 4	None	17.03
5	8	2 - 8	4 - 4	12	12x16	0.34	2280	317	1.73	2.02	0.027	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	# 4@ 9	22.74
6	8	2 - 3	4 - 2	12	12x16	0.36	2154	339	1.76	2.01	0.068	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	# 4@ 9	24.15
7	9	2 - 8	4 -10	12	12x16	0.43	2401	414	1.57	2.02	0.102	# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9	7 # 4	# 4@ 9	29.70
8	8	3 - 2	5 - 6	12	12x20	0.47	2669	471	1.52	2.00	0.284	# 7@15	None	None	# 4@15	# 4@12	# 6@15	5 # 5	# 6@15	40.90
9	9	3 - 7	6 - 2	12	12x24	0.57	2938	548	1.51	2.02	0.360	# 6@ 9	None	None	# 4@ 9	# 5@12	# 5@ 9	8 # 4	# 5@ 9	54.19
10	12	4 - 0	7 - 0	18	12x24	0.85	3479	579	1.51	2.01	0.257	H# 8@18	None	None	# 5@18	# 5@12	H# 7@18	9 # 5	# 6@18	61.99
11	11	4 - 2	7 - 4	12	18x32	0.82	3519	654	1.51	2.01	0.538	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 5@12	# 6@ 9	10 # 4	# 5@ 9	71.15
12	13	4 - 6	8 - 0	14	18x34	1.01	3886	695	1.51	2.01	0.503	# 7@ 9	2 - 5	# 6@18	# 5@ 9	# 6@12	# 7@ 9	8 # 5	# 5@ 9	91.85
13	14	5 - 0	8 -10	16	18x36	1.20	4136	828	1.50	2.03	0.601	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 7@ 9	7 # 6	# 5@ 9	116.12
14	16	5 - 4	9 - 6	18	19x38	1.44	4511	871	1.50	2.03	0.584	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 7@15	# 7@ 9	12 # 5	# 6@ 9	130.90
15	18	5 - 8	10 - 2	20	20x40	1.71	4888	913	1.50	2.02	0.579	# 8@ 9	3 - 2	# 7@18	# 6@ 9	# 8@17	# 7@ 9	10 # 6	# 6@ 9	149.07
16	18	6 - 1	10 -10	20	22x44	1.86	5129	998	1.50	2.03	0.799	# 9@ 9	3 - 5	# 7@18	# 6@ 9	# 8@17	# 8@ 9	6 # 8	# 6@ 9	175.75
17	20	6 - 5	11 - 6	22	23x46	2.16	5505	1041	1.51	2.02	0.789	# 8@ 6	2 - 9	# 6@12	# 5@ 6	# 8@15	# 7@ 6	7 # 8	# 5@ 6	207.67
18	22	6 - 6	12 - 0	24	24x48	2.47	5876	1030	1.51	2.00	0.789	# 8@ 6	3 - 2	# 7@12	# 6@ 6	# 8@14	# 7@ 6	8 # 8	# 5@ 6	236.51
19	23	6 -11	12 - 8	24	26x52	2.70	6159	1109	1.51	2.01	0.905	#10@ 9	4 - 3	# 8@18	# 7@ 9	# 9@17	# 9@ 9	15 # 6	# 6@ 9	261.61
20	25	7 - 3	13 - 4	26	27x54	3.06	6536	1151	1.51	2.01	0.910	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@16	# 8@ 6	25 # 5	# 5@ 6	305.51
21	26	7 - 7	14 - 0	28	28x56	3.38	6869	1199	1.51	2.00	1.033	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@15	# 8@ 6	11 # 8	# 6@ 6	333.31
22	28	7 -11	14 - 8	30	29x58	3.78	7246	1241	1.51	2.00	1.043	#11@ 9	5 - 1	# 9@18	# 8@ 9	# 9@14	#10@ 9	16 # 7	# 7@ 9	389.42

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 40°, μ = 0.45

BACKFILL SLOPE: 40°

$f_c' =$ 3,000 psi

$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	705	612	2.00	2.79	0.002	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	1292	413	1.58	2.12	0.008	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	10	1 - 7	3 - 5	16	None	0.32	1903	439	1.50	2.07	0.012	H# 6@15	None	None	# 4@15	# 5@12	H# 6@15H	6 # 4	None	24.07
6	8	1 -10	3 - 9	12	12x18	0.35	2148	472	2.11	2.04	0.059	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	# 4@ 9	23.26
7	8	2 - 4	4 - 5	12	12x18	0.40	2414	561	1.77	2.04	0.128	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	# 4@ 9	26.08
8	9	2 - 7	5 - 0	12	12x18	0.47	2580	675	1.58	2.05	0.175	# 6@15	None	None	# 4@15	# 5@12	# 6@15	7 # 4	# 6@15	38.10
9	8	3 - 2	5 - 8	12	12x22	0.51	2917	744	1.53	2.03	0.448	# 6@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 5	# 5@ 9	47.06
10	12	3 - 0	6 - 0	12	12x24	0.68	3161	779	1.51	2.02	0.225	# 6@12	None	None	# 4@12	# 5@12	# 6@12	8 # 4	# 5@12	49.82
11	12	3 - 8	6 -11	18	12x24	0.88	3676	870	1.51	2.02	0.362	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 5@ 9	9 # 5	# 5@ 9	65.22
12	12	3 -11	7 - 4	14	18x30	0.92	3843	940	1.51	2.02	0.560	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 5@12	# 6@ 9	12 # 4	# 5@ 9	75.87
13	14	4 - 0	7 -10	16	18x32	1.12	4131	1019	1.52	2.02	0.526	# 6@ 6	1 -10	# 5@12	# 4@ 6	# 6@12	# 5@ 6	9 # 5	# 5@ 6	96.34
14	15	4 - 6	8 - 7	20	18x32	1.35	4625	1062	1.50	2.00	0.619	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 6@11	# 6@ 9	12 # 5	# 5@ 9	117.00
15	18	4 -10	9 - 4	24	18x32	1.70	5022	1171	1.50	2.02	0.506	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 8@17	# 6@ 9	11 # 6	# 5@ 9	134.55
16	18	5 -11	10 - 8	20	20x40	1.79	4677	1763	1.52	2.19	0.699	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@17	# 6@ 6	15 # 5	# 5@ 6	159.67
17	20	6 - 3	11 - 4	20	21x42	2.02	4881	1909	1.50	2.21	0.690	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@15	# 7@ 6	16 # 5	# 5@ 6	187.57
18	22	6 - 6	12 - 0	22	22x44	2.34	5136	2040	1.51	2.22	0.690	# 9@ 9	3 - 7	# 8@18	# 6@ 9	# 8@14	# 8@ 9	13 # 6	# 6@ 9	209.77
19	22	7 - 0	12 - 8	24	23x46	2.55	5559	2091	1.50	2.19	0.904	# 8@ 6	3 - 2	# 7@12	# 5@ 6	# 8@14	# 7@ 6	15 # 6	# 5@ 6	241.17
20	24	7 - 4	13 - 4	26	24x48	2.91	5900	2192	1.51	2.19	0.900	#10@ 9	4 - 3	# 8@18	# 7@ 9	# 9@16	# 9@ 9	25 # 5	# 6@ 9	279.75
21	25	7 - 8	14 - 0	30	24x48	3.27	6320	2248	1.50	2.17	1.016	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@16	# 7@ 6	21 # 6	# 5@ 6	309.00
22	27	8 - 0	14 - 8	32	25x50	3.67	6661	2348	1.51	2.17	1.018	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@14	# 7@ 6	17 # 7	# 5@ 6	332.68

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 115 pcf, ϕ = 40°, μ = 0.55

BACKFILL SLOPE: 40°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	705	612	2.23	2.79	0.002	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	1292	413	1.78	2.12	0.008	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	8	1 - 8	3 - 4	12	None	0.25	1736	449	1.51	2.07	0.024	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	None	17.32
6	8	2 - 8	4 - 7	16	None	0.37	1972	774	1.50	2.25	0.059	H# 6@15	None	None	# 4@15	# 4@12	H# 6@15	8 # 4	None	26.68
7	8	2 - 4	4 - 5	12	12x18	0.40	2414	561	1.97	2.04	0.128	# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	# 4@ 9	26.08
8	9	2 - 7	5 - 0	12	12x18	0.47	2580	675	1.77	2.05	0.175	# 6@15	None	None	# 4@15	# 5@12	# 6@15	7 # 4	# 6@15	38.10
9	8	3 - 2	5 - 8	12	12x18	0.50	2897	740	1.60	2.03	0.448	# 6@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 5	# 4@ 9	44.40
10	10	3 - 4	6 - 2	12	12x18	0.60	3151	803	1.51	2.02	0.389	# 6@ 9	None	None	# 4@ 9	# 5@12	# 5@ 9	8 # 4	# 4@ 9	54.60
11	12	3 - 8	6 -11	12	12x20	0.73	3221	1029	1.50	2.09	0.362	# 6@ 9	2 - 2	# 6@18	# 4@ 9	# 5@12	# 5@ 9	9 # 4	# 4@ 9	56.86
12	12	3 -11	7 - 4	14	12x22	0.84	3771	922	1.51	2.00	0.560	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 5@12	# 5@ 9	12 # 4	# 5@ 9	71.25
13	14	4 - 6	8 - 4	14	12x24	1.01	3698	1325	1.50	2.13	0.526	# 6@ 6	1 -10	# 5@12	# 4@ 6	# 6@12	# 5@ 6	13 # 4	# 4@ 6	89.93
14	15	4 - 6	8 - 7	18	12x24	1.21	4408	1107	1.50	2.01	0.619	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 6@11	# 6@ 9	17 # 4	# 5@ 9	113.99
15	16	5 - 0	9 - 4	22	12x24	1.46	4904	1155	1.51	2.00	0.721	# 7@ 6	2 - 5	# 6@12	# 4@ 6	# 7@15	# 5@ 6	15 # 5	# 4@ 6	131.39
16	18	5 - 0	9 - 9	20	18x28	1.64	5008	1264	1.52	2.01	0.699	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@17	# 5@ 6	14 # 5	# 4@ 6	142.64
17	20	5 - 3	10 - 4	20	18x30	1.85	5239	1368	1.51	2.02	0.690	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@15	# 6@ 6	15 # 5	# 4@ 6	164.17
18	22	5 - 4	10 -10	22	18x32	2.13	5531	1446	1.53	2.02	0.690	# 9@ 9	3 - 7	# 8@18	# 6@ 9	# 8@14	# 7@ 9	17 # 5	# 5@ 9	189.71
19	22	5 -11	11 - 7	24	18x32	2.32	5924	1521	1.50	2.02	0.904	# 8@ 6	3 - 2	# 7@12	# 5@ 6	# 8@14	# 6@ 6	14 # 6	# 5@ 6	220.10
20	24	10 - 4	16 - 4	24	18x32	2.87	4845	3378	1.50	2.59	0.900	#10@ 9	4 - 3	# 8@18	# 7@ 9	# 9@16	# 9@ 9	28 # 5	# 5@ 9	288.52
21	25	7 - 8	14 - 0	26	18x36	2.94	5967	2330	1.51	2.19	1.016	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@16	# 7@ 6	10 # 8	# 5@ 6	298.39
22	27	8 - 0	14 - 8	28	18x36	3.30	6296	2429	1.50	2.19	1.018	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@14	# 7@ 6	29 # 5	# 5@ 6	322.06

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 30°, μ = 0.45

BACKFILL SLOPE: 30°

$f_c' =$ 3,000 psi

$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	12x18	0.24	1087	395	3.02	2.43	0.003	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	# 4@ 9	17.62
4	8	1 - 6	3 - 2	12	12x18	0.28	1637	237	2.10	2.08	0.011	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	# 4@ 9	19.62
5	8	2 - 4	4 - 0	12	12x18	0.34	2049	250	1.62	2.06	0.034	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	# 4@ 9	22.59
6	8	2 -10	4 - 9	12	12x22	0.40	2290	341	1.51	2.07	0.085	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	7 # 4	# 5@ 9	28.15
7	9	3 - 1	5 - 3	12	18x28	0.54	2769	293	1.52	2.01	0.129	H# 5@12	None	None	# 4@12	# 5@12	# 5@12	7 # 4	# 6@12	36.47
8	12	3 - 4	6 - 0	14	18x32	0.73	3044	390	1.50	2.03	0.106	H# 6@15	None	None	# 4@15	# 5@12	# 6@15	6 # 5	# 7@15	46.51
9	21	3 - 3	6 -10	22	18x32	1.22	3580	428	1.51	2.03	0.036	H# 7@15	None	None	# 5@15	# 8@15	# 7@15H	11 # 5	# 7@15	78.12
10	32	3 - 0	7 - 8	32	18x30	1.91	4201	442	1.51	2.03	0.017	H# 8@12	None	None	# 5@12	# 9@12	# 8@12H	9 # 7	# 6@12	130.35
11	36	3 - 1	8 - 4	36	18x32	2.32	4643	441	1.50	2.00	0.019	H# 7@ 9	5 - 6	#10@18	# 5@ 9	# 9@11	# 7@ 9H	15 # 6	# 5@ 9	166.50
12	37	3 -10	9 - 4	40	18x36	2.72	5120	500	1.50	2.01	0.028	# 6@ 6	4 - 5	# 9@12	# 4@ 6	# 9@10	# 6@ 6	14 # 7	# 5@ 6	198.24
13	42	3 -10	10 - 0	44	19x38	3.27	5530	528	1.51	2.00	0.028	H# 8@ 9	6 - 7	#11@18	# 6@ 9	# 9@ 9	# 8@ 9	16 # 7	# 6@ 9	250.86
14	43	4 - 5	10 -10	46	21x42	3.67	5941	580	1.50	2.01	0.038	H# 8@ 9	6 - 7	#11@18	# 6@ 9	# 9@ 9	# 8@ 9	18 # 7	# 6@ 9	271.11
15	49	4 - 5	11 - 6	50	22x44	4.34	6392	600	1.51	2.01	0.036	# 7@ 6	5 - 6	#10@12	# 5@ 6	# 9@ 8	# 7@ 6	21 # 7	# 5@ 6	322.95
16	54	8 - 3	16 - 0	54	24x48	5.69	5412	2178	1.50	2.59	0.037	# 7@ 6	5 - 6	#10@12	# 6@ 6	# 9@ 7	# 7@ 6	24 # 8	# 5@ 6	397.54
17	59	8 - 8	17 - 0	59	25x50	6.58	5825	2294	1.50	2.58	0.039	H# 9@ 9	5 - 6	#10@18	# 7@ 9	# 9@ 6	# 9@ 9	28 # 8	# 6@ 9	439.02

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 30°, μ = 0.55

BACKFILL SLOPE: 30°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	9	1 - 0	2 - 9	12	None	0.19	934	351	1.52	2.32	0.002	H# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9H	5 # 4	None	14.92
4	8	1 - 6	3 - 2	12	12x18	0.28	1637	237	2.28	2.08	0.011	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	# 4@ 9	19.62
5	8	2 - 4	4 - 0	12	12x18	0.34	2049	250	1.79	2.06	0.034	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	# 4@ 9	22.59
6	8	2 -10	4 - 9	12	12x18	0.39	2262	341	1.54	2.06	0.085	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	7 # 4	# 4@ 9	25.49
7	10	3 - 2	5 - 5	12	12x22	0.50	2549	401	1.50	2.06	0.094	# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9	5 # 5	# 5@ 9	33.67
8	8	4 - 0	6 - 4	12	18x28	0.58	2858	526	1.50	2.11	0.359	# 6@ 9	None	None	# 4@ 9	# 4@12	# 5@ 9	9 # 4	# 5@ 9	49.25
9	11	4 - 1	6 -10	14	18x32	0.78	3332	461	1.50	2.04	0.249	# 8@18	None	None	# 5@18	# 5@12	# 7@18	7 # 5	# 8@18	61.87
10	13	5 - 1	8 - 2	24	18x32	1.18	4044	520	1.50	2.04	0.256	# 6@ 9	None	None	# 4@ 9	# 6@12	# 6@ 9	14 # 5	# 5@ 9	84.21
11	24	6 - 4	10 - 7	24	18x32	1.77	3374	1454	1.50	2.56	0.065	# 6@ 9	3 - 7	# 8@18	# 5@ 9	# 9@16	# 6@ 9	7 # 8	# 5@ 9	118.09
12	25	4 - 8	9 - 2	28	18x36	1.92	4699	543	1.50	2.01	0.089	# 5@ 6	3 - 2	# 7@12	# 4@ 6	# 9@16	# 5@ 6	18 # 5	# 5@ 6	129.55
13	27	5 - 1	10 - 0	32	19x38	2.29	5137	581	1.50	2.00	0.106	# 7@ 9	4 - 5	# 9@18	# 6@ 9	# 9@14	# 7@ 9	16 # 6	# 6@ 9	173.11
14	29	5 - 9	11 - 0	32	21x42	2.61	5279	817	1.50	2.07	0.124	# 7@ 9	4 - 5	# 9@18	# 6@ 9	# 9@13	# 7@ 9	13 # 7	# 6@ 9	189.26
15	32	5 -10	11 - 6	36	22x44	3.06	5916	674	1.50	2.01	0.130	# 7@ 9	5 - 6	#10@18	# 6@ 9	# 9@12	# 7@ 9	15 # 7	# 6@ 9	217.71
16	32	6 - 5	12 - 4	38	24x48	3.38	6286	738	1.50	2.01	0.180	# 6@ 6	3 - 7	# 8@12	# 6@ 6	# 9@12	# 6@ 6	17 # 7	# 5@ 6	238.58
17	36	7 - 3	13 - 8	40	25x50	3.96	6345	1112	1.50	2.11	0.171	# 6@ 6	3 - 7	# 8@12	# 6@ 6	# 9@11	# 6@ 6	15 # 8	# 5@ 6	264.48
18	36	7 - 8	14 - 4	42	27x54	4.31	6790	1096	1.50	2.09	0.227	# 8@ 9	5 - 6	#10@18	# 7@ 9	# 9@11	# 8@ 9	22 # 7	# 7@ 9	311.48
19	42	7 - 0	14 - 4	44	28x56	4.89	7398	838	1.50	2.00	0.188	# 8@ 9	6 - 7	#11@18	# 8@ 9	# 9@ 9	# 8@ 9	23 # 7	# 7@ 9	361.06
20	42	7 - 8	15 - 2	46	30x60	5.30	7848	867	1.50	2.00	0.243	# 7@ 6	4 - 5	# 9@12	# 7@ 6	# 9@ 9	# 7@ 6	26 # 7	# 6@ 6	395.84
21	50	7 - 5	15 -10	50	30x60	6.24	8129	965	1.50	2.01	0.183	# 7@ 6	5 - 6	#10@12	# 7@ 6	# 9@ 8	# 7@ 6	22 # 8	# 6@ 6	453.68
22	52	13 -11	22 - 8	52	30x60	7.72	6543	3304	1.50	2.71	0.206	# 9@ 9	5 - 6	#10@18	# 9@ 9	# 9@ 7	# 9@ 9	43 # 7	# 7@ 9	536.31

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 35°, μ = 0.45

BACKFILL SLOPE: 35°

$f_c' =$ 3,000 psi

$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	881	477	1.59	2.44	0.002	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	2 - 0	3 - 8	12	12x16	0.29	2004	358	1.83	2.03	0.010	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	# 4@ 9	19.92
5	8	2 - 0	3 - 8	12	12x16	0.32	2054	363	1.85	2.06	0.031	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	# 4@ 9	21.48
6	8	2 - 5	4 - 4	12	12x16	0.36	2284	455	1.55	2.05	0.076	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	# 4@ 9	24.30
7	10	2 - 7	4 -10	12	12x20	0.47	2623	474	1.51	2.01	0.084	# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9	7 # 4	# 4@ 9	30.10
8	11	3 - 1	5 - 8	14	12x24	0.61	2912	620	1.51	2.05	0.124	H# 6@15	None	None	# 4@15	# 5@12	# 6@15	9 # 4	# 6@15	41.29
9	17	3 - 1	6 - 4	20	12x24	0.95	3446	634	1.50	2.03	0.060	H# 6@12	None	None	# 4@12	# 7@14	# 6@12	9 # 5	# 5@12	61.56
10	15	3 - 9	7 - 0	20	18x30	1.06	3939	642	1.50	2.00	0.149	# 6@12	None	None	# 5@12	# 6@11	# 6@12	7 # 6	# 6@12	70.03
11	18	4 - 1	7 -10	24	18x32	1.37	4283	775	1.51	2.03	0.139	# 6@ 9	3 - 2	# 7@18	# 4@ 9	# 8@17	# 6@ 9	7 # 7	# 5@ 9	93.91
12	21	4 - 0	8 - 2	22	18x36	1.53	4496	800	1.50	2.01	0.135	# 6@ 9	3 - 7	# 8@18	# 5@ 9	# 8@15	# 6@ 9	5 # 8	# 5@ 9	109.00
13	23	4 - 5	9 - 0	26	19x38	1.87	4896	903	1.51	2.02	0.153	# 6@ 9	3 - 7	# 8@18	# 5@ 9	# 9@17	# 6@ 9	17 # 5	# 6@ 9	127.11
14	22	5 - 2	9 -10	28	21x42	2.07	5382	958	1.50	2.02	0.254	# 7@ 9	3 - 7	# 8@18	# 6@ 9	# 8@14	# 7@ 9	10 # 7	# 6@ 9	156.46
15	26	5 - 2	10 - 4	30	22x44	2.46	5787	962	1.50	2.00	0.217	# 7@ 9	4 - 5	# 9@18	# 6@ 9	# 9@15	# 7@ 9	16 # 6	# 6@ 9	183.15
16	27	5 - 6	11 - 0	30	24x48	2.71	6009	1089	1.50	2.02	0.268	# 8@ 9	4 - 5	# 9@18	# 6@ 9	# 9@14	# 7@ 9	12 # 7	# 6@ 9	207.42
17	29	6 - 0	11 -10	34	25x50	3.15	6500	1156	1.50	2.02	0.293	# 8@ 9	4 - 5	# 9@18	# 7@ 9	# 9@13	# 7@ 9	20 # 6	# 6@ 9	233.86
18	30	6 - 2	12 - 4	34	27x54	3.41	6809	1185	1.50	2.01	0.352	# 7@ 6	3 - 7	# 8@12	# 6@ 6	# 9@13	# 7@ 6	21 # 6	# 5@ 6	272.41
19	32	6 - 8	13 - 2	38	28x56	3.90	7299	1252	1.50	2.01	0.380	# 9@ 9	5 - 6	#10@18	# 7@ 9	# 9@12	# 8@ 9	25 # 6	# 7@ 9	313.03
20	34	6 -10	13 - 8	38	30x60	4.26	7653	1273	1.50	2.00	0.409	# 8@ 6	3 - 7	# 8@12	# 6@ 6	# 9@11	# 7@ 6	19 # 7	# 6@ 6	342.65
21	40	6 - 9	14 - 4	42	30x60	5.01	7932	1398	1.50	2.01	0.321	# 9@ 9	6 - 7	#11@18	# 8@ 9	# 9@10	# 9@ 9	22 # 7	# 7@ 9	398.73
22	44	7 - 1	15 - 2	48	31x60	5.81	8478	1447	1.50	2.01	0.304	# 8@ 6	4 - 5	# 9@12	# 7@ 6	# 9@ 9	# 7@ 6	20 # 8	# 6@ 6	438.29

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 35°, μ = 0.55

BACKFILL SLOPE: 35°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	881	477	1.78	2.44	0.002	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 8	3 - 4	14	None	0.24	1459	462	1.51	2.19	0.010	H# 5@12	None	None	# 4@12	# 4@12	H# 5@12	6 # 4	None	17.83
5	8	2 - 0	3 - 8	12	12x18	0.32	2070	365	2.16	2.06	0.031	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	5 # 4	# 4@ 9	21.63
6	8	2 - 4	4 - 3	12	12x18	0.37	2340	409	1.82	2.02	0.076	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	# 4@ 9	24.37
7	10	2 - 8	4 -11	12	12x18	0.46	2569	520	1.62	2.04	0.084	# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9	7 # 4	# 4@ 9	30.03
8	8	3 - 8	6 - 0	12	12x20	0.49	2717	784	1.50	2.14	0.322	# 8@18	None	None	# 5@18	# 4@12	# 6@18	8 # 4	# 6@18	41.67
9	11	3 - 5	6 - 2	12	12x24	0.62	3157	651	1.50	2.02	0.223	# 7@15	None	None	# 5@15	# 5@12	# 6@15	8 # 4	# 6@15	49.14
10	12	4 - 2	7 - 2	12	18x28	0.79	3353	918	1.50	2.13	0.291	# 6@ 9	None	None	# 4@ 9	# 5@12	# 6@ 9	6 # 5	# 5@ 9	64.44
11	12	4 - 4	7 - 7	14	18x32	0.91	3879	814	1.52	2.03	0.468	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 5@12	# 6@ 9	12 # 4	# 5@ 9	73.82
12	14	4 -10	8 - 5	18	18x32	1.16	4348	882	1.50	2.03	0.456	# 6@ 6	1 -10	# 5@12	# 4@ 6	# 6@12	# 5@ 6	11 # 5	# 5@ 6	96.86
13	15	5 - 7	9 - 6	24	18x32	1.48	4814	1032	1.50	2.05	0.553	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 6@11	# 6@ 9	16 # 5	# 5@ 9	120.80
14	24	7 - 2	12 - 0	24	18x32	2.10	4145	2085	1.50	2.48	0.195	# 7@ 9	3 - 7	# 8@18	# 6@ 9	# 9@16	# 6@ 9	8 # 8	# 5@ 9	152.49
15	19	6 - 9	11 - 4	22	20x40	1.90	4982	1567	1.51	2.19	0.556	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 8@16	# 6@ 6	9 # 7	# 5@ 6	163.14
16	19	6 - 0	10 -10	20	23x46	1.93	5635	1114	1.51	2.01	0.768	# 8@ 6	2 - 9	# 6@12	# 5@ 6	# 8@16	# 7@ 6	6 # 8	# 5@ 6	192.16
17	21	6 - 6	11 - 8	24	23x46	2.29	6107	1181	1.50	2.01	0.770	# 8@ 6	3 - 2	# 7@12	# 6@ 6	# 8@15	# 7@ 6	14 # 6	# 5@ 6	227.64
18	22	6 -10	12 - 4	24	25x50	2.52	6332	1304	1.51	2.02	0.892	#10@ 9	4 - 3	# 8@18	# 7@ 9	# 8@14	# 9@ 9	21 # 5	# 6@ 9	251.16
19	24	7 - 2	13 - 0	26	26x52	2.87	6744	1348	1.50	2.02	0.900	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@16	# 8@ 6	24 # 5	# 5@ 6	294.47
20	26	7 - 6	13 - 8	28	27x54	3.24	7155	1392	1.50	2.01	0.915	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@15	# 8@ 6	19 # 6	# 5@ 6	315.47
21	28	7 - 9	14 - 4	30	28x56	3.63	7479	1470	1.50	2.01	0.935	#11@ 9	5 - 1	# 9@18	# 8@ 9	# 9@14	#10@ 9	12 # 8	# 7@ 9	378.73
22	32	8 - 1	15 - 2	34	28x56	4.25	7862	1592	1.50	2.03	0.790	# 9@ 6	3 - 7	# 8@12	# 7@ 6	# 9@12	# 8@ 6	19 # 7	# 6@ 6	401.17

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 40°, μ = 0.45

BACKFILL SLOPE: 40°

$f_c' =$ 3,000 psi

$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	762	658	1.96	2.71	0.002	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	1421	428	1.54	2.07	0.009	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	12	1 - 5	3 - 5	16	None	0.35	1980	522	1.51	2.09	0.008	H# 6@15	None	None	# 4@15	# 5@12	H# 6@15H	6 # 4	None	24.20
6	8	2 - 0	3 -11	12	12x18	0.36	2274	604	2.05	2.07	0.067	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9	6 # 4	# 4@ 9	24.08
7	9	2 - 3	4 - 5	12	12x18	0.42	2605	638	1.77	2.03	0.101	# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9	6 # 4	# 4@ 9	28.81
8	8	2 -10	5 - 2	12	12x18	0.45	2820	804	1.53	2.05	0.281	# 6@12	None	None	# 4@12	# 4@12	# 5@12	7 # 4	# 5@12	36.69
9	9	3 - 1	5 - 8	12	12x22	0.54	3173	845	1.53	2.03	0.356	# 6@ 9	None	None	# 4@ 9	# 5@12	# 5@ 9	5 # 5	# 5@ 9	53.14
10	11	3 - 5	6 - 4	14	12x24	0.70	3538	954	1.50	2.04	0.330	# 6@ 9	None	None	# 4@ 9	# 5@12	# 5@ 9	10 # 4	# 5@ 9	59.76
11	11	4 - 1	7 - 3	20	12x24	0.91	4107	1058	1.50	2.03	0.532	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 5@12	# 6@ 9	11 # 5	# 5@ 9	78.51
12	14	3 - 9	7 - 4	14	18x30	1.00	4135	1091	1.51	2.02	0.398	# 7@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 6@ 9	12 # 4	# 5@ 9	88.71
13	15	3 -11	7 -10	16	18x32	1.16	4510	1137	1.51	2.00	0.483	# 6@ 6	2 - 2	# 6@12	# 4@ 6	# 6@11	# 5@ 6	9 # 5	# 5@ 6	104.43
14	16	4 - 8	8 -10	22	18x32	1.47	5098	1265	1.51	2.01	0.577	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 7@15	# 6@ 9	7 # 7	# 5@ 9	120.43
15	22	4 - 4	9 - 2	24	18x32	1.87	5407	1288	1.51	2.00	0.313	# 6@ 6	3 - 2	# 7@12	# 5@ 6	# 8@14	# 5@ 6	8 # 7	# 5@ 6	151.19
16	18	5 -11	10 - 8	24	19x38	1.90	5447	1827	1.51	2.12	0.790	# 9@ 9	3 - 5	# 7@18	# 6@ 9	# 8@17	# 7@ 9	7 # 8	# 6@ 9	170.29
17	20	6 - 3	11 - 4	22	21x42	2.09	5528	2055	1.50	2.16	0.780	# 8@ 6	2 - 9	# 6@12	# 5@ 6	# 8@15	# 7@ 6	9 # 7	# 5@ 6	206.00
18	21	6 - 7	12 - 0	24	22x44	2.35	5857	2169	1.50	2.16	0.897	# 8@ 6	3 - 2	# 7@12	# 6@ 6	# 8@15	# 7@ 6	8 # 8	# 5@ 6	232.68
19	23	6 -11	12 - 8	24	24x48	2.64	6093	2337	1.52	2.18	0.894	#10@ 9	4 - 3	# 8@18	# 7@ 9	# 9@17	# 9@ 9	15 # 6	# 6@ 9	260.95
20	25	7 - 3	13 - 4	30	23x46	3.10	6740	2326	1.50	2.14	0.900	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@16	# 7@ 6	11 # 8	# 5@ 6	295.93
21	26	7 - 7	14 - 0	32	25x48	3.44	7069	2440	1.50	2.13	1.021	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@15	# 7@ 6	22 # 6	# 5@ 6	316.32
22	29	7 -10	14 - 8	30	27x52	3.76	7100	2693	1.50	2.17	0.929	# 9@ 6	3 - 7	# 8@12	# 7@ 6	# 9@13	# 8@ 6	16 # 7	# 5@ 6	371.50

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: γ = 130 pcf, ϕ = 40°, μ = 0.55

BACKFILL SLOPE: 40°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

CONCRETE DIMENSIONS & VOLUME							SERVICE LOAD ANALYSES					STEM REINFORCEMENT (4)					BASE REINFORCEMENT			
Height Above Base (h_w)	Stem Thick-ness (A_{stem})	Heel (C)	Width of Base (W)	Base Depth (A_{base})	Key ($t \times k$)	(1) Concrete Quantity	Base Soil Pressure		Safety Factors		Deflection at Top	(2) "O" Bars	Dowels into Stem	(3) "M" Bars	"D" Bars	(5) "L_w" Bars	(2) "P" Bars	"L_b" Bars	(6) "K" Bars	(7) Total Steel Weight
							Toe	Heel	Sliding	Overturning										
ft	in.	ft-in.	ft-in.	in.	in. × in.	cy / lf	psf	psf			in.	Size @ in.	ft-in.	Size @ in.	Size @ in.	Size @ in.	Size @ in.	No. Size	Size @ in.	lb / lf
3	8	1 - 0	2 - 8	12	None	0.17	762	658	2.17	2.71	0.002	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	13.61
4	8	1 - 0	2 - 8	12	None	0.20	1421	428	1.73	2.07	0.009	H# 4@ 9	None	None	# 4@ 9	# 4@12	# 4@ 9H	5 # 4	None	15.17
5	9	1 - 9	3 - 6	12	None	0.27	1778	609	1.50	2.15	0.019	H# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9	5 # 4	None	19.45
6	8	2 - 4	4 - 3	18	None	0.38	2486	590	1.51	2.03	0.067	H# 7@18	None	None	# 4@18	# 4@12	H# 7@18H	6 # 5	None	30.67
7	9	2 - 3	4 - 5	12	12x18	0.42	2605	638	1.96	2.03	0.101	# 4@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9	6 # 4	# 4@ 9	28.81
8	8	2 -10	5 - 2	12	12x18	0.45	2820	804	1.72	2.05	0.281	# 6@12	None	None	# 4@12	# 4@12	# 5@12	7 # 4	# 5@12	36.69
9	9	3 - 1	5 - 8	12	12x18	0.52	3153	841	1.59	2.02	0.356	# 6@ 9	None	None	# 4@ 9	# 5@12	# 4@ 9	5 # 5	# 4@ 9	47.97
10	11	3 - 3	6 - 2	12	12x20	0.64	3442	911	1.54	2.01	0.330	# 6@ 9	None	None	# 4@ 9	# 5@12	# 5@ 9	8 # 4	# 4@ 9	54.91
11	11	3 - 9	6 -11	14	12x20	0.74	3770	1044	1.50	2.02	0.532	# 7@ 9	2 - 5	# 6@18	# 4@ 9	# 5@12	# 5@ 9	7 # 5	# 4@ 9	64.32
12	13	4 - 0	7 - 6	14	12x24	0.89	4041	1147	1.53	2.03	0.498	# 7@ 9	2 - 5	# 6@18	# 5@ 9	# 6@12	# 6@ 9	12 # 4	# 5@ 9	82.86
13	14	4 - 2	8 - 0	16	12x24	1.05	4411	1193	1.50	2.01	0.595	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 6@12	# 6@ 9	9 # 5	# 5@ 9	104.16
14	16	4 - 7	8 - 9	20	12x24	1.32	4903	1276	1.51	2.01	0.577	# 8@ 9	3 - 2	# 7@18	# 5@ 9	# 7@15	# 6@ 9	5 # 8	# 5@ 9	117.49
15	17	4 - 9	9 - 2	18	18x28	1.45	5171	1327	1.51	2.00	0.679	# 7@ 6	2 - 5	# 6@12	# 5@ 6	# 7@14	# 6@ 6	6 # 7	# 4@ 6	138.68
16	18	5 - 2	9 -11	20	18x30	1.66	5460	1482	1.52	2.02	0.790	# 9@ 9	3 - 5	# 7@18	# 6@ 9	# 8@17	# 7@ 9	14 # 5	# 5@ 9	156.73
17	20	5 - 5	10 - 6	22	18x30	1.92	5873	1524	1.51	2.01	0.780	# 8@ 6	2 - 9	# 6@12	# 5@ 6	# 8@15	# 6@ 6	17 # 5	# 4@ 6	183.48
18	21	5 - 9	11 - 2	24	18x32	2.17	6163	1680	1.51	2.02	0.897	# 8@ 6	3 - 2	# 7@12	# 6@ 6	# 8@15	# 6@ 6	19 # 5	# 5@ 6	213.17
19	24	8 - 3	14 - 1	24	18x32	2.63	5438	3039	1.50	2.38	0.787	# 8@ 6	3 - 2	# 7@12	# 6@ 6	# 9@16	# 7@ 6	24 # 5	# 5@ 6	258.04
20	25	7 - 3	13 - 4	26	18x34	2.80	6361	2430	1.50	2.16	0.900	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@16	# 7@ 6	25 # 5	# 5@ 6	286.87
21	26	7 - 7	14 - 0	28	18x36	3.10	6686	2542	1.51	2.15	1.021	# 9@ 6	3 - 5	# 7@12	# 6@ 6	# 9@15	# 7@ 6	11 # 8	# 5@ 6	306.88
22	29	7 -10	14 - 8	30	18x36	3.53	6998	2675	1.50	2.16	0.929	# 9@ 6	3 - 7	# 8@12	# 7@ 6	# 9@13	# 7@ 6	16 # 7	# 5@ 6	352.83

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = h_w – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 A_g (0.002 A_g for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

Click On The Column Criteria You Need

SQUARE TIED COLUMNS

$f_c' = 5{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 10{,}000$ psi, $f_y = 75{,}000$ psi

RECTANGULAR TIED COLUMNS

$f_c' = 5{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 10{,}000$ psi, $f_y = 75{,}000$ psi

DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

ROUND SPIRAL COLUMNS

$f_c' = 4{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 5{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 10{,}000$ psi, $f_y = 75{,}000$ psi

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

SQUARE TIED COLUMNS

$f'_c = 5{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

10″ × 10″	12″ × 12″	14″ × 14″	16″ × 16″	18″ × 18″
20″ × 20″	22″ × 22″	24″ × 24″	26″ × 26″	28″ × 28″
30″ × 30″	32″ × 32″	34″ × 34″	36″ × 36″	38″ × 38″
40″ × 40″	42″ × 42″	44″ × 44″	46″ × 46″	48″ × 48″

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

SQUARE TIED COLUMNS

$f'_c = 6{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

10″ × 10″	12″ × 12″	14″ × 14″	16″ × 16″	18″ × 18″
20″ × 20″	22″ × 22″	24″ × 24″	26″ × 26″	28″ × 28″
30″ × 30″	32″ × 32″	34″ × 34″	36″ × 36″	38″ × 38″
40″ × 40″	42″ × 42″	44″ × 44″	46″ × 46″	48″ × 48″

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

SQUARE TIED COLUMNS

$f'_c = 8{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

10″ × 10″	12″ × 12″	14″ × 14″	16″ × 16″	18″ × 18″
20″ × 20″	22″ × 22″	24″ × 24″	26″ × 26″	28″ × 28″
30″ × 30″	32″ × 32″	34″ × 34″	36″ × 36″	38″ × 38″
40″ × 40″	42″ × 42″	44″ × 44″	46″ × 46″	48″ × 48″

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

SQUARE TIED COLUMNS

$f'_c = 6{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

24″ × 24″	26″ × 26″	28″ × 28″	30″ × 30″	32″ × 32″
34″ × 34″	36″ × 36″	38″ × 38″	40″ × 40″	42″ × 42″
	44″ × 44″	46″ × 46″	48″ × 48″	

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

SQUARE TIED COLUMNS

$f'_c = 8{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

24″ × 24″	26″ × 26″	28″ × 28″	30″ × 30″	32″ × 32″
34″ × 34″	36″ × 36″	38″ × 38″	40″ × 40″	42″ × 42″
	44″ × 44″	46″ × 46″	48″ × 48″	

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

SQUARE TIED COLUMNS

$f'_c = 10{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

24″ × 24″	26″ × 26″	28″ × 28″	30″ × 30″	32″ × 32″
34″ × 34″	36″ × 36″	38″ × 38″	40″ × 40″	42″ × 42″
	44″ × 44″	46″ × 46″	48″ × 48″	

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

RECTANGULAR TIED COLUMNS

$f'_c = 5{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

10″ × 10″
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Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

RECTANGULAR TIED COLUMNS

$f'_c = 6{,}000$ psi, $f_y = 60{,}000$ psi

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24″ × 46″
24″ × 48″

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

RECTANGULAR TIED COLUMNS

$f'_c = 8{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

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24″ × 46″
24″ × 48″

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

RECTANGULAR TIED COLUMNS

$f'_c = 6{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

24″ × 24″	26″ × 26″	28″ × 28″	30″ × 30″	32″ × 32″	34″ × 34″	36″ × 36″	38″ × 38″
24″ × 26″	26″ × 28″	28″ × 30″	30″ × 32″	32″ × 34″	34″ × 36″	36″ × 38″	38″ × 40″
24″ × 28″	26″ × 30″	28″ × 32″	30″ × 34″	32″ × 36″	34″ × 38″	36″ × 40″	38″ × 42″
24″ × 30″	26″ × 32″	28″ × 34″	30″ × 36″	32″ × 38″	34″ × 40″	36″ × 42″	38″ × 44″
24″ × 32″	26″ × 34″	28″ × 36″	30″ × 38″	32″ × 40″	34″ × 42″	36″ × 44″	38″ × 46″
24″ × 34″	26″ × 36″	28″ × 38″	30″ × 40″	32″ × 42″	34″ × 44″	36″ × 46″	38″ × 48″
24″ × 36″	26″ × 38″	28″ × 40″	30″ × 42″	32″ × 44″	34″ × 46″	36″ × 48″	
24″ × 38″	26″ × 40″	28″ × 42″	30″ × 44″	32″ × 46″	34″ × 48″		
24″ × 40″	26″ × 42″	28″ × 44″	30″ × 46″	32″ × 48″			40″ × 40″
24″ × 42″	26″ × 44″	28″ × 46″	30″ × 48″			42″ × 42″	40″ × 42″
24″ × 44″	26″ × 46″	28″ × 48″			44″ × 44″	42″ × 44″	40″ × 44″
24″ × 46″	26″ × 48″			46″ × 46″	44″ × 46″	42″ × 46″	40″ × 46″
24″ × 48″			48″ × 48″	46″ × 48″	44″ × 48″	42″ × 48″	40″ × 48″

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

RECTANGULAR TIED COLUMNS

$f'_c = 8{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

24″ × 24″	26″ × 26″	28″ × 28″	30″ × 30″	32″ × 32″	34″ × 34″	36″ × 36″	38″ × 38″
24″ × 26″	26″ × 28″	28″ × 30″	30″ × 32″	32″ × 34″	34″ × 36″	36″ × 38″	38″ × 40″
24″ × 28″	26″ × 30″	28″ × 32″	30″ × 34″	32″ × 36″	34″ × 38″	36″ × 40″	38″ × 42″
24″ × 30″	26″ × 32″	28″ × 34″	30″ × 36″	32″ × 38″	34″ × 40″	36″ × 42″	38″ × 44″
24″ × 32″	26″ × 34″	28″ × 36″	30″ × 38″	32″ × 40″	34″ × 42″	36″ × 44″	38″ × 46″
24″ × 34″	26″ × 36″	28″ × 38″	30″ × 40″	32″ × 42″	34″ × 44″	36″ × 46″	38″ × 48″
24″ × 36″	26″ × 38″	28″ × 40″	30″ × 42″	32″ × 44″	34″ × 46″	36″ × 48″	
24″ × 38″	26″ × 40″	28″ × 42″	30″ × 44″	32″ × 46″	34″ × 48″		
24″ × 40″	26″ × 42″	28″ × 44″	30″ × 46″	32″ × 48″			40″ × 40″
24″ × 42″	26″ × 44″	28″ × 46″	30″ × 48″			42″ × 42″	40″ × 42″
24″ × 44″	26″ × 46″	28″ × 48″			44″ × 44″	42″ × 44″	40″ × 44″
24″ × 46″	26″ × 48″			46″ × 46″	44″ × 46″	42″ × 46″	40″ × 46″
24″ × 48″			48″ × 48″	46″ × 48″	44″ × 48″	42″ × 48″	40″ × 48″

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

RECTANGULAR TIED COLUMNS

$f'_c = 10{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

24″ × 24″	26″ × 26″	28″ × 28″	30″ × 30″	32″ × 32″	34″ × 34″	36″ × 36″	38″ × 38″
24″ × 26″	26″ × 28″	28″ × 30″	30″ × 32″	32″ × 34″	34″ × 36″	36″ × 38″	38″ × 40″
24″ × 28″	26″ × 30″	28″ × 32″	30″ × 34″	32″ × 36″	34″ × 38″	36″ × 40″	38″ × 42″
24″ × 30″	26″ × 32″	28″ × 34″	30″ × 36″	32″ × 38″	34″ × 40″	36″ × 42″	38″ × 44″
24″ × 32″	26″ × 34″	28″ × 36″	30″ × 38″	32″ × 40″	34″ × 42″	36″ × 44″	38″ × 46″
24″ × 34″	26″ × 36″	28″ × 38″	30″ × 40″	32″ × 42″	34″ × 44″	36″ × 46″	38″ × 48″
24″ × 36″	26″ × 38″	28″ × 40″	30″ × 42″	32″ × 44″	34″ × 46″	36″ × 48″	
24″ × 38″	26″ × 40″	28″ × 42″	30″ × 44″	32″ × 46″	34″ × 48″		
24″ × 40″	26″ × 42″	28″ × 44″	30″ × 46″	32″ × 48″			40″ × 40″
24″ × 42″	26″ × 44″	28″ × 46″	30″ × 48″			42″ × 42″	40″ × 42″
24″ × 44″	26″ × 46″	28″ × 48″			44″ × 44″	42″ × 44″	40″ × 44″
24″ × 46″	26″ × 48″			46″ × 46″	44″ × 46″	42″ × 46″	40″ × 46″
24″ × 48″			48″ × 48″	46″ × 48″	44″ × 48″	42″ × 48″	40″ × 48″

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

ROUND SPIRAL COLUMNS

$f'_c = 4{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

12″ DIA. 14″ DIA. 16″ DIA. 18″ DIA. 20″ DIA.

22″ DIA. 24″ DIA. 26″ DIA. 28″ DIA. 30″ DIA.

32″ DIA. 34″ DIA. 36″ DIA.

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

ROUND SPIRAL COLUMNS

$f'_c = 5{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

12″ DIA. 14″ DIA. 16″ DIA. 18″ DIA. 20″ DIA.

22″ DIA. 24″ DIA. 26″ DIA. 28″ DIA. 30″ DIA.

32″ DIA. 34″ DIA. 36″ DIA.

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

ROUND SPIRAL COLUMNS

$f'_c = 6{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

12″ DIA. 14″ DIA. 16″ DIA. 18″ DIA. 20″ DIA.

22″ DIA. 24″ DIA. 26″ DIA. 28″ DIA. 30″ DIA.

32″ DIA. 34″ DIA. 36″ DIA.

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

ROUND SPIRAL COLUMNS

$f'_c = 8{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

12″ DIA. 14″ DIA. 16″ DIA. 18″ DIA. 20″ DIA.

22″ DIA. 24″ DIA. 26″ DIA. 28″ DIA. 30″ DIA.

32″ DIA. 34″ DIA. 36″ DIA.

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

ROUND SPIRAL COLUMNS

$f'_c = 6{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

24″ DIA. 26″ DIA. 28″ DIA. 30″ DIA. 32″ DIA.

34″ DIA. 36″ DIA. 38″ DIA. 40″ DIA. 42″ DIA.

44″ DIA. 46″ DIA. 48″ DIA.

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

ROUND SPIRAL COLUMNS

f'_c = 8,000 psi, f_y = 75,000 psi

Click On The Column Size Below

24″ DIA.	26″ DIA.	28″ DIA.	30″ DIA.	32″ DIA.
34″ DIA.	36″ DIA.	38″ DIA.	40″ DIA.	42″ DIA.
	44″ DIA.	46″ DIA.	48″ DIA.	

Return To Column Criteria

DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

ROUND SPIRAL COLUMNS

$f'_c = 10{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

24″ DIA.	26″ DIA.	28″ DIA.	30″ DIA.	32″ DIA.
34″ DIA.	36″ DIA.	38″ DIA.	40″ DIA.	42″ DIA.
	44″ DIA.	46″ DIA.	48″ DIA.	

Return To Column Criteria

SQUARE TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.24	244	257	387	195	422	163	434	136	437	95	465	66	265
4-#6	1.76	252	272	413	203	451	168	467	138	478	90	505	54	349
4-#7	2.40	262	291	444	213	485	174	505	140	526	84	563	42	445
4-#8	3.16	273	313	479	226	523	181	548	142	580	76	616	23	553
4-#9	4.00	284	337	512	238	561	188	592	144	635	67	668	1	666
4-#10	5.08	298	368	552	254	606	197	644	145	700	54	727	-30	716
4-#11	6.24	305	402	571	264	624	198	662	139	723	31	720	-82	729
8-#5	2.48	251	293	419	217	461	178	480	145	495	88	526	21	467
8-#6	3.52	262	323	457	234	505	189	529	150	557	80	588	-12	588
8-#7	4.80	276	360	502	256	555	201	587	155	630	69	676	-46	657

SQUARE TIED COLUMNS 12" x 12"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.22	430	369	663	290	741	244	780	207	798	147	874	110	457
4-#7	1.67	444	388	706	300	794	251	840	210	873	142	954	98	591
4-#8	2.19	461	410	756	313	855	260	908	214	959	137	1045	83	742
4-#9	2.78	478	434	810	326	920	269	979	218	1048	131	1137	66	903
4-#10	3.53	499	466	876	344	1001	282	1066	223	1158	122	1247	42	1101
4-#11	4.33	512	499	935	360	1050	287	1119	221	1222	105	1286	2	1278
4-#14	6.25	558	579	1081	406	1205	312	1296	228	1446	77	1539	-57	1497
8-#5	1.72	428	390	668	306	752	255	794	215	820	147	902	80	617
8-#6	2.44	445	420	722	323	817	267	872	223	915	141	1007	54	829
8-#7	3.33	466	457	786	345	896	282	962	231	1028	134	1128	19	1075
8-#8	4.39	489	501	860	370	986	300	1064	241	1157	125	1265	-23	1259
8-#9	5.56	515	550	939	399	1083	320	1171	251	1292	114	1405	-72	1385
8-#10	7.06	547	613	1037	436	1204	346	1302	263	1457	99	1572	-138	1537

SQUARE TIED COLUMNS 14" x 14"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.22	692	503	1045	405	1188	340	1261	289	1322	209	1475	163	735
4-#8	1.61	716	525	1110	417	1267	349	1355	294	1440	205	1609	152	930
4-#9	2.04	740	549	1180	430	1352	358	1456	299	1565	201	1748	139	1139
4-#10	2.59	769	580	1268	448	1458	370	1583	307	1721	195	1919	121	1398
4-#11	3.18	790	614	1353	463	1554	381	1684	310	1832	182	2014	89	1642
4-#14	4.59	854	694	1553	508	1800	414	1952	324	2169	161	2360	32	2234
8-#5	1.27	669	505	994	412	1132	345	1197	293	1245	214	1394	145	765
8-#6	1.80	693	535	1063	429	1216	358	1297	302	1375	210	1543	122	1037
8-#7	2.45	722	572	1147	451	1317	373	1418	312	1529	206	1721	94	1357
8-#8	3.22	754	616	1242	477	1435	391	1558	324	1707	200	1922	59	1721
8-#9	4.08	789	665	1346	506	1562	412	1710	337	1896	193	2133	19	2092
8-#10	5.18	833	728	1475	543	1721	438	1901	354	2131	183	2391	-35	2370
8-#11	6.37	865	795	1596	578	1862	462	2053	364	2300	161	2540	-116	2486

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.23	1045	657	1551	539	1786	453	1910	385	2030	281	2308	225	1117
4-#9	1.56	1078	682	1638	552	1891	462	2034	390	2196	278	2497	215	1373
4-#10	1.98	1118	713	1747	569	2024	474	2192	397	2403	275	2730	201	1694
4-#11	2.44	1147	747	1859	583	2149	484	2335	402	2562	264	2887	175	2005
4-#14	3.52	1232	827	2114	628	2460	516	2706	421	3017	249	3387	130	2752
4-#18	6.25	1422	1030	2710	745	3193	600	3548	465	4045	202	4463	-6	4459
8-#6	1.38	1016	668	1491	552	1721	463	1837	392	1936	285	2215	196	1244
8-#7	1.88	1052	705	1593	574	1846	479	1985	401	2134	282	2449	172	1638
8-#8	2.47	1094	749	1712	600	1990	497	2157	412	2364	279	2718	142	2089
8-#9	3.13	1142	798	1840	629	2147	518	2344	425	2614	276	3002	108	2569
8-#10	3.97	1198	860	2000	667	2344	545	2580	441	2926	271	3355	62	3165
8-#11	4.88	1241	928	2159	701	2529	568	2795	462	3168	254	3597	-7	3591
8-#14	7.03	1371	1088	2534	797	2993	636	3353	505	3853	228	4353	-144	4236
12-#10	5.95	1343	1008	2324	764	2736	622	3052	491	3557	260	4151	-27	4124

SQUARE TIED COLUMNS 18" x 18"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.23	1502	832	2194	691	2552	581	2744	494	2935	361	3399	297	1607
4-#10	1.57	1552	863	2325	708	2711	593	2932	501	3185	358	3696	286	1988
4-#11	1.93	1592	897	2465	721	2866	602	3108	505	3415	351	3917	265	2367
4-#14	2.78	1701	977	2775	766	3243	633	3557	524	4003	343	4577	229	3269
4-#18	4.94	1943	1180	3507	881	4141	716	4631	574	5333	308	6051	120	5398
8-#6	1.09	1425	818	2015	693	2348	583	2507	497	2625	369	3038	277	1449
8-#7	1.48	1470	855	2137	715	2495	599	2682	506	2858	366	3330	256	1916
8-#8	1.95	1522	899	2278	741	2667	618	2887	518	3131	364	3667	230	2454
8-#9	2.47	1577	948	2431	770	2854	638	3109	530	3429	361	4027	200	3030
8-#10	3.14	1647	1011	2624	807	3090	665	3391	546	3805	357	4476	160	3750
8-#11	3.85	1708	1078	2821	842	3317	689	3656	559	4154	348	4816	100	4440
8-#14	5.56	1869	1238	3277	938	3879	758	4329	600	5040	335	5813	-19	5789
12-#10	4.70	1829	1158	3009	907	3555	745	3952	599	4557	349	5477	80	5139
12-#11	5.78	1916	1259	3279	963	3870	785	4322	622	5046	336	5964	-5	5958

SQUARE TIED COLUMNS 20" x 20"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.00	2023	1000	2858	849	3349	715	3600	611	3822	454	4473	386	1840
4-#10	1.27	2083	1031	3012	865	3534	727	3818	617	4112	451	4835	377	2282
4-#11	1.56	2134	1065	3181	877	3720	735	4029	621	4384	444	5120	359	2727
4-#14	2.25	2270	1145	3546	921	4163	766	4556	639	5087	436	5944	330	3784
4-#18	4.00	2570	1348	4417	1036	5227	848	5826	688	6777	418	7826	241	6304
8-#7	1.20	1984	1023	2788	873	3281	734	3526	624	3731	461	4382	346	2193
8-#8	1.58	2047	1067	2953	899	3480	753	3763	636	4046	458	4789	323	2818
8-#9	2.00	2113	1116	3132	928	3697	774	4021	648	4391	455	5225	296	3490
8-#10	2.54	2197	1179	3356	966	3971	801	4349	665	4828	452	5772	261	4331
8-#11	3.12	2268	1246	3593	1000	4243	824	4663	677	5241	444	6211	208	5156
8-#14	4.50	2469	1406	4129	1096	4903	894	5453	719	6298	434	7454	103	7130
8-#18	8.00	2932	1812	5413	1343	6491	1070	7358	825	8841	406	10293	-195	9981
12-#10	3.81	2403	1326	3803	1066	4511	882	4999	719	5699	446	6980	187	6068
12-#11	4.68	2522	1427	4126	1122	4887	922	5439	743	6280	435	7612	112	7083
12-#14	6.75	2822	1667	4881	1272	5811	1034	6547	812	7764	419	9389	-42	9313
16-#10	5.08	2610	1473	4276	1167	5090	956	5692	767	6622	448	8194	109	7783

SQUARE TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.05	2722	1217	3818	1040	4508	876	4868	747	5204	554	6164	476	2575
4-#11	1.29	2783	1251	4017	1051	4724	883	5112	750	5518	547	6516	460	3087
4-#14	1.86	2945	1331	4439	1094	5234	913	5717	768	6324	539	7505	436	4299
4-#18	3.31	3311	1533	5449	1207	6466	995	7185	816	8285	521	9803	363	7208
8-#8	1.31	2679	1253	3746	1075	4443	903	4802	767	5126	563	6101	423	3180
8-#9	1.65	2757	1302	3951	1104	4691	924	5096	779	5517	560	6614	399	3947
8-#10	2.10	2855	1364	4208	1141	5004	951	5469	796	6015	557	7260	367	4911
8-#11	2.58	2940	1431	4486	1175	5320	974	5834	808	6492	549	7799	319	5869
8-#14	3.72	3168	1591	5103	1272	6078	1044	6740	851	7704	540	9293	225	8157
8-#18	6.61	3725	1997	6590	1519	7914	1222	8940	959	10654	517	12758	-41	12673
12-#10	3.15	3095	1511	4717	1243	5618	1033	6209	852	7006	553	8677	299	7035
12-#11	3.87	3223	1612	5094	1299	6055	1074	6719	876	7678	542	9456	230	8224
12-#14	5.58	3590	1852	5964	1449	7118	1187	7992	947	9382	529	11594	92	11123
16-#10	4.20	3319	1659	5255	1344	6277	1108	6998	901	8057	556	10097	229	8943
16-#11	5.16	3504	1793	5738	1422	6843	1165	7664	934	8935	544	11119	136	10556

SQUARE TIED COLUMNS 24" x 24"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.08	3551	1454	4984	1243	5895	1046	6375	892	6834	660	8121	568	3446
4-#14	1.56	3740	1534	5463	1285	6471	1076	7058	910	7742	652	9277	548	4812
4-#18	2.78	4173	1737	6614	1397	7871	1156	8724	957	9965	633	11995	488	8112
8-#8	1.10	3428	1456	4669	1268	5571	1068	6020	911	6387	678	7591	527	3541
8-#9	1.39	3519	1505	4900	1297	5849	1089	6350	924	6825	675	8193	506	4403
8-#10	1.76	3632	1567	5190	1334	6201	1116	6769	940	7384	672	8958	480	5489
8-#11	2.17	3732	1635	5509	1367	6562	1139	7183	952	7925	664	9599	435	6580
8-#14	3.13	3995	1795	6209	1464	7419	1209	8206	995	9292	656	11344	350	9180
8-#18	5.56	4643	2201	7900	1712	9503	1387	10702	1105	12635	635	15443	111	15057
12-#10	2.65	3906	1715	5761	1437	6890	1199	7598	997	8494	670	10585	416	7994
12-#11	3.25	4055	1816	6194	1492	7388	1240	8179	1021	9258	660	11513	352	9407
12-#14	4.69	4454	2056	7180	1643	8590	1353	9617	1093	11182	648	14015	226	12717
16-#10	3.53	4159	1862	6365	1539	7629	1275	8484	1047	9672	674	12212	352	10119
16-#11	4.33	4356	1997	6918	1617	8275	1332	9241	1081	10671	664	13429	267	11978
16-#14	6.25	4893	2317	8206	1823	9847	1486	11123	1179	13185	652	16695	96	16273
20-#10	4.41	4396	2009	6928	1646	8389	1351	9378	1104	10864	672	13858	271	12313
20-#11	5.42	4638	2177	7602	1749	9186	1425	10314	1150	12117	668	15431	175	14458

SQUARE TIED COLUMNS 26" x 26"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.33	4664	1755	6630	1493	7889	1254	8594	1065	9358	775	11278	667	5325
4-#18	2.37	5163	1958	7923	1604	9457	1333	10458	1111	11842	756	14420	618	9016
8-#9	1.18	4409	1726	5989	1508	7186	1269	7798	1081	8331	801	9955	618	4858
8-#10	1.50	4538	1788	6313	1545	7578	1296	8263	1097	8950	798	10805	592	6065
8-#11	1.85	4653	1856	6674	1577	7984	1318	8728	1109	9555	789	11626	558	7289
8-#14	2.66	4954	2016	7457	1674	8940	1388	9868	1152	11077	782	13627	481	10201
8-#18	4.73	5668	2422	9354	1922	11273	1568	12659	1263	14812	763	18365	262	17166
12-#10	2.25	4847	1936	6945	1648	8341	1380	9182	1155	10180	796	12618	529	8861
12-#11	2.77	5019	2037	7435	1703	8902	1420	9834	1179	11035	786	13797	479	10615
12-#14	3.99	5471	2277	8537	1855	10243	1535	11438	1252	13179	776	16670	363	14362
12-#18	7.10	6612	2885	11213	2240	13518	1824	15363	1436	18434	747	23460	38	23231

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	3.01	5129	2083	7615	1751	9161	1457	10164	1206	11486	802	14425	469	11317
16-#11	3.69	5354	2218	8240	1829	9887	1514	11014	1241	12605	792	15966	402	13415
16-#14	5.33	5936	2538	9680	2036	11642	1669	13113	1340	15408	783	19714	245	18476
20-#10	3.76	5396	2230	8233	1858	10003	1534	11156	1264	12807	801	16258	388	13850
20-#11	4.62	5671	2398	8990	1961	10899	1608	12206	1311	14194	789	18162	302	16306

SQUARE TIED COLUMNS 28" x 28"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.15	5728	1994	7949	1720	9501	1447	10342	1233	11187	909	13494	791	5837
4-#18	2.04	6296	2196	9387	1829	11239	1525	12403	1278	13933	889	17096	753	9917
8-#9	1.02	5438	1965	7229	1736	8717	1464	9457	1251	10050	936	11962	738	5311
8-#10	1.30	5582	2027	7586	1773	9148	1490	9968	1267	10730	933	12895	712	6640
8-#11	1.59	5714	2094	7992	1805	9600	1512	10484	1279	11399	925	13801	679	7996
8-#14	2.30	6053	2254	8859	1902	10655	1582	11741	1322	13076	918	16108	612	11218
8-#18	4.08	6857	2660	10963	2150	13238	1762	14827	1433	17204	900	21541	416	18973
12-#10	1.94	5927	2174	8281	1877	9986	1575	10977	1326	12080	933	14892	650	9725
12-#11	2.39	6123	2275	8828	1932	10610	1616	11700	1350	13026	923	16199	601	11679
12-#14	3.44	6630	2515	10048	2083	12091	1730	13469	1424	15390	914	19508	499	16057
12-#18	6.12	7913	3124	13016	2470	15718	2022	17813	1610	21203	889	27295	204	25955
16-#10	2.59	6240	2322	9016	1981	10886	1653	12055	1378	13514	940	16879	592	12539
16-#11	3.18	6494	2456	9714	2058	11694	1710	12998	1413	14754	931	18589	527	14878
16-#14	4.59	7144	2776	11307	2265	13632	1866	15315	1513	17846	923	22902	389	20499
20-#10	3.24	6537	2469	9688	2087	11811	1731	13144	1437	14964	940	18899	512	15291
20-#11	3.98	6847	2637	10531	2189	12807	1805	14310	1484	16501	929	21013	428	18211
20-#14	5.74	7647	3037	12477	2455	15215	2002	17180	1614	20330	920	26341	245	24793
24-#10	3.89	6869	2616	10407	2186	12700	1813	14252	1488	16437	947	20941	463	17956
24-#11	4.78	7243	2818	11397	2311	13889	1906	15645	1546	18275	936	23469	364	21276

SQUARE TIED COLUMNS 30" x 30"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.00	6942	2250	9432	1963	11323	1655	12317	1414	13248	1053	15911	918	6348
4-#18	1.78	7581	2453	11016	2071	13230	1731	14577	1459	16254	1032	20040	894	10817
8-#10	1.13	6777	2284	9022	2019	10927	1700	11900	1450	12741	1079	15250	841	7214
8-#11	1.39	6925	2351	9472	2050	11425	1722	12467	1461	13474	1071	16242	808	8702
8-#14	2.00	7303	2511	10423	2146	12580	1792	13841	1505	15305	1064	18760	742	12234
8-#18	3.56	8200	2917	12737	2394	15414	1972	17223	1616	19827	1047	24986	573	20777
12-#10	1.69	7158	2431	9778	2123	11839	1786	12998	1510	14211	1080	17431	780	10586
12-#11	2.08	7378	2532	10384	2177	12526	1826	13793	1534	15249	1070	18865	731	12740
12-#14	3.00	7941	2772	11722	2329	14148	1941	15728	1608	17832	1062	22486	631	17803
12-#18	5.33	9302	3381	14985	2717	18128	2234	20492	1796	24203	1040	31405	372	28747
16-#10	2.26	7502	2578	10579	2227	12820	1864	14172	1562	15772	1088	19599	724	13785
16-#11	2.77	7786	2713	11351	2305	13709	1921	15209	1597	17133	1079	21477	661	16367
16-#14	4.00	8506	3033	13097	2512	15831	2078	17744	1698	20514	1073	26199	526	22553
16-#18	7.11	10298	3844	17364	3040	21041	2474	23981	1954	28846	1054	37817	173	36884
20-#10	2.82	7830	2725	11306	2333	13827	1942	15359	1622	17353	1088	21805	645	16746
20-#11	3.47	8176	2893	12235	2435	14924	2017	16641	1669	19039	1078	24130	562	19995
20-#14	5.00	9059	3294	14364	2701	17561	2214	19782	1801	23228	1071	29967	383	27432
24-#10	3.39	8195	2873	12088	2433	14788	2024	16567	1674	18957	1096	24034	598	19770
24-#11	4.16	8612	3074	13179	2557	16094	2118	18098	1733	20975	1087	26814	501	23437

SQUARE TIED COLUMNS 32" x 32"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.56	9027	2727	12820	2332	15445	1953	16994	1652	18823	1186	23098	1030	11716
8-#11	1.22	8296	2625	11126	2313	13473	1946	14693	1657	15796	1227	18966	946	9406
8-#14	1.76	8714	2785	12162	2409	14728	2016	16184	1700	17782	1220	21696	881	13247
8-#18	3.13	9707	3191	14686	2656	17813	2196	19863	1812	22696	1204	28462	715	22576
12-#10	1.49	8550	2705	11448	2387	13915	2011	15263	1706	16589	1237	20256	918	11445
12-#11	1.83	8793	2806	12114	2441	14666	2051	16129	1730	17718	1228	21816	870	13798
12-#14	2.64	9415	3046	13570	2593	16428	2166	18231	1805	20521	1220	25748	771	19375
12-#18	4.69	10914	3655	17129	2981	20762	2460	23414	1994	27450	1200	35460	516	31606
16-#10	1.98	8926	2852	12315	2492	14976	2090	16533	1760	18278	1246	22604	865	15007
16-#11	2.44	9240	2987	13161	2569	15947	2147	17664	1794	19759	1237	24649	802	17881
16-#14	3.52	10032	3307	15062	2777	18254	2304	20417	1896	23429	1232	29780	670	24638
16-#18	6.25	11937	4118	19715	3305	23928	2702	27206	2155	32495	1217	42439	325	40778
20-#10	2.48	9285	2999	13096	2597	16066	2169	17817	1820	19988	1247	24996	786	18216
20-#11	3.05	9668	3168	14112	2699	17264	2243	19215	1867	21825	1237	27531	705	21771
20-#14	4.39	10636	3568	16425	2965	20130	2442	22627	2001	26373	1232	33879	528	30139
24-#10	2.98	9685	3147	13941	2698	17098	2250	19124	1873	21724	1256	27412	741	21564
24-#11	3.66	10145	3348	15134	2822	18522	2343	20793	1932	23922	1247	30444	646	25641
24-#14	5.27	11315	3829	17882	3141	21933	2587	24876	2093	29360	1244	38024	441	35320

SQUARE TIED COLUMNS 34" x 34"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.38	10646	3019	14811	2610	17899	2190	19670	1859	21655	1351	26459	1174	12615
8-#11	1.08	9837	2917	12964	2593	15758	2185	17178	1866	18382	1393	21994	1093	10109
8-#14	1.56	10297	3077	14086	2689	17114	2255	18787	1909	20522	1387	24935	1029	14259
8-#18	2.77	11388	3482	16822	2936	20451	2435	22763	2021	25829	1371	32239	865	24372
12-#10	1.32	10112	2997	13301	2668	16227	2251	17786	1916	19231	1405	23384	1066	12302
12-#11	1.62	10381	3097	14028	2722	17043	2290	18725	1939	20451	1395	25071	1018	14853
12-#14	2.34	11062	3337	15604	2873	18946	2406	20992	2014	23474	1388	29314	920	20899
12-#18	4.15	12701	3946	19459	3262	23635	2701	26596	2205	30960	1370	39817	668	34533
16-#10	1.76	10520	3144	14233	2773	17368	2331	19153	1970	21048	1414	25912	1014	16154
16-#11	2.16	10866	3278	15156	2850	18423	2387	20377	2005	22649	1405	28125	952	19422
16-#14	3.11	11731	3598	17212	3058	20915	2545	23349	2107	26609	1401	33665	822	26755
16-#18	5.54	13810	4410	22253	3588	27054	2945	30691	2368	36407	1390	47363	484	44458
20-#10	2.20	10912	3291	15069	2879	18540	2410	20534	2030	22887	1416	28489	937	19702
20-#11	2.70	11332	3459	16173	2980	19842	2484	22048	2078	24874	1407	31236	855	23565
20-#14	3.89	12389	3859	18671	3246	22937	2684	25731	2213	29781	1403	38094	681	32789
24-#10	2.64	11347	3438	15978	2980	19645	2491	21940	2084	24755	1425	31093	892	23287
24-#11	3.24	11851	3640	17274	3103	21187	2584	23748	2143	27133	1417	34378	799	27887
24-#14	4.67	13126	4120	20241	3423	24866	2828	28156	2306	33002	1416	42569	598	38392

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.23	12447	3328	16999	2905	20606	2443	22622	2079	24767	1526	30141	1327	13513
8-#14	1.39	12061	3386	16206	2986	19752	2509	21665	2131	23543	1563	28497	1186	15269
8-#18	2.47	13252	3792	19155	3233	23342	2688	25938	2243	29242	1548	36338	1024	26164
12-#10	1.18	11855	3306	15347	2967	18791	2506	20584	2139	22153	1582	26836	1222	13157
12-#11	1.44	12149	3407	16136	3020	19672	2545	21595	2162	23465	1572	28648	1175	15906
12-#14	2.08	12891	3647	17833	3172	21717	2661	24029	2237	26707	1566	33202	1078	22420
12-#18	3.70	14674	4256	21987	3560	26761	2956	30053	2429	34751	1549	44496	828	37527
16-#10	1.57	12297	3453	16342	3072	20013	2586	22047	2193	24098	1592	29544	1172	17297
16-#11	1.93	12675	3588	17345	3149	21151	2643	23366	2228	25820	1583	31924	1111	20872
16-#14	2.78	13615	3908	19558	3357	23827	2800	26556	2331	30068	1581	37873	983	28903
16-#18	4.94	15871	4720	24988	3888	30433	3202	34451	2593	40601	1572	52610	651	48029
20-#10	1.96	12722	3601	17235	3178	21261	2665	23526	2254	26067	1595	32304	1096	21203
20-#11	2.41	13180	3769	18429	3278	22671	2740	25156	2302	28204	1586	35263	1015	25376
20-#14	3.47	14327	4169	21113	3544	25996	2940	29111	2437	33470	1583	42632	843	35323
20-#18	6.17	17106	5183	27721	4222	34206	3448	38896	2779	46521	1573	60861	400	58125
24-#10	2.35	13192	3748	18208	3279	22443	2747	25028	2308	28066	1604	35099	1052	25021
24-#11	2.89	13741	3950	19608	3402	24104	2840	26979	2367	30624	1597	38636	960	30032
24-#14	4.17	15122	4430	22795	3722	28052	3084	31711	2531	36925	1598	47437	762	41516

SQUARE TIED COLUMNS 38" x 38"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.11	14440	3655	19394	3218	23580	2710	25865	2312	28176	1711	34164	1490	14410
8-#14	1.25	14017	3713	18531	3301	22657	2778	24834	2365	26860	1751	32400	1352	16278
8-#18	2.22	15311	4119	21695	3547	26500	2957	29404	2477	32952	1736	40778	1191	27955
12-#10	1.06	13790	3633	17598	3284	21620	2777	23673	2375	25372	1770	30630	1388	14011
12-#11	1.30	14110	3734	18450	3336	22567	2815	24756	2397	26775	1760	32568	1341	16957
12-#14	1.87	14912	3974	20268	3487	24753	2930	27357	2472	30237	1754	37433	1244	23937
12-#18	3.32	16843	4583	24722	3876	30154	3226	33802	2665	38839	1739	49517	997	40588
16-#10	1.41	14265	3780	18654	3389	22922	2857	25232	2429	27445	1781	33519	1339	18438
16-#11	1.73	14676	3915	19736	3465	24144	2913	26645	2463	29287	1772	36065	1278	22278
16-#14	2.49	15693	4235	22109	3673	27007	3071	30055	2567	33825	1770	42423	1152	31083
16-#18	4.43	18131	5047	27930	4205	34080	3474	38503	2831	45091	1764	58199	825	51643
20-#10	1.76	14724	3928	19606	3495	24247	2935	26809	2491	29544	1784	36462	1264	22720
20-#11	2.16	15221	4096	20891	3595	25759	3010	28556	2538	31830	1775	39629	1184	27203
20-#14	3.12	16460	4496	23760	3860	29322	3211	32782	2674	37457	1773	47509	1014	37877
20-#18	5.54	19456	5510	30834	4538	38113	3721	43255	3019	51419	1766	67037	575	62744
24-#10	2.11	15230	4075	20642	3596	25507	3017	28403	2544	31675	1794	39447	1221	26764
24-#11	2.59	15826	4277	22147	3719	27286	3110	30499	2604	34412	1787	43235	1130	32150
24-#14	3.74	17315	4757	25555	4038	31504	3355	35558	2769	41144	1789	52648	935	44690

SQUARE TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.00	16636	4000	22008	3549	26836	2992	29416	2558	31898	1907	38549	1662	15307
8-#14	1.13	16176	4058	21073	3634	25842	3062	28310	2613	30491	1948	36665	1526	17285
8-#18	2.00	17574	4464	24453	3879	29940	3241	33178	2725	36975	1934	45579	1367	29742
12-#11	1.17	16274	4079	20980	3669	25742	3100	28224	2646	30398	1958	36849	1515	18006
12-#14	1.69	17138	4319	22919	3821	28071	3215	30992	2721	34080	1953	42025	1419	25452
12-#18	3.00	19218	4928	27675	4209	33829	3511	37859	2914	43240	1938	54899	1174	43554
16-#10	1.27	16436	4125	21182	3723	26112	3142	28724	2678	31105	1979	37855	1515	19577
16-#11	1.56	16880	4260	22342	3798	27419	3198	30232	2712	33068	1971	40568	1454	23681
16-#14	2.25	17975	4580	24871	4006	30467	3356	33861	2816	37894	1969	47335	1329	33294
16-#18	4.00	20598	5391	31091	4539	38008	3760	42863	3081	49894	1965	64149	1007	55298
20-#10	1.59	16928	4272	22192	3829	27514	3221	30398	2740	33334	1983	40982	1441	24209
20-#11	1.95	17466	4440	23568	3928	29128	3295	32262	2788	35770	1974	44358	1362	29048
20-#14	2.81	18799	4841	26625	4194	32919	3496	36761	2924	41756	1974	52746	1193	40451
20-#18	5.00	22016	5855	34166	4872	42302	4008	47922	3271	56630	1970	73574	758	67453
24-#10	1.90	17471	4420	23291	3931	28850	3303	32084	2793	35596	1994	44156	1398	28518
24-#11	2.34	18114	4621	24902	4053	30750	3395	34318	2854	38514	1987	48197	1308	34279
24-#14	3.38	19715	5101	28532	4373	35237	3640	39712	3020	45676	1991	58221	1115	47916

SQUARE TIED COLUMNS 42" x 42"

8-#14	1.02	18548	4420	23842	3984	29323	3361	32109	2874	34451	2156	41310	1710	18292
8-#18	1.81	20051	4826	27440	4229	33676	3539	37275	2985	41328	2142	50759	1551	31528
12-#11	1.06	18650	4441	23736	4021	29212	3399	32016	2907	34352	2167	41511	1699	19054
12-#14	1.53	19577	4681	25798	4171	31684	3515	34950	2982	38253	2161	46997	1603	26964
12-#18	2.72	21809	5290	30857	4560	37800	3811	42239	3176	47970	2148	60661	1360	46253
16-#10	1.15	18820	4488	23935	4074	29596	3443	32539	2941	35095	2189	42483	1690	20713
16-#11	1.41	19297	4622	25174	4149	30988	3498	34142	2974	37178	2180	45452	1639	25081
16-#14	2.04	20472	4942	27860	4357	34222	3656	37989	3079	42294	2179	52627	1516	35413
16-#18	3.63	23284	5754	34480	4890	42232	4061	47546	3345	55028	2176	70479	1197	58996
20-#10	1.44	19346	4635	25003	4181	31074	3521	34311	3003	37454	2193	45883	1627	25634
20-#11	1.77	19925	4803	26471	4280	32791	3595	36291	3050	40040	2184	49467	1548	30911
20-#14	2.55	21353	5203	29716	4545	36810	3796	41062	3187	46385	2184	58363	1382	43046
20-#18	4.54	24795	6218	37726	5223	46786	4310	52912	3535	62172	2183	80484	952	72252
24-#10	1.73	19926	4782	26166	4283	32488	3604	36087	3056	39848	2204	49248	1584	30283
24-#11	2.12	20617	4984	27884	4404	34508	3695	38460	3116	42946	2197	53539	1495	36419
24-#14	3.06	22330	5464	31736	4724	39266	3941	44176	3282	50539	2202	64175	1304	51007
24-#18	5.44	26488	6681	41256	5540	51077	4566	58373	3704	69425	2211	90596	812	84315

SQUARE TIED COLUMNS 44" x 44"

8-#18	1.65	22753	5206	30667	4596	37722	3853	41712	3259	46027	2360	56339	1745	33312
12-#14	1.39	22239	5061	28915	4540	35607	3829	39248	3257	42773	2380	52369	1796	28473
12-#18	2.48	24626	5670	34278	4928	42081	4125	46959	3451	53047	2368	66822	1555	48947
16-#10	1.05	21427	4868	26924	4444	33389	3758	36692	3216	39432	2408	47595	1884	21848
16-#11	1.29	21938	5002	28243	4518	34866	3813	38390	3249	41635	2399	50620	1821	26479
16-#14	1.86	23193	5322	31086	4725	38288	3971	42457	3354	47040	2399	58318	1711	37435
16-#18	3.31	26198	6134	38096	5258	46767	4376	52569	3621	60507	2398	77208	1395	62736

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	1.31	21988	5015	28050	4551	34944	3837	38561	3278	41920	2412	51184	1821	27056
20-#11	1.61	22608	5183	29612	4648	36764	3909	40660	3325	44656	2404	54976	1743	32747
20-#14	2.32	24132	5583	33045	4913	41011	4111	45703	3463	51361	2405	64380	1579	45663
20-#18	4.13	27804	6598	41525	5591	51562	4625	58242	3812	68060	2405	87792	1154	76920
24-#10	1.57	22605	5162	29277	4653	36435	3919	40430	3331	44446	2424	54739	1779	32059
24-#11	1.93	23345	5364	31103	4773	38575	4011	42941	3391	47724	2417	59282	1690	38571
24-#14	2.79	25172	5844	35178	5093	43604	4256	48979	3557	55748	2423	70528	1502	54043
24-#18	4.96	29601	7062	45256	5909	56097	4882	64013	3982	75728	2435	98501	1015	89805

SQUARE TIED COLUMNS 46" x 46"

8-#18	1.51	25690	5604	34143	4981	42093	4181	46504	3546	51089	2589	62337	1947	35094
12-#14	1.28	25137	5459	32280	4926	39853	4159	43900	3544	47655	2610	58159	1998	29980
12-#18	2.27	27679	6068	37950	5313	46687	4455	52034	3739	58487	2598	73402	1758	51636
16-#11	1.18	24813	5400	31560	4904	39068	4143	42994	3537	46455	2629	56317	2024	27874
16-#14	1.70	26149	5720	34561	5111	42677	4301	47281	3642	52149	2629	64256	1897	39453
16-#18	3.02	29349	6532	41962	5643	51627	4706	57947	3909	66350	2629	84357	1602	66519
20-#10	1.20	24864	5413	31344	4938	39136	4167	43167	3567	46749	2643	56905	2025	28475
20-#11	1.47	25525	5581	33000	5035	41060	4239	45383	3614	49635	2634	60904	1947	34497
20-#14	2.13	27147	5981	36623	5300	45536	4440	50699	3752	56699	2635	70816	1784	48300
20-#18	3.78	31053	6996	45574	5977	56664	4955	63927	4102	74311	2638	95518	1364	81438
24-#10	1.44	25519	5560	32635	5040	40705	4250	45127	3620	49407	2654	60650	1983	33846
24-#11	1.77	26308	5762	34569	5160	42966	4341	47776	3679	52864	2648	65444	1895	40735
24-#14	2.55	28251	6242	38869	5480	48266	4586	54137	3846	61320	2655	77301	1708	57092
24-#18	4.54	32955	7459	49505	6296	61442	5212	69986	4271	82394	2669	106825	1226	95309

SQUARE TIED COLUMNS 48" x 48"

8-#18	1.39	28872	6020	37880	5383	46803	4524	51668	3845	56530	2828	68773	2159	36874
12-#14	1.17	28279	5875	35905	5330	44438	4503	48924	3845	52916	2849	64388	2209	31486
12-#18	2.08	30979	6483	41882	5716	51633	4799	57480	4039	64306	2838	80420	1970	54321
16-#11	1.08	27934	5815	35135	5308	43608	4488	47968	3838	51654	2869	62453	2236	29267
16-#14	1.56	29351	6135	38295	5515	47404	4646	52475	3943	57637	2869	70796	2110	41467
16-#18	2.78	32749	6947	46089	6046	56825	5052	63697	4211	72572	2870	91943	1817	70345
20-#10	1.10	27985	5828	34895	5343	43666	4512	48143	3869	51958	2883	63065	2237	29892
20-#11	1.35	28687	5996	36647	5439	45694	4584	50477	3915	54994	2875	67271	2160	36243
20-#14	1.95	30408	6396	40460	5703	50400	4785	56066	4053	62417	2876	77690	1998	50959
20-#18	3.47	34552	7411	49884	6380	62104	5299	69984	4405	80941	2881	103682	1582	85974
24-#10	1.32	28677	5975	36249	5445	45312	4596	50194	3921	54748	2895	67000	2195	35602
24-#11	1.63	29516	6177	38294	5564	47695	4686	52983	3980	58385	2889	72044	2108	42911
24-#14	2.34	31576	6657	42818	5884	53266	4931	59666	4147	67272	2896	84512	1923	60155
24-#18	4.17	36560	7875	54016	6700	67125	5558	76332	4573	89439	2913	115588	1446	100881

SQUARE TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.24	289	301	464	216	492	181	497	152	490	107	514	77	274
4-#6	1.76	297	315	490	224	520	186	529	154	530	102	565	68	360
4-#7	2.40	307	334	520	234	553	191	567	155	577	96	613	53	459
4-#8	3.16	318	355	554	246	590	198	609	157	630	88	666	34	570
4-#9	4.00	330	379	586	258	627	205	651	158	684	78	717	11	686
4-#10	5.08	345	410	625	273	671	213	702	159	749	65	776	-19	783
4-#11	6.24	354	443	642	282	687	214	719	152	770	41	767	-72	799
8-#5	2.48	298	336	495	238	531	198	542	161	547	100	575	31	482
8-#6	3.52	311	366	533	255	573	208	591	165	608	92	651	5	639
8-#7	4.80	326	402	577	275	622	222	647	170	680	80	725	-35	705

SQUARE TIED COLUMNS 12" x 12"

4-#6	1.22	506	432	800	322	865	271	892	231	892	165	962	126	469
4-#7	1.67	521	450	842	332	916	278	950	234	966	161	1041	114	606
4-#8	2.19	538	472	891	344	976	286	1017	237	1050	155	1129	99	761
4-#9	2.78	556	496	943	357	1039	295	1087	241	1138	149	1220	81	924
4-#10	3.53	577	527	1008	374	1119	307	1173	245	1246	140	1328	57	1126
4-#11	4.33	592	560	1064	389	1165	312	1223	242	1309	122	1411	30	1309
4-#14	6.25	640	639	1207	434	1317	336	1397	248	1529	92	1624	-41	1575
8-#5	1.72	507	453	806	338	876	282	906	239	914	166	990	96	632
8-#6	2.44	526	482	858	354	940	293	983	246	1008	160	1093	69	849
8-#7	3.33	548	519	921	375	1017	308	1071	254	1119	152	1213	35	1103
8-#8	4.39	573	562	993	400	1106	325	1172	263	1247	143	1347	-8	1346
8-#9	5.56	601	610	1070	428	1201	344	1277	273	1380	132	1485	-58	1473
8-#10	7.06	635	672	1166	463	1320	369	1406	284	1543	116	1650	-125	1625

SQUARE TIED COLUMNS 14" x 14"

4-#7	1.22	812	588	1265	450	1387	378	1442	322	1473	235	1617	185	751
4-#8	1.61	836	610	1329	461	1465	386	1534	326	1590	231	1749	174	950
4-#9	2.04	861	634	1398	474	1548	395	1633	332	1714	226	1886	160	1162
4-#10	2.59	891	665	1483	491	1652	407	1758	338	1867	220	2054	142	1425
4-#11	3.18	913	698	1565	504	1745	416	1856	341	1975	206	2146	110	1676
4-#14	4.59	980	777	1761	549	1986	448	2120	353	2308	184	2486	50	2278
8-#5	1.27	792	591	1217	457	1333	383	1380	328	1399	240	1538	168	781
8-#6	1.80	817	620	1285	473	1416	395	1478	335	1527	236	1686	145	1058
8-#7	2.45	847	657	1366	494	1515	410	1597	345	1680	232	1860	116	1386
8-#8	3.22	884	700	1460	520	1631	428	1736	356	1856	225	2060	81	1758
8-#9	4.08	921	748	1561	547	1755	447	1885	369	2042	218	2268	40	2152
8-#10	5.18	967	810	1687	584	1911	473	2073	385	2274	207	2523	-15	2515
8-#11	6.37	1003	876	1804	617	2049	495	2222	394	2440	184	2667	-97	2629

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.23	1223	769	1884	598	2087	503	2183	429	2260	316	2524	255	1138
4-#9	1.56	1255	793	1969	611	2191	512	2306	434	2424	313	2709	244	1398
4-#10	1.98	1296	824	2076	627	2320	524	2461	440	2628	309	2940	230	1723
4-#11	2.44	1328	857	2184	640	2441	532	2600	444	2783	297	3091	204	2041
4-#14	3.52	1416	936	2433	684	2746	563	2965	462	3233	281	3585	157	2799
4-#18	6.25	1614	1136	3015	798	3467	644	3794	503	4248	231	4645	18	4563
8-#6	1.38	1199	779	1826	612	2025	514	2113	439	2169	320	2433	227	1266
8-#7	1.88	1237	816	1926	633	2147	528	2259	449	2364	317	2664	202	1666
8-#8	2.47	1281	859	2042	658	2289	546	2429	460	2592	314	2930	172	2127
8-#9	3.13	1328	907	2168	686	2443	566	2613	473	2839	310	3211	137	2617
8-#10	3.97	1393	969	2325	723	2637	592	2846	490	3147	304	3559	90	3225
8-#11	4.88	1440	1035	2479	756	2816	614	3056	503	3384	286	3795	20	3743
8-#14	7.03	1578	1193	2846	849	3273	679	3605	545	4063	259	4542	-119	4456
12-#10	5.95	1548	1114	2645	818	3022	669	3311	531	3787	299	4350	1	4348

SQUARE TIED COLUMNS 18" x 18"

4-#9	1.23	1753	973	2672	768	2986	646	3138	550	3266	406	3709	336	1633
4-#10	1.57	1803	1004	2800	784	3141	657	3322	557	3513	402	4003	324	2019
4-#11	1.93	1845	1037	2935	796	3291	665	3494	559	3738	395	4217	302	2405
4-#14	2.78	1958	1116	3238	839	3660	695	3936	577	4319	385	4869	264	3318
4-#18	4.94	2209	1316	3954	951	4543	775	4994	624	5633	347	6323	152	5475
8-#6	1.09	1684	960	2499	770	2787	649	2907	557	2962	414	3355	317	1472
8-#7	1.48	1731	996	2618	791	2932	664	3079	567	3192	412	3643	295	1946
8-#8	1.95	1784	1040	2756	816	3100	682	3281	578	3462	408	3977	268	2492
8-#9	2.47	1842	1088	2906	845	3284	702	3500	592	3756	405	4333	238	3079
8-#10	3.14	1915	1149	3095	881	3515	727	3777	609	4129	400	4777	197	3811
8-#11	3.85	1976	1216	3286	914	3737	750	4036	622	4471	391	5109	136	4519
8-#14	5.56	2154	1373	3732	1007	4289	816	4700	665	5348	375	6094	15	6053
12-#10	4.70	2099	1294	3476	978	3973	806	4331	652	4873	390	5771	116	5261
12-#11	5.78	2206	1394	3738	1032	4280	845	4693	673	5376	386	6250	30	6122

SQUARE TIED COLUMNS 20" x 20"

4-#9	1.00	2367	1175	3521	945	3952	797	4148	682	4283	510	4907	435	1868
4-#10	1.27	2426	1206	3672	960	4133	808	4363	688	4570	506	5265	426	2315
4-#11	1.56	2478	1239	3835	971	4312	814	4567	690	4836	499	5543	406	2768
4-#14	2.25	2615	1318	4192	1014	4746	844	5085	707	5530	490	6356	376	3836
4-#18	4.00	2928	1518	5043	1124	5792	923	6337	753	7202	469	8215	284	6386
8-#7	1.20	2339	1198	3455	969	3886	816	4078	699	4195	518	4820	395	2224
8-#8	1.58	2403	1241	3616	994	4082	834	4311	711	4508	515	5222	372	2856
8-#9	2.00	2472	1289	3791	1022	4295	854	4565	724	4848	511	5653	344	3539
8-#10	2.54	2559	1351	4011	1059	4565	880	4888	742	5280	507	6194	308	4394
8-#11	3.12	2634	1417	4241	1091	4829	901	5195	754	5686	498	6624	254	5236
8-#14	4.50	2836	1575	4766	1185	5477	968	5973	798	6733	486	7854	147	7246
8-#18	8.00	3337	1974	6024	1425	7041	1138	7854	910	9250	454	10661	-156	10431
12-#10	3.81	2776	1496	4453	1157	5096	960	5529	787	6143	499	7395	234	6213
12-#11	4.68	2890	1595	4767	1211	5462	999	5960	809	6715	486	8017	156	7247
12-#14	6.75	3224	1832	5509	1357	6371	1107	7053	875	8220	483	9777	1	9774
16-#10	5.08	2969	1641	4889	1264	5668	1032	6216	841	7059	500	8602	154	7933

SQUARE TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.05	3179	1429	4705	1157	5313	975	5602	834	5822	623	6746	535	2609
4-#11	1.29	3240	1462	4896	1167	5522	981	5838	835	6129	614	7089	518	3129
4-#14	1.86	3402	1540	5309	1208	6022	1010	6433	852	6925	605	8066	493	4353
4-#18	3.31	3776	1740	6297	1318	7231	1088	7879	897	8864	584	10336	417	7294
8-#8	1.31	3151	1464	4637	1192	5253	1002	5540	859	5748	632	6687	483	3219
8-#9	1.65	3231	1512	4837	1220	5496	1022	5829	872	6135	629	7194	458	3997
8-#10	2.10	3332	1574	5089	1256	5803	1048	6197	889	6627	625	7833	426	4974
8-#11	2.58	3421	1640	5358	1288	6110	1070	6552	902	7095	616	8362	376	5951
8-#14	3.72	3658	1797	5963	1382	6856	1137	7446	946	8295	605	9839	280	8275
8-#18	6.61	4251	2197	7420	1623	8662	1308	9617	1060	11216	578	13267	10	13235
12-#10	3.15	3584	1719	5592	1356	6408	1130	6927	936	7608	619	9242	356	7205
12-#11	3.87	3719	1818	5960	1409	6834	1169	7426	958	8269	607	10009	286	8417
12-#14	5.58	4080	2054	6814	1556	7879	1278	8682	1026	9956	590	12127	145	11352
16-#10	4.20	3802	1864	6089	1464	7059	1203	7708	991	8651	621	10653	285	9103
16-#11	5.16	3980	1996	6553	1541	7612	1257	8361	1024	9517	608	11662	191	10755

SQUARE TIED COLUMNS 24" x 24"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.08	4144	1706	6136	1382	6941	1165	7328	995	7636	742	8876	639	3490
4-#14	1.56	4331	1784	6604	1423	7506	1193	8000	1011	8534	732	10018	618	4869
4-#18	2.78	4766	1984	7730	1531	8880	1270	9640	1056	10731	711	12704	554	8201
8-#8	1.10	4039	1708	5834	1409	6631	1188	6987	1015	7203	761	8361	600	3581
8-#9	1.39	4130	1756	6060	1437	6904	1208	7311	1027	7636	758	8957	578	4453
8-#10	1.76	4246	1818	6344	1473	7250	1234	7724	1051	8188	754	9713	551	5554
8-#11	2.17	4351	1884	6653	1504	7600	1255	8128	1063	8719	745	10343	505	6663
8-#14	3.13	4623	2041	7339	1598	8442	1322	9136	1108	10072	735	12070	418	9300
8-#18	5.56	5275	2441	8996	1839	10493	1494	11598	1223	13381	710	16126	174	15486
12-#10	2.65	4533	1963	6908	1574	7927	1316	8542	1099	9287	750	11332	486	8101
12-#11	3.25	4691	2062	7330	1627	8413	1355	9110	1121	10039	738	12246	421	9630
12-#14	4.69	5105	2298	8298	1774	9595	1466	10529	1190	11943	723	14725	292	12984
16-#10	3.53	4778	2108	7465	1682	8658	1390	9419	1155	10457	754	12949	422	10298
16-#11	4.33	4984	2240	7998	1759	9289	1445	10162	1189	11442	741	14151	335	12188
16-#14	6.25	5514	2555	9244	1964	10836	1594	12019	1287	13931	726	17389	160	16653
20-#10	4.41	5030	2253	8054	1780	9393	1473	10303	1203	11654	758	14641	349	12573
20-#11	5.42	5283	2418	8712	1880	10171	1545	11222	1247	12878	744	16142	241	14749

SQUARE TIED COLUMNS 26" x 26"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.33	5414	2050	8092	1657	9218	1393	9804	1186	10376	871	12235	750	5384
4-#18	2.37	5913	2250	9358	1764	10757	1469	11639	1229	12832	848	15341	697	9106
8-#9	1.18	5184	2021	7474	1674	8538	1410	9031	1204	9371	899	10937	703	4908
8-#10	1.50	5314	2083	7790	1710	8922	1436	9488	1219	9983	895	11778	676	6130
8-#11	1.85	5434	2149	8141	1740	9316	1456	9942	1239	10577	886	12585	641	7374
8-#14	2.66	5744	2307	8908	1834	10256	1524	11065	1285	12082	876	14566	562	10321
8-#18	4.73	6484	2706	10767	2075	12551	1697	13818	1400	15781	853	19256	338	17387
12-#10	2.25	5638	2228	8415	1811	9673	1519	10395	1276	11201	892	13581	612	8968
12-#11	2.77	5818	2327	8892	1864	10220	1558	11033	1298	12042	880	14745	561	10756
12-#14	3.99	6286	2564	9975	2011	11538	1669	12614	1368	14163	867	17591	443	14669
12-#18	7.10	7418	3163	12604	2387	14760	1951	16485	1545	19366	831	24320	111	23629

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	3.01	5910	2373	9034	1921	10483	1594	11367	1325	12497	897	15378	551	11517
16-#11	3.69	6143	2505	9635	1997	11193	1649	12201	1368	13600	885	16901	483	13648
16-#14	5.33	6741	2820	11029	2203	12920	1799	14273	1467	16376	873	20618	323	18770
20-#10	3.76	6193	2518	9679	2018	11298	1678	12347	1383	13824	902	17262	479	14056
20-#11	4.62	6479	2683	10419	2118	12173	1750	13379	1427	15196	890	19159	394	16642

SQUARE TIED COLUMNS 28" x 28"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.15	6665	2336	9789	1912	11174	1610	11866	1375	12472	1021	14703	889	5899
4-#18	2.04	7229	2536	11195	2017	12879	1684	13895	1417	15185	998	18265	847	10011
8-#9	1.02	6403	2308	9093	1931	10416	1629	11007	1395	11360	1052	13201	838	5362
8-#10	1.30	6549	2369	9443	1967	10839	1655	11510	1410	12031	1048	14123	811	6705
8-#11	1.59	6685	2435	9836	1996	11277	1675	12013	1420	12688	1038	15014	777	8082
8-#14	2.30	7032	2593	10684	2090	12314	1742	13251	1460	14346	1029	17298	708	11341
8-#18	4.08	7863	2993	12747	2331	14854	1915	16295	1592	18433	1007	22676	507	19197
12-#10	1.94	6909	2514	10129	2068	11663	1739	12505	1468	13368	1046	16109	748	9831
12-#11	2.39	7112	2614	10662	2120	12271	1777	13212	1490	14299	1034	17398	698	11820
12-#14	3.44	7636	2850	11860	2268	13727	1889	14957	1561	16637	1022	20679	593	16407
12-#18	6.12	8903	3449	14776	2645	17294	2173	19241	1740	22392	989	28398	292	26411
16-#10	2.59	7210	2659	10808	2178	12552	1815	13572	1518	14791	1052	18085	690	12760
16-#11	3.18	7472	2792	11480	2255	13342	1869	14498	1550	16013	1040	19775	623	15136
16-#14	4.59	8137	3107	13022	2461	15249	2021	16784	1646	19075	1030	24054	482	20823
20-#10	3.24	7523	2804	11511	2276	13467	1890	14649	1576	16248	1058	20080	607	15512
20-#11	3.98	7845	2970	12334	2375	14420	1972	15794	1621	17768	1047	22267	535	18501
20-#14	5.74	8668	3364	14244	2634	16782	2168	18627	1747	21570	1037	27588	353	25246
24-#10	3.89	7870	2949	12220	2373	14342	1972	15746	1626	17690	1056	22110	556	18269
24-#11	4.78	8259	3148	13189	2494	15508	2062	17115	1681	19505	1042	24610	455	21633

SQUARE TIED COLUMNS 30" x 30"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.00	8094	2644	11708	2186	13394	1844	14205	1579	14841	1184	17414	1031	6412
4-#18	1.78	8725	2844	13257	2290	15265	1917	16429	1620	17812	1160	21498	1004	10914
8-#10	1.13	7963	2677	11317	2243	13018	1891	13809	1616	14353	1212	16775	957	7279
8-#11	1.39	8115	2743	11753	2272	13501	1910	14361	1625	15072	1202	17749	922	8788
8-#14	2.00	8500	2901	12684	2365	14636	1977	15714	1666	16883	1193	20242	854	12358
8-#18	3.56	9424	3300	14951	2606	17422	2151	19050	1797	21358	1172	26408	679	21001
12-#10	1.69	8359	2822	12064	2345	13916	1976	14893	1675	15809	1211	18944	894	10693
12-#11	2.08	8587	2921	12655	2397	14585	2013	15669	1697	16829	1199	20358	844	12881
12-#14	3.00	9167	3158	13968	2544	16179	2125	17577	1768	19385	1188	23947	741	18063
12-#18	5.33	10572	3757	17173	2922	20093	2411	22274	1948	25691	1158	32790	475	29265
16-#10	2.26	8689	2967	12804	2456	14884	2052	16055	1725	17358	1218	21099	838	14016
16-#11	2.77	8981	3099	13547	2532	15754	2106	17071	1758	18699	1207	22955	772	16650
16-#14	4.00	9716	3415	15237	2739	17842	2258	19573	1855	22046	1197	27639	634	22909
16-#18	7.11	11497	4214	19369	3265	22971	2644	25729	2126	30298	1170	39166	274	37627
20-#10	2.82	9035	3112	13564	2553	15881	2128	17228	1784	18946	1225	23278	755	16984
20-#11	3.47	9393	3277	14471	2651	16956	2199	18486	1829	20614	1214	25576	670	20280
20-#14	5.00	10300	3671	16561	2911	19517	2406	21586	1956	24772	1207	31512	507	27948
24-#10	3.39	9416	3257	14336	2651	16827	2209	18423	1834	20517	1223	25494	707	20107
24-#11	4.16	9848	3456	15403	2771	18107	2299	19928	1890	22509	1211	28243	608	23836

SQUARE TIED COLUMNS 32" x 32"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.56	10415	3172	15557	2582	17933	2167	19260	1838	20731	1333	24889	1156	11817
8-#11	1.22	9736	3072	13907	2567	16007	2162	17006	1845	17749	1378	20812	1077	9492
8-#14	1.76	10161	3230	14922	2660	17240	2229	18474	1886	19713	1369	23513	1010	13373
8-#18	3.13	11180	3629	17395	2900	20273	2402	22101	1991	24576	1348	30213	838	22803
12-#10	1.49	10002	3151	14236	2642	16450	2229	17576	1896	18542	1387	22107	1050	11552
12-#11	1.83	10254	3250	14884	2693	17181	2266	18423	1917	19652	1376	23646	1000	13939
12-#14	2.64	10892	3486	16314	2840	18913	2378	20493	1989	22425	1365	27543	898	19591
12-#18	4.69	12437	4086	19809	3218	23174	2665	25605	2171	29282	1337	37172	636	32190
16-#10	1.98	10361	3296	15037	2753	17498	2306	18834	1947	20219	1395	24442	996	15164
16-#11	2.44	10683	3428	15851	2829	18447	2360	19942	1979	21677	1384	26462	931	18192
16-#14	3.52	11490	3743	17691	3036	20716	2512	22658	2077	25311	1376	31552	795	25028
16-#18	6.25	13442	4543	22197	3563	26302	2900	29359	2324	34289	1353	44112	443	41488
20-#10	2.48	10739	3441	15853	2850	18577	2383	20103	2006	21936	1403	26806	914	18471
20-#11	3.05	11133	3606	16846	2948	19750	2454	21475	2051	23752	1392	29310	829	22077
20-#14	4.39	12128	4000	19116	3208	22573	2647	24842	2180	28267	1387	35601	648	30681
24-#10	2.98	11155	3586	16688	2948	19592	2463	21397	2057	23636	1402	29206	867	21833
24-#11	3.66	11631	3784	17855	3068	20987	2553	23037	2113	25806	1391	32205	770	26083
24-#14	5.27	12834	4257	20555	3380	24346	2791	27068	2268	31193	1383	39720	559	35859

SQUARE TIED COLUMNS 34" x 34"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.38	12310	3522	18113	2895	20903	2433	22408	2070	23962	1518	28628	1318	12719
8-#11	1.08	11563	3422	16314	2883	18812	2432	19967	2080	20738	1565	24224	1243	10196
8-#14	1.56	12027	3580	17413	2975	20144	2498	21551	2120	22855	1556	27134	1176	14386
8-#18	2.77	13142	3979	20093	3215	23424	2671	25470	2226	28106	1536	34366	1006	24600
12-#10	1.32	11849	3501	16658	2959	19283	2499	20576	2132	21588	1575	25621	1216	12409
12-#11	1.62	12125	3600	17366	3009	20076	2536	21493	2153	22787	1564	27284	1166	14994
12-#14	2.34	12822	3837	18913	3156	21947	2648	23727	2224	25777	1554	31489	1065	21115
12-#18	4.15	14510	4436	22699	3534	26557	2935	29252	2408	33186	1528	41901	806	35186
16-#10	1.76	12237	3646	17519	3070	20410	2576	21929	2183	23392	1584	28135	1163	16310
16-#11	2.16	12590	3778	18408	3145	21440	2630	23129	2215	24969	1573	30321	1099	19673
16-#14	3.11	13470	4093	20398	3352	23891	2783	26060	2314	28888	1566	35816	965	27179
16-#18	5.54	15597	4893	25279	3880	29935	3173	33306	2563	38592	1546	49406	620	45066
20-#10	2.20	12648	3791	18394	3166	21570	2654	23295	2243	25239	1592	30681	1082	19976
20-#11	2.70	13080	3956	19472	3264	22844	2724	24780	2288	27203	1582	33395	998	23891
20-#14	3.89	14163	4350	21924	3523	25893	2918	28415	2418	32075	1578	40191	820	33220
24-#10	2.64	13100	3936	19291	3265	22656	2734	24687	2295	27068	1592	33269	1037	23570
24-#11	3.24	13621	4135	20558	3384	24167	2824	26463	2351	29415	1581	36517	941	28274
24-#14	4.67	14930	4607	23473	3697	27790	3062	30814	2507	35229	1576	44638	734	38988

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.23	14423	3894	20937	3228	24191	2717	25892	2317	27525	1715	32739	1491	13620
8-#14	1.39	14110	3951	20171	3310	23366	2784	24963	2370	26329	1755	31128	1352	15397
8-#18	2.47	15324	4351	23060	3549	26894	2956	29175	2475	31968	1735	38891	1184	26395
12-#10	1.18	13913	3872	19347	3295	22434	2786	23912	2382	24967	1775	29508	1392	13265
12-#11	1.44	14214	3971	20115	3344	23290	2823	24898	2403	26255	1763	31294	1342	16047
12-#14	2.08	14970	4208	21779	3491	25299	2935	27296	2475	29462	1754	35807	1242	22635
12-#18	3.70	16803	4807	25859	3869	30258	3222	33236	2659	37422	1729	47003	986	38254
16-#10	1.57	14331	4017	20265	3406	23641	2864	25361	2434	26897	1784	32202	1340	17452
16-#11	1.93	14715	4150	21231	3481	24752	2917	26652	2466	28592	1773	34552	1277	21081
16-#14	2.78	15669	4465	23373	3688	27385	3070	29799	2565	32798	1767	40452	1145	29365
16-#18	4.94	17974	5264	28630	4217	33887	3461	37590	2816	43227	1750	55072	805	48688
20-#10	1.96	14776	4162	21200	3503	24876	2941	26822	2495	28875	1793	34929	1261	21496
20-#11	2.41	15246	4328	22365	3599	26256	3012	28421	2539	30987	1783	37850	1177	25723
20-#14	3.47	16418	4722	24999	3859	29531	3206	32324	2670	36215	1781	45154	1000	35780
20-#18	6.17	19269	5721	31488	4522	37621	3700	41982	3000	49174	1770	63222	545	59187
24-#10	2.35	15263	4307	22160	3602	26039	3022	28309	2546	30833	1794	37706	1216	25317
24-#11	2.89	15829	4506	23529	3720	27665	3111	30225	2602	33357	1783	41203	1122	30397
24-#14	4.17	17246	4979	26660	4033	31553	3349	34897	2760	39597	1779	49929	918	42171

SQUARE TIED COLUMNS 38" x 38"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.11	16766	4286	24045	3580	27818	3018	29732	2579	31439	1923	37244	1674	14520
8-#14	1.25	16423	4343	23212	3664	26925	3086	28732	2633	30154	1965	35516	1538	16407
8-#18	2.22	17736	4743	26311	3902	30702	3258	33235	2738	36181	1946	43809	1372	28187
12-#10	1.06	16207	4265	22317	3651	25920	3090	27603	2648	28697	1987	33790	1578	14119
12-#11	1.30	16533	4364	23145	3699	26841	3126	28660	2668	30074	1974	35700	1528	17098
12-#14	1.87	17349	4600	24929	3846	28989	3238	31222	2739	33498	1965	40520	1429	24152
12-#18	3.32	19329	5200	29303	4224	34298	3525	37575	2924	42009	1942	52499	1175	41289
16-#10	1.41	16655	4410	23292	3762	27207	3168	29147	2700	30754	1996	36664	1528	18592
16-#11	1.73	17071	4542	24333	3836	28400	3221	30530	2731	32567	1985	39178	1465	22485
16-#14	2.49	18099	4857	26630	4044	31215	3374	33893	2830	37059	1980	45483	1335	31583
16-#18	4.43	20586	5657	32265	4573	38176	3766	42229	3083	48214	1965	61132	1000	52355
20-#10	1.76	17133	4555	24287	3859	28518	3245	30705	2761	32835	1997	39572	1450	22992
20-#11	2.16	17642	4720	25541	3955	29998	3316	32418	2805	35122	1996	42699	1367	27574
20-#14	3.12	18906	5114	28357	4214	33507	3511	36588	2936	40707	1994	50508	1191	38362
20-#18	5.54	21977	6113	35303	4878	42168	4007	46925	3269	54570	1987	69864	741	63931
24-#10	2.11	17657	4700	25311	3958	29757	3326	32283	2812	34949	2007	42538	1405	27076
24-#11	2.59	18269	4898	26781	4076	31500	3415	34342	2869	37651	1996	46283	1312	32531
24-#14	3.74	19795	5371	30129	4389	35652	3654	39336	3027	44318	1994	55615	1111	45408

SQUARE TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.00	19352	4700	27453	3952	31799	3335	33947	2856	35725	2144	42164	1867	15420
8-#14	1.13	18979	4757	26551	4038	30840	3406	32875	2912	34351	2187	40320	1734	17415
8-#18	2.00	20393	5157	29861	4276	34866	3577	37672	3017	40765	2168	49143	1569	29976
12-#11	1.17	19095	4778	26473	4075	30746	3446	32797	2947	34265	2197	40522	1724	18148
12-#14	1.69	19971	5014	28376	4221	33033	3558	35522	3019	37905	2188	45650	1625	25666
12-#18	3.00	22100	5614	33045	4599	38693	3845	42290	3204	46968	2166	58411	1374	43991
16-#10	1.27	19222	4823	26614	4138	31128	3489	33309	2980	34983	2220	41543	1725	19730
16-#11	1.56	19669	4956	27730	4211	32403	3542	34784	3011	36914	2209	44221	1662	23887
16-#14	2.25	20773	5271	30178	4418	35400	3695	38362	3111	41691	2204	50931	1534	33715
16-#18	4.00	23444	6070	36200	4949	42822	4087	47245	3364	53572	2191	67610	1203	56066
20-#10	1.59	19733	4968	27671	4235	32515	3566	34963	3041	37192	2221	44633	1648	24418
20-#11	1.95	20281	5134	29013	4330	34094	3636	36790	3086	39593	2210	47965	1566	29443
20-#14	2.81	21638	5528	32013	4589	37827	3831	41228	3217	45570	2219	56277	1393	40966
20-#18	5.00	24932	6527	39417	5253	47072	4329	52244	3552	60338	2215	76922	945	68771
24-#10	1.90	20294	5113	28757	4334	33829	3647	36631	3092	39437	2231	47788	1604	28845
24-#11	2.34	20953	5312	30330	4452	35689	3735	38826	3149	42316	2221	51781	1511	34677
24-#14	3.38	22589	5785	33896	4764	40107	3974	44149	3309	49409	2220	61719	1313	48533

SQUARE TIED COLUMNS 42" x 42"

8-#14	1.02	21790	5192	30202	4432	35128	3742	37414	3205	38939	2421	45563	1940	18422
8-#18	1.81	23306	5592	33725	4669	39403	3913	42503	3310	45740	2402	54916	1776	31764
12-#11	1.06	21911	5213	30112	4470	35024	3783	37328	3241	38846	2432	45784	1931	19196
12-#14	1.53	22849	5449	32135	4616	37451	3895	40218	3313	42704	2423	51219	1832	27178
12-#18	2.72	25128	6048	37102	4993	43462	4182	47401	3498	52317	2402	64762	1582	46687
16-#10	1.15	22043	5258	30247	4533	35421	3827	37865	3275	39603	2455	46862	1933	20866
16-#11	1.41	22523	5391	31440	4606	36779	3879	39433	3306	41652	2444	49704	1870	25286
16-#14	2.04	23704	5706	34039	4813	39959	4033	43227	3405	46714	2439	56818	1743	35739
16-#18	3.63	26561	6505	40449	5344	47841	4425	52655	3660	59321	2428	74526	1416	59822
20-#10	1.44	22589	5403	31365	4631	36884	3904	39616	3336	41940	2457	50133	1857	25841
20-#11	1.77	23176	5569	32797	4725	38563	3973	41557	3380	44488	2445	53670	1775	31276
20-#14	2.55	24626	5963	35981	4984	42520	4168	46264	3513	50769	2441	62485	1604	43591
20-#18	4.54	28148	6962	43844	5647	52348	4668	57958	3849	66497	2454	84411	1161	73414
24-#10	1.73	23186	5548	32514	4730	38275	3985	41374	3387	44317	2467	53477	1813	30627
24-#11	2.12	23893	5747	34192	4847	40252	4073	43704	3443	47372	2457	57718	1721	36835
24-#14	3.06	25641	6220	37975	5160	44935	4312	49345	3604	54892	2457	68261	1525	51577
24-#18	5.44	29903	7419	47330	5957	56568	4922	63363	4010	73601	2454	94460	1018	85757

SQUARE TIED COLUMNS 44" x 44"

8-#18	1.65	26487	6048	37918	5082	44334	4265	47749	3617	51126	2647	61149	1994	33550
12-#14	1.39	25995	5905	36222	5030	42261	4248	45328	3621	47913	2669	57249	2049	28687
12-#18	2.48	28426	6505	41488	5407	48624	4536	52926	3807	58077	2649	71574	1800	49379
16-#10	1.05	25133	5714	34206	4949	40106	4182	42836	3585	44634	2702	52643	2150	22000
16-#11	1.29	25645	5847	35476	5020	41546	4233	44496	3615	46800	2690	55648	2088	26682
16-#14	1.86	26903	6162	38227	5227	44910	4387	48506	3714	52148	2686	63166	1962	37758
16-#18	3.31	29949	6961	45014	5757	53254	4780	58481	3970	65481	2676	81903	1638	63623

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	1.31	25713	5859	35385	5046	41645	4258	44683	3646	47100	2704	56096	2075	27261
20-#11	1.61	26340	6025	36908	5140	43424	4327	46739	3690	49794	2692	59837	1994	33026
20-#14	2.32	27884	6419	40276	5399	47606	4522	51713	3822	56431	2688	69155	1824	46239
20-#18	4.13	31635	7418	48601	6061	57999	5022	64087	4160	73067	2704	92359	1387	77898
24-#10	1.57	26347	6004	36596	5146	43111	4340	46532	3697	49607	2715	59629	2032	32420
24-#11	1.93	27101	6203	38380	5262	45206	4427	48997	3753	52839	2705	64117	1940	39007
24-#14	2.79	28962	6676	42382	5575	50155	4667	54955	3913	60785	2705	75266	1746	54636
24-#18	4.96	33498	7875	52284	6373	62459	5277	69799	4323	80576	2705	103003	1245	91298

SQUARE TIED COLUMNS 46" x 46"

8-#18	1.51	29950	6525	42455	5514	49675	4635	53430	3940	56941	2904	67865	2221	35333
12-#14	1.28	29422	6382	40651	5464	47481	4619	50872	3945	53552	2927	63763	2276	30194
12-#18	2.27	32005	6982	46217	5840	54196	4906	58886	4130	64266	2907	78869	2029	52065
16-#11	1.18	29047	6324	39853	5455	46724	4605	49993	3939	52379	2948	62076	2316	28077
16-#14	1.70	30383	6639	42757	5661	50271	4758	54219	4038	58013	2945	69998	2190	39773
16-#18	3.02	33620	7439	49922	6190	59077	5151	64741	4295	72071	2936	89763	1870	67469
20-#10	1.20	29117	6337	39745	5482	46814	4630	50184	3971	52689	2963	62543	2304	28679
20-#11	1.47	29784	6502	41360	5575	48694	4698	52355	4014	55531	2951	66488	2223	34773
20-#14	2.13	31424	6896	44914	5833	53101	4893	57598	4147	62523	2948	76308	2055	48910
20-#18	3.78	35407	7895	53701	6495	64061	5393	70651	4485	79961	2938	100790	1622	82412
24-#10	1.44	29789	6482	41020	5582	48357	4712	52123	4021	55327	2974	66265	2261	34162
24-#11	1.77	30591	6680	42909	5697	50570	4799	54723	4077	58736	2964	71001	2170	41191
24-#14	2.55	32566	7153	47131	6009	55785	5038	61000	4237	67109	2965	82754	1977	57709
24-#18	4.54	37379	8352	57582	6807	68760	5648	76649	4648	87983	2968	112029	1482	96913

SQUARE TIED COLUMNS 48" x 48"

8-#18	1.39	33706	7024	47350	5967	55445	5021	59565	4277	63206	3173	75086	2458	37116
12-#14	1.17	33142	6881	45438	5918	53130	5006	56870	4283	59641	3196	70783	2513	31700
12-#18	2.08	35880	7481	51305	6294	60198	5293	65300	4468	70906	3177	86669	2267	54747
16-#11	1.08	32743	6823	44587	5909	52329	4993	55944	4277	58407	3218	69010	2554	29469
16-#14	1.56	34157	7138	47644	6115	56061	5146	60386	4377	64327	3215	77336	2429	41785
16-#18	2.78	37587	7937	55189	6643	65329	5539	71455	4634	79110	3207	98128	2111	71361
20-#10	1.10	32815	6835	44461	5937	52412	5018	56138	4310	58729	3233	69497	2543	30094
20-#11	1.35	33522	7001	46169	6029	54393	5086	58424	4353	61718	3221	73646	2462	36517
20-#14	1.95	35257	7395	49909	6287	59025	5281	63935	4486	69065	3218	83968	2295	51603
20-#18	3.47	39476	8394	59160	6949	70553	5780	77668	4825	87405	3211	109727	1867	86955
24-#10	1.32	33524	6980	45799	6038	54030	5101	58168	4361	61498	3245	73408	2500	35864
24-#11	1.63	34374	7179	47795	6152	56362	5187	60904	4415	65083	3235	78390	2409	43388
24-#14	2.34	36464	7652	52237	6464	61844	5426	67498	4576	73882	3237	90748	2218	60797
24-#18	4.17	41558	8851	63239	7261	75491	6036	83952	4987	95839	3241	121561	1727	102600

SQUARE TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.24	377	388	613	246	618	206	607	174	577	124	601	95	288
4-#6	1.76	386	402	636	253	645	210	638	175	616	119	642	84	377
4-#7	2.40	397	420	664	262	676	215	673	176	661	112	690	68	481
4-#8	3.16	409	441	696	274	710	221	713	177	713	103	742	49	596
4-#9	4.00	422	464	726	285	745	227	754	178	765	93	793	27	716
4-#10	5.08	437	494	762	299	787	235	802	178	827	79	851	-4	853
4-#11	6.24	449	526	774	307	799	234	815	170	845	54	840	-57	871
8-#5	2.48	392	422	643	266	656	222	651	182	633	117	665	51	504
8-#6	3.52	407	451	678	282	696	233	698	186	693	108	729	20	668
8-#7	4.80	425	486	720	307	743	245	752	190	762	96	802	-19	804

SQUARE TIED COLUMNS 12" x 12"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.22	657	558	1066	367	1092	309	1089	263	1049	191	1097	148	488
4-#7	1.67	672	576	1105	375	1140	315	1145	266	1120	186	1174	135	629
4-#8	2.19	690	597	1151	386	1197	322	1209	269	1202	180	1294	129	789
4-#9	2.78	708	620	1200	399	1257	331	1276	272	1287	173	1390	113	958
4-#10	3.53	731	650	1261	415	1333	342	1358	275	1392	163	1506	91	1166
4-#11	4.33	749	682	1310	428	1374	345	1403	271	1450	144	1545	53	1358
4-#14	6.25	800	758	1445	471	1518	367	1570	275	1663	112	1756	-19	1764
8-#5	1.72	664	578	1074	381	1104	322	1105	272	1071	191	1126	119	655
8-#6	2.44	685	607	1123	397	1165	333	1178	278	1162	185	1226	91	880
8-#7	3.33	710	642	1182	417	1238	348	1264	286	1271	177	1342	55	1144
8-#8	4.39	740	684	1250	440	1324	366	1361	294	1395	167	1526	26	1443
8-#9	5.56	771	730	1323	467	1415	386	1462	302	1525	155	1672	-21	1603
8-#10	7.06	810	790	1414	501	1530	411	1587	312	1684	138	1848	-84	1756

SQUARE TIED COLUMNS 14" x 14"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.22	1049	759	1700	512	1757	431	1764	368	1728	271	1838	216	776
4-#8	1.61	1073	780	1759	522	1830	438	1852	372	1842	267	1966	204	980
4-#9	2.04	1098	804	1823	534	1910	446	1948	376	1962	261	2099	190	1197
4-#10	2.59	1129	834	1904	550	2009	457	2068	382	2111	254	2263	170	1468
4-#11	3.18	1155	866	1976	562	2093	465	2158	383	2213	238	2347	137	1729
4-#14	4.59	1225	942	2160	604	2324	494	2412	393	2536	215	2791	102	2347
8-#5	1.27	1038	762	1657	519	1708	439	1707	374	1658	277	1763	199	805
8-#6	1.80	1065	790	1720	534	1787	451	1801	381	1782	273	1907	176	1090
8-#7	2.45	1097	826	1797	554	1882	466	1916	390	1931	267	2077	146	1428
8-#8	3.22	1135	868	1886	578	1992	484	2050	400	2103	260	2271	110	1814
8-#9	4.08	1175	914	1981	605	2112	504	2194	412	2286	252	2474	68	2224
8-#10	5.18	1226	974	2101	639	2262	530	2376	427	2512	240	2722	11	2695
8-#11	6.37	1275	1038	2208	669	2390	552	2516	435	2670	215	2858	-72	2839

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.23	1575	993	2544	681	2650	573	2673	490	2648	364	2860	296	1170
4-#9	1.56	1606	1016	2624	693	2748	581	2791	494	2807	360	3040	285	1436
4-#10	1.98	1646	1046	2724	708	2872	592	2940	499	3007	355	3264	269	1768
4-#11	2.44	1680	1078	2820	719	2981	599	3069	501	3153	342	3407	242	2097
4-#14	3.52	1771	1154	3054	760	3273	627	3422	517	3591	324	3887	192	2873
4-#18	6.25	1982	1348	3606	868	3964	703	4222	553	4581	269	4915	47	4681
8-#6	1.38	1564	1003	2494	695	2594	588	2609	501	2562	369	2774	269	1299
8-#7	1.88	1604	1038	2589	714	2711	603	2749	510	2752	365	2999	243	1710
8-#8	2.47	1651	1080	2698	738	2847	621	2913	520	2975	361	3259	212	2183
8-#9	3.13	1701	1127	2816	765	2994	641	3091	532	3217	356	3533	176	2689
8-#10	3.97	1765	1186	2965	799	3181	667	3317	548	3518	349	3873	128	3320
8-#11	4.88	1820	1250	3105	829	3348	689	3516	559	3745	329	4099	56	3922
8-#14	7.03	1968	1403	3455	918	3787	756	4049	598	4408	300	4826	-87	4777
12-#10	5.95	1932	1327	3257	901	3553	731	3769	585	4150	343	4653	36	4508

SQUARE TIED COLUMNS 18" x 18"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.23	2252	1256	3627	874	3798	736	3845	629	3826	467	4194	389	1673
4-#10	1.57	2299	1286	3747	889	3946	746	4023	634	4067	463	4480	376	2066
4-#11	1.93	2342	1318	3866	899	4082	752	4182	635	4281	454	4684	352	2464
4-#14	2.78	2453	1395	4151	939	4435	780	4608	651	4849	442	5319	312	3396
4-#18	4.94	2717	1588	4829	1046	5282	855	5632	693	6131	399	6734	193	5598
8-#6	1.09	2200	1243	3469	878	3614	744	3627	637	3534	478	3853	371	1506
8-#7	1.48	2248	1278	3581	897	3752	759	3793	646	3758	474	4134	349	1990
8-#8	1.95	2304	1321	3712	921	3914	777	3988	657	4022	470	4460	321	2550
8-#9	2.47	2365	1367	3853	947	4089	797	4200	669	4309	466	4808	289	3152
8-#10	3.14	2441	1427	4032	982	4312	824	4468	685	4674	460	5242	247	3906
8-#11	3.85	2510	1491	4206	1012	4517	846	4713	696	5004	448	5560	184	4645
8-#14	5.56	2690	1644	4630	1101	5049	913	5357	736	5862	430	6522	59	6341
12-#10	4.70	2638	1567	4379	1086	4754	890	5007	724	5427	457	6223	164	5450
12-#11	5.78	2746	1664	4618	1138	5043	925	5351	742	5898	443	6686	76	6341

SQUARE TIED COLUMNS 20" x 20"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.00	3051	1525	4854	1078	5087	910	5137	780	5067	588	5588	502	1909
4-#10	1.27	3107	1555	4995	1093	5259	920	5343	786	5347	584	5936	492	2364
4-#11	1.56	3158	1587	5139	1102	5421	925	5532	786	5600	574	6201	471	2830
4-#14	2.25	3290	1663	5475	1141	5836	952	6032	801	6277	563	6994	438	3918
4-#18	4.00	3604	1857	6280	1246	6838	1026	7242	842	7911	537	8807	339	6514
8-#7	1.20	3046	1547	4799	1103	5032	934	5075	799	4987	597	5508	464	2269
8-#8	1.58	3111	1589	4951	1126	5219	953	5300	810	5291	593	5901	439	2915
8-#9	2.00	3182	1636	5116	1153	5422	973	5546	822	5624	588	6322	410	3612
8-#10	2.54	3271	1695	5324	1187	5681	999	5858	838	6047	583	6852	373	4488
8-#11	3.12	3354	1760	5532	1216	5926	1021	6147	849	6437	572	7265	316	5362
8-#14	4.50	3567	1912	6031	1305	6550	1089	6902	890	7462	557	8468	205	7433
8-#18	8.00	4078	2300	7230	1533	8057	1263	8729	994	9929	518	11211	-107	11077
12-#10	3.81	3498	1836	5727	1292	6195	1067	6482	879	6920	582	8038	296	6435
12-#11	4.68	3626	1932	6013	1345	6538	1102	6891	898	7478	569	8640	216	7503
12-#14	6.75	3952	2161	6709	1489	7414	1205	7952	959	8931	551	10366	56	10086
16-#10	5.08	3681	1977	6170	1387	6752	1146	7154	931	7794	570	9230	215	8159

SQUARE TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.05	4085	1852	6493	1320	6837	1114	6928	954	6873	718	7658	618	2661
4-#11	1.29	4144	1884	6662	1327	7026	1118	7146	954	7165	708	7984	599	3194
4-#14	1.86	4298	1960	7050	1366	7502	1144	7720	968	7941	697	8938	571	4439
4-#18	3.31	4664	2154	7983	1469	8661	1216	9117	1008	9836	671	11154	488	7428
8-#8	1.31	4088	1886	6440	1355	6788	1147	6877	980	6808	728	7607	566	3279
8-#9	1.65	4170	1933	6628	1381	7020	1168	7156	992	7186	724	8103	540	4071
8-#10	2.10	4273	1992	6866	1415	7315	1194	7511	1008	7667	719	8728	506	5069
8-#11	2.58	4369	2057	7110	1443	7599	1215	7846	1019	8117	708	9238	454	6077
8-#14	3.72	4616	2209	7684	1532	8316	1283	8712	1060	9291	694	10684	355	8463
8-#18	6.61	5211	2597	9071	1761	10056	1459	10820	1166	12153	660	14037	75	13768
12-#10	3.15	4530	2133	7325	1521	7900	1263	8221	1051	8660	720	10121	435	7397
12-#11	3.87	4677	2229	7659	1573	8299	1298	8696	1069	9306	707	10865	362	8711
12-#14	5.58	5053	2458	8461	1719	9305	1402	9914	1132	10973	692	12943	216	11712
16-#10	4.20	4739	2274	7830	1617	8535	1343	8987	1104	9655	710	11516	362	9354
16-#11	5.16	4927	2402	8262	1689	9058	1396	9612	1134	10496	693	12499	264	11055

SQUARE TIED COLUMNS 24" x 24"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.08	5319	2209	8461	1576	8921	1330	9051	1139	9003	855	10060	736	3558
4-#14	1.56	5494	2286	8900	1614	9460	1356	9698	1152	9877	843	11176	713	4958
4-#18	2.78	5914	2479	9962	1716	10774	1426	11282	1191	12024	816	13800	642	8340
8-#8	1.10	5252	2212	8202	1606	8649	1362	8744	1167	8598	878	9574	700	3642
8-#9	1.39	5345	2258	8414	1632	8909	1382	9057	1179	9020	873	10157	678	4529
8-#10	1.76	5462	2318	8683	1666	9240	1408	9455	1195	9559	868	10898	648	5649
8-#11	2.17	5572	2382	8962	1693	9564	1428	9836	1205	10069	857	11505	601	6789
8-#14	3.13	5853	2535	9612	1782	10373	1497	10812	1247	11393	844	13196	510	9490
8-#18	5.56	6533	2922	11189	2011	12347	1673	13201	1354	14635	812	17167	256	15929
12-#10	2.65	5749	2458	9198	1773	9896	1478	10251	1239	10672	871	12498	581	8266
12-#11	3.25	5917	2555	9580	1824	10351	1513	10791	1258	11405	858	13386	514	9908
12-#14	4.69	6343	2784	10487	1970	11488	1618	12166	1321	13287	845	15820	380	13396
16-#10	3.53	5986	2599	9764	1869	10608	1559	11110	1294	11788	862	14097	515	10575
16-#11	4.33	6200	2727	10259	1942	11205	1612	11821	1324	12744	846	15268	425	12518
16-#14	6.25	6743	3033	11449	2138	12699	1759	13626	1415	15184	825	18452	245	17177
20-#10	4.41	6260	2739	10337	1963	11322	1629	11973	1337	12969	865	15770	441	12915
20-#11	5.42	6527	2900	10928	2071	12061	1697	12856	1376	14161	848	17237	329	15200

SQUARE TIED COLUMNS 26" x 26"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.33	6895	2639	11049	1885	11735	1587	11994	1354	12110	1004	13733	864	5476
4-#18	2.37	7370	2833	12241	1985	13206	1656	13764	1391	14507	976	16769	804	9251
8-#9	1.18	6724	2612	10498	1906	11115	1607	11275	1383	11152	1036	12484	822	4985
8-#10	1.50	6855	2671	10797	1939	11482	1630	11716	1399	11749	1031	13308	793	6226
8-#11	1.85	6979	2736	11113	1966	11846	1661	12142	1409	12319	1019	14089	756	7499
8-#14	2.66	7296	2888	11839	2055	12747	1730	13229	1450	13791	1007	16029	672	10514
8-#18	4.73	8062	3276	13607	2283	14956	1906	15899	1558	17413	976	20623	439	17745
12-#10	2.25	7173	2812	11368	2047	12209	1712	12599	1444	12982	1035	15090	727	9132
12-#11	2.77	7362	2908	11800	2098	12720	1747	13203	1462	13802	1022	16224	674	10975
12-#14	3.99	7839	3137	12814	2244	13988	1853	14736	1527	15897	1010	19019	550	15136
12-#18	7.10	8999	3718	15284	2617	17092	2121	18495	1689	21042	976	25627	206	24263

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	3.01	7438	2952	11996	2144	12999	1783	13551	1499	14219	1027	16866	664	11822
16-#11	3.69	7678	3081	12554	2216	13670	1847	14348	1530	15289	1012	18356	593	14010
16-#14	5.33	8286	3386	13885	2414	15336	1996	16361	1623	18009	993	22011	426	19237
20-#10	3.76	7744	3093	12624	2237	13791	1865	14507	1544	15528	1031	18730	590	14376
20-#11	4.62	8044	3253	13317	2331	14621	1933	15498	1584	16864	1015	20589	501	17133

SQUARE TIED COLUMNS 28" x 28"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.15	8518	3021	13522	2179	14353	1838	14633	1572	14665	1178	16602	1023	5994
4-#18	2.04	9049	3215	14846	2277	15981	1905	16590	1608	17312	1149	20085	974	10160
8-#9	1.02	8324	2994	12905	2202	13664	1860	13837	1604	13606	1212	15155	977	5441
8-#10	1.30	8469	3053	13234	2236	14068	1883	14321	1620	14261	1207	16058	949	6803
8-#11	1.59	8608	3117	13587	2262	14472	1900	14792	1629	14890	1195	16920	912	8208
8-#14	2.30	8960	3270	14390	2350	15466	1982	15990	1670	16511	1183	19158	839	11531
8-#18	4.08	9814	3657	16349	2578	17909	2158	18941	1779	20512	1153	24430	628	19556
12-#10	1.94	8819	3194	13861	2344	14866	1966	15290	1665	15614	1212	18021	884	9995
12-#11	2.39	9029	3290	14343	2394	15433	2001	15959	1684	16521	1200	19277	831	12038
12-#14	3.44	9557	3519	15464	2540	16832	2106	17649	1748	18830	1188	22500	721	16869
12-#18	6.12	10845	4100	18203	2914	20269	2376	21807	1914	24519	1158	30085	407	27127
16-#10	2.59	9111	3334	14551	2442	15733	2038	16335	1722	16972	1205	19975	823	13095
16-#11	3.18	9379	3463	15173	2513	16478	2088	17219	1752	18157	1190	21627	753	15530
16-#14	4.59	10053	3768	16644	2711	18318	2251	19440	1846	21157	1173	25837	606	21332
20-#10	3.24	9449	3475	15234	2535	16603	2120	17386	1767	18410	1210	22028	750	15854
20-#11	3.98	9784	3635	16004	2628	17525	2188	18484	1807	19889	1195	24091	662	18919
20-#14	5.74	10627	4017	17834	2877	19806	2375	21238	1924	23619	1179	29333	474	25950
24-#10	3.89	9781	3615	15882	2639	17475	2189	18461	1824	19867	1215	24045	698	18748
24-#11	4.78	10183	3808	16785	2755	18586	2273	19778	1876	21643	1199	26516	595	22189

SQUARE TIED COLUMNS 30" x 30"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.00	10379	3431	16343	2496	17342	2108	17642	1808	17567	1365	19778	1188	6510
4-#18	1.78	10967	3625	17798	2593	19127	2174	19785	1843	20464	1335	23775	1154	11069
8-#10	1.13	10322	3463	16018	2555	17023	2156	17296	1858	17121	1397	19180	1116	7378
8-#11	1.39	10476	3528	16409	2580	17467	2172	17813	1866	17809	1384	20122	1079	8916
8-#14	2.00	10863	3680	17289	2668	18554	2234	19121	1907	19579	1372	22564	1007	12548
8-#18	3.56	11806	4068	19440	2896	21232	2430	22353	2016	23958	1343	28612	823	21363
12-#10	1.69	10703	3604	16700	2664	17892	2239	18351	1904	18594	1402	21325	1052	10854
12-#11	2.08	10935	3700	17233	2713	18515	2273	19085	1922	19587	1390	22701	999	13098
12-#14	3.00	11515	3929	18461	2859	20046	2379	20933	1987	22110	1379	26227	891	18399
12-#18	5.33	12931	4510	21470	3234	23815	2650	25490	2154	28343	1351	34922	612	30067
16-#10	2.26	11023	3745	17452	2762	18837	2311	19490	1961	20074	1397	23456	994	14256
16-#11	2.77	11319	3873	18139	2833	19656	2361	20460	1991	21372	1382	25268	925	17080
16-#14	4.00	12059	4178	19751	3031	21669	2505	22888	2086	24651	1366	29878	780	23461
16-#18	7.11	13868	4953	23701	3537	26623	2906	28875	2327	32741	1324	41225	405	38765
20-#10	2.82	11393	3885	18191	2855	19785	2395	20635	2007	21640	1402	25698	921	17348
20-#11	3.47	11763	4046	19038	2947	20799	2462	21840	2047	23262	1388	27966	835	20724
20-#14	5.00	12689	4427	21039	3196	23296	2650	24853	2166	27341	1373	33708	650	28740
24-#10	3.39	11754	4026	18896	2960	20727	2463	21806	2065	23226	1408	27770	855	20504
24-#11	4.16	12198	4218	19890	3075	21945	2547	23252	2117	25175	1393	30616	770	24449

SQUARE TIED COLUMNS 32" x 32"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.56	13141	4063	21124	2931	22669	2463	23377	2094	23988	1536	27693	1329	11976
8-#11	1.22	12598	3966	19602	2921	20858	2463	21230	2120	21100	1587	23721	1258	9622
8-#14	1.76	13021	4119	20559	3009	22038	2525	22648	2161	23018	1575	26368	1187	13563
8-#18	3.13	14054	4506	22904	3236	24951	2685	26162	2270	27776	1547	32938	1005	23166
12-#10	1.49	12842	4042	19911	3007	21314	2532	21809	2159	21947	1606	25027	1231	11712
12-#11	1.83	13096	4139	20494	3055	21994	2565	22608	2177	23026	1594	26523	1179	14155
12-#14	2.64	13728	4368	21831	3201	23657	2671	24613	2242	25763	1583	30352	1072	19925
12-#18	4.69	15275	4949	25110	3576	27758	2943	29570	2410	32539	1558	39818	797	33084
16-#10	1.98	13190	4183	20724	3105	22337	2605	23041	2217	23548	1601	27335	1175	15402
16-#11	2.44	13514	4311	21477	3176	23230	2654	24097	2247	24960	1587	29308	1107	18582
16-#14	3.52	14321	4617	23230	3374	25417	2798	26734	2343	28518	1572	34316	965	25626
16-#18	6.25	16297	5391	27535	3880	30810	3165	33248	2586	37318	1534	46679	598	42381
20-#10	2.48	13593	4324	21518	3198	23363	2688	24280	2264	25242	1608	29767	1103	18860
20-#11	3.05	13998	4484	22443	3289	24468	2756	25593	2304	27007	1593	32238	1018	22547
20-#14	4.39	15008	4866	24616	3538	27181	2944	28865	2423	31435	1581	38482	836	31318
24-#10	2.98	13984	4464	22281	3303	24374	2756	25547	2322	26959	1614	32012	1039	22248
24-#11	3.66	14469	4657	23366	3418	25701	2840	27123	2374	29081	1600	34945	937	26682
24-#14	5.27	15677	5115	25930	3723	28948	3066	31045	2524	34389	1589	42574	743	36700

SQUARE TIED COLUMNS 34" x 34"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.38	15587	4530	24846	3292	26634	2771	27392	2363	27908	1749	32033	1517	12882
8-#11	1.08	14993	4433	23190	3286	24672	2774	25070	2391	24789	1803	27745	1449	10327
8-#14	1.56	15452	4586	24226	3372	25945	2835	26599	2432	26855	1791	30595	1378	14576
8-#18	2.77	16575	4973	26765	3598	29094	2995	30393	2541	31991	1763	37686	1199	24966
12-#10	1.32	15253	4509	23515	3373	25158	2844	25690	2431	25697	1823	29154	1423	12568
12-#11	1.62	15529	4605	24151	3420	25895	2877	26554	2449	26862	1811	30771	1370	15208
12-#14	2.34	16214	4835	25597	3566	27689	2983	28716	2514	29812	1801	34901	1264	21447
12-#18	4.15	17892	5415	29147	3940	32124	3255	34073	2683	37132	1777	45136	993	36178
16-#10	1.76	15629	4650	24390	3471	26259	2917	27016	2490	27420	1819	31640	1368	16546
16-#11	2.16	15982	4778	25210	3541	27226	2966	28158	2520	28945	1804	33774	1301	19991
16-#14	3.11	16856	5084	27105	3739	29587	3110	31002	2616	32783	1791	39179	1161	27826
16-#18	5.54	19001	5858	31767	4246	35421	3479	38045	2861	42293	1755	52556	800	46027
20-#10	2.20	16065	4790	25240	3564	27361	3001	28349	2537	29243	1826	34259	1297	20389
20-#11	2.70	16505	4951	26244	3654	28561	3069	29769	2577	31150	1812	36936	1212	24390
20-#14	3.89	17601	5332	28589	3903	31490	3258	33300	2698	35927	1801	43681	1032	33892
24-#10	2.64	16486	4931	26060	3669	28444	3069	29712	2596	31089	1833	36681	1235	24003
24-#11	3.24	17014	5123	27237	3784	29879	3152	31418	2648	33384	1820	39856	1133	28813
24-#14	4.67	18322	5581	30005	4089	33380	3379	35651	2799	39112	1811	47839	916	39908

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.23	18323	5025	28990	3676	31047	3098	31857	2649	32250	1977	36824	1716	13788
8-#14	1.39	18172	5081	28312	3759	30300	3165	30998	2720	31114	2021	35275	1581	15588
8-#18	2.47	19386	5468	31047	3984	33684	3324	35074	2828	36627	1993	42885	1404	26763
12-#10	1.18	17952	5004	27539	3761	29450	3176	30021	2721	29813	2043	33735	1626	13422
12-#11	1.44	18251	5101	28228	3808	30244	3208	30950	2737	31121	2041	35470	1573	16260
12-#14	2.08	18989	5330	29782	3953	32170	3313	33269	2803	34285	2032	39902	1468	22966
12-#18	3.70	20801	5911	33605	4327	36939	3586	39025	2972	42147	2009	50906	1199	39263
16-#10	1.57	18358	5145	28472	3860	30629	3249	31440	2780	31714	2050	36398	1573	17687
16-#11	1.93	18739	5273	29362	3929	31671	3297	32668	2809	33353	2036	38691	1506	21396
16-#14	2.78	19682	5579	31401	4127	34206	3442	35721	2906	37470	2023	44495	1368	30062
16-#18	4.94	21996	6353	36420	4635	40480	3812	43291	3152	47690	1990	58884	1012	49721
20-#10	1.96	18826	5285	29381	3952	31803	3333	32867	2827	33666	2058	39204	1503	21883
20-#11	2.41	19302	5446	30465	4042	33101	3400	34395	2867	35716	2044	42084	1418	26252
20-#14	3.47	20483	5828	32982	4291	36247	3590	38185	2988	40842	2034	49332	1240	36489
20-#18	6.17	23384	6796	39199	4927	44030	4073	47579	3296	53557	2006	67271	782	60637
24-#10	2.35	19278	5426	30258	4058	32961	3401	34324	2886	35585	2054	41802	1441	25769
24-#11	2.89	19848	5618	31528	4172	34505	3484	36162	2939	38109	2052	45220	1341	30957
24-#14	4.17	21257	6077	34500	4477	38261	3711	40706	3091	44257	2045	53798	1127	43174

SQUARE TIED COLUMNS 38" x 38"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.11	21366	5549	33579	4084	35936	3446	36797	2952	37040	2218	42093	1928	14692
8-#14	1.25	21197	5604	32843	4168	35130	3514	35874	3025	35821	2264	40433	1796	16599
8-#18	2.22	22503	5991	35774	4393	38750	3673	40230	3133	41711	2236	48561	1620	28558
12-#10	1.06	20958	5528	32006	4173	34217	3527	34828	3027	34431	2287	38795	1841	14276
12-#11	1.30	21279	5624	32748	4218	35068	3558	35821	3043	35753	2271	40649	1788	17309
12-#14	1.87	22071	5853	34412	4363	37126	3663	38297	3109	39204	2276	45382	1683	24483
12-#18	3.32	24016	6434	38508	4737	42229	3936	44453	3279	47609	2254	57154	1417	41966
16-#10	1.41	21392	5668	32997	4271	35473	3600	36341	3086	36457	2295	41636	1789	18826
16-#11	1.73	21802	5796	33954	4339	36590	3648	37654	3115	38209	2280	44088	1722	22799
16-#14	2.49	22813	6102	36140	4538	39299	3793	40915	3212	42605	2268	50289	1586	32189
16-#18	4.43	25299	6876	41518	5046	46014	4163	49014	3460	53534	2237	65690	1235	53462
20-#10	1.76	21894	5809	33965	4364	36719	3684	37862	3134	38538	2303	44628	1721	23308
20-#11	2.16	22406	5969	35129	4453	38109	3751	39497	3174	40730	2289	47710	1636	28133
20-#14	3.12	23672	6351	37819	4701	41478	3942	43546	3296	46204	2280	55458	1460	39108
20-#18	5.54	26788	7319	44471	5337	49810	4426	53597	3606	59806	2255	74674	1007	65531
24-#10	2.11	22376	5949	34900	4470	37953	3753	39407	3193	40583	2300	47404	1659	27548
24-#11	2.59	22988	6142	36262	4583	39605	3835	41382	3246	43208	2284	51064	1559	33113
24-#14	3.74	24499	6600	39439	4888	43616	4062	46238	3399	49850	2292	60236	1348	46322

SQUARE TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.00	24731	6100	38637	4514	41326	3813	42240	3271	42301	2472	47867	2151	15596
8-#14	1.13	24546	6156	37842	4601	40461	3883	41253	3347	41000	2520	46097	2022	17608
8-#18	2.00	25944	6543	40970	4824	44318	4041	45889	3454	47267	2493	54742	1847	30350
12-#11	1.17	24630	6175	37736	4652	40393	3928	41195	3366	40928	2528	46334	2014	18358
12-#14	1.69	25476	6405	39510	4796	42583	4033	43829	3431	44483	2513	51368	1910	25996
12-#18	3.00	27556	6985	43881	5169	48020	4305	50384	3601	53544	2513	63907	1645	44663
16-#10	1.27	24750	6220	37989	4705	40818	3971	41744	3410	41674	2553	47381	2017	19962
16-#11	1.56	25188	6348	39014	4772	42010	4018	43143	3438	43537	2538	49991	1950	24198
16-#14	2.25	26269	6654	41342	4971	44894	4163	46612	3535	48212	2526	56589	1815	34211
16-#18	4.00	28927	7428	47086	5479	52050	4534	55239	3784	59850	2497	73002	1469	57250
20-#10	1.59	25284	6360	39016	4798	42136	4055	43359	3458	43882	2562	50559	1950	24731
20-#11	1.95	25832	6521	40260	4886	43618	4121	45102	3497	46216	2548	53842	1866	29948
20-#14	2.81	27185	6902	43125	5134	47201	4312	49410	3620	52039	2539	62089	1691	41752
20-#18	5.00	30517	7871	50213	5770	56091	4798	60118	3932	66527	2517	82583	1241	70226
24-#10	1.90	25797	6501	40008	4905	43446	4124	44993	3517	46054	2559	53512	1888	29339
24-#11	2.34	26452	6693	41465	5017	45207	4205	47095	3569	48850	2544	57413	1789	35283
24-#14	3.38	28066	7151	44846	5322	49472	4432	52271	3724	55802	2533	67180	1580	49381

SQUARE TIED COLUMNS 42" x 42"

8-#14	1.02	28235	6735	43333	5056	46319	4272	47160	3686	46677	2790	52293	2260	18617
8-#18	1.81	29726	7123	46660	5278	50412	4429	52077	3792	53320	2762	61455	2086	32140
12-#11	1.06	28321	6755	43217	5108	46245	4317	47098	3705	46601	2799	52552	2253	19405
12-#14	1.53	29221	6984	45101	5252	48568	4422	49889	3771	50366	2784	57886	2149	27507
12-#18	2.72	31436	7565	49747	5624	54339	4694	56844	3941	59976	2784	71193	1885	47355
16-#10	1.15	28447	6800	43472	5162	46690	4362	47676	3751	47388	2825	53659	2256	21095
16-#11	1.41	28914	6928	44565	5229	47957	4408	49161	3779	49364	2809	56428	2190	25596
16-#14	2.04	30064	7233	47035	5426	51016	4553	52838	3876	54317	2798	63423	2056	36230
16-#18	3.63	32895	8008	53147	5935	58613	4924	61993	4125	66664	2771	80846	1713	61087
20-#10	1.44	29014	6940	44558	5255	48080	4445	49385	3799	49725	2834	57024	2190	26151
20-#11	1.77	29599	7101	45884	5343	49653	4511	51235	3838	52201	2820	60508	2107	31697
20-#14	2.55	31039	7482	48923	5590	53450	4701	55803	3961	58372	2812	69253	1934	44419
20-#18	4.54	34587	8451	56448	6225	62898	5189	67169	4274	73745	2792	91016	1489	74739
24-#10	1.73	29558	7081	45608	5362	49465	4514	51107	3857	52024	2831	60155	2129	31142
24-#11	2.12	30257	7273	47159	5473	51335	4595	53338	3909	54990	2816	64297	2031	37466
24-#14	3.06	31973	7731	50746	5778	55856	4822	58821	4064	62359	2806	74658	1824	52454
24-#18	5.44	36199	8893	59633	6558	67103	5403	72464	4458	80917	2814	100417	1291	87793

SQUARE TIED COLUMNS 44" x 44"

8-#18	1.65	33864	7731	52867	5755	57061	4836	58821	4148	59896	3046	68728	2337	33923
12-#14	1.39	33323	7593	51208	5730	55105	4831	56505	4127	56773	3068	64965	2399	29017
12-#18	2.48	35674	8174	56131	6102	61212	5103	63859	4298	66708	3034	79037	2137	50042
16-#10	1.05	32501	7408	49471	5642	53114	4772	54164	4108	53626	3110	60499	2507	22227
16-#11	1.29	32997	7536	50632	5708	54457	4817	55735	4136	55714	3094	63424	2441	26992
16-#14	1.86	34217	7842	53245	5905	57691	4962	59619	4233	60945	3083	70816	2308	38245
16-#18	3.31	37222	8616	59713	6413	65730	5333	69302	4483	74001	3057	89250	1968	64971

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	1.31	33101	7548	50616	5736	54576	4855	55967	4157	56092	3119	64050	2442	27569
20-#11	1.61	33722	7709	52024	5822	56242	4920	57925	4195	58708	3105	67734	2359	33443
20-#14	2.32	35250	8091	55237	6069	60253	5110	62751	4318	65228	3098	76976	2188	47110
20-#18	4.13	39016	9059	63200	6704	70242	5598	74775	4633	81487	3080	100007	1748	79283
24-#10	1.57	33676	7689	51724	5843	56037	4924	57778	4215	58517	3117	67358	2381	32854
24-#11	1.93	34418	7881	53370	5953	58017	5004	60136	4267	61653	3102	71741	2284	39664
24-#14	2.79	36238	8340	57162	6258	62793	5232	65926	4422	69439	3093	82696	2079	55544
24-#18	4.96	40722	9501	66567	7037	74685	5812	80370	4818	88846	3068	109965	1551	93482

SQUARE TIED COLUMNS 46" x 46"

8-#18	1.51	38377	8367	59616	6255	64289	5263	66146	4520	67019	3343	76586	2599	35706
12-#14	1.28	37798	8229	57857	6232	62222	5259	63703	4501	63727	3366	72631	2661	30520
12-#18	2.27	40286	8810	63057	6603	68664	5530	71456	4671	74198	3332	87468	2400	52725
16-#11	1.18	37454	8173	57240	6210	61537	5246	62890	4510	62612	3392	71009	2704	28383
16-#14	1.70	38743	8478	59995	6406	64946	5390	66983	4607	68121	3382	78797	2572	40257
16-#18	3.02	41924	9253	66821	6913	73428	5762	77194	4857	81885	3356	98240	2235	68904
20-#10	1.20	37562	8185	57213	6239	61652	5284	63131	4532	63007	3418	71664	2706	28984
20-#11	1.47	38220	8345	58705	6324	63410	5348	65196	4570	65764	3403	75547	2623	35187
20-#14	2.13	39835	8727	62092	6571	67635	5538	70281	4693	72631	3397	85287	2454	49825
20-#18	3.78	43821	9695	70494	7205	78166	6026	82963	5008	89775	3381	109584	2018	83859
24-#10	1.44	38168	8325	58378	6346	63189	5354	65030	4590	65558	3416	75150	2645	34555
24-#11	1.77	38953	8518	60121	6455	65278	5433	67516	4641	68864	3401	79772	2548	41875
24-#14	2.55	40877	8976	64119	6760	70309	5660	73614	4796	77067	3392	91321	2345	58649
24-#18	4.54	45621	10138	74042	7539	82847	6241	88838	5193	97533	3370	120101	1823	99241

SQUARE TIED COLUMNS 48" x 48"

8-#18	1.39	43280	9032	66931	6778	72123	5709	74080	4909	74714	3653	85057	2873	37488
12-#14	1.17	42665	8894	65070	6757	69945	5707	71509	4891	71254	3677	80911	2935	32024
12-#18	2.08	45290	9475	70548	7127	76722	5977	79661	5061	82260	3643	96512	2675	55404
16-#11	1.08	42301	8837	64412	6735	69223	5694	70655	4901	70083	3704	79208	2978	29772
16-#14	1.56	43661	9143	67311	6930	72806	5838	74955	4998	75870	3693	87391	2847	42266
16-#18	2.78	47017	9917	74494	7436	81731	6210	85694	5249	90342	3669	107844	2513	72884
20-#10	1.10	42413	8850	64375	6765	69333	5733	70904	4924	70495	3730	79893	2981	30398
20-#11	1.35	43108	9010	65949	6849	71184	5796	73076	4961	73393	3716	83975	2899	36927
20-#14	1.95	44811	9392	69513	7096	75623	5986	78420	5084	80608	3709	94212	2730	52363
20-#18	3.47	49017	10360	78354	7729	86696	6473	91759	5400	98637	3695	119775	2299	88466
24-#10	1.32	43050	8990	65597	6872	70946	5803	72891	4981	73173	3729	83557	2921	36253
24-#11	1.63	43879	9183	67436	6981	73145	5882	75504	5032	76649	3713	88418	2824	44008
24-#14	2.34	45907	9641	71641	7285	78431	6108	81909	5187	85268	3706	100561	2622	61771
24-#18	4.17	50912	10803	82082	8064	91616	6689	97913	5584	106793	3686	130851	2105	104995

SQUARE TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.08	4283	1754	6419	1412	7321	1146	7653	946	7832	655	9267	596	4289
4-#14	1.56	4520	1855	7006	1467	7998	1182	8443	963	8864	634	10574	557	5996
4-#18	2.78	5064	2109	8374	1603	9610	1271	10331	1004	11333	578	13663	446	10115
8-#11	2.17	4365	1981	7077	1550	8143	1242	8629	1009	9117	632	10930	442	8194
8-#14	3.13	4624	2182	7941	1664	9155	1317	9818	1051	10672	598	12904	327	11398
8-#18	5.56	5218	2691	9962	1948	11566	1503	12654	1151	14391	501	17563	12	17520
12-#11	3.25	4576	2208	7895	1688	9126	1348	9801	1062	10698	610	13159	294	11355
12-#14	4.69	4925	2509	9101	1862	10539	1468	11467	1125	12898	562	16023	110	15383
16-#11	4.33	4836	2435	8705	1835	10174	1444	11046	1125	12305	577	15325	187	14420
16-#14	6.25	5261	2836	10248	2074	12013	1603	13219	1213	15160	511	19057	-53	18792
20-#11	5.42	5092	2662	9569	1973	11228	1550	12301	1178	13980	554	17572	61	17333

SQUARE TIED COLUMNS 26" x 26"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.33	5632	2120	8538	1701	9815	1378	10342	1131	10770	766	12852	690	6635
4-#18	2.37	6259	2374	10128	1842	11654	1469	12494	1175	13581	715	16407	589	11243
8-#11	1.85	5463	2246	8611	1786	9969	1440	10543	1179	11044	766	13239	578	9083
8-#14	2.66	5762	2447	9576	1900	11116	1517	11888	1224	12804	735	15491	471	12683
8-#18	4.73	6463	2956	11922	2192	13866	1709	15121	1331	17039	649	20855	176	20131
12-#11	2.77	5709	2473	9519	1925	11073	1548	11858	1234	12817	747	15760	435	12804
12-#14	3.99	6098	2774	10866	2099	12674	1671	13744	1301	15307	704	19031	260	17342
12-#18	7.10	7015	3537	14144	2543	16511	1976	18274	1460	21295	582	26808	-213	25614
16-#11	3.69	5989	2700	10418	2073	12249	1646	13255	1300	14621	717	18207	336	16400
16-#14	5.33	6509	3101	12143	2313	14332	1811	15715	1394	17851	659	22469	110	21912
20-#11	4.62	6311	2927	11378	2212	13432	1755	14663	1356	16500	698	20742	217	19661

SQUARE TIED COLUMNS 28" x 28"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.15	6910	2406	10278	1956	11881	1590	12501	1312	12922	907	15414	831	7273
4-#18	2.04	7623	2661	12043	2095	13950	1684	14918	1359	16078	860	19439	739	12370
8-#11	1.59	6728	2533	10351	2042	12022	1652	12716	1362	13218	909	15832	723	9969
8-#14	2.30	7070	2733	11418	2156	13327	1732	14219	1408	15183	881	18365	621	13963
8-#18	4.08	7883	3242	14019	2448	16419	1930	17850	1522	19937	803	24437	345	22871
12-#11	2.39	7011	2760	11349	2181	13239	1761	14175	1420	15185	893	18647	584	14295
12-#14	3.44	7455	3061	12838	2356	15058	1890	16281	1490	17964	855	22327	417	19354
12-#18	6.12	8513	3824	16472	2801	19373	2202	21370	1658	24686	746	31137	-32	30896
16-#11	3.18	7331	2986	12339	2331	14535	1861	15724	1488	17185	866	21376	491	18213
16-#14	4.59	7933	3388	14245	2571	16901	2032	18472	1586	20792	814	26171	277	24629
20-#11	3.98	7665	3213	13395	2470	15840	1970	17286	1546	19269	850	24201	379	21923
20-#14	5.74	8398	3715	15746	2771	18756	2189	20680	1667	23739	788	30153	108	29670
24-#11	4.78	8007	3440	14464	2610	17169	2069	18874	1614	21375	834	26994	245	25567

SQUARE TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.00	8368	2714	12242	2230	14187	1816	14939	1507	15341	1058	18284	981	7909
4-#18	1.78	9169	2968	14182	2368	16517	1913	17622	1556	18842	1014	22780	896	13493
8-#11	1.39	8172	2840	12314	2318	14335	1879	15168	1558	15658	1061	18733	876	10852
8-#14	2.00	8558	3041	13484	2431	15762	1959	16830	1606	17828	1036	21547	779	15238
8-#18	3.56	9448	3550	16340	2723	19244	2164	20860	1725	23103	965	28331	517	25735
12-#11	2.08	8494	3067	13403	2458	15662	1989	16771	1618	17776	1038	21843	740	15831
12-#14	3.00	8996	3368	15034	2632	17651	2118	19100	1690	20888	1014	25933	580	21418
12-#18	5.33	10202	4132	19025	3078	22506	2442	24748	1867	28345	916	35782	151	34688
16-#11	2.77	8855	3294	14482	2608	17076	2089	18473	1688	20016	1024	24854	653	20019
16-#14	4.00	9492	3695	16570	2848	19664	2261	21510	1790	24000	977	30184	448	27446
16-#18	7.11	11032	4713	21684	3460	25982	2693	28877	2036	33676	841	43012	-104	42223
20-#11	3.47	9231	3521	15634	2748	18499	2200	20190	1748	22305	1011	27865	532	24244
20-#14	5.00	10013	4022	18210	3050	21690	2420	23940	1874	27242	955	34584	288	33023
24-#11	4.16	9614	3748	16801	2888	19949	2300	21934	1818	24576	987	31058	416	28390

SQUARE TIED COLUMNS 32" x 32"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.56	10909	3297	16561	2660	19337	2156	20627	1766	21891	1178	26451	1061	14616
8-#11	1.22	9809	3169	14514	2613	16935	2122	17900	1766	18383	1224	21964	1038	11733
8-#14	1.76	10239	3370	15788	2726	18485	2202	19740	1817	20759	1201	25059	945	16509
8-#18	3.13	11235	3879	18901	3017	22304	2410	24171	1940	26555	1136	32557	696	28009
12-#11	1.83	10170	3396	15693	2754	18372	2233	19640	1827	20691	1203	25366	906	17171
12-#14	2.64	10731	3697	17468	2928	20533	2362	22218	1904	24032	1167	29870	751	23535
12-#18	4.69	12093	4460	21817	3374	25858	2690	28427	2087	32292	1094	40760	339	38095
16-#11	2.44	10573	3623	16862	2905	19903	2334	21488	1898	23132	1191	28663	822	21850
16-#14	3.52	11285	4024	19134	3145	22715	2507	24848	2006	27495	1149	34529	626	30130
16-#18	6.25	13014	5042	24707	3758	29644	2945	32947	2261	38128	1025	48713	98	48121
20-#11	3.05	10992	3850	18110	3045	21446	2445	23352	1959	25627	1180	31956	706	26625
20-#14	4.39	11864	4351	20912	3347	24912	2666	27501	2092	31033	1130	39186	453	36238
24-#11	3.66	11417	4077	19375	3186	23016	2546	25246	2031	28102	1159	35451	594	31167
24-#14	5.27	12524	4678	22714	3549	27149	2811	30197	2194	34543	1097	44126	287	42219

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 34" x 34"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.38	12854	3647	19195	2973	22445	2413	23951	1989	25245	1352	30475	1235	15737
8-#11	1.08	11650	3519	16966	2928	19841	2382	20937	1986	21412	1397	25546	1209	12612
8-#14	1.56	12126	3720	18344	3041	21513	2462	22930	2038	23994	1376	28923	1120	17778
8-#18	2.77	13231	4229	21716	3332	25642	2669	27802	2167	30312	1316	37136	882	30274
12-#11	1.62	12051	3746	18235	3069	21388	2493	22811	2048	23911	1377	29238	1081	18498
12-#14	2.34	12673	4047	20155	3244	23720	2622	25604	2126	27542	1345	34155	931	25705
12-#18	4.15	14119	4810	24863	3690	29478	2952	32428	2319	36423	1253	46094	533	41573
16-#11	2.16	12498	3973	19495	3221	23037	2595	24801	2120	26553	1368	32824	1000	23707
16-#14	3.11	13287	4374	21950	3462	26072	2768	28442	2230	31294	1329	39227	812	32701
16-#18	5.54	15213	5392	27984	4075	33566	3208	37338	2498	42886	1217	54771	304	52783
20-#11	2.70	12961	4200	20839	3362	24698	2707	26808	2182	29253	1359	36401	888	29007
20-#14	3.89	13925	4701	23867	3665	28441	2928	31304	2318	35129	1314	44292	644	39524
24-#11	3.24	13430	4427	22201	3503	26389	2808	28848	2254	31933	1339	40194	779	33868
24-#14	4.67	14576	5029	25809	3867	30852	3074	34214	2421	38933	1283	49666	483	46245

SQUARE TIED COLUMNS 36" x 36"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.23	15017	4019	22097	3306	25878	2686	27603	2224	28922	1536	34872	1418	16857
8-#14	1.39	14231	4091	21168	3375	24867	2737	26450	2273	27552	1560	33161	1304	19043
8-#18	2.47	15448	4600	24800	3666	29305	2944	31756	2407	34393	1505	42090	1075	32533
12-#11	1.44	14150	4117	21045	3405	24729	2770	26319	2283	27453	1562	33483	1264	19820
12-#14	2.08	14835	4418	23109	3579	27232	2899	29316	2362	31375	1532	38810	1120	27861
12-#18	3.70	16427	5182	28179	4025	33424	3229	36745	2562	40991	1447	51804	733	45121
16-#11	1.93	14641	4344	22394	3557	26496	2872	28451	2356	30298	1555	37360	1187	25591
16-#14	2.78	15509	4746	25035	3798	29755	3045	32359	2466	35418	1519	44300	1004	35303
16-#18	4.94	17539	5763	31530	4412	37814	3486	42042	2744	47970	1416	61207	516	57578
20-#11	2.41	15149	4571	23835	3699	28275	2984	30602	2419	33204	1547	41220	1078	31230
20-#14	3.47	16209	5073	27090	4001	32294	3206	35428	2555	39549	1506	49773	843	42882
20-#18	6.17	18813	6345	35106	4772	42233	3771	47383	2900	55102	1385	70607	212	69560
24-#11	2.89	15663	4798	25294	3840	30087	3086	32788	2491	36088	1529	45312	973	36612
24-#14	4.17	16920	5400	29172	4205	34880	3353	38548	2659	43648	1478	55579	687	50339

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.11	17411	4411	25283	3658	29655	2976	31568	2471	32941	1730	39665	1610	17976
8-#14	1.25	16566	4484	24275	3730	28565	3029	30328	2521	31452	1755	37794	1497	20306
8-#18	2.22	17897	4993	28168	4019	33313	3236	36000	2655	38816	1703	47440	1277	34786
12-#11	1.30	16479	4510	24137	3760	28413	3062	30186	2532	31338	1757	38124	1458	21139
12-#14	1.87	17227	4811	26346	3934	31089	3191	33386	2611	35550	1729	43861	1317	29773
12-#18	3.32	18970	5574	31779	4380	37714	3521	41331	2812	45903	1650	57897	943	48739
16-#11	1.73	17015	4737	25576	3913	30298	3165	32460	2606	34384	1751	42292	1382	27501
16-#14	2.49	17964	5138	28402	4153	33781	3338	36634	2716	39884	1718	49770	1205	37936
16-#18	4.43	20182	6156	35360	4768	42406	3781	46992	2996	53398	1624	68042	733	62507
20-#11	2.16	17569	4964	27112	4055	32196	3278	34754	2669	37496	1745	46435	1276	33469
20-#14	3.12	18727	5465	30596	4358	36492	3501	39910	2806	44311	1708	55653	1048	46311
20-#18	5.54	21451	6737	39183	5129	47129	4066	52701	3153	61056	1597	78167	438	75512
24-#11	2.59	18129	5190	28669	4197	34129	3380	37086	2742	40585	1729	50827	1174	39399
24-#14	3.74	19500	5792	32819	4562	39252	3648	43240	2911	48706	1682	61889	897	54238

SQUARE TIED COLUMNS 40" x 40"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.00	20048	4825	28769	4030	33796	3283	35912	2731	37321	1934	44875	1812	19094
8-#14	1.13	19143	4897	27679	4104	32625	3337	34585	2783	35713	1960	42845	1699	21567
8-#18	2.00	20590	5406	31835	4393	37685	3543	40623	2916	43601	1911	53209	1486	37034
12-#11	1.17	19051	4924	27525	4135	32460	3371	34431	2795	35567	1961	43182	1660	22454
12-#14	1.69	19864	5225	29881	4309	35308	3500	37834	2873	40087	1936	49331	1524	31679
12-#18	3.00	21760	5988	35677	4755	42368	3830	46296	3075	51177	1862	64409	1161	52428
16-#11	1.56	19633	5150	29055	4288	34463	3474	36847	2869	38810	1956	47642	1586	29438
16-#14	2.25	20664	5552	32066	4529	38170	3648	41287	2979	44711	1927	55659	1415	40601
16-#18	4.00	23075	6569	39490	5144	47361	4091	52321	3261	59188	1840	75297	957	67499
20-#11	1.95	20233	5377	30687	4431	36480	3588	39284	2932	42124	1952	52069	1483	35723
20-#14	2.81	21491	5879	34399	4733	41052	3811	44770	3070	49436	1919	61951	1262	49742
20-#18	5.00	24447	7151	43559	5506	52389	4378	58397	3420	67374	1818	86149	671	81126
24-#11	2.34	20839	5604	32341	4573	38534	3691	41762	3006	45414	1936	56760	1385	42231
24-#14	3.38	22328	6206	36762	4938	43987	3959	48311	3176	54126	1895	68619	1115	58114

SQUARE TIED COLUMNS 42" x 42"

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.02	21976	5332	31396	4498	37067	3662	39238	3058	40337	2174	48335	1911	22826
8-#18	1.81	23541	5841	35816	4786	42438	3867	45644	3192	48767	2129	59418	1704	39277
12-#11	1.06	21878	5359	31225	4530	36888	3697	39073	3071	40148	2174	48681	1872	23767
12-#14	1.53	22756	5660	33728	4704	39908	3825	42681	3150	44980	2152	55240	1739	33580
12-#18	2.72	24809	6423	39890	5149	47403	4155	51659	3352	56831	2084	71362	1386	56188
16-#11	1.41	22506	5585	32845	4683	39008	3800	41631	3146	43582	2170	53432	1800	31230
16-#14	2.04	23621	5987	36043	4924	42940	3974	46338	3257	49890	2144	61989	1633	43298
16-#18	3.63	26230	7004	43934	5539	52698	4417	58048	3539	65360	2065	82995	1188	71998
20-#11	1.77	23154	5812	34574	4826	41144	3914	44212	3210	47091	2166	58144	1700	37994
20-#14	2.55	24513	6314	38515	5129	45994	4137	50028	3348	54906	2137	68690	1484	52930
20-#18	4.54	27707	7586	48249	5902	58031	4706	64492	3699	74073	2047	94574	909	86837
24-#11	2.12	23807	6039	36325	4969	43319	4017	46836	3284	50574	2151	63135	1603	44971
24-#14	3.06	25415	6641	41019	5334	49103	4285	53779	3455	59886	2115	75790	1341	62043
24-#18	5.44	29213	8168	52622	6265	63461	4967	71042	3886	82722	2002	106849	642	101416

SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	1.65	26760	6297	40126	5199	47592	4207	51083	3481	54332	2357	66090	1932	41517
12-#14	1.39	25917	6116	37903	5118	44909	4166	47945	3440	50232	2375	61612	1964	35476
12-#18	2.48	28130	6879	44432	5563	52839	4497	57439	3643	62886	2315	78777	1620	60019
16-#11	1.29	25648	6042	36962	5098	43954	4142	46834	3436	48753	2394	59685	2023	32986
16-#14	1.86	26847	6443	40348	5339	48111	4315	51807	3547	55416	2369	68781	1860	46027
16-#18	3.31	29658	7461	48706	5953	58437	4760	64192	3831	71931	2300	91156	1426	76537
20-#11	1.61	26343	6268	38787	5241	46209	4256	49558	3501	52457	2390	64682	1925	40283
20-#14	2.32	27806	6770	42958	5544	51336	4479	55704	3640	60714	2363	75893	1715	56137
20-#18	4.13	31243	8042	53268	6318	64074	5049	71004	3992	81173	2285	103463	1155	92642
24-#11	1.93	27045	6495	40636	5384	48505	4359	52328	3576	56134	2376	69972	1831	47628
24-#14	2.79	28774	7097	45603	5750	54620	4628	59665	3747	65973	2341	83424	1575	66024
24-#18	4.96	32856	8624	57891	6682	69814	5312	77929	4181	90347	2243	116505	894	108456

SQUARE TIED COLUMNS 46" x 46"

8-#18	1.51	30262	6775	44779	5631	53165	4564	56959	3784	60287	2594	73245	2168	43752
12-#14	1.28	29359	6593	42420	5552	50329	4524	53646	3744	55901	2610	68469	2198	37369
12-#18	2.27	31734	7356	49317	5996	58695	4854	63657	3947	69322	2555	86677	1862	63921
16-#11	1.18	29071	6519	41421	5533	49319	4500	52473	3741	54343	2629	66422	2256	34739
16-#14	1.70	30355	6920	44995	5773	53701	4673	57714	3852	61360	2604	76058	2096	48788
16-#18	3.02	33371	7938	53822	6388	64595	5118	70775	4136	78876	2542	99803	1673	81119
20-#11	1.47	29814	6746	43342	5677	51692	4614	55341	3806	58241	2625	71704	2160	42588
20-#14	2.13	31381	7247	47744	5979	57097	4838	61817	3945	66939	2598	83580	1954	59363
20-#18	3.78	35067	8519	58631	6753	70536	5408	77954	4299	88638	2529	112839	1408	98544
24-#11	1.77	30564	6973	45289	5820	54109	4718	58257	3881	62111	2612	77294	2068	50294
24-#14	2.55	32417	7574	50529	6186	60555	4987	65989	4053	72477	2578	91544	1818	70058
24-#18	4.54	36788	9101	63504	7118	76587	5672	85253	4488	98327	2490	126648	1154	115762

SQUARE TIED COLUMNS 48" x 48"

8-#18	1.39	34057	7273	49792	6084	59177	4936	63292	4101	66621	2838	80907	2413	45985
12-#14	1.17	33095	7092	47294	6006	56187	4898	59805	4062	62007	2854	75831	2441	39258
12-#18	2.08	35633	7855	54561	6450	64990	5228	70333	4265	76117	2800	95085	2113	67448
16-#11	1.08	32787	7017	46236	5988	55121	4874	58570	4059	60369	2874	73666	2499	36488
16-#14	1.56	34158	7419	49999	6228	59728	5048	64077	4170	67742	2850	83842	2342	51577
16-#18	2.78	37382	8436	59297	6842	71191	5492	77815	4455	86160	2788	108957	1928	85743
20-#11	1.35	33578	7244	48253	6132	57613	4989	61582	4124	64463	2871	79233	2404	44911
20-#14	1.95	35252	7746	52887	6434	63296	5212	68388	4264	73602	2845	91775	2203	62609
20-#18	3.47	39190	9018	64353	7208	77437	5784	85362	4619	96421	2777	122722	1668	104541
24-#11	1.63	34377	7471	50298	6275	60152	5093	64643	4200	68527	2858	85123	2314	52972
24-#14	2.34	36356	8073	55813	6641	66929	5362	72770	4372	79419	2825	100171	2069	74146
24-#18	4.17	41023	9600	69475	7573	83798	6048	93035	4809	106607	2739	137300	1420	122825

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.08	5464	2258	8743	1607	9230	1305	9271	1081	9069	757	10452	694	4363
4-#14	1.56	5695	2356	9301	1658	9881	1338	10037	1095	10079	735	11732	652	6096
4-#18	2.78	6240	2604	10606	1788	11434	1421	11870	1131	12498	674	14758	534	10284
8-#11	2.17	5609	2479	9386	1739	10036	1410	10231	1142	10338	733	12093	537	8366
8-#14	3.13	5893	2675	10214	1848	11015	1486	11388	1181	11865	696	14030	419	11667
8-#18	5.56	6564	3172	12155	2120	13351	1676	14154	1273	15518	592	18604	94	18222
12-#11	3.25	5867	2701	10145	1885	10993	1500	11376	1190	11903	709	14299	387	11739
12-#14	4.69	6253	2994	11291	2058	12361	1614	13000	1247	14068	658	17117	198	15870
16-#11	4.33	6155	2922	10966	2018	12019	1604	12600	1251	13478	671	16443	278	14976
16-#14	6.25	6654	3313	12453	2248	13805	1762	14721	1333	16375	619	20120	32	19961
20-#11	5.42	6454	3143	11785	2164	13047	1695	13855	1312	15134	646	18668	150	18000

SQUARE TIED COLUMNS 26" x 26"

4-#14	1.33	7124	2710	11495	1929	12241	1565	12397	1289	12339	886	14349	804	6738
4-#18	2.37	7745	2958	13011	2063	14013	1650	14486	1327	15094	829	17835	696	11415
8-#11	1.85	7030	2833	11583	2012	12408	1638	12608	1337	12620	886	14742	693	9253
8-#14	2.66	7354	3029	12508	2120	13518	1716	13918	1379	14348	853	16954	581	12949
8-#18	4.73	8121	3525	14762	2400	16182	1912	17070	1479	18509	759	22222	277	20958
12-#11	2.77	7326	3054	12426	2159	13482	1731	13894	1388	14376	865	17239	548	13233
12-#14	3.99	7766	3348	13705	2332	15033	1848	15731	1449	16826	820	20459	368	17886
12-#18	7.10	8811	4093	16824	2773	18755	2139	20151	1594	22721	688	28115	-118	27476
16-#11	3.69	7653	3276	13337	2292	14635	1837	15267	1452	16144	831	19661	446	16885
16-#14	5.33	8223	3667	14999	2523	16658	2000	17669	1539	19320	767	23862	214	22682
20-#11	4.62	7993	3497	14276	2426	15789	1930	16675	1516	18002	810	22172	325	20269

SQUARE TIED COLUMNS 28" x 28"

4-#14	1.15	8775	3091	14012	2223	14946	1809	15098	1498	14908	1048	17313	965	7379
4-#18	2.04	9473	3340	15694	2355	16940	1896	17445	1539	18000	996	21259	866	12544
8-#11	1.59	8673	3215	14103	2307	15102	1882	15325	1548	15212	1050	17738	858	10137
8-#14	2.30	9038	3411	15124	2416	16365	1964	16789	1591	17140	1020	20225	752	14227
8-#18	4.08	9903	3907	17621	2695	19361	2164	20329	1697	21811	934	26191	466	23836
12-#11	2.39	9007	3436	15030	2455	16286	1976	16752	1601	17159	1033	20526	717	14774
12-#14	3.44	9503	3730	16442	2628	18049	2099	18805	1665	19894	991	24149	545	19959
12-#18	6.12	10682	4474	19899	3070	22234	2397	23769	1820	26512	873	32824	83	32230
16-#11	3.18	9376	3657	16032	2589	17557	2084	18275	1667	19121	1001	23227	621	18697
16-#14	4.59	10017	4049	17868	2821	19855	2253	20958	1759	22666	943	27954	401	25512
20-#11	3.98	9758	3879	17065	2724	18830	2178	19837	1734	21181	984	26026	506	22601
20-#14	5.74	10553	4368	19335	3014	21666	2388	23167	1852	25580	914	31898	229	30733
24-#11	4.78	10147	4100	18060	2871	20132	2286	21366	1786	23265	966	28900	385	26418

SQUARE TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.00	10664	3502	16876	2540	17993	2070	18166	1722	17810	1222	20648	1138	8018
4-#18	1.78	11440	3750	18724	2671	20239	2161	20771	1765	21240	1173	25057	1046	13672
8-#11	1.39	10555	3625	16970	2626	18159	2144	18409	1774	18137	1226	21106	1033	11018
8-#14	2.00	10961	3821	18089	2734	19539	2226	20026	1819	20267	1198	23870	932	15501
8-#18	3.56	11927	4317	20829	3013	22914	2434	23956	1929	25448	1119	30536	661	26284
12-#11	2.08	10928	3846	17981	2774	19450	2239	19977	1829	20276	1211	24186	895	16153
12-#14	3.00	11480	4140	19528	2947	21378	2362	22246	1896	23296	1173	28214	730	22087
12-#18	5.33	12796	4885	23322	3390	26089	2672	27756	2058	30638	1066	37913	288	35657
16-#11	2.77	11338	4068	19074	2909	20836	2348	21651	1897	22431	1182	27168	805	20537
16-#14	4.00	12053	4459	21084	3141	23350	2518	24616	1992	26348	1129	32422	595	28296
16-#18	7.11	13765	5452	26016	3732	29494	2945	31815	2223	35864	977	45071	27	44909
20-#11	3.47	11763	4289	20201	3044	22225	2443	23367	1966	24695	1167	30255	696	24996
20-#14	5.00	12648	4778	22688	3335	25328	2654	27046	2089	29554	1104	36781	431	33968
24-#11	4.16	12195	4510	21287	3193	23645	2552	25048	2020	26984	1152	33430	578	29269

SQUARE TIED COLUMNS 32" x 32"

4-#18	1.56	13664	4188	22128	3009	23902	2441	24490	2007	24837	1361	29255	1235	14799
8-#11	1.22	12692	4063	20208	2967	21613	2425	21866	2014	21419	1414	24873	1219	11897
8-#14	1.76	13140	4259	21425	3074	23110	2507	23657	2062	23750	1387	27914	1122	16771
8-#18	3.13	14208	4756	24410	3353	26812	2717	27978	2176	29444	1315	35282	864	28550
12-#11	1.83	13104	4285	21303	3116	23012	2521	23568	2070	23750	1401	28244	1084	17479
12-#14	2.64	13714	4578	22985	3289	25104	2644	26081	2141	27056	1366	32679	925	24272
12-#18	4.69	15171	5323	27118	3732	30271	2958	32139	2310	35124	1268	43406	500	39159
16-#11	2.44	13556	4506	22488	3252	24513	2631	25386	2140	26099	1374	31509	999	22404
16-#14	3.52	14347	4898	24673	3484	27243	2801	28668	2240	30388	1325	37292	797	30880
16-#18	6.25	16239	5891	30045	4075	33982	3234	36582	2480	40846	1186	51281	253	49612
20-#11	3.05	14025	4727	23708	3387	26018	2726	27250	2209	28566	1361	34885	894	27418
20-#14	4.39	15003	5217	26412	3678	29388	2938	31320	2340	33887	1304	42067	640	37280
24-#11	3.66	14501	4949	24885	3536	27556	2836	29075	2265	31061	1348	38191	760	31986
24-#14	5.27	15670	5536	28089	3893	31579	3095	33919	2419	37425	1283	46981	471	43565

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 34" x 34"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.38	16160	4655	25928	3370	27969	2738	28629	2264	28816	1561	33880	1434	15924
8-#11	1.08	15101	4530	23842	3331	25491	2725	25729	2269	25082	1613	29067	1415	12775
8-#14	1.56	15591	4726	25157	3438	27106	2806	27669	2317	27615	1588	32384	1323	18039
8-#18	2.77	16764	5222	28388	3715	31105	3016	32419	2438	33821	1521	40456	1075	30810
12-#11	1.62	15552	4752	25021	3481	26997	2822	27562	2325	27605	1602	32725	1285	18801
12-#14	2.34	16221	5045	26839	3653	29254	2944	30284	2398	31198	1570	37567	1130	26445
12-#18	4.15	17822	5790	31311	4096	34839	3259	36942	2577	39993	1480	49329	719	42736
16-#11	2.16	16048	4973	26297	3617	28614	2932	29519	2396	30149	1577	36277	1202	24299
16-#14	3.11	16915	5364	28658	3849	31560	3102	33075	2498	34810	1532	42590	1007	33497
16-#18	5.54	18992	6357	34472	4441	38845	3537	41771	2751	46212	1404	57921	485	54459
20-#11	2.70	16561	5194	27611	3753	30235	3028	31487	2453	32820	1566	39942	1101	29650
20-#14	3.89	17633	5683	30532	4044	33872	3240	35937	2599	38602	1514	47782	857	40668
24-#11	3.24	17081	5415	28879	3903	31891	3138	33492	2523	35521	1555	43533	972	34750
24-#14	4.67	18363	6003	32340	4260	36234	3398	38741	2680	42437	1496	52867	665	47702

SQUARE TIED COLUMNS 36" x 36"

4-#18	1.23	18947	5150	30150	3754	32487	3054	33202	2535	33199	1773	38957	1644	17048
8-#14	1.39	18332	5221	29309	3825	31553	3125	32117	2588	31885	1800	37308	1533	19302
8-#18	2.47	19610	5718	32787	4101	35849	3334	37289	2713	38604	1737	46084	1295	33064
12-#11	1.44	18290	5247	29158	3869	31433	3141	32000	2597	31866	1815	37658	1496	20119
12-#14	2.08	19019	5540	31112	4041	33855	3263	34919	2669	35746	1785	42905	1346	28355
12-#18	3.70	20765	6285	35925	4483	39858	3579	42169	2855	45268	1702	55707	946	46388
16-#11	1.93	18830	5468	30525	4005	33165	3251	34097	2668	34605	1792	41499	1415	26222
16-#14	2.78	19774	5859	33063	4237	36327	3422	37912	2771	39638	1750	48343	1227	36148
16-#18	4.94	22039	6852	39320	4830	44160	3858	47378	3033	51985	1631	65019	723	59449
20-#11	2.41	19387	5689	31934	4141	34902	3348	36205	2725	37479	1782	45454	1318	31898
20-#14	3.47	20555	6179	35073	4433	38806	3561	40921	2853	43724	1734	53952	1082	44133
20-#18	6.17	23362	7420	42817	5176	48474	4103	52719	3211	59037	1596	74655	449	71779
24-#11	2.89	19952	5910	33293	4292	36677	3459	38354	2796	40386	1773	49329	1192	37561
24-#14	4.17	21348	6498	37012	4649	41340	3720	43988	2954	47856	1718	59447	896	51661

SQUARE TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.11	22039	5673	34817	4162	37482	3389	38201	2820	38012	1996	44514	1864	18171
8-#14	1.25	21379	5744	33906	4234	36476	3462	37036	2874	36584	2025	42711	1755	20562
8-#18	2.22	22764	6241	37631	4510	41071	3671	42563	2999	43816	1965	52192	1524	35313
12-#11	1.30	21334	5770	33740	4279	36346	3479	36910	2884	36556	2039	43073	1717	21435
12-#14	1.87	22123	6064	35830	4451	38933	3601	40026	2957	40723	2011	48723	1572	30258
12-#18	3.32	24017	6808	40984	4893	45354	3917	47777	3144	50973	1934	62552	1184	50116
16-#11	1.73	21918	5991	35198	4416	38193	3590	39147	2956	39490	2018	47202	1639	28170
16-#14	2.49	22941	6383	37912	4648	41571	3761	43221	3059	44896	1978	54576	1456	38832
16-#18	4.43	25397	7376	44613	5241	49952	4198	53345	3323	58188	1868	72600	968	64501
20-#11	2.16	22520	6212	36700	4553	40047	3687	41396	3014	42568	2010	51447	1545	34164
20-#14	3.12	23785	6702	40058	4844	44218	3901	46432	3142	49275	1965	60603	1316	47571
20-#18	5.54	26827	7943	48352	5589	54564	4444	58941	3467	65762	1837	82978	704	77455
24-#11	2.59	23131	6434	38150	4703	41940	3798	43688	3086	45681	2002	55607	1422	40418
24-#14	3.74	24642	7021	42128	5061	46922	4060	49706	3245	53705	1952	66510	1135	55571

SQUARE TIED COLUMNS 40" x 40"

4-#18	1.00	25455	6225	39953	4592	42981	3743	43698	3121	43277	2231	50577	2096	19293
8-#14	1.13	24749	6296	38970	4667	41902	3818	42452	3177	41737	2261	48621	1987	21821
8-#18	2.00	26242	6792	42944	4941	46795	4026	48335	3302	49482	2204	58808	1764	37558
12-#11	1.17	24702	6321	38789	4712	41762	3836	42317	3188	41682	2275	48994	1950	22747
12-#14	1.69	25551	6615	41016	4884	44514	3958	45631	3260	46153	2250	55048	1808	32157
12-#18	3.00	27594	7360	46513	5325	51354	4273	53883	3447	57132	2178	69905	1432	53920
16-#11	1.56	25329	6543	40338	4850	43725	3947	44694	3260	44806	2254	53412	1874	29928
16-#14	2.25	26431	6934	43229	5081	47319	4118	49027	3364	50607	2219	61318	1696	41551
16-#18	4.00	29081	7927	50375	5674	56248	4556	59809	3628	64846	2116	80690	1222	69032
20-#11	1.95	25977	6764	41935	4987	45694	4045	47084	3318	48084	2248	57947	1783	36448
20-#14	2.81	27340	7253	45511	5278	50133	4259	52442	3447	55281	2207	67763	1560	50774
20-#18	5.00	30621	8495	54355	6023	61157	4803	65766	3774	72942	2089	91810	967	83233
24-#11	2.34	26633	6985	43475	5138	47706	4157	49519	3391	51399	2241	62393	1663	43138
24-#14	3.38	28261	7573	47712	5496	53008	4419	55922	3550	60008	2196	74080	1383	59538

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 42" x 42"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.02	28459	6876	44528	5122	47859	4192	48393	3495	47349	2508	55065	2231	23078
8-#18	1.81	30060	7372	48751	5395	53050	4400	54630	3620	55625	2455	65958	2014	39798
12-#11	1.06	28409	6901	44330	5169	47708	4211	48249	3507	47258	2521	55449	2194	24057
12-#14	1.53	29319	7195	46694	5340	50625	4333	51760	3579	52037	2498	61908	2055	34052
12-#18	2.72	31513	7940	52535	5780	57884	4648	60513	3767	63769	2432	77792	1689	57800
16-#11	1.41	29081	7123	45970	5306	49786	4309	50765	3580	50566	2501	60156	2120	31681
16-#14	2.04	30262	7514	49040	5537	53597	4494	55357	3684	56766	2469	68594	1946	44304
16-#18	3.63	33108	8507	56632	6130	63074	4932	66797	3949	71981	2374	89316	1485	73607
20-#11	1.77	29774	7344	47661	5444	51871	4421	53295	3639	54037	2495	64982	2031	38750
20-#14	2.55	31236	7833	51457	5735	56578	4635	58975	3768	61728	2459	75458	1814	53997
20-#18	4.54	34758	9075	60852	6480	68280	5181	73114	4096	80600	2351	101179	1237	89113
24-#11	2.12	30477	7565	49293	5595	54002	4520	55875	3711	57547	2489	69713	1913	45804
24-#14	3.06	32223	8153	53789	5953	59624	4796	62662	3872	66747	2449	82186	1640	63560
24-#18	5.44	36435	9642	64925	6866	73599	5465	79554	4279	89317	2327	112805	915	104407

SQUARE TIED COLUMNS 44" x 44"

8-#18	1.65	34236	7981	55075	5872	59861	4793	61475	3954	62269	2717	73668	2274	42035
12-#14	1.39	33444	7803	52889	5818	57292	4728	58438	3915	58381	2756	69328	2313	35943
12-#18	2.48	35790	8548	59075	6258	64970	5042	67693	4102	70907	2698	86240	1956	61727
16-#11	1.29	33189	7731	52119	5786	56403	4704	57387	3915	56826	2759	67461	2376	33431
16-#14	1.86	34451	8122	55366	6017	60431	4869	62237	4019	63375	2728	76431	2206	47092
16-#18	3.31	37495	9115	63405	6609	70456	5327	74335	4286	79619	2643	98504	1757	78226
20-#11	1.61	33928	7952	53904	5923	58605	4817	60058	3975	60490	2754	72578	2290	41071
20-#14	2.32	35490	8442	57919	6215	63579	5031	66058	4104	68615	2719	83714	2078	57241
20-#18	4.13	39257	9683	67867	6960	75959	5577	81013	4434	88761	2623	111111	1516	95096
24-#11	1.93	34678	8173	55626	6075	60854	4915	62781	4048	64195	2748	77595	2174	48480
24-#14	2.79	36543	8761	60383	6433	66796	5172	69953	4209	73915	2710	90855	1908	67639
24-#18	4.96	41046	10250	72173	7346	81583	5862	87821	4618	98007	2603	123468	1201	111716

SQUARE TIED COLUMNS 46" x 46"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	1.51	38787	8617	61941	6372	67255	5204	68897	4304	69411	2990	81966	2545	44269
12-#14	1.28	37943	8440	59625	6320	64542	5141	65694	4266	65249	3027	77336	2583	37830
12-#18	2.27	40442	9184	66157	6759	72638	5455	75449	4453	78534	2973	95277	2233	65108
16-#11	1.18	37672	8367	58807	6288	63603	5118	64585	4267	63612	3030	75355	2644	35177
16-#14	1.70	39014	8759	62234	6519	67847	5283	69694	4371	70508	2999	84856	2478	49785
16-#18	3.02	42258	9752	70721	7111	78420	5741	82449	4638	87736	2920	108281	2038	82892
20-#11	1.47	38457	8589	60686	6426	65920	5231	67397	4327	67469	3025	80763	2560	43411
20-#14	2.13	40119	9078	64922	6717	71163	5444	73718	4456	76027	2991	92559	2353	60507
20-#18	3.78	44133	10319	75424	7462	84222	5991	89488	4788	97392	2903	121632	1804	101182
24-#11	1.77	39253	8810	62500	6578	68288	5329	70263	4400	71369	3020	86066	2446	51169
24-#14	2.55	41238	9397	67517	6936	74551	5587	77819	4562	81609	2983	100111	2185	71720
24-#18	4.54	46035	10887	79963	7849	90149	6277	96664	4973	107158	2886	134721	1494	118738

SQUARE TIED COLUMNS 48" x 48"

8-#18	1.39	43728	9282	69373	6895	75257	5635	76921	4670	77042	3272	90878	2827	46499
12-#14	1.17	42833	9104	66926	6844	72401	5572	73552	4633	72667	3309	85959	2863	39715
12-#18	2.08	45487	9849	73804	7283	80916	5886	83807	4820	86631	3256	104928	2521	68481
16-#11	1.08	42545	9032	66060	6813	71411	5550	72386	4635	70947	3313	83864	2923	36920
16-#14	1.56	43969	9424	69666	7043	75872	5715	77754	4739	78191	3282	93897	2760	52311
16-#18	2.78	47414	10417	78602	7635	86994	6173	91166	5006	96304	3205	118673	2330	87602
20-#11	1.35	43377	9253	68034	6952	73845	5663	75338	4695	74997	3309	89563	2841	45727
20-#14	1.95	45139	9743	72491	7242	79355	5877	81980	4825	83988	3275	102019	2638	63795
20-#18	3.47	49403	10984	83547	7988	93093	6425	98566	5157	106455	3189	132770	2101	107370
24-#11	1.63	44220	9475	69938	7104	76332	5762	78349	4769	79093	3304	95152	2729	53869
24-#14	2.34	46326	10062	75217	7461	82915	6020	86289	4930	89851	3268	109984	2473	75540
24-#18	4.17	51420	11551	88319	8375	99325	6711	106110	5343	116721	3173	146590	1797	125597

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.08	6671	2762	10576	1970	11102	1604	11077	1334	10670	951	12200	880	4440
4-#14	1.56	6897	2857	11125	2018	11739	1633	11825	1345	11661	926	13453	834	6196
4-#18	2.78	7432	3099	12404	2139	13256	1708	13617	1373	14035	858	16416	709	10432
8-#11	2.17	6804	2977	11203	2097	11892	1706	12021	1393	11923	925	13819	721	8491
8-#14	3.13	7077	3168	12015	2200	12850	1779	13154	1428	13424	885	15719	598	11854
8-#18	5.56	7722	3652	13914	2458	15133	1959	15862	1511	17015	772	20208	262	19081
12-#11	3.25	7049	3193	11935	2242	12822	1792	13139	1436	13472	899	16003	569	12151
12-#14	4.69	7418	3480	13053	2408	14158	1899	14727	1487	15604	843	18775	373	16359
16-#11	4.33	7324	3409	12734	2369	13827	1894	14341	1496	15015	856	18125	457	15459
16-#14	6.25	7800	3791	14186	2590	15572	2045	16418	1570	17888	802	21746	204	20695
20-#11	5.42	7609	3625	13527	2514	14830	1980	15577	1555	16652	830	20327	326	18534

SQUARE TIED COLUMNS 26" x 26"

4-#14	1.33	8655	3299	13812	2356	14613	1915	14686	1586	14369	1113	16565	1021	6842
4-#18	2.37	9263	3541	15302	2481	16345	1992	16729	1617	17073	1050	19979	906	11570
8-#11	1.85	8553	3419	13892	2438	14778	1991	14898	1636	14654	1115	16964	911	9379
8-#14	2.66	8866	3610	14799	2540	15864	2064	16181	1673	16352	1077	19134	795	13139
8-#18	4.73	9604	4094	17009	2805	18470	2250	19269	1764	20444	975	24306	481	21992
12-#11	2.77	8835	3635	14705	2584	15823	2078	16154	1681	16392	1092	19436	764	13699
12-#14	3.99	9257	3922	15954	2749	17337	2189	17953	1736	18805	1042	22604	578	18453
12-#18	7.10	10255	4648	18998	3173	20970	2463	22277	1866	24613	900	30138	80	29608
16-#11	3.69	9149	3851	15593	2712	16951	2183	17504	1744	18125	1053	21833	660	17288
16-#14	5.33	9693	4233	17214	2933	18929	2338	19856	1824	21248	981	25972	421	23558
20-#11	4.62	9475	4067	16510	2840	18078	2271	18891	1806	19962	1030	24320	536	20890

SQUARE TIED COLUMNS 28" x 28"

4-#14	1.15	10689	3777	16903	2724	17918	2221	17973	1846	17463	1315	20108	1221	7486
4-#18	2.04	11373	4019	18557	2847	19868	2299	20268	1879	20499	1255	23975	1114	12706
8-#11	1.59	10580	3897	16984	2807	18072	2296	18201	1898	17772	1319	20541	1115	10265
8-#14	2.30	10931	4088	17988	2909	19309	2373	19635	1937	19668	1284	22982	1004	14419
8-#18	4.08	11766	4572	20437	3173	22241	2563	23104	2033	24262	1190	28840	707	24363
12-#11	2.39	10899	4113	17879	2954	19224	2384	19595	1946	19700	1299	23302	971	15035
12-#14	3.44	11375	4399	19260	3119	20947	2500	21605	2004	22393	1253	26867	793	20609
12-#18	6.12	12503	5125	22634	3544	25035	2782	26464	2143	28914	1124	35407	318	33071
16-#11	3.18	11252	4328	18855	3083	20469	2491	21093	2011	21622	1262	25976	873	19146
16-#14	4.59	11867	4710	20648	3304	22717	2652	23721	2095	25111	1197	30634	646	26303
20-#11	3.98	11619	4544	19864	3212	21711	2580	22631	2075	23660	1243	28748	756	23317
20-#14	5.74	12380	5021	22082	3490	24483	2779	25896	2186	27991	1166	34539	471	31572
24-#11	4.78	11993	4760	20825	3358	22985	2686	24126	2123	25722	1224	31595	632	27230

SQUARE TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.00	13022	4289	20429	3120	21658	2546	21717	2126	20973	1532	24116	1435	8130
4-#18	1.78	13782	4531	22248	3241	23857	2628	24266	2161	24341	1475	28437	1334	13840
8-#11	1.39	12904	4410	20511	3205	21822	2623	21963	2180	21306	1537	24583	1331	11149
8-#14	2.00	13296	4600	21611	3306	23174	2700	23547	2220	23400	1505	27296	1226	15691
8-#18	3.56	14228	5085	24300	3569	26479	2897	27399	2321	28497	1417	33843	943	26639
12-#11	2.08	13261	4625	21487	3352	23078	2713	23495	2229	23424	1520	27634	1191	16366
12-#14	3.00	13792	4912	23000	3517	24962	2828	25717	2290	26399	1478	31598	1020	22828
12-#18	5.33	15055	5638	26705	3942	29567	3122	31111	2437	33634	1359	41148	565	36617
16-#11	2.77	13655	4841	22552	3482	24435	2820	25141	2296	25537	1486	30586	1099	21035
16-#14	4.00	14342	5223	24516	3704	26894	2982	28046	2384	29391	1426	35765	881	28914
16-#18	7.11	15978	6191	29330	4271	32902	3391	35100	2596	38755	1257	48233	297	46366
20-#11	3.47	14064	5057	23653	3611	25791	2910	26831	2363	27775	1469	33644	987	25676
20-#14	5.00	14913	5534	26083	3890	28824	3110	30440	2478	32560	1399	40082	714	34929
24-#11	4.16	14479	5273	24701	3758	27181	3017	28474	2412	30041	1452	36790	866	29981

SQUARE TIED COLUMNS 32" x 32"

4-#18	1.56	16510	5079	26405	3664	28309	2978	28755	2462	28630	1709	33398	1567	14973
8-#11	1.22	15547	4958	24502	3632	26068	2974	26195	2479	25286	1770	29124	1561	12031
8-#14	1.76	15979	5149	25699	3732	27535	3051	27951	2522	27579	1740	32108	1460	16961
8-#18	3.13	17011	5633	28630	3994	31161	3250	32186	2627	33179	1658	39346	1190	28907
12-#11	1.83	15942	5173	25559	3779	27429	3065	27859	2530	27595	1756	32463	1424	17692
12-#14	2.64	16529	5460	27205	3944	29474	3180	30320	2594	30852	1716	36829	1259	24858
12-#18	4.69	17929	6186	31243	4369	34526	3477	36252	2748	38803	1607	47392	820	40247
16-#11	2.44	16378	5389	26713	3909	28899	3172	29646	2598	29898	1724	35696	1336	22956
16-#14	3.52	17138	5771	28849	4131	31570	3335	32863	2691	34118	1668	41396	1127	31561
16-#18	6.25	18951	6739	34095	4699	38161	3749	40620	2913	44411	1512	55187	567	51301
20-#11	3.05	16829	5605	27906	4040	30368	3263	31482	2666	32338	1709	39040	1229	27928
20-#14	4.39	17768	6082	30549	4319	33662	3464	35477	2788	37578	1644	46126	968	38372
24-#11	3.66	17287	5821	29042	4187	31874	3371	33267	2717	34807	1694	42272	1088	32782
24-#14	5.27	18410	6393	32167	4531	35808	3619	38016	2860	41079	1620	50994	795	44969

SQUARE TIED COLUMNS 34" x 34"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.38	19579	5663	31058	4115	33271	3349	33769	2782	33394	1957	38892	1813	16104
8-#11	1.08	18530	5541	28987	4087	30845	3349	30938	2798	29743	2018	34197	1805	12912
8-#14	1.56	19003	5732	30282	4186	32427	3425	32840	2841	32233	1989	37453	1707	18228
8-#18	2.77	20136	6216	33456	4447	36345	3623	37497	2951	38338	1912	45383	1448	31169
12-#11	1.62	18963	5757	30125	4235	32310	3440	32730	2849	32242	2005	37820	1672	19014
12-#14	2.34	19608	6043	31905	4399	34517	3555	35396	2914	35782	1969	42588	1511	26772
12-#18	4.15	21147	6769	36277	4823	39977	3853	41918	3077	44449	1867	54171	1086	43960
16-#11	2.16	19441	5973	31368	4366	33893	3548	34654	2918	34737	1976	41339	1587	24907
16-#14	3.11	20275	6354	33677	4587	36775	3711	38140	3013	39323	1923	47562	1385	34246
16-#18	5.54	22269	7323	39356	5155	43902	4126	46666	3247	50545	1778	62679	845	56397
20-#11	2.70	19935	6188	32653	4496	35475	3639	36582	2969	37378	1963	44970	1484	30199
20-#14	3.89	20967	6666	35509	4775	39031	3841	40960	3111	43073	1902	52705	1231	41900
24-#11	3.24	20437	6404	33877	4644	37097	3748	38554	3038	40051	1950	48481	1347	35636
24-#14	4.67	21670	6977	37254	4988	41344	3997	43701	3184	46868	1882	57677	1029	48875

SQUARE TIED COLUMNS 36" x 36"

4-#18	1.23	23010	6282	36237	4596	38797	3745	39327	3121	38665	2220	44951	2073	17233
8-#14	1.39	22389	6351	35390	4669	37882	3822	38276	3179	37395	2253	43365	1968	19493
8-#18	2.47	23624	6835	38809	4929	42093	4020	43349	3294	44004	2180	51987	1718	33425
12-#11	1.44	22346	6376	35216	4719	37754	3839	38157	3188	37396	2270	43745	1933	20330
12-#14	2.08	23048	6662	37130	4883	40122	3954	41016	3254	41218	2235	48910	1777	28680
12-#18	3.70	24729	7388	41837	5307	45992	4251	48119	3423	50603	2141	61519	1363	47758
16-#11	1.93	22866	6591	36548	4850	39450	3948	40219	3258	40082	2242	47549	1851	26717
16-#14	2.78	23776	6973	39030	5072	42544	4110	43959	3353	45035	2193	54296	1655	36968
16-#18	4.94	25953	7941	45144	5640	50207	4527	53240	3596	57188	2056	70740	1133	61164
20-#11	2.41	23404	6807	37925	4982	41145	4039	42285	3310	42924	2231	51467	1751	32489
20-#14	3.47	24529	7284	40995	5260	44963	4242	46907	3427	49075	2175	59852	1507	45153
20-#18	6.17	27224	8495	48563	5973	54416	4758	58503	3770	64161	2017	80285	854	73539
24-#11	2.89	23950	7023	39236	5130	42884	4148	44397	3379	45802	2220	55258	1618	38429
24-#14	4.17	25293	7596	42867	5474	47443	4398	49921	3526	53165	2156	65226	1310	52843

SQUARE TIED COLUMNS 38" x 38"

4-#18	1.11	26823	6936	41973	5105	44919	4163	45431	3476	44472	2498	51609	2346	18362
8-#14	1.25	26157	7005	41053	5181	43934	4244	44301	3537	43092	2533	49875	2243	20757
8-#18	2.22	27495	7489	44717	5439	48437	4440	49722	3651	50207	2463	59190	2000	35677
12-#11	1.30	26112	7030	40861	5232	43794	4261	44173	3547	43086	2550	50269	2208	21643
12-#14	1.87	26872	7316	42910	5395	46324	4376	47225	3612	47190	2517	55832	2056	30583
12-#18	3.32	28696	8042	47954	5818	52604	4673	54819	3782	57293	2428	69453	1654	51640
16-#11	1.73	26674	7246	42282	5364	45604	4370	46372	3617	45964	2523	54359	2128	28477
16-#14	2.49	27660	7627	44939	5585	48909	4533	50366	3712	51283	2476	61630	1937	39728
16-#18	4.43	30024	8596	51489	6153	57108	4950	60293	3957	64368	2348	79403	1432	65750

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.16	27256	7461	43751	5495	47412	4463	48576	3670	49008	2514	58565	2031	34798
20-#14	3.12	28475	7939	47036	5774	51491	4665	53513	3788	55615	2461	67601	1794	48387
20-#18	5.54	31400	9149	55143	6487	61607	5183	65777	4088	71858	2313	89684	1162	79422
24-#11	2.59	27846	7677	45150	5644	49266	4572	50829	3740	52090	2504	62635	1901	41104
24-#14	3.74	29302	8250	49035	5988	54139	4822	56731	3888	59999	2445	73377	1602	56873

SQUARE TIED COLUMNS 40" x 40"

4-#18	1.00	31040	7625	48296	5642	51670	4606	52155	3852	50845	2791	58900	2634	19489
8-#14	1.13	30328	7694	47302	5721	50614	4688	50949	3915	49356	2827	57019	2531	22018
8-#18	2.00	31771	8179	51213	5978	55410	4884	56717	4029	56975	2760	67027	2296	37924
12-#11	1.17	30281	7719	47092	5774	50463	4707	50811	3926	49326	2843	57427	2497	22954
12-#14	1.69	31099	8006	49276	5936	53155	4821	54056	3991	53730	2813	63387	2349	32481
12-#18	3.00	33069	8732	54657	6358	59844	5118	62141	4161	64551	2729	78021	1958	55607
16-#11	1.56	30886	7935	48601	5906	52386	4817	53148	3997	52390	2818	61803	2419	30233
16-#14	2.25	31948	8317	51433	6126	55903	4979	57395	4092	58098	2774	69598	2233	42526
16-#18	4.00	34501	9285	58420	6694	64639	5396	67968	4338	72115	2653	88703	1742	70385
20-#11	1.95	31512	8151	50162	6038	54307	4909	55490	4050	55633	2809	66297	2325	37129
20-#14	2.81	32826	8628	53663	6316	58649	5112	60742	4168	62721	2761	75984	2094	51644
20-#18	5.00	35984	9838	62311	7029	69428	5630	73805	4470	80122	2622	99719	1480	85419
24-#11	2.34	32147	8367	51650	6187	56278	5019	57884	4120	58914	2801	70647	2197	43791
24-#14	3.38	33717	8939	55788	6531	61464	5270	64163	4269	67400	2747	82163	1906	60966

SQUARE TIED COLUMNS 42" x 42"

8-#14	1.02	34925	8419	54166	6291	57957	5157	58251	4313	56199	3135	64830	2834	23278
8-#18	1.81	36472	8903	58325	6546	63045	5351	64367	4426	64340	3072	75531	2604	40167
12-#11	1.06	34874	8444	53937	6344	57794	5176	58105	4325	56134	3150	65252	2800	24263
12-#14	1.53	35752	8731	56257	6506	60648	5290	61542	4390	60842	3122	71610	2655	34375
12-#18	2.72	37867	9457	61978	6926	67747	5587	70118	4560	72405	3044	87256	2274	59004
16-#11	1.41	35523	8660	55536	6476	59830	5269	60579	4396	59379	3125	69915	2723	31985
16-#14	2.04	36662	9042	58543	6696	63559	5449	65080	4491	65481	3085	78234	2542	45203
16-#18	3.63	39406	10010	65969	7263	72832	5866	76297	4738	80459	2972	98670	2063	75070
20-#11	1.77	36193	8876	57189	6608	61865	5379	63059	4450	62812	3117	74697	2632	39479
20-#14	2.55	37603	9353	60906	6887	66468	5582	68625	4568	70389	3073	85035	2407	54925
20-#18	4.54	40997	10563	70095	7600	77912	6101	82488	4872	88984	2945	110424	1809	91530
24-#11	2.12	36873	9092	58764	6758	63952	5472	65594	4521	66287	3110	79327	2507	46491
24-#14	3.06	38558	9664	63157	7102	69451	5740	72250	4670	75357	3061	91618	2223	65050
24-#18	5.44	42614	11117	74025	7981	83121	6381	88817	5050	97611	2917	121795	1469	107333

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	1.65	41620	9664	66084	7142	71376	5842	72704	4843	72331	3398	84736	2927	42407
12-#14	1.39	40850	9491	63885	7104	68836	5783	69716	4809	68539	3445	80534	2975	36267
12-#18	2.48	43113	10217	69945	7523	76346	6078	78783	4978	80886	3374	97192	2603	62387
16-#11	1.29	40605	9420	63115	7075	67969	5762	68697	4815	66994	3448	78728	3042	33733
16-#14	1.86	41822	9802	66298	7295	71911	5917	73452	4911	73438	3409	87571	2864	47735
16-#18	3.31	44759	10770	74164	7861	81721	6359	85313	5158	89431	3305	109340	2397	79806
20-#11	1.61	41320	9636	64860	7208	70118	5873	71315	4869	70618	3441	83799	2953	41759
20-#14	2.32	42827	10113	68794	7486	74983	6076	77196	4988	78622	3397	94788	2733	58230
20-#18	4.13	46460	11324	78526	8199	87091	6595	91858	5293	98473	3281	121832	2150	97756
24-#11	1.93	42045	9852	66523	7358	72321	5966	73992	4941	74286	3434	88709	2831	49204
24-#14	2.79	43846	10424	71172	7701	78134	6210	81024	5090	83868	3386	101775	2552	68886
24-#18	4.96	48187	11877	82682	8580	92598	6876	98549	5472	107624	3257	133919	1816	114227

SQUARE TIED COLUMNS 46" x 46"

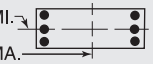
8-#18	1.51	47235	10459	74521	7766	80436	6356	81762	5280	80951	3738	94674	3263	44641
12-#14	1.28	46416	10286	72188	7731	77753	6299	78611	5247	76893	3783	90192	3309	38155
12-#18	2.27	48828	11013	78590	8149	85673	6594	88167	5417	89986	3716	107863	2944	65762
16-#11	1.18	46155	10216	71370	7703	76837	6279	77537	5255	75266	3786	88276	3375	35480
16-#14	1.70	47450	10598	74730	7922	80991	6433	82545	5350	82052	3747	97643	3201	50261
16-#18	3.02	50581	11566	83036	8487	91338	6875	95050	5597	99013	3650	120746	2743	84592
20-#11	1.47	46915	10432	73207	7836	79098	6390	80293	5309	79081	3780	93636	3288	43946
20-#14	2.13	48519	10909	77358	8113	84226	6593	86488	5428	87510	3737	105276	3072	61559
20-#18	3.78	52393	12119	87634	8826	96998	7113	101949	5733	108564	3628	133976	2503	103593
24-#11	1.77	47686	10647	74958	7986	81417	6484	83110	5381	82942	3773	98826	3168	51931
24-#14	2.55	49603	11220	79863	8329	87545	6727	90519	5531	93035	3726	112667	2895	72735
24-#18	4.54	54231	12672	92015	9208	102803	7394	109002	5914	118230	3607	146780	2175	121205

SQUARE TIED COLUMNS 48" x 48"

8-#18	1.39	53339	11290	83664	8420	90256	6894	91572	5737	90198	4089	105380	3612	46870
12-#14	1.17	52471	11117	81197	8386	87430	6838	88258	5706	85932	4136	100619	3657	40036
12-#18	2.08	55031	11844	87941	8803	95761	7132	98305	5875	99694	4069	119302	3300	69130
16-#11	1.08	52194	11047	80330	8359	86465	6820	87130	5714	84224	4140	98593	3722	37220
16-#14	1.56	53567	11429	83867	8578	90831	6973	92391	5809	91351	4101	108484	3551	52783
16-#18	2.78	56893	12397	92616	9142	101716	7415	105541	6056	109183	4005	132920	3102	89430
20-#11	1.35	52998	11263	82260	8493	88840	6931	90024	5769	88230	4134	104241	3637	46129
20-#14	1.95	54700	11740	86628	8769	94231	7133	96533	5888	97085	4091	116533	3425	64913
20-#18	3.47	58816	12950	97450	9481	107667	7653	112793	6194	119223	3984	146889	2868	109284
24-#11	1.63	53814	11478	84098	8643	91275	7025	92982	5841	92284	4127	109712	3519	54672
24-#14	2.34	55849	12051	89260	8986	97716	7268	100768	5991	102889	4081	124328	3251	76600
24-#18	4.17	60767	13503	102056	9865	113770	7936	120208	6375	129384	3964	160411	2545	128267

RECTANGULAR TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.86	MA	255	275	419	206	461	171	480	140	495	91	526	54	366
2L-3S		MI	239	275	387	206	422	170	434	141	437	92	465	33	370
6-#6	2.64	MA	268	298	457	219	505	179	529	143	557	84	588	36	485
2L-3S		MI	246	298	413	218	451	178	467	145	478	85	505	6	489
6-#7	3.60	MA	282	325	502	235	555	188	587	147	630	75	676	19	624
2L-3S		MI	254	325	444	234	485	187	505	149	526	77	563	-23	551

RECTANGULAR TIED COLUMNS 10" x 12"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.03	MA	353	301	536	239	599	201	629	172	641	124	704	96	332
2E		MI	288	301	452	230	491	193	503	162	501	115	534	84	276
4-#6	1.47	MA	366	316	572	247	643	207	681	175	704	121	773	87	444
2E		MI	297	316	478	237	520	197	536	164	542	110	574	71	362
4-#7	2.00	MA	380	335	615	258	696	214	740	179	779	117	853	76	575
2E		MI	306	335	509	247	554	203	574	165	590	104	631	60	461
4-#8	2.63	MA	397	357	665	270	756	223	808	183	865	112	944	61	724
2E		MI	317	357	544	259	592	209	617	167	644	96	684	41	572
4-#9	3.33	MA	414	381	718	284	821	233	880	187	955	106	1037	44	882
2E		MI	328	381	578	272	630	216	660	169	698	87	735	18	687
4-#10	4.23	MA	435	412	783	302	902	246	967	192	1064	97	1148	21	1078
2E		MI	342	412	618	287	676	225	712	170	764	74	794	-13	799
4-#11	5.20	MA	448	446	841	318	950	252	1020	191	1130	81	1187	-19	1189
2E		MI	349	446	638	296	693	226	730	163	785	50	785	-65	792
6-#5	1.55	MA	370	319	578	251	654	210	695	177	725	122	800	88	467
2L-3S		MI	283	319	452	241	491	200	503	167	501	112	534	51	384
6-#5	1.55	MA	347	319	536	251	599	210	629	178	641	123	704	66	471
3L-2S		MI	300	319	483	241	530	200	548	166	559	111	595	72	379
6-#6	2.20	MA	388	342	632	263	719	219	773	182	821	118	905	75	628
2L-3S		MI	290	342	478	253	520	207	536	170	542	106	574	24	506
6-#6	2.20	MA	358	342	572	264	643	219	681	184	704	119	773	43	631
3L-2S		MI	312	342	522	253	574	208	598	169	621	105	656	54	501
6-#7	3.00	MA	410	370	695	279	797	230	862	188	934	112	1027	58	818
2L-3S		MI	298	370	509	268	554	216	574	174	590	97	631	-5	619
6-#7	3.00	MA	371	370	615	280	696	230	740	190	779	114	853	15	816
3L-2S		MI	326	370	568	269	624	217	655	172	694	96	743	37	642
6-#8	3.95	MA	386	403	665	299	756	243	808	197	865	107	944	-21	939
3L-2S		MI	343	403	619	288	681	228	719	175	774	84	823	8	801
6-#9	5.00	MA	403	439	718	320	821	258	880	205	955	99	1037	-61	1023
3L-2S		MI	359	439	669	307	738	239	785	178	857	71	901	-25	882
6-#10	6.35	MA	423	486	783	348	902	276	967	213	1064	88	1148	-116	1124
3L-2S		MI	380	486	729	331	806	253	863	181	956	52	991	-71	976

RECTANGULAR TIED COLUMNS 10" x 14"

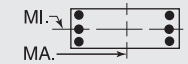
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.26	MA	497	360	749	292	855	245	910	208	960	151	1076	118	539
2E		MI	341	360	543	272	589	226	604	189	607	131	642	89	375
4-#7	1.71	MA	518	379	804	302	922	252	990	212	1063	148	1194	109	704
2E		MI	351	379	575	281	623	232	642	191	654	124	699	77	476
4-#8	2.26	MA	541	401	869	314	1001	261	1084	217	1181	145	1328	98	895
2E		MI	361	401	610	293	661	238	685	192	707	116	751	58	589
4-#9	2.86	MA	564	425	938	328	1085	271	1185	223	1307	140	1469	86	1098
2E		MI	372	425	644	305	699	245	728	193	762	106	802	35	707
4-#10	3.63	MA	593	457	1024	346	1192	284	1312	231	1463	135	1641	68	1352
2E		MI	386	457	685	320	745	253	780	195	827	93	861	4	849
4-#11	4.46	MA	614	490	1105	363	1286	296	1414	236	1576	122	1739	37	1586
2E		MI	393	490	705	328	762	253	798	187	848	69	851	-49	873

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 10" x 14"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

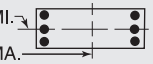
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.33	MA	502	363	756	295	867	247	926	210	986	152	1111	119	567
2L-3S		MI	327	363	516	275	560	229	572	193	566	133	603	68	396
6-#5	1.33	MA	472	363	702	296	798	248	843	210	874	153	977	96	571
3L-2S		MI	344	363	548	275	599	230	617	192	623	132	664	90	392
6-#6	1.89	MA	528	386	824	308	951	256	1026	215	1115	149	1261	109	771
2L-3S		MI	334	386	543	287	589	236	604	196	607	126	642	42	522
6-#6	1.89	MA	488	386	749	309	855	257	910	218	960	150	1076	77	774
3L-2S		MI	356	386	587	288	643	237	666	194	685	125	724	72	516
6-#7	2.57	MA	558	414	906	324	1052	268	1147	222	1270	145	1439	97	1013
2L-3S		MI	342	414	575	302	623	245	642	199	654	117	699	12	665
6-#7	2.57	MA	507	414	804	326	922	269	990	225	1063	147	1194	53	1010
3L-2S		MI	371	414	633	303	693	246	724	197	757	116	811	54	660
6-#8	3.39	MA	528	447	869	345	1001	283	1084	234	1181	143	1328	23	1277
3L-2S		MI	387	447	685	322	749	257	788	201	838	104	891	26	821
6-#9	4.29	MA	551	483	938	367	1085	298	1185	244	1307	138	1469	-11	1463
3L-2S		MI	404	483	735	341	807	267	853	203	921	90	969	-8	971
6-#10	5.44	MA	580	530	1024	395	1192	318	1312	257	1463	131	1641	-56	1611
3L-2S		MI	424	530	795	364	875	281	931	206	1019	71	1058	-54	1042
6-#11	6.69	MA	601	581	1105	421	1286	335	1414	265	1576	114	1739	-122	1690
3L-2S		MI	436	581	822	379	902	284	959	196	1053	37	1047	-131	1061
8-#5	1.77	MA	495	381	756	307	867	256	926	215	986	152	1111	90	735
3E		MI	339	381	548	286	599	237	617	197	623	129	664	57	497
8-#5	1.77	MA	478	381	717	309	814	259	861	217	897	151	1013	80	735
4L-2S		MI	355	381	580	287	638	238	662	196	681	128	725	78	493
8-#6	2.51	MA	520	411	824	325	951	269	1026	225	1115	149	1261	69	999
3E		MI	350	411	587	303	643	247	666	201	685	120	724	24	657
8-#6	2.51	MA	496	411	770	327	876	272	935	225	992	148	1126	54	956
4L-2S		MI	372	411	631	304	696	248	728	200	764	119	806	54	653
8-#7	3.43	MA	549	449	906	347	1052	285	1147	235	1270	145	1439	40	1308
3E		MI	363	449	633	323	693	259	724	206	757	109	811	-11	794
8-#7	3.43	MA	519	449	833	350	950	289	1023	235	1105	143	1260	22	1195
4L-2S		MI	391	449	692	325	763	261	805	204	861	107	923	31	838
8-#8	4.51	MA	545	493	905	377	1037	309	1126	247	1236	137	1412	-18	1408
4L-2S		MI	412	493	760	350	838	275	891	209	969	92	1030	-6	1032
8-#9	5.71	MA	574	541	983	406	1130	331	1237	260	1384	135	1570	-64	1552
4L-2S		MI	435	541	826	376	915	290	978	213	1079	74	1135	-51	1111

RECTANGULAR TIED COLUMNS 10" x 16"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.10	MA	647	405	943	336	1090	282	1166	241	1234	177	1414	146	634
2E		MI	385	405	608	306	658	256	673	215	671	151	710	107	386
4-#7	1.50	MA	674	423	1011	346	1173	290	1264	245	1366	176	1570	139	834
2E		MI	395	423	640	315	692	261	711	216	718	144	767	95	490
4-#8	1.98	MA	703	445	1090	358	1269	299	1379	250	1520	174	1750	131	1065
2E		MI	406	445	676	327	729	267	753	217	771	136	819	76	605
4-#9	2.50	MA	735	470	1175	372	1374	309	1504	256	1686	172	1940	121	1314
2E		MI	417	470	710	338	768	273	797	218	825	126	869	53	725
4-#10	3.17	MA	772	501	1282	390	1505	322	1661	264	1894	169	2175	108	1626
2E		MI	430	501	751	353	814	281	848	219	890	113	927	22	871
4-#11	3.90	MA	801	534	1387	407	1628	333	1805	271	2056	159	2337	84	1923
2E		MI	437	534	772	360	831	281	866	211	910	88	916	-32	932
6-#5	1.16	MA	653	408	951	339	1105	285	1185	243	1261	178	1455	147	668
2L-3S		MI	372	408	581	310	629	258	640	218	630	153	671	86	407
6-#5	1.16	MA	616	408	886	341	1022	286	1084	243	1126	180	1283	124	672
3L-2S		MI	388	408	613	310	668	259	686	218	688	152	732	108	403
6-#6	1.65	MA	686	430	1035	352	1207	294	1307	248	1424	176	1653	140	913
2L-3S		MI	378	430	608	321	658	265	673	221	671	146	710	59	536
6-#6	1.65	MA	636	430	943	354	1090	296	1166	249	1234	178	1414	108	916
3L-2S		MI	401	430	652	322	711	266	735	220	749	145	792	89	530

RECTANGULAR TIED COLUMNS 10" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

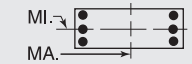
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	2.25	MA	725	458	1135	368	1330	306	1454	255	1622	174	1888	130	1207
2L-3S		MI	386	458	640	336	692	274	711	224	718	137	767	30	683
6-#7	2.25	MA	659	458	1011	371	1173	308	1264	256	1366	177	1570	87	1205
3L-2S		MI	415	458	699	337	762	275	792	223	821	136	879	72	676
6-#8	2.96	MA	686	491	1090	391	1269	322	1379	265	1520	175	1750	61	1532
3L-2S		MI	431	491	751	355	818	285	856	226	902	124	958	43	840
6-#9	3.75	MA	718	528	1175	413	1374	338	1504	274	1686	172	1940	32	1871
3L-2S		MI	448	528	801	374	876	296	922	228	984	110	1036	10	1010
6-#10	4.76	MA	756	575	1282	442	1505	358	1661	286	1894	169	2175	-8	2168
3L-2S		MI	468	575	861	398	944	309	999	230	1082	91	1124	-36	1106
6-#11	5.85	MA	785	625	1387	469	1628	377	1805	304	2056	156	2337	-64	2289
3L-2S		MI	480	625	890	412	971	311	1027	220	1116	56	1113	-115	1125
8-#5	1.55	MA	645	425	951	352	1105	295	1185	249	1261	179	1455	120	869
3E		MI	383	425	613	321	668	266	686	222	688	150	732	75	510
8-#5	1.55	MA	624	425	905	354	1041	298	1107	251	1155	179	1332	109	869
4L-2S		MI	400	425	644	321	707	267	731	222	745	149	793	96	506
8-#6	2.20	MA	676	456	1035	370	1207	308	1307	256	1424	177	1653	102	1189
3E		MI	394	456	652	337	711	276	735	226	749	141	792	42	673
8-#6	2.20	MA	647	456	970	373	1117	312	1197	260	1274	177	1481	86	1163
4L-2S		MI	416	456	696	338	765	277	797	225	828	139	874	72	668
8-#7	3.00	MA	712	493	1135	393	1330	324	1454	266	1622	175	1888	78	1567
3E		MI	407	493	699	357	762	288	792	231	821	129	879	7	860
8-#7	3.00	MA	675	493	1047	396	1209	329	1306	271	1420	174	1659	57	1459
4L-2S		MI	435	493	757	359	832	290	874	230	925	127	991	49	856
8-#8	3.95	MA	712	537	1136	423	1315	350	1433	284	1589	171	1863	21	1791
4L-2S		MI	457	537	826	384	907	304	959	234	1033	112	1098	11	1068
8-#9	5.00	MA	750	586	1232	454	1431	373	1571	298	1773	167	2079	-19	2069
4L-2S		MI	479	586	892	410	984	319	1046	238	1143	94	1202	-33	1176
8-#10	6.35	MA	798	648	1353	493	1576	402	1744	315	2002	161	2346	-73	2300
4L-2S		MI	507	648	971	442	1075	337	1151	242	1274	69	1321	-94	1302

RECTANGULAR TIED COLUMNS 10" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.33	MA	848	467	1236	390	1448	327	1565	278	1688	202	1981	168	964
2E		MI	439	467	706	349	761	290	780	241	782	164	835	113	503
4-#8	1.76	MA	885	489	1329	403	1562	336	1701	283	1871	200	2206	162	1236
2E		MI	450	489	742	360	798	296	822	242	835	156	886	93	621
4-#9	2.22	MA	923	514	1430	416	1686	346	1849	289	2069	198	2447	154	1530
2E		MI	461	514	776	372	837	302	865	243	889	146	936	70	743
4-#10	2.82	MA	971	545	1557	434	1843	359	2037	297	2321	196	2747	144	1901
2E		MI	474	545	817	386	883	310	917	244	953	133	994	39	891
4-#11	3.47	MA	1009	579	1686	451	1994	371	2213	304	2554	191	2975	124	2260
2E		MI	481	579	839	393	900	308	934	235	973	107	981	-15	990
6-#5	1.03	MA	823	452	1164	383	1366	323	1470	275	1564	204	1834	174	768
2L-3S		MI	416	452	646	344	697	288	709	244	695	174	740	104	417
6-#5	1.03	MA	778	452	1088	385	1269	324	1352	277	1405	206	1623	151	772
3L-2S		MI	433	452	677	344	736	289	754	243	752	173	801	126	414
6-#6	1.47	MA	863	474	1263	396	1486	332	1614	281	1756	202	2079	168	1056
2L-3S		MI	422	474	673	355	727	294	742	247	735	167	779	77	549
6-#6	1.47	MA	802	474	1155	399	1350	334	1448	283	1533	205	1786	136	1059
3L-2S		MI	445	474	717	356	780	296	804	245	814	165	861	107	543
6-#7	2.00	MA	910	502	1381	412	1632	343	1788	288	1990	200	2373	161	1401
2L-3S		MI	430	502	706	370	761	303	780	250	782	158	835	48	700
6-#7	2.00	MA	831	502	1236	416	1448	346	1565	290	1688	204	1981	118	1399
3L-2S		MI	459	502	764	371	831	304	861	248	885	156	947	89	692
6-#8	2.63	MA	865	535	1329	436	1562	361	1701	299	1871	202	2206	95	1788
3L-2S		MI	476	535	817	389	887	314	925	251	966	144	1026	61	858
6-#9	3.33	MA	901	572	1430	459	1686	377	1849	309	2069	201	2447	69	2202
3L-2S		MI	492	572	867	407	945	324	990	253	1048	130	1103	27	1031

RECTANGULAR TIED COLUMNS 10" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	4.23	MA	951	619	1557	488	1843	398	2037	321	2321	198	2747	35	2666
3L-2S		MI	513	619	928	431	1013	337	1068	255	1146	111	1191	-19	1198
6-#11	5.20	MA	990	669	1686	515	1994	417	2213	332	2554	192	2975	-15	2958
3L-2S		MI	524	669	957	444	1040	339	1095	244	1178	75	1178	-98	1188
8-#5	1.38	MA	813	470	1164	397	1366	333	1470	282	1564	206	1834	148	1003
3E		MI	427	470	677	355	736	296	754	248	752	170	801	93	522
8-#5	1.38	MA	788	470	1111	399	1292	336	1379	285	1440	206	1684	136	1003
4L-2S		MI	444	470	709	356	776	297	800	247	810	169	862	114	518
8-#6	1.96	MA	851	500	1263	415	1486	346	1614	290	1756	204	2079	132	1379
3E		MI	438	500	717	371	780	305	804	252	814	161	861	60	689
8-#6	1.96	MA	817	500	1187	418	1382	351	1486	294	1581	205	1870	115	1367
4L-2S		MI	461	500	761	372	834	307	866	251	892	160	943	89	683
8-#7	2.67	MA	895	537	1381	438	1632	362	1788	300	1990	202	2373	112	1827
3E		MI	451	537	764	391	831	317	861	256	885	149	947	25	879
8-#7	2.67	MA	852	537	1279	441	1491	369	1615	306	1754	203	2093	89	1731
4L-2S		MI	480	537	822	393	901	319	942	255	989	147	1059	66	874
8-#8	3.51	MA	893	581	1385	470	1618	390	1766	319	1956	200	2351	56	2129
4L-2S		MI	501	581	892	418	976	333	1028	259	1096	132	1165	29	1088
8-#9	4.44	MA	938	630	1500	501	1756	414	1931	334	2175	198	2625	20	2550
4L-2S		MI	523	630	958	443	1053	347	1115	263	1206	114	1269	-16	1240
8-#10	5.64	MA	1004	692	1644	541	1929	444	2139	353	2452	194	2967	-29	2941
4L-2S		MI	551	692	1038	475	1144	365	1219	266	1338	89	1388	-77	1368
8-#11	6.93	MA	1053	760	1787	579	2095	472	2332	369	2707	185	3224	-94	3139
4L-2S		MI	567	760	1074	495	1179	369	1256	254	1384	43	1374	-181	1394
10-#10	7.06	MA	1051	766	1753	594	2049	483	2277	377	2628	196	3198	-101	3121
5L-2S		MI	590	766	1148	519	1275	393	1370	277	1530	67	1585	-135	1560

RECTANGULAR TIED COLUMNS 10" x 20"

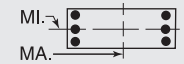
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.20	MA	1040	512	1478	434	1746	365	1892	311	2039	228	2425	195	1093
2E		MI	484	512	771	383	830	319	848	266	846	184	903	130	516
4-#8	1.58	MA	1084	534	1586	447	1879	374	2050	316	2250	226	2697	190	1407
2E		MI	494	534	807	394	867	324	890	267	899	176	954	111	636
4-#9	2.00	MA	1131	558	1703	461	2022	384	2221	322	2480	224	2989	184	1746
2E		MI	505	558	842	405	906	330	933	268	952	166	1003	87	760
4-#10	2.54	MA	1188	589	1851	479	2204	397	2439	330	2772	222	3355	177	2175
2E		MI	519	589	884	420	952	338	985	269	1017	152	1061	56	911
4-#11	3.12	MA	1237	623	2003	495	2383	409	2649	336	3048	218	3651	160	2597
2E		MI	525	623	906	425	970	336	1001	259	1035	126	1047	2	1043
6-#6	1.32	MA	1058	519	1508	440	1790	370	1947	314	2116	229	2538	196	1198
2L-3S		MI	466	519	739	390	796	324	810	272	799	187	847	95	562
6-#6	1.32	MA	987	519	1385	443	1633	372	1757	316	1859	232	2190	164	1202
3L-2S		MI	489	519	782	390	849	325	872	271	878	186	929	125	556
6-#7	1.80	MA	1114	546	1645	456	1958	381	2149	321	2386	226	2891	191	1596
2L-3S		MI	474	546	771	404	830	332	848	275	846	178	903	65	715
6-#7	1.80	MA	1021	546	1478	461	1746	385	1892	324	2039	231	2425	147	1594
3L-2S		MI	504	546	829	405	900	333	929	273	949	176	1015	107	707
6-#8	2.37	MA	1062	579	1586	481	1879	400	2050	333	2250	230	2697	127	2044
3L-2S		MI	520	579	882	423	956	343	993	276	1029	164	1093	78	875
6-#9	3.00	MA	1105	616	1703	504	2022	416	2221	343	2480	228	2989	103	2526
3L-2S		MI	537	616	933	441	1014	353	1058	278	1111	150	1170	44	1050
6-#10	3.81	MA	1160	663	1851	533	2204	437	2439	356	2772	227	3355	72	3124
3L-2S		MI	557	663	994	464	1082	366	1136	280	1209	130	1258	-2	1259

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 10" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	4.68	MA	1213	713	2003	561	2383	457	2649	367	3048	222	3651	28	3580
3L-2S		MI	568	713	1024	476	1109	366	1163	268	1241	94	1243	-81	1280
8-#5	1.24	MA	999	514	1395	441	1651	371	1781	315	1894	232	2245	175	1137
3E		MI	472	514	742	390	805	325	823	274	817	190	869	110	534
8-#5	1.24	MA	970	514	1334	443	1567	374	1678	319	1752	233	2070	163	1137
4L-2S		MI	488	514	774	390	844	326	869	273	874	190	931	132	530
8-#6	1.76	MA	1044	544	1508	459	1790	384	1947	323	2116	231	2538	161	1569
3E		MI	482	544	782	406	849	335	872	277	878	181	929	77	703
8-#6	1.76	MA	1005	544	1422	463	1671	389	1801	328	1916	232	2293	143	1557
4L-2S		MI	505	544	826	406	903	336	934	276	957	180	1011	107	697
8-#7	2.40	MA	1097	581	1645	482	1958	401	2149	334	2386	229	2891	143	2086
3E		MI	495	581	829	425	900	346	929	282	949	169	1015	42	897
8-#7	2.40	MA	1047	581	1528	487	1797	408	1951	340	2115	231	2561	119	2011
4L-2S		MI	524	581	888	427	970	348	1011	280	1053	168	1127	84	890
8-#8	3.16	MA	1096	625	1651	515	1944	430	2126	354	2349	229	2873	89	2476
4L-2S		MI	545	625	957	451	1045	361	1096	284	1160	152	1233	46	1107
8-#9	4.00	MA	1150	674	1785	547	2104	454	2317	370	2604	227	3207	55	2969
4L-2S		MI	568	674	1024	476	1122	376	1183	288	1270	134	1336	1	1333
8-#10	5.08	MA	1219	737	1953	588	2307	485	2560	389	2927	224	3625	11	3581
4L-2S		MI	595	737	1104	508	1213	393	1287	291	1401	108	1455	-60	1432
8-#11	6.24	MA	1290	804	2123	627	2504	514	2790	406	3231	217	3961	-49	3902
4L-2S		MI	611	804	1141	527	1248	396	1324	278	1446	62	1440	-164	1458
10-#10	6.35	MA	1279	810	2081	642	2448	525	2723	415	3135	229	3903	-56	3845
5L-2S		MI	634	810	1214	552	1344	421	1438	302	1593	87	1652	-118	1627

RECTANGULAR TIED COLUMNS 12" x 12"

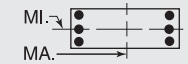
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.29	MA	434	372	668	294	752	247	794	209	820	148	902	111	480
2L-3S		MI	411	372	626	295	697	247	728	210	735	149	805	88	484
6-#6	1.83	MA	452	395	722	306	817	256	872	214	915	143	1007	98	644
2L-3S		MI	421	395	663	307	741	255	780	216	798	145	874	66	649
6-#7	2.50	MA	474	423	786	322	896	267	962	220	1028	138	1128	81	837
2L-3S		MI	434	423	706	323	794	266	840	222	873	139	954	37	839
6-#8	3.29	MA	498	456	860	341	986	280	1064	227	1157	130	1265	59	1057
2L-3S		MI	449	456	756	342	855	279	908	229	959	132	1045	2	1042
6-#9	4.17	MA	524	492	939	362	1083	296	1171	233	1292	121	1405	33	1290
2L-3S		MI	465	492	810	363	920	294	979	236	1048	124	1137	-39	1129
6-#10	5.29	MA	555	539	1037	390	1204	316	1302	241	1457	109	1572	-2	1572
2L-3S		MI	485	539	876	390	1001	312	1066	245	1158	113	1247	-94	1230

RECTANGULAR TIED COLUMNS 12" x 14"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.05	MA	584	422	868	343	987	289	1045	246	1089	181	1217	145	552
2E		MI	493	422	753	334	840	281	879	239	893	172	976	132	470
4-#7	1.43	MA	605	441	924	353	1055	296	1126	251	1192	178	1335	136	720
2E		MI	508	441	797	343	892	287	939	242	967	168	1056	120	606
4-#8	1.88	MA	628	463	989	366	1134	305	1219	256	1310	175	1469	125	913
2E		MI	525	463	848	355	953	296	1007	246	1052	162	1145	106	760
4-#9	2.38	MA	652	487	1059	379	1219	314	1320	261	1436	171	1608	112	1119
2E		MI	542	487	902	368	1018	305	1078	250	1141	156	1237	88	923
4-#10	3.02	MA	681	519	1146	397	1325	327	1447	269	1592	165	1780	94	1376
2E		MI	563	519	968	386	1099	318	1165	254	1251	147	1347	64	1124
4-#11	3.71	MA	702	552	1229	413	1420	338	1549	273	1704	152	1877	63	1615
2E		MI	577	552	1029	401	1149	322	1218	252	1315	130	1384	24	1305
4-#14	5.36	MA	766	632	1428	459	1666	371	1817	287	2042	132	2223	6	2200
2E		MI	621	632	1176	446	1304	347	1395	258	1538	100	1636	-36	1595
6-#5	1.11	MA	590	425	875	347	999	292	1062	249	1115	183	1252	146	580
2L-3S		MI	474	425	716	338	795	284	827	242	830	174	907	111	496

RECTANGULAR TIED COLUMNS 12" x 14"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

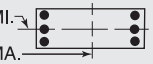
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.11	MA	559	425	821	348	931	293	978	249	1003	184	1118	123	585
3L-2S		MI	498	425	758	337	850	284	893	241	914	174	1004	133	492
6-#6	1.57	MA	615	448	944	359	1083	301	1162	254	1245	180	1402	136	786
2L-3S		MI	485	448	753	350	840	292	879	248	893	170	976	88	664
6-#6	1.57	MA	574	448	868	361	987	302	1045	256	1089	181	1217	104	791
3L-2S		MI	516	448	813	349	916	292	971	246	1009	169	1108	120	658
6-#7	2.14	MA	645	476	1026	375	1184	312	1282	261	1400	176	1580	123	1031
2L-3S		MI	498	476	797	366	892	303	939	254	967	165	1056	59	859
6-#7	2.14	MA	593	476	924	377	1055	313	1126	264	1192	178	1335	80	1034
3L-2S		MI	538	476	877	365	994	303	1061	252	1122	163	1230	103	854
6-#8	2.82	MA	679	509	1122	394	1302	326	1423	269	1578	171	1782	108	1313
2L-3S		MI	512	509	848	384	953	316	1007	260	1052	158	1145	24	1077
6-#8	2.82	MA	614	509	989	397	1134	327	1219	273	1310	173	1469	50	1307
3L-2S		MI	563	509	952	384	1085	317	1163	258	1250	155	1366	81	1077
6-#9	3.57	MA	714	545	1224	415	1428	341	1575	278	1767	165	1993	88	1614
2L-3S		MI	528	545	902	405	1018	330	1078	267	1141	149	1237	-17	1234
6-#9	3.57	MA	636	545	1059	418	1219	342	1320	282	1436	168	1608	16	1578
3L-2S		MI	588	545	1031	405	1182	332	1270	265	1385	146	1505	55	1313
6-#10	4.54	MA	757	592	1352	443	1587	361	1765	290	2002	157	2252	62	1989
2L-3S		MI	548	592	968	431	1099	348	1165	276	1251	137	1347	-72	1335
6-#10	4.54	MA	665	592	1146	446	1325	361	1447	295	1592	161	1780	-30	1765
3L-2S		MI	620	592	1129	432	1303	351	1401	272	1550	134	1672	20	1604
6-#11	5.57	MA	685	643	1229	471	1420	378	1549	302	1704	144	1877	-96	1841
3L-2S		MI	641	643	1215	457	1376	361	1481	271	1649	109	1732	-39	1735
8-#5	1.48	MA	612	443	929	358	1068	300	1145	254	1227	182	1386	140	747
2L-4S		MI	477	443	727	350	807	294	841	247	849	173	932	94	635
8-#5	1.48	MA	582	443	875	360	999	301	1062	254	1115	183	1252	118	751
3E		MI	492	443	758	349	850	292	893	248	914	172	1004	103	631
8-#5	1.48	MA	564	443	836	361	946	303	996	256	1026	182	1155	107	754
4L-2S		MI	514	443	801	349	904	292	959	247	999	172	1101	125	627
8-#6	2.10	MA	646	473	1020	375	1179	312	1278	261	1401	178	1587	127	1016
2L-4S		MI	489	473	769	367	855	306	898	254	920	168	1009	64	837
8-#6	2.10	MA	606	473	944	377	1083	313	1162	264	1245	179	1402	95	1019
3E		MI	509	473	813	366	916	304	971	255	1009	167	1108	76	847
8-#6	2.10	MA	582	473	889	379	1008	317	1070	264	1121	178	1268	81	1006
4L-2S		MI	539	473	873	365	991	304	1063	254	1126	166	1241	108	843
8-#7	2.86	MA	635	510	1026	399	1184	329	1282	274	1400	175	1580	67	1334
3E		MI	529	510	877	387	994	319	1061	263	1122	160	1230	42	1098
8-#7	2.86	MA	605	510	953	401	1083	333	1159	274	1235	174	1401	49	1252
4L-2S		MI	568	510	958	387	1096	319	1183	262	1277	158	1404	85	1097
8-#8	3.76	MA	668	554	1122	425	1302	348	1423	286	1578	170	1782	33	1692
3E		MI	552	554	952	413	1085	336	1163	273	1250	151	1366	-1	1365
8-#8	3.76	MA	630	554	1026	428	1170	353	1262	285	1365	168	1552	9	1527
4L-2S		MI	600	554	1055	412	1217	338	1319	270	1449	148	1586	57	1388
8-#9	4.76	MA	703	603	1224	454	1428	368	1575	299	1767	163	1993	-8	1988
3E		MI	577	603	1031	441	1182	356	1270	282	1385	139	1505	-50	1493
8-#9	4.76	MA	658	603	1104	457	1263	375	1373	298	1513	165	1710	-37	1703
4L-2S		MI	634	603	1160	441	1346	358	1462	280	1629	137	1773	22	1696
8-#10	6.05	MA	747	666	1352	492	1587	395	1765	316	2002	153	2252	-62	2212
3E		MI	609	666	1129	477	1303	382	1401	294	1550	124	1672	-116	1646

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

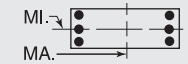
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#7	1.25	MA	787	494	1164	406	1345	341	1441	290	1536	212	1757	171	850
2E		MI	572	494	888	386	991	324	1038	274	1061	193	1157	143	620
4-#8	1.65	MA	818	516	1243	419	1442	350	1556	295	1690	209	1936	162	1084
2E		MI	589	516	939	398	1052	332	1106	278	1146	188	1246	128	776
4-#9	2.08	MA	850	540	1329	432	1546	360	1681	301	1856	207	2125	153	1335
2E		MI	606	540	994	411	1117	341	1177	281	1235	181	1337	110	941
4-#10	2.65	MA	888	572	1437	450	1678	372	1838	309	2064	204	2360	139	1650
2E		MI	627	572	1061	428	1198	353	1264	286	1344	172	1447	86	1145
4-#11	3.25	MA	917	605	1544	466	1801	383	1981	314	2224	194	2520	114	1952
2E		MI	641	605	1123	442	1248	358	1317	282	1407	154	1482	45	1331
4-#14	4.69	MA	1000	685	1796	512	2112	417	2353	335	2681	180	3023	70	2686
2E		MI	685	685	1271	487	1403	381	1493	289	1629	124	1734	-15	1689
6-#6	1.38	MA	800	501	1187	412	1378	346	1483	293	1595	212	1840	171	929
2L-3S		MI	548	501	844	393	938	329	979	280	987	196	1077	110	679
6-#6	1.38	MA	749	501	1095	415	1262	348	1342	294	1405	214	1601	139	934
3L-2S		MI	580	501	903	393	1014	329	1071	278	1103	194	1210	142	672
6-#7	1.88	MA	839	529	1288	428	1502	357	1631	300	1793	210	2075	162	1225
2L-3S		MI	561	529	888	409	991	339	1038	285	1061	190	1157	81	878
6-#7	1.88	MA	772	529	1164	431	1345	359	1441	301	1536	212	1757	118	1228
3L-2S		MI	602	529	968	408	1093	340	1160	284	1216	188	1331	125	870
6-#8	2.47	MA	883	562	1404	447	1646	371	1804	308	2024	207	2345	150	1569
2L-3S		MI	575	562	939	427	1052	352	1106	292	1146	183	1246	46	1100
6-#8	2.47	MA	799	562	1243	451	1442	374	1556	310	1690	210	1936	92	1563
3L-2S		MI	627	562	1043	426	1184	353	1262	290	1344	181	1466	103	1096
6-#9	3.13	MA	928	598	1531	468	1802	386	1991	318	2275	205	2631	135	1938
2L-3S		MI	591	598	994	447	1117	366	1177	299	1235	174	1337	4	1329
6-#9	3.13	MA	831	598	1329	473	1546	389	1681	319	1856	208	2125	63	1917
3L-2S		MI	653	598	1123	447	1281	368	1369	296	1478	171	1605	77	1334
6-#10	3.97	MA	984	645	1690	496	1999	406	2227	330	2587	200	2985	116	2401
2L-3S		MI	610	645	1061	473	1198	384	1264	307	1344	162	1447	-50	1439
6-#10	3.97	MA	868	645	1437	501	1678	409	1838	331	2064	204	2360	23	2310
3L-2S		MI	684	645	1221	474	1402	387	1500	304	1643	159	1771	42	1629
6-#11	4.88	MA	896	696	1544	527	1801	427	1981	348	2224	191	2520	-33	2496
3L-2S		MI	705	696	1309	498	1475	396	1580	301	1741	134	1830	-18	1833
6-#14	7.03	MA	983	816	1796	599	2112	477	2353	381	2681	173	3023	-149	2923
3L-2S		MI	773	816	1528	568	1708	434	1845	312	2077	91	2212	-106	2145
8-#5	1.29	MA	795	496	1168	411	1359	345	1462	293	1568	213	1815	175	881
2L-4S		MI	541	496	817	393	905	331	940	279	944	199	1034	117	649
8-#5	1.29	MA	759	496	1102	413	1276	347	1361	294	1432	215	1643	152	885
3E		MI	555	496	848	393	948	329	993	280	1009	198	1106	125	644
8-#5	1.29	MA	737	496	1056	415	1212	350	1283	297	1325	215	1520	141	888
4L-2S		MI	578	496	891	392	1002	329	1059	279	1093	197	1203	148	640
8-#6	1.83	MA	839	526	1278	428	1495	358	1624	301	1785	211	2079	165	1206
2L-4S		MI	553	526	860	410	954	343	997	286	1014	194	1111	86	867
8-#6	1.83	MA	789	526	1187	431	1378	359	1483	302	1595	213	1840	133	1209
3E		MI	572	526	903	409	1014	340	1071	287	1103	192	1210	98	863
8-#6	1.83	MA	760	526	1122	433	1288	364	1373	305	1445	213	1669	117	1205
4L-2S		MI	603	526	963	409	1090	341	1163	286	1220	191	1342	130	858
8-#7	2.50	MA	826	563	1288	453	1502	375	1631	311	1793	211	2075	109	1593
3E		MI	593	563	968	430	1093	355	1160	295	1216	185	1331	64	1119
8-#7	2.50	MA	788	563	1200	456	1380	381	1483	316	1590	210	1846	88	1526
4L-2S		MI	632	563	1049	430	1194	356	1282	293	1371	183	1505	107	1116
8-#8	3.29	MA	870	608	1404	480	1646	394	1804	323	2024	208	2345	80	2033
3E		MI	616	608	1043	456	1184	373	1262	304	1344	176	1466	21	1406

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

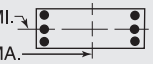
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#8	3.29	MA	820	608	1290	484	1488	401	1610	328	1759	207	2050	53	1867
4L-2S		MI	664	608	1147	455	1315	374	1418	302	1542	174	1687	79	1409
8-#9	4.17	MA	915	656	1531	509	1802	416	1991	335	2275	205	2631	46	2502
3E		MI	640	656	1123	483	1281	392	1369	314	1478	165	1605	-28	1599
8-#9	4.17	MA	860	656	1387	514	1603	424	1747	342	1943	203	2265	12	2225
4L-2S		MI	698	656	1252	483	1445	394	1561	311	1722	162	1873	44	1720
8-#10	5.29	MA	972	719	1690	547	1999	443	2227	352	2587	200	2985	0	2985
3E		MI	671	719	1221	519	1402	417	1500	325	1643	149	1771	-95	1753
8-#10	5.29	MA	907	719	1508	553	1749	453	1921	360	2171	197	2531	-42	2510
4L-2S		MI	740	719	1382	520	1606	421	1736	322	1942	145	2096	-2	2096
10-#10	6.61	MA	1016	792	1761	599	2069	487	2310	381	2694	193	3156	-65	3098
4L-3S		MI	732	792	1382	565	1606	451	1736	343	1942	136	2096	-139	2061

RECTANGULAR TIED COLUMNS 12" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#7	1.11	MA	992	547	1424	460	1663	387	1788	329	1905	243	2220	204	979
2E		MI	636	547	979	429	1089	360	1138	306	1155	218	1258	165	633
4-#8	1.46	MA	1029	569	1519	472	1778	395	1925	335	2088	241	2445	197	1254
2E		MI	653	569	1031	440	1150	368	1205	309	1240	213	1347	150	792
4-#9	1.85	MA	1068	593	1621	485	1903	405	2073	340	2286	239	2685	190	1551
2E		MI	670	593	1086	453	1216	377	1276	313	1328	206	1437	132	959
4-#10	2.35	MA	1117	625	1749	503	2060	418	2261	348	2537	236	2984	179	1924
2E		MI	691	625	1153	470	1297	389	1363	317	1437	197	1546	108	1165
4-#11	2.89	MA	1156	658	1881	519	2212	429	2437	354	2769	231	3210	159	2289
2E		MI	705	658	1216	483	1347	393	1415	313	1500	178	1580	66	1356
4-#14	4.17	MA	1261	738	2184	565	2586	462	2886	374	3360	224	3875	124	3172
2E		MI	749	738	1365	527	1503	416	1592	319	1721	148	1831	6	1811
4-#18	7.41	MA	1500	941	2906	684	3481	548	3960	427	4693	191	5358	17	5265
2E		MI	848	941	1643	624	1817	466	1950	322	2172	58	2203	-211	2197
6-#6	1.22	MA	1007	554	1451	466	1702	391	1837	333	1973	244	2318	205	1071
2L-3S		MI	612	554	934	436	1036	366	1078	312	1081	221	1179	133	692
6-#6	1.22	MA	945	554	1343	468	1565	394	1671	334	1750	246	2025	173	1076
3L-2S		MI	644	554	994	436	1112	366	1170	310	1198	220	1311	165	686
6-#7	1.67	MA	1055	582	1570	481	1848	403	2012	339	2207	241	2612	197	1420
2L-3S		MI	624	582	979	451	1089	376	1138	317	1155	215	1258	104	894
6-#7	1.67	MA	974	582	1424	485	1663	406	1788	342	1905	245	2220	154	1422
3L-2S		MI	666	582	1059	451	1191	376	1260	316	1310	214	1432	147	886
6-#8	2.19	MA	1109	615	1709	500	2019	416	2216	348	2481	239	2951	188	1825
2L-3S		MI	639	615	1031	469	1150	388	1205	324	1240	208	1347	68	1121
6-#8	2.19	MA	1008	615	1519	505	1778	420	1925	350	2088	243	2445	131	1819
3L-2S		MI	691	615	1135	469	1282	389	1362	321	1438	206	1567	125	1114
6-#9	2.78	MA	1166	651	1859	521	2204	431	2439	357	2779	236	3313	178	2262
2L-3S		MI	654	651	1086	489	1216	402	1276	330	1328	199	1437	26	1357
6-#9	2.78	MA	1044	651	1621	527	1903	436	2073	360	2286	241	2685	105	2241
3L-2S		MI	717	651	1215	489	1380	404	1468	327	1572	196	1705	99	1355
6-#10	3.53	MA	1236	698	2048	549	2439	451	2720	369	3157	233	3764	162	2812
2L-3S		MI	673	698	1153	515	1297	419	1363	338	1437	187	1546	-29	1543
6-#10	3.53	MA	1089	698	1749	556	2060	456	2261	372	2537	239	2984	70	2763
3L-2S		MI	748	698	1314	516	1501	423	1599	335	1736	183	1871	64	1652
6-#11	4.33	MA	1131	749	1881	583	2212	475	2437	382	2769	232	3210	20	3163
3L-2S		MI	769	749	1403	539	1574	431	1678	332	1834	158	1928	3	1917
6-#14	6.25	MA	1240	869	2184	656	2586	527	2886	413	3360	223	3875	-81	3789
3L-2S		MI	837	869	1622	608	1807	469	1944	343	2169	115	2309	-85	2246
8-#5	1.15	MA	1001	549	1428	464	1678	391	1811	333	1940	245	2284	207	1015
2L-4S		MI	604	549	907	437	1003	367	1039	311	1038	225	1136	139	661
8-#5	1.15	MA	957	549	1351	466	1581	392	1693	334	1781	247	2074	185	1019
3E		MI	619	549	938	436	1046	366	1092	312	1103	224	1208	148	656

RECTANGULAR TIED COLUMNS 12" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#5	1.15	MA	931	549	1298	469	1507	396	1602	337	1657	247	1925	172	1022
4L-2S		MI	642	549	981	435	1100	366	1158	311	1187	223	1305	170	652
8-#6	1.63	MA	1054	579	1558	481	1838	403	2002	340	2197	242	2611	200	1396
2L-4S		MI	616	579	950	453	1052	379	1096	318	1108	219	1212	109	885
8-#6	1.63	MA	994	579	1451	484	1702	405	1837	342	1973	245	2318	168	1399
3E		MI	636	579	994	452	1112	377	1170	319	1198	218	1311	121	879
8-#6	1.63	MA	960	579	1375	487	1597	410	1709	346	1799	246	2110	151	1395
4L-2S		MI	667	579	1054	452	1188	377	1262	318	1314	217	1444	153	873
8-#7	2.22	MA	1039	617	1570	507	1848	421	2012	352	2207	243	2612	148	1853
3E		MI	656	617	1059	473	1191	392	1260	327	1310	210	1432	86	1138
8-#7	2.22	MA	994	617	1467	511	1706	428	1838	357	1971	244	2333	125	1810
4L-2S		MI	696	617	1140	472	1293	392	1382	325	1465	209	1606	130	1133
8-#8	2.93	MA	1091	661	1709	534	2019	441	2216	364	2481	241	2951	122	2375
3E		MI	679	661	1135	498	1282	409	1362	336	1438	201	1567	43	1430
8-#8	2.93	MA	1035	661	1575	539	1834	449	1990	370	2172	241	2590	92	2218
4L-2S		MI	729	661	1238	497	1414	410	1518	334	1636	199	1787	101	1429
8-#9	3.70	MA	1151	709	1859	564	2204	462	2439	377	2779	239	3313	93	2934
3E		MI	704	709	1215	526	1380	428	1468	345	1572	190	1705	-6	1704
8-#9	3.70	MA	1079	709	1690	569	1972	472	2154	385	2391	238	2864	56	2648
4L-2S		MI	763	709	1344	525	1543	430	1660	342	1816	187	1973	66	1743
8-#10	4.70	MA	1221	772	2048	602	2439	490	2720	394	3157	235	3764	53	3619
3E		MI	734	772	1314	561	1501	453	1599	356	1736	174	1871	-73	1858
8-#10	4.70	MA	1143	772	1836	609	2146	502	2362	404	2668	234	3205	7	3179
4L-2S		MI	805	772	1474	562	1705	457	1835	353	2036	170	2196	19	2130
8-#11	5.78	MA	1190	839	1982	647	2313	529	2556	419	2923	225	3460	-59	3416
4L-2S		MI	833	839	1589	596	1802	470	1941	351	2168	138	2276	-59	2280
10-#10	5.88	MA	1276	846	2135	655	2525	536	2822	425	3288	231	3985	-10	3972
4L-3S		MI	794	846	1474	607	1705	487	1835	374	2036	160	2196	-117	2169
10-#10	5.88	MA	1191	846	1945	662	2266	541	2500	428	2844	237	3435	-65	3390
5L-2S		MI	861	846	1635	608	1909	490	2070	371	2335	157	2520	-25	2515
12-#10	7.06	MA	1321	919	2243	708	2645	575	2960	449	3464	233	4215	-82	4128
5L-3S		MI	854	919	1635	653	1909	520	2070	392	2335	147	2520	-161	2475

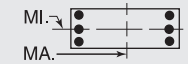
RECTANGULAR TIED COLUMNS 12" x 20"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.00	MA	1218	600	1706	513	2011	432	2167	369	2308	274	2723	235	1109
2E		MI	700	600	1070	472	1188	397	1237	338	1249	244	1359	187	645
4-#8	1.32	MA	1263	622	1815	525	2143	441	2325	374	2519	272	2994	231	1425
2E		MI	717	622	1122	483	1249	405	1305	341	1333	238	1447	172	806
4-#9	1.67	MA	1310	646	1934	538	2288	450	2497	380	2748	270	3285	225	1767
2E		MI	734	646	1177	495	1314	413	1376	344	1422	231	1538	154	976
4-#10	2.12	MA	1368	678	2083	556	2470	463	2715	387	3040	267	3651	217	2199
2E		MI	756	678	1246	512	1396	425	1462	348	1530	222	1646	130	1185
4-#11	2.60	MA	1417	711	2238	572	2650	474	2925	393	3316	263	3945	200	2626
2E		MI	769	711	1310	524	1446	428	1514	343	1592	203	1679	88	1380
4-#14	3.75	MA	1546	791	2594	618	3090	507	3451	414	4021	257	4775	172	3658
2E		MI	813	791	1460	567	1602	450	1690	349	1813	172	1928	27	1840
4-#18	6.67	MA	1835	994	3447	737	4148	594	4721	467	5717	241	6669	86	6129
2E		MI	911	994	1739	663	1917	500	2048	351	2262	81	2298	-191	2293
6-#6	1.10	MA	1236	607	1736	519	2054	436	2223	372	2385	275	2837	237	1214
2L-3S		MI	676	607	1025	480	1134	402	1177	344	1175	247	1280	155	704
6-#6	1.10	MA	1164	607	1612	522	1897	439	2032	374	2128	279	2489	205	1219
3L-2S		MI	708	607	1084	479	1210	403	1269	343	1292	245	1413	187	698

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 20"

Short columns – no sidesway
Bending on major or minor axis

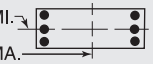


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.50	MA	1293	635	1873	534	2223	448	2424	379	2655	273	3189	231	1614
2L-3S		MI	688	635	1070	494	1188	412	1237	349	1249	241	1359	126	910
6-#7	1.50	MA	1198	635	1706	539	2011	451	2167	382	2308	277	2723	188	1617
3L-2S		MI	730	635	1150	493	1289	413	1359	347	1404	239	1533	169	901
6-#8	1.98	MA	1357	668	2034	553	2420	461	2661	387	2972	270	3599	225	2081
2L-3S		MI	702	668	1122	512	1249	424	1305	355	1333	233	1447	90	1140
6-#8	1.98	MA	1238	668	1815	559	2143	466	2325	391	2519	276	2994	167	2075
3L-2S		MI	755	668	1226	511	1381	426	1461	353	1532	231	1668	147	1131
6-#9	2.50	MA	1426	704	2208	574	2635	477	2918	397	3317	267	4038	216	2586
2L-3S		MI	717	704	1177	532	1314	438	1376	362	1422	224	1538	48	1381
6-#9	2.50	MA	1282	704	1934	581	2288	482	2497	401	2748	274	3285	144	2565
3L-2S		MI	781	704	1307	531	1478	440	1567	359	1665	221	1805	121	1374
6-#10	3.17	MA	1510	751	2427	602	2908	497	3245	409	3756	264	4588	205	3224
2L-3S		MI	736	751	1246	557	1396	455	1462	369	1530	212	1646	-7	1645
6-#10	3.17	MA	1336	751	2083	610	2470	503	2715	414	3040	272	3651	112	3174
3L-2S		MI	813	751	1406	558	1600	459	1698	366	1830	208	1971	85	1675
6-#11	3.90	MA	1383	802	2238	638	2650	522	2925	424	3316	267	3945	68	3762
3L-2S		MI	833	802	1496	580	1674	466	1777	362	1926	182	2027	25	1945
6-#14	5.63	MA	1520	922	2594	712	3090	575	3451	456	4021	261	4775	-23	4741
3L-2S		MI	900	922	1717	649	1906	503	2043	373	2260	139	2406	-64	2344
8-#5	1.03	MA	1228	602	1709	517	2026	436	2192	372	2346	276	2794	239	1149
2L-4S		MI	667	602	997	480	1101	404	1139	344	1132	250	1238	162	673
8-#5	1.03	MA	1177	602	1621	520	1915	438	2057	374	2163	279	2545	216	1152
3E		MI	683	602	1028	479	1144	403	1191	344	1197	249	1310	170	668
8-#5	1.03	MA	1147	602	1560	522	1830	442	1953	377	2022	280	2369	203	1156
4L-2S		MI	706	602	1071	479	1199	403	1257	343	1282	249	1407	193	664
8-#6	1.47	MA	1291	632	1859	535	2211	448	2413	379	2642	274	3185	234	1587
2L-4S		MI	679	632	1041	496	1150	416	1196	350	1202	245	1314	131	900
8-#6	1.47	MA	1221	632	1736	538	2054	451	2223	382	2385	277	2837	202	1589
3E		MI	700	632	1084	495	1210	414	1269	351	1292	243	1413	143	893
8-#6	1.47	MA	1181	632	1650	541	1935	456	2076	386	2185	279	2592	184	1585
4L-2S		MI	731	632	1144	495	1286	414	1361	350	1408	242	1545	175	887
8-#7	2.00	MA	1275	670	1873	560	2223	467	2424	392	2655	276	3189	184	2112
3E		MI	720	670	1150	516	1289	428	1359	359	1404	236	1533	108	1156
8-#7	2.00	MA	1223	670	1757	565	2061	474	2226	398	2384	277	2860	159	2088
4L-2S		MI	760	670	1231	515	1391	429	1481	357	1559	234	1707	152	1150
8-#8	2.63	MA	1337	714	2034	588	2420	487	2661	404	2972	274	3599	161	2716
3E		MI	743	714	1226	541	1381	445	1461	368	1532	226	1668	65	1453
8-#8	2.63	MA	1272	714	1881	593	2209	496	2402	412	2618	275	3171	129	2578
4L-2S		MI	793	714	1330	540	1512	447	1617	365	1730	224	1888	123	1448
8-#9	3.33	MA	1403	762	2208	618	2635	509	2918	417	3317	272	4038	135	3366
3E		MI	767	762	1307	568	1478	464	1567	377	1665	215	1805	16	1762
8-#9	3.33	MA	1325	762	2016	625	2370	520	2593	427	2872	273	3504	95	3082
4L-2S		MI	827	762	1436	568	1642	466	1759	374	1909	212	2073	88	1765
8-#10	4.23	MA	1486	825	2427	656	2908	537	3245	435	3756	269	4588	100	4179
3E		MI	797	825	1406	603	1600	489	1698	387	1830	198	1971	-51	1963
8-#10	4.23	MA	1393	825	2185	665	2573	551	2835	447	3195	270	3922	51	3704
4L-2S		MI	869	825	1567	604	1804	492	1934	384	2129	195	2295	41	2155
8-#11	5.20	MA	1461	892	2359	703	2771	579	3066	463	3498	262	4255	-9	4245
4L-2S		MI	897	892	1683	637	1901	505	2040	381	2260	162	2375	-38	2379
8-#14	7.50	MA	1630	1052	2763	805	3258	656	3648	511	4276	252	5200	-135	5031
4L-2S		MI	988	1052	1974	730	2211	556	2395	397	2708	105	2884	-156	2791
10-#10	5.29	MA	1559	899	2530	711	3010	584	3366	468	3911	267	4859	39	4685
4L-3S		MI	857	899	1567	649	1804	522	1934	405	2129	185	2295	-95	2276
10-#10	5.29	MA	1446	899	2313	719	2714	591	2999	473	3403	275	4199	-16	4184
5L-2S		MI	925	899	1728	650	2007	526	2169	402	2428	182	2620	-3	2620
12-#10	6.35	MA	1606	972	2658	765	3152	625	3529	494	4119	272	5136	-28	5096
5L-3S		MI	917	972	1728	695	2007	556	2169	423	2428	172	2620	-139	2585

RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

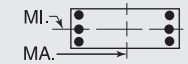
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.20	MA	1518	675	2133	578	2537	486	2758	413	2983	304	3584	263	1596
2E		MI	781	675	1214	525	1348	441	1404	373	1427	263	1548	194	821
4-#9	1.52	MA	1573	699	2268	591	2702	495	2953	419	3244	301	3927	258	1983
2E		MI	798	699	1269	537	1413	449	1475	375	1515	256	1638	176	993
4-#10	1.92	MA	1641	731	2438	609	2910	508	3202	427	3576	299	4358	252	2473
2E		MI	820	731	1338	553	1495	461	1561	379	1623	246	1746	151	1204
4-#11	2.36	MA	1701	764	2617	625	3118	519	3444	433	3895	294	4721	238	2963
2E		MI	833	764	1404	565	1545	463	1613	374	1684	227	1777	109	1403
4-#14	3.41	MA	1855	844	3025	671	3622	552	4048	453	4704	288	5719	216	4144
2E		MI	877	844	1555	608	1701	485	1789	379	1905	196	2025	48	1869
4-#18	6.06	MA	2198	1047	4009	790	4843	639	5515	506	6673	274	8033	147	6993
2E		MI	974	1047	1835	702	2016	533	2146	380	2353	104	2393	-171	2387
6-#6	1.00	MA	1486	660	2042	572	2435	482	2640	412	2829	306	3389	267	1356
2L-3S		MI	739	660	1115	523	1233	439	1277	376	1269	272	1382	178	716
6-#6	1.00	MA	1403	660	1903	575	2258	485	2425	414	2540	310	2988	235	1362
3L-2S		MI	772	660	1175	522	1309	439	1369	375	1386	271	1514	210	710
6-#7	1.36	MA	1553	688	2198	587	2627	493	2869	418	3135	304	3807	264	1809
2L-3S		MI	752	688	1161	537	1286	449	1336	381	1343	266	1460	148	924
6-#7	1.36	MA	1444	688	2009	592	2387	497	2578	422	2743	309	3265	220	1811
3L-2S		MI	794	688	1241	536	1388	449	1458	379	1498	264	1634	192	915
6-#8	1.80	MA	1628	721	2380	606	2851	507	3137	427	3495	301	4287	259	2337
2L-3S		MI	766	721	1214	555	1348	461	1404	387	1427	258	1548	112	1158
6-#8	1.80	MA	1491	721	2133	613	2537	512	2758	431	2983	308	3584	201	2330
3L-2S		MI	819	721	1317	554	1479	462	1560	385	1625	256	1768	169	1148
6-#9	2.27	MA	1708	757	2578	627	3095	522	3430	436	3888	299	4804	253	2910
2L-3S		MI	781	757	1269	574	1413	474	1475	393	1515	249	1638	70	1403
6-#9	2.27	MA	1541	757	2268	635	2702	528	2953	441	3244	307	3927	180	2889
3L-2S		MI	845	757	1398	574	1577	476	1667	390	1759	246	1906	143	1394
6-#10	2.89	MA	1807	804	2828	655	3406	542	3803	448	4387	295	5454	244	3635
2L-3S		MI	799	804	1338	599	1495	491	1561	401	1623	237	1746	15	1699
6-#10	2.89	MA	1605	804	2438	664	2910	550	3202	454	3576	306	4358	152	3586
3L-2S		MI	877	804	1499	599	1699	494	1797	397	1923	233	2070	107	1696
6-#11	3.55	MA	1661	855	2617	692	3118	569	3444	465	3895	301	4721	111	4267
3L-2S		MI	897	855	1590	622	1773	501	1876	393	2018	207	2125	46	1971
6-#14	5.11	MA	1824	975	3025	767	3622	623	4048	499	4704	296	5719	29	5641
3L-2S		MI	964	975	1811	689	2006	538	2141	403	2352	163	2503	-43	2439
8-#6	1.33	MA	1550	685	2182	588	2612	493	2855	419	3119	305	3790	265	1777
2L-4S		MI	743	685	1131	539	1248	453	1295	382	1296	270	1415	154	914
8-#6	1.33	MA	1470	685	2042	591	2435	497	2640	422	2829	309	3389	233	1779
3E		MI	763	685	1175	539	1309	451	1369	383	1386	269	1514	165	907
8-#6	1.33	MA	1425	685	1946	595	2301	502	2476	427	2605	311	3108	215	1775
4L-2S		MI	795	685	1235	538	1385	451	1461	382	1503	268	1647	197	901
8-#7	1.82	MA	1533	723	2198	614	2627	513	2869	432	3135	308	3807	218	2371
3E		MI	783	723	1241	559	1388	465	1458	391	1498	261	1634	130	1173
8-#7	1.82	MA	1473	723	2067	619	2445	521	2646	439	2831	310	3426	192	2347
4L-2S		MI	825	723	1322	558	1490	465	1580	389	1653	260	1808	174	1166
8-#8	2.39	MA	1604	767	2380	641	2851	533	3137	444	3495	306	4287	198	3057
3E		MI	806	767	1317	583	1479	482	1560	399	1625	251	1768	87	1473
8-#8	2.39	MA	1530	767	2209	648	2613	543	2846	453	3097	309	3792	164	2948
4L-2S		MI	857	767	1421	582	1611	483	1716	397	1823	249	1989	145	1467
8-#9	3.03	MA	1682	815	2578	671	3095	555	3430	458	3888	304	4804	174	3798
3E		MI	830	815	1398	610	1577	500	1667	408	1759	240	1906	38	1787
8-#9	3.03	MA	1593	815	2362	679	2796	567	3064	469	3387	307	4185	133	3526
4L-2S		MI	892	815	1528	610	1741	502	1859	405	2002	237	2173	110	1786

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

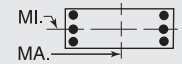
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	3.85	MA	1779	878	2828	710	3406	583	3803	476	4387	302	5454	143	4728
3E		MI	860	878	1499	645	1699	525	1797	419	1923	223	2070	-29	2066
8-#10	3.85	MA	1672	878	2556	720	3028	598	3341	489	3756	305	4680	91	4242
4L-2S		MI	933	878	1659	645	1902	528	2033	415	2222	220	2395	63	2180
8-#11	4.73	MA	1742	945	2757	759	3258	627	3608	506	4108	299	5094	36	4927
4L-2S		MI	961	945	1776	678	2000	540	2139	412	2352	186	2473	-17	2476
8-#14	6.82	MA	1954	1105	3222	863	3818	706	4278	556	5002	291	6233	-81	6107
4L-2S		MI	1052	1105	2068	771	2310	590	2493	427	2800	129	2981	-135	2894
10-#10	4.81	MA	1851	952	2946	766	3524	632	3942	510	4567	302	5775	83	5359
4L-3S		MI	920	952	1659	691	1902	558	2033	437	2222	210	2395	-73	2382
10-#10	4.81	MA	1728	952	2703	776	3191	640	3529	517	3995	312	5004	30	4905
5L-2S		MI	990	952	1820	692	2106	562	2269	433	2521	206	2720	19	2656
10-#11	5.91	MA	1811	1036	2932	826	3451	677	3832	539	4391	305	5473	-44	5422
5L-2S		MI	1025	1036	1963	735	2227	578	2402	431	2686	166	2821	-80	2824
12-#10	5.77	MA	1903	1025	3094	822	3687	674	4130	538	4806	308	6100	21	6024
5L-3S		MI	980	1025	1820	737	2106	592	2269	455	2521	197	2720	-118	2693
12-#10	5.77	MA	1770	1025	2821	837	3372	681	3726	551	4258	319	5392	-38	5280
6L-2S		MI	1046	1025	1981	738	2310	595	2504	451	2820	193	3044	-25	3039
14-#10	6.73	MA	1962	1099	3212	883	3868	715	4327	573	5070	315	6487	-46	6335
6L-3S		MI	1038	1099	1981	783	2310	626	2504	473	2820	183	3044	-162	2999

RECTANGULAR TIED COLUMNS 12" x 24"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.10	MA	1795	728	2472	631	2960	531	3222	453	3480	335	4192	292	1766
2E		MI	845	728	1305	568	1446	477	1503	404	1521	288	1648	216	834
4-#9	1.39	MA	1859	752	2623	644	3144	541	3441	459	3772	333	4595	289	2199
2E		MI	862	752	1361	580	1512	486	1574	407	1609	281	1738	198	1008
4-#10	1.76	MA	1937	784	2813	662	3378	553	3720	466	4145	330	5106	286	2747
2E		MI	884	784	1431	595	1594	497	1661	410	1717	271	1845	173	1222
4-#11	2.17	MA	2007	817	3017	678	3614	564	3996	472	4508	326	5539	274	3300
2E		MI	897	817	1498	606	1644	498	1712	405	1777	251	1875	130	1425
4-#14	3.13	MA	2185	897	3478	724	4183	598	4677	492	5421	320	6706	257	4630
2E		MI	941	897	1649	648	1800	519	1888	409	1996	220	2122	69	1896
4-#18	5.56	MA	2586	1100	4593	843	5567	684	6340	545	7652	305	9446	201	7857
2E		MI	1038	1100	1931	741	2116	567	2244	410	2444	127	2489	-150	2480
6-#7	1.25	MA	1834	741	2544	640	3059	538	3345	458	3649	335	4429	292	2003
2L-3S		MI	815	741	1252	580	1385	485	1436	413	1437	291	1561	170	938
6-#7	1.25	MA	1711	741	2334	646	2792	543	3021	462	3212	341	3823	249	2006
3L-2S		MI	858	741	1332	579	1486	486	1557	411	1592	290	1735	214	929
6-#8	1.65	MA	1921	774	2748	659	3310	552	3646	466	4052	333	4984	289	2592
2L-3S		MI	829	774	1305	597	1446	497	1503	419	1521	283	1648	134	1175
6-#8	1.65	MA	1765	774	2472	666	2960	558	3222	471	3480	341	4192	232	2586
3L-2S		MI	883	774	1409	596	1578	498	1659	416	1719	281	1869	191	1164
6-#9	2.08	MA	2013	810	2970	681	3584	567	3974	475	4492	330	5591	285	3234
2L-3S		MI	844	810	1361	616	1512	510	1574	425	1609	274	1738	92	1424
6-#9	2.08	MA	1823	810	2623	689	3144	574	3441	482	3772	340	4595	213	3213
3L-2S		MI	909	810	1490	616	1676	512	1766	422	1852	271	2006	165	1412
6-#10	2.65	MA	2126	857	3250	708	3932	587	4392	488	5052	327	6361	281	4047
2L-3S		MI	862	857	1431	641	1594	527	1661	432	1717	261	1845	37	1725
6-#10	2.65	MA	1896	857	2813	718	3378	596	3720	495	4145	338	5106	189	3997
3L-2S		MI	941	857	1591	641	1797	530	1896	428	2016	258	2170	129	1718
6-#11	3.25	MA	1962	908	3017	746	3614	616	3996	506	4508	334	5539	152	4773
3L-2S		MI	961	908	1684	663	1872	536	1975	423	2111	231	2223	67	1997
6-#14	4.69	MA	2136	1028	3478	822	4183	670	4677	540	5421	330	6706	76	6480
3L-2S		MI	1028	1028	1906	730	2105	572	2240	433	2444	187	2600	-22	2533

RECTANGULAR TIED COLUMNS 12" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#6	1.22	MA	1831	739	2525	641	3042	539	3329	458	3630	337	4405	293	1967
2L-4S		MI	806	739	1222	582	1347	490	1394	414	1390	296	1517	176	928
8-#6	1.22	MA	1741	739	2370	645	2845	542	3090	461	3307	341	3958	262	1969
3E		MI	827	739	1265	582	1407	487	1468	415	1480	294	1616	188	920
8-#6	1.22	MA	1689	739	2263	648	2696	548	2908	467	3058	343	3649	244	1965
4L-2S		MI	859	739	1325	581	1483	488	1560	414	1597	293	1748	220	914
8-#7	1.67	MA	1812	776	2544	667	3059	559	3345	472	3649	340	4429	247	2630
3E		MI	847	776	1332	602	1486	501	1557	422	1592	287	1735	153	1189
8-#7	1.67	MA	1745	776	2399	673	2857	567	3098	479	3311	343	4009	222	2607
4L-2S		MI	889	776	1413	601	1588	502	1679	421	1747	285	1909	196	1181
8-#8	2.19	MA	1894	820	2748	695	3310	579	3646	484	4052	338	4984	229	3399
3E		MI	870	820	1409	626	1578	518	1659	431	1719	277	1869	110	1493
8-#8	2.19	MA	1811	820	2557	702	3046	589	3322	494	3609	342	4432	196	3327
4L-2S		MI	922	820	1513	625	1710	519	1815	429	1917	274	2089	167	1485
8-#9	2.78	MA	1983	868	2970	725	3584	601	3974	498	4492	337	5591	210	4230
3E		MI	894	868	1490	652	1676	536	1766	439	1852	265	2006	59	1811
8-#9	2.78	MA	1882	868	2730	734	3252	614	3567	510	3935	341	4894	167	3981
4L-2S		MI	956	868	1619	652	1839	538	1958	437	2096	262	2274	132	1806
8-#10	3.53	MA	2094	931	3250	764	3932	630	4392	516	5052	335	6361	184	5277
3E		MI	923	931	1591	687	1797	560	1896	450	2016	248	2170	-7	2169
8-#10	3.53	MA	1974	931	2947	775	3512	646	3878	531	4349	339	5479	130	4791
4L-2S		MI	998	931	1752	687	2001	564	2132	446	2315	245	2495	85	2203
8-#11	4.33	MA	2055	998	3176	815	3774	675	4183	549	4750	334	5974	78	5573
4L-2S		MI	1025	998	1870	719	2099	575	2238	442	2445	211	2571	5	2556
8-#14	6.25	MA	2278	1158	3702	919	4408	756	4940	601	5761	328	7310	-31	7249
4L-2S		MI	1115	1158	2163	811	2410	625	2592	457	2892	153	3078	-114	2994
10-#10	4.41	MA	2177	1005	3384	821	4067	679	4550	552	5256	336	6734	125	6044
4L-3S		MI	983	1005	1752	733	2001	594	2132	468	2315	235	2495	-52	2487
10-#10	4.41	MA	2033	1005	3114	831	3697	688	4092	560	4620	348	5851	71	5585
5L-2S		MI	1054	1005	1912	733	2205	598	2368	464	2614	231	2819	41	2682
10-#11	5.42	MA	2129	1089	3375	883	3994	727	4437	583	5072	342	6412	2	6403
5L-2S		MI	1089	1089	2056	776	2327	614	2501	461	2779	190	2919	-58	2924
10-#14	7.81	MA	2400	1289	3982	1017	4717	829	5298	649	6215	339	7921	-144	7705
5L-2S		MI	1203	1289	2420	893	2714	678	2944	481	3339	119	3556	-205	3437
12-#10	5.29	MA	2231	1078	3551	877	4252	722	4763	581	5527	344	7106	66	6844
5L-3S		MI	1043	1078	1912	779	2205	628	2368	486	2614	222	2819	-96	2800
12-#10	5.29	MA	2081	1078	3241	892	3902	731	4314	595	4906	349	6243	-5	6232
6L-2S		MI	1110	1078	2073	779	2409	631	2603	482	2914	218	3144	-3	3144
12-#11	6.50	MA	2188	1179	3533	958	4238	778	4702	626	5427	351	6936	-81	6728
6L-2S		MI	1153	1179	2243	832	2554	652	2764	480	3113	170	3267	-121	3266
14-#10	6.17	MA	2283	1152	3678	938	4457	764	4986	617	5812	345	7497	-10	7463
6L-3S		MI	1102	1152	2073	825	2409	661	2603	504	2914	208	3144	-140	3109

RECTANGULAR TIED COLUMNS 14" x 14"

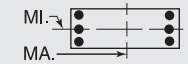
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#6	1.35	MA	703	510	1063	411	1216	345	1297	292	1375	211	1543	163	801
2L-3S		MI	661	510	988	413	1120	346	1181	295	1219	212	1359	131	807
6-#7	1.84	MA	733	538	1147	427	1317	356	1418	299	1529	207	1721	150	1048
2L-3S		MI	678	538	1045	429	1188	357	1261	302	1322	208	1475	107	1054
6-#8	2.42	MA	767	571	1242	446	1435	370	1558	307	1707	202	1922	134	1333
2L-3S		MI	700	571	1110	448	1267	371	1355	311	1440	204	1609	77	1333
6-#9	3.06	MA	802	607	1346	466	1562	385	1710	316	1896	196	2133	115	1637
2L-3S		MI	722	607	1180	469	1352	385	1456	320	1565	198	1748	42	1626

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 14"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

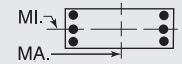
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	3.89	MA	845	654	1475	494	1721	404	1901	328	2131	187	2391	89	2015
2L-3S		MI	750	654	1268	497	1458	405	1583	333	1721	191	1919	-3	1917
6-#11	4.78	MA	877	705	1596	519	1862	422	2053	335	2300	169	2540	43	2363
2L-3S		MI	770	705	1353	521	1554	420	1684	339	1832	173	2014	-70	1990
8-#6	1.80	MA	733	535	1139	427	1312	357	1414	300	1530	209	1728	154	1033
2L-4S		MI	668	535	1009	431	1141	361	1205	302	1251	209	1409	108	1038
8-#7	2.45	MA	773	572	1248	449	1447	372	1575	309	1737	204	1966	138	1356
2L-4S		MI	691	572	1073	453	1216	377	1294	312	1364	204	1541	75	1305
8-#8	3.22	MA	817	616	1375	474	1603	390	1762	320	1975	198	2236	117	1729
2L-4S		MI	716	616	1147	479	1303	397	1397	324	1495	198	1692	35	1587
8-#9	4.08	MA	863	665	1511	503	1771	411	1964	333	2228	190	2518	91	2128
2L-4S		MI	743	665	1226	508	1396	418	1508	336	1641	196	1849	-11	1848

RECTANGULAR TIED COLUMNS 14" x 16"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.07	MA	901	565	1317	467	1517	393	1618	335	1706	247	1944	202	865
2E		MI	779	565	1165	457	1321	384	1396	327	1451	240	1616	190	749
4-#8	1.41	MA	932	587	1397	479	1614	401	1733	340	1860	245	2122	194	1101
2E		MI	803	587	1231	468	1400	392	1490	332	1569	236	1749	178	947
4-#9	1.79	MA	964	611	1484	492	1719	411	1857	345	2026	243	2311	184	1355
2E		MI	827	611	1302	481	1485	402	1591	337	1694	231	1888	165	1157
4-#10	2.27	MA	1003	642	1592	509	1851	423	2015	353	2233	239	2545	170	1672
2E		MI	857	642	1390	498	1592	414	1718	345	1849	225	2058	147	1419
4-#11	2.79	MA	1032	676	1702	524	1975	433	2158	358	2393	229	2703	145	1979
2E		MI	878	676	1477	512	1688	423	1819	347	1959	211	2152	115	1668
4-#14	4.02	MA	1116	756	1955	570	2286	466	2530	378	2849	214	3205	100	2720
2E		MI	942	756	1678	557	1934	456	2087	360	2296	190	2496	57	2266
4-#18	7.14	MA	1307	959	2548	688	3018	552	3371	423	3878	168	4284	-35	4255
2E		MI	1085	959	2142	674	2456	528	2669	385	3029	126	3190	-117	3178
6-#6	1.18	MA	914	572	1339	473	1550	398	1660	338	1766	248	2027	203	944
2L-3S		MI	747	572	1107	465	1252	390	1316	334	1349	242	1500	158	821
6-#6	1.18	MA	862	572	1247	476	1433	400	1519	339	1575	250	1789	171	949
3L-2S		MI	790	572	1183	463	1348	389	1432	331	1504	241	1685	190	815
6-#7	1.61	MA	953	599	1440	489	1674	409	1808	345	1963	246	2262	193	1243
2L-3S		MI	765	599	1165	481	1321	401	1396	341	1451	239	1616	133	1072
6-#7	1.61	MA	885	599	1317	492	1517	411	1618	346	1706	248	1944	150	1248
3L-2S		MI	821	599	1267	478	1450	400	1553	337	1659	237	1861	177	1065
6-#8	2.12	MA	998	632	1558	507	1818	422	1980	353	2194	243	2531	181	1589
2L-3S		MI	787	632	1231	499	1400	414	1490	349	1569	234	1749	103	1356
6-#8	2.12	MA	912	632	1397	511	1614	425	1733	354	1860	246	2122	124	1589
3L-2S		MI	855	632	1363	497	1568	413	1694	345	1837	232	2063	161	1352
6-#9	2.68	MA	1044	669	1685	528	1974	437	2167	362	2445	240	2817	167	1961
2L-3S		MI	809	669	1302	520	1485	429	1591	358	1694	229	1888	69	1655
6-#9	2.68	MA	941	669	1484	533	1719	440	1857	363	2026	243	2311	94	1950
3L-2S		MI	890	669	1467	518	1695	428	1845	354	2025	226	2273	142	1658
6-#10	3.40	MA	1100	716	1845	555	2171	457	2403	374	2756	236	3170	147	2427
2L-3S		MI	836	716	1390	547	1592	448	1718	371	1849	221	2058	23	2013
6-#10	3.40	MA	980	716	1592	561	1851	460	2015	375	2233	239	2545	54	2394
3L-2S		MI	934	716	1597	544	1854	447	2036	366	2259	217	2531	115	2040
6-#11	4.18	MA	1144	766	2001	581	2355	475	2619	384	2999	222	3414	111	2869
2L-3S		MI	855	766	1477	571	1688	463	1819	377	1959	203	2152	-44	2138
6-#11	4.18	MA	1008	766	1702	586	1975	477	2158	392	2393	226	2703	-3	2702
3L-2S		MI	965	766	1720	569	1996	465	2188	372	2428	198	2678	69	2394
6-#14	6.03	MA	1093	886	1955	657	2286	527	2530	424	2849	207	3205	-119	3129
3L-2S		MI	1061	886	2017	639	2364	515	2591	394	2935	169	3199	-17	3192
8-#6	1.57	MA	953	597	1430	489	1666	409	1801	346	1956	247	2266	197	1223
2L-4S		MI	754	597	1128	483	1273	405	1341	341	1381	240	1550	135	1057

RECTANGULAR TIED COLUMNS 14" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

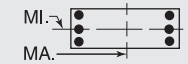
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#6	1.57	MA	903	597	1339	492	1550	411	1660	347	1766	249	2027	165	1227
3E		MI	779	597	1183	481	1348	402	1432	341	1504	241	1685	149	1053
8-#6	1.57	MA	873	597	1274	494	1460	415	1550	350	1616	249	1856	149	1228
4L-2S		MI	821	597	1259	479	1444	401	1549	338	1660	240	1870	181	1048
8-#7	2.14	MA	1004	634	1564	510	1831	425	1998	355	2220	244	2580	184	1616
2L-4S		MI	775	634	1193	505	1349	421	1429	350	1494	235	1682	102	1356
8-#7	2.14	MA	939	634	1440	514	1674	427	1808	356	1963	247	2262	141	1617
3E		MI	809	634	1267	502	1450	417	1553	351	1659	236	1861	121	1378
8-#7	2.14	MA	900	634	1352	517	1552	432	1659	361	1760	246	2033	120	1589
4L-2S		MI	861	634	1369	500	1579	416	1710	347	1867	235	2106	165	1375
8-#8	2.82	MA	1062	678	1719	536	2022	443	2228	366	2529	241	2940	169	2071
2L-4S		MI	801	678	1267	531	1436	441	1532	362	1624	228	1832	62	1644
8-#8	2.82	MA	981	678	1558	540	1818	446	1980	368	2194	244	2531	111	2062
3E		MI	841	678	1363	528	1568	435	1694	362	1837	231	2063	86	1747
8-#8	2.82	MA	932	678	1443	544	1660	453	1787	373	1930	242	2236	84	1938
4L-2S		MI	905	678	1496	526	1736	434	1897	359	2104	228	2376	143	1750
8-#9	3.57	MA	1122	727	1887	565	2230	464	2477	379	2863	237	3322	150	2560
2L-4S		MI	828	727	1347	559	1530	462	1643	374	1770	226	1989	16	1943
8-#9	3.57	MA	1028	727	1685	569	1974	467	2167	380	2445	240	2817	77	2537
3E		MI	875	727	1467	557	1695	455	1845	375	2025	223	2273	45	2137
8-#9	3.57	MA	972	727	1541	574	1776	475	1924	387	2113	238	2451	43	2303
4L-2S		MI	952	727	1632	554	1904	455	2099	371	2356	220	2658	118	2152
8-#10	4.54	MA	1085	790	1845	607	2171	494	2403	396	2756	235	3170	31	3093
3E		MI	919	790	1597	593	1854	481	2036	392	2259	213	2531	-9	2526
8-#10	4.54	MA	1017	790	1663	612	1922	504	2098	404	2341	232	2716	-11	2712
4L-2S		MI	1009	790	1803	590	2116	481	2354	387	2669	210	3003	83	2652
8-#11	5.57	MA	1129	857	2001	643	2355	518	2619	418	2999	219	3414	-37	3381
3E		MI	950	857	1720	627	1996	504	2188	402	2428	190	2678	-90	2639
10-#10	5.67	MA	1126	863	1916	658	2242	537	2487	425	2864	228	3341	-34	3314
4L-3S		MI	999	863	1803	639	2116	515	2354	413	2669	205	3003	-41	2975

RECTANGULAR TIED COLUMNS 14" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.25	MA	1173	649	1709	541	1994	454	2148	386	2304	282	2683	233	1272
2E		MI	890	649	1352	520	1533	436	1625	370	1698	266	1889	205	962
4-#9	1.59	MA	1213	673	1812	554	2119	464	2296	391	2502	279	2923	225	1571
2E		MI	915	673	1423	532	1618	445	1726	375	1823	261	2028	192	1175
4-#10	2.02	MA	1262	704	1941	571	2277	476	2484	399	2753	277	3222	215	1947
2E		MI	945	704	1512	549	1725	457	1853	382	1978	255	2197	173	1440
4-#11	2.48	MA	1302	738	2076	586	2430	486	2661	404	2984	271	3446	194	2316
2E		MI	965	738	1601	562	1822	466	1954	384	2087	241	2289	141	1693
4-#14	3.57	MA	1408	818	2381	632	2805	519	3110	424	3574	263	4109	159	3206
2E		MI	1029	818	1804	607	2069	498	2222	397	2423	219	2633	83	2297
4-#18	6.35	MA	1648	1021	3106	750	3701	604	4184	476	4906	230	5589	51	5310
2E		MI	1172	1021	2269	722	2591	569	2803	421	3155	154	3324	-92	3321
6-#6	1.05	MA	1151	633	1639	535	1917	451	2060	384	2191	285	2558	241	1086
2L-3S		MI	834	633	1227	517	1385	435	1451	372	1478	273	1641	185	834
6-#6	1.05	MA	1089	633	1531	538	1780	453	1895	386	1967	288	2265	209	1092
3L-2S		MI	877	633	1302	515	1481	434	1568	370	1634	272	1826	217	828
6-#7	1.43	MA	1199	661	1759	551	2064	462	2235	391	2424	282	2851	233	1437
2L-3S		MI	852	661	1285	532	1453	445	1532	379	1580	269	1757	160	1089
6-#7	1.43	MA	1118	661	1613	554	1879	465	2011	393	2122	286	2459	190	1443
3L-2S		MI	908	661	1387	530	1583	444	1688	376	1788	268	2002	204	1080
6-#8	1.88	MA	1254	694	1898	569	2235	475	2440	399	2698	280	3190	224	1844
2L-3S		MI	872	694	1352	551	1533	458	1625	387	1698	265	1889	130	1377
6-#8	1.88	MA	1151	694	1709	574	1994	479	2148	402	2304	284	2683	167	1845
3L-2S		MI	942	694	1484	548	1701	457	1829	384	1966	262	2203	188	1370
6-#9	2.38	MA	1312	731	2050	590	2421	490	2662	408	2996	277	3551	213	2285
2L-3S		MI	895	731	1423	571	1618	473	1726	396	1823	259	2028	95	1681

RECTANGULAR TIED COLUMNS 14" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

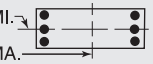
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#9	2.38	MA	1187	731	1812	596	2119	495	2296	411	2502	282	2923	141	2274
3L-2S		MI	978	731	1588	569	1828	472	1981	392	2154	256	2413	168	1679
6-#10	3.02	MA	1383	778	2240	617	2656	510	2944	420	3373	273	4002	198	2838
2L-3S		MI	922	778	1512	598	1725	491	1853	408	1978	251	2197	49	2052
6-#10	3.02	MA	1232	778	1941	624	2277	515	2484	423	2753	279	3222	106	2805
3L-2S		MI	1022	778	1719	595	1987	491	2171	404	2388	247	2670	142	2064
6-#11	3.71	MA	1440	828	2431	643	2881	528	3208	430	3723	267	4345	169	3374
2L-3S		MI	941	828	1601	621	1822	505	1954	414	2087	232	2289	-18	2284
6-#11	3.71	MA	1274	828	2076	650	2430	532	2661	432	2984	272	3446	55	3311
3L-2S		MI	1053	828	1844	619	2130	507	2323	409	2556	228	2815	95	2423
6-#14	5.36	MA	1380	948	2381	723	2805	584	3110	463	3574	262	4109	-47	4062
3L-2S		MI	1149	948	2142	688	2498	557	2725	430	3063	198	3335	9	3300
8-#6	1.40	MA	1198	659	1746	551	2054	462	2226	392	2414	284	2851	237	1413
2L-4S		MI	841	659	1248	535	1406	450	1476	380	1510	270	1691	162	1075
8-#6	1.40	MA	1138	659	1639	554	1917	465	2060	394	2191	286	2558	205	1417
3E		MI	866	659	1302	533	1481	446	1568	380	1634	272	1826	176	1069
8-#6	1.40	MA	1103	659	1563	557	1813	469	1932	398	2016	287	2350	187	1418
4L-2S		MI	908	659	1378	531	1577	445	1684	377	1790	270	2011	208	1063
8-#7	1.90	MA	1262	696	1904	572	2248	478	2459	401	2726	281	3243	227	1875
2L-4S		MI	861	696	1313	556	1481	465	1565	389	1623	265	1823	129	1398
8-#7	1.90	MA	1183	696	1759	576	2064	481	2235	403	2424	284	2851	184	1876
3E		MI	895	696	1387	554	1583	461	1688	389	1788	267	2002	148	1398
8-#7	1.90	MA	1137	696	1656	580	1922	487	2062	409	2188	285	2572	161	1863
4L-2S		MI	948	696	1489	552	1712	460	1845	386	1996	265	2247	191	1392
8-#8	2.51	MA	1333	740	2088	598	2476	496	2732	412	3092	277	3696	215	2412
2L-4S		MI	887	740	1388	582	1569	484	1668	400	1753	259	1973	89	1697
8-#8	2.51	MA	1235	740	1898	603	2235	500	2440	415	2698	282	3190	158	2404
3E		MI	928	740	1484	580	1701	479	1829	401	1966	261	2203	113	1772
8-#8	2.51	MA	1177	740	1765	608	2050	508	2213	422	2389	282	2828	128	2301
4L-2S		MI	993	740	1616	577	1869	478	2033	397	2233	259	2516	170	1770
8-#9	3.17	MA	1408	789	2287	626	2723	517	3028	425	3489	274	4179	201	2992
2L-4S		MI	913	789	1468	611	1663	505	1779	412	1899	256	2129	42	2003
8-#9	3.17	MA	1290	789	2050	632	2421	521	2662	428	2996	279	3551	128	2969
3E		MI	962	789	1588	608	1828	499	1981	413	2154	253	2413	72	2166
8-#9	3.17	MA	1221	789	1881	638	2189	531	2378	436	2607	279	3102	91	2739
4L-2S		MI	1040	789	1754	605	2038	498	2235	409	2485	251	2798	144	2175
8-#10	4.03	MA	1364	851	2240	670	2656	548	2944	445	3373	276	4002	89	3674
3E		MI	1005	851	1719	644	1987	525	2171	430	2388	243	2670	17	2631
8-#10	4.03	MA	1277	851	2028	678	2363	561	2586	455	2884	275	3442	43	3279
4L-2S		MI	1098	851	1925	641	2250	524	2489	425	2798	240	3142	110	2679
8-#11	4.95	MA	1422	919	2431	707	2881	574	3208	458	3723	268	4345	30	4264
3E		MI	1035	919	1844	677	2130	547	2323	439	2556	220	2815	-64	2789
8-#11	4.95	MA	1329	919	2177	714	2531	587	2779	469	3138	265	3695	-24	3680
4L-2S		MI	1140	919	2086	675	2438	549	2692	434	3024	215	3341	49	3141
10-#10	5.04	MA	1416	925	2327	724	2742	594	3045	476	3505	271	4222	26	4120
4L-3S		MI	1085	925	1925	690	2250	558	2489	451	2798	235	3142	-15	3133
10-#10	5.04	MA	1332	925	2136	731	2483	599	2724	479	3060	277	3673	-30	3653
5L-2S		MI	1172	925	2132	687	2512	558	2807	446	3208	232	3615	78	3289
10-#11	6.19	MA	1485	1009	2533	771	2982	628	3327	495	3877	261	4594	-49	4540
4L-3S		MI	1128	1009	2086	734	2438	588	2692	464	3024	207	3341	-110	3286
12-#10	6.05	MA	1462	999	2435	777	2862	633	3184	500	3680	274	4453	-47	4406
5L-3S		MI	1164	999	2132	736	2512	592	2807	472	3208	228	3615	-47	3579

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

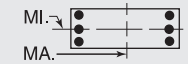
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.13	MA	1441	710	2045	603	2408	507	2601	432	2787	318	3292	271	1442
2E		MI	977	710	1472	571	1666	480	1761	409	1827	297	2029	232	977
4-#9	1.43	MA	1488	735	2165	616	2553	516	2773	437	3017	316	3582	265	1787
2E		MI	1002	735	1544	583	1751	489	1862	413	1952	292	2167	218	1192
4-#10	1.81	MA	1547	766	2315	633	2736	529	2991	445	3308	313	3947	257	2221
2E		MI	1032	766	1634	600	1859	500	1989	420	2107	285	2336	200	1459
4-#11	2.23	MA	1597	800	2474	648	2918	539	3201	450	3583	308	4238	240	2653
2E		MI	1053	800	1725	612	1956	508	2089	421	2215	270	2427	167	1717
4-#14	3.21	MA	1728	880	2832	694	3358	572	3727	470	4287	302	5067	212	3692
2E		MI	1117	880	1929	656	2203	540	2357	434	2550	249	2769	108	2326
4-#18	5.71	MA	2020	1083	3689	812	4418	657	4998	522	5982	285	6959	125	6174
2E		MI	1259	1083	2396	770	2726	610	2938	457	3281	183	3458	-67	3460
6-#7	1.29	MA	1471	723	2102	612	2487	514	2700	437	2924	319	3488	272	1632
2L-3S		MI	938	723	1405	584	1586	489	1667	417	1710	300	1898	187	1104
6-#7	1.29	MA	1375	723	1935	617	2275	518	2443	440	2577	324	3021	228	1637
3L-2S		MI	995	723	1507	582	1715	488	1824	414	1918	298	2143	231	1095
6-#8	1.69	MA	1537	756	2264	631	2685	528	2936	445	3240	316	3896	265	2100
2L-3S		MI	958	756	1472	602	1666	502	1761	426	1827	295	2029	157	1396
6-#8	1.69	MA	1415	756	2045	637	2408	533	2601	449	2787	322	3292	208	2101
3L-2S		MI	1030	756	1605	600	1834	501	1964	422	2095	293	2343	214	1387
6-#9	2.14	MA	1606	793	2439	652	2901	543	3194	454	3585	313	4334	257	2609
2L-3S		MI	981	793	1544	623	1751	516	1862	434	1952	289	2167	122	1705
6-#9	2.14	MA	1459	793	2165	659	2553	548	2773	458	3017	320	3582	184	2598
3L-2S		MI	1066	793	1710	620	1961	515	2116	430	2283	286	2552	195	1699
6-#10	2.72	MA	1692	840	2660	679	3174	562	3521	466	4024	310	4884	245	3250
2L-3S		MI	1008	840	1634	649	1859	534	1989	446	2107	281	2336	76	2082
6-#10	2.72	MA	1513	840	2315	688	2736	569	2991	471	3308	318	3947	153	3217
3L-2S		MI	1110	840	1841	646	2121	534	2306	441	2517	277	2809	168	2086
6-#11	3.34	MA	1764	890	2886	705	3441	580	3835	476	4439	304	5329	221	3880
2L-3S		MI	1026	890	1725	671	1956	548	2089	451	2215	262	2427	8	2412
6-#11	3.34	MA	1559	890	2474	714	2918	587	3201	481	3583	312	4238	107	3818
3L-2S		MI	1141	890	1968	669	2264	550	2458	446	2683	258	2953	121	2450
6-#14	4.82	MA	1695	1010	2832	787	3358	640	3727	512	4287	305	5067	16	5026
3L-2S		MI	1237	1010	2267	738	2633	599	2860	467	3190	227	3472	34	3334
8-#6	1.26	MA	1470	721	2087	613	2475	515	2688	438	2911	320	3484	275	1603
2L-4S		MI	927	721	1367	587	1538	494	1611	418	1640	301	1832	189	1090
8-#6	1.26	MA	1399	721	1963	616	2318	518	2498	440	2654	324	3136	243	1607
3E		MI	953	721	1422	585	1613	491	1703	418	1764	302	1967	203	1083
8-#6	1.26	MA	1358	721	1877	620	2199	523	2352	445	2455	325	2890	224	1608
4L-2S		MI	995	721	1497	583	1709	490	1820	416	1919	301	2152	235	1077
8-#7	1.71	MA	1545	758	2269	634	2699	530	2957	447	3271	317	3954	268	2134
2L-4S		MI	947	758	1433	608	1614	510	1700	427	1753	296	1964	156	1420
8-#7	1.71	MA	1452	758	2102	639	2487	534	2700	450	2924	322	3488	224	2135
3E		MI	981	758	1507	606	1715	505	1824	427	1918	298	2143	175	1416
8-#7	1.71	MA	1399	758	1985	643	2326	541	2502	456	2653	323	3158	200	2122
4L-2S		MI	1036	758	1609	604	1845	504	1981	424	2125	296	2388	218	1409
8-#8	2.26	MA	1630	802	2482	660	2962	549	3272	458	3694	314	4501	259	2753
2L-4S		MI	973	802	1509	633	1702	528	1803	438	1882	289	2113	115	1749
8-#8	2.26	MA	1514	802	2264	665	2685	553	2936	462	3240	320	3896	202	2745
3E		MI	1014	802	1605	631	1834	523	1964	439	2095	291	2343	139	1794
8-#8	2.26	MA	1448	802	2111	671	2474	562	2678	470	2887	321	3468	170	2674
4L-2S		MI	1081	802	1737	628	2002	522	2168	435	2363	289	2657	197	1790
8-#9	2.86	MA	1720	851	2713	688	3249	569	3616	471	4154	311	5087	248	3424
2L-4S		MI	999	851	1590	662	1796	549	1914	450	2028	286	2269	69	2060

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

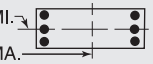
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.86	MA	1581	851	2439	695	2901	575	3194	475	3585	318	4334	175	3401
3E		MI	1049	851	1710	659	1961	543	2116	451	2283	284	2552	98	2194
8-#9	2.86	MA	1500	851	2247	702	2635	586	2869	485	3141	319	3801	136	3188
4L-2S		MI	1128	851	1875	656	2171	542	2370	447	2614	281	2937	171	2197
8-#10	3.63	MA	1664	913	2660	734	3174	603	3521	492	4024	315	4884	140	4223
3E		MI	1091	913	1841	695	2121	568	2306	467	2517	273	2809	44	2686
8-#10	3.63	MA	1567	913	2417	742	2839	617	3111	504	3463	316	4218	91	3821
4L-2S		MI	1186	913	2047	692	2383	568	2624	463	2927	270	3281	136	2704
8-#11	4.46	MA	1742	981	2886	771	3441	629	3835	507	4439	308	5329	88	5017
3E		MI	1121	981	1968	727	2264	589	2458	476	2683	249	2953	-38	2938
8-#11	4.46	MA	1624	981	2595	780	3038	644	3342	520	3766	308	4549	31	4420
4L-2S		MI	1228	981	2210	725	2572	591	2827	472	3152	245	3478	75	3172
8-#14	6.43	MA	1800	1141	3001	881	3526	721	3924	567	4543	297	5492	-96	5390
4L-2S		MI	1355	1141	2606	819	3062	659	3364	500	3829	205	4174	-39	4157
10-#10	4.54	MA	1723	987	2762	788	3276	650	3641	526	4179	312	5155	79	4796
4L-3S		MI	1172	987	2047	741	2383	602	2624	489	2927	265	3281	12	3253
10-#10	4.54	MA	1621	987	2545	797	2980	657	3274	530	3671	321	4495	25	4419
5L-2S		MI	1261	987	2254	738	2645	601	2942	484	3337	262	3754	104	3315
10-#11	5.57	MA	1818	1071	3007	836	3562	685	3976	546	4622	303	5639	12	5588
4L-3S		MI	1214	1071	2210	784	2572	631	2827	501	3152	237	3478	-84	3439
12-#10	5.44	MA	1773	1061	2890	843	3418	691	3805	552	4387	317	5432	13	5391
5L-3S		MI	1251	1061	2254	787	2645	635	2942	510	3337	258	3754	-20	3739

RECTANGULAR TIED COLUMNS 14" x 22"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.03	MA	1734	772	2406	664	2856	560	3091	478	3309	355	3946	308	1613
2E		MI	1064	772	1593	622	1799	524	1896	447	1956	327	2170	258	991
4-#9	1.30	MA	1789	797	2542	678	3021	569	3286	484	3570	353	4289	303	2003
2E		MI	1089	797	1666	635	1884	532	1997	451	2081	322	2307	245	1209
4-#10	1.65	MA	1858	828	2714	695	3229	582	3535	491	3902	350	4719	297	2495
2E		MI	1119	828	1756	651	1992	544	2124	458	2235	315	2476	226	1478
4-#11	2.03	MA	1918	862	2897	710	3439	592	3778	496	4220	345	5080	283	2990
2E		MI	1140	862	1849	662	2090	551	2225	459	2343	300	2564	193	1740
4-#14	2.92	MA	2075	942	3308	756	3944	625	4382	516	5028	338	6076	260	4178
2E		MI	1205	942	2054	705	2337	582	2492	470	2678	278	2905	134	2355
4-#18	5.19	MA	2423	1145	4297	874	5168	710	5849	568	6995	323	8387	190	7038
2E		MI	1346	1145	2524	818	2861	651	3072	492	3407	211	3592	-42	3596
6-#7	1.17	MA	1769	785	2470	674	2944	567	3202	483	3462	356	4171	309	1826
2L-3S		MI	1025	785	1525	636	1719	533	1802	456	1839	331	2038	214	1119
6-#7	1.17	MA	1658	785	2281	679	2705	571	2911	487	3070	361	3629	265	1831
3L-2S		MI	1082	785	1627	633	1848	532	1959	453	2047	329	2284	258	1110
6-#8	1.54	MA	1845	818	2653	693	3169	581	3470	491	3821	353	4650	304	2356
2L-3S		MI	1045	818	1593	654	1799	546	1896	464	1956	325	2170	183	1414
6-#8	1.54	MA	1705	818	2406	699	2856	586	3091	496	3309	360	3946	247	2357
3L-2S		MI	1117	818	1725	651	1967	545	2100	460	2224	323	2483	241	1404
6-#9	1.95	MA	1926	855	2853	714	3414	596	3764	500	4214	350	5166	298	2933
2L-3S		MI	1068	855	1666	674	1884	560	1997	472	2081	319	2307	148	1727
6-#9	1.95	MA	1756	855	2542	722	3021	602	3286	506	3570	358	4289	225	2922
3L-2S		MI	1153	855	1831	671	2094	559	2251	468	2412	317	2692	221	1718
6-#10	2.47	MA	2026	902	3104	741	3725	615	4136	512	4713	346	5815	289	3661
2L-3S		MI	1095	902	1756	700	1992	578	2124	484	2235	311	2476	102	2110
6-#10	2.47	MA	1819	902	2714	751	3229	623	3535	519	3902	357	4719	196	3628
3L-2S		MI	1198	902	1963	697	2254	577	2442	479	2645	307	2948	194	2108
6-#11	3.04	MA	2114	952	3366	767	4034	633	4499	522	5193	340	6364	269	4385
2L-3S		MI	1112	952	1849	721	2090	591	2225	488	2343	291	2564	34	2468
6-#11	3.04	MA	1875	952	2897	777	3439	642	3778	529	4220	351	5080	155	4323
3L-2S		MI	1229	952	2091	719	2398	592	2594	484	2811	287	3090	147	2476

RECTANGULAR TIED COLUMNS 14" x 22"

Short columns – no sidesway
Bending on major or minor axis

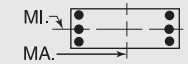


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	4.38	MA	2025	1072	3308	852	3944	695	4382	561	5028	346	6076	73	5872
3L-2S		MI	1325	1072	2393	787	2767	641	2995	504	3317	256	3608	60	3367
6-#18	7.79	MA	2408	1376	4297	1040	5168	831	5849	644	6995	330	8387	-157	8112
3L-2S		MI	1540	1376	3085	963	3549	750	3868	542	4418	160	4651	-201	4620
8-#6	1.14	MA	1766	783	2452	675	2929	568	3187	484	3446	357	4154	311	1793
2L-4S		MI	1014	783	1487	639	1671	538	1747	457	1770	332	1974	216	1104
8-#6	1.14	MA	1685	783	2313	679	2752	571	2973	487	3156	361	3753	279	1797
3E		MI	1039	783	1541	637	1746	535	1838	457	1893	333	2108	230	1097
8-#6	1.14	MA	1638	783	2216	682	2619	577	2809	492	2932	363	3473	260	1798
4L-2S		MI	1082	783	1617	635	1842	534	1955	454	2049	332	2293	262	1091
8-#7	1.56	MA	1854	820	2659	696	3184	583	3492	493	3854	354	4712	307	2393
2L-4S		MI	1034	820	1553	660	1747	554	1835	466	1882	326	2104	183	1439
8-#7	1.56	MA	1747	820	2470	701	2944	587	3202	497	3462	359	4171	263	2394
3E		MI	1068	820	1627	657	1848	549	1959	466	2047	328	2284	201	1432
8-#7	1.56	MA	1687	820	2339	706	2763	595	2979	503	3158	361	3790	237	2381
4L-2S		MI	1123	820	1729	655	1977	548	2116	463	2255	326	2529	245	1425
8-#8	2.05	MA	1953	864	2900	722	3483	602	3850	504	4334	351	5353	300	3095
2L-4S		MI	1057	864	1630	685	1835	572	1938	476	2011	320	2253	142	1798
8-#8	2.05	MA	1820	864	2653	728	3169	607	3470	509	3821	358	4650	243	3086
3E		MI	1101	864	1725	682	1967	567	2100	477	2224	322	2483	166	1815
8-#8	2.05	MA	1744	864	2482	734	2932	617	3179	518	3423	360	4155	210	3044
4L-2S		MI	1169	864	1858	680	2135	566	2303	473	2492	320	2797	223	1808
8-#9	2.60	MA	2059	913	3163	750	3808	622	4241	517	4858	347	6043	292	3856
2L-4S		MI	1084	913	1711	713	1929	593	2049	488	2157	317	2408	95	2115
8-#9	2.60	MA	1897	913	2853	758	3414	629	3764	522	4214	356	5166	219	3833
3E		MI	1135	913	1831	710	2094	586	2251	489	2412	314	2692	125	2219
8-#9	2.60	MA	1805	913	2637	766	3115	641	3397	533	3713	358	4547	178	3647
4L-2S		MI	1216	913	1996	707	2304	585	2505	485	2743	311	3077	198	2218
8-#10	3.30	MA	1994	975	3104	797	3725	657	4136	540	4713	353	5815	188	4772
3E		MI	1178	975	1963	746	2254	611	2442	505	2645	303	2948	70	2717
8-#10	3.30	MA	1884	975	2832	806	3348	672	3674	553	4081	356	5041	136	4375
4L-2S		MI	1274	975	2170	743	2516	611	2759	500	3055	300	3421	162	2728
8-#11	4.05	MA	2080	1042	3366	834	4034	683	4499	555	5193	347	6364	142	5691
3E		MI	1207	1042	2091	777	2398	632	2594	513	2811	279	3090	-12	3086
8-#11	4.05	MA	1952	1042	3037	845	3579	700	3942	570	4432	349	5453	80	5073
4L-2S		MI	1316	1042	2334	775	2706	634	2963	509	3280	274	3616	101	3201
8-#14	5.84	MA	2142	1202	3504	947	4141	778	4612	619	5326	341	6590	-37	6538
4L-2S		MI	1443	1202	2731	868	3197	701	3499	537	3956	235	4311	-14	4306
10-#10	4.12	MA	2064	1049	3222	852	3844	705	4275	574	4892	353	6137	128	5485
4L-3S		MI	1258	1049	2170	792	2516	645	2759	526	3055	295	3421	38	3319
10-#10	4.12	MA	1941	1049	2979	862	3511	713	3862	581	4321	363	5366	74	5108
5L-2S		MI	1350	1049	2376	789	2779	645	3077	522	3465	292	3893	130	3342
10-#11	5.06	MA	2164	1133	3506	901	4174	742	4663	596	5406	345	6736	67	6407
4L-3S		MI	1300	1133	2334	834	2706	673	2963	538	3280	266	3616	-59	3590
10-#11	5.06	MA	2023	1133	3212	912	3772	750	4165	602	4716	356	5832	0	5832
5L-2S		MI	1403	1133	2577	832	3014	675	3332	534	3748	262	4142	55	3919
12-#10	4.95	MA	2116	1122	3370	908	4007	747	4463	602	5132	359	6461	66	6219
5L-3S		MI	1338	1122	2376	838	2779	679	3077	548	3465	288	3893	6	3877
12-#10	4.95	MA	1980	1122	3097	923	3692	755	4059	615	4584	369	5753	6	5726
6L-2S		MI	1425	1122	2583	835	3041	678	3395	543	3876	284	4366	99	3952
12-#11	6.08	MA	2242	1223	3681	968	4367	791	4887	629	5689	351	7116	-14	7094
5L-3S		MI	1391	1223	2577	890	3014	715	3332	563	3748	254	4142	-105	4087
14-#10	5.77	MA	2158	1196	3488	969	4188	789	4660	637	5395	366	6849	-2	6846
6L-3S		MI	1416	1196	2583	884	3041	712	3395	569	3876	280	4366	-26	4345

RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis



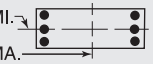
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.19	MA	2116	859	2945	740	3522	622	3837	530	4161	389	5028	339	2219
2E		MI	1176	859	1787	686	2018	576	2132	489	2210	352	2447	271	1224
4-#10	1.51	MA	2195	890	3137	757	3756	634	4116	537	4534	386	5539	335	2770
2E		MI	1207	890	1878	701	2125	587	2259	496	2364	345	2615	253	1496
4-#11	1.86	MA	2266	923	3345	772	3994	645	4392	542	4895	381	5969	323	3327
2E		MI	1228	923	1973	712	2224	594	2360	496	2471	329	2702	219	1762
4-#14	2.68	MA	2446	1003	3809	818	4564	677	5074	562	5808	375	7134	306	4664
2E		MI	1292	1003	2179	755	2472	624	2627	507	2805	307	3042	160	2382
4-#18	4.76	MA	2854	1206	4930	936	5951	763	6737	614	8038	360	9871	249	7902
2E		MI	1434	1206	2651	867	2996	691	3207	528	3533	240	3726	-17	3728
6-#7	1.07	MA	2091	847	2863	736	3435	620	3741	529	4039	392	4864	342	2020
2L-3S		MI	1111	847	1645	687	1852	577	1938	494	1969	361	2179	241	1132
6-#7	1.07	MA	1966	847	2652	741	3168	625	3417	533	3601	398	4259	299	2026
3L-2S		MI	1169	847	1747	685	1981	576	2095	491	2176	359	2424	284	1124
6-#8	1.41	MA	2179	880	3068	755	3687	633	4042	537	4441	389	5418	338	2612
2L-3S		MI	1132	880	1714	705	1932	590	2031	502	2086	356	2310	210	1431
6-#8	1.41	MA	2020	880	2792	762	3337	639	3618	542	3869	397	4626	282	2613
3L-2S		MI	1204	880	1846	702	2100	589	2235	498	2353	354	2623	268	1420
6-#9	1.79	MA	2272	917	3291	776	3961	648	4370	546	4881	387	6024	335	3257
2L-3S		MI	1154	916	1787	725	2018	603	2132	510	2210	350	2447	175	1748
6-#9	1.79	MA	2078	916	2945	784	3522	656	3837	552	4161	396	5028	263	3246
3L-2S		MI	1241	917	1953	722	2227	602	2387	506	2541	347	2832	248	1736
6-#10	2.27	MA	2387	963	3574	803	4310	668	4788	558	5441	383	6793	330	4073
2L-3S		MI	1181	963	1878	751	2125	621	2259	522	2364	341	2615	128	2136
6-#10	2.27	MA	2151	963	3137	813	3756	677	4116	566	4534	395	5539	238	4039
3L-2S		MI	1285	963	2085	747	2388	621	2577	517	2774	337	3087	221	2129
6-#11	2.79	MA	2489	1014	3871	828	4661	686	5201	568	5986	377	7447	314	4891
2L-3S		MI	1198	1014	1973	771	2224	633	2360	525	2471	321	2702	59	2502
6-#11	2.79	MA	2216	1014	3345	840	3994	696	4392	576	4895	390	5969	200	4829
3L-2S		MI	1317	1014	2215	769	2532	635	2729	521	2939	317	3228	173	2502
6-#14	4.02	MA	2390	1134	3809	915	4564	750	5074	610	5808	385	7134	125	6697
3L-2S		MI	1412	1134	2518	836	2901	683	3130	540	3444	285	3744	86	3399
6-#18	7.14	MA	2833	1438	4930	1106	5951	888	6737	695	8038	373	9871	-85	9682
3L-2S		MI	1627	1438	3212	1011	3684	791	4003	578	4544	189	4785	-176	4767
8-#6	1.05	MA	2088	845	2843	737	3418	621	3724	530	4020	393	4841	343	1983
2L-4S		MI	1100	845	1606	690	1803	582	1882	496	1899	363	2115	243	1118
8-#6	1.05	MA	1996	845	2687	741	3220	624	3485	533	3697	398	4394	312	1987
3E		MI	1126	845	1661	689	1878	579	1974	495	2023	364	2250	257	1110
8-#6	1.05	MA	1944	845	2580	745	3072	630	3303	538	3448	400	4085	294	1988
4L-2S		MI	1169	845	1736	687	1974	578	2090	493	2179	363	2435	289	1104
8-#7	1.43	MA	2188	882	3074	758	3702	636	4065	539	4476	390	5470	339	2652
2L-4S		MI	1120	882	1673	711	1880	598	1971	504	2011	357	2245	209	1457
8-#7	1.43	MA	2068	882	2863	763	3435	641	3741	543	4039	397	4864	297	2653
3E		MI	1154	882	1747	709	1981	593	2095	504	2176	359	2424	228	1449
8-#7	1.43	MA	1999	882	2718	768	3234	648	3494	550	3701	399	4444	272	2640
4L-2S		MI	1210	882	1849	707	2110	592	2251	501	2384	357	2669	272	1441
8-#8	1.88	MA	2303	926	3344	784	4036	654	4465	550	5013	387	6210	335	3436
2L-4S		MI	1143	926	1750	736	1968	616	2074	515	2141	350	2393	169	1836
8-#8	1.88	MA	2151	926	3068	790	3687	660	4042	555	4441	395	5418	279	3428
3E		MI	1188	926	1846	734	2100	611	2235	515	2353	352	2623	193	1834
8-#8	1.88	MA	2065	926	2878	797	3423	671	3718	565	3999	398	4867	246	3385
4L-2S		MI	1256	926	1979	731	2268	610	2439	511	2621	350	2937	250	1826
8-#9	2.38	MA	2423	974	3638	812	4401	675	4903	563	5600	384	7020	331	4288
2L-4S		MI	1170	974	1832	764	2062	636	2185	526	2286	347	2548	122	2168

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.38	MA	2239	974	3291	820	3961	682	4370	569	4881	393	6024	259	4265
3E		MI	1222	974	1953	761	2227	630	2387	527	2541	344	2832	151	2243
8-#9	2.38	MA	2136	974	3051	829	3629	695	3963	581	4324	397	5328	217	4117
4L-2S		MI	1304	974	2118	758	2437	629	2641	523	2872	341	3217	224	2238
8-#10	3.02	MA	2351	1037	3574	859	4310	711	4788	587	5441	391	6793	233	5320
3E		MI	1264	1037	2085	797	2388	655	2577	543	2774	333	3087	96	2746
8-#10	3.02	MA	2226	1037	3271	870	3891	727	4274	601	4738	396	5912	179	4941
4L-2S		MI	1363	1037	2292	794	2650	654	2895	538	3184	330	3560	189	2751
8-#11	3.71	MA	2451	1104	3871	897	4661	737	5201	602	5986	385	7447	191	6365
3E		MI	1293	1104	2215	827	2532	675	2729	550	2939	308	3228	13	3198
8-#11	3.71	MA	2306	1104	3504	909	4154	756	4580	619	5137	390	6404	127	5738
4L-2S		MI	1404	1104	2458	825	2840	676	3098	546	3407	304	3753	127	3230
8-#14	5.36	MA	2526	1264	4033	1013	4789	835	5337	670	6148	384	7738	17	7651
4L-2S		MI	1531	1264	2856	918	3331	743	3634	574	4083	264	4447	12	4400
10-#10	3.78	MA	2431	1111	3707	916	4445	760	4946	623	5644	392	7167	174	6188
4L-3S		MI	1345	1111	2292	843	2650	688	2895	564	3184	326	3560	65	3350
10-#10	3.78	MA	2286	1111	3438	926	4075	769	4488	630	5009	404	6284	121	5802
5L-2S		MI	1439	1111	2498	840	2912	688	3213	559	3594	322	4032	157	3367
10-#11	4.64	MA	2548	1195	4030	965	4821	797	5388	645	6228	385	7883	117	7240
4L-3S		MI	1386	1195	2458	884	2840	716	3098	575	3407	296	3753	-33	3740
10-#11	4.64	MA	2381	1195	3703	977	4374	807	4834	653	5460	398	6842	51	6653
5L-2S		MI	1491	1195	2701	882	3148	718	3467	571	3876	291	4279	81	3949
10-#14	6.70	MA	2632	1395	4313	1111	5098	908	5695	718	6602	394	8350	-96	8214
5L-2S		MI	1650	1395	3195	999	3761	803	4138	607	4723	242	5150	-62	5120
12-#10	4.54	MA	2486	1184	3875	972	4630	803	5159	651	5916	400	7538	116	7069
5L-3S		MI	1425	1184	2498	889	2912	722	3213	585	3594	318	4032	33	3947
12-#10	4.54	MA	2332	1184	3565	987	4281	812	4711	666	5294	405	6676	44	6471
6L-2S		MI	1514	1184	2705	886	3174	722	3530	581	4004	314	4505	125	3979
12-#11	5.57	MA	2617	1285	4228	1034	5041	848	5642	679	6551	394	8320	42	8157
5L-3S		MI	1478	1285	2701	940	3148	757	3467	600	3876	283	4279	-79	4241
12-#11	5.57	MA	2437	1285	3861	1053	4618	858	5098	696	5815	406	7366	-32	7238
6L-2S		MI	1577	1285	2944	938	3457	759	3836	596	4344	279	4805	35	4664
14-#10	5.29	MA	2534	1258	4001	1033	4835	845	5382	687	6201	401	7930	39	7742
6L-3S		MI	1503	1258	2705	935	3174	756	3530	607	4004	310	4505	1	4503
14-#11	6.50	MA	2677	1376	4387	1109	5285	900	5907	722	6906	402	8844	-41	8670
6L-3S		MI	1568	1376	2944	997	3457	799	3836	625	4344	270	4805	-125	4734

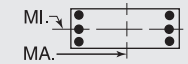
RECTANGULAR TIED COLUMNS 14" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.10	MA	2467	920	3372	801	4056	675	4425	576	4791	426	5783	371	2435
2E		MI	1263	920	1909	737	2151	620	2268	527	2339	382	2586	298	1239
4-#10	1.40	MA	2558	952	3585	819	4316	687	4735	583	5204	423	6352	368	3044
2E		MI	1294	952	2000	752	2259	630	2394	533	2492	375	2754	279	1514
4-#11	1.71	MA	2639	985	3818	834	4583	697	5044	588	5610	418	6904	362	3664
2E		MI	1315	985	2096	762	2358	636	2495	533	2598	359	2839	245	1783
4-#14	2.47	MA	2845	1065	4334	879	5218	730	5803	608	6625	412	8241	349	5150
2E		MI	1379	1065	2304	804	2606	666	2762	544	2932	336	3178	185	2409
4-#18	4.40	MA	3315	1268	5587	998	6768	815	7663	660	9119	397	11406	303	8766
2E		MI	1521	1268	2779	915	3130	732	3342	564	3659	268	3860	7	3832
6-#8	1.30	MA	2538	942	3507	817	4238	686	4650	583	5099	426	6212	370	2868
2L-3S		MI	1218	942	1835	756	2065	633	2167	540	2215	386	2450	237	1447

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis

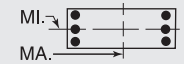


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.30	MA	2360	942	3203	824	3852	693	4182	589	4467	435	5338	316	2869
3L-2S		MI	1291	942	1967	754	2233	633	2370	536	2482	384	2764	294	1436
6-#9	1.65	MA	2643	978	3755	838	4542	701	5014	592	5586	423	6883	367	3581
2L-3S		MI	1241	978	1909	776	2151	647	2268	548	2339	380	2586	202	1767
6-#9	1.65	MA	2426	978	3372	847	4056	709	4425	599	4791	434	5783	297	3570
3L-2S		MI	1328	978	2074	773	2361	646	2522	544	2670	377	2971	274	1754
6-#10	2.09	MA	2774	1025	4068	865	4929	721	5477	604	6207	420	7740	363	4484
2L-3S		MI	1267	1025	2000	801	2259	664	2394	559	2492	371	2754	155	2160
6-#10	2.09	MA	2509	1025	3585	876	4316	731	4735	613	5204	432	6352	273	4451
3L-2S		MI	1373	1025	2207	798	2521	664	2712	555	2903	368	3226	247	2149
6-#11	2.57	MA	2891	1076	4400	890	5322	739	5939	614	6818	414	8577	356	5396
2L-3S		MI	1284	1076	2096	821	2358	676	2495	562	2598	351	2839	85	2533
6-#11	2.57	MA	2584	1076	3818	903	4583	750	5044	624	5610	428	6904	243	5334
3L-2S		MI	1404	1076	2339	819	2666	678	2864	558	3067	346	3365	199	2527
6-#14	3.71	MA	2781	1196	4334	979	5218	805	5803	658	6625	425	8241	173	7426
3L-2S		MI	1500	1196	2643	885	3036	725	3265	577	3571	315	3881	111	3430
6-#18	6.59	MA	3287	1500	5587	1171	6768	944	7663	745	9119	415	11406	-20	11352
3L-2S		MI	1714	1500	3340	1060	3819	832	4138	613	4670	217	4919	-151	4911
8-#7	1.32	MA	2548	944	3513	820	4254	689	4675	585	5136	427	6267	371	2912
2L-4S		MI	1207	944	1794	763	2012	642	2106	543	2141	388	2386	236	1473
8-#7	1.32	MA	2413	944	3281	825	3959	694	4317	590	4654	434	5599	330	2913
3E		MI	1241	944	1867	761	2114	637	2230	543	2306	389	2565	255	1464
8-#7	1.32	MA	2337	944	3121	831	3738	702	4046	597	4282	437	5141	305	2900
4L-2S		MI	1297	944	1969	759	2243	636	2387	540	2514	388	2810	299	1456
8-#8	1.74	MA	2677	988	3812	845	4624	707	5118	596	5730	424	7087	367	3777
2L-4S		MI	1230	988	1871	788	2101	660	2209	553	2270	380	2534	195	1859
8-#8	1.74	MA	2507	988	3507	853	4238	714	4650	602	5099	432	6212	313	3769
3E		MI	1273	988	1967	785	2233	654	2370	553	2482	383	2764	219	1853
8-#8	1.74	MA	2411	988	3298	860	3948	724	4294	612	4612	436	5610	280	3726
4L-2S		MI	1344	988	2099	782	2401	653	2574	550	2750	380	3077	277	1844
8-#9	2.20	MA	2814	1036	4137	874	5028	728	5603	609	6381	420	7984	363	4720
2L-4S		MI	1256	1036	1954	815	2195	680	2320	564	2415	377	2688	148	2219
8-#9	2.20	MA	2607	1036	3755	883	4542	736	5014	616	5586	431	6883	293	4697
3E		MI	1308	1036	2074	812	2361	673	2522	565	2670	374	2971	178	2266
8-#9	2.20	MA	2492	1036	3491	892	4176	749	4566	628	4973	436	6123	251	4598
4L-2S		MI	1392	1036	2239	809	2570	673	2776	561	3001	372	3357	251	2258
8-#10	2.79	MA	2733	1099	4068	922	4929	764	5477	634	6207	429	7740	268	5869
3E		MI	1351	1099	2207	847	2521	698	2712	581	2903	363	3226	123	2773
8-#10	2.79	MA	2594	1099	3734	933	4467	781	4911	649	5433	435	6777	215	5519
4L-2S		MI	1451	1099	2414	844	2783	698	3030	576	3313	360	3699	215	2774
8-#11	3.43	MA	2848	1166	4400	960	5322	791	5939	650	6818	424	8577	237	7039
3E		MI	1379	1166	2339	877	2666	717	2864	587	3067	338	3365	39	3246
8-#11	3.43	MA	2686	1166	3996	973	4763	811	5254	668	5881	429	7402	171	6417
4L-2S		MI	1492	1166	2582	875	2974	719	3233	583	3535	334	3891	153	3258
8-#14	4.95	MA	2936	1326	4586	1078	5471	892	6100	720	7009	425	8935	68	8563
4L-2S		MI	1619	1326	2982	967	3465	785	3769	610	4211	293	4583	37	4434
10-#10	3.49	MA	2823	1173	4217	979	5079	815	5654	671	6435	431	8164	210	6902
4L-3S		MI	1432	1173	2414	893	2783	732	3030	602	3313	356	3699	91	3380
10-#10	3.49	MA	2658	1173	3921	990	4674	824	5150	679	5736	444	7196	160	6446
5L-2S		MI	1527	1173	2620	890	3046	731	3348	597	3723	352	4171	183	3392
10-#11	4.29	MA	2958	1257	4578	1029	5501	852	6150	694	7090	425	9075	165	8087
4L-3S		MI	1472	1257	2582	934	2974	758	3233	612	3535	325	3891	-7	3888
10-#11	4.29	MA	2765	1257	4219	1042	5009	863	5540	703	6243	440	7898	99	7495
5L-2S		MI	1579	1257	2825	932	3282	760	3602	608	4004	321	4417	107	3979
10-#14	6.18	MA	3047	1457	4900	1177	5819	966	6502	770	7520	438	9631	-39	9564
5L-2S		MI	1738	1457	3320	1049	3895	845	4273	644	4850	271	5286	-36	5271
12-#10	4.19	MA	2882	1246	4404	1036	5286	858	5893	700	6738	441	8584	155	7855
5L-3S		MI	1512	1246	2620	939	3046	765	3348	623	3723	348	4171	59	3984

RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

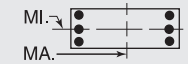
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	4.19	MA	2709	1246	4057	1051	4903	868	5400	716	6055	446	7641	84	7232
6L-2S		MI	1602	1246	2827	936	3308	765	3666	618	4133	344	4644	151	4005
12-#11	5.14	MA	3030	1347	4801	1098	5748	904	6435	729	7452	435	9571	93	9172
5L-3S		MI	1564	1347	2825	990	3282	800	3602	637	4004	313	4417	-53	4392
12-#11	5.14	MA	2829	1347	4388	1117	5283	916	5837	747	6624	441	8421	5	8395
6L-2S		MI	1666	1347	3068	988	3591	801	3971	633	4472	308	4943	61	4696
14-#10	4.88	MA	2936	1320	4539	1097	5516	902	6142	737	7057	443	9029	79	8642
6L-3S		MI	1590	1320	2827	985	3308	799	3666	644	4133	340	4644	27	4570
14-#10	4.88	MA	2793	1320	4229	1104	5108	917	5667	746	6394	456	8110	37	7968
7L-2S		MI	1677	1320	3034	982	3570	799	3984	640	4543	337	5116	119	4615
14-#11	6.00	MA	3098	1438	4970	1173	6021	957	6732	773	7832	437	10094	-1	10091
6L-3S		MI	1655	1438	3068	1047	3591	841	3971	662	4472	300	4943	-99	4889
16-#10	5.58	MA	3023	1394	4711	1150	5721	950	6409	767	7396	452	9498	32	9375
7L-3S		MI	1668	1394	3034	1031	3570	833	3984	666	4543	332	5116	-5	5112

RECTANGULAR TIED COLUMNS 14" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.02	MA	2844	982	3824	863	4624	728	5051	622	5460	463	6583	403	2651
2E		MI	1350	982	2030	788	2284	663	2403	565	2468	413	2726	324	1254
4-#10	1.30	MA	2945	1014	4058	881	4910	740	5391	629	5914	460	7208	400	3318
2E		MI	1381	1014	2123	803	2392	674	2530	571	2621	405	2893	305	1531
4-#11	1.59	MA	3037	1047	4315	896	5205	750	5733	634	6362	455	7818	394	4001
2E		MI	1402	1047	2220	812	2492	679	2630	570	2726	388	2977	271	1804
4-#14	2.30	MA	3269	1127	4884	941	5905	783	6570	654	7482	448	9361	387	5636
2E		MI	1467	1127	2429	853	2740	708	2897	580	3059	365	3314	211	2435
4-#18	4.08	MA	3804	1330	6269	1059	7619	868	8626	706	10238	433	12993	353	9630
2E		MI	1608	1330	2906	963	3265	773	3476	599	3785	296	3994	32	3869
6-#8	1.21	MA	2923	1004	3972	879	4822	739	5296	629	5796	463	7051	403	3124
2L-3S		MI	1305	1004	1955	808	2198	677	2302	578	2344	417	2590	264	1463
6-#8	1.21	MA	2725	1004	3639	886	4400	746	4784	635	5105	472	6094	349	3125
3L-2S		MI	1378	1004	2088	805	2366	676	2506	575	2612	415	2904	321	1451
6-#9	1.53	MA	3041	1040	4243	900	5156	754	5695	638	6330	460	7788	399	3905
2L-3S		MI	1327	1040	2030	827	2284	690	2403	586	2468	410	2726	228	1785
6-#9	1.53	MA	2799	1040	3824	909	4624	762	5051	646	5460	471	6583	331	3894
3L-2S		MI	1416	1040	2195	824	2494	690	2657	582	2799	407	3111	301	1771
6-#10	1.94	MA	3187	1087	4586	927	5581	774	6204	650	7012	456	8728	395	4896
2L-3S		MI	1354	1087	2123	852	2392	708	2530	597	2621	401	2893	181	2183
6-#10	1.94	MA	2892	1087	4058	938	4910	784	5391	659	5914	470	7208	307	4862
3L-2S		MI	1461	1087	2329	849	2654	707	2848	592	3031	398	3365	273	2169
6-#11	2.39	MA	3320	1138	4954	952	6016	791	6715	660	7688	450	9654	388	5902
2L-3S		MI	1371	1138	2220	870	2492	718	2630	599	2726	380	2977	111	2563
6-#11	2.39	MA	2977	1138	4315	966	5205	804	5733	671	6362	466	7818	278	5840
3L-2S		MI	1492	1138	2463	869	2800	720	2999	595	3195	376	3503	225	2551
6-#14	3.44	MA	3198	1258	4884	1042	5905	859	6570	706	7482	463	9361	216	8155
3L-2S		MI	1588	1258	2768	935	3170	767	3400	614	3698	344	4017	137	3460
6-#18	6.12	MA	3767	1562	6269	1235	7619	1000	8626	794	10238	455	12993	39	12868
3L-2S		MI	1801	1562	3467	1108	3954	873	4272	649	4796	246	5053	-126	5052
8-#7	1.22	MA	2934	1005	3977	882	4839	741	5322	631	5835	464	7109	403	3171
2L-4S		MI	1293	1005	1914	815	2145	686	2241	581	2270	418	2527	263	1489
8-#7	1.22	MA	2784	1005	3723	888	4517	747	4931	636	5308	471	6379	363	3172
3E		MI	1328	1005	1987	812	2246	681	2365	581	2435	420	2706	282	1479
8-#7	1.22	MA	2700	1005	3549	893	4276	755	4635	644	4903	474	5883	339	3159
4L-2S		MI	1384	1005	2089	810	2376	680	2522	578	2643	418	2951	326	1470
8-#8	1.61	MA	3078	1050	4304	907	5245	760	5808	642	6487	461	8008	400	4118
2L-4S		MI	1316	1050	1992	839	2234	704	2345	591	2399	411	2674	222	1879
8-#8	1.61	MA	2888	1050	3972	915	4822	767	5296	649	5796	470	7051	346	4110
3E		MI	1360	1050	2088	836	2366	698	2506	592	2612	413	2904	246	1871

RECTANGULAR TIED COLUMNS 14" x 28"

Short columns – no sidesway
Bending on major or minor axis

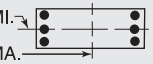


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#8	1.61	MA	2783	1050	3743	922	4506	778	4908	659	5265	474	6399	314	4068
4L-2S		MI	1431	1050	2220	834	2534	697	2709	588	2879	411	3217	303	1861
8-#9	2.04	MA	3231	1098	4662	936	5688	781	6340	655	7200	457	8992	395	5152
2L-4S		MI	1342	1098	2075	866	2329	723	2455	602	2544	407	2828	175	2268
8-#9	2.04	MA	3001	1098	4243	945	5156	789	5695	663	6330	468	7788	327	5129
3E		MI	1395	1098	2195	863	2494	717	2657	603	2799	405	3111	204	2287
8-#9	2.04	MA	2873	1098	3955	955	4757	803	5206	676	5661	474	6964	286	5037
4L-2S		MI	1480	1098	2361	860	2704	716	2911	599	3130	402	3496	277	2278
8-#10	2.59	MA	3142	1161	4586	984	5581	818	6204	681	7012	467	8728	303	6418
3E		MI	1437	1161	2329	898	2654	741	2848	618	3031	393	3365	149	2800
8-#10	2.59	MA	2987	1161	4223	996	5077	835	5586	697	6166	473	7684	250	6108
4L-2S		MI	1538	1161	2536	895	2917	741	3165	614	3441	390	3838	241	2796
8-#11	3.18	MA	3271	1228	4954	1022	6016	845	6715	697	7688	462	9654	272	7713
3E		MI	1466	1228	2463	927	2800	760	2999	624	3195	367	3503	65	3279
8-#11	3.18	MA	3092	1228	4513	1036	5405	865	5967	716	6664	469	8380	207	7108
4L-2S		MI	1580	1228	2706	925	3108	761	3368	620	3663	363	4029	179	3284
8-#14	4.59	MA	3371	1388	5164	1142	6186	947	6900	770	7908	466	10147	112	9490
4L-2S		MI	1707	1388	3107	1016	3600	827	3904	647	4338	322	4720	63	4468
10-#10	3.24	MA	3242	1234	4752	1042	5748	869	6399	718	7264	470	9204	245	7628
4L-3S		MI	1519	1234	2536	944	2917	775	3165	640	3441	386	3838	117	3409
10-#10	3.24	MA	3054	1234	4430	1054	5305	879	5851	728	6502	484	8151	197	7098
5L-2S		MI	1615	1234	2742	941	3179	775	3483	635	3851	382	4310	210	3416
10-#11	3.98	MA	3394	1319	5151	1093	6215	907	6949	742	7990	465	10216	201	8946
4L-3S		MI	1559	1319	2706	984	3108	801	3368	649	3663	355	4029	19	3981
10-#11	3.98	MA	3175	1319	4760	1106	5678	919	6283	752	7065	480	8935	139	8359
5L-2S		MI	1668	1319	2949	982	3416	803	3737	645	4131	351	4554	133	4009
10-#14	5.74	MA	3488	1519	5513	1243	6573	1023	7347	821	8476	481	10927	11	10888
5L-2S		MI	1826	1519	3445	1098	4030	887	4408	681	4977	300	5422	-11	5418
12-#10	3.89	MA	3303	1308	4958	1100	5976	913	6664	749	7600	480	9672	192	8644
5L-3S		MI	1599	1308	2742	990	3179	809	3483	661	3851	378	4310	85	4015
12-#10	3.89	MA	3112	1308	4573	1114	5559	923	6127	765	6855	487	8651	122	8006
6L-2S		MI	1691	1308	2949	987	3441	808	3801	656	4261	374	4783	178	4031
12-#11	4.78	MA	3470	1409	5399	1163	6489	960	7265	778	8391	476	10770	133	10210
5L-3S		MI	1650	1409	2949	1040	3416	842	3737	674	4131	342	4554	-27	4543
12-#11	4.78	MA	3247	1409	4939	1181	5981	972	6613	797	7487	483	9524	46	9308
6L-2S		MI	1754	1409	3192	1038	3724	844	4106	670	4600	338	5080	87	4727
12-#14	6.89	MA	3602	1649	5774	1350	7002	1099	7813	885	9072	484	11751	-124	11388
6L-2S		MI	1945	1649	3784	1179	4459	946	4911	714	5616	279	6125	-85	6083
14-#10	4.54	MA	3364	1382	5102	1160	6230	957	6940	786	7953	484	10171	117	9553
6L-3S		MI	1677	1382	2949	1036	3441	842	3801	682	4261	370	4783	53	4618
14-#10	4.54	MA	3206	1382	4763	1168	5778	972	6422	796	7230	497	9173	78	8842
7L-2S		MI	1766	1382	3156	1033	3703	842	4119	677	4672	367	5255	146	4642
14-#11	5.57	MA	3545	1499	5578	1237	6792	1013	7595	823	8813	479	11359	40	11155
6L-3S		MI	1741	1499	3192	1097	3724	884	4106	700	4600	330	5080	-73	5043
14-#11	5.57	MA	3361	1499	5167	1246	6253	1032	6965	834	7936	495	10144	-12	10114
7L-2S		MI	1840	1499	3434	1095	4033	885	4475	695	5068	325	5606	40	5442
16-#10	5.18	MA	3460	1455	5291	1214	6449	1006	7235	817	8328	494	10694	73	10383
7L-3S		MI	1755	1455	3156	1082	3703	876	4119	703	4672	362	5255	21	5194
16-#10	5.18	MA	3302	1455	4965	1222	6012	1012	6711	832	7617	508	9734	19	9668
8L-2S		MI	1840	1455	3362	1079	3966	876	4437	699	5082	359	5728	114	5251
16-#11	6.37	MA	3664	1590	5805	1302	7064	1074	7948	860	9261	490	11979	-18	11914
7L-3S		MI	1831	1590	3434	1153	4033	925	4475	725	5068	317	5606	-119	5537
18-#10	5.83	MA	3552	1529	5494	1268	6683	1046	7524	854	8715	504	11254	14	11205
8L-3S		MI	1833	1529	3362	1128	3966	910	4437	725	5082	355	5728	-10	5719

RECTANGULAR TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

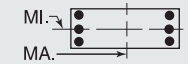
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.41	MA	1067	670	1593	549	1846	460	1985	390	2134	281	2449	225	1259
2L-3S		MI	998	670	1469	552	1689	463	1794	391	1877	284	2131	181	1266
6-#8	1.85	MA	1112	703	1712	568	1990	474	2157	398	2364	279	2718	212	1607
2L-3S		MI	1025	703	1551	572	1786	476	1910	399	2030	281	2308	155	1612
6-#9	2.34	MA	1160	740	1840	588	2147	488	2344	407	2614	276	3002	198	1982
2L-3S		MI	1054	740	1638	593	1891	491	2034	408	2196	279	2497	125	1979
6-#10	2.98	MA	1216	787	2000	615	2344	508	2580	418	2926	271	3355	178	2452
2L-3S		MI	1093	787	1747	620	2024	511	2192	419	2403	274	2730	85	2431
6-#11	3.66	MA	1260	837	2159	640	2529	525	2795	428	3168	256	3597	141	2899
2L-3S		MI	1120	837	1859	645	2149	527	2335	435	2562	261	2887	28	2826
6-#14	5.27	MA	1384	957	2534	710	2993	576	3353	459	3853	236	4353	75	3994
2L-3S		MI	1204	957	2114	715	2460	576	2706	468	3017	242	3387	-89	3333
8-#7	1.88	MA	1119	705	1717	571	2002	476	2175	400	2390	280	2767	216	1634
2L-4S		MI	1013	705	1505	577	1724	484	1836	406	1931	282	2220	151	1632
8-#8	2.47	MA	1178	749	1873	596	2195	495	2405	411	2699	276	3127	200	2092
2L-4S		MI	1045	749	1597	604	1832	504	1963	418	2100	278	2422	115	2005
8-#9	3.13	MA	1238	798	2041	624	2403	515	2654	424	3033	273	3508	181	2584
2L-4S		MI	1079	798	1695	634	1948	526	2101	431	2283	273	2636	74	2377
8-#10	3.97	MA	1312	860	2253	661	2665	541	2969	440	3449	267	3980	154	3201
2L-4S		MI	1128	860	1819	672	2094	555	2275	448	2511	267	2901	20	2833

RECTANGULAR TIED COLUMNS 16" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.10	MA	1318	728	1899	610	2210	513	2372	437	2521	323	2922	269	1288
2E		MI	1159	728	1704	599	1958	504	2086	429	2200	316	2495	256	1133
4-#9	1.39	MA	1358	752	2003	623	2336	522	2520	443	2718	320	3161	261	1589
2E		MI	1192	752	1792	612	2064	513	2211	435	2366	314	2682	246	1391
4-#10	1.76	MA	1407	784	2133	640	2494	534	2708	450	2969	317	3459	250	1968
2E		MI	1232	784	1903	629	2196	525	2368	442	2572	310	2915	232	1714
4-#11	2.17	MA	1448	817	2270	654	2648	544	2885	454	3199	311	3681	229	2342
2E		MI	1262	817	2017	642	2322	534	2512	445	2731	298	3070	206	2030
4-#14	3.13	MA	1555	897	2578	699	3024	576	3334	474	3789	303	4343	194	3238
2E		MI	1347	897	2273	686	2634	565	2883	464	3185	283	3569	160	2783
4-#18	5.56	MA	1796	1100	3307	816	3921	660	4408	525	5120	269	5820	85	5354
2E		MI	1538	1100	2872	802	3368	649	3724	507	4212	236	4643	24	4534
6-#7	1.25	MA	1344	741	1948	620	2279	521	2459	443	2641	323	3090	269	1454
2L-3S		MI	1112	741	1622	613	1860	514	1971	436	2047	320	2317	212	1283
6-#7	1.25	MA	1261	741	1802	624	2095	524	2235	445	2339	327	2698	226	1461
3L-2S		MI	1181	741	1746	610	2017	512	2161	435	2304	317	2635	256	1275
6-#8	1.65	MA	1399	774	2088	638	2451	534	2663	451	2915	320	3428	260	1863
2L-3S		MI	1138	774	1704	632	1958	528	2086	444	2200	317	2495	186	1633
6-#8	1.65	MA	1294	774	1899	643	2210	538	2372	453	2521	325	2922	203	1868
3L-2S		MI	1227	774	1865	628	2162	525	2334	443	2535	314	2904	244	1626
6-#9	2.08	MA	1458	810	2241	659	2637	549	2886	459	3212	317	3789	249	2306
2L-3S		MI	1167	810	1792	653	2064	542	2211	452	2366	314	2682	156	2005
6-#9	2.08	MA	1330	810	2003	665	2336	553	2520	462	2718	323	3161	176	2303
3L-2S		MI	1274	810	1994	648	2319	540	2521	451	2784	311	3188	229	2003
6-#10	2.65	MA	1530	857	2432	686	2873	568	3167	471	3589	314	4239	233	2863
2L-3S		MI	1203	857	1903	680	2196	562	2368	464	2572	310	2915	116	2464
6-#10	2.65	MA	1375	857	2133	693	2494	573	2708	474	2969	320	3459	141	2842
3L-2S		MI	1332	857	2155	675	2517	559	2757	463	3095	306	3540	209	2475
6-#11	3.25	MA	1587	908	2626	710	3099	585	3432	480	3938	307	4580	204	3404
2L-3S		MI	1233	908	2017	704	2322	577	2512	479	2731	296	3070	58	2899
6-#11	3.25	MA	1416	908	2270	718	2648	590	2885	483	3199	312	3681	90	3361
3L-2S		MI	1376	908	2316	698	2702	575	2972	472	3336	291	3780	172	2928
6-#14	4.69	MA	1743	1028	3080	780	3661	636	4105	511	4825	296	5579	152	4723
2L-3S		MI	1315	1028	2273	774	2634	626	2883	511	3185	276	3569	-59	3535
6-#14	4.69	MA	1522	1028	2578	790	3024	641	3334	513	3789	302	4343	-12	4332
3L-2S		MI	1501	1028	2694	768	3167	625	3529	502	4022	270	4535	105	4029

RECTANGULAR TIED COLUMNS 16" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#7	1.67	MA	1406	776	2093	642	2464	537	2682	453	2943	322	3482	263	1893
2L-4S		MI	1126	776	1658	638	1896	536	2013	451	2101	317	2406	182	1657
8-#7	1.67	MA	1326	776	1948	646	2279	540	2459	455	2641	325	3090	220	1897
3E		MI	1166	776	1746	635	2017	530	2161	446	2304	318	2635	204	1657
8-#7	1.67	MA	1280	776	1845	649	2138	546	2285	460	2404	326	2811	197	1891
4L-2S		MI	1233	776	1869	631	2174	528	2352	445	2561	316	2953	247	1651
8-#8	2.19	MA	1479	820	2278	667	2692	555	2955	464	3308	318	3935	251	2433
2L-4S		MI	1157	820	1750	664	2004	555	2140	463	2270	313	2608	146	2069
8-#8	2.19	MA	1378	820	2088	672	2451	559	2663	466	2915	323	3428	194	2430
3E		MI	1208	820	1865	660	2162	549	2334	457	2535	315	2904	174	2113
8-#8	2.19	MA	1320	820	1954	677	2266	567	2437	473	2606	323	3067	164	2379
4L-2S		MI	1292	820	2026	657	2367	546	2582	456	2869	312	3313	231	2112
8-#9	2.78	MA	1555	868	2478	695	2939	575	3251	476	3706	315	4417	237	3016
2L-4S		MI	1191	868	1850	694	2121	577	2278	476	2453	309	2822	105	2448
8-#9	2.78	MA	1434	868	2241	701	2637	580	2886	479	3212	320	3789	164	3001
3E		MI	1255	868	1994	689	2319	569	2521	469	2784	311	3188	139	2598
8-#9	2.78	MA	1363	868	2072	707	2405	590	2601	487	2824	320	3340	127	2826
4L-2S		MI	1354	868	2195	684	2575	566	2831	468	3203	308	3694	212	2607
8-#10	3.53	MA	1648	931	2731	732	3252	602	3627	492	4209	310	5019	217	3750
2L-4S		MI	1239	931	1974	732	2267	606	2451	493	2680	302	3086	51	2912
8-#10	3.53	MA	1503	931	2432	739	2873	607	3167	495	3589	316	4239	124	3714
3E		MI	1311	931	2155	726	2517	595	2757	485	3095	306	3540	93	3201
8-#10	3.53	MA	1418	931	2220	746	2580	619	2809	506	3100	315	3679	78	3375
4L-2S		MI	1428	931	2408	721	2838	592	3146	484	3618	302	4165	185	3227
8-#11	4.33	MA	1565	998	2626	774	3099	631	3432	509	3938	308	4580	65	4394
3E		MI	1354	998	2316	760	2702	618	2972	505	3336	288	3780	24	3721
8-#11	4.33	MA	1469	998	2372	782	2749	645	3003	519	3353	305	3930	11	3888
4L-2S		MI	1486	998	2616	755	3082	616	3433	498	3942	284	4490	137	3815
8-#14	6.25	MA	1727	1158	3080	871	3661	701	4105	550	4825	295	5579	-54	5509
3E		MI	1482	1158	2694	855	3167	686	3529	548	4022	263	4535	-114	4446
10-#10	4.41	MA	1632	1005	2731	785	3252	641	3627	517	4209	313	5019	107	4585
3L-4S		MI	1349	1005	2227	778	2588	639	2840	514	3203	299	3711	28	3612
10-#10	4.41	MA	1558	1005	2519	792	2959	653	3269	527	3721	312	4460	61	4211
4L-3S		MI	1413	1005	2408	772	2838	629	3146	506	3618	302	4165	70	3937
10-#10	4.41	MA	1468	1005	2328	799	2700	658	2948	530	3276	318	3910	6	3894
5L-2S		MI	1523	1005	2661	767	3158	626	3534	505	4141	299	4790	162	3974
10-#11	5.42	MA	1625	1089	2728	838	3200	686	3550	546	4092	301	4829	-14	4815
4L-3S		MI	1472	1089	2616	817	3082	660	3433	531	3942	281	4490	-10	4480
12-#10	5.29	MA	1687	1078	2817	838	3338	686	3728	548	4341	308	5240	44	5054
4E		MI	1455	1078	2479	824	2908	673	3229	535	3726	295	4336	4	4320
12-#10	5.29	MA	1604	1078	2627	845	3079	691	3407	551	3896	314	4690	-11	4680
5L-3S		MI	1513	1078	2661	818	3158	663	3534	527	4141	298	4790	46	4654

RECTANGULAR TIED COLUMNS 16" x 20"

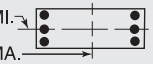
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.25	MA	1667	823	2396	693	2819	583	3048	495	3285	362	3879	305	1805
2E		MI	1306	823	1947	672	2236	564	2388	479	2536	349	2868	277	1408
4-#10	1.59	MA	1726	854	2547	710	3002	595	3267	502	3576	359	4243	297	2242
2E		MI	1346	854	2058	688	2369	576	2545	486	2742	345	3100	263	1734
4-#11	1.95	MA	1777	888	2710	725	3185	604	3477	507	3850	353	4532	280	2679
2E		MI	1377	888	2175	701	2496	584	2689	489	2899	333	3253	236	2054
4-#14	2.81	MA	1910	968	3070	770	3626	637	4003	526	4554	347	5359	251	3724
2E		MI	1462	968	2433	744	2808	615	3060	508	3354	318	3751	191	2812

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

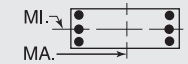
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	5.00	MA	2204	1171	3932	886	4687	721	5274	578	6247	330	7248	164	6218
2E		MI	1653	1171	3034	859	3543	697	3901	549	4379	269	4822	53	4576
6-#7	1.13	MA	1649	812	2331	691	2752	581	2975	495	3193	365	3786	312	1648
2L-3S		MI	1225	812	1775	673	2032	566	2148	481	2218	356	2504	244	1298
6-#7	1.13	MA	1552	812	2164	695	2540	585	2718	498	2846	370	3319	269	1655
3L-2S		MI	1295	812	1899	670	2189	564	2338	480	2474	353	2822	287	1290
6-#8	1.48	MA	1716	845	2493	709	2950	594	3212	503	3509	362	4194	305	2119
2L-3S		MI	1251	845	1858	692	2130	579	2263	489	2370	353	2681	218	1652
6-#8	1.48	MA	1592	845	2275	715	2673	599	2876	507	3056	368	3589	248	2124
3L-2S		MI	1341	845	2019	688	2335	576	2511	487	2705	350	3090	275	1643
6-#9	1.88	MA	1786	881	2670	730	3166	609	3470	512	3854	359	4631	297	2630
2L-3S		MI	1280	881	1947	713	2236	594	2388	497	2536	350	2868	187	2029
6-#9	1.88	MA	1635	881	2396	737	2819	615	3048	516	3285	366	3879	224	2627
3L-2S		MI	1389	881	2148	708	2492	591	2698	496	2954	346	3374	260	2023
6-#10	2.38	MA	1872	928	2892	757	3440	628	3797	524	4292	355	5180	285	3275
2L-3S		MI	1316	928	2058	740	2369	613	2545	508	2742	345	3100	147	2494
6-#10	2.38	MA	1690	928	2547	765	3002	635	3267	529	3576	364	4243	193	3254
3L-2S		MI	1447	928	2311	734	2690	609	2934	507	3265	341	3725	240	2498
6-#11	2.92	MA	1946	979	3122	781	3708	646	4111	533	4706	349	5623	261	3910
2L-3S		MI	1345	979	2175	762	2496	627	2689	523	2899	330	3253	89	2938
6-#11	2.92	MA	1735	979	2710	790	3185	652	3477	538	3850	357	4532	147	3866
3L-2S		MI	1491	979	2474	757	2876	625	3149	515	3505	326	3963	202	2955
6-#14	4.22	MA	2135	1099	3653	851	4366	696	4900	564	5765	340	6870	219	5452
2L-3S		MI	1427	1099	2433	832	2808	676	3060	554	3354	311	3751	-28	3735
6-#14	4.22	MA	1870	1099	3070	863	3626	705	4003	569	4554	350	5359	56	5215
3L-2S		MI	1617	1099	2853	826	3341	675	3706	545	4190	304	4717	135	4063
6-#18	7.50	MA	2180	1403	3932	1049	4687	837	5274	647	6247	329	7248	-200	6995
3L-2S		MI	1902	1403	3741	1004	4439	803	4968	613	5734	235	6337	-68	6278
8-#7	1.50	MA	1724	846	2498	712	2964	597	3232	505	3540	364	4253	308	2152
2L-4S		MI	1238	846	1811	698	2068	587	2189	496	2272	353	2593	214	1679
8-#7	1.50	MA	1630	846	2331	717	2752	601	2975	508	3193	368	3786	265	2156
3E		MI	1279	846	1899	695	2189	582	2338	491	2474	354	2822	235	1675
8-#7	1.50	MA	1576	846	2214	721	2590	608	2777	514	2922	370	3456	240	2150
4L-2S		MI	1347	846	2022	692	2346	580	2528	490	2731	351	3140	279	1668
8-#8	1.98	MA	1810	890	2712	738	3227	615	3548	516	3962	360	4798	299	2774
2L-4S		MI	1270	890	1904	725	2176	607	2317	507	2440	349	2795	178	2126
8-#8	1.98	MA	1692	890	2493	743	2950	620	3212	520	3509	366	4194	242	2771
3E		MI	1321	890	2019	721	2335	600	2511	502	2705	351	3090	205	2135
8-#8	1.98	MA	1624	890	2341	749	2739	629	2953	528	3155	368	3766	210	2743
4L-2S		MI	1407	890	2180	717	2539	597	2758	501	3039	348	3499	262	2131
8-#9	2.50	MA	1901	939	2944	766	3514	636	3891	529	4423	356	5383	288	3448
2L-4S		MI	1304	939	2004	754	2293	628	2455	520	2622	344	3008	136	2516
8-#9	2.50	MA	1758	939	2670	773	3166	641	3470	533	3854	363	4631	216	3433
3E		MI	1366	939	2148	749	2492	620	2698	514	2954	347	3374	170	2626
8-#9	2.50	MA	1676	939	2478	780	2901	652	3145	543	3409	365	4098	176	3287
4L-2S		MI	1469	939	2350	744	2748	617	3008	513	3373	344	3879	243	2629
8-#10	3.17	MA	2014	1002	3237	803	3877	662	4327	545	5007	352	6117	273	4298
2L-4S		MI	1346	1002	2129	791	2440	656	2628	537	2850	338	3271	82	2987
8-#10	3.17	MA	1842	1002	2892	811	3440	669	3797	550	4292	360	5180	181	4262
3E		MI	1424	1002	2311	786	2690	646	2934	529	3265	341	3725	124	3234
8-#10	3.17	MA	1742	1002	2650	819	3105	682	3387	562	3732	362	4514	131	3931
4L-2S		MI	1544	1002	2563	780	3010	643	3322	528	3788	338	4350	216	3253
8-#11	3.90	MA	1920	1069	3122	847	3708	694	4111	564	4706	353	5623	128	5068
3E		MI	1467	1069	2474	819	2876	669	3149	549	3505	323	3963	54	3808

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

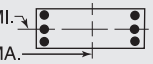
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	3.90	MA	1798	1069	2830	856	3305	709	3618	577	4033	353	4843	70	4542
4L-2S		MI	1603	1069	2773	814	3256	667	3609	541	4111	319	4674	168	3845
8-#14	5.63	MA	2115	1229	3653	945	4366	764	4900	607	5765	344	6870	24	6800
3E		MI	1594	1229	2853	913	3341	735	3706	592	4190	297	4717	-84	4655
8-#14	5.63	MA	1971	1229	3239	957	3794	785	4201	624	4809	342	5784	-57	5730
4L-2S		MI	1768	1229	3273	908	3875	734	4352	583	5026	291	5682	79	5301
10-#10	3.97	MA	1989	1075	3237	857	3877	702	4327	571	5007	357	6117	169	5271
3L-4S		MI	1460	1075	2382	837	2761	690	3017	558	3373	334	3896	59	3685
10-#10	3.97	MA	1898	1075	2994	866	3542	716	3917	583	4447	358	5451	119	4901
4L-3S		MI	1527	1075	2563	832	3010	680	3322	550	3788	337	4350	101	3972
10-#10	3.97	MA	1796	1075	2778	874	3246	723	3550	588	3939	367	4791	65	4586
5L-2S		MI	1640	1075	2816	826	3331	677	3711	550	4311	334	4975	193	4001
10-#11	4.88	MA	1992	1159	3243	913	3829	751	4252	603	4889	349	5933	51	5704
4L-3S		MI	1585	1159	2773	875	3256	710	3609	575	4111	316	4674	20	4619
10-#14	7.03	MA	2228	1359	3822	1039	4534	845	5098	662	6020	336	7294	-89	7156
4L-3S		MI	1758	1359	3273	995	3875	795	4352	629	5026	284	5682	-140	5556
12-#10	4.76	MA	2061	1149	3339	912	3980	750	4447	604	5163	355	6388	107	5878
4E		MI	1567	1149	2635	883	3081	724	3406	580	3896	330	4521	35	4390
12-#10	4.76	MA	1949	1149	3122	920	3683	756	4080	609	4655	363	5728	53	5552
5L-3S		MI	1627	1149	2816	878	3331	714	3711	572	4311	334	4975	77	4708
14-#10	5.56	MA	2107	1223	3467	966	4121	790	4611	630	5370	360	6665	41	6522
5L-4S		MI	1671	1223	2887	929	3402	757	3794	601	4419	326	5146	12	5100

RECTANGULAR TIED COLUMNS 16" x 22"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.14	MA	2005	894	2817	764	3340	643	3619	548	3896	404	4651	348	2021
2E		MI	1419	894	2101	732	2409	615	2565	524	2706	385	3054	308	1425
4-#10	1.44	MA	2075	925	2990	781	3549	655	3868	555	4227	401	5081	342	2517
2E		MI	1460	925	2213	748	2542	627	2722	530	2912	381	3285	294	1752
4-#11	1.77	MA	2135	959	3177	795	3761	665	4112	560	4544	395	5439	327	3016
2E		MI	1491	959	2332	759	2670	634	2865	533	3068	368	3436	267	2076
4-#14	2.56	MA	2293	1039	3591	840	4267	697	4716	579	5352	388	6433	304	4210
2E		MI	1577	1039	2592	803	2982	665	3236	551	3522	352	3933	221	2841
4-#18	4.55	MA	2646	1242	4585	957	5492	781	6183	630	7318	373	8741	233	7082
2E		MI	1768	1242	3197	916	3718	746	4077	592	4545	303	5001	83	4616
6-#7	1.02	MA	1984	882	2742	761	3262	641	3535	548	3788	407	4534	354	1842
2L-3S		MI	1338	882	1928	734	2204	617	2325	526	2388	391	2691	275	1313
6-#7	1.02	MA	1872	882	2553	766	3023	646	3244	551	3396	412	3992	311	1850
3L-2S		MI	1409	882	2051	731	2361	615	2515	525	2645	389	3009	319	1304
6-#8	1.35	MA	2061	915	2927	780	3488	655	3803	556	4148	404	5012	349	2375
2L-3S		MI	1365	915	2011	752	2302	630	2440	533	2541	388	2867	249	1670
6-#8	1.35	MA	1919	915	2680	786	3174	660	3424	560	3635	411	4309	292	2380
3L-2S		MI	1454	915	2172	748	2507	628	2688	532	2875	386	3276	306	1660
6-#9	1.70	MA	2143	952	3127	800	3733	669	4097	565	4540	401	5528	342	2954
2L-3S		MI	1393	952	2101	773	2409	645	2565	542	2706	385	3054	218	2051
6-#9	1.70	MA	1970	952	2817	808	3340	676	3619	570	3896	409	4651	270	2951
3L-2S		MI	1503	952	2303	768	2664	642	2875	540	3124	382	3559	291	2042
6-#10	2.16	MA	2244	999	3380	827	4045	689	4469	576	5038	397	6176	333	3686
2L-3S		MI	1429	999	2213	799	2542	663	2722	552	2912	380	3285	178	2522
6-#10	2.16	MA	2033	999	2990	837	3549	697	3868	583	4227	408	5081	241	3665
3L-2S		MI	1562	999	2466	794	2863	660	3111	551	3435	377	3910	271	2519
6-#11	2.66	MA	2333	1049	3646	852	4356	706	4833	586	5518	391	6723	313	4415
2L-3S		MI	1458	1049	2332	821	2670	677	2865	567	3068	365	3436	119	2974
6-#11	2.66	MA	2088	1049	3177	863	3761	714	4112	592	4544	402	5439	200	4372
3L-2S		MI	1606	1049	2632	816	3049	675	3326	559	3674	361	4147	233	2982
6-#14	3.84	MA	2560	1169	4255	922	5110	756	5738	617	6732	382	8221	280	6181
2L-3S		MI	1538	1169	2592	890	2982	725	3236	597	3522	345	3933	2	3929

RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

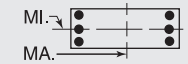
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	3.84	MA	2238	1169	3591	936	4267	768	4716	624	5352	396	6433	117	6042
3L-2S		MI	1732	1169	3012	884	3516	724	3883	589	4358	339	4899	165	4096
6-#18	6.82	MA	2616	1474	4585	1124	5492	902	6183	706	7318	380	8741	-114	8548
3L-2S		MI	2018	1474	3903	1061	4615	852	5145	655	5901	269	6516	-38	6486
8-#7	1.36	MA	2070	917	2931	783	3502	657	3825	558	4181	405	5076	352	2412
2L-4S		MI	1351	917	1963	759	2240	639	2366	541	2442	389	2780	245	1698
8-#7	1.36	MA	1962	917	2742	788	3262	662	3535	561	3788	411	4534	308	2415
3E		MI	1392	917	2051	756	2361	633	2515	536	2645	390	3009	266	1692
8-#7	1.36	MA	1900	917	2611	793	3081	669	3312	568	3484	413	4153	283	2410
4L-2S		MI	1461	917	2175	752	2518	631	2705	535	2902	387	3327	310	1684
8-#8	1.80	MA	2171	961	3174	808	3801	676	4183	569	4660	402	5716	345	3115
2L-4S		MI	1382	961	2057	785	2348	658	2494	552	2610	385	2981	209	2153
8-#8	1.80	MA	2035	961	2927	815	3488	681	3803	573	4148	409	5012	288	3113
3E		MI	1434	961	2172	781	2507	651	2688	547	2875	386	3276	236	2156
8-#8	1.80	MA	1957	961	2755	821	3250	691	3512	582	3750	411	4518	255	3085
4L-2S		MI	1521	961	2333	777	2711	649	2935	545	3209	383	3685	294	2149
8-#9	2.27	MA	2277	1010	3437	837	4127	696	4574	581	5184	398	6405	337	3880
2L-4S		MI	1416	1010	2159	814	2465	680	2631	565	2792	380	3193	168	2580
8-#9	2.27	MA	2112	1010	3127	844	3733	702	4097	587	4540	407	5528	264	3865
3E		MI	1479	1010	2303	809	2664	671	2875	558	3124	382	3559	201	2651
8-#9	2.27	MA	2018	1010	2911	852	3434	714	3730	597	4039	410	4910	223	3761
4L-2S		MI	1584	1010	2504	804	2920	668	3184	557	3543	379	4065	274	2650
8-#10	2.89	MA	2409	1072	3771	873	4541	722	5070	597	5850	394	7271	325	4847
2L-4S		MI	1458	1072	2285	851	2613	707	2805	581	3019	373	3456	113	3059
8-#10	2.89	MA	2210	1072	3380	883	4045	730	4469	604	5038	404	6176	233	4811
3E		MI	1538	1072	2466	845	2863	697	3111	574	3435	376	3910	155	3265
8-#10	2.89	MA	2096	1072	3108	892	3668	745	4007	617	4407	407	5403	181	4501
4L-2S		MI	1660	1072	2719	840	3183	694	3499	573	3958	373	4535	247	3277
8-#11	3.55	MA	2295	1140	3646	919	4356	756	4833	618	5518	397	6723	186	5742
3E		MI	1580	1140	2632	878	3049	719	3326	593	3674	358	4147	85	3848
8-#11	3.55	MA	2163	1140	3317	930	3901	773	4276	633	4757	400	5811	125	5211
4L-2S		MI	1718	1140	2931	873	3429	717	3786	585	4280	354	4857	198	3875
8-#14	5.11	MA	2535	1300	4255	1018	5110	827	5738	662	6732	390	8221	93	7919
3E		MI	1706	1300	3012	971	3516	785	3883	635	4358	332	4899	-54	4861
8-#14	5.11	MA	2351	1300	3787	1032	4463	851	4946	682	5650	391	6947	7	6914
4L-2S		MI	1885	1300	3432	966	4049	784	4529	626	5194	325	5864	110	5337
10-#10	3.61	MA	2381	1146	3771	929	4541	764	5070	625	5850	401	7271	225	5957
3L-4S		MI	1572	1146	2537	897	2933	741	3194	603	3542	369	4081	90	3755
10-#10	3.61	MA	2277	1146	3498	938	4163	779	4608	638	5218	404	6498	173	5606
4L-3S		MI	1641	1146	2719	891	3183	731	3499	595	3958	373	4535	132	4005
10-#10	3.61	MA	2154	1146	3255	948	3831	787	4196	645	4646	414	5727	119	5277
5L-2S		MI	1756	1146	2971	886	3504	728	3888	594	4481	369	5160	224	4028
10-#11	4.43	MA	2376	1230	3786	986	4496	814	4997	659	5730	395	7095	111	6539
4L-3S		MI	1699	1230	2931	934	3429	760	3786	619	4280	351	4857	51	4716
10-#11	4.43	MA	2235	1230	3492	997	4094	823	4499	666	5040	406	6191	44	6041
5L-2S		MI	1829	1230	3230	929	3809	758	4247	611	4886	346	5567	164	4761
10-#14	6.39	MA	2667	1430	4452	1114	5307	910	5968	720	7030	385	8735	-17	8701
4L-3S		MI	1870	1430	3432	1053	4049	844	4529	673	5194	318	5864	-109	5769
12-#10	4.33	MA	2452	1220	3889	984	4659	813	5209	660	6029	400	7593	165	6717
4E		MI	1679	1220	2790	943	3254	775	3582	624	4065	365	4706	66	4458
12-#10	4.33	MA	2330	1220	3646	994	4326	820	4797	666	5457	410	6822	111	6406
5L-3S		MI	1742	1220	2971	937	3504	764	3888	616	4481	369	5160	108	4743

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

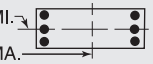
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	4.33	MA	2191	1220	3373	1009	4011	828	4392	679	4909	420	6115	51	5888
6L-2S		MI	1851	1220	3224	932	3825	761	4276	615	5004	365	5785	201	4775
12-#11	5.32	MA	2443	1321	3961	1054	4689	864	5220	692	6014	402	7475	30	7365
5L-3S		MI	1815	1321	3230	991	3809	801	4247	645	4886	343	5567	16	5520
14-#10	5.05	MA	2502	1293	4037	1040	4822	854	5398	687	6269	407	7918	103	7515
5L-4S		MI	1783	1293	3043	989	3575	808	3971	645	4588	362	5331	43	5166
14-#10	5.05	MA	2370	1293	3764	1055	4507	862	4993	701	5721	417	7210	43	7013
6L-3S		MI	1841	1293	3224	983	3825	798	4276	637	5004	365	5785	85	5480
16-#10	5.77	MA	2545	1367	4155	1101	5003	896	5594	722	6532	413	8305	35	8141
6L-4S		MI	1885	1367	3295	1035	3895	842	4360	666	5111	358	5956	20	5879

RECTANGULAR TIED COLUMNS 16" x 24"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.04	MA	2372	965	3266	835	3899	703	4233	600	4550	446	5462	388	2237
2E		MI	1533	965	2256	792	2581	666	2741	568	2876	420	3239	339	1440
4-#10	1.32	MA	2453	996	3460	852	4134	715	4512	608	4922	443	5972	385	2791
2E		MI	1574	996	2369	808	2715	678	2899	575	3081	416	3470	325	1770
4-#11	1.63	MA	2524	1030	3673	866	4375	725	4789	612	5283	437	6399	372	3353
2E		MI	1605	1030	2490	818	2843	684	3042	577	3237	403	3620	297	2099
4-#14	2.34	MA	2706	1110	4139	911	4946	757	5471	632	6194	430	7563	354	4696
2E		MI	1692	1110	2751	861	3157	714	3413	594	3690	386	4115	251	2868
4-#18	4.17	MA	3121	1312	5267	1028	6335	841	7134	683	8423	415	10296	297	7946
2E		MI	1883	1312	3359	973	3894	794	4253	634	4712	337	5181	112	4656
6-#8	1.23	MA	2436	986	3388	851	4064	715	4437	608	4830	446	5853	388	2631
2L-3S		MI	1478	986	2165	812	2475	682	2617	578	2711	424	3053	280	1687
6-#8	1.23	MA	2275	986	3113	857	3714	721	4014	613	4258	454	5061	332	2636
3L-2S		MI	1568	986	2326	809	2679	679	2864	577	3045	421	3463	337	1676
6-#9	1.56	MA	2530	1023	3613	871	4339	730	4766	617	5270	443	6458	384	3278
2L-3S		MI	1506	1023	2256	833	2581	696	2741	586	2876	421	3239	250	2072
6-#9	1.56	MA	2333	1023	3266	879	3899	737	4233	623	4550	452	5462	312	3275
3L-2S		MI	1617	1023	2457	828	2837	693	3051	585	3294	417	3745	322	2060
6-#10	1.98	MA	2647	1070	3897	898	4688	749	5184	629	5829	439	7226	380	4098
2L-3S		MI	1541	1070	2369	859	2715	714	2899	597	3081	416	3470	209	2548
6-#10	1.98	MA	2407	1070	3460	908	4134	758	4512	636	4922	451	5972	287	4076
3L-2S		MI	1677	1070	2621	854	3035	711	3287	596	3604	412	4095	302	2540
6-#11	2.44	MA	2750	1120	4198	923	5041	766	5597	638	6374	433	7878	363	4921
2L-3S		MI	1571	1120	2490	880	2843	727	3042	610	3237	400	3620	150	3007
6-#11	2.44	MA	2471	1120	3673	934	4375	776	4789	646	5283	445	6399	249	4877
3L-2S		MI	1721	1120	2789	875	3223	725	3503	603	3843	396	4330	263	3007
6-#14	3.52	MA	3015	1240	4886	993	5893	817	6619	669	7744	424	9630	337	6910
2L-3S		MI	1651	1240	2751	948	3157	775	3413	640	3690	379	4115	32	4044
6-#14	3.52	MA	2644	1240	4139	1009	4946	830	5471	679	6194	441	7563	173	6771
3L-2S		MI	1848	1240	3171	942	3690	774	4059	632	4526	373	5081	195	4128
6-#18	6.25	MA	3084	1544	5267	1198	6335	967	7134	763	8423	428	10296	-37	10215
3L-2S		MI	2133	1544	4065	1118	4790	900	5321	697	6068	303	6695	-9	6689
8-#7	1.25	MA	2446	988	3392	854	4079	718	4460	610	4865	447	5905	389	2671
2L-4S		MI	1464	988	2116	819	2411	690	2543	586	2613	425	2967	277	1716
8-#7	1.25	MA	2323	988	3182	859	3811	722	4136	614	4428	453	5299	347	2674
3E		MI	1506	988	2204	816	2533	685	2692	581	2815	426	3196	298	1708
8-#7	1.25	MA	2254	988	3036	864	3610	730	3889	622	4090	456	4879	321	2669
4L-2S		MI	1575	988	2328	813	2690	683	2882	580	3072	423	3514	341	1700
8-#8	1.65	MA	2561	1032	3664	879	4413	736	4861	621	5402	444	6645	385	3457
2L-4S		MI	1495	1032	2211	845	2520	710	2670	597	2780	420	3167	240	2178
8-#8	1.65	MA	2406	1032	3388	886	4064	742	4437	627	4830	452	5853	329	3454
3E		MI	1548	1032	2326	841	2679	703	2864	591	3045	422	3463	268	2176
8-#8	1.65	MA	2319	1032	3198	893	3800	752	4114	636	4388	455	5301	295	3426
4L-2S		MI	1635	1032	2487	837	2883	700	3112	590	3379	419	3872	325	2167

RECTANGULAR TIED COLUMNS 16" x 24"

Short columns – no sidesway
Bending on major or minor axis

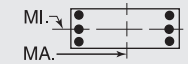


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#9	2.08	MA	2684	1081	3959	907	4779	756	5299	634	5989	440	7454	381	4312
2L-4S		MI	1528	1081	2313	873	2638	731	2808	610	2962	415	3379	199	2643
8-#9	2.08	MA	2496	1081	3613	916	4339	764	4766	640	5270	450	6458	309	4297
3E		MI	1592	1081	2457	869	2837	722	3051	603	3294	418	3745	232	2675
8-#9	2.08	MA	2390	1081	3373	924	4007	776	4359	652	4713	454	5761	266	4230
4L-2S		MI	1699	1081	2659	864	3092	719	3361	602	3713	415	4251	305	2670
8-#10	2.65	MA	2835	1143	4334	944	5243	783	5856	650	6736	436	8481	375	5396
2L-4S		MI	1570	1143	2440	910	2786	758	2982	626	3189	408	3641	144	3128
8-#10	2.65	MA	2607	1143	3897	954	4688	792	5184	658	5829	447	7226	282	5360
3E		MI	1651	1143	2621	905	3035	748	3287	618	3604	412	4095	186	3294
8-#10	2.65	MA	2479	1143	3594	965	4269	808	4670	672	5126	452	6345	228	5084
4L-2S		MI	1776	1143	2874	900	3356	745	3676	617	4127	408	4720	278	3300
8-#11	3.25	MA	2707	1210	4198	991	5041	817	5597	672	6374	441	7878	240	6416
3E		MI	1693	1210	2789	936	3223	769	3503	636	3843	393	4330	115	3884
8-#11	3.25	MA	2559	1210	3832	1003	4534	836	4976	689	5525	445	6835	176	5895
4L-2S		MI	1834	1210	3089	931	3603	767	3963	629	4449	388	5040	229	3904
8-#14	4.69	MA	2971	1370	4886	1090	5893	890	6619	717	7744	435	9630	156	8950
3E		MI	1819	1370	3171	1030	3690	834	4059	678	4526	366	5081	-24	5065
8-#14	4.69	MA	2775	1370	4363	1106	5170	915	5734	740	6535	439	8167	66	7832
4L-2S		MI	2001	1370	3591	1024	4223	833	4706	669	5362	360	6046	140	5372
10-#10	3.31	MA	2802	1217	4334	1000	5243	825	5856	679	6736	444	8481	277	6642
3L-4S		MI	1685	1217	2692	956	3106	792	3371	647	3712	404	4266	121	3822
10-#10	3.31	MA	2685	1217	4031	1011	4823	841	5342	693	6033	448	7599	223	6324
4L-3S		MI	1755	1217	2874	951	3356	782	3676	639	4127	408	4720	163	4036
10-#10	3.31	MA	2540	1217	3761	1021	4454	850	4884	701	5398	460	6717	170	5926
5L-2S		MI	1873	1217	3126	946	3677	778	4065	638	4650	404	5345	255	4053
10-#11	4.06	MA	2801	1301	4357	1059	5201	877	5784	715	6616	441	8313	166	7389
4L-3S		MI	1812	1301	3089	993	3603	810	3963	662	4449	385	5040	81	4758
10-#11	4.06	MA	2634	1301	4031	1071	4754	887	5230	723	5848	454	7273	100	6892
5L-2S		MI	1945	1301	3388	988	3983	808	4423	655	5055	381	5751	194	4792
10-#14	5.86	MA	3113	1501	5110	1188	6118	975	6882	777	8085	433	10234	49	9974
4L-3S		MI	1982	1501	3591	1111	4223	894	4706	716	5362	353	6046	-79	5980
10-#14	5.86	MA	2883	1501	4643	1204	5480	988	6092	788	6989	449	8779	-47	8715
5L-2S		MI	2152	1501	4012	1105	4756	893	5352	707	6198	347	7012	84	6608
12-#10	3.97	MA	2884	1290	4467	1057	5377	875	6014	715	6940	445	8854	218	7570
4E		MI	1791	1290	2945	1002	3427	825	3759	668	4235	401	4891	97	4524
12-#10	3.97	MA	2741	1290	4198	1067	5008	884	5556	722	6304	457	7971	165	7192
5L-3S		MI	1856	1290	3126	997	3677	815	4065	660	4650	404	5345	139	4776
12-#10	3.97	MA	2584	1290	3888	1082	4659	893	5107	737	5683	461	7108	93	6657
6L-2S		MI	1968	1290	3379	992	3997	812	4453	660	5173	401	5970	231	4802
12-#11	4.88	MA	2871	1391	4556	1128	5421	929	6038	749	6939	449	8751	91	8387
5L-3S		MI	1929	1391	3388	1049	3983	851	4423	689	5055	378	5751	47	5612
12-#11	4.88	MA	2687	1391	4189	1147	4998	939	5495	766	6203	462	7796	17	7716
6L-2S		MI	2055	1391	3687	1044	4363	849	4884	681	5660	374	6461	160	5675
12-#14	7.03	MA	3233	1631	5390	1286	6427	1048	7240	825	8539	443	10846	-64	10717
5L-3S		MI	2143	1631	4012	1193	4756	954	5352	753	6198	340	7012	-135	6880
14-#10	4.63	MA	2937	1364	4635	1113	5562	917	6227	743	7211	453	9226	160	8461
5L-4S		MI	1896	1364	3198	1048	3747	859	4148	689	4758	397	5516	74	5230
14-#10	4.63	MA	2787	1364	4325	1128	5213	926	5778	758	6590	458	8363	88	7920
6L-3S		MI	1955	1364	3379	1043	3997	849	4453	682	5173	400	5970	116	5514
14-#11	5.69	MA	2928	1482	4714	1203	5665	980	6303	792	7294	458	9275	8	9237
6L-3S		MI	2044	1482	3687	1106	4363	893	4884	715	5660	371	6461	12	6422
16-#10	5.29	MA	2985	1438	4761	1174	5767	960	6450	779	7496	454	9617	83	9186
6L-4S		MI	1998	1438	3450	1095	4068	893	4536	711	5281	393	6141	51	5942

RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

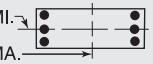
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#10	1.22	MA	2860	1067	3959	923	4758	776	5199	660	5662	485	6863	422	3065
2E		MI	1687	1067	2524	867	2888	728	3076	619	3251	451	3655	356	1788
4-#11	1.50	MA	2942	1100	4197	937	5027	785	5509	665	6066	479	7412	416	3690
2E		MI	1719	1100	2648	877	3017	734	3219	620	3406	438	3803	328	2120
4-#14	2.16	MA	3150	1180	4717	982	5663	818	6268	684	7081	472	8747	402	5182
2E		MI	1806	1180	2910	919	3331	764	3590	637	3858	421	4297	281	2895
4-#18	3.85	MA	3629	1383	5977	1099	7216	902	8128	735	9572	457	11909	355	8810
2E		MI	1998	1383	3521	1029	4069	843	4430	676	4879	370	5360	142	4696
6-#8	1.14	MA	2840	1057	3878	921	4678	775	5114	661	5557	488	6725	425	2887
2L-3S		MI	1591	1057	2318	873	2647	733	2793	623	2881	460	3240	311	1703
6-#8	1.14	MA	2659	1057	3574	928	4292	782	4646	666	4925	496	5851	370	2892
3L-2S		MI	1682	1057	2479	869	2851	731	3041	622	3215	457	3649	369	1692
6-#9	1.44	MA	2947	1093	4127	942	4983	790	5478	670	6043	485	7395	421	3602
2L-3S		MI	1619	1093	2410	893	2753	747	2918	631	3046	456	3425	281	2091
6-#9	1.44	MA	2725	1093	3744	951	4497	798	4889	677	5249	495	6295	351	3599
3L-2S		MI	1731	1093	2611	888	3009	744	3228	630	3464	453	3931	353	2078
6-#10	1.83	MA	3078	1140	4442	969	5370	809	5942	681	6664	481	8251	417	4509
2L-3S		MI	1654	1140	2524	919	2888	765	3076	641	3251	451	3655	240	2572
6-#10	1.83	MA	2809	1140	3959	980	4758	819	5199	690	5662	494	6863	327	4488
3L-2S		MI	1791	1140	2776	913	3208	762	3464	640	3774	447	4280	332	2561
6-#11	2.25	MA	3197	1191	4779	993	5765	827	6404	691	7274	475	9085	410	5426
2L-3S		MI	1683	1191	2648	939	3017	778	3219	654	3406	435	3803	180	3038
6-#11	2.25	MA	2883	1191	4197	1006	5027	838	5509	700	6066	489	7412	297	5383
3L-2S		MI	1836	1191	2947	934	3397	776	3679	646	4012	430	4513	294	3032
6-#14	3.25	MA	3499	1311	5544	1063	6714	877	7542	722	8800	466	11096	390	7639
2L-3S		MI	1763	1311	2910	1006	3331	824	3590	684	3858	414	4297	62	4124
6-#14	3.25	MA	3080	1311	4717	1081	5663	892	6268	734	7081	485	8747	227	7500
3L-2S		MI	1963	1311	3330	1000	3864	823	4236	675	4694	408	5263	226	4159
6-#18	5.77	MA	3583	1615	5977	1272	7216	1031	8128	820	9572	474	11909	32	11811
3L-2S		MI	2249	1615	4227	1174	4965	949	5498	740	6235	336	6874	21	6779
8-#7	1.15	MA	2850	1059	3882	925	4693	778	5138	663	5594	489	6781	426	2930
2L-4S		MI	1577	1059	2269	880	2583	742	2720	631	2783	461	3154	308	1732
8-#7	1.15	MA	2713	1059	3650	930	4398	783	4781	667	5112	496	6113	384	2934
3E		MI	1619	1059	2357	877	2705	737	2868	626	2986	461	3383	329	1723
8-#7	1.15	MA	2636	1059	3490	936	4177	791	4509	675	4740	499	5654	360	2928
4L-2S		MI	1689	1059	2481	873	2862	734	3058	625	3242	459	3701	373	1715
8-#8	1.52	MA	2981	1103	4182	950	5064	796	5582	674	6188	486	7599	422	3798
2L-4S		MI	1608	1103	2365	905	2693	761	2847	642	2951	456	3353	271	2200
8-#8	1.52	MA	2807	1103	3878	957	4678	803	5114	680	5557	494	6725	367	3795
3E		MI	1661	1103	2479	901	2851	754	3041	636	3215	458	3649	299	2194
8-#8	1.52	MA	2710	1103	3669	964	4387	813	4758	690	5070	498	6123	334	3767
4L-2S		MI	1749	1103	2640	897	3055	751	3289	635	3550	455	4058	356	2185
8-#9	1.92	MA	3119	1151	4510	978	5468	817	6067	686	6838	482	8496	417	4744
2L-4S		MI	1641	1151	2467	933	2810	782	2985	654	3132	451	3565	230	2690
8-#9	1.92	MA	2908	1151	4127	987	4983	824	5478	693	6043	492	7395	347	4729
3E		MI	1706	1151	2611	929	3009	773	3228	647	3464	453	3931	264	2698
8-#9	1.92	MA	2790	1151	3863	996	4617	838	5030	706	5430	497	6635	306	4662
4L-2S		MI	1813	1151	2813	924	3265	771	3538	646	3882	450	4436	336	2690
8-#10	2.44	MA	3290	1214	4925	1015	5983	843	6684	703	7666	478	9638	412	5944
2L-4S		MI	1683	1214	2595	970	2958	809	3159	670	3359	444	3826	175	3195
8-#10	2.44	MA	3035	1214	4442	1026	5370	853	5942	711	6664	490	8251	322	5908
3E		MI	1761	1214	2776	965	3208	799	3464	662	3774	447	4280	217	3322
8-#10	2.44	MA	2891	1214	4109	1037	4908	870	5376	727	5890	496	7287	269	5679
4L-2S		MI	1891	1214	3029	959	3529	796	3853	661	4297	444	4905	309	3323

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

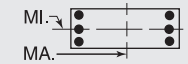
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	3.00	MA	3149	1281	4779	1063	5765	879	6404	726	7274	485	9085	291	7090
3E		MI	1806	1281	2947	995	3397	819	3679	680	4012	427	4513	146	3919
8-#11	3.00	MA	2983	1281	4375	1075	5206	899	5719	744	6338	490	7910	224	6593
4L-2S		MI	1949	1281	3246	990	3777	817	4140	672	4617	423	5223	259	3932
8-#14	4.33	MA	3448	1441	5544	1162	6714	952	7542	772	8800	479	11096	215	9922
3E		MI	1931	1441	3330	1088	3864	884	4236	721	4694	401	5263	7	5246
8-#14	4.33	MA	3230	1441	4968	1180	5916	979	6565	796	7464	486	9441	121	8766
4L-2S		MI	2117	1441	3751	1082	4397	883	4882	713	5530	394	6228	170	5406
8-#18	7.69	MA	3884	1847	6405	1445	7646	1181	8632	926	10223	470	13058	-159	12691
4L-2S		MI	2498	1847	4933	1319	5861	1055	6566	803	7590	303	8389	-100	8300
10-#10	3.05	MA	3254	1288	4925	1072	5983	886	6684	732	7666	487	9638	317	7328
3L-4S		MI	1797	1288	2848	1016	3279	843	3547	691	3882	440	4451	152	3888
10-#10	3.05	MA	3122	1288	4591	1083	5521	903	6118	748	6892	493	8675	264	7054
4L-3S		MI	1868	1288	3029	1011	3529	832	3853	683	4297	443	4905	193	4066
10-#10	3.05	MA	2956	1288	4295	1094	5115	913	5615	756	6193	506	7707	214	6583
5L-2S		MI	1988	1288	3282	1005	3849	829	4241	683	4820	440	5530	286	4078
10-#11	3.75	MA	3256	1372	4957	1132	5945	940	6614	770	7546	486	9583	218	8253
4L-3S		MI	1926	1372	3246	1052	3777	860	4140	706	4617	420	5223	112	4795
10-#11	3.75	MA	3063	1372	4598	1145	5453	951	6004	780	6700	500	8406	153	7737
5L-2S		MI	2061	1372	3546	1047	4156	858	4600	699	5223	416	5934	225	4822
10-#14	5.41	MA	3610	1572	5796	1262	6967	1039	7838	834	9183	480	11790	109	11152
4L-3S		MI	2095	1572	3751	1169	4397	944	4882	759	5530	387	6228	-49	6189
10-#14	5.41	MA	3343	1572	5283	1279	6264	1054	6967	846	7975	499	10137	14	10082
5L-2S		MI	2269	1572	4171	1163	4930	943	5529	750	6366	381	7194	114	6644
12-#10	3.66	MA	3346	1361	5074	1129	6134	937	6861	769	7894	489	10063	259	8437
4E		MI	1904	1361	3100	1062	3600	876	3936	713	4405	436	5076	128	4587
12-#10	3.66	MA	3182	1361	4778	1140	5728	947	6357	778	7196	502	9095	209	7985
5L-3S		MI	1970	1361	3282	1057	3849	866	4241	705	4820	439	5530	170	4807
12-#10	3.66	MA	3005	1361	4431	1155	5344	956	5864	793	6512	508	8152	138	7440
6L-2S		MI	2084	1361	3534	1051	4170	863	4630	704	5343	436	6155	262	4828
12-#11	4.50	MA	3329	1462	5180	1201	6192	992	6900	806	7908	496	10079	147	9431
5L-3S		MI	2043	1462	3546	1108	4156	902	4600	732	5223	413	5934	77	5668
12-#11	4.50	MA	3124	1462	4767	1220	5726	1003	6302	824	7080	502	8929	59	8634
6L-2S		MI	2171	1462	3845	1103	4536	900	5061	725	5829	409	6644	191	5707
12-#14	6.49	MA	3714	1702	6111	1361	7315	1113	8241	884	9694	493	12486	3	12475
5L-3S		MI	2256	1702	4171	1251	4930	1003	5529	797	6366	374	7194	-105	7096
14-#10	4.27	MA	3401	1435	5261	1186	6340	980	7100	799	8198	498	10483	204	9391
5L-4S		MI	2009	1435	3353	1108	3920	910	4325	734	4928	432	5701	105	5293
14-#10	4.27	MA	3234	1435	4913	1201	5957	990	6607	814	7515	504	9540	133	8843
6L-3S		MI	2070	1435	3534	1103	4170	900	4630	726	5343	436	6155	147	5547
14-#10	4.27	MA	3087	1435	4603	1207	5550	1005	6131	823	6851	517	8621	90	8258
7L-2S		MI	2179	1435	3787	1097	4491	897	5019	725	5866	432	6780	239	5575
14-#11	5.25	MA	3394	1553	5349	1276	6465	1045	7197	850	8288	498	10602	53	10327
6L-3S		MI	2158	1553	3845	1165	4536	943	5061	758	5829	406	6644	43	6510
16-#10	4.88	MA	3456	1508	5396	1247	6570	1024	7349	836	8517	501	10928	128	10248
6L-4S		MI	2111	1508	3606	1154	4241	944	4713	755	5451	428	6326	82	6003
16-#10	4.88	MA	3318	1508	5085	1253	6163	1039	6873	844	7854	514	10009	86	9666
7L-3S		MI	2168	1508	3787	1149	4491	933	5019	747	5866	432	6780	123	6286
18-#10	5.50	MA	3543	1582	5568	1300	6775	1073	7616	865	8856	510	11397	81	11073
7L-4S		MI	2212	1582	3858	1200	4562	977	5102	776	5974	425	6951	58	6717

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis

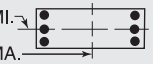


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.13	MA	3295	1137	4486	993	5419	836	5928	713	6445	526	7803	458	3340
2E		MI	1801	1137	2679	927	3060	779	3252	663	3421	486	3840	387	1805
4-#11	1.39	MA	3389	1171	4749	1007	5717	846	6272	717	6893	521	8411	452	4027
2E		MI	1833	1171	2805	936	3190	784	3396	664	3574	472	3986	359	2141
4-#14	2.01	MA	3623	1251	5322	1052	6419	878	7109	737	8011	514	9952	445	5668
2E		MI	1920	1251	3069	977	3505	813	3767	681	4026	455	4479	311	2921
4-#18	3.57	MA	4164	1454	6715	1169	8136	962	9165	788	10766	498	13579	410	9674
2E		MI	2113	1454	3683	1086	4244	891	4606	719	5046	404	5539	171	4733
6-#8	1.06	MA	3273	1127	4396	992	5330	836	5833	713	6327	530	7648	461	3143
2L-3S		MI	1704	1127	2472	933	2819	784	2970	668	3051	495	3426	343	1719
6-#8	1.06	MA	3072	1127	4063	1000	4908	842	5321	720	5636	539	6692	408	3148
3L-2S		MI	1796	1127	2633	929	3023	782	3218	667	3385	492	3835	400	1707
6-#9	1.34	MA	3392	1164	4669	1013	5665	850	6233	722	6861	527	8384	458	3926
2L-3S		MI	1732	1164	2564	952	2926	798	3095	675	3216	491	3611	312	2109
6-#9	1.34	MA	3146	1164	4250	1022	5133	859	5588	730	5992	538	7180	390	3923
3L-2S		MI	1845	1164	2766	948	3182	795	3405	674	3634	488	4116	384	2095
6-#10	1.70	MA	3540	1211	5015	1039	6090	870	6742	734	7543	523	9323	453	4921
2L-3S		MI	1767	1211	2679	978	3060	816	3252	685	3421	486	3840	271	2594
6-#10	1.70	MA	3239	1211	4486	1051	5419	880	5928	743	6445	537	7803	366	4899
3L-2S		MI	1905	1211	2932	973	3381	813	3641	684	3944	483	4465	363	2581
6-#11	2.09	MA	3675	1261	5388	1064	6528	887	7254	743	8218	516	10246	447	5932
2L-3S		MI	1796	1261	2805	997	3190	828	3396	698	3574	469	3986	211	3068
6-#11	2.09	MA	3324	1261	4749	1078	5717	899	6272	754	6893	532	8411	336	5888
3L-2S		MI	1950	1261	3104	992	3570	826	3856	690	4180	465	4696	324	3057
6-#14	3.01	MA	4013	1381	6231	1134	7573	937	8507	774	9899	508	12566	436	8368
2L-3S		MI	1875	1381	3069	1064	3505	874	3767	727	4026	448	4479	92	4166
6-#14	3.01	MA	3545	1381	5322	1153	6419	954	7109	788	8011	529	9952	274	8229
3L-2S		MI	2078	1381	3490	1059	4038	873	4413	718	4862	442	5444	256	4189
6-#18	5.36	MA	4080	1686	6715	1345	8136	1094	9165	876	10766	521	13579	96	13262
3L-2S		MI	2364	1686	4389	1231	5140	997	5674	782	6401	370	7054	50	6821
8-#7	1.07	MA	3284	1129	4400	995	5346	838	5859	716	6367	531	7708	462	3189
2L-4S		MI	1690	1129	2422	940	2755	794	2896	676	2953	496	3341	339	1748
8-#7	1.07	MA	3132	1129	4146	1001	5024	844	5468	720	5840	538	6977	422	3193
3E		MI	1732	1129	2510	937	2877	788	3045	671	3156	497	3569	361	1738
8-#7	1.07	MA	3046	1129	3972	1007	4783	852	5172	728	5435	542	6481	398	3187
4L-2S		MI	1802	1129	2633	934	3034	786	3235	670	3413	495	3887	404	1729
8-#8	1.41	MA	3430	1173	4729	1021	5752	857	6345	727	7018	528	8605	458	4139
2L-4S		MI	1721	1173	2518	965	2865	812	3024	687	3121	492	3540	303	2221
8-#8	1.41	MA	3237	1173	4396	1028	5330	863	5833	733	6327	537	7648	405	4136
3E		MI	1774	1173	2633	962	3023	805	3218	681	3385	493	3835	330	2212
8-#8	1.41	MA	3129	1173	4168	1036	5014	875	5445	743	5796	541	6997	372	4108
4L-2S		MI	1863	1173	2794	958	3228	803	3466	680	3720	490	4244	387	2202
8-#9	1.79	MA	3584	1222	5088	1049	6196	877	6877	739	7731	524	9588	454	5176
2L-4S		MI	1754	1222	2622	993	2983	833	3162	699	3302	486	3750	261	2717
8-#9	1.79	MA	3350	1222	4669	1058	5665	885	6233	747	6861	535	8384	386	5161
3E		MI	1819	1222	2766	989	3182	825	3405	692	3634	489	4116	295	2719
8-#9	1.79	MA	3219	1222	4382	1068	5266	899	5744	760	6192	541	7560	344	5094
4L-2S		MI	1928	1222	2967	984	3437	822	3715	691	4052	486	4622	367	2710
8-#10	2.27	MA	3776	1285	5544	1085	6761	903	7555	755	8641	519	10843	449	6493
2L-4S		MI	1795	1285	2750	1030	3131	860	3335	714	3528	479	4011	206	3260
8-#10	2.27	MA	3491	1285	5015	1097	6090	914	6742	765	7543	533	9323	361	6457
3E		MI	1875	1285	2932	1024	3381	850	3641	707	3944	482	4465	248	3348
8-#10	2.27	MA	3333	1285	4652	1109	5586	931	6124	781	6697	540	8279	308	6286
4L-2S		MI	2006	1285	3184	1019	3702	847	4030	706	4467	479	5090	340	3345
8-#11	2.79	MA	3621	1352	5388	1134	6528	940	7254	780	8218	528	10246	330	7764
3E		MI	1919	1352	3104	1054	3570	869	3856	724	4180	462	4696	176	3953
8-#11	2.79	MA	3437	1352	4947	1148	5917	961	6505	799	7194	535	8973	265	7303
4L-2S		MI	2065	1352	3404	1049	3950	867	4316	716	4786	458	5407	290	3958

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

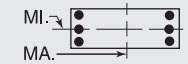
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	4.02	MA	3956	1512	6231	1234	7573	1013	8507	826	9899	523	12566	265	10894
3E		MI	2044	1512	3490	1146	4038	934	4413	765	4862	435	5444	37	5351
8-#14	4.02	MA	3713	1512	5602	1253	6700	1042	7439	852	8438	532	10737	170	9716
4L-2S		MI	2233	1512	3910	1140	4571	933	5059	756	5698	429	6410	200	5440
8-#18	7.14	MA	4400	1918	7192	1521	8616	1248	9728	986	11493	521	14889	-92	14638
4L-2S		MI	2613	1918	5096	1376	6036	1103	6742	845	7757	336	8568	-71	8510
10-#10	2.83	MA	3735	1358	5544	1143	6761	947	7555	786	8641	530	10843	356	8014
3L-4S		MI	1904	1358	3003	1076	3452	893	3724	736	4051	475	4636	183	3951
10-#10	2.83	MA	3589	1358	5180	1155	6257	965	6937	802	7795	537	9800	304	7798
4L-3S		MI	1982	1358	3184	1070	3702	883	4030	728	4467	479	5090	224	4095
10-#10	2.83	MA	3401	1358	4858	1167	5815	975	6388	811	7033	550	8747	256	7247
5L-2S		MI	2104	1358	3437	1065	4022	880	4418	727	4990	475	5715	317	4102
10-#11	3.48	MA	3740	1442	5585	1204	6727	1002	7487	825	8520	531	10808	259	9132
4L-3S		MI	2039	1442	3404	1110	3950	910	4316	750	4786	455	5407	142	4831
10-#11	3.48	MA	3521	1442	5194	1218	6190	1014	6821	835	7596	546	9527	197	8529
5L-2S		MI	2177	1442	3703	1105	4330	908	4777	742	5392	451	6117	256	4851
10-#14	5.02	MA	4136	1642	6511	1335	7854	1102	8837	890	10326	526	13351	161	12346
4L-3S		MI	2208	1642	3910	1227	4571	993	5059	802	5698	422	6410	-19	6396
10-#14	5.02	MA	3832	1642	5951	1354	7087	1118	7886	904	9005	547	11517	69	11247
5L-2S		MI	2385	1642	4330	1222	5105	992	5705	794	6534	415	7376	145	6680
12-#10	3.40	MA	3837	1432	5709	1201	6928	999	7750	823	8893	533	11320	299	9316
4E		MI	2017	1432	3256	1122	3772	927	4113	757	4574	471	5261	159	4650
12-#10	3.40	MA	3652	1432	5387	1213	6486	1009	7202	833	8131	547	10267	251	8787
5L-3S		MI	2084	1432	3437	1116	4022	917	4418	749	4990	475	5715	201	4838
12-#10	3.40	MA	3456	1432	5002	1227	6069	1020	6664	849	7386	554	9246	181	8239
6L-2S		MI	2201	1432	3690	1111	4343	914	4807	748	5513	471	6340	293	4854
12-#11	4.18	MA	3817	1533	5833	1275	7001	1055	7803	862	8921	542	11363	191	10392
5L-3S		MI	2157	1533	3703	1167	4330	952	4777	776	5392	448	6117	108	5706
12-#11	4.18	MA	3589	1533	5373	1292	6494	1067	7151	881	8017	549	10116	104	9570
6L-2S		MI	2288	1533	4002	1162	4710	950	5237	768	5998	443	6827	221	5738
12-#14	6.03	MA	4245	1773	6861	1435	8241	1178	9284	941	10893	541	14131	60	13892
5L-3S		MI	2369	1773	4330	1309	5105	1053	5705	840	6534	408	7376	-74	7309
12-#14	6.03	MA	3940	1773	6212	1462	7516	1194	8352	968	9602	550	12341	-67	12149
6L-2S		MI	2536	1773	4750	1303	5638	1052	6352	831	7371	402	8342	89	7915
14-#10	3.97	MA	3896	1506	5916	1259	7157	1043	8015	854	9229	543	11787	246	10330
5L-4S		MI	2122	1506	3508	1168	4093	961	4501	778	5097	467	5886	136	5354
14-#10	3.97	MA	3710	1506	5531	1273	6740	1053	7478	870	8484	550	10766	176	9781
6L-3S		MI	2184	1506	3690	1162	4343	951	4807	770	5513	471	6340	178	5578
14-#10	3.97	MA	3547	1506	5191	1280	6287	1068	6959	879	7761	564	9769	136	9167
7L-2S		MI	2296	1506	3942	1157	4664	947	5196	770	6035	467	6965	270	5602
14-#11	4.88	MA	3889	1623	6012	1349	7304	1109	8133	907	9343	545	11952	98	11434
6L-3S		MI	2272	1623	4002	1224	4710	993	5237	802	5998	440	6827	73	6579
14-#11	4.88	MA	3700	1623	5601	1357	6765	1128	7504	917	8466	561	10736	46	10545
7L-2S		MI	2397	1623	4302	1218	5090	991	5698	795	6604	436	7538	187	6621
14-#14	7.03	MA	4360	1903	7121	1543	8670	1254	9750	1005	11490	544	14955	-75	14645
6L-3S		MI	2528	1903	4750	1390	5638	1112	6352	878	7371	395	8342	-130	8207
16-#10	4.54	MA	3956	1579	6059	1319	7411	1087	8291	891	9582	547	12286	171	11326
6L-4S		MI	2224	1579	3761	1214	4414	994	4890	799	5620	464	6511	113	6063
16-#10	4.54	MA	3803	1579	5720	1326	6958	1102	7773	901	8859	561	11289	131	10709
7L-3S		MI	2283	1579	3942	1208	4664	984	5196	792	6035	467	6965	154	6318
16-#10	4.54	MA	3645	1579	5393	1335	6521	1109	7248	916	8149	574	10329	78	9996
8L-2S		MI	2390	1579	4195	1203	4984	981	5584	791	6558	464	7590	247	6348

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

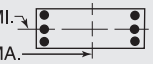
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	5.57	MA	4004	1714	6239	1414	7576	1169	8486	943	9791	556	12572	40	12406
7L-3S		MI	2386	1714	4302	1280	5090	1034	5698	828	6604	433	7538	39	7410
18-#10	5.10	MA	4052	1653	6249	1372	7629	1135	8586	922	9957	557	12809	126	12251
7L-4S		MI	2326	1653	4014	1260	4734	1028	5279	821	6143	460	7136	89	6775
18-#10	5.10	MA	3896	1653	5922	1381	7192	1142	8062	938	9246	571	11849	73	11542
8L-3S		MI	2381	1653	4195	1254	4984	1018	5584	813	6558	463	7590	131	7057
20-#10	5.67	MA	4142	1726	6451	1427	7864	1176	8875	959	10344	567	13369	68	13088
8L-4S		MI	2426	1726	4266	1306	5055	1062	5667	842	6666	456	7761	66	7491

RECTANGULAR TIED COLUMNS 16" x 30"

4-#10	1.06	MA	3760	1208	5042	1064	6119	896	6700	765	7272	568	8794	495	3614
2E		MI	1914	1208	2834	986	3233	830	3429	708	3590	522	4025	418	1822
4-#11	1.30	MA	3865	1242	5330	1078	6446	906	7077	770	7763	563	9461	489	4364
2E		MI	1947	1242	2963	995	3364	834	3572	708	3743	507	4169	389	2161
4-#14	1.88	MA	4126	1322	5956	1123	7212	938	7991	789	8986	556	11145	481	6154
2E		MI	2035	1322	3229	1035	3679	863	3943	724	4194	490	4661	342	2946
4-#18	3.33	MA	4729	1525	7481	1240	9094	1022	10245	840	12003	540	15305	463	10538
2E		MI	2228	1525	3846	1143	4419	940	4783	761	5213	438	5718	201	4769
6-#9	1.25	MA	3866	1235	5240	1083	6385	911	7030	775	7724	568	9424	495	4250
2L-3S		MI	1845	1235	2719	1012	3098	849	3272	720	3385	527	3796	343	2127
6-#9	1.25	MA	3596	1235	4785	1093	5808	920	6330	783	6779	580	8115	428	4247
3L-2S		MI	1958	1235	2920	1008	3354	846	3582	719	3804	524	4302	416	2112
6-#10	1.59	MA	4030	1282	5617	1110	6849	930	7584	787	8466	565	10447	490	5332
2L-3S		MI	1880	1282	2834	1038	3233	867	3429	730	3590	521	4025	302	2616
6-#10	1.59	MA	3699	1282	5042	1122	6119	941	6700	797	7272	579	8794	404	5311
3L-2S		MI	2019	1282	3087	1032	3554	864	3818	729	4113	518	4650	394	2600
6-#11	1.95	MA	4181	1332	6025	1135	7328	947	8146	796	9206	558	11460	483	6437
2L-3S		MI	1909	1332	2963	1056	3364	878	3572	741	3743	504	4169	241	3095
6-#11	1.95	MA	3794	1332	5330	1149	6446	960	7077	807	7763	575	9461	375	6393
3L-2S		MI	2065	1332	3262	1051	3744	876	4033	734	4349	500	4880	355	3080
6-#14	2.81	MA	4558	1452	6946	1205	8470	998	9516	827	11043	550	13994	473	9097
2L-3S		MI	1988	1452	3229	1122	3679	924	3943	770	4194	483	4661	122	4205
6-#14	2.81	MA	4040	1452	5956	1225	7212	1015	7991	842	8986	573	11145	315	8958
3L-2S		MI	2193	1452	3649	1117	4212	923	4590	761	5030	476	5626	286	4218
6-#18	5.00	MA	4634	1757	7481	1418	9094	1157	10245	931	12003	566	15305	157	14749
3L-2S		MI	2479	1757	4552	1288	5315	1046	5851	824	6568	404	7233	80	6863
8-#7	1.00	MA	3746	1200	4946	1066	6038	899	6622	768	7184	573	8686	499	3448
2L-4S		MI	1803	1200	2574	1001	2927	845	3073	721	3124	532	3527	371	1762
8-#7	1.00	MA	3579	1200	4670	1072	5688	904	6198	773	6612	580	7893	460	3452
3E		MI	1845	1200	2662	998	3048	840	3222	716	3327	533	3756	392	1752
8-#7	1.00	MA	3485	1200	4482	1078	5427	913	5877	782	6173	584	7359	435	3446
4L-2S		MI	1916	1200	2786	994	3205	838	3412	715	3583	530	4074	436	1744
8-#8	1.32	MA	3907	1244	5304	1091	6480	917	7151	779	7893	569	9662	495	4480
2L-4S		MI	1834	1244	2672	1026	3037	864	3201	731	3291	527	3726	334	2240
8-#8	1.32	MA	3695	1244	4943	1099	6021	924	6595	786	7142	579	8623	443	4478
3E		MI	1887	1244	2787	1022	3195	857	3395	726	3556	529	4021	361	2229
8-#8	1.32	MA	3577	1244	4696	1107	5678	936	6175	797	6567	584	7922	411	4450
4L-2S		MI	1977	1244	2948	1018	3400	854	3642	725	3890	526	4430	419	2218
8-#9	1.67	MA	4079	1293	5695	1120	6963	937	7730	792	8669	566	10733	491	5608
2L-4S		MI	1866	1293	2776	1053	3155	884	3339	743	3472	522	3936	292	2743
8-#9	1.67	MA	3820	1293	5240	1129	6385	946	7030	800	7724	578	9424	424	5593
3E		MI	1932	1293	2920	1049	3354	876	3582	737	3804	524	4302	326	2739
8-#9	1.67	MA	3676	1293	4929	1139	5953	961	6500	813	6998	584	8537	383	5526
4L-2S		MI	2042	1293	3122	1044	3610	873	3892	736	4222	521	4808	399	2728
8-#10	2.12	MA	4291	1355	6191	1156	7578	964	8469	808	9659	561	12099	485	7042
2L-4S		MI	1907	1355	2906	1089	3304	911	3512	759	3698	514	4196	237	3323

RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

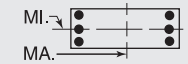
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	2.12	MA	3977	1355	5617	1168	6849	975	7584	818	8466	576	10447	400	7006
3E		MI	1988	1355	3087	1084	3554	901	3818	751	4113	518	4650	279	3373
8-#10	2.12	MA	3802	1355	5223	1181	6302	993	6915	835	7549	584	9323	348	6863
4L-2S		MI	2121	1355	3340	1078	3874	897	4206	750	4636	514	5275	371	3366
8-#11	2.60	MA	4122	1423	6025	1206	7328	1001	8146	833	9206	571	11460	370	8437
3E		MI	2032	1423	3262	1113	3744	919	4033	767	4349	497	4880	207	3984
8-#11	2.60	MA	3919	1423	5547	1220	6665	1023	7333	853	8095	579	10087	305	8026
4L-2S		MI	2180	1423	3561	1108	4124	917	4493	760	4955	493	5590	320	3984
8-#14	3.75	MA	4493	1583	6946	1306	8470	1075	9516	880	11043	567	13994	306	11866
3E		MI	2156	1583	3649	1204	4212	983	4590	808	5030	469	5626	67	5430
8-#14	3.75	MA	4226	1583	6263	1326	7523	1105	8355	908	9455	577	12022	212	10682
4L-2S		MI	2348	1583	4069	1198	4746	982	5236	799	5866	463	6592	230	5472
8-#18	6.67	MA	4989	1988	8008	1596	9625	1313	10866	1044	12807	570	16776	-29	16614
4L-2S		MI	2729	1988	5258	1433	6211	1152	6919	887	7924	370	8747	-41	8716
10-#10	2.65	MA	4245	1429	6191	1214	7578	1008	8469	839	9659	572	12099	395	8700
3L-4S		MI	2017	1429	3158	1135	3625	944	3901	780	4221	510	4821	214	4013
10-#10	2.65	MA	4085	1429	5798	1227	7032	1026	7799	856	8743	580	10976	343	8550
4L-3S		MI	2096	1429	3340	1130	3874	934	4206	772	4636	514	5275	255	4122
10-#10	2.65	MA	3875	1429	5449	1239	6553	1038	7205	866	7917	595	9838	297	7918
5L-2S		MI	2220	1429	3592	1124	4195	931	4595	771	5159	510	5900	348	4125
10-#11	3.25	MA	4254	1513	6242	1276	7548	1064	8403	879	9538	575	12085	299	10023
4L-3S		MI	2153	1513	3561	1169	4124	960	4493	794	4955	490	5590	173	4865
10-#11	3.25	MA	4008	1513	5818	1291	6966	1077	7681	891	8536	592	10700	240	9329
5L-2S		MI	2293	1513	3861	1164	4504	958	4954	786	5561	485	6300	286	4880
10-#14	4.69	MA	4693	1713	7254	1408	8780	1165	9879	945	11513	571	14871	203	13556
4L-3S		MI	2321	1713	4069	1285	4746	1043	5236	845	5866	456	6592	11	6561
10-#14	4.69	MA	4351	1713	6648	1428	7948	1182	8847	961	10080	594	12886	115	12423
5L-2S		MI	2501	1713	4489	1280	5279	1042	5882	837	6703	450	7558	175	6715
12-#10	3.17	MA	4358	1503	6372	1273	7761	1060	8683	877	9936	577	12628	338	10208
4E		MI	2130	1503	3411	1181	3945	978	4290	801	4744	507	5446	190	4710
12-#10	3.17	MA	4151	1503	6024	1285	7283	1071	8089	887	9111	591	11491	292	9595
5L-3S		MI	2198	1503	3592	1176	4195	968	4595	793	5159	510	5900	232	4867
12-#10	3.17	MA	3936	1503	5601	1299	6831	1082	7507	904	8304	599	10392	223	9053
6L-2S		MI	2317	1503	3845	1171	4516	965	4984	793	5682	507	6525	324	4879
12-#11	3.90	MA	4335	1603	6513	1347	7848	1118	8750	917	9979	587	12698	234	11362
5L-3S		MI	2270	1603	3861	1226	4504	1002	4954	820	5561	482	6300	138	5742
12-#11	3.90	MA	4084	1603	6008	1365	7299	1131	8043	937	8999	596	11355	148	10521
6L-2S		MI	2404	1603	4160	1221	4884	1000	5414	812	6167	478	7011	252	5768
12-#14	5.63	MA	4806	1844	7639	1509	9206	1242	10371	998	12137	588	15735	107	15307
5L-3S		MI	2482	1844	4489	1367	5279	1102	5882	883	6703	443	7558	-44	7519
12-#14	5.63	MA	4470	1844	6923	1535	8420	1259	9360	1026	10736	599	13806	-19	13743
6L-2S		MI	2653	1844	4909	1361	5812	1101	6529	874	7539	437	8524	119	7952
14-#10	3.70	MA	4420	1576	6599	1331	8012	1105	8973	909	10304	588	13143	288	11275
5L-4S		MI	2235	1576	3664	1227	4266	1012	4678	822	5267	503	6071	167	5413
14-#10	3.70	MA	4215	1576	6176	1345	7561	1116	8391	925	9497	596	12044	218	10735
6L-3S		MI	2299	1576	3845	1222	4516	1001	4984	815	5682	506	6525	209	5609
14-#10	3.70	MA	4037	1576	5808	1353	7063	1130	7831	935	8715	610	10968	180	10078
7L-2S		MI	2412	1576	4098	1217	4836	998	5372	814	6205	503	7150	301	5628
14-#11	4.55	MA	4414	1694	6703	1421	8181	1172	9112	963	10442	591	13353	142	12555
6L-3S		MI	2386	1694	4160	1282	4884	1043	5414	846	6167	475	7011	104	6617
14-#11	4.55	MA	4207	1694	6257	1430	7587	1191	8431	974	9492	608	12041	93	11618
7L-2S		MI	2514	1694	4459	1277	5263	1041	5874	838	6773	471	7721	217	6653

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

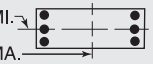
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	6.56	MA	4932	1974	7914	1616	9678	1319	10884	1064	12793	593	16654	-27	16523
6L-3S		MI	2641	1974	4909	1449	5812	1162	6529	921	7539	430	8524	-100	8424
16-#10	4.23	MA	4486	1650	6751	1391	8290	1150	9275	947	10691	592	13697	213	12419
6L-4S		MI	2338	1650	3916	1273	4586	1045	5067	844	5790	499	6696	144	6121
16-#10	4.23	MA	4318	1650	6383	1399	7792	1164	8715	957	9908	607	12621	176	11764
7L-3S		MI	2398	1650	4098	1268	4836	1035	5372	836	6205	502	7150	185	6350
16-#10	4.23	MA	4141	1650	6029	1408	7319	1171	8137	972	9140	621	11585	124	10970
8L-2S		MI	2507	1650	4350	1263	5157	1032	5761	835	6728	499	7775	278	6375
16-#11	5.20	MA	4541	1784	6952	1487	8469	1232	9500	1000	10935	604	14040	87	13643
7L-3S		MI	2501	1784	4459	1339	5263	1084	5874	872	6773	468	7721	70	7490
18-#10	4.76	MA	4592	1724	6958	1445	8522	1198	9599	978	11102	603	14273	171	13449
7L-4S		MI	2439	1724	4169	1319	4907	1079	5455	865	6313	495	7321	120	6833
18-#10	4.76	MA	4417	1724	6604	1454	8048	1205	9021	993	10333	618	13237	119	12651
8L-3S		MI	2496	1724	4350	1314	5157	1069	5761	857	6728	499	7775	162	7089
20-#10	5.29	MA	4687	1797	7179	1500	8778	1239	9905	1014	11527	614	14890	115	14331
8L-4S		MI	2540	1797	4422	1365	5228	1112	5844	886	6836	491	7946	97	7548

RECTANGULAR TIED COLUMNS 16" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.22	MA	4370	1312	5939	1149	7213	966	7925	822	8678	604	10563	526	4701
2E		MI	2060	1312	3120	1053	3538	885	3749	751	3912	542	4353	420	2181
4-#14	1.76	MA	4658	1392	6617	1194	8045	998	8917	842	10004	598	12390	518	6640
2E		MI	2149	1392	3388	1093	3853	913	4120	767	4362	524	4843	372	2971
4-#18	3.13	MA	5325	1595	8276	1311	10090	1083	11366	893	13285	582	16913	499	11402
2E		MI	2342	1595	4008	1200	4594	988	4959	803	5379	471	5898	230	4804
6-#9	1.17	MA	4369	1305	5839	1154	7144	971	7870	827	8630	610	10515	531	4574
2L-3S		MI	1958	1305	2873	1072	3271	900	3449	764	3555	562	3982	374	2144
6-#9	1.17	MA	4074	1305	5347	1164	6520	980	7114	836	7609	623	9103	466	4571
3L-2S		MI	2072	1305	3075	1068	3527	897	3758	763	3974	559	4488	447	2129
6-#10	1.49	MA	4550	1352	6246	1181	7646	990	8470	839	9433	607	11622	527	5744
2L-3S		MI	1994	1352	2990	1097	3406	918	3606	774	3760	557	4210	333	2636
6-#10	1.49	MA	4188	1352	5625	1193	6858	1002	7515	850	8144	622	9837	443	5722
3L-2S		MI	2133	1352	3242	1092	3727	915	3995	773	4283	553	4835	425	2619
6-#11	1.83	MA	4717	1403	6690	1205	8167	1007	9081	849	10239	600	12724	520	6943
2L-3S		MI	2019	1403	3120	1115	3538	928	3749	785	3912	539	4353	272	3121
6-#11	1.83	MA	4293	1403	5939	1220	7213	1021	7925	861	8678	618	10563	414	6899
3L-2S		MI	2179	1403	3420	1110	3918	926	4210	777	4518	535	5063	385	3103
6-#14	2.64	MA	5133	1523	7690	1275	9406	1058	10566	880	12231	591	15473	509	9826
2L-3S		MI	2100	1523	3388	1181	3853	973	4120	813	4362	517	4843	153	4243
6-#14	2.64	MA	4564	1523	6617	1296	8045	1077	8917	896	10004	616	12390	355	9687
3L-2S		MI	2308	1523	3808	1175	4386	972	4766	805	5198	511	5808	316	4247
6-#18	4.69	MA	5219	1827	8276	1490	10090	1219	11366	986	13285	611	16913	200	16271
3L-2S		MI	2595	1827	4714	1345	5490	1094	6027	867	6735	437	7412	109	6904
8-#8	1.23	MA	4414	1315	5907	1162	7245	977	7999	832	8811	611	10771	532	4822
2L-4S		MI	1947	1315	2825	1086	3209	915	3378	776	3461	563	3912	365	2258
8-#8	1.23	MA	4182	1315	5517	1170	6750	985	7399	839	8001	621	9650	480	4819
3E		MI	2001	1315	2940	1082	3368	908	3571	771	3726	564	4207	393	2246
8-#8	1.23	MA	4053	1315	5252	1178	6381	997	6947	850	7382	627	8898	449	4791
4L-2S		MI	2091	1315	3101	1078	3572	906	3819	769	4060	562	4617	450	2235
8-#9	1.56	MA	4602	1363	6330	1190	7768	998	8626	844	9650	608	11928	527	6040
2L-4S		MI	1979	1363	2930	1113	3328	935	3515	788	3642	557	4122	323	2766
8-#9	1.56	MA	4319	1363	5839	1200	7144	1007	7870	853	8630	620	10515	462	6025
3E		MI	2045	1363	3075	1109	3527	927	3758	781	3974	560	4488	357	2759
8-#9	1.56	MA	4162	1363	5504	1210	6679	1022	7299	867	7849	627	9566	422	5958
4L-2S		MI	2156	1363	3276	1104	3782	924	4068	780	4392	557	4993	430	2747

RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis

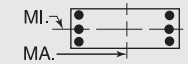


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	1.98	MA	4836	1426	6867	1227	8433	1024	9425	860	10722	603	13407	522	7590
2L-4S		MI	2020	1426	3061	1149	3477	962	3689	803	3867	549	4381	268	3385
8-#10	1.98	MA	4491	1426	6246	1240	7646	1036	8470	871	9433	619	11622	438	7554
3E		MI	2101	1426	3242	1144	3727	951	3995	795	4283	553	4835	310	3397
8-#10	1.98	MA	4301	1426	5822	1252	7057	1054	7748	889	8445	627	10418	387	7412
4L-2S		MI	2235	1426	3495	1138	4047	948	4383	794	4806	549	5460	402	3387
8-#11	2.44	MA	4652	1493	6690	1277	8167	1062	9081	887	10239	614	12724	408	9111
3E		MI	2146	1493	3420	1171	3918	969	4210	811	4518	532	5063	237	4015
8-#11	2.44	MA	4431	1493	6175	1292	7453	1084	8205	908	9040	623	11253	344	8762
4L-2S		MI	2295	1493	3719	1166	4297	967	4670	804	5124	527	5773	351	4010
8-#14	3.52	MA	5060	1653	7690	1378	9406	1136	10566	934	12231	610	15473	346	12838
3E		MI	2269	1653	3808	1262	4386	1033	4766	851	5198	504	5808	97	5471
8-#14	3.52	MA	4769	1653	6953	1399	8384	1168	9314	963	10517	622	13359	253	11661
4L-2S		MI	2464	1653	4228	1256	4920	1032	5413	842	6035	498	6774	261	5504
8-#18	6.25	MA	5608	2059	8853	1670	10672	1377	12048	1101	14165	618	18547	16	18455
4L-2S		MI	2844	2059	5420	1490	6386	1200	7095	930	8090	404	8927	-12	8919
10-#10	2.48	MA	4785	1500	6867	1286	8433	1069	9425	892	10722	615	13407	433	9386
3L-4S		MI	2130	1500	3314	1195	3797	995	4078	824	4390	546	5006	244	4073
10-#10	2.48	MA	4610	1500	6443	1298	7845	1088	8703	910	9734	624	12203	382	9236
4L-3S		MI	2207	1500	3495	1190	4047	985	4383	816	4806	549	5460	286	4149
10-#10	2.48	MA	4377	1500	6069	1311	7330	1099	8064	920	8845	639	10981	338	8596
5L-2S		MI	2335	1500	3748	1184	4368	982	4772	816	5329	546	6085	379	4148
10-#11	3.05	MA	4797	1584	6927	1348	8406	1126	9361	934	10600	619	13413	339	10927
4L-3S		MI	2266	1584	3719	1228	4297	1011	4670	837	5124	524	5773	203	4898
10-#11	3.05	MA	4524	1584	6471	1363	7780	1139	8583	946	9520	637	11925	282	10137
5L-2S		MI	2408	1584	4018	1223	4677	1009	5130	830	5730	520	6484	317	4908
10-#14	4.39	MA	5279	1784	8026	1480	9745	1227	10963	1000	12744	616	16442	244	14781
4L-3S		MI	2434	1784	4228	1344	4920	1092	5413	889	6035	490	6774	41	6659
10-#14	4.39	MA	4899	1784	7373	1501	8848	1246	9851	1017	11198	641	14308	160	13604
5L-2S		MI	2617	1784	4648	1338	5453	1091	6059	880	6871	484	7740	205	6749
10-#18	7.81	MA	5832	2291	9574	1850	11470	1514	12970	1195	15336	646	20163	-159	19532
5L-2S		MI	3093	2291	6126	1635	7282	1306	8163	993	9446	370	10441	-133	10321
12-#10	2.98	MA	4909	1573	7064	1344	8633	1121	9658	931	11023	620	13988	377	11063
4E		MI	2242	1573	3566	1241	4118	1029	4466	846	4913	542	5631	221	4769
12-#10	2.98	MA	4679	1573	6689	1357	8118	1133	9018	942	10134	635	12766	333	10411
5L-3S		MI	2312	1573	3748	1236	4368	1019	4772	838	5329	545	6085	263	4895
12-#10	2.98	MA	4445	1573	6229	1371	7632	1145	8393	959	9266	644	11589	264	9875
6L-2S		MI	2432	1573	4000	1230	4688	1016	5160	837	5852	542	6710	355	4903
12-#11	3.66	MA	4882	1674	7223	1420	8734	1181	9739	972	11081	632	14085	276	12339
5L-3S		MI	2384	1674	4018	1285	4677	1052	5130	863	5730	517	6484	169	5777
12-#11	3.66	MA	4607	1674	6670	1437	8143	1194	8978	993	10026	642	12646	191	11473
6L-2S		MI	2520	1674	4318	1279	5057	1050	5591	856	6335	513	7194	282	5798
12-#14	5.27	MA	5396	1914	8445	1583	10209	1305	11500	1055	13425	635	17391	152	16725
5L-3S		MI	2595	1914	4648	1425	5453	1152	6059	926	6871	477	7740	-14	7728
12-#14	5.27	MA	5030	1914	7663	1608	9363	1324	10411	1084	11915	647	15323	27	15164
6L-2S		MI	2769	1914	5069	1419	5986	1151	6705	918	7707	471	8706	149	7988
14-#10	3.47	MA	4973	1647	7310	1403	8906	1167	9973	963	11423	632	14551	328	12228
5L-4S		MI	2348	1647	3819	1287	4439	1062	4855	867	5436	538	6256	198	5471
14-#10	3.47	MA	4749	1647	6849	1417	8420	1178	9348	980	10555	640	13374	259	11692
6L-3S		MI	2413	1647	4000	1282	4688	1052	5160	859	5852	542	6710	240	5639
14-#10	3.47	MA	4555	1647	6453	1425	7877	1192	8745	991	9713	656	12220	224	10955
7L-2S		MI	2529	1647	4253	1276	5009	1049	5549	858	6375	538	7335	332	5654
14-#11	4.27	MA	4969	1765	7422	1493	9097	1235	10134	1019	11586	637	14807	185	13672
6L-3S		MI	2500	1765	4318	1341	5057	1093	5591	889	6335	510	7194	134	6653
14-#11	4.27	MA	4742	1765	6941	1503	8447	1253	9401	1031	10562	655	13399	138	12711
7L-2S		MI	2630	1765	4617	1336	5437	1091	6051	882	6941	506	7904	248	6684
14-#14	6.15	MA	5535	2045	8735	1689	10724	1384	12060	1121	14142	641	18406	19	18297
6L-3S		MI	2755	2045	5069	1507	5986	1212	6705	964	7707	464	8706	-70	8639

RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	6.15	MA	5233	2045	8047	1702	9805	1410	11010	1138	12676	665	16385	-51	16232
7L-2S		MI	2920	2045	5489	1501	6519	1211	7352	955	8543	458	9671	94	9222
16-#10	3.97	MA	5046	1721	7470	1463	9208	1212	10303	1002	11844	637	15159	254	13510
6L-4S		MI	2451	1721	4072	1333	4759	1096	5244	888	5959	534	6881	174	6178
16-#10	3.97	MA	4862	1721	7074	1471	8665	1226	9700	1012	11002	652	14005	219	12777
7L-3S		MI	2513	1721	4253	1328	5009	1086	5549	880	6375	538	7335	216	6380
16-#10	3.97	MA	4666	1721	6693	1480	8155	1234	9068	1027	10175	668	12893	169	11959
8L-2S		MI	2624	1721	4506	1322	5330	1083	5938	879	6898	534	7960	309	6402
16-#11	4.88	MA	5107	1855	7692	1560	9401	1295	10557	1057	12123	651	15559	132	14902
7L-3S		MI	2615	1855	4617	1398	5437	1135	6051	916	6941	503	7904	100	7528
16-#11	4.88	MA	4877	1855	7230	1571	8782	1304	9803	1076	11117	669	14204	69	13913
8L-2S		MI	2740	1855	4916	1392	5817	1133	6512	908	7547	498	8614	214	7567
16-#14	7.03	MA	5746	2175	9120	1784	11166	1469	12660	1176	14903	659	19468	-60	19206
7L-3S		MI	2913	2175	5489	1588	6519	1271	7352	1002	8543	451	9671	-125	9537
18-#10	4.46	MA	5161	1794	7695	1517	9452	1260	10654	1034	12291	649	15789	214	14598
7L-4S		MI	2553	1794	4324	1379	5080	1130	5632	909	6482	530	7506	151	6889
18-#10	4.46	MA	4968	1794	7314	1526	8943	1268	10023	1048	11464	664	14678	165	13775
8L-3S		MI	2611	1794	4506	1374	5330	1120	5938	902	6898	534	7960	193	7121
18-#10	4.46	MA	4751	1794	6944	1537	8447	1277	9398	1056	10623	673	13580	119	12960
9L-2S		MI	2718	1794	4758	1368	5650	1116	6326	901	7421	530	8585	285	7148
18-#11	5.48	MA	5236	1946	7981	1627	9735	1345	10959	1102	12677	665	16364	63	16109
8L-3S		MI	2729	1946	4916	1454	5817	1176	6512	942	7547	495	8614	66	8391
20-#10	4.96	MA	5262	1868	7935	1572	9731	1301	10978	1069	12753	661	16462	160	15590
8L-4S		MI	2654	1868	4577	1425	5401	1163	6021	931	7005	527	8131	128	7603
20-#10	4.96	MA	5055	1868	7565	1583	9235	1310	10353	1077	11912	669	15365	114	14770
9L-3S		MI	2708	1868	4758	1420	5650	1153	6326	923	7421	530	8585	170	7861
22-#10	5.46	MA	5352	1942	8186	1629	10023	1344	11308	1098	13201	666	17150	109	16580
9L-4S		MI	2753	1942	4829	1471	5721	1197	6409	952	7528	523	8756	104	8320

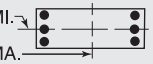
RECTANGULAR TIED COLUMNS 18" x 18"

6-#8	1.46	MA	1544	853	2278	707	2667	593	2887	502	3131	361	3667	296	1882
2L-3S		MI	1437	853	2089	712	2427	597	2595	504	2738	366	3161	239	1889
6-#9	1.85	MA	1603	890	2431	728	2854	607	3109	511	3429	358	4027	285	2327
2L-3S		MI	1473	890	2194	734	2552	612	2744	513	2935	363	3399	212	2329
6-#10	2.35	MA	1675	937	2624	754	3090	626	3391	522	3805	354	4476	269	2887
2L-3S		MI	1518	937	2325	761	2711	632	2932	525	3185	360	3696	177	2875
6-#11	2.89	MA	1734	987	2821	778	3317	643	3656	531	4154	347	4816	239	3433
2L-3S		MI	1554	987	2465	785	2866	648	3108	533	3415	352	3917	126	3404
6-#14	4.17	MA	1891	1107	3277	847	3879	693	4329	561	5040	335	5813	186	4758
2L-3S		MI	1663	1107	2775	857	3243	698	3557	562	4003	342	4577	23	4523
6-#18	7.41	MA	2249	1412	4358	1026	5221	822	5940	641	7040	286	8037	26	7897
2L-3S		MI	1914	1412	3507	1038	4141	826	4631	658	5333	297	6051	-265	5830
8-#8	1.95	MA	1624	899	2468	736	2908	614	3179	515	3525	359	4173	287	2453
2L-4S		MI	1462	899	2144	746	2482	626	2661	525	2822	364	3306	200	2437
8-#9	2.47	MA	1701	948	2669	764	3156	634	3475	527	3922	355	4655	272	3039
2L-4S		MI	1505	948	2263	776	2622	648	2825	539	3040	360	3578	163	2908
8-#10	3.14	MA	1795	1011	2923	800	3469	660	3850	543	4425	351	5256	252	3776
2L-4S		MI	1559	1011	2412	815	2797	677	3033	556	3317	356	3917	114	3466
8-#11	3.85	MA	1870	1078	3177	835	3769	684	4203	557	4892	343	5715	213	4489
2L-4S		MI	1610	1078	2567	849	2967	702	3227	570	3568	345	4166	46	3989

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 18"

Short columns – no sidesway
Bending on major or minor axis

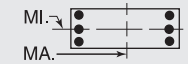


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	3.92	MA	1911	1084	3221	846	3848	694	4310	564	5046	347	6036	235	4660
2L-5S		MI	1610	1084	2520	868	2917	716	3171	581	3492	359	4147	41	4029
10-#10	3.92	MA	1777	1084	2923	853	3469	699	3850	568	4425	353	5256	143	4623
3L-4S		MI	1692	1084	2711	861	3176	711	3492	578	3937	352	4697	97	4299
10-#11	4.81	MA	1853	1168	3177	899	3769	730	4203	585	4892	344	5715	74	5475
3L-4S		MI	1766	1168	2923	906	3418	744	3774	596	4307	341	5065	21	4982
RECTANGULAR TIED COLUMNS 18" x 20"															
4-#9	1.11	MA	1845	912	2627	771	3084	649	3324	553	3553	408	4176	346	1823
2E		MI	1646	912	2385	760	2769	640	2967	545	3151	402	3637	333	1624
4-#10	1.41	MA	1905	943	2779	788	3268	661	3543	560	3844	405	4539	337	2263
2E		MI	1696	943	2517	777	2928	651	3155	552	3401	398	3934	322	2008
4-#11	1.73	MA	1955	976	2945	801	3452	669	3753	564	4117	399	4826	319	2704
2E		MI	1737	976	2660	789	3084	659	3332	555	3630	391	4152	300	2390
4-#14	2.50	MA	2090	1057	3308	845	3894	701	4279	583	4820	391	5652	291	3755
2E		MI	1847	1057	2972	833	3461	690	3781	573	4218	382	4811	263	3298
4-#18	4.44	MA	2387	1259	4174	961	4957	784	5550	633	6512	374	7537	203	6262
2E		MI	2090	1259	3708	947	4361	773	4855	623	5546	347	6282	154	5440
6-#8	1.32	MA	1894	933	2723	787	3215	661	3488	561	3778	408	4491	346	2138
2L-3S		MI	1581	933	2279	781	2643	656	2819	556	2954	407	3399	274	1908
6-#8	1.32	MA	1769	933	2505	793	2938	665	3152	565	3325	414	3887	288	2145
3L-2S		MI	1688	933	2468	777	2883	652	3110	553	3348	402	3906	332	1899
6-#9	1.67	MA	1965	970	2901	807	3432	675	3746	570	4122	405	4928	337	2651
2L-3S		MI	1616	970	2385	802	2769	671	2967	565	3151	404	3637	248	2353
6-#9	1.67	MA	1812	970	2627	814	3084	681	3324	574	3553	412	4176	264	2653
3L-2S		MI	1747	970	2622	797	3070	666	3333	562	3645	399	4265	320	2347
6-#10	2.12	MA	2052	1017	3124	834	3706	694	4073	581	4560	401	5476	325	3298
2L-3S		MI	1661	1017	2517	830	2928	690	3155	576	3401	401	3934	212	2905
6-#10	2.12	MA	1866	1017	2779	842	3268	701	3543	586	3844	410	4539	233	3287
3L-2S		MI	1821	1017	2816	823	3307	685	3615	573	4021	395	4714	305	2909
6-#11	2.60	MA	2126	1067	3358	858	3976	711	4387	590	4973	394	5917	300	3939
2L-3S		MI	1697	1067	2660	853	3084	705	3332	583	3630	393	4152	161	3443
6-#11	2.60	MA	1912	1067	2945	867	3452	718	3753	594	4117	403	4826	187	3909
3L-2S		MI	1880	1067	3016	846	3535	701	3879	581	4369	387	5051	274	3461
6-#14	3.75	MA	2319	1187	3891	927	4635	761	5177	620	6031	385	7162	259	5487
2L-3S		MI	1805	1187	2972	924	3461	755	3781	612	4218	381	4811	58	4670
6-#14	3.75	MA	2046	1187	3308	939	3894	769	4279	625	4820	395	5652	95	5378
3L-2S		MI	2039	1187	3473	914	4098	750	4553	611	5254	375	6047	221	4792
6-#18	6.67	MA	2753	1491	5170	1106	6221	890	7082	700	8576	362	10004	130	9193
2L-3S		MI	2053	1491	3708	1104	4361	882	4855	707	5546	336	6282	-231	6095
6-#18	6.67	MA	2352	1491	4174	1123	4957	900	5550	703	6512	373	7537	-161	7339
3L-2S		MI	2398	1491	4559	1092	5441	879	6164	690	7253	325	8268	60	7943
8-#8	1.76	MA	1989	979	2941	816	3492	682	3823	574	4231	406	5096	340	2794
2L-4S		MI	1605	979	2334	815	2698	685	2884	576	3039	405	3544	236	2467
8-#8	1.76	MA	1869	979	2723	821	3215	686	3488	578	3778	412	4491	282	2795
3E		MI	1666	979	2468	810	2883	676	3110	569	3348	405	3906	266	2477
8-#8	1.76	MA	1800	979	2570	827	3004	695	3229	586	3424	414	4063	251	2778
4L-2S		MI	1769	979	2658	805	3124	673	3402	566	3742	400	4412	323	2472
8-#9	2.22	MA	2081	1028	3175	844	3779	702	4167	586	4691	402	5680	329	3471
2L-4S		MI	1647	1028	2454	845	2838	707	3049	590	3257	401	3816	198	2987
8-#9	2.22	MA	1936	1028	2901	850	3432	707	3746	591	4122	409	4928	256	3462
3E		MI	1721	1028	2622	839	3070	697	3333	581	3645	401	4265	235	3058
8-#9	2.22	MA	1852	1028	2708	857	3166	718	3420	600	3678	411	4395	216	3382
4L-2S		MI	1847	1028	2860	833	3372	693	3699	578	4139	396	4893	308	3061
8-#10	2.82	MA	2195	1090	3469	880	4143	728	4603	602	5276	398	6413	313	4324
2L-4S		MI	1701	1090	2604	883	3014	736	3257	607	3533	396	4154	149	3553
8-#10	2.82	MA	2019	1090	3124	888	3706	735	4073	607	4560	406	5476	221	4298
3E		MI	1791	1090	2816	876	3307	724	3615	597	4021	397	4714	195	3783

RECTANGULAR TIED COLUMNS 18" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

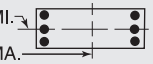
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	2.82	MA	1918	1090	2882	897	3371	748	3663	619	4000	407	4810	171	4036
4L-2S		MI	1943	1090	3115	869	3686	719	4074	594	4641	391	5494	288	3801
8-#11	3.47	MA	2291	1157	3770	914	4499	752	5021	616	5830	390	7007	281	5163
2L-4S		MI	1744	1157	2762	917	3185	760	3451	620	3783	385	4401	82	4085
8-#11	3.47	MA	2090	1157	3358	923	3976	759	4387	621	4973	398	5917	168	5114
3E		MI	1852	1157	3016	910	3535	747	3879	609	4369	388	5051	135	4482
8-#11	3.47	MA	1972	1157	3066	933	3573	775	3894	634	4300	398	5137	110	4658
4L-2S		MI	2018	1157	3372	902	3987	742	4427	607	5108	383	5950	248	4519
8-#14	5.00	MA	2292	1317	3891	1021	4635	829	5177	663	6031	389	7162	63	6972
3E		MI	2012	1317	3473	1005	4098	815	4553	650	5254	374	6047	16	6004
8-#14	5.00	MA	2143	1317	3477	1033	4063	850	4477	680	5076	387	6077	-17	6062
4L-2S		MI	2225	1317	3975	996	4735	810	5324	649	6290	368	7282	179	6273
10-#10	3.53	MA	2335	1164	3814	926	4580	762	5133	624	5991	394	7350	301	5346
2L-5S		MI	1753	1164	2712	936	3134	775	3395	632	3708	399	4385	77	4160
10-#10	3.53	MA	2168	1164	3469	934	4143	768	4603	629	5276	403	6413	209	5308
3L-4S		MI	1834	1164	2903	929	3393	769	3716	629	4153	393	4934	132	4383
10-#10	3.53	MA	2074	1164	3227	943	3808	782	4193	640	4715	404	5747	159	5002
4L-3S		MI	1922	1164	3115	922	3686	757	4074	619	4641	394	5494	178	4658
10-#10	3.53	MA	1972	1164	3010	951	3512	789	3826	645	4207	412	5087	105	4731
5L-2S		MI	2059	1164	3413	915	4065	752	4533	615	5262	388	6274	271	4687
10-#11	4.33	MA	2270	1248	3770	980	4499	800	5021	647	5830	394	7007	149	6318
3L-4S		MI	1907	1248	3118	974	3636	801	3998	646	4522	381	5300	56	5075
10-#11	4.33	MA	2156	1248	3478	989	4096	816	4528	660	5156	394	6227	91	5815
4L-3S		MI	1997	1248	3372	966	3987	788	4427	635	5108	384	5950	109	5519
10-#14	6.25	MA	2400	1448	4060	1114	4803	909	5374	718	6287	380	7587	-49	7515
4L-3S		MI	2212	1448	3975	1087	4735	875	5324	687	6290	367	7282	-27	7244
12-#10	4.23	MA	2320	1237	3814	980	4580	802	5133	650	5991	399	7350	197	6318
3L-5S		MI	1883	1237	3011	982	3513	808	3854	653	4329	396	5165	60	4980
12-#10	4.23	MA	2226	1237	3571	989	4246	816	4723	662	5431	400	6684	147	5975
4E		MI	1972	1237	3201	975	3772	803	4176	650	4773	389	5714	115	5220
12-#10	4.23	MA	2126	1237	3355	997	3949	822	4356	667	4923	409	6024	93	5706
5L-3S		MI	2044	1237	3413	968	4065	791	4533	640	5262	390	6274	161	5531
12-#11	5.20	MA	2346	1338	3891	1046	4619	857	5163	686	6012	389	7318	72	6981
4E		MI	2058	1338	3473	1030	4088	843	4545	672	5261	376	6199	30	6074
14-#10	4.94	MA	2387	1311	3916	1035	4683	849	5253	683	6147	397	7621	135	6953
4L-5S		MI	2017	1311	3310	1028	3892	842	4314	674	4949	392	5945	43	5806
14-#10	4.94	MA	2275	1311	3699	1043	4387	856	4886	688	5638	405	6961	81	6672
5L-4S		MI	2098	1311	3500	1021	4151	837	4635	671	5393	386	6494	98	6063
RECTANGULAR TIED COLUMNS 18" x 22"															
4-#9	1.01	MA	2220	991	3092	851	3659	717	3953	612	4221	455	5013	393	2039
2E		MI	1790	991	2575	829	2985	698	3191	596	3368	442	3875	368	1641
4-#10	1.28	MA	2291	1022	3266	867	3869	729	4202	619	4553	452	5442	386	2537
2E		MI	1840	1022	2709	845	3145	710	3379	603	3617	439	4171	357	2027
4-#11	1.58	MA	2352	1056	3457	881	4082	737	4445	623	4869	446	5798	371	3041
2E		MI	1881	1056	2855	857	3302	717	3556	605	3845	431	4387	335	2413
4-#14	2.27	MA	2511	1136	3873	925	4589	769	5050	642	5676	439	6790	348	4241
2E		MI	1993	1136	3168	900	3680	748	4005	623	4432	422	5045	298	3327
4-#18	4.04	MA	2869	1339	4873	1041	5817	852	6517	692	7640	422	9095	277	7126
2E		MI	2237	1339	3908	1013	4581	829	5079	672	5759	385	6513	188	5480

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

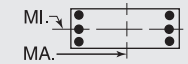
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.20	MA	2277	1013	3200	867	3806	729	4136	620	4474	455	5375	394	2393
2L-3S		MI	1724	1013	2468	850	2859	714	3042	607	3171	448	3638	310	1926
6-#8	1.20	MA	2133	1013	2953	873	3493	734	3757	625	3961	462	4672	337	2401
3L-2S		MI	1832	1013	2658	846	3100	711	3334	605	3565	443	4144	368	1916
6-#9	1.52	MA	2360	1049	3402	887	4052	743	4430	629	4866	452	5890	387	2975
2L-3S		MI	1760	1049	2575	871	2985	729	3191	616	3368	445	3875	283	2375
6-#9	1.52	MA	2184	1049	3092	895	3659	750	3953	634	4221	461	5013	315	2977
3L-2S		MI	1892	1049	2813	865	3287	725	3556	613	3861	439	4503	356	2366
6-#10	1.92	MA	2462	1096	3656	913	4365	762	4803	640	5364	448	6537	378	3709
2L-3S		MI	1804	1096	2709	898	3145	748	3379	627	3617	441	4171	248	2933
6-#10	1.92	MA	2248	1096	3266	923	3869	770	4202	647	4553	459	5442	286	3698
3L-2S		MI	1966	1096	3008	891	3524	743	3838	624	4237	435	4951	340	2931
6-#11	2.36	MA	2551	1147	3926	937	4677	779	5166	649	5843	441	7082	357	4444
2L-3S		MI	1840	1147	2855	921	3302	763	3556	633	3845	433	4387	196	3479
6-#11	2.36	MA	2302	1147	3457	948	4082	787	4445	656	4869	452	5798	244	4415
3L-2S		MI	2026	1147	3211	913	3753	758	4103	631	4584	427	5286	309	3487
6-#14	3.41	MA	2783	1267	4538	1007	5433	829	6072	680	7056	432	8578	324	6216
2L-3S		MI	1948	1267	3168	991	3680	812	4005	662	4432	421	5045	92	4759
6-#14	3.41	MA	2451	1267	3873	1021	4589	840	5050	687	5676	446	6790	161	6107
3L-2S		MI	2186	1267	3670	981	4317	807	4777	661	5469	415	6281	256	4825
6-#18	6.06	MA	3297	1571	6014	1186	7265	958	8272	759	10009	411	12050	220	10489
2L-3S		MI	2192	1571	3908	1169	4581	938	5079	756	5759	375	6513	-197	6359
6-#18	6.06	MA	2826	1571	4873	1207	5817	973	6517	768	7640	429	9095	-71	8979
3L-2S		MI	2546	1571	4760	1158	5662	935	6388	739	7466	364	8499	94	7988
8-#8	1.60	MA	2388	1058	3447	895	4120	750	4516	633	4986	453	6079	390	3135
2L-4S		MI	1748	1058	2524	884	2915	743	3108	627	3256	446	3783	272	2494
8-#8	1.60	MA	2249	1058	3200	901	3806	755	4136	638	4474	460	5375	333	3137
3E		MI	1809	1058	2658	879	3100	735	3334	620	3565	445	4144	301	2497
8-#8	1.60	MA	2170	1058	3028	908	3569	765	3845	647	4076	463	4880	300	3119
4L-2S		MI	1914	1058	2848	874	3340	732	3626	618	3958	441	4651	359	2491
8-#9	2.02	MA	2495	1107	3712	923	4446	770	4907	646	5510	449	6767	382	3903
2L-4S		MI	1790	1107	2645	913	3055	766	3272	641	3473	442	4054	234	3060
8-#9	2.02	MA	2327	1107	3402	931	4052	776	4430	651	4866	458	5890	309	3894
3E		MI	1865	1107	2813	907	3287	756	3556	632	3861	442	4503	271	3083
8-#9	2.02	MA	2231	1107	3186	939	3753	788	4064	662	4365	461	5272	268	3846
4L-2S		MI	1992	1107	3051	902	3589	751	3922	630	4355	437	5131	344	3082
8-#10	2.57	MA	2628	1170	4047	959	4860	796	5404	662	6175	445	7633	370	4873
2L-4S		MI	1843	1170	2796	951	3231	794	3480	658	3749	437	4392	185	3637
8-#10	2.57	MA	2425	1170	3656	969	4365	804	4803	668	5364	455	6537	278	4847
3E		MI	1934	1170	3008	944	3524	782	3838	648	4237	438	4951	231	3814
8-#10	2.57	MA	2309	1170	3384	978	3987	819	4340	681	4732	458	5764	226	4621
4L-2S		MI	2088	1170	3306	937	3903	777	4298	645	4858	432	5731	323	3826
8-#11	3.15	MA	2745	1237	4395	994	5272	820	5888	675	6816	437	8365	344	5837
2L-4S		MI	1885	1237	2956	985	3403	818	3674	670	3999	425	4637	117	4178
8-#11	3.15	MA	2510	1237	3926	1004	4677	829	5166	682	5843	448	7082	230	5788
3E		MI	1996	1237	3211	977	3753	804	4103	659	4584	428	5286	170	4521
8-#11	3.15	MA	2375	1237	3597	1015	4222	846	4609	697	5082	450	6170	169	5343
4L-2S		MI	2165	1237	3567	970	4205	800	4651	657	5323	423	6185	283	4549
8-#14	4.55	MA	2739	1397	4538	1102	5433	899	6072	725	7056	440	8578	137	8043
3E		MI	2155	1397	3670	1072	4317	872	4777	700	5469	414	6281	50	6141
8-#14	4.55	MA	2561	1397	4070	1117	4786	923	5280	745	5974	441	7304	51	7067
4L-2S		MI	2374	1397	4172	1063	4954	867	5548	698	6505	408	7516	214	6309
10-#10	3.21	MA	2791	1243	4438	1005	5356	829	6004	683	6986	441	8728	362	6032
2L-5S		MI	1895	1243	2904	1005	3351	833	3619	683	3925	440	4622	113	4245

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

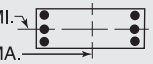
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	3.21	MA	2597	1243	4047	1015	4860	837	5404	689	6175	451	7633	270	5994
3L-4S		MI	1976	1243	3095	998	3610	828	3940	680	4369	433	5172	168	4464
10-#10	3.21	MA	2490	1243	3774	1024	4483	852	4941	702	5544	455	6859	218	5720
4L-3S		MI	2061	1243	3306	990	3903	816	4298	669	4858	434	5731	214	4691
10-#10	3.21	MA	2367	1243	3531	1034	4150	860	4529	709	4972	465	6088	164	5383
5L-2S		MI	2207	1243	3605	983	4282	811	4757	666	5478	428	6511	306	4713
10-#11	3.94	MA	2712	1327	4395	1061	5272	870	5888	708	6816	444	8365	217	7160
3L-4S		MI	2049	1327	3312	1041	3855	859	4222	696	4738	421	5536	91	5165
10-#11	3.94	MA	2588	1327	4066	1072	4817	887	5331	723	6055	446	7454	155	6665
4L-3S		MI	2142	1327	3567	1034	4205	846	4651	686	5323	424	6185	144	5561
10-#11	3.94	MA	2447	1327	3772	1082	4415	896	4833	729	5365	456	6550	88	6241
5L-2S		MI	2301	1327	3922	1026	4657	841	5198	684	6062	419	7084	258	5603
10-#14	5.68	MA	2877	1527	4734	1198	5629	982	6302	783	7354	435	9092	27	8959
4L-3S		MI	2355	1527	4172	1154	4954	932	5548	737	6505	407	7516	8	7492
12-#10	3.85	MA	2765	1317	4438	1061	5356	871	6004	710	6986	448	8728	261	7141
3L-5S		MI	2026	1317	3203	1051	3730	867	4078	704	4545	436	5402	96	5094
12-#10	3.85	MA	2666	1317	4165	1071	4979	886	5542	724	6355	451	7954	209	6827
4E		MI	2106	1317	3393	1044	3989	861	4399	701	4989	430	5952	151	5298
12-#10	3.85	MA	2544	1317	3922	1080	4646	894	5130	730	5783	461	7183	156	6508
5L-3S		MI	2189	1317	3605	1036	4282	849	4757	691	5478	431	6511	197	5566
12-#10	3.85	MA	2402	1317	3649	1096	4331	902	4725	743	5235	471	6476	96	6044
6L-2S		MI	2323	1317	3904	1029	4661	844	5216	688	6098	425	7291	289	5598
12-#11	4.73	MA	2795	1418	4535	1128	5412	928	6052	749	7029	441	8738	141	7995
4E		MI	2200	1418	3668	1098	4306	900	4769	722	5476	416	6435	65	6160
12-#11	4.73	MA	2656	1418	4240	1139	5010	937	5554	755	6339	452	7834	75	7558
5L-3S		MI	2284	1418	3922	1090	4657	887	5198	712	6062	420	7084	119	6599
14-#10	4.49	MA	2838	1391	4556	1117	5475	920	6143	745	7166	448	9050	201	7940
4L-5S		MI	2160	1391	3502	1097	4109	900	4537	725	5165	433	6182	79	5926
14-#10	4.49	MA	2718	1391	4313	1126	5142	928	5731	751	6594	458	8279	147	7636
5L-4S		MI	2241	1391	3692	1090	4368	895	4859	722	5609	426	6732	134	6139
14-#10	4.49	MA	2582	1391	4040	1142	4827	936	5326	765	6046	468	7571	88	7163
6L-3S		MI	2310	1391	3904	1082	4661	883	5216	712	6098	427	7291	180	6440
14-#11	5.52	MA	2873	1508	4709	1195	5605	978	6275	781	7312	448	9118	61	8882
5L-4S		MI	2347	1508	4024	1154	4758	942	5316	749	6215	412	7334	40	7163
16-#10	5.13	MA	2887	1464	4703	1172	5638	961	6332	773	7405	454	9374	139	8768
5E		MI	2285	1464	3800	1143	4488	934	4997	746	5785	429	6962	62	6753
16-#10	5.13	MA	2757	1464	4431	1188	5323	969	5927	786	6858	464	8667	80	8286
6L-4S		MI	2365	1464	3991	1136	4747	929	5318	743	6229	423	7512	117	6984

RECTANGULAR TIED COLUMNS 18" x 24"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.18	MA	2709	1102	3783	947	4512	796	4908	678	5311	499	6405	434	2811
2E		MI	1984	1102	2901	914	3362	768	3602	653	3833	479	4408	393	2045
4-#11	1.44	MA	2781	1136	4001	960	4755	805	5186	682	5671	493	6830	421	3378
2E		MI	2026	1136	3050	924	3520	775	3780	655	4060	472	4623	370	2436
4-#14	2.08	MA	2966	1216	4470	1005	5327	837	5868	701	6581	486	7991	403	4727
2E		MI	2138	1216	3365	967	3899	805	4229	673	4647	461	5279	333	3354
4-#18	3.70	MA	3387	1419	5603	1120	6719	920	7532	751	8808	469	10720	345	7990
2E		MI	2384	1419	4109	1079	4802	885	5302	720	5972	424	6744	222	5520
6-#8	1.10	MA	2693	1092	3708	946	4440	797	4833	679	5219	503	6287	438	2649
2L-3S		MI	1867	1092	2658	920	3075	773	3266	658	3388	489	3877	346	1943
6-#8	1.10	MA	2530	1092	3433	953	4091	802	4409	684	4647	510	5495	381	2657
3L-2S		MI	1976	1092	2848	915	3316	770	3557	656	3781	484	4383	404	1932
6-#9	1.39	MA	2788	1129	3935	966	4716	811	5162	688	5658	499	6892	434	3299
2L-3S		MI	1903	1129	2766	940	3202	788	3414	667	3584	486	4113	319	2396
6-#9	1.39	MA	2588	1129	3588	975	4277	818	4629	694	4939	509	5896	362	3301
3L-2S		MI	2036	1129	3004	934	3504	783	3780	664	4078	480	4741	392	2384

RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

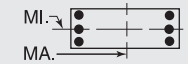
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	1.76	MA	2906	1176	4220	993	5067	830	5580	699	6218	495	7659	429	4121
2L-3S		MI	1947	1176	2901	967	3362	807	3602	678	3833	482	4408	283	2959
6-#10	1.76	MA	2662	1176	3783	1003	4512	839	4908	707	5311	507	6405	337	4110
3L-2S		MI	2111	1176	3200	960	3741	802	4062	675	4454	476	5188	376	2952
6-#11	2.17	MA	3010	1226	4526	1017	5421	847	5994	708	6762	488	8308	412	4950
2L-3S		MI	1983	1226	3050	988	3520	821	3780	684	4060	473	4623	231	3513
6-#11	2.17	MA	2726	1226	4001	1029	4755	856	5186	716	5671	501	6830	298	4920
3L-2S		MI	2172	1226	3406	981	3972	816	4327	682	4799	467	5522	344	3513
6-#14	3.13	MA	3278	1346	5217	1086	6274	897	7016	739	8131	479	10059	385	6945
2L-3S		MI	2090	1346	3365	1058	3899	870	4229	712	4647	461	5279	127	4808
6-#14	3.13	MA	2898	1346	4470	1102	5327	910	5868	749	6581	496	7991	222	6836
3L-2S		MI	2333	1346	3867	1048	4536	864	5000	711	5683	454	6515	291	4857
6-#18	5.56	MA	3879	1650	6889	1265	8351	1026	9510	818	11478	458	14169	301	11785
2L-3S		MI	2332	1650	4109	1235	4802	994	5302	805	5972	414	6744	-163	6620
6-#18	5.56	MA	3335	1650	5603	1290	6719	1045	7532	832	8808	482	10720	11	10690
3L-2S		MI	2694	1650	4960	1224	5882	991	6612	787	7679	403	8730	128	8032
8-#8	1.46	MA	2819	1138	3984	975	4790	817	5257	693	5791	500	7080	435	3477
2L-4S		MI	1891	1138	2714	953	3131	802	3331	679	3472	487	4022	308	2519
8-#8	1.46	MA	2662	1138	3708	982	4440	823	4833	698	5219	508	6287	378	3478
3E		MI	1953	1138	2848	948	3316	794	3557	672	3781	486	4383	337	2517
8-#8	1.46	MA	2573	1138	3518	988	4176	834	4510	707	4777	512	5736	345	3461
4L-2S		MI	2058	1138	3038	943	3556	791	3849	669	4175	482	4889	395	2509
8-#9	1.85	MA	2943	1187	4281	1003	5156	838	5695	705	6378	497	7888	430	4335
2L-4S		MI	1933	1187	2836	982	3271	824	3496	692	3689	483	4292	270	3092
8-#9	1.85	MA	2752	1187	3935	1011	4716	845	5162	711	5658	506	6892	358	4326
3E		MI	2008	1187	3004	976	3504	814	3780	684	4078	483	4741	307	3107
8-#9	1.85	MA	2643	1187	3695	1019	4384	858	4755	723	5102	510	6195	316	4278
4L-2S		MI	2137	1187	3242	970	3805	810	4146	681	4571	477	5369	380	3102
8-#10	2.35	MA	3096	1249	4657	1039	5621	864	6252	721	7125	492	8914	424	5422
2L-4S		MI	1986	1249	2988	1020	3448	853	3704	709	3965	477	4629	220	3718
8-#10	2.35	MA	2864	1249	4220	1049	5067	873	5580	728	6218	504	7659	332	5396
3E		MI	2078	1249	3200	1013	3741	840	4062	699	4454	478	5188	266	3843
8-#10	2.35	MA	2733	1249	3917	1060	4647	889	5066	743	5515	508	6778	278	5219
4L-2S		MI	2234	1249	3498	1006	4120	835	4521	696	5074	472	5968	359	3849
8-#11	2.89	MA	3232	1317	5051	1073	6088	888	6802	734	7853	484	9787	402	6511
2L-4S		MI	2027	1317	3151	1052	3621	875	3898	720	4214	465	4872	152	4268
8-#11	2.89	MA	2964	1317	4526	1085	5421	898	5994	742	6762	497	8308	289	6462
3E		MI	2139	1317	3406	1045	3972	862	4327	710	4799	468	5522	205	4558
8-#11	2.89	MA	2811	1317	4160	1097	4914	916	5373	759	5913	501	7265	224	6044
4L-2S		MI	2312	1317	3761	1037	4423	857	4874	708	5538	463	6421	319	4578
8-#14	4.17	MA	3227	1477	5217	1184	6274	969	7016	787	8131	490	10059	205	9015
3E		MI	2298	1477	3867	1139	4536	929	5000	749	5683	453	6515	85	6264
8-#14	4.17	MA	3026	1477	4694	1200	5552	995	6131	809	6922	494	8595	114	8005
4L-2S		MI	2521	1477	4369	1130	5172	924	5772	748	6719	447	7750	249	6344
8-#18	7.41	MA	3878	1882	6889	1435	8351	1151	9510	899	11478	471	14169	-33	14077
3E		MI	2673	1882	4960	1380	5882	1100	6612	872	7679	393	8730	-256	8470
8-#18	7.41	MA	3592	1882	5983	1461	7098	1193	7976	934	9384	473	11710	-185	11381
4L-2S		MI	2999	1882	5811	1369	6962	1097	7921	854	9386	382	10715	34	10529
10-#10	2.94	MA	3281	1323	5094	1085	6175	897	6924	742	8031	488	10168	419	6718
2L-5S		MI	2038	1323	3096	1073	3568	891	3842	734	4141	480	4859	148	4318
10-#10	2.94	MA	3060	1323	4657	1095	5621	906	6252	749	7125	500	8914	327	6680
3L-4S		MI	2119	1323	3287	1066	3827	886	4163	730	4585	474	5409	203	4542
10-#10	2.94	MA	2939	1323	4354	1106	5201	922	5738	764	6422	505	8032	273	6453
4L-3S		MI	2205	1323	3498	1059	4120	874	4521	720	5074	475	5968	249	4722

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

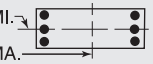
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.94	MA	2795	1323	4084	1116	4832	931	5280	771	5786	516	7150	219	6043
5L-2S		MI	2355	1323	3797	1052	4499	869	4981	717	5694	469	6748	342	4739
10-#11	3.61	MA	3194	1407	5051	1142	6088	939	6802	768	7853	493	9787	279	8002
3L-4S		MI	2190	1407	3507	1109	4073	917	4445	747	4953	461	5771	126	5252
10-#11	3.61	MA	3054	1407	4685	1153	5581	958	6181	785	7004	497	8743	215	7531
4L-3S		MI	2286	1407	3761	1101	4423	903	4874	736	5538	464	6421	180	5600
10-#11	3.61	MA	2888	1407	4358	1165	5134	968	5627	793	6235	509	7703	149	7086
5L-2S		MI	2449	1407	4117	1094	4875	899	5422	734	6277	459	7320	293	5634
10-#14	5.21	MA	3365	1607	5441	1281	6499	1055	7279	847	8471	488	10662	97	10138
4L-3S		MI	2499	1607	4369	1221	5172	989	5772	787	6719	446	7750	43	7620
10-#14	5.21	MA	3135	1607	4974	1298	5861	1068	6488	857	7376	505	9207	2	9201
5L-2S		MI	2707	1607	4870	1211	5809	984	6544	786	7756	440	8986	206	7823
12-#10	3.53	MA	3252	1397	5094	1141	6175	940	6924	771	8031	497	10168	322	7964
3L-5S		MI	2169	1397	3395	1119	3947	925	4302	755	4761	477	5639	131	5165
12-#10	3.53	MA	3139	1397	4791	1152	5755	956	6410	785	7328	501	9287	268	7694
4E		MI	2249	1397	3585	1112	4206	920	4623	752	5205	470	6189	186	5374
12-#10	3.53	MA	2997	1397	4521	1162	5386	965	5952	793	6693	513	8404	214	7303
5L-3S		MI	2334	1397	3797	1105	4499	908	4981	742	5694	471	6748	233	5599
12-#10	3.53	MA	2836	1397	4211	1177	5037	974	5503	807	6071	517	7541	143	6833
6L-2S		MI	2471	1397	4096	1098	4878	903	5440	738	6314	465	7529	325	5625
12-#11	4.33	MA	3290	1497	5211	1210	6248	999	6989	811	8095	492	10222	206	9027
4E		MI	2342	1497	3863	1165	4524	958	4993	773	5692	456	6670	100	6245
12-#11	4.33	MA	3126	1497	4884	1222	5801	1009	6435	819	7326	505	9181	140	8606
5L-3S		MI	2429	1497	4117	1158	4875	945	5422	762	6277	460	7320	154	6640
12-#11	4.33	MA	2938	1497	4517	1241	5378	1019	5892	836	6590	518	8227	66	7909
6L-2S		MI	2583	1497	4473	1150	5326	940	5969	760	7016	454	8219	267	6686
12-#14	6.25	MA	3466	1737	5721	1379	6808	1127	7636	895	8926	499	11274	-16	11245
5L-3S		MI	2696	1737	4870	1302	5809	1048	6544	825	7756	439	8986	1	8984
14-#10	4.12	MA	3335	1470	5227	1198	6310	990	7081	806	8235	498	10541	263	8942
4L-5S		MI	2297	1470	3694	1165	4326	959	4761	776	5381	473	6419	114	6016
14-#10	4.12	MA	3193	1470	4958	1208	5940	998	6623	814	7600	509	9659	209	8568
5L-4S		MI	2385	1470	3884	1158	4585	954	5082	773	5825	467	6969	169	6213
14-#10	4.12	MA	3040	1470	4648	1223	5591	1007	6175	829	6978	514	8796	138	8090
6L-3S		MI	2456	1470	4096	1151	4878	941	5440	763	6314	468	7529	216	6474
14-#11	5.06	MA	3358	1588	5409	1278	6468	1050	7243	845	8417	501	10660	130	10103
5L-4S		MI	2490	1588	4219	1222	4976	999	5540	799	6430	452	7569	75	7245
14-#11	5.06	MA	3179	1588	5042	1297	6045	1060	6700	862	7681	514	9705	56	9423
6L-3S		MI	2570	1588	4473	1214	5326	986	5969	788	7016	455	8219	128	7679
16-#10	4.70	MA	3386	1544	5395	1254	6495	1032	7295	835	8507	506	10913	204	9836
5E		MI	2429	1544	3992	1211	4705	992	5221	797	6001	470	7200	97	6866
16-#10	4.70	MA	3239	1544	5085	1269	6145	1041	6846	850	7885	510	10050	133	9351
6L-4S		MI	2509	1544	4183	1204	4964	987	5542	794	6445	463	7749	152	7056
16-#11	5.78	MA	3415	1678	5567	1354	6712	1101	7508	888	8772	509	11183	47	10941
6L-4S		MI	2635	1678	4575	1278	5427	1041	6087	825	7169	448	8468	49	8251
18-#10	5.29	MA	3434	1617	5521	1315	6700	1075	7518	871	8792	507	11305	128	10614
6L-5S		MI	2552	1617	4291	1257	5084	1026	5680	819	6621	466	7980	80	7696

RECTANGULAR TIED COLUMNS 18" x 26"

4-#10	1.09	MA	3161	1182	4333	1026	5199	864	5663	737	6119	546	7374	475	3086
2E		MI	2128	1182	3093	982	3579	826	3826	704	4050	520	4646	428	2062
4-#11	1.33	MA	3244	1215	4576	1040	5470	873	5974	741	6522	540	7920	469	3715
2E		MI	2170	1215	3245	992	3738	832	4003	706	4276	512	4858	405	2457
4-#14	1.92	MA	3454	1295	5099	1084	6108	905	6734	760	7536	533	9253	455	5213
2E		MI	2283	1295	3562	1034	4118	862	4452	723	4862	501	5513	368	3381
4-#18	3.42	MA	3938	1498	6366	1200	7665	988	8594	810	10026	516	12411	408	8854
2E		MI	2530	1498	4310	1144	5022	941	5526	769	6185	463	6975	256	5560

RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis



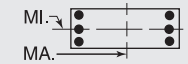
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.01	MA	3141	1172	4249	1026	5118	864	5578	738	6014	550	7238	479	2905
2L-3S		MI	2010	1172	2848	989	3291	832	3489	710	3604	529	4116	382	1959
6-#8	1.01	MA	2959	1172	3945	1033	4732	871	5110	744	5383	558	6363	424	2913
3L-2S		MI	2120	1172	3038	984	3532	829	3781	707	3998	525	4622	439	1948
6-#9	1.28	MA	3249	1208	4499	1046	5423	879	5942	747	6501	546	7907	475	3623
2L-3S		MI	2046	1208	2957	1009	3418	847	3638	718	3800	526	4351	355	2415
6-#9	1.28	MA	3025	1208	4117	1055	4938	887	5353	754	5706	557	6807	405	3625
3L-2S		MI	2181	1208	3195	1003	3720	842	4004	715	4294	521	4979	428	2402
6-#10	1.63	MA	3382	1255	4816	1072	5812	898	6406	759	7121	543	8761	471	4532
2L-3S		MI	2090	1255	3093	1035	3579	865	3826	729	4050	522	4646	319	2983
6-#10	1.63	MA	3108	1255	4333	1084	5199	908	5663	767	6119	555	7374	381	4521
3L-2S		MI	2255	1255	3392	1028	3958	860	4285	726	4670	516	5426	411	2972
6-#11	2.00	MA	3502	1306	5158	1096	6209	914	6869	767	7730	536	9593	463	5455
2L-3S		MI	2126	1306	3245	1056	3738	878	4003	734	4276	513	4858	266	3544
6-#11	2.00	MA	3183	1306	4576	1109	5470	925	5974	777	6522	550	7920	350	5426
3L-2S		MI	2316	1306	3600	1048	4190	874	4551	732	5014	507	5757	379	3538
6-#14	2.88	MA	3807	1426	5927	1166	7159	964	8007	798	9255	526	11602	443	7674
2L-3S		MI	2233	1426	3562	1125	4118	927	4452	762	4862	500	5513	162	4853
6-#14	2.88	MA	3379	1426	5099	1183	6108	979	6734	810	7536	546	9253	280	7565
3L-2S		MI	2479	1426	4064	1115	4755	921	5224	760	5898	494	6749	326	4888
6-#18	5.13	MA	4498	1730	7797	1345	9480	1094	10795	877	12997	505	16356	375	13081
2L-3S		MI	2473	1730	4310	1301	5022	1050	5526	854	6185	453	6975	-128	6880
6-#18	5.13	MA	3853	1730	6366	1373	7665	1117	8594	895	10026	534	12411	85	12146
3L-2S		MI	2841	1730	5161	1289	6102	1047	6835	836	7892	442	8961	162	8075
8-#8	1.35	MA	3284	1217	4553	1054	5504	885	6046	752	6646	547	8112	476	3818
2L-4S		MI	2034	1217	2904	1022	3347	861	3555	730	3689	527	4261	343	2541
8-#8	1.35	MA	3107	1217	4249	1062	5118	892	5578	757	6014	556	7238	421	3819
3E		MI	2096	1217	3038	1017	3532	853	3781	723	3998	527	4622	373	2535
8-#8	1.35	MA	3008	1217	4040	1069	4827	902	5222	767	5528	560	6636	388	3802
4L-2S		MI	2203	1217	3228	1012	3772	849	4073	720	4392	523	5128	431	2526
8-#9	1.71	MA	3423	1266	4882	1082	5909	905	6531	764	7296	544	9007	471	4767
2L-4S		MI	2075	1266	3027	1051	3488	883	3719	743	3906	523	4530	306	3122
8-#9	1.71	MA	3209	1266	4499	1091	5423	913	5942	771	6501	554	7907	401	4758
3E		MI	2152	1266	3195	1045	3720	873	4004	735	4294	523	4979	343	3130
8-#9	1.71	MA	3088	1266	4236	1100	5058	927	5494	783	5888	559	7147	360	4710
4L-2S		MI	2282	1266	3433	1039	4022	869	4369	732	4788	518	5608	415	3122
8-#10	2.17	MA	3597	1329	5299	1119	6424	932	7148	780	8123	539	10149	466	5970
2L-4S		MI	2128	1329	3180	1088	3665	911	3928	760	4181	518	4866	256	3796
8-#10	2.17	MA	3336	1329	4816	1130	5812	941	6406	788	7121	552	8761	376	5944
3E		MI	2221	1329	3392	1081	3958	899	4285	750	4670	519	5426	302	3871
8-#10	2.17	MA	3189	1329	4483	1141	5350	958	5840	804	6347	558	7798	323	5831
4L-2S		MI	2379	1329	3690	1074	4337	894	4745	747	5290	513	6206	394	3871
8-#11	2.67	MA	3753	1396	5740	1153	6948	956	7764	794	8939	531	11266	457	7185
2L-4S		MI	2169	1396	3346	1120	3839	933	4122	771	4429	505	5107	187	4355
8-#11	2.67	MA	3450	1396	5158	1166	6209	967	6869	803	7730	546	9593	344	7135
3E		MI	2278	1396	3600	1112	4190	920	4551	760	5014	508	5757	240	4593
8-#11	2.67	MA	3280	1396	4754	1178	5650	986	6184	821	6794	551	8418	277	6760
4L-2S		MI	2458	1396	3956	1105	4641	915	5098	758	5753	503	6656	354	4605
8-#14	3.85	MA	3749	1556	5927	1265	7159	1039	8007	848	9255	540	11602	268	9987
3E		MI	2441	1556	4064	1206	4755	986	5224	799	5898	493	6749	120	6313
8-#14	3.85	MA	3525	1556	5351	1282	6361	1066	7030	872	7920	546	9948	174	8960
4L-2S		MI	2669	1556	4566	1197	5391	981	5996	798	6934	487	7984	283	6378
8-#18	6.84	MA	4492	1962	7797	1518	9480	1223	10795	962	12997	523	16356	52	16170
3E		MI	2814	1962	5161	1446	6102	1156	6835	920	7892	432	8961	-222	8742

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis

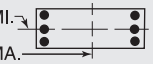


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	6.84	MA	4171	1962	6794	1546	8094	1268	9098	1002	10677	530	13560	-107	13329
4L-2S		MI	3148	1962	6012	1434	7182	1153	8144	903	9600	421	10946	68	10575
10-#10	2.71	MA	3806	1402	5782	1165	7037	965	7891	801	9126	535	11537	461	7403
2L-5S		MI	2180	1402	3288	1142	3785	950	4066	785	4357	521	5097	184	4388
10-#10	2.71	MA	3557	1402	5299	1176	6424	975	7148	810	8123	548	10149	371	7366
3L-4S		MI	2261	1402	3479	1134	4044	945	4387	781	4801	514	5646	239	4618
10-#10	2.71	MA	3421	1402	4966	1187	5962	992	6582	825	7349	554	9186	318	7200
4L-3S		MI	2349	1402	3690	1127	4337	932	4745	771	5290	515	6206	285	4752
10-#10	2.71	MA	3255	1402	4670	1198	5557	1002	6079	834	6650	567	8218	267	6711
5L-2S		MI	2501	1402	3989	1120	4716	927	5204	768	5910	509	6986	377	4764
10-#11	3.33	MA	3710	1487	5740	1222	6948	1008	7764	829	8939	541	11266	338	8845
3L-4S		MI	2333	1487	3702	1176	4291	974	4669	797	5168	501	6006	161	5336
10-#11	3.33	MA	3554	1487	5336	1235	6389	1028	7079	847	8002	547	10091	271	8413
4L-3S		MI	2430	1487	3956	1169	4641	961	5098	786	5753	504	6656	215	5638
10-#11	3.33	MA	3361	1487	4977	1248	5897	1039	6469	856	7156	561	8914	206	7882
5L-2S		MI	2596	1487	4312	1162	5093	956	5645	784	6492	499	7555	328	5664
10-#14	4.81	MA	3906	1687	6179	1364	7412	1126	8303	910	9638	540	12296	162	11335
4L-3S		MI	2643	1687	4566	1288	5391	1046	5996	837	6934	486	7984	78	7745
10-#14	4.81	MA	3639	1687	5666	1382	6709	1141	7432	922	8430	559	10643	67	10376
5L-2S		MI	2856	1687	5067	1278	6028	1041	6767	836	7970	480	9220	241	7859
12-#10	3.26	MA	3772	1476	5782	1222	7037	1009	7891	831	9126	545	11537	366	8787
3L-5S		MI	2312	1476	3587	1188	4164	983	4525	806	4977	517	5877	167	5233
12-#10	3.26	MA	3646	1476	5448	1233	6575	1025	7325	846	8352	551	10574	313	8576
4E		MI	2392	1476	3777	1180	4423	978	4846	803	5421	511	6426	222	5448
12-#10	3.26	MA	3482	1476	5152	1244	6169	1035	6822	855	7653	563	9606	263	8108
5L-3S		MI	2474	1476	3989	1173	4716	966	5204	793	5910	512	6986	268	5630
12-#10	3.26	MA	3302	1476	4805	1258	5786	1045	6328	870	6969	569	8663	192	7639
6L-2S		MI	2619	1476	4288	1166	5095	961	5664	789	6530	506	7766	360	5651
12-#11	4.00	MA	3819	1577	5918	1292	7127	1069	7974	873	9210	543	11764	266	10075
4E		MI	2485	1577	4058	1233	4742	1016	5217	823	5907	496	6905	136	6327
12-#11	4.00	MA	3629	1577	5559	1304	6635	1080	7364	882	8364	557	10587	200	9570
5L-3S		MI	2574	1577	4312	1226	5093	1002	5645	812	6492	500	7555	189	6679
12-#11	4.00	MA	3419	1577	5146	1323	6170	1091	6766	900	7536	563	9437	112	8851
6L-2S		MI	2732	1577	4668	1218	5544	998	6193	810	7231	494	8454	302	6718
12-#14	5.77	MA	4012	1817	6494	1463	7760	1200	8706	960	10149	553	12992	56	12757
5L-3S		MI	2840	1817	5067	1369	6028	1106	6767	875	7970	479	9220	36	9104
14-#10	3.80	MA	3865	1550	5931	1279	7188	1059	8068	868	9354	547	11962	308	9958
4L-5S		MI	2440	1550	3886	1234	4543	1017	4985	827	5597	514	6657	150	6083
14-#10	3.80	MA	3703	1550	5635	1290	6782	1069	7564	876	8655	560	10993	258	9509
5L-4S		MI	2528	1550	4076	1226	4802	1012	5306	824	6041	507	7206	205	6285
14-#10	3.80	MA	3531	1550	5288	1304	6399	1079	7071	892	7972	566	10051	187	9035
6L-3S		MI	2601	1550	4288	1219	5095	1000	5664	814	6530	508	7766	251	6507
14-#10	3.80	MA	3382	1550	4977	1311	5991	1094	6595	900	7308	579	9132	144	8520
7L-2S		MI	2735	1550	4586	1212	5474	995	6123	811	7150	502	8546	343	6535
14-#11	4.67	MA	3890	1667	6141	1361	7374	1121	8260	908	9572	553	12260	194	11262
5L-4S		MI	2633	1667	4414	1289	5194	1057	5764	849	6646	492	7804	110	7325
14-#11	4.67	MA	3690	1667	5728	1379	6909	1132	7662	926	8744	559	11110	106	10536
6L-3S		MI	2715	1667	4668	1282	5544	1044	6193	838	7231	495	8454	163	7719
16-#10	4.34	MA	3919	1623	6118	1336	7395	1102	8307	897	9657	556	12381	253	10913
5E		MI	2573	1623	4184	1280	4922	1051	5444	848	6217	510	7437	133	6936
16-#10	4.34	MA	3755	1623	5770	1350	7011	1112	7813	913	8974	562	11439	182	10434
6L-4S		MI	2653	1623	4375	1273	5181	1046	5765	845	6661	504	7986	188	7126
16-#10	4.34	MA	3613	1623	5460	1357	6604	1128	7338	921	8311	575	10520	140	9924
7L-3S		MI	2721	1623	4586	1265	5474	1033	6123	835	7150	505	8546	234	7383
16-#11	5.33	MA	3954	1758	6310	1436	7647	1174	8557	952	9953	554	12783	100	12224
6L-4S		MI	2778	1758	4770	1346	5645	1098	6311	875	7385	488	8703	84	8329

RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	4.88	MA	3974	1697	6253	1396	7624	1146	8556	934	9976	559	12827	177	11835
6L-5S		MI	2697	1697	4483	1326	5301	1084	5904	870	6837	507	8217	116	7792
18-#10	4.88	MA	3839	1697	5942	1403	7217	1161	8080	942	9313	572	11908	135	11329
7L-4S		MI	2776	1697	4673	1319	5560	1079	6225	866	7282	500	8767	171	7972
20-#10	5.43	MA	4060	1771	6425	1449	7829	1195	8823	964	10315	568	13296	130	12735
7L-5S		MI	2819	1771	4782	1372	5680	1118	6363	891	7457	503	8997	99	8634

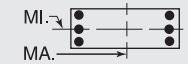
RECTANGULAR TIED COLUMNS 18" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.01	MA	3645	1261	4915	1106	5929	932	6466	797	6976	593	8398	517	3360
2E		MI	2272	1261	3285	1051	3795	885	4050	755	4266	560	4883	464	2079
4-#11	1.24	MA	3739	1295	5183	1119	6229	941	6810	800	7423	587	9003	511	4051
2E		MI	2314	1295	3439	1060	3956	890	4227	756	4491	552	5093	440	2478
4-#14	1.79	MA	3976	1375	5760	1164	6932	973	7647	819	8541	580	10542	502	5699
2E		MI	2428	1375	3759	1101	4337	919	4676	773	5076	541	5747	403	3407
4-#18	3.17	MA	4522	1578	7160	1279	8653	1056	9705	870	11294	563	14165	467	9718
2E		MI	2676	1578	4510	1210	5242	997	5750	818	6399	502	7206	290	5597
6-#9	1.19	MA	3742	1288	5096	1126	6174	947	6770	806	7393	594	8980	516	3947
2L-3S		MI	2189	1288	3148	1078	3635	905	3862	769	4017	567	4589	391	2433
6-#9	1.19	MA	3494	1288	4677	1135	5642	955	6126	814	6523	605	7776	448	3949
3L-2S		MI	2325	1288	3386	1072	3937	901	4227	766	4511	562	5217	463	2419
6-#10	1.51	MA	3892	1335	5444	1152	6600	966	7279	818	8074	590	9918	512	4944
2L-3S		MI	2234	1335	3285	1104	3795	924	4050	780	4266	563	4883	354	3006
6-#10	1.51	MA	3587	1335	4915	1164	5929	976	6466	827	6976	603	8398	424	4933
3L-2S		MI	2400	1335	3584	1097	4175	918	4509	777	4886	557	5663	447	2992
6-#11	1.86	MA	4028	1385	5822	1176	7040	982	7792	827	8748	583	10839	505	5961
2L-3S		MI	2269	1385	3439	1124	3956	936	4227	784	4491	553	5093	301	3573
6-#11	1.86	MA	3672	1385	5183	1189	6229	994	6810	837	7423	598	9003	394	5931
3L-2S		MI	2461	1385	3795	1116	4408	931	4774	782	5230	547	5992	414	3562
6-#14	2.68	MA	4370	1505	6669	1245	8086	1032	9046	857	10429	574	13156	494	8403
2L-3S		MI	2376	1505	3759	1192	4337	984	4676	811	5076	540	5747	197	4895
6-#14	2.68	MA	3892	1505	5760	1264	6932	1049	7647	871	8541	595	10542	332	8294
3L-2S		MI	2625	1505	4261	1182	4973	979	5448	810	6112	534	6982	360	4918
6-#18	4.76	MA	5155	1810	8736	1424	10653	1162	12129	937	14565	552	18610	444	14377
2L-3S		MI	2614	1810	4510	1367	5242	1106	5750	902	6399	492	7206	-94	7138
6-#18	4.76	MA	4425	1810	7160	1455	8653	1188	9705	957	11294	586	14165	154	13643
3L-2S		MI	2988	1810	5361	1355	6322	1103	7059	885	8106	481	9192	196	8117
8-#8	1.25	MA	3780	1297	5154	1134	6260	953	6882	811	7550	595	9202	517	4159
2L-4S		MI	2176	1297	3094	1091	3563	920	3778	781	3906	568	4499	379	2562
8-#8	1.25	MA	3585	1297	4821	1141	5838	960	6370	817	6859	604	8246	464	4161
3E		MI	2240	1297	3228	1086	3748	912	4004	774	4215	568	4861	409	2553
8-#8	1.25	MA	3475	1297	4593	1149	5522	971	5982	827	6328	608	7594	431	4143
4L-2S		MI	2347	1297	3418	1081	3989	908	4296	772	4609	564	5367	466	2543
8-#9	1.59	MA	3937	1346	5515	1162	6705	973	7414	823	8263	591	10185	513	5199
2L-4S		MI	2218	1346	3218	1120	3704	942	3943	794	4122	564	4768	341	3149
8-#9	1.59	MA	3698	1346	5096	1171	6174	982	6770	831	7393	602	8980	444	5190
3E		MI	2295	1346	3386	1114	3937	932	4227	786	4511	564	5217	378	3151
8-#9	1.59	MA	3565	1346	4808	1181	5775	996	6281	844	6724	608	8157	403	5142
4L-2S		MI	2426	1346	3624	1108	4238	927	4593	783	5004	559	5846	451	3142
8-#10	2.02	MA	4131	1408	5972	1198	7271	999	8093	839	9172	586	11438	507	6519
2L-4S		MI	2271	1408	3372	1157	3882	969	4151	811	4397	559	5104	291	3870
8-#10	2.02	MA	3840	1408	5444	1210	6600	1010	7279	848	8074	600	9918	420	6493
3E		MI	2365	1408	3584	1150	4175	957	4509	801	4886	559	5663	338	3897

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis

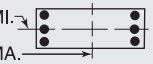


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	2.02	MA	3678	1408	5080	1221	6096	1027	6662	865	7229	607	8875	367	6383
4L-2S		MI	2524	1408	3882	1143	4554	952	4969	798	5506	553	6443	430	3893
8-#11	2.48	MA	4308	1476	6460	1232	7850	1024	8774	853	10074	578	12675	499	7858
2L-4S		MI	2311	1476	3541	1188	4057	991	4346	821	4644	545	5343	222	4439
8-#11	2.48	MA	3970	1476	5822	1246	7040	1036	7792	863	8748	594	10839	388	7809
3E		MI	2421	1476	3795	1180	4408	977	4774	810	5230	548	5992	275	4627
8-#11	2.48	MA	3782	1476	5381	1260	6429	1056	7043	882	7724	601	9565	323	7489
4L-2S		MI	2605	1476	4151	1173	4859	973	5322	808	5968	543	6891	389	4632
8-#14	3.57	MA	4306	1636	6669	1346	8086	1108	9046	909	10429	589	13156	323	10959
3E		MI	2584	1636	4261	1273	4973	1043	5448	849	6112	533	6982	155	6358
8-#14	3.57	MA	4056	1636	6039	1364	7214	1137	7977	935	8967	598	11327	228	9932
4L-2S		MI	2816	1636	4762	1264	5610	1038	6219	848	7149	527	8218	318	6412
8-#18	6.35	MA	5142	2042	8736	1600	10653	1293	12129	1024	14565	575	18610	130	18108
3E		MI	2955	2042	5361	1512	6322	1212	7059	969	8106	471	9192	-188	9012
8-#18	6.35	MA	4736	2042	7638	1631	9133	1341	10267	1067	12021	586	15475	-35	15385
4L-2S		MI	3296	2042	6212	1500	7402	1209	8368	952	9813	460	11177	103	10620
10-#10	2.52	MA	4364	1482	6501	1244	7942	1033	8906	860	10270	583	12959	502	8089
2L-5S		MI	2323	1482	3480	1210	4002	1008	4290	835	4573	561	5334	219	4454
10-#10	2.52	MA	4086	1482	5972	1256	7271	1044	8093	870	9172	596	11438	415	8052
3L-4S		MI	2404	1482	3671	1203	4261	1003	4611	832	5017	555	5884	274	4691
10-#10	2.52	MA	3936	1482	5609	1268	6767	1061	7475	886	8326	603	10395	362	7931
4L-3S		MI	2493	1482	3882	1196	4554	991	4969	822	5506	556	6443	321	4780
10-#10	2.52	MA	3748	1482	5287	1279	6325	1072	6926	895	7564	617	9342	314	7386
5L-2S		MI	2647	1482	4181	1189	4933	986	5428	819	6126	550	7223	413	4788
10-#11	3.10	MA	4260	1566	6460	1303	7850	1077	8774	889	10074	590	12675	382	9687
3L-4S		MI	2467	1566	3897	1244	4509	1032	4893	847	5383	541	6242	196	5418
10-#11	3.10	MA	4086	1566	6019	1316	7239	1097	8026	908	9050	597	11401	317	9309
4L-3S		MI	2574	1566	4151	1237	4859	1019	5322	836	5968	544	6891	250	5673
10-#11	3.10	MA	3867	1566	5628	1330	6702	1110	7360	919	8126	613	10120	255	8688
5L-2S		MI	2743	1566	4507	1229	5311	1014	5869	834	6707	539	7790	363	5694
10-#14	4.46	MA	4481	1766	6949	1446	8368	1197	9376	973	10855	591	13942	219	12550
4L-3S		MI	2787	1766	4762	1355	5610	1103	6219	887	7149	526	8218	112	7819
10-#14	4.46	MA	4177	1766	6389	1465	7601	1213	8424	986	9535	613	12107	126	11579
5L-2S		MI	3004	1766	5264	1345	6247	1098	6991	886	8185	519	9454	276	7895
10-#18	7.94	MA	5505	2273	9214	1776	11133	1447	12691	1134	15293	575	19920	-58	19694
4L-3S		MI	3287	2273	6212	1657	7402	1318	8368	1036	9813	449	11177	-282	10847
12-#10	3.02	MA	4326	1556	6501	1302	7942	1077	8906	891	10270	593	12959	410	9610
3L-5S		MI	2455	1556	3779	1256	4381	1042	4749	857	5193	558	6114	202	5298
12-#10	3.02	MA	4186	1556	6138	1314	7438	1095	8288	907	9424	600	11915	357	9471
4E		MI	2535	1556	3969	1249	4640	1037	5070	854	5637	551	6664	257	5520
12-#10	3.02	MA	4000	1556	5816	1325	6996	1105	7739	916	8662	614	10862	309	8920
5L-3S		MI	2619	1556	4181	1242	4933	1025	5428	843	6126	552	7223	304	5661
12-#10	3.02	MA	3801	1556	5430	1339	6578	1116	7202	933	7917	620	9841	239	8461
6L-2S		MI	2767	1556	4480	1235	5312	1019	5887	840	6746	546	8003	396	5677
12-#11	3.71	MA	4382	1657	6658	1373	8049	1139	9008	934	10376	593	13236	311	11138
4E		MI	2627	1657	4253	1301	4960	1073	5440	873	6122	536	7141	171	6406
12-#11	3.71	MA	4165	1657	6267	1386	7513	1151	8342	945	9451	608	11955	249	10544
5L-3S		MI	2719	1657	4507	1293	5311	1060	5869	863	6707	540	7790	224	6717
12-#11	3.71	MA	3933	1657	5807	1404	7006	1163	7689	964	8548	615	10709	162	9812
6L-2S		MI	2879	1657	4863	1286	5762	1055	6416	860	7446	534	8689	337	6749
12-#14	5.36	MA	4591	1897	7298	1546	8755	1273	9823	1024	11423	607	14722	118	14212
5L-3S		MI	2984	1897	5264	1436	6247	1163	6991	924	8185	519	9454	70	9222
12-#14	5.36	MA	4280	1897	6650	1573	8030	1289	8891	1050	10131	616	12931	-9	12905
6L-2S		MI	3189	1897	5766	1427	6884	1157	7763	923	9221	512	10690	234	9373
14-#10	3.53	MA	4430	1629	6666	1360	8109	1128	9102	928	10522	596	13435	352	10989
4L-5S		MI	2583	1629	4078	1302	4760	1075	5208	878	5813	554	6894	185	6147
14-#10	3.53	MA	4246	1629	6344	1371	7667	1139	8553	938	9760	610	12382	305	10458
5L-4S		MI	2663	1629	4268	1295	5019	1070	5529	875	6257	548	7444	241	6354

RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	3.53	MA	4056	1629	5959	1385	7249	1149	8015	954	9015	617	11361	234	9996
6L-3S		MI	2747	1629	4480	1288	5312	1058	5887	865	6746	549	8003	287	6539
14-#10	3.53	MA	3890	1629	5620	1393	6797	1164	7497	963	8292	631	10364	195	9427
7L-2S		MI	2883	1629	4778	1281	5691	1053	6347	862	7366	543	8783	379	6562
14-#11	4.33	MA	4455	1747	6905	1443	8323	1192	9324	971	10777	604	13791	243	12404
5L-4S		MI	2776	1747	4609	1357	5412	1115	5988	899	6861	532	8040	145	7402
14-#11	4.33	MA	4234	1747	6446	1461	7816	1204	8672	990	9873	611	12544	156	11668
6L-3S		MI	2861	1747	4863	1350	5762	1101	6416	889	7446	535	8689	198	7758
14-#11	4.33	MA	4041	1747	6035	1469	7277	1223	8042	1000	8996	627	11329	104	10882
7L-2S		MI	3014	1747	5219	1342	6214	1097	6964	887	8185	530	9589	312	7800
14-#14	6.25	MA	4701	2027	7559	1654	9184	1349	10289	1088	12019	609	15546	-17	15466
6L-3S		MI	3179	2027	5766	1518	6884	1222	7763	962	9221	511	10690	28	10593
16-#10	4.03	MA	4486	1703	6873	1417	8338	1172	9366	959	10858	607	13902	300	11998
5E		MI	2718	1703	4376	1348	5139	1109	5668	899	6433	551	7674	168	6999
16-#10	4.03	MA	4304	1703	6488	1431	7920	1183	8829	975	10113	613	12882	229	11533
6L-4S		MI	2797	1703	4567	1341	5398	1104	5989	896	6878	544	8224	224	7194
16-#10	4.03	MA	4147	1703	6149	1439	7468	1198	8310	984	9390	627	11884	190	10980
7L-3S		MI	2867	1703	4778	1334	5691	1092	6347	886	7366	545	8783	270	7415
16-#10	4.03	MA	3988	1703	5822	1447	7031	1205	7786	1000	8680	641	10924	136	10272
8L-2S		MI	2998	1703	5077	1327	6070	1087	6806	883	7986	539	9563	362	7445
16-#11	4.95	MA	4528	1837	7084	1517	8626	1245	9654	1016	11199	607	14380	150	13527
6L-4S		MI	2922	1837	4964	1414	5864	1156	6535	925	7600	528	8939	119	8405
16-#11	4.95	MA	4345	1837	6673	1526	8088	1264	9024	1026	10322	623	13164	98	12744
7L-3S		MI	3000	1837	5219	1406	6214	1143	6964	915	8185	531	9589	173	8799
18-#10	4.54	MA	4547	1777	7017	1478	8591	1217	9642	996	11211	610	14402	225	13073
6L-5S		MI	2842	1777	4675	1394	5518	1143	6127	920	7053	547	8454	151	7854
18-#10	4.54	MA	4397	1777	6677	1485	8139	1231	9124	1006	10488	624	13404	185	12533
7L-4S		MI	2921	1777	4865	1387	5777	1138	6448	917	7498	541	9004	207	8039
18-#10	4.54	MA	4241	1777	6351	1494	7702	1238	8599	1021	9778	638	12444	131	11818
8L-3S		MI	2986	1777	5077	1380	6070	1125	6806	907	7986	542	9563	253	8291
18-#11	5.57	MA	4643	1928	7312	1582	8898	1306	10007	1052	11647	618	15000	92	14605
7L-4S		MI	3065	1928	5320	1470	6315	1197	7082	952	8339	523	9838	94	9412
20-#10	5.04	MA	4643	1850	7206	1531	8810	1265	9937	1027	11586	620	14924	180	14084
7L-5S		MI	2964	1850	4974	1440	5897	1176	6587	942	7673	544	9234	134	8711
20-#10	5.04	MA	4488	1850	6880	1540	8373	1272	9413	1043	10875	634	13965	127	13365
8L-4S		MI	3042	1850	5164	1433	6156	1171	6908	939	8118	537	9784	190	8887
22-#10	5.54	MA	4731	1924	7408	1586	9044	1306	10226	1064	11973	631	15485	122	14911
8L-5S		MI	3084	1924	5272	1486	6276	1210	7046	963	8294	540	10014	117	9570

RECTANGULAR TIED COLUMNS 18" x 30"

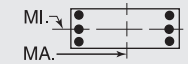
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.16	MA	4266	1374	5822	1199	7031	1009	7694	860	8373	634	10145	552	4388
2E		MI	2458	1374	3634	1127	4174	948	4451	806	4706	592	5329	475	2498
4-#14	1.67	MA	4530	1454	6452	1243	7800	1041	8609	879	9595	627	11826	544	6185
2E		MI	2572	1454	3956	1168	4555	976	4900	822	5291	580	5981	437	3432
4-#18	2.96	MA	5140	1657	7986	1359	9685	1124	10863	929	12611	611	15981	524	10582
2E		MI	2822	1657	4711	1276	5462	1053	5974	867	6612	541	7437	324	5633
6-#9	1.11	MA	4268	1367	5724	1205	6967	1015	7646	865	8335	641	10111	558	4271
2L-3S		MI	2332	1367	3339	1146	3851	964	4085	820	4233	608	4827	426	2451
6-#9	1.11	MA	3995	1367	5269	1215	6389	1024	6946	874	7390	652	8803	491	4273
3L-2S		MI	2469	1367	3577	1140	4153	959	4451	817	4727	602	5455	499	2436

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis

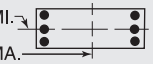


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	1.41	MA	4434	1414	6103	1232	7431	1034	8201	877	9076	637	11133	553	5355
2L-3S		MI	2377	1414	3477	1172	4012	982	4273	831	4482	603	5120	390	3027
6-#10	1.41	MA	4098	1414	5528	1244	6702	1045	7317	887	7883	651	9481	468	5344
3L-2S		MI	2544	1414	3776	1165	4391	977	4733	827	5102	597	5900	482	3012
6-#11	1.73	MA	4587	1465	6517	1255	7914	1050	8763	886	9816	630	12143	546	6466
2L-3S		MI	2412	1465	3634	1191	4174	994	4451	834	4706	593	5329	336	3601
6-#11	1.73	MA	4193	1465	5822	1270	7031	1063	7694	897	8373	647	10145	438	6437
3L-2S		MI	2606	1465	3990	1184	4626	989	4998	832	5445	587	6228	450	3586
6-#14	2.50	MA	4968	1585	7443	1325	9057	1100	10134	916	11652	621	14675	535	9132
2L-3S		MI	2513	1585	3956	1259	4555	1041	4900	861	5291	579	5981	232	4934
6-#14	2.50	MA	4439	1585	6452	1345	7800	1118	8609	932	9595	644	11826	377	9023
3L-2S		MI	2771	1585	4458	1249	5192	1036	5672	860	6327	573	7216	395	4947
6-#18	4.44	MA	5849	1889	9707	1504	11869	1230	13510	996	16183	599	20928	509	15673
2L-3S		MI	2755	1889	4711	1432	5462	1162	5974	951	6612	531	7437	-60	7395
6-#18	4.44	MA	5032	1889	7986	1537	9685	1258	10863	1019	12611	636	15981	218	15179
3L-2S		MI	3136	1889	5562	1421	6542	1159	7283	934	8319	520	9423	231	8159
8-#8	1.17	MA	4310	1377	5786	1213	7060	1021	7767	870	8504	642	10351	559	4501
2L-4S		MI	2319	1377	3284	1160	3779	979	4002	833	4122	609	4738	415	2581
8-#8	1.17	MA	4095	1377	5425	1221	6602	1028	7211	877	7754	651	9312	506	4502
3E		MI	2383	1377	3418	1155	3964	971	4228	826	4431	609	5099	445	2570
8-#8	1.17	MA	3974	1377	5178	1229	6259	1040	6791	887	7178	656	8610	474	4484
4L-2S		MI	2491	1377	3607	1150	4205	967	4520	823	4825	604	5606	502	2560
8-#9	1.48	MA	4483	1425	6179	1241	7544	1041	8346	882	9280	638	11420	554	5631
2L-4S		MI	2361	1425	3409	1188	3921	1000	4167	845	4339	605	5006	377	3175
8-#9	1.48	MA	4220	1425	5724	1251	6967	1050	7646	890	8335	650	10111	487	5622
3E		MI	2439	1425	3577	1183	4153	990	4451	837	4727	605	5455	414	3171
8-#9	1.48	MA	4074	1425	5413	1261	6535	1064	7116	904	7610	656	9225	446	5574
4L-2S		MI	2571	1425	3815	1177	4455	986	4816	834	5221	600	6084	487	3160
8-#10	1.88	MA	4698	1488	6678	1278	8161	1067	9085	898	10270	633	12786	548	7068
2L-4S		MI	2413	1488	3564	1225	4099	1028	4375	862	4613	599	5341	327	3904
8-#10	1.88	MA	4378	1488	6103	1290	7431	1078	8201	908	9076	648	11133	463	7041
3E		MI	2508	1488	3776	1218	4391	1016	4733	852	5102	600	5900	373	3922
8-#10	1.88	MA	4200	1488	5709	1302	6885	1096	7531	925	8160	656	10009	411	6931
4L-2S		MI	2669	1488	4074	1211	4771	1011	5192	849	5722	594	6680	465	3915
8-#11	2.31	MA	4896	1555	7212	1312	8796	1091	9832	912	11259	625	14141	540	8532
2L-4S		MI	2453	1555	3736	1255	4275	1048	4569	871	4860	585	5578	257	4521
8-#11	2.31	MA	4523	1555	6517	1326	7914	1104	8763	923	9816	642	12143	432	8483
3E		MI	2564	1555	3990	1248	4626	1035	4998	861	5445	588	6228	310	4658
8-#11	2.31	MA	4316	1555	6039	1341	7251	1126	7951	943	8705	651	10770	367	8232
4L-2S		MI	2750	1555	4346	1240	5077	1030	5545	858	6184	583	7127	424	4658
8-#14	3.33	MA	4895	1715	7443	1426	9057	1177	10134	969	11652	638	14675	368	11931
3E		MI	2728	1715	4458	1340	5192	1101	5672	899	6327	572	7216	189	6402
8-#14	3.33	MA	4621	1715	6760	1446	8110	1207	8973	997	10064	648	12703	274	10920
4L-2S		MI	2963	1715	4959	1331	5829	1095	6443	898	7363	566	8452	353	6444
8-#18	5.93	MA	5827	2121	9707	1682	11869	1364	13510	1086	16183	625	20928	203	20088
3E		MI	3096	2121	5562	1577	6542	1268	7283	1018	8319	510	9423	-154	9279
8-#18	5.93	MA	5376	2121	8513	1714	10216	1414	11485	1132	13414	640	17453	32	17252
4L-2S		MI	3444	2121	6413	1566	7622	1265	8592	1001	10026	499	11409	137	10665
10-#10	2.35	MA	4955	1562	7253	1324	8890	1101	9969	919	11463	630	14438	544	8775
2L-5S		MI	2466	1562	3672	1279	4219	1067	4513	886	4789	602	5571	255	4519
10-#10	2.35	MA	4649	1562	6678	1336	8161	1112	9085	929	10270	644	12786	458	8737
3L-4S		MI	2547	1562	3863	1271	4478	1061	4834	883	5233	596	6121	310	4763
10-#10	2.35	MA	4483	1562	6284	1348	7615	1130	8415	946	9353	652	11662	406	8617
4L-3S		MI	2637	1562	4074	1264	4771	1049	5192	873	5722	596	6680	356	4808
10-#10	2.35	MA	4273	1562	5936	1360	7136	1141	7821	956	8528	667	10524	360	8070
5L-2S		MI	2792	1562	4373	1257	5150	1044	5652	870	6342	590	7460	448	4811
10-#11	2.89	MA	4843	1646	7212	1383	8796	1146	9832	949	11259	638	14141	426	10530
3L-4S		MI	2609	1646	4092	1312	4727	1090	5117	897	5598	581	6477	231	5497

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis

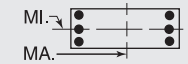


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.89	MA	4652	1646	6734	1397	8133	1167	9020	969	10148	646	12768	362	10219
4L-3S		MI	2719	1646	4346	1304	5077	1076	5545	887	6184	584	7127	285	5708
10-#11	2.89	MA	4406	1646	6311	1411	7551	1180	8298	980	9146	663	11383	303	9502
5L-2S		MI	2890	1646	4702	1297	5529	1072	6093	885	6923	579	8026	398	5722
10-#14	4.17	MA	5090	1846	7751	1528	9367	1267	10497	1035	12121	642	15552	266	13782
4L-3S		MI	2931	1846	4959	1422	5829	1160	6443	936	7363	565	8452	147	7864
10-#14	4.17	MA	4747	1846	7144	1548	8536	1285	9465	1050	10689	665	13567	178	12811
5L-2S		MI	3152	1846	5461	1412	6466	1155	7215	935	8399	559	9688	311	7930
10-#18	7.41	MA	6227	2353	10234	1859	12399	1520	14132	1199	16987	629	22399	17	22288
4L-3S		MI	3429	2353	6413	1722	7622	1374	8592	1085	10026	488	11409	-248	11126
10-#18	7.41	MA	5595	2353	9172	1892	10945	1548	12328	1223	14484	666	18919	-151	18385
5L-2S		MI	3749	2353	7264	1711	8702	1371	9901	1068	11733	477	13394	43	13162
12-#10	2.82	MA	4913	1635	7253	1382	8890	1146	9969	951	11463	641	14438	453	10433
3L-5S		MI	2598	1635	3971	1325	4598	1100	4973	908	5409	598	6351	238	5361
12-#10	2.82	MA	4759	1635	6859	1394	8344	1164	9299	968	10547	649	13314	401	10305
4E		MI	2678	1635	4161	1317	4857	1095	5294	904	5853	592	6901	293	5589
12-#10	2.82	MA	4551	1635	6511	1406	7865	1175	8705	978	9721	663	12177	356	9740
5L-3S		MI	2763	1635	4373	1310	5150	1083	5652	894	6342	593	7460	339	5690
12-#10	2.82	MA	4333	1635	6088	1420	7414	1186	8124	995	8915	671	11078	286	9298
6L-2S		MI	2914	1635	4672	1303	5529	1078	6111	891	6962	587	8241	431	5702
12-#11	3.47	MA	4978	1736	7430	1454	9015	1208	10089	995	11591	642	14766	356	12215
4E		MI	2770	1736	4448	1368	5178	1131	5664	923	6337	576	7376	206	6484
12-#11	3.47	MA	4735	1736	7006	1468	8433	1221	9367	1007	10589	659	13381	297	11526
5L-3S		MI	2864	1736	4702	1361	5529	1118	6093	913	6923	580	8026	259	6753
12-#11	3.47	MA	4479	1736	6500	1485	7884	1234	8661	1027	9609	667	12038	210	10789
6L-2S		MI	3027	1736	5058	1353	5981	1113	6640	911	7661	574	8925	373	6779
12-#14	5.00	MA	5205	1976	8135	1629	9793	1344	10989	1088	12746	659	16416	169	15695
5L-3S		MI	3129	1976	5461	1503	6466	1220	7215	974	8399	558	9688	105	9326
12-#14	5.00	MA	4862	1976	7420	1655	9007	1362	9978	1115	11345	670	14487	43	14249
6L-2S		MI	3338	1976	5963	1494	7102	1215	7987	973	9435	552	10924	269	9410
14-#10	3.29	MA	5027	1709	7434	1440	9073	1197	10184	989	11740	645	14967	396	11996
4L-5S		MI	2727	1709	4270	1371	4977	1134	5432	929	6029	595	7131	221	6209
14-#10	3.29	MA	4822	1709	7085	1452	8595	1209	9589	999	10915	660	13829	351	11415
5L-4S		MI	2806	1709	4460	1363	5236	1129	5753	926	6474	589	7681	276	6422
14-#10	3.29	MA	4613	1709	6662	1466	8143	1220	9008	1016	10108	667	12730	281	10972
6L-3S		MI	2888	1709	4672	1356	5529	1117	6111	916	6962	589	8241	322	6569
14-#10	3.29	MA	4431	1709	6295	1474	7645	1234	8447	1026	9326	682	11654	244	10328
7L-2S		MI	3031	1709	4970	1349	5908	1111	6570	912	7582	583	9021	414	6588
14-#11	4.04	MA	5055	1827	7701	1524	9315	1262	10436	1033	12032	655	15379	291	13555
5L-4S		MI	2919	1827	4803	1425	5630	1172	6211	950	7076	572	8275	180	7478
14-#11	4.04	MA	4811	1827	7195	1542	8766	1275	9730	1053	11052	663	14037	204	12817
6L-3S		MI	3006	1827	5058	1417	5981	1159	6640	939	7661	575	8925	233	7796
14-#11	4.04	MA	4598	1827	6749	1551	8172	1293	9048	1064	10102	680	12725	155	11993
7L-2S		MI	3162	1827	5414	1410	6432	1154	7188	937	8400	570	9824	347	7832
14-#14	5.83	MA	5326	2107	8411	1736	10265	1421	11502	1153	13402	664	17335	35	17145
6L-3S		MI	3324	2107	5963	1585	7102	1279	7987	1012	9435	551	10924	63	10705
16-#10	3.76	MA	5086	1782	7660	1498	9324	1242	10473	1020	12108	656	15482	346	13092
5E		MI	2854	1782	4568	1417	5356	1167	5891	950	6649	591	7912	204	7060
16-#10	3.76	MA	4886	1782	7237	1512	8873	1253	9892	1037	11302	664	14383	276	12649
6L-4S		MI	2942	1782	4759	1409	5615	1162	6213	947	7094	585	8461	259	7261
16-#10	3.76	MA	4713	1782	6869	1520	8375	1268	9331	1047	10519	679	13307	239	12015
7L-3S		MI	3014	1782	4970	1402	5908	1150	6570	937	7582	586	9021	305	7447
16-#10	3.76	MA	4536	1782	6516	1529	7901	1275	8753	1062	9750	693	12271	187	11275
8L-2S		MI	3147	1782	5269	1395	6287	1145	7030	934	8202	580	9801	398	7473
16-#11	4.62	MA	5135	1917	7890	1598	9648	1317	10799	1079	12495	659	16035	198	14847
6L-4S		MI	3065	1917	5159	1481	6082	1214	6759	976	7815	568	9174	154	8479
16-#11	4.62	MA	4934	1917	7444	1608	9054	1335	10117	1090	11545	675	14723	149	14020
7L-3S		MI	3146	1917	5414	1474	6432	1200	7188	965	8400	571	9824	208	8838

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	4.23	MA	5153	1856	7812	1558	9602	1287	10776	1058	12495	660	16035	271	14328
6L-5S		MI	2986	1856	4867	1463	5735	1201	6351	971	7269	588	8692	187	7914
18-#10	4.23	MA	4989	1856	7444	1566	9104	1301	10215	1068	11713	675	14959	234	13702
7L-4S		MI	3065	1856	5057	1455	5994	1196	6672	968	7714	581	9241	242	8104
18-#10	4.23	MA	4814	1856	7091	1575	8631	1309	9638	1083	10944	690	13924	183	12956
8L-3S		MI	3133	1856	5269	1448	6287	1184	7030	958	8202	582	9801	288	8324
18-#11	5.20	MA	5261	2007	8139	1664	9936	1376	11186	1116	12988	671	16721	143	16046
7L-4S		MI	3209	2007	5515	1538	6533	1255	7306	1002	8554	563	10073	129	9485
20-#10	4.70	MA	5259	1930	8019	1612	9834	1335	11100	1090	12906	672	16612	229	15378
7L-5S		MI	3109	1930	5166	1509	6114	1235	6810	993	7890	584	9472	170	8770
20-#10	4.70	MA	5086	1930	7665	1621	9360	1342	10522	1105	12137	686	15576	178	14638
8L-4S		MI	3187	1930	5356	1501	6373	1230	7131	989	8334	578	10021	225	8951
22-#10	5.17	MA	5352	2003	8240	1667	10090	1376	11406	1126	13331	683	17228	173	16319
8L-5S		MI	3230	2003	5464	1555	6493	1268	7270	1014	8510	581	10252	153	9629

RECTANGULAR TIED COLUMNS 18" x 32"

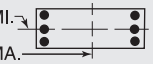
4-#11	1.08	MA	4827	1454	6493	1278	7877	1077	8626	919	9373	681	11344	593	4725
2E		MI	2601	1454	3829	1195	4392	1005	4674	857	4921	632	5564	510	2518
4-#14	1.56	MA	5118	1534	7177	1323	8710	1108	9619	938	10698	674	13168	585	6671
2E		MI	2716	1534	4153	1235	4774	1033	5124	872	5505	620	6215	472	3457
4-#18	2.78	MA	5793	1737	8844	1438	10760	1192	12070	988	13977	658	17686	566	11446
2E		MI	2968	1737	4911	1342	5682	1109	6197	916	6825	580	7668	358	5668
6-#9	1.04	MA	4826	1447	6384	1285	7803	1082	8570	925	9326	688	11300	599	4595
2L-3S		MI	2476	1447	3530	1215	4068	1022	4309	871	4450	648	5065	462	2468
6-#9	1.04	MA	4528	1447	5893	1295	7180	1092	7814	933	8306	700	9887	534	4597
3L-2S		MI	2613	1447	3768	1209	4370	1018	4674	869	4943	643	5693	535	2453
6-#10	1.32	MA	5009	1494	6794	1311	8306	1102	9170	936	10129	684	12406	595	5767
2L-3S		MI	2520	1494	3669	1241	4229	1040	4497	881	4698	644	5358	426	3048
6-#10	1.32	MA	4641	1494	6173	1324	7518	1113	8215	947	8840	699	10621	511	5756
3L-2S		MI	2688	1494	3968	1234	4608	1035	4956	878	5318	638	6138	518	3031
6-#11	1.63	MA	5178	1544	7245	1335	8830	1118	9782	945	10933	677	13504	587	6972
2L-3S		MI	2555	1544	3829	1259	4392	1051	4674	885	4921	633	5564	371	3627
6-#11	1.63	MA	4747	1544	6493	1350	7877	1131	8626	957	9373	695	11344	482	6942
3L-2S		MI	2750	1544	4185	1251	4844	1047	5222	883	5660	627	6463	485	3609
6-#14	2.34	MA	5599	1664	8249	1404	10071	1168	11269	975	12925	668	16251	576	9861
2L-3S		MI	2655	1664	4153	1326	4774	1098	5124	911	5505	619	6215	266	4972
6-#14	2.34	MA	5018	1664	7177	1425	8710	1187	9619	992	10698	692	13168	422	9752
3L-2S		MI	2917	1664	4654	1316	5411	1093	5895	910	6541	613	7450	430	4976
6-#18	4.17	MA	6571	1969	10710	1583	13127	1297	14940	1055	17851	647	23050	550	16969
2L-3S		MI	2896	1969	4911	1498	5682	1218	6197	1000	6825	570	7668	-26	7650
6-#18	4.17	MA	5672	1969	8844	1618	10760	1328	12070	1081	13977	686	17686	266	16475
3L-2S		MI	3282	1969	5762	1487	6762	1215	7506	983	8532	559	9654	265	8200
8-#8	1.10	MA	4871	1456	6451	1293	7903	1089	8699	929	9507	689	11557	600	4842
2L-4S		MI	2463	1456	3474	1229	3995	1038	4225	884	4339	650	4977	451	2599
8-#8	1.10	MA	4636	1456	6061	1301	7408	1096	8099	936	8697	699	10435	548	4843
3E		MI	2526	1456	3608	1224	4180	1030	4452	877	4648	650	5338	481	2587
8-#8	1.10	MA	4506	1456	5795	1309	7039	1108	7647	947	8078	704	9684	517	4826
4L-2S		MI	2635	1456	3797	1220	4421	1026	4743	875	5042	645	5844	538	2576
8-#9	1.39	MA	5062	1505	6876	1321	8427	1109	9326	941	10346	685	12713	595	6063
2L-4S		MI	2504	1505	3600	1257	4137	1059	4390	897	4555	645	5244	413	3198

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

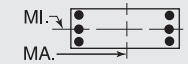
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	1.39	MA	4774	1505	6384	1331	7803	1118	8570	950	9326	697	11300	530	6054
3E		MI	2582	1505	3768	1251	4370	1049	4674	888	4943	646	5693	450	3191
8-#9	1.39	MA	4615	1505	6049	1341	7338	1133	7999	964	8545	704	10350	489	6006
4L-2S		MI	2715	1505	4005	1245	4671	1045	5040	885	5437	640	6322	522	3179
8-#10	1.76	MA	5298	1567	7415	1357	9094	1135	10125	957	11418	680	14190	590	7616
2L-4S		MI	2556	1567	3756	1294	4316	1086	4599	913	4829	640	5578	363	3935
8-#10	1.76	MA	4947	1567	6794	1370	8306	1147	9170	968	10129	696	12406	506	7590
3E		MI	2652	1567	3968	1287	4608	1074	4956	903	5318	640	6138	409	3946
8-#10	1.76	MA	4753	1567	6370	1383	7717	1165	8449	985	9141	704	11202	454	7480
4L-2S		MI	2814	1567	4266	1280	4987	1069	5416	900	5938	634	6918	501	3936
8-#11	2.17	MA	5518	1635	7996	1391	9784	1159	10938	971	12494	672	15665	581	9206
2L-4S		MI	2596	1635	3931	1323	4493	1106	4793	922	5075	625	5814	292	4601
8-#11	2.17	MA	5109	1635	7245	1406	8830	1173	9782	983	10933	690	13504	476	9157
3E		MI	2708	1635	4185	1315	4844	1093	5222	911	5660	628	6463	346	4689
8-#11	2.17	MA	4882	1635	6730	1421	8116	1195	8906	1004	9734	700	12033	412	8963
4L-2S		MI	2895	1635	4541	1308	5295	1088	5769	909	6399	623	7362	459	4684
8-#14	3.13	MA	5519	1795	8249	1507	10071	1246	11269	1030	12925	686	16251	413	12903
3E		MI	2871	1795	4654	1407	5411	1158	5895	949	6541	612	7450	224	6443
8-#14	3.13	MA	5218	1795	7512	1528	9049	1277	10016	1059	11211	698	14136	320	11924
4L-2S		MI	3110	1795	5156	1398	6048	1152	6667	948	7578	606	8686	388	6476
8-#18	5.56	MA	6503	2201	10710	1763	13127	1434	14940	1148	17851	675	23050	251	21965
3E		MI	3238	2201	5762	1643	6762	1324	7506	1067	8532	548	9654	-120	9545
8-#18	5.56	MA	6050	2201	9421	1798	11341	1486	12751	1196	14857	693	19320	83	18842
4L-2S		MI	3591	2201	6613	1632	7842	1321	8815	1050	10239	537	11640	171	10709
10-#10	2.20	MA	5580	1641	8036	1403	9882	1169	11080	979	12707	677	15975	585	9461
2L-5S		MI	2609	1641	3864	1347	4436	1125	4737	937	5005	642	5809	290	4581
10-#10	2.20	MA	5244	1641	7415	1416	9094	1180	10125	989	11418	692	14190	501	9423
3L-4S		MI	2690	1641	4054	1340	4695	1120	5058	934	5449	636	6358	346	4811
10-#10	2.20	MA	5063	1641	6991	1429	8505	1199	9404	1007	10430	701	12987	449	9303
4L-3S		MI	2781	1641	4266	1333	4987	1108	5416	924	5938	637	6918	392	4834
10-#10	2.20	MA	4831	1641	6617	1441	7990	1211	8764	1017	9541	716	11765	406	8760
5L-2S		MI	2938	1641	4565	1326	5367	1103	5875	921	6558	631	7698	484	4834
10-#11	2.71	MA	5459	1725	7996	1463	9784	1214	10938	1009	12494	686	15665	470	11372
3L-4S		MI	2752	1725	4287	1379	4945	1147	5340	948	5814	621	6713	266	5575
10-#11	2.71	MA	5250	1725	7481	1478	9070	1236	10062	1030	11295	695	14194	406	11143
4L-3S		MI	2858	1725	4541	1372	5295	1134	5769	937	6399	624	7362	320	5741
10-#11	2.71	MA	4977	1725	7025	1493	8443	1250	9285	1042	10215	713	12705	349	10323
5L-2S		MI	3036	1725	4897	1364	5747	1129	6317	935	7138	619	8261	433	5750
10-#14	3.91	MA	5731	1925	8585	1609	10410	1337	11666	1096	13437	692	17220	311	15030
4L-3S		MI	3075	1925	5156	1489	6048	1217	6667	986	7578	605	8686	182	7908
10-#14	3.91	MA	5351	1925	7932	1630	9514	1356	10553	1113	11892	717	15086	227	13990
5L-2S		MI	3300	1925	5658	1479	6684	1212	7439	985	8614	599	9922	346	7964
10-#18	6.94	MA	6914	2433	11287	1943	13709	1592	15621	1263	18731	682	24684	67	24295
4L-3S		MI	3571	2433	6613	1788	7842	1430	8815	1134	10239	527	11640	-214	11402
10-#18	6.94	MA	6278	2433	10142	1977	12139	1623	13673	1289	16028	722	20936	-93	20579
5L-2S		MI	3897	2433	7465	1776	8922	1427	10124	1117	11946	516	13625	77	13207
12-#10	2.65	MA	5533	1715	8036	1462	9882	1214	11080	1010	12707	689	15975	496	11256
3L-5S		MI	2741	1715	4163	1393	4815	1159	5196	959	5625	639	6589	273	5422
12-#10	2.65	MA	5365	1715	7612	1475	9293	1233	10359	1028	11719	697	14771	445	11128
4E		MI	2821	1715	4353	1386	5074	1153	5517	955	6070	633	7138	329	5657
12-#10	2.65	MA	5135	1715	7237	1487	8778	1244	9719	1039	10830	713	13550	401	10568
5L-3S		MI	2908	1715	4565	1379	5367	1141	5875	945	6558	633	7698	375	5718
12-#10	2.65	MA	4896	1715	6777	1501	8293	1256	9093	1056	9962	721	12373	332	10127
6L-2S		MI	3060	1715	4864	1372	5746	1136	6335	942	7178	627	8478	467	5726

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis

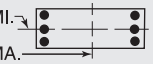


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	3.25	MA	5607	1816	8233	1534	10023	1278	11218	1056	12855	691	16354	400	13307
4E		MI	2913	1816	4642	1436	5396	1189	5888	974	6552	616	7612	241	6559
12-#11	3.25	MA	5337	1816	7777	1549	9397	1291	10441	1068	11775	709	14866	344	12517
5L-3S		MI	3008	1816	4897	1428	5747	1175	6317	963	7138	620	8261	294	6788
12-#11	3.25	MA	5058	1816	7225	1566	8806	1305	9680	1089	10720	718	13427	258	11783
6L-2S		MI	3174	1816	5253	1421	6199	1171	6864	961	7877	614	9160	408	6809
12-#14	4.69	MA	5851	2056	9004	1711	10875	1415	12202	1150	14119	711	18169	219	17140
5L-3S		MI	3273	2056	5658	1570	6684	1277	7439	1024	8614	598	9922	140	9371
12-#14	4.69	MA	5476	2056	8222	1737	10028	1434	11113	1179	12609	723	16101	94	15574
6L-2S		MI	3486	2056	6159	1561	7321	1272	8210	1023	9650	592	11158	303	9446
14-#10	3.09	MA	5658	1788	8233	1521	10081	1266	11314	1049	13008	694	16556	440	12956
4L-5S		MI	2870	1788	4462	1439	5194	1192	5656	980	6245	635	7369	256	6269
14-#10	3.09	MA	5431	1788	7858	1533	9566	1278	10674	1060	12119	709	15334	396	12379
5L-4S		MI	2950	1788	4652	1432	5453	1187	5977	977	6690	629	7918	312	6489
14-#10	3.09	MA	5202	1788	7397	1547	9080	1290	10048	1077	11251	718	14157	327	11955
6L-3S		MI	3032	1788	4864	1425	5746	1175	6335	966	7178	630	8478	358	6599
14-#10	3.09	MA	5004	1788	7001	1555	8537	1304	9445	1088	10409	733	13003	291	11227
7L-2S		MI	3179	1788	5162	1418	6125	1170	6794	963	7798	624	9258	450	6614
14-#11	3.79	MA	5687	1906	8529	1606	10351	1332	11597	1094	13336	705	17026	338	14714
5L-4S		MI	3062	1906	4998	1492	5848	1230	6435	1000	7291	612	8511	215	7552
14-#11	3.79	MA	5421	1906	7976	1623	9760	1346	10836	1115	12281	714	15587	252	13983
6L-3S		MI	3151	1906	5253	1485	6199	1217	6864	989	7877	615	9160	269	7833
14-#11	3.79	MA	5189	1906	7495	1633	9110	1364	10102	1127	11257	732	14179	205	13127
7L-2S		MI	3310	1906	5608	1477	6650	1212	7411	987	8615	610	10059	382	7863
14-#14	5.47	MA	5984	2186	9294	1818	11389	1494	12763	1217	14835	717	19184	86	18709
6L-3S		MI	3469	2186	6159	1652	7321	1336	8210	1062	9650	591	11158	98	10815
14-#14	5.47	MA	5675	2186	8606	1831	10470	1520	11712	1234	13370	742	17163	16	17089
7L-2S		MI	3671	2186	6661	1642	7958	1331	8982	1060	10686	584	12393	261	10923
16-#10	3.53	MA	5720	1862	8479	1579	10354	1312	11629	1081	13408	706	17119	391	14194
5E		MI	2998	1862	4760	1485	5573	1226	6115	1001	6865	632	8149	239	7119
16-#10	3.53	MA	5501	1862	8018	1593	9868	1323	11003	1099	12540	714	15942	322	13781
6L-4S		MI	3077	1862	4951	1478	5832	1221	6436	998	7310	626	8698	295	7326
16-#10	3.53	MA	5312	1862	7622	1601	9325	1337	10400	1109	11698	730	14788	287	13049
7L-3S		MI	3159	1862	5162	1471	6125	1209	6794	988	7798	626	9258	341	7478
16-#10	3.53	MA	5116	1862	7241	1611	8815	1345	9769	1124	10871	745	13676	237	12295
8L-2S		MI	3295	1862	5461	1464	6504	1203	7253	985	8419	620	10038	433	7499
16-#11	4.33	MA	5775	1997	8728	1679	10714	1387	11992	1141	13841	710	17748	246	16185
6L-4S		MI	3209	1997	5354	1549	6300	1271	6982	1026	8030	608	9410	189	8552
16-#11	4.33	MA	5556	1997	8247	1689	10064	1405	11258	1153	12817	728	16340	199	15319
7L-3S		MI	3292	1997	5608	1541	6650	1258	7411	1015	8615	611	10059	243	8876
16-#11	4.33	MA	5325	1997	7784	1700	9445	1414	10504	1172	11812	746	14984	136	14280
8L-2S		MI	3444	1997	5964	1534	7102	1253	7959	1013	9354	606	10958	356	8915
16-#14	6.25	MA	6189	2317	9679	1913	11831	1579	13362	1271	15597	735	20246	7	20212
7L-3S		MI	3662	2317	6661	1733	7958	1396	8982	1099	10686	584	12393	55	12191
18-#10	3.97	MA	5793	1936	8639	1639	10656	1357	11958	1120	13829	711	17727	317	15599
6L-5S		MI	3131	1936	5059	1531	5952	1260	6574	1022	7486	628	8929	222	7972
18-#10	3.97	MA	5613	1936	8243	1647	10113	1371	11355	1130	12987	726	16573	282	14872
7L-4S		MI	3210	1936	5249	1524	6211	1254	6896	1019	7930	622	9479	278	8168
18-#10	3.97	MA	5420	1936	7862	1657	9603	1379	10724	1145	12160	741	15461	232	14111
8L-3S		MI	3279	1936	5461	1517	6504	1242	7253	1009	8419	623	10038	324	8355
18-#10	3.97	MA	5199	1936	7492	1667	9107	1388	10098	1153	11319	750	14364	187	13365
9L-2S		MI	3410	1936	5760	1510	6883	1237	7713	1006	9039	617	10818	416	8383
18-#11	4.88	MA	5913	2087	8998	1746	11018	1446	12414	1179	14378	723	18500	193	17510
7L-4S		MI	3353	2087	5710	1605	6751	1313	7530	1052	8769	603	10309	164	9556
18-#11	4.88	MA	5686	2087	8536	1757	10399	1455	11660	1198	13372	741	17144	130	16477
8L-3S		MI	3431	2087	5964	1598	7102	1299	7959	1041	9354	607	10958	217	9917

RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

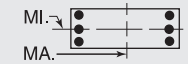
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	4.41	MA	5908	2009	8864	1693	10901	1405	12310	1152	14276	723	18358	277	16694
7L-5S		MI	3254	2009	5358	1577	6331	1293	7034	1044	8106	625	9709	205	8828
20-#10	4.41	MA	5716	2009	8483	1703	10391	1412	11679	1166	13449	738	17246	227	15927
8L-4S		MI	3332	2009	5548	1570	6590	1288	7355	1040	8550	618	10259	261	9014
20-#10	4.41	MA	5504	2009	8113	1713	9895	1421	11053	1174	12607	746	16148	182	15176
9L-3S		MI	3398	2009	5760	1563	6883	1276	7713	1030	9039	619	10818	307	9232
20-#11	5.42	MA	6038	2177	9287	1813	11352	1497	12816	1224	14932	737	19305	124	18674
8L-4S		MI	3496	2177	6066	1662	7203	1354	8077	1078	9508	599	11208	138	10565
22-#10	4.85	MA	6007	2083	9104	1749	11179	1446	12634	1188	14738	734	19031	223	17744
8L-5S		MI	3375	2083	5656	1623	6710	1327	7493	1065	8726	621	10489	188	9686
22-#10	4.85	MA	5803	2083	8734	1759	10683	1455	12008	1195	13896	743	17933	177	16987
9L-4S		MI	3453	2083	5847	1616	6969	1322	7814	1062	9170	615	11039	244	9863
24-#10	5.29	MA	6096	2157	9355	1805	11471	1489	12963	1216	15185	739	19718	172	18798
9L-5S		MI	3495	2157	5955	1669	7089	1360	7953	1086	9346	618	11269	172	10546

RECTANGULAR TIED COLUMNS 18" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.02	MA	5419	1533	7196	1358	8765	1144	9606	978	10422	728	12601	634	5062
2E		MI	2745	1533	4024	1262	4610	1063	4898	907	5136	672	5800	545	2537
4-#14	1.47	MA	5738	1613	7933	1402	9664	1176	10677	997	11851	721	14567	626	7157
2E		MI	2860	1613	4349	1302	4993	1090	5347	922	5720	660	6449	507	3481
4-#18	2.61	MA	6479	1816	9734	1518	11878	1259	13324	1047	15393	705	19448	607	12310
2E		MI	3113	1816	5112	1407	5902	1165	6421	965	7038	619	7899	393	5703
6-#10	1.25	MA	5616	1573	7517	1391	9223	1169	10188	995	11230	731	13736	636	6178
2L-3S		MI	2663	1573	3861	1309	4446	1099	4721	932	4914	684	5595	461	3067
6-#10	1.25	MA	5217	1573	6850	1404	8377	1181	9162	1006	9846	747	11819	553	6167
3L-2S		MI	2832	1573	4160	1302	4825	1094	5180	929	5534	678	6375	553	3049
6-#11	1.53	MA	5803	1624	8004	1415	9790	1186	10849	1004	12100	724	14924	628	7477
2L-3S		MI	2698	1624	4024	1326	4610	1109	4898	935	5136	673	5800	406	3652
6-#11	1.53	MA	5334	1624	7196	1430	8765	1200	9606	1017	10422	743	12601	525	7448
3L-2S		MI	2894	1624	4380	1319	5062	1104	5446	933	5875	667	6699	520	3631
6-#14	2.21	MA	6263	1744	9087	1484	11128	1236	12452	1034	14247	715	17885	618	10590
2L-3S		MI	2798	1744	4349	1393	4993	1155	5347	961	5720	659	6449	301	5008
6-#14	2.21	MA	5630	1744	7933	1506	9664	1255	10677	1052	11851	741	14567	466	10481
3L-2S		MI	3062	1744	4851	1383	5630	1150	6119	960	6756	653	7684	465	5004
6-#18	3.92	MA	7329	2048	11744	1663	14429	1365	16417	1114	19568	694	25228	592	18265
2L-3S		MI	3038	2048	5112	1564	5902	1274	6421	1049	7038	609	7899	8	7879
6-#18	3.92	MA	6345	2048	9734	1699	11878	1398	13324	1142	15393	736	19448	314	17771
3L-2S		MI	3429	2048	5963	1552	6982	1271	7730	1032	8745	598	9885	299	8241
8-#8	1.03	MA	5465	1536	7147	1373	8789	1157	9679	988	10560	736	12820	641	5183
2L-4S		MI	2606	1536	3664	1298	4211	1097	4449	935	4556	691	5215	487	2616
8-#8	1.03	MA	5210	1536	6729	1381	8258	1164	9035	996	9691	746	11617	591	5184
3E		MI	2670	1536	3798	1293	4396	1089	4675	928	4865	691	5577	517	2603
8-#8	1.03	MA	5069	1536	6444	1389	7863	1177	8551	1007	9027	752	10816	559	5167
4L-2S		MI	2779	1536	3987	1289	4637	1085	4967	926	5259	686	6083	574	2592
8-#9	1.31	MA	5673	1584	7604	1400	9352	1177	10353	1001	11462	732	14064	637	6495
2L-4S		MI	2647	1584	3790	1326	4354	1118	4614	948	4771	686	5482	448	3220
8-#9	1.31	MA	5361	1584	7077	1411	8683	1186	9542	1009	10367	745	12547	572	6486
3E		MI	2726	1584	3959	1320	4586	1108	4898	939	5160	686	5932	485	3210
8-#9	1.31	MA	5188	1584	6718	1421	8184	1202	8930	1024	9530	752	11534	532	6438
4L-2S		MI	2859	1584	4196	1314	4888	1103	5264	936	5653	681	6560	558	3197
8-#10	1.66	MA	5931	1647	8184	1437	10070	1203	11213	1017	12615	727	15653	631	8165
2L-4S		MI	2699	1647	3948	1362	4533	1145	4822	964	5045	680	5816	398	3965
8-#10	1.66	MA	5550	1647	7517	1450	9223	1215	10188	1028	11230	743	13736	548	8139
3E		MI	2795	1647	4160	1355	4825	1132	5180	954	5534	681	6375	444	3968
8-#10	1.66	MA	5339	1647	7063	1463	8593	1234	9414	1046	10171	753	12452	497	8028
4L-2S		MI	2959	1647	4458	1348	5204	1127	5639	951	6154	675	7155	536	3956

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

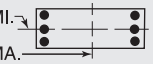
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	2.04	MA	6174	1714	8812	1471	10816	1227	12092	1030	13778	720	17247	623	9880
2L-4S		MI	2738	1714	4125	1390	4711	1164	5017	972	5290	665	6049	327	4678
8-#11	2.04	MA	5728	1714	8004	1486	9790	1241	10849	1043	12100	738	14924	519	9831
3E		MI	2851	1714	4380	1383	5062	1150	5446	961	5875	668	6699	381	4718
8-#11	2.04	MA	5481	1714	7452	1502	9024	1264	9909	1064	10814	749	13354	456	9637
4L-2S		MI	3040	1714	4736	1375	5513	1146	5993	959	6614	663	7598	494	4709
8-#14	2.94	MA	6175	1874	9087	1587	11128	1315	12452	1090	14247	735	17885	457	13875
3E		MI	3014	1874	4851	1474	5630	1215	6119	998	6756	652	7684	259	6483
8-#14	2.94	MA	5848	1874	8296	1609	10031	1347	11107	1120	12407	748	15628	365	12942
4L-2S		MI	3256	1874	5353	1465	6266	1210	6891	997	7792	645	8920	422	6508
8-#18	5.23	MA	7250	2280	11744	1844	14429	1504	16417	1209	19568	725	25228	298	23693
3E		MI	3380	2280	5963	1709	6982	1380	7730	1116	8745	587	9885	-86	9809
8-#18	5.23	MA	6758	2280	10360	1880	12510	1558	14065	1260	16350	746	21245	132	20419
4L-2S		MI	3739	2280	6814	1697	8062	1377	9039	1099	10452	576	11871	205	10752
10-#10	2.08	MA	6239	1721	8851	1483	10916	1237	12239	1038	13999	724	17570	626	10147
2L-5S		MI	2752	1721	4056	1415	4653	1183	4960	988	5221	683	6046	326	4641
10-#10	2.08	MA	5872	1721	8184	1496	10070	1249	11213	1049	12615	740	15653	544	10109
3L-4S		MI	2833	1721	4246	1408	4912	1178	5282	985	5665	677	6596	381	4843
10-#10	2.08	MA	5676	1721	7730	1509	9439	1268	10440	1067	11556	749	14369	493	9989
4L-3S		MI	2925	1721	4458	1401	5204	1166	5639	975	6154	677	7155	427	4860
10-#10	2.08	MA	5420	1721	7329	1522	8888	1280	9755	1078	10604	765	13063	451	9458
5L-2S		MI	3083	1721	4757	1394	5583	1161	6099	972	6774	671	7935	520	4856
10-#11	2.55	MA	6109	1805	8812	1543	10816	1283	12092	1069	13778	734	17247	513	12214
3L-4S		MI	2894	1805	4481	1447	5163	1205	5564	998	6029	661	6948	302	5650
10-#11	2.55	MA	5881	1805	8260	1558	10050	1305	11152	1091	12492	744	15677	450	12011
4L-3S		MI	3001	1805	4736	1439	5513	1192	5993	987	6614	664	7598	355	5773
10-#11	2.55	MA	5581	1805	7772	1574	9379	1319	10319	1103	11334	763	14085	396	11153
5L-2S		MI	3183	1805	5091	1432	5965	1187	6540	985	7353	659	8497	468	5777
10-#14	3.68	MA	6406	2005	9450	1690	11496	1407	12882	1158	14803	742	18946	357	16294
4L-3S		MI	3219	2005	5353	1556	6266	1274	6891	1036	7792	645	8920	217	7951
10-#14	3.68	MA	5987	2005	8751	1712	10535	1426	11689	1175	13146	768	16662	276	15114
5L-2S		MI	3447	2005	5855	1546	6903	1269	7662	1035	8828	638	10156	380	7998
10-#18	6.54	MA	7696	2512	12371	2025	15062	1664	17157	1327	20524	735	27026	116	26297
4L-3S		MI	3713	2512	6814	1854	8062	1486	9039	1183	10452	566	11871	-179	11676
10-#18	6.54	MA	6994	2512	11143	2061	13377	1696	15067	1355	17622	777	23012	-37	22859
5L-2S		MI	4045	2512	7665	1842	9142	1483	10348	1166	12159	555	13856	111	13253
12-#10	2.49	MA	6187	1794	8851	1542	10916	1282	12239	1070	13999	736	17570	539	12079
3L-5S		MI	2884	1794	4355	1461	5032	1217	5420	1009	5841	679	6826	309	5482
12-#10	2.49	MA	6003	1794	8397	1555	10285	1301	11466	1088	12940	746	16286	488	11951
4E		MI	2964	1794	4545	1454	5291	1212	5741	1006	6286	673	7376	364	5718
12-#10	2.49	MA	5751	1794	7996	1568	9734	1314	10781	1099	11988	762	14980	446	11403
5L-3S		MI	3052	1794	4757	1447	5583	1200	6099	996	6774	674	7935	410	5745
12-#10	2.49	MA	5492	1794	7497	1581	9213	1325	10111	1117	11059	771	13723	378	10915
6L-2S		MI	3205	1794	5056	1440	5963	1195	6558	993	7394	668	8715	503	5750
12-#11	3.06	MA	6269	1895	9068	1615	11075	1347	12395	1117	14170	740	18000	444	14389
4E		MI	3047	1895	4837	1503	5614	1246	6111	1024	6768	656	7847	276	6633
12-#11	3.06	MA	5972	1895	8580	1630	10404	1361	11562	1129	13012	759	16408	390	13515
5L-3S		MI	3153	1895	5091	1496	5965	1233	6540	1013	7353	660	8497	329	6822
12-#11	3.06	MA	5669	1895	7981	1647	9772	1375	10747	1151	11881	769	14873	304	12787
6L-2S		MI	3321	1895	5447	1488	6417	1228	7088	1011	8092	654	9396	443	6838
12-#14	4.41	MA	6531	2135	9905	1793	11999	1486	13464	1213	15542	762	19980	267	18504
5L-3S		MI	3418	2135	5855	1637	6903	1334	7662	1074	8828	637	10156	175	9416
12-#14	4.41	MA	6124	2135	9056	1818	11093	1506	12297	1243	13922	776	17773	144	16885
6L-2S		MI	3634	2135	6356	1628	7540	1329	8434	1073	9865	631	11392	338	9481

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

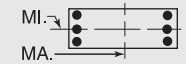
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	7.84	MA	7906	2744	13154	2206	15929	1802	18160	1422	21797	766	28792	-52	28468
5L-3S		MI	4040	2744	7665	1999	9142	1592	10348	1250	12159	545	13856	-273	13510
14-#10	2.91	MA	6322	1868	9064	1601	11132	1335	12491	1109	14325	742	18203	483	13916
4L-5S		MI	3014	1868	4654	1507	5411	1251	5879	1031	6461	676	7606	292	6327
14-#10	2.91	MA	6072	1868	8662	1614	10580	1347	11807	1121	13373	758	16898	441	13351
5L-4S		MI	3093	1868	4844	1500	5670	1246	6200	1028	6906	670	8156	347	6554
14-#10	2.91	MA	5825	1868	8164	1627	10059	1359	11137	1139	12443	767	15640	373	12881
6L-3S		MI	3177	1868	5056	1493	5963	1233	6558	1017	7394	670	8715	393	6627
14-#10	2.91	MA	5610	1868	7740	1636	9472	1373	10491	1150	11542	783	14410	338	12135
7L-2S		MI	3326	1868	5354	1486	6342	1228	7018	1014	8015	664	9495	486	6640
14-#11	3.57	MA	6353	1986	9388	1687	11430	1402	12805	1156	14690	754	18731	384	15881
5L-4S		MI	3206	1986	5193	1560	6066	1288	6659	1050	7507	652	8746	250	7625
14-#11	3.57	MA	6064	1986	8789	1704	10797	1416	11990	1177	13559	765	17196	298	15153
6L-3S		MI	3296	1986	5447	1552	6417	1274	7088	1039	8092	655	9396	304	7868
14-#11	3.57	MA	5812	1986	8273	1714	10091	1434	11204	1190	12462	783	15692	254	14203
7L-2S		MI	3458	1986	5803	1545	6868	1270	7635	1037	8831	650	10295	417	7894
14-#14	5.15	MA	6675	2266	10210	1900	12557	1565	14072	1281	16318	769	21091	135	20259
6L-3S		MI	3614	2266	6356	1719	7540	1394	8434	1111	9865	630	11392	132	10879
14-#14	5.15	MA	6339	2266	9471	1914	11558	1591	12946	1298	14747	795	18931	69	18583
7L-2S		MI	3820	2266	6858	1709	8177	1388	9206	1110	10901	624	12627	296	10960
16-#10	3.32	MA	6386	1942	9329	1660	11427	1381	12832	1142	14758	755	18815	436	15303
5E		MI	3142	1942	4952	1554	5790	1284	6339	1052	7081	672	8386	275	7177
16-#10	3.32	MA	6149	1942	8831	1673	10906	1393	12162	1160	13828	764	17557	368	14848
6L-4S		MI	3220	1942	5143	1546	6049	1279	6660	1049	7526	666	8936	330	7390
16-#10	3.32	MA	5944	1942	8406	1682	10318	1407	11517	1171	12927	780	16327	334	14093
7L-3S		MI	3305	1942	5354	1539	6342	1267	7018	1039	8015	667	9495	376	7508
16-#10	3.32	MA	5729	1942	7999	1692	9772	1415	10832	1185	12041	796	15140	286	13331
8L-2S		MI	3443	1942	5653	1532	6721	1262	7477	1036	8635	661	10275	469	7526
16-#11	4.08	MA	6448	2076	9598	1760	11823	1458	13233	1203	15237	760	19520	293	17519
6L-4S		MI	3353	2076	5549	1616	6518	1329	7206	1076	8245	648	9645	225	8623
16-#11	4.08	MA	6210	2076	9081	1770	11117	1475	12447	1216	14140	779	18015	248	16574
7L-3S		MI	3438	2076	5803	1609	6868	1316	7635	1066	8831	651	10295	278	8912
16-#11	4.08	MA	5956	2076	8585	1782	10453	1485	11628	1234	13062	798	16566	187	15488
8L-2S		MI	3593	2076	6159	1602	7320	1311	8182	1063	9570	646	11194	391	8947
16-#14	5.88	MA	6897	2396	10625	1995	13022	1650	14721	1336	17143	789	22248	60	21944
7L-3S		MI	3807	2396	6858	1800	8177	1453	9206	1149	10901	623	12627	90	12297
18-#10	3.74	MA	6465	2015	9498	1719	11752	1426	13188	1181	15213	760	19474	363	16816
6L-5S		MI	3268	2015	5251	1600	6169	1318	6798	1073	7702	669	9166	258	8029
18-#10	3.74	MA	6270	2015	9073	1728	11164	1440	12543	1192	14311	776	18244	329	16051
7L-4S		MI	3354	2015	5441	1592	6428	1313	7119	1070	8146	663	9716	313	8231
18-#10	3.74	MA	6058	2015	8665	1738	10618	1449	11858	1207	13426	793	17057	281	15282
8L-3S		MI	3426	2015	5653	1585	6721	1301	7477	1060	8635	663	10275	359	8386
18-#10	3.74	MA	5819	2015	8269	1749	10087	1458	11188	1214	12525	802	15888	236	14518
9L-2S		MI	3559	2015	5952	1578	7100	1296	7936	1057	9255	657	11055	452	8410
18-#11	4.59	MA	6598	2167	9890	1827	12142	1516	13690	1242	15818	775	20338	242	18944
7L-4S		MI	3497	2167	5905	1673	6969	1370	7754	1102	8984	643	10544	199	9626
18-#11	4.59	MA	6348	2167	9394	1838	11478	1526	12871	1260	14740	794	18889	181	17851
8L-3S		MI	3577	2167	6159	1666	7320	1357	8182	1092	9570	647	11194	252	9955
20-#10	4.15	MA	6590	2089	9740	1774	12010	1474	13569	1213	15696	773	20161	324	18009
7L-5S		MI	3399	2089	5550	1646	6548	1352	7257	1094	8322	665	9946	241	8884
20-#10	4.15	MA	6380	2089	9332	1784	11464	1482	12883	1228	14810	789	18974	276	17233
8L-4S		MI	3477	2089	5740	1638	6807	1346	7579	1091	8766	659	10496	296	9076

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

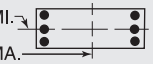
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	4.15	MA	6149	2089	8936	1795	10933	1492	12213	1236	13910	798	17806	231	16471
9L-3S		MI	3544	2089	5952	1631	7100	1334	7936	1081	9255	660	11055	342	9264
20-#10	4.15	MA	5936	2089	8520	1802	10380	1509	11558	1244	13028	814	16543	179	15575
10L-2S		MI	3673	2089	6250	1624	7479	1329	8396	1078	9875	654	11835	435	9293
20-#11	5.10	MA	6731	2257	10202	1895	12504	1567	14114	1286	16418	789	21212	175	20213
8L-4S		MI	3640	2257	6261	1730	7421	1412	8301	1128	9723	639	11443	173	10634
22-#10	4.57	MA	6695	2163	9999	1830	12311	1516	13909	1249	16195	785	20891	271	19184
8L-5S		MI	3521	2163	5848	1692	6927	1385	7717	1116	8942	662	10726	224	9741
22-#10	4.57	MA	6473	2163	9603	1841	11780	1525	13239	1257	15294	795	19723	226	18417
9L-4S		MI	3599	2163	6039	1684	7186	1380	8038	1113	9386	656	11276	279	9923
22-#10	4.57	MA	6269	2163	9187	1848	11226	1542	12583	1266	14412	810	18460	175	17525
10L-3S		MI	3662	2163	6250	1677	7479	1368	8396	1102	9875	656	11835	325	10141
24-#10	4.98	MA	6791	2236	10270	1887	12626	1559	14265	1278	16679	791	21640	221	20362
9L-5S		MI	3641	2236	6147	1738	7306	1419	8176	1137	9562	658	11506	207	10600
24-#10	4.98	MA	6594	2236	9853	1894	12072	1576	13609	1287	15797	807	20377	170	19474
10L-4S		MI	3719	2236	6337	1730	7565	1414	8497	1134	10006	652	12056	262	10774

RECTANGULAR TIED COLUMNS 18" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.39	MA	6391	1693	8721	1482	10660	1244	11783	1056	13054	768	16024	668	7643
2E		MI	3004	1693	4546	1369	5212	1148	5571	972	5934	699	6683	542	3505
4-#18	2.47	MA	7199	1896	10655	1598	13039	1327	14627	1106	16859	752	21267	648	13174
2E		MI	3258	1896	5312	1473	6122	1221	6645	1014	7251	658	8130	427	5737
6-#10	1.18	MA	6255	1653	8272	1470	10184	1237	11253	1054	12381	778	15124	677	6590
2L-3S		MI	2806	1653	4053	1378	4663	1157	4944	983	5130	725	5832	497	3086
6-#10	1.18	MA	5825	1653	7559	1484	9279	1250	10157	1066	10901	795	13075	596	6579
3L-2S		MI	2976	1653	4352	1370	5042	1152	5404	980	5750	719	6612	589	3067
6-#11	1.44	MA	6460	1703	8795	1494	10794	1254	11964	1063	13317	771	16401	670	7982
2L-3S		MI	2841	1703	4219	1394	4828	1167	5122	985	5352	713	6035	441	3676
6-#11	1.44	MA	5952	1703	7930	1510	9696	1268	10634	1077	11522	791	13915	568	7953
3L-2S		MI	3038	1703	4575	1386	5280	1162	5669	983	6091	707	6934	555	3653
6-#14	2.08	MA	6960	1823	9956	1563	12228	1304	13683	1094	15619	762	19576	659	11319
2L-3S		MI	2941	1823	4546	1460	5212	1212	5571	1011	5934	698	6683	336	5042
6-#14	2.08	MA	6274	1823	8721	1586	10660	1324	11783	1112	13054	789	16024	510	11210
3L-2S		MI	3207	1823	5048	1450	5849	1207	6343	1009	6971	692	7918	499	5031
6-#18	3.70	MA	8121	2128	12811	1742	15774	1433	17942	1173	21335	741	27464	633	19561
2L-3S		MI	3180	2128	5312	1630	6122	1330	6645	1098	7251	648	8130	42	8026
6-#18	3.70	MA	7051	2128	10655	1780	13039	1467	14627	1203	16859	786	21267	360	19067
3L-2S		MI	3576	2128	6164	1618	7202	1327	7954	1081	8958	636	10116	333	8280
8-#9	1.23	MA	6317	1664	8364	1480	10321	1245	11429	1060	12628	779	15472	678	6927
2L-4S		MI	2790	1664	3981	1395	4570	1176	4837	999	4988	727	5720	484	3241
8-#9	1.23	MA	5980	1664	7800	1491	9605	1255	10561	1069	11457	792	13851	614	6918
3E		MI	2869	1664	4150	1389	4803	1166	5122	990	5376	727	6170	521	3228
8-#9	1.23	MA	5793	1664	7418	1501	9074	1270	9909	1084	10564	800	12776	575	6870
4L-2S		MI	3003	1664	4387	1383	5104	1162	5487	988	5870	722	6798	594	3214
8-#10	1.57	MA	6597	1727	8985	1516	11089	1271	12350	1076	13862	774	17174	672	8714
2L-4S		MI	2841	1727	4140	1431	4750	1203	5046	1015	5261	721	6053	434	3992
8-#10	1.57	MA	6184	1727	8272	1530	10184	1283	11253	1087	12381	791	15124	591	8687
3E		MI	2939	1727	4352	1424	5042	1191	5404	1005	5750	721	6612	480	3990
8-#10	1.57	MA	5957	1727	7788	1543	9511	1303	10428	1106	11252	801	13761	540	8577
4L-2S		MI	3103	1727	4650	1416	5421	1186	5863	1001	6370	715	7392	572	3977
8-#11	1.93	MA	6862	1794	9660	1551	11891	1295	13294	1089	15112	767	18887	664	10554
2L-4S		MI	2881	1794	4320	1458	4929	1221	5240	1022	5505	705	6284	362	4730
8-#11	1.93	MA	6378	1794	8795	1566	10794	1310	11964	1103	13317	786	16401	562	10505
3E		MI	2995	1794	4575	1450	5280	1208	5669	1011	6091	708	6934	416	4745
8-#11	1.93	MA	6112	1794	8206	1582	9975	1333	10961	1125	11943	797	14733	499	10311
4L-2S		MI	3185	1794	4930	1443	5732	1203	6217	1009	6829	703	7833	529	4733

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis



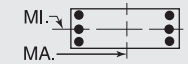
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.78	MA	6864	1954	9956	1667	12228	1384	13683	1150	15619	783	19576	501	14847
3E		MI	3158	1954	5048	1541	5849	1272	6343	1048	6971	691	7918	294	6521
8-#14	2.78	MA	6511	1954	9112	1690	11057	1417	12246	1181	13653	798	17178	410	13975
4L-2S		MI	3403	1954	5550	1532	6485	1267	7115	1047	8007	685	9154	457	6538
8-#18	4.94	MA	8031	2360	12811	1925	15774	1573	17942	1270	21335	775	27464	345	25421
3E		MI	3522	2360	6164	1775	7202	1436	7954	1165	8958	626	10116	-52	10072
8-#18	4.94	MA	7498	2360	11331	1963	13722	1629	15427	1323	17892	797	23229	180	22013
4L-2S		MI	3886	2360	7015	1763	8282	1433	9263	1148	10665	615	12102	239	10795
10-#10	1.96	MA	6930	1800	9698	1562	11994	1305	13446	1097	15342	771	19223	667	10832
2L-5S		MI	2895	1800	4248	1484	4869	1242	5184	1039	5437	723	6283	361	4699
10-#10	1.96	MA	6533	1800	8985	1576	11089	1317	12350	1108	13862	788	17174	586	10795
3L-4S		MI	2976	1800	4438	1477	5129	1237	5505	1036	5882	717	6833	417	4873
10-#10	1.96	MA	6321	1800	8501	1589	10416	1336	11524	1127	12732	797	15810	536	10675
4L-3S		MI	3068	1800	4650	1470	5421	1224	5863	1026	6370	718	7392	463	4884
10-#10	1.96	MA	6043	1800	8069	1602	9828	1349	10794	1139	11716	814	14420	495	10163
5L-2S		MI	3228	1800	4949	1462	5800	1219	6322	1023	6990	712	8173	555	4878
10-#11	2.41	MA	6791	1884	9660	1623	11891	1351	13294	1129	15112	782	18887	556	13057
3L-4S		MI	3037	1884	4676	1514	5381	1263	5788	1048	6244	701	7183	337	5724
10-#11	2.41	MA	6545	1884	9071	1639	11073	1374	12291	1151	13738	793	17219	493	12854
4L-3S		MI	3145	1884	4930	1507	5732	1249	6217	1037	6829	704	7833	390	5803
10-#11	2.41	MA	6217	1884	8550	1655	10357	1389	11402	1164	12503	812	15523	441	11990
5L-2S		MI	3329	1884	5286	1500	6183	1245	6764	1035	7568	699	8732	504	5803
10-#14	3.47	MA	7114	2084	10348	1771	12625	1476	14147	1219	16218	792	20730	401	17573
4L-3S		MI	3363	2084	5550	1623	6485	1332	7115	1086	8007	684	9154	252	7992
10-#14	3.47	MA	6656	2084	9602	1794	11599	1497	12873	1237	14449	819	18297	324	16246
5L-2S		MI	3594	2084	6051	1613	7122	1326	7886	1085	9043	678	10390	415	8031
10-#18	6.17	MA	8513	2592	13487	2108	16458	1735	18742	1390	22368	786	29426	165	28316
4L-3S		MI	3855	2592	7015	1919	8282	1542	9263	1232	10665	605	12102	-145	11948
10-#18	6.17	MA	7743	2592	12177	2145	14659	1769	16509	1420	19266	831	25146	18	25067
5L-2S		MI	4194	2592	7866	1908	9363	1539	10572	1215	12373	594	14087	145	13298
12-#10	2.35	MA	6873	1874	9698	1622	11994	1351	13446	1130	15342	784	19223	581	12902
3L-5S		MI	3027	1874	4547	1530	5249	1275	5644	1060	6057	720	7063	344	5539
12-#10	2.35	MA	6674	1874	9214	1635	11321	1370	12621	1148	14212	794	17859	531	12774
4E		MI	3107	1874	4737	1523	5508	1270	5965	1057	6502	714	7613	400	5750
12-#10	2.35	MA	6399	1874	8782	1648	10733	1383	11891	1160	13197	811	16469	490	12245
5L-3S		MI	3196	1874	4949	1516	5800	1258	6322	1047	6990	714	8173	446	5772
12-#10	2.35	MA	6121	1874	8250	1662	10172	1394	11177	1178	12206	820	15131	424	11708
6L-2S		MI	3351	1874	5248	1509	6179	1253	6782	1044	7610	708	8953	538	5773
12-#11	2.89	MA	6964	1975	9935	1695	12170	1416	13621	1177	15533	789	19704	487	15400
4E		MI	3190	1975	5032	1571	5833	1304	6335	1074	6983	696	8082	311	6705
12-#11	2.89	MA	6640	1975	9415	1711	11454	1430	12732	1190	14298	808	18009	435	14521
5L-3S		MI	3298	1975	5286	1564	6183	1291	6764	1064	7568	700	8732	364	6855
12-#11	2.89	MA	6312	1975	8770	1728	10780	1445	11862	1212	13092	819	16376	351	13796
6L-2S		MI	3468	1975	5642	1556	6635	1286	7311	1062	8307	694	9631	478	6867
12-#14	4.17	MA	7244	2215	10837	1875	13167	1556	14774	1275	17014	813	21849	315	19877
5L-3S		MI	3563	2215	6051	1704	7122	1391	7886	1124	9043	677	10390	209	9459
12-#14	4.17	MA	6804	2215	9921	1899	12200	1577	13528	1306	15286	827	19504	192	18214
6L-2S		MI	3782	2215	6553	1695	7759	1386	8658	1122	10079	671	11625	373	9516
12-#18	7.41	MA	8729	2824	14333	2290	17394	1875	19825	1487	23742	820	31343	2	31332
5L-3S		MI	4182	2824	7866	2064	9363	1648	10572	1299	12373	584	14087	-239	13792
12-#18	7.41	MA	8042	2824	12755	2334	15696	1909	17638	1539	20710	843	27200	-218	26308
6L-2S		MI	4499	2824	8717	2053	10443	1645	11881	1281	14080	573	16073	52	15794

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis

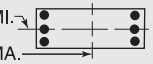


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.74	MA	7019	1948	9927	1681	12225	1404	13717	1170	15692	790	19909	526	14876
4L-5S		MI	3157	1948	4846	1576	5628	1309	6103	1082	6677	716	7844	327	6384
14-#10	2.74	MA	6747	1948	9495	1694	11638	1416	12987	1181	14677	807	18519	485	14330
5L-4S		MI	3237	1948	5036	1569	5887	1304	6424	1078	7122	710	8393	383	6617
14-#10	2.74	MA	6479	1948	8963	1708	11077	1428	12273	1200	13686	817	17180	419	13811
6L-3S		MI	3322	1948	5248	1562	6179	1292	6782	1068	7610	711	8953	429	6655
14-#10	2.74	MA	6247	1948	8510	1717	10450	1442	11582	1211	12725	833	15876	385	13054
7L-2S		MI	3472	1948	5546	1555	6559	1287	7241	1065	8231	705	9733	521	6664
14-#11	3.37	MA	7052	2065	10280	1768	12552	1472	14062	1217	16093	804	20494	429	17057
5L-4S		MI	3349	2065	5388	1628	6284	1345	6883	1100	7722	692	8981	285	7696
14-#11	3.37	MA	6739	2065	9634	1784	11877	1486	13192	1239	14887	815	18862	345	16328
6L-3S		MI	3441	2065	5642	1620	6635	1332	7311	1090	8307	695	9631	339	7903
14-#11	3.37	MA	6467	2065	9083	1795	11115	1503	12355	1252	13717	834	17263	302	15287
7L-2S		MI	3605	2065	5998	1613	7086	1327	7859	1088	9046	690	10530	452	7924
14-#14	4.86	MA	7399	2345	11157	1981	13768	1636	15428	1343	17851	821	23056	184	21826
6L-3S		MI	3759	2345	6553	1786	7759	1451	8658	1161	10079	670	11625	167	10923
14-#14	4.86	MA	7037	2345	10368	1995	12688	1661	14228	1362	16175	848	20757	120	20102
7L-2S		MI	3968	2345	7055	1776	8395	1445	9430	1160	11115	664	12861	331	10996
16-#10	3.14	MA	7086	2021	10208	1740	12542	1450	14084	1202	16157	803	20568	481	16419
5E		MI	3285	2021	5144	1622	6007	1343	6562	1103	7298	713	8624	310	7233
16-#10	3.14	MA	6829	2021	9676	1754	11981	1462	13370	1221	15166	813	19229	414	15915
6L-4S		MI	3364	2021	5334	1615	6266	1338	6883	1100	7742	707	9173	366	7452
16-#10	3.14	MA	6608	2021	9223	1763	11354	1476	12679	1232	14205	830	17925	380	15148
7L-3S		MI	3446	2021	5546	1608	6559	1325	7241	1090	8231	707	9733	412	7537
16-#10	3.14	MA	6374	2021	8788	1773	10772	1485	11943	1246	13246	840	16662	334	14383
8L-2S		MI	3591	2021	5845	1601	6938	1320	7701	1086	8851	701	10513	504	7552
16-#11	3.85	MA	7154	2156	10499	1841	12975	1528	14522	1265	16682	810	21347	339	18859
6L-4S		MI	3496	2156	5744	1684	6736	1387	7430	1127	8461	688	9880	260	8692
16-#11	3.85	MA	6897	2156	9948	1851	12213	1545	13685	1278	15512	830	19749	296	17824
7L-3S		MI	3583	2156	5998	1677	7086	1373	7859	1116	9046	691	10530	313	8948
16-#11	3.85	MA	6620	2156	9419	1863	11504	1555	12799	1296	14363	850	18207	237	16713
8L-2S		MI	3741	2156	6354	1669	7538	1368	8406	1114	9785	686	11429	427	8978
16-#14	5.56	MA	7639	2476	11603	2077	14256	1721	16128	1400	18740	842	24309	112	23701
7L-3S		MI	3953	2476	7055	1867	8395	1510	9430	1199	11115	663	12861	125	12387
16-#14	5.56	MA	7250	2476	10845	2094	13241	1735	14873	1426	17093	869	22095	24	21992
8L-2S		MI	4153	2476	7557	1858	9032	1505	10201	1198	12151	657	14097	289	12473
18-#10	3.53	MA	7171	2095	10389	1800	12886	1495	14466	1242	16646	810	21279	409	18017
6L-5S		MI	3412	2095	5443	1668	6386	1376	7022	1124	7918	709	9404	294	8085
18-#10	3.53	MA	6960	2095	9936	1809	12259	1509	13775	1253	15685	826	19974	375	17241
7L-4S		MI	3490	2095	5633	1661	6645	1371	7343	1121	8362	703	9953	349	8292
18-#10	3.53	MA	6729	2095	9501	1819	11676	1518	13040	1268	14726	836	18711	329	16469
8L-3S		MI	3572	2095	5845	1654	6938	1359	7701	1111	8851	704	10513	395	8416
18-#10	3.53	MA	6471	2095	9074	1829	11110	1528	12325	1276	13781	853	17472	284	15631
9L-2S		MI	3707	2095	6144	1647	7317	1354	8160	1108	9471	698	11293	487	8437
18-#11	4.33	MA	7316	2246	10813	1908	13310	1586	15015	1304	17307	826	22235	291	20360
7L-4S		MI	3641	2246	6100	1741	7187	1428	7977	1153	9199	683	10779	234	9695
18-#11	4.33	MA	7043	2246	10283	1920	12601	1596	14129	1322	16158	845	20693	231	19241
8L-3S		MI	3723	2246	6354	1733	7538	1415	8406	1142	9785	687	11429	287	9992
18-#11	4.33	MA	6740	2246	9770	1933	11912	1607	13260	1331	14989	856	19174	176	18134
9L-2S		MI	3875	2246	6710	1726	7990	1410	8953	1140	10524	681	12328	401	10029
18-#14	6.25	MA	7842	2606	12081	2175	14809	1795	16774	1463	19659	863	25647	15	25581
8L-3S		MI	4145	2606	7557	1949	9032	1570	10201	1237	12151	656	14097	83	13783
20-#10	3.92	MA	7305	2168	10648	1855	13164	1543	14872	1275	17165	823	22024	370	19334
7L-5S		MI	3544	2168	5742	1714	6765	1410	7481	1145	8538	706	10184	277	8939
20-#10	3.92	MA	7076	2168	10214	1865	12581	1552	14136	1289	16206	833	20761	324	18555
8L-4S		MI	3622	2168	5932	1707	7024	1405	7802	1142	8982	700	10733	332	9136
20-#10	3.92	MA	6827	2168	9787	1875	12015	1562	13422	1297	15261	849	19521	279	17721
9L-3S		MI	3691	2168	6144	1700	7317	1393	8160	1132	9471	700	11293	378	9295

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	3.92	MA	6597	2168	9343	1883	11424	1579	12722	1306	14309	865	18178	229	16802
10L-2S		MI	3822	2168	6442	1693	7696	1388	8619	1129	10091	694	12073	470	9320
20-#11	4.81	MA	7456	2337	11148	1977	13699	1637	15459	1348	17954	841	23178	225	21770
8L-4S		MI	3784	2337	6455	1797	7639	1469	8525	1179	9938	679	11678	208	10701
20-#11	4.81	MA	7166	2337	10634	1990	13009	1649	14589	1358	16785	852	21659	170	20655
9L-3S		MI	3861	2337	6710	1790	7990	1456	8953	1168	10524	682	12328	262	11035
22-#10	4.31	MA	7416	2242	10926	1911	13486	1585	15233	1310	17686	829	22810	319	20641
8L-5S		MI	3666	2242	6040	1760	7144	1444	7941	1167	9158	702	10964	260	9796
22-#10	4.31	MA	7176	2242	10500	1921	12919	1595	14518	1319	16741	846	21570	274	19810
9L-4S		MI	3744	2242	6231	1753	7403	1438	8262	1163	9602	696	11513	315	9983
22-#10	4.31	MA	6956	2242	10056	1929	12329	1613	13819	1328	15789	861	20228	224	18886
10L-3S		MI	3809	2242	6442	1746	7696	1426	8619	1153	10091	697	12073	361	10173
22-#11	5.30	MA	7581	2427	11499	2046	14107	1690	15919	1384	18580	848	24145	164	23177
9L-4S		MI	3926	2427	6811	1854	8091	1511	9072	1205	10677	675	12577	183	11712
24-#10	4.70	MA	7519	2316	11213	1967	13824	1629	15615	1340	18222	842	23620	270	21899
9L-5S		MI	3787	2316	6339	1806	7523	1477	8400	1188	9778	699	11744	243	10654
24-#10	4.70	MA	7307	2316	10769	1975	13234	1646	14915	1349	17269	857	22277	219	20970
10L-4S		MI	3864	2316	6529	1799	7782	1472	8721	1185	10222	693	12293	298	10833

RECTANGULAR TIED COLUMNS 20" x 20"

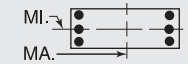
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.19	MA	2072	1021	2953	865	3480	727	3763	619	4046	455	4789	386	2155
2L-3S		MI	1946	1021	2735	871	3203	732	3428	623	3593	460	4184	329	2164
6-#9	1.50	MA	2143	1058	3132	885	3697	742	4021	627	4391	451	5225	377	2671
2L-3S		MI	1989	1058	2858	892	3349	747	3600	632	3822	458	4473	305	2677
6-#10	1.90	MA	2231	1105	3356	911	3971	760	4349	639	4828	447	5772	365	3321
2L-3S		MI	2043	1105	3012	920	3534	767	3818	644	4112	455	4835	273	3317
6-#11	2.34	MA	2306	1155	3593	934	4243	776	4663	647	5241	439	6211	340	3966
2L-3S		MI	2088	1155	3181	943	3720	783	4029	651	4384	448	5120	227	3949
6-#14	3.38	MA	2501	1275	4129	1003	4903	825	5453	677	6298	430	7454	298	5521
2L-3S		MI	2222	1275	3546	1015	4163	834	4556	682	5087	440	5944	134	5436
6-#18	6.00	MA	2938	1580	5413	1181	6491	954	7358	755	8841	406	10293	168	9239
2L-3S		MI	2525	1580	4417	1198	5227	964	5826	758	6777	417	7826	-122	7680
8-#8	1.58	MA	2168	1067	3171	894	3757	748	4099	632	4500	452	5393	380	2813
2L-4S		MI	1976	1067	2800	905	3269	762	3504	644	3693	460	4361	291	2808
8-#9	2.00	MA	2261	1116	3406	921	4045	768	4443	644	4960	448	5977	369	3493
2L-4S		MI	2028	1116	2939	935	3431	785	3696	658	3946	457	4691	257	3455
8-#10	2.54	MA	2376	1179	3701	957	4409	794	4879	660	5544	443	6709	353	4350
2L-4S		MI	2093	1179	3114	974	3637	814	3939	677	4268	453	5106	211	4137
8-#11	3.12	MA	2474	1246	4006	991	4766	817	5297	673	6097	435	7301	321	5193
2L-4S		MI	2147	1246	3301	1009	3840	840	4170	691	4567	443	5431	150	4769
8-#14	4.50	MA	2724	1406	4713	1084	5643	885	6350	714	7509	424	8964	266	7245
2L-4S		MI	2315	1406	3715	1109	4331	915	4753	737	5342	431	6369	22	6277
10-#10	3.17	MA	2517	1252	4046	1003	4846	828	5409	681	6259	440	7646	341	5373
2L-5S		MI	2148	1252	3242	1029	3778	855	4102	703	4475	458	5383	145	4821
10-#10	3.17	MA	2346	1252	3701	1012	4409	834	4879	686	5544	448	6709	249	5343
3L-4S		MI	2250	1252	3459	1020	4074	848	4469	698	4983	450	6043	199	5099
10-#11	3.90	MA	2449	1336	4006	1056	4766	866	5297	703	6097	439	7301	189	6362
3L-4S		MI	2331	1336	3714	1066	4363	881	4804	717	5423	439	6521	131	5922
10-#14	5.63	MA	2707	1536	4713	1178	5643	953	6350	757	7509	428	8964	71	8730
3L-4S		MI	2573	1536	4298	1190	5071	974	5650	774	6553	425	7879	-10	7866

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.15	MA	2506	1120	3542	954	4188	802	4535	683	4878	503	5803	431	2556
2E		MI	2261	1120	3244	942	3800	793	4094	675	4380	496	5131	417	2301
4-#11	1.42	MA	2568	1153	3737	966	4403	810	4779	686	5194	496	6157	415	3064
2E		MI	2312	1153	3416	954	3987	800	4305	677	4651	489	5414	399	2750
4-#14	2.05	MA	2728	1233	4156	1010	4912	841	5383	705	6000	489	7148	392	4270
2E		MI	2449	1233	3784	997	4431	831	4832	695	5353	481	6237	369	3813
4-#18	3.64	MA	3090	1436	5161	1124	6141	923	6851	754	7963	472	9449	320	7168
2E		MI	2752	1436	4659	1110	5497	912	6103	744	7042	462	8115	280	6344
6-#8	1.08	MA	2493	1110	3473	953	4125	803	4469	685	4800	507	5738	439	2411
2L-3S		MI	2123	1110	2965	948	3468	798	3703	680	3862	506	4482	369	2182
6-#8	1.08	MA	2348	1110	3226	960	3811	808	4090	689	4287	514	5035	382	2420
3L-2S		MI	2250	1110	3183	943	3745	794	4039	677	4315	501	5086	427	2172
6-#9	1.36	MA	2576	1146	3676	973	4371	817	4763	693	5191	503	6252	432	2995
2L-3S		MI	2166	1146	3089	969	3615	813	3876	689	4090	504	4770	345	2699
6-#9	1.36	MA	2398	1146	3366	981	3978	823	4286	698	4547	512	5375	360	3001
3L-2S		MI	2322	1146	3363	963	3962	808	4297	685	4659	497	5522	418	2690
6-#10	1.73	MA	2679	1193	3932	1000	4684	836	5136	704	5690	499	6899	423	3732
2L-3S		MI	2220	1193	3244	997	3800	833	4094	701	4380	501	5131	313	3345
6-#10	1.73	MA	2462	1193	3542	1009	4188	844	4535	711	4878	509	5803	331	3728
3L-2S		MI	2410	1193	3589	988	4237	826	4624	696	5096	493	6068	405	3342
6-#11	2.13	MA	2769	1244	4206	1022	4998	851	5500	712	6167	492	7441	402	4472
2L-3S		MI	2265	1244	3416	1020	3987	848	4305	708	4651	493	5414	266	3985
6-#11	2.13	MA	2516	1244	3737	1033	4403	860	4779	719	5194	503	6157	288	4454
3L-2S		MI	2486	1244	3829	1010	4510	841	4939	704	5508	485	6505	380	3993
6-#14	3.07	MA	3002	1364	4821	1091	5755	901	6406	742	7380	482	8935	368	6250
2L-3S		MI	2390	1364	3784	1091	4431	899	4832	738	5353	485	6237	174	5488
6-#14	3.07	MA	2665	1364	4156	1106	4912	912	5383	750	6000	496	7148	205	6165
3L-2S		MI	2683	1364	4367	1079	5171	890	5729	733	6564	475	7747	337	5554
6-#18	5.45	MA	3522	1668	6302	1269	7589	1029	8606	821	10332	461	12404	263	10535
2L-3S		MI	2699	1668	4659	1272	5497	1027	6103	814	7042	461	8115	-84	8018
6-#18	5.45	MA	3037	1668	5161	1291	6141	1044	6851	830	7963	478	9449	-27	9405
3L-2S		MI	3122	1668	5655	1255	6761	1018	7635	811	9106	450	10583	207	9284
8-#8	1.44	MA	2604	1156	3720	982	4438	824	4849	698	5313	505	6441	435	3155
2L-4S		MI	2153	1156	3030	983	3534	828	3780	702	3962	506	4658	332	2836
8-#8	1.44	MA	2464	1156	3473	988	4125	829	4469	702	4800	512	5738	378	3159
3E		MI	2224	1156	3183	977	3745	819	4039	694	4315	504	5086	363	2839
8-#8	1.44	MA	2384	1156	3301	994	3887	839	4178	711	4402	514	5243	345	3150
4L-2S		MI	2347	1156	3401	971	4022	815	4375	690	4768	498	5691	421	2832
8-#9	1.82	MA	2713	1204	3987	1010	4765	843	5240	710	5836	501	7129	427	3925
2L-4S		MI	2204	1204	3170	1013	3697	851	3972	716	4214	503	4988	297	3492
8-#9	1.82	MA	2542	1204	3676	1017	4371	850	4763	715	5191	509	6252	354	3922
3E		MI	2291	1204	3363	1006	3962	840	4297	706	4659	501	5522	337	3515
8-#9	1.82	MA	2445	1204	3460	1025	4072	862	4397	726	4691	512	5634	312	3887
4L-2S		MI	2440	1204	3637	999	4310	834	4718	702	5228	494	6274	409	3514
8-#10	2.31	MA	2847	1267	4323	1046	5180	869	5737	726	6501	496	7994	415	4898
2L-4S		MI	2269	1267	3346	1051	3902	880	4214	734	4536	499	5402	252	4233
8-#10	2.31	MA	2640	1267	3932	1055	4684	877	5136	732	5690	506	6899	322	4880
3E		MI	2374	1267	3589	1043	4237	867	4624	722	5096	498	6068	301	4362
8-#10	2.31	MA	2522	1267	3660	1065	4307	892	4674	745	5058	509	6125	270	4735
4L-2S		MI	2556	1267	3933	1034	4675	860	5155	717	5812	489	7005	393	4374
8-#11	2.84	MA	2964	1334	4675	1079	5593	893	6221	739	7141	488	8724	388	5867
2L-4S		MI	2322	1334	3537	1086	4107	905	4446	747	4834	489	5725	189	4876
8-#11	2.84	MA	2725	1334	4206	1090	4998	901	5500	745	6167	498	7441	275	5830
3E		MI	2445	1334	3829	1076	4510	889	4939	734	5508	489	6505	247	5195
8-#11	2.84	MA	2587	1334	3877	1100	4543	918	4943	760	5406	500	6529	213	5470
4L-2S		MI	2655	1334	4241	1067	5034	883	5573	730	6364	480	7595	361	5223
8-#14	4.09	MA	3264	1494	5486	1173	6599	960	7428	780	8761	476	10723	345	8217
2L-4S		MI	2489	1494	3953	1184	4599	979	5029	793	5609	476	6661	61	6401

RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	4.09	MA	2953	1494	4821	1187	5755	972	6406	788	7380	490	8935	181	8102
3E		MI	2646	1494	4367	1172	5171	958	5729	776	6564	479	7747	142	7185
8-#14	4.09	MA	2771	1494	4352	1201	5108	995	5614	808	6298	491	7662	95	7214
4L-2S		MI	2908	1494	4951	1160	5911	950	6626	771	7775	469	9257	305	7281
8-#18	7.27	MA	3512	1900	6302	1436	7589	1150	8606	897	10332	467	12404	-84	12223
3E		MI	3106	1900	5655	1417	6761	1133	7635	881	9106	450	10583	-157	10339
10-#10	2.89	MA	3011	1341	4714	1092	5676	903	6338	747	7312	492	9089	407	6059
2L-5S		MI	2324	1341	3474	1106	4044	921	4378	760	4743	504	5679	185	4906
10-#10	2.89	MA	2813	1341	4323	1101	5180	911	5737	753	6501	502	7994	314	6029
3L-4S		MI	2426	1341	3691	1097	4340	914	4745	755	5251	495	6339	240	5192
10-#10	2.89	MA	2703	1341	4050	1111	4803	926	5275	767	5869	506	7220	262	5830
4L-3S		MI	2525	1341	3933	1089	4675	900	5155	744	5812	494	7005	289	5377
10-#10	2.89	MA	2580	1341	3807	1120	4470	934	4862	773	5297	516	6449	208	5482
5L-2S		MI	2699	1341	4278	1080	5112	894	5685	739	6527	486	7942	381	5399
10-#11	3.55	MA	2928	1425	4675	1146	5593	943	6221	771	7141	494	8724	261	7204
3L-4S		MI	2507	1425	3949	1142	4631	946	5080	773	5691	484	6815	170	6024
10-#11	3.55	MA	2801	1425	4346	1157	5138	960	5664	786	6380	496	7813	199	6786
4L-3S		MI	2620	1425	4241	1133	5034	931	5573	760	6364	484	7595	228	6403
10-#11	3.55	MA	2660	1425	4051	1168	4736	968	5166	793	5690	507	6909	133	6412
5L-2S		MI	2818	1425	4654	1124	5557	924	6208	756	7220	476	8686	342	6446
10-#14	5.11	MA	3243	1625	5486	1269	6599	1031	7428	826	8761	484	10723	157	10042
3L-4S		MI	2747	1625	4536	1266	5339	1039	5926	831	6820	470	8172	30	8041
10-#14	5.11	MA	3069	1625	5017	1283	5952	1055	6636	846	7678	485	9449	71	9098
4L-3S		MI	2886	1625	4951	1254	5911	1018	6626	813	7775	473	9257	110	8883
12-#10	3.46	MA	2983	1414	4714	1147	5676	945	6338	774	7312	499	9089	306	7177
3L-5S		MI	2479	1414	3819	1152	4481	954	4908	782	5459	500	6616	173	5889
12-#10	3.46	MA	2880	1414	4441	1157	5299	959	5876	788	6680	502	8316	254	6933
4E		MI	2580	1414	4036	1143	4777	948	5275	777	5967	492	7276	228	6158
12-#10	3.46	MA	2759	1414	4198	1166	4966	967	5463	794	6109	512	7545	200	6603
5L-3S		MI	2672	1414	4278	1135	5112	934	5685	765	6527	491	7942	277	6389
12-#10	3.46	MA	2614	1414	3925	1182	4651	975	5059	808	5561	522	6837	141	6194
6L-2S		MI	2839	1414	4623	1126	5550	927	6215	760	7243	482	8879	369	6421
12-#11	4.25	MA	3009	1515	4815	1213	5733	1001	6386	812	7353	492	9097	186	8112
4E		MI	2698	1515	4362	1199	5154	988	5715	800	6547	480	7906	151	7182
12-#11	4.25	MA	2870	1515	4520	1224	5331	1010	5887	819	6663	503	8193	119	7745
5L-3S		MI	2797	1515	4654	1189	5557	972	6208	786	7220	480	8686	209	7610
12-#14	6.14	MA	3377	1755	5682	1365	6795	1114	7659	884	9058	479	11237	48	10994
4E		MI	2996	1755	5119	1348	6079	1098	6823	868	8031	464	9682	-2	9678
14-#10	4.04	MA	3053	1488	4832	1203	5794	993	6477	809	7492	499	9411	246	8042
4L-5S		MI	2630	1488	4164	1198	4919	988	5438	803	6175	497	7553	161	6877
14-#10	4.04	MA	2933	1488	4589	1212	5462	1001	6064	815	6920	509	8640	192	7729
5L-4S		MI	2730	1488	4380	1189	5215	981	5805	798	6683	488	8213	215	7131
14-#10	4.04	MA	2794	1488	4316	1228	5147	1009	5660	829	6372	519	7932	132	7308
6L-3S		MI	2823	1488	4623	1181	5550	967	6215	786	7243	487	8879	265	7400
14-#11	4.96	MA	3074	1606	4989	1281	5926	1051	6609	845	7637	498	9477	105	9062
5L-4S		MI	2874	1606	4774	1255	5677	1029	6349	826	7403	476	8996	132	8348
16-#10	4.62	MA	3103	1561	4979	1258	5957	1035	6665	837	7731	505	9735	184	8857
5E		MI	2778	1561	4508	1244	5356	1022	5968	824	6890	493	8490	149	7868
16-#10	4.62	MA	2970	1561	4707	1274	5643	1043	6261	850	7183	515	9028	124	8426
6L-4S		MI	2889	1561	4725	1235	5652	1015	6335	819	7399	485	9150	203	8109

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 24"

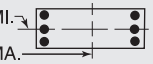
Short columns – no sidesway
Bending on major or minor axis

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.06	MA	2966	1208	4107	1042	4890	877	5305	749	5700	555	6838	483	2831
2E		MI	2439	1208	3476	1020	4066	859	4370	732	4648	542	5427	458	2319
4-#11	1.30	MA	3038	1242	4328	1054	5135	885	5582	752	6058	548	7260	470	3401
2E		MI	2490	1242	3652	1030	4254	865	4581	734	4919	534	5708	438	2773
4-#14	1.88	MA	3224	1322	4801	1098	5709	917	6264	771	6968	541	8420	451	4756
2E		MI	2628	1322	4022	1073	4699	895	5108	752	5620	526	6529	409	3840
4-#18	3.33	MA	3651	1525	5940	1212	7103	999	7929	820	9194	524	11145	392	8032
2E		MI	2934	1525	4902	1185	5767	975	6379	799	7308	506	8405	319	6384
6-#9	1.25	MA	3045	1235	4256	1062	5094	892	5558	759	6047	556	7326	483	3319
2L-3S		MI	2343	1235	3320	1047	3880	880	4151	747	4359	550	5067	385	2720
6-#9	1.25	MA	2843	1235	3910	1070	4654	900	5025	765	5328	565	6330	411	3325
3L-2S		MI	2500	1235	3594	1040	4228	874	4573	743	4927	543	5819	458	2708
6-#10	1.59	MA	3164	1282	4544	1088	5445	911	5976	770	6606	552	8092	478	4144
2L-3S		MI	2397	1282	3476	1074	4066	899	4370	758	4648	547	5427	353	3371
6-#10	1.59	MA	2917	1282	4107	1098	4890	920	5305	778	5700	563	6838	386	4140
3L-2S		MI	2589	1282	3821	1066	4503	892	4900	754	5364	539	6364	446	3363
6-#11	1.95	MA	3269	1332	4854	1111	5802	927	6390	778	7149	544	8739	460	4977
2L-3S		MI	2442	1332	3652	1096	4254	913	4581	765	4919	538	5708	306	4018
6-#11	1.95	MA	2981	1332	4328	1123	5135	937	5582	786	6058	557	7260	347	4959
3L-2S		MI	2665	1332	4064	1087	4777	906	5215	760	5775	530	6799	419	4018
6-#14	2.81	MA	3539	1452	5548	1180	6656	976	7412	808	8518	535	10487	434	6979
2L-3S		MI	2566	1452	4022	1167	4699	963	5108	794	5620	530	6529	213	5537
6-#14	2.81	MA	3153	1452	4801	1196	5709	989	6264	818	6968	551	8420	271	6894
3L-2S		MI	2865	1452	4605	1154	5439	955	6005	790	6831	520	8039	377	5586
6-#18	5.00	MA	4148	1757	7226	1357	8735	1105	9907	887	11864	513	14594	349	11831
2L-3S		MI	2873	1757	4902	1347	5767	1091	6379	869	7308	505	8405	-45	8354
6-#18	5.00	MA	3588	1757	5940	1383	7103	1124	7929	900	9194	537	11145	58	10973
3L-2S		MI	3306	1757	5898	1330	7031	1081	7911	866	9371	494	10872	246	9328
8-#8	1.32	MA	3077	1244	4304	1070	5167	899	5653	764	6181	557	7514	484	3496
2L-4S		MI	2329	1244	3260	1061	3799	895	4056	760	4230	552	4956	372	2860
8-#8	1.32	MA	2918	1244	4029	1077	4817	905	5229	769	5609	565	6722	428	3501
3E		MI	2401	1244	3413	1055	4010	886	4314	752	4584	550	5384	404	2858
8-#8	1.32	MA	2827	1244	3838	1084	4553	915	4905	778	5166	568	6170	395	3491
4L-2S		MI	2525	1244	3631	1049	4287	881	4650	748	5037	545	5988	461	2850
8-#9	1.67	MA	3202	1293	4603	1098	5534	919	6091	776	6767	553	8322	480	4357
2L-4S		MI	2380	1293	3401	1090	3962	917	4247	774	4483	549	5285	337	3524
8-#9	1.67	MA	3008	1293	4256	1106	5094	926	5558	782	6047	562	7326	408	4354
3E		MI	2468	1293	3594	1083	4228	906	4573	764	4927	547	5819	377	3539
8-#9	1.67	MA	2898	1293	4016	1115	4761	939	5151	793	5490	566	6629	365	4319
4L-2S		MI	2619	1293	3868	1076	4576	900	4994	760	5496	540	6571	450	3534
8-#10	2.12	MA	3356	1355	4980	1134	5999	945	6648	791	7513	548	9347	473	5447
2L-4S		MI	2445	1355	3579	1129	4168	946	4490	792	4804	545	5698	292	4326
8-#10	2.12	MA	3120	1355	4544	1144	5445	954	5976	799	6606	560	8092	381	5429
3E		MI	2552	1355	3821	1120	4503	933	4900	780	5364	543	6364	341	4392
8-#10	2.12	MA	2986	1355	4241	1155	5025	970	5462	813	5903	564	7211	327	5343
4L-2S		MI	2736	1355	4166	1112	4941	926	5430	775	6080	535	7301	433	4397
8-#11	2.60	MA	3493	1423	5379	1167	6468	968	7199	804	8240	540	10217	451	6541
2L-4S		MI	2498	1423	3773	1162	4375	970	4722	804	5102	534	6019	229	4979
8-#11	2.60	MA	3220	1423	4854	1179	5802	978	6390	812	7149	553	8739	338	6504
3E		MI	2622	1423	4064	1153	4777	955	5215	791	5775	534	6799	287	5232
8-#11	2.60	MA	3064	1423	4487	1191	5295	997	5769	829	6300	557	7695	273	6187
4L-2S		MI	2835	1423	4477	1143	5301	948	5849	787	6631	526	7889	400	5252
8-#14	3.75	MA	3844	1583	6294	1261	7603	1036	8560	846	10067	528	12555	417	9189
2L-4S		MI	2650	1583	4191	1260	4867	1044	5305	849	5875	521	6954	101	6522
8-#14	3.75	MA	3483	1583	5548	1277	6656	1049	7412	856	8518	545	10487	253	9074
3E		MI	2824	1583	4605	1248	5439	1023	6005	832	6831	524	8039	181	7236
8-#14	3.75	MA	3277	1583	5025	1293	5933	1075	6528	879	7309	550	9024	163	8171
4L-2S		MI	3092	1583	5189	1236	6179	1014	6902	827	8042	514	9549	345	7316

RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

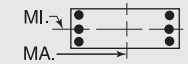
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	6.67	MA	4132	1988	7226	1528	8735	1230	9907	967	11864	526	14594	15	14543
3E		MI	3281	1988	5898	1492	7031	1197	7911	936	9371	494	10872	-118	10694
8-#18	6.67	MA	3836	1988	6319	1553	7482	1272	8373	1003	9769	528	12135	-137	11909
4L-2S		MI	3671	1988	6894	1475	8295	1187	9443	933	11434	483	13339	173	12257
10-#10	2.65	MA	3543	1429	5417	1180	6553	978	7320	813	8420	545	10601	468	6744
2L-5S		MI	2501	1429	3706	1183	4310	987	4653	818	5011	550	5975	225	4987
10-#10	2.65	MA	3318	1429	4980	1190	5999	987	6648	820	7513	556	9347	376	6715
3L-4S		MI	2603	1429	3923	1175	4606	980	5020	813	5520	541	6635	280	5281
10-#10	2.65	MA	3193	1429	4677	1201	5579	1003	6134	835	6810	561	8465	322	6577
4L-3S		MI	2703	1429	4166	1166	4941	966	5430	801	6080	540	7301	329	5408
10-#10	2.65	MA	3049	1429	4408	1211	5210	1012	5676	842	6175	572	7582	269	6152
5L-2S		MI	2880	1429	4510	1158	5378	959	5961	796	6795	531	8238	421	5425
10-#11	3.25	MA	3452	1513	5379	1236	6468	1019	7199	838	8240	548	10217	328	8047
3L-4S		MI	2682	1513	4185	1219	4898	1011	5356	830	5958	529	7109	210	6124
10-#11	3.25	MA	3308	1513	5013	1248	5961	1038	6578	855	7391	552	9174	264	7668
4L-3S		MI	2798	1513	4477	1209	5301	996	5849	817	6631	530	7889	268	6442
10-#11	3.25	MA	3142	1513	4686	1259	5514	1048	6023	863	6623	565	8133	198	7211
5L-2S		MI	3001	1513	4889	1200	5824	989	6484	813	7487	521	8980	381	6477
10-#14	4.69	MA	3803	1713	6294	1359	7603	1109	8560	894	10067	539	12555	236	11257
3L-4S		MI	2921	1713	4774	1342	5607	1103	6202	887	7086	515	8464	69	8156
10-#14	4.69	MA	3617	1713	5771	1375	6880	1134	7676	916	8858	543	11091	146	10295
4L-3S		MI	3064	1713	5189	1330	6179	1083	6902	870	8042	517	9549	149	8936
10-#14	4.69	MA	3387	1713	5305	1391	6243	1147	6885	927	7763	560	9636	50	9451
5L-2S		MI	3313	1713	5772	1317	6920	1074	7799	865	9253	507	11059	313	9038
12-#10	3.17	MA	3511	1503	5417	1236	6553	1021	7320	841	8420	553	10601	371	8000
3L-5S		MI	2656	1503	4051	1229	4747	1020	5184	839	5727	546	6912	213	5968
12-#10	3.17	MA	3395	1503	5114	1247	6134	1037	6806	856	7717	557	9720	317	7814
4E		MI	2756	1503	4268	1221	5043	1013	5551	834	6235	538	7572	268	6245
12-#10	3.17	MA	3252	1503	4845	1257	5764	1046	6348	863	7082	569	8837	264	7409
5L-3S		MI	2851	1503	4510	1212	5378	1000	5961	822	6795	536	8238	317	6422
12-#10	3.17	MA	3089	1503	4535	1272	5415	1055	5899	878	6460	574	7974	192	7003
6L-2S		MI	3021	1503	4855	1204	5816	993	6491	817	7511	528	9175	409	6447
12-#11	3.90	MA	3545	1603	5538	1304	6628	1079	7386	881	8482	548	10652	254	9158
4E		MI	2863	1603	4597	1275	5421	1053	5991	856	6814	525	8200	191	7279
12-#11	3.90	MA	3381	1603	5212	1316	6181	1089	6832	889	7714	561	9612	188	8726
5L-3S		MI	2977	1603	4889	1266	5824	1037	6484	843	7487	525	8980	249	7651
12-#11	3.90	MA	3190	1603	4844	1335	5758	1099	6288	906	6978	574	8657	115	8094
6L-2S		MI	3161	1603	5302	1257	6348	1030	7118	839	8344	517	10070	362	7697
12-#14	5.63	MA	3946	1844	6518	1456	7828	1194	8824	954	10408	537	13158	129	12431
4E		MI	3171	1844	5357	1423	6348	1163	7099	925	8297	509	9974	37	9803
12-#14	5.63	MA	3719	1844	6051	1473	7190	1207	8033	964	9312	554	11703	33	11574
5L-3S		MI	3298	1844	5772	1411	6920	1142	7799	907	9253	511	11059	118	10632
14-#10	3.70	MA	3591	1576	5551	1293	6688	1071	7478	877	8624	554	10974	312	9057
4L-5S		MI	2807	1576	4396	1275	5185	1054	5714	860	6443	543	7849	201	6954
14-#10	3.70	MA	3450	1576	5281	1303	6319	1080	7020	885	7988	565	10091	259	8670
5L-4S		MI	2907	1576	4613	1267	5481	1047	6081	855	6951	534	8509	256	7215
14-#10	3.70	MA	3294	1576	4971	1318	5969	1088	6571	899	7367	570	9229	187	8254
6L-3S		MI	2996	1576	4855	1258	5816	1033	6491	844	7511	533	9175	305	7434
14-#11	4.55	MA	3614	1694	5737	1373	6848	1130	7640	915	8805	557	11090	179	10245
5L-4S		MI	3051	1694	5010	1332	5945	1094	6625	883	7670	521	9290	172	8441
14-#11	4.55	MA	3432	1694	5370	1391	6425	1140	7096	932	8069	569	10135	105	9602
6L-3S		MI	3144	1694	5302	1322	6348	1079	7118	869	8344	521	10070	230	8858

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

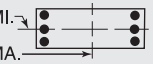
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	6.56	MA	4064	1974	6798	1554	8137	1267	9181	1002	10862	548	13770	16	13705
5L-4S		MI	3414	1974	5941	1505	7088	1223	7996	962	9508	503	11484	5	11460
16-#10	4.23	MA	3644	1650	5718	1349	6873	1113	7691	906	8895	562	11346	254	9934
5E		MI	2956	1650	4741	1321	5622	1087	6244	882	7158	539	8787	189	7943
16-#10	4.23	MA	3494	1650	5408	1364	6524	1122	7242	920	8274	567	10483	182	9509
6L-4S		MI	3055	1650	4957	1313	5918	1081	6611	877	7667	531	9446	244	8191
16-#11	5.20	MA	3668	1784	5895	1448	7092	1182	7905	958	9160	565	11614	96	11114
6L-4S		MI	3223	1784	5422	1388	6468	1135	7259	909	8526	517	10380	153	9610
18-#10	4.76	MA	3690	1724	5845	1410	7078	1156	7914	942	9180	563	11738	177	10768
6L-5S		MI	3113	1724	5085	1367	6059	1121	6774	903	7874	536	9724	177	8935

RECTANGULAR TIED COLUMNS 20" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.20	MA	3545	1330	4955	1143	5914	961	6439	818	6978	601	8428	523	3738
2E		MI	2668	1330	3888	1107	4521	930	4857	791	5186	580	6002	478	2794
4-#14	1.73	MA	3757	1410	5482	1186	6553	992	7199	836	7992	593	9760	508	5242
2E		MI	2806	1410	4260	1149	4967	960	5384	808	5886	571	6821	448	3867
4-#18	3.08	MA	4246	1613	6755	1301	8113	1074	9060	886	10480	576	12913	460	8896
2E		MI	3115	1613	5144	1259	6037	1039	6655	855	7573	550	8694	357	6424
6-#9	1.15	MA	3551	1323	4872	1150	5864	968	6406	825	6958	608	8419	529	3643
2L-3S		MI	2520	1323	3551	1125	4145	946	4427	805	4627	596	5363	426	2739
6-#9	1.15	MA	3324	1323	4489	1159	5378	976	5817	831	6164	618	7319	459	3649
3L-2S		MI	2678	1323	3825	1118	4493	940	4848	801	5196	589	6116	498	2726
6-#10	1.47	MA	3685	1370	5190	1176	6253	986	6870	836	7578	604	9272	525	4555
2L-3S		MI	2574	1370	3708	1152	4332	965	4646	816	4916	593	5723	393	3395
6-#10	1.47	MA	3407	1370	4707	1187	5641	996	6128	844	6576	617	7884	435	4551
3L-2S		MI	2768	1370	4053	1143	4769	958	5176	811	5632	584	6660	486	3384
6-#11	1.80	MA	3806	1421	5537	1199	6653	1002	7334	844	8186	596	10101	517	5483
2L-3S		MI	2618	1421	3888	1173	4521	978	4857	822	5186	584	6002	346	4049
6-#11	1.80	MA	3482	1421	4955	1212	5914	1013	6439	853	6978	611	8428	403	5465
3L-2S		MI	2844	1421	4300	1163	5045	972	5491	817	6042	575	7093	459	4043
6-#14	2.60	MA	4114	1541	6310	1268	7604	1052	8472	874	9710	587	12108	496	7708
2L-3S		MI	2742	1541	4260	1242	4967	1028	5384	851	5886	575	6821	253	5582
6-#14	2.60	MA	3678	1541	5482	1286	6553	1067	7199	886	7992	606	9760	333	7623
3L-2S		MI	3046	1541	4843	1230	5707	1019	6281	846	7097	565	8331	416	5617
6-#18	4.62	MA	4815	1845	8186	1446	9929	1180	11261	953	13451	565	16859	428	13127
2L-3S		MI	3048	1845	5144	1421	6037	1155	6655	924	7573	550	8694	-6	8687
6-#18	4.62	MA	4150	1845	6755	1474	8113	1203	9060	970	10480	594	12913	137	12471
3L-2S		MI	3489	1845	6140	1404	7301	1145	8187	922	9636	539	11161	284	9371
8-#8	1.22	MA	3586	1332	4924	1159	5944	974	6509	829	7104	609	8625	530	3837
2L-4S		MI	2506	1332	3490	1139	4064	961	4331	817	4499	598	5254	413	2883
8-#8	1.22	MA	3407	1332	4620	1166	5558	981	6041	835	6472	618	7750	475	3842
3E		MI	2578	1332	3642	1133	4275	952	4590	810	4853	597	5681	444	2877
8-#8	1.22	MA	3307	1332	4410	1173	5267	992	5686	845	5986	622	7149	442	3832
4L-2S		MI	2704	1332	3861	1127	4552	948	4926	806	5306	591	6286	502	2868
8-#9	1.54	MA	3727	1381	5254	1186	6350	994	6995	841	7753	605	9519	525	4789
2L-4S		MI	2557	1381	3632	1168	4227	983	4523	831	4751	595	5582	378	3554
8-#9	1.54	MA	3509	1381	4872	1195	5864	1002	6406	848	6958	616	8419	455	4786
3E		MI	2645	1381	3825	1161	4493	972	4848	821	5196	593	6116	417	3562
8-#9	1.54	MA	3386	1381	4608	1204	5498	1016	5958	861	6345	621	7659	414	4751
4L-2S		MI	2798	1381	4099	1154	4841	967	5270	817	5765	586	6868	490	3554
8-#10	1.95	MA	3902	1444	5673	1222	6866	1020	7613	857	8581	600	10660	520	5996
2L-4S		MI	2621	1444	3811	1206	4434	1012	4766	849	5072	590	5994	332	4382
8-#10	1.95	MA	3636	1444	5190	1233	6253	1030	6870	866	7578	613	9272	430	5977
3E		MI	2729	1444	4053	1198	4769	998	5176	837	5632	589	6660	381	4419
8-#10	1.95	MA	3487	1444	4857	1245	5791	1047	6304	881	6804	619	8309	377	5892
4L-2S		MI	2915	1444	4398	1189	5207	992	5706	832	6348	581	7597	474	4420

RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

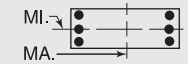
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	2.40	MA	4059	1511	6119	1256	7391	1044	8229	870	9395	592	11774	511	7215
2L-4S		MI	2673	1511	4008	1238	4642	1035	4998	861	5369	579	6313	269	5079
8-#11	2.40	MA	3751	1511	5537	1269	6653	1055	7334	879	8186	607	10101	397	7178
3E		MI	2800	1511	4300	1229	5045	1020	5491	848	6042	579	7093	327	5267
8-#11	2.40	MA	3577	1511	5133	1281	6094	1074	6649	897	7250	612	8926	331	6919
4L-2S		MI	3015	1511	4712	1220	5568	1013	6125	843	6898	571	8183	440	5279
8-#14	3.46	MA	4459	1671	7137	1350	8655	1111	9745	912	11429	581	14457	485	10161
2L-4S		MI	2824	1671	4429	1336	5135	1109	5581	906	6142	566	7246	140	6639
8-#14	3.46	MA	4051	1671	6310	1367	7604	1126	8472	924	9710	600	12108	321	10046
3E		MI	3001	1671	4843	1324	5707	1088	6281	888	7097	569	8331	221	7285
8-#14	3.46	MA	3820	1671	5734	1385	6807	1154	7495	949	8375	607	10454	227	9146
4L-2S		MI	3274	1671	5427	1312	6448	1079	7178	884	8308	558	9842	384	7350
8-#18	6.15	MA	4792	2077	8186	1619	9929	1309	11261	1037	13451	583	16859	105	16476
3E		MI	3456	2077	6140	1566	7301	1261	8187	991	9636	538	11161	-79	11044
8-#18	6.15	MA	4418	2077	7184	1647	8542	1354	9564	1077	11131	590	14063	-55	13952
4L-2S		MI	3856	2077	7136	1549	8565	1251	9719	989	11699	527	13628	211	12303
10-#10	2.44	MA	4113	1517	6156	1268	7479	1054	8355	878	9583	597	12048	515	7430
2L-5S		MI	2677	1517	3939	1261	4576	1052	4929	875	5279	595	6271	265	5065
10-#10	2.44	MA	3859	1517	5673	1279	6866	1064	7613	887	8581	610	10660	425	7401
3L-4S		MI	2779	1517	4155	1252	4872	1046	5296	870	5788	587	6931	320	5368
10-#10	2.44	MA	3720	1517	5340	1291	6404	1080	7047	902	7806	616	9697	372	7304
4L-3S		MI	2881	1517	4398	1244	5207	1032	5706	858	6348	586	7597	369	5438
10-#10	2.44	MA	3554	1517	5044	1302	5998	1090	6543	911	7108	628	8729	321	6831
5L-2S		MI	3060	1517	4742	1235	5644	1025	6236	854	7064	577	8534	462	5450
10-#11	3.00	MA	4013	1601	6119	1325	7391	1096	8229	905	9395	602	11774	391	8889
3L-4S		MI	2858	1601	4421	1295	5165	1077	5632	887	6225	575	7403	250	6220
10-#11	3.00	MA	3852	1601	5715	1338	6832	1116	7544	923	8458	608	10599	325	8566
4L-3S		MI	2976	1601	4712	1286	5568	1061	6125	874	6898	575	8183	308	6480
10-#11	3.00	MA	3659	1601	5356	1351	6340	1127	6934	933	7612	622	9422	260	8020
5L-2S		MI	3183	1601	5125	1276	6091	1054	6760	870	7755	567	9273	421	6507
10-#14	4.33	MA	4411	1801	7137	1449	8655	1186	9745	962	11429	594	14457	309	12472
3L-4S		MI	3096	1801	5012	1418	5876	1168	6478	943	7353	560	8756	108	8268
10-#14	4.33	MA	4203	1801	6561	1466	7857	1213	8769	986	10094	601	12803	215	11512
4L-3S		MI	3243	1801	5427	1405	6448	1147	7178	926	8308	562	9842	189	8986
10-#14	4.33	MA	3936	1801	6048	1484	7155	1228	7898	998	8886	620	11150	121	10660
5L-2S		MI	3497	1801	6010	1393	7188	1139	8075	921	9519	552	11352	352	9074
10-#18	7.69	MA	5108	2309	8614	1792	10358	1460	11764	1144	14102	579	18008	-87	17737
4L-3S		MI	3853	2309	7136	1711	8565	1367	9719	1058	11699	526	13628	-152	13354
12-#10	2.93	MA	4076	1591	6156	1325	7479	1097	8355	908	9583	606	12048	420	8823
3L-5S		MI	2833	1591	4283	1307	5013	1086	5459	897	5995	592	7208	253	6044
12-#10	2.93	MA	3946	1591	5822	1337	7017	1114	7789	924	8809	612	11085	367	8710
4E		MI	2933	1591	4500	1298	5309	1079	5826	892	6503	583	7868	308	6329
12-#10	2.93	MA	3782	1591	5527	1348	6611	1124	7286	932	8110	625	10116	317	8223
5L-3S		MI	3029	1591	4742	1290	5644	1066	6236	880	7064	582	8534	357	6453
12-#10	2.93	MA	3599	1591	5179	1362	6228	1134	6793	947	7427	631	9174	246	7829
6L-2S		MI	3202	1591	5087	1281	6082	1059	6767	875	7779	574	9472	450	6474
12-#11	3.60	MA	4119	1692	6297	1394	7571	1157	8439	949	9667	604	12273	319	10221
4E		MI	3039	1692	4833	1351	5689	1118	6267	913	7081	570	8494	231	7372
12-#11	3.60	MA	3929	1692	5938	1407	7079	1168	7829	959	8820	618	11096	254	9702
5L-3S		MI	3157	1692	5125	1342	6091	1102	6760	900	7755	571	9273	289	7690
12-#11	3.60	MA	3715	1692	5525	1426	6614	1179	7231	977	7992	624	9945	166	9060
6L-2S		MI	3345	1692	5537	1333	6615	1096	7394	896	8611	562	10364	402	7729
12-#14	5.19	MA	4574	1932	7389	1548	8908	1273	10042	1024	11813	594	15151	204	13888
4E		MI	3346	1932	5595	1499	6616	1228	7375	981	8564	554	10267	76	9911

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

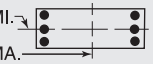
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	5.19	MA	4310	1932	6876	1565	8205	1288	9171	1036	10605	614	13498	109	13031
5L-3S		MI	3478	1932	6010	1487	7188	1207	8075	964	9519	556	11352	157	10688
14-#10	3.42	MA	4167	1665	6305	1383	7629	1148	8532	945	9811	609	12473	362	10087
4L-5S		MI	2985	1665	4628	1353	5450	1120	5990	918	6711	588	8146	241	7027
14-#10	3.42	MA	4004	1665	6009	1394	7224	1157	8028	953	9112	621	11504	312	9620
5L-4S		MI	3085	1665	4845	1344	5747	1113	6357	913	7219	580	8805	296	7297
14-#10	3.42	MA	3830	1665	5662	1408	6840	1167	7535	969	8429	627	10562	241	9219
6L-3S		MI	3175	1665	5087	1336	6082	1099	6767	901	7779	579	9472	345	7467
14-#10	3.42	MA	3677	1665	5351	1415	6433	1182	7059	977	7765	640	9643	198	8722
7L-2S		MI	3343	1665	5432	1327	6519	1093	7297	896	8495	570	10409	437	7495
14-#11	4.20	MA	4191	1782	6520	1464	7818	1209	8724	985	10028	614	12769	248	11389
5L-4S		MI	3228	1782	5245	1408	6212	1159	6901	939	7937	566	9584	212	8532
14-#11	4.20	MA	3987	1782	6107	1482	7352	1220	8126	1003	9200	619	11618	160	10737
6L-3S		MI	3325	1782	5537	1399	6615	1144	7394	926	8611	566	10364	270	8899
14-#14	6.06	MA	4674	2062	7704	1647	9256	1347	10444	1074	12323	608	15847	97	15410
5L-4S		MI	3590	2062	6179	1581	7356	1287	8273	1019	9775	547	11777	45	11564
16-#10	3.91	MA	4222	1738	6492	1440	7836	1191	8771	974	10115	618	12892	307	11021
5E		MI	3134	1738	4973	1399	5888	1153	6520	939	7426	585	9083	229	8015
16-#10	3.91	MA	4054	1738	6145	1454	7453	1201	8278	990	9431	624	11950	236	10612
6L-4S		MI	3233	1738	5190	1390	6184	1147	6887	934	7935	576	9742	284	8270
16-#10	3.91	MA	3909	1738	5834	1461	7046	1216	7802	998	8768	637	11031	193	10129
7L-3S		MI	3326	1738	5432	1382	6519	1133	7297	922	8495	575	10409	333	8480
16-#11	4.80	MA	4253	1873	6689	1539	8091	1262	9022	1029	10409	615	13292	154	12419
6L-4S		MI	3401	1873	5658	1465	6735	1201	7535	965	8794	562	10674	193	9699
18-#10	4.40	MA	4274	1812	6627	1500	8066	1234	9020	1011	10434	620	13338	231	12008
6L-5S		MI	3281	1812	5318	1445	6325	1187	7050	960	8142	581	10020	217	9005
18-#10	4.40	MA	4136	1812	6317	1507	7658	1250	8544	1020	9770	633	12419	189	11538
7L-4S		MI	3392	1812	5534	1436	6622	1180	7417	955	8650	573	10679	272	9248
20-#10	4.88	MA	4358	1886	6799	1553	8271	1283	9287	1041	10773	630	13806	184	12945
7L-5S		MI	3436	1886	5662	1491	6763	1221	7580	982	8858	578	10957	205	9998

RECTANGULAR TIED COLUMNS 20" x 28"

4-#11	1.11	MA	4088	1418	5617	1231	6742	1036	7348	884	7953	653	9596	569	4075
2E		MI	2846	1418	4123	1183	4789	995	5133	848	5453	625	6296	518	2815
4-#14	1.61	MA	4327	1499	6198	1275	7446	1067	8186	902	9070	646	11132	560	5728
2E		MI	2985	1499	4498	1225	5235	1025	5660	865	6153	616	7114	487	3893
4-#18	2.86	MA	4879	1701	7605	1389	9170	1150	10245	951	11821	629	14751	524	9760
2E		MI	3296	1701	5387	1334	6307	1102	6931	910	7838	594	8983	396	6461
6-#9	1.07	MA	4092	1412	5522	1239	6682	1043	7307	890	7924	660	9577	575	3967
2L-3S		MI	2697	1412	3781	1202	4411	1012	4703	862	4895	642	5660	466	2757
6-#9	1.07	MA	3841	1412	5104	1248	6151	1052	6663	898	7055	672	8372	507	3973
3L-2S		MI	2856	1412	4055	1195	4759	1006	5124	858	5464	635	6412	539	2743
6-#10	1.36	MA	4243	1459	5872	1265	7110	1062	7817	902	8605	656	10514	570	4966
2L-3S		MI	2751	1459	3941	1229	4598	1031	4922	873	5185	638	6019	433	3417
6-#10	1.36	MA	3934	1459	5343	1276	6439	1072	7004	911	7507	670	8994	483	4963
3L-2S		MI	2946	1459	4285	1220	5035	1024	5452	869	5900	630	6956	526	3404
6-#11	1.67	MA	4380	1509	6256	1288	7552	1078	8331	910	9278	649	11431	563	5988
2L-3S		MI	2795	1509	4123	1249	4789	1044	5133	879	5453	629	6296	385	4079
6-#11	1.67	MA	4019	1509	5617	1301	6742	1090	7348	920	7953	665	9596	452	5970
3L-2S		MI	3022	1509	4536	1240	5312	1037	5767	874	6309	620	7387	499	4068
6-#14	2.41	MA	4726	1629	7107	1356	8600	1127	9585	940	10958	639	13747	551	8437
2L-3S		MI	2919	1629	4498	1318	5235	1093	5660	907	6153	620	7114	292	5624
6-#14	2.41	MA	4240	1629	6198	1375	7446	1143	8186	954	9070	661	11132	389	8352
3L-2S		MI	3225	1629	5081	1306	5976	1084	6557	902	7364	610	8624	455	5647

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



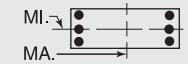
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	4.29	MA	5523	1933	9181	1534	11170	1256	12668	1018	15093	617	19196	501	14423
2L-3S		MI	3223	1933	5387	1496	6307	1218	6931	980	7838	594	8983	32	8898
6-#18	4.29	MA	4771	1933	7605	1565	9170	1281	10245	1039	11821	651	14751	211	14001
3L-2S		MI	3672	1933	6383	1479	7571	1208	8463	977	9901	583	11450	323	9413
8-#8	1.13	MA	4131	1421	5579	1247	6768	1050	7419	895	8082	662	9800	576	4179
2L-4S		MI	2683	1421	3719	1216	4328	1028	4607	875	4768	644	5551	453	2903
8-#8	1.13	MA	3933	1421	5246	1255	6346	1057	6907	901	7391	671	8843	523	4183
3E		MI	2756	1421	3872	1211	4540	1019	4866	867	5121	643	5979	485	2895
8-#8	1.13	MA	3822	1421	5018	1262	6029	1068	6519	912	6860	675	8191	490	4174
4L-2S		MI	2882	1421	4091	1205	4817	1014	5201	864	5574	637	6583	542	2885
8-#9	1.43	MA	4289	1470	5941	1275	7214	1070	7952	907	8794	658	10781	571	5221
2L-4S		MI	2733	1470	3863	1245	4493	1050	4799	889	5020	641	5879	418	3581
8-#9	1.43	MA	4047	1470	5522	1284	6682	1078	7307	915	7924	669	9577	503	5218
3E		MI	2823	1470	4055	1239	4759	1038	5124	879	5464	639	6412	457	3583
8-#9	1.43	MA	3911	1470	5235	1294	6283	1092	6819	928	7255	674	8753	462	5183
4L-2S		MI	2977	1470	4329	1232	5106	1033	5546	875	6033	632	7165	530	3574
8-#10	1.81	MA	4484	1532	6401	1311	7781	1096	8630	923	9703	653	12034	566	6544
2L-4S		MI	2797	1532	4043	1283	4700	1078	5042	907	5340	636	6290	372	4419
8-#10	1.81	MA	4189	1532	5872	1322	7110	1106	7817	932	8605	667	10514	478	6526
3E		MI	2907	1532	4285	1275	5035	1064	5452	895	5900	635	6956	421	4446
8-#10	1.81	MA	4024	1532	5509	1334	6606	1124	7199	948	7760	673	9470	425	6441
4L-2S		MI	3094	1532	4630	1266	5473	1058	5982	890	6616	627	7893	514	4442
8-#11	2.23	MA	4663	1599	6894	1344	8362	1119	9313	936	10604	644	13267	557	7889
2L-4S		MI	2849	1599	4244	1315	4909	1101	5274	918	5636	624	6607	308	5175
8-#11	2.23	MA	4320	1599	6256	1358	7552	1131	8331	946	9278	660	11431	446	7852
3E		MI	2977	1599	4536	1306	5312	1085	5767	905	6309	625	7387	366	5300
8-#11	2.23	MA	4127	1599	5815	1371	6941	1152	7582	965	8254	667	10157	381	7666
4L-2S		MI	3195	1599	4948	1296	5835	1078	6402	900	7165	616	8477	480	5306
8-#14	3.21	MA	5112	1759	8016	1438	9754	1187	10984	977	12846	633	16361	543	11133
2L-4S		MI	2999	1759	4667	1412	5404	1173	5857	962	6408	611	7539	180	6752
8-#14	3.21	MA	4655	1759	7107	1457	8600	1203	9585	991	10958	655	13747	381	11018
3E		MI	3179	1759	5081	1400	5976	1152	6557	945	7364	613	8624	260	7330
8-#14	3.21	MA	4400	1759	6477	1476	7728	1232	8516	1018	9496	663	11918	285	10139
4L-2S		MI	3457	1759	5665	1388	6716	1144	7454	940	8575	603	10134	424	7384
8-#18	5.71	MA	5492	2165	9181	1710	11170	1387	12668	1106	15093	640	19196	187	18457
3E		MI	3632	2165	6383	1641	7571	1324	8463	1047	9901	582	11450	-41	11392
8-#18	5.71	MA	5073	2165	8083	1741	9650	1435	10807	1149	12549	651	16061	22	15934
4L-2S		MI	4040	2165	7379	1624	8835	1314	9995	1044	11964	571	13917	250	12348
10-#10	2.27	MA	4720	1606	6930	1357	8452	1129	9444	944	10801	649	13554	561	8116
2L-5S		MI	2854	1606	4171	1338	4841	1118	5205	933	5548	641	6568	306	5139
10-#10	2.27	MA	4437	1606	6401	1368	7781	1140	8630	953	9703	663	12034	473	8087
3L-4S		MI	2956	1606	4388	1329	5138	1112	5572	928	6056	633	7227	360	5426
10-#10	2.27	MA	4283	1606	6037	1380	7277	1157	8013	970	8858	670	10990	421	7990
4L-3S		MI	3059	1606	4630	1321	5473	1098	5982	916	6616	631	7893	409	5466
10-#10	2.27	MA	4094	1606	5715	1392	6834	1168	7464	979	8095	684	9937	373	7518
5L-2S		MI	3240	1606	4975	1312	5910	1091	6512	911	7332	623	8831	502	5474
10-#11	2.79	MA	4611	1690	6894	1414	8362	1172	9313	972	10604	656	13267	440	9731
3L-4S		MI	3034	1690	4656	1371	5433	1142	5908	944	6492	620	7697	289	6313
10-#11	2.79	MA	4433	1690	6454	1428	7751	1193	8564	991	9580	663	11993	375	9479
4L-3S		MI	3154	1690	4948	1362	5835	1126	6402	931	7165	620	8477	347	6516
10-#11	2.79	MA	4213	1690	6062	1442	7214	1205	7898	1002	8656	679	10712	313	8838
5L-2S		MI	3363	1690	5360	1353	6359	1119	7036	926	8022	612	9567	461	6536
10-#14	4.02	MA	5057	1890	8016	1538	9754	1263	10984	1029	12846	648	16361	372	13687
3L-4S		MI	3271	1890	5250	1493	6144	1233	6754	1000	7619	605	9049	148	8377

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis

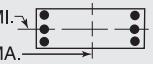


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	4.02	MA	4826	1890	7387	1557	8882	1291	9915	1055	11384	657	14532	277	12747
4L-3S		MI	3421	1890	5665	1481	6716	1212	7454	982	8575	607	10134	228	9034
10-#14	4.02	MA	4522	1890	6827	1576	8115	1308	8963	1069	10064	679	12698	184	11900
5L-2S		MI	3681	1890	6248	1469	7456	1203	8351	978	9786	597	11644	392	9110
10-#18	7.14	MA	5844	2397	9659	1885	11650	1541	13231	1216	15820	640	20506	-1	20502
4L-3S		MI	4029	2397	7379	1786	8835	1430	9995	1114	11964	570	13917	-113	13718
12-#10	2.72	MA	4678	1679	6930	1414	8452	1173	9444	975	10801	660	13554	468	9646
3L-5S		MI	3010	1679	4516	1384	5279	1152	5735	954	6263	638	7505	293	6116
12-#10	2.72	MA	4534	1679	6566	1426	7948	1191	8826	991	9955	666	12510	416	9541
4E		MI	3110	1679	4732	1375	5575	1145	6102	949	6771	629	8164	348	6411
12-#10	2.72	MA	4348	1679	6244	1438	7505	1201	8277	1000	9193	680	11457	368	9046
5L-3S		MI	3208	1679	4975	1367	5910	1132	6512	937	7332	628	8831	397	6484
12-#10	2.72	MA	4146	1679	5859	1452	7088	1212	7740	1016	8448	687	10437	298	8673
6L-2S		MI	3383	1679	5319	1358	6347	1125	7042	932	8047	619	9768	490	6500
12-#11	3.34	MA	4730	1780	7092	1484	8562	1234	9546	1017	10906	659	13829	369	11301
4E		MI	3215	1780	5069	1428	5956	1183	6543	970	7348	616	8788	270	7463
12-#11	3.34	MA	4513	1780	6701	1498	8025	1246	8880	1028	9982	674	12548	307	10687
5L-3S		MI	3328	1780	5360	1419	6359	1168	7036	957	8022	616	9567	328	7728
12-#11	3.34	MA	4277	1780	6241	1516	7518	1258	8228	1047	9078	682	11301	220	10044
6L-2S		MI	3528	1780	5773	1409	6882	1161	7670	952	8878	608	10658	442	7760
12-#14	4.82	MA	5239	2020	8296	1639	10036	1351	11314	1093	13273	651	17146	268	15365
4E		MI	3522	2020	5833	1575	6884	1292	7652	1037	8830	599	10559	116	10016
12-#14	4.82	MA	4938	2020	7736	1658	9269	1367	10362	1107	11952	672	15312	176	14521
5L-3S		MI	3657	2020	6248	1563	7456	1271	8351	1020	9786	601	11644	196	10737
12-#14	4.82	MA	4621	2020	7088	1684	8543	1384	9429	1133	10660	681	13522	49	13285
6L-2S		MI	3902	2020	6831	1551	8196	1263	9249	1015	10997	591	13154	360	10831
14-#10	3.17	MA	4780	1753	7095	1472	8619	1224	9639	1012	11053	663	14031	411	11093
4L-5S		MI	3162	1753	4860	1430	5716	1186	6265	975	6979	634	8442	281	7098
14-#10	3.17	MA	4596	1753	6773	1484	8176	1235	9090	1021	10291	677	12978	363	10579
5L-4S		MI	3262	1753	5077	1421	6013	1179	6632	970	7487	626	9101	336	7377
14-#10	3.17	MA	4402	1753	6388	1498	7759	1245	8553	1038	9546	684	11957	293	10201
6L-3S		MI	3355	1753	5319	1413	6347	1165	7042	958	8047	624	9768	385	7499
14-#10	3.17	MA	4233	1753	6048	1506	7306	1260	8035	1047	8823	697	10959	253	9624
7L-2S		MI	3524	1753	5664	1404	6785	1159	7573	954	8763	616	10705	478	7522
14-#11	3.90	MA	4805	1871	7339	1555	8835	1288	9862	1054	11307	670	14383	301	12542
5L-4S		MI	3406	1871	5481	1484	6479	1224	7177	996	8205	611	9878	251	8620
14-#11	3.90	MA	4579	1871	6880	1573	8328	1300	9210	1073	10403	677	13137	214	11892
6L-3S		MI	3505	1871	5773	1475	6882	1209	7670	983	8878	612	10658	309	8938
14-#11	3.90	MA	4382	1871	6469	1581	7789	1318	8581	1083	9526	693	11921	162	11190
7L-2S		MI	3688	1871	6185	1466	7405	1202	8304	979	9734	603	11748	423	8980
14-#14	5.63	MA	5343	2151	8646	1739	10423	1427	11761	1144	13840	666	17926	167	17148
5L-4S		MI	3766	2151	6416	1657	7624	1352	8549	1075	10041	592	12069	84	11665
14-#14	5.63	MA	5043	2151	7997	1765	9697	1443	10828	1171	12548	675	16136	40	15943
6L-3S		MI	3889	2151	6831	1644	8196	1331	9249	1058	10997	595	13154	164	12440
16-#10	3.63	MA	4838	1827	7302	1530	8848	1269	9904	1043	11389	673	14498	358	12116
5E		MI	3312	1827	5205	1476	6154	1219	6796	997	7695	631	9379	269	8084
16-#10	3.63	MA	4652	1827	6916	1544	8430	1279	9366	1059	10644	680	13477	288	11732
6L-4S		MI	3411	1827	5422	1467	6450	1213	7162	992	8203	622	10039	324	8348
16-#10	3.63	MA	4491	1827	6577	1552	7978	1294	8848	1068	9921	694	12479	248	11169
7L-3S		MI	3499	1827	5664	1459	6785	1199	7573	980	8763	621	10705	373	8513
16-#10	3.63	MA	4333	1827	6251	1560	7541	1301	8324	1084	9211	708	11520	195	10535
8L-2S		MI	3663	1827	6009	1450	7222	1192	8103	975	9479	612	11642	466	8543
16-#11	4.46	MA	4875	1961	7518	1629	9138	1341	10192	1099	11729	673	14972	208	13744
6L-4S		MI	3579	1961	5893	1541	7003	1266	7811	1022	9061	607	10968	232	9785
16-#11	4.46	MA	4688	1961	7107	1637	8600	1360	9563	1109	10852	689	13757	156	13048
7L-3S		MI	3671	1961	6185	1532	7405	1250	8304	1009	9734	607	11748	290	10147
16-#14	6.43	MA	5455	2281	8906	1847	10852	1503	12227	1208	14437	669	18750	32	18589
6L-4S		MI	4005	2281	7000	1738	8364	1412	9446	1113	11252	586	13579	52	13323

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

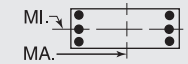
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
18-#10	4.08	MA	4896	1900	7445	1590	9101	1313	10180	1080	11742	677	14997	283	13266
6L-5S		MI	3460	1900	5550	1522	6591	1253	7326	1018	8410	627	10316	257	9073
18-#10	4.08	MA	4743	1900	7106	1598	8649	1328	9661	1089	11019	690	14000	243	12716
7L-4S		MI	3558	1900	5766	1513	6887	1246	7693	1013	8918	619	10976	312	9324
18-#10	4.08	MA	4586	1900	6779	1606	8212	1334	9137	1105	10309	704	13040	190	12083
8L-3S		MI	3648	1900	6009	1505	7222	1233	8103	1001	9479	617	11642	361	9526
18-#11	5.01	MA	4987	2052	7746	1694	9410	1401	10545	1136	12177	684	15592	150	14909
7L-4S		MI	3749	2052	6306	1598	7526	1307	8446	1048	9917	603	12059	213	10954
20-#10	4.54	MA	4989	1974	7635	1644	9320	1361	10475	1111	12117	687	15520	239	14265
7L-5S		MI	3616	1974	5894	1568	7029	1287	7856	1039	9126	624	11253	245	10065
20-#10	4.54	MA	4835	1974	7308	1652	8883	1368	9950	1126	11407	701	14560	185	13630
8L-4S		MI	3715	1974	6111	1559	7325	1280	8223	1034	9634	615	11913	300	10305
22-#10	4.99	MA	5079	2048	7837	1698	9554	1402	10764	1148	12504	697	16080	180	15177
8L-5S		MI	3758	2048	6239	1614	7466	1320	8386	1060	9842	620	12190	233	11059

RECTANGULAR TIED COLUMNS 20" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#11	1.04	MA	4668	1507	6315	1319	7617	1112	8311	949	8983	705	10828	614	4412
2E		MI	3024	1507	4359	1260	5056	1061	5409	905	5720	670	6590	557	2835
4-#14	1.50	MA	4934	1587	6949	1363	8387	1143	9227	968	10203	698	12507	606	6214
2E		MI	3163	1587	4736	1300	5504	1089	5936	921	6420	661	7406	527	3918
4-#18	2.67	MA	5550	1790	8491	1478	10276	1225	11482	1017	13218	681	16658	586	10624
2E		MI	3476	1790	5629	1408	6577	1166	7208	966	8103	639	9272	435	6497
6-#9	1.00	MA	4669	1500	6209	1327	7548	1119	8262	956	8946	713	10799	621	4291
2L-3S		MI	2874	1500	4012	1280	4676	1078	4978	920	5164	688	5957	506	2775
6-#9	1.00	MA	4393	1500	5753	1337	6971	1127	7562	964	8001	725	9490	554	4297
3L-2S		MI	3034	1500	4286	1273	5024	1073	5400	916	5733	681	6709	579	2760
6-#10	1.27	MA	4837	1547	6590	1353	8014	1137	8817	967	9687	709	11819	616	5378
2L-3S		MI	2928	1547	4173	1306	4864	1097	5197	931	5453	684	6315	474	3439
6-#10	1.27	MA	4497	1547	6015	1365	7284	1148	7933	977	8494	723	10167	531	5374
3L-2S		MI	3124	1547	4518	1298	5301	1090	5728	926	6168	676	7253	566	3423
6-#11	1.56	MA	4991	1597	7010	1376	8499	1153	9381	975	10426	701	12826	609	6493
2L-3S		MI	2972	1597	4359	1326	5056	1109	5409	935	5720	674	6590	425	4106
6-#11	1.56	MA	4592	1597	6315	1390	7617	1166	8311	987	8983	718	10828	501	6476
3L-2S		MI	3201	1597	4771	1316	5579	1102	6043	931	6576	666	7681	538	4091
6-#14	2.25	MA	5376	1717	7940	1445	9644	1202	10751	1005	12261	692	15356	597	9166
2L-3S		MI	3096	1717	4736	1394	5504	1157	5936	964	6420	664	7406	331	5663
6-#14	2.25	MA	4838	1717	6949	1465	8387	1220	9227	1021	10203	715	12507	439	9081
3L-2S		MI	3404	1717	5319	1382	6244	1149	6833	959	7630	654	8916	495	5676
6-#18	4.00	MA	6265	2022	10212	1623	12460	1331	14129	1084	16791	670	21604	571	15719
2L-3S		MI	3398	2022	5629	1571	6577	1282	7208	1035	8103	638	9272	71	9083
6-#18	4.00	MA	5429	2022	8491	1655	10276	1359	11482	1108	13218	707	16658	280	15297
3L-2S		MI	3855	2022	6625	1553	7841	1272	8740	1033	10166	627	11739	362	9455
8-#8	1.05	MA	4711	1509	6269	1336	7641	1125	8383	961	9115	714	11039	622	4520
2L-4S		MI	2859	1509	3949	1294	4593	1094	4883	933	5036	690	5849	493	2922
8-#8	1.05	MA	4494	1509	5907	1343	7182	1132	7827	967	8365	723	10000	570	4524
3E		MI	2933	1509	4102	1289	4805	1085	5141	925	5390	689	6277	525	2912
8-#8	1.05	MA	4372	1509	5660	1351	6839	1144	7406	978	7790	729	9298	537	4515
4L-2S		MI	3060	1509	4320	1283	5082	1080	5477	922	5843	683	6881	583	2901
8-#9	1.33	MA	4886	1558	6664	1363	8126	1145	8962	973	9891	710	12107	617	5653
2L-4S		MI	2910	1558	4094	1323	4758	1116	5074	947	5288	687	6176	458	3607
8-#9	1.33	MA	4620	1558	6209	1373	7548	1154	8262	981	8946	722	10799	550	5650
3E		MI	3000	1558	4286	1316	5024	1105	5400	937	5733	685	6709	498	3603
8-#9	1.33	MA	4471	1558	5897	1383	7116	1168	7732	994	8221	728	9912	510	5615
4L-2S		MI	3155	1558	4560	1309	5372	1099	5821	933	6302	678	7461	570	3592
8-#10	1.69	MA	5104	1621	7164	1399	8743	1171	9702	989	10881	705	13472	611	7093
2L-4S		MI	2974	1621	4275	1361	4966	1144	5318	964	5608	682	6586	412	4453

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

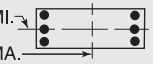
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#10	1.69	MA	4778	1621	6590	1411	8014	1182	8817	998	9687	720	11819	526	7075
3E		MI	3084	1621	4518	1352	5301	1130	5728	952	6168	681	7253	462	4471
8-#10	1.69	MA	4597	1621	6196	1424	7468	1200	8148	1015	8771	727	10695	474	6989
4L-2S		MI	3273	1621	4862	1344	5738	1124	6258	947	6884	672	8190	554	4464
8-#11	2.08	MA	5304	1688	7705	1433	9381	1194	10450	1002	11869	697	14824	603	8563
2L-4S		MI	3025	1688	4479	1391	5176	1166	5550	975	5903	670	6901	348	5269
8-#11	2.08	MA	4924	1688	7010	1447	8499	1207	9381	1013	10426	714	12826	495	8526
3E		MI	3154	1688	4771	1382	5579	1150	6043	962	6576	670	7681	406	5332
8-#11	2.08	MA	4712	1688	6532	1461	7836	1229	8568	1033	9314	722	11453	430	8371
4L-2S		MI	3374	1688	5184	1373	6103	1143	6678	957	7433	661	8771	519	5332
8-#14	3.00	MA	5803	1848	8931	1526	10902	1262	12276	1043	14318	685	18204	589	12105
2L-4S		MI	3174	1848	4905	1488	5672	1238	6133	1018	6675	656	7831	219	6862
8-#14	3.00	MA	5297	1848	7940	1546	9644	1280	10751	1058	12261	709	15356	431	11990
3E		MI	3347	1848	5319	1476	6244	1217	6833	1001	7630	658	8916	299	7374
8-#14	3.00	MA	5016	1848	7257	1566	8697	1310	9591	1086	10673	719	13384	336	11149
4L-2S		MI	3638	1848	5902	1463	6984	1208	7730	996	8841	648	10426	463	7416
8-#18	5.33	MA	6192	2254	10212	1800	12460	1465	14129	1175	16791	695	21604	265	20346
3E		MI	3808	2254	6625	1716	7841	1388	8740	1102	10166	626	11739	-2	11737
8-#18	5.33	MA	5765	2254	9018	1833	10806	1516	12104	1221	14021	710	18129	94	17538
4L-2S		MI	4224	2254	7621	1698	9105	1378	10272	1100	12229	615	14206	289	12393
10-#10	2.12	MA	5364	1694	7739	1445	9473	1205	10586	1010	12074	702	15124	607	8802
2L-5S		MI	3030	1694	4403	1415	5107	1184	5481	990	5816	687	6864	346	5211
10-#10	2.12	MA	5051	1694	7164	1457	8743	1216	9702	1020	10881	716	13472	521	8772
3L-4S		MI	3132	1694	4620	1407	5404	1178	5848	985	6324	678	7523	400	5463
10-#10	2.12	MA	4882	1694	6771	1470	8197	1234	9032	1037	9964	724	12348	469	8676
4L-3S		MI	3237	1694	4862	1398	5738	1164	6258	973	6884	677	8190	450	5494
10-#10	2.12	MA	4671	1694	6422	1482	7718	1245	8438	1047	9139	739	11211	423	8213
5L-2S		MI	3420	1694	5207	1390	6176	1157	6788	969	7600	669	9127	542	5497
10-#11	2.60	MA	5246	1778	7705	1503	9381	1248	10450	1039	11869	709	14824	489	10574
3L-4S		MI	3211	1778	4892	1448	5700	1207	6185	1001	6759	665	7991	329	6404
10-#11	2.60	MA	5050	1778	7227	1518	8718	1270	9637	1059	10757	718	13451	424	10407
4L-3S		MI	3332	1778	5184	1439	6103	1192	6678	988	7433	665	8771	387	6550
10-#11	2.60	MA	4804	1778	6803	1532	8137	1283	8916	1070	9755	735	12066	365	9664
5L-2S		MI	3544	1778	5596	1429	6626	1185	7312	983	8289	657	9861	500	6565
10-#14	3.75	MA	5741	1978	8931	1628	10902	1339	12276	1096	14318	702	18204	422	14902
3L-4S		MI	3446	1978	5488	1569	6412	1297	7031	1056	7886	650	9341	187	8483
10-#14	3.75	MA	5487	1978	8247	1648	9955	1369	11115	1124	12730	713	16233	328	14000
4L-3S		MI	3600	1978	5902	1557	6984	1277	7730	1039	8841	652	10426	268	9079
10-#14	3.75	MA	5144	1978	7641	1668	9123	1387	10082	1139	11297	736	14248	240	13069
5L-2S		MI	3864	1978	6486	1545	7724	1268	8628	1034	10052	642	11937	431	9145
10-#18	6.67	MA	6556	2486	10739	1978	12990	1621	14751	1287	17594	699	23076	79	22555
4L-3S		MI	4206	2486	7621	1861	9105	1494	10272	1169	12229	614	14206	-75	14078
10-#18	6.67	MA	5986	2486	9677	2011	11535	1650	12947	1311	15091	736	19595	-89	19288
5L-2S		MI	4588	2486	8617	1843	10369	1484	11804	1167	14293	603	16673	216	15322
12-#10	2.54	MA	5318	1768	7739	1503	9473	1249	10586	1041	12074	713	15124	516	10469
3L-5S		MI	3186	1768	4748	1461	5545	1218	6011	1012	6531	683	7801	334	6186
12-#10	2.54	MA	5159	1768	7345	1516	8927	1267	9916	1058	11157	720	14000	464	10364
4E		MI	3287	1768	4965	1453	5841	1211	6378	1007	7040	675	8460	388	6471
12-#10	2.54	MA	4951	1768	6997	1528	8448	1279	9322	1068	10332	735	12863	419	9878
5L-3S		MI	3386	1768	5207	1444	6176	1198	6788	995	7600	674	9127	437	6513
12-#10	2.54	MA	4729	1768	6574	1542	7996	1290	8740	1085	9525	743	11764	349	9484
6L-2S		MI	3564	1768	5552	1436	6613	1191	7318	990	8315	665	10064	530	6525
12-#11	3.12	MA	5378	1869	7922	1574	9600	1311	10706	1085	12200	713	15449	418	12395
4E		MI	3392	1869	5304	1504	6223	1248	6819	1027	7616	661	9081	310	7551

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

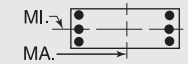
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	3.12	MA	5135	1869	7498	1589	9019	1324	9985	1096	11198	730	14065	359	11682
5L-3S		MI	3507	1869	5596	1495	6626	1233	7312	1014	8289	661	9861	368	7764
12-#11	3.12	MA	4874	1869	6992	1606	8470	1337	9278	1116	10219	739	12722	273	11046
6L-2S		MI	3710	1869	6008	1486	7149	1226	7946	1009	9145	653	10952	481	7790
12-#14	4.50	MA	5942	2109	9238	1729	11212	1429	12639	1162	14788	707	19081	319	16861
4E		MI	3698	2109	6071	1651	7152	1357	7928	1094	9097	643	10851	155	10119
12-#14	4.50	MA	5604	2109	8632	1749	10380	1447	11607	1177	13355	730	17097	231	15972
5L-3S		MI	3837	2109	6486	1639	7724	1336	8628	1077	10052	646	11937	236	10784
12-#14	4.50	MA	5254	2109	7917	1775	9595	1464	10596	1205	11954	741	15168	106	14605
6L-2S		MI	4086	2109	7069	1626	8464	1328	9525	1072	11263	636	13447	399	10868
12-#18	8.00	MA	6808	2718	11398	2156	13719	1756	15593	1378	18664	725	24542	-104	23999
5L-3S		MI	4594	2718	8617	2005	10369	1600	11804	1236	14293	603	16673	-148	16379
14-#10	2.96	MA	5430	1841	7920	1562	9656	1301	10800	1079	12351	717	15653	459	12053
4L-5S		MI	3340	1841	5093	1507	5982	1252	6541	1033	7247	680	8738	322	7167
14-#10	2.96	MA	5224	1841	7572	1574	9177	1312	10206	1089	11525	732	14516	414	11547
5L-4S		MI	3439	1841	5309	1499	6278	1245	6908	1028	7755	671	9398	376	7454
14-#10	2.96	MA	5011	1841	7149	1588	8726	1323	9624	1106	10719	739	13417	344	11168
6L-3S		MI	3534	1841	5552	1490	6613	1231	7318	1016	8315	670	10064	425	7529
14-#10	2.96	MA	4826	1841	6781	1596	8228	1338	9064	1116	9936	754	12341	307	10538
7L-2S		MI	3706	1841	5896	1482	7051	1225	7848	1011	9031	662	11001	518	7548
14-#11	3.64	MA	5457	1959	8193	1645	9901	1365	11054	1122	12641	726	16063	353	13704
5L-4S		MI	3570	1959	5717	1561	6747	1290	7453	1053	8472	657	10172	291	8706
14-#11	3.64	MA	5208	1959	7688	1663	9352	1378	10347	1142	11662	734	14720	267	13065
6L-3S		MI	3685	1959	6008	1552	7149	1274	7946	1040	9145	657	10952	349	8975
14-#11	3.64	MA	4992	1959	7241	1672	8757	1396	9666	1154	10711	751	13408	218	12324
7L-2S		MI	3872	1959	6421	1542	7673	1267	8580	1035	10001	648	12042	462	9011
14-#14	5.25	MA	6050	2239	9623	1831	11638	1506	13131	1214	15412	724	19946	223	18879
5L-4S		MI	3943	2239	6654	1732	7892	1417	8825	1131	10308	637	12361	123	11765
14-#14	5.25	MA	5720	2239	8907	1856	10852	1524	12120	1242	14011	735	18016	97	17503
6L-3S		MI	4069	2239	7069	1720	8464	1396	9525	1114	11263	640	13447	204	12488
16-#10	3.39	MA	5490	1915	8147	1620	9907	1346	11090	1110	12719	728	16168	409	13219
5E		MI	3490	1915	5437	1553	6420	1285	7071	1054	7963	676	9675	310	8151
16-#10	3.39	MA	5285	1915	7724	1634	9455	1357	10508	1127	11912	736	15069	339	12855
6L-4S		MI	3589	1915	5654	1545	6716	1279	7438	1049	8471	668	10335	364	8424
16-#10	3.39	MA	5109	1915	7356	1642	8957	1371	9948	1137	11130	751	13993	302	12222
7L-3S		MI	3679	1915	5896	1536	7051	1265	7848	1037	9031	667	11001	413	8544
16-#10	3.39	MA	4932	1915	7002	1651	8484	1379	9370	1153	10361	765	12957	251	11567
8L-2S		MI	3847	1915	6241	1528	7488	1258	8379	1032	9747	658	11938	506	8570
16-#11	4.16	MA	5534	2050	8383	1719	10234	1419	11416	1168	13105	730	16718	261	15088
6L-4S		MI	3757	2050	6129	1617	7270	1331	8087	1079	9328	652	11262	272	9869
16-#11	4.16	MA	5328	2050	7937	1728	9640	1438	10735	1180	12154	747	15406	212	14363
7L-3S		MI	3852	2050	6421	1608	7673	1315	8580	1066	10001	653	12042	330	10186
16-#14	6.00	MA	6173	2370	9898	1938	12110	1583	13644	1280	16069	728	20865	89	20400
6L-4S		MI	4182	2370	7238	1814	8633	1476	9722	1169	11519	631	13872	91	13420
18-#10	3.81	MA	5554	1989	8298	1680	10185	1391	11393	1149	13106	732	16721	334	14543
6L-5S		MI	3638	1989	5782	1599	6857	1319	7602	1075	8678	673	10612	297	9139
18-#10	3.81	MA	5386	1989	7931	1688	9687	1405	10832	1159	12323	747	15646	297	13908
7L-4S		MI	3737	1989	5999	1591	7153	1312	7968	1070	9187	664	11272	352	9399
18-#10	3.81	MA	5211	1989	7577	1697	9213	1412	10254	1174	11555	762	14610	246	13249
8L-3S		MI	3829	1989	6241	1582	7488	1299	8379	1058	9747	663	11938	401	9558
18-#11	4.68	MA	5657	2140	8632	1785	10522	1479	11804	1206	13597	743	17404	206	16402
7L-4S		MI	3928	2140	6541	1674	7793	1372	8722	1105	10184	648	12353	253	11037

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

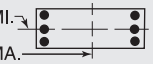
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	4.23	MA	5657	2062	8506	1734	10416	1439	11716	1180	13517	744	17298	292	15595
7L-5S		MI	3784	2062	6127	1645	7295	1353	8132	1097	9394	669	11549	285	10130
20-#10	4.23	MA	5484	2062	8152	1743	9943	1446	11138	1195	12748	758	16262	241	14931
8L-4S		MI	3895	2062	6343	1637	7591	1346	8499	1092	9902	661	12209	340	10377
22-#10	4.66	MA	5752	2136	8727	1789	10672	1480	12022	1216	13941	755	17915	236	16613
8L-5S		MI	3939	2136	6471	1691	7732	1386	8662	1118	10110	666	12486	273	11123

RECTANGULAR TIED COLUMNS 20" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.41	MA	5577	1675	7736	1452	9375	1218	10321	1033	11392	750	13945	652	6700
2E		MI	3341	1675	4974	1376	5772	1154	6212	977	6686	706	7698	566	3943
4-#18	2.50	MA	6258	1878	9412	1566	11429	1300	12773	1083	14669	733	18459	632	11488
2E		MI	3656	1878	5871	1483	6847	1230	7484	1021	8368	683	9561	474	6532
6-#10	1.19	MA	5467	1635	7342	1442	8966	1213	9871	1033	10824	761	13189	662	5789
2L-3S		MI	3104	1635	4405	1383	5130	1163	5473	988	5721	730	6612	514	3459
6-#10	1.19	MA	5095	1635	6721	1454	8178	1224	8916	1044	9535	776	11404	578	5786
3L-2S		MI	3302	1635	4750	1375	5567	1156	6003	984	6436	722	7549	606	3442
6-#11	1.46	MA	5638	1686	7799	1464	9494	1228	10484	1041	11628	753	14285	654	6999
2L-3S		MI	3149	1686	4594	1402	5323	1174	5685	992	5987	719	6884	465	4132
6-#11	1.46	MA	5201	1686	7048	1479	8540	1242	9328	1053	10068	771	12124	549	6981
3L-2S		MI	3379	1686	5007	1393	5847	1167	6319	988	6844	711	7974	578	4114
6-#14	2.11	MA	6063	1806	8808	1533	10736	1278	11971	1071	13619	744	17029	643	9895
2L-3S		MI	3272	1806	4974	1470	5772	1222	6212	1020	6686	709	7698	371	5701
6-#14	2.11	MA	5472	1806	7736	1554	9375	1297	10321	1088	11392	769	13945	489	9810
3L-2S		MI	3584	1806	5557	1458	6512	1213	7110	1015	7897	699	9209	534	5705
6-#18	3.75	MA	7045	2110	11278	1711	13797	1406	15643	1150	18543	722	23823	617	17015
2L-3S		MI	3574	2110	5871	1645	6847	1346	7484	1091	8368	682	9561	110	9264
6-#18	3.75	MA	6125	2110	9412	1746	11429	1437	12773	1176	14669	762	18459	333	16593
3L-2S		MI	4037	2110	6867	1628	8111	1336	9016	1088	10431	671	12029	401	9496
8-#9	1.25	MA	5521	1646	7421	1452	9086	1220	10026	1039	11042	762	13497	663	6085
2L-4S		MI	3086	1646	4325	1401	5024	1182	5350	1004	5557	733	6473	499	3630
8-#9	1.25	MA	5229	1646	6930	1462	8462	1230	9270	1047	10022	775	12085	598	6082
3E		MI	3177	1646	4517	1394	5289	1171	5675	995	6001	731	7006	538	3623
8-#9	1.25	MA	5067	1646	6595	1472	7997	1245	8700	1061	9241	782	11135	557	6047
4L-2S		MI	3333	1646	4791	1387	5637	1165	6097	990	6570	724	7758	611	3611
8-#10	1.59	MA	5759	1709	7963	1488	9754	1246	10826	1054	12113	757	14974	657	7642
2L-4S		MI	3150	1709	4507	1438	5232	1210	5593	1022	5876	728	6882	452	4484
8-#10	1.59	MA	5403	1709	7342	1500	8966	1258	9871	1065	10824	773	13189	573	7623
3E		MI	3261	1709	4750	1429	5567	1196	6003	1010	6436	726	7549	502	4494
8-#10	1.59	MA	5205	1709	6918	1513	8378	1277	9149	1082	9837	781	11985	522	7538
4L-2S		MI	3452	1709	5094	1421	6004	1190	6534	1005	7152	718	8486	594	4485
8-#11	1.95	MA	5982	1776	8551	1521	10447	1270	11640	1067	13188	749	16445	648	9237
2L-4S		MI	3201	1776	4715	1468	5444	1231	5826	1032	6170	715	7195	388	5328
8-#11	1.95	MA	5565	1776	7799	1536	9494	1283	10484	1079	11628	767	14285	543	9200
3E		MI	3331	1776	5007	1458	5847	1215	6319	1018	6844	715	7974	446	5363
8-#11	1.95	MA	5334	1776	7284	1551	8779	1305	9608	1100	10429	776	12813	479	9045
4L-2S		MI	3553	1776	5419	1449	6370	1209	6954	1014	7700	707	9065	559	5358
8-#14	2.81	MA	6532	1936	9881	1615	12097	1337	13620	1109	15845	738	20112	635	13077
2L-4S		MI	3349	1936	5143	1564	5940	1303	6410	1075	6941	701	8123	258	6970
8-#14	2.81	MA	5976	1936	8808	1636	10736	1356	11971	1125	13619	762	17029	480	12962
3E		MI	3524	1936	5557	1551	6512	1282	7110	1058	7897	703	9209	339	7415
8-#14	2.81	MA	5669	1936	8071	1656	9714	1387	10718	1154	11905	775	14914	387	12176
4L-2S		MI	3820	1936	6140	1539	7252	1273	8007	1053	9108	693	10719	502	7448
8-#18	5.00	MA	6961	2342	11278	1891	13797	1543	15643	1243	18543	751	23823	317	22074
3E		MI	3984	2342	6867	1790	8111	1451	9016	1158	10431	670	12029	37	11917
8-#18	5.00	MA	6494	2342	9989	1925	12011	1595	13454	1291	15549	769	20094	149	19165
4L-2S		MI	4408	2342	7864	1773	9375	1441	10548	1155	12495	659	14496	328	12437

RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis

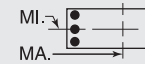


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.98	MA	6045	1783	8584	1534	10542	1280	11781	1076	13402	754	16759	653	9488
2L-5S		MI	3207	1783	4635	1492	5373	1250	5757	1048	6084	733	7160	386	5280
10-#10	1.98	MA	5702	1783	7963	1546	9754	1292	10826	1086	12113	769	14974	569	9458
3L-4S		MI	3309	1783	4852	1484	5669	1244	6124	1043	6592	724	7820	440	5497
10-#10	1.98	MA	5517	1783	7539	1559	9165	1310	10104	1104	11126	778	13770	517	9361
4L-3S		MI	3414	1783	5094	1475	6004	1230	6534	1031	7152	723	8486	490	5520
10-#10	1.98	MA	5284	1783	7165	1572	8651	1322	9465	1114	10237	793	12548	473	8915
5L-2S		MI	3599	1783	5439	1467	6442	1223	7064	1026	7868	714	9423	582	5519
10-#11	2.44	MA	5918	1867	8551	1592	10447	1325	11640	1105	13188	763	16445	537	11416
3L-4S		MI	3387	1867	5127	1524	5967	1272	6461	1058	7027	710	8285	369	6493
10-#11	2.44	MA	5704	1867	8036	1607	9733	1347	10764	1126	11990	772	14974	473	11249
4L-3S		MI	3510	1867	5419	1515	6370	1257	6954	1045	7700	711	9065	427	6583
10-#11	2.44	MA	5430	1867	7580	1622	9107	1360	9986	1138	10910	790	13485	417	10499
5L-2S		MI	3724	1867	5832	1506	6893	1250	7588	1040	8556	702	10155	540	6592
10-#14	3.52	MA	6463	2067	9881	1717	12097	1416	13620	1163	15845	756	20112	471	16117
3L-4S		MI	3607	2067	5726	1645	6680	1362	7307	1113	8152	695	9634	226	8587
10-#14	3.52	MA	6184	2067	9144	1738	11075	1447	12368	1192	14131	769	17998	378	15270
4L-3S		MI	3778	2067	6140	1633	7252	1341	8007	1095	9108	697	10719	307	9123
10-#14	3.52	MA	5803	2067	8491	1759	10179	1466	11255	1209	12586	793	15864	294	14211
5L-2S		MI	4047	2067	6724	1621	7992	1333	8904	1090	10319	687	12229	470	9179
10-#18	6.25	MA	7361	2574	11855	2070	14378	1701	16324	1358	19423	758	25457	134	24620
4L-3S		MI	4382	2574	7864	1935	9375	1557	10548	1225	12495	659	14496	-36	14435
10-#18	6.25	MA	6725	2574	10710	2105	12809	1732	14377	1384	16720	797	21710	-26	21611
5L-2S		MI	4773	2574	8860	1918	10639	1547	12080	1222	14558	648	16963	255	15367
12-#10	2.38	MA	5994	1856	8584	1592	10542	1325	11781	1107	13402	766	16759	564	11292
3L-5S		MI	3363	1856	4980	1538	5811	1284	6287	1069	6799	729	8097	374	6254
12-#10	2.38	MA	5820	1856	8160	1605	9953	1344	11059	1125	12415	774	15555	512	11187
4E		MI	3464	1856	5197	1530	6107	1277	6654	1064	7308	721	8757	428	6507
12-#10	2.38	MA	5590	1856	7785	1618	9438	1355	10420	1135	11526	790	14333	469	10717
5L-3S		MI	3565	1856	5439	1521	6442	1264	7064	1052	7868	719	9423	478	6541
12-#10	2.38	MA	5348	1856	7325	1631	8953	1367	9794	1153	10658	798	13156	399	10276
6L-2S		MI	3744	1856	5784	1513	6879	1257	7594	1047	8583	711	10360	570	6549
12-#11	2.92	MA	6063	1957	8787	1664	10687	1388	11920	1152	13550	768	17134	467	13456
4E		MI	3569	1957	5540	1581	6490	1314	7095	1084	7883	706	9375	350	7637
12-#11	2.92	MA	5792	1957	8332	1679	10060	1402	11142	1164	12470	786	15646	411	12685
5L-3S		MI	3685	1957	5832	1572	6893	1298	7588	1071	8556	706	10155	408	7799
12-#11	2.92	MA	5508	1957	7779	1696	9470	1415	10381	1185	11415	795	14207	325	12066
6L-2S		MI	3892	1957	6244	1562	7417	1291	8222	1066	9412	698	11246	521	7820
12-#14	4.22	MA	6682	2197	10216	1819	12436	1507	14017	1230	16358	762	21081	370	18374
4E		MI	3874	2197	6309	1727	7420	1422	8204	1150	9363	688	11144	195	10219
12-#14	4.22	MA	6306	2197	9563	1840	11540	1525	12905	1246	14813	787	18947	286	17359
5L-3S		MI	4016	2197	6724	1714	7992	1401	8904	1133	10319	691	12229	275	10829
12-#14	4.22	MA	5924	2197	8781	1865	10694	1544	11815	1275	13303	799	16879	161	15931
6L-2S		MI	4270	2197	7307	1702	8733	1392	9801	1128	11530	681	13739	439	10904
12-#18	7.50	MA	7626	2806	12576	2250	15176	1837	17246	1451	20594	786	27073	-42	26838
5L-3S		MI	4772	2806	8860	2080	10639	1663	12080	1292	14558	647	16963	-109	16750
14-#10	2.78	MA	6116	1930	8781	1651	10741	1377	12014	1146	13704	771	17340	507	13013
4L-5S		MI	3517	1930	5325	1584	6248	1318	6817	1090	7515	726	9034	362	7233
14-#10	2.78	MA	5888	1930	8406	1664	10226	1389	11375	1157	12815	786	16118	464	12522
5L-4S		MI	3617	1930	5542	1576	6544	1311	7184	1085	8023	717	9694	416	7516
14-#10	2.78	MA	5656	1930	7945	1677	9741	1401	10749	1174	11947	795	14941	395	12098
6L-3S		MI	3713	1930	5784	1568	6879	1297	7594	1073	8583	716	10360	466	7559
14-#10	2.78	MA	5454	1930	7549	1686	9197	1415	10146	1185	11105	810	13787	359	11464
7L-2S		MI	3887	1930	6129	1559	7317	1290	8124	1069	9299	707	11297	558	7574
14-#11	3.41	MA	6145	2048	9083	1735	11014	1443	12298	1191	14031	781	17807	405	14875
5L-4S		MI	3747	2048	5952	1637	7014	1355	7729	1110	8739	702	10466	331	8790
14-#11	3.41	MA	5873	2048	8531	1752	10423	1456	11537	1211	12975	791	16368	319	14256
6L-3S		MI	3865	2048	6244	1628	7417	1339	8222	1097	9412	702	11246	389	9012

RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis

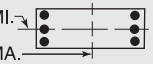


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	3.41	MA	5637	2048	8050	1762	9773	1474	10804	1223	11952	809	14959	273	13423
7L-2S		MI	4055	2048	6656	1619	7940	1332	8856	1092	10269	694	12336	502	9043
14-#14	4.92	MA	6795	2328	10636	1922	12901	1585	14554	1284	17040	781	22030	277	20510
5L-4S		MI	4119	2328	6892	1808	8161	1481	9101	1188	10574	682	12654	163	11862
14-#14	4.92	MA	6434	2328	9853	1947	12055	1604	13465	1313	15529	793	19962	153	19068
6L-3S		MI	4249	2328	7307	1796	8733	1460	9801	1171	11530	684	13739	243	12535
14-#14	4.92	MA	6118	2328	9166	1960	11136	1630	12414	1329	14064	818	17940	83	17544
7L-2S		MI	4491	2328	7890	1784	9473	1452	10698	1166	12741	674	15249	407	12624
16-#10	3.17	MA	6179	2003	9027	1710	11014	1423	12329	1178	14104	783	17903	459	14332
5E		MI	3668	2003	5669	1630	6686	1351	7347	1112	8231	722	9971	350	8217
16-#10	3.17	MA	5956	2003	8566	1723	10529	1434	11704	1196	13236	791	16726	390	13921
6L-4S		MI	3767	2003	5886	1622	6982	1345	7714	1107	8739	714	10631	404	8498
16-#10	3.17	MA	5763	2003	8170	1732	9985	1448	11101	1206	12394	807	15572	354	13287
7L-3S		MI	3858	2003	6129	1614	7317	1331	8124	1095	9299	712	11297	454	8575
16-#10	3.17	MA	5567	2003	7789	1741	9475	1456	10469	1221	11567	822	14460	305	12615
8L-2S		MI	4028	2003	6473	1605	7754	1324	8654	1090	10015	704	12234	546	8597
16-#11	3.90	MA	6229	2138	9282	1809	11377	1498	12693	1237	14536	786	18528	313	16450
6L-4S		MI	3935	2138	6365	1694	7537	1396	8363	1136	9595	698	11556	312	9951
16-#11	3.90	MA	6005	2138	8801	1819	10727	1515	11960	1250	13512	804	17120	267	15612
7L-3S		MI	4033	2138	6656	1685	7940	1381	8856	1123	10269	698	12336	370	10223
16-#11	3.90	MA	5774	2138	8339	1830	10108	1524	11206	1268	12506	822	15764	203	14632
8L-2S		MI	4215	2138	7069	1675	8463	1374	9491	1118	11125	689	13427	483	10263
16-#14	5.63	MA	6929	2458	10926	2028	13416	1663	15114	1351	17756	787	23045	144	22204
6L-4S		MI	4360	2458	7476	1890	8901	1541	9998	1226	11785	676	14164	131	13514
16-#14	5.63	MA	6634	2458	10238	2042	12497	1689	14064	1367	16290	812	21024	74	20669
7L-3S		MI	4478	2458	7890	1878	9473	1520	10698	1208	12741	678	15249	211	14240
18-#10	3.57	MA	6250	2077	9187	1769	11316	1468	12659	1217	14525	788	18510	385	15747
6L-5S		MI	3816	2077	6014	1677	7123	1385	7877	1133	8946	719	10908	338	9204
18-#10	3.57	MA	6066	2077	8791	1778	10773	1482	12056	1227	13683	803	17356	349	15112
7L-4S		MI	3915	2077	6231	1668	7419	1378	8244	1128	9455	710	11568	392	9471
18-#10	3.57	MA	5872	2077	8410	1787	10263	1490	11424	1242	12856	819	16245	300	14432
8L-3S		MI	4002	2077	6473	1660	7754	1364	8654	1116	10015	709	12234	441	9590
18-#10	3.57	MA	5648	2077	8040	1797	9767	1499	10799	1249	12014	827	15147	254	13713
9L-2S		MI	4167	2077	6818	1651	8192	1358	9185	1111	10731	700	13171	534	9617
18-#11	4.39	MA	6364	2228	9553	1875	11681	1557	13116	1276	15072	800	19281	261	17818
7L-4S		MI	4107	2228	6777	1750	8061	1438	8998	1162	10451	693	12647	293	11117
18-#11	4.39	MA	6137	2228	9090	1886	11062	1566	12362	1294	14067	818	17925	197	16830
8L-3S		MI	4198	2228	7069	1741	8463	1422	9491	1149	11125	693	13427	351	11434
18-#14	6.33	MA	7136	2588	11310	2123	13858	1749	15714	1405	18517	805	24107	65	23794
7L-4S		MI	4596	2588	8059	1971	9641	1601	10895	1263	12996	670	15674	99	15174
20-#10	3.97	MA	6362	2151	9412	1824	11561	1516	13011	1249	14972	800	19141	344	16938
7L-5S		MI	3963	2151	6359	1723	7561	1418	8408	1154	9662	715	11845	326	10193
20-#10	3.97	MA	6170	2151	9031	1833	11051	1524	12379	1263	14145	815	18029	295	16249
8L-4S		MI	4061	2151	6576	1714	7857	1412	8774	1149	10170	707	12505	380	10448
20-#10	3.97	MA	5954	2151	8661	1843	10555	1533	11754	1271	13303	824	16932	249	15533
9L-3S		MI	4151	2151	6818	1706	8192	1398	9185	1137	10731	705	13171	429	10604
20-#11	4.88	MA	6491	2319	9842	1943	12016	1607	13518	1320	15627	814	20085	191	19028
8L-4S		MI	4276	2319	7189	1807	8584	1479	9632	1188	11308	689	13737	274	12288
22-#10	4.37	MA	6463	2224	9652	1879	11839	1557	13334	1285	15434	812	19814	290	18066
8L-5S		MI	4119	2224	6704	1769	7998	1452	8938	1175	10378	712	12782	314	11185
22-#10	4.37	MA	6254	2224	9282	1889	11343	1566	12709	1292	14592	820	18717	245	17353
9L-4S		MI	4217	2224	6920	1760	8294	1445	9305	1170	10886	703	13442	368	11429
24-#10	4.76	MA	6549	2298	9903	1935	12131	1600	13664	1313	15881	817	20501	240	19172
9L-5S		MI	4261	2298	7048	1815	8435	1486	9468	1197	11093	708	13719	301	12179

RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

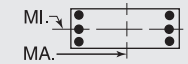


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.32	MA	6256	1764	8558	1540	10412	1294	11469	1099	12636	803	15448	698	7186
2E		MI	3519	1764	5212	1452	6040	1219	6489	1034	6953	750	7991	605	3967
4-#18	2.35	MA	7004	1967	10368	1654	12630	1376	14117	1149	16176	785	20324	678	12352
2E		MI	3836	1967	6114	1558	7117	1293	7760	1077	8633	727	9851	512	6567
6-#10	1.12	MA	6132	1724	8130	1530	9966	1288	10978	1099	12017	813	14623	708	6201
2L-3S		MI	3281	1724	4637	1461	5395	1229	5749	1046	5989	776	6908	554	3479
6-#10	1.12	MA	5729	1724	7463	1543	9120	1300	9952	1110	10632	829	12706	626	6197
3L-2S		MI	3480	1724	4982	1452	5833	1222	6279	1041	6705	767	7845	646	3461
6-#11	1.38	MA	6321	1774	8624	1553	10536	1304	11640	1107	12885	806	15808	700	7504
2L-3S		MI	3326	1774	4830	1478	5591	1239	5961	1049	6255	765	7178	504	4157
6-#11	1.38	MA	5846	1774	7816	1568	9511	1318	10397	1120	11208	825	13484	597	7487
3L-2S		MI	3557	1774	5242	1469	6114	1232	6595	1045	7111	756	8268	618	4137
6-#14	1.99	MA	6786	1894	9712	1622	11876	1353	13244	1137	15032	796	18766	689	10624
2L-3S		MI	3449	1894	5212	1546	6040	1287	6489	1076	6953	754	7991	410	5737
6-#14	1.99	MA	6143	1894	8558	1643	10412	1373	11469	1155	12636	822	15448	537	10539
3L-2S		MI	3763	1894	5795	1534	6780	1278	7386	1071	8163	744	9501	574	5733
6-#18	3.53	MA	7864	2199	12379	1799	15182	1482	17210	1215	20351	774	26104	663	18311
2L-3S		MI	3749	2199	6114	1720	7117	1409	7760	1146	8633	726	9851	149	9391
6-#18	3.53	MA	6857	2199	10368	1836	12630	1514	14117	1244	16176	817	20324	384	17889
3L-2S		MI	4219	2199	7110	1703	8381	1399	9292	1144	10696	715	12318	439	9537
8-#9	1.18	MA	6191	1735	8215	1540	10094	1296	11143	1104	12249	815	14952	709	6517
2L-4S		MI	3263	1735	4556	1478	5289	1248	5626	1062	5825	778	6770	539	3652
8-#9	1.18	MA	5874	1735	7687	1550	9424	1305	10331	1113	11153	827	13435	645	6514
3E		MI	3354	1735	4748	1471	5555	1237	5951	1052	6269	777	7303	578	3642
8-#9	1.18	MA	5699	1735	7328	1561	8926	1321	9720	1128	10316	835	12422	605	6479
4L-2S		MI	3511	1735	5022	1464	5902	1231	6373	1048	6838	770	8055	651	3629
8-#10	1.49	MA	6451	1797	8797	1576	10812	1322	12003	1120	13401	810	16540	703	8190
2L-4S		MI	3326	1797	4740	1515	5498	1276	5869	1079	6144	774	7179	492	4513
8-#10	1.49	MA	6064	1797	8130	1589	9966	1334	10978	1131	12017	826	14623	621	8172
3E		MI	3438	1797	4982	1507	5833	1262	6279	1067	6705	772	7845	542	4517
8-#10	1.49	MA	5850	1797	7676	1602	9336	1353	10204	1149	10958	835	13339	570	8087
4L-2S		MI	3631	1797	5327	1498	6270	1255	6809	1062	7420	764	8782	634	4505
8-#11	1.84	MA	6696	1865	9432	1609	11562	1345	12883	1133	14563	801	18131	694	9911
2L-4S		MI	3377	1865	4951	1544	5711	1296	6102	1088	6437	760	7489	427	5367
8-#11	1.84	MA	6243	1865	8624	1625	10536	1359	11640	1146	12885	820	15808	591	9873
3E		MI	3509	1865	5242	1535	6114	1281	6595	1075	7111	760	8268	485	5392
8-#11	1.84	MA	5991	1865	8072	1640	9770	1382	10701	1167	11599	830	14238	527	9719
4L-2S		MI	3732	1865	5655	1526	6637	1274	7230	1071	7967	752	9359	599	5383
8-#14	2.65	MA	7298	2025	10866	1703	13341	1413	15019	1175	17428	790	22083	681	14049
2L-4S		MI	3524	2025	5381	1639	6208	1367	6686	1131	7208	746	8416	298	7075
8-#14	2.65	MA	6692	2025	9712	1725	11876	1433	13244	1192	15032	816	18766	529	13934
3E		MI	3701	2025	5795	1627	6780	1346	7386	1114	8163	748	9501	378	7455
8-#14	2.65	MA	6357	2025	8921	1746	10779	1465	11899	1222	13191	830	16510	437	13217
4L-2S		MI	4001	2025	6378	1615	7521	1338	8283	1109	9374	738	11011	542	7480
8-#18	4.71	MA	7768	2430	12379	1981	15182	1620	17210	1311	20351	806	26104	369	23802
3E		MI	4161	2430	7110	1865	8381	1515	9292	1213	10696	714	12318	76	12087
8-#18	4.71	MA	7261	2430	10995	2017	13263	1674	14858	1361	17133	826	22122	203	20812
4L-2S		MI	4592	2430	8106	1848	9645	1505	10824	1210	12760	703	14785	366	12480
10-#10	1.87	MA	6762	1871	9464	1622	11659	1355	13029	1141	14786	806	18457	698	10173
2L-5S		MI	3383	1871	4868	1570	5639	1316	6032	1105	6352	778	7456	426	5347
10-#10	1.87	MA	6389	1871	8797	1635	10812	1367	12003	1152	13401	822	16540	616	10144
3L-4S		MI	3485	1871	5084	1561	5935	1310	6399	1100	6860	770	8116	480	5529
10-#10	1.87	MA	6188	1871	8343	1648	10182	1387	11230	1170	12342	831	15256	565	10047
4L-3S		MI	3592	1871	5327	1553	6270	1296	6809	1088	7420	769	8782	530	5546
10-#10	1.87	MA	5932	1871	7942	1661	9631	1399	10545	1182	11390	848	13951	523	9625
5L-2S		MI	3779	1871	5671	1544	6708	1289	7340	1084	8136	760	9719	622	5542
10-#11	2.29	MA	6627	1955	9432	1681	11562	1401	12883	1172	14563	816	18131	585	12259
3L-4S		MI	3563	1955	5363	1601	6234	1337	6737	1115	7294	756	8579	408	6573

RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis



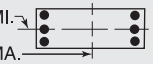
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.29	MA	6394	1955	8880	1697	10796	1423	11944	1193	13277	826	16561	521	12091
4L-3S		MI	3688	1955	5655	1591	6637	1322	7230	1101	7967	756	9359	466	6615
10-#11	2.29	MA	6092	1955	8392	1712	10125	1437	11110	1206	12119	845	14969	467	11343
5L-2S		MI	3903	1955	6067	1582	7161	1315	7864	1097	8823	748	10449	580	6619
10-#14	3.31	MA	7222	2155	10866	1806	13341	1492	15019	1230	17428	810	22083	520	17332
3L-4S		MI	3782	2155	5964	1721	6948	1427	7583	1169	8419	739	9926	266	8688
10-#14	3.31	MA	6918	2155	10075	1828	12244	1524	13674	1260	15587	824	19827	428	16556
4L-3S		MI	3957	2155	6378	1709	7521	1406	8283	1152	9374	742	11011	346	9166
10-#14	3.31	MA	6498	2155	9376	1850	11283	1544	12481	1278	13930	850	17544	347	15363
5L-2S		MI	4230	2155	6962	1697	8261	1397	9180	1147	10585	732	12521	510	9213
10-#18	5.88	MA	8203	2662	13006	2162	15815	1780	17951	1428	21307	815	27902	187	26703
4L-3S		MI	4560	2662	8106	2010	9645	1621	10824	1280	12760	703	14785	3	14776
10-#18	5.88	MA	7500	2662	11778	2198	14130	1813	15860	1456	18405	858	23888	34	23742
5L-2S		MI	4958	2662	9102	1992	10909	1611	12356	1277	14823	692	17252	293	15413
12-#10	2.24	MA	6706	1945	9464	1681	11659	1401	13029	1174	14786	819	18457	611	12115
3L-5S		MI	3540	1945	5212	1616	6077	1350	6563	1127	7067	775	8393	414	6320
12-#10	2.24	MA	6518	1945	9010	1694	11028	1420	12256	1192	13727	828	17174	560	12009
4E		MI	3641	1945	5429	1607	6373	1343	6930	1122	7576	766	9053	468	6541
12-#10	2.24	MA	6265	1945	8609	1707	10477	1432	11571	1203	12775	844	15868	518	11564
5L-3S		MI	3743	1945	5671	1599	6708	1329	7340	1110	8136	765	9719	518	6568
12-#10	2.24	MA	6003	1945	8110	1721	9956	1444	10901	1221	11845	853	14610	450	11073
6L-2S		MI	3924	1945	6016	1590	7145	1323	7870	1105	8852	757	10656	610	6573
12-#11	2.75	MA	6784	2045	9688	1753	11821	1465	13186	1219	14955	822	18884	515	14467
4E		MI	3745	2045	5775	1657	6758	1379	7371	1141	8150	751	9669	389	7721
12-#11	2.75	MA	6487	2045	9200	1769	11150	1479	12353	1232	13797	841	17292	461	13696
5L-3S		MI	3863	2045	6067	1648	7161	1363	7864	1128	8823	752	10449	447	7833
12-#11	2.75	MA	6178	2045	8601	1786	10518	1493	11538	1254	12666	851	15757	376	13102
6L-2S		MI	4072	2045	6480	1639	7684	1356	8498	1123	9679	743	11540	561	7849
12-#14	3.97	MA	7460	2286	11229	1909	13708	1584	15449	1298	17983	817	23145	419	19904
4E		MI	4050	2286	6547	1802	7689	1486	8480	1207	9630	733	11436	234	10317
12-#14	3.97	MA	7046	2286	10530	1931	12748	1603	14256	1315	16326	843	20861	339	18756
5L-3S		MI	4195	2286	6962	1790	8261	1465	9180	1189	10585	736	12521	314	10874
12-#14	3.97	MA	6630	2286	9681	1956	11841	1623	13088	1345	14707	857	18655	215	17276
6L-2S		MI	4454	2286	7545	1778	9001	1457	10077	1184	11796	726	14031	478	10939
12-#18	7.06	MA	8417	2894	13789	2343	16682	1918	18953	1523	22580	847	29668	19	29587
5L-3S		MI	4950	2894	9102	2155	10909	1727	12356	1347	14823	691	17252	-70	17118
14-#10	2.61	MA	6839	2018	9677	1740	11874	1454	13282	1213	15111	824	19091	555	13974
4L-5S		MI	3694	2018	5557	1662	6514	1384	7093	1148	7783	771	9330	402	7298
14-#10	2.61	MA	6589	2018	9275	1753	11323	1466	12597	1224	14159	841	17785	513	13506
5L-4S		MI	3794	2018	5774	1653	6810	1377	7460	1143	8291	763	9990	456	7552
14-#10	2.61	MA	6337	2018	8777	1767	10802	1478	11927	1242	13230	850	16527	445	13032
6L-3S		MI	3891	2018	6016	1645	7145	1363	7870	1131	8852	762	10656	506	7588
14-#10	2.61	MA	6118	2018	8353	1775	10214	1492	11281	1253	12328	866	15298	411	12398
7L-2S		MI	4067	2018	6361	1636	7583	1356	8400	1126	9567	753	11593	598	7600
14-#11	3.21	MA	6870	2136	10008	1825	12176	1520	13596	1258	15475	836	19615	455	16055
5L-4S		MI	3924	2136	6188	1714	7281	1420	8005	1167	9006	747	10760	370	8872
14-#11	3.21	MA	6575	2136	9409	1842	11543	1534	12781	1280	14344	846	18080	370	15465
6L-3S		MI	4036	2136	6480	1705	7684	1405	8498	1154	9679	747	11540	428	9047
14-#11	3.21	MA	6318	2136	8893	1852	10837	1552	11996	1293	13247	865	16576	326	14518
7L-2S		MI	4237	2136	6892	1695	8207	1398	9132	1149	10536	739	12630	542	9073
14-#14	4.63	MA	7577	2416	11684	2013	14212	1663	16031	1353	18722	837	24179	330	22152
5L-4S		MI	4296	2416	7130	1884	8429	1546	9377	1244	10841	727	12946	202	11958
14-#14	4.63	MA	7184	2416	10835	2037	13305	1683	14863	1383	17103	851	21972	207	20651
6L-3S		MI	4429	2416	7545	1872	9001	1525	10077	1227	11796	729	14031	282	12580

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

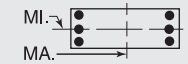


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	4.63	MA	6841	2416	10096	2051	12306	1708	13738	1401	15532	877	19812	140	19084
7L-2S		MI	4675	2416	8128	1860	9741	1517	10974	1222	13007	719	15542	446	12661
16-#10	2.99	MA	6905	2092	9942	1799	12169	1500	13622	1245	15544	837	19702	508	15452
5E		MI	3846	2092	5902	1708	6952	1417	7623	1169	8499	768	10267	390	8280
16-#10	2.99	MA	6663	2092	9444	1813	11648	1511	12953	1263	14614	846	18444	441	14993
6L-4S		MI	3945	2092	6118	1699	7248	1410	7990	1164	9007	759	10927	444	8561
16-#10	2.99	MA	6454	2092	9019	1821	11061	1525	12307	1274	13713	862	17215	406	14357
7L-3S		MI	4038	2092	6361	1691	7583	1397	8400	1152	9567	758	11593	494	8605
16-#10	2.99	MA	6238	2092	8612	1831	10514	1534	11622	1289	12827	878	16027	358	13681
8L-2S		MI	4209	2092	6705	1682	8020	1390	8930	1147	10283	750	12530	586	8623
16-#11	3.67	MA	6962	2226	10217	1899	12569	1576	14024	1306	16022	842	20403	364	17830
6L-4S		MI	4100	2226	6600	1770	7804	1461	8639	1193	9862	743	11850	351	10031
16-#11	3.67	MA	6718	2226	9701	1909	11863	1593	13239	1319	14925	861	18899	320	16890
7L-3S		MI	4213	2226	6892	1761	8207	1446	9132	1180	10536	743	12630	409	10260
16-#11	3.67	MA	6464	2226	9205	1920	11199	1603	12419	1337	13848	880	17450	259	15873
8L-2S		MI	4399	2226	7304	1752	8731	1439	9767	1175	11392	735	13721	523	10294
16-#14	5.29	MA	7722	2546	11989	2119	14770	1742	16638	1421	19499	845	25289	198	24027
6L-4S		MI	4537	2546	7714	1966	9169	1606	10274	1282	12052	721	14456	170	13607
16-#14	5.29	MA	7401	2546	11250	2133	13770	1768	15513	1438	17928	871	23129	132	22447
7L-3S		MI	4659	2546	8128	1953	9741	1585	10974	1265	13007	723	15542	251	14286
18-#10	3.36	MA	6982	2166	10111	1859	12495	1545	13978	1285	15999	843	20361	436	16956
6L-5S		MI	3995	2166	6246	1754	7389	1451	8153	1190	9215	764	11204	378	9266
18-#10	3.36	MA	6782	2166	9686	1867	11907	1559	13333	1296	15097	859	19132	401	16316
7L-4S		MI	4093	2166	6463	1745	7685	1444	8520	1185	9723	756	11864	432	9542
18-#10	3.36	MA	6569	2166	9278	1877	11361	1567	12648	1310	14212	875	17944	353	15633
8L-3S		MI	4182	2166	6705	1737	8020	1430	8930	1173	10283	755	12530	482	9621
18-#10	3.36	MA	6326	2166	8882	1888	10830	1577	11978	1318	13311	884	16776	308	14839
9L-2S		MI	4349	2166	7050	1728	8458	1424	9460	1169	10999	746	13467	574	9644
18-#11	4.13	MA	7108	2317	10510	1965	12888	1634	14482	1345	16603	857	21222	314	19262
7L-4S		MI	4286	2317	7013	1827	8328	1503	9274	1219	10719	738	12941	332	11196
18-#11	4.13	MA	6858	2317	10014	1977	12224	1644	13662	1363	15525	875	19773	253	18236
8L-3S		MI	4379	2317	7304	1818	8731	1487	9767	1206	11392	739	13721	390	11471
18-#14	5.96	MA	7946	2677	12404	2214	15235	1827	17288	1476	20324	864	26447	123	25809
7L-4S		MI	4774	2677	8297	2047	9909	1665	11171	1320	13263	715	15967	138	15265
20-#10	3.74	MA	7103	2239	10353	1913	12753	1593	14359	1317	16482	855	21049	396	18275
7L-5S		MI	4142	2239	6591	1800	7826	1484	8683	1212	9930	761	12141	366	10255
20-#10	3.74	MA	6893	2239	9945	1923	12207	1601	13674	1331	15597	871	19861	348	17585
8L-4S		MI	4240	2239	6808	1791	8123	1478	9050	1207	10438	752	12801	420	10518
20-#10	3.74	MA	6658	2239	9549	1934	11676	1610	13004	1339	14696	880	18693	303	16794
9L-3S		MI	4333	2239	7050	1783	8458	1464	9460	1195	10999	751	13467	470	10636
20-#10	3.74	MA	6441	2239	9133	1941	11122	1627	12348	1348	13814	896	17430	252	15962
10L-2S		MI	4486	2239	7395	1774	8895	1457	9990	1190	11714	743	14404	562	10664
20-#11	4.59	MA	7243	2407	10822	2033	13250	1685	14905	1389	17203	871	22096	247	20600
8L-4S		MI	4455	2407	7425	1883	8851	1544	9908	1245	11575	734	14031	313	12366
22-#10	4.11	MA	7211	2313	10612	1969	13053	1635	14699	1353	16981	868	21778	344	19537
8L-5S		MI	4287	2313	6936	1846	8264	1518	9214	1233	10646	757	13078	354	11246
22-#10	4.11	MA	6984	2313	10216	1980	12522	1644	14029	1360	16080	877	20610	298	18749
9L-4S		MI	4398	2313	7153	1837	8560	1511	9580	1228	11154	749	13738	408	11498
22-#10	4.11	MA	6775	2313	9800	1987	11969	1661	13373	1369	15199	893	19347	247	17912
10L-3S		MI	4472	2313	7395	1829	8895	1498	9990	1216	11714	748	14404	457	11650
24-#10	4.48	MA	7303	2386	10883	2026	13369	1678	15055	1382	17465	873	22527	294	20704
9L-5S		MI	4442	2386	7281	1892	8701	1552	9744	1254	11362	754	14015	342	12239
24-#10	4.48	MA	7102	2386	10466	2033	12815	1695	14399	1390	16583	889	21264	242	19862
10L-4S		MI	4540	2386	7497	1883	8998	1545	10111	1249	11870	745	14675	396	12481

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

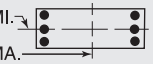
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.25	MA	6971	1852	9415	1628	11496	1369	12669	1165	13935	855	17016	744	7672
2E		MI	3697	1852	5450	1528	6308	1283	6765	1090	7219	795	8283	645	3991
4-#18	2.22	MA	7788	2055	11360	1743	13880	1451	15515	1214	17738	838	22253	724	13216
2E		MI	4016	2055	6356	1632	7387	1357	8036	1132	8898	771	10140	551	6601
6-#10	1.06	MA	6834	1812	8954	1618	11014	1363	12138	1164	13264	866	16122	754	6612
2L-3S		MI	3458	1812	4869	1538	5661	1294	6025	1103	6257	821	7204	594	3498
6-#10	1.06	MA	6399	1812	8241	1632	10110	1376	11041	1176	11784	882	14072	673	6609
3L-2S		MI	3658	1812	5214	1530	6099	1288	6555	1098	6973	813	8141	686	3479
6-#11	1.30	MA	7041	1863	9484	1641	11627	1379	12850	1173	14198	858	17395	746	8010
2L-3S		MI	3502	1863	5066	1555	5858	1304	6237	1106	6522	810	7472	544	4181
6-#11	1.30	MA	6527	1863	8619	1657	10530	1394	11520	1186	12403	878	14909	644	7992
3L-2S		MI	3735	1863	5478	1546	6381	1298	6871	1102	7378	801	8562	657	4159
6-#14	1.88	MA	7547	1983	10650	1710	13064	1429	14570	1203	16500	849	20568	735	11353
2L-3S		MI	3625	1983	5450	1621	6308	1351	6765	1133	7219	799	8283	449	5771
6-#14	1.88	MA	6849	1983	9415	1732	11496	1449	12669	1221	13935	876	17016	586	11268
3L-2S		MI	3941	1983	6033	1609	7049	1343	7662	1128	8430	789	9793	613	5760
6-#18	3.33	MA	8721	2287	13516	1888	16615	1557	18831	1281	22213	827	28450	709	19607
2L-3S		MI	3925	2287	6356	1794	7387	1473	8036	1202	8898	770	10140	187	9453
6-#18	3.33	MA	7627	2287	11360	1925	13880	1591	15515	1311	17738	872	22253	436	19185
3L-2S		MI	4400	2287	7352	1777	8651	1463	9568	1199	10961	759	12607	478	9576
8-#9	1.11	MA	6897	1823	9043	1628	11150	1371	12313	1170	13511	867	16471	755	6949
2L-4S		MI	3440	1823	4787	1556	5554	1314	5902	1120	6093	824	7066	579	3673
8-#9	1.11	MA	6555	1823	8479	1639	10434	1381	11446	1179	12340	880	14850	691	6946
3E		MI	3531	1823	4979	1549	5820	1303	6227	1110	6538	823	7600	619	3660
8-#9	1.11	MA	6366	1823	8097	1650	9902	1397	10794	1194	11447	888	13774	652	6911
4L-2S		MI	3689	1823	5253	1542	6168	1298	6648	1106	7107	816	8352	691	3646
8-#10	1.41	MA	7179	1886	9667	1664	11919	1397	13234	1186	14744	862	18171	749	8739
2L-4S		MI	3503	1886	4972	1593	5764	1342	6145	1137	6412	819	7475	533	4541
8-#10	1.41	MA	6761	1886	8954	1678	11014	1410	12138	1197	13264	879	16122	668	8721
3E		MI	3616	1886	5214	1584	6099	1328	6555	1125	6973	818	8141	582	4539
8-#10	1.41	MA	6530	1886	8470	1691	10341	1429	11313	1216	12134	888	14758	617	8635
4L-2S		MI	3809	1886	5559	1576	6536	1321	7085	1120	7688	810	9078	674	4525
8-#11	1.73	MA	7447	1953	10349	1698	12724	1421	14180	1199	15993	854	19881	740	10585
2L-4S		MI	3553	1953	5186	1621	5978	1361	6378	1145	6705	805	7782	467	5404
8-#11	1.73	MA	6956	1953	9484	1714	11627	1435	12850	1212	14198	873	17395	638	10547
3E		MI	3686	1953	5478	1611	6381	1346	6871	1132	7378	805	8562	525	5419
8-#11	1.73	MA	6685	1953	8895	1730	10809	1458	11847	1234	12824	884	15727	576	10393
4L-2S		MI	3911	1953	5890	1602	6905	1339	7506	1128	8234	797	9653	638	5407
8-#14	2.50	MA	8102	2113	11886	1792	14632	1488	16470	1240	19065	842	24119	726	15021
2L-4S		MI	3700	2113	5619	1715	6477	1432	6962	1188	7474	790	8708	337	7177
8-#14	2.50	MA	7444	2113	10650	1814	13064	1509	14570	1259	16500	870	20568	577	14906
3E		MI	3878	2113	6033	1703	7049	1411	7662	1170	8430	793	9793	418	7493
8-#14	2.50	MA	7082	2113	9807	1836	11893	1542	13133	1290	14534	884	18169	486	14274
4L-2S		MI	4180	2113	6616	1691	7789	1402	8559	1165	9641	783	11304	581	7510
8-#18	4.44	MA	8613	2519	13516	2070	16615	1697	18831	1378	22213	861	28450	420	25530
3E		MI	4338	2519	7352	1939	8651	1579	9568	1269	10961	759	12607	114	12253
8-#18	4.44	MA	8063	2519	12036	2108	14563	1753	16315	1431	18771	883	24215	255	22451
4L-2S		MI	4775	2519	8348	1922	9915	1569	11100	1266	13025	748	15074	405	12523
10-#10	1.76	MA	7516	1959	10379	1710	12824	1431	14331	1207	16224	859	20220	744	10859
2L-5S		MI	3560	1959	5100	1647	5905	1382	6308	1163	6620	824	7752	466	5413
10-#10	1.76	MA	7112	1959	9667	1724	11919	1443	13234	1219	14744	875	18171	663	10830
3L-4S		MI	3662	1959	5317	1639	6201	1375	6675	1158	7128	816	8412	521	5559

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis



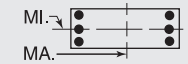
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.76	MA	6895	1959	9182	1737	11246	1463	12409	1237	13614	885	16807	612	10733
4L-3S		MI	3770	1959	5559	1630	6536	1362	7085	1146	7688	814	9078	570	5570
10-#10	1.76	MA	6616	1959	8751	1750	10658	1475	11679	1249	12599	902	15417	572	10343
5L-2S		MI	3958	1959	5904	1622	6974	1355	7615	1141	8404	806	10015	662	5563
10-#11	2.17	MA	7372	2043	10349	1770	12724	1476	14180	1238	15993	869	19881	632	13101
3L-4S		MI	3740	2043	5599	1677	6502	1403	7013	1171	7561	801	8873	448	6613
10-#11	2.17	MA	7120	2043	9760	1786	11906	1500	13177	1260	14619	880	18212	570	12934
4L-3S		MI	3865	2043	5890	1668	6905	1387	7506	1158	8234	801	9653	506	6646
10-#11	2.17	MA	6790	2043	9239	1802	11191	1514	12288	1274	13384	900	16517	518	12194
5L-2S		MI	4083	2043	6303	1659	7428	1380	8140	1154	9090	793	10743	619	6646
10-#14	3.13	MA	8018	2243	11886	1895	14632	1568	16470	1297	19065	863	24119	569	18547
3L-4S		MI	3958	2243	6202	1797	7217	1491	7859	1225	8685	784	10218	305	8787
10-#14	3.13	MA	7689	2243	11042	1918	13461	1601	15034	1328	17099	878	21721	477	17858
4L-3S		MI	4135	2243	6616	1785	7789	1471	8559	1208	9641	787	11304	386	9207
10-#14	3.13	MA	7229	2243	10296	1940	12435	1622	13760	1346	15329	905	19288	400	16525
5L-2S		MI	4412	2243	7200	1772	8529	1462	9456	1203	10852	777	12814	549	9246
10-#18	5.56	MA	9082	2751	14192	2253	17299	1859	19631	1498	23247	872	30411	240	28756
4L-3S		MI	4737	2751	8348	2084	9915	1685	11100	1336	13025	747	15074	41	14936
10-#18	5.56	MA	8312	2751	12882	2291	15500	1893	17397	1528	20145	917	26132	93	25703
5L-2S		MI	5142	2751	9344	2067	11179	1675	12632	1333	15088	736	17541	332	15458
12-#10	2.12	MA	7455	2033	10379	1770	12824	1477	14331	1240	16224	872	20220	658	12938
3L-5S		MI	3717	2033	5445	1693	6343	1416	6838	1184	7336	821	8689	454	6384
12-#10	2.12	MA	7251	2033	9895	1783	12151	1496	13506	1258	15094	881	18857	608	12832
4E		MI	3818	2033	5661	1685	6639	1409	7205	1179	7844	812	9349	508	6573
12-#10	2.12	MA	6976	2033	9464	1796	11563	1509	12776	1270	14079	898	17467	567	12418
5L-3S		MI	3921	2033	5904	1676	6974	1395	7615	1167	8404	811	10015	558	6595
12-#10	2.12	MA	6693	2033	8932	1810	11002	1521	12062	1288	13088	908	16128	501	11875
6L-2S		MI	4104	2033	6248	1668	7411	1389	8146	1162	9120	802	10952	650	6596
12-#11	2.60	MA	7542	2134	10624	1843	13003	1541	14507	1286	16415	876	20698	564	15478
4E		MI	3922	2134	6011	1734	7025	1444	7647	1197	8417	797	9963	429	7803
12-#11	2.60	MA	7217	2134	10104	1859	12288	1556	13618	1300	15179	895	19003	512	14716
5L-3S		MI	4042	2134	6303	1724	7428	1428	8140	1184	9090	797	10743	487	7866
12-#11	2.60	MA	6884	2134	9459	1875	11614	1570	12748	1322	13973	906	17370	428	14089
6L-2S		MI	4252	2134	6715	1715	7951	1422	8774	1180	9947	789	11834	600	7878
12-#14	3.75	MA	8275	2374	12278	1999	15029	1661	16934	1365	19664	872	25273	469	21451
4E		MI	4226	2374	6785	1878	7957	1551	8756	1263	9896	778	11728	273	10413
12-#14	3.75	MA	7822	2374	11532	2022	14003	1681	15661	1384	17895	899	22840	391	20162
5L-3S		MI	4374	2374	7200	1866	8529	1530	9456	1246	10852	780	12814	354	10917
12-#14	3.75	MA	7373	2374	10616	2046	13036	1702	14415	1415	16166	914	20495	268	18639
6L-2S		MI	4637	2374	7783	1854	9269	1522	10353	1241	12063	770	14324	517	10974
12-#18	6.67	MA	9303	2983	15037	2435	18235	1999	20713	1595	24620	906	32329	78	31970
5L-3S		MI	5128	2983	9344	2229	11179	1791	12632	1403	15088	735	17541	-32	17482
12-#18	6.67	MA	8601	2983	13460	2480	16537	2033	18527	1647	21589	929	28186	-143	27610
6L-2S		MI	5506	2983	10340	2212	12443	1781	14164	1400	17151	724	20008	259	18386
14-#10	2.47	MA	7598	2107	10608	1829	13055	1530	14602	1280	16574	878	20906	603	14934
4L-5S		MI	3872	2107	5789	1739	6780	1449	7369	1205	8051	817	9626	442	7361
14-#10	2.47	MA	7326	2107	10177	1842	12468	1542	13872	1291	15559	895	19516	562	14497
5L-4S		MI	3972	2107	6006	1731	7076	1443	7735	1200	8559	809	10286	496	7586
14-#10	2.47	MA	7054	2107	9645	1856	11907	1554	13158	1310	14568	904	18177	496	13971
6L-3S		MI	4070	2107	6248	1722	7411	1429	8146	1188	9120	807	10952	546	7616
14-#10	2.47	MA	6818	2107	9191	1865	11280	1568	12467	1321	13607	921	16873	462	13338
7L-2S		MI	4248	2107	6593	1714	7849	1422	8676	1184	9835	799	11889	638	7625
14-#11	3.03	MA	7632	2224	10969	1915	13385	1597	14948	1326	16975	891	21488	506	17243
5L-4S		MI	4101	2224	6423	1790	7548	1485	8281	1224	9273	792	11054	410	8953

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis

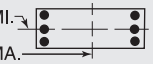


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	3.03	MA	7313	2224	10323	1932	12711	1612	14078	1348	15768	902	19855	422	16639
6L-3S		MI	4215	2224	6715	1781	7951	1470	8774	1210	9947	793	11834	468	9082
14-#11	3.03	MA	7036	2224	9772	1942	11949	1629	13241	1361	14598	921	18257	379	15625
7L-2S		MI	4420	2224	7128	1772	8475	1463	9408	1206	10803	784	12924	581	9103
14-#14	4.38	MA	8396	2504	12767	2103	15571	1741	17561	1421	20460	893	26392	383	23796
5L-4S		MI	4473	2504	7368	1960	8697	1611	9653	1301	11107	772	13239	241	12051
14-#14	4.38	MA	7971	2504	11851	2127	14604	1761	16315	1452	18732	908	24047	260	22253
6L-3S		MI	4609	2504	7783	1948	9269	1590	10353	1283	12063	774	14324	322	12624
14-#14	4.38	MA	7601	2504	11062	2142	13524	1786	15115	1471	17055	935	21749	197	20651
7L-2S		MI	4860	2504	8366	1935	10009	1581	11250	1278	13274	764	15834	485	12697
14-#18	7.78	MA	9610	3215	15615	2625	19273	2139	21842	1714	26065	918	34382	-158	33494
6L-3S		MI	5512	3215	10340	2374	12443	1897	14164	1470	17151	723	20008	-105	19788
16-#10	2.82	MA	7668	2180	10889	1888	13372	1576	14968	1312	17039	891	21565	557	16580
5E		MI	4023	2180	6134	1785	7217	1483	7899	1227	8767	814	10563	430	8342
16-#10	2.82	MA	7406	2180	10357	1902	12811	1588	14255	1331	16048	901	20227	491	16070
6L-4S		MI	4123	2180	6351	1777	7514	1476	8266	1222	9275	805	11223	484	8597
16-#10	2.82	MA	7180	2180	9904	1911	12184	1602	13564	1342	15087	917	18922	457	15432
7L-3S		MI	4217	2180	6593	1768	7849	1463	8676	1210	9835	804	11889	534	8634
16-#10	2.82	MA	6945	2180	9469	1921	11602	1611	12828	1356	14128	927	17659	411	14741
8L-2S		MI	4390	2180	6938	1760	8286	1456	9206	1205	10551	795	12826	626	8649
16-#11	3.47	MA	7731	2315	11188	1988	13808	1653	15408	1374	17563	898	22341	416	19190
6L-4S		MI	4278	2315	6836	1847	8072	1527	8915	1250	10130	788	12144	391	10110
16-#11	3.47	MA	7468	2315	10637	1999	13046	1670	14571	1388	16393	917	20743	373	18164
7L-3S		MI	4393	2315	7128	1838	8475	1511	9408	1237	10803	788	12924	449	10296
16-#11	3.47	MA	7190	2315	10108	2011	12338	1680	13685	1405	15244	937	19201	314	17132
8L-2S		MI	4582	2315	7540	1828	8998	1504	10043	1232	11659	780	14015	562	10326
16-#14	5.00	MA	8552	2635	13087	2209	16172	1821	18216	1490	21297	902	27599	251	25867
6L-4S		MI	4715	2635	7952	2041	9437	1670	10550	1338	12318	766	14749	209	13699
16-#14	5.00	MA	8205	2635	12298	2223	15092	1846	17015	1509	19620	929	25300	188	24252
7L-3S		MI	4840	2635	8366	2029	10009	1649	11250	1321	13274	768	15834	290	14331
16-#14	5.00	MA	7817	2635	11540	2240	14077	1860	15760	1535	17974	956	23086	100	22633
8L-2S		MI	5079	2635	8949	2017	10749	1641	12147	1316	14485	758	17344	453	14417
18-#10	3.17	MA	7750	2254	11070	1948	13716	1621	15351	1352	17528	897	22276	486	18170
6L-5S		MI	4173	2254	6479	1831	7655	1517	8429	1248	9483	810	11500	418	9327
18-#10	3.17	MA	7534	2254	10617	1957	13089	1636	14660	1363	16567	914	20972	452	17527
7L-4S		MI	4272	2254	6695	1823	7951	1510	8796	1243	9991	802	12160	472	9607
18-#10	3.17	MA	7302	2254	10182	1967	12506	1644	13925	1378	15608	924	19709	406	16837
8L-3S		MI	4362	2254	6938	1814	8286	1496	9206	1231	10551	800	12826	522	9651
18-#10	3.17	MA	7040	2254	9756	1977	11940	1654	13210	1386	14664	940	18469	361	15978
9L-2S		MI	4531	2254	7282	1806	8723	1490	9736	1226	11267	792	13763	614	9671
18-#11	3.90	MA	7889	2405	11502	2055	14144	1711	15901	1414	18189	913	23228	367	20702
7L-4S		MI	4464	2405	7248	1903	8595	1568	9550	1276	10986	784	13235	372	11273
18-#11	3.90	MA	7615	2405	10972	2067	13435	1722	15015	1431	17040	932	21686	308	19661
8L-3S		MI	4560	2405	7540	1894	8998	1552	10043	1263	11659	784	14015	430	11508
18-#11	3.90	MA	7307	2405	10459	2080	12746	1733	14146	1441	15871	943	20167	252	18641
9L-2S		MI	4742	2405	7952	1885	9521	1546	10677	1258	12515	776	15105	543	11545
18-#14	5.63	MA	8794	2765	13533	2305	16660	1906	18915	1546	22186	923	28852	179	27852
7L-4S		MI	4952	2765	8535	2123	10177	1730	11447	1376	13529	759	16259	178	15354
18-#14	5.63	MA	8411	2765	12775	2322	15645	1920	17661	1572	20539	950	26638	92	26234
8L-3S		MI	5068	2765	8949	2111	10749	1709	12147	1359	14485	762	17344	258	16038
20-#10	3.53	MA	7881	2328	11330	2003	13994	1669	15757	1385	18047	910	23021	447	19621
7L-5S		MI	4321	2328	6823	1877	8092	1550	8959	1269	10198	807	12437	406	10315
20-#10	3.53	MA	7652	2328	10895	2013	13411	1678	15021	1399	17088	920	21758	401	18933
8L-4S		MI	4419	2328	7040	1869	8389	1544	9326	1264	10706	798	13097	460	10586
20-#10	3.53	MA	7398	2328	10469	2023	12845	1688	14307	1407	16144	937	20518	356	18068
9L-3S		MI	4506	2328	7282	1860	8723	1530	9736	1252	11267	797	13763	510	10666
20-#10	3.53	MA	7164	2328	10024	2031	12254	1705	13607	1416	15192	952	19176	306	17224
10L-2S		MI	4671	2328	7627	1852	9161	1523	10266	1247	11982	788	14700	602	10692

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

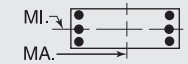
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	4.33	MA	8031	2496	11837	2124	14532	1763	16345	1458	18835	928	24172	302	22191
8L-4S		MI	4635	2496	7661	1960	9118	1609	10184	1302	11842	779	14325	353	12441
20-#11	4.33	MA	7735	2496	11323	2137	13843	1774	15475	1467	17666	939	22653	246	21163
9L-3S		MI	4725	2496	7952	1951	9521	1594	10677	1289	12515	780	15105	411	12720
20-#14	6.25	MA	8990	2896	14011	2403	17213	1979	19561	1610	23104	944	30190	83	29824
8L-4S		MI	5186	2896	9118	2204	10918	1789	12345	1414	14740	753	17769	146	17016
22-#10	3.88	MA	7995	2401	11608	2059	14316	1712	16118	1420	18568	917	23807	396	21024
8L-5S		MI	4467	2401	7168	1923	8530	1584	9489	1290	10914	803	13374	394	11305
22-#10	3.88	MA	7750	2401	11182	2069	13749	1721	15403	1429	17624	933	22568	351	20158
9L-4S		MI	4565	2401	7385	1915	8826	1577	9856	1285	11422	795	14034	448	11565
22-#10	3.88	MA	7524	2401	10737	2077	13159	1739	14704	1438	16672	949	21225	301	19309
10L-3S		MI	4654	2401	7627	1906	9161	1564	10266	1273	11982	793	14700	498	11681
22-#11	4.77	MA	8153	2586	12188	2193	14940	1815	16805	1493	19461	935	25139	240	23685
9L-4S		MI	4803	2586	8073	2016	9642	1651	10818	1328	12698	775	15415	334	13614
24-#10	4.23	MA	8094	2475	11894	2116	14654	1755	16500	1450	19104	930	24617	346	22249
9L-5S		MI	4622	2475	7513	1969	8967	1618	10020	1312	11630	800	14311	382	12298
24-#10	4.23	MA	7877	2475	11450	2123	14064	1772	15800	1459	18152	945	23274	296	21394
10L-4S		MI	4720	2475	7729	1961	9263	1611	10386	1307	12138	791	14971	436	12547

RECTANGULAR TIED COLUMNS 20" x 38"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.18	MA	7723	1941	10308	1717	12628	1444	13923	1231	15288	907	18647	790	8158
2E		MI	3875	1941	5688	1604	6577	1348	7041	1146	7486	840	8576	684	4014
4-#18	2.11	MA	8608	2143	12387	1831	15177	1527	16966	1280	19354	890	24247	770	14080
2E		MI	4195	2143	6599	1707	7657	1420	8313	1187	9163	815	10429	590	6634
6-#10	1.00	MA	7572	1901	9813	1707	12110	1439	13351	1230	14566	918	17684	800	7024
2L-3S		MI	3635	1901	5102	1615	5927	1360	6301	1161	6525	867	7500	634	3516
6-#10	1.00	MA	7104	1901	9054	1720	11147	1452	12184	1242	12991	935	15503	720	7020
3L-2S		MI	3836	1901	5446	1607	6365	1354	6831	1156	7241	859	8437	726	3496
6-#11	1.23	MA	7796	1951	10380	1730	12766	1455	14113	1238	15566	910	19046	792	8515
2L-3S		MI	3679	1951	5301	1631	6125	1370	6513	1163	6789	855	7766	584	4204
6-#11	1.23	MA	7243	1951	9458	1746	11597	1470	12696	1252	13653	931	16398	692	8498
3L-2S		MI	3913	1951	5714	1622	6648	1363	7147	1158	7645	847	8856	697	4180
6-#14	1.78	MA	8344	2071	11625	1798	14300	1504	15949	1268	18023	901	22433	781	12082
2L-3S		MI	3802	2071	5688	1697	6577	1416	7041	1189	7486	844	8576	489	5803
6-#14	1.78	MA	7592	2071	10308	1821	12628	1525	13923	1288	15288	929	18647	634	11997
3L-2S		MI	4120	2071	6271	1685	7317	1407	7938	1184	8696	834	10086	652	5787
6-#18	3.16	MA	9616	2375	14688	1976	18096	1633	20504	1347	24131	879	30861	754	20903
2L-3S		MI	4101	2375	6599	1869	7657	1536	8313	1257	9163	814	10429	226	9511
6-#18	3.16	MA	8433	2375	12387	2015	15177	1668	16966	1379	19354	926	24247	486	20481
3L-2S		MI	4582	2375	7595	1852	8921	1526	9845	1254	11226	803	12896	517	9615
8-#9	1.05	MA	7638	1912	9907	1717	12253	1447	13537	1236	14827	919	18054	801	7381
2L-4S		MI	3616	1912	5018	1634	5820	1381	6177	1178	6362	870	7363	619	3692
8-#9	1.05	MA	7271	1912	9307	1728	11492	1457	12614	1245	13581	933	16329	738	7378
3E		MI	3709	1912	5210	1627	6086	1369	6503	1168	6806	869	7897	659	3678
8-#9	1.05	MA	7069	1912	8900	1739	10927	1473	11921	1260	12632	941	15190	699	7343
4L-2S		MI	3867	1912	5484	1620	6433	1364	6924	1164	7375	862	8649	732	3663
8-#10	1.34	MA	7944	1974	10571	1753	13073	1473	14518	1251	16142	914	19866	795	9288
2L-4S		MI	3679	1974	5204	1670	6030	1408	6421	1194	6680	865	7771	573	4567
8-#10	1.34	MA	7493	1974	9813	1766	12110	1485	13351	1263	14566	932	17684	715	9269
3E		MI	3793	1974	5446	1661	6365	1394	6831	1182	7241	864	8437	622	4560
8-#10	1.34	MA	7245	1974	9298	1780	11395	1505	12474	1282	13365	942	16241	665	9184
4L-2S		MI	3987	1974	5791	1653	6802	1387	7361	1177	7956	855	9374	714	4545
8-#11	1.64	MA	8234	2041	11301	1786	13935	1496	15530	1264	17478	906	21695	786	11259
2L-4S		MI	3730	2041	5422	1697	6246	1427	6654	1202	6972	850	8076	507	5439
8-#11	1.64	MA	7705	2041	10380	1802	12766	1511	14113	1278	15566	926	19046	686	11221
3E		MI	3863	2041	5714	1688	6648	1411	7147	1189	7645	851	8856	565	5446

RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

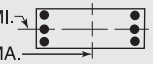
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.64	MA	7414	2041	9753	1819	11896	1535	13046	1301	14105	938	17280	623	11067
4L-2S		MI	4089	2041	6126	1679	7172	1404	7782	1184	8501	842	9947	678	5431
8-#14	2.37	MA	8942	2201	12942	1880	15971	1564	17975	1306	20757	895	26220	772	15993
2L-4S		MI	3875	2201	5857	1791	6745	1497	7238	1244	7741	835	9000	376	7277
8-#14	2.37	MA	8232	2201	11625	1903	14300	1585	15949	1325	18023	923	22433	625	15878
3E		MI	4055	2201	6271	1779	7317	1476	7938	1227	8696	838	10086	457	7530
8-#14	2.37	MA	7843	2201	10727	1926	13054	1618	14421	1357	15931	939	19893	535	15346
4L-2S		MI	4360	2201	6854	1767	8057	1467	8835	1222	9907	828	11596	620	7539
8-#18	4.21	MA	9495	2607	14688	2160	18096	1774	20504	1446	24131	915	30861	471	27258
3E		MI	4514	2607	7595	2014	8921	1642	9845	1324	11226	803	12896	153	12403
8-#18	4.21	MA	8903	2607	13113	2199	15911	1831	17825	1500	20465	940	26372	307	24098
4L-2S		MI	4957	2607	8591	1997	10185	1632	11377	1321	13290	792	15363	444	12565
10-#10	1.67	MA	8306	2048	11330	1799	14036	1506	15686	1273	17718	911	22048	790	11545
2L-5S		MI	3737	2048	5332	1724	6171	1448	6584	1220	6888	870	8048	506	5476
10-#10	1.67	MA	7872	2048	10571	1812	13073	1519	14518	1285	16142	928	19866	710	11516
3L-4S		MI	3839	2048	5549	1716	6467	1441	6951	1215	7396	862	8708	561	5588
10-#10	1.67	MA	7638	2048	10057	1826	12358	1539	13642	1304	14941	938	18422	660	11419
4L-3S		MI	3947	2048	5791	1707	6802	1428	7361	1203	7956	860	9374	610	5593
10-#10	1.67	MA	7336	2048	9595	1839	11734	1552	12866	1316	13863	955	16948	621	11067
5L-2S		MI	4137	2048	6136	1699	7240	1421	7891	1198	8672	852	10311	702	5585
10-#11	2.05	MA	8153	2132	11301	1859	13935	1552	15530	1305	17478	922	21695	680	13943
3L-4S		MI	3916	2132	5834	1754	6769	1468	7289	1228	7828	846	9167	488	6651
10-#11	2.05	MA	7881	2132	10675	1875	13065	1576	14463	1327	16017	934	19928	617	13776
4L-3S		MI	4043	2132	6126	1744	7172	1452	7782	1215	8501	846	9947	546	6676
10-#11	2.05	MA	7524	2132	10118	1891	12305	1591	13519	1341	14704	954	18129	567	13053
5L-2S		MI	4262	2132	6538	1735	7695	1445	8416	1211	9358	838	11037	659	6672
10-#14	2.96	MA	8850	2332	12942	1984	15971	1644	17975	1363	20757	917	26220	617	19762
3L-4S		MI	4134	2332	6440	1873	7485	1556	8135	1282	8952	829	10511	345	8884
10-#14	2.96	MA	8495	2332	12044	2007	14725	1678	16447	1395	18665	933	23680	526	19175
4L-3S		MI	4313	2332	6854	1860	8057	1535	8835	1264	9907	832	11596	425	9246
10-#14	2.96	MA	7997	2332	11252	2030	13635	1699	15093	1414	16784	961	21097	451	17690
5L-2S		MI	4593	2332	7438	1848	8797	1527	9732	1259	11118	821	13106	589	9279
10-#18	5.26	MA	9999	2839	15414	2344	18831	1937	21364	1567	25241	929	32986	292	30828
4L-3S		MI	4914	2839	8591	2159	10185	1748	11377	1391	13290	791	15363	80	15093
10-#18	5.26	MA	9161	2839	14021	2383	16917	1973	18988	1599	21940	976	28440	150	27695
5L-2S		MI	5326	2839	9587	2142	11449	1738	12909	1388	15353	780	17830	371	15502
12-#10	2.01	MA	8241	2121	11330	1858	14036	1553	15686	1306	17718	925	22048	705	13761
3L-5S		MI	3894	2121	5677	1770	6608	1482	7114	1242	7604	866	8985	494	6446
12-#10	2.01	MA	8021	2121	10816	1872	13321	1572	14809	1325	16517	935	20604	655	13655
4E		MI	3995	2121	5893	1762	6905	1475	7481	1237	8112	858	9645	549	6604
12-#10	2.01	MA	7722	2121	10354	1885	12697	1585	14033	1337	15438	952	19130	616	13279
5L-3S		MI	4099	2121	6136	1753	7240	1461	7891	1225	8672	857	10311	598	6620
12-#10	2.01	MA	7419	2121	9788	1899	12096	1597	13275	1356	14386	962	17710	551	12682
6L-2S		MI	4283	2121	6481	1745	7677	1455	8421	1220	9388	848	11248	690	6619
12-#11	2.46	MA	8336	2222	11596	1932	14234	1617	15880	1353	17930	929	22576	612	16489
4E		MI	4099	2222	6247	1810	7292	1509	7923	1254	8684	842	10257	469	7859
12-#11	2.46	MA	7983	2222	11039	1948	13474	1633	14935	1367	16617	950	20777	561	15744
5L-3S		MI	4220	2222	6538	1801	7695	1494	8416	1241	9358	842	11037	527	7898
12-#11	2.46	MA	7625	2222	10351	1964	12751	1647	14012	1390	15335	961	19045	479	15058
6L-2S		MI	4432	2222	6951	1792	8219	1487	9050	1237	10214	834	12128	640	7906
12-#14	3.55	MA	9126	2462	13362	2089	16396	1738	18472	1433	21400	926	27466	518	23013
4E		MI	4403	2462	7023	1954	8225	1616	9032	1319	10163	823	12021	313	10507
12-#14	3.55	MA	8634	2462	12569	2112	15307	1759	17119	1452	19518	955	24884	443	21563
5L-3S		MI	4554	2462	7438	1942	8797	1595	9732	1302	11118	825	13106	393	10958

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

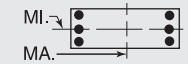
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	3.55	MA	8151	2462	11586	2136	14280	1780	15795	1484	17681	971	22397	322	20020
6L-2S		MI	4820	2462	8021	1930	9537	1586	10629	1297	12329	815	14616	557	11008
12-#18	6.32	MA	10227	3071	16322	2528	19837	2079	22526	1665	26717	965	35054	135	34384
5L-3S		MI	5306	3071	9587	2304	11449	1854	12909	1458	15353	779	17830	7	17805
12-#18	6.32	MA	9470	3071	14625	2571	18031	2114	20201	1719	23491	990	30665	-84	30302
6L-2S		MI	5691	3071	10583	2287	12713	1844	14441	1455	17416	768	20297	298	18432
14-#10	2.34	MA	8394	2195	11575	1918	14284	1606	15976	1346	18092	931	22786	650	15894
4L-5S		MI	4049	2195	6021	1816	7046	1515	7644	1263	8319	863	9922	482	7422
14-#10	2.34	MA	8099	2195	11113	1931	13660	1619	15201	1358	17014	948	21312	611	15495
5L-4S		MI	4149	2195	6238	1808	7342	1509	8011	1258	8828	854	10582	537	7618
14-#10	2.34	MA	7807	2195	10547	1945	13059	1630	14443	1377	15961	959	19892	546	14916
6L-3S		MI	4249	2195	6481	1799	7677	1495	8421	1246	9388	853	11248	586	7643
14-#10	2.34	MA	7553	2195	10065	1954	12393	1645	13702	1388	14941	976	18513	512	14288
7L-2S		MI	4428	2195	6825	1791	8114	1488	8952	1241	10103	845	12185	678	7649
14-#11	2.87	MA	8430	2313	11960	2004	14643	1674	16352	1393	18529	945	23426	555	18440
5L-4S		MI	4279	2313	6659	1867	7816	1550	8557	1280	9541	838	11348	450	9031
14-#11	2.87	MA	8087	2313	11273	2021	13920	1688	15429	1416	17247	957	21693	473	17775
6L-3S		MI	4394	2313	6951	1857	8219	1535	9050	1267	10214	838	12128	508	9116
14-#11	2.87	MA	7789	2313	10687	2032	13109	1706	14539	1430	16004	977	20003	431	16744
7L-2S		MI	4600	2313	7363	1848	8742	1528	9685	1263	11070	829	13218	621	9133
14-#14	4.14	MA	9252	2593	13886	2193	16978	1818	19145	1490	22253	949	28670	434	25436
5L-4S		MI	4650	2593	7606	2036	8965	1675	9929	1357	11374	817	13531	281	12143
14-#14	4.14	MA	8794	2593	12903	2217	15951	1840	17821	1522	20416	964	26183	313	23873
6L-3S		MI	4789	2593	8021	2023	9537	1654	10629	1340	12329	819	14616	361	12667
14-#14	4.14	MA	8396	2593	12064	2232	14790	1864	16545	1541	18634	993	23750	252	22244
7L-2S		MI	5043	2593	8604	2011	10278	1646	11526	1335	13540	809	16126	525	12733
14-#18	7.37	MA	10555	3303	16925	2716	20951	2220	23740	1786	28268	979	37278	-99	36683
6L-3S		MI	5691	3303	10583	2449	12713	1960	14441	1525	17416	768	20297	-66	20162
16-#10	2.67	MA	8467	2269	11872	1977	14624	1653	16368	1379	18589	945	23493	606	17715
5E		MI	4201	2269	6366	1862	7483	1549	8175	1284	9035	859	10859	470	8402
16-#10	2.67	MA	8185	2269	11306	1991	14022	1664	15610	1398	17537	955	22074	541	17152
6L-4S		MI	4301	2269	6583	1854	7780	1542	8541	1279	9543	851	11519	525	8630
16-#10	2.67	MA	7943	2269	10824	2000	13356	1679	14869	1409	16517	972	20694	507	16518
7L-3S		MI	4396	2269	6825	1845	8114	1529	8952	1267	10103	850	12185	574	8662
16-#10	2.67	MA	7688	2269	10362	2011	12737	1688	14087	1424	15498	983	19356	462	15768
8L-2S		MI	4571	2269	7170	1837	8552	1522	9482	1262	10819	841	13122	666	8674
16-#11	3.28	MA	8536	2403	12194	2077	15089	1730	16846	1442	19160	953	24341	467	20490
6L-4S		MI	4455	2403	7071	1923	8339	1592	9191	1307	10397	833	12438	431	10187
16-#11	3.28	MA	8253	2403	11608	2088	14278	1747	15955	1456	17917	973	22651	425	19449
7L-3S		MI	4566	2403	7363	1914	8742	1576	9685	1293	11070	834	13218	489	10331
16-#11	3.28	MA	7952	2403	11045	2101	13524	1758	15004	1473	16676	985	21016	367	18408
8L-2S		MI	4765	2403	7776	1905	9265	1569	10319	1289	11926	825	14308	602	10356
16-#14	4.74	MA	9419	2723	14220	2299	17622	1899	19846	1559	23150	958	29970	305	27726
6L-4S		MI	4892	2723	8190	2117	9705	1735	10826	1395	12585	810	15041	249	13788
16-#14	4.74	MA	9046	2723	13381	2314	16462	1924	18571	1579	21368	986	27536	243	26082
7L-3S		MI	5021	2723	8604	2105	10278	1714	11526	1377	13540	813	16126	329	14375
16-#14	4.74	MA	8624	2723	12575	2331	15382	1938	17221	1604	19618	1015	25188	158	24312
8L-2S		MI	5264	2723	9187	2093	11018	1705	12423	1372	14751	803	17637	493	14454
18-#10	3.01	MA	8555	2342	12065	2037	14986	1698	16777	1420	19113	952	24255	536	19390
6L-5S		MI	4351	2342	6711	1908	7921	1583	8705	1305	9751	856	11796	458	9387
18-#10	3.01	MA	8323	2342	11583	2046	14319	1712	16036	1431	18092	969	22876	502	18748
7L-4S		MI	4450	2342	6928	1900	8217	1576	9072	1300	10259	847	12456	512	9642

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	3.01	MA	8072	2342	11121	2057	13700	1721	15255	1445	17074	979	21538	457	18000
8L-3S		MI	4542	2342	7170	1891	8552	1562	9482	1288	10819	846	13122	562	9680
18-#10	3.01	MA	7790	2342	10665	2067	13098	1731	14496	1454	16071	996	20227	413	17131
9L-2S		MI	4713	2342	7515	1883	8989	1556	10012	1284	11535	838	14059	654	9698
18-#11	3.69	MA	8706	2494	12529	2145	15447	1788	17372	1482	19830	969	25299	419	22153
7L-4S		MI	4643	2494	7484	1980	8862	1633	9826	1333	11253	829	13529	412	11349
18-#11	3.69	MA	8409	2494	11966	2157	14693	1799	16421	1499	18589	980	23664	361	21104
8L-3S		MI	4741	2494	7776	1970	9265	1618	10319	1320	11926	829	14308	470	11544
18-#11	3.69	MA	8078	2494	11417	2170	13961	1811	15497	1510	17367	1000	22058	306	20041
9L-2S		MI	4925	2494	8188	1961	9789	1611	10953	1315	12782	821	15399	583	11577
18-#14	5.33	MA	9678	2854	14698	2395	18133	1983	20597	1616	24103	980	31323	234	29921
7L-4S		MI	5130	2854	8773	2199	10446	1795	11724	1432	13796	804	16551	217	15441
18-#14	5.33	MA	9262	2854	13892	2413	17054	1998	19247	1642	22353	1009	28974	149	28160
8L-3S		MI	5249	2854	9187	2187	11018	1774	12423	1415	14751	807	17637	297	16083
20-#10	3.34	MA	8696	2416	12342	2092	15282	1746	17204	1452	19668	965	25058	497	20977
7L-5S		MI	4499	2416	7056	1954	8358	1616	9235	1327	10466	852	12733	446	10374
20-#10	3.34	MA	8447	2416	11880	2103	14663	1755	16422	1466	18650	976	23719	452	20232
8L-4S		MI	4598	2416	7272	1946	8654	1610	9602	1322	10975	844	13393	500	10652
20-#10	3.34	MA	8175	2416	11424	2113	14061	1765	15663	1475	17647	993	22409	408	19356
9L-3S		MI	4686	2416	7515	1937	8989	1596	10012	1310	11535	843	14059	550	10697
20-#10	3.34	MA	7923	2416	10951	2121	13434	1783	14920	1485	16624	1008	20986	359	18503
10L-2S		MI	4853	2416	7859	1929	9427	1589	10542	1305	12250	834	14996	642	10719
20-#11	4.11	MA	8856	2584	12888	2214	15862	1840	17838	1526	20501	976	26313	355	23799
8L-4S		MI	4814	2584	7896	2036	9386	1674	10460	1359	12109	825	14619	393	12516
20-#11	4.11	MA	8537	2584	12338	2227	15130	1852	16914	1536	19280	996	24706	300	22741
9L-3S		MI	4906	2584	8188	2027	9789	1659	10953	1346	12782	825	15399	451	12757
20-#11	4.11	MA	8242	2584	11763	2236	14366	1873	16010	1547	18054	1015	22968	238	21513
10L-2S		MI	5085	2584	8600	2018	10312	1652	11587	1341	13639	817	16489	564	12796
20-#14	5.92	MA	9884	2984	15209	2494	18725	2058	21273	1679	25087	1002	32761	141	32008
8L-4S		MI	5365	2984	9356	2280	11186	1854	12621	1470	15007	798	18061	185	17101
22-#10	3.68	MA	8815	2490	12639	2149	15626	1789	17589	1488	20225	972	25901	448	22464
8L-5S		MI	4646	2490	7400	2000	8796	1650	9765	1348	11182	849	13670	434	11363
22-#10	3.68	MA	8552	2490	12183	2159	15024	1799	16830	1496	19223	989	24590	403	21582
9L-4S		MI	4744	2490	7617	1992	9092	1643	10132	1343	11690	840	14330	488	11631
22-#10	3.68	MA	8309	2490	11710	2167	14397	1816	16087	1506	18200	1004	23167	354	20723
10L-3S		MI	4836	2490	7859	1984	9427	1630	10542	1331	12250	839	14996	538	11712
22-#10	3.68	MA	8069	2490	11179	2183	13797	1826	15334	1523	17158	1012	21864	307	19838
11L-2S		MI	4990	2490	8204	1975	9864	1623	11072	1326	12966	831	15933	630	11739
22-#11	4.52	MA	8986	2675	13259	2283	16299	1893	18331	1562	21192	992	27355	294	25440
9L-4S		MI	4982	2675	8309	2093	9909	1716	11094	1385	12965	820	15709	374	13688
22-#11	4.52	MA	8703	2675	12685	2293	15535	1914	17426	1573	19966	1011	25616	232	24206
10L-3S		MI	5069	2675	8600	2084	10312	1700	11587	1372	13639	821	16489	432	13968
24-#10	4.01	MA	8922	2563	12941	2205	15988	1832	17997	1518	20798	986	26772	398	23807
9L-5S		MI	4791	2563	7745	2046	9233	1684	10295	1369	11898	845	14607	422	12355
24-#10	4.01	MA	8688	2563	12469	2213	15360	1850	17255	1527	19776	1001	25349	350	22943
10L-4S		MI	4901	2563	7962	2038	9529	1677	10662	1364	12406	837	15267	476	12612
24-#10	4.01	MA	8450	2563	11937	2229	14760	1860	16501	1544	18734	1008	24046	302	22061
11L-3S		MI	4976	2563	8204	2030	9864	1663	11072	1352	12966	836	15933	526	12727
24-#11	4.93	MA	9155	2765	13606	2349	16704	1956	18843	1599	21879	1007	28264	226	26899
10L-4S		MI	5149	2765	8721	2149	10432	1757	11729	1411	13822	816	16800	355	14863

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.13	MA	8510	2029	11236	1805	13809	1520	15230	1296	16697	959	20343	835	8644
2E		MI	4052	2029	5926	1679	6845	1413	7317	1203	7752	885	8868	724	4036
4-#18	2.00	MA	9465	2232	13449	1920	16522	1602	18470	1346	21026	942	26305	816	14944
2E		MI	4374	2232	6841	1781	7927	1484	8589	1243	9428	859	10718	628	6667
6-#11	1.17	MA	8587	2039	11310	1818	13952	1530	15429	1304	16988	963	20762	838	9021
2L-3S		MI	3856	2039	5537	1708	6392	1435	6789	1220	7056	900	8060	623	4226
6-#11	1.17	MA	7995	2039	10333	1835	12711	1546	13926	1319	14958	984	17951	739	9003
3L-2S		MI	4091	2039	5949	1698	6916	1428	7423	1215	7912	892	9150	737	4202
6-#14	1.69	MA	9177	2159	12634	1887	15583	1579	17382	1334	19601	953	24364	827	12811
2L-3S		MI	3979	2159	5926	1773	6845	1481	7317	1245	7752	889	8868	528	5834
6-#14	1.69	MA	8370	2159	11236	1910	13809	1601	15230	1354	16697	982	20343	682	12726
3L-2S		MI	4299	2159	6509	1761	7585	1472	8214	1241	8963	879	10378	692	5813
6-#18	3.00	MA	10548	2464	15895	2065	19625	1708	22231	1413	26104	931	33335	800	22199
2L-3S		MI	4277	2464	6841	1943	7927	1600	8589	1313	9428	859	10718	265	9567
6-#18	3.00	MA	9275	2464	13449	2105	16522	1745	18470	1446	21026	980	26305	536	21777
3L-2S		MI	4763	2464	7837	1926	9191	1590	10121	1310	11491	848	13185	555	9654
8-#9	1.00	MA	8416	2000	10806	1805	13405	1522	14813	1301	16199	972	19701	847	7813
2L-4S		MI	3793	2000	5249	1711	6085	1447	6453	1235	6630	916	7660	660	3711
8-#9	1.00	MA	8023	2000	10170	1816	12597	1532	13835	1311	14878	986	17872	785	7810
3E		MI	3886	2000	5441	1704	6351	1436	6778	1226	7075	915	8194	699	3695
8-#9	1.00	MA	7807	2000	9740	1827	11999	1548	13101	1327	13873	994	16671	746	7775
4L-2S		MI	4045	2000	5715	1697	6699	1430	7200	1221	7644	908	8946	772	3680
8-#10	1.27	MA	8744	2063	11512	1841	14275	1548	15856	1317	17595	967	21625	841	9836
2L-4S		MI	3856	2063	5436	1747	6296	1474	6697	1252	6949	911	8067	613	4591
8-#10	1.27	MA	8261	2063	10707	1855	13254	1561	14618	1330	15924	984	19311	762	9818
3E		MI	3970	2063	5679	1739	6631	1460	7107	1240	7509	909	8733	662	4580
8-#10	1.27	MA	7996	2063	10162	1869	12497	1581	13689	1349	14652	995	17788	712	9732
4L-2S		MI	4166	2063	6023	1730	7068	1453	7637	1235	8224	901	9670	755	4564
8-#11	1.56	MA	9058	2130	12288	1875	15193	1571	16933	1330	19018	958	23573	832	11933
2L-4S		MI	3906	2130	5657	1774	6513	1492	6930	1259	7239	896	8370	547	5471
8-#11	1.56	MA	8490	2130	11310	1891	13952	1587	15429	1345	16988	979	20762	733	11895
3E		MI	4040	2130	5949	1764	6916	1476	7423	1246	7912	896	9150	604	5472
8-#11	1.56	MA	8178	2130	10647	1908	13030	1611	14299	1368	15440	992	18898	671	11740
4L-2S		MI	4268	2130	6362	1755	7439	1469	8058	1241	8769	888	10241	718	5455
8-#14	2.25	MA	9820	2290	14033	1968	17358	1639	19533	1372	22505	947	28384	818	16965
2L-4S		MI	4051	2290	6094	1867	7013	1561	7514	1300	8007	880	9293	416	7375
8-#14	2.25	MA	9057	2290	12634	1992	15583	1661	17382	1392	19601	976	24364	673	16850
3E		MI	4233	2290	6509	1855	7585	1540	8214	1283	8963	883	10378	496	7565
8-#14	2.25	MA	8640	2290	11684	2015	14263	1695	15762	1425	17383	993	21682	584	16412
4L-2S		MI	4539	2290	7092	1843	8325	1532	9111	1278	10174	873	11888	660	7568
8-#18	4.00	MA	10415	2696	15895	2249	19625	1851	22231	1513	26104	969	33335	521	28986
3E		MI	4691	2696	7837	2088	9191	1706	10121	1380	11491	847	13185	192	12462
8-#18	4.00	MA	9778	2696	14225	2289	17307	1909	19389	1568	22213	996	28594	359	25761
4L-2S		MI	5140	2696	8833	2071	10455	1696	11653	1377	13555	836	15652	483	12607
10-#10	1.59	MA	9132	2136	12317	1887	15297	1582	17094	1338	19266	963	23939	836	12231
2L-5S		MI	3914	2136	5564	1802	6437	1514	6860	1278	7156	916	8344	546	5537
10-#10	1.59	MA	8667	2136	11512	1901	14275	1595	15856	1351	17595	981	21625	757	12201
3L-4S		MI	4016	2136	5781	1793	6733	1507	7227	1273	7664	907	9004	601	5615
10-#10	1.59	MA	8417	2136	10967	1915	13518	1615	14927	1370	16323	991	20102	707	12105
4L-3S		MI	4125	2136	6023	1785	7068	1494	7637	1261	8224	906	9670	650	5616
10-#10	1.59	MA	8092	2136	10475	1928	12858	1628	14106	1382	15181	1009	18544	669	11798
5L-2S		MI	4315	2136	6368	1776	7506	1487	8167	1256	8940	898	10607	743	5606
10-#11	1.95	MA	8970	2220	12288	1948	15193	1628	16933	1371	19018	975	23573	727	14786
3L-4S		MI	4093	2220	6070	1830	7036	1533	7565	1285	8095	891	9461	528	6687
10-#11	1.95	MA	8679	2220	11625	1964	14271	1652	15803	1394	17470	987	21708	665	14619
4L-3S		MI	4220	2220	6362	1821	7439	1518	8058	1272	8769	892	10241	585	6705
10-#11	1.95	MA	8294	2220	11031	1980	13466	1668	14803	1408	16079	1008	19806	616	13919
5L-2S		MI	4441	2220	6774	1812	7962	1511	8692	1267	9625	883	11331	699	6697

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#14	2.81	MA	9720	2420	14033	2073	17358	1721	19533	1430	22505	970	28384	665	20977
3L-4S		MI	4310	2420	6678	1948	7753	1621	8411	1338	9218	874	10803	384	8979
10-#14	2.81	MA	9339	2420	13082	2097	16037	1755	17913	1462	20287	987	25702	575	20507
4L-3S		MI	4481	2420	7092	1936	8325	1600	9111	1321	10174	876	11888	464	9285
10-#14	2.81	MA	8800	2420	12237	2120	14883	1777	16479	1482	18293	1016	22971	502	18858
5L-2S		MI	4775	2420	7676	1924	9065	1591	10008	1316	11385	866	13398	628	9311
10-#18	5.00	MA	10953	2928	16671	2434	20411	2015	23151	1635	27291	985	35625	343	32916
4L-3S		MI	5092	2928	8833	2233	10455	1812	11653	1447	13555	835	15652	119	15248
10-#18	5.00	MA	10047	2928	15196	2474	18383	2052	20632	1669	23791	1034	30814	206	29717
5L-2S		MI	5510	2928	9829	2216	11719	1802	13185	1444	15618	824	18120	410	15546
12-#10	1.90	MA	9062	2210	12317	1947	15297	1628	17094	1372	19266	977	23939	752	14584
3L-5S		MI	4071	2210	5909	1848	6874	1548	7390	1299	7872	912	9281	534	6507
12-#10	1.90	MA	8826	2210	11772	1961	14540	1649	16165	1391	17994	988	22416	702	14478
4E		MI	4172	2210	6126	1839	7171	1541	7757	1294	8380	904	9941	589	6634
12-#10	1.90	MA	8505	2210	11280	1974	13880	1662	15345	1404	16853	1006	20858	664	14147
5L-3S		MI	4277	2210	6368	1831	7506	1527	8167	1282	8940	902	10607	638	6646
12-#10	1.90	MA	8181	2210	10680	1988	13238	1673	14542	1423	15739	1016	19357	600	13493
6L-2S		MI	4463	2210	6713	1822	7943	1521	8697	1277	9656	894	11544	730	6641
12-#11	2.34	MA	9166	2311	12603	2021	15512	1694	17306	1420	19500	983	24519	659	17500
4E		MI	4276	2311	6482	1887	7560	1574	8199	1311	8951	887	10551	509	7897
12-#11	2.34	MA	8786	2311	12009	2037	14707	1709	16306	1434	18109	1004	22617	610	16780
5L-3S		MI	4398	2311	6774	1877	7962	1559	8692	1298	9625	887	11331	566	7929
12-#11	2.34	MA	8403	2311	11280	2054	13935	1723	15329	1458	16752	1016	20785	530	16028
6L-2S		MI	4612	2311	7186	1868	8486	1552	9326	1294	10481	879	12422	680	7933
12-#14	3.38	MA	10014	2551	14481	2178	17812	1814	20064	1500	23191	981	29723	566	24591
4E		MI	4579	2551	7261	2030	8493	1680	9308	1376	10429	868	12313	352	10600
12-#14	3.38	MA	9483	2551	13636	2201	16658	1836	18630	1520	21197	1010	26992	494	22972
5L-3S		MI	4733	2551	7676	2018	9065	1659	10008	1358	11385	870	13398	432	10999
12-#14	3.38	MA	8966	2551	12592	2225	15560	1857	17228	1553	19251	1027	24362	375	21418
6L-2S		MI	5003	2551	8259	2006	9806	1651	10905	1354	12596	860	14909	596	11042
12-#18	6.00	MA	11189	3160	17641	2619	21486	2158	24393	1736	28868	1023	37844	191	36829
5L-3S		MI	5484	3160	9829	2378	11719	1918	13185	1513	15618	823	18120	46	17954
12-#18	6.00	MA	10377	3160	15825	2662	19574	2194	21929	1791	25449	1049	33209	-27	33086
6L-2S		MI	5876	3160	10825	2361	12983	1908	14717	1511	17682	812	20587	337	18477
14-#10	2.22	MA	9226	2283	12577	2007	15561	1682	17403	1413	19665	984	24730	697	16854
4L-5S		MI	4226	2283	6254	1894	7312	1581	7920	1320	8587	909	10218	522	7482
14-#10	2.22	MA	8908	2283	12085	2020	14901	1695	16583	1425	18524	1002	23172	659	16501
5L-4S		MI	4326	2283	6470	1885	7608	1575	8287	1315	9096	900	10878	577	7649
14-#10	2.22	MA	8595	2283	11485	2034	14260	1707	15781	1444	17410	1013	21671	595	15865
6L-3S		MI	4427	2283	6713	1877	7943	1561	8697	1303	9656	899	11544	626	7669
14-#10	2.22	MA	8325	2283	10975	2043	13553	1721	14990	1455	16330	1030	20217	562	15249
7L-2S		MI	4608	2283	7057	1868	8380	1554	9227	1298	10372	890	12481	718	7672
14-#11	2.73	MA	9264	2401	12987	2093	15948	1751	17810	1461	20139	999	25427	605	19644
5L-4S		MI	4456	2401	6895	1943	8083	1616	8833	1337	9808	883	11642	490	9105
14-#11	2.73	MA	8897	2401	12257	2110	15176	1765	16833	1484	18782	1012	23595	524	18911
6L-3S		MI	4572	2401	7186	1934	8486	1600	9326	1324	10481	883	12422	547	9148
14-#11	2.73	MA	8578	2401	11636	2121	14316	1783	15881	1497	17466	1033	21814	482	17874
7L-2S		MI	4781	2401	7599	1925	9009	1593	9961	1320	11337	875	13512	661	9162
14-#14	3.94	MA	10145	2681	15034	2283	18433	1896	20781	1558	24101	1004	31013	485	27085
5L-4S		MI	4827	2681	7844	2111	9234	1740	10206	1413	11640	862	13823	320	12233
14-#14	3.94	MA	9654	2681	13990	2307	17335	1917	19379	1590	22155	1020	28382	367	25510
6L-3S		MI	4969	2681	8259	2099	9806	1719	10905	1396	12596	864	14909	401	12710
14-#14	3.94	MA	9228	2681	13101	2323	16104	1942	18028	1610	20268	1050	25816	306	23862
7L-2S		MI	5227	2681	8842	2087	10546	1711	11803	1391	13807	854	16419	564	12768

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 40"

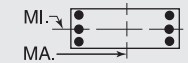
Short columns – no sidesway
Bending on major or minor axis

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	7.00	MA	11538	3391	18271	2807	22677	2300	25690	1858	30526	1038	40239	-42	39974
6L-3S		MI	5870	3391	10825	2523	12983	2024	14717	1580	17682	812	20587	-27	20532
16-#10	2.54	MA	9302	2357	12890	2066	15923	1729	17821	1446	20195	999	25486	655	18858
5E		MI	4379	2357	6598	1940	7749	1615	8450	1342	9303	905	11155	510	8461
16-#10	2.54	MA	9000	2357	12290	2080	15281	1740	17019	1466	19081	1009	23985	590	18238
6L-4S		MI	4478	2357	6815	1931	8045	1608	8817	1337	9811	897	11815	565	8663
16-#10	2.54	MA	8741	2357	11780	2089	14575	1755	16228	1476	18001	1027	22531	557	17614
7L-3S		MI	4575	2357	7057	1923	8380	1595	9227	1325	10372	895	12481	614	8690
16-#10	2.54	MA	8467	2357	11291	2100	13919	1765	15400	1491	16924	1038	21117	513	16804
8L-2S		MI	4752	2357	7402	1914	8818	1588	9758	1320	11087	887	13418	706	8700
16-#11	3.12	MA	9378	2492	13235	2167	16416	1806	18336	1510	20812	1007	26406	518	21793
6L-4S		MI	4633	2492	7307	2000	8606	1657	9468	1363	10664	878	12732	471	10262
16-#11	3.12	MA	9075	2492	12614	2178	15557	1824	17385	1523	19496	1028	24624	476	20745
7L-3S		MI	4745	2492	7599	1990	9009	1641	9961	1350	11337	879	13512	528	10365
16-#11	3.12	MA	8750	2492	12018	2191	14759	1835	16377	1541	18182	1041	22896	420	19703
8L-2S		MI	4947	2492	8011	1981	9533	1635	10595	1346	12193	870	14602	642	10387
16-#14	4.50	MA	10323	2812	15389	2389	19110	1976	21530	1628	25059	1014	32403	358	29602
6L-4S		MI	5070	2812	8428	2193	9974	1800	11103	1451	12851	855	15334	288	13876
16-#14	4.50	MA	9923	2812	14499	2404	17879	2001	20179	1648	23172	1043	29837	297	27939
7L-3S		MI	5201	2812	8842	2181	10546	1779	11803	1434	13807	858	16419	369	14419
16-#14	4.50	MA	9467	2812	13645	2422	16735	2017	18735	1673	21288	1060	27355	214	26011
8L-2S		MI	5448	2812	9425	2169	11286	1770	12700	1429	15018	848	17929	532	14490
18-#10	2.86	MA	9396	2431	13095	2126	16303	1774	18257	1487	20752	1006	26299	586	20614
6L-5S		MI	4529	2431	6943	1986	8187	1649	8981	1363	10019	902	12092	498	9445
18-#10	2.86	MA	9148	2431	12585	2136	15596	1789	17466	1497	19673	1023	24845	552	19979
7L-4S		MI	4628	2431	7160	1977	8483	1642	9347	1358	10527	893	12752	553	9675
18-#10	2.86	MA	8877	2431	12096	2146	14941	1798	16638	1513	18595	1034	23431	508	19172
8L-3S		MI	4721	2431	7402	1969	8818	1628	9758	1346	11087	892	13418	602	9709
18-#10	2.86	MA	8576	2431	11609	2156	14304	1808	15834	1522	17534	1052	22050	464	18296
9L-2S		MI	4894	2431	7747	1960	9255	1621	10288	1341	11803	883	14355	694	9724
18-#11	3.51	MA	9559	2582	13592	2234	16798	1865	18889	1549	21526	1024	27435	470	23616
7L-4S		MI	4808	2582	7719	2056	9130	1698	10102	1389	11520	874	13822	452	11423
18-#11	3.51	MA	9239	2582	12996	2247	15999	1876	17881	1567	20212	1036	25707	414	22564
8L-3S		MI	4922	2582	8011	2047	9533	1683	10595	1376	12193	874	14602	509	11580
18-#11	3.51	MA	8885	2582	12409	2260	15224	1888	16902	1578	18919	1057	24014	360	21410
9L-2S		MI	5109	2582	8424	2038	10056	1676	11229	1372	13050	866	15693	623	11609
18-#14	5.06	MA	10599	2942	15898	2486	19654	2061	22330	1686	26075	1037	33858	289	32015
7L-4S		MI	5309	2942	9011	2274	10714	1859	12000	1489	14062	849	16844	256	15528
18-#14	5.06	MA	10150	2942	15044	2504	18510	2076	20886	1711	24192	1054	31375	206	30098
8L-3S		MI	5431	2942	9425	2262	11286	1838	12700	1471	15018	852	17929	337	16127
18-#14	5.06	MA	9674	2942	14209	2522	17398	2093	19483	1725	22337	1083	28937	126	28133
9L-2S		MI	5668	2942	10009	2250	12026	1830	13597	1466	16229	842	19439	500	16210
20-#10	3.17	MA	9546	2504	13390	2182	16618	1822	18704	1519	21344	1020	27159	547	22344
7L-5S		MI	4678	2504	7288	2032	8624	1682	9511	1384	10734	898	13029	486	10431
20-#10	3.17	MA	9278	2504	12901	2192	15962	1832	17876	1534	20266	1031	25745	504	21540
8L-4S		MI	4776	2504	7505	2023	8920	1676	9878	1379	11243	890	13689	541	10687
20-#10	3.17	MA	8987	2504	12414	2202	15326	1842	17072	1543	19205	1048	24364	460	20657
9L-3S		MI	4866	2504	7747	2015	9255	1662	10288	1367	11803	888	14355	590	10726
20-#10	3.17	MA	8718	2504	11914	2211	14662	1860	16286	1553	18112	1063	22860	412	19801
10L-2S		MI	5035	2504	8092	2006	9693	1655	10818	1362	12519	880	15292	682	10746
20-#11	3.90	MA	9717	2672	13974	2304	17240	1918	19385	1593	22242	1032	28518	408	25424
8L-4S		MI	4993	2672	8132	2113	9653	1740	10736	1416	12376	870	14913	433	12589
20-#11	3.90	MA	9375	2672	13387	2316	16465	1930	18406	1604	20949	1053	26824	354	24276
9L-3S		MI	5087	2672	8424	2103	10056	1724	11229	1402	13050	870	15693	490	12793
20-#11	3.90	MA	9060	2672	12778	2326	15656	1951	17448	1615	19637	1071	24987	293	23023
10L-2S		MI	5269	2672	8836	2094	10579	1717	11863	1398	13906	862	16783	604	12828
20-#14	5.63	MA	10816	3073	16442	2585	20285	2136	23037	1748	27095	1048	35396	197	34185
8L-4S		MI	5544	3073	9594	2356	11454	1919	12897	1526	15273	843	18354	224	17186

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

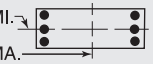
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	5.63	MA	10361	3073	15608	2604	19173	2153	21634	1763	25240	1077	32958	118	32209
9L-3S		MI	5657	3073	10009	2344	12026	1898	13597	1509	16229	845	19439	305	17835
22-#10	3.49	MA	9672	2578	13706	2238	16984	1865	19114	1555	21937	1027	28059	499	23907
8L-5S		MI	4825	2578	7633	2078	9062	1716	10041	1405	11450	895	13966	474	11420
22-#10	3.49	MA	9390	2578	13219	2248	16347	1876	18310	1564	20876	1045	26678	455	23018
9L-4S		MI	4923	2578	7849	2069	9358	1709	10408	1400	11958	886	14626	529	11695
22-#10	3.49	MA	9131	2578	12719	2257	15684	1894	17524	1574	19783	1059	25174	407	22156
10L-3S		MI	5009	2578	8092	2061	9693	1695	10818	1388	12519	885	15292	578	11743
22-#10	3.49	MA	8872	2578	12156	2273	15043	1903	16726	1591	18680	1067	23798	361	21195
11L-2S		MI	5174	2578	8436	2052	10130	1689	11348	1383	13234	876	16229	670	11767
22-#11	4.29	MA	9856	2763	14365	2373	17705	1971	19910	1630	22979	1048	29635	348	27141
9L-4S		MI	5162	2763	8544	2169	10176	1781	11370	1442	13233	866	16003	414	13760
22-#11	4.29	MA	9553	2763	13756	2383	16897	1993	18952	1641	21666	1067	27798	287	25881
10L-3S		MI	5251	2763	8836	2160	10579	1765	11863	1429	13906	866	16783	471	14005
22-#14	6.19	MA	11033	3203	17006	2685	20948	2212	23785	1801	28144	1071	36978	109	36284
9L-4S		MI	5776	3203	10177	2438	12194	1978	13794	1564	16484	837	19864	193	18850
24-#10	3.81	MA	9786	2652	14024	2294	17369	1909	19549	1585	22547	1041	28992	450	25379
9L-5S		MI	4970	2652	7977	2124	9499	1750	10571	1427	12166	891	14903	462	12412
24-#10	3.81	MA	9535	2652	13524	2303	16705	1927	18762	1595	21455	1056	27488	402	24510
10L-4S		MI	5068	2652	8194	2115	9795	1743	10938	1422	12674	883	15563	516	12675
24-#10	3.81	MA	9279	2652	12960	2319	16065	1937	17965	1613	20352	1064	26112	356	23552
11L-3S		MI	5158	2652	8436	2107	10130	1729	11348	1410	13234	881	16229	566	12758
24-#11	4.68	MA	10036	2853	14734	2439	18138	2034	20456	1668	23696	1063	30609	281	28739
10L-4S		MI	5329	2853	8957	2226	10700	1822	12005	1468	14089	861	17094	395	14934

RECTANGULAR TIED COLUMNS 22" x 22"

6-#9	1.24	MA	2792	1244	3951	1060	4691	891	5096	757	5517	555	6614	477	3014
2L-3S		MI	2612	1244	3641	1068	4297	897	4619	763	4873	563	5737	404	3023
6-#10	1.57	MA	2896	1291	4208	1086	5004	909	5469	768	6015	550	7260	468	3754
2L-3S		MI	2676	1291	3818	1095	4508	917	4868	775	5204	560	6164	375	3756
6-#11	1.93	MA	2986	1341	4486	1108	5320	924	5834	776	6492	542	7799	446	4498
2L-3S		MI	2730	1341	4017	1118	4724	933	5112	782	5518	553	6516	333	4490
6-#14	2.79	MA	3221	1461	5103	1176	6078	973	6740	805	7704	532	9293	412	6283
2L-3S		MI	2878	1461	4439	1190	5234	984	5717	813	6324	546	7505	249	6217
6-#18	4.96	MA	3746	1765	6590	1352	7914	1100	8940	883	10654	510	12758	307	10580
2L-3S		MI	3249	1765	5449	1374	6466	1116	7185	892	8285	528	9803	16	9759
8-#8	1.31	MA	2820	1253	3993	1069	4757	898	5182	762	5639	556	6804	480	3173
2L-4S		MI	2598	1253	3575	1081	4206	913	4511	776	4728	565	5606	390	3177
8-#9	1.65	MA	2930	1302	4261	1096	5084	917	5573	774	6161	552	7491	472	3946
2L-4S		MI	2658	1302	3735	1111	4391	936	4730	790	5017	563	5996	357	3924
8-#10	2.10	MA	3065	1364	4599	1132	5500	943	6070	790	6826	547	8355	459	4923
2L-4S		MI	2735	1364	3936	1151	4627	966	5007	809	5384	560	6486	315	4845
8-#11	2.58	MA	3183	1431	4955	1164	5915	965	6555	802	7466	538	9083	432	5897
2L-4S		MI	2800	1431	4157	1186	4865	991	5277	824	5731	551	6888	257	5591
8-#14	3.72	MA	3488	1591	5768	1257	6921	1033	7762	843	9085	526	11080	389	8253
2L-4S		MI	2982	1591	4635	1286	5430	1067	5947	871	6622	541	8019	139	7356
10-#10	2.62	MA	3231	1438	4990	1178	5996	976	6671	811	7638	543	9450	451	6085
2L-5S		MI	2794	1438	4083	1206	4790	1007	5196	837	5623	567	6811	253	5577
10-#10	2.62	MA	3029	1438	4599	1187	5500	984	6070	817	6826	553	8355	359	6062
3L-4S		MI	2917	1438	4326	1197	5122	999	5608	831	6195	557	7582	307	5936
10-#11	3.22	MA	3376	1522	5424	1221	6510	1007	7276	828	8439	534	10367	418	7288
2L-5S		MI	2873	1522	4331	1253	5058	1041	5500	856	6014	557	7268	177	6520
10-#11	3.22	MA	3144	1522	4955	1231	5915	1015	6555	835	7466	544	9083	305	7246
3L-4S		MI	3014	1522	4625	1242	5460	1033	5998	850	6704	547	8172	244	6903
10-#14	4.65	MA	3460	1722	5768	1353	6921	1103	7762	889	9085	534	11080	201	10098
3L-4S		MI	3280	1722	5300	1368	6274	1127	6970	909	8002	535	9806	115	9233

RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis



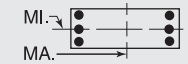
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.18	MA	3295	1348	4656	1148	5515	966	5979	822	6446	604	7691	519	3424
2E		MI	2999	1348	4297	1136	5046	956	5446	813	5843	597	6875	504	3110
4-#14	1.70	MA	3482	1428	5132	1192	6090	996	6661	840	7355	596	8848	500	4785
2E		MI	3162	1428	4721	1179	5556	986	6051	831	6648	589	7862	480	4326
4-#18	3.03	MA	3913	1631	6277	1305	7487	1077	8326	888	9579	578	11570	440	8072
2E		MI	3531	1631	5737	1291	6790	1066	7519	878	8608	570	10156	407	7248
6-#9	1.14	MA	3302	1341	4578	1157	5471	974	5954	830	6436	612	7759	533	3338
2L-3S		MI	2827	1341	3915	1154	4616	971	4952	827	5199	614	6099	449	3044
6-#9	1.14	MA	3098	1341	4232	1165	5032	981	5421	836	5717	622	6763	461	3347
3L-2S		MI	3007	1341	4225	1146	5010	964	5429	822	5843	606	6976	522	3032
6-#10	1.44	MA	3422	1388	4867	1183	5823	992	6372	841	6995	608	8525	528	4165
2L-3S		MI	2890	1388	4094	1181	4828	991	5201	839	5530	611	6526	420	3782
6-#10	1.44	MA	3172	1388	4430	1193	5269	1001	5701	848	6088	619	7270	435	4168
3L-2S		MI	3112	1388	4484	1172	5323	983	5802	832	6341	601	7621	512	3775
6-#11	1.77	MA	3528	1438	5181	1205	6182	1007	6787	848	7537	600	9169	509	5004
2L-3S		MI	2944	1438	4297	1204	5046	1005	5446	846	5843	604	6875	377	4523
6-#11	1.77	MA	3236	1438	4656	1217	5515	1017	5979	856	6446	613	7691	396	4995
3L-2S		MI	3203	1438	4766	1193	5641	997	6167	839	6817	593	8158	490	4524
6-#14	2.56	MA	3800	1558	5878	1273	7037	1056	7809	878	8905	590	10916	483	7012
2L-3S		MI	3092	1558	4721	1275	5556	1056	6051	876	6648	596	7862	293	6266
6-#14	2.56	MA	3408	1558	5132	1289	6090	1069	6661	888	7355	607	8848	319	6946
3L-2S		MI	3440	1558	5386	1261	6400	1045	7074	868	8028	583	9650	456	6315
6-#18	4.55	MA	4415	1863	7563	1450	9119	1183	10304	955	12249	567	15019	397	11876
2L-3S		MI	3461	1863	5737	1457	6790	1187	7519	954	8608	577	10156	59	9990
6-#18	4.55	MA	3841	1863	6277	1475	7487	1203	8326	969	9579	591	11570	106	11249
3L-2S		MI	3969	1863	6878	1436	8238	1172	9274	945	10977	559	13112	350	10624
8-#8	1.20	MA	3334	1350	4624	1166	5544	980	6048	835	6570	614	7949	534	3515
2L-4S		MI	2811	1350	3848	1168	4524	987	4844	840	5054	617	5969	435	3201
8-#8	1.20	MA	3173	1350	4349	1173	5194	986	5625	840	5998	621	7157	478	3521
3E		MI	2893	1350	4020	1162	4762	977	5135	831	5452	614	6464	468	3199
8-#8	1.20	MA	3082	1350	4158	1179	4930	997	5301	849	5555	625	6605	444	3518
4L-2S		MI	3036	1350	4267	1155	5075	972	5515	827	5965	607	7167	525	3191
8-#9	1.52	MA	3460	1399	4924	1193	5911	1000	6487	846	7156	609	8755	529	4378
2L-4S		MI	2872	1399	4009	1198	4711	1009	5063	855	5343	614	6358	402	3956
8-#9	1.52	MA	3263	1399	4578	1202	5471	1007	5954	853	6436	619	7759	457	4379
3E		MI	2972	1399	4225	1190	5010	997	5429	844	5843	611	6976	444	3971
8-#9	1.52	MA	3152	1399	4338	1210	5139	1020	5547	864	5879	623	7063	415	4356
4L-2S		MI	3146	1399	4536	1182	5403	991	5906	838	6487	603	7853	516	3966
8-#10	1.92	MA	3615	1461	5304	1229	6377	1026	7044	862	7902	604	9779	523	5471
2L-4S		MI	2948	1461	4212	1237	4946	1039	5340	873	5709	611	6848	360	4890
8-#10	1.92	MA	3376	1461	4867	1239	5823	1035	6372	869	6995	616	8525	430	5460
3E		MI	3070	1461	4484	1227	5323	1024	5802	860	6341	608	7621	412	4940
8-#10	1.92	MA	3240	1461	4564	1250	5403	1051	5858	884	6292	621	7644	376	5394
4L-2S		MI	3283	1461	4875	1218	5819	1016	6403	854	7152	598	8716	504	4946
8-#11	2.36	MA	3753	1529	5707	1261	6848	1048	7595	874	8628	596	10647	500	6571
2L-4S		MI	3013	1529	4436	1271	5186	1064	5610	887	6056	601	7247	302	5709
8-#11	2.36	MA	3476	1529	5181	1273	6182	1058	6787	882	7537	608	9169	386	6543
3E		MI	3155	1529	4766	1260	5641	1047	6167	872	6817	599	8158	363	5906
8-#11	2.36	MA	3317	1529	4815	1285	5675	1077	6166	899	6688	612	8126	322	6324
4L-2S		MI	3401	1529	5235	1250	6236	1038	6889	865	7790	588	9442	476	5926
8-#14	3.41	MA	4108	1689	6625	1355	7984	1116	8957	915	10454	584	12983	465	9225
2L-4S		MI	3193	1689	4918	1371	5753	1140	6281	934	6946	591	8376	183	7493
8-#14	3.41	MA	3739	1689	5878	1371	7037	1129	7809	926	8905	601	10916	302	9129
3E		MI	3383	1689	5386	1356	6400	1116	7074	914	8028	590	9650	269	8208

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis

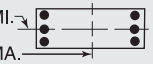


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	3.41	MA	3529	1689	5356	1387	6315	1154	6925	948	7696	605	9452	212	8331
4L-2S		MI	3710	1689	6051	1342	7244	1105	8096	906	9409	576	11437	432	8288
8-#18	6.06	MA	4387	2095	7563	1620	9119	1309	10304	1036	12249	580	15019	63	14803
3E		MI	3938	2095	6878	1602	8238	1293	9274	1021	10977	566	13112	3	13103
8-#18	6.06	MA	4082	2095	6656	1645	7866	1350	8771	1072	10154	582	12560	-89	12421
4L-2S		MI	4395	2095	8019	1581	9686	1278	11029	1012	13346	548	16067	293	13985
10-#10	2.41	MA	3804	1535	5740	1275	6931	1059	7716	883	8808	601	11034	518	6771
2L-5S		MI	3008	1535	4359	1292	5109	1081	5529	901	5949	618	7172	298	5666
10-#10	2.41	MA	3575	1535	5304	1285	6377	1068	7044	891	7902	612	9779	425	6748
3L-4S		MI	3131	1535	4602	1283	5442	1073	5941	895	6520	608	7943	352	6031
10-#10	2.41	MA	3448	1535	5001	1296	5958	1084	6530	905	7199	617	8898	371	6670
4L-3S		MI	3245	1535	4875	1273	5819	1058	6403	881	7152	604	8716	404	6094
10-#10	2.41	MA	3303	1535	4731	1306	5588	1093	6072	913	6563	629	8015	318	6256
5L-2S		MI	3450	1535	5266	1264	6315	1050	7004	875	7963	594	9812	496	6111
10-#11	2.95	MA	3974	1619	6232	1318	7515	1090	8403	900	9719	591	12126	490	8131
2L-5S		MI	3087	1619	4611	1338	5379	1114	5833	919	6339	608	7627	221	6624
10-#11	2.95	MA	3709	1619	5707	1330	6848	1100	7595	908	8628	604	10647	377	8088
3L-4S		MI	3227	1619	4905	1327	5781	1105	6332	913	7029	597	8531	288	7016
10-#11	2.95	MA	3562	1619	5341	1342	6341	1118	6974	925	7779	608	9604	313	7799
4L-3S		MI	3360	1619	5235	1317	6236	1088	6889	898	7790	595	9442	349	7285
10-#11	2.95	MA	3396	1619	5014	1354	5894	1128	6420	933	7011	621	8564	247	7330
5L-2S		MI	3596	1619	5703	1306	6831	1080	7610	892	8764	584	10726	463	7319
10-#14	4.26	MA	4061	1819	6625	1452	7984	1188	8957	963	10454	594	12983	285	11313
3L-4S		MI	3492	1819	5582	1452	6596	1199	7304	972	8326	585	10164	159	9364
10-#14	4.26	MA	3870	1819	6102	1468	7262	1214	8073	986	9245	599	11519	194	10447
4L-3S		MI	3665	1819	6051	1438	7244	1176	8096	952	9409	584	11437	245	10151
10-#14	4.26	MA	3640	1819	5636	1485	6624	1227	7282	996	8150	616	10064	99	9693
5L-2S		MI	3969	1819	6716	1424	8087	1164	9119	944	10789	570	13225	409	10253
10-#18	7.58	MA	4657	2326	7942	1790	9498	1456	10749	1139	12824	571	16008	-132	15688
4L-3S		MI	4399	2326	8019	1747	9686	1399	11029	1088	13346	555	16067	-54	15932
12-#10	2.89	MA	3990	1609	6177	1321	7486	1093	8388	904	9715	597	12288	513	8067
2L-6S		MI	3039	1609	4477	1354	5290	1122	5725	936	6212	624	7560	230	6476
12-#10	2.89	MA	3769	1609	5740	1331	6931	1102	7716	912	8808	609	11034	420	8035
3L-5S		MI	3187	1609	4750	1338	5605	1114	6130	922	6760	614	8267	290	6782
12-#10	2.89	MA	3650	1609	5437	1342	6512	1118	7202	926	8106	614	10153	366	7929
4E		MI	3309	1609	4993	1329	5938	1106	6542	916	7332	604	9038	344	7134
12-#10	2.89	MA	3507	1609	5168	1352	6143	1127	6744	934	7470	625	9270	313	7509
5L-3S		MI	3416	1609	5266	1319	6315	1091	7004	903	7963	601	9812	396	7245
12-#10	2.89	MA	3342	1609	4858	1367	5793	1136	6295	949	6849	630	8407	241	7165
6L-2S		MI	3614	1609	5656	1310	6811	1084	7605	896	8774	591	10907	488	7270
12-#11	3.55	MA	3937	1710	6232	1386	7515	1141	8403	935	9719	600	12126	368	9632
3L-5S		MI	3297	1710	5080	1395	5974	1155	6555	946	7312	604	8911	208	7964
12-#11	3.55	MA	3800	1710	5866	1398	7008	1160	7782	951	8870	604	11082	303	9285
4E		MI	3436	1710	5374	1384	6376	1147	7053	939	8003	593	9815	274	8333
12-#11	3.55	MA	3636	1710	5539	1410	6561	1169	7228	959	8102	617	10042	237	8840
5L-3S		MI	3560	1710	5703	1373	6831	1129	7610	924	8764	591	10726	336	8662
12-#11	3.55	MA	3442	1710	5172	1429	6138	1179	6685	976	7366	629	9087	164	8273
6L-2S		MI	3787	1710	6172	1363	7426	1121	8331	918	9737	580	12010	449	8708
12-#14	5.11	MA	4200	1950	6849	1550	8209	1274	9220	1024	10795	593	13587	177	12576
4E		MI	3803	1950	6247	1534	7440	1259	8326	1009	9706	579	11951	136	11248
12-#14	5.11	MA	3973	1950	6382	1566	7571	1287	8430	1034	9699	609	12131	82	11808
5L-3S		MI	3949	1950	6716	1519	8087	1235	9119	989	10789	578	13225	221	12094
14-#10	3.37	MA	3959	1682	6177	1377	7486	1136	8388	933	9715	605	12288	415	9321
3L-6S		MI	3220	1682	4868	1400	5786	1156	6326	957	7023	621	8655	222	7582
14-#10	3.37	MA	3848	1682	5874	1388	7066	1152	7874	948	9012	610	11407	361	9168
4L-5S		MI	3363	1682	5141	1384	6101	1148	6731	944	7571	611	9363	282	7902
14-#10	3.37	MA	3706	1682	5605	1398	6697	1161	7416	955	8377	622	10524	308	8767
5L-4S		MI	3483	1682	5384	1375	6434	1140	7143	937	8143	601	10134	335	8236

RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	3.37	MA	3547	1682	5295	1413	6348	1169	6967	970	7755	626	9661	236	8412
6L-3S		MI	3585	1682	5656	1365	6811	1125	7605	924	8774	597	10907	387	8395
14-#11	4.14	MA	4033	1800	6391	1455	7675	1201	8590	977	9961	599	12561	294	10778
4L-5S		MI	3503	1800	5549	1451	6569	1196	7276	972	8286	599	10195	194	9310
14-#11	4.14	MA	3870	1800	6065	1467	7228	1211	8036	985	9193	612	11520	228	10356
5L-4S		MI	3641	1800	5843	1441	6971	1188	7774	965	8976	588	11098	261	9659
14-#11	4.14	MA	3685	1800	5697	1486	6805	1221	7493	1002	8456	625	10566	154	9774
6L-3S		MI	3767	1800	6172	1430	7426	1171	8331	950	9737	586	12010	322	10038
14-#14	5.97	MA	4298	2080	7129	1648	8518	1346	9578	1072	11249	603	14199	64	13930
5L-4S		MI	4085	2080	6912	1615	8284	1318	9349	1047	11087	573	13739	112	13143
16-#10	3.85	MA	4042	1756	6311	1434	7620	1185	8545	969	9919	607	12661	356	10413
4L-6S		MI	3398	1756	5259	1446	6282	1190	6927	978	7834	617	9750	214	8692
16-#10	3.85	MA	3901	1756	6041	1444	7251	1194	8087	977	9284	618	11779	303	10028
5E		MI	3535	1756	5531	1431	6597	1182	7332	965	8382	607	10458	273	9025
16-#10	3.85	MA	3748	1756	5731	1459	6902	1203	7639	991	8662	623	10916	231	9663
6L-4S		MI	3655	1756	5775	1421	6930	1174	7744	958	8954	597	11229	327	9345
16-#11	4.73	MA	4099	1890	6590	1523	7895	1252	8845	1011	10284	608	12999	219	11876
5E		MI	3705	1890	6018	1508	7164	1238	7997	998	9260	595	11478	180	10660
16-#11	4.73	MA	3922	1890	6223	1542	7472	1262	8301	1028	9547	621	12044	145	11281
6L-4S		MI	3858	1890	6312	1497	7566	1229	8495	991	9950	584	12382	247	10991
18-#10	4.33	MA	4093	1830	6478	1490	7805	1228	8759	998	10191	615	13033	298	11293
5L-6S		MI	3572	1830	5650	1492	6778	1223	7528	999	8646	614	10846	206	9805
18-#10	4.33	MA	3946	1830	6168	1505	7456	1237	8310	1012	9569	619	12170	226	10916
6L-5S		MI	3704	1830	5922	1477	7093	1215	7933	986	9193	604	11553	265	10152
18-#11	5.32	MA	4154	1981	6748	1599	8139	1303	9109	1054	10638	616	13522	135	12792
6L-5S		MI	3917	1981	6487	1564	7759	1279	8718	1024	10233	591	12762	166	12014

RECTANGULAR TIED COLUMNS 22" x 26"

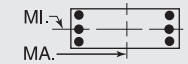
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.09	MA	3846	1445	5334	1246	6358	1049	6903	894	7434	662	8936	576	3761
2E		MI	3214	1445	4577	1222	5367	1028	5780	877	6168	648	7234	548	3131
4-#14	1.57	MA	4060	1525	5864	1289	6999	1079	7664	912	8447	654	10266	561	5271
2E		MI	3378	1525	5004	1264	5879	1058	6385	894	6972	639	8219	524	4353
4-#18	2.80	MA	4553	1728	7145	1402	8561	1160	9526	961	10934	636	13416	513	8936
2E		MI	3751	1728	6024	1374	7115	1137	7853	940	8930	620	10510	450	7288
6-#9	1.05	MA	3852	1438	5244	1254	6305	1057	6870	902	7416	670	8931	583	3662
2L-3S		MI	3041	1438	4190	1240	4935	1045	5285	891	5525	665	6461	494	3063
6-#9	1.05	MA	3623	1438	4861	1263	5819	1064	6281	909	6621	680	7831	513	3671
3L-2S		MI	3223	1438	4500	1233	5329	1038	5762	886	6169	657	7338	567	3050
6-#10	1.33	MA	3987	1485	5564	1280	6695	1075	7334	913	8035	665	9783	578	4577
2L-3S		MI	3104	1485	4370	1267	5147	1064	5535	903	5855	662	6887	465	3806
6-#10	1.33	MA	3707	1485	5082	1291	6082	1085	6592	921	7033	678	8395	489	4579
3L-2S		MI	3328	1485	4760	1258	5643	1056	6136	897	6666	652	7982	557	3795
6-#11	1.64	MA	4110	1535	5916	1302	7096	1090	7799	921	8642	657	10609	570	5509
2L-3S		MI	3158	1535	4577	1289	5367	1078	5780	909	6168	654	7234	421	4555
6-#11	1.64	MA	3781	1535	5334	1315	6358	1101	6903	930	7434	672	8936	457	5501
3L-2S		MI	3419	1535	5045	1278	5962	1070	6501	903	7141	643	8517	534	4549
6-#14	2.36	MA	4420	1655	6692	1370	8049	1139	8937	950	10166	648	12614	549	7741
2L-3S		MI	3306	1655	5004	1360	5879	1129	6385	939	6972	646	8219	337	6311
6-#14	2.36	MA	3977	1655	5864	1388	6999	1154	7664	962	8447	667	10266	386	7675
3L-2S		MI	3658	1655	5669	1345	6723	1118	7407	931	8352	633	10007	500	6346
6-#18	4.20	MA	5130	1960	8575	1547	10377	1266	11727	1028	13905	625	17361	480	13172
2L-3S		MI	3673	1960	6024	1541	7115	1258	7853	1016	8930	627	10510	103	10216

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis

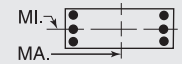


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	4.20	MA	4447	1960	7145	1575	8561	1289	9526	1045	10934	654	13416	190	12787
3L-2S		MI	4192	1960	7165	1519	8563	1243	9608	1007	11299	609	13465	393	10667
8-#8	1.10	MA	3887	1447	5294	1263	6384	1063	6973	907	7562	671	9138	584	3856
2L-4S		MI	3025	1447	4121	1255	4842	1061	5177	905	5381	668	6332	480	3224
8-#8	1.10	MA	3707	1447	4990	1270	5998	1070	6505	913	6930	680	8263	530	3862
3E		MI	3108	1447	4293	1248	5080	1051	5468	896	5779	666	6827	513	3218
8-#8	1.10	MA	3605	1447	4781	1278	5707	1081	6150	923	6443	684	7661	497	3859
4L-2S		MI	3252	1447	4540	1242	5393	1046	5848	891	6291	659	7530	570	3209
8-#9	1.40	MA	4030	1496	5627	1290	6790	1083	7459	919	8210	667	10031	579	4810
2L-4S		MI	3085	1496	4284	1284	5030	1083	5396	919	5668	665	6720	447	3986
8-#9	1.40	MA	3809	1496	5244	1299	6305	1091	6870	926	7416	677	8931	510	4811
3E		MI	3186	1496	4500	1277	5329	1071	5762	908	6169	663	7338	489	3994
8-#9	1.40	MA	3685	1496	4980	1308	5939	1104	6422	938	6803	682	8171	468	4788
4L-2S		MI	3363	1496	4810	1269	5722	1065	6240	903	6813	654	8215	561	3986
8-#10	1.78	MA	4206	1559	6047	1326	7307	1109	8077	934	9038	662	11171	574	6020
2L-4S		MI	3161	1559	4488	1323	5266	1113	5674	937	6035	662	7209	405	4931
8-#10	1.78	MA	3937	1559	5564	1337	6695	1118	7334	943	8035	675	9783	484	6008
3E		MI	3285	1559	4760	1314	5643	1098	6136	924	6666	659	7982	457	4968
8-#10	1.78	MA	3786	1559	5231	1348	6233	1135	6768	958	7261	681	8820	430	5943
4L-2S		MI	3500	1559	5151	1304	6139	1090	6737	918	7478	649	9078	549	4969
8-#11	2.18	MA	4365	1626	6498	1359	7835	1131	8694	947	9851	653	12282	564	7245
2L-4S		MI	3225	1626	4716	1356	5507	1137	5944	950	6380	652	7606	346	5822
8-#11	2.18	MA	4052	1626	5916	1372	7096	1142	7799	956	8642	667	10609	451	7217
3E		MI	3370	1626	5045	1346	5962	1119	6501	935	7141	650	8517	407	5941
8-#11	2.18	MA	3875	1626	5513	1384	6537	1162	7114	974	7706	673	9435	384	7073
4L-2S		MI	3619	1626	5514	1335	6557	1111	7222	929	8115	639	9801	521	5953
8-#14	3.15	MA	4768	1786	7520	1452	9100	1199	10211	988	11885	641	14963	538	10197
2L-4S		MI	3405	1786	5200	1455	6075	1212	6615	997	7270	642	8733	227	7626
8-#14	3.15	MA	4352	1786	6692	1469	8049	1213	8937	1000	10166	661	12614	374	10101
3E		MI	3598	1786	5669	1441	6723	1188	7407	977	8352	640	10007	313	8257
8-#14	3.15	MA	4116	1786	6116	1487	7252	1241	7961	1025	8830	667	10960	280	9326
4L-2S		MI	3930	1786	6333	1427	7566	1177	8430	969	9732	626	11795	476	8322
8-#18	5.59	MA	5094	2192	8575	1720	10377	1395	11727	1112	13905	643	17361	157	16775
3E		MI	4152	2192	7165	1686	8563	1364	9608	1083	11299	615	13465	46	13317
8-#18	5.59	MA	4709	2192	7573	1748	8990	1440	10029	1152	11585	650	14565	-2	14561
4L-2S		MI	4621	2192	8306	1664	10011	1349	11363	1074	13668	598	16421	337	14031
10-#10	2.22	MA	4419	1632	6530	1372	7920	1142	8819	956	10040	658	12559	569	7457
2L-5S		MI	3221	1632	4635	1379	5429	1154	5862	965	6274	669	7533	343	5753
10-#10	2.22	MA	4161	1632	6047	1383	7307	1152	8077	964	9038	671	11171	479	7434
3L-4S		MI	3345	1632	4878	1369	5762	1146	6275	959	6846	659	8304	396	6073
10-#10	2.22	MA	4019	1632	5714	1394	6846	1169	7511	979	8263	677	10208	426	7356
4L-3S		MI	3461	1632	5151	1360	6139	1131	6737	945	7478	655	9078	448	6124
10-#10	2.22	MA	3853	1632	5418	1406	6440	1179	7007	988	7565	690	9240	375	6945
5L-2S		MI	3668	1632	5542	1350	6635	1123	7338	939	8289	645	10173	541	6135
10-#11	2.73	MA	4614	1716	7080	1415	8574	1173	9589	973	11059	649	13956	558	8973
2L-5S		MI	3300	1716	4891	1423	5700	1187	6167	983	6664	658	7986	266	6722
10-#11	2.73	MA	4315	1716	6498	1428	7835	1184	8694	982	9851	663	12282	445	8930
3L-4S		MI	3441	1716	5185	1413	6102	1178	6665	976	7354	648	8890	332	7125
10-#11	2.73	MA	4151	1716	6095	1441	7276	1203	8009	1000	8914	669	11108	378	8713
4L-3S		MI	3575	1716	5514	1402	6557	1161	7222	961	8115	645	9801	394	7322
10-#11	2.73	MA	3958	1716	5736	1454	6784	1214	7399	1009	8068	683	9931	313	8150
5L-2S		MI	3815	1716	5983	1391	7152	1152	7943	955	9089	635	11085	507	7349
10-#14	3.93	MA	4714	1916	7520	1551	9100	1273	10211	1038	11885	654	14963	363	12528
3L-4S		MI	3704	1916	5865	1537	6919	1271	7638	1035	8650	635	10521	203	9491
10-#14	3.93	MA	4500	1916	6944	1569	8302	1300	9234	1062	10549	661	13309	269	11682
4L-3S		MI	3881	1916	6333	1523	7566	1248	8430	1015	9732	634	11795	289	10201
10-#14	3.93	MA	4234	1916	6431	1586	7600	1315	8363	1075	9341	681	11656	174	10936
5L-2S		MI	4192	1916	6998	1508	8410	1237	9452	1007	11113	620	13582	453	10289

RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

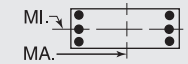
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	6.99	MA	5399	2424	9004	1893	10806	1546	12230	1219	14556	639	18510	-34	18408
4L-3S		MI	4614	2424	8306	1831	10011	1470	11363	1150	13668	604	16421	-10	16395
12-#10	2.66	MA	4628	1706	7013	1418	8533	1176	9562	977	11042	655	13947	564	8889
2L-6S		MI	3252	1706	4753	1440	5610	1196	6059	1000	6537	675	7921	275	6610
12-#10	2.66	MA	4379	1706	6530	1429	7920	1186	8819	985	10040	668	12559	474	8858
3L-5S		MI	3402	1706	5026	1425	5925	1188	6463	986	7085	665	8629	335	6865
12-#10	2.66	MA	4246	1706	6197	1440	7458	1203	8253	1001	9266	674	11596	421	8770
4E		MI	3523	1706	5269	1415	6258	1180	6876	980	7657	655	9399	388	7215
12-#10	2.66	MA	4082	1706	5901	1452	7052	1212	7750	1009	8567	686	10627	370	8334
5L-3S		MI	3633	1706	5542	1406	6635	1165	7338	967	8289	652	10173	440	7276
12-#10	2.66	MA	3897	1706	5553	1466	6669	1222	7257	1025	7884	692	9685	299	8012
6L-2S		MI	3833	1706	5932	1396	7131	1157	7939	960	9100	642	11268	533	7297
12-#11	3.27	MA	4572	1807	7080	1485	8574	1225	9589	1008	11059	659	13956	439	10643
3L-5S		MI	3511	1807	5360	1480	6295	1228	6888	1009	7637	654	9270	252	8060
12-#11	3.27	MA	4419	1807	6677	1497	8015	1245	8904	1026	10123	665	12781	372	10363
4E		MI	3650	1807	5654	1469	6697	1219	7386	1003	8327	643	10174	319	8439
12-#11	3.27	MA	4228	1807	6318	1510	7523	1256	8294	1035	9276	679	11604	307	9827
5L-3S		MI	3777	1807	5983	1459	7152	1202	7943	988	9089	641	11085	380	8701
12-#11	3.27	MA	4012	1807	5904	1529	7058	1267	7696	1053	8448	685	10454	219	9260
6L-2S		MI	4007	1807	6452	1448	7747	1194	8665	981	10062	630	12368	493	8739
12-#14	4.72	MA	4873	2047	7772	1650	9353	1360	10507	1100	12268	655	15657	257	14051
4E		MI	3995	2047	6530	1618	7763	1331	8660	1072	10030	629	12309	179	11370
12-#14	4.72	MA	4609	2047	7259	1668	8650	1375	9636	1112	11060	674	14005	162	13298
5L-3S		MI	4168	2047	6998	1604	8410	1307	9452	1052	11113	628	13582	265	12146
14-#10	3.11	MA	4594	1780	7013	1475	8533	1219	9562	1006	11042	664	13947	469	10281
3L-6S		MI	3433	1780	5144	1486	6106	1229	6660	1021	7349	672	9016	267	7712
14-#10	3.11	MA	4469	1780	6679	1486	8071	1236	8996	1022	10268	670	12984	416	10185
4L-5S		MI	3578	1780	5417	1471	6421	1222	7064	1008	7897	662	9724	326	7983
14-#10	3.11	MA	4306	1780	6384	1498	7665	1246	8493	1030	9569	683	12015	366	9727
5L-4S		MI	3698	1780	5660	1461	6753	1214	7477	1001	8468	652	10495	380	8329
14-#10	3.11	MA	4128	1780	6036	1512	7282	1256	7999	1046	8886	689	11073	295	9396
6L-3S		MI	3802	1780	5932	1452	7131	1199	7939	988	9100	648	11268	432	8427
14-#10	3.11	MA	3973	1780	5725	1519	6874	1271	7524	1054	8223	701	10154	252	8885
7L-2S		MI	3996	1780	6323	1442	7627	1191	8540	982	9911	638	12364	524	8455
14-#11	3.82	MA	4681	1897	7259	1554	8753	1286	9799	1052	11331	660	14454	366	12021
4L-5S		MI	3718	1897	5829	1537	6890	1269	7610	1035	8611	650	10553	238	9402
14-#11	3.82	MA	4492	1897	6900	1567	8261	1297	9189	1061	10485	675	13277	301	11509
5L-4S		MI	3856	1897	6123	1526	7292	1261	8108	1029	9301	639	11457	305	9761
14-#11	3.82	MA	4285	1897	6486	1585	7796	1308	8591	1079	9657	680	12127	213	10931
6L-3S		MI	3975	1897	6452	1515	7747	1243	8665	1014	10062	637	12368	366	10078
14-#14	5.51	MA	4974	2177	8087	1749	9701	1435	10909	1150	12779	668	16353	150	15667
5L-4S		MI	4299	2177	7195	1700	8606	1391	9683	1110	11411	623	14096	156	13260
16-#10	3.55	MA	4686	1853	7162	1532	8684	1270	9739	1043	11270	667	14371	411	11590
4L-6S		MI	3611	1853	5535	1532	6601	1263	7261	1042	8160	668	10112	259	8818
16-#10	3.55	MA	4525	1853	6866	1544	8278	1280	9235	1052	10572	679	13403	361	11123
5E		MI	3751	1853	5807	1517	6916	1255	7665	1029	8708	658	10819	318	9105
16-#10	3.55	MA	4354	1853	6519	1558	7894	1289	8742	1067	9888	685	12461	290	10784
6L-4S		MI	3870	1853	6051	1507	7249	1247	8078	1022	9280	648	11590	372	9435
16-#10	3.55	MA	4206	1853	6208	1565	7487	1305	8266	1076	9225	698	11542	247	10287
7L-3S		MI	3969	1853	6323	1498	7627	1232	8540	1009	9911	645	12364	424	9577
16-#11	4.36	MA	4750	1988	7482	1623	9000	1338	10084	1088	11693	670	14950	295	13196
5E		MI	3921	1988	6298	1593	7485	1311	8331	1061	9584	645	11837	224	10750

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

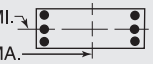
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	4.36	MA	4551	1988	7068	1642	8535	1349	9486	1105	10865	676	13800	207	12606
6L-4S		MI	4058	1988	6592	1582	7888	1302	8829	1055	10275	635	12741	291	11091
18-#10	4.00	MA	4740	1927	7349	1590	8890	1313	9978	1073	11574	676	14791	356	12524
5L-6S		MI	3786	1927	5926	1578	7097	1297	7861	1063	8971	665	11207	250	9929
18-#10	4.00	MA	4575	1927	7002	1604	8507	1323	9484	1088	10891	682	13848	285	12175
6L-5S		MI	3921	1927	6198	1563	7412	1289	8266	1050	9519	655	11914	310	10230
18-#10	4.00	MA	4434	1927	6691	1611	8100	1338	9009	1097	10227	694	12929	242	11691
7L-4S		MI	4040	1927	6441	1553	7745	1281	8678	1044	10091	645	12685	364	10546
18-#11	4.91	MA	4812	2078	7650	1698	9273	1391	10382	1132	12073	672	15473	201	14286
6L-5S		MI	4135	2078	6767	1650	8081	1352	9052	1087	10558	641	13121	211	12102
20-#10	4.44	MA	4792	2000	7484	1650	9120	1357	10227	1110	11893	678	15236	280	13569
6E		MI	3958	2000	6316	1624	7593	1330	8462	1085	9782	661	12302	242	11043
20-#10	4.44	MA	4657	2000	7174	1657	8712	1372	9751	1118	11230	691	14317	238	13097
7L-5S		MI	4088	2000	6589	1609	7908	1322	8867	1071	10330	651	13010	302	11357

RECTANGULAR TIED COLUMNS 22" x 28"

4-#11	1.01	MA	4438	1542	6051	1343	7254	1132	7887	967	8483	719	10188	627	4098
2E		MI	3429	1542	4856	1307	5688	1101	6113	940	6492	698	7593	593	3152
4-#14	1.46	MA	4678	1622	6636	1386	7960	1162	8725	985	9599	711	11723	618	5757
2E		MI	3594	1622	5287	1348	6201	1130	6719	957	7296	689	8577	568	4379
4-#18	2.60	MA	5235	1825	8051	1499	9687	1243	10784	1033	12349	694	15337	582	9800
2E		MI	3969	1825	6312	1458	7439	1208	8188	1002	9253	669	10864	493	7325
6-#10	1.24	MA	4593	1582	6301	1377	7619	1158	8355	985	9136	723	11109	629	4988
2L-3S		MI	3318	1582	4646	1354	5467	1138	5868	967	6181	713	7248	509	3829
6-#10	1.24	MA	4281	1582	5772	1389	6948	1168	7542	995	8038	737	9589	541	4991
3L-2S		MI	3544	1582	5036	1344	5963	1130	6469	961	6992	703	8344	602	3815
6-#11	1.52	MA	4732	1633	6690	1399	8064	1173	8869	993	9809	715	12024	621	6014
2L-3S		MI	3372	1633	4856	1374	5688	1151	6113	973	6492	705	7593	465	4584
6-#11	1.52	MA	4366	1633	6051	1413	7254	1185	7887	1003	8483	731	10188	510	6006
3L-2S		MI	3636	1633	5325	1364	6283	1142	6835	966	7466	694	8876	579	4573
6-#14	2.19	MA	5081	1753	7545	1468	9114	1222	10124	1022	11487	705	14337	609	8470
2L-3S		MI	3520	1753	5287	1444	6201	1201	6719	1002	7296	697	8577	381	6353
6-#14	2.19	MA	4587	1753	6636	1486	7960	1238	8725	1036	9599	727	11723	447	8404
3L-2S		MI	3875	1753	5951	1430	7045	1190	7741	994	8676	683	10364	544	6376
6-#18	3.90	MA	5886	2057	9627	1644	11687	1349	13208	1100	15621	683	19782	558	14468
2L-3S		MI	3886	2057	6312	1624	7439	1329	8188	1078	9253	676	10864	146	10437
6-#18	3.90	MA	5117	2057	8051	1675	9687	1375	10784	1121	12349	716	15337	268	14106
3L-2S		MI	4414	2057	7453	1603	8887	1314	9943	1069	11622	658	13819	437	10709
8-#8	1.03	MA	4480	1545	6003	1360	7276	1146	7956	979	8614	729	10397	635	4197
2L-4S		MI	3239	1545	4394	1341	5161	1135	5510	969	5707	719	6695	525	3244
8-#8	1.03	MA	4280	1545	5670	1368	6854	1153	7445	985	7923	738	9440	581	4204
3E		MI	3322	1545	4566	1335	5399	1125	5801	960	6105	717	7190	558	3236
8-#8	1.03	MA	4168	1545	5442	1375	6537	1164	7057	996	7392	742	8788	549	4201
4L-2S		MI	3467	1545	4813	1329	5712	1120	6181	956	6617	710	7893	615	3226
8-#9	1.30	MA	4639	1593	6368	1388	7723	1166	8489	991	9326	724	11377	630	5242
2L-4S		MI	3299	1593	4558	1371	5349	1157	5729	983	5994	717	7082	492	4013
8-#9	1.30	MA	4395	1593	5949	1397	7191	1174	7845	999	8456	736	10173	562	5243
3E		MI	3401	1593	4775	1363	5648	1145	6096	972	6495	714	7700	534	4015
8-#9	1.30	MA	4257	1593	5662	1407	6792	1188	7356	1012	7787	741	9350	520	5220
4L-2S		MI	3579	1593	5085	1355	6041	1138	6573	967	7139	705	8577	606	4006
8-#10	1.65	MA	4837	1656	6830	1423	8290	1192	9168	1007	10234	719	12629	624	6569
2L-4S		MI	3375	1656	4764	1409	5585	1186	6007	1002	6360	713	7570	449	4968
8-#10	1.65	MA	4538	1656	6301	1435	7619	1202	8355	1016	9136	733	11109	537	6557
3E		MI	3499	1656	5036	1400	5963	1171	6469	988	6992	710	8344	501	4994
8-#10	1.65	MA	4370	1656	5937	1447	7115	1220	7737	1032	8291	740	10065	484	6491
4L-2S		MI	3717	1656	5427	1390	6459	1163	7070	982	7803	700	9439	594	4991

RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis



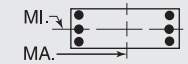
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	2.03	MA	5017	1723	7328	1456	8874	1214	9851	1019	11134	711	13859	615	7919
2L-4S		MI	3438	1723	4996	1441	5828	1209	6278	1014	6705	702	7965	390	5913
8-#11	2.03	MA	4669	1723	6690	1470	8064	1226	8869	1029	9809	726	12024	504	7891
3E		MI	3584	1723	5325	1431	6283	1192	6835	999	7466	700	8876	452	5974
8-#11	2.03	MA	4473	1723	6249	1483	7453	1247	8120	1048	8785	734	10750	439	7767
4L-2S		MI	3837	1723	5794	1420	6879	1184	7556	992	8440	689	10160	565	5980
8-#14	2.92	MA	5470	1883	8454	1549	10268	1282	11523	1060	13376	699	16951	601	11169
2L-4S		MI	3617	1883	5483	1540	6398	1284	6949	1060	7594	692	9090	271	7755
8-#14	2.92	MA	5005	1883	7545	1568	9114	1298	10124	1074	11487	720	14337	439	11073
3E		MI	3812	1883	5951	1526	7045	1260	7741	1040	8676	690	10364	357	8302
8-#14	2.92	MA	4744	1883	6915	1587	8242	1327	9055	1100	10026	729	12508	343	10339
4L-2S		MI	4149	1883	6616	1511	7889	1249	8764	1032	10056	677	12152	520	8356
8-#18	5.19	MA	5843	2289	9627	1820	11687	1481	13208	1188	15621	705	19782	245	18717
3E		MI	4366	2289	7453	1769	8887	1435	9943	1145	11622	665	13819	89	13527
8-#18	5.19	MA	5412	2289	8529	1850	10167	1529	11347	1231	13076	716	16647	79	16183
4L-2S		MI	4845	2289	8594	1748	10335	1420	11698	1136	13990	647	16775	380	14076
10-#10	2.06	MA	5075	1730	7358	1469	8961	1225	9982	1028	11332	716	14149	619	8142
2L-5S		MI	3435	1730	4911	1465	5749	1228	6195	1029	6600	720	7894	387	5835
10-#10	2.06	MA	4787	1730	6830	1481	8290	1236	9168	1037	10234	730	12629	532	8120
3L-4S		MI	3558	1730	5154	1455	6081	1220	6608	1023	7172	710	8665	441	6112
10-#10	2.06	MA	4630	1730	6466	1493	7786	1253	8550	1053	9389	737	11586	479	8041
4L-3S		MI	3676	1730	5427	1446	6459	1205	7070	1009	7803	706	9439	493	6152
10-#10	2.06	MA	4441	1730	6144	1505	7344	1264	8001	1063	8627	750	10533	431	7643
5L-2S		MI	3886	1730	5818	1436	6955	1197	7671	1003	8614	696	10534	585	6159
10-#11	2.53	MA	5296	1814	7967	1512	9685	1256	10833	1045	12460	706	15695	609	9815
2L-5S		MI	3513	1814	5171	1509	6021	1259	6501	1046	6988	709	8345	310	6817
10-#11	2.53	MA	4962	1814	7328	1526	8874	1268	9851	1055	11134	722	13859	498	9773
3L-4S		MI	3654	1814	5465	1498	6424	1251	6999	1040	7678	698	9249	377	7231
10-#11	2.53	MA	4780	1814	6888	1540	8263	1288	9102	1074	10110	729	12586	433	9634
4L-3S		MI	3791	1814	5794	1487	6879	1234	7556	1025	8440	696	10160	438	7358
10-#11	2.53	MA	4560	1814	6496	1553	7727	1300	8437	1085	9186	745	11305	371	8980
5L-2S		MI	4034	1814	6263	1477	7474	1225	8277	1018	9413	685	11444	551	7378
10-#14	3.65	MA	5409	2014	8454	1650	10268	1357	11523	1112	13376	714	16951	430	13743
3L-4S		MI	3917	2014	6148	1622	7241	1344	7971	1098	8974	685	10878	247	9615
10-#14	3.65	MA	5172	2014	7825	1668	9396	1386	10454	1138	11914	723	15123	334	12936
4L-3S		MI	4097	2014	6616	1607	7889	1320	8764	1077	10056	684	12152	333	10249
10-#14	3.65	MA	4867	2014	7265	1687	8628	1403	9502	1152	10593	744	13288	242	12113
5L-2S		MI	4418	2014	7281	1593	8732	1309	9786	1070	11437	670	13940	497	10325
10-#18	6.49	MA	6184	2521	10104	1995	12167	1635	13771	1298	16348	705	21092	56	20747
4L-3S		MI	4829	2521	8594	1914	10335	1541	11698	1212	13990	654	16775	33	16657
12-#10	2.47	MA	5308	1803	7887	1515	9632	1259	10795	1049	12430	712	15669	614	9712
2L-6S		MI	3465	1803	5029	1526	5929	1269	6392	1064	6863	726	8282	320	6730
12-#10	2.47	MA	5030	1803	7358	1527	8961	1269	9982	1058	11332	726	14149	527	9681
3L-5S		MI	3616	1803	5302	1511	6244	1261	6796	1050	7411	716	8990	379	6946
12-#10	2.47	MA	4883	1803	6995	1539	8457	1287	9364	1075	10487	733	13106	474	9593
4E		MI	3738	1803	5545	1501	6577	1253	7209	1044	7983	706	9761	433	7256
12-#10	2.47	MA	4696	1803	6673	1551	8015	1297	8815	1084	9724	747	12053	426	9167
5L-3S		MI	3849	1803	5818	1492	6955	1238	7671	1031	8614	703	10534	485	7306
12-#10	2.47	MA	4492	1803	6287	1565	7598	1308	8277	1100	8979	754	11032	356	8819
6L-2S		MI	4052	1803	6208	1482	7450	1231	8272	1024	9426	693	11630	577	7322
12-#11	3.04	MA	5248	1904	7967	1583	9685	1309	10833	1082	12460	718	15695	492	11653
3L-5S		MI	3725	1904	5640	1565	6617	1301	7222	1072	7962	705	9629	296	8152
12-#11	3.04	MA	5078	1904	7526	1596	9074	1330	10085	1101	11436	725	14421	427	11458
4E		MI	3865	1904	5934	1555	7019	1292	7720	1066	8652	694	10533	363	8541

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	3.04	MA	4861	1904	7135	1610	8537	1342	9419	1111	10512	741	13140	365	10823
5L-3S		MI	3993	1904	6263	1544	7474	1275	8277	1051	9413	692	11444	424	8738
12-#11	3.04	MA	4621	1904	6675	1628	8030	1354	8766	1130	9608	748	11893	278	10267
6L-2S		MI	4227	1904	6732	1533	8069	1266	8998	1044	10387	681	12727	538	8770
12-#14	4.38	MA	5587	2144	8734	1750	10550	1446	11853	1176	13802	717	17737	326	15546
4E		MI	4208	2144	6812	1703	8085	1403	8994	1135	10354	679	12666	223	11489
12-#14	4.38	MA	5286	2144	8174	1769	9782	1462	10901	1189	12481	738	15902	233	14762
5L-3S		MI	4386	2144	7281	1689	8732	1380	9786	1115	11437	678	13940	309	12195
12-#14	4.38	MA	4963	2144	7525	1795	9057	1479	9968	1216	11190	747	14112	107	13543
6L-2S		MI	4673	2144	7946	1674	9576	1369	10809	1107	12817	664	15727	473	12289
14-#10	2.89	MA	5269	1877	7887	1573	9632	1303	10795	1080	12430	723	15669	522	11241
3L-6S		MI	3647	1877	5420	1572	6425	1303	6993	1085	7674	723	9378	311	7839
14-#10	2.89	MA	5130	1877	7524	1585	9128	1321	10177	1096	11585	730	14626	469	11145
4L-5S		MI	3793	1877	5693	1557	6740	1295	7397	1072	8222	713	10085	371	8061
14-#10	2.89	MA	4945	1877	7202	1597	8686	1331	9628	1105	10822	743	13573	422	10695
5L-4S		MI	3914	1877	5936	1547	7073	1287	7810	1065	8794	703	10856	425	8400
14-#10	2.89	MA	4749	1877	6816	1611	8269	1342	9091	1121	10077	750	12552	351	10362
6L-3S		MI	4019	1877	6208	1538	7450	1272	8272	1052	9426	699	11630	477	8459
14-#10	2.89	MA	4577	1877	6477	1618	7816	1356	8573	1131	9354	764	11555	312	9804
7L-2S		MI	4216	1877	6599	1528	7946	1264	8873	1046	10237	689	12725	569	8482
14-#11	3.55	MA	5370	1995	8165	1653	9884	1371	11067	1127	12762	721	16257	421	13282
4L-5S		MI	3933	1995	6109	1622	7212	1342	7943	1099	8935	700	10912	282	9492
14-#11	3.55	MA	5155	1995	7773	1666	9347	1383	10401	1137	11837	736	14976	359	12673
5L-4S		MI	4071	1995	6403	1611	7614	1333	8441	1092	9626	689	11816	349	9861
14-#11	3.55	MA	4925	1995	7314	1684	8840	1395	9748	1156	10934	743	13729	272	12108
6L-3S		MI	4192	1995	6732	1600	8069	1316	8998	1077	10387	687	12727	411	10117
14-#11	3.55	MA	4725	1995	6903	1693	8302	1414	9119	1166	10056	759	12514	220	11457
7L-2S		MI	4418	1995	7201	1590	8664	1308	9720	1071	11360	676	14011	524	10159
14-#14	5.11	MA	5693	2275	9084	1850	10937	1522	12300	1227	14370	732	18517	225	17417
5L-4S		MI	4514	2275	7477	1785	8929	1463	10016	1173	11735	673	14453	200	13375
14-#14	5.11	MA	5387	2275	8435	1877	10211	1538	11367	1253	13078	741	16727	98	16191
6L-3S		MI	4655	2275	7946	1770	9576	1439	10809	1153	12817	672	15727	286	14141
16-#10	3.30	MA	5372	1950	8052	1631	9799	1354	10990	1117	12682	726	16146	464	12699
4L-6S		MI	3825	1950	5811	1618	6921	1337	7594	1106	8485	719	10473	303	8942
16-#10	3.30	MA	5189	1950	7730	1643	9357	1365	10441	1126	11920	740	15093	417	12228
5E		MI	3966	1950	6083	1603	7236	1329	7998	1093	9033	709	11180	363	9181
16-#10	3.30	MA	4999	1950	7345	1657	8940	1375	9904	1143	11175	747	14072	346	11907
6L-4S		MI	4086	1950	6327	1593	7569	1321	8411	1087	9605	699	11951	417	9522
16-#10	3.30	MA	4836	1950	7006	1664	8487	1390	9386	1152	10452	761	13075	307	11343
7L-3S		MI	4187	1950	6599	1584	7946	1306	8873	1073	10237	696	12725	469	9610
16-#10	3.30	MA	4677	1950	6679	1673	8050	1397	8862	1168	9742	774	12115	253	10777
8L-2S		MI	4377	1950	6990	1574	8442	1298	9474	1067	11048	686	13820	561	9640
16-#11	4.05	MA	5442	2085	8412	1723	10157	1424	11383	1163	13163	732	16811	353	14527
5E		MI	4136	2085	6578	1678	7807	1383	8664	1125	9909	696	12196	269	10838
16-#11	4.05	MA	5222	2085	7952	1741	9650	1436	10731	1182	12259	739	15565	266	13953
6L-4S		MI	4273	2085	6872	1668	8209	1375	9163	1118	10599	685	13100	335	11188
16-#11	4.05	MA	5031	2085	7541	1749	9112	1455	10101	1193	11382	755	14349	214	13313
7L-3S		MI	4398	2085	7201	1657	8664	1358	9720	1103	11360	683	14011	397	11495
16-#14	5.84	MA	5800	2405	9344	1958	11365	1598	12766	1291	14966	735	19341	89	18843
6L-4S		MI	4792	2405	8142	1866	9772	1522	11039	1211	13115	667	16241	176	15270
18-#10	3.71	MA	5428	2024	8259	1689	10028	1398	11255	1148	13018	736	16613	412	13764
5L-6S		MI	4000	2024	6202	1664	7417	1370	8195	1128	9297	716	11568	295	10049
18-#10	3.71	MA	5245	2024	7874	1703	9611	1409	10717	1164	12273	743	15592	342	13453
6L-5S		MI	4137	2024	6474	1649	7732	1362	8599	1114	9845	706	12276	355	10304
18-#10	3.71	MA	5089	2024	7535	1710	9158	1424	10199	1173	11550	757	14595	302	12885
7L-4S		MI	4256	2024	6717	1639	8065	1354	9012	1108	10416	696	13047	409	10631
18-#10	3.71	MA	4932	2024	7208	1719	8721	1430	9675	1189	10840	771	13635	248	12321
8L-3S		MI	4352	2024	6990	1630	8442	1339	9474	1094	11048	692	13820	461	10760

RECTANGULAR TIED COLUMNS 22" x 28"

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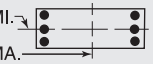
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

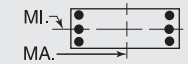
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
18-#11	4.56	MA	5512	2175	8591	1797	10461	1478	11713	1208	13585	735	17400	260	15801
6L-5S		MI	4337	2175	7047	1735	8402	1425	9386	1151	10883	692	13480	255	12187
18-#11	4.56	MA	5331	2175	8180	1806	9922	1496	11083	1219	12708	751	16185	208	15180
7L-4S		MI	4489	2175	7341	1724	8804	1416	9884	1144	11573	681	14384	322	12521
20-#10	4.12	MA	5486	2098	8403	1749	10282	1442	11531	1185	13371	740	17113	337	14984
6E		MI	4173	2098	6592	1710	7913	1404	8796	1149	10108	712	12663	287	11160
20-#10	4.12	MA	5336	2098	8063	1756	9829	1457	11013	1194	12648	754	16115	297	14429
7L-5S		MI	4305	2098	6865	1695	8228	1396	9200	1135	10656	702	13371	347	11431
20-#10	4.12	MA	5182	2098	7737	1765	9392	1464	10488	1210	11938	767	15155	244	13867
8L-4S		MI	4424	2098	7108	1685	8561	1388	9613	1129	11228	692	14142	400	11744
20-#11	5.06	MA	5625	2266	8818	1862	10732	1538	12065	1245	14033	746	18020	202	17044
7L-5S		MI	4548	2266	7516	1791	8997	1466	10107	1177	11856	687	14764	241	13540
22-#10	4.54	MA	5580	2171	8592	1802	10500	1491	11826	1216	13746	750	17635	292	15975
7L-6S		MI	4343	2171	6983	1756	8409	1437	9397	1170	10919	709	13759	279	12274
22-#10	4.54	MA	5427	2171	8266	1811	10064	1498	11302	1231	13036	764	16675	239	15414
8L-5S		MI	4472	2171	7256	1741	8724	1430	9801	1157	11467	699	14466	339	12560

RECTANGULAR TIED COLUMNS 22" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.36	MA	5337	1720	7446	1483	8974	1245	9845	1057	10812	769	13188	668	6243
2E		MI	3809	1720	5569	1433	6524	1202	7053	1020	7620	739	8934	612	4404
4-#18	2.42	MA	5958	1922	8996	1596	10867	1326	12101	1105	13825	751	17334	648	10664
2E		MI	4187	1922	6600	1541	7764	1279	8522	1064	9575	718	11218	537	7361
6-#10	1.15	MA	5239	1680	7076	1475	8596	1241	9434	1058	10298	781	12505	679	5400
2L-3S		MI	3532	1680	4922	1440	5787	1211	6201	1031	6506	764	7610	554	3850
6-#10	1.15	MA	4895	1680	6501	1487	7867	1252	8550	1068	9104	795	10853	594	5402
3L-2S		MI	3759	1680	5312	1430	6282	1203	6802	1025	7318	754	8705	647	3835
6-#11	1.42	MA	5394	1730	7502	1497	9084	1256	9998	1065	11035	772	13509	671	6520
2L-3S		MI	3587	1730	5136	1460	6010	1224	6447	1036	6817	755	7951	510	4612
6-#11	1.42	MA	4991	1730	6807	1511	8202	1269	8929	1076	9592	789	11511	563	6512
3L-2S		MI	3852	1730	5605	1449	6605	1215	7168	1030	7791	744	9235	623	4597
6-#14	2.05	MA	5783	1850	8437	1565	10232	1305	11369	1095	12870	763	16036	660	9199
2L-3S		MI	3734	1850	5569	1529	6524	1273	7053	1065	7620	747	8934	425	6392
6-#14	2.05	MA	5237	1850	7446	1585	8974	1322	9845	1110	10812	786	13188	502	9133
3L-2S		MI	4092	1850	6234	1514	7367	1262	8075	1057	9000	733	10722	588	6405
6-#18	3.64	MA	6680	2154	10717	1741	13050	1432	14748	1172	17398	740	22280	632	15764
2L-3S		MI	4099	2154	6600	1708	7764	1400	8522	1140	9575	725	11218	189	10552
6-#18	3.64	MA	5827	2154	8996	1774	10867	1460	12101	1196	13825	777	17334	342	15402
3L-2S		MI	4636	2154	7741	1686	9212	1385	10277	1131	11944	707	14173	480	10751
8-#9	1.21	MA	5289	1691	7148	1485	8708	1249	9579	1063	10502	782	12794	680	5674
2L-4S		MI	3513	1691	4833	1457	5668	1231	6062	1047	6320	768	7444	537	4039
8-#9	1.21	MA	5019	1691	6693	1495	8130	1258	8878	1071	9557	794	11486	614	5675
3E		MI	3615	1691	5049	1450	5967	1219	6429	1037	6821	765	8062	578	4035
8-#9	1.21	MA	4869	1691	6382	1505	7698	1272	8349	1085	8832	800	10599	573	5652
4L-2S		MI	3794	1691	5359	1442	6360	1212	6906	1031	7465	756	8939	651	4024
8-#10	1.54	MA	5508	1753	7651	1521	9326	1275	10318	1079	11491	777	14158	675	7117
2L-4S		MI	3588	1753	5040	1495	5905	1260	6340	1066	6686	764	7931	494	5001
8-#10	1.54	MA	5178	1753	7076	1533	8596	1286	9434	1089	10298	792	12505	589	7106
3E		MI	3714	1753	5312	1486	6282	1245	6802	1052	7318	761	8705	546	5019
8-#10	1.54	MA	4994	1753	6682	1545	8050	1304	8764	1106	9381	799	11382	537	7040
4L-2S		MI	3933	1753	5703	1476	6778	1237	7403	1046	8129	751	9800	638	5012
8-#11	1.89	MA	5710	1820	8197	1553	9966	1297	11067	1091	12478	768	15507	665	8593
2L-4S		MI	3652	1820	5276	1527	6150	1282	6611	1077	7029	753	8324	435	5959
8-#11	1.89	MA	5325	1820	7502	1568	9084	1310	9998	1103	11035	785	13509	557	8565
3E		MI	3799	1820	5605	1516	6605	1265	7168	1062	7791	751	9235	496	6006
8-#11	1.89	MA	5110	1820	7024	1582	8421	1331	9185	1122	9924	793	12136	493	8441
4L-2S		MI	4054	1820	6074	1505	7200	1256	7889	1056	8764	740	10519	609	6006

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

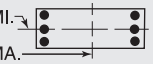
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#14	2.73	MA	6214	1980	9428	1646	11489	1364	12893	1132	14927	756	18885	651	12141
2L-4S		MI	3829	1980	5765	1625	6720	1356	7283	1123	7918	742	9448	315	7880
8-#14	2.73	MA	5699	1980	8437	1666	10232	1382	11369	1148	12870	780	16036	493	12045
3E		MI	4027	1980	6234	1610	7367	1333	8075	1103	9000	740	10722	401	8346
8-#14	2.73	MA	5412	1980	7753	1686	9284	1412	10208	1175	11282	790	14065	399	11369
4L-2S		MI	4368	1980	6899	1596	8211	1322	9098	1095	10380	727	12509	564	8388
8-#18	4.85	MA	6593	2386	10717	1919	13050	1566	14748	1263	17398	766	22280	326	20445
3E		MI	4580	2386	7741	1853	9212	1506	10277	1207	11944	714	14173	133	13733
8-#18	4.85	MA	6156	2386	9523	1952	11397	1617	12723	1309	14629	780	18806	156	17815
4L-2S		MI	5069	2386	8882	1831	10660	1491	12032	1198	14313	696	17128	423	14121
10-#10	1.92	MA	5771	1827	8226	1567	10055	1308	11202	1100	12685	773	15810	670	8828
2L-5S		MI	3649	1827	5187	1551	6068	1301	6529	1093	6925	771	8256	432	5915
10-#10	1.92	MA	5453	1827	7651	1579	9326	1319	10318	1110	11491	788	14158	584	8806
3L-4S		MI	3772	1827	5430	1541	6401	1293	6941	1087	7497	761	9027	486	6149
10-#10	1.92	MA	5281	1827	7257	1591	8780	1337	9648	1127	10575	796	13034	532	8727
4L-3S		MI	3892	1827	5703	1532	6778	1278	7403	1073	8129	757	9800	538	6180
10-#10	1.92	MA	5070	1827	6909	1603	8301	1348	9054	1137	9749	811	11897	487	8349
5L-2S		MI	4103	1827	6094	1522	7274	1270	8004	1067	8940	747	10895	630	6182
10-#11	2.36	MA	6018	1911	8892	1610	10848	1339	12136	1117	13921	764	17505	659	10658
2L-5S		MI	3727	1911	5451	1594	6343	1332	6834	1110	7313	759	8704	354	6908
10-#11	2.36	MA	5649	1911	8197	1624	9966	1351	11067	1129	12478	781	15507	551	10615
3L-4S		MI	3868	1911	5745	1583	6745	1323	7332	1103	8003	749	9608	421	7328
10-#11	2.36	MA	5449	1911	7719	1638	9303	1373	10255	1149	11367	789	14134	487	10477
4L-3S		MI	4007	1911	6074	1573	7200	1306	7889	1088	8764	746	10519	482	7392
10-#11	2.36	MA	5202	1911	7296	1653	8722	1386	9533	1160	10365	806	12750	428	9818
5L-2S		MI	4252	1911	6543	1562	7795	1298	8611	1082	9738	736	11803	596	7407
10-#14	3.41	MA	6146	2111	9428	1748	11489	1442	12893	1185	14927	773	18885	484	14958
3L-4S		MI	4129	2111	6430	1706	7564	1416	8305	1161	9298	736	11235	291	9735
10-#14	3.41	MA	5884	2111	8744	1768	10542	1472	11733	1213	13339	784	16913	390	14209
4L-3S		MI	4313	2111	6899	1692	8211	1392	9098	1140	10380	734	12509	377	10294
10-#14	3.41	MA	5542	2111	8138	1788	9710	1489	10700	1228	11906	807	14929	302	13259
5L-2S		MI	4638	2111	7564	1678	9055	1381	10120	1133	11761	720	14297	541	10360
10-#18	6.06	MA	6949	2618	11244	2097	13581	1723	15370	1376	18201	769	23752	140	22814
4L-3S		MI	5045	2618	8882	1998	10660	1612	12032	1274	14313	703	17128	76	16854
10-#18	6.06	MA	6379	2618	10182	2130	12126	1751	13565	1400	15698	806	20272	-27	20181
5L-2S		MI	5494	2618	10023	1976	12108	1597	13787	1265	16682	685	20084	367	17482
12-#10	2.31	MA	6028	1900	8800	1613	10785	1342	12086	1121	13878	770	17463	665	10535
2L-6S		MI	3678	1900	5305	1612	6249	1343	6725	1128	7189	777	8643	364	6808
12-#10	2.31	MA	5722	1900	8226	1625	10055	1353	11202	1131	12685	785	15810	579	10504
3L-5S		MI	3830	1900	5578	1597	6564	1335	7130	1114	7737	767	9351	424	7023
12-#10	2.31	MA	5559	1900	7832	1637	9509	1371	10532	1148	11768	792	14687	527	10416
4E		MI	3952	1900	5821	1587	6897	1327	7542	1108	8308	757	10122	478	7294
12-#10	2.31	MA	5351	1900	7484	1649	9030	1382	9938	1158	10943	807	13549	482	10008
5L-3S		MI	4065	1900	6094	1578	7274	1312	8004	1095	8940	754	10895	530	7336
12-#10	2.31	MA	5126	1900	7061	1663	8579	1393	9357	1175	10136	815	12450	412	9614
6L-2S		MI	4271	1900	6485	1568	7770	1304	8605	1088	9751	744	11991	622	7348
12-#11	2.84	MA	5965	2001	8892	1681	10848	1393	12136	1155	13921	776	17505	546	12664
3L-5S		MI	3940	2001	5920	1651	6938	1373	7556	1136	8286	755	9988	340	8240
12-#11	2.84	MA	5778	2001	8414	1695	10185	1414	11324	1175	12810	785	16132	481	12515
4E		MI	4079	2001	6214	1640	7340	1365	8054	1129	8977	744	10891	407	8641
12-#11	2.84	MA	5534	2001	7991	1709	9604	1427	10602	1186	11808	802	14748	422	11829
5L-3S		MI	4210	2001	6543	1629	7795	1348	8611	1114	9738	742	11803	469	8775
12-#11	2.84	MA	5270	2001	7485	1727	9055	1440	9895	1206	10828	810	13405	336	11293
6L-2S		MI	4447	2001	7012	1618	8390	1339	9332	1108	10711	731	13086	582	8801

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis

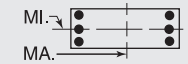


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	4.09	MA	6342	2241	9735	1849	11799	1531	13257	1251	15397	778	19762	382	17061
4E		MI	4422	2241	7095	1788	8407	1475	9328	1198	10678	729	13023	267	11605
12-#14	4.09	MA	6003	2241	9129	1869	10967	1549	12225	1266	13964	801	17778	294	16152
5L-3S		MI	4592	2241	7564	1773	9055	1452	10120	1178	11761	728	14297	353	12242
12-#14	4.09	MA	5648	2241	8413	1895	10182	1567	11214	1294	12563	812	15849	168	14899
6L-2S		MI	4897	2241	8228	1759	9898	1441	11143	1170	13141	714	16084	517	12326
12-#18	7.27	MA	7204	2850	11903	2275	14310	1857	16212	1466	19271	795	25218	-43	25002
5L-3S		MI	5498	2850	10023	2143	12108	1718	13787	1341	16682	692	20084	20	20008
14-#10	2.69	MA	5985	1974	8800	1671	10785	1387	12086	1153	13878	781	17463	574	12201
3L-6S		MI	3860	1974	5696	1658	6745	1376	7326	1149	8000	774	9739	356	7932
14-#10	2.69	MA	5832	1974	8407	1683	10239	1405	11417	1170	12962	789	16339	522	12106
4L-5S		MI	4008	1974	5969	1643	7060	1368	7731	1136	8548	764	10446	416	8137
14-#10	2.69	MA	5625	1974	8058	1695	9760	1416	10822	1180	12136	804	15202	477	11673
5L-4S		MI	4129	1974	6212	1633	7393	1361	8143	1129	9120	754	11217	470	8439
14-#10	2.69	MA	5409	1974	7635	1709	9308	1427	10241	1197	11330	811	14103	407	11294
6L-3S		MI	4236	1974	6485	1624	7770	1346	8605	1116	9751	750	11991	522	8489
14-#10	2.69	MA	5221	1974	7268	1717	8810	1441	9680	1206	10547	826	13027	370	10735
7L-2S		MI	4435	1974	6875	1614	8266	1338	9206	1110	10562	740	13086	614	8509
14-#11	3.31	MA	6100	2092	9110	1751	11067	1455	12393	1201	14253	780	18131	475	14556
4L-5S		MI	4148	2092	6389	1707	7533	1415	8277	1162	9260	751	11271	327	9579
14-#11	3.31	MA	5858	2092	8686	1766	10486	1468	11671	1212	13251	797	16746	416	13846
5L-4S		MI	4285	2092	6683	1696	7935	1406	8775	1156	9950	740	12175	393	9958
14-#11	3.31	MA	5606	2092	8180	1783	9937	1481	10964	1232	12271	806	15403	330	13305
6L-3S		MI	4409	2092	7012	1686	8390	1389	9332	1140	10711	738	13086	455	10155
14-#11	3.31	MA	5385	2092	7734	1792	9343	1499	10283	1243	11321	823	14091	281	12557
7L-2S		MI	4638	2092	7481	1675	8985	1380	10053	1134	11685	727	14370	568	10191
14-#14	4.77	MA	6452	2372	10120	1951	12225	1609	13749	1304	16021	795	20627	285	19051
5L-4S		MI	4729	2372	7760	1869	9251	1535	10350	1236	12059	723	14811	244	13487
14-#14	4.77	MA	6115	2372	9404	1976	11439	1626	12738	1332	14620	806	18697	160	17795
6L-3S		MI	4875	2372	8228	1855	9898	1511	11143	1216	13141	722	16084	330	14189
16-#10	3.08	MA	6098	2048	8982	1729	10968	1438	12301	1191	14155	785	17991	517	13797
4L-6S		MI	4039	2048	6087	1704	7241	1410	7927	1170	8811	770	10834	348	9059
16-#10	3.08	MA	5893	2048	8633	1741	10489	1449	11706	1201	13330	800	16854	472	13341
5E		MI	4182	2048	6359	1689	7556	1402	8332	1157	9359	760	11542	408	9255
16-#10	3.08	MA	5685	2048	8210	1755	10038	1461	11125	1218	12523	808	15755	402	12975
6L-4S		MI	4302	2048	6603	1679	7889	1394	8744	1151	9931	750	12313	461	9584
16-#10	3.08	MA	5506	2048	7842	1763	9540	1475	10564	1228	11740	823	14679	365	12413
7L-3S		MI	4405	2048	6875	1670	8266	1379	9206	1137	10562	747	13086	513	9642
16-#10	3.08	MA	5328	2048	7489	1772	9067	1482	9986	1243	10972	837	13643	314	11846
8L-2S		MI	4598	2048	7266	1660	8762	1371	9807	1131	11374	737	14181	606	9667
16-#11	3.78	MA	6175	2182	9381	1822	11368	1510	12740	1238	14694	793	18744	410	15867
5E		MI	4352	2182	6858	1764	8128	1456	8998	1188	10234	746	12555	313	10922
16-#11	3.78	MA	5933	2182	8875	1840	10819	1522	12033	1258	13714	801	17401	324	15320
6L-4S		MI	4489	2182	7152	1753	8530	1447	9496	1182	10924	736	13459	380	11282
16-#11	3.78	MA	5723	2182	8429	1849	10225	1541	11352	1269	12764	818	16089	275	14590
7L-3S		MI	4606	2182	7481	1742	8985	1430	10053	1167	11685	733	14370	441	11534
16-#14	5.45	MA	6570	2502	10395	2058	12697	1686	14262	1369	16677	799	21546	151	20695
6L-4S		MI	5008	2502	8425	1951	10095	1595	11373	1274	13439	717	16598	220	15379
18-#10	3.46	MA	6157	2121	9208	1787	11219	1483	12591	1222	14523	797	18507	467	15013
5L-6S		MI	4215	2121	6478	1750	7737	1444	8528	1192	9622	767	11929	340	10166
18-#10	3.46	MA	5956	2121	8785	1801	10767	1494	12009	1239	13716	804	17408	397	14660
6L-5S		MI	4353	2121	6750	1735	8052	1436	8933	1178	10170	757	12637	400	10377
18-#10	3.46	MA	5784	2121	8417	1809	10269	1509	11448	1249	12934	819	16332	360	14093
7L-4S		MI	4473	2121	6993	1725	8384	1428	9345	1172	10742	747	13408	453	10715
18-#10	3.46	MA	5609	2121	8064	1818	9796	1516	10871	1264	12165	834	15296	309	13529
8L-3S		MI	4571	2121	7266	1716	8762	1413	9807	1159	11374	743	14181	505	10793
18-#11	4.25	MA	6253	2273	9570	1896	11701	1564	13102	1284	15158	797	19399	318	17338
6L-5S		MI	4553	2273	7327	1820	8723	1497	9719	1214	11207	742	13839	299	12270

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	4.25	MA	6053	2273	9124	1905	11107	1582	12421	1296	14207	814	18087	269	16626
7L-4S		MI	4689	2273	7621	1809	9125	1489	10217	1208	11897	731	14743	366	12613
20-#10	3.85	MA	6221	2195	9360	1847	11497	1528	12893	1260	14910	801	19060	393	16346
6E		MI	4388	2195	6868	1796	8233	1477	9129	1213	10434	763	13025	332	11274
20-#10	3.85	MA	6056	2195	8992	1855	10999	1542	12333	1270	14127	815	17984	355	15775
7L-5S		MI	4523	2195	7141	1781	8547	1469	9534	1199	10981	753	13732	391	11502
20-#10	3.85	MA	5883	2195	8638	1864	10526	1550	11755	1285	13359	830	16948	304	15212
8L-4S		MI	4641	2195	7384	1771	8880	1461	9946	1193	11553	743	14503	445	11826
20-#11	4.73	MA	6377	2363	9819	1962	11989	1623	13490	1322	15650	810	20085	263	18664
7L-5S		MI	4766	2363	7796	1877	9318	1539	10441	1240	12181	738	15122	286	13621
22-#10	4.23	MA	6324	2269	9567	1901	11728	1576	13217	1292	15321	812	19637	350	17459
7L-6S		MI	4559	2269	7259	1843	8728	1511	9730	1234	11245	760	14120	324	12386
22-#10	4.23	MA	6153	2269	9213	1910	11255	1583	12639	1307	14552	827	18601	299	16894
8L-5S		MI	4690	2269	7532	1827	9043	1503	10135	1221	11793	750	14828	383	12629
24-#10	4.62	MA	6418	2342	9788	1956	11984	1617	13523	1328	15746	823	20253	294	18577
8L-6S		MI	4728	2342	7650	1889	9224	1545	10331	1255	12056	756	15215	315	13500

RECTANGULAR TIED COLUMNS 22" x 32"

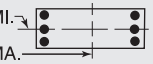
4-#14	1.28	MA	6035	1817	8295	1581	10041	1328	11024	1129	12086	826	14723	719	6729
2E		MI	4025	1817	5852	1518	6846	1275	7386	1083	7944	789	9291	656	4429
4-#18	2.27	MA	6723	2020	9980	1694	12098	1409	13477	1178	15362	809	19232	698	11528
2E		MI	4404	2020	6888	1624	8088	1350	8856	1126	9898	768	11572	580	7396
6-#10	1.08	MA	5924	1777	7890	1572	9626	1324	10572	1130	11520	838	13973	730	5811
2L-3S		MI	3747	1777	5198	1526	6106	1284	6535	1095	6832	815	7971	599	3871
6-#10	1.08	MA	5549	1777	7269	1585	8838	1335	9617	1140	10231	854	12188	646	5814
3L-2S		MI	3975	1777	5588	1516	6602	1277	7136	1089	7643	805	9066	691	3854
6-#11	1.33	MA	6097	1827	8354	1594	10157	1339	11185	1137	12323	830	15065	722	7025
2L-3S		MI	3801	1827	5416	1545	6331	1296	6781	1099	7142	805	8310	554	4638
6-#11	1.33	MA	5655	1827	7602	1609	9203	1352	10029	1150	10762	848	12904	616	7017
3L-2S		MI	4067	1827	5885	1534	6926	1288	7502	1093	8115	795	9594	667	4620
6-#14	1.92	MA	6525	1947	9367	1662	11402	1388	12673	1167	14313	820	17807	710	9928
2L-3S		MI	3948	1947	5852	1614	6846	1345	7386	1128	7944	797	9291	469	6430
6-#14	1.92	MA	5926	1947	8295	1683	10041	1406	11024	1184	12086	845	14723	555	9862
3L-2S		MI	4309	1947	6517	1599	7690	1334	8409	1120	9324	783	11079	632	6434
6-#18	3.41	MA	7517	2252	11846	1839	14466	1515	16346	1245	19235	798	24596	683	17060
2L-3S		MI	4295	2252	6888	1791	8088	1471	8856	1202	9898	775	11572	233	10622
6-#18	3.41	MA	6578	2252	9980	1873	12098	1546	13477	1271	15362	837	19232	399	16698
3L-2S		MI	4857	2252	8029	1769	9536	1456	10611	1193	12267	757	14527	523	10792
8-#9	1.14	MA	5978	1788	7967	1582	9745	1332	10726	1136	11738	840	14282	731	6106
2L-4S		MI	3726	1788	5108	1544	5987	1304	6396	1112	6646	819	7806	582	4062
8-#9	1.14	MA	5684	1788	7476	1592	9121	1341	9970	1144	10718	852	12869	665	6107
3E		MI	3830	1788	5324	1536	6286	1292	6762	1101	7147	816	8425	623	4055
8-#9	1.14	MA	5520	1788	7141	1602	8656	1356	9400	1158	9937	859	11920	625	6084
4L-2S		MI	4010	1788	5634	1528	6679	1286	7239	1096	7791	808	9302	696	4043
8-#10	1.44	MA	6219	1850	8511	1618	10414	1358	11527	1151	12809	835	15757	725	7666
2L-4S		MI	3802	1850	5316	1581	6225	1333	6673	1130	7011	815	8293	539	5033
8-#10	1.44	MA	5858	1850	7890	1631	9626	1369	10572	1162	11520	850	13973	641	7654
3E		MI	3929	1850	5588	1572	6602	1318	7136	1116	7643	812	9066	591	5043
8-#10	1.44	MA	5658	1850	7466	1643	9038	1388	9850	1179	10532	858	12769	590	7589
4L-2S		MI	4149	1850	5979	1562	7098	1310	7737	1110	8454	802	10161	683	5033

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

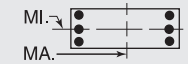
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.77	MA	6444	1918	9105	1650	11111	1380	12341	1164	13883	826	17226	716	9267
2L-4S		MI	3865	1918	5556	1612	6471	1355	6945	1141	7354	803	8683	479	6002
8-#11	1.77	MA	6021	1918	8354	1665	10157	1394	11185	1176	12323	844	15065	610	9239
3E		MI	4014	1918	5885	1601	6926	1338	7502	1126	8115	801	9594	540	6037
8-#11	1.77	MA	5786	1918	7839	1680	9442	1416	10309	1196	11124	853	13594	546	9115
4L-2S		MI	4271	1918	6354	1591	7521	1329	8223	1119	9089	790	10878	654	6032
8-#14	2.56	MA	6999	2078	10440	1744	12763	1447	14323	1205	16539	814	20890	702	13113
2L-4S		MI	4042	2078	6048	1709	7043	1428	7617	1186	8242	792	9805	359	8002
8-#14	2.56	MA	6433	2078	9367	1764	11402	1466	12673	1221	14313	839	17807	547	13017
3E		MI	4242	2078	6517	1695	7690	1405	8409	1166	9324	791	11079	445	8387
8-#14	2.56	MA	6120	2078	8630	1785	10380	1497	11420	1250	12598	851	15692	454	12417
4L-2S		MI	4586	2078	7181	1681	8534	1394	9431	1158	10704	777	12866	608	8420
8-#18	4.55	MA	7419	2484	11846	2018	14466	1652	16346	1338	19235	826	24596	384	22173
3E		MI	4795	2484	8029	1936	9536	1577	10611	1269	12267	764	14527	176	13935
8-#18	4.55	MA	6940	2484	10557	2053	12680	1704	14158	1386	16241	844	20867	215	19469
4L-2S		MI	5292	2484	9170	1914	10984	1562	12366	1260	14635	746	17482	467	14165
10-#10	1.80	MA	6507	1924	9132	1664	11202	1391	12481	1172	14098	831	17542	720	9514
2L-5S		MI	3863	1924	5463	1637	6388	1375	6862	1157	7251	822	8617	477	5992
10-#10	1.80	MA	6160	1924	8511	1677	10414	1403	11527	1183	12809	847	15757	636	9491
3L-4S		MI	3986	1924	5706	1628	6721	1367	7274	1151	7823	812	9388	531	6183
10-#10	1.80	MA	5971	1924	8087	1689	9826	1421	10805	1201	11821	855	14553	585	9413
4L-3S		MI	4107	1924	5979	1618	7098	1352	7737	1138	8454	808	10161	583	6206
10-#10	1.80	MA	5737	1924	7713	1702	9311	1433	10165	1211	10933	870	13332	541	9063
5L-2S		MI	4321	1924	6370	1608	7594	1344	8337	1131	9266	798	11257	675	6205
10-#11	2.22	MA	6782	2008	9857	1707	12064	1421	13497	1190	15444	821	19386	710	11500
2L-5S		MI	3941	2008	5731	1679	6664	1405	7168	1173	7638	810	9063	398	6996
10-#11	2.22	MA	6377	2008	9105	1722	11111	1435	12341	1202	13883	839	17226	604	11458
3L-4S		MI	4081	2008	6025	1669	7066	1396	7666	1167	8328	799	9967	465	7373
10-#11	2.22	MA	6157	2008	8590	1737	10396	1457	11465	1223	12684	849	15754	540	11319
4L-3S		MI	4222	2008	6354	1658	7521	1379	8223	1152	9089	797	10878	527	7425
10-#11	2.22	MA	5883	2008	8134	1752	9770	1471	10688	1235	11604	867	14266	484	10666
5L-2S		MI	4470	2008	6823	1647	8116	1370	8944	1145	10063	786	12162	640	7435
10-#14	3.20	MA	6924	2208	10440	1846	12763	1526	14323	1259	16539	833	20890	538	16173
3L-4S		MI	4342	2208	6713	1791	7886	1488	8639	1224	9622	786	11593	335	9853
10-#14	3.20	MA	6637	2208	9703	1867	11741	1557	13070	1288	14825	845	18775	445	15500
4L-3S		MI	4528	2208	7181	1777	8534	1464	9431	1203	10704	784	12866	421	10338
10-#14	3.20	MA	6256	2208	9050	1888	10844	1576	11957	1304	13280	870	16641	361	14416
5L-2S		MI	4858	2208	7846	1762	9377	1453	10454	1196	12085	771	14654	585	10394
10-#18	5.68	MA	7809	2715	12423	2198	15048	1810	17027	1453	20115	833	26230	200	24906
4L-3S		MI	5260	2715	9170	2081	10984	1683	12366	1336	14635	753	17482	119	17047
10-#18	5.68	MA	7173	2715	11278	2232	13478	1840	15080	1479	17413	873	22483	40	22321
5L-2S		MI	5719	2715	10311	2059	12432	1668	14121	1327	17004	735	20437	410	17527
12-#10	2.16	MA	6790	1998	9753	1710	11990	1425	13436	1194	15387	828	19327	715	11358
2L-6S		MI	3891	1998	5581	1699	6569	1416	7058	1192	7514	828	9005	409	6883
12-#10	2.16	MA	6454	1998	9132	1723	11202	1436	12481	1204	14098	843	17542	631	11327
3L-5S		MI	4045	1998	5854	1683	6884	1408	7463	1178	8062	818	9712	469	7098
12-#10	2.16	MA	6276	1998	8708	1735	10614	1455	11760	1222	13110	851	16338	580	11239
4E		MI	4167	1998	6097	1674	7217	1400	7875	1172	8634	808	10483	522	7330
12-#10	2.16	MA	6045	1998	8333	1748	10099	1467	11120	1232	12222	867	15117	536	10858
5L-3S		MI	4281	1998	6370	1664	7594	1385	8337	1159	9266	805	11257	574	7364
12-#10	2.16	MA	5800	1998	7873	1762	9613	1478	10495	1250	11353	875	13940	467	10415
6L-2S		MI	4489	1998	6761	1654	8090	1377	8938	1152	10077	795	12352	667	7372
12-#11	2.66	MA	6723	2099	9857	1778	12064	1476	13497	1228	15444	835	19386	598	13675
3L-5S		MI	4154	2099	6200	1736	7259	1446	7889	1199	8611	805	10347	385	8326

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

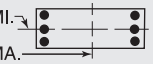


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.66	MA	6518	2099	9342	1793	11350	1498	12621	1249	14245	844	17915	534	13526
4E		MI	4293	2099	6494	1725	7661	1438	8387	1193	9301	795	11250	451	8738
12-#11	2.66	MA	6248	2099	8886	1808	10724	1512	11844	1261	13165	862	16426	478	12845
5L-3S		MI	4426	2099	6823	1714	8116	1420	8944	1178	10063	793	12162	513	8810
12-#11	2.66	MA	5959	2099	8334	1825	10133	1525	11083	1281	12110	872	14987	392	12332
6L-2S		MI	4665	2099	7292	1704	8711	1412	9666	1171	11036	782	13445	626	8831
12-#14	3.84	MA	7138	2339	10775	1948	13102	1616	14720	1326	17052	839	21859	437	18594
4E		MI	4635	2339	7378	1872	8730	1548	9662	1261	11002	779	13380	311	11719
12-#14	3.84	MA	6762	2339	10122	1969	12205	1635	13607	1342	15507	863	19725	352	17553
5L-3S		MI	4809	2339	7846	1858	9377	1524	10454	1241	12085	778	14654	397	12287
12-#14	3.84	MA	6373	2339	9340	1994	11359	1654	12518	1371	13997	876	17656	228	16275
6L-2S		MI	5120	2339	8511	1844	10221	1513	11476	1233	13465	764	16442	561	12362
12-#18	6.82	MA	8019	2947	13144	2377	15846	1946	17950	1546	21286	862	27846	25	27747
5L-3S		MI	5714	2947	10311	2226	12432	1789	14121	1403	17004	741	20437	63	20193
14-#10	2.53	MA	6741	2071	9753	1769	11990	1470	13436	1226	15387	839	19327	626	13161
3L-6S		MI	4074	2071	5972	1745	7065	1450	7659	1213	8325	825	10100	401	8005
14-#10	2.53	MA	6574	2071	9329	1781	11401	1489	12715	1243	14399	848	18123	575	13066
4L-5S		MI	4223	2071	6245	1729	7380	1442	8064	1200	8873	815	10808	461	8211
14-#10	2.53	MA	6345	2071	8954	1794	10886	1500	12075	1254	13511	863	16901	531	12659
5L-4S		MI	4344	2071	6488	1720	7712	1434	8476	1193	9445	805	11579	514	8476
14-#10	2.53	MA	6109	2071	8493	1808	10401	1512	11449	1271	12642	872	15724	462	12231
6L-3S		MI	4453	2071	6761	1710	8090	1419	8938	1180	10077	801	12352	566	8519
14-#10	2.53	MA	5904	2071	8097	1816	9857	1526	10847	1282	11800	887	14570	427	11679
7L-2S		MI	4654	2071	7151	1700	8586	1411	9539	1174	10888	791	13447	659	8534
14-#11	3.10	MA	6870	2189	10093	1850	12304	1540	13777	1275	15805	840	20075	528	15735
4L-5S		MI	4362	2189	6669	1792	7854	1487	8610	1225	9585	801	11630	371	9663
14-#11	3.10	MA	6602	2189	9638	1865	11677	1553	13000	1287	14725	858	18587	472	15029
5L-4S		MI	4500	2189	6963	1782	8256	1479	9109	1219	10275	790	12534	438	10052
14-#11	3.10	MA	6326	2189	9085	1882	11087	1567	12239	1308	13670	867	17148	386	14520
6L-3S		MI	4626	2189	7292	1771	8711	1462	9666	1204	11036	788	13445	499	10191
14-#11	3.10	MA	6086	2189	8604	1891	10437	1585	11505	1320	12646	885	15740	340	13670
7L-2S		MI	4858	2189	7761	1760	9306	1453	10387	1197	12010	777	14729	612	10222
14-#14	4.47	MA	7253	2469	11195	2051	13566	1695	15256	1380	17733	857	22808	344	20696
5L-4S		MI	4922	2469	8042	1954	9574	1607	10684	1299	12382	773	15168	288	13597
14-#14	4.47	MA	6884	2469	10412	2076	12720	1713	14167	1409	16223	869	20740	219	19412
6L-3S		MI	5094	2469	8511	1940	10221	1584	11476	1279	13465	772	16442	374	14236
14-#14	4.47	MA	6563	2469	9725	2089	11801	1740	13117	1425	14758	894	18718	150	17985
7L-2S		MI	5377	2469	9176	1925	11065	1573	12499	1271	14845	758	18229	537	14325
16-#10	2.89	MA	6865	2145	9950	1827	12189	1522	13670	1264	15688	844	19908	570	14894
4L-6S		MI	4253	2145	6363	1791	7560	1484	8260	1234	9137	821	11195	393	9130
16-#10	2.89	MA	6638	2145	9575	1840	11674	1534	13030	1275	14800	860	18686	527	14464
5E		MI	4397	2145	6635	1775	7875	1476	8665	1221	9685	811	11903	452	9327
16-#10	2.89	MA	6411	2145	9114	1854	11189	1546	12404	1292	13931	868	17509	457	14050
6L-4S		MI	4518	2145	6879	1766	8208	1468	9077	1215	10256	801	12674	506	9622
16-#10	2.89	MA	6215	2145	8718	1862	10645	1560	11801	1303	13089	884	16355	422	13495
7L-3S		MI	4622	2145	7151	1756	8586	1453	9539	1201	10888	798	13447	558	9672
16-#10	2.89	MA	6018	2145	8337	1871	10136	1568	11170	1318	12262	899	15243	373	12923
8L-2S		MI	4818	2145	7542	1747	9081	1445	10140	1195	11699	788	14543	650	9694
16-#11	3.55	MA	6949	2279	10389	1921	12631	1595	14156	1313	16286	854	20747	466	17217
5E		MI	4567	2279	7138	1849	8449	1529	9332	1251	10558	797	12914	357	11004
16-#11	3.55	MA	6684	2279	9837	1938	12040	1608	13395	1334	15230	863	19309	380	16705
6L-4S		MI	4704	2279	7432	1838	8851	1520	9830	1245	11249	786	13818	424	11375
16-#11	3.55	MA	6455	2279	9356	1948	11390	1626	12661	1346	14207	881	17900	334	15875
7L-3S		MI	4824	2279	7761	1827	9306	1503	10387	1230	12010	784	14729	485	11571
16-#11	3.55	MA	6225	2279	8893	1959	10771	1635	11907	1364	13201	899	16544	271	14970
8L-2S		MI	5049	2279	8230	1817	9902	1494	11108	1224	12983	773	16013	599	11611
16-#14	5.11	MA	7382	2599	11485	2157	14081	1773	15817	1446	18450	863	23823	211	22550
6L-4S		MI	5223	2599	8707	2036	10417	1667	11707	1337	13763	767	16956	264	15485

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

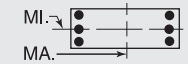
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	5.11	MA	7080	2599	10797	2171	13162	1799	14766	1463	16984	888	21802	141	21111
7L-3S		MI	5361	2599	9176	2021	11065	1643	12499	1316	14845	766	18229	350	16184
18-#10	3.25	MA	6926	2219	10196	1886	12462	1568	13985	1296	16089	856	20471	522	16272
5L-6S		MI	4430	2219	6754	1837	8056	1517	8861	1256	9948	818	12291	385	10259
18-#10	3.25	MA	6707	2219	9735	1900	11977	1579	13359	1314	15220	865	19294	453	15871
6L-5S		MI	4570	2219	7026	1821	8371	1509	9266	1242	10496	808	12998	444	10448
18-#10	3.25	MA	6519	2219	9339	1908	11433	1593	12756	1324	14378	880	18140	417	15314
7L-4S		MI	4689	2219	7269	1812	8704	1501	9678	1236	11068	797	13769	498	10768
18-#10	3.25	MA	6325	2219	8958	1917	10923	1601	12125	1339	13551	896	17028	368	14740
8L-3S		MI	4789	2219	7542	1802	9081	1486	10140	1223	11699	794	14543	550	10824
18-#10	3.25	MA	6097	2219	8588	1928	10428	1610	11500	1346	12710	904	15931	322	13994
9L-2S		MI	4980	2219	7933	1793	9577	1478	10741	1216	12510	784	15638	642	10852
18-#11	3.99	MA	7034	2370	10588	1995	12994	1649	14551	1360	16791	859	21469	374	18894
6L-5S		MI	4769	2370	7607	1905	9044	1570	10053	1278	11532	793	14198	344	12350
18-#11	3.99	MA	6816	2370	10107	2005	12344	1667	13818	1372	15767	877	20061	328	18081
7L-4S		MI	4905	2370	7901	1895	9447	1562	10551	1271	12222	782	15102	410	12703
18-#11	3.99	MA	6589	2370	9645	2016	11725	1676	13063	1391	14761	894	18705	265	17169
8L-3S		MI	5029	2370	8230	1884	9902	1544	11108	1256	12983	780	16013	472	12950
18-#14	5.75	MA	7584	2730	11870	2252	14523	1859	16416	1501	19211	882	24885	132	24236
7L-4S		MI	5498	2730	9372	2117	11261	1726	12729	1374	15143	761	18743	240	17381
20-#10	3.61	MA	6997	2292	10356	1946	12765	1613	14314	1335	16509	861	21079	448	17694
6E		MI	4603	2292	7144	1883	8552	1551	9462	1277	10759	814	13386	376	11386
20-#10	3.61	MA	6817	2292	9960	1954	12221	1627	13711	1346	15667	877	19925	412	17135
7L-5S		MI	4739	2292	7417	1867	8867	1543	9867	1264	11307	804	14094	436	11571
20-#10	3.61	MA	6625	2292	9579	1963	11711	1635	13080	1360	14840	892	18813	363	16558
8L-4S		MI	4858	2292	7660	1858	9200	1535	10279	1257	11879	794	14865	490	11906
20-#10	3.61	MA	6405	2292	9209	1974	11215	1644	12454	1368	13999	901	17715	317	15815
9L-3S		MI	4954	2292	7933	1848	9577	1520	10741	1244	12510	791	15638	542	11976
20-#11	4.43	MA	7170	2460	10859	2061	13298	1709	14974	1398	17328	872	22221	322	20289
7L-5S		MI	4968	2460	8075	1962	9640	1611	10774	1304	12505	788	15481	330	13700
20-#11	4.43	MA	6945	2460	10396	2072	12679	1718	14219	1417	16322	890	20866	259	19368
8L-4S		MI	5120	2460	8370	1951	10042	1603	11272	1297	13196	777	16385	397	14037
22-#10	3.97	MA	7109	2366	10580	2000	13009	1661	14666	1367	16956	873	21709	407	18956
7L-6S		MI	4775	2366	7535	1929	9048	1584	10063	1298	11570	811	14481	368	12495
22-#10	3.97	MA	6919	2366	10200	2009	12499	1668	14035	1382	16129	889	20598	358	18376
8L-5S		MI	4907	2366	7808	1913	9363	1576	10468	1285	12118	801	15189	428	12698
22-#10	3.97	MA	6706	2366	9830	2020	12003	1677	13409	1389	15288	897	19500	312	17635
9L-4S		MI	5025	2366	8051	1904	9696	1569	10880	1278	12690	790	15960	482	13019
22-#11	4.88	MA	7294	2551	11148	2129	13633	1759	15376	1443	17882	886	23026	253	21567
8L-5S		MI	5178	2551	8544	2018	10235	1653	11495	1330	13479	784	16765	316	15053
24-#10	4.33	MA	7209	2439	10820	2056	13287	1702	14990	1403	17418	885	22382	353	20193
8L-6S		MI	4944	2439	7926	1975	9544	1618	10664	1319	12382	807	15577	360	13607
24-#10	4.33	MA	7002	2439	10451	2066	12791	1711	14364	1410	16577	894	21285	307	19456
9L-5S		MI	5073	2439	8198	1959	9859	1610	11069	1306	12929	797	16284	420	13826

RECTANGULAR TIED COLUMNS 22" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.20	MA	6773	1914	9183	1678	11160	1411	12261	1202	13420	884	16330	769	7215
2E		MI	4240	1914	6134	1602	7169	1347	7720	1145	8268	839	9648	700	4453
4-#18	2.14	MA	7528	2117	11003	1791	13383	1492	14911	1250	16959	866	21201	749	12392
2E		MI	4621	2117	7176	1708	8413	1421	9190	1188	10220	817	11925	623	7431
6-#10	1.02	MA	6648	1874	8743	1669	10709	1407	11768	1202	12803	896	15511	780	6223
2L-3S		MI	3961	1874	5474	1612	6426	1358	6868	1159	7157	866	8332	644	3890
6-#10	1.02	MA	6241	1874	8076	1682	9863	1419	10742	1213	11418	912	13594	698	6225
3L-2S		MI	4190	1874	5864	1603	6922	1350	7469	1153	7969	856	9427	736	3872

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

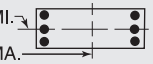
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.25	MA	6839	1924	9244	1691	11282	1422	12431	1210	13671	888	16691	772	7531
2L-3S		MI	4015	1924	5696	1630	6652	1369	7114	1163	7466	856	8669	598	4663
6-#11	1.25	MA	6358	1924	8436	1707	10257	1436	11188	1223	11993	906	14368	669	7523
3L-2S		MI	4283	1924	6165	1619	7247	1361	7835	1156	8440	845	9953	712	4642
6-#14	1.80	MA	7308	2044	10337	1759	12625	1471	14036	1239	15816	878	19647	761	10657
2L-3S		MI	4162	2044	6134	1698	7169	1417	7720	1191	8268	847	9648	513	6466
6-#14	1.80	MA	6655	2044	9183	1781	11160	1490	12261	1257	13420	904	16330	609	10591
3L-2S		MI	4526	2044	6799	1684	8012	1406	8743	1183	9648	833	11436	676	6462
6-#18	3.21	MA	8396	2349	13014	1936	15935	1598	18003	1317	21133	855	26981	733	18356
2L-3S		MI	4508	2349	7176	1875	8413	1543	9190	1264	10220	824	11925	276	10687
6-#18	3.21	MA	7370	2349	11003	1972	13383	1630	14911	1345	16959	898	21201	455	17994
3L-2S		MI	5077	2349	8317	1853	9861	1527	10945	1255	12589	806	14881	567	10833
8-#9	1.07	MA	6707	1885	8825	1679	10835	1415	11933	1208	13036	897	15840	781	6538
2L-4S		MI	3940	1885	5382	1630	6306	1378	6729	1176	6972	870	8168	627	4084
8-#9	1.07	MA	6387	1885	8297	1690	10166	1424	11121	1217	11940	910	14324	717	6539
3E		MI	4044	1885	5598	1623	6605	1366	7095	1165	7473	867	8787	668	4074
8-#9	1.07	MA	6210	1885	7938	1700	9667	1440	10510	1231	11103	917	13311	677	6516
4L-2S		MI	4225	1885	5908	1615	6998	1360	7572	1160	8117	859	9664	741	4061
8-#10	1.36	MA	6970	1948	9410	1715	11555	1440	12794	1223	14187	892	17428	776	8215
2L-4S		MI	4015	1948	5592	1668	6544	1407	7007	1194	7337	866	8654	584	5062
8-#10	1.36	MA	6578	1948	8743	1728	10709	1453	11768	1235	12803	908	15511	693	8203
3E		MI	4143	1948	5864	1658	6922	1392	7469	1180	7969	863	9427	636	5065
8-#10	1.36	MA	6361	1948	8289	1741	10078	1472	10994	1253	11744	917	14227	642	8137
4L-2S		MI	4365	1948	6255	1649	7418	1384	8070	1174	8780	853	10523	728	5054
8-#11	1.67	MA	7217	2015	10052	1748	12308	1463	13674	1236	15348	883	19015	766	9940
2L-4S		MI	4078	2015	5836	1697	6792	1428	7278	1204	7679	854	9042	523	6041
8-#11	1.67	MA	6757	2015	9244	1763	11282	1477	12431	1249	13671	902	16691	663	9913
3E		MI	4228	2015	6165	1687	7247	1410	7835	1189	8440	852	9953	585	6066
8-#11	1.67	MA	6502	2015	8692	1779	10516	1500	11492	1270	12384	912	15122	599	9789
4L-2S		MI	4487	2015	6634	1676	7842	1402	8557	1183	9414	841	11237	698	6057
8-#14	2.41	MA	7825	2175	11491	1841	14089	1530	15811	1277	18212	872	22965	752	14085
2L-4S		MI	4254	2175	6331	1794	7365	1501	7950	1249	8566	842	10162	403	8121
8-#14	2.41	MA	7208	2175	10337	1862	12625	1550	14036	1295	15816	898	19647	600	13989
3E		MI	4457	2175	6799	1780	8012	1477	8743	1229	9648	841	11436	489	8427
8-#14	2.41	MA	6867	2175	9546	1884	11528	1582	12691	1325	13976	911	17391	508	13481
4L-2S		MI	4804	2175	7464	1765	8856	1466	9765	1221	11028	827	13224	652	8452
8-#18	4.28	MA	8286	2581	13014	2117	15935	1736	18003	1412	21133	887	26981	440	23901
3E		MI	5009	2581	8317	2019	9861	1648	10945	1331	12589	813	14881	219	14004
8-#18	4.28	MA	7765	2581	11630	2153	14016	1791	15651	1463	17915	907	22998	273	21145
4L-2S		MI	5515	2581	9458	1998	11309	1633	12700	1322	14958	795	17836	510	14208
10-#10	1.70	MA	7284	2021	10077	1761	12401	1474	13819	1245	15572	889	19345	771	10200
2L-5S		MI	4077	2021	5739	1723	6708	1448	7195	1221	7576	873	8978	522	6067
10-#10	1.70	MA	6905	2021	9410	1774	11555	1486	12794	1256	14187	905	17428	688	10177
3L-4S		MI	4200	2021	5982	1714	7040	1440	7608	1215	8148	863	9749	575	6215
10-#10	1.70	MA	6701	2021	8956	1787	10925	1505	12020	1274	13129	914	16144	637	10099
4L-3S		MI	4322	2021	6255	1704	7418	1425	8070	1202	8780	859	10523	627	6231
10-#10	1.70	MA	6444	2021	8555	1800	10373	1517	11335	1285	12177	930	14838	595	9784
5L-2S		MI	4537	2021	6646	1695	7913	1417	8671	1195	9591	849	11618	720	6227
10-#11	2.09	MA	7586	2105	10860	1804	13334	1504	14917	1262	17026	879	21338	760	12343
2L-5S		MI	4154	2105	6011	1765	6985	1478	7502	1237	7962	860	9422	443	7082
10-#11	2.09	MA	7144	2105	10052	1820	12308	1519	13674	1275	15348	898	19015	657	12300
3L-4S		MI	4295	2105	6305	1754	7387	1469	8000	1230	8652	849	10326	509	7415
10-#11	2.09	MA	6906	2105	9500	1835	11542	1541	12735	1296	14062	908	17445	593	12162
4L-3S		MI	4437	2105	6634	1743	7842	1452	8557	1215	9414	847	11237	571	7457

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis



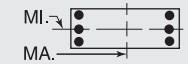
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.09	MA	6604	2105	9012	1851	10871	1555	11902	1309	12905	927	15853	539	11522
5L-2S		MI	4687	2105	7103	1732	8438	1443	9278	1209	10387	837	12520	684	7462
10-#14	3.01	MA	7742	2305	11491	1944	14089	1610	15811	1332	18212	891	22965	592	17388
3L-4S		MI	4555	2305	6996	1876	8209	1560	8973	1287	9946	836	11950	379	9967
10-#14	3.01	MA	7430	2305	10700	1966	12992	1642	14466	1362	16372	905	20708	500	16808
4L-3S		MI	4744	2305	7464	1861	8856	1537	9765	1266	11028	834	13224	465	10381
10-#14	3.01	MA	7009	2305	10001	1987	12031	1661	13273	1380	14715	931	18425	419	15584
5L-2S		MI	5077	2305	8129	1847	9700	1526	10788	1258	12409	821	15011	629	10428
10-#18	5.35	MA	8710	2813	13640	2298	16567	1897	18744	1530	22090	896	28778	258	27020
4L-3S		MI	5476	2813	9458	2164	11309	1754	12700	1398	14958	802	17836	163	17236
10-#18	5.35	MA	8008	2813	12413	2334	14883	1929	16653	1558	19188	939	24764	105	24303
5L-2S		MI	5944	2813	10599	2143	12757	1739	14455	1389	17327	784	20791	453	17573
12-#10	2.04	MA	7591	2095	10744	1807	13248	1508	14845	1266	16956	885	21262	766	12181
2L-6S		MI	4104	2095	5858	1785	6888	1490	7392	1256	7840	879	9366	454	6954
12-#10	2.04	MA	7225	2095	10077	1820	12401	1520	13819	1277	15572	901	19345	683	12150
3L-5S		MI	4259	2095	6130	1769	7203	1482	7796	1243	8388	869	10074	513	7171
12-#10	2.04	MA	7032	2095	9623	1833	11771	1539	13046	1295	14513	910	18061	632	12062
4E		MI	4381	2095	6373	1760	7536	1474	8209	1236	8960	859	10845	567	7364
12-#10	2.04	MA	6778	2095	9222	1846	11220	1551	12361	1306	13561	926	16755	590	11716
5L-3S		MI	4497	2095	6646	1750	7913	1459	8671	1223	9591	856	11618	619	7391
12-#10	2.04	MA	6513	2095	8723	1860	10699	1563	11691	1324	12631	936	15497	523	11220
6L-2S		MI	4707	2095	7037	1741	8409	1451	9272	1217	10402	846	12713	712	7396
12-#11	2.50	MA	7522	2196	10860	1876	13334	1560	14917	1301	17026	893	21338	651	14686
3L-5S		MI	4368	2196	6480	1821	7580	1519	8223	1263	8936	856	10706	429	8410
12-#11	2.50	MA	7299	2196	10308	1892	12567	1583	13978	1322	15740	904	19768	587	14537
4E		MI	4507	2196	6774	1810	7983	1510	8721	1256	9626	845	11609	496	8788
12-#11	2.50	MA	7000	2196	9820	1907	11896	1597	13145	1335	14582	922	18176	533	13869
5L-3S		MI	4642	2196	7103	1800	8438	1493	9278	1241	10387	843	12520	557	8844
12-#11	2.50	MA	6688	2196	9221	1924	11264	1611	12329	1357	13452	933	16641	448	13300
6L-2S		MI	4884	2196	7572	1789	9033	1485	9999	1235	11361	832	13804	670	8860
12-#14	3.61	MA	7975	2436	11854	2047	14457	1701	16241	1400	18768	899	24026	491	20145
4E		MI	4849	2436	7660	1957	9052	1620	9995	1324	11326	830	13737	355	11830
12-#14	3.61	MA	7560	2436	11155	2069	13496	1721	15048	1418	17111	925	21742	410	18965
5L-3S		MI	5025	2436	8129	1943	9700	1596	10788	1304	12409	828	15011	441	12332
12-#14	3.61	MA	7138	2436	10306	2093	12589	1741	13880	1448	15491	939	19536	287	17651
6L-2S		MI	5346	2436	8794	1928	10543	1585	11810	1296	13789	814	16799	605	12397
12-#18	6.42	MA	8928	3045	14424	2479	17434	2035	19746	1625	23362	927	30545	90	30151
5L-3S		MI	5931	3045	10599	2309	12757	1860	14455	1465	17327	791	20791	106	20375
14-#10	2.38	MA	7538	2169	10744	1866	13248	1553	14845	1298	16956	898	21262	678	14121
3L-6S		MI	4288	2169	6248	1831	7384	1523	7993	1277	8651	876	10461	446	8075
14-#10	2.38	MA	7355	2169	10290	1879	12617	1573	14072	1316	15898	907	19978	627	14026
4L-5S		MI	4437	2169	6521	1815	7699	1515	8397	1264	9199	866	11169	505	8282
14-#10	2.38	MA	7105	2169	9888	1892	12066	1585	13387	1328	14946	923	18672	586	13653
5L-4S		MI	4558	2169	6764	1806	8032	1507	8810	1257	9771	855	11940	559	8512
14-#10	2.38	MA	6849	2169	9390	1906	11545	1596	12717	1346	14016	932	17414	518	13174
6L-3S		MI	4670	2169	7037	1796	8409	1493	9272	1244	10402	852	12713	611	8548
14-#10	2.38	MA	6627	2169	8966	1914	10957	1610	12072	1357	13115	948	16185	483	12634
7L-2S		MI	4873	2169	7427	1787	8905	1485	9873	1238	11214	842	13809	703	8560
14-#11	2.92	MA	7682	2286	11116	1948	13593	1624	15221	1348	17418	899	22091	581	16914
4L-5S		MI	4577	2286	6949	1878	8176	1560	8944	1289	9909	852	11989	415	9744
14-#11	2.92	MA	7387	2286	10628	1964	12922	1638	14387	1361	16260	918	20499	527	16221
5L-4S		MI	4715	2286	7243	1867	8578	1552	9442	1282	10600	841	12893	482	10145
14-#11	2.92	MA	7087	2286	10029	1980	12289	1652	13572	1383	15129	928	18964	442	15673
6L-3S		MI	4843	2286	7572	1856	9033	1534	9999	1267	11361	839	13804	543	10227

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis

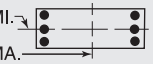


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.92	MA	6826	2286	9513	1990	11583	1670	12787	1395	14033	947	17460	398	14797
7L-2S		MI	5078	2286	8041	1846	9628	1526	10721	1261	12334	828	15088	657	10253
14-#14	4.21	MA	8095	2566	12309	2150	14960	1780	16823	1455	19506	919	25060	402	22352
5L-4S		MI	5137	2566	8325	2039	9896	1679	11018	1362	12706	823	15525	332	13705
14-#14	4.21	MA	7694	2566	11460	2175	14054	1800	15655	1485	17887	932	22853	278	21028
6L-3S		MI	5312	2566	8794	2024	10543	1656	11810	1342	13789	822	16799	418	14281
14-#14	4.21	MA	7345	2566	10721	2189	13054	1826	14530	1503	16316	958	20693	212	19569
7L-2S		MI	5601	2566	9458	2010	11387	1645	12833	1334	15169	808	18587	581	14362
16-#10	2.72	MA	7672	2242	10957	1925	13463	1606	15097	1338	17282	903	21895	623	15991
4L-6S		MI	4467	2242	6639	1877	7880	1557	8594	1298	9462	872	11557	437	9199
16-#10	2.72	MA	7424	2242	10555	1938	12912	1618	14412	1349	16330	919	20589	581	15594
5E		MI	4613	2242	6911	1861	8195	1549	8998	1285	10010	862	12264	497	9397
16-#10	2.72	MA	7177	2242	10057	1952	12391	1630	13743	1367	15401	929	19331	513	15130
6L-4S		MI	4733	2242	7155	1852	8528	1541	9411	1279	10582	852	13035	551	9659
16-#10	2.72	MA	6964	2242	9632	1960	11803	1644	13097	1378	14499	945	18102	478	14590
7L-3S		MI	4839	2242	7427	1842	8905	1526	9873	1265	11214	849	13809	603	9702
16-#10	2.72	MA	6748	2242	9225	1970	11257	1652	12412	1392	13614	961	16914	430	13959
8L-2S		MI	5038	2242	7818	1833	9401	1518	10474	1259	12025	839	14904	695	9720
16-#11	3.34	MA	7764	2377	11436	2020	13947	1679	15630	1387	17938	914	22822	521	18577
5E		MI	4783	2377	7418	1934	8771	1602	9665	1315	10883	847	13273	402	11084
16-#11	3.34	MA	7476	2377	10837	2037	13315	1694	14815	1409	16807	924	21287	436	18049
6L-4S		MI	4920	2377	7712	1923	9173	1593	10163	1308	11573	837	14177	468	11465
16-#11	3.34	MA	7227	2377	10321	2047	12609	1711	14030	1422	15710	943	19783	392	17172
7L-3S		MI	5042	2377	8041	1913	9628	1576	10721	1293	12334	834	15088	530	11608
16-#11	3.34	MA	6973	2377	9825	2059	11945	1720	13210	1440	14633	962	18334	331	16242
8L-2S		MI	5270	2377	8510	1902	10223	1567	11442	1287	13308	824	16372	643	11642
16-#14	4.81	MA	8235	2697	12614	2256	15518	1860	17430	1523	20283	926	26171	270	24404
6L-4S		MI	5439	2697	8990	2120	10740	1739	12041	1400	14087	817	17313	308	15590
16-#14	4.81	MA	7906	2697	11875	2270	14519	1885	16305	1541	18712	952	24011	203	22933
7L-3S		MI	5581	2697	9458	2106	11387	1715	12833	1379	15169	816	18587	394	16230
18-#10	3.06	MA	7736	2316	11222	1984	13758	1652	15438	1370	17715	916	22506	576	17538
5L-6S		MI	4644	2316	7030	1923	8376	1591	9195	1320	10273	869	12652	429	10327
18-#10	3.06	MA	7498	2316	10724	1998	13237	1664	14768	1388	16785	925	21248	508	17088
6L-5S		MI	4786	2316	7302	1907	8691	1583	9599	1306	10821	859	13360	489	10516
18-#10	3.06	MA	7294	2316	10299	2006	12650	1678	14123	1399	15884	941	20019	473	16548
7L-4S		MI	4905	2316	7545	1898	9024	1575	10012	1300	11393	848	14130	543	10805
18-#10	3.06	MA	7081	2316	9891	2016	12103	1686	13438	1414	14998	957	18832	426	15920
8L-3S		MI	5007	2316	7818	1888	9401	1560	10474	1287	12025	845	14904	595	10855
18-#10	3.06	MA	6834	2316	9495	2027	11572	1695	12768	1421	14098	966	17663	380	15144
9L-2S		MI	5200	2316	8209	1879	9897	1552	11075	1280	12836	835	15999	687	10879
18-#11	3.75	MA	7856	2467	11646	2093	14340	1735	16058	1435	18485	920	23610	430	20427
6L-5S		MI	4985	2467	7886	1991	9366	1643	10387	1341	11857	843	14557	388	12429
18-#11	3.75	MA	7619	2467	11130	2104	13634	1752	15273	1448	17388	939	22106	386	19545
7L-4S		MI	5121	2467	8181	1980	9768	1634	10885	1335	12547	832	15460	455	12791
18-#11	3.75	MA	7369	2467	10634	2115	12970	1762	14453	1466	16311	957	20657	325	18607
8L-3S		MI	5238	2467	8510	1969	10223	1617	11442	1320	13308	830	16372	516	12988
18-#14	5.41	MA	8454	2827	13029	2352	15983	1945	18080	1578	21108	946	27328	195	26297
7L-4S		MI	5715	2827	9655	2202	11583	1799	13063	1437	15467	811	19100	284	17483
20-#10	3.40	MA	7813	2389	11391	2044	14084	1697	15794	1409	18170	922	23166	503	19048
6E		MI	4818	2389	7420	1969	8872	1624	9796	1341	11085	865	13747	421	11456
20-#10	3.40	MA	7617	2389	10966	2052	13496	1711	15149	1420	17268	938	21936	468	18507
7L-5S		MI	4956	2389	7693	1953	9187	1616	10200	1328	11633	855	14455	481	11639
20-#10	3.40	MA	7406	2389	10558	2062	12950	1720	14464	1435	16383	954	20749	421	17882
8L-4S		MI	5075	2389	7936	1944	9520	1608	10613	1321	12204	845	15226	535	11951
20-#10	3.40	MA	7168	2389	10162	2073	12419	1729	13794	1443	15482	963	19580	376	17100
9L-3S		MI	5173	2389	8209	1934	9897	1593	11075	1308	12836	842	15999	587	12007
20-#10	3.40	MA	6947	2389	9746	2081	11865	1746	13138	1451	14600	979	18318	324	16334
10L-2S		MI	5361	2389	8599	1925	10393	1586	11676	1302	13647	832	17095	679	12036

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

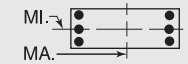
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
20-#11	4.17	MA	8003	2558	11938	2160	14660	1794	16516	1474	19066	934	24429	380	21918
7L-5S		MI	5185	2558	8355	2047	9961	1684	11108	1367	12830	839	15840	374	13777
20-#11	4.17	MA	7755	2558	11442	2172	13996	1803	15696	1492	17989	953	22980	319	20971
8L-4S		MI	5320	2558	8650	2037	10363	1676	11606	1361	13520	828	16744	441	14124
22-#10	3.74	MA	7935	2463	11633	2098	14342	1745	16174	1442	18653	934	23853	464	20467
7L-6S		MI	4990	2463	7811	2015	9368	1658	10397	1362	11896	862	14843	413	12588
22-#10	3.74	MA	7726	2463	11225	2108	13796	1753	15489	1456	17767	950	22666	416	19843
8L-5S		MI	5124	2463	8084	1999	9683	1650	10801	1349	12444	852	15550	473	12764
22-#10	3.74	MA	7495	2463	10829	2119	13265	1763	14819	1464	16867	959	21497	371	19056
9L-4S		MI	5243	2463	8327	1990	10015	1642	11214	1342	13016	841	16321	526	13096
22-#10	3.74	MA	7282	2463	10413	2127	12711	1780	14163	1473	15985	975	20235	319	18285
10L-3S		MI	5336	2463	8599	1980	10393	1627	11676	1329	13647	838	17095	578	13159
22-#11	4.59	MA	8134	2648	12250	2228	15021	1844	16939	1518	19666	949	25303	313	23336
8L-5S		MI	5397	2648	8824	2104	10556	1725	11829	1393	13804	834	17124	360	15128
24-#10	4.07	MA	8040	2537	11892	2154	14642	1787	16515	1477	19152	947	24583	411	21805
8L-6S		MI	5160	2537	8202	2061	9864	1692	10998	1383	12707	858	15938	405	13712
24-#10	4.07	MA	7816	2537	11496	2165	14111	1796	15845	1485	18251	956	23414	366	21012
9L-5S		MI	5291	2537	8474	2045	10179	1684	11402	1370	13255	848	16645	465	13892
24-#10	4.07	MA	7611	2537	11079	2173	13558	1813	15189	1494	17369	972	22152	314	20236
10L-4S		MI	5409	2537	8717	2036	10511	1676	11815	1364	13827	838	17416	518	14211

RECTANGULAR TIED COLUMNS 22" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.14	MA	7550	2011	10109	1775	12332	1494	13556	1274	14815	942	18007	820	7701
2E		MI	4456	2011	6417	1687	7491	1419	8054	1208	8592	889	10006	744	4477
4-#18	2.02	MA	8374	2214	12065	1888	14720	1575	16403	1322	18616	924	23239	799	13256
2E		MI	4837	2214	7464	1791	8737	1493	9524	1250	10543	866	12279	666	7465
6-#11	1.18	MA	7620	2022	10173	1788	12461	1505	13736	1282	15079	945	18389	823	8036
2L-3S		MI	4229	2022	5976	1715	6974	1442	7448	1226	7791	906	9028	643	4686
6-#11	1.18	MA	7101	2022	9309	1804	11363	1519	12406	1295	13284	965	15903	721	8028
3L-2S		MI	4498	2022	6445	1705	7569	1433	8169	1220	8765	896	10312	756	4664
6-#14	1.70	MA	8131	2142	11345	1857	13900	1554	15457	1312	17380	935	21559	811	11386
2L-3S		MI	4376	2142	6417	1783	7491	1490	8054	1254	8592	897	10006	556	6500
6-#14	1.70	MA	7424	2142	10109	1879	12332	1574	13556	1330	14815	963	18007	662	11320
3L-2S		MI	4742	2142	7082	1768	8335	1479	9077	1246	9972	883	11793	720	6489
6-#18	3.03	MA	9317	2446	14220	2033	17456	1681	19719	1389	23092	913	29436	784	19652
2L-3S		MI	4721	2446	7464	1958	8737	1614	9524	1326	10543	873	12279	319	10749
6-#18	3.03	MA	8202	2446	12065	2071	14720	1715	16403	1419	18616	958	23239	511	19290
3L-2S		MI	5297	2446	8605	1936	10185	1598	11279	1317	12911	855	15234	610	10872
8-#9	1.01	MA	7475	1982	9722	1777	11978	1498	13198	1280	14393	955	17470	832	6970
2L-4S		MI	4154	1982	5657	1717	6625	1452	7062	1240	7298	921	8531	672	4105
8-#9	1.01	MA	7130	1982	9158	1787	11263	1508	12330	1290	13223	968	15848	768	6971
3E		MI	4259	1982	5873	1709	6924	1440	7428	1229	7799	918	9149	713	4092
8-#9	1.01	MA	6939	1982	8775	1798	10731	1523	11678	1304	12330	976	14773	729	6948
4L-2S		MI	4441	1982	6183	1701	7317	1433	7905	1224	8443	910	10026	786	4078
8-#10	1.28	MA	7761	2045	10348	1812	12749	1523	14119	1296	15626	950	19168	826	8763
2L-4S		MI	4229	2045	5868	1754	6864	1480	7340	1258	7663	917	9015	628	5089
8-#10	1.28	MA	7337	2045	9635	1826	11844	1536	13023	1307	14146	966	17119	745	8752
3E		MI	4358	2045	6140	1744	7241	1465	7802	1244	8294	914	9789	680	5087
8-#10	1.28	MA	7102	2045	9151	1839	11171	1555	12198	1326	13016	976	15755	694	8686
4L-2S		MI	4581	2045	6531	1735	7737	1457	8403	1238	9106	904	10884	773	5074
8-#11	1.58	MA	8031	2112	11038	1845	13558	1546	15066	1308	16874	941	20874	817	10614
2L-4S		MI	4292	2112	6116	1783	7114	1500	7612	1267	8003	904	9401	567	6078
8-#11	1.58	MA	7533	2112	10173	1861	12461	1561	13736	1322	15079	960	18389	715	10587
3E		MI	4443	2112	6445	1772	7569	1483	8169	1252	8765	902	10312	629	6093
8-#11	1.58	MA	7257	2112	9584	1877	11642	1584	12733	1344	13706	971	16720	652	10463
4L-2S		MI	4703	2112	6914	1761	8164	1475	8890	1246	9738	891	11596	742	6081

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

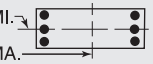
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#14	2.27	MA	8692	2272	12580	1938	15468	1613	17357	1349	19945	929	25111	803	15057
2L-4S		MI	4467	2272	6613	1879	7687	1573	8284	1312	8890	892	10519	447	8237
8-#14	2.27	MA	8023	2272	11345	1960	13900	1634	15457	1368	17380	956	21559	653	14961
3E		MI	4671	2272	7082	1864	8335	1549	9077	1292	9972	891	11793	533	8465
8-#14	2.27	MA	7654	2272	10501	1983	12729	1667	14020	1399	15414	971	19160	562	14561
4L-2S		MI	5022	2272	7747	1850	9178	1538	10099	1284	11352	877	13581	696	8482
8-#18	4.04	MA	9194	2678	14220	2216	17456	1821	19719	1486	23092	947	29436	496	25629
3E		MI	5224	2678	8605	2103	10185	1720	11279	1393	12911	862	15234	263	14068
8-#18	4.04	MA	8630	2678	12741	2253	15404	1877	17203	1539	19650	969	25200	331	22842
4L-2S		MI	5738	2678	9746	2081	11633	1704	13034	1384	15280	844	18190	553	14251
10-#10	1.60	MA	8100	2118	11061	1858	13654	1557	15216	1317	17106	946	21218	821	10886
2L-5S		MI	4291	2118	6015	1809	7027	1522	7529	1285	7902	924	9339	566	6139
10-#10	1.60	MA	7691	2118	10348	1872	12749	1569	14119	1329	15626	963	19168	740	10863
3L-4S		MI	4414	2118	6258	1800	7360	1514	7941	1279	8474	913	10110	620	6245
10-#10	1.60	MA	7470	2118	9864	1885	12076	1589	13294	1347	14496	973	17805	689	10785
4L-3S		MI	4537	2118	6531	1790	7737	1499	8403	1266	9106	910	10884	672	6256
10-#10	1.60	MA	7190	2118	9432	1898	11488	1601	12564	1359	13481	989	16415	649	10514
5L-2S		MI	4754	2118	6922	1781	8233	1491	9004	1259	9917	900	11979	764	6249
10-#11	1.97	MA	8430	2203	11902	1901	14655	1587	16396	1334	18670	937	23360	811	13185
2L-5S		MI	4368	2203	6291	1850	7307	1550	7835	1300	8287	911	9781	487	7165
10-#11	1.97	MA	7952	2203	11038	1917	13558	1602	15066	1348	16874	956	20874	709	13142
3L-4S		MI	4509	2203	6585	1839	7709	1542	8333	1294	8977	900	10685	554	7455
10-#11	1.97	MA	7694	2203	10449	1933	12740	1625	14063	1370	15501	967	19206	646	13004
4L-3S		MI	4652	2203	6914	1828	8164	1525	8890	1278	9738	898	11596	615	7488
10-#11	1.97	MA	7364	2203	9928	1949	12024	1640	13174	1383	14265	987	17511	594	12387
5L-2S		MI	4904	2203	7383	1818	8759	1516	9612	1272	10712	887	12879	728	7488
10-#14	2.84	MA	8601	2403	12580	2042	15468	1693	17357	1405	19945	950	25111	645	18603
3L-4S		MI	4769	2403	7278	1960	8531	1632	9307	1350	10270	886	12307	423	10079
10-#14	2.84	MA	8263	2403	11737	2064	14297	1726	15921	1436	17979	965	22712	554	18132
4L-3S		MI	4959	2403	7747	1946	9178	1609	10099	1329	11352	885	13581	509	10422
10-#14	2.84	MA	7803	2403	10991	2087	13271	1747	14647	1455	16210	992	20279	476	16762
5L-2S		MI	5296	2403	8411	1932	10022	1598	11122	1321	12733	871	15369	672	10461
10-#18	5.05	MA	9653	2910	14897	2398	18140	1983	20519	1606	24125	958	31397	316	29157
4L-3S		MI	5692	2910	9746	2248	11633	1826	13034	1460	15280	851	18190	206	17390
10-#18	5.05	MA	8882	2910	13587	2436	16340	2017	18286	1636	21023	1003	27118	169	26319
5L-2S		MI	6168	2910	10887	2226	13081	1810	14789	1451	17649	833	21145	497	17618
12-#10	1.92	MA	8433	2192	11774	1904	14558	1591	16312	1338	18586	943	23267	816	13004
2L-6S		MI	4318	2192	6134	1871	7208	1563	7725	1320	8165	930	9727	498	7022
12-#10	1.92	MA	8037	2192	11061	1918	13654	1603	15216	1350	17106	959	21218	735	12973
3L-5S		MI	4473	2192	6406	1855	7523	1555	8130	1307	8713	920	10435	558	7242
12-#10	1.92	MA	7828	2192	10577	1931	12981	1623	14391	1368	15976	969	19854	684	12885
4E		MI	4595	2192	6649	1846	7856	1547	8542	1300	9285	910	11206	612	7396
12-#10	1.92	MA	7551	2192	10145	1944	12393	1635	13660	1380	14961	986	18464	644	12582
5L-3S		MI	4713	2192	6922	1836	8233	1532	9004	1287	9917	907	11979	664	7418
12-#10	1.92	MA	7266	2192	9613	1958	11832	1647	12946	1399	13970	995	17125	578	12031
6L-2S		MI	4924	2192	7313	1827	8729	1524	9605	1281	10728	897	13075	756	7419
12-#11	2.36	MA	8360	2293	11902	1974	14655	1643	16396	1374	18670	952	23360	703	15697
3L-5S		MI	4582	2293	6760	1906	7902	1592	8556	1326	9260	906	11064	473	8490
12-#11	2.36	MA	8119	2293	11313	1990	13837	1667	15393	1396	17296	963	21692	640	15548
4E		MI	4721	2293	7054	1896	8304	1583	9055	1320	9951	896	11968	540	8830
12-#11	2.36	MA	7793	2293	10793	2006	13121	1681	14504	1409	16061	982	19996	588	14902
5L-3S		MI	4858	2293	7383	1885	8759	1566	9612	1305	10712	893	12879	601	8877
12-#11	2.36	MA	7456	2293	10148	2022	12447	1696	13634	1431	14854	993	18363	504	14274
6L-2S		MI	5102	2293	7852	1874	9354	1557	10333	1298	11685	883	14163	715	8889

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

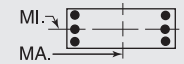
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	3.41	MA	8852	2533	12972	2146	15865	1786	17821	1474	20544	959	26264	545	21713
4E		MI	5063	2533	7943	2042	9375	1692	10329	1387	11650	880	14095	399	11938
12-#14	3.41	MA	8399	2533	12226	2168	14839	1806	16548	1493	18775	986	23831	467	20387
5L-3S		MI	5242	2533	8411	2027	10022	1668	11122	1367	12733	878	15369	485	12375
12-#14	3.41	MA	7942	2533	11310	2192	13872	1827	15302	1524	17047	1001	21487	345	19047
6L-2S		MI	5566	2533	9076	2013	10866	1657	12144	1359	14113	865	17156	649	12432
12-#18	6.06	MA	9878	3142	15742	2581	19076	2123	21601	1703	25499	992	33315	153	32588
5L-3S		MI	6149	3142	10887	2393	13081	1932	14789	1527	17649	840	21145	150	20554
12-#18	6.06	MA	9161	3142	14165	2625	17378	2157	19415	1755	22468	1015	29171	-67	28901
6L-2S		MI	6593	3142	12028	2371	14529	1916	16544	1518	20018	822	24100	440	20978
14-#10	2.24	MA	8375	2266	11774	1964	14558	1637	16312	1371	18586	956	23267	730	15081
3L-6S		MI	4501	2266	6524	1917	7704	1597	8326	1341	8977	927	10823	490	8142
14-#10	2.24	MA	8177	2266	11290	1977	13885	1656	15487	1390	17457	966	21903	680	14986
4L-5S		MI	4652	2266	6797	1901	8019	1589	8731	1328	9525	917	11530	550	8351
14-#10	2.24	MA	7904	2266	10858	1990	13298	1669	14757	1401	16441	982	20513	639	14656
5L-4S		MI	4773	2266	7040	1892	8352	1581	9143	1322	10096	906	12301	604	8546
14-#10	2.24	MA	7628	2266	10326	2004	12737	1680	14043	1420	15450	992	19175	573	14122
6L-3S		MI	4886	2266	7313	1882	8729	1566	9605	1308	10728	903	13075	656	8576
14-#10	2.24	MA	7389	2266	9873	2013	12110	1695	13352	1431	14489	1009	17870	539	13602
7L-2S		MI	5092	2266	7703	1873	9225	1558	10206	1302	11539	893	14170	748	8585
14-#11	2.76	MA	8533	2383	12178	2046	14934	1708	16722	1422	19091	958	24177	634	18094
4L-5S		MI	4792	2383	7229	1963	8497	1633	9278	1352	10234	902	12348	460	9823
14-#11	2.76	MA	8211	2383	11658	2062	14219	1723	15834	1435	17856	978	22482	582	17421
5L-4S		MI	4930	2383	7523	1952	8899	1624	9776	1346	10924	891	13252	526	10203
14-#11	2.76	MA	7887	2383	11012	2079	13544	1737	14964	1457	16649	989	20849	498	16816
6L-3S		MI	5060	2383	7852	1942	9354	1607	10333	1331	11685	889	14163	588	10261
14-#11	2.76	MA	7605	2383	10461	2089	12782	1754	14127	1471	15480	1009	19251	455	15928
7L-2S		MI	5297	2383	8321	1931	9949	1599	11054	1324	12659	878	15447	701	10283
14-#14	3.98	MA	8977	2664	13462	2250	16407	1866	18448	1530	21340	980	27383	459	24018
5L-4S		MI	5351	2664	8608	2123	10218	1752	11352	1425	13030	873	15882	376	13810
14-#14	3.98	MA	8543	2664	12545	2274	15440	1886	17202	1561	19612	995	25038	336	22662
6L-3S		MI	5520	2664	9076	2109	10866	1728	12144	1405	14113	872	17156	461	14325
14-#14	3.98	MA	8166	2664	11757	2288	14360	1911	16002	1580	17936	1022	22740	273	21182
7L-2S		MI	5824	2664	9741	2095	11709	1717	13167	1397	15493	858	18944	625	14398
14-#18	7.07	MA	10174	3374	16320	2770	20114	2263	22731	1822	26943	1004	35368	-83	34903
6L-3S		MI	6596	3374	12028	2538	14529	2037	16544	1594	20018	829	24100	93	23714
16-#10	2.57	MA	8520	2339	12003	2023	14790	1690	16583	1411	18937	962	23953	675	17088
4L-6S		MI	4681	2339	6915	1963	8200	1630	8927	1362	9788	923	11918	482	9266
16-#10	2.57	MA	8249	2339	11571	2036	14202	1702	15853	1422	17921	979	22563	634	16733
5E		MI	4828	2339	7187	1947	8515	1623	9331	1349	10336	913	12625	542	9465
16-#10	2.57	MA	7982	2339	11039	2050	13641	1714	15139	1441	16930	988	21224	568	16215
6L-4S		MI	4949	2339	7431	1938	8848	1615	9744	1343	10908	903	13396	596	9694
16-#10	2.57	MA	7753	2339	10586	2059	13014	1728	14448	1452	15970	1005	19920	534	15697
7L-3S		MI	5056	2339	7703	1928	9225	1600	10206	1329	11539	900	14170	648	9731
16-#10	2.57	MA	7517	2339	10151	2069	12432	1737	13713	1467	15010	1015	18657	487	15006
8L-2S		MI	5257	2339	8094	1919	9721	1592	10807	1323	12350	890	15265	740	9746
16-#11	3.15	MA	8619	2474	12522	2119	15316	1764	17164	1462	19651	974	24968	576	19946
5E		MI	4998	2474	7697	2019	9092	1674	9999	1378	11208	898	13632	446	11162
16-#11	3.15	MA	8307	2474	11877	2135	14642	1779	16294	1484	18445	985	23335	492	19360
6L-4S		MI	5135	2474	7992	2009	9494	1666	10497	1372	11898	887	14536	513	11553
16-#11	3.15	MA	8039	2474	11326	2146	13880	1796	15457	1497	17275	1004	21737	449	18468
7L-3S		MI	5259	2474	8321	1998	9949	1648	11054	1357	12659	885	15447	574	11644
16-#11	3.15	MA	7761	2474	10797	2158	13171	1806	14571	1515	16126	1024	20195	390	17533
8L-2S		MI	5490	2474	8790	1987	10544	1640	11775	1350	13633	874	16731	687	11673

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis

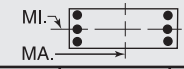


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	4.55	MA	9128	2794	13781	2355	17008	1946	19103	1599	22177	988	28590	327	26278
6L-4S		MI	5634	2794	9273	2205	11062	1811	12374	1463	14411	867	17670	352	15692
16-#14	4.55	MA	8773	2794	12992	2370	15928	1971	17902	1618	20501	1016	26292	264	24784
7L-3S		MI	5800	2794	9741	2190	11709	1788	13167	1442	15493	866	18944	438	16275
16-#14	4.55	MA	8384	2794	12234	2387	14913	1985	16647	1644	18854	1043	24078	176	23101
8L-2S		MI	6081	2794	10406	2176	12553	1777	14189	1434	16873	852	20732	601	16361
18-#10	2.89	MA	8587	2413	12284	2082	15107	1736	16950	1444	19402	975	24612	629	18814
5L-6S		MI	4859	2413	7306	2009	8696	1664	9528	1384	10599	920	13013	474	10392
18-#10	2.89	MA	8329	2413	11752	2096	14546	1748	16236	1462	18411	985	23273	563	18310
6L-5S		MI	5002	2413	7578	1993	9011	1656	9932	1370	11147	910	13721	534	10583
18-#10	2.89	MA	8109	2413	11299	2105	13919	1762	15545	1474	17450	1002	21969	529	17793
7L-4S		MI	5121	2413	7821	1984	9343	1648	10345	1364	11719	899	14492	588	10841
18-#10	2.89	MA	7876	2413	10864	2115	13336	1771	14809	1488	16490	1011	20706	483	17092
8L-3S		MI	5225	2413	8094	1974	9721	1633	10807	1351	12350	896	15265	640	10885
18-#10	2.89	MA	7610	2413	10437	2125	12770	1780	14095	1496	15546	1028	19466	438	16308
9L-2S		MI	5420	2413	8485	1965	10217	1625	11408	1344	13162	886	16361	732	10906
18-#11	3.55	MA	8718	2564	12742	2192	15739	1820	17624	1510	20240	980	25820	486	21907
6L-5S		MI	5201	2564	8166	2076	9687	1716	10720	1404	12181	894	14916	432	12505
18-#11	3.55	MA	8462	2564	12191	2202	14977	1837	16787	1523	19070	1000	24222	443	21007
7L-4S		MI	5337	2564	8460	2065	10089	1707	11218	1398	12871	883	15819	499	12878
18-#11	3.55	MA	8188	2564	11661	2214	14268	1847	15901	1541	17921	1020	22680	384	20064
8L-3S		MI	5456	2564	8790	2055	10544	1690	11775	1383	13633	881	16731	560	13025
18-#11	3.55	MA	7876	2564	11148	2227	13579	1858	15032	1550	16752	1030	21161	329	19056
9L-2S		MI	5680	2564	9259	2044	11139	1681	12497	1376	14606	870	18014	674	13062
18-#14	5.11	MA	9364	2924	14228	2452	17496	2031	19802	1655	23066	1009	29843	255	28385
7L-4S		MI	5932	2924	9937	2286	11906	1871	13397	1500	15791	861	19458	328	17583
18-#14	5.11	MA	8981	2924	13470	2468	16481	2044	18548	1681	21419	1037	27629	168	26712
8L-3S		MI	6066	2924	10406	2272	12553	1847	14189	1480	16873	860	20732	414	18225
20-#10	3.21	MA	8669	2487	12465	2142	15451	1781	17332	1484	19891	981	25323	558	20407
6E		MI	5033	2487	7696	2055	9192	1698	10129	1405	11410	916	14108	466	11521
20-#10	3.21	MA	8458	2487	12011	2151	14824	1796	16641	1495	18930	998	24018	524	19891
7L-5S		MI	5173	2487	7969	2039	9506	1690	10533	1392	11958	906	14816	526	11705
20-#10	3.21	MA	8228	2487	11577	2161	14241	1804	15906	1509	17971	1008	22755	478	19189
8L-4S		MI	5292	2487	8212	2030	9839	1682	10946	1385	12530	896	15587	579	11988
20-#10	3.21	MA	7970	2487	11150	2172	13675	1814	15191	1517	17026	1024	21516	433	18399
9L-3S		MI	5391	2487	8485	2020	10217	1667	11408	1372	13162	893	16361	631	12038
20-#10	3.21	MA	7732	2487	10706	2179	13084	1831	14492	1526	16074	1040	20173	383	17628
10L-2S		MI	5582	2487	8875	2011	10712	1659	12009	1366	13973	883	17456	724	12063
20-#11	3.94	MA	8877	2655	13055	2259	16074	1878	18117	1549	20865	996	26708	437	23546
7L-5S		MI	5401	2655	8635	2133	10282	1757	11441	1431	13155	889	16199	418	13852
20-#11	3.94	MA	8606	2655	12526	2271	15366	1888	17231	1567	19716	1015	25166	378	22594
8L-4S		MI	5537	2655	8929	2122	10684	1748	11940	1424	13845	878	17103	485	14208
20-#11	3.94	MA	8305	2655	12012	2284	14677	1900	16362	1576	18547	1026	23647	323	21590
9L-3S		MI	5660	2655	9259	2111	11139	1731	12497	1409	14606	876	18014	546	14404
20-#14	5.68	MA	9563	3055	14705	2550	18049	2104	20448	1719	23985	1030	31181	159	30323
8L-4S		MI	6204	3055	10602	2368	12749	1930	14419	1538	17171	855	21245	304	19481
22-#10	3.53	MA	8800	2560	12724	2197	15728	1829	17738	1516	20410	995	26068	519	21988
7L-6S		MI	5206	2560	8087	2101	9687	1731	10730	1426	12222	913	15204	458	12652
22-#10	3.53	MA	8573	2560	12289	2207	15146	1838	17002	1530	19451	1004	24805	473	21287
8L-5S		MI	5342	2560	8360	2085	10002	1723	11134	1413	12769	903	15911	517	12829
22-#10	3.53	MA	8323	2560	11863	2218	14579	1848	16288	1539	18506	1021	23565	428	20490
9L-4S		MI	5460	2560	8603	2076	10335	1716	11547	1407	13341	892	16682	571	13135
22-#10	3.53	MA	8094	2560	11419	2225	13989	1865	15589	1548	17554	1036	22222	378	19714
10L-3S		MI	5556	2560	8875	2066	10712	1701	12009	1393	13973	889	17456	623	13190
22-#11	4.33	MA	9016	2745	13391	2327	16463	1930	18561	1593	21511	1011	27651	372	25124
8L-5S		MI	5599	2745	9104	2189	10877	1798	12163	1457	14128	885	17483	405	15202
22-#11	4.33	MA	8725	2745	12877	2340	15774	1941	17691	1603	20342	1022	26132	317	24124
9L-4S		MI	5751	2745	9398	2178	11279	1790	12661	1450	14819	874	18387	471	15544

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#10	3.85	MA	8912	2634	13002	2253	16050	1872	18099	1552	20931	1001	26854	468	23384
8L-6S		MI	5376	2634	8478	2147	10183	1765	11331	1448	13033	909	16299	450	13784
24-#10	3.85	MA	8670	2634	12576	2264	15484	1881	17384	1560	19986	1017	25615	423	22582
9L-5S		MI	5509	2634	8750	2131	10498	1757	11735	1434	13581	899	17007	509	13956
24-#10	3.85	MA	8448	2634	12132	2271	14894	1899	16685	1569	19034	1033	24272	373	21800
10L-4S		MI	5627	2634	8993	2122	10831	1749	12148	1428	14153	889	17778	563	14282
24-#11	4.73	MA	9137	2836	13742	2397	16871	1982	19021	1629	22137	1018	28618	311	26658
9L-5S		MI	5809	2836	9573	2246	11472	1840	12884	1483	15102	881	18767	391	16556
RECTANGULAR TIED COLUMNS 22" x 38"															
4-#14	1.08	MA	8367	2108	11075	1872	13557	1577	14910	1346	16270	999	19755	870	8187
2E		MI	4671	2108	6700	1772	7814	1491	8388	1271	8916	940	10363	788	4500
4-#18	1.91	MA	9261	2311	13166	1985	16110	1658	17955	1395	20335	981	25349	850	14120
2E		MI	5054	2311	7752	1875	9062	1564	9858	1312	10865	916	12633	710	7498
6-#11	1.12	MA	8441	2119	11141	1886	13692	1588	15099	1354	16548	1003	20157	873	8542
2L-3S		MI	4443	2119	6256	1801	7295	1515	7782	1290	8116	957	9387	687	4709
6-#11	1.12	MA	7883	2119	10220	1902	12523	1603	13683	1368	14636	1023	17508	773	8534
3L-2S		MI	4714	2119	6725	1790	7890	1506	8503	1283	9089	946	10671	800	4686
6-#14	1.61	MA	8994	2239	12392	1954	15228	1637	16936	1384	19005	993	23541	862	12115
2L-3S		MI	4590	2239	6700	1867	7814	1562	8388	1317	8916	947	10363	600	6532
6-#14	1.61	MA	8232	2239	11075	1977	13557	1658	14910	1403	16270	1021	19755	715	12049
3L-2S		MI	4959	2239	7365	1853	8657	1551	9410	1309	10296	933	12151	764	6516
6-#18	2.87	MA	10280	2543	15466	2130	19030	1764	21493	1462	25111	970	31962	834	20948
2L-3S		MI	4935	2543	7752	2041	9062	1685	9858	1388	10865	923	12633	363	10807
6-#18	2.87	MA	9074	2543	13166	2169	16110	1799	17955	1493	20335	1017	25349	566	20586
3L-2S		MI	5517	2543	8893	2020	10510	1670	11613	1379	13234	905	15588	653	10911
8-#10	1.22	MA	8591	2142	11325	1910	13995	1606	15503	1368	17126	1007	20980	877	9312
2L-4S		MI	4443	2142	6144	1840	7184	1554	7673	1322	7988	968	9376	673	5115
8-#10	1.22	MA	8135	2142	10566	1923	13032	1619	14336	1380	15550	1024	18798	796	9300
3E		MI	4572	2142	6416	1830	7561	1539	8135	1308	8620	965	10150	725	5108
8-#10	1.22	MA	7884	2142	10052	1937	12317	1639	13459	1399	14349	1035	17355	746	9234
4L-2S		MI	4797	2142	6807	1821	8057	1531	8736	1302	9431	955	11245	817	5094
8-#11	1.49	MA	8884	2209	12062	1942	14861	1629	16516	1380	18461	998	22805	867	11288
2L-4S		MI	4505	2209	6396	1868	7435	1573	7946	1331	8328	955	9760	612	6112
8-#11	1.49	MA	8348	2209	11141	1958	13692	1644	15099	1394	16548	1019	20157	767	11261
3E		MI	4657	2209	6725	1857	7890	1556	8503	1316	9089	953	10671	673	6120
8-#11	1.49	MA	8052	2209	10515	1975	12822	1668	14032	1417	15087	1030	18390	704	11137
4L-2S		MI	4920	2209	7194	1847	8485	1547	9224	1309	10063	942	11955	786	6105
8-#14	2.15	MA	9600	2369	13709	2035	16900	1696	18962	1422	21739	987	27327	853	16029
2L-4S		MI	4680	2369	6896	1963	8010	1645	8618	1375	9214	942	10877	491	8350
8-#14	2.15	MA	8877	2369	12392	2058	15228	1717	16936	1441	19005	1015	23541	706	15933
3E		MI	4886	2369	7365	1949	8657	1621	9410	1355	10296	941	12151	577	8502
8-#14	2.15	MA	8480	2369	11495	2081	13982	1751	15408	1473	16913	1031	21001	616	15565
4L-2S		MI	5239	2369	8029	1935	9501	1610	10433	1347	11676	927	13938	740	8511
8-#18	3.83	MA	10144	2775	15466	2314	19030	1905	21493	1560	25111	1006	31962	551	27357
3E		MI	5439	2775	8893	2186	10510	1791	11613	1455	13234	912	15588	306	14131
8-#18	3.83	MA	9535	2775	13892	2353	16845	1963	18814	1614	21445	1031	27474	387	24551
4L-2S		MI	5959	2775	10034	2165	11958	1776	13368	1446	15603	894	18544	597	14293
10-#10	1.52	MA	8957	2216	12084	1956	14958	1640	16671	1389	18702	1004	23162	872	11571
2L-5S		MI	4504	2216	6291	1895	7347	1595	7862	1349	8228	975	9701	611	6209
10-#10	1.52	MA	8516	2216	11325	1969	13995	1653	15503	1401	17126	1021	20980	791	11549
3L-4S		MI	4628	2216	6534	1886	7680	1587	8274	1343	8799	964	10472	665	6274

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 38"

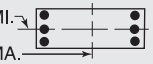
Short columns – no sidesway
Bending on major or minor axis

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.52	MA	8278	2216	10811	1983	13280	1673	14626	1420	15925	1031	19536	741	11470
4L-3S		MI	4752	2216	6807	1876	8057	1572	8736	1330	9431	961	11245	717	6279
10-#10	1.52	MA	7976	2216	10349	1996	12656	1685	13851	1432	14846	1048	18062	702	11250
5L-2S		MI	4971	2216	7198	1867	8553	1564	9337	1323	10242	951	12341	809	6271
10-#11	1.87	MA	9315	2300	12984	1999	16030	1670	17933	1407	20373	994	25453	861	14027
2L-5S		MI	4582	2300	6571	1935	7628	1623	8169	1363	8612	961	10140	531	7245
10-#11	1.87	MA	8799	2300	12062	2015	14861	1685	16516	1421	18461	1014	22805	761	13985
3L-4S		MI	4723	2300	6865	1924	8030	1614	8667	1357	9302	950	11044	598	7493
10-#11	1.87	MA	8522	2300	11436	2031	13991	1709	15449	1443	17000	1026	21038	699	13846
4L-3S		MI	4867	2300	7194	1914	8485	1597	9224	1342	10063	948	11955	659	7518
10-#11	1.87	MA	8164	2300	10880	2047	13230	1724	14505	1457	15687	1046	19239	648	13260
5L-2S		MI	5121	2300	7663	1903	9080	1589	9945	1335	11036	937	13238	773	7514
10-#14	2.69	MA	9500	2500	13709	2140	16900	1777	18962	1479	21739	1009	27327	698	19818
3L-4S		MI	4982	2500	7561	2045	8854	1705	9641	1412	10594	936	12664	467	10189
10-#14	2.69	MA	9136	2500	12812	2163	15654	1811	17434	1510	19647	1025	24787	607	19443
4L-3S		MI	5175	2500	8029	2031	9501	1681	10433	1392	11676	935	13938	553	10461
10-#14	2.69	MA	8636	2500	12019	2186	14564	1832	16080	1530	17766	1053	22205	532	17949
5L-2S		MI	5515	2500	8694	2016	10344	1670	11455	1384	13056	921	15726	716	10494
10-#18	4.78	MA	10636	3007	16192	2498	19765	2069	22353	1681	26221	1020	34088	372	31284
4L-3S		MI	5908	3007	10034	2331	11958	1897	13368	1522	15603	901	18544	249	17454
10-#18	4.78	MA	9798	3007	14800	2537	17851	2104	19977	1713	22920	1067	29542	230	28368
5L-2S		MI	6392	3007	11175	2310	13406	1882	15123	1513	17972	883	21499	540	17662
12-#10	1.82	MA	9315	2289	12843	2002	15921	1674	17838	1411	20277	1000	25343	867	13827
2L-6S		MI	4531	2289	6410	1957	7528	1637	8058	1384	8491	981	10088	543	7088
12-#10	1.82	MA	8888	2289	12084	2015	14958	1686	16671	1423	18702	1017	23162	787	13796
3L-5S		MI	4687	2289	6682	1941	7843	1629	8463	1371	9039	971	10796	603	7311
12-#10	1.82	MA	8663	2289	11570	2029	14243	1706	15794	1442	17501	1028	21718	736	13708
4E		MI	4810	2289	6925	1932	8176	1621	8875	1364	9611	961	11567	657	7427
12-#10	1.82	MA	8364	2289	11108	2042	13619	1719	15018	1453	16422	1045	20244	697	13456
5L-3S		MI	4928	2289	7198	1922	8553	1606	9337	1351	10242	958	12341	709	7443
12-#10	1.82	MA	8057	2289	10542	2056	13018	1731	14260	1472	15370	1055	18824	632	12847
6L-2S		MI	5141	2289	7589	1913	9049	1598	9938	1345	11054	948	13436	801	7442
12-#11	2.24	MA	9239	2390	12984	2072	16030	1727	17933	1447	20373	1010	25453	755	16708
3L-5S		MI	4796	2390	7039	1992	8223	1664	8890	1389	9585	957	11423	518	8569
12-#11	2.24	MA	8979	2390	12357	2088	15160	1751	16866	1469	18912	1022	23686	693	16559
4E		MI	4935	2390	7334	1981	8625	1656	9388	1383	10275	946	12327	584	8870
12-#11	2.24	MA	8625	2390	11801	2104	14399	1766	15922	1483	17599	1042	21888	642	15943
5L-3S		MI	5074	2390	7663	1970	9080	1639	9945	1368	11036	944	13238	646	8909
12-#11	2.24	MA	8263	2390	11113	2120	13676	1780	14998	1506	16318	1054	20155	560	15253
6L-2S		MI	5320	2390	8132	1960	9675	1630	10667	1362	12010	933	14522	759	8916
12-#14	3.23	MA	9770	2630	14129	2244	17325	1870	19460	1548	22382	1018	28573	598	23298
4E		MI	5277	2630	8226	2126	9697	1764	10663	1450	11974	930	14452	443	12044
12-#14	3.23	MA	9277	2630	13337	2267	16235	1891	18106	1568	20500	1047	25991	524	21820
5L-3S		MI	5458	2630	8694	2112	10344	1741	11455	1430	13056	928	15726	529	12416
12-#14	3.23	MA	8787	2630	12353	2291	15208	1913	16782	1599	18663	1063	23505	403	20461
6L-2S		MI	5785	2630	9359	2098	11188	1730	12478	1422	14437	915	17513	693	12466
12-#18	5.74	MA	10869	3239	17100	2682	20770	2210	23515	1780	27697	1056	36156	215	35060
5L-3S		MI	6366	3239	11175	2476	13406	2003	15123	1589	17972	890	21499	193	20730
12-#18	5.74	MA	10097	3239	15403	2725	18965	2245	21190	1834	24472	1081	31767	-4	31747
6L-2S		MI	6818	3239	12316	2455	14854	1987	16878	1580	20341	872	24454	484	21024
14-#10	2.13	MA	9252	2363	12843	2061	15921	1720	17838	1444	20277	1014	25343	782	16042
3L-6S		MI	4715	2363	6800	2003	8024	1670	8659	1405	9302	978	11184	535	8208
14-#10	2.13	MA	9039	2363	12328	2075	15207	1740	16961	1463	19076	1024	23900	732	15946
4L-5S		MI	4867	2363	7073	1988	8339	1662	9064	1392	9850	968	11891	595	8419
14-#10	2.13	MA	8743	2363	11867	2088	14583	1753	16186	1475	17998	1041	22426	692	15666
5L-4S		MI	4988	2363	7316	1978	8671	1654	9476	1386	10422	957	12662	649	8578
14-#10	2.13	MA	8447	2363	11301	2102	13981	1764	15428	1494	16945	1051	21006	627	15075
6L-3S		MI	5102	2363	7589	1968	9049	1639	9938	1372	11054	954	13436	701	8603

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

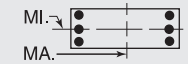
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.13	MA	8190	2363	10819	2111	13315	1779	14687	1505	15925	1069	19627	593	14578
7L-2S		MI	5310	2363	7979	1959	9545	1632	10539	1366	11865	944	14531	793	8609
14-#11	2.61	MA	9424	2481	13279	2144	16329	1792	18283	1495	20825	1017	26335	687	19273
4L-5S		MI	5006	2481	7508	2048	8818	1706	9611	1416	10559	953	12707	504	9901
14-#11	2.61	MA	9075	2481	12722	2160	15568	1807	17339	1509	19512	1038	24536	636	18631
5L-4S		MI	5145	2481	7803	2038	9220	1697	10109	1409	11249	942	13611	571	10245
14-#11	2.61	MA	8726	2481	12034	2177	14845	1821	16415	1532	18230	1049	22803	554	17964
6L-3S		MI	5276	2481	8132	2027	9675	1680	10667	1394	12010	940	14522	632	10295
14-#11	2.61	MA	8424	2481	11448	2188	14034	1839	15525	1546	16987	1070	21113	512	17070
7L-2S		MI	5516	2481	8601	2016	10270	1671	11388	1388	12984	929	15806	745	10312
14-#14	3.77	MA	9900	2761	14654	2349	17907	1951	20132	1605	23235	1040	29778	515	25695
5L-4S		MI	5565	2761	8890	2208	10541	1824	11686	1488	13354	924	16240	419	13913
14-#14	3.77	MA	9433	2761	13670	2373	16880	1972	18808	1637	21397	1056	27291	394	24316
6L-3S		MI	5737	2761	9359	2194	11188	1800	12478	1468	14437	922	17513	505	14368
14-#14	3.77	MA	9027	2761	12831	2388	15719	1997	17532	1656	19616	1085	24857	332	22787
7L-2S		MI	6047	2761	10024	2179	12032	1789	13501	1460	15817	908	19301	669	14434
14-#18	6.70	MA	11186	3471	17704	2870	21885	2351	24728	1901	29248	1070	38380	-19	38258
6L-3S		MI	6815	3471	12316	2621	14854	2109	16878	1656	20341	878	24454	136	23884
16-#10	2.43	MA	9407	2437	13087	2121	16170	1774	18128	1484	20652	1021	26081	727	18186
4L-6S		MI	4896	2437	7191	2049	8519	1704	9260	1427	10113	974	12279	527	9330
16-#10	2.43	MA	9114	2437	12626	2134	15546	1786	17353	1496	19573	1038	24607	688	17879
5E		MI	5044	2437	7463	2034	8834	1696	9665	1413	10661	964	12987	587	9532
16-#10	2.43	MA	8827	2437	12060	2148	14945	1798	16595	1515	18521	1048	23187	622	17305
6L-4S		MI	5164	2437	7707	2024	9167	1688	10077	1407	11233	954	13758	640	9728
16-#10	2.43	MA	8581	2437	11578	2157	14278	1812	15854	1526	17501	1065	21808	589	16809
7L-3S		MI	5273	2437	7979	2014	9545	1673	10539	1393	11865	951	14531	692	9760
16-#10	2.43	MA	8326	2437	11116	2168	13659	1822	15072	1541	16482	1075	20470	544	16050
8L-2S		MI	5476	2437	8370	2005	10040	1665	11140	1387	12676	941	15626	785	9772
16-#11	2.99	MA	9514	2571	13643	2217	16738	1848	18755	1535	21425	1033	27184	630	21323
5E		MI	5213	2571	7977	2105	9413	1747	10333	1442	11532	948	13991	490	11238
16-#11	2.99	MA	9179	2571	12955	2233	16014	1863	17832	1558	20143	1045	25451	548	20677
6L-4S		MI	5350	2571	8271	2094	9815	1738	10831	1435	12222	937	14895	557	11618
16-#11	2.99	MA	8890	2571	12369	2244	15203	1880	16942	1572	18900	1065	23761	506	19775
7L-3S		MI	5476	2571	8601	2083	10270	1721	11388	1420	12984	935	15806	618	11679
16-#11	2.99	MA	8589	2571	11807	2257	14450	1891	15991	1589	17659	1077	22126	448	18843
8L-2S		MI	5709	2571	9069	2073	10865	1713	12109	1414	13957	925	17089	732	11704
16-#14	4.31	MA	10062	2891	14987	2454	18551	2032	20834	1675	24132	1050	31077	385	28170
6L-4S		MI	5849	2891	9555	2290	11384	1883	12708	1525	14735	917	18027	396	15793
16-#14	4.31	MA	9679	2891	14148	2469	17390	2056	19558	1694	22350	1078	28644	324	26649
7L-3S		MI	6020	2891	10024	2275	12032	1860	13501	1505	15817	916	19301	482	16319
16-#14	4.31	MA	9257	2891	13342	2487	16311	2071	18208	1720	20600	1107	26296	238	24820
8L-2S		MI	6305	2891	10688	2261	12875	1849	14523	1497	17197	902	21089	645	16398
18-#10	2.73	MA	9477	2510	13384	2180	16509	1820	18520	1517	21149	1034	26789	683	20097
5L-6S		MI	5073	2510	7582	2095	9015	1738	9861	1448	10925	971	13374	519	10456
18-#10	2.73	MA	9200	2510	12818	2194	15908	1831	17762	1536	20097	1044	25369	617	19537
6L-5S		MI	5217	2510	7854	2080	9330	1730	10266	1434	11473	961	14082	578	10649
18-#10	2.73	MA	8963	2510	12337	2203	15241	1846	17021	1547	19076	1062	23990	584	19039
7L-4S		MI	5337	2510	8097	2070	9663	1722	10678	1428	12044	950	14853	632	10876
18-#10	2.73	MA	8711	2510	11875	2214	14622	1855	16240	1562	18058	1072	22651	539	18283
8L-3S		MI	5442	2510	8370	2060	10040	1707	11140	1415	12676	947	15626	684	10915
18-#10	2.73	MA	8426	2510	11418	2224	14020	1865	15481	1571	17055	1089	21341	494	17486
9L-2S		MI	5640	2510	8761	2051	10536	1699	11741	1408	13487	937	16722	777	10932
18-#11	3.36	MA	9621	2662	13877	2290	17183	1904	19249	1584	22055	1041	28100	542	23393
6L-5S		MI	5417	2662	8446	2161	10008	1788	11054	1468	12506	944	15274	476	12580

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

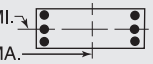


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	3.36	MA	9346	2662	13291	2301	16372	1921	18359	1598	20812	1061	26409	500	22481
7L-4S		MI	5553	2662	8740	2151	10410	1780	11552	1461	13196	933	16178	543	12963
18-#11	3.36	MA	9048	2662	12728	2313	15619	1932	17408	1615	19572	1073	24775	442	21540
8L-3S		MI	5674	2662	9069	2140	10865	1763	12109	1446	13957	931	17089	604	13061
18-#11	3.36	MA	8712	2662	12178	2326	14887	1944	16483	1626	18350	1093	23168	387	20438
9L-2S		MI	5901	2662	9538	2129	11461	1754	12830	1440	14931	920	18373	718	13094
18-#14	4.84	MA	10315	3022	15465	2551	19061	2116	21584	1732	25085	1072	32430	315	30502
7L-4S		MI	6148	3022	10220	2371	12228	1943	13731	1563	16115	911	19815	372	17681
18-#14	4.84	MA	9898	3022	14659	2568	17982	2131	20234	1757	23335	1101	30082	230	28669
8L-3S		MI	6286	3022	10688	2357	12875	1919	14523	1543	17197	910	21089	458	18270
20-#10	3.04	MA	9566	2584	13577	2240	16871	1865	18929	1557	21672	1041	27551	613	21772
6E		MI	5249	2584	7972	2141	9511	1771	10462	1469	11736	967	14470	511	11584
20-#10	3.04	MA	9338	2584	13096	2249	16204	1880	18188	1568	20652	1058	26172	579	21270
7L-5S		MI	5389	2584	8245	2126	9826	1763	10867	1456	12284	957	15177	570	11769
20-#10	3.04	MA	9089	2584	12634	2260	15585	1889	17407	1583	19634	1068	24833	534	20517
8L-4S		MI	5508	2584	8488	2116	10159	1755	11279	1449	12856	947	15948	624	12024
20-#10	3.04	MA	8812	2584	12177	2270	14983	1899	16648	1592	18631	1086	23523	490	19713
9L-3S		MI	5609	2584	8761	2107	10536	1740	11741	1436	13487	944	16722	676	12068
20-#10	3.04	MA	8557	2584	11705	2278	14356	1917	15905	1601	17608	1100	22099	441	18942
10L-2S		MI	5803	2584	9151	2097	11032	1732	12342	1430	14298	934	17817	768	12091
20-#11	3.73	MA	9791	2752	14212	2357	17541	1963	19775	1624	22725	1057	29058	494	25187
7L-5S		MI	5618	2752	8915	2218	10603	1830	11775	1494	13479	940	16558	463	13926
20-#11	3.73	MA	9497	2752	13649	2370	16788	1973	18824	1642	21484	1068	27423	436	24236
8L-4S		MI	5753	2752	9209	2207	11006	1821	12273	1488	14170	929	17462	529	14292
20-#11	3.73	MA	9173	2752	13100	2383	16056	1985	17900	1652	20262	1089	25817	381	23139
9L-3S		MI	5869	2752	9538	2196	11461	1804	12830	1472	14931	927	18373	591	14441
20-#11	3.73	MA	8873	2752	12525	2392	15292	2006	16996	1663	19037	1107	24078	319	21994
10L-2S		MI	6089	2752	10007	2186	12056	1795	13552	1466	15904	916	19657	704	14481
20-#14	5.38	MA	10524	3152	15976	2650	19654	2190	22260	1795	26069	1094	33868	221	32519
8L-4S		MI	6421	3152	10885	2453	13072	2003	14753	1601	17495	905	21603	348	19576
22-#10	3.34	MA	9706	2658	13855	2295	17167	1913	19356	1590	22228	1055	28353	574	23500
7L-6S		MI	5422	2658	8363	2187	10007	1805	11063	1490	12547	964	15565	502	12714
22-#10	3.34	MA	9460	2658	13393	2306	16548	1922	18574	1604	21209	1065	27015	529	22750
8L-5S		MI	5559	2658	8636	2172	10322	1797	11468	1477	13095	954	16273	562	12892
22-#10	3.34	MA	9191	2658	12936	2316	15947	1933	17815	1613	20206	1082	25704	485	21939
9L-4S		MI	5677	2658	8879	2162	10655	1789	11880	1471	13667	943	17044	616	13172
22-#10	3.34	MA	8945	2658	12464	2324	15319	1950	17072	1623	19184	1097	24281	436	21163
10L-3S		MI	5775	2658	9151	2153	11032	1774	12342	1457	14298	940	17817	668	13221
22-#10	3.34	MA	8704	2658	11932	2340	14719	1960	16318	1640	18142	1105	22978	389	20244
11L-2S		MI	5964	2658	9542	2143	11528	1766	12943	1451	15110	930	18912	760	13248
22-#11	4.11	MA	9937	2842	14570	2426	17957	2015	20241	1668	23397	1064	30071	430	26932
8L-5S		MI	5816	2842	9384	2274	11199	1871	12496	1520	14453	935	17842	449	15275
22-#11	4.11	MA	9624	2842	14021	2439	17225	2026	19317	1678	22175	1084	28465	375	25839
9L-4S		MI	5951	2842	9678	2264	11601	1862	12994	1514	15143	925	18746	516	15625
22-#11	4.11	MA	9336	2842	13446	2449	16461	2048	18413	1689	20949	1103	26726	313	24687
10L-3S		MI	6070	2842	10007	2253	12056	1845	13552	1499	15904	922	19657	577	15821
24-#10	3.65	MA	9824	2731	14152	2352	17511	1956	19741	1626	22785	1061	29196	524	24971
8L-6S		MI	5592	2731	8754	2233	10503	1839	11664	1512	13358	960	16660	494	13845
24-#10	3.65	MA	9564	2731	13695	2362	16910	1966	18982	1634	21782	1079	27886	480	24166
9L-5S		MI	5726	2731	9026	2218	10818	1831	12069	1498	13906	950	17368	554	14018
24-#10	3.65	MA	9325	2731	13223	2370	16283	1984	18240	1644	20760	1093	26463	431	23383
10L-4S		MI	5845	2731	9269	2208	11151	1823	12481	1492	14478	940	18139	608	14319
24-#10	3.65	MA	9087	2731	12691	2386	15683	1994	17486	1661	19718	1101	25160	384	22468
11L-3S		MI	5938	2731	9542	2199	11528	1808	12943	1479	15110	937	18912	660	14373
24-#11	4.48	MA	10067	2933	14942	2496	18394	2068	20734	1704	24088	1080	31113	369	28540
9L-5S		MI	6028	2933	9853	2331	11794	1912	13218	1546	15427	931	19126	435	16627
24-#11	4.48	MA	9790	2933	14367	2505	17630	2089	19830	1715	22862	1099	29375	307	27381
10L-4S		MI	6163	2933	10147	2320	12196	1904	13716	1540	16117	920	20029	502	16963

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis

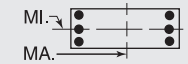


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.02	MA	9224	2206	12080	1969	14834	1660	16323	1419	17786	1057	21573	921	8673
2E		MI	4886	2206	6982	1856	8136	1563	8722	1334	9240	990	10720	832	4522
4-#18	1.82	MA	10188	2409	14305	2083	17553	1741	19564	1467	22114	1039	27529	900	14984
2E		MI	5270	2409	8040	1958	9387	1635	10192	1374	11188	965	12987	753	7531
6-#11	1.06	MA	9302	2216	12148	1983	14975	1671	16521	1427	18078	1060	21995	924	9047
2L-3S		MI	4657	2216	6536	1886	7616	1587	8115	1353	8440	1007	9746	731	4732
6-#11	1.06	MA	8704	2216	11170	2000	13734	1686	15017	1441	16048	1081	19185	825	9039
3L-2S		MI	4929	2216	7005	1875	8211	1579	8836	1347	9414	997	11030	844	4707
6-#14	1.53	MA	9897	2336	13478	2051	16609	1720	18474	1456	20690	1050	25594	912	12844
2L-3S		MI	4804	2336	6982	1952	8136	1634	8722	1380	9240	997	10720	644	6563
6-#14	1.53	MA	9080	2336	12080	2075	14834	1741	16323	1476	17786	1080	21573	767	12778
3L-2S		MI	5175	2336	7647	1938	8980	1623	9744	1372	10620	983	12508	808	6542
6-#18	2.73	MA	11283	2641	16751	2228	20657	1847	23326	1534	27191	1028	34559	885	22244
2L-3S		MI	5148	2641	8040	2125	9387	1756	10192	1450	11188	972	12987	406	10863
6-#18	2.73	MA	9986	2641	14305	2267	17553	1884	19564	1567	22114	1077	27529	621	21882
3L-2S		MI	5736	2641	9181	2103	10834	1741	11947	1441	13556	954	15942	697	10950
8-#10	1.15	MA	9460	2239	12341	2007	15294	1689	16946	1440	18686	1065	22862	927	9861
2L-4S		MI	4656	2239	6420	1926	7503	1627	8007	1386	8314	1019	9738	718	5140
8-#10	1.15	MA	8972	2239	11536	2021	14273	1702	15708	1453	17015	1082	20548	848	9849
3E		MI	4787	2239	6692	1917	7881	1612	8469	1373	8945	1016	10511	770	5129
8-#10	1.15	MA	8704	2239	10991	2035	13516	1723	14779	1472	15743	1093	19025	798	9783
4L-2S		MI	5013	2239	7083	1907	8377	1604	9070	1366	9757	1006	11606	862	5113
8-#11	1.42	MA	9777	2307	13126	2039	16216	1712	18025	1453	20108	1056	24806	918	11962
2L-4S		MI	4719	2307	6676	1953	7756	1646	8279	1394	8653	1005	10119	656	6145
8-#11	1.42	MA	9202	2307	12148	2056	14975	1727	16521	1467	18078	1077	21995	819	11935
3E		MI	4872	2307	7005	1943	8211	1629	8836	1379	9414	1003	11030	717	6145
8-#11	1.42	MA	8885	2307	11485	2073	14053	1752	15391	1490	16530	1089	20131	757	11811
4L-2S		MI	5136	2307	7474	1932	8806	1620	9558	1373	10388	992	12314	831	6129
8-#14	2.05	MA	10547	2467	14877	2133	18384	1779	20626	1494	23594	1044	29614	904	17001
2L-4S		MI	4893	2467	7179	2048	8332	1717	8952	1438	9538	992	11234	535	8458
8-#14	2.05	MA	9771	2467	13478	2156	16609	1801	18474	1514	20690	1073	25594	759	16905
3E		MI	5100	2467	7647	2034	8980	1694	9744	1418	10620	991	12508	621	8537
8-#14	2.05	MA	9346	2467	12527	2180	15288	1835	16854	1547	18472	1090	22912	669	16537
4L-2S		MI	5457	2467	8312	2019	9823	1683	10767	1410	12000	977	14295	784	8540
8-#18	3.64	MA	11134	2872	16751	2412	20657	1990	23326	1634	27191	1066	34559	605	29085
3E		MI	5653	2872	9181	2270	10834	1862	11947	1517	13556	961	15942	349	14190
8-#18	3.64	MA	10480	2872	15081	2452	18339	2048	20484	1690	23301	1092	29819	443	26250
4L-2S		MI	6181	2872	10322	2248	12282	1847	13702	1508	15925	943	18897	640	14335
10-#10	1.44	MA	9853	2313	13146	2053	16316	1723	18184	1462	20357	1061	25176	922	12257
2L-5S		MI	4718	2313	6567	1982	7667	1669	8195	1413	8553	1026	10062	656	6271
10-#10	1.44	MA	9380	2313	12341	2067	15294	1736	16946	1474	18686	1079	22862	843	12235
3L-4S		MI	4842	2313	6810	1972	7999	1661	8608	1407	9125	1015	10833	710	6301
10-#10	1.44	MA	9126	2313	11796	2081	14537	1756	16018	1493	17414	1090	21339	793	12156
4L-3S		MI	4967	2313	7083	1963	8377	1646	9070	1394	9757	1012	11606	762	6302
10-#10	1.44	MA	8800	2313	11304	2093	13877	1769	15197	1506	16272	1107	19781	755	11958
5L-2S		MI	5187	2313	7474	1953	8872	1638	9671	1387	10568	1002	12702	854	6292
10-#11	1.77	MA	10240	2397	14104	2096	17457	1753	19529	1479	22138	1052	27617	912	14870
2L-5S		MI	4796	2397	6850	2020	7949	1696	8502	1427	8936	1012	10499	576	7323
10-#11	1.77	MA	9686	2397	13126	2113	16216	1769	18025	1493	20108	1072	24806	813	14827
3L-4S		MI	4936	2397	7145	2010	8351	1687	9001	1420	9626	1001	11402	642	7529
10-#11	1.77	MA	9389	2397	12463	2129	15294	1793	16894	1516	18560	1085	22941	751	14689
4L-3S		MI	5082	2397	7474	1999	8806	1670	9558	1405	10388	999	12314	704	7547
10-#11	1.77	MA	9003	2397	11869	2145	14489	1809	15894	1531	17169	1106	21039	702	14140
5L-2S		MI	5338	2397	7943	1988	9401	1661	10279	1399	11361	988	13597	817	7540
10-#14	2.56	MA	10440	2597	14877	2238	18384	1861	20626	1552	23594	1067	29614	750	21033
3L-4S		MI	5195	2597	7843	2130	9176	1777	9974	1475	10918	986	13022	511	10296
10-#14	2.56	MA	10048	2597	13926	2261	17063	1895	19006	1584	21376	1084	26933	660	20658
4L-3S		MI	5390	2597	8312	2115	9823	1753	10767	1455	12000	985	14295	597	10500

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis



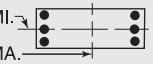
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.56	MA	9509	2597	13081	2284	15909	1917	17572	1604	19382	1113	24201	588	19146
5L-2S		MI	5733	2597	8977	2101	10667	1742	11789	1447	13380	971	16083	760	10526
10-#18	4.55	MA	11660	3104	17527	2597	21442	2154	24245	1757	28378	1081	36849	428	33407
4L-3S		MI	6124	3104	10322	2415	12282	1968	13702	1584	15925	950	18897	293	17516
10-#18	4.55	MA	10753	3104	16051	2637	19414	2191	21726	1790	24878	1130	32038	291	30449
5L-2S		MI	6615	3104	11463	2393	13730	1953	15457	1575	18294	932	21853	583	17706
12-#10	1.73	MA	10237	2387	13951	2099	17337	1757	19422	1483	22028	1058	27490	917	14650
2L-6S		MI	4745	2387	6686	2043	7847	1710	8392	1448	8817	1032	10450	588	7152
12-#10	1.73	MA	9779	2387	13146	2113	16316	1770	18184	1495	20357	1075	25176	838	14618
3L-5S		MI	4902	2387	6958	2028	8162	1702	8796	1435	9364	1022	11157	648	7378
12-#10	1.73	MA	9538	2387	12601	2127	15559	1790	17256	1515	19085	1086	23653	788	14531
4E		MI	5024	2387	7201	2018	8495	1694	9209	1428	9936	1012	11928	701	7457
12-#10	1.73	MA	9216	2387	12109	2139	14899	1803	16435	1527	17944	1104	22095	750	14330
5L-3S		MI	5144	2387	7474	2009	8872	1679	9671	1415	10568	1009	12702	753	7469
12-#10	1.73	MA	8888	2387	11509	2154	14257	1814	15633	1546	16830	1114	20594	686	13668
6L-2S		MI	5358	2387	7865	1999	9368	1671	10272	1409	11379	999	13797	846	7464
12-#11	2.13	MA	10158	2487	14104	2169	17457	1810	19529	1519	22138	1068	27617	807	17719
3L-5S		MI	5010	2487	7319	2077	8544	1737	9224	1453	9910	1007	11782	562	8646
12-#11	2.13	MA	9878	2487	13440	2186	16535	1834	18398	1543	20590	1080	25752	745	17570
4E		MI	5150	2487	7614	2066	8946	1729	9722	1446	10600	997	12686	629	8908
12-#11	2.13	MA	9497	2487	12847	2201	15730	1850	17398	1557	19199	1101	23850	696	16992
5L-3S		MI	5289	2487	7943	2056	9401	1711	10279	1431	11361	994	13597	690	8940
12-#11	2.13	MA	9110	2487	12117	2219	14958	1864	16421	1580	17842	1114	22018	615	16237
6L-2S		MI	5538	2487	8412	2045	9997	1703	11000	1425	12335	984	14881	803	8943
12-#14	3.07	MA	10728	2728	15325	2343	18838	1954	21157	1622	24280	1078	30953	652	24785
4E		MI	5490	2728	8508	2211	10020	1836	10997	1513	12298	980	14809	487	12149
12-#14	3.07	MA	10196	2728	14480	2365	17684	1976	19723	1642	22286	1107	28222	579	23262
5L-3S		MI	5674	2728	8977	2197	10667	1813	11789	1493	13380	979	16083	573	12457
12-#14	3.07	MA	9670	2728	13435	2390	16586	1997	18321	1675	20340	1124	25592	460	21894
6L-2S		MI	6005	2728	9642	2182	11511	1802	12812	1485	14761	965	17871	737	12500
12-#18	5.45	MA	11901	3336	18497	2782	22518	2297	25488	1857	29955	1119	39068	276	37563
5L-3S		MI	6583	3336	11463	2560	13730	2074	15457	1651	18294	939	21853	236	20844
12-#18	5.45	MA	11073	3336	16681	2825	20605	2333	23024	1912	26536	1146	34434	58	34014
6L-2S		MI	7043	3336	12604	2538	15178	2059	17212	1642	20663	921	24808	527	21069
14-#10	2.02	MA	10169	2460	13951	2159	17337	1803	19422	1516	22028	1072	27490	833	17002
3L-6S		MI	4929	2460	7076	2089	8343	1744	8993	1469	9628	1029	11545	580	8271
14-#10	2.02	MA	9940	2460	13406	2173	16580	1823	18494	1536	20756	1083	25967	783	16906
4L-5S		MI	5082	2460	7349	2074	8658	1736	9397	1456	10176	1019	12253	639	8484
14-#10	2.02	MA	9621	2460	12914	2185	15920	1837	17673	1548	19615	1100	24409	745	16683
5L-4S		MI	5203	2460	7592	2064	8991	1728	9810	1450	10748	1008	13024	693	8609
14-#10	2.02	MA	9305	2460	12314	2200	15279	1848	16871	1567	18501	1111	22908	681	16033
6L-3S		MI	5318	2460	7865	2055	9368	1713	10272	1436	11379	1005	13797	745	8629
14-#10	2.02	MA	9030	2460	11804	2209	14572	1863	16080	1578	17421	1129	21454	648	15543
7L-2S		MI	5527	2460	8255	2045	9864	1705	10873	1430	12190	995	14892	838	8632
14-#11	2.48	MA	10356	2578	14418	2242	17776	1876	19902	1569	22620	1076	28563	739	20453
4L-5S		MI	5221	2578	7788	2133	9139	1778	9945	1479	10883	1003	13066	548	9976
14-#11	2.48	MA	9979	2578	13824	2258	16971	1891	18902	1583	21229	1097	26661	690	19849
5L-4S		MI	5359	2578	8082	2123	9542	1770	10443	1473	11574	992	13970	615	10285
14-#11	2.48	MA	9606	2578	13095	2275	16199	1905	17924	1606	19872	1109	24828	609	19117
6L-3S		MI	5493	2578	8412	2112	9997	1753	11000	1458	12335	990	14881	676	10328
14-#11	2.48	MA	9282	2578	12474	2286	15339	1923	16973	1620	18556	1130	23047	568	18223
7L-2S		MI	5734	2578	8880	2101	10592	1744	11721	1451	13308	979	16165	790	10341
14-#14	3.58	MA	10863	2858	15878	2447	19459	2036	21874	1680	25190	1101	32243	571	27382
5L-4S		MI	5780	2858	9173	2293	10863	1896	12019	1551	13678	974	16597	463	14015

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.58	MA	10363	2858	14834	2471	18361	2057	20472	1712	23244	1118	29612	452	25988
6L-3S		MI	5954	2858	9642	2278	11511	1872	12812	1530	14761	972	17871	549	14411
14-#14	3.58	MA	9928	2858	13944	2487	17130	2082	19120	1732	21357	1147	27046	391	24331
7L-2S		MI	6273	2858	10306	2264	12354	1861	13834	1523	16141	959	19658	713	14469
14-#18	6.36	MA	12239	3568	19127	2970	23709	2439	26785	1979	31614	1135	41464	42	41156
6L-3S		MI	7033	3568	12604	2705	15178	2180	17212	1718	20663	928	24808	180	24052
16-#10	2.31	MA	10334	2534	14211	2219	17602	1857	19732	1557	22428	1079	28281	779	19283
4L-6S		MI	5110	2534	7467	2135	8839	1777	9594	1491	10439	1025	12640	572	9392
16-#10	2.31	MA	10018	2534	13719	2231	16941	1870	18911	1569	21286	1097	26723	741	19034
5E		MI	5259	2534	7739	2120	9154	1769	9998	1477	10987	1015	13348	631	9596
16-#10	2.31	MA	9712	2534	13119	2246	16300	1882	18109	1589	20172	1107	25222	676	18400
6L-4S		MI	5379	2534	7983	2110	9487	1762	10411	1471	11559	1005	14119	685	9760
16-#10	2.31	MA	9448	2534	12609	2255	15594	1896	17318	1599	19092	1125	23768	643	17920
7L-3S		MI	5490	2534	8255	2101	9864	1747	10873	1458	12190	1002	14892	737	9787
16-#10	2.31	MA	9174	2534	12120	2266	14938	1906	16490	1614	18015	1136	22354	599	17103
8L-2S		MI	5694	2534	8646	2091	10360	1739	11474	1451	13002	992	15988	829	9797
16-#11	2.84	MA	10449	2668	14802	2314	18212	1933	20406	1609	23259	1093	29471	684	22709
5E		MI	5428	2668	8257	2190	9735	1820	10666	1505	11857	999	14350	534	11312
16-#11	2.84	MA	10090	2668	14073	2332	17439	1947	19428	1632	21902	1105	27639	603	22000
6L-4S		MI	5565	2668	8551	2179	10137	1811	11164	1499	12547	988	15254	601	11660
16-#11	2.84	MA	9781	2668	13452	2343	16580	1964	18477	1646	20586	1126	25857	562	21095
7L-3S		MI	5693	2668	8880	2169	10592	1794	11721	1484	13308	986	16165	662	11713
16-#11	2.84	MA	9456	2668	12856	2356	15782	1975	17469	1664	19272	1138	24129	506	20144
8L-2S		MI	5929	2668	9349	2158	11187	1785	12443	1477	14282	975	17448	776	11735
16-#14	4.09	MA	11036	2988	16233	2553	20136	2116	22623	1750	26148	1111	33633	443	30081
6L-4S		MI	6065	2988	9838	2374	11707	1956	13042	1588	15059	967	18385	440	15892
16-#14	4.09	MA	10626	2988	15343	2568	18905	2141	21272	1770	24260	1141	31067	382	28433
7L-3S		MI	6229	2988	10306	2360	12354	1932	13834	1568	16141	966	19658	526	16363
16-#14	4.09	MA	10170	2988	14489	2586	17761	2157	19828	1795	22377	1157	28585	300	26560
8L-2S		MI	6529	2988	10971	2345	13198	1921	14857	1560	17521	952	21446	689	16434
18-#10	2.60	MA	10408	2608	14524	2277	17963	1904	20149	1591	22957	1093	29037	736	21388
5L-6S		MI	5288	2608	7858	2181	9335	1811	10195	1512	11250	1022	13736	563	10517
18-#10	2.60	MA	10111	2608	13924	2292	17322	1915	19347	1610	21843	1104	27536	672	20770
6L-5S		MI	5433	2608	8130	2166	9650	1803	10599	1498	11798	1012	14443	623	10712
18-#10	2.60	MA	9857	2608	13414	2301	16615	1930	18556	1621	20764	1122	26082	638	20291
7L-4S		MI	5553	2608	8373	2156	9983	1795	11011	1492	12370	1001	15214	677	10910
18-#10	2.60	MA	9586	2608	12925	2312	15960	1939	17728	1636	19686	1132	24668	594	19472
8L-3S		MI	5660	2608	8646	2147	10360	1780	11474	1479	13002	998	15988	729	10943
18-#10	2.60	MA	9281	2608	12438	2322	15323	1950	16925	1645	18625	1150	23287	550	18678
9L-2S		MI	5859	2608	9037	2137	10856	1772	12075	1472	13813	988	17083	821	10958
18-#11	3.19	MA	10564	2759	15050	2388	18680	1988	20932	1658	23931	1101	30450	597	24884
6L-5S		MI	5632	2759	8726	2247	10330	1861	11387	1531	12831	994	15633	521	12653
18-#11	3.19	MA	10268	2759	14429	2399	17821	2006	19980	1672	22616	1122	28668	556	23967
7L-4S		MI	5769	2759	9020	2236	10732	1852	11886	1525	13521	984	16537	587	13034
18-#11	3.19	MA	9947	2759	13834	2412	17022	2017	18973	1690	21302	1134	26940	500	23019
8L-3S		MI	5891	2759	9349	2225	11187	1835	12443	1510	14282	981	17448	649	13096
18-#11	3.19	MA	9588	2759	13247	2425	16247	2029	17994	1700	20009	1155	25247	445	21836
9L-2S		MI	6121	2759	9818	2214	11782	1827	13164	1503	15255	971	18732	762	13125
18-#14	4.60	MA	11306	3119	16742	2650	20680	2201	23423	1808	27164	1134	35088	374	32534
7L-4S		MI	6365	3119	10503	2456	12551	2015	14065	1626	16439	961	20172	416	17777
18-#14	4.60	MA	10856	3119	15887	2668	19536	2216	21979	1833	25281	1151	32606	291	30648
8L-3S		MI	6506	3119	10971	2441	13198	1992	14857	1606	17521	960	21446	502	18314
18-#14	4.60	MA	10372	3119	15053	2686	18424	2233	20576	1847	23426	1180	30167	211	28791
9L-2S		MI	6785	3119	11636	2427	14042	1981	15879	1598	18901	946	23234	665	18397

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
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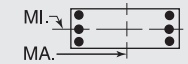
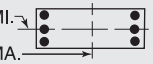


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	2.89	MA	10502	2681	14729	2338	18343	1949	20585	1631	23514	1100	29850	667	23142
6E		MI	5464	2681	8248	2227	9831	1845	10795	1533	12061	1018	14831	555	11644
20-#10	2.89	MA	10258	2681	14219	2347	17637	1964	19794	1642	22435	1118	28396	633	22657
7L-5S		MI	5605	2681	8521	2212	10146	1837	11200	1520	12609	1008	15539	615	11832
20-#10	2.89	MA	9990	2681	13730	2358	16981	1973	18966	1657	21357	1129	26982	590	21841
8L-4S		MI	5725	2681	8764	2202	10479	1829	11612	1513	13181	998	16310	669	12059
20-#10	2.89	MA	9694	2681	13243	2368	16345	1983	18163	1666	20296	1146	25601	546	21040
9L-3S		MI	5827	2681	9037	2193	10856	1814	12075	1500	13813	995	17083	721	12098
20-#10	2.89	MA	9421	2681	12743	2377	15681	2001	17377	1676	19203	1161	24097	498	20210
10L-2S		MI	6023	2681	9427	2183	11352	1806	12676	1494	14624	985	18178	813	12117
20-#11	3.55	MA	10746	2849	15407	2456	19061	2047	21484	1698	24646	1117	31479	550	26839
7L-5S		MI	5834	2849	9195	2303	10925	1902	12109	1557	13804	990	16917	507	13998
20-#11	3.55	MA	10428	2849	14811	2469	18263	2058	20477	1716	23332	1129	29751	494	25894
8L-4S		MI	5970	2849	9489	2292	11327	1894	12607	1551	14494	979	17821	574	14373
20-#11	3.55	MA	10081	2849	14225	2481	17488	2070	19498	1727	22039	1150	28057	439	24703
9L-3S		MI	6087	2849	9818	2282	11782	1877	13164	1536	15255	977	18732	635	14477
20-#11	3.55	MA	9760	2849	13616	2491	16679	2092	18540	1738	20726	1169	26220	378	23542
10L-2S		MI	6311	2849	10287	2271	12377	1868	13885	1529	16229	966	20016	748	14513
20-#14	5.11	MA	11526	3249	17286	2749	21311	2276	24130	1870	28184	1145	36626	282	34737
8L-4S		MI	6639	3249	11167	2537	13394	2075	15087	1664	17819	955	21960	392	19671
20-#14	5.11	MA	11062	3249	16452	2768	20199	2293	22727	1885	26329	1174	34188	203	32869
9L-3S		MI	6770	3249	11636	2523	14042	2051	15879	1643	18901	954	23234	478	20265
22-#10	3.17	MA	10652	2755	15024	2393	18658	1997	21032	1663	24106	1115	30710	629	25023
7L-6S		MI	5637	2755	8639	2273	10327	1878	11396	1554	12873	1015	15926	547	12774
22-#10	3.17	MA	10386	2755	14535	2404	18003	2007	20204	1678	23028	1125	29296	585	24210
8L-5S		MI	5776	2755	8912	2258	10642	1870	11801	1541	13421	1005	16634	607	12954
22-#10	3.17	MA	10099	2755	14048	2414	17366	2017	19401	1687	21967	1143	27915	541	23402
9L-4S		MI	5894	2755	9155	2248	10974	1862	12213	1535	13992	994	17405	661	13207
22-#10	3.17	MA	9835	2755	13548	2423	16703	2035	18615	1697	20874	1157	26411	493	22575
10L-3S		MI	5993	2755	9427	2239	11352	1848	12676	1521	14624	991	18178	713	13251
22-#10	3.17	MA	9567	2755	12985	2439	16062	2045	17817	1714	19771	1165	25035	447	21632
11L-2S		MI	6184	2755	9818	2229	11848	1840	13277	1515	15435	981	19274	805	13275
22-#11	3.90	MA	10899	2940	15789	2525	19504	2099	21980	1742	25362	1125	32561	488	28757
8L-5S		MI	6033	2940	9664	2360	11520	1944	12830	1583	14778	986	18201	493	15346
22-#11	3.90	MA	10564	2940	15202	2538	18728	2112	21002	1753	24069	1146	30868	433	27570
9L-4S		MI	6168	2940	9958	2349	11922	1935	13328	1577	15468	975	19105	560	15706
22-#11	3.90	MA	10255	2940	14594	2548	17920	2133	20044	1764	22756	1165	29031	373	26401
10L-3S		MI	6291	2940	10287	2338	12377	1918	13885	1562	16229	973	20016	621	15858
22-#14	5.63	MA	11736	3380	17850	2850	21974	2352	24878	1923	29233	1168	38208	194	36946
9L-4S		MI	6909	3380	11832	2619	14238	2134	16110	1701	19199	949	23747	368	21571
24-#10	3.46	MA	10776	2828	15340	2450	19024	2040	21443	1700	24700	1122	31610	580	26579
8L-6S		MI	5809	2828	9030	2319	10823	1912	11997	1576	13684	1011	17022	539	13905
24-#10	3.46	MA	10497	2828	14853	2460	18388	2051	20639	1709	23638	1139	30229	536	25764
9L-5S		MI	5944	2828	9302	2304	11137	1904	12402	1562	14232	1001	17729	599	14079
24-#10	3.46	MA	10242	2828	14353	2469	17724	2069	19853	1718	22546	1154	28725	488	24939
10L-4S		MI	6062	2828	9546	2294	11470	1896	12814	1556	14804	991	18500	653	14355
24-#10	3.46	MA	9986	2828	13790	2485	17084	2078	19055	1736	21443	1162	27348	442	23990
11L-3S		MI	6158	2828	9818	2285	11848	1881	13277	1543	15435	988	19274	705	14404
24-#11	4.25	MA	11038	3030	16180	2594	19969	2153	22505	1779	26099	1142	33679	427	30436
9L-5S		MI	6230	3030	10133	2416	12115	1985	13551	1610	15751	982	19485	479	16697
24-#11	4.25	MA	10740	3030	15571	2604	19161	2174	21547	1790	24786	1160	31842	367	29260
10L-4S		MI	6382	3030	10427	2405	12517	1976	14049	1603	16441	971	20388	546	17042

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

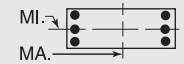


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.73	MA	11155	2506	15484	2180	19049	1824	21233	1539	23953	1096	29780	951	15848
2E		MI	5486	2506	8328	2042	9711	1706	10526	1436	11510	1015	13341	796	7563
6-#11	1.01	MA	10202	2313	13194	2080	16312	1754	18002	1499	19668	1118	23904	974	9553
2L-3S		MI	4871	2313	6816	1971	7938	1660	8449	1417	8765	1058	10105	775	4753
6-#11	1.01	MA	9564	2313	12160	2097	14999	1769	16411	1514	17521	1139	20931	876	9544
3L-2S		MI	5144	2313	7285	1961	8533	1652	9170	1410	9739	1047	11389	889	4728
6-#14	1.46	MA	10840	2433	14603	2148	18043	1802	20071	1529	22436	1108	27717	963	13573
2L-3S		MI	5018	2433	7265	2037	8458	1706	9056	1443	9564	1047	11077	688	6593
6-#14	1.46	MA	9967	2433	13123	2172	16165	1825	17795	1549	19363	1138	23462	820	13507
3L-2S		MI	5390	2433	7930	2022	9302	1695	10078	1435	10944	1034	12865	852	6568
6-#18	2.60	MA	12328	2738	18074	2325	22336	1930	25217	1606	29331	1085	37227	935	23540
2L-3S		MI	5362	2738	8328	2208	9711	1827	10526	1512	11510	1021	13341	449	10917
6-#18	2.60	MA	10938	2738	15484	2366	19049	1968	21233	1641	23953	1136	29780	675	23178
3L-2S		MI	5954	2738	9469	2187	11159	1812	12281	1503	13879	1004	16296	740	10987
8-#10	1.10	MA	10369	2337	13395	2104	16646	1772	18448	1513	20307	1122	24815	977	10409
2L-4S		MI	4870	2337	6696	2012	7823	1700	8340	1450	8639	1070	10099	762	5162
8-#10	1.10	MA	9849	2337	12545	2118	15566	1786	17139	1525	18540	1140	22369	899	10398
3E		MI	5001	2337	6968	2003	8200	1686	8802	1437	9271	1067	10872	814	5149
8-#10	1.10	MA	9563	2337	11970	2133	14767	1806	16158	1545	17197	1151	20766	850	10332
4L-2S		MI	5228	2337	7359	1993	8696	1678	9403	1430	10082	1057	11968	907	5132
8-#11	1.35	MA	10710	2404	14228	2137	17624	1795	19592	1525	21816	1113	26878	968	12636
2L-4S		MI	4932	2404	6956	2038	8078	1719	8613	1458	8977	1056	10478	700	6176
8-#11	1.35	MA	10096	2404	13194	2154	16312	1811	18002	1540	19668	1135	23904	870	12608
3E		MI	5086	2404	7285	2028	8533	1701	9170	1443	9739	1054	11389	762	6170
8-#11	1.35	MA	9758	2404	12494	2171	15338	1835	16807	1564	18033	1148	21942	809	12485
4L-2S		MI	5351	2404	7754	2017	9128	1693	9891	1436	10712	1043	12673	875	6152
8-#14	1.95	MA	11536	2564	16083	2230	19921	1862	22348	1566	25509	1102	31972	954	17973
2L-4S		MI	5106	2564	7461	2133	8655	1789	9286	1501	9861	1042	11591	579	8507
8-#14	1.95	MA	10705	2564	14603	2254	18043	1885	20071	1587	22436	1132	27717	811	17877
3E		MI	5315	2564	7930	2118	9302	1766	10078	1480	10944	1041	12865	665	8572
8-#14	1.95	MA	10251	2564	13599	2278	16647	1919	18359	1620	20092	1149	24894	722	17509
4L-2S		MI	5673	2564	8595	2104	10146	1755	11101	1473	12324	1027	14653	828	8569
8-#18	3.46	MA	12165	2970	18074	2511	22336	2074	25217	1708	29331	1125	37227	659	30813
3E		MI	5868	2970	9469	2353	11159	1933	12281	1579	13879	1010	16296	393	14248
8-#18	3.46	MA	11465	2970	16310	2552	19885	2134	22212	1765	25217	1153	32234	499	27966
4L-2S		MI	6402	2970	10610	2331	12607	1918	14036	1570	16248	992	19251	683	14376
10-#10	1.37	MA	10788	2410	14246	2150	17726	1806	19756	1534	22074	1119	27261	973	12943
2L-5S		MI	4932	2410	6843	2068	7986	1742	8528	1478	8879	1077	10423	700	6305
10-#10	1.37	MA	10284	2410	13395	2164	16646	1819	18448	1547	20307	1137	24815	894	12920
3L-4S		MI	5056	2410	7086	2058	8319	1734	8941	1471	9451	1066	11194	754	6327
10-#10	1.37	MA	10013	2410	12821	2179	15847	1840	17467	1566	18964	1148	23212	845	12842
4L-3S		MI	5182	2410	7359	2049	8696	1719	9403	1458	10082	1063	11968	806	6324
10-#10	1.37	MA	9664	2410	12299	2191	15150	1853	16601	1579	17759	1166	21480	798	12644
5L-2S		MI	5403	2410	7750	2039	9192	1711	10004	1451	10894	1053	13063	899	6312
10-#11	1.69	MA	11204	2494	15263	2193	18937	1836	21183	1551	23963	1109	29851	962	15712
2L-5S		MI	5009	2494	7130	2106	8271	1769	8836	1490	9261	1062	10858	620	7399
10-#11	1.69	MA	10612	2494	14228	2210	17624	1852	19592	1566	21816	1131	26878	864	15670
3L-4S		MI	5150	2494	7425	2095	8673	1760	9334	1484	9951	1051	11761	687	7563
10-#11	1.69	MA	10295	2494	13528	2227	16651	1877	18398	1590	20180	1143	24915	803	15531
4L-3S		MI	5297	2494	7754	2084	9128	1743	9891	1469	10712	1049	12673	748	7575
10-#11	1.69	MA	9881	2494	12897	2243	15801	1893	17343	1605	18712	1165	22910	756	15029
5L-2S		MI	5555	2494	8223	2074	9723	1734	10613	1462	11686	1038	13956	861	7565
10-#14	2.44	MA	11419	2694	16083	2335	19921	1944	22348	1625	25509	1126	31972	802	22248
3L-4S		MI	5409	2694	8126	2214	9498	1849	10308	1538	11242	1036	13379	555	10401
10-#14	2.44	MA	11001	2694	15079	2359	18526	1979	20636	1658	23165	1143	29149	713	21873
4L-3S		MI	5606	2694	8595	2200	10146	1825	11101	1518	12324	1035	14653	641	10537
10-#14	2.44	MA	10421	2694	14181	2382	17307	2001	19122	1679	21060	1173	26269	643	20352
5L-2S		MI	5951	2694	9259	2185	10989	1814	12123	1510	13704	1021	16440	804	10557

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

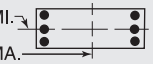
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	4.33	MA	12725	3202	18900	2697	23173	2239	26196	1832	30596	1142	39681	483	35549
4L-3S		MI	6340	3202	10610	2498	12607	2039	14036	1646	16248	999	19251	336	17576
10-#18	4.33	MA	11748	3202	17342	2738	21030	2277	23535	1866	26896	1193	34605	351	32561
5L-2S		MI	6838	3202	11751	2476	14055	2024	15791	1637	18617	981	22206	627	17749
12-#10	1.65	MA	11199	2484	15097	2196	18806	1839	21065	1555	23840	1115	29708	968	15473
2L-6S		MI	4958	2484	6962	2129	8167	1784	8725	1512	9142	1083	10811	633	7214
12-#10	1.65	MA	10709	2484	14246	2210	17726	1853	19756	1568	22074	1133	27261	889	15441
3L-5S		MI	5116	2484	7234	2114	8482	1776	9129	1499	9690	1073	11519	692	7443
12-#10	1.65	MA	10452	2484	13672	2225	16927	1873	18776	1588	20730	1144	25658	840	15354
4E		MI	5238	2484	7477	2104	8815	1768	9542	1492	10262	1063	12290	746	7485
12-#10	1.65	MA	10107	2484	13149	2237	16230	1887	17910	1600	19526	1163	23926	793	15153
5L-3S		MI	5359	2484	7750	2095	9192	1753	10004	1479	10894	1060	13063	798	7493
12-#10	1.65	MA	9758	2484	12516	2251	15549	1898	17064	1620	18350	1174	22434	740	14493
6L-2S		MI	5575	2484	8141	2085	9688	1745	10605	1473	11705	1050	14158	890	7486
12-#11	2.03	MA	11116	2585	15263	2267	18937	1893	21183	1592	23963	1126	29851	858	18730
3L-5S		MI	5225	2585	7599	2162	8866	1810	9557	1516	10234	1058	12141	606	8721
12-#11	2.03	MA	10817	2585	14562	2284	17963	1918	19989	1616	22327	1139	27888	797	18580
4E		MI	5364	2585	7893	2152	9268	1801	10055	1510	10925	1047	13045	673	8945
12-#11	2.03	MA	10408	2585	13931	2299	17114	1934	18933	1631	20859	1161	25883	750	18049
5L-3S		MI	5505	2585	8223	2141	9723	1784	10613	1495	11686	1045	13956	734	8970
12-#11	2.03	MA	9996	2585	13160	2317	16292	1948	17902	1654	19426	1173	23951	670	17227
6L-2S		MI	5755	2585	8691	2130	10318	1776	11334	1488	12659	1034	15240	848	8970
12-#14	2.92	MA	11726	2825	16559	2441	20404	2039	22913	1696	26238	1137	33404	705	26243
4E		MI	5704	2825	8791	2296	10342	1909	11331	1576	12622	1030	15166	531	12251
12-#14	2.92	MA	11154	2825	15661	2463	19186	2061	21399	1716	24133	1167	30524	634	24713
5L-3S		MI	5890	2825	9259	2281	10989	1885	12123	1556	13704	1029	16440	617	12496
12-#14	2.92	MA	10594	2825	14557	2488	18017	2081	19918	1750	22078	1185	27750	518	23345
6L-2S		MI	6224	2825	9924	2267	11833	1874	13146	1548	15085	1015	18228	781	12533
12-#18	5.19	MA	12974	3434	19933	2882	24318	2383	27519	1933	32274	1182	42052	335	40098
5L-3S		MI	6800	3434	11751	2643	14055	2145	15791	1713	18617	988	22206	279	20905
12-#18	5.19	MA	12089	3434	17998	2925	22296	2421	24916	1990	28662	1210	37163	121	36257
6L-2S		MI	7268	3434	12891	2621	15503	2130	17546	1704	20986	970	25162	570	21114
14-#10	1.92	MA	11126	2557	15097	2256	18806	1887	21065	1589	23840	1130	29708	885	17962
3L-6S		MI	5143	2557	7352	2175	8663	1817	9326	1533	9953	1080	11906	624	8332
14-#10	1.92	MA	10881	2557	14523	2271	18007	1907	20085	1609	22497	1141	28105	835	17866
4L-5S		MI	5296	2557	7625	2160	8978	1809	9730	1520	10501	1070	12614	684	8549
14-#10	1.92	MA	10539	2557	14000	2283	17310	1920	19219	1621	21292	1159	26373	788	17664
5L-4S		MI	5418	2557	7868	2150	9311	1801	10143	1514	11073	1059	13385	738	8640
14-#10	1.92	MA	10202	2557	13367	2297	16629	1932	18373	1641	20117	1170	24881	735	16996
6L-3S		MI	5534	2557	8141	2141	9688	1786	10605	1500	11705	1056	14158	790	8655
14-#10	1.92	MA	9910	2557	12828	2307	15883	1947	17532	1652	18978	1188	23352	702	16470
7L-2S		MI	5745	2557	8531	2131	10184	1778	11206	1494	12516	1046	15254	882	8655
14-#11	2.36	MA	11327	2675	15596	2340	19275	1959	21580	1642	24475	1135	30861	791	21632
4L-5S		MI	5436	2675	8068	2219	9461	1851	10279	1542	11208	1054	13425	592	10049
14-#11	2.36	MA	10922	2675	14966	2356	18426	1975	20524	1657	23007	1156	28856	744	21074
5L-4S		MI	5574	2675	8362	2208	9863	1843	10777	1536	11898	1043	14329	659	10323
14-#11	2.36	MA	10525	2675	14195	2373	17605	1989	19492	1680	21574	1169	26924	664	20276
6L-3S		MI	5709	2675	8691	2197	10318	1825	11334	1521	12659	1041	15240	720	10360
14-#11	2.36	MA	10180	2675	13539	2385	16696	2007	18479	1694	20185	1190	25051	623	19387
7L-2S		MI	5953	2675	9160	2187	10913	1817	12055	1515	13633	1030	16524	834	10370
14-#14	3.41	MA	11866	2955	17141	2545	21064	2121	23675	1754	27206	1161	34779	626	29069
5L-4S		MI	5994	2955	9456	2377	11186	1968	12353	1614	14002	1024	16954	507	14114
14-#14	3.41	MA	11332	2955	16037	2570	19895	2141	22195	1787	25151	1179	32005	509	27677
6L-3S		MI	6171	2955	9924	2363	11833	1945	13146	1593	15085	1022	18228	593	14452

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

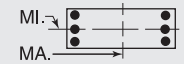


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.41	MA	10868	2955	15097	2586	18594	2167	20755	1807	23158	1209	29307	449	25888
7L-2S		MI	6493	2955	10589	2349	12677	1934	14168	1586	16465	1009	20016	757	14504
14-#18	6.06	MA	13332	3665	20588	3070	25584	2527	28900	2057	34040	1199	44610	106	43823
6L-3S		MI	7251	3665	12891	2788	15503	2251	17546	1780	20986	977	25162	223	24217
14-#18	6.06	MA	12610	3665	18938	3097	23300	2570	26392	2092	30537	1249	39828	-4	39811
7L-2S		MI	7692	3665	14032	2766	16951	2236	19301	1771	23355	959	28117	514	24474
16-#10	2.20	MA	11302	2631	15374	2317	19087	1941	21394	1630	24264	1137	30551	830	20380
4L-6S		MI	5324	2631	7743	2221	9159	1851	9927	1555	10765	1076	13002	616	9453
16-#10	2.20	MA	10963	2631	14851	2329	18390	1954	20528	1643	23059	1155	28819	784	20177
5E		MI	5474	2631	8015	2206	9474	1843	10331	1541	11313	1066	13709	676	9660
16-#10	2.20	MA	10636	2631	14218	2344	17709	1965	19682	1662	21884	1167	27327	730	19501
6L-4S		MI	5594	2631	8259	2196	9807	1835	10744	1535	11884	1056	14480	730	9792
16-#10	2.20	MA	10355	2631	13679	2353	16963	1980	18841	1673	20745	1185	25799	697	18983
7L-3S		MI	5706	2631	8531	2187	10184	1820	11206	1522	12516	1053	15254	782	9815
16-#10	2.20	MA	10061	2631	13163	2364	16271	1990	17967	1688	19608	1196	24309	654	18164
8L-2S		MI	5912	2631	8922	2177	10680	1812	11807	1515	13327	1043	16349	874	9822
16-#11	2.70	MA	11425	2766	16000	2412	19739	2017	22115	1683	25154	1152	31829	738	24104
5E		MI	5643	2766	8537	2275	10056	1892	11000	1569	12182	1049	14709	579	11384
16-#11	2.70	MA	11041	2766	15229	2430	18917	2031	21083	1706	23721	1165	29898	658	23328
6L-4S		MI	5781	2766	8831	2265	10458	1884	11498	1562	12872	1038	15613	645	11700
16-#11	2.70	MA	10712	2766	14573	2441	18009	2049	20070	1720	22332	1186	28024	617	22426
7L-3S		MI	5910	2766	9160	2254	10913	1867	12055	1547	13633	1036	16524	707	11746
16-#11	2.70	MA	10362	2766	13944	2454	17166	2060	19006	1738	20946	1199	26203	562	21404
8L-2S		MI	6148	2766	9629	2243	11508	1858	12776	1541	14607	1025	17807	820	11764
16-#14	3.90	MA	12050	3086	17517	2651	21774	2201	24472	1825	28224	1172	36260	500	32010
6L-4S		MI	6280	3086	10120	2459	12029	2028	13376	1651	15383	1018	18742	484	15989
16-#14	3.90	MA	11612	3086	16577	2667	20472	2226	23031	1845	26231	1202	33562	440	30230
7L-3S		MI	6447	3086	10589	2444	12677	2004	14168	1631	16465	1016	20016	570	16405
16-#14	3.90	MA	11123	3086	15675	2686	19264	2242	21506	1870	24243	1220	30945	359	28321
8L-2S		MI	6752	3086	11254	2430	13520	1993	15191	1623	17845	1002	21803	733	16470
16-#18	6.93	MA	13871	3897	21528	3242	26588	2676	30377	2158	35915	1238	47275	-19	47155
7L-3S		MI	7695	3897	14032	2933	16951	2357	19301	1847	23355	966	28117	166	27384
18-#10	2.47	MA	11378	2705	15702	2375	19470	1988	21837	1664	24826	1152	31265	779	22686
5L-6S		MI	5502	2705	8134	2267	9655	1885	10528	1576	11576	1073	14097	608	10577
18-#10	2.47	MA	11061	2705	15069	2390	18789	1999	20991	1684	23651	1163	29773	725	22008
6L-5S		MI	5649	2705	8406	2252	9970	1877	10932	1563	12124	1063	14805	668	10775
18-#10	2.47	MA	10791	2705	14530	2399	18043	2014	20150	1694	22512	1181	28245	692	21496
7L-4S		MI	5769	2705	8649	2242	10302	1869	11345	1556	12696	1052	15575	722	10942
18-#10	2.47	MA	10500	2705	14014	2410	17351	2024	19276	1709	21375	1192	26755	650	20669
8L-3S		MI	5877	2705	8922	2233	10680	1854	11807	1543	13327	1049	16349	774	10972
18-#10	2.47	MA	10175	2705	13497	2420	16679	2034	18428	1719	20245	1210	25214	596	19884
9L-2S		MI	6078	2705	9313	2223	11176	1846	12408	1537	14138	1039	17444	866	10984
18-#11	3.04	MA	11547	2856	16263	2486	20230	2072	22674	1732	25868	1160	32871	652	26381
6L-5S		MI	5848	2856	9006	2332	10651	1934	11721	1595	13155	1045	15992	565	12724
18-#11	3.04	MA	11231	2856	15607	2498	19321	2090	21661	1746	24480	1182	30997	611	25464
7L-4S		MI	5985	2856	9300	2321	11053	1925	12219	1588	13845	1034	16896	632	13075
18-#11	3.04	MA	10886	2856	14978	2511	18479	2101	20597	1764	23093	1195	29177	556	24446
8L-3S		MI	6109	2856	9629	2310	11508	1908	12776	1573	14607	1032	17807	693	13130
18-#11	3.04	MA	10503	2856	14355	2523	17660	2114	19563	1775	21728	1216	27396	502	23249
9L-2S		MI	6341	2856	10098	2300	12103	1899	13498	1567	15580	1021	19091	806	13156
18-#14	4.38	MA	12337	3216	18057	2749	22351	2286	25308	1882	29305	1196	37817	432	34572
7L-4S		MI	6561	3216	10785	2540	12873	2087	14398	1689	16763	1011	20529	460	17872
18-#14	4.38	MA	11854	3216	17155	2767	21142	2302	23782	1908	27316	1214	35200	351	32649
8L-3S		MI	6727	3216	11254	2526	13520	2064	15191	1669	17845	1010	21803	546	18357
18-#14	4.38	MA	11337	3216	16267	2786	19968	2319	22300	1923	25358	1244	32636	272	30755
9L-2S		MI	7009	3216	11919	2512	14364	2053	16213	1661	19225	996	23591	709	18434
20-#10	2.75	MA	11479	2778	15920	2436	19868	2032	22299	1705	25417	1160	32219	720	24517
6E		MI	5679	2778	8524	2313	10150	1918	11129	1597	12387	1069	15192	600	11704

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	2.75	MA	11218	2778	15381	2445	19123	2048	21458	1715	24278	1178	30691	687	24008
7L-5S		MI	5822	2778	8797	2298	10465	1910	11533	1584	12935	1059	15900	660	11894
20-#10	2.75	MA	10930	2778	14865	2456	18431	2057	20585	1731	23142	1189	29202	645	23174
8L-4S		MI	5941	2778	9040	2288	10798	1902	11946	1577	13507	1049	16671	714	12092
20-#10	2.75	MA	10615	2778	14348	2466	17759	2068	19736	1740	22012	1206	27660	591	22381
9L-3S		MI	6045	2778	9313	2279	11176	1887	12408	1564	14138	1046	17444	766	12127
20-#10	2.75	MA	10324	2778	13820	2475	17059	2086	18907	1750	20859	1221	26166	554	21486
10L-2S		MI	6242	2778	9703	2269	11671	1879	13009	1558	14950	1036	18540	858	12144
20-#11	3.38	MA	11740	2947	16641	2554	20634	2131	23252	1772	26627	1178	33970	605	28503
7L-5S		MI	6050	2947	9475	2388	11246	1975	12442	1621	14129	1041	17276	551	14068
20-#11	3.38	MA	11399	2947	16012	2567	19791	2143	22187	1790	25241	1190	32150	550	27487
8L-4S		MI	6186	2947	9769	2378	11648	1967	12940	1614	14819	1030	18180	618	14450
20-#11	3.38	MA	11028	2947	15389	2580	18972	2155	21154	1801	23876	1212	30370	496	26282
9L-3S		MI	6305	2947	10098	2367	12103	1949	13498	1599	15580	1028	19091	679	14513
20-#11	3.38	MA	10686	2947	14746	2590	18119	2177	20143	1813	22477	1230	28434	437	25110
10L-2S		MI	6532	2947	10567	2356	12698	1941	14219	1593	16554	1017	20375	793	14545
20-#14	4.87	MA	12568	3347	18635	2849	23021	2361	26059	1946	30389	1208	39456	342	36976
8L-4S		MI	6856	3347	11450	2622	13717	2147	15421	1727	18143	1005	22317	436	19764
20-#14	4.87	MA	12072	3347	17747	2867	21846	2379	24577	1961	28431	1238	36891	263	35070
9L-3S		MI	6991	3347	11919	2608	14364	2123	16213	1706	19225	1004	23591	522	20309
22-#10	3.02	MA	11638	2852	16232	2491	20202	2081	22767	1737	26045	1174	33137	683	26521
7L-6S		MI	5853	2852	8915	2359	10646	1952	11730	1618	13198	1066	16288	592	12833
22-#10	3.02	MA	11353	2852	15716	2502	19511	2091	21893	1752	24908	1185	31648	640	25678
8L-5S		MI	5992	2852	9188	2344	10961	1944	12134	1605	13746	1056	16995	652	13015
22-#10	3.02	MA	11047	2852	15199	2512	18839	2102	21045	1761	23779	1203	30106	586	24878
9L-4S		MI	6111	2852	9431	2334	11294	1936	12547	1599	14318	1045	17766	705	13241
22-#10	3.02	MA	10765	2852	14671	2521	18139	2120	20216	1771	22626	1217	28612	550	23986
10L-3S		MI	6212	2852	9703	2325	11671	1921	13009	1585	14950	1042	18540	757	13281
22-#10	3.02	MA	10477	2852	14076	2538	17458	2129	19374	1789	21461	1226	27162	504	23035
11L-2S		MI	6405	2852	10094	2315	12167	1913	13610	1579	15761	1032	19635	850	13302
22-#11	3.71	MA	11901	3037	17047	2624	21103	2184	23778	1816	27388	1186	35123	544	30529
8L-5S		MI	6250	3037	9944	2445	11841	2016	13164	1647	15102	1036	18560	537	15415
22-#11	3.71	MA	11543	3037	16423	2636	20285	2197	22745	1827	26023	1207	33343	490	29315
9L-4S		MI	6385	3037	10238	2434	12243	2008	13662	1640	15793	1026	19464	604	15785
22-#11	3.71	MA	11214	3037	15780	2646	19431	2218	21733	1839	24624	1225	31407	431	28135
10L-3S		MI	6500	3037	10567	2423	12698	1991	14219	1625	16554	1023	20375	666	15894
22-#11	3.71	MA	10883	3037	15056	2667	18611	2230	20707	1860	23205	1235	29635	374	26931
11L-2S		MI	6720	3037	11036	2413	13293	1982	14940	1619	17527	1013	21658	779	15932
22-#14	5.36	MA	12791	3477	19227	2949	23725	2438	26854	1998	31504	1231	41147	255	39385
9L-4S		MI	7127	3477	12115	2703	14560	2207	16443	1764	19523	999	24105	412	21662
24-#10	3.30	MA	11768	2926	16567	2548	20590	2125	23202	1773	26675	1182	34094	635	28183
8L-6S		MI	6024	2926	9306	2405	11142	1985	12331	1640	14010	1062	17383	584	13963
24-#10	3.30	MA	11471	2926	16050	2558	19919	2135	22354	1783	25546	1199	32552	582	27375
9L-5S		MI	6161	2926	9578	2390	11457	1978	12735	1626	14557	1052	18091	643	14140
24-#10	3.30	MA	11198	2926	15522	2567	19219	2153	21524	1793	24392	1214	31058	545	26486
10L-4S		MI	6279	2926	9822	2380	11790	1970	13148	1620	15129	1042	18861	697	14390
24-#10	3.30	MA	10916	2926	14927	2584	18538	2163	20683	1810	23228	1222	29608	500	25529
11L-3S		MI	6377	2926	10094	2371	12167	1955	13610	1607	15761	1039	19635	749	14434
24-#10	3.30	MA	10599	2926	14416	2594	17858	2172	19868	1821	22092	1239	28139	462	24561
12L-2S		MI	6566	2926	10485	2361	12663	1947	14211	1600	16572	1029	20730	842	14460
24-#11	4.05	MA	12048	3127	17457	2693	21597	2238	24335	1853	28170	1203	36316	484	32347
9L-5S		MI	6448	3127	10413	2501	12436	2058	13885	1673	16076	1032	19843	524	16766
24-#11	4.05	MA	11731	3127	16814	2703	20744	2260	23324	1865	26771	1221	34380	425	31160
10L-4S		MI	6583	3127	10707	2491	12838	2049	14383	1667	16766	1021	20747	590	17120
24-#11	4.05	MA	11405	3127	16090	2723	19923	2272	22298	1886	25353	1231	32608	368	29960
11L-3S		MI	6701	3127	11036	2480	13293	2032	14940	1652	17527	1019	21658	652	17275

RECTANGULAR TIED COLUMNS 22" x 44"

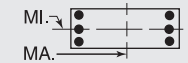
Short columns – no sidesway
Bending on major or minor axis

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#18	1.65	MA	12162	2603	16701	2277	20597	1907	22960	1612	25853	1154	32101	1001	16712
2E		MI	5702	2603	8615	2125	10036	1777	10861	1498	11832	1064	13694	840	7594
6-#14	1.39	MA	11823	2531	15767	2245	19529	1885	21727	1601	24242	1166	29911	1013	14302
2L-3S		MI	5232	2531	7548	2121	8781	1778	9389	1506	9888	1097	11435	732	6621
6-#14	1.39	MA	10893	2531	14205	2270	17547	1908	19325	1622	21000	1196	25422	872	14236
3L-2S		MI	5606	2531	8212	2107	9624	1767	10412	1498	11268	1084	13222	896	6594
6-#18	2.48	MA	13413	2835	19437	2422	24068	2013	27167	1678	31533	1143	39965	986	24836
2L-3S		MI	5575	2835	8615	2292	10036	1898	10861	1574	11832	1071	13694	492	10968
6-#18	2.48	MA	11930	2835	16701	2464	20597	2052	22960	1714	25853	1195	32101	728	24474
3L-2S		MI	6172	2835	9756	2270	11484	1883	12616	1565	14201	1053	16650	783	11023
8-#10	1.05	MA	11318	2434	14489	2201	18051	1855	20008	1585	21988	1180	26839	1028	10958
2L-4S		MI	5084	2434	6972	2098	8143	1774	8673	1514	8965	1121	10460	807	5184
8-#10	1.05	MA	10765	2434	13592	2216	16912	1869	18628	1598	20126	1198	24260	951	10946
3E		MI	5215	2434	7244	2089	8520	1759	9135	1501	9597	1118	11234	859	5168
8-#10	1.05	MA	10462	2434	12987	2230	16071	1890	17596	1618	18712	1210	22577	901	10880
4L-2S		MI	5443	2434	7635	2079	9016	1751	9736	1494	10408	1108	12329	951	5151
8-#11	1.29	MA	11682	2501	15370	2234	19085	1878	21218	1597	23584	1171	29020	1019	13310
2L-4S		MI	5146	2501	7235	2124	8399	1791	8947	1521	9302	1106	10837	745	6206
8-#11	1.29	MA	11029	2501	14279	2251	17701	1894	19541	1613	21319	1193	25884	922	13282
3E		MI	5301	2501	7565	2113	8854	1774	9504	1506	10063	1104	11748	806	6195
8-#11	1.29	MA	10670	2501	13542	2268	16675	1919	18283	1637	19597	1206	23824	861	13159
4L-2S		MI	5567	2501	8034	2102	9449	1766	10225	1500	11037	1093	13031	919	6175
8-#14	1.86	MA	12564	2661	17329	2327	21511	1945	24129	1638	27485	1159	34401	1004	18945
2L-4S		MI	5319	2661	7744	2217	8977	1862	9620	1564	10185	1092	11948	623	8553
8-#14	1.86	MA	11679	2661	15767	2351	19529	1968	21727	1660	24242	1190	29911	863	18849
3E		MI	5530	2661	8212	2203	9624	1838	10412	1543	11268	1091	13222	709	8605
8-#14	1.86	MA	11196	2661	14710	2376	18059	2003	19923	1694	21773	1209	26947	775	18481
4L-2S		MI	5890	2661	8877	2189	10468	1827	11434	1536	12648	1077	15010	872	8597
8-#18	3.31	MA	13236	3067	19437	2609	24068	2158	27167	1781	31533	1184	39965	713	32541
3E		MI	6083	3067	9756	2437	11484	2004	12616	1641	14201	1060	16650	436	14304
8-#18	3.31	MA	12490	3067	17577	2651	21485	2219	23999	1839	27194	1214	34721	554	29699
4L-2S		MI	6623	3067	10897	2415	12932	1989	14370	1632	16570	1042	19605	727	14417
10-#10	1.31	MA	11763	2507	15386	2247	19189	1889	21387	1606	23850	1176	29417	1023	13629
2L-5S		MI	5146	2507	7119	2154	8306	1816	8862	1542	9204	1128	10785	745	6337
10-#10	1.31	MA	11227	2507	14489	2262	18051	1902	20008	1619	21988	1195	26839	946	13606
3L-4S		MI	5270	2507	7362	2144	8639	1808	9274	1535	9776	1117	11555	799	6352
10-#10	1.31	MA	10939	2507	13884	2276	17209	1923	18975	1639	20574	1206	25156	896	13528
4L-3S		MI	5396	2507	7635	2135	9016	1793	9736	1522	10408	1114	12329	851	6346
10-#10	1.31	MA	10567	2507	13332	2289	16476	1937	18064	1652	19306	1225	23335	851	13330
5L-2S		MI	5619	2507	8026	2125	9512	1785	10337	1516	11219	1104	13424	943	6332
10-#11	1.61	MA	12209	2592	16460	2290	20469	1919	22896	1624	25849	1167	32156	1013	16555
2L-5S		MI	5223	2592	7410	2191	8592	1841	9170	1554	9585	1113	11216	664	7474
10-#11	1.61	MA	11578	2592	15370	2308	19085	1935	21218	1639	23584	1189	29020	916	16512
3L-4S		MI	5364	2592	7704	2180	8994	1833	9668	1547	10276	1102	12120	731	7596
10-#11	1.61	MA	11241	2592	14632	2325	18060	1960	19961	1663	21861	1202	26960	855	16374
4L-3S		MI	5512	2592	8034	2170	9449	1815	10225	1532	11037	1100	13031	792	7602
10-#11	1.61	MA	10798	2592	13964	2340	17166	1977	18849	1678	20315	1224	24736	797	15925
5L-2S		MI	5771	2592	8502	2159	10044	1807	10946	1526	12010	1089	14315	906	7589
10-#14	2.32	MA	12439	2792	17329	2433	21511	2028	24129	1698	27485	1184	34401	855	23463
3L-4S		MI	5622	2792	8409	2299	9821	1921	10642	1601	11566	1086	13736	599	10495
10-#14	2.32	MA	11993	2792	16271	2457	20041	2063	22325	1731	25015	1202	31436	766	23088
4L-3S		MI	5821	2792	8877	2285	10468	1898	11434	1581	12648	1085	15010	685	10573
10-#14	2.32	MA	11373	2792	15319	2480	18758	2086	20731	1753	22798	1233	28407	697	21561
5L-2S		MI	6169	2792	9542	2270	11312	1887	12457	1573	14028	1071	16798	848	10587
10-#18	4.13	MA	13830	3299	20313	2796	24956	2324	28206	1906	32874	1203	42584	538	37707
4L-3S		MI	6556	3299	10897	2581	12932	2110	14370	1708	16570	1049	19605	379	17634
10-#18	4.13	MA	12784	3299	18660	2836	22699	2363	25402	1942	28975	1255	37243	409	34688
5L-2S		MI	7061	3299	12038	2560	14379	2095	16125	1699	18939	1031	22560	670	17792

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis



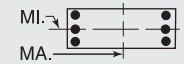
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#10	1.57	MA	12200	2581	16283	2293	20327	1922	22767	1628	25713	1173	31996	1018	16296
2L-6S		MI	5172	2581	7238	2215	8487	1857	9058	1576	9468	1134	11172	677	7274
12-#10	1.57	MA	11680	2581	15386	2308	19189	1936	21387	1640	23850	1191	29417	941	16264
3L-5S		MI	5330	2581	7510	2200	8802	1849	9463	1563	10016	1124	11880	737	7486
12-#10	1.57	MA	11405	2581	14781	2322	18348	1957	20355	1660	22436	1203	27735	892	16176
4E		MI	5453	2581	7753	2190	9134	1841	9875	1556	10587	1114	12651	791	7513
12-#10	1.57	MA	11037	2581	14229	2335	17615	1971	19444	1673	21168	1221	25914	846	15976
5L-3S		MI	5574	2581	8026	2181	9512	1826	10337	1543	11219	1111	13424	843	7516
12-#10	1.57	MA	10668	2581	13561	2349	16893	1981	18554	1693	19932	1233	24346	793	15323
6L-2S		MI	5792	2581	8417	2171	10008	1818	10938	1537	12030	1101	14520	935	7508
12-#11	1.93	MA	12115	2682	16460	2364	20469	1977	22896	1665	25849	1184	32156	910	19741
3L-5S		MI	5439	2682	7879	2248	9187	1883	9891	1580	10559	1108	12500	650	8794
12-#11	1.93	MA	11796	2682	15723	2382	19444	2002	21638	1689	24126	1198	30095	849	19591
4E		MI	5578	2682	8173	2237	9589	1874	10389	1573	11249	1098	13404	717	8980
12-#11	1.93	MA	11359	2682	15055	2397	18550	2018	20527	1704	22580	1220	27872	791	19114
5L-3S		MI	5720	2682	8502	2226	10044	1857	10946	1558	12010	1095	14315	778	9000
12-#11	1.93	MA	10921	2682	14242	2415	17679	2032	19441	1728	21072	1233	25956	724	18222
6L-2S		MI	5972	2682	8971	2215	10639	1848	11667	1552	12984	1085	15599	892	8996
12-#14	2.79	MA	12764	2922	17833	2539	22023	2123	24727	1769	28257	1196	35926	757	27701
4E		MI	5918	2922	9074	2380	10664	1981	11665	1639	12946	1080	15524	575	12351
12-#14	2.79	MA	12153	2922	16881	2561	20740	2146	23133	1791	26040	1227	32896	689	26158
5L-3S		MI	6106	2922	9542	2366	11312	1957	12457	1619	14028	1079	16798	661	12535
12-#14	2.79	MA	11557	2922	15716	2586	19500	2166	21575	1824	23876	1245	29979	574	24813
6L-2S		MI	6443	2922	10207	2352	12155	1946	13479	1611	15409	1065	18585	825	12566
12-#18	4.96	MA	14088	3531	21395	2981	26170	2469	29609	2009	34654	1244	45107	394	42665
5L-3S		MI	7017	3531	12038	2726	14379	2216	16125	1775	18939	1038	22560	323	20965
12-#18	4.96	MA	13145	3531	19353	3024	24023	2506	26867	2067	30848	1274	39963	183	38522
6L-2S		MI	7492	3531	13179	2705	15827	2201	17880	1766	21308	1020	25516	613	21159
14-#10	1.84	MA	12122	2655	16283	2354	20327	1970	22767	1662	25713	1188	31996	936	18922
3L-6S		MI	5356	2655	7628	2261	8983	1891	9659	1597	10279	1131	12268	669	8391
14-#10	1.84	MA	11861	2655	15678	2368	19486	1990	21735	1682	24299	1199	30313	887	18826
4L-5S		MI	5511	2655	7901	2246	9298	1883	10064	1584	10827	1121	12975	729	8611
14-#10	1.84	MA	11497	2655	15126	2381	18753	2004	20824	1695	23031	1218	28492	841	18624
5L-4S		MI	5632	2655	8144	2236	9630	1875	10476	1578	11399	1110	13746	783	8669
14-#10	1.84	MA	11139	2655	14458	2395	18031	2015	19933	1715	21794	1229	26924	788	17964
6L-3S		MI	5750	2655	8417	2227	10008	1860	10938	1564	12030	1107	14520	835	8681
14-#10	1.84	MA	10829	2655	13891	2405	17246	2031	19042	1725	20596	1248	25322	756	17399
7L-2S		MI	5962	2655	8807	2217	10503	1852	11539	1558	12842	1097	15615	927	8678
14-#11	2.26	MA	12338	2772	16814	2438	20828	2043	23316	1715	26391	1193	33231	843	22811
4L-5S		MI	5650	2772	8348	2304	9782	1924	10612	1606	11533	1104	13784	637	10121
14-#11	2.26	MA	11905	2772	16146	2453	19934	2059	22205	1730	24845	1215	31007	785	22308
5L-4S		MI	5789	2772	8642	2293	10184	1915	11110	1599	12223	1093	14688	703	10360
14-#11	2.26	MA	11483	2772	15333	2471	19063	2073	21119	1754	23337	1229	29091	719	21440
6L-3S		MI	5925	2772	8971	2283	10639	1898	11667	1584	12984	1091	15599	765	10391
14-#11	2.26	MA	11117	2772	14642	2483	18106	2091	20045	1767	21875	1250	27126	678	20563
7L-2S		MI	6170	2772	9440	2272	11234	1890	12389	1578	13958	1080	16883	878	10398
14-#14	3.25	MA	12910	3052	18442	2643	22722	2205	25535	1828	29282	1221	37386	680	30754
5L-4S		MI	6209	3052	9738	2462	11508	2040	12687	1677	14326	1074	17311	551	14212
14-#14	3.25	MA	12341	3052	17278	2668	21482	2225	23977	1862	27118	1239	34468	565	29385
6L-3S		MI	6387	3052	10207	2448	12155	2017	13479	1656	15409	1073	18585	637	14492
14-#14	3.25	MA	11848	3052	16288	2685	20111	2251	22448	1881	25021	1270	31638	506	27460
7L-2S		MI	6713	3052	10872	2433	12999	2006	14502	1649	16789	1059	20373	801	14538
14-#18	5.79	MA	14466	3763	22088	3169	27494	2612	31075	2134	36527	1263	47826	168	46513
6L-3S		MI	7469	3763	13179	2871	15827	2322	17880	1842	21308	1027	25516	266	24296

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

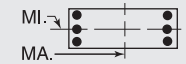
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	5.79	MA	13697	3763	20348	3197	25086	2657	28431	2170	32837	1315	42808	60	42425
7L-2S		MI	7917	3763	14320	2850	17275	2307	19635	1833	23677	1009	28471	557	24520
16-#10	2.10	MA	12308	2728	16575	2414	20624	2024	23114	1703	26161	1196	32892	882	21477
4L-6S		MI	5538	2728	8019	2307	9478	1924	10260	1619	11090	1127	13363	661	9512
16-#10	2.10	MA	11947	2728	16023	2427	19891	2038	22203	1716	24893	1214	31071	836	21275
5E		MI	5689	2728	8291	2292	9793	1916	10665	1605	11638	1117	14070	721	9721
16-#10	2.10	MA	11600	2728	15355	2441	19170	2049	21313	1736	23656	1226	29503	784	20606
6L-4S		MI	5810	2728	8535	2282	10126	1909	11077	1599	12210	1107	14841	775	9822
16-#10	2.10	MA	11301	2728	14788	2451	18384	2064	20422	1746	22458	1244	27900	751	20049
7L-3S		MI	5923	2728	8807	2273	10503	1894	11539	1586	12842	1104	15615	827	9841
16-#10	2.10	MA	10987	2728	14245	2462	17656	2074	19502	1762	21262	1255	26335	709	19233
8L-2S		MI	6130	2728	9198	2263	10999	1886	12140	1579	13653	1094	16710	919	9846
16-#11	2.58	MA	12440	2863	17237	2510	21318	2101	23883	1756	27109	1211	34143	779	25506
5E		MI	5859	2863	8817	2361	10377	1965	11333	1632	12506	1100	15068	623	11455
16-#11	2.58	MA	12032	2863	16424	2528	20447	2114	22797	1780	25601	1224	32227	713	24661
6L-4S		MI	5996	2863	9111	2350	10779	1957	11832	1626	13196	1089	15971	690	11739
16-#11	2.58	MA	11682	2863	15733	2539	19491	2133	21722	1793	24139	1246	30262	672	23768
7L-3S		MI	6127	2863	9440	2339	11234	1939	12389	1610	13958	1087	16883	751	11779
16-#11	2.58	MA	11308	2863	15071	2553	18603	2144	20601	1812	22680	1259	28348	618	22673
8L-2S		MI	6366	2863	9909	2328	11829	1931	13110	1604	14931	1076	18166	864	11794
16-#14	3.72	MA	13105	3183	18840	2749	23464	2285	26379	1900	30361	1233	38958	557	33956
6L-4S		MI	6495	3183	10403	2543	12352	2100	13710	1714	15706	1068	19099	528	16084
16-#14	3.72	MA	12638	3183	17849	2766	22092	2311	24850	1919	28263	1264	36127	497	32041
7L-3S		MI	6664	3183	10872	2529	12999	2076	14502	1694	16789	1066	20373	614	16447
16-#14	3.72	MA	12115	3183	16899	2785	20819	2327	23243	1945	26170	1282	33377	418	30103
8L-2S		MI	6975	3183	11536	2515	13843	2065	15525	1686	18169	1053	22160	777	16506
16-#18	6.61	MA	15036	3995	23084	3342	28558	2763	32638	2237	38516	1303	50672	44	50387
7L-3S		MI	7914	3995	14320	3016	17275	2428	19635	1909	23677	1016	28471	210	27542
18-#10	2.36	MA	12388	2802	16920	2473	21030	2071	23583	1737	26755	1211	33649	831	23926
5L-6S		MI	5717	2802	8410	2353	9974	1958	10861	1640	11901	1124	14458	653	10635
18-#10	2.36	MA	12051	2802	16252	2487	20308	2082	22693	1757	25519	1222	32081	779	23251
6L-5S		MI	5864	2802	8682	2338	10289	1950	11266	1627	12449	1114	15166	713	10836
18-#10	2.36	MA	11764	2802	15685	2497	19523	2098	21802	1767	24320	1241	30479	746	22698
7L-4S		MI	5984	2802	8925	2328	10622	1942	11678	1620	13021	1103	15937	766	10974
18-#10	2.36	MA	11453	2802	15142	2508	18794	2108	20882	1783	23124	1252	28914	704	21874
8L-3S		MI	6094	2802	9198	2319	10999	1927	12140	1607	13653	1100	16710	818	10999
18-#10	2.36	MA	11108	2802	14595	2518	18088	2119	19989	1793	21927	1269	27296	651	21102
9L-2S		MI	6297	2802	9589	2309	11495	1919	12741	1601	14464	1090	17806	911	11009
18-#11	2.90	MA	12569	2953	17515	2584	21832	2156	24474	1806	27866	1220	35363	707	27884
6L-5S		MI	6064	2953	9286	2417	10972	2007	12055	1658	13480	1095	16351	609	12794
18-#11	2.90	MA	12233	2953	16824	2596	20875	2174	23400	1819	26404	1242	33397	666	26973
7L-4S		MI	6200	2953	9580	2406	11374	1998	12553	1652	14170	1085	17255	676	13115
18-#11	2.90	MA	11865	2953	16162	2609	19987	2186	22279	1838	24945	1255	31484	612	25882
8L-3S		MI	6326	2953	9909	2396	11829	1981	13110	1637	14931	1082	18166	737	13164
18-#11	2.90	MA	11457	2953	15501	2622	19125	2199	21191	1849	23503	1277	29502	547	24676
9L-2S		MI	6560	2953	10378	2385	12424	1972	13831	1630	15905	1072	19450	851	13186
18-#14	4.18	MA	13408	3313	19411	2848	24074	2371	27252	1957	31506	1258	40617	489	36623
7L-4S		MI	6777	3313	11068	2625	13195	2160	14732	1752	17087	1061	20887	504	17966
18-#14	4.18	MA	12892	3313	18461	2866	22801	2387	25645	1983	29412	1276	37867	410	34670
8L-3S		MI	6946	3313	11536	2611	13843	2136	15525	1732	18169	1060	22160	590	18400
18-#14	4.18	MA	12342	3313	17520	2885	21565	2405	24084	1999	27351	1307	35177	332	32745
9L-2S		MI	7233	3313	12201	2596	14686	2125	16547	1724	19549	1046	23948	753	18471

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

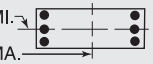


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	2.62	MA	12495	2876	17149	2533	21446	2116	24072	1778	27381	1219	34660	774	25897
6E		MI	5894	2876	8800	2400	10470	1992	11462	1661	12713	1120	15554	645	11762
20-#10	2.62	MA	12218	2876	16582	2543	20661	2131	23181	1789	26183	1237	33057	741	25347
7L-5S		MI	6038	2876	9073	2384	10785	1984	11867	1648	13261	1110	16261	704	11954
20-#10	2.62	MA	11910	2876	16039	2554	19933	2141	22261	1804	24987	1248	31492	699	24514
8L-4S		MI	6157	2876	9316	2374	11118	1976	12279	1642	13832	1100	17032	758	12125
20-#10	2.62	MA	11575	2876	15492	2564	19226	2152	21369	1814	23789	1266	29875	646	23735
9L-3S		MI	6263	2876	9589	2365	11495	1961	12741	1628	14464	1097	17806	810	12155
20-#10	2.62	MA	11257	2876	14936	2573	18489	2171	20496	1824	22575	1281	28305	610	22773
10L-2S		MI	6462	2876	9979	2355	11991	1953	13342	1622	15275	1087	18901	903	12170
20-#11	3.22	MA	12774	3044	17915	2652	22259	2215	25078	1846	28669	1238	36533	660	30178
7L-5S		MI	6266	3044	9755	2474	11567	2048	12776	1684	14453	1091	17635	596	14137
20-#11	3.22	MA	12409	3044	17252	2666	21372	2227	23957	1864	27210	1251	34620	607	29090
8L-4S		MI	6402	3044	10049	2463	11969	2039	13274	1678	15144	1080	18539	662	14491
20-#11	3.22	MA	12016	3044	16592	2678	20510	2240	22868	1875	25768	1272	32638	541	27875
9L-3S		MI	6523	3044	10378	2452	12424	2022	13831	1663	15905	1078	19450	724	14548
20-#11	3.22	MA	11652	3044	15914	2689	19611	2262	21804	1888	24288	1290	30718	495	26698
10L-2S		MI	6752	3044	10847	2442	13020	2014	14552	1656	16878	1067	20734	837	14576
20-#14	4.65	MA	13650	3444	20023	2948	24783	2447	28047	2021	32654	1270	42356	401	39236
8L-4S		MI	7074	3444	11733	2707	14039	2219	15755	1790	18467	1055	22674	480	19855
20-#14	4.65	MA	13123	3444	19081	2966	23547	2465	26486	2036	30593	1301	39667	323	37299
9L-3S		MI	7212	3444	12201	2692	14686	2196	16547	1769	19549	1054	23948	566	20352
22-#10	2.89	MA	12663	2949	17479	2589	21799	2165	24561	1810	28045	1234	35636	736	27996
7L-6S		MI	6068	2949	9191	2446	10966	2025	12063	1682	13524	1117	16649	637	12890
22-#10	2.89	MA	12359	2949	16936	2601	21071	2175	23641	1826	26849	1245	34071	694	27155
8L-5S		MI	6209	2949	9464	2430	11281	2017	12468	1669	14072	1107	17356	696	13075
22-#10	2.89	MA	12034	2949	16389	2610	20364	2186	22748	1835	25651	1262	32454	641	26367
9L-4S		MI	6328	2949	9707	2421	11614	2009	12880	1663	14644	1096	18127	750	13274
22-#10	2.89	MA	11735	2949	15833	2619	19627	2204	21875	1846	24437	1277	30884	605	25408
10L-3S		MI	6430	2949	9979	2411	11991	1994	13342	1649	15275	1093	18901	802	13310
22-#10	2.89	MA	11427	2949	15207	2636	18906	2214	20989	1864	23212	1286	29361	561	24454
11L-2S		MI	6625	2949	10370	2401	12487	1987	13943	1643	16086	1083	19996	894	13329
22-#11	3.55	MA	12943	3134	18343	2722	22756	2268	25634	1890	29474	1247	37755	601	32298
8L-5S		MI	6467	3134	10224	2530	12162	2089	13497	1710	15427	1087	18919	582	15483
22-#11	3.55	MA	12562	3134	17683	2735	21894	2281	24546	1902	28032	1268	35773	535	31074
9L-4S		MI	6602	3134	10518	2519	12565	2081	13995	1704	16117	1076	19823	648	15862
22-#11	3.55	MA	12212	3134	17005	2745	20995	2304	23482	1914	26553	1286	33854	489	29888
10L-3S		MI	6719	3134	10847	2509	13020	2063	14552	1689	16878	1074	20734	710	15930
22-#11	3.55	MA	11859	3134	16242	2766	20126	2315	22401	1935	25059	1296	31991	433	28592
11L-2S		MI	6943	3134	11316	2498	13615	2055	15274	1682	17852	1063	22017	823	15964
22-#14	5.11	MA	13886	3574	20643	3048	25528	2524	28888	2074	33835	1294	44156	314	41852
9L-4S		MI	7346	3574	12397	2788	14883	2279	16777	1827	19847	1049	24462	456	21751
24-#10	3.15	MA	12800	3023	17833	2647	22209	2209	25021	1847	28711	1241	36649	690	29795
8L-6S		MI	6240	3023	9582	2492	11462	2059	12664	1704	14335	1113	17744	628	14020
24-#10	3.15	MA	12484	3023	17286	2656	21502	2219	24128	1856	27513	1259	35032	637	29000
9L-5S		MI	6378	3023	9854	2476	11777	2051	13069	1690	14883	1103	18452	688	14199
24-#10	3.15	MA	12194	3023	16730	2665	20766	2238	23255	1867	26300	1274	33463	601	28044
10L-4S		MI	6497	3023	10098	2467	12110	2043	13481	1684	15455	1093	19223	742	14424
24-#10	3.15	MA	11892	3023	16104	2682	20045	2247	22369	1885	25075	1283	31939	556	27083
11L-3S		MI	6595	3023	10370	2457	12487	2028	13943	1671	16086	1090	19996	794	14464
24-#10	3.15	MA	11556	3023	15565	2693	19329	2257	21512	1896	23879	1299	30399	519	26136
12L-2S		MI	6787	3023	10761	2447	12983	2020	14544	1664	16898	1080	21092	886	14487
24-#11	3.87	MA	13099	3225	18773	2791	23278	2323	26224	1928	30297	1264	38909	529	34273
9L-5S		MI	6665	3225	10693	2587	12758	2130	14218	1736	16401	1082	20202	568	16833
24-#11	3.87	MA	12761	3225	18096	2802	22380	2345	25159	1940	28817	1282	36990	483	33079
10L-4S		MI	6800	3225	10987	2576	13160	2122	14717	1730	17091	1072	21106	635	17197
24-#11	3.87	MA	12412	3225	17333	2822	21510	2356	24079	1961	27323	1292	35127	427	31787
11L-3S		MI	6922	3225	11316	2565	13615	2105	15274	1715	17852	1070	22017	696	17311

RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#9	1.04	MA	3558	1447	4900	1252	5849	1055	6350	901	6825	669	8193	582	3356
2L-3S		MI	3353	1447	4553	1261	5409	1062	5817	907	6106	678	7197	510	3368
6-#10	1.32	MA	3679	1494	5190	1278	6201	1073	6769	911	7384	664	8958	577	4186
2L-3S		MI	3427	1494	4753	1288	5647	1082	6097	919	6477	676	7703	485	4194
6-#11	1.63	MA	3786	1544	5509	1299	6562	1087	7183	918	7925	656	9599	558	5029
2L-3S		MI	3491	1544	4984	1311	5895	1097	6375	926	6834	668	8121	445	5029
6-#14	2.34	MA	4060	1664	6209	1367	7419	1136	8206	947	9292	645	11344	531	7044
2L-3S		MI	3662	1664	5463	1383	6471	1149	7058	958	7742	662	9277	368	6995
6-#18	4.17	MA	4682	1969	7900	1542	9503	1262	10702	1024	12635	622	15443	445	11920
2L-3S		MI	4072	1969	6614	1567	7871	1281	8724	1038	9965	646	11995	154	11517
8-#8	1.10	MA	3591	1456	4945	1262	5921	1062	6444	906	6959	670	8383	583	3533
2L-4S		MI	3336	1456	4479	1275	5307	1078	5697	920	5945	681	7039	494	3543
8-#9	1.39	MA	3717	1505	5246	1289	6288	1081	6883	917	7545	666	9189	578	4398
2L-4S		MI	3406	1505	4660	1305	5516	1101	5942	935	6268	679	7496	464	4388
8-#10	1.76	MA	3874	1567	5627	1324	6755	1107	7440	933	8290	661	10212	572	5495
2L-4S		MI	3494	1567	4887	1345	5782	1132	6254	955	6681	677	8076	426	5439
8-#11	2.17	MA	4013	1635	6035	1356	7229	1129	7992	944	9016	651	11078	549	6600
2L-4S		MI	3571	1635	5143	1379	6055	1157	6562	969	7076	668	8556	371	6456
8-#14	3.13	MA	4370	1795	6956	1448	8366	1195	9354	985	10841	639	13412	514	9260
2L-4S		MI	3781	1795	5687	1480	6696	1234	7321	1018	8083	660	9881	260	8486
8-#18	5.56	MA	5171	2201	9186	1687	11135	1368	12679	1091	15304	611	18892	402	15713
2L-4S		MI	4329	2201	6993	1737	8250	1429	9168	1140	10540	637	12985	-41	12924
10-#10	2.20	MA	4065	1641	6064	1370	7310	1140	8112	954	9197	657	11467	567	6796
2L-5S		MI	3558	1641	5054	1401	5966	1174	6468	983	6952	685	8448	367	6356
10-#10	2.20	MA	3832	1641	5627	1380	6755	1149	7440	961	8290	669	10212	475	6779
3L-4S		MI	3703	1641	5324	1391	6336	1165	6926	976	7587	673	9331	421	6716
10-#11	2.71	MA	4236	1725	6560	1412	7895	1170	8800	970	10107	647	12556	539	8161
2L-5S		MI	3650	1725	5342	1448	6275	1208	6817	1003	7398	677	8994	296	7444
10-#11	2.71	MA	3966	1725	6035	1424	7229	1180	7992	978	9016	660	11078	426	8127
3L-4S		MI	3816	1725	5668	1436	6722	1198	7371	995	8167	664	10034	362	7926
10-#14	3.91	MA	4674	1925	7702	1530	9313	1255	10502	1023	12391	633	15479	497	11468
2L-5S		MI	3893	1925	5967	1578	7005	1307	7679	1066	8537	671	10493	147	9929
10-#14	3.91	MA	4318	1925	6956	1546	8366	1268	9354	1033	10841	650	13412	333	11366
3L-4S		MI	4123	1925	6433	1562	7643	1294	8469	1056	9632	654	11948	243	10595
10-#18	6.94	MA	5170	2433	9186	1857	11135	1493	12679	1171	15304	624	18892	68	18634
3L-4S		MI	4905	2433	8279	1882	9882	1535	11146	1207	13210	626	16433	-84	16238

RECTANGULAR TIED COLUMNS 24" x 26"

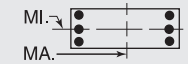
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.00	MA	4147	1560	5713	1349	6802	1137	7368	971	7890	723	9445	630	3783
2E		MI	3808	1560	5312	1337	6275	1126	6772	962	7221	716	8551	616	3468
4-#14	1.44	MA	4363	1640	6247	1391	7444	1167	8129	988	8902	714	10772	614	5298
2E		MI	3997	1640	5794	1379	6853	1156	7455	979	8129	707	9705	597	4839
4-#18	2.56	MA	4858	1843	7534	1503	9009	1247	9992	1036	11388	696	13918	565	8976
2E		MI	4433	1843	6951	1489	8255	1235	9121	1026	10350	688	12420	536	8152
6-#10	1.22	MA	4289	1600	5939	1384	7136	1164	7799	990	8492	727	10294	632	4598
2L-3S		MI	3681	1600	5077	1383	6025	1163	6493	989	6865	732	8136	534	4218
6-#10	1.22	MA	4006	1600	5456	1395	6524	1173	7056	999	7490	740	8906	543	4605
3L-2S		MI	3936	1600	5514	1373	6579	1154	7165	982	7772	720	9391	626	4207
6-#11	1.50	MA	4412	1650	6295	1405	7540	1178	8263	997	9099	718	11118	624	5535
2L-3S		MI	3746	1650	5312	1405	6275	1178	6772	996	7221	724	8551	494	5060
6-#11	1.50	MA	4081	1650	5713	1418	6802	1189	7368	1006	7890	733	9445	510	5534
3L-2S		MI	4043	1650	5837	1393	6942	1168	7580	988	8312	711	10030	607	5054

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

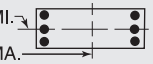


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	2.16	MA	4725	1770	7075	1473	8494	1226	9403	1026	10621	708	13121	603	7773
2L-3S		MI	3917	1770	5794	1476	6853	1229	7455	1027	8129	717	9705	416	7040
6-#14	2.16	MA	4277	1770	6247	1490	7444	1241	8129	1038	8902	727	10772	439	7724
3L-2S		MI	4319	1770	6540	1460	7800	1216	8603	1017	9679	701	11773	580	7075
6-#18	3.85	MA	5443	2075	8965	1648	10825	1353	12193	1103	14359	685	17863	533	13216
2L-3S		MI	4326	2075	6951	1659	8255	1360	9121	1106	10350	701	12420	202	11695
6-#18	3.85	MA	4745	2075	7534	1676	9009	1375	9992	1120	11388	714	13918	242	12904
3L-2S		MI	4948	2075	8237	1634	9887	1341	11099	1093	13020	677	15868	493	11963
8-#8	1.01	MA	4188	1562	5665	1368	6824	1152	7437	985	8019	733	9650	639	3874
2L-4S		MI	3591	1562	4799	1371	5684	1160	6093	991	6334	738	7474	543	3565
8-#8	1.01	MA	4007	1562	5361	1375	6438	1159	6969	990	7388	741	8776	584	3882
3E		MI	3684	1562	4989	1364	5948	1149	6416	982	6776	734	8026	577	3559
8-#8	1.01	MA	3904	1562	5152	1382	6147	1170	6613	1000	6901	745	8174	551	3884
4L-2S		MI	3847	1562	5265	1357	6297	1144	6840	977	7348	727	8818	633	3550
8-#9	1.28	MA	4332	1611	5999	1395	7231	1172	7923	996	8668	729	10543	634	4830
2L-4S		MI	3660	1611	4982	1401	5894	1183	6338	1006	6657	736	7930	514	4418
8-#9	1.28	MA	4109	1611	5616	1404	6746	1180	7334	1003	7873	739	9443	564	4835
3E		MI	3774	1611	5221	1392	6226	1170	6746	994	7214	732	8627	556	4426
8-#9	1.28	MA	3983	1611	5353	1412	6380	1193	6886	1016	7260	744	8682	522	4820
4L-2S		MI	3975	1611	5568	1384	6666	1163	7279	988	7934	722	9623	628	4418
8-#10	1.63	MA	4510	1674	6421	1430	7749	1197	8541	1011	9495	723	11682	627	6043
2L-4S		MI	3748	1674	5211	1440	6160	1213	6651	1025	7069	733	8509	475	5479
8-#10	1.63	MA	4237	1674	5939	1441	7136	1207	7799	1020	8492	736	10294	538	6038
3E		MI	3888	1674	5514	1429	6579	1197	7165	1011	7772	728	9391	529	5517
8-#10	1.63	MA	4084	1674	5605	1452	6674	1224	7233	1035	7718	742	9331	484	5988
4L-2S		MI	4132	1674	5950	1419	7134	1188	7836	1003	8679	717	10645	621	5517
8-#11	2.00	MA	4670	1741	6877	1462	8279	1219	9159	1023	10307	714	12791	618	7274
2L-4S		MI	3825	1741	5471	1473	6435	1237	6959	1039	7463	724	8986	420	6537
8-#11	2.00	MA	4353	1741	6295	1475	7540	1230	8263	1032	9099	728	11118	504	7254
3E		MI	3988	1741	5837	1462	6942	1219	7580	1022	8312	720	10030	484	6615
8-#11	2.00	MA	4173	1741	5892	1487	6981	1250	7579	1050	8162	734	9943	438	7156
4L-2S		MI	4272	1741	6362	1450	7609	1209	8388	1014	9403	707	11508	598	6627
8-#14	2.88	MA	5076	1901	7903	1554	9545	1286	10676	1064	12340	702	15469	591	10232
2L-4S		MI	4034	1901	6018	1574	7078	1314	7718	1087	8470	716	10309	309	8635
8-#14	2.88	MA	4653	1901	7075	1572	8494	1301	9403	1076	10621	721	13121	427	10152
3E		MI	4251	1901	6540	1558	7800	1288	8603	1065	9679	711	11773	399	9229
8-#14	2.88	MA	4413	1901	6499	1589	7697	1328	8426	1101	9286	728	11466	333	9499
4L-2S		MI	4632	1901	7286	1542	8747	1275	9751	1054	11228	695	13840	563	9294
8-#18	5.13	MA	5998	2307	10396	1793	12641	1459	14394	1170	17329	674	21808	501	17441
2L-4S		MI	4577	2307	7330	1830	8634	1508	9565	1209	10925	691	13409	7	13376
8-#18	5.13	MA	5395	2307	8965	1821	10825	1481	12193	1187	14359	703	17863	210	17067
3E		MI	4899	2307	8237	1804	9887	1466	11099	1173	13020	690	15868	159	15306
8-#18	5.13	MA	5001	2307	7962	1849	9438	1526	10495	1227	12039	710	15067	50	14793
4L-2S		MI	5441	2307	9523	1779	11519	1447	13077	1160	15690	666	19317	450	15759
10-#10	2.04	MA	4725	1747	6904	1476	8362	1231	9284	1033	10497	720	13070	623	7482
2L-5S		MI	3812	1747	5378	1496	6345	1255	6864	1054	7341	741	8881	417	6451
10-#10	2.04	MA	4463	1747	6421	1487	7749	1241	8541	1041	9495	733	11682	533	7465
3L-4S		MI	3957	1747	5647	1486	6714	1246	7322	1046	7976	729	9764	470	6759
10-#10	2.04	MA	4318	1747	6088	1498	7287	1257	7975	1057	8721	738	10719	479	7402
4L-3S		MI	4089	1747	5950	1475	7134	1230	7836	1032	8679	725	10645	524	6809
10-#10	2.04	MA	4151	1747	5792	1509	6881	1267	7472	1065	8022	751	9750	429	7054
5L-2S		MI	4325	1747	6387	1465	7688	1221	8508	1024	9586	713	11900	616	6821
10-#11	2.50	MA	4921	1831	7459	1518	9017	1260	10054	1049	11515	710	14464	612	9004
2L-5S		MI	3904	1831	5669	1542	6655	1289	7213	1073	7786	732	9424	345	7552
10-#11	2.50	MA	4617	1831	6877	1531	8279	1272	9159	1059	10307	724	12791	498	8970
3L-4S		MI	4071	1831	5996	1530	7102	1279	7767	1065	8554	720	10465	411	8049
10-#11	2.50	MA	4450	1831	6474	1544	7720	1291	8474	1077	9370	730	11616	432	8854
4L-3S		MI	4223	1831	6362	1518	7609	1260	8388	1048	9403	715	11508	475	8165

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

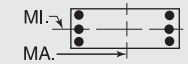
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.50	MA	4256	1831	6115	1557	7228	1302	7864	1086	8524	744	10439	367	8274
5L-2S		MI	4497	1831	6888	1506	8276	1250	9196	1040	10494	703	12986	588	8191
10-#14	3.61	MA	5419	2031	8731	1636	10596	1345	11949	1101	14059	696	17818	579	12683
2L-5S		MI	4147	2031	6298	1672	7387	1387	8076	1135	8924	726	10921	196	10128
10-#14	3.61	MA	5017	2031	7903	1653	9545	1360	10676	1114	12340	715	15469	416	12581
3L-4S		MI	4376	2031	6764	1655	8025	1374	8866	1125	10019	709	12377	292	10738
10-#14	3.61	MA	4798	2031	7327	1671	8748	1388	9699	1138	11005	722	13815	322	11847
4L-3S		MI	4576	2031	7286	1639	8747	1348	9751	1102	11228	705	13840	382	11416
10-#14	3.61	MA	4531	2031	6813	1689	8045	1403	8828	1151	9797	741	12162	227	11131
5L-2S		MI	4937	2031	8033	1623	9694	1335	10899	1092	12778	688	15907	545	11504
10-#18	6.41	MA	5991	2539	10396	1966	12641	1587	14394	1254	17329	692	21808	177	21073
3L-4S		MI	5154	2539	8616	1975	10266	1614	11543	1276	13595	680	16858	-36	16777
10-#18	6.41	MA	5692	2539	9393	1994	11254	1632	12696	1294	15010	699	19012	18	18909
4L-3S		MI	5428	2539	9523	1949	11519	1572	13077	1240	15690	678	19317	116	18870
12-#10	2.44	MA	4936	1821	7387	1522	8974	1265	10026	1054	11499	716	14458	618	8916
2L-6S		MI	3849	1821	5505	1557	6550	1298	7087	1090	7626	742	9273	340	7439
12-#10	2.44	MA	4683	1821	6904	1533	8362	1274	9284	1062	10497	729	13070	528	8891
3L-5S		MI	4018	1821	5815	1542	6899	1289	7536	1075	8247	738	10136	412	7697
12-#10	2.44	MA	4547	1821	6571	1544	7900	1291	8718	1078	9723	735	12107	475	8817
4E		MI	4161	1821	6084	1532	7268	1280	7994	1068	8883	726	11018	465	8038
12-#10	2.44	MA	4382	1821	6275	1555	7494	1301	8214	1086	9024	748	11138	424	8439
5L-3S		MI	4285	1821	6387	1521	7688	1264	8508	1053	9586	721	11900	519	8099
12-#10	2.44	MA	4195	1821	5927	1570	7111	1311	7721	1102	8341	754	10196	353	8137
6L-2S		MI	4513	1821	6824	1511	8242	1255	9180	1046	10492	710	13154	611	8120
12-#11	3.00	MA	5168	1922	8041	1575	9756	1302	10949	1075	12724	705	16137	606	10730
2L-6S		MI	3947	1922	5828	1617	6898	1340	7478	1116	8141	741	9948	261	8612
12-#11	3.00	MA	4875	1922	7459	1588	9017	1313	10054	1085	11515	720	14464	492	10683
3L-5S		MI	4146	1922	6195	1598	7321	1330	8021	1099	8877	728	10903	335	9055
12-#11	3.00	MA	4719	1922	7056	1600	8458	1333	9369	1103	10579	726	13289	426	10499
4E		MI	4311	1922	6521	1587	7769	1320	8575	1091	9645	715	11943	401	9526
12-#11	3.00	MA	4528	1922	6697	1613	7966	1344	8759	1112	9732	740	12112	361	9947
5L-3S		MI	4453	1922	6888	1575	8276	1302	9196	1075	10494	711	12986	465	9712
12-#11	3.00	MA	4309	1922	6283	1632	7501	1355	8161	1130	8904	746	10962	273	9454
6L-2S		MI	4717	1922	7413	1563	8942	1292	10005	1067	11585	698	14465	579	9750
12-#14	4.33	MA	5373	2162	8731	1735	10596	1420	11949	1151	14059	709	17818	404	15010
3L-5S		MI	4482	2162	7044	1753	8334	1446	9224	1173	10473	720	12988	179	12257
12-#14	4.33	MA	5172	2162	8154	1753	9798	1447	10972	1176	12723	716	16164	310	14209
4E		MI	4709	2162	7510	1737	8972	1433	10014	1163	11569	703	14444	274	12855
12-#14	4.33	MA	4908	2162	7641	1770	9096	1462	10101	1188	11515	735	14511	215	13530
5L-3S		MI	4893	2162	8033	1721	9694	1408	10899	1140	12778	699	15907	365	13604
12-#18	7.69	MA	6317	2771	10824	2139	13070	1738	14897	1361	17980	688	22958	-14	22904
4E		MI	5709	2771	9902	2119	11898	1720	13521	1343	16265	669	20306	-80	20072
14-#10	2.85	MA	4898	1894	7387	1579	8974	1308	10026	1084	11499	726	14458	523	10315
3L-6S		MI	4056	1894	5941	1603	7104	1331	7759	1111	8533	739	10527	335	8703
14-#10	2.85	MA	4770	1894	7054	1590	8512	1325	9460	1099	10725	731	13495	470	10233
4L-5S		MI	4219	1894	6251	1588	7453	1323	8208	1097	9154	734	11390	407	8949
14-#10	2.85	MA	4607	1894	6758	1601	8107	1335	8957	1108	10026	744	12526	419	9828
5L-4S		MI	4361	1894	6521	1578	7822	1314	8666	1089	9790	722	12273	460	9318
14-#10	2.85	MA	4427	1894	6410	1616	7723	1344	8464	1123	9343	750	11584	349	9539
6L-3S		MI	4478	1894	6824	1567	8242	1298	9180	1074	10492	718	13154	514	9387
14-#10	2.85	MA	4270	1894	6099	1623	7316	1360	7988	1132	8680	763	10665	306	9041
7L-2S		MI	4699	1894	7261	1557	8796	1289	9852	1067	11399	706	14409	606	9415
14-#11	3.50	MA	5129	2012	8041	1644	9756	1354	10949	1111	12724	715	16137	486	12397
3L-6S		MI	4191	2012	6353	1674	7565	1381	8286	1142	9232	736	11426	252	10103

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

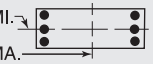
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	3.50	MA	4982	2012	7638	1657	9197	1374	10264	1129	11787	721	14962	420	12153
4L-5S		MI	4382	2012	6720	1655	7988	1371	8829	1125	9968	724	12381	326	10563
14-#11	3.50	MA	4793	2012	7279	1670	8705	1385	9654	1138	10941	736	13785	355	11625
5L-4S		MI	4545	2012	7047	1643	8435	1361	9384	1117	10736	711	13421	392	11011
14-#11	3.50	MA	4583	2012	6865	1688	8240	1396	9056	1156	10113	741	12635	267	11119
6L-3S		MI	4679	2012	7413	1631	8942	1343	10005	1101	11585	707	14465	456	11257
14-#14	5.05	MA	5536	2292	8982	1834	10849	1507	12246	1214	14442	709	18512	298	16581
4L-5S		MI	4809	2292	7790	1835	9281	1506	10372	1211	12023	714	15056	161	14365
14-#14	5.05	MA	5275	2292	8469	1852	10146	1522	11375	1226	13234	729	16859	203	15917
5L-4S		MI	5033	2292	8257	1819	9919	1493	11162	1200	13118	697	16511	257	14982
16-#10	3.26	MA	4989	1968	7536	1636	9125	1358	10203	1120	11728	728	14882	465	11650
4L-6S		MI	4258	1968	6378	1649	7658	1365	8431	1132	9439	735	11782	330	9954
16-#10	3.26	MA	4827	1968	7241	1647	8719	1368	9699	1129	11029	741	13914	415	11222
5E		MI	4416	1968	6688	1634	8007	1356	8880	1118	10061	731	12645	402	10206
16-#10	3.26	MA	4653	1968	6893	1662	8336	1378	9206	1144	10345	747	12971	344	10944
6L-4S		MI	4557	1968	6958	1624	8377	1347	9338	1110	10696	719	13527	455	10598
16-#10	3.26	MA	4503	1968	6582	1669	7929	1393	8730	1153	9682	759	12052	301	10438
7L-3S		MI	4668	1968	7261	1613	8796	1331	9852	1096	11399	714	14409	509	10675
16-#11	4.00	MA	5240	2103	8220	1713	9935	1415	11159	1155	12995	717	16635	414	13814
4L-6S		MI	4430	2103	6878	1730	8232	1423	9094	1168	10323	732	12905	243	11600
16-#11	4.00	MA	5052	2103	7861	1726	9443	1426	10549	1164	12149	731	15458	349	13308
5E		MI	4613	2103	7246	1711	8655	1413	9638	1151	11059	719	13859	316	12077
16-#11	4.00	MA	4850	2103	7447	1745	8978	1437	9951	1182	11321	737	14308	261	12788
6L-4S		MI	4775	2103	7572	1700	9102	1403	10192	1143	11827	707	14900	382	12505
16-#14	5.77	MA	5634	2423	9297	1933	11197	1581	12648	1264	14953	722	19208	192	18285
5E		MI	5151	2423	8537	1916	10228	1566	11520	1248	13572	708	17123	144	16481
18-#10	3.66	MA	5043	2042	7723	1693	9332	1402	10442	1150	12031	737	15302	410	12619
5L-6S		MI	4457	2042	6815	1695	8212	1399	9103	1154	10346	732	13036	325	11200
18-#10	3.66	MA	4876	2042	7376	1708	8949	1412	9949	1166	11348	743	14359	339	12337
6L-5S		MI	4609	2042	7125	1680	8562	1390	9551	1139	10968	727	13899	397	11465
18-#10	3.66	MA	4732	2042	7065	1715	8541	1427	9473	1174	10684	756	13440	296	11838
7L-4S		MI	4749	2042	7394	1670	8931	1381	10009	1132	11603	715	14782	450	11862
18-#11	4.50	MA	5307	2193	8443	1783	10182	1468	11444	1190	13357	727	17131	343	14995
5L-6S		MI	4664	2193	7404	1787	8899	1464	9902	1194	11414	728	14383	233	13101
18-#11	4.50	MA	5112	2193	8029	1801	9717	1479	10846	1208	12529	733	15981	255	14462
6L-5S		MI	4841	2193	7771	1768	9322	1454	10446	1177	12150	715	15338	307	13595
20-#10	4.07	MA	5094	2115	7859	1754	9561	1445	10691	1187	12350	740	15747	334	13726
6E		MI	4652	2115	7252	1741	8767	1432	9774	1175	11253	728	14291	320	12450
20-#10	4.07	MA	4956	2115	7548	1761	9154	1461	10216	1195	11687	752	14828	292	13240
7L-5S		MI	4800	2115	7562	1726	9116	1423	10223	1160	11875	724	15153	392	12728
20-#11	5.00	MA	5370	2284	8611	1858	10456	1520	11742	1234	13738	728	17654	249	16140
6E		MI	4894	2284	7929	1843	9566	1505	10711	1220	12505	723	15861	224	14607

RECTANGULAR TIED COLUMNS 24" x 28"

4-#14	1.34	MA	5029	1746	7073	1497	8474	1257	9264	1067	10129	777	12313	676	5784
2E		MI	4254	1746	6125	1472	7234	1236	7852	1049	8516	762	10134	645	4865
4-#18	2.38	MA	5589	1949	8496	1609	10204	1337	11324	1115	12877	759	15924	639	9840
2E		MI	4692	1949	7288	1581	8639	1313	9518	1094	10735	742	12845	584	8189
6-#10	1.13	MA	4943	1706	6729	1490	8129	1254	8893	1069	9667	790	11704	687	5009
2L-3S		MI	3936	1706	5400	1478	6403	1244	6889	1060	7254	788	8569	583	4240
6-#10	1.13	MA	4629	1706	6201	1502	7458	1265	8079	1078	8570	803	10184	600	5017
3L-2S		MI	4193	1706	5837	1468	6958	1235	7561	1053	8161	777	9823	676	4227
6-#11	1.39	MA	5083	1756	7124	1511	8576	1268	9407	1076	10339	781	12616	679	6040
2L-3S		MI	4001	1756	5639	1499	6655	1258	7168	1066	7609	780	8982	543	5090
6-#11	1.39	MA	4713	1756	6485	1525	7766	1280	8425	1086	9013	797	10781	568	6040
3L-2S		MI	4300	1756	6165	1487	7322	1248	7977	1058	8700	767	10460	656	5078

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

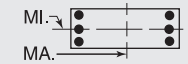
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	2.01	MA	5434	1876	7983	1579	9628	1317	10663	1105	12017	771	14927	667	8502
2L-3S		MI	4172	1876	6125	1570	7234	1308	7852	1097	8516	773	10134	465	7082
6-#14	2.01	MA	4934	1876	7073	1598	8474	1333	9264	1119	10129	792	12313	505	8453
3L-2S		MI	4578	1876	6871	1554	8181	1295	9000	1086	10066	756	12201	628	7105
6-#18	3.57	MA	6245	2181	10072	1754	12204	1443	13748	1182	16149	748	20368	615	14512
2L-3S		MI	4580	2181	7288	1752	8639	1439	9518	1175	10735	755	12845	250	11774
6-#18	3.57	MA	5463	2181	8496	1785	10204	1469	11324	1203	12877	781	15924	325	14200
3L-2S		MI	5212	2181	8574	1726	10271	1419	11496	1161	13405	731	16293	541	12005
8-#9	1.19	MA	4990	1717	6795	1501	8231	1262	9027	1075	9857	791	11974	689	5262
2L-4S		MI	3915	1717	5303	1496	6271	1264	6734	1077	7046	792	8364	563	4445
8-#9	1.19	MA	4742	1717	6376	1510	7700	1271	8382	1083	8987	803	10769	620	5267
3E		MI	4030	1717	5543	1488	6604	1251	7142	1065	7603	788	9061	605	4447
8-#9	1.19	MA	4604	1717	6088	1519	7301	1285	7893	1096	8318	808	9946	579	5252
4L-2S		MI	4231	1717	5890	1479	7043	1244	7674	1059	8322	779	10057	677	4438
8-#10	1.51	MA	5189	1780	7258	1536	8800	1288	9706	1090	10765	786	13224	683	6592
2L-4S		MI	4003	1780	5534	1535	6538	1294	7047	1096	7458	789	8942	524	5516
8-#10	1.51	MA	4886	1780	6729	1548	8129	1298	8893	1100	9667	800	11704	595	6586
3E		MI	4143	1780	5837	1524	6958	1278	7561	1081	8161	785	9823	578	5543
8-#10	1.51	MA	4716	1780	6366	1559	7625	1316	8275	1116	8822	807	10661	542	6536
4L-2S		MI	4390	1780	6274	1514	7512	1269	8233	1074	9068	773	11078	671	5539
8-#11	1.86	MA	5371	1847	7762	1568	9386	1310	10389	1102	11664	777	14452	673	7948
2L-4S		MI	4079	1847	5798	1568	6815	1318	7356	1109	7851	780	9417	469	6587
8-#11	1.86	MA	5017	1847	7124	1581	8576	1322	9407	1112	10339	793	12616	562	7928
3E		MI	4243	1847	6165	1556	7322	1299	7977	1092	8700	775	10460	533	6648
8-#11	1.86	MA	4818	1847	6683	1595	7965	1342	8659	1131	9315	800	11342	497	7829
4L-2S		MI	4531	1847	6690	1544	7989	1289	8785	1084	9791	763	11938	646	6654
8-#14	2.68	MA	5827	2007	8892	1660	10782	1376	12062	1143	13905	765	17542	658	11204
2L-4S		MI	4287	2007	6349	1667	7459	1394	8115	1157	8857	771	10738	357	8780
8-#14	2.68	MA	5354	2007	7983	1679	9628	1393	10663	1157	12017	786	14927	496	11124
3E		MI	4507	2007	6871	1651	8181	1368	9000	1134	10066	767	12201	448	9274
8-#14	2.68	MA	5089	2007	7353	1698	8755	1422	9594	1183	10555	795	13099	401	10531
4L-2S		MI	4893	2007	7617	1635	9129	1355	10148	1124	11615	750	14269	611	9328
8-#18	4.76	MA	6874	2413	11648	1899	14204	1549	16172	1249	19421	737	24813	592	19169
2L-4S		MI	4792	2413	7667	1922	9018	1586	9963	1277	11311	746	13834	55	13560
8-#18	4.76	MA	6159	2413	10072	1930	12204	1575	13748	1270	16149	770	20368	302	18809
3E		MI	5155	2413	8574	1897	10271	1545	11496	1242	13405	744	16293	207	15517
8-#18	4.76	MA	5752	2413	8974	1960	10684	1623	11886	1313	13604	781	17234	136	16426
4L-2S		MI	5709	2413	9860	1871	11902	1525	13474	1228	16075	720	19741	497	15804
10-#10	1.89	MA	5429	1853	7787	1582	9471	1321	10519	1112	11863	783	14745	678	8168
2L-5S		MI	4067	1853	5701	1591	6723	1336	7260	1125	7729	797	9314	466	6542
10-#10	1.89	MA	5137	1853	7258	1594	8800	1332	9706	1121	10765	796	13224	590	8151
3L-4S		MI	4212	1853	5971	1581	7092	1327	7718	1117	8365	786	10197	519	6798
10-#10	1.89	MA	4977	1853	6895	1606	8296	1349	9088	1137	9920	803	12181	538	8088
4L-3S		MI	4345	1853	6274	1570	7512	1311	8233	1103	9068	781	11078	573	6838
10-#10	1.89	MA	4788	1853	6573	1617	7854	1360	8539	1146	9158	817	11128	490	7762
5L-2S		MI	4584	1853	6710	1560	8066	1302	8904	1095	9974	769	12332	666	6845
10-#11	2.32	MA	5651	1937	8401	1624	10197	1351	11372	1128	12990	772	16287	667	9846
2L-5S		MI	4158	1937	5997	1636	7035	1369	7610	1143	8174	788	9855	393	7657
10-#11	2.32	MA	5312	1937	7762	1638	9386	1363	10389	1139	11664	788	14452	556	9812
3L-4S		MI	4325	1937	6324	1624	7482	1359	8164	1135	8942	775	10895	459	8122
10-#11	2.32	MA	5127	1937	7322	1652	8775	1384	9641	1158	10640	795	13178	491	9697
4L-3S		MI	4480	1937	6690	1612	7989	1340	8785	1118	9791	771	11938	524	8200
10-#11	2.32	MA	4907	1937	6930	1665	8239	1396	8975	1168	9716	811	11897	429	9115
5L-2S		MI	4757	1937	7216	1600	8656	1331	9593	1110	10882	758	13417	637	8221

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

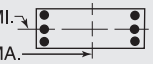


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	3.35	MA	6210	2137	9802	1742	11936	1436	13460	1180	15793	759	20156	650	13898
2L-5S		MI	4400	2137	6629	1765	7768	1466	8473	1205	9311	782	11350	244	10257
10-#14	3.35	MA	5761	2137	8892	1761	10782	1452	12062	1194	13905	780	17542	488	13796
3L-4S		MI	4630	2137	7095	1749	8406	1453	9263	1195	10406	765	12805	340	10877
10-#14	3.35	MA	5518	2137	8263	1780	9910	1481	10993	1221	12443	789	15713	392	13120
4L-3S		MI	4833	2137	7617	1733	9129	1428	10148	1172	11615	760	14269	430	11464
10-#14	3.35	MA	5213	2137	7703	1798	9142	1498	10041	1235	11123	810	13879	300	12280
5L-2S		MI	5200	2137	8364	1717	10076	1414	11296	1162	13165	744	16336	594	11540
10-#18	5.95	MA	6860	2645	11648	2075	14204	1681	16172	1337	19421	759	24813	278	23428
3L-4S		MI	5404	2645	8953	2067	10650	1692	11941	1344	13981	735	17283	11	17223
10-#18	5.95	MA	6472	2645	10550	2105	12684	1729	14310	1380	16876	770	21678	113	20974
4L-3S		MI	5686	2645	9860	2042	11902	1651	13474	1309	16075	733	19741	163	19102
12-#10	2.27	MA	5664	1927	8316	1628	10142	1355	11333	1133	12961	779	16265	673	9739
2L-6S		MI	4103	1927	5828	1652	6928	1379	7483	1160	8014	798	9706	389	7528
12-#10	2.27	MA	5382	1927	7787	1640	9471	1365	10519	1142	11863	793	14745	585	9714
3L-5S		MI	4273	1927	6138	1637	7277	1370	7932	1146	8636	794	10568	461	7786
12-#10	2.27	MA	5231	1927	7423	1652	8967	1383	9901	1158	11018	800	13701	533	9640
4E		MI	4417	1927	6407	1627	7646	1361	8390	1138	9271	782	11451	514	8079
12-#10	2.27	MA	5044	1927	7101	1663	8525	1393	9352	1168	10256	814	12648	485	9282
5L-3S		MI	4543	1927	6710	1616	8066	1345	8904	1124	9974	778	12332	568	8129
12-#10	2.27	MA	4838	1927	6716	1677	8107	1404	8815	1184	9511	820	11627	415	8933
6L-2S		MI	4774	1927	7147	1606	8620	1336	9576	1116	10881	766	13587	661	8145
12-#11	2.79	MA	5927	2028	9039	1681	11007	1392	12354	1154	14316	768	18123	661	11741
2L-6S		MI	4201	2028	6155	1711	7278	1420	7874	1186	8528	796	10378	310	8774
12-#11	2.79	MA	5600	2028	8401	1694	10197	1404	11372	1165	12990	784	16287	551	11694
3L-5S		MI	4401	2028	6523	1693	7702	1410	8418	1169	9265	784	11333	384	9156
12-#11	2.79	MA	5427	2028	7960	1708	9586	1425	10623	1184	11966	791	15014	485	11568
4E		MI	4566	2028	6849	1681	8149	1400	8972	1161	10033	771	12373	450	9641
12-#11	2.79	MA	5209	2028	7569	1722	9049	1437	9957	1194	11042	807	13733	423	10954
5L-3S		MI	4711	2028	7216	1669	8656	1382	9593	1145	10882	767	13417	514	9749
12-#11	2.79	MA	4966	2028	7109	1740	8542	1449	9305	1213	10138	814	12486	336	10483
6L-2S		MI	4978	2028	7741	1657	9322	1372	10401	1137	11973	754	14895	628	9781
12-#14	4.02	MA	6158	2268	9802	1842	11936	1512	13460	1232	15793	774	20156	479	16468
3L-5S		MI	4736	2268	7375	1847	8715	1526	9621	1242	10860	775	13417	227	12403
12-#14	4.02	MA	5934	2268	9172	1861	11064	1541	12392	1258	14331	783	18327	384	15722
4E		MI	4963	2268	7841	1830	9353	1513	10411	1232	11956	759	14872	323	12988
12-#14	4.02	MA	5633	2268	8612	1880	10296	1557	11440	1272	13011	804	16493	291	14921
5L-3S		MI	5152	2268	8364	1814	10076	1487	11296	1210	13165	754	16336	413	13653
12-#14	4.02	MA	5306	2268	7963	1906	9571	1574	10507	1299	11719	813	14703	164	13792
6L-2S		MI	5503	2268	9110	1798	11023	1474	12444	1199	14714	737	18403	577	13747
12-#18	7.14	MA	7222	2877	12126	2250	14684	1835	16734	1447	20148	759	26123	90	25540
4E		MI	5959	2877	10239	2212	12282	1798	13919	1411	16650	724	20731	-32	20641
14-#10	2.65	MA	5622	2001	8316	1686	10142	1399	11333	1163	12961	789	16265	580	11275
3L-6S		MI	4310	2001	6265	1698	7482	1413	8155	1182	8921	795	10960	384	8789
14-#10	2.65	MA	5480	2001	7952	1698	9638	1417	10715	1180	12116	796	15221	528	11194
4L-5S		MI	4475	2001	6575	1683	7831	1404	8604	1167	9543	790	11823	456	9036
14-#10	2.65	MA	5295	2001	7630	1709	9196	1427	10166	1189	11353	810	14168	480	10806
5L-4S		MI	4617	2001	6844	1673	8201	1395	9062	1160	10178	779	12706	509	9360
14-#10	2.65	MA	5095	2001	7245	1723	8778	1438	9628	1205	10609	817	13147	410	10472
6L-3S		MI	4737	2001	7147	1662	8620	1379	9576	1145	10881	774	13587	563	9419
14-#10	2.65	MA	4922	2001	6906	1731	8326	1452	9110	1215	9886	831	12150	370	9976
7L-2S		MI	4961	2001	7584	1652	9175	1370	10248	1138	11788	762	14841	656	9442
14-#11	3.25	MA	5883	2118	9039	1751	11007	1446	12354	1191	14316	780	18123	545	13576
3L-6S		MI	4445	2118	6681	1768	7945	1462	8683	1212	9619	792	11857	301	10261
14-#11	3.25	MA	5720	2118	8599	1765	10396	1466	11605	1210	13292	787	16849	479	13428
4L-5S		MI	4638	2118	7048	1749	8368	1452	9226	1195	10356	779	12811	375	10662
14-#11	3.25	MA	5504	2118	8207	1778	9859	1478	10939	1220	12368	802	15568	417	12798
5L-4S		MI	4801	2118	7375	1737	8815	1442	9780	1187	11124	767	13852	441	11123

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

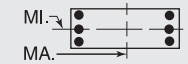


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	3.25	MA	5271	2118	7748	1796	9352	1490	10287	1239	11464	810	14322	330	12317
6L-3S		MI	4939	2118	7741	1725	9322	1423	10401	1171	11973	762	14895	505	11296
14-#11	3.25	MA	5068	2118	7337	1805	8814	1509	9658	1250	10586	825	13106	278	11650
7L-2S		MI	5197	2118	8267	1713	9989	1413	11209	1163	13064	750	16373	618	11339
14-#14	4.69	MA	6340	2398	10081	1943	12218	1600	13790	1296	16219	776	20942	375	18334
4L-5S		MI	5064	2398	8121	1928	9663	1586	10769	1280	12410	769	15484	210	14557
14-#14	4.69	MA	6042	2398	9521	1962	11450	1617	12839	1310	14899	798	19107	282	17569
5L-4S		MI	5289	2398	8588	1912	10300	1572	11559	1270	13505	752	16940	306	15111
14-#14	4.69	MA	5731	2398	8873	1988	10725	1633	11906	1336	13607	807	17317	156	16431
6L-3S		MI	5478	2398	9110	1896	11023	1547	12444	1247	14714	748	18403	396	15842
16-#10	3.02	MA	5723	2074	8481	1744	10309	1450	11528	1201	13214	793	16741	523	12748
4L-6S		MI	4513	2074	6701	1744	8036	1446	8827	1203	9828	791	12215	379	10053
16-#10	3.02	MA	5540	2074	8159	1755	9867	1461	10979	1210	12451	807	15688	475	12336
5E		MI	4673	2074	7011	1729	8386	1437	9276	1188	10450	787	13077	451	10290
16-#10	3.02	MA	5347	2074	7774	1769	9449	1471	10442	1226	11706	813	14668	405	12014
6L-4S		MI	4814	2074	7281	1719	8755	1428	9734	1181	11085	775	13960	504	10641
16-#10	3.02	MA	5181	2074	7434	1777	8997	1486	9924	1236	10983	827	13670	365	11510
7L-3S		MI	4927	2074	7584	1708	9175	1412	10248	1166	11788	771	14841	558	10707
16-#10	3.02	MA	5022	2074	7108	1785	8560	1493	9399	1251	10273	841	12710	312	11007
8L-2S		MI	5145	2074	8021	1698	9729	1403	10920	1159	12695	759	16096	651	10737
16-#11	3.71	MA	6007	2209	9237	1821	11206	1508	12587	1236	14618	782	18685	473	15254
4L-6S		MI	4684	2209	7206	1825	8612	1503	9491	1238	10710	788	13335	291	11753
16-#11	3.71	MA	5793	2209	8846	1835	10670	1520	11921	1246	13693	798	17404	411	14648
5E		MI	4870	2209	7574	1806	9035	1493	10034	1221	11446	775	14290	365	12172
16-#11	3.71	MA	5569	2209	8386	1853	10163	1532	11269	1265	12789	805	16157	324	14155
6L-4S		MI	5032	2209	7900	1794	9482	1483	10588	1213	12215	762	15330	431	12613
16-#11	3.71	MA	5375	2209	7975	1861	9624	1550	10640	1276	11912	821	14942	272	13507
7L-3S		MI	5162	2209	8267	1782	9989	1464	11209	1197	13064	758	16373	495	12843
16-#14	5.36	MA	6441	2529	10431	2043	12604	1676	14237	1347	16787	792	21721	274	20223
5E		MI	5386	2529	8868	2010	10610	1645	11917	1318	13959	763	17552	193	16684
16-#14	5.36	MA	6145	2529	9782	2069	11879	1693	13305	1374	15495	801	19931	147	19075
6L-4S		MI	5634	2529	9334	1994	11248	1632	12707	1308	15055	746	19007	289	17244
18-#10	3.40	MA	5780	2148	8688	1801	10538	1494	11792	1231	13549	803	17209	470	13868
5L-6S		MI	4713	2148	7138	1790	8591	1480	9499	1224	10735	788	13469	374	11320
18-#10	3.40	MA	5594	2148	8302	1815	10120	1505	11255	1248	12804	810	16188	400	13558
6L-5S		MI	4867	2148	7448	1775	8940	1471	9947	1210	11356	783	14332	446	11547
18-#10	3.40	MA	5435	2148	7963	1823	9668	1520	10737	1257	12081	824	15190	360	13047
7L-4S		MI	5007	2148	7718	1765	9309	1462	10405	1202	11992	772	15215	499	11922
18-#10	3.40	MA	5278	2148	7637	1832	9231	1527	10213	1273	11371	838	14230	307	12546
8L-3S		MI	5116	2148	8021	1754	9729	1446	10920	1188	12695	767	16096	553	11995
18-#11	4.18	MA	6076	2299	9484	1891	11480	1561	12903	1272	15019	794	19239	405	16502
5L-6S		MI	4919	2299	7732	1881	9279	1544	10299	1264	11801	783	14813	282	13250
18-#11	4.18	MA	5861	2299	9025	1909	10973	1573	12251	1291	14115	801	17993	318	15998
6L-5S		MI	5099	2299	8099	1862	9702	1534	10842	1247	12537	771	15768	356	13688
18-#11	4.18	MA	5676	2299	8614	1918	10434	1592	11622	1302	13238	817	16777	266	15367
7L-4S		MI	5260	2299	8426	1850	10149	1524	11397	1239	13306	758	16808	422	14109
18-#14	6.03	MA	6550	2659	10692	2151	13033	1752	14704	1411	17383	794	22546	139	21724
6L-5S		MI	5722	2659	9614	2091	11557	1705	13064	1355	15509	757	19619	176	18802
20-#10	3.78	MA	5837	2221	8831	1862	10791	1539	12068	1269	13902	806	17708	395	15104
6E		MI	4909	2221	7575	1836	9145	1513	10170	1245	11641	784	14723	369	12582
20-#10	3.78	MA	5684	2221	8492	1869	10339	1553	11550	1278	13179	820	16710	356	14587
7L-5S		MI	5059	2221	7885	1821	9494	1504	10619	1231	12263	780	15586	441	12808
20-#10	3.78	MA	5529	2221	8165	1878	9902	1560	11026	1294	12469	834	15750	302	14086
8L-4S		MI	5198	2221	8154	1811	9863	1496	11077	1223	12898	768	16469	494	13204
20-#11	4.64	MA	6147	2390	9663	1966	11783	1614	13233	1318	15441	797	19828	312	17844
6E		MI	5150	2390	8257	1938	9946	1585	11107	1290	12892	779	16292	273	14752
20-#11	4.64	MA	5971	2390	9252	1974	11245	1633	12604	1328	14563	812	18613	260	17229
7L-5S		MI	5324	2390	8624	1919	10369	1576	11651	1274	13628	766	17246	346	15206

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	4.16	MA	5928	2295	9021	1915	11010	1587	12364	1300	14277	817	18231	351	16128
7L-6S		MI	5102	2295	8012	1882	9699	1547	10842	1267	12548	781	15978	364	13831
22-#10	4.16	MA	5775	2295	8694	1924	10573	1594	11839	1315	13567	831	17271	297	15629
8L-5S		MI	5248	2295	8322	1867	10048	1538	11291	1252	13170	776	16841	436	14072
22-#11	5.11	MA	6260	2480	9891	2031	12055	1674	13586	1354	15889	808	20448	254	19094
7L-6S		MI	5378	2480	8783	1994	10613	1627	11915	1316	13983	775	17770	263	16257

RECTANGULAR TIED COLUMNS 24" x 30"

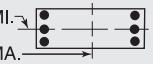
4-#14	1.25	MA	5739	1852	7942	1603	9561	1348	10463	1146	11421	840	13869	731	6270
2E		MI	4511	1852	6455	1566	7616	1315	8249	1118	8903	818	10563	694	4890
4-#18	2.22	MA	6365	2055	9501	1715	11457	1428	12720	1194	14432	821	18011	709	10704
2E		MI	4951	2055	7625	1674	9023	1392	9916	1163	11121	797	13269	632	8225
6-#10	1.06	MA	5640	1812	7563	1596	9179	1345	10050	1148	10909	852	13192	743	5421
2L-3S		MI	4191	1812	5723	1573	6781	1325	7285	1131	7643	844	9002	633	4262
6-#10	1.06	MA	5294	1812	6988	1608	8450	1356	9166	1158	9715	867	11539	657	5428
3L-2S		MI	4449	1812	6160	1563	7336	1316	7957	1123	8549	833	10256	725	4246
6-#11	1.30	MA	5797	1863	7995	1617	9669	1359	10615	1155	11645	844	14192	734	6546
2L-3S		MI	4255	1863	5967	1593	7035	1338	7565	1136	7997	835	9412	591	5117
6-#11	1.30	MA	5389	1863	7300	1632	8787	1372	9546	1166	10202	861	12194	626	6545
3L-2S		MI	4557	1863	6492	1581	7702	1328	8373	1128	9088	823	10890	705	5102
6-#14	1.88	MA	6189	1983	8933	1685	10819	1407	11987	1184	13479	834	16717	722	9231
2L-3S		MI	4427	1983	6455	1663	7616	1388	8249	1166	8903	828	10563	513	7121
6-#14	1.88	MA	5636	1983	7942	1705	9561	1425	10463	1199	11421	857	13869	564	9182
3L-2S		MI	4836	1983	7202	1647	8563	1375	9397	1156	10452	811	12630	677	7134
6-#18	3.33	MA	7093	2287	11222	1860	13641	1534	15367	1261	18005	810	22957	694	15808
2L-3S		MI	4833	2287	7625	1844	9023	1518	9916	1243	11121	810	13269	298	11848
6-#18	3.33	MA	6226	2287	9501	1893	11457	1562	12720	1284	14432	847	18011	403	15496
3L-2S		MI	5476	2287	8911	1819	10654	1498	11894	1230	13791	786	16718	589	12047
8-#9	1.11	MA	5691	1823	7632	1607	9289	1353	10195	1154	11113	854	13482	744	5694
2L-4S		MI	4169	1823	5625	1591	6649	1345	7130	1148	7435	848	8798	612	4471
8-#9	1.11	MA	5419	1823	7177	1617	8711	1362	9495	1162	10168	866	12173	677	5699
3E		MI	4285	1823	5865	1583	6981	1333	7537	1136	7992	844	9494	655	4467
8-#9	1.11	MA	5267	1823	6866	1626	8279	1376	8965	1176	9443	872	11286	636	5684
4L-2S		MI	4488	1823	6211	1574	7421	1325	8070	1130	8711	835	10490	727	4456
8-#10	1.41	MA	5912	1886	8137	1642	9908	1378	10935	1169	12102	849	14844	738	7141
2L-4S		MI	4257	1886	5857	1630	6916	1375	7443	1166	7846	845	9375	573	5550
8-#10	1.41	MA	5578	1886	7563	1654	9179	1389	10050	1179	10909	864	13192	652	7135
3E		MI	4399	1886	6160	1619	7336	1359	7957	1152	8549	841	10256	628	5568
8-#10	1.41	MA	5392	1886	7169	1667	8633	1407	9381	1196	9992	871	12068	600	7085
4L-2S		MI	4648	1886	6597	1609	7890	1350	8629	1144	9456	829	11511	720	5561
8-#11	1.73	MA	6116	1953	8690	1674	10551	1400	11684	1181	13088	840	16190	728	8622
2L-4S		MI	4332	1953	6126	1662	7195	1398	7752	1179	8239	835	9847	518	6633
8-#11	1.73	MA	5725	1953	7995	1688	9669	1413	10615	1192	11645	856	14192	620	8602
3E		MI	4499	1953	6492	1650	7702	1379	8373	1162	9088	831	10890	582	6680
8-#11	1.73	MA	5507	1953	7517	1703	9007	1434	9803	1212	10534	865	12819	555	8503
4L-2S		MI	4789	1953	7018	1638	8369	1370	9181	1154	10178	818	12369	695	6680
8-#14	2.50	MA	6624	2113	9924	1766	12076	1467	13511	1222	15536	828	19566	713	12176
2L-4S		MI	4540	2113	6679	1761	7840	1473	8512	1226	9243	826	11166	406	8921
8-#14	2.50	MA	6100	2113	8933	1786	10819	1484	11987	1237	13479	851	16717	555	12096
3E		MI	4763	2113	7202	1745	8563	1448	9397	1204	10452	822	12630	496	9318
8-#14	2.50	MA	5808	2113	8250	1806	9871	1515	10826	1265	11891	861	14746	461	11582
4L-2S		MI	5153	2113	7948	1729	9510	1435	10545	1194	12002	805	14697	660	9360

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

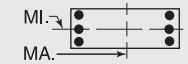
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	4.44	MA	7799	2519	12942	2005	15825	1639	18014	1328	21578	799	27903	679	20897
2L-4S		MI	5042	2519	8004	2014	9402	1665	10360	1346	11696	801	14259	103	13739
8-#18	4.44	MA	6995	2519	11222	2038	13641	1668	15367	1351	18005	836	22957	388	20537
3E		MI	5411	2519	8911	1989	10654	1623	11894	1310	13791	799	16718	255	15593
8-#18	4.44	MA	6547	2519	10028	2071	11988	1718	13342	1397	15236	851	19482	217	18083
4L-2S		MI	5976	2519	10196	1964	12286	1604	13871	1297	16461	775	20166	545	15849
10-#10	1.76	MA	6177	1959	8712	1688	10638	1412	11819	1190	13295	845	16497	733	8854
2L-5S		MI	4322	1959	6024	1686	7101	1417	7657	1195	8118	854	9747	515	6630
10-#10	1.76	MA	5855	1959	8137	1700	9908	1423	10935	1200	12102	860	14844	647	8837
3L-4S		MI	4467	1959	6294	1676	7470	1408	8115	1188	8753	842	10629	569	6834
10-#10	1.76	MA	5679	1959	7744	1713	9362	1441	10265	1217	11185	868	13720	595	8774
4L-3S		MI	4601	1959	6597	1665	7890	1392	8629	1173	9456	837	11511	623	6865
10-#10	1.76	MA	5468	1959	7395	1725	8884	1452	9671	1227	10360	883	12583	550	8478
5L-2S		MI	4843	1959	7034	1655	8444	1383	9300	1166	10363	826	12765	715	6868
10-#11	2.17	MA	6426	2043	9385	1730	11433	1441	12753	1207	14531	835	18188	722	10689
2L-5S		MI	4413	2043	6325	1730	7415	1449	8006	1213	8561	844	10285	442	7757
10-#11	2.17	MA	6052	2043	8690	1745	10551	1454	11684	1218	13088	852	16190	614	10654
3L-4S		MI	4580	2043	6652	1718	7862	1439	8560	1205	9330	831	11325	508	8170
10-#11	2.17	MA	5847	2043	8212	1759	9889	1476	10872	1238	11977	860	14818	549	10540
4L-3S		MI	4737	2043	7018	1706	8369	1421	9181	1188	10178	827	12369	573	8235
10-#11	2.17	MA	5600	2043	7788	1773	9307	1489	10150	1250	10974	877	13433	491	9965
5L-2S		MI	5017	2043	7543	1695	9036	1411	9990	1180	11269	814	13847	686	8250
10-#14	3.13	MA	7047	2243	10915	1848	13334	1526	15036	1259	17593	821	22415	705	15113
2L-5S		MI	4654	2243	6959	1859	8150	1546	8870	1274	9698	837	11778	293	10381
10-#14	3.13	MA	6550	2243	9924	1868	12076	1544	13511	1275	15536	844	19566	547	15011
3L-4S		MI	4883	2243	7426	1842	8788	1533	9660	1264	10793	820	13234	389	11012
10-#14	3.13	MA	6282	2243	9241	1888	11129	1574	12351	1302	13948	855	17594	452	14412
4L-3S		MI	5091	2243	7948	1826	9510	1507	10545	1241	12002	816	14697	479	11509
10-#14	3.13	MA	5939	2243	8634	1908	10297	1592	11318	1318	12515	878	15610	364	13440
5L-2S		MI	5463	2243	8694	1810	10457	1494	11693	1231	13552	799	16765	642	11575
10-#18	5.56	MA	7776	2751	12942	2183	15825	1774	18014	1418	21578	825	27903	373	25588
3L-4S		MI	5654	2751	9290	2159	11034	1771	12338	1413	14366	790	17708	59	17393
10-#18	5.56	MA	7342	2751	11749	2216	14172	1824	15988	1464	18808	840	24429	202	23066
4L-3S		MI	5944	2751	10196	2134	12286	1729	13871	1377	16461	788	20166	211	19329
10-#18	5.56	MA	6773	2751	10687	2248	12717	1852	14184	1488	16306	876	20948	34	20796
5L-2S		MI	6464	2751	11482	2109	13918	1710	15849	1364	19131	764	23615	502	19642
12-#10	2.12	MA	6437	2033	9287	1734	11367	1445	12703	1212	14489	842	18149	728	10562
2L-6S		MI	4356	2033	6151	1747	7306	1460	7879	1231	8403	855	10138	439	7612
12-#10	2.12	MA	6125	2033	8712	1746	10638	1457	11819	1222	13295	857	16497	642	10537
3L-5S		MI	4529	2033	6461	1732	7655	1451	8328	1217	9025	850	11001	510	7872
12-#10	2.12	MA	5959	2033	8318	1759	10092	1475	11149	1239	12379	864	15373	590	10463
4E		MI	4672	2033	6731	1722	8025	1442	8786	1209	9660	838	11884	564	8117
12-#10	2.12	MA	5750	2033	7970	1771	9613	1486	10555	1249	11553	879	14235	545	10133
5L-3S		MI	4800	2033	7034	1711	8444	1426	9300	1194	10363	834	12765	618	8159
12-#10	2.12	MA	5523	2033	7547	1785	9161	1497	9973	1266	10747	887	13136	475	9736
6L-2S		MI	5034	2033	7470	1701	8999	1417	9972	1187	11270	822	14020	710	8171
12-#11	2.60	MA	6731	2134	10080	1787	12315	1483	13822	1233	15974	831	20186	716	12751
2L-6S		MI	4454	2134	6483	1806	7659	1500	8271	1256	8916	852	10809	359	8932
12-#11	2.60	MA	6370	2134	9385	1801	11433	1496	12753	1244	14531	848	18188	608	12705
3L-5S		MI	4656	2134	6850	1787	8082	1491	8814	1239	9652	839	11763	433	9253
12-#11	2.60	MA	6178	2134	8907	1816	10771	1517	11941	1264	13420	856	16816	543	12578
4E		MI	4821	2134	7177	1775	8529	1481	9369	1231	10421	827	12804	499	9707
12-#11	2.60	MA	5934	2134	8483	1830	10189	1530	11219	1276	12418	873	15431	485	11971
5L-3S		MI	4969	2134	7543	1763	9036	1462	9990	1215	11269	822	13847	563	9786

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

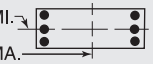


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.60	MA	5667	2134	7977	1847	9640	1543	10513	1296	11438	881	14088	398	11515
6L-2S		MI	5239	2134	8069	1751	9703	1452	10798	1207	12360	810	15325	676	9812
12-#14	3.75	MA	6988	2374	10915	1949	13334	1604	15036	1312	17593	838	22415	538	17926
3L-5S		MI	4991	2374	7706	1940	9097	1606	10018	1312	11247	831	13846	276	12523
12-#14	3.75	MA	6742	2374	10232	1969	12387	1634	13875	1340	16005	849	20443	444	17255
4E		MI	5218	2374	8172	1924	9735	1593	10808	1302	12343	814	15301	371	13119
12-#14	3.75	MA	6403	2374	9625	1989	11555	1651	12842	1355	14573	872	18459	356	16325
5L-3S		MI	5410	2374	8694	1908	10457	1567	11693	1279	13552	810	16765	462	13700
12-#14	3.75	MA	6042	2374	8910	2015	10769	1669	11831	1383	13172	883	16529	230	15176
6L-2S		MI	5767	2374	9441	1892	11404	1554	12840	1269	15101	793	18832	625	13784
12-#18	6.67	MA	8175	2983	13470	2361	16356	1930	18635	1531	22381	829	29375	187	28066
4E		MI	6211	2983	10576	2304	12666	1877	14316	1480	17036	778	21156	16	21068
12-#18	6.67	MA	7548	2983	12408	2393	14901	1958	16831	1555	19878	865	25895	19	25805
5L-3S		MI	6463	2983	11482	2279	13918	1835	15849	1444	19131	777	23615	168	22904
14-#10	2.47	MA	6390	2107	9287	1792	11367	1490	12703	1243	14489	853	18149	637	12235
3L-6S		MI	4564	2107	6588	1793	7860	1494	8551	1252	9310	851	11393	434	8871
14-#10	2.47	MA	6233	2107	8893	1805	10821	1508	12033	1260	13572	861	17025	585	12154
4L-5S		MI	4731	2107	6898	1778	8210	1485	9000	1238	9931	847	12256	505	9119
14-#10	2.47	MA	6026	2107	8545	1817	10342	1519	11439	1270	12747	876	15888	540	11794
5L-4S		MI	4873	2107	7167	1768	8579	1476	9458	1230	10567	835	13138	559	9399
14-#10	2.47	MA	5807	2107	8122	1831	9891	1531	10857	1287	11940	883	14789	470	11411
6L-3S		MI	4995	2107	7470	1757	8999	1460	9972	1216	11270	830	14020	613	9449
14-#10	2.47	MA	5617	2107	7754	1839	9393	1545	10297	1297	11158	898	13713	433	10924
7L-2S		MI	5222	2107	7907	1747	9553	1451	10644	1208	12176	819	15274	705	9469
14-#11	3.03	MA	6682	2224	10080	1858	12315	1537	13822	1271	15974	844	20186	602	14755
3L-6S		MI	4699	2224	7008	1862	8325	1542	9079	1282	10007	848	12287	350	10414
14-#11	3.03	MA	6502	2224	9602	1872	11653	1558	13010	1291	14863	852	18814	537	14619
4L-5S		MI	4894	2224	7376	1843	8748	1532	9623	1265	10743	835	13242	423	10756
14-#11	3.03	MA	6260	2224	9178	1886	11071	1571	12288	1302	13861	869	17429	479	13982
5L-4S		MI	5057	2224	7702	1831	9196	1522	10177	1257	11512	822	14282	489	11232
14-#11	3.03	MA	6003	2224	8672	1904	10522	1584	11582	1322	12881	877	16086	392	13536
6L-3S		MI	5197	2224	8069	1819	9703	1503	10798	1241	12360	818	15325	554	11334
14-#11	3.03	MA	5780	2224	8226	1913	9928	1602	10900	1333	11930	894	14774	343	12768
7L-2S		MI	5459	2224	8594	1808	10369	1493	11606	1233	13451	805	16804	667	11370
14-#14	4.38	MA	7189	2504	11223	2051	13644	1693	15399	1378	18063	843	23292	435	20108
4L-5S		MI	5320	2504	8452	2022	10044	1665	11165	1350	12797	824	15913	259	14672
14-#14	4.38	MA	6854	2504	10616	2071	12812	1711	14367	1393	16630	866	21308	347	19215
5L-4S		MI	5545	2504	8918	2006	10682	1652	11956	1339	13892	808	17368	354	15237
14-#14	4.38	MA	6511	2504	9901	2096	12026	1729	13356	1421	15229	877	19378	222	18062
6L-3S		MI	5724	2504	9441	1989	11404	1627	12840	1317	15101	803	18832	445	15890
14-#18	7.78	MA	8354	3215	14129	2538	17085	2064	19478	1622	23451	854	30841	4	30823
5L-4S		MI	6752	3215	11861	2449	14297	1983	16294	1547	19706	767	24604	-27	24513
16-#10	2.82	MA	6502	2180	9468	1851	11551	1542	12917	1281	14766	857	18678	581	13845
4L-6S		MI	4768	2180	7025	1839	8415	1527	9223	1274	10217	848	12647	429	10133
16-#10	2.82	MA	6296	2180	9120	1863	11072	1553	12323	1291	13940	872	17540	535	13458
5E		MI	4930	2180	7335	1824	8764	1518	9672	1259	10838	843	13510	500	10371
16-#10	2.82	MA	6085	2180	8697	1877	10620	1564	11741	1308	13134	880	16441	465	13089
6L-4S		MI	5071	2180	7604	1814	9133	1509	10130	1252	11473	831	14393	554	10681
16-#10	2.82	MA	5902	2180	8329	1885	10122	1579	11181	1318	12351	894	15366	428	12596
7L-3S		MI	5187	2180	7907	1803	9553	1493	10644	1237	12176	827	15274	608	10739
16-#10	2.82	MA	5725	2180	7975	1894	9649	1586	10603	1333	11582	909	14330	377	12098
8L-2S		MI	5407	2180	8344	1793	10107	1484	11316	1230	13083	815	16529	700	10764
16-#11	3.47	MA	6818	2315	10297	1929	12535	1600	14079	1317	16306	848	20812	532	16661
4L-6S		MI	4939	2315	7534	1919	8992	1583	9887	1308	11098	844	13765	340	11902
16-#11	3.47	MA	6579	2315	9873	1943	11953	1612	13357	1328	15304	864	19427	473	15999
5E		MI	5127	2315	7901	1900	9415	1573	10431	1291	11834	831	14720	414	12265
16-#11	3.47	MA	6332	2315	9367	1960	11404	1625	12651	1348	14324	873	18084	386	15544
6L-4S		MI	5289	2315	8228	1888	9862	1563	10985	1283	12602	818	15760	480	12719

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	3.47	MA	6119	2315	8921	1969	10810	1644	11969	1359	13374	890	16772	337	14795
7L-3S		MI	5422	2315	8594	1876	10369	1545	11606	1267	13451	814	16804	544	12881
16-#14	5.00	MA	7295	2635	11607	2152	14070	1771	15891	1431	18687	860	24156	339	22112
5E		MI	5643	2635	9198	2103	10991	1725	12313	1387	14346	818	17980	241	16828
16-#14	5.00	MA	6968	2635	10892	2178	13284	1788	14880	1458	17286	870	22227	213	20953
6L-4S		MI	5866	2635	9665	2087	11629	1712	13104	1377	15442	801	19436	337	17365
18-#10	3.17	MA	6561	2254	9695	1909	11801	1587	13207	1312	15134	868	19193	530	15127
5L-6S		MI	4968	2254	7461	1885	8969	1561	9895	1295	11123	844	13902	424	11398
18-#10	3.17	MA	6357	2254	9272	1923	11350	1598	12626	1329	14327	876	18094	461	14770
6L-5S		MI	5125	2254	7771	1870	9318	1552	10344	1280	11745	840	14765	495	11627
18-#10	3.17	MA	6182	2254	8904	1931	10852	1612	12065	1339	13545	891	17018	423	14271
7L-4S		MI	5265	2254	8041	1860	9687	1543	10802	1273	12380	828	15647	549	11963
18-#10	3.17	MA	6006	2254	8550	1940	10379	1620	11487	1354	12776	906	15982	372	13781
8L-3S		MI	5376	2254	8344	1849	10107	1527	11316	1258	13083	823	16529	603	12027
18-#11	3.90	MA	6891	2405	10568	1999	12835	1654	14426	1354	16747	860	21425	467	18020
5L-6S		MI	5175	2405	8059	1975	9659	1624	10696	1334	12189	839	15244	331	13395
18-#11	3.90	MA	6653	2405	10063	2017	12286	1667	13720	1374	15767	868	20082	380	17556
6L-5S		MI	5356	2405	8427	1956	10082	1615	11239	1317	12925	826	16198	405	13778
18-#11	3.90	MA	6450	2405	9617	2026	11692	1685	13038	1385	14817	885	18770	331	16824
7L-4S		MI	5518	2405	8753	1944	10529	1605	11793	1309	13693	814	17239	471	14212
18-#14	5.63	MA	7415	2765	11883	2259	14542	1848	16404	1496	19344	864	25076	205	23847
6L-5S		MI	5981	2765	9945	2185	11938	1785	13461	1425	15896	812	20048	224	18990
20-#10	3.53	MA	6624	2328	9846	1969	12079	1631	13510	1351	15521	873	19746	456	16453
6E		MI	5165	2328	7898	1931	9523	1594	10566	1316	12030	841	15156	419	12666
20-#10	3.53	MA	6456	2328	9479	1977	11581	1646	12949	1361	14738	887	18670	418	15948
7L-5S		MI	5318	2328	8208	1916	9872	1586	11015	1302	12652	836	16019	490	12886
20-#10	3.53	MA	6282	2328	9125	1986	11108	1653	12371	1376	13969	902	17635	367	15461
8L-4S		MI	5457	2328	8478	1906	10242	1577	11473	1294	13287	824	16902	544	13245
20-#11	4.33	MA	6969	2496	10758	2073	13168	1708	14789	1400	17210	864	22080	374	19571
6E		MI	5406	2496	8585	2032	10326	1666	11504	1360	13280	835	16722	321	14893
20-#11	4.33	MA	6775	2496	10312	2083	12574	1726	14107	1411	16260	881	20768	325	18856
7L-5S		MI	5583	2496	8952	2013	10749	1656	12047	1344	14016	822	17677	395	15295
22-#10	3.88	MA	6725	2401	10053	2023	12311	1679	13833	1382	15932	884	20323	413	17627
7L-6S		MI	5360	2401	8335	1977	10077	1628	11238	1337	12937	837	16411	414	13935
22-#10	3.88	MA	6553	2401	9700	2032	11838	1687	13255	1397	15163	899	19287	362	17143
8L-5S		MI	5508	2401	8645	1962	10427	1619	11687	1323	13558	833	17274	485	14148
22-#11	4.77	MA	7094	2586	11007	2139	13456	1767	15177	1438	17703	877	22766	319	20890
7L-6S		MI	5635	2586	9110	2088	10993	1707	12312	1386	14371	831	18200	312	16395
24-#10	4.23	MA	6820	2475	10274	2078	12567	1721	14139	1418	16356	895	20939	357	18826
8L-6S		MI	5551	2475	8772	2023	10632	1662	11910	1359	13844	834	17665	409	15206

RECTANGULAR TIED COLUMNS 24" x 32"

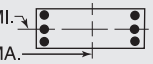
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.17	MA	6492	1958	8854	1709	10706	1438	11726	1225	12780	903	15501	786	6756
2E		MI	4767	1958	6786	1659	7997	1395	8646	1188	9290	873	10991	742	4915
4-#18	2.08	MA	7186	2161	10548	1821	12768	1518	14180	1273	16054	884	20006	765	11568
2E		MI	5210	2161	7961	1766	9407	1471	10313	1231	11506	851	13694	680	8260
6-#11	1.22	MA	6554	1969	8908	1723	10820	1449	11887	1234	13017	907	15845	789	7051
2L-3S		MI	4510	1969	6295	1687	7415	1418	7961	1206	8384	891	9842	640	5143
6-#11	1.22	MA	6108	1969	8157	1738	9866	1463	10731	1246	11457	925	13685	683	7051
3L-2S		MI	4814	1969	6820	1676	8082	1408	8770	1198	9475	878	11321	754	5125
6-#14	1.76	MA	6987	2089	9926	1791	12067	1498	13375	1263	15006	897	18584	777	9960
2L-3S		MI	4682	2089	6786	1757	7997	1468	8646	1236	9290	883	10991	562	7159
6-#14	1.76	MA	6380	2089	8854	1812	10706	1516	11726	1279	12780	921	15501	622	9911
3L-2S		MI	5095	2089	7533	1741	8944	1455	9794	1225	10839	867	13058	725	7163
6-#18	3.13	MA	7987	2393	12414	1966	15136	1624	17050	1340	19927	873	25369	749	17104
2L-3S		MI	5087	2393	7961	1936	9407	1596	10313	1312	11506	864	13694	346	11918
6-#18	3.13	MA	7032	2393	10548	2001	12768	1654	14180	1366	16054	913	20006	465	16792
3L-2S		MI	5738	2393	9247	1911	11038	1577	12291	1298	14176	840	17143	637	12088
8-#9	1.04	MA	6435	1929	8513	1713	10404	1443	11427	1233	12434	917	15067	799	6126
2L-4S		MI	4424	1929	5947	1687	7026	1427	7526	1219	7824	905	9231	662	4494
8-#9	1.04	MA	6138	1929	8021	1723	9781	1453	10671	1241	11414	929	13654	733	6131
3E		MI	4540	1929	6186	1678	7359	1414	7933	1207	8381	901	9928	704	4487
8-#9	1.04	MA	5972	1929	7686	1733	9315	1467	10100	1255	10633	936	12704	693	6116
4L-2S		MI	4745	1929	6533	1670	7798	1407	8466	1201	9100	891	10924	776	4475
8-#10	1.32	MA	6678	1992	9059	1748	11074	1469	12227	1248	13505	912	16541	793	7689
2L-4S		MI	4511	1992	6181	1725	7294	1456	7839	1237	8235	902	9808	623	5581
8-#10	1.32	MA	6313	1992	8438	1761	10287	1480	11272	1259	12216	927	14756	709	7683
3E		MI	4654	1992	6484	1714	7714	1440	8353	1223	8938	897	10689	677	5591
8-#10	1.32	MA	6110	1992	8014	1774	9698	1499	10551	1276	11228	936	13552	657	7634
4L-2S		MI	4905	1992	6920	1704	8268	1431	9025	1215	9845	885	11944	769	5582
8-#11	1.63	MA	6904	2059	9660	1780	11774	1491	13043	1260	14578	902	18006	783	9295
2L-4S		MI	4587	2059	6454	1756	7575	1478	8149	1249	8626	891	10278	567	6676
8-#11	1.63	MA	6477	2059	8908	1795	10820	1504	11887	1272	13017	920	15845	677	9276
3E		MI	4755	2059	6820	1744	8082	1460	8770	1232	9475	887	11321	631	6710
8-#11	1.63	MA	6238	2059	8393	1810	10106	1526	11011	1293	11818	930	14374	613	9177
4L-2S		MI	5047	2059	7346	1732	8749	1450	9578	1224	10566	874	12799	744	6706
8-#14	2.34	MA	7465	2219	10999	1872	13428	1557	15025	1300	17233	890	21668	768	13148
2L-4S		MI	4793	2219	7010	1854	8222	1553	8909	1296	9630	882	11595	454	9058
8-#14	2.34	MA	6890	2219	9926	1893	12067	1576	13375	1317	15006	915	18584	614	13068
3E		MI	5019	2219	7533	1838	8944	1528	9794	1273	10839	877	13058	545	9359
8-#14	2.34	MA	6571	2219	9189	1914	11045	1607	12123	1346	13292	927	16470	521	12650
4L-2S		MI	5413	2219	8279	1822	9891	1514	10941	1263	12389	861	15126	708	9392
8-#18	4.17	MA	8761	2625	14280	2111	17503	1730	19919	1406	23801	862	30733	734	22625
2L-4S		MI	5293	2625	8341	2106	9786	1744	10757	1415	12081	855	14684	150	13914
8-#18	4.17	MA	7877	2625	12414	2146	15136	1760	17050	1433	19927	902	25369	450	22265
3E		MI	5667	2625	9247	2081	11038	1702	12291	1379	14176	853	17143	303	15664
8-#18	4.17	MA	7387	2625	11125	2180	13349	1813	14861	1481	16934	920	21640	281	19764
4L-2S		MI	6243	2625	10533	2056	12670	1683	14269	1365	16846	829	20591	593	15893
10-#10	1.65	MA	6969	2065	9680	1794	11862	1502	13182	1269	14794	908	18326	788	9540
2L-5S		MI	4576	2065	6348	1781	7479	1498	8053	1266	8506	910	10180	565	6715
10-#10	1.65	MA	6616	2065	9059	1807	11074	1514	12227	1280	13505	924	16541	704	9523
3L-4S		MI	4722	2065	6617	1771	7849	1489	8511	1258	9142	898	11062	618	6868
10-#10	1.65	MA	6425	2065	8635	1820	10486	1533	11506	1298	12517	932	15337	652	9460
4L-3S		MI	4858	2065	6920	1760	8268	1473	9025	1244	9845	894	11944	672	6892
10-#10	1.65	MA	6190	2065	8261	1832	9971	1544	10866	1308	11628	948	14115	609	9203
5L-2S		MI	5101	2065	7357	1750	8822	1464	9696	1236	10751	882	13198	764	6891
10-#11	2.03	MA	7246	2150	10411	1836	12728	1532	14199	1286	16138	898	20166	777	11531
2L-5S		MI	4667	2150	6653	1824	7795	1530	8403	1283	8949	899	10715	491	7854
10-#11	2.03	MA	6834	2150	9660	1851	11774	1545	13043	1298	14578	916	18006	671	11497
3L-4S		MI	4834	2150	6979	1812	8242	1520	8957	1275	9717	887	11756	557	8216
10-#11	2.03	MA	6611	2150	9145	1866	11059	1568	12167	1319	13379	925	16534	607	11382
4L-3S		MI	4993	2150	7346	1800	8749	1501	9578	1258	10566	883	12799	621	8268
10-#11	2.03	MA	6336	2150	8689	1881	10433	1581	11389	1331	12299	943	15046	551	10825
5L-2S		MI	5276	2150	7871	1789	9416	1491	10386	1250	11657	870	14277	735	8277
10-#14	2.93	MA	7930	2350	12071	1954	14789	1617	16675	1338	19460	884	24751	760	16328
2L-5S		MI	4908	2350	7290	1952	8531	1626	9266	1344	10084	892	12207	341	10501
10-#14	2.93	MA	7384	2350	10999	1975	13428	1636	15025	1355	17233	909	21668	605	16226
3L-4S		MI	5137	2350	7757	1936	9169	1613	10057	1334	11180	875	13662	437	11144

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

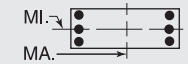
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.93	MA	7090	2350	10262	1996	12406	1667	13772	1384	15519	921	19553	512	15722
4L-3S		MI	5348	2350	8279	1920	9891	1587	10941	1311	12389	871	15126	527	11553
10-#14	2.93	MA	6708	2350	9609	2017	11510	1685	12660	1400	13974	946	17419	428	14612
5L-2S		MI	5724	2350	9025	1904	10839	1574	12089	1301	13938	854	17193	691	11609
10-#18	5.21	MA	8691	2857	14280	2291	17503	1866	19919	1500	23801	891	30733	435	27748
3L-4S		MI	5905	2857	9626	2251	11418	1850	12735	1482	14751	844	18132	107	17559
10-#18	5.21	MA	8258	2857	12991	2325	15717	1919	17731	1548	20807	909	27004	266	25183
4L-3S		MI	6203	2857	10533	2226	12670	1808	14269	1446	16846	842	20591	259	19416
10-#18	5.21	MA	7623	2857	11846	2360	14147	1949	15783	1574	18105	948	23256	106	22815
5L-2S		MI	6734	2857	11819	2201	14302	1789	16247	1432	19516	818	24040	550	19687
12-#10	1.98	MA	7254	2139	10301	1840	12650	1536	14137	1291	16083	905	20110	783	11385
2L-6S		MI	4610	2139	6475	1842	7684	1541	8276	1302	8792	911	10571	488	7692
12-#10	1.98	MA	6912	2139	9680	1853	11862	1548	13182	1301	14794	920	18326	699	11360
3L-5S		MI	4784	2139	6785	1827	8034	1532	8724	1287	9413	906	11434	560	7954
12-#10	1.98	MA	6731	2139	9256	1866	11274	1566	12460	1319	13806	929	17122	648	11286
4E		MI	4927	2139	7054	1817	8403	1523	9182	1280	10049	895	12317	613	8153
12-#10	1.98	MA	6500	2139	8881	1878	10759	1578	11821	1329	12917	944	15900	604	10994
5L-3S		MI	5057	2139	7357	1806	8822	1507	9696	1265	10751	890	13198	667	8187
12-#10	1.98	MA	6252	2139	8421	1892	10273	1589	11195	1347	12049	953	14723	535	10545
6L-2S		MI	5293	2139	7794	1796	9377	1498	10368	1258	11658	878	14453	759	8195
12-#11	2.44	MA	7580	2240	11163	1893	13682	1573	15355	1312	17699	894	22327	771	13762
2L-6S		MI	4707	2240	6811	1900	8039	1581	8668	1326	9304	908	11239	408	9055
12-#11	2.44	MA	7183	2240	10411	1908	12728	1587	14199	1324	16138	912	20166	665	13716
3L-5S		MI	4911	2240	7178	1881	8462	1571	9211	1309	10040	895	12194	482	9348
12-#11	2.44	MA	6974	2240	9896	1923	12013	1609	13323	1345	14939	921	18695	601	13589
4E		MI	5076	2240	7505	1869	8909	1561	9765	1301	10808	882	13234	548	9754
12-#11	2.44	MA	6702	2240	9440	1938	11387	1622	12545	1357	13859	939	17207	545	12998
5L-3S		MI	5227	2240	7871	1857	9416	1542	10386	1284	11657	878	14277	612	9821
12-#11	2.44	MA	6411	2240	8888	1955	10796	1636	11785	1378	12804	948	15768	459	12486
6L-2S		MI	5500	2240	8397	1845	10083	1532	11194	1276	12748	865	15756	725	9842
12-#14	3.52	MA	7864	2480	12071	2056	14789	1695	16675	1392	19460	903	24751	597	19384
3L-5S		MI	5246	2480	8037	2034	9478	1686	10414	1382	11634	886	14274	324	12638
12-#14	3.52	MA	7594	2480	11334	2077	13767	1726	15422	1421	17746	915	22636	503	18807
4E		MI	5473	2480	8503	2017	10116	1672	11205	1371	12729	869	15729	420	13246
12-#14	3.52	MA	7217	2480	10681	2098	12871	1745	14309	1438	16201	940	20503	419	17740
5L-3S		MI	5669	2480	9025	2001	10839	1647	12089	1349	13938	865	17193	510	13745
12-#14	3.52	MA	6822	2480	9899	2123	12024	1764	13220	1467	14690	952	18434	295	16582
6L-2S		MI	6030	2480	9772	1985	11786	1634	13237	1338	15488	848	19260	674	13820
12-#18	6.25	MA	9099	3089	14856	2470	18085	2025	20600	1615	24681	898	32367	251	30618
4E		MI	6463	3089	10912	2396	13049	1956	14713	1548	17421	833	21581	64	21226
12-#18	6.25	MA	8472	3089	13712	2505	16515	2055	18653	1641	21978	937	28620	91	28242
5L-3S		MI	6723	3089	11819	2371	14302	1914	16247	1513	19516	831	24040	216	23118
14-#10	2.32	MA	7203	2213	10301	1899	12650	1581	14137	1322	16083	917	20110	694	13195
3L-6S		MI	4819	2213	6911	1888	8239	1575	8947	1323	9698	907	11826	483	8950
14-#10	2.32	MA	7031	2213	9877	1912	12062	1600	13415	1340	15095	925	18907	643	13114
4L-5S		MI	4987	2213	7221	1873	8588	1566	9396	1308	10320	903	12689	555	9200
14-#10	2.32	MA	6801	2213	9502	1924	11547	1611	12776	1351	14206	941	17685	599	12790
5L-4S		MI	5129	2213	7491	1863	8957	1557	9854	1301	10955	891	13571	608	9436
14-#10	2.32	MA	6562	2213	9041	1938	11061	1623	12150	1368	13338	949	16508	530	12356
6L-3S		MI	5253	2213	7794	1852	9377	1541	10368	1286	11658	887	14453	662	9479
14-#10	2.32	MA	6355	2213	8645	1946	10518	1637	11547	1379	12496	964	15354	494	11884
7L-2S		MI	5483	2213	8231	1842	9931	1532	11040	1279	12565	875	15707	754	9494
14-#11	2.84	MA	7525	2330	11163	1964	13682	1628	15355	1350	17699	907	22327	659	15935
3L-6S		MI	4953	2330	7336	1956	8706	1622	9476	1352	10395	904	12717	399	10563

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

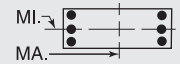


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.84	MA	7328	2330	10648	1979	12967	1650	14479	1371	16500	917	20856	596	15798
4L-5S		MI	5150	2330	7704	1937	9129	1612	10019	1335	11131	891	13672	472	10848
14-#11	2.84	MA	7059	2330	10192	1994	12341	1664	13701	1383	15420	935	19367	539	15176
5L-4S		MI	5313	2330	8030	1925	9576	1602	10573	1327	11899	878	14712	538	11293
14-#11	2.84	MA	6779	2330	9640	2011	11750	1677	12941	1404	14365	944	17928	453	14684
6L-3S		MI	5456	2330	8397	1914	10083	1584	11194	1311	12748	874	15756	603	11371
14-#11	2.84	MA	6535	2330	9159	2021	11100	1695	12207	1416	13341	962	16520	407	13900
7L-2S		MI	5721	2330	8922	1902	10750	1574	12003	1303	13839	861	17234	716	11401
14-#14	4.10	MA	8084	2610	12407	2159	15128	1786	17071	1459	19972	909	25720	495	21902
4L-5S		MI	5576	2610	8783	2115	10425	1745	11562	1419	13184	880	16341	307	14784
14-#14	4.10	MA	7711	2610	11754	2180	14232	1805	15959	1476	18427	933	23586	411	20873
5L-4S		MI	5800	2610	9249	2099	11063	1732	12353	1409	14279	863	17797	403	15360
14-#14	4.10	MA	7336	2610	10971	2205	13385	1823	14869	1505	16917	946	21518	286	19716
6L-3S		MI	5984	2610	9772	2083	11786	1706	13237	1386	15488	859	19260	493	15937
14-#14	4.10	MA	7009	2610	10284	2218	12466	1850	13819	1521	15452	970	19496	216	18412
7L-2S		MI	6332	2610	10518	2067	12733	1693	14385	1376	17038	842	21328	657	16026
14-#18	7.29	MA	9358	3321	15578	2650	18883	2161	21523	1708	25852	926	33983	76	33670
5L-4S		MI	7005	3321	12198	2541	14681	2062	16691	1615	20091	822	25029	21	24911
16-#10	2.65	MA	7324	2286	10498	1958	12850	1633	14370	1361	16384	922	20691	638	14942
4L-6S		MI	5023	2286	7348	1934	8793	1608	9619	1344	10605	904	13080	478	10210
16-#10	2.65	MA	7097	2286	10123	1970	12335	1645	13731	1372	15495	937	19470	594	14590
5E		MI	5186	2286	7658	1919	9142	1599	10068	1330	11227	899	13943	550	10450
16-#10	2.65	MA	6866	2286	9662	1984	11849	1657	13105	1389	14627	945	18293	525	14171
6L-4S		MI	5328	2286	7928	1909	9511	1590	10526	1322	11862	888	14826	603	10719
16-#10	2.65	MA	6667	2286	9266	1992	11306	1671	12502	1400	13785	961	17139	490	13695
7L-3S		MI	5446	2286	8231	1898	9931	1574	11040	1308	12565	883	15707	657	10770
16-#10	2.65	MA	6470	2286	8885	2002	10796	1679	11871	1415	12958	976	16027	440	13143
8L-2S		MI	5669	2286	8667	1888	10485	1565	11712	1300	13472	871	16962	749	10791
16-#11	3.25	MA	7675	2421	11399	2036	13921	1692	15635	1397	18060	912	23016	590	18009
4L-6S		MI	5194	2421	7862	2013	9372	1663	10284	1378	11486	899	14196	389	12047
16-#11	3.25	MA	7408	2421	10944	2051	13294	1705	14857	1409	16980	930	21528	533	17360
5E		MI	5384	2421	8229	1994	9795	1653	10827	1361	12222	886	15150	463	12355
16-#11	3.25	MA	7139	2421	10391	2068	12704	1719	14097	1430	15925	940	20089	448	16886
6L-4S		MI	5546	2421	8556	1982	10242	1644	11382	1353	12990	874	16191	529	12822
16-#11	3.25	MA	6906	2421	9910	2078	12054	1736	13363	1442	14901	958	18681	401	16097
7L-3S		MI	5682	2421	8922	1970	10750	1625	12003	1337	13839	870	17234	593	12919
16-#11	3.25	MA	6675	2421	9447	2089	11435	1745	12609	1461	13896	975	17325	338	15295
8L-2S		MI	5939	2421	9447	1958	11416	1615	12811	1329	14930	857	18712	706	12958
16-#14	4.69	MA	8193	2741	12826	2261	15593	1864	17608	1513	20654	927	26669	402	24013
5E		MI	5899	2741	9529	2197	11373	1805	12710	1457	14733	874	18409	290	16937
16-#14	4.69	MA	7836	2741	12044	2286	14746	1883	16519	1542	19144	939	24601	278	22854
6L-4S		MI	6122	2741	9996	2181	12010	1792	13501	1447	15829	857	19864	386	17485
16-#14	4.69	MA	7527	2741	11356	2299	13827	1909	15468	1559	17678	964	22579	208	21539
7L-3S		MI	6307	2741	10518	2164	12733	1766	14385	1424	17038	852	21328	476	18128
18-#10	2.98	MA	7387	2360	10744	2016	13122	1679	14686	1393	16784	934	21254	589	16394
5L-6S		MI	5224	2360	7785	1980	9347	1642	10291	1365	11512	900	14335	473	11474
18-#10	2.98	MA	7163	2360	10283	2030	12637	1690	14060	1411	15916	942	20077	520	15988
6L-5S		MI	5383	2360	8095	1965	9696	1633	10740	1351	12134	896	15198	545	11704
18-#10	2.98	MA	6972	2360	9887	2038	12093	1704	13457	1421	15074	957	18923	485	15508
7L-4S		MI	5523	2360	8364	1955	10066	1624	11198	1343	12769	884	16080	598	12002
18-#10	2.98	MA	6778	2360	9506	2048	11584	1712	12826	1436	14247	973	17812	435	14963
8L-3S		MI	5636	2360	8667	1944	10485	1608	11712	1329	13472	880	16962	652	12059
18-#10	2.98	MA	6547	2360	9136	2058	11088	1721	12200	1443	13406	981	16714	390	14263
9L-2S		MI	5854	2360	9104	1934	11039	1599	12384	1321	14379	868	18216	744	12086
18-#11	3.66	MA	7751	2511	11695	2107	14248	1746	16013	1435	18541	926	23688	527	19548
5L-6S		MI	5430	2511	8387	2069	10039	1705	11092	1404	12577	895	15674	380	13537
18-#11	3.66	MA	7491	2511	11143	2124	13657	1760	15253	1456	17486	935	22249	442	19090
6L-5S		MI	5614	2511	8754	2050	10462	1695	11636	1387	13313	882	16629	453	13866

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

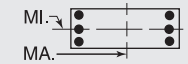
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	3.66	MA	7268	2511	10662	2134	13007	1778	14519	1468	16462	953	20841	395	18297
7L-4S		MI	5775	2511	9081	2038	10909	1685	12190	1379	14081	869	17669	519	14313
18-#11	3.66	MA	7041	2511	10199	2145	12388	1787	13765	1487	15456	971	19485	332	17495
8L-3S		MI	5904	2511	9447	2027	11416	1666	12811	1363	14930	865	18712	584	14466
18-#14	5.27	MA	8324	2871	13116	2368	16107	1943	18168	1580	21370	933	27684	269	25996
6L-5S		MI	6217	2871	10276	2278	12320	1864	13858	1494	16283	867	20476	273	19095
18-#14	5.27	MA	8033	2871	12429	2381	15188	1969	17118	1596	19905	958	25663	199	24665
7L-4S		MI	6464	2871	10742	2262	12957	1851	14649	1484	17378	851	21931	369	19618
20-#10	3.31	MA	7455	2434	10904	2076	13425	1724	15015	1432	17205	938	21862	515	17808
6E		MI	5422	2434	8222	2026	9901	1675	10963	1387	12419	897	15589	468	12740
20-#10	3.31	MA	7271	2434	10508	2084	12881	1738	14412	1442	16363	954	20708	480	17323
7L-5S		MI	5576	2434	8532	2011	10251	1667	11411	1372	13040	892	16452	540	12962
20-#10	3.31	MA	7079	2434	10127	2094	12372	1746	13780	1457	15536	969	19596	430	16791
8L-4S		MI	5716	2434	8801	2001	10620	1658	11869	1365	13676	881	17335	593	13285
20-#10	3.31	MA	6856	2434	9757	2104	11876	1755	13155	1465	14695	978	18499	385	16084
9L-3S		MI	5824	2434	9104	1990	11039	1642	12384	1350	14379	876	18216	647	13347
20-#11	4.06	MA	7836	2602	11894	2181	14611	1801	16409	1482	19046	931	24410	436	21296
6E		MI	5662	2602	8913	2126	10706	1746	11900	1430	13668	891	17152	370	15031
20-#11	4.06	MA	7624	2602	11413	2191	13961	1819	15675	1494	18022	949	23002	389	20499
7L-5S		MI	5841	2602	9280	2107	11129	1736	12444	1414	14404	878	18107	444	15381
20-#11	4.06	MA	7398	2602	10951	2202	13342	1828	14921	1513	17016	967	21646	326	19695
8L-4S		MI	6002	2602	9607	2095	11576	1726	12998	1406	15172	865	19147	510	15810
20-#14	5.86	MA	8528	3002	13501	2462	16549	2028	18768	1634	22132	952	28746	191	27792
7L-5S		MI	6551	3002	11022	2360	13267	1924	15006	1532	17832	861	22543	256	21258
22-#10	3.64	MA	7566	2507	11128	2130	13669	1772	15367	1464	17652	950	22493	475	19140
7L-6S		MI	5617	2507	8658	2072	10456	1709	11634	1408	13325	893	16844	463	14008
22-#10	3.64	MA	7375	2507	10748	2140	13159	1780	14735	1478	16825	966	21381	426	18620
8L-5S		MI	5767	2507	8968	2057	10805	1700	12083	1393	13947	889	17707	535	14223
22-#10	3.64	MA	7159	2507	10378	2150	12664	1789	14110	1486	15984	974	20284	380	17906
9L-4S		MI	5906	2507	9238	2047	11174	1691	12541	1386	14582	877	18589	588	14568
22-#11	4.47	MA	7972	2692	12165	2247	14915	1860	16831	1520	19583	945	25162	383	22703
7L-6S		MI	5892	2692	9438	2182	11373	1787	12709	1456	14759	886	18631	361	16530
22-#11	4.47	MA	7749	2692	11702	2258	14296	1869	16077	1539	18577	963	23807	320	21894
8L-5S		MI	6065	2692	9805	2163	11796	1777	13252	1440	15495	874	19585	435	16899
24-#10	3.97	MA	7666	2581	11368	2186	13947	1813	15690	1500	18114	962	23166	421	20447
8L-6S		MI	5809	2581	9095	2118	11010	1743	12306	1429	14232	890	18098	458	15278
24-#10	3.97	MA	7456	2581	10999	2196	13451	1822	15065	1507	17273	971	22068	375	19727
9L-5S		MI	5955	2581	9405	2103	11359	1734	12755	1415	14854	885	18961	530	15486
24-#11	4.88	MA	8094	2783	12454	2315	15250	1911	17233	1565	20137	958	25967	314	24094
8L-6S		MI	6118	2783	9963	2239	12040	1829	13517	1482	15849	882	20109	351	18033

RECTANGULAR TIED COLUMNS 24" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.10	MA	7289	2064	9807	1815	11908	1529	13052	1304	14204	966	17211	841	7242
2E		MI	5024	2064	7117	1753	8379	1475	9042	1257	9677	928	11420	791	4939
4-#18	1.96	MA	8050	2267	11638	1927	14136	1609	15704	1351	17741	947	22077	820	12432
2E		MI	5468	2267	8298	1858	9790	1550	10710	1300	11892	906	14119	728	8295
6-#11	1.15	MA	7355	2075	9864	1829	12028	1540	13223	1313	14456	969	17575	844	7556
2L-3S		MI	4765	2075	6622	1782	7795	1499	8358	1276	8772	947	10273	689	5168
6-#11	1.15	MA	6870	2075	9056	1845	11003	1554	11980	1325	12778	988	15252	740	7556
3L-2S		MI	5071	2075	7148	1770	8462	1489	9166	1268	9863	934	11751	803	5148
6-#14	1.65	MA	7829	2195	10961	1897	13373	1588	14827	1342	16600	959	20529	832	10689
2L-3S		MI	4936	2195	7117	1850	8379	1548	9042	1305	9677	939	11420	610	7195
6-#14	1.65	MA	7168	2195	9807	1919	11908	1608	13052	1359	14204	985	17211	680	10640
3L-2S		MI	5352	2195	7863	1834	9326	1535	10190	1295	11226	922	13487	774	7191
6-#18	2.94	MA	8927	2499	13648	2072	16687	1714	18797	1418	21916	936	27857	804	18400
2L-3S		MI	5342	2499	8298	2028	9790	1675	10710	1381	11892	919	14119	394	11983

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

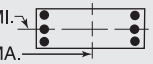
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	2.94	MA	7883	2499	11638	2109	14136	1747	15704	1447	17741	978	22077	526	18088
3L-2S		MI	5999	2499	9584	2003	11422	1656	12688	1367	14562	895	17568	684	12129
8-#10	1.25	MA	7488	2098	10023	1854	12298	1559	13584	1327	14974	974	18315	848	8238
2L-4S		MI	4765	2098	6504	1820	7673	1537	8235	1308	8624	958	10241	672	5611
8-#10	1.25	MA	7091	2098	9356	1867	11452	1571	12558	1338	13589	991	16398	765	8232
3E		MI	4910	2098	6807	1809	8092	1521	8749	1293	9327	953	11122	726	5614
8-#10	1.25	MA	6871	2098	8902	1880	10821	1590	11785	1356	12530	1000	15114	714	8182
4L-2S		MI	5162	2098	7244	1799	8646	1512	9421	1286	10233	942	12376	819	5602
8-#11	1.53	MA	7737	2165	10672	1886	13054	1581	14466	1339	16134	965	19898	838	9969
2L-4S		MI	4841	2165	6782	1850	7955	1559	8545	1319	9014	947	10708	615	6715
8-#11	1.53	MA	7271	2165	9864	1901	12028	1595	13223	1352	14456	984	17575	734	9950
3E		MI	5010	2165	7148	1838	8462	1540	9166	1302	9863	943	11751	680	6740
8-#11	1.53	MA	7013	2165	9312	1917	11262	1618	12283	1373	13170	994	16005	671	9851
4L-2S		MI	5305	2165	7673	1826	9129	1530	9974	1294	10954	930	13229	793	6731
8-#14	2.21	MA	8351	2325	12115	1979	14837	1648	16602	1379	18996	953	23846	824	14120
2L-4S		MI	5046	2325	7341	1948	8603	1633	9306	1365	10017	937	12023	503	9192
8-#14	2.21	MA	7724	2325	10961	2000	13373	1667	14827	1397	16600	979	20529	672	14040
3E		MI	5275	2325	7863	1932	9326	1607	10190	1343	11226	933	13487	593	9399
8-#14	2.21	MA	7377	2325	10171	2022	12276	1699	13483	1427	14760	993	18272	580	13729
4L-2S		MI	5672	2325	8610	1916	10273	1594	11338	1333	12776	916	15554	757	9424
8-#18	3.92	MA	9772	2731	15659	2217	19239	1820	21889	1485	26091	925	33637	789	24353
2L-4S		MI	5543	2731	8677	2199	10170	1822	11155	1483	12467	910	15109	198	14086
8-#18	3.92	MA	8804	2731	13648	2253	16687	1853	18797	1514	21916	967	27857	511	23993
3E		MI	5900	2731	9584	2173	11422	1781	12688	1448	14562	908	17568	350	15732
8-#18	3.92	MA	8270	2731	12264	2290	14768	1907	16444	1564	18698	988	23874	344	21468
4L-2S		MI	6508	2731	10870	2148	13054	1761	14666	1434	17231	884	21016	641	15936
10-#10	1.56	MA	7804	2172	10690	1900	13144	1593	14609	1348	16358	971	20232	843	10225
2L-5S		MI	4831	2172	6671	1876	7857	1579	8449	1337	8895	966	10612	614	6797
10-#10	1.56	MA	7421	2172	10023	1913	12298	1605	13584	1359	14974	987	18315	760	10208
3L-4S		MI	4976	2172	6941	1866	8227	1570	8907	1329	9530	954	11495	667	6900
10-#10	1.56	MA	7213	2172	9569	1926	11667	1624	12810	1377	13915	996	17031	709	10145
4L-3S		MI	5114	2172	7244	1855	8646	1554	9421	1315	10233	950	12376	721	6917
10-#10	1.56	MA	6956	2172	9168	1939	11116	1636	12125	1389	12963	1012	15725	668	9936
5L-2S		MI	5359	2172	7680	1845	9201	1545	10093	1307	11140	938	13631	814	6913
10-#11	1.91	MA	8109	2256	11480	1943	14079	1622	15709	1365	17811	961	22222	832	12373
2L-5S		MI	4922	2256	6980	1918	8175	1610	8799	1353	9337	955	11146	540	7948
10-#11	1.91	MA	7661	2256	10672	1958	13054	1637	14466	1378	16134	980	19898	728	12339
3L-4S		MI	5089	2256	7307	1906	8622	1600	9353	1345	10105	942	12186	606	8258
10-#11	1.91	MA	7418	2256	10120	1973	12288	1659	13526	1399	14847	990	18329	665	12225
4L-3S		MI	5249	2256	7673	1895	9129	1581	9974	1328	10954	938	13229	670	8300
10-#11	1.91	MA	7116	2256	9632	1989	11617	1673	12693	1412	13690	1009	16737	611	11694
5L-2S		MI	5535	2256	8199	1883	9796	1571	10783	1320	12045	925	14708	784	8304
10-#14	2.76	MA	8858	2456	13269	2060	16302	1707	18377	1417	21392	947	27164	815	17543
2L-5S		MI	5162	2456	7621	2046	8913	1706	9663	1413	10471	948	12635	390	10617
10-#14	2.76	MA	8261	2456	12115	2082	14837	1727	16602	1435	18996	973	23846	663	17441
3L-4S		MI	5391	2456	8087	2029	9550	1693	10454	1403	11567	931	14091	486	11273
10-#14	2.76	MA	7942	2456	11325	2103	13741	1759	15258	1465	17156	987	21590	571	17051
4L-3S		MI	5604	2456	8610	2013	10273	1667	11338	1380	12776	926	15554	576	11596
10-#14	2.76	MA	7521	2456	10626	2125	12780	1779	14065	1482	15499	1013	19306	490	15794
5L-2S		MI	5985	2456	9356	1997	11220	1654	12486	1370	14325	910	17622	740	11643
10-#18	4.90	MA	9691	2963	15659	2398	19239	1959	21889	1581	26091	956	33637	496	29908
3L-4S		MI	6156	2963	9963	2344	11801	1928	13133	1550	15137	899	18557	155	17722
10-#18	4.90	MA	9219	2963	14275	2435	17320	2013	19537	1631	22873	977	29655	329	27325
4L-3S		MI	6461	2963	10870	2318	13054	1887	14666	1514	17231	897	21016	307	19484

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	4.90	MA	8516	2963	13048	2471	15636	2045	17447	1659	19970	1019	25641	176	24848
5L-2S		MI	7002	2963	12156	2293	14686	1867	16644	1501	19901	873	24464	598	19733
12-#10	1.87	MA	8115	2245	11357	1946	13991	1626	15635	1370	17743	967	22149	838	12208
2L-6S		MI	4865	2245	6798	1937	8063	1622	8672	1372	9180	967	11004	537	7769
12-#10	1.87	MA	7743	2245	10690	1959	13144	1639	14609	1381	16358	984	20232	756	12182
3L-5S		MI	5039	2245	7108	1922	8412	1613	9121	1358	9802	962	11867	609	8034
12-#10	1.87	MA	7546	2245	10236	1972	12514	1658	13836	1399	15299	993	18948	705	12109
4E		MI	5183	2245	7377	1912	8781	1604	9579	1350	10437	951	12750	662	8187
12-#10	1.87	MA	7292	2245	9835	1985	11962	1670	13151	1410	14347	1009	17642	663	11863
5L-3S		MI	5314	2245	7680	1901	9201	1588	10093	1336	11140	946	13631	716	8214
12-#10	1.87	MA	7024	2245	9336	1999	11441	1682	12481	1428	13418	1018	16385	595	11358
6L-2S		MI	5552	2245	8117	1891	9755	1579	10764	1328	12047	935	14885	809	8219
12-#11	2.29	MA	8473	2346	12288	1999	15105	1664	16951	1391	19489	957	24545	826	14773
2L-6S		MI	4961	2346	7138	1994	8419	1661	9064	1396	9691	964	11670	457	9147
12-#11	2.29	MA	8041	2346	11480	2015	14079	1678	15709	1404	17811	975	22222	722	14727
3L-5S		MI	5166	2346	7506	1975	8842	1651	9608	1379	10428	951	12624	531	9439
12-#11	2.29	MA	7813	2346	10928	2030	13313	1701	14769	1425	16525	986	20652	659	14600
4E		MI	5331	2346	7832	1963	9289	1641	10162	1371	11196	938	13665	597	9799
12-#11	2.29	MA	7514	2346	10440	2045	12642	1715	13936	1438	15368	1004	19060	605	14034
5L-3S		MI	5484	2346	8199	1951	9796	1623	10783	1354	12045	934	14708	661	9855
12-#11	2.29	MA	7198	2346	9841	2062	12010	1729	13121	1459	14237	1015	17525	520	13463
6L-2S		MI	5760	2346	8724	1939	10463	1613	11591	1346	13136	921	16186	774	9871
12-#14	3.31	MA	8784	2586	13269	2163	16302	1787	18377	1472	21392	967	27164	655	20842
3L-5S		MI	5501	2586	8367	2127	9860	1765	10811	1451	12021	941	14703	373	12751
12-#14	3.31	MA	8490	2586	12479	2185	15205	1819	17033	1502	19552	980	24907	562	20378
4E		MI	5727	2586	8834	2111	10498	1752	11602	1441	13116	925	16158	469	13370
12-#14	3.31	MA	8074	2586	11780	2207	14244	1838	15840	1520	17895	1006	22624	482	19166
5L-3S		MI	5927	2586	9356	2095	11220	1727	12486	1418	14325	920	17622	559	13790
12-#14	3.31	MA	7646	2586	10930	2231	13338	1858	14672	1550	16276	1020	20417	358	18010
6L-2S		MI	6293	2586	10102	2079	12167	1713	13634	1408	15875	903	19689	722	13855
12-#18	5.88	MA	10134	3195	16286	2580	19872	2119	22630	1698	27047	966	35435	314	33196
4E		MI	6715	3195	11249	2488	13433	2034	15111	1617	17807	888	22006	112	21382
12-#18	5.88	MA	9440	3195	15058	2616	18187	2151	20539	1726	24145	1008	31421	161	30698
5L-3S		MI	6983	3195	12156	2463	14686	1993	16644	1581	19901	886	24464	264	23242
14-#10	2.18	MA	8059	2319	11357	2005	13991	1672	15635	1402	17743	980	22149	751	14155
3L-6S		MI	5073	2319	7235	1983	8617	1656	9343	1394	10087	964	12259	532	9025
14-#10	2.18	MA	7871	2319	10903	2018	13360	1691	14862	1420	16684	989	20865	700	14074
4L-5S		MI	5243	2319	7545	1968	8966	1647	9792	1379	10709	959	13121	604	9278
14-#10	2.18	MA	7620	2319	10501	2031	12809	1703	14177	1431	15732	1005	19559	658	13794
5L-4S		MI	5385	2319	7814	1958	9335	1638	10250	1372	11344	947	14004	657	9472
14-#10	2.18	MA	7361	2319	10003	2045	12288	1715	13507	1449	14802	1014	18302	590	13307
6L-3S		MI	5511	2319	8117	1947	9755	1622	10764	1357	12047	943	14885	711	9508
14-#10	2.18	MA	7136	2319	9579	2054	11700	1729	12862	1460	13901	1031	17072	555	12858
7L-2S		MI	5743	2319	8554	1937	10309	1613	11436	1350	12954	931	16140	804	9520
14-#11	2.68	MA	8413	2437	12288	2071	15105	1719	16951	1430	19489	971	24545	716	17114
3L-6S		MI	5207	2437	7664	2050	9086	1702	9872	1422	10782	959	13148	447	10659
14-#11	2.68	MA	8198	2437	11736	2086	14339	1742	16012	1451	18203	981	22975	653	16978
4L-5S		MI	5405	2437	8031	2031	9509	1692	10416	1405	11518	946	14102	521	10938
14-#11	2.68	MA	7902	2437	11248	2102	13668	1756	15179	1464	17045	1000	21383	599	16380
5L-4S		MI	5569	2437	8358	2020	9956	1683	10970	1397	12287	934	15143	587	11339
14-#11	2.68	MA	7598	2437	10649	2119	13035	1770	14364	1486	15915	1010	19848	514	15830
6L-3S		MI	5714	2437	8724	2008	10463	1664	11591	1381	13136	930	16186	651	11406
14-#11	2.68	MA	7334	2437	10133	2129	12329	1788	13578	1498	14818	1029	18344	470	15047
7L-2S		MI	5982	2437	9250	1996	11130	1654	12399	1373	14227	917	17664	765	11432

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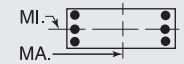
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

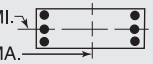


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.86	MA	9023	2717	13633	2266	16670	1878	18808	1540	21948	974	28225	554	23715
4L-5S		MI	5832	2717	9114	2209	10807	1825	11959	1489	13570	935	16770	356	14893
14-#14	3.86	MA	8612	2717	12934	2288	15709	1898	17615	1558	20291	1000	25941	473	22543
5L-4S		MI	6056	2717	9580	2193	11445	1812	12750	1478	14666	918	18225	451	15480
14-#14	3.86	MA	8204	2717	12084	2313	14802	1918	16447	1588	18672	1014	23735	350	21390
6L-3S		MI	6243	2717	10102	2176	12167	1786	13634	1456	15875	914	19689	542	15982
14-#14	3.86	MA	7849	2717	11346	2327	13802	1943	15322	1605	17101	1040	21575	283	20039
7L-2S		MI	6596	2717	10849	2160	13114	1773	14782	1446	17424	897	21756	705	16063
14-#18	6.86	MA	10336	3427	17069	2761	20739	2257	23632	1793	28319	997	37201	145	36547
5L-4S		MI	7258	3427	12535	2633	15065	2140	17088	1684	20477	877	25454	69	25060
16-#10	2.49	MA	8190	2392	11570	2065	14206	1725	15887	1441	18068	986	22782	695	16039
4L-6S		MI	5278	2392	7671	2029	9171	1689	10015	1415	10994	960	13513	527	10284
16-#10	2.49	MA	7941	2392	11168	2077	13655	1737	15202	1452	17116	1002	21476	653	15731
5E		MI	5443	2392	7981	2014	9520	1680	10464	1400	11615	955	14376	599	10527
16-#10	2.49	MA	7690	2392	10670	2091	13134	1749	14533	1470	16187	1011	20219	585	15258
6L-4S		MI	5584	2392	8251	2004	9890	1671	10922	1393	12251	944	15259	652	10756
16-#10	2.49	MA	7474	2392	10245	2100	12546	1763	13887	1481	15285	1027	18989	550	14807
7L-3S		MI	5705	2392	8554	1993	10309	1655	11436	1378	12954	939	16140	706	10799
16-#10	2.49	MA	7258	2392	9837	2110	12000	1771	13202	1496	14400	1043	17802	503	14191
8L-2S		MI	5931	2392	8991	1983	10863	1646	12108	1371	13860	928	17394	799	10818
16-#11	3.06	MA	8575	2527	12544	2143	15364	1783	17255	1477	19881	977	25298	647	19357
4L-6S		MI	5448	2527	8189	2107	9752	1744	10681	1448	11873	955	14626	438	12175
16-#11	3.06	MA	8282	2527	12056	2158	14693	1797	16422	1490	18723	996	23706	593	18730
5E		MI	5640	2527	8557	2088	10176	1734	11224	1431	12609	942	15581	512	12442
16-#11	3.06	MA	7989	2527	11457	2175	14061	1811	15606	1512	17592	1006	22171	508	18200
6L-4S		MI	5803	2527	8883	2076	10623	1724	11778	1423	13378	929	16621	578	12878
16-#11	3.06	MA	7737	2527	10941	2185	13355	1829	14821	1524	16496	1025	20667	464	17414
7L-3S		MI	5941	2527	9250	2064	11130	1705	12399	1407	14227	925	17664	642	12956
16-#11	3.06	MA	7482	2527	10445	2197	12691	1838	14001	1543	15418	1043	19218	403	16597
8L-2S		MI	6201	2527	9775	2052	11796	1695	13207	1399	15318	913	19143	755	12990
16-#14	4.41	MA	9136	2847	14088	2370	17173	1958	19390	1595	22687	994	29259	465	25926
5E		MI	6156	2847	9860	2290	11754	1885	13107	1526	15120	929	18837	339	17042
16-#14	4.41	MA	8748	2847	13238	2394	16267	1977	18222	1625	21068	1008	27052	341	24768
6L-4S		MI	6379	2847	10326	2274	12392	1871	13898	1516	16215	912	20293	434	17601
16-#14	4.41	MA	8413	2847	12500	2408	15267	2003	17097	1643	19497	1034	24892	275	23404
7L-3S		MI	6555	2847	10849	2258	13114	1846	14782	1493	17424	908	21756	525	18174
18-#10	2.80	MA	8256	2466	11835	2124	14501	1771	16228	1474	18501	998	23393	648	17671
5L-6S		MI	5480	2466	8108	2075	9725	1723	10687	1436	11900	957	14768	522	11547
18-#10	2.80	MA	8013	2466	11337	2137	13980	1782	15558	1492	17571	1007	22136	580	17212
6L-5S		MI	5640	2466	8418	2060	10074	1714	11136	1422	12522	952	15630	594	11779
18-#10	2.80	MA	7806	2466	10912	2146	13392	1796	14913	1503	16670	1024	20906	546	16759
7L-4S		MI	5780	2466	8688	2050	10444	1705	11594	1414	13157	940	16513	647	12040
18-#10	2.80	MA	7592	2466	10504	2156	12846	1805	14228	1517	15785	1040	19719	498	16155
8L-3S		MI	5896	2466	8991	2039	10863	1689	12108	1400	13860	936	17394	701	12090
18-#10	2.80	MA	7343	2466	10108	2166	12315	1814	13558	1525	14884	1049	18550	453	15436
9L-2S		MI	6116	2466	9427	2029	11418	1680	12780	1392	14767	924	18649	794	12113
18-#11	3.44	MA	8655	2617	12864	2215	15719	1839	17665	1516	20401	991	26029	587	21086
5L-6S		MI	5685	2617	8715	2163	10419	1785	11489	1474	12964	951	16105	429	13675
18-#11	3.44	MA	8372	2617	12266	2232	15086	1853	16849	1538	19270	1002	24494	502	20572
6L-5S		MI	5872	2617	9082	2144	10842	1775	12032	1457	13700	938	17059	502	13951
18-#11	3.44	MA	8130	2617	11749	2242	14380	1870	16064	1551	18173	1020	22990	458	19784
7L-4S		MI	6033	2617	9409	2133	11289	1765	12586	1449	14469	925	18099	568	14411
18-#11	3.44	MA	7879	2617	11253	2253	13716	1880	15244	1569	17096	1039	21541	397	18963
8L-3S		MI	6165	2617	9775	2121	11796	1747	13207	1433	15318	921	19143	633	14504
18-#14	4.96	MA	9279	2977	14392	2476	17731	2037	19997	1663	23463	1001	30370	332	28145
6L-5S		MI	6475	2977	10606	2372	12701	1944	14255	1564	16670	923	20905	321	19198
18-#14	4.96	MA	8962	2977	13654	2490	16731	2062	18872	1681	21892	1027	28210	266	26769
7L-4S		MI	6697	2977	11073	2356	13339	1931	15045	1554	17765	906	22360	417	19731

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	3.11	MA	8331	2540	12004	2183	14826	1816	16584	1513	18956	1004	24053	575	19169
6E		MI	5678	2540	8545	2121	10280	1756	11359	1457	12807	953	16022	517	12811
20-#10	3.11	MA	8131	2540	11579	2192	14239	1830	15939	1524	18055	1020	22823	541	18712
7L-5S		MI	5834	2540	8855	2106	10629	1748	11808	1443	13429	948	16885	589	13036
20-#10	3.11	MA	7920	2540	11171	2202	13692	1838	15254	1538	17169	1036	21636	493	18117
8L-4S		MI	5974	2540	9124	2096	10998	1739	12266	1435	14064	937	17768	642	13323
20-#10	3.11	MA	7678	2540	10775	2212	13161	1848	14584	1546	16268	1045	20467	448	17393
9L-3S		MI	6084	2540	9427	2085	11418	1723	12780	1421	14767	932	18649	696	13379
20-#10	3.11	MA	7454	2540	10359	2220	12608	1865	13928	1555	15387	1061	19205	396	16692
10L-2S		MI	6300	2540	9864	2075	11972	1714	13451	1413	15674	921	19903	789	13408
20-#11	3.82	MA	8747	2708	13074	2288	16112	1894	18092	1564	20948	997	26817	496	22947
6E		MI	5919	2708	9240	2220	11086	1826	12297	1500	14055	946	17583	419	15166
20-#11	3.82	MA	8516	2708	12558	2298	15406	1911	17307	1577	19851	1016	25313	452	22156
7L-5S		MI	6099	2708	9608	2201	11509	1816	12840	1484	14791	934	18537	493	15464
20-#11	3.82	MA	8268	2708	12062	2310	14742	1921	16487	1595	18774	1035	23864	391	21328
8L-4S		MI	6260	2708	9934	2189	11956	1806	13395	1476	15560	921	19578	559	15906
20-#14	5.51	MA	9499	3108	14808	2571	18196	2122	20647	1718	24288	1021	31527	257	30133
7L-5S		MI	6811	3108	11353	2453	13648	2004	15403	1602	18219	916	22972	304	21358
22-#10	3.42	MA	8450	2613	12246	2238	15085	1864	16964	1545	19439	1016	24740	536	20667
7L-6S		MI	5874	2613	8982	2167	10834	1790	12030	1479	13714	950	17277	512	14078
22-#10	3.42	MA	8241	2613	11838	2248	14539	1872	16279	1560	18554	1033	23553	488	20080
8L-5S		MI	6026	2613	9292	2152	11183	1781	12479	1464	14336	945	18139	584	14295
22-#10	3.42	MA	8006	2613	11442	2258	14008	1881	15609	1567	17653	1042	22384	443	19349
9L-4S		MI	6165	2613	9561	2142	11552	1772	12937	1457	14971	933	19022	637	14607
22-#10	3.42	MA	7790	2613	11025	2266	13454	1898	14954	1576	16771	1057	21122	391	18643
10L-3S		MI	6271	2613	9864	2131	11972	1756	13451	1442	15674	929	19903	691	14667
22-#11	4.21	MA	8895	2798	13366	2355	16431	1953	18550	1603	21529	1012	27636	446	24530
7L-6S		MI	6149	2798	9766	2276	11753	1868	13105	1526	15146	942	19061	410	16662
22-#11	4.21	MA	8649	2798	12870	2367	15767	1962	17730	1621	20452	1031	26187	385	23694
8L-5S		MI	6324	2798	10133	2258	12176	1858	13649	1510	15882	929	20016	483	16981
24-#10	3.74	MA	8557	2687	12505	2294	15385	1906	17305	1581	19938	1029	25470	483	22043
8L-6S		MI	6067	2687	9418	2213	11388	1824	12702	1500	14621	946	18531	507	15347
24-#10	3.74	MA	8329	2687	12109	2304	14854	1915	16635	1589	19038	1038	24301	438	21306
9L-5S		MI	6215	2687	9728	2198	11737	1815	13151	1485	15242	941	19394	579	15557
24-#10	3.74	MA	8120	2687	11692	2312	14300	1932	15979	1597	18156	1054	23039	386	20595
10L-4S		MI	6354	2687	9998	2188	12107	1806	13609	1478	15878	930	20277	632	15890
24-#11	4.59	MA	9024	2889	13678	2423	16793	2004	18973	1647	22129	1026	28510	379	26059
8L-6S		MI	6376	2889	10291	2333	12420	1909	13913	1552	16237	938	20539	400	18162

RECTANGULAR TIED COLUMNS 24" x 36"

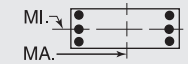
4-#14	1.04	MA	8129	2170	10804	1922	13168	1619	14443	1383	15695	1028	18998	896	7728
2E		MI	5280	2170	7448	1846	8760	1555	9439	1327	10064	984	11848	840	4963
4-#18	1.85	MA	8959	2373	12770	2033	15561	1699	17292	1430	19495	1010	24225	875	13296
2E		MI	5726	2373	8635	1950	10174	1628	11108	1369	12277	961	14544	776	8329
6-#11	1.08	MA	8199	2181	10862	1936	13294	1630	14622	1391	15960	1032	19382	899	8062
2L-3S		MI	5020	2181	6950	1876	8176	1579	8755	1346	9159	1003	10703	738	5192
6-#11	1.08	MA	7675	2181	9998	1951	12197	1645	13292	1405	14165	1052	16897	797	8062
3L-2S		MI	5327	2181	7476	1864	8842	1569	9563	1338	10250	990	12181	851	5170
6-#14	1.56	MA	8714	2301	12039	2003	14736	1679	16343	1421	18261	1022	22550	887	11418
2L-3S		MI	5191	2301	7448	1944	8760	1627	9439	1375	10064	994	11848	659	7229
6-#14	1.56	MA	7999	2301	10804	2025	13168	1699	14443	1439	15695	1049	18998	738	11369
3L-2S		MI	5610	2301	8194	1928	9707	1614	10587	1364	11613	977	13915	822	7218

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

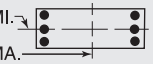


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	2.78	MA	9911	2605	14925	2178	18297	1805	20607	1497	23971	999	30422	859	19696
2L-3S		MI	5596	2605	8635	2121	10174	1754	11108	1449	12277	974	14544	442	12045
6-#18	2.78	MA	8777	2605	12770	2216	15561	1839	17292	1528	19495	1044	24225	586	19384
3L-2S		MI	6259	2605	9921	2095	11806	1734	13086	1436	14947	950	17992	732	12168
8-#10	1.18	MA	8341	2204	11030	1960	13579	1650	15004	1406	16509	1037	20166	903	8786
2L-4S		MI	5020	2204	6827	1915	8051	1618	8631	1378	9012	1014	10673	721	5638
8-#10	1.18	MA	7912	2204	10317	1974	12674	1662	13908	1417	15029	1054	18117	822	8781
3E		MI	5165	2204	7130	1904	8470	1602	9145	1364	9715	1009	11555	776	5636
8-#10	1.18	MA	7675	2204	9833	1987	12001	1682	13082	1436	13899	1064	16753	771	8731
4L-2S		MI	5419	2204	7567	1894	9025	1593	9817	1356	10622	998	12809	868	5623
8-#11	1.44	MA	8613	2271	11727	1992	14391	1672	15952	1418	17756	1028	21868	893	10643
2L-4S		MI	5095	2271	7109	1944	8335	1639	8942	1389	9402	1002	11138	664	6752
8-#11	1.44	MA	8109	2271	10862	2008	13294	1686	14622	1431	15960	1048	19382	791	10624
3E		MI	5265	2271	7476	1932	8842	1620	9563	1372	10250	998	12181	729	6767
8-#11	1.44	MA	7830	2271	10273	2024	12476	1709	13619	1453	14587	1058	17714	728	10525
4L-2S		MI	5562	2271	8001	1920	9509	1610	10371	1364	11341	985	13660	842	6755
8-#14	2.08	MA	9280	2431	13275	2085	16304	1738	18244	1458	20826	1016	26102	879	15092
2L-4S		MI	5300	2431	7672	2041	8985	1713	9703	1435	10404	992	12452	551	9322
8-#14	2.08	MA	8601	2431	12039	2107	14736	1759	16343	1477	18261	1043	22550	729	15012
3E		MI	5531	2431	8194	2025	9707	1687	10587	1412	11613	988	13915	642	9437
8-#14	2.08	MA	8226	2431	11195	2129	13565	1792	14907	1508	16294	1058	20152	638	14701
4L-2S		MI	5931	2431	8941	2009	10654	1674	11735	1402	13163	971	15983	805	9454
8-#18	3.70	MA	10828	2837	17081	2323	21032	1911	23923	1564	28446	988	36619	844	26081
2L-4S		MI	5794	2837	9014	2291	10553	1901	11552	1552	12852	964	15534	246	14253
8-#18	3.70	MA	9775	2837	14925	2361	18297	1945	20607	1594	23971	1033	30422	571	25721
3E		MI	6155	2837	9921	2266	11806	1860	13086	1516	14947	963	17992	398	15796
8-#18	3.70	MA	9198	2837	13446	2399	16245	2001	18092	1647	20528	1055	26186	406	23194
4L-2S		MI	6773	2837	11207	2240	13438	1840	15063	1503	17617	939	21441	689	15979
10-#10	1.47	MA	8683	2278	11743	2006	14484	1683	16101	1427	17989	1034	22215	898	10911
2L-5S		MI	5086	2278	6994	1971	8236	1660	8845	1407	9284	1022	11045	663	6877
10-#10	1.47	MA	8269	2278	11030	2020	13579	1696	15004	1439	16509	1050	20166	817	10894
3L-4S		MI	5231	2278	7264	1961	8605	1651	9303	1400	9919	1011	11928	716	6931
10-#10	1.47	MA	8044	2278	10545	2033	12906	1715	14179	1457	15379	1060	18802	766	10831
4L-3S		MI	5370	2278	7567	1950	9025	1635	9817	1385	10622	1006	12809	771	6942
10-#10	1.47	MA	7764	2278	10114	2046	12318	1728	13449	1469	14364	1077	17412	726	10668
5L-2S		MI	5617	2278	8004	1940	9579	1627	10489	1378	11529	994	14064	863	6935
10-#11	1.81	MA	9016	2362	12591	2049	15489	1713	17282	1444	19551	1024	24354	887	13216
2L-5S		MI	5176	2362	7308	2012	8555	1690	9196	1423	9724	1011	11576	589	8039
10-#11	1.81	MA	8531	2362	11727	2065	14391	1728	15952	1457	17756	1043	21868	785	13182
3L-4S		MI	5343	2362	7635	2001	9002	1680	9750	1415	10493	998	12617	655	8298
10-#11	1.81	MA	8268	2362	11138	2080	13573	1751	14949	1479	16382	1054	20200	722	13067
4L-3S		MI	5506	2362	8001	1989	9509	1662	10371	1398	11341	994	13660	719	8331
10-#11	1.81	MA	7938	2362	10617	2096	12858	1765	14060	1493	15147	1074	18504	670	12571
5L-2S		MI	5793	2362	8527	1977	10176	1652	11179	1390	12432	981	15138	833	8331
10-#14	2.60	MA	9831	2562	14510	2166	17872	1798	20144	1496	23391	1010	29654	870	18758
2L-5S		MI	5416	2562	7952	2139	9294	1785	10060	1483	10858	1003	13064	439	10729
10-#14	2.60	MA	9183	2562	13275	2188	16304	1818	18244	1514	20826	1037	26102	721	18656
3L-4S		MI	5645	2562	8418	2123	9932	1772	10851	1473	11954	986	14519	534	11399
10-#14	2.60	MA	8837	2562	12431	2211	15133	1851	16807	1545	18860	1052	23703	630	18333
4L-3S		MI	5861	2562	8941	2107	10654	1747	11735	1450	13163	982	15983	625	11637
10-#14	2.60	MA	8377	2562	11685	2233	14107	1872	15534	1564	17090	1079	21271	552	16987
5L-2S		MI	6246	2562	9687	2091	11601	1733	12883	1440	14712	965	18050	788	11676
10-#18	4.63	MA	10736	3069	17081	2506	21032	2051	23923	1661	28446	1021	36619	556	32068
3L-4S		MI	6408	3069	10300	2436	12185	2007	13530	1619	15522	953	18982	203	17882
10-#18	4.63	MA	10224	3069	15602	2543	18980	2107	21407	1714	25004	1044	32383	391	29489
4L-3S		MI	6719	3069	11207	2411	13438	1965	15063	1583	17617	951	21441	355	19550
10-#18	4.63	MA	9454	3069	14292	2581	17181	2141	19174	1744	21902	1089	28104	244	26917
5L-2S		MI	7270	3069	12493	2385	15070	1946	17041	1570	20287	928	24889	646	19778

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

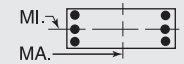


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	1.76	MA	9019	2351	12455	2052	15388	1717	17197	1448	19469	1030	24265	893	13031
2L-6S		MI	5119	2351	7121	2032	8441	1703	9068	1443	9569	1023	11437	587	7844
12-#10	1.76	MA	8617	2351	11743	2066	14484	1729	16101	1460	17989	1047	22215	812	13005
3L-5S		MI	5294	2351	7431	2017	8790	1694	9517	1428	10190	1019	12300	658	8112
12-#10	1.76	MA	8404	2351	11258	2079	13811	1749	15275	1478	16859	1057	20851	761	12932
4E		MI	5438	2351	7701	2007	9159	1685	9975	1421	10826	1007	13182	712	8219
12-#10	1.76	MA	8127	2351	10827	2092	13223	1761	14545	1490	15844	1073	19461	721	12739
5L-3S		MI	5571	2351	8004	1996	9579	1669	10489	1406	11529	1002	14064	766	8241
12-#10	1.76	MA	7838	2351	10295	2106	12662	1773	13831	1509	14853	1083	18123	654	12178
6L-2S		MI	5811	2351	8440	1986	10133	1660	11160	1399	12435	991	15318	858	8242
12-#11	2.17	MA	9411	2452	13456	2105	16586	1754	18612	1470	21346	1019	26839	881	15784
2L-6S		MI	5215	2452	7466	2088	8799	1741	9461	1466	10079	1019	12100	506	9235
12-#11	2.17	MA	8942	2452	12591	2121	15489	1769	17282	1483	19551	1039	24354	779	15738
3L-5S		MI	5421	2452	7834	2069	9222	1731	10004	1449	10815	1006	13054	579	9528
12-#11	2.17	MA	8695	2452	12002	2137	14671	1792	16279	1505	18177	1050	22686	716	15611
4E		MI	5587	2452	8160	2057	9669	1721	10558	1441	11583	994	14095	645	9841
12-#11	2.17	MA	8369	2452	11482	2153	13955	1807	15390	1519	16942	1069	20990	664	15079
5L-3S		MI	5741	2452	8527	2045	10176	1703	11179	1424	12432	990	15138	710	9887
12-#11	2.17	MA	8028	2452	10837	2169	13281	1821	14521	1541	15735	1080	19357	580	14446
6L-2S		MI	6020	2452	9052	2033	10843	1693	11987	1416	13523	977	16616	823	9900
12-#14	3.13	MA	9749	2692	14510	2270	17872	1878	20144	1552	23391	1031	29654	712	22300
3L-5S		MI	5756	2692	8698	2221	10241	1845	11208	1521	12408	997	15131	421	12859
12-#14	3.13	MA	9430	2692	13666	2292	16701	1911	18708	1583	21425	1045	27255	621	21967
4E		MI	5982	2692	9165	2204	10879	1832	11998	1510	13503	980	16586	517	13492
12-#14	3.13	MA	8975	2692	12921	2315	15675	1931	17434	1602	19655	1073	24823	543	20603
5L-3S		MI	6185	2692	9687	2188	11601	1806	12883	1488	14712	976	18050	607	13833
12-#14	3.13	MA	8513	2692	12004	2339	14708	1952	16189	1633	17927	1088	22478	421	19439
6L-2S		MI	6555	2692	10433	2172	12549	1793	14031	1477	16262	959	20117	771	13890
12-#18	5.56	MA	11214	3301	17757	2688	21716	2213	24723	1781	29479	1033	38580	376	35798
4E		MI	6968	3301	11586	2581	13817	2113	15508	1686	18192	942	22431	160	21535
12-#18	5.56	MA	10454	3301	16447	2726	19917	2247	22490	1811	26378	1078	34300	229	33189
5L-3S		MI	7243	3301	12493	2555	15070	2071	17041	1650	20287	940	24889	312	23308
12-#18	5.56	MA	9724	3301	14869	2770	18219	2281	20303	1863	23346	1101	30157	8	30105
6L-2S		MI	7757	3301	13779	2530	16702	2052	19019	1636	22957	916	28338	602	23570
14-#10	2.06	MA	8958	2425	12455	2112	15388	1763	17197	1481	19469	1043	24265	807	15115
3L-6S		MI	5328	2425	7558	2078	8995	1737	9739	1464	10476	1020	12691	582	9098
14-#10	2.06	MA	8756	2425	11971	2125	14715	1783	16372	1500	18339	1053	22901	756	15034
4L-5S		MI	5498	2425	7868	2063	9344	1728	10188	1450	11097	1015	13554	653	9354
14-#10	2.06	MA	8482	2425	11540	2138	14128	1795	15642	1511	17324	1070	21511	716	14807
5L-4S		MI	5641	2425	8137	2053	9713	1719	10646	1442	11733	1004	14437	707	9506
14-#10	2.06	MA	8202	2425	11008	2152	13567	1807	14928	1530	16333	1080	20172	650	14263
6L-3S		MI	5768	2425	8440	2042	10133	1703	11160	1428	12435	999	15318	761	9536
14-#10	2.06	MA	7960	2425	10554	2161	12940	1821	14237	1541	15372	1096	18868	615	13843
7L-2S		MI	6003	2425	8877	2032	10687	1694	11832	1420	13342	987	16573	853	9545
14-#11	2.53	MA	9345	2543	13456	2178	16586	1810	18612	1509	21346	1035	26839	773	18293
3L-6S		MI	5461	2543	7992	2144	9466	1783	10269	1492	11170	1015	13578	496	10745
14-#11	2.53	MA	9112	2543	12867	2193	15768	1833	17609	1531	19972	1046	25171	710	18157
4L-5S		MI	5661	2543	8359	2126	9889	1773	10812	1475	11906	1002	14533	570	11024
14-#11	2.53	MA	8789	2543	12347	2209	15052	1848	16720	1545	18737	1065	23476	658	17592
5L-4S		MI	5825	2543	8686	2114	10336	1763	11366	1467	12674	989	15573	636	11382
14-#11	2.53	MA	8461	2543	11701	2226	14378	1863	15850	1567	17531	1076	21843	575	16981
6L-3S		MI	5972	2543	9052	2102	10843	1744	11987	1451	13523	985	16616	700	11441
14-#11	2.53	MA	8175	2543	11150	2236	13616	1880	15013	1580	16361	1096	20245	532	16207
7L-2S		MI	6243	2543	9577	2090	11510	1734	12796	1443	14614	973	18095	814	11462
14-#14	3.65	MA	10007	2823	14902	2374	18269	1970	20608	1621	23990	1039	30807	612	25547
4L-5S		MI	6087	2823	9445	2302	11188	1905	12356	1558	13957	990	17198	404	14998
14-#14	3.65	MA	9557	2823	14156	2396	17243	1991	19335	1639	22221	1067	28374	535	24224
5L-4S		MI	6312	2823	9911	2286	11826	1891	13146	1548	15053	974	18654	500	15598
14-#14	3.65	MA	9116	2823	13240	2420	16276	2011	18089	1670	20492	1081	26030	412	23056
6L-3S		MI	6502	2823	10433	2270	12549	1866	14031	1525	16262	969	20117	590	16026

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

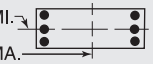
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.65	MA	8733	2823	12451	2435	15196	2036	16888	1689	18816	1109	23731	349	21613
7L-2S		MI	6860	2823	11180	2254	13496	1853	15179	1515	17811	953	22185	754	16099
14-#18	6.48	MA	11422	3533	18603	2871	22652	2353	25805	1878	30853	1067	40497	213	39460
5L-4S		MI	7512	3533	12872	2726	15449	2219	17486	1753	20862	931	25879	116	25207
14-#18	6.48	MA	10740	3533	17025	2915	20955	2386	23619	1930	27822	1090	36354	-7	36307
6L-3S		MI	7756	3533	13779	2700	16702	2177	19019	1717	22957	929	28338	268	27070
16-#10	2.35	MA	9101	2499	12684	2171	15620	1816	17468	1521	19819	1050	24950	752	17137
4L-6S		MI	5533	2499	7995	2124	9549	1770	10411	1485	11382	1016	13946	577	10356
16-#10	2.35	MA	8829	2499	12252	2184	15033	1829	16738	1533	18804	1066	23560	711	16880
5E		MI	5699	2499	8305	2109	9898	1761	10860	1471	12004	1012	14809	648	10601
16-#10	2.35	MA	8558	2499	11720	2198	14471	1840	16024	1551	17813	1076	22221	645	16351
6L-4S		MI	5841	2499	8574	2099	10268	1752	11318	1463	12639	1000	15691	702	10791
16-#10	2.35	MA	8325	2499	11267	2207	13844	1855	15333	1562	16852	1093	20917	611	15932
7L-3S		MI	5963	2499	8877	2088	10687	1736	11832	1449	13342	995	16573	756	10829
16-#10	2.35	MA	8090	2499	10832	2217	13262	1863	14598	1577	15893	1102	19654	564	15243
8L-2S		MI	6191	2499	9314	2078	11242	1727	12504	1441	14249	984	17827	848	10844
16-#11	2.89	MA	9520	2633	13732	2250	16865	1875	18938	1558	21768	1041	27657	705	20705
4L-6S		MI	5703	2633	8517	2201	10133	1824	11077	1518	12261	1011	15057	487	12259
16-#11	2.89	MA	9200	2633	13211	2266	16150	1889	18050	1571	20532	1061	25961	652	20111
5E		MI	5897	2633	8884	2182	10556	1814	11621	1501	12997	998	16011	561	12527
16-#11	2.89	MA	8883	2633	12566	2282	15475	1904	17180	1593	19326	1072	24329	569	19520
6L-4S		MI	6060	2633	9211	2170	11003	1804	12175	1493	13765	985	17052	627	12923
16-#11	2.89	MA	8611	2633	12015	2293	14713	1921	16343	1606	18156	1091	22730	526	18745
7L-3S		MI	6200	2633	9577	2158	11510	1786	12796	1477	14614	981	18095	691	12992
16-#11	2.89	MA	8333	2633	11486	2305	14005	1931	15457	1624	17007	1111	21188	467	17920
8L-2S		MI	6463	2633	10103	2146	12177	1776	13604	1469	15705	968	19573	804	13021
16-#14	4.17	MA	10125	2953	15392	2478	18811	2050	21235	1677	24786	1060	31926	526	27850
5E		MI	6413	2953	10191	2384	12135	1964	13504	1596	15507	984	19266	387	17145
16-#14	4.17	MA	9704	2953	14475	2502	17844	2071	19989	1708	23058	1075	29581	403	26673
6L-4S		MI	6636	2953	10657	2368	12773	1951	14294	1586	16602	967	20721	483	17716
16-#14	4.17	MA	9342	2953	13687	2517	16764	2096	18789	1727	21381	1102	27283	340	25237
7L-3S		MI	6815	2953	11180	2351	13496	1925	15179	1563	17811	963	22185	573	18219
16-#14	4.17	MA	8953	2953	12928	2533	15749	2110	17534	1753	19734	1130	25069	252	23553
8L-2S		MI	7156	2953	11926	2335	14443	1912	16327	1553	19361	946	24252	737	18305
16-#18	7.41	MA	11726	3765	19181	3060	23690	2492	26935	1997	32298	1079	42551	-23	42370
6L-4S		MI	8045	3765	14158	2871	17081	2325	19464	1820	23532	920	29327	73	28894
18-#10	2.65	MA	9169	2572	12965	2230	15937	1862	17835	1554	20284	1063	25609	706	18956
5L-6S		MI	5736	2572	8431	2170	10103	1804	11083	1507	12289	1013	15200	572	11617
18-#10	2.65	MA	8907	2572	12433	2244	15376	1874	17121	1572	19293	1072	24271	640	18442
6L-5S		MI	5897	2572	8741	2155	10453	1795	11532	1492	12911	1008	16063	643	11853
18-#10	2.65	MA	8683	2572	11980	2253	14749	1888	16430	1584	18332	1089	22966	606	18022
7L-4S		MI	6038	2572	9011	2145	10822	1786	11990	1485	13546	997	16946	697	12076
18-#10	2.65	MA	8450	2572	11545	2263	14166	1897	15694	1598	17373	1099	21703	559	17342
8L-3S		MI	6155	2572	9314	2134	11242	1770	12504	1470	14249	992	17827	751	12120
18-#10	2.65	MA	8181	2572	11119	2274	13600	1907	14980	1606	16428	1116	20464	515	16624
9L-2S		MI	6378	2572	9751	2124	11796	1761	13176	1463	15156	980	19082	843	12140
18-#11	3.25	MA	9603	2723	14076	2322	17247	1931	19380	1597	22327	1056	28447	647	22633
5L-6S		MI	5941	2723	9043	2258	10799	1865	11885	1544	13352	1006	16535	477	13777
18-#11	3.25	MA	9297	2723	13431	2339	16572	1945	18510	1619	21121	1067	26814	563	22061
6L-5S		MI	6129	2723	9410	2239	11222	1855	12429	1527	14088	994	17489	551	14034
18-#11	3.25	MA	9036	2723	12880	2349	15811	1962	17673	1633	19951	1087	25216	520	21285
7L-4S		MI	6291	2723	9737	2227	11670	1845	12983	1519	14856	981	18530	617	14464
18-#11	3.25	MA	8762	2723	12350	2362	15102	1973	16787	1650	18802	1107	23674	461	20451
8L-3S		MI	6425	2723	10103	2215	12177	1827	13604	1503	15705	977	19573	681	14541

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

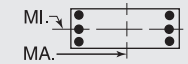


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	3.25	MA	8445	2723	11837	2375	14413	1984	15918	1660	17633	1118	22155	405	19408
9L-2S		MI	6681	2723	10628	2203	12843	1817	14412	1495	16796	964	21051	795	14578
18-#14	4.69	MA	10278	3084	15711	2583	19412	2131	21890	1746	25623	1069	33133	395	30290
6L-5S		MI	6733	3084	10937	2465	13083	2024	14652	1634	17056	978	21333	370	19298
18-#14	4.69	MA	9935	3084	14922	2598	18332	2156	20689	1764	23946	1096	30835	332	28861
7L-4S		MI	6955	3084	11404	2449	13720	2011	15442	1623	18152	961	22788	466	19842
18-#14	4.69	MA	9552	3084	14164	2615	17317	2169	19434	1790	22300	1123	28621	244	27165
8L-3S		MI	7136	3084	11926	2433	14443	1985	16327	1601	19361	957	24252	556	20412
20-#10	2.94	MA	9250	2646	13146	2290	16281	1908	18217	1594	20773	1069	26320	635	20535
6E		MI	5935	2646	8868	2216	10658	1838	11755	1528	13196	1009	16455	567	12881
20-#10	2.94	MA	9034	2646	12693	2299	15654	1922	17526	1605	19812	1086	25016	601	20114
7L-5S		MI	6092	2646	9178	2201	11007	1829	12204	1513	13818	1005	17318	638	13108
20-#10	2.94	MA	8803	2646	12258	2309	15071	1931	16791	1619	18853	1095	23753	555	19440
8L-4S		MI	6232	2646	9448	2191	11376	1820	12662	1506	14453	993	18200	692	13360
20-#10	2.94	MA	8542	2646	11832	2320	14505	1940	16076	1627	17908	1112	22513	510	18716
9L-3S		MI	6345	2646	9751	2180	11796	1804	13176	1491	15156	988	19082	746	13410
20-#10	2.94	MA	8301	2646	11387	2327	13914	1958	15377	1637	16956	1127	21170	460	17991
10L-2S		MI	6562	2646	10187	2170	12350	1795	13848	1484	16063	977	20336	838	13435
20-#11	3.61	MA	9703	2814	14295	2395	17670	1987	19840	1645	22916	1063	29300	557	24604
6E		MI	6175	2814	9568	2314	11466	1907	12693	1570	14443	1002	18013	468	15298
20-#11	3.61	MA	9453	2814	13744	2406	16908	2004	19003	1659	21746	1083	27702	514	23828
7L-5S		MI	6358	2814	9935	2295	11889	1897	13237	1554	15179	989	18968	542	15546
20-#11	3.61	MA	9181	2814	13215	2418	16199	2014	18117	1676	20597	1102	26160	455	22982
8L-4S		MI	6518	2814	10262	2283	12336	1887	13791	1546	15947	977	20008	608	16001
20-#11	3.61	MA	8875	2814	12701	2431	15510	2025	17248	1686	19428	1113	24641	399	21944
9L-3S		MI	6647	2814	10628	2271	12843	1868	14412	1529	16796	972	21051	672	16089
20-#14	5.21	MA	10515	3214	16158	2680	19900	2215	22590	1802	26512	1090	34387	323	32485
7L-5S		MI	7048	3214	11684	2547	14030	2083	15800	1671	18606	972	23400	353	21455
20-#14	5.21	MA	10136	3214	15400	2696	18885	2229	21335	1828	24865	1117	32173	235	30777
8L-4S		MI	7294	3214	12150	2531	14667	2070	16590	1661	19701	955	24856	449	21977
22-#10	3.23	MA	9379	2719	13406	2345	16558	1956	18623	1626	21292	1082	27065	596	22207
7L-6S		MI	6131	2719	9305	2262	11212	1871	12427	1549	14103	1006	17709	562	14147
22-#10	3.23	MA	9150	2719	12971	2355	15976	1964	17887	1640	20333	1092	25802	550	21539
8L-5S		MI	6285	2719	9615	2247	11561	1862	12875	1535	14724	1001	18572	633	14366
22-#10	3.23	MA	8897	2719	12545	2366	15409	1974	17173	1649	19389	1109	24563	505	20808
9L-4S		MI	6424	2719	9884	2237	11930	1853	13333	1527	15360	990	19455	687	14644
22-#10	3.23	MA	8664	2719	12100	2373	14819	1991	16473	1658	18436	1124	23220	455	20085
10L-3S		MI	6532	2719	10187	2226	12350	1837	13848	1513	16063	985	20336	741	14699
22-#11	3.97	MA	9862	2904	14609	2463	18005	2045	20332	1685	23542	1078	30187	508	26372
7L-6S		MI	6406	2904	10093	2371	12133	1948	13502	1596	15534	998	19492	459	16791
22-#11	3.97	MA	9593	2904	14080	2475	17296	2055	19447	1702	22392	1098	28645	449	25513
8L-5S		MI	6583	2904	10461	2352	12556	1938	14045	1580	16270	985	20446	532	17061
22-#11	3.97	MA	9297	2904	13566	2488	16607	2066	18577	1712	21223	1109	27126	393	24479
9L-4S		MI	6744	2904	10787	2340	13003	1928	14599	1572	17038	972	21487	598	17499
22-#14	5.73	MA	10709	3344	16635	2778	20453	2289	23235	1866	27430	1111	35724	226	34389
8L-5S		MI	7379	3344	12430	2628	14977	2143	16948	1709	20156	966	25468	336	23618
24-#10	3.53	MA	9492	2793	13684	2401	16880	1998	18984	1662	21813	1088	27851	545	23637
8L-6S		MI	6325	2793	9742	2308	11766	1905	13098	1570	15009	1002	18964	557	15415
24-#10	3.53	MA	9245	2793	13257	2412	16314	2008	18269	1670	20869	1105	26612	500	22900
9L-5S		MI	6475	2793	10052	2293	12115	1896	13547	1556	15631	998	19827	628	15627
24-#10	3.53	MA	9020	2793	12813	2419	15724	2025	17570	1679	19917	1120	25269	450	22179
10L-4S		MI	6614	2793	10321	2283	12485	1887	14005	1548	16266	986	20709	682	15928
24-#11	4.33	MA	9998	2995	14944	2531	18394	2097	20777	1729	24188	1094	31131	443	28045
8L-6S		MI	6634	2995	10619	2427	12800	1989	14310	1622	16625	993	20970	449	18289
24-#11	4.33	MA	9711	2995	14431	2544	17705	2108	19907	1738	23019	1105	29612	387	27014
9L-5S		MI	6807	2995	10986	2408	13223	1979	14853	1606	17361	981	21924	523	18580

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

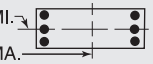
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.75	MA	9912	2479	13944	2139	17044	1789	18943	1509	21315	1073	26451	930	14160
2E		MI	5983	2479	8972	2043	10558	1707	11505	1437	12663	1015	14969	824	8362
6-#11	1.03	MA	9086	2287	11903	2042	14617	1721	16086	1470	17531	1095	21267	954	8567
2L-3S		MI	5275	2287	7278	1970	8556	1659	9151	1416	9547	1058	11133	787	5215
6-#11	1.03	MA	8522	2287	10982	2058	13448	1736	14669	1484	15619	1115	18619	854	8567
3L-2S		MI	5583	2287	7803	1958	9223	1649	9959	1408	10638	1045	12612	900	5191
6-#14	1.48	MA	9644	2407	13159	2109	16157	1769	17923	1499	19987	1085	24648	942	12147
2L-3S		MI	5446	2407	7779	2037	9141	1707	9836	1444	10451	1050	12277	707	7261
6-#14	1.48	MA	8873	2407	11842	2132	14486	1790	15898	1519	17252	1113	20862	795	12098
3L-2S		MI	5867	2407	8525	2021	10089	1694	10984	1434	12000	1033	14344	871	7245
6-#18	2.63	MA	10941	2711	16245	2284	19964	1895	22482	1576	26091	1062	33064	914	20992
2L-3S		MI	5850	2711	8972	2213	10558	1832	11505	1518	12663	1028	14969	490	12103
6-#18	2.63	MA	9715	2711	13944	2323	17044	1931	18943	1608	21315	1108	26451	646	20680
3L-2S		MI	6519	2711	10258	2188	12190	1813	13483	1504	15332	1004	18417	780	12207
8-#10	1.11	MA	9236	2310	12079	2066	14917	1740	16488	1485	18110	1100	22094	958	9335
2L-4S		MI	5274	2310	7151	2010	8429	1699	9027	1449	9401	1070	11106	771	5664
8-#10	1.11	MA	8776	2310	11320	2080	13954	1753	15321	1497	16534	1117	19912	878	9329
3E		MI	5420	2310	7454	1999	8849	1683	9541	1435	10104	1066	11988	825	5657
8-#10	1.11	MA	8522	2310	10805	2094	13239	1773	14444	1516	15333	1127	18469	828	9279
4L-2S		MI	5676	2310	7890	1989	9403	1674	10213	1427	11010	1054	13242	917	5642
8-#11	1.37	MA	9532	2377	12824	2098	15786	1762	17503	1496	19444	1091	23915	948	11317
2L-4S		MI	5349	2377	7437	2038	8715	1719	9338	1459	9789	1058	11569	713	6786
8-#11	1.37	MA	8990	2377	11903	2114	14617	1777	16086	1510	17531	1111	21267	848	11298
3E		MI	5521	2377	7803	2026	9223	1701	9959	1442	10638	1054	12612	777	6794
8-#11	1.37	MA	8690	2377	11277	2131	13747	1801	15019	1533	16070	1123	19500	785	11199
4L-2S		MI	5820	2377	8329	2014	9889	1691	10768	1434	11729	1041	14090	891	6779
8-#14	1.97	MA	10255	2537	14476	2191	17828	1829	19949	1537	22721	1079	28435	934	16064
2L-4S		MI	5554	2537	8003	2135	9366	1792	10099	1505	10791	1048	12880	600	9378
8-#14	1.97	MA	9521	2537	13159	2214	16157	1850	17923	1557	19987	1107	24648	787	15984
3E		MI	5786	2537	8525	2119	10089	1767	10984	1482	12000	1043	14344	690	9474
8-#14	1.97	MA	9118	2537	12262	2237	14911	1884	16395	1588	17895	1123	22108	696	15673
4L-2S		MI	6190	2537	9272	2103	11036	1754	12132	1472	13550	1027	16411	854	9483
8-#18	3.51	MA	11931	2943	18545	2429	22883	2001	26021	1643	30868	1050	39678	899	27809
2L-4S		MI	6046	2943	9351	2383	10937	1980	11949	1620	13238	1019	15959	294	14418
8-#18	3.51	MA	10792	2943	16245	2468	19964	2037	22482	1675	26091	1097	33064	631	27449
3E		MI	6411	2943	10258	2358	12190	1938	13483	1585	15332	1017	18417	446	15859
8-#18	3.51	MA	10169	2943	14670	2507	17779	2094	19803	1729	22425	1122	28576	467	24941
4L-2S		MI	7038	2943	11544	2333	13822	1919	15461	1571	18002	993	21866	737	16021
10-#10	1.39	MA	9606	2384	12837	2112	15880	1774	17656	1506	19685	1097	24276	953	11597
2L-5S		MI	5340	2384	7318	2066	8614	1741	9241	1478	9672	1078	11478	713	6920
10-#10	1.39	MA	9159	2384	12079	2126	14917	1787	16488	1518	18110	1114	22094	873	11580
3L-4S		MI	5486	2384	7587	2056	8983	1732	9699	1470	10308	1067	12361	766	6959
10-#10	1.39	MA	8918	2384	11564	2140	14202	1806	15611	1537	16909	1124	20650	823	11517
4L-3S		MI	5626	2384	7890	2045	9403	1716	10213	1456	11010	1062	13242	820	6965
10-#10	1.39	MA	8615	2384	11102	2153	13578	1819	14836	1549	15830	1141	19176	784	11353
5L-2S		MI	5874	2384	8327	2035	9957	1708	10885	1448	11917	1051	14497	912	6956
10-#11	1.71	MA	9967	2468	13745	2155	16955	1803	18919	1523	21356	1086	26563	942	14058
2L-5S		MI	5431	2468	7636	2107	8935	1770	9592	1493	10112	1067	12006	638	8128
10-#11	1.71	MA	9444	2468	12824	2171	15786	1818	17503	1537	19444	1107	23915	842	14024
3L-4S		MI	5598	2468	7962	2095	9382	1760	10147	1485	10880	1054	13047	704	8335
10-#11	1.71	MA	9162	2468	12198	2187	14916	1842	16436	1559	17983	1118	22149	780	13909
4L-3S		MI	5762	2468	8329	2083	9889	1742	10768	1468	11729	1050	14090	768	8361

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

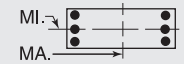
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.71	MA	8803	2468	11641	2203	14156	1857	15491	1573	16670	1139	20350	729	13457
5L-2S		MI	6051	2468	8854	2071	10556	1732	11576	1460	12820	1037	15568	881	8357
10-#14	2.47	MA	10849	2668	15794	2272	19500	1888	21975	1575	25456	1072	32221	925	19973
2L-5S		MI	5670	2668	8283	2233	9675	1865	10457	1552	11245	1058	13492	487	10838
10-#14	2.47	MA	10149	2668	14476	2295	17828	1910	19949	1594	22721	1101	28435	778	19871
3L-4S		MI	5900	2668	8749	2216	10313	1852	11247	1542	12341	1041	14948	583	11522
10-#14	2.47	MA	9776	2668	13579	2318	16582	1943	18421	1626	20629	1117	25894	688	19548
4L-3S		MI	6118	2668	9272	2200	11036	1826	12132	1520	13550	1037	16411	673	11676
10-#14	2.47	MA	9276	2668	12787	2341	15492	1964	17067	1645	18748	1145	23312	613	18191
5L-2S		MI	6506	2668	10018	2184	11983	1813	13280	1509	15099	1020	18479	837	11709
10-#18	4.39	MA	11827	3175	18545	2613	22883	2143	26021	1742	30868	1086	39678	615	34228
3L-4S		MI	6622	3175	10637	2528	12569	2086	13927	1687	15908	1008	19407	251	18039
10-#18	4.39	MA	11274	3175	16971	2652	20698	2200	23342	1796	27201	1111	35190	452	31676
4L-3S		MI	6977	3175	11544	2503	13822	2044	15461	1652	18002	1006	21866	403	19614
10-#18	4.39	MA	10435	3175	15578	2691	18785	2236	20966	1828	23900	1158	30644	310	29020
5L-2S		MI	7537	3175	12830	2478	15454	2025	17439	1638	20672	982	25314	694	19822
12-#10	1.67	MA	9967	2457	13596	2159	16844	1807	18823	1527	21261	1093	26457	948	13854
2L-6S		MI	5373	2457	7445	2127	8819	1784	9464	1514	9957	1080	11870	636	7915
12-#10	1.67	MA	9534	2457	12837	2172	15880	1820	17656	1539	19685	1110	24276	868	13828
3L-5S		MI	5549	2457	7755	2112	9168	1775	9913	1499	10579	1075	12733	708	8188
12-#10	1.67	MA	9305	2457	12323	2186	15166	1840	16779	1558	18484	1120	22832	818	13755
4E		MI	5693	2457	8024	2102	9537	1766	10371	1492	11214	1063	13615	761	8250
12-#10	1.67	MA	9005	2457	11861	2199	14542	1853	16003	1570	17406	1138	21358	779	13586
5L-3S		MI	5827	2457	8327	2091	9957	1750	10885	1477	11917	1059	14497	815	8266
12-#10	1.67	MA	8696	2457	11295	2213	13940	1864	15245	1589	16354	1148	19938	714	13002
6L-2S		MI	6069	2457	8764	2081	10511	1741	11557	1470	12824	1047	15751	907	8265
12-#11	2.05	MA	10393	2558	14666	2211	18125	1845	20336	1549	23269	1082	29211	936	16795
2L-6S		MI	5469	2558	7794	2182	9179	1822	9857	1536	10467	1075	12530	555	9319
12-#11	2.05	MA	9887	2558	13745	2228	16955	1860	18919	1563	21356	1102	26563	836	16749
3L-5S		MI	5676	2558	8161	2163	9602	1812	10401	1519	11203	1062	13485	628	9614
12-#11	2.05	MA	9621	2558	13119	2244	16085	1884	17852	1585	19895	1114	24797	774	16622
4E		MI	5842	2558	8488	2151	10049	1802	10955	1511	11971	1049	14525	694	9881
12-#11	2.05	MA	9267	2558	12562	2260	15325	1899	16908	1599	18582	1134	22998	723	16132
5L-3S		MI	5998	2558	8854	2139	10556	1783	11576	1494	12820	1045	15568	759	9919
12-#11	2.05	MA	8901	2558	11875	2276	14602	1913	15984	1622	17300	1146	21265	641	15435
6L-2S		MI	6279	2558	9380	2128	11223	1773	12384	1486	13911	1033	17047	872	9927
12-#14	2.96	MA	10759	2798	15794	2377	19500	1969	21975	1632	25456	1095	32221	770	23758
3L-5S		MI	6011	2798	9029	2314	10623	1925	11605	1590	12795	1052	15560	470	12965
12-#14	2.96	MA	10414	2798	14896	2400	18254	2003	20447	1664	23364	1110	29681	679	23427
4E		MI	6237	2798	9496	2298	11260	1912	12395	1580	13890	1035	17015	566	13611
12-#14	2.96	MA	9920	2798	14104	2423	17164	2024	19093	1683	21482	1139	27099	604	22050
5L-3S		MI	6443	2798	10018	2282	11983	1886	13280	1557	15099	1031	18479	656	13874
12-#14	2.96	MA	9423	2798	13121	2446	16137	2045	17769	1715	19645	1155	24612	483	20886
6L-2S		MI	6817	2798	10764	2266	12930	1873	14428	1547	16649	1014	20546	820	13924
12-#18	5.26	MA	12339	3407	19272	2797	23618	2306	26880	1863	31978	1100	41803	437	38423
4E		MI	7222	3407	11923	2673	14201	2192	15905	1754	18577	997	22855	208	21685
12-#18	5.26	MA	11512	3407	17879	2836	21704	2341	24504	1895	28677	1147	37258	295	35715
5L-3S		MI	7503	3407	12830	2648	15454	2150	17439	1719	20672	995	25314	360	23373
12-#18	5.26	MA	10726	3407	16182	2879	19899	2377	22179	1949	25452	1172	32869	76	32343
6L-2S		MI	8026	3407	14116	2622	17086	2131	19417	1705	23342	971	28763	650	23616
14-#10	1.95	MA	9902	2531	13596	2218	16844	1854	18823	1560	21261	1107	26457	863	16076
3L-6S		MI	5583	2531	7881	2173	9373	1818	10136	1535	10864	1076	13124	631	9168
14-#10	1.95	MA	9683	2531	13082	2232	16129	1874	17946	1579	20060	1117	25014	813	15994
4L-5S		MI	5754	2531	8191	2158	9722	1809	10584	1520	11486	1071	13987	703	9428

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

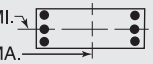


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	1.95	MA	9386	2531	12620	2245	15505	1887	17171	1591	18982	1134	23540	774	15822
5L-4S		MI	5897	2531	8461	2148	10092	1800	11042	1513	12121	1060	14870	756	9538
14-#10	1.95	MA	9087	2531	12054	2259	14904	1898	16413	1610	17929	1144	22120	709	15225
6L-3S		MI	6026	2531	8764	2137	10511	1784	11557	1498	12824	1055	15751	810	9563
14-#10	1.95	MA	8827	2531	11573	2268	14237	1913	15672	1621	16909	1162	20741	675	14785
7L-2S		MI	6262	2531	9201	2127	11066	1775	12228	1491	13731	1044	17006	902	9569
14-#11	2.39	MA	10321	2649	14666	2284	18125	1901	20336	1589	23269	1098	29211	830	19473
3L-6S		MI	5716	2649	8319	2239	9846	1863	10665	1562	11558	1071	14009	545	10828
14-#11	2.39	MA	10070	2649	14040	2300	17255	1925	19269	1611	21808	1110	27445	768	19336
4L-5S		MI	5917	2649	8687	2220	10269	1853	11209	1545	12294	1058	14963	619	11109
14-#11	2.39	MA	9719	2649	13484	2316	16494	1940	18325	1625	20495	1130	25646	717	18814
5L-4S		MI	6081	2649	9013	2208	10716	1843	11763	1537	13062	1045	16004	685	11424
14-#11	2.39	MA	9366	2649	12796	2333	15771	1954	17401	1648	19213	1142	23914	635	18139
6L-3S		MI	6230	2649	9380	2196	11223	1825	12384	1521	13911	1041	17047	749	11474
14-#11	2.39	MA	9060	2649	12210	2344	14960	1972	16511	1662	17970	1162	22223	593	17379
7L-2S		MI	6503	2649	9905	2184	11890	1815	13192	1513	15002	1028	18525	863	11492
14-#14	3.45	MA	11035	2929	16213	2481	19925	2062	22473	1701	26098	1104	33467	671	27311
4L-5S		MI	6343	2929	9775	2396	11570	1984	12753	1628	14344	1046	17627	453	15101
14-#14	3.45	MA	10546	2929	15421	2504	18835	2084	21119	1721	24217	1132	30885	596	25915
5L-4S		MI	6568	2929	10242	2380	12208	1971	13543	1618	15440	1029	19082	549	15714
14-#14	3.45	MA	10072	2929	14438	2528	17808	2105	19795	1753	22379	1148	28398	475	24742
6L-3S		MI	6761	2929	10764	2363	12930	1946	14428	1595	16649	1025	20546	639	16069
14-#14	3.45	MA	9660	2929	13598	2543	16647	2129	18519	1772	20598	1177	25965	413	23169
7L-2S		MI	7123	2929	11510	2347	13877	1932	15576	1585	18198	1008	22613	802	16135
14-#18	6.14	MA	12554	3639	20179	2981	24624	2447	28043	1962	33453	1136	43871	280	42409
5L-4S		MI	7767	3639	13209	2818	15833	2298	17883	1821	21247	986	26304	164	25351
14-#18	6.14	MA	11819	3639	18483	3024	22819	2483	25717	2016	30228	1161	39482	61	39063
6L-3S		MI	8018	3639	14116	2793	17086	2256	19417	1786	23342	984	28763	316	27134
16-#10	2.23	MA	10054	2605	13841	2278	17092	1907	19113	1601	21636	1113	27195	808	18234
4L-6S		MI	5789	2605	8318	2219	9927	1851	10807	1556	11771	1072	14379	626	10425
16-#10	2.23	MA	9760	2605	13379	2291	16468	1920	18338	1613	20557	1131	25721	769	18037
5E		MI	5956	2605	8628	2204	10277	1842	11256	1542	12393	1068	15242	698	10674
16-#10	2.23	MA	9469	2605	12813	2305	15867	1932	17580	1632	19505	1141	24301	704	17450
6L-4S		MI	6097	2605	8898	2194	10646	1833	11714	1534	13028	1056	16124	751	10825
16-#10	2.23	MA	9219	2605	12332	2314	15200	1946	16839	1643	18485	1158	22922	670	17023
7L-3S		MI	6221	2605	9201	2183	11066	1817	12228	1520	13731	1052	17006	805	10857
16-#10	2.23	MA	8964	2605	11870	2324	14581	1955	16057	1657	17466	1168	21584	625	16304
8L-2S		MI	6452	2605	9637	2173	11620	1808	12900	1512	14638	1040	18260	897	10869
16-#11	2.74	MA	10509	2739	14961	2357	18424	1966	20686	1637	23720	1105	30093	762	22052
4L-6S		MI	5958	2739	8845	2295	10513	1904	11474	1588	12649	1066	15487	536	12341
16-#11	2.74	MA	10162	2739	14405	2373	17663	1981	19742	1651	22407	1126	28294	711	21500
5E		MI	6153	2739	9212	2276	10936	1894	12017	1571	13385	1054	16441	609	12610
16-#11	2.74	MA	9821	2739	13717	2389	16940	1996	18818	1674	21126	1137	26562	629	20846
6L-4S		MI	6316	2739	9539	2264	11383	1884	12571	1563	14153	1041	17482	675	12966
16-#11	2.74	MA	9528	2739	13131	2400	16129	2013	17928	1688	19883	1158	24872	587	20087
7L-3S		MI	6459	2739	9905	2252	11890	1866	13192	1547	15002	1037	18525	740	13026
16-#11	2.74	MA	9226	2739	12568	2413	15376	2024	16977	1705	18642	1169	23237	529	19189
8L-2S		MI	6725	2739	10431	2241	12557	1856	14000	1539	16093	1024	20003	853	13052
16-#14	3.95	MA	11157	3059	16738	2586	20507	2143	23145	1758	26951	1126	34671	587	29785
5E		MI	6669	3059	10522	2477	12517	2044	13901	1665	15894	1040	19694	436	17245
16-#14	3.95	MA	10704	3059	15755	2610	19480	2164	21821	1790	25114	1142	32185	466	28598
6L-4S		MI	6893	3059	10988	2461	13155	2031	14691	1655	16989	1023	21150	531	17828
16-#14	3.95	MA	10314	3059	14916	2625	18319	2189	20545	1810	23332	1170	29751	404	27033
7L-3S		MI	7075	3059	11510	2445	13877	2005	15576	1632	18198	1018	22613	622	18263
16-#14	3.95	MA	9892	3059	14109	2642	17239	2203	19195	1835	21582	1199	27403	319	25309
8L-2S		MI	7425	3059	12257	2429	14824	1992	16724	1622	19748	1002	24681	785	18342
16-#18	7.02	MA	12878	3871	20783	3169	25738	2589	29256	2083	35005	1150	46096	45	45783
6L-4S		MI	8300	3871	14495	2963	17465	2404	19861	1888	23917	975	29752	121	29033

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

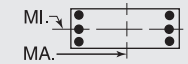
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.51	MA	10126	2678	14138	2337	17431	1954	19505	1634	22133	1127	27903	764	20250
5L-6S		MI	5991	2678	8755	2265	10482	1885	11479	1577	12678	1069	15633	621	11685
18-#10	2.51	MA	9844	2678	13572	2351	16830	1965	18747	1653	21080	1137	26483	699	19678
6L-5S		MI	6154	2678	9065	2250	10831	1876	11928	1563	13299	1064	16496	693	11924
18-#10	2.51	MA	9603	2678	13090	2360	16163	1980	18006	1664	20060	1155	25104	665	19263
7L-4S		MI	6295	2678	9334	2240	11200	1867	12386	1555	13935	1053	17379	746	12111
18-#10	2.51	MA	9351	2678	12628	2370	15544	1989	17225	1679	19042	1165	23765	620	18538
8L-3S		MI	6414	2678	9637	2229	11620	1851	12900	1541	14638	1048	18260	800	12149
18-#10	2.51	MA	9062	2678	12172	2381	14942	1999	16465	1687	18039	1182	22455	576	17827
9L-2S		MI	6639	2678	10074	2219	12174	1842	13572	1533	15544	1037	19515	892	12166
18-#11	3.08	MA	10595	2830	15326	2429	18832	2023	21159	1678	24320	1121	30942	705	24190
5L-6S		MI	6196	2830	9370	2352	11180	1946	12282	1614	13740	1062	16965	526	13858
18-#11	3.08	MA	10266	2830	14638	2446	18109	2037	20235	1700	23038	1133	29210	623	23555
6L-5S		MI	6386	2830	9738	2333	11603	1936	12825	1597	14476	1049	17920	600	14116
18-#11	3.08	MA	9985	2830	14052	2457	17298	2055	19345	1714	21795	1153	27520	581	22794
7L-4S		MI	6548	2830	10064	2321	12050	1926	13379	1589	15244	1037	18960	666	14508
18-#11	3.08	MA	9687	2830	13490	2469	16545	2065	18394	1731	20554	1165	25885	523	21898
8L-3S		MI	6684	2830	10431	2309	12557	1907	14000	1573	16093	1032	20003	730	14577
18-#11	3.08	MA	9347	2830	12940	2482	15813	2077	17470	1742	19333	1185	24279	468	20818
9L-2S		MI	6944	2830	10956	2297	13223	1897	14809	1565	17184	1020	21482	844	14610
18-#14	4.44	MA	11321	3190	17072	2691	21151	2224	23847	1828	27848	1136	35971	457	32454
6L-5S		MI	6990	3190	11268	2559	13464	2104	15049	1703	17443	1033	21762	418	19395
18-#14	4.44	MA	10952	3190	16233	2706	19990	2248	22571	1847	26067	1164	33537	396	30896
7L-4S		MI	7212	3190	11734	2543	14102	2090	15839	1693	18539	1017	23217	514	19952
18-#14	4.44	MA	10536	3190	15426	2724	18911	2263	21221	1873	24317	1192	31189	311	29160
8L-3S		MI	7385	3190	12257	2526	14824	2065	16724	1670	19748	1012	24681	605	20457
20-#10	2.79	MA	10213	2752	14331	2397	17793	1999	19914	1674	22656	1134	28665	694	21908
6E		MI	6191	2752	9192	2311	11036	1919	12151	1599	13584	1065	16888	616	12948
20-#10	2.79	MA	9980	2752	13849	2406	17126	2014	19173	1685	21636	1151	27286	660	21505
7L-5S		MI	6350	2752	9501	2296	11385	1910	12600	1584	14206	1061	17751	688	13178
20-#10	2.79	MA	9731	2752	13387	2416	16507	2023	18392	1700	20617	1161	25947	615	20772
8L-4S		MI	6490	2752	9771	2286	11754	1901	13058	1577	14841	1049	18633	741	13396
20-#10	2.79	MA	9450	2752	12931	2427	15906	2033	17633	1709	19615	1178	24637	571	20054
9L-3S		MI	6604	2752	10074	2275	12174	1885	13572	1562	15544	1045	19515	795	13440
20-#10	2.79	MA	9191	2752	12459	2435	15278	2050	16890	1718	18592	1193	23213	522	19266
10L-2S		MI	6825	2752	10511	2265	12728	1876	14244	1555	16451	1033	20769	887	13462
20-#11	3.42	MA	10703	2920	15559	2503	19278	2078	21652	1726	24951	1129	31858	617	26267
6E		MI	6431	2920	9896	2408	11846	1987	13090	1640	14831	1058	18444	517	15378
20-#11	3.42	MA	10433	2920	14973	2513	18467	2096	20762	1740	23708	1149	30168	575	25500
7L-5S		MI	6616	2920	10263	2389	12269	1977	13634	1624	15567	1045	19398	591	15626
20-#11	3.42	MA	10139	2920	14411	2526	17714	2106	19811	1758	22467	1161	28533	517	24608
8L-4S		MI	6777	2920	10590	2377	12716	1967	14188	1616	16335	1032	20439	657	16050
20-#11	3.42	MA	9809	2920	13861	2539	16982	2118	18887	1768	21245	1181	26927	462	23520
9L-3S		MI	6907	2920	10956	2366	13223	1948	14809	1599	17184	1028	21482	721	16126
20-#11	3.42	MA	9505	2920	13287	2548	16218	2139	17982	1779	20019	1200	25188	400	22457
10L-2S		MI	7161	2920	11482	2354	13890	1939	15617	1591	18275	1015	22960	834	16166
20-#14	4.93	MA	11576	3320	17550	2788	21661	2308	24597	1885	28801	1158	37324	387	34760
7L-5S		MI	7307	3320	12014	2640	14411	2163	16197	1741	18993	1027	23829	401	21551
20-#14	4.93	MA	11164	3320	16744	2805	20582	2323	23247	1911	27051	1186	34976	302	33011
8L-4S		MI	7528	3320	12481	2624	15049	2150	16987	1730	20088	1010	25284	497	22083
22-#10	3.06	MA	10351	2826	14608	2452	18089	2047	20341	1706	23212	1148	29467	655	23747
7L-6S		MI	6388	2825	9628	2357	11590	1952	12823	1620	14491	1062	18142	611	14213
22-#10	3.06	MA	10103	2826	14146	2462	17470	2056	19559	1721	22193	1158	28129	611	23006
8L-5S		MI	6543	2826	9938	2342	11939	1943	13272	1605	15113	1057	19005	683	14435

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

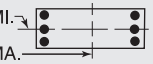
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	3.06	MA	9831	2825	13690	2473	16869	2066	18800	1730	21190	1175	26818	566	22281
9L-4S		MI	6683	2825	10208	2332	12309	1934	13730	1598	15748	1046	19888	736	14680
22-#10	3.06	MA	9581	2826	13217	2481	16242	2084	18057	1739	20168	1190	25395	517	21495
10L-3S		MI	6793	2826	10511	2321	12728	1918	14244	1583	16451	1041	20769	790	14730
22-#10	3.06	MA	9331	2826	12686	2497	15642	2094	17303	1756	19126	1197	24092	470	20634
11L-2S		MI	7009	2826	10947	2311	13283	1909	14915	1576	17358	1030	22024	882	14757
22-#11	3.76	MA	10873	3010	15895	2570	19636	2137	22179	1766	25620	1145	32816	569	28207
7L-6S		MI	6662	3010	10421	2465	12513	2028	13898	1666	15921	1053	19922	507	16900
22-#11	3.76	MA	10581	3010	15332	2582	18883	2148	21227	1784	24380	1156	31181	511	27317
8L-5S		MI	6842	3010	10789	2446	12936	2018	14442	1650	16658	1041	20876	581	17140
22-#11	3.76	MA	10263	3010	14782	2595	18151	2159	20303	1794	23158	1177	29575	456	26221
9L-4S		MI	7003	3010	11115	2434	13383	2008	14996	1642	17426	1028	21917	647	17589
22-#11	3.76	MA	9970	3010	14208	2605	17387	2181	19399	1805	21932	1195	27837	394	25151
10L-3S		MI	7128	3010	11482	2422	13890	1990	15617	1625	18275	1024	22960	711	17675
22-#14	5.43	MA	11780	3451	18061	2887	22253	2382	25273	1948	29786	1180	38762	293	36862
8L-5S		MI	7640	3451	12761	2722	15358	2223	17345	1778	20542	1021	25896	384	23711
24-#10	3.34	MA	10470	2899	14905	2509	18433	2090	20726	1742	23769	1154	30310	606	25240
8L-6S		MI	6583	2899	10065	2403	12144	1986	13494	1641	15398	1058	19397	606	15480
24-#10	3.34	MA	10205	2899	14449	2519	17832	2100	19967	1751	22766	1171	29000	561	24509
9L-5S		MI	6734	2899	10375	2388	12494	1977	13943	1627	16020	1054	20260	678	15695
24-#10	3.34	MA	9963	2899	13976	2527	17205	2118	19225	1760	21744	1186	27577	513	23725
10L-4S		MI	6873	2899	10645	2378	12863	1968	14401	1619	16655	1042	21142	731	15965
24-#10	3.34	MA	9724	2899	13445	2543	16605	2127	18471	1777	20701	1194	26274	465	22858
11L-3S		MI	6979	2899	10947	2367	13283	1952	14915	1605	17358	1038	22024	785	16019
24-#11	4.11	MA	11017	3101	16253	2639	20052	2189	22644	1810	26292	1152	33829	505	30026
8L-6S		MI	6891	3101	10947	2521	13180	2070	14706	1692	17012	1049	21400	498	18413
24-#11	4.11	MA	10708	3101	15703	2652	19320	2201	21720	1820	25070	1172	32223	450	28923
9L-5S		MI	7066	3101	11314	2502	13603	2060	15250	1676	17749	1036	22355	572	18657
24-#11	4.11	MA	10425	3101	15129	2661	18556	2222	20816	1831	23844	1191	30485	388	27846
10L-4S		MI	7226	3101	11641	2490	14050	2050	15804	1668	18517	1024	23395	638	19090

RECTANGULAR TIED COLUMNS 24" x 40"

4-#18	1.67	MA	10909	2585	15161	2246	18585	1880	20659	1588	23201	1135	28753	985	15024
2E		MI	6241	2585	9309	2135	10942	1786	11902	1506	13048	1070	15394	871	8395
6-#14	1.41	MA	10616	2513	14322	2215	17635	1860	19567	1578	21779	1148	26824	997	12876
2L-3S		MI	5701	2513	8110	2131	9523	1787	10233	1514	10838	1105	12705	756	7292
6-#14	1.41	MA	9789	2513	12923	2239	15860	1881	17416	1598	18875	1177	22803	853	12827
3L-2S		MI	6124	2513	8856	2115	10470	1774	11381	1503	12387	1088	14772	919	7271
6-#18	2.50	MA	12015	2817	17607	2391	21688	1986	24421	1655	28278	1124	35784	970	22288
2L-3S		MI	6104	2817	9309	2305	10942	1911	11902	1586	13048	1083	15394	537	12159
6-#18	2.50	MA	10697	2817	15161	2430	18585	2023	20659	1688	23201	1173	28753	705	21976
3L-2S		MI	6779	2817	10595	2280	12574	1892	13880	1573	15718	1059	18842	828	12246
8-#10	1.06	MA	10175	2416	13170	2173	16313	1831	18037	1564	19777	1163	24099	1013	9884
2L-4S		MI	5529	2416	7474	2105	8807	1780	9423	1520	9789	1127	11539	820	5688
8-#10	1.06	MA	9683	2416	12365	2187	15292	1844	16799	1576	18106	1180	21785	934	9878
3E		MI	5675	2416	7777	2094	9227	1764	9937	1505	10492	1122	12421	874	5677
8-#10	1.06	MA	9411	2416	11821	2200	14535	1864	15870	1595	16834	1191	20262	884	9828
4L-2S		MI	5932	2416	8214	2084	9781	1755	10609	1498	11399	1110	13675	967	5662
8-#11	1.30	MA	10495	2483	13964	2204	17239	1853	19117	1575	21198	1153	26039	1003	11991
2L-4S		MI	5603	2483	7765	2132	9096	1799	9735	1529	10177	1114	11999	762	6819
8-#11	1.30	MA	9913	2483	12986	2221	15998	1868	17613	1590	19168	1174	23228	904	11972
3E		MI	5776	2483	8131	2120	9603	1781	10356	1512	11026	1110	13042	826	6819
8-#11	1.30	MA	9593	2483	12323	2238	15076	1892	16482	1613	17620	1187	21364	842	11873
4L-2S		MI	6077	2483	8657	2109	10269	1771	11164	1504	12117	1097	14520	940	6803
8-#14	1.88	MA	11272	2643	15721	2297	19410	1919	21718	1616	24683	1141	30844	989	17036
2L-4S		MI	5807	2643	8334	2228	9748	1872	10496	1574	11178	1103	13309	649	9430

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

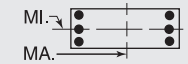
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.88	MA	10485	2643	14322	2320	17635	1941	19567	1636	21779	1171	26824	844	16956
3E		MI	6042	2643	8856	2212	10470	1847	11381	1551	12387	1099	14772	739	9509
8-#14	1.88	MA	10053	2643	13371	2344	16314	1975	17947	1669	19561	1187	24142	754	16645
4L-2S		MI	6449	2643	9602	2196	11417	1833	12529	1541	13937	1082	16840	902	9512
8-#18	3.33	MA	13079	3049	20052	2535	24792	2092	28182	1722	33356	1113	42814	954	29537
2L-4S		MI	6298	3049	9688	2475	11321	2058	12347	1689	13623	1074	16383	342	14579
8-#18	3.33	MA	11852	3049	17607	2575	21688	2129	24421	1755	28278	1162	35784	690	29177
3E		MI	6666	3049	10595	2450	12574	2017	13880	1653	15718	1072	18842	494	15918
8-#18	3.33	MA	11183	3049	15937	2615	19370	2187	21578	1811	24388	1189	31043	528	26709
4L-2S		MI	7302	3049	11881	2425	14206	1998	15858	1640	18388	1048	22291	785	16063
10-#10	1.32	MA	10571	2490	13975	2219	17335	1864	19275	1585	21448	1159	26413	1008	12283
2L-5S		MI	5595	2490	7641	2161	8992	1822	9637	1548	10061	1135	11911	762	6957
10-#10	1.32	MA	10093	2490	13170	2233	16313	1877	18037	1597	19777	1177	24099	929	12266
3L-4S		MI	5741	2490	7911	2151	9361	1813	10095	1541	10696	1123	12794	815	6987
10-#10	1.32	MA	9835	2490	12626	2247	15556	1898	17108	1617	18505	1188	22576	879	12203
4L-3S		MI	5881	2490	8214	2140	9781	1797	10609	1526	11399	1118	13675	869	6988
10-#10	1.32	MA	9509	2490	12133	2259	14896	1911	16287	1629	17363	1205	21018	841	12039
5L-2S		MI	6131	2490	8650	2130	10335	1789	11281	1519	12306	1107	14930	962	6977
10-#11	1.63	MA	10962	2574	14941	2261	18480	1894	20621	1601	23228	1149	28850	997	14901
2L-5S		MI	5685	2574	7964	2201	9315	1851	9989	1563	10499	1122	12437	687	8214
10-#11	1.63	MA	10400	2574	13964	2277	17239	1909	19117	1616	21198	1170	26039	898	14866
3L-4S		MI	5853	2574	8290	2189	9762	1841	10543	1555	11268	1109	13477	753	8371
10-#11	1.63	MA	10098	2574	13300	2294	16317	1934	17986	1639	19650	1182	24174	836	14752
4L-3S		MI	6018	2574	8657	2177	10269	1822	11164	1538	12117	1105	14520	817	8390
10-#11	1.63	MA	9711	2574	12707	2310	15512	1949	16986	1653	18259	1203	22272	788	14351
5L-2S		MI	6309	2574	9182	2165	10936	1812	11972	1530	13208	1093	15999	930	8382
10-#14	2.34	MA	11910	2774	17119	2378	21185	1979	23870	1654	27587	1135	34865	980	21188
2L-5S		MI	5925	2774	8614	2326	10057	1945	10854	1622	11632	1114	13921	536	10945
10-#14	2.34	MA	11158	2774	15721	2402	19410	2001	21718	1674	24683	1164	30844	835	21086
3L-4S		MI	6154	2774	9080	2310	10695	1932	11644	1612	12728	1097	15376	631	11609
10-#14	2.34	MA	10758	2774	14770	2425	18089	2035	20098	1706	22465	1181	28163	746	20763
4L-3S		MI	6374	2774	9602	2294	11417	1906	12529	1589	13937	1092	16840	722	11715
10-#14	2.34	MA	10218	2774	13925	2448	16935	2057	18665	1727	20471	1210	25432	673	19404
5L-2S		MI	6766	2774	10349	2278	12364	1893	13677	1579	15486	1076	18907	885	11741
10-#18	4.17	MA	12963	3281	20052	2720	24792	2234	28182	1822	33356	1151	42814	675	36388
3L-4S		MI	6875	3281	10974	2620	12953	2164	14325	1756	16293	1063	19832	299	18193
10-#18	4.17	MA	12368	3281	18383	2760	22474	2293	25340	1878	29465	1178	38073	513	33879
4L-3S		MI	7235	3281	11881	2595	14206	2123	15858	1720	18388	1061	22291	451	19676
10-#18	4.17	MA	11460	3281	16907	2800	20446	2330	22821	1911	25965	1227	33262	376	31158
5L-2S		MI	7803	3281	13167	2570	15838	2103	17836	1707	21058	1037	25739	742	19866
12-#10	1.59	MA	10959	2563	14780	2265	18356	1898	20513	1606	23119	1156	28727	1003	14677
2L-6S		MI	5627	2563	7768	2222	9197	1865	9860	1584	10346	1136	12303	685	7984
12-#10	1.59	MA	10495	2563	13975	2279	17335	1911	19275	1618	21448	1173	26413	924	14651
3L-5S		MI	5804	2563	8078	2207	9546	1856	10309	1570	10968	1131	13165	757	8238
12-#10	1.59	MA	10249	2563	13430	2293	16578	1931	18346	1638	20176	1184	24890	874	14578
4E		MI	5948	2563	8347	2197	9916	1847	10767	1562	11603	1120	14048	810	8280
12-#10	1.59	MA	9926	2563	12938	2305	15917	1944	17525	1650	19035	1202	23332	836	14409
5L-3S		MI	6084	2563	8650	2186	10335	1831	11281	1548	12306	1115	14930	864	8291
12-#10	1.59	MA	9596	2563	12339	2319	15276	1956	16723	1669	17921	1212	21831	772	13832
6L-2S		MI	6328	2563	9087	2176	10889	1822	11953	1540	13213	1103	16184	957	8287
12-#11	1.95	MA	11419	2664	15919	2317	19720	1935	22124	1628	25258	1145	31660	991	17806
2L-6S		MI	5723	2664	8122	2276	9559	1902	10254	1606	10854	1131	12961	603	9401
12-#11	1.95	MA	10876	2664	14941	2334	18480	1951	20621	1642	23228	1166	28850	892	17760
3L-5S		MI	5931	2664	8489	2257	9982	1892	10797	1589	11590	1118	13915	677	9699

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

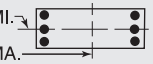


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.95	MA	10590	2664	14278	2351	17558	1975	19490	1665	21680	1178	26985	830	17633
4E		MI	6097	2664	8816	2245	10429	1882	11351	1581	12359	1105	14956	743	9919
12-#11	1.95	MA	10208	2664	13684	2366	16753	1990	18490	1680	20289	1199	25083	782	17195
5L-3S		MI	6254	2664	9182	2234	10936	1863	11972	1564	13208	1101	15999	807	9951
12-#11	1.95	MA	9817	2664	12955	2383	15981	2005	17512	1703	18932	1211	23251	701	16430
6L-2S		MI	6538	2664	9707	2222	11603	1854	12781	1556	14299	1088	17477	921	9954
12-#14	2.81	MA	11813	2904	17119	2483	21185	2060	23870	1711	27587	1158	34865	827	25216
3L-5S		MI	6265	2904	9360	2408	11004	2005	12002	1660	13182	1107	15988	518	13068
12-#14	2.81	MA	11442	2904	16168	2507	19864	2095	22250	1744	25369	1175	32183	737	24885
4E		MI	6492	2904	9826	2391	11642	1991	12792	1649	14277	1091	17444	614	13728
12-#14	2.81	MA	10909	2904	15323	2530	18710	2116	20816	1764	23375	1204	29452	664	23508
5L-3S		MI	6700	2904	10349	2375	12364	1966	13677	1627	15486	1086	18907	705	13915
12-#14	2.81	MA	10376	2904	14279	2554	17612	2137	19414	1797	21429	1221	26822	546	22352
6L-2S		MI	7078	2904	11095	2359	13311	1953	14825	1616	17036	1069	20974	868	13958
12-#18	5.00	MA	13509	3513	20828	2905	25577	2399	29101	1945	34543	1167	45104	497	41039
4E		MI	7475	3513	12260	2765	14585	2270	16303	1823	18963	1051	23280	256	21833
12-#18	5.00	MA	12614	3513	19353	2945	23549	2436	26583	1978	31042	1215	40293	360	38275
5L-3S		MI	7763	3513	13167	2740	15838	2229	17836	1787	21058	1050	25739	408	23436
12-#18	5.00	MA	11771	3513	17537	2988	21637	2472	24118	2033	27623	1242	35658	142	34606
6L-2S		MI	8295	3513	14453	2715	17470	2209	19814	1774	23727	1026	29187	698	23661
14-#10	1.85	MA	10888	2637	14780	2325	18356	1945	20513	1640	23119	1170	28727	919	17036
3L-6S		MI	5837	2637	8205	2268	9751	1899	10532	1605	11253	1132	13557	680	9236
14-#10	1.85	MA	10654	2637	14235	2339	17599	1965	19584	1659	21847	1181	27204	869	16954
4L-5S		MI	6010	2637	8515	2253	10101	1890	10981	1591	11874	1128	14420	752	9501
14-#10	1.85	MA	10334	2637	13743	2351	16939	1978	18763	1671	20706	1198	25646	831	16782
5L-4S		MI	6153	2637	8784	2243	10470	1881	11439	1583	12510	1116	15303	805	9570
14-#10	1.85	MA	10014	2637	13143	2365	16298	1989	17961	1691	19592	1209	24145	767	16191
6L-3S		MI	6283	2637	9087	2232	10889	1865	11953	1569	13213	1111	16184	859	9590
14-#10	1.85	MA	9736	2637	12633	2375	15591	2004	17170	1701	18512	1227	22691	734	15717
7L-2S		MI	6521	2637	9524	2222	11444	1856	12624	1561	14119	1100	17439	952	9593
14-#11	2.27	MA	11341	2755	15919	2391	19720	1992	22124	1668	25258	1161	31660	886	20652
3L-6S		MI	5970	2755	8647	2333	10226	1943	11062	1632	11945	1126	14439	594	10908
14-#11	2.27	MA	11071	2755	15256	2407	18799	2016	20994	1691	23709	1174	29796	824	20516
4L-5S		MI	6173	2755	9015	2314	10649	1933	11605	1615	12681	1114	15393	668	11191
14-#11	2.27	MA	10693	2755	14662	2423	17994	2032	19994	1706	22319	1195	27894	776	20044
5L-4S		MI	6337	2755	9341	2302	11096	1923	12160	1607	13450	1101	16434	734	11464
14-#11	2.27	MA	10315	2755	13933	2440	17222	2046	19016	1729	20961	1207	26061	695	19302
6L-3S		MI	6487	2755	9707	2290	11603	1905	12781	1591	14299	1097	17477	798	11507
14-#11	2.27	MA	9987	2755	13312	2451	16362	2064	18065	1742	19646	1228	24280	653	18556
7L-2S		MI	6763	2755	10233	2278	12270	1895	13589	1583	15390	1084	18955	911	11521
14-#14	3.28	MA	12107	3035	17567	2588	21639	2154	24401	1782	28272	1169	36204	728	29012
4L-5S		MI	6599	3035	10106	2489	11951	2064	13150	1697	14731	1101	18055	501	15202
14-#14	3.28	MA	11580	3035	16722	2611	20485	2176	22967	1802	26279	1198	33473	656	27617
5L-4S		MI	6824	3035	10573	2473	12589	2051	13940	1687	15827	1084	19511	597	15827
14-#14	3.28	MA	11071	3035	15678	2635	19387	2197	21565	1834	24333	1215	30843	537	26447
6L-3S		MI	7020	3035	11095	2457	13311	2025	14825	1664	17036	1080	20974	687	16112
14-#14	3.28	MA	10630	3035	14788	2651	18156	2222	20213	1855	22446	1244	28277	476	24740
7L-2S		MI	7385	3035	11841	2441	14259	2012	15973	1654	18585	1063	23042	851	16170
14-#18	5.83	MA	13731	3745	21798	3090	26653	2542	30344	2045	36120	1204	47323	345	45391
5L-4S		MI	8022	3745	13546	2910	16217	2376	18280	1890	21633	1040	26729	212	25493
14-#18	5.83	MA	12941	3745	19982	3133	24740	2578	27880	2100	32701	1231	42688	127	41750
6L-3S		MI	8279	3745	14453	2885	17470	2335	19814	1854	23727	1039	29187	364	27197
16-#10	2.12	MA	11051	2711	15040	2385	18621	1998	20822	1680	23519	1177	29518	865	19331
4L-6S		MI	6044	2711	8641	2314	10306	1932	11203	1627	12159	1129	14812	675	10492
16-#10	2.12	MA	10734	2711	14548	2397	17960	2012	20001	1693	22377	1195	27960	827	19156
5E		MI	6212	2711	8951	2299	10655	1923	11652	1612	12781	1124	15674	747	10745
16-#10	2.12	MA	10423	2711	13948	2411	17319	2023	19199	1712	21263	1205	26459	762	18554
6L-4S		MI	6354	2711	9221	2289	11024	1914	12110	1605	13416	1112	16557	800	10857

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

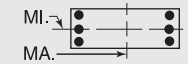


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.12	MA	10156	2711	13438	2421	16613	2038	18408	1723	20183	1223	25005	729	18094
7L-3S		MI	6479	2711	9524	2278	11444	1898	12624	1590	14119	1108	17439	854	10885
16-#10	2.12	MA	9881	2711	12949	2432	15957	2047	17581	1738	19106	1234	23591	685	17373
8L-2S		MI	6712	2711	9961	2268	11998	1889	13296	1583	15026	1096	18693	947	10894
16-#11	2.60	MA	11542	2845	16233	2464	20039	2058	22498	1717	25739	1169	32606	818	23400
4L-6S		MI	6213	2845	9173	2389	10893	1985	11870	1658	13036	1122	15917	585	12420
16-#11	2.60	MA	11167	2845	15640	2479	19235	2073	21498	1732	24349	1190	30704	770	22898
5E		MI	6410	2845	9540	2370	11316	1975	12414	1641	13772	1109	16872	658	12691
16-#11	2.60	MA	10802	2845	14910	2496	18462	2087	20520	1755	22991	1203	28872	689	22178
6L-4S		MI	6573	2845	9867	2358	11763	1965	12968	1633	14541	1097	17912	724	13008
16-#11	2.60	MA	10488	2845	14290	2508	17603	2105	19568	1768	21676	1223	27090	647	21429
7L-3S		MI	6717	2845	10233	2347	12270	1946	13589	1617	15390	1092	18955	789	13061
16-#11	2.60	MA	10162	2845	13694	2520	16805	2116	18561	1786	20362	1236	25362	591	20458
8L-2S		MI	6986	2845	10758	2335	12937	1936	14397	1609	16481	1080	20434	902	13082
16-#14	3.75	MA	12234	3165	18121	2693	22260	2236	25118	1840	29183	1192	37494	647	31731
5E		MI	6926	3165	10853	2571	12898	2124	14298	1735	16281	1095	20123	484	17343
16-#14	3.75	MA	11748	3165	17077	2717	21162	2256	23716	1872	27237	1209	34863	529	30542
6L-4S		MI	7149	3165	11319	2555	13536	2111	15088	1725	17376	1078	21578	580	17938
16-#14	3.75	MA	11330	3165	16187	2733	19931	2281	22364	1892	25349	1238	32297	468	28843
7L-3S		MI	7335	3165	11841	2538	14259	2085	15973	1702	18585	1074	23042	670	18307
16-#14	3.75	MA	10874	3165	15333	2751	18787	2297	20920	1917	23466	1255	29815	385	27089
8L-2S		MI	7689	3165	12588	2522	15206	2072	17121	1692	20135	1057	25109	834	18378
16-#18	6.67	MA	14076	3977	22428	3278	27844	2684	31641	2167	37778	1220	49719	112	48895
6L-4S		MI	8556	3977	14832	3055	17849	2482	20258	1957	24303	1029	30177	169	29170
18-#10	2.38	MA	11126	2784	15353	2443	18982	2045	21239	1714	24048	1191	30273	822	21532
5L-6S		MI	6247	2784	9078	2360	10860	1966	11875	1648	13066	1125	16066	670	11751
18-#10	2.38	MA	10825	2784	14753	2457	18341	2057	20437	1733	22934	1202	28773	758	20918
6L-5S		MI	6411	2784	9388	2345	11209	1957	12324	1633	13688	1121	16929	742	11994
18-#10	2.38	MA	10567	2784	14243	2467	17634	2071	19646	1744	21855	1220	27319	724	20471
7L-4S		MI	6552	2784	9658	2335	11578	1948	12782	1626	14323	1109	17812	795	12144
18-#10	2.38	MA	10295	2784	13754	2478	16979	2081	18819	1759	20777	1230	25905	680	19743
8L-3S		MI	6673	2784	9961	2324	11998	1932	13296	1611	15026	1104	18693	849	12178
18-#10	2.38	MA	9986	2784	13268	2488	16342	2091	18015	1768	19716	1248	24524	637	19044
9L-2S		MI	6900	2784	10397	2314	12552	1923	13968	1604	15933	1093	19948	942	12193
18-#11	2.92	MA	11631	2936	16617	2536	20475	2114	23001	1758	26379	1186	33515	764	25757
5L-6S		MI	6452	2936	9698	2446	11560	2026	12678	1684	14127	1118	17396	575	13936
18-#11	2.92	MA	11279	2936	15888	2553	19703	2129	22024	1781	25021	1198	31683	683	25056
6L-5S		MI	6643	2936	10065	2427	11983	2016	13222	1667	14863	1105	18350	649	14195
18-#11	2.92	MA	10978	2936	15267	2564	18844	2146	21072	1795	23705	1219	29901	641	24302
7L-4S		MI	6805	2936	10392	2415	12430	2006	13776	1659	15632	1092	19391	715	14551
18-#11	2.92	MA	10656	2936	14671	2577	18045	2157	20065	1812	22392	1231	28173	585	23334
8L-3S		MI	6943	2936	10758	2403	12937	1987	14397	1643	16481	1088	20434	779	14612
18-#11	2.92	MA	10292	2936	14085	2590	17270	2170	19086	1823	21099	1252	26480	531	22244
9L-2S		MI	7206	2936	11284	2391	13604	1978	15205	1635	17571	1075	21912	893	14641
18-#14	4.22	MA	12409	3296	18475	2798	22937	2316	25867	1910	30140	1202	38884	520	34637
6L-5S		MI	7248	3296	11599	2652	13845	2183	15446	1773	17830	1089	22190	467	19491
18-#14	4.22	MA	12013	3296	17585	2814	21706	2341	24516	1930	28253	1232	36318	459	32947
7L-4S		MI	7470	3296	12065	2636	14483	2170	16236	1762	18926	1072	23645	563	20059
18-#14	4.22	MA	11563	3296	16731	2832	20562	2356	23072	1955	26370	1248	33836	376	31179
8L-3S		MI	7646	3296	12588	2620	15206	2145	17121	1740	20135	1068	25109	653	20501
18-#14	4.22	MA	11071	3296	15897	2851	19450	2373	21669	1969	24515	1278	31397	297	29430
9L-2S		MI	7983	3296	13334	2604	16153	2131	18269	1729	21684	1051	27176	817	20584
20-#10	2.65	MA	11219	2858	15558	2503	19362	2090	21675	1754	24605	1198	31087	753	23285
6E		MI	6447	2858	9515	2406	11414	2000	12547	1669	13973	1122	17321	665	13013
20-#10	2.65	MA	10970	2858	15048	2513	18656	2105	20884	1765	23526	1216	29633	719	22850
7L-5S		MI	6607	2858	9825	2391	11763	1991	12996	1655	14595	1117	18183	737	13247
20-#10	2.65	MA	10701	2858	14559	2524	18000	2114	20057	1780	22448	1227	28219	676	22113
8L-4S		MI	6748	2858	10094	2381	12133	1982	13454	1647	15230	1105	19066	790	13430

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

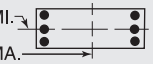


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	2.65	MA	10401	2858	14072	2534	17364	2125	19253	1789	21387	1244	26838	632	21407
9L-3S		MI	6864	2858	10397	2370	12552	1966	13968	1633	15933	1101	19948	844	13469
20-#10	2.65	MA	10124	2858	13572	2542	16700	2143	18467	1799	20294	1259	25334	584	20552
10L-2S		MI	7087	2858	10834	2360	13107	1957	14640	1625	16840	1089	21202	937	13489
20-#11	3.25	MA	11746	3026	16866	2609	20944	2170	23528	1807	27051	1194	34493	677	27936
6E		MI	6687	3026	10224	2502	12226	2067	13487	1710	15218	1113	18874	566	15454
20-#11	3.25	MA	11457	3026	16245	2621	20084	2188	22576	1821	25735	1215	32712	635	27175
7L-5S		MI	6873	3026	10591	2483	12650	2057	14030	1694	15954	1101	19828	639	15704
20-#11	3.25	MA	11139	3026	15649	2633	19286	2199	21568	1839	24422	1227	30984	579	26210
8L-4S		MI	7035	3026	10917	2472	13097	2047	14584	1686	16723	1088	20869	705	16093
20-#11	3.25	MA	10787	3026	15062	2646	18511	2211	20590	1849	23129	1248	29291	525	25112
9L-3S		MI	7167	3026	11284	2460	13604	2029	15205	1669	17571	1084	21912	770	16162
20-#11	3.25	MA	10461	3026	14454	2656	17702	2232	19632	1860	21816	1266	27453	464	24042
10L-2S		MI	7424	3026	11809	2448	14270	2019	16013	1661	18662	1071	23390	883	16198
20-#14	4.69	MA	12681	3426	18984	2896	23481	2401	26667	1968	31157	1225	40339	450	37050
7L-5S		MI	7565	3426	12345	2734	14793	2243	16594	1810	19380	1082	24257	450	21644
20-#14	4.69	MA	12236	3426	18130	2914	22337	2416	25223	1993	29273	1242	37856	368	35268
8L-4S		MI	7786	3426	12812	2718	15430	2230	17384	1800	20475	1066	25713	546	22188
20-#14	4.69	MA	11764	3426	17295	2932	21225	2433	23820	2007	27418	1271	35418	288	33509
9L-3S		MI	7964	3426	13334	2701	16153	2204	18269	1777	21684	1061	27176	636	22695
22-#10	2.91	MA	11366	2932	15853	2559	19677	2139	22123	1786	25197	1213	31947	715	25230
7L-6S		MI	6645	2932	9952	2452	11968	2033	13219	1690	14880	1118	18575	660	14278
22-#10	2.91	MA	11100	2932	15364	2570	19022	2148	21295	1801	24119	1223	30533	671	24483
8L-5S		MI	6801	2932	10262	2437	12318	2024	13668	1676	15501	1114	19438	732	14503
22-#10	2.91	MA	10808	2932	14877	2580	18385	2158	20491	1811	23058	1241	29152	627	23769
9L-4S		MI	6941	2932	10531	2427	12687	2015	14126	1668	16137	1102	20321	785	14716
22-#10	2.91	MA	10540	2932	14377	2588	17722	2176	19705	1820	21965	1255	27648	579	22917
10L-3S		MI	7053	2932	10834	2416	13107	1999	14640	1654	16840	1097	21202	839	14760
22-#10	2.91	MA	10271	2932	13814	2605	17081	2186	18907	1838	20862	1264	26271	533	22051
11L-2S		MI	7271	2932	11271	2406	13661	1990	15311	1646	17747	1086	22456	932	14784
22-#11	3.57	MA	11928	3117	17223	2677	21325	2229	24080	1847	27765	1210	35522	629	30048
7L-6S		MI	6919	3117	10749	2559	12893	2109	14295	1736	16309	1109	20352	556	16976
22-#11	3.57	MA	11613	3117	16627	2690	20527	2240	23072	1865	26452	1223	33794	573	29086
8L-5S		MI	7101	3117	11116	2540	13316	2099	14838	1720	17045	1096	21307	630	17217
22-#11	3.57	MA	11272	3117	16040	2703	19751	2252	22093	1875	25158	1244	32101	519	27980
9L-4S		MI	7261	3117	11443	2528	13763	2089	15392	1712	17814	1084	22347	696	17635
22-#11	3.57	MA	10958	3117	15431	2713	18943	2274	21135	1887	23846	1262	30264	458	26902
10L-3S		MI	7389	3117	11809	2516	14270	2070	16013	1695	18662	1079	23390	760	17711
22-#14	5.16	MA	12895	3557	19529	2995	24111	2476	27374	2030	32177	1236	41877	359	39358
8L-5S		MI	7901	3557	13092	2815	15740	2303	17742	1848	20929	1076	26325	433	23803
22-#14	5.16	MA	12441	3557	18694	3014	23000	2492	25971	2045	30322	1265	39438	280	37587
9L-4S		MI	8123	3557	13558	2799	16377	2289	18532	1838	22025	1059	27780	528	24324
24-#10	3.17	MA	11492	3005	16169	2616	20043	2182	22533	1823	25791	1220	32847	666	26853
8L-6S		MI	6840	3005	10388	2498	12523	2067	13891	1712	15787	1115	19830	655	15544
24-#10	3.17	MA	11209	3005	15682	2626	19407	2192	21729	1832	24729	1237	31466	622	26132
9L-5S		MI	6993	3005	10698	2483	12872	2058	14339	1697	16408	1110	20692	727	15761
24-#10	3.17	MA	10949	3005	15182	2634	18743	2210	20943	1842	23637	1252	29962	574	25282
10L-4S		MI	7132	3005	10968	2473	13241	2049	14797	1690	17044	1098	21575	780	16001
24-#10	3.17	MA	10685	3005	14619	2651	18103	2220	20145	1859	22534	1260	28585	528	24410
11L-3S		MI	7240	3005	11271	2462	13661	2033	15311	1675	17747	1094	22456	834	16050
24-#11	3.90	MA	12079	3207	17605	2747	21768	2281	24576	1891	28482	1218	36605	567	31962
8L-6S		MI	7148	3207	11274	2615	13560	2150	15103	1762	17400	1105	21831	547	18500
24-#11	3.90	MA	11748	3207	17018	2759	20992	2294	23597	1901	27188	1239	34912	513	30847
9L-5S		MI	7326	3207	11642	2596	13983	2140	15646	1746	18136	1092	22785	621	18733
24-#11	3.90	MA	11446	3207	16409	2769	20184	2315	22639	1913	25876	1258	33075	452	29762
10L-4S		MI	7486	3207	11968	2585	14430	2130	16201	1738	18905	1079	23826	687	19178
24-#14	5.63	MA	13105	3687	20093	3095	24775	2552	28122	2082	33226	1259	43459	271	41666
9L-5S		MI	8207	3687	13838	2897	16687	2362	18889	1886	22479	1070	28392	416	25965

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#18	1.59	MA	11949	2692	16420	2352	20182	1970	22439	1667	25153	1198	31133	1040	15888
2E		MI	6498	2692	9646	2227	11326	1864	12300	1574	13433	1124	15818	919	8427
6-#14	1.34	MA	11632	2619	15527	2321	19171	1950	21275	1657	23638	1210	29076	1052	13605
2L-3S		MI	5956	2619	8441	2224	9904	1867	10630	1583	11224	1160	13134	805	7322
6-#14	1.34	MA	10749	2619	14047	2345	17293	1973	18998	1678	20564	1240	24821	909	13556
3L-2S		MI	6381	2619	9187	2208	10851	1854	11778	1573	12774	1143	15201	968	7297
6-#18	2.38	MA	13134	2923	19011	2497	23470	2076	26423	1734	30531	1187	38580	1025	23584
2L-3S		MI	6359	2923	9646	2397	11326	1990	12300	1655	13433	1137	15818	585	12213
6-#18	2.38	MA	11722	2923	16420	2538	20182	2114	22439	1769	25153	1238	31133	764	23272
3L-2S		MI	7038	2923	10932	2372	12958	1970	14277	1641	16103	1113	19267	876	12283
8-#10	1.01	MA	11157	2522	14304	2279	17767	1921	19649	1643	21510	1226	26182	1068	10432
2L-4S		MI	5783	2522	7797	2200	9185	1861	9819	1590	10178	1183	11972	869	5711
8-#10	1.01	MA	10632	2522	13453	2293	16687	1935	18340	1655	19744	1244	23735	990	10427
3E		MI	5931	2522	8100	2189	9605	1845	10333	1576	10881	1178	12853	924	5697
8-#10	1.01	MA	10343	2522	12878	2307	15888	1955	17359	1675	18401	1255	22132	940	10377
4L-2S		MI	6188	2522	8537	2179	10159	1836	11005	1568	11788	1167	14108	1016	5681
8-#11	1.24	MA	11501	2589	15146	2310	18749	1943	20795	1654	23018	1216	28240	1058	12665
2L-4S		MI	5858	2589	8093	2226	9476	1880	10132	1599	10564	1169	12429	811	6850
8-#11	1.24	MA	10880	2589	14111	2327	17436	1959	19204	1669	20871	1238	25267	960	12645
3E		MI	6031	2589	8459	2215	9983	1861	10753	1582	11413	1165	13472	875	6844
8-#11	1.24	MA	10538	2589	13411	2344	16463	1984	18010	1693	19235	1251	23304	899	12547
4L-2S		MI	6333	2589	8984	2203	10650	1851	11561	1574	12504	1153	14951	989	6826
8-#14	1.79	MA	12334	2750	17007	2403	21049	2010	23552	1695	26711	1204	33331	1044	18008
2L-4S		MI	6061	2750	8665	2322	10129	1952	10893	1644	11565	1158	13737	697	9479
8-#14	1.79	MA	11492	2750	15527	2427	19171	2032	21275	1716	23638	1234	29076	901	17928
3E		MI	6297	2749	9187	2306	10851	1926	11778	1621	12774	1154	15201	787	9544
8-#14	1.79	MA	11031	2750	14523	2451	17775	2067	19563	1749	21293	1252	26253	812	17617
4L-2S		MI	6707	2749	9933	2290	11799	1913	12926	1611	14324	1137	17268	951	9541
8-#18	3.17	MA	14273	3155	21601	2642	26757	2182	30407	1801	35910	1176	46027	1009	31265
2L-4S		MI	6550	3155	10025	2568	11705	2137	12744	1758	14009	1128	16808	390	14736
8-#18	3.17	MA	12957	3155	19011	2682	23470	2220	26423	1836	30531	1227	38580	749	30905
3E		MI	6922	3155	10932	2542	12958	2096	14277	1722	16103	1126	19267	542	15976
8-#18	3.17	MA	12241	3155	17246	2723	21019	2280	23418	1892	26417	1255	33587	588	28469
4L-2S		MI	7564	3155	12218	2517	14590	2076	16255	1708	18773	1102	22715	833	16104
10-#10	1.26	MA	11580	2596	15155	2325	18847	1955	20958	1664	23277	1222	28628	1063	12969
2L-5S		MI	5850	2596	7964	2256	9370	1903	10033	1619	10449	1191	12344	811	6991
10-#10	1.26	MA	11070	2596	14304	2339	17767	1968	19649	1676	21510	1240	26182	985	12952
3L-4S		MI	5995	2596	8234	2246	9740	1894	10491	1612	11085	1179	13227	864	7013
10-#10	1.26	MA	10795	2596	13729	2353	16968	1989	18668	1696	20167	1251	24578	935	12889
4L-3S		MI	6137	2596	8537	2235	10159	1879	11005	1597	11788	1175	14108	919	7010
10-#10	1.26	MA	10445	2596	13207	2365	16271	2002	17802	1709	18963	1269	22846	889	12725
5L-2S		MI	6388	2596	8974	2225	10713	1870	11677	1590	12694	1163	15362	1011	6998
10-#11	1.55	MA	12000	2680	16180	2367	20061	1984	22386	1680	25165	1212	31213	1052	15743
2L-5S		MI	5940	2680	8291	2295	9695	1931	10386	1633	10887	1178	12867	736	8298
10-#11	1.55	MA	11400	2680	15146	2384	18749	2000	20795	1695	23018	1233	28240	954	15709
3L-4S		MI	6107	2680	8618	2283	10143	1921	10940	1625	11655	1165	13908	802	8406
10-#11	1.55	MA	11077	2680	14445	2401	17775	2025	19601	1719	21383	1246	26277	893	15594
4L-3S		MI	6273	2680	8984	2271	10650	1902	11561	1608	12504	1161	14951	866	8417
10-#11	1.55	MA	10662	2680	13815	2416	16926	2041	18545	1734	19914	1268	24272	846	15253
5L-2S		MI	6567	2680	9510	2259	11316	1893	12369	1600	13595	1148	16429	979	8407
10-#14	2.23	MA	13016	2880	18487	2484	22928	2069	25828	1733	29784	1198	37587	1035	22403
2L-5S		MI	6179	2880	8945	2420	10438	2025	11251	1691	12019	1169	14349	584	11048
10-#14	2.23	MA	12211	2880	17007	2508	21049	2092	23552	1753	26711	1228	33331	892	22301
3L-4S		MI	6408	2880	9411	2403	11076	2012	12041	1681	13115	1152	15805	680	11661
10-#14	2.23	MA	11784	2880	16003	2532	19654	2127	21840	1787	24367	1246	30508	803	21978
4L-3S		MI	6631	2880	9933	2387	11799	1986	12926	1659	14324	1148	17268	770	11752
10-#14	2.23	MA	11203	2880	15104	2555	18435	2149	20326	1807	22261	1276	27628	733	20627
5L-2S		MI	7026	2880	10680	2371	12746	1973	14074	1648	15873	1131	19336	934	11772

RECTANGULAR TIED COLUMNS 24" x 42"

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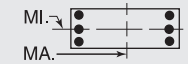


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#18	3.97	MA	14144	3387	21601	2827	26757	2326	30407	1903	35910	1215	46027	733	38548
3L-4S		MI	7127	3387	11311	2713	13337	2243	14722	1825	16678	1117	20257	347	18344
10-#18	3.97	MA	13507	3387	19837	2868	24307	2386	27402	1959	31795	1244	41034	573	36054
4L-3S		MI	7493	3387	12218	2687	14590	2202	16255	1789	18773	1115	22715	499	19736
10-#18	3.97	MA	12529	3387	18279	2909	22164	2424	24741	1994	28096	1294	35958	440	33174
5L-2S		MI	8069	3387	13503	2662	16222	2182	18233	1775	21443	1091	26164	789	19909
12-#10	1.51	MA	11994	2669	16006	2371	19926	1988	22266	1685	25044	1219	31074	1058	15500
2L-6S		MI	5881	2669	8091	2317	9575	1946	10256	1655	10735	1192	12735	735	8051
12-#10	1.51	MA	11498	2669	15155	2385	18847	2002	20958	1698	23277	1237	28628	980	15474
3L-5S		MI	6059	2669	8401	2302	9925	1937	10705	1640	11356	1187	13598	806	8274
12-#10	1.51	MA	11236	2669	14580	2399	18047	2022	19977	1717	21934	1248	27025	931	15401
4E		MI	6204	2669	8671	2292	10294	1928	11163	1633	11992	1176	14481	859	8308
12-#10	1.51	MA	10890	2669	14058	2412	17351	2036	19111	1730	20729	1266	25293	884	15232
5L-3S		MI	6340	2669	8974	2281	10713	1912	11677	1618	12694	1171	15362	914	8316
12-#10	1.51	MA	10538	2669	13424	2426	16669	2047	18265	1750	19554	1277	23801	831	14667
6L-2S		MI	6585	2669	9410	2271	11268	1903	12349	1611	13601	1159	16617	1006	8309
12-#11	1.86	MA	12488	2770	17214	2423	21374	2026	23977	1706	27313	1208	34186	1046	18817
2L-6S		MI	5977	2770	8449	2370	9939	1982	10650	1676	11242	1186	13391	652	9480
12-#11	1.86	MA	11908	2770	16180	2440	20061	2042	22386	1721	25165	1229	31213	948	18771
3L-5S		MI	6186	2770	8817	2351	10362	1972	11194	1659	11978	1174	14345	726	9781
12-#11	1.86	MA	11602	2770	15480	2457	19088	2066	21192	1745	23530	1242	29251	887	18644
4E		MI	6352	2770	9143	2340	10809	1962	11748	1651	12746	1161	15386	792	9956
12-#11	1.86	MA	11192	2770	14849	2473	18239	2082	20136	1760	22062	1263	27245	840	18265
5L-3S		MI	6511	2770	9510	2328	11316	1944	12369	1634	13595	1157	16429	856	9981
12-#11	1.86	MA	10775	2770	14078	2490	17417	2096	19104	1783	20629	1276	25313	760	17430
6L-2S		MI	6797	2770	10035	2316	11983	1934	13177	1626	14686	1144	17907	970	9981
12-#14	2.68	MA	12910	3010	18487	2590	22928	2151	25828	1791	29784	1222	37587	884	26674
3L-5S		MI	6520	3010	9691	2501	11385	2084	12399	1729	13569	1163	16417	567	13169
12-#14	2.68	MA	12513	3010	17483	2614	21532	2186	24116	1824	27440	1239	34763	794	26343
4E		MI	6747	3010	10157	2485	12023	2071	13189	1719	14664	1146	17872	663	13842
12-#14	2.68	MA	11940	3010	16585	2636	20314	2209	22602	1845	25334	1270	31883	724	24975
5L-3S		MI	6958	3010	10680	2469	12746	2046	14074	1696	15873	1142	19336	753	13954
12-#14	2.68	MA	11372	3010	15480	2661	19145	2229	21122	1878	23279	1287	29109	607	23792
6L-2S		MI	7339	3010	11426	2453	13693	2032	15222	1686	17423	1125	21403	917	13991
12-#18	4.76	MA	14724	3619	22427	3013	27594	2492	31387	2026	37174	1233	48481	557	43640
4E		MI	7729	3619	12597	2857	14969	2349	16700	1891	19348	1106	23705	303	21978
12-#18	4.76	MA	13761	3619	20869	3054	25452	2530	28725	2061	33474	1283	43405	425	40778
5L-3S		MI	8022	3619	13503	2832	16222	2307	18233	1856	21443	1104	26164	455	23497
12-#18	4.76	MA	12860	3619	18934	3097	23430	2567	26122	2118	29861	1312	38517	210	36893
6L-2S		MI	8563	3619	14789	2807	17854	2288	20211	1842	24113	1080	29612	746	23706
14-#10	1.76	MA	11918	2743	16006	2431	19926	2035	22266	1719	25044	1233	31074	975	17996
3L-6S		MI	6092	2743	8528	2363	10130	1980	10928	1676	11641	1188	13990	730	9302
14-#10	1.76	MA	11668	2743	15431	2445	19127	2056	21286	1739	23701	1244	29471	926	17914
4L-5S		MI	6265	2743	8838	2348	10479	1971	11377	1662	12263	1184	14853	801	9556
14-#10	1.76	MA	11325	2743	14909	2458	18431	2069	20420	1751	22496	1262	27739	879	17742
5L-4S		MI	6408	2743	9107	2338	10848	1962	11835	1654	12898	1172	15736	855	9600
14-#10	1.76	MA	10984	2743	14275	2472	17749	2080	19574	1771	21321	1273	26247	826	17163
6L-3S		MI	6540	2743	9410	2327	11268	1946	12349	1640	13601	1168	16617	909	9615
14-#10	1.76	MA	10688	2743	13737	2482	17003	2096	18733	1781	20182	1291	24719	793	16654
7L-2S		MI	6780	2743	9847	2317	11822	1937	13021	1632	14508	1156	17871	1001	9616
14-#11	2.17	MA	12404	2861	17214	2497	21374	2083	23977	1747	27313	1225	34186	943	21831
3L-6S		MI	6224	2861	8975	2427	10606	2024	11459	1702	12333	1182	14869	643	10986
14-#11	2.17	MA	12115	2861	16514	2514	20400	2107	22782	1771	25677	1238	32224	881	21695
4L-5S		MI	6428	2861	9342	2408	11029	2014	12002	1685	13069	1169	15824	717	11272

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

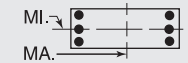
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.17	MA	11709	2861	15883	2529	19551	2123	21727	1786	24209	1259	30218	834	21283
5L-4S		MI	6592	2861	9669	2396	11476	2004	12556	1677	13837	1157	16864	783	11503
14-#11	2.17	MA	11307	2861	15112	2547	18730	2137	20695	1809	22776	1272	28287	754	20471
6L-3S		MI	6745	2861	10035	2384	11983	1985	13177	1661	14686	1152	17907	847	11539
14-#11	2.17	MA	10958	2861	14456	2558	17821	2156	19682	1823	21387	1293	26413	713	19743
7L-2S		MI	7023	2861	10561	2372	12650	1975	13985	1653	15777	1140	19386	960	11550
14-#14	3.13	MA	13224	3141	18963	2695	23411	2246	26393	1862	30513	1233	39018	786	30713
4L-5S		MI	6855	3141	10437	2583	12333	2144	13547	1767	15118	1156	18484	550	15300
14-#14	3.13	MA	12657	3141	18065	2718	22192	2268	24879	1883	28407	1263	36138	715	29329
5L-4S		MI	7079	3141	10904	2567	12970	2131	14337	1757	16214	1140	19939	646	15938
14-#14	3.13	MA	12114	3141	16961	2743	21023	2289	23399	1916	26352	1281	33364	599	28152
6L-3S		MI	7279	3141	11426	2550	13693	2105	15222	1734	17423	1135	21403	736	16153
14-#14	3.13	MA	11643	3141	16020	2759	19722	2314	21959	1936	24360	1311	30666	539	26356
7L-2S		MI	7648	3141	12172	2534	14640	2092	16370	1724	18972	1119	23470	899	16205
14-#18	5.56	MA	14952	3851	23460	3199	28739	2636	32709	2128	38852	1272	50852	409	48382
5L-4S		MI	8276	3851	13883	3002	16601	2455	18678	1958	22018	1095	27153	260	25633
14-#18	5.56	MA	14108	3851	21525	3241	26718	2673	30106	2185	35240	1301	45964	195	44462
6L-3S		MI	8540	3851	14789	2977	17854	2413	20211	1923	24113	1093	29612	412	27259
14-#18	5.56	MA	13372	3851	19874	3269	24434	2717	27598	2219	31736	1351	41181	85	40655
7L-2S		MI	9050	3851	16075	2952	19486	2394	22189	1909	26783	1069	33061	703	27498
16-#10	2.02	MA	12091	2817	16282	2491	20207	2090	22595	1760	25468	1241	31917	921	20429
4L-6S		MI	6299	2817	8965	2409	10684	2013	11600	1697	12548	1185	15244	725	10557
16-#10	2.02	MA	11752	2817	15760	2504	19511	2103	21729	1772	24263	1259	30185	874	20253
5E		MI	6468	2817	9275	2394	11033	2004	12048	1683	13170	1180	16107	796	10814
16-#10	2.02	MA	11420	2817	15126	2518	18829	2114	20883	1792	23087	1270	28693	821	19663
6L-4S		MI	6610	2817	9544	2384	11402	1995	12506	1675	13805	1169	16990	850	10889
16-#10	2.02	MA	11135	2817	14587	2528	18083	2129	20042	1803	21948	1288	27165	788	19167
7L-3S		MI	6737	2817	9847	2373	11822	1979	13021	1661	14508	1164	17871	904	10912
16-#10	2.02	MA	10840	2817	14071	2539	17392	2139	19168	1818	20812	1299	25675	745	18450
8L-2S		MI	6971	2817	10284	2363	12376	1970	13692	1653	15415	1152	19126	996	10919
16-#11	2.48	MA	12618	2951	17548	2570	21713	2149	24373	1797	27824	1233	35197	875	24748
4L-6S		MI	6468	2951	9500	2483	11273	2065	12267	1728	13424	1178	16348	633	12497
16-#11	2.48	MA	12215	2951	16917	2586	20864	2165	23318	1812	26356	1255	33191	828	24305
5E		MI	6666	2951	9868	2464	11696	2055	12810	1711	14160	1165	17302	707	12770
16-#11	2.48	MA	11826	2951	16146	2603	20042	2179	22286	1836	24923	1268	31260	748	23515
6L-4S		MI	6829	2951	10194	2453	12143	2045	13364	1703	14928	1152	18343	773	13048
16-#11	2.48	MA	11491	2951	15490	2615	19134	2197	21273	1849	23535	1289	29386	707	22782
7L-3S		MI	6975	2951	10561	2441	12650	2026	13985	1687	15777	1148	19386	837	13094
16-#11	2.48	MA	11141	2951	14861	2628	18291	2208	20208	1867	22148	1302	27566	653	21753
8L-2S		MI	7247	2951	11086	2429	13317	2016	14794	1679	16868	1135	20864	951	13112
16-#14	3.57	MA	13356	3271	19545	2800	24070	2328	27156	1920	31480	1257	40393	707	33687
5E		MI	7183	3271	11184	2664	13280	2204	14695	1804	16668	1150	20551	533	17439
16-#14	3.57	MA	12836	3271	18441	2824	22902	2348	25675	1954	29425	1275	37619	590	32505
6L-4S		MI	7406	3271	11650	2648	13918	2190	15485	1794	17763	1133	22007	628	18047
16-#14	3.57	MA	12390	3271	17501	2840	21600	2374	24235	1973	27433	1305	34921	530	30699
7L-3S		MI	7595	3271	12172	2632	14640	2165	16370	1772	18972	1129	23470	719	18349
16-#14	3.57	MA	11899	3271	16599	2859	20392	2390	22710	1999	25444	1322	32305	449	28890
8L-2S		MI	7952	3271	12919	2616	15587	2151	17518	1761	20522	1112	25538	882	18414
16-#18	6.35	MA	15319	4083	24115	3386	30005	2779	34091	2252	40618	1290	53411	179	52031
6L-4S		MI	8812	4083	15168	3147	18233	2561	20656	2025	24688	1084	30602	217	29305
16-#18	6.35	MA	14636	4083	22465	3414	27722	2823	31582	2286	37115	1340	48628	70	48197
7L-3S		MI	9049	4083	16075	3122	19486	2519	22189	1990	26783	1082	33061	369	31024
18-#10	2.27	MA	12170	2890	16611	2550	20591	2137	23038	1794	26030	1255	32632	869	22766
5L-6S		MI	6502	2890	9401	2455	11238	2047	12271	1719	13455	1181	16499	720	11816

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

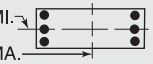


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.27	MA	11848	2890	15977	2564	19909	2148	22192	1813	24854	1266	31140	816	22165
6L-5S		MI	6668	2890	9711	2440	11587	2038	12720	1704	14077	1177	17362	791	12062
18-#10	2.27	MA	11573	2890	15438	2574	19163	2163	21351	1824	23715	1284	29611	783	21683
7L-4S		MI	6809	2890	9981	2430	11957	2029	13178	1697	14712	1165	18245	845	12177
18-#10	2.27	MA	11282	2890	14922	2585	18471	2173	20477	1839	22578	1296	28122	740	20956
8L-3S		MI	6931	2890	10284	2419	12376	2013	13692	1682	15415	1161	19126	899	12206
18-#10	2.27	MA	10953	2890	14406	2595	17800	2183	19629	1849	21449	1313	26580	687	20244
9L-2S		MI	7161	2890	10721	2409	12930	2004	14364	1675	16322	1149	20380	991	12218
18-#11	2.79	MA	12711	3042	17951	2642	22176	2206	24908	1838	28504	1250	36165	822	27332
5L-6S		MI	6707	3042	10026	2540	11940	2106	13075	1754	14515	1173	17826	624	14011
18-#11	2.79	MA	12335	3042	17181	2660	21354	2220	23877	1862	27071	1263	34233	742	26562
6L-5S		MI	6900	3042	10393	2521	12363	2096	13618	1737	15251	1161	18780	698	14273
18-#11	2.79	MA	12013	3042	16525	2671	20446	2238	22864	1875	25682	1285	32359	701	25822
7L-4S		MI	7062	3042	10720	2509	12810	2086	14173	1729	16019	1148	19821	764	14592
18-#11	2.79	MA	11668	3042	15896	2684	19603	2250	21799	1893	24296	1297	30539	647	24796
8L-3S		MI	7203	3042	11086	2497	13317	2068	14794	1713	16868	1144	20864	828	14647
18-#11	2.79	MA	11280	3042	15272	2697	18785	2262	20766	1904	22931	1319	28759	592	23686
9L-2S		MI	7468	3042	11612	2485	13984	2058	15602	1705	17959	1131	22342	941	14672
18-#14	4.02	MA	13541	3402	19921	2906	24780	2408	27952	1991	32498	1269	41874	582	36839
6L-5S		MI	7505	3402	11930	2746	14227	2263	15843	1842	18217	1144	22619	516	19585
18-#14	4.02	MA	13118	3402	18981	2922	23479	2433	26512	2011	30506	1299	39176	521	35043
7L-4S		MI	7727	3402	12396	2730	14865	2250	16633	1832	19313	1127	24074	611	20165
18-#14	4.02	MA	12634	3402	18079	2940	22270	2449	24986	2037	28517	1316	36560	441	33219
8L-3S		MI	7907	3402	12919	2713	15587	2224	17518	1809	20522	1123	25538	702	20544
18-#14	4.02	MA	12109	3402	17191	2959	21096	2467	23504	2052	26559	1346	33996	362	31445
9L-2S		MI	8254	3402	13665	2697	16534	2211	18665	1799	22071	1106	27605	865	20621
18-#18	7.14	MA	15864	4315	25055	3558	31009	2929	35567	2353	42493	1329	56075	55	55738
7L-4S		MI	9337	4315	16454	3292	19865	2667	22634	2092	27358	1073	34050	174	32992
20-#10	2.52	MA	12269	2964	16828	2610	20989	2181	23501	1835	26621	1263	33586	811	24669
6E		MI	6703	2964	9838	2501	11792	2081	12943	1740	14362	1178	17753	715	13077
20-#10	2.52	MA	12003	2964	16289	2620	20243	2197	22659	1845	25482	1281	32058	778	24199
7L-5S		MI	6865	2964	10148	2486	12142	2072	13392	1725	14983	1173	18616	786	13314
20-#10	2.52	MA	11714	2964	15773	2631	19551	2206	21786	1860	24345	1292	30568	735	23462
8L-4S		MI	7005	2964	10418	2476	12511	2063	13850	1718	15619	1162	19499	840	13464
20-#10	2.52	MA	11395	2964	15256	2641	18880	2217	20938	1870	23216	1309	29026	682	22751
9L-3S		MI	7123	2964	10721	2465	12930	2047	14364	1703	16322	1157	20380	894	13499
20-#10	2.52	MA	11091	2964	14728	2649	18179	2235	20108	1880	22062	1324	27532	645	21850
10L-2S		MI	7348	2964	11157	2455	13485	2038	15036	1696	17228	1145	21635	986	13515
20-#11	3.10	MA	12834	3132	18215	2716	22667	2261	25467	1888	29218	1259	37206	736	29611
6E		MI	6943	3132	10551	2596	12607	2147	13883	1780	15606	1169	19304	615	15529
20-#11	3.10	MA	12525	3132	17559	2728	21759	2279	24454	1901	27829	1280	35333	695	28861
7L-5S		MI	7131	3132	10919	2577	13030	2138	14427	1764	16342	1156	20259	688	15781
20-#11	3.10	MA	12183	3132	16930	2741	20916	2291	23390	1919	26443	1293	33512	641	27822
8L-4S		MI	7292	3132	11245	2566	13477	2128	14981	1756	17110	1144	21299	754	16135
20-#11	3.10	MA	11807	3132	16306	2753	20097	2303	22356	1930	25078	1315	31732	586	26719
9L-3S		MI	7427	3132	11612	2554	13984	2109	15602	1739	17959	1139	22342	819	16198
20-#11	3.10	MA	11460	3132	15663	2764	19244	2325	21345	1942	23679	1333	29796	527	25648
10L-2S		MI	7686	3132	12137	2542	14651	2099	16410	1731	19050	1127	23821	932	16230
20-#14	4.46	MA	13829	3532	20461	3003	25357	2493	28788	2049	33579	1292	43431	513	39355
7L-5S		MI	7824	3532	12676	2827	15174	2323	16990	1880	19767	1138	24686	498	21736
20-#14	4.46	MA	13351	3532	19559	3022	24149	2509	27263	2074	31591	1310	40815	432	37548
8L-4S		MI	8045	3532	13143	2811	15812	2310	17781	1870	20862	1121	26141	594	22292
20-#14	4.46	MA	12848	3532	18671	3040	22974	2526	25781	2089	29632	1340	38251	353	35762
9L-3S		MI	8215	3532	13665	2795	16534	2284	18665	1847	22071	1117	27605	684	22739
22-#10	2.77	MA	12426	3038	17140	2666	21323	2230	23968	1866	27249	1277	34504	773	26716
7L-6S		MI	6901	3038	10275	2547	12347	2114	13615	1761	15268	1174	19008	710	14340
22-#10	2.77	MA	12140	3038	16624	2677	20631	2240	23095	1882	26112	1288	33014	730	25968
8L-5S		MI	7060	3038	10585	2532	12696	2105	14064	1747	15890	1170	19871	781	14569

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



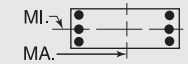
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	2.77	MA	11829	3038	16107	2687	19959	2250	22246	1891	24982	1306	31473	677	25258
9L-4S		MI	7199	3038	10854	2522	13065	2096	14522	1739	16525	1158	20754	835	14750
22-#10	2.77	MA	11543	3038	15579	2695	19259	2269	21417	1901	23829	1321	29978	640	24351
10L-3S		MI	7313	3038	11157	2511	13485	2080	15036	1725	17228	1154	21635	889	14790
22-#10	2.77	MA	11254	3038	14985	2712	18579	2278	20575	1919	22665	1329	28529	595	23484
11L-2S		MI	7533	3038	11594	2501	14039	2071	15708	1717	18135	1142	22889	981	14811
22-#11	3.40	MA	13027	3223	18593	2784	23071	2321	26045	1927	29977	1276	38306	689	31900
7L-6S		MI	7176	3223	11077	2653	13273	2189	14691	1806	16697	1165	20783	605	17050
22-#11	3.40	MA	12689	3223	17964	2797	22228	2332	24981	1945	28590	1289	36485	635	30865
8L-5S		MI	7359	3223	11444	2634	13696	2179	15235	1790	17433	1152	21737	679	17292
22-#11	3.40	MA	12325	3223	17340	2810	21410	2345	23947	1956	27225	1310	34705	580	29753
9L-4S		MI	7520	3223	11771	2622	14144	2169	15789	1782	18201	1139	22778	745	17678
22-#11	3.40	MA	11990	3223	16697	2820	20556	2367	22936	1968	25827	1328	32769	521	28674
10L-3S		MI	7650	3223	12137	2610	14651	2150	16410	1765	19050	1135	23821	809	17748
22-#11	3.40	MA	11659	3223	15973	2840	19736	2378	21910	1989	24408	1338	30997	464	27429
11L-2S		MI	7903	3223	12662	2598	15317	2140	17218	1757	20141	1122	25299	923	17786
22-#14	4.91	MA	14054	3663	21039	3103	26027	2569	29539	2112	34664	1304	45070	424	41876
8L-5S		MI	8138	3663	13423	2909	16121	2382	18138	1917	21316	1132	26753	481	23892
22-#14	4.91	MA	13570	3663	20151	3122	24853	2586	28057	2127	32705	1334	42506	345	40078
9L-4S		MI	8383	3663	13889	2893	16759	2369	18929	1907	22412	1115	28209	577	24425
24-#10	3.02	MA	12558	3111	17475	2723	21711	2273	24403	1903	27879	1285	35460	726	28474
8L-6S		MI	7097	3111	10712	2593	12901	2148	14287	1782	16175	1171	20262	705	15606
24-#10	3.02	MA	12255	3111	16958	2733	21039	2284	23555	1912	26749	1302	33919	672	27765
9L-5S		MI	7252	3111	11022	2578	13250	2139	14736	1768	16797	1166	21125	776	15827
24-#10	3.02	MA	11978	3111	16430	2741	20339	2302	22726	1923	25596	1317	32425	635	26851
10L-4S		MI	7391	3111	11291	2568	13619	2130	15194	1760	17432	1155	22008	830	16036
24-#10	3.02	MA	11695	3111	15835	2758	19659	2312	21884	1940	24432	1326	30975	590	25979
11L-3S		MI	7501	3111	11594	2557	14039	2114	15708	1746	18135	1150	22889	884	16080
24-#10	3.02	MA	11374	3111	15324	2769	18979	2321	21069	1951	23296	1342	29506	553	25071
12L-2S		MI	7717	3111	12031	2547	14593	2105	16379	1738	19042	1138	24144	976	16106
24-#11	3.71	MA	13186	3313	18998	2854	23541	2373	26572	1972	30738	1284	39458	629	33908
8L-6S		MI	7406	3313	11602	2709	13940	2230	15500	1832	17788	1161	22261	596	18573
24-#11	3.71	MA	12832	3313	18375	2867	22722	2386	25538	1982	29373	1306	37678	575	32787
9L-5S		MI	7585	3313	11970	2691	14363	2220	16043	1816	18524	1148	23215	669	18807
24-#11	3.71	MA	12509	3313	17731	2877	21869	2408	24527	1994	27974	1324	35742	515	31700
10L-4S		MI	7745	3313	12296	2679	14810	2210	16597	1808	19292	1135	24256	735	19221
24-#11	3.71	MA	12182	3313	17007	2897	21048	2420	23501	2015	26555	1334	33970	458	30459
11L-3S		MI	7870	3313	12662	2667	15317	2192	17218	1791	20141	1131	25299	800	19297
24-#14	5.36	MA	14277	3793	21631	3203	26731	2646	30334	2165	35779	1328	46761	336	44395
9L-5S		MI	8469	3793	14169	2990	17068	2442	19286	1955	22866	1125	28821	464	26053

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

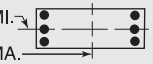


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.52	MA	13033	2798	17722	2458	21838	2061	24282	1746	27171	1261	33590	1095	16752
2E		MI	6755	2798	9983	2319	11710	1943	12697	1643	13819	1179	16243	967	8458
6-#14	1.28	MA	12691	2725	16775	2427	20764	2041	23047	1736	25562	1273	31406	1108	14334
2L-3S		MI	6210	2725	8771	2318	10286	1946	11027	1653	11611	1216	13562	853	7350
6-#14	1.28	MA	11751	2725	15213	2452	18782	2064	20645	1758	22320	1304	26917	966	14285
3L-2S		MI	6638	2725	9518	2302	11233	1933	12175	1643	13161	1199	15630	1017	7323
6-#18	2.27	MA	14297	3030	20458	2603	25309	2167	28489	1813	32850	1250	41454	1080	24880
2L-3S		MI	6613	3030	9983	2490	11710	2068	12697	1724	13819	1192	16243	633	12264
6-#18	2.27	MA	12790	3030	17722	2645	21838	2206	24282	1849	27171	1302	33590	822	24568
3L-2S		MI	7297	3030	11268	2464	13342	2049	14675	1710	16489	1168	19692	924	12319
8-#11	1.18	MA	12549	2696	16370	2416	20316	2033	22537	1733	24905	1279	30518	1113	13339
2L-4S		MI	6112	2696	8420	2321	9856	1960	10528	1669	10952	1225	12860	860	6880
8-#11	1.18	MA	11889	2696	15279	2434	18932	2050	20860	1748	22640	1301	27382	1017	13319
3E		MI	6287	2696	8787	2309	10363	1941	11149	1652	11801	1221	13903	924	6869
8-#11	1.18	MA	11526	2696	14542	2451	17907	2075	19602	1772	20917	1314	25322	956	13221
4L-2S		MI	6590	2696	9312	2297	11030	1931	11957	1644	12892	1208	15381	1037	6849
8-#14	1.70	MA	13439	2856	18336	2509	22746	2100	25449	1774	28804	1267	35896	1099	18980
2L-4S		MI	6315	2856	8995	2415	10510	2032	11290	1713	11952	1214	14166	746	9525
8-#14	1.70	MA	12542	2856	16775	2533	20764	2123	23047	1795	25562	1298	31406	958	18900
3E		MI	6553	2856	9518	2399	11233	2006	12175	1690	13161	1209	15630	836	9577
8-#14	1.70	MA	12051	2856	15717	2558	19294	2159	21243	1829	23092	1316	28441	869	18589
4L-2S		MI	6965	2856	10264	2383	12180	1993	13323	1680	14710	1193	17697	999	9569
8-#18	3.03	MA	15512	3261	23193	2748	28781	2273	32697	1880	38530	1239	49317	1064	32993
2L-4S		MI	6802	3261	10362	2660	12089	2216	13141	1826	14394	1183	17233	438	14891
8-#18	3.03	MA	14105	3261	20458	2789	25309	2312	28489	1916	32850	1291	41454	807	32633
3E		MI	7178	3261	11268	2635	13342	2174	14675	1791	16489	1181	19692	590	16032
8-#18	3.03	MA	13343	3261	18598	2831	22726	2373	25321	1974	28512	1321	36209	647	30238
4L-2S		MI	7825	3261	12554	2609	14974	2155	16653	1777	19158	1157	23140	881	16145
10-#10	1.20	MA	12631	2702	16377	2431	20416	2045	22704	1743	25172	1285	30920	1118	13654
2L-5S		MI	6104	2702	8288	2351	9748	1984	10429	1690	10838	1247	12777	861	7023
10-#10	1.20	MA	12089	2702	15480	2445	19278	2059	21325	1756	23310	1303	28341	1041	13637
3L-4S		MI	6250	2702	8557	2341	10118	1975	10887	1682	11473	1235	13659	914	7038
10-#10	1.20	MA	11797	2702	14875	2460	18436	2080	20293	1776	21896	1315	26658	992	13574
4L-3S		MI	6393	2702	8860	2330	10537	1960	11401	1668	12176	1231	14541	968	7031
10-#10	1.20	MA	11424	2702	14323	2472	17703	2093	19381	1788	20628	1333	24837	946	13411
5L-2S		MI	6645	2702	9297	2320	11092	1951	12073	1660	13083	1219	15795	1060	7018
10-#11	1.48	MA	13081	2786	17461	2473	21701	2075	24215	1759	27169	1275	33654	1107	16585
2L-5S		MI	6194	2786	8619	2389	10076	2011	10782	1703	11275	1234	13297	784	8380
10-#11	1.48	MA	12442	2786	16370	2490	20316	2091	22537	1775	24905	1297	30518	1011	16551
3L-4S		MI	6362	2786	8946	2377	10523	2001	11336	1695	12043	1221	14338	850	8438
10-#11	1.48	MA	12099	2786	15633	2508	19291	2116	21280	1798	23182	1310	28458	950	16437
4L-3S		MI	6529	2786	9312	2365	11030	1983	11957	1678	12892	1217	15381	915	8444
10-#11	1.48	MA	11656	2786	14965	2523	18397	2132	20168	1814	21636	1332	26234	892	16150
5L-2S		MI	6824	2786	9838	2353	11697	1973	12766	1670	13983	1204	16859	1028	8432
10-#14	2.13	MA	14166	2986	19898	2590	24728	2160	27851	1811	32047	1261	40385	1090	23618
2L-5S		MI	6433	2986	9275	2513	10820	2104	11648	1761	12406	1224	14778	633	11149
10-#14	2.13	MA	13308	2986	18336	2615	22746	2183	25449	1833	28804	1292	35896	949	23516
3L-4S		MI	6663	2986	9742	2497	11458	2091	12438	1751	13501	1207	16233	728	11710
10-#14	2.13	MA	12852	2986	17279	2639	21276	2218	23645	1867	26334	1310	32931	860	23193
4L-3S		MI	6887	2986	10264	2481	12180	2066	13323	1728	14710	1203	17697	819	11788
10-#14	2.13	MA	12231	2986	16326	2662	19993	2241	22051	1888	24117	1341	29902	792	21859
5L-2S		MI	7285	2986	11010	2465	13127	2052	14471	1718	16260	1186	19764	982	11802
10-#18	3.79	MA	15369	3493	23193	2934	28781	2418	32697	1983	38530	1280	49317	792	40708
3L-4S		MI	7380	3493	11648	2805	13721	2322	15119	1893	17064	1172	20681	395	18493
10-#18	3.79	MA	14689	3493	21334	2976	26197	2479	29528	2041	34191	1310	44073	632	38248
4L-3S		MI	7751	3493	12554	2780	14974	2280	16653	1857	19158	1170	23140	547	19794
10-#18	3.79	MA	13641	3493	19681	3017	23940	2517	26724	2076	30293	1362	38732	503	35158
5L-2S		MI	8334	3493	13840	2754	16606	2261	18631	1844	21828	1146	26589	837	19952

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

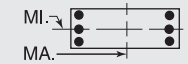
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	1.44	MA	13072	2776	17274	2477	21554	2079	24084	1764	27034	1281	33498	1113	16323
2L-6S		MI	6136	2776	8415	2412	9954	2027	10652	1725	11123	1248	13168	784	8116
12-#10	1.44	MA	12545	2776	16377	2491	20416	2093	22704	1777	25172	1300	30920	1036	16297
3L-5S		MI	6314	2776	8725	2397	10303	2018	11101	1711	11745	1244	14031	856	8309
12-#10	1.44	MA	12266	2776	15772	2506	19575	2113	21672	1797	23758	1311	29237	987	16224
4E		MI	6459	2776	8994	2387	10672	2009	11559	1703	12380	1232	14914	909	8336
12-#10	1.44	MA	11897	2776	15220	2518	18842	2127	20761	1810	22490	1330	27416	941	16055
5L-3S		MI	6596	2776	9297	2376	11092	1993	12073	1689	13083	1227	15795	963	8339
12-#10	1.44	MA	11524	2776	14552	2533	18120	2138	19871	1830	21253	1341	25848	889	15506
6L-2S		MI	6843	2776	9734	2366	11646	1984	12745	1681	13990	1216	17050	1055	8331
12-#11	1.77	MA	13601	2876	18552	2529	23085	2116	25893	1785	29434	1270	36789	1101	19828
2L-6S		MI	6231	2876	8777	2464	10319	2062	11047	1746	11630	1242	13821	701	9557
12-#11	1.77	MA	12983	2876	17461	2547	21701	2132	24215	1801	27169	1292	33654	1005	19781
3L-5S		MI	6441	2876	9145	2445	10742	2053	11590	1729	12366	1229	14776	775	9861
12-#11	1.77	MA	12658	2876	16724	2564	20675	2157	22957	1825	25446	1306	31593	944	19655
4E		MI	6607	2876	9471	2434	11189	2043	12145	1721	13134	1217	15816	841	9991
12-#11	1.77	MA	12219	2876	16056	2579	19781	2174	21846	1840	23901	1328	29370	886	19344
5L-3S		MI	6768	2876	9838	2422	11697	2024	12766	1704	13983	1212	16859	905	10011
12-#11	1.77	MA	11776	2876	15243	2597	18911	2187	20760	1864	22392	1341	27453	819	18435
6L-2S		MI	7055	2876	10363	2410	12363	2014	13574	1696	15074	1200	18338	1019	10007
12-#14	2.56	MA	14052	3116	19898	2696	24728	2242	27851	1870	32047	1285	40385	940	28132
3L-5S		MI	6775	3116	10022	2595	11767	2164	12796	1799	13956	1218	16845	616	13267
12-#14	2.56	MA	13628	3116	18840	2721	23258	2278	26047	1904	29577	1304	37420	852	27801
4E		MI	7002	3116	10488	2578	12405	2151	13586	1788	15051	1201	18301	711	13893
12-#14	2.56	MA	13015	3116	17888	2743	21975	2301	24453	1926	27359	1335	34391	783	26453
5L-3S		MI	7215	3116	11010	2562	13127	2125	14471	1766	16260	1197	19764	802	13993
12-#14	2.56	MA	12411	3116	16724	2768	20735	2321	22895	1960	25196	1353	31474	668	25174
6L-2S		MI	7599	3116	11757	2546	14074	2112	15619	1755	17810	1180	21832	965	14024
12-#18	4.55	MA	15984	3725	24069	3121	29669	2585	33736	2108	39871	1299	51937	617	46259
4E		MI	7983	3725	12933	2950	15353	2428	17097	1960	19734	1161	24130	351	22121
12-#18	4.55	MA	14952	3725	22416	3162	27412	2623	30932	2143	35972	1351	46595	488	43190
5L-3S		MI	8282	3725	13840	2924	16606	2386	18631	1924	21828	1159	26589	503	23557
12-#18	4.55	MA	13993	3725	20374	3205	25264	2660	28189	2201	32166	1380	41451	277	39204
6L-2S		MI	8831	3725	15126	2899	18238	2367	20608	1911	24498	1135	30037	794	23751
14-#10	1.68	MA	12991	2849	17274	2537	21554	2126	24084	1798	27034	1296	33498	1031	18956
3L-6S		MI	6346	2849	8851	2458	10508	2061	11324	1747	12030	1245	14423	779	9366
14-#10	1.68	MA	12725	2849	16669	2552	20713	2147	23052	1818	25620	1308	31815	982	18875
4L-5S		MI	6521	2849	9161	2443	10857	2052	11773	1732	12652	1240	15286	851	9592
14-#10	1.68	MA	12359	2849	16117	2564	19980	2161	22141	1831	24352	1326	29995	936	18702
5L-4S		MI	6664	2849	9431	2433	11226	2043	12231	1725	13287	1228	16168	904	9629
14-#10	1.68	MA	11997	2849	15449	2579	19259	2171	21251	1851	23116	1338	28426	884	18140
6L-3S		MI	6797	2849	9734	2422	11646	2027	12745	1710	13990	1224	17050	958	9641
14-#10	1.68	MA	11683	2849	14882	2589	18473	2187	20359	1861	21917	1356	26824	851	17594
7L-2S		MI	7038	2849	10171	2412	12200	2018	13417	1703	14897	1212	18304	1050	9638
14-#11	2.07	MA	13511	2967	18552	2603	23085	2174	25893	1827	29434	1288	36789	999	23011
3L-6S		MI	6479	2967	9303	2521	10986	2104	11855	1772	12721	1238	15300	692	11062
14-#11	2.07	MA	13203	2967	17814	2621	22060	2199	24635	1851	27711	1301	34729	938	22874
4L-5S		MI	6684	2967	9670	2502	11409	2094	12399	1755	13457	1225	16254	766	11351
14-#11	2.07	MA	12769	2967	17146	2636	21166	2215	23524	1866	26165	1323	32505	880	22530
5L-4S		MI	6848	2967	9997	2490	11856	2084	12953	1747	14225	1212	17295	832	11540
14-#11	2.07	MA	12341	2967	16334	2654	20295	2229	22438	1890	24657	1337	30589	813	21645
6L-3S		MI	7002	2967	10363	2478	12363	2065	13574	1731	15074	1208	18338	896	11570
14-#11	2.07	MA	11971	2967	15643	2665	19338	2247	21363	1903	23195	1359	28624	773	20942
7L-2S		MI	7282	2967	10888	2466	13030	2055	14382	1723	16165	1195	19816	1009	11577

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.98	MA	14384	3247	20402	2802	25240	2337	28449	1942	32819	1298	41910	843	32414
4L-5S		MI	7110	3247	10768	2676	12714	2224	13943	1836	15505	1212	18913	598	15396
14-#14	2.98	MA	13777	3247	19450	2825	23957	2360	26855	1963	30602	1328	38881	775	31051
5L-4S		MI	7335	3247	11234	2660	13352	2210	14734	1826	16601	1195	20368	694	16048
14-#14	2.98	MA	13200	3247	18286	2850	22717	2380	25297	1997	28438	1347	35963	660	29776
6L-3S		MI	7537	3247	11757	2644	14074	2185	15619	1803	17810	1191	21832	784	16193
14-#14	2.98	MA	12699	3247	17295	2866	21345	2407	23768	2017	26340	1378	33133	600	27955
7L-2S		MI	7909	3247	12503	2628	15021	2172	16766	1793	19359	1174	23899	948	16239
14-#18	5.30	MA	16219	3957	25151	3307	30883	2729	35139	2210	41651	1340	54459	473	51221
5L-4S		MI	8532	3957	14219	3095	16985	2534	19075	2027	22404	1150	27578	308	25771
14-#18	5.30	MA	15320	3957	23109	3350	28735	2766	32397	2268	37845	1369	49315	262	47198
6L-3S		MI	8801	3957	15126	3069	18238	2492	20608	1991	24498	1148	30037	460	27320
14-#18	5.30	MA	14535	3957	21369	3378	26327	2811	29753	2304	34154	1421	44297	153	43292
7L-2S		MI	9319	3957	16412	3044	19870	2473	22586	1978	27168	1124	33485	751	27544
16-#10	1.92	MA	13175	2923	17566	2598	21851	2181	24431	1839	27483	1304	34394	977	21526
4L-6S		MI	6554	2923	9288	2504	11062	2094	11996	1768	12937	1241	15677	774	10621
16-#10	1.92	MA	12812	2923	17014	2610	21118	2194	23520	1852	26215	1323	32573	931	21350
5E		MI	6724	2923	9598	2489	11411	2085	12445	1753	13558	1237	16540	846	10875
16-#10	1.92	MA	12460	2923	16346	2625	20397	2205	22630	1872	24978	1334	31005	879	20777
6L-4S		MI	6866	2923	9868	2479	11781	2076	12903	1746	14194	1225	17423	899	10919
16-#10	1.92	MA	12158	2923	15779	2635	19611	2221	21739	1882	23780	1353	29402	846	20245
7L-3S		MI	6994	2923	10171	2468	12200	2060	13417	1731	14897	1220	18304	953	10938
16-#10	1.92	MA	11843	2923	15236	2646	18883	2230	20819	1898	22584	1364	27837	804	19537
8L-2S		MI	7230	2923	10607	2458	12754	2051	14088	1724	15803	1209	19559	1045	10943
16-#11	2.36	MA	13738	3057	18905	2677	23444	2240	26313	1877	29976	1297	37865	932	26096
4L-6S		MI	6722	3057	9828	2577	11653	2145	12663	1798	13812	1233	16778	682	12571
16-#11	2.36	MA	13307	3057	18237	2692	22550	2256	25201	1892	28430	1319	35641	874	25720
5E		MI	6922	3057	10195	2559	12076	2135	13207	1781	14548	1221	17732	756	12847
16-#11	2.36	MA	12893	3057	17425	2710	21679	2270	24116	1916	26922	1332	33725	807	24858
6L-4S		MI	7085	3057	10522	2547	12523	2125	13761	1773	15316	1208	18773	822	13086
16-#11	2.36	MA	12538	3057	16734	2722	20722	2288	23041	1929	25460	1354	31760	767	24148
7L-3S		MI	7233	3057	10888	2535	13030	2107	14382	1757	16165	1204	19816	886	13127
16-#11	2.36	MA	12164	3057	16072	2735	19835	2300	21920	1948	24001	1368	29846	713	23040
8L-2S		MI	7507	3057	11414	2523	13697	2097	15190	1749	17256	1191	21294	1000	13142
16-#14	3.41	MA	14521	3377	21011	2906	25939	2420	29257	2001	33844	1322	43370	766	35654
5E		MI	7439	3377	11514	2758	13661	2283	15091	1874	17055	1206	20980	581	17533
16-#14	3.41	MA	13967	3377	19847	2931	24699	2440	27699	2035	31680	1341	40453	651	34377
6L-4S		MI	7662	3377	11981	2742	14299	2270	15882	1864	18150	1189	22435	677	18153
16-#14	3.41	MA	13492	3377	18857	2948	23327	2466	26170	2054	29583	1371	37622	592	32539
7L-3S		MI	7854	3377	12503	2725	15021	2244	16766	1841	19359	1184	23899	767	18391
16-#14	3.41	MA	12968	3377	17907	2967	22054	2482	24563	2080	27489	1390	34872	513	30713
8L-2S		MI	8215	3377	13249	2709	15969	2231	17914	1831	20909	1168	25966	931	18450
16-#18	6.06	MA	16606	4189	25845	3495	32207	2872	36604	2335	43524	1358	57179	246	55192
6L-4S		MI	9068	4189	15505	3240	18617	2640	21053	2094	25073	1139	31027	265	29438
16-#18	6.06	MA	15879	4189	24105	3523	29799	2917	33960	2371	39834	1410	52161	138	51256
7L-3S		MI	9311	4189	16412	3214	19870	2598	22586	2058	27168	1137	33485	417	31085
18-#10	2.16	MA	13257	2996	17911	2656	22257	2228	24900	1874	28077	1319	35152	927	24001
5L-6S		MI	6758	2996	9725	2550	11616	2128	12667	1789	13843	1238	16932	769	11878
18-#10	2.16	MA	12915	2996	17243	2671	21535	2239	24010	1893	26840	1331	33584	874	23416
6L-5S		MI	6924	2996	10035	2535	11965	2119	13116	1775	14465	1233	17795	841	12129
18-#10	2.16	MA	12623	2996	16676	2681	20750	2254	23119	1904	25642	1349	31981	841	22898
7L-4S		MI	7066	2996	10304	2525	12335	2110	13574	1767	15100	1221	18677	894	12208
18-#10	2.16	MA	12311	2996	16133	2692	20021	2264	22199	1919	24446	1361	30416	799	22178
8L-3S		MI	7189	2996	10607	2514	12754	2094	14088	1753	15803	1217	19559	948	12234
18-#10	2.16	MA	11963	2996	15586	2702	19315	2275	21306	1929	23248	1378	28799	746	21419
9L-2S		MI	7421	2996	11044	2504	13309	2085	14760	1745	16710	1205	20813	1040	12243
18-#11	2.66	MA	13835	3148	19328	2749	23934	2298	26879	1918	30695	1315	38777	868	28915
5L-6S		MI	6962	3148	10354	2634	12320	2186	13472	1824	14902	1229	18256	673	14085

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

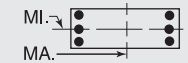
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.66	MA	13434	3148	18515	2767	23063	2311	25793	1942	29186	1328	36861	801	28074
6L-5S		MI	7157	3148	10721	2615	12743	2177	14015	1807	15639	1216	19211	747	14349
18-#11	2.66	MA	13092	3148	17825	2778	22107	2330	24719	1955	27725	1350	34895	761	27353
7L-4S		MI	7319	3148	11047	2603	13190	2167	14569	1799	16407	1204	20251	813	14632
18-#11	2.66	MA	12723	3148	17162	2792	21219	2341	23598	1974	26266	1363	32982	707	26250
8L-3S		MI	7461	3148	11414	2591	13697	2148	15190	1783	17256	1199	21294	877	14681
18-#11	2.66	MA	12310	3148	16502	2804	20357	2354	22510	1985	24823	1385	31000	642	25142
9L-2S		MI	7729	3148	11939	2580	14364	2138	15998	1775	18347	1187	22773	990	14703
18-#14	3.84	MA	14717	3508	21409	3013	26681	2500	30101	2073	34923	1334	44942	643	38978
6L-5S		MI	7763	3508	12261	2839	14608	2343	16239	1912	18604	1199	23047	564	19677
18-#14	3.84	MA	14266	3508	20418	3029	25309	2526	28572	2092	32825	1365	42111	583	37122
7L-4S		MI	7985	3508	12727	2823	15246	2330	17030	1901	19700	1183	24503	660	20269
18-#14	3.84	MA	13749	3508	19468	3048	24036	2542	26965	2118	30732	1384	39361	504	35281
8L-3S		MI	8167	3508	13249	2807	15969	2304	17914	1879	20909	1178	25966	750	20587
18-#14	3.84	MA	13190	3508	18527	3066	22800	2560	25404	2134	28670	1414	36672	426	33488
9L-2S		MI	8518	3508	13996	2791	16916	2291	19062	1868	22458	1161	28033	914	20658
18-#18	6.82	MA	17183	4421	26840	3668	33270	3023	38168	2438	45513	1399	60024	123	59220
7L-4S		MI	9595	4421	16791	3385	20249	2746	23031	2161	27743	1128	34475	221	33121
20-#10	2.41	MA	13362	3070	18140	2717	22673	2272	25389	1915	28703	1327	36162	869	26057
6E		MI	6959	3070	10162	2596	12171	2162	13339	1810	14750	1234	18186	764	13139
20-#10	2.41	MA	13079	3070	17573	2727	21888	2288	24498	1925	27504	1346	34559	836	25550
7L-5S		MI	7122	3070	10471	2581	12520	2153	13788	1796	15372	1230	19049	836	13379
20-#10	2.41	MA	12771	3070	17030	2738	21160	2298	23578	1941	26308	1357	32994	795	24820
8L-4S		MI	7263	3070	10741	2571	12889	2144	14246	1788	16007	1218	19932	889	13496
20-#10	2.41	MA	12432	3070	16483	2748	20453	2309	22686	1950	25111	1374	31377	742	24062
9L-3S		MI	7382	3070	11044	2560	13309	2128	14760	1774	16710	1213	20813	943	13527
20-#10	2.41	MA	12109	3070	15927	2757	19716	2327	21813	1961	23897	1389	29808	706	23160
10L-2S		MI	7609	3070	11481	2550	13863	2119	15432	1766	17617	1202	22068	1035	13541
20-#11	2.95	MA	13965	3238	19606	2823	24448	2353	27471	1968	31451	1324	39996	795	31292
6E		MI	7199	3238	10879	2691	12987	2228	14280	1850	15993	1225	19735	663	15602
20-#11	2.95	MA	13636	3238	18915	2835	23491	2371	26397	1981	29989	1346	38031	755	30559
7L-5S		MI	7389	3238	11246	2672	13410	2218	14823	1833	16730	1212	20689	737	15856
20-#11	2.95	MA	13270	3238	18253	2848	22603	2383	25276	2000	28530	1359	36118	701	29460
8L-4S		MI	7550	3238	11573	2660	13857	2208	15377	1825	17498	1199	21730	803	16176
20-#11	2.95	MA	12871	3238	17592	2861	21741	2396	24187	2011	27088	1380	34135	636	28342
9L-3S		MI	7687	3238	11939	2648	14364	2189	15998	1809	18347	1195	22773	867	16233
20-#11	2.95	MA	12502	3238	16915	2871	20843	2418	23123	2023	25608	1398	32216	589	27224
10L-2S		MI	7948	3238	12465	2636	15031	2179	16807	1801	19438	1182	24251	981	16261
20-#14	4.26	MA	15022	3638	21980	3111	27291	2585	30974	2130	36068	1359	46601	575	41706
7L-5S		MI	8082	3638	13007	2921	15555	2402	17387	1949	20154	1193	25115	547	21826
20-#14	4.26	MA	14511	3638	21030	3130	26018	2602	29367	2156	33974	1377	43851	496	39849
8L-4S		MI	8303	3638	13473	2905	16193	2389	18178	1939	21249	1176	26570	643	22393
20-#14	4.26	MA	13975	3638	20089	3148	24782	2620	27806	2172	31913	1408	41161	418	38043
9L-3S		MI	8476	3638	13996	2888	16916	2364	19062	1916	22458	1172	28033	733	22782
22-#10	2.65	MA	13528	3144	18470	2773	23026	2321	25878	1946	29367	1342	37138	832	28201
7L-6S		MI	7158	3144	10598	2642	12725	2195	14011	1832	15657	1231	19441	759	14402
22-#10	2.65	MA	13223	3144	17927	2784	22298	2331	24958	1962	28171	1354	35573	790	27461
8L-5S		MI	7317	3144	10908	2627	13074	2186	14460	1817	16279	1226	20304	831	14634
22-#10	2.65	MA	12892	3144	17380	2794	21591	2342	24065	1972	26973	1371	33956	737	26705
9L-4S		MI	7457	3144	11178	2617	13443	2177	14918	1810	16914	1214	21186	884	14783
22-#10	2.65	MA	12581	3144	16824	2803	20854	2361	23192	1982	25759	1386	32386	701	25796
10L-3S		MI	7573	3144	11481	2606	13863	2161	15432	1795	17617	1210	22068	938	14819
22-#10	2.65	MA	12280	3144	16198	2820	20133	2370	22307	2000	24534	1395	30863	656	24934
11L-2S		MI	7795	3144	11917	2596	14417	2152	16104	1788	18524	1198	23322	1030	14838

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

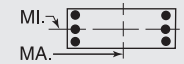


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.25	MA	14170	3329	20006	2891	24875	2412	28074	2007	32254	1341	41167	749	33765
7L-6S		MI	7432	3329	11404	2747	13653	2269	15088	1876	17084	1221	21213	654	17122
22-#11	3.25	MA	13808	3329	19344	2905	23987	2424	26953	2026	30795	1355	39253	695	32670
8L-5S		MI	7618	3329	11772	2728	14077	2259	15631	1860	17821	1208	22167	728	17366
22-#11	3.25	MA	13420	3329	18683	2917	23125	2437	25865	2037	29353	1376	37271	630	31542
9L-4S		MI	7778	3329	12098	2716	14524	2249	16186	1852	18589	1195	23208	794	17720
22-#11	3.25	MA	13064	3329	18006	2928	22227	2459	24800	2050	27873	1394	35352	584	30427
10L-3S		MI	7910	3329	12465	2704	15031	2231	16807	1835	19438	1191	24251	858	17783
22-#11	3.25	MA	12698	3329	17243	2948	21357	2471	23720	2071	26379	1404	33489	527	29124
11L-2S		MI	8166	3329	12990	2693	15697	2221	17615	1827	20529	1178	25729	971	17818
22-#14	4.69	MA	15257	3769	22592	3211	28000	2661	31769	2193	37216	1371	48340	487	44416
8L-5S		MI	8397	3769	13753	3002	16503	2462	18535	1987	21703	1187	27182	530	23981
22-#14	4.69	MA	14742	3769	21651	3229	26763	2679	30208	2209	35155	1402	45651	409	42598
9L-4S		MI	8617	3769	14220	2986	17140	2449	19326	1977	22799	1170	28637	626	24525
24-#10	2.89	MA	13667	3217	18824	2830	23436	2365	26338	1983	30033	1350	38151	785	30103
8L-6S		MI	7355	3217	11035	2688	13279	2229	14683	1853	16564	1227	20695	754	15667
24-#10	2.89	MA	13345	3217	18277	2840	22729	2376	25445	1993	28835	1367	36534	732	29348
9L-5S		MI	7511	3217	11345	2673	13628	2220	15132	1838	17185	1223	21558	826	15891
24-#10	2.89	MA	13051	3217	17721	2849	21993	2394	24572	2003	27621	1382	34965	696	28432
10L-4S		MI	7650	3217	11615	2663	13998	2211	15590	1831	17821	1211	22441	879	16070
24-#10	2.89	MA	12748	3217	17095	2866	21272	2404	23686	2021	26396	1391	33442	652	27564
11L-3S		MI	7762	3217	11917	2652	14417	2195	16104	1816	18524	1206	23322	933	16110
24-#10	2.89	MA	12407	3217	16556	2876	20556	2413	22829	2032	25201	1408	31901	614	26588
12L-2S		MI	7980	3217	12354	2642	14971	2186	16775	1809	19431	1195	24577	1025	16133
24-#11	3.55	MA	14336	3419	20435	2961	25372	2465	28631	2052	33060	1350	42389	689	35880
8L-6S		MI	7663	3419	11930	2804	14320	2310	15896	1902	18175	1216	22691	645	18644
24-#11	3.55	MA	13960	3419	19774	2974	24510	2478	27543	2063	31617	1372	40407	624	34742
9L-5S		MI	7844	3419	12297	2785	14743	2300	16440	1886	18911	1203	23646	718	18880
24-#11	3.55	MA	13616	3419	19096	2984	23611	2501	26478	2076	30138	1390	38487	578	33631
10L-4S		MI	8004	3419	12624	2773	15190	2291	16994	1878	19680	1191	24686	784	19263
24-#11	3.55	MA	13267	3419	18334	3005	22741	2512	25398	2097	28644	1400	36625	521	32320
11L-3S		MI	8131	3419	12990	2761	15697	2272	17615	1861	20529	1187	25729	849	19333
24-#14	5.11	MA	15493	3899	23212	3311	28745	2739	32610	2247	38397	1396	50140	400	47153
9L-5S		MI	8731	3899	14500	3084	17450	2522	19683	2025	23253	1181	29249	513	26139

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

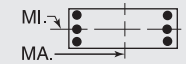
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#18	1.45	MA	14160	2904	19066	2564	23551	2151	26189	1825	29255	1324	36124	1150	17616
2E		MI	7012	2904	10319	2412	12094	2022	13094	1712	14204	1234	16668	1015	8489
6-#14	1.22	MA	13793	2831	18064	2533	22415	2131	24882	1815	27553	1336	33813	1163	15063
2L-3S		MI	6465	2831	9102	2411	10667	2026	11424	1722	11998	1271	13991	902	7378
6-#14	1.22	MA	12797	2831	16421	2558	20330	2154	22355	1837	24141	1368	29089	1023	15014
3L-2S		MI	6895	2831	9849	2395	11614	2013	12572	1712	13548	1254	16058	1065	7348
6-#18	2.17	MA	15504	3136	21947	2709	27206	2257	30620	1892	35235	1313	44404	1135	26176
2L-3S		MI	6868	3136	10319	2582	12094	2147	13094	1792	14204	1247	16668	681	12314
6-#18	2.17	MA	13902	3136	19066	2751	23551	2297	26189	1929	29255	1366	36124	880	25864
3L-2S		MI	7556	3136	11605	2557	13726	2128	15072	1779	16874	1223	20117	972	12355
8-#11	1.13	MA	13641	2802	17637	2522	21941	2124	24343	1812	26857	1342	32873	1168	14013
2L-4S		MI	6366	2802	8748	2415	10236	2040	10925	1739	11340	1281	13290	909	6907
8-#11	1.13	MA	12941	2802	16490	2540	20485	2141	22579	1828	24475	1364	29575	1073	13993
3E		MI	6542	2802	9114	2403	10743	2022	11546	1722	12189	1277	14333	973	6892
8-#11	1.13	MA	12557	2802	15716	2558	19408	2166	21257	1852	22665	1378	27417	1012	13895
4L-2S		MI	6846	2802	9640	2391	11410	2012	12354	1714	13280	1264	15811	1086	6871
8-#14	1.63	MA	14588	2962	19708	2615	24500	2191	27410	1853	30964	1330	38537	1154	19952
2L-4S		MI	6569	2962	9326	2509	10892	2111	11687	1783	12339	1269	14594	794	9569
8-#14	1.63	MA	13635	2962	18064	2640	22415	2214	24882	1875	27553	1361	33813	1014	19872
3E		MI	6808	2962	9849	2493	11614	2086	12572	1760	13548	1265	16058	884	9609
8-#14	1.63	MA	13115	2962	16954	2665	20870	2250	22987	1909	24957	1380	30707	926	19561
4L-2S		MI	7222	2962	10595	2477	12561	2073	13719	1750	15097	1248	18125	1048	9597
8-#18	2.90	MA	16795	3368	24827	2854	30861	2363	35050	1959	41216	1302	52685	1119	34721
2L-4S		MI	7054	3368	10698	2752	12473	2294	13539	1895	14779	1237	17658	486	15044
8-#18	2.90	MA	15298	3368	21947	2896	27206	2403	30620	1996	35235	1355	44404	865	34361
3E		MI	7433	3368	11605	2727	13726	2253	15072	1859	16874	1236	20117	638	16086
8-#18	2.90	MA	14487	3368	19992	2939	24490	2465	27288	2055	30673	1386	38908	706	32024
4L-2S		MI	8086	3368	12891	2702	15358	2234	17050	1846	19544	1212	23565	929	16185
10-#10	1.15	MA	13726	2808	17642	2537	22043	2136	24515	1822	27133	1348	33289	1173	14340
2L-5S		MI	6359	2808	8611	2446	10127	2065	10825	1760	11227	1303	13210	910	7053
10-#10	1.15	MA	13152	2808	16699	2551	20846	2150	23065	1835	25175	1366	30578	1097	14323
3L-4S		MI	6505	2808	8881	2436	10496	2057	11283	1753	11862	1292	14092	963	7062
10-#10	1.15	MA	12842	2808	16064	2566	19963	2171	21981	1855	23690	1378	28815	1048	14260
4L-3S		MI	6648	2808	9184	2425	10916	2041	11797	1738	12565	1287	14974	1017	7052
10-#10	1.15	MA	12446	2808	15481	2578	19193	2184	21024	1868	22359	1397	26906	1003	14097
5L-2S		MI	6902	2808	9620	2415	11470	2032	12469	1731	13472	1275	16228	1110	7038
10-#11	1.41	MA	14206	2892	18784	2579	23397	2165	26108	1838	29239	1338	36172	1163	17428
2L-5S		MI	6449	2892	8947	2483	10456	2092	11179	1773	11662	1289	13728	833	8432
10-#11	1.41	MA	13528	2892	17637	2597	21941	2182	24343	1854	26857	1360	32873	1067	17394
3L-4S		MI	6617	2892	9273	2471	10903	2082	11733	1765	12431	1277	14768	899	8470
10-#11	1.41	MA	13164	2892	16863	2614	20864	2207	23022	1878	25047	1374	30715	1006	17279
4L-3S		MI	6785	2892	9640	2459	11410	2063	12354	1748	13280	1272	15811	964	8470
10-#11	1.41	MA	12692	2892	16158	2629	19926	2224	21855	1894	23424	1396	28382	949	16992
5L-2S		MI	7082	2892	10165	2448	12077	2053	13162	1740	14371	1260	17290	1077	8456
10-#14	2.04	MA	15360	3092	21351	2697	26586	2250	29937	1890	34376	1324	43261	1145	24833
2L-5S		MI	6688	3092	9606	2607	11201	2184	12044	1831	12793	1280	15206	681	11247
10-#14	2.04	MA	14447	3092	19708	2721	24500	2274	27410	1912	30964	1355	38537	1006	24731
3L-4S		MI	6917	3092	10073	2590	11839	2171	12835	1820	13888	1263	16662	777	11757
10-#14	2.04	MA	13964	3092	18597	2746	22955	2310	25514	1947	28369	1374	35431	917	24408
4L-3S		MI	7144	3092	10595	2574	12561	2145	13719	1798	15097	1258	18125	867	11824
10-#14	2.04	MA	13302	3092	17591	2768	21608	2333	23840	1969	26039	1406	32079	834	23100
5L-2S		MI	7544	3092	11341	2558	13509	2132	14867	1787	16647	1242	20193	1031	11832

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

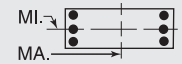


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#18	3.62	MA	16639	3599	24827	3041	30861	2509	35050	2063	41216	1344	52685	850	42868
3L-4S		MI	7633	3599	11984	2897	14105	2400	15517	1962	17449	1226	21106	443	18639
10-#18	3.62	MA	15914	3599	22873	3084	28145	2571	31719	2122	36654	1375	47189	691	40459
4L-3S		MI	7983	3599	12891	2872	15358	2359	17050	1926	19544	1224	23565	595	19851
10-#18	3.62	MA	14797	3599	21125	3124	25774	2611	28772	2159	32556	1429	41582	566	37153
5L-2S		MI	8599	3599	14177	2847	16990	2340	19028	1912	22214	1201	27013	885	19995
12-#10	1.38	MA	14194	2882	18585	2583	23239	2169	25966	1843	29091	1344	35999	1169	17146
2L-6S		MI	6390	2882	8738	2507	10332	2108	11048	1796	11512	1304	13601	833	8180
12-#10	1.38	MA	13634	2882	17642	2597	22043	2183	24515	1856	27133	1363	33289	1092	17120
3L-5S		MI	6569	2882	9048	2492	10681	2099	11497	1782	12133	1300	14464	905	8341
12-#10	1.38	MA	13338	2882	17007	2612	21159	2204	23431	1876	25648	1375	31526	1043	17047
4E		MI	6714	2882	9317	2482	11050	2090	11955	1774	12769	1288	15347	958	8362
12-#10	1.38	MA	12946	2882	16424	2624	20390	2218	22475	1889	24317	1394	29616	998	16878
5L-3S		MI	6852	2882	9620	2471	11470	2074	12469	1760	13472	1284	16228	1012	8361
12-#10	1.38	MA	12552	2882	15722	2639	19628	2229	21541	1910	23019	1405	27972	946	16351
6L-2S		MI	7100	2882	10057	2461	12024	2065	13141	1752	14378	1272	17483	1105	8352
12-#11	1.70	MA	14758	2983	19932	2636	24853	2207	27873	1864	31621	1333	39470	1157	20838
2L-6S		MI	6485	2983	9105	2559	10699	2143	11444	1816	12017	1298	14252	750	9631
12-#11	1.70	MA	14101	2983	18784	2653	23397	2223	26108	1880	29239	1356	36172	1061	20792
3L-5S		MI	6696	2983	9472	2540	11123	2133	11987	1799	12753	1285	15206	824	9939
12-#11	1.70	MA	13756	2983	18010	2671	22320	2248	24787	1904	27429	1369	34013	1000	20665
4E		MI	6862	2983	9799	2528	11570	2123	12541	1791	13522	1272	16247	890	10025
12-#11	1.70	MA	13289	2983	17305	2686	21382	2265	23620	1920	25806	1392	31680	943	20377
5L-3S		MI	7024	2983	10165	2516	12077	2104	13162	1774	14371	1268	17290	954	10040
12-#11	1.70	MA	12821	2983	16451	2704	20462	2279	22480	1944	24222	1405	29671	878	19446
6L-2S		MI	7313	2983	10691	2504	12743	2094	13970	1766	15462	1255	18768	1067	10033
12-#14	2.45	MA	15237	3223	21351	2803	26586	2333	29937	1950	34376	1349	43261	997	29590
3L-5S		MI	7030	3223	10353	2688	12148	2244	13192	1868	14342	1273	17274	664	13363
12-#14	2.45	MA	14786	3223	20240	2828	25041	2369	28042	1984	31780	1368	40155	909	29259
4E		MI	7257	3223	10819	2672	12786	2231	13983	1858	15438	1257	18729	760	13942
12-#14	2.45	MA	14133	3223	19234	2850	23694	2393	26367	2006	29451	1399	36803	825	27939
5L-3S		MI	7472	3223	11341	2656	13509	2205	14867	1835	16647	1252	20193	850	14030
12-#14	2.45	MA	13493	3223	18010	2875	22383	2412	24731	2041	27178	1419	33916	729	26563
6L-2S		MI	7859	3223	12088	2640	14456	2192	16015	1825	18196	1235	22260	1014	14057
12-#18	4.35	MA	17288	3831	25753	3229	31801	2677	36149	2189	42634	1364	55469	676	48895
4E		MI	8237	3831	13270	3042	15737	2506	17494	2029	20119	1215	24555	399	22262
12-#18	4.35	MA	16187	3831	24005	3269	29429	2717	33202	2226	38536	1417	49863	550	45613
5L-3S		MI	8541	3831	14177	3017	16990	2465	19028	1993	22214	1213	27013	551	23615
12-#18	4.35	MA	15168	3831	21856	3313	27155	2753	30321	2285	34536	1449	44463	343	41539
6L-2S		MI	9097	3831	15463	2991	18622	2445	21006	1979	24884	1189	30462	842	23795
14-#10	1.61	MA	14108	2955	18585	2643	23239	2217	25966	1877	29091	1359	35999	1087	19916
3L-6S		MI	6601	2955	9175	2553	10886	2142	11720	1817	12419	1301	14856	828	9429
14-#10	1.61	MA	13824	2955	17950	2658	22356	2238	24882	1897	27606	1371	34237	1038	19835
4L-5S		MI	6776	2955	9485	2538	11235	2133	12169	1803	13040	1296	15719	900	9627
14-#10	1.61	MA	13436	2955	17367	2670	21587	2252	23925	1911	26275	1390	32327	993	19662
5L-4S		MI	6920	2955	9754	2528	11604	2124	12627	1795	13675	1285	16601	953	9657
14-#10	1.61	MA	13053	2955	16665	2685	20825	2263	22991	1931	24977	1402	30683	941	19122
6L-3S		MI	7053	2955	10057	2517	12024	2108	13141	1781	14378	1280	17483	1007	9666
14-#10	1.61	MA	12721	2955	16070	2695	20000	2278	22050	1941	23719	1421	29006	909	18537
7L-2S		MI	7296	2955	10494	2507	12578	2099	13813	1773	15285	1268	18737	1100	9661
14-#11	1.98	MA	14662	3073	19932	2710	24853	2265	27873	1906	31621	1351	39470	1055	24190
3L-6S		MI	6733	3073	9630	2615	11366	2184	12252	1842	13108	1293	15730	741	11135
14-#11	1.98	MA	14334	3073	19157	2727	23776	2290	26551	1930	29811	1365	37311	994	24054
4L-5S		MI	6939	3073	9998	2596	11789	2174	12795	1825	13844	1281	16684	814	11427
14-#11	1.98	MA	13872	3073	18452	2742	22838	2306	25385	1946	28188	1387	34978	937	23765
5L-4S		MI	7104	3073	10324	2584	12236	2164	13349	1817	14613	1268	17725	880	11576
14-#11	1.98	MA	13419	3073	17598	2760	21918	2320	24245	1970	26604	1401	32969	872	22825
6L-3S		MI	7259	3073	10691	2572	12743	2146	13970	1801	15462	1264	18768	945	11601
14-#11	1.98	MA	13026	3073	16872	2772	20912	2339	23109	1983	25069	1424	30912	832	22094
7L-2S		MI	7541	3073	11216	2561	13410	2136	14778	1793	16553	1251	20246	1058	11604

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



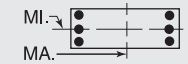
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.85	MA	15588	3353	21883	2909	27126	2429	30569	2022	35192	1362	44879	900	34115
4L-5S		MI	7366	3353	11099	2770	13095	2303	14340	1906	15892	1267	19341	647	15490
14-#14	2.85	MA	14941	3353	20877	2931	25779	2452	28895	2044	32863	1393	41527	816	32783
5L-4S		MI	7591	3353	11565	2754	13733	2290	15131	1896	16987	1250	20796	743	16126
14-#14	2.85	MA	14329	3353	19653	2957	24468	2472	27259	2078	30590	1412	38639	720	31405
6L-3S		MI	7795	3353	12088	2737	14456	2265	16015	1873	18196	1246	22260	833	16232
14-#14	2.85	MA	13798	3353	18612	2974	23027	2499	25641	2097	28387	1444	35677	662	29568
7L-2S		MI	8171	3353	12834	2721	15403	2251	17163	1863	19746	1229	24327	997	16273
14-#18	5.07	MA	17531	4063	26885	3414	33085	2823	37632	2292	44516	1406	58143	535	54071
5L-4S		MI	8787	4063	14556	3187	17369	2612	19472	2096	22789	1204	28003	356	25907
14-#18	5.07	MA	16575	4063	24736	3458	30811	2859	34751	2352	40517	1438	52744	327	49958
6L-3S		MI	9062	4063	15463	3162	18622	2571	21006	2060	24884	1202	30462	508	27379
14-#18	5.07	MA	15742	4063	22907	3486	28278	2905	31950	2386	36639	1491	47490	220	45962
7L-2S		MI	9588	4063	16749	3136	20253	2551	22984	2046	27554	1178	33910	799	27590
16-#10	1.84	MA	14301	3029	18893	2704	23553	2271	26332	1919	29564	1368	36948	1033	22623
4L-6S		MI	6809	3029	9611	2599	11440	2175	12392	1839	13325	1297	16110	823	10682
16-#10	1.84	MA	13916	3029	18310	2716	22784	2285	25376	1932	28233	1386	35038	988	22448
5E		MI	6980	3029	9921	2584	11789	2166	12841	1824	13947	1293	16973	895	10911
16-#10	1.84	MA	13543	3029	17608	2731	22022	2296	24442	1952	26935	1398	33394	937	21896
6L-4S		MI	7122	3029	10191	2574	12159	2157	13299	1817	14582	1281	17856	948	10949
16-#10	1.84	MA	13223	3029	17013	2741	21197	2312	23500	1962	25677	1417	31717	904	21326
7L-3S		MI	7252	3029	10494	2563	12578	2141	13813	1802	15285	1277	18737	1002	10964
16-#10	1.84	MA	12888	3029	16443	2753	20432	2322	22534	1978	24422	1429	30076	863	20631
8L-2S		MI	7489	3029	10931	2553	13133	2133	14484	1795	16192	1265	19992	1095	10966
16-#11	2.26	MA	14901	3163	20305	2784	25232	2331	28316	1956	32193	1361	40610	988	27444
4L-6S		MI	6977	3163	10156	2672	12033	2225	13060	1868	14199	1289	17208	731	12644
16-#11	2.26	MA	14443	3163	19600	2799	24294	2348	27149	1972	30570	1383	38277	931	27144
5E		MI	7178	3163	10523	2653	12456	2215	13603	1851	14935	1276	18163	805	12923
16-#11	2.26	MA	14004	3163	18745	2817	23374	2361	26009	1996	28986	1397	36267	866	26207
6L-4S		MI	7342	3163	10850	2641	12903	2206	14158	1843	15704	1264	19203	871	13124
16-#11	2.26	MA	13627	3163	18020	2829	22368	2380	24873	2009	27451	1419	34210	826	25481
7L-3S		MI	7491	3163	11216	2629	13410	2187	14778	1827	16553	1260	20246	935	13159
16-#11	2.26	MA	13228	3163	17324	2842	21436	2392	23696	2028	25920	1433	32204	773	24337
8L-2S		MI	7767	3163	11742	2617	14077	2177	15587	1819	17643	1247	21725	1049	13171
16-#14	3.26	MA	15730	3483	22521	3013	27864	2512	31422	2082	36274	1387	46251	808	37631
5E		MI	7696	3483	11845	2851	14043	2363	15488	1944	17442	1261	21408	630	17625
16-#14	3.26	MA	15142	3483	21296	3038	26553	2532	29786	2116	34002	1406	43363	712	36248
6L-4S		MI	7919	3483	12312	2835	14680	2350	16279	1933	18537	1244	22864	726	18258
16-#14	3.26	MA	14638	3483	20255	3055	25112	2558	28169	2135	31799	1438	40401	653	34392
7L-3S		MI	8113	3483	12834	2819	15403	2324	17163	1911	19746	1240	24327	816	18431
16-#14	3.26	MA	14079	3483	19258	3075	23774	2575	26480	2162	29600	1457	37517	576	32558
8L-2S		MI	8478	3483	13580	2803	16350	2311	18311	1900	21296	1223	26395	979	18485
16-#18	5.80	MA	17938	4295	27617	3603	34466	2965	39182	2418	46497	1427	61024	312	58376
6L-4S		MI	9324	4295	15842	3332	19001	2718	21450	2163	25459	1193	31452	313	29570
16-#18	5.80	MA	17165	4295	25787	3631	31933	3011	36380	2453	42619	1480	55771	205	54349
7L-3S		MI	9574	4295	16749	3307	20253	2677	22984	2127	27554	1191	33910	465	31144
16-#18	5.80	MA	16216	4295	24031	3664	29581	3039	33411	2499	38748	1511	50678	61	50345
8L-2S		MI	10073	4295	18035	3281	21885	2657	24962	2113	30223	1167	37359	755	31381
18-#10	2.07	MA	14387	3103	19253	2762	23980	2319	26826	1953	30191	1383	37749	983	25235
5L-6S		MI	7013	3103	10048	2645	11994	2209	13064	1860	14232	1294	17365	818	11939
18-#10	2.07	MA	14025	3103	18551	2777	23219	2330	25892	1973	28893	1395	36105	932	24672
6L-5S		MI	7181	3103	10358	2630	12344	2200	13512	1845	14854	1289	18228	890	12194
18-#10	2.07	MA	13715	3103	17956	2787	22394	2345	24951	1984	27635	1414	34428	899	24113
7L-4S		MI	7322	3103	10628	2620	12713	2191	13970	1838	15489	1278	19110	943	12239

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

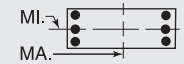


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.07	MA	13384	3103	17386	2799	21629	2356	23985	1999	26380	1425	32787	858	23408
8L-3S		MI	7447	3103	10931	2609	13133	2175	14484	1823	16192	1273	19992	997	12261
18-#10	2.07	MA	13015	3103	16809	2809	20887	2367	23048	2009	25114	1442	31095	806	22600
9L-2S		MI	7680	3103	11367	2599	13687	2166	15156	1816	17099	1261	21246	1090	12268
18-#11	2.54	MA	15002	3254	20747	2855	25750	2389	28914	1998	32952	1379	41575	925	30507
5L-6S		MI	7218	3254	10681	2728	12700	2267	13868	1894	15290	1285	18687	722	14157
18-#11	2.54	MA	14577	3254	19893	2873	24830	2403	27774	2022	31368	1393	39565	860	29592
6L-5S		MI	7414	3254	11049	2709	13123	2257	14412	1877	16026	1272	19641	796	14424
18-#11	2.54	MA	14214	3254	19167	2885	23824	2421	26638	2035	29833	1415	37509	820	28868
7L-4S		MI	7576	3254	11375	2697	13570	2247	14966	1869	16795	1259	20682	862	14670
18-#11	2.54	MA	13821	3254	18471	2899	22892	2433	25460	2054	28302	1429	35502	767	27714
8L-3S		MI	7720	3254	11742	2685	14077	2228	15587	1853	17643	1255	21725	926	14714
18-#11	2.54	MA	13384	3254	17774	2911	21987	2446	24317	2066	26776	1450	33428	702	26613
9L-2S		MI	7990	3254	12267	2674	14744	2218	16395	1845	18734	1242	23203	1039	14733
18-#14	3.67	MA	15937	3614	22940	3120	28639	2591	32313	2154	37413	1400	48087	703	41090
6L-5S		MI	8020	3614	12592	2933	14990	2423	16636	1981	18991	1255	23476	613	19767
18-#14	3.67	MA	15458	3614	21899	3137	27197	2618	30696	2173	35210	1431	45124	644	39215
7L-4S		MI	8242	3614	13058	2917	15628	2409	17427	1971	20087	1238	24931	708	20372
18-#14	3.67	MA	14906	3614	20901	3156	25860	2635	29007	2199	33012	1451	42241	567	37364
8L-3S		MI	8427	3614	13580	2900	16350	2384	18311	1948	21296	1234	26395	799	20628
18-#14	3.67	MA	14315	3614	19906	3174	24561	2653	27367	2216	30841	1482	39252	472	35446
9L-2S		MI	8782	3614	14327	2884	17297	2371	19459	1938	22845	1217	28462	962	20694
18-#18	6.52	MA	18546	4527	28668	3776	35589	3116	40811	2520	48599	1469	64051	190	62736
7L-4S		MI	9852	4527	17128	3477	20633	2824	23428	2230	28129	1182	34900	269	33248
18-#18	6.52	MA	17611	4527	26912	3809	33237	3145	37841	2566	44729	1500	58959	46	58709
8L-3S		MI	10078	4527	18035	3452	21885	2783	24962	2194	30223	1180	37359	421	34912
20-#10	2.30	MA	14498	3176	19494	2823	24415	2363	27342	1995	30850	1391	38816	927	27450
6E		MI	7215	3176	10485	2691	12549	2243	13735	1881	15139	1290	18619	813	13199
20-#10	2.30	MA	14198	3176	18899	2833	23590	2379	26401	2005	29593	1410	37139	894	26900
7L-5S		MI	7379	3176	10795	2676	12898	2234	14184	1867	15760	1286	19482	885	13444
20-#10	2.30	MA	13871	3176	18329	2845	22826	2389	25435	2021	28338	1422	35498	853	26186
8L-4S		MI	7520	3176	11064	2666	13267	2225	14642	1859	16396	1274	20365	938	13528
20-#10	2.30	MA	13511	3176	17752	2855	22084	2400	24498	2031	27072	1439	33805	801	25379
9L-3S		MI	7641	3176	11367	2655	13687	2209	15156	1845	17099	1270	21246	992	13555
20-#10	2.30	MA	13169	3176	17168	2864	21310	2419	23582	2041	25797	1454	32161	766	24480
10L-2S		MI	7869	3176	11804	2645	14241	2200	15828	1837	18006	1258	22501	1085	13567
20-#11	2.83	MA	15139	3344	21040	2930	26286	2444	29539	2049	33750	1388	42864	854	32979
6E		MI	7455	3344	11207	2785	13367	2308	14676	1920	16381	1281	20165	712	15673
20-#11	2.83	MA	14790	3344	20314	2942	25280	2463	28403	2061	32215	1411	40807	814	32255
7L-5S		MI	7646	3344	11574	2766	13790	2298	15220	1903	17117	1268	21119	786	15929
20-#11	2.83	MA	14401	3344	19619	2956	24348	2475	27225	2080	30684	1424	38801	761	31091
8L-4S		MI	7808	3344	11901	2754	14237	2288	15774	1895	17886	1255	22160	852	16216
20-#11	2.83	MA	13978	3344	18921	2968	23443	2488	26082	2092	29158	1446	36726	696	29980
9L-3S		MI	7946	3344	12267	2742	14744	2270	16395	1879	18734	1251	23203	916	16267
20-#11	2.83	MA	13587	3344	18209	2978	22499	2510	24964	2105	27604	1464	34714	651	28783
10L-2S		MI	8210	3344	12793	2730	15411	2260	17203	1871	19825	1238	24681	1030	16292
20-#14	4.08	MA	16259	3744	23542	3218	29282	2677	33223	2210	38622	1425	49848	636	44039
7L-5S		MI	8340	3744	13338	3014	15937	2482	17784	2019	20541	1248	25543	595	21915
20-#14	4.08	MA	15714	3744	22544	3238	27945	2694	31534	2237	36424	1444	46964	559	42171
8L-4S		MI	8561	3744	13804	2998	16575	2469	18575	2009	21636	1232	26998	691	22494
20-#14	4.08	MA	15145	3744	21549	3256	26646	2713	29895	2253	34253	1475	43976	464	40261
9L-3S		MI	8737	3744	14327	2982	17297	2443	19459	1986	22845	1227	28462	782	22824
20-#14	4.08	MA	14619	3744	20528	3271	25292	2745	28291	2271	32023	1501	41083	397	38101
10L-2S		MI	9083	3744	15073	2966	18244	2430	20607	1976	24395	1211	30529	945	22900
20-#18	7.25	MA	18969	4759	29792	3954	36892	3251	42272	2633	50709	1489	67239	31	67072
8L-4S		MI	10372	4759	18414	3622	22265	2930	25406	2296	30799	1171	38348	226	36939
22-#10	2.53	MA	14674	3250	19842	2879	24787	2413	27852	2026	31551	1407	39849	890	29687
7L-6S		MI	7415	3250	10922	2737	13103	2276	14407	1902	16046	1287	19874	808	14461
22-#10	2.53	MA	14349	3250	19272	2891	24022	2423	26886	2042	30295	1418	38209	849	28963

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



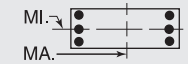
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8L-5S		MI	7575	3250	11232	2722	13452	2267	14856	1888	16667	1282	20737	880	14697
22-#10	2.53	MA	13999	3250	18695	2901	23280	2434	25948	2052	29029	1435	36516	796	28158
9L-4S		MI	7715	3250	11501	2712	13821	2258	15314	1880	17303	1271	21619	933	14816
22-#10	2.53	MA	13669	3250	18111	2910	22507	2453	25032	2063	27755	1451	34871	761	27252
10L-3S		MI	7832	3250	11804	2701	14241	2242	15828	1866	18006	1266	22501	987	14848
22-#10	2.53	MA	13349	3250	17453	2927	21746	2462	24102	2081	26469	1460	33275	717	26391
11L-2S		MI	8057	3250	12241	2691	14795	2233	16500	1858	18912	1254	23755	1080	14864
22-#11	3.11	MA	15356	3435	21461	2998	26736	2504	30167	2087	34598	1406	44105	808	35641
7L-6S		MI	7689	3435	11732	2841	14034	2349	15485	1946	17472	1276	21643	703	17192
22-#11	3.11	MA	14970	3435	20766	3012	25804	2516	28990	2106	33066	1420	42099	755	34467
8L-5S		MI	7876	3435	12100	2822	14457	2339	16028	1930	18208	1263	22598	777	17439
22-#11	3.11	MA	14559	3435	20068	3024	24899	2529	27847	2118	31540	1441	40024	690	33346
9L-4S		MI	8036	3435	12426	2810	14904	2329	16582	1922	18976	1251	23638	843	17761
22-#11	3.11	MA	14182	3435	19356	3035	23955	2552	26729	2131	29986	1460	38012	645	32153
10L-3S		MI	8170	3435	12793	2799	15411	2311	17203	1905	19825	1247	24681	907	17818
22-#11	3.11	MA	13792	3435	18555	3056	23036	2563	25595	2152	28417	1470	36059	590	30837
11L-2S		MI	8429	3435	13318	2787	16078	2301	18011	1897	20916	1234	26160	1020	17849
22-#14	4.48	MA	16505	3875	24187	3319	30030	2754	34062	2275	39835	1438	51688	550	46978
8L-5S		MI	8656	3875	14084	3096	16884	2542	18932	2056	22090	1242	27610	578	24067
22-#14	4.48	MA	15957	3875	23192	3337	28732	2772	32422	2291	37665	1469	48700	455	45075
9L-4S		MI	8876	3875	14551	3080	17522	2529	19722	2046	23186	1225	29066	674	24623
22-#14	4.48	MA	15453	3875	22172	3352	27377	2804	30818	2309	35435	1495	45807	388	42903
10L-3S		MI	9057	3875	15073	3063	18244	2503	20607	2024	24395	1221	30529	764	25020
24-#10	2.76	MA	14819	3323	20215	2937	25219	2457	28336	2063	32253	1415	40920	844	31741
8L-6S		MI	7612	3323	11358	2783	13657	2310	15079	1924	16952	1283	21128	803	15726
24-#10	2.76	MA	14478	3323	19638	2947	24477	2468	27399	2073	30987	1432	39227	791	30937
9L-5S		MI	7769	3323	11668	2768	14006	2301	15528	1909	17574	1279	21991	875	15954
24-#10	2.76	MA	14166	3323	19054	2956	23704	2486	26482	2084	29713	1447	37582	756	30024
10L-4S		MI	7909	3323	11938	2758	14376	2292	15986	1902	18209	1267	22874	928	16103
24-#10	2.76	MA	13843	3323	18396	2973	22942	2495	25553	2102	28427	1456	35986	712	29165
11L-3S		MI	8022	3323	12241	2747	14795	2276	16500	1887	18912	1262	23755	982	16140
24-#10	2.76	MA	13483	3323	17831	2984	22191	2505	24649	2113	27172	1473	34374	676	28118
12L-2S		MI	8242	3323	12678	2737	15350	2267	17172	1880	19819	1251	25010	1075	16160
24-#11	3.39	MA	15530	3525	21913	3069	27260	2557	30754	2133	35448	1416	45397	750	37844
8L-6S		MI	7920	3525	12258	2898	14700	2391	16293	1972	18563	1272	23122	693	18713
24-#11	3.39	MA	15131	3525	21216	3081	26355	2570	29611	2144	33922	1437	43322	684	36712
9L-5S		MI	8103	3525	12625	2879	15123	2381	16836	1956	19299	1259	24076	767	18952
24-#11	3.39	MA	14766	3525	20504	3091	25411	2593	28494	2157	32368	1455	41310	639	35523
10L-4S		MI	8263	3525	12952	2867	15571	2371	17390	1948	20067	1246	25117	833	19305
24-#11	3.39	MA	14394	3525	19702	3112	24492	2604	27359	2179	30799	1466	39358	584	34199
11L-3S		MI	8392	3525	13318	2855	16078	2352	18011	1931	20916	1242	26160	897	19369
24-#11	3.39	MA	13958	3525	19013	3125	23576	2616	26261	2192	29268	1486	37381	538	32861
12L-2S		MI	8645	3525	13843	2843	16744	2342	18820	1923	22007	1230	27638	1011	19405
24-#14	4.89	MA	16753	4005	24836	3419	30817	2832	34950	2329	41076	1463	53424	446	49889
9L-5S		MI	8969	4005	14831	3177	17831	2601	20080	2094	23640	1236	29678	561	26225
24-#14	4.89	MA	16270	4005	23815	3434	29463	2864	33345	2346	38847	1489	50531	380	47705
10L-4S		MI	9213	4005	15297	3161	18469	2588	20870	2084	24735	1219	31133	657	26759

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

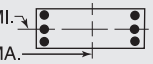


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#18	1.39	MA	15330	3010	20453	2670	25321	2242	28161	1904	31405	1386	38735	1205	18480
2E		MI	7268	3010	10656	2504	12478	2100	13492	1780	14590	1288	17093	1063	8520
6-#14	1.17	MA	14938	2937	19397	2640	24123	2222	26782	1894	29610	1399	36297	1218	15792
2L-3S		MI	6720	2937	9433	2505	11049	2106	11820	1792	12385	1326	14419	950	7405
6-#14	1.17	MA	13885	2937	17672	2665	21934	2245	24129	1916	26029	1431	31339	1079	15743
3L-2S		MI	7151	2937	10179	2489	11996	2093	12968	1782	13935	1309	16487	1114	7372
6-#18	2.08	MA	16755	3242	23478	2815	29160	2348	32814	1971	37687	1375	47432	1190	27472
2L-3S		MI	7122	3242	10656	2674	12478	2226	13492	1861	14590	1301	17093	729	12361
6-#18	2.08	MA	15057	3242	20453	2858	25321	2388	28161	2009	31405	1430	38735	938	27160
3L-2S		MI	7814	3242	11942	2649	14110	2206	15469	1847	17259	1277	20541	1020	12390
8-#11	1.08	MA	14776	2908	18946	2629	23624	2214	26213	1891	28876	1405	35306	1224	14687
2L-4S		MI	6621	2908	9076	2509	10616	2121	11321	1809	11727	1337	13720	958	6934
8-#11	1.08	MA	14036	2908	17743	2646	22096	2231	24362	1907	26376	1427	31845	1129	14667
3E		MI	6797	2908	9442	2497	11123	2102	11942	1792	12576	1332	14763	1022	6915
8-#11	1.08	MA	13631	2908	16931	2664	20967	2257	22977	1931	24479	1442	29589	1068	14569
4L-2S		MI	7103	2908	9968	2485	11790	2092	12750	1784	13667	1320	16242	1135	6893
8-#14	1.56	MA	15780	3068	21122	2721	26312	2281	29435	1931	33190	1393	41255	1209	20924
2L-4S		MI	6823	3068	9657	2602	11273	2191	12084	1852	12726	1324	15023	843	9611
8-#14	1.56	MA	14771	3068	19397	2746	24123	2305	26782	1954	29610	1425	36297	1071	20844
3E		MI	7064	3068	10179	2586	11996	2166	12968	1829	13935	1320	16487	933	9641
8-#14	1.56	MA	14221	3068	18232	2772	22504	2341	24795	1989	26888	1444	33050	983	20533
4L-2S		MI	7480	3068	10926	2570	12943	2152	14116	1819	15484	1303	18554	1097	9624
8-#18	2.78	MA	18124	3474	26504	2960	33000	2454	37467	2038	43968	1364	56129	1175	36449
2L-4S		MI	7307	3474	11035	2844	12857	2373	13936	1963	15165	1292	18083	534	15193
8-#18	2.78	MA	16534	3474	23478	3003	29160	2494	32814	2075	37687	1419	47432	923	36089
3E		MI	7689	3474	11942	2819	14110	2332	15469	1928	17259	1290	20541	686	16138
8-#18	2.78	MA	15675	3474	21429	3047	26312	2557	29319	2136	32901	1451	41685	765	33827
4L-2S		MI	8346	3474	13228	2794	15742	2312	17447	1914	19929	1266	23990	976	16225
10-#10	1.10	MA	14864	2914	18949	2643	23727	2226	26390	1900	29161	1410	35735	1229	15026
2L-5S		MI	6614	2914	8934	2541	10505	2146	11221	1831	11615	1359	13642	959	7081
10-#10	1.10	MA	14257	2914	17960	2658	22472	2240	24869	1914	27107	1430	32891	1152	15009
3L-4S		MI	6759	2914	9204	2531	10874	2138	11679	1823	12251	1348	14525	1012	7085
10-#10	1.10	MA	13930	2914	17295	2673	21546	2261	23733	1934	25551	1442	31049	1104	14946
4L-3S		MI	6904	2914	9507	2520	11294	2122	12194	1809	12953	1343	15406	1067	7073
10-#10	1.10	MA	13510	2914	16682	2685	20741	2276	22731	1948	24157	1461	29051	1060	14782
5L-2S		MI	7159	2914	9944	2510	11848	2113	12865	1801	13860	1332	16661	1159	7058
10-#11	1.35	MA	15373	2998	20150	2685	25151	2256	28065	1917	31375	1400	38766	1218	18270
2L-5S		MI	6704	2998	9275	2577	10836	2172	11575	1843	12050	1345	14158	882	8471
10-#11	1.35	MA	14656	2998	18946	2703	23624	2273	26213	1933	28876	1423	35306	1123	18236
3L-4S		MI	6871	2998	9601	2565	11283	2162	12129	1835	12818	1332	15199	948	8500
10-#11	1.35	MA	14272	2998	18135	2721	22495	2298	24828	1958	26978	1437	33050	1062	18121
4L-3S		MI	7041	2998	9968	2553	11790	2143	12750	1818	13667	1328	16242	1012	8496
10-#11	1.35	MA	13771	2998	17393	2736	21512	2315	23606	1974	25277	1460	30607	1006	17834
5L-2S		MI	7339	2998	10493	2542	12457	2133	13559	1810	14758	1315	17720	1126	8480
10-#14	1.95	MA	16598	3198	22846	2803	28501	2341	32087	1969	36771	1386	46213	1200	26048
2L-5S		MI	6942	3198	9937	2700	11583	2264	12441	1900	13180	1335	15635	730	11344
10-#14	1.95	MA	15631	3198	21122	2828	26312	2365	29435	1992	33190	1418	41255	1062	25946
3L-4S		MI	7172	3198	10403	2684	12220	2251	13232	1890	14275	1318	17090	826	11802
10-#14	1.95	MA	15118	3198	19957	2853	24693	2401	27448	2027	30469	1438	38008	974	25623
4L-3S		MI	7400	3198	10926	2668	12943	2225	14116	1867	15484	1314	18554	916	11858
10-#14	1.95	MA	14415	3198	18898	2875	23281	2425	25693	2049	28028	1470	34499	892	24351
5L-2S		MI	7802	3198	11672	2652	13890	2212	15264	1857	17034	1297	20621	1079	11862
10-#18	3.47	MA	17954	3706	26504	3148	33000	2600	37467	2142	43968	1408	56129	908	45028
3L-4S		MI	7886	3706	12321	2989	14489	2479	15914	2030	17835	1281	21531	490	18783
10-#18	3.47	MA	17184	3706	24454	3191	30151	2663	33973	2202	39182	1440	50382	750	42688
4L-3S		MI	8240	3706	13228	2964	15742	2438	17447	1995	19929	1279	23990	642	19906
10-#18	3.47	MA	15996	3706	22611	3231	27665	2704	30883	2240	34885	1495	44511	628	39160
5L-2S		MI	8863	3706	14514	2939	17374	2418	19425	1981	22599	1255	27438	933	20037

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



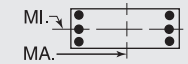
f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	1.32	MA	15358	2988	19938	2689	24982	2260	27911	1922	31214	1407	38578	1224	17969
2L-6S		MI	6644	2988	9061	2602	10710	2189	11444	1867	11900	1361	14034	883	8241
12-#10	1.32	MA	14767	2988	18949	2704	23727	2274	26390	1935	29161	1426	35735	1148	17943
3L-5S		MI	6824	2988	9371	2587	11059	2180	11893	1852	12522	1356	14897	954	8372
12-#10	1.32	MA	14454	2988	18284	2719	22801	2295	25254	1956	27604	1438	33892	1099	17870
4E		MI	6969	2988	9641	2577	11428	2171	12351	1845	13157	1344	15780	1007	8387
12-#10	1.32	MA	14038	2988	17671	2731	21996	2309	24253	1969	26210	1457	31894	1055	17701
5L-3S		MI	7108	2988	9944	2566	11848	2155	12865	1830	13860	1340	16661	1062	8384
12-#10	1.32	MA	13622	2988	16935	2746	21194	2320	23274	1990	24851	1469	30174	1004	17200
6L-2S		MI	7358	2988	10380	2556	12402	2146	13537	1823	14767	1328	17915	1154	8373
12-#11	1.63	MA	15958	3089	21354	2742	26679	2297	29917	1943	33875	1396	42227	1212	21849
2L-6S		MI	6739	3089	9433	2653	11080	2223	11840	1886	12405	1353	14682	799	9703
12-#11	1.63	MA	15262	3089	20150	2759	25151	2314	28065	1959	31375	1419	38766	1117	21803
3L-5S		MI	6951	3089	9800	2634	11503	2213	12384	1869	13141	1341	15637	873	10014
12-#11	1.63	MA	14897	3089	19339	2777	24023	2339	26680	1984	29478	1433	36510	1056	21676
4E		MI	7117	3089	10127	2622	11950	2203	12938	1861	13909	1328	16677	939	10058
12-#11	1.63	MA	14402	3089	18597	2792	23040	2356	25458	2000	27777	1456	34068	1000	21388
5L-3S		MI	7280	3089	10493	2610	12457	2185	13559	1844	14758	1324	17720	1003	10067
12-#11	1.63	MA	13907	3089	17701	2810	22070	2370	24264	2024	26118	1470	31965	936	20462
6L-2S		MI	7571	3089	11018	2598	13124	2175	14367	1836	15849	1311	19198	1116	10058
12-#14	2.34	MA	16466	3329	22846	2909	28501	2424	32087	2029	36771	1412	46213	1053	31048
3L-5S		MI	7285	3329	10683	2782	12530	2324	13589	1938	14729	1329	17702	713	13457
12-#14	2.34	MA	15988	3329	21682	2935	26881	2460	30101	2064	34050	1432	42966	966	30717
4E		MI	7512	3329	11150	2765	13168	2310	14380	1927	15825	1312	19158	808	13990
12-#14	2.34	MA	15294	3329	20623	2957	25470	2484	28346	2087	31609	1464	39457	883	29434
5L-3S		MI	7729	3329	11672	2749	13890	2285	15264	1905	17034	1308	20621	899	14067
12-#14	2.34	MA	14618	3329	19338	2982	24088	2504	26632	2122	29227	1484	36435	789	27957
6L-2S		MI	8119	3329	12418	2733	14837	2272	16412	1895	18583	1291	22689	1062	14089
12-#18	4.17	MA	18637	3937	27480	3336	33990	2769	38626	2269	45463	1429	59079	735	51549
4E		MI	8451	3937	13607	3134	16121	2585	17892	2097	20504	1270	24980	447	22401
12-#18	4.17	MA	17466	3937	25636	3376	31504	2810	35537	2307	41167	1484	53208	612	48047
5L-3S		MI	8800	3937	14514	3109	17374	2544	19425	2062	22599	1268	27438	599	23672
12-#18	4.17	MA	16388	3937	23381	3421	29104	2846	32517	2367	36973	1516	47553	408	43987
6L-2S		MI	9364	3937	15800	3084	19005	2524	21403	2048	25269	1244	30887	890	23839
14-#10	1.54	MA	15267	3061	19938	2750	24982	2308	27911	1956	31214	1423	38578	1143	20876
3L-6S		MI	6856	3061	9498	2648	11264	2223	12116	1888	12807	1357	15289	878	9490
14-#10	1.54	MA	14967	3061	19273	2765	24057	2329	26775	1977	29658	1435	36736	1094	20795
4L-5S		MI	7032	3061	9808	2633	11613	2214	12565	1873	13429	1352	16151	949	9660
14-#10	1.54	MA	14555	3061	18660	2777	23251	2343	25774	1990	28264	1454	34737	1050	20622
5L-4S		MI	7175	3061	10077	2623	11983	2205	13023	1866	14064	1341	17034	1002	9684
14-#10	1.54	MA	14151	3061	17924	2792	22449	2354	24796	2011	26904	1466	33017	999	20109
6L-3S		MI	7310	3061	10380	2612	12402	2189	13537	1851	14767	1336	17915	1057	9689
14-#10	1.54	MA	13801	3061	17301	2802	21585	2369	23804	2021	25587	1485	31265	967	19483
7L-2S		MI	7554	3061	10817	2602	12957	2180	14209	1844	15674	1325	19170	1149	9683
14-#11	1.90	MA	15856	3179	21354	2816	26679	2355	29917	1985	33875	1414	42227	1111	25369
3L-6S		MI	6988	3179	9958	2709	11746	2264	12648	1912	13496	1349	16160	790	11207
14-#11	1.90	MA	15508	3179	20543	2834	25550	2381	28532	2010	31977	1429	39971	1050	25233
4L-5S		MI	7195	3179	10325	2690	12169	2254	13192	1895	14232	1336	17115	863	11503
14-#11	1.90	MA	15018	3179	19800	2849	24567	2398	27309	2026	30276	1451	37529	995	24944
5L-4S		MI	7359	3179	10652	2678	12617	2244	13746	1887	15000	1324	18155	929	11611
14-#11	1.90	MA	14539	3179	18905	2867	23598	2411	26115	2050	28617	1466	35426	930	24010
6L-3S		MI	7516	3179	11018	2667	13124	2226	14367	1871	15849	1320	19198	994	11631
14-#11	1.90	MA	14125	3179	18144	2879	22544	2430	24918	2063	27010	1488	33278	890	23232
7L-2S		MI	7800	3179	11544	2655	13790	2216	15175	1863	16940	1307	20677	1107	11631

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

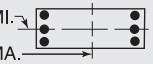


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.73	MA	16835	3459	23407	3016	29070	2520	32753	2102	37631	1426	47925	957	35816
4L-5S		MI	7622	3459	11430	2863	13477	2383	14737	1975	16279	1322	19770	695	15582
14-#14	2.73	MA	16149	3459	22347	3038	27659	2544	30999	2124	35190	1458	44416	875	34513
5L-4S		MI	7847	3459	11896	2847	14115	2370	15528	1965	17374	1306	21225	791	16176
14-#14	2.73	MA	15501	3459	21063	3064	26277	2564	29284	2159	32808	1478	41393	780	33041
6L-3S		MI	8053	3459	12418	2831	14837	2344	16412	1942	18583	1301	22689	882	16271
14-#14	2.73	MA	14940	3459	19972	3081	24765	2591	27578	2178	30500	1510	38298	722	31195
7L-2S		MI	8432	3459	13165	2815	15784	2331	17560	1932	20133	1285	24756	1045	16307
14-#18	4.86	MA	18887	4169	28661	3521	35344	2916	40190	2374	47448	1473	61905	597	56933
5L-4S		MI	9042	4169	14893	3279	17753	2691	19870	2164	23174	1259	28428	404	26041
14-#18	4.86	MA	17874	4169	26406	3566	32944	2952	37170	2434	43254	1505	56250	392	52831
6L-3S		MI	9323	4169	15800	3254	19005	2650	21403	2129	25269	1257	30887	556	27437
14-#18	4.86	MA	16992	4169	24487	3595	30286	2998	34211	2469	39190	1560	50762	286	48665
7L-2S		MI	9856	4169	17086	3229	20637	2630	23381	2115	27939	1233	34335	847	27635
16-#10	1.76	MA	15471	3135	20262	2811	25312	2362	28297	1998	31711	1431	39579	1089	23720
4L-6S		MI	7064	3135	9935	2694	11818	2256	12788	1909	13714	1354	16543	873	10742
16-#10	1.76	MA	15063	3135	19649	2823	24506	2376	27295	2012	30317	1450	37580	1045	23545
5E		MI	7236	3135	10245	2679	12168	2247	13237	1895	14336	1349	17406	944	10945
16-#10	1.76	MA	14669	3135	18913	2838	23704	2387	26317	2032	28958	1462	35860	994	23020
6L-4S		MI	7378	3135	10514	2669	12537	2238	13695	1887	14971	1337	18289	997	10978
16-#10	1.76	MA	14331	3135	18290	2848	22840	2403	25325	2042	27641	1481	34109	962	22406
7L-3S		MI	7509	3135	10817	2658	12957	2222	14209	1873	15674	1333	19170	1052	10990
16-#10	1.76	MA	13976	3135	17692	2860	22039	2413	24313	2058	26326	1493	32393	922	21733
8L-2S		MI	7748	3135	11254	2648	13511	2214	14881	1865	16581	1321	20424	1144	10989
16-#11	2.17	MA	16107	3270	21747	2890	27078	2422	30383	2036	34477	1424	43432	1044	28792
4L-6S		MI	7232	3270	10484	2766	12413	2306	13456	1938	14587	1345	17639	780	12715
16-#11	2.17	MA	15621	3270	21004	2905	26095	2439	29161	2052	32776	1447	40990	989	28503
5E		MI	7434	3270	10851	2747	12836	2296	14000	1921	15323	1332	18593	854	12997
16-#11	2.17	MA	15157	3270	20108	2923	25126	2452	27967	2076	31117	1461	38887	924	27561
6L-4S		MI	7598	3270	11178	2735	13283	2286	14554	1913	16091	1319	19634	920	13160
16-#11	2.17	MA	14759	3270	19348	2936	24072	2471	26769	2089	29509	1484	36738	884	26787
7L-3S		MI	7749	3270	11544	2723	13790	2267	15175	1897	16940	1315	20677	984	13190
16-#11	2.17	MA	14336	3270	18619	2950	23095	2484	25535	2108	27905	1498	34640	833	25643
8L-2S		MI	8026	3270	12069	2711	14457	2257	15983	1889	18031	1302	22155	1097	13200
16-#14	3.13	MA	16983	3590	24072	3120	29848	2604	33652	2162	38770	1452	49374	866	39592
5E		MI	7952	3590	12176	2945	14424	2443	15885	2013	17828	1316	21837	678	17715
16-#14	3.13	MA	16361	3590	22788	3145	28465	2623	31937	2197	36389	1471	46351	772	38125
6L-4S		MI	8175	3590	12642	2929	15062	2430	16676	2003	18924	1299	23292	774	18361
16-#14	3.13	MA	15827	3590	21696	3163	26954	2650	30231	2215	34081	1504	43257	713	36259
7L-3S		MI	8372	3590	13165	2912	15784	2404	17560	1980	20133	1295	24756	864	18471
16-#14	3.13	MA	15234	3590	20651	3182	25552	2667	28460	2243	31778	1523	40239	638	34423
8L-2S		MI	8740	3590	13911	2896	16731	2391	18708	1970	21682	1278	26823	1028	18520
16-#18	5.56	MA	19314	4401	29431	3711	36783	3058	41823	2501	49536	1494	64947	377	61583
6L-4S		MI	9581	4401	16179	3424	19385	2797	21848	2231	25844	1248	31876	361	29700
16-#18	5.56	MA	18495	4401	27512	3740	34126	3104	38865	2536	45471	1549	59459	271	57476
7L-3S		MI	9836	4401	17086	3399	20637	2755	23381	2195	27939	1246	34335	513	31203
16-#18	5.56	MA	17487	4401	25671	3773	31659	3133	35750	2582	41414	1581	54128	130	53380
8L-2S		MI	10343	4401	18372	3374	22269	2736	25359	2182	30609	1222	37784	803	31427
18-#10	1.98	MA	15561	3209	20638	2869	25761	2410	28816	2033	32370	1447	40424	1040	26470
5L-6S		MI	7269	3209	10371	2740	12373	2290	13460	1930	14621	1350	17798	868	11999
18-#10	1.98	MA	15178	3209	19902	2884	24959	2421	27838	2053	31011	1459	38703	989	25933
6L-5S		MI	7437	3209	10681	2725	12722	2281	13909	1916	15242	1345	18660	939	12229
18-#10	1.98	MA	14850	3209	19279	2894	24095	2437	26847	2063	29694	1478	36952	957	25330
7L-4S		MI	7579	3209	10951	2715	13091	2272	14367	1908	15878	1334	19543	993	12269
18-#10	1.98	MA	14499	3209	18681	2906	23294	2447	25835	2079	28380	1490	35236	917	24647
8L-3S		MI	7705	3209	11254	2704	13511	2256	14881	1894	16581	1329	20424	1047	12287
18-#10	1.98	MA	14103	3209	18074	2915	22517	2458	24853	2090	27045	1507	33468	864	23788
9L-2S		MI	7940	3209	11691	2694	14065	2247	15552	1886	17487	1318	21679	1139	12293

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

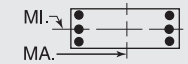
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
18-#11	2.44	MA	16213	3360	22208	2962	27623	2480	31013	2078	35275	1443	44450	983	32064
5L-6S		MI	7473	3360	11009	2822	13080	2347	14265	1964	15678	1341	19117	771	14227
18-#11	2.44	MA	15763	3360	21312	2980	26653	2494	29819	2103	33616	1457	42347	918	31115
6L-5S		MI	7670	3360	11376	2803	13503	2337	14808	1947	16414	1328	20072	844	14497
18-#11	2.44	MA	15379	3360	20552	2992	25599	2513	28621	2115	32008	1480	40199	878	30342
7L-4S		MI	7833	3360	11703	2791	13950	2327	15362	1939	17182	1315	21112	910	14708
18-#11	2.44	MA	14962	3360	19823	3006	24622	2525	27387	2134	30404	1494	38100	827	29187
8L-3S		MI	7978	3360	12069	2780	14457	2309	15983	1923	18031	1311	22155	975	14746
18-#11	2.44	MA	14501	3360	19088	3018	23674	2538	26189	2146	28794	1515	35933	762	28099
9L-2S		MI	8250	3360	12595	2768	15124	2299	16791	1915	19122	1298	23633	1088	14762
18-#14	3.52	MA	17201	3720	24512	3227	30654	2683	34590	2235	39970	1465	51310	763	43208
6L-5S		MI	8277	3720	12922	3026	15371	2502	17033	2051	19378	1310	23904	661	19855
18-#14	3.52	MA	16693	3720	23421	3244	29143	2710	32884	2253	37662	1497	48215	705	41322
7L-4S		MI	8499	3720	13389	3010	16009	2489	17823	2040	20473	1293	25360	757	20472
18-#14	3.52	MA	16107	3720	22375	3264	27741	2727	31113	2280	35359	1517	45197	629	39469
8L-3S		MI	8687	3720	13911	2994	16731	2464	18708	2018	21682	1289	26823	847	20670
18-#14	3.52	MA	15482	3720	21327	3281	26380	2746	29395	2297	33067	1548	42075	535	37418
9L-2S		MI	9045	3720	14657	2978	17679	2450	19856	2008	23232	1272	28891	1011	20729
18-#18	6.25	MA	19954	4633	30537	3885	37965	3210	43518	2603	51752	1538	68156	256	66286
7L-4S		MI	10110	4633	17465	3569	21017	2903	23826	2298	28514	1237	35325	317	33374
18-#18	6.25	MA	18960	4633	28696	3918	35498	3239	40403	2649	47695	1570	62825	115	62165
8L-3S		MI	10342	4633	18372	3544	22269	2861	25359	2262	30609	1235	37784	469	34971
20-#10	2.20	MA	15677	3282	20891	2930	26215	2454	29359	2075	33064	1455	41547	984	28849
6E		MI	7471	3282	10808	2786	12927	2324	14131	1952	15527	1347	19052	863	13258
20-#10	2.20	MA	15361	3282	20268	2940	25350	2470	28368	2084	31747	1474	39795	952	28254
7L-5S		MI	7636	3282	11118	2771	13276	2315	14580	1937	16149	1342	19915	934	13507
20-#10	2.20	MA	15013	3282	19670	2952	24549	2481	27356	2101	30433	1486	38079	912	27560
8L-4S		MI	7777	3282	11388	2761	13645	2306	15038	1930	16784	1330	20798	988	13559
20-#10	2.20	MA	14634	3282	19063	2961	23772	2492	26374	2111	29099	1503	36311	859	26704
9L-3S		MI	7899	3282	11691	2750	14065	2290	15552	1915	17487	1326	21679	1042	13583
20-#10	2.20	MA	14272	3282	18451	2970	22962	2511	25414	2122	27764	1519	34591	825	25812
10L-2S		MI	8130	3282	12127	2740	14619	2281	16224	1908	18394	1314	22933	1134	13593
20-#11	2.71	MA	16357	3450	22516	3037	28181	2535	31670	2129	36115	1453	45808	912	34671
6E		MI	7711	3450	11534	2879	13747	2388	15073	1990	16769	1336	20595	761	15742
20-#11	2.71	MA	15988	3450	21755	3049	27127	2554	30473	2141	34508	1475	43660	872	33897
7L-5S		MI	7903	3450	11902	2860	14170	2378	15616	1973	17505	1323	21550	835	16002
20-#11	2.71	MA	15575	3450	21027	3063	26150	2566	29238	2161	32904	1490	41561	821	32730
8L-4S		MI	8065	3450	12228	2848	14617	2368	16170	1965	18273	1311	22590	901	16255
20-#11	2.71	MA	15127	3450	20292	3075	25202	2580	28041	2173	31294	1510	39393	756	31631
9L-3S		MI	8205	3450	12595	2836	15124	2350	16791	1949	19122	1307	23633	965	16300
20-#11	2.71	MA	14701	3450	19546	3086	24213	2603	26870	2185	29665	1529	37289	712	30354
10L-2S		MI	8471	3450	13120	2824	15791	2340	17600	1941	20213	1294	25112	1079	16323
20-#14	3.91	MA	17540	3850	25146	3326	31331	2769	35537	2291	41243	1491	53173	696	46385
7L-5S		MI	8598	3850	13669	3108	16318	2562	18181	2088	20928	1304	25972	644	22001
20-#14	3.91	MA	16961	3850	24100	3345	29929	2787	33766	2318	38940	1511	50155	621	44514
8L-4S		MI	8819	3850	14135	3092	16956	2549	18971	2078	22023	1287	27427	740	22592
20-#14	3.91	MA	16359	3850	23052	3363	28568	2805	32047	2335	36648	1542	47033	526	42472
9L-3S		MI	8998	3850	14657	3075	17679	2523	19856	2055	23232	1283	28891	830	22866
20-#14	3.91	MA	15802	3850	21982	3378	27149	2838	30366	2353	34311	1568	44007	461	40277
10L-2S		MI	9347	3850	15404	3059	18626	2510	21004	2045	24782	1266	30958	994	22937
20-#18	6.94	MA	20394	4865	31722	4063	39338	3345	45057	2716	53976	1559	71522	100	70950
8L-4S		MI	10630	4865	18751	3714	22648	3009	25803	2365	31184	1226	38773	274	37061
22-#10	2.43	MA	15862	3356	21257	2986	26605	2504	29889	2106	33801	1471	42638	947	31177
7L-6S		MI	7671	3356	11245	2832	13481	2357	14803	1973	16434	1343	20307	858	14520

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

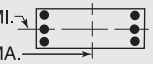


f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
22-#10	2.43	MA	15518	3356	20659	2998	25804	2514	28877	2122	32486	1483	40922	907	30473
8L-5S		MI	7833	3356	11555	2817	13830	2348	15252	1958	17056	1338	21169	929	14760
22-#10	2.43	MA	15148	3356	20052	3007	25027	2526	27895	2132	31152	1500	39154	855	29619
9L-4S		MI	7973	3356	11824	2807	14200	2339	15710	1951	17691	1327	22052	983	14848
22-#10	2.43	MA	14799	3356	19440	3017	24217	2545	26936	2143	29817	1515	37434	820	28720
10L-3S		MI	8091	3356	12127	2796	14619	2323	16224	1936	18394	1322	22933	1037	14876
22-#10	2.43	MA	14460	3356	18751	3034	23416	2553	25962	2161	28470	1525	35764	778	27804
11L-2S		MI	8318	3356	12564	2786	15174	2314	16896	1929	19301	1311	24188	1129	14890
22-#11	2.98	MA	16585	3541	22959	3105	28655	2595	32324	2167	37007	1471	47121	866	37451
7L-6S		MI	7945	3541	12060	2935	14414	2430	15881	2016	17860	1332	22074	752	17260
22-#11	2.98	MA	16176	3541	22231	3119	27678	2608	31090	2187	35403	1485	45022	815	36274
8L-5S		MI	8134	3541	12427	2916	14837	2420	16425	2000	18596	1319	23028	826	17510
22-#11	2.98	MA	15742	3541	21496	3131	26730	2621	29892	2199	33793	1506	42854	750	35164
9L-4S		MI	8295	3541	12754	2905	15284	2410	16979	1992	19364	1306	24069	892	17800
22-#11	2.98	MA	15343	3541	20749	3142	25741	2644	28721	2212	32165	1525	40749	706	33891
10L-3S		MI	8430	3541	13120	2893	15791	2391	17600	1975	20213	1302	25112	956	17853
22-#11	2.98	MA	14928	3541	19910	3163	24772	2655	27533	2234	30521	1536	38707	652	32567
11L-2S		MI	8691	3541	13646	2881	16458	2381	18408	1967	21304	1290	26590	1069	17881
22-#14	4.30	MA	17796	3981	25825	3427	32118	2846	36419	2356	42521	1505	55114	612	49560
8L-5S		MI	8915	3981	14415	3189	17265	2622	19329	2126	22477	1298	28039	627	24153
22-#14	4.30	MA	17216	3981	24777	3445	30757	2865	34700	2372	40229	1535	51992	518	47526
9L-4S		MI	9135	3981	14881	3173	17903	2608	20119	2116	23573	1281	29494	723	24720
22-#14	4.30	MA	16683	3981	23706	3460	29338	2897	33019	2391	37892	1562	48965	453	45318
10L-3S		MI	9307	3981	15404	3157	18626	2583	21004	2093	24782	1276	30958	813	25062
24-#10	2.65	MA	16015	3430	21648	3044	27059	2548	30398	2143	34540	1479	43765	902	33386
8L-6S		MI	7869	3430	11682	2878	14035	2391	15475	1994	17341	1340	21561	853	15784
24-#10	2.65	MA	15654	3430	21041	3053	26282	2559	29417	2153	33205	1496	41997	850	32534
9L-5S		MI	8027	3430	11992	2863	14385	2382	15924	1980	17963	1335	22424	924	16016
24-#10	2.65	MA	15317	3430	20429	3063	25472	2578	28457	2164	31871	1512	40277	815	31627
10L-4S		MI	8167	3430	12261	2853	14754	2373	16382	1972	18598	1323	23307	978	16135
24-#10	2.65	MA	14982	3430	19740	3080	24671	2587	27483	2183	30524	1521	38608	773	30714
11L-3S		MI	8282	3430	12564	2842	15174	2357	16896	1958	19301	1319	24188	1032	16169
24-#10	2.65	MA	14602	3430	19148	3091	23883	2597	26531	2194	29209	1538	36925	736	29663
12L-2S		MI	8504	3430	13001	2832	15728	2348	17568	1950	20208	1307	25442	1124	16187
24-#11	3.25	MA	16767	3631	23434	3176	29206	2649	32942	2213	37902	1481	48482	809	39817
8L-6S		MI	8177	3631	12585	2992	15081	2471	16689	2042	18951	1328	23552	742	18781
24-#11	3.25	MA	16345	3631	22700	3188	28257	2662	31744	2225	36292	1502	46315	744	38696
9L-5S		MI	8361	3631	12953	2973	15504	2461	17233	2026	19687	1315	24506	816	19022
24-#11	3.25	MA	15959	3631	21953	3199	27269	2685	30573	2238	34664	1521	44210	700	37427
10L-4S		MI	8522	3631	13279	2961	15951	2451	17787	2018	20455	1302	25547	882	19345
24-#11	3.25	MA	15552	3631	21113	3220	26300	2696	29385	2260	33020	1532	42168	646	36095
11L-3S		MI	8653	3631	13646	2949	16458	2433	18408	2001	21304	1298	26590	946	19404
24-#11	3.25	MA	15103	3631	20391	3233	25340	2708	28234	2274	31417	1552	40103	601	34749
12L-2S		MI	8908	3631	14171	2937	17125	2423	19216	1993	22395	1285	28068	1060	19438
24-#14	4.69	MA	18057	4111	26502	3526	32946	2925	37353	2410	43810	1529	56950	509	52579
9L-5S		MI	9228	4111	15161	3271	18213	2681	20477	2164	24027	1291	30106	610	26309
24-#14	4.69	MA	17545	4111	25431	3541	31527	2957	35672	2428	41473	1556	53923	444	50359
10L-4S		MI	9448	4111	15628	3255	18850	2668	21267	2153	25122	1275	31562	705	26854

RECTANGULAR TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.86	MA	300	318	495	227	531	189	542	156	547	103	575	65	378
2L-3S		MI	286	318	464	227	492	190	497	157	490	104	514	43	382
6-#6	2.64	MA	313	341	533	240	573	196	591	159	608	96	651	52	499
2L-3S		MI	294	341	490	239	520	198	529	160	530	98	565	21	505
6-#7	3.60	MA	328	368	577	255	622	205	647	162	680	87	725	30	641
2L-3S		MI	304	368	520	254	553	207	567	164	577	89	613	-12	614

RECTANGULAR TIED COLUMNS 10" x 12"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.03	MA	416	354	650	266	703	224	723	191	720	140	777	110	341
2E		MI	342	354	545	255	575	214	579	181	565	130	593	97	286
4-#6	1.47	MA	429	368	686	274	746	230	774	194	782	137	845	101	455
2E		MI	350	368	570	263	603	219	611	182	605	125	643	88	374
4-#7	2.00	MA	444	387	728	284	797	237	832	198	856	132	925	89	589
2E		MI	360	387	601	272	636	224	648	184	652	118	691	73	476
4-#8	2.63	MA	461	408	776	296	857	245	899	202	940	127	1014	74	741
2E		MI	372	408	635	284	673	230	690	185	704	110	743	54	590
4-#9	3.33	MA	479	432	828	309	920	255	969	205	1029	120	1105	56	902
2E		MI	383	432	668	296	710	237	732	186	758	100	794	31	708
4-#10	4.23	MA	501	463	892	327	999	267	1055	210	1137	112	1214	32	1101
2E		MI	398	463	707	311	754	245	783	187	822	87	852	0	852
4-#11	5.20	MA	516	496	948	342	1046	273	1106	208	1201	94	1299	6	1278
2E		MI	406	496	724	318	770	245	799	179	842	63	842	-53	868
6-#5	1.55	MA	433	371	693	277	757	232	788	196	803	138	873	102	478
2L-3S		MI	339	371	545	266	575	223	579	186	565	127	593	64	396
6-#5	1.55	MA	413	371	650	278	703	232	723	198	720	139	777	79	483
3L-2S		MI	353	371	576	266	613	222	624	185	622	126	653	85	392
6-#6	2.20	MA	452	394	745	290	821	241	865	202	898	133	976	88	642
2L-3S		MI	347	394	570	277	603	231	611	189	605	120	643	41	523
6-#6	2.20	MA	426	394	686	290	746	241	774	203	782	135	845	57	648
3L-2S		MI	366	394	614	278	656	229	672	187	683	119	730	72	516
6-#7	3.00	MA	474	421	807	305	898	252	953	207	1010	127	1097	71	835
2L-3S		MI	357	421	601	292	636	240	648	192	652	112	691	8	668
6-#7	3.00	MA	440	421	728	306	797	251	832	209	856	129	925	28	839
3L-2S		MI	381	421	658	294	705	238	728	190	754	110	803	50	661
6-#8	3.95	MA	457	454	776	324	857	264	899	216	940	122	1014	-8	1012
3L-2S		MI	398	454	709	312	760	248	791	193	834	98	882	22	823
6-#9	5.00	MA	475	490	828	345	920	278	969	223	1029	114	1105	-49	1097
3L-2S		MI	416	490	757	331	816	259	855	195	915	84	960	-12	964
6-#10	6.35	MA	498	536	892	371	999	296	1055	232	1137	102	1214	-104	1197
3L-2S		MI	438	536	815	354	883	272	932	198	1013	64	1049	-58	1030

RECTANGULAR TIED COLUMNS 10" x 14"

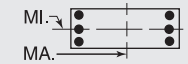
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.26	MA	583	422	907	324	998	272	1040	231	1068	169	1178	134	550
2E		MI	403	422	651	301	686	251	692	211	680	148	721	108	388
4-#7	1.71	MA	603	440	961	333	1064	279	1119	235	1170	166	1294	125	718
2E		MI	413	440	682	310	719	256	729	212	726	141	769	93	492
4-#8	2.26	MA	627	461	1024	345	1141	287	1211	240	1287	163	1427	114	911
2E		MI	425	461	716	322	755	262	771	213	779	133	820	73	609
4-#9	2.86	MA	651	485	1091	359	1224	297	1311	246	1412	158	1565	101	1118
2E		MI	436	485	749	333	793	269	813	214	832	123	871	51	730
4-#10	3.63	MA	681	516	1176	376	1328	310	1436	254	1566	152	1735	83	1375
2E		MI	451	516	788	348	837	276	863	215	896	109	928	19	876
4-#11	4.46	MA	704	549	1254	392	1420	320	1535	257	1676	139	1830	51	1615
2E		MI	459	549	806	355	853	276	879	206	915	84	917	-34	935

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 10" x 14"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

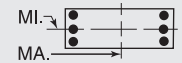
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.33	MA	588	424	915	327	1010	275	1056	233	1095	171	1213	135	578
2L-3S		MI	392	424	625	305	658	256	660	215	640	150	672	84	409
6-#5	1.33	MA	562	424	861	328	943	275	974	236	983	172	1080	113	583
3L-2S		MI	406	424	656	305	696	255	705	214	697	149	732	105	405
6-#6	1.89	MA	613	447	981	339	1093	283	1155	239	1223	168	1361	125	785
2L-3S		MI	400	447	651	316	686	264	692	217	680	143	721	61	540
6-#6	1.89	MA	578	447	907	341	998	284	1040	241	1068	169	1178	93	791
3L-2S		MI	419	447	694	317	739	262	753	216	758	142	808	92	532
6-#7	2.57	MA	644	474	1062	355	1192	295	1274	245	1376	164	1537	112	1030
2L-3S		MI	409	474	682	330	719	273	729	221	726	134	769	28	689
6-#7	2.57	MA	598	474	961	357	1064	295	1119	249	1170	166	1294	69	1034
3L-2S		MI	434	474	739	332	788	271	810	219	829	132	881	70	680
6-#8	3.39	MA	622	507	1024	376	1141	309	1211	257	1287	161	1427	39	1308
3L-2S		MI	451	507	790	350	843	280	872	221	908	120	960	41	845
6-#9	4.29	MA	647	543	1091	397	1224	323	1311	267	1412	156	1565	4	1557
3L-2S		MI	469	543	839	368	899	291	936	223	989	106	1037	7	1017
6-#10	5.44	MA	678	589	1176	424	1328	342	1436	279	1566	148	1735	-42	1716
3L-2S		MI	491	589	897	391	966	303	1013	225	1086	87	1126	-39	1140
6-#11	6.69	MA	702	638	1254	449	1420	358	1535	287	1676	131	1830	-108	1793
3L-2S		MI	504	638	922	405	990	305	1038	215	1118	51	1113	-117	1124
8-#5	1.77	MA	584	442	915	339	1010	283	1056	241	1095	171	1213	107	750
3E		MI	404	442	656	316	696	264	705	219	697	146	732	72	513
8-#5	1.77	MA	570	442	877	340	957	286	991	241	1009	172	1117	97	753
4L-2S		MI	418	442	687	316	735	263	750	218	754	145	792	93	508
8-#6	2.51	MA	609	472	981	356	1093	295	1155	248	1223	167	1361	84	1019
3E		MI	416	472	694	332	739	274	753	223	758	137	808	45	678
8-#6	2.51	MA	590	472	928	358	1018	299	1063	248	1104	169	1228	71	997
4L-2S		MI	435	472	738	333	792	273	815	221	836	136	895	76	672
8-#7	3.43	MA	641	508	1062	378	1192	311	1274	258	1376	163	1537	56	1335
3E		MI	431	508	739	352	788	287	810	227	829	126	881	5	867
8-#7	3.43	MA	614	508	990	380	1091	315	1151	258	1218	165	1360	38	1243
4L-2S		MI	455	508	797	353	858	285	890	225	931	124	993	47	861
8-#8	4.51	MA	645	552	1061	406	1176	335	1252	269	1349	160	1510	-3	1510
4L-2S		MI	477	552	864	378	931	299	974	229	1038	108	1099	9	1074
8-#9	5.71	MA	677	600	1137	435	1267	356	1361	281	1488	153	1667	-49	1659
4L-2S		MI	501	600	928	403	1006	313	1060	233	1147	89	1203	-36	1214

RECTANGULAR TIED COLUMNS 10" x 16"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.10	MA	758	475	1153	373	1280	314	1338	268	1379	199	1550	165	645
2E		MI	456	475	732	340	769	284	773	240	755	171	799	128	400
4-#7	1.50	MA	784	493	1219	383	1361	321	1435	272	1509	197	1704	158	848
2E		MI	466	493	763	349	802	289	810	240	801	164	846	113	507
4-#8	1.98	MA	814	515	1296	395	1456	330	1549	277	1661	195	1882	150	1082
2E		MI	478	515	797	360	838	295	852	241	853	155	898	93	626
4-#9	2.50	MA	846	539	1380	409	1559	339	1671	283	1826	193	2069	139	1334
2E		MI	489	539	830	371	875	301	894	242	906	145	947	70	750
4-#10	3.17	MA	886	569	1484	426	1688	352	1827	291	2032	189	2302	126	1649
2E		MI	504	569	870	385	920	308	944	243	969	131	1005	39	900
4-#11	3.90	MA	916	602	1586	442	1807	363	1967	296	2190	179	2460	101	1952
2E		MI	512	602	888	391	935	306	959	233	987	106	992	-15	1000
6-#5	1.16	MA	764	477	1161	377	1295	317	1358	270	1407	200	1592	166	679
2L-3S		MI	445	477	706	343	740	289	742	244	715	173	750	104	421
6-#5	1.16	MA	732	477	1097	378	1213	318	1258	273	1272	202	1421	144	684
3L-2S		MI	459	477	737	344	779	288	787	243	772	172	811	125	417
6-#6	1.65	MA	797	500	1243	389	1395	326	1478	276	1568	198	1787	158	927
2L-3S		MI	453	500	732	354	769	296	773	246	755	166	799	81	554
6-#6	1.65	MA	752	500	1153	391	1280	327	1338	279	1379	200	1550	127	933
3L-2S		MI	472	500	775	355	822	295	835	245	833	165	886	112	547

RECTANGULAR TIED COLUMNS 10" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	2.25	MA	835	527	1341	405	1516	337	1624	282	1764	195	2020	149	1224
2L-3S		MI	462	527	763	368	802	305	810	249	801	157	846	48	707
6-#7	2.25	MA	777	527	1219	407	1361	339	1435	287	1509	198	1704	106	1228
3L-2S		MI	487	527	820	370	871	303	891	247	903	155	958	89	698
6-#8	2.96	MA	806	560	1296	427	1456	353	1549	296	1661	196	1882	80	1564
3L-2S		MI	504	560	871	388	926	313	953	249	982	143	1037	61	865
6-#9	3.75	MA	838	596	1380	448	1559	368	1671	306	1826	193	2069	50	1919
3L-2S		MI	522	596	920	406	982	323	1017	251	1063	128	1114	27	1040
6-#10	4.76	MA	882	642	1484	476	1688	387	1827	320	2032	189	2302	10	2280
3L-2S		MI	544	642	978	429	1049	335	1093	253	1160	109	1202	-19	1210
6-#11	5.85	MA	915	692	1586	502	1807	404	1967	330	2190	176	2460	-47	2428
3L-2S		MI	557	692	1004	441	1073	336	1118	242	1191	73	1188	-98	1233
8-#5	1.55	MA	760	495	1161	389	1295	326	1358	278	1407	201	1592	139	884
3E		MI	457	495	737	355	779	297	787	248	772	169	811	92	527
8-#5	1.55	MA	743	495	1116	391	1231	329	1280	279	1300	201	1470	128	887
4L-2S		MI	471	495	768	355	818	296	831	247	829	168	871	113	522
8-#6	2.20	MA	792	525	1243	407	1395	339	1478	286	1568	199	1787	120	1209
3E		MI	469	525	775	370	822	307	835	251	833	160	886	65	695
8-#6	2.20	MA	768	525	1179	409	1306	343	1368	287	1418	198	1617	105	1205
4L-2S		MI	488	525	818	371	875	306	896	250	911	159	973	96	689
8-#7	3.00	MA	830	561	1341	429	1516	354	1624	297	1764	196	2020	96	1594
3E		MI	484	561	820	390	871	319	891	255	903	148	958	25	889
8-#7	3.00	MA	799	561	1255	432	1396	360	1476	298	1569	199	1793	75	1514
4L-2S		MI	508	561	878	391	940	317	971	253	1006	146	1070	66	881
8-#8	3.95	MA	835	605	1342	458	1500	380	1601	310	1739	197	1996	40	1855
4L-2S		MI	531	605	945	416	1014	331	1055	257	1112	130	1177	29	1097
8-#9	5.00	MA	875	653	1437	488	1613	403	1736	323	1923	194	2209	-1	2209
4L-2S		MI	554	653	1010	441	1088	345	1141	260	1220	112	1280	-16	1286
8-#10	6.35	MA	932	714	1555	526	1756	431	1907	340	2152	189	2473	-55	2447
4L-2S		MI	584	714	1087	472	1178	362	1243	263	1350	86	1399	-77	1374

RECTANGULAR TIED COLUMNS 10" x 18"

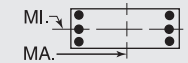
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.33	MA	987	546	1502	433	1689	364	1784	309	1873	227	2154	189	978
2E		MI	520	546	843	387	884	322	892	269	875	186	924	132	522
4-#8	1.76	MA	1024	568	1594	445	1802	372	1919	314	2054	225	2377	183	1253
2E		MI	531	568	878	398	921	327	933	270	927	177	975	113	643
4-#9	2.22	MA	1063	592	1693	458	1924	382	2065	320	2250	222	2615	175	1550
2E		MI	543	592	912	408	958	333	974	270	980	167	1024	90	769
4-#10	2.82	MA	1111	622	1817	476	2078	394	2250	327	2499	220	2912	164	1924
2E		MI	557	622	951	422	1002	340	1025	270	1043	153	1081	58	922
4-#11	3.47	MA	1152	655	1942	492	2225	405	2423	333	2728	215	3135	144	2289
2E		MI	565	656	970	427	1018	337	1039	260	1060	127	1067	4	1057
6-#5	1.03	MA	962	530	1433	426	1610	359	1692	307	1751	230	2009	196	779
2L-3S		MI	498	530	786	382	823	322	823	273	790	196	829	124	431
6-#5	1.03	MA	923	530	1358	428	1514	361	1575	311	1593	232	1801	173	784
3L-2S		MI	513	530	817	383	862	321	868	272	847	195	889	145	429
6-#6	1.47	MA	1002	553	1529	439	1728	368	1833	313	1941	227	2252	190	1070
2L-3S		MI	506	553	813	393	852	329	855	275	829	189	878	101	568
6-#6	1.47	MA	949	553	1423	441	1593	370	1670	317	1719	231	1961	158	1076
3L-2S		MI	525	553	856	394	905	328	916	273	907	187	964	132	562
6-#7	2.00	MA	1049	580	1645	454	1872	379	2006	319	2173	225	2543	183	1418
2L-3S		MI	515	580	843	407	884	338	892	277	875	179	924	68	724

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 10" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

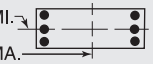
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	2.00	MA	979	580	1502	458	1689	382	1784	325	1873	229	2154	139	1423
3L-2S		MI	540	580	901	408	954	336	972	275	978	177	1036	109	714
6-#8	2.63	MA	1015	613	1594	478	1802	396	1919	335	2054	227	2377	116	1820
3L-2S		MI	557	613	952	426	1009	345	1034	278	1057	165	1114	81	885
6-#9	3.33	MA	1053	649	1693	499	1924	412	2065	345	2250	225	2615	90	2243
3L-2S		MI	575	649	1001	443	1065	355	1098	279	1137	151	1191	47	1063
6-#10	4.23	MA	1102	695	1817	528	2078	432	2250	359	2499	222	2912	55	2767
3L-2S		MI	597	695	1060	466	1131	367	1174	281	1233	131	1278	0	1278
6-#11	5.20	MA	1150	745	1942	554	2225	450	2423	370	2728	216	3135	5	3124
3L-2S		MI	609	745	1086	477	1155	367	1198	269	1263	94	1263	-79	1302
8-#5	1.38	MA	958	548	1433	439	1610	369	1692	316	1751	231	2009	170	1017
3E		MI	510	548	817	393	862	330	868	276	847	192	889	112	540
8-#5	1.38	MA	937	548	1381	441	1536	373	1601	317	1627	231	1862	158	1021
4L-2S		MI	524	548	848	394	901	329	913	275	904	191	950	133	536
8-#6	1.96	MA	996	578	1529	457	1728	382	1833	324	1941	229	2252	154	1399
3E		MI	522	578	856	409	905	340	916	280	907	183	964	85	712
8-#6	1.96	MA	968	578	1455	460	1624	387	1706	326	1767	229	2046	137	1396
4L-2S		MI	541	578	899	410	958	338	977	278	985	181	1051	116	705
8-#7	2.67	MA	1042	614	1645	479	1872	398	2006	335	2173	227	2543	133	1854
3E		MI	537	614	901	428	954	352	972	284	978	171	1036	45	909
8-#7	2.67	MA	1006	614	1545	483	1731	404	1833	336	1937	227	2267	110	1794
4L-2S		MI	561	614	959	430	1023	350	1052	282	1080	169	1148	86	900
8-#8	3.51	MA	1051	658	1649	510	1856	425	1982	349	2136	224	2522	78	2202
4L-2S		MI	584	658	1026	454	1097	363	1136	285	1186	153	1254	48	1119
8-#9	4.44	MA	1099	706	1762	540	1991	448	2144	364	2353	221	2794	41	2632
4L-2S		MI	607	706	1091	478	1171	377	1221	288	1294	134	1357	3	1348
8-#10	5.64	MA	1160	767	1904	579	2161	478	2349	382	2627	216	3132	-8	3126
4L-2S		MI	636	767	1168	509	1260	394	1323	291	1424	108	1475	-58	1495
8-#11	6.93	MA	1224	834	2044	616	2322	504	2538	397	2900	217	3385	-74	3332
4L-2S		MI	654	834	1201	528	1292	396	1358	277	1467	61	1460	-162	1475
10-#10	7.06	MA	1205	840	1985	639	2279	515	2485	413	2802	219	3363	-80	3309
5L-2S		MI	677	840	1277	553	1389	421	1473	302	1614	85	1672	-116	1642

RECTANGULAR TIED COLUMNS 10" x 20"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.20	MA	1212	599	1810	483	2048	406	2166	346	2270	256	2642	219	1107
2E		MI	573	599	924	425	967	354	973	297	950	209	1002	152	535
4-#8	1.58	MA	1255	621	1916	495	2178	415	2322	351	2479	254	2911	214	1423
2E		MI	584	621	959	435	1004	359	1014	298	1001	200	1052	133	659
4-#9	2.00	MA	1301	645	2030	508	2319	424	2491	357	2706	252	3200	208	1766
2E		MI	596	645	993	446	1041	365	1055	298	1054	189	1101	109	788
4-#10	2.54	MA	1359	675	2175	525	2498	437	2706	364	2995	249	3562	200	2198
2E		MI	610	675	1033	460	1085	372	1105	298	1117	175	1157	77	943
4-#11	3.12	MA	1409	709	2323	541	2673	448	2911	370	3268	244	3853	183	2626
2E		MI	618	709	1052	463	1100	368	1119	287	1133	149	1141	23	1083
6-#6	1.32	MA	1229	606	1841	488	2092	411	2222	350	2347	257	2755	220	1212
2L-3S		MI	559	606	893	432	935	362	936	303	904	212	956	121	581
6-#6	1.32	MA	1166	606	1719	492	1937	413	2034	354	2092	261	2410	189	1218
3L-2S		MI	579	606	936	432	987	361	997	302	982	210	1043	152	575
6-#7	1.80	MA	1284	633	1975	504	2258	422	2421	356	2614	254	3105	215	1613
2L-3S		MI	568	633	924	445	967	370	973	306	950	202	1002	87	741
6-#7	1.80	MA	1203	633	1810	508	2048	425	2166	363	2270	259	2642	172	1617
3L-2S		MI	594	633	982	446	1037	368	1053	304	1052	200	1114	129	731
6-#8	2.37	MA	1245	666	1916	528	2178	439	2322	373	2479	258	2911	151	2076
3L-2S		MI	610	666	1033	464	1092	378	1115	306	1131	188	1192	100	904
6-#9	3.00	MA	1290	702	2030	550	2319	455	2491	384	2706	256	3200	127	2567
3L-2S		MI	628	702	1083	481	1147	387	1179	307	1211	173	1267	66	1084

RECTANGULAR TIED COLUMNS 10" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	3.81	MA	1348	748	2175	579	2498	476	2706	398	2995	254	3562	95	3178
3L-2S		MI	650	748	1141	503	1214	399	1255	308	1307	153	1355	19	1303
6-#11	4.68	MA	1399	798	2323	605	2673	494	2911	409	3268	248	3853	50	3717
3L-2S		MI	662	798	1168	514	1238	398	1278	296	1336	115	1338	-60	1369
8-#5	1.24	MA	1177	601	1730	489	1955	412	2058	353	2127	261	2465	200	1151
3E		MI	563	601	898	432	945	363	950	305	922	215	968	132	552
8-#5	1.24	MA	1153	601	1670	492	1871	416	1955	354	1986	262	2292	188	1155
4L-2S		MI	577	601	929	433	984	362	994	304	979	214	1028	154	548
8-#6	1.76	MA	1222	631	1841	507	2092	425	2222	362	2347	259	2755	186	1589
3E		MI	575	631	936	447	987	373	997	309	982	206	1043	105	727
8-#6	1.76	MA	1190	631	1756	510	1973	430	2076	364	2148	260	2512	168	1586
4L-2S		MI	594	631	980	448	1040	371	1059	307	1060	204	1129	136	720
8-#7	2.40	MA	1277	667	1975	530	2258	441	2421	372	2614	257	3105	167	2113
3E		MI	589	667	982	466	1037	385	1053	312	1052	193	1114	64	928
8-#7	2.40	MA	1235	667	1860	534	2097	448	2224	375	2345	258	2779	143	2083
4L-2S		MI	614	667	1039	468	1106	383	1133	310	1155	191	1226	106	918
8-#8	3.16	MA	1288	711	1981	561	2241	469	2397	389	2576	256	3087	113	2559
4L-2S		MI	637	711	1107	492	1179	396	1217	314	1260	175	1331	68	1140
8-#9	4.00	MA	1346	759	2112	592	2399	493	2585	403	2828	254	3418	79	3062
4L-2S		MI	660	759	1172	516	1254	409	1302	316	1368	156	1434	23	1372
8-#10	5.08	MA	1419	820	2278	632	2597	523	2823	422	3147	250	3833	34	3685
4L-2S		MI	689	820	1250	547	1343	426	1404	319	1497	130	1552	-39	1567
8-#11	6.24	MA	1483	887	2444	669	2789	551	3049	438	3447	242	4164	-26	4137
4L-2S		MI	707	887	1283	564	1375	427	1438	304	1539	82	1534	-143	1597
10-#10	6.35	MA	1466	893	2374	693	2737	562	2985	456	3353	255	4110	-33	4080
5L-2S		MI	729	893	1358	590	1472	453	1553	329	1688	107	1749	-97	1717

RECTANGULAR TIED COLUMNS 12" x 12"

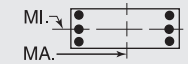
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.29	MA	510	435	806	326	876	274	906	233	914	167	990	127	492
2L-3S		MI	489	435	764	326	822	274	841	234	830	168	894	105	497
6-#6	1.83	MA	529	457	858	338	940	282	983	238	1008	162	1093	113	659
2L-3S		MI	502	457	800	339	865	282	892	239	892	163	962	82	666
6-#7	2.50	MA	551	485	921	353	1017	293	1071	243	1119	156	1213	96	855
2L-3S		MI	516	485	842	354	916	292	950	245	966	158	1041	53	863
6-#8	3.29	MA	576	517	993	372	1106	306	1172	249	1247	148	1347	74	1079
2L-3S		MI	533	517	891	372	976	305	1017	252	1050	150	1129	17	1082
6-#9	4.17	MA	603	553	1070	392	1201	321	1277	255	1380	138	1485	47	1316
2L-3S		MI	551	553	943	392	1039	318	1087	258	1138	142	1220	-24	1216
6-#10	5.29	MA	635	599	1166	419	1320	340	1406	262	1543	126	1650	12	1609
2L-3S		MI	573	599	1008	418	1119	336	1173	267	1246	130	1328	-80	1318

RECTANGULAR TIED COLUMNS 12" x 14"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.05	MA	687	496	1058	382	1159	322	1201	275	1220	204	1340	164	565
2E		MI	582	496	913	371	984	312	1010	267	1002	194	1078	151	483
4-#7	1.43	MA	708	514	1113	392	1226	329	1280	279	1322	201	1456	155	735
2E		MI	597	514	956	380	1036	319	1069	269	1076	189	1157	139	622
4-#8	1.88	MA	731	536	1177	403	1303	337	1373	283	1439	197	1588	144	931
2E		MI	614	536	1005	391	1095	327	1135	273	1159	184	1245	124	779
4-#9	2.38	MA	756	560	1245	416	1386	346	1472	289	1563	192	1726	130	1140
2E		MI	632	560	1058	404	1159	336	1205	276	1247	177	1335	106	946
4-#10	3.02	MA	786	591	1330	433	1490	358	1597	296	1717	186	1895	112	1401
2E		MI	654	591	1123	421	1238	348	1290	280	1355	167	1443	81	1151
4-#11	3.71	MA	809	624	1410	448	1582	368	1695	299	1825	172	1988	80	1646
2E		MI	669	624	1180	435	1284	351	1340	277	1416	149	1524	54	1339
4-#14	5.36	MA	875	702	1605	493	1823	401	1959	312	2159	151	2329	22	2241
2E		MI	716	702	1324	479	1436	375	1513	282	1636	119	1736	-17	1741

RECTANGULAR TIED COLUMNS 12" x 14"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

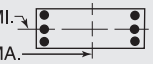
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.11	MA	692	499	1066	386	1172	325	1218	277	1247	205	1375	165	593
2L-3S		MI	566	499	877	375	941	315	959	270	940	197	1011	130	509
6-#5	1.11	MA	665	499	1012	387	1104	325	1136	279	1136	206	1243	143	597
3L-2S		MI	586	499	919	375	995	315	1025	269	1024	196	1107	152	505
6-#6	1.57	MA	718	521	1133	398	1254	333	1317	282	1375	202	1523	155	802
2L-3S		MI	578	521	913	387	984	323	1010	275	1002	192	1078	107	682
6-#6	1.57	MA	682	521	1058	399	1159	334	1201	285	1220	204	1340	124	809
3L-2S		MI	605	521	972	386	1059	324	1101	274	1118	191	1209	139	675
6-#7	2.14	MA	749	548	1214	413	1353	344	1436	288	1528	198	1699	142	1050
2L-3S		MI	592	548	956	402	1036	333	1069	281	1076	186	1157	78	883
6-#7	2.14	MA	701	548	1113	415	1226	345	1280	292	1322	200	1456	99	1057
3L-2S		MI	628	548	1035	401	1136	334	1189	279	1229	184	1329	121	874
6-#8	2.82	MA	783	581	1307	431	1469	357	1574	296	1704	193	1898	126	1335
2L-3S		MI	609	581	1005	420	1095	346	1135	287	1159	179	1245	42	1109
6-#8	2.82	MA	726	581	1177	434	1303	358	1373	300	1439	195	1588	69	1338
3L-2S		MI	653	581	1107	420	1225	347	1290	285	1356	176	1463	99	1101
6-#9	3.57	MA	819	617	1407	452	1593	372	1724	305	1891	186	2107	106	1640
2L-3S		MI	626	617	1058	440	1159	359	1205	294	1247	170	1335	0	1334
6-#9	3.57	MA	750	617	1245	454	1386	372	1472	310	1563	190	1726	34	1633
3L-2S		MI	680	617	1185	440	1320	362	1395	290	1489	167	1600	72	1341
6-#10	4.54	MA	864	663	1533	479	1749	391	1912	317	2124	178	2363	79	2021
2L-3S		MI	648	663	1123	465	1238	376	1290	302	1355	158	1443	-55	1437
6-#10	4.54	MA	781	663	1330	481	1490	391	1597	322	1717	182	1895	-12	1890
3L-2S		MI	712	663	1281	466	1439	381	1523	298	1652	153	1764	36	1637
6-#11	5.57	MA	804	713	1410	505	1582	406	1695	328	1825	164	1988	-79	1963
3L-2S		MI	735	713	1364	491	1509	389	1600	295	1747	128	1891	-3	1825
8-#5	1.48	MA	714	516	1119	397	1240	333	1301	282	1358	204	1508	159	761
2L-4S		MI	571	516	888	387	952	325	972	274	960	195	1036	113	653
8-#5	1.48	MA	688	516	1066	398	1172	333	1218	284	1247	205	1375	137	766
3E		MI	583	516	919	386	995	323	1025	275	1024	194	1107	122	647
8-#5	1.48	MA	674	516	1028	399	1119	336	1153	284	1161	206	1279	127	771
4L-2S		MI	603	516	961	386	1048	323	1090	274	1108	193	1203	144	642
8-#6	2.10	MA	748	546	1208	413	1349	345	1432	289	1529	200	1707	146	1034
2L-4S		MI	586	546	929	403	999	337	1028	281	1029	190	1112	83	874
8-#6	2.10	MA	713	546	1133	415	1254	345	1317	292	1375	202	1523	115	1039
3E		MI	602	546	972	403	1059	335	1101	282	1118	189	1209	94	868
8-#6	2.10	MA	693	546	1080	416	1179	349	1225	292	1256	203	1390	101	1042
4L-2S		MI	628	546	1031	402	1134	335	1192	281	1234	187	1341	126	862
8-#7	2.86	MA	743	583	1214	436	1353	360	1436	302	1528	197	1699	86	1362
3E		MI	624	583	1035	423	1136	349	1189	290	1229	181	1329	60	1126
8-#7	2.86	MA	717	583	1142	438	1253	365	1312	301	1370	199	1522	68	1304
4L-2S		MI	658	583	1114	423	1237	350	1310	288	1383	179	1501	103	1121
8-#8	3.76	MA	780	626	1307	462	1469	378	1574	313	1704	191	1898	51	1728
3E		MI	649	626	1107	448	1225	366	1290	299	1356	171	1463	17	1417
8-#8	3.76	MA	748	626	1213	464	1338	384	1414	312	1500	194	1671	27	1587
4L-2S		MI	691	626	1210	448	1355	368	1444	296	1553	169	1681	73	1416
8-#9	4.76	MA	817	674	1407	490	1593	398	1724	326	1891	184	2107	10	2085
3E		MI	676	674	1185	475	1320	385	1395	308	1489	160	1600	-33	1594
8-#9	4.76	MA	779	674	1290	492	1429	405	1523	324	1639	187	1827	-19	1825
4L-2S		MI	727	674	1312	476	1482	388	1585	305	1730	156	1865	39	1729
8-#10	6.05	MA	864	736	1533	526	1749	424	1912	343	2124	173	2363	-45	2337
3E		MI	710	736	1281	511	1439	409	1523	319	1652	144	1764	-100	1748

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

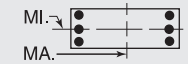
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.25	MA	920	578	1414	451	1572	379	1647	323	1709	238	1919	193	865
2E		MI	674	578	1070	428	1155	360	1187	305	1185	218	1273	164	637
4-#8	1.65	MA	951	599	1492	463	1667	388	1760	328	1861	235	2096	185	1102
2E		MI	691	599	1120	439	1214	368	1253	308	1269	212	1360	149	797
4-#9	2.08	MA	983	623	1576	476	1769	397	1883	333	2026	233	2283	174	1356
2E		MI	709	623	1173	452	1278	376	1323	311	1356	205	1450	130	966
4-#10	2.65	MA	1023	654	1681	493	1899	409	2038	340	2231	229	2514	160	1675
2E		MI	731	654	1238	468	1357	388	1408	315	1464	195	1557	106	1174
4-#11	3.25	MA	1054	687	1785	508	2018	419	2178	345	2388	219	2671	135	1983
2E		MI	746	687	1297	481	1404	391	1457	311	1524	176	1636	78	1367
4-#14	4.69	MA	1140	766	2031	553	2323	451	2544	365	2840	203	3167	89	2727
2E		MI	793	766	1441	525	1555	413	1630	316	1742	146	1847	6	1827
6-#6	1.38	MA	933	585	1437	457	1605	384	1690	326	1768	238	2002	194	944
2L-3S		MI	654	585	1027	435	1103	365	1128	311	1112	221	1195	132	697
6-#6	1.38	MA	888	585	1347	460	1490	386	1550	330	1579	241	1765	162	951
3L-2S		MI	682	585	1086	435	1178	365	1219	310	1228	219	1326	164	690
6-#7	1.88	MA	972	612	1536	473	1727	395	1835	333	1964	236	2234	184	1244
2L-3S		MI	669	612	1070	450	1155	374	1187	317	1185	215	1273	103	902
6-#7	1.88	MA	913	612	1414	475	1572	397	1647	338	1709	239	1919	141	1251
3L-2S		MI	704	612	1149	450	1255	375	1308	315	1339	213	1445	146	892
6-#8	2.47	MA	1016	645	1651	491	1868	408	2005	341	2193	233	2501	172	1591
2L-3S		MI	685	645	1120	468	1214	386	1253	323	1269	207	1360	67	1132
6-#8	2.47	MA	942	645	1492	495	1667	410	1760	347	1861	236	2096	115	1594
3L-2S		MI	730	645	1222	467	1344	388	1408	320	1465	204	1578	123	1121
6-#9	3.13	MA	1064	680	1775	512	2022	423	2190	349	2441	230	2784	157	1964
2L-3S		MI	702	680	1173	487	1278	400	1323	329	1356	198	1450	25	1372
6-#9	3.13	MA	973	680	1576	516	1769	425	1883	357	2026	233	2283	85	1957
3L-2S		MI	757	680	1300	487	1440	402	1513	326	1598	195	1715	97	1364
6-#10	3.97	MA	1121	727	1930	538	2215	442	2423	361	2750	225	3134	136	2432
2L-3S		MI	724	727	1238	513	1357	417	1408	337	1464	186	1557	-31	1554
6-#10	3.97	MA	1012	727	1681	543	1899	445	2038	369	2231	229	2514	45	2405
3L-2S		MI	789	727	1396	513	1559	421	1641	333	1760	181	1878	61	1664
6-#11	4.88	MA	1049	776	1785	568	2018	461	2178	379	2388	216	2671	-13	2663
3L-2S		MI	812	776	1480	537	1628	429	1717	329	1855	155	2004	21	1933
6-#14	7.03	MA	1142	895	2031	638	2323	510	2544	411	2840	196	3167	-130	3089
3L-2S		MI	883	895	1694	605	1856	465	1978	339	2186	111	2325	-85	2251
8-#5	1.29	MA	928	580	1419	456	1587	384	1669	326	1742	240	1978	197	895
2L-4S		MI	647	580	1002	436	1071	367	1091	311	1070	224	1153	139	666
8-#5	1.29	MA	896	580	1355	458	1505	385	1570	329	1607	242	1808	175	900
3E		MI	659	580	1032	435	1114	365	1143	312	1135	223	1224	147	661
8-#5	1.29	MA	878	580	1310	460	1441	388	1492	330	1501	241	1686	164	905
4L-2S		MI	680	580	1074	435	1167	365	1208	310	1218	222	1320	169	656
8-#6	1.83	MA	971	610	1528	473	1720	396	1829	334	1957	237	2239	188	1224
2L-4S		MI	662	610	1043	452	1118	378	1146	317	1139	219	1228	108	893
8-#6	1.83	MA	928	610	1437	475	1605	397	1690	337	1768	239	2002	156	1229
3E		MI	678	610	1086	451	1178	376	1219	318	1228	217	1326	120	885
8-#6	1.83	MA	904	610	1374	477	1516	401	1580	338	1619	239	1833	140	1232
4L-2S		MI	705	610	1145	451	1253	376	1311	317	1344	216	1457	151	879
8-#7	2.50	MA	966	646	1536	497	1727	412	1835	347	1964	237	2234	132	1621
3E		MI	700	646	1149	471	1255	390	1308	326	1339	209	1445	85	1148
8-#7	2.50	MA	934	646	1450	500	1606	418	1687	348	1769	239	2008	111	1587
4L-2S		MI	735	646	1228	471	1356	391	1428	324	1493	207	1617	128	1140
8-#8	3.29	MA	1010	690	1651	523	1868	431	2005	359	2193	233	2501	102	2069
3E		MI	725	690	1222	496	1344	407	1408	335	1465	200	1578	41	1444

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

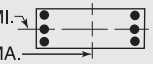
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#8	3.29	MA	970	690	1538	526	1711	438	1812	360	1939	237	2210	75	1937
4L-2S		MI	768	690	1324	496	1475	409	1562	332	1662	197	1796	98	1439
8-#9	4.17	MA	1057	738	1775	551	2022	451	2190	373	2441	230	2784	67	2547
3E		MI	752	738	1300	523	1440	425	1513	343	1598	188	1715	-9	1713
8-#9	4.17	MA	1009	738	1633	555	1824	460	1948	373	2122	234	2422	34	2304
4L-2S		MI	804	738	1427	523	1602	428	1703	340	1840	185	1980	63	1755
8-#10	5.29	MA	1121	799	1930	588	2215	477	2423	390	2750	224	3134	20	3083
3E		MI	786	799	1396	558	1559	450	1641	354	1760	172	1878	-76	1868
8-#10	5.29	MA	1058	799	1753	593	1967	488	2118	390	2351	229	2686	-20	2678
4L-2S		MI	847	799	1554	559	1760	454	1874	350	2057	167	2200	16	2146
10-#10	6.61	MA	1174	872	2002	639	2284	521	2503	411	2870	224	3305	-45	3272
4L-3S		MI	847	872	1554	603	1760	482	1874	371	2057	158	2200	-121	2177

RECTANGULAR TIED COLUMNS 12" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.11	MA	1159	641	1745	511	1954	430	2053	367	2128	273	2429	230	995
2E		MI	750	641	1184	476	1274	401	1305	341	1295	246	1389	189	651
4-#8	1.46	MA	1196	663	1838	523	2067	439	2187	372	2308	271	2651	223	1273
2E		MI	768	663	1234	487	1334	408	1371	344	1378	240	1476	173	814
4-#9	1.85	MA	1236	687	1937	536	2189	448	2333	378	2504	268	2888	215	1572
2E		MI	786	687	1287	499	1397	417	1441	347	1465	233	1564	155	985
4-#10	2.35	MA	1284	718	2063	553	2344	460	2518	385	2752	265	3184	204	1949
2E		MI	808	718	1353	515	1477	428	1526	350	1572	223	1671	130	1196
4-#11	2.89	MA	1326	751	2190	568	2491	470	2691	390	2981	260	3406	183	2320
2E		MI	822	751	1413	527	1523	430	1574	346	1632	204	1749	102	1394
4-#14	4.17	MA	1435	830	2488	613	2860	502	3133	409	3565	251	4063	147	3213
2E		MI	869	830	1558	570	1675	452	1747	350	1849	173	1958	30	1860
4-#18	7.41	MA	1683	1030	3195	729	3740	586	4193	459	4885	216	5527	37	5325
2E		MI	974	1030	1826	663	1981	499	2096	351	2292	79	2327	-189	2315
6-#6	1.22	MA	1174	648	1772	517	1993	435	2102	371	2196	274	2528	231	1087
2L-3S		MI	731	648	1140	484	1222	406	1247	347	1222	249	1311	157	711
6-#6	1.22	MA	1121	648	1666	520	1858	437	1938	375	1974	277	2237	199	1094
3L-2S		MI	759	648	1199	483	1297	406	1338	346	1338	248	1442	189	704
6-#7	1.67	MA	1222	676	1889	532	2137	446	2274	377	2428	271	2818	223	1439
2L-3S		MI	745	676	1184	498	1274	416	1305	352	1295	243	1389	128	919
6-#7	1.67	MA	1151	676	1745	536	1954	449	2053	383	2128	275	2429	180	1446
3L-2S		MI	781	676	1263	498	1374	416	1426	350	1449	241	1561	171	909
6-#8	2.19	MA	1276	708	2024	551	2305	459	2476	385	2699	268	3153	214	1847
2L-3S		MI	761	708	1234	516	1334	427	1371	358	1378	235	1476	91	1153
6-#8	2.19	MA	1186	708	1838	555	2067	462	2187	392	2308	273	2651	157	1850
3L-2S		MI	807	708	1336	515	1464	429	1526	356	1575	233	1694	148	1141
6-#9	2.78	MA	1334	744	2172	571	2487	474	2695	394	2994	265	3512	202	2288
2L-3S		MI	778	744	1287	535	1397	440	1441	364	1465	226	1564	50	1398
6-#9	2.78	MA	1225	744	1937	577	2189	478	2333	403	2504	271	2888	130	2281
3L-2S		MI	833	744	1414	535	1559	443	1631	361	1707	223	1830	122	1387
6-#10	3.53	MA	1406	790	2357	598	2718	493	2973	405	3368	261	3958	186	2844
2L-3S		MI	800	790	1353	560	1477	457	1526	372	1572	214	1671	-6	1671
6-#10	3.53	MA	1273	790	2063	605	2344	497	2518	416	2752	268	3184	95	2816
3L-2S		MI	866	790	1511	561	1678	461	1759	368	1869	209	1993	85	1690
6-#11	4.33	MA	1314	840	2190	630	2491	515	2691	427	2981	261	3406	44	3296
3L-2S		MI	888	840	1596	583	1748	468	1835	364	1963	183	2117	45	1964
6-#14	6.25	MA	1437	958	2488	701	2860	565	3133	460	3565	250	4063	-59	4006
3L-2S		MI	960	958	1811	650	1975	504	2095	373	2293	138	2436	-62	2363
8-#5	1.15	MA	1168	644	1750	516	1970	435	2077	371	2164	275	2495	234	1029
2L-4S		MI	724	644	1115	484	1190	408	1209	347	1181	253	1270	164	679
8-#5	1.15	MA	1130	644	1675	518	1874	436	1960	374	2006	277	2286	211	1034
3E		MI	736	644	1145	484	1233	407	1261	348	1245	252	1341	172	673

RECTANGULAR TIED COLUMNS 12" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#5	1.15	MA	1109	644	1622	520	1800	440	1870	375	1882	278	2138	199	1039
4L-2S		MI	756	644	1188	483	1287	407	1327	347	1329	251	1437	195	669
8-#6	1.63	MA	1220	673	1878	533	2128	446	2266	378	2418	272	2818	226	1414
2L-4S		MI	738	673	1156	500	1237	420	1265	353	1249	247	1345	133	910
8-#6	1.63	MA	1168	673	1772	535	1993	449	2102	382	2196	275	2528	195	1420
3E		MI	755	673	1199	500	1297	417	1338	354	1338	246	1442	145	902
8-#6	1.63	MA	1140	673	1698	538	1889	454	1974	384	2022	276	2322	178	1422
4L-2S		MI	782	673	1258	499	1372	418	1429	353	1454	244	1574	176	895
8-#7	2.22	MA	1214	710	1889	557	2137	464	2274	393	2428	273	2818	173	1881
3E		MI	777	710	1263	520	1374	431	1426	362	1449	238	1561	110	1168
8-#7	2.22	MA	1177	710	1788	561	1996	471	2102	394	2192	273	2542	151	1870
4L-2S		MI	811	710	1342	519	1475	432	1546	360	1602	236	1733	153	1159
8-#8	2.93	MA	1268	753	2024	583	2305	483	2476	405	2699	270	3153	147	2411
3E		MI	802	753	1336	544	1464	448	1526	370	1575	228	1694	66	1469
8-#8	2.93	MA	1222	753	1893	588	2121	491	2251	407	2391	270	2796	118	2298
4L-2S		MI	845	753	1439	544	1594	449	1680	368	1771	225	1912	123	1460
8-#9	3.70	MA	1326	801	2172	612	2487	504	2695	419	2994	267	3512	117	2979
3E		MI	828	801	1414	570	1559	466	1631	379	1707	216	1830	16	1783
8-#9	3.70	MA	1269	801	2007	618	2256	514	2412	421	2607	267	3067	81	2738
4L-2S		MI	881	801	1541	571	1721	469	1820	376	1949	213	2095	88	1780
8-#10	4.70	MA	1399	863	2357	650	2718	530	2973	437	3368	264	3958	77	3688
3E		MI	862	863	1511	605	1678	490	1759	389	1869	199	1993	-51	1987
8-#10	4.70	MA	1330	863	2150	656	2427	543	2617	439	2881	262	3405	32	3281
4L-2S		MI	924	863	1669	606	1879	494	1992	385	2166	195	2314	40	2174
8-#11	5.78	MA	1381	929	2292	692	2589	569	2805	453	3152	262	3655	-35	3635
4L-2S		MI	955	929	1780	639	1972	506	2095	382	2294	162	2484	-12	2397
10-#10	5.88	MA	1459	935	2444	702	2802	576	3072	460	3496	258	4179	14	4122
4L-3S		MI	923	935	1669	650	1879	523	1992	407	2166	185	2314	-96	2298
10-#10	5.88	MA	1375	935	2231	716	2545	581	2754	471	3055	265	3636	-40	3611
5L-2S		MI	982	935	1828	651	2081	527	2225	402	2463	181	2635	-5	2635
12-#10	7.06	MA	1503	1008	2525	762	2920	614	3208	491	3671	260	4409	-58	4354
5L-3S		MI	983	1008	1828	696	2081	556	2225	424	2463	171	2635	-141	2605

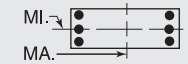
RECTANGULAR TIED COLUMNS 12" x 20"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.00	MA	1424	705	2106	571	2374	481	2498	412	2586	308	2985	265	1124
2E		MI	827	705	1298	525	1393	442	1423	377	1405	275	1505	214	665
4-#8	1.32	MA	1468	727	2213	582	2504	489	2653	417	2795	306	3253	260	1443
2E		MI	844	727	1349	535	1453	449	1489	380	1488	268	1591	198	830
4-#9	1.67	MA	1515	751	2329	595	2646	499	2823	422	3022	303	3541	253	1788
2E		MI	862	751	1402	547	1517	457	1558	382	1574	261	1679	180	1004
4-#10	2.12	MA	1573	782	2475	612	2825	511	3038	429	3310	300	3903	245	2224
2E		MI	884	782	1468	563	1596	468	1643	385	1681	251	1786	155	1217
4-#11	2.60	MA	1624	815	2626	627	3001	521	3243	434	3582	295	4191	228	2657
2E		MI	899	815	1529	574	1642	470	1692	380	1739	231	1862	126	1420
4-#14	3.75	MA	1758	893	2974	672	3433	553	3762	453	4280	288	5012	199	3699
2E		MI	946	893	1674	616	1794	491	1863	384	1956	200	2070	53	1892
4-#18	6.67	MA	2058	1093	3811	789	4474	637	5016	504	5960	270	6886	109	6189
2E		MI	1050	1093	1944	707	2100	537	2211	383	2397	105	2436	-166	2508
6-#6	1.10	MA	1442	712	2136	577	2417	486	2553	415	2664	309	3099	266	1229
2L-3S		MI	807	712	1254	532	1341	447	1365	383	1332	278	1428	183	723
6-#6	1.10	MA	1379	712	2014	580	2262	488	2365	420	2409	313	2754	234	1236
3L-2S		MI	835	712	1313	532	1416	448	1456	382	1448	277	1559	214	718

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 20"

Short columns – no sidesway
Bending on major or minor axis

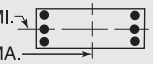


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.50	MA	1498	739	2271	592	2583	497	2752	422	2931	306	3448	260	1633
2L-3S		MI	821	739	1298	546	1393	457	1423	388	1405	272	1505	153	935
6-#7	1.50	MA	1415	739	2106	596	2374	500	2498	428	2586	311	2985	217	1640
3L-2S		MI	858	739	1377	546	1494	458	1544	386	1558	270	1677	196	925
6-#8	1.98	MA	1562	772	2428	610	2778	510	2986	429	3244	303	3853	253	2103
2L-3S		MI	837	772	1349	563	1453	468	1489	394	1488	264	1591	116	1173
6-#8	1.98	MA	1457	772	2213	616	2504	514	2653	438	2795	310	3253	196	2106
3L-2S		MI	883	772	1451	563	1583	470	1644	391	1684	261	1809	173	1160
6-#9	2.50	MA	1631	808	2598	631	2989	525	3240	438	3586	300	4288	244	2612
2L-3S		MI	854	808	1402	582	1517	481	1558	400	1574	254	1679	74	1422
6-#9	2.50	MA	1502	808	2329	637	2646	530	2823	448	3022	308	3541	172	2605
3L-2S		MI	910	808	1529	582	1678	483	1748	397	1816	251	1945	146	1408
6-#10	3.17	MA	1716	854	2814	658	3257	544	3563	450	4021	296	4832	232	3255
2L-3S		MI	876	854	1468	607	1596	497	1643	407	1681	241	1786	18	1725
6-#10	3.17	MA	1560	854	2475	666	2825	550	3038	462	3310	305	3903	141	3228
3L-2S		MI	943	854	1627	608	1797	501	1876	403	1978	237	2107	110	1714
6-#11	3.90	MA	1610	904	2626	691	3001	568	3243	473	3582	299	4191	95	3833
3L-2S		MI	965	904	1712	629	1867	507	1952	398	2070	210	2229	69	1993
6-#14	5.63	MA	1746	1022	2974	764	3433	619	3762	508	4280	292	5012	3	5004
3L-2S		MI	1036	1022	1927	696	2095	543	2212	407	2400	165	2548	-38	2559
8-#5	1.03	MA	1434	707	2110	576	2390	485	2524	415	2625	310	3057	269	1163
2L-4S		MI	800	707	1228	533	1309	450	1328	383	1291	282	1387	189	690
8-#5	1.03	MA	1389	707	2024	578	2280	487	2390	419	2444	313	2810	246	1168
3E		MI	812	707	1259	533	1352	448	1380	384	1355	281	1458	198	686
8-#5	1.03	MA	1365	707	1964	580	2196	491	2287	420	2303	314	2636	234	1173
4L-2S		MI	833	707	1301	532	1406	448	1445	383	1439	280	1554	220	682
8-#6	1.47	MA	1496	737	2257	592	2572	497	2742	422	2918	308	3444	263	1604
2L-4S		MI	815	737	1270	549	1357	461	1383	389	1359	276	1461	159	926
8-#6	1.47	MA	1435	737	2136	595	2417	500	2553	427	2664	311	3099	231	1610
3E		MI	831	737	1313	548	1416	459	1456	390	1448	275	1559	170	917
8-#6	1.47	MA	1402	737	2052	599	2299	505	2408	429	2465	312	2856	214	1612
4L-2S		MI	858	737	1372	548	1491	459	1547	389	1564	273	1690	202	910
8-#7	2.00	MA	1490	774	2271	617	2583	516	2752	438	2931	309	3448	213	2140
3E		MI	853	774	1377	568	1494	472	1544	398	1558	267	1677	135	1187
8-#7	2.00	MA	1447	774	2156	622	2423	523	2555	440	2661	310	3122	189	2129
4L-2S		MI	888	774	1456	567	1594	473	1665	396	1712	265	1849	178	1178
8-#8	2.63	MA	1553	817	2428	644	2778	535	2986	451	3244	307	3853	190	2752
3E		MI	878	817	1451	592	1583	488	1644	406	1684	256	1809	91	1491
8-#8	2.63	MA	1499	817	2278	649	2568	544	2728	454	2892	308	3430	159	2670
4L-2S		MI	922	817	1553	591	1713	490	1798	403	1881	254	2027	148	1482
8-#9	3.33	MA	1622	865	2598	673	2989	556	3240	465	3586	304	4288	163	3411
3E		MI	904	865	1529	618	1678	507	1748	414	1816	244	1945	41	1811
8-#9	3.33	MA	1556	865	2410	679	2725	567	2916	468	3143	305	3760	124	3185
4L-2S		MI	957	865	1656	618	1840	509	1938	411	2058	241	2210	113	1804
8-#10	4.23	MA	1708	927	2814	711	3257	583	3563	483	4021	301	4832	128	4237
3E		MI	937	927	1627	652	1797	530	1876	424	1978	227	2107	-27	2105
8-#10	4.23	MA	1629	927	2577	719	2924	597	3154	487	3462	302	4174	79	3820
4L-2S		MI	1001	927	1785	653	1999	534	2110	420	2275	223	2428	65	2201
8-#11	5.20	MA	1692	993	2746	755	3117	624	3380	502	3760	293	4502	18	4423
4L-2S		MI	1031	993	1896	685	2092	545	2212	416	2402	189	2597	12	2555
8-#14	7.50	MA	1865	1150	3143	855	3595	699	3953	548	4565	296	5437	-109	5326
4L-2S		MI	1127	1150	2180	776	2395	594	2560	429	2843	130	3026	-129	2926
10-#10	5.29	MA	1781	999	2916	764	3356	630	3679	508	4173	298	5103	66	4796
4L-3S		MI	998	999	1785	698	1999	563	2110	442	2275	213	2428	-72	2419
10-#10	5.29	MA	1677	999	2673	780	3064	636	3316	520	3668	307	4451	13	4411
5L-2S		MI	1059	999	1943	698	2200	567	2343	437	2571	209	2750	19	2682
12-#10	6.35	MA	1826	1072	3013	825	3496	669	3841	541	4378	302	5381	0	5380
5L-3S		MI	1059	1072	1943	743	2200	596	2343	459	2571	199	2750	-117	2728

RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

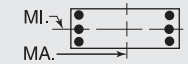
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.20	MA	1766	790	2618	642	2978	540	3159	461	3320	341	3901	295	1614
2E		MI	921	790	1463	583	1572	490	1607	415	1597	297	1707	223	845
4-#9	1.52	MA	1821	814	2750	655	3139	550	3351	466	3579	339	4241	290	2004
2E		MI	939	814	1517	594	1636	498	1676	418	1684	289	1794	204	1021
4-#10	1.92	MA	1888	845	2916	672	3344	562	3596	473	3908	336	4668	284	2498
2E		MI	961	845	1584	610	1715	509	1761	421	1790	279	1900	179	1238
4-#11	2.36	MA	1949	878	3091	687	3547	572	3834	479	4222	330	5025	269	2994
2E		MI	975	878	1645	620	1762	509	1809	414	1847	259	1974	150	1445
4-#14	3.41	MA	2105	957	3491	732	4043	604	4429	498	5023	323	6012	246	4185
2E		MI	1022	957	1791	661	1913	530	1980	418	2063	227	2181	77	1923
4-#18	6.06	MA	2464	1157	4456	849	5245	688	5877	548	6973	307	8302	173	7053
2E		MI	1126	1157	2062	752	2219	575	2327	416	2502	132	2545	-143	2612
6-#6	1.00	MA	1735	775	2530	636	2878	537	3044	460	3170	344	3710	300	1372
2L-3S		MI	883	775	1368	581	1461	489	1483	419	1442	307	1544	208	736
6-#6	1.00	MA	1663	775	2392	640	2703	540	2832	462	2883	349	3312	268	1379
3L-2S		MI	912	775	1427	580	1536	489	1574	418	1558	305	1675	239	731
6-#7	1.36	MA	1800	803	2683	652	3067	548	3270	466	3473	342	4124	296	1827
2L-3S		MI	897	803	1412	595	1512	498	1541	424	1515	300	1621	178	950
6-#7	1.36	MA	1705	803	2497	656	2830	552	2982	473	3084	347	3586	253	1835
3L-2S		MI	934	803	1491	594	1613	499	1662	422	1668	298	1793	221	940
6-#8	1.80	MA	1875	835	2861	670	3287	561	3535	474	3829	339	4599	291	2359
2L-3S		MI	914	835	1463	611	1572	509	1607	430	1597	292	1707	141	1191
6-#8	1.80	MA	1753	835	2618	676	2978	566	3159	483	3320	346	3901	234	2362
3L-2S		MI	960	835	1565	611	1702	511	1762	427	1794	289	1925	198	1178
6-#9	2.27	MA	1955	871	3055	691	3528	576	3824	483	4218	335	5111	284	2936
2L-3S		MI	931	871	1517	630	1636	521	1676	435	1684	282	1794	99	1445
6-#9	2.27	MA	1806	871	2750	698	3139	582	3351	494	3579	344	4241	212	2929
3L-2S		MI	987	871	1644	630	1798	524	1866	432	1925	279	2059	171	1429
6-#10	2.89	MA	2054	918	3301	717	3834	595	4191	494	4713	332	5755	275	3667
2L-3S		MI	952	918	1584	654	1715	537	1761	442	1790	269	1900	43	1753
6-#10	2.89	MA	1873	918	2916	726	3344	602	3596	508	3908	342	4668	183	3639
3L-2S		MI	1020	918	1742	655	1917	542	1994	438	2087	265	2221	134	1738
6-#11	3.55	MA	1933	967	3091	753	3547	620	3834	520	4222	337	5025	142	4339
3L-2S		MI	1042	967	1829	675	1986	547	2069	432	2178	237	2342	93	2022
6-#14	5.11	MA	2092	1086	3491	825	4043	672	4429	556	5023	331	6012	58	5844
3L-2S		MI	1113	1086	2044	741	2214	581	2328	440	2507	192	2659	-14	2664
8-#6	1.33	MA	1797	801	2667	652	3053	548	3257	467	3458	343	4108	298	1794
2L-4S		MI	891	801	1384	597	1476	502	1501	425	1469	305	1578	184	940
8-#6	1.33	MA	1727	801	2530	655	2878	551	3044	469	3170	347	3710	266	1800
3E		MI	907	801	1427	597	1536	500	1574	427	1558	303	1675	195	931
8-#6	1.33	MA	1690	801	2435	659	2745	557	2881	474	2946	349	3432	248	1802
4L-2S		MI	935	801	1485	596	1611	501	1665	425	1674	302	1807	227	925
8-#7	1.82	MA	1791	837	2683	678	3067	567	3270	483	3473	345	4124	250	2399
3E		MI	929	837	1491	616	1613	513	1662	433	1668	295	1793	160	1205
8-#7	1.82	MA	1742	837	2554	682	2886	575	3048	486	3170	347	3747	225	2388
4L-2S		MI	965	837	1570	616	1713	514	1783	431	1822	293	1965	203	1195
8-#8	2.39	MA	1865	881	2861	704	3287	586	3535	496	3829	343	4599	230	3093
3E		MI	954	881	1565	639	1702	529	1762	441	1794	285	1925	116	1513
8-#8	2.39	MA	1803	881	2693	710	3051	596	3245	500	3432	346	4109	197	3051
4L-2S		MI	999	881	1667	639	1832	531	1916	439	1990	282	2143	173	1502
8-#9	3.03	MA	1944	929	3055	734	3528	607	3824	510	4218	341	5111	206	3843
3E		MI	980	929	1644	666	1798	547	1866	450	1925	272	2059	65	1837
8-#9	3.03	MA	1869	929	2844	741	3231	620	3459	515	3719	343	4499	165	3642
4L-2S		MI	1034	929	1771	666	1959	550	2056	446	2167	269	2325	137	1827

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	3.85	MA	2045	990	3301	772	3834	635	4191	529	4713	338	5755	174	4785
3E		MI	1013	990	1742	699	1917	570	1994	459	2087	255	2221	-2	2221
8-#10	3.85	MA	1954	990	3034	780	3458	651	3731	534	4083	341	4990	123	4372
4L-2S		MI	1078	990	1900	700	2118	574	2227	455	2383	251	2543	89	2227
8-#11	4.73	MA	2029	1056	3230	818	3682	679	3993	551	4429	333	5397	67	5073
4L-2S		MI	1108	1056	2012	731	2211	585	2329	450	2509	216	2710	36	2587
8-#14	6.82	MA	2232	1214	3687	919	4232	755	4653	599	5314	323	6526	-51	6456
4L-2S		MI	1203	1214	2297	822	2514	633	2677	463	2950	157	3137	-106	3039
10-#10	4.81	MA	2129	1063	3419	826	3948	684	4326	555	4888	336	6077	114	5483
4L-3S		MI	1074	1063	1900	745	2118	603	2227	477	2383	241	2543	-47	2537
10-#10	4.81	MA	2005	1063	3146	843	3619	691	3918	569	4321	347	5314	61	5096
5L-2S		MI	1136	1063	2058	746	2319	607	2461	472	2680	237	2864	44	2711
10-#11	5.91	MA	2093	1145	3362	894	3873	727	4214	592	4710	339	5777	-14	5763
5L-2S		MI	1174	1145	2195	787	2436	622	2589	469	2841	195	3077	-20	2968
12-#10	5.77	MA	2177	1135	3531	888	4109	724	4513	589	5126	343	6401	52	6206
5L-3S		MI	1135	1135	2058	790	2319	636	2461	494	2680	227	2864	-92	2849
12-#10	5.77	MA	2059	1135	3293	896	3785	739	4111	595	4583	354	5702	-7	5695
6L-2S		MI	1194	1135	2216	791	2521	640	2694	490	2977	223	3185	-1	3185
14-#10	6.73	MA	2234	1208	3677	941	4275	772	4706	616	5388	350	6789	-16	6762
6L-3S		MI	1195	1208	2216	835	2521	669	2694	511	2977	213	3185	-138	3157

RECTANGULAR TIED COLUMNS 12" x 24"

4-#8	1.10	MA	2090	854	3053	702	3488	591	3703	505	3885	377	4574	328	1785
2E		MI	997	854	1577	631	1691	531	1725	451	1707	325	1822	248	860
4-#9	1.39	MA	2152	878	3201	715	3669	601	3919	511	4175	374	4973	325	2220
2E		MI	1015	878	1632	642	1755	538	1794	453	1793	317	1909	229	1038
4-#10	1.76	MA	2230	909	3387	732	3899	613	4194	518	4544	371	5479	321	2772
2E		MI	1037	909	1699	657	1835	549	1879	456	1899	307	2014	204	1257
4-#11	2.17	MA	2300	942	3585	747	4129	623	4464	523	4901	366	5905	309	3331
2E		MI	1052	942	1761	666	1881	549	1926	449	1955	286	2087	174	1469
4-#14	3.13	MA	2480	1021	4037	792	4689	655	5136	542	5805	359	7061	290	4671
2E		MI	1099	1021	1908	707	2032	569	2097	452	2170	254	2293	101	1953
4-#18	5.56	MA	2900	1221	5131	908	6052	739	6778	593	8016	342	9773	231	7917
2E		MI	1202	1221	2180	796	2338	612	2443	449	2608	158	2654	-120	2714
6-#7	1.25	MA	2128	867	3125	711	3587	599	3826	510	4054	377	4810	328	2022
2L-3S		MI	974	867	1526	643	1632	539	1659	460	1624	329	1737	203	964
6-#7	1.25	MA	2020	867	2917	716	3323	603	3506	514	3620	383	4209	286	2029
3L-2S		MI	1011	867	1605	642	1732	540	1780	458	1778	327	1909	246	955
6-#8	1.65	MA	2214	899	3324	730	3834	612	4123	518	4453	374	5360	324	2615
2L-3S		MI	990	899	1577	659	1691	550	1725	465	1707	320	1822	166	1209
6-#8	1.65	MA	2076	899	3053	736	3488	617	3703	523	3885	382	4574	268	2618
3L-2S		MI	1037	899	1680	659	1821	551	1880	463	1903	318	2040	223	1195
6-#9	2.08	MA	2305	935	3542	750	4103	626	4447	527	4889	371	5961	320	3260
2L-3S		MI	1007	935	1632	677	1755	562	1794	471	1793	311	1909	124	1466
6-#9	2.08	MA	2136	935	3201	758	3669	633	3919	533	4175	381	4973	249	3253
3L-2S		MI	1063	935	1759	678	1917	564	1984	467	2034	307	2174	196	1449
6-#10	2.65	MA	2418	981	3817	777	4446	646	4859	538	5444	367	6725	315	4078
2L-3S		MI	1028	981	1699	701	1835	578	1879	477	1899	297	2014	67	1778
6-#10	2.65	MA	2213	981	3387	787	3899	654	4194	554	4544	379	5479	224	4051
3L-2S		MI	1096	981	1857	702	2036	582	2112	473	2195	293	2336	159	1761
6-#11	3.25	MA	2282	1031	3585	813	4129	672	4464	566	4901	374	5905	186	4844
3L-2S		MI	1118	1031	1945	722	2106	586	2186	467	2286	265	2455	117	2050
6-#14	4.69	MA	2465	1149	4037	887	4689	725	5136	602	5805	369	7061	109	6714
3L-2S		MI	1189	1149	2161	787	2333	620	2445	474	2614	219	2771	9	2740

RECTANGULAR TIED COLUMNS 12" x 24"

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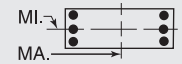


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#6	1.22	MA	2125	864	3107	712	3571	599	3811	511	4036	378	4787	329	1984
2L-4S		MI	967	864	1497	646	1595	544	1619	461	1579	333	1694	209	953
8-#6	1.22	MA	2045	864	2954	715	3376	602	3574	514	3716	383	4344	298	1990
3E		MI	984	864	1540	645	1655	541	1693	463	1668	332	1792	220	945
8-#6	1.22	MA	2003	864	2849	719	3228	609	3393	520	3468	385	4038	280	1993
4L-2S		MI	1011	864	1599	645	1730	542	1784	461	1784	331	1923	252	939
8-#7	1.67	MA	2118	901	3125	738	3587	618	3826	524	4054	381	4810	283	2658
3E		MI	1005	901	1605	664	1732	554	1780	469	1778	324	1909	185	1221
8-#7	1.67	MA	2063	901	2982	743	3386	627	3580	531	3718	384	4395	258	2648
4L-2S		MI	1041	901	1684	664	1833	555	1901	467	1932	322	2081	228	1212
8-#8	2.19	MA	2202	944	3324	764	3834	638	4123	536	4453	380	5360	265	3435
3E		MI	1030	944	1680	687	1821	570	1880	477	1903	313	2040	141	1533
8-#8	2.19	MA	2133	944	3138	771	3571	648	3801	545	4012	383	4814	232	3397
4L-2S		MI	1076	944	1782	687	1952	572	2034	474	2100	310	2258	198	1521
8-#9	2.78	MA	2293	992	3542	794	4103	659	4447	549	4889	378	5961	244	4275
3E		MI	1057	992	1759	713	1917	588	1984	485	2034	300	2174	90	1861
8-#9	2.78	MA	2209	992	3307	802	3773	673	4042	561	4334	381	5272	203	4110
4L-2S		MI	1111	992	1886	713	2079	590	2174	482	2276	297	2439	162	1849
8-#10	3.53	MA	2407	1054	3817	832	4446	687	4859	574	5444	375	6725	218	5334
3E		MI	1089	1054	1857	747	2036	611	2112	494	2195	283	2336	22	2262
8-#10	3.53	MA	2305	1054	3521	842	4029	704	4348	581	4743	379	5853	165	4936
4L-2S		MI	1155	1054	2015	748	2237	615	2345	490	2492	279	2657	114	2253
8-#11	4.33	MA	2393	1120	3744	880	4284	732	4646	598	5138	372	6340	112	5736
4L-2S		MI	1185	1120	2128	777	2330	624	2446	485	2617	244	2822	60	2618
8-#14	6.25	MA	2627	1278	4261	982	4906	811	5392	648	6138	365	7664	2	7655
4L-2S		MI	1280	1278	2414	867	2634	672	2793	497	3057	184	3249	-82	3151
10-#10	4.41	MA	2504	1126	3951	887	4576	736	5013	602	5643	375	7098	159	6183
4L-3S		MI	1150	1126	2015	792	2237	643	2345	512	2492	269	2657	-23	2655
10-#10	4.41	MA	2359	1126	3648	905	4212	745	4559	617	5013	387	6224	106	5803
5L-2S		MI	1213	1126	2173	793	2439	648	2578	508	2789	265	2978	69	2738
10-#11	5.42	MA	2460	1209	3895	957	4501	782	4898	641	5458	381	6778	37	6639
5L-2S		MI	1251	1209	2312	833	2555	662	2706	503	2948	222	3190	4	3178
10-#14	7.81	MA	2724	1406	4473	1092	5212	881	5746	708	6588	375	8276	-111	8125
5L-2S		MI	1370	1406	2667	947	2934	723	3142	520	3501	149	3727	-174	3599
12-#10	5.29	MA	2554	1199	4078	951	4759	778	5224	637	5913	383	7470	100	7052
5L-3S		MI	1211	1199	2173	837	2439	676	2578	529	2789	255	2978	-68	2969
12-#10	5.29	MA	2421	1199	3807	958	4399	794	4778	644	5310	395	6671	40	6476
6L-2S		MI	1271	1199	2331	838	2640	681	2812	525	3086	251	3299	23	3219
12-#11	6.50	MA	2536	1298	4092	1022	4724	842	5157	673	5811	389	7302	-46	7238
6L-2S		MI	1317	1298	2495	889	2779	699	2966	521	3279	201	3558	-53	3426
14-#10	6.17	MA	2619	1271	4237	1003	4947	827	5443	665	6210	391	7917	34	7745
6L-3S		MI	1270	1271	2331	883	2640	709	2812	546	3086	241	3299	-113	3280

RECTANGULAR TIED COLUMNS 14" x 14"

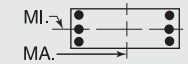
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#6	1.35	MA	822	595	1285	456	1416	383	1478	325	1527	237	1686	186	818
2L-3S		MI	786	595	1210	458	1321	384	1363	328	1372	238	1502	154	825
6-#7	1.84	MA	853	623	1366	471	1515	394	1597	332	1680	232	1860	172	1069
2L-3S		MI	805	623	1265	473	1387	394	1442	335	1473	234	1617	129	1077
6-#8	2.42	MA	888	655	1460	489	1631	407	1736	339	1856	227	2060	156	1357
2L-3S		MI	828	655	1329	491	1465	407	1534	343	1590	230	1749	99	1365
6-#9	3.06	MA	924	691	1561	509	1755	421	1885	348	2042	220	2268	136	1665
2L-3S		MI	854	691	1398	512	1548	421	1633	353	1714	224	1886	64	1667

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 14"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

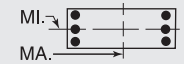
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	3.89	MA	969	737	1687	536	1911	440	2073	359	2274	211	2523	109	2049
2L-3S		MI	884	737	1483	538	1652	440	1758	364	1867	216	2054	18	2019
6-#11	4.78	MA	1003	787	1804	560	2049	457	2222	365	2440	192	2667	62	2406
2L-3S		MI	907	787	1565	561	1745	454	1856	370	1975	197	2146	-50	2132
8-#6	1.80	MA	853	620	1359	472	1511	394	1594	333	1681	235	1869	177	1052
2L-4S		MI	797	620	1231	475	1341	399	1387	335	1408	238	1553	131	1064
8-#7	2.45	MA	894	657	1466	492	1643	409	1752	341	1886	230	2103	159	1380
2L-4S		MI	821	657	1294	496	1414	415	1474	344	1521	234	1683	98	1362
8-#8	3.22	MA	939	700	1590	517	1797	427	1937	352	2121	223	2370	138	1757
2L-4S		MI	848	700	1366	522	1499	433	1575	355	1652	228	1832	57	1652
8-#9	4.08	MA	987	748	1723	545	1962	447	2137	364	2371	214	2649	112	2161
2L-4S		MI	881	748	1443	550	1591	454	1684	367	1790	221	1987	11	1955

RECTANGULAR TIED COLUMNS 14" x 16"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.07	MA	1057	663	1610	519	1782	437	1859	374	1909	278	2134	229	881
2E		MI	916	663	1418	508	1549	428	1604	365	1625	270	1779	215	767
4-#8	1.41	MA	1087	684	1688	531	1877	445	1972	378	2060	275	2310	220	1121
2E		MI	940	684	1482	519	1626	435	1696	369	1741	265	1910	204	968
4-#9	1.79	MA	1119	708	1773	543	1980	454	2094	383	2225	273	2496	209	1378
2E		MI	965	708	1551	531	1710	444	1795	374	1864	260	2046	190	1182
4-#10	2.27	MA	1159	739	1879	560	2109	466	2249	390	2429	269	2727	195	1699
2E		MI	996	739	1637	548	1814	456	1920	381	2018	254	2214	172	1448
4-#11	2.79	MA	1191	772	1984	574	2230	476	2389	395	2586	258	2881	169	2013
2E		MI	1018	772	1720	561	1907	464	2017	383	2124	239	2304	139	1704
4-#14	4.02	MA	1278	851	2232	618	2535	507	2755	413	3036	242	3376	123	2764
2E		MI	1085	851	1917	604	2148	495	2280	394	2456	217	2642	79	2313
4-#18	7.14	MA	1476	1051	2812	734	3255	590	3584	455	4053	193	4439	-16	4429
2E		MI	1234	1051	2369	718	2659	564	2851	416	3179	150	3465	-62	3325
6-#6	1.18	MA	1069	669	1632	526	1815	442	1901	377	1969	279	2218	229	960
2L-3S		MI	890	669	1362	516	1482	434	1525	372	1524	273	1665	184	839
6-#6	1.18	MA	1024	669	1542	528	1700	444	1762	381	1780	281	1981	198	967
3L-2S		MI	926	669	1436	515	1577	433	1640	369	1679	271	1848	216	833
6-#7	1.61	MA	1108	697	1731	541	1937	453	2047	383	2164	276	2449	219	1263
2L-3S		MI	909	697	1418	531	1549	444	1604	378	1625	269	1779	159	1096
6-#7	1.61	MA	1049	697	1610	543	1782	455	1859	388	1909	279	2134	176	1272
3L-2S		MI	957	697	1518	529	1677	443	1759	375	1831	267	2022	203	1086
6-#8	2.12	MA	1153	729	1847	559	2079	466	2217	391	2392	273	2715	207	1613
2L-3S		MI	931	729	1482	549	1626	456	1696	386	1741	264	1910	129	1388
6-#8	2.12	MA	1078	729	1688	562	1877	468	1972	397	2060	276	2310	150	1621
3L-2S		MI	993	729	1612	547	1792	456	1897	382	2007	261	2221	186	1377
6-#9	2.68	MA	1201	765	1971	579	2233	480	2401	400	2640	269	2997	192	1989
2L-3S		MI	955	765	1551	569	1710	470	1795	395	1864	258	2046	94	1696
6-#9	2.68	MA	1109	765	1773	583	1980	483	2094	407	2225	273	2496	120	1991
3L-2S		MI	1029	765	1714	567	1917	470	2046	391	2193	254	2428	166	1688
6-#10	3.40	MA	1260	812	2127	606	2426	499	2634	411	2949	264	3347	171	2460
2L-3S		MI	988	812	1637	595	1814	488	1920	407	2018	249	2214	47	2072
6-#10	3.40	MA	1148	812	1879	610	2109	502	2249	419	2429	269	2727	80	2447
3L-2S		MI	1074	812	1841	593	2073	489	2234	402	2425	245	2682	139	2075
6-#11	4.18	MA	1305	861	2279	630	2605	516	2845	420	3187	250	3585	134	2911
2L-3S		MI	1010	861	1720	617	1907	502	2017	412	2124	231	2304	-21	2299
6-#11	4.18	MA	1184	861	1984	634	2230	517	2389	428	2586	255	2881	22	2832
3L-2S		MI	1108	861	1959	616	2211	505	2382	407	2589	225	2824	92	2438
6-#14	6.03	MA	1275	979	2232	703	2535	565	2755	460	3036	235	3376	-96	3322
3L-2S		MI	1207	979	2251	685	2573	553	2778	427	3090	194	3338	4	3323
8-#6	1.57	MA	1108	695	1722	541	1930	454	2041	384	2157	277	2454	223	1242
2L-4S		MI	901	695	1383	533	1503	449	1549	379	1560	272	1715	162	1083

RECTANGULAR TIED COLUMNS 14" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

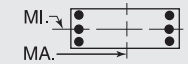
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#6	1.57	MA	1063	695	1632	544	1815	455	1901	388	1969	280	2218	191	1248
3E		MI	921	695	1436	532	1577	445	1640	379	1679	271	1848	175	1076
8-#6	1.57	MA	1039	695	1568	546	1726	460	1792	389	1819	279	2048	176	1254
4L-2S		MI	957	695	1511	530	1672	444	1756	376	1833	269	2031	207	1069
8-#7	2.14	MA	1159	731	1853	562	2092	469	2235	393	2419	274	2765	210	1639
2L-4S		MI	924	731	1446	554	1576	464	1636	388	1673	268	1845	128	1411
8-#7	2.14	MA	1101	731	1731	565	1937	470	2047	398	2164	277	2449	167	1645
3E		MI	951	731	1518	552	1677	459	1759	388	1831	266	2022	146	1407
8-#7	2.14	MA	1070	731	1645	568	1816	476	1899	399	1969	280	2223	146	1643
4L-2S		MI	998	731	1618	551	1805	459	1914	385	2037	264	2265	190	1400
8-#8	2.82	MA	1218	774	2005	587	2281	486	2462	404	2724	270	3121	194	2098
2L-4S		MI	951	774	1518	579	1661	483	1737	398	1803	262	1993	87	1714
8-#8	2.82	MA	1146	774	1847	590	2079	489	2217	410	2392	274	2715	137	2099
3E		MI	988	774	1612	577	1792	477	1897	399	2007	260	2221	111	1786
8-#8	2.82	MA	1105	774	1734	594	1921	496	2024	411	2138	277	2424	110	2014
4L-2S		MI	1044	774	1743	575	1958	476	2099	395	2272	257	2531	168	1780
8-#9	3.57	MA	1281	822	2170	615	2485	506	2708	416	3055	266	3499	174	2593
2L-4S		MI	984	822	1596	607	1753	503	1846	410	1941	255	2148	41	2023
8-#9	3.57	MA	1193	822	1971	619	2233	509	2401	423	2640	270	2997	102	2584
3E		MI	1024	822	1714	605	1917	496	2046	412	2193	252	2428	70	2185
8-#9	3.57	MA	1143	822	1830	623	2035	518	2159	423	2322	273	2636	69	2389
4L-2S		MI	1092	822	1876	603	2124	496	2298	407	2522	248	2810	141	2187
8-#10	4.54	MA	1257	884	2127	656	2426	535	2634	440	2949	264	3347	55	3184
3E		MI	1071	884	1841	641	2073	521	2234	427	2425	241	2682	14	2649
8-#10	4.54	MA	1192	884	1950	660	2178	545	2330	440	2550	268	2898	14	2849
4L-2S		MI	1152	884	2044	638	2333	522	2549	422	2831	237	3150	106	2695
8-#11	5.57	MA	1305	950	2279	690	2605	558	2845	454	3187	247	3585	-14	3574
3E		MI	1105	950	1959	673	2211	543	2382	436	2589	217	2824	-68	2800
10-#10	5.67	MA	1308	957	2199	706	2494	578	2715	461	3069	264	3518	-10	3511
4L-3S		MI	1152	957	2044	686	2333	554	2549	448	2831	233	3150	-18	3139

RECTANGULAR TIED COLUMNS 14" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.25	MA	1369	759	2082	600	2332	505	2455	430	2562	317	2926	263	1291
2E		MI	1044	759	1635	577	1788	485	1857	412	1892	300	2071	234	984
4-#9	1.59	MA	1408	782	2182	613	2455	514	2601	435	2758	314	3162	255	1594
2E		MI	1069	782	1704	589	1872	493	1956	417	2015	294	2207	220	1201
4-#10	2.02	MA	1458	813	2309	630	2609	526	2786	442	3006	311	3457	244	1974
2E		MI	1100	813	1791	605	1976	504	2081	423	2168	287	2374	201	1470
4-#11	2.48	MA	1499	846	2439	644	2758	535	2958	446	3233	305	3676	223	2350
2E		MI	1123	846	1876	617	2069	512	2178	424	2274	272	2462	168	1731
4-#14	3.57	MA	1610	925	2738	688	3127	567	3401	465	3817	295	4332	186	3250
2E		MI	1189	925	2073	660	2311	542	2440	436	2605	250	2799	108	2346
4-#18	6.35	MA	1859	1125	3448	803	4008	649	4460	514	5134	259	5792	75	5377
2E		MI	1339	1125	2527	772	2822	610	3011	457	3326	182	3619	-34	3483
6-#6	1.05	MA	1347	744	2014	595	2258	502	2370	429	2451	320	2804	271	1103
2L-3S		MI	993	744	1513	574	1644	483	1687	415	1676	307	1827	215	853
6-#6	1.05	MA	1292	744	1908	598	2123	504	2206	433	2230	323	2513	240	1110
3L-2S		MI	1030	744	1588	573	1739	483	1802	412	1831	306	2010	246	847
6-#7	1.43	MA	1394	771	2132	610	2402	512	2542	435	2682	317	3093	264	1457
2L-3S		MI	1013	771	1570	589	1711	493	1765	422	1776	303	1941	190	1113
6-#7	1.43	MA	1323	771	1988	614	2219	515	2321	441	2383	321	2704	220	1466
3L-2S		MI	1061	771	1670	587	1838	493	1921	418	1983	301	2184	233	1103
6-#8	1.88	MA	1449	804	2268	628	2570	525	2744	443	2953	314	3428	254	1869
2L-3S		MI	1035	804	1635	607	1788	506	1857	429	1892	298	2071	159	1409
6-#8	1.88	MA	1358	804	2082	633	2332	529	2455	450	2562	319	2926	197	1876
3L-2S		MI	1097	804	1765	605	1954	505	2059	425	2158	295	2382	216	1397
6-#9	2.38	MA	1507	840	2416	649	2753	540	2963	451	3248	311	3785	242	2313
2L-3S		MI	1059	840	1704	627	1872	519	1956	438	2015	292	2207	124	1722

RECTANGULAR TIED COLUMNS 14" x 18"

Short columns – no sidesway
Bending on major or minor axis



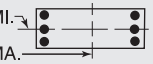
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#9	2.38	MA	1396	840	2182	654	2455	544	2601	460	2758	317	3162	170	2315
3L-2S		MI	1134	840	1867	624	2079	519	2208	433	2344	288	2588	196	1711
6-#10	3.02	MA	1580	886	2603	675	2984	559	3241	463	3622	306	4231	226	2872
2L-3S		MI	1091	886	1791	653	1976	537	2081	449	2168	283	2374	77	2106
6-#10	3.02	MA	1444	886	2309	682	2609	563	2786	473	3006	313	3457	135	2858
3L-2S		MI	1179	886	1994	650	2236	537	2395	444	2575	279	2842	168	2101
6-#11	3.71	MA	1642	936	2789	699	3204	575	3500	472	3966	300	4568	196	3417
2L-3S		MI	1113	936	1876	674	2069	550	2178	454	2274	264	2462	9	2444
6-#11	3.71	MA	1485	936	2439	706	2758	579	2958	483	3233	306	3676	84	3383
3L-2S		MI	1213	936	2115	672	2374	553	2543	449	2738	259	2982	121	2469
6-#14	5.36	MA	1607	1054	2738	776	3127	629	3401	516	3817	295	4332	-20	4314
3L-2S		MI	1312	1054	2407	740	2735	601	2939	468	3239	227	3494	33	3362
8-#6	1.40	MA	1393	769	2120	611	2393	513	2534	436	2673	319	3094	267	1432
2L-4S		MI	1005	769	1534	592	1664	498	1711	422	1712	307	1877	192	1100
8-#6	1.40	MA	1340	769	2014	614	2258	515	2370	441	2451	322	2804	235	1438
3E		MI	1025	769	1588	590	1739	495	1802	422	1831	306	2010	206	1092
8-#6	1.40	MA	1312	769	1940	616	2154	520	2243	442	2277	322	2598	218	1444
4L-2S		MI	1061	769	1662	589	1834	494	1917	419	1985	304	2193	237	1085
8-#7	1.90	MA	1456	805	2275	632	2584	528	2764	445	2982	315	3482	257	1898
2L-4S		MI	1028	805	1598	612	1738	514	1797	431	1824	302	2007	158	1435
8-#7	1.90	MA	1387	805	2132	635	2402	531	2542	451	2682	319	3093	214	1904
3E		MI	1055	805	1670	611	1838	509	1921	431	1983	300	2184	177	1427
8-#7	1.90	MA	1349	805	2031	639	2261	537	2370	452	2446	319	2817	191	1902
4L-2S		MI	1102	805	1770	609	1966	508	2076	428	2189	298	2427	220	1419
8-#8	2.51	MA	1528	849	2455	657	2808	546	3033	456	3344	311	3930	244	2440
2L-4S		MI	1055	849	1671	637	1823	532	1898	441	1954	296	2154	117	1772
8-#8	2.51	MA	1440	849	2268	661	2570	549	2744	463	2953	316	3428	188	2441
3E		MI	1089	849	1765	635	1954	526	2059	442	2158	294	2382	141	1810
8-#8	2.51	MA	1393	849	2137	666	2386	558	2519	465	2645	316	3071	158	2388
4L-2S		MI	1149	849	1895	633	2120	526	2260	438	2424	291	2692	198	1802
8-#9	3.17	MA	1605	897	2651	684	3051	566	3325	467	3738	307	4408	229	3025
2L-4S		MI	1084	897	1749	665	1915	552	2007	452	2092	289	2308	71	2087
8-#9	3.17	MA	1498	897	2416	690	2753	570	2963	476	3248	313	3785	157	3016
3E		MI	1128	897	1867	662	2079	545	2208	454	2344	286	2588	99	2215
8-#9	3.17	MA	1440	897	2252	695	2522	580	2680	479	2861	312	3341	121	2838
4L-2S		MI	1198	897	2030	660	2286	545	2460	449	2673	283	2970	171	2212
8-#10	4.03	MA	1571	958	2603	727	2984	596	3241	494	3622	309	4231	117	3733
3E		MI	1174	958	1994	698	2236	570	2395	470	2575	275	2842	44	2713
8-#10	4.03	MA	1500	958	2396	733	2693	609	2885	496	3134	308	3678	72	3390
4L-2S		MI	1257	958	2198	695	2495	570	2710	465	2982	271	3310	135	2723
8-#11	4.95	MA	1641	1025	2789	762	3204	620	3500	508	3966	301	4568	57	4405
3E		MI	1209	1025	2115	729	2374	590	2543	478	2738	250	2982	-39	2970
8-#11	4.95	MA	1550	1025	2540	768	2855	634	3073	510	3405	307	3926	5	3908
4L-2S		MI	1302	1025	2354	728	2678	593	2908	473	3203	245	3503	73	3196
10-#10	5.04	MA	1630	1031	2690	779	3067	642	3340	517	3750	303	4452	54	4228
4L-3S		MI	1256	1031	2198	743	2495	603	2710	491	2982	266	3310	11	3282
10-#10	5.04	MA	1546	1031	2477	794	2811	646	3022	528	3309	310	3908	-1	3908
5L-2S		MI	1334	1031	2401	741	2754	603	3025	485	3389	262	3778	103	3338
10-#11	6.19	MA	1715	1114	2891	824	3301	675	3615	535	4138	302	4817	-22	4796
4L-3S		MI	1302	1114	2354	785	2678	631	2908	502	3203	237	3503	-86	3467
12-#10	6.05	MA	1673	1103	2771	839	3186	679	3476	548	3924	306	4682	-18	4666
5L-3S		MI	1336	1103	2401	789	2754	636	3025	511	3389	258	3778	-22	3764

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

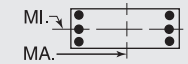
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.13	MA	1681	833	2510	670	2830	564	2985	482	3110	358	3596	305	1462
2E		MI	1148	833	1787	634	1950	534	2019	455	2043	334	2232	264	1000
4-#9	1.43	MA	1728	857	2627	683	2972	573	3154	487	3337	355	3883	299	1810
2E		MI	1174	857	1857	646	2034	542	2118	460	2166	328	2367	250	1220
4-#10	1.81	MA	1787	888	2774	699	3152	585	3369	494	3625	352	4243	290	2248
2E		MI	1205	888	1945	662	2138	553	2242	466	2319	321	2534	231	1492
4-#11	2.23	MA	1838	921	2928	713	3328	594	3574	498	3895	346	4529	272	2687
2E		MI	1227	921	2031	673	2232	560	2339	466	2423	305	2619	197	1757
4-#14	3.21	MA	1972	999	3279	758	3761	626	4093	517	4593	338	5348	243	3736
2E		MI	1294	999	2230	715	2473	590	2601	477	2753	283	2955	137	2378
4-#18	5.71	MA	2277	1199	4119	873	4804	708	5346	566	6271	320	7218	153	6241
2E		MI	1443	1199	2685	826	2984	656	3170	497	3473	214	3772	-6	3773
6-#7	1.29	MA	1711	845	2567	680	2909	572	3084	487	3247	358	3791	306	1652
2L-3S		MI	1117	845	1722	647	1872	543	1927	465	1928	338	2102	220	1129
6-#7	1.29	MA	1627	845	2402	684	2700	575	2829	493	2902	363	3328	263	1661
3L-2S		MI	1166	845	1822	645	2000	542	2082	461	2134	336	2345	263	1119
6-#8	1.69	MA	1776	878	2725	698	3104	585	3317	495	3560	355	4195	299	2125
2L-3S		MI	1139	878	1787	665	1950	555	2019	472	2043	332	2232	189	1429
6-#8	1.69	MA	1669	878	2510	703	2830	589	2985	503	3110	362	3596	242	2132
3L-2S		MI	1201	878	1918	663	2116	555	2220	468	2309	330	2543	246	1416
6-#9	2.14	MA	1845	914	2897	718	3316	599	3571	503	3902	352	4629	290	2637
2L-3S		MI	1163	914	1857	684	2034	568	2118	481	2166	326	2367	154	1746
6-#9	2.14	MA	1714	914	2627	725	2972	604	3154	513	3337	359	3883	218	2639
3L-2S		MI	1239	914	2020	682	2241	568	2369	476	2495	322	2749	225	1732
6-#10	2.72	MA	1931	960	3113	745	3584	618	3894	514	4336	348	5173	277	3283
2L-3S		MI	1195	960	1945	710	2138	586	2242	492	2319	317	2534	107	2137
6-#10	2.72	MA	1772	960	2774	753	3152	624	3369	527	3625	357	4243	186	3270
3L-2S		MI	1284	960	2148	707	2398	586	2557	487	2725	313	3002	198	2126
6-#11	3.34	MA	2007	1010	3334	769	3845	635	4202	523	4745	341	5611	252	3922
2L-3S		MI	1216	1010	2031	730	2232	598	2339	495	2423	297	2619	38	2503
6-#11	3.34	MA	1821	1010	2928	777	3328	641	3574	537	3895	350	4529	140	3888
3L-2S		MI	1318	1010	2270	729	2536	600	2704	490	2888	292	3140	150	2499
6-#14	4.82	MA	1957	1128	3279	849	3761	692	4093	572	4593	342	5348	47	5221
3L-2S		MI	1417	1128	2563	795	2898	648	3099	509	3387	260	3651	61	3399
8-#6	1.26	MA	1709	843	2553	681	2898	573	3073	488	3235	360	3788	309	1622
2L-4S		MI	1108	843	1686	650	1826	548	1872	466	1864	342	2039	222	1116
8-#6	1.26	MA	1647	843	2431	684	2743	575	2885	493	2980	364	3443	277	1628
3E		MI	1129	843	1739	649	1900	545	1964	466	1982	340	2172	236	1107
8-#6	1.26	MA	1614	843	2347	687	2624	581	2739	495	2781	365	3200	259	1634
4L-2S		MI	1165	843	1814	647	1995	544	2079	463	2137	339	2356	268	1100
8-#7	1.71	MA	1783	880	2731	701	3119	587	3338	497	3591	356	4254	301	2157
2L-4S		MI	1132	880	1750	670	1899	563	1959	474	1976	337	2168	188	1456
8-#7	1.71	MA	1702	880	2567	705	2909	591	3084	503	3247	361	3791	258	2163
3E		MI	1159	880	1822	669	2000	559	2082	474	2134	335	2345	207	1446
8-#7	1.71	MA	1659	880	2453	710	2748	598	2887	506	2977	362	3465	234	2161
4L-2S		MI	1207	880	1922	667	2128	558	2237	471	2340	333	2588	250	1437
8-#8	2.26	MA	1869	923	2940	726	3378	605	3650	507	4010	353	4795	292	2781
2L-4S		MI	1158	923	1824	695	1985	581	2060	484	2105	331	2315	147	1827
8-#8	2.26	MA	1766	923	2725	731	3104	609	3317	516	3560	359	4195	235	2782
3E		MI	1193	923	1918	693	2116	576	2220	485	2309	328	2543	171	1833
8-#8	2.26	MA	1711	923	2576	737	2894	619	3059	519	3208	360	3772	204	2760
4L-2S		MI	1254	923	2048	691	2282	575	2422	481	2575	325	2853	228	1823
8-#9	2.86	MA	1960	971	3166	754	3659	625	3989	519	4466	349	5375	280	3457
2L-4S		MI	1187	971	1903	722	2077	601	2168	495	2243	323	2469	100	2149

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

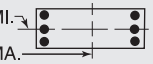
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.86	MA	1835	971	2897	760	3316	630	3571	530	3902	356	4629	208	3448
3E		MI	1232	971	2020	720	2241	594	2369	497	2495	320	2749	129	2243
8-#9	2.86	MA	1767	971	2709	767	3051	642	3247	533	3459	357	4101	170	3299
4L-2S		MI	1303	971	2183	718	2448	594	2621	492	2824	317	3130	201	2236
8-#10	3.63	MA	1921	1033	3113	798	3584	657	3894	548	4336	353	5173	173	4282
3E		MI	1278	1033	2148	755	2398	619	2557	512	2725	309	3002	74	2748
8-#10	3.63	MA	1839	1033	2876	806	3251	671	3486	552	3777	353	4514	124	3947
4L-2S		MI	1362	1033	2352	753	2657	619	2871	507	3132	304	3470	165	2750
8-#11	4.46	MA	1997	1099	3334	833	3845	681	4202	563	4745	345	5611	120	5094
3E		MI	1312	1099	2270	785	2536	638	2704	520	2888	284	3140	-10	3137
8-#11	4.46	MA	1901	1099	3048	841	3445	698	3711	566	4074	344	4839	63	4562
4L-2S		MI	1407	1099	2509	784	2840	641	3069	514	3352	278	3661	103	3229
8-#14	6.43	MA	2073	1256	3447	940	3923	772	4284	612	4878	346	5773	-65	5715
4L-2S		MI	1540	1256	2897	876	3322	706	3598	541	4021	237	4346	-14	4342
10-#10	4.54	MA	1992	1105	3216	851	3683	704	4011	572	4488	349	5444	111	4917
4L-3S		MI	1359	1105	2352	800	2657	652	2871	533	3132	300	3470	41	3354
10-#10	4.54	MA	1888	1105	2973	867	3391	710	3647	585	3983	358	4791	58	4602
5L-2S		MI	1440	1105	2555	798	2916	652	3186	528	3539	296	3938	132	3368
10-#11	5.57	MA	2081	1188	3455	897	3962	738	4339	592	4924	339	5921	43	5725
4L-3S		MI	1406	1188	2509	841	2840	679	3069	544	3352	270	3661	-57	3639
12-#10	5.44	MA	2038	1178	3312	912	3823	743	4172	606	4693	354	5721	45	5567
5L-3S		MI	1440	1178	2555	846	2916	685	3186	554	3539	292	3938	8	3917

RECTANGULAR TIED COLUMNS 14" x 22"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.03	MA	2024	907	2973	739	3371	624	3560	534	3704	399	4319	346	1633
2E		MI	1252	907	1940	692	2112	583	2180	498	2195	368	2393	294	1016
4-#9	1.30	MA	2079	931	3106	752	3533	633	3752	539	3962	396	4657	341	2026
2E		MI	1278	931	2011	704	2196	591	2279	503	2317	362	2528	280	1237
4-#10	1.65	MA	2147	962	3274	769	3738	645	3997	546	4290	393	5083	334	2522
2E		MI	1309	962	2098	719	2300	602	2403	508	2469	355	2693	261	1512
4-#11	2.03	MA	2208	995	3452	783	3942	654	4235	550	4603	387	5437	319	3024
2E		MI	1332	995	2186	729	2394	608	2499	508	2572	339	2777	226	1782
4-#14	2.92	MA	2366	1074	3854	827	4438	685	4830	569	5403	380	6423	295	4222
2E		MI	1398	1074	2386	771	2635	637	2761	518	2902	315	3112	166	2409
4-#18	5.19	MA	2730	1274	4824	942	5642	768	6278	618	7351	362	8709	222	7105
2E		MI	1548	1274	2843	880	3147	702	3330	537	3619	246	3926	22	3838
6-#7	1.17	MA	2058	920	3037	750	3459	631	3671	539	3857	400	4542	347	1846
2L-3S		MI	1221	920	1874	705	2034	593	2089	508	2080	372	2264	250	1144
6-#7	1.17	MA	1961	920	2851	754	3222	635	3383	546	3468	405	4005	304	1855
3L-2S		MI	1270	920	1974	704	2162	592	2244	504	2286	370	2507	293	1135
6-#8	1.54	MA	2133	952	3216	768	3680	644	3936	546	4213	396	5017	342	2380
2L-3S		MI	1243	952	1940	723	2112	604	2180	515	2195	366	2393	219	1447
6-#8	1.54	MA	2010	952	2973	774	3371	649	3560	556	3704	404	4319	285	2388
3L-2S		MI	1306	952	2070	720	2278	604	2382	511	2460	364	2704	276	1434
6-#9	1.95	MA	2214	988	3412	788	3922	659	4225	555	4601	393	5528	335	2961
2L-3S		MI	1267	988	2011	742	2196	617	2279	524	2317	360	2528	183	1769
6-#9	1.95	MA	2063	988	3106	795	3533	665	3752	566	3962	402	4657	263	2963
3L-2S		MI	1344	988	2173	739	2403	617	2531	519	2646	356	2909	255	1753
6-#10	2.47	MA	2314	1034	3658	814	4227	677	4592	566	5096	389	6170	325	3695
2L-3S		MI	1298	1034	2098	767	2300	635	2403	534	2469	351	2693	136	2164
6-#10	2.47	MA	2130	1034	3274	823	3738	685	3997	580	4290	400	5083	234	3681
3L-2S		MI	1389	1034	2302	764	2560	635	2718	529	2876	347	3161	228	2149
6-#11	3.04	MA	2404	1084	3914	839	4530	694	4949	575	5569	382	6711	304	4428
2L-3S		MI	1320	1084	2186	786	2394	646	2499	537	2572	330	2777	67	2540
6-#11	3.04	MA	2189	1084	3452	848	3942	702	4235	591	4603	394	5437	192	4394
3L-2S		MI	1423	1084	2425	785	2698	648	2865	532	3037	325	3298	179	2528

RECTANGULAR TIED COLUMNS 14" x 22"

Short columns – no sidesway
Bending on major or minor axis

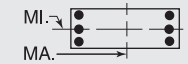


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	4.38	MA	2347	1202	3854	921	4438	754	4830	627	5403	387	6423	108	6078
3L-2S		MI	1522	1202	2719	851	3060	695	3260	550	3536	293	3807	90	3435
6-#18	7.79	MA	2757	1502	4824	1105	5642	884	6278	716	7351	369	8709	-125	8504
3L-2S		MI	1747	1502	3396	1023	3826	800	4117	584	4622	193	5044	-121	4825
8-#6	1.14	MA	2055	917	3020	750	3446	632	3658	540	3842	401	4528	349	1812
2L-4S		MI	1212	917	1837	708	1987	598	2034	509	2016	376	2201	253	1130
8-#6	1.14	MA	1984	917	2883	754	3271	635	3445	542	3555	405	4129	317	1819
3E		MI	1233	917	1891	707	2062	595	2126	509	2134	375	2335	266	1121
8-#6	1.14	MA	1946	917	2788	757	3137	641	3282	547	3331	407	3852	299	1824
4L-2S		MI	1270	917	1965	706	2157	594	2241	506	2289	373	2518	298	1115
8-#7	1.56	MA	2142	954	3223	771	3696	647	3958	548	4246	398	5080	344	2417
2L-4S		MI	1235	954	1902	729	2061	613	2121	517	2127	371	2330	219	1475
8-#7	1.56	MA	2048	954	3037	775	3459	651	3671	556	3857	403	4542	301	2422
3E		MI	1263	954	1974	727	2162	608	2244	518	2286	369	2507	237	1464
8-#7	1.56	MA	1998	954	2909	780	3279	658	3449	559	3554	405	4166	276	2421
4L-2S		MI	1311	954	2075	725	2290	608	2399	514	2492	367	2750	280	1454
8-#8	2.05	MA	2241	997	3459	796	3990	665	4312	559	4722	394	5715	337	3122
2L-4S		MI	1262	997	1976	753	2147	631	2221	527	2256	365	2476	177	1863
8-#8	2.05	MA	2122	997	3216	802	3680	670	3936	568	4213	401	5017	280	3123
3E		MI	1297	997	2070	751	2278	625	2382	528	2460	362	2704	201	1854
8-#8	2.05	MA	2059	997	3048	808	3444	680	3646	572	3816	403	4527	248	3101
4L-2S		MI	1358	997	2201	749	2444	624	2584	524	2726	360	3014	258	1843
8-#9	2.60	MA	2346	1045	3717	824	4311	684	4697	571	5241	390	6398	328	3889
2L-4S		MI	1291	1045	2056	780	2238	650	2330	538	2393	357	2629	130	2208
8-#9	2.60	MA	2202	1045	3412	831	3922	690	4225	582	4601	399	5528	256	3880
3E		MI	1334	1045	2173	777	2403	643	2531	540	2646	354	2909	159	2269
8-#9	2.60	MA	2125	1045	3200	838	3624	703	3860	587	4102	401	4916	216	3772
4L-2S		MI	1407	1045	2336	775	2610	643	2782	535	2974	351	3291	231	2259
8-#10	3.30	MA	2302	1107	3658	869	4227	718	4592	601	5096	396	6170	224	4830
3E		MI	1382	1107	2302	812	2560	667	2718	555	2876	342	3161	103	2780
8-#10	3.30	MA	2209	1107	3392	877	3852	733	4132	606	4466	398	5405	173	4517
4L-2S		MI	1468	1107	2505	810	2819	668	3033	550	3283	338	3630	195	2776
8-#11	4.05	MA	2392	1173	3914	904	4530	742	4949	616	5569	388	6711	177	5767
3E		MI	1415	1173	2425	842	2698	686	2865	561	3037	317	3298	20	3252
8-#11	4.05	MA	2283	1173	3592	914	4077	760	4394	622	4811	390	5810	117	5232
4L-2S		MI	1512	1173	2664	840	3003	689	3230	556	3502	312	3819	132	3261
8-#14	5.84	MA	2485	1331	4051	1014	4628	837	5054	670	5694	380	6936	-2	6934
4L-2S		MI	1645	1331	3053	931	3485	754	3758	583	4170	270	4503	15	4444
10-#10	4.12	MA	2385	1179	3776	923	4342	766	4727	627	5271	394	6492	164	5621
4L-3S		MI	1463	1179	2505	857	2819	700	3033	576	3283	334	3630	71	3389
10-#10	4.12	MA	2260	1179	3504	940	4013	773	4319	641	4703	405	5730	111	5308
5L-2S		MI	1545	1179	2709	855	3078	701	3347	570	3690	330	4098	162	3396
10-#11	5.06	MA	2491	1262	4053	970	4665	801	5108	647	5777	385	7084	102	6560
4L-3S		MI	1509	1262	2664	897	3003	727	3230	586	3502	303	3819	-28	3809
10-#11	5.06	MA	2348	1262	3723	990	4268	809	4615	663	5092	396	6190	36	6062
5L-2S		MI	1601	1262	2903	896	3307	729	3595	580	3966	298	4339	84	3987
12-#10	4.95	MA	2433	1252	3888	985	4503	806	4914	662	5509	400	6817	102	6421
5L-3S		MI	1544	1252	2709	903	3078	733	3347	596	3690	326	4098	38	3995
12-#10	4.95	MA	2313	1252	3650	993	4179	822	4512	667	4965	411	6117	44	5919
6L-2S		MI	1622	1252	2912	900	3337	734	3662	591	4097	321	4566	129	4012
12-#11	6.08	MA	2552	1351	4185	1045	4856	849	5329	688	6058	391	7464	21	7384
5L-3S		MI	1602	1351	2903	953	3307	767	3595	610	3966	290	4339	-75	4307
14-#10	5.77	MA	2488	1324	4035	1038	4669	855	5107	688	5771	407	7204	35	7042
6L-3S		MI	1623	1324	2912	948	3337	766	3662	617	4097	317	4566	5	4553

RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

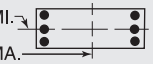
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.19	MA	2459	1005	3620	822	4136	692	4397	590	4633	438	5472	380	2242
2E		MI	1382	1005	2164	761	2357	640	2440	545	2468	396	2688	310	1254
4-#10	1.51	MA	2538	1036	3808	839	4366	704	4672	597	5001	434	5978	377	2797
2E		MI	1414	1036	2252	776	2463	651	2565	551	2619	389	2853	290	1532
4-#11	1.86	MA	2609	1069	4010	853	4598	713	4942	602	5357	428	6400	364	3360
2E		MI	1436	1069	2341	785	2556	656	2660	550	2722	372	2935	255	1806
4-#14	2.68	MA	2790	1148	4465	897	5159	745	5614	620	6260	421	7554	345	4708
2E		MI	1503	1148	2542	826	2798	684	2922	559	3050	348	3268	194	2439
4-#18	4.76	MA	3216	1348	5564	1012	6524	827	7255	670	8468	403	10262	285	7969
2E		MI	1652	1348	3002	934	3309	749	3489	577	3766	278	4079	51	3881
6-#7	1.07	MA	2435	994	3542	819	4052	691	4304	590	4513	441	5311	384	2041
2L-3S		MI	1324	994	2026	763	2196	642	2250	551	2231	406	2426	280	1159
6-#7	1.07	MA	2326	994	3334	824	3788	695	3983	594	4079	447	4710	342	2049
3L-2S		MI	1374	994	2126	762	2324	642	2406	548	2437	404	2669	323	1150
6-#8	1.41	MA	2521	1026	3743	837	4300	703	4600	598	4911	438	5860	380	2636
2L-3S		MI	1347	1026	2092	780	2274	654	2342	558	2346	401	2554	249	1465
6-#8	1.41	MA	2382	1026	3471	844	3954	709	4181	603	4344	446	5074	324	2644
3L-2S		MI	1410	1026	2223	778	2440	653	2543	554	2612	398	2865	306	1451
6-#9	1.79	MA	2613	1062	3961	858	4570	718	4924	607	5347	434	6461	376	3285
2L-3S		MI	1370	1062	2164	799	2357	666	2440	566	2468	394	2688	213	1790
6-#9	1.79	MA	2442	1062	3620	865	4136	725	4397	612	4633	444	5472	305	3287
3L-2S		MI	1448	1062	2326	797	2565	666	2692	562	2797	391	3070	285	1773
6-#10	2.27	MA	2728	1109	4238	884	4913	737	5337	618	5901	430	7223	371	4106
2L-3S		MI	1402	1109	2252	824	2463	683	2565	577	2619	385	2853	166	2190
6-#10	2.27	MA	2518	1109	3808	894	4366	745	4672	633	5001	442	5978	279	4093
3L-2S		MI	1494	1109	2456	822	2722	684	2879	571	3026	380	3321	257	2172
6-#11	2.79	MA	2832	1158	4528	908	5257	754	5742	627	6440	423	7868	353	4933
2L-3S		MI	1423	1158	2341	842	2556	694	2660	579	2722	364	2935	96	2573
6-#11	2.79	MA	2587	1158	4010	919	4598	763	4942	644	5357	437	6400	241	4899
3L-2S		MI	1527	1158	2580	841	2860	696	3026	574	3186	358	3456	208	2556
6-#14	4.02	MA	2769	1276	4465	992	5159	815	5614	681	6260	431	7554	164	6807
3L-2S		MI	1627	1276	2876	906	3222	743	3420	592	3684	325	3963	119	3469
6-#18	7.14	MA	3243	1576	5564	1178	6524	948	7255	772	8468	416	10262	-49	10159
3L-2S		MI	1852	1576	3554	1077	3989	846	4277	625	4769	225	5198	-93	4988
8-#6	1.05	MA	2432	992	3522	820	4036	691	4288	591	4495	442	5289	385	2002
2L-4S		MI	1316	992	1989	767	2149	648	2196	552	2167	411	2364	283	1143
8-#6	1.05	MA	2351	992	3369	824	3841	695	4051	594	4175	447	4846	355	2009
3E		MI	1337	992	2042	765	2223	644	2287	553	2286	409	2497	297	1135
8-#6	1.05	MA	2309	992	3264	827	3694	701	3870	600	3927	449	4540	337	2014
4L-2S		MI	1374	992	2117	764	2318	644	2403	550	2441	408	2680	328	1129
8-#7	1.43	MA	2530	1028	3749	841	4316	706	4624	600	4947	439	5912	381	2676
2L-4S		MI	1339	1028	2054	787	2223	662	2282	560	2279	406	2492	249	1492
8-#7	1.43	MA	2424	1028	3542	845	4052	710	4304	604	4513	445	5311	339	2682
3E		MI	1367	1028	2126	785	2324	658	2406	561	2437	404	2669	267	1481
8-#7	1.43	MA	2368	1028	3399	850	3852	719	4058	611	4176	448	4896	314	2680
4L-2S		MI	1415	1028	2227	783	2451	657	2561	557	2644	402	2912	310	1471
8-#8	1.88	MA	2643	1071	4014	865	4645	724	5020	611	5479	435	6647	376	3463
2L-4S		MI	1366	1071	2129	811	2308	680	2383	570	2408	399	2637	207	1886
8-#8	1.88	MA	2508	1071	3743	872	4300	729	4600	616	4911	443	5860	321	3465
3E		MI	1401	1071	2223	809	2440	674	2543	571	2612	396	2865	231	1875
8-#8	1.88	MA	2438	1071	3556	878	4037	740	4278	625	4470	446	5314	288	3442
4L-2S		MI	1463	1071	2353	806	2606	674	2745	567	2877	394	3175	288	1863
8-#9	2.38	MA	2764	1119	4303	893	5005	744	5452	623	6061	431	7449	371	4321
2L-4S		MI	1394	1119	2209	837	2400	699	2491	581	2544	391	2789	160	2265

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

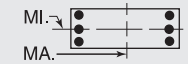
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.38	MA	2599	1119	3961	901	4570	751	4924	628	5347	441	6461	300	4312
3E		MI	1438	1119	2326	835	2565	692	2692	583	2797	388	3070	189	2293
8-#9	2.38	MA	2513	1119	3727	909	4240	764	4519	641	4792	444	5771	258	4254
4L-2S		MI	1512	1119	2489	833	2772	692	2944	578	3125	385	3451	261	2281
8-#10	3.02	MA	2714	1181	4238	939	4913	778	5337	654	5901	438	7223	273	5379
3E		MI	1485	1181	2456	869	2722	716	2879	597	3026	376	3321	133	2810
8-#10	3.02	MA	2609	1181	3942	949	4496	795	4825	660	5201	442	6351	220	5099
4L-2S		MI	1572	1181	2659	867	2981	717	3194	592	3433	372	3789	224	2801
8-#11	3.71	MA	2819	1247	4528	975	5257	803	5742	670	6440	432	7868	230	6441
3E		MI	1519	1247	2580	898	2860	734	3026	603	3186	350	3456	49	3294
8-#11	3.71	MA	2696	1247	4170	986	4753	823	5123	677	5594	435	6836	167	5916
4L-2S		MI	1617	1247	2819	897	3165	737	3391	598	3651	345	3976	161	3292
8-#14	5.36	MA	2928	1405	4689	1087	5376	900	5869	726	6593	427	8157	56	7863
4L-2S		MI	1750	1405	3209	987	3647	801	3918	624	4318	303	4659	43	4483
10-#10	3.78	MA	2809	1254	4372	994	5044	828	5490	681	6101	438	7596	214	6339
4L-3S		MI	1567	1254	2659	915	2981	749	3194	618	3433	368	3789	100	3422
10-#10	3.78	MA	2663	1254	4069	1012	4679	836	5037	696	5470	450	6722	162	5958
5L-2S		MI	1650	1254	2863	912	3240	749	3509	613	3840	364	4257	192	3424
10-#11	4.64	MA	2933	1336	4687	1042	5411	863	5924	702	6676	430	8303	156	7409
4L-3S		MI	1613	1336	2819	953	3165	775	3391	627	3651	337	3976	1	3973
10-#11	4.64	MA	2764	1336	4320	1063	4970	872	5375	720	5913	443	7273	92	6914
5L-2S		MI	1707	1336	3059	952	3469	777	3756	622	4116	331	4497	114	4021
10-#14	6.70	MA	3026	1533	4900	1197	5681	971	6223	786	7043	438	8769	-56	8697
5L-2S		MI	1872	1533	3543	1067	4072	859	4417	656	4953	280	5354	-32	5344
12-#10	4.54	MA	2860	1326	4499	1057	5226	869	5702	717	6370	446	7968	156	7224
5L-3S		MI	1648	1326	2863	960	3240	782	3509	639	3840	359	4257	67	4030
12-#10	4.54	MA	2724	1326	4228	1065	4867	885	5255	724	5767	458	7169	95	6688
6L-2S		MI	1728	1326	3066	958	3499	782	3823	633	4247	355	4726	159	4042
12-#11	5.57	MA	2996	1425	4838	1119	5628	913	6175	745	6996	438	8741	81	8407
5L-3S		MI	1706	1425	3059	1009	3469	815	3756	652	4116	323	4497	-46	4479
12-#11	5.57	MA	2837	1425	4517	1128	5193	932	5635	752	6267	452	7797	9	7756
6L-2S		MI	1795	1425	3298	1008	3774	818	4122	646	4580	318	5018	66	4742
14-#10	5.29	MA	2922	1399	4658	1110	5414	918	5921	744	6667	454	8415	89	7949
6L-3S		MI	1728	1399	3066	1005	3499	815	3823	659	4247	351	4726	34	4628
14-#11	6.50	MA	3072	1515	5034	1184	5851	972	6435	777	7350	447	9264	-2	9261
6L-3S		MI	1798	1515	3298	1065	3774	856	4122	676	4580	310	5018	-93	4974

RECTANGULAR TIED COLUMNS 14" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.10	MA	2870	1080	4169	891	4782	751	5087	642	5349	479	6309	417	2458
2E		MI	1486	1080	2317	819	2519	689	2602	588	2619	430	2849	339	1271
4-#10	1.40	MA	2959	1110	4378	908	5037	763	5392	649	5758	475	6872	413	3071
2E		MI	1518	1110	2406	833	2625	699	2726	593	2770	423	3013	320	1550
4-#11	1.71	MA	3040	1143	4604	922	5297	773	5694	653	6156	470	7416	407	3697
2E		MI	1540	1143	2497	841	2718	704	2821	591	2871	405	3093	285	1829
4-#14	2.47	MA	3246	1222	5110	966	5921	804	6443	672	7162	462	8740	392	5194
2E		MI	1607	1222	2698	882	2960	732	3082	601	3199	381	3424	223	2468
4-#18	4.40	MA	3728	1422	6339	1082	7448	887	8278	721	9631	445	11874	343	8833
2E		MI	1756	1422	3160	988	3471	795	3649	617	3913	310	4233	79	3922
6-#8	1.30	MA	2939	1101	4304	907	4962	763	5311	650	5656	479	6736	416	2892
2L-3S		MI	1451	1101	2245	838	2435	703	2503	601	2497	435	2715	279	1482
6-#8	1.30	MA	2783	1101	4004	914	4581	769	4847	655	5029	488	5868	362	2900
3L-2S		MI	1514	1101	2376	836	2601	702	2705	597	2763	432	3026	336	1468
6-#9	1.65	MA	3043	1137	4546	927	5262	777	5670	658	6138	475	7401	412	3609
2L-3S		MI	1474	1137	2317	857	2519	715	2602	609	2619	428	2849	243	1810
6-#9	1.65	MA	2851	1137	4169	936	4782	785	5087	665	5349	486	6309	343	3611
3L-2S		MI	1552	1137	2480	854	2727	715	2854	604	2947	425	3230	315	1792

RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

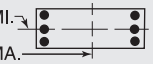
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	2.09	MA	3173	1183	4853	954	5642	796	6127	670	6753	471	8250	407	4518
2L-3S		MI	1506	1183	2406	881	2625	732	2726	619	2770	419	3013	196	2214
6-#10	2.09	MA	2937	1183	4378	964	5037	805	5392	677	5758	485	6872	318	4504
3L-2S		MI	1598	1183	2609	879	2884	732	3041	614	3177	414	3481	287	2195
6-#11	2.57	MA	3292	1233	5177	978	6027	813	6580	679	7356	464	9076	400	5439
2L-3S		MI	1527	1233	2497	898	2718	742	2821	621	2871	397	3093	125	2604
6-#11	2.57	MA	3016	1233	4604	990	5297	823	5694	697	6156	480	7416	287	5405
3L-2S		MI	1632	1233	2736	897	3023	744	3186	616	3336	392	3614	237	2583
6-#14	3.71	MA	3222	1351	5110	1063	5921	876	6443	734	7162	475	8740	216	7536
3L-2S		MI	1732	1351	3032	962	3385	790	3581	633	3833	358	4120	148	3503
6-#18	6.59	MA	3722	1650	6339	1250	7448	1011	8278	828	9631	463	11874	20	11813
3L-2S		MI	1956	1650	3712	1131	4151	892	4436	665	4916	257	5351	-65	5147
8-#7	1.32	MA	2949	1102	4310	910	4979	765	5336	652	5694	480	6792	417	2935
2L-4S		MI	1443	1102	2206	845	2384	712	2444	604	2431	440	2653	279	1509
8-#7	1.32	MA	2830	1102	4081	915	4688	770	4982	656	5215	487	6129	376	2941
3E		MI	1471	1102	2278	843	2485	707	2567	604	2589	438	2830	297	1497
8-#7	1.32	MA	2768	1102	3925	921	4468	779	4712	664	4845	490	5676	352	2939
4L-2S		MI	1519	1102	2379	841	2613	707	2722	601	2795	436	3073	340	1487
8-#8	1.74	MA	3076	1146	4603	935	5344	783	5774	663	6283	476	7604	412	3805
2L-4S		MI	1469	1146	2282	868	2470	729	2544	613	2559	433	2798	237	1908
8-#8	1.74	MA	2925	1146	4304	942	4962	789	5311	668	5656	485	6736	358	3806
3E		MI	1505	1146	2376	866	2601	723	2705	614	2763	431	3026	261	1894
8-#8	1.74	MA	2846	1146	4099	949	4673	801	4956	678	5171	489	6141	326	3784
4L-2S		MI	1567	1146	2506	864	2767	723	2907	610	3028	428	3336	318	1882
8-#9	2.20	MA	3212	1194	4923	963	5741	803	6252	675	6927	472	8493	407	4753
2L-4S		MI	1498	1194	2362	895	2562	748	2653	623	2695	425	2950	190	2325
8-#9	2.20	MA	3028	1194	4546	971	5262	811	5670	681	6138	483	7401	338	4744
3E		MI	1542	1194	2480	892	2727	741	2854	625	2947	422	3230	219	2316
8-#9	2.20	MA	2931	1194	4288	980	4898	825	5223	694	5527	487	6649	297	4686
4L-2S		MI	1617	1194	2642	890	2934	741	3105	620	3276	419	3612	291	2303
8-#10	2.79	MA	3157	1255	4853	1009	5642	838	6127	698	6753	481	8250	312	5928
3E		MI	1589	1255	2609	926	2884	765	3041	640	3177	410	3481	163	2838
8-#10	2.79	MA	3040	1255	4527	1020	5183	856	5563	714	5981	486	7297	260	5694
4L-2S		MI	1677	1255	2813	924	3143	765	3355	635	3584	406	3949	254	2826
8-#11	3.43	MA	3276	1322	5177	1045	6027	864	6580	723	7356	474	9076	280	7115
3E		MI	1622	1322	2736	954	3023	782	3186	645	3336	383	3614	78	3330
8-#11	3.43	MA	3139	1322	4782	1057	5471	884	5899	731	6422	479	7914	215	6613
4L-2S		MI	1722	1322	2975	953	3327	785	3552	640	3800	378	4134	190	3322
8-#14	4.95	MA	3402	1479	5362	1160	6166	963	6731	782	7537	473	9434	111	8798
4L-2S		MI	1855	1479	3365	1042	3809	848	4079	665	4467	335	4815	72	4520
10-#10	3.49	MA	3264	1328	5003	1065	5788	889	6299	735	6976	481	8674	254	7069
4L-3S		MI	1671	1328	2813	972	3143	798	3355	660	3584	402	3949	130	3454
10-#10	3.49	MA	3097	1328	4670	1084	5387	898	5800	742	6282	495	7716	205	6615
5L-2S		MI	1756	1328	3016	969	3402	798	3670	655	3991	397	4417	221	3450
10-#11	4.29	MA	3405	1411	5355	1113	6200	925	6785	756	7622	474	9575	208	8274
4L-3S		MI	1716	1411	2975	1010	3327	822	3552	669	3800	370	4134	31	4046
10-#11	4.29	MA	3211	1411	4952	1135	5714	935	6181	775	6781	489	8410	144	7779
5L-2S		MI	1812	1411	3214	1008	3632	825	3917	664	4265	365	4655	143	4053
10-#14	6.18	MA	3504	1608	5601	1271	6510	1035	7129	844	8044	486	10130	4	10113
5L-2S		MI	1977	1608	3699	1122	4234	907	4577	697	5101	313	5511	-3	5510
12-#10	4.19	MA	3317	1400	5145	1129	5993	931	6535	763	7277	491	9094	199	8017
5L-3S		MI	1752	1400	3016	1017	3402	831	3670	681	3991	393	4417	97	4064

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

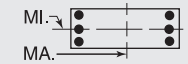
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	4.19	MA	3165	1400	4841	1136	5597	948	6045	779	6614	504	8223	139	7473
6L-2S		MI	1833	1400	3220	1015	3661	831	3985	676	4398	389	4885	188	4070
12-#11	5.14	MA	3472	1500	5525	1191	6444	975	7067	800	7981	484	10071	136	9454
5L-3S		MI	1809	1500	3214	1065	3632	863	3917	693	4265	356	4655	-17	4649
12-#11	5.14	MA	3294	1500	5163	1200	5965	996	6473	809	7178	499	9007	62	8676
6L-2S		MI	1901	1500	3453	1064	3936	866	4282	688	4730	351	5175	96	4777
14-#10	4.88	MA	3387	1473	5316	1181	6203	981	6780	800	7609	500	9600	133	8873
6L-3S		MI	1832	1473	3220	1062	3661	864	3985	702	4398	385	4885	64	4672
14-#10	4.88	MA	3263	1473	5012	1187	5815	989	6309	807	6933	505	8617	80	8285
7L-2S		MI	1910	1473	3423	1060	3920	864	4299	696	4805	381	5353	155	4686
14-#11	6.00	MA	3557	1589	5736	1256	6695	1036	7359	834	8377	494	10667	54	10366
6L-3S		MI	1902	1589	3453	1121	3936	903	4282	718	4730	343	5175	-64	5148
16-#10	5.58	MA	3488	1545	5487	1233	6420	1022	7044	828	7928	501	9994	74	9687
7L-3S		MI	1911	1545	3423	1108	3920	897	4299	722	4805	376	5353	31	5262

RECTANGULAR TIED COLUMNS 14" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.02	MA	3311	1154	4753	961	5470	811	5823	694	6112	520	7198	453	2674
2E		MI	1590	1154	2470	876	2681	738	2763	631	2770	464	3009	369	1286
4-#10	1.30	MA	3410	1185	4982	978	5751	823	6158	701	6560	517	7816	449	3345
2E		MI	1622	1185	2560	891	2787	748	2887	636	2920	457	3172	350	1569
4-#11	1.59	MA	3502	1218	5232	992	6039	832	6493	705	7002	511	8418	443	4034
2E		MI	1645	1218	2652	898	2881	752	2982	633	3020	438	3251	314	1851
4-#14	2.30	MA	3733	1297	5790	1036	6727	863	7318	724	8110	503	9947	434	5680
2E		MI	1712	1297	2855	937	3122	779	3243	642	3347	414	3581	252	2497
4-#18	4.08	MA	4274	1496	7149	1151	8415	946	9347	773	10840	486	13544	397	9697
2E		MI	1861	1496	3318	1042	3634	841	3808	658	4060	342	4387	107	3963
6-#8	1.21	MA	3388	1175	4899	977	5667	822	6067	702	6446	520	7664	452	3148
2L-3S		MI	1554	1175	2398	896	2597	752	2665	644	2648	469	2876	309	1498
6-#8	1.21	MA	3214	1175	4572	984	5250	829	5560	707	5760	530	6714	399	3156
3L-2S		MI	1618	1175	2528	894	2763	752	2867	640	2914	466	3187	366	1485
6-#9	1.53	MA	3503	1211	5165	997	5996	837	6461	710	6975	517	8394	448	3933
2L-3S		MI	1578	1211	2470	914	2681	765	2763	652	2770	462	3009	273	1829
6-#9	1.53	MA	3290	1211	4753	1006	5470	845	5823	717	6112	528	7198	381	3935
3L-2S		MI	1656	1211	2633	912	2889	764	3015	647	3098	459	3391	345	1811
6-#10	1.94	MA	3648	1257	5503	1023	6414	856	6963	721	7650	512	9325	443	4929
2L-3S		MI	1608	1257	2560	938	2787	781	2887	662	2920	452	3172	225	2237
6-#10	1.94	MA	3386	1257	4982	1034	5751	865	6158	730	6560	527	7816	357	4916
3L-2S		MI	1703	1257	2763	936	3046	781	3202	656	3327	448	3641	317	2216
6-#11	2.39	MA	3782	1307	5861	1047	6839	872	7465	730	8318	506	10240	436	5944
2L-3S		MI	1631	1307	2652	954	2881	789	2982	663	3020	430	3251	154	2633
6-#11	2.39	MA	3475	1307	5232	1060	6039	883	6493	740	7002	522	8418	327	5910
3L-2S		MI	1736	1307	2891	953	3185	792	3347	657	3485	425	3771	266	2609
6-#14	3.44	MA	3706	1425	5790	1134	6727	937	7318	773	8110	518	9947	263	8265
3L-2S		MI	1836	1425	3188	1017	3547	837	3741	674	3981	391	4276	177	3535
6-#18	6.12	MA	4265	1725	7149	1322	8415	1073	9347	883	10840	508	13544	83	13262
3L-2S		MI	2060	1725	3870	1185	4314	938	4596	705	5062	289	5505	-36	5303
8-#7	1.22	MA	3398	1177	4906	980	5685	825	6094	704	6486	521	7723	453	3194
2L-4S		MI	1547	1177	2358	903	2546	762	2606	647	2582	474	2815	309	1524
8-#7	1.22	MA	3266	1177	4656	985	5367	830	5707	708	5963	529	6998	413	3200
3E		MI	1575	1177	2431	901	2647	757	2729	647	2740	472	2992	327	1512
8-#7	1.22	MA	3198	1177	4485	991	5127	839	5412	717	5559	532	6507	389	3198
4L-2S		MI	1624	1177	2531	899	2775	756	2884	644	2947	470	3235	371	1503
8-#8	1.61	MA	3540	1220	5227	1005	6084	843	6573	714	7132	517	8614	449	4146
2L-4S		MI	1573	1220	2434	926	2632	779	2706	656	2710	467	2959	267	1928
8-#8	1.61	MA	3372	1220	4899	1012	5667	849	6067	720	6446	527	7664	396	4147
3E		MI	1609	1220	2528	924	2763	773	2867	657	2914	465	3187	291	1913

RECTANGULAR TIED COLUMNS 14" x 28"

Short columns – no sidesway
Bending on major or minor axis

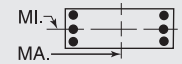


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#8	1.61	MA	3285	1220	4676	1019	5352	861	5680	731	5917	531	7019	364	4125
4L-2S		MI	1671	1220	2659	922	2929	772	3068	653	3180	462	3498	348	1900
8-#9	2.04	MA	3691	1268	5578	1032	6521	863	7099	726	7838	513	9589	444	5185
2L-4S		MI	1601	1268	2515	952	2724	797	2814	666	2846	459	3110	220	2351
8-#9	2.04	MA	3486	1268	5165	1041	5996	871	6461	733	6975	525	8394	376	5176
3E		MI	1646	1268	2633	950	2889	790	3015	668	3098	456	3391	249	2338
8-#9	2.04	MA	3380	1268	4884	1050	5599	885	5974	747	6308	530	7579	336	5118
4L-2S		MI	1722	1268	2796	948	3096	790	3267	663	3427	453	3772	321	2324
8-#10	2.59	MA	3630	1330	5503	1080	6414	898	6963	751	7650	523	9325	351	6476
3E		MI	1693	1330	2763	984	3046	814	3202	682	3327	444	3641	192	2865
8-#10	2.59	MA	3501	1330	5147	1091	5912	917	6348	768	6808	529	8293	299	6301
4L-2S		MI	1782	1330	2967	981	3305	814	3517	677	3734	440	4109	284	2850
8-#11	3.18	MA	3765	1396	5861	1116	6839	924	7465	765	8318	517	10240	319	7789
3E		MI	1726	1396	2891	1010	3185	830	3347	687	3485	417	3771	107	3364
8-#11	3.18	MA	3613	1396	5430	1129	6232	945	6720	785	7297	523	8980	255	7324
4L-2S		MI	1827	1396	3130	1009	3489	833	3713	682	3950	411	4292	219	3351
8-#14	4.59	MA	3907	1553	6070	1232	7000	1025	7639	837	8527	519	10732	159	9748
4L-2S		MI	1960	1553	3522	1098	3972	896	4239	706	4616	368	4972	101	4556
10-#10	3.24	MA	3749	1402	5668	1136	6575	949	7153	788	7897	525	9802	293	7812
4L-3S		MI	1775	1402	2967	1029	3305	847	3517	703	3734	435	4109	160	3484
10-#10	3.24	MA	3561	1402	5306	1155	6139	959	6610	797	7141	539	8760	247	7280
5L-2S		MI	1861	1402	3170	1026	3564	847	3831	698	4141	431	4577	251	3476
10-#11	3.98	MA	3908	1485	6059	1184	7032	986	7692	810	8613	518	10802	248	9151
4L-3S		MI	1820	1485	3130	1066	3489	870	3713	711	3950	403	4292	60	4084
10-#11	3.98	MA	3688	1485	5619	1207	6502	997	7033	820	7695	535	9535	187	8573
5L-2S		MI	1917	1485	3369	1065	3794	873	4078	706	4414	398	4813	172	4084
10-#14	5.74	MA	4014	1682	6336	1345	7382	1099	8081	886	9090	534	11512	58	11279
5L-2S		MI	2082	1682	3855	1178	4396	954	4738	739	5250	345	5667	25	5564
12-#10	3.89	MA	3805	1475	5826	1201	6802	992	7415	817	8230	535	10269	241	8819
5L-3S		MI	1856	1475	3170	1074	3564	880	3831	724	4141	427	4577	127	4096
12-#10	3.89	MA	3637	1475	5488	1207	6390	1002	6881	834	7508	550	9246	169	8273
6L-2S		MI	1938	1475	3374	1072	3823	880	4146	718	4548	423	5045	218	4098
12-#11	4.78	MA	3978	1574	6248	1263	7303	1038	8005	845	9011	530	11357	180	10435
5L-3S		MI	1913	1574	3369	1121	3794	911	4078	735	4414	390	4813	13	4779
12-#11	4.78	MA	3781	1574	5844	1272	6780	1059	7357	865	8135	546	10204	106	9613
6L-2S		MI	2006	1574	3608	1120	4098	913	4443	730	4879	384	5333	125	4812
12-#14	6.89	MA	4153	1810	6663	1438	7774	1187	8539	950	9712	549	12451	-60	12090
6L-2S		MI	2204	1810	4189	1258	4821	1012	5236	771	5884	323	6363	-50	6346
14-#10	4.54	MA	3883	1547	6008	1252	7053	1035	7686	855	8598	545	10755	164	9812
6L-3S		MI	1936	1547	3374	1120	3823	912	4146	744	4548	419	5045	94	4706
14-#10	4.54	MA	3746	1547	5676	1259	6603	1050	7173	863	7860	552	9767	125	9195
7L-2S		MI	2015	1547	3577	1117	4082	913	4461	739	4955	414	5513	185	4715
14-#11	5.57	MA	4073	1663	6473	1327	7581	1099	8329	890	9451	541	12026	99	11474
6L-3S		MI	2005	1663	3608	1177	4098	951	4443	759	4879	376	5333	-35	5319
14-#11	5.57	MA	3912	1663	6071	1335	7067	1109	7706	900	8556	547	10726	34	10580
7L-2S		MI	2094	1663	3847	1176	4403	954	4808	754	5344	371	5854	77	5532
16-#10	5.18	MA	3994	1620	6197	1304	7266	1083	7978	884	8950	547	11276	119	10731
7L-3S		MI	2016	1620	3577	1165	4082	945	4461	765	4955	410	5513	61	5313
16-#10	5.18	MA	3835	1620	5878	1312	6834	1090	7457	900	8246	562	10326	67	10042
8L-2S		MI	2092	1620	3781	1162	4341	946	4775	759	5362	406	5981	152	5329
16-#11	6.37	MA	4208	1752	6699	1390	7868	1149	8678	925	9872	542	12548	26	12433
7L-3S		MI	2097	1752	3847	1233	4403	992	4808	784	5344	363	5854	-82	5815
18-#10	5.83	MA	4080	1692	6398	1358	7497	1122	8262	921	9335	558	11835	61	11582
8L-3S		MI	2094	1692	3781	1210	4341	978	4775	785	5362	402	5981	28	5896

RECTANGULAR TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

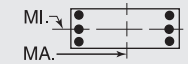
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.41	MA	1244	782	1926	609	2147	511	2259	434	2364	316	2664	255	1281
2L-3S		MI	1184	782	1805	612	1992	513	2070	439	2109	319	2348	212	1290
6-#8	1.85	MA	1290	814	2042	627	2289	524	2429	441	2592	313	2930	242	1633
2L-3S		MI	1213	814	1884	630	2087	526	2183	447	2260	316	2524	185	1644
6-#9	2.34	MA	1337	850	2168	647	2443	538	2613	450	2839	309	3211	227	2012
2L-3S		MI	1244	850	1969	651	2191	540	2306	457	2424	313	2709	155	2020
6-#10	2.98	MA	1397	896	2325	673	2637	557	2846	461	3147	304	3559	206	2487
2L-3S		MI	1283	896	2076	677	2320	559	2461	469	2628	308	2940	114	2484
6-#11	3.66	MA	1443	946	2479	696	2816	572	3056	469	3384	289	3795	168	2943
2L-3S		MI	1319	946	2184	700	2441	574	2600	477	2783	294	3091	56	2926
6-#14	5.27	MA	1573	1064	2846	764	3273	621	3605	498	4063	266	4542	100	4052
2L-3S		MI	1409	1064	2433	769	2746	621	2965	508	3233	274	3585	-62	3552
8-#7	1.88	MA	1296	816	2048	630	2302	527	2447	444	2619	314	2979	245	1659
2L-4S		MI	1205	816	1840	636	2026	534	2111	449	2169	320	2438	181	1670
8-#8	2.47	MA	1355	859	2201	655	2491	544	2674	454	2924	310	3335	229	2121
2L-4S		MI	1240	859	1930	662	2132	554	2236	461	2338	317	2638	145	2086
8-#9	3.13	MA	1418	907	2366	682	2696	564	2920	466	3255	306	3712	209	2619
2L-4S		MI	1278	907	2027	690	2245	575	2371	474	2521	313	2849	104	2469
8-#10	3.97	MA	1495	969	2574	718	2954	589	3230	481	3666	300	4179	181	3243
2L-4S		MI	1326	969	2147	727	2389	603	2541	490	2749	308	3111	49	2938

RECTANGULAR TIED COLUMNS 16" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.10	MA	1541	854	2326	678	2597	571	2724	488	2817	363	3200	304	1309
2E		MI	1359	854	2080	666	2298	561	2395	479	2460	356	2738	290	1155
4-#9	1.39	MA	1581	878	2427	690	2720	580	2870	493	3012	360	3436	295	1614
2E		MI	1392	878	2166	678	2401	570	2518	484	2623	353	2923	279	1417
4-#10	1.76	MA	1630	909	2555	707	2875	591	3054	499	3260	356	3730	284	1997
2E		MI	1432	909	2273	694	2531	581	2672	490	2827	348	3152	265	1745
4-#11	2.17	MA	1672	942	2687	720	3024	600	3226	503	3485	350	3947	262	2378
2E		MI	1465	942	2383	706	2652	588	2811	493	2981	336	3302	238	2068
4-#14	3.13	MA	1785	1021	2988	763	3393	631	3668	521	4068	340	4600	225	3285
2E		MI	1553	1021	2633	749	2958	619	3176	511	3430	319	3794	191	2832
4-#18	5.56	MA	2034	1221	3701	877	4275	712	4727	569	5384	303	6058	113	5427
2E		MI	1751	1221	3219	862	3678	699	4004	550	4443	269	4851	51	4611
6-#7	1.25	MA	1567	867	2375	688	2667	579	2811	493	2937	363	3368	304	1475
2L-3S		MI	1320	867	2000	680	2202	571	2282	489	2309	359	2563	247	1308
6-#7	1.25	MA	1495	867	2232	692	2484	582	2589	499	2637	367	2979	261	1485
3L-2S		MI	1381	867	2122	677	2358	569	2470	485	2564	357	2879	290	1298
6-#8	1.65	MA	1622	899	2512	706	2835	592	3012	501	3208	360	3702	294	1889
2L-3S		MI	1349	899	2080	698	2298	584	2395	498	2460	356	2738	220	1665
6-#8	1.65	MA	1530	899	2326	711	2597	595	2724	508	2817	365	3200	237	1900
3L-2S		MI	1426	899	2238	694	2500	582	2640	492	2791	353	3144	277	1653
6-#9	2.08	MA	1680	935	2661	726	3018	606	3232	509	3502	356	4059	282	2336
2L-3S		MI	1380	935	2166	718	2401	598	2518	507	2623	353	2923	190	2046
6-#9	2.08	MA	1568	935	2427	731	2720	610	2870	518	3012	362	3436	210	2344
3L-2S		MI	1474	935	2364	714	2654	595	2824	500	3038	349	3424	262	2035
6-#10	2.65	MA	1753	981	2849	752	3250	624	3509	520	3875	352	4504	266	2898
2L-3S		MI	1418	981	2273	744	2531	616	2672	519	2827	348	3152	149	2517
6-#10	2.65	MA	1616	981	2555	759	2875	629	3054	531	3260	359	3730	175	2895
3L-2S		MI	1534	981	2522	740	2848	614	3057	511	3346	344	3772	241	2513
6-#11	3.25	MA	1815	1031	3037	775	3470	640	3768	528	4219	345	4838	235	3449
2L-3S		MI	1454	1031	2383	766	2652	630	2811	527	2981	333	3302	90	2969
6-#11	3.25	MA	1656	1031	2687	782	3024	644	3226	540	3485	351	3947	123	3431
3L-2S		MI	1581	1031	2678	762	3028	629	3267	518	3582	328	4006	202	2974
6-#14	4.69	MA	1978	1149	3482	844	4023	689	4432	557	5097	332	5825	181	4781
2L-3S		MI	1544	1149	2633	834	2958	677	3176	557	3430	312	3794	-28	3780
6-#14	4.69	MA	1777	1149	2988	852	3393	693	3668	572	4068	339	4600	19	4552
3L-2S		MI	1711	1149	3047	830	3485	677	3816	547	4259	305	4751	134	4091

RECTANGULAR TIED COLUMNS 16" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#7	1.67	MA	1629	901	2518	710	2849	595	3032	503	3237	361	3757	297	1918
2L-4S		MI	1340	901	2035	704	2237	592	2322	500	2369	360	2652	217	1694
8-#7	1.67	MA	1559	901	2375	713	2667	597	2811	509	2937	365	3368	254	1926
3E		MI	1373	901	2122	701	2358	587	2470	499	2564	357	2879	238	1686
8-#7	1.67	MA	1520	901	2275	717	2526	604	2638	510	2701	366	3092	232	1930
4L-2S		MI	1432	901	2243	698	2513	585	2659	494	2818	355	3194	281	1678
8-#8	2.19	MA	1701	944	2699	734	3073	612	3301	513	3599	357	4205	285	2462
2L-4S		MI	1375	944	2126	729	2342	612	2447	511	2537	357	2852	180	2149
8-#8	2.19	MA	1612	944	2512	739	2835	615	3012	521	3208	362	3702	228	2468
3E		MI	1417	944	2238	726	2500	604	2640	511	2791	354	3144	207	2151
8-#8	2.19	MA	1564	944	2381	743	2651	624	2787	523	2900	362	3345	199	2457
4L-2S		MI	1492	944	2397	723	2702	602	2886	505	3123	350	3549	264	2143
8-#9	2.78	MA	1778	992	2895	762	3316	632	3594	525	3992	353	4682	269	3051
2L-4S		MI	1413	992	2223	758	2456	633	2582	524	2720	353	3062	139	2546
8-#9	2.78	MA	1670	992	2661	767	3018	636	3232	534	3502	359	4059	197	3049
3E		MI	1464	992	2364	754	2654	624	2824	523	3038	350	3424	172	2647
8-#9	2.78	MA	1611	992	2497	772	2787	646	2949	536	3115	358	3615	161	2931
4L-2S		MI	1555	992	2563	750	2907	621	3131	516	3454	346	3925	244	2644
8-#10	3.53	MA	1874	1054	3143	797	3624	657	3964	540	4491	348	5278	248	3792
2L-4S		MI	1461	1054	2345	794	2599	660	2753	540	2947	348	3323	84	3023
8-#10	3.53	MA	1743	1054	2849	804	3250	662	3509	551	3875	355	4504	157	3774
3E		MI	1523	1054	2522	790	2848	649	3057	540	3346	344	3772	125	3262
8-#10	3.53	MA	1670	1054	2641	810	2959	675	3153	554	3388	353	3951	112	3494
4L-2S		MI	1634	1054	2771	785	3165	647	3442	531	3865	339	4391	216	3271
8-#11	4.33	MA	1805	1120	3037	838	3470	685	3768	565	4219	346	4838	96	4471
3E		MI	1576	1120	2678	822	3028	670	3267	552	3582	325	4006	55	3845
8-#11	4.33	MA	1720	1120	2789	844	3122	699	3341	566	3657	352	4196	44	4023
4L-2S		MI	1695	1120	2973	818	3403	669	3723	543	4183	320	4710	167	3870
8-#14	6.25	MA	1983	1278	3482	932	4023	752	4432	609	5097	331	5825	-24	5797
3E		MI	1712	1278	3047	914	3485	735	3816	593	4259	298	4751	-85	4692
10-#10	4.41	MA	1867	1126	3143	849	3624	695	3964	572	4491	350	5278	139	4649
3L-4S		MI	1568	1126	2593	840	2916	693	3137	560	3467	343	3943	60	3722
10-#10	4.41	MA	1800	1126	2936	856	3333	708	3608	574	4004	349	4724	94	4328
4L-3S		MI	1631	1126	2771	835	3165	682	3442	560	3865	339	4391	101	4003
10-#10	4.41	MA	1716	1126	2723	871	3077	712	3290	585	3562	356	4181	39	4065
5L-2S		MI	1731	1126	3020	830	3482	680	3826	552	4384	335	5011	192	4024
10-#11	5.42	MA	1872	1209	3139	900	3568	739	3883	591	4390	347	5088	17	5017
4L-3S		MI	1695	1209	2973	878	3403	711	3723	577	4183	317	4710	19	4656
12-#10	5.29	MA	1928	1199	3230	901	3708	740	4063	595	4619	345	5498	76	5168
4E		MI	1682	1199	2842	885	3233	726	3522	581	3986	339	4562	35	4428
12-#10	5.29	MA	1844	1199	3017	916	3451	745	3745	606	4178	352	4955	22	4888
5L-3S		MI	1732	1199	3020	880	3482	715	3826	581	4384	335	5011	76	4743

RECTANGULAR TIED COLUMNS 16" x 20"

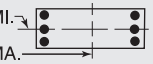
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.25	MA	1941	963	2925	770	3299	648	3485	552	3652	407	4224	344	1830
2E		MI	1528	963	2362	746	2612	627	2729	534	2822	392	3136	314	1436
4-#10	1.59	MA	2000	994	3073	786	3479	659	3700	558	3940	403	4584	335	2271
2E		MI	1568	994	2471	761	2742	638	2884	540	3026	388	3365	300	1766
4-#11	1.95	MA	2052	1027	3230	799	3656	668	3905	562	4209	397	4867	317	2715
2E		MI	1601	1027	2582	772	2864	645	3022	542	3178	375	3512	272	2094
4-#14	2.81	MA	2187	1106	3583	843	4089	699	4423	580	4905	389	5684	287	3771
2E		MI	1690	1106	2834	815	3170	675	3387	559	3626	358	4002	225	2864

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

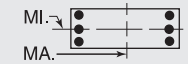
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	5.00	MA	2495	1305	4427	957	5133	780	5676	629	6581	369	7550	196	6291
2E		MI	1889	1305	3422	926	3890	753	4213	598	4638	307	5056	84	4658
6-#7	1.13	MA	1924	951	2863	768	3235	647	3415	552	3563	410	4134	352	1670
2L-3S		MI	1456	951	2195	748	2413	629	2494	540	2509	400	2778	282	1324
6-#7	1.13	MA	1839	951	2698	772	3025	650	3161	559	3219	415	3671	309	1679
3L-2S		MI	1517	951	2317	745	2568	627	2682	535	2763	397	3093	325	1314
6-#8	1.48	MA	1989	984	3022	786	3430	659	3648	560	3876	407	4538	344	2145
2L-3S		MI	1485	984	2276	766	2508	641	2607	548	2659	396	2952	255	1685
6-#8	1.48	MA	1881	984	2807	791	3156	664	3316	568	3426	413	3938	287	2156
3L-2S		MI	1562	984	2434	762	2710	639	2852	542	2991	393	3358	312	1672
6-#9	1.88	MA	2059	1020	3195	806	3642	674	3903	568	4217	403	4971	335	2660
2L-3S		MI	1515	1020	2362	785	2612	655	2729	557	2822	393	3136	225	2070
6-#9	1.88	MA	1927	1020	2925	812	3299	679	3485	578	3652	411	4224	263	2668
3L-2S		MI	1610	1020	2561	781	2864	653	3036	550	3238	389	3637	297	2056
6-#10	2.38	MA	2146	1066	3413	832	3911	692	4225	579	4651	399	5513	322	3310
2L-3S		MI	1554	1066	2471	811	2742	673	2884	569	3026	388	3365	184	2548
6-#10	2.38	MA	1984	1066	3073	839	3479	698	3700	592	3940	408	4584	231	3307
3L-2S		MI	1670	1066	2719	807	3059	671	3268	560	3545	383	3984	275	2537
6-#11	2.92	MA	2222	1116	3636	855	4173	708	4533	587	5059	392	5949	297	3954
2L-3S		MI	1585	1116	2582	832	2864	686	3022	576	3178	372	3512	125	3009
6-#11	2.92	MA	2033	1116	3230	863	3656	714	3905	601	4209	401	4867	184	3937
3L-2S		MI	1718	1116	2877	828	3239	685	3478	567	3779	367	4216	237	3004
6-#14	4.22	MA	2421	1234	4157	923	4821	757	5312	617	6107	381	7182	253	5510
2L-3S		MI	1678	1234	2834	899	3170	733	3387	606	3626	351	4002	6	3989
6-#14	4.22	MA	2168	1234	3583	934	4089	764	4423	635	4905	393	5684	92	5422
3L-2S		MI	1848	1234	3248	895	3696	733	4027	596	4456	344	4959	168	4128
6-#18	7.50	MA	2510	1534	4427	1114	5133	891	5676	720	6581	369	7550	-167	7355
3L-2S		MI	2145	1534	4117	1068	4776	857	5271	659	5983	271	6556	-40	6529
8-#7	1.50	MA	1997	986	3028	789	3444	662	3670	562	3907	408	4597	347	2177
2L-4S		MI	1476	986	2231	772	2447	650	2534	551	2569	401	2867	252	1715
8-#7	1.50	MA	1915	986	2863	793	3235	666	3415	569	3563	413	4134	304	2185
3E		MI	1509	986	2317	769	2568	645	2682	550	2763	398	3093	273	1705
8-#7	1.50	MA	1870	986	2749	797	3074	673	3218	571	3293	415	3808	280	2189
4L-2S		MI	1568	986	2439	766	2723	643	2870	545	3018	395	3409	316	1696
8-#8	1.98	MA	2083	1029	3237	814	3704	680	3981	572	4326	404	5137	337	2804
2L-4S		MI	1511	1029	2322	797	2553	669	2659	562	2737	397	3066	216	2178
8-#8	1.98	MA	1978	1029	3022	819	3430	684	3648	581	3876	411	4538	281	2809
3E		MI	1553	1029	2434	794	2710	662	2852	561	2991	394	3358	242	2174
8-#8	1.98	MA	1922	1029	2873	824	3220	694	3391	584	3523	412	4114	250	2798
4L-2S		MI	1628	1029	2593	790	2912	660	3097	555	3323	390	3763	299	2164
8-#9	2.50	MA	2174	1077	3465	841	3986	700	4320	584	4782	400	5717	326	3483
2L-4S		MI	1548	1077	2420	825	2667	690	2794	574	2919	393	3276	174	2619
8-#9	2.50	MA	2047	1077	3195	848	3642	705	3903	594	4217	408	4971	254	3481
3E		MI	1600	1077	2561	821	2864	681	3036	573	3238	390	3637	207	2675
8-#9	2.50	MA	1979	1077	3007	854	3378	716	3579	598	3774	409	4443	215	3407
4L-2S		MI	1692	1077	2759	817	3117	679	3343	566	3653	386	4139	279	2668
8-#10	3.17	MA	2288	1139	3752	877	4343	725	4750	600	5361	395	6443	309	4340
2L-4S		MI	1596	1139	2542	862	2810	717	2964	590	3146	387	3536	119	3104
8-#10	3.17	MA	2133	1139	3413	885	3911	731	4225	612	4651	404	5513	218	4322
3E		MI	1659	1139	2719	857	3059	706	3268	590	3545	383	3984	160	3296
8-#10	3.17	MA	2050	1139	3176	893	3578	746	3817	616	4092	405	4855	169	4066
4L-2S		MI	1771	1139	2968	852	3376	704	3653	581	4064	379	4604	251	3298
8-#11	3.90	MA	2209	1205	3636	919	4173	755	4533	627	5059	396	5949	164	5145
3E		MI	1711	1205	2877	888	3239	727	3478	601	3779	364	4216	89	3888

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

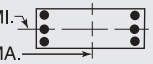
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	3.90	MA	2111	1205	3351	927	3772	771	4042	630	4387	395	5177	108	4695
4L-2S		MI	1833	1205	3172	884	3614	726	3934	593	4381	359	4920	201	3903
8-#14	5.63	MA	2426	1363	4157	1014	4821	823	5312	672	6107	385	7182	58	7003
3E		MI	1847	1363	3248	980	3696	791	4027	642	4456	337	4959	-51	4926
8-#14	5.63	MA	2281	1363	3752	1025	4252	845	4615	675	5190	397	6109	-21	6093
4L-2S		MI	2005	1363	3661	975	4223	791	4667	632	5286	329	5916	110	5376
10-#10	3.97	MA	2280	1211	3752	930	4343	764	4750	633	5361	400	6443	205	5335
3L-4S		MI	1703	1211	2791	907	3127	750	3349	610	3665	383	4155	95	3801
10-#10	3.97	MA	2203	1211	3515	938	4010	779	4342	637	4803	400	5784	156	5032
4L-3S		MI	1768	1211	2968	902	3376	739	3653	610	4064	379	4604	135	4040
10-#10	3.97	MA	2099	1211	3272	954	3717	785	3979	650	4298	410	5132	103	4774
5L-2S		MI	1869	1211	3217	897	3692	737	4038	602	4583	374	5223	227	4054
10-#11	4.88	MA	2291	1294	3757	983	4289	812	4670	655	5237	389	6259	87	5852
4L-3S		MI	1831	1294	3172	944	3614	767	3934	626	4381	356	4920	53	4764
10-#14	7.03	MA	2556	1491	4326	1106	4983	903	5503	712	6392	389	7607	-54	7533
4L-3S		MI	2012	1491	3661	1060	4223	849	4667	678	5286	322	5916	-109	5829
12-#10	4.76	MA	2353	1284	3854	983	4442	811	4867	658	5513	396	6714	143	6005
4E		MI	1817	1284	3040	952	3444	783	3734	631	4184	378	4775	70	4505
12-#10	4.76	MA	2249	1284	3611	999	4150	817	4503	670	5008	405	6062	90	5744
5L-3S		MI	1869	1284	3217	947	3692	772	4038	631	4583	374	5223	111	4781
14-#10	5.56	MA	2397	1356	3951	1045	4582	850	5028	691	5719	401	6991	77	6708
5L-4S		MI	1921	1356	3288	997	3761	816	4118	651	4704	374	5394	46	5214

RECTANGULAR TIED COLUMNS 16" x 22"

4-#9	1.14	MA	2336	1048	3463	850	3926	716	4154	611	4345	454	5074	391	2046
2E		MI	1664	1048	2559	813	2822	685	2941	584	3021	432	3349	349	1453
4-#10	1.44	MA	2405	1079	3631	866	4132	727	4399	618	4673	450	5499	384	2546
2E		MI	1704	1079	2668	829	2953	695	3095	590	3224	428	3577	335	1786
4-#11	1.77	MA	2466	1112	3813	879	4337	736	4636	621	4985	444	5850	369	3052
2E		MI	1737	1112	2782	839	3075	701	3233	591	3376	414	3723	307	2119
4-#14	2.56	MA	2625	1190	4218	923	4834	767	5231	639	5784	436	6833	345	4257
2E		MI	1827	1190	3034	880	3381	730	3597	608	3823	397	4211	259	2895
4-#18	4.55	MA	2994	1390	5192	1036	6040	848	6678	688	7729	418	9116	271	7155
2E		MI	2026	1390	3625	990	4102	808	4423	646	4833	345	5262	117	4702
6-#7	1.02	MA	2315	1036	3391	847	3852	715	4072	611	4241	458	4961	398	1864
2L-3S		MI	1592	1036	2390	816	2623	687	2705	591	2708	440	2992	318	1339
6-#7	1.02	MA	2218	1036	3205	852	3615	719	3784	619	3852	463	4423	355	1874
3L-2S		MI	1653	1036	2512	813	2778	685	2894	586	2963	437	3308	361	1329
6-#8	1.35	MA	2391	1069	3572	865	4074	727	4337	619	4597	454	5434	392	2401
2L-3S		MI	1620	1069	2471	833	2719	699	2818	599	2859	437	3166	291	1703
6-#8	1.35	MA	2267	1069	3328	871	3764	732	3961	628	4088	462	4736	335	2412
3L-2S		MI	1698	1069	2630	830	2921	697	3064	593	3190	433	3572	347	1690
6-#9	1.70	MA	2473	1105	3768	885	4315	742	4626	627	4985	451	5944	385	2984
2L-3S		MI	1651	1105	2559	853	2822	713	2941	607	3021	433	3349	260	2093
6-#9	1.70	MA	2320	1105	3463	892	3926	747	4154	639	4345	460	5074	313	2992
3L-2S		MI	1747	1105	2757	849	3075	710	3247	600	3437	429	3851	332	2077
6-#10	2.16	MA	2574	1151	4016	911	4621	760	4994	638	5478	446	6586	375	3721
2L-3S		MI	1689	1151	2668	879	2953	731	3095	619	3224	427	3577	219	2576
6-#10	2.16	MA	2386	1151	3631	920	4132	767	4399	652	4673	457	5499	284	3718
3L-2S		MI	1807	1151	2917	874	3270	728	3480	610	3744	423	4197	310	2561
6-#11	2.66	MA	2664	1201	4275	935	4925	776	5350	646	5951	439	7124	354	4460
2L-3S		MI	1720	1201	2782	898	3075	743	3233	625	3376	411	3723	159	3045
6-#11	2.66	MA	2446	1201	3813	944	4337	784	4636	662	4985	450	5850	242	4442
3L-2S		MI	1855	1201	3076	894	3450	742	3689	616	3977	406	4427	271	3033
6-#14	3.84	MA	2897	1319	4873	1003	5668	825	6243	676	7154	429	8607	319	6239
2L-3S		MI	1813	1319	3034	965	3381	788	3597	654	3823	390	4211	40	4119

RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis



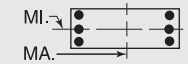
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	3.84	MA	2603	1319	4218	1016	4834	835	5231	697	5784	444	6833	157	6151
3L-2S		MI	1986	1319	3448	960	3908	789	4237	644	4653	382	5168	202	4164
6-#18	6.82	MA	3010	1619	5192	1198	6040	965	6678	785	7729	425	9116	-77	8995
3L-2S		MI	2283	1619	4320	1132	4988	912	5481	707	6177	309	6762	-7	6758
8-#7	1.36	MA	2400	1071	3577	869	4089	730	4360	621	4631	456	5499	395	2436
2L-4S		MI	1612	1071	2426	840	2657	708	2746	601	2769	441	3082	287	1734
8-#7	1.36	MA	2305	1071	3391	873	3852	734	4072	628	4241	461	4961	352	2444
3E		MI	1645	1071	2512	837	2778	703	2894	600	2963	438	3308	308	1723
8-#7	1.36	MA	2255	1071	3263	878	3671	742	3850	632	3938	463	4584	327	2448
4L-2S		MI	1705	1071	2634	834	2933	701	3082	596	3218	435	3623	351	1713
8-#8	1.80	MA	2500	1114	3815	893	4383	748	4713	632	5106	452	6132	388	3145
2L-4S		MI	1646	1114	2518	865	2763	727	2871	612	2936	437	3280	251	2204
8-#8	1.80	MA	2379	1114	3572	899	4074	753	4337	641	4597	459	5434	331	3151
3E		MI	1689	1114	2630	861	2921	720	3064	611	3190	434	3572	277	2195
8-#8	1.80	MA	2315	1114	3404	905	3837	763	4047	645	4200	461	4945	298	3140
4L-2S		MI	1765	1114	2789	858	3123	718	3309	605	3522	431	3977	334	2184
8-#9	2.27	MA	2606	1162	4074	921	4704	767	5098	643	5624	447	6815	379	3915
2L-4S		MI	1684	1162	2616	893	2877	748	3005	624	3118	433	3489	209	2688
8-#9	2.27	MA	2459	1162	3768	928	4315	773	4626	655	4985	456	5944	307	3913
3E		MI	1736	1162	2757	889	3075	739	3247	623	3437	429	3851	242	2701
8-#9	2.27	MA	2381	1162	3557	935	4018	786	4261	659	4485	459	5333	266	3874
4L-2S		MI	1829	1162	2956	884	3328	736	3554	616	3852	426	4352	314	2691
8-#10	2.89	MA	2739	1224	4401	957	5111	793	5589	659	6284	442	7673	366	4889
2L-4S		MI	1731	1224	2739	929	3021	774	3176	640	3345	427	3748	154	3182
8-#10	2.89	MA	2560	1224	4016	965	4621	800	4994	673	5478	453	6586	275	4871
3E		MI	1795	1224	2917	924	3270	764	3480	639	3744	423	4197	195	3329
8-#10	2.89	MA	2464	1224	3749	974	4246	816	4533	678	4849	455	5821	224	4653
4L-2S		MI	1908	1224	3165	919	3586	761	3865	631	4263	419	4816	286	3325
8-#11	3.55	MA	2649	1290	4275	1000	4925	824	5350	688	5951	445	7124	227	5819
3E		MI	1847	1290	3076	954	3450	783	3689	650	3977	403	4427	123	3929
8-#11	3.55	MA	2538	1290	3953	1010	4472	842	4795	693	5192	447	6223	166	5382
4L-2S		MI	1970	1290	3371	950	3826	782	4145	642	4578	398	5131	235	3935
8-#14	5.11	MA	2887	1447	4873	1096	5668	893	6243	734	7154	436	8607	132	8091
3E		MI	1982	1447	3448	1045	3908	847	4237	691	4653	375	5168	-18	5158
8-#14	5.11	MA	2738	1447	4414	1109	5024	918	5454	740	6075	436	7347	48	7119
4L-2S		MI	2143	1447	3862	1041	4435	847	4877	681	5482	368	6125	144	5416
10-#10	3.61	MA	2729	1296	4401	1011	5111	833	5589	693	6284	449	7673	266	6021
3L-4S		MI	1838	1296	2988	974	3338	807	3560	660	3864	423	4368	129	3877
10-#10	3.61	MA	2641	1296	4134	1020	4736	849	5128	699	5654	451	6908	215	5752
4L-3S		MI	1899	1296	3165	969	3586	796	3865	660	4263	418	4816	170	4075
10-#10	3.61	MA	2516	1296	3861	1037	4407	856	4720	713	5086	462	6145	162	5427
5L-2S		MI	2007	1296	3414	964	3903	794	4249	651	4782	414	5436	262	4082
10-#11	4.43	MA	2746	1379	4414	1066	5060	883	5509	718	6159	441	7497	152	6704
4L-3S		MI	1967	1379	3371	1010	3826	824	4145	675	4578	395	5131	88	4808
10-#11	4.43	MA	2603	1379	4085	1086	4663	890	5016	734	5473	453	6603	86	6291
5L-2S		MI	2084	1379	3666	1006	4201	823	4600	667	5180	390	5835	200	4829
10-#14	6.39	MA	3029	1576	5069	1190	5857	976	6467	777	7445	429	9121	22	9010
4L-3S		MI	2147	1576	3862	1125	4435	905	4877	727	5482	361	6125	-75	6068
12-#10	4.33	MA	2813	1369	4519	1065	5226	882	5723	720	6459	447	7995	205	6859
4E		MI	1944	1369	3237	1019	3655	840	3945	681	4383	418	4987	105	4579
12-#10	4.33	MA	2690	1369	4246	1082	4897	889	5315	734	5891	458	7232	153	6552
5L-3S		MI	2006	1369	3414	1015	3903	829	4249	681	4782	414	5436	146	4818

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

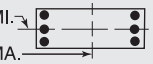
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	4.33	MA	2567	1369	4008	1090	4573	905	4913	739	5348	469	6533	94	6096
6L-2S		MI	2104	1369	3663	1010	4220	827	4634	672	5301	410	6056	237	4835
12-#11	5.32	MA	2808	1468	4546	1141	5251	931	5730	760	6440	448	7876	71	7605
5L-3S		MI	2085	1468	3666	1065	4201	864	4600	701	5180	387	5835	52	5675
14-#10	5.05	MA	2860	1441	4631	1127	5387	922	5910	754	6697	454	8319	144	7681
5L-4S		MI	2057	1441	3486	1065	3971	873	4330	701	4902	414	5607	81	5287
14-#10	5.05	MA	2743	1441	4393	1135	5063	938	5508	760	6154	464	7620	85	7214
6L-3S		MI	2106	1441	3663	1060	4220	862	4634	701	5301	409	6056	122	5560
16-#10	5.77	MA	2915	1514	4778	1181	5552	971	6103	780	6959	460	8707	76	8335
6L-4S		MI	2160	1514	3734	1110	4288	906	4715	722	5421	409	6227	56	5999

RECTANGULAR TIED COLUMNS 16" x 24"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.04	MA	2766	1133	4040	929	4602	783	4874	670	5090	501	5971	436	2262
2E		MI	1800	1133	2755	881	3033	742	3152	634	3221	472	3563	384	1470
4-#10	1.32	MA	2845	1163	4229	946	4833	795	5149	677	5459	498	6476	432	2820
2E		MI	1841	1163	2865	896	3164	752	3306	640	3423	467	3790	369	1806
4-#11	1.63	MA	2916	1197	4436	958	5067	803	5419	680	5813	491	6895	419	3389
2E		MI	1874	1197	2981	905	3286	758	3444	640	3573	453	3933	341	2143
4-#14	2.34	MA	3099	1275	4893	1002	5628	834	6091	699	6714	483	8047	399	4743
2E		MI	1964	1275	3235	945	3593	786	3808	656	4020	436	4420	293	2925
4-#18	4.17	MA	3526	1475	5998	1116	6995	916	7732	747	8921	465	10750	338	8019
2E		MI	2163	1475	3828	1054	4314	863	4633	693	5027	383	5468	150	4745
6-#8	1.23	MA	2828	1154	4161	945	4766	795	5078	678	5370	501	6361	436	2657
2L-3S		MI	1756	1154	2667	901	2929	757	3030	649	3058	477	3380	326	1721
6-#8	1.23	MA	2687	1154	3890	951	4421	801	4658	683	4802	509	5574	380	2668
3L-2S		MI	1835	1154	2826	898	3131	755	3275	643	3390	473	3786	383	1707
6-#9	1.56	MA	2921	1190	4381	965	5037	809	5402	686	5805	498	6960	432	3308
2L-3S		MI	1787	1190	2755	920	3033	770	3152	657	3221	473	3563	295	2114
6-#9	1.56	MA	2748	1190	4040	973	4602	816	4874	692	5090	508	5971	360	3316
3L-2S		MI	1883	1190	2954	916	3286	768	3459	650	3636	469	4064	367	2097
6-#10	1.98	MA	3037	1236	4660	991	5381	828	5814	697	6359	493	7721	426	4133
2L-3S		MI	1825	1236	2865	946	3164	788	3306	669	3423	467	3790	254	2601
6-#10	1.98	MA	2824	1236	4229	1001	4833	836	5149	713	5459	506	6476	335	4130
3L-2S		MI	1943	1236	3114	941	3481	785	3691	660	3942	463	4409	345	2584
6-#11	2.44	MA	3142	1286	4953	1014	5726	844	6219	706	6896	486	8363	408	4965
2L-3S		MI	1856	1286	2981	965	3286	799	3444	674	3573	450	3933	193	3079
6-#11	2.44	MA	2893	1286	4436	1025	5067	853	5419	723	5813	499	6895	296	4948
3L-2S		MI	1992	1286	3276	960	3662	798	3900	666	4175	445	4637	305	3061
6-#14	3.52	MA	3410	1404	5628	1082	6564	893	7227	735	8253	476	10098	380	6968
2L-3S		MI	1948	1404	3235	1030	3593	844	3808	703	4020	428	4420	74	4186
6-#14	3.52	MA	3074	1404	4893	1097	5628	905	6091	759	6714	494	8047	219	6880
3L-2S		MI	2124	1404	3649	1026	4120	845	4448	693	4849	421	5377	236	4198
6-#18	6.25	MA	3513	1704	5998	1282	6995	1037	7732	849	8921	478	10750	4	10737
3L-2S		MI	2421	1704	4523	1196	5200	966	5690	754	6372	347	6967	26	6844
8-#7	1.25	MA	2837	1155	4166	948	4782	798	5102	680	5406	503	6414	437	2696
2L-4S		MI	1747	1155	2621	908	2868	766	2958	652	2969	481	3296	323	1752
8-#7	1.25	MA	2730	1155	3959	953	4518	802	4781	684	4972	509	5812	395	2703
3E		MI	1781	1155	2707	905	2988	761	3106	651	3163	478	3523	344	1740
8-#7	1.25	MA	2673	1155	3816	958	4318	811	4535	692	4635	511	5397	370	2707
4L-2S		MI	1841	1155	2829	902	3143	759	3294	646	3418	475	3838	387	1730
8-#8	1.65	MA	2951	1199	4432	973	5112	816	5497	691	5938	499	7147	432	3486
2L-4S		MI	1782	1199	2713	933	2974	785	3082	662	3136	477	3494	286	2227
8-#8	1.65	MA	2815	1199	4161	979	4766	821	5078	695	5370	507	6361	376	3492
3E		MI	1825	1199	2826	929	3131	778	3275	662	3390	474	3786	313	2216
8-#8	1.65	MA	2743	1199	3975	986	4504	832	4756	705	4929	510	5815	344	3481
4L-2S		MI	1901	1199	2984	926	3333	775	3520	656	3722	471	4191	369	2204

RECTANGULAR TIED COLUMNS 16" x 24"

Short columns – no sidesway
Bending on major or minor axis

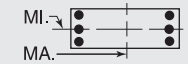


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.08	MA	3073	1247	4722	1000	5471	835	5929	703	6519	494	7949	427	4347
2L-4S		MI	1819	1247	2813	960	3088	805	3217	674	3317	473	3702	244	2729
8-#9	2.08	MA	2906	1247	4381	1008	5037	842	5402	708	5805	504	6960	356	4345
3E		MI	1872	1247	2954	956	3286	796	3459	674	3636	469	4064	277	2725
8-#9	2.08	MA	2818	1247	4146	1016	4706	855	4996	720	5249	508	6271	314	4306
4L-2S		MI	1965	1247	3152	952	3538	794	3766	666	4051	466	4565	349	2713
8-#10	2.65	MA	3225	1308	5090	1036	5928	861	6479	718	7259	489	8966	420	5438
2L-4S		MI	1866	1308	2936	996	3232	832	3387	689	3544	467	3961	188	3257
8-#10	2.65	MA	3021	1308	4660	1046	5381	869	5814	733	6359	501	7721	329	5419
3E		MI	1930	1308	3114	991	3481	821	3691	689	3942	463	4409	229	3359
8-#10	2.65	MA	2914	1308	4363	1056	4963	886	5302	740	5658	505	6849	276	5253
4L-2S		MI	2045	1308	3363	986	3797	818	4076	681	4461	458	5029	321	3350
8-#11	3.25	MA	3125	1375	4953	1081	5726	893	6219	748	6896	494	8363	285	6493
3E		MI	1982	1375	3276	1020	3662	840	3900	699	4175	442	4637	158	3968
8-#11	3.25	MA	3000	1375	4595	1092	5221	913	5601	756	6049	498	7331	222	6086
4L-2S		MI	2108	1375	3570	1016	4037	838	4356	691	4776	437	5341	270	3966
8-#14	4.69	MA	3398	1532	5628	1178	6564	963	7227	795	8253	486	10098	200	9063
3E		MI	2117	1532	3649	1111	4120	903	4448	739	4849	414	5377	16	5335
8-#14	4.69	MA	3230	1532	5117	1192	5845	990	6347	804	7047	489	8650	111	8060
4L-2S		MI	2281	1532	4063	1106	4646	903	5088	729	5679	407	6334	178	5455
10-#10	3.31	MA	3213	1381	5090	1091	5928	902	6479	754	7259	497	8966	323	6707
3L-4S		MI	1973	1381	3185	1041	3549	865	3772	710	4063	462	4580	164	3950
10-#10	3.31	MA	3114	1381	4793	1101	5511	919	5967	760	6558	501	8094	270	6487
4L-3S		MI	2034	1381	3363	1036	3797	854	4076	710	4461	458	5029	205	4108
10-#10	3.31	MA	2968	1381	4490	1119	5146	927	5514	776	5927	513	7221	217	6089
5L-2S		MI	2145	1381	3612	1032	4114	851	4461	701	4981	454	5649	296	4110
10-#11	4.06	MA	3237	1464	5112	1147	5880	953	6401	781	7132	492	8798	211	7572
4L-3S		MI	2103	1464	3570	1076	4037	880	4356	725	4776	434	5341	122	4849
10-#11	4.06	MA	3068	1464	4745	1169	5438	962	5852	798	6369	506	7768	147	7145
5L-2S		MI	2222	1464	3865	1072	4412	879	4811	716	5377	429	6045	234	4863
10-#14	5.86	MA	3562	1661	5852	1273	6781	1048	7483	841	8586	482	10702	92	10191
4L-3S		MI	2282	1661	4063	1191	4646	961	5088	776	5679	399	6334	-41	6304
10-#14	5.86	MA	3329	1661	5328	1303	6151	1060	6700	865	7498	500	9262	-2	9260
5L-2S		MI	2436	1661	4476	1186	5173	961	5728	766	6509	392	7291	121	6699
12-#10	3.97	MA	3310	1453	5223	1146	6058	952	6633	781	7458	497	9339	264	7727
4E		MI	2079	1453	3434	1086	3865	897	4156	731	4582	458	5200	140	4651
12-#10	3.97	MA	3165	1453	4921	1164	5694	960	6179	796	6827	509	8466	211	7350
5L-3S		MI	2142	1453	3612	1082	4114	887	4461	730	4981	454	5649	181	4853
12-#10	3.97	MA	3027	1453	4649	1172	5334	977	5733	803	6224	522	7668	151	6889
6L-2S		MI	2243	1453	3860	1077	4431	884	4845	722	5500	449	6268	272	4865
12-#11	4.88	MA	3302	1553	5263	1224	6097	1003	6652	823	7452	501	9236	136	8661
5L-3S		MI	2221	1553	3865	1132	4412	921	4811	750	5377	426	6045	87	5727
12-#11	4.88	MA	3139	1553	4942	1234	5661	1022	6112	831	6723	514	8292	63	7976
6L-2S		MI	2334	1553	4160	1127	4788	919	5267	741	5978	421	6749	199	5753
12-#14	7.03	MA	3655	1789	6063	1383	7086	1119	7837	901	9036	492	11314	-21	11276
5L-3S		MI	2445	1789	4476	1271	5173	1019	5728	812	6509	385	7291	-98	7206
14-#10	4.63	MA	3359	1526	5351	1210	6241	993	6844	817	7727	505	9711	206	8615
5L-4S		MI	2192	1526	3683	1132	4182	930	4541	751	5101	453	5820	116	5357
14-#10	4.63	MA	3226	1526	5079	1217	5881	1010	6398	824	7124	517	8913	145	8144
6L-3S		MI	2243	1526	3860	1127	4431	920	4845	751	5500	449	6268	156	5597
14-#11	5.69	MA	3375	1642	5459	1290	6320	1063	6912	856	7806	509	9760	53	9487
6L-3S		MI	2338	1642	4160	1187	4788	961	5267	775	5978	418	6749	51	6585
16-#10	5.29	MA	3422	1598	5509	1262	6429	1042	7063	844	8024	513	10158	139	9402
6L-4S		MI	2295	1598	3932	1177	4499	963	4926	772	5620	449	6439	91	6068

RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.22	MA	3319	1248	4867	1025	5584	863	5952	736	6296	545	7460	474	3094
2E		MI	1977	1248	3062	963	3375	810	3518	690	3622	507	4002	404	1825
4-#11	1.50	MA	3401	1281	5098	1038	5845	871	6254	740	6693	538	8000	467	3726
2E		MI	2010	1281	3180	971	3498	814	3655	690	3771	492	4144	375	2166
4-#14	2.16	MA	3609	1360	5607	1082	6471	902	7003	758	7698	530	9322	451	5229
2E		MI	2100	1360	3436	1011	3804	842	4019	705	4216	474	4629	327	2954
4-#18	3.85	MA	4094	1560	6842	1195	7999	984	8838	806	10165	512	12452	402	8883
2E		MI	2300	1560	4031	1118	4526	917	4843	741	5222	421	5673	184	4786
6-#8	1.14	MA	3300	1239	4790	1024	5508	863	5871	737	6195	548	7326	477	2913
2L-3S		MI	1892	1239	2863	969	3140	815	3242	699	3258	517	3594	361	1738
6-#8	1.14	MA	3142	1239	4490	1031	5126	869	5407	742	5568	557	6458	423	2924
3L-2S		MI	1971	1239	3022	965	3342	813	3487	693	3589	513	4000	418	1724
6-#9	1.44	MA	3404	1275	5034	1044	5808	877	6230	745	6677	545	7990	473	3632
2L-3S		MI	1922	1275	2952	988	3244	828	3364	708	3420	513	3776	330	2134
6-#9	1.44	MA	3210	1275	4657	1053	5328	885	5647	752	5888	556	6898	404	3640
3L-2S		MI	2019	1275	3150	984	3496	826	3670	700	3835	509	4277	402	2116
6-#10	1.83	MA	3535	1321	5343	1070	6189	896	6687	756	7291	540	8838	468	4544
2L-3S		MI	1961	1321	3062	1013	3375	845	3518	719	3622	507	4002	289	2626
6-#10	1.83	MA	3296	1321	4867	1081	5584	905	5952	764	6296	554	7460	379	4541
3L-2S		MI	2080	1321	3311	1008	3691	843	3903	710	4141	503	4622	380	2606
6-#11	2.25	MA	3655	1370	5671	1094	6575	912	7141	765	7893	533	9661	460	5471
2L-3S		MI	1991	1370	3180	1031	3498	856	3655	723	3771	489	4144	227	3109
6-#11	2.25	MA	3375	1370	5098	1106	5845	922	6254	784	6693	548	8000	348	5453
3L-2S		MI	2129	1370	3475	1026	3873	854	4111	715	4372	484	4848	340	3088
6-#14	3.25	MA	3959	1489	6422	1162	7509	961	8264	794	9404	523	11653	438	7697
2L-3S		MI	2083	1489	3436	1096	3804	900	4019	751	4216	467	4629	108	4231
6-#14	3.25	MA	3580	1489	5607	1178	6471	974	7003	820	7698	543	9322	276	7609
3L-2S		MI	2261	1489	3850	1091	4331	900	4659	742	5046	460	5586	270	4232
6-#18	5.77	MA	4078	1788	6842	1364	7999	1108	8838	913	10165	530	12452	79	12197
3L-2S		MI	2558	1788	4726	1260	5412	1021	5900	802	6567	385	7173	60	6892
8-#7	1.15	MA	3310	1240	4795	1028	5524	866	5896	740	6234	550	7383	478	2955
2L-4S		MI	1883	1240	2816	976	3078	825	3169	702	3168	521	3511	358	1768
8-#7	1.15	MA	3189	1240	4566	1033	5233	871	5542	744	5755	557	6720	437	2962
3E		MI	1916	1240	2902	973	3199	819	3317	702	3363	519	3737	379	1756
8-#7	1.15	MA	3126	1240	4410	1038	5013	879	5272	752	5385	560	6267	413	2966
4L-2S		MI	1977	1240	3024	970	3354	817	3506	697	3618	516	4053	422	1746
8-#8	1.52	MA	3438	1284	5089	1053	5889	884	6334	750	6822	546	8194	473	3828
2L-4S		MI	1917	1284	2909	1000	3184	843	3294	713	3336	517	3708	321	2249
8-#8	1.52	MA	3284	1284	4790	1059	5508	890	5871	755	6195	555	7326	419	3833
3E		MI	1960	1284	3022	997	3342	835	3487	712	3589	514	4000	348	2235
8-#8	1.52	MA	3204	1284	4585	1066	5219	901	5517	766	5710	558	6731	387	3822
4L-2S		MI	2037	1284	3180	994	3544	833	3732	706	3921	511	4405	405	2223
8-#9	1.92	MA	3575	1332	5411	1080	6287	903	6813	762	7466	541	9083	468	4779
2L-4S		MI	1954	1332	3009	1027	3299	863	3428	724	3517	513	3916	279	2757
8-#9	1.92	MA	3387	1332	5034	1088	5808	911	6230	768	6677	552	7990	399	4777
3E		MI	2007	1332	3150	1023	3496	854	3670	724	3835	509	4277	312	2748
8-#9	1.92	MA	3289	1332	4776	1097	5444	925	5784	781	6066	557	7238	358	4738
4L-2S		MI	2102	1332	3349	1019	3749	851	3977	717	4250	506	4779	384	2735
8-#10	2.44	MA	3746	1393	5818	1116	6794	929	7422	777	8286	536	10215	462	5986
2L-4S		MI	2001	1393	3134	1063	3443	889	3598	739	3742	507	4173	223	3329
8-#10	2.44	MA	3517	1393	5343	1126	6189	938	6687	785	7291	550	8838	373	5968
3E		MI	2066	1393	3311	1058	3691	878	3903	739	4141	502	4622	264	3387
8-#10	2.44	MA	3397	1393	5017	1137	5729	955	6124	801	6519	555	7885	321	5867
4L-2S		MI	2182	1393	3560	1053	4008	876	4287	731	4660	498	5242	356	3375

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

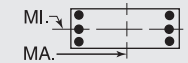
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	3.00	MA	3636	1460	5671	1161	6575	962	7141	809	7893	543	9661	340	7167
3E		MI	2118	1460	3475	1086	3873	896	4111	748	4372	481	4848	192	4004
8-#11	3.00	MA	3496	1460	5276	1173	6019	983	6459	817	6959	548	8499	275	6803
4L-2S		MI	2245	1460	3770	1082	4248	895	4567	740	4973	476	5552	304	3996
8-#14	4.33	MA	3945	1617	6422	1259	7509	1033	8264	856	9404	536	11653	263	10035
3E		MI	2252	1617	3850	1176	4331	958	4659	788	5046	453	5586	50	5453
8-#14	4.33	MA	3757	1617	5859	1275	6716	1061	7291	867	8073	541	10017	171	9019
4L-2S		MI	2419	1617	4263	1171	4858	959	5299	778	5876	445	6543	212	5492
8-#18	7.69	MA	4397	2017	7271	1533	8414	1259	9327	993	10801	521	13601	-113	13370
4L-2S		MI	2814	2017	5422	1403	6297	1125	6957	863	7912	349	8673	-65	8627
10-#10	3.05	MA	3733	1466	5818	1171	6794	971	7422	805	8286	546	10215	367	7393
3L-4S		MI	2108	1466	3383	1108	3760	922	3983	760	4262	502	4793	199	4021
10-#10	3.05	MA	3622	1466	5492	1182	6335	988	6859	822	7514	551	9262	315	7235
4L-3S		MI	2170	1466	3560	1103	4008	911	4287	760	4660	498	5242	240	4140
10-#10	3.05	MA	3455	1466	5160	1201	5934	997	6360	829	6821	564	8304	266	6759
5L-2S		MI	2283	1466	3809	1099	4325	908	4672	751	5179	494	5861	331	4136
10-#11	3.75	MA	3763	1549	5849	1229	6749	1023	7345	843	8159	543	10159	268	8455
4L-3S		MI	2238	1549	3770	1142	4248	936	4567	774	4973	473	5552	156	4889
10-#11	3.75	MA	3568	1549	5446	1251	6263	1034	6741	861	7318	558	8995	204	7944
5L-2S		MI	2360	1549	4064	1138	4624	935	5023	765	5575	468	6256	269	4895
10-#14	5.41	MA	4130	1746	6674	1355	7754	1120	8552	904	9779	534	12348	157	11391
4L-3S		MI	2418	1746	4263	1256	4858	1017	5299	824	5876	438	6543	-7	6538
10-#14	5.41	MA	3861	1746	6098	1387	7059	1133	7689	930	8579	554	10712	64	10449
5L-2S		MI	2575	1746	4677	1252	5385	1017	5939	814	6705	431	7500	155	6740
12-#10	3.66	MA	3841	1538	5968	1227	6940	1021	7594	842	8509	546	10640	309	8610
4E		MI	2214	1538	3631	1153	4076	955	4368	780	4781	498	5413	175	4720
12-#10	3.66	MA	3676	1538	5635	1246	6539	1030	7095	850	7815	560	9682	260	8156
5L-3S		MI	2279	1538	3809	1149	4325	944	4672	780	5179	493	5861	216	4887
12-#10	3.66	MA	3522	1538	5330	1253	6144	1048	6605	866	7153	573	8811	199	7699
6L-2S		MI	2381	1538	4058	1144	4642	941	5057	772	5698	489	6481	307	4893
12-#11	4.50	MA	3830	1638	6019	1307	6992	1074	7627	887	8518	553	10656	197	9631
5L-3S		MI	2357	1638	4064	1198	4624	977	5023	799	5575	465	6256	121	5769
12-#11	4.50	MA	3649	1638	5657	1316	6513	1095	7033	895	7714	568	9591	122	8923
6L-2S		MI	2473	1638	4359	1193	4999	976	5478	791	6176	460	6960	233	5788
12-#14	6.49	MA	4227	1874	6913	1467	8097	1192	8950	966	10285	547	13043	51	12824
5L-3S		MI	2581	1874	4677	1337	5385	1075	5939	861	6705	424	7500	-64	7447
14-#10	4.27	MA	3893	1611	6110	1291	7144	1063	7831	870	8810	556	11060	254	9557
5L-4S		MI	2328	1611	3880	1199	4393	988	4753	801	5300	493	6032	150	5426
14-#10	4.27	MA	3745	1611	5805	1298	6749	1081	7340	887	8148	569	10188	194	9092
6L-3S		MI	2380	1611	4058	1194	4642	977	5057	801	5698	489	6481	191	5632
14-#10	4.27	MA	3618	1611	5501	1304	6361	1088	6869	894	7471	574	9205	141	8615
7L-2S		MI	2478	1611	4306	1189	4959	974	5442	792	6218	485	7100	283	5646
14-#11	5.25	MA	3914	1727	6230	1371	7243	1135	7919	920	8914	563	11252	115	10605
6L-3S		MI	2474	1727	4359	1253	4999	1017	5478	824	6176	457	6960	85	6647
16-#10	4.88	MA	3963	1683	6281	1343	7355	1114	8076	907	9143	565	11566	188	10488
6L-4S		MI	2431	1683	4129	1244	4710	1021	5137	822	5819	489	6652	126	6136
16-#10	4.88	MA	3843	1683	5977	1350	6966	1121	7604	915	8466	570	10583	135	10013
7L-3S		MI	2480	1683	4306	1239	4959	1010	5442	821	6218	484	7100	167	6375
18-#10	5.50	MA	4064	1756	6452	1395	7572	1154	8339	935	9461	566	11960	129	11412
7L-4S		MI	2533	1756	4378	1289	5027	1053	5522	842	6338	484	7271	102	6849

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis

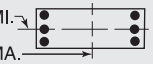


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.13	MA	3828	1333	5545	1105	6383	931	6807	795	7186	592	8502	515	3369
2E		MI	2113	1333	3260	1030	3585	867	3729	739	3821	547	4215	439	1843
4-#11	1.39	MA	3921	1366	5800	1118	6673	939	7142	799	7626	585	9100	508	4063
2E		MI	2146	1366	3379	1037	3709	870	3866	739	3968	532	4354	410	2188
4-#14	2.01	MA	4153	1445	6361	1161	7362	970	7968	817	8733	577	10626	499	5715
2E		MI	2237	1445	3636	1076	4016	898	4230	754	4413	513	4838	361	2983
4-#18	3.57	MA	4699	1645	7727	1275	9053	1051	9997	865	11461	559	14218	461	9747
2E		MI	2437	1645	4234	1182	4738	972	5053	788	5417	458	5879	217	4827
6-#8	1.06	MA	3805	1323	5459	1104	6298	931	6716	796	7073	595	8352	518	3169
2L-3S		MI	2027	1323	3059	1037	3350	873	3453	750	3457	557	3808	396	1754
6-#8	1.06	MA	3630	1323	5131	1111	5881	937	6209	802	6387	605	7402	466	3179
3L-2S		MI	2107	1323	3217	1033	3552	870	3698	744	3789	554	4214	453	1741
6-#9	1.34	MA	3922	1359	5727	1124	6627	945	7110	805	7601	592	9080	514	3956
2L-3S		MI	2058	1359	3148	1055	3454	885	3575	758	3619	552	3989	365	2153
6-#9	1.34	MA	3706	1359	5314	1133	6102	953	6472	812	6738	604	7885	447	3964
3L-2S		MI	2155	1359	3347	1051	3707	883	3882	751	4034	549	4491	437	2135
6-#10	1.70	MA	4068	1406	6066	1150	7046	964	7613	816	8276	587	10011	509	4956
2L-3S		MI	2096	1406	3260	1080	3585	902	3729	769	3821	547	4215	323	2649
6-#10	1.70	MA	3802	1406	5545	1161	6383	973	6807	824	7186	602	8502	422	4953
3L-2S		MI	2216	1406	3509	1075	3902	900	4114	760	4340	542	4835	415	2628
6-#11	2.09	MA	4203	1455	6429	1173	7473	980	8115	824	8942	580	10922	501	5976
2L-3S		MI	2127	1455	3379	1097	3709	912	3866	772	3968	529	4354	262	3139
6-#11	2.09	MA	3892	1455	5800	1186	6673	991	7142	833	7626	597	9100	392	5959
3L-2S		MI	2265	1455	3674	1093	4084	911	4322	764	4570	523	5058	374	3115
6-#14	3.01	MA	4544	1573	7257	1241	8503	1029	9353	853	10608	570	13221	489	8426
2L-3S		MI	2218	1573	3636	1161	4016	956	4230	800	4413	506	4838	142	4274
6-#14	3.01	MA	4122	1573	6361	1259	7362	1044	7968	866	8733	592	10626	328	8338
3L-2S		MI	2398	1573	4050	1157	4543	956	4869	790	5243	498	5795	303	4264
6-#18	5.36	MA	4679	1873	7727	1446	9053	1179	9997	975	11461	581	14218	147	13698
3L-2S		MI	2696	1873	4929	1324	5624	1075	6110	849	6762	422	7379	93	6940
8-#7	1.07	MA	3816	1325	5464	1107	6315	934	6743	799	7114	597	8412	520	3214
2L-4S		MI	2019	1325	3011	1044	3288	883	3381	753	3368	562	3726	393	1784
8-#7	1.07	MA	3683	1325	5213	1113	5997	939	6356	803	6590	604	7687	480	3222
3E		MI	2052	1325	3097	1041	3409	877	3529	752	3563	559	3952	414	1772
8-#7	1.07	MA	3613	1325	5043	1118	5757	948	6061	812	6186	608	7196	456	3226
4L-2S		MI	2113	1325	3219	1038	3564	875	3717	747	3818	556	4267	457	1762
8-#8	1.41	MA	3959	1369	5787	1132	6715	951	7223	809	7759	593	9301	515	4169
2L-4S		MI	2053	1369	3105	1068	3394	900	3505	763	3535	558	3922	356	2269
8-#8	1.41	MA	3789	1369	5459	1139	6298	958	6716	815	7073	602	8352	462	4174
3E		MI	2096	1369	3217	1065	3552	893	3698	762	3789	554	4214	383	2254
8-#8	1.41	MA	3700	1369	5236	1146	5983	969	6330	826	6544	607	7707	430	4163
4L-2S		MI	2174	1369	3376	1061	3754	891	3944	756	4121	551	4619	440	2241
8-#9	1.79	MA	4112	1416	6139	1160	7152	971	7748	821	8465	589	10276	510	5211
2L-4S		MI	2090	1416	3206	1095	3509	920	3640	774	3716	553	4129	314	2783
8-#9	1.79	MA	3903	1416	5727	1168	6627	979	7110	828	7601	600	9080	442	5209
3E		MI	2143	1416	3347	1091	3707	911	3882	774	4034	549	4491	347	2770
8-#9	1.79	MA	3795	1416	5445	1177	6230	993	6623	841	6934	605	8266	402	5170
4L-2S		MI	2238	1416	3545	1087	3960	909	4189	767	4449	545	4992	419	2756
8-#10	2.27	MA	4303	1478	6586	1195	7709	997	8418	836	9366	583	11520	503	6535
2L-4S		MI	2136	1478	3331	1130	3654	946	3810	789	3941	546	4386	258	3399
8-#10	2.27	MA	4048	1478	6066	1206	7046	1006	7613	845	8276	598	10011	417	6517
3E		MI	2202	1478	3509	1125	3902	935	4114	789	4340	542	4835	299	3413
8-#10	2.27	MA	3916	1478	5710	1217	6544	1025	6997	862	7433	604	8978	365	6424
4L-2S		MI	2318	1478	3757	1120	4219	933	4499	781	4859	538	5454	390	3399
8-#11	2.79	MA	4182	1544	6429	1242	7473	1031	8115	859	8942	591	10922	385	7841
3E		MI	2249	1544	3674	1152	4084	952	4322	798	4570	520	5058	226	4038
8-#11	2.79	MA	4027	1544	5998	1254	6866	1053	7369	879	7921	598	9662	320	7535
4L-2S		MI	2382	1544	3969	1148	4460	951	4778	789	5171	515	5762	338	4025

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

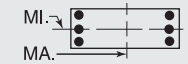
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	4.02	MA	4527	1702	7257	1339	8503	1102	9353	902	10608	585	13221	318	11007
3E		MI	2387	1702	4050	1241	4543	1014	4869	836	5243	491	5795	84	5509
8-#14	4.02	MA	4320	1702	6641	1357	7635	1132	8288	930	9150	593	11412	224	9994
4L-2S		MI	2556	1702	4464	1237	5070	1014	5509	827	6072	484	6752	246	5528
8-#18	7.14	MA	5037	2102	8205	1617	9517	1333	10543	1059	12172	577	15528	-41	15428
4L-2S		MI	2952	2102	5625	1467	6509	1179	7167	910	8107	386	8878	-31	8859
10-#10	2.83	MA	4288	1551	6586	1252	7709	1039	8418	865	9366	594	11520	411	8078
3L-4S		MI	2244	1551	3580	1175	3970	979	4194	810	4460	542	5006	234	4090
10-#10	2.83	MA	4165	1551	6231	1263	7207	1058	7803	882	8523	600	10487	359	7975
4L-3S		MI	2306	1551	3757	1170	4219	968	4499	810	4859	538	5454	275	4170
10-#10	2.83	MA	3976	1551	5868	1282	6771	1067	7259	891	7766	614	9446	312	7437
5L-2S		MI	2419	1551	4006	1166	4536	966	4884	801	5378	533	6074	366	4162
10-#11	3.48	MA	4323	1633	6627	1310	7666	1093	8342	904	9237	593	11484	313	9354
4L-3S		MI	2374	1633	3969	1208	4460	993	4778	823	5171	512	5762	191	4927
10-#11	3.48	MA	4103	1633	6187	1333	7136	1104	7682	913	8319	609	10217	253	8752
5L-2S		MI	2497	1633	4264	1204	4835	992	5234	814	5772	507	6466	303	4927
10-#14	5.02	MA	4734	1830	7536	1437	8775	1190	9673	966	11025	585	14007	214	12609
4L-3S		MI	2553	1830	4464	1322	5070	1073	5509	873	6072	477	6752	27	6675
10-#14	5.02	MA	4428	1830	6907	1470	8017	1206	8731	979	9713	608	12192	123	11659
5L-2S		MI	2713	1830	4878	1317	5596	1073	6149	863	6902	469	7709	189	6779
12-#10	3.40	MA	4408	1623	6752	1308	7870	1090	8608	903	9613	596	11996	353	9506
4E		MI	2349	1623	3829	1220	4287	1012	4579	830	4979	537	5625	210	4788
12-#10	3.40	MA	4222	1623	6389	1327	7434	1100	8064	911	8856	610	10954	307	8970
5L-3S		MI	2410	1623	4006	1216	4536	1001	4884	830	5378	533	6074	250	4919
12-#10	3.40	MA	4051	1623	6051	1334	7023	1110	7530	928	8134	625	9931	235	8525
6L-2S		MI	2519	1623	4255	1211	4853	999	5268	822	5897	529	6693	342	4921
12-#11	4.18	MA	4394	1723	6815	1389	7937	1145	8655	939	9635	604	12039	245	10607
5L-3S		MI	2493	1723	4264	1264	4835	1033	5234	848	5772	504	6466	155	5809
12-#11	4.18	MA	4193	1723	6412	1397	7414	1166	8006	958	8759	621	10886	171	9888
6L-2S		MI	2611	1723	4558	1260	5210	1032	5689	840	6374	499	7170	267	5823
12-#14	6.03	MA	4835	1959	7803	1550	9157	1264	10116	1015	11588	600	14787	113	14283
5L-3S		MI	2717	1959	4878	1402	5596	1131	6149	909	6902	462	7709	-30	7685
12-#14	6.03	MA	4563	1959	7235	1563	8410	1294	9189	1043	10335	623	13131	5	13105
6L-2S		MI	2868	1959	5291	1397	6123	1131	6789	899	7732	455	8666	132	8022
14-#10	3.97	MA	4462	1696	6910	1373	8097	1133	8870	932	9946	606	12463	301	10507
5L-4S		MI	2454	1696	4077	1266	4604	1045	4964	851	5499	533	6245	185	5492
14-#10	3.97	MA	4298	1696	6571	1379	7686	1143	8335	949	9224	620	11440	229	10056
6L-3S		MI	2516	1696	4255	1261	4853	1034	5268	851	5897	529	6693	226	5666
14-#10	3.97	MA	4158	1696	6239	1386	7235	1159	7822	958	8486	627	10453	191	9514
7L-2S		MI	2617	1696	4504	1256	5169	1032	5653	842	6416	524	7313	317	5676
14-#11	4.88	MA	4487	1812	7041	1453	8215	1207	8979	984	10075	615	12708	164	11740
6L-3S		MI	2611	1812	4558	1319	5210	1074	5689	873	6374	496	7170	120	6689
14-#11	4.88	MA	4323	1812	6638	1460	7701	1216	8355	993	9180	622	11408	99	10965
7L-2S		MI	2724	1812	4853	1315	5586	1073	6145	865	6975	491	7874	232	6712
14-#14	7.03	MA	4975	2087	8130	1643	9550	1352	10573	1079	12209	616	15726	-5	15702
6L-3S		MI	2878	2087	5291	1482	6123	1189	6789	946	7732	448	8666	-88	8586
16-#10	4.54	MA	4540	1768	7092	1424	8349	1176	9141	970	10314	616	12949	224	11591
6L-4S		MI	2567	1768	4326	1311	4921	1078	5349	871	6018	528	6864	161	6201
16-#10	4.54	MA	4407	1768	6760	1431	7898	1191	8627	978	9576	622	11962	185	11062
7L-3S		MI	2617	1768	4504	1306	5169	1067	5653	871	6416	524	7313	202	6410
16-#10	4.54	MA	4248	1768	6441	1439	7467	1198	8107	994	8871	637	11012	132	10355
8L-2S		MI	2714	1768	4753	1302	5486	1065	6038	863	6935	520	7932	293	6426

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

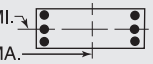
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	5.57	MA	4620	1901	7267	1516	8502	1256	9328	1018	10496	617	13230	92	12819
7L-3S		MI	2727	1901	4853	1375	5586	1114	6145	899	6975	488	7874	84	7567
18-#10	5.10	MA	4652	1841	7281	1476	8561	1224	9433	999	10666	618	13471	179	12613
7L-4S		MI	2669	1841	4575	1356	5238	1111	5734	892	6537	524	7484	137	6914
18-#10	5.10	MA	4494	1841	6961	1484	8130	1231	8912	1015	9961	633	12521	127	11897
8L-3S		MI	2716	1841	4753	1352	5486	1100	6038	892	6935	520	7932	178	7153
20-#10	5.67	MA	4736	1913	7482	1530	8793	1264	9717	1036	11051	628	14030	121	13439
8L-4S		MI	2770	1913	4824	1402	5554	1144	6118	912	7056	519	8103	112	7630

RECTANGULAR TIED COLUMNS 16" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.06	MA	4371	1418	6262	1184	7231	999	7715	854	8129	639	9603	556	3643
2E		MI	2249	1418	3457	1097	3796	924	3941	789	4019	586	4428	474	1861
4-#11	1.30	MA	4475	1451	6542	1197	7549	1007	8083	858	8611	632	10260	549	4400
2E		MI	2282	1451	3579	1103	3920	927	4077	788	4166	571	4564	444	2210
4-#14	1.88	MA	4733	1530	7155	1241	8303	1038	8985	876	9821	624	11927	540	6201
2E		MI	2373	1530	3837	1142	4228	954	4440	802	4610	552	5047	395	3010
4-#18	3.33	MA	5340	1730	8652	1354	10155	1119	11208	924	12810	606	16048	518	10611
2E		MI	2574	1730	4437	1246	4950	1026	5263	836	5612	496	6085	250	4866
6-#9	1.25	MA	4475	1444	6459	1203	7496	1013	8043	864	8578	639	10230	556	4280
2L-3S		MI	2194	1444	3345	1123	3665	943	3787	808	3818	592	4203	400	2171
6-#9	1.25	MA	4237	1444	6011	1213	6925	1021	7350	871	7640	651	8931	489	4288
3L-2S		MI	2292	1444	3543	1119	3918	941	4094	801	4233	589	4704	472	2153
6-#10	1.59	MA	4636	1490	6828	1230	7952	1032	8590	875	9313	635	11243	550	5367
2L-3S		MI	2232	1490	3457	1147	3796	959	3941	818	4019	586	4428	358	2671
6-#10	1.59	MA	4343	1490	6262	1241	7231	1042	7715	884	8129	650	9603	466	5364
3L-2S		MI	2352	1490	3706	1142	4113	957	4325	810	4538	582	5047	450	2649
6-#11	1.95	MA	4787	1540	7226	1253	8421	1047	9141	883	10044	627	12243	542	6482
2L-3S		MI	2262	1540	3579	1163	3920	968	4077	822	4166	568	4564	296	3167
6-#11	1.95	MA	4443	1540	6542	1266	7549	1059	8083	894	8611	645	10260	436	6464
3L-2S		MI	2402	1540	3873	1159	4296	967	4533	813	4767	563	5268	408	3141
6-#14	2.81	MA	5164	1658	8131	1321	9545	1096	10494	912	11864	617	14755	530	9155
2L-3S		MI	2354	1658	3837	1226	4228	1012	4440	849	4610	545	5047	176	4314
6-#14	2.81	MA	4698	1658	7155	1340	8303	1113	8985	927	9821	641	11927	374	9067
3L-2S		MI	2535	1658	4251	1222	4754	1012	5080	839	5439	537	6004	337	4296
6-#18	5.00	MA	5316	1958	8652	1528	10155	1249	11208	1037	12810	632	16048	212	15238
3L-2S		MI	2833	1958	5133	1388	5836	1130	6320	897	6957	460	7585	126	6987
8-#7	1.00	MA	4357	1410	6172	1187	7155	1002	7642	858	8046	644	9500	561	3473
2L-4S		MI	2154	1410	3206	1112	3498	941	3593	804	3568	602	3940	429	1798
8-#7	1.00	MA	4210	1410	5900	1193	6810	1007	7222	863	7478	652	8713	522	3481
3E		MI	2188	1410	3292	1109	3619	935	3741	803	3763	599	4167	450	1786
8-#7	1.00	MA	4134	1410	5716	1198	6550	1016	6903	871	7041	655	8185	498	3485
4L-2S		MI	2249	1410	3414	1107	3774	933	3929	798	4018	596	4482	493	1777
8-#8	1.32	MA	4514	1453	6523	1212	7590	1019	8164	868	8748	640	10468	556	4510
2L-4S		MI	2189	1453	3301	1136	3605	958	3717	814	3735	598	4136	391	2288
8-#8	1.32	MA	4327	1453	6167	1219	7137	1026	7614	874	8003	650	9436	504	4516
3E		MI	2232	1453	3413	1132	3763	951	3910	813	3989	594	4428	418	2272
8-#8	1.32	MA	4231	1453	5926	1226	6796	1038	7195	886	7430	655	8742	473	4505
4L-2S		MI	2310	1453	3572	1129	3965	949	4155	807	4320	591	4833	475	2259
8-#9	1.67	MA	4683	1501	6907	1239	8066	1039	8736	880	9517	636	11528	551	5643
2L-4S		MI	2225	1501	3402	1162	3720	978	3851	825	3915	593	4342	349	2807
8-#9	1.67	MA	4454	1501	6459	1248	7496	1047	8043	887	8578	648	10230	485	5641
3E		MI	2279	1501	3543	1158	3918	969	4094	824	4233	589	4704	382	2792
8-#9	1.67	MA	4335	1501	6155	1258	7066	1062	7515	902	7856	654	9352	445	5602
4L-2S		MI	2374	1501	3742	1154	4170	966	4400	817	4649	585	5205	454	2776
8-#10	2.12	MA	4894	1563	7394	1275	8673	1064	9466	895	10498	630	12883	544	7084
2L-4S		MI	2272	1563	3528	1197	3864	1003	4021	839	4140	586	4599	293	3444

RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

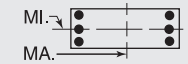
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	2.12	MA	4613	1563	6828	1286	7952	1075	8590	905	9313	646	11243	460	7065
3E		MI	2338	1563	3706	1192	4113	992	4325	839	4538	582	5047	334	3439
8-#10	2.12	MA	4468	1563	6443	1298	7408	1094	7923	922	8400	653	10131	409	6972
4L-2S		MI	2455	1563	3955	1187	4430	990	4710	830	5058	577	5667	425	3422
8-#11	2.60	MA	4763	1629	7226	1322	8421	1100	9141	919	10044	640	12243	429	8515
3E		MI	2385	1629	3873	1219	4296	1009	4533	847	4767	560	5268	261	4070
8-#11	2.60	MA	4593	1629	6759	1335	7762	1122	8332	940	8936	647	10885	365	8280
4L-2S		MI	2520	1629	4168	1214	4671	1008	4989	838	5369	554	5972	373	4054
8-#14	3.75	MA	5144	1787	8131	1420	9545	1171	10494	963	11864	634	14755	363	11979
3E		MI	2523	1787	4251	1307	4754	1070	5080	885	5439	530	6004	118	5554
8-#14	3.75	MA	4917	1787	7463	1439	8603	1202	9338	992	10281	643	12804	271	10986
4L-2S		MI	2694	1787	4665	1302	5281	1070	5720	875	6269	523	6961	280	5563
8-#18	6.67	MA	5713	2186	9179	1701	10668	1405	11812	1123	13596	631	17520	26	17353
4L-2S		MI	3090	2186	5828	1531	6721	1234	7377	958	8301	424	9084	2	9076
10-#10	2.65	MA	4877	1636	7394	1332	8673	1108	9466	925	10498	642	12883	454	8764
3L-4S		MI	2379	1636	3777	1242	4181	1036	4406	860	4659	581	5218	269	4156
10-#10	2.65	MA	4742	1636	7009	1343	8129	1127	8799	943	9584	649	11772	403	8661
4L-3S		MI	2442	1636	3955	1238	4430	1025	4710	859	5058	577	5667	310	4198
10-#10	2.65	MA	4532	1636	6617	1363	7656	1137	8210	952	8765	664	10646	358	8123
5L-2S		MI	2556	1636	4203	1233	4747	1023	5095	851	5577	573	6286	401	4188
10-#11	3.25	MA	4919	1718	7444	1391	8633	1163	9391	965	10368	642	12868	358	10266
4L-3S		MI	2510	1718	4168	1274	4671	1049	4989	872	5369	551	5972	225	4963
10-#11	3.25	MA	4672	1718	6967	1415	8059	1175	8676	975	9373	660	11498	300	9569
5L-2S		MI	2635	1718	4463	1270	5046	1048	5445	864	5970	546	6676	337	4957
10-#14	4.69	MA	5374	1915	8439	1519	9846	1261	10847	1028	12323	636	15632	260	13843
4L-3S		MI	2689	1915	4665	1387	5281	1128	5720	922	6269	516	6961	61	6785
10-#14	4.69	MA	5030	1915	7757	1553	9024	1277	9825	1042	10900	660	13668	174	12897
5L-2S		MI	2851	1915	5078	1383	5808	1129	6360	912	7099	508	7918	223	6818
12-#10	3.17	MA	5010	1708	7575	1389	8850	1160	9674	963	10769	644	13412	397	10351
4E		MI	2485	1708	4026	1288	4498	1069	4791	880	5178	577	5838	244	4853
12-#10	3.17	MA	4802	1708	7183	1408	8377	1170	9086	973	9949	660	12287	353	9792
5L-3S		MI	2546	1708	4203	1283	4747	1058	5095	880	5577	573	6286	285	4950
12-#10	3.17	MA	4615	1708	6811	1415	7933	1180	8508	990	9167	675	11185	282	9366
6L-2S		MI	2657	1708	4452	1278	5063	1056	5480	872	6096	568	6906	377	4948
12-#11	3.90	MA	4993	1807	7651	1471	8930	1215	9735	1001	10806	655	13482	293	11591
5L-3S		MI	2629	1807	4463	1330	5046	1090	5445	897	5970	543	6676	190	5848
12-#11	3.90	MA	4772	1807	7207	1479	8390	1227	9032	1021	9856	672	12136	206	10871
6L-2S		MI	2749	1807	4758	1326	5422	1089	5900	889	6571	538	7380	302	5855
12-#14	5.63	MA	5478	2044	8733	1633	10266	1336	11334	1079	12942	653	16496	164	15771
5L-3S		MI	2853	2044	5078	1467	5808	1187	6360	958	7099	501	7918	4	7906
12-#14	5.63	MA	5179	2044	8105	1645	9456	1367	10329	1108	11584	677	14713	57	14388
6L-2S		MI	3007	2044	5492	1463	6335	1187	7000	948	7928	494	8874	165	8063
14-#10	3.70	MA	5066	1781	7749	1454	9098	1203	9961	993	11134	656	13927	347	11465
5L-4S		MI	2590	1781	4275	1333	4815	1102	5175	901	5697	572	6457	220	5557
14-#10	3.70	MA	4886	1781	7377	1460	8653	1213	9383	1011	10352	671	12826	276	11037
6L-3S		MI	2653	1781	4452	1328	5063	1091	5480	901	6096	568	6906	261	5699
14-#10	3.70	MA	4733	1781	7017	1467	8157	1228	8828	1020	9554	678	11760	240	10410
7L-2S		MI	2755	1781	4701	1323	5380	1089	5864	892	6615	564	7525	352	5704
14-#11	4.55	MA	5096	1896	7891	1534	9261	1267	10091	1047	11288	667	14119	198	12894
6L-3S		MI	2747	1896	4758	1386	5422	1130	5900	923	6571	535	7380	154	6730
14-#11	4.55	MA	4916	1896	7455	1542	8669	1287	9416	1057	10319	675	12820	150	12083
7L-2S		MI	2862	1896	5053	1381	5797	1129	6356	914	7172	530	8084	266	6747

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

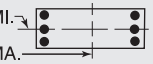
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	6.56	MA	5633	2172	9081	1725	10699	1425	11838	1144	13626	670	17541	47	17274
6L-3S		MI	3014	2172	5492	1548	6335	1245	7000	994	7928	487	8874	-54	8828
16-#10	4.23	MA	5152	1853	7943	1505	9374	1246	10258	1031	11537	667	14466	270	12710
6L-4S		MI	2703	1853	4524	1378	5132	1135	5560	921	6216	568	7077	196	6265
16-#10	4.23	MA	5006	1853	7583	1512	8878	1261	9703	1041	10739	674	13401	234	12093
7L-3S		MI	2754	1853	4701	1373	5380	1124	5864	921	6615	564	7525	237	6445
16-#10	4.23	MA	4829	1853	7237	1521	8411	1268	9129	1057	9976	689	12376	184	11365
8L-2S		MI	2852	1853	4950	1369	5697	1122	6249	913	7134	559	8145	328	6456
16-#11	5.20	MA	5242	1986	8139	1598	9540	1327	10474	1082	11751	669	14803	143	14101
7L-3S		MI	2863	1986	5053	1441	5797	1171	6356	948	7172	527	8084	119	7609
18-#10	4.76	MA	5275	1926	8149	1558	9598	1294	10578	1061	11923	670	15041	228	13776
7L-4S		MI	2805	1926	4772	1423	5448	1168	5945	942	6736	563	7696	171	6977
18-#10	4.76	MA	5099	1926	7803	1566	9131	1301	10004	1077	11161	685	14016	178	13041
8L-3S		MI	2853	1926	4950	1419	5697	1157	6249	942	7134	559	8145	212	7189
20-#10	5.29	MA	5364	1998	8369	1611	9852	1334	10880	1098	12345	681	15656	172	14717
8L-4S		MI	2907	1998	5021	1469	5765	1201	6330	962	7255	559	8316	147	7693

RECTANGULAR TIED COLUMNS 16" x 32"

4-#11	1.22	MA	5063	1536	7324	1277	8475	1075	9075	917	9649	679	11478	591	4737
2E		MI	2418	1536	3778	1169	4132	983	4288	837	4364	610	4775	478	2231
4-#14	1.76	MA	5347	1615	7989	1320	9292	1106	10054	935	10962	671	13287	582	6687
2E		MI	2510	1615	4038	1207	4439	1009	4651	851	4806	590	5256	429	3037
4-#18	3.13	MA	6017	1815	9616	1434	11306	1187	12471	983	14211	653	17769	560	11475
2E		MI	2711	1815	4640	1310	5162	1081	5473	883	5807	534	6291	283	4905
6-#9	1.17	MA	5061	1529	7231	1283	8413	1081	9028	923	9608	686	11438	597	4604
2L-3S		MI	2329	1529	3542	1190	3876	1000	3998	858	4017	632	4416	435	2189
6-#9	1.17	MA	4802	1529	6747	1293	7797	1090	8280	931	8595	699	10036	532	4612
3L-2S		MI	2428	1529	3740	1186	4128	998	4305	851	4432	629	4917	507	2171
6-#10	1.49	MA	5238	1575	7631	1309	8907	1099	9620	934	10403	682	12535	592	5779
2L-3S		MI	2368	1575	3654	1214	4007	1017	4152	868	4218	626	4640	393	2692
6-#10	1.49	MA	4918	1575	7019	1321	8128	1110	8675	944	9124	698	10763	509	5776
3L-2S		MI	2489	1575	3903	1209	4324	1014	4537	860	4737	622	5260	484	2669
6-#11	1.83	MA	5405	1625	8064	1332	9417	1115	10220	942	11198	674	13623	584	6987
2L-3S		MI	2398	1625	3778	1229	4132	1025	4288	871	4364	607	4775	330	3193
6-#11	1.83	MA	5028	1625	7324	1346	8475	1128	9075	954	9649	693	11478	479	6969
3L-2S		MI	2538	1625	4073	1225	4507	1024	4744	862	4965	602	5479	443	3166
6-#14	2.64	MA	5820	1743	9045	1401	10637	1164	11687	972	13172	664	16347	571	9884
2L-3S		MI	2489	1743	4038	1292	4439	1067	4651	897	4806	583	5256	210	4351
6-#14	2.64	MA	5308	1743	7989	1420	9292	1182	10054	987	10962	690	13287	418	9796
3L-2S		MI	2672	1743	4451	1287	4966	1068	5291	887	5636	576	6213	371	4327
6-#18	4.69	MA	5988	2043	9616	1609	11306	1319	12471	1072	14211	682	17769	260	16568
3L-2S		MI	2970	2043	5336	1452	6048	1185	6530	944	7151	498	7790	159	7031
8-#8	1.23	MA	5104	1538	7300	1291	8514	1087	9158	927	9789	687	11694	597	4851
2L-4S		MI	2324	1538	3497	1204	3815	1016	3929	864	3934	638	4350	427	2306
8-#8	1.23	MA	4900	1538	6916	1299	8025	1094	8564	934	8985	697	10581	547	4857
3E		MI	2368	1538	3609	1200	3973	1009	4122	863	4188	634	4642	453	2290
8-#8	1.23	MA	4795	1538	6656	1307	7658	1106	8113	946	8368	703	9837	515	4846
4L-2S		MI	2446	1538	3768	1197	4175	1007	4367	857	4520	631	5047	510	2276
8-#9	1.56	MA	5289	1586	7715	1319	9029	1107	9776	939	10621	683	12840	592	6075
2L-4S		MI	2361	1586	3599	1230	3931	1035	4063	875	4114	633	4556	384	2830
8-#9	1.56	MA	5038	1586	7231	1328	8413	1116	9028	947	9608	696	11438	527	6073
3E		MI	2415	1586	3740	1226	4128	1026	4305	874	4432	629	4917	417	2812
8-#9	1.56	MA	4909	1586	6903	1338	7950	1131	8460	962	8829	702	10499	488	6034
4L-2S		MI	2511	1586	3938	1222	4381	1024	4612	867	4848	625	5419	489	2796

RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis

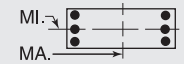


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	1.98	MA	5521	1648	8242	1354	9685	1132	10566	955	11683	677	14306	586	7632
2L-4S		MI	2407	1648	3726	1264	4075	1060	4233	889	4339	626	4811	328	3475
8-#10	1.98	MA	5213	1648	7631	1366	8907	1143	9620	964	10403	694	12535	503	7614
3E		MI	2473	1648	3903	1259	4324	1050	4537	889	4737	621	5260	369	3463
8-#10	1.98	MA	5055	1648	7216	1378	8321	1163	8902	983	9419	701	11344	452	7521
4L-2S		MI	2591	1648	4152	1255	4641	1047	4922	880	5256	617	5879	460	3445
8-#11	2.44	MA	5379	1714	8064	1402	9417	1168	10220	979	11198	688	13623	472	9189
3E		MI	2521	1714	4073	1285	4507	1065	4744	896	4965	599	5479	295	4101
8-#11	2.44	MA	5193	1714	7560	1416	8706	1191	9348	1000	10003	696	12167	409	9021
4L-2S		MI	2657	1714	4368	1280	4882	1064	5200	888	5566	594	6183	407	4082
8-#14	3.52	MA	5797	1872	9045	1500	10637	1240	11687	1023	13172	682	16347	408	12951
3E		MI	2658	1872	4451	1372	4966	1126	5291	934	5636	569	6213	152	5597
8-#14	3.52	MA	5549	1872	8325	1520	9620	1272	10440	1054	11463	694	14256	316	11992
4L-2S		MI	2831	1872	4865	1368	5493	1126	5931	924	6466	561	7169	314	5597
8-#18	6.25	MA	6425	2271	10193	1784	11869	1477	13133	1187	15072	684	19403	77	18942
4L-2S		MI	3227	2271	6031	1595	6933	1288	7587	1005	8496	462	9290	35	9125
10-#10	2.48	MA	5501	1720	8242	1412	9685	1176	10566	985	11683	689	14306	497	9450
3L-4S		MI	2514	1720	3974	1309	4392	1093	4617	909	4858	621	5431	303	4221
10-#10	2.48	MA	5354	1720	7828	1424	9100	1196	9847	1003	10698	697	13116	446	9347
4L-3S		MI	2578	1720	4152	1305	4641	1083	4922	909	5256	617	5879	344	4225
10-#10	2.48	MA	5122	1720	7406	1444	8591	1206	9214	1013	9816	713	11907	404	8815
5L-2S		MI	2693	1720	4401	1300	4957	1080	5306	901	5775	613	6499	436	4212
10-#11	3.05	MA	5549	1803	8300	1472	9649	1232	10492	1026	11552	691	14312	402	11191
4L-3S		MI	2646	1803	4368	1340	4882	1106	5200	921	5566	591	6183	259	4998
10-#11	3.05	MA	5276	1803	7787	1496	9030	1245	9722	1037	10480	710	12840	347	10393
5L-2S		MI	2772	1803	4662	1336	5258	1104	5656	913	6167	585	6887	372	4988
10-#14	4.39	MA	6048	2000	9381	1600	10965	1331	12073	1090	13674	686	17316	306	15094
4L-3S		MI	2825	2000	4865	1452	5493	1184	5931	970	6466	554	7169	95	6831
10-#14	4.39	MA	5666	2000	8646	1635	10079	1348	10971	1105	12139	712	15205	224	14090
5L-2S		MI	2989	2000	5279	1448	6020	1184	6571	960	7295	547	8126	257	6856
10-#18	7.81	MA	6632	2500	10743	1986	12657	1609	14046	1276	16233	713	21019	-99	20650
5L-2S		MI	3483	2500	6726	1738	7818	1392	8644	1066	9841	426	10790	-89	10725
12-#10	2.98	MA	5646	1793	8439	1469	9878	1228	10793	1024	11978	693	14887	441	11174
4E		MI	2620	1793	4223	1355	4709	1126	5002	930	5377	617	6050	279	4917
12-#10	2.98	MA	5416	1793	8017	1489	9369	1239	10159	1034	11095	709	13679	398	10621
5L-3S		MI	2682	1793	4401	1350	4957	1115	5306	930	5775	612	6499	320	4981
12-#10	2.98	MA	5213	1793	7611	1495	8891	1250	9537	1052	10254	725	12499	328	10203
6L-2S		MI	2794	1793	4650	1345	5274	1113	5691	921	6295	608	7118	411	4974
12-#11	3.66	MA	5626	1892	8527	1552	9972	1285	10867	1062	12029	705	14984	340	12584
5L-3S		MI	2766	1892	4662	1396	5258	1146	5656	946	6167	582	6887	224	5885
12-#11	3.66	MA	5386	1892	8042	1560	9391	1298	10111	1084	11005	723	13542	253	11869
6L-2S		MI	2887	1892	4957	1392	5633	1145	6111	938	6769	577	7591	336	5887
12-#14	5.27	MA	6156	2129	9702	1715	11424	1407	12604	1142	14350	705	18265	214	17234
5L-3S		MI	2988	2129	5279	1533	6020	1242	6571	1007	7295	540	8126	38	8011
12-#14	5.27	MA	5830	2129	9015	1727	10591	1424	11522	1172	12885	731	16193	87	15688
6L-2S		MI	3145	2129	5693	1528	6546	1243	7210	997	8125	532	9083	199	8103
14-#10	3.47	MA	5705	1865	8628	1535	10148	1272	11105	1054	12375	705	15450	392	12431
5L-4S		MI	2725	1865	4472	1400	5026	1159	5387	951	5896	612	6670	255	5620
14-#10	3.47	MA	5509	1865	8223	1541	9670	1283	10483	1072	11533	721	14271	322	12029
6L-3S		MI	2790	1865	4650	1395	5274	1148	5691	950	6295	608	7118	296	5730
14-#10	3.47	MA	5342	1865	7835	1548	9128	1298	9886	1082	10674	729	13128	287	11313
7L-2S		MI	2893	1865	4898	1391	5591	1146	6076	942	6814	604	7738	387	5732
14-#11	4.27	MA	5739	1981	8782	1615	10333	1338	11255	1109	12554	718	15687	246	14064
6L-3S		MI	2883	1981	4957	1452	5633	1187	6111	972	6769	574	7591	188	6769
14-#11	4.27	MA	5543	1981	8311	1624	9685	1357	10528	1120	11510	727	14292	201	13257
7L-2S		MI	3000	1981	5252	1447	6008	1185	6567	963	7370	569	8295	301	6782
14-#14	6.15	MA	6325	2257	10071	1807	11936	1482	13155	1208	15096	723	19253	77	18813
6L-3S		MI	3150	2257	5693	1613	6546	1301	7210	1043	8125	525	9083	-20	9067

RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	6.15	MA	6061	2257	9397	1819	11020	1510	12114	1224	13601	734	17252	9	17209
7L-2S		MI	3300	2257	6107	1609	7073	1301	7850	1033	8955	518	10040	142	9346
16-#10	3.97	MA	5799	1938	8834	1586	10448	1316	11428	1093	12813	717	16042	316	13845
6L-4S		MI	2839	1938	4721	1445	5342	1192	5772	971	6415	608	7289	231	6328
16-#10	3.97	MA	5640	1938	8446	1593	9907	1331	10831	1103	11954	725	14900	282	13131
7L-3S		MI	2891	1938	4898	1441	5591	1181	6076	971	6814	603	7738	271	6478
16-#10	3.97	MA	5444	1938	8074	1602	9404	1338	10204	1118	11133	741	13800	233	12391
8L-2S		MI	2991	1938	5147	1436	5908	1179	6461	963	7333	599	8357	363	6486
16-#11	4.88	MA	5899	2070	9051	1680	10628	1397	11673	1145	13059	722	16437	193	15407
7L-3S		MI	3000	2070	5252	1507	6008	1227	6567	997	7370	566	8295	153	7650
16-#11	4.88	MA	5667	2070	8598	1690	10017	1405	10924	1165	12061	740	15096	131	14394
8L-2S		MI	3113	2070	5547	1503	6383	1226	7023	989	7971	561	8999	265	7670
16-#14	7.03	MA	6562	2386	10453	1899	12364	1568	13747	1260	15811	727	20312	-2	20306
7L-3S		MI	3311	2386	6107	1693	7073	1359	7850	1079	8955	511	10040	-77	9968
18-#10	4.46	MA	5933	2010	9057	1639	10685	1364	11776	1123	13233	720	16671	276	14949
7L-4S		MI	2941	2010	4970	1491	5659	1225	6156	992	6934	603	7909	206	7039
18-#10	4.46	MA	5738	2010	8685	1648	10182	1371	11149	1139	12413	737	15572	227	14201
8L-3S		MI	2991	2010	5147	1486	5908	1214	6461	992	7333	599	8357	247	7223
18-#10	4.46	MA	5548	2010	8267	1666	9665	1388	10529	1146	11574	744	14486	183	13470
9L-2S		MI	3087	2010	5396	1481	6225	1212	6845	983	7852	595	8977	339	7237
18-#11	5.48	MA	6018	2159	9338	1745	10959	1446	12068	1190	13610	735	17240	124	16584
8L-3S		MI	3116	2159	5547	1563	6383	1267	7023	1022	7971	558	8999	117	8529
20-#10	4.96	MA	6027	2083	9296	1693	10960	1404	12095	1159	13692	732	17343	222	16012
8L-4S		MI	3043	2083	5219	1536	5976	1258	6541	1012	7453	599	8529	182	7754
20-#10	4.96	MA	5844	2083	8879	1711	10444	1421	11475	1166	12854	740	16258	177	15274
9L-3S		MI	3090	2083	5396	1531	6225	1247	6845	1012	7852	594	8977	223	7967
22-#10	5.46	MA	6135	2155	9490	1756	11222	1454	12420	1187	14133	736	18029	171	17079
9L-4S		MI	3144	2155	5467	1581	6293	1291	6926	1033	7973	594	9148	158	8471

RECTANGULAR TIED COLUMNS 18" x 18"

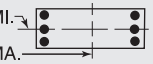
6-#8	1.46	MA	1794	995	2756	784	3100	658	3281	558	3462	406	3977	335	1909
2L-3S		MI	1702	995	2570	788	2863	661	2992	566	3071	411	3475	278	1921
6-#9	1.85	MA	1853	1031	2906	803	3284	672	3500	566	3756	402	4333	323	2359
2L-3S		MI	1740	1031	2672	809	2986	676	3138	575	3266	408	3709	251	2370
6-#10	2.35	MA	1927	1077	3095	829	3515	690	3777	577	4129	398	4777	306	2924
2L-3S		MI	1787	1077	2800	836	3141	695	3322	588	3513	404	4003	215	2929
6-#11	2.89	MA	1989	1126	3286	851	3737	705	4036	585	4471	390	5109	275	3480
2L-3S		MI	1827	1126	2935	858	3291	709	3494	596	3738	396	4217	163	3475
6-#14	4.17	MA	2153	1245	3732	919	4289	753	4700	614	5348	376	6094	220	4820
2L-3S		MI	1948	1245	3238	927	3660	757	3936	628	4319	384	4869	59	4721
6-#18	7.41	MA	2524	1544	4793	1094	5610	879	6290	689	7327	324	8291	55	7987
2L-3S		MI	2217	1544	3954	1103	4543	880	4994	709	5633	337	6323	-233	6148
8-#8	1.95	MA	1874	1040	2943	812	3338	678	3569	571	3853	403	4479	325	2484
2L-4S		MI	1735	1040	2625	821	2916	690	3055	581	3154	408	3619	239	2490
8-#9	2.47	MA	1952	1088	3140	839	3582	698	3862	583	4246	399	4956	310	3076
2L-4S		MI	1782	1088	2742	850	3053	712	3217	594	3369	404	3888	201	3020
8-#10	3.14	MA	2048	1149	3389	874	3890	723	4232	598	4744	393	5550	288	3820
2L-4S		MI	1841	1149	2887	887	3225	740	3421	611	3642	399	4223	152	3593
8-#11	3.85	MA	2130	1216	3636	907	4183	746	4578	610	5204	384	6000	248	4544
2L-4S		MI	1890	1216	3037	920	3388	764	3609	623	3909	397	4467	84	4133

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	3.92	MA	2169	1222	3683	920	4264	756	4687	618	5360	389	6324	270	4710
2L-5S		MI	1887	1222	2968	948	3343	778	3558	642	3816	401	4454	79	4213
10-#10	3.92	MA	2040	1222	3389	926	3890	760	4232	629	4744	396	5550	179	4689
3L-4S		MI	1971	1222	3181	933	3599	773	3876	632	4257	394	4997	134	4423
10-#11	4.81	MA	2130	1305	3636	969	4183	790	4578	647	5204	385	6000	109	5560
3L-4S		MI	2043	1305	3387	976	3834	804	4151	648	4643	392	5358	57	5123

RECTANGULAR TIED COLUMNS 18" x 20"

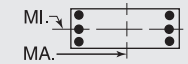
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.11	MA	2154	1069	3223	857	3625	722	3817	617	3968	458	4566	389	1849
2E		MI	1926	1069	2917	845	3251	712	3406	608	3520	451	3983	376	1652
4-#10	1.41	MA	2213	1100	3372	873	3806	733	4032	623	4255	455	4924	380	2293
2E		MI	1975	1100	3046	861	3407	723	3591	614	3767	447	4276	364	2040
4-#11	1.73	MA	2265	1133	3532	885	3984	741	4236	626	4522	448	5205	361	2742
2E		MI	2018	1133	3184	872	3557	730	3762	616	3990	440	4488	341	2431
4-#14	2.50	MA	2401	1212	3887	928	4418	771	4754	644	5218	439	6020	331	3804
2E		MI	2131	1212	3488	914	3927	759	4203	633	4571	429	5138	303	3350
4-#18	4.44	MA	2712	1411	4735	1041	5462	851	6007	691	6892	419	7882	240	6339
2E		MI	2384	1411	4208	1025	4811	838	5261	679	5883	391	6588	190	5522
6-#8	1.32	MA	2202	1090	3319	873	3756	734	3980	625	4192	459	4880	390	2165
2L-3S		MI	1874	1090	2814	866	3128	727	3260	623	3326	457	3749	318	1941
6-#8	1.32	MA	2093	1090	3104	879	3482	738	3647	633	3742	465	4280	333	2177
3L-2S		MI	1967	1090	3000	862	3366	724	3549	616	3717	452	4251	375	1928
6-#9	1.67	MA	2272	1126	3493	893	3969	748	4234	633	4533	455	5312	380	2683
2L-3S		MI	1911	1126	2917	886	3251	742	3406	633	3520	454	3983	291	2394
6-#9	1.67	MA	2139	1126	3223	899	3625	753	3817	643	3968	463	4566	308	2694
3L-2S		MI	2026	1126	3151	881	3549	738	3768	624	4010	448	4606	363	2380
6-#10	2.12	MA	2360	1172	3712	919	4238	766	4557	644	4966	451	5854	367	3336
2L-3S		MI	1959	1172	3046	913	3407	760	3591	645	3767	450	4276	255	2960
6-#10	2.12	MA	2196	1172	3372	926	3806	772	4032	656	4255	460	4924	276	3340
3L-2S		MI	2100	1172	3340	906	3781	756	4045	634	4382	443	5049	346	2949
6-#11	2.60	MA	2436	1222	3938	941	4501	782	4864	651	5372	443	6287	341	3985
2L-3S		MI	1999	1222	3184	934	3557	774	3762	653	3990	441	4488	202	3514
6-#11	2.60	MA	2245	1222	3532	949	3984	788	4236	665	4522	452	5205	229	3980
3L-2S		MI	2162	1222	3534	928	4003	770	4304	641	4723	435	5379	314	3510
6-#14	3.75	MA	2636	1340	4462	1009	5149	830	5643	680	6420	432	7518	298	5549
2L-3S		MI	2110	1340	3488	1003	3927	822	4203	684	4571	428	5138	98	4814
6-#14	3.75	MA	2379	1340	3887	1019	4418	837	4754	699	5218	443	6020	136	5485
3L-2S		MI	2328	1340	3982	994	4556	818	4967	670	5599	421	6363	260	4857
6-#18	6.67	MA	3088	1640	5716	1183	6711	955	7524	756	8940	405	10328	164	9283
2L-3S		MI	2385	1640	4208	1177	4811	943	5261	764	5883	381	6588	-194	6448
6-#18	6.67	MA	2719	1640	4735	1198	5462	963	6007	783	6892	418	7882	-124	7743
3L-2S		MI	2700	1640	5046	1168	5878	942	6557	744	7577	367	8556	93	8039
8-#8	1.76	MA	2297	1135	3534	902	4030	755	4312	638	4642	456	5480	383	2826
2L-4S		MI	1907	1135	2869	899	3182	756	3324	638	3408	454	3894	279	2519
8-#8	1.76	MA	2191	1135	3319	907	3756	759	3980	646	4192	463	4880	326	2834
3E		MI	1956	1135	3000	894	3366	748	3549	636	3717	454	4251	309	2515
8-#8	1.76	MA	2134	1135	3170	912	3546	768	3722	649	3839	464	4457	295	2831
4L-2S		MI	2047	1135	3187	890	3603	745	3838	629	4107	449	4754	365	2505
8-#9	2.22	MA	2389	1183	3763	929	4312	774	4651	649	5097	452	6058	371	3508
2L-4S		MI	1953	1183	2986	927	3318	778	3485	651	3623	450	4162	241	3094
8-#9	2.22	MA	2260	1183	3493	935	3969	779	4234	659	4533	459	5312	299	3511
3E		MI	2014	1183	3151	922	3549	768	3768	649	4010	451	4606	278	3107

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

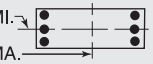
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.22	MA	2190	1183	3305	941	3704	791	3910	663	4089	460	4784	260	3487
4L-2S		MI	2125	1183	3385	917	3847	764	4130	640	4500	445	5229	350	3099
8-#10	2.82	MA	2503	1245	4051	964	4670	799	5081	664	5676	446	6784	354	4369
2L-4S		MI	2012	1245	3133	964	3490	806	3689	668	3895	444	4496	192	3687
8-#10	2.82	MA	2346	1245	3712	972	4238	805	4557	677	4966	455	5854	263	4359
3E		MI	2087	1245	3340	958	3781	793	4045	666	4382	446	5049	237	3845
8-#10	2.82	MA	2261	1245	3475	980	3905	820	4148	681	4407	456	5195	215	4180
4L-2S		MI	2222	1245	3635	952	4156	789	4500	655	4998	439	5823	328	3847
8-#11	3.47	MA	2604	1311	4345	997	5018	822	5492	677	6222	437	7368	321	5218
2L-4S		MI	2061	1311	3285	996	3655	829	3877	679	4162	442	4737	123	4237
8-#11	3.47	MA	2421	1311	3938	1005	4501	828	4864	691	5372	447	6287	209	5193
3E		MI	2148	1311	3534	990	4003	814	4304	678	4723	436	5379	175	4562
8-#11	3.47	MA	2322	1311	3653	1013	4100	844	4373	694	4701	446	5515	152	4820
4L-2S		MI	2305	1311	3884	983	4449	811	4846	667	5457	429	6271	287	4577
8-#14	5.00	MA	2624	1469	4462	1100	5149	895	5643	735	6420	436	7518	102	7186
3E		MI	2326	1469	3982	1083	4556	880	4967	721	5599	420	6363	54	6208
8-#14	5.00	MA	2490	1469	4056	1111	4580	918	4946	739	5503	447	6445	24	6343
4L-2S		MI	2520	1469	4476	1075	5185	876	5731	706	6628	413	7588	216	6348
10-#10	3.53	MA	2645	1317	4391	1009	5102	832	5606	685	6386	442	7713	341	5396
2L-5S		MI	2059	1317	3214	1025	3608	843	3826	700	4069	447	4727	119	4305
10-#10	3.53	MA	2493	1317	4051	1017	4670	838	5081	697	5676	451	6784	250	5375
3L-4S		MI	2142	1317	3427	1010	3865	839	4144	689	4511	440	5270	174	4515
10-#10	3.53	MA	2414	1317	3814	1025	4337	853	4673	702	5118	452	6125	202	5142
4L-3S		MI	2212	1317	3635	1003	4156	826	4500	686	4998	442	5823	219	4726
10-#10	3.53	MA	2310	1317	3571	1041	4044	859	4310	714	4613	461	5472	148	4875
5L-2S		MI	2343	1317	3929	997	4530	822	4955	676	5613	435	6597	310	4740
10-#11	4.33	MA	2595	1400	4345	1061	5018	868	5492	716	6222	441	7368	189	6402
3L-4S		MI	2213	1400	3636	1052	4101	869	4419	705	4895	437	5629	96	5225
10-#11	4.33	MA	2502	1400	4059	1069	4617	885	5001	719	5551	440	6597	132	5973
4L-3S		MI	2295	1400	3884	1045	4449	855	4846	703	5457	430	6271	148	5607
10-#14	6.25	MA	2742	1597	4630	1191	5311	976	5834	775	6705	440	7943	-10	7930
4L-3S		MI	2528	1597	4476	1163	5185	938	5731	757	6628	412	7588	10	7557
12-#10	4.23	MA	2639	1390	4391	1062	5102	871	5606	718	6386	447	7713	237	6389
3L-5S		MI	2187	1390	3508	1070	3983	876	4281	720	4685	443	5501	102	5154
12-#10	4.23	MA	2564	1390	4154	1070	4769	886	5198	722	5828	448	7055	189	6111
4E		MI	2270	1390	3721	1055	4239	872	4599	709	5126	436	6044	156	5349
12-#10	4.23	MA	2461	1390	3911	1086	4476	892	4835	735	5323	457	6402	135	5861
5L-3S		MI	2336	1390	3929	1049	4530	859	4955	707	5613	437	6597	201	5604
12-#11	5.20	MA	2679	1489	4465	1125	5134	925	5629	745	6401	435	7679	112	7135
4E		MI	2376	1489	3986	1108	4547	910	4960	730	5628	431	6520	69	6221
14-#10	4.94	MA	2712	1462	4493	1116	5201	919	5723	743	6538	444	7984	175	7087
4L-5S		MI	2313	1462	3802	1115	4357	909	4736	741	5301	438	6274	84	5992
14-#10	4.94	MA	2610	1462	4250	1132	4909	925	5360	755	6034	453	7332	122	6851
5L-4S		MI	2396	1462	4015	1100	4614	905	5054	730	5742	432	6818	138	6190

RECTANGULAR TIED COLUMNS 18" x 22"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.01	MA	2594	1164	3819	947	4320	799	4555	683	4729	511	5490	442	2065
2E		MI	2098	1164	3162	923	3517	778	3674	665	3774	497	4257	416	1669
4-#10	1.28	MA	2663	1195	3989	963	4526	810	4800	690	5056	508	5915	435	2568
2E		MI	2148	1195	3292	938	3673	789	3859	671	4020	493	4549	404	2061
4-#11	1.58	MA	2725	1228	4174	975	4732	817	5037	693	5366	501	6263	419	3079
2E		MI	2190	1228	3432	948	3824	794	4029	673	4242	485	4758	381	2456
4-#14	2.27	MA	2884	1307	4581	1018	5230	848	5632	710	6164	492	7244	394	4290
2E		MI	2304	1307	3738	989	4194	824	4471	689	4822	474	5407	343	3381
4-#18	4.04	MA	3256	1507	5560	1130	6437	928	7078	757	8108	473	9522	319	7203
2E		MI	2559	1507	4461	1099	5078	901	5528	734	6132	434	6854	229	5566

RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

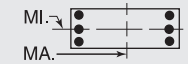
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.20	MA	2649	1186	3927	963	4467	811	4738	691	4980	512	5852	443	2421
2L-3S		MI	2045	1186	3058	944	3393	794	3528	681	3580	503	4023	358	1959
6-#8	1.20	MA	2524	1186	3684	969	4157	815	4362	701	4471	519	5154	386	2433
3L-2S		MI	2139	1186	3244	939	3631	790	3817	674	3971	498	4526	415	1946
6-#9	1.52	MA	2731	1221	4125	982	4709	824	5027	699	5368	508	6361	436	3007
2L-3S		MI	2083	1221	3162	964	3517	808	3674	690	3774	500	4257	331	2417
6-#9	1.52	MA	2577	1221	3819	990	4320	830	4555	711	4729	517	5490	364	3018
3L-2S		MI	2199	1221	3396	958	3815	804	4036	681	4264	494	4880	403	2401
6-#10	1.92	MA	2833	1268	4374	1008	5015	843	5395	710	5861	504	7002	426	3747
2L-3S		MI	2131	1268	3292	990	3673	826	3859	703	4020	496	4549	295	2987
6-#10	1.92	MA	2643	1268	3989	1017	4526	850	4800	724	5056	514	5915	334	3752
3L-2S		MI	2273	1268	3586	983	4047	821	4313	692	4636	489	5322	386	2972
6-#11	2.36	MA	2923	1317	4636	1031	5320	858	5751	718	6332	496	7537	404	4491
2L-3S		MI	2170	1317	3432	1010	3824	839	4029	709	4242	486	4758	242	3551
6-#11	2.36	MA	2702	1317	4174	1040	4732	866	5037	734	5366	507	6263	291	4486
3L-2S		MI	2335	1317	3782	1004	4270	835	4571	698	4976	480	5650	354	3539
6-#14	3.41	MA	3158	1436	5236	1098	6064	906	6644	747	7534	485	9018	369	6278
2L-3S		MI	2281	1436	3738	1078	4194	886	4471	740	4822	473	5407	137	4866
6-#14	3.41	MA	2859	1436	4581	1111	5230	916	5632	768	6164	500	7244	207	6214
3L-2S		MI	2503	1436	4232	1070	4823	882	5235	726	5851	465	6632	299	4893
6-#18	6.06	MA	3696	1735	6684	1273	7867	1032	8816	822	10459	460	12454	260	10579
2L-3S		MI	2554	1735	4461	1251	5078	1006	5528	819	6132	424	6854	-156	6745
6-#18	6.06	MA	3238	1735	5560	1292	6437	1045	7078	855	8108	480	9522	-28	9480
3L-2S		MI	2876	1735	5299	1242	6145	1005	6824	799	7826	411	8821	132	8090
8-#8	1.60	MA	2758	1231	4170	991	4776	831	5114	704	5489	509	6550	438	3167
2L-4S		MI	2078	1231	3113	976	3447	823	3592	696	3663	500	4168	320	2545
8-#8	1.60	MA	2636	1231	3927	997	4467	836	4738	713	4980	517	5852	382	3175
3E		MI	2128	1231	3244	972	3631	814	3817	694	3971	500	4526	349	2537
8-#8	1.60	MA	2572	1231	3759	1003	4230	846	4448	717	4584	519	5362	349	3173
4L-2S		MI	2220	1231	3431	967	3869	811	4106	687	4362	495	5028	406	2526
8-#9	2.02	MA	2865	1279	4430	1018	5098	850	5500	716	6007	505	7231	429	3940
2L-4S		MI	2125	1279	3231	1005	3584	844	3753	709	3877	496	4436	282	3129
8-#9	2.02	MA	2716	1279	4125	1025	4709	856	5027	727	5368	514	6361	357	3943
3E		MI	2186	1279	3396	999	3815	834	4036	707	4264	496	4880	318	3133
8-#9	2.02	MA	2637	1279	3913	1033	4411	869	4662	732	4869	516	5749	317	3919
4L-2S		MI	2298	1279	3630	994	4113	830	4398	698	4754	490	5503	390	3123
8-#10	2.57	MA	2999	1340	4759	1054	5505	876	5990	731	6667	499	8089	416	4917
2L-4S		MI	2183	1340	3379	1041	3756	872	3957	726	4149	490	4769	232	3778
8-#10	2.57	MA	2817	1340	4374	1062	5015	883	5395	745	5861	510	7002	325	4908
3E		MI	2259	1340	3586	1035	4047	859	4313	723	4636	491	5322	277	3877
8-#10	2.57	MA	2720	1340	4107	1071	4640	899	4934	750	5232	513	6236	274	4782
4L-2S		MI	2396	1340	3880	1029	4421	854	4768	712	5251	485	6096	368	3873
8-#11	3.15	MA	3118	1406	5098	1086	5908	898	6465	743	7299	490	8811	389	5892
2L-4S		MI	2231	1406	3533	1072	3921	894	4144	736	4414	487	5008	163	4338
8-#11	3.15	MA	2907	1406	4636	1096	5320	906	5751	759	6332	502	7537	277	5867
3E		MI	2320	1406	3782	1066	4270	879	4571	735	4976	481	5650	215	4603
8-#11	3.15	MA	2793	1406	4314	1106	4867	924	5196	765	5574	503	6636	216	5526
4L-2S		MI	2478	1406	4133	1059	4716	875	5113	723	5709	474	6541	327	4609
8-#14	4.55	MA	3144	1564	5236	1191	6064	974	6644	805	7534	492	9018	181	8158
3E		MI	2497	1564	4232	1158	4823	944	5235	777	5851	465	6632	93	6331
8-#14	4.55	MA	2991	1564	4778	1205	5420	999	5855	811	6455	493	7758	97	7286
4L-2S		MI	2695	1564	4726	1150	5452	940	5999	762	6879	457	7857	255	6388
10-#10	3.21	MA	3162	1413	5143	1099	5995	909	6585	751	7472	495	9176	407	6081
2L-5S		MI	2230	1413	3460	1102	3874	909	4094	757	4323	492	5000	159	4385

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

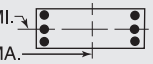
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	3.21	MA	2987	1413	4759	1108	5505	916	5990	765	6667	506	8089	316	6061
3L-4S		MI	2313	1413	3673	1087	4131	905	4412	746	4764	486	5543	214	4602
10-#10	3.21	MA	2897	1413	4492	1116	5130	932	5530	771	6037	508	7324	265	5877
4L-3S		MI	2384	1413	3880	1080	4421	892	4768	744	5251	487	6096	259	4761
10-#10	3.21	MA	2772	1413	4219	1134	4801	939	5121	785	5469	519	6561	212	5539
5L-2S		MI	2517	1413	4174	1074	4796	887	5223	733	5867	480	6870	350	4768
10-#11	3.94	MA	3107	1496	5098	1152	5908	947	6465	784	7299	497	8811	262	7245
3L-4S		MI	2384	1496	3884	1128	4367	934	4686	761	5147	482	5899	136	5322
10-#11	3.94	MA	3002	1496	4776	1162	5455	965	5910	790	6540	498	7909	201	6841
4L-3S		MI	2467	1496	4133	1122	4716	920	5113	760	5709	475	6541	188	5650
10-#11	3.94	MA	2859	1496	4446	1182	5058	972	5417	806	5855	510	7015	136	6483
5L-2S		MI	2619	1496	4483	1115	5162	916	5655	748	6443	469	7433	300	5672
10-#14	5.68	MA	3284	1693	5432	1285	6253	1058	6868	848	7825	485	9532	72	9169
4L-3S		MI	2700	1693	4726	1238	5452	1003	5999	813	6879	456	7857	49	7703
12-#10	3.85	MA	3155	1485	5143	1153	5995	949	6585	786	7472	502	9176	307	7212
3L-5S		MI	2358	1485	3754	1147	4249	942	4549	777	4938	488	5773	142	5233
12-#10	3.85	MA	3070	1485	4877	1162	5620	964	6125	792	6842	504	8411	256	6979
4E		MI	2441	1485	3967	1132	4505	938	4867	767	5380	481	6317	196	5435
12-#10	3.85	MA	2947	1485	4604	1179	5291	972	5716	806	6274	515	7648	203	6660
5L-3S		MI	2509	1485	4174	1126	4796	925	5223	764	5867	483	6870	241	5641
12-#10	3.85	MA	2822	1485	4366	1187	4967	987	5314	811	5731	526	6949	144	6265
6L-2S		MI	2637	1485	4469	1119	5170	920	5678	753	6483	476	7644	332	5658
12-#11	4.73	MA	3206	1585	5237	1217	6043	1005	6624	815	7506	493	9183	186	8167
4E		MI	2534	1585	4234	1184	4813	974	5228	786	5881	476	6791	109	6316
12-#11	4.73	MA	3064	1585	4908	1237	5646	1013	6131	831	6821	505	8289	121	7818
5L-3S		MI	2620	1585	4483	1177	5162	960	5655	785	6443	470	7433	161	6695
14-#10	4.49	MA	3240	1558	5261	1207	6110	997	6720	812	7647	500	9498	247	8088
4L-5S		MI	2485	1558	4048	1192	4623	975	5004	798	5554	484	6547	124	6086
14-#10	4.49	MA	3118	1558	4989	1224	5781	1005	6311	826	7080	511	8735	194	7786
5L-4S		MI	2568	1558	4261	1177	4880	971	5322	787	5995	477	7090	178	6274
14-#10	4.49	MA	2998	1558	4751	1232	5456	1020	5909	832	6536	522	8036	135	7378
6L-3S		MI	2632	1558	4469	1171	5170	958	5678	785	6483	479	7644	223	6520
14-#11	5.52	MA	3266	1674	5369	1293	6234	1053	6845	856	7787	499	9563	106	9132
5L-4S		MI	2695	1674	4585	1239	5260	1015	5770	812	6614	471	7682	82	7317
16-#10	5.13	MA	3286	1630	5373	1270	6271	1038	6906	847	7885	507	9822	185	8915
5E		MI	2610	1630	4342	1238	4998	1008	5458	819	6170	480	7321	106	6941
16-#10	5.13	MA	3171	1630	5135	1277	5946	1053	6504	852	7342	518	9123	126	8494
6L-4S		MI	2692	1630	4555	1223	5254	1003	5777	808	6611	473	7864	160	7117

RECTANGULAR TIED COLUMNS 18" x 24"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.18	MA	3152	1291	4651	1052	5300	886	5626	756	5916	561	6974	487	2842
2E		MI	2320	1291	3538	1015	3938	854	4127	728	4274	539	4821	444	2080
4-#11	1.44	MA	3224	1324	4861	1064	5535	894	5896	759	6268	554	7391	474	3416
2E		MI	2362	1324	3680	1024	4090	859	4297	729	4495	530	5029	420	2480
4-#14	2.08	MA	3408	1403	5320	1107	6098	924	6568	777	7169	545	8539	454	4776
2E		MI	2477	1403	3988	1065	4461	888	4738	745	5074	518	5675	382	3411
4-#18	3.70	MA	3837	1602	6431	1220	7466	1004	8209	824	9374	526	11239	392	8067
2E		MI	2733	1602	4714	1173	5346	964	5794	789	6382	478	7119	267	5609
6-#8	1.10	MA	3135	1281	4579	1052	5232	887	5555	758	5828	565	6861	492	2677
2L-3S		MI	2217	1281	3302	1021	3658	860	3797	739	3834	549	4298	399	1977
6-#8	1.10	MA	2993	1281	4308	1059	4887	892	5135	763	5260	573	6074	436	2689
3L-2S		MI	2312	1281	3488	1017	3896	857	4085	732	4225	544	4800	456	1963
6-#9	1.39	MA	3229	1317	4801	1072	5504	901	5879	766	6262	561	7459	487	3331
2L-3S		MI	2255	1317	3407	1041	3782	874	3942	748	4028	545	4530	371	2438
6-#9	1.39	MA	3053	1317	4460	1080	5069	908	5351	772	5548	571	6470	416	3342
3L-2S		MI	2371	1317	3641	1036	4080	870	4304	739	4518	540	5154	443	2421

RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

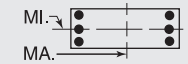
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	1.76	MA	3345	1363	5081	1098	5848	919	6292	777	6816	557	8219	482	4158
2L-3S		MI	2302	1363	3538	1067	3938	892	4127	760	4274	541	4821	335	3013
6-#10	1.76	MA	3130	1363	4651	1107	5300	927	5626	792	5916	569	6974	390	4163
3L-2S		MI	2445	1363	3832	1060	4313	887	4582	749	4889	534	5595	426	2995
6-#11	2.17	MA	3451	1413	5378	1120	6194	934	6696	784	7351	549	8858	463	4996
2L-3S		MI	2342	1413	3680	1086	4090	904	4297	766	4495	531	5029	281	3584
6-#11	2.17	MA	3198	1413	4861	1131	5535	943	5896	802	6268	562	7391	351	4991
3L-2S		MI	2508	1413	4031	1080	4536	900	4839	754	5228	525	5920	393	3567
6-#14	3.13	MA	3720	1531	6055	1188	7033	983	7705	813	8707	538	10591	435	7007
2L-3S		MI	2452	1531	3988	1153	4461	950	4738	796	5074	518	5675	176	4915
6-#14	3.13	MA	3379	1531	5320	1202	6098	994	6568	837	7169	556	8539	273	6943
3L-2S		MI	2677	1531	4482	1145	5090	946	5502	782	6102	510	6900	338	4927
6-#18	5.56	MA	4349	1831	7697	1362	9079	1108	10167	889	12024	513	14660	346	11875
2L-3S		MI	2724	1831	4714	1325	5346	1069	5794	874	6382	468	7119	-117	7040
6-#18	5.56	MA	3816	1831	6431	1385	7466	1125	8209	927	9374	539	11239	58	11061
3L-2S		MI	3051	1831	5552	1316	6413	1068	7091	854	8076	455	9087	170	8140
8-#8	1.46	MA	3259	1326	4851	1081	5578	907	5975	771	6396	562	7647	488	3508
2L-4S		MI	2250	1326	3357	1054	3712	889	3860	754	3917	546	4443	360	2569
8-#8	1.46	MA	3121	1326	4579	1087	5232	913	5555	775	5828	570	6861	432	3516
3E		MI	2300	1326	3488	1050	3896	880	4085	752	4225	546	4800	389	2557
8-#8	1.46	MA	3048	1326	4393	1093	4970	924	5233	785	5387	573	6315	400	3514
4L-2S		MI	2393	1326	3675	1045	4134	877	4374	744	4616	541	5302	446	2545
8-#9	1.85	MA	3382	1374	5142	1108	5938	927	6407	782	6976	558	8448	483	4372
2L-4S		MI	2296	1374	3476	1082	3849	910	4021	766	4131	541	4709	322	3161
8-#9	1.85	MA	3212	1374	4801	1115	5504	933	5879	788	6262	568	7459	411	4375
3E		MI	2358	1374	3641	1077	4080	900	4304	764	4518	542	5154	358	3157
8-#9	1.85	MA	3123	1374	4566	1123	5173	947	5474	800	5707	571	6770	370	4351
4L-2S		MI	2471	1374	3875	1071	4378	896	4666	755	5008	536	5777	430	3145
8-#10	2.35	MA	3534	1436	5511	1143	6396	952	6957	797	7716	552	9464	476	5466
2L-4S		MI	2354	1436	3625	1118	4022	937	4225	783	4402	535	5042	272	3865
8-#10	2.35	MA	3327	1436	5081	1153	5848	960	6292	813	6816	565	8219	384	5457
3E		MI	2431	1436	3832	1112	4313	925	4582	780	4889	537	5595	317	3908
8-#10	2.35	MA	3218	1436	4784	1162	5431	977	5780	819	6115	569	7347	331	5389
4L-2S		MI	2569	1436	4126	1106	4687	920	5036	770	5505	530	6369	408	3899
8-#11	2.89	MA	3673	1502	5895	1176	6853	975	7497	810	8434	543	10325	452	6566
2L-4S		MI	2402	1502	3782	1149	4187	958	4412	792	4666	532	5278	202	4435
8-#11	2.89	MA	3432	1502	5378	1187	6194	984	6696	827	7351	557	8858	340	6540
3E		MI	2492	1502	4031	1142	4536	944	4839	791	5228	526	5920	254	4642
8-#11	2.89	MA	3304	1502	5020	1198	5690	1003	6078	834	6505	560	7826	277	6247
4L-2S		MI	2652	1502	4381	1135	4982	940	5381	780	5961	519	6812	366	4640
8-#14	4.17	MA	3704	1660	6055	1283	7033	1053	7705	874	8707	548	10591	254	9130
3E		MI	2669	1660	4482	1234	5090	1009	5502	833	6102	509	6900	132	6384
8-#14	4.17	MA	3532	1660	5544	1298	6315	1080	6824	883	7502	552	9143	166	8249
4L-2S		MI	2871	1660	4976	1225	5719	1005	6266	818	7131	502	8126	294	6427
8-#18	7.41	MA	4394	2059	7697	1528	9079	1229	10167	991	12024	526	14660	12	14619
3E		MI	3067	2059	5552	1468	6413	1173	7091	938	8076	445	9087	-214	8891
8-#18	7.41	MA	4090	2059	6810	1551	7832	1273	8640	1003	9936	526	12229	-137	12019
4L-2S		MI	3366	2059	6390	1458	7480	1172	8387	919	9770	431	11054	73	10650
10-#10	2.94	MA	3720	1508	5941	1188	6943	985	7622	818	8616	548	10710	470	6767
2L-5S		MI	2401	1508	3706	1179	4140	975	4362	814	4576	538	5272	199	4462
10-#10	2.94	MA	3521	1508	5511	1198	6396	993	6957	833	7716	560	9464	378	6746
3L-4S		MI	2485	1508	3919	1164	4396	970	4680	803	5018	531	5816	254	4687
10-#10	2.94	MA	3419	1508	5214	1208	5978	1010	6445	840	7015	564	8592	325	6627
4L-3S		MI	2557	1508	4126	1157	4687	957	5036	801	5505	533	6369	299	4794

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

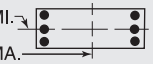
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.94	MA	3273	1508	4912	1226	5613	1018	5991	855	6384	577	7719	273	6212
5L-2S		MI	2691	1508	4420	1151	5062	953	5491	790	6121	526	7143	390	4795
10-#11	3.61	MA	3660	1591	5895	1242	6853	1024	7497	852	8434	552	10325	330	8087
3L-4S		MI	2555	1591	4132	1204	4634	999	4954	818	5400	527	6169	175	5417
10-#11	3.61	MA	3541	1591	5537	1253	6349	1044	6878	860	7588	555	9293	266	7727
4L-3S		MI	2639	1591	4381	1198	4982	985	5381	816	5961	520	6812	227	5692
10-#11	3.61	MA	3373	1591	5170	1275	5907	1053	6329	877	6825	569	8264	202	7286
5L-2S		MI	2794	1591	4731	1191	5429	981	5923	805	6695	514	7703	340	5705
10-#14	5.21	MA	3865	1788	6279	1378	7251	1138	7960	919	9040	544	11195	147	10370
4L-3S		MI	2872	1788	4976	1314	5719	1067	6266	869	7131	501	8126	88	7844
10-#14	5.21	MA	3632	1788	5756	1408	6620	1150	7178	943	7953	562	9755	53	9554
5L-2S		MI	3061	1788	5470	1306	6348	1063	7030	854	8159	493	9351	250	7914
12-#10	3.53	MA	3711	1581	5941	1243	6943	1026	7622	854	8616	556	10710	372	8034
3L-5S		MI	2530	1581	4000	1224	4514	1008	4817	835	5192	534	6046	182	5309
12-#10	3.53	MA	3616	1581	5645	1253	6526	1043	7110	860	7915	560	9837	319	7863
4E		MI	2613	1581	4213	1209	4771	1003	5135	824	5633	527	6589	236	5518
12-#10	3.53	MA	3471	1581	5342	1271	6161	1051	6656	876	7285	572	8964	267	7469
5L-3S		MI	2681	1581	4420	1203	5062	990	5491	821	6121	529	7143	281	5676
12-#10	3.53	MA	3331	1581	5070	1278	5801	1068	6210	882	6682	585	8166	206	7081
6L-2S		MI	2812	1581	4714	1196	5436	986	5946	811	6736	522	7916	372	5688
12-#11	4.33	MA	3774	1680	6055	1309	7007	1084	7678	885	8671	550	10760	256	9216
4E		MI	2705	1680	4483	1260	5080	1039	5496	843	6133	521	7061	148	6408
12-#11	4.33	MA	3607	1680	5688	1330	6566	1093	7130	902	7908	563	9731	191	8800
5L-3S		MI	2793	1680	4731	1253	5429	1025	5923	842	6695	515	7703	201	6738
12-#11	4.33	MA	3442	1680	5367	1340	6130	1113	6589	909	7178	577	8787	118	8186
6L-2S		MI	2932	1680	5082	1247	5875	1021	6465	830	7428	509	8595	313	6764
12-#14	6.25	MA	3959	1916	6491	1488	7556	1208	8314	979	9491	555	11807	34	11670
5L-3S		MI	3071	1916	5470	1394	6348	1125	7030	906	8159	492	9351	44	9201
14-#10	4.12	MA	3809	1653	6075	1298	7073	1076	7775	881	8816	556	11083	313	9105
4L-5S		MI	2657	1653	4294	1269	4889	1041	5272	855	5808	530	6820	164	6159
14-#10	4.12	MA	3665	1653	5772	1316	6708	1084	7321	896	8185	568	10209	261	8730
5L-4S		MI	2739	1653	4507	1254	5145	1036	5590	844	6249	523	7363	218	6355
14-#10	4.12	MA	3531	1653	5500	1324	6349	1101	6875	903	7582	581	9411	200	8330
6L-3S		MI	2805	1653	4714	1248	5436	1023	5946	842	6736	524	7916	263	6557
14-#11	5.06	MA	3836	1769	6205	1386	7225	1134	7930	927	8991	558	11198	180	10319
5L-4S		MI	2867	1769	4833	1316	5526	1080	6038	868	6866	516	7952	121	7407
14-#11	5.06	MA	3679	1769	5884	1395	6789	1153	7390	935	8261	572	10255	108	9691
6L-3S		MI	2935	1769	5082	1309	5875	1066	6465	867	7428	510	8595	174	7783
16-#10	4.70	MA	3857	1726	6202	1362	7256	1117	7987	917	9085	564	11455	255	9994
5E		MI	2782	1726	4588	1315	5263	1074	5727	876	6423	525	7594	146	7014
16-#10	4.70	MA	3727	1726	5931	1369	6896	1134	7540	924	8482	576	10656	194	9583
6L-4S		MI	2864	1726	4801	1300	5520	1069	6045	865	6865	519	8137	200	7197
16-#11	5.78	MA	3911	1858	6402	1451	7447	1193	8190	960	9344	567	11722	97	11200
6L-4S		MI	3013	1858	5183	1371	5972	1120	6580	893	7600	511	8844	95	8412
18-#10	5.29	MA	3920	1798	6361	1414	7444	1167	8205	944	9382	572	11902	188	10839
6L-5S		MI	2906	1798	4882	1360	5638	1107	6181	896	7039	521	8367	128	7871

RECTANGULAR TIED COLUMNS 18" x 26"

4-#10	1.09	MA	3680	1386	5357	1142	6130	963	6512	823	6835	614	8048	534	3116
2E		MI	2492	1386	3784	1092	4204	920	4395	786	4527	584	5094	484	2099
4-#11	1.33	MA	3762	1419	5592	1154	6394	970	6815	826	7230	607	8585	527	3753
2E		MI	2535	1419	3928	1100	4357	924	4565	786	4747	575	5299	460	2503
4-#14	1.92	MA	3971	1498	6104	1197	7020	1001	7563	843	8233	598	9905	511	5262
2E		MI	2649	1498	4238	1140	4728	952	5006	801	5325	563	5944	421	3440
4-#18	3.42	MA	4460	1698	7346	1309	8551	1081	9398	891	10698	579	13030	461	8931
2E		MI	2907	1698	4967	1247	5614	1027	6061	844	6631	522	7384	305	5650

RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

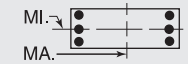
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.01	MA	3660	1376	5276	1142	6053	963	6431	825	6734	618	7917	538	2933
2L-3S		MI	2389	1376	3546	1099	3924	926	4065	797	4089	595	4572	439	1994
6-#8	1.01	MA	3500	1376	4977	1149	5672	969	5968	830	6107	627	7049	484	2945
3L-2S		MI	2484	1376	3732	1095	4161	923	4354	789	4480	590	5075	496	1980
6-#9	1.28	MA	3765	1412	5522	1161	6354	977	6790	833	7216	614	8580	534	3655
2L-3S		MI	2427	1412	3652	1118	4048	940	4210	805	4282	591	4804	411	2458
6-#9	1.28	MA	3569	1412	5145	1170	5874	985	6207	839	6427	625	7488	464	3666
3L-2S		MI	2544	1412	3886	1113	4346	936	4572	797	4772	585	5427	483	2440
6-#10	1.63	MA	3897	1459	5832	1187	6735	995	7247	843	7829	610	9426	528	4570
2L-3S		MI	2474	1459	3784	1144	4204	957	4395	817	4527	587	5094	375	3037
6-#10	1.63	MA	3655	1459	5357	1198	6130	1005	6512	851	6835	623	8048	440	4575
3L-2S		MI	2618	1459	4078	1137	4579	953	4850	806	5143	580	5868	466	3018
6-#11	2.00	MA	4017	1508	6165	1210	7123	1011	7701	851	8429	601	10246	520	5502
2L-3S		MI	2514	1508	3928	1162	4357	969	4565	823	4747	576	5299	321	3615
6-#11	2.00	MA	3734	1508	5592	1221	6394	1021	6815	870	7230	617	8585	408	5496
3L-2S		MI	2681	1508	4279	1156	4803	965	5107	811	5480	570	6191	433	3594
6-#14	2.88	MA	4323	1627	6919	1277	8058	1059	8824	880	9940	591	12236	498	7736
2L-3S		MI	2623	1627	4238	1229	4728	1015	5006	852	5325	562	5944	215	4960
6-#14	2.88	MA	3939	1627	6104	1293	7020	1073	7563	906	8233	611	9905	336	7672
3L-2S		MI	2850	1627	4732	1220	5357	1011	5770	838	6353	555	7169	377	4961
6-#18	5.13	MA	5040	1926	8755	1452	10345	1184	11577	955	13647	566	16945	425	13171
2L-3S		MI	2894	1926	4967	1399	5614	1132	6061	929	6631	512	7384	-79	7333
6-#18	5.13	MA	4435	1926	7346	1478	8551	1205	9398	997	10698	597	13030	138	12568
3L-2S		MI	3227	1926	5805	1390	6681	1131	7357	909	8325	499	9352	209	8188
8-#8	1.35	MA	3799	1422	5576	1170	6434	984	6894	837	7361	615	8785	534	3849
2L-4S		MI	2422	1422	3601	1132	3977	955	4128	812	4171	592	4717	400	2590
8-#8	1.35	MA	3644	1422	5276	1177	6053	990	6431	843	6734	624	7917	480	3857
3E		MI	2472	1422	3732	1127	4161	947	4354	810	4480	592	5075	430	2577
8-#8	1.35	MA	3563	1422	5072	1184	5764	1001	6077	853	6249	628	7321	448	3855
4L-2S		MI	2565	1422	3919	1123	4399	943	4642	802	4871	587	5577	486	2564
8-#9	1.71	MA	3937	1470	5899	1197	6833	1003	7373	849	8004	611	9672	529	4804
2L-4S		MI	2468	1470	3721	1159	4115	976	4289	824	4385	587	4983	362	3189
8-#9	1.71	MA	3747	1470	5522	1206	6354	1010	6790	855	7216	622	8580	460	4807
3E		MI	2530	1470	3886	1154	4346	966	4572	822	4772	588	5427	398	3180
8-#9	1.71	MA	3648	1470	5264	1214	5990	1024	6344	868	6605	626	7828	419	4783
4L-2S		MI	2644	1470	4120	1149	4644	962	4935	813	5262	582	6050	470	3167
8-#10	2.17	MA	4109	1531	6308	1233	7341	1028	7983	864	8824	605	10803	523	6014
2L-4S		MI	2526	1531	3870	1195	4288	1003	4493	840	4656	581	5315	312	3925
8-#10	2.17	MA	3877	1531	5832	1243	6735	1037	7247	872	7829	619	9426	434	6005
3E		MI	2603	1531	4078	1189	4579	990	4850	838	5143	583	5868	357	3935
8-#10	2.17	MA	3755	1531	5506	1253	6276	1055	6684	888	7058	624	8473	381	5938
4L-2S		MI	2742	1531	4372	1183	4953	986	5304	827	5759	576	6642	448	3923
8-#11	2.67	MA	4268	1597	6738	1265	7853	1051	8587	876	9629	596	11907	513	7240
2L-4S		MI	2573	1597	4030	1225	4454	1023	4680	849	4919	577	5548	242	4529
8-#11	2.67	MA	3996	1597	6165	1277	7123	1061	7701	895	8429	612	10246	401	7214
3E		MI	2663	1597	4279	1218	4803	1009	5107	848	5480	571	6191	294	4678
8-#11	2.67	MA	3854	1597	5770	1289	6567	1082	7019	903	7496	616	9084	335	6984
4L-2S		MI	2825	1597	4629	1211	5249	1005	5649	836	6214	564	7082	406	4670
8-#14	3.85	MA	4305	1755	6919	1374	8058	1131	8824	942	9940	604	12236	323	10102
3E		MI	2841	1755	4732	1309	5357	1073	5770	889	6353	554	7169	171	6433
8-#14	3.85	MA	4113	1755	6356	1390	7265	1160	7851	953	8608	610	10599	230	9230
4L-2S		MI	3046	1755	5226	1301	5986	1069	6534	874	7382	546	8394	333	6464
8-#18	6.84	MA	5047	2155	8755	1621	10345	1309	11577	1062	13647	584	16945	102	16559
3E		MI	3237	2155	5805	1542	6681	1236	7357	993	8325	488	9352	-176	9197

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis

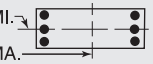


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	6.84	MA	4748	2155	7774	1647	8966	1356	9887	1077	11335	589	14179	-54	14076
4L-2S		MI	3542	2155	6643	1532	7748	1235	8653	974	10019	475	11320	112	10702
10-#10	2.71	MA	4318	1604	6783	1278	7946	1061	8718	884	9819	601	12181	517	7453
2L-5S		MI	2573	1604	3952	1256	4406	1040	4630	871	4830	584	5545	239	4535
10-#10	2.71	MA	4094	1604	6308	1288	7341	1070	7983	892	8824	615	10803	428	7432
3L-4S		MI	2656	1604	4165	1241	4662	1036	4948	861	5271	577	6089	294	4769
10-#10	2.71	MA	3980	1604	5982	1299	6881	1088	7419	908	8053	620	9851	376	7353
4L-3S		MI	2729	1604	4372	1234	4953	1023	5304	858	5759	578	6642	339	4825
10-#10	2.71	MA	3813	1604	5649	1317	6480	1097	6920	916	7359	633	8892	326	6894
5L-2S		MI	2864	1604	4666	1228	5328	1019	5759	847	6374	572	7415	430	4822
10-#11	3.33	MA	4253	1686	6738	1333	7853	1102	8587	920	9629	606	11907	393	8930
3L-4S		MI	2726	1686	4380	1280	4900	1064	5222	874	5652	572	6440	215	5508
10-#11	3.33	MA	4121	1686	6343	1345	7297	1122	7905	929	8695	611	10744	328	8629
4L-3S		MI	2811	1686	4629	1274	5249	1050	5649	873	6214	565	7082	267	5731
10-#11	3.33	MA	3926	1686	5940	1367	6811	1132	7301	947	7855	627	9580	264	8099
5L-2S		MI	2968	1686	4980	1267	5695	1046	6191	861	6947	559	7974	379	5738
10-#14	4.81	MA	4487	1883	7171	1470	8303	1218	9112	989	10315	602	12930	217	11592
4L-3S		MI	3044	1883	5226	1389	5986	1131	6534	925	7382	545	8394	127	7902
10-#14	4.81	MA	4217	1883	6595	1502	7609	1232	8249	1015	9115	623	11295	124	10774
5L-2S		MI	3237	1883	5720	1381	6615	1127	7298	910	8411	538	9619	289	7955
12-#10	3.26	MA	4307	1676	6783	1334	7946	1103	8718	913	9819	610	12181	422	8857
3L-5S		MI	2701	1676	4246	1301	4780	1073	5085	892	5446	579	6319	222	5381
12-#10	3.26	MA	4201	1676	6457	1344	7487	1121	8154	929	9048	616	11228	370	8762
4E		MI	2784	1676	4459	1286	5037	1069	5403	881	5887	573	6862	276	5598
12-#10	3.26	MA	4035	1676	6124	1363	7086	1130	7656	937	8354	629	10270	320	8286
5L-3S		MI	2854	1676	4666	1280	5328	1056	5759	879	6374	574	7415	321	5710
12-#10	3.26	MA	3879	1676	5820	1370	6691	1147	7165	953	7691	643	9399	260	7914
6L-2S		MI	2986	1676	4960	1273	5702	1052	6214	868	6990	567	8189	412	5716
12-#11	4.00	MA	4382	1776	6916	1400	8027	1163	8792	954	9895	606	12405	321	10283
4E		MI	2876	1776	4731	1336	5346	1104	5764	899	6385	567	7331	188	6497
12-#11	4.00	MA	4189	1776	6513	1423	7541	1173	8187	973	9054	621	11240	257	9780
5L-3S		MI	2957	1776	4980	1329	5695	1090	6191	898	6947	560	7974	240	6780
12-#11	4.00	MA	4005	1776	6151	1432	7061	1193	7593	981	8251	637	10176	182	9159
6L-2S		MI	3108	1776	5330	1323	6141	1086	6733	887	7681	554	8865	352	6799
12-#14	5.77	MA	4585	2012	7410	1582	8647	1290	9510	1052	10821	615	13626	110	13137
5L-3S		MI	3244	2012	5720	1469	6615	1190	7298	962	8411	537	9619	83	9335
14-#10	3.80	MA	4417	1749	6933	1389	8092	1154	8889	950	10043	611	12606	364	10138
4L-5S		MI	2829	1749	4540	1346	5155	1106	5540	913	6061	575	7093	204	6231
14-#10	3.80	MA	4253	1749	6600	1408	7691	1163	8391	957	9349	625	11648	315	9682
5L-4S		MI	2911	1749	4753	1331	5411	1102	5858	902	6503	568	7636	258	6433
14-#10	3.80	MA	4102	1749	6295	1415	7296	1180	7901	973	8686	638	10776	254	9301
6L-3S		MI	2977	1749	4960	1325	5702	1089	6214	899	6990	570	8189	303	6592
14-#10	3.80	MA	3974	1749	5991	1421	6908	1188	7429	981	8009	644	9793	201	8818
7L-2S		MI	3106	1749	5254	1319	6077	1085	6669	888	7605	563	8963	394	6606
14-#11	4.67	MA	4447	1865	7086	1478	8270	1213	9074	998	10254	616	12901	250	11466
5L-4S		MI	3025	1865	5081	1392	5792	1145	6306	925	7119	561	8223	161	7494
14-#11	4.67	MA	4270	1865	6724	1487	7791	1234	8479	1006	9451	631	11837	175	10833
6L-3S		MI	3109	1865	5330	1385	6141	1130	6733	924	7681	555	8865	213	7826
16-#10	4.34	MA	4467	1821	7075	1453	8296	1196	9126	978	10344	621	13025	309	11082
5E		MI	2954	1821	4834	1392	5529	1139	5995	933	6677	571	7867	186	7084
16-#10	4.34	MA	4322	1821	6770	1460	7901	1213	8636	994	9681	634	12154	248	10691
6L-4S		MI	3036	1821	5047	1377	5786	1135	6313	922	7118	564	8410	240	7274
16-#10	4.34	MA	4199	1821	6466	1466	7513	1221	8165	1002	9004	639	11171	195	10222
7L-3S		MI	3100	1821	5254	1370	6077	1122	6669	920	7605	566	8963	285	7472
16-#11	5.33	MA	4531	1954	7297	1543	8521	1274	9366	1032	10650	626	13498	168	12511
6L-4S		MI	3185	1954	5432	1447	6239	1185	6848	950	7852	556	9114	134	8497

RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	4.88	MA	4538	1894	7246	1506	8507	1246	9371	1015	10676	630	13532	243	12084
6L-5S		MI	3079	1894	5128	1437	5904	1172	6449	954	7292	567	8640	168	7940
18-#10	4.88	MA	4421	1894	6941	1512	8118	1254	8900	1022	9999	635	12548	189	11628
7L-4S		MI	3161	1894	5341	1422	6160	1168	6768	943	7734	560	9184	222	8118
20-#10	5.43	MA	4639	1966	7417	1557	8724	1287	9635	1043	10994	631	13926	184	13036
7L-5S		MI	3202	1966	5422	1482	6278	1205	6904	974	7908	563	9414	150	8798

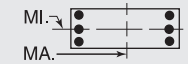
RECTANGULAR TIED COLUMNS 18" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.01	MA	4246	1482	6108	1231	7015	1039	7457	889	7812	667	9187	581	3391
2E		MI	2665	1482	4029	1169	4470	986	4663	843	4781	630	5367	524	2117
4-#11	1.24	MA	4339	1515	6368	1243	7307	1046	7792	892	8250	660	9782	573	4090
2E		MI	2707	1515	4177	1176	4623	989	4833	842	4999	620	5570	499	2525
4-#14	1.79	MA	4573	1594	6933	1286	7998	1077	8617	910	9356	651	11306	564	5748
2E		MI	2822	1594	4488	1215	4995	1016	5273	857	5576	608	6213	460	3469
4-#18	3.17	MA	5123	1793	8305	1399	9690	1157	10647	957	12082	632	14893	526	9795
2E		MI	3081	1793	5220	1321	5881	1091	6328	899	6880	566	7649	344	5691
6-#9	1.19	MA	4340	1508	6288	1251	7259	1054	7760	899	8228	667	9767	580	3979
2L-3S		MI	2599	1508	3896	1196	4313	1006	4479	863	4536	637	5078	452	2477
6-#9	1.19	MA	4122	1508	5875	1260	6733	1061	7122	906	7364	679	8571	513	3990
3L-2S		MI	2716	1508	4131	1190	4611	1002	4841	854	5026	631	5701	523	2459
6-#10	1.51	MA	4487	1554	6628	1277	7678	1072	8262	910	8902	663	10696	575	4981
2L-3S		MI	2646	1554	4029	1221	4470	1023	4663	874	4781	632	5367	415	3060
6-#10	1.51	MA	4218	1554	6108	1288	7015	1082	7457	918	7812	677	9187	488	4986
3L-2S		MI	2791	1554	4324	1214	4844	1019	5118	864	5396	626	6141	506	3039
6-#11	1.86	MA	4624	1604	6997	1299	8107	1087	8764	918	9566	654	11604	566	6007
2L-3S		MI	2685	1604	4177	1238	4623	1033	4833	879	4999	621	5570	360	3644
6-#11	1.86	MA	4308	1604	6368	1312	7307	1098	7792	927	8250	671	9782	457	6002
3L-2S		MI	2854	1604	4527	1232	5069	1030	5375	867	5733	615	6461	472	3620
6-#14	2.68	MA	4967	1722	7828	1367	9138	1135	10002	946	11231	644	13901	554	8465
2L-3S		MI	2795	1722	4488	1304	4995	1079	5273	908	5576	607	6213	254	5003
6-#14	2.68	MA	4538	1722	6933	1384	7998	1150	8617	959	9356	666	11306	393	8401
3L-2S		MI	3024	1722	4982	1296	5624	1075	6037	894	6605	599	7438	416	4993
6-#18	4.76	MA	5770	2022	9857	1541	11666	1261	13046	1022	15329	619	19304	499	14467
2L-3S		MI	3064	2022	5220	1473	5881	1195	6328	984	6880	556	7649	-41	7624
6-#18	4.76	MA	5094	2022	8305	1570	9690	1284	10647	1067	12082	654	14893	212	14106
3L-2S		MI	3402	2022	6058	1463	6948	1194	7624	964	8575	542	9617	247	8236
8-#8	1.25	MA	4377	1517	6346	1260	7346	1060	7872	904	8386	668	9989	581	4191
2L-4S		MI	2593	1517	3845	1209	4243	1022	4397	869	4426	638	4992	441	2610
8-#8	1.25	MA	4205	1517	6018	1267	6929	1066	7366	910	7700	678	9040	528	4199
3E		MI	2644	1517	3976	1205	4427	1013	4622	867	4734	638	5349	470	2595
8-#8	1.25	MA	4116	1517	5795	1274	6614	1078	6979	920	7170	682	8395	496	4196
4L-2S		MI	2738	1517	4163	1200	4664	1010	4911	860	5125	633	5851	527	2583
8-#9	1.59	MA	4532	1565	6700	1287	7784	1079	8398	915	9091	664	10963	576	5236
2L-4S		MI	2639	1565	3966	1237	4380	1042	4558	882	4639	633	5257	402	3215
8-#9	1.59	MA	4320	1565	6288	1295	7259	1087	7760	922	8228	676	9767	508	5239
3E		MI	2702	1565	4131	1231	4611	1032	4841	879	5026	634	5701	438	3202
8-#9	1.59	MA	4211	1565	6007	1304	6862	1102	7273	936	7561	681	8952	468	5215
4L-2S		MI	2817	1565	4365	1226	4909	1028	5203	870	5516	628	6324	510	3188
8-#10	2.02	MA	4724	1627	7149	1322	8341	1105	9067	930	9992	658	12205	569	6563
2L-4S		MI	2697	1627	4116	1272	4553	1069	4761	897	4909	627	5588	352	3961
8-#10	2.02	MA	4465	1627	6628	1333	7678	1115	8262	939	8902	673	10696	482	6554
3E		MI	2774	1627	4324	1266	4844	1056	5118	895	5396	628	6141	397	3962

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis

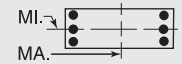


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	2.02	MA	4331	1627	6273	1344	7177	1133	7647	956	8059	679	9664	431	6486
4L-2S		MI	2915	1627	4618	1260	5219	1052	5573	884	6012	621	6915	488	3948
8-#11	2.48	MA	4902	1693	7625	1355	8908	1127	9737	943	10882	649	13427	559	7914
2L-4S		MI	2744	1693	4278	1301	4720	1088	4948	906	5171	622	5819	281	4620
8-#11	2.48	MA	4600	1693	6997	1367	8107	1139	8764	952	9566	666	11604	450	7888
3E		MI	2835	1693	4527	1294	5069	1074	5375	904	5733	616	6461	333	4712
8-#11	2.48	MA	4442	1693	6566	1380	7500	1160	8019	972	8546	672	10344	386	7736
4L-2S		MI	2998	1693	4878	1287	5515	1070	5917	893	6466	609	7353	445	4699
8-#14	3.57	MA	4945	1850	7828	1464	9138	1209	10002	995	11231	659	13901	383	11074
3E		MI	3003	1850	4982	1384	5624	1137	6037	945	6605	598	7438	210	6481
8-#14	3.57	MA	4733	1850	7212	1482	8270	1239	8938	1023	9773	667	12091	289	10229
4L-2S		MI	3221	1850	5476	1376	6253	1133	6801	930	7633	591	8663	372	6500
8-#18	6.35	MA	5776	2250	9857	1713	11666	1388	13046	1132	15329	641	19304	185	18547
3E		MI	3407	2250	6058	1616	6948	1299	7624	1048	8575	532	9617	-138	9500
8-#18	6.35	MA	5446	2250	8783	1741	10154	1438	11193	1150	12793	650	16203	23	16065
4L-2S		MI	3717	2250	6896	1606	8015	1298	8920	1029	10269	519	11585	150	10753
10-#10	2.52	MA	4956	1699	7670	1367	9004	1138	9873	951	11082	654	13714	563	8139
2L-5S		MI	2744	1699	4197	1333	4671	1106	4898	929	5084	629	5818	279	4606
10-#10	2.52	MA	4706	1699	7149	1378	8341	1147	9067	960	9992	669	12205	477	8118
3L-4S		MI	2827	1699	4410	1318	4928	1102	5216	918	5525	622	6361	334	4840
10-#10	2.52	MA	4581	1699	6794	1389	7840	1166	8452	977	9149	675	11173	425	8039
4L-3S		MI	2901	1699	4618	1311	5219	1089	5573	915	6012	624	6915	379	4856
10-#10	2.52	MA	4392	1699	6431	1409	7403	1175	7909	985	8392	689	10131	378	7585
5L-2S		MI	3038	1699	4912	1305	5593	1084	6027	905	6628	617	7688	470	4848
10-#11	3.10	MA	4885	1782	7625	1423	8908	1179	9737	978	10882	661	13427	443	9772
3L-4S		MI	2897	1782	4629	1356	5167	1129	5490	931	5904	617	6710	254	5597
10-#11	3.10	MA	4739	1782	7194	1436	8300	1200	8991	997	9861	667	12166	379	9546
4L-3S		MI	2983	1782	4878	1350	5515	1114	5917	930	6466	610	7353	306	5769
10-#11	3.10	MA	4518	1782	6754	1459	7770	1212	8332	1007	8944	684	10899	318	8920
5L-2S		MI	3141	1782	5228	1343	5962	1110	6459	918	7199	604	8244	419	5769
10-#14	4.46	MA	5149	1979	8108	1562	9410	1297	10323	1059	11648	659	14686	279	12832
4L-3S		MI	3217	1979	5476	1464	6253	1196	6801	981	7633	590	8663	166	7952
10-#14	4.46	MA	4842	1979	7479	1595	8652	1312	9380	1072	10336	682	12871	188	12025
5L-2S		MI	3413	1979	5970	1456	6882	1192	7566	967	8662	583	9888	328	7994
10-#18	7.94	MA	6150	2479	10335	1884	12130	1542	13593	1215	16041	637	20614	-3	20603
4L-3S		MI	3742	2479	6896	1758	8015	1403	8920	1113	10269	509	11585	-234	11337
12-#10	3.02	MA	4943	1772	7670	1424	9004	1180	9873	980	11082	664	13714	471	9680
3L-5S		MI	2873	1772	4492	1378	5046	1139	5353	949	5699	625	6592	262	5450
12-#10	3.02	MA	4825	1772	7315	1435	8503	1199	9257	997	10239	671	12682	419	9592
4E		MI	2956	1772	4705	1363	5302	1135	5671	938	6141	618	7135	316	5675
12-#10	3.02	MA	4638	1772	6952	1454	8066	1208	8714	1006	9482	685	11640	372	9112
5L-3S		MI	3026	1772	4912	1357	5593	1122	6027	936	6628	620	7688	361	5742
12-#10	3.02	MA	4465	1772	6614	1461	7655	1218	8180	1023	8760	700	10617	301	8764
6L-2S		MI	3159	1772	5206	1350	5968	1117	6482	925	7243	613	8462	452	5744
12-#11	3.71	MA	5029	1871	7823	1492	9101	1241	9964	1023	11177	662	13988	371	11366
4E		MI	3047	1871	4979	1412	5613	1169	6032	956	6638	612	7602	227	6584
12-#11	3.71	MA	4811	1871	7383	1515	8571	1252	9304	1032	10260	678	12721	311	10768
5L-3S		MI	3130	1871	5228	1405	5962	1155	6459	955	7199	605	8244	280	6820
12-#11	3.71	MA	4607	1871	6980	1523	8048	1274	8656	1052	9383	695	11568	237	10151
6L-2S		MI	3283	1871	5578	1399	6408	1151	7001	943	7933	599	9136	392	6833
12-#14	5.36	MA	5250	2107	8374	1675	9792	1371	10765	1108	12211	674	15466	178	14636
5L-3S		MI	3417	2107	5970	1545	6882	1254	7566	1018	8662	582	9888	123	9420
12-#14	5.36	MA	4974	2107	7806	1688	9045	1401	9838	1136	10958	697	13810	70	13423
6L-2S		MI	3603	2107	6464	1537	7511	1250	8330	1003	9690	574	11113	284	9480
14-#10	3.53	MA	5065	1844	7835	1480	9166	1232	10063	1018	11329	666	14191	413	11146
4L-5S		MI	3000	1844	4786	1423	5420	1172	5808	970	6315	621	7366	244	6299
14-#10	3.53	MA	4880	1844	7473	1499	8729	1241	9519	1026	10572	681	13149	367	10644
5L-4S		MI	3083	1844	4999	1408	5677	1168	6126	959	6756	614	7909	298	6509

RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	3.53	MA	4713	1844	7134	1506	8318	1251	8985	1043	9850	695	12126	295	10289
6L-3S		MI	3150	1844	5206	1402	5968	1155	6482	957	7243	616	8462	343	6626
14-#10	3.53	MA	4571	1844	6802	1513	7867	1267	8472	1052	9112	702	11138	257	9726
7L-2S		MI	3280	1844	5500	1396	6342	1150	6937	946	7859	609	9236	434	6636
14-#11	4.33	MA	5097	1960	8012	1570	9371	1293	10277	1057	11576	673	14543	304	12622
5L-4S		MI	3196	1960	5330	1468	6059	1210	6574	981	7371	606	8493	200	7579
14-#11	4.33	MA	4902	1960	7609	1579	8849	1314	9628	1077	10699	690	13390	230	11995
6L-3S		MI	3282	1960	5578	1461	6408	1195	7001	980	7933	600	9136	253	7868
14-#11	4.33	MA	4735	1960	7206	1586	8335	1323	9005	1087	9804	696	12090	164	11353
7L-2S		MI	3421	1960	5929	1454	6854	1191	7542	968	8666	594	10027	365	7891
14-#14	6.25	MA	5387	2236	8701	1768	10185	1459	11223	1172	12832	690	16405	60	16073
6L-3S		MI	3614	2236	6464	1625	7511	1312	8330	1054	9690	573	11113	79	10831
16-#10	4.03	MA	5117	1917	7994	1545	9392	1274	10325	1047	11662	677	14658	361	12180
5E		MI	3126	1917	5080	1469	5795	1205	6263	990	6930	617	8139	226	7152
16-#10	4.03	MA	4957	1917	7655	1551	8981	1284	9790	1064	10939	691	13635	289	11817
6L-4S		MI	3208	1917	5293	1454	6051	1201	6581	980	7372	610	8683	280	7348
16-#10	4.03	MA	4821	1917	7323	1558	8530	1300	9277	1072	10202	697	12647	251	11268
7L-3S		MI	3273	1917	5500	1447	6342	1188	6937	977	7859	611	9236	325	7508
16-#10	4.03	MA	4662	1917	7003	1566	8099	1306	8756	1089	9497	712	11697	198	10653
8L-2S		MI	3400	1917	5794	1441	6717	1183	7392	966	8474	605	10010	416	7523
16-#11	4.95	MA	5191	2049	8238	1634	9649	1354	10601	1103	12015	685	15213	222	13842
6L-4S		MI	3357	2049	5680	1523	6505	1250	7115	1007	8105	601	9385	174	8581
16-#11	4.95	MA	5032	2049	7835	1642	9136	1364	9977	1112	11120	691	13912	157	13202
7L-3S		MI	3424	2049	5929	1517	6854	1236	7542	1005	8666	595	10027	226	8915
18-#10	4.54	MA	5196	1989	8176	1597	9644	1317	10596	1084	12029	687	15144	284	13348
6L-5S		MI	3251	1989	5374	1514	6169	1238	6718	1011	7546	612	8913	208	8007
18-#10	4.54	MA	5066	1989	7844	1603	9193	1333	10082	1093	11292	693	14156	245	12812
7L-4S		MI	3333	1989	5587	1499	6426	1233	7036	1000	7987	606	9456	262	8192
18-#10	4.54	MA	4908	1989	7524	1611	8762	1339	9561	1109	10587	708	13206	192	12196
8L-3S		MI	3395	1989	5794	1493	6717	1221	7392	998	8474	607	10010	307	8388
18-#11	5.57	MA	5324	2138	8464	1698	9936	1404	10950	1137	12436	686	15734	150	15054
7L-4S		MI	3502	2138	6030	1579	6951	1290	7657	1032	8838	596	10276	147	9588
20-#10	5.04	MA	5308	2062	8364	1649	9856	1365	10888	1113	12382	689	15665	239	14358
7L-5S		MI	3375	2062	5668	1559	6544	1271	7172	1032	8161	608	9687	190	8864
20-#10	5.04	MA	5151	2062	8045	1656	9425	1372	10367	1130	11677	703	14715	187	13739
8L-4S		MI	3456	2062	5881	1544	6800	1266	7490	1021	8603	601	10230	244	9039
22-#10	5.54	MA	5390	2134	8566	1702	10088	1405	11172	1150	12767	699	16224	181	15281
8L-5S		MI	3497	2134	5962	1605	6918	1304	7627	1052	8777	604	10461	172	9724

RECTANGULAR TIED COLUMNS 18" x 30"

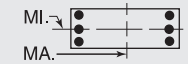
4-#11	1.16	MA	4954	1610	7189	1333	8275	1123	8828	959	9330	713	11046	620	4427
2E		MI	2879	1610	4425	1252	4889	1054	5101	899	5252	665	5840	539	2547
4-#14	1.67	MA	5215	1689	7806	1376	9030	1153	9730	976	10538	704	12711	610	6234
2E		MI	2994	1689	4738	1291	5262	1081	5541	913	5828	652	6482	499	3496
4-#18	2.96	MA	5826	1889	9310	1488	10885	1233	11954	1024	13524	685	16827	588	10659
2E		MI	3254	1889	5473	1395	6149	1154	6595	954	7130	610	7915	382	5730
6-#9	1.11	MA	4954	1603	7098	1340	8218	1130	8788	966	9299	720	11021	627	4303
2L-3S		MI	2770	1603	4141	1273	4579	1072	4747	921	4790	683	5351	492	2495
6-#9	1.11	MA	4715	1603	6650	1350	7648	1138	8095	973	8361	732	9722	561	4314
3L-2S		MI	2888	1603	4375	1268	4877	1068	5109	912	5280	677	5975	564	2477

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis

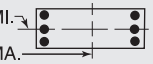


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	1.41	MA	5117	1650	7470	1366	8676	1148	9336	976	10033	715	12033	621	5393
2L-3S		MI	2818	1650	4275	1298	4736	1089	4931	932	5034	678	5640	455	3082
6-#10	1.41	MA	4821	1650	6903	1378	7955	1159	8460	986	8849	731	10393	537	5398
3L-2S		MI	2963	1650	4569	1291	5110	1084	5386	921	5650	671	6414	546	3060
6-#11	1.73	MA	5269	1699	7873	1389	9147	1163	9887	984	10762	707	13030	613	6513
2L-3S		MI	2857	1699	4425	1314	4889	1098	5101	936	5252	666	5840	400	3672
6-#11	1.73	MA	4921	1699	7189	1402	8275	1175	8828	995	9330	725	11046	506	6507
3L-2S		MI	3026	1699	4775	1308	5336	1094	5643	924	5985	660	6732	512	3646
6-#14	2.50	MA	5650	1817	8782	1456	10273	1212	11239	1013	12581	697	15538	600	9194
2L-3S		MI	2966	1817	4738	1379	5262	1143	5541	965	5828	651	6482	293	5043
6-#14	2.50	MA	5175	1817	7806	1475	9030	1228	9730	1027	10538	721	12711	444	9131
3L-2S		MI	3197	1817	5232	1371	5891	1139	6305	950	6856	644	7707	455	5025
6-#18	4.44	MA	6542	2117	11004	1631	13042	1337	14574	1088	17071	672	21737	569	15763
2L-3S		MI	3234	2117	5473	1547	6149	1258	6595	1038	7130	599	7915	-2	7913
6-#18	4.44	MA	5793	2117	9310	1661	10885	1363	11954	1136	13524	711	16827	282	15402
3L-2S		MI	3576	2117	6311	1537	7216	1257	7891	1019	8824	586	9882	285	8283
8-#8	1.17	MA	4995	1613	7161	1349	8313	1136	8910	970	9469	721	11261	627	4532
2L-4S		MI	2765	1613	4089	1287	4508	1088	4665	927	4680	684	5266	481	2629
8-#8	1.17	MA	4806	1613	6805	1356	7859	1143	8359	977	8724	731	10229	576	4540
3E		MI	2816	1613	4220	1283	4692	1079	4890	925	4988	684	5623	510	2613
8-#8	1.17	MA	4708	1613	6564	1364	7518	1155	7941	988	8151	736	9535	544	4538
4L-2S		MI	2910	1613	4407	1278	4930	1076	5179	918	5379	679	6126	567	2600
8-#9	1.48	MA	5165	1660	7546	1376	8789	1156	9481	982	10237	717	12320	622	5668
2L-4S		MI	2811	1660	4211	1314	4646	1108	4826	939	4893	679	5530	442	3239
8-#9	1.48	MA	4932	1660	7098	1385	8218	1164	8788	989	9299	729	11021	556	5671
3E		MI	2874	1660	4375	1309	4877	1098	5109	937	5280	680	5975	479	3224
8-#9	1.48	MA	4812	1660	6794	1395	7789	1179	8261	1004	8576	735	10144	516	5647
4L-2S		MI	2989	1660	4610	1303	5175	1094	5471	928	5770	674	6598	551	3208
8-#10	1.88	MA	5378	1722	8036	1412	9396	1181	10211	997	11218	711	13674	615	7112
2L-4S		MI	2869	1722	4362	1350	4819	1134	5029	955	5163	672	5860	392	3993
8-#10	1.88	MA	5092	1722	7470	1423	8676	1191	9336	1006	10033	727	12033	531	7102
3E		MI	2946	1722	4569	1343	5110	1122	5386	952	5650	674	6414	437	3987
8-#10	1.88	MA	4945	1722	7085	1435	8132	1210	8669	1024	9120	734	10922	480	7035
4L-2S		MI	3088	1722	4864	1337	5485	1117	5841	941	6266	667	7187	528	3971
8-#11	2.31	MA	5577	1788	8558	1444	10018	1204	10945	1009	12195	702	15013	606	8588
2L-4S		MI	2916	1788	4527	1377	4987	1153	5215	962	5423	667	6089	320	4708
8-#11	2.31	MA	5243	1788	7873	1458	9147	1216	9887	1020	10762	720	13030	499	8562
3E		MI	3007	1788	4775	1370	5336	1139	5643	961	5985	661	6732	373	4744
8-#11	2.31	MA	5069	1788	7406	1471	8487	1238	9078	1041	9654	727	11671	436	8435
4L-2S		MI	3171	1788	5126	1363	5782	1135	6184	949	6718	654	7623	485	4728
8-#14	3.33	MA	5624	1946	8782	1555	10273	1286	11239	1063	12581	714	15538	433	12046
3E		MI	3174	1946	5232	1460	5891	1201	6305	1001	6856	643	7707	249	6526
8-#14	3.33	MA	5392	1946	8113	1574	9330	1318	10084	1092	10998	723	13588	341	11245
4L-2S		MI	3395	1946	5726	1451	6520	1197	7069	986	7885	636	8932	411	6535
8-#18	5.93	MA	6546	2346	11004	1804	13042	1467	14574	1201	17071	698	21737	263	20454
3E		MI	3577	2346	6311	1690	7216	1362	7891	1103	8824	576	9882	-99	9801
8-#18	5.93	MA	6183	2346	9837	1835	11398	1519	12558	1223	14310	710	18299	96	17678
4L-2S		MI	3893	2346	7149	1680	8283	1361	9187	1084	10518	563	11850	189	10804
10-#10	2.35	MA	5633	1795	8602	1457	10117	1214	11086	1018	12403	707	15314	610	8825
2L-5S		MI	2916	1795	4443	1410	4937	1172	5166	986	5337	675	6091	319	4674
10-#10	2.35	MA	5358	1795	8036	1468	9396	1224	10211	1027	11218	722	13674	525	8804
3L-4S		MI	2999	1795	4656	1395	5194	1167	5484	975	5778	668	6634	374	4876
10-#10	2.35	MA	5220	1795	7651	1480	8853	1243	9544	1045	10304	729	12562	474	8724
4L-3S		MI	3073	1795	4864	1388	5485	1155	5841	973	6266	670	7187	419	4883
10-#10	2.35	MA	5010	1795	7258	1500	8380	1254	8956	1054	9485	745	11437	429	8283
5L-2S		MI	3211	1795	5158	1382	5859	1150	6295	962	6881	663	7961	510	4873
10-#11	2.89	MA	5557	1877	8558	1513	10018	1256	10945	1045	12195	715	15013	492	10614
3L-4S		MI	3068	1877	4877	1432	5433	1194	5757	987	6157	662	6981	294	5683

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis

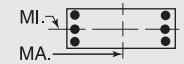


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.89	MA	5396	1877	8090	1527	9359	1278	10136	1066	11087	722	13655	428	10474
4L-3S		MI	3155	1877	5126	1426	5782	1179	6184	986	6718	656	7623	346	5805
10-#11	2.89	MA	5150	1877	7614	1551	8784	1290	9422	1076	10092	740	12285	371	9751
5L-2S		MI	3315	1877	5476	1419	6228	1175	6726	975	7452	649	8515	458	5800
10-#14	4.17	MA	5850	2074	9089	1654	10573	1376	11593	1129	13040	716	16416	330	14090
4L-3S		MI	3389	2074	5726	1540	6520	1260	7069	1037	7885	635	8932	206	8000
10-#14	4.17	MA	5506	2074	8407	1688	9751	1392	10571	1143	11617	740	14452	244	13192
5L-2S		MI	3588	2074	6220	1532	7149	1256	7833	1023	8913	627	10157	367	8033
10-#18	7.41	MA	6960	2574	11531	1977	13556	1623	15179	1287	17857	697	23209	77	22683
4L-3S		MI	3913	2574	7149	1832	8283	1466	9187	1168	10518	552	11850	-196	11650
10-#18	7.41	MA	6385	2574	10338	2035	12118	1649	13392	1336	15371	736	19765	-87	19474
5L-2S		MI	4207	2574	7988	1823	9350	1465	10483	1149	12212	539	13818	92	13312
12-#10	2.82	MA	5619	1867	8602	1514	10117	1257	11086	1047	12403	718	15314	519	10503
3L-5S		MI	3045	1867	4737	1455	5312	1205	5621	1007	5953	671	6865	302	5517
12-#10	2.82	MA	5489	1867	8217	1525	9574	1276	10420	1065	11489	725	14202	468	10415
4E		MI	3128	1867	4950	1440	5568	1200	5939	996	6394	664	7408	356	5751
12-#10	2.82	MA	5280	1867	7825	1545	9101	1287	9831	1074	10669	741	13077	424	9947
5L-3S		MI	3199	1867	5158	1434	5859	1188	6295	993	6881	665	7961	401	5773
12-#10	2.82	MA	5091	1867	7452	1551	8656	1297	9253	1092	9887	756	11976	353	9573
6L-2S		MI	3333	1867	5452	1427	6234	1183	6750	982	7497	659	8735	492	5771
12-#11	3.47	MA	5716	1966	8775	1582	10230	1319	11195	1091	12519	717	15638	421	12464
4E		MI	3219	1966	5227	1488	5879	1234	6299	1013	6890	657	7872	267	6668
12-#11	3.47	MA	5471	1966	8298	1606	9656	1331	10480	1101	11524	735	14268	364	11766
5L-3S		MI	3302	1966	5476	1481	6228	1220	6726	1011	7452	650	8515	319	6859
12-#11	3.47	MA	5248	1966	7854	1614	9115	1343	9778	1122	10574	753	12922	276	11162
6L-2S		MI	3457	1966	5827	1475	6674	1216	7268	1000	8185	644	9406	431	6866
12-#14	5.00	MA	5956	2203	9383	1768	10993	1451	12080	1179	13659	733	17280	234	16090
5L-3S		MI	3590	2203	6220	1620	7149	1318	7833	1074	8913	626	10157	162	9470
12-#14	5.00	MA	5652	2203	8755	1780	10183	1482	11075	1208	12301	757	15497	127	14756
6L-2S		MI	3779	2203	6714	1612	7778	1314	8597	1059	9942	619	11382	323	9521
14-#10	3.29	MA	5753	1940	8783	1571	10294	1309	11295	1086	12674	721	15843	462	12107
4L-5S		MI	3172	1940	5032	1500	5686	1238	6076	1027	6568	666	7638	284	6365
14-#10	3.29	MA	5546	1940	8391	1590	9821	1319	10707	1095	11854	736	14717	418	11614
5L-4S		MI	3255	1940	5244	1485	5943	1233	6394	1016	7010	660	8182	338	6583
14-#10	3.29	MA	5363	1940	8018	1597	9377	1330	10129	1113	11072	752	13616	347	11256
6L-3S		MI	3323	1940	5452	1479	6234	1220	6750	1014	7497	661	8735	383	6659
14-#10	3.29	MA	5208	1940	7658	1604	8881	1345	9573	1122	10274	759	12551	311	10646
7L-2S		MI	3454	1940	5746	1473	6608	1216	7205	1003	8112	654	9509	474	6664
14-#11	4.04	MA	5786	2056	8983	1662	10527	1371	11539	1127	12956	730	16252	356	13787
5L-4S		MI	3367	2056	5578	1544	6325	1274	6841	1038	7623	651	8764	240	7662
14-#11	4.04	MA	5572	2056	8538	1670	9987	1383	10836	1148	12007	748	14906	269	13175
6L-3S		MI	3447	2056	5827	1537	6674	1260	7268	1037	8185	645	9406	292	7909
14-#11	4.04	MA	5389	2056	8101	1678	9395	1402	10161	1158	11037	755	13607	221	12468
7L-2S		MI	3597	2056	6177	1530	7120	1256	7810	1025	8919	639	10298	404	7926
14-#14	5.83	MA	6107	2331	9731	1860	11426	1540	12584	1245	14343	750	18325	117	17644
6L-3S		MI	3788	2331	6714	1700	7778	1377	8597	1110	9942	618	11382	118	10939
16-#10	3.76	MA	5807	2012	8957	1636	10542	1352	11582	1115	13039	732	16358	412	13286
5E		MI	3298	2012	5326	1546	6061	1271	6531	1048	7184	662	8412	266	7217
16-#10	3.76	MA	5630	2012	8584	1642	10098	1363	11004	1133	12257	748	15256	341	12941
6L-4S		MI	3380	2012	5539	1531	6317	1266	6849	1037	7625	655	8955	320	7421
16-#10	3.76	MA	5482	2012	8224	1649	9601	1378	10449	1142	11458	755	14191	305	12327
7L-3S		MI	3446	2012	5746	1524	6608	1253	7205	1034	8112	657	9509	365	7542
16-#10	3.76	MA	5304	2012	7878	1658	9134	1385	9874	1158	10696	770	13166	255	11694
8L-2S		MI	3574	2012	6040	1518	6983	1249	7660	1024	8728	650	10282	456	7554
16-#11	4.62	MA	5890	2145	9223	1726	10858	1424	11895	1173	13439	742	16889	262	15193
6L-4S		MI	3529	2145	5928	1599	6772	1315	7383	1063	8357	646	9655	213	8663
16-#11	4.62	MA	5716	2145	8786	1734	10266	1443	11220	1183	12469	750	15590	214	14504
7L-3S		MI	3598	2145	6177	1593	7120	1301	7810	1062	8919	640	10298	265	8957

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	4.23	MA	5893	2085	9150	1687	10818	1396	11879	1154	13441	743	16897	335	14628
6L-5S		MI	3423	2085	5620	1591	6435	1304	6986	1068	7799	658	9186	248	8072
18-#10	4.23	MA	5751	2085	8790	1694	10322	1411	11324	1163	12643	750	15831	299	14009
7L-4S		MI	3505	2085	5833	1576	6692	1299	7304	1057	8241	651	9729	302	8264
18-#10	4.23	MA	5575	2085	8445	1703	9855	1418	10750	1179	11881	766	14806	249	13371
8L-3S		MI	3568	2085	6040	1570	6983	1286	7660	1055	8728	653	10282	347	8423
18-#11	5.20	MA	6037	2234	9470	1789	11138	1483	12278	1208	13902	745	17573	207	16541
7L-4S		MI	3674	2234	6279	1655	7218	1355	7925	1088	9090	641	10547	186	9668
20-#10	4.70	MA	6016	2157	9356	1740	11043	1444	12199	1183	13828	746	17472	293	15693
7L-5S		MI	3547	2157	5914	1636	6810	1337	7440	1089	8415	654	9960	230	8929
20-#10	4.70	MA	5841	2157	9011	1748	10576	1451	11625	1199	13065	762	16447	243	15048
8L-4S		MI	3629	2157	6127	1621	7066	1332	7759	1078	8856	647	10503	284	9110
22-#10	5.17	MA	6104	2230	9577	1793	11296	1483	12501	1220	14250	757	18087	237	16725
8L-5S		MI	3670	2230	6208	1682	7184	1369	7895	1109	9031	650	10733	212	9788

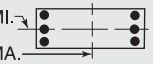
RECTANGULAR TIED COLUMNS 18" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.08	MA	5609	1706	8054	1422	9298	1199	9923	1025	10468	766	12377	666	4763
2E		MI	3052	1706	4673	1328	5156	1119	5368	955	5504	710	6111	578	2568
4-#14	1.56	MA	5895	1784	8724	1465	10118	1230	10902	1043	11779	757	14183	657	6720
2E		MI	3167	1784	4988	1366	5529	1145	5808	969	6079	697	6750	538	3523
4-#18	2.78	MA	6570	1984	10359	1578	12134	1310	13320	1090	15026	738	18659	634	11523
2E		MI	3428	1984	5726	1469	6416	1217	6862	1009	7379	653	8180	421	5769
6-#9	1.04	MA	5607	1699	7953	1430	9233	1206	9876	1032	10429	773	12342	673	4627
2L-3S		MI	2942	1699	4386	1350	4844	1138	5015	978	5044	729	5625	532	2513
6-#9	1.04	MA	5345	1699	7470	1440	8617	1215	9127	1040	9416	786	10940	608	4638
3L-2S		MI	3061	1699	4620	1345	5142	1134	5377	969	5534	723	6248	604	2495
6-#10	1.32	MA	5785	1745	8355	1456	9728	1224	10468	1043	11224	768	13437	668	5804
2L-3S		MI	2990	1745	4521	1375	5001	1154	5199	989	5288	724	5913	495	3103
6-#10	1.32	MA	5462	1745	7744	1468	8950	1235	9523	1053	9944	785	11666	585	5809
3L-2S		MI	3136	1745	4815	1368	5376	1150	5654	978	5904	717	6686	586	3081
6-#11	1.63	MA	5954	1795	8794	1478	10241	1240	11068	1051	12017	760	14522	659	7018
2L-3S		MI	3029	1795	4673	1390	5156	1163	5368	992	5504	711	6111	439	3699
6-#11	1.63	MA	5572	1795	8054	1492	9298	1252	9923	1062	10468	779	12377	555	7013
3L-2S		MI	3199	1795	5024	1384	5602	1159	5910	981	6237	705	7002	551	3671
6-#14	2.34	MA	6372	1913	9780	1546	11462	1288	12535	1079	13989	750	17243	646	9923
2L-3S		MI	3138	1913	4988	1455	5529	1207	5808	1021	6079	696	6750	332	5080
6-#14	2.34	MA	5852	1913	8724	1565	10118	1305	10902	1095	11779	776	14183	493	9860
3L-2S		MI	3369	1913	5482	1446	6158	1203	6572	1006	7108	688	7975	494	5056
6-#18	4.17	MA	7355	2213	12196	1720	14474	1413	16161	1155	18871	725	23983	616	17059
2L-3S		MI	3405	2213	5726	1621	6416	1322	6862	1093	7379	643	8180	36	8088
6-#18	4.17	MA	6531	2213	10359	1753	12134	1441	13320	1179	15026	767	18659	335	16698
3L-2S		MI	3751	2213	6565	1611	7484	1320	8158	1074	9073	630	10148	324	8327
8-#8	1.10	MA	5651	1708	8020	1439	9334	1213	10006	1037	10611	774	12599	674	4873
2L-4S		MI	2937	1708	4333	1365	4773	1154	4933	985	4935	730	5540	521	2647
8-#8	1.10	MA	5444	1708	7636	1446	8845	1220	9412	1043	9807	785	11486	623	4881
3E		MI	2988	1708	4464	1360	4957	1146	5158	983	5243	730	5898	551	2631
8-#8	1.10	MA	5338	1708	7377	1454	8478	1232	8961	1055	9190	790	10742	592	4879
4L-2S		MI	3082	1708	4651	1356	5195	1142	5447	976	5634	725	6400	607	2618
8-#9	1.39	MA	5837	1756	8437	1466	9850	1232	10624	1048	11442	770	13744	669	6100
2L-4S		MI	2982	1756	4456	1392	4911	1174	5094	997	5147	725	5804	483	3262

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

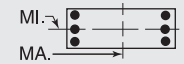
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	1.39	MA	5583	1756	7953	1475	9233	1241	9876	1056	10429	783	12342	604	6103
3E		MI	3046	1756	4620	1386	5142	1164	5377	994	5534	725	6248	519	3244
8-#9	1.39	MA	5452	1756	7626	1485	8771	1256	9308	1071	9650	789	11403	564	6079
4L-2S		MI	3162	1756	4854	1381	5440	1160	5739	985	6024	719	6871	591	3228
8-#10	1.76	MA	6070	1818	8967	1501	10507	1257	11414	1064	12503	764	15209	662	7660
2L-4S		MI	3040	1818	4608	1427	5085	1200	5298	1012	5416	718	6133	432	4023
8-#10	1.76	MA	5758	1818	8355	1513	9728	1268	10468	1073	11224	780	13437	579	7651
3E		MI	3118	1818	4815	1420	5376	1187	5654	1009	5904	719	6686	477	4012
8-#10	1.76	MA	5598	1818	7941	1525	9143	1288	9750	1092	10239	788	12246	528	7584
4L-2S		MI	3261	1818	5109	1414	5750	1183	6109	999	6519	713	7460	568	3994
8-#11	2.17	MA	6291	1884	9534	1534	11183	1280	12213	1076	13566	755	16666	652	9262
2L-4S		MI	3087	1884	4775	1453	5253	1218	5483	1019	5675	712	6360	360	4773
8-#11	2.17	MA	5924	1884	8794	1548	10241	1293	11068	1087	12017	774	14522	548	9236
3E		MI	3179	1884	5024	1446	5602	1204	5910	1017	6237	706	7002	412	4775
8-#11	2.17	MA	5735	1884	8291	1562	9530	1316	10196	1109	10822	782	13066	485	9109
4L-2S		MI	3344	1884	5374	1440	6048	1200	6452	1006	6971	700	7894	524	4756
8-#14	3.13	MA	6344	2041	9780	1645	11462	1364	12535	1131	13989	768	17243	483	13018
3E		MI	3346	2041	5482	1535	6158	1266	6572	1057	7108	688	7975	289	6569
8-#14	3.13	MA	6090	2041	9059	1665	10446	1396	11288	1161	12281	779	15152	392	12277
4L-2S		MI	3569	2041	5976	1527	6787	1262	7336	1042	8136	680	9201	450	6569
8-#18	5.56	MA	7356	2441	12196	1895	14474	1545	16161	1244	18871	754	23983	317	22182
3E		MI	3748	2441	6565	1763	7484	1425	8158	1158	9073	620	10148	-61	10099
8-#18	5.56	MA	6961	2441	10936	1928	12697	1600	13982	1294	15887	769	20293	151	19313
4L-2S		MI	4068	2441	7403	1754	8551	1424	9454	1139	10768	606	12115	227	10853
10-#10	2.20	MA	6350	1890	9578	1546	11285	1290	12359	1084	13783	760	16981	656	9510
2L-5S		MI	3087	1890	4689	1487	5203	1238	5434	1043	5591	720	6364	359	4740
10-#10	2.20	MA	6048	1890	8967	1558	10507	1301	11414	1094	12503	776	15209	573	9490
3L-4S		MI	3170	1890	4902	1472	5459	1233	5752	1032	6032	714	6907	414	4909
10-#10	2.20	MA	5898	1890	8552	1570	9921	1321	10695	1112	11519	784	14018	523	9410
4L-3S		MI	3246	1890	5109	1465	5750	1220	6109	1030	6519	715	7460	459	4910
10-#10	2.20	MA	5666	1890	8130	1591	9412	1332	10062	1122	10636	800	12810	480	8989
5L-2S		MI	3384	1890	5403	1459	6125	1216	6564	1019	7135	708	8234	550	4898
10-#11	2.71	MA	6269	1973	9534	1603	11183	1333	12213	1112	13566	769	16666	541	11457
3L-4S		MI	3239	1973	5125	1508	5700	1258	6025	1044	6409	707	7251	333	5767
10-#11	2.71	MA	6093	1973	9031	1617	10472	1356	11340	1134	12371	777	15211	478	11316
4L-3S		MI	3328	1973	5374	1502	6048	1244	6452	1043	6971	701	7894	385	5840
10-#11	2.71	MA	5819	1973	8518	1642	9854	1369	10571	1145	11298	796	13738	423	10590
5L-2S		MI	3488	1973	5724	1495	6495	1240	6994	1031	7704	694	8785	498	5830
10-#14	3.91	MA	6591	2170	10115	1745	11790	1454	12921	1198	14491	772	18212	381	15365
4L-3S		MI	3561	2170	5976	1615	6787	1324	7336	1093	8136	679	9201	245	8046
10-#14	3.91	MA	6209	2170	9381	1780	10905	1472	11820	1213	12957	798	16101	299	14340
5L-2S		MI	3764	2170	6470	1607	7416	1320	8101	1079	9165	672	10426	406	8071
10-#18	6.94	MA	7810	2669	12773	2071	15036	1704	16823	1359	19732	756	25617	133	24755
4L-3S		MI	4084	2669	7403	1906	8551	1529	9454	1223	10768	596	12115	-158	11959
10-#18	6.94	MA	7170	2669	11486	2130	13486	1732	14895	1383	17048	798	21909	-24	21822
5L-2S		MI	4383	2669	8241	1897	9618	1528	10750	1203	12462	583	14083	130	13364
12-#10	2.65	MA	6333	1963	9578	1604	11285	1334	12359	1115	13783	772	16981	567	11326
3L-5S		MI	3217	1963	4983	1532	5578	1270	5889	1064	6206	716	7137	341	5582
12-#10	2.65	MA	6191	1963	9164	1616	10700	1354	11641	1133	12798	780	15790	517	11238
4E		MI	3299	1963	5196	1517	5834	1266	6207	1053	6648	709	7681	396	5791
12-#10	2.65	MA	5961	1963	8742	1636	10191	1364	11007	1143	11916	796	14581	474	10789
5L-3S		MI	3371	1963	5403	1511	6125	1253	6564	1051	7135	711	8234	441	5803
12-#10	2.65	MA	5755	1963	8336	1642	9713	1375	10385	1161	11074	812	13402	404	10368
6L-2S		MI	3507	1963	5698	1504	6499	1249	7018	1040	7750	704	9008	532	5797

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis

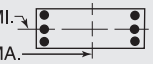


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	3.25	MA	6442	2062	9771	1673	11415	1397	12485	1159	13920	772	17355	471	13526
4E		MI	3390	2062	5476	1564	6146	1299	6567	1069	7142	702	8143	306	6751
12-#11	3.25	MA	6171	2062	9258	1698	10796	1409	11715	1170	12847	791	15883	416	12773
5L-3S		MI	3474	2062	5724	1557	6495	1285	6994	1068	7704	695	8785	359	6896
12-#11	3.25	MA	5927	2062	8772	1705	10214	1422	10959	1192	11824	810	14441	329	12189
6L-2S		MI	3631	2062	6075	1551	6941	1281	7536	1056	8438	689	9677	471	6898
12-#14	4.69	MA	6701	2298	10437	1860	12249	1530	13453	1250	15167	790	19161	289	17482
5L-3S		MI	3763	2298	6470	1695	7416	1382	8101	1130	9165	671	10426	201	9519
12-#14	4.69	MA	6369	2298	9749	1872	11416	1548	12370	1280	13703	816	17089	163	16093
6L-2S		MI	3955	2298	6964	1687	8045	1378	8865	1115	10193	663	11651	363	9561
14-#10	3.09	MA	6480	2035	9775	1661	11478	1386	12586	1153	14078	776	17561	511	13067
4L-5S		MI	3344	2035	5277	1577	5952	1303	6344	1084	6822	712	7911	324	6430
14-#10	3.09	MA	6251	2035	9353	1681	10969	1397	11953	1163	13195	792	16353	468	12593
5L-4S		MI	3426	2035	5490	1563	6208	1299	6662	1074	7263	705	8455	378	6655
14-#10	3.09	MA	6052	2035	8947	1687	10491	1408	11331	1182	12354	808	15173	398	12188
6L-3S		MI	3496	2035	5698	1556	6499	1286	7018	1071	7750	707	9008	423	6691
14-#10	3.09	MA	5882	2035	8559	1695	9950	1423	10734	1191	11495	816	14030	364	11578
7L-2S		MI	3628	2035	5992	1550	6874	1282	7473	1060	8366	700	9781	514	6692
14-#11	3.79	MA	6516	2151	9998	1753	11738	1450	12860	1196	14396	786	18028	408	14961
5L-4S		MI	3539	2151	5826	1620	6592	1339	7109	1094	7876	696	9034	279	7743
14-#11	3.79	MA	6281	2151	9512	1761	11157	1462	12103	1217	13373	805	16585	321	14374
6L-3S		MI	3620	2151	6075	1613	6941	1325	7536	1093	8438	690	9677	332	7948
14-#11	3.79	MA	6082	2151	9041	1770	10509	1481	11377	1229	12329	813	15191	276	13563
7L-2S		MI	3772	2151	6425	1607	7387	1321	8078	1082	9171	684	10568	444	7961
14-#14	5.47	MA	6866	2427	10805	1952	12761	1606	14003	1316	15913	809	20149	152	19220
6L-3S		MI	3961	2427	6964	1776	8045	1441	8865	1166	10193	662	11651	157	10989
14-#14	5.47	MA	6596	2427	10132	1964	11845	1633	12963	1332	14418	820	18147	84	17727
7L-2S		MI	4145	2427	7458	1768	8674	1437	9629	1151	11222	655	12876	319	11047
16-#10	3.53	MA	6536	2108	9964	1727	11748	1430	12898	1184	14475	787	18125	463	14401
5E		MI	3470	2108	5571	1623	6326	1336	6799	1105	7437	708	8685	306	7281
16-#10	3.53	MA	6343	2108	9559	1733	11270	1441	12276	1202	13633	804	16945	392	14010
6L-4S		MI	3552	2108	5784	1608	6583	1332	7117	1094	7879	701	9228	360	7492
16-#10	3.53	MA	6181	2108	9170	1740	10728	1456	11679	1212	12774	811	15802	358	13397
7L-3S		MI	3619	2108	5992	1601	6874	1319	7473	1092	8366	703	9781	405	7575
16-#10	3.53	MA	5985	2108	8798	1749	10225	1463	11052	1227	11954	828	14702	309	12753
8L-2S		MI	3749	2108	6286	1595	7248	1315	7928	1081	8981	696	10555	496	7584
16-#11	4.33	MA	6629	2240	10252	1817	12099	1503	13248	1243	14922	799	18730	314	16562
6L-4S		MI	3687	2240	6177	1675	7038	1380	7651	1120	8609	691	9926	253	8742
16-#11	4.33	MA	6439	2240	9781	1825	11451	1522	12521	1254	13878	808	17336	269	15764
7L-3S		MI	3772	2240	6425	1669	7387	1366	8078	1118	9171	685	10568	305	8998
16-#11	4.33	MA	6207	2240	9329	1835	10840	1530	11772	1273	12880	827	15994	207	14792
8L-2S		MI	3910	2240	6776	1662	7833	1362	8620	1107	9904	679	11460	417	9018
16-#14	6.25	MA	7098	2555	11188	2044	13190	1692	14596	1368	16629	812	21208	74	20839
7L-3S		MI	4157	2555	7458	1856	8674	1499	9629	1203	11222	654	12876	113	12449
18-#10	3.97	MA	6630	2180	10170	1778	12048	1474	13222	1223	14913	799	18717	386	15834
6L-5S		MI	3596	2180	5866	1668	6701	1369	7254	1126	8053	704	9459	288	8135
18-#10	3.97	MA	6475	2180	9782	1785	11507	1489	12624	1232	14054	807	17574	352	15218
7L-4S		MI	3677	2180	6079	1653	6957	1365	7572	1115	8494	697	10002	342	8334
18-#10	3.97	MA	6280	2180	9410	1794	11004	1496	11997	1248	13233	823	16474	304	14564
8L-3S		MI	3742	2180	6286	1647	7248	1352	7928	1112	8981	698	10555	387	8458
18-#10	3.97	MA	6087	2180	8992	1812	10487	1513	11377	1255	12395	831	15389	259	13864
9L-2S		MI	3869	2180	6580	1640	7623	1348	8383	1101	9597	691	11329	478	8471
18-#11	4.88	MA	6789	2329	10521	1881	12394	1562	13666	1279	15427	803	19480	262	17964
7L-4S		MI	3847	2329	6527	1731	7484	1420	8193	1145	9343	686	10817	226	9747
18-#11	4.88	MA	6560	2329	10069	1891	11783	1570	12917	1299	14429	821	18139	200	16983
8L-3S		MI	3913	2329	6776	1724	7833	1406	8620	1144	9904	680	11460	278	10045

RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

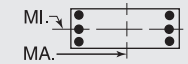
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	4.41	MA	6764	2253	10393	1831	12285	1522	13570	1253	15333	803	19345	346	17041
7L-5S		MI	3720	2253	6160	1713	7075	1402	7709	1146	8669	699	10232	270	8991
20-#10	4.41	MA	6571	2253	10021	1840	11782	1529	12943	1268	14513	819	18246	298	16376
8L-4S		MI	3801	2253	6373	1698	7332	1398	8027	1135	9110	693	10776	324	9179
20-#10	4.41	MA	6384	2253	9603	1858	11265	1546	12323	1275	13674	827	17160	253	15679
9L-3S		MI	3863	2253	6580	1692	7623	1385	8383	1133	9597	694	11329	369	9339
20-#11	5.42	MA	6906	2418	10809	1947	12725	1611	14061	1324	15978	816	20284	193	19175
8L-4S		MI	3991	2418	6877	1787	7930	1461	8735	1170	10076	681	11709	199	10755
22-#10	4.85	MA	6857	2325	10632	1885	12560	1562	13888	1289	15792	815	20017	292	18187
8L-5S		MI	3843	2325	6454	1759	7450	1435	8163	1167	9284	695	11006	252	9850
22-#10	4.85	MA	6676	2325	10215	1903	12044	1579	13268	1296	14954	823	18932	247	17494
9L-4S		MI	3924	2325	6667	1744	7706	1431	8481	1156	9726	688	11550	306	10028
24-#10	5.29	MA	6964	2398	10826	1948	12822	1612	14214	1316	16233	818	20704	241	19309
9L-5S		MI	3965	2398	6748	1804	7824	1468	8618	1187	9900	691	11780	234	10710

RECTANGULAR TIED COLUMNS 18" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.02	MA	6302	1801	8964	1512	10377	1275	11077	1092	11665	819	13774	713	5100
2E		MI	3224	1801	4921	1404	5422	1184	5636	1012	5756	755	6381	618	2589
4-#14	1.47	MA	6615	1880	9686	1555	11260	1306	12133	1110	13079	810	15721	703	7206
2E		MI	3339	1880	5238	1442	5796	1209	6076	1025	6330	741	7019	577	3549
4-#18	2.61	MA	7354	2080	11453	1667	13439	1386	14745	1157	16586	791	20556	681	12387
2E		MI	3601	2080	5980	1543	6684	1280	7129	1064	7629	697	8445	459	5807
6-#10	1.25	MA	6492	1841	9286	1545	10836	1301	11659	1110	12473	821	14908	714	6216
2L-3S		MI	3161	1841	4767	1452	5267	1220	5467	1046	5542	769	6185	535	3124
6-#10	1.25	MA	6141	1841	8629	1558	10000	1312	10644	1120	11099	838	13005	633	6221
3L-2S		MI	3308	1841	5061	1445	5642	1216	5922	1035	6157	762	6959	626	3101
6-#11	1.53	MA	6677	1890	9760	1568	11390	1316	12308	1117	13330	813	16080	706	7523
2L-3S		MI	3200	1890	4921	1467	5422	1228	5636	1049	5756	756	6381	479	3724
6-#11	1.53	MA	6262	1890	8964	1582	10377	1329	11077	1129	11665	833	13774	603	7518
3L-2S		MI	3371	1890	5272	1460	5869	1224	6178	1037	6490	750	7273	591	3695
6-#14	2.21	MA	7134	2008	10823	1635	12707	1364	13890	1146	15457	803	19014	693	10652
2L-3S		MI	3309	2008	5238	1530	5796	1272	6076	1077	6330	741	7019	372	5116
6-#14	2.21	MA	6568	2008	9686	1655	11260	1383	12133	1162	13079	830	15721	543	10589
3L-2S		MI	3542	2008	5732	1522	6425	1268	6840	1062	7359	733	8244	533	5087
6-#18	3.92	MA	8209	2308	13433	1810	15960	1490	17807	1222	20730	778	26294	662	18355
2L-3S		MI	3576	2308	5980	1695	6684	1385	7129	1148	7629	687	8445	75	8253
6-#18	3.92	MA	7309	2308	11453	1844	13439	1520	14745	1248	16586	823	20556	387	17994
3L-2S		MI	3925	2308	6818	1685	7751	1383	8425	1129	9323	674	10413	362	8370
8-#8	1.03	MA	6345	1803	8925	1528	10411	1289	11161	1104	11812	827	14004	720	5215
2L-4S		MI	3108	1803	4578	1442	5038	1220	5201	1043	5189	776	5815	562	2664
8-#8	1.03	MA	6121	1803	8512	1536	9886	1296	10523	1110	10949	838	12809	670	5223
3E		MI	3160	1803	4709	1438	5222	1212	5427	1041	5497	776	6172	591	2648
8-#8	1.03	MA	6006	1803	8234	1544	9493	1309	10040	1122	10288	844	12017	640	5220
4L-2S		MI	3255	1803	4895	1434	5460	1209	5715	1033	5888	771	6675	648	2635
8-#9	1.31	MA	6548	1851	9373	1555	10965	1308	11826	1115	12705	823	15236	715	6532
2L-4S		MI	3154	1851	4701	1469	5177	1240	5362	1054	5401	770	6078	523	3283
8-#9	1.31	MA	6272	1851	8854	1565	10303	1318	11022	1123	11618	836	13730	651	6535
3E		MI	3218	1851	4865	1464	5408	1230	5645	1052	5788	771	6522	559	3264
8-#9	1.31	MA	6131	1851	8503	1575	9808	1333	10414	1138	10784	843	12728	612	6511
4L-2S		MI	3334	1851	5099	1458	5706	1226	6007	1043	6278	765	7145	631	3247
8-#10	1.66	MA	6802	1913	9943	1591	11672	1334	12675	1130	13847	817	16811	708	8209
2L-4S		MI	3212	1913	4854	1504	5351	1266	5566	1069	5670	763	6406	472	4051
8-#10	1.66	MA	6463	1913	9286	1603	10836	1345	11659	1141	12473	834	14908	627	8200
3E		MI	3290	1913	5061	1497	5642	1253	5922	1067	6157	765	6959	517	4035
8-#10	1.66	MA	6289	1913	8842	1615	10208	1365	10890	1159	11417	842	13638	577	8132
4L-2S		MI	3433	1913	5355	1491	6016	1249	6377	1056	6773	758	7733	608	4016

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



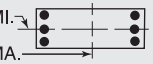
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	2.04	MA	7044	1979	10556	1623	12403	1356	13539	1142	14996	808	18386	699	9936
2L-4S		MI	3258	1979	5023	1529	5520	1283	5751	1075	5928	757	6630	399	4811
8-#11	2.04	MA	6645	1979	9760	1638	11390	1370	12308	1154	13330	828	16080	596	9910
3E		MI	3351	1979	5272	1522	5869	1269	6178	1074	6490	751	7273	452	4804
8-#11	2.04	MA	6440	1979	9220	1652	10628	1393	11372	1177	12048	837	14527	534	9783
4L-2S		MI	3517	1979	5622	1516	6315	1265	6720	1062	7223	745	8164	564	4783
8-#14	2.94	MA	7102	2137	10823	1736	12707	1441	13890	1199	15457	823	19014	533	13990
3E		MI	3518	2137	5732	1610	6425	1330	6840	1113	7359	732	8244	328	6610
8-#14	2.94	MA	6826	2137	10050	1756	11616	1474	12552	1230	13623	835	16782	442	13325
4L-2S		MI	3743	2137	6226	1602	7054	1326	7604	1098	8388	725	9469	490	6603
8-#18	5.23	MA	8206	2537	13433	1987	15960	1623	17807	1312	20730	809	26294	369	23910
3E		MI	3919	2537	6818	1837	7751	1488	8425	1213	9323	663	10413	-22	10396
8-#18	5.23	MA	7777	2537	12079	2021	14051	1680	15465	1365	17522	828	22354	205	20970
4L-2S		MI	4244	2537	7656	1828	8818	1487	9721	1194	11017	650	12381	265	10902
10-#10	2.08	MA	7106	1986	10599	1636	12508	1367	13691	1151	15222	813	18714	703	10196
2L-5S		MI	3259	1986	4935	1564	5469	1303	5702	1101	5844	766	6637	399	4803
10-#10	2.08	MA	6778	1986	9943	1648	11672	1378	12675	1161	13847	830	16811	621	10175
3L-4S		MI	3342	1986	5148	1549	5725	1299	6020	1090	6286	759	7180	454	4941
10-#10	2.08	MA	6614	1986	9499	1661	11045	1398	11905	1180	12792	838	15541	571	10096
4L-3S		MI	3418	1986	5355	1542	6016	1286	6377	1087	6773	761	7733	499	4937
10-#10	2.08	MA	6360	1986	9046	1681	10500	1409	11227	1190	11847	855	14249	530	9703
5L-2S		MI	3557	1986	5649	1536	6391	1282	6832	1076	7388	754	8507	590	4922
10-#11	2.55	MA	7019	2068	10556	1693	12403	1410	13539	1180	14996	823	18386	589	12299
3L-4S		MI	3411	2068	5373	1584	5966	1323	6293	1100	6661	752	7522	373	5848
10-#11	2.55	MA	6828	2068	10016	1708	11641	1434	12603	1202	13714	832	16834	527	12158
4L-3S		MI	3500	2068	5622	1578	6315	1309	6720	1099	7223	746	8164	425	5873
10-#11	2.55	MA	6528	2068	9467	1733	10978	1447	11778	1214	12564	852	15259	474	11438
5L-2S		MI	3661	2068	5973	1571	6761	1305	7262	1088	7956	739	9056	537	5859
10-#14	3.68	MA	7371	2265	11186	1836	13063	1533	14309	1266	16001	828	20076	432	16657
4L-3S		MI	3734	2265	6226	1691	7054	1388	7604	1149	8388	724	9469	284	8091
10-#14	3.68	MA	6951	2265	10399	1872	12114	1551	13128	1283	14356	855	17816	353	15497
5L-2S		MI	3938	2265	6720	1682	7683	1384	8368	1135	9416	716	10694	446	8107
10-#18	6.54	MA	8700	2765	14059	2163	16572	1784	18527	1430	21666	814	28092	187	26843
4L-3S		MI	4255	2765	7656	1980	8818	1592	9721	1278	11017	640	12381	-119	12266
10-#18	6.54	MA	7995	2765	12679	2224	14908	1814	16457	1456	18784	859	24120	37	23955
5L-2S		MI	4559	2765	8494	1971	9885	1591	11017	1258	12711	627	14348	168	13416
12-#10	2.49	MA	7087	2058	10599	1694	12508	1411	13691	1182	15222	826	18714	615	12149
3L-5S		MI	3388	2058	5229	1609	5843	1336	6157	1121	6460	762	7410	381	5645
12-#10	2.49	MA	6933	2058	10155	1706	11881	1431	12921	1200	14166	834	17444	565	12061
4E		MI	3471	2058	5442	1594	6100	1332	6475	1110	6901	755	7954	436	5825
12-#10	2.49	MA	6681	2058	9703	1727	11336	1442	12242	1211	13221	851	16152	524	11639
5L-3S		MI	3544	2058	5649	1588	6391	1319	6832	1108	7388	757	8507	481	5832
12-#10	2.49	MA	6457	2058	9264	1732	10823	1453	11577	1230	12320	868	14892	455	11168
6L-2S		MI	3680	2058	5943	1581	6765	1314	7287	1097	8004	750	9281	572	5823
12-#11	3.06	MA	7207	2157	10812	1764	12654	1474	13834	1227	15379	827	19140	520	14537
4E		MI	3562	2157	5724	1640	6412	1364	6835	1126	7395	747	8413	346	6831
12-#11	3.06	MA	6910	2157	10262	1789	11991	1487	13009	1239	14230	847	17565	467	13789
5L-3S		MI	3647	2157	5973	1634	6761	1349	7262	1124	7956	740	9056	398	6932
12-#11	3.06	MA	6645	2157	9735	1796	11369	1501	12199	1261	13134	866	16026	380	13234
6L-2S		MI	3804	2157	6323	1627	7207	1346	7804	1113	8690	734	9947	510	6929
12-#14	4.41	MA	7485	2394	11535	1952	13561	1609	14885	1319	16734	847	21110	343	18883
5L-3S		MI	3935	2394	6720	1771	7683	1447	8368	1186	9416	715	10694	240	9566
12-#14	4.41	MA	7125	2394	10788	1963	12668	1628	13724	1351	15164	875	18898	217	17449
6L-2S		MI	4131	2394	7214	1763	8312	1443	9132	1171	10445	708	11920	402	9601

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

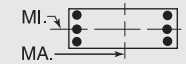
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	7.84	MA	8897	2993	14659	2367	17429	1918	19519	1521	22928	846	29858	19	29775
5L-3S		MI	4586	2993	8494	2123	9885	1696	11017	1343	12711	616	14348	-216	14103
14-#10	2.91	MA	7245	2131	10812	1751	12717	1464	13936	1221	15541	830	19347	559	14027
4L-5S		MI	3516	2131	5523	1654	6218	1369	6612	1142	7075	758	8184	364	6492
14-#10	2.91	MA	6995	2131	10360	1772	12172	1475	13258	1231	14595	847	18055	518	13579
5L-4S		MI	3598	2131	5736	1640	6474	1365	6930	1131	7517	751	8727	418	6706
14-#10	2.91	MA	6779	2131	9921	1778	11659	1486	12592	1250	13694	863	16795	450	13125
6L-3S		MI	3668	2131	5943	1633	6765	1352	7287	1128	8004	752	9281	463	6721
14-#10	2.91	MA	6596	2131	9505	1786	11074	1501	11953	1261	12775	872	15578	416	12521
7L-2S		MI	3802	2131	6238	1627	7140	1347	7741	1118	8619	745	10054	554	6719
14-#11	3.57	MA	7284	2247	11058	1844	13005	1528	14239	1264	15895	841	19871	460	16145
5L-4S		MI	3711	2247	6074	1696	6858	1404	7377	1151	8128	741	9305	319	7822
14-#11	3.57	MA	7030	2247	10531	1852	12382	1541	13429	1287	14799	861	18332	373	15590
6L-3S		MI	3792	2247	6323	1689	7207	1390	7804	1150	8690	735	9947	371	7986
14-#11	3.57	MA	6813	2247	10026	1861	11678	1559	12651	1299	13680	870	16843	330	14667
7L-2S		MI	3947	2247	6674	1683	7653	1386	8346	1138	9423	729	10839	483	7994
14-#14	5.15	MA	7664	2522	11925	2043	14115	1686	15482	1387	17542	867	22191	207	20814
6L-3S		MI	4134	2522	7214	1851	8312	1505	9132	1222	10445	707	11920	196	11039
14-#14	5.15	MA	7371	2522	11202	2056	13119	1713	14367	1403	15940	880	20052	142	19282
7L-2S		MI	4321	2522	7708	1843	8941	1501	9896	1207	11473	700	13145	358	11088
16-#10	3.32	MA	7304	2203	11016	1817	13008	1508	14274	1252	15970	842	19958	513	15523
5E		MI	3643	2203	5817	1700	6592	1402	7067	1162	7691	753	8958	346	7342
16-#10	3.32	MA	7095	2203	10577	1823	12495	1519	13608	1271	15069	859	18698	444	15084
6L-4S		MI	3725	2203	6030	1685	6849	1398	7385	1151	8132	747	9501	400	7562
16-#10	3.32	MA	6920	2203	10161	1831	11910	1534	12969	1281	14149	868	17481	410	14475
7L-3S		MI	3792	2203	6238	1678	7140	1385	7741	1149	8619	748	10054	445	7607
16-#10	3.32	MA	6705	2203	9763	1840	11371	1542	12288	1296	13271	884	16306	363	13828
8L-2S		MI	3923	2203	6532	1672	7514	1380	8196	1138	9235	741	10828	536	7612
16-#11	4.08	MA	7407	2336	11327	1907	13395	1582	14660	1312	16464	856	20639	366	17949
6L-4S		MI	3858	2336	6425	1751	7305	1445	7919	1176	8861	736	10196	292	8820
16-#11	4.08	MA	7201	2336	10821	1916	12692	1600	13882	1324	15345	865	19149	323	17033
7L-3S		MI	3945	2336	6674	1745	7653	1430	8346	1175	9423	730	10839	344	9037
16-#11	4.08	MA	6946	2336	10336	1927	12036	1609	13067	1343	14277	885	17715	263	16044
8L-2S		MI	4085	2336	7024	1738	8100	1426	8888	1163	10157	724	11730	456	9054
16-#14	5.88	MA	7916	2651	12338	2136	14566	1771	16124	1440	18318	872	23346	132	22631
7L-3S		MI	4331	2651	7708	1931	8941	1563	9896	1259	11473	699	13145	152	12509
18-#10	3.74	MA	7406	2276	11234	1868	13332	1552	14623	1291	16443	855	20601	438	17045
6L-5S		MI	3768	2276	6111	1745	6967	1435	7522	1183	8307	749	9732	328	8196
18-#10	3.74	MA	7238	2276	10818	1876	12746	1567	13984	1302	15523	863	19383	404	16430
7L-4S		MI	3850	2276	6324	1730	7223	1431	7840	1172	8748	742	10275	382	8402
18-#10	3.74	MA	7025	2276	10419	1885	12207	1574	13303	1317	14645	880	18209	357	15774
8L-3S		MI	3915	2276	6532	1724	7514	1418	8196	1170	9235	744	10828	427	8491
18-#10	3.74	MA	6816	2276	9972	1904	11653	1591	12639	1324	13747	889	17053	313	14998
9L-2S		MI	4043	2276	6826	1717	7889	1413	8651	1159	9851	737	11602	518	8502
18-#11	4.59	MA	7580	2425	11617	1972	13705	1640	15112	1349	17011	860	21455	316	19400
7L-4S		MI	4019	2425	6775	1807	7751	1485	8461	1201	9595	731	11088	265	9823
18-#11	4.59	MA	7328	2425	11132	1983	13050	1649	14298	1368	15942	880	20021	256	18401
8L-3S		MI	4087	2425	7024	1801	8100	1471	8888	1200	10157	725	11730	317	10086
20-#10	4.15	MA	7551	2348	11475	1922	13582	1600	15000	1322	16898	859	21286	398	18384
7L-5S		MI	3892	2348	6405	1790	7341	1468	7977	1203	8922	745	10505	310	9052
20-#10	4.15	MA	7340	2348	11076	1931	13043	1607	14319	1337	16020	876	20112	352	17721
8L-4S		MI	3974	2348	6618	1775	7598	1464	8295	1192	9363	738	11049	364	9247

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

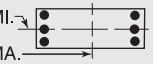
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	4.15	MA	7137	2348	10628	1949	12490	1624	13655	1344	15122	884	18956	307	16948
9L-3S		MI	4037	2348	6826	1769	7889	1451	8651	1190	9851	740	11602	409	9373
20-#10	4.15	MA	6952	2348	10215	1956	11968	1634	12992	1361	14247	901	17785	267	16140
10L-2S		MI	4163	2348	7120	1763	8263	1446	9106	1179	10466	733	12376	501	9389
20-#11	5.10	MA	7704	2514	11928	2039	14063	1690	15528	1393	17608	874	22328	249	20757
8L-4S		MI	4163	2514	7126	1863	8197	1526	9003	1227	10328	726	11979	238	10831
22-#10	4.57	MA	7650	2421	11733	1976	13879	1640	15334	1358	17394	872	22015	346	19667
8L-5S		MI	4016	2421	6700	1836	7716	1501	8432	1224	9538	741	11279	292	9910
22-#10	4.57	MA	7454	2421	11285	1994	13326	1657	14670	1365	16496	880	20859	302	18898
9L-4S		MI	4097	2421	6913	1821	7972	1496	8750	1213	9979	734	11822	346	10095
22-#10	4.57	MA	7275	2421	10871	2001	12804	1667	14008	1381	15621	897	19688	261	18084
10L-3S		MI	4158	2421	7120	1814	8263	1484	9106	1211	10466	735	12376	391	10254
24-#10	4.98	MA	7765	2493	11942	2040	14162	1690	15686	1386	17870	876	22762	296	20848
9L-5S		MI	4138	2493	6994	1881	8090	1534	8886	1244	10153	737	12053	274	10770
24-#10	4.98	MA	7593	2493	11528	2047	13640	1700	15023	1402	16996	892	21591	255	20028
10L-4S		MI	4220	2493	7207	1866	8347	1529	9204	1234	10595	730	12596	328	10945

RECTANGULAR TIED COLUMNS 18" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.39	MA	7373	1975	10694	1644	12458	1382	13422	1176	14438	863	17327	750	7692
2E		MI	3511	1975	5488	1517	6063	1274	6343	1081	6582	786	7288	616	3574
4-#18	2.47	MA	8177	2175	12591	1757	14798	1462	16229	1223	18205	844	22521	727	13251
2E		MI	3775	2175	6233	1617	6952	1343	7396	1119	7878	741	8710	497	5844
6-#10	1.18	MA	7238	1936	10261	1635	11998	1377	12910	1176	13781	874	16446	761	6627
2L-3S		MI	3333	1936	5013	1529	5533	1286	5735	1103	5795	815	6458	575	3143
6-#10	1.18	MA	6859	1936	9559	1647	11104	1389	11824	1187	12312	892	14411	680	6632
3L-2S		MI	3480	1936	5307	1522	5907	1281	6190	1093	6411	808	7232	666	3120
6-#11	1.44	MA	7439	1986	10771	1657	12594	1392	13607	1184	14703	866	17706	752	8029
2L-3S		MI	3372	1986	5170	1543	5689	1293	5904	1105	6008	801	6651	518	3749
6-#11	1.44	MA	6991	1986	9920	1672	11510	1406	12290	1196	12921	887	15238	651	8024
3L-2S		MI	3544	1986	5520	1536	6135	1289	6446	1094	6742	795	7543	630	3719
6-#14	2.08	MA	7935	2104	11911	1725	14007	1441	15304	1213	16984	856	20853	739	11381
2L-3S		MI	3481	2104	5488	1605	6063	1336	6343	1133	6582	785	7288	411	5149
6-#14	2.08	MA	7322	2104	10694	1746	12458	1460	13422	1230	14438	884	17327	592	11318
3L-2S		MI	3715	2104	5982	1597	6692	1332	7107	1118	7610	778	8513	573	5117
6-#18	3.70	MA	9104	2404	14714	1899	17501	1566	19511	1288	22648	831	28672	709	19651
2L-3S		MI	3746	2404	6233	1769	6952	1448	7396	1203	7878	731	8710	113	8366
6-#18	3.70	MA	8127	2404	12591	1935	14798	1598	16229	1316	18205	878	22521	439	19290
3L-2S		MI	4099	2404	7071	1759	8019	1447	8692	1184	9572	717	10678	401	8413
8-#9	1.23	MA	7298	1947	10354	1645	12136	1385	13086	1182	14028	876	16793	761	6964
2L-4S		MI	3326	1947	4945	1546	5442	1306	5630	1112	5655	816	6351	563	3303
8-#9	1.23	MA	7000	1947	9798	1655	11429	1394	12227	1190	12866	890	15184	699	6967
3E		MI	3390	1947	5110	1541	5673	1296	5913	1109	6042	817	6796	599	3283
8-#9	1.23	MA	6848	1947	9424	1665	10900	1410	11578	1206	11976	897	14121	660	6943
4L-2S		MI	3507	1947	5344	1536	5971	1292	6275	1100	6532	811	7419	671	3266
8-#10	1.57	MA	7573	2009	10963	1680	12892	1410	13995	1197	15250	870	18480	755	8758
2L-4S		MI	3383	2009	5099	1581	5616	1332	5834	1126	5924	809	6679	512	4077
8-#10	1.57	MA	7206	2009	10261	1693	11998	1422	12910	1208	13781	888	16446	675	8748
3E		MI	3462	2009	5307	1574	5907	1319	6190	1124	6411	811	7232	557	4058
8-#10	1.57	MA	7019	2009	9788	1705	11329	1442	12088	1227	12655	897	15097	625	8681
4L-2S		MI	3606	2009	5601	1568	6282	1314	6645	1113	7026	804	8006	648	4038
8-#11	1.93	MA	7836	2075	11622	1713	13678	1433	14924	1209	16485	861	20173	745	10610
2L-4S		MI	3430	2075	5271	1605	5786	1348	6019	1132	6180	802	6901	439	4847
8-#11	1.93	MA	7404	2075	10771	1728	12594	1447	13607	1222	14703	882	17706	644	10584
3E		MI	3523	2075	5520	1598	6135	1333	6446	1131	6742	796	7543	491	4833
8-#11	1.93	MA	7183	2075	10195	1743	11780	1471	12608	1244	13334	892	16056	583	10457
4L-2S		MI	3690	2075	5871	1592	6581	1329	6988	1119	7475	790	8434	603	4810

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis



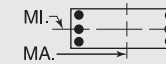
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#14	2.78	MA	7899	2232	11911	1826	14007	1518	15304	1266	16984	877	20853	582	14962
3E		MI	3690	2232	5982	1686	6692	1394	7107	1169	7610	777	8513	367	6649
8-#14	2.78	MA	7602	2232	11085	1847	12842	1552	13874	1299	15024	890	18480	492	14388
4L-2S		MI	3916	2232	6476	1677	7321	1390	7872	1154	8639	769	9738	529	6636
8-#18	4.94	MA	9096	2632	14714	2077	17501	1701	19511	1381	22648	865	28672	420	25638
3E		MI	4090	2632	7071	1911	8019	1551	8692	1268	9572	707	10678	16	10632
8-#18	4.94	MA	8633	2632	13268	2113	15460	1760	17007	1435	19217	885	24482	259	22621
4L-2S		MI	4419	2632	7909	1902	9086	1550	9988	1249	11266	694	12646	304	10950
10-#10	1.96	MA	7901	2081	11665	1725	13786	1443	15081	1217	16720	866	20514	749	10882
2L-5S		MI	3431	2081	5181	1641	5735	1369	5970	1158	6098	812	6909	439	4865
10-#10	1.96	MA	7546	2081	10963	1738	12892	1455	13995	1228	15250	883	18480	669	10861
3L-4S		MI	3514	2081	5394	1626	5991	1365	6289	1147	6539	805	7453	494	4971
10-#10	1.96	MA	7369	2081	10490	1751	12223	1475	13174	1247	14124	892	17131	619	10782
4L-3S		MI	3590	2081	5601	1619	6282	1352	6645	1145	7026	806	8006	539	4962
10-#10	1.96	MA	7093	2081	10004	1771	11642	1487	12451	1258	13116	910	15756	580	10424
5L-2S		MI	3730	2081	5895	1613	6656	1347	7100	1134	7642	799	8780	630	4946
10-#11	2.41	MA	7809	2164	11622	1783	13678	1487	14924	1247	16485	876	20173	637	13142
3L-4S		MI	3582	2164	5622	1661	6233	1388	6561	1157	6914	797	7792	412	5901
10-#11	2.41	MA	7602	2164	11046	1798	12864	1511	13925	1270	15116	887	18523	576	13001
4L-3S		MI	3672	2164	5871	1654	6581	1374	6988	1156	7475	791	8434	464	5904
10-#11	2.41	MA	7275	2164	10460	1824	12158	1525	13045	1282	13889	907	16846	525	12293
5L-2S		MI	3834	2164	6221	1647	7027	1370	7530	1144	8209	784	9326	577	5888
10-#14	3.47	MA	8190	2361	12302	1927	14391	1611	15755	1335	17570	883	22006	482	17964
4L-3S		MI	3896	2361	6476	1766	7321	1453	7872	1205	8639	768	9738	323	8134
10-#14	3.47	MA	7731	2361	11462	1963	13378	1630	14495	1352	15814	911	19599	406	16665
5L-2S		MI	4113	2361	6970	1758	7950	1449	8636	1191	9667	761	10963	485	8143
10-#18	6.17	MA	9631	2860	15390	2256	18163	1863	20290	1500	23659	872	30634	240	28907
4L-3S		MI	4427	2860	7909	2054	9086	1655	9988	1333	11266	684	12646	-81	12571
10-#18	6.17	MA	8858	2860	13916	2318	16386	1895	18078	1528	20579	919	26399	96	25934
5L-2S		MI	4735	2860	8747	2045	10153	1654	11284	1313	12961	670	14614	207	13467
12-#10	2.35	MA	7880	2154	11665	1783	13786	1488	15081	1249	16720	879	20514	663	12972
3L-5S		MI	3560	2154	5475	1686	6109	1402	6425	1178	6713	807	7683	421	5706
12-#10	2.35	MA	7713	2154	11192	1796	13117	1508	14259	1268	15593	888	19165	613	12884
4E		MI	3643	2154	5688	1671	6365	1397	6743	1168	7155	801	8226	476	5858
12-#10	2.35	MA	7439	2154	10706	1817	12536	1520	13536	1279	14585	906	17790	574	12496
5L-3S		MI	3716	2154	5895	1665	6656	1385	7100	1165	7642	802	8780	521	5859
12-#10	2.35	MA	7198	2154	10237	1823	11984	1531	12827	1298	13625	923	16449	506	11973
6L-2S		MI	3853	2154	6189	1658	7031	1380	7555	1154	8257	795	9553	612	5848
12-#11	2.89	MA	8012	2253	11898	1854	13948	1552	15242	1295	16898	881	20991	568	15547
4E		MI	3733	2253	5972	1716	6679	1429	7103	1182	7647	792	8684	385	6909
12-#11	2.89	MA	7687	2253	11312	1880	13242	1565	14362	1308	15671	902	19313	518	14812
5L-3S		MI	3819	2253	6221	1710	7027	1414	7530	1181	8209	785	9326	437	6968
12-#11	2.89	MA	7402	2253	10743	1887	12578	1579	13498	1330	14502	922	17677	432	14216
6L-2S		MI	3978	2253	6571	1703	7474	1410	8072	1169	8942	779	10218	550	6960
12-#14	4.17	MA	8308	2489	12679	2044	14927	1688	16376	1389	18360	904	23125	396	20295
5L-3S		MI	4108	2489	6970	1846	7950	1511	8636	1242	9667	760	10963	279	9612
12-#14	4.17	MA	7920	2489	11872	2054	13975	1707	15138	1421	16684	932	20775	271	18824
6L-2S		MI	4306	2489	7464	1838	8579	1507	9400	1227	10696	753	12188	441	9640
12-#18	7.41	MA	9833	3089	16039	2460	19088	1999	21361	1593	25022	906	32551	78	32174
5L-3S		MI	4758	3089	8747	2197	10153	1759	11284	1398	12961	660	14614	-178	14418
12-#18	7.41	MA	9212	3089	14652	2480	17417	2031	19188	1647	22083	953	28399	-146	27834
6L-2S		MI	5048	3089	9585	2188	11220	1758	12580	1378	14655	647	16581	110	15975

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis

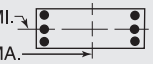


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#10	2.74	MA	8050	2226	11894	1841	14011	1541	15345	1288	17062	884	21200	607	14987
4L-5S		MI	3688	2226	5769	1731	6484	1435	6880	1199	7329	803	8457	404	6552
14-#10	2.74	MA	7778	2226	11408	1862	13430	1553	14622	1299	16054	901	19825	568	14573
5L-4S		MI	3770	2226	5982	1717	6740	1430	7198	1188	7770	796	9000	458	6741
14-#10	2.74	MA	7545	2226	10939	1868	12878	1564	13913	1319	15094	919	18483	501	14067
6L-3S		MI	3841	2226	6189	1710	7031	1418	7555	1186	8257	798	9553	503	6751
14-#10	2.74	MA	7348	2226	10495	1876	12253	1579	13228	1329	14113	928	17192	467	13468
7L-2S		MI	3975	2226	6483	1704	7405	1413	8009	1175	8873	791	10327	594	6746
14-#11	3.37	MA	8091	2342	12163	1935	14326	1606	15678	1333	17453	897	21781	510	17336
5L-4S		MI	3882	2342	6323	1772	7125	1469	7645	1207	8380	786	9575	358	7899
14-#11	3.37	MA	7817	2342	11594	1942	13662	1620	14814	1356	16284	917	20144	425	16762
6L-3S		MI	3965	2342	6571	1765	7474	1455	8072	1206	8942	780	10218	411	8024
14-#11	3.37	MA	7584	2342	11055	1952	12903	1638	13985	1368	15090	927	18562	384	15782
7L-2S		MI	4120	2342	6922	1759	7920	1451	8614	1195	9676	774	11109	523	8026
14-#14	4.86	MA	8502	2618	13089	2134	15524	1766	17019	1457	19231	925	24301	261	22427
6L-3S		MI	4307	2618	7464	1926	8579	1569	9400	1278	10696	752	12188	235	11086
14-#14	4.86	MA	8186	2618	12316	2148	14448	1792	15830	1475	17521	939	22025	199	20865
7L-2S		MI	4497	2618	7958	1918	9208	1565	10164	1263	11724	744	13414	397	11128
16-#10	3.14	MA	8111	2299	12110	1907	14324	1586	15708	1320	17524	897	21859	562	16654
5E		MI	3815	2299	6063	1777	6858	1468	7335	1220	7945	799	9231	386	7403
16-#10	3.14	MA	7886	2299	11641	1913	13772	1597	14998	1339	16563	915	20517	495	16164
6L-4S		MI	3897	2299	6276	1762	7114	1463	7653	1209	8386	792	9774	440	7621
16-#10	3.14	MA	7697	2299	11197	1922	13147	1612	14314	1350	15583	924	19226	462	15557
7L-3S		MI	3965	2299	6483	1755	7405	1450	8009	1206	8873	794	10327	485	7639
16-#10	3.14	MA	7463	2299	10772	1931	12572	1620	13583	1365	14647	941	17977	416	14903
8L-2S		MI	4097	2299	6777	1749	7780	1446	8464	1195	9489	787	11101	576	7640
16-#11	3.85	MA	8224	2431	12446	1998	14746	1660	16131	1381	18066	912	22612	418	19310
6L-4S		MI	4030	2431	6673	1828	7571	1509	8187	1233	9114	781	10467	332	8896
16-#11	3.85	MA	8001	2431	11906	2008	13987	1678	15301	1393	16872	922	21029	376	18315
7L-3S		MI	4110	2431	6922	1821	7920	1495	8614	1232	9676	775	11109	384	9076
16-#11	3.85	MA	7724	2431	11389	2019	13288	1687	14421	1412	15733	942	19504	319	17315
8L-2S		MI	4261	2431	7272	1814	8366	1491	9156	1220	10409	769	12001	496	9088
16-#14	5.56	MA	8774	2746	13533	2228	15997	1850	17712	1511	20067	931	25551	189	24451
7L-3S		MI	4504	2746	7958	2007	9208	1628	10164	1315	11724	743	13414	191	12558
16-#14	5.56	MA	8384	2746	12792	2244	14996	1863	16465	1538	18434	960	23360	103	22868
8L-2S		MI	4687	2746	8452	1999	9837	1624	10928	1300	12753	736	14639	353	12613
18-#10	3.53	MA	8222	2371	12343	1959	14665	1629	16084	1360	18032	910	22552	489	18262
6L-5S		MI	3940	2371	6357	1822	7233	1501	7790	1240	8560	795	10004	368	8256
18-#10	3.53	MA	8040	2371	11899	1967	14040	1644	15399	1370	17052	919	21260	456	17647
7L-4S		MI	4022	2371	6570	1807	7489	1496	8108	1229	9001	788	10548	422	8469
18-#10	3.53	MA	7808	2371	11474	1976	13465	1653	14668	1385	16116	937	20011	410	16996
8L-3S		MI	4088	2371	6777	1801	7780	1483	8464	1227	9489	789	11101	467	8524
18-#10	3.53	MA	7583	2371	10993	1995	12875	1670	13960	1393	15159	946	18785	367	16147
9L-2S		MI	4217	2371	7072	1794	8154	1479	8919	1216	10104	783	11875	558	8532
18-#11	4.33	MA	8411	2520	12758	2063	15071	1718	16618	1419	18654	917	23497	369	20847
7L-4S		MI	4177	2520	7023	1883	8017	1550	8728	1258	9847	776	11358	305	9899
18-#11	4.33	MA	8136	2520	12240	2074	14372	1728	15738	1437	17515	937	21971	311	19836
8L-3S		MI	4261	2520	7272	1877	8366	1536	9156	1257	10409	770	12001	357	10126
18-#11	4.33	MA	7871	2520	11660	2097	13653	1748	14876	1446	16349	947	20469	257	18848
9L-2S		MI	4398	2520	7623	1870	8812	1532	9697	1245	11142	764	12892	469	10146
18-#14	6.25	MA	8964	2875	14008	2324	16545	1921	18347	1575	20980	952	26886	92	26458
8L-3S		MI	4700	2875	8452	2087	9837	1686	10928	1351	12753	735	14639	147	14028
20-#10	3.92	MA	8377	2444	12601	2012	14934	1677	16485	1391	18521	915	23295	450	19736
7L-5S		MI	4065	2444	6651	1867	7607	1534	8245	1261	9176	791	10778	350	9111
20-#10	3.92	MA	8147	2444	12176	2022	14359	1685	15754	1406	17585	933	22045	405	19075
8L-4S		MI	4146	2444	6864	1853	7863	1529	8563	1250	9617	784	11321	404	9313
20-#10	3.92	MA	7929	2444	11695	2040	13769	1703	15046	1413	16628	941	20820	361	18232
9L-3S		MI	4210	2444	7072	1846	8154	1516	8919	1247	10104	785	11875	449	9407

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	3.92	MA	7720	2444	11253	2047	13213	1712	14339	1430	15684	957	19474	310	17414
10L-2S		MI	4337	2444	7366	1840	8529	1512	9374	1236	10720	778	12648	541	9419
20-#11	4.81	MA	8541	2609	13092	2130	15456	1768	17055	1463	19297	932	24439	304	22358
8L-4S		MI	4336	2609	7374	1939	8463	1590	9270	1283	10581	771	12250	278	10906
20-#11	4.81	MA	8285	2609	12511	2153	14737	1789	16193	1471	18131	942	22937	250	21361
9L-3S		MI	4402	2609	7623	1932	8812	1576	9697	1282	11142	765	12892	330	11175
22-#10	4.31	MA	8481	2516	12878	2067	15253	1718	16840	1426	19054	928	24080	399	21163
8L-5S		MI	4188	2516	6945	1913	7982	1567	8700	1281	9791	786	11552	332	9969
22-#10	4.31	MA	8270	2516	12397	2085	14663	1736	16131	1434	18098	937	22854	355	20317
9L-4S		MI	4270	2516	7158	1898	8238	1562	9018	1270	10233	779	12095	386	10160
22-#10	4.31	MA	8077	2516	11955	2092	14107	1745	15425	1451	17153	953	21509	304	19492
10L-3S		MI	4332	2516	7366	1891	8529	1549	9374	1268	10720	781	12648	431	10289
22-#11	5.30	MA	8692	2698	13363	2208	15822	1829	17510	1496	19913	937	25404	243	23874
9L-4S		MI	4479	2698	7724	1995	8910	1631	9812	1308	11314	766	13141	251	11916
24-#10	4.70	MA	8606	2589	13099	2131	15557	1769	17217	1454	19567	933	24888	349	22402
9L-5S		MI	4311	2589	7240	1958	8356	1600	9154	1302	10407	782	12326	314	10829
24-#10	4.70	MA	8420	2589	12657	2138	15001	1778	16510	1471	18622	949	23543	298	21571
10L-4S		MI	4393	2589	7453	1943	8612	1595	9473	1291	10848	775	12869	368	11010

RECTANGULAR TIED COLUMNS 20" x 20"

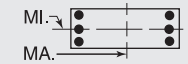
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.19	MA	2415	1196	3616	961	4082	809	4311	690	4508	511	5222	435	2184
2L-3S		MI	2306	1196	3401	966	3809	813	3979	698	4058	517	4622	378	2197
6-#9	1.50	MA	2486	1232	3791	980	4295	823	4565	698	4848	507	5653	426	2704
2L-3S		MI	2351	1232	3521	987	3952	828	4148	708	4283	514	4907	354	2718
6-#10	1.90	MA	2574	1278	4011	1006	4565	841	4888	708	5280	502	6194	412	3360
2L-3S		MI	2408	1278	3672	1013	4133	847	4363	721	4570	511	5265	321	3371
6-#11	2.34	MA	2650	1328	4241	1027	4829	855	5195	715	5686	493	6624	386	4015
2L-3S		MI	2457	1328	3835	1035	4312	861	4567	729	4836	503	5543	274	4020
6-#14	3.38	MA	2851	1446	4766	1094	5477	903	5973	743	6733	482	7854	342	5586
2L-3S		MI	2590	1446	4192	1105	4746	910	5085	762	5530	494	6356	180	5543
6-#18	6.00	MA	3306	1746	6024	1267	7041	1027	7854	818	9250	455	10661	208	9335
2L-3S		MI	2929	1746	5043	1282	5792	1035	6337	845	7202	468	8215	-80	8128
8-#8	1.58	MA	2510	1241	3831	989	4356	829	4644	703	4957	508	5822	428	2847
2L-4S		MI	2346	1241	3467	1000	3872	843	4054	714	4155	516	4799	341	2861
8-#9	2.00	MA	2603	1289	4061	1016	4639	849	4983	714	5413	504	6400	416	3531
2L-4S		MI	2402	1289	3603	1029	4031	865	4241	728	4405	512	5126	306	3526
8-#10	2.54	MA	2718	1351	4351	1051	4997	874	5413	729	5991	498	7124	399	4396
2L-4S		MI	2472	1351	3774	1067	4232	894	4480	746	4722	508	5536	260	4288
8-#11	3.12	MA	2819	1417	4647	1083	5346	895	5823	740	6536	488	7706	366	5251
2L-4S		MI	2533	1417	3955	1099	4428	918	4704	758	5015	496	5853	197	4941
8-#14	4.50	MA	3083	1575	5340	1174	6209	961	6862	780	7935	475	9352	308	7320
2L-4S		MI	2700	1575	4360	1196	4908	990	5277	802	5815	498	6781	68	6484
10-#10	3.17	MA	2861	1423	4690	1096	5429	906	5938	749	6701	494	8054	386	5426
2L-5S		MI	2522	1423	3871	1128	4371	933	4641	779	4928	512	5813	193	4969
10-#10	3.17	MA	2707	1423	4351	1104	4997	912	5413	762	5991	503	7124	295	5412
3L-4S		MI	2626	1423	4114	1112	4664	927	5004	766	5432	503	6465	247	5247
10-#11	3.90	MA	2808	1506	4647	1147	5346	942	5823	780	6536	492	7706	233	6449
3L-4S		MI	2713	1506	4361	1155	4945	958	5332	783	5865	491	6935	177	6089
10-#14	5.63	MA	3091	1703	5340	1265	6209	1027	6862	835	7935	479	9352	113	8950
3L-4S		MI	2952	1703	4935	1276	5640	1049	6165	839	7018	490	8279	34	8123

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.15	MA	2921	1312	4347	1060	4920	892	5201	762	5439	565	6330	485	2589
2E		MI	2639	1312	3971	1047	4459	882	4694	752	4885	558	5605	471	2335
4-#11	1.42	MA	2983	1345	4535	1071	5127	899	5437	764	5747	557	6676	468	3105
2E		MI	2691	1345	4137	1057	4639	888	4898	754	5150	550	5881	451	2792
4-#14	2.05	MA	3143	1424	4945	1113	5626	929	6033	781	6545	549	7655	444	4322
2E		MI	2828	1424	4496	1099	5075	917	5416	771	5843	540	6692	420	3867
4-#18	3.64	MA	3516	1624	5929	1224	6834	1008	7479	827	8486	529	9929	368	7250
2E		MI	3146	1624	5351	1208	6121	995	6667	816	7513	518	8547	327	6430
6-#8	1.08	MA	2907	1302	4282	1060	4860	894	5139	764	5364	570	6269	494	2440
2L-3S		MI	2518	1302	3699	1054	4135	888	4310	764	4374	569	4965	424	2215
6-#8	1.08	MA	2781	1302	4039	1066	4550	899	4763	773	4855	577	5571	437	2453
3L-2S		MI	2628	1302	3914	1049	4408	884	4643	755	4823	563	5564	481	2202
6-#9	1.36	MA	2989	1338	4481	1080	5102	907	5428	772	5751	566	6778	486	3028
2L-3S		MI	2563	1338	3820	1074	4278	902	4479	773	4599	566	5248	399	2741
6-#9	1.36	MA	2833	1338	4175	1087	4713	913	4956	783	5112	575	5907	414	3042
3L-2S		MI	2699	1338	4089	1068	4622	897	4897	763	5163	559	5995	471	2725
6-#10	1.73	MA	3091	1384	4732	1105	5409	925	5796	782	6244	561	7417	476	3772
2L-3S		MI	2620	1384	3971	1100	4459	921	4694	786	4885	563	5605	366	3399
6-#10	1.73	MA	2900	1384	4347	1114	4920	933	5201	796	5439	572	6330	385	3783
3L-2S		MI	2787	1384	4310	1093	4892	915	5219	773	5595	554	6535	458	3384
6-#11	2.13	MA	3182	1434	4997	1126	5715	940	6152	789	6714	552	7950	453	4521
2L-3S		MI	2669	1434	4137	1121	4639	934	4898	793	5150	554	5881	318	4056
6-#11	2.13	MA	2959	1434	4535	1136	5127	947	5437	805	5747	564	6676	341	4525
3L-2S		MI	2864	1434	4543	1113	5156	928	5526	779	5999	544	6962	431	4044
6-#14	3.07	MA	3418	1552	5600	1193	6460	987	7045	817	7915	541	9429	418	6315
2L-3S		MI	2802	1552	4496	1190	5075	983	5416	825	5843	544	6692	225	5595
6-#14	3.07	MA	3116	1552	4945	1206	5626	997	6033	839	6545	556	7655	256	6272
3L-2S		MI	3066	1552	5070	1179	5806	975	6304	807	7045	533	8190	386	5622
6-#18	5.45	MA	3962	1852	7052	1367	8265	1112	9216	892	10838	516	12860	308	10631
2L-3S		MI	3138	1852	5351	1366	6121	1106	6667	907	7513	518	8547	-37	8508
6-#18	5.45	MA	3492	1852	5929	1386	6834	1125	7479	925	8486	536	9929	21	9870
3L-2S		MI	3524	1852	6332	1351	7370	1098	8184	880	9561	504	10993	251	9386
8-#8	1.44	MA	3017	1347	4525	1089	5169	914	5515	777	5873	567	6967	489	3188
2L-4S		MI	2558	1347	3764	1087	4198	918	4385	780	4471	567	5141	386	2887
8-#8	1.44	MA	2893	1347	4282	1094	4860	919	5139	786	5364	574	6269	432	3198
3E		MI	2616	1347	3914	1082	4408	908	4643	776	4823	566	5564	417	2878
8-#8	1.44	MA	2828	1347	4114	1100	4623	929	4849	790	4967	577	5780	400	3202
4L-2S		MI	2723	1347	4129	1077	4682	904	4975	768	5273	560	6164	474	2867
8-#9	1.82	MA	3124	1395	4786	1115	5491	933	5901	788	6391	562	7648	480	3963
2L-4S		MI	2613	1395	3901	1116	4357	940	4573	793	4720	564	5467	351	3561
8-#9	1.82	MA	2974	1395	4481	1123	5102	939	5428	799	5751	571	6778	408	3971
3E		MI	2685	1395	4089	1110	4622	928	4897	789	5163	563	5995	390	3565
8-#9	1.82	MA	2893	1395	4270	1130	4805	952	5063	804	5252	574	6166	367	3958
4L-2S		MI	2816	1395	4359	1103	4965	923	5314	779	5728	555	6741	462	3555
8-#10	2.31	MA	3259	1457	5116	1150	5899	958	6391	803	7049	557	8504	467	4944
2L-4S		MI	2684	1457	4073	1153	4558	968	4811	810	5037	559	5876	305	4393
8-#10	2.31	MA	3074	1457	4732	1159	5409	966	5796	817	6244	568	7417	375	4942
3E		MI	2771	1457	4310	1146	4892	954	5219	806	5595	558	6535	353	4426
8-#10	2.31	MA	2976	1457	4465	1168	5034	981	5336	823	5614	570	6652	324	4894
4L-2S		MI	2932	1457	4650	1138	5324	948	5744	794	6306	549	7465	445	4422
8-#11	2.84	MA	3378	1523	5459	1182	6303	980	6866	814	7680	547	9223	439	5925
2L-4S		MI	2744	1523	4257	1185	4756	991	5035	822	5328	547	6191	242	5056
8-#11	2.84	MA	3164	1523	4997	1192	5715	988	6152	830	6714	559	7950	326	5910
3E		MI	2846	1523	4543	1177	5156	975	5526	818	5999	548	6962	298	5277
8-#11	2.84	MA	3049	1523	4675	1202	5263	1006	5597	836	5955	560	7048	266	5662
4L-2S		MI	3034	1523	4949	1169	5673	969	6154	804	6849	539	8044	410	5283
8-#14	4.09	MA	3688	1681	6254	1274	7293	1046	8057	854	9285	534	11202	393	8292
2L-4S		MI	2910	1681	4665	1281	5237	1063	5607	866	6128	548	7117	112	6620

RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis

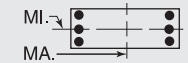
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	4.09	MA	3401	1681	5600	1287	6460	1056	7045	875	7915	549	9429	231	8218
3E		MI	3048	1681	5070	1270	5806	1041	6304	862	7045	537	8190	191	7303
8-#14	4.09	MA	3246	1681	5141	1300	5816	1080	6256	882	6836	549	8169	147	7446
4L-2S		MI	3301	1681	5645	1259	6537	1034	7193	843	8247	525	9688	353	7360
8-#18	7.27	MA	3995	2080	7052	1529	8265	1228	9216	990	10838	522	12860	-39	12782
3E		MI	3548	2080	6332	1509	7370	1210	8184	972	9561	504	10993	-113	10832
10-#10	2.89	MA	3423	1529	5501	1196	6389	991	6986	823	7855	553	9591	458	6111
2L-5S		MI	2734	1529	4170	1215	4698	1007	4972	844	5243	564	6153	238	5059
10-#10	2.89	MA	3245	1529	5116	1205	5899	999	6391	837	7049	563	8504	366	6097
3L-4S		MI	2837	1529	4413	1199	4991	1001	5336	831	5747	555	6806	292	5347
10-#10	2.89	MA	3153	1529	4850	1213	5524	1014	5931	843	6420	566	7739	315	5996
4L-3S		MI	2920	1529	4650	1191	5324	987	5744	827	6306	554	7465	340	5447
10-#10	2.89	MA	3029	1529	4577	1231	5195	1021	5522	857	5852	577	6976	262	5644
5L-2S		MI	3076	1529	4989	1183	5756	981	6269	814	7016	545	8394	432	5454
10-#11	3.55	MA	3365	1612	5459	1248	6303	1028	6866	856	7680	554	9223	311	7291
3L-4S		MI	2924	1612	4664	1241	5273	1032	5663	847	6178	542	7273	221	6201
10-#11	3.55	MA	3258	1612	5137	1257	5850	1046	6311	861	6921	555	8322	251	6973
4L-3S		MI	3020	1612	4949	1233	5673	1015	6154	844	6849	543	8044	278	6493
10-#11	3.55	MA	3115	1612	4807	1278	5453	1054	5818	877	6236	567	7428	186	6604
5L-2S		MI	3201	1612	5355	1224	6191	1009	6782	830	7699	534	9126	390	6514
10-#14	5.11	MA	3681	1809	6254	1367	7293	1114	8057	912	9285	541	11202	205	10165
3L-4S		MI	3162	1809	5239	1362	5968	1122	6496	902	7330	541	8615	79	8253
10-#14	5.11	MA	3538	1809	5796	1380	6649	1139	7268	918	8206	541	9942	121	9322
4L-3S		MI	3305	1809	5645	1351	6537	1099	7193	898	8247	529	9688	157	9008
12-#10	3.46	MA	3414	1602	5501	1250	6389	1031	6986	858	7855	559	9591	357	7250
3L-5S		MI	2885	1602	4509	1260	5130	1040	5497	864	5953	560	7083	225	6041
12-#10	3.46	MA	3327	1602	5234	1259	6014	1047	6526	864	7225	562	8826	306	7094
4E		MI	2988	1602	4752	1244	5423	1034	5861	852	6458	551	7736	279	6311
12-#10	3.46	MA	3203	1602	4962	1276	5685	1054	6117	878	6657	573	8064	253	6762
5L-3S		MI	3066	1602	4989	1236	5756	1020	6269	847	7016	550	8394	327	6464
12-#10	3.46	MA	3078	1602	4724	1284	5361	1070	5715	883	6114	583	7364	195	6427
6L-2S		MI	3217	1602	5329	1229	6188	1014	6794	835	7727	541	9324	419	6481
12-#11	4.25	MA	3463	1701	5599	1313	6438	1087	7025	886	7888	550	9596	236	8294
4E		MI	3102	1701	5070	1297	5790	1072	6291	873	7028	537	8355	201	7356
12-#11	4.25	MA	3321	1701	5269	1333	6041	1095	6532	902	7203	561	8702	171	7947
5L-3S		MI	3192	1701	5355	1288	6191	1056	6782	869	7699	538	9126	258	7705
12-#14	6.14	MA	3824	1938	6451	1460	7483	1197	8281	955	9576	534	11716	96	11210
4E		MI	3434	1938	5813	1442	6699	1180	7384	938	8532	533	10113	45	9899
14-#10	4.04	MA	3498	1674	5619	1304	6504	1080	7121	884	8030	557	9913	297	8200
4L-5S		MI	3034	1674	4849	1306	5562	1073	6022	885	6663	556	8013	212	7027
14-#10	4.04	MA	3375	1674	5346	1321	6175	1087	6712	898	7462	568	9151	244	7885
5L-4S		MI	3137	1674	5092	1289	5855	1067	6386	872	7168	546	8665	266	7281
14-#10	4.04	MA	3254	1674	5108	1329	5850	1103	6310	904	6919	579	8451	185	7535
6L-3S		MI	3210	1674	5329	1282	6188	1053	6794	868	7727	546	9324	314	7480
14-#11	4.96	MA	3523	1790	5730	1389	6629	1135	7246	928	8169	556	9976	156	9296
5L-4S		MI	3277	1790	5476	1352	6307	1112	6919	898	7878	532	9436	181	8519
16-#10	4.62	MA	3544	1747	5731	1367	6665	1120	7307	919	8268	564	10238	235	9011
5E		MI	3181	1747	5188	1351	5994	1106	6547	905	7374	551	8943	199	8016
16-#10	4.62	MA	3427	1747	5493	1374	6340	1136	6905	924	7725	575	9538	176	8647
6L-4S		MI	3284	1747	5431	1335	6287	1100	6911	893	7879	542	9595	253	8257

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis

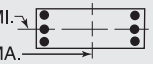


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.06	MA	3459	1418	5072	1159	5768	977	6104	836	6373	624	7472	543	2863
2E		MI	2852	1418	4270	1134	4786	956	5025	817	5200	609	5946	516	2354
4-#11	1.30	MA	3531	1451	5286	1170	6004	984	6373	838	6724	616	7886	529	3442
2E		MI	2904	1451	4439	1143	4967	961	5229	818	5463	600	6219	495	2816
4-#14	1.88	MA	3716	1530	5748	1212	6567	1014	7045	855	7624	608	9032	508	4808
2E		MI	3042	1530	4800	1184	5403	990	5747	834	6156	591	7028	464	3897
4-#18	3.33	MA	4147	1730	6864	1323	7938	1093	8686	901	9826	588	11727	446	8114
2E		MI	3360	1730	5660	1292	6451	1066	6998	878	7824	568	8879	371	6473
6-#9	1.25	MA	3536	1444	5221	1179	5970	992	6356	846	6720	625	7958	543	3352
2L-3S		MI	2775	1444	4118	1161	4605	977	4811	838	4914	618	5590	444	2762
6-#9	1.25	MA	3359	1444	4879	1187	5536	999	5829	851	6006	635	6970	472	3366
3L-2S		MI	2912	1444	4388	1155	4948	972	5228	828	5479	610	6336	516	2745
6-#10	1.59	MA	3653	1490	5502	1205	6315	1010	6769	856	7273	620	8717	537	4183
2L-3S		MI	2832	1490	4270	1187	4786	995	5025	850	5200	614	5946	411	3424
6-#10	1.59	MA	3435	1490	5072	1214	5768	1019	6104	871	6373	632	7472	446	4194
3L-2S		MI	3000	1490	4610	1180	5218	989	5550	838	5910	605	6875	503	3407
6-#11	1.95	MA	3759	1540	5803	1226	6663	1025	7174	863	7807	611	9353	518	5026
2L-3S		MI	2881	1540	4439	1207	4967	1008	5229	857	5463	604	6219	363	4089
6-#11	1.95	MA	3504	1540	5286	1237	6004	1034	6373	881	6724	625	7886	406	5030
3L-2S		MI	3077	1540	4845	1199	5484	1002	5857	843	6313	595	7300	475	4072
6-#14	2.81	MA	4030	1658	6483	1293	7503	1072	8182	891	9162	600	11084	490	7044
2L-3S		MI	3014	1658	4800	1275	5403	1055	5747	889	6156	595	7028	269	5644
6-#14	2.81	MA	3685	1658	5748	1308	6567	1084	7045	915	7624	618	9032	328	7001
3L-2S		MI	3280	1658	5375	1264	6134	1048	6635	870	7358	583	8526	431	5656
6-#18	5.00	MA	4666	1958	8130	1466	9550	1196	10644	966	12476	574	15149	400	11927
2L-3S		MI	3330	1958	5660	1450	6451	1178	6998	970	7824	567	8879	7	8860
6-#18	5.00	MA	4120	1958	6864	1489	7938	1214	8686	1004	9826	601	11727	112	11374
3L-2S		MI	3742	1958	6640	1435	7699	1170	8515	943	9872	554	11325	295	9436
8-#8	1.32	MA	3566	1453	5269	1188	6044	999	6452	851	6854	626	8147	544	3529
2L-4S		MI	2770	1453	4061	1175	4524	993	4716	845	4787	619	5483	432	2910
8-#8	1.32	MA	3427	1453	4998	1194	5699	1005	6032	855	6286	634	7361	488	3539
3E		MI	2828	1453	4211	1170	4734	983	4974	842	5139	618	5907	463	2898
8-#8	1.32	MA	3353	1453	4811	1201	5436	1015	5710	865	5845	637	6815	455	3543
4L-2S		MI	2936	1453	4426	1164	5008	979	5307	833	5589	612	6506	519	2886
8-#9	1.67	MA	3690	1501	5562	1215	6405	1018	6884	862	7434	621	8947	538	4395
2L-4S		MI	2825	1501	4200	1203	4684	1014	4904	858	5036	615	5809	396	3593
8-#9	1.67	MA	3518	1501	5221	1223	5970	1025	6356	868	6720	631	7958	467	4403
3E		MI	2897	1501	4388	1197	4948	1003	5228	854	5479	614	6336	435	3589
8-#9	1.67	MA	3428	1501	4986	1231	5640	1038	5951	880	6165	635	7269	425	4390
4L-2S		MI	3030	1501	4657	1191	5292	998	5645	844	6043	607	7083	507	3577
8-#10	2.12	MA	3843	1563	5932	1250	6863	1043	7434	877	8173	616	9962	531	5493
2L-4S		MI	2895	1563	4373	1240	4885	1042	5142	875	5352	611	6217	350	4436
8-#10	2.12	MA	3634	1563	5502	1260	6315	1051	6769	892	7273	628	8717	440	5491
3E		MI	2983	1563	4610	1233	5218	1028	5550	871	5910	610	6875	398	4456
8-#10	2.12	MA	3523	1563	5206	1269	5898	1068	6257	899	6572	632	7845	387	5443
4L-2S		MI	3146	1563	4949	1225	5651	1022	6075	858	6621	601	7805	490	4447
8-#11	2.60	MA	3983	1629	6321	1282	7322	1065	7974	888	8890	606	10820	507	6599
2L-4S		MI	2955	1629	4560	1271	5083	1064	5366	886	5642	598	6529	286	5168
8-#11	2.60	MA	3738	1629	5803	1293	6663	1074	7174	906	7807	620	9353	395	6584
3E		MI	3059	1629	4845	1263	5484	1048	5857	882	6313	599	7300	343	5315
8-#11	2.60	MA	3608	1629	5445	1304	6158	1093	6555	913	6961	623	8321	332	6401
4L-2S		MI	3248	1629	5251	1255	6001	1042	6485	868	7163	590	8382	455	5314
8-#14	3.75	MA	4339	1787	7218	1373	8439	1131	9318	928	10700	593	13135	471	9264
2L-4S		MI	3120	1787	4969	1367	5565	1136	5938	929	6441	598	7453	156	6751
8-#14	3.75	MA	4011	1787	6483	1388	7503	1143	8182	952	9162	611	11084	309	9190
3E		MI	3261	1787	5375	1356	6134	1114	6635	925	7358	587	8526	235	7356
8-#14	3.75	MA	3836	1787	5972	1403	6784	1169	7301	961	7957	614	9636	220	8429
4L-2S		MI	3515	1787	5949	1345	6865	1106	7523	907	8560	576	10024	397	7399

RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

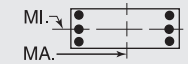
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	6.67	MA	4700	2186	8130	1632	9550	1317	10644	1069	12476	587	15149	66	14916
3E		MI	3758	2186	6640	1593	7699	1281	8515	1035	9872	553	11325	-69	11230
8-#18	6.67	MA	4390	2186	7243	1655	8304	1361	9117	1080	10388	587	12717	-83	12599
4L-2S		MI	4117	2186	7621	1578	8948	1274	10031	1008	11920	540	13771	219	12378
10-#10	2.65	MA	4031	1636	6362	1295	7410	1076	8099	897	9073	611	11208	525	6797
2L-5S		MI	2945	1636	4469	1302	5025	1081	5304	908	5558	615	6494	284	5145
10-#10	2.65	MA	3828	1636	5932	1305	6863	1084	7434	913	8173	624	9962	434	6783
3L-4S		MI	3049	1636	4712	1286	5317	1075	5667	896	6062	606	7146	337	5444
10-#10	2.65	MA	3724	1636	5636	1315	6445	1101	6922	919	7473	628	9090	381	6723
4L-3S		MI	3132	1636	4949	1278	5651	1061	6075	891	6621	606	7805	385	5480
10-#10	2.65	MA	3579	1636	5333	1333	6081	1109	6469	935	6842	640	8217	328	6328
5L-2S		MI	3290	1636	5289	1270	6083	1055	6600	879	7331	597	8735	477	5481
10-#11	3.25	MA	3967	1718	6321	1348	7322	1115	7974	931	8890	614	10820	384	8134
3L-4S		MI	3136	1718	4966	1327	5600	1105	5994	911	6492	593	7611	266	6309
10-#11	3.25	MA	3846	1718	5962	1359	6817	1134	7356	938	8044	618	9788	321	7875
4L-3S		MI	3233	1718	5251	1319	6001	1089	6485	908	7163	594	8382	323	6534
10-#11	3.25	MA	3678	1718	5596	1381	6376	1143	6807	956	7281	631	8759	257	7419
5L-2S		MI	3416	1718	5657	1310	6518	1083	7113	894	8013	585	9464	435	6548
10-#14	4.69	MA	4329	1915	7218	1468	8439	1201	9318	988	10700	603	13135	290	11380
3L-4S		MI	3373	1915	5543	1447	6296	1194	6826	965	7643	591	8951	123	8379
10-#14	4.69	MA	4169	1915	6707	1483	7720	1228	8438	997	9495	606	11688	201	10543
4L-3S		MI	3503	1915	5949	1436	6865	1172	7523	962	8560	580	10024	202	9064
10-#14	4.69	MA	3936	1915	6184	1513	7090	1240	7655	1021	8407	624	10248	107	9829
5L-2S		MI	3745	1915	6523	1425	7597	1165	8412	943	9762	568	11522	363	9129
12-#10	3.17	MA	4019	1708	6362	1350	7410	1117	8099	933	9073	619	11208	428	8073
3L-5S		MI	3097	1708	4809	1347	5457	1114	5829	929	6268	611	7424	271	6125
12-#10	3.17	MA	3922	1708	6066	1360	6993	1134	7587	940	8373	623	10336	375	7993
4E		MI	3200	1708	5052	1331	5750	1108	6192	916	6773	602	8076	324	6405
12-#10	3.17	MA	3777	1708	5763	1378	6628	1142	7134	955	7742	636	9462	322	7581
5L-3S		MI	3279	1708	5289	1323	6083	1094	6600	912	7331	601	8735	372	6499
12-#10	3.17	MA	3635	1708	5492	1385	6268	1159	6687	962	7139	648	8664	261	7264
6L-2S		MI	3433	1708	5628	1316	6515	1088	7125	899	8042	592	9665	464	6511
12-#11	3.90	MA	4080	1807	6480	1415	7476	1174	8156	963	9127	613	11255	311	9359
4E		MI	3313	1807	5372	1383	6118	1145	6622	937	7342	588	8693	246	7461
12-#11	3.90	MA	3912	1807	6113	1436	7034	1183	7607	981	8364	626	10226	246	8928
5L-3S		MI	3406	1807	5657	1374	6518	1129	7113	933	8013	589	9464	302	7749
12-#11	3.90	MA	3746	1807	5792	1446	6598	1203	7067	988	7634	640	9283	173	8387
6L-2S		MI	3583	1807	6063	1366	7035	1123	7741	919	8863	580	10546	415	7775
12-#14	5.63	MA	4495	2044	7442	1563	8656	1286	9574	1034	11033	599	13739	183	12669
4E		MI	3620	2044	6118	1527	7028	1253	7715	1002	8845	584	10449	89	10021
12-#14	5.63	MA	4264	2044	6919	1593	8026	1298	8791	1057	9945	617	12300	88	11936
5L-3S		MI	3755	2044	6523	1516	7597	1230	8412	998	9762	572	11522	168	10771
14-#10	3.70	MA	4116	1781	6496	1405	7541	1167	8252	960	9273	619	11581	369	9231
4L-5S		MI	3247	1781	5148	1393	5889	1147	6354	949	6978	607	8353	257	7109
14-#10	3.70	MA	3972	1781	6193	1423	7176	1175	7799	976	8642	632	10707	316	8838
5L-4S		MI	3349	1781	5391	1376	6182	1141	6717	937	7483	598	9006	311	7373
14-#10	3.70	MA	3835	1781	5922	1431	6816	1192	7353	983	8039	644	9909	256	8508
6L-3S		MI	3424	1781	5628	1369	6515	1127	7125	933	8042	597	9665	359	7517
14-#11	4.55	MA	4143	1896	6630	1492	7693	1224	8407	1006	9447	621	11693	235	10443
5L-4S		MI	3489	1896	5778	1438	6635	1186	7250	962	8192	583	9774	226	8621
14-#11	4.55	MA	3982	1896	6310	1501	7257	1243	7867	1013	8717	635	10750	163	9886
6L-3S		MI	3576	1896	6063	1430	7035	1169	7741	958	8863	584	10546	282	8962

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

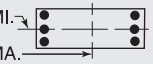
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	6.56	MA	4585	2172	7654	1674	8961	1356	9928	1094	11484	609	14351	70	14051
5L-4S		MI	3889	2172	6692	1607	7759	1311	8603	1038	10047	576	11947	56	11674
16-#10	4.23	MA	4164	1853	6623	1469	7723	1208	8464	996	9542	627	11953	311	10100
5E		MI	3394	1853	5487	1438	6321	1180	6879	970	7689	603	9283	244	8097
16-#10	4.23	MA	4032	1853	6352	1476	7363	1225	8018	1003	8939	640	11154	250	9756
6L-4S		MI	3496	1853	5730	1422	6614	1174	7242	957	8194	594	9936	298	8347
16-#11	5.20	MA	4215	1986	6827	1557	7916	1284	8667	1039	9800	629	12217	152	11389
6L-4S		MI	3662	1986	6184	1494	7152	1226	7878	987	9042	578	10856	205	9788
18-#10	4.76	MA	4226	1926	6782	1521	7911	1258	8683	1024	9839	635	12400	244	11007
6L-5S		MI	3540	1926	5827	1483	6754	1213	7403	991	8399	599	10213	231	9088

RECTANGULAR TIED COLUMNS 20" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.20	MA	4122	1557	6086	1270	6942	1069	7375	912	7767	675	9170	587	3778
2E		MI	3117	1557	4741	1229	5295	1034	5560	882	5777	651	6557	540	2840
4-#14	1.73	MA	4332	1636	6601	1312	7570	1099	8124	929	8769	666	10487	571	5294
2E		MI	3255	1636	5104	1269	5731	1062	6078	897	6468	641	7364	509	3926
4-#18	3.08	MA	4824	1836	7849	1423	9102	1178	9958	975	11232	647	13607	520	8978
2E		MI	3574	1836	5968	1376	6780	1138	7328	940	8134	618	9211	414	6514
6-#9	1.15	MA	4125	1550	6010	1279	6900	1077	7350	920	7754	683	9169	595	3676
2L-3S		MI	2987	1550	4416	1249	4931	1051	5142	903	5229	669	5931	490	2782
6-#9	1.15	MA	3927	1550	5633	1287	6420	1084	6767	926	6966	694	8077	525	3690
3L-2S		MI	3125	1550	4686	1242	5274	1046	5559	893	5794	662	6678	562	2764
6-#10	1.47	MA	4258	1597	6322	1304	7282	1095	7808	930	8368	679	10014	589	4595
2L-3S		MI	3044	1597	4570	1274	5113	1069	5357	915	5515	666	6286	457	3449
6-#10	1.47	MA	4013	1597	5846	1314	6677	1104	7072	938	7373	692	8636	500	4606
3L-2S		MI	3214	1597	4909	1267	5545	1063	5882	902	6225	656	7216	548	3429
6-#11	1.80	MA	4379	1646	6659	1325	7672	1109	8261	937	8966	670	10831	580	5532
2L-3S		MI	3093	1646	4741	1293	5295	1081	5560	921	5777	655	6557	408	4120
6-#11	1.80	MA	4092	1646	6086	1337	6942	1120	7375	956	7767	685	9170	468	5536
3L-2S		MI	3291	1646	5147	1285	5812	1075	6188	907	6627	646	7638	520	4099
6-#14	2.60	MA	4687	1764	7416	1392	8608	1157	9384	965	10475	659	12818	558	7773
2L-3S		MI	3226	1764	5104	1361	5731	1128	6078	952	6468	645	7364	313	5689
6-#14	2.60	MA	4297	1764	6601	1409	7570	1171	8124	991	8769	680	10487	396	7730
3L-2S		MI	3494	1764	5679	1350	6463	1121	6966	934	7670	634	8862	475	5690
6-#18	4.62	MA	5408	2064	9258	1566	10896	1281	12137	1040	14181	633	17522	484	13223
2L-3S		MI	3541	2064	5968	1534	6780	1249	7328	1032	8134	617	9211	51	9073
6-#18	4.62	MA	4792	2064	7849	1592	9102	1302	9958	1082	11232	664	13607	197	12924
3L-2S		MI	3959	2064	6949	1519	8029	1241	8845	1005	10182	604	11657	338	9484
8-#8	1.22	MA	4159	1559	6062	1288	6980	1084	7454	925	7900	685	9375	595	3870
2L-4S		MI	2982	1559	4358	1263	4850	1067	5048	910	5102	671	5826	477	2931
8-#8	1.22	MA	4003	1559	5763	1294	6598	1090	6991	930	7274	694	8507	541	3880
3E		MI	3040	1559	4508	1257	5061	1058	5306	907	5455	670	6249	508	2918
8-#8	1.22	MA	3921	1559	5558	1301	6310	1101	6637	940	6788	697	7912	509	3884
4L-2S		MI	3149	1559	4723	1252	5334	1054	5638	898	5905	664	6849	565	2905
8-#9	1.54	MA	4298	1607	6387	1314	7379	1103	7933	936	8543	680	10261	590	4827
2L-4S		MI	3037	1607	4498	1291	5010	1089	5235	923	5351	667	6150	442	3621
8-#9	1.54	MA	4106	1607	6010	1323	6900	1110	7350	942	7754	691	9169	521	4835
3E		MI	3109	1607	4686	1284	5274	1077	5559	919	5794	666	6678	480	3612
8-#9	1.54	MA	4006	1607	5752	1331	6536	1124	6904	955	7143	695	8417	480	4822
4L-2S		MI	3243	1607	4955	1278	5618	1072	5977	909	6359	659	7424	552	3599
8-#10	1.95	MA	4472	1669	6797	1349	7887	1128	8543	951	9363	674	11392	583	6042
2L-4S		MI	3107	1669	4672	1327	5212	1116	5473	940	5667	662	6557	395	4474
8-#10	1.95	MA	4236	1669	6322	1360	7282	1137	7808	959	8368	688	10014	494	6040
3E		MI	3196	1669	4909	1320	5545	1102	5882	936	6225	661	7216	444	4484
8-#10	1.95	MA	4113	1669	5996	1370	6823	1155	7244	975	7596	693	9061	442	5992
4L-2S		MI	3360	1669	5248	1312	5977	1096	6407	923	6936	652	8146	535	4472

RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

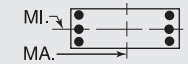
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	2.40	MA	4631	1735	7232	1381	8401	1150	9147	962	10166	665	12492	573	7273
2L-4S		MI	3166	1735	4862	1357	5411	1138	5697	950	5955	649	6867	331	5275
8-#11	2.40	MA	4356	1735	6659	1393	7672	1160	8261	981	8966	680	10831	461	7258
3E		MI	3271	1735	5147	1349	5812	1121	6188	946	6627	650	7638	388	5352
8-#11	2.40	MA	4211	1735	6264	1405	7115	1181	7579	990	8033	685	9668	395	7156
4L-2S		MI	3462	1735	5553	1341	6329	1115	6816	932	7477	641	8720	500	5344
8-#14	3.46	MA	5035	1893	8232	1472	9645	1215	10645	1002	12181	652	15150	544	10236
2L-4S		MI	3331	1893	5273	1452	5893	1209	6269	992	6753	649	7789	201	6878
8-#14	3.46	MA	4664	1893	7416	1489	8608	1229	9384	1028	10475	672	12818	382	10162
3E		MI	3473	1893	5679	1441	6463	1186	6966	989	7670	638	8862	279	7405
8-#14	3.46	MA	4469	1893	6853	1505	7814	1258	8412	1039	9144	678	11182	290	9432
4L-2S		MI	3730	1893	6253	1430	7194	1179	7854	970	8873	626	10360	441	7436
8-#18	6.15	MA	5406	2293	9258	1734	10896	1406	12137	1146	14181	651	17522	161	16899
3E		MI	3970	2293	6949	1677	8029	1353	8845	1097	10182	603	11657	-25	11623
8-#18	6.15	MA	5100	2293	8277	1760	9517	1453	10447	1162	11868	656	14757	5	14729
4L-2S		MI	4335	2293	7929	1662	9278	1345	10362	1070	12230	590	14103	262	12430
10-#10	2.44	MA	4683	1742	7273	1395	8493	1161	9278	971	10358	670	12769	577	7483
2L-5S		MI	3157	1742	4768	1389	5352	1155	5635	973	5872	667	6834	329	5227
10-#10	2.44	MA	4455	1742	6797	1405	7887	1170	8543	979	9363	684	11392	489	7469
3L-4S		MI	3261	1742	5011	1373	5644	1149	5998	960	6377	658	7487	382	5487
10-#10	2.44	MA	4339	1742	6471	1415	7428	1188	7979	995	8591	689	10439	436	7408
4L-3S		MI	3345	1742	5248	1365	5977	1135	6407	956	6936	657	8146	431	5511
10-#10	2.44	MA	4172	1742	6139	1434	7027	1197	7481	1003	7897	702	9480	387	7022
5L-2S		MI	3505	1742	5588	1357	6410	1129	6932	943	7646	648	9075	522	5508
10-#11	3.00	MA	4614	1824	7232	1449	8401	1200	9147	1006	10166	675	12492	454	8976
3L-4S		MI	3347	1824	5268	1413	5928	1178	6325	975	6805	644	7949	311	6413
10-#11	3.00	MA	4479	1824	6837	1461	7845	1221	8466	1015	9232	680	11329	388	8794
4L-3S		MI	3446	1824	5553	1405	6329	1162	6816	972	7477	645	8720	367	6574
10-#11	3.00	MA	4284	1824	6434	1483	7359	1231	7861	1034	8392	695	10165	324	8244
5L-2S		MI	3631	1824	5960	1396	6846	1156	7444	958	8327	636	9802	480	6580
10-#14	4.33	MA	5023	2021	8232	1569	9645	1287	10645	1064	12181	665	15150	369	12595
3L-4S		MI	3583	2021	5848	1532	6625	1267	7157	1029	7955	642	9287	167	8502
10-#14	4.33	MA	4844	2021	7668	1586	8852	1316	9672	1075	10850	670	13513	277	11785
4L-3S		MI	3716	2021	6253	1521	7194	1245	7854	1025	8873	630	10360	246	9117
10-#14	4.33	MA	4575	2021	7092	1617	8158	1330	8810	1101	9651	691	11877	184	11086
5L-2S		MI	3963	2021	6828	1510	7925	1238	8743	1007	10075	619	11858	408	9170
10-#18	7.69	MA	5734	2521	9686	1903	11311	1557	12626	1227	14817	643	18672	-30	18586
4L-3S		MI	4370	2521	7929	1819	9278	1457	10362	1162	12230	589	14103	-102	13936
12-#10	2.93	MA	4669	1814	7273	1450	8493	1203	9278	1000	10358	680	12769	483	8896
3L-5S		MI	3309	1814	5108	1434	5784	1188	6160	994	6583	663	7764	316	6205
12-#10	2.93	MA	4560	1814	6947	1461	8033	1220	8714	1016	9586	685	11816	430	8826
4E		MI	3412	1814	5351	1418	6076	1182	6523	981	7088	654	8417	369	6496
12-#10	2.93	MA	4394	1814	6614	1480	7632	1230	8216	1024	8892	698	10858	381	8409
5L-3S		MI	3493	1814	5588	1410	6410	1168	6932	977	7646	653	9075	418	6533
12-#10	2.93	MA	4236	1814	6309	1486	7237	1247	7726	1040	8229	712	9987	321	8120
6L-2S		MI	3648	1814	5927	1403	6842	1162	7457	964	8356	644	10005	509	6539
12-#11	3.60	MA	4741	1913	7410	1516	8575	1261	9352	1040	10432	675	12990	381	10443
4E		MI	3525	1913	5674	1469	6445	1219	6953	1000	7655	639	9031	290	7562
12-#11	3.60	MA	4548	1913	7007	1539	8089	1272	8748	1059	9591	690	11825	317	9920
5L-3S		MI	3619	1913	5960	1460	6846	1202	7444	997	8327	640	9802	347	7791
12-#11	3.60	MA	4362	1913	6645	1547	7610	1292	8153	1067	8788	705	10761	242	9385
6L-2S		MI	3798	1913	6366	1452	7363	1196	8072	983	9176	631	10883	459	7810
12-#14	5.19	MA	5210	2150	8483	1666	9890	1374	10933	1111	12556	663	15844	263	14150
4E		MI	3831	2150	6422	1612	7356	1325	8046	1065	9158	634	10785	134	10140

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis

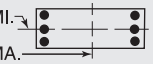


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	5.19	MA	4943	2150	7907	1697	9196	1388	10070	1137	11357	683	14208	170	13439
5L-3S		MI	3969	2150	6828	1602	7925	1303	8743	1062	10075	623	11858	212	10825
14-#10	3.42	MA	4778	1887	7422	1506	8639	1253	9450	1036	10581	680	13194	424	10244
4L-5S		MI	3459	1887	5447	1480	6216	1221	6685	1014	7293	658	8694	303	7188
14-#10	3.42	MA	4613	1887	7089	1525	8238	1262	8951	1044	9887	694	12236	375	9802
5L-4S		MI	3562	1887	5690	1463	6509	1215	7048	1001	7798	649	9346	356	7462
14-#10	3.42	MA	4460	1887	6785	1532	7843	1280	8461	1060	9224	708	11365	315	9500
6L-3S		MI	3638	1887	5927	1456	6842	1201	7457	997	8356	649	10005	405	7552
14-#10	3.42	MA	4330	1887	6480	1538	7454	1288	7990	1068	8548	713	10381	262	9000
7L-2S		MI	3789	1887	6267	1448	7274	1195	7981	985	9067	640	10935	496	7566
14-#11	4.20	MA	4807	2003	7580	1594	8819	1312	9634	1084	10791	685	13486	310	11601
5L-4S		MI	3701	2003	6080	1524	6962	1259	7581	1026	8505	634	10112	270	8720
14-#11	4.20	MA	4628	2003	7218	1603	8339	1333	9040	1092	9987	700	12422	235	11052
6L-3S		MI	3790	2003	6366	1516	7363	1243	8072	1022	9176	635	10883	327	9006
14-#14	6.06	MA	5304	2278	8722	1777	10234	1446	11331	1174	13063	676	16540	157	15800
5L-4S		MI	4101	2278	6996	1693	8087	1384	8934	1102	10360	627	12283	100	11788
16-#10	3.91	MA	4828	1959	7565	1570	8843	1295	9686	1065	10882	690	13613	369	11198
5E		MI	3607	1959	5787	1525	6648	1254	7210	1035	8004	654	9624	290	8174
16-#10	3.91	MA	4681	1959	7260	1577	8448	1313	9196	1081	10219	703	12742	309	10885
6L-4S		MI	3709	1959	6030	1509	6941	1248	7573	1022	8508	645	10276	343	8434
16-#10	3.91	MA	4556	1959	6956	1583	8060	1321	8725	1089	9543	708	11759	256	10399
7L-3S		MI	3782	1959	6267	1501	7274	1234	7981	1018	9067	645	10935	392	8569
16-#11	4.80	MA	4889	2092	7791	1659	9069	1373	9926	1118	11187	695	14083	228	12723
6L-4S		MI	3874	2092	6486	1580	7479	1300	8209	1051	9355	628	11194	250	9885
18-#10	4.40	MA	4897	2032	7735	1622	9053	1346	9931	1101	11214	699	14120	303	12273
6L-5S		MI	3753	2032	6126	1570	7080	1287	7735	1055	8714	650	10553	277	9164
18-#10	4.40	MA	4778	2032	7431	1629	8665	1353	9460	1109	10538	704	13136	250	11800
7L-4S		MI	3855	2032	6369	1554	7373	1281	8098	1043	9219	641	11206	330	9410
20-#10	4.88	MA	4996	2104	7906	1674	9270	1386	10195	1130	11533	700	14514	244	13204
7L-5S		MI	3898	2104	6466	1616	7513	1320	8260	1076	9425	646	11483	264	10156
RECTANGULAR TIED COLUMNS 20" x 28"															
4-#11	1.11	MA	4756	1663	6936	1369	7941	1154	8442	986	8875	734	10464	639	4115
2E		MI	3330	1663	5043	1315	5623	1108	5891	946	6090	702	6895	585	2862
4-#14	1.61	MA	4992	1742	7504	1411	8633	1184	9267	1003	9979	725	11985	629	5780
2E		MI	3468	1742	5409	1355	6060	1135	6409	961	6781	692	7700	553	3955
4-#18	2.86	MA	5545	1942	8883	1522	10328	1262	11296	1049	12702	705	15567	590	9842
2E		MI	3788	1942	6276	1460	7109	1209	7658	1003	8445	667	9544	458	6555
6-#9	1.07	MA	4758	1656	6849	1378	7890	1162	8409	994	8854	742	10454	646	4000
2L-3S		MI	3199	1656	4714	1336	5257	1126	5474	968	5545	721	6273	535	2801
6-#9	1.07	MA	4538	1656	6436	1387	7365	1170	7771	1001	7991	754	9258	579	4014
3L-2S		MI	3338	1656	4984	1330	5601	1121	5891	958	6109	714	7019	607	2783
6-#10	1.36	MA	4906	1703	7191	1403	8310	1180	8912	1004	9528	738	11382	641	5006
2L-3S		MI	3256	1703	4869	1361	5440	1143	5688	980	5830	717	6627	502	3472
6-#10	1.36	MA	4635	1703	6671	1414	7647	1190	8106	1013	8438	752	9873	554	5017
3L-2S		MI	3427	1703	5208	1354	5872	1137	6213	967	6540	708	7556	593	3451
6-#11	1.67	MA	5043	1752	7564	1425	8741	1194	9414	1011	10191	729	12286	632	6037
2L-3S		MI	3305	1752	5043	1379	5623	1154	5891	985	6090	706	6895	452	4150
6-#11	1.67	MA	4724	1752	6936	1438	7941	1205	8442	1021	8875	746	10464	522	6041
3L-2S		MI	3504	1752	5450	1371	6140	1148	6519	971	6940	697	7976	565	4126
6-#14	2.41	MA	5388	1871	8399	1492	9773	1242	10652	1039	11854	718	14580	618	8502
2L-3S		MI	3437	1871	5409	1446	6060	1201	6409	1016	6781	696	7700	357	5732
6-#14	2.41	MA	4954	1871	7504	1509	8633	1257	9267	1052	9979	740	11985	458	8459
3L-2S		MI	3708	1871	5983	1435	6791	1194	7297	997	7983	684	9198	519	5722

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



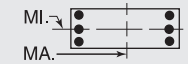
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	4.29	MA	6198	2170	10435	1665	12304	1366	13696	1114	15950	692	19979	564	14519
2L-3S		MI	3752	2170	6276	1618	7109	1321	7658	1095	8445	667	9544	94	9281
6-#18	4.29	MA	5509	2170	8883	1693	10328	1390	11296	1159	12702	728	15567	276	14220
3L-2S		MI	4176	2170	7257	1603	8358	1313	9175	1068	10493	653	11990	382	9532
8-#8	1.13	MA	4795	1666	6905	1387	7977	1169	8522	999	9012	744	10677	647	4212
2L-4S		MI	3194	1666	4656	1350	5176	1142	5379	975	5418	723	6168	523	2952
8-#8	1.13	MA	4622	1666	6578	1394	7559	1175	8015	1004	8327	753	9727	594	4222
3E		MI	3253	1666	4805	1345	5387	1133	5637	972	5771	722	6591	554	2937
8-#8	1.13	MA	4532	1666	6355	1401	7245	1187	7629	1015	7797	757	9083	562	4226
4L-2S		MI	3362	1666	5020	1340	5660	1128	5969	964	6221	716	7191	610	2924
8-#9	1.43	MA	4951	1714	7261	1414	8415	1188	9047	1010	9718	739	11649	642	5259
2L-4S		MI	3249	1714	4796	1378	5337	1163	5567	988	5666	719	6491	487	3647
8-#9	1.43	MA	4737	1714	6849	1423	7890	1196	8409	1017	8854	751	10454	574	5267
3E		MI	3322	1714	4984	1372	5601	1151	5891	984	6109	718	7019	526	3634
8-#9	1.43	MA	4626	1714	6568	1431	7493	1210	7922	1030	8187	756	9639	534	5254
4L-2S		MI	3457	1714	5254	1365	5944	1146	6308	974	6674	710	7765	598	3620
8-#10	1.81	MA	5144	1775	7712	1449	8973	1213	9717	1025	10618	733	12891	635	6590
2L-4S		MI	3319	1775	4971	1414	5539	1191	5805	1004	5982	714	6898	440	4509
8-#10	1.81	MA	4882	1775	7191	1460	8310	1223	8912	1033	9528	748	11382	548	6588
3E		MI	3408	1775	5208	1407	5872	1176	6213	1000	6540	713	7556	489	4510
8-#10	1.81	MA	4746	1775	6836	1471	7809	1241	8296	1050	8685	754	10349	497	6540
4L-2S		MI	3574	1775	5548	1399	6304	1170	6738	988	7251	704	8486	580	4496
8-#11	2.23	MA	5324	1841	8193	1480	9542	1235	10387	1036	11507	724	14109	624	7947
2L-4S		MI	3378	1841	5164	1443	5739	1211	6028	1014	6269	700	7205	375	5363
8-#11	2.23	MA	5017	1841	7564	1493	8741	1246	9414	1046	10191	740	12286	515	7932
3E		MI	3483	1841	5450	1435	6140	1195	6519	1010	6940	701	7976	432	5386
8-#11	2.23	MA	4857	1841	7133	1506	8134	1267	8669	1066	9170	747	11026	451	7836
4L-2S		MI	3676	1841	5856	1427	6657	1189	7147	996	7790	692	9058	544	5373
8-#14	3.21	MA	5776	1999	9295	1572	10913	1300	12037	1076	13728	710	17175	608	11208
2L-4S		MI	3542	1999	5577	1537	6222	1281	6600	1056	7066	699	8125	245	7000
8-#14	3.21	MA	5362	1999	8399	1590	9773	1315	10652	1088	11854	733	14580	448	11134
3E		MI	3685	1999	5983	1526	6791	1259	7297	1052	7983	688	9198	324	7453
8-#14	3.21	MA	5147	1999	7783	1607	8905	1345	9588	1116	10397	741	12771	354	10453
4L-2S		MI	3945	1999	6557	1515	7522	1252	8185	1034	9185	677	10696	486	7472
8-#18	5.71	MA	6193	2399	10435	1836	12304	1493	13696	1224	15950	714	19979	250	18835
3E		MI	4181	2399	7257	1760	8358	1425	9175	1159	10493	653	11990	18	11934
8-#18	5.71	MA	5855	2399	9361	1865	10792	1544	11843	1242	13414	723	16877	87	16348
4L-2S		MI	4554	2399	8238	1745	9607	1417	10692	1132	12541	639	14436	306	12481
10-#10	2.27	MA	5378	1848	8233	1494	9636	1246	10522	1045	11707	729	14400	629	8169
2L-5S		MI	3369	1848	5068	1476	5678	1230	5966	1038	6187	718	7175	374	5306
10-#10	2.27	MA	5125	1848	7712	1505	8973	1256	9717	1054	10618	744	12891	542	8155
3L-4S		MI	3473	1848	5311	1460	5971	1224	6330	1025	6692	709	7827	427	5526
10-#10	2.27	MA	4996	1848	7357	1516	8472	1274	9102	1071	9775	750	11858	491	8094
4L-3S		MI	3558	1848	5548	1452	6304	1209	6738	1021	7251	709	8486	476	5541
10-#10	2.27	MA	4808	1848	6994	1536	8035	1284	8558	1079	9018	764	10816	444	7724
5L-2S		MI	3719	1848	5887	1444	6736	1203	7263	1008	7961	700	9416	567	5534
10-#11	2.79	MA	5304	1930	8193	1549	9542	1286	10387	1071	11507	735	14109	508	9819
3L-4S		MI	3559	1930	5570	1499	6256	1252	6656	1039	7119	695	8287	355	6514
10-#11	2.79	MA	5155	1930	7762	1562	8934	1308	9641	1091	10486	741	12848	444	9707
4L-3S		MI	3659	1930	5856	1491	6657	1235	7147	1036	7790	696	9058	412	6611
10-#11	2.79	MA	4934	1930	7322	1585	8404	1319	8982	1100	9568	758	11581	383	9079
5L-2S		MI	3846	1930	6262	1482	7174	1229	7775	1022	8640	687	10140	524	6611
10-#14	4.02	MA	5761	2127	9295	1670	10913	1374	12037	1125	13728	726	17175	438	13810
3L-4S		MI	3794	2127	6152	1617	6953	1340	7488	1092	8268	692	9623	211	8620

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis

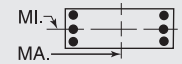


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	4.02	MA	5564	2127	8679	1687	10046	1404	10973	1152	12271	733	15366	344	13046
4L-3S		MI	3928	2127	6557	1607	7522	1318	8185	1089	9185	681	10696	290	9167
10-#14	4.02	MA	5257	2127	8050	1720	9287	1419	10030	1165	10960	756	13551	253	12250
5L-2S		MI	4180	2127	7132	1596	8254	1310	9073	1070	10387	669	12194	452	9209
10-#18	7.14	MA	6561	2627	10913	2007	12768	1647	14243	1307	16661	710	21289	61	20901
4L-3S		MI	4582	2627	8238	1903	9607	1528	10692	1224	12541	639	14436	-58	14343
12-#10	2.72	MA	5363	1920	8233	1550	9636	1289	10522	1074	11707	739	14400	537	9719
3L-5S		MI	3521	1920	5407	1521	6111	1263	6491	1058	6898	714	8105	361	6282
12-#10	2.72	MA	5242	1920	7877	1561	9135	1307	9907	1091	10865	746	13367	485	9649
4E		MI	3624	1920	5650	1505	6403	1257	6855	1046	7403	705	8757	414	6540
12-#10	2.72	MA	5055	1920	7515	1581	8698	1317	9364	1100	10108	760	12325	438	9247
5L-3S		MI	3706	1920	5887	1497	6736	1242	7263	1041	7961	704	9416	463	6565
12-#10	2.72	MA	4880	1920	7177	1587	8287	1326	8829	1117	9386	775	11302	367	8917
6L-2S		MI	3863	1920	6227	1489	7169	1236	7788	1029	8671	695	10346	554	6567
12-#11	3.34	MA	5446	2020	8391	1617	9735	1348	10614	1116	11802	736	14670	437	11543
4E		MI	3737	2020	5976	1555	6773	1292	7284	1064	7969	690	9368	335	7661
12-#11	3.34	MA	5227	2020	7951	1640	9205	1359	9954	1126	10884	753	13403	376	10921
5L-3S		MI	3832	2020	6262	1546	7174	1276	7775	1061	8640	691	10140	392	7831
12-#11	3.34	MA	5021	2020	7548	1649	8682	1381	9306	1146	10007	769	12250	302	10403
6L-2S		MI	4013	2020	6668	1538	7691	1270	8403	1047	9490	682	11221	504	7844
12-#14	4.82	MA	5971	2256	9575	1768	11186	1462	12358	1189	14145	726	17961	333	15652
4E		MI	4042	2256	6726	1698	7684	1398	8376	1129	9470	685	11121	178	10255
12-#14	4.82	MA	5666	2256	8945	1800	10428	1477	11415	1201	12834	748	16146	243	14896
5L-3S		MI	4184	2256	7132	1687	8254	1376	9073	1125	10387	673	12194	257	10878
12-#14	4.82	MA	5386	2256	8377	1813	9680	1507	10488	1229	11581	771	14490	135	13714
6L-2S		MI	4407	2256	7706	1676	8985	1369	9962	1106	11589	662	13692	418	10938
14-#10	3.17	MA	5483	1993	8398	1607	9798	1340	10712	1112	11955	741	14876	479	11204
4L-5S		MI	3671	1993	5747	1567	6543	1295	7016	1079	7608	710	9034	348	7264
14-#10	3.17	MA	5298	1993	8036	1626	9361	1349	10169	1121	11198	756	13834	432	10774
5L-4S		MI	3774	1993	5990	1550	6835	1289	7380	1066	8113	701	9687	401	7549
14-#10	3.17	MA	5129	1993	7697	1633	8950	1359	9635	1137	10475	770	12811	361	10459
6L-3S		MI	3852	1993	6227	1543	7169	1275	7788	1062	8671	700	10346	450	7586
14-#10	3.17	MA	4985	1993	7365	1639	8499	1375	9121	1146	9738	777	11824	322	9927
7L-2S		MI	4005	1993	6566	1535	7601	1269	8313	1049	9382	691	11276	541	7596
14-#11	3.90	MA	5515	2109	8580	1696	10005	1400	10926	1151	12200	748	15225	369	12769
5L-4S		MI	3913	2109	6382	1610	7290	1333	7912	1090	8819	684	10450	315	8816
14-#11	3.90	MA	5316	2109	8177	1705	9483	1421	10278	1171	11323	764	14072	295	12239
6L-3S		MI	4003	2109	6668	1602	7691	1316	8403	1086	9490	686	11221	372	9048
14-#11	3.90	MA	5147	2109	7774	1712	8969	1431	9655	1180	10428	771	12772	230	11605
7L-2S		MI	4180	2109	7074	1594	8208	1310	9031	1072	10340	676	12303	484	9070
14-#14	5.63	MA	6067	2384	9841	1881	11568	1536	12800	1238	14708	741	18741	232	17547
5L-4S		MI	4312	2384	7301	1778	8416	1456	9265	1165	10672	677	12619	144	11901
14-#14	5.63	MA	5800	2384	9273	1893	10820	1566	11873	1265	13455	764	17085	125	16354
6L-3S		MI	4418	2384	7706	1767	8985	1434	9962	1161	11589	666	13692	223	12588
16-#10	3.63	MA	5536	2065	8556	1671	10024	1382	10974	1141	12288	752	15343	427	12306
5E		MI	3820	2065	6086	1612	6975	1328	7541	1099	8319	706	9964	335	8249
16-#10	3.63	MA	5373	2065	8218	1678	9613	1392	10440	1158	11565	766	14320	355	12003
6L-4S		MI	3922	2065	6329	1596	7268	1322	7904	1087	8823	697	10617	388	8519
16-#10	3.63	MA	5235	2065	7886	1685	9162	1408	9927	1167	10828	772	13333	316	11463
7L-3S		MI	3996	2065	6566	1588	7601	1308	8313	1082	9382	696	11276	437	8605
16-#10	3.63	MA	5076	2065	7566	1693	8731	1414	9406	1183	10123	787	12383	264	10924
8L-2S		MI	4146	2065	6906	1580	8033	1302	8838	1070	10092	687	12205	528	8621
16-#11	4.46	MA	5606	2198	8805	1760	10283	1462	11250	1196	12639	759	15895	288	14079
6L-4S		MI	4087	2198	6789	1666	7807	1373	8540	1115	9669	679	11532	295	9979
16-#11	4.46	MA	5445	2198	8403	1768	9770	1471	10627	1206	11744	765	14594	222	13464
7L-3S		MI	4173	2198	7074	1658	8208	1357	9031	1111	10340	680	12303	351	10262
16-#14	6.43	MA	6206	2513	10168	1973	11961	1624	13258	1302	15329	756	19680	114	18999
6L-4S		MI	4553	2513	7875	1858	9147	1515	10153	1201	11874	670	14117	111	13555

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	4.08	MA	5613	2138	8739	1723	10276	1425	11245	1179	12655	762	15829	349	13549
6L-5S		MI	3967	2138	6425	1657	7407	1361	8066	1120	9029	702	10894	322	9238
18-#10	4.08	MA	5481	2138	8406	1730	9825	1441	10732	1187	11918	768	14842	311	13002
7L-4S		MI	4068	2138	6668	1641	7700	1355	8429	1107	9534	692	11546	375	9493
18-#10	4.08	MA	5323	2138	8087	1738	9394	1447	10211	1203	11213	783	13892	258	12464
8L-3S		MI	4140	2138	6906	1633	8033	1341	8838	1103	10092	692	12205	424	9622
18-#11	5.01	MA	5737	2287	9032	1823	10570	1512	11599	1231	13060	760	16416	215	15325
7L-4S		MI	4259	2287	7195	1722	8324	1413	9168	1140	10519	674	12614	275	11147
20-#10	4.54	MA	5723	2210	8927	1775	10488	1474	11537	1208	13007	764	16351	305	14543
7L-5S		MI	4112	2210	6765	1703	7839	1394	8591	1140	9740	697	11824	309	10229
20-#10	4.54	MA	5567	2210	8608	1783	10057	1480	11016	1224	12303	779	15401	252	14005
8L-4S		MI	4213	2210	7008	1686	8132	1388	8954	1128	10244	688	12476	362	10472
22-#10	4.99	MA	5807	2283	9129	1829	10720	1513	11822	1245	13393	774	16910	247	15548
8L-5S		MI	4256	2283	7104	1748	8272	1427	9116	1161	10450	693	12753	296	11223

RECTANGULAR TIED COLUMNS 20" x 30"

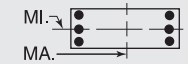
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.04	MA	5434	1769	7835	1469	9001	1239	9574	1060	10048	793	11833	690	4452
2E		MI	3542	1769	5346	1401	5950	1181	6222	1010	6404	753	7232	629	2884
4-#14	1.50	MA	5696	1848	8456	1511	9757	1268	10476	1077	11255	784	13495	680	6266
2E		MI	3681	1848	5713	1440	6388	1208	6740	1024	7094	742	8036	597	3982
4-#18	2.67	MA	6311	2048	9967	1622	11615	1347	12700	1123	14239	764	17605	657	10706
2E		MI	4002	2048	6584	1544	7439	1281	7989	1065	8755	717	9876	501	6594
6-#9	1.00	MA	5434	1762	7737	1478	8941	1247	9534	1068	10019	801	11813	698	4324
2L-3S		MI	3412	1762	5012	1423	5584	1200	5805	1033	5860	773	6614	580	2819
6-#9	1.00	MA	5192	1762	7289	1487	8371	1255	8841	1075	9081	814	10514	632	4338
3L-2S		MI	3550	1762	5282	1417	5927	1195	6222	1023	6425	765	7361	652	2801
6-#10	1.27	MA	5597	1809	8111	1503	9399	1265	10081	1078	10753	796	12824	692	5418
2L-3S		MI	3468	1809	5168	1448	5767	1217	6019	1044	6145	769	6967	547	3494
6-#10	1.27	MA	5299	1809	7545	1514	8679	1275	9206	1087	9569	812	11183	608	5428
3L-2S		MI	3640	1809	5508	1440	6199	1212	6544	1032	6855	759	7897	638	3472
6-#11	1.56	MA	5751	1858	8520	1524	9872	1279	10632	1085	11480	788	13816	683	6542
2L-3S		MI	3517	1858	5346	1465	5950	1228	6222	1049	6404	757	7232	497	4178
6-#11	1.56	MA	5398	1858	7835	1538	9001	1291	9574	1095	10048	806	11833	577	6547
3L-2S		MI	3717	1858	5752	1457	6467	1222	6850	1035	7254	748	8314	609	4151
6-#14	2.25	MA	6134	1977	9432	1591	11000	1327	11985	1113	13298	777	16322	670	9231
2L-3S		MI	3649	1977	5713	1531	6388	1274	6740	1079	7094	746	8036	402	5772
6-#14	2.25	MA	5653	1977	8456	1610	9757	1343	10476	1127	11255	801	13495	514	9188
3L-2S		MI	3922	1977	6287	1520	7119	1266	7628	1061	8296	735	9534	563	5754
6-#18	4.00	MA	7033	2276	11662	1764	13772	1451	15320	1188	17785	751	22515	639	15815
2L-3S		MI	3963	2276	6584	1702	7439	1392	7989	1157	8755	716	9876	138	9466
6-#18	4.00	MA	6270	2276	9967	1795	11615	1477	12700	1236	14239	790	17605	351	15516
3L-2S		MI	4392	2276	7565	1687	8688	1385	9506	1130	10803	703	12322	425	9579
8-#8	1.05	MA	5474	1772	7798	1486	9035	1254	9655	1073	10190	803	12053	699	4553
2L-4S		MI	3406	1772	4953	1438	5503	1217	5711	1040	5734	775	6510	568	2970
8-#8	1.05	MA	5284	1772	7442	1494	8582	1260	9104	1079	9445	812	11022	647	4563
3E		MI	3465	1772	5102	1433	5713	1207	5968	1037	6087	774	6933	599	2955
8-#8	1.05	MA	5185	1772	7201	1501	8241	1272	8686	1090	8872	817	10328	616	4567
4L-2S		MI	3575	1772	5317	1427	5986	1203	6301	1029	6536	768	7533	656	2942
8-#9	1.33	MA	5646	1820	8186	1513	9512	1273	10227	1084	10958	798	13112	693	5691
2L-4S		MI	3461	1820	5094	1465	5663	1238	5898	1053	5982	771	6833	532	3671

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis

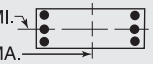


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	1.33	MA	5411	1820	7737	1522	8941	1281	9534	1091	10019	810	11813	627	5699
3E		MI	3534	1820	5282	1459	5927	1226	6222	1049	6425	770	7361	571	3656
8-#9	1.33	MA	5289	1820	7433	1532	8512	1296	9006	1105	9297	816	10936	587	5686
4L-2S		MI	3670	1820	5552	1453	6271	1221	6639	1039	6989	762	8107	643	3640
8-#10	1.69	MA	5860	1881	8677	1548	10120	1298	10957	1099	11938	792	14464	686	7139
2L-4S		MI	3531	1881	5271	1501	5866	1265	6136	1069	6297	765	7238	486	4542
8-#10	1.69	MA	5571	1881	8111	1560	9399	1308	10081	1108	10753	808	12824	602	7137
3E		MI	3621	1881	5508	1494	6199	1250	6544	1065	6855	764	7897	534	4536
8-#10	1.69	MA	5422	1881	7726	1571	8856	1327	9414	1126	9840	815	11712	551	7089
4L-2S		MI	3787	1881	5847	1486	6631	1244	7069	1052	7565	755	8827	625	4520
8-#11	2.08	MA	6061	1947	9204	1580	10744	1319	11691	1110	12913	783	15800	676	8621
2L-4S		MI	3589	1947	5466	1529	6067	1285	6359	1078	6583	751	7543	420	5407
8-#11	2.08	MA	5722	1947	8520	1593	9872	1331	10632	1121	11480	800	13816	570	8606
3E		MI	3696	1947	5752	1521	6467	1268	6850	1074	7254	752	8314	477	5418
8-#11	2.08	MA	5546	1947	8052	1607	9213	1354	9824	1141	10372	808	12458	506	8510
4L-2S		MI	3890	1947	6158	1513	6984	1262	7478	1060	8104	743	9396	589	5402
8-#14	3.00	MA	6561	2105	10408	1671	12242	1385	13494	1150	15340	769	19150	660	12180
2L-4S		MI	3752	2105	5882	1622	6550	1354	6931	1119	7379	750	8461	289	7120
8-#14	3.00	MA	6104	2105	9432	1690	11000	1401	11985	1164	13298	794	16322	503	12106
3E		MI	3897	2105	6287	1612	7119	1332	7628	1116	8296	739	9534	368	7498
8-#14	3.00	MA	5867	2105	8764	1709	10058	1433	10829	1193	11715	803	14372	411	11493
4L-2S		MI	4159	2105	6862	1601	7851	1325	8516	1097	9498	727	11032	530	7507
8-#18	5.33	MA	7025	2505	11662	1938	13772	1581	15320	1301	17785	777	22515	333	20563
3E		MI	4393	2505	7565	1844	8688	1496	9506	1222	10803	702	12322	62	12128
8-#18	5.33	MA	6655	2505	10495	1968	12128	1633	13304	1322	15025	789	19077	165	17992
4L-2S		MI	4772	2505	8546	1829	9937	1488	11022	1195	12852	689	14768	349	12532
10-#10	2.12	MA	6118	1954	9243	1594	10841	1331	11832	1119	13123	788	16104	681	8855
2L-5S		MI	3581	1954	5367	1563	6005	1304	6298	1102	6502	770	7515	419	5382
10-#10	2.12	MA	5838	1954	8677	1605	10120	1341	10957	1128	11938	803	14464	596	8841
3L-4S		MI	3685	1954	5610	1547	6298	1298	6661	1090	7007	761	8168	472	5562
10-#10	2.12	MA	5697	1954	8292	1617	9577	1360	10290	1146	11024	810	13352	545	8780
4L-3S		MI	3771	1954	5847	1539	6631	1283	7069	1085	7565	760	8827	521	5569
10-#10	2.12	MA	5487	1954	7900	1637	9104	1370	9701	1155	10205	826	12227	500	8435
5L-2S		MI	3933	1954	6186	1531	7063	1277	7594	1073	8276	751	9756	612	5559
10-#11	2.60	MA	6038	2037	9204	1649	10744	1372	11691	1146	12913	795	15800	562	10661
3L-4S		MI	3770	2037	5872	1585	6584	1325	6987	1103	7433	746	8625	400	6612
10-#11	2.60	MA	5874	2037	8737	1663	10085	1394	10882	1167	11805	803	14441	499	10549
4L-3S		MI	3871	2037	6158	1577	6984	1309	7478	1099	8104	747	9396	457	6648
10-#11	2.60	MA	5627	2037	8260	1686	9510	1406	10167	1177	10810	820	13071	441	9923
5L-2S		MI	4060	2037	6564	1568	7502	1303	8106	1085	8954	738	10478	569	6642
10-#14	3.75	MA	6544	2234	10408	1770	12242	1460	13494	1200	15340	786	19150	493	15025
3L-4S		MI	4005	2234	6456	1703	7282	1413	7819	1156	8581	742	9959	256	8736
10-#14	3.75	MA	6327	2234	9740	1789	11300	1491	12338	1229	13757	796	17199	401	14327
4L-3S		MI	4141	2234	6862	1692	7851	1390	8516	1152	9498	731	11032	334	9215
10-#14	3.75	MA	5982	2234	9058	1823	10478	1508	11316	1243	12334	820	15236	314	13404
5L-2S		MI	4394	2234	7436	1681	8582	1383	9404	1133	10700	720	12530	496	9248
10-#18	6.67	MA	7433	2733	12189	2111	14286	1737	15924	1387	18571	776	23987	147	22978
4L-3S		MI	4794	2733	8546	1987	9937	1600	11022	1286	12852	688	14768	-14	14745
10-#18	6.67	MA	6859	2733	10996	2168	12848	1763	14138	1435	16086	815	20543	-18	20486
5L-2S		MI	5146	2733	9527	1972	11185	1592	12539	1259	14900	675	17214	273	15472
12-#10	2.54	MA	6101	2026	9243	1650	10841	1374	11832	1149	13123	799	16104	590	10542
3L-5S		MI	3733	2026	5706	1608	6437	1337	6823	1123	7213	766	8445	406	6357
12-#10	2.54	MA	5967	2026	8858	1662	10297	1393	11165	1167	12209	806	14993	539	10472
4E		MI	3836	2026	5949	1592	6730	1331	7186	1110	7717	757	9098	459	6578
12-#10	2.54	MA	5759	2026	8466	1682	9824	1403	10577	1176	11389	822	13867	495	10093
5L-3S		MI	3919	2026	6186	1584	7063	1316	7594	1106	8276	756	9756	508	6596
12-#10	2.54	MA	5567	2026	8094	1688	9380	1414	9999	1194	10607	837	12766	424	9716
6L-2S		MI	4077	2026	6526	1576	7495	1310	8119	1093	8986	747	10686	599	6593

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

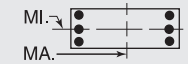
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	3.12	MA	6195	2126	9421	1718	10956	1435	11941	1192	13237	797	16425	492	12591
4E		MI	3949	2126	6279	1641	7101	1365	7615	1128	8283	741	9706	380	7757
12-#11	3.12	MA	5950	2126	8945	1742	10382	1447	11226	1202	12242	815	15055	434	11932
5L-3S		MI	4045	2126	6564	1632	7502	1349	8106	1125	8954	742	10478	436	7870
12-#11	3.12	MA	5723	2126	8500	1750	9841	1459	10524	1223	11292	833	13709	346	11440
6L-2S		MI	4228	2126	6970	1624	8019	1343	8734	1111	9804	732	11559	549	7877
12-#14	4.50	MA	6775	2362	10715	1869	12542	1549	13848	1266	15799	788	20027	390	17173
4E		MI	4254	2362	7030	1783	8013	1471	8707	1192	9783	735	11457	222	10367
12-#14	4.50	MA	6434	2362	10033	1903	11721	1566	12825	1280	14377	813	18064	304	16292
5L-3S		MI	4382	2362	7436	1772	8582	1449	9404	1188	10700	724	12530	301	10928
12-#14	4.50	MA	6126	2362	9406	1915	10911	1597	11820	1309	13018	837	16281	197	15085
6L-2S		MI	4625	2362	8010	1761	9313	1441	10292	1170	11902	712	14028	463	10979
12-#18	8.00	MA	7620	2962	12691	2311	15006	1867	16758	1500	19632	802	25453	-36	25275
5L-3S		MI	5188	2962	9527	2130	11185	1704	12539	1351	14900	674	17214	-90	17048
14-#10	2.96	MA	6233	2099	9424	1707	11018	1426	12040	1187	13394	802	16633	533	12164
4L-5S		MI	3884	2099	6046	1654	6870	1370	7348	1143	7923	761	9375	393	7337
14-#10	2.96	MA	6026	2099	9032	1727	10545	1436	11452	1197	12574	817	15508	489	11756
5L-4S		MI	3986	2099	6289	1637	7162	1364	7711	1131	8428	752	10027	446	7592
14-#10	2.96	MA	5840	2099	8660	1733	10101	1446	10874	1214	11792	833	14406	418	11394
6L-3S		MI	4065	2099	6526	1630	7495	1349	8119	1127	8986	752	10686	495	7619
14-#10	2.96	MA	5683	2099	8299	1740	9604	1462	10319	1223	10994	840	13341	382	10867
7L-2S		MI	4220	2099	6865	1622	7928	1343	8644	1114	9697	743	11616	586	7624
14-#11	3.64	MA	6266	2215	9629	1798	11253	1487	12284	1228	13675	810	17038	427	13947
5L-4S		MI	4125	2215	6685	1696	7618	1406	8243	1154	9132	735	10788	360	8910
14-#11	3.64	MA	6049	2215	9185	1806	10713	1499	11582	1248	12725	828	15692	339	13445
6L-3S		MI	4217	2215	6970	1688	8019	1390	8734	1150	9804	737	11559	416	9088
14-#11	3.64	MA	5863	2215	8748	1814	10120	1518	10907	1259	11755	835	14393	291	12714
7L-2S		MI	4395	2215	7376	1680	8536	1383	9362	1136	10654	727	12641	528	9106
14-#14	5.25	MA	6875	2490	11009	1983	12963	1624	14334	1316	16419	805	20892	294	19186
5L-4S		MI	4499	2490	7605	1863	8744	1529	9596	1228	10985	728	12955	188	12010
14-#14	5.25	MA	6582	2490	10382	1995	12153	1656	13329	1345	15060	830	19109	187	17971
6L-3S		MI	4633	2490	8010	1852	9313	1507	10292	1225	11902	716	14028	267	12640
16-#10	3.39	MA	6288	2171	9598	1772	11266	1469	12327	1217	13759	813	17148	483	13423
5E		MI	4033	2171	6385	1699	7302	1403	7872	1164	8634	757	10305	380	8321
16-#10	3.39	MA	6109	2171	9226	1779	10821	1479	11749	1235	12977	829	16047	412	13075
6L-4S		MI	4135	2171	6628	1683	7594	1397	8236	1151	9138	748	10957	433	8601
16-#10	3.39	MA	5958	2171	8866	1786	10325	1495	11194	1244	12178	836	14981	376	12541
7L-3S		MI	4210	2171	6865	1675	7928	1382	8644	1147	9697	747	11616	482	8639
16-#10	3.39	MA	5780	2171	8520	1794	9858	1501	10620	1260	11416	851	13956	325	12032
8L-2S		MI	4361	2171	7205	1667	8360	1376	9169	1134	10407	738	12546	573	8651
16-#11	4.16	MA	6368	2304	9869	1861	11584	1539	12640	1274	14157	823	17676	332	15455
6L-4S		MI	4299	2304	7091	1752	8135	1446	8871	1179	9982	730	11870	339	10071
16-#11	4.16	MA	6190	2304	9432	1869	10992	1559	11965	1284	13188	830	16377	284	14743
7L-3S		MI	4387	2304	7376	1744	8536	1430	9362	1175	10654	731	12641	396	10305
16-#14	6.00	MA	7028	2619	11357	2075	13396	1714	14839	1382	17102	822	21937	177	20862
6L-4S		MI	4766	2619	8179	1944	9475	1588	10484	1265	12187	720	14453	155	13662
18-#10	3.81	MA	6373	2244	9792	1824	11542	1512	12625	1255	14161	824	17687	406	14757
6L-5S		MI	4180	2244	6725	1744	7734	1436	8397	1185	9344	753	11234	367	9309
18-#10	3.81	MA	6228	2244	9432	1831	11046	1527	12069	1265	13363	831	16622	370	14217
7L-4S		MI	4281	2244	6968	1728	8027	1430	8761	1172	9849	744	11887	420	9574
18-#10	3.81	MA	6052	2244	9086	1840	10579	1534	11495	1280	12601	847	15597	320	13710
8L-3S		MI	4354	2244	7205	1720	8360	1415	9169	1168	10407	743	12546	469	9658

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

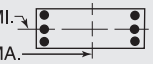
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	4.68	MA	6512	2393	10117	1925	11863	1599	13024	1309	14620	825	18360	277	16774
7L-4S		MI	4472	2393	7497	1808	8652	1487	9499	1204	10832	725	12952	319	11238
20-#10	4.23	MA	6494	2316	9998	1876	11767	1560	12945	1285	14548	827	18262	364	15895
7L-5S		MI	4325	2316	7064	1789	8166	1468	8922	1205	10054	749	12164	354	10300
20-#10	4.23	MA	6319	2316	9652	1885	11299	1567	12371	1301	13785	843	17237	314	15389
8L-4S		MI	4427	2316	7307	1773	8459	1462	9286	1192	10559	740	12817	407	10552
22-#10	4.66	MA	6583	2389	10218	1930	12020	1600	13246	1322	14970	838	18877	308	17042
8L-5S		MI	4470	2389	7404	1835	8598	1501	9447	1226	10765	745	13094	341	11292

RECTANGULAR TIED COLUMNS 20" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.41	MA	6442	1954	9458	1610	10943	1353	11751	1151	12597	843	15078	732	6752
2E		MI	3894	1954	6017	1525	6716	1281	7070	1088	7406	793	8372	641	4009
4-#18	2.50	MA	7122	2154	11101	1721	12963	1432	14169	1197	15841	823	19549	709	11570
2E		MI	4216	2154	6892	1628	7768	1352	8319	1128	9066	767	10208	545	6633
6-#10	1.19	MA	6332	1915	9080	1602	10550	1350	11316	1152	12044	855	14340	744	5829
2L-3S		MI	3681	1915	5467	1535	6093	1292	6351	1109	6460	820	7308	592	3515
6-#10	1.19	MA	6005	1915	8469	1614	9771	1360	10371	1162	10765	871	12568	661	5840
3L-2S		MI	3853	1915	5807	1527	6526	1286	6876	1096	7170	811	8237	683	3492
6-#11	1.46	MA	6501	1964	9525	1624	11064	1364	11916	1159	12836	847	15420	735	7048
2L-3S		MI	3729	1964	5648	1551	6278	1301	6553	1113	6718	808	7570	542	4204
6-#11	1.46	MA	6116	1964	8785	1638	10122	1377	10772	1170	11287	865	13275	631	7052
3L-2S		MI	3930	1964	6054	1543	6795	1295	7181	1099	7568	799	8652	654	4176
6-#14	2.11	MA	6923	2083	10514	1691	12288	1412	13384	1187	14807	836	18139	722	9960
2L-3S		MI	3861	2083	6017	1617	6716	1346	7070	1143	7406	797	8372	446	5809
6-#14	2.11	MA	6396	2083	9458	1710	10943	1429	11751	1203	12597	862	15078	569	9917
3L-2S		MI	4136	2083	6592	1606	7448	1339	7959	1124	8608	785	9870	608	5785
6-#18	3.75	MA	7914	2382	12939	1864	15302	1536	17010	1262	19686	810	24873	690	17111
2L-3S		MI	4174	2382	6892	1786	7768	1464	8319	1219	9066	766	10208	181	9535
6-#18	3.75	MA	7075	2382	11101	1896	12963	1564	14169	1286	15841	852	19549	409	16812
3L-2S		MI	4612	2382	7873	1771	9017	1456	9836	1192	11114	753	12654	469	9623
8-#9	1.25	MA	6384	1926	9160	1613	10670	1357	11472	1158	12263	857	14648	745	6123
2L-4S		MI	3673	1926	5392	1553	5990	1312	6230	1118	6297	822	7174	578	3694
8-#9	1.25	MA	6127	1926	8676	1622	10054	1366	10724	1166	11250	870	13246	680	6131
3E		MI	3746	1926	5580	1546	6254	1300	6554	1114	6740	821	7702	616	3676
8-#9	1.25	MA	5995	1926	8348	1632	9591	1382	10156	1180	10472	876	12307	640	6118
4L-2S		MI	3883	1926	5850	1540	6597	1295	6971	1104	7305	814	8448	688	3660
8-#10	1.59	MA	6619	1987	9691	1648	11328	1382	12262	1173	13324	851	16111	738	7687
2L-4S		MI	3742	1987	5570	1588	6192	1339	6467	1134	6611	816	7579	531	4572
8-#10	1.59	MA	6303	1987	9080	1660	10550	1393	11316	1182	12044	867	14340	655	7685
3E		MI	3833	1987	5807	1581	6526	1325	6876	1130	7170	816	8237	579	4560
8-#10	1.59	MA	6140	1987	8666	1672	9964	1413	10598	1201	11060	875	13149	605	7638
4L-2S		MI	4001	1987	6146	1573	6958	1319	7401	1117	7880	807	9167	670	4543
8-#11	1.95	MA	6841	2054	10265	1679	12007	1404	13061	1184	14385	841	17565	728	9295
2L-4S		MI	3801	2054	5769	1615	6394	1358	6690	1142	6896	802	7881	465	5447
8-#11	1.95	MA	6470	2054	9525	1693	11064	1417	11916	1195	12836	860	15420	623	9280
3E		MI	3908	2054	6054	1607	6795	1342	7181	1138	7568	803	8652	521	5449
8-#11	1.95	MA	6278	2054	9021	1707	10354	1440	11044	1217	11641	869	13965	561	9184
4L-2S		MI	4103	2054	6460	1599	7312	1335	7809	1124	8417	794	9734	634	5430
8-#14	2.81	MA	7391	2211	11570	1771	13632	1470	15017	1224	17017	828	21199	711	13152
2L-4S		MI	3964	2211	6186	1708	6879	1427	7262	1183	7691	800	8797	334	7236
8-#14	2.81	MA	6890	2211	10514	1790	12288	1487	13384	1239	14807	854	18139	558	13078
3E		MI	4109	2211	6592	1697	7448	1405	7959	1179	8608	789	9870	412	7541
8-#14	2.81	MA	6631	2211	9794	1810	11271	1520	12137	1269	13098	865	16047	467	12549
4L-2S		MI	4374	2211	7166	1686	8179	1397	8847	1160	9810	778	11368	574	7541
8-#18	5.00	MA	7902	2611	12939	2039	15302	1668	17010	1350	19686	839	24873	391	22291
3E		MI	4604	2611	7873	1928	9017	1568	9836	1284	11114	752	12654	105	12319

RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis

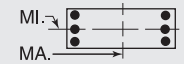


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	5.00	MA	7498	2611	11678	2071	13525	1722	14831	1401	16702	854	21183	226	19658
4L-2S		MI	4989	2611	8854	1913	10266	1560	11353	1257	13162	739	15100	393	12581
10-#10	1.98	MA	6901	2060	10303	1693	12106	1415	13207	1193	14603	847	17883	732	9540
2L-5S		MI	3793	2060	5666	1650	6332	1378	6629	1167	6817	821	7856	464	5455
10-#10	1.98	MA	6595	2060	9691	1705	11328	1426	12262	1203	13324	863	16111	649	9526
3L-4S		MI	3897	2060	5909	1634	6625	1372	6992	1154	7322	812	8508	518	5595
10-#10	1.98	MA	6441	2060	9277	1717	10743	1446	11543	1221	12339	871	14921	599	9466
4L-3S		MI	3983	2060	6146	1626	6958	1358	7401	1150	7880	812	9167	566	5596
10-#10	1.98	MA	6209	2060	8855	1737	10234	1457	10910	1231	11457	887	13712	556	9153
5L-2S		MI	4147	2060	6486	1618	7390	1352	7925	1137	8591	802	10097	657	5584
10-#11	2.44	MA	6816	2143	10265	1749	12007	1457	13061	1221	14385	855	17565	616	11503
3L-4S		MI	3982	2143	6175	1671	6911	1398	7318	1167	7746	797	8963	445	6662
10-#11	2.44	MA	6636	2143	9761	1763	11296	1480	12189	1242	13190	863	16109	553	11392
4L-3S		MI	4084	2143	6460	1663	7312	1382	7809	1163	8417	798	9734	501	6682
10-#11	2.44	MA	6363	2143	9248	1788	10677	1493	11419	1254	12117	882	14637	498	10776
5L-2S		MI	4274	2143	6866	1654	7829	1376	8437	1149	9267	789	10816	613	6672
10-#14	3.52	MA	7371	2340	11570	1871	13632	1546	15017	1275	17017	847	21199	548	16240
3L-4S		MI	4216	2340	6760	1788	7610	1485	8150	1219	8893	793	10295	300	8849
10-#14	3.52	MA	7134	2340	10850	1890	12616	1578	13770	1306	15309	858	19108	457	15625
4L-3S		MI	4354	2340	7166	1777	8179	1463	8847	1215	9810	782	11368	379	9261
10-#14	3.52	MA	6751	2340	10115	1925	11730	1596	12668	1321	13775	884	16996	374	14568
5L-2S		MI	4609	2340	7740	1766	8910	1456	9735	1197	11012	770	12866	541	9286
10-#18	6.25	MA	8349	2839	13516	2214	15865	1826	17672	1466	20547	841	26507	207	25080
4L-3S		MI	5006	2839	8854	2071	10266	1671	11353	1349	13162	738	15100	29	15000
10-#18	6.25	MA	7710	2839	12229	2273	14314	1854	15744	1490	17863	883	22799	50	22585
5L-2S		MI	5365	2839	9835	2056	11515	1664	12870	1322	15210	725	17546	317	15524
12-#10	2.38	MA	6881	2132	10303	1750	12106	1459	13207	1224	14603	859	17883	643	11365
3L-5S		MI	3946	2132	6006	1695	6764	1411	7154	1188	7528	817	8786	451	6429
12-#10	2.38	MA	6736	2132	9888	1762	11521	1479	12489	1242	13619	867	16692	593	11295
4E		MI	4049	2132	6249	1679	7057	1405	7517	1175	8032	808	9438	505	6614
12-#10	2.38	MA	6506	2132	9466	1783	11012	1490	11855	1252	12736	883	15484	550	10947
5L-3S		MI	4132	2132	6486	1671	7390	1390	7925	1171	8591	807	10097	553	6626
12-#10	2.38	MA	6297	2132	9060	1789	10534	1500	11233	1270	11895	899	14304	480	10521
6L-2S		MI	4291	2132	6825	1663	7822	1384	8450	1158	9301	798	11027	644	6620
12-#11	2.92	MA	6987	2232	10501	1819	12238	1521	13333	1268	14739	858	18254	546	13602
4E		MI	4161	2232	6581	1727	7429	1439	7946	1192	8596	791	10044	424	7850
12-#11	2.92	MA	6716	2232	9988	1843	11620	1534	12563	1279	13666	877	16781	491	12952
5L-3S		MI	4258	2232	6866	1718	7829	1422	8437	1189	9267	793	10816	481	7907
12-#11	2.92	MA	6469	2232	9502	1851	11038	1546	11807	1300	12643	896	15339	404	12467
6L-2S		MI	4443	2232	7272	1710	8346	1416	9065	1175	10117	783	11897	593	7909
12-#14	4.22	MA	7624	2468	11906	1971	13960	1636	15403	1342	17519	850	22168	446	18713
4E		MI	4465	2468	7335	1868	8341	1544	9038	1255	10095	785	11793	266	10477
12-#14	4.22	MA	7245	2468	11171	2005	13075	1654	14301	1357	15985	876	20057	364	17700
5L-3S		MI	4595	2468	7740	1857	8910	1521	9735	1252	11012	774	12866	345	10977
12-#14	4.22	MA	6908	2468	10484	2017	12242	1671	13218	1388	14520	902	17984	238	16477
6L-2S		MI	4842	2468	8315	1846	9642	1514	10623	1233	12215	763	14364	507	11019
12-#18	7.50	MA	8542	3068	14066	2416	16653	1958	18585	1554	21708	870	28123	32	27987
5L-3S		MI	5401	3068	9835	2214	11515	1775	12870	1414	15210	724	17546	-47	17463
14-#10	2.78	MA	7026	2205	10500	1808	12299	1512	13434	1262	14898	862	18464	587	13124
4L-5S		MI	4096	2205	6345	1740	7196	1444	7679	1208	8238	813	9715	438	7408
14-#10	2.78	MA	6797	2205	10078	1828	11791	1522	12801	1272	14016	878	17255	544	12746
5L-4S		MI	4199	2205	6588	1724	7489	1438	8042	1195	8743	804	10368	492	7630
14-#10	2.78	MA	6595	2205	9672	1834	11313	1533	12179	1291	13174	895	16076	474	12335
6L-3S		MI	4279	2205	6825	1717	7822	1423	8450	1191	9301	803	11027	540	7651
14-#10	2.78	MA	6423	2205	9284	1841	10771	1548	11582	1300	12315	902	14933	440	11819
7L-2S		MI	4435	2205	7165	1709	8254	1417	8975	1179	10012	794	11957	631	7652
14-#11	3.41	MA	7062	2321	10728	1899	12562	1574	13708	1304	15215	872	18926	484	15134
5L-4S		MI	4337	2321	6987	1782	7946	1479	8575	1218	9446	786	11126	404	9002

RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	3.41	MA	6824	2321	10243	1907	11980	1587	12952	1326	14192	891	17484	397	14669
6L-3S		MI	4430	2321	7272	1774	8346	1463	9065	1214	10117	787	11897	461	9128
14-#11	3.41	MA	6622	2321	9771	1915	11333	1605	12225	1337	13148	899	16090	352	13838
7L-2S		MI	4611	2321	7678	1766	8863	1457	9693	1200	10967	778	12979	573	9140
14-#14	4.92	MA	7728	2597	12227	2085	14420	1712	15934	1394	18195	869	23117	354	20837
5L-4S		MI	4710	2597	7909	1949	9072	1602	9926	1292	11298	778	13291	233	12117
14-#14	4.92	MA	7407	2597	11540	2097	13586	1730	14852	1424	16731	895	21045	228	19607
6L-3S		MI	4848	2597	8315	1938	9642	1580	10623	1288	12215	767	14364	312	12690
14-#14	4.92	MA	7132	2597	10866	2109	12670	1757	13811	1439	15236	906	19043	159	18226
7L-2S		MI	5068	2597	8889	1927	10373	1573	11512	1270	13417	755	15862	473	12748
16-#10	3.17	MA	7083	2277	10689	1873	12569	1555	13746	1293	15295	874	19027	539	14549
5E		MI	4245	2277	6685	1786	7629	1477	8204	1229	8949	809	10645	425	8392
16-#10	3.17	MA	6888	2277	10283	1879	12091	1566	13124	1311	14454	890	17847	468	14152
6L-4S		MI	4347	2277	6928	1770	7921	1471	8567	1216	9453	800	11298	479	8644
16-#10	3.17	MA	6723	2277	9895	1887	11550	1581	12527	1321	13595	898	16705	434	13631
7L-3S		MI	4424	2277	7165	1762	8254	1456	8975	1212	10012	799	11957	527	8672
16-#10	3.17	MA	6527	2277	9523	1896	11047	1588	11900	1336	12774	914	15605	386	13102
8L-2S		MI	4577	2277	7504	1754	8687	1450	9500	1199	10722	790	12886	618	8681
16-#11	3.90	MA	7173	2410	10983	1962	12923	1627	14096	1351	15741	886	19629	390	16850
6L-4S		MI	4512	2410	7393	1838	8463	1520	9203	1243	10296	781	12208	384	10161
16-#11	3.90	MA	6979	2410	10512	1971	12275	1646	13369	1362	14697	894	18234	345	16036
7L-3S		MI	4601	2410	7678	1830	8863	1503	9693	1239	10967	782	12979	441	10345
16-#11	3.90	MA	6748	2410	10059	1981	11664	1654	12620	1382	13699	913	16893	283	15172
8L-2S		MI	4777	2410	8085	1821	9380	1497	10321	1225	11817	773	14061	553	10366
16-#14	5.63	MA	7895	2725	12596	2177	14931	1788	16485	1460	18941	887	24105	217	22735
6L-4S		MI	4978	2725	8483	2029	9804	1660	10815	1328	12500	771	14789	199	13767
16-#14	5.63	MA	7636	2725	11923	2189	14015	1815	15444	1476	17446	898	22104	149	21339
7L-3S		MI	5081	2725	8889	2018	10373	1638	11512	1325	13417	759	15862	278	14402
18-#10	3.57	MA	7176	2350	10894	1924	12870	1599	14070	1332	15733	886	19619	463	15972
6L-5S		MI	4393	2350	7024	1831	8061	1510	8729	1249	9659	804	11575	412	9378
18-#10	3.57	MA	7018	2350	10506	1932	12328	1614	13472	1342	14874	894	18476	428	15445
7L-4S		MI	4494	2350	7267	1815	8353	1504	9092	1237	10164	795	12227	466	9653
18-#10	3.57	MA	6823	2350	10134	1941	11825	1621	12845	1357	14054	910	17376	380	14925
8L-3S		MI	4569	2350	7504	1807	8687	1489	9500	1232	10722	795	12886	514	9692
18-#10	3.57	MA	6628	2350	9717	1959	11308	1638	12225	1364	13215	918	16291	335	14178
9L-2S		MI	4718	2350	7844	1799	9119	1483	10025	1220	11433	786	13816	605	9706
18-#11	4.39	MA	7331	2499	11252	2027	13217	1686	14514	1387	16246	889	20379	338	18237
7L-4S		MI	4684	2499	7799	1894	8980	1560	9831	1268	11146	776	13289	364	11326
18-#11	4.39	MA	7101	2499	10799	2037	12606	1694	13765	1407	15248	908	19038	275	17364
8L-3S		MI	4770	2499	8085	1885	9380	1544	10321	1264	11817	777	14061	421	11561
18-#14	6.33	MA	8129	2853	12979	2269	15360	1874	17077	1512	19656	891	25164	139	24453
7L-4S		MI	5217	2853	9058	2109	10535	1719	11703	1365	13702	763	16287	166	15424
20-#10	3.97	MA	7308	2422	11118	1977	13106	1647	14418	1362	16154	890	20248	422	17262
7L-5S		MI	4539	2422	7363	1876	8493	1543	9254	1270	10369	800	12505	399	10368
20-#10	3.97	MA	7115	2422	10746	1986	12603	1654	13791	1377	15333	906	19148	374	16748
8L-4S		MI	4640	2422	7606	1860	8786	1537	9617	1257	10874	791	13157	453	10630
20-#10	3.97	MA	6925	2422	10328	2004	12087	1671	13171	1384	14495	914	18063	329	15994
9L-3S		MI	4712	2422	7844	1852	9119	1522	10025	1253	11433	791	13816	501	10710
20-#11	4.88	MA	7449	2588	11539	2093	13549	1735	14909	1432	16797	902	21182	268	19557
8L-4S		MI	4856	2588	8205	1949	9497	1601	10459	1293	11996	771	14371	344	12496
22-#10	4.37	MA	7402	2495	11357	2032	13382	1687	14736	1398	16613	902	20920	368	18566
8L-5S		MI	4684	2495	7703	1922	8925	1576	9779	1290	11080	796	13434	386	11360
22-#10	4.37	MA	7218	2495	10939	2050	12865	1704	14116	1405	15774	909	19834	323	17810
9L-4S		MI	4785	2495	7946	1906	9218	1570	10142	1278	11584	787	14087	439	11610
24-#10	4.76	MA	7507	2567	11551	2095	13643	1737	15062	1425	17054	905	21606	318	19626
9L-5S		MI	4828	2567	8042	1967	9357	1609	10303	1311	11790	792	14364	373	12354

RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

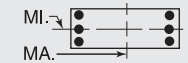
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.32	MA	7232	2060	10510	1710	12190	1438	13090	1225	14004	902	16736	784	7238
2E		MI	4107	2060	6322	1611	7045	1353	7401	1151	7719	843	8709	686	4035
4-#18	2.35	MA	7976	2260	12285	1821	14372	1517	15703	1271	17508	882	21565	760	12434
2E		MI	4429	2260	7200	1712	8098	1424	8649	1190	9376	816	10540	588	6671
6-#10	1.12	MA	7109	2021	10099	1702	11761	1434	12616	1226	13401	914	15930	796	6241
2L-3S		MI	3893	2021	5767	1622	6420	1366	6682	1174	6774	871	7648	637	3535
6-#10	1.12	MA	6755	2021	9442	1714	10925	1446	11601	1236	12026	931	14027	714	6251
3L-2S		MI	4065	2021	6106	1614	6852	1360	7207	1161	7485	862	8578	729	3512
6-#11	1.38	MA	7295	2071	10579	1723	12318	1449	13265	1233	14256	905	17098	787	7553
2L-3S		MI	3941	2071	5950	1637	6606	1374	6884	1177	7031	859	7908	586	4230
6-#11	1.38	MA	6876	2071	9784	1738	11305	1462	12035	1245	12591	925	14792	684	7558
3L-2S		MI	4143	2071	6356	1629	7123	1368	7512	1163	7881	850	8990	699	4201
6-#14	1.99	MA	7755	2189	11646	1790	13637	1496	14848	1261	16382	894	20029	773	10689
2L-3S		MI	4073	2189	6322	1702	7045	1419	7401	1206	7719	847	8709	490	5845
6-#14	1.99	MA	7182	2189	10510	1810	12190	1515	13090	1278	14004	922	16736	623	10646
3L-2S		MI	4349	2189	6896	1691	7776	1412	8290	1187	8921	836	10206	652	5816
6-#18	3.53	MA	8839	2489	14265	1963	16893	1621	18765	1336	21652	869	27303	742	18407
2L-3S		MI	4385	2489	7200	1869	8098	1535	8649	1282	9376	816	10540	225	9600
6-#18	3.53	MA	7923	2489	12285	1997	14372	1651	15703	1362	17508	913	21565	467	18108
3L-2S		MI	4826	2489	8181	1854	9347	1528	10166	1255	11425	802	12986	512	9666
8-#9	1.18	MA	7165	2032	10184	1712	11889	1442	12783	1232	13634	916	16259	797	6555
2L-4S		MI	3885	2032	5690	1640	6316	1387	6561	1183	6612	874	7516	623	3715
8-#9	1.18	MA	6887	2032	9664	1722	11228	1451	11979	1240	12546	929	14753	733	6563
3E		MI	3959	2032	5878	1634	6580	1375	6885	1179	7056	873	8043	662	3696
8-#9	1.18	MA	6744	2032	9313	1732	10732	1467	11370	1255	11712	936	13752	694	6550
4L-2S		MI	4096	2032	6148	1627	6924	1370	7302	1169	7620	865	8790	734	3679
8-#10	1.49	MA	7421	2093	10755	1747	12597	1467	13632	1247	14775	910	17833	790	8236
2L-4S		MI	3954	2093	5869	1675	6519	1413	6799	1198	6926	868	7919	576	4599
8-#10	1.49	MA	7078	2093	10099	1759	11761	1479	12616	1257	13401	927	15930	708	8234
3E		MI	4045	2093	6106	1668	6852	1399	7207	1194	7485	867	8578	624	4584
8-#10	1.49	MA	6902	2093	9655	1772	11134	1498	11846	1276	12345	935	14660	658	8186
4L-2S		MI	4214	2093	6446	1660	7285	1393	7732	1182	8195	858	9508	716	4565
8-#11	1.84	MA	7664	2160	11375	1779	13331	1489	14496	1258	15922	900	19404	779	9969
2L-4S		MI	4013	2160	6071	1701	6722	1431	7022	1206	7210	853	8219	509	5485
8-#11	1.84	MA	7260	2160	10579	1793	12318	1502	13265	1270	14256	920	17098	677	9954
3E		MI	4120	2160	6356	1693	7123	1415	7512	1202	7881	854	8990	566	5478
8-#11	1.84	MA	7053	2160	10040	1808	11555	1526	12330	1292	12974	929	15545	615	9858
4L-2S		MI	4317	2160	6762	1685	7640	1409	8140	1188	8731	845	10072	678	5457
8-#14	2.65	MA	8266	2317	12783	1870	15084	1555	16605	1298	18760	887	23323	763	14124
2L-4S		MI	4175	2317	6490	1793	7207	1500	7593	1246	8004	851	9133	378	7349
8-#14	2.65	MA	7719	2317	11646	1891	13637	1573	14848	1314	16382	914	20029	613	14050
3E		MI	4322	2317	6896	1782	7776	1477	8290	1242	8921	840	10206	457	7582
8-#14	2.65	MA	7438	2317	10874	1911	12546	1606	13509	1345	14548	927	17797	523	13622
4L-2S		MI	4588	2317	7470	1771	8507	1470	9178	1224	10123	828	11704	618	7575
8-#18	4.71	MA	8824	2717	14265	2140	16893	1754	18765	1427	21652	900	27303	449	24019
3E		MI	4798	2717	8181	2012	9347	1639	10166	1347	11425	802	12986	149	12504
8-#18	4.71	MA	8385	2717	12912	2174	14984	1811	16423	1479	18444	918	23363	285	21347
4L-2S		MI	5206	2717	9162	1997	10595	1631	11683	1319	13473	788	15432	436	12630
10-#10	1.87	MA	7727	2166	11412	1792	13433	1500	14648	1267	16149	906	19736	784	10226
2L-5S		MI	4005	2166	5966	1737	6659	1452	6960	1232	7132	873	8196	509	5527
10-#10	1.87	MA	7395	2166	10755	1805	12597	1512	13632	1277	14775	922	17833	702	10212
3L-4S		MI	4109	2166	6209	1721	6951	1446	7324	1219	7637	864	8849	563	5627

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

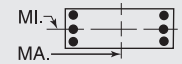


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.87	MA	7228	2166	10312	1817	11970	1531	12862	1296	13720	931	16563	652	10152
4L-3S		MI	4196	2166	6446	1713	7285	1432	7732	1215	8195	863	9508	611	5622
10-#10	1.87	MA	6974	2166	9859	1838	11425	1543	12184	1307	12774	948	15272	611	9880
5L-2S		MI	4361	2166	6785	1705	7717	1426	8257	1202	8906	854	10437	703	5608
10-#11	2.29	MA	7637	2249	11375	1849	13331	1543	14496	1295	15922	915	19404	670	12346
3L-4S		MI	4194	2249	6477	1757	7239	1472	7650	1231	8060	848	9301	489	6704
10-#11	2.29	MA	7442	2249	10835	1864	12569	1566	13560	1318	14640	924	17852	608	12234
4L-3S		MI	4297	2249	6762	1749	7640	1455	8140	1227	8731	849	10072	546	6715
10-#11	2.29	MA	7141	2249	10286	1889	11906	1580	12736	1330	13490	944	16277	555	11638
5L-2S		MI	4488	2249	7168	1740	8157	1449	8768	1213	9581	839	11153	658	6702
10-#14	3.31	MA	8242	2446	12783	1971	15084	1631	16605	1350	18760	907	23323	603	17455
3L-4S		MI	4428	2446	7065	1873	7938	1558	8481	1282	9206	843	10631	344	8959
10-#14	3.31	MA	7984	2446	12010	1991	13993	1665	15267	1382	16926	919	21091	512	16941
4L-3S		MI	4566	2446	7470	1862	8507	1536	9178	1279	10123	832	11704	423	9306
10-#14	3.31	MA	7563	2446	11223	2027	13043	1683	14085	1398	15280	947	18831	433	15743
5L-2S		MI	4824	2446	8045	1851	9239	1529	10066	1260	11325	821	13202	585	9322
10-#18	5.88	MA	9310	2945	14892	2317	17505	1915	19485	1544	22588	905	29101	267	27206
4L-3S		MI	5219	2945	9162	2155	10595	1743	11683	1411	13473	788	15432	73	15180
10-#18	5.88	MA	8604	2945	13511	2377	15841	1945	17415	1570	19706	950	25129	117	24591
5L-2S		MI	5583	2945	10143	2140	11844	1735	13200	1384	15521	774	17878	360	15576
12-#10	2.24	MA	7706	2238	11412	1850	13433	1545	14648	1298	16149	918	19736	696	12188
3L-5S		MI	4158	2238	6305	1782	7091	1485	7485	1252	7843	869	9126	496	6499
12-#10	2.24	MA	7548	2238	10968	1862	12806	1564	13878	1317	15094	927	18466	646	12118
4E		MI	4261	2238	6548	1766	7384	1479	7849	1240	8347	860	9779	550	6648
12-#10	2.24	MA	7295	2238	10516	1883	12261	1576	13199	1327	14149	944	17174	606	11810
5L-3S		MI	4345	2238	6785	1758	7717	1465	8257	1235	8906	859	10437	598	6655
12-#10	2.24	MA	7069	2238	10077	1889	11748	1587	12534	1346	13248	960	15914	537	11330
6L-2S		MI	4506	2238	7124	1750	8149	1459	8782	1223	9616	850	11367	690	6646
12-#11	2.75	MA	7823	2338	11631	1919	13582	1607	14791	1343	16305	919	20158	600	14612
4E		MI	4373	2338	6883	1813	7756	1512	8278	1256	8910	842	10382	469	7918
12-#11	2.75	MA	7525	2338	11082	1944	12919	1620	13966	1355	15156	939	18583	548	13981
5L-3S		MI	4471	2338	7168	1804	8157	1496	8768	1253	9581	843	11153	526	7943
12-#11	2.75	MA	7257	2338	10554	1952	12296	1633	13156	1377	14060	958	17044	461	13440
6L-2S		MI	4658	2338	7575	1796	8674	1490	9397	1239	10431	834	12235	638	7940
12-#14	3.97	MA	8516	2574	13147	2072	15439	1723	17024	1418	19304	912	24384	502	20271
4E		MI	4676	2574	7639	1954	8670	1616	9369	1319	10408	836	12129	311	10584
12-#14	3.97	MA	8100	2574	12359	2107	14490	1742	15843	1434	17659	939	22125	423	19118
5L-3S		MI	4808	2574	8045	1943	9239	1594	10066	1315	11325	825	13202	389	11024
12-#14	3.97	MA	7735	2574	11612	2118	13598	1760	14682	1466	16089	966	19913	298	17871
6L-2S		MI	5060	2574	8619	1932	9970	1587	10954	1297	12527	813	14700	551	11059
12-#18	7.06	MA	9509	3174	15491	2520	18362	2048	20477	1635	23850	937	30867	98	30414
5L-3S		MI	5614	3174	10143	2298	11844	1847	13200	1476	15521	774	17878	-3	17873
14-#10	2.61	MA	7862	2311	11625	1908	13642	1597	14893	1337	16468	922	20369	641	14084
4L-5S		MI	4309	2311	6644	1827	7523	1518	8010	1273	8553	864	10056	483	7477
14-#10	2.61	MA	7611	2311	11173	1928	13097	1609	14215	1348	15523	939	19077	600	13744
5L-4S		MI	4411	2311	6887	1811	7816	1512	8373	1260	9058	855	10708	537	7666
14-#10	2.61	MA	7393	2311	10734	1934	12585	1620	13549	1367	14622	956	17817	531	13282
6L-3S		MI	4492	2311	7124	1803	8149	1498	8782	1256	9616	855	11367	585	7682
14-#10	2.61	MA	7207	2311	10318	1942	11999	1634	12910	1377	13702	965	16600	497	12783
7L-2S		MI	4649	2311	7464	1796	8581	1492	9307	1243	10327	846	12297	677	7679
14-#11	3.21	MA	7901	2427	11877	2000	13932	1661	15197	1380	16821	933	20889	540	16331
5L-4S		MI	4549	2427	7289	1868	8273	1553	8906	1282	9760	837	11464	449	9091
14-#11	3.21	MA	7643	2427	11350	2007	13310	1674	14387	1402	15725	953	19350	454	15810
6L-3S		MI	4644	2427	7575	1860	8674	1536	9397	1278	10431	838	12235	506	9166
14-#11	3.21	MA	7423	2427	10845	2016	12606	1692	13608	1414	14606	962	17861	411	14975
7L-2S		MI	4826	2427	7981	1852	9191	1530	10025	1264	11281	829	13317	618	9173
14-#14	4.63	MA	8624	2703	13495	2187	15937	1800	17600	1471	20037	932	25418	413	22499
5L-4S		MI	4922	2703	8213	2034	9401	1675	10257	1355	11610	829	13627	277	12222

RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

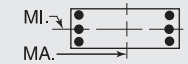


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	4.63	MA	8276	2703	12748	2198	15045	1818	16439	1502	18467	959	23206	287	21237
6L-3S		MI	5062	2703	8619	2023	9970	1653	10954	1352	12527	817	14700	356	12740
14-#14	4.63	MA	7978	2703	12025	2211	14049	1845	15324	1519	16864	971	21067	223	19831
7L-2S		MI	5287	2703	9193	2012	10701	1645	11842	1333	13729	806	16198	518	12789
16-#10	2.99	MA	7922	2383	11829	1974	13934	1642	15231	1368	16898	935	20980	594	15683
5E		MI	4458	2383	6984	1873	7955	1551	8535	1293	9263	860	10986	470	8460
16-#10	2.99	MA	7710	2383	11390	1980	13421	1653	14565	1387	15996	952	19720	525	15236
6L-4S		MI	4560	2383	7227	1857	8248	1545	8898	1281	9768	851	11638	524	8682
16-#10	2.99	MA	7532	2383	10974	1987	12835	1667	13926	1398	15077	960	18503	491	14734
7L-3S		MI	4638	2383	7464	1849	8581	1531	9307	1276	10327	850	12297	572	8705
16-#10	2.99	MA	7316	2383	10576	1997	12296	1675	13245	1413	14199	977	17328	445	14137
8L-2S		MI	4792	2383	7803	1841	9013	1525	9832	1264	11037	841	13227	663	8709
16-#11	3.67	MA	8021	2516	12146	2063	14323	1714	15617	1428	17390	948	21657	447	18182
6L-4S		MI	4724	2516	7695	1924	8790	1593	9534	1307	10610	832	12546	429	10248
16-#11	3.67	MA	7812	2516	11641	2072	13619	1733	14839	1440	16271	957	20167	404	17343
7L-3S		MI	4815	2516	7981	1916	9191	1577	10025	1303	11281	833	13317	485	10385
16-#11	3.67	MA	7557	2516	11156	2083	12964	1741	14025	1459	15203	977	18733	344	16459
8L-2S		MI	4992	2516	8387	1907	9708	1571	10653	1289	12131	824	14399	598	10402
16-#14	5.29	MA	8805	2831	13885	2278	16492	1877	18197	1539	20846	951	26499	277	24604
6L-4S		MI	5191	2831	8788	2114	10132	1733	11146	1392	12812	821	15125	243	13869
16-#14	5.29	MA	8524	2831	13162	2291	15495	1903	17082	1555	19243	964	24361	212	23182
7L-3S		MI	5296	2831	9193	2103	10701	1711	11842	1388	13729	810	16198	322	14453
18-#10	3.36	MA	8023	2456	12047	2025	14257	1686	15580	1408	17371	948	21623	519	17192
6L-5S		MI	4606	2456	7323	1918	8388	1584	9060	1314	9974	856	11915	457	9446
18-#10	3.36	MA	7851	2456	11631	2033	13671	1700	14941	1418	16451	956	20406	485	16687
7L-4S		MI	4707	2456	7566	1902	8680	1578	9423	1301	10479	847	12568	511	9697
18-#10	3.36	MA	7638	2456	11232	2042	13132	1708	14260	1433	15573	973	19231	439	16096
8L-3S		MI	4783	2456	7803	1894	9013	1563	9832	1297	11037	846	13227	559	9726
18-#10	3.36	MA	7426	2456	10784	2060	12579	1725	13596	1440	14675	981	18075	395	15340
9L-2S		MI	4934	2456	8143	1886	9446	1557	10357	1284	11747	837	14157	650	9736
18-#11	4.13	MA	8193	2605	12436	2128	14633	1773	16070	1465	17937	952	22473	397	19714
7L-4S		MI	4897	2605	8101	1980	9307	1634	10162	1332	11460	827	13627	408	11412
18-#11	4.13	MA	7941	2605	11951	2139	13977	1782	15255	1484	16868	972	21039	337	18817
8L-3S		MI	4984	2605	8387	1971	9708	1617	10653	1328	12131	828	14399	465	11603
18-#14	5.96	MA	9059	2960	14298	2371	16942	1962	18839	1591	21621	956	27654	202	26532
7L-4S		MI	5430	2960	9362	2194	10863	1791	12034	1428	14014	814	16623	210	15524
20-#10	3.74	MA	8166	2528	12288	2078	14507	1733	15957	1439	17825	952	22309	480	18641
7L-5S		MI	4752	2528	7663	1963	8820	1617	9585	1334	10684	852	12845	444	10435
20-#10	3.74	MA	7954	2528	11889	2087	13968	1741	15276	1454	16947	969	21134	433	18054
8L-4S		MI	4854	2528	7906	1947	9112	1611	9948	1322	11189	843	13498	498	10706
20-#10	3.74	MA	7749	2528	11441	2106	13415	1758	14612	1461	16049	977	19978	389	17291
9L-3S		MI	4926	2528	8143	1939	9446	1596	10357	1318	11747	842	14157	546	10745
20-#10	3.74	MA	7561	2528	11028	2113	12893	1767	13949	1477	15175	994	18808	348	16558
10L-2S		MI	5074	2528	8482	1932	9878	1590	10881	1305	12458	833	15086	637	10760
20-#11	4.59	MA	8318	2694	12747	2194	14991	1822	16486	1509	18534	967	23346	330	21175
8L-4S		MI	5069	2694	8507	2035	9825	1674	10790	1357	12309	822	14709	388	12581
22-#10	4.11	MA	8266	2601	12546	2133	14804	1774	16291	1474	18322	965	23037	427	20012
8L-5S		MI	4897	2601	8002	2009	9252	1650	10110	1355	11395	848	13775	431	11426
22-#10	4.11	MA	8066	2601	12098	2151	14251	1791	15627	1481	17424	973	21881	383	19242
9L-4S		MI	4999	2601	8245	1993	9545	1644	10473	1342	11899	838	14428	485	11685
22-#10	4.11	MA	7885	2601	11684	2158	13729	1800	14965	1498	16549	989	20710	342	18503
10L-3S		MI	5069	2601	8482	1985	9878	1629	10881	1338	12458	838	15086	533	11763
24-#10	4.48	MA	8379	2674	12755	2196	15087	1824	16643	1502	18798	969	23784	377	21193
9L-5S		MI	5042	2674	8342	2054	9684	1683	10635	1376	12105	843	14705	418	12420
24-#10	4.48	MA	8204	2674	12341	2203	14565	1833	15980	1518	17923	985	22613	336	20448
10L-4S		MI	5143	2674	8585	2038	9977	1677	10998	1363	12610	834	15357	472	12667

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis



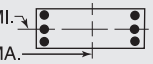
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.25	MA	8065	2166	11612	1809	13498	1523	14496	1299	15476	961	18469	835	7724
2E		MI	4319	2166	6626	1696	7373	1426	7732	1214	8031	894	9045	730	4060
4-#18	2.22	MA	8875	2366	13519	1920	15842	1602	17302	1345	19241	941	23656	812	13298
2E		MI	4642	2366	7508	1796	8427	1495	8980	1252	9687	866	10873	632	6708
6-#10	1.06	MA	7929	2127	11167	1801	13033	1519	13982	1300	14823	973	17595	847	6652
2L-3S		MI	4105	2127	6066	1709	6747	1440	7013	1238	7089	923	7989	682	3555
6-#10	1.06	MA	7547	2127	10465	1814	12140	1531	12897	1311	13353	990	15560	767	6663
3L-2S		MI	4278	2127	6405	1701	7179	1434	7538	1226	7800	914	8918	774	3532
6-#11	1.30	MA	8132	2177	11684	1823	13632	1533	14680	1307	15743	964	18851	838	8059
2L-3S		MI	4153	2177	6252	1723	6934	1448	7216	1241	7345	910	8246	631	4255
6-#11	1.30	MA	7679	2177	10832	1838	12548	1547	13363	1319	13961	985	16383	737	8063
3L-2S		MI	4356	2177	6659	1715	7451	1442	7844	1227	8195	901	9328	743	4225
6-#14	1.88	MA	8632	2295	12828	1889	15047	1581	16377	1335	18022	953	21994	825	11418
2L-3S		MI	4285	2295	6626	1787	7373	1492	7732	1269	8031	898	9045	535	5878
6-#14	1.88	MA	8010	2295	11612	1911	13498	1600	14496	1352	15476	982	18469	678	11375
3L-2S		MI	4562	2295	7200	1776	8104	1485	8620	1251	9234	886	10542	696	5846
6-#18	3.33	MA	9810	2595	15641	2063	18545	1705	20585	1410	23683	928	29808	794	19703
2L-3S		MI	4596	2595	7508	1953	8427	1607	8980	1344	9687	865	10873	268	9662
6-#18	3.33	MA	8815	2595	13519	2098	15842	1737	17302	1438	19241	975	23656	524	19404
3L-2S		MI	5040	2595	8489	1938	9676	1599	10497	1317	11735	852	13319	556	9709
8-#9	1.11	MA	7989	2138	11257	1812	13170	1527	14159	1306	15070	974	17944	848	6987
2L-4S		MI	4097	2138	5989	1727	6642	1461	6892	1247	6928	926	7857	668	3735
8-#9	1.11	MA	7689	2138	10702	1822	12463	1537	13300	1314	13908	988	16335	785	6995
3E		MI	4171	2138	6177	1721	6907	1449	7216	1244	7371	925	8385	707	3715
8-#9	1.11	MA	7535	2138	10328	1832	11934	1553	12651	1330	13018	996	15271	746	6982
4L-2S		MI	4308	2138	6446	1715	7250	1444	7633	1234	7936	917	9131	779	3698
8-#10	1.41	MA	8266	2199	11869	1847	13927	1552	15068	1321	16292	969	19629	841	8785
2L-4S		MI	4166	2199	6168	1762	6846	1487	7130	1263	7241	919	8260	621	4625
8-#10	1.41	MA	7895	2199	11167	1859	13033	1564	13982	1331	14823	986	17595	761	8783
3E		MI	4258	2199	6405	1754	7179	1473	7538	1259	7800	919	8918	669	4607
8-#10	1.41	MA	7706	2199	10694	1872	12364	1584	13161	1351	13696	995	16246	711	8735
4L-2S		MI	4427	2199	6745	1747	7611	1467	8063	1246	8510	910	9848	761	4587
8-#11	1.73	MA	8531	2266	12535	1878	14716	1574	15997	1332	17525	959	21318	831	10643
2L-4S		MI	4224	2266	6373	1787	7050	1505	7353	1270	7524	904	8557	554	5521
8-#11	1.73	MA	8094	2266	11684	1893	13632	1588	14680	1345	15743	980	18851	730	10628
3E		MI	4333	2266	6659	1779	7451	1488	7844	1266	8195	905	9328	611	5507
8-#11	1.73	MA	7870	2266	11108	1908	12818	1612	13681	1368	14373	990	17201	669	10532
4L-2S		MI	4530	2266	7065	1771	7968	1482	8472	1252	9045	895	10410	723	5483
8-#14	2.50	MA	9184	2423	14045	1970	16596	1640	18259	1372	20569	946	25520	815	15096
2L-4S		MI	4386	2423	6795	1878	7535	1572	7924	1310	8317	901	9470	422	7459
8-#14	2.50	MA	8591	2423	12828	1991	15047	1659	16377	1389	18022	974	21994	667	15022
3E		MI	4534	2423	7200	1867	8104	1550	8620	1306	9234	890	10542	501	7621
8-#14	2.50	MA	8288	2423	12003	2012	13881	1693	14947	1421	16062	988	19622	578	14712
4L-2S		MI	4802	2423	7775	1856	8836	1543	9509	1287	10436	879	12040	663	7608
8-#18	4.44	MA	9790	2823	15641	2241	18545	1841	20585	1502	23683	961	29808	505	25747
3E		MI	5009	2823	8489	2096	9676	1711	10497	1409	11735	851	13319	192	12571
8-#18	4.44	MA	9315	2823	14195	2276	16504	1899	18081	1557	20252	982	25617	344	23057
4L-2S		MI	5423	2823	9470	2081	10925	1703	12013	1382	13783	838	15765	480	12678
10-#10	1.76	MA	8597	2272	12571	1892	14821	1585	16153	1341	17761	965	21663	836	10912
2L-5S		MI	4217	2272	6265	1824	6986	1526	7292	1296	7447	924	8537	554	5595
10-#10	1.76	MA	8237	2272	11869	1905	13927	1597	15068	1352	16292	982	19629	755	10898
3L-4S		MI	4321	2272	6508	1808	7278	1520	7655	1284	7952	915	9189	608	5657

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.76	MA	8057	2272	11396	1917	13258	1617	14246	1371	15165	991	18280	706	10837
4L-3S		MI	4409	2272	6745	1800	7611	1506	8063	1279	8510	915	9848	656	5648
10-#10	1.76	MA	7781	2272	10910	1938	12678	1629	13523	1382	14158	1008	16905	666	10614
5L-2S		MI	4574	2272	7084	1792	8044	1500	8588	1267	9221	905	10778	748	5632
10-#11	2.17	MA	8501	2355	12535	1949	14716	1628	15997	1370	17525	974	21318	723	13188
3L-4S		MI	4406	2355	6779	1843	7567	1545	7981	1295	8373	898	9638	534	6743
10-#11	2.17	MA	8290	2355	11959	1964	13902	1652	14998	1393	16155	985	19668	662	13077
4L-3S		MI	4509	2355	7065	1835	7968	1529	8472	1291	9045	900	10410	591	6746
10-#11	2.17	MA	7963	2355	11373	1989	13196	1666	14118	1405	14929	1005	17991	611	12508
5L-2S		MI	4702	2355	7471	1826	8485	1523	9100	1277	9895	890	11491	703	6731
10-#14	3.13	MA	9157	2552	14045	2071	16596	1717	18259	1425	20569	967	25520	657	18670
3L-4S		MI	4639	2552	7369	1959	8267	1631	8812	1346	9519	894	10967	389	9066
10-#14	3.13	MA	8877	2552	13220	2092	15431	1751	16829	1458	18609	980	23148	567	18273
4L-3S		MI	4779	2552	7775	1948	8836	1609	9509	1342	10436	883	12040	467	9349
10-#14	3.13	MA	8419	2552	12380	2128	14418	1770	15568	1475	16852	1009	20741	491	16929
5L-2S		MI	5038	2552	8349	1937	9567	1601	10397	1324	11638	871	13538	629	9358
10-#18	5.56	MA	10315	3051	16318	2419	19206	2003	21363	1622	24695	969	31769	325	29353
4L-3S		MI	5431	3051	9470	2239	10925	1814	12013	1474	13783	837	15765	116	15357
10-#18	5.56	MA	9543	3051	14843	2481	17429	2034	19152	1650	21615	1016	27535	181	26632
5L-2S		MI	5801	3051	10451	2224	12174	1807	13530	1447	15832	824	18211	404	15627
12-#10	2.12	MA	8573	2345	12571	1950	14821	1630	16153	1372	17761	978	21663	749	13011
3L-5S		MI	4370	2345	6604	1869	7418	1559	7816	1317	8157	920	9467	541	6567
12-#10	2.12	MA	8402	2345	12098	1963	14152	1650	15332	1392	16635	987	20315	700	12941
4E		MI	4473	2345	6847	1853	7710	1553	8180	1304	8662	911	10119	595	6681
12-#10	2.12	MA	8128	2345	11612	1983	13571	1662	14609	1403	15627	1004	18940	660	12680
5L-3S		MI	4558	2345	7084	1845	8044	1539	8588	1300	9221	910	10778	643	6682
12-#10	2.12	MA	7885	2345	11143	1989	13019	1673	13899	1422	14666	1022	17598	593	12145
6L-2S		MI	4720	2345	7424	1837	8476	1533	9113	1287	9931	901	11708	735	6671
12-#11	2.60	MA	8702	2444	12811	2020	14986	1693	16315	1418	17937	979	22136	654	15623
4E		MI	4585	2444	7185	1899	8084	1585	8609	1320	9223	893	10720	514	7960
12-#11	2.60	MA	8377	2444	12225	2045	14280	1707	15435	1431	16711	1000	20458	604	15019
5L-3S		MI	4684	2444	7471	1890	8485	1569	9100	1317	9895	894	11491	570	7978
12-#11	2.60	MA	8088	2444	11656	2052	13616	1720	14571	1454	15541	1020	18822	518	14419
6L-2S		MI	4872	2444	7877	1882	9002	1563	9728	1303	10745	885	12573	683	7971
12-#14	3.75	MA	9453	2680	14437	2173	16980	1810	18710	1494	21155	973	26674	557	21846
4E		MI	4888	2680	7943	2039	8998	1689	9700	1382	10721	886	12465	355	10689
12-#14	3.75	MA	8998	2680	13597	2209	15967	1829	17449	1511	19398	1001	24267	481	20547
5L-3S		MI	5021	2680	8349	2028	9567	1667	10397	1379	11638	875	13538	434	11070
12-#14	3.75	MA	8604	2680	12790	2219	15015	1848	16211	1544	17723	1030	21917	357	19282
6L-2S		MI	5273	2680	8923	2017	10298	1660	11285	1360	12840	864	15036	596	11098
12-#18	6.67	MA	10521	3280	16966	2624	20132	2138	22435	1714	26058	1003	33686	163	32875
5L-3S		MI	5827	3280	10451	2382	12174	1918	13530	1538	15832	823	18211	40	18061
12-#18	6.67	MA	9889	3280	15579	2644	18460	2170	20262	1769	23118	1050	29534	-61	29300
6L-2S		MI	6175	3280	11432	2367	13422	1910	15047	1511	17880	810	20657	328	18567
14-#10	2.47	MA	8742	2417	12800	2008	15046	1683	16418	1412	18104	982	22349	694	15044
4L-5S		MI	4521	2417	6944	1914	7850	1592	8341	1337	8868	916	10396	528	7544
14-#10	2.47	MA	8469	2417	12314	2028	14465	1695	15695	1423	17096	1000	20974	655	14751
5L-4S		MI	4624	2417	7187	1898	8143	1586	8705	1325	9373	907	11049	582	7701
14-#10	2.47	MA	8233	2417	11845	2034	13913	1706	14985	1442	16135	1017	19632	587	14233
6L-3S		MI	4705	2417	7424	1890	8476	1572	9113	1321	9931	906	11708	630	7712
14-#10	2.47	MA	8033	2417	11401	2043	13288	1721	14301	1453	15155	1026	18341	554	13760
7L-2S		MI	4864	2417	7763	1883	8908	1566	9638	1308	10641	897	12638	722	7706
14-#11	3.03	MA	8783	2533	13076	2101	15364	1747	16751	1456	18493	995	22926	596	17536
5L-4S		MI	4762	2533	7591	1954	8601	1626	9237	1345	10073	888	11802	494	9174

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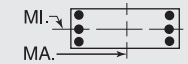
RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis

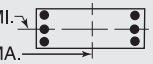


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	3.03	MA	8505	2533	12507	2108	14700	1761	15887	1479	17323	1015	21289	511	16957
6L-3S		MI	4857	2533	7877	1946	9002	1610	9728	1342	10745	889	12573	550	9203
14-#11	3.03	MA	8268	2533	11968	2117	13941	1779	15058	1491	16130	1025	19707	470	16120
7L-2S		MI	5040	2533	8283	1938	9519	1604	10356	1328	11594	880	13655	662	9206
14-#14	4.38	MA	9564	2809	14813	2289	17516	1887	19331	1548	21945	994	27793	471	24171
5L-4S		MI	5134	2809	8518	2119	9729	1747	10588	1419	11923	879	13963	321	12324
14-#14	4.38	MA	9188	2809	14006	2299	16564	1906	18093	1580	20269	1022	25443	346	22887
6L-3S		MI	5260	2809	8923	2108	10298	1725	11285	1415	12840	868	15036	400	12787
14-#14	4.38	MA	8867	2809	13234	2313	15488	1933	16903	1597	18559	1036	23167	285	21465
7L-2S		MI	5504	2809	9498	2097	11030	1718	12173	1397	14042	856	16534	562	12829
14-#18	7.78	MA	10881	3508	17702	2786	21163	2274	23544	1834	27561	1036	35685	-79	35255
6L-3S		MI	6217	3508	11432	2524	13422	2022	15047	1603	17880	809	20657	-36	20588
16-#10	2.82	MA	8804	2490	13016	2074	15359	1728	16780	1444	18565	996	23008	649	16826
5E		MI	4671	2490	7283	1960	8282	1625	8866	1358	9578	912	11326	515	8526
16-#10	2.82	MA	8576	2490	12547	2080	14807	1739	16071	1463	17605	1013	21667	581	16324
6L-4S		MI	4773	2490	7526	1944	8575	1619	9230	1345	10083	903	11979	569	8719
16-#10	2.82	MA	8383	2490	12103	2088	14182	1754	15386	1473	16624	1022	20375	548	15849
7L-3S		MI	4852	2490	7763	1936	8908	1605	9638	1341	10641	902	12638	617	8736
16-#10	2.82	MA	8149	2490	11678	2098	13607	1762	14655	1488	15688	1039	19126	503	15181
8L-2S		MI	5007	2490	8103	1928	9340	1599	10163	1328	11352	893	13567	709	8737
16-#11	3.47	MA	8913	2622	13359	2163	15784	1801	17204	1504	19105	1010	23757	504	19498
6L-4S		MI	4937	2622	7997	2010	9118	1666	9865	1371	10923	883	12884	473	10334
16-#11	3.47	MA	8687	2622	12819	2173	15025	1819	16374	1517	17912	1020	22174	462	18654
7L-3S		MI	5028	2622	8283	2002	9519	1650	10356	1367	11594	884	13655	530	10424
16-#11	3.47	MA	8409	2622	12302	2184	14326	1829	15494	1535	16772	1040	20649	404	17766
8L-2S		MI	5208	2622	8689	1993	10036	1644	10984	1353	12444	875	14737	642	10436
16-#14	5.00	MA	9760	2937	15223	2380	18113	1965	19974	1616	22816	1015	28969	336	26492
6L-4S		MI	5377	2937	9092	2199	10460	1806	11476	1455	13125	872	15461	288	13969
16-#14	5.00	MA	9456	2937	14451	2393	17037	1991	18785	1634	21105	1029	26692	274	25053
7L-3S		MI	5512	2937	9498	2189	11030	1784	12173	1452	14042	860	16534	366	14502
16-#14	5.00	MA	9067	2937	13709	2409	16035	2004	17538	1661	19472	1057	24502	188	23396
8L-2S		MI	5730	2937	10072	2178	11761	1776	13062	1433	15244	849	18032	528	14557
18-#10	3.17	MA	8913	2562	13249	2125	15701	1772	17156	1483	19074	1009	23701	575	18417
6L-5S		MI	4819	2562	7623	2005	8714	1658	9391	1379	10289	907	12256	502	9511
18-#10	3.17	MA	8728	2562	12805	2133	15076	1787	16472	1494	18093	1018	22410	542	17940
7L-4S		MI	4920	2562	7866	1989	9007	1652	9755	1366	10793	898	12908	556	9735
18-#10	3.17	MA	8495	2562	12380	2143	14501	1795	15741	1509	17158	1035	21160	497	17275
8L-3S		MI	4997	2562	8103	1981	9340	1638	10163	1362	11352	898	13567	604	9758
18-#10	3.17	MA	8267	2562	11899	2161	13910	1812	15033	1517	16201	1044	19935	453	16517
9L-2S		MI	5149	2562	8442	1973	9772	1632	10688	1349	12062	889	14497	696	9766
18-#11	3.90	MA	9098	2711	13671	2229	16109	1860	17691	1542	19694	1015	24642	455	21188
7L-4S		MI	5110	2711	8404	2066	9635	1707	10493	1396	11773	878	13965	453	11497
18-#11	3.90	MA	8823	2711	13153	2240	15410	1869	16811	1560	18554	1035	23116	397	20289
8L-3S		MI	5198	2711	8689	2057	10036	1691	10984	1392	12444	879	14737	510	11643
18-#11	3.90	MA	8554	2711	12573	2262	14691	1890	15949	1569	17389	1045	21614	343	19302
9L-2S		MI	5374	2711	9095	2049	10553	1684	11612	1378	13294	870	15818	622	11662
18-#14	5.63	MA	10034	3066	15667	2473	18586	2049	20667	1670	23652	1021	30218	264	28641
7L-4S		MI	5643	3066	9666	2280	11192	1864	12365	1492	14327	864	16959	254	15623
18-#14	5.63	MA	9648	3066	14926	2489	17585	2062	19420	1697	22018	1050	28028	178	26995
8L-3S		MI	5743	3066	10072	2269	11761	1842	13062	1488	15244	853	18032	333	16215
20-#10	3.53	MA	9067	2635	13507	2179	15969	1819	17557	1515	19563	1014	24444	536	20033
7L-5S		MI	4965	2635	7962	2050	9147	1691	9916	1399	10999	903	13186	489	10500
20-#10	3.53	MA	8836	2635	13082	2188	15394	1828	16827	1530	18627	1031	23194	491	19369
8L-4S		MI	5067	2635	8205	2034	9439	1685	10280	1386	11504	894	13838	543	10749
20-#10	3.53	MA	8615	2635	12601	2206	14804	1845	16118	1537	17670	1040	21969	447	18603
9L-3S		MI	5141	2635	8442	2026	9772	1671	10688	1382	12062	893	14497	591	10779
20-#10	3.53	MA	8403	2635	12159	2214	14248	1855	15412	1554	16725	1056	20624	396	17869
10L-2S		MI	5290	2635	8782	2019	10205	1665	11213	1370	12773	884	15427	683	10791

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	4.33	MA	9230	2800	14005	2296	16494	1909	18128	1586	20336	1030	25584	390	22812
8L-4S		MI	5282	2800	8810	2121	10152	1747	11121	1421	12623	873	15047	433	12665
20-#11	4.33	MA	8969	2800	13424	2318	15775	1930	17266	1594	19171	1040	24081	336	21830
9L-3S		MI	5367	2800	9095	2113	10553	1731	11612	1418	13294	874	15818	490	12860
20-#14	6.25	MA	10218	3194	16143	2569	19134	2120	21301	1734	24565	1042	31554	168	30595
8L-4S		MI	5880	3194	10241	2360	11923	1923	13253	1528	15529	857	18457	220	17283
22-#10	3.88	MA	9172	2707	13784	2234	16288	1860	17912	1550	20096	1027	25229	485	21463
8L-5S		MI	5111	2707	8301	2096	9579	1724	10441	1420	11710	899	14115	476	11491
22-#10	3.88	MA	8957	2707	13303	2252	15698	1878	17204	1558	19139	1036	24003	441	20689
9L-4S		MI	5212	2707	8544	2080	9871	1718	10804	1407	12214	890	14768	530	11759
22-#10	3.88	MA	8762	2707	12861	2259	15142	1887	16497	1575	18194	1052	22658	390	19948
10L-3S		MI	5284	2707	8782	2072	10205	1704	11213	1403	12773	889	15427	578	11798
22-#11	4.77	MA	9378	2889	14276	2374	16860	1971	18583	1620	20953	1035	26549	329	24358
9L-4S		MI	5453	2889	9216	2177	10669	1788	11749	1446	13473	867	16129	413	13837
24-#10	4.23	MA	9294	2780	14005	2297	16592	1911	18290	1578	20608	1032	26038	436	22775
9L-5S		MI	5256	2780	8641	2141	10011	1757	10966	1440	12420	895	15045	463	12484
24-#10	4.23	MA	9105	2780	13563	2304	16036	1920	17583	1595	19663	1048	24692	385	22028
10L-4S		MI	5357	2780	8884	2125	10304	1751	11329	1428	12925	886	15698	517	12740

RECTANGULAR TIED COLUMNS 20" x 38"

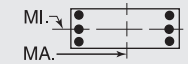
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.18	MA	8941	2272	12763	1909	14867	1608	15966	1373	17014	1020	20275	887	8210
2E		MI	4532	2272	6930	1781	7701	1499	8063	1278	8344	944	9381	774	4085
4-#18	2.11	MA	9817	2472	14802	2019	17373	1686	18967	1419	21039	1000	25822	864	14162
2E		MI	4856	2472	7817	1879	8757	1567	9310	1315	9998	916	11205	676	6744
6-#10	1.00	MA	8792	2233	12286	1901	14367	1604	15413	1374	16310	1032	19334	899	7063
2L-3S		MI	4317	2233	6365	1796	7074	1514	7345	1303	7404	974	8329	728	3574
6-#10	1.00	MA	8382	2233	11538	1914	13416	1616	14258	1385	14746	1050	17168	820	7074
3L-2S		MI	4491	2233	6705	1788	7506	1508	7869	1290	8115	965	9259	819	3551
6-#11	1.23	MA	9012	2283	12838	1922	15008	1618	16160	1381	17294	1023	20677	890	8564
2L-3S		MI	4366	2283	6555	1809	7261	1521	7547	1305	7658	961	8584	676	4278
6-#11	1.23	MA	8524	2283	11931	1937	13853	1633	14757	1394	15396	1044	18049	791	8569
3L-2S		MI	4569	2283	6961	1801	7778	1515	8175	1291	8508	952	9666	788	4248
6-#14	1.78	MA	9551	2401	14060	1989	16518	1666	17972	1409	19728	1012	24033	877	12147
2L-3S		MI	4497	2401	6930	1872	7701	1565	8063	1333	8344	948	9381	579	5911
6-#14	1.78	MA	8882	2401	12763	2011	14867	1686	15966	1427	17014	1042	20275	731	12104
3L-2S		MI	4776	2401	7505	1861	8433	1557	8951	1314	9546	937	10879	741	5875
6-#18	3.16	MA	10825	2701	17067	2162	20258	1790	22471	1484	25780	986	32387	845	20999
2L-3S		MI	4808	2701	7817	2037	8757	1679	9310	1407	9998	915	11205	312	9720
6-#18	3.16	MA	9751	2701	14802	2199	17373	1823	18967	1513	21039	1036	25822	580	20700
3L-2S		MI	5255	2701	8797	2022	10005	1671	10827	1379	12046	902	13651	600	9751
8-#9	1.05	MA	8856	2244	12381	1911	14511	1612	15600	1380	16572	1033	19704	900	7419
2L-4S		MI	4309	2244	6287	1815	6969	1536	7224	1312	7243	977	8199	714	3755
8-#9	1.05	MA	8533	2244	11790	1921	13759	1622	14686	1389	15335	1048	17991	838	7427
3E		MI	4383	2244	6475	1808	7233	1524	7548	1309	7686	976	8726	752	3734
8-#9	1.05	MA	8368	2244	11392	1932	13197	1638	13996	1404	14389	1055	16865	799	7414
4L-2S		MI	4521	2244	6745	1802	7577	1519	7965	1298	8251	969	9473	824	3717
8-#10	1.34	MA	9154	2306	13033	1946	15319	1637	16569	1394	17874	1028	21499	893	9333
2L-4S		MI	4378	2306	6468	1849	7173	1562	7461	1328	7556	971	8600	666	4650
8-#10	1.34	MA	8756	2306	12286	1959	14367	1649	15413	1406	16310	1046	19334	814	9331
3E		MI	4470	2306	6705	1841	7506	1547	7869	1324	8115	970	9259	715	4629

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

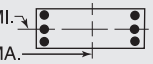


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	1.34	MA	8552	2306	11783	1972	13656	1670	14540	1425	15113	1055	17906	765	9284
4L-2S		MI	4640	2306	7044	1834	7938	1541	8394	1311	8825	961	10189	806	4608
8-#11	1.64	MA	9442	2372	13745	1978	16163	1659	17563	1406	19193	1018	23306	883	11316
2L-4S		MI	4436	2372	6675	1873	7378	1578	7684	1334	7837	954	8895	599	5553
8-#11	1.64	MA	8971	2372	12838	1993	15008	1673	16160	1419	17294	1039	20677	783	11302
3E		MI	4545	2372	6961	1865	7778	1562	8175	1330	8508	956	9666	655	5534
8-#11	1.64	MA	8730	2372	12226	2009	14142	1698	15098	1443	15838	1050	18930	722	11205
4L-2S		MI	4743	2372	7367	1857	8295	1556	8803	1316	9358	946	10748	768	5510
8-#14	2.37	MA	10146	2529	15357	2069	18169	1724	19978	1445	22443	1005	27792	866	16068
2L-4S		MI	4597	2529	7099	1964	7864	1645	8254	1373	8629	952	9806	466	7567
8-#14	2.37	MA	9506	2529	14060	2091	16518	1744	17972	1464	19728	1034	24033	721	15994
3E		MI	4746	2529	7505	1953	8433	1623	8951	1369	9546	941	10879	545	7659
8-#14	2.37	MA	9180	2529	13183	2113	15278	1779	16451	1497	17643	1049	21521	632	15686
4L-2S		MI	5016	2529	8079	1942	9164	1616	9840	1351	10748	929	12376	707	7641
8-#18	4.21	MA	10800	2929	17067	2342	20258	1927	22471	1578	25780	1022	32387	562	27475
3E		MI	5221	2929	8797	2180	10005	1782	10827	1471	12046	901	13651	236	12635
8-#18	4.21	MA	10289	2929	15528	2378	18085	1987	19804	1634	22126	1045	27947	401	24787
4L-2S		MI	5640	2929	9778	2165	11254	1775	12344	1444	14094	888	16097	524	12725
10-#10	1.67	MA	9510	2378	13780	1991	16270	1670	17725	1415	19438	1023	23665	887	11598
2L-5S		MI	4429	2378	6564	1911	7312	1601	7623	1361	7762	976	8877	600	5662
10-#10	1.67	MA	9123	2378	13033	2004	15319	1682	16569	1426	17874	1041	21499	808	11584
3L-4S		MI	4533	2378	6807	1895	7605	1595	7986	1348	8267	967	9530	653	5685
10-#10	1.67	MA	8930	2378	12530	2017	14608	1703	15696	1446	16677	1051	20072	759	11523
4L-3S		MI	4621	2378	7044	1887	7938	1580	8394	1344	8825	966	10189	702	5672
10-#10	1.67	MA	8631	2378	12010	2038	13991	1715	14928	1457	15606	1069	18614	721	11356
5L-2S		MI	4787	2378	7384	1879	8370	1574	8919	1331	9536	957	11118	793	5655
10-#11	2.05	MA	9408	2461	13745	2049	16163	1714	17563	1444	19193	1034	23306	776	14031
3L-4S		MI	4618	2461	7081	1929	7895	1618	8312	1359	8687	949	9976	579	6781
10-#11	2.05	MA	9182	2461	13133	2064	15297	1738	16501	1468	17737	1045	21559	715	13919
4L-3S		MI	4722	2461	7367	1921	8295	1602	8803	1355	9358	950	10748	635	6777
10-#11	2.05	MA	8827	2461	12506	2090	14546	1752	15566	1481	16433	1066	19780	666	13387
5L-2S		MI	4915	2461	7773	1912	8813	1596	9431	1341	10208	941	11829	747	6759
10-#14	2.96	MA	10115	2658	15357	2171	18169	1803	19978	1500	22443	1027	27792	711	19885
3L-4S		MI	4850	2658	7673	2044	8595	1704	9143	1409	9831	944	11303	433	9171
10-#14	2.96	MA	9814	2658	14480	2193	16930	1838	18456	1533	20357	1041	25280	622	19565
4L-3S		MI	4992	2658	8079	2033	9164	1681	9840	1406	10748	933	12376	512	9391
10-#14	2.96	MA	9317	2658	13587	2230	15853	1857	17116	1551	18489	1071	22725	549	18124
5L-2S		MI	5253	2658	8653	2022	9895	1674	10728	1387	11950	922	13874	673	9392
10-#18	5.26	MA	11365	3157	17793	2521	20969	2091	23307	1699	26867	1032	34512	383	31500
4L-3S		MI	5644	3157	9778	2323	11254	1886	12344	1536	14094	887	16097	160	15531
10-#18	5.26	MA	10525	3157	16225	2584	19079	2124	20954	1729	23589	1081	30015	244	28707
5L-2S		MI	6019	3157	10759	2308	12503	1878	13861	1509	16142	874	18543	447	15677
12-#10	2.01	MA	9484	2451	13780	2050	16270	1715	17725	1447	19438	1037	23665	802	13834
3L-5S		MI	4582	2451	6904	1956	7745	1633	8148	1382	8472	972	9807	587	6633
12-#10	2.01	MA	9300	2451	13277	2063	15559	1736	16852	1466	18241	1047	22237	753	13764
4E		MI	4685	2451	7147	1940	8037	1627	8511	1369	8977	962	10460	640	6712
12-#10	2.01	MA	9004	2451	12758	2083	14943	1748	16084	1478	17170	1065	20779	715	13558
5L-3S		MI	4771	2451	7384	1932	8370	1613	8919	1365	9536	962	11118	689	6708
12-#10	2.01	MA	8743	2451	12259	2089	14351	1758	15331	1497	16122	1074	19356	649	12965
6L-2S		MI	4933	2451	7723	1924	8803	1607	9444	1352	10246	953	12048	780	6696
12-#11	2.46	MA	9624	2550	14040	2120	16452	1779	17903	1493	19635	1040	24188	708	16634
4E		MI	4797	2550	7488	1985	8412	1659	8940	1384	9537	944	11058	558	8001
12-#11	2.46	MA	9272	2550	13413	2145	15701	1793	16968	1506	18331	1061	22408	659	16066
5L-3S		MI	4897	2550	7773	1976	8813	1642	9431	1381	10208	945	11829	615	8012
12-#11	2.46	MA	8962	2550	12807	2153	14990	1806	16050	1530	17089	1082	20672	575	15403
6L-2S		MI	5086	2550	8179	1968	9330	1636	10059	1367	11058	936	12911	727	8001
12-#14	3.55	MA	10433	2786	15777	2273	18581	1896	20462	1570	23072	1034	29038	612	23439
4E		MI	5100	2786	8248	2124	9326	1762	10031	1446	11033	937	12801	399	10791

RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

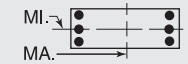
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	3.55	MA	9940	2786	14884	2310	17505	1916	19122	1588	21203	1063	26484	539	21986
5L-3S		MI	5234	2786	8653	2113	9895	1740	10728	1442	11950	926	13874	478	11115
12-#14	3.55	MA	9516	2786	14017	2320	16494	1936	17806	1621	19422	1093	23992	416	20712
6L-2S		MI	5488	2786	9228	2102	10627	1732	11616	1424	13152	914	15372	640	11136
12-#18	6.32	MA	11576	3386	18491	2727	21963	2227	24458	1793	28331	1068	36580	226	35370
5L-3S		MI	6040	3386	10759	2465	12503	1990	13861	1601	16142	873	18543	84	18230
12-#18	6.32	MA	10897	3386	16997	2746	20186	2261	22147	1849	25204	1117	32181	4	32155
6L-2S		MI	6394	3386	11740	2450	13752	1982	15377	1574	18190	860	20989	371	18619
14-#10	2.34	MA	9664	2523	14025	2108	16511	1768	18007	1487	19805	1042	24403	747	16004
4L-5S		MI	4733	2523	7243	2001	8177	1666	8673	1402	9183	967	10737	574	7609
14-#10	2.34	MA	9369	2523	13505	2128	15894	1781	17240	1498	18734	1060	22945	709	15765
5L-4S		MI	4836	2523	7486	1985	8470	1660	9036	1389	9688	958	11389	627	7734
14-#10	2.34	MA	9117	2523	13006	2135	15302	1791	16486	1518	17686	1070	21522	643	15191
6L-3S		MI	4919	2523	7723	1977	8803	1646	9444	1385	10246	958	12048	675	7740
14-#10	2.34	MA	8902	2523	12535	2143	14638	1807	15752	1528	16673	1088	20157	610	14747
7L-2S		MI	5078	2523	8062	1970	9235	1640	9969	1373	10956	948	12978	767	7732
14-#11	2.87	MA	9708	2639	14320	2201	16856	1833	18371	1531	20230	1056	25037	652	18750
5L-4S		MI	4974	2639	7894	2040	8929	1699	9568	1409	10387	939	12140	538	9216
14-#11	2.87	MA	9409	2639	13714	2208	16145	1847	17453	1555	18987	1077	23301	568	18109
6L-3S		MI	5070	2639	8179	2032	9330	1683	10059	1406	11058	940	12911	595	9239
14-#11	2.87	MA	9156	2639	13140	2218	15336	1865	16572	1568	17719	1087	21627	527	17273
7L-2S		MI	5255	2639	8585	2024	9847	1677	10687	1392	11908	931	13993	707	9237
14-#14	4.14	MA	10548	2915	16181	2390	19156	1974	21128	1624	23918	1056	30242	528	25854
5L-4S		MI	5346	2915	8822	2204	10058	1820	10919	1482	12235	929	14299	366	12424
14-#14	4.14	MA	10144	2915	15314	2400	18145	1994	19812	1657	22137	1086	27750	406	24555
6L-3S		MI	5474	2915	9228	2194	10627	1798	11616	1479	13152	918	15372	444	12834
14-#14	4.14	MA	9799	2915	14492	2414	16988	2020	18548	1675	20319	1100	25341	346	23063
7L-2S		MI	5722	2915	9802	2183	11358	1791	12504	1460	14355	907	16870	606	12869
14-#18	7.37	MA	11963	3614	19263	2889	23071	2364	25650	1914	29945	1104	38746	-15	38655
6L-3S		MI	6431	3614	11740	2608	13752	2094	15377	1665	18190	859	20989	8	20959
16-#10	2.67	MA	9730	2596	14252	2174	16846	1814	18395	1519	20298	1056	25111	703	17976
5E		MI	4883	2596	7582	2047	8609	1699	9198	1423	9893	963	11667	561	8591
16-#10	2.67	MA	9484	2596	13754	2180	16254	1824	17642	1539	19251	1066	23688	637	17418
6L-4S		MI	4985	2596	7825	2031	8902	1693	9561	1410	10398	954	12319	614	8754
16-#10	2.67	MA	9278	2596	13282	2189	15589	1840	16908	1549	18237	1083	22322	604	16974
7L-3S		MI	5065	2596	8062	2023	9235	1679	9969	1406	10956	953	12978	662	8767
16-#10	2.67	MA	9024	2596	12830	2198	14979	1848	16131	1564	17244	1101	20998	560	16234
8L-2S		MI	5222	2596	8402	2015	9667	1673	10494	1393	11667	944	13908	754	8764
16-#11	3.28	MA	9848	2728	14621	2264	17299	1887	18856	1580	20886	1071	25929	561	20819
6L-4S		MI	5149	2728	8300	2096	9446	1740	10196	1435	11237	934	13222	518	10418
16-#11	3.28	MA	9605	2728	14048	2274	16491	1906	17974	1593	19618	1082	24256	520	19972
7L-3S		MI	5242	2728	8585	2088	9847	1723	10687	1431	11908	935	13993	575	10462
16-#11	3.28	MA	9305	2728	13498	2285	15748	1915	17029	1611	18407	1103	22639	464	19092
8L-2S		MI	5423	2728	8991	2079	10364	1717	11315	1417	12758	926	15074	687	10470
16-#14	4.74	MA	10758	3043	16611	2481	19796	2052	21817	1694	24851	1078	31509	395	28399
6L-4S		MI	5589	3043	9396	2285	10789	1879	11807	1519	13437	922	15797	332	14068
16-#14	4.74	MA	10432	3043	15789	2494	18639	2078	20554	1712	23033	1093	29099	335	26916
7L-3S		MI	5727	3043	9802	2274	11358	1856	12504	1515	14355	911	16870	411	14550
16-#14	4.74	MA	10009	3043	15001	2511	17574	2092	19212	1739	21298	1122	26776	252	25135
8L-2S		MI	5948	3043	10376	2263	12089	1849	13392	1496	15557	899	18368	573	14598
18-#10	3.01	MA	9846	2668	14501	2225	17205	1857	18798	1559	20815	1061	25853	631	19648
6L-5S		MI	5032	2668	7922	2092	9041	1732	9723	1443	10604	959	12596	548	9575

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

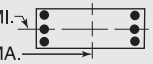


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	3.01	MA	9647	2668	14029	2234	16541	1873	18064	1569	19801	1079	24488	598	19200
7L-4S		MI	5133	2668	8165	2076	9334	1726	10086	1431	11108	950	13249	601	9771
18-#10	3.01	MA	9396	2668	13578	2244	15930	1881	17287	1585	18808	1097	23164	554	18463
8L-3S		MI	5211	2668	8402	2068	9667	1712	10494	1426	11667	949	13908	649	9790
18-#10	3.01	MA	9151	2668	13063	2262	15303	1899	16535	1593	17792	1107	21868	511	17707
9L-2S		MI	5364	2668	8741	2060	10099	1706	11019	1414	12377	940	14838	741	9795
18-#11	3.69	MA	10047	2817	14955	2330	17646	1946	19377	1618	21516	1077	26885	513	22672
7L-4S		MI	5323	2817	8706	2152	9963	1780	10824	1460	12087	929	14303	498	11579
18-#11	3.69	MA	9749	2817	14405	2341	16903	1956	18432	1637	20306	1098	25268	457	21780
8L-3S		MI	5412	2817	8991	2143	10364	1764	11315	1456	12758	930	15074	554	11682
18-#11	3.69	MA	9460	2817	13784	2363	16139	1977	17516	1646	19068	1109	23679	403	20700
9L-2S		MI	5590	2817	9397	2135	10881	1758	11943	1442	13608	921	16156	667	11697
18-#14	5.33	MA	11052	3172	17086	2575	20291	2137	22559	1748	25748	1085	32858	325	30768
7L-4S		MI	5857	3172	9971	2365	11520	1937	12696	1555	14640	915	17295	298	15719
18-#14	5.33	MA	10633	3172	16298	2591	19226	2150	21218	1775	24012	1115	30535	241	28972
8L-3S		MI	5959	3172	10376	2354	12089	1915	13392	1551	15557	903	18368	377	16264
20-#10	3.34	MA	10011	2741	14777	2279	17493	1905	19219	1590	21365	1075	26654	592	21425
7L-5S		MI	5179	2741	8261	2137	9473	1765	10248	1464	11314	955	13526	535	10563
20-#10	3.34	MA	9761	2741	14325	2289	16882	1914	18443	1605	20372	1093	25330	548	20693
8L-4S		MI	5280	2741	8504	2121	9766	1759	10611	1451	11819	946	14179	588	10787
20-#10	3.34	MA	9524	2741	13810	2307	16255	1932	17690	1613	19356	1102	24034	505	19928
9L-3S		MI	5355	2741	8741	2113	10099	1745	11019	1447	12377	945	14838	636	10812
20-#10	3.34	MA	9296	2741	13341	2314	15664	1942	16940	1630	18341	1118	22608	455	19183
10L-2S		MI	5506	2741	9081	2106	10531	1739	11544	1434	13088	936	15767	728	10821
20-#11	4.11	MA	10186	2906	15312	2397	18058	1996	19835	1662	22204	1093	27896	449	24468
8L-4S		MI	5495	2906	9112	2207	10480	1821	11452	1485	12937	923	15385	478	12746
20-#11	4.11	MA	9906	2906	14691	2419	17294	2017	18919	1671	20966	1104	26308	396	23393
9L-3S		MI	5581	2906	9397	2199	10881	1804	11943	1481	13608	925	16156	534	12900
20-#11	4.11	MA	9650	2906	14121	2428	16575	2029	18005	1692	19750	1124	24696	346	22290
10L-2S		MI	5755	2906	9803	2191	11398	1798	12571	1468	14458	915	17238	646	12922
20-#14	5.92	MA	11245	3300	17595	2671	20877	2208	23224	1811	26727	1107	34293	231	32809
8L-4S		MI	6094	3300	10545	2445	12251	1995	13584	1591	15842	907	18793	265	17378
22-#10	3.68	MA	10122	2813	15072	2334	17833	1947	19599	1626	21936	1089	27495	543	22922
8L-5S		MI	5325	2813	8601	2183	9906	1798	10772	1484	12025	950	14456	521	11554
22-#10	3.68	MA	9891	2813	14557	2352	17206	1965	18846	1634	20920	1098	26200	499	22149
9L-4S		MI	5426	2813	8844	2166	10198	1792	11136	1472	12529	941	15109	575	11802
22-#10	3.68	MA	9672	2813	14088	2360	16616	1975	18096	1651	19905	1114	24774	449	21407
10L-3S		MI	5498	2813	9081	2159	10531	1778	11544	1467	13088	941	15767	623	11832
22-#10	3.68	MA	9429	2813	13631	2368	16024	1984	17361	1660	18867	1121	23484	403	20510
11L-2S		MI	5646	2813	9420	2151	10964	1772	12069	1455	13798	932	16697	715	11846
22-#11	4.52	MA	10344	2995	15598	2475	18449	2058	20322	1696	22865	1099	28937	388	26087
9L-4S		MI	5666	2995	9518	2263	10997	1861	12080	1510	13787	918	16467	457	13917
22-#11	4.52	MA	10098	2995	15028	2483	17730	2070	19408	1717	21648	1118	27325	339	24975
10L-3S		MI	5750	2995	9803	2255	11398	1845	12571	1507	14458	919	17238	514	14117
24-#10	4.01	MA	10253	2886	15305	2398	18158	1997	20002	1654	22484	1094	28365	493	24370
9L-5S		MI	5469	2886	8940	2228	10338	1831	11297	1505	12735	946	15386	508	12546
24-#10	4.01	MA	10050	2886	14836	2405	17567	2007	19251	1672	21469	1110	26939	444	23627
10L-4S		MI	5571	2886	9183	2212	10630	1825	11661	1492	13240	937	16038	562	12811
24-#10	4.01	MA	9801	2886	14378	2414	16976	2016	18517	1681	20431	1117	25650	397	22728
11L-3S		MI	5641	2886	9420	2204	10964	1811	12069	1488	13798	937	16697	610	12851
24-#11	4.93	MA	10539	3084	15935	2539	18885	2110	20811	1742	23547	1113	29954	332	27660
10L-4S		MI	5836	3084	9924	2319	11514	1902	12708	1536	14637	913	17548	437	15092

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

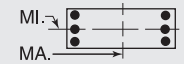


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.13	MA	9860	2379	13964	2008	16297	1692	17503	1447	18617	1078	22156	939	8696
2E		MI	4745	2379	7234	1866	8030	1572	8394	1341	8657	995	9717	819	4110
4-#18	2.00	MA	10802	2578	16135	2119	18966	1771	20698	1493	22903	1059	28061	915	15026
2E		MI	5069	2578	8125	1963	9086	1639	9640	1377	10308	965	11537	719	6780
6-#11	1.17	MA	9934	2389	14042	2021	16444	1703	17706	1455	18911	1082	22578	941	9070
2L-3S		MI	4578	2389	6857	1895	7589	1594	7878	1369	7972	1012	8922	720	4302
6-#11	1.17	MA	9413	2389	13079	2037	15218	1718	16217	1468	16896	1104	19788	844	9074
3L-2S		MI	4782	2389	7263	1887	8106	1588	8506	1355	8822	1002	10004	832	4271
6-#14	1.69	MA	10514	2507	15341	2088	18050	1751	19632	1483	21499	1071	26147	928	12876
2L-3S		MI	4709	2507	7234	1958	8030	1637	8394	1396	8657	999	9717	623	5942
6-#14	1.69	MA	9796	2507	13964	2111	16297	1771	17503	1502	18617	1101	22156	785	12833
3L-2S		MI	4989	2507	7809	1947	8761	1630	9282	1378	9859	987	11215	785	5904
6-#18	3.00	MA	11884	2807	18543	2262	22032	1875	24422	1558	27943	1045	35040	897	22295
2L-3S		MI	5019	2807	8125	2121	9086	1750	9640	1469	10308	964	11537	355	9777
6-#18	3.00	MA	10729	2807	16135	2299	18966	1909	20698	1589	22903	1096	28061	636	21996
3L-2S		MI	5469	2807	9106	2106	10335	1742	11157	1442	12356	951	13983	643	9792
8-#9	1.00	MA	9766	2350	13554	2010	15914	1697	17107	1454	18139	1092	21537	951	7851
2L-4S		MI	4521	2350	6585	1902	7295	1610	7555	1377	7559	1029	8540	759	3773
8-#9	1.00	MA	9421	2350	12927	2021	15116	1707	16138	1463	16828	1107	19721	890	7859
3E		MI	4596	2350	6773	1896	7560	1598	7879	1374	8002	1028	9068	798	3752
8-#9	1.00	MA	9245	2350	12507	2032	14521	1723	15407	1479	15826	1115	18533	852	7846
4L-2S		MI	4734	2350	7043	1889	7903	1593	8296	1363	8566	1020	9814	870	3735
8-#10	1.27	MA	10085	2412	14246	2045	16771	1722	18136	1468	19522	1086	23444	945	9882
2L-4S		MI	4590	2412	6767	1936	7500	1636	7793	1392	7871	1022	8941	711	4674
8-#10	1.27	MA	9659	2412	13454	2059	15762	1734	16910	1480	17863	1105	21147	866	9880
3E		MI	4682	2412	7004	1928	7833	1621	8201	1388	8430	1022	9599	760	4651
8-#10	1.27	MA	9442	2412	12921	2072	15009	1755	15985	1500	16595	1115	19640	818	9832
4L-2S		MI	4853	2412	7343	1921	8265	1615	8726	1376	9140	1013	10529	851	4629
8-#11	1.56	MA	10395	2478	15005	2077	17670	1744	19194	1480	20927	1077	25368	934	11990
2L-4S		MI	4648	2478	6978	1959	7705	1651	8015	1398	8151	1005	9233	643	5584
8-#11	1.56	MA	9891	2478	14042	2093	16444	1758	17706	1494	18911	1099	22578	836	11976
3E		MI	4757	2478	7263	1951	8106	1635	8506	1394	8822	1007	10004	700	5561
8-#11	1.56	MA	9633	2478	13394	2109	15527	1783	16580	1518	17368	1110	20734	776	11879
4L-2S		MI	4956	2478	7669	1943	8623	1629	9134	1380	9672	997	11086	812	5535
8-#14	2.25	MA	11151	2635	16718	2169	19804	1809	21762	1519	24382	1064	30138	918	17040
2L-4S		MI	4809	2635	7403	2049	8192	1718	8585	1436	8942	1002	10142	511	7671
8-#14	2.25	MA	10465	2635	15341	2191	18050	1830	19632	1538	21499	1094	26147	775	16966
3E		MI	4958	2635	7809	2038	8761	1696	9282	1433	9859	991	11215	590	7695
8-#14	2.25	MA	10116	2635	14412	2213	16736	1865	18020	1572	19288	1110	23494	687	16658
4L-2S		MI	5229	2635	8383	2027	9492	1688	10170	1414	11061	980	12712	751	7672
8-#18	4.00	MA	11854	3035	18543	2442	22032	2013	24422	1653	27943	1083	35040	617	29203
3E		MI	5433	3035	9106	2264	10335	1854	11157	1534	12356	951	13983	279	12696
8-#18	4.00	MA	11306	3035	16911	2480	19727	2074	21593	1711	24065	1108	30350	458	26501
4L-2S		MI	5856	3035	10086	2249	11584	1846	12674	1507	14405	937	16429	567	12772
10-#10	1.59	MA	10466	2484	15039	2091	17780	1755	19362	1489	21181	1082	25741	939	12284
2L-5S		MI	4641	2484	6863	1998	7639	1675	7954	1426	8077	1027	9218	645	5711
10-#10	1.59	MA	10051	2484	14246	2104	16771	1767	18136	1501	19522	1101	23444	861	12270
3L-4S		MI	4745	2484	7106	1982	7932	1669	8317	1413	8582	1018	9870	698	5711
10-#10	1.59	MA	9845	2484	13714	2117	16018	1788	17211	1521	18254	1111	21937	812	12209
4L-3S		MI	4834	2484	7343	1974	8265	1654	8726	1409	9140	1017	10529	747	5696
10-#10	1.59	MA	9524	2484	13161	2138	15366	1800	16399	1532	17120	1129	20396	775	12045
5L-2S		MI	5001	2484	7683	1966	8697	1648	9251	1396	9850	1008	11459	838	5678
10-#11	1.95	MA	10359	2567	15005	2149	17670	1799	19194	1519	20927	1093	25368	829	14873
3L-4S		MI	4830	2567	7384	2015	8222	1692	8643	1423	9001	1000	10314	623	6816
10-#11	1.95	MA	10116	2567	14356	2164	16753	1824	18069	1543	19383	1105	23524	769	14761
4L-3S		MI	4934	2567	7669	2007	8623	1675	9134	1419	9672	1001	11086	680	6807
10-#11	1.95	MA	9734	2567	13688	2190	15958	1839	17079	1556	18003	1127	21643	721	14274
5L-2S		MI	5129	2567	8075	1998	9140	1669	9762	1405	10522	992	12167	792	6787

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

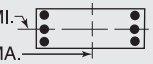
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#14	2.81	MA	11117	2764	16718	2271	19804	1888	21762	1575	24382	1087	30138	765	21100
3L-4S		MI	5062	2764	7978	2129	8923	1776	9474	1473	10144	995	11639	477	9274
10-#14	2.81	MA	10794	2764	15789	2293	18490	1924	20149	1609	22171	1102	27486	676	20780
4L-3S		MI	5204	2764	8383	2118	9492	1754	10170	1469	11061	984	12712	556	9432
10-#14	2.81	MA	10258	2764	14837	2330	17350	1944	18730	1628	20192	1133	24784	606	19328
5L-2S		MI	5467	2764	8958	2107	10224	1747	11059	1451	12263	972	14210	718	9427
10-#18	5.00	MA	12458	3264	19319	2623	22793	2178	25317	1776	29105	1094	37329	440	33638
4L-3S		MI	5857	3264	10086	2407	11584	1958	12674	1598	14405	937	16429	203	15608
10-#18	5.00	MA	11550	3264	17657	2687	20790	2212	22823	1807	25630	1145	32570	306	30814
5L-2S		MI	6237	3264	11067	2392	12832	1950	14191	1571	16453	923	18875	491	15726
12-#10	1.90	MA	10437	2557	15039	2149	17780	1800	19362	1521	21181	1096	25741	855	14657
3L-5S		MI	4794	2557	7203	2043	8071	1708	8479	1446	8787	1023	10148	632	6697
12-#10	1.90	MA	10241	2557	14507	2163	17027	1821	18437	1541	19913	1106	24234	806	14586
4E		MI	4897	2557	7446	2027	8364	1702	8842	1434	9292	1014	10800	685	6742
12-#10	1.90	MA	9922	2557	13953	2183	16375	1833	17624	1553	18779	1125	22693	769	14418
5L-3S		MI	4984	2557	7683	2019	8697	1687	9251	1429	9850	1013	11459	734	6734
12-#10	1.90	MA	9643	2557	13425	2189	15744	1844	16827	1573	17670	1135	21189	704	13790
6L-2S		MI	5147	2557	8022	2011	9130	1681	9776	1417	10561	1004	12389	825	6720
12-#11	2.34	MA	10589	2656	15319	2220	17979	1864	19558	1568	21398	1100	26314	761	17645
4E		MI	5009	2656	7790	2071	8740	1732	9271	1448	9851	995	11396	603	8039
12-#11	2.34	MA	10210	2656	14651	2245	17184	1879	18568	1582	20018	1121	24433	714	17121
5L-3S		MI	5110	2656	8075	2062	9140	1716	9762	1444	10522	996	12167	660	8044
12-#11	2.34	MA	9879	2656	14008	2253	16424	1892	17596	1606	18666	1133	22597	632	16392
6L-2S		MI	5300	2656	8481	2054	9657	1710	10390	1430	11372	987	13249	772	8030
12-#14	3.38	MA	11456	2892	17166	2374	20244	1982	22279	1645	25053	1095	31477	666	24906
4E		MI	5311	2892	8552	2209	9655	1835	10362	1509	11346	987	13137	444	10892
12-#14	3.38	MA	10924	2892	16215	2410	19104	2003	20860	1664	23074	1125	28775	595	23435
5L-3S		MI	5447	2892	8958	2199	10224	1812	11059	1506	12263	976	14210	522	11158
12-#14	3.38	MA	10471	2892	15294	2421	18023	2022	19466	1698	21188	1156	26139	475	22161
6L-2S		MI	5703	2892	9532	2188	10955	1805	11947	1487	13465	965	15708	684	11172
12-#18	6.00	MA	12676	3492	20065	2830	23856	2316	26547	1872	30670	1132	39549	288	37898
5L-3S		MI	6254	3492	11067	2549	12832	2061	14191	1663	16453	923	18875	127	18395
12-#18	6.00	MA	11948	3492	18466	2848	21973	2351	24097	1929	27355	1183	34903	67	34398
6L-2S		MI	6612	3492	12048	2534	14081	2054	15708	1636	18501	909	21321	415	18671
14-#10	2.22	MA	10630	2629	15299	2208	18037	1854	19663	1562	21572	1102	26531	800	16965
4L-5S		MI	4946	2629	7542	2088	8504	1741	9004	1467	9498	1019	11077	619	7673
14-#10	2.22	MA	10313	2629	14746	2228	17384	1866	18850	1573	20438	1121	24990	763	16787
5L-4S		MI	5048	2629	7785	2072	8796	1735	9367	1454	10002	1010	11730	672	7766
14-#10	2.22	MA	10043	2629	14217	2235	16753	1877	18053	1593	19329	1130	23486	698	16153
6L-3S		MI	5132	2629	8022	2064	9130	1720	9776	1450	10561	1009	12389	721	7767
14-#10	2.22	MA	9814	2629	13718	2244	16049	1893	17270	1603	18257	1149	22047	666	15697
7L-2S		MI	5292	2629	8362	2057	9562	1714	10301	1437	11271	1000	13319	812	7758
14-#11	2.73	MA	10677	2745	15614	2301	18410	1919	20057	1607	22033	1116	27223	707	19973
5L-4S		MI	5186	2745	8196	2126	9257	1773	9899	1473	10701	990	12478	583	9257
14-#11	2.73	MA	10357	2745	14971	2309	17650	1933	19085	1631	20681	1128	25387	625	19268
6L-3S		MI	5283	2745	8481	2118	9657	1756	10390	1470	11372	991	13249	640	9274
14-#11	2.73	MA	10086	2745	14363	2319	16793	1951	18142	1644	19374	1149	23623	584	18437
7L-2S		MI	5470	2745	8887	2110	10174	1750	11018	1456	12222	982	14331	752	9268
14-#14	3.94	MA	11576	3021	17592	2491	20857	2061	22990	1700	25957	1118	32766	585	27548
5L-4S		MI	5558	3021	9126	2290	10386	1893	11250	1546	12548	980	14635	410	12523
14-#14	3.94	MA	11143	3021	16671	2501	19777	2081	21596	1734	24070	1148	30130	465	26243
6L-3S		MI	5687	3021	9532	2279	10955	1871	11947	1542	13465	969	15708	489	12879
14-#14	3.94	MA	10774	3021	15800	2516	18549	2107	20257	1753	22145	1164	27590	405	24655
7L-2S		MI	5939	3021	10106	2268	11686	1864	12835	1523	14667	957	17206	650	12909

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

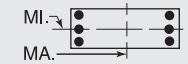
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	7.00	MA	13089	3720	20874	2991	25039	2454	27822	1994	32395	1170	41882	48	41516
6L-3S		MI	6645	3720	12048	2692	14081	2165	15708	1728	18501	909	21321	51	21119
16-#10	2.54	MA	10698	2702	15538	2274	18394	1899	20076	1594	22097	1116	27287	757	19134
5E		MI	5096	2702	7882	2134	8936	1773	9529	1487	10208	1015	12007	606	8654
16-#10	2.54	MA	10436	2702	15010	2280	17762	1910	19279	1614	20988	1126	25783	692	18517
6L-4S		MI	5198	2702	8125	2117	9229	1767	9892	1475	10713	1005	12660	659	8787
16-#10	2.54	MA	10215	2702	14510	2289	17058	1925	18495	1624	19916	1145	24344	660	18072
7L-3S		MI	5279	2702	8362	2110	9562	1753	10301	1470	11271	1005	13319	708	8797
16-#10	2.54	MA	9942	2702	14032	2299	16412	1934	17673	1640	18864	1163	22945	617	17295
8L-2S		MI	5436	2702	8701	2102	9994	1747	10825	1458	11982	996	14248	799	8791
16-#11	3.12	MA	10826	2834	15934	2364	18876	1973	20574	1656	22696	1122	28177	618	22146
6L-4S		MI	5362	2834	8602	2182	9774	1813	10527	1499	11550	985	13560	563	10473
16-#11	3.12	MA	10567	2834	15326	2375	18019	1992	19631	1669	21389	1144	26413	577	21302
7L-3S		MI	5455	2834	8887	2174	10174	1797	11018	1495	12222	986	14331	619	10499
16-#11	3.12	MA	10243	2834	14743	2386	17231	2002	18630	1688	20108	1166	24704	522	20401
8L-2S		MI	5638	2834	9294	2165	10691	1791	11646	1481	13072	977	15412	731	10502
16-#14	4.50	MA	11800	3149	18049	2581	21530	2139	23726	1771	26953	1141	34121	454	30324
6L-4S		MI	5802	3149	9701	2370	11117	1951	12138	1582	13750	972	16133	376	14164
16-#14	4.50	MA	11450	3149	17178	2596	20303	2165	22387	1789	25027	1156	31581	395	28748
7L-3S		MI	5942	3149	10106	2359	11686	1929	12835	1578	14667	961	17206	455	14597
16-#14	4.50	MA	10995	3149	16343	2612	19174	2179	20952	1816	23189	1187	29125	314	26895
8L-2S		MI	6166	3149	10681	2348	12418	1922	13723	1560	15869	950	18704	617	14639
18-#10	2.86	MA	10822	2774	15803	2325	18771	1943	20505	1634	22647	1122	28080	686	20884
6L-5S		MI	5244	2774	8221	2179	9368	1806	10054	1508	10919	1010	12937	593	9638
18-#10	2.86	MA	10610	2774	15303	2334	18068	1958	19721	1644	21575	1140	26641	654	20446
7L-4S		MI	5346	2774	8464	2163	9661	1800	10417	1495	11423	1001	13589	646	9806
18-#10	2.86	MA	10339	2774	14825	2344	17421	1967	18899	1660	20523	1159	25242	611	19660
8L-3S		MI	5424	2774	8701	2155	9994	1786	10825	1491	11982	1001	14248	695	9821
18-#10	2.86	MA	10078	2774	14276	2362	16757	1985	18102	1669	19448	1169	23877	568	18912
9L-2S		MI	5579	2774	9041	2147	10426	1780	11350	1478	12692	992	15178	786	9822
18-#11	3.51	MA	11039	2923	16288	2430	19245	2032	21120	1694	23404	1139	29203	570	24168
7L-4S		MI	5536	2923	9008	2238	10291	1854	11155	1524	12400	980	14641	542	11661
18-#11	3.51	MA	10717	2923	15706	2442	18457	2042	20119	1713	22123	1161	27494	515	23271
8L-3S		MI	5626	2923	9294	2229	10691	1837	11646	1520	13072	981	15412	599	11720
18-#11	3.51	MA	10408	2923	15044	2464	17649	2064	19148	1722	20812	1172	25820	462	22113
9L-2S		MI	5805	2923	9700	2221	11209	1831	12274	1506	13922	971	16494	711	11732
18-#14	5.06	MA	12113	3278	18555	2676	22057	2224	24517	1826	27910	1149	35572	385	32840
7L-4S		MI	6070	3278	10275	2450	11848	2010	13026	1618	14952	965	17631	343	15814
18-#14	5.06	MA	11662	3278	17720	2693	20928	2238	23082	1852	26072	1179	33116	304	30971
8L-3S		MI	6175	3278	10681	2439	12418	1988	13723	1615	15869	954	18704	421	16313
18-#14	5.06	MA	11241	3278	16777	2725	19769	2268	21691	1865	24192	1195	30705	226	29171
9L-2S		MI	6392	3278	11255	2429	13149	1980	14612	1596	17071	942	20202	583	16366
20-#10	3.17	MA	10998	2847	16096	2380	19077	1991	20947	1665	23234	1136	28938	648	22820
7L-5S		MI	5392	2847	8561	2224	9800	1839	10579	1528	11629	1006	13867	580	10625
20-#10	3.17	MA	10730	2847	15618	2390	18430	2000	20124	1681	22182	1155	27539	605	22025
8L-4S		MI	5493	2847	8804	2208	10093	1833	10942	1516	12134	997	14519	633	10823
20-#10	3.17	MA	10476	2847	15069	2407	17766	2018	19328	1689	21107	1165	26174	562	21268
9L-3S		MI	5569	2847	9041	2200	10426	1819	11350	1512	12692	996	15178	682	10844
20-#10	3.17	MA	10233	2847	14572	2415	17142	2028	18533	1707	20023	1180	24667	514	20460
10L-2S		MI	5721	2847	9380	2193	10858	1813	11875	1499	13403	987	16108	773	10851
20-#11	3.90	MA	11184	3012	16669	2498	19683	2083	21608	1738	24138	1156	30284	508	26122
8L-4S		MI	5708	3012	9414	2293	10808	1894	11783	1549	13250	974	15723	522	12826

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

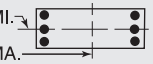
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.90	MA	10885	3012	16007	2520	18875	2105	20637	1748	22827	1167	28610	455	24972
9L-3S		MI	5796	3012	9700	2285	11209	1878	12274	1545	13922	975	16494	579	12940
20-#11	3.90	MA	10597	3012	15402	2529	18113	2117	19669	1769	21525	1186	26769	393	23857
10L-2S		MI	5971	3012	10106	2277	11726	1872	12902	1531	14771	966	17576	691	12958
20-#14	5.63	MA	12316	3406	19097	2773	22681	2296	25212	1889	28954	1172	37108	293	35046
8L-4S		MI	6308	3406	10849	2531	12580	2068	13915	1655	16154	958	19129	309	17471
20-#14	5.63	MA	11912	3406	18155	2805	21522	2327	23821	1902	27075	1187	34696	216	33233
9L-3S		MI	6406	3406	11255	2520	13149	2046	14612	1651	17071	946	20202	388	18027
22-#10	3.49	MA	11115	2919	16410	2435	19439	2033	21350	1701	23841	1150	29836	599	24390
8L-5S		MI	5538	2919	8900	2270	10232	1872	11104	1549	12339	1002	14796	567	11615
22-#10	3.49	MA	10868	2919	15862	2453	18776	2051	20554	1710	22766	1160	28471	556	23624
9L-4S		MI	5639	2919	9143	2253	10525	1866	11467	1536	12844	993	15449	620	11839
22-#10	3.49	MA	10634	2919	15365	2460	18151	2061	19759	1727	21681	1176	26964	508	22819
10L-3S		MI	5713	2919	9380	2246	10858	1852	11875	1532	13403	992	16108	669	11865
22-#10	3.49	MA	10372	2919	14880	2469	17520	2070	18982	1737	20582	1183	25602	463	21913
11L-2S		MI	5862	2919	9720	2238	11290	1846	12400	1519	14113	983	17038	760	11876
22-#11	4.29	MA	11354	3101	16970	2576	20100	2145	22126	1773	24842	1162	31400	447	27831
9L-4S		MI	5880	3101	9820	2349	11325	1934	12411	1574	14100	969	16805	502	13997
22-#11	4.29	MA	11090	3101	16365	2585	19339	2157	21158	1794	23540	1181	29559	386	26707
10L-3S		MI	5964	3101	10106	2341	11726	1918	12902	1571	14771	970	17576	559	14157
22-#14	6.19	MA	12570	3535	19532	2886	23276	2385	25951	1938	29957	1180	38688	205	37295
9L-4S		MI	6543	3535	11424	2611	13311	2126	14803	1691	17356	950	20627	275	19134
24-#10	3.81	MA	11255	2992	16654	2498	19785	2084	21779	1730	24425	1156	30768	551	25980
9L-5S		MI	5683	2992	9239	2315	10665	1905	11629	1570	13050	998	15726	554	12607
24-#10	3.81	MA	11029	2992	16157	2506	19160	2094	20985	1748	23340	1171	29261	502	25178
10L-4S		MI	5784	2992	9482	2299	10957	1899	11992	1557	13555	989	16379	607	12855
24-#10	3.81	MA	10770	2992	15673	2515	18529	2103	20208	1757	22241	1179	27899	457	24266
11L-3S		MI	5856	2992	9720	2291	11290	1885	12400	1553	14113	988	17038	656	12885
24-#11	4.68	MA	11561	3190	17328	2640	20565	2198	22647	1819	25555	1176	32349	378	29558
10L-4S		MI	6050	3190	10226	2405	11842	1975	13039	1600	14950	964	17886	482	15171

RECTANGULAR TIED COLUMNS 22" x 22"

6-#9	1.24	MA	3247	1455	4837	1177	5496	990	5829	844	6135	623	7194	537	3049
2L-3S		MI	3090	1455	4532	1184	5107	996	5357	856	5495	632	6324	465	3065
6-#10	1.57	MA	3350	1501	5089	1202	5803	1008	6197	854	6627	618	7833	526	3795
2L-3S		MI	3157	1501	4705	1211	5313	1015	5602	868	5822	629	6746	435	3810
6-#11	1.93	MA	3441	1551	5358	1222	6110	1022	6552	861	7095	609	8362	503	4550
2L-3S		MI	3215	1551	4896	1232	5522	1029	5838	876	6129	621	7089	391	4562
6-#14	2.79	MA	3678	1669	5963	1289	6856	1069	7446	888	8295	598	9839	468	6351
2L-3S		MI	3372	1669	5309	1302	6022	1079	6433	910	6925	613	8066	306	6324
6-#18	4.96	MA	4227	1969	7420	1460	8662	1192	9617	962	11216	571	13267	357	10682
2L-3S		MI	3747	1969	6297	1480	7231	1205	7879	995	8864	591	10336	69	10132
8-#8	1.31	MA	3275	1464	4881	1186	5563	998	5916	849	6257	625	7385	540	3208
2L-4S		MI	3085	1464	4470	1198	5017	1013	5250	863	5351	634	6197	450	3228
8-#9	1.65	MA	3383	1512	5143	1213	5885	1016	6302	860	6774	620	8065	530	3987
2L-4S		MI	3150	1512	4626	1227	5198	1035	5465	876	5635	631	6582	418	3993
8-#10	2.10	MA	3518	1574	5474	1247	6293	1041	6792	875	7432	614	8920	517	4971
2L-4S		MI	3232	1574	4823	1265	5428	1064	5737	895	5997	627	7068	375	4942
8-#11	2.58	MA	3638	1640	5820	1278	6698	1062	7267	886	8062	604	9636	488	5957
2L-4S		MI	3304	1640	5036	1298	5658	1088	5998	907	6337	617	7461	316	5794
8-#14	3.72	MA	3950	1797	6618	1369	7689	1127	8458	925	9665	590	11613	442	8332
2L-4S		MI	3500	1797	5505	1395	6212	1162	6657	953	7216	605	8580	196	7601
10-#10	2.62	MA	3684	1646	5859	1293	6783	1074	7387	895	8237	610	10007	508	6140
2L-5S		MI	3285	1646	4934	1328	5589	1104	5923	929	6235	634	7392	313	5744

RECTANGULAR TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.62	MA	3503	1646	5474	1301	6293	1081	6792	910	7432	621	8920	417	6132
3L-4S		MI	3409	1646	5207	1310	5918	1097	6332	915	6803	623	8155	366	6087
10-#11	3.22	MA	3832	1729	6282	1334	7286	1102	7981	911	9028	599	10910	473	7356
2L-5S		MI	3371	1729	5168	1374	5848	1136	6219	948	6618	623	7841	236	6718
10-#11	3.22	MA	3623	1729	5820	1344	6698	1110	7267	927	8062	610	9636	361	7335
3L-4S		MI	3514	1729	5498	1353	6246	1128	6712	933	7303	612	8735	301	7100
10-#14	4.65	MA	3939	1926	6618	1462	7689	1195	8458	983	9665	598	11613	255	10223
3L-4S		MI	3793	1926	6160	1475	7045	1220	7669	989	8586	598	10353	171	9470

RECTANGULAR TIED COLUMNS 22" x 24"

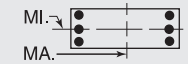
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.18	MA	3837	1578	5711	1276	6473	1074	6851	917	7180	679	8381	584	3466
2E		MI	3498	1578	5258	1263	5917	1063	6239	907	6510	671	7501	568	3153
4-#14	1.70	MA	4023	1657	6176	1318	7037	1104	7523	933	8079	670	9525	563	4839
2E		MI	3660	1657	5672	1303	6418	1092	6834	923	7305	661	8477	542	4383
4-#18	3.03	MA	4457	1857	7297	1427	8409	1181	9163	978	10279	649	12216	500	8158
2E		MI	4036	1857	6665	1412	7629	1168	8279	967	9243	640	10742	465	7337
6-#9	1.14	MA	3843	1572	5640	1286	6437	1084	6834	925	7178	688	8458	599	3373
2L-3S		MI	3347	1572	4888	1281	5500	1079	5758	928	5879	690	6740	515	3086
6-#9	1.14	MA	3665	1572	5299	1294	6003	1090	6306	931	6464	698	7469	527	3389
3L-2S		MI	3505	1572	5194	1274	5889	1073	6230	916	6518	681	7611	587	3069
6-#10	1.44	MA	3960	1618	5923	1311	6782	1101	7246	936	7730	683	9215	593	4207
2L-3S		MI	3413	1618	5062	1308	5707	1098	6003	940	6204	687	7161	485	3836
6-#10	1.44	MA	3741	1618	5493	1321	6235	1110	6581	951	6830	695	7970	501	4221
3L-2S		MI	3608	1618	5447	1299	6197	1091	6598	926	7010	676	8249	576	3818
6-#11	1.77	MA	4067	1667	6228	1332	7131	1115	7651	942	8263	674	9848	573	5055
2L-3S		MI	3472	1667	5258	1328	5917	1111	6239	948	6510	678	7501	441	4595
6-#11	1.77	MA	3810	1667	5711	1343	6473	1124	6851	959	7180	687	8381	461	5067
3L-2S		MI	3700	1667	5719	1318	6505	1103	6953	932	7477	666	8775	553	4578
6-#14	2.56	MA	4340	1786	6911	1398	7973	1162	8659	970	9617	662	11577	544	7080
2L-3S		MI	3628	1786	5672	1397	6418	1160	6834	981	7305	669	8477	355	6373
6-#14	2.56	MA	3990	1786	6176	1413	7037	1174	7523	994	8079	680	9525	382	7053
3L-2S		MI	3938	1786	6327	1384	7252	1150	7847	959	8675	654	10250	517	6385
6-#18	4.55	MA	4982	2085	8563	1570	10021	1285	11121	1043	12929	636	15637	454	11978
2L-3S		MI	4002	2085	6665	1574	7629	1285	8279	1065	9243	647	10742	118	10388
6-#18	4.55	MA	4424	2085	7297	1593	8409	1302	9163	1081	10279	662	12216	166	11678
3L-2S		MI	4491	2085	7788	1554	9059	1272	10017	1032	11594	627	13674	406	10732
8-#8	1.20	MA	3873	1581	5687	1296	6510	1091	6929	931	7312	690	8647	600	3549
2L-4S		MI	3341	1581	4825	1295	5410	1096	5651	935	5735	692	6615	501	3251
8-#8	1.20	MA	3733	1581	5416	1302	6165	1096	6510	935	6744	698	7861	544	3561
3E		MI	3408	1581	4993	1290	5646	1086	5941	931	6132	690	7104	534	3240
8-#8	1.20	MA	3658	1581	5230	1308	5902	1107	6188	945	6303	701	7315	511	3569
4L-2S		MI	3532	1581	5236	1284	5956	1081	6317	922	6641	683	7802	590	3228
8-#9	1.52	MA	3997	1629	5981	1322	6871	1110	7361	942	7892	685	9446	594	4419
2L-4S		MI	3406	1629	4983	1324	5592	1118	5866	949	6019	689	6999	468	4025
8-#9	1.52	MA	3824	1629	5640	1330	6437	1116	6834	947	7178	695	8458	523	4429
3E		MI	3488	1629	5194	1317	5889	1105	6230	944	6518	686	7611	509	4021
8-#9	1.52	MA	3733	1629	5406	1338	6106	1130	6428	960	6623	698	7768	481	4425
4L-2S		MI	3641	1629	5499	1310	6278	1099	6703	933	7157	678	8481	581	4009
8-#10	1.92	MA	4152	1690	6353	1357	7330	1134	7911	956	8631	679	10461	587	5519
2L-4S		MI	3488	1690	5180	1362	5822	1147	6138	967	6380	685	7483	425	4984
8-#10	1.92	MA	3940	1690	5923	1366	6782	1143	7246	971	7730	691	9215	495	5523
3E		MI	3589	1690	5447	1353	6197	1131	6598	961	7010	682	8249	476	5005

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis

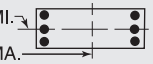


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	1.92	MA	3828	1690	5627	1376	6365	1159	6734	978	7030	695	8343	442	5490
4L-2S		MI	3777	1690	5832	1344	6687	1124	7193	947	7815	671	9336	567	4996
8-#11	2.36	MA	4292	1757	6746	1387	7790	1155	8451	967	9346	669	11315	562	6631
2L-4S		MI	3560	1757	5397	1394	6053	1170	6399	979	6718	674	7874	366	5920
8-#11	2.36	MA	4044	1757	6228	1398	7131	1164	7651	985	8263	682	9848	450	6625
3E		MI	3678	1757	5719	1384	6505	1152	6953	973	7477	672	8775	426	5989
8-#11	2.36	MA	3913	1757	5870	1409	6627	1184	7033	992	7417	686	8816	387	6549
4L-2S		MI	3898	1757	6181	1374	7093	1144	7668	957	8443	661	10049	538	5988
8-#14	3.41	MA	4650	1914	7646	1478	8908	1220	9796	1006	11155	655	13628	525	9304
2L-4S		MI	3755	1914	5868	1490	6608	1243	7058	1024	7596	662	8990	246	7749
8-#14	3.41	MA	4317	1914	6911	1493	7973	1232	8659	1030	9617	673	11577	363	9247
3E		MI	3915	1914	6327	1477	7252	1218	7847	1017	8675	662	10250	330	8328
8-#14	3.41	MA	4139	1914	6400	1508	7254	1259	7778	1039	8412	676	10129	275	8603
4L-2S		MI	4211	1914	6982	1464	8085	1208	8859	996	10046	647	12024	492	8371
8-#18	6.06	MA	5006	2314	8563	1736	10021	1406	11121	1146	12929	649	15637	120	15204
3E		MI	4507	2314	7788	1716	9059	1388	10017	1129	11594	634	13674	59	13478
8-#18	6.06	MA	4690	2314	7676	1759	8775	1450	9594	1157	10841	648	13206	-29	13167
4L-2S		MI	4928	2314	8912	1697	10490	1375	11755	1096	13946	613	16605	346	14106
10-#10	2.41	MA	4341	1763	6783	1402	7878	1167	8576	977	9531	675	11706	581	6825
2L-5S		MI	3541	1763	5292	1424	5983	1187	6324	1001	6618	691	7808	363	5839
10-#10	2.41	MA	4135	1763	6353	1412	7330	1176	7911	992	8631	687	10461	489	6818
3L-4S		MI	3666	1763	5565	1407	6312	1180	6733	987	7185	681	8570	416	6132
10-#10	2.41	MA	4030	1763	6057	1421	6913	1192	7400	999	7930	691	9588	436	6772
4L-3S		MI	3761	1763	5832	1398	6687	1164	7193	982	7815	678	9336	467	6165
10-#10	2.41	MA	3884	1763	5754	1440	6548	1200	6946	1014	7299	703	8715	384	6439
5L-2S		MI	3944	1763	6217	1390	7177	1157	7788	968	8620	667	10423	558	6167
10-#11	2.95	MA	4513	1846	7263	1443	8449	1196	9251	992	10429	664	12783	552	8199
2L-5S		MI	3627	1846	5529	1470	6243	1218	6619	1020	6999	680	8254	285	6827
10-#11	2.95	MA	4275	1846	6746	1454	7790	1205	8451	1010	9346	677	11315	439	8177
3L-4S		MI	3770	1846	5859	1449	6641	1210	7113	1004	7684	669	9148	351	7222
10-#11	2.95	MA	4151	1846	6387	1465	7286	1224	7833	1017	8500	680	10283	376	8018
4L-3S		MI	3881	1846	6181	1440	7093	1192	7668	998	8443	667	10049	411	7376
10-#11	2.95	MA	3983	1846	6021	1486	6844	1233	7284	1034	7737	694	9254	312	7545
5L-2S		MI	4093	1846	6643	1430	7681	1184	8382	982	9410	656	11323	523	7390
10-#14	4.26	MA	4637	2043	7646	1573	8908	1291	9796	1066	11155	666	13628	345	11438
3L-4S		MI	4048	2043	6523	1571	7441	1301	8070	1060	8967	654	10764	220	9613
10-#14	4.26	MA	4473	2043	7135	1588	8190	1317	8915	1075	9950	669	12181	256	10709
4L-3S		MI	4196	2043	6982	1557	8085	1276	8859	1053	10046	654	12024	304	10279
10-#14	4.26	MA	4240	2043	6612	1618	7559	1329	8132	1099	8862	687	10741	162	10095
5L-2S		MI	4480	2043	7636	1544	8919	1267	9871	1032	11416	639	13797	466	10344
10-#18	7.58	MA	5310	2542	8942	1901	10387	1553	11553	1222	13491	635	16627	-76	16463
4L-3S		MI	4972	2542	8912	1859	10490	1492	11755	1194	13946	620	16605	-1	16602
12-#10	2.89	MA	4527	1835	7213	1447	8425	1200	9242	997	10431	670	12951	575	8127
2L-6S		MI	3589	1835	5439	1478	6149	1235	6517	1028	6880	698	8195	295	6733
12-#10	2.89	MA	4327	1835	6783	1457	7878	1208	8576	1013	9531	683	11706	483	8110
3L-5S		MI	3717	1835	5677	1470	6473	1220	6919	1022	7423	687	8895	354	6952
12-#10	2.89	MA	4227	1835	6487	1467	7460	1225	8065	1019	8830	687	10834	430	8054
4E		MI	3840	1835	5950	1453	6802	1212	7328	1008	7991	676	9657	407	7278
12-#10	2.89	MA	4083	1835	6184	1485	7095	1233	7611	1035	8199	699	9960	378	7688
5L-3S		MI	3931	1835	6217	1444	7177	1197	7788	1002	8620	674	10423	458	7322
12-#10	2.89	MA	3940	1835	5913	1492	6735	1250	7165	1041	7596	711	9162	317	7440
6L-2S		MI	4108	1835	6601	1435	7667	1190	8383	988	9426	663	11510	549	7334
12-#11	3.55	MA	4501	1935	7263	1510	8449	1245	9251	1035	10429	672	12783	429	9727
3L-5S		MI	3834	1935	5991	1525	6831	1258	7334	1045	7965	675	9528	270	8165
12-#11	3.55	MA	4385	1935	6905	1521	7945	1265	8633	1042	9583	675	11750	366	9497
4E		MI	3976	1935	6321	1505	7229	1251	7827	1029	8651	663	10422	336	8535
12-#11	3.55	MA	4218	1935	6538	1542	7503	1274	8084	1060	8820	689	10721	301	9050
5L-3S		MI	4080	1935	6643	1495	7681	1232	8382	1024	9410	662	11323	396	8760

RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	3.55	MA	4049	1935	6217	1552	7067	1293	7544	1067	8090	702	9778	228	8581
6L-2S		MI	4286	1935	7105	1485	8269	1225	9096	1008	10376	650	12597	508	8785
12-#14	5.11	MA	4800	2171	7870	1669	9125	1376	10051	1112	11488	661	14232	237	12829
4E		MI	4335	2171	7178	1651	8275	1360	9082	1096	10337	647	12538	195	11490
12-#14	5.11	MA	4568	2171	7347	1698	8495	1388	9269	1136	10400	679	12793	143	12193
5L-3S		MI	4473	2171	7636	1638	8919	1335	9871	1090	11416	647	13797	279	12229
14-#10	3.37	MA	4517	1908	7213	1502	8425	1241	9242	1033	10431	679	12951	477	9400
3L-6S		MI	3766	1908	5824	1523	6638	1268	7112	1048	7685	694	9282	286	7832
14-#10	3.37	MA	4422	1908	6917	1512	8008	1258	8730	1040	9730	682	12079	424	9336
4L-5S		MI	3889	1908	6062	1515	6963	1253	7514	1042	8228	683	9982	345	8070
14-#10	3.37	MA	4279	1908	6614	1530	7643	1266	8276	1055	9099	695	11206	372	8942
5L-4S		MI	4012	1908	6335	1498	7292	1245	7923	1028	8796	672	10745	398	8411
14-#10	3.37	MA	4140	1908	6343	1537	7283	1283	7830	1062	8496	707	10407	311	8679
6L-3S		MI	4098	1908	6601	1489	7667	1230	8383	1023	9426	670	11510	449	8477
14-#11	4.14	MA	4615	2024	7422	1576	8603	1305	9433	1067	10666	670	13218	355	10986
4L-5S		MI	4037	2024	6453	1581	7419	1299	8048	1070	8932	670	10801	255	9508
14-#11	4.14	MA	4449	2024	7055	1598	8162	1314	8884	1085	9903	684	12188	290	10562
5L-4S		MI	4178	2024	6783	1561	7817	1291	8541	1054	9617	658	11695	321	9857
14-#11	4.14	MA	4287	2024	6735	1607	7726	1334	8344	1092	9173	697	11245	218	10074
6L-3S		MI	4277	2024	7105	1551	8269	1273	9096	1049	10376	657	12597	381	10142
14-#14	5.97	MA	4891	2300	8082	1779	9431	1446	10405	1172	11938	672	14844	124	14301
5L-4S		MI	4618	2300	7832	1731	9108	1418	10095	1133	11707	639	14311	169	13378
16-#10	3.85	MA	4614	1980	7347	1557	8555	1291	9395	1061	10630	678	13324	418	10593
4L-6S		MI	3940	1980	6209	1568	7128	1301	7707	1069	8490	690	10370	277	8936
16-#10	3.85	MA	4471	1980	7044	1575	8191	1299	8941	1076	9999	691	12451	366	10201
5E		MI	4060	1980	6447	1560	7453	1286	8109	1063	9033	679	11069	336	9192
16-#10	3.85	MA	4337	1980	6773	1583	7831	1316	8495	1083	9396	703	11653	305	9922
6L-4S		MI	4182	1980	6719	1543	7782	1278	8518	1049	9601	668	11832	389	9517
16-#11	4.73	MA	4677	2113	7573	1653	8821	1355	9685	1110	10986	678	13656	280	12078
5E		MI	4238	2113	6915	1637	8007	1339	8762	1096	9898	665	12075	241	10856
16-#11	4.73	MA	4520	2113	7252	1663	8385	1374	9144	1117	10256	692	12712	207	11572
6L-4S		MI	4378	2113	7244	1616	8405	1331	9255	1080	10584	653	12969	306	11186
18-#10	4.33	MA	4661	2053	7474	1621	8738	1332	9606	1096	10899	686	13696	360	11463
5L-6S		MI	4111	2053	6593	1614	7618	1334	8302	1089	9295	685	11457	268	10044
18-#10	4.33	MA	4532	2053	7203	1628	8378	1349	9160	1103	10296	699	12898	299	11169
6L-5S		MI	4228	2053	6831	1606	7943	1319	8704	1084	9839	675	12156	327	10317
18-#11	5.32	MA	4750	2202	7769	1719	9044	1415	9945	1143	11339	687	14179	197	13074
6L-5S		MI	4436	2202	7376	1692	8595	1380	9476	1121	10865	659	13349	226	12208

RECTANGULAR TIED COLUMNS 22" x 26"

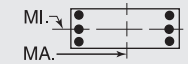
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.09	MA	4482	1695	6580	1386	7490	1168	7935	998	8304	744	9755	647	3803
2E		MI	3756	1695	5619	1359	6313	1145	6640	978	6892	728	7914	618	3177
4-#14	1.57	MA	4693	1774	7098	1427	8119	1197	8684	1015	9305	735	11070	631	5325
2E		MI	3918	1774	6036	1399	6814	1173	7235	993	7686	718	8887	592	4412
4-#18	2.80	MA	5188	1974	8352	1536	9654	1275	10518	1060	11765	714	14185	579	9022
2E		MI	4295	1974	7033	1505	8026	1248	8680	1037	9621	695	11149	514	7378
6-#9	1.05	MA	4486	1688	6498	1396	7446	1177	7910	1007	8293	753	9758	655	3697
2L-3S		MI	3604	1688	5245	1379	5894	1162	6159	1000	6262	747	7157	566	3106
6-#9	1.05	MA	4286	1688	6121	1404	6966	1184	7327	1013	7504	764	8666	586	3713
3L-2S		MI	3762	1688	5550	1372	6283	1156	6631	989	6901	738	8027	638	3088

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis

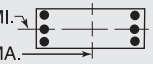


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	1.33	MA	4619	1734	6811	1421	7829	1195	8368	1017	8906	748	10602	650	4618
2L-3S		MI	3670	1734	5420	1405	6101	1181	6404	1013	6587	744	7577	535	3860
6-#10	1.33	MA	4372	1734	6336	1431	7223	1204	7633	1025	7911	761	9224	561	4633
3L-2S		MI	3866	1734	5805	1396	6591	1173	6999	999	7393	733	8664	627	3841
6-#11	1.64	MA	4741	1784	7153	1441	8220	1208	8821	1023	9503	739	11416	640	5560
2L-3S		MI	3729	1784	5619	1424	6313	1193	6640	1019	6892	734	7914	491	4626
6-#11	1.64	MA	4451	1784	6580	1453	7490	1218	7935	1042	8304	754	9755	528	5572
3L-2S		MI	3958	1784	6081	1414	6901	1185	7354	1003	7858	723	9188	603	4605
6-#14	2.36	MA	5050	1902	7913	1507	9157	1255	9944	1051	11011	727	13401	617	7809
2L-3S		MI	3885	1902	6036	1492	6814	1241	7235	1051	7686	725	8887	405	6418
6-#14	2.36	MA	4656	1902	7098	1524	8119	1269	8684	1077	9305	748	11070	456	7782
3L-2S		MI	4197	1902	6690	1479	7647	1231	8247	1030	9056	710	10661	566	6419
6-#18	4.20	MA	5775	2202	9761	1679	11448	1378	12698	1124	14714	701	18100	543	13274
2L-3S		MI	4258	2202	7033	1668	8026	1365	8680	1134	9621	702	11149	167	10610
6-#18	4.20	MA	5150	2202	8352	1705	9654	1399	10518	1166	11765	732	14185	256	13025
3L-2S		MI	4754	2202	8157	1648	9457	1352	10417	1101	11973	682	14080	455	10780
8-#8	1.10	MA	4520	1697	6549	1405	7525	1184	8014	1012	8440	754	9965	656	3891
2L-4S		MI	3598	1697	5180	1393	5803	1179	6053	1008	6119	750	7032	552	3273
8-#8	1.10	MA	4362	1697	6249	1412	7144	1190	7551	1017	7813	763	9097	602	3902
3E		MI	3665	1697	5348	1387	6039	1169	6342	1004	6515	748	7522	584	3259
8-#8	1.10	MA	4279	1697	6045	1419	6855	1201	7197	1028	7328	767	8502	570	3910
4L-2S		MI	3790	1697	5591	1381	6349	1164	6718	994	7024	740	8220	641	3247
8-#9	1.40	MA	4659	1745	6875	1431	7925	1203	8493	1023	9082	749	10850	651	4851
2L-4S		MI	3663	1745	5339	1422	5985	1201	6267	1021	6402	746	7416	519	4053
8-#9	1.40	MA	4465	1745	6498	1440	7446	1210	7910	1029	8293	760	9758	582	4861
3E		MI	3745	1745	5550	1414	6283	1188	6631	1016	6901	744	8027	559	4044
8-#9	1.40	MA	4364	1745	6240	1448	7082	1224	7464	1042	7682	765	9006	541	4857
4L-2S		MI	3899	1745	5856	1407	6672	1182	7104	1005	7541	735	8898	631	4031
8-#10	1.78	MA	4834	1807	7287	1466	8434	1228	9103	1038	9901	744	11980	644	6068
2L-4S		MI	3745	1807	5538	1459	6216	1229	6539	1039	6763	742	7899	475	5023
8-#10	1.78	MA	4596	1807	6811	1477	7829	1237	8368	1045	8906	757	10602	555	6072
3E		MI	3846	1807	5805	1450	6591	1214	6999	1033	7393	740	8664	526	5033
8-#10	1.78	MA	4471	1807	6485	1487	7369	1254	7804	1062	8134	762	9649	503	6039
4L-2S		MI	4036	1807	6190	1441	7081	1206	7594	1019	8198	729	9751	618	5021
8-#11	2.18	MA	4994	1873	7726	1497	8949	1249	9708	1048	10702	733	13077	633	7305
2L-4S		MI	3816	1873	5759	1490	6448	1251	6800	1050	7099	730	8287	416	5989
8-#11	2.18	MA	4715	1873	7153	1509	8220	1259	8821	1067	9503	749	11416	521	7299
3E		MI	3935	1873	6081	1480	6901	1233	7354	1044	7858	729	9188	476	6026
8-#11	2.18	MA	4569	1873	6758	1521	7664	1279	8140	1076	8569	754	10253	456	7227
4L-2S		MI	4157	1873	6542	1470	7489	1226	8068	1028	8825	717	10462	588	6018
8-#14	3.15	MA	5400	2031	8729	1588	10195	1314	11205	1087	12717	720	15732	604	10276
2L-4S		MI	4011	2031	6232	1586	7003	1324	7458	1094	7977	718	9401	295	7893
8-#14	3.15	MA	5024	2031	7913	1604	9157	1327	9944	1113	11011	740	13401	442	10219
3E		MI	4172	2031	6690	1572	7647	1299	8247	1088	9056	718	10661	379	8377
8-#14	3.15	MA	4826	2031	7350	1620	8364	1356	8972	1124	9680	746	11764	350	9626
4L-2S		MI	4471	2031	7345	1559	8481	1289	9260	1066	10426	703	12435	541	8408
8-#18	5.59	MA	5765	2430	9761	1848	11448	1503	12698	1231	14714	719	18100	220	17208
3E		MI	4737	2430	8157	1810	9457	1468	10417	1199	11973	689	14080	107	13715
8-#18	5.59	MA	5453	2430	8780	1874	10069	1550	11007	1246	12401	723	15334	64	14975
4L-2S		MI	5194	2430	9280	1791	10887	1455	12155	1166	14324	669	17011	395	14158
10-#10	2.22	MA	5046	1880	7762	1511	9039	1261	9838	1058	10896	739	13357	638	7511
2L-5S		MI	3798	1880	5650	1521	6377	1269	6725	1073	7000	749	8223	413	5930
10-#10	2.22	MA	4815	1880	7287	1522	8434	1270	9103	1066	9901	753	11980	549	7504
3L-4S		MI	3922	1880	5923	1504	6706	1262	7134	1059	7568	738	8986	466	6173
10-#10	2.22	MA	4697	1880	6961	1532	7975	1287	8539	1082	9129	758	11027	497	7458
4L-3S		MI	4019	1880	6190	1495	7081	1247	7594	1054	8198	735	9751	517	6197
10-#10	2.22	MA	4530	1880	6628	1551	7574	1296	8041	1090	8435	772	10068	447	7143
5L-2S		MI	4203	1880	6574	1486	7571	1239	8189	1040	9003	725	10838	609	6194

RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

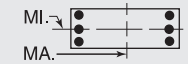
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.73	MA	5244	1962	8299	1553	9679	1289	10594	1074	11902	728	14737	626	9041
2L-5S		MI	3883	1962	5890	1565	6639	1300	7020	1091	7380	737	8667	335	6932
10-#11	2.73	MA	4975	1962	7726	1564	8949	1299	9708	1092	10702	743	13077	514	9020
3L-4S		MI	4026	1962	6220	1545	7036	1292	7514	1075	8066	725	9561	401	7340
10-#11	2.73	MA	4837	1962	7331	1576	8393	1320	9026	1101	9769	748	11914	448	8932
4L-3S		MI	4139	1962	6542	1535	7489	1274	8068	1070	8825	724	10462	461	7416
10-#11	2.73	MA	4642	1962	6928	1599	7907	1330	8422	1120	8928	764	10749	384	8382
5L-2S		MI	4353	1962	7004	1526	8076	1266	8783	1054	9791	712	11736	573	7422
10-#14	3.93	MA	5384	2159	8729	1684	10195	1386	11205	1150	12717	733	15732	429	12653
3L-4S		MI	4304	2159	6887	1666	7837	1382	8471	1131	9347	711	11175	270	9751
10-#14	3.93	MA	5202	2159	8165	1701	9402	1414	10233	1161	11386	738	14095	336	11971
4L-3S		MI	4454	2159	7345	1653	8481	1358	9260	1124	10426	710	12435	354	10332
10-#14	3.93	MA	4932	2159	7589	1732	8707	1428	9370	1187	10186	759	12460	243	11278
5L-2S		MI	4741	2159	8000	1640	9314	1348	10272	1103	11796	695	14208	516	10385
10-#18	6.99	MA	6088	2659	10189	2017	11863	1654	13186	1311	15350	710	19249	29	19081
4L-3S		MI	5230	2659	9280	1953	10887	1572	12155	1264	14324	676	17011	48	16835
12-#10	2.66	MA	5255	1952	8238	1557	9645	1294	10573	1079	11891	735	14735	632	8950
2L-6S		MI	3845	1952	5797	1574	6542	1318	6918	1100	7262	755	8611	346	6839
12-#10	2.66	MA	5031	1952	7762	1567	9039	1303	9838	1086	10896	749	13357	543	8933
3L-5S		MI	3974	1952	6035	1567	6867	1302	7320	1094	7806	745	9310	404	7041
12-#10	2.66	MA	4919	1952	7436	1578	8580	1320	9275	1103	10124	754	12404	491	8877
4E		MI	4097	1952	6308	1549	7196	1295	7729	1080	8373	734	10073	457	7322
12-#10	2.66	MA	4753	1952	7104	1596	8179	1329	8776	1110	9430	767	11446	442	8527
5L-3S		MI	4189	1952	6574	1541	7571	1279	8189	1074	9003	731	10838	508	7356
12-#10	2.66	MA	4594	1952	6799	1603	7784	1347	8286	1127	8768	781	10575	381	8241
6L-2S		MI	4368	1952	6959	1532	8061	1272	8784	1060	9808	720	11925	599	7362
12-#11	3.27	MA	5229	2051	8299	1620	9679	1340	10594	1118	11902	738	14737	507	10738
3L-5S		MI	4090	2051	6352	1621	7226	1340	7735	1116	8347	732	9940	320	8266
12-#11	3.27	MA	5100	2051	7904	1632	9123	1360	9912	1126	10968	743	13575	441	10596
4E		MI	4232	2051	6682	1601	7624	1332	8228	1100	9032	720	10834	386	8650
12-#11	3.27	MA	4907	2051	7501	1654	8637	1370	9308	1145	10128	758	12410	377	10053
5L-3S		MI	4339	2051	7004	1591	8076	1314	8783	1095	9791	719	11736	446	8802
12-#11	3.27	MA	4719	2051	7139	1663	8158	1391	8714	1153	9325	774	11346	302	9602
6L-2S		MI	4547	2051	7466	1581	8664	1307	9497	1079	10758	707	13009	558	8821
12-#14	4.72	MA	5569	2288	8981	1781	10440	1473	11493	1197	13092	731	16426	323	14329
4E		MI	4591	2288	7541	1746	8671	1441	9483	1167	10717	703	12948	244	11624
12-#14	4.72	MA	5301	2288	8404	1812	9745	1486	10631	1223	11892	751	14791	230	13674
5L-3S		MI	4732	2288	8000	1733	9314	1416	10272	1161	11796	703	14208	328	12283
14-#10	3.11	MA	5244	2025	8238	1612	9645	1336	10573	1107	11891	744	14735	538	10360
3L-6S		MI	4022	2025	6182	1620	7032	1351	7513	1120	8068	751	9698	336	7965
14-#10	3.11	MA	5138	2025	7912	1623	9185	1353	10010	1123	11119	750	13782	485	10296
4L-5S		MI	4147	2025	6419	1612	7357	1335	7915	1114	8611	740	10397	395	8157
14-#10	3.11	MA	4973	2025	7579	1642	8784	1362	9511	1131	10425	763	12824	436	9916
5L-4S		MI	4270	2025	6692	1595	7686	1328	8324	1100	9179	729	11160	448	8470
14-#10	3.11	MA	4818	2025	7274	1649	8389	1380	9021	1147	9763	777	11953	376	9642
6L-3S		MI	4357	2025	6959	1586	8061	1312	8784	1095	9808	727	11925	499	8512
14-#10	3.11	MA	4687	2025	6970	1655	8001	1387	8550	1155	9086	782	10969	322	9174
7L-2S		MI	4532	2025	7344	1577	8551	1305	9379	1081	10614	716	13012	590	8526
14-#11	3.82	MA	5358	2140	8478	1688	9853	1401	10798	1151	12168	738	15236	434	12248
4L-5S		MI	4294	2140	6814	1677	7814	1381	8449	1142	9313	727	11214	305	9607
14-#11	3.82	MA	5166	2140	8074	1710	9367	1411	10194	1170	11327	753	14071	370	11730
5L-4S		MI	4435	2140	7144	1657	8212	1373	8942	1126	9999	715	12108	371	9969
14-#11	3.82	MA	4985	2140	7712	1719	8887	1431	9600	1179	10524	769	13007	295	11263
6L-3S		MI	4537	2140	7466	1647	8664	1355	9497	1120	10758	714	13009	431	10185

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

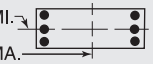
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	5.51	MA	5663	2416	9220	1893	10783	1545	11891	1259	13599	744	17122	217	16077
5L-4S		MI	4874	2416	8196	1826	9504	1499	10495	1204	12087	696	14722	219	13508
16-#10	3.55	MA	5353	2097	8387	1668	9790	1386	10745	1144	12114	745	15160	479	11716
4L-6S		MI	4196	2097	6566	1665	7522	1384	8108	1141	8873	747	10785	327	9074
16-#10	3.55	MA	5189	2097	8054	1687	9390	1395	10246	1152	11420	759	14201	430	11309
5E		MI	4318	2097	6804	1657	7847	1368	8510	1135	9416	736	11484	386	9277
16-#10	3.55	MA	5039	2097	7750	1694	8994	1413	9756	1168	10758	772	13330	370	11046
6L-4S		MI	4440	2097	7077	1640	8176	1361	8919	1121	9984	725	12247	439	9615
16-#10	3.55	MA	4913	2097	7445	1700	8606	1420	9285	1175	10081	778	12347	317	10568
7L-3S		MI	4524	2097	7344	1631	8551	1345	9379	1115	10614	723	13012	490	9667
16-#11	4.36	MA	5422	2230	8647	1766	10096	1451	11081	1195	12527	748	15732	363	13412
5E		MI	4495	2230	7276	1732	8402	1421	9163	1167	10280	721	12488	290	10953
16-#11	4.36	MA	5247	2230	8285	1775	9617	1472	10486	1204	11724	763	14668	288	12928
6L-4S		MI	4636	2230	7606	1712	8800	1413	9656	1151	10965	710	13382	356	11295
18-#10	4.00	MA	5402	2170	8530	1732	9995	1428	10982	1172	12415	755	15579	424	12705
5L-6S		MI	4368	2170	6951	1710	8012	1417	8703	1161	9678	743	11872	318	10179
18-#10	4.00	MA	5257	2170	8225	1739	9600	1445	10491	1188	11753	768	14708	364	12453
6L-5S		MI	4486	2170	7189	1703	8337	1401	9105	1156	10221	732	12572	377	10401
18-#10	4.00	MA	5135	2170	7921	1745	9212	1453	10020	1196	11076	773	13724	311	11965
7L-4S		MI	4608	2170	7462	1685	8665	1394	9514	1142	10789	721	13334	430	10723
18-#11	4.91	MA	5505	2319	8858	1830	10347	1512	11372	1229	12923	758	16328	281	14598
6L-5S		MI	4694	2319	7738	1788	8990	1461	9877	1192	11246	716	13762	275	12303
20-#10	4.44	MA	5472	2242	8700	1785	10205	1478	11227	1209	12748	764	16086	358	13842
6E		MI	4538	2242	7336	1756	8502	1450	9298	1182	10484	739	12959	309	11288
20-#10	4.44	MA	5355	2242	8396	1791	9817	1486	10755	1217	12071	769	15102	305	13364
7L-5S		MI	4653	2242	7574	1748	8827	1434	9700	1176	11027	728	13659	368	11527

RECTANGULAR TIED COLUMNS 22" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.01	MA	5174	1812	7504	1495	8575	1261	9091	1079	9499	809	11146	704	4140
2E		MI	4013	1812	5980	1455	6708	1227	7041	1049	7273	785	8327	668	3199
4-#14	1.46	MA	5411	1891	8075	1536	9268	1290	9917	1096	10603	799	12665	694	5811
2E		MI	4176	1891	6399	1494	7210	1254	7636	1064	8066	774	9298	641	4441
4-#18	2.60	MA	5967	2090	9461	1646	10966	1368	11946	1141	13323	779	16242	654	9886
2E		MI	4554	2090	7401	1599	8423	1328	9080	1106	9999	751	11556	563	7419
6-#10	1.24	MA	5324	1851	7754	1530	8942	1288	9561	1098	10154	813	12067	706	5030
2L-3S		MI	3927	1851	5778	1502	6495	1263	6805	1085	6970	801	7993	586	3883
6-#10	1.24	MA	5051	1851	7234	1541	8279	1298	8756	1107	9064	827	10558	620	5044
3L-2S		MI	4124	1851	6163	1493	6985	1256	7400	1071	7775	790	9080	677	3862
6-#11	1.52	MA	5462	1901	8132	1551	9375	1301	10064	1105	10815	803	12968	697	6066
2L-3S		MI	3985	1901	5980	1520	6708	1275	7041	1090	7273	791	8327	541	4655
6-#11	1.52	MA	5140	1901	7504	1563	8575	1313	9091	1114	9499	820	11146	588	6078
3L-2S		MI	4216	1901	6442	1510	7296	1267	7755	1075	8240	779	9601	653	4631
6-#14	2.19	MA	5810	2019	8971	1617	10408	1349	11302	1132	12477	792	15260	683	8538
2L-3S		MI	4141	2019	6399	1587	7210	1322	7636	1122	8066	782	9298	454	6461
6-#14	2.19	MA	5370	2019	8075	1634	9268	1364	9917	1145	10603	815	12665	523	8511
3L-2S		MI	4456	2019	7054	1574	8043	1312	8648	1101	9436	767	11072	616	6451
6-#18	3.90	MA	6624	2319	11013	1789	12941	1472	14346	1206	16571	765	20653	628	14570
2L-3S		MI	4513	2319	7401	1761	8423	1445	9080	1204	9999	758	11556	216	10689
6-#18	3.90	MA	5924	2319	9461	1817	10966	1495	11946	1251	13323	801	16242	340	14321
3L-2S		MI	5014	2319	8525	1742	9854	1432	10818	1171	12351	738	14487	503	10828
8-#8	1.03	MA	5213	1814	7465	1514	8607	1277	9171	1093	9639	819	11365	713	4232
2L-4S		MI	3854	1814	5535	1491	6196	1262	6454	1080	6502	808	7450	602	3293
8-#8	1.03	MA	5038	1814	7137	1521	8190	1284	8664	1099	8953	829	10415	660	4243
3E		MI	3921	1814	5703	1485	6432	1252	6744	1076	6899	805	7939	635	3278

RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

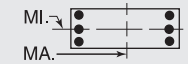
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#8	1.03	MA	4947	1814	6914	1529	7875	1295	8278	1110	8424	833	9770	629	4252
4L-2S		MI	4048	1814	5946	1479	6742	1247	7120	1067	7408	798	8637	692	3265
8-#9	1.30	MA	5369	1862	7822	1541	9047	1296	9697	1104	10344	814	12336	708	5283
2L-4S		MI	3919	1862	5695	1519	6379	1284	6668	1093	6785	804	7832	569	4079
8-#9	1.30	MA	5154	1862	7410	1550	8521	1304	9059	1111	9481	826	11140	640	5293
3E		MI	4002	1862	5907	1512	6676	1271	7033	1089	7285	802	8444	610	4066
8-#9	1.30	MA	5042	1862	7129	1559	8125	1319	8572	1125	8814	831	10326	600	5289
4L-2S		MI	4157	1862	6212	1504	7065	1265	7505	1077	7924	793	9314	682	4052
8-#10	1.65	MA	5564	1924	8275	1576	9605	1321	10367	1119	11243	808	13576	701	6616
2L-4S		MI	4001	1924	5896	1556	6610	1312	6940	1111	7146	799	8315	526	5058
8-#10	1.65	MA	5299	1924	7754	1587	8942	1331	9561	1128	10154	823	12067	614	6620
3E		MI	4103	1924	6163	1547	6985	1296	7400	1105	7775	797	9080	577	5059
8-#10	1.65	MA	5161	1924	7399	1598	8441	1349	8946	1145	9311	829	11035	562	6588
4L-2S		MI	4294	1924	6547	1538	7475	1289	7995	1091	8581	786	10167	668	5045
8-#11	2.03	MA	5745	1990	8761	1606	10176	1342	11036	1130	12131	798	14791	690	7979
2L-4S		MI	4072	1990	6120	1586	6843	1333	7201	1121	7481	787	8700	465	6037
8-#11	2.03	MA	5434	1990	8132	1619	9375	1353	10064	1139	10815	815	12968	581	7973
3E		MI	4193	1990	6442	1576	7296	1315	7755	1116	8240	786	9601	526	6060
8-#11	2.03	MA	5272	1990	7701	1632	8768	1375	9318	1159	9794	821	11708	516	7901
4L-2S		MI	4416	1990	6903	1566	7884	1308	8469	1100	9206	774	10875	638	6047
8-#14	2.92	MA	6199	2147	9866	1697	11549	1407	12687	1169	14351	784	17855	673	11248
2L-4S		MI	4266	2147	6596	1681	7399	1405	7859	1165	8357	774	9812	344	8032
8-#14	2.92	MA	5780	2147	8971	1715	10408	1422	11302	1181	12477	807	15260	513	11191
3E		MI	4429	2147	7054	1668	8043	1381	8648	1159	9436	774	11072	429	8425
8-#14	2.92	MA	5561	2147	8355	1732	9541	1452	10238	1209	11020	815	13450	419	10669
4L-2S		MI	4731	2147	7709	1655	8877	1371	9660	1137	10806	759	12845	590	8444
8-#18	5.19	MA	6611	2547	11013	1960	12941	1599	14346	1316	16571	787	20653	314	18936
3E		MI	4993	2547	8525	1904	9854	1548	10818	1269	12351	745	14487	156	13947
8-#18	5.19	MA	6266	2547	9939	1988	11430	1649	12492	1334	14034	796	17552	151	16622
4L-2S		MI	5459	2547	9648	1885	11285	1536	12555	1236	14702	724	17418	444	14209
10-#10	2.06	MA	5800	1996	8796	1621	10268	1354	11172	1140	12333	804	15085	695	8197
2L-5S		MI	4054	1996	6008	1618	6771	1352	7126	1145	7383	806	8639	464	6018
10-#10	2.06	MA	5543	1996	8275	1632	9605	1364	10367	1148	11243	819	13576	608	8190
3L-4S		MI	4179	1996	6281	1601	7100	1345	7535	1131	7951	795	9402	517	6212
10-#10	2.06	MA	5412	1996	7920	1643	9104	1382	9751	1165	10401	825	12544	557	8144
4L-3S		MI	4276	1996	6547	1592	7475	1329	7995	1126	8581	793	10167	568	6227
10-#10	2.06	MA	5224	1996	7557	1662	8667	1392	9208	1174	9644	839	11502	510	7856
5L-2S		MI	4462	1996	6932	1583	7965	1322	8590	1112	9386	782	11254	659	6220
10-#11	2.53	MA	6022	2079	9390	1662	10976	1382	12009	1155	13447	793	16613	683	9884
2L-5S		MI	4139	2079	6252	1661	7034	1381	7421	1162	7762	794	9079	385	7032
10-#11	2.53	MA	5723	2079	8761	1675	10176	1394	11036	1165	12131	810	14791	573	9862
3L-4S		MI	4282	2079	6582	1641	7431	1374	7915	1147	8447	782	9973	450	7413
10-#11	2.53	MA	5570	2079	8330	1687	9568	1415	10291	1184	11110	816	13530	509	9774
4L-3S		MI	4396	2079	6903	1631	7884	1356	8469	1141	9206	781	10875	511	7454
10-#11	2.53	MA	5350	2079	7890	1711	9038	1426	9631	1194	10192	832	12263	449	9229
5L-2S		MI	4613	2079	7365	1622	8472	1348	9183	1125	10173	769	12148	623	7454
10-#14	3.65	MA	6181	2276	9866	1795	11549	1480	12687	1218	14351	800	17855	502	13868
3L-4S		MI	4559	2276	7250	1761	8233	1464	8871	1202	9727	767	11586	319	9886
10-#14	3.65	MA	5979	2276	9250	1813	10681	1510	11622	1245	12894	807	16045	409	13253
4L-3S		MI	4712	2276	7709	1748	8877	1439	9660	1195	10806	767	12845	403	10382
10-#14	3.65	MA	5672	2276	8621	1845	9923	1526	10680	1258	11583	830	14230	318	12435
5L-2S		MI	5002	2276	8363	1735	9710	1429	10673	1174	12177	752	14619	565	10424
10-#18	6.49	MA	6972	2776	11491	2131	13405	1753	14892	1399	17282	783	21963	125	21159
4L-3S		MI	5488	2776	9648	2047	11285	1652	12555	1334	14702	731	17418	96	17058

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis

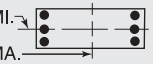


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#10	2.47	MA	6032	2069	9317	1666	10931	1387	11977	1160	13423	800	16594	689	9773
2L-6S		MI	4101	2069	6155	1671	6936	1401	7319	1172	7645	813	9027	396	6923
12-#10	2.47	MA	5782	2069	8796	1677	10268	1397	11172	1169	12333	814	15085	602	9756
3L-5S		MI	4230	2069	6392	1664	7261	1385	7721	1166	8188	802	9726	455	7126
12-#10	2.47	MA	5659	2069	8440	1688	9767	1415	10557	1186	11491	821	14053	551	9700
4E		MI	4354	2069	6665	1646	7590	1378	8130	1152	8756	791	10489	507	7363
12-#10	2.47	MA	5472	2069	8078	1708	9330	1425	10013	1194	10734	835	13011	504	9375
5L-3S		MI	4447	2069	6932	1638	7965	1362	8590	1146	9386	789	11254	558	7388
12-#10	2.47	MA	5295	2069	7739	1714	8919	1434	9479	1211	10011	850	11988	433	9042
6L-2S		MI	4628	2069	7317	1629	8455	1355	9185	1132	10191	778	12341	650	7390
12-#11	3.04	MA	6006	2168	9390	1730	10976	1434	12009	1190	13447	804	16613	566	11749
3L-5S		MI	4347	2168	6713	1717	7622	1422	8135	1188	8728	789	10353	370	8364
12-#11	3.04	MA	5863	2168	8959	1743	10369	1455	11263	1210	12426	811	15352	502	11648
4E		MI	4489	2168	7043	1697	8019	1414	8629	1172	9414	777	11247	436	8761
12-#11	3.04	MA	5644	2168	8519	1766	9839	1467	10604	1219	11508	827	14085	441	11066
5L-3S		MI	4597	2168	7365	1687	8472	1396	9183	1166	10173	776	12148	496	8842
12-#11	3.04	MA	5435	2168	8116	1775	9316	1488	9955	1239	10632	844	12932	367	10645
6L-2S		MI	4807	2168	7827	1677	9060	1388	9898	1150	11139	764	13422	608	8855
12-#14	4.38	MA	6387	2404	10146	1893	11821	1569	13007	1282	14768	800	18640	398	15850
4E		MI	4847	2404	7905	1841	9066	1522	9884	1238	11098	759	13359	293	11754
12-#14	4.38	MA	6083	2404	9517	1925	11063	1584	12065	1294	13457	822	16825	307	15073
5L-3S		MI	4991	2404	8363	1828	9710	1497	10673	1231	12177	759	14619	378	12336
12-#14	4.38	MA	5798	2404	8948	1938	10315	1614	11138	1322	12204	845	15169	200	13996
6L-2S		MI	5271	2404	9018	1815	10544	1487	11685	1210	13547	744	16393	539	12396
14-#10	2.89	MA	6019	2141	9317	1722	10931	1430	11977	1189	13423	810	16594	597	11321
3L-6S		MI	4278	2141	6539	1717	7426	1434	7914	1192	8451	809	10114	387	8048
14-#10	2.89	MA	5901	2141	8961	1733	10430	1448	11362	1206	12580	816	15562	545	11256
4L-5S		MI	4404	2141	6777	1709	7751	1418	8316	1187	8994	798	10813	445	8241
14-#10	2.89	MA	5715	2141	8599	1753	9993	1458	10818	1215	11824	831	14520	498	10898
5L-4S		MI	4527	2141	7050	1692	8080	1411	8725	1172	9562	787	11576	498	8512
14-#10	2.89	MA	5544	2141	8260	1759	9582	1467	10284	1232	11101	845	13497	427	10580
6L-3S		MI	4616	2141	7317	1683	8455	1395	9185	1167	10191	784	12341	549	8546
14-#10	2.89	MA	5399	2141	7928	1766	9131	1483	9771	1240	10364	852	12509	388	10119
7L-2S		MI	4793	2141	7702	1674	8945	1388	9780	1153	10996	774	13428	641	8556
14-#11	3.55	MA	6150	2257	9588	1799	11169	1496	12236	1235	13742	806	17174	495	13523
4L-5S		MI	4551	2257	7175	1773	8210	1462	8850	1213	9695	783	11627	355	9703
14-#11	3.55	MA	5932	2257	9148	1822	10639	1507	11576	1244	12824	822	15907	434	12909
5L-4S		MI	4692	2257	7505	1753	8607	1455	9343	1197	10380	772	12521	421	10077
14-#11	3.55	MA	5731	2257	8744	1830	10117	1529	10928	1264	11948	839	14755	360	12473
6L-3S		MI	4795	2257	7827	1743	9060	1437	9898	1191	11139	770	13422	481	10227
14-#11	3.55	MA	5560	2257	8342	1838	9603	1538	10304	1274	11053	845	13454	295	11820
7L-2S		MI	5000	2257	8289	1733	9647	1429	10612	1176	12105	759	14696	593	10250
14-#14	5.11	MA	6485	2533	10412	2006	12203	1642	13450	1331	15331	815	19420	297	17717
5L-4S		MI	5131	2533	8560	1922	9900	1580	10896	1275	12468	752	15133	268	13634
14-#14	5.11	MA	6214	2533	9844	2018	11456	1672	12523	1358	14078	838	17764	189	16626
6L-3S		MI	5265	2533	9018	1909	10544	1556	11685	1268	13547	752	16393	352	14289
16-#10	3.30	MA	6140	2214	9482	1779	11093	1481	12167	1227	13670	812	17071	539	12813
4L-6S		MI	4453	2214	6924	1762	7916	1467	8509	1213	9256	804	11201	378	9175
16-#10	3.30	MA	5955	2214	9119	1798	10656	1490	11624	1235	12913	827	16029	492	12426
5E		MI	4575	2214	7162	1754	8241	1451	8911	1207	9799	794	11900	436	9359
16-#10	3.30	MA	5789	2214	8781	1805	10245	1500	11090	1252	12191	841	15006	421	12120
6L-4S		MI	4698	2214	7435	1737	8570	1444	9320	1193	10367	783	12663	489	9660
16-#10	3.30	MA	5649	2214	8449	1811	9794	1516	10576	1261	11454	847	14018	382	11650
7L-3S		MI	4783	2214	7702	1728	8945	1428	9780	1187	10996	780	13428	540	9702
16-#10	3.30	MA	5490	2214	8129	1819	9363	1522	10055	1277	10749	862	13068	330	11205
8L-2S		MI	4955	2214	8086	1719	9435	1421	10375	1173	11802	769	14515	632	9718
16-#11	4.05	MA	6216	2346	9776	1878	11440	1548	12549	1270	14140	817	17729	427	14758
5E		MI	4753	2346	7637	1828	8798	1503	9564	1238	10661	778	12901	340	11047

RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	4.05	MA	6022	2346	9373	1886	10917	1569	11900	1290	13264	834	16577	353	14307
6L-4S		MI	4894	2346	7967	1808	9195	1495	10057	1222	11347	767	13795	406	11401
16-#11	4.05	MA	5858	2346	8971	1894	10404	1578	11277	1299	12369	840	15276	288	13672
7L-3S		MI	4992	2346	8289	1798	9647	1477	10612	1217	12105	765	14696	466	11610
16-#14	5.84	MA	6620	2661	10739	2099	12596	1731	13908	1395	15952	830	20359	179	19261
6L-4S		MI	5411	2661	9214	2002	10734	1639	11909	1311	13838	745	16906	243	15524
18-#10	3.71	MA	6192	2286	9640	1844	11319	1523	12429	1256	14003	822	17538	487	13958
5L-6S		MI	4625	2286	7309	1807	8406	1499	9104	1233	10061	800	12288	369	10305
18-#10	3.71	MA	6031	2286	9302	1850	10908	1533	11895	1273	13281	837	16515	415	13663
6L-5S		MI	4745	2286	7547	1800	8731	1484	9506	1228	10604	789	12987	427	10481
18-#10	3.71	MA	5896	2286	8969	1857	10457	1549	11381	1281	12543	843	15527	376	13183
7L-4S		MI	4867	2286	7820	1782	9059	1477	9915	1214	11172	778	13750	480	10809
18-#10	3.71	MA	5738	2286	8650	1865	10026	1555	10861	1298	11839	858	14577	324	12738
8L-3S		MI	4948	2286	8086	1774	9435	1461	10375	1208	11802	776	14515	531	10857
18-#11	4.56	MA	6309	2435	10002	1942	11718	1610	12872	1315	14580	828	18399	346	16145
6L-5S		MI	4952	2435	8099	1884	9385	1543	10278	1263	11628	773	14175	325	12395
18-#11	4.56	MA	6151	2435	9599	1949	11204	1619	12249	1324	13685	835	17098	281	15528
7L-4S		MI	5093	2435	8429	1864	9783	1536	10771	1248	12313	761	15069	391	12732
20-#10	4.12	MA	6269	2359	9822	1895	11571	1566	12700	1293	14371	833	18024	409	15208
6E		MI	4796	2359	7694	1853	8896	1532	9699	1254	10866	796	13375	359	11416
20-#10	4.12	MA	6139	2359	9490	1902	11120	1582	12187	1302	13633	839	17036	371	14719
7L-5S		MI	4912	2359	7932	1845	9221	1517	10101	1248	11410	785	14074	418	11607
20-#10	4.12	MA	5982	2359	9171	1910	10689	1588	11666	1318	12929	854	16086	318	14272
8L-4S		MI	5034	2359	8204	1828	9549	1510	10510	1234	11977	774	14837	471	11928
20-#11	5.06	MA	6440	2524	10228	2005	12005	1659	13221	1350	15001	829	18920	273	17386
7L-5S		MI	5150	2524	8560	1940	9973	1584	10992	1289	12594	768	15449	310	13747
22-#10	4.54	MA	6379	2431	10011	1947	11783	1615	12992	1323	14723	835	18545	365	16258
7L-6S		MI	4965	2431	8078	1898	9386	1565	10294	1274	11672	792	14462	350	12525
22-#10	4.54	MA	6223	2431	9692	1955	11352	1621	12471	1339	14018	849	17595	312	15808
8L-5S		MI	5078	2431	8316	1890	9710	1550	10696	1269	12215	781	15161	409	12735

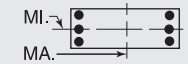
RECTANGULAR TIED COLUMNS 22" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.36	MA	6176	2007	9107	1646	10485	1384	11222	1177	11972	864	14279	751	6297
2E		MI	4434	2007	6763	1589	7606	1335	8036	1135	8447	831	9709	691	4468
4-#18	2.42	MA	6796	2207	10625	1755	12345	1461	13446	1222	14953	843	18384	726	10750
2E		MI	4813	2207	7769	1693	8821	1408	9481	1176	10378	807	11962	612	7458
6-#10	1.15	MA	6077	1968	8752	1640	10123	1381	10827	1180	11473	877	13614	763	5441
2L-3S		MI	4184	1968	6136	1598	6889	1346	7206	1157	7353	859	8408	636	3905
6-#10	1.15	MA	5776	1968	8186	1651	9402	1392	9951	1189	10289	893	11973	679	5456
3L-2S		MI	4381	1968	6520	1590	7379	1339	7801	1143	8158	848	9495	727	3883
6-#11	1.42	MA	6231	2018	9166	1660	10598	1395	11378	1186	12199	868	14603	754	6571
2L-3S		MI	4242	2018	6341	1616	7103	1357	7442	1162	7655	848	8740	590	4683
6-#11	1.42	MA	5876	2018	8482	1673	9727	1407	10320	1196	10766	886	12619	647	6583
3L-2S		MI	4474	2018	6803	1606	7691	1349	8156	1146	8621	836	10014	703	4657
6-#14	2.05	MA	6617	2136	10082	1726	11727	1442	12731	1214	14015	857	17106	740	9267
2L-3S		MI	4398	2136	6763	1683	7606	1403	8036	1193	8447	838	9709	504	6501
6-#14	2.05	MA	6131	2136	9107	1745	10485	1458	11222	1228	11972	881	14279	584	9240
3L-2S		MI	4715	2136	7418	1669	8439	1394	9049	1172	9817	823	11482	665	6483
6-#18	3.64	MA	7522	2435	12320	1898	14502	1565	16066	1287	18500	830	23294	708	15866
2L-3S		MI	4769	2435	7769	1855	8821	1525	9481	1274	10378	813	11962	264	10762

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis

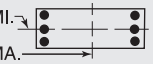


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	3.64	MA	6747	2435	10625	1929	12345	1591	13446	1335	14953	869	18384	420	15617
3L-2S		MI	5275	2435	8893	1836	10251	1512	11218	1241	12729	793	14893	552	10875
8-#9	1.21	MA	6126	1979	8825	1650	10235	1390	10972	1186	11678	879	13903	764	5715
2L-4S		MI	4176	1979	6052	1616	6772	1367	7069	1166	7169	862	8249	620	4103
8-#9	1.21	MA	5889	1979	8377	1659	9664	1398	10279	1193	10740	891	12604	698	5725
3E		MI	4259	1979	6263	1609	7070	1354	7434	1161	7668	859	8861	660	4088
8-#9	1.21	MA	5766	1979	8072	1669	9235	1413	9752	1207	10017	897	11727	658	5721
4L-2S		MI	4415	1979	6569	1602	7459	1348	7906	1150	8307	850	9731	732	4072
8-#10	1.54	MA	6342	2040	9318	1685	10844	1414	11702	1200	12658	873	15254	757	7165
2L-4S		MI	4257	2040	6254	1653	7004	1395	7341	1183	7529	857	8730	576	5090
8-#10	1.54	MA	6050	2040	8752	1696	10123	1425	10827	1210	11473	888	13614	673	7169
3E		MI	4360	2040	6520	1644	7379	1379	7801	1177	8158	854	9495	627	5085
8-#10	1.54	MA	5899	2040	8367	1708	9580	1443	10160	1227	10560	895	12502	622	7136
4L-2S		MI	4552	2040	6905	1635	7869	1372	8396	1163	8963	844	10582	718	5068
8-#11	1.89	MA	6543	2107	9851	1716	11470	1435	12437	1211	13631	863	16586	747	8653
2L-4S		MI	4328	2107	6481	1682	7238	1415	7602	1193	7862	844	9112	515	6081
8-#11	1.89	MA	6201	2107	9166	1729	10598	1447	11378	1222	12199	881	14603	640	8647
3E		MI	4450	2107	6803	1672	7691	1397	8156	1187	8621	843	10014	575	6092
8-#11	1.89	MA	6023	2107	8699	1743	9939	1470	10569	1242	11091	888	13245	576	8575
4L-2S		MI	4674	2107	7265	1662	8279	1389	8870	1171	9588	831	11287	688	6076
8-#14	2.73	MA	7048	2264	11058	1806	12970	1500	14240	1250	16057	849	19934	730	12220
2L-4S		MI	4521	2264	6959	1776	7795	1487	8260	1236	8738	831	10223	394	8168
8-#14	2.73	MA	6584	2264	10082	1825	11727	1517	12731	1264	14015	874	17106	573	12163
3E		MI	4686	2264	7418	1763	8439	1462	9049	1229	9817	831	11482	478	8470
8-#14	2.73	MA	6343	2264	9414	1844	10785	1548	11575	1293	12432	883	15156	481	11731
4L-2S		MI	4991	2264	8072	1750	9273	1452	10061	1208	11187	816	13256	640	8479
8-#18	4.85	MA	7505	2664	12320	2071	14502	1695	16066	1400	18500	856	23294	402	20664
3E		MI	5250	2664	8893	1998	10251	1629	11218	1339	12729	800	14893	205	14089
8-#18	4.85	MA	7127	2664	11152	2102	12858	1747	14050	1421	15739	868	19856	234	18294
4L-2S		MI	5724	2664	10017	1979	11682	1616	12956	1306	15081	780	17825	492	14260
10-#10	1.92	MA	6601	2113	9884	1730	11564	1447	12577	1221	13843	869	16894	752	8883
2L-5S		MI	4311	2113	6365	1715	7165	1435	7527	1217	7766	864	9055	514	6102
10-#10	1.92	MA	6318	2113	9318	1742	10844	1458	11702	1230	12658	884	15254	667	8876
3L-4S		MI	4435	2113	6638	1698	7494	1428	7936	1203	8334	853	9817	567	6247
10-#10	1.92	MA	6175	2113	8933	1753	10300	1476	11035	1248	11744	891	14142	616	8830
4L-3S		MI	4534	2113	6905	1689	7869	1412	8396	1198	8963	850	10582	618	6255
10-#10	1.92	MA	5964	2113	8541	1773	9828	1487	10447	1257	10925	907	13017	571	8578
5L-2S		MI	4721	2113	7290	1680	8359	1405	8991	1184	9769	839	11670	709	6245
10-#11	2.36	MA	6850	2196	10535	1771	12341	1476	13495	1236	15064	858	18570	739	10726
2L-5S		MI	4396	2196	6613	1757	7429	1463	7822	1234	8143	851	9492	435	7129
10-#11	2.36	MA	6519	2196	9851	1785	11470	1488	12437	1247	13631	876	16586	633	10705
3L-4S		MI	4539	2196	6943	1737	7826	1456	8316	1218	8829	839	10386	500	7460
10-#11	2.36	MA	6351	2196	9384	1798	10810	1510	11628	1268	12523	883	15228	569	10616
4L-3S		MI	4654	2196	7265	1727	8279	1438	8870	1212	9588	838	11287	560	7490
10-#11	2.36	MA	6104	2196	8907	1822	10236	1522	10913	1278	11528	901	13858	512	10086
5L-2S		MI	4872	2196	7726	1718	8867	1430	9584	1196	10554	826	12561	673	7485
10-#14	3.41	MA	7026	2393	11058	1905	12970	1575	14240	1301	16057	866	19934	563	15083
3L-4S		MI	4815	2393	7614	1856	8629	1545	9272	1272	10108	823	11996	368	10016
10-#14	3.41	MA	6804	2393	10390	1924	12027	1606	13084	1330	14474	876	17983	471	14554
4L-3S		MI	4970	2393	8072	1843	9273	1520	10061	1266	11187	823	13256	453	10430
10-#14	3.41	MA	6459	2393	9708	1958	11205	1623	12062	1344	13051	900	16020	384	13605
5L-2S		MI	5263	2393	8727	1830	10106	1510	11074	1244	12557	808	15030	614	10463
10-#18	6.06	MA	7906	2892	12847	2245	15016	1851	16670	1486	19286	855	24766	216	23264
4L-3S		MI	5746	2892	10017	2141	11682	1732	12956	1403	15081	787	17825	145	17276
10-#18	6.06	MA	7332	2892	11654	2302	13578	1877	14884	1534	16801	894	21322	51	21085
5L-2S		MI	6161	2892	11140	2121	13112	1719	14693	1370	17432	767	20756	433	17632
12-#10	2.31	MA	6857	2185	10450	1776	12285	1480	13453	1241	15027	865	18535	746	10596
2L-6S		MI	4357	2185	6512	1768	7330	1483	7720	1244	8028	870	9442	446	7003

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

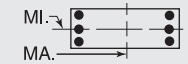
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	2.31	MA	6582	2185	9884	1787	11564	1491	12577	1251	13843	880	16894	661	10579
3L-5S		MI	4487	2185	6750	1761	7655	1468	8122	1238	8571	859	10142	505	7209
12-#10	2.31	MA	6446	2185	9499	1799	11021	1509	11911	1268	12929	887	15783	610	10523
4E		MI	4611	2185	7023	1743	7984	1460	8531	1224	9139	848	10904	558	7401
12-#10	2.31	MA	6237	2185	9107	1819	10548	1520	11322	1278	12109	902	14658	566	10232
5L-3S		MI	4705	2185	7290	1734	8359	1445	8991	1218	9769	846	11670	609	7419
12-#10	2.31	MA	6044	2185	8735	1825	10104	1530	10744	1295	11327	918	13556	495	9850
6L-2S		MI	4888	2185	7675	1726	8849	1438	9586	1204	10574	835	12757	700	7416
12-#11	2.84	MA	6831	2285	10535	1840	12341	1528	13495	1272	15064	870	18570	626	12760
3L-5S		MI	4603	2285	7075	1813	8017	1504	8536	1259	9110	845	10766	420	8459
12-#11	2.84	MA	6673	2285	10068	1854	11682	1550	12686	1293	13956	878	17211	562	12659
4E		MI	4745	2285	7404	1793	8414	1496	9030	1243	9795	834	11660	485	8837
12-#11	2.84	MA	6428	2285	9591	1878	11107	1562	11972	1303	12961	896	15841	505	12089
5L-3S		MI	4855	2285	7726	1783	8867	1478	9584	1238	10554	832	12561	546	8881
12-#11	2.84	MA	6199	2285	9147	1886	10567	1574	11269	1324	12011	913	14496	417	11659
6L-2S		MI	5067	2285	8188	1773	9455	1470	10299	1222	11520	821	13835	658	8888
12-#14	4.09	MA	7254	2521	11366	2004	13270	1665	14593	1366	16516	868	20811	460	17391
4E		MI	5103	2521	8269	1937	9462	1603	10285	1309	11478	816	13770	343	11881
12-#14	4.09	MA	6912	2521	10684	2038	12448	1681	13571	1380	15094	893	18848	374	16484
5L-3S		MI	5249	2521	8727	1923	10106	1579	11074	1302	12557	816	15030	427	12386
12-#14	4.09	MA	6600	2521	10056	2050	11638	1712	12566	1409	13735	917	17065	268	15396
6L-2S		MI	5533	2521	9382	1910	10940	1569	12086	1281	13927	801	16803	589	12437
12-#18	7.27	MA	8096	3121	13349	2445	15736	1981	17504	1599	20347	881	26232	33	26071
5L-3S		MI	6205	3121	11140	2283	13112	1836	14693	1468	17432	774	20756	86	20412
14-#10	2.69	MA	6842	2258	10450	1832	12285	1523	13453	1271	15027	876	18535	655	12281
3L-6S		MI	4534	2258	6897	1814	7820	1516	8315	1264	8833	866	10529	437	8127
14-#10	2.69	MA	6713	2258	10065	1844	11742	1542	12786	1289	14114	883	17423	604	12216
4L-5S		MI	4661	2258	7135	1806	8145	1501	8717	1259	9377	855	11229	496	8322
14-#10	2.69	MA	6505	2258	9673	1864	11269	1553	12198	1298	13294	898	16298	560	11891
5L-4S		MI	4784	2258	7408	1789	8474	1493	9126	1245	9944	844	11991	549	8552
14-#10	2.69	MA	6318	2258	9301	1870	10824	1563	11620	1316	12512	914	15196	489	11523
6L-3S		MI	4874	2258	7675	1780	8849	1478	9586	1239	10574	842	12757	600	8579
14-#10	2.69	MA	6158	2258	8941	1877	10328	1578	11064	1325	11714	921	14131	453	11077
7L-2S		MI	5053	2258	8059	1771	9339	1470	10181	1225	11379	831	13844	691	8584
14-#11	3.31	MA	6990	2374	10752	1910	12553	1591	13745	1318	15388	873	19195	555	14702
4L-5S		MI	4808	2374	7536	1869	8605	1544	9250	1284	10076	840	12040	405	9796
14-#11	3.31	MA	6746	2374	10276	1933	11979	1603	13030	1329	14393	890	17825	497	14099
5L-4S		MI	4950	2374	7866	1849	9002	1536	9744	1268	10762	829	12934	470	10183
14-#11	3.31	MA	6525	2374	9831	1941	11438	1615	12328	1349	13443	908	16479	410	13686
6L-3S		MI	5054	2374	8188	1839	9455	1518	10299	1263	11520	827	13835	531	10268
14-#11	3.31	MA	6337	2374	9395	1950	10846	1634	11653	1360	12474	916	15180	362	12950
7L-2S		MI	5261	2374	8650	1829	10043	1511	11013	1247	12487	816	15109	643	10285
14-#14	4.77	MA	7355	2650	11660	2118	13690	1739	15080	1417	17136	885	21676	364	19371
5L-4S		MI	5387	2650	8923	2017	10296	1662	11297	1345	12848	808	15544	317	13757
14-#14	4.77	MA	7057	2650	11032	2130	12880	1771	14075	1446	15777	910	19893	257	18272
6L-3S		MI	5525	2650	9382	2004	10940	1637	12086	1339	13927	808	16803	402	14341
16-#10	3.08	MA	6975	2330	10631	1889	12462	1575	13661	1309	15298	879	19063	598	13910
4L-6S		MI	4709	2330	7282	1859	8310	1549	8910	1285	9639	862	11616	428	9253
16-#10	3.08	MA	6769	2330	10239	1909	11990	1586	13073	1319	14479	894	17938	554	13554
5E		MI	4833	2330	7520	1851	8635	1534	9312	1279	10182	851	12316	487	9439
16-#10	3.08	MA	6587	2330	9867	1915	11545	1596	12495	1336	13697	909	16837	483	13200
6L-4S		MI	4956	2330	7793	1834	8964	1526	9721	1265	10750	840	13078	540	9702
16-#10	3.08	MA	6434	2330	9507	1923	11049	1611	11940	1346	12898	916	15771	447	12745
7L-3S		MI	5042	2330	8059	1825	9339	1511	10181	1259	11379	838	13844	591	9736

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

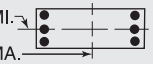
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	3.08	MA	6256	2330	9161	1931	10582	1618	11365	1361	12136	932	14747	396	12271
8L-2S		MI	5217	2330	8444	1816	9829	1503	10776	1245	12185	827	14931	682	9748
16-#11	3.78	MA	7059	2463	10960	1989	12850	1643	14089	1354	15826	885	19808	490	16114
5E		MI	5010	2463	7998	1924	9193	1585	9965	1310	11043	835	13314	390	11138
16-#11	3.78	MA	6846	2463	10516	1997	12310	1655	13386	1375	14876	903	18462	403	15707
6L-4S		MI	5151	2463	8328	1904	9590	1577	10458	1294	11728	823	14208	456	11505
16-#11	3.78	MA	6666	2463	10079	2005	11718	1674	12711	1385	13906	910	17163	355	14971
7L-3S		MI	5251	2463	8650	1894	10043	1559	11013	1288	12487	822	15109	516	11652
16-#14	5.45	MA	7505	2778	12008	2210	14123	1829	15584	1482	17819	902	22720	247	21153
6L-4S		MI	5668	2778	9578	2097	11129	1720	12309	1382	14218	801	17317	292	15644
18-#10	3.46	MA	7029	2403	10805	1954	12710	1619	13948	1339	15663	890	19579	548	15221
5L-6S		MI	4882	2403	7667	1904	8800	1582	9505	1305	10444	858	12703	419	10382
18-#10	3.46	MA	6852	2403	10433	1961	12266	1629	13370	1357	14881	905	18477	477	14879
6L-5S		MI	5003	2403	7904	1896	9125	1566	9907	1300	10987	847	13403	478	10560
18-#10	3.46	MA	6705	2403	10073	1968	11770	1644	12815	1366	14083	912	17412	441	14416
7L-4S		MI	5125	2403	8177	1879	9453	1559	10316	1286	11555	836	14165	530	10851
18-#10	3.46	MA	6528	2403	9727	1976	11303	1651	12241	1382	13321	928	16387	391	13955
8L-3S		MI	5208	2403	8444	1870	9829	1544	10776	1280	12185	833	14931	581	10892
18-#11	4.25	MA	7161	2552	11200	2053	13181	1696	14445	1400	16308	898	20446	395	17714
6L-5S		MI	5210	2552	8460	1980	9781	1625	10679	1335	12009	830	14588	375	12485
18-#11	4.25	MA	6988	2552	10763	2061	12589	1715	13770	1410	15338	905	19147	348	16996
7L-4S		MI	5351	2552	8790	1960	10178	1617	11172	1319	12695	818	15481	441	12833
20-#10	3.85	MA	7114	2475	10999	2006	12986	1662	14246	1378	16066	901	20117	472	16561
6E		MI	5053	2475	8051	1950	9290	1615	10100	1326	11249	853	13791	410	11514
20-#10	3.85	MA	6972	2475	10639	2013	12490	1677	13690	1387	15268	908	19052	435	16089
7L-5S		MI	5171	2475	8289	1942	9615	1599	10502	1320	11792	842	14490	468	11684
20-#10	3.85	MA	6797	2475	10293	2022	12023	1684	13116	1403	14505	923	18027	385	15639
8L-4S		MI	5293	2475	8562	1925	9943	1592	10911	1306	12360	832	15253	521	12000
20-#11	4.73	MA	7306	2641	11448	2117	13461	1755	14828	1436	16771	900	21130	340	19023
7L-5S		MI	5408	2641	8922	2036	10369	1666	11393	1360	12976	825	15861	360	13835
22-#10	4.23	MA	7236	2548	11205	2058	13211	1710	14566	1407	16452	904	20692	429	17765
7L-6S		MI	5222	2548	8436	1995	9780	1648	10695	1346	12054	849	14878	401	12647
22-#10	4.23	MA	7062	2548	10859	2067	12744	1717	13992	1423	15690	919	19668	379	17325
8L-5S		MI	5338	2548	8674	1987	10104	1632	11097	1341	12598	838	15577	459	12811
24-#10	4.62	MA	7323	2620	11425	2112	13465	1750	14867	1444	16875	915	21308	373	19013
8L-6S		MI	5390	2620	8821	2040	10270	1681	11290	1367	12860	845	15965	391	13758

RECTANGULAR TIED COLUMNS 22" x 32"

4-#14	1.28	MA	6989	2124	10193	1755	11768	1477	12599	1259	13414	929	15974	807	6783
2E		MI	4691	2124	7127	1684	8002	1416	8437	1206	8827	887	10120	740	4495
4-#18	2.27	MA	7673	2324	11844	1865	13791	1554	15017	1304	16656	908	20439	783	11614
2E		MI	5072	2324	8137	1787	9218	1488	9881	1246	10756	862	12369	660	7497
6-#10	1.08	MA	6878	2085	9804	1749	11371	1475	12164	1261	12865	942	15242	820	5853
2L-3S		MI	4440	2085	6493	1695	7283	1429	7607	1229	7736	916	8824	686	3926
6-#10	1.08	MA	6549	2085	9193	1761	10593	1486	11219	1271	11585	958	13471	737	5867
3L-2S		MI	4639	2085	6878	1687	7773	1421	8202	1215	8541	905	9911	778	3904
6-#11	1.33	MA	7048	2134	10255	1769	11888	1488	12765	1267	13655	933	16319	811	7077
2L-3S		MI	4499	2134	6702	1712	7498	1438	7843	1233	8036	905	9153	640	4710
6-#11	1.33	MA	6659	2134	9515	1783	10946	1501	11620	1278	12106	952	14174	706	7089
3L-2S		MI	4732	2134	7164	1702	8086	1431	8557	1217	9003	893	10427	752	4682
6-#14	1.92	MA	7472	2252	11249	1835	13113	1535	14232	1295	15625	921	19035	797	9996
2L-3S		MI	4655	2252	7127	1778	8002	1485	8437	1264	8827	894	10120	553	6538
6-#14	1.92	MA	6940	2252	10193	1855	11768	1553	12599	1310	13414	947	15974	644	9969
3L-2S		MI	4973	2252	7781	1765	8835	1475	9450	1242	10197	879	11893	715	6514

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis



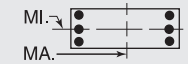
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#18	3.41	MA	8470	2552	13681	2007	16131	1658	17858	1368	20501	895	25763	765	17162
2L-3S		MI	5025	2552	8137	1949	9218	1605	9881	1344	10756	869	12369	313	10831
6-#18	3.41	MA	7618	2552	11844	2040	13791	1686	15017	1392	16656	937	20439	484	16913
3L-2S		MI	5535	2552	9261	1930	10649	1592	11619	1311	13107	849	15300	601	10919
8-#9	1.14	MA	6930	2095	9882	1760	11491	1483	12320	1267	13084	944	15552	821	6147
2L-4S		MI	4432	2095	6408	1713	7166	1450	7470	1238	7552	919	8666	670	4126
8-#9	1.14	MA	6672	2095	9398	1769	10875	1492	11572	1275	12071	957	14150	756	6157
3E		MI	4516	2095	6620	1706	7463	1437	7835	1233	8051	917	9277	711	4108
8-#9	1.14	MA	6538	2095	9071	1779	10412	1507	11003	1290	11293	963	13210	717	6153
4L-2S		MI	4673	2095	6925	1699	7852	1431	8307	1222	8691	908	10148	783	4092
8-#10	1.44	MA	7167	2157	10416	1794	12149	1508	13110	1282	14144	938	17014	814	7714
2L-4S		MI	4514	2157	6611	1750	7398	1477	7742	1255	7911	914	9146	626	5121
8-#10	1.44	MA	6848	2157	9804	1806	11371	1518	12164	1292	12865	954	15242	731	7718
3E		MI	4617	2157	6878	1741	7773	1462	8202	1249	8541	912	9911	677	5109
8-#10	1.44	MA	6683	2157	9390	1818	10786	1538	11446	1310	11880	962	14051	681	7685
4L-2S		MI	4811	2157	7263	1732	8263	1454	8797	1235	9346	901	10998	769	5091
8-#11	1.77	MA	7390	2223	10995	1825	12831	1529	13909	1292	15204	928	18463	803	9326
2L-4S		MI	4585	2223	6842	1777	7633	1497	8002	1264	8244	901	9525	565	6121
8-#11	1.77	MA	7014	2223	10255	1839	11888	1541	12765	1304	13655	946	16319	699	9321
3E		MI	4707	2223	7164	1768	8086	1479	8557	1258	9003	900	10427	625	6123
8-#11	1.77	MA	6820	2223	9752	1853	11177	1564	11892	1325	12459	955	14863	636	9249
4L-2S		MI	4933	2223	7626	1758	8674	1471	9271	1242	9969	888	11700	737	6103
8-#14	2.56	MA	7944	2381	12305	1916	14458	1594	15865	1331	17835	914	22095	787	13192
2L-4S		MI	4777	2381	7323	1871	8191	1568	8661	1307	9118	887	10633	443	8299
8-#14	2.56	MA	7435	2381	11249	1935	13113	1611	14232	1347	15625	940	19035	634	13135
3E		MI	4944	2381	7781	1858	8835	1543	9450	1300	10197	887	11893	528	8513
8-#14	2.56	MA	7172	2381	10528	1955	12096	1643	12985	1377	13916	951	16943	542	12810
4L-2S		MI	5250	2381	8436	1845	9669	1533	10462	1279	11567	872	13667	689	8513
8-#18	4.55	MA	8449	2781	13681	2183	16131	1790	17858	1457	20501	924	25763	466	22392
3E		MI	5506	2781	9261	2092	10649	1709	11619	1408	13107	856	15300	253	14162
8-#18	4.55	MA	8036	2781	12421	2215	14354	1845	15679	1508	17517	939	22073	300	19991
4L-2S		MI	5988	2781	10385	2072	12079	1696	13356	1375	15459	836	18231	541	14309
10-#10	1.80	MA	7451	2230	11027	1840	12928	1541	14055	1302	15424	934	18786	808	9569
2L-5S		MI	4567	2230	6723	1812	7559	1517	7928	1290	8149	921	9470	564	6184
10-#10	1.80	MA	7141	2230	10416	1852	12149	1551	13110	1312	14144	950	17014	725	9561
3L-4S		MI	4692	2230	6996	1795	7888	1510	8337	1276	8717	910	10233	617	6281
10-#10	1.80	MA	6985	2230	10001	1864	11564	1571	12391	1330	13160	958	15823	675	9516
4L-3S		MI	4791	2230	7263	1786	8263	1495	8797	1270	9346	908	10998	668	6282
10-#10	1.80	MA	6752	2230	9580	1884	11055	1582	11758	1340	12277	974	14615	632	9309
5L-2S		MI	4980	2230	7648	1777	8753	1487	9392	1256	10152	897	12085	760	6270
10-#11	2.22	MA	7726	2312	11735	1881	13773	1569	15054	1318	16753	922	20608	796	11568
2L-5S		MI	4652	2312	6974	1853	7824	1545	8223	1305	8525	907	9905	485	7222
10-#11	2.22	MA	7362	2312	10995	1895	12831	1582	13909	1329	15204	941	18463	692	11547
3L-4S		MI	4795	2312	7304	1833	8221	1537	8717	1289	9210	896	10799	550	7505
10-#11	2.22	MA	7180	2312	10492	1909	12120	1605	13037	1351	14008	950	17008	629	11459
4L-3S		MI	4911	2312	7626	1823	8674	1519	9271	1284	9969	894	11700	610	7525
10-#11	2.22	MA	6906	2312	9979	1933	11501	1617	12267	1362	12936	968	15535	574	10953
5L-2S		MI	5131	2312	8088	1813	9262	1512	9985	1268	10935	883	12974	722	7515
10-#14	3.20	MA	7919	2509	12305	2016	14458	1669	15865	1383	17835	932	22095	623	16298
3L-4S		MI	5071	2509	7977	1952	9025	1626	9673	1343	10488	880	12407	418	10144
10-#14	3.20	MA	7677	2509	11585	2035	13441	1702	14618	1413	16126	943	20003	532	15875
4L-3S		MI	5227	2509	8436	1938	9669	1601	10462	1337	11567	880	13667	502	10476
10-#14	3.20	MA	7294	2509	10850	2070	12556	1719	13516	1429	14592	969	17892	450	14785
5L-2S		MI	5524	2509	9090	1925	10502	1592	11474	1315	12937	865	15440	664	10501

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

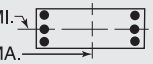


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#18	5.68	MA	8889	3009	14258	2358	16693	1949	18520	1572	21362	926	27397	282	25395
4L-3S		MI	6005	3009	10385	2235	12079	1812	13356	1473	15459	842	18231	194	17489
10-#18	5.68	MA	8250	3009	12971	2417	15142	1977	16592	1596	18678	968	23689	125	23143
5L-2S		MI	6426	3009	11508	2215	13510	1799	15094	1440	17810	822	21163	481	17684
12-#10	2.16	MA	7730	2302	11639	1885	13706	1573	15000	1323	16703	929	20557	803	11418
2L-6S		MI	4613	2302	6870	1865	7724	1566	8121	1316	8411	928	9858	497	7080
12-#10	2.16	MA	7429	2302	11027	1897	12928	1584	14055	1333	15424	946	18786	720	11402
3L-5S		MI	4744	2302	7108	1857	8049	1550	8523	1310	8954	917	10557	555	7289
12-#10	2.16	MA	7281	2302	10613	1909	12342	1604	13337	1351	14439	953	17595	669	11346
4E		MI	4868	2302	7381	1840	8378	1543	8932	1296	9522	906	11320	608	7437
12-#10	2.16	MA	7050	2302	10191	1929	11834	1615	12703	1361	13557	969	16386	626	11098
5L-3S		MI	4963	2302	7648	1831	8753	1527	9392	1290	10152	903	12085	659	7449
12-#10	2.16	MA	6839	2302	9785	1935	11356	1626	12081	1379	12715	986	15207	556	10663
6L-2S		MI	5147	2302	8032	1823	9243	1520	9987	1276	10957	892	13172	750	7443
12-#11	2.66	MA	7704	2401	11735	1950	13773	1622	15054	1354	16753	936	20608	685	13771
3L-5S		MI	4860	2401	7436	1909	8412	1586	8937	1330	9491	902	11179	470	8550
12-#11	2.66	MA	7532	2401	11232	1964	13062	1645	14181	1376	15557	945	19153	622	13670
4E		MI	5002	2401	7766	1889	8809	1578	9431	1314	10177	890	12073	535	8884
12-#11	2.66	MA	7260	2401	10719	1989	12444	1658	13412	1387	14485	963	17680	567	13122
5L-3S		MI	5113	2401	8088	1879	9262	1560	9985	1309	10935	889	12974	595	8918
12-#11	2.66	MA	7011	2401	10233	1997	11862	1670	12655	1409	13462	982	16238	480	12636
6L-2S		MI	5327	2401	8549	1869	9850	1552	10699	1293	11902	878	14248	708	8920
12-#14	3.84	MA	8169	2638	12641	2116	14786	1760	16251	1450	18337	936	23064	522	18953
4E		MI	5360	2638	8632	2032	9858	1685	10685	1380	11858	872	14181	392	12004
12-#14	3.84	MA	7790	2638	11906	2150	13900	1778	15150	1465	16802	962	20953	439	17907
5L-3S		MI	5507	2638	9090	2019	10502	1660	11474	1373	12937	872	15440	477	12435
12-#14	3.84	MA	7449	2638	11219	2162	13067	1795	14067	1495	15338	988	18880	313	16819
6L-2S		MI	5794	2638	9745	2006	11336	1650	12487	1352	14308	857	17214	638	12477
12-#18	6.82	MA	9085	3237	14809	2559	17482	2081	19433	1661	22523	955	29013	107	28548
5L-3S		MI	6465	3237	11508	2377	13510	1916	15094	1538	17810	829	21163	134	20618
14-#10	2.53	MA	7713	2375	11639	1942	13706	1617	15000	1353	16703	941	20557	714	13241
3L-6S		MI	4790	2375	7255	1911	8214	1599	8716	1336	9216	923	10945	487	8202
14-#10	2.53	MA	7572	2375	11224	1954	13121	1637	14282	1371	15719	949	19366	663	13177
4L-5S		MI	4918	2375	7493	1903	8539	1583	9118	1331	9759	912	11644	546	8400
14-#10	2.53	MA	7342	2375	10802	1975	12612	1648	13649	1381	14836	965	18158	621	12892
5L-4S		MI	5042	2375	7766	1886	8868	1576	9527	1317	10327	902	12407	599	8590
14-#10	2.53	MA	7138	2375	10396	1980	12134	1658	13027	1400	13995	981	16978	550	12473
6L-3S		MI	5133	2375	8032	1877	9243	1560	9987	1311	10957	899	13172	650	8611
14-#10	2.53	MA	6965	2375	10008	1988	11593	1673	12430	1409	13136	989	15835	516	12048
7L-2S		MI	5313	2375	8417	1868	9733	1553	10582	1297	11762	888	14259	741	8612
14-#11	3.10	MA	7878	2490	11972	2020	14004	1686	15326	1401	17106	939	21297	615	15882
4L-5S		MI	5065	2490	7898	1965	9000	1626	9651	1356	10458	897	12453	455	9886
14-#11	3.10	MA	7608	2490	11459	2045	13386	1698	14556	1412	16034	958	19825	560	15299
5L-4S		MI	5207	2490	8227	1944	9397	1618	10145	1340	11143	885	13347	520	10262
14-#11	3.10	MA	7367	2490	10973	2052	12804	1711	13800	1434	15011	977	18383	473	14831
6L-3S		MI	5313	2490	8549	1935	9850	1600	10699	1334	11902	884	14248	580	10307
14-#11	3.10	MA	7162	2490	10502	2061	12157	1730	13073	1445	13967	985	16988	428	14094
7L-2S		MI	5522	2490	9011	1925	10438	1593	11414	1318	12868	872	15522	693	10320
14-#14	4.47	MA	8274	2766	12962	2230	15245	1836	16783	1502	19013	954	24013	429	21036
5L-4S		MI	5644	2766	9287	2112	10692	1743	11698	1416	13229	865	15954	367	13878
14-#14	4.47	MA	7949	2766	12275	2242	14412	1853	15700	1532	17548	980	21940	303	19942
6L-3S		MI	5784	2766	9745	2099	11336	1718	12487	1410	14308	865	17214	451	14391
14-#14	4.47	MA	7670	2766	11601	2254	13496	1881	14659	1547	16053	991	19939	235	18707
7L-2S		MI	6062	2766	10400	2086	12169	1708	13499	1388	15678	850	18988	613	14449
16-#10	2.89	MA	7859	2447	11836	2000	13899	1670	15227	1392	16998	945	21138	657	15007
4L-6S		MI	4966	2447	7640	1956	8704	1632	9311	1357	10021	919	12032	478	9328
16-#10	2.89	MA	7631	2447	11414	2020	13391	1680	14594	1402	16116	961	19929	615	14690
5E		MI	5091	2447	7877	1948	9029	1616	9713	1351	10565	908	12731	537	9516

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

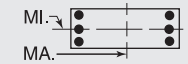
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.89	MA	7432	2447	11008	2026	12913	1691	13972	1420	15274	977	18750	545	14286
6L-4S		MI	5213	2447	8150	1931	9357	1609	10122	1337	11133	897	13494	590	9742
16-#10	2.89	MA	7265	2447	10620	2033	12371	1706	13375	1430	14415	985	17607	510	13854
7L-3S		MI	5301	2447	8417	1922	9733	1593	10582	1332	11762	895	14259	641	9770
16-#10	2.89	MA	7069	2447	10247	2042	11868	1713	12748	1445	13595	1001	16507	462	13319
8L-2S		MI	5477	2447	8802	1913	10223	1586	11177	1317	12567	884	15346	732	9778
16-#11	3.55	MA	7950	2580	12199	2100	14328	1739	15701	1438	17583	953	21970	553	17480
5E		MI	5268	2580	8359	2020	9588	1666	10365	1381	11424	892	13727	440	11226
16-#11	3.55	MA	7717	2580	11713	2108	13747	1751	14944	1459	16560	972	20527	466	17030
6L-4S		MI	5409	2580	8689	2000	9985	1659	10859	1365	12110	880	14620	505	11605
16-#11	3.55	MA	7521	2580	11242	2117	13099	1770	14218	1470	15516	980	19133	420	16285
7L-3S		MI	5510	2580	9011	1990	10438	1641	11414	1359	12868	879	15522	566	11693
16-#11	3.55	MA	7289	2580	10790	2127	12488	1778	13469	1490	14518	999	17791	358	15536
8L-2S		MI	5714	2580	9473	1980	11026	1633	12128	1343	13835	867	16796	678	11714
16-#14	5.11	MA	8438	2895	13331	2322	15756	1912	17333	1568	19759	973	25001	293	23070
6L-4S		MI	5925	2895	9941	2192	11525	1801	12710	1453	14599	857	17728	341	15761
16-#14	5.11	MA	8174	2895	12657	2334	14841	1939	16293	1584	18264	984	22999	224	21822
7L-3S		MI	6057	2895	10400	2179	12169	1776	13499	1446	15678	857	18988	426	16346
18-#10	3.25	MA	7915	2520	12025	2065	14169	1713	15540	1422	17395	957	21701	609	16493
5L-6S		MI	5139	2520	8024	2001	9194	1665	9906	1377	10827	915	13119	469	10456
18-#10	3.25	MA	7722	2520	11619	2071	13691	1724	14918	1441	16554	973	20521	539	16102
6L-5S		MI	5261	2520	8262	1993	9519	1649	10309	1372	11370	904	13818	528	10636
18-#10	3.25	MA	7561	2520	11231	2079	13149	1739	14320	1451	15695	981	19379	504	15663
7L-4S		MI	5383	2520	8535	1976	9847	1642	10717	1358	11938	893	14581	581	10892
18-#10	3.25	MA	7366	2520	10859	2088	12646	1746	13693	1466	14875	997	18279	456	15140
8L-3S		MI	5468	2520	8802	1967	10223	1626	11177	1352	12567	891	15346	632	10926
18-#10	3.25	MA	7168	2520	10441	2106	12130	1763	13073	1473	14036	1005	17194	411	14477
9L-2S		MI	5640	2520	9187	1959	10713	1619	11772	1338	13373	880	16433	723	10940
18-#11	3.99	MA	8061	2669	12453	2164	14689	1792	16089	1484	18109	967	22672	458	19231
6L-5S		MI	5468	2669	8821	2076	10176	1707	11080	1406	12391	887	15000	425	12572
18-#11	3.99	MA	7873	2669	11982	2172	14041	1810	15362	1496	17065	975	21278	413	18479
7L-4S		MI	5609	2669	9151	2056	10573	1699	11573	1390	13076	875	15894	490	12932
18-#11	3.99	MA	7643	2669	11530	2183	13430	1819	14613	1515	16067	994	19936	351	17730
8L-3S		MI	5706	2669	9473	2046	11026	1681	12128	1385	13835	874	16796	551	13078
18-#14	5.75	MA	8669	3023	13713	2414	16185	1997	17926	1620	20474	977	26060	214	24937
7L-4S		MI	6203	3023	10596	2273	12359	1860	13723	1489	15969	850	19502	316	17654
20-#10	3.61	MA	8008	2592	12230	2116	14469	1757	15863	1461	17833	969	22293	533	17920
6E		MI	5310	2592	8409	2047	9684	1698	10501	1398	11632	911	14206	460	11587
20-#10	3.61	MA	7852	2592	11842	2124	13928	1772	15266	1471	16974	977	21150	498	17473
7L-5S		MI	5429	2592	8647	2039	10008	1682	10904	1392	12175	900	14905	519	11759
20-#10	3.61	MA	7659	2592	11470	2133	13425	1779	14639	1486	16154	993	20051	450	16962
8L-4S		MI	5551	2592	8920	2021	10337	1675	11312	1378	12743	889	15668	572	12042
20-#10	3.61	MA	7467	2592	11053	2151	12908	1796	14019	1493	15315	1000	18965	405	16294
9L-3S		MI	5633	2592	9187	2013	10713	1659	11772	1373	13373	886	16433	623	12082
20-#11	4.43	MA	8220	2758	12722	2228	14983	1851	16507	1521	18614	970	23422	406	20675
7L-5S		MI	5667	2758	9283	2132	10764	1747	11794	1431	13357	881	16274	410	13921
20-#11	4.43	MA	7992	2758	12270	2238	14373	1859	15758	1540	17616	989	22081	344	19923
8L-4S		MI	5807	2758	9613	2111	11161	1740	12287	1415	14042	870	17168	476	14264
22-#10	3.97	MA	8140	2665	12454	2169	14706	1805	16211	1492	18254	972	22922	493	19286
7L-6S		MI	5480	2665	8794	2092	10174	1731	11096	1419	12437	906	15293	451	12719
22-#10	3.97	MA	7948	2665	12081	2178	14203	1812	15584	1507	17434	989	21822	444	18786
8L-5S		MI	5597	2665	9032	2084	10498	1715	11499	1413	12980	896	15993	510	12885

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

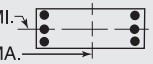
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	3.97	MA	7761	2665	11664	2196	13686	1829	14964	1514	16595	996	20737	400	18111
9L-4S		MI	5718	2665	9305	2067	10827	1708	11907	1399	13548	885	16755	562	13191
22-#11	4.88	MA	8336	2847	13010	2294	15315	1900	16902	1566	19165	983	24226	337	22116
8L-5S		MI	5864	2847	9745	2187	11352	1788	12508	1457	14323	876	17548	395	15273
24-#10	4.33	MA	8233	2737	12693	2224	14982	1845	16529	1528	18713	984	23594	438	20611
8L-6S		MI	5648	2737	9179	2137	10664	1764	11691	1439	13243	902	16380	442	13853
24-#10	4.33	MA	8051	2737	12275	2242	14465	1862	15909	1534	17874	992	22508	394	19928
9L-5S		MI	5762	2737	9417	2129	10988	1748	12094	1433	13786	891	17080	501	14013

RECTANGULAR TIED COLUMNS 22" x 34"

4-#14	1.20	MA	7849	2241	11334	1865	13119	1570	14048	1340	14928	994	17751	864	7269
2E		MI	4949	2241	7490	1780	8398	1498	8838	1277	9207	943	10530	790	4521
4-#18	2.14	MA	8598	2440	13118	1974	15305	1648	16661	1385	18430	973	22574	840	12478
2E		MI	5330	2440	8506	1881	9615	1568	10281	1316	11134	918	12776	709	7535
6-#10	1.02	MA	7725	2201	10912	1858	12686	1568	13573	1342	14328	1007	16952	877	6264
2L-3S		MI	4697	2201	6851	1792	7677	1511	8008	1301	8119	973	9240	737	3947
6-#10	1.02	MA	7368	2201	10255	1871	11850	1579	12558	1353	12954	1024	15049	795	6279
3L-2S		MI	4897	2201	7236	1783	8167	1504	8603	1287	8924	962	10327	828	3924
6-#11	1.25	MA	7912	2251	11399	1879	13246	1581	14223	1349	15182	998	18116	867	7582
2L-3S		MI	4756	2251	7063	1808	7893	1520	8244	1304	8418	961	9566	690	4735
6-#11	1.25	MA	7490	2251	10603	1893	12232	1595	12992	1361	13517	1017	15810	765	7594
3L-2S		MI	4989	2251	7525	1798	8481	1513	8958	1289	9384	950	10839	802	4706
6-#14	1.80	MA	8376	2369	12470	1945	14566	1628	15805	1376	17307	986	21044	854	10725
2L-3S		MI	4911	2369	7490	1873	8398	1566	8838	1335	9207	951	10530	602	6574
6-#14	1.80	MA	7796	2369	11334	1965	13119	1647	14048	1393	14928	1013	17751	704	10698
3L-2S		MI	5232	2369	8145	1860	9231	1556	9850	1313	10578	936	12304	764	6545
6-#18	3.21	MA	9467	2669	15098	2117	17826	1751	19723	1450	22574	960	28312	822	18458
2L-3S		MI	5281	2669	8506	2043	9615	1685	10281	1413	11134	924	12776	362	10896
6-#18	3.21	MA	8537	2669	13118	2151	15305	1782	16661	1476	18430	1004	22574	547	18209
3L-2S		MI	5795	2669	9629	2023	11046	1672	12019	1380	13486	904	15707	649	10962
8-#9	1.07	MA	7782	2212	10994	1869	12814	1576	13739	1348	14562	1008	17283	878	6579
2L-4S		MI	4689	2212	6765	1811	7559	1533	7871	1310	7935	977	9082	721	4147
8-#9	1.07	MA	7501	2212	10475	1879	12152	1585	12936	1357	13475	1022	15777	814	6589
3E		MI	4773	2212	6976	1803	7857	1520	8236	1306	8434	974	9694	761	4128
8-#9	1.07	MA	7357	2212	10124	1889	11656	1601	12327	1372	12640	1029	14775	775	6585
4L-2S		MI	4930	2212	7282	1796	8246	1514	8708	1294	9074	965	10564	833	4111
8-#10	1.36	MA	8039	2274	11568	1904	13522	1601	14589	1363	15703	1003	18855	871	8262
2L-4S		MI	4770	2274	6969	1846	7792	1560	8143	1327	8294	972	9561	677	5148
8-#10	1.36	MA	7693	2274	10912	1916	12686	1612	13573	1373	14328	1019	16952	789	8266
3E		MI	4874	2274	7236	1838	8167	1544	8603	1321	8924	969	10327	728	5133
8-#10	1.36	MA	7515	2274	10468	1928	12059	1632	12803	1392	13273	1028	15682	739	8234
4L-2S		MI	5069	2274	7621	1829	8657	1537	9198	1307	9729	958	11414	819	5114
8-#11	1.67	MA	8284	2340	12194	1934	14259	1622	15453	1374	16848	992	20422	860	10000
2L-4S		MI	4841	2340	7203	1873	8028	1579	8403	1335	8625	958	9938	615	6159
8-#11	1.67	MA	7876	2340	11399	1949	13246	1635	14223	1386	15182	1012	18116	758	9995
3E		MI	4964	2340	7525	1864	8481	1561	8958	1330	9384	956	10839	675	6152
8-#11	1.67	MA	7665	2340	10859	1964	12483	1659	13287	1408	13900	1021	16563	696	9923
4L-2S		MI	5191	2340	7987	1854	9069	1553	9672	1314	10350	945	12113	787	6131
8-#14	2.41	MA	8890	2498	13607	2025	16013	1687	17563	1413	19685	979	24338	843	14164
2L-4S		MI	5033	2498	7686	1966	8587	1649	9061	1378	9499	943	11044	493	8428
8-#14	2.41	MA	8335	2498	12470	2046	14566	1705	15805	1429	17307	1006	21044	693	14107
3E		MI	5201	2498	8145	1953	9231	1624	9850	1371	10578	943	12304	577	8554
8-#14	2.41	MA	8050	2498	11697	2066	13475	1739	14467	1460	15472	1018	18812	603	13854
4L-2S		MI	5510	2498	8799	1940	10065	1614	10863	1350	11948	928	14078	739	8547
8-#18	4.28	MA	9442	2897	15098	2294	17826	1885	19723	1541	22574	991	28312	528	24120
3E		MI	5763	2897	9629	2186	11046	1789	12019	1478	13486	911	15707	302	14232

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

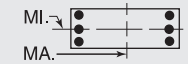
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	4.28	MA	8993	2897	13744	2328	15917	1942	17381	1593	19366	1009	24372	365	21710
4L-2S		MI	6251	2897	10753	2166	12476	1776	13756	1445	15837	891	18638	590	14358
10-#10	1.70	MA	8348	2346	12225	1949	14358	1634	15605	1384	17077	998	20758	865	10254
2L-5S		MI	4824	2346	7081	1909	7953	1600	8329	1362	8532	978	9886	615	6263
10-#10	1.70	MA	8011	2346	11568	1961	13522	1645	14589	1394	15703	1015	18855	784	10247
3L-4S		MI	4949	2346	7354	1892	8282	1593	8738	1348	9100	967	10648	668	6313
10-#10	1.70	MA	7842	2346	11124	1974	12895	1665	13819	1413	14647	1024	17585	734	10201
4L-3S		MI	5049	2346	7621	1883	8657	1577	9198	1342	9729	965	11414	719	6308
10-#10	1.70	MA	7587	2346	10672	1994	12350	1676	13141	1423	13702	1040	16294	693	10048
5L-2S		MI	5239	2346	8005	1874	9147	1570	9793	1328	10534	954	12501	810	6294
10-#11	2.09	MA	8649	2429	12990	1990	15272	1662	16684	1399	18513	987	22728	853	12411
2L-5S		MI	4909	2429	7335	1949	8219	1627	8624	1376	8906	964	10318	534	7312
10-#11	2.09	MA	8254	2429	12194	2005	14259	1676	15453	1411	16848	1007	20422	751	12389
3L-4S		MI	5051	2429	7665	1929	8616	1619	9117	1361	9592	952	11212	600	7546
10-#11	2.09	MA	8055	2429	11655	2019	13496	1699	14518	1433	15566	1016	18870	688	12301
4L-3S		MI	5169	2429	7987	1919	9069	1601	9672	1355	10350	951	12113	660	7557
10-#11	2.09	MA	7755	2429	11105	2044	12834	1712	13693	1445	14416	1036	17295	636	11828
5L-2S		MI	5390	2429	8449	1909	9657	1593	10386	1339	11317	939	13387	772	7544
10-#14	3.01	MA	8861	2626	13607	2126	16013	1764	17563	1466	19685	999	24338	683	17513
3L-4S		MI	5327	2626	8341	2047	9421	1707	10074	1414	10869	936	12818	467	10268
10-#14	3.01	MA	8597	2626	12834	2146	14922	1797	16224	1497	17851	1011	22106	593	17214
4L-3S		MI	5485	2626	8799	2034	10065	1683	10863	1408	11948	936	14078	552	10521
10-#14	3.01	MA	8176	2626	12046	2182	13973	1815	15043	1513	16205	1038	19846	514	15977
5L-2S		MI	5784	2626	9454	2021	10898	1673	11875	1386	13318	921	15851	713	10537
10-#18	5.35	MA	9921	3126	15724	2470	18438	2046	20443	1658	23510	996	30110	346	27550
4L-3S		MI	6235	3126	10753	2328	12476	1892	13756	1543	15837	898	18638	243	17566
10-#18	5.35	MA	9215	3126	14344	2531	16774	2076	18373	1684	20628	1041	26138	196	25207
5L-2S		MI	6692	3126	11876	2309	13907	1879	15494	1510	18189	878	21569	530	17736
12-#10	2.04	MA	8652	2419	12882	1994	15195	1667	16620	1404	18452	994	22661	859	12241
2L-6S		MI	4869	2419	7228	1962	8118	1649	8522	1388	8794	985	10273	547	7154
12-#10	2.04	MA	8324	2419	12225	2007	14358	1678	15605	1414	17077	1011	20758	778	12225
3L-5S		MI	5001	2419	7466	1954	8443	1633	8925	1382	9337	974	10973	606	7366
12-#10	2.04	MA	8163	2419	11781	2019	13731	1698	14835	1433	16022	1019	19488	728	12169
4E		MI	5125	2419	7739	1937	8772	1626	9333	1368	9905	963	11735	658	7471
12-#10	2.04	MA	7910	2419	11329	2040	13187	1709	14156	1444	15077	1036	18197	687	11972
5L-3S		MI	5221	2419	8005	1928	9147	1610	9793	1362	10534	961	12501	709	7477
12-#10	2.04	MA	7682	2419	10890	2045	12674	1720	13491	1462	14175	1053	16936	618	11482
6L-2S		MI	5407	2419	8390	1919	9637	1603	10388	1348	11340	950	13588	801	7469
12-#11	2.50	MA	8625	2518	12990	2060	15272	1716	16684	1436	18513	1002	22728	743	14782
3L-5S		MI	5117	2518	7797	2005	8807	1667	9338	1402	9873	959	11592	520	8639
12-#11	2.50	MA	8438	2518	12450	2075	14510	1740	15748	1459	17231	1011	21176	681	14681
4E		MI	5259	2518	8127	1985	9204	1660	9832	1386	10558	947	12486	585	8929
12-#11	2.50	MA	8139	2518	11901	2100	13847	1753	14924	1471	16082	1031	19601	628	14165
5L-3S		MI	5371	2518	8449	1975	9657	1642	10386	1380	11317	946	13387	645	8954
12-#11	2.50	MA	7869	2518	11374	2107	13224	1766	14113	1493	14986	1050	18062	542	13618
6L-2S		MI	5587	2518	8911	1965	10245	1634	11100	1364	12283	934	14661	757	8951
12-#14	3.61	MA	9132	2754	13970	2227	16369	1855	17981	1533	20229	1003	25399	582	20533
4E		MI	5616	2754	8996	2127	10254	1766	11086	1451	12239	929	14591	442	12125
12-#14	3.61	MA	8715	2754	13183	2262	15420	1874	16800	1550	18584	1031	23140	503	19342
5L-3S		MI	5766	2754	9454	2114	10898	1741	11875	1444	13318	928	15851	526	12482
12-#14	3.61	MA	8345	2754	12436	2273	14527	1892	15640	1581	17013	1058	20928	378	18265
6L-2S		MI	6055	2754	10109	2101	11732	1731	12888	1422	14688	913	17625	688	12517
12-#18	6.42	MA	10123	3354	16324	2674	19295	2179	21435	1749	24772	1027	31876	178	31032
5L-3S		MI	6724	3354	11876	2471	13907	1996	15494	1608	18189	885	21569	183	20820

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis

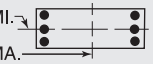


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.38	MA	8632	2491	12882	2052	15195	1711	16620	1435	18452	1007	22661	772	14201
3L-6S		MI	5047	2491	7613	2007	8608	1682	9117	1408	9599	981	11361	538	8275
14-#10	2.38	MA	8479	2491	12438	2064	14567	1731	15850	1454	17396	1015	21391	722	14137
4L-5S		MI	5176	2491	7850	2000	8933	1666	9520	1403	10142	970	12060	596	8476
14-#10	2.38	MA	8227	2491	11986	2085	14023	1742	15172	1464	16451	1032	20100	681	13902
5L-4S		MI	5299	2491	8123	1982	9262	1659	9928	1389	10710	959	12823	649	8626
14-#10	2.38	MA	8006	2491	11546	2091	13510	1753	14506	1483	15550	1049	18839	612	13428
6L-3S		MI	5391	2491	8390	1974	9637	1643	10388	1383	11340	956	13588	700	8642
14-#10	2.38	MA	7818	2491	11130	2099	12924	1768	13867	1493	14630	1057	17622	578	13032
7L-2S		MI	5573	2491	8775	1965	10127	1636	10983	1369	12145	946	14675	792	8639
14-#11	2.92	MA	8814	2607	13246	2131	15523	1780	16979	1484	18897	1006	23482	674	17061
4L-5S		MI	5322	2607	8259	2061	9395	1708	10052	1427	10839	954	12866	505	9973
14-#11	2.92	MA	8517	2607	12697	2156	14860	1793	16154	1496	17747	1026	21907	621	16508
5L-4S		MI	5464	2607	8589	2040	9792	1700	10546	1411	11525	942	13759	570	10309
14-#11	2.92	MA	8256	2607	12169	2163	14237	1807	15344	1518	16651	1045	20368	535	15982
6L-3S		MI	5571	2607	8911	2031	10245	1682	11100	1405	12283	941	14661	630	10345
14-#11	2.92	MA	8034	2607	11664	2172	13534	1825	14566	1530	15532	1055	18879	492	15253
7L-2S		MI	5782	2607	9372	2021	10833	1674	11814	1390	13250	929	15935	742	10353
14-#14	4.21	MA	9242	2883	14319	2342	16867	1932	18558	1586	20962	1023	26433	493	22713
5L-4S		MI	5901	2883	9650	2207	11088	1824	12099	1487	13609	921	16365	416	13995
14-#14	4.21	MA	8888	2883	13572	2353	15974	1950	17397	1617	19392	1051	24221	368	21635
6L-3S		MI	6043	2883	10109	2194	11732	1799	12888	1480	14688	921	17625	501	14441
14-#14	4.21	MA	8586	2883	12849	2366	14978	1977	16282	1634	17789	1063	22082	303	20385
7L-2S		MI	6324	2883	10763	2181	12565	1789	13900	1459	16058	906	19398	662	14490
16-#10	2.72	MA	8790	2564	13094	2110	15403	1764	16866	1474	18770	1011	23294	716	16105
4L-6S		MI	5222	2564	7997	2053	9098	1715	9712	1429	10404	976	12448	529	9400
16-#10	2.72	MA	8540	2564	12642	2130	14859	1775	16188	1485	17825	1028	22003	675	15836
5E		MI	5348	2564	8235	2045	9423	1699	10115	1423	10947	966	13147	587	9591
16-#10	2.72	MA	8325	2564	12203	2136	14346	1786	15522	1504	16924	1045	20742	606	15378
6L-4S		MI	5471	2564	8508	2028	9751	1692	10523	1409	11515	955	13910	640	9779
16-#10	2.72	MA	8144	2564	11787	2144	13760	1801	14883	1514	16004	1053	19525	573	14976
7L-3S		MI	5560	2564	8775	2019	10127	1676	10983	1404	12145	952	14675	691	9802
16-#10	2.72	MA	7928	2564	11388	2153	13221	1809	14202	1529	15126	1070	18350	526	14376
8L-2S		MI	5738	2564	9160	2010	10617	1669	11578	1390	12950	941	15762	783	9807
16-#11	3.34	MA	8889	2696	13492	2211	15873	1834	17385	1521	19413	1020	24213	614	18856
5E		MI	5525	2696	8720	2116	9983	1748	10766	1452	11806	949	14139	490	11312
16-#11	3.34	MA	8636	2696	12965	2219	15251	1847	16575	1543	18316	1040	22675	528	18349
6L-4S		MI	5666	2696	9050	2096	10380	1741	11260	1436	12491	937	15033	555	11687
16-#11	3.34	MA	8423	2696	12460	2228	14547	1865	15796	1555	17197	1049	21185	485	17613
7L-3S		MI	5769	2696	9372	2086	10833	1723	11814	1431	13250	936	15935	615	11733
16-#11	3.34	MA	8168	2696	11975	2238	13892	1874	14982	1574	16129	1069	19751	425	16898
8L-2S		MI	5975	2696	9834	2076	11421	1715	12529	1415	14216	924	17208	728	11749
16-#14	4.81	MA	9419	3011	14708	2433	17421	2009	19154	1654	21770	1043	27514	358	25010
6L-4S		MI	6182	3011	10305	2288	11921	1882	13111	1523	14979	914	18139	391	15876
16-#14	4.81	MA	9133	3011	13985	2446	16425	2036	18039	1670	20168	1056	25376	293	23762
7L-3S		MI	6317	3011	10763	2275	12565	1858	13900	1517	16058	914	19398	475	16397
18-#10	3.06	MA	8848	2636	13299	2176	15695	1808	17203	1505	19200	1024	23906	669	17774
5L-6S		MI	5396	2636	8382	2098	9588	1747	10307	1449	11210	972	13535	519	10527
18-#10	3.06	MA	8639	2636	12860	2181	15182	1819	16537	1524	18299	1040	22645	601	17330
6L-5S		MI	5519	2636	8620	2090	9913	1732	10710	1444	11753	961	14234	578	10710
18-#10	3.06	MA	8465	2636	12444	2189	14596	1834	15898	1535	17379	1049	21428	567	16922
7L-4S		MI	5641	2636	8893	2073	10241	1725	11118	1430	12321	951	14997	631	10931
18-#10	3.06	MA	8251	2636	12045	2199	14057	1842	15217	1550	16501	1066	20253	520	16335
8L-3S		MI	5727	2636	9160	2064	10617	1709	11578	1424	12950	948	15762	682	10960
18-#10	3.06	MA	8037	2636	11597	2217	13504	1859	14553	1557	15603	1074	19098	476	15665
9L-2S		MI	5901	2636	9544	2055	11107	1702	12173	1410	13756	937	16849	773	10971
18-#11	3.75	MA	9010	2785	13761	2274	16264	1888	17805	1569	19982	1035	24981	521	20718
6L-5S		MI	5726	2785	9182	2172	10571	1789	11481	1477	12772	943	15413	475	12656

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	3.75	MA	8805	2785	13256	2283	15560	1906	17027	1581	18863	1044	23491	478	19977
7L-4S		MI	5867	2785	9512	2152	10968	1781	11974	1462	13457	932	16307	540	13028
18-#11	3.75	MA	8553	2785	12771	2294	14905	1915	16213	1600	17794	1064	22057	418	19257
8L-3S		MI	5966	2785	9834	2142	11421	1763	12529	1456	14216	930	17208	600	13119
18-#14	5.41	MA	9670	3140	15122	2526	17872	2094	19797	1707	22546	1048	28669	283	27064
7L-4S		MI	6461	3140	10960	2368	12755	1941	14123	1560	16349	906	19912	365	17766
20-#10	3.40	MA	8949	2709	13516	2227	16018	1852	17553	1545	19673	1036	24548	595	19284
6E		MI	5568	2709	8767	2143	10078	1780	10902	1470	12015	968	14622	510	11657
20-#10	3.40	MA	8780	2709	13101	2235	15433	1867	16914	1555	18753	1045	23331	561	18871
7L-5S		MI	5688	2709	9005	2136	10402	1765	11305	1464	12558	957	15321	569	11832
20-#10	3.40	MA	8568	2709	12702	2244	14894	1875	16233	1570	17875	1061	22156	514	18295
8L-4S		MI	5810	2709	9278	2118	10731	1758	11713	1450	13126	946	16084	622	12082
20-#10	3.40	MA	8360	2709	12254	2262	14340	1892	15569	1577	16977	1070	21001	470	17617
9L-3S		MI	5892	2709	9544	2110	11107	1742	12173	1445	13756	944	16849	673	12117
20-#10	3.40	MA	8170	2709	11841	2269	13819	1901	14906	1594	16102	1086	19830	429	16959
10L-2S		MI	6064	2709	9929	2101	11596	1735	12768	1431	14561	933	17936	764	12132
20-#11	4.17	MA	9182	2874	14051	2339	16574	1946	18258	1606	20528	1039	25797	471	22343
7L-5S		MI	5925	2874	9644	2228	11159	1829	12195	1503	13738	938	16687	460	14004
20-#11	4.17	MA	8932	2874	13566	2350	15918	1955	17443	1625	19460	1059	24364	411	21616
8L-4S		MI	6065	2874	9974	2207	11556	1822	12688	1487	14424	927	17581	525	14358
22-#10	3.74	MA	9092	2781	13757	2280	16269	1900	17929	1576	20128	1040	25234	555	20821
7L-6S		MI	5738	2781	9152	2189	10568	1813	11497	1491	12820	964	15709	501	12789
22-#10	3.74	MA	8881	2781	13359	2289	15730	1907	17248	1591	19249	1057	24059	508	20257
8L-5S		MI	5855	2781	9389	2181	10892	1798	11900	1485	13363	953	16408	560	12957
22-#10	3.74	MA	8679	2781	12911	2308	15176	1924	16584	1598	18352	1066	22904	464	19569
9L-4S		MI	5977	2781	9662	2164	11221	1790	12308	1471	13931	942	17171	613	13233
22-#10	3.74	MA	8495	2781	12497	2314	14655	1934	15922	1614	17477	1082	21733	423	18905
10L-3S		MI	6057	2781	9929	2155	11596	1775	12768	1465	14561	940	17936	664	13272
22-#11	4.59	MA	9304	2963	14362	2405	16932	1995	18674	1650	21125	1054	26670	403	23933
8L-5S		MI	6122	2963	10106	2283	11747	1870	12909	1528	14705	933	17961	445	15355
24-#10	4.07	MA	9190	2854	14015	2335	16566	1940	18264	1611	20624	1053	25962	503	22219
8L-6S		MI	5907	2854	9536	2234	11058	1846	12092	1511	13625	960	16796	492	13922
24-#10	4.07	MA	8993	2854	13567	2353	16012	1957	17600	1618	19726	1061	24807	458	21521
9L-5S		MI	6022	2854	9774	2226	11382	1831	12495	1506	14169	949	17495	551	14084
24-#10	4.07	MA	8815	2854	13154	2360	15491	1967	16937	1635	18851	1078	23636	417	20851
10L-4S		MI	6143	2854	10047	2209	11711	1823	12903	1491	14736	938	18258	604	14382

RECTANGULAR TIED COLUMNS 22" x 36"

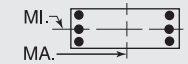
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.14	MA	8757	2357	12529	1974	14538	1663	15569	1421	16514	1058	19610	921	7755
2E		MI	5206	2357	7854	1875	8793	1579	9239	1348	9588	1000	10941	839	4546
4-#18	2.02	MA	9571	2557	14446	2083	16886	1741	18376	1466	20276	1038	24792	897	13342
2E		MI	5589	2557	8874	1975	10013	1648	10682	1385	11512	973	13182	758	7572
6-#11	1.18	MA	8824	2368	12597	1988	14670	1675	15753	1430	16782	1062	19996	924	8088
2L-3S		MI	5012	2368	7425	1904	8288	1602	8645	1376	8799	1018	9978	740	4760
6-#11	1.18	MA	8367	2368	11745	2003	13586	1689	14436	1443	15000	1083	17528	823	8100
3L-2S		MI	5247	2368	7886	1894	8876	1594	9359	1360	9765	1007	11252	852	4730
6-#14	1.70	MA	9327	2486	13746	2054	16087	1722	17451	1458	19061	1051	23136	911	11454
2L-3S		MI	5168	2486	7854	1968	8793	1647	9239	1406	9588	1007	10941	652	6607
6-#14	1.70	MA	8699	2486	12529	2075	14538	1741	15569	1475	16514	1079	19610	763	11427
3L-2S		MI	5490	2486	8508	1955	9627	1637	10251	1384	10958	992	12715	814	6575

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis

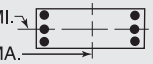


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	3.03	MA	10514	2786	16569	2226	19589	1845	21659	1531	24719	1024	30943	878	19754
2L-3S		MI	5537	2786	8874	2137	10013	1765	10682	1483	11512	980	13182	411	10958
6-#18	3.03	MA	9504	2786	14446	2262	16886	1876	18376	1559	20276	1071	24792	609	19505
3L-2S		MI	6054	2786	9997	2117	11443	1752	12419	1450	13864	960	16113	698	11005
8-#9	1.01	MA	8680	2329	12161	1978	14204	1669	15231	1430	16112	1073	19095	935	7011
2L-4S		MI	4945	2329	7121	1908	7953	1616	8272	1383	8319	1034	9499	771	4167
8-#9	1.01	MA	8377	2329	11606	1989	13497	1679	14372	1438	14950	1087	17486	872	7021
3E		MI	5030	2329	7333	1901	8250	1603	8637	1378	8818	1032	10110	812	4147
8-#9	1.01	MA	8222	2329	11232	1999	12968	1695	13723	1454	14060	1094	16422	833	7017
4L-2S		MI	5188	2329	7638	1894	8639	1597	9109	1367	9457	1023	10981	884	4130
8-#10	1.28	MA	8959	2390	12775	2013	14962	1694	16140	1444	17333	1067	20778	928	8811
2L-4S		MI	5027	2390	7327	1943	8186	1643	8544	1399	8677	1029	9977	727	5174
8-#10	1.28	MA	8585	2390	12073	2026	14069	1706	15055	1455	15864	1085	18744	847	8815
3E		MI	5131	2390	7594	1935	8561	1627	9004	1393	9307	1026	10742	778	5156
8-#10	1.28	MA	8393	2390	11600	2038	13399	1726	14233	1474	14738	1094	17395	798	8782
4L-2S		MI	5326	2390	7978	1926	9051	1620	9599	1379	10112	1016	11829	869	5135
8-#11	1.58	MA	9226	2457	13448	2044	15754	1715	17070	1455	18564	1057	22463	917	10674
2L-4S		MI	5097	2457	7564	1969	8424	1661	8804	1407	9007	1014	10351	665	6194
8-#11	1.58	MA	8784	2457	12597	2059	14670	1729	15753	1468	16782	1078	19996	816	10668
3E		MI	5221	2457	7886	1960	8876	1643	9359	1401	9765	1013	11252	725	6181
8-#11	1.58	MA	8557	2457	12021	2074	13856	1753	14754	1491	15413	1088	18346	755	10597
4L-2S		MI	5449	2457	8348	1950	9464	1635	10073	1385	10732	1001	12526	837	6157
8-#14	2.27	MA	9883	2614	14963	2135	17636	1780	19332	1494	21607	1043	26662	900	15136
2L-4S		MI	5289	2614	8050	2062	8983	1730	9462	1449	9879	1000	11455	542	8541
8-#14	2.27	MA	9282	2614	13746	2156	16087	1799	17451	1511	19061	1072	23136	753	15079
3E		MI	5458	2614	8508	2049	9627	1706	10251	1442	10958	1000	12715	626	8593
8-#14	2.27	MA	8974	2614	12921	2177	14921	1834	16020	1544	17101	1085	20764	663	14826
4L-2S		MI	5769	2614	9163	2035	10461	1696	11264	1420	12328	985	14488	788	8580
8-#18	4.04	MA	10483	3014	16569	2404	19589	1980	21659	1624	24719	1058	30943	590	25848
3E		MI	6019	3014	9997	2279	11443	1869	12419	1548	13864	967	16113	351	14299
8-#18	4.04	MA	9998	3014	15122	2440	17547	2038	19154	1678	21288	1079	26753	428	23452
4L-2S		MI	6512	3014	11121	2260	12874	1856	14157	1515	16216	947	19045	639	14406
10-#10	1.60	MA	9292	2463	13477	2058	15856	1727	17226	1465	18803	1063	22813	922	10940
2L-5S		MI	5081	2463	7439	2006	8347	1683	8731	1434	8914	1036	10301	665	6327
10-#10	1.60	MA	8928	2463	12775	2071	14962	1739	16140	1476	17333	1080	20778	842	10933
3L-4S		MI	5205	2463	7712	1989	8676	1675	9139	1420	9482	1025	11064	718	6343
10-#10	1.60	MA	8745	2463	12302	2084	14293	1759	15319	1495	16207	1089	19429	792	10887
4L-3S		MI	5306	2463	7978	1980	9051	1660	9599	1414	10112	1022	11829	769	6333
10-#10	1.60	MA	8469	2463	11816	2104	13713	1771	14596	1506	15199	1107	18055	753	10757
5L-2S		MI	5497	2463	8363	1971	9541	1653	10194	1400	10917	1011	12916	860	6318
10-#11	1.97	MA	9621	2546	14300	2099	16838	1756	18387	1480	20346	1052	24930	910	13253
2L-5S		MI	5165	2546	7696	2045	8614	1709	9025	1448	9288	1021	10731	584	7400
10-#11	1.97	MA	9193	2546	13448	2115	15754	1769	17070	1493	18564	1072	22463	809	13232
3L-4S		MI	5308	2546	8026	2025	9012	1701	9518	1432	9973	1009	11625	650	7586
10-#11	1.97	MA	8978	2546	12872	2130	14940	1794	16071	1516	17195	1083	20813	747	13144
4L-3S		MI	5426	2546	8348	2015	9464	1683	10073	1426	10732	1008	12526	710	7589
10-#11	1.97	MA	8651	2546	12286	2155	14234	1807	15191	1528	15969	1103	19136	697	12713
5L-2S		MI	5649	2546	8810	2005	10052	1675	10787	1410	11698	996	13800	822	7573
10-#14	2.84	MA	9851	2743	14963	2236	17636	1858	19332	1548	21607	1064	26662	742	18728
3L-4S		MI	5583	2743	8705	2142	9817	1789	10475	1485	11249	992	13229	517	10389
10-#14	2.84	MA	9565	2743	14138	2257	16471	1892	17902	1580	19647	1078	24290	653	18460
4L-3S		MI	5743	2743	9163	2129	10461	1764	11264	1478	12328	992	14488	601	10564
10-#14	2.84	MA	9106	2743	13298	2293	15458	1911	16641	1597	17890	1106	21883	577	17179
5L-2S		MI	6044	2743	9818	2116	11294	1754	12276	1457	13698	977	16262	763	10573
10-#18	5.05	MA	11001	3242	17245	2583	20250	2142	22437	1743	25730	1065	32904	410	29728
4L-3S		MI	6493	3242	11121	2422	12874	1972	14157	1613	16216	953	19045	291	17636
10-#18	5.05	MA	10228	3242	15771	2644	18473	2174	20226	1771	22651	1113	28670	266	27307
5L-2S		MI	6956	3242	12245	2403	14304	1959	15894	1580	18567	933	21976	579	17787

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	1.92	MA	9620	2535	14179	2104	16750	1760	18312	1485	20272	1059	24847	916	13064
2L-6S		MI	5125	2535	7585	2059	8512	1731	8923	1460	9177	1042	10689	597	7225
12-#10	1.92	MA	9266	2535	13477	2116	15856	1772	17226	1496	18803	1076	22813	836	13048
3L-5S		MI	5258	2535	7823	2051	8837	1716	9326	1454	9720	1031	11388	656	7441
12-#10	1.92	MA	9092	2535	13004	2129	15187	1792	16404	1516	17676	1085	21464	786	12992
4E		MI	5382	2535	8096	2034	9166	1708	9734	1440	10288	1020	12151	709	7504
12-#10	1.92	MA	8817	2535	12518	2150	14607	1804	15682	1526	16668	1103	20089	747	12855
5L-3S		MI	5479	2535	8363	2025	9541	1693	10194	1435	10917	1018	12916	760	7505
12-#10	1.92	MA	8572	2535	12049	2156	14054	1815	14972	1546	15708	1120	18747	679	12306
6L-2S		MI	5665	2535	8748	2016	10031	1686	10789	1420	11723	1007	14003	851	7494
12-#11	2.36	MA	9594	2635	14300	2170	16838	1810	18387	1518	20346	1067	24930	802	15792
3L-5S		MI	5374	2635	8158	2101	9202	1749	9739	1473	10254	1016	12005	569	8725
12-#11	2.36	MA	9391	2635	13724	2185	16024	1834	17388	1541	18977	1077	23280	740	15691
4E		MI	5516	2635	8488	2081	9600	1742	10233	1457	10940	1004	12899	635	8971
12-#11	2.36	MA	9066	2635	13138	2211	15318	1848	16508	1554	17751	1098	21603	689	15216
5L-3S		MI	5629	2635	8810	2071	10052	1723	10787	1452	11698	1003	13800	695	8989
12-#11	2.36	MA	8775	2635	12569	2218	14654	1862	15643	1577	16581	1118	19967	604	14607
6L-2S		MI	5846	2635	9272	2061	10640	1716	11501	1436	12665	991	15074	807	8982
12-#14	3.41	MA	10143	2871	15355	2337	18020	1950	19784	1617	22194	1071	27815	643	22098
4E		MI	5872	2871	9359	2222	10650	1847	11487	1521	12619	985	15002	491	12243
12-#14	3.41	MA	9688	2871	14514	2373	17007	1969	18523	1634	20437	1099	25409	567	20787
5L-3S		MI	6024	2871	9818	2209	11294	1822	12276	1515	13698	985	16262	576	12528
12-#14	3.41	MA	9289	2871	13707	2384	16055	1989	17284	1666	18761	1128	23059	442	19721
6L-2S		MI	6316	2871	10472	2196	12128	1812	13288	1493	15068	970	18036	737	12556
12-#18	6.06	MA	11210	3471	17893	2787	21176	2278	23508	1836	27093	1099	34821	248	33553
5L-3S		MI	6983	3471	12245	2565	14304	2076	15894	1677	18567	940	21976	232	20972
12-#18	6.06	MA	10568	3471	16506	2807	19504	2309	21335	1890	24154	1146	30669	24	30585
6L-2S		MI	7393	3471	13368	2546	15735	2063	17632	1644	20919	920	24907	519	21159
14-#10	2.24	MA	9599	2608	14179	2162	16750	1805	18312	1517	20272	1072	24847	830	15161
3L-6S		MI	5303	2608	7970	2104	9002	1764	9518	1480	9982	1038	11776	588	8345
14-#10	2.24	MA	9433	2608	13706	2174	16081	1825	17490	1536	19145	1081	23498	780	15097
4L-5S		MI	5433	2608	8208	2097	9327	1749	9921	1475	10525	1027	12475	647	8550
14-#10	2.24	MA	9159	2608	13220	2195	15501	1837	16767	1547	18137	1098	22123	741	14920
5L-4S		MI	5556	2608	8481	2079	9656	1741	10329	1461	11093	1016	13238	700	8661
14-#10	2.24	MA	8921	2608	12751	2201	14948	1848	16058	1566	17177	1116	20781	674	14389
6L-3S		MI	5649	2608	8748	2071	10031	1726	10789	1455	11723	1014	14003	751	8672
14-#10	2.24	MA	8719	2608	12307	2209	14323	1863	15373	1577	16196	1125	19490	640	14010
7L-2S		MI	5832	2608	9133	2062	10521	1718	11384	1441	12528	1003	15090	842	8666
14-#11	2.76	MA	9797	2724	14575	2241	17108	1874	18704	1566	20759	1072	25748	733	18240
4L-5S		MI	5579	2724	8620	2157	9790	1790	10453	1498	11221	1011	13278	554	10057
14-#11	2.76	MA	9474	2724	13989	2266	16402	1888	17824	1579	19533	1093	24071	682	17726
5L-4S		MI	5721	2724	8950	2136	10187	1782	10947	1482	11906	999	14172	620	10353
14-#11	2.76	MA	9192	2724	13420	2273	15738	1902	16960	1602	18363	1113	22434	597	17139
6L-3S		MI	5829	2724	9272	2127	10640	1764	11501	1477	12665	998	15074	680	10382
14-#11	2.76	MA	8953	2724	12881	2283	14979	1920	16131	1614	17169	1123	20852	556	16425
7L-2S		MI	6042	2724	9733	2117	11228	1756	12215	1461	13631	986	16347	792	10385
14-#14	3.98	MA	10257	3000	15731	2454	18556	2028	20404	1670	22983	1092	28934	556	24401
5L-4S		MI	6158	3000	10014	2303	11484	1905	12499	1558	13989	977	16776	466	14110
14-#14	3.98	MA	9875	3000	14924	2464	17604	2047	19166	1703	21308	1120	26584	432	23327
6L-3S		MI	6301	3000	10472	2289	12128	1881	13288	1551	15068	977	18036	550	14488
14-#14	3.98	MA	9549	3000	14152	2478	16528	2073	17977	1720	19597	1134	24308	370	21943
7L-2S		MI	6585	3000	11127	2276	12961	1871	14301	1530	16439	962	19809	712	14530
14-#18	7.07	MA	11563	3699	18629	2950	22207	2413	24618	1955	28597	1133	36821	6	36782
6L-3S		MI	7438	3699	13368	2708	15735	2180	17632	1742	20919	927	24907	172	24163

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 36"

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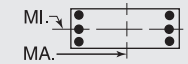
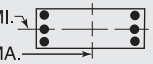


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.57	MA	9768	2680	14408	2220	16975	1858	18576	1557	20615	1077	25532	775	17202
4L-6S		MI	5479	2680	8355	2150	9492	1797	10113	1501	10787	1034	12863	579	9469
16-#10	2.57	MA	9497	2680	13922	2240	16394	1870	17853	1568	19607	1094	24157	735	16990
5E		MI	5606	2680	8593	2142	9817	1782	10516	1495	11330	1023	13563	638	9664
16-#10	2.57	MA	9265	2680	13453	2246	15842	1881	17143	1587	18646	1112	22816	668	16475
6L-4S		MI	5728	2680	8866	2125	10145	1774	10924	1481	11898	1012	14325	690	9816
16-#10	2.57	MA	9070	2680	13009	2255	15217	1896	16459	1597	17666	1121	21524	634	16108
7L-3S		MI	5818	2680	9133	2116	10521	1759	11384	1476	12528	1010	15090	741	9833
16-#10	2.57	MA	8835	2680	12584	2264	14642	1904	15728	1612	16730	1138	20275	589	15443
8L-2S		MI	5998	2680	9517	2107	11011	1751	11979	1462	13333	999	16178	833	9834
16-#11	3.15	MA	9875	2813	14841	2322	17486	1929	19141	1604	21315	1087	26538	675	20242
5E		MI	5783	2813	9082	2212	10378	1830	11167	1524	12187	1005	14552	539	11396
16-#11	3.15	MA	9602	2813	14272	2329	16822	1943	18277	1627	20145	1108	24901	590	19674
6L-4S		MI	5924	2813	9412	2192	10775	1822	11661	1508	12872	994	15446	605	11733
16-#11	3.15	MA	9373	2813	13732	2339	16063	1960	17447	1640	18951	1118	23319	548	18956
7L-3S		MI	6028	2813	9733	2182	11228	1804	12215	1502	13631	992	16347	665	11772
16-#11	3.15	MA	9095	2813	13215	2350	15363	1970	16567	1658	17812	1138	21794	490	18190
8L-2S		MI	6236	2813	10195	2172	11816	1797	12929	1486	14598	981	17621	777	11784
16-#14	4.55	MA	10449	3128	16141	2544	19153	2105	21048	1739	23854	1113	30110	422	26934
6L-4S		MI	6440	3128	10669	2383	12317	1964	13512	1594	15360	970	18549	440	15989
16-#14	4.55	MA	10140	3128	15368	2558	18077	2132	19858	1756	22144	1126	27834	360	25559
7L-3S		MI	6576	3128	11127	2370	12961	1939	14301	1588	16439	970	19809	525	16446
16-#14	4.55	MA	9750	3128	14627	2573	17075	2144	18612	1784	20510	1155	25644	274	23904
8L-2S		MI	6853	3128	11782	2357	13795	1929	15313	1566	17809	955	21583	686	16501
18-#10	2.89	MA	9829	2753	14624	2286	17288	1903	18938	1588	21076	1090	26192	729	19064
5L-6S		MI	5653	2753	8740	2195	9982	1830	10708	1522	11592	1030	13950	570	10596
18-#10	2.89	MA	9604	2753	14155	2292	16736	1914	18229	1607	20115	1107	24850	662	18564
6L-5S		MI	5777	2753	8978	2187	10307	1814	11111	1516	12136	1019	14650	629	10782
18-#10	2.89	MA	9416	2753	13711	2300	16111	1929	17544	1618	19135	1116	23559	629	18195
7L-4S		MI	5899	2753	9251	2170	10635	1807	11519	1502	12703	1008	15412	681	10969
18-#10	2.89	MA	9183	2753	13286	2309	15536	1937	16814	1633	18199	1134	22309	583	17538
8L-3S		MI	5986	2753	9517	2161	11011	1792	11979	1496	13333	1005	16178	732	10993
18-#10	2.89	MA	8953	2753	12805	2328	14946	1954	16105	1640	17242	1143	21084	540	16868
9L-2S		MI	6162	2753	9902	2152	11501	1784	12574	1482	14138	995	17265	824	11000
18-#11	3.55	MA	10006	2902	15123	2385	17906	1983	19594	1652	21927	1103	27369	583	22212
6L-5S		MI	5984	2902	9543	2268	10966	1871	11881	1549	13153	1000	15826	525	12739
18-#11	3.55	MA	9785	2902	14584	2394	17147	2001	18764	1665	20733	1113	25786	541	21489
7L-4S		MI	6124	2902	9873	2248	11363	1863	12375	1533	13839	989	16720	590	13112
18-#11	3.55	MA	9510	2902	14066	2405	16448	2010	17884	1684	19594	1133	24261	483	20729
8L-3S		MI	6225	2902	10195	2238	11816	1845	12929	1527	14598	987	17621	650	13159
18-#11	3.55	MA	9238	2902	13486	2428	15729	2031	17022	1692	18429	1143	22759	429	19695
9L-2S		MI	6429	2902	10657	2228	12404	1837	13644	1511	15564	976	18895	762	13178
18-#14	5.11	MA	10719	3257	16585	2638	19626	2190	21740	1793	24690	1119	31360	350	29175
7L-4S		MI	6719	3257	11323	2463	13151	2022	14524	1631	16730	963	20323	415	17876
18-#14	5.11	MA	10333	3257	15844	2654	18625	2203	20493	1820	23057	1147	29169	264	27505
8L-3S		MI	6849	3257	11782	2450	13795	1997	15313	1624	17809	962	21583	499	18402
20-#10	3.21	MA	9938	2826	14857	2337	17630	1947	19314	1628	21585	1103	26884	656	20655
6E		MI	5825	2826	9125	2240	10472	1863	11304	1542	12398	1025	15037	561	11725
20-#10	3.21	MA	9756	2826	14413	2345	17005	1961	18630	1638	20604	1112	25593	623	20282
7L-5S		MI	5946	2826	9362	2233	10796	1847	11706	1536	12941	1015	15737	619	11903
20-#10	3.21	MA	9525	2826	13988	2355	16430	1970	17899	1653	19668	1130	24344	578	19633
8L-4S		MI	6068	2826	9635	2215	11125	1840	12114	1522	13509	1004	16499	672	12121
20-#10	3.21	MA	9301	2826	13507	2373	15839	1987	17191	1661	18711	1139	23118	534	18955
9L-3S		MI	6152	2826	9902	2206	11501	1825	12574	1517	14138	1001	17265	723	12150
20-#10	3.21	MA	9087	2826	13066	2380	15283	1997	16484	1678	17766	1155	21773	483	18249
10L-2S		MI	6325	2826	10287	2198	11990	1817	13169	1503	14944	990	18352	815	12163
20-#11	3.94	MA	10192	2991	15435	2450	18231	2041	20081	1690	22515	1108	28254	534	24025
7L-5S		MI	6184	2991	10005	2324	11554	1911	12596	1574	14120	995	17100	510	14086

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.94	MA	9919	2991	14918	2461	17532	2051	19201	1709	21376	1128	26728	476	23267
8L-4S		MI	6323	2991	10335	2303	11951	1903	13089	1558	14805	983	17994	575	14451
20-#11	3.94	MA	9654	2991	14337	2484	16813	2071	18339	1717	20211	1138	25226	422	22225
9L-3S		MI	6420	2991	10657	2294	12404	1885	13644	1553	15564	982	18895	635	14544
20-#14	5.68	MA	10905	3385	17061	2734	20174	2261	22375	1856	25603	1140	32695	253	31105
8L-4S		MI	6995	3385	11978	2543	13984	2080	15537	1667	18100	955	22097	389	19771
22-#10	3.53	MA	10092	2898	15115	2391	17898	1994	19716	1659	22073	1108	27627	617	22370
7L-6S		MI	5996	2898	9509	2286	10962	1896	11899	1563	13203	1021	16124	552	12857
22-#10	3.53	MA	9863	2898	14690	2400	17323	2002	18985	1674	21137	1125	26378	572	21728
8L-5S		MI	6114	2898	9747	2278	11286	1880	12301	1557	13746	1010	16824	610	13027
22-#10	3.53	MA	9644	2898	14209	2418	16733	2020	18276	1682	20181	1134	25152	528	21042
9L-4S		MI	6236	2898	10020	2261	11615	1873	12709	1543	14314	999	17586	663	13272
22-#10	3.53	MA	9438	2898	13768	2425	16177	2030	17570	1698	19236	1150	23807	477	20338
10L-3S		MI	6317	2898	10287	2252	11990	1857	13169	1537	14944	997	18352	714	13307
22-#11	4.33	MA	10321	3080	15769	2517	18616	2091	20517	1734	23158	1123	29196	469	25805
8L-5S		MI	6381	3080	10467	2379	12142	1952	13310	1599	15086	990	18374	495	15436
22-#11	4.33	MA	10064	3080	15189	2539	17898	2112	19656	1743	21993	1133	27694	415	24754
9L-4S		MI	6521	3080	10797	2359	12539	1944	13803	1583	15772	978	19268	560	15785
24-#10	3.85	MA	10196	2971	15392	2445	18217	2035	20070	1695	22607	1121	28412	566	23822
8L-6S		MI	6165	2971	9894	2331	11452	1929	12494	1583	14008	1017	17211	542	13990
24-#10	3.85	MA	9983	2971	14911	2464	17627	2053	19362	1702	21650	1130	27187	522	23129
9L-5S		MI	6281	2971	10132	2323	11776	1913	12896	1578	14551	1006	17911	601	14153
24-#10	3.85	MA	9791	2971	14470	2471	17071	2062	18656	1719	20705	1146	25841	471	22428
10L-4S		MI	6402	2971	10405	2306	12105	1906	13304	1564	15119	995	18674	654	14423
24-#11	4.73	MA	10469	3169	16040	2595	18982	2152	20972	1768	23775	1128	30161	407	27283
9L-5S		MI	6578	3169	10929	2435	12730	1992	14024	1625	16053	985	19647	480	16789

RECTANGULAR TIED COLUMNS 22" x 38"

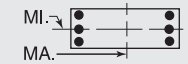
4-#14	1.08	MA	9711	2474	13780	2083	16023	1757	17162	1503	18172	1123	21551	978	8241
2E		MI	5464	2474	8217	1970	9189	1660	9640	1418	9968	1056	11352	889	4571
4-#18	1.91	MA	10592	2674	15829	2193	18534	1834	20164	1548	22195	1102	27091	954	14206
2E		MI	5847	2674	9242	2068	10410	1728	11082	1455	11891	1029	13589	807	7608
6-#11	1.12	MA	9782	2484	13850	2098	16162	1768	17355	1511	18454	1127	21956	981	8593
2L-3S		MI	5269	2484	7786	2000	8683	1684	9046	1447	9180	1075	10391	790	4784
6-#11	1.12	MA	9291	2484	12943	2113	15007	1782	15952	1524	16556	1148	19328	882	8605
3L-2S		MI	5505	2484	8248	1990	9271	1676	9760	1431	10147	1063	11665	902	4754
6-#14	1.61	MA	10325	2602	15077	2164	17674	1815	19168	1539	20887	1116	25309	967	12183
2L-3S		MI	5424	2602	8217	2064	9189	1728	9640	1476	9968	1064	11352	701	6640
6-#14	1.61	MA	9649	2602	13780	2185	16023	1835	17162	1557	18172	1145	21551	822	12156
3L-2S		MI	5748	2602	8872	2050	10023	1719	10652	1455	11338	1049	13126	863	6604
6-#18	2.87	MA	11608	2902	18094	2336	21418	1938	23667	1613	26936	1089	33656	935	21050
2L-3S		MI	5793	2902	9242	2231	10410	1845	11082	1553	11891	1036	13589	459	11016
6-#18	2.87	MA	10518	2902	15829	2372	18534	1971	20164	1642	22195	1138	27091	670	20801
3L-2S		MI	6313	2902	10366	2211	11840	1832	12820	1520	14242	1015	16520	747	11047
8-#10	1.22	MA	9926	2507	14037	2122	16470	1787	17764	1526	19036	1132	22783	985	9360
2L-4S		MI	5283	2507	7685	2040	8580	1725	8945	1471	9060	1086	10393	777	5199
8-#10	1.22	MA	9524	2507	13290	2135	15518	1800	16608	1537	17472	1150	20617	905	9364
3E		MI	5388	2507	7951	2031	8955	1710	9405	1466	9690	1084	11158	828	5178
8-#10	1.22	MA	9318	2507	12787	2148	14807	1820	15735	1557	16275	1159	19190	856	9331
4L-2S		MI	5584	2507	8336	2023	9445	1702	10000	1451	10495	1073	12245	920	5157

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

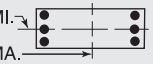


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.49	MA	10215	2573	14757	2153	17317	1808	18758	1537	20353	1122	24585	974	11348
2L-4S		MI	5354	2573	7926	2065	8819	1742	9205	1478	9388	1071	10764	714	6227
8-#11	1.49	MA	9739	2573	13850	2169	16162	1823	17355	1550	18454	1143	21956	875	11342
3E		MI	5478	2573	8248	2055	9271	1724	9760	1472	10147	1070	11665	775	6208
8-#11	1.49	MA	9496	2573	13238	2184	15297	1847	16293	1573	16998	1154	20210	813	11271
4L-2S		MI	5707	2573	8709	2046	9859	1717	10474	1457	11113	1058	12939	887	6184
8-#14	2.15	MA	10924	2731	16374	2244	19326	1873	21173	1575	23601	1108	29068	957	16108
2L-4S		MI	5545	2731	8414	2157	9379	1812	9863	1519	10259	1056	11866	592	8594
8-#14	2.15	MA	10276	2731	15077	2266	17674	1893	19168	1594	20887	1138	25309	812	16051
3E		MI	5715	2731	8872	2144	10023	1787	10652	1513	11338	1056	13126	676	8631
8-#14	2.15	MA	9945	2731	14200	2287	16435	1928	17646	1627	18801	1152	22797	723	15798
4L-2S		MI	6027	2731	9527	2131	10856	1777	11664	1491	12709	1041	14899	838	8613
8-#18	3.83	MA	11572	3131	18094	2515	21418	2075	23667	1707	26936	1125	33656	652	27576
3E		MI	6276	3131	10366	2373	11840	1949	12820	1618	14242	1022	16520	400	14363
8-#18	3.83	MA	11051	3131	16555	2552	19245	2135	21000	1763	23281	1148	29216	491	25216
4L-2S		MI	6773	3131	11489	2354	13271	1936	14557	1585	16594	1002	19451	687	14453
10-#10	1.52	MA	10284	2580	14785	2168	17421	1820	18919	1546	20600	1128	24949	979	11626
2L-5S		MI	5337	2580	7796	2103	8741	1765	9132	1506	9297	1093	10717	715	6363
10-#10	1.52	MA	9892	2580	14037	2181	16470	1833	17764	1557	19036	1146	22783	900	11619
3L-4S		MI	5462	2580	8069	2086	9070	1758	9540	1492	9865	1082	11480	768	6371
10-#10	1.52	MA	9696	2580	13534	2194	15759	1853	16891	1577	17839	1155	21355	850	11573
4L-3S		MI	5563	2580	8336	2077	9445	1742	10000	1486	10495	1080	12245	819	6358
10-#10	1.52	MA	9397	2580	13015	2214	15143	1865	16123	1588	16768	1173	19897	812	11443
5L-2S		MI	5755	2580	8721	2068	9935	1735	10595	1472	11300	1069	13332	911	6341
10-#11	1.87	MA	10640	2662	15664	2209	18472	1849	20161	1562	22251	1117	27214	967	14096
2L-5S		MI	5422	2662	8057	2141	9009	1791	9426	1519	9669	1078	11144	634	7485
10-#11	1.87	MA	10179	2662	14757	2224	17317	1863	18758	1575	20353	1138	24585	867	14074
3L-4S		MI	5564	2662	8387	2121	9407	1783	9919	1503	10355	1066	12038	700	7623
10-#11	1.87	MA	9948	2662	14145	2240	16451	1888	17696	1598	18896	1149	22838	806	13986
4L-3S		MI	5683	2662	8709	2111	9859	1765	10474	1498	11113	1065	12939	760	7619
10-#11	1.87	MA	9593	2662	13518	2265	15701	1902	16761	1611	17593	1170	21059	757	13606
5L-2S		MI	5908	2662	9171	2101	10447	1757	11188	1482	12080	1053	14213	872	7601
10-#14	2.69	MA	10888	2859	16374	2346	19326	1952	21173	1630	23601	1130	29068	802	19943
3L-4S		MI	5839	2859	9068	2237	10213	1870	10875	1556	11630	1049	13639	566	10507
10-#14	2.69	MA	10581	2859	15497	2368	18086	1987	19652	1663	21516	1145	26555	713	19675
4L-3S		MI	6000	2859	9527	2224	10856	1845	11664	1549	12709	1049	14899	650	10606
10-#14	2.69	MA	10083	2859	14604	2404	17010	2007	18312	1681	19648	1174	24001	640	18392
5L-2S		MI	6303	2859	10181	2211	11690	1835	12677	1528	14079	1034	16673	812	10607
10-#18	4.78	MA	12129	3359	18821	2694	22130	2238	24503	1828	28023	1134	35781	473	31930
4L-3S		MI	6750	3359	11489	2516	13271	2052	14557	1682	16594	1009	19451	340	17703
10-#18	4.78	MA	11289	3359	17252	2758	20239	2272	22151	1857	24745	1184	31284	334	29443
5L-2S		MI	7221	3359	12613	2497	14702	2039	16295	1649	18945	989	22383	628	17837
12-#10	1.82	MA	10637	2652	15532	2213	18373	1853	20075	1567	22164	1124	27114	973	13887
2L-6S		MI	5382	2652	7943	2156	8906	1814	9324	1532	9559	1100	11105	647	7293
12-#10	1.82	MA	10255	2652	14785	2226	17421	1865	18919	1578	20600	1142	24949	894	13871
3L-5S		MI	5515	2652	8181	2148	9231	1798	9727	1526	10103	1089	11804	706	7514
12-#10	1.82	MA	10068	2652	14282	2239	16710	1886	18046	1598	19403	1151	23521	845	13815
4E		MI	5639	2652	8454	2131	9560	1791	10135	1512	10670	1078	12567	759	7535
12-#10	1.82	MA	9771	2652	13762	2260	16094	1898	17279	1609	18332	1169	22063	806	13678
5L-3S		MI	5736	2652	8721	2122	9935	1775	10595	1507	11300	1075	13332	810	7531
12-#10	1.82	MA	9508	2652	13263	2266	15502	1909	16525	1629	17284	1178	20640	740	13136
6L-2S		MI	5924	2652	9106	2113	10425	1768	11190	1493	12105	1065	14419	901	7519
12-#11	2.24	MA	10610	2751	15664	2280	18472	1904	20161	1600	22251	1133	27214	860	16803
3L-5S		MI	5630	2751	8519	2197	9597	1831	10140	1544	10636	1072	12417	619	8809
12-#11	2.24	MA	10392	2751	15052	2295	17606	1928	19099	1624	20795	1143	25467	799	16702
4E		MI	5772	2751	8849	2177	9995	1823	10633	1529	11321	1061	13311	685	9011
12-#11	2.24	MA	10040	2751	14425	2321	16856	1943	18164	1637	19491	1165	23688	750	16277
5L-3S		MI	5887	2751	9171	2167	10447	1805	11188	1523	12080	1060	14213	745	9023

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis



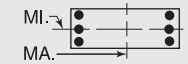
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.24	MA	9727	2751	13819	2328	16144	1956	17246	1660	18249	1186	21951	667	15602
6L-2S		MI	6106	2751	9633	2157	11035	1798	11902	1507	13046	1048	15486	857	9012
12-#14	3.23	MA	11202	2988	16794	2448	19737	2045	21658	1700	24230	1137	30314	702	23556
4E		MI	6129	2988	9723	2318	11046	1928	11888	1592	13000	1041	15413	541	12358
12-#14	3.23	MA	10708	2988	15901	2485	18661	2065	20317	1718	22362	1167	27760	629	22243
5L-3S		MI	6282	2988	10181	2304	11690	1903	12677	1586	14079	1041	16673	625	12573
12-#14	3.23	MA	10280	2988	15034	2495	17650	2085	19001	1751	20581	1196	25267	507	21187
6L-2S		MI	6576	2988	10836	2291	12523	1894	13689	1564	15449	1026	18446	787	12594
12-#18	5.74	MA	12345	3587	19518	2900	23124	2375	25654	1922	29487	1170	37849	316	36109
5L-3S		MI	7243	3587	12613	2659	14702	2156	16295	1747	18945	996	22383	280	21041
12-#18	5.74	MA	11655	3587	18025	2919	21347	2408	23343	1978	26360	1219	33450	94	32853
6L-2S		MI	7659	3587	13736	2639	16132	2143	18032	1714	21297	976	25314	568	21211
14-#10	2.13	MA	10613	2725	15532	2271	18373	1898	20075	1599	22164	1137	27114	888	16121
3L-6S		MI	5560	2725	8328	2201	9396	1847	9919	1553	10365	1095	12192	638	8413
14-#10	2.13	MA	10434	2725	15029	2284	17662	1919	19202	1618	20967	1147	25687	839	16057
4L-5S		MI	5690	2725	8566	2194	9721	1831	10322	1547	10908	1085	12891	697	8622
14-#10	2.13	MA	10139	2725	14509	2305	17046	1931	18434	1630	19896	1165	24229	801	15915
5L-4S		MI	5813	2725	8839	2176	10050	1824	10730	1533	11476	1074	13654	750	8694
14-#10	2.13	MA	9883	2725	14011	2311	16454	1942	17681	1649	18848	1174	22806	734	15356
6L-3S		MI	5907	2725	9106	2167	10425	1808	11190	1527	12105	1071	14419	801	8700
14-#10	2.13	MA	9667	2725	13539	2320	15789	1957	16947	1659	17835	1192	21440	702	14944
7L-2S		MI	6092	2725	9490	2159	10915	1801	11785	1513	12911	1060	15506	892	8692
14-#11	2.61	MA	10828	2841	15959	2351	18761	1969	20501	1649	22693	1138	28096	792	19420
4L-5S		MI	5836	2841	8981	2252	10185	1872	10854	1570	11602	1067	13691	604	10140
14-#11	2.61	MA	10478	2841	15332	2376	18011	1983	19566	1662	21390	1159	26316	743	18954
5L-4S		MI	5978	2841	9311	2232	10583	1864	11348	1554	12287	1056	14585	670	10396
14-#11	2.61	MA	10176	2841	14726	2384	17299	1997	18648	1685	20147	1181	24580	659	18302
6L-3S		MI	6088	2841	9633	2222	11035	1846	11902	1548	13046	1054	15486	730	10418
14-#11	2.61	MA	9919	2841	14152	2394	16491	2015	17767	1698	18879	1191	22907	618	17610
7L-2S		MI	6302	2841	10095	2213	11623	1838	12616	1532	14013	1043	16760	842	10417
14-#14	3.77	MA	11320	3116	17198	2565	20312	2123	22323	1754	25076	1159	31518	619	26100
5L-4S		MI	6415	3116	10377	2398	11880	1987	12900	1629	14370	1034	17187	515	14223
14-#14	3.77	MA	10909	3116	16331	2575	19301	2143	21007	1787	23295	1189	29026	496	25032
6L-3S		MI	6560	3116	10836	2385	12523	1962	13689	1622	15449	1034	18446	599	14535
14-#14	3.77	MA	10560	3116	15509	2589	18144	2169	19743	1805	21477	1204	26617	436	23517
7L-2S		MI	6847	3116	11491	2372	13357	1952	14702	1600	16819	1019	20220	761	14570
14-#18	6.70	MA	12724	3816	20290	3062	24231	2512	26846	2043	31101	1206	40015	75	39553
6L-3S		MI	7698	3816	13736	2802	16132	2260	18032	1812	21297	982	25314	221	24352
16-#10	2.43	MA	10795	2797	15776	2330	18613	1952	20358	1639	22531	1143	27852	833	18299
4L-6S		MI	5736	2797	8713	2247	9886	1880	10515	1573	11170	1091	13279	629	9537
16-#10	2.43	MA	10501	2797	15257	2350	17997	1964	19590	1650	21460	1161	26394	795	18152
5E		MI	5863	2797	8951	2239	10211	1864	10917	1567	11713	1080	13978	688	9735
16-#10	2.43	MA	10252	2797	14758	2356	17405	1975	18837	1670	20412	1170	24971	729	17578
6L-4S		MI	5986	2797	9224	2222	10539	1857	11325	1553	12281	1069	14741	741	9851
16-#10	2.43	MA	10043	2797	14286	2365	16741	1990	18103	1680	19399	1188	23606	696	17179
7L-3S		MI	6077	2797	9490	2213	10915	1841	11785	1548	12911	1067	15506	792	9864
16-#10	2.43	MA	9789	2797	13835	2375	16130	1999	17326	1695	18405	1206	22282	652	16513
8L-2S		MI	6258	2797	9875	2204	11405	1834	12380	1534	13716	1056	16593	883	9862
16-#11	2.99	MA	10909	2930	16239	2432	19166	2023	20969	1687	23288	1154	28945	736	21637
5E		MI	6040	2930	9443	2308	10773	1912	11568	1595	12568	1062	14965	589	11477
16-#11	2.99	MA	10616	2930	15633	2439	18454	2037	20051	1711	22046	1175	27209	652	21005
6L-4S		MI	6181	2930	9773	2288	11171	1904	12062	1579	13254	1050	15859	655	11778
16-#11	2.99	MA	10370	2930	15059	2449	17646	2055	19169	1724	20778	1186	25535	611	20312
7L-3S		MI	6287	2930	10095	2278	11623	1886	12616	1573	14013	1049	16760	715	11810

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

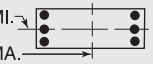


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.99	MA	10069	2930	14509	2461	16902	2065	18224	1742	19567	1207	23918	555	19462
8L-2S		MI	6496	2930	10556	2268	12211	1879	13330	1558	14979	1038	18034	827	11818
16-#14	4.31	MA	11526	3245	17628	2655	20953	2202	23013	1824	26010	1182	32784	486	28877
6L-4S		MI	6697	3245	11032	2478	12713	2045	13913	1665	15740	1026	18960	490	16099
16-#14	4.31	MA	11194	3245	16806	2669	19796	2227	21749	1842	24192	1196	30375	426	27372
7L-3S		MI	6836	3245	11491	2465	13357	2020	14702	1658	16819	1026	20220	574	16494
16-#14	4.31	MA	10772	3245	16018	2685	18731	2241	20408	1869	22456	1226	28052	343	25684
8L-2S		MI	7115	3245	12145	2452	14191	2010	15714	1637	18189	1011	21994	736	16542
18-#10	2.73	MA	10858	2870	16004	2395	18949	1997	20746	1671	23024	1156	28560	789	20362
5L-6S		MI	5910	2870	9098	2292	10376	1913	11110	1594	11975	1087	14366	620	10663
18-#10	2.73	MA	10616	2870	15505	2402	18357	2008	19992	1690	21976	1166	27137	723	19804
6L-5S		MI	6034	2870	9335	2284	10700	1897	11512	1588	12518	1076	15065	679	10852
18-#10	2.73	MA	10414	2870	15034	2410	17692	2023	19258	1701	20963	1184	25772	690	19416
7L-4S		MI	6157	2870	9608	2267	11029	1890	11920	1574	13086	1065	15828	732	11005
18-#10	2.73	MA	10162	2870	14582	2420	17081	2031	18482	1716	19969	1202	24448	646	18744
8L-3S		MI	6245	2870	9875	2258	11405	1874	12380	1568	13716	1063	16593	783	11025
18-#10	2.73	MA	9915	2870	14067	2438	16454	2049	17729	1724	18953	1211	23152	603	18086
9L-2S		MI	6422	2870	10260	2249	11895	1867	12975	1554	14521	1052	17680	874	11029
18-#11	3.36	MA	11050	3019	16540	2495	19609	2078	21454	1736	23944	1170	29837	645	23711
6L-5S		MI	6242	3019	9905	2364	11361	1952	12282	1620	13535	1057	16239	574	12819
18-#11	3.36	MA	10813	3019	15966	2505	18801	2096	20572	1749	22676	1181	28164	604	23015
7L-4S		MI	6382	3019	10234	2344	11758	1945	12776	1604	14220	1045	17133	640	13158
18-#11	3.36	MA	10515	3019	15417	2517	18057	2106	19627	1767	21466	1202	26547	548	22166
8L-3S		MI	6484	3019	10556	2334	12211	1927	13330	1599	14979	1044	18034	700	13198
18-#11	3.36	MA	10222	3019	14796	2539	17294	2127	18711	1776	20228	1213	24959	494	21123
9L-2S		MI	6690	3019	11018	2324	12799	1919	14045	1583	15946	1032	19308	812	13214
18-#14	4.84	MA	11816	3373	18103	2750	21447	2286	23755	1878	26906	1189	34133	416	31227
7L-4S		MI	6977	3373	11687	2558	13547	2103	14925	1701	17110	1019	20734	464	17984
18-#14	4.84	MA	11398	3373	17315	2766	20382	2299	22414	1905	25171	1218	31810	332	29524
8L-3S		MI	7109	3373	12145	2545	14191	2079	15714	1695	18189	1019	21994	549	18451
20-#10	3.04	MA	10975	2942	16253	2447	19308	2041	21148	1711	23540	1162	29302	717	22031
6E		MI	6082	2942	9482	2337	10866	1946	11705	1614	12781	1083	15453	611	11792
20-#10	3.04	MA	10779	2942	15781	2456	18644	2056	20414	1721	22527	1180	27937	684	21654
7L-5S		MI	6204	2942	9720	2329	11190	1930	12107	1609	13324	1072	16152	670	11972
20-#10	3.04	MA	10529	2942	15329	2465	18033	2064	19637	1736	21534	1197	26613	640	20974
8L-4S		MI	6326	2942	9993	2312	11519	1923	12515	1594	13892	1061	16915	723	12159
20-#10	3.04	MA	10289	2942	14814	2483	17406	2082	18885	1745	20518	1207	25318	597	20308
9L-3S		MI	6412	2942	10260	2303	11895	1907	12975	1589	14521	1059	17680	774	12183
20-#10	3.04	MA	10059	2942	14345	2491	16816	2092	18134	1762	19503	1222	23892	547	19537
10L-2S		MI	6586	2942	10645	2295	12384	1900	13570	1575	15326	1048	18767	865	12193
20-#11	3.73	MA	11249	3108	16873	2561	19956	2136	21975	1774	24575	1176	30793	597	25720
7L-5S		MI	6442	3108	10366	2419	11949	1993	12996	1645	14501	1052	17513	559	14165
20-#11	3.73	MA	10953	3108	16324	2572	19212	2146	21030	1792	23364	1197	29175	541	24871
8L-4S		MI	6582	3108	10696	2399	12346	1985	13490	1629	15187	1040	18407	625	14537
20-#11	3.73	MA	10669	3108	15703	2595	18449	2167	20114	1802	22126	1208	27587	487	23818
9L-3S		MI	6680	3108	11018	2389	12799	1967	14045	1624	15946	1039	19308	685	14585
20-#11	3.73	MA	10410	3108	15132	2603	17730	2179	19200	1822	20910	1228	25975	438	22809
10L-2S		MI	6881	3108	11480	2380	13387	1959	14759	1608	16912	1027	20582	797	14606
20-#14	5.38	MA	12012	3502	18612	2846	22033	2357	24419	1941	27885	1211	35569	322	33363
8L-4S		MI	7254	3502	12341	2639	14380	2162	15937	1738	18480	1011	22507	439	19877
22-#10	3.34	MA	11140	3015	16528	2501	19595	2089	21570	1742	24091	1175	30103	678	23894
7L-6S		MI	6253	3015	9867	2383	11356	1979	12300	1635	13586	1079	16540	602	12923
22-#10	3.34	MA	10892	3015	16077	2511	18984	2097	20793	1757	23098	1193	28779	634	23205
8L-5S		MI	6373	3015	10105	2375	11680	1963	12702	1629	14129	1068	17239	661	13096
22-#10	3.34	MA	10657	3015	15562	2529	18357	2115	20041	1765	22082	1203	27483	591	22530
9L-4S		MI	6495	3015	10378	2358	12009	1956	13110	1615	14697	1057	18002	713	13311
22-#10	3.34	MA	10436	3015	15093	2536	17767	2125	19290	1782	21067	1218	26057	541	21762
10L-3S		MI	6577	3015	10645	2349	12384	1940	13570	1609	15326	1054	18767	764	13341

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	3.34	MA	10192	3015	14635	2545	17176	2134	18556	1792	20029	1225	24768	495	20945
11L-2S		MI	6748	3015	11029	2340	12874	1933	14165	1595	16132	1043	19854	856	13354
22-#11	4.11	MA	11385	3197	17231	2628	20367	2186	22433	1818	25263	1192	31804	533	27576
8L-5S		MI	6640	3197	10828	2475	12537	2033	13711	1671	15468	1047	18786	545	15514
22-#11	4.11	MA	11110	3197	16610	2650	19604	2208	21517	1827	24025	1203	30216	480	26513
9L-4S		MI	6780	3197	11158	2455	12934	2026	14204	1655	16153	1035	19680	610	15875
22-#11	4.11	MA	10859	3197	16039	2659	18885	2219	20603	1847	22808	1222	28604	430	25495
10L-3S		MI	6874	3197	11480	2445	13387	2008	14759	1649	16912	1034	20582	670	15970
24-#10	3.65	MA	11249	3087	16824	2556	19936	2130	21949	1778	24662	1189	30944	628	25435
8L-6S		MI	6423	3087	10252	2428	11846	2012	12895	1655	14391	1074	17627	593	14055
24-#10	3.65	MA	11021	3087	16309	2574	19309	2148	21196	1786	23646	1199	29649	585	24752
9L-5S		MI	6540	3087	10490	2420	12170	1996	13297	1650	14934	1063	18326	651	14222
24-#10	3.65	MA	10814	3087	15840	2582	18719	2158	20446	1803	22631	1214	28223	535	23987
10L-4S		MI	6661	3087	10763	2403	12499	1989	13705	1636	15502	1053	19089	704	14462
24-#10	3.65	MA	10565	3087	15382	2590	18127	2167	19711	1812	21593	1221	26934	489	23163
11L-3S		MI	6741	3087	11029	2394	12874	1973	14165	1630	16132	1050	19854	755	14497
24-#11	4.48	MA	11544	3286	17517	2706	20759	2248	22920	1852	25923	1197	32845	472	29208
9L-5S		MI	6837	3286	11290	2531	13125	2074	14425	1696	16434	1041	20060	530	16867
24-#11	4.48	MA	11302	3286	16946	2715	20039	2260	22006	1873	24707	1217	31233	423	28182
10L-4S		MI	6976	3286	11620	2511	13522	2066	14918	1680	17120	1030	20954	595	17212

RECTANGULAR TIED COLUMNS 22" x 40"

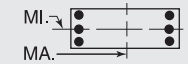
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.02	MA	10713	2591	15085	2193	17576	1850	18827	1584	19902	1188	23573	1035	8727
2E		MI	5721	2591	8581	2065	9585	1741	10040	1489	10349	1112	11763	938	4596
4-#18	1.82	MA	11661	2791	17266	2302	20249	1928	22023	1629	24185	1167	29471	1010	15070
2E		MI	6105	2791	9610	2162	10807	1808	11482	1525	12269	1084	13996	855	7644
6-#11	1.06	MA	10788	2601	15157	2207	17721	1861	19029	1593	20198	1192	23999	1038	9099
2L-3S		MI	5526	2601	8147	2096	9079	1766	9447	1519	9562	1132	10804	839	4807
6-#11	1.06	MA	10262	2601	14195	2223	16495	1876	17541	1606	18183	1214	21209	940	9110
3L-2S		MI	5762	2601	8609	2086	9667	1758	10161	1503	10528	1120	12078	952	4776
6-#14	1.53	MA	11371	2719	16462	2273	19329	1908	20957	1620	22785	1180	27564	1024	12912
2L-3S		MI	5681	2719	8581	2159	9585	1810	10040	1547	10349	1120	11763	751	6671
6-#14	1.53	MA	10646	2719	15085	2295	17576	1929	18827	1639	19902	1211	23573	881	12885
3L-2S		MI	6006	2719	9235	2146	10419	1800	11053	1526	11719	1105	13536	913	6633
6-#18	2.73	MA	12752	3019	19675	2445	23316	2031	25747	1694	29225	1154	36450	992	22346
2L-3S		MI	6049	3019	9610	2324	10807	1925	11482	1623	12269	1091	13996	508	11073
6-#18	2.73	MA	11580	3019	17266	2483	20249	2066	22023	1725	24185	1205	29471	731	22097
3L-2S		MI	6573	3019	10734	2305	12238	1912	13220	1590	14621	1071	16927	796	11088
8-#10	1.15	MA	10940	2624	15354	2232	18044	1881	19459	1607	20810	1197	24869	1041	9908
2L-4S		MI	5540	2624	8042	2137	8974	1808	9346	1543	9443	1144	10808	828	5222
8-#10	1.15	MA	10510	2624	14561	2245	17035	1893	18233	1619	19151	1215	22572	963	9912
3E		MI	5645	2624	8309	2128	9349	1792	9806	1538	10072	1141	11573	879	5199
8-#10	1.15	MA	10290	2624	14029	2258	16282	1914	17309	1639	17883	1225	21066	914	9880
4L-2S		MI	5842	2624	8694	2120	9839	1785	10401	1524	10878	1130	12660	970	5178
8-#11	1.42	MA	11251	2690	16120	2263	18947	1902	20518	1618	22213	1187	26789	1031	12022
2L-4S		MI	5610	2690	8287	2161	9214	1824	9606	1549	9770	1128	11177	764	6258
8-#11	1.42	MA	10742	2690	15157	2278	17721	1916	19029	1631	20198	1208	23999	933	12016
3E		MI	5735	2690	8609	2151	9667	1806	10161	1544	10528	1127	12078	824	6235
8-#11	1.42	MA	10482	2690	14509	2294	16804	1942	17904	1655	18655	1220	22155	872	11945
4L-2S		MI	5965	2690	9070	2142	10254	1799	10875	1528	11495	1115	13352	937	6209
8-#14	2.05	MA	12013	2848	17839	2353	21083	1967	23087	1657	25667	1173	31555	1014	17080
2L-4S		MI	5801	2848	8777	2252	9775	1893	10264	1590	10640	1113	12277	641	8643

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis

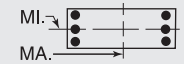


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.05	MA	11318	2848	16462	2376	19329	1987	20957	1676	22785	1203	27564	871	17023
3E		MI	5972	2848	9235	2239	10419	1868	11053	1584	11719	1113	13536	725	8667
8-#14	2.05	MA	10964	2848	15533	2398	18015	2023	19344	1710	20574	1219	24912	783	16770
4L-2S		MI	6286	2848	9890	2226	11252	1858	12065	1562	13089	1098	15310	887	8644
8-#18	3.64	MA	12710	3247	19675	2625	23316	2170	25747	1790	29225	1192	36450	712	29304
3E		MI	6533	3247	10734	2467	12238	2029	13220	1688	14621	1078	16927	448	14424
8-#18	3.64	MA	12151	3247	18043	2663	21010	2231	22917	1847	25347	1216	31761	554	27001
4L-2S		MI	7033	3247	11857	2448	13668	2016	14958	1655	16972	1058	19858	736	14500
10-#10	1.44	MA	11323	2696	16146	2277	19054	1914	20685	1628	22469	1193	27166	1036	12312
2L-5S		MI	5594	2696	8154	2200	9135	1848	9533	1578	9680	1150	11133	766	6397
10-#10	1.44	MA	10904	2696	15354	2290	18044	1926	19459	1639	20810	1211	24869	957	12305
3L-4S		MI	5719	2696	8427	2183	9464	1841	9941	1564	10248	1139	11895	818	6397
10-#10	1.44	MA	10694	2696	14822	2304	17292	1947	18534	1659	19542	1221	23363	909	12259
4L-3S		MI	5820	2696	8694	2174	9839	1825	10401	1558	10878	1137	12660	869	6382
10-#10	1.44	MA	10373	2696	14268	2324	16639	1959	17722	1671	18409	1239	21822	872	12129
5L-2S		MI	6013	2696	9079	2165	10329	1818	10996	1544	11683	1126	13748	961	6364
10-#11	1.77	MA	11707	2779	17083	2318	20173	1942	22007	1643	24228	1181	29579	1023	14938
2L-5S		MI	5678	2779	8419	2237	9405	1872	9827	1591	10051	1134	11556	684	7568
10-#11	1.77	MA	11212	2779	16120	2334	18947	1957	20518	1657	22213	1203	26789	926	14917
3L-4S		MI	5821	2779	8749	2217	9802	1865	10320	1575	10736	1123	12450	749	7659
10-#11	1.77	MA	10966	2779	15472	2350	18030	1982	19393	1681	20670	1215	24945	865	14828
4L-3S		MI	5941	2779	9070	2207	10254	1847	10875	1569	11495	1121	13352	810	7649
10-#11	1.77	MA	10583	2779	14804	2375	17235	1997	18403	1694	19289	1236	23064	817	14508
5L-2S		MI	6166	2779	9532	2197	10842	1839	11589	1553	12461	1110	14625	922	7629
10-#14	2.56	MA	11973	2976	17839	2456	21083	2046	23087	1712	25667	1196	31555	860	21158
3L-4S		MI	6095	2976	9432	2333	10608	1951	11276	1627	12010	1105	14050	616	10595
10-#14	2.56	MA	11644	2976	16910	2478	19769	2081	21474	1746	23456	1211	28903	772	20890
4L-3S		MI	6258	2976	9890	2319	11252	1926	12065	1620	13089	1105	15310	700	10647
10-#14	2.56	MA	11107	2976	15958	2515	18629	2102	20054	1765	21477	1242	26201	702	19614
5L-2S		MI	6563	2976	10545	2306	12086	1916	13078	1598	14459	1090	17084	862	10642
10-#18	4.55	MA	13306	3476	20451	2806	24076	2334	26642	1912	30387	1203	38740	535	34153
4L-3S		MI	7007	3476	11857	2610	13668	2132	14958	1752	16972	1065	19858	389	17768
10-#18	4.55	MA	12398	3476	18789	2870	22073	2369	24148	1943	26912	1254	33980	401	31571
5L-2S		MI	7485	3476	12981	2590	15099	2119	16695	1719	19324	1044	22789	676	17886
12-#10	1.73	MA	11701	2769	16939	2323	20063	1947	21911	1648	24128	1188	29463	1030	14710
2L-6S		MI	5638	2769	8301	2253	9300	1897	9726	1604	9942	1157	11520	698	7359
12-#10	1.73	MA	11292	2769	16146	2336	19054	1959	20685	1660	22469	1207	27166	952	14694
3L-5S		MI	5771	2769	8539	2245	9625	1881	10128	1598	10485	1146	12220	757	7552
12-#10	1.73	MA	11092	2769	15614	2349	18301	1980	19760	1680	21201	1217	25660	903	14638
4E		MI	5895	2769	8812	2228	9954	1874	10536	1584	11053	1135	12982	809	7565
12-#10	1.73	MA	10772	2769	15061	2369	17649	1992	18948	1691	20068	1235	24119	866	14501
5L-3S		MI	5994	2769	9079	2219	10329	1858	10996	1579	11683	1133	13748	860	7557
12-#10	1.73	MA	10492	2769	14532	2376	17017	2003	18151	1711	18959	1245	22614	801	13971
6L-2S		MI	6183	2769	9463	2210	10819	1851	11591	1565	12488	1122	14835	952	7543
12-#11	2.13	MA	11674	2868	17083	2390	20173	1997	22007	1682	24228	1198	29579	918	17814
3L-5S		MI	5887	2868	8880	2293	9992	1913	10541	1616	11017	1129	12830	669	8890
12-#11	2.13	MA	11440	2868	16435	2406	19256	2022	20882	1706	22685	1209	27735	858	17713
4E		MI	6029	2868	9210	2273	10390	1905	11034	1600	11702	1118	13724	734	9050
12-#11	2.13	MA	11061	2868	15766	2431	18461	2037	19891	1720	21304	1231	25854	810	17346
5L-3S		MI	6144	2868	9532	2263	10842	1887	11589	1594	12461	1116	14625	795	9054
12-#11	2.13	MA	10727	2868	15123	2438	17701	2050	18920	1743	19953	1243	24017	728	16603
6L-2S		MI	6365	2868	9994	2253	11430	1879	12303	1578	13428	1105	15899	907	9041
12-#14	3.07	MA	12309	3105	18287	2559	21523	2140	23604	1782	26339	1204	32894	762	25014
4E		MI	6385	3105	10086	2413	11442	2009	12289	1663	13380	1098	15824	590	12471
12-#14	3.07	MA	11776	3105	17336	2595	20383	2160	22184	1801	24359	1234	30193	691	23709
5L-3S		MI	6540	3105	10545	2400	12086	1985	13078	1656	14459	1098	17084	674	12616
12-#14	3.07	MA	11318	3105	16415	2606	19302	2180	20790	1835	22473	1265	27556	571	22673
6L-2S		MI	6837	3105	11199	2387	12919	1975	14090	1635	15829	1083	18857	836	12630

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

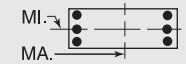
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	5.45	MA	13528	3704	21197	3013	25139	2472	27872	2008	31952	1241	40959	383	38700
5L-3S		MI	7502	3704	12981	2753	15099	2236	16695	1817	19324	1051	22789	329	21109
12-#18	5.45	MA	12789	3704	19598	3032	23257	2507	25422	2066	28637	1292	36314	162	35148
6L-2S		MI	7924	3704	14104	2733	16529	2223	18433	1784	21675	1031	25720	617	21263
14-#10	2.02	MA	11674	2841	16939	2381	20063	1992	21911	1680	24128	1203	29463	946	17081
3L-6S		MI	5816	2841	8686	2298	9790	1930	10321	1625	10748	1153	12607	689	8479
14-#10	2.02	MA	11483	2841	16407	2394	19310	2013	20986	1700	22860	1212	27957	897	17017
4L-5S		MI	5947	2841	8924	2290	10115	1914	10723	1619	11291	1142	13307	747	8692
14-#10	2.02	MA	11165	2841	15853	2415	18658	2025	20174	1712	21727	1231	26416	860	16875
5L-4S		MI	6070	2841	9197	2273	10443	1907	11131	1605	11859	1131	14069	800	8726
14-#10	2.02	MA	10892	2841	15325	2421	18026	2036	19376	1732	20618	1241	24911	795	16327
6L-3S		MI	6165	2841	9463	2264	10819	1891	11591	1599	12488	1129	14835	851	8727
14-#10	2.02	MA	10661	2841	14825	2430	17323	2052	18593	1742	19545	1259	23473	762	15881
7L-2S		MI	6351	2841	9848	2256	11309	1884	12186	1585	13293	1118	15922	943	8718
14-#11	2.48	MA	11907	2957	17397	2461	20482	2063	22370	1731	24700	1204	30525	851	20599
4L-5S		MI	6093	2957	9342	2348	10580	1953	11255	1641	11983	1124	14104	654	10220
14-#11	2.48	MA	11530	2957	16729	2486	19687	2078	21380	1745	23319	1226	28644	803	20191
5L-4S		MI	6235	2957	9672	2328	10978	1946	11748	1625	12669	1112	14998	720	10437
14-#11	2.48	MA	11207	2957	16086	2494	18926	2091	20409	1769	21968	1237	26807	721	19471
6L-3S		MI	6346	2957	9994	2318	11430	1928	12303	1620	13428	1111	15899	780	10454
14-#11	2.48	MA	10932	2957	15478	2504	18070	2110	19466	1781	20661	1259	25043	681	18806
7L-2S		MI	6561	2957	10456	2309	12018	1920	13017	1604	14394	1099	17173	892	10448
14-#14	3.58	MA	12431	3233	18713	2675	22136	2219	24314	1838	27242	1227	34184	681	27810
5L-4S		MI	6672	3233	10741	2493	12275	2068	13301	1699	14750	1090	17597	565	14333
14-#14	3.58	MA	11991	3233	17792	2686	21055	2238	22920	1872	25355	1258	31547	560	26756
6L-3S		MI	6819	3233	11199	2480	12919	2043	14090	1693	15829	1090	18857	649	14580
14-#14	3.58	MA	11618	3233	16921	2700	19828	2264	21581	1890	23430	1273	29007	501	25105
7L-2S		MI	7108	3233	11854	2467	13753	2033	15102	1671	17199	1075	20631	811	14610
14-#18	6.36	MA	13933	3932	22006	3174	26323	2611	29147	2130	33678	1278	43293	144	42270
6L-3S		MI	7958	3932	14104	2895	16529	2340	18433	1882	21675	1038	25720	270	24448
16-#10	2.31	MA	11868	2914	17200	2440	20319	2046	22212	1721	24519	1208	30254	891	19397
4L-6S		MI	5992	2914	9070	2344	10280	1963	10916	1645	11553	1149	13694	680	9602
16-#10	2.31	MA	11553	2914	16646	2460	19667	2058	21399	1733	23386	1227	28713	854	19250
5E		MI	6120	2914	9308	2336	10605	1947	11318	1639	12096	1138	14394	738	9804
16-#10	2.31	MA	11287	2914	16117	2467	19036	2069	20602	1753	22277	1237	27208	789	18687
6L-4S		MI	6243	2914	9581	2318	10933	1940	11726	1625	12664	1127	15156	791	9885
16-#10	2.31	MA	11063	2914	15618	2475	18332	2084	19819	1763	21204	1255	25769	757	18253
7L-3S		MI	6335	2914	9848	2310	11309	1924	12186	1620	13293	1124	15922	842	9894
16-#10	2.31	MA	10790	2914	15140	2485	17685	2093	18996	1778	20153	1273	24371	714	17593
8L-2S		MI	6517	2914	10233	2301	11799	1917	12781	1606	14099	1113	17009	933	9889
16-#11	2.84	MA	11991	3046	17692	2542	20913	2118	22869	1770	25334	1221	31434	796	23041
5E		MI	6298	3046	9804	2404	11168	1994	11969	1666	12950	1119	15378	639	11556
16-#11	2.84	MA	11678	3046	17049	2550	20152	2131	21898	1794	23983	1232	29597	714	22342
6L-4S		MI	6438	3046	10134	2384	11566	1986	12463	1650	13635	1107	16272	705	11821
16-#11	2.84	MA	11414	3046	16441	2560	19296	2150	20955	1807	22676	1254	27833	673	21673
7L-3S		MI	6545	3046	10456	2374	12018	1968	13017	1645	14394	1106	17173	765	11847
16-#11	2.84	MA	11090	3046	15859	2572	18508	2160	19954	1825	21394	1276	26124	619	20743
8L-2S		MI	6757	3046	10918	2364	12606	1960	13731	1629	15361	1094	18447	877	11850
16-#14	4.09	MA	12651	3361	19170	2766	22809	2296	25050	1908	28238	1250	35539	550	30839
6L-4S		MI	6954	3361	11396	2573	13109	2126	14313	1736	16120	1083	19371	539	16207
16-#14	4.09	MA	12296	3361	18298	2781	21582	2323	23711	1927	26312	1266	32998	491	29200
7L-3S		MI	7095	3361	11854	2560	13753	2101	15102	1729	17199	1083	20631	623	16541
16-#14	4.09	MA	11840	3361	17464	2797	20453	2337	22276	1953	24474	1296	30543	410	27488
8L-2S		MI	7377	3361	12509	2547	14586	2092	16115	1708	18570	1068	22404	785	16583

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis

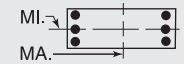


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.60	MA	11934	2986	17439	2505	20676	2091	22625	1753	25045	1222	31010	848	21627
5L-6S		MI	6167	2986	9455	2389	10770	1995	11511	1666	12358	1144	14781	670	10728
18-#10	2.60	MA	11675	2986	16910	2512	20045	2102	21828	1773	23936	1232	29505	783	21049
6L-5S		MI	6292	2986	9693	2381	11094	1980	11913	1660	12901	1133	15481	729	10920
18-#10	2.60	MA	11459	2986	16411	2521	19341	2117	21044	1783	22863	1251	28066	751	20627
7L-4S		MI	6415	2986	9966	2364	11423	1973	12321	1646	13469	1123	16244	782	11041
18-#10	2.60	MA	11189	2986	15933	2531	18694	2126	20222	1799	21812	1269	26668	708	19959
8L-3S		MI	6504	2986	10233	2355	11799	1957	12781	1640	14099	1120	17009	833	11056
18-#10	2.60	MA	10918	2986	15384	2549	18031	2144	19425	1807	20737	1279	25302	665	19319
9L-2S		MI	6683	2986	10618	2346	12288	1950	13376	1626	14904	1109	18096	924	11057
18-#11	3.19	MA	12142	3135	18012	2605	21378	2172	23387	1819	25998	1227	32388	707	25216
6L-5S		MI	6500	3135	10266	2460	11756	2034	12683	1692	13916	1114	16652	624	12898
18-#11	3.19	MA	11888	3135	17404	2616	20522	2191	22444	1832	24691	1249	30624	666	24540
7L-4S		MI	6640	3135	10596	2440	12154	2027	13177	1676	14602	1102	17546	690	13202
18-#11	3.19	MA	11566	3135	16822	2628	19734	2201	21443	1851	23409	1271	28914	611	23614
8L-3S		MI	6743	3135	10918	2430	12606	2009	13731	1670	15361	1101	18447	750	13237
18-#11	3.19	MA	11254	3135	16159	2650	18925	2222	20472	1860	22099	1282	27240	558	22567
9L-2S		MI	6950	3135	11379	2420	13194	2001	14445	1654	16327	1089	19721	862	13249
18-#14	4.60	MA	12961	3490	19676	2861	23336	2381	25841	1963	29195	1258	36989	481	33294
7L-4S		MI	7234	3490	12050	2654	13943	2185	15326	1772	17490	1075	21145	514	18090
18-#14	4.60	MA	12509	3490	18841	2878	22207	2395	24406	1990	27357	1289	34534	400	31566
8L-3S		MI	7369	3490	12509	2641	14586	2160	16115	1766	18570	1075	22404	598	18500
18-#14	4.60	MA	12083	3490	17898	2910	21048	2426	23016	2003	25478	1304	32123	322	29891
9L-2S		MI	7644	3490	13163	2627	15420	2150	17127	1744	19940	1060	24178	760	18553
20-#10	2.89	MA	12059	3059	17703	2557	21054	2135	23054	1794	25595	1228	31802	777	23413
6E		MI	6340	3059	9840	2434	11260	2028	12106	1686	13163	1140	15869	661	11856
20-#10	2.89	MA	11850	3059	17203	2566	20350	2150	22270	1804	24522	1247	30363	745	23003
7L-5S		MI	6462	3059	10078	2426	11584	2013	12508	1681	13706	1129	16568	720	12040
20-#10	2.89	MA	11581	3059	16725	2576	19704	2159	21448	1819	23471	1265	28965	702	22325
8L-4S		MI	6585	3059	10351	2409	11913	2006	12916	1667	14274	1118	17331	773	12195
20-#10	2.89	MA	11324	3059	16176	2594	19040	2177	20651	1828	22396	1275	27599	659	21676
9L-3S		MI	6671	3059	10618	2400	12288	1990	13376	1661	14904	1116	18096	824	12216
20-#10	2.89	MA	11078	3059	15680	2602	18415	2187	19857	1845	21311	1290	26093	610	20837
10L-2S		MI	6847	3059	11002	2391	12778	1983	13971	1647	15709	1105	19183	915	12223
20-#11	3.55	MA	12354	3224	18367	2671	21747	2231	23933	1857	26706	1244	33414	659	27407
7L-5S		MI	6700	3224	10728	2515	12344	2075	13397	1717	14883	1109	17925	609	14243
20-#11	3.55	MA	12035	3224	17784	2683	20960	2241	22931	1876	25424	1265	31704	604	26485
8L-4S		MI	6840	3224	11057	2495	12742	2067	13891	1701	15568	1097	18819	675	14583
20-#11	3.55	MA	11732	3224	17122	2705	20151	2263	21961	1886	24114	1277	30030	551	25428
9L-3S		MI	6940	3224	11379	2485	13194	2049	14445	1695	16327	1096	19721	735	14624
20-#11	3.55	MA	11441	3224	16517	2714	19390	2275	20993	1906	22812	1296	28190	489	24417
10L-2S		MI	7143	3224	11841	2476	13782	2041	15160	1679	17293	1084	20994	847	14642
20-#14	5.11	MA	13166	3618	20218	2958	23960	2454	26536	2026	30239	1281	38525	389	35643
8L-4S		MI	7512	3618	12705	2734	14776	2243	16338	1809	18861	1068	22918	488	19981
20-#14	5.11	MA	12755	3618	19275	2990	22801	2484	25145	2039	28360	1297	36114	311	33954
9L-3S		MI	7640	3618	13163	2721	15420	2218	17127	1802	19940	1068	24178	573	20457
22-#10	3.17	MA	12235	3131	17996	2611	21359	2183	23496	1824	26181	1242	32660	739	25380
7L-6S		MI	6511	3131	10225	2479	11750	2061	12701	1707	13969	1136	16956	652	12987
22-#10	3.17	MA	11968	3131	17518	2621	20713	2192	22674	1840	25130	1261	31262	696	24691
8L-5S		MI	6631	3131	10463	2472	12074	2046	13103	1701	14512	1125	17655	711	13163
22-#10	3.17	MA	11717	3131	16969	2639	20049	2210	21877	1848	24055	1271	29896	653	24033
9L-4S		MI	6753	3131	10736	2454	12403	2038	13511	1687	15080	1114	18418	764	13348
22-#10	3.17	MA	11480	3131	16472	2647	19424	2220	21082	1866	22970	1286	28390	605	23198
10L-3S		MI	6837	3131	11002	2446	12778	2023	13971	1681	15709	1112	19183	815	13374
22-#10	3.17	MA	11218	3131	15988	2656	18793	2229	20305	1875	21871	1293	27028	559	22381
11L-2S		MI	7010	3131	11387	2437	13268	2016	14566	1667	16515	1101	20270	906	13385
22-#11	3.90	MA	12497	3314	18747	2739	22186	2282	24420	1901	27439	1260	34494	597	29356
8L-5S		MI	6899	3314	11189	2571	12932	2115	14112	1742	15849	1103	19199	594	15591

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.90	MA	12202	3314	18085	2761	21377	2303	23450	1911	26129	1272	32820	544	28288
9L-4S		MI	7038	3314	11519	2551	13329	2107	14605	1726	16535	1092	20093	660	15962
22-#11	3.90	MA	11935	3314	17480	2770	20616	2315	22482	1932	24827	1291	30980	482	27269
10L-3S		MI	7134	3314	11841	2541	13782	2089	15160	1721	17293	1090	20994	720	16011
22-#14	5.63	MA	13416	3747	20653	3070	24555	2543	27275	2076	31242	1289	40105	301	38018
9L-4S		MI	7787	3747	13360	2814	15610	2301	17351	1845	20231	1060	24692	463	21878
24-#10	3.46	MA	12350	3204	18311	2667	21722	2225	23899	1861	26789	1257	33559	690	27057
8L-6S		MI	6681	3204	10610	2525	12240	2094	13296	1727	14774	1132	18043	643	14119
24-#10	3.46	MA	12106	3204	17762	2685	21058	2243	23103	1869	25714	1266	32193	647	26390
9L-5S		MI	6799	3204	10847	2517	12564	2079	13698	1722	15317	1121	18742	702	14288
24-#10	3.46	MA	11877	3204	17265	2692	20433	2253	22308	1886	24629	1282	30687	599	25558
10L-4S		MI	6920	3204	11120	2500	12893	2071	14106	1708	15885	1110	19505	755	14501
24-#10	3.46	MA	11617	3204	16781	2701	19802	2262	21531	1896	23530	1289	29325	554	24734
11L-3S		MI	7002	3204	11387	2491	13268	2056	14566	1702	16515	1107	20270	806	14531
24-#11	4.25	MA	12666	3403	19048	2817	22603	2344	24939	1936	28144	1266	35610	537	31149
9L-5S		MI	7096	3403	11651	2627	13520	2156	14826	1767	16816	1098	20473	579	16943
24-#11	4.25	MA	12407	3403	18443	2826	21842	2356	23971	1957	26842	1286	33770	475	30120
10L-4S		MI	7235	3403	11981	2607	13917	2148	15319	1751	17501	1087	21367	645	17299

RECTANGULAR TIED COLUMNS 22" x 42"

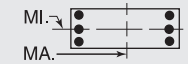
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.73	MA	12778	2907	18759	2412	22032	2021	23954	1710	26247	1232	31934	1067	15934
2E		MI	6363	2907	9978	2256	11205	1888	11883	1595	12647	1140	14402	904	7679
6-#11	1.01	MA	11841	2718	16520	2316	19347	1955	20776	1674	22014	1257	26123	1095	9604
2L-3S		MI	5782	2718	8508	2192	9474	1848	9848	1590	9943	1189	11217	889	4829
6-#11	1.01	MA	11280	2718	15501	2332	18050	1970	19201	1688	19883	1279	23172	998	9616
3L-2S		MI	6019	2718	8970	2182	10062	1840	10562	1574	10910	1177	12491	1001	4799
6-#14	1.46	MA	12464	2836	17902	2382	21051	2002	22818	1702	24755	1245	29901	1081	13641
2L-3S		MI	5938	2836	8944	2254	9981	1891	10441	1618	10729	1176	12173	800	6701
6-#14	1.46	MA	11691	2836	16445	2405	19196	2023	20564	1721	21704	1276	25677	940	13614
3L-2S		MI	6264	2836	9599	2241	10815	1881	11454	1596	12099	1161	13947	962	6661
6-#18	2.60	MA	13944	3136	21310	2554	25280	2125	27899	1775	31586	1219	39326	1049	23642
2L-3S		MI	6306	3136	9978	2418	11205	2005	11883	1693	12647	1147	14402	557	11127
6-#18	2.60	MA	12689	3136	18759	2593	22032	2160	23954	1808	26247	1271	31934	791	23393
3L-2S		MI	6832	3136	11102	2399	12635	1992	13620	1660	14999	1126	17333	844	11128
8-#10	1.10	MA	12001	2740	16725	2341	19686	1974	21226	1688	22657	1262	27037	1098	10457
2L-4S		MI	5796	2740	8400	2234	9368	1891	9747	1615	9826	1201	11224	878	5245
8-#10	1.10	MA	11543	2740	15887	2355	18619	1987	19930	1700	20903	1280	24609	1021	10461
3E		MI	5902	2740	8667	2225	9743	1875	10207	1610	10455	1199	11989	929	5220
8-#10	1.10	MA	11309	2740	15325	2368	17825	2008	18954	1721	19564	1291	23024	972	10428
4L-2S		MI	6099	2740	9051	2216	10233	1868	10802	1596	11260	1188	13076	1020	5198
8-#11	1.35	MA	12335	2807	17538	2372	20644	1995	22351	1699	24146	1251	29075	1087	12696
2L-4S		MI	5866	2807	8648	2257	9609	1906	10007	1621	10151	1185	11589	814	6288
8-#11	1.35	MA	11792	2807	16520	2388	19347	2010	20776	1713	22014	1274	26123	991	12690
3E		MI	5992	2807	8970	2247	10062	1888	10562	1615	10910	1183	12491	874	6261
8-#11	1.35	MA	11514	2807	15835	2404	18379	2036	19587	1738	20384	1286	24183	930	12619
4L-2S		MI	6223	2807	9432	2238	10650	1880	11276	1599	11876	1172	13764	986	6234
8-#14	1.95	MA	13150	2964	19360	2463	22907	2060	25072	1738	27805	1238	34124	1071	18052
2L-4S		MI	6057	2964	9141	2347	10171	1974	10665	1661	11020	1169	12687	691	8690
8-#14	1.95	MA	12407	2964	17902	2486	21051	2081	22818	1758	24755	1269	29901	929	17995
3E		MI	6229	2964	9599	2334	10815	1949	11454	1654	12099	1169	13947	775	8702
8-#14	1.95	MA	12029	2964	16921	2508	19663	2117	21114	1792	22418	1285	27109	842	17742
4L-2S		MI	6545	2964	10254	2321	11648	1939	12466	1633	13469	1154	15721	937	8676

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

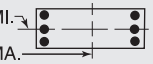


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.46	MA	13895	3364	21310	2736	25280	2264	27899	1872	31586	1258	39326	773	31032
3E		MI	6789	3364	11102	2561	12635	2109	13620	1757	14999	1133	17333	497	14484
8-#18	3.46	MA	13298	3364	19585	2775	22842	2326	24907	1931	27485	1284	34388	615	28795
4L-2S		MI	7293	3364	12225	2542	14066	2096	15358	1724	17350	1113	20265	785	14544
10-#10	1.37	MA	12410	2813	17563	2387	20753	2007	22522	1709	24411	1257	29466	1092	12998
2L-5S		MI	5851	2813	8512	2297	9529	1931	9934	1650	10063	1208	11548	816	6429
10-#10	1.37	MA	11963	2813	16725	2400	19686	2020	21226	1721	22657	1276	27037	1015	12990
3L-4S		MI	5975	2813	8785	2279	9858	1923	10342	1636	10631	1197	12311	869	6423
10-#10	1.37	MA	11739	2813	16163	2414	18892	2041	20250	1741	21318	1286	25452	967	12945
4L-3S		MI	6078	2813	9051	2271	10233	1908	10802	1630	11260	1194	13076	920	6405
10-#10	1.37	MA	11395	2813	15576	2434	18204	2054	19393	1753	20122	1305	23828	931	12815
5L-2S		MI	6271	2813	9436	2262	10723	1901	11397	1616	12066	1183	14163	1011	6386
10-#11	1.69	MA	12821	2896	18557	2428	21941	2036	23926	1724	26277	1246	32026	1080	15780
2L-5S		MI	5935	2896	8780	2333	9800	1954	10228	1662	10432	1191	11969	734	7648
10-#11	1.69	MA	12293	2896	17538	2444	20644	2051	22351	1739	24146	1268	29075	984	15759
3L-4S		MI	6078	2896	9110	2313	10197	1947	10721	1646	11117	1180	12863	799	7692
10-#11	1.69	MA	12030	2896	16854	2460	19676	2076	21162	1763	22515	1280	27134	923	15671
4L-3S		MI	6198	2896	9432	2303	10650	1929	11276	1640	11876	1178	13764	859	7678
10-#11	1.69	MA	11620	2896	16144	2485	18837	2091	20116	1777	21058	1303	25150	877	15417
5L-2S		MI	6424	2896	9893	2293	11238	1921	11990	1624	12843	1167	15038	972	7657
10-#14	2.44	MA	13106	3093	19360	2566	22907	2140	25072	1794	27805	1261	34124	919	22373
3L-4S		MI	6352	3093	9795	2428	11004	2032	11677	1697	12390	1161	14461	665	10646
10-#14	2.44	MA	12754	3093	18378	2589	21519	2176	23368	1829	25469	1278	31332	832	22105
4L-3S		MI	6515	3093	10254	2415	11648	2008	12466	1691	13469	1161	15721	749	10686
10-#14	2.44	MA	12178	3093	17367	2625	20316	2197	21869	1848	23378	1309	28483	763	20847
5L-2S		MI	6822	3093	10908	2402	12482	1998	13478	1669	14840	1146	17494	911	10676
10-#18	4.33	MA	14530	3592	22136	2917	26090	2430	28852	1996	32824	1271	41780	597	36358
4L-3S		MI	7265	3592	12225	2704	14066	2212	15358	1822	17350	1120	20265	437	17831
10-#18	4.33	MA	13554	3592	20380	2983	23974	2466	26217	2029	29151	1324	36759	467	33560
5L-2S		MI	7748	3592	13349	2684	15496	2200	17095	1789	19702	1100	23196	725	17935
12-#10	1.65	MA	12812	2886	18401	2432	21820	2040	23818	1729	26164	1253	31894	1087	15533
2L-6S		MI	5894	2886	8659	2350	9694	1979	10127	1676	10325	1214	11936	748	7424
12-#10	1.65	MA	12376	2886	17563	2445	20753	2053	22522	1741	24411	1272	29466	1009	15517
3L-5S		MI	6028	2886	8897	2342	10019	1964	10529	1670	10868	1203	12635	807	7587
12-#10	1.65	MA	12162	2886	17001	2459	19958	2074	21546	1762	23072	1282	27880	961	15461
4E		MI	6152	2886	9170	2325	10348	1956	10937	1656	11436	1193	13398	860	7593
12-#10	1.65	MA	11821	2886	16414	2479	19271	2087	20689	1774	21876	1301	26256	925	15324
5L-3S		MI	6251	2886	9436	2316	10723	1941	11397	1651	12066	1190	14163	911	7582
12-#10	1.65	MA	11522	2886	15856	2486	18600	2097	19848	1794	20706	1311	24671	861	14811
6L-2S		MI	6441	2886	9821	2307	11213	1934	11992	1637	12871	1179	15250	1002	7567
12-#11	2.03	MA	12785	2985	18557	2499	21941	2091	23926	1764	26277	1263	32026	976	18825
3L-5S		MI	6144	2985	9242	2389	10388	1995	10942	1687	11398	1186	13243	719	8969
12-#11	2.03	MA	12536	2985	17872	2516	20972	2117	22737	1788	24647	1275	30085	916	18724
4E		MI	6286	2985	9571	2369	10785	1987	11435	1671	12084	1174	14137	784	9087
12-#11	2.03	MA	12129	2985	17162	2541	20133	2132	21691	1802	23189	1298	28102	870	18424
5L-3S		MI	6402	2985	9893	2359	11238	1969	11990	1666	12843	1173	15038	844	9086
12-#11	2.03	MA	11774	2985	16483	2548	19325	2145	20666	1827	21763	1309	26166	789	17609
6L-2S		MI	6623	2985	10355	2349	11825	1961	12704	1650	13809	1161	16312	957	9071
12-#14	2.92	MA	13463	3221	19836	2669	23375	2234	25622	1865	28519	1270	35556	821	26472
4E		MI	6642	3221	10450	2508	11838	2091	12689	1734	13761	1154	16235	640	12582
12-#14	2.92	MA	12892	3221	18824	2705	22172	2255	24123	1885	26429	1302	32707	753	25186
5L-3S		MI	6798	3221	10908	2495	12482	2066	13478	1727	14840	1154	17494	724	12658
12-#14	2.92	MA	12403	3221	17851	2716	21021	2274	22651	1919	24383	1318	29927	634	24068
6L-2S		MI	7097	3221	11563	2482	13315	2056	14491	1706	16210	1139	19268	886	12666
12-#18	5.19	MA	14760	3821	22931	3125	27222	2569	30162	2093	34490	1310	44151	449	41149
5L-3S		MI	7761	3821	13349	2846	15496	2316	17095	1887	19702	1107	23196	378	21174
12-#18	5.19	MA	13971	3821	21225	3143	25232	2605	27574	2152	30988	1363	39251	231	37467
6L-2S		MI	8189	3821	14473	2827	16927	2303	18833	1854	22054	1087	26127	665	21314

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

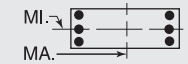
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	1.92	MA	12783	2958	18401	2491	21820	2086	23818	1762	26164	1268	31894	1003	18041
3L-6S		MI	6073	2958	9043	2395	10184	2012	10722	1697	11130	1210	13023	739	8543
14-#10	1.92	MA	12579	2958	17839	2504	21025	2107	22842	1782	24826	1278	30309	955	17977
4L-5S		MI	6204	2958	9281	2387	10509	1997	11124	1691	11673	1199	13722	798	8741
14-#10	1.92	MA	12239	2958	17252	2524	20337	2120	21985	1794	23629	1297	28685	919	17835
5L-4S		MI	6327	2958	9554	2370	10837	1989	11532	1677	12241	1188	14485	851	8757
14-#10	1.92	MA	11948	2958	16694	2531	19666	2130	21144	1815	22459	1307	27099	855	17304
6L-3S		MI	6423	2958	9821	2361	11213	1974	11992	1671	12871	1186	15250	902	8754
14-#10	1.92	MA	11703	2958	16166	2540	18923	2146	20311	1824	21328	1326	25587	823	16822
7L-2S		MI	6610	2958	10206	2352	11703	1966	12587	1657	13676	1175	16337	993	8743
14-#11	2.36	MA	13033	3074	18891	2571	22269	2157	24312	1813	26778	1270	33037	909	21778
4L-5S		MI	6350	3074	9703	2444	10976	2035	11656	1712	12365	1181	14517	704	10299
14-#11	2.36	MA	12629	3074	18181	2596	21430	2172	23266	1827	25321	1292	31053	863	21436
5L-4S		MI	6492	3074	10033	2424	11373	2027	12149	1696	13050	1169	15411	769	10476
14-#11	2.36	MA	12284	3074	17501	2604	20621	2185	22241	1852	23894	1304	29117	782	20645
6L-3S		MI	6604	3074	10355	2414	11825	2009	12704	1691	13809	1168	16312	830	10488
14-#11	2.36	MA	11993	3074	16859	2615	19716	2204	21237	1864	22515	1327	27262	742	20007
7L-2S		MI	6821	3074	10817	2405	12413	2002	13418	1675	14776	1156	17586	942	10478
14-#14	3.41	MA	13590	3350	20282	2785	24027	2314	26377	1921	29479	1294	36931	742	29530
5L-4S		MI	6929	3350	11105	2588	12671	2149	13702	1770	15131	1147	18008	614	14442
14-#14	3.41	MA	13121	3350	19308	2796	22877	2333	24905	1956	27433	1311	34151	624	28423
6L-3S		MI	7077	3350	11563	2575	13315	2124	14491	1764	16210	1146	19268	698	14624
14-#14	3.41	MA	12723	3350	18388	2811	21580	2360	23479	1974	25454	1342	31480	566	26708
7L-2S		MI	7369	3350	12218	2562	14149	2114	15503	1742	17580	1131	21042	860	14648
14-#18	6.06	MA	15190	4049	23776	3286	28480	2708	31519	2217	36326	1350	46644	213	45013
6L-3S		MI	8219	4049	14473	2989	16927	2420	18833	1952	22054	1094	26127	318	24516
14-#18	6.06	MA	14554	4049	22160	3311	26205	2754	29035	2250	32752	1376	41909	106	41220
7L-2S		MI	8625	4049	15596	2970	18357	2407	20571	1919	24405	1073	29058	606	24685
16-#10	2.20	MA	12989	3031	18677	2550	22092	2140	24138	1803	26579	1274	32737	949	20494
4L-6S		MI	6249	3031	9428	2440	10674	2045	11317	1717	11936	1206	14110	730	9665
16-#10	2.20	MA	12651	3031	18090	2570	21404	2152	23281	1815	25383	1293	31113	913	20348
5E		MI	6378	3031	9666	2433	10999	2030	11719	1712	12479	1195	14809	789	9872
16-#10	2.20	MA	12368	3031	17532	2576	20733	2163	22440	1835	24213	1303	29527	849	19800
6L-4S		MI	6501	3031	9939	2415	11327	2022	12127	1697	13047	1184	15572	841	9917
16-#10	2.20	MA	12130	3031	17004	2586	19990	2179	21606	1845	23082	1322	28015	817	19331
7L-3S		MI	6594	3031	10206	2407	11703	2007	12587	1692	13676	1182	16337	892	9922
16-#10	2.20	MA	11838	3031	16500	2596	19308	2188	20738	1861	21973	1341	26541	775	18681
8L-2S		MI	6777	3031	10591	2398	12193	1999	13182	1678	14482	1171	17424	984	9915
16-#11	2.70	MA	13121	3163	19199	2652	22727	2213	24841	1853	27452	1287	34004	856	24454
5E		MI	6555	3163	10165	2500	11563	2076	12370	1738	13331	1176	15791	689	11634
16-#11	2.70	MA	12786	3163	18520	2660	21918	2226	23816	1877	26026	1299	32068	775	23685
6L-4S		MI	6696	3163	10495	2480	11961	2068	12863	1722	14017	1164	16685	754	11862
16-#11	2.70	MA	12506	3163	17878	2670	21013	2245	22812	1890	24646	1321	30214	735	23040
7L-3S		MI	6804	3163	10817	2470	12413	2050	13418	1716	14776	1163	17586	815	11883
16-#11	2.70	MA	12158	3163	17263	2683	20181	2255	21755	1909	23294	1344	28413	682	22033
8L-2S		MI	7017	3163	11279	2460	13001	2042	14132	1700	15742	1151	18860	927	11882
16-#14	3.90	MA	13824	3478	20766	2877	24732	2391	27160	1992	30484	1303	38375	614	32777
6L-4S		MI	7212	3478	11759	2669	13505	2207	14714	1807	16501	1139	19782	589	16313
16-#14	3.90	MA	13445	3478	19846	2892	23435	2418	25733	2010	28505	1335	35703	555	31042
7L-3S		MI	7354	3478	12218	2656	14149	2183	15503	1800	17580	1139	21042	673	16587
16-#14	3.90	MA	12956	3478	18964	2909	22243	2433	24217	2037	26565	1366	33115	476	29315
8L-2S		MI	7638	3478	12872	2642	14982	2173	16515	1779	18950	1124	22815	835	16623
16-#18	6.93	MA	15787	4278	24711	3454	29453	2858	32980	2314	38091	1363	49301	88	48732
7L-3S		MI	8670	4278	15596	3132	18357	2524	20571	2016	24405	1080	29058	259	27857

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

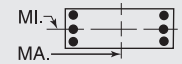


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.47	MA	13058	3103	18928	2615	22471	2185	24576	1835	27137	1288	33541	907	22861
5L-6S		MI	6424	3103	9813	2486	11164	2078	11912	1738	12741	1202	15197	721	10791
18-#10	2.47	MA	12782	3103	18370	2622	21800	2196	23736	1856	25967	1299	31956	843	22299
6L-5S		MI	6550	3103	10051	2478	11488	2062	12314	1732	13284	1191	15896	779	10987
18-#10	2.47	MA	12552	3103	17842	2631	21057	2212	22902	1866	24836	1318	30443	811	21843
7L-4S		MI	6672	3103	10324	2461	11817	2055	12722	1718	13852	1180	16659	832	11075
18-#10	2.47	MA	12262	3103	17338	2641	20374	2221	22034	1882	23727	1336	28970	769	21182
8L-3S		MI	6762	3103	10591	2452	12193	2040	13182	1712	14482	1177	17424	883	11086
18-#10	2.47	MA	11973	3103	16755	2659	19674	2239	21193	1890	22582	1346	27535	727	20509
9L-2S		MI	6943	3103	10975	2443	12682	2032	13777	1698	15287	1167	18511	975	11084
18-#11	3.04	MA	13281	3252	19538	2715	23215	2266	25391	1902	28157	1294	35020	768	26728
6L-5S		MI	6757	3252	10627	2556	12151	2116	13084	1763	14298	1171	17064	674	12974
18-#11	3.04	MA	13010	3252	18896	2726	22310	2285	24387	1915	26778	1316	33165	728	26073
7L-4S		MI	6898	3252	10957	2536	12549	2108	13578	1747	14983	1159	17958	740	13245
18-#11	3.04	MA	12665	3252	18281	2738	21478	2296	23330	1934	25425	1339	31364	674	25071
8L-3S		MI	7002	3252	11279	2526	13001	2090	14132	1741	15742	1158	18860	800	13274
18-#11	3.04	MA	12332	3252	17578	2760	20624	2318	22305	1944	24042	1351	29604	621	24026
9L-2S		MI	7211	3252	11741	2516	13589	2083	14846	1725	16708	1146	20133	912	13283
18-#14	4.38	MA	14153	3607	21303	2972	25291	2476	27987	2047	31556	1327	39927	545	35376
7L-4S		MI	7492	3607	12414	2749	14338	2266	15727	1843	17871	1132	21555	563	18194
18-#14	4.38	MA	13669	3607	20421	2989	24099	2491	26471	2074	29615	1358	37339	466	33631
8L-3S		MI	7628	3607	12872	2736	14982	2241	16515	1836	18950	1132	22815	647	18547
18-#14	4.38	MA	13214	3607	19419	3021	22875	2522	25002	2088	27631	1375	34804	389	31938
9L-2S		MI	7906	3607	13527	2723	15816	2231	17528	1815	20320	1117	24589	809	18595
20-#10	2.75	MA	13190	3176	19208	2667	22867	2229	25031	1876	27721	1295	34384	837	24800
6E		MI	6597	3176	10198	2531	11654	2111	12507	1758	13546	1197	16284	712	11919
20-#10	2.75	MA	12967	3176	18680	2676	22124	2245	24198	1886	26589	1313	32871	805	24356
7L-5S		MI	6721	3176	10436	2523	11978	2095	12909	1753	14089	1187	16984	770	12106
20-#10	2.75	MA	12680	3176	18176	2686	21441	2254	23330	1902	25480	1332	31398	763	23684
8L-4S		MI	6843	3176	10709	2506	12307	2088	13317	1739	14657	1176	17746	823	12230
20-#10	2.75	MA	12406	3176	17593	2704	20741	2272	22489	1911	24336	1342	29963	721	23013
9L-3S		MI	6930	3176	10975	2497	12682	2073	13777	1733	15287	1173	18511	874	12247
20-#10	2.75	MA	12144	3176	17069	2712	20082	2282	21651	1929	23192	1357	28376	673	22150
10L-2S		MI	7107	3176	11360	2488	13172	2065	14372	1719	16092	1162	19599	966	12251
20-#11	3.38	MA	13507	3341	19914	2782	23606	2326	25962	1940	28909	1311	36116	721	29106
7L-5S		MI	6958	3341	11089	2611	12739	2157	13798	1788	15264	1165	18338	659	14319
20-#11	3.38	MA	13165	3341	19300	2794	22775	2336	24905	1959	27557	1333	34315	667	28109
8L-4S		MI	7098	3341	11419	2591	13137	2149	14292	1772	15950	1154	19232	725	14627
20-#11	3.38	MA	12841	3341	18596	2816	21921	2358	23880	1969	26174	1345	32556	614	27053
9L-3S		MI	7199	3341	11741	2581	13589	2131	14846	1767	16708	1152	20133	785	14663
20-#11	3.38	MA	12531	3341	17957	2825	21117	2370	22859	1991	24786	1364	30616	554	26038
10L-2S		MI	7404	3341	12202	2572	14177	2123	15560	1751	17675	1141	21407	897	14678
20-#14	4.87	MA	14369	3735	21879	3069	25955	2549	28725	2110	32666	1351	41563	455	37946
8L-4S		MI	7770	3735	13069	2829	15172	2324	16739	1879	19241	1124	23329	538	20083
20-#14	4.87	MA	13930	3735	20877	3101	24731	2581	27256	2124	30682	1367	39028	378	36239
9L-3S		MI	7901	3735	13527	2816	15816	2299	17528	1873	20320	1124	24589	622	20505
22-#10	3.02	MA	13378	3248	19518	2721	23191	2278	25494	1907	28343	1309	35300	799	26870
7L-6S		MI	6768	3248	10583	2576	12144	2144	13102	1779	14351	1193	17371	703	13049
22-#10	3.02	MA	13091	3248	19014	2732	22508	2287	24626	1923	27234	1328	33826	758	26185
8L-5S		MI	6890	3248	10820	2569	12468	2128	13504	1773	14895	1182	18071	761	13228
22-#10	3.02	MA	12825	3248	18431	2750	21808	2305	23785	1931	26090	1338	32391	715	25516
9L-4S		MI	7012	3248	11093	2551	12797	2121	13912	1759	15462	1172	18833	814	13385
22-#10	3.02	MA	12572	3248	17907	2757	21149	2315	22947	1949	24945	1353	30804	667	24646
10L-3S		MI	7096	3248	11360	2543	13172	2105	14372	1754	16092	1169	19599	865	13406
22-#10	3.02	MA	12291	3248	17395	2766	20478	2324	22127	1959	23786	1361	29370	623	23833
11L-2S		MI	7271	3248	11745	2534	13662	2098	14967	1739	16897	1158	20686	956	13415
22-#11	3.71	MA	13657	3430	20318	2850	24071	2377	26480	1984	29688	1328	37267	660	31147
8L-5S		MI	7157	3430	11550	2667	13327	2197	14512	1813	16231	1160	19612	644	15667

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.71	MA	13343	3430	19615	2872	23218	2399	25455	1994	28306	1340	35507	607	30079
9L-4S		MI	7297	3430	11880	2647	13725	2189	15006	1797	16916	1149	20506	710	16008
22-#11	3.71	MA	13045	3430	18976	2881	22414	2411	24434	2016	26917	1359	33567	547	29064
10L-3S		MI	7394	3430	12202	2637	14177	2171	15560	1792	17675	1147	21407	770	16050
22-#11	3.71	MA	12710	3430	18353	2892	21605	2422	23434	2027	25504	1368	31814	490	27836
11L-2S		MI	7596	3430	12664	2627	14765	2164	16275	1776	18641	1136	22681	882	16071
22-#14	5.36	MA	14634	3864	22334	3182	26586	2639	29510	2160	33732	1360	43252	368	40539
9L-4S		MI	8046	3864	13723	2909	16005	2382	17751	1916	20611	1117	25103	512	21979
24-#10	3.30	MA	13498	3321	19852	2777	23575	2319	25922	1943	28988	1324	36255	752	28687
8L-6S		MI	6939	3321	10967	2622	12634	2177	13697	1799	15157	1189	18458	693	14181
24-#10	3.30	MA	13238	3321	19269	2795	22875	2338	25081	1952	27844	1333	34820	709	28008
9L-5S		MI	7058	3321	11205	2614	12958	2161	14099	1794	15700	1178	19158	752	14353
24-#10	3.30	MA	12994	3321	18745	2803	22216	2348	24243	1970	26699	1349	33233	662	27141
10L-4S		MI	7179	3321	11478	2597	13287	2154	14507	1780	16268	1167	19920	805	14538
24-#10	3.30	MA	12715	3321	18233	2812	21545	2357	23422	1980	25539	1357	31798	617	26322
11L-3S		MI	7262	3321	11745	2588	13662	2138	14967	1774	16897	1165	20686	856	14564
24-#10	3.30	MA	12438	3321	17733	2822	20832	2374	22602	1998	24411	1374	30345	581	25432
12L-2S		MI	7433	3321	12130	2579	14152	2131	15562	1760	17703	1154	21773	947	14577
24-#11	4.05	MA	13837	3519	20633	2927	24515	2439	27030	2020	30437	1335	38458	600	33106
9L-5S		MI	7355	3519	12012	2723	13915	2237	15227	1839	17197	1155	20886	629	17018
24-#11	4.05	MA	13560	3519	19994	2937	23711	2451	26009	2041	29049	1354	36519	540	32081
10L-4S		MI	7494	3519	12342	2703	14313	2230	15720	1823	17883	1143	21780	695	17384
24-#11	4.05	MA	13219	3519	19371	2947	22902	2462	25009	2053	27635	1363	34765	483	30858
11L-3S		MI	7589	3519	12664	2693	14765	2212	16275	1817	18641	1142	22681	755	17436

RECTANGULAR TIED COLUMNS 22" x 44"

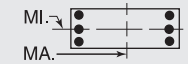
4-#18	1.65	MA	13942	3024	20306	2521	23882	2114	25957	1792	28382	1297	34477	1124	16798
2E		MI	6621	3024	10346	2350	11602	1968	12283	1665	13026	1195	14809	953	7713
6-#14	1.39	MA	13605	2953	19397	2492	22841	2095	24751	1783	26797	1310	32319	1138	14370
2L-3S		MI	6194	2953	9308	2349	10377	1972	10842	1689	11110	1233	12584	850	6731
6-#14	1.39	MA	12782	2953	17859	2515	20883	2117	22373	1803	23578	1342	27862	998	14343
3L-2S		MI	6521	2953	9963	2336	11211	1962	11854	1667	12480	1218	14358	1012	6688
6-#18	2.48	MA	15184	3252	23000	2664	27311	2218	30123	1857	34019	1283	42283	1106	24938
2L-3S		MI	6562	3252	10346	2512	11602	2085	12283	1762	13026	1202	14809	605	11179
6-#18	2.48	MA	13846	3252	20306	2703	23882	2255	25957	1890	28382	1338	34477	851	24689
3L-2S		MI	7091	3252	11470	2493	13032	2072	14021	1729	15377	1182	17740	893	11168
8-#10	1.05	MA	13109	2857	18151	2451	21395	2067	23066	1770	24575	1326	29287	1155	11006
2L-4S		MI	6053	2857	8758	2331	9762	1973	10148	1687	10208	1258	11639	928	5266
8-#10	1.05	MA	12622	2857	17268	2464	20271	2080	21700	1782	22727	1345	26727	1079	11010
3E		MI	6159	2857	9024	2322	10137	1958	10608	1682	10838	1256	12405	979	5241
8-#10	1.05	MA	12375	2857	16677	2478	19434	2102	20672	1803	21317	1356	25063	1030	10977
4L-2S		MI	6357	2857	9409	2313	10627	1950	11203	1668	11643	1245	13492	1071	5218
8-#11	1.29	MA	13466	2923	19011	2481	22408	2088	24255	1781	26150	1316	31442	1144	13370
2L-4S		MI	6123	2923	9009	2353	10004	1988	10408	1692	10532	1242	12002	864	6316
8-#11	1.29	MA	12888	2923	17937	2498	21041	2104	22594	1795	23902	1339	28329	1049	13364
3E		MI	6248	2923	9331	2343	10457	1970	10963	1686	11291	1240	12903	924	6287
8-#11	1.29	MA	12594	2923	17216	2514	20021	2130	21341	1820	22185	1351	26292	989	13293
4L-2S		MI	6481	2923	9793	2333	11045	1962	11677	1671	12258	1229	14177	1036	6259
8-#14	1.86	MA	14334	3081	20935	2572	24799	2153	27129	1819	30015	1302	36775	1127	19024
2L-4S		MI	6313	3081	9504	2443	10567	2055	11065	1732	11401	1225	13098	740	8734
8-#14	1.86	MA	13543	3081	19397	2595	22841	2175	24751	1840	26797	1334	32319	988	18967
3E		MI	6486	3081	9963	2430	11211	2030	11854	1725	12480	1225	14358	824	8736

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.86	MA	13142	3081	18363	2619	21378	2212	22955	1875	24335	1352	29387	901	18714
4L-2S		MI	6803	3081	10617	2416	12044	2021	12867	1704	13850	1210	16132	986	8706
8-#18	3.31	MA	15129	3481	23000	2846	27311	2358	30123	1955	34019	1324	42283	833	32760
3E		MI	7046	3481	11470	2655	13032	2189	14021	1827	15377	1189	17740	546	14542
8-#18	3.31	MA	14493	3481	21182	2886	24742	2422	26969	2015	29695	1352	37097	676	30583
4L-2S		MI	7553	3481	12594	2635	14463	2176	15758	1794	17729	1169	20671	833	14588
10-#10	1.31	MA	13543	2930	19034	2496	22520	2100	24432	1790	26424	1322	31847	1149	13683
2L-5S		MI	6107	2930	8870	2394	9923	2013	10335	1722	10446	1265	11964	866	6459
10-#10	1.31	MA	13068	2930	18151	2510	21395	2113	23066	1803	24575	1341	29287	1073	13676
3L-4S		MI	6232	2930	9142	2376	10252	2006	10743	1708	11014	1254	12726	919	6447
10-#10	1.31	MA	12831	2930	17560	2523	20559	2135	22038	1823	23166	1352	27623	1024	13631
4L-3S		MI	6335	2930	9409	2368	10627	1990	11203	1702	11643	1252	13492	970	6428
10-#10	1.31	MA	12465	2930	16939	2543	19835	2148	21136	1835	21907	1371	25916	989	13500
5L-2S		MI	6529	2930	9794	2359	11117	1983	11798	1688	12449	1241	14579	1061	6408
10-#11	1.61	MA	13982	3012	20085	2537	23776	2129	25916	1806	28398	1311	34554	1137	16623
2L-5S		MI	6191	3012	9141	2429	10195	2036	10629	1733	10814	1248	12382	784	7717
10-#11	1.61	MA	13421	3012	19011	2554	22408	2144	24255	1820	26150	1334	31442	1041	16601
3L-4S		MI	6334	3012	9471	2409	10592	2028	11122	1717	11499	1236	13276	849	7724
10-#11	1.61	MA	13141	3012	18290	2570	21388	2170	23002	1845	24433	1346	29404	982	16513
4L-3S		MI	6455	3012	9793	2399	11045	2010	11677	1712	12258	1235	14177	909	7706
10-#11	1.61	MA	12704	3012	17539	2595	20506	2185	21902	1859	22898	1369	27319	937	16279
5L-2S		MI	6682	3012	10255	2389	11633	2003	12391	1696	13224	1223	15451	1021	7683
10-#14	2.32	MA	14287	3209	20935	2676	24799	2233	27129	1876	30015	1327	36775	978	23588
3L-4S		MI	6608	3209	10159	2523	11400	2114	12078	1768	12771	1218	14872	715	10694
10-#14	2.32	MA	13912	3209	19901	2699	23336	2270	25333	1911	27553	1344	33844	891	23320
4L-3S		MI	6773	3209	10617	2510	12044	2089	12867	1762	13850	1218	16132	799	10724
10-#14	2.32	MA	13297	3209	18830	2735	22070	2292	23755	1931	25352	1376	30847	824	22089
5L-2S		MI	7081	3209	11272	2497	12878	2079	13879	1740	15220	1203	17905	961	10709
10-#18	4.13	MA	15802	3709	23876	3029	28172	2525	31134	2080	35333	1339	44903	658	38570
4L-3S		MI	7522	3709	12594	2798	14463	2293	15758	1892	17729	1176	20671	486	17893
10-#18	4.13	MA	14758	3709	22014	3093	25942	2562	28358	2114	31462	1393	39619	532	35560
5L-2S		MI	8010	3709	13717	2778	15894	2280	17496	1859	20080	1156	23602	774	17983
12-#10	1.57	MA	13971	3002	19917	2541	23645	2133	25798	1811	28273	1318	34406	1143	16356
2L-6S		MI	6151	3002	9016	2447	10088	2062	10528	1748	10708	1272	12351	798	7486
12-#10	1.57	MA	13507	3002	19034	2555	22520	2146	24432	1823	26424	1337	31847	1067	16340
3L-5S		MI	6285	3002	9254	2439	10413	2046	10930	1743	11251	1261	13051	857	7620
12-#10	1.57	MA	13280	3002	18443	2569	21683	2168	23404	1844	25014	1348	30183	1019	16284
4E		MI	6409	3002	9527	2422	10742	2039	11338	1728	11819	1250	13814	910	7620
12-#10	1.57	MA	12916	3002	17822	2589	20960	2181	22502	1856	23756	1367	28476	984	16147
5L-3S		MI	6509	3002	9794	2413	11117	2023	11798	1723	12449	1247	14579	961	7607
12-#10	1.57	MA	12599	3002	17234	2596	20249	2191	21617	1877	22524	1378	26809	920	15656
6L-2S		MI	6700	3002	10179	2404	11607	2016	12393	1709	13254	1237	15666	1052	7591
12-#11	1.93	MA	13944	3102	20085	2609	23776	2185	25916	1845	28398	1329	34554	1034	19836
3L-5S		MI	6401	3102	9603	2485	10783	2077	11343	1758	11780	1243	13656	769	9047
12-#11	1.93	MA	13678	3102	19364	2626	22756	2211	24664	1870	26681	1341	32517	974	19735
4E		MI	6543	3102	9933	2464	11180	2069	11836	1743	12465	1231	14550	834	9123
12-#11	1.93	MA	13244	3102	18613	2650	21873	2226	23563	1885	25146	1364	30431	930	19496
5L-3S		MI	6659	3102	10255	2455	11633	2051	12391	1737	13224	1230	15451	894	9116
12-#11	1.93	MA	12867	3102	17897	2659	21016	2239	22484	1909	23644	1376	28396	850	18621
6L-2S		MI	6882	3102	10716	2445	12221	2043	13105	1721	14191	1218	16725	1006	9099
12-#14	2.79	MA	14665	3338	21439	2779	25295	2328	27712	1948	30772	1337	38300	880	27930
4E		MI	6899	3338	10814	2603	12234	2172	13090	1805	14141	1210	16645	689	12649
12-#14	2.79	MA	14055	3338	20368	2815	24028	2350	26133	1968	28570	1369	35304	814	26672
5L-3S		MI	7056	3338	11272	2590	12878	2147	13879	1798	15220	1210	17905	773	12699
12-#14	2.79	MA	13536	3338	19341	2827	22807	2369	24585	2003	26416	1386	32380	697	25459
6L-2S		MI	7356	3338	11927	2577	13711	2137	14891	1777	16590	1195	19679	935	12701
12-#18	4.96	MA	16039	3937	24708	3236	29372	2666	32524	2178	37099	1380	47425	514	43576
5L-3S		MI	7991	3937	13717	2940	15894	2396	17496	1957	20080	1162	23602	427	21238

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

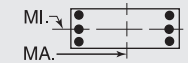
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	4.96	MA	15200	3937	22908	3255	27258	2700	29798	2238	33410	1434	42269	300	39810
6L-2S		MI	8453	3937	14841	2921	17324	2383	19233	1924	22432	1142	26534	714	21364
14-#10	1.84	MA	13939	3075	19917	2600	23645	2179	25798	1844	28273	1333	34406	1061	19002
3L-6S		MI	6329	3075	9401	2492	10578	2095	11123	1769	11513	1267	13439	789	8604
14-#10	1.84	MA	13722	3075	19326	2614	22808	2201	24770	1864	26863	1344	32742	1013	18937
4L-5S		MI	6461	3075	9639	2484	10903	2079	11525	1763	12056	1257	14138	848	8776
14-#10	1.84	MA	13360	3075	18705	2634	22084	2214	23868	1877	25604	1363	31035	978	18795
5L-4S		MI	6584	3075	9912	2467	11231	2072	11933	1749	12624	1246	14901	901	8787
14-#10	1.84	MA	13052	3075	18117	2641	21374	2224	22983	1897	24373	1373	29369	915	18286
6L-3S		MI	6681	3075	10179	2458	11607	2056	12393	1743	13254	1243	15666	952	8780
14-#10	1.84	MA	12791	3075	17562	2650	20591	2240	22100	1907	23183	1393	27782	883	17766
7L-2S		MI	6868	3075	10564	2449	12097	2049	12988	1729	14059	1232	16753	1043	8768
14-#11	2.26	MA	14206	3191	20438	2681	24124	2251	26325	1896	28929	1336	35630	967	22958
4L-5S		MI	6607	3191	10065	2540	11371	2117	12057	1784	12746	1238	14930	754	10375
14-#11	2.26	MA	13775	3191	19687	2706	23241	2266	25225	1910	27394	1359	33544	922	22690
5L-4S		MI	6749	3191	10394	2520	11768	2109	12550	1768	13432	1226	15824	819	10514
14-#11	2.26	MA	13409	3191	18971	2714	22383	2279	24145	1935	25892	1371	31508	843	21826
6L-3S		MI	6862	3191	10716	2510	12221	2091	13105	1762	14191	1225	16725	879	10520
14-#11	2.26	MA	13100	3191	18295	2725	21430	2299	23081	1947	24441	1394	29563	803	21191
7L-2S		MI	7080	3191	11178	2500	12809	2084	13819	1746	15157	1213	17999	992	10509
14-#14	3.25	MA	14796	3466	21905	2895	25986	2408	28511	2004	31789	1361	39760	803	31261
5L-4S		MI	7185	3466	11468	2684	13067	2230	14103	1841	15511	1203	18419	664	14548
14-#14	3.25	MA	14298	3466	20879	2907	24765	2427	26963	2039	29634	1378	36836	687	30055
6L-3S		MI	7336	3466	11927	2670	13711	2206	14891	1834	16590	1203	19679	748	14668
14-#14	3.25	MA	13875	3466	19909	2922	23398	2455	25448	2057	27551	1411	34034	629	28326
7L-2S		MI	7629	3466	12581	2657	14545	2196	15904	1813	17960	1188	21452	910	14687
14-#18	5.79	MA	16495	4166	25601	3398	30688	2804	33964	2303	39048	1421	50075	282	47779
6L-3S		MI	8479	4166	14841	3083	17324	2500	19233	2021	22432	1149	26534	367	24581
14-#18	5.79	MA	15819	4166	23897	3423	28288	2851	31345	2337	35282	1448	45107	176	43896
7L-2S		MI	8891	4166	15964	3064	18755	2487	20971	1988	24783	1129	29465	655	24737
16-#10	2.10	MA	14158	3147	20210	2659	23933	2234	26136	1885	28712	1339	35302	1007	21591
4L-6S		MI	6506	3147	9786	2537	11068	2128	11718	1789	12318	1263	14526	780	9727
16-#10	2.10	MA	13797	3147	19589	2679	23209	2247	25234	1897	27453	1358	33595	972	21445
5E		MI	6635	3147	10024	2530	11393	2112	12120	1784	12862	1252	15225	839	9930
16-#10	2.10	MA	13497	3147	19000	2686	22498	2257	24349	1918	26222	1369	31928	909	20919
6L-4S		MI	6758	3147	10297	2512	11721	2105	12528	1770	13429	1242	15988	892	9949
16-#10	2.10	MA	13245	3147	18445	2696	21716	2273	23466	1927	25031	1388	30342	877	20413
7L-3S		MI	6852	3147	10564	2503	12097	2089	12988	1764	14059	1239	16753	943	9950
16-#10	2.10	MA	12933	3147	17915	2706	20997	2282	22552	1944	23865	1408	28794	836	19777
8L-2S		MI	7036	3147	10948	2495	12587	2082	13583	1750	14864	1228	17840	1034	9941
16-#11	2.58	MA	14298	3280	20761	2762	24608	2307	26886	1935	29642	1353	36657	915	25875
5E		MI	6812	3280	10526	2596	11959	2158	12771	1809	13713	1232	16203	739	11710
16-#11	2.58	MA	13942	3280	20045	2770	23751	2320	25806	1960	28141	1366	34621	836	25034
6L-4S		MI	6953	3280	10856	2576	12356	2150	13264	1793	14398	1221	17097	804	11902
16-#11	2.58	MA	13644	3280	19369	2781	22798	2339	24742	1972	26689	1389	32676	796	24408
7L-3S		MI	7062	3280	11178	2566	12809	2132	13819	1787	15157	1220	17999	864	11918
16-#11	2.58	MA	13273	3280	18722	2793	21922	2350	23628	1992	25265	1411	30783	744	23333
8L-2S		MI	7276	3280	11640	2556	13396	2124	14533	1772	16123	1208	19272	977	11914
16-#14	3.72	MA	15044	3595	22417	2987	26723	2486	29341	2076	32853	1371	41293	676	34650
6L-4S		MI	7469	3595	12123	2764	13901	2289	15115	1877	16881	1195	20193	638	16418
16-#14	3.72	MA	14642	3595	21447	3002	25356	2513	27826	2094	30770	1403	38491	619	32899
7L-3S		MI	7613	3595	12581	2751	14545	2264	15904	1871	17960	1195	21452	722	16632
16-#14	3.72	MA	14119	3595	20519	3020	24100	2528	26229	2121	28727	1435	35770	541	31164
8L-2S		MI	7899	3595	13236	2738	15378	2254	16916	1849	19330	1180	23226	884	16663

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

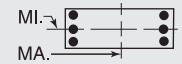


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	6.61	MA	17128	4394	26591	3566	31718	2955	35511	2401	40919	1435	52913	158	51829
7L-3S		MI	8931	4394	15964	3226	18755	2604	20971	2086	24783	1136	29465	307	27924
18-#10	2.36	MA	14229	3220	20472	2725	24334	2279	26600	1918	29301	1354	36154	966	24096
5L-6S		MI	6681	3220	10171	2583	11558	2161	12313	1810	13124	1259	15613	771	10852
18-#10	2.36	MA	13936	3220	19884	2732	23623	2290	25715	1938	28070	1365	34488	903	23555
6L-5S		MI	6807	3220	10409	2575	11882	2145	12715	1804	13667	1248	16312	830	11053
18-#10	2.36	MA	13692	3220	19329	2741	22840	2306	24832	1948	26880	1384	32902	871	23062
7L-4S		MI	6930	3220	10682	2558	12211	2138	13123	1790	14235	1237	17075	883	11108
18-#10	2.36	MA	13382	3220	18798	2751	22122	2315	23918	1964	25713	1403	31354	830	22415
8L-3S		MI	7021	3220	10948	2549	12587	2122	13583	1784	14864	1235	17840	934	11116
18-#10	2.36	MA	13076	3220	18182	2769	21385	2334	23033	1973	24500	1413	29849	788	21693
9L-2S		MI	7202	3220	11333	2540	13076	2115	14178	1770	15670	1224	18927	1025	11111
18-#11	2.90	MA	14467	3369	21119	2826	25118	2360	27467	1985	30389	1361	37734	829	28245
6L-5S		MI	7015	3369	10988	2652	12547	2198	13485	1834	14679	1227	17477	724	13049
18-#11	2.90	MA	14180	3369	20443	2837	24165	2380	26403	1997	28937	1384	35788	789	27618
7L-4S		MI	7155	3369	11318	2631	12944	2190	13979	1818	15365	1216	18371	789	13287
18-#11	2.90	MA	13811	3369	19796	2849	23289	2390	25289	2017	27513	1406	33896	737	26538
8L-3S		MI	7261	3369	11640	2622	13396	2172	14533	1813	16123	1214	19272	850	13311
18-#11	2.90	MA	13448	3369	19051	2871	22391	2413	24210	2027	26052	1418	32050	684	25501
9L-2S		MI	7471	3369	12102	2612	13984	2164	15247	1797	17090	1203	20546	962	13315
18-#14	4.18	MA	15393	3723	22985	3083	27314	2571	30205	2130	33988	1396	42947	608	37472
7L-4S		MI	7750	3723	12778	2844	14734	2347	16127	1914	18251	1188	21966	613	18297
18-#14	4.18	MA	14876	3723	22057	3100	26058	2587	28608	2158	31946	1428	40227	531	35718
8L-3S		MI	7888	3723	13236	2831	15378	2322	16916	1907	19330	1188	23226	697	18594
18-#14	4.18	MA	14392	3723	20995	3132	24769	2618	27060	2172	29857	1445	37568	455	33964
9L-2S		MI	8168	3723	13891	2818	16212	2312	17929	1886	20700	1173	25000	859	18636
20-#10	2.62	MA	14369	3292	20767	2777	24748	2323	27081	1959	29919	1361	37048	897	26193
6E		MI	6854	3292	10555	2628	12048	2194	12908	1830	13929	1255	16700	762	11980
20-#10	2.62	MA	14132	3292	20212	2786	23965	2339	26198	1968	28729	1380	35461	865	25712
7L-5S		MI	6978	3292	10793	2620	12372	2178	13310	1825	14472	1244	17399	821	12171
20-#10	2.62	MA	13825	3292	19681	2797	23246	2348	25284	1985	27562	1399	33913	824	25052
8L-4S		MI	7101	3292	11066	2603	12701	2171	13718	1811	15040	1233	18162	874	12265
20-#10	2.62	MA	13528	3292	19065	2814	22509	2367	24399	1994	26349	1408	32408	782	24333
9L-3S		MI	7189	3292	11333	2594	13076	2155	14178	1805	15670	1231	18927	925	12278
20-#10	2.62	MA	13257	3292	18512	2823	21816	2377	23517	2012	25144	1424	30741	735	23474
10L-2S		MI	7367	3292	11718	2585	13566	2148	14773	1791	16475	1220	20014	1016	12279
20-#11	3.22	MA	14707	3458	21517	2892	25533	2420	28064	2023	31185	1378	38901	782	30816
7L-5S		MI	7216	3458	11450	2707	13134	2238	14199	1859	15646	1222	18751	709	14393
20-#11	3.22	MA	14341	3458	20870	2905	24657	2431	26950	2042	29761	1401	37008	730	29742
8L-4S		MI	7356	3458	11780	2687	13532	2231	14693	1844	16331	1210	19645	774	14670
20-#11	3.22	MA	13998	3458	20125	2927	23758	2453	25871	2053	28300	1413	35163	677	28693
9L-3S		MI	7458	3458	12102	2677	13984	2213	15247	1838	17090	1209	20546	835	14701
20-#11	3.22	MA	13668	3458	19452	2936	22912	2466	24796	2074	26832	1432	33124	618	27602
10L-2S		MI	7665	3458	12563	2667	14572	2205	15961	1822	18056	1198	21820	947	14713
20-#14	4.65	MA	15619	3852	23595	3181	28016	2645	30986	2194	35164	1420	44683	521	40272
8L-4S		MI	8028	3852	13432	2924	15568	2405	17140	1950	19621	1181	23740	587	20184
20-#14	4.65	MA	15153	3852	22533	3212	26727	2677	29438	2209	33076	1437	42024	444	38526
9L-3S		MI	8161	3852	13891	2911	16212	2381	17929	1944	20700	1180	25000	671	20553
22-#10	2.89	MA	14568	3365	21095	2832	25090	2372	27564	1989	30577	1376	38021	860	28364
7L-6S		MI	7026	3365	10940	2673	12538	2227	13503	1851	14734	1251	17787	753	13110
22-#10	2.89	MA	14262	3365	20564	2842	24371	2381	26650	2005	29411	1395	36473	819	27689
8L-5S		MI	7148	3365	11178	2666	12862	2211	13905	1845	15277	1240	18486	812	13293
22-#10	2.89	MA	13979	3365	19948	2860	23634	2400	25765	2014	28197	1404	34968	776	26972
9L-4S		MI	7270	3365	11451	2648	13191	2204	14313	1831	15845	1229	19249	864	13420
22-#10	2.89	MA	13710	3365	19396	2868	22940	2410	24883	2032	26993	1420	33301	730	26105
10L-3S		MI	7356	3365	11718	2639	13566	2188	14773	1826	16475	1226	20014	915	13438
22-#10	2.89	MA	13411	3365	18858	2877	22230	2419	24020	2043	25772	1428	31794	686	25303
11L-2S		MI	7531	3365	12103	2631	14056	2181	15369	1812	17280	1216	21101	1007	13445

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.55	MA	14864	3547	21944	2960	26025	2471	28611	2067	32010	1396	40121	723	32946
8L-5S		MI	7415	3547	11912	2763	13722	2279	14913	1885	16612	1217	20025	694	15741
22-#11	3.55	MA	14530	3547	21199	2982	25126	2494	27533	2078	30548	1408	38275	670	31886
9L-4S		MI	7555	3547	12242	2743	14120	2271	15407	1869	17298	1205	20919	760	16052
22-#11	3.55	MA	14213	3547	20526	2992	24280	2506	26457	2100	29080	1427	36237	611	30798
10L-3S		MI	7654	3547	12563	2733	14572	2253	15961	1863	18056	1204	21820	820	16089
22-#11	3.55	MA	13856	3547	19870	3003	23422	2517	25404	2112	27592	1436	34395	556	29554
11L-2S		MI	7857	3547	13025	2723	15160	2245	16676	1847	19023	1192	23094	932	16107
22-#14	5.11	MA	15899	3980	24070	3293	28685	2735	31817	2245	36294	1430	46481	434	43089
9L-4S		MI	8305	3980	14087	3005	16401	2464	18152	1987	20992	1173	25513	562	22078
24-#10	3.15	MA	14694	3437	21448	2887	25496	2414	28016	2026	31259	1391	39033	813	30326
8L-6S		MI	7196	3437	11325	2719	13028	2260	14098	1871	15540	1246	18874	744	14241
24-#10	3.15	MA	14418	3437	20831	2905	24758	2432	27131	2035	30046	1400	37528	770	29612
9L-5S		MI	7316	3437	11563	2711	13352	2244	14500	1866	16083	1236	19573	802	14417
24-#10	3.15	MA	14158	3437	20279	2913	24065	2443	26249	2053	28841	1416	35860	724	28736
10L-4S		MI	7438	3437	11836	2694	13681	2237	14908	1852	16651	1225	20336	855	14574
24-#10	3.15	MA	13861	3437	19741	2922	23354	2452	25386	2063	27621	1424	34354	680	27926
11L-3S		MI	7521	3437	12103	2685	14056	2221	15369	1846	17280	1222	21101	906	14597
24-#10	3.15	MA	13567	3437	19215	2932	22604	2469	24523	2082	26434	1441	32830	644	26967
12L-2S		MI	7694	3437	12487	2676	14546	2214	15964	1832	18085	1211	22188	998	14607
24-#11	3.87	MA	15054	3636	22273	3038	26493	2534	29194	2103	32796	1403	41388	663	35078
9L-5S		MI	7613	3636	12373	2819	14310	2319	15627	1910	17579	1212	21299	679	17091
24-#11	3.87	MA	14750	3636	21600	3047	25647	2547	28118	2125	31328	1422	39350	604	33995
10L-4S		MI	7753	3636	12703	2798	14708	2312	16121	1894	18264	1200	22193	745	17433
24-#11	3.87	MA	14396	3636	20944	3058	24790	2558	27065	2137	29840	1431	37507	549	32742
11L-3S		MI	7849	3636	13025	2789	15160	2294	16676	1888	19023	1199	23094	805	17476

RECTANGULAR TIED COLUMNS 24" x 24"

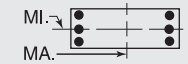
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#9	1.04	MA	4149	1699	6060	1394	6904	1175	7311	1005	7636	751	8957	654	3393
2L-3S		MI	3970	1699	5719	1401	6469	1182	6784	1011	6922	762	7968	583	3410
6-#10	1.32	MA	4268	1745	6344	1418	7250	1193	7724	1015	8188	746	9713	648	4230
2L-3S		MI	4046	1745	5914	1428	6702	1201	7059	1030	7288	759	8468	557	4247
6-#11	1.63	MA	4374	1795	6653	1438	7600	1205	8128	1021	8719	737	10343	628	5083
2L-3S		MI	4115	1795	6136	1449	6941	1214	7328	1038	7636	750	8876	516	5100
6-#14	2.34	MA	4649	1913	7339	1503	8442	1252	9136	1048	10072	725	12070	599	7114
2L-3S		MI	4295	1913	6604	1518	7506	1264	8000	1072	8534	743	10018	437	7102
6-#18	4.17	MA	5289	2213	8996	1674	10493	1373	11598	1120	13381	697	16126	508	12028
2L-3S		MI	4728	2213	7730	1697	8880	1391	9640	1158	10731	723	12704	220	11822
8-#8	1.10	MA	4180	1708	6106	1403	6976	1183	7407	1011	7771	753	9148	655	3569
2L-4S		MI	3964	1708	5648	1416	6368	1199	6665	1025	6762	764	7815	567	3592
8-#9	1.39	MA	4305	1756	6401	1429	7338	1201	7839	1021	8350	748	9946	650	4441
2L-4S		MI	4038	1756	5825	1445	6573	1221	6906	1039	7081	762	8267	537	4457
8-#10	1.76	MA	4460	1818	6774	1464	7797	1225	8389	1036	9088	742	10959	642	5545
2L-4S		MI	4133	1818	6048	1483	6832	1250	7212	1058	7487	758	8841	498	5533
8-#11	2.17	MA	4601	1884	7171	1493	8259	1246	8928	1046	9802	731	11810	617	6662
2L-4S		MI	4217	1884	6295	1515	7096	1274	7510	1070	7873	748	9311	442	6611
8-#14	3.13	MA	4961	2041	8074	1583	9378	1310	10273	1084	11610	717	14121	580	9343
2L-4S		MI	4443	2041	6828	1613	7724	1349	8256	1117	8867	738	10622	330	8770
8-#18	5.56	MA	5799	2441	10263	1816	12105	1477	13556	1185	16032	684	19547	461	15834
2L-4S		MI	4990	2441	8109	1862	9246	1538	10071	1234	11293	710	13694	25	13567
10-#10	2.20	MA	4650	1890	7204	1509	8345	1258	9054	1056	9988	738	12204	636	6853
2L-5S		MI	4189	1890	6175	1546	7015	1292	7423	1094	7756	766	9213	439	6544

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

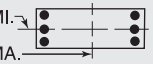
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.20	MA	4442	1890	6774	1519	7797	1267	8389	1072	9088	750	10959	545	6851
3L-4S		MI	4335	1890	6478	1528	7380	1283	7877	1078	8387	754	10087	492	6818
10-#11	2.71	MA	4823	1973	7688	1549	8918	1286	9729	1071	10885	726	13278	607	8233
2L-5S		MI	4288	1973	6446	1592	7313	1324	7761	1113	8193	757	9749	367	7665
10-#11	2.71	MA	4582	1973	7171	1560	8259	1295	8928	1089	9802	740	11810	494	8219
3L-4S		MI	4456	1973	6812	1571	7754	1315	8310	1096	8956	743	10778	431	8150
10-#14	3.91	MA	5267	2170	8809	1664	10314	1368	11409	1121	13148	710	16173	561	11559
2L-5S		MI	4544	2170	7040	1723	8029	1419	8609	1178	9317	749	11234	217	10281
10-#14	3.91	MA	4944	2170	8074	1679	9378	1380	10273	1145	11610	728	14121	399	11494
3L-4S		MI	4777	2170	7563	1693	8659	1407	9392	1154	10405	731	12673	311	10870
10-#18	6.94	MA	5845	2669	10263	1982	12105	1598	13556	1288	16032	697	19547	127	19038
3L-4S		MI	5554	2669	9375	2005	10859	1642	12029	1299	13944	697	17115	-22	17071

RECTANGULAR TIED COLUMNS 24" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.00	MA	4842	1833	7074	1501	8038	1267	8495	1084	8840	812	10340	707	3827
2E		MI	4450	1833	6561	1488	7410	1255	7805	1074	8092	804	9371	693	3514
4-#14	1.44	MA	5054	1912	7595	1542	8668	1295	9244	1100	9840	803	11652	691	5355
2E		MI	4638	1912	7032	1528	7976	1283	8477	1090	8988	794	10511	672	4898
4-#18	2.56	MA	5551	2112	8855	1650	10205	1372	11079	1144	12298	781	14763	638	9065
2E		MI	5075	2112	8163	1635	9352	1358	10117	1133	11184	772	13193	608	8242
6-#10	1.22	MA	4979	1872	7301	1538	8375	1294	8928	1104	9444	817	11190	710	4641
2L-3S		MI	4352	1872	6335	1535	7169	1292	7536	1110	7745	822	8966	612	4272
6-#10	1.22	MA	4731	1872	6825	1548	7770	1303	8193	1112	8449	830	9812	621	4659
3L-2S		MI	4575	1872	6765	1525	7717	1284	8201	1095	8645	810	10212	703	4252
6-#11	1.50	MA	5102	1922	7647	1557	8768	1307	9382	1109	10040	807	12001	700	5588
2L-3S		MI	4421	1922	6561	1555	7410	1305	7805	1117	8092	813	9371	571	5131
6-#11	1.50	MA	4810	1922	7074	1569	8038	1317	8495	1128	8840	822	10340	588	5606
3L-2S		MI	4682	1922	7078	1544	8069	1296	8606	1099	9175	799	10838	683	5110
6-#14	2.16	MA	5413	2040	8411	1622	9706	1353	10505	1137	11547	795	13983	677	7843
2L-3S		MI	4601	2040	7032	1623	7976	1353	8477	1150	8988	805	10511	492	7147
6-#14	2.16	MA	5015	2040	7595	1639	8668	1367	9244	1162	9840	816	11652	515	7831
3L-2S		MI	4957	2040	7767	1608	8912	1341	9614	1126	10527	787	12563	653	7148
6-#18	3.85	MA	6141	2340	10264	1793	11999	1475	13258	1209	15247	768	18678	602	13324
2L-3S		MI	5033	2340	8163	1800	9352	1479	10117	1235	11184	785	13193	274	11906
6-#18	3.85	MA	5507	2340	8855	1819	10205	1496	11079	1251	12298	799	14763	315	13118
3L-2S		MI	5600	2340	9429	1777	10964	1462	12075	1197	13834	759	16614	561	12076
8-#8	1.01	MA	4880	1835	7035	1522	8071	1284	8574	1099	8979	824	10556	717	3910
2L-4S		MI	4269	1835	6066	1523	6835	1291	7142	1105	7220	828	8316	623	3614
8-#8	1.01	MA	4721	1835	6736	1529	7689	1290	8111	1105	8352	833	9688	663	3922
3E		MI	4344	1835	6253	1517	7097	1280	7464	1095	7661	825	8862	656	3601
8-#8	1.01	MA	4638	1835	6531	1536	7401	1302	7757	1115	7867	836	9092	631	3934
4L-2S		MI	4487	1835	6524	1511	7443	1274	7884	1091	8229	817	9648	711	3588
8-#9	1.28	MA	5020	1883	7362	1549	8471	1303	9053	1110	9621	819	11440	712	4873
2L-4S		MI	4344	1883	6245	1552	7040	1313	7383	1119	7538	825	8767	592	4485
8-#9	1.28	MA	4825	1883	6986	1557	7992	1310	8470	1117	8832	830	10347	642	4885
3E		MI	4436	1883	6480	1544	7370	1299	7789	1107	8093	822	9456	634	4476
8-#9	1.28	MA	4722	1883	6728	1565	7628	1324	8024	1129	8221	834	9595	601	4889
4L-2S		MI	4612	1883	6821	1536	7805	1293	8316	1101	8808	812	10445	705	4463
8-#10	1.63	MA	5196	1945	7776	1583	8981	1327	9663	1124	10439	813	12568	704	6093
2L-4S		MI	4438	1945	6469	1590	7299	1342	7689	1137	7944	822	9339	553	5571
8-#10	1.63	MA	4955	1945	7301	1593	8375	1336	8928	1132	9444	826	11190	616	6102
3E		MI	4552	1945	6765	1580	7717	1325	8201	1130	8645	818	10212	606	5581
8-#10	1.63	MA	4829	1945	6975	1604	7916	1354	8364	1148	8673	831	10237	563	6081
4L-2S		MI	4768	1945	7195	1570	8264	1317	8866	1115	9545	805	11457	698	5569
8-#11	2.00	MA	5357	2011	8220	1613	9498	1347	10268	1135	11239	802	13661	693	7336
2L-4S		MI	4522	2011	6720	1621	7564	1364	7987	1149	8329	811	9806	497	6663
8-#11	2.00	MA	5075	2011	7647	1625	8768	1358	9382	1153	10040	817	12001	581	7337
3E		MI	4657	2011	7078	1610	8069	1345	8606	1142	9175	808	10838	560	6700

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



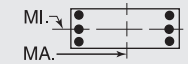
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	2.00	MA	4927	2011	7252	1637	8212	1378	8700	1162	9106	822	10838	516	7285
4L-2S		MI	4909	2011	7596	1599	8727	1336	9406	1125	10258	794	12306	672	6692
8-#14	2.88	MA	5765	2169	9226	1703	10744	1412	11765	1173	13253	788	16314	664	10315
2L-4S		MI	4747	2169	7256	1718	8193	1439	8733	1195	9321	801	11115	384	8932
8-#14	2.88	MA	5384	2169	8411	1719	9706	1426	10505	1199	11547	808	13983	502	10272
3E		MI	4929	2169	7767	1703	8912	1412	9614	1186	10527	797	12563	473	9349
8-#14	2.88	MA	5183	2169	7847	1736	8913	1454	9532	1210	10215	814	12347	410	9813
4L-2S		MI	5271	2169	8502	1689	9848	1400	10750	1162	12065	779	14614	635	9380
8-#18	5.13	MA	6720	2568	11673	1936	13793	1579	15437	1274	18196	755	22593	567	17562
2L-4S		MI	5292	2568	8542	1966	9718	1627	10548	1311	11746	771	14183	79	13774
8-#18	5.13	MA	6125	2568	10264	1962	11999	1600	13258	1316	15247	786	18678	279	17301
3E		MI	5581	2568	9429	1943	10964	1583	12075	1300	13834	772	16614	227	15659
8-#18	5.13	MA	5807	2568	9283	1988	10620	1647	11567	1331	12935	791	15912	123	15213
4L-2S		MI	6116	2568	10696	1920	12576	1566	14033	1262	16484	745	20035	515	15886
10-#10	2.04	MA	5409	2017	8252	1628	9586	1360	10398	1145	11434	808	13945	699	7539
2L-5S		MI	4495	2017	6596	1653	7482	1383	7901	1173	8214	830	9711	495	6644
10-#10	2.04	MA	5175	2017	7776	1639	8981	1369	9663	1153	10439	822	12568	610	7537
3L-4S		MI	4640	2017	6899	1635	7847	1374	8354	1158	8844	817	10585	547	6859
10-#10	2.04	MA	5056	2017	7450	1649	8521	1387	9100	1169	9668	827	11615	557	7503
4L-3S		MI	4749	2017	7195	1625	8264	1358	8866	1151	9545	813	11457	600	6883
10-#10	2.04	MA	4889	2017	7118	1668	8120	1396	8601	1177	8974	841	10657	508	7258
5L-2S		MI	4959	2017	7625	1616	8812	1350	9531	1136	10445	801	12702	692	6879
10-#11	2.50	MA	5607	2100	8793	1668	10227	1388	11154	1160	12439	797	15322	686	9075
2L-5S		MI	4593	2100	6871	1698	7781	1414	8239	1192	8649	819	10244	422	7780
10-#11	2.50	MA	5335	2100	8220	1680	9498	1398	10268	1179	11239	812	13661	574	9061
3L-4S		MI	4762	2100	7237	1677	8223	1405	8787	1174	9412	806	11274	486	8205
10-#11	2.50	MA	5195	2100	7825	1692	8942	1419	9586	1187	10306	817	12499	508	8992
4L-3S		MI	4889	2100	7596	1666	8727	1385	9406	1167	10258	802	12306	549	8258
10-#11	2.50	MA	5001	2100	7422	1715	8456	1429	8982	1206	9465	832	11334	444	8513
5L-2S		MI	5133	2100	8113	1655	9386	1376	10206	1150	11341	789	13773	662	8265
10-#14	3.61	MA	6110	2297	10041	1783	11782	1470	13026	1209	14959	780	18646	650	12774
2L-5S		MI	4849	2297	7467	1829	8499	1509	9087	1256	9772	811	11727	271	10423
10-#14	3.61	MA	5745	2297	9226	1799	10744	1484	11765	1235	13253	801	16314	489	12709
3L-4S		MI	5082	2297	7991	1799	9129	1497	9869	1232	10859	793	13166	365	11026
10-#14	3.61	MA	5559	2297	8662	1816	9951	1512	10793	1246	11922	806	14678	396	12150
4L-3S		MI	5251	2297	8502	1784	9848	1470	10750	1223	12065	790	14614	454	11547
10-#14	3.61	MA	5290	2297	8086	1847	9257	1526	9930	1272	10722	827	13042	303	11440
5L-2S		MI	5579	2297	9237	1769	10783	1458	11887	1199	13603	772	16666	616	11600
10-#18	6.41	MA	6728	2797	11673	2104	13793	1703	15437	1380	18196	773	22593	244	21491
3L-4S		MI	5856	2797	9808	2109	11330	1730	12506	1376	14396	758	17604	32	17429
10-#18	6.41	MA	6442	2797	10692	2130	12414	1751	13746	1396	15884	777	19827	88	19307
4L-3S		MI	6153	2797	10696	2086	12576	1687	14033	1365	16484	758	20035	181	19300
12-#10	2.44	MA	5619	2090	8727	1674	10191	1393	11134	1166	12429	804	15323	693	8980
2L-6S		MI	4549	2090	6755	1706	7670	1432	8120	1200	8511	838	10158	428	7642
12-#10	2.44	MA	5392	2090	8252	1684	9586	1402	10398	1173	11434	818	13945	604	8968
3L-5S		MI	4694	2090	7026	1699	8030	1416	8566	1194	9114	825	10957	489	7888
12-#10	2.44	MA	5278	2090	7926	1694	9126	1420	9835	1190	10663	823	12992	552	8924
4E		MI	4839	2090	7329	1680	8395	1407	9019	1178	9745	813	11830	541	8145
12-#10	2.44	MA	5113	2090	7593	1713	8726	1429	9336	1197	9969	836	12034	502	8639
5L-3S		MI	4943	2090	7625	1671	8812	1391	9531	1172	10445	809	12702	594	8179
12-#10	2.44	MA	4952	2090	7288	1720	8330	1446	8846	1213	9306	850	11163	442	8350
6L-2S		MI	5147	2090	8056	1661	9360	1383	10196	1156	11345	797	13947	686	8185
12-#11	3.00	MA	5855	2189	9366	1724	10957	1428	12041	1185	13638	792	16983	679	10807
2L-6S		MI	4658	2189	7067	1763	8004	1474	8499	1224	9002	828	10768	338	8949

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

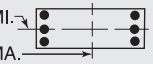


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	3.00	MA	5591	2189	8793	1736	10227	1439	11154	1204	12439	807	15322	567	10782
3L-5S		MI	4829	2189	7388	1754	8440	1454	9039	1217	9732	814	11711	411	9279
12-#11	3.00	MA	5459	2189	8398	1748	9671	1459	10472	1212	11505	812	14160	501	10699
4E		MI	4997	2189	7755	1733	8882	1445	9588	1200	10494	801	12741	476	9745
12-#11	3.00	MA	5266	2189	7995	1770	9185	1469	9868	1231	10665	827	12995	437	10180
5L-3S		MI	5117	2189	8113	1722	9386	1426	10206	1193	11341	797	13773	539	9813
12-#11	3.00	MA	5076	2189	7633	1779	8706	1490	9274	1239	9861	842	11931	362	9812
6L-2S		MI	5354	2189	8631	1711	10045	1417	11006	1175	12424	784	15240	651	9832
12-#14	4.33	MA	6100	2426	10041	1880	11782	1542	13026	1272	14959	793	18646	475	15145
3L-5S		MI	5179	2426	8202	1909	9434	1567	10223	1292	11310	804	13778	252	12567
12-#14	4.33	MA	5927	2426	9478	1896	10989	1571	12054	1283	13628	799	17009	383	14501
4E		MI	5410	2426	8726	1879	10065	1555	11006	1268	12398	786	15218	346	13134
12-#14	4.33	MA	5660	2426	8901	1927	10295	1585	11191	1309	12428	820	15373	290	13830
5L-3S		MI	5568	2426	9237	1864	10783	1528	11887	1259	13603	783	16666	435	13741
12-#18	7.69	MA	7062	3025	12101	2273	14208	1854	15925	1460	18833	764	23742	52	23420
4E		MI	6467	3025	11075	2252	12942	1834	14465	1441	17046	745	21025	-14	20988
14-#10	2.85	MA	5606	2162	8727	1729	10191	1435	11134	1194	12429	814	15323	598	10397
3L-6S		MI	4750	2162	7185	1751	8218	1465	8785	1221	9411	834	11404	422	8903
14-#10	2.85	MA	5498	2162	8401	1740	9732	1453	10570	1210	11657	819	14370	546	10345
4L-5S		MI	4891	2162	7456	1744	8577	1449	9231	1214	10014	821	12202	483	9137
14-#10	2.85	MA	5333	2162	8069	1759	9331	1462	10071	1218	10964	832	13412	496	10024
5L-4S		MI	5035	2162	7759	1726	8942	1440	9684	1199	10645	809	13075	535	9430
14-#10	2.85	MA	5177	2162	7764	1765	8936	1479	9581	1234	10301	846	12541	436	9748
6L-3S		MI	5134	2162	8056	1716	9360	1424	10196	1192	11345	805	13947	588	9472
14-#10	2.85	MA	5044	2162	7459	1771	8548	1487	9110	1242	9624	851	11557	383	9341
7L-2S		MI	5333	2162	8486	1706	9907	1415	10861	1177	12246	793	15193	680	9486
14-#11	3.50	MA	5843	2278	9366	1792	10957	1479	12041	1229	13638	802	16983	560	12500
3L-6S		MI	4896	2278	7585	1819	8663	1514	9299	1250	10085	823	12235	328	10431
14-#11	3.50	MA	5718	2278	8971	1804	10401	1500	11359	1238	12705	807	15820	494	12392
4L-5S		MI	5061	2278	7906	1810	9099	1495	9839	1242	10814	809	13179	400	10784
14-#11	3.50	MA	5526	2278	8568	1826	9915	1510	10754	1256	11864	822	14656	430	11854
5L-4S		MI	5228	2278	8272	1788	9541	1486	10388	1225	11577	795	14208	465	11240
14-#11	3.50	MA	5343	2278	8206	1835	9436	1530	10160	1265	11061	837	13592	355	11466
6L-3S		MI	5342	2278	8631	1777	10045	1466	11006	1218	12424	792	15240	528	11364
14-#14	5.05	MA	6289	2554	10293	1976	12027	1629	13314	1319	15334	792	19340	369	16864
4L-5S		MI	5502	2554	8937	1989	10370	1626	11360	1329	12848	796	15830	233	14719
14-#14	5.05	MA	6023	2554	9717	2008	11333	1643	12452	1345	14134	812	17705	276	16227
5L-4S		MI	5732	2554	9461	1959	11000	1614	12142	1305	13936	778	17270	328	15254
16-#10	3.26	MA	5714	2235	8877	1785	10337	1486	11305	1231	12652	815	15748	540	11765
4L-6S		MI	4948	2235	7615	1796	8765	1498	9450	1241	10311	829	12649	416	10168
16-#10	3.26	MA	5550	2235	8544	1804	9936	1495	10807	1238	11959	828	14790	491	11415
5E		MI	5085	2235	7887	1789	9125	1482	9896	1235	10914	817	13447	477	10391
16-#10	3.26	MA	5398	2235	8239	1811	9541	1512	10316	1255	11296	842	13918	430	11150
6L-4S		MI	5229	2235	8189	1771	9490	1473	10350	1219	11545	805	14321	529	10714
16-#10	3.26	MA	5270	2235	7935	1817	9153	1520	9845	1262	10619	847	12935	377	10731
7L-3S		MI	5323	2235	8486	1761	9907	1457	10861	1213	12246	801	15193	582	10764
16-#11	4.00	MA	5974	2367	9545	1859	11131	1540	12245	1263	13904	801	17481	487	14048
4L-6S		MI	5130	2367	8102	1875	9322	1555	10099	1275	11168	817	13702	317	11919
16-#11	4.00	MA	5783	2367	9141	1882	10645	1550	11641	1282	13064	817	16317	423	13533
5E		MI	5291	2367	8423	1865	9758	1535	10639	1268	11897	804	14646	390	12295
16-#11	4.00	MA	5605	2367	8779	1890	10165	1571	11046	1290	12260	832	15252	348	13126
6L-4S		MI	5456	2367	8790	1844	10200	1526	11188	1250	12660	790	15675	454	12728
16-#14	5.77	MA	6380	2683	10532	2088	12371	1701	13712	1381	15840	805	20036	263	18630
5E		MI	5821	2683	9672	2069	11306	1684	12496	1365	14386	789	17882	215	16877
18-#10	3.66	MA	5764	2307	9019	1849	10541	1528	11542	1259	12954	824	16167	485	12809
5L-6S		MI	5144	2307	8045	1842	9313	1531	10115	1262	11211	825	13894	410	11434
18-#10	3.66	MA	5617	2307	8715	1856	10146	1545	11052	1275	12291	837	15296	425	12555
6L-5S		MI	5277	2307	8317	1835	9673	1514	10561	1255	11814	813	14692	471	11649

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	3.66	MA	5493	2307	8410	1862	9758	1553	10580	1283	11614	842	14313	371	12123
7L-4S		MI	5420	2307	8619	1816	10037	1506	11015	1240	12445	801	15566	523	11998
18-#11	4.50	MA	6036	2456	9714	1937	11374	1591	12527	1307	14263	811	17977	416	15216
5L-6S		MI	5361	2456	8620	1930	9981	1595	10899	1300	12251	812	15170	307	13413
18-#11	4.50	MA	5864	2456	9352	1946	10895	1611	11933	1315	13460	827	16913	341	14791
6L-5S		MI	5517	2456	8941	1921	10417	1576	11439	1293	12980	799	16113	379	13810
20-#10	4.07	MA	5832	2380	9190	1901	10752	1578	11787	1296	13286	833	16674	419	13961
6E		MI	5337	2380	8475	1887	9860	1564	10780	1283	12111	821	15139	404	12704
20-#10	4.07	MA	5713	2380	8886	1907	10364	1586	11315	1303	12609	838	15690	366	13519
7L-5S		MI	5467	2380	8747	1880	10220	1547	11226	1276	12714	809	15938	465	12910
20-#11	5.00	MA	6119	2546	9925	2002	11625	1652	12819	1340	14659	822	18574	334	16460
6E		MI	5589	2546	9137	1986	10640	1636	11699	1325	13334	807	16637	296	14912

RECTANGULAR TIED COLUMNS 24" x 28"

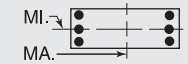
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.34	MA	5829	2039	8646	1661	9903	1397	10567	1189	11226	873	13344	759	5841
2E		MI	4945	2039	7460	1633	8446	1373	8954	1168	9443	857	11004	727	4927
4-#18	2.38	MA	6388	2239	10039	1770	11603	1473	12596	1233	13944	852	16916	718	9929
2E		MI	5384	2239	8596	1738	9823	1447	10594	1210	11636	833	13681	662	8283
6-#10	1.13	MA	5742	2000	8317	1657	9574	1396	10211	1193	10779	888	12753	772	5053
2L-3S		MI	4658	2000	6756	1642	7637	1383	8013	1189	8202	885	9464	668	4295
6-#10	1.13	MA	5467	2000	7797	1668	8911	1406	9406	1201	9690	902	11244	686	5070
3L-2S		MI	4881	2000	7186	1632	8184	1375	8678	1174	9102	873	10710	759	4274
6-#11	1.39	MA	5881	2049	8700	1676	10009	1409	10714	1198	11439	878	13650	762	6094
2L-3S		MI	4726	2049	6986	1660	7878	1395	8283	1196	8548	875	9866	626	5160
6-#11	1.39	MA	5556	2049	8071	1689	9209	1420	9741	1208	10123	894	11828	653	6111
3L-2S		MI	4989	2049	7503	1649	8537	1386	9083	1178	9631	862	11333	738	5137
6-#14	2.01	MA	6230	2168	9542	1742	11044	1455	11952	1225	13100	866	15939	748	8572
2L-3S		MI	4906	2168	7460	1728	8446	1443	8954	1228	9443	867	11004	546	7190
6-#14	2.01	MA	5786	2168	8646	1759	9903	1470	10567	1238	11226	889	13344	588	8560
3L-2S		MI	5266	2168	8195	1713	9381	1431	10091	1204	10981	849	13056	708	7180
6-#18	3.57	MA	7048	2467	11591	1912	13579	1577	14996	1298	17192	839	21327	692	14620
2L-3S		MI	5337	2467	8596	1904	9823	1568	10594	1312	11636	846	13681	328	11985
6-#18	3.57	MA	6339	2467	10039	1941	11603	1601	12596	1343	13944	874	16916	404	14414
3L-2S		MI	5911	2467	9862	1881	11435	1551	12552	1275	14287	820	17103	615	12124
8-#9	1.19	MA	5787	2011	8384	1668	9678	1405	10346	1199	10970	889	13023	774	5305
2L-4S		MI	4649	2011	6665	1659	7506	1404	7860	1199	7996	889	9266	648	4511
8-#9	1.19	MA	5570	2011	7971	1677	9153	1413	9708	1206	10107	901	11827	706	5317
3E		MI	4742	2011	6899	1652	7837	1391	8266	1186	8551	885	9955	690	4498
8-#9	1.19	MA	5457	2011	7690	1686	8756	1427	9221	1219	9440	906	11012	666	5321
4L-2S		MI	4919	2011	7240	1644	8272	1384	8794	1181	9265	875	10944	761	4484
8-#10	1.51	MA	5983	2072	8838	1702	10237	1429	11016	1213	11869	883	14262	766	6642
2L-4S		MI	4743	2072	6890	1697	7767	1433	8167	1217	8402	885	9838	609	5606
8-#10	1.51	MA	5716	2072	8317	1713	9574	1439	10211	1222	10779	898	12753	680	6651
3E		MI	4858	2072	7186	1687	8184	1416	8678	1210	9102	881	10710	662	5608
8-#10	1.51	MA	5577	2072	7962	1724	9073	1457	9596	1239	9937	904	11720	628	6630
4L-2S		MI	5076	2072	7617	1677	8732	1408	9343	1195	10002	869	11955	753	5593
8-#11	1.86	MA	6165	2138	9329	1732	10810	1449	11686	1223	12755	873	15473	755	8009
2L-4S		MI	4827	2138	7145	1727	8033	1455	8465	1228	8784	874	10301	552	6711
8-#11	1.86	MA	5851	2138	8700	1745	10009	1460	10714	1233	11439	889	13650	646	8011
3E		MI	4963	2138	7503	1716	8537	1435	9083	1221	9631	870	11333	615	6734
8-#11	1.86	MA	5687	2138	8269	1758	9402	1482	9968	1253	10418	895	12390	582	7959
4L-2S		MI	5217	2138	8021	1705	9196	1426	9883	1203	10714	857	12801	727	6721

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

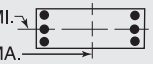


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.68	MA	6622	2296	10437	1822	12184	1514	13336	1262	14974	858	18534	738	11287
2L-4S		MI	5051	2296	7684	1824	8663	1528	9210	1274	9776	863	11608	439	9089
8-#14	2.68	MA	6197	2296	9542	1840	11044	1529	11952	1274	13100	881	15939	578	11244
3E		MI	5236	2296	8195	1809	9381	1501	10091	1265	10981	860	13056	527	9397
8-#14	2.68	MA	5975	2296	8926	1857	10176	1559	10887	1302	11643	889	14130	484	10877
4L-2S		MI	5580	2296	8929	1794	10317	1489	11227	1241	12519	842	15107	689	9416
8-#18	4.76	MA	7694	2696	13143	2055	15555	1681	17395	1363	20439	825	25739	666	19290
2L-4S		MI	5594	2696	8975	2070	10189	1715	11025	1389	12198	833	14671	132	13975
8-#18	4.76	MA	7028	2696	11591	2084	13579	1704	14996	1408	17192	861	21327	378	19029
3E		MI	5887	2696	9862	2047	11435	1671	12552	1377	14287	833	17103	281	15741
8-#18	4.76	MA	6677	2696	10517	2112	12067	1754	13142	1426	14655	870	18226	216	16887
4L-2S		MI	6432	2696	11129	2024	13047	1654	14510	1339	16937	807	20524	569	15937
10-#10	1.89	MA	6220	2145	9359	1748	10900	1462	11821	1234	12959	879	15771	761	8224
2L-5S		MI	4800	2145	7017	1760	7949	1474	8378	1252	8671	893	10209	550	6741
10-#10	1.89	MA	5961	2145	8838	1759	10237	1472	11016	1242	11869	894	14262	674	8223
3L-4S		MI	4946	2145	7320	1742	8314	1466	8832	1237	9302	881	11083	603	6897
10-#10	1.89	MA	5828	2145	8483	1770	9736	1490	10401	1259	11027	900	13229	622	8189
4L-3S		MI	5055	2145	7617	1732	8732	1449	9343	1230	10002	877	11955	656	6913
10-#10	1.89	MA	5640	2145	8120	1789	9299	1500	9857	1268	10270	914	12187	576	7982
5L-2S		MI	5267	2145	8047	1723	9279	1441	10009	1215	10903	864	13200	747	6905
10-#11	2.32	MA	6444	2227	9958	1788	11610	1490	12658	1249	14071	867	17295	748	9917
2L-5S		MI	4898	2227	7296	1804	8250	1504	8716	1271	9104	882	10739	477	7890
10-#11	2.32	MA	6141	2227	9329	1800	10810	1501	11686	1258	12755	884	15473	639	9904
3L-4S		MI	5067	2227	7663	1783	8692	1495	9265	1253	9867	868	11769	541	8256
10-#11	2.32	MA	5986	2227	8898	1813	10202	1522	10941	1278	11734	890	14212	574	9834
4L-3S		MI	5195	2227	8021	1772	9196	1476	9883	1246	10714	865	12801	604	8296
10-#11	2.32	MA	5765	2227	8458	1836	9672	1533	10281	1287	10816	907	12945	514	9372
5L-2S		MI	5442	2227	8538	1761	9855	1467	10683	1229	11797	852	14268	717	8296
10-#14	3.35	MA	7007	2424	11333	1902	13324	1572	14721	1298	16848	851	21129	728	13989
2L-5S		MI	5154	2424	7895	1934	8968	1599	9564	1334	10226	873	12220	326	10560
10-#14	3.35	MA	6600	2424	10437	1920	12184	1587	13336	1311	14974	874	18534	567	13924
3L-4S		MI	5386	2424	8419	1904	9598	1587	10347	1310	11314	855	13659	420	11177
10-#14	3.35	MA	6394	2424	9822	1938	11316	1617	12272	1338	13517	881	16725	474	13452
4L-3S		MI	5559	2424	8929	1889	10317	1560	11227	1301	12519	852	15107	508	11597
10-#14	3.35	MA	6087	2424	9192	1970	10558	1632	11330	1351	12206	904	14909	383	12612
5L-2S		MI	5890	2424	9664	1874	11253	1548	12364	1277	14058	834	17159	670	11639
10-#18	5.95	MA	7700	2924	13143	2226	15555	1808	17395	1472	20439	847	25739	352	23651
3L-4S		MI	6158	2924	10242	2213	11801	1819	12983	1453	14849	819	18092	86	17620
10-#18	5.95	MA	7385	2924	12069	2255	14043	1858	15542	1491	17903	856	22638	189	21410
4L-3S		MI	6461	2924	11129	2190	13047	1775	14510	1442	16937	820	20524	235	19500
12-#10	2.27	MA	6454	2217	9879	1793	11563	1495	12627	1254	14049	875	17279	755	9803
2L-6S		MI	4854	2217	7176	1813	8137	1523	8597	1280	8968	901	10656	483	7733
12-#10	2.27	MA	6201	2217	9359	1804	10900	1505	11821	1263	12959	889	15771	668	9791
3L-5S		MI	5000	2217	7447	1805	8497	1507	9043	1273	9571	889	11455	544	7982
12-#10	2.27	MA	6076	2217	9003	1815	10399	1523	11206	1280	12116	896	14738	617	9747
4E		MI	5145	2217	7750	1787	8862	1499	9497	1258	10202	876	12328	597	8185
12-#10	2.27	MA	5888	2217	8641	1834	9962	1533	10663	1288	11360	910	13696	570	9497
5L-3S		MI	5250	2217	8047	1778	9279	1482	10009	1251	10903	872	13200	650	8211
12-#10	2.27	MA	5710	2217	8302	1841	9551	1543	10129	1305	10637	925	12673	499	9159
6L-2S		MI	5456	2217	8477	1768	9827	1474	10674	1236	11803	860	14446	741	8212
12-#11	2.79	MA	6720	2317	10586	1843	12411	1530	13631	1274	15387	862	19117	741	11818
2L-6S		MI	4962	2317	7492	1869	8473	1564	8976	1303	9458	890	11263	393	9112
12-#11	2.79	MA	6425	2317	9958	1856	11610	1541	12658	1283	14071	879	17295	632	11793
3L-5S		MI	5135	2317	7813	1860	8909	1545	9516	1296	10187	877	12206	466	9386
12-#11	2.79	MA	6279	2317	9527	1869	11003	1563	11913	1303	13050	885	16034	567	11710
4E		MI	5302	2317	8180	1838	9351	1536	10065	1278	10950	863	13236	531	9799
12-#11	2.79	MA	6060	2317	9087	1892	10473	1574	11253	1313	12132	902	14767	507	11205
5L-3S		MI	5424	2317	8538	1827	9855	1516	10683	1271	11797	860	14268	594	9853

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



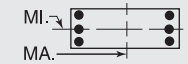
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.79	MA	5850	2317	8683	1900	9950	1595	10605	1333	11256	918	13614	433	10827
6L-2S		MI	5664	2317	9056	1816	10514	1507	11483	1254	12880	846	15735	706	9866
12-#14	4.02	MA	6995	2553	11333	2000	13324	1645	14721	1347	16848	866	21129	557	16603
3L-5S		MI	5484	2553	8630	2014	9904	1657	10700	1370	11765	866	14271	307	12699
12-#14	4.02	MA	6803	2553	10717	2018	12456	1676	13657	1375	15391	874	19320	463	16041
4E		MI	5715	2553	9153	1984	10534	1645	11483	1346	12852	848	15711	401	13280
12-#14	4.02	MA	6499	2553	10088	2050	11698	1691	12715	1387	14080	896	17505	372	15243
5L-3S		MI	5876	2553	9664	1969	11253	1618	12364	1337	14058	845	17159	490	13794
12-#14	4.02	MA	6212	2553	9520	2063	10951	1721	11788	1415	12827	919	15849	265	14267
6L-2S		MI	6196	2553	10399	1954	12189	1606	13500	1314	15596	827	19210	651	13854
12-#18	7.14	MA	8074	3152	13620	2397	16019	1962	17942	1556	21150	843	27049	163	25953
4E		MI	6770	3152	11508	2355	13414	1923	14942	1518	17499	806	21514	40	21288
14-#10	2.65	MA	6439	2290	9879	1849	11563	1538	12627	1283	14049	885	17279	662	11357
3L-6S		MI	5055	2290	7606	1858	8685	1556	9262	1300	9868	897	11902	477	8993
14-#10	2.65	MA	6319	2290	9524	1860	11062	1556	12011	1300	13206	891	16247	611	11305
4L-5S		MI	5198	2290	7878	1851	9045	1540	9708	1294	10471	884	12700	538	9229
14-#10	2.65	MA	6133	2290	9162	1880	10625	1566	11468	1309	12449	906	15205	564	11017
5L-4S		MI	5342	2290	8180	1833	9410	1531	10162	1278	11102	872	13573	591	9472
14-#10	2.65	MA	5960	2290	8823	1886	10214	1575	10934	1326	11727	920	14182	493	10694
6L-3S		MI	5442	2290	8477	1823	9827	1515	10674	1272	11803	868	14446	644	9506
14-#10	2.65	MA	5813	2290	8491	1893	9763	1591	10420	1335	10990	927	13194	454	10302
7L-2S		MI	5643	2290	8907	1813	10375	1507	11339	1256	12703	856	15691	735	9516
14-#11	3.25	MA	6706	2406	10586	1912	12411	1582	13631	1309	15387	874	19117	624	13680
3L-6S		MI	5200	2406	8010	1925	9132	1605	9776	1328	10541	885	12730	383	10601
14-#11	3.25	MA	6568	2406	10155	1925	11803	1603	12885	1328	14366	880	17856	560	13586
4L-5S		MI	5368	2406	8331	1915	9568	1585	10316	1321	11270	872	13674	455	10889
14-#11	3.25	MA	6350	2406	9715	1948	11273	1614	12226	1338	13448	897	16589	499	13044
5L-4S		MI	5534	2406	8697	1894	10009	1576	10865	1304	12033	858	14703	520	11341
14-#11	3.25	MA	6147	2406	9312	1956	10750	1636	11577	1358	12572	913	15437	425	12683
6L-3S		MI	5650	2406	9056	1883	10514	1557	11483	1297	12880	855	15735	583	11406
14-#11	3.25	MA	5973	2406	8910	1964	10237	1645	10954	1367	11677	919	14136	360	12026
7L-2S		MI	5884	2406	9573	1872	11173	1548	12284	1279	13962	841	17202	695	11429
14-#14	4.69	MA	7205	2681	11613	2098	13596	1734	15042	1411	17266	866	21915	453	18643
4L-5S		MI	5808	2681	9365	2094	10840	1715	11837	1407	13303	858	16323	288	14847
14-#14	4.69	MA	6903	2681	10984	2131	12838	1749	14099	1424	15954	889	20100	362	17881
5L-4S		MI	6038	2681	9888	2064	11470	1703	12620	1383	14391	840	17762	382	15396
14-#14	4.69	MA	6627	2681	10415	2143	12091	1779	13172	1451	14701	912	18444	254	16888
6L-3S		MI	6189	2681	10399	2050	12189	1676	13500	1374	15596	837	19210	471	15990
16-#10	3.02	MA	6559	2362	10045	1906	11725	1589	12817	1321	14296	887	17756	605	12862
4L-6S		MI	5254	2362	8036	1903	9232	1589	9927	1321	10768	893	13147	472	10255
16-#10	3.02	MA	6373	2362	9682	1925	11288	1599	12273	1330	13539	902	16714	558	12542
5E		MI	5392	2362	8308	1896	9592	1573	10373	1314	11371	880	13945	532	10481
16-#10	3.02	MA	6206	2362	9344	1931	10877	1608	11739	1347	12817	916	15691	487	12231
6L-4S		MI	5536	2362	8611	1878	9957	1564	10827	1299	12002	868	14819	585	10758
16-#10	3.02	MA	6064	2362	9012	1938	10426	1624	11226	1355	12079	922	14703	448	11829
7L-3S		MI	5632	2362	8907	1868	10375	1548	11339	1292	12703	864	15691	638	10799
16-#10	3.02	MA	5905	2362	8692	1946	9995	1630	10705	1371	11375	937	13754	396	11407
8L-2S		MI	5828	2362	9337	1859	10922	1540	12004	1277	13603	852	16936	729	10815
16-#11	3.71	MA	6852	2495	10784	1980	12604	1644	13858	1354	15682	875	19678	553	15463
4L-6S		MI	5435	2495	8527	1981	9791	1645	10576	1354	11624	880	14198	372	12086
16-#11	3.71	MA	6635	2495	10344	2003	12074	1655	13198	1363	14764	891	18411	492	14888
5E		MI	5597	2495	8848	1971	10226	1626	11117	1346	12353	867	15141	445	12397
16-#11	3.71	MA	6438	2495	9941	2012	11551	1676	12550	1383	13888	908	17259	418	14527
6L-4S		MI	5763	2495	9215	1950	10668	1617	11665	1329	13116	853	16170	509	12847

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

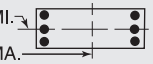
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	3.71	MA	6272	2495	9538	2019	11038	1686	11926	1393	12993	914	15958	353	13873
7L-3S		MI	5874	2495	9573	1939	11173	1597	12284	1322	13962	850	17202	573	12958
16-#14	5.36	MA	7300	2810	11879	2211	13979	1807	15484	1460	17828	882	22695	352	20525
5E		MI	6128	2810	10100	2175	11775	1774	12973	1443	14841	851	18374	269	17002
16-#14	5.36	MA	7035	2810	11311	2224	13231	1837	14557	1488	16576	904	21039	244	19516
6L-4S		MI	6357	2810	10623	2145	12406	1762	13756	1419	15929	833	19814	363	17522
18-#10	3.40	MA	6611	2435	10203	1970	11951	1632	13079	1350	14629	898	18223	552	14071
5L-6S		MI	5450	2435	8466	1949	9780	1622	10592	1341	11668	888	14392	466	11521
18-#10	3.40	MA	6448	2435	9865	1977	11540	1641	12544	1367	13907	912	17200	481	13772
6L-5S		MI	5585	2435	8738	1941	10140	1606	11038	1335	12271	876	15191	527	11737
18-#10	3.40	MA	6311	2435	9532	1983	11089	1657	12031	1376	13169	918	16212	442	13358
7L-4S		MI	5728	2435	9041	1923	10505	1597	11492	1319	12902	864	16064	579	12043
18-#10	3.40	MA	6153	2435	9213	1991	10658	1663	11510	1392	12465	933	15263	390	12948
8L-3S		MI	5819	2435	9337	1914	10922	1581	12004	1313	13603	860	16936	632	12091
18-#11	4.18	MA	6916	2584	10973	2059	12874	1695	14171	1388	16080	886	20233	485	16737
5L-6S		MI	5667	2584	9045	2036	10449	1686	11377	1379	12706	875	15665	362	13575
18-#11	4.18	MA	6726	2584	10570	2067	12352	1717	13522	1408	15204	903	19081	411	16359
6L-5S		MI	5824	2584	9366	2027	10885	1666	11917	1372	13436	861	16608	434	13910
18-#11	4.18	MA	6566	2584	10167	2075	11838	1726	12899	1418	14309	909	17780	346	15723
7L-4S		MI	5990	2584	9732	2005	11327	1657	12466	1354	14199	848	17638	499	14340
18-#14	6.03	MA	7437	2938	12206	2304	14371	1896	15942	1524	18450	897	23634	234	22149
6L-5S		MI	6444	2938	10835	2255	12711	1832	14110	1480	16379	844	20426	250	19162
20-#10	3.78	MA	6687	2507	10385	2022	12203	1674	13350	1388	14996	908	18709	475	15314
6E		MI	5643	2507	8897	1994	10328	1655	11257	1362	12568	884	15637	460	12788
20-#10	3.78	MA	6555	2507	10053	2029	11752	1690	12836	1396	14259	914	17721	436	14889
7L-5S		MI	5775	2507	9168	1987	10687	1639	11704	1355	13171	872	16436	521	12997
20-#10	3.78	MA	6398	2507	9734	2037	11321	1696	12315	1413	13554	929	16772	384	14491
8L-4S		MI	5917	2507	9471	1969	11052	1630	12157	1340	13802	860	17309	573	13328
20-#11	4.64	MA	7009	2673	11199	2123	13152	1757	14495	1434	16520	898	20903	404	18196
6E		MI	5896	2673	9562	2092	11108	1726	12177	1404	13789	870	17132	351	15070
20-#11	4.64	MA	6856	2673	10796	2131	12639	1767	13871	1443	15625	904	19602	339	17576
7L-5S		MI	6049	2673	9883	2082	11544	1707	12717	1397	14519	856	18075	423	15427
22-#10	4.16	MA	6796	2580	10574	2074	12415	1723	13642	1417	15349	910	19230	431	16424
7L-6S		MI	5835	2580	9327	2039	10875	1688	11922	1383	13469	880	16883	454	14058
22-#10	4.16	MA	6640	2580	10254	2082	11984	1729	13121	1433	14644	924	18281	378	16035
8L-5S		MI	5964	2580	9598	2032	11235	1671	12369	1376	14072	868	17681	515	14259
22-#11	5.11	MA	7142	2762	11425	2186	13440	1807	14844	1468	16941	899	21424	332	19432
7L-6S		MI	6122	2762	10080	2148	11767	1766	12977	1429	14872	865	18599	340	16569

RECTANGULAR TIED COLUMNS 24" x 30"

4-#14	1.25	MA	6656	2166	9757	1781	11212	1499	11968	1278	12690	944	15062	821	6327
2E		MI	5251	2166	7887	1738	8915	1462	9431	1246	9898	919	11497	781	4954
4-#18	2.22	MA	7279	2366	11283	1889	13075	1575	14192	1322	15668	922	19162	796	10793
2E		MI	5692	2366	9029	1842	10294	1535	11071	1287	12089	895	14170	716	8322
6-#10	1.06	MA	6557	2127	9393	1776	10847	1498	11572	1281	12193	958	14404	834	5464
2L-3S		MI	4963	2127	7178	1749	8104	1474	8491	1269	8659	948	9963	723	4317
6-#10	1.06	MA	6254	2127	8827	1788	10126	1508	10697	1291	11008	974	12764	750	5482
3L-2S		MI	5188	2127	7608	1739	8651	1466	9156	1254	9560	936	11208	814	4295
6-#11	1.30	MA	6712	2177	9813	1796	11324	1511	12124	1287	12917	948	15389	824	6599
2L-3S		MI	5032	2177	7411	1766	8347	1485	8760	1274	9004	938	10361	681	5188
6-#11	1.30	MA	6354	2177	9129	1809	10453	1523	11065	1297	11484	966	13406	718	6617
3L-2S		MI	5296	2177	7929	1755	9006	1476	9560	1257	10087	925	11829	793	5162
6-#14	1.88	MA	7099	2295	10733	1861	12454	1557	13477	1314	14732	937	17890	810	9301
2L-3S		MI	5212	2295	7887	1834	8915	1533	9431	1306	9898	929	11497	601	7230
6-#14	1.88	MA	6609	2295	9757	1880	11212	1573	11968	1328	12690	961	15062	654	9289
3L-2S		MI	5573	2295	8622	1819	9851	1521	10568	1282	11436	911	13549	763	7212

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

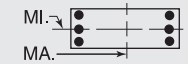
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	3.33	MA	8010	2595	12978	2032	15232	1679	16812	1387	19214	909	24072	777	15916
2L-3S		MI	5642	2595	9029	2008	10294	1656	11071	1390	12089	908	14170	382	12058
6-#18	3.33	MA	7224	2595	11283	2062	13075	1705	14192	1435	15668	948	19162	490	15710
3L-2S		MI	6221	2595	10296	1985	11906	1639	13029	1352	14739	882	17591	669	12171
8-#9	1.11	MA	6606	2138	9464	1787	10958	1506	11718	1288	12399	960	14695	836	5737
2L-4S		MI	4954	2138	7084	1767	7973	1496	8338	1278	8454	952	9765	704	4535
8-#9	1.11	MA	6367	2138	9016	1797	10387	1515	11025	1295	11460	972	13396	769	5749
3E		MI	5048	2138	7319	1759	8304	1482	8743	1266	9009	949	10455	745	4520
8-#9	1.11	MA	6244	2138	8712	1806	9957	1530	10497	1309	10738	978	12519	729	5753
4L-2S		MI	5226	2138	7660	1751	8738	1475	9271	1261	9723	939	11443	817	4504
8-#10	1.41	MA	6823	2199	9959	1822	11567	1531	12448	1302	13378	954	16044	828	7191
2L-4S		MI	5048	2199	7311	1804	8234	1524	8644	1296	8859	948	10336	664	5639
8-#10	1.41	MA	6528	2199	9393	1833	10847	1541	11572	1311	12193	969	14404	744	7199
3E		MI	5164	2199	7608	1794	8651	1507	9156	1289	9560	944	11208	717	5633
8-#10	1.41	MA	6376	2199	9008	1845	10303	1560	10905	1329	11279	976	13292	693	7179
4L-2S		MI	5383	2199	8038	1784	9199	1499	9821	1274	10460	932	12453	809	5617
8-#11	1.73	MA	7026	2266	10497	1851	12195	1551	13182	1312	14349	943	17373	817	8683
2L-4S		MI	5132	2266	7570	1833	8502	1545	8942	1307	9240	936	10797	607	6755
8-#11	1.73	MA	6679	2266	9813	1865	11324	1563	12124	1323	12917	961	15389	710	8685
3E		MI	5269	2266	7929	1822	9006	1526	9560	1300	10087	933	11829	670	6766
8-#11	1.73	MA	6499	2266	9346	1878	10665	1585	11315	1343	11809	968	14031	647	8633
4L-2S		MI	5525	2266	8446	1811	9665	1517	10360	1282	11169	919	13296	782	6749
8-#14	2.50	MA	7533	2423	11709	1941	13697	1615	14986	1350	16774	929	20718	800	12259
2L-4S		MI	5356	2423	8111	1929	9132	1618	9687	1352	10231	925	12101	493	9241
8-#14	2.50	MA	7063	2423	10733	1960	12454	1632	13477	1365	14732	953	17890	644	12216
3E		MI	5542	2423	8622	1914	9851	1591	10568	1343	11436	922	13549	582	9442
8-#14	2.50	MA	6819	2423	10065	1979	11512	1663	12321	1394	13149	963	15939	551	11959
4L-2S		MI	5890	2423	9357	1899	10787	1579	11705	1319	12974	904	15600	744	9451
8-#18	4.44	MA	8723	2823	14672	2174	17390	1783	19433	1451	22761	896	28982	759	21018
2L-4S		MI	5896	2823	9408	2174	10660	1804	11502	1466	12651	894	15160	186	14171
8-#18	4.44	MA	7985	2823	12978	2205	15232	1809	16812	1499	19214	935	24072	471	20757
3E		MI	6193	2823	10296	2151	11906	1760	13029	1454	14739	894	17591	335	15817
8-#18	4.44	MA	7600	2823	11810	2236	13588	1861	14796	1521	16454	947	20634	304	18587
4L-2S		MI	6741	2823	11562	2128	13519	1743	14987	1417	17389	868	21012	623	15988
10-#10	1.76	MA	7084	2272	10525	1867	12288	1564	13323	1323	14562	950	17685	823	8910
2L-5S		MI	5105	2272	7439	1867	8417	1565	8855	1332	9128	956	10708	606	6834
10-#10	1.76	MA	6798	2272	9959	1878	11567	1574	12448	1332	13378	965	16044	738	8909
3L-4S		MI	5251	2272	7741	1849	8782	1557	9309	1317	9759	944	11581	658	6933
10-#10	1.76	MA	6653	2272	9574	1890	11024	1593	11781	1349	12464	972	14933	687	8875
4L-3S		MI	5362	2272	8038	1839	9199	1540	9821	1310	10460	940	12453	711	6941
10-#10	1.76	MA	6442	2272	9182	1910	10551	1603	11192	1359	11645	988	13808	642	8716
5L-2S		MI	5575	2272	8468	1829	9747	1532	10486	1295	11360	928	13698	803	6931
10-#11	2.17	MA	7334	2355	11182	1907	13067	1591	14241	1337	15782	938	19356	810	10760
2L-5S		MI	5203	2355	7721	1910	8719	1595	9193	1349	9560	945	11234	532	7996
10-#11	2.17	MA	6999	2355	10497	1920	12195	1603	13182	1348	14349	956	17373	703	10746
3L-4S		MI	5372	2355	8088	1889	9160	1586	9742	1332	10323	931	12264	596	8303
10-#11	2.17	MA	6829	2355	10030	1934	11536	1626	12374	1369	13241	963	16015	640	10677
4L-3S		MI	5502	2355	8446	1878	9665	1566	10360	1325	11169	928	13296	659	8332
10-#11	2.17	MA	6581	2355	9554	1958	10962	1638	11659	1379	12246	981	14645	582	10242
5L-2S		MI	5751	2355	8963	1867	10324	1557	11161	1307	12252	914	14763	772	8327
10-#14	3.13	MA	7958	2552	12685	2022	14939	1674	16495	1387	18816	922	23546	790	15204
2L-5S		MI	5459	2552	8323	2039	9438	1688	10041	1412	10681	936	12713	380	10691
10-#14	3.13	MA	7507	2552	11709	2040	13697	1690	14986	1401	16774	946	20718	633	15139
3L-4S		MI	5691	2552	8846	2009	10068	1676	10824	1388	11769	918	14152	474	11323

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

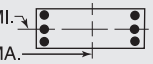


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	3.13	MA	7281	2552	11041	2059	12755	1721	13830	1430	15191	956	18767	541	14774
4L-3S		MI	5866	2552	9357	1994	10787	1649	11705	1379	12974	915	15600	563	11645
10-#14	3.13	MA	6936	2552	10359	2093	11933	1738	12808	1444	13768	980	16804	455	13796
5L-2S		MI	6201	2552	10092	1979	11722	1638	12841	1355	14512	896	17652	725	11678
10-#18	5.56	MA	8726	3051	14672	2348	17390	1912	19433	1564	22761	922	28982	453	25811
3L-4S		MI	6460	3051	10675	2317	12273	1907	13460	1530	15301	881	18581	140	17807
10-#18	5.56	MA	8381	3051	13505	2378	15746	1965	17416	1586	20000	934	25544	285	23541
4L-3S		MI	6731	3051	11562	2293	13519	1864	14987	1519	17389	881	21012	289	19579
10-#18	5.56	MA	7807	3051	12312	2435	14308	1991	15630	1634	17515	973	22100	121	21532
5L-2S		MI	7249	3051	12828	2270	15131	1847	16945	1481	20040	855	24434	577	19792
12-#10	2.12	MA	7341	2345	11091	1912	13009	1597	14198	1343	15747	946	19325	817	10625
2L-6S		MI	5159	2345	7597	1920	8604	1615	9074	1359	9425	964	11155	539	7820
12-#10	2.12	MA	7063	2345	10525	1924	12288	1607	13323	1352	14562	961	17685	732	10614
3L-5S		MI	5306	2345	7869	1912	8964	1598	9521	1352	10028	952	11953	600	8073
12-#10	2.12	MA	6925	2345	10141	1935	11745	1626	12656	1370	13649	968	16573	681	10570
4E		MI	5451	2345	8171	1894	9329	1590	9974	1337	10659	940	12826	652	8224
12-#10	2.12	MA	6715	2345	9748	1955	11272	1636	12068	1379	12829	983	15448	637	10365
5L-3S		MI	5557	2345	8468	1884	9747	1573	10486	1330	11360	936	13698	705	8242
12-#10	2.12	MA	6520	2345	9376	1961	10827	1647	11490	1397	12047	999	14346	566	9975
6L-2S		MI	5765	2345	8898	1875	10294	1565	11151	1315	12260	923	14944	797	8239
12-#11	2.60	MA	7638	2444	11866	1963	13938	1632	15299	1363	17214	933	21340	803	12829
2L-6S		MI	5267	2444	7917	1975	8942	1654	9453	1382	9913	953	11758	448	9215
12-#11	2.60	MA	7313	2444	11182	1976	13067	1644	14241	1373	15782	951	19356	696	12804
3L-5S		MI	5440	2444	8238	1966	9377	1635	9993	1375	10643	940	12702	521	9490
12-#11	2.60	MA	7152	2444	10715	1990	12408	1666	13432	1394	14674	958	17998	633	12721
4E		MI	5608	2444	8605	1944	9819	1626	10542	1357	11406	926	13731	586	9848
12-#11	2.60	MA	6906	2444	10238	2013	11833	1678	12717	1404	13679	976	16628	575	12240
5L-3S		MI	5732	2444	8963	1933	10324	1607	11161	1350	12252	923	14763	649	9892
12-#11	2.60	MA	6676	2444	9794	2021	11293	1690	12015	1425	12729	994	15282	487	11807
6L-2S		MI	5974	2444	9481	1922	10982	1598	11961	1333	13335	909	16230	761	9899
12-#14	3.75	MA	7943	2680	12685	2121	14939	1748	16495	1437	18816	939	23546	623	18061
3L-5S		MI	5789	2680	9058	2119	10374	1747	11178	1449	12219	928	14764	362	12827
12-#14	3.75	MA	7732	2680	12016	2139	13997	1780	15339	1466	17233	948	21595	530	17603
4E		MI	6020	2680	9581	2089	11004	1735	11960	1425	13307	910	16204	456	13422
12-#14	3.75	MA	7390	2680	11334	2173	13175	1796	14317	1480	15811	972	19632	444	16668
5L-3S		MI	6184	2680	10092	2074	11722	1708	12841	1416	14512	907	17652	544	13844
12-#14	3.75	MA	7075	2680	10707	2185	12365	1827	13312	1509	14452	997	17849	338	15696
6L-2S		MI	6508	2680	10827	2060	12658	1696	13978	1392	16051	889	19703	706	13895
12-#18	6.67	MA	9141	3280	15199	2521	17903	2069	20037	1650	23547	921	30454	267	28515
4E		MI	7013	3280	11941	2459	13885	2011	15419	1595	17951	868	22002	94	21467
12-#18	6.67	MA	8572	3280	14006	2578	16466	2095	18250	1698	21062	960	27010	102	26501
5L-3S		MI	7295	3280	12828	2436	15131	1967	16945	1584	20040	868	24434	243	23343
14-#10	2.47	MA	7324	2417	11091	1969	13009	1640	14198	1373	15747	957	19325	726	12317
3L-6S		MI	5361	2417	8027	1965	9152	1648	9739	1380	10325	960	12400	533	9078
14-#10	2.47	MA	7192	2417	10707	1981	12465	1659	13531	1391	14833	964	18213	675	12265
4L-5S		MI	5504	2417	8299	1958	9512	1631	10186	1373	10928	948	13198	594	9318
14-#10	2.47	MA	6984	2417	10314	2001	11993	1669	12943	1400	14014	979	17088	631	12019
5L-4S		MI	5648	2417	8602	1940	9877	1623	10639	1358	11559	935	14072	646	9512
14-#10	2.47	MA	6795	2417	9942	2007	11548	1680	12365	1417	13232	995	15987	560	11645
6L-3S		MI	5750	2417	8898	1930	10294	1606	11151	1351	12260	932	14944	699	9539
14-#10	2.47	MA	6634	2417	9582	2014	11052	1695	11810	1427	12434	1002	14921	524	11278
7L-2S		MI	5953	2417	9328	1920	10842	1598	11816	1336	13160	919	16189	791	9544
14-#11	3.03	MA	7622	2533	11866	2032	13938	1684	15299	1398	17214	945	21340	689	14859
3L-6S		MI	5505	2533	8435	2031	9600	1695	10253	1407	10996	948	13225	438	10729
14-#11	3.03	MA	7469	2533	11399	2045	13279	1707	14490	1419	16106	953	19981	625	14765
4L-5S		MI	5674	2533	8756	2021	10036	1676	10794	1400	11726	934	14169	510	10990
14-#11	3.03	MA	7226	2533	10922	2069	12705	1719	13776	1430	15111	971	18611	568	14245
5L-4S		MI	5841	2533	9122	2000	10478	1666	11342	1382	12489	921	15198	575	11392

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

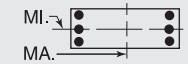
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	3.03	MA	7002	2533	10478	2077	12164	1731	13073	1450	14162	988	17266	480	13830
6L-3S		MI	5959	2533	9481	1989	10982	1647	11961	1375	13335	917	16230	638	11447
14-#11	3.03	MA	6812	2533	10041	2085	11572	1750	12398	1461	13192	996	15966	432	13175
7L-2S		MI	6194	2533	9998	1978	11641	1638	12761	1358	14418	904	17698	750	11464
14-#14	4.38	MA	8175	2809	12992	2220	15239	1838	16848	1503	19276	941	24423	520	20443
4L-5S		MI	6114	2809	9793	2199	11309	1805	12314	1485	13757	921	16816	343	14971
14-#14	4.38	MA	7835	2809	12310	2253	14418	1855	15826	1517	17853	965	22459	434	19547
5L-4S		MI	6344	2809	10316	2170	11940	1793	13097	1461	14845	903	18255	437	15533
14-#14	4.38	MA	7533	2809	11682	2265	13608	1886	14821	1546	16494	989	20677	327	18563
6L-3S		MI	6498	2809	10827	2155	12658	1766	13978	1452	16051	900	19703	525	16042
14-#18	7.78	MA	9320	3508	15701	2721	18623	2199	20871	1763	24608	947	31920	84	31482
5L-4S		MI	7617	3508	13207	2602	15497	2115	17377	1660	20602	854	25423	47	25146
16-#10	2.82	MA	7456	2490	11273	2026	13186	1692	14407	1411	16018	960	19854	669	13960
4L-6S		MI	5559	2490	8458	2010	9700	1680	10405	1400	11225	956	13645	527	10339
16-#10	2.82	MA	7249	2490	10880	2046	12713	1702	13818	1420	15199	975	18728	625	13679
5E		MI	5699	2490	8729	2003	10059	1664	10851	1394	11828	944	14443	588	10569
16-#10	2.82	MA	7065	2490	10508	2052	12269	1713	13240	1438	14417	990	17627	554	13319
6L-4S		MI	5843	2490	9032	1985	10424	1656	11304	1378	12459	931	15317	640	10799
16-#10	2.82	MA	6910	2490	10148	2059	11773	1728	12685	1447	13618	997	16562	518	12941
7L-3S		MI	5940	2490	9328	1975	10842	1639	11816	1372	13160	927	16189	693	10834
16-#10	2.82	MA	6732	2490	9802	2068	11306	1734	12111	1463	12856	1013	15537	467	12458
8L-2S		MI	6139	2490	9758	1965	11389	1631	12481	1356	14060	915	17434	785	10846
16-#11	3.47	MA	7782	2622	12084	2101	14151	1747	15549	1444	17539	948	21965	618	16811
4L-6S		MI	5740	2622	8952	2086	10259	1735	11054	1432	12079	943	14693	427	12247
16-#11	3.47	MA	7540	2622	11607	2125	13576	1759	14834	1455	16544	966	20595	561	16255
5E		MI	5904	2622	9273	2077	10695	1716	11594	1425	12809	929	15636	500	12497
16-#11	3.47	MA	7324	2622	11162	2133	13036	1771	14132	1476	15594	983	19249	473	15857
6L-4S		MI	6070	2622	9640	2056	11137	1707	12143	1408	13572	916	16665	564	12936
16-#11	3.47	MA	7141	2622	10726	2141	12444	1790	13457	1486	14624	991	17950	425	15190
7L-3S		MI	6183	2622	9998	2045	11641	1687	12761	1401	14418	912	17698	628	13000
16-#14	5.00	MA	8273	2937	13286	2334	15660	1913	17335	1553	19895	958	25287	424	22433
5E		MI	6435	2937	10528	2280	12245	1863	13451	1521	15296	913	18867	324	17122
16-#14	5.00	MA	7982	2937	12658	2346	14850	1944	16330	1582	18537	982	23504	317	21435
6L-4S		MI	6664	2937	11051	2250	12875	1851	14233	1497	16383	895	20307	418	17656
18-#10	3.17	MA	7511	2562	11446	2091	13434	1735	14694	1441	16383	971	20369	619	15343
5L-6S		MI	5756	2562	8888	2056	10247	1713	11070	1421	12126	952	14890	521	11603
18-#10	3.17	MA	7332	2562	11074	2097	12990	1746	14116	1459	15601	986	19267	548	14995
6L-5S		MI	5892	2562	9159	2048	10607	1697	11516	1414	12729	939	15689	582	11823
18-#10	3.17	MA	7182	2562	10714	2105	12493	1761	13560	1468	14803	993	18202	512	14607
7L-4S		MI	6035	2562	9462	2030	10972	1689	11969	1399	13359	927	16562	634	12086
18-#10	3.17	MA	7005	2562	10368	2113	12026	1767	12986	1484	14040	1009	17177	462	14136
8L-3S		MI	6129	2562	9758	2020	11389	1672	12481	1392	14060	923	17434	687	12126
18-#11	3.90	MA	7850	2711	12291	2180	14448	1800	15893	1480	17976	960	22578	554	18270
5L-6S		MI	5972	2711	9470	2142	10918	1776	11854	1458	13162	938	16160	416	13733
18-#11	3.90	MA	7640	2711	11847	2188	13907	1811	15190	1501	17026	978	21232	466	17886
6L-5S		MI	6132	2711	9791	2133	11354	1756	12394	1450	13892	924	17103	489	14008
18-#11	3.90	MA	7465	2711	11410	2197	13315	1831	14515	1511	16057	986	19933	418	17209
7L-4S		MI	6297	2711	10157	2111	11796	1747	12943	1433	14655	910	18133	554	14452
18-#14	5.63	MA	8424	3066	13634	2426	16093	2003	17839	1619	20579	975	26332	307	24312
6L-5S		MI	6751	3066	11263	2360	13181	1922	14587	1558	16834	906	20919	305	19279
20-#10	3.53	MA	7595	2635	11640	2143	13710	1778	14991	1479	16786	982	20908	543	16674
6E		MI	5950	2635	9318	2101	10795	1746	11735	1441	13026	947	16136	515	12869

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

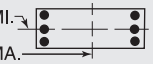
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	3.53	MA	7450	2635	11280	2150	13214	1794	14436	1488	15988	989	19842	506	16276
7L-5S		MI	6083	2635	9589	2094	11155	1730	12181	1435	13629	935	16934	576	13081
20-#10	3.53	MA	7275	2635	10934	2158	12747	1800	13862	1504	15225	1004	18817	456	15816
8L-4S		MI	6226	2635	9892	2075	11520	1721	12634	1419	14260	923	17807	628	13372
20-#11	4.33	MA	7952	2800	12531	2244	14779	1852	16249	1526	18459	973	23216	459	19919
6E		MI	6202	2800	9987	2198	11577	1816	12654	1483	14245	932	17627	406	15224
20-#11	4.33	MA	7783	2800	12095	2252	14186	1871	15574	1536	17489	980	21917	411	19230
7L-5S		MI	6357	2800	10308	2188	12013	1797	13194	1476	14975	919	18571	478	15523
22-#10	3.88	MA	7715	2707	11846	2195	13935	1827	15311	1509	17172	985	21483	500	17947
7L-6S		MI	6142	2707	9748	2146	11342	1779	12400	1462	13926	943	17381	509	14138
22-#10	3.88	MA	7540	2707	11500	2204	13468	1833	14737	1525	16410	1000	20458	450	17498
8L-5S		MI	6272	2707	10019	2139	11702	1763	12846	1455	14529	931	18179	570	14342
22-#11	4.77	MA	8098	2889	12779	2308	15058	1911	16632	1562	18922	975	23900	404	21254
7L-6S		MI	6429	2889	10505	2254	12236	1857	13454	1508	15328	927	19094	395	16720
24-#10	4.23	MA	7803	2780	12066	2249	14188	1866	15612	1545	17594	996	22098	444	19182
8L-6S		MI	6333	2780	10178	2191	11890	1812	13065	1483	14826	939	18626	503	15408

RECTANGULAR TIED COLUMNS 24" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.17	MA	7535	2294	10927	1900	12594	1600	13447	1366	14232	1015	16870	883	6813
2E		MI	5558	2294	8315	1844	9385	1552	9909	1324	10353	981	11990	836	4981
4-#18	2.08	MA	8222	2494	12587	2008	14620	1677	15866	1411	17471	993	21329	858	11657
2E		MI	6000	2494	9462	1946	10765	1624	11547	1364	12541	956	14658	769	8361
6-#11	1.22	MA	7595	2304	10986	1915	12712	1612	13613	1376	14473	1019	17217	886	7105
2L-3S		MI	5337	2304	7836	1872	8816	1576	9237	1353	9459	1001	10856	736	5215
6-#11	1.22	MA	7203	2304	10246	1929	11770	1625	12468	1387	12924	1038	15073	782	7122
3L-2S		MI	5603	2304	8354	1861	9475	1566	10038	1336	10542	987	12324	848	5187
6-#14	1.76	MA	8021	2422	11984	1980	13938	1659	15081	1403	16442	1007	19930	872	10030
2L-3S		MI	5517	2422	8315	1939	9385	1622	9909	1385	10353	992	11990	655	7267
6-#14	1.76	MA	7483	2422	10927	2000	12594	1676	13447	1418	14232	1033	16870	719	10018
3L-2S		MI	5881	2422	9050	1924	10321	1611	11045	1361	11891	974	14041	817	7243
6-#18	3.13	MA	9025	2722	14424	2151	16959	1781	18707	1475	21316	980	26653	839	17212
2L-3S		MI	5947	2722	9462	2112	10765	1745	11547	1467	12541	969	14658	436	12127
6-#18	3.13	MA	8161	2722	12587	2183	14620	1809	15866	1499	17471	1022	21329	558	17006
3L-2S		MI	6531	2722	10729	2089	12378	1728	13506	1429	15192	943	18080	723	12215
8-#9	1.04	MA	7476	2265	10605	1907	12311	1608	13168	1376	13905	1031	16456	898	6169
2L-4S		MI	5260	2265	7504	1874	8440	1587	8815	1358	8912	1015	10264	759	4558
8-#9	1.04	MA	7216	2265	10121	1916	11695	1617	12419	1384	12892	1044	15054	833	6181
3E		MI	5354	2265	7739	1866	8771	1574	9221	1346	9467	1012	10954	801	4540
8-#9	1.04	MA	7081	2265	9793	1926	11232	1632	11851	1399	12114	1050	14114	793	6185
4L-2S		MI	5532	2265	8080	1858	9205	1567	9748	1340	10181	1002	11942	872	4524
8-#10	1.32	MA	7714	2327	11140	1941	12971	1633	13958	1391	14965	1025	17916	890	7739
2L-4S		MI	5354	2327	7732	1910	8701	1615	9121	1376	9316	1011	10834	720	5669
8-#10	1.32	MA	7392	2327	10529	1953	12192	1644	13012	1401	13685	1041	16145	807	7748
3E		MI	5470	2327	8029	1901	9119	1598	9633	1369	10017	1007	11706	773	5658
8-#10	1.32	MA	7226	2327	10115	1965	11607	1663	12294	1419	12701	1049	14954	757	7727
4L-2S		MI	5690	2327	8459	1891	9666	1590	10298	1354	10917	995	12951	864	5640
8-#11	1.63	MA	7938	2393	11726	1971	13654	1653	14757	1401	16022	1014	19362	879	9357
2L-4S		MI	5437	2393	7995	1939	8970	1635	9419	1385	9696	999	11292	662	6795
8-#11	1.63	MA	7559	2393	10986	1985	12712	1665	13613	1412	14473	1033	17217	775	9359
3E		MI	5575	2393	8354	1928	9475	1616	10038	1378	10542	996	12324	725	6796
8-#11	1.63	MA	7363	2393	10482	1999	12001	1688	12741	1434	13278	1041	15762	712	9307
4L-2S		MI	5833	2393	8871	1917	10133	1607	10838	1361	11625	982	13791	837	6777
8-#14	2.34	MA	8496	2551	13040	2061	15283	1717	16714	1439	18653	1000	22991	862	13231
2L-4S		MI	5660	2551	8539	2034	9602	1708	10164	1430	10686	987	12594	548	9389
8-#14	2.34	MA	7981	2551	11984	2080	13938	1735	15081	1455	16442	1026	19930	709	13188
3E		MI	5848	2551	9050	2019	10321	1681	11045	1421	11891	984	14041	637	9485

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

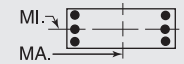
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.34	MA	7714	2551	11263	2100	12922	1767	13833	1485	14734	1037	17839	618	12981
4L-2S		MI	6198	2551	9785	2004	11256	1669	12182	1397	13429	966	16093	798	9485
8-#18	4.17	MA	9807	2950	16261	2294	19298	1884	21548	1540	25161	967	31977	821	22746
2L-4S		MI	6198	2950	9841	2278	11132	1892	11979	1543	13103	956	15648	240	14362
8-#18	4.17	MA	8996	2950	14424	2326	16959	1913	18707	1564	21316	1009	26653	540	22485
3E		MI	6498	2950	10729	2255	12378	1848	13506	1532	15192	956	18080	389	15890
8-#18	4.17	MA	8575	2950	13164	2359	15182	1967	16528	1614	18332	1024	22963	375	20312
4L-2S		MI	7052	2950	11995	2231	13990	1831	15464	1494	17842	930	21501	677	16037
10-#10	1.65	MA	7999	2399	11752	1986	13749	1666	14903	1411	16244	1020	19688	885	9596
2L-5S		MI	5411	2399	7860	1974	8884	1656	9333	1411	9585	1019	11206	661	6924
10-#10	1.65	MA	7686	2399	11140	1998	12971	1676	13958	1421	14965	1037	17916	801	9594
3L-4S		MI	5557	2399	8163	1956	9249	1648	9786	1396	10216	1007	12079	714	6967
10-#10	1.65	MA	7528	2399	10726	2010	12385	1696	13239	1439	13980	1044	16726	751	9561
4L-3S		MI	5668	2399	8459	1946	9666	1631	10298	1389	10917	1003	12951	767	6968
10-#10	1.65	MA	7296	2399	10304	2031	11877	1707	12606	1449	13098	1060	15517	708	9458
5L-2S		MI	5883	2399	8889	1936	10214	1623	10963	1374	11817	991	14197	858	6956
10-#11	2.03	MA	8276	2482	12466	2026	14597	1693	15902	1426	17571	1009	21507	872	11602
2L-5S		MI	5509	2482	8146	2016	9187	1685	9671	1428	10016	1007	11730	587	8099
10-#11	2.03	MA	7909	2482	11726	2040	13654	1706	14757	1437	16022	1027	19362	767	11588
3L-4S		MI	5677	2482	8513	1995	9629	1676	10219	1411	10779	994	12759	651	8347
10-#11	2.03	MA	7723	2482	11222	2054	12944	1729	13885	1459	14827	1036	17906	705	11519
4L-3S		MI	5808	2482	8871	1984	10133	1656	10838	1404	11625	990	13791	714	8367
10-#11	2.03	MA	7449	2482	10709	2079	12325	1742	13115	1470	13755	1055	16434	650	11121
5L-2S		MI	6059	2482	9388	1973	10792	1647	11638	1386	12708	977	15258	827	8357
10-#14	2.93	MA	8962	2679	14096	2141	16628	1776	18347	1476	20863	992	26051	852	16419
2L-5S		MI	5763	2679	8751	2144	9907	1778	10518	1490	11136	998	13206	435	10818
10-#14	2.93	MA	8467	2679	13040	2161	15283	1793	16714	1491	18653	1018	22991	699	16354
3L-4S		MI	5996	2679	9274	2114	10538	1766	11301	1466	12224	980	14645	529	11466
10-#14	2.93	MA	8220	2679	12319	2180	14266	1825	15467	1521	16944	1029	20899	607	16116
4L-3S		MI	6172	2679	9785	2099	11256	1739	12182	1457	13429	977	16093	618	11691
10-#14	2.93	MA	7837	2679	11584	2215	13381	1843	14365	1537	15410	1055	18788	525	14992
5L-2S		MI	6511	2679	10520	2084	12192	1727	13318	1434	14967	959	18145	779	11716
10-#18	5.21	MA	9807	3179	16261	2469	19298	2016	21548	1629	25161	995	31977	522	27971
3L-4S		MI	6763	3179	11108	2420	12744	1996	13937	1608	15754	942	19069	194	17990
10-#18	5.21	MA	9430	3179	15001	2501	17522	2071	19369	1679	22177	1011	28287	356	25699
4L-3S		MI	7038	3179	11995	2397	13990	1952	15464	1596	17842	943	21501	343	19654
10-#18	5.21	MA	8790	3179	13714	2560	15971	2099	17441	1703	19493	1053	24579	200	23667
5L-2S		MI	7566	3179	13261	2374	15602	1935	17422	1558	20492	916	24922	630	19844
12-#10	1.98	MA	8281	2472	12363	2032	14528	1699	15848	1432	17524	1016	21460	879	11448
2L-6S		MI	5464	2472	8018	2026	9072	1706	9552	1439	9882	1028	11653	594	7903
12-#10	1.98	MA	7976	2472	11752	2044	13749	1709	14903	1442	16244	1032	19688	796	11437
3L-5S		MI	5612	2472	8290	2019	9432	1689	9998	1432	10485	1015	12451	655	8161
12-#10	1.98	MA	7825	2472	11337	2056	13164	1729	14185	1460	15260	1040	18497	745	11393
4E		MI	5757	2472	8593	2001	9796	1681	10451	1417	11116	1003	13324	708	8260
12-#10	1.98	MA	7594	2472	10915	2076	12655	1740	13551	1470	14377	1056	17289	703	11242
5L-3S		MI	5864	2472	8889	1991	10214	1664	10963	1410	11817	999	14197	761	8272
12-#10	1.98	MA	7382	2472	10510	2082	12177	1751	12929	1488	13536	1072	16109	632	10797
6L-2S		MI	6074	2472	9319	1982	10761	1656	11628	1395	12717	987	15442	852	8266
12-#11	2.44	MA	8609	2571	13206	2082	15539	1734	17046	1451	19120	1004	23651	865	13840
2L-6S		MI	5571	2571	8343	2081	9410	1745	9931	1461	10369	1016	12253	503	9313
12-#11	2.44	MA	8252	2571	12466	2096	14597	1746	15902	1463	17571	1022	21507	760	13814
3L-5S		MI	5746	2571	8663	2072	9846	1725	10471	1453	11099	1002	13197	576	9590
12-#11	2.44	MA	8076	2571	11962	2110	13886	1769	15030	1484	16376	1031	20051	698	13732
4E		MI	5914	2571	9030	2050	10288	1716	11020	1436	11862	989	14226	641	9895

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

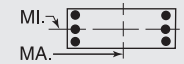


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.44	MA	7804	2571	11449	2135	13267	1782	14260	1495	15304	1050	18579	642	13285
5L-3S		MI	6039	2571	9388	2039	10792	1697	11638	1429	12708	985	15258	704	9929
12-#11	2.44	MA	7553	2571	10963	2142	12686	1795	13504	1517	14281	1068	17137	556	12793
6L-2S		MI	6283	2571	9906	2028	11451	1688	12438	1411	13791	972	16725	816	9930
12-#14	3.52	MA	8944	2808	14096	2241	16628	1851	18347	1527	20863	1011	26051	688	19519
3L-5S		MI	6095	2808	9486	2224	10843	1836	11655	1527	12674	990	15257	416	12950
12-#14	3.52	MA	8713	2808	13375	2261	15611	1884	17100	1558	19154	1022	23960	597	19185
4E		MI	6326	2808	10009	2195	11473	1824	12438	1503	13762	972	16697	510	13560
12-#14	3.52	MA	8334	2808	12641	2295	14726	1901	15998	1573	17620	1048	21848	515	18106
5L-3S		MI	6492	2808	10520	2180	12192	1798	13318	1494	14967	969	18145	599	13893
12-#14	3.52	MA	7989	2808	11953	2306	13892	1919	14915	1603	16156	1074	19776	388	17149
6L-2S		MI	6819	2808	11255	2165	13128	1786	14455	1470	16505	951	20196	761	13935
12-#18	6.25	MA	10262	3407	16838	2644	19861	2175	22210	1744	26022	998	33611	338	31105
4E		MI	7316	3407	12374	2563	14356	2100	15895	1672	18404	929	22491	147	21642
12-#18	6.25	MA	9628	3407	15551	2703	18310	2203	20282	1768	23338	1040	29903	181	29083
5L-3S		MI	7605	3407	13261	2540	15602	2056	17422	1661	20492	929	24922	296	23419
14-#10	2.32	MA	8262	2544	12363	2089	14528	1742	15848	1462	17524	1028	21460	790	13278
3L-6S		MI	5666	2544	8449	2072	9619	1739	10217	1459	10783	1023	12898	588	9160
14-#10	2.32	MA	8118	2544	11949	2101	13942	1762	15130	1480	16539	1036	20269	739	13225
4L-5S		MI	5810	2544	8720	2064	9979	1722	10663	1452	11386	1011	13696	649	9405
14-#10	2.32	MA	7888	2544	11527	2121	13434	1773	14497	1490	15657	1052	19060	697	13031
5L-4S		MI	5954	2544	9023	2046	10344	1714	11117	1437	12017	999	14570	702	9550
14-#10	2.32	MA	7682	2544	11121	2127	12956	1784	13875	1509	14815	1068	17881	627	12603
6L-3S		MI	6057	2544	9319	2037	10761	1697	11628	1430	12717	995	15442	755	9571
14-#10	2.32	MA	7506	2544	10733	2135	12414	1798	13278	1518	13956	1076	16738	592	12267
7L-2S		MI	6262	2544	9749	2027	11309	1689	12293	1415	13617	982	16687	846	9572
14-#11	2.84	MA	8590	2660	13206	2152	15539	1787	17046	1488	19120	1017	23651	753	16038
3L-6S		MI	5810	2660	8860	2137	10069	1785	10731	1486	11452	1011	13721	493	10826
14-#11	2.84	MA	8424	2660	12702	2166	14828	1810	16174	1509	17925	1026	22196	690	15945
4L-5S		MI	5980	2660	9181	2127	10505	1766	11271	1479	12182	997	14664	565	11089
14-#11	2.84	MA	8153	2660	12189	2190	14210	1822	15404	1521	16853	1044	20723	635	15456
5L-4S		MI	6147	2660	9548	2106	10947	1757	11820	1461	12945	983	15693	630	11441
14-#11	2.84	MA	7910	2660	11703	2198	13628	1835	14648	1542	15830	1063	19281	548	14984
6L-3S		MI	6266	2660	9906	2095	11451	1737	12438	1454	13791	980	16725	693	11486
14-#11	2.84	MA	7703	2660	11232	2207	12980	1854	13921	1554	14786	1072	17887	503	14339
7L-2S		MI	6505	2660	10423	2084	12110	1728	13238	1437	14874	967	18193	805	11499
14-#14	4.10	MA	9198	2936	14431	2341	16956	1942	18733	1594	21365	1014	27020	587	22265
4L-5S		MI	6420	2936	10221	2305	11779	1895	12791	1563	14212	983	17309	397	15091
14-#14	4.10	MA	8821	2936	13697	2375	16070	1960	17631	1609	19830	1040	24909	504	21227
5L-4S		MI	6650	2936	10744	2275	12409	1883	13574	1539	15300	965	18748	491	15668
14-#14	4.10	MA	8490	2936	13009	2387	15237	1977	16548	1640	18366	1066	22836	378	20262
6L-3S		MI	6807	2936	11255	2260	13128	1856	14455	1530	16505	962	20196	580	16092
14-#14	4.10	MA	8209	2936	12336	2399	14321	2004	15508	1655	16871	1077	20835	310	19163
7L-2S		MI	7125	2936	11990	2245	14064	1844	15591	1506	18043	944	22248	742	16150
14-#18	7.29	MA	10446	3635	17389	2846	20649	2307	23123	1833	27184	1026	35227	163	34498
5L-4S		MI	7922	3635	13640	2706	15968	2203	17854	1737	21054	916	25912	101	25314
16-#10	2.65	MA	8406	2617	12560	2146	14721	1795	16075	1501	17819	1032	22040	734	15057
4L-6S		MI	5865	2617	8879	2117	10167	1772	10882	1480	11683	1019	14143	583	10419
16-#10	2.65	MA	8177	2617	12138	2167	14212	1806	15442	1511	16936	1048	20832	691	14826
5E		MI	6006	2617	9150	2110	10527	1755	11328	1473	12286	1007	14942	643	10653
16-#10	2.65	MA	7977	2617	11732	2172	13734	1816	14820	1529	16095	1064	19652	621	14412
6L-4S		MI	6149	2617	9453	2092	10892	1747	11782	1458	12917	994	15815	696	10839
16-#10	2.65	MA	7808	2617	11344	2180	13192	1831	14223	1539	15236	1072	18510	586	14068
7L-3S		MI	6248	2617	9749	2082	11309	1730	12293	1451	13617	991	16687	749	10867
16-#10	2.65	MA	7611	2617	10972	2189	12689	1838	13596	1554	14416	1088	17410	538	13520
8L-2S		MI	6449	2617	10179	2072	11857	1722	12959	1436	14518	978	17932	840	10875
16-#11	3.25	MA	8766	2749	13443	2222	15770	1850	17319	1535	19474	1020	24341	683	18159
4L-6S		MI	6046	2749	9377	2192	10728	1826	11531	1511	12535	1005	15188	482	12342

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

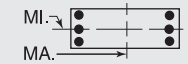
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	3.25	MA	8497	2749	12929	2246	15152	1863	16549	1546	18402	1039	22868	628	17633
5E		MI	6211	2749	9698	2183	11164	1806	12071	1504	13265	992	16131	555	12593
16-#11	3.25	MA	8261	2749	12444	2254	14570	1876	15793	1568	17379	1058	21426	541	17178
6L-4S		MI	6377	2749	10065	2162	11605	1797	12620	1486	14028	978	17161	619	12986
16-#11	3.25	MA	8062	2749	11972	2262	13923	1894	15066	1579	16335	1066	20031	496	16524
7L-3S		MI	6491	2749	10423	2151	12110	1778	13238	1479	14874	975	18193	682	13041
16-#11	3.25	MA	7830	2749	11520	2273	13312	1902	14317	1598	15337	1085	18690	434	15904
8L-2S		MI	6724	2749	10941	2140	12769	1769	14038	1462	15957	961	19660	795	13062
16-#14	4.69	MA	9299	3064	14753	2456	17415	2018	19264	1646	22041	1033	27969	494	24354
5E		MI	6742	3064	10956	2385	12715	1953	13928	1600	15750	976	19360	378	17239
16-#14	4.69	MA	8982	3064	14065	2467	16582	2035	18182	1676	20576	1059	25897	368	23380
6L-4S		MI	6970	3064	11479	2355	13345	1941	14711	1576	16838	957	20800	472	17786
16-#14	4.69	MA	8714	3064	13392	2479	15666	2063	17141	1691	19081	1070	23895	300	22302
7L-3S		MI	7119	3064	11990	2340	14064	1914	15591	1567	18043	954	22248	561	18290
18-#10	2.98	MA	8463	2689	12750	2212	14990	1838	16388	1531	18216	1044	22604	685	16625
5L-6S		MI	6062	2689	9309	2162	10714	1805	11547	1500	12583	1015	15388	577	11682
18-#10	2.98	MA	8267	2689	12344	2218	14512	1849	15766	1550	17374	1060	21424	615	16225
6L-5S		MI	6199	2689	9580	2155	11074	1788	11993	1494	13186	1003	16187	638	11906
18-#10	2.98	MA	8104	2689	11956	2225	13971	1864	15168	1560	16515	1068	20281	580	15871
7L-4S		MI	6342	2689	9883	2137	11439	1780	12447	1478	13817	990	17060	690	12127
18-#10	2.98	MA	7909	2689	11583	2234	13468	1871	14541	1575	15695	1084	19181	532	15336
8L-3S		MI	6438	2689	10179	2127	11857	1763	12959	1472	14518	986	17932	743	12161
18-#10	2.98	MA	7710	2689	11166	2252	12951	1888	13921	1582	14856	1091	18096	487	14761
9L-2S		MI	6635	2689	10609	2118	12404	1755	13624	1456	15418	974	19178	834	12175
18-#11	3.66	MA	8836	2838	13670	2302	16094	1903	17694	1571	19951	1034	25013	621	19814
5L-6S		MI	6278	2838	9895	2248	11387	1866	12331	1536	13618	1000	16655	471	13862
18-#11	3.66	MA	8607	2838	13184	2309	15513	1916	16937	1593	18928	1053	23571	534	19375
6L-5S		MI	6439	2838	10216	2239	11823	1847	12871	1529	14348	987	17598	544	14102
18-#11	3.66	MA	8415	2838	12713	2318	14865	1935	16211	1604	17883	1061	22176	489	18711
7L-4S		MI	6605	2838	10582	2217	12264	1838	13420	1512	15111	973	18628	609	14531
18-#11	3.66	MA	8186	2838	12260	2328	14254	1943	15461	1624	16886	1080	20835	427	18092
8L-3S		MI	6714	2838	10941	2206	12769	1818	14038	1505	15957	970	19660	672	14594
18-#14	5.27	MA	9464	3193	15122	2547	17926	2094	19815	1712	22787	1051	28957	357	26502
6L-5S		MI	7059	3193	11691	2465	13650	2011	15064	1636	17289	968	21412	360	19393
18-#14	5.27	MA	9209	3193	14448	2559	17011	2121	18774	1728	21292	1062	26956	289	25441
7L-4S		MI	7287	3193	12214	2435	14281	1999	15847	1612	18376	950	22851	454	19914
20-#10	3.31	MA	8555	2762	12955	2263	15291	1882	16711	1570	18654	1056	23196	609	18040
6E		MI	6257	2762	9739	2208	11262	1838	12212	1521	13483	1011	16634	571	12948
20-#10	3.31	MA	8397	2762	12567	2271	14749	1897	16114	1580	17795	1063	22053	575	17677
7L-5S		MI	6391	2762	10010	2200	11622	1821	12658	1514	14086	998	17432	632	13163
20-#10	3.31	MA	8203	2762	12195	2280	14246	1904	15487	1596	16975	1080	20953	526	17154
8L-4S		MI	6534	2762	10313	2182	11987	1813	13112	1499	14717	986	18306	684	13414
20-#10	3.31	MA	8009	2762	11777	2298	13729	1921	14867	1602	16136	1087	19868	481	16580
9L-3S		MI	6625	2762	10609	2173	12404	1796	13624	1492	15418	982	19178	737	13454
20-#11	4.06	MA	8948	2927	13924	2365	16455	1957	18082	1618	20477	1048	25715	527	21575
6E		MI	6508	2927	10412	2304	12046	1907	13131	1562	14701	995	18122	461	15375
20-#11	4.06	MA	8764	2927	13453	2374	15807	1975	17355	1629	19432	1056	24321	482	20901
7L-5S		MI	6665	2927	10733	2294	12481	1887	13672	1554	15431	981	19066	533	15616
20-#11	4.06	MA	8536	2927	13000	2384	15196	1983	16606	1649	18435	1075	22979	420	20283
8L-4S		MI	6830	2927	11100	2273	12923	1878	14220	1537	16194	968	20095	598	16056
20-#14	5.86	MA	9697	3321	15504	2640	18355	2179	20408	1764	23502	1055	30016	279	28579
7L-5S		MI	7373	3321	12426	2546	14586	2070	16201	1672	18827	961	23463	341	21553

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

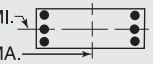
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	3.64	MA	8685	2834	13178	2316	15528	1930	17059	1601	19074	1059	23825	569	19485
7L-6S		MI	6449	2834	10169	2253	11810	1870	12877	1541	14383	1006	17879	565	14215
22-#10	3.64	MA	8493	2834	12806	2325	15025	1937	16432	1616	18254	1075	22725	520	18973
8L-5S		MI	6581	2834	10440	2246	12170	1854	13323	1535	14986	994	18677	626	14422
22-#10	3.64	MA	8303	2834	12388	2343	14508	1954	15812	1623	17415	1083	21639	476	18399
9L-4S		MI	6723	2834	10743	2228	12534	1846	13777	1519	15617	982	19551	678	14700
22-#11	4.47	MA	9107	3017	14193	2429	16750	2016	18500	1654	20981	1051	26466	475	23094
7L-6S		MI	6736	3017	10930	2359	12704	1947	13932	1587	15784	990	19589	450	16868
22-#11	4.47	MA	8881	3017	13740	2440	16139	2024	17751	1674	19984	1070	25124	412	22475
8L-5S		MI	6889	3017	11251	2350	13140	1928	14472	1580	16514	976	20533	523	17133
24-#10	3.97	MA	8779	2907	13417	2370	15803	1970	17377	1637	19534	1071	24496	515	20793
8L-6S		MI	6640	2907	10599	2298	12357	1903	13542	1562	15283	1002	19124	559	15485
24-#10	3.97	MA	8595	2907	13000	2388	15286	1987	16757	1643	18695	1079	23411	470	20217
9L-5S		MI	6769	2907	10870	2291	12717	1887	13989	1555	15886	990	19923	620	15684
24-#11	4.88	MA	9221	3106	14481	2495	17081	2064	18895	1699	21533	1065	27269	405	24670
8L-6S		MI	6961	3106	11447	2415	13363	1988	14732	1612	16867	985	21057	440	18365

RECTANGULAR TIED COLUMNS 24" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.10	MA	8465	2421	12158	2020	14049	1702	15006	1455	15853	1085	18766	945	7299
2E		MI	5865	2421	8743	1949	9854	1642	10386	1402	10807	1043	12483	891	5007
4-#18	1.96	MA	9218	2621	13950	2128	16238	1779	17619	1499	19352	1064	23583	920	12521
2E		MI	6307	2621	9895	2050	11237	1712	12024	1441	12994	1018	15147	823	8399
6-#11	1.15	MA	8529	2431	12218	2034	14173	1714	15180	1464	16108	1090	19134	948	7610
2L-3S		MI	5643	2431	8261	1978	9284	1666	9715	1432	9915	1063	11352	791	5241
6-#11	1.15	MA	8103	2431	11422	2049	13160	1727	13950	1476	14443	1109	16828	846	7627
3L-2S		MI	5909	2431	8779	1967	9943	1657	10515	1414	10998	1050	12819	903	5212
6-#14	1.65	MA	8995	2549	13294	2100	15496	1761	16763	1492	18231	1078	22059	934	10759
2L-3S		MI	5823	2549	8743	2044	9854	1712	10386	1463	10807	1054	12483	710	7303
6-#14	1.65	MA	8409	2549	12158	2120	14049	1779	15006	1508	15853	1105	18766	784	10747
3L-2S		MI	6189	2549	9478	2029	10790	1700	11522	1439	12346	1036	14534	872	7274
6-#18	2.94	MA	10094	2849	15930	2270	18759	1882	20681	1564	23496	1050	29321	901	18508
2L-3S		MI	6252	2849	9895	2216	11237	1833	12024	1544	12994	1031	15147	489	12192
6-#18	2.94	MA	9151	2849	13950	2304	16238	1912	17619	1590	19352	1095	23583	626	18302
3L-2S		MI	6840	2849	11162	2193	12849	1816	13983	1506	15644	1004	18568	777	12258
8-#10	1.25	MA	8656	2454	12381	2060	14448	1734	15546	1479	16631	1095	19877	952	8288
2L-4S		MI	5659	2454	8154	2017	9168	1706	9599	1455	9773	1075	11332	775	5697
8-#10	1.25	MA	8307	2454	11724	2073	13611	1746	14530	1490	15256	1112	17974	871	8297
3E		MI	5776	2454	8450	2008	9586	1689	10110	1448	10474	1071	12204	828	5681
8-#10	1.25	MA	8127	2454	11281	2085	12984	1766	13760	1509	14201	1120	16705	821	8276
4L-2S		MI	5997	2454	8880	1998	10133	1681	10776	1433	11374	1058	13449	919	5662
8-#11	1.53	MA	8903	2520	13014	2090	15187	1755	16411	1490	17774	1084	21440	941	10031
2L-4S		MI	5742	2520	8420	2045	9439	1726	9897	1464	10152	1062	11787	717	6833
8-#11	1.53	MA	8491	2520	12218	2105	14173	1768	15180	1502	16108	1104	19134	839	10033
3E		MI	5881	2520	8779	2034	9943	1706	10515	1457	10998	1058	12819	780	6826
8-#11	1.53	MA	8278	2520	11678	2119	13411	1791	14245	1524	14826	1113	17581	776	9981
4L-2S		MI	6140	2520	9296	2023	10602	1697	11315	1440	12081	1045	14286	892	6805
8-#14	2.21	MA	9512	2678	14430	2180	16943	1819	18520	1528	20610	1070	25353	924	14203
2L-4S		MI	5965	2678	8967	2139	10071	1797	10642	1508	11140	1050	13087	603	9457
8-#14	2.21	MA	8951	2678	13294	2200	15496	1837	16763	1544	18231	1098	22059	774	14160
3E		MI	6154	2678	9478	2124	10790	1771	11522	1499	12346	1046	14534	691	9526
8-#14	2.21	MA	8662	2678	12521	2221	14405	1871	15424	1576	16397	1110	19827	683	13953
4L-2S		MI	6507	2678	10213	2109	11726	1759	12659	1475	13884	1028	16586	853	9519
8-#18	3.92	MA	10946	3078	17910	2413	21280	1986	23743	1629	27640	1037	35059	883	24474
2L-4S		MI	6501	3078	10275	2381	11603	1981	12456	1620	13556	1017	16137	294	14548
8-#18	3.92	MA	10059	3078	15930	2447	18759	2016	20681	1655	23496	1082	29321	608	24213
3E		MI	6804	3078	11162	2358	12849	1937	13983	1609	15644	1017	18568	443	15960

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

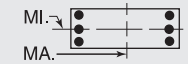
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.92	MA	9602	3078	14577	2481	16850	2073	18339	1707	20288	1100	25381	445	22061
4L-2S		MI	7364	3078	12428	2335	14461	1920	15941	1571	18294	991	21989	731	16086
10-#10	1.56	MA	8967	2527	13038	2106	15284	1767	16562	1500	18005	1091	21780	946	10282
2L-5S		MI	5716	2527	8281	2081	9351	1747	9810	1491	10043	1083	11704	717	6973
10-#10	1.56	MA	8627	2527	12381	2118	14448	1779	15546	1510	16631	1108	19877	865	10280
3L-4S		MI	5862	2527	8584	2063	9716	1739	10264	1476	10674	1070	12577	769	6999
10-#10	1.56	MA	8455	2527	11937	2130	13820	1799	14776	1529	15575	1116	18607	815	10247
4L-3S		MI	5975	2527	8880	2053	10133	1722	10776	1469	11374	1066	13449	822	6994
10-#10	1.56	MA	8200	2527	11485	2151	13276	1810	14098	1540	14630	1133	17316	774	10144
5L-2S		MI	6191	2527	9310	2043	10681	1714	11441	1454	12274	1054	14695	914	6980
10-#11	1.91	MA	9270	2609	13809	2146	16200	1795	17641	1515	19439	1079	23746	934	12445
2L-5S		MI	5814	2609	8571	2122	9656	1775	10148	1507	10472	1070	12225	642	8198
10-#11	1.91	MA	8870	2609	13014	2160	15187	1808	16411	1527	17774	1099	21440	831	12431
3L-4S		MI	5983	2609	8938	2100	10098	1766	10697	1489	11235	1056	13254	706	8389
10-#11	1.91	MA	8669	2609	12474	2175	14424	1832	15475	1549	16492	1108	19888	769	12362
4L-3S		MI	6115	2609	9296	2089	10602	1747	11315	1482	12081	1053	14286	769	8400
10-#11	1.91	MA	8368	2609	11924	2200	13762	1845	14650	1561	15342	1128	18313	716	12010
5L-2S		MI	6367	2609	9814	2078	11261	1738	12115	1465	13164	1040	15753	882	8387
10-#14	2.76	MA	10019	2806	15567	2260	18390	1877	20278	1564	22988	1063	28646	914	17634
2L-5S		MI	6068	2806	9179	2249	10377	1868	10995	1569	11591	1060	13699	490	10940
10-#14	2.76	MA	9480	2806	14430	2281	16943	1896	18520	1581	20610	1090	25353	764	17569
3L-4S		MI	6301	2806	9702	2219	11007	1856	11778	1545	12679	1042	15138	584	11605
10-#14	2.76	MA	9211	2806	13658	2301	15852	1929	17182	1612	18775	1103	23121	673	17343
4L-3S		MI	6479	2806	10213	2205	11726	1829	12659	1536	13884	1039	16586	672	11736
10-#14	2.76	MA	8789	2806	12870	2337	14903	1947	16000	1628	17130	1130	20861	594	16199
5L-2S		MI	6821	2806	10948	2190	12662	1817	13796	1512	15422	1021	18638	834	11752
10-#18	4.90	MA	10942	3306	17910	2590	21280	2120	23743	1720	27640	1069	35059	590	30131
3L-4S		MI	7066	3306	11541	2524	13215	2084	14414	1685	16206	1004	19558	248	18168
10-#18	4.90	MA	10532	3306	16557	2624	19371	2177	21401	1772	24432	1087	31119	426	27883
4L-3S		MI	7345	3306	12428	2501	14461	2041	15941	1673	18294	1004	21989	397	19726
10-#18	4.90	MA	9826	3306	15176	2684	17707	2207	19331	1798	21550	1132	27147	276	25804
5L-2S		MI	7882	3306	13694	2478	16074	2024	17899	1636	20945	978	25411	684	19896
12-#10	1.87	MA	9273	2599	13695	2151	16120	1800	17577	1521	19379	1087	23683	941	12271
2L-6S		MI	5769	2599	8440	2133	9539	1797	10029	1518	10340	1091	12151	650	7983
12-#10	1.87	MA	8941	2599	13038	2163	15284	1812	16562	1531	18005	1104	21780	859	12260
3L-5S		MI	5918	2599	8711	2126	9899	1780	10475	1511	10943	1078	12949	711	8246
12-#10	1.87	MA	8777	2599	12594	2176	14656	1831	15792	1550	16949	1112	20510	809	12216
4E		MI	6063	2599	9014	2108	10264	1772	10929	1496	11574	1066	13823	763	8294
12-#10	1.87	MA	8524	2599	12142	2196	14112	1843	15113	1560	16004	1129	19219	768	12104
5L-3S		MI	6171	2599	9310	2098	10681	1755	11441	1489	12274	1062	14695	816	8300
12-#10	1.87	MA	8295	2599	11703	2202	13599	1854	14448	1579	15103	1146	17958	699	11624
6L-2S		MI	6382	2599	9740	2089	11229	1747	12106	1474	13175	1050	15940	908	8292
12-#11	2.29	MA	9632	2698	14605	2201	17213	1836	18872	1540	21105	1074	26052	927	14851
2L-6S		MI	5876	2698	8768	2187	9879	1835	10408	1539	10825	1078	12748	558	9407
12-#11	2.29	MA	9244	2698	13809	2216	16200	1849	17641	1552	19439	1094	23746	824	14825
3L-5S		MI	6052	2698	9089	2177	10315	1816	10948	1532	11555	1065	13692	631	9687
12-#11	2.29	MA	9053	2698	13270	2231	15437	1872	16706	1574	18157	1103	22194	762	14743
4E		MI	6219	2698	9455	2156	10756	1807	11497	1515	12318	1051	14721	696	9940
12-#11	2.29	MA	8754	2698	12720	2255	14775	1886	15881	1586	17008	1123	20619	709	14340
5L-3S		MI	6346	2698	9814	2145	11261	1787	12115	1508	13164	1048	15753	759	9965
12-#11	2.29	MA	8481	2698	12193	2263	14152	1899	15071	1609	15912	1142	19080	623	13786
6L-2S		MI	6592	2698	10331	2134	11920	1778	12915	1490	14247	1034	17221	871	9962
12-#14	3.31	MA	9998	2935	15567	2361	18390	1954	20278	1617	22988	1083	28646	753	20977
3L-5S		MI	6400	2935	9914	2330	11313	1926	12132	1605	13129	1053	15750	471	13069

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

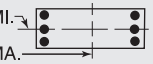


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	3.31	MA	9747	2935	14794	2381	17299	1987	18939	1648	21154	1095	26414	663	20736
4E		MI	6631	2935	10437	2300	11943	1914	12915	1581	14217	1035	17190	565	13695
12-#14	3.31	MA	9330	2935	14007	2417	16349	2006	17758	1665	19508	1122	24155	584	19555
5L-3S		MI	6800	2935	10948	2285	12662	1887	13796	1572	15422	1032	18638	653	13940
12-#14	3.31	MA	8956	2935	13259	2428	15457	2024	16597	1696	17938	1150	21943	459	18626
6L-2S		MI	7130	2935	11683	2270	13597	1875	14932	1548	16960	1014	20689	815	13975
12-#18	5.88	MA	11437	3534	18537	2767	21892	2280	24463	1837	28576	1074	36856	408	33722
4E		MI	7620	3534	12807	2667	14827	2188	16372	1750	18857	990	22979	201	21814
12-#18	5.88	MA	10737	3534	17156	2827	20228	2310	22393	1863	25694	1118	32885	258	31631
5L-3S		MI	7915	3534	13694	2644	16074	2144	17899	1738	20945	991	25411	350	23493
14-#10	2.18	MA	9251	2672	13695	2209	16120	1845	17577	1551	19379	1099	23683	853	14238
3L-6S		MI	5971	2672	8870	2179	10087	1830	10694	1539	11240	1087	13396	644	9238
14-#10	2.18	MA	9095	2672	13251	2221	15493	1864	16807	1570	18324	1108	22413	803	14185
4L-5S		MI	6116	2672	9141	2171	10446	1813	11140	1532	11843	1074	14194	705	9488
14-#10	2.18	MA	8843	2672	12798	2242	14948	1876	16129	1581	17379	1125	21122	762	14052
5L-4S		MI	6261	2672	9444	2153	10811	1805	11594	1517	12474	1062	15068	757	9586
14-#10	2.18	MA	8620	2672	12359	2247	14435	1887	15463	1599	16478	1141	19861	693	13567
6L-3S		MI	6365	2672	9740	2144	11229	1788	12106	1510	13175	1058	15940	810	9602
14-#10	2.18	MA	8430	2672	11943	2255	13849	1902	14824	1610	15558	1150	18644	660	13226
7L-2S		MI	6572	2672	10170	2134	11776	1780	12771	1495	14075	1046	17185	902	9599
14-#11	2.68	MA	9611	2788	14605	2272	17213	1889	18872	1577	21105	1089	26052	817	17218
3L-6S		MI	6115	2788	9285	2243	10538	1876	11208	1565	11908	1073	14216	548	10918
14-#11	2.68	MA	9430	2788	14065	2286	16451	1913	17936	1600	19823	1098	24500	755	17124
4L-5S		MI	6286	2788	9606	2233	10974	1856	11748	1557	12638	1060	15159	620	11184
14-#11	2.68	MA	9133	2788	13516	2311	15788	1926	17112	1611	18673	1118	22925	702	16677
5L-4S		MI	6453	2788	9973	2212	11415	1847	12297	1540	13401	1046	16188	685	11488
14-#11	2.68	MA	8869	2788	12989	2318	15165	1939	16301	1634	17577	1137	21386	616	16144
6L-3S		MI	6574	2788	10331	2201	11920	1828	12915	1533	14247	1043	17221	748	11525
14-#11	2.68	MA	8645	2788	12483	2328	14462	1958	15523	1646	16458	1147	19897	573	15519
7L-2S		MI	6815	2788	10848	2190	12578	1819	13716	1515	15330	1029	18688	860	11532
14-#14	3.86	MA	10273	3063	15930	2462	18746	2046	20696	1685	23532	1088	29707	652	24107
4L-5S		MI	6727	3063	10649	2410	12248	1984	13269	1641	14667	1045	17802	452	15207
14-#14	3.86	MA	9859	3063	15143	2497	17796	2064	19515	1701	21887	1115	27448	574	22918
5L-4S		MI	6956	3063	11172	2380	12879	1972	14051	1617	15755	1027	19241	546	15799
14-#14	3.86	MA	9500	3063	14396	2508	16904	2083	18355	1733	20317	1142	25236	448	21985
6L-3S		MI	7116	3063	11683	2365	13597	1946	14932	1608	16960	1024	20689	635	16142
14-#14	3.86	MA	9195	3063	13673	2521	15908	2109	17240	1749	18714	1155	23097	384	20731
7L-2S		MI	7437	3063	12418	2350	14533	1934	16069	1585	18498	1006	22741	796	16191
14-#18	6.86	MA	11626	3763	19136	2970	22749	2414	25455	1928	29838	1105	38623	239	37458
5L-4S		MI	8227	3763	14074	2810	16440	2292	18331	1814	21507	977	26400	155	25479
16-#10	2.49	MA	9407	2744	13907	2266	16329	1897	17823	1591	19698	1104	24316	797	16154
4L-6S		MI	6171	2744	9300	2224	10634	1863	11359	1559	12140	1082	14641	638	10497
16-#10	2.49	MA	9157	2744	13455	2287	15784	1909	17144	1601	18753	1120	23025	756	15982
5E		MI	6312	2744	9571	2217	10994	1846	11805	1552	12743	1070	15440	699	10735
16-#10	2.49	MA	8940	2744	13016	2293	15271	1920	16479	1620	17852	1137	21764	688	15512
6L-4S		MI	6456	2744	9874	2199	11359	1838	12259	1537	13374	1058	16313	751	10877
16-#10	2.49	MA	8756	2744	12600	2301	14686	1935	15840	1630	16932	1146	20547	654	15183
7L-3S		MI	6557	2744	10170	2189	11776	1821	12771	1530	14075	1054	17185	804	10899
16-#10	2.49	MA	8541	2744	12201	2310	14147	1942	15159	1645	16054	1163	19372	607	14593
8L-2S		MI	6759	2744	10600	2179	12324	1813	13436	1515	14975	1041	18431	896	10904
16-#11	3.06	MA	9802	2877	14861	2342	17464	1953	19167	1625	21488	1093	26806	748	19506
4L-6S		MI	6351	2877	9803	2298	11197	1916	12008	1590	12991	1068	15683	537	12434
16-#11	3.06	MA	9506	2877	14312	2367	16801	1967	18342	1637	20339	1112	25231	695	19021
5E		MI	6518	2877	10123	2289	11632	1897	12548	1583	13721	1055	16626	610	12687
16-#11	3.06	MA	9250	2877	13784	2374	16178	1980	17532	1659	19242	1132	23693	609	18506
6L-4S		MI	6684	2877	10490	2267	12074	1888	13097	1565	14484	1041	17656	674	13035
16-#11	3.06	MA	9035	2877	13279	2383	15475	1998	16754	1671	18123	1141	22203	566	17872
7L-3S		MI	6800	2877	10848	2256	12578	1868	13716	1558	15330	1038	18688	737	13081

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

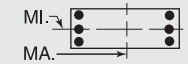
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	3.06	MA	8780	2877	12794	2394	14820	2007	15939	1690	17055	1161	20769	506	17189
8L-2S		MI	7035	2877	11366	2245	13237	1859	14516	1541	16413	1024	20155	850	13097
16-#14	4.41	MA	10378	3192	16279	2577	19243	2123	21273	1738	24265	1108	30741	563	26287
5E		MI	7048	3192	11384	2490	13184	2043	14405	1678	16205	1038	19853	433	17353
16-#14	4.41	MA	10034	3192	15532	2588	18351	2141	20112	1769	22695	1135	28529	438	25349
6L-4S		MI	7277	3192	11907	2460	13814	2031	15188	1654	17293	1020	21293	527	17914
16-#14	4.41	MA	9743	3192	14809	2601	17355	2168	18997	1785	21092	1147	26391	373	24110
7L-3S		MI	7428	3192	12418	2445	14533	2004	16069	1645	18498	1017	22741	616	18341
18-#10	2.80	MA	9467	2817	14112	2332	16620	1942	18160	1622	20127	1116	24928	751	17916
5L-6S		MI	6368	2817	9730	2269	11182	1896	12024	1580	13040	1078	15887	632	11759
18-#10	2.80	MA	9255	2817	13673	2338	16107	1953	17494	1641	19226	1133	23667	682	17461
6L-5S		MI	6507	2817	10001	2262	11542	1879	12471	1573	13643	1066	16685	693	11987
18-#10	2.80	MA	9078	2817	13257	2346	15522	1967	16855	1651	18307	1141	22450	648	17141
7L-4S		MI	6650	2817	10304	2244	11906	1871	12924	1558	14274	1053	17558	745	12166
18-#10	2.80	MA	8864	2817	12858	2355	14983	1975	16174	1666	17428	1158	21275	601	16546
8L-3S		MI	6746	2817	10600	2234	12324	1854	13436	1551	14975	1050	18431	798	12194
18-#10	2.80	MA	8648	2817	12410	2374	14429	1992	15510	1673	16531	1167	20120	557	15976
9L-2S		MI	6945	2817	11030	2224	12871	1846	14101	1536	15875	1037	19676	890	12205
18-#11	3.44	MA	9874	2966	15107	2422	17814	2007	19573	1662	22004	1107	27537	688	21369
5L-6S		MI	6584	2966	10320	2354	11855	1956	12808	1615	14074	1063	17150	526	13953
18-#11	3.44	MA	9626	2966	14580	2430	17192	2020	18763	1684	20908	1127	25999	601	20871
6L-5S		MI	6747	2966	10641	2344	12291	1937	13349	1608	14804	1049	18094	599	14195
18-#11	3.44	MA	9418	2966	14075	2439	16488	2039	17984	1696	19789	1136	24509	558	20229
7L-4S		MI	6912	2966	11008	2323	12733	1928	13897	1590	15567	1036	19123	664	14580
18-#11	3.44	MA	9166	2966	13590	2450	15833	2047	17170	1715	18720	1156	23075	499	19561
8L-3S		MI	7024	2966	11366	2312	13237	1909	14516	1583	16413	1032	20155	727	14635
18-#14	4.96	MA	10558	3320	16669	2669	19798	2199	21869	1805	25073	1127	31823	428	28718
6L-5S		MI	7366	3320	12119	2570	14120	2101	15542	1714	17743	1030	21905	414	19504
18-#14	4.96	MA	10281	3320	15946	2681	18802	2226	20754	1822	23471	1140	29684	363	27488
7L-4S		MI	7594	3320	12642	2541	14750	2089	16324	1690	18831	1012	23344	508	20039
20-#10	3.11	MA	9566	2889	14329	2383	16943	1986	18510	1661	20601	1129	25570	676	19412
6E		MI	6563	2889	10160	2315	11729	1929	12689	1600	13940	1074	17132	626	13023
20-#10	3.11	MA	9395	2889	13913	2391	16358	2000	17871	1672	19681	1137	24353	642	19092
7L-5S		MI	6699	2889	10431	2307	12089	1912	13136	1594	14543	1062	17930	687	13242
20-#10	3.11	MA	9183	2889	13515	2401	15819	2008	17190	1687	18803	1154	23178	596	18502
8L-4S		MI	6841	2889	10734	2289	12454	1904	13589	1578	15174	1049	18804	739	13454
20-#10	3.11	MA	8972	2889	13067	2419	15265	2025	16526	1694	17905	1162	22023	551	17929
9L-3S		MI	6935	2889	11030	2279	12871	1887	14101	1572	15875	1045	19676	793	13488
20-#10	3.11	MA	8772	2889	12653	2426	14744	2034	15863	1710	17030	1179	20852	510	17265
10L-2S		MI	7130	2889	11461	2270	13419	1879	14766	1556	16775	1033	20921	884	13503
20-#11	3.82	MA	9996	3055	15376	2485	18205	2061	19993	1710	22573	1122	28305	594	23239
6E		MI	6815	3055	10837	2410	12514	1997	13609	1640	15157	1058	18617	516	15474
20-#11	3.82	MA	9796	3055	14871	2495	17501	2079	19215	1721	21454	1131	26815	551	22588
7L-5S		MI	6973	3055	11158	2400	12950	1978	14149	1633	15887	1044	19561	588	15707
20-#11	3.82	MA	9545	3055	14386	2505	16846	2088	18401	1741	20386	1151	25382	491	21936
8L-4S		MI	7138	3055	11525	2379	13392	1968	14698	1616	16650	1031	20590	653	16126
20-#14	5.51	MA	10810	3449	17082	2762	20248	2284	22512	1858	25849	1132	32977	353	30866
7L-5S		MI	7681	3449	12854	2651	15056	2160	16678	1751	19282	1023	23956	395	21661
22-#10	3.42	MA	9708	2962	14570	2437	17194	2033	18886	1692	21055	1133	26256	636	21037
7L-6S		MI	6756	2962	10590	2360	12277	1962	13355	1621	14840	1070	18377	620	14290
22-#10	3.42	MA	9497	2962	14171	2446	16655	2041	18205	1707	20177	1150	25081	590	20458
8L-5S		MI	6889	2962	10861	2353	12637	1945	13801	1614	15443	1057	19175	681	14501

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

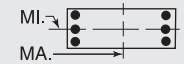
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	3.42	MA	9292	2962	13724	2464	16101	2058	17541	1714	19279	1158	23926	546	19882
9L-4S		MI	7031	2962	11164	2335	13002	1937	14254	1599	16074	1045	20049	733	14741
22-#10	3.42	MA	9106	2962	13310	2471	15580	2067	16879	1731	18404	1175	22755	505	19220
10L-3S		MI	7122	2962	11461	2325	13419	1920	14766	1592	16775	1041	20921	787	14781
22-#11	4.21	MA	10169	3144	15666	2550	18515	2119	20446	1747	23120	1126	29121	544	24950
7L-6S		MI	7043	3144	11355	2465	13173	2037	14409	1666	16240	1053	20085	505	16999
22-#11	4.21	MA	9920	3144	15181	2561	17859	2128	19631	1766	22051	1146	27688	484	24313
8L-5S		MI	7198	3144	11676	2456	13609	2018	14949	1658	16970	1039	21028	578	17222
24-#10	3.74	MA	9807	3034	14828	2491	17491	2074	19221	1728	21552	1146	26984	584	22417
8L-6S		MI	6948	3034	11020	2405	12825	1995	14020	1641	15741	1065	19622	614	15559
24-#10	3.74	MA	9607	3034	14380	2509	16938	2091	18557	1735	20654	1154	25829	540	21835
9L-5S		MI	7078	3034	11291	2398	13184	1978	14466	1635	16344	1053	20421	675	15762
24-#10	3.74	MA	9427	3034	13967	2516	16416	2100	17894	1751	19779	1170	24658	499	21175
10L-4S		MI	7220	3034	11594	2380	13549	1970	14919	1619	16974	1041	21294	727	16028
24-#11	4.59	MA	10290	3233	15977	2617	18873	2169	20862	1791	23717	1140	29994	477	26688
8L-6S		MI	7269	3233	11872	2521	13832	2078	15209	1691	17323	1047	21552	495	18506

RECTANGULAR TIED COLUMNS 24" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.04	MA	9447	2548	13447	2139	15577	1804	16642	1544	17553	1156	20752	1007	7785
2E		MI	6171	2548	9171	2054	10324	1732	10863	1481	11262	1106	12976	945	5032
4-#18	1.85	MA	10266	2748	15373	2247	17929	1880	19450	1588	21312	1134	25927	982	13385
2E		MI	6615	2748	10329	2154	11708	1801	12501	1519	13446	1079	15635	877	8436
6-#11	1.08	MA	9515	2559	13510	2154	15708	1816	16826	1553	17822	1160	21140	1010	8116
2L-3S		MI	5948	2559	8686	2084	9753	1756	10192	1511	10371	1126	11847	846	5265
6-#11	1.08	MA	9055	2559	12658	2169	14624	1830	15509	1566	16040	1181	18673	909	8133
3L-2S		MI	6216	2559	9204	2073	10412	1747	10992	1493	11454	1113	13314	958	5236
6-#14	1.56	MA	10021	2677	14664	2219	17127	1862	18524	1580	20099	1148	24278	996	11488
2L-3S		MI	6128	2677	9171	2149	10324	1802	10863	1541	11262	1116	12976	765	7336
6-#14	1.56	MA	9387	2677	13447	2240	15577	1882	16642	1598	17553	1177	20752	849	11476
3L-2S		MI	6496	2677	9906	2134	11260	1790	12000	1517	12800	1098	15027	926	7304
6-#18	2.78	MA	11215	2976	17496	2390	20632	1984	22733	1653	25755	1121	32078	963	19804
2L-3S		MI	6557	2976	10329	2319	11708	1922	12501	1621	13446	1092	15635	543	12254
6-#18	2.78	MA	10192	2976	15373	2425	17929	2016	19450	1681	21312	1168	25927	693	19598
3L-2S		MI	7150	2976	11595	2296	13320	1905	14460	1583	16097	1066	19057	831	12301
8-#10	1.18	MA	9651	2581	13682	2180	15998	1836	17213	1568	18375	1166	21927	1014	8836
2L-4S		MI	5964	2581	8575	2124	9636	1797	10076	1535	10231	1138	11830	830	5723
8-#10	1.18	MA	9274	2581	12980	2192	15104	1848	16127	1579	16906	1183	19893	934	8845
3E		MI	6082	2581	8871	2114	10053	1781	10588	1528	10931	1134	12702	884	5704
8-#10	1.18	MA	9080	2581	12506	2205	14435	1868	15306	1598	15779	1192	18544	884	8825
4L-2S		MI	6304	2581	9301	2105	10601	1772	11253	1512	11832	1122	13948	975	5684
8-#11	1.44	MA	9919	2648	14361	2209	16792	1856	18143	1578	19604	1155	23608	1003	10705
2L-4S		MI	6048	2648	8845	2151	9907	1816	10374	1543	10608	1124	12282	772	6868
8-#11	1.44	MA	9473	2648	13510	2224	15708	1870	16826	1591	17822	1176	21140	902	10707
3E		MI	6187	2648	9204	2140	10412	1797	10992	1536	11454	1121	13314	835	6855
8-#11	1.44	MA	9244	2648	12934	2239	14894	1894	15827	1614	16453	1186	19490	841	10655
4L-2S		MI	6447	2648	9721	2129	11071	1788	11792	1518	12537	1107	14781	947	6831
8-#14	2.08	MA	10580	2805	15881	2299	18676	1921	20405	1617	22645	1141	27803	986	15175
2L-4S		MI	6270	2805	9395	2244	10541	1887	11119	1586	11595	1112	13579	657	9513
8-#14	2.08	MA	9972	2805	14664	2321	17127	1940	18524	1634	20099	1169	24278	838	15132
3E		MI	6460	2805	9906	2229	11260	1860	12000	1577	12800	1109	15027	746	9565
8-#14	2.08	MA	9660	2805	13839	2342	15961	1974	17094	1666	18139	1183	21905	749	14925
4L-2S		MI	6815	2805	10641	2215	12195	1848	13136	1554	14339	1091	17079	908	9552
8-#18	3.70	MA	12139	3205	19619	2532	23335	2088	26015	1717	30197	1108	38230	945	26202
2L-4S		MI	6804	3205	10708	2485	12074	2069	12933	1697	14009	1078	16625	348	14730
8-#18	3.70	MA	11175	3205	17496	2568	20632	2120	22733	1745	25755	1155	32078	675	25941
3E		MI	7110	3205	11595	2462	13320	2026	14460	1686	16097	1079	19057	497	16027

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

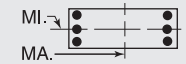
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.70	MA	10682	3205	16050	2603	18591	2178	20228	1800	22323	1175	27888	513	23834
4L-2S		MI	7674	3205	12861	2439	14933	2008	16418	1648	18747	1053	22478	785	16134
10-#10	1.47	MA	9986	2654	14384	2225	16891	1869	18299	1589	19844	1162	23962	1008	10968
2L-5S		MI	6022	2654	8702	2188	9818	1838	10287	1570	10500	1146	12202	772	7012
10-#10	1.47	MA	9618	2654	13682	2238	15998	1881	17213	1600	18375	1179	21927	928	10966
3L-4S		MI	6168	2654	9005	2169	10183	1830	10741	1555	11131	1134	13075	825	7029
10-#10	1.47	MA	9434	2654	13208	2250	15328	1901	16391	1619	17248	1188	20579	879	10932
4L-3S		MI	6281	2654	9301	2160	10601	1814	11253	1548	11832	1130	13948	878	7019
10-#10	1.47	MA	9156	2654	12722	2271	14748	1913	15668	1630	16241	1205	19204	839	10829
5L-2S		MI	6498	2654	9731	2150	11148	1805	11918	1533	12732	1117	15193	969	7004
10-#11	1.81	MA	10317	2737	15213	2265	17876	1897	19459	1604	21386	1150	26075	996	13287
2L-5S		MI	6119	2737	8996	2228	10125	1866	10625	1586	10928	1133	12720	696	8295
10-#11	1.81	MA	9884	2737	14361	2280	16792	1911	18143	1616	19604	1170	23608	895	13273
3L-4S		MI	6288	2737	9363	2206	10566	1856	11174	1568	11691	1119	13749	761	8428
10-#11	1.81	MA	9666	2737	13785	2295	15978	1935	17144	1639	18235	1180	21958	833	13204
4L-3S		MI	6421	2737	9721	2195	11071	1837	11792	1561	12537	1116	14781	824	8431
10-#11	1.81	MA	9338	2737	13199	2321	15272	1949	16264	1652	17008	1201	20281	783	12908
5L-2S		MI	6675	2737	10239	2184	11729	1828	12593	1544	13620	1102	16248	937	8416
10-#14	2.60	MA	11129	2934	17097	2380	20225	1979	22287	1653	25192	1134	31329	976	18849
2L-5S		MI	6373	2934	9607	2354	10847	1957	11473	1647	12045	1122	14191	544	11059
10-#14	2.60	MA	10544	2934	15881	2401	18676	1998	20405	1670	22645	1162	27803	828	18784
3L-4S		MI	6606	2934	10130	2325	11477	1946	12255	1623	13133	1104	15631	638	11701
10-#14	2.60	MA	10253	2934	15056	2422	17510	2032	18975	1703	20685	1176	25431	739	18558
4L-3S		MI	6786	2934	10641	2310	12195	1919	13136	1614	14339	1101	17079	727	11779
10-#14	2.60	MA	9794	2934	14216	2458	16498	2052	17714	1720	18929	1204	23025	663	17418
5L-2S		MI	7130	2934	11376	2295	13131	1907	14273	1590	15877	1083	19130	889	11788
10-#18	4.63	MA	12131	3433	19619	2711	23335	2223	26015	1810	30197	1142	38230	657	32291
3L-4S		MI	7370	3433	11974	2628	13686	2173	14891	1762	16659	1065	20046	302	18343
10-#18	4.63	MA	11687	3433	18172	2746	21294	2282	23511	1865	26766	1162	34040	495	30091
4L-3S		MI	7652	3433	12861	2605	14933	2129	16418	1751	18747	1065	22478	451	19796
10-#18	4.63	MA	10914	3433	16698	2808	19517	2313	21299	1893	23686	1209	29805	351	27961
5L-2S		MI	8198	3433	14128	2582	16545	2112	18376	1713	21397	1039	25899	738	19947
12-#10	1.76	MA	10317	2726	15086	2270	17785	1902	19384	1609	21313	1157	25996	1003	13094
2L-6S		MI	6074	2726	8861	2240	10006	1888	10506	1598	10797	1154	12649	705	8060
12-#10	1.76	MA	9958	2726	14384	2283	16891	1914	18299	1620	19844	1175	23962	922	13083
3L-5S		MI	6223	2726	9132	2233	10366	1871	10953	1591	11400	1142	13447	766	8299
12-#10	1.76	MA	9781	2726	13910	2296	16222	1934	17477	1639	18718	1184	22613	873	13039
4E		MI	6368	2726	9435	2215	10731	1863	11406	1576	12031	1129	14321	819	8327
12-#10	1.76	MA	9506	2726	13424	2316	15642	1946	16754	1650	17710	1201	21238	833	12927
5L-3S		MI	6478	2726	9731	2205	11148	1846	11918	1569	12732	1125	15193	872	8328
12-#10	1.76	MA	9259	2726	12955	2322	15090	1957	16045	1669	16749	1219	19896	766	12458
6L-2S		MI	6690	2726	10161	2195	11696	1838	12583	1554	13632	1113	16438	963	8317
12-#11	2.17	MA	10708	2826	16064	2321	18960	1937	20776	1629	23168	1145	28543	989	15862
2L-6S		MI	6181	2826	9193	2293	10348	1925	10885	1618	11281	1141	13244	613	9498
12-#11	2.17	MA	10287	2826	15213	2336	17876	1951	19459	1641	21386	1165	26075	888	15836
3L-5S		MI	6357	2826	9514	2283	10783	1906	11425	1611	12011	1128	14187	686	9782
12-#11	2.17	MA	10081	2826	14637	2351	17062	1975	18461	1664	20017	1175	24425	826	15754
4E		MI	6525	2826	9880	2262	11225	1897	11974	1593	12774	1114	15216	751	9982
12-#11	2.17	MA	9755	2826	14051	2376	16356	1989	17581	1677	18790	1196	22748	775	15405
5L-3S		MI	6653	2826	10239	2251	11729	1878	12593	1586	13620	1111	16248	814	10000
12-#11	2.17	MA	9461	2826	13482	2383	15692	2003	16716	1700	17621	1216	21112	690	14785
6L-2S		MI	6901	2826	10756	2240	12388	1868	13393	1569	14703	1097	17716	926	9992
12-#14	3.13	MA	11105	3062	17097	2481	20225	2057	22287	1707	25192	1155	31329	818	22435
3L-5S		MI	6706	3062	10342	2435	11782	2016	12609	1683	13584	1115	16243	525	13185

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

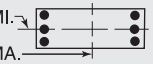


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	3.13	MA	10833	3062	16272	2502	19060	2091	20857	1739	23232	1168	28957	728	22194
4E		MI	6937	3062	10865	2405	12413	2004	13392	1659	14671	1097	17683	619	13827
12-#14	3.13	MA	10377	3062	15432	2538	18047	2110	19596	1756	21475	1197	26550	652	21016
5L-3S		MI	7107	3062	11376	2390	13131	1977	14273	1650	15877	1094	19130	708	13986
12-#14	3.13	MA	9974	3062	14625	2549	17095	2129	18358	1789	19799	1225	24200	528	20125
6L-2S		MI	7441	3062	12111	2375	14067	1965	15409	1626	17415	1076	21182	870	14014
12-#18	5.56	MA	12665	3662	20295	2889	23996	2385	26793	1929	31209	1149	40191	477	36364
4E		MI	7924	3662	13240	2771	15299	2277	16849	1827	19309	1052	23468	255	21982
12-#18	5.56	MA	11899	3662	18821	2951	22219	2417	24582	1957	28129	1196	35957	333	34209
5L-3S		MI	8225	3662	14128	2748	16545	2233	18376	1815	21397	1052	25899	404	23564
12-#18	5.56	MA	11249	3662	17433	2971	20548	2449	22409	2012	25190	1243	31805	109	31128
6L-2S		MI	8699	3662	15394	2725	18157	2216	20335	1778	24048	1026	29321	692	23751
14-#10	2.06	MA	10292	2799	15086	2328	17785	1947	19384	1641	21313	1171	25996	916	15198
3L-6S		MI	6276	2799	9291	2285	10554	1921	11171	1618	11697	1150	13894	699	9314
14-#10	2.06	MA	10123	2799	14612	2341	17116	1967	18563	1660	20187	1180	24647	867	15145
4L-5S		MI	6422	2799	9562	2278	10914	1904	11618	1611	12300	1137	14693	760	9569
14-#10	2.06	MA	9850	2799	14126	2362	16536	1979	17840	1671	19179	1197	23272	827	15027
5L-4S		MI	6567	2799	9865	2260	11278	1896	12071	1596	12931	1125	15566	813	9621
14-#10	2.06	MA	9609	2799	13657	2368	15983	1990	17130	1690	18218	1214	21931	760	14536
6L-3S		MI	6672	2799	10161	2250	11696	1879	12583	1589	13632	1121	16438	866	9632
14-#10	2.06	MA	9405	2799	13214	2376	15358	2005	16446	1701	17238	1223	20639	727	14163
7L-2S		MI	6880	2799	10591	2241	12243	1871	13248	1574	14532	1109	17683	957	9626
14-#11	2.53	MA	10684	2915	16064	2391	18960	1992	20776	1667	23168	1160	28543	881	18397
3L-6S		MI	6420	2915	9710	2348	11006	1966	11685	1643	12364	1136	14711	603	11008
14-#11	2.53	MA	10488	2915	15488	2406	18146	2016	19777	1690	21799	1170	26893	819	18303
4L-5S		MI	6592	2915	10031	2339	11442	1946	12226	1636	13094	1122	15654	675	11277
14-#11	2.53	MA	10165	2915	14902	2432	17440	2030	18897	1702	20572	1191	25215	768	17909
5L-4S		MI	6759	2915	10398	2318	11884	1937	12774	1619	13857	1109	16684	740	11532
14-#11	2.53	MA	9880	2915	14333	2439	16776	2043	18033	1725	19403	1211	23579	683	17310
6L-3S		MI	6882	2915	10756	2307	12388	1918	13393	1612	14703	1105	17716	803	11562
14-#11	2.53	MA	9638	2915	13794	2449	16017	2061	17204	1738	18209	1221	21997	642	16712
7L-2S		MI	7124	2915	11274	2296	13047	1909	14193	1594	15786	1092	19183	915	11564
14-#14	3.65	MA	11402	3191	17489	2583	20609	2149	22738	1776	25778	1161	32483	718	25834
4L-5S		MI	7033	3191	11077	2515	12718	2074	13746	1720	15122	1107	18295	507	15320
14-#14	3.65	MA	10949	3191	16649	2619	19596	2168	21478	1793	24021	1189	30076	642	24621
5L-4S		MI	7262	3191	11600	2485	13348	2062	14529	1696	16210	1089	19734	601	15928
14-#14	3.65	MA	10562	3191	15842	2629	18644	2188	20239	1825	22346	1218	27726	518	23732
6L-3S		MI	7424	3191	12111	2470	14067	2035	15409	1687	17415	1086	21182	689	16189
14-#14	3.65	MA	10232	3191	15070	2642	17568	2214	19050	1842	20636	1231	25450	456	22316
7L-2S		MI	7748	3191	12846	2455	15003	2023	16546	1663	18953	1068	23234	851	16231
14-#18	6.48	MA	12859	3890	20943	3093	24922	2521	27865	2022	32572	1183	42108	314	40457
5L-4S		MI	8532	3890	14507	2913	16911	2380	18808	1891	21959	1039	26889	209	25642
14-#18	6.48	MA	12245	3890	19556	3113	23250	2552	25692	2077	29632	1230	37956	91	37407
6L-3S		MI	8745	3890	15394	2890	18157	2337	20335	1880	24048	1039	29321	358	27333
16-#10	2.35	MA	10461	2871	15314	2386	18010	2000	19648	1680	21656	1175	26682	861	17251
4L-6S		MI	6476	2871	9721	2331	11101	1954	11837	1639	12597	1146	15139	693	10572
16-#10	2.35	MA	10189	2871	14828	2407	17430	2012	18925	1691	20648	1193	25307	822	17128
5E		MI	6619	2871	9992	2324	11461	1937	12283	1632	13200	1133	15938	754	10815
16-#10	2.35	MA	9954	2871	14359	2413	16877	2023	18216	1711	19688	1210	23965	754	16618
6L-4S		MI	6763	2871	10295	2305	11826	1929	12736	1617	13831	1121	16811	807	10913
16-#10	2.35	MA	9757	2871	13916	2421	16252	2038	17531	1721	18707	1219	22674	721	16256
7L-3S		MI	6864	2871	10591	2296	12243	1912	13248	1610	14532	1117	17683	860	10931
16-#10	2.35	MA	9522	2871	13490	2431	15677	2046	16801	1736	17771	1237	21424	676	15676
8L-2S		MI	7069	2871	11022	2286	12791	1904	13913	1595	15432	1105	18929	951	10932
16-#11	2.89	MA	10890	3004	16340	2462	19231	2056	21094	1715	23581	1165	29360	812	20854
4L-6S		MI	6656	3004	10228	2404	11665	2006	12486	1669	13447	1131	16178	592	12522
16-#11	2.89	MA	10568	3004	15753	2488	18524	2070	20214	1727	22354	1185	27683	761	20418
5E		MI	6824	3004	10548	2395	12101	1987	13026	1661	14177	1117	17121	665	12778

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

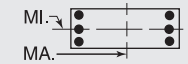
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.89	MA	10292	3004	15185	2495	17860	2084	19350	1750	21185	1206	26046	676	19840
6L-4S		MI	6990	3004	10915	2373	12543	1978	13575	1644	14940	1104	18151	729	13081
16-#11	2.89	MA	10059	3004	14645	2504	17101	2102	18520	1763	19991	1216	24464	634	19235
7L-3S		MI	7108	3004	11274	2362	13047	1958	14193	1637	15786	1100	19183	792	13120
16-#11	2.89	MA	9781	3004	14128	2515	16401	2111	17640	1781	18852	1236	22938	576	18475
8L-2S		MI	7345	3004	11791	2351	13706	1949	14993	1619	16869	1087	20650	905	13132
16-#14	4.17	MA	11510	3319	17866	2699	21145	2227	23359	1829	26568	1182	33602	632	28233
5E		MI	7355	3319	11811	2595	13654	2133	14882	1756	16660	1100	20346	488	17463
16-#14	4.17	MA	11138	3319	17059	2709	20193	2246	22121	1862	24892	1210	31252	507	27343
6L-4S		MI	7584	3319	12335	2565	14284	2121	15665	1732	17748	1082	21786	582	18040
16-#14	4.17	MA	10824	3319	16286	2723	19117	2272	20931	1879	23182	1224	28976	446	25934
7L-3S		MI	7738	3319	12846	2551	15003	2094	16546	1723	18953	1079	23234	670	18390
16-#14	4.17	MA	10435	3319	15545	2738	18115	2285	19685	1906	21549	1252	26785	360	24392
8L-2S		MI	8053	3319	13581	2536	15938	2082	17682	1699	20491	1061	25285	832	18445
16-#18	7.41	MA	13219	4118	21679	3256	25953	2656	28974	2141	34075	1217	44107	72	43686
6L-4S		MI	9068	4118	15773	3056	18523	2484	20766	1956	24610	1025	30310	163	29318
18-#10	2.65	MA	10523	2944	15530	2452	18323	2045	20011	1712	22117	1189	27341	816	19217
5L-6S		MI	6674	2944	10151	2376	11649	1987	12502	1659	13497	1141	16385	688	11833
18-#10	2.65	MA	10294	2944	15061	2458	17771	2056	19301	1731	21157	1206	25999	748	18703
6L-5S		MI	6814	2944	10422	2369	12009	1970	12948	1652	14100	1129	17183	748	12066
18-#10	2.65	MA	10103	2944	14618	2466	17146	2071	18617	1742	20176	1215	24708	715	18352
7L-4S		MI	6957	2944	10725	2351	12374	1962	13401	1637	14731	1117	18057	801	12203
18-#10	2.65	MA	9871	2944	14192	2476	16571	2079	17886	1757	19240	1232	23459	670	17767
8L-3S		MI	7055	2944	11022	2341	12791	1945	13913	1630	15432	1113	18929	854	12227
18-#10	2.65	MA	9638	2944	13711	2494	15981	2096	17178	1764	18284	1241	22233	626	17233
9L-2S		MI	7255	2944	11452	2331	13339	1937	14578	1615	16332	1100	20174	945	12235
18-#11	3.25	MA	10965	3093	16605	2543	19608	2110	21531	1753	24136	1180	30150	754	22933
5L-6S		MI	6890	3093	10745	2460	12324	2047	13286	1694	14530	1126	17645	581	14040
18-#11	3.25	MA	10697	3093	16036	2550	18944	2124	20667	1775	22967	1201	28514	669	22373
6L-5S		MI	7054	3093	11066	2450	12760	2027	13826	1687	15260	1112	18589	654	14284
18-#11	3.25	MA	10473	3093	15497	2560	18185	2142	19837	1788	21773	1211	26931	627	21761
7L-4S		MI	7219	3093	11433	2429	13202	2018	14375	1669	16023	1098	19618	719	14628
18-#11	3.25	MA	10197	3093	14979	2571	17486	2151	18957	1807	20634	1231	25406	569	21015
8L-3S		MI	7332	3093	11791	2418	13706	1999	14993	1662	16869	1095	20650	782	14675
18-#11	3.25	MA	9922	3093	14399	2594	16767	2172	18095	1815	19468	1241	23904	515	20071
9L-2S		MI	7565	3093	12308	2407	14365	1990	15793	1645	17952	1082	22117	894	14695
18-#14	4.69	MA	11704	3448	18275	2790	21742	2304	24002	1898	27439	1203	34778	497	30958
6L-5S		MI	7674	3448	12546	2676	14590	2191	16019	1792	18198	1093	22398	469	19613
18-#14	4.69	MA	11405	3448	17503	2803	20666	2331	22813	1915	25728	1216	32502	435	29552
7L-4S		MI	7902	3448	13070	2646	15220	2179	16802	1769	19286	1075	23837	563	20162
18-#14	4.69	MA	11019	3448	16762	2819	19664	2343	21566	1943	24095	1245	30311	349	27995
8L-3S		MI	8048	3448	13581	2631	15938	2152	17682	1760	20491	1071	25285	651	20589
20-#10	2.94	MA	10630	3016	15763	2504	18665	2089	20387	1752	22626	1202	28034	742	20790
6E		MI	6870	3016	10581	2421	12197	2020	13167	1680	14398	1137	17630	682	13097
20-#10	2.94	MA	10445	3016	15320	2512	18040	2104	19703	1762	21646	1211	26742	709	20449
7L-5S		MI	7006	3016	10852	2414	12556	2003	13613	1673	15001	1125	18428	743	13320
20-#10	2.94	MA	10214	3016	14894	2521	17465	2112	18972	1777	20710	1228	25493	664	19860
8L-4S		MI	7149	3016	11155	2396	12921	1995	14067	1658	15631	1113	19302	795	13493
20-#10	2.94	MA	9987	3016	14413	2539	16875	2129	18263	1785	19753	1237	24267	620	19321
9L-3S		MI	7244	3016	11452	2386	13339	1978	14578	1651	16332	1109	20174	848	13522
20-#10	2.94	MA	9771	3016	13972	2547	16319	2139	17557	1802	18808	1253	22922	569	18562
10L-2S		MI	7441	3016	11882	2377	13886	1970	15244	1636	17232	1096	21419	939	13534
20-#11	3.61	MA	11097	3182	16888	2606	20028	2165	21983	1801	24749	1196	30981	662	24909
6E		MI	7121	3182	11262	2516	12983	2087	14086	1719	15613	1120	19113	571	15561

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

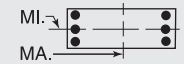
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.61	MA	10881	3182	16348	2616	19269	2183	21154	1813	23555	1206	29399	620	24290
7L-5S		MI	7281	3182	11583	2506	13419	2068	14626	1712	16343	1107	20056	643	15795
20-#11	3.61	MA	10607	3182	15831	2627	18570	2192	20274	1832	22416	1226	27873	562	23555
8L-4S		MI	7446	3182	11950	2485	13860	2059	15175	1694	17106	1093	21085	708	16175
20-#11	3.61	MA	10340	3182	15250	2649	17851	2213	19412	1841	21250	1236	26371	508	22602
9L-3S		MI	7555	3182	12308	2474	14365	2039	15793	1687	17952	1090	22117	771	16229
20-#14	5.21	MA	11976	3576	18720	2883	22215	2389	24695	1952	28275	1209	36027	425	33169
7L-5S		MI	7989	3576	13281	2756	15525	2249	17155	1829	19736	1085	24449	450	21768
20-#14	5.21	MA	11593	3576	17979	2899	21214	2402	23448	1979	26641	1237	33837	339	31597
8L-4S		MI	8216	3576	13805	2726	16156	2237	17938	1805	20824	1067	25889	544	22291
22-#10	3.23	MA	10783	3089	16022	2557	18934	2136	20788	1783	23115	1207	28777	703	22548
7L-6S		MI	7063	3089	11011	2467	12744	2053	13832	1700	15298	1133	18875	676	14363
22-#10	3.23	MA	10553	3089	15596	2567	18359	2145	20057	1798	22179	1224	27527	658	21955
8L-5S		MI	7197	3089	11283	2459	13104	2036	14278	1694	15901	1121	19674	737	14577
22-#10	3.23	MA	10332	3089	15115	2585	17768	2162	19349	1805	21222	1233	26302	614	21409
9L-4S		MI	7340	3089	11585	2441	13469	2028	14732	1678	16532	1108	20547	789	14781
22-#10	3.23	MA	10124	3089	14674	2592	17212	2172	18642	1822	20277	1249	24956	563	20653
10L-3S		MI	7431	3089	11882	2432	13886	2011	15244	1672	17232	1104	21419	842	14815
22-#11	3.97	MA	11283	3271	17199	2671	20353	2223	22470	1839	25337	1200	31866	613	26821
7L-6S		MI	7350	3271	11780	2571	13642	2128	14886	1744	16696	1115	20580	560	17084
22-#11	3.97	MA	11011	3271	16682	2682	19654	2232	21590	1857	24197	1221	30341	555	26094
8L-5S		MI	7506	3271	12101	2562	14077	2108	15426	1737	17425	1102	21523	633	17309
22-#11	3.97	MA	10751	3271	16102	2705	18935	2253	20729	1866	23032	1231	28839	500	25132
9L-4S		MI	7670	3271	12467	2540	14519	2099	15975	1720	18188	1088	22553	698	17720
22-#14	5.73	MA	12158	3704	19195	2979	22763	2460	25329	2015	29188	1230	37363	329	35200
8L-5S		MI	8302	3704	14016	2836	16461	2308	18292	1865	21274	1078	26501	431	23927
24-#10	3.53	MA	10888	3161	16298	2612	19252	2177	21143	1818	23648	1220	29561	652	24050
8L-6S		MI	7255	3161	11441	2512	13292	2086	14497	1721	16198	1129	20121	670	15630
24-#10	3.53	MA	10672	3161	15817	2630	18662	2195	20435	1826	22691	1229	28336	609	23468
9L-5S		MI	7387	3161	11713	2505	13652	2069	14943	1714	16801	1116	20919	731	15837
24-#10	3.53	MA	10477	3161	15376	2637	18106	2204	19728	1843	21746	1245	26991	557	22744
10L-4S		MI	7529	3161	12015	2487	14016	2061	15397	1699	17432	1104	21792	783	16069
24-#11	4.33	MA	11410	3360	17534	2738	20738	2273	22907	1882	25979	1216	32808	548	28634
8L-6S		MI	7576	3360	12297	2627	14300	2168	15686	1770	17779	1110	22047	550	18610
24-#11	4.33	MA	11157	3360	16953	2761	20020	2294	22045	1891	24814	1226	31306	493	27662
9L-5S		MI	7729	3360	12618	2617	14736	2149	16227	1762	18508	1096	22990	622	18827

RECTANGULAR TIED COLUMNS 24" x 38"

4-#18	1.75	MA	11367	2875	16856	2366	19694	1982	21360	1677	23350	1205	28360	1044	14249
2E		MI	6922	2875	10762	2257	12179	1889	12978	1596	13899	1141	16124	931	8472
6-#11	1.03	MA	10552	2686	14861	2273	17316	1918	18550	1642	19614	1231	23236	1072	8621
2L-3S		MI	6254	2686	9111	2190	10222	1846	10669	1589	10827	1189	12342	901	5289
6-#11	1.03	MA	10058	2686	13954	2289	16161	1932	17148	1655	17716	1252	20607	973	8638
3L-2S		MI	6522	2686	9629	2179	10880	1837	11469	1572	11910	1175	13809	1013	5259
6-#14	1.48	MA	11098	2804	16094	2338	18831	1964	20363	1669	22045	1219	26585	1058	12217
2L-3S		MI	6434	2804	9599	2254	10794	1892	11340	1619	11717	1178	13469	819	7369
6-#14	1.48	MA	10416	2804	14797	2360	17179	1984	18357	1687	19331	1249	22827	913	12205
3L-2S		MI	6803	2804	10334	2239	11729	1880	12477	1595	13255	1160	15520	981	7333
6-#18	2.63	MA	12390	3104	19121	2509	22579	2086	24863	1741	28092	1192	34925	1025	21100
2L-3S		MI	6862	3104	10762	2423	12179	2010	12978	1698	13899	1153	16124	597	12312
6-#18	2.63	MA	11285	3104	16856	2546	19694	2119	21360	1771	23350	1241	28360	760	20894
3L-2S		MI	7458	3104	12028	2400	13792	1993	14937	1660	16549	1127	19545	885	12343
8-#10	1.11	MA	10696	2709	15042	2299	17621	1938	18958	1657	20198	1236	24067	1076	9385
2L-4S		MI	6270	2709	8996	2231	10103	1888	10553	1614	10688	1201	12328	886	5747
8-#10	1.11	MA	10291	2709	14294	2312	16670	1950	17803	1668	18633	1254	21901	997	9394
3E		MI	6388	2709	9292	2221	10520	1872	11065	1607	11389	1197	13200	939	5726

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



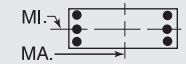
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#10	1.11	MA	10084	2709	13792	2325	15959	1971	16930	1688	17436	1264	20473	948	9373
4L-2S		MI	6611	2709	9722	2212	11068	1863	11730	1592	12289	1185	14446	1030	5705
8-#11	1.37	MA	10987	2775	15769	2329	18471	1958	19953	1667	21513	1226	25864	1065	11379
2L-4S		MI	6353	2775	9270	2257	10376	1906	10851	1622	11064	1187	12777	827	6901
8-#11	1.37	MA	10507	2775	14861	2344	17316	1972	18550	1680	19614	1247	23236	966	11381
3E		MI	6493	2775	9629	2246	10880	1887	11469	1615	11910	1184	13809	890	6882
8-#11	1.37	MA	10261	2775	14249	2360	16451	1997	17488	1704	18158	1258	21489	905	11329
4L-2S		MI	6754	2775	10146	2235	11539	1878	12270	1597	12993	1170	15276	1002	6857
8-#14	1.97	MA	11701	2932	17391	2419	20482	2023	22369	1705	24760	1212	30343	1048	16147
2L-4S		MI	6575	2932	9823	2350	11011	1977	11596	1665	12050	1174	14072	712	9566
8-#14	1.97	MA	11046	2932	16094	2441	18831	2043	20363	1724	22045	1241	26585	903	16104
3E		MI	6766	2932	10334	2335	11729	1950	12477	1656	13255	1171	15520	800	9603
8-#14	1.97	MA	10710	2932	15216	2462	17591	2077	18842	1757	19960	1256	24073	814	15897
4L-2S		MI	7123	2932	11069	2320	12665	1938	13613	1632	14793	1153	17572	962	9585
8-#18	3.51	MA	13385	3332	21387	2652	25463	2190	28367	1806	32833	1178	41490	1007	27930
2L-4S		MI	7108	3332	11141	2589	12545	2158	13410	1774	14461	1140	17114	402	14908
8-#18	3.51	MA	12344	3332	19121	2688	22579	2223	24863	1836	28092	1228	34925	742	27669
3E		MI	7416	3332	12028	2566	13792	2114	14937	1763	16549	1140	19545	551	16091
8-#18	3.51	MA	11813	3332	17582	2725	20406	2283	22196	1892	24437	1250	30485	581	25630
4L-2S		MI	7985	3332	13294	2543	15404	2097	16895	1725	19200	1114	22966	838	16181
10-#10	1.39	MA	11057	2781	15789	2344	18573	1971	20114	1677	21762	1232	26232	1070	11653
2L-5S		MI	6327	2781	9123	2294	10286	1930	10765	1650	10957	1209	12700	828	7049
10-#10	1.39	MA	10662	2781	15042	2357	17621	1983	18958	1689	20198	1250	24067	991	11652
3L-4S		MI	6473	2781	9426	2276	10651	1921	11218	1635	11588	1197	13574	880	7056
10-#10	1.39	MA	10463	2781	14539	2370	16910	2004	18085	1708	19000	1260	22639	942	11618
4L-3S		MI	6587	2781	9722	2267	11068	1905	11730	1628	12289	1193	14446	933	7044
10-#10	1.39	MA	10164	2781	14019	2391	16294	2016	17318	1720	17930	1278	21181	904	11515
5L-2S		MI	6805	2781	10152	2257	11616	1896	12395	1613	13189	1181	15691	1025	7027
10-#11	1.71	MA	11415	2864	16676	2384	19626	1999	21356	1692	23411	1221	28493	1058	14129
2L-5S		MI	6425	2864	9421	2334	10593	1956	11103	1664	11384	1195	13215	751	8389
10-#11	1.71	MA	10949	2864	15769	2400	18471	2013	19953	1705	21513	1242	25864	958	14116
3L-4S		MI	6593	2864	9788	2312	11035	1947	11651	1647	12147	1182	14244	816	8465
10-#11	1.71	MA	10715	2864	15156	2415	17606	2038	18891	1729	20056	1252	24117	897	14046
4L-3S		MI	6728	2864	10146	2301	11539	1927	12270	1640	12993	1178	15276	879	8462
10-#11	1.71	MA	10360	2864	14530	2441	16855	2052	17956	1742	18753	1274	22338	848	13815
5L-2S		MI	6983	2864	10664	2290	12198	1918	13070	1622	14076	1165	16744	991	8444
10-#14	2.47	MA	12292	3061	18688	2499	22133	2081	24375	1742	27474	1204	34102	1038	20064
2L-5S		MI	6679	3061	10034	2460	11316	2047	11950	1725	12500	1185	14684	599	11175
10-#14	2.47	MA	11661	3061	17391	2521	20482	2101	22369	1760	24760	1234	30343	892	19999
3L-4S		MI	6911	3061	10558	2430	11946	2035	12733	1701	13588	1167	16124	693	11757
10-#14	2.47	MA	11348	3061	16513	2543	19243	2136	20847	1793	22674	1248	27831	804	19773
4L-3S		MI	7093	3061	11069	2415	12665	2008	13613	1692	14793	1164	17572	782	11821
10-#14	2.47	MA	10849	3061	15621	2579	18166	2156	19507	1811	20806	1278	25277	730	18647
5L-2S		MI	7439	3061	11804	2400	13601	1996	14750	1668	16331	1146	19623	943	11822
10-#18	4.39	MA	13373	3561	21387	2831	25463	2327	28367	1901	32833	1214	41490	723	34451
3L-4S		MI	7673	3561	12407	2732	14158	2262	15368	1839	17111	1127	20535	355	18514
10-#18	4.39	MA	12895	3561	19848	2868	23290	2386	25699	1957	29178	1237	37050	563	32323
4L-3S		MI	7959	3561	13294	2709	15404	2218	16895	1828	19200	1127	22966	504	19863
10-#18	4.39	MA	12054	3561	18279	2931	21400	2419	23347	1986	25901	1286	32553	424	30005
5L-2S		MI	8504	3561	14561	2686	17016	2201	18853	1790	21850	1101	26388	792	19997
12-#10	1.67	MA	11412	2854	16536	2390	19524	2004	21270	1698	23326	1228	28398	1065	13917
2L-6S		MI	6379	2854	9282	2347	10473	1979	10984	1677	11254	1217	13147	761	8134
12-#10	1.67	MA	11026	2854	15789	2403	18573	2016	20114	1709	21762	1246	26232	985	13906
3L-5S		MI	6529	2854	9553	2340	10833	1963	11430	1670	11857	1205	13945	822	8338

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

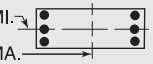


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#10	1.67	MA	10836	2854	15286	2416	17862	2037	19241	1729	20564	1255	24805	936	13862
4E		MI	6674	2854	9856	2322	11198	1954	11884	1655	12488	1193	14819	874	8358
12-#10	1.67	MA	10539	2854	14766	2436	17245	2049	18473	1740	19494	1273	23347	898	13750
5L-3S		MI	6784	2854	10152	2312	11616	1938	12395	1648	13189	1189	15691	927	8354
12-#10	1.67	MA	10274	2854	14268	2442	16653	2059	17720	1760	18446	1283	21924	832	13297
6L-2S		MI	6998	2854	10583	2302	12163	1929	13060	1633	14089	1176	16936	1019	8342
12-#11	2.05	MA	11836	2953	17583	2440	20781	2039	22759	1718	25310	1215	31122	1051	16873
2L-6S		MI	6486	2953	9618	2399	10816	2016	11362	1697	11737	1204	13739	668	9585
12-#11	2.05	MA	11383	2953	16676	2456	19626	2053	21356	1731	23411	1237	28493	951	16847
3L-5S		MI	6663	2953	9939	2389	11252	1996	11903	1690	12467	1190	14682	741	9874
12-#11	2.05	MA	11161	2953	16064	2471	18761	2078	20294	1754	21955	1247	26746	890	16764
4E		MI	6831	2953	10305	2368	11694	1987	12452	1672	13230	1177	15712	806	10022
12-#11	2.05	MA	10808	2953	15437	2496	18010	2092	19359	1767	20651	1268	24967	841	16479
5L-3S		MI	6960	2953	10664	2357	12198	1968	13070	1665	14076	1173	16744	869	10033
12-#11	2.05	MA	10493	2953	14830	2504	17298	2106	18441	1791	19409	1290	23230	758	15790
6L-2S		MI	7209	2953	11181	2346	12857	1959	13870	1648	15159	1160	18211	981	10023
12-#14	2.96	MA	12264	3189	18688	2601	22133	2159	24375	1796	27474	1226	34102	882	23893
3L-5S		MI	7011	3189	10769	2540	12252	2106	13086	1761	14038	1177	16736	580	13298
12-#14	2.96	MA	11971	3189	17810	2623	20894	2194	22853	1830	25389	1241	31590	793	23652
4E		MI	7242	3189	11293	2510	12882	2094	13869	1738	15126	1159	18175	674	13946
12-#14	2.96	MA	11477	3189	16918	2659	19817	2214	21513	1848	23520	1270	29035	720	22488
5L-3S		MI	7415	3189	11804	2495	13601	2067	14750	1729	16331	1156	19623	763	14031
12-#14	2.96	MA	11044	3189	16051	2670	18806	2234	20197	1881	21739	1300	26543	597	21579
6L-2S		MI	7751	3189	12539	2480	14537	2055	15887	1705	17870	1138	21675	924	14052
12-#18	5.26	MA	13946	3789	22113	3011	26174	2490	29203	2022	33920	1224	43615	545	39032
4E		MI	8228	3789	13673	2874	15770	2365	17326	1904	19762	1113	23956	309	22147
12-#18	5.26	MA	13113	3789	20545	3074	24284	2523	26850	2051	30642	1273	39118	406	36747
5L-3S		MI	8493	3789	14561	2851	17016	2322	18853	1893	21850	1114	26388	458	23633
12-#18	5.26	MA	12414	3789	19052	3093	22507	2556	24539	2107	27515	1322	34719	184	33442
6L-2S		MI	9016	3789	15827	2828	18629	2304	20811	1855	24500	1087	29809	746	23803
14-#10	1.95	MA	11386	2926	16536	2448	19524	2049	21270	1730	23326	1242	28398	980	16158
3L-6S		MI	6582	2926	9712	2392	11021	2012	11649	1698	12154	1213	14392	755	9387
14-#10	1.95	MA	11204	2926	16033	2461	18813	2069	20397	1749	22129	1251	26970	930	16105
4L-5S		MI	6728	2926	9983	2385	11381	1995	12095	1691	12757	1201	15191	816	9625
14-#10	1.95	MA	10908	2926	15514	2481	18197	2082	19629	1761	21058	1269	25512	892	15987
5L-4S		MI	6873	2926	10286	2367	11746	1987	12549	1676	13388	1188	16064	868	9654
14-#10	1.95	MA	10650	2926	15015	2488	17605	2092	18876	1780	20010	1279	24089	826	15512
6L-3S		MI	6979	2926	10583	2357	12163	1971	13060	1669	14089	1184	16936	921	9660
14-#10	1.95	MA	10431	2926	14543	2496	16940	2108	18142	1791	18997	1297	22724	793	15103
7L-2S		MI	7189	2926	11013	2348	12711	1962	13726	1654	14989	1172	18182	1013	9652
14-#11	2.39	MA	11810	3042	17583	2511	20781	2094	22759	1756	25310	1231	31122	944	19576
3L-6S		MI	6725	3042	10135	2454	11475	2056	12163	1722	12820	1199	15206	658	11094
14-#11	2.39	MA	11598	3042	16971	2527	19916	2118	21697	1779	23853	1242	29375	883	19483
4L-5S		MI	6898	3042	10456	2445	11911	2037	12703	1715	13550	1185	16149	730	11367
14-#11	2.39	MA	11248	3042	16344	2552	19165	2133	20761	1792	22550	1263	27595	834	19149
5L-4S		MI	7065	3042	10823	2424	12353	2028	13252	1697	14313	1171	17179	795	11575
14-#11	2.39	MA	10942	3042	15738	2559	18453	2146	19844	1816	21307	1284	25859	751	18483
6L-3S		MI	7189	3042	11181	2413	12857	2008	13870	1690	15159	1168	18211	858	11598
14-#11	2.39	MA	10683	3042	15164	2569	17645	2165	18962	1829	20039	1295	24186	710	17920
7L-2S		MI	7433	3042	11699	2402	13516	1999	14670	1673	16242	1155	19678	970	11596
14-#14	3.45	MA	12582	3318	19107	2703	22545	2252	24859	1866	28103	1233	35348	783	27535
4L-5S		MI	7339	3318	11504	2620	13188	2164	14223	1798	15577	1170	18787	561	15430
14-#14	3.45	MA	12091	3318	18215	2740	21469	2272	23519	1884	26235	1263	32794	710	26336
5L-4S		MI	7568	3318	12028	2590	13818	2152	15006	1774	16664	1152	20227	655	16054
14-#14	3.45	MA	11675	3318	17348	2750	20458	2292	22203	1917	24454	1292	30302	587	25456
6L-3S		MI	7732	3318	12539	2575	14537	2125	15887	1765	17870	1149	21675	744	16236
14-#14	3.45	MA	11321	3318	16526	2764	19301	2318	20939	1935	22636	1307	27892	527	23918
7L-2S		MI	8060	3318	13274	2561	15472	2113	17023	1741	19408	1131	23726	906	16271
14-#18	6.14	MA	14146	4017	22810	3216	27169	2627	30354	2116	35384	1260	45683	388	43487
5L-4S		MI	8774	4017	14940	3017	17382	2469	19285	1969	22412	1100	27377	263	25801

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

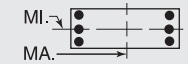


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	6.14	MA	13486	4017	21317	3236	25392	2660	28042	2172	32257	1309	41284	165	40144
6L-3S		MI	9057	4017	15827	2994	18629	2425	20811	1957	24500	1100	29809	412	27404
16-#10	2.23	MA	11566	2999	16781	2506	19765	2102	21552	1770	23693	1247	29136	925	18349
4L-6S		MI	6782	2999	10142	2438	11569	2045	12314	1718	13055	1209	15638	749	10644
16-#10	2.23	MA	11272	2999	16261	2527	19148	2115	20785	1781	22622	1265	27678	886	18225
5E		MI	6925	2999	10413	2430	11928	2028	12760	1711	13658	1196	16436	810	10893
16-#10	2.23	MA	11020	2999	15762	2533	18556	2125	20031	1801	21574	1274	26255	820	17730
6L-4S		MI	7069	2999	10716	2412	12293	2020	13214	1696	14288	1184	17309	862	10948
16-#10	2.23	MA	10809	2999	15291	2541	17892	2141	19297	1811	20561	1292	24890	787	17334
7L-3S		MI	7172	2999	11013	2403	12711	2003	13726	1689	14989	1180	18182	915	10961
16-#10	2.23	MA	10555	2999	14839	2551	17281	2149	18521	1827	19567	1310	23566	743	16768
8L-2S		MI	7378	2999	11443	2393	13258	1995	14391	1674	15889	1168	19427	1007	10959
16-#11	2.74	MA	12030	3131	17878	2582	21071	2159	23099	1805	25752	1237	32003	876	22202
4L-6S		MI	6962	3131	10653	2510	12134	2097	12963	1747	13903	1193	16673	647	12607
16-#11	2.74	MA	11681	3131	17251	2608	20320	2173	22164	1818	24448	1258	30224	827	21826
5E		MI	7131	3131	10974	2501	12570	2077	13503	1740	14632	1180	17617	720	12867
16-#11	2.74	MA	11384	3131	16645	2615	19608	2187	21246	1841	23206	1279	28488	743	21181
6L-4S		MI	7297	3131	11340	2479	13011	2068	14052	1723	15395	1166	18646	784	13125
16-#11	2.74	MA	11135	3131	16071	2625	18800	2205	20365	1854	21938	1290	26814	702	20613
7L-3S		MI	7416	3131	11699	2468	13516	2049	14670	1715	16242	1163	19678	847	13157
16-#11	2.74	MA	10834	3131	15521	2636	18056	2215	19420	1872	20727	1311	25197	646	19765
8L-2S		MI	7655	3131	12216	2457	14175	2040	15470	1698	17325	1149	21145	960	13166
16-#14	3.95	MA	12695	3446	19512	2820	23120	2331	25524	1921	28949	1255	36552	699	30190
5E		MI	7662	3446	12239	2700	14123	2222	15360	1834	17115	1162	20839	542	17571
16-#14	3.95	MA	12294	3446	18645	2830	22109	2351	24208	1954	27168	1285	34060	577	29331
6L-4S		MI	7891	3446	12763	2671	14754	2210	16142	1810	18203	1144	22279	636	18163
16-#14	3.95	MA	11957	3446	17823	2844	20952	2376	22945	1972	25350	1300	31651	517	27775
7L-3S		MI	8047	3446	13274	2656	15472	2183	17023	1801	19408	1141	23726	725	18438
16-#14	3.95	MA	11535	3446	17035	2860	19887	2390	21604	1999	23615	1329	29328	433	26214
8L-2S		MI	8366	3446	14008	2641	16408	2171	18160	1777	20946	1123	25778	887	18486
16-#18	7.02	MA	14532	4246	23583	3378	28276	2764	31546	2237	36998	1296	47850	147	46846
6L-4S		MI	9375	4246	16206	3160	18995	2573	21243	2033	25062	1087	30799	216	29473
18-#10	2.51	MA	11631	3071	17008	2572	20100	2147	21940	1802	24186	1261	29843	881	20464
5L-6S		MI	6980	3071	10572	2483	12116	2078	12979	1739	13955	1205	16883	743	11905
18-#10	2.51	MA	11385	3071	16510	2578	19508	2158	21187	1822	23138	1270	28420	814	19951
6L-5S		MI	7121	3071	10844	2476	12476	2061	13425	1732	14558	1192	17681	804	12142
18-#10	2.51	MA	11180	3071	16038	2587	18844	2174	20453	1832	22125	1288	27055	782	19566
7L-4S		MI	7264	3071	11146	2458	12841	2053	13879	1717	15189	1180	18555	856	12240
18-#10	2.51	MA	10929	3071	15586	2597	18233	2182	19676	1847	21131	1306	25731	738	18998
8L-3S		MI	7363	3071	11443	2448	13258	2036	14391	1710	15889	1176	19427	909	12259
18-#10	2.51	MA	10673	3071	15071	2615	17606	2200	18924	1855	20115	1316	24436	694	18418
9L-2S		MI	7565	3071	11873	2438	13806	2028	15056	1695	16789	1164	20672	1001	12263
18-#11	3.08	MA	12108	3220	18158	2663	21475	2214	23567	1843	26347	1253	32853	820	24508
5L-6S		MI	7196	3220	11170	2566	12793	2137	13763	1772	14986	1188	18140	636	14124
18-#11	3.08	MA	11820	3220	17552	2671	20763	2227	22649	1866	25104	1274	31116	736	23881
6L-5S		MI	7361	3220	11491	2556	13228	2118	14303	1765	15715	1175	19084	709	14372
18-#11	3.08	MA	11579	3220	16978	2681	19955	2245	21767	1879	23836	1285	29443	695	23308
7L-4S		MI	7526	3220	11858	2535	13670	2109	14852	1748	16478	1161	20113	774	14674
18-#11	3.08	MA	11281	3220	16428	2692	19211	2255	20822	1898	22625	1306	27826	639	22472
8L-3S		MI	7641	3220	12216	2524	14175	2089	15470	1741	17325	1158	21145	837	14715
18-#11	3.08	MA	10985	3220	15807	2714	18448	2276	19906	1907	21388	1317	26238	585	21528
9L-2S		MI	7876	3220	12733	2513	14833	2080	16271	1723	18408	1144	22612	949	14730
18-#14	4.44	MA	12903	3575	19942	2910	23760	2409	26214	1990	29883	1278	37819	566	33182
6L-5S		MI	7981	3575	12974	2781	15059	2281	16496	1871	18653	1155	22891	523	19719
18-#14	4.44	MA	12581	3575	19120	2924	22604	2435	24950	2008	28065	1292	35409	506	31631
7L-4S		MI	8209	3575	13498	2751	15689	2269	17279	1847	19741	1137	24330	617	20282
18-#14	4.44	MA	12162	3575	18332	2941	21538	2448	23609	2035	26329	1322	33086	423	30054
8L-3S		MI	8358	3575	14008	2736	16408	2242	18160	1838	20946	1134	25778	706	20638

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

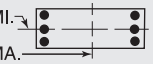


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	2.79	MA	11746	3144	17257	2624	20460	2191	22343	1842	24702	1266	30586	808	22175
6E		MI	7176	3144	11002	2528	12664	2111	13644	1759	14855	1200	18128	737	13168
20-#10	2.79	MA	11547	3144	16785	2632	19795	2207	21609	1852	23689	1284	29221	776	21800
7L-5S		MI	7314	3144	11274	2521	13024	2094	14090	1753	15458	1188	18926	798	13395
20-#10	2.79	MA	11297	3144	16334	2642	19184	2215	20832	1868	22695	1302	27897	732	21229
8L-4S		MI	7457	3144	11576	2503	13389	2086	14544	1737	16089	1176	19800	850	13530
20-#10	2.79	MA	11054	3144	15819	2660	18557	2233	20080	1876	21679	1311	26601	688	20651
9L-3S		MI	7553	3144	11873	2493	13806	2069	15056	1730	16789	1172	20672	903	13555
20-#10	2.79	MA	10822	3144	15350	2667	17967	2243	19329	1893	20665	1327	25175	639	19873
10L-2S		MI	7751	3144	12303	2484	14354	2061	15721	1715	17690	1160	21917	995	13565
20-#11	3.42	MA	12249	3309	18459	2726	21918	2268	24052	1892	27003	1269	33745	729	26585
6E		MI	7427	3309	11688	2621	13451	2178	14563	1798	16069	1183	19608	626	15644
20-#11	3.42	MA	12017	3309	17885	2736	21110	2286	23170	1905	25735	1280	32072	688	26007
7L-5S		MI	7588	3309	12008	2612	13887	2158	15103	1791	16798	1170	20551	698	15881
20-#11	3.42	MA	11721	3309	17335	2748	20366	2296	22225	1923	24524	1301	30454	632	25178
8L-4S		MI	7753	3309	12375	2591	14329	2149	15652	1773	17561	1156	21580	763	16222
20-#11	3.42	MA	11434	3309	16714	2770	19603	2317	21309	1932	23286	1312	28866	578	24224
9L-3S		MI	7864	3309	12733	2580	14833	2130	16271	1766	18408	1153	22612	826	16270
20-#11	3.42	MA	11159	3309	16144	2779	18884	2329	20395	1953	22070	1331	27254	529	23309
10L-2S		MI	8094	3309	13251	2569	15492	2121	17071	1749	19491	1139	24080	938	16291
20-#14	4.93	MA	13194	3703	20417	3005	24255	2493	26956	2045	30779	1285	39168	496	35488
7L-5S		MI	8297	3703	13709	2861	15995	2339	17633	1907	20191	1147	24942	505	21872
20-#14	4.93	MA	12779	3703	19629	3021	23190	2507	25615	2071	29044	1314	36845	413	33895
8L-4S		MI	8525	3703	14232	2831	16625	2327	18415	1883	21279	1129	26382	599	22409
22-#10	3.06	MA	11910	3216	17533	2677	20747	2239	22764	1873	25253	1280	31387	770	24036
7L-6S		MI	7370	3216	11432	2574	13211	2144	14309	1780	15755	1196	19373	731	14433
22-#10	3.06	MA	11661	3216	17081	2687	20136	2248	21988	1888	24259	1298	30063	726	23461
8L-5S		MI	7505	3216	11704	2566	13571	2127	14755	1773	16358	1184	20172	792	14652
22-#10	3.06	MA	11424	3216	16566	2705	19509	2266	21235	1896	23243	1307	28767	683	22884
9L-4S		MI	7648	3216	12007	2548	13936	2119	15209	1758	16989	1172	21045	844	14820
22-#10	3.06	MA	11200	3216	16097	2713	18918	2276	20485	1913	22229	1323	27341	633	22099
10L-3S		MI	7741	3216	12303	2539	14354	2102	15721	1751	17690	1168	21917	898	14849
22-#10	3.06	MA	10956	3216	15639	2721	18327	2285	19750	1923	21190	1330	26052	586	21361
11L-2S		MI	7936	3216	12733	2529	14901	2094	16386	1736	18590	1155	23163	989	14863
22-#11	3.76	MA	12449	3398	18792	2792	22265	2326	24573	1930	27633	1274	34701	681	28707
7L-6S		MI	7656	3398	12205	2677	14110	2218	15363	1823	17152	1178	21075	615	17167
22-#11	3.76	MA	12155	3398	18242	2803	21521	2336	23628	1948	26422	1296	33083	625	27884
8L-5S		MI	7814	3398	12526	2668	14546	2199	15904	1816	17881	1164	22018	688	17395
22-#11	3.76	MA	11875	3398	17622	2826	20758	2357	22712	1957	25185	1306	31495	571	26920
9L-4S		MI	7979	3398	12893	2646	14988	2190	16452	1798	18644	1151	23048	752	17769
22-#11	3.76	MA	11622	3398	17051	2834	20039	2369	21798	1978	23968	1326	29883	522	25996
10L-3S		MI	8086	3398	13251	2635	15492	2170	17071	1791	19491	1147	24080	816	17823
22-#14	5.43	MA	13386	3832	20926	3101	24841	2565	27621	2108	31758	1307	40603	402	37736
8L-5S		MI	8610	3832	14444	2941	16931	2397	18769	1944	21729	1140	26994	486	24029
24-#10	3.34	MA	12020	3289	17828	2733	21087	2281	23144	1909	25823	1293	32228	720	25695
8L-6S		MI	7563	3289	11862	2619	13759	2177	14974	1800	16655	1192	20619	725	15700
24-#10	3.34	MA	11789	3289	17313	2751	20460	2299	22391	1917	24807	1303	30933	677	25117
9L-5S		MI	7695	3289	12134	2612	14119	2160	15421	1794	17258	1180	21417	786	15911
24-#10	3.34	MA	11572	3289	16844	2758	19870	2308	21641	1934	23793	1319	29507	627	24325
10L-4S		MI	7837	3289	12437	2594	14484	2152	15874	1778	17889	1167	22291	838	16108
24-#10	3.34	MA	11330	3289	16387	2767	19278	2317	20906	1943	22754	1326	28217	581	23581
11L-3S		MI	7928	3289	12733	2584	14901	2135	16386	1772	18590	1163	23163	892	16143
24-#11	4.11	MA	12583	3487	19150	2859	22676	2377	25031	1973	28321	1290	35712	617	30590
8L-6S		MI	7883	3487	12722	2733	14769	2258	16164	1848	18235	1173	22542	605	18692
24-#11	4.11	MA	12311	3487	18529	2882	21913	2398	24115	1983	27083	1301	34124	564	29616
9L-5S		MI	8038	3487	13043	2723	15205	2239	16704	1841	18964	1159	23486	677	18911
24-#11	4.11	MA	12065	3487	17958	2890	21194	2409	23201	2003	25867	1321	32512	514	28684
10L-4S		MI	8202	3487	13410	2702	15647	2230	17253	1824	19727	1146	24515	742	19315

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

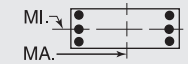
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.67	MA	12519	3003	18398	2486	21533	2084	23348	1765	25467	1276	30882	1106	15113
2E		MI	7230	3003	11195	2361	12651	1978	13455	1673	14352	1202	16612	985	8508
6-#14	1.41	MA	12227	2931	17583	2458	20608	2066	22281	1758	24070	1290	28981	1120	12946
2L-3S		MI	6739	2931	10027	2359	11263	1981	11818	1697	12172	1241	13962	874	7400
6-#14	1.41	MA	11496	2931	16206	2480	18855	2087	20151	1777	21187	1320	24990	977	12934
3L-2S		MI	7110	2931	10762	2345	12199	1969	12954	1674	13710	1223	16013	1036	7362
6-#18	2.50	MA	13617	3231	20806	2628	24599	2188	27072	1830	30507	1262	37860	1087	22396
2L-3S		MI	7168	3231	11195	2527	12651	2099	13455	1776	14352	1215	16612	651	12369
6-#18	2.50	MA	12431	3231	18398	2666	21533	2222	23348	1861	25467	1313	30882	826	22190
3L-2S		MI	7767	3231	12461	2504	14263	2082	15413	1738	17002	1189	20034	939	12384
8-#10	1.06	MA	11793	2836	16461	2418	19318	2040	20782	1746	22099	1307	26295	1138	9934
2L-4S		MI	6575	2836	9417	2338	10570	1980	11031	1693	11145	1264	12826	941	5771
8-#10	1.06	MA	11360	2836	15669	2432	18309	2052	19557	1757	20440	1325	23998	1060	9943
3E		MI	6694	2836	9713	2328	10988	1963	11543	1687	11846	1260	13699	995	5748
8-#10	1.06	MA	11139	2836	15136	2445	17556	2073	18632	1777	19172	1335	22491	1011	9922
4L-2S		MI	6917	2836	10144	2318	11535	1955	12208	1671	12746	1248	14944	1086	5726
8-#11	1.30	MA	12107	2902	17236	2448	20223	2060	21842	1756	23500	1296	28210	1127	12053
2L-4S		MI	6658	2902	9696	2362	10845	1997	11328	1700	11520	1250	13272	882	6932
8-#11	1.30	MA	11593	2902	16273	2464	18997	2075	20353	1769	21485	1318	25420	1029	12055
3E		MI	6798	2902	10054	2351	11349	1977	11947	1693	12366	1246	14304	945	6909
8-#11	1.30	MA	11330	2902	15624	2480	18081	2100	19228	1793	19941	1330	23576	968	12003
4L-2S		MI	7061	2902	10571	2340	12008	1968	12747	1676	13449	1233	15771	1057	6883
8-#14	1.88	MA	12874	3060	18960	2538	22362	2124	24411	1794	26952	1282	32973	1110	17119
2L-4S		MI	6879	3060	10251	2455	11480	2067	12073	1743	12505	1236	14565	766	9615
8-#14	1.88	MA	12170	3060	17583	2560	20608	2145	22281	1813	24070	1313	28981	967	17076
3E		MI	7072	3060	10762	2440	12199	2040	12954	1734	13710	1233	16013	855	9639
8-#14	1.88	MA	11812	3060	16654	2583	19294	2180	20668	1847	21859	1328	26329	879	16869
4L-2S		MI	7431	3060	11497	2425	13135	2028	14091	1710	15248	1215	18065	1017	9616
8-#18	3.33	MA	14685	3459	23215	2771	27665	2292	30796	1895	35548	1249	44839	1069	29658
2L-4S		MI	7411	3459	11574	2693	13017	2246	13887	1852	14914	1201	17602	456	15083
8-#18	3.33	MA	13565	3459	20806	2809	24599	2326	27072	1926	30507	1300	37860	808	29397
3E		MI	7722	3459	12461	2670	14263	2203	15413	1840	17002	1202	20034	605	16152
8-#18	3.33	MA	12996	3459	19174	2847	22293	2387	24242	1984	26629	1325	33171	649	27448
4L-2S		MI	8295	3459	13727	2647	15875	2185	17372	1802	19652	1175	23455	892	16228
10-#10	1.32	MA	12179	2908	17254	2464	20327	2073	22008	1766	23758	1303	28592	1132	12339
2L-5S		MI	6633	2908	9544	2401	10753	2021	11242	1729	11414	1272	13198	883	7083
10-#10	1.32	MA	11756	2908	16461	2477	19318	2085	20782	1778	22099	1321	26295	1054	12338
3L-4S		MI	6779	2908	9847	2383	11118	2012	11696	1714	12045	1260	14072	936	7083
10-#10	1.32	MA	11544	2908	15929	2490	18565	2106	19858	1798	20831	1331	24788	1005	12304
4L-3S		MI	6893	2908	10144	2373	11535	1996	12208	1707	12746	1256	14944	989	7068
10-#10	1.32	MA	11222	2908	15376	2510	17913	2118	19045	1809	19698	1350	23247	968	12201
5L-2S		MI	7113	2908	10574	2364	12083	1988	12873	1692	13646	1244	16189	1080	7050
10-#11	1.63	MA	12565	2991	18198	2504	21449	2100	23331	1781	25515	1291	31000	1120	14972
2L-5S		MI	6730	2991	9846	2439	11062	2046	11580	1743	11839	1258	13710	806	8475
10-#11	1.63	MA	12065	2991	17236	2520	20223	2115	21842	1795	23500	1313	28210	1022	14958
3L-4S		MI	6899	2991	10213	2418	11504	2037	12129	1726	12602	1244	14739	871	8501
10-#11	1.63	MA	11815	2991	16587	2535	19307	2140	20717	1819	21956	1324	26366	961	14889
4L-3S		MI	7034	2991	10571	2407	12008	2018	12747	1718	13449	1241	15771	934	8491
10-#11	1.63	MA	11433	2991	15919	2560	18512	2155	19726	1832	20576	1346	24484	914	14697
5L-2S		MI	7291	2991	11089	2396	12667	2009	13547	1701	14532	1228	17239	1046	8472
10-#14	2.34	MA	13507	3188	20338	2618	24115	2183	26541	1831	29835	1275	36964	1099	21279
2L-5S		MI	6984	3188	10462	2565	11786	2137	12427	1803	12955	1247	15177	654	11287

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

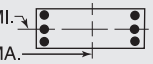


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.34	MA	12829	3188	18960	2641	22362	2203	24411	1850	26952	1305	32973	956	21214
3L-4S		MI	7216	3188	10986	2535	12416	2125	13210	1779	14043	1229	16617	748	11810
10-#14	2.34	MA	12494	3188	18031	2663	21048	2239	22798	1883	24741	1321	30320	868	20988
4L-3S		MI	7399	3188	11497	2520	13135	2098	14091	1770	15248	1226	18065	836	11862
10-#14	2.34	MA	11956	3188	17079	2699	19908	2259	21378	1902	22762	1351	27619	797	19887
5L-2S		MI	7748	3188	12231	2505	14070	2086	15227	1746	16786	1208	20116	998	11857
10-#18	4.17	MA	14668	3688	23215	2952	27665	2430	30796	1991	35548	1287	44839	789	36611
3L-4S		MI	7977	3688	12840	2835	14629	2350	15845	1916	17564	1188	21023	409	18682
10-#18	4.17	MA	14154	3688	21583	2989	25360	2491	27967	2048	31670	1311	40150	630	34578
4L-3S		MI	8266	3688	13727	2812	15875	2306	17372	1905	19652	1188	23455	558	19928
10-#18	4.17	MA	13246	3688	19921	3054	23356	2525	25473	2080	28194	1362	35391	496	32006
5L-2S		MI	8815	3688	14994	2789	17488	2289	19330	1867	22302	1162	26876	846	20046
12-#10	1.59	MA	12559	2981	18047	2509	21336	2106	23234	1787	25417	1299	30889	1127	14740
2L-6S		MI	6684	2981	9703	2454	10941	2070	11461	1757	11712	1280	13645	816	8206
12-#10	1.59	MA	12146	2981	17254	2522	20327	2118	22008	1798	23758	1317	28592	1048	14729
3L-5S		MI	6835	2981	9974	2447	11300	2054	11907	1750	12315	1268	14444	877	8375
12-#10	1.59	MA	11943	2981	16722	2535	19574	2139	21084	1818	22490	1327	27085	999	14685
4E		MI	6980	2981	10277	2428	11665	2045	12361	1735	12946	1256	15317	930	8388
12-#10	1.59	MA	11623	2981	16168	2556	18922	2151	20271	1830	21356	1345	25544	963	14573
5L-3S		MI	7091	2981	10574	2419	12083	2029	12873	1728	13646	1252	16189	983	8380
12-#10	1.59	MA	11340	2981	15640	2562	18291	2162	19474	1850	20247	1355	24040	897	14141
6L-2S		MI	7306	2981	11004	2409	12630	2021	13538	1713	14546	1240	17434	1074	8366
12-#11	1.95	MA	13016	3080	19161	2559	22675	2141	24820	1806	27530	1286	33790	1113	17883
2L-6S		MI	6791	3080	10043	2505	11285	2106	11840	1775	12193	1266	14234	723	9670
12-#11	1.95	MA	12530	3080	18198	2575	21449	2156	23331	1820	25515	1308	31000	1015	17858
3L-5S		MI	6969	3080	10364	2495	11721	2087	12380	1768	12922	1253	15177	796	9963
12-#11	1.95	MA	12292	3080	17550	2591	20532	2181	22205	1844	23971	1319	29156	954	17775
4E		MI	7137	3080	10730	2474	12162	2078	12929	1751	13685	1239	16207	861	10061
12-#11	1.95	MA	11912	3080	16882	2616	19738	2195	21215	1857	22591	1341	27274	906	17562
5L-3S		MI	7266	3080	11089	2463	12667	2058	13547	1744	14532	1236	17239	924	10065
12-#11	1.95	MA	11575	3080	16239	2624	18977	2209	20244	1881	21239	1352	25438	824	16801
6L-2S		MI	7518	3080	11606	2452	13326	2049	14347	1726	15615	1222	18706	1036	10052
12-#14	2.81	MA	13475	3317	20338	2721	24115	2262	26541	1886	29835	1298	36964	946	25351
3L-5S		MI	7317	3317	11197	2645	12721	2195	13564	1840	14493	1239	17229	635	13407
12-#14	2.81	MA	13161	3317	19408	2743	22802	2297	24928	1920	27624	1313	34311	858	25110
4E		MI	7548	3317	11721	2615	13352	2183	14346	1816	15581	1221	18668	729	14002
12-#14	2.81	MA	12628	3317	18456	2780	21662	2318	23508	1939	25645	1344	31610	787	23971
5L-3S		MI	7722	3317	12231	2600	14070	2156	15227	1807	16786	1218	20116	817	14074
12-#14	2.81	MA	12165	3317	17536	2790	20581	2337	22115	1973	23758	1374	28974	667	22972
6L-2S		MI	8061	3317	12966	2585	15006	2144	16364	1783	18324	1200	22168	979	14088
12-#18	5.00	MA	15280	3916	23991	3132	28426	2594	31691	2113	36710	1298	47129	612	41723
4E		MI	8532	3916	14107	2978	16241	2454	17803	1981	20214	1175	24445	363	22309
12-#18	5.00	MA	14380	3916	22329	3196	26422	2629	29197	2144	33234	1349	42369	478	39174
5L-3S		MI	8801	3916	14994	2955	17488	2410	19330	1970	22302	1175	26876	512	23701
12-#18	5.00	MA	13631	3916	20729	3215	24540	2663	26747	2202	29920	1400	37724	257	35782
6L-2S		MI	9332	3916	16260	2932	19100	2393	21288	1932	24953	1149	30297	800	23855
14-#10	1.85	MA	12530	3054	18047	2568	21336	2151	23234	1819	25417	1313	30889	1043	17118
3L-6S		MI	6887	3054	10133	2499	11488	2103	12126	1777	12612	1276	14890	810	9458
14-#10	1.85	MA	12335	3054	17514	2581	20583	2172	22309	1839	24149	1323	29382	994	17065
4L-5S		MI	7034	3054	10405	2492	11848	2087	12572	1770	13215	1264	15689	871	9664
14-#10	1.85	MA	12017	3054	16961	2601	19931	2184	21497	1851	23015	1341	27841	957	16947
5L-4S		MI	7179	3054	10707	2474	12213	2078	13026	1755	13846	1252	16562	924	9687
14-#10	1.85	MA	11742	3054	16432	2608	19300	2195	20700	1871	21906	1351	26337	892	16492
6L-3S		MI	7286	3054	11004	2464	12630	2062	13538	1748	14546	1248	17434	977	9687
14-#10	1.85	MA	11509	3054	15933	2616	18596	2211	19916	1881	20834	1370	24898	859	16048
7L-2S		MI	7497	3054	11434	2454	13178	2053	14203	1733	15447	1235	18680	1068	9678
14-#11	2.27	MA	12987	3169	19161	2631	22675	2196	24820	1845	27530	1303	33790	1007	20756
3L-6S		MI	7031	3169	10560	2560	11944	2147	12640	1801	13276	1261	15701	713	11177

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

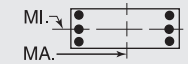
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.27	MA	12760	3169	18513	2647	21758	2221	23694	1869	25987	1314	31946	947	20662
4L-5S		MI	7204	3169	10881	2551	12379	2127	13180	1794	14005	1248	16644	785	11455
14-#11	2.27	MA	12383	3169	17845	2672	20963	2236	22704	1883	24606	1336	30064	899	20399
5L-4S		MI	7371	3169	11248	2529	12821	2118	13729	1776	14768	1234	17674	850	11616
14-#11	2.27	MA	12056	3169	17202	2679	20203	2249	21733	1907	23254	1347	28228	817	19662
6L-3S		MI	7496	3169	11606	2518	13326	2099	14347	1769	15615	1231	18706	913	11633
14-#11	2.27	MA	11779	3169	16594	2690	19346	2268	20790	1919	21948	1369	26464	777	19132
7L-2S		MI	7742	3169	12124	2507	13984	2090	15148	1752	16698	1217	20173	1025	11627
14-#14	3.28	MA	13815	3445	20785	2824	24555	2356	27058	1956	30506	1306	38303	848	29236
4L-5S		MI	7645	3445	11932	2725	13657	2254	14700	1876	16031	1232	19280	616	15538
14-#14	3.28	MA	13286	3445	19834	2860	23415	2376	25638	1975	28527	1336	35601	777	28062
5L-4S		MI	7875	3445	12455	2696	14287	2242	15483	1852	17119	1214	20720	710	16177
14-#14	3.28	MA	12841	3445	18913	2871	22334	2396	24245	2009	26641	1367	32965	656	27089
6L-3S		MI	8040	3445	12966	2681	15006	2215	16364	1843	18324	1211	22168	798	16281
14-#14	3.28	MA	12462	3445	18042	2885	21107	2422	22906	2028	24715	1382	30424	597	25534
7L-2S		MI	8371	3445	13701	2666	15942	2203	17500	1819	19863	1193	24219	960	16311
14-#18	5.83	MA	15486	4145	24737	3339	29489	2733	32921	2209	38274	1336	49348	460	46341
5L-4S		MI	9078	4145	15373	3121	17854	2558	19761	2046	22865	1161	27866	317	25958
14-#18	5.83	MA	14778	4145	23138	3358	27606	2767	30472	2267	34960	1387	44703	239	42908
6L-3S		MI	9367	4145	16260	3098	19100	2514	21288	2034	24953	1162	30297	466	27472
16-#10	2.12	MA	12723	3126	18307	2626	21593	2205	23535	1860	25808	1319	31679	988	19446
4L-6S		MI	7088	3126	10563	2544	12036	2136	12791	1798	13512	1272	16136	804	10715
16-#10	2.12	MA	12406	3126	17754	2646	20941	2217	22723	1871	24674	1337	30138	951	19322
5E		MI	7232	3126	10835	2537	12396	2120	13238	1791	14115	1260	16934	865	10952
16-#10	2.12	MA	12138	3126	17225	2653	20309	2228	21925	1891	23565	1347	28634	886	18847
6L-4S		MI	7376	3126	11137	2519	12761	2111	13691	1776	14746	1247	17808	918	10982
16-#10	2.12	MA	11912	3126	16726	2662	19605	2243	21142	1901	22493	1365	27195	853	18415
7L-3S		MI	7480	3126	11434	2509	13178	2095	14203	1769	15447	1244	18680	971	10991
16-#10	2.12	MA	11639	3126	16248	2672	18959	2252	20319	1917	21442	1384	25796	810	17871
8L-2S		MI	7687	3126	11864	2500	13726	2086	14868	1754	16347	1231	19925	1062	10986
16-#11	2.60	MA	13222	3258	19476	2702	22984	2262	25183	1894	28002	1309	34736	940	23550
4L-6S		MI	7267	3258	11078	2616	12602	2187	13440	1826	14359	1256	17168	702	12690
16-#11	2.60	MA	12846	3258	18807	2727	22189	2276	24193	1908	26621	1331	32855	892	23243
5E		MI	7437	3258	11399	2606	13038	2168	13980	1819	15088	1243	18112	775	12953
16-#11	2.60	MA	12529	3258	18164	2735	21429	2290	23222	1932	25269	1342	31018	810	22528
6L-4S		MI	7603	3258	11765	2585	13480	2158	14529	1801	15851	1229	19141	839	13168
16-#11	2.60	MA	12262	3258	17556	2745	20572	2308	22279	1945	23963	1364	29254	770	22004
7L-3S		MI	7724	3258	12124	2574	13984	2139	15148	1794	16698	1226	20173	902	13194
16-#11	2.60	MA	11938	3258	16974	2757	19785	2318	21278	1963	22681	1385	27545	715	21066
8L-2S		MI	7965	3258	12641	2563	14643	2130	15948	1777	17780	1212	21640	1015	13198
16-#14	3.75	MA	13932	3574	21211	2940	25169	2434	27768	2012	31410	1329	39592	766	32159
5E		MI	7968	3574	12667	2806	14593	2312	15837	1912	17570	1225	21332	597	17677
16-#14	3.75	MA	13503	3574	20291	2951	24088	2454	26374	2045	29523	1359	36956	646	31205
6L-4S		MI	8197	3574	13190	2776	15223	2300	16620	1889	18657	1207	22772	691	18283
16-#14	3.75	MA	13142	3574	19419	2965	22861	2480	25036	2064	27598	1375	34415	587	29631
7L-3S		MI	8356	3574	13701	2761	15942	2273	17500	1880	19863	1203	24219	780	18485
16-#14	3.75	MA	12686	3574	18585	2982	21732	2494	23601	2090	25760	1405	31960	506	28059
8L-2S		MI	8677	3574	14436	2746	16878	2261	18637	1856	21401	1185	26271	941	18527
16-#18	6.67	MA	15898	4373	25546	3500	30672	2871	34196	2331	40000	1374	51682	220	50033
6L-4S		MI	9681	4373	16639	3264	19466	2661	21720	2111	25515	1148	31287	270	29625
18-#10	2.38	MA	12790	3199	18546	2692	21950	2250	23948	1892	26333	1333	32435	945	21699
5L-6S		MI	7286	3199	10993	2590	12583	2169	13456	1818	14412	1268	17381	798	11974
18-#10	2.38	MA	12528	3199	18018	2698	21318	2261	23151	1912	25224	1343	30931	880	21204
6L-5S		MI	7427	3199	11265	2583	12943	2152	13903	1811	15015	1256	18179	859	12217

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

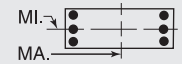


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.38	MA	12309	3199	17518	2707	20614	2276	22368	1922	24152	1361	29492	848	20785
7L-4S		MI	7571	3199	11568	2564	13308	2144	14356	1796	15646	1243	19053	912	12275
18-#10	2.38	MA	12038	3199	17040	2717	19968	2285	21545	1937	23101	1379	28093	805	20238
8L-3S		MI	7671	3199	11864	2555	13726	2128	14868	1789	16347	1239	19925	965	12290
18-#10	2.38	MA	11765	3199	16491	2735	19304	2303	20749	1946	22025	1389	26728	762	19602
9L-2S		MI	7875	3199	12294	2545	14273	2119	15533	1774	17247	1227	21170	1056	12291
18-#11	2.92	MA	13303	3348	19770	2783	23415	2317	25682	1933	28636	1325	35645	885	26092
5L-6S		MI	7502	3348	11595	2672	13261	2227	14240	1851	15442	1251	18636	691	14206
18-#11	2.92	MA	12995	3348	19127	2791	22655	2330	24710	1957	27284	1337	33808	803	25396
6L-5S		MI	7668	3348	11916	2662	13697	2208	14781	1844	16171	1237	19579	764	14457
18-#11	2.92	MA	12737	3348	18519	2801	21798	2349	23768	1970	25978	1359	32044	763	24870
7L-4S		MI	7833	3348	12283	2641	14139	2199	15329	1827	16934	1224	20608	829	14719
18-#11	2.92	MA	12415	3348	17937	2813	21011	2359	22766	1989	24696	1380	30335	708	23938
8L-3S		MI	7950	3348	12641	2630	14643	2180	15948	1819	17780	1220	21640	892	14753
18-#11	2.92	MA	12100	3348	17275	2835	20202	2380	21796	1998	23386	1392	28661	654	23001
9L-2S		MI	8186	3348	13159	2619	15302	2170	16748	1802	18863	1207	23108	1004	14765
18-#14	4.22	MA	14154	3702	21668	3031	25842	2512	28504	2082	32405	1352	40947	636	35321
6L-5S		MI	8288	3702	13402	2886	15529	2370	16973	1949	19108	1217	23384	578	19822
18-#14	4.22	MA	13809	3702	20797	3046	24615	2539	27165	2101	30480	1367	38407	577	33727
7L-4S		MI	8516	3702	13925	2856	16159	2358	17756	1925	20196	1199	24823	672	20400
18-#14	4.22	MA	13357	3702	19962	3062	23486	2553	25731	2127	28642	1398	35951	495	32138
8L-3S		MI	8668	3702	14436	2841	16878	2331	18637	1916	21401	1196	26271	761	20687
18-#14	4.22	MA	12925	3702	19019	3095	22327	2583	24340	2140	26763	1414	33540	418	30584
9L-2S		MI	8982	3702	15171	2826	17813	2320	19773	1892	22939	1178	28323	922	20740
20-#10	2.65	MA	12913	3271	18810	2744	22328	2294	24377	1932	26883	1339	33228	874	23565
6E		MI	7482	3271	11423	2635	13131	2202	14122	1839	15312	1264	18626	793	13237
20-#10	2.65	MA	12701	3271	18311	2752	21624	2309	23593	1942	25811	1357	31789	842	23156
7L-5S		MI	7621	3271	11695	2628	13491	2185	14568	1832	15915	1251	19425	854	13469
20-#10	2.65	MA	12432	3271	17833	2762	20977	2318	22771	1958	24760	1375	30390	799	22607
8L-4S		MI	7764	3271	11998	2610	13856	2177	15021	1817	16546	1239	20298	906	13567
20-#10	2.65	MA	12172	3271	17284	2780	20313	2336	21974	1966	23684	1385	29025	756	21971
9L-3S		MI	7861	3271	12294	2600	14273	2161	15533	1810	17247	1235	21170	959	13587
20-#10	2.65	MA	11924	3271	16787	2788	19688	2346	21180	1984	22600	1400	27518	707	21197
10L-2S		MI	8062	3271	12724	2590	14821	2152	16198	1795	18147	1223	22415	1050	13594
20-#11	3.25	MA	13454	3437	20090	2846	23881	2370	26199	1982	29300	1332	36598	796	28268
6E		MI	7733	3437	12113	2727	13920	2268	15041	1876	16524	1246	20103	681	15725
20-#11	3.25	MA	13206	3437	19482	2857	23024	2389	25257	1995	27993	1353	34834	755	27738
7L-5S		MI	7896	3437	12434	2718	14356	2248	15581	1869	17254	1232	21046	753	15966
20-#11	3.25	MA	12886	3437	18900	2869	22236	2399	24255	2014	26711	1375	33125	701	26811
8L-4S		MI	8061	3437	12800	2696	14798	2239	16130	1852	18017	1219	22076	818	16267
20-#11	3.25	MA	12579	3437	18237	2891	21428	2421	23285	2023	25401	1386	31451	647	25863
9L-3S		MI	8173	3437	13159	2685	15302	2220	16748	1845	18863	1215	23108	881	16309
20-#11	3.25	MA	12285	3437	17633	2900	20667	2433	22317	2044	24098	1406	29611	585	24896
10L-2S		MI	8405	3437	13676	2674	15961	2211	17548	1827	19946	1202	24575	993	16327
20-#14	4.69	MA	14465	3831	22174	3126	26368	2597	29295	2137	33363	1360	42398	566	37823
7L-5S		MI	8605	3831	14137	2966	16464	2429	18110	1985	20646	1210	25435	559	21973
20-#14	4.69	MA	14017	3831	21339	3143	25239	2611	27861	2163	31525	1390	39942	485	36217
8L-4S		MI	8833	3831	14660	2936	17095	2417	18893	1961	21734	1192	26875	653	22525
20-#14	4.69	MA	13600	3831	20396	3175	24080	2642	26470	2177	29645	1406	37531	407	34652
9L-3S		MI	8977	3831	15171	2922	17813	2390	19773	1952	22939	1188	28323	742	22887
22-#10	2.91	MA	13088	3344	19103	2798	22633	2342	24819	1963	27470	1353	34086	836	25529
7L-6S		MI	7677	3344	11854	2680	13679	2235	14787	1859	16212	1259	19872	787	14501
22-#10	2.91	MA	12820	3344	18626	2808	21986	2351	23997	1979	26418	1371	32687	793	24975
8L-5S		MI	7813	3344	12125	2673	14038	2218	15233	1853	16815	1247	20670	848	14725
22-#10	2.91	MA	12567	3344	18077	2826	21322	2369	23200	1987	25343	1381	31322	750	24340
9L-4S		MI	7956	3344	12428	2655	14403	2210	15686	1837	17446	1235	21543	900	14857
22-#10	2.91	MA	12327	3344	17580	2833	20698	2379	22406	2004	24259	1396	29815	701	23558
10L-3S		MI	8050	3344	12724	2645	14821	2193	16198	1831	18147	1231	22415	953	14883

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	2.91	MA	12065	3344	17095	2842	20066	2388	21628	2014	23160	1404	28454	656	22828
11L-2S		MI	8247	3344	13154	2636	15368	2185	16863	1815	19047	1219	23661	1044	14894
22-#11	3.57	MA	13668	3526	20445	2912	24250	2430	26746	2020	30008	1348	37624	748	30608
7L-6S		MI	7963	3526	12630	2783	14579	2308	15841	1902	17607	1241	21570	670	17247
22-#11	3.57	MA	13350	3526	19862	2924	23462	2440	25744	2039	28726	1370	35915	693	29683
8L-5S		MI	8122	3526	12951	2773	15015	2289	16381	1895	18337	1227	22513	743	17478
22-#11	3.57	MA	13051	3526	19200	2947	22654	2461	24774	2049	27416	1381	34241	640	28725
9L-4S		MI	8287	3526	13318	2752	15456	2280	16930	1877	19100	1213	23543	807	17815
22-#11	3.57	MA	12769	3526	18596	2956	21892	2473	23806	2070	26113	1401	32401	578	27761
10L-3S		MI	8395	3526	13676	2741	15961	2260	17548	1870	19946	1210	24575	871	17864
22-#14	5.16	MA	14666	3959	22716	3223	26993	2669	29990	2200	34407	1383	43933	475	40296
8L-5S		MI	8919	3959	14872	3047	17400	2487	19246	2022	22184	1202	27487	540	24129
22-#14	5.16	MA	14263	3959	21774	3255	25834	2700	28600	2213	32528	1399	41522	397	38717
9L-4S		MI	9146	3959	15395	3017	18030	2475	20029	1998	23272	1184	28926	634	24657
24-#10	3.17	MA	13204	3416	19418	2853	22995	2384	25223	1999	28077	1367	34984	787	27342
8L-6S		MI	7870	3416	12284	2726	14226	2268	15452	1880	17112	1255	21117	781	15768
24-#10	3.17	MA	12957	3416	18869	2871	22332	2402	24426	2008	27002	1377	33619	744	26709
9L-5S		MI	8004	3416	12555	2719	14586	2251	15898	1873	17715	1243	21915	842	15984
24-#10	3.17	MA	12725	3416	18372	2879	21707	2412	23632	2025	25918	1392	32112	696	25919
10L-4S		MI	8146	3416	12858	2700	14951	2243	16352	1858	18346	1231	22789	894	16147
24-#10	3.17	MA	12464	3416	17888	2887	21076	2421	22854	2035	24819	1399	30751	650	25183
11L-3S		MI	8237	3416	13154	2691	15368	2226	16863	1851	19047	1227	23661	947	16177
24-#11	3.90	MA	13808	3615	20825	2980	24688	2480	27233	2064	30741	1365	38705	686	32556
8L-6S		MI	8191	3615	13148	2839	15238	2349	16641	1927	18690	1235	23037	660	18771
24-#11	3.90	MA	13517	3615	20163	3002	23880	2502	26263	2074	29431	1376	37031	633	31587
9L-5S		MI	8347	3615	13468	2829	15674	2329	17181	1920	19420	1222	23981	732	18994
24-#11	3.90	MA	13254	3615	19558	3011	23118	2514	25295	2095	28128	1395	35191	571	30627
10L-4S		MI	8511	3615	13835	2808	16115	2320	17730	1902	20183	1208	25010	797	19363
24-#14	5.63	MA	14916	4088	23151	3335	27588	2758	30729	2249	35410	1391	45513	387	42782
9L-5S		MI	9230	4088	15607	3127	18336	2545	20383	2058	23722	1195	29538	521	26289

RECTANGULAR TIED COLUMNS 24" x 42"

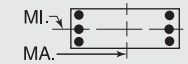
4-#18	1.59	MA	13723	3130	20000	2605	23444	2186	25415	1854	27663	1346	33493	1168	15977
2E		MI	7537	3130	11628	2465	13122	2066	13932	1750	14804	1263	17101	1039	8543
6-#14	1.34	MA	13408	3059	19132	2577	22459	2168	24277	1846	26173	1360	31467	1182	13675
2L-3S		MI	7045	3059	10454	2465	11733	2071	12295	1776	12627	1303	14455	929	7430
6-#14	1.34	MA	12627	3059	17674	2600	20603	2189	22023	1866	23123	1392	27243	1041	13663
3L-2S		MI	7417	3059	11189	2450	12668	2059	13431	1752	14165	1285	16506	1090	7390
6-#18	2.38	MA	14897	3358	22551	2748	26692	2290	29360	1919	33002	1333	40885	1149	23692
2L-3S		MI	7473	3358	11628	2631	13122	2187	13932	1853	14804	1276	17101	705	12423
6-#18	2.38	MA	13627	3358	20000	2786	23444	2325	25415	1951	27663	1386	33493	892	23486
3L-2S		MI	8076	3358	12894	2608	14734	2170	15890	1815	17454	1250	20522	993	12424
8-#10	1.01	MA	12942	2963	17941	2538	21088	2142	22685	1834	24079	1378	28612	1200	10482
2L-4S		MI	6880	2963	9838	2445	11037	2071	11508	1773	11603	1327	13325	997	5793
8-#10	1.01	MA	12480	2963	17103	2551	20021	2154	21389	1846	22325	1397	26184	1123	10491
3E		MI	6999	2963	10135	2435	11455	2054	12020	1766	12303	1324	14197	1050	5769
8-#10	1.01	MA	12245	2963	16541	2565	19226	2175	20413	1867	20986	1407	24599	1074	10471
4L-2S		MI	7224	2963	10565	2425	12002	2046	12685	1751	13203	1311	15442	1141	5747
8-#11	1.24	MA	13278	3029	18762	2567	22049	2162	23810	1845	25566	1367	30644	1189	12727
2L-4S		MI	6963	3029	10121	2468	11313	2087	11806	1779	11975	1312	13767	937	6961
8-#11	1.24	MA	12730	3029	17744	2584	20752	2177	22235	1859	23434	1389	27693	1092	12729
3E		MI	7104	3029	10479	2457	11818	2068	12424	1772	12822	1309	14799	1000	6935

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

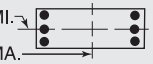


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.24	MA	12450	3029	17059	2600	19784	2202	21046	1883	21804	1401	25752	1032	12676
4L-2S		MI	7368	3029	10996	2446	12477	2059	13224	1754	13905	1295	16267	1112	6908
8-#14	1.79	MA	14098	3187	20590	2657	24315	2226	26531	1883	29224	1353	35691	1172	18091
2L-4S		MI	7184	3187	10678	2560	11950	2156	12551	1821	12959	1299	15058	821	9662
8-#14	1.79	MA	13347	3187	19132	2680	22459	2247	24277	1902	26173	1384	31467	1030	18048
3E		MI	7378	3187	11189	2545	12668	2129	13431	1812	14165	1295	16506	910	9674
8-#14	1.79	MA	12964	3187	18150	2703	21071	2283	22573	1937	23837	1401	28675	943	17841
4L-2S		MI	7739	3187	11924	2530	13604	2117	14568	1788	15703	1277	18558	1071	9648
8-#18	3.17	MA	16038	3587	25102	2890	29940	2393	33304	1984	38341	1320	48277	1131	31386
2L-4S		MI	7715	3587	12007	2796	13488	2335	14364	1929	15366	1263	18091	510	15254
8-#18	3.17	MA	14839	3587	22551	2929	26692	2429	29360	2016	33002	1372	40885	873	31125
3E		MI	8028	3587	12894	2773	14734	2291	15890	1917	17454	1263	20522	659	16212
8-#18	3.17	MA	14231	3587	20826	2968	24255	2491	26367	2075	28900	1399	35947	716	29287
4L-2S		MI	8605	3587	14161	2750	16347	2274	17849	1880	20105	1237	23943	946	16272
10-#10	1.26	MA	13353	3036	18779	2583	22155	2175	23981	1855	25833	1374	31041	1194	13025
2L-5S		MI	6938	3036	9966	2508	11220	2112	11720	1809	11872	1336	13696	939	7114
10-#10	1.26	MA	12902	3036	17941	2596	21088	2187	22685	1867	24079	1392	28612	1117	13023
3L-4S		MI	7084	3036	10268	2490	11585	2104	12173	1793	12503	1323	14570	991	7109
10-#10	1.26	MA	12676	3036	17379	2610	20293	2208	21709	1887	22740	1403	27027	1068	12990
4L-3S		MI	7199	3036	10565	2480	12002	2087	12685	1787	13203	1319	15442	1044	7091
10-#10	1.26	MA	12332	3036	16792	2630	19605	2221	20851	1899	21544	1421	25403	1033	12887
5L-2S		MI	7420	3036	10995	2471	12550	2079	13350	1771	14104	1307	16687	1135	7072
10-#11	1.55	MA	13767	3119	19781	2623	23346	2202	25385	1870	27697	1362	33596	1182	15814
2L-5S		MI	7036	3119	10271	2545	11530	2137	12057	1822	12295	1321	14205	861	8518
10-#11	1.55	MA	13233	3119	18762	2639	22049	2217	23810	1884	25566	1384	30644	1085	15800
3L-4S		MI	7204	3119	10638	2524	11972	2127	12606	1804	13058	1307	15235	926	8535
10-#11	1.55	MA	12967	3119	18078	2655	21081	2243	22621	1908	23935	1396	28704	1025	15731
4L-3S		MI	7340	3119	10996	2513	12477	2108	13224	1797	13905	1304	16267	989	8520
10-#11	1.55	MA	12557	3119	17368	2680	20242	2258	21576	1922	22478	1418	26720	979	15539
5L-2S		MI	7598	3119	11514	2502	13135	2099	14024	1780	14987	1290	17734	1101	8499
10-#14	2.23	MA	14774	3316	22047	2738	26171	2284	28785	1919	32274	1345	39915	1161	22494
2L-5S		MI	7289	3316	10890	2670	12255	2227	12904	1881	13410	1309	15670	708	11396
10-#14	2.23	MA	14050	3316	20590	2761	24315	2306	26531	1939	29224	1377	35691	1020	22429
3L-4S		MI	7522	3316	11413	2640	12886	2215	13687	1858	14498	1291	17110	802	11861
10-#14	2.23	MA	13692	3316	19608	2783	22927	2342	24827	1973	26887	1393	32899	933	22203
4L-3S		MI	7706	3316	11924	2625	13604	2188	14568	1849	15703	1288	18558	891	11901
10-#14	2.23	MA	13115	3316	18597	2820	21723	2363	23328	1993	24797	1424	30050	864	21137
5L-2S		MI	8057	3316	12659	2610	14540	2176	15704	1825	17241	1270	20609	1053	11891
10-#18	3.97	MA	16015	3815	25102	3072	29940	2533	33304	2081	38341	1359	48277	855	38771
3L-4S		MI	8281	3815	13273	2939	15100	2439	16322	1994	18017	1249	21512	463	18847
10-#18	3.97	MA	15466	3815	23377	3111	27503	2595	30312	2140	34239	1385	43339	697	36856
4L-3S		MI	8573	3815	14161	2916	16347	2395	17849	1982	20105	1250	23943	612	19991
10-#18	3.97	MA	14489	3815	21622	3176	25386	2630	27677	2172	30566	1438	38318	568	34020
5L-2S		MI	9127	3815	15427	2893	17959	2378	19807	1944	22755	1224	27365	900	20095
12-#10	1.51	MA	13758	3108	19617	2628	23222	2207	25277	1876	27586	1369	33469	1189	15563
2L-6S		MI	6990	3108	10124	2561	11408	2161	11938	1836	12169	1344	14143	872	8276
12-#10	1.51	MA	13317	3108	18779	2642	22155	2220	23981	1887	25833	1388	31041	1111	15552
3L-5S		MI	7140	3108	10396	2553	11768	2145	12385	1829	12772	1331	14942	933	8410
12-#10	1.51	MA	13100	3108	18217	2655	21360	2241	23005	1908	24494	1398	29455	1063	15508
4E		MI	7286	3108	10698	2535	12133	2137	12838	1814	13403	1319	15815	985	8416
12-#10	1.51	MA	12758	3108	17630	2675	20672	2254	22147	1920	23298	1417	27831	1027	15396
5L-3S		MI	7397	3108	10995	2526	12550	2120	13350	1807	14104	1315	16687	1038	8405
12-#10	1.51	MA	12458	3108	17071	2682	20001	2264	21306	1940	22128	1428	26246	963	14991
6L-2S		MI	7613	3108	11425	2516	13098	2112	14015	1792	15004	1303	17933	1130	8390
12-#11	1.86	MA	14248	3208	20799	2679	24642	2243	26960	1895	29829	1357	36547	1174	18894
2L-6S		MI	7096	3208	10468	2610	11753	2196	12317	1854	12649	1329	14729	778	9752
12-#11	1.86	MA	13728	3208	19781	2695	23346	2258	25385	1909	27697	1379	33596	1078	18869
3L-5S		MI	7274	3208	10789	2601	12189	2177	12857	1847	13378	1316	15672	851	10050

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



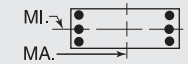
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.86	MA	13474	3208	19096	2711	22377	2283	24196	1933	26067	1391	31655	1018	18786
4E		MI	7442	3208	11156	2580	12631	2168	13406	1830	14141	1302	16702	916	10098
12-#11	1.86	MA	13067	3208	18386	2736	21539	2298	23151	1947	24609	1413	29672	971	18587
5L-3S		MI	7573	3208	11514	2569	13135	2148	14024	1822	14987	1299	17734	979	10097
12-#11	1.86	MA	12709	3208	17707	2744	20730	2311	22125	1972	23183	1425	27736	891	17818
6L-2S		MI	7826	3208	12031	2558	13794	2139	14825	1805	16070	1285	19201	1091	10081
12-#14	2.68	MA	14738	3444	22047	2841	26171	2364	28785	1975	32274	1369	39915	1010	26809
3L-5S		MI	7622	3444	11625	2750	13191	2285	14041	1918	14948	1302	17722	689	13514
12-#14	2.68	MA	14403	3444	21066	2864	24783	2400	27081	2010	29938	1386	37122	922	26568
4E		MI	7853	3444	12148	2720	13821	2273	14824	1894	16036	1284	19161	783	14056
12-#14	2.68	MA	13831	3444	20054	2900	23579	2421	25582	2029	27847	1417	34274	854	25464
5L-3S		MI	8029	3444	12659	2706	14540	2246	15704	1885	17241	1281	20609	872	14116
12-#14	2.68	MA	13337	3444	19081	2911	22428	2441	24111	2064	25801	1433	31493	735	24371
6L-2S		MI	8370	3444	13394	2691	15476	2234	16841	1861	18779	1263	22661	1034	14124
12-#18	4.76	MA	16667	4044	25928	3253	30751	2699	34257	2205	39578	1372	50731	679	44438
4E		MI	8837	4044	14540	3082	16713	2542	18280	2058	20667	1236	24933	417	22469
12-#18	4.76	MA	15700	4044	24173	3319	28634	2734	31622	2237	35905	1425	45710	549	41615
5L-3S		MI	9109	4044	15427	3059	17959	2499	19807	2047	22755	1236	27365	566	23766
12-#18	4.76	MA	14900	4044	22467	3337	26645	2770	29035	2296	32403	1477	40810	332	38149
6L-2S		MI	9648	4044	16693	3036	19571	2481	21765	2009	25405	1210	30786	854	23906
14-#10	1.76	MA	13727	3181	19617	2687	23222	2253	25277	1908	27586	1384	33469	1105	18078
3L-6S		MI	7193	3181	10554	2606	11955	2194	12604	1857	13069	1340	15389	866	9527
14-#10	1.76	MA	13519	3181	19055	2701	22427	2274	24300	1928	26248	1394	31884	1057	18026
4L-5S		MI	7340	3181	10826	2599	12315	2178	13050	1850	13672	1327	16187	927	9701
14-#10	1.76	MA	13178	3181	18468	2721	21739	2287	23443	1940	25051	1413	30259	1021	17907
5L-4S		MI	7485	3181	11129	2581	12680	2170	13503	1835	14303	1315	17060	979	9718
14-#10	1.76	MA	12885	3181	17909	2728	21068	2297	22602	1961	23881	1423	28674	957	17479
6L-3S		MI	7593	3181	11425	2571	13098	2153	14015	1828	15004	1311	17933	1032	9714
14-#10	1.76	MA	12637	3181	17382	2737	20325	2313	21769	1970	22750	1442	27161	925	16996
7L-2S		MI	7805	3181	11855	2561	13645	2145	14680	1813	15904	1299	19178	1124	9703
14-#11	2.17	MA	14216	3297	20799	2751	24642	2298	26960	1934	29829	1374	36547	1071	21935
3L-6S		MI	7336	3297	10985	2666	12412	2237	13117	1879	13731	1324	16196	768	11258
14-#11	2.17	MA	13974	3297	20115	2767	23674	2324	25771	1959	28198	1386	34606	1010	21842
4L-5S		MI	7510	3297	11306	2657	12848	2217	13658	1872	14461	1310	17140	840	11541
14-#11	2.17	MA	13569	3297	19405	2792	22835	2339	24726	1973	26741	1408	32623	964	21636
5L-4S		MI	7677	3297	11673	2635	13290	2208	14206	1855	15224	1297	18169	905	11656
14-#11	2.17	MA	13221	3297	18725	2800	22026	2352	23700	1997	25314	1420	30687	884	20847
6L-3S		MI	7804	3297	12031	2624	13794	2189	14825	1848	16070	1293	19201	968	11667
14-#11	2.17	MA	12926	3297	18083	2810	21121	2371	22697	2010	23935	1442	28832	844	20277
7L-2S		MI	8051	3297	12549	2613	14453	2180	15625	1830	17153	1280	20668	1080	11658
14-#14	3.13	MA	15100	3572	22523	2944	26638	2458	29335	2046	32988	1378	41346	912	30937
4L-5S		MI	7951	3572	12360	2831	14127	2343	15177	1954	16486	1294	19773	670	15643
14-#14	3.13	MA	14532	3572	21512	2980	25435	2480	27836	2066	30898	1410	38497	843	29798
5L-4S		MI	8181	3572	12883	2801	14757	2331	15960	1930	17574	1276	21213	764	16248
14-#14	3.13	MA	14057	3572	20538	2991	24284	2499	26365	2100	28852	1426	35717	725	28729
6L-3S		MI	8348	3572	13394	2786	15476	2304	16841	1921	18779	1273	22661	853	16325
14-#14	3.13	MA	13654	3572	19618	3006	22987	2526	24938	2119	26873	1457	33046	667	27166
7L-2S		MI	8681	3572	14129	2771	16411	2293	17978	1897	20317	1255	24712	1015	16349
14-#18	5.56	MA	16879	4272	26724	3461	31882	2838	35567	2302	41244	1412	53102	531	49208
5L-4S		MI	9384	4272	15806	3225	18325	2646	20238	2123	23317	1223	28354	371	26113
14-#18	5.56	MA	16123	4272	25018	3479	29893	2873	32980	2361	37742	1464	48203	313	45698
6L-3S		MI	9678	4272	16693	3202	19571	2602	21765	2112	25405	1223	30786	520	27540
14-#18	5.56	MA	15477	4272	23402	3504	27617	2919	30495	2393	34167	1490	43468	207	42102
7L-2S		MI	10148	4272	17959	3179	21184	2585	23724	2074	28055	1197	34207	807	27709

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

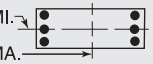


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.02	MA	13931	3253	19893	2746	23494	2307	25596	1949	28001	1390	34312	1051	20543
4L-6S		MI	7393	3253	10984	2651	12503	2227	13269	1877	13969	1335	16634	860	10783
16-#10	2.02	MA	13593	3253	19306	2766	22806	2320	24739	1961	26805	1409	32688	1015	20420
5E		MI	7538	3253	11256	2644	12863	2211	13715	1870	14572	1323	17432	921	10990
16-#10	2.02	MA	13306	3253	18747	2773	22135	2330	23898	1981	25635	1419	31102	951	19970
6L-4S		MI	7682	3253	11559	2626	13228	2202	14168	1855	15203	1311	18306	973	11015
16-#10	2.02	MA	13066	3253	18220	2782	21392	2346	23065	1991	24504	1438	29590	919	19501
7L-3S		MI	7787	3253	11855	2616	13645	2186	14680	1848	15904	1307	19178	1026	11020
16-#10	2.02	MA	12774	3253	17716	2792	20709	2355	22197	2007	23395	1457	28116	877	18980
8L-2S		MI	7996	3253	12285	2607	14193	2178	15345	1833	16804	1294	20423	1118	11012
16-#11	2.48	MA	14466	3386	21133	2822	24971	2364	27346	1984	30330	1381	37558	1003	24898
4L-6S		MI	7573	3386	11503	2722	13071	2277	13917	1905	14814	1319	17663	757	12770
16-#11	2.48	MA	14063	3386	20423	2847	24132	2379	26301	1998	28872	1403	35574	957	24669
5E		MI	7744	3386	11824	2712	13507	2258	14458	1898	15544	1305	18607	830	13038
16-#11	2.48	MA	13725	3386	19744	2855	23323	2392	25275	2022	27446	1415	33638	876	23881
6L-4S		MI	7910	3386	12190	2691	13949	2249	15007	1880	16307	1292	19636	894	13210
16-#11	2.48	MA	13441	3386	19102	2866	22418	2411	24272	2035	26066	1437	31784	836	23327
7L-3S		MI	8032	3386	12549	2680	14453	2229	15625	1873	17153	1288	20668	957	13230
16-#11	2.48	MA	13093	3386	18487	2878	21586	2422	23214	2054	24714	1459	29983	783	22376
8L-2S		MI	8275	3386	13066	2669	15112	2220	16425	1855	18236	1275	22136	1070	13230
16-#14	3.57	MA	15221	3701	22969	3060	27291	2538	30090	2102	33948	1402	42721	833	34139
5E		MI	8275	3701	13095	2911	15063	2402	16314	1991	18024	1287	21825	652	17780
16-#14	3.57	MA	14763	3701	21996	3071	26140	2557	28619	2137	31902	1418	39941	715	33086
6L-4S		MI	8504	3701	13618	2881	15693	2390	17097	1967	19112	1269	23264	746	18401
16-#14	3.57	MA	14378	3701	21075	3086	24843	2584	27192	2155	29923	1450	37270	656	31502
7L-3S		MI	8664	3701	14129	2866	16411	2363	17978	1958	20317	1266	24712	834	18531
16-#14	3.57	MA	13889	3701	20194	3103	23651	2599	25676	2182	27983	1481	34682	577	29929
8L-2S		MI	8989	3701	14864	2851	17347	2351	19114	1934	21856	1248	26764	996	18567
16-#18	6.35	MA	17317	4500	27569	3622	33140	2977	36925	2426	43081	1451	55595	295	53247
6L-4S		MI	9988	4500	17072	3367	19937	2750	22197	2188	25967	1210	31776	324	29775
16-#18	6.35	MA	16713	4500	25953	3647	30865	3023	34440	2458	39506	1477	50860	188	49616
7L-3S		MI	10196	4500	17959	3344	21184	2706	23724	2176	28055	1210	34207	473	31313
18-#10	2.27	MA	14001	3326	20144	2811	23873	2353	26035	1981	28559	1405	35116	1009	22933
5L-6S		MI	7592	3326	11415	2697	13051	2260	13934	1898	14869	1331	17879	854	12042
18-#10	2.27	MA	13722	3326	19585	2818	23202	2363	25194	2002	27389	1415	33531	945	22464
6L-5S		MI	7734	3326	11686	2689	13411	2244	14380	1891	15472	1319	18677	915	12278
18-#10	2.27	MA	13489	3326	19058	2827	22459	2379	24361	2012	26258	1434	32018	913	22007
7L-4S		MI	7878	3326	11989	2671	13775	2235	14834	1876	16103	1306	19551	967	12309
18-#10	2.27	MA	13199	3326	18554	2838	21776	2388	23493	2028	25149	1453	30545	871	21483
8L-3S		MI	7979	3326	12285	2662	14193	2219	15345	1869	16804	1303	20423	1020	12321
18-#10	2.27	MA	12907	3326	17971	2855	21076	2406	22652	2036	24004	1462	29110	829	20794
9L-2S		MI	8184	3326	12715	2652	14740	2210	16010	1854	17704	1290	21668	1112	12319
18-#11	2.79	MA	14551	3475	21442	2903	25429	2420	27876	2023	31004	1398	38526	950	27685
5L-6S		MI	7807	3475	12020	2778	13730	2318	14718	1930	15897	1314	19131	746	14285
18-#11	2.79	MA	14221	3475	20762	2911	24620	2433	26850	2048	29577	1410	36590	869	26918
6L-5S		MI	7975	3475	12341	2768	14166	2298	15258	1923	16627	1300	20074	819	14541
18-#11	2.79	MA	13947	3475	20120	2922	23715	2452	25847	2060	28198	1432	34735	829	26380
7L-4S		MI	8140	3475	12708	2747	14607	2289	15807	1905	17390	1286	21103	884	14762
18-#11	2.79	MA	13602	3475	19505	2934	22883	2462	24789	2079	26845	1454	32934	776	25415
8L-3S		MI	8258	3475	13066	2736	15112	2270	16425	1898	18236	1283	22136	947	14790
18-#11	2.79	MA	13266	3475	18802	2956	22030	2484	23764	2089	25462	1466	31174	723	24491
9L-2S		MI	8496	3475	13584	2725	15771	2261	17225	1881	19319	1270	23603	1059	14799
18-#14	4.02	MA	15457	3829	23454	3152	27996	2616	30873	2173	34953	1411	44165	704	37442
6L-5S		MI	8596	3829	13830	2991	15998	2460	17451	2027	19562	1279	23876	633	19923
18-#14	4.02	MA	15089	3829	22533	3167	26699	2642	29447	2192	32974	1442	41493	646	35838
7L-4S		MI	8824	3829	14353	2961	16629	2448	18233	2003	20650	1261	25316	727	20515
18-#14	4.02	MA	14604	3829	21651	3184	25507	2657	27931	2219	31034	1474	38906	567	34246
8L-3S		MI	8977	3829	14864	2946	17347	2421	19114	1994	21856	1258	26764	815	20734
18-#14	4.02	MA	14144	3829	20649	3216	24282	2688	26461	2232	29050	1490	36370	490	32563
9L-2S		MI	9294	3829	15599	2932	18283	2409	20251	1970	23394	1240	28815	977	20782

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

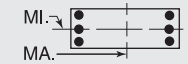
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	7.14	MA	17920	4729	28504	3790	34113	3127	38385	2523	44845	1464	58252	170	57130
7L-4S		MI	10519	4729	18339	3510	21550	2854	24155	2252	28618	1196	35197	278	33452
20-#10	2.52	MA	14132	3398	20423	2863	24269	2396	26490	2022	29143	1411	35959	939	24960
6E		MI	7789	3398	11845	2742	13598	2293	14599	1918	15769	1327	19124	848	13304
20-#10	2.52	MA	13906	3398	19896	2873	23526	2412	25657	2032	28011	1430	34446	907	24515
7L-5S		MI	7928	3398	12116	2735	13958	2277	15045	1911	16372	1315	19923	909	13542
20-#10	2.52	MA	13618	3398	19392	2883	22843	2421	24788	2048	26902	1448	32973	865	23985
8L-4S		MI	8071	3398	12419	2717	14323	2268	15499	1896	17003	1302	20796	961	13602
20-#10	2.52	MA	13335	3398	18809	2901	22143	2439	23948	2057	25758	1458	31538	823	23299
9L-3S		MI	8170	3398	12715	2707	14740	2252	16010	1889	17704	1298	21668	1014	13619
20-#10	2.52	MA	13077	3398	18284	2908	21483	2450	23109	2075	24614	1474	29951	775	22533
10L-2S		MI	8372	3398	13145	2697	15288	2243	16676	1874	18604	1286	22914	1106	13623
20-#11	3.10	MA	14711	3564	21781	2967	25917	2473	28425	2073	31709	1404	39541	862	29957
6E		MI	8040	3564	12538	2833	14389	2358	15518	1955	16980	1308	20598	736	15804
20-#11	3.10	MA	14446	3564	21139	2977	25012	2492	27422	2085	30329	1427	37686	822	29434
7L-5S		MI	8203	3564	12859	2824	14825	2339	16058	1948	17710	1295	21541	808	16048
20-#11	3.10	MA	14103	3564	20524	2989	24180	2503	26364	2104	28977	1449	35885	769	28454
8L-4S		MI	8368	3564	13225	2802	15266	2330	16607	1931	18473	1281	22571	873	16312
20-#11	3.10	MA	13776	3564	19820	3011	23326	2525	25339	2115	27594	1461	34125	716	27519
9L-3S		MI	8482	3564	13584	2791	15771	2310	17225	1923	19319	1278	23603	936	16348
20-#11	3.10	MA	13463	3564	19181	3021	22523	2537	24318	2136	26206	1480	32186	655	26472
10L-2S		MI	8716	3564	14101	2780	16429	2301	18025	1906	20402	1264	25070	1048	16363
20-#14	4.46	MA	15788	3958	23991	3247	28555	2701	31701	2228	36025	1435	45717	636	40173
7L-5S		MI	8913	3958	14565	3071	16934	2518	18587	2064	21101	1272	25928	614	22073
20-#14	4.46	MA	15307	3958	23109	3264	27362	2715	30185	2255	34084	1466	43129	557	38563
8L-4S		MI	9140	3958	15088	3042	17564	2506	19370	2040	22188	1254	27368	708	22638
20-#14	4.46	MA	14862	3958	22107	3296	26138	2747	28716	2269	32100	1483	40594	479	36888
9L-3S		MI	9287	3958	15599	3027	18283	2480	20251	2031	23394	1251	28815	796	22935
22-#10	2.77	MA	14318	3471	20734	2918	24593	2445	26952	2053	29765	1425	36875	901	27025
7L-6S		MI	7984	3471	12275	2787	14146	2326	15264	1939	16670	1323	20370	842	14568
22-#10	2.77	MA	14031	3471	20230	2928	23910	2454	26084	2069	28656	1444	35401	860	26488
8L-5S		MI	8121	3471	12546	2780	14506	2309	15710	1932	17273	1310	21168	903	14796
22-#10	2.77	MA	13761	3471	19647	2946	23210	2472	25243	2077	27512	1454	33966	817	25804
9L-4S		MI	8263	3471	12849	2762	14871	2301	16164	1917	17903	1298	22042	955	14893
22-#10	2.77	MA	13505	3471	19122	2954	22550	2483	24405	2095	26367	1469	32379	769	25029
10L-3S		MI	8359	3471	13145	2752	15288	2285	16676	1910	18604	1294	22914	1009	14915
22-#10	2.77	MA	13225	3471	18611	2963	21879	2492	23585	2105	25207	1477	30945	725	24282
11L-2S		MI	8558	3471	13575	2743	15836	2276	17341	1895	19504	1282	24159	1100	14924
22-#11	3.40	MA	14938	3653	22157	3033	26308	2533	28997	2111	32461	1422	40638	815	32490
7L-6S		MI	8270	3653	13055	2889	15047	2399	16318	1980	18063	1303	22065	725	17325
22-#11	3.40	MA	14597	3653	21542	3045	25477	2543	27939	2130	31108	1444	38837	762	31493
8L-5S		MI	8430	3653	13376	2879	15483	2379	16858	1973	18793	1290	23009	798	17560
22-#11	3.40	MA	14279	3653	20839	3067	24623	2565	26914	2140	29725	1456	37077	709	30546
9L-4S		MI	8595	3653	13743	2858	15925	2370	17407	1956	19556	1276	24038	862	17861
22-#11	3.40	MA	13977	3653	20200	3076	23819	2578	25893	2161	28337	1475	35137	648	29504
10L-3S		MI	8705	3653	14101	2847	16429	2351	18025	1949	20402	1273	25070	926	17904
22-#11	3.40	MA	13643	3653	19577	3087	23011	2589	24893	2173	26924	1484	33384	592	28369
11L-2S		MI	8935	3653	14619	2836	17088	2342	18826	1931	21485	1259	26537	1038	17924
22-#14	4.91	MA	15998	4086	24567	3344	29218	2774	32439	2291	37135	1459	47353	546	42880
8L-5S		MI	9228	4086	15300	3152	17870	2577	19724	2100	22639	1264	27980	595	24227
22-#14	4.91	MA	15568	4086	23564	3376	27994	2805	30970	2305	35151	1475	44818	469	41214
9L-4S		MI	9454	4086	15823	3122	18500	2565	20506	2076	23727	1246	29419	689	24768

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

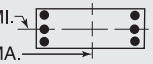
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#10	3.02	MA	14440	3543	21068	2973	24977	2487	27380	2089	30410	1440	37830	854	28990
8L-6S		MI	8177	3543	12705	2833	14693	2359	15929	1959	17570	1318	21615	836	15834
24-#10	3.02	MA	14176	3543	20485	2991	24276	2505	26539	2098	29266	1450	36394	811	28309
9L-5S		MI	8312	3543	12976	2825	15053	2342	16375	1953	18173	1306	22413	897	16054
24-#10	3.02	MA	13929	3543	19960	2999	23617	2516	25701	2116	28121	1465	34807	764	27526
10L-4S		MI	8454	3543	13279	2807	15418	2334	16829	1937	18804	1294	23287	949	16184
24-#10	3.02	MA	13650	3543	19449	3008	22946	2524	24881	2126	26961	1473	33373	719	26781
11L-3S		MI	8547	3543	13575	2798	15836	2318	17341	1931	19504	1290	24159	1003	16210
24-#10	3.02	MA	13371	3543	18949	3018	22234	2541	24060	2144	25833	1490	31920	683	25881
12L-2S		MI	8742	3543	14005	2788	16383	2309	18006	1915	20404	1278	25404	1094	16223
24-#11	3.71	MA	15085	3742	22561	3101	26773	2584	29514	2155	33240	1439	41788	754	34532
8L-6S		MI	8498	3742	13573	2945	15706	2439	17118	2006	19146	1298	23532	714	18849
24-#11	3.71	MA	14775	3742	21857	3123	25920	2606	28489	2165	31857	1451	40028	701	33574
9L-5S		MI	8655	3742	13893	2935	16142	2420	17658	1999	19876	1285	24476	787	19075
24-#11	3.71	MA	14494	3742	21218	3132	25116	2618	27468	2186	30469	1470	38089	641	32536
10L-4S		MI	8819	3742	14260	2914	16584	2411	18207	1981	20639	1271	25505	852	19409
24-#11	3.71	MA	14153	3742	20595	3143	24307	2629	26468	2198	29055	1478	36335	585	31392
11L-3S		MI	8926	3742	14619	2903	17088	2391	18826	1974	21485	1268	26537	915	19458
24-#14	5.36	MA	16264	4215	25022	3457	29850	2863	33224	2342	38201	1468	49042	459	45540
9L-5S		MI	9540	4215	16035	3232	18806	2635	20860	2136	24177	1257	30031	576	26386

RECTANGULAR TIED COLUMNS 24" x 44"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.52	MA	14979	3257	21662	2724	25429	2288	27560	1943	29937	1417	36193	1230	16841
2E		MI	7844	3257	12061	2569	13593	2155	14409	1827	15257	1325	17589	1093	8577
6-#14	1.28	MA	14640	3186	20741	2697	24383	2270	26352	1935	28355	1431	34041	1244	14404
2L-3S		MI	7351	3186	10882	2570	12202	2161	12772	1854	13081	1365	14947	983	7460
6-#14	1.28	MA	13810	3186	19203	2720	22425	2291	23974	1955	25136	1463	29585	1104	14392
3L-2S		MI	7724	3186	11617	2555	13138	2149	13909	1830	14619	1347	16999	1145	7417
6-#18	2.27	MA	16229	3486	24356	2867	28859	2391	31726	2008	35574	1404	43999	1211	24988
2L-3S		MI	7778	3486	12061	2734	13593	2276	14409	1930	15257	1338	17589	759	12475
6-#18	2.27	MA	14876	3486	21662	2907	25429	2428	27560	2041	29937	1458	36193	957	24782
3L-2S		MI	8384	3486	13327	2711	15206	2259	16367	1892	17907	1312	21011	1046	12464
8-#11	1.18	MA	14500	3157	20348	2687	23948	2264	25856	1933	27710	1438	33168	1251	13401
2L-4S		MI	7268	3157	10546	2574	11782	2177	12283	1858	12431	1375	14262	992	6990
8-#11	1.18	MA	13918	3157	19274	2703	22580	2279	24195	1948	25462	1460	30056	1155	13403
3E		MI	7410	3157	10904	2563	12286	2158	12901	1851	13277	1372	15294	1055	6961
8-#11	1.18	MA	13621	3157	18554	2720	21561	2305	22942	1972	23745	1473	28018	1095	13350
4L-2S		MI	7675	3157	11422	2552	12945	2149	13702	1833	14360	1358	16762	1167	6933
8-#14	1.70	MA	15374	3314	22279	2777	26341	2328	28730	1972	31574	1423	38498	1234	19063
2L-4S		MI	7489	3314	11106	2665	12419	2246	13028	1899	13414	1361	15551	876	9706
8-#14	1.70	MA	14574	3314	20741	2800	24383	2350	26352	1992	28355	1456	34041	1094	19020
3E		MI	7684	3314	11617	2650	13138	2219	13909	1890	14619	1358	16999	964	9708
8-#14	1.70	MA	14168	3314	19707	2823	22921	2386	24557	2027	25893	1473	31110	1007	18813
4L-2S		MI	8047	3314	12352	2635	14074	2207	15045	1866	16158	1340	19051	1126	9678
8-#18	3.03	MA	17444	3714	27049	3010	32289	2495	35891	2072	41212	1390	51805	1193	33114
2L-4S		MI	8019	3714	12440	2900	13959	2423	14840	2006	15819	1324	18579	564	15421
8-#18	3.03	MA	16164	3714	24356	3049	28859	2532	31726	2106	35574	1445	43999	938	32853
3E		MI	8334	3714	13327	2877	15206	2380	16367	1995	17907	1324	21011	712	16270
8-#18	3.03	MA	15517	3714	22538	3089	26289	2595	28571	2166	31250	1472	38812	782	31147
4L-2S		MI	8914	3714	14594	2854	16818	2362	18326	1957	20557	1298	24432	1000	16316
10-#10	1.20	MA	14578	3163	20363	2702	24056	2276	26032	1944	27986	1444	33578	1256	13711
2L-5S		MI	7244	3163	10387	2615	11687	2203	12197	1888	12329	1399	14195	994	7144
10-#10	1.20	MA	14099	3163	19480	2716	22932	2289	24666	1956	26137	1463	31019	1180	13709
3L-4S		MI	7390	3163	10690	2597	12052	2195	12650	1873	12960	1387	15068	1046	7133
10-#10	1.20	MA	13859	3163	18889	2730	22095	2311	23638	1977	24728	1474	29355	1132	13676
4L-3S		MI	7505	3163	10986	2587	12470	2178	13162	1866	13661	1383	15940	1100	7114

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

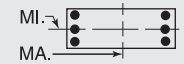
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.20	MA	13492	3163	18268	2750	21371	2324	22736	1989	23469	1493	27648	1097	13573
5L-2S		MI	7726	3163	11416	2577	13017	2170	13827	1851	14561	1370	17185	1191	7094
10-#11	1.48	MA	15020	3246	21423	2742	25316	2304	27517	1959	29958	1432	36281	1244	16657
2L-5S		MI	7341	3246	10696	2651	11999	2227	12534	1901	12751	1383	14700	916	8559
10-#11	1.48	MA	14452	3246	20348	2759	23948	2319	25856	1973	27710	1455	33168	1148	16643
3L-4S		MI	7510	3246	11063	2630	12441	2218	13083	1883	13514	1370	15730	981	8567
10-#11	1.48	MA	14169	3246	19628	2775	22928	2345	24603	1998	25993	1468	31131	1088	16574
4L-3S		MI	7646	3246	11422	2619	12945	2198	13702	1876	14360	1366	16762	1044	8549
10-#11	1.48	MA	13732	3246	18877	2800	22045	2361	23503	2012	24458	1490	29045	1043	16382
5L-2S		MI	7905	3246	11939	2608	13604	2189	14502	1858	15443	1353	18229	1156	8526
10-#14	2.13	MA	16094	3443	23816	2857	28299	2386	31109	2008	34792	1416	42954	1223	23709
2L-5S		MI	7594	3443	11318	2775	12725	2316	13382	1960	13865	1371	16163	763	11503
10-#14	2.13	MA	15322	3443	22279	2880	26341	2408	28730	2028	31574	1448	38498	1084	23644
3L-4S		MI	7827	3443	11841	2745	13355	2304	14164	1936	14952	1353	17603	857	11909
10-#14	2.13	MA	14941	3443	21245	2904	24879	2445	26935	2063	29111	1465	35566	997	23418
4L-3S		MI	8012	3443	12352	2730	14074	2278	15045	1927	16158	1350	19051	945	11939
10-#14	2.13	MA	14325	3443	20174	2940	23612	2466	25356	2084	26910	1497	32570	930	22397
5L-2S		MI	8365	3443	13087	2716	15010	2266	16182	1903	17696	1332	21102	1107	11924
10-#18	3.79	MA	17416	3942	27049	3192	32289	2635	35891	2171	41212	1431	51805	920	40931
3L-4S		MI	8585	3942	13706	3043	15572	2527	16799	2071	18469	1311	22000	517	19009
10-#18	3.79	MA	16831	3942	25232	3232	29719	2699	32737	2231	36888	1459	46618	764	39150
4L-3S		MI	8879	3942	14594	3020	16818	2483	18326	2059	20557	1311	24432	666	20053
10-#18	3.79	MA	15785	3942	23370	3297	27490	2735	29960	2265	33017	1513	41334	638	36047
5L-2S		MI	9438	3942	15860	2997	18430	2466	20284	2021	23208	1285	27853	954	20143
12-#10	1.44	MA	15008	3236	21246	2748	25181	2309	27398	1964	29834	1440	36138	1250	16386
2L-6S		MI	7295	3236	10545	2668	11875	2253	12416	1915	12626	1407	14641	927	8344
12-#10	1.44	MA	14540	3236	20363	2761	24056	2322	26032	1976	27986	1459	33578	1174	16375
3L-5S		MI	7446	3236	10817	2660	12235	2236	12862	1909	13229	1395	15440	988	8443
12-#10	1.44	MA	14309	3236	19772	2775	23219	2344	25004	1997	26576	1470	31914	1126	16331
4E		MI	7591	3236	11120	2642	12600	2228	13316	1893	13860	1382	16313	1041	8443
12-#10	1.44	MA	13945	3236	19151	2795	22496	2357	24102	2009	25318	1489	30207	1091	16219
5L-3S		MI	7704	3236	11416	2633	13017	2211	13827	1887	14561	1378	17185	1094	8430
12-#10	1.44	MA	13626	3236	18563	2802	21785	2367	23217	2030	24086	1500	28541	1027	15846
6L-2S		MI	7921	3236	11846	2623	13565	2203	14493	1871	15461	1366	18431	1185	8414
12-#11	1.77	MA	15532	3335	22497	2798	26683	2344	29178	1984	32206	1427	39394	1236	19905
2L-6S		MI	7401	3335	10893	2716	12222	2287	12794	1933	13104	1392	15224	833	9831
12-#11	1.77	MA	14979	3335	21423	2815	25316	2360	27517	1998	29958	1450	36281	1141	19880
3L-5S		MI	7580	3335	11214	2707	12658	2267	13335	1926	13834	1378	16167	906	10111
12-#11	1.77	MA	14708	3335	20702	2831	24296	2386	26264	2023	28241	1463	34243	1081	19797
4E		MI	7748	3335	11581	2686	13100	2258	13883	1908	14597	1365	17197	971	10134
12-#11	1.77	MA	14274	3335	19951	2856	23413	2401	25164	2037	26706	1485	32158	1036	19597
5L-3S		MI	7880	3335	11939	2675	13604	2239	14502	1901	15443	1361	18229	1034	10127
12-#11	1.77	MA	13894	3335	19235	2864	22555	2414	24085	2062	25204	1498	30122	957	18841
6L-2S		MI	8134	3335	12456	2664	14263	2230	15302	1884	16526	1348	19696	1146	10110
12-#14	2.56	MA	16054	3571	23816	2961	28299	2466	31109	2065	34792	1441	42954	1073	28267
3L-5S		MI	7928	3571	12053	2855	13661	2375	14518	1996	15403	1364	18215	744	13619
12-#14	2.56	MA	15696	3571	22783	2984	26837	2503	29313	2100	32330	1458	40023	987	28026
4E		MI	8159	3571	12576	2826	14291	2363	15301	1972	16491	1346	19654	838	14107
12-#14	2.56	MA	15085	3571	21712	3020	25570	2525	27735	2120	30129	1490	37027	920	26968
5L-3S		MI	8336	3571	13087	2811	15010	2336	16182	1963	17696	1343	21102	927	14157
12-#14	2.56	MA	14561	3571	20685	3031	24349	2544	26186	2155	27974	1507	34102	803	25777
6L-2S		MI	8680	3571	13822	2796	15945	2324	17318	1939	19234	1325	23154	1088	14159
12-#18	4.55	MA	18107	4171	27925	3374	33149	2802	36902	2296	42525	1446	54424	745	47140
4E		MI	9141	4171	14973	3186	17184	2631	18757	2135	21119	1298	25422	471	22625

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

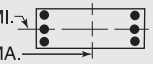


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	4.55	MA	17071	4171	26064	3439	30920	2839	34126	2329	38654	1500	49140	619	44068
5L-3S		MI	9417	4171	15860	3163	18430	2587	20284	2124	23208	1298	27853	620	23830
12-#18	4.55	MA	16221	4171	24264	3458	28805	2874	31401	2390	34965	1554	43984	405	40541
6L-2S		MI	9964	4171	17126	3140	20043	2570	22242	2086	25858	1272	31274	907	23956
14-#10	1.68	MA	14975	3308	21246	2807	25181	2355	27398	1997	29834	1455	36138	1168	19038
3L-6S		MI	7498	3308	10976	2713	12423	2286	13081	1936	13526	1403	15887	921	9594
14-#10	1.68	MA	14753	3308	20655	2820	24344	2377	26370	2018	28425	1466	34474	1120	18986
4L-5S		MI	7646	3308	11247	2706	12783	2269	13527	1929	14129	1390	16685	982	9736
14-#10	1.68	MA	14391	3308	20034	2840	23620	2390	25468	2030	27166	1485	32767	1085	18867
5L-4S		MI	7791	3308	11550	2688	13147	2261	13981	1914	14760	1378	17559	1035	9748
14-#10	1.68	MA	14080	3308	19446	2847	22910	2400	24583	2051	25935	1496	31100	1022	18470
6L-3S		MI	7900	3308	11846	2678	13565	2244	14493	1907	15461	1374	18431	1088	9740
14-#10	1.68	MA	13817	3308	18891	2857	22127	2416	23700	2060	24745	1515	29514	990	17948
7L-2S		MI	8113	3308	12276	2668	14112	2236	15158	1892	16361	1362	19676	1179	9728
14-#11	2.07	MA	15497	3424	22497	2870	26683	2400	29178	2023	32206	1445	39394	1134	23114
3L-6S		MI	7641	3424	11410	2772	12881	2327	13595	1958	14187	1387	16691	823	11337
14-#11	2.07	MA	15239	3424	21776	2887	25663	2426	27926	2048	30489	1457	37356	1074	23021
4L-5S		MI	7816	3424	11731	2763	13317	2308	14135	1951	14917	1373	17635	895	11624
14-#11	2.07	MA	14807	3424	21025	2911	24781	2442	26825	2063	28954	1480	35270	1029	22815
5L-4S		MI	7983	3424	12098	2741	13758	2299	14684	1934	15680	1359	18664	960	11694
14-#11	2.07	MA	14438	3424	20309	2920	23923	2454	25746	2087	27452	1493	33235	949	22038
6L-3S		MI	8111	3424	12456	2730	14263	2279	15302	1926	16526	1356	19696	1023	11699
14-#11	2.07	MA	14125	3424	19632	2931	22970	2474	24682	2100	26001	1515	31289	910	21426
7L-2S		MI	8360	3424	12974	2719	14922	2270	16102	1909	17609	1343	21163	1135	11688
14-#14	2.98	MA	16437	3700	24321	3064	28795	2561	31691	2136	35549	1450	44479	976	32638
4L-5S		MI	8257	3700	12788	2936	14596	2433	15655	2032	16941	1356	20266	725	15745
14-#14	2.98	MA	15831	3700	23249	3100	27528	2583	30113	2156	33347	1482	41483	909	31546
5L-4S		MI	8487	3700	13311	2906	15227	2421	16437	2009	18029	1338	21706	819	16301
14-#14	2.98	MA	15326	3700	22223	3111	26307	2602	28564	2192	31193	1500	38559	793	30375
6L-3S		MI	8656	3700	13822	2891	15945	2394	17318	2000	19234	1335	23154	908	16369
14-#14	2.98	MA	14898	3700	21253	3127	24941	2629	27050	2209	29109	1532	35757	735	28813
7L-2S		MI	8991	3700	14557	2876	16881	2382	18455	1976	20772	1317	25205	1069	16388
14-#18	5.30	MA	18325	4399	28758	3582	34349	2943	38292	2394	44292	1487	56946	601	52088
5L-4S		MI	9689	4399	16239	3328	18796	2735	20715	2200	23770	1284	28843	424	26264
14-#18	5.30	MA	17520	4399	26957	3601	32235	2978	35566	2454	40603	1541	51790	387	48514
6L-3S		MI	9989	4399	17126	3305	20043	2691	22242	2189	25858	1285	31274	573	27605
14-#18	5.30	MA	16833	4399	25254	3626	29835	3024	32947	2488	36837	1569	46822	282	44847
7L-2S		MI	10466	4399	18393	3282	21655	2674	24201	2151	28508	1258	34696	861	27761
16-#10	1.92	MA	15191	3381	21539	2866	25469	2410	27736	2038	30274	1461	37034	1114	21640
4L-6S		MI	7699	3381	11406	2758	12970	2318	13746	1957	14426	1399	17132	915	10849
16-#10	1.92	MA	14830	3381	20918	2886	24745	2423	26834	2050	29015	1481	35326	1079	21517
5E		MI	7844	3381	11677	2751	13330	2302	14192	1950	15029	1386	17930	976	11028
16-#10	1.92	MA	14527	3381	20329	2893	24034	2433	25949	2071	27783	1491	33660	1016	21098
6L-4S		MI	7989	3381	11980	2733	13695	2294	14646	1935	15660	1374	18804	1029	11046
16-#10	1.92	MA	14271	3381	19774	2902	23252	2449	25066	2081	26593	1510	32074	984	20590
7L-3S		MI	8094	3381	12276	2723	14112	2277	15158	1928	16361	1370	19676	1082	11047
16-#10	1.92	MA	13960	3381	19243	2912	22533	2458	24152	2097	25427	1530	30526	943	20095
8L-2S		MI	8304	3381	12706	2713	14660	2269	15823	1913	17261	1358	20921	1173	11038
16-#11	2.36	MA	15761	3513	22850	2942	27031	2467	29587	2073	32737	1452	40469	1067	26246
4L-6S		MI	7878	3513	11928	2828	13540	2368	14395	1983	15270	1381	18159	812	12848
16-#11	2.36	MA	15332	3513	22099	2967	26148	2482	28487	2088	31202	1475	38383	1022	26036
5E		MI	8050	3513	12249	2818	13976	2348	14935	1976	16000	1368	19102	885	13121
16-#11	2.36	MA	14972	3513	21383	2975	25291	2495	27407	2113	29700	1487	36347	942	25240
6L-4S		MI	8216	3513	12615	2797	14417	2339	15484	1959	16763	1354	20131	949	13250
16-#11	2.36	MA	14671	3513	20706	2986	24337	2514	26343	2125	28249	1510	34402	903	24645
7L-3S		MI	8339	3513	12974	2786	14922	2320	16102	1952	17609	1351	21163	1012	13266
16-#11	2.36	MA	14299	3513	20059	2999	23462	2525	25229	2144	26825	1533	32510	851	23696
8L-2S		MI	8584	3513	13491	2775	15580	2311	16902	1934	18692	1337	22631	1125	13262

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

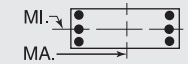
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.41	MA	16562	3828	24787	3180	29486	2641	32491	2193	36566	1475	45940	899	36129
5E		MI	8582	3828	13523	3016	15532	2491	16791	2069	18479	1349	22318	706	17880
16-#14	3.41	MA	16075	3828	23761	3192	28265	2660	30942	2228	34411	1492	43015	783	34973
6L-4S		MI	8811	3828	14046	2986	16162	2479	17574	2045	19567	1331	23757	800	18494
16-#14	3.41	MA	15667	3828	22791	3207	26899	2688	29428	2246	32328	1524	40213	725	33388
7L-3S		MI	8973	3828	14557	2971	16881	2453	18455	2036	20772	1328	25205	889	18576
16-#14	3.41	MA	15143	3828	21863	3225	25643	2703	27831	2273	30285	1556	37493	648	31822
8L-2S		MI	9300	3828	15292	2956	17817	2441	19591	2012	22310	1310	27257	1051	18607
16-#18	6.06	MA	18788	4628	29651	3744	35665	3081	39732	2519	46240	1528	59596	369	56486
6L-4S		MI	10295	4628	17505	3471	20409	2838	22674	2265	26420	1271	32264	378	29922
16-#18	6.06	MA	18145	4628	27947	3769	33265	3128	37113	2553	42475	1555	54628	264	52782
7L-3S		MI	10507	4628	18393	3448	21655	2795	24201	2254	28508	1271	34696	527	31380
18-#10	2.16	MA	15264	3453	21801	2931	25870	2455	28200	2071	30863	1476	37886	1073	24167
5L-6S		MI	7898	3453	11836	2804	13518	2351	14411	1977	15327	1394	18377	909	12108
18-#10	2.16	MA	14968	3453	21213	2938	25159	2466	27315	2092	29632	1487	36220	1010	23728
6L-5S		MI	8041	3453	12107	2796	13878	2335	14857	1970	15930	1382	19176	970	12317
18-#10	2.16	MA	14720	3453	20658	2947	24376	2482	26432	2101	28442	1506	34633	978	23233
7L-4S		MI	8184	3453	12410	2778	14243	2327	15311	1955	16560	1370	20049	1023	12342
18-#10	2.16	MA	14410	3453	20127	2958	23658	2491	25518	2118	27275	1525	33085	937	22733
8L-3S		MI	8287	3453	12706	2768	14660	2310	15823	1948	17261	1366	20921	1076	12351
18-#10	2.16	MA	14101	3453	19510	2975	22921	2510	24633	2127	26062	1535	31580	895	21993
9L-2S		MI	8493	3453	13136	2759	15208	2302	16488	1933	18161	1353	22166	1167	12346
18-#11	2.66	MA	15849	3602	23173	3023	27516	2522	30148	2113	33450	1470	41496	1015	29258
5L-6S		MI	8113	3602	12445	2883	14198	2408	15195	2009	16353	1376	19626	801	14363
18-#11	2.66	MA	15500	3602	22457	3031	26658	2535	29068	2138	31948	1482	39460	935	28445
6L-5S		MI	8281	3602	12766	2874	14634	2389	15735	2002	17083	1363	20569	874	14623
18-#11	2.66	MA	15208	3602	21781	3042	25705	2555	28004	2150	30497	1505	37515	896	27866
7L-4S		MI	8447	3602	13133	2853	15076	2380	16284	1984	17846	1349	21599	939	14803
18-#11	2.66	MA	14839	3602	21133	3054	24829	2566	26890	2170	29073	1528	35622	843	26902
8L-3S		MI	8566	3602	13491	2842	15580	2360	16902	1977	18692	1346	22631	1002	14827
18-#11	2.66	MA	14473	3602	20388	3076	23930	2588	25811	2180	27612	1540	33777	791	25997
9L-2S		MI	8806	3602	14009	2831	16239	2351	17703	1959	19775	1332	24098	1114	14832
18-#14	3.84	MA	16812	3957	25299	3272	30223	2719	33321	2264	37630	1485	47472	772	39571
6L-5S		MI	8903	3957	14258	3096	16468	2550	17928	2105	20017	1342	24369	687	20023
18-#14	3.84	MA	16421	3957	24329	3287	28857	2746	31806	2282	35547	1517	44670	715	37963
7L-4S		MI	9131	3957	14781	3067	17098	2538	18711	2081	21105	1324	25809	781	20629
18-#14	3.84	MA	15903	3957	23401	3305	27601	2761	30209	2310	33504	1549	41950	637	36377
8L-3S		MI	9286	3957	15292	3052	17817	2511	19591	2072	22310	1320	27257	870	20781
18-#14	3.84	MA	15414	3957	22339	3337	26311	2793	28662	2324	31415	1566	39291	561	34560
9L-2S		MI	9606	3957	16027	3037	18753	2499	20728	2048	23848	1302	29308	1032	20823
18-#18	6.82	MA	19427	4856	30641	3912	36695	3232	41279	2617	48112	1542	62434	245	60717
7L-4S		MI	10827	4856	18772	3614	22021	2942	24632	2330	29070	1258	35685	332	33596
20-#10	2.41	MA	15403	3526	22096	2983	26284	2499	28681	2112	31481	1483	38779	1004	26362
6E		MI	8095	3526	12266	2849	14066	2384	15076	1998	16227	1390	19623	904	13369
20-#10	2.41	MA	15162	3526	21541	2993	25501	2515	27798	2122	30291	1502	37193	972	25879
7L-5S		MI	8235	3526	12537	2842	14425	2368	15522	1991	16830	1378	20421	964	13605
20-#10	2.41	MA	14855	3526	21010	3003	24782	2524	26884	2138	29124	1521	35645	932	25371
8L-4S		MI	8378	3526	12840	2823	14790	2359	15976	1976	17461	1365	21294	1017	13636
20-#10	2.41	MA	14555	3526	20394	3021	24045	2543	25999	2147	27911	1531	34140	889	24634
9L-3S		MI	8478	3526	13136	2814	15208	2343	16488	1969	18161	1362	22166	1070	13650
20-#10	2.41	MA	14281	3526	19841	3029	23352	2553	25117	2165	26706	1547	32473	843	23881
10L-2S		MI	8681	3526	13566	2804	15755	2335	17153	1954	19061	1349	23412	1161	13651
20-#11	2.95	MA	16019	3691	23531	3087	28026	2576	30729	2163	34196	1477	42573	928	31652
6E		MI	8346	3691	12963	2939	14857	2449	15995	2034	17436	1371	21093	791	15881

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.95	MA	15737	3691	22855	3098	27072	2595	29665	2175	32745	1500	40627	888	31088
7L-5S		MI	8511	3691	13284	2930	15293	2429	16535	2027	18166	1358	22036	863	16129
20-#11	2.95	MA	15371	3691	22207	3110	26197	2606	28551	2195	31321	1523	38735	836	30108
8L-4S		MI	8676	3691	13650	2908	15735	2420	17084	2009	18929	1344	23066	928	16355
20-#11	2.95	MA	15024	3691	21463	3132	25298	2628	27472	2205	29860	1535	36889	784	29190
9L-3S		MI	8791	3691	14009	2897	16239	2401	17703	2002	19775	1341	24098	991	16386
20-#11	2.95	MA	14691	3691	20790	3141	24452	2641	26397	2227	28391	1554	34851	724	28063
10L-2S		MI	9027	3691	14526	2886	16898	2392	18503	1985	20858	1327	25565	1103	16398
20-#14	4.26	MA	17163	4085	25867	3368	30815	2804	34184	2319	38765	1509	49126	704	42538
7L-5S		MI	9221	4085	14993	3177	17404	2608	19064	2142	21555	1334	26421	668	22171
20-#14	4.26	MA	16649	4085	24939	3385	29559	2819	32587	2346	36723	1541	46406	627	40932
8L-4S		MI	9448	4085	15516	3147	18034	2596	19847	2118	22643	1316	27861	762	22750
20-#14	4.26	MA	16176	4085	23877	3417	28269	2851	31040	2361	34634	1559	43747	551	39125
9L-3S		MI	9597	4085	16027	3132	18753	2569	20728	2109	23848	1313	29308	851	22983
22-#10	2.65	MA	15600	3598	22424	3038	26626	2548	29164	2142	32139	1498	39753	967	28526
7L-6S		MI	8290	3598	12696	2894	14613	2417	15741	2018	17127	1386	20868	898	14633
22-#10	2.65	MA	15294	3598	21893	3048	25907	2557	28250	2159	30973	1517	38205	926	28009
8L-5S		MI	8428	3598	12967	2887	14973	2401	16188	2011	17730	1374	21666	959	14866
22-#10	2.65	MA	15002	3598	21277	3066	25170	2575	27365	2168	29759	1526	36700	883	27275
9L-4S		MI	8571	3598	13270	2869	15338	2392	16641	1996	18361	1361	22540	1011	14929
22-#10	2.65	MA	14735	3598	20725	3074	24476	2586	26483	2186	28555	1542	35032	837	26513
10L-3S		MI	8668	3598	13566	2859	15755	2376	17153	1989	19061	1357	23412	1064	14947
22-#10	2.65	MA	14436	3598	20186	3083	23766	2595	25620	2196	27334	1551	33526	793	25711
11L-2S		MI	8868	3598	13996	2849	16303	2367	17818	1974	19962	1345	24657	1155	14954
22-#11	3.25	MA	16260	3780	23929	3153	28440	2636	31326	2201	34993	1495	43740	881	34307
7L-6S		MI	8576	3780	13480	2995	15516	2489	16795	2059	18519	1366	22560	780	17402
22-#11	3.25	MA	15896	3780	23282	3166	27564	2646	30212	2220	33569	1517	41848	829	33313
8L-5S		MI	8738	3780	13801	2985	15952	2470	17336	2052	19249	1352	23504	853	17640
22-#11	3.25	MA	15558	3780	22537	3188	26666	2669	29133	2231	32108	1530	40002	777	32384
9L-4S		MI	8903	3780	14168	2964	16394	2461	17884	2035	20012	1339	24533	917	17905
22-#11	3.25	MA	15237	3780	21864	3197	25820	2682	28058	2252	30640	1548	37964	717	31261
10L-3S		MI	9014	3780	14526	2953	16898	2441	18503	2027	20858	1335	25565	980	17943
22-#11	3.25	MA	14880	3780	21208	3208	24962	2692	27005	2264	29151	1558	36121	662	30124
11L-2S		MI	9246	3780	15044	2942	17557	2432	19303	2010	21941	1322	27032	1093	17960
22-#14	4.69	MA	17383	4214	26476	3466	31517	2878	34965	2383	39941	1534	50862	617	45488
8L-5S		MI	9536	4214	15728	3257	18339	2666	20201	2178	23094	1327	28473	650	24324
22-#14	4.69	MA	16926	4214	25414	3497	30228	2910	33418	2397	37853	1551	48204	540	43690
9L-4S		MI	9763	4214	16251	3227	18970	2654	20984	2154	24181	1309	29912	744	24878
24-#10	2.89	MA	15728	3671	22777	3094	27032	2590	29616	2179	32821	1513	40764	920	30647
8L-6S		MI	8484	3671	13126	2939	15161	2450	16406	2039	18027	1382	22113	892	15899
24-#10	2.89	MA	15448	3671	22160	3111	26295	2608	28731	2188	31608	1522	39259	878	29915
9L-5S		MI	8620	3671	13397	2932	15521	2434	16853	2032	18630	1369	22911	953	16124
24-#10	2.89	MA	15184	3671	21608	3119	25601	2619	27849	2206	30403	1538	37592	831	29145
10L-4S		MI	8762	3671	13700	2914	15885	2425	17306	2017	19261	1357	23785	1005	16220
24-#10	2.89	MA	14887	3671	21070	3129	24890	2628	26986	2217	29183	1546	36085	788	28345
11L-3S		MI	8856	3671	13996	2904	16303	2409	17818	2010	19962	1353	24657	1058	16243
24-#10	2.89	MA	14591	3671	20544	3139	24140	2645	26123	2236	27996	1563	34562	751	27445
12L-2S		MI	9053	3671	14427	2895	16850	2400	18483	1995	20862	1341	25902	1149	16253
24-#11	3.55	MA	16414	3869	24356	3221	28932	2687	31873	2245	35817	1512	44960	822	36519
8L-6S		MI	8805	3869	13998	3050	16175	2529	17596	2084	19602	1361	24027	769	18925
24-#11	3.55	MA	16084	3869	23611	3243	28033	2709	30795	2256	34356	1524	43115	769	35577
9L-5S		MI	8963	3869	14319	3041	16611	2510	18136	2077	20332	1347	24971	842	19154
24-#11	3.55	MA	15775	3869	22938	3253	27187	2722	29719	2278	32888	1543	41076	710	34459
10L-4S		MI	9128	3869	14685	3020	17053	2501	18685	2060	21095	1334	26000	907	19454
24-#11	3.55	MA	15421	3869	22282	3264	26330	2733	28666	2289	31399	1553	39234	655	33312
11L-3S		MI	9236	3869	15044	3009	17557	2482	19303	2053	21941	1330	27032	970	19498
24-#14	5.11	MA	17664	4342	26952	3578	32186	2968	35796	2434	41071	1544	52660	530	48254
9L-5S		MI	9849	4342	16463	3337	19275	2725	21337	2215	24632	1319	30524	631	26481

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

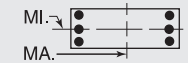
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.45	MA	16286	3385	23383	2844	27488	2389	29784	2032	32289	1487	38982	1292	17705
2E		MI	8150	3385	12494	2673	14065	2243	14886	1904	15709	1386	18078	1147	8611
6-#14	1.22	MA	15924	3313	22409	2816	26381	2371	28506	2024	30615	1502	36705	1306	15133
2L-3S		MI	7656	3313	11310	2675	12672	2251	13249	1932	13536	1427	15440	1038	7488
6-#14	1.22	MA	15044	3313	20791	2839	24320	2394	26003	2045	27229	1534	32016	1168	15121
3L-2S		MI	8031	3313	12045	2660	13608	2239	14386	1908	15074	1409	17492	1200	7445
6-#18	2.17	MA	17614	3613	26220	2986	31099	2493	34170	2096	38226	1474	47201	1273	26284
2L-3S		MI	8083	3613	12494	2838	14065	2364	14886	2007	15709	1399	18078	813	12525
6-#18	2.17	MA	16176	3613	23383	3027	27488	2531	29784	2131	32289	1530	38982	1022	26078
3L-2S		MI	8692	3613	13760	2815	15677	2347	16844	1969	18360	1373	21499	1100	12503
8-#11	1.13	MA	15774	3284	21994	2806	25920	2365	27980	2022	29933	1508	35781	1313	14075
2L-4S		MI	7574	3284	10971	2680	12251	2268	12760	1937	12887	1438	14758	1047	7017
8-#11	1.13	MA	15157	3284	20865	2823	24482	2381	26233	2037	27568	1532	32507	1218	14076
3E		MI	7716	3284	11329	2669	12755	2248	13379	1929	13733	1434	15790	1110	6986
8-#11	1.13	MA	14843	3284	20108	2839	23411	2407	24917	2062	25764	1544	30373	1159	14024
4L-2S		MI	7981	3284	11847	2658	13414	2239	14179	1912	14816	1421	17257	1222	6957
8-#14	1.63	MA	16702	3442	24027	2896	28441	2430	31008	2060	34002	1494	41394	1296	20035
2L-4S		MI	7794	3442	11534	2770	12889	2336	13505	1978	13869	1423	16044	930	9748
8-#14	1.63	MA	15854	3442	22409	2920	26381	2452	28506	2081	30615	1527	36705	1158	19992
3E		MI	7990	3442	12045	2755	13608	2309	14386	1969	15074	1420	17492	1019	9740
8-#14	1.63	MA	15423	3442	21323	2943	24844	2489	26619	2117	28028	1545	33634	1071	19785
4L-2S		MI	8354	3442	12780	2740	14543	2297	15522	1945	16612	1402	19543	1181	9709
8-#18	2.90	MA	18903	3841	29056	3129	34710	2597	38556	2161	44162	1461	55421	1255	34842
2L-4S		MI	8323	3841	12873	3004	14431	2512	15317	2083	16271	1386	19067	617	15586
8-#18	2.90	MA	17542	3841	26220	3170	31099	2634	34170	2196	38226	1517	47201	1003	34581
3E		MI	8640	3841	13760	2981	15677	2468	16844	2072	18360	1386	21499	766	16325
8-#18	2.90	MA	16855	3841	24309	3210	28398	2699	30853	2257	33678	1546	41766	848	33004
4L-2S		MI	9224	3841	15027	2958	17289	2451	18803	2034	21010	1360	24920	1054	16359
10-#10	1.15	MA	15854	3290	22007	2822	26031	2378	28161	2032	30218	1515	36205	1318	14397
2L-5S		MI	7549	3290	10808	2722	12155	2294	12674	1968	12786	1462	14693	1050	7172
10-#10	1.15	MA	15347	3290	21079	2836	24848	2391	26725	2045	28274	1534	33514	1243	14395
3L-4S		MI	7695	3290	11111	2704	12519	2286	13128	1952	13417	1450	15566	1102	7157
10-#10	1.15	MA	15093	3290	20458	2850	23970	2413	25646	2066	26794	1545	31772	1194	14361
4L-3S		MI	7811	3290	11407	2694	12937	2269	13640	1946	14118	1446	16438	1155	7136
10-#10	1.15	MA	14704	3290	19803	2869	23210	2426	24699	2078	25472	1565	29981	1160	14258
5L-2S		MI	8033	3290	11837	2684	13484	2261	14305	1930	15018	1434	17684	1246	7116
10-#11	1.41	MA	16325	3373	23124	2862	27359	2406	29727	2047	32297	1503	39055	1306	17499
2L-5S		MI	7646	3373	11122	2757	12468	2317	13012	1979	13207	1446	15195	971	8598
10-#11	1.41	MA	15723	3373	21994	2878	25920	2422	27980	2062	29933	1526	35781	1211	17485
3L-4S		MI	7815	3373	11488	2736	12909	2308	13561	1962	13970	1432	16225	1036	8597
10-#11	1.41	MA	15423	3373	21238	2895	24849	2448	26665	2087	28128	1539	33647	1151	17416
4L-3S		MI	7952	3373	11847	2725	13414	2289	14179	1955	14816	1429	17257	1099	8576
10-#11	1.41	MA	14958	3373	20445	2920	23922	2463	25509	2102	26517	1562	31459	1108	17224
5L-2S		MI	8213	3373	12364	2714	14073	2280	14979	1937	15899	1416	18724	1211	8552
10-#14	2.04	MA	17465	3570	25645	2976	30501	2488	33510	2097	37389	1487	46083	1285	24924
2L-5S		MI	7899	3570	11746	2880	13194	2406	13859	2038	14319	1434	16656	817	11607
10-#14	2.04	MA	16645	3570	24027	3000	28441	2510	31008	2118	34002	1519	41394	1147	24859
3L-4S		MI	8132	3570	12269	2851	13825	2394	14642	2014	15407	1416	18096	911	11956
10-#14	2.04	MA	16241	3570	22941	3024	26904	2547	29121	2153	31414	1537	38323	1061	24633
4L-3S		MI	8319	3570	12780	2836	14543	2367	15522	2005	16612	1413	19543	1000	11975
10-#14	2.04	MA	15586	3570	21810	3059	25574	2570	27463	2174	29102	1570	35180	996	23667
5L-2S		MI	8673	3570	13515	2821	15479	2355	16659	1981	18151	1395	21595	1162	11956

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

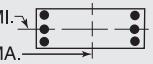


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.62	MA	18869	4070	29056	3312	34710	2738	38556	2261	44162	1503	55421	985	43091
3L-4S		MI	8890	4070	14140	3147	16043	2616	17276	2148	18922	1372	22489	571	19168
10-#18	3.62	MA	18247	4070	27146	3353	32009	2802	35240	2322	39615	1532	49985	830	41418
4L-3S		MI	9186	4070	15027	3124	17289	2572	18803	2137	21010	1373	24920	720	20112
10-#18	3.62	MA	17132	4070	25178	3417	29667	2840	32322	2357	35546	1588	44440	707	38086
5L-2S		MI	9748	4070	16293	3101	18902	2555	20761	2099	23660	1346	28342	1008	20191
12-#10	1.38	MA	16310	3363	22936	2867	27213	2411	29597	2053	32161	1511	38896	1312	17209
2L-6S		MI	7600	3363	10967	2774	12342	2344	12893	1995	13083	1470	15140	983	8409
12-#10	1.38	MA	15813	3363	22007	2881	26031	2424	28161	2065	30218	1530	36205	1237	17198
3L-5S		MI	7752	3363	11238	2767	12702	2327	13339	1988	13686	1458	15938	1044	8474
12-#10	1.38	MA	15570	3363	21387	2895	25152	2446	27082	2086	28737	1541	34463	1189	17154
4E		MI	7897	3363	11541	2749	13067	2319	13793	1973	14317	1446	16811	1096	8469
12-#10	1.38	MA	15182	3363	20732	2915	24393	2459	26135	2099	27416	1561	32672	1155	17042
5L-3S		MI	8010	3363	11837	2739	13484	2302	14305	1966	15018	1442	17684	1149	8454
12-#10	1.38	MA	14846	3363	20114	2922	23642	2469	25207	2120	26124	1572	30925	1092	16706
6L-2S		MI	8228	3363	12267	2730	14032	2294	14970	1951	15918	1429	18929	1241	8437
12-#11	1.70	MA	16867	3462	24254	2917	28797	2446	31474	2072	34662	1498	42329	1298	20916
2L-6S		MI	7706	3462	11318	2822	12691	2377	13272	2012	13560	1454	15719	888	9908
12-#11	1.70	MA	16280	3462	23124	2934	27359	2462	29727	2087	32297	1521	39055	1204	20891
3L-5S		MI	7886	3462	11639	2813	13127	2358	13812	2005	14290	1441	16663	961	10153
12-#11	1.70	MA	15994	3462	22367	2951	26288	2488	28412	2112	30493	1534	36921	1144	20808
4E		MI	8054	3462	12006	2791	13568	2349	14361	1987	15053	1427	17692	1026	10168
12-#11	1.70	MA	15532	3462	21575	2975	25361	2504	27257	2127	28881	1557	34733	1101	20608
5L-3S		MI	8186	3462	12364	2780	14073	2329	14979	1980	15899	1424	18724	1089	10157
12-#11	1.70	MA	15130	3462	20822	2984	24455	2517	26124	2152	27305	1570	32598	1022	19869
6L-2S		MI	8441	3462	12881	2769	14731	2320	15779	1962	16982	1410	20191	1201	10138
12-#14	2.45	MA	17421	3699	25645	3080	30501	2569	33510	2154	37389	1512	46083	1137	29725
3L-5S		MI	8233	3699	12481	2961	14130	2464	14995	2074	15857	1426	18708	799	13721
12-#14	2.45	MA	17041	3699	24560	3104	28965	2606	31623	2190	34801	1530	43012	1051	29484
4E		MI	8465	3699	13004	2931	14760	2452	15778	2050	16945	1408	20147	893	14156
12-#14	2.45	MA	16391	3699	23429	3140	27634	2628	29966	2210	32488	1563	39869	986	28482
5L-3S		MI	8643	3699	13515	2916	15479	2426	16659	2041	18151	1405	21595	981	14197
12-#14	2.45	MA	15836	3699	22350	3152	26343	2647	28339	2246	30226	1580	36801	871	27189
6L-2S		MI	8989	3699	14250	2901	16415	2414	17795	2017	19689	1387	23647	1143	14194
12-#18	4.35	MA	19599	4298	29982	3495	35620	2906	39626	2387	45551	1519	58205	811	49833
4E		MI	9446	4298	15406	3290	17655	2719	19234	2213	21572	1359	25910	525	22779
12-#18	4.35	MA	18495	4298	28015	3560	33278	2944	36708	2421	41483	1575	52660	689	46533
5L-3S		MI	9724	4298	16293	3266	18902	2676	20761	2201	23660	1359	28342	674	23893
12-#18	4.35	MA	17594	4298	26120	3579	31040	2978	33845	2483	37500	1604	47248	478	42959
6L-2S		MI	10267	4298	17559	3243	20514	2658	22719	2163	26310	1333	31763	961	24006
14-#10	1.61	MA	16274	3435	22936	2926	27213	2457	29597	2086	32161	1526	38896	1231	19998
3L-6S		MI	7803	3435	11397	2820	12890	2377	13558	2015	13984	1466	16385	977	9659
14-#10	1.61	MA	16039	3435	22315	2940	26334	2479	28518	2107	30681	1537	37153	1183	19946
4L-5S		MI	7952	3435	11668	2812	13250	2360	14004	2009	14587	1454	17183	1038	9770
14-#10	1.61	MA	15654	3435	21660	2960	25575	2492	27571	2119	29359	1556	35363	1149	19828
5L-4S		MI	8097	3435	11971	2794	13615	2352	14458	1993	15217	1441	18057	1090	9776
14-#10	1.61	MA	15325	3435	21042	2967	24825	2502	26643	2140	28067	1568	33616	1086	19467
6L-3S		MI	8207	3435	12267	2785	14032	2335	14970	1987	15918	1437	18929	1143	9766
14-#10	1.61	MA	15047	3435	20459	2977	24003	2519	25710	2150	26818	1587	31956	1055	18904
7L-2S		MI	8421	3435	12697	2775	14580	2327	15635	1971	16818	1425	20174	1235	9752
14-#11	1.98	MA	16829	3551	24254	2990	28797	2502	31474	2113	34662	1516	42329	1197	24294
3L-6S		MI	7946	3551	11836	2878	13349	2417	14072	2037	14643	1449	17186	878	11414
14-#11	1.98	MA	16555	3551	23497	3006	27726	2529	30159	2138	32858	1529	40195	1137	24200
4L-5S		MI	8122	3551	12156	2868	13785	2398	14612	2030	15373	1436	18130	950	11703
14-#11	1.98	MA	16096	3551	22705	3031	26799	2544	29004	2152	31246	1552	38007	1093	23995
5L-4S		MI	8289	3551	12523	2847	14227	2389	15161	2012	16136	1422	19159	1015	11731
14-#11	1.98	MA	15705	3551	21952	3040	25893	2557	27871	2178	29669	1565	35872	1015	23235
6L-3S		MI	8418	3551	12881	2836	14731	2370	15779	2005	16982	1419	20191	1078	11731

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

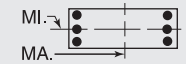
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#11	1.98	MA	15375	3551	21241	3051	24891	2577	26745	2190	28145	1588	33836	976	22578
7L-2S		MI	8668	3551	13399	2825	15390	2361	16579	1988	18065	1405	21659	1190	11718
14-#14	2.85	MA	17826	3827	26178	3184	31025	2664	34126	2226	38188	1522	47701	1040	34339
4L-5S		MI	8563	3827	13216	3041	15066	2523	16132	2111	17396	1419	20759	780	15846
14-#14	2.85	MA	17181	3827	25047	3220	29695	2686	32468	2247	35875	1555	44558	975	33303
5L-4S		MI	8793	3827	13739	3011	15696	2511	16915	2087	18483	1401	22199	874	16353
14-#14	2.85	MA	16646	3827	23968	3232	28404	2705	30842	2282	33612	1573	41490	860	32028
6L-3S		MI	8964	3827	14250	2996	16415	2484	17795	2078	19689	1398	23647	962	16411
14-#14	2.85	MA	16192	3827	22949	3248	26967	2733	29239	2300	31425	1606	38557	803	30475
7L-2S		MI	9301	3827	14985	2981	17351	2472	18932	2054	21227	1380	25698	1124	16424
14-#18	5.07	MA	19824	4526	30851	3703	36890	3047	41095	2486	47419	1561	60879	670	54980
5L-4S		MI	9994	4526	16672	3432	19268	2823	21192	2277	24222	1346	29331	478	26414
14-#18	5.07	MA	18969	4526	28957	3722	34651	3082	38231	2547	43437	1590	55468	460	51354
6L-3S		MI	10256	4526	17559	3409	20514	2779	22719	2266	26310	1346	31763	627	27670
14-#18	5.07	MA	18241	4526	27165	3749	32127	3129	35457	2580	39585	1646	50267	356	47627
7L-2S		MI	10782	4526	18826	3386	22126	2762	24677	2228	28961	1320	35184	915	27813
16-#10	1.84	MA	16502	3508	23244	2985	27517	2512	29954	2128	32624	1533	39844	1177	22738
4L-6S		MI	8005	3508	11827	2865	13438	2410	14223	2036	14884	1462	17630	971	10914
16-#10	1.84	MA	16119	3508	22589	3005	26757	2525	29007	2140	31303	1552	38054	1143	22614
5E		MI	8151	3508	12098	2858	13797	2393	14670	2029	15487	1449	18428	1032	11063
16-#10	1.84	MA	15798	3508	21971	3013	26007	2535	28079	2161	30010	1563	36307	1080	22231
6L-4S		MI	8295	3508	12401	2840	14162	2385	15123	2014	16118	1437	19302	1084	11077
16-#10	1.84	MA	15528	3508	21388	3022	25185	2551	27146	2170	28761	1583	34647	1049	21683
7L-3S		MI	8401	3508	12697	2830	14580	2368	15635	2007	16818	1433	20174	1137	11074
16-#10	1.84	MA	15197	3508	20831	3033	24431	2561	26187	2187	27537	1602	33024	1009	21218
8L-2S		MI	8612	3508	13127	2820	15127	2360	16300	1992	17718	1421	21419	1229	11064
16-#11	2.26	MA	17109	3640	24627	3062	29165	2569	31906	2163	35222	1524	43469	1130	27593
4L-6S		MI	8184	3640	12353	2934	14008	2458	14872	2062	15726	1444	18654	867	12924
16-#11	2.26	MA	16652	3640	23834	3087	28238	2585	30751	2178	33610	1547	41281	1086	27383
5E		MI	8356	3640	12674	2924	14444	2439	15412	2055	16456	1431	19597	940	13202
16-#11	2.26	MA	16271	3640	23082	3095	27332	2597	29618	2203	32034	1560	39146	1008	26605
6L-4S		MI	8523	3640	13041	2903	14886	2429	15961	2038	17219	1417	20626	1004	13289
16-#11	2.26	MA	15952	3640	22371	3106	26330	2617	28493	2215	30509	1583	37110	969	25967
7L-3S		MI	8647	3640	13399	2892	15390	2410	16579	2030	18065	1414	21659	1067	13300
16-#11	2.26	MA	15557	3640	21691	3119	25410	2628	27322	2235	29015	1606	35126	918	25026
8L-2S		MI	8893	3640	13916	2881	16049	2401	17380	2013	19148	1400	23126	1180	13293
16-#14	3.26	MA	17956	3956	26665	3300	31755	2745	34971	2283	39262	1548	49247	965	38130
5E		MI	8888	3956	13951	3121	16002	2581	17268	2147	18934	1411	22811	761	17979
16-#14	3.26	MA	17439	3956	25586	3312	30464	2763	33344	2319	36999	1566	46179	850	36867
6L-4S		MI	9117	3956	14474	3091	16632	2569	18051	2123	20022	1393	24250	855	18547
16-#14	3.26	MA	17006	3956	24567	3328	29027	2791	31742	2336	34811	1598	43246	793	35289
7L-3S		MI	9281	3956	14985	3077	17351	2542	18932	2114	21227	1390	25698	943	18620
16-#14	3.26	MA	16449	3956	23591	3346	27708	2807	30064	2365	32666	1631	40394	717	33737
8L-2S		MI	9611	3956	15720	3062	18286	2530	20069	2090	22765	1372	27750	1105	18646
16-#18	5.80	MA	20312	4755	31793	3865	38263	3185	42618	2612	49373	1577	63687	441	59750
6L-4S		MI	10535	4755	17938	3575	20880	2927	23151	2342	26872	1332	32753	432	30068
16-#18	5.80	MA	19630	4755	30002	3891	35739	3233	39843	2645	45522	1633	58486	337	55984
7L-3S		MI	10819	4755	18826	3552	22126	2883	24677	2331	28961	1333	35184	581	31445
16-#18	5.80	MA	18682	4755	28286	3922	33418	3259	36892	2693	41745	1688	53449	197	52295
8L-2S		MI	11281	4755	20092	3529	23738	2866	26636	2293	31611	1307	38606	869	31615
18-#10	2.07	MA	16579	3580	23518	3051	27940	2558	30443	2161	33246	1548	40745	1137	25402
5L-6S		MI	8204	3580	12257	2910	13985	2443	14888	2057	15784	1458	18875	965	12172
18-#10	2.07	MA	16264	3580	22900	3058	27189	2568	29515	2182	31954	1559	38998	1075	24998
6L-5S		MI	8347	3580	12528	2903	14345	2426	15335	2050	16387	1445	19674	1026	12354

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

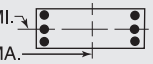


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
18-#10	2.07	MA	16002	3580	22317	3067	26367	2584	28582	2191	30705	1579	37338	1043	24464
7L-4S		MI	8491	3580	12831	2885	14710	2418	15788	2035	17018	1433	20547	1078	12375
18-#10	2.07	MA	15674	3580	21759	3078	25613	2594	27623	2208	29481	1598	35715	1003	23992
8L-3S		MI	8595	3580	13127	2875	15127	2401	16300	2028	17718	1429	21419	1131	12379
18-#10	2.07	MA	15346	3580	21110	3095	24839	2613	26694	2217	28198	1607	34141	961	23200
9L-2S		MI	8802	3580	13557	2866	15675	2393	16965	2013	18619	1417	22665	1223	12372
18-#11	2.54	MA	17200	3729	24964	3142	29676	2625	32498	2203	35975	1542	44555	1079	30774
5L-6S		MI	8419	3729	12870	2989	14667	2498	15672	2087	16809	1439	20121	856	14438
18-#11	2.54	MA	16829	3729	24211	3151	28770	2638	31365	2228	34398	1555	42420	1001	29978
6L-5S		MI	8588	3729	13191	2980	15103	2479	16213	2080	17539	1425	21064	929	14703
18-#11	2.54	MA	16520	3729	23501	3162	27768	2658	30240	2240	32874	1578	40384	961	29355
7L-4S		MI	8754	3729	13558	2958	15545	2470	16761	2063	18302	1412	22094	994	14844
18-#11	2.54	MA	16128	3729	22821	3175	26848	2669	29070	2260	31380	1601	38400	910	28398
8L-3S		MI	8874	3729	13916	2947	16049	2450	17380	2056	19148	1408	23126	1057	14863
18-#11	2.54	MA	15740	3729	22035	3197	25905	2691	27937	2271	29834	1613	36468	858	27478
9L-2S		MI	9116	3729	14434	2936	16708	2441	18180	2038	20231	1395	24593	1169	14864
18-#14	3.67	MA	18219	4084	27204	3392	32524	2822	35847	2355	40386	1558	50868	840	41706
6L-5S		MI	9210	4084	14686	3202	16937	2639	18405	2184	20472	1404	24862	742	20120
18-#14	3.67	MA	17805	4084	26185	3408	31088	2849	34244	2373	38198	1591	47936	783	40104
7L-4S		MI	9438	4084	15209	3172	17568	2628	19188	2160	21560	1386	26302	836	20741
18-#14	3.67	MA	17253	4084	25210	3426	29768	2865	32566	2401	36053	1624	45083	707	38531
8L-3S		MI	9595	4084	15720	3157	18286	2601	20069	2151	22765	1383	27750	925	20826
18-#14	3.67	MA	16735	4084	24088	3458	28414	2897	30940	2416	33854	1641	42300	631	36577
9L-2S		MI	9918	4084	16455	3142	19222	2589	21205	2127	24303	1365	29801	1086	20863
18-#18	6.52	MA	20983	4983	32838	4034	39350	3337	44229	2710	51458	1619	66706	319	64341
7L-4S		MI	11135	4983	19205	3718	22492	3031	25109	2407	29523	1319	36174	386	33737
18-#18	6.52	MA	20049	4983	31122	4064	37029	3363	41279	2757	47682	1675	61668	178	60623
8L-3S		MI	11333	4983	20092	3695	23738	2987	26636	2395	31611	1320	38606	535	35221
20-#10	2.30	MA	16725	3653	23828	3103	28372	2601	30951	2202	33897	1555	41689	1069	27768
6E		MI	8401	3653	12687	2956	14533	2476	15554	2077	16684	1453	20121	959	13433
20-#10	2.30	MA	16470	3653	23245	3113	27550	2617	30018	2211	32648	1574	40029	1037	27246
7L-5S		MI	8542	3653	12958	2948	14893	2459	16000	2070	17287	1441	20919	1020	13643
20-#10	2.30	MA	16144	3653	22688	3123	26795	2627	29059	2228	31424	1594	38406	997	26765
8L-4S		MI	8686	3653	13261	2930	15257	2451	16453	2055	17918	1429	21793	1072	13670
20-#10	2.30	MA	15826	3653	22038	3141	26021	2646	28130	2237	30142	1603	36832	955	25976
9L-3S		MI	8786	3653	13557	2921	15675	2434	16965	2048	18619	1425	22665	1125	13680
20-#10	2.30	MA	15536	3653	21458	3149	25294	2657	27204	2256	28877	1619	35084	909	25241
10L-2S		MI	8991	3653	13988	2911	16222	2426	17630	2033	19519	1412	23910	1217	13678
20-#11	2.83	MA	17380	3819	25341	3207	30209	2678	33112	2253	36763	1550	45694	994	33354
6E		MI	8652	3819	13388	3045	15326	2539	16472	2113	17892	1434	21588	846	15956
20-#11	2.83	MA	17081	3819	24631	3218	29207	2698	31987	2265	35239	1573	43658	954	32741
7L-5S		MI	8818	3819	13709	3035	15762	2519	17013	2106	18622	1420	22532	918	16208
20-#11	2.83	MA	16691	3819	23951	3231	28287	2709	30817	2285	33744	1596	41674	903	31771
8L-4S		MI	8983	3819	14075	3014	16204	2510	17562	2088	19385	1407	23561	983	16397
20-#11	2.83	MA	16316	3819	23165	3252	27343	2732	29684	2296	32198	1608	39742	851	30853
9L-3S		MI	9100	3819	14434	3003	16708	2491	18180	2081	20231	1403	24593	1046	16423
20-#11	2.83	MA	15971	3819	22457	3262	26455	2745	28554	2318	30656	1627	37605	793	29666
10L-2S		MI	9337	3819	14951	2992	17367	2482	18980	2063	21314	1390	26060	1158	16432
20-#14	4.08	MA	18590	4212	27803	3488	33148	2908	36747	2409	41585	1583	52625	772	44918
7L-5S		MI	9528	4212	15421	3282	17873	2698	19542	2220	22010	1396	26914	723	22266
20-#14	4.08	MA	18042	4212	26828	3506	31828	2923	35068	2437	39440	1616	49772	697	43324
8L-4S		MI	9756	4212	15944	3252	18503	2686	20324	2196	23098	1378	28353	817	22860
20-#14	4.08	MA	17542	4212	25706	3538	30474	2955	33443	2452	37240	1634	46990	621	41380
9L-3S		MI	9907	4212	16455	3237	19222	2659	21205	2187	24303	1375	29801	906	23030
20-#14	4.08	MA	17059	4212	24692	3552	29199	2974	31822	2484	35027	1661	43917	535	39440
10L-2S		MI	10223	4212	17190	3222	20158	2647	22342	2163	25841	1357	31853	1067	23077
20-#18	7.25	MA	21387	5212	33959	4207	40641	3466	45665	2822	53618	1662	69888	160	68950
8L-4S		MI	11661	5212	20471	3860	24104	3134	27067	2472	32173	1306	39595	339	37420

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



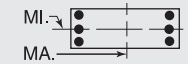
f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	2.53	MA	16933	3725	24174	3158	28732	2650	31455	2232	34592	1570	42720	1032	30030
7L-6S		MI	8597	3725	13117	3001	15080	2508	16219	2098	17584	1449	21366	953	14697
22-#10	2.53	MA	16608	3725	23617	3169	27978	2660	30495	2249	33368	1590	41097	991	29539
8L-5S		MI	8736	3725	13388	2994	15440	2492	16665	2091	18187	1437	22164	1014	14931
22-#10	2.53	MA	16299	3725	22967	3186	27204	2679	29566	2258	32085	1599	39523	949	28753
9L-4S		MI	8878	3725	13691	2976	15805	2484	17118	2076	18818	1425	23038	1066	14963
22-#10	2.53	MA	16016	3725	22387	3194	26476	2690	28640	2276	30820	1615	37775	904	28009
10L-3S		MI	8976	3725	13988	2966	16222	2467	17630	2069	19519	1421	23910	1119	14979
22-#10	2.53	MA	15699	3725	21821	3204	25725	2698	27734	2287	29539	1624	36196	861	27150
11L-2S		MI	9178	3725	14418	2956	16770	2459	18295	2054	20419	1408	25155	1211	14982
22-#11	3.11	MA	17634	3908	25760	3273	30645	2738	33734	2291	37603	1568	46932	947	36126
7L-6S		MI	8883	3908	13905	3101	15985	2579	17273	2138	18975	1429	23055	835	17476
22-#11	3.11	MA	17247	3908	25081	3286	29725	2750	32564	2310	36109	1591	44948	896	35143
8L-5S		MI	9045	3908	14226	3091	16421	2560	17813	2131	19705	1415	23999	908	17718
22-#11	3.11	MA	16888	3908	24294	3308	28782	2772	31431	2321	34563	1603	43016	844	34227
9L-4S		MI	9210	3908	14593	3070	16862	2551	18362	2113	20468	1401	25028	972	17948
22-#11	3.11	MA	16548	3908	23587	3318	27893	2785	30301	2343	33021	1622	40879	786	33030
10L-3S		MI	9323	3908	14951	3059	17367	2531	18980	2106	21314	1398	26060	1035	17981
22-#11	3.11	MA	16168	3908	22898	3329	26987	2796	29196	2356	31458	1632	38948	732	31896
11L-2S		MI	9557	3908	15469	3048	18026	2522	19780	2089	22397	1385	27527	1148	17995
22-#14	4.48	MA	18819	4341	28446	3587	33889	2982	37571	2474	42826	1609	54461	686	48118
8L-5S		MI	9844	4341	16156	3362	18809	2756	20678	2256	23548	1389	28965	704	24418
22-#14	4.48	MA	18335	4341	27324	3618	32534	3014	35945	2489	40627	1626	51679	610	46184
9L-4S		MI	10071	4341	16679	3332	19439	2744	21461	2232	24636	1371	30405	798	24986
22-#14	4.48	MA	17895	4341	26310	3632	31260	3032	34324	2520	38414	1653	48607	525	44229
10L-3S		MI	10217	4341	17190	3317	20158	2717	22342	2223	25841	1368	31853	887	25232
24-#10	2.76	MA	17067	3798	24545	3214	29160	2693	31931	2269	35311	1585	43788	986	32313
8L-6S		MI	8791	3798	13547	3046	15628	2541	16884	2118	18484	1445	22611	947	15962
24-#10	2.76	MA	16766	3798	23895	3231	28386	2711	31002	2278	34029	1595	42214	944	31529
9L-5S		MI	8928	3798	13818	3039	15988	2525	17330	2111	19087	1433	23410	1008	16192
24-#10	2.76	MA	16491	3798	23315	3240	27658	2722	30076	2297	32764	1611	40466	898	30776
10L-4S		MI	9070	3798	14121	3021	16353	2516	17784	2096	19718	1420	24283	1060	16256
24-#10	2.76	MA	16175	3798	22750	3249	26908	2731	29170	2307	31482	1619	38887	855	29920
11L-3S		MI	9165	3798	14418	3011	16770	2500	18295	2089	20419	1416	25155	1114	16275
24-#10	2.76	MA	15862	3798	22198	3259	26120	2748	28259	2326	30237	1637	37293	819	29025
12L-2S		MI	9364	3798	14848	3002	17318	2492	18961	2074	21319	1404	26400	1205	16283
24-#11	3.39	MA	17795	3997	26210	3342	31164	2790	34311	2336	38473	1586	48222	889	38515
8L-6S		MI	9112	3997	14423	3156	16644	2620	18073	2163	20058	1423	24523	824	18999
24-#11	3.39	MA	17446	3997	25424	3364	30220	2813	33178	2346	36927	1597	46290	837	37596
9L-5S		MI	9272	3997	14744	3147	17079	2600	18613	2156	20788	1410	25466	897	19232
24-#11	3.39	MA	17117	3997	24717	3373	29332	2826	32049	2368	35385	1617	44153	779	36394
10L-4S		MI	9436	3997	15110	3125	17521	2591	19162	2139	21551	1396	26495	962	19499
24-#11	3.39	MA	16741	3997	24028	3385	28426	2836	30944	2381	33822	1626	42222	725	35251
11L-3S		MI	9546	3997	15469	3114	18026	2572	19780	2131	22397	1393	27527	1025	19537
24-#11	3.39	MA	16368	3997	23354	3397	27466	2857	29838	2404	32302	1647	40266	680	34062
12L-2S		MI	9775	3997	15986	3103	18684	2563	20580	2114	23480	1379	28995	1137	19557
24-#14	4.89	MA	19116	4469	28942	3699	34595	3072	38448	2525	44014	1619	56368	600	50988
9L-5S		MI	10158	4469	16890	3442	19745	2815	21815	2293	25086	1381	31017	685	26574
24-#14	4.89	MA	18692	4469	27928	3712	33320	3090	36827	2556	41801	1646	53296	515	49018
10L-4S		MI	10384	4469	17414	3413	20375	2803	22597	2269	26174	1363	32457	779	27119

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.39	MA	17645	3512	25164	2963	29619	2491	32086	2120	34721	1558	41860	1354	18569
2E		MI	8457	3512	12927	2776	14536	2332	15363	1982	16162	1448	18566	1201	8644
6-#14	1.17	MA	17259	3441	24137	2935	28452	2473	30737	2113	32954	1572	39458	1368	15862
2L-3S		MI	7962	3441	11738	2780	13141	2340	13726	2010	13991	1490	15933	1092	7516
6-#14	1.17	MA	16329	3441	22439	2959	26289	2496	28111	2134	29400	1606	34536	1231	15850
3L-2S		MI	8337	3441	12473	2765	14077	2328	14863	1986	15529	1472	17985	1254	7471
6-#18	2.08	MA	19050	3740	28144	3106	33412	2595	36693	2185	40956	1545	50493	1335	27580
2L-3S		MI	8389	3740	12927	2942	14536	2453	15363	2084	16162	1461	18566	867	12573
6-#18	2.08	MA	17527	3740	25164	3147	29619	2633	32086	2221	34721	1602	41860	1086	27374
3L-2S		MI	9000	3740	14194	2919	16148	2436	17321	2046	18812	1434	21988	1154	12541
8-#11	1.08	MA	17099	3411	23700	2925	27966	2467	30183	2111	32234	1579	38483	1375	14749
2L-4S		MI	7879	3411	11396	2786	12719	2358	13238	2015	13343	1500	15253	1102	7043
8-#11	1.08	MA	16447	3411	22515	2942	26457	2483	28350	2126	29753	1603	35048	1281	14750
3E		MI	8022	3411	11754	2775	13224	2339	13856	2008	14189	1497	16285	1165	7010
8-#11	1.08	MA	16116	3411	21722	2959	25334	2510	26971	2151	27862	1616	32817	1222	14698
4L-2S		MI	8288	3411	12272	2764	13882	2329	14656	1991	15272	1483	17752	1277	6981
8-#14	1.56	MA	18082	3569	25836	3015	30614	2532	33364	2149	36509	1565	44380	1358	21007
2L-4S		MI	8099	3569	11962	2875	13358	2425	13982	2056	14324	1485	16537	985	9788
8-#14	1.56	MA	17184	3569	24137	3039	28452	2554	30737	2170	32954	1598	39458	1221	20964
3E		MI	8296	3569	12473	2861	14077	2399	14863	2047	15529	1482	17985	1073	9772
8-#14	1.56	MA	16729	3569	22999	3063	26841	2592	28759	2207	30241	1617	36247	1135	20757
4L-2S		MI	8661	3569	13208	2846	15013	2387	16000	2023	17067	1464	20036	1235	9738
8-#18	2.78	MA	20415	3969	31123	3248	37206	2699	41300	2250	47191	1532	59126	1317	36570
2L-4S		MI	8627	3969	13306	3108	14902	2600	15794	2160	16724	1447	19556	671	15748
8-#18	2.78	MA	18971	3969	28144	3290	33412	2737	36693	2286	40956	1588	50493	1068	36309
3E		MI	8946	3969	14194	3085	16148	2557	17321	2149	18812	1447	21988	820	16380
8-#18	2.78	MA	18245	3969	26140	3331	30579	2802	33214	2348	36185	1619	44809	913	34866
4L-2S		MI	9533	3969	15460	3062	17761	2539	19280	2111	21462	1421	25409	1108	16401
10-#10	1.10	MA	17182	3418	23711	2941	28079	2480	30369	2121	32528	1585	38921	1380	15082
2L-5S		MI	7855	3418	11229	2829	12622	2385	13152	2047	13244	1525	15191	1105	7198
10-#10	1.10	MA	16646	3418	22737	2955	26839	2493	28863	2134	30490	1605	36099	1305	15081
3L-4S		MI	8001	3418	11532	2811	12987	2377	13605	2032	13875	1513	16064	1157	7180
10-#10	1.10	MA	16379	3418	22087	2969	25918	2515	27733	2155	28939	1617	34277	1257	15047
4L-3S		MI	8117	3418	11828	2801	13404	2360	14117	2025	14575	1509	16936	1211	7158
10-#10	1.10	MA	15967	3418	21398	2989	25123	2529	26741	2168	27555	1636	32404	1224	14944
5L-2S		MI	8340	3418	12258	2791	13952	2352	14782	2010	15475	1497	18182	1302	7137
10-#11	1.35	MA	17681	3500	24885	2981	29475	2508	32016	2136	34715	1574	41918	1368	18341
2L-5S		MI	7952	3500	11547	2863	12936	2407	13489	2058	13663	1509	15691	1026	8635
10-#11	1.35	MA	17045	3500	23700	2998	27966	2524	30183	2151	32234	1597	38483	1274	18328
3L-4S		MI	8121	3500	11913	2842	13378	2398	14038	2041	14426	1495	16720	1091	8627
10-#11	1.35	MA	16728	3500	22907	3015	26843	2550	28804	2177	30343	1611	36252	1215	18258
4L-3S		MI	8258	3500	12272	2831	13882	2379	14656	2033	15272	1492	17752	1154	8603
10-#11	1.35	MA	16235	3500	22073	3040	25873	2566	27594	2192	28654	1634	33963	1172	18067
5L-2S		MI	8520	3500	12789	2820	14541	2370	15456	2016	16355	1478	19219	1266	8578
10-#14	1.95	MA	18889	3697	27534	3096	32776	2590	35990	2186	40064	1557	49301	1347	26139
2L-5S		MI	8205	3697	12174	2986	13664	2496	14336	2116	14774	1496	17149	872	11709
10-#14	1.95	MA	18020	3697	25836	3120	30614	2612	33364	2207	36509	1591	44380	1211	26074
3L-4S		MI	8437	3697	12697	2956	14294	2484	15119	2092	15862	1478	18589	966	12000
10-#14	1.95	MA	17593	3697	24698	3144	29003	2650	31386	2243	33796	1609	41169	1125	25848
4L-3S		MI	8625	3697	13208	2941	15013	2457	16000	2083	17067	1475	20036	1055	12011
10-#14	1.95	MA	16898	3697	23507	3179	27610	2673	29649	2264	31372	1643	37878	1061	24946
5L-2S		MI	8981	3697	13943	2926	15949	2445	17136	2059	18605	1457	22088	1216	11989
10-#18	3.47	MA	20374	4197	31123	3432	37206	2841	41300	2350	47191	1575	59126	1050	45251
3L-4S		MI	9194	4197	14573	3251	16514	2704	17753	2225	19374	1434	22977	625	19324
10-#18	3.47	MA	19714	4197	29120	3474	34372	2906	37821	2413	42420	1605	53443	895	43705
4L-3S		MI	9493	4197	15460	3228	17761	2660	19280	2214	21462	1434	25409	774	20170
10-#18	3.47	MA	18531	4197	27046	3538	31917	2944	34762	2448	38154	1662	47635	776	40137
5L-2S		MI	10059	4197	16726	3205	19373	2643	21238	2176	24113	1408	28830	1062	20238

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

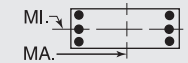
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	1.32	MA	17663	3490	24685	2986	29319	2513	31875	2142	34566	1581	41743	1374	18032
2L-6S		MI	7905	3490	11388	2881	12810	2435	13371	2074	13541	1533	15638	1038	8474
12-#10	1.32	MA	17139	3490	23711	3000	28079	2526	30369	2154	32528	1601	38921	1299	18021
3L-5S		MI	8057	3490	11659	2874	13169	2418	13817	2068	14144	1521	16436	1099	8504
12-#10	1.32	MA	16881	3490	23061	3015	27158	2548	29239	2176	30977	1612	37100	1252	17977
4E		MI	8203	3490	11962	2856	13534	2410	14270	2052	14775	1509	17310	1152	8494
12-#10	1.32	MA	16471	3490	22372	3034	26363	2562	28247	2188	29593	1632	35227	1218	17865
5L-3S		MI	8316	3490	12258	2846	13952	2393	14782	2046	15475	1505	18182	1205	8478
12-#10	1.32	MA	16116	3490	21724	3042	25573	2572	27275	2210	28239	1644	33398	1156	17571
6L-2S		MI	8535	3490	12688	2837	14499	2385	15447	2030	16376	1493	19427	1296	8460
12-#11	1.63	MA	18254	3590	26071	3037	30985	2548	33850	2161	37196	1569	45353	1360	21927
2L-6S		MI	8011	3590	11743	2928	13159	2467	13749	2090	14016	1517	16214	943	9984
12-#11	1.63	MA	17634	3590	24885	3054	29475	2564	32016	2176	34715	1592	41918	1267	21901
3L-5S		MI	8191	3590	12064	2919	13595	2448	14289	2083	14746	1504	17158	1016	10193
12-#11	1.63	MA	17331	3590	24093	3071	28353	2590	30638	2202	32824	1606	39687	1207	21819
4E		MI	8359	3590	12431	2897	14037	2439	14838	2066	15509	1490	18187	1081	10201
12-#11	1.63	MA	16841	3590	23258	3095	27382	2606	29427	2217	31135	1629	37398	1165	21619
5L-3S		MI	8493	3590	12789	2886	14541	2419	15456	2059	16355	1487	19219	1144	10186
12-#11	1.63	MA	16417	3590	22469	3104	26427	2619	28241	2242	29484	1642	35163	1087	20903
6L-2S		MI	8749	3590	13307	2875	15200	2410	16257	2041	17438	1473	20686	1256	10166
12-#14	2.34	MA	18841	3826	27534	3200	32776	2671	35990	2243	40064	1583	49301	1200	31183
3L-5S		MI	8539	3826	12909	3066	14600	2554	15473	2153	16312	1488	19201	853	13821
12-#14	2.34	MA	18438	3826	26396	3224	31166	2708	34012	2279	37351	1602	46091	1114	30942
4E		MI	8770	3826	13432	3036	15230	2542	16255	2129	17400	1470	20640	947	14204
12-#14	2.34	MA	17748	3826	25205	3260	29772	2731	32275	2301	34927	1635	42800	1051	30005
5L-3S		MI	8950	3826	13943	3021	15949	2515	17136	2120	18605	1467	22088	1036	14237
12-#14	2.34	MA	17163	3826	24073	3272	28411	2749	30572	2337	32556	1654	39588	938	28607
6L-2S		MI	9298	3826	14678	3006	16884	2503	18273	2096	20143	1449	24140	1198	14228
12-#18	4.17	MA	21143	4425	32099	3616	38165	3010	42428	2477	48655	1592	62076	877	52544
4E		MI	9751	4425	15839	3393	18127	2808	19711	2290	22024	1420	26399	579	22931
12-#18	4.17	MA	19971	4425	30025	3680	35710	3048	39370	2513	44389	1649	56269	758	49011
5L-3S		MI	10032	4425	16726	3370	19373	2764	21238	2278	24113	1421	28830	728	23954
12-#18	4.17	MA	19018	4425	28037	3700	33347	3082	36368	2575	40214	1679	50601	550	45400
6L-2S		MI	10578	4425	17993	3347	20985	2747	23196	2241	26763	1395	32251	1015	24056
14-#10	1.54	MA	17624	3563	24685	3046	29319	2559	31875	2175	34566	1597	41743	1293	20959
3L-6S		MI	8109	3563	11818	2927	13357	2468	14036	2095	14441	1529	16883	1032	9723
14-#10	1.54	MA	17376	3563	24035	3060	28398	2581	30745	2196	33015	1608	39922	1246	20906
4L-5S		MI	8258	3563	12089	2919	13717	2451	14482	2088	15044	1517	17681	1093	9802
14-#10	1.54	MA	16969	3563	23346	3080	27603	2594	29753	2209	31631	1628	38049	1212	20788
5L-4S		MI	8403	3563	12392	2901	14082	2443	14935	2073	15675	1505	18555	1146	9803
14-#10	1.54	MA	16622	3563	22698	3087	26813	2604	28781	2230	30278	1639	36220	1151	20469
6L-3S		MI	8513	3563	12688	2892	14499	2426	15447	2066	16376	1501	19427	1199	9791
14-#10	1.54	MA	16329	3563	22088	3097	25952	2621	27799	2239	28970	1659	34487	1120	19863
7L-2S		MI	8729	3563	13118	2882	15047	2418	16112	2051	17276	1488	20672	1290	9777
14-#11	1.90	MA	18213	3679	26071	3109	30985	2605	33850	2202	37196	1587	45353	1260	25473
3L-6S		MI	8252	3679	12261	2984	13818	2508	14549	2116	15099	1512	17682	933	11488
14-#11	1.90	MA	17923	3679	25278	3126	29862	2631	32471	2227	35305	1600	43123	1200	25380
4L-5S		MI	8428	3679	12582	2974	14254	2488	15089	2109	15829	1498	18625	1005	11745
14-#11	1.90	MA	17437	3679	24444	3151	28891	2647	31261	2242	33616	1624	40833	1158	25174
5L-4S		MI	8595	3679	12948	2953	14696	2479	15638	2091	16592	1485	19654	1070	11767
14-#11	1.90	MA	17024	3679	23654	3159	27936	2659	30074	2268	31965	1637	38598	1080	24437
6L-3S		MI	8724	3679	13307	2942	15200	2460	16257	2084	17438	1481	20686	1133	11762
14-#11	1.90	MA	16675	3679	22910	3171	26886	2679	28887	2279	30368	1661	36472	1041	23735
7L-2S		MI	8976	3679	13824	2931	15859	2451	17057	2066	18521	1468	22154	1245	11747

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

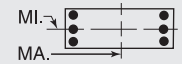


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.73	MA	19267	3954	28094	3304	33328	2767	36639	2316	40905	1594	51012	1104	36040
4L-5S		MI	8869	3954	13644	3146	15536	2612	16609	2189	17850	1481	21252	834	15944
14-#14	2.73	MA	18582	3954	26904	3340	31935	2789	34902	2337	38482	1628	47722	1041	35070
5L-4S		MI	9099	3954	14167	3116	16166	2601	17392	2165	18938	1463	22692	928	16403
14-#14	2.73	MA	18017	3954	25772	3352	30573	2808	33198	2373	36111	1646	44510	927	33688
6L-3S		MI	9271	3954	14678	3101	16884	2574	18273	2156	20143	1460	24140	1017	16453
14-#14	2.73	MA	17538	3954	24703	3368	29067	2836	31508	2390	33819	1680	41447	871	32151
7L-2S		MI	9611	3954	15413	3086	17820	2562	19409	2132	21682	1442	26191	1179	16460
14-#18	4.86	MA	21375	4654	33004	3823	39503	3152	43977	2578	50625	1636	64902	739	57884
5L-4S		MI	10299	4654	17105	3536	19739	2912	21669	2355	24675	1407	29820	532	26561
14-#18	4.86	MA	20471	4654	31016	3843	37140	3185	40975	2640	46450	1666	59234	532	54220
6L-3S		MI	10564	4654	17993	3513	20985	2868	23196	2343	26763	1408	32251	681	27733
14-#18	4.86	MA	19701	4654	29137	3870	34492	3234	38044	2672	42413	1723	53801	429	50444
7L-2S		MI	11099	4654	19259	3490	22597	2851	25154	2305	29413	1381	35673	969	27865
16-#10	1.76	MA	17865	3635	25009	3105	29638	2614	32251	2217	35054	1604	42744	1240	23835
4L-6S		MI	8310	3635	12248	2972	13905	2501	14701	2115	15341	1525	18128	1026	10977
16-#10	1.76	MA	17459	3635	24320	3125	28843	2627	31259	2229	33670	1624	40871	1207	23711
5E		MI	8457	3635	12519	2965	14265	2484	15147	2109	15944	1513	18927	1087	11097
16-#10	1.76	MA	17121	3635	23672	3132	28053	2637	30287	2251	32316	1635	39043	1145	23370
6L-4S		MI	8601	3635	12822	2947	14630	2476	15601	2093	16575	1500	19800	1140	11107
16-#10	1.76	MA	16836	3635	23062	3142	27192	2654	29305	2260	31008	1655	37309	1114	22779
7L-3S		MI	8708	3635	13118	2937	15047	2459	16112	2087	17276	1496	20672	1193	11101
16-#10	1.76	MA	16486	3635	22478	3153	26401	2664	28299	2277	29726	1675	35612	1074	22290
8L-2S		MI	8920	3635	13548	2927	15595	2451	16777	2071	18176	1484	21918	1284	11089
16-#11	2.17	MA	18508	3768	26463	3182	31371	2671	34304	2252	37786	1595	46558	1193	28941
4L-6S		MI	8490	3768	12778	3040	14477	2548	15349	2141	16182	1507	19149	922	12998
16-#11	2.17	MA	18024	3768	25629	3207	30401	2687	33094	2267	36097	1619	44268	1150	28731
5E		MI	8663	3768	13099	3030	14913	2529	15890	2134	16912	1493	20092	994	13281
16-#11	2.17	MA	17622	3768	24840	3215	29446	2700	31907	2293	34446	1632	42033	1073	27975
6L-4S		MI	8829	3768	13466	3009	15355	2520	16438	2116	17675	1480	21122	1059	13327
16-#11	2.17	MA	17284	3768	24095	3227	28396	2720	30721	2305	32849	1656	39907	1034	27290
7L-3S		MI	8954	3768	13824	2998	15859	2500	17057	2109	18521	1476	22154	1122	13333
16-#11	2.17	MA	16865	3768	23383	3240	27432	2731	29494	2325	31284	1679	37831	984	26365
8L-2S		MI	9201	3768	14341	2987	16518	2491	17857	2092	19604	1463	23621	1235	13323
16-#14	3.13	MA	19401	4083	28602	3420	34097	2848	37528	2373	42036	1620	52644	1030	40141
5E		MI	9195	4083	14379	3226	16471	2671	17746	2225	19389	1474	23304	815	18076
16-#14	3.13	MA	18855	4083	27470	3432	32736	2866	35825	2410	39665	1639	49432	917	38767
6L-4S		MI	9424	4083	14902	3197	17102	2659	18528	2201	20476	1456	24743	909	18599
16-#14	3.13	MA	18397	4083	26402	3448	31230	2894	34134	2427	37373	1672	46369	860	37205
7L-3S		MI	9589	4083	15413	3182	17820	2632	19409	2192	21682	1452	26191	998	18664
16-#14	3.13	MA	17806	4083	25380	3467	29846	2910	32375	2455	35126	1705	43384	786	35563
8L-2S		MI	9921	4083	16148	3167	18756	2620	20546	2168	23220	1434	28243	1160	18685
16-#18	5.56	MA	21889	4882	33995	3986	40934	3289	45583	2705	52685	1653	67868	513	63039
6L-4S		MI	10841	4882	18372	3679	21351	3015	23627	2419	27325	1394	33241	486	30211
16-#18	5.56	MA	21167	4882	32116	4013	38285	3338	42651	2737	48648	1710	62434	410	59222
7L-3S		MI	11131	4882	19259	3656	22597	2972	25154	2408	29413	1394	35673	635	31510
16-#18	5.56	MA	20160	4882	30317	4044	35852	3364	39557	2786	44689	1766	57161	273	55288
8L-2S		MI	11598	4882	20525	3633	24210	2954	27113	2370	32063	1368	39094	922	31668
18-#10	1.98	MA	17944	3708	25294	3170	30083	2660	32765	2250	35708	1620	43694	1201	26636
5L-6S		MI	8510	3708	12678	3017	14452	2534	15366	2136	16241	1521	19374	1020	12235
18-#10	1.98	MA	17613	3708	24646	3178	29293	2670	31793	2271	34354	1631	41865	1139	26274
6L-5S		MI	8654	3708	12949	3010	14812	2517	15812	2129	16844	1508	20172	1081	12390
18-#10	1.98	MA	17336	3708	24036	3187	28432	2687	30811	2280	33046	1651	40131	1108	25697
7L-4S		MI	8798	3708	13252	2992	15177	2509	16266	2114	17475	1496	21045	1134	12406
18-#10	1.98	MA	16988	3708	23452	3198	27641	2697	29805	2297	31764	1671	38434	1069	25212
8L-3S		MI	8902	3708	13548	2982	15595	2492	16777	2107	18176	1492	21918	1187	12407
18-#10	1.98	MA	16642	3708	22768	3216	26831	2716	28832	2307	30413	1679	36790	1027	24413
9L-2S		MI	9111	3708	13979	2972	16142	2484	17443	2092	19076	1480	23163	1278	12399

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

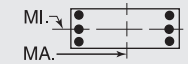
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.44	MA	18602	3857	26815	3262	31910	2728	34927	2293	38578	1614	47704	1143	32290
5L-6S		MI	8725	3857	13296	3095	15136	2589	16150	2166	17265	1502	20616	911	14512
18-#11	2.44	MA	18211	3857	26025	3271	30955	2740	33741	2318	36927	1627	45469	1066	31517
6L-5S		MI	8895	3857	13616	3086	15572	2569	16690	2159	17995	1488	21559	984	14781
18-#11	2.44	MA	17884	3857	25281	3282	29905	2760	32554	2330	35330	1651	43342	1027	30843
7L-4S		MI	9061	3857	13983	3064	16013	2560	17239	2142	18758	1474	22589	1049	14883
18-#11	2.44	MA	17468	3857	24569	3295	28941	2772	31328	2350	33765	1674	41267	977	29904
8L-3S		MI	9182	3857	14341	3053	16518	2541	17857	2134	19604	1471	23621	1112	14899
18-#11	2.44	MA	17058	3857	23741	3317	27952	2795	30141	2361	32134	1686	39250	925	28943
9L-2S		MI	9425	3857	14859	3042	17177	2532	18657	2117	20687	1458	25088	1224	14896
18-#14	3.52	MA	19679	4211	29169	3513	34898	2924	38451	2446	43220	1631	54354	907	43847
6L-5S		MI	9517	4211	15113	3307	17407	2729	18882	2262	20927	1466	25355	797	20215
18-#14	3.52	MA	19240	4211	28100	3529	33392	2953	36761	2463	40928	1665	51291	850	42259
7L-4S		MI	9745	4211	15637	3277	18037	2717	19665	2238	22015	1448	26795	891	20794
18-#14	3.52	MA	18655	4211	27078	3547	32009	2969	35001	2492	38681	1698	48306	776	40623
8L-3S		MI	9904	4211	16148	3262	18756	2690	20546	2229	23220	1445	28243	979	20871
18-#14	3.52	MA	18108	4211	25897	3578	30590	3001	33298	2507	36359	1715	45400	701	38611
9L-2S		MI	10229	4211	16883	3247	19692	2678	21682	2205	24758	1427	30294	1141	20903
18-#18	6.25	MA	22591	5111	35095	4156	42079	3442	47259	2802	54883	1696	71068	392	68000
7L-4S		MI	11443	5111	19638	3822	22963	3119	25586	2484	29975	1381	36662	440	33877
18-#18	6.25	MA	21603	5111	33296	4187	39645	3468	44164	2850	50924	1753	65795	254	64094
8L-3S		MI	11646	5111	20525	3798	24210	3075	27113	2473	32063	1381	39094	589	35287
20-#10	2.20	MA	18099	3780	25620	3223	30533	2703	33300	2292	36393	1627	44687	1133	29180
6E		MI	8707	3780	13108	3063	15000	2567	16031	2157	17141	1517	20619	1014	13495
20-#10	2.20	MA	17830	3780	25009	3233	29672	2720	32317	2301	35085	1647	42954	1102	28617
7L-5S		MI	8849	3780	13379	3055	15360	2550	16477	2150	17744	1504	21417	1075	13680
20-#10	2.20	MA	17484	3780	24426	3243	28881	2729	31312	2318	33803	1666	41257	1063	28134
8L-4S		MI	8993	3780	13682	3037	15725	2542	16931	2135	18375	1492	22291	1128	13702
20-#10	2.20	MA	17148	3780	23742	3261	28071	2748	30338	2327	32451	1675	39612	1021	27325
9L-3S		MI	9094	3780	13979	3028	16142	2525	17443	2128	19076	1488	23163	1181	13710
20-#10	2.20	MA	16843	3780	23134	3269	27309	2760	29369	2346	31126	1692	37784	976	26613
10L-2S		MI	9300	3780	14409	3018	16690	2517	18108	2113	19976	1476	24408	1272	13706
20-#11	2.71	MA	18792	3946	27211	3326	32465	2781	35574	2343	39408	1622	48904	1059	35061
6E		MI	8958	3946	13813	3151	15795	2629	16950	2191	18348	1496	22083	901	16029
20-#11	2.71	MA	18475	3946	26466	3338	31414	2801	34387	2355	37811	1645	46778	1020	34397
7L-5S		MI	9125	3946	14134	3141	16230	2610	17490	2184	19078	1483	23027	973	16286
20-#11	2.71	MA	18063	3946	25754	3351	30450	2812	33161	2375	36246	1669	44702	970	33443
8L-4S		MI	9290	3946	14501	3120	16672	2601	18039	2167	19841	1469	24056	1038	16438
20-#11	2.71	MA	17665	3946	24926	3372	29461	2835	31974	2386	34615	1680	42685	918	32485
9L-3S		MI	9408	3946	14859	3109	17177	2581	18657	2160	20687	1466	25088	1101	16460
20-#11	2.71	MA	17302	3946	24185	3382	28531	2848	30790	2409	32999	1700	40449	861	31283
10L-2S		MI	9647	3946	15376	3098	17835	2572	19457	2142	21770	1452	26555	1213	16465
20-#14	3.91	MA	20069	4340	29799	3609	35555	3011	39387	2500	44483	1657	56212	840	47312
7L-5S		MI	9836	4340	15848	3387	18343	2788	20019	2298	22465	1459	27407	778	22360
20-#14	3.91	MA	19488	4340	28777	3627	34171	3027	37628	2528	42236	1691	53228	766	45684
8L-4S		MI	10064	4340	16372	3357	18973	2776	20802	2274	23553	1441	28846	872	22968
20-#14	3.91	MA	18959	4340	27595	3659	32752	3060	35924	2544	39914	1707	50322	690	43654
9L-3S		MI	10217	4340	16883	3342	19692	2749	21682	2265	24758	1437	30294	960	23076
20-#14	3.91	MA	18449	4340	26532	3673	31416	3078	34226	2575	37594	1735	47107	606	41699
10L-2S		MI	10535	4340	17618	3327	20627	2737	22819	2241	26296	1419	32346	1122	23118
20-#18	6.94	MA	23016	5339	36275	4330	43438	3572	48771	2915	57160	1740	74428	236	72900
8L-4S		MI	11970	5339	20904	3964	24576	3223	27544	2549	32626	1367	40084	393	37556
22-#10	2.43	MA	18317	3853	25983	3278	30912	2753	33823	2322	37123	1642	45776	1096	31538
7L-6S		MI	8903	3853	13538	3108	15548	2600	16696	2177	18041	1512	21864	1009	14759

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

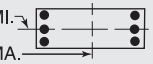


f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	2.43	MA	17973	3853	25400	3289	30121	2762	32818	2338	35841	1662	44079	1057	31055
8L-5S		MI	9043	3853	13810	3101	15907	2583	17142	2170	18644	1500	22662	1070	14970
22-#10	2.43	MA	17647	3853	24716	3306	29311	2781	31845	2348	34489	1671	42435	1015	30238
9L-4S		MI	9186	3853	14112	3083	16272	2575	17596	2155	19275	1488	23536	1122	14997
22-#10	2.43	MA	17349	3853	24108	3315	28549	2793	30875	2367	33165	1688	40607	970	29516
10L-3S		MI	9285	3853	14409	3073	16690	2558	18108	2148	19976	1484	24408	1175	15009
22-#10	2.43	MA	17012	3853	23516	3324	27758	2801	29926	2377	31823	1696	38955	928	28599
11L-2S		MI	9487	3853	14839	3063	17237	2550	18773	2133	20876	1472	25653	1266	15010
22-#11	2.98	MA	19059	4035	27652	3394	32924	2841	36221	2380	40292	1640	50213	1013	37950
7L-6S		MI	9189	4035	14330	3207	16453	2670	17750	2217	19431	1491	23550	890	17549
22-#11	2.98	MA	18649	4035	26939	3407	31960	2853	34994	2401	38727	1664	48137	963	36982
8L-5S		MI	9353	4035	14651	3197	16889	2650	18290	2210	20161	1478	24494	963	17795
22-#11	2.98	MA	18270	4035	26112	3428	30971	2875	33807	2412	37096	1675	46120	911	36026
9L-4S		MI	9518	4035	15018	3176	17331	2641	18839	2192	20924	1464	25523	1027	17990
22-#11	2.98	MA	17911	4035	25370	3438	30040	2889	32624	2434	35480	1695	43884	854	34813
10L-3S		MI	9632	4035	15376	3165	17835	2622	19457	2185	21770	1461	26555	1090	18019
22-#11	2.98	MA	17508	4035	24648	3450	29085	2899	31466	2447	33843	1705	41864	801	33688
11L-2S		MI	9867	4035	15894	3154	18494	2613	20258	2167	22853	1447	28023	1203	18030
22-#14	4.30	MA	20308	4468	30475	3708	36334	3085	40255	2565	45790	1683	58150	755	50744
8L-5S		MI	10152	4468	16583	3467	19279	2846	21155	2335	24003	1451	29458	759	24511
22-#14	4.30	MA	19796	4468	29294	3739	34915	3118	38551	2580	43468	1700	55243	680	48697
9L-4S		MI	10379	4468	17107	3437	19909	2834	21938	2311	25091	1433	30898	853	25092
22-#14	4.30	MA	19309	4468	28230	3753	33579	3137	36852	2612	41149	1728	52029	596	46726
10L-3S		MI	10527	4468	17618	3423	20627	2807	22819	2302	26296	1430	32346	941	25279
24-#10	2.65	MA	18457	3925	26374	3334	31361	2795	34324	2359	37879	1658	46901	1051	33977
8L-6S		MI	9098	3925	13968	3153	16095	2633	17361	2198	18941	1508	23109	1003	16024
24-#10	2.65	MA	18139	3925	25690	3351	30551	2814	33351	2368	36528	1667	45257	1009	33150
9L-5S		MI	9235	3925	14240	3146	16455	2616	17807	2191	19544	1496	23908	1064	16258
24-#10	2.65	MA	17849	3925	25082	3360	29789	2826	32381	2387	35203	1683	43429	964	32418
10L-4S		MI	9378	3925	14542	3128	16820	2608	18261	2176	20175	1484	24781	1116	16290
24-#10	2.65	MA	17514	3925	24490	3370	28998	2834	31432	2398	33861	1692	41777	923	31504
11L-3S		MI	9474	3925	14839	3118	17237	2591	18773	2169	20876	1480	25653	1169	16307
24-#10	2.65	MA	17185	3925	23912	3380	28173	2851	30473	2417	32556	1710	40113	887	30618
12L-2S		MI	9674	3925	15269	3108	17785	2583	19438	2154	21776	1467	26899	1260	16313
24-#11	3.25	MA	19228	4124	28125	3462	33469	2893	36827	2426	41208	1659	51572	956	40520
8L-6S		MI	9419	4124	14848	3262	17112	2710	18550	2242	20514	1486	25018	879	19071
24-#11	3.25	MA	18858	4124	27297	3484	32480	2916	35640	2437	39577	1670	49555	904	39551
9L-5S		MI	9580	4124	15169	3253	17548	2691	19090	2235	21243	1473	25961	952	19308
24-#11	3.25	MA	18511	4124	26556	3494	31550	2929	34457	2459	37961	1690	47320	847	38343
10L-4S		MI	9744	4124	15535	3231	17990	2682	19639	2217	22006	1459	26991	1017	19542
24-#11	3.25	MA	18112	4124	25834	3505	30595	2940	33299	2472	36324	1700	45299	794	37208
11L-3S		MI	9855	4124	15894	3220	18494	2662	20258	2210	22853	1456	28023	1080	19576
24-#11	3.25	MA	17719	4124	25128	3518	29589	2961	32141	2495	34732	1721	43257	749	35936
12L-2S		MI	10086	4124	16411	3209	19153	2653	21058	2193	23936	1442	29490	1192	19593
24-#14	4.69	MA	20620	4597	30992	3819	37077	3176	41177	2617	47023	1693	60165	670	53740
9L-5S		MI	10466	4597	17318	3548	20214	2904	22292	2371	25541	1444	31510	740	26666
24-#14	4.69	MA	20172	4597	29929	3833	35741	3195	39479	2648	44704	1720	56950	586	51753
10L-4S		MI	10693	4597	17842	3518	20845	2892	23075	2347	26629	1426	32950	834	27224

RECTANGULAR TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.86	MA	389	405	643	257	656	214	651	177	633	120	665	85	395
2L-3S		MI	380	405	613	256	618	215	607	179	577	122	601	62	400
6-#6	2.64	MA	402	427	678	268	696	220	698	179	693	112	729	68	521
2L-3S		MI	390	427	636	267	645	222	638	181	616	114	642	36	530
6-#7	3.60	MA	418	453	720	283	743	229	752	182	762	103	802	45	668
2L-3S		MI	403	453	664	286	676	231	673	184	661	105	690	4	679

RECTANGULAR TIED COLUMNS 10" x 12"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#5	1.03	MA	542	459	874	303	893	256	888	219	851	162	891	129	355
2E		MI	448	459	723	291	727	245	711	207	670	151	695	119	301
4-#6	1.47	MA	555	473	907	311	934	261	937	222	912	158	957	119	472
2E		MI	457	473	747	298	753	248	741	208	708	145	736	107	393
4-#7	2.00	MA	570	491	947	320	983	267	994	224	984	153	1034	107	610
2E		MI	467	491	775	307	784	253	776	209	754	138	783	91	499
4-#8	2.63	MA	588	512	992	331	1040	275	1058	228	1066	147	1156	101	767
2E		MI	480	512	806	317	818	259	816	210	804	129	835	72	618
4-#9	3.33	MA	606	535	1041	344	1101	284	1126	231	1152	140	1252	85	932
2E		MI	492	535	836	328	853	264	856	210	856	119	885	49	742
4-#10	4.23	MA	629	565	1102	360	1177	296	1208	235	1257	131	1369	63	1137
2E		MI	508	565	872	343	895	271	904	210	918	105	942	18	892
4-#11	5.20	MA	647	597	1151	375	1218	300	1254	231	1317	112	1410	25	1323
2E		MI	519	597	884	349	906	270	916	201	934	79	930	-35	951
6-#5	1.55	MA	559	476	915	314	946	264	952	224	934	159	986	120	495
2L-3S		MI	451	476	723	301	727	253	711	212	670	148	695	85	415
6-#5	1.55	MA	545	476	874	314	893	266	888	225	851	161	891	98	501
3L-2S		MI	460	476	753	302	764	252	755	211	726	147	759	108	410
6-#6	2.20	MA	578	497	964	326	1007	272	1027	228	1026	154	1086	106	664
2L-3S		MI	461	497	747	311	753	260	741	215	708	141	736	59	549
6-#6	2.20	MA	560	497	907	326	934	275	937	230	912	156	957	75	673
3L-2S		MI	473	497	788	313	805	258	801	213	785	139	823	91	540
6-#7	3.00	MA	601	524	1023	341	1081	282	1112	233	1135	147	1203	88	862
2L-3S		MI	473	524	775	330	784	269	776	217	754	131	783	27	703
6-#7	3.00	MA	577	524	947	340	983	286	994	236	984	150	1034	45	874
3L-2S		MI	489	524	830	327	851	266	855	215	854	129	895	68	690
6-#8	3.95	MA	598	555	992	358	1040	299	1058	242	1066	142	1156	19	1099
3L-2S		MI	507	555	878	345	904	276	915	217	932	116	974	40	858
6-#9	5.00	MA	620	590	1041	377	1101	314	1126	248	1152	133	1252	-21	1207
3L-2S		MI	526	590	923	362	957	285	977	218	1010	101	1051	6	1034
6-#10	6.35	MA	647	635	1102	402	1177	333	1208	256	1257	121	1369	-73	1309
3L-2S		MI	550	635	977	385	1020	297	1050	219	1105	81	1139	-40	1156

RECTANGULAR TIED COLUMNS 10" x 14"

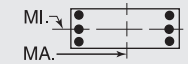
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.26	MA	752	544	1218	368	1263	310	1270	264	1251	195	1336	156	567
2E		MI	528	544	857	342	861	286	845	241	801	172	830	130	408
4-#7	1.71	MA	772	561	1270	377	1326	316	1347	268	1351	192	1449	147	740
2E		MI	538	561	885	351	892	291	880	242	846	164	876	114	517
4-#8	2.26	MA	795	582	1329	389	1400	324	1436	272	1465	188	1579	135	937
2E		MI	550	582	917	361	926	296	919	242	896	155	927	95	639
4-#9	2.86	MA	820	606	1392	401	1480	333	1532	277	1586	183	1713	121	1148
2E		MI	563	606	947	372	961	301	959	242	947	145	977	72	765
4-#10	3.63	MA	852	636	1472	418	1580	345	1653	284	1737	176	1879	102	1411
2E		MI	579	636	983	386	1002	308	1006	242	1008	130	1034	40	919
4-#11	4.46	MA	877	668	1544	432	1665	354	1746	286	1842	162	1968	69	1660
2E		MI	590	668	995	391	1012	306	1017	232	1023	104	1019	-13	1028

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 10" x 14"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

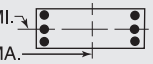
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.33	MA	756	546	1228	372	1277	313	1288	266	1278	197	1371	157	596
2L-3S		MI	522	546	834	346	835	292	815	246	763	175	789	108	428
6-#5	1.33	MA	739	546	1176	372	1211	316	1207	269	1169	198	1241	135	601
3L-2S		MI	530	546	864	346	873	290	859	244	819	173	854	131	425
6-#6	1.89	MA	781	568	1291	383	1356	321	1383	271	1404	193	1516	147	806
2L-3S		MI	532	568	857	356	861	298	845	248	801	167	830	82	566
6-#6	1.89	MA	758	568	1218	384	1263	325	1270	274	1251	195	1336	116	816
3L-2S		MI	544	568	899	357	913	296	905	246	878	165	917	114	557
6-#7	2.57	MA	812	595	1367	398	1451	331	1499	277	1554	188	1688	133	1056
2L-3S		MI	544	595	885	374	892	307	880	250	846	158	876	50	724
6-#7	2.57	MA	780	595	1270	399	1326	336	1347	281	1351	191	1449	90	1068
3L-2S		MI	560	595	941	371	960	304	958	247	946	155	988	91	711
6-#8	3.39	MA	806	626	1329	417	1400	350	1436	289	1465	186	1579	60	1355
3L-2S		MI	578	626	988	388	1012	313	1018	249	1023	142	1067	63	882
6-#9	4.29	MA	834	661	1392	437	1480	366	1532	298	1586	180	1713	24	1658
3L-2S		MI	597	661	1034	406	1064	322	1079	250	1102	127	1143	29	1061
6-#10	5.44	MA	868	706	1472	463	1580	386	1653	310	1737	171	1879	-22	1871
3L-2S		MI	621	706	1088	428	1128	334	1152	251	1195	106	1231	-18	1239
6-#11	6.69	MA	898	754	1544	486	1665	402	1746	316	1842	153	1968	-90	1947
3L-2S		MI	638	754	1106	439	1146	334	1173	239	1223	69	1216	-96	1266
8-#5	1.77	MA	761	564	1228	383	1277	323	1288	273	1278	197	1371	129	772
3E		MI	533	564	864	356	873	299	859	249	819	170	854	98	537
8-#5	1.77	MA	754	564	1187	387	1224	324	1224	273	1195	198	1278	119	779
4L-2S		MI	542	564	894	357	911	298	903	248	875	169	918	121	532
8-#6	2.51	MA	787	592	1291	399	1356	336	1383	281	1404	193	1516	106	1049
3E		MI	548	592	899	371	913	309	905	252	878	161	917	66	710
8-#6	2.51	MA	778	592	1234	404	1282	336	1293	280	1287	195	1386	93	1056
4L-2S		MI	560	592	941	373	965	307	965	250	954	159	1003	98	701
8-#7	3.43	MA	820	628	1367	420	1451	351	1499	290	1554	188	1688	77	1376
3E		MI	566	628	941	395	960	320	958	256	946	148	988	26	910
8-#7	3.43	MA	806	628	1290	426	1351	351	1377	289	1399	190	1515	59	1316
4L-2S		MI	581	628	997	392	1027	318	1037	253	1047	146	1101	68	898
8-#8	4.51	MA	840	670	1355	453	1432	370	1474	299	1527	184	1662	18	1603
4L-2S		MI	606	670	1060	416	1097	330	1118	256	1150	129	1206	31	1119
8-#9	5.71	MA	875	716	1424	482	1519	390	1580	310	1663	177	1815	-29	1815
4L-2S		MI	631	716	1120	440	1168	343	1200	259	1256	109	1309	-14	1315

RECTANGULAR TIED COLUMNS 10" x 16"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.10	MA	978	614	1570	425	1636	359	1648	307	1624	230	1763	191	662
2E		MI	598	614	968	387	970	324	948	274	893	198	924	153	421
4-#7	1.50	MA	1003	632	1633	435	1713	365	1741	311	1751	227	1913	184	869
2E		MI	609	632	996	395	1000	328	983	274	938	190	970	137	533
4-#8	1.98	MA	1032	653	1706	446	1804	373	1851	315	1900	225	2086	174	1108
2E		MI	621	653	1027	405	1034	333	1022	275	987	181	1020	118	658
4-#9	2.50	MA	1063	676	1784	459	1902	382	1970	320	2062	222	2270	164	1364
2E		MI	634	676	1057	415	1068	338	1061	275	1038	170	1069	94	788
4-#10	3.17	MA	1102	706	1884	475	2027	394	2120	326	2263	218	2497	149	1686
2E		MI	650	706	1093	429	1109	345	1109	274	1099	156	1125	63	945
4-#11	3.90	MA	1136	738	1977	490	2138	403	2253	331	2415	206	2648	123	1997
2E		MI	661	738	1105	433	1119	342	1118	263	1113	129	1109	8	1086
6-#5	1.16	MA	983	617	1580	429	1651	362	1668	309	1653	231	1805	192	696
2L-3S		MI	592	617	944	390	944	330	919	279	856	201	884	132	440
6-#5	1.16	MA	962	617	1518	430	1572	365	1571	312	1520	233	1637	170	702
3L-2S		MI	601	617	974	391	981	328	963	278	912	200	948	155	438
6-#6	1.65	MA	1014	639	1657	441	1748	370	1784	314	1811	228	1996	184	949
2L-3S		MI	602	639	968	400	970	336	948	281	893	194	924	105	581
6-#6	1.65	MA	985	639	1570	442	1636	375	1648	318	1624	231	1763	153	958
3L-2S		MI	614	639	1009	402	1021	334	1008	279	970	192	1010	137	574

RECTANGULAR TIED COLUMNS 10" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	2.25	MA	1051	665	1751	455	1864	380	1926	320	2002	225	2223	173	1251
2L-3S		MI	615	665	996	419	1000	344	983	283	938	184	970	72	743
6-#7	2.25	MA	1012	665	1633	458	1713	387	1741	325	1751	228	1913	131	1262
3L-2S		MI	630	665	1051	416	1068	342	1062	280	1038	181	1082	114	730
6-#8	2.96	MA	1044	697	1706	476	1804	401	1851	334	1900	225	2086	104	1611
3L-2S		MI	649	697	1099	432	1119	350	1121	282	1115	168	1159	85	905
6-#9	3.75	MA	1079	732	1784	496	1902	417	1970	343	2062	222	2270	74	1982
3L-2S		MI	668	732	1144	449	1172	359	1182	283	1193	153	1235	51	1088
6-#10	4.76	MA	1122	777	1884	523	2027	437	2120	356	2263	217	2497	33	2417
3L-2S		MI	692	777	1198	471	1235	370	1254	283	1286	132	1322	5	1309
6-#11	5.85	MA	1161	825	1977	546	2138	455	2253	365	2415	203	2648	-25	2635
3L-2S		MI	708	825	1216	481	1252	369	1274	270	1312	94	1305	-75	1347
8-#5	1.55	MA	988	634	1580	441	1651	373	1668	317	1653	231	1805	166	905
3E		MI	604	634	974	401	981	337	963	282	912	197	948	121	551
8-#5	1.55	MA	979	634	1532	445	1589	374	1591	317	1552	234	1686	155	913
4L-2S		MI	613	634	1004	402	1019	336	1007	281	968	196	1012	144	547
8-#6	2.20	MA	1021	663	1657	458	1748	386	1784	324	1811	229	1996	146	1239
3E		MI	619	663	1009	416	1021	347	1008	285	970	187	1010	90	729
8-#6	2.20	MA	1009	663	1589	463	1659	387	1676	325	1669	232	1830	131	1246
4L-2S		MI	631	663	1051	417	1073	345	1068	283	1047	185	1097	121	720
8-#7	3.00	MA	1061	699	1751	478	1864	401	1926	334	2002	226	2223	121	1636
3E		MI	637	699	1051	439	1068	358	1062	289	1038	174	1082	49	932
8-#7	3.00	MA	1045	699	1658	486	1745	403	1779	334	1812	229	2002	101	1598
4L-2S		MI	652	699	1107	436	1135	355	1140	286	1139	172	1194	91	920
8-#8	3.95	MA	1087	741	1739	513	1845	422	1900	346	1978	226	2200	65	1953
4L-2S		MI	676	741	1170	460	1205	368	1221	289	1242	155	1299	53	1144
8-#9	5.00	MA	1132	787	1825	543	1953	443	2030	358	2158	222	2409	23	2325
4L-2S		MI	702	787	1231	483	1276	380	1302	291	1347	135	1401	8	1378
8-#10	6.35	MA	1188	847	1934	581	2090	470	2195	373	2383	217	2668	-32	2660
4L-2S		MI	734	847	1303	513	1360	396	1400	292	1473	108	1519	-53	1541

RECTANGULAR TIED COLUMNS 10" x 18"

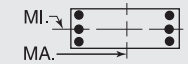
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.33	MA	1263	703	2036	492	2144	414	2180	353	2186	261	2424	219	999
2E		MI	680	703	1106	439	1108	366	1086	307	1030	217	1063	160	549
4-#8	1.76	MA	1297	724	2123	504	2252	422	2310	358	2363	259	2642	212	1279
2E		MI	692	724	1138	449	1142	371	1125	307	1079	207	1112	140	676
4-#9	2.22	MA	1335	747	2216	516	2369	431	2451	363	2555	256	2875	203	1580
2E		MI	704	747	1168	459	1176	375	1164	307	1129	196	1161	117	809
4-#10	2.82	MA	1382	777	2335	533	2517	443	2631	369	2799	252	3166	191	1960
2E		MI	720	777	1204	472	1217	382	1211	306	1190	181	1216	85	969
4-#11	3.47	MA	1424	809	2450	547	2655	452	2795	374	3021	246	3381	170	2334
2E		MI	731	809	1215	474	1225	377	1219	294	1202	154	1198	30	1116
6-#5	1.03	MA	1239	688	1973	486	2070	411	2092	352	2068	265	2285	226	796
2L-3S		MI	663	688	1055	435	1052	368	1023	312	948	228	978	155	452
6-#5	1.03	MA	1213	688	1900	488	1976	415	1978	355	1913	267	2079	204	802
3L-2S		MI	672	688	1085	436	1090	367	1067	311	1005	226	1042	178	451
6-#6	1.47	MA	1276	710	2064	498	2183	419	2229	356	2255	262	2522	220	1091
2L-3S		MI	673	710	1078	445	1078	374	1052	314	986	220	1017	129	596
6-#6	1.47	MA	1240	710	1962	500	2052	424	2069	361	2036	266	2236	189	1101
3L-2S		MI	685	710	1120	446	1130	372	1112	312	1063	218	1104	160	590
6-#7	2.00	MA	1320	736	2175	513	2322	429	2397	362	2482	259	2807	211	1445
2L-3S		MI	685	736	1106	463	1108	382	1086	316	1030	210	1063	95	761

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 10" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

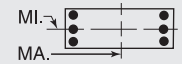
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	2.00	MA	1273	736	2036	516	2144	436	2180	369	2186	264	2424	169	1457
3L-2S		MI	701	736	1162	460	1176	379	1165	313	1130	207	1175	137	749
6-#8	2.63	MA	1312	768	2123	534	2252	451	2310	378	2363	261	2642	145	1867
3L-2S		MI	719	768	1209	476	1227	388	1224	314	1206	194	1252	108	927
6-#9	3.33	MA	1353	802	2216	555	2369	467	2451	388	2555	258	2875	118	2306
3L-2S		MI	738	802	1255	493	1280	396	1284	315	1284	178	1327	74	1113
6-#10	4.23	MA	1406	847	2335	582	2517	488	2631	401	2799	255	3166	82	2850
3L-2S		MI	762	847	1309	514	1342	407	1357	315	1377	157	1413	27	1338
6-#11	5.20	MA	1453	895	2450	606	2655	507	2795	411	3021	247	3381	31	3300
3L-2S		MI	779	895	1327	523	1359	405	1375	301	1401	119	1395	-53	1426
8-#5	1.38	MA	1244	705	1973	499	2070	422	2092	360	2068	266	2285	201	1039
3E		MI	675	705	1085	446	1090	376	1067	316	1005	224	1042	145	565
8-#5	1.38	MA	1233	705	1917	503	1997	423	2002	361	1951	269	2140	189	1047
4L-2S		MI	684	705	1115	447	1128	374	1110	314	1061	222	1107	167	561
8-#6	1.96	MA	1284	734	2064	516	2183	435	2229	368	2255	264	2522	183	1429
3E		MI	690	734	1120	460	1130	385	1112	319	1063	213	1104	113	746
8-#6	1.96	MA	1268	734	1985	522	2081	437	2103	369	2090	267	2321	167	1436
4L-2S		MI	701	734	1162	462	1181	383	1172	317	1139	211	1191	144	738
8-#7	2.67	MA	1332	769	2175	537	2322	451	2397	378	2482	261	2807	162	1895
3E		MI	707	769	1162	484	1176	396	1165	322	1130	200	1175	72	953
8-#7	2.67	MA	1311	769	2067	545	2182	453	2226	379	2259	266	2537	140	1889
4L-2S		MI	723	769	1218	481	1243	393	1243	319	1231	198	1287	114	941
8-#8	3.51	MA	1361	811	2163	572	2302	473	2369	391	2457	263	2787	107	2313
4L-2S		MI	747	811	1281	503	1313	405	1323	321	1334	181	1391	76	1169
8-#9	4.44	MA	1415	858	2267	603	2431	495	2526	404	2672	261	3054	69	2759
4L-2S		MI	773	858	1341	527	1383	417	1405	323	1438	161	1493	31	1406
8-#10	5.64	MA	1484	918	2397	642	2595	523	2723	421	2945	257	3386	19	3308
4L-2S		MI	804	918	1414	556	1468	433	1502	324	1564	133	1610	-31	1625
8-#11	6.93	MA	1547	982	2522	679	2745	548	2903	434	3192	248	3630	-48	3609
4L-2S		MI	827	982	1438	572	1492	433	1530	308	1601	84	1591	-136	1660
10-#10	7.06	MA	1521	988	2494	691	2710	569	2857	452	3092	249	3617	-53	3591
5L-2S		MI	847	988	1518	598	1593	458	1648	333	1751	109	1808	-89	1842

RECTANGULAR TIED COLUMNS 10" x 20"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.20	MA	1551	774	2479	550	2618	463	2662	396	2663	295	2982	253	1129
2E		MI	750	774	1217	483	1216	404	1189	340	1122	243	1156	183	564
4-#8	1.58	MA	1592	795	2580	561	2743	471	2813	400	2867	293	3246	247	1449
2E		MI	762	795	1248	493	1250	408	1227	340	1171	233	1205	163	694
4-#9	2.00	MA	1636	818	2689	574	2879	480	2977	405	3090	290	3529	240	1796
2E		MI	775	818	1278	502	1284	413	1266	339	1221	222	1253	139	829
4-#10	2.54	MA	1691	848	2826	590	3051	492	3186	412	3373	286	3883	231	2234
2E		MI	791	848	1314	515	1324	418	1313	338	1280	207	1308	107	993
4-#11	3.12	MA	1742	880	2963	605	3215	501	3381	417	3637	280	4165	213	2671
2E		MI	802	880	1325	516	1332	413	1320	326	1291	179	1288	52	1145
6-#6	1.32	MA	1566	780	2512	556	2663	468	2719	399	2740	296	3095	254	1234
2L-3S		MI	744	780	1189	490	1186	412	1155	347	1078	246	1111	152	609
6-#6	1.32	MA	1524	780	2394	558	2512	474	2534	405	2489	300	2755	223	1243
3L-2S		MI	756	780	1230	491	1238	410	1215	345	1155	244	1198	183	604
6-#7	1.80	MA	1618	807	2639	570	2823	478	2912	405	3002	293	3438	247	1640
2L-3S		MI	756	807	1217	507	1216	420	1189	349	1122	236	1156	118	778
6-#7	1.80	MA	1563	807	2479	574	2618	486	2662	412	2663	298	2982	205	1651
3L-2S		MI	772	807	1272	504	1284	417	1268	346	1222	233	1268	160	767
6-#8	2.37	MA	1608	838	2580	593	2743	501	2813	422	2867	296	3246	184	2123
3L-2S		MI	790	838	1320	520	1335	425	1327	347	1298	220	1345	131	948
6-#9	3.00	MA	1656	873	2689	614	2879	518	2977	432	3090	294	3529	159	2630
3L-2S		MI	809	873	1365	536	1387	434	1387	347	1375	204	1419	96	1137

RECTANGULAR TIED COLUMNS 10" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	3.81	MA	1718	918	2826	641	3051	539	3186	445	3373	291	3883	127	3262
3L-2S		MI	833	918	1419	557	1450	444	1459	347	1467	183	1505	49	1365
6-#11	4.68	MA	1775	966	2963	665	3215	558	3381	456	3637	284	4165	80	3880
3L-2S		MI	850	966	1437	565	1465	441	1475	332	1491	144	1484	-31	1504
8-#5	1.24	MA	1529	776	2406	557	2532	472	2560	403	2526	301	2811	235	1173
3E		MI	746	776	1195	491	1199	414	1170	349	1098	250	1137	168	578
8-#5	1.24	MA	1515	776	2342	561	2449	473	2458	404	2393	304	2641	222	1181
4L-2S		MI	754	776	1225	492	1236	412	1214	348	1154	249	1201	191	575
8-#6	1.76	MA	1575	805	2512	573	2663	485	2719	411	2740	298	3095	219	1619
3E		MI	760	805	1230	505	1238	422	1215	352	1155	240	1198	136	762
8-#6	1.76	MA	1555	805	2421	580	2546	487	2574	413	2553	303	2858	202	1626
4L-2S		MI	772	805	1272	506	1289	421	1275	350	1232	238	1285	167	754
8-#7	2.40	MA	1631	840	2639	595	2823	501	2912	421	3002	296	3438	200	2154
3E		MI	778	840	1272	528	1284	433	1268	355	1222	227	1268	95	973
8-#7	2.40	MA	1605	840	2516	603	2664	504	2717	423	2748	302	3119	177	2153
4L-2S		MI	793	840	1328	525	1351	431	1347	352	1323	224	1380	137	961
8-#8	3.16	MA	1663	882	2627	631	2802	524	2883	436	2978	300	3422	146	2684
4L-2S		MI	818	882	1391	547	1421	442	1426	354	1425	207	1484	99	1192
8-#9	4.00	MA	1726	929	2748	662	2952	546	3065	449	3228	298	3747	111	3205
4L-2S		MI	843	929	1452	570	1491	455	1507	355	1529	186	1585	53	1433
8-#10	5.08	MA	1806	988	2901	702	3143	575	3296	467	3546	296	4154	65	3847
4L-2S		MI	875	988	1524	599	1575	470	1605	356	1654	159	1702	-9	1706
8-#11	6.24	MA	1882	1052	3050	740	3323	601	3510	481	3841	288	4475	4	4459
4L-2S		MI	897	1052	1548	614	1599	469	1631	339	1690	109	1681	-114	1742
10-#10	6.35	MA	1850	1059	3015	752	3279	622	3454	500	3720	290	4432	-1	4431
5L-2S		MI	917	1059	1629	641	1700	495	1750	365	1841	135	1899	-67	1927

RECTANGULAR TIED COLUMNS 12" x 12"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.29	MA	660	561	1074	370	1104	312	1105	266	1071	193	1126	149	511
2L-3S		MI	647	561	1033	371	1051	314	1041	267	988	194	1032	127	515
6-#6	1.83	MA	680	582	1123	382	1165	319	1178	270	1162	187	1226	135	683
2L-3S		MI	662	582	1066	382	1092	322	1089	272	1049	189	1097	104	692
6-#7	2.50	MA	703	609	1182	396	1238	330	1264	274	1271	180	1342	116	884
2L-3S		MI	679	609	1105	396	1140	333	1145	277	1120	183	1174	74	897
6-#8	3.29	MA	729	640	1250	414	1324	342	1361	280	1395	172	1526	108	1114
2L-3S		MI	700	640	1151	413	1197	346	1209	283	1202	175	1294	47	1129
6-#9	4.17	MA	757	675	1323	433	1415	356	1462	285	1525	161	1672	84	1358
2L-3S		MI	722	675	1200	432	1257	361	1276	289	1287	166	1390	8	1371
6-#10	5.29	MA	791	720	1414	459	1530	374	1587	291	1684	147	1848	52	1659
2L-3S		MI	748	720	1261	457	1333	379	1358	297	1392	153	1506	-45	1450

RECTANGULAR TIED COLUMNS 12" x 14"

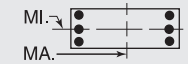
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#6	1.05	MA	891	643	1433	436	1479	367	1479	314	1441	235	1531	191	583
2E		MI	759	643	1224	423	1249	356	1241	305	1185	224	1237	177	503
4-#7	1.43	MA	911	660	1485	444	1542	373	1555	318	1539	232	1644	181	759
2E		MI	774	660	1264	431	1298	362	1297	307	1256	219	1313	164	647
4-#8	1.88	MA	934	681	1544	455	1615	381	1644	322	1653	227	1772	169	959
2E		MI	792	681	1310	442	1354	369	1360	310	1337	213	1433	158	809
4-#9	2.38	MA	959	705	1608	468	1695	390	1740	327	1774	222	1906	155	1174
2E		MI	810	705	1359	454	1414	378	1427	312	1422	205	1528	142	981
4-#10	3.02	MA	990	735	1688	484	1795	401	1861	333	1924	215	2071	136	1440
2E		MI	833	735	1419	470	1490	389	1509	316	1527	195	1643	120	1193

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 14"

Short columns – no sidesway
Bending on major or minor axis

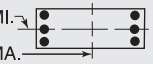


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	3.71	MA	1016	767	1760	497	1879	410	1952	335	2027	200	2158	103	1695
2E		MI	851	767	1469	482	1529	391	1552	311	1583	175	1680	80	1392
4-#14	5.36	MA	1086	843	1944	540	2110	440	2207	345	2352	177	2603	69	2306
2E		MI	902	843	1604	524	1673	412	1718	314	1795	143	1890	8	1861
6-#5	1.11	MA	895	646	1442	439	1492	370	1497	317	1468	237	1567	192	611
2L-3S		MI	749	646	1191	427	1209	362	1193	309	1126	227	1173	157	529
6-#5	1.11	MA	878	646	1390	440	1426	373	1417	319	1359	238	1437	171	616
3L-2S		MI	762	646	1232	427	1261	360	1257	308	1208	226	1267	179	525
6-#6	1.57	MA	920	667	1506	451	1571	378	1592	321	1593	233	1712	182	825
2L-3S		MI	763	667	1224	438	1249	370	1241	313	1185	222	1237	133	708
6-#6	1.57	MA	896	667	1433	452	1479	382	1479	324	1441	235	1531	151	834
3L-2S		MI	782	667	1281	438	1322	367	1330	312	1299	220	1366	164	700
6-#7	2.14	MA	950	694	1582	465	1666	388	1707	327	1743	228	1883	168	1079
2L-3S		MI	781	694	1264	452	1298	381	1297	318	1256	216	1313	103	918
6-#7	2.14	MA	919	694	1485	466	1542	394	1555	331	1539	231	1644	125	1092
3L-2S		MI	805	694	1341	452	1396	377	1415	316	1407	213	1482	145	905
6-#8	2.82	MA	985	725	1670	483	1777	401	1842	334	1915	222	2077	150	1370
2L-3S		MI	802	725	1310	468	1354	393	1360	324	1337	208	1433	76	1155
6-#8	2.82	MA	944	725	1544	484	1615	407	1644	339	1653	226	1772	94	1385
3L-2S		MI	831	725	1409	469	1481	389	1512	321	1531	204	1664	136	1138
6-#9	3.57	MA	1023	760	1766	502	1897	414	1987	342	2098	215	2281	129	1682
2L-3S		MI	823	760	1359	487	1414	408	1427	330	1422	198	1528	36	1403
6-#9	3.57	MA	972	760	1608	504	1695	422	1740	348	1774	219	1906	59	1695
3L-2S		MI	859	760	1482	488	1572	402	1613	326	1660	194	1810	113	1385
6-#10	4.54	MA	1070	805	1885	528	2047	432	2169	352	2325	205	2530	101	2070
2L-3S		MI	850	805	1419	511	1490	426	1509	337	1527	185	1643	-17	1642
6-#10	4.54	MA	1007	805	1688	529	1795	442	1861	359	1924	211	2071	12	2045
3L-2S		MI	893	805	1573	513	1686	420	1737	332	1819	180	1985	80	1690
6-#11	5.57	MA	1037	853	1760	551	1879	458	1952	364	2027	192	2158	-57	2147
3L-2S		MI	920	853	1647	536	1748	427	1807	327	1908	153	2048	23	1966
8-#5	1.48	MA	916	663	1494	450	1559	378	1578	322	1578	235	1698	186	783
2L-4S		MI	760	663	1199	441	1219	369	1205	313	1145	226	1198	140	678
8-#5	1.48	MA	899	663	1442	451	1492	381	1497	324	1468	237	1567	164	789
3E		MI	766	663	1232	438	1261	370	1257	314	1208	225	1267	148	671
8-#5	1.48	MA	892	663	1401	455	1440	381	1433	324	1384	238	1474	155	797
4L-2S		MI	779	663	1273	438	1314	367	1321	312	1291	223	1361	170	665
8-#6	2.10	MA	950	691	1578	466	1664	389	1705	328	1745	231	1892	172	1062
2L-4S		MI	778	691	1236	457	1263	380	1262	322	1212	220	1271	109	911
8-#6	2.10	MA	926	691	1506	467	1571	393	1592	331	1593	233	1712	141	1070
3E		MI	786	691	1281	453	1322	381	1330	320	1299	218	1366	120	900
8-#6	2.10	MA	916	691	1448	472	1497	393	1502	330	1477	235	1582	128	1081
4L-2S		MI	804	691	1339	453	1395	378	1419	318	1413	216	1495	151	891
8-#7	2.86	MA	958	727	1582	487	1666	409	1707	340	1743	227	1883	111	1403
3E		MI	811	727	1341	472	1396	396	1415	327	1407	210	1482	84	1169
8-#7	2.86	MA	945	727	1505	494	1567	409	1585	339	1587	230	1710	94	1392
4L-2S		MI	835	727	1417	473	1494	392	1533	324	1559	207	1651	126	1157
8-#8	3.76	MA	996	769	1670	511	1777	427	1842	351	1915	220	2077	75	1784
3E		MI	842	769	1409	496	1481	413	1512	335	1531	200	1664	55	1473
8-#8	3.76	MA	978	769	1570	520	1647	427	1682	349	1715	224	1856	53	1680
4L-2S		MI	870	769	1508	496	1608	409	1663	332	1724	196	1896	115	1460
8-#9	4.76	MA	1036	815	1766	538	1897	447	1987	363	2098	212	2281	33	2187
3E		MI	873	815	1482	522	1572	432	1613	343	1660	187	1810	7	1792
8-#9	4.76	MA	1014	815	1640	548	1734	446	1787	360	1851	217	2008	6	1989
4L-2S		MI	907	815	1605	523	1730	427	1799	339	1898	183	2091	84	1781
8-#10	6.05	MA	1087	875	1885	573	2047	474	2169	378	2325	201	2530	-23	2520
3E		MI	912	875	1573	555	1686	457	1737	353	1819	170	1985	-56	1899

RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

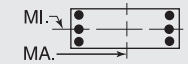
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.25	MA	1184	745	1912	513	1995	432	2016	369	2001	274	2172	225	888
2E		MI	876	745	1423	487	1455	410	1448	349	1393	252	1452	193	663
4-#8	1.65	MA	1213	766	1985	524	2086	440	2125	373	2149	271	2344	215	1130
2E		MI	894	766	1469	497	1511	417	1511	351	1473	245	1572	187	829
4-#9	2.08	MA	1244	790	2064	537	2184	448	2243	378	2310	268	2527	204	1390
2E		MI	912	790	1518	509	1571	425	1578	353	1558	238	1666	170	1004
4-#10	2.65	MA	1283	819	2164	553	2308	460	2393	384	2511	263	2753	189	1715
2E		MI	935	819	1578	524	1647	435	1659	356	1662	227	1780	148	1219
4-#11	3.25	MA	1318	852	2258	566	2419	468	2525	388	2661	252	2901	162	2032
2E		MI	953	852	1628	535	1685	436	1701	350	1716	207	1815	108	1423
4-#14	4.69	MA	1409	928	2491	609	2712	499	2880	405	3102	234	3385	114	2792
2E		MI	1004	928	1763	576	1828	457	1866	353	1927	174	2023	36	1901
6-#6	1.38	MA	1195	752	1936	520	2030	437	2059	372	2061	275	2255	225	968
2L-3S		MI	865	752	1383	494	1407	418	1393	355	1322	255	1377	162	724
6-#6	1.38	MA	1166	752	1849	521	1918	442	1922	377	1875	278	2022	194	977
3L-2S		MI	883	752	1440	494	1480	415	1482	353	1436	253	1506	193	717
6-#7	1.88	MA	1233	779	2030	534	2147	447	2200	378	2252	271	2482	214	1273
2L-3S		MI	882	779	1423	507	1455	428	1448	360	1393	249	1452	132	938
6-#7	1.88	MA	1193	779	1912	536	1995	454	2016	384	2001	275	2172	172	1286
3L-2S		MI	907	779	1499	508	1553	425	1567	357	1544	246	1621	174	925
6-#8	2.47	MA	1276	810	2139	552	2283	460	2365	385	2476	268	2743	201	1626
2L-3S		MI	902	810	1469	524	1511	441	1511	365	1473	241	1572	105	1179
6-#8	2.47	MA	1225	810	1985	554	2086	468	2125	392	2149	272	2344	145	1641
3L-2S		MI	933	810	1568	524	1638	436	1663	362	1667	237	1803	165	1161
6-#9	3.13	MA	1323	845	2257	571	2431	473	2544	393	2719	263	3019	185	2006
2L-3S		MI	925	845	1518	542	1571	454	1578	371	1558	231	1666	65	1432
6-#9	3.13	MA	1260	845	2064	574	2184	483	2243	401	2310	268	2527	114	2019
3L-2S		MI	961	845	1641	543	1729	449	1764	366	1795	226	1948	141	1412
6-#10	3.97	MA	1381	890	2405	597	2617	491	2770	403	3022	258	3362	163	2482
2L-3S		MI	952	890	1578	566	1647	472	1659	378	1662	218	1780	12	1741
6-#10	3.97	MA	1303	890	2164	600	2308	504	2393	413	2511	263	2753	73	2487
3L-2S		MI	995	890	1732	568	1843	467	1887	372	1954	212	2122	109	1720
6-#11	4.88	MA	1342	938	2258	623	2419	520	2525	422	2661	249	2901	14	2866
3L-2S		MI	1021	938	1806	589	1904	472	1956	367	2042	184	2183	51	2003
6-#14	7.03	MA	1443	1052	2491	689	2712	572	2880	451	3102	227	3385	-105	3336
3L-2S		MI	1098	1052	2008	654	2121	506	2206	373	2363	137	2501	-56	2519
8-#5	1.29	MA	1190	748	1921	519	2014	437	2041	373	2036	276	2233	229	917
2L-4S		MI	862	748	1358	497	1377	417	1357	354	1282	260	1338	169	692
8-#5	1.29	MA	1169	748	1859	520	1934	441	1943	376	1904	278	2065	207	923
3E		MI	867	748	1391	494	1419	418	1409	356	1345	258	1407	177	685
8-#5	1.29	MA	1160	748	1810	524	1871	441	1866	376	1803	281	1946	196	930
4L-2S		MI	880	748	1431	494	1471	416	1473	354	1428	257	1502	199	681
8-#6	1.83	MA	1232	776	2024	535	2142	448	2196	379	2247	273	2488	218	1252
2L-4S		MI	880	776	1394	513	1421	428	1414	364	1349	253	1411	138	930
8-#6	1.83	MA	1202	776	1936	537	2030	453	2059	383	2061	276	2255	187	1261
3E		MI	888	776	1440	509	1480	429	1482	362	1436	251	1506	149	919
8-#6	1.83	MA	1190	776	1868	542	1942	454	1951	384	1920	278	2090	172	1271
4L-2S		MI	906	776	1497	509	1553	426	1571	360	1550	250	1635	180	910
8-#7	2.50	MA	1242	812	2030	557	2147	469	2200	393	2252	272	2482	162	1663
3E		MI	913	812	1499	528	1553	443	1567	369	1544	243	1621	113	1192
8-#7	2.50	MA	1226	812	1938	564	2027	470	2053	393	2061	276	2261	142	1670
4L-2S		MI	937	812	1576	528	1651	439	1685	366	1695	240	1790	155	1179
8-#8	3.29	MA	1289	854	2139	582	2283	487	2365	404	2476	268	2743	131	2125
3E		MI	943	854	1568	551	1638	460	1663	376	1667	232	1803	83	1500

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

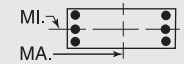
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#8	3.29	MA	1268	854	2018	591	2127	489	2174	404	2227	272	2458	105	2043
4L-2S		MI	972	854	1667	552	1765	456	1814	373	1860	229	2034	144	1486
8-#9	4.17	MA	1339	900	2257	609	2431	508	2544	416	2719	264	3019	95	2619
3E		MI	974	900	1641	577	1729	479	1764	384	1795	220	1948	36	1825
8-#9	4.17	MA	1313	900	2105	621	2235	509	2304	416	2407	269	2666	63	2426
4L-2S		MI	1009	900	1764	578	1887	474	1950	380	2033	215	2229	112	1810
8-#10	5.29	MA	1403	960	2405	644	2617	535	2770	432	3022	257	3362	47	3231
3E		MI	1013	960	1732	610	1843	504	1887	394	1954	202	2122	-28	2120
8-#10	5.29	MA	1369	960	2215	659	2371	536	2469	431	2631	263	2924	8	2894
4L-2S		MI	1055	960	1885	612	2040	498	2116	388	2245	196	2464	69	2211
10-#10	6.61	MA	1470	1030	2456	703	2680	568	2846	450	3143	257	3533	-18	3524
4L-3S		MI	1074	1030	1885	653	2040	535	2116	409	2245	187	2464	-67	2348

RECTANGULAR TIED COLUMNS 12" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.11	MA	1492	830	2388	582	2501	491	2529	420	2505	315	2756	266	1018
2E		MI	978	830	1582	542	1612	457	1600	390	1529	285	1591	222	679
4-#8	1.46	MA	1527	851	2475	593	2609	499	2659	424	2681	312	2973	258	1301
2E		MI	996	851	1628	552	1668	464	1663	392	1609	278	1710	215	847
4-#9	1.85	MA	1564	874	2569	606	2726	507	2800	429	2873	309	3205	249	1606
2E		MI	1014	874	1677	564	1728	471	1728	394	1693	270	1804	199	1025
4-#10	2.35	MA	1611	904	2688	622	2874	519	2979	435	3116	305	3494	238	1989
2E		MI	1037	904	1737	579	1803	482	1809	397	1796	260	1917	176	1244
4-#11	2.89	MA	1654	936	2804	635	3012	527	3142	439	3336	298	3707	215	2369
2E		MI	1054	936	1788	589	1841	482	1851	390	1849	239	1950	136	1453
4-#14	4.17	MA	1765	1013	3087	678	3366	557	3571	456	3908	288	4348	177	3278
2E		MI	1106	1013	1922	629	1984	502	2014	392	2059	206	2157	63	1938
4-#18	7.41	MA	2029	1206	3761	789	4215	636	4601	502	5199	248	5777	60	5431
2E		MI	1222	1206	2169	716	2270	543	2345	388	2485	107	2519	-156	2601
6-#6	1.22	MA	1505	837	2416	589	2541	496	2579	424	2574	316	2855	267	1110
2L-3S		MI	967	837	1542	550	1564	466	1545	397	1459	289	1517	191	738
6-#6	1.22	MA	1469	837	2313	591	2410	501	2418	429	2356	319	2569	236	1119
3L-2S		MI	985	837	1599	550	1637	463	1634	395	1573	287	1646	222	732
6-#7	1.67	MA	1550	863	2526	603	2679	506	2746	429	2801	312	3139	258	1468
2L-3S		MI	984	863	1582	563	1612	476	1600	401	1529	282	1591	161	956
6-#7	1.67	MA	1502	863	2388	606	2501	513	2529	436	2505	317	2756	216	1480
3L-2S		MI	1009	863	1658	563	1711	472	1718	399	1680	279	1760	203	944
6-#8	2.19	MA	1602	895	2656	621	2841	518	2942	436	3066	308	3468	248	1882
2L-3S		MI	1004	895	1628	579	1668	488	1663	406	1609	273	1710	133	1201
6-#8	2.19	MA	1541	895	2475	624	2609	528	2659	445	2681	314	2973	192	1897
3L-2S		MI	1035	895	1727	580	1795	483	1814	403	1802	270	1941	194	1183
6-#9	2.78	MA	1658	930	2796	640	3017	532	3155	444	3356	304	3818	235	2330
2L-3S		MI	1027	930	1677	597	1728	501	1728	412	1693	263	1804	93	1459
6-#9	2.78	MA	1582	930	2569	644	2726	544	2800	454	2873	311	3205	165	2343
3L-2S		MI	1063	930	1800	598	1886	496	1914	407	1931	259	2086	170	1437
6-#10	3.53	MA	1728	975	2973	666	3240	550	3425	455	3722	299	4256	218	2893
2L-3S		MI	1053	975	1737	620	1803	519	1809	418	1796	250	1917	40	1773
6-#10	3.53	MA	1635	975	2688	671	2874	564	2979	467	3116	307	3494	128	2899
3L-2S		MI	1097	975	1891	623	2000	513	2038	413	2088	244	2259	137	1749
6-#11	4.33	MA	1682	1023	2804	694	3012	582	3142	476	3336	299	3707	76	3438
3L-2S		MI	1123	1023	1965	643	2060	518	2105	407	2175	216	2318	79	2038
6-#14	6.25	MA	1806	1137	3087	761	3366	635	3571	508	3908	287	4348	-29	4325
3L-2S		MI	1200	1137	2167	707	2276	551	2355	413	2495	168	2635	-28	2645
8-#5	1.15	MA	1499	832	2397	588	2521	496	2556	424	2544	317	2824	270	1051
2L-4S		MI	964	832	1516	553	1534	465	1509	396	1420	293	1479	199	704
8-#5	1.15	MA	1473	832	2324	590	2428	500	2442	428	2389	320	2618	248	1057
3E		MI	969	832	1549	550	1577	466	1561	398	1483	292	1548	206	699

RECTANGULAR TIED COLUMNS 12" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#5	1.15	MA	1462	832	2267	594	2355	501	2352	428	2272	323	2474	236	1064
4L-2S		MI	982	832	1590	550	1629	464	1625	396	1565	290	1642	228	695
8-#6	1.63	MA	1548	861	2518	604	2673	507	2740	430	2793	314	3141	261	1442
2L-4S		MI	982	861	1553	569	1578	476	1566	405	1486	287	1551	167	947
8-#6	1.63	MA	1513	861	2416	606	2541	512	2579	435	2574	317	2855	230	1451
3E		MI	990	861	1599	565	1637	477	1634	403	1573	285	1646	178	936
8-#6	1.63	MA	1497	861	2336	612	2438	514	2453	436	2410	321	2653	214	1461
4L-2S		MI	1008	861	1656	565	1711	474	1723	401	1687	283	1774	209	928
8-#7	2.22	MA	1561	897	2526	627	2679	528	2746	445	2801	314	3139	208	1922
3E		MI	1015	897	1658	584	1711	491	1718	410	1680	276	1760	142	1213
8-#7	2.22	MA	1540	897	2419	635	2540	530	2575	446	2578	319	2869	187	1930
4L-2S		MI	1039	897	1735	584	1809	487	1836	407	1831	273	1929	184	1200
8-#8	2.93	MA	1617	939	2656	652	2841	547	2942	456	3066	311	3468	181	2467
3E		MI	1045	939	1727	606	1795	507	1814	417	1802	265	1941	112	1526
8-#8	2.93	MA	1590	939	2515	662	2659	550	2718	458	2776	317	3118	153	2419
4L-2S		MI	1074	939	1826	607	1922	503	1965	414	1996	262	2173	172	1510
8-#9	3.70	MA	1677	985	2796	679	3017	568	3155	469	3356	307	3818	150	3051
3E		MI	1076	985	1800	631	1886	526	1914	425	1931	252	2086	64	1856
8-#9	3.70	MA	1644	985	2619	692	2788	571	2874	471	2990	314	3384	115	2877
4L-2S		MI	1111	985	1923	633	2044	521	2100	421	2168	248	2367	141	1838
8-#10	4.70	MA	1754	1045	2973	715	3240	596	3425	486	3722	302	4256	108	3780
3E		MI	1115	1045	1891	664	2000	550	2038	434	2088	234	2259	1	2258
8-#10	4.70	MA	1713	1045	2750	731	2952	599	3071	487	3262	310	3715	65	3439
4L-2S		MI	1157	1045	2044	666	2196	545	2266	429	2380	229	2601	98	2243
8-#11	5.78	MA	1776	1109	2876	767	3102	623	3249	499	3507	300	3956	-3	3955
4L-2S		MI	1192	1109	2143	696	2279	554	2359	423	2500	193	2686	22	2609
10-#10	5.88	MA	1832	1115	3035	775	3317	630	3517	506	3869	304	4476	45	4277
4L-3S		MI	1176	1115	2044	708	2196	582	2266	450	2380	219	2601	-39	2597
10-#10	5.88	MA	1750	1115	2847	780	3067	645	3205	518	3409	301	3945	-7	3943
5L-2S		MI	1217	1115	2197	710	2393	576	2494	444	2672	213	2942	58	2731
12-#10	7.06	MA	1870	1185	3132	824	3432	676	3651	538	4016	296	4707	-27	4687
5L-3S		MI	1237	1185	2197	752	2393	613	2494	466	2672	204	2942	-78	2796

RECTANGULAR TIED COLUMNS 12" x 20"

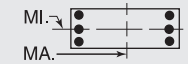
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.00	MA	1834	915	2912	651	3060	550	3095	472	3060	356	3396	306	1147
2E		MI	1080	915	1740	598	1770	505	1751	431	1665	318	1731	251	693
4-#8	1.32	MA	1875	936	3012	662	3185	558	3245	476	3264	353	3659	300	1471
2E		MI	1097	936	1786	608	1826	511	1814	433	1745	311	1849	244	865
4-#9	1.67	MA	1919	959	3122	675	3321	566	3409	480	3486	349	3940	293	1822
2E		MI	1116	959	1835	619	1885	518	1879	435	1828	303	1942	227	1045
4-#10	2.12	MA	1974	989	3260	691	3493	577	3617	487	3768	346	4294	283	2263
2E		MI	1139	989	1896	633	1960	528	1960	437	1931	292	2055	205	1267
4-#11	2.60	MA	2025	1021	3398	704	3656	586	3811	490	4030	339	4572	264	2706
2E		MI	1156	1021	1947	642	1997	528	2000	430	1982	270	2085	164	1482
4-#14	3.75	MA	2156	1098	3730	747	4073	616	4315	508	4714	330	5375	233	3764
2E		MI	1207	1098	2081	681	2139	547	2162	432	2191	237	2290	90	1974
4-#18	6.67	MA	2470	1291	4528	858	5078	695	5535	553	6361	308	7207	138	6295
2E		MI	1323	1291	2328	767	2424	587	2491	426	2615	137	2650	-130	2723
6-#6	1.10	MA	1849	922	2943	658	3105	555	3152	475	3138	356	3510	307	1253
2L-3S		MI	1069	922	1700	606	1722	514	1696	438	1596	322	1657	220	752
6-#6	1.10	MA	1807	922	2825	660	2954	561	2967	480	2887	361	3170	276	1262
3L-2S		MI	1087	922	1757	606	1795	511	1786	436	1710	320	1786	251	747

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 20"

Short columns – no sidesway
Bending on major or minor axis

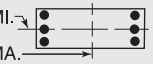


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.50	MA	1902	948	3071	672	3264	565	3344	481	3399	353	3852	300	1662
2L-3S		MI	1086	948	1740	619	1770	523	1751	443	1665	315	1731	190	972
6-#7	1.50	MA	1846	948	2912	675	3060	573	3095	488	3060	359	3396	258	1675
3L-2S		MI	1110	948	1817	619	1868	519	1869	440	1816	312	1900	232	961
6-#8	1.98	MA	1963	980	3221	690	3452	577	3571	488	3707	349	4249	292	2138
2L-3S		MI	1106	980	1786	634	1826	535	1814	448	1745	306	1849	162	1221
6-#8	1.98	MA	1891	980	3012	694	3185	587	3245	497	3264	356	3659	236	2153
3L-2S		MI	1137	980	1885	635	1953	531	1965	444	1938	303	2080	223	1204
6-#9	2.50	MA	2028	1015	3383	709	3656	591	3818	495	4042	345	4675	282	2654
2L-3S		MI	1128	1015	1835	652	1885	548	1879	453	1828	296	1942	122	1483
6-#9	2.50	MA	1939	1015	3122	714	3321	604	3409	507	3486	354	3940	212	2667
3L-2S		MI	1165	1015	1959	653	2043	543	2065	448	2066	291	2223	198	1461
6-#10	3.17	MA	2111	1059	3589	735	3915	609	4132	506	4468	340	5209	268	3305
2L-3S		MI	1155	1059	1896	675	1960	565	1960	459	1931	282	2055	68	1803
6-#10	3.17	MA	2001	1059	3260	741	3493	625	3617	520	3768	351	4294	179	3310
3L-2S		MI	1199	1059	2050	677	2157	560	2188	453	2223	276	2396	165	1777
6-#11	3.90	MA	2058	1108	3398	765	3656	643	3811	530	4030	343	4572	132	3943
3L-2S		MI	1225	1108	2124	696	2216	564	2254	446	2308	247	2453	107	2071
6-#14	5.63	MA	2205	1222	3730	833	4073	697	4315	563	4714	334	5375	38	5268
3L-2S		MI	1302	1222	2326	759	2432	596	2503	452	2627	199	2768	-1	2768
8-#5	1.03	MA	1842	917	2921	657	3081	555	3125	475	3102	358	3470	310	1185
2L-4S		MI	1066	917	1675	610	1692	513	1661	438	1557	326	1620	228	716
8-#5	1.03	MA	1812	917	2837	659	2974	559	2994	479	2924	361	3227	288	1191
3E		MI	1071	917	1707	607	1735	514	1713	440	1620	325	1689	236	712
8-#5	1.03	MA	1797	917	2773	664	2890	560	2891	480	2791	364	3057	276	1198
4L-2S		MI	1084	917	1748	607	1787	512	1777	438	1702	324	1783	258	709
8-#6	1.47	MA	1899	946	3061	673	3256	566	3336	482	3389	354	3850	303	1632
2L-4S		MI	1084	946	1711	625	1736	524	1718	447	1623	320	1691	196	962
8-#6	1.47	MA	1858	946	2943	675	3105	572	3152	487	3138	359	3510	272	1641
3E		MI	1092	946	1757	621	1795	524	1786	445	1710	318	1786	207	952
8-#6	1.47	MA	1838	946	2853	682	2987	574	3008	489	2950	363	3273	255	1651
4L-2S		MI	1110	946	1814	621	1868	522	1875	443	1824	316	1914	238	945
8-#7	2.00	MA	1914	981	3071	696	3264	588	3344	497	3399	356	3852	253	2181
3E		MI	1117	981	1817	639	1868	538	1869	451	1816	309	1900	171	1233
8-#7	2.00	MA	1888	981	2948	705	3105	590	3149	499	3145	362	3533	229	2189
4L-2S		MI	1141	981	1893	640	1966	534	1988	449	1967	306	2069	213	1220
8-#8	2.63	MA	1979	1023	3221	721	3452	607	3571	509	3707	353	4249	228	2808
3E		MI	1147	1023	1885	662	1953	555	1965	459	1938	298	2080	141	1550
8-#8	2.63	MA	1946	1023	3060	733	3244	610	3316	511	3374	360	3835	199	2801
4L-2S		MI	1176	1023	1984	662	2080	550	2116	455	2132	294	2311	201	1533
8-#9	3.33	MA	2050	1070	3383	749	3656	628	3818	522	4042	349	4675	201	3483
3E		MI	1178	1070	1959	686	2043	573	2065	466	2066	285	2223	93	1884
8-#9	3.33	MA	2009	1070	3181	763	3394	632	3497	524	3624	358	4159	163	3340
4L-2S		MI	1213	1070	2082	688	2201	568	2251	461	2304	280	2505	169	1865
8-#10	4.23	MA	2140	1130	3589	785	3915	656	4132	539	4468	345	5209	164	4329
3E		MI	1216	1130	2050	719	2157	597	2188	475	2223	267	2396	29	2294
8-#10	4.23	MA	2089	1130	3335	803	3585	661	3727	542	3941	355	4565	117	3998
4L-2S		MI	1259	1130	2203	721	2353	591	2416	469	2515	261	2738	126	2274
8-#11	5.20	MA	2165	1194	3485	839	3764	686	3940	555	4234	347	4883	55	4625
4L-2S		MI	1294	1194	2302	750	2435	600	2508	463	2633	225	2821	50	2646
8-#14	7.50	MA	2358	1347	3851	939	4223	757	4495	598	4999	338	5800	-75	5746
4L-2S		MI	1397	1347	2572	837	2724	644	2843	472	3063	162	3246	-93	3273
10-#10	5.29	MA	2228	1200	3663	847	4007	692	4242	561	4641	350	5480	102	4969
4L-3S		MI	1277	1200	2203	763	2353	628	2416	491	2515	251	2738	-10	2737
10-#10	5.29	MA	2133	1200	3449	853	3721	708	3885	575	4115	349	4842	51	4665
5L-2S		MI	1319	1200	2356	765	2550	623	2645	485	2807	246	3079	87	2764
12-#10	6.35	MA	2273	1270	3777	897	4143	740	4400	594	4815	343	5757	36	5626
5L-3S		MI	1338	1270	2356	806	2550	660	2645	506	2807	236	3079	-50	3073

RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

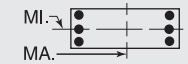
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.20	MA	2257	1021	3598	731	3813	616	3885	527	3896	393	4399	340	1642
2E		MI	1199	1021	1945	663	1983	558	1965	474	1881	344	1987	273	881
4-#9	1.52	MA	2308	1044	3723	744	3967	625	4072	532	4149	390	4732	334	2038
2E		MI	1218	1044	1994	673	2042	565	2030	476	1964	335	2080	256	1065
4-#10	1.92	MA	2372	1074	3881	760	4164	636	4309	538	4470	386	5150	327	2538
2E		MI	1241	1074	2055	688	2117	575	2110	478	2066	324	2192	233	1289
4-#11	2.36	MA	2431	1106	4041	773	4354	645	4534	542	4774	380	5495	311	3043
2E		MI	1258	1106	2106	695	2153	573	2149	470	2116	302	2220	191	1509
4-#14	3.41	MA	2584	1182	4422	816	4832	675	5113	559	5559	371	6462	285	4250
2E		MI	1309	1182	2240	734	2294	591	2310	471	2323	268	2423	118	2009
4-#18	6.06	MA	2948	1376	5344	927	5993	754	6521	604	7471	350	8705	206	7159
2E		MI	1425	1376	2487	818	2578	630	2637	463	2744	167	2780	-104	2842
6-#6	1.00	MA	2228	1007	3519	727	3721	614	3777	526	3752	397	4215	345	1395
2L-3S		MI	1171	1007	1859	662	1879	561	1848	480	1732	355	1797	249	765
6-#6	1.00	MA	2179	1007	3386	729	3550	620	3569	532	3469	402	3822	315	1404
3L-2S		MI	1189	1007	1916	662	1953	558	1937	478	1846	353	1926	280	761
6-#7	1.36	MA	2288	1033	3664	741	3902	624	3996	532	4048	394	4621	341	1856
2L-3S		MI	1188	1033	1899	674	1927	571	1903	484	1801	348	1870	219	988
6-#7	1.36	MA	2223	1033	3484	745	3671	632	3714	540	3665	400	4091	299	1869
3L-2S		MI	1212	1033	1976	675	2025	567	2021	481	1953	345	2039	261	978
6-#8	1.80	MA	2358	1065	3834	759	4115	636	4254	539	4397	390	5087	335	2394
2L-3S		MI	1208	1065	1945	690	1983	582	1965	489	1881	339	1987	191	1241
6-#8	1.80	MA	2275	1065	3598	764	3813	647	3885	549	3896	398	4399	279	2409
3L-2S		MI	1239	1065	2044	690	2110	578	2116	485	2074	335	2219	251	1224
6-#9	2.27	MA	2434	1099	4019	778	4347	650	4535	547	4778	386	5589	327	2978
2L-3S		MI	1230	1099	1994	707	2042	595	2030	493	1964	328	2080	150	1506
6-#9	2.27	MA	2331	1099	3723	784	3967	663	4072	559	4149	396	4732	256	2991
3L-2S		MI	1266	1099	2117	708	2200	590	2216	489	2201	324	2361	227	1484
6-#10	2.89	MA	2529	1144	4254	804	4642	668	4892	557	5264	381	6221	316	3716
2L-3S		MI	1257	1144	2055	729	2117	612	2110	499	2066	314	2192	96	1832
6-#10	2.89	MA	2402	1144	3881	811	4164	685	4309	573	4470	393	5150	226	3721
3L-2S		MI	1301	1144	2209	732	2313	606	2338	494	2358	309	2533	194	1803
6-#11	3.55	MA	2468	1192	4041	835	4354	703	4534	583	4774	386	5495	184	4448
3L-2S		MI	1327	1192	2283	749	2372	609	2403	486	2441	279	2588	134	2104
6-#14	5.11	MA	2638	1307	4422	904	4832	758	5113	617	5559	378	6462	98	6149
3L-2S		MI	1404	1307	2486	812	2587	640	2651	491	2759	230	2901	26	2812
8-#6	1.33	MA	2285	1031	3652	742	3892	624	3986	533	4035	395	4607	343	1822
2L-4S		MI	1186	1031	1870	681	1893	571	1870	489	1759	353	1831	225	977
8-#6	1.33	MA	2237	1031	3519	745	3721	631	3777	539	3752	400	4215	312	1831
3E		MI	1194	1031	1916	677	1953	572	1937	487	1846	351	1926	236	967
8-#6	1.33	MA	2214	1031	3417	752	3589	633	3616	541	3541	405	3943	294	1841
4L-2S		MI	1212	1031	1973	677	2026	569	2027	485	1960	349	2054	267	961
8-#7	1.82	MA	2302	1066	3664	766	3902	647	3996	549	4048	398	4621	295	2440
3E		MI	1219	1066	1976	695	2025	586	2021	493	1953	342	2039	200	1251
8-#7	1.82	MA	2270	1066	3526	775	3723	650	3777	551	3762	404	4252	271	2448
4L-2S		MI	1243	1066	2052	695	2123	582	2139	490	2104	339	2208	242	1240
8-#8	2.39	MA	2377	1108	3834	791	4115	667	4254	561	4397	395	5087	273	3149
3E		MI	1249	1108	2044	717	2110	602	2116	500	2074	331	2219	169	1573
8-#8	2.39	MA	2336	1108	3654	803	3881	671	3966	564	4023	403	4608	242	3143
4L-2S		MI	1278	1108	2143	718	2237	597	2268	496	2268	327	2450	230	1556
8-#9	3.03	MA	2458	1155	4019	819	4347	688	4535	574	4778	392	5589	248	3915
3E		MI	1279	1155	2117	741	2200	620	2216	507	2201	317	2361	121	1911
8-#9	3.03	MA	2408	1155	3792	834	4052	693	4173	578	4308	402	4990	209	3816
4L-2S		MI	1315	1155	2241	743	2358	615	2402	502	2439	313	2643	198	1891

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

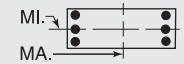
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	3.85	MA	2561	1215	4254	855	4642	716	4892	592	5264	387	6221	215	4877
3E		MI	1318	1215	2209	773	2313	643	2338	515	2358	299	2533	57	2326
8-#10	3.85	MA	2499	1215	3967	874	4271	722	4436	596	4670	400	5472	166	4570
4L-2S		MI	1361	1215	2362	775	2510	638	2567	510	2650	293	2875	154	2303
8-#11	4.73	MA	2587	1279	4143	911	4480	748	4684	610	5010	393	5868	109	5298
4L-2S		MI	1396	1279	2461	803	2591	645	2658	502	2767	256	2956	78	2682
8-#14	6.82	MA	2808	1431	4564	1013	5008	821	5323	655	5890	386	6976	-12	6964
4L-2S		MI	1499	1431	2731	889	2880	689	2991	511	3195	193	3379	-65	3401
10-#10	4.81	MA	2659	1285	4340	918	4748	754	5019	615	5463	394	6543	155	5675
4L-3S		MI	1379	1285	2362	817	2510	675	2567	531	2650	284	2875	18	2813
10-#10	4.81	MA	2550	1285	4099	925	4428	771	4618	631	4871	395	5796	104	5387
5L-2S		MI	1421	1285	2515	819	2706	669	2795	525	2942	278	3217	115	2796
10-#11	5.91	MA	2647	1365	4298	973	4665	807	4900	651	5248	386	6248	28	6142
5L-2S		MI	1465	1365	2639	857	2810	681	2912	519	3092	233	3323	21	3252
12-#10	5.77	MA	2710	1355	4472	969	4906	802	5202	650	5665	390	6867	93	6485
5L-3S		MI	1440	1355	2515	861	2706	706	2795	547	2942	268	3217	-21	3215
12-#10	5.77	MA	2632	1355	4224	987	4586	808	4804	654	5131	402	6184	36	6008
6L-2S		MI	1480	1355	2669	863	2903	701	3023	541	3233	262	3558	76	3284
14-#10	6.73	MA	2794	1425	4597	1030	5064	840	5387	673	5925	396	7255	25	7129
6L-3S		MI	1501	1425	2669	905	2903	738	3023	563	3233	253	3558	-61	3388

RECTANGULAR TIED COLUMNS 12" x 24"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.10	MA	2674	1106	4233	800	4493	675	4578	578	4579	434	5174	377	1813
2E		MI	1301	1106	2104	718	2140	605	2116	515	2016	376	2126	302	897
4-#9	1.39	MA	2732	1129	4372	812	4667	684	4787	583	4862	431	5565	374	2254
2E		MI	1320	1129	2153	728	2199	612	2181	517	2099	368	2218	284	1083
4-#10	1.76	MA	2804	1159	4550	829	4887	695	5053	589	5223	427	6062	369	2812
2E		MI	1343	1159	2214	742	2273	621	2260	518	2201	356	2329	261	1311
4-#11	2.17	MA	2872	1191	4732	842	5103	704	5310	593	5568	421	6475	355	3380
2E		MI	1360	1191	2265	749	2309	619	2298	509	2249	334	2355	219	1536
4-#14	3.13	MA	3046	1267	5162	885	5643	734	5963	610	6454	412	7608	334	4736
2E		MI	1411	1267	2400	787	2450	636	2459	510	2455	299	2557	145	2042
4-#18	5.56	MA	3462	1461	6208	996	6960	812	7560	656	8623	391	10267	269	8023
2E		MI	1527	1461	2646	869	2732	674	2783	501	2874	198	2910	-77	2959
6-#7	1.25	MA	2708	1118	4305	810	4592	682	4701	583	4747	435	5409	377	2051
2L-3S		MI	1290	1118	2058	730	2085	618	2054	525	1938	381	2009	248	1003
6-#7	1.25	MA	2635	1118	4104	814	4334	686	4386	591	4320	442	4817	336	2064
3L-2S		MI	1314	1118	2134	730	2183	614	2172	523	2089	378	2178	290	995
6-#8	1.65	MA	2788	1149	4496	827	4830	695	4989	590	5138	431	5949	373	2650
2L-3S		MI	1310	1149	2104	745	2140	629	2116	530	2016	372	2126	220	1259
6-#8	1.65	MA	2693	1149	4233	833	4493	706	4578	601	4579	440	5174	318	2665
3L-2S		MI	1340	1149	2203	746	2267	625	2267	526	2210	368	2357	280	1243
6-#9	2.08	MA	2873	1184	4703	847	5090	709	5304	598	5565	427	6540	368	3302
2L-3S		MI	1332	1184	2153	762	2199	642	2181	534	2099	361	2218	179	1528
6-#9	2.08	MA	2756	1184	4372	854	4667	723	4787	611	4862	438	5565	298	3315
3L-2S		MI	1368	1184	2276	763	2357	637	2367	530	2337	356	2499	255	1506
6-#10	2.65	MA	2982	1229	4966	873	5422	727	5705	608	6110	422	7289	361	4127
2L-3S		MI	1358	1229	2214	784	2273	658	2260	540	2201	347	2329	125	1858
6-#10	2.65	MA	2837	1229	4550	881	4887	745	5053	625	5223	435	6062	272	4133
3L-2S		MI	1403	1229	2368	786	2470	653	2489	534	2492	341	2670	222	1829
6-#11	3.25	MA	2913	1277	4732	905	5103	764	5310	636	5568	429	6475	232	4954
3L-2S		MI	1429	1277	2443	803	2528	655	2552	526	2574	311	2723	162	2135
6-#14	4.69	MA	3107	1392	5162	975	5643	819	5963	670	6454	422	7608	153	6896
3L-2S		MI	1506	1392	2645	864	2742	685	2799	530	2891	262	3035	53	2851

RECTANGULAR TIED COLUMNS 12" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#6	1.22	MA	2705	1116	4291	811	4579	683	4688	584	4732	436	5388	379	2012
2L-4S		MI	1288	1116	2029	737	2051	619	2021	530	1896	386	1971	255	990
8-#6	1.22	MA	2651	1116	4143	814	4389	686	4456	590	4416	441	4951	349	2021
3E		MI	1296	1116	2075	733	2110	620	2089	528	1983	384	2066	265	982
8-#6	1.22	MA	2623	1116	4030	821	4243	693	4277	593	4182	447	4652	331	2031
4L-2S		MI	1314	1116	2132	733	2183	617	2178	526	2097	382	2194	296	976
8-#7	1.67	MA	2723	1151	4305	835	4592	701	4701	600	4747	439	5409	333	2699
3E		MI	1321	1151	2134	751	2183	633	2172	534	2089	375	2178	229	1269
8-#7	1.67	MA	2686	1151	4152	845	4394	710	4457	604	4430	446	5002	309	2707
4L-2S		MI	1345	1151	2211	751	2281	629	2291	531	2240	372	2347	271	1258
8-#8	2.19	MA	2808	1193	4496	860	4830	726	4989	613	5138	436	5949	313	3490
3E		MI	1350	1193	2203	772	2267	649	2267	541	2210	363	2357	198	1594
8-#8	2.19	MA	2760	1193	4295	873	4570	731	4670	617	4722	445	5415	282	3484
4L-2S		MI	1380	1193	2302	773	2394	645	2419	537	2403	360	2589	259	1578
8-#9	2.78	MA	2900	1240	4703	888	5090	748	5304	626	5565	433	6540	292	4347
3E		MI	1381	1240	2276	796	2357	667	2367	548	2337	350	2499	150	1937
8-#9	2.78	MA	2841	1240	4451	904	4763	753	4902	631	5042	445	5865	252	4303
4L-2S		MI	1417	1240	2400	798	2515	662	2553	543	2574	345	2781	226	1916
8-#10	3.53	MA	3017	1299	4966	925	5422	776	5705	644	6110	430	7289	264	5426
3E		MI	1420	1299	2368	828	2470	690	2489	556	2492	331	2670	86	2357
8-#10	3.53	MA	2944	1299	4648	944	5009	783	5198	650	5449	443	6436	213	5156
4L-2S		MI	1463	1299	2521	830	2666	684	2717	550	2784	326	3012	183	2332
8-#11	4.33	MA	3043	1364	4848	982	5247	810	5481	665	5837	438	6910	159	5986
4L-2S		MI	1498	1364	2620	857	2747	691	2807	542	2900	288	3091	105	2717
8-#14	6.25	MA	3294	1516	5325	1085	5845	884	6203	711	6833	433	8212	46	7958
4L-2S		MI	1600	1516	2890	942	3035	734	3139	550	3327	224	3513	-38	3527
10-#10	4.41	MA	3124	1370	5065	988	5543	815	5850	669	6336	438	7662	205	6395
4L-3S		MI	1481	1370	2521	872	2666	721	2717	572	2784	316	3012	46	2847
10-#10	4.41	MA	3001	1370	4797	997	5187	833	5405	685	5678	440	6807	154	6044
5L-2S		MI	1523	1370	2674	874	2863	716	2945	566	3076	310	3354	143	2827
10-#11	5.42	MA	3112	1450	5026	1046	5459	869	5727	707	6109	432	7348	83	7001
5L-2S		MI	1566	1450	2798	911	2966	727	3061	558	3225	265	3458	48	3289
10-#14	7.81	MA	3391	1641	5575	1175	6143	970	6550	771	7215	424	8824	-67	8749
5L-2S		MI	1695	1641	3135	1020	3328	783	3480	570	3762	187	3991	-129	4026
12-#10	5.29	MA	3182	1440	5214	1040	5721	864	6057	704	6565	435	8034	146	7310
5L-3S		MI	1541	1440	2674	916	2863	753	2945	588	3076	300	3354	7	3331
12-#10	5.29	MA	3094	1440	4953	1046	5367	871	5616	710	5973	448	7254	87	6784
6L-2S		MI	1582	1440	2828	918	3059	747	3174	582	3368	295	3695	104	3317
12-#11	6.50	MA	3223	1536	5193	1121	5672	916	5977	736	6459	441	7872	0	7872
6L-2S		MI	1635	1536	2976	965	3185	763	3316	575	3551	242	3826	-9	3828
14-#10	6.17	MA	3277	1510	5370	1090	5901	902	6268	729	6860	443	8481	80	8041
6L-3S		MI	1602	1510	2828	959	3059	784	3174	603	3368	285	3695	-32	3692

RECTANGULAR TIED COLUMNS 14" x 14"

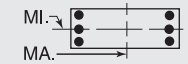
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#6	1.35	MA	1059	766	1720	518	1787	436	1801	371	1782	273	1907	217	843
2L-3S		MI	1035	766	1648	519	1694	440	1688	375	1630	275	1727	186	851
6-#7	1.84	MA	1089	793	1797	532	1882	446	1916	377	1931	268	2077	202	1100
2L-3S		MI	1057	793	1700	534	1757	451	1764	381	1728	270	1838	160	1113
6-#8	2.42	MA	1124	824	1886	550	1992	458	2050	383	2103	262	2271	185	1394
2L-3S		MI	1083	824	1759	551	1830	464	1852	389	1842	265	1966	129	1411
6-#9	3.06	MA	1161	859	1981	569	2112	471	2194	391	2286	254	2474	164	1709
2L-3S		MI	1111	859	1823	570	1910	479	1948	397	1962	259	2099	93	1727

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 14"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

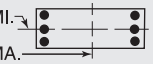
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	3.89	MA	1208	904	2101	594	2262	489	2376	401	2512	244	2722	135	2102
2L-3S		MI	1146	904	1904	595	2009	498	2068	408	2111	250	2263	46	2117
6-#11	4.78	MA	1247	952	2208	616	2390	504	2516	405	2670	223	2858	87	2471
2L-3S		MI	1175	952	1976	615	2093	513	2158	412	2213	230	2347	-23	2344
8-#6	1.80	MA	1088	790	1793	533	1879	447	1914	378	1935	271	2087	207	1081
2L-4S		MI	1055	790	1663	539	1713	451	1711	381	1666	275	1777	163	1101
8-#7	2.45	MA	1128	826	1894	553	2006	461	2068	386	2135	264	2316	189	1416
2L-4S		MI	1084	826	1720	561	1782	466	1794	389	1776	270	1904	129	1440
8-#8	3.22	MA	1175	868	2012	577	2154	477	2247	395	2365	257	2576	165	1801
2L-4S		MI	1117	868	1785	586	1863	484	1891	399	1903	264	2049	88	1764
8-#9	4.08	MA	1225	914	2139	603	2314	496	2441	406	2609	247	2848	138	2213
2L-4S		MI	1153	914	1855	615	1949	503	1995	409	2038	256	2200	40	2069

RECTANGULAR TIED COLUMNS 14" x 16"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#7	1.07	MA	1365	858	2191	592	2277	499	2290	427	2251	321	2430	265	906
2E		MI	1188	858	1915	579	1972	488	1972	418	1917	311	2033	251	793
4-#8	1.41	MA	1394	879	2265	603	2368	507	2399	431	2399	317	2602	256	1151
2E		MI	1211	879	1974	589	2046	495	2060	421	2030	306	2159	239	999
4-#9	1.79	MA	1425	903	2344	615	2466	515	2517	436	2559	314	2783	244	1413
2E		MI	1236	903	2039	601	2125	503	2155	425	2150	300	2292	224	1220
4-#10	2.27	MA	1464	933	2444	630	2590	526	2667	442	2759	309	3008	229	1742
2E		MI	1268	933	2119	616	2224	514	2275	431	2299	293	2455	205	1493
4-#11	2.79	MA	1499	965	2539	643	2700	534	2797	445	2907	297	3154	202	2066
2E		MI	1294	965	2192	627	2307	520	2365	431	2398	277	2537	170	1760
4-#14	4.02	MA	1590	1041	2773	685	2993	563	3151	461	3347	279	3636	153	2833
2E		MI	1364	1041	2377	668	2538	549	2617	441	2721	253	2978	136	2387
4-#18	7.14	MA	1800	1235	3324	794	3685	640	3953	498	4339	226	4668	8	4626
2E		MI	1524	1235	2803	776	3025	613	3166	458	3423	181	3709	-27	3714
6-#6	1.18	MA	1376	865	2215	599	2312	504	2334	431	2311	321	2514	266	985
2L-3S		MI	1174	865	1863	587	1910	498	1897	425	1820	315	1922	221	866
6-#6	1.18	MA	1347	865	2128	600	2200	509	2197	435	2125	324	2282	235	994
3L-2S		MI	1197	865	1935	586	2002	493	2010	422	1972	313	2102	252	859
6-#7	1.61	MA	1414	892	2309	613	2429	514	2475	437	2502	318	2741	255	1294
2L-3S		MI	1196	892	1915	601	1972	508	1972	431	1917	310	2033	195	1132
6-#7	1.61	MA	1374	892	2191	615	2277	521	2290	442	2251	321	2430	213	1307
3L-2S		MI	1228	892	2012	599	2097	503	2124	427	2120	308	2271	237	1119
6-#8	2.12	MA	1457	923	2418	630	2565	526	2639	443	2726	314	3001	241	1650
2L-3S		MI	1222	923	1974	618	2046	521	2060	438	2030	305	2159	164	1435
6-#8	2.12	MA	1406	923	2265	633	2368	535	2399	450	2399	318	2602	186	1667
3L-2S		MI	1262	923	2101	616	2208	515	2258	433	2292	301	2465	219	1417
6-#9	2.68	MA	1504	958	2537	649	2713	540	2818	451	2968	310	3276	225	2033
2L-3S		MI	1249	958	2039	636	2125	536	2155	446	2150	298	2292	128	1756
6-#9	2.68	MA	1441	958	2344	652	2466	550	2517	459	2559	314	2783	155	2051
3L-2S		MI	1300	958	2196	635	2327	528	2402	440	2473	293	2667	198	1736
6-#10	3.40	MA	1562	1003	2685	674	2899	557	3044	461	3270	303	3617	203	2513
2L-3S		MI	1284	1003	2119	661	2224	555	2275	457	2299	289	2455	80	2153
6-#10	3.40	MA	1484	1003	2444	678	2590	570	2667	471	2759	309	3008	114	2529
3L-2S		MI	1347	1003	2316	660	2477	545	2584	450	2699	283	2914	170	2132
6-#11	4.18	MA	1614	1051	2824	697	3066	572	3244	468	3499	287	3845	164	2977
2L-3S		MI	1314	1051	2192	680	2307	569	2365	460	2398	269	2537	11	2529
6-#11	4.18	MA	1523	1051	2539	699	2700	586	2797	478	2907	294	3154	54	2986
3L-2S		MI	1386	1051	2424	681	2604	559	2722	454	2855	262	3047	121	2508
6-#14	6.03	MA	1624	1166	2773	764	2993	636	3151	508	3347	272	3636	-66	3608
3L-2S		MI	1490	1166	2700	746	2952	605	3105	470	3344	227	3717	71	3416
8-#6	1.57	MA	1413	889	2303	614	2424	515	2471	438	2497	320	2747	259	1272
2L-4S		MI	1194	889	1878	607	1928	509	1919	431	1856	314	1972	198	1120

RECTANGULAR TIED COLUMNS 14" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#6	1.57	MA	1383	889	2215	616	2312	520	2334	442	2311	322	2514	228	1280
3E		MI	1203	889	1935	602	2002	508	2010	431	1972	313	2102	211	1109
8-#6	1.57	MA	1371	889	2147	621	2224	521	2225	442	2170	325	2349	213	1292
4L-2S		MI	1227	889	2007	601	2095	504	2123	428	2124	311	2282	242	1100
8-#7	2.14	MA	1462	925	2427	634	2580	529	2659	446	2753	315	3051	245	1675
2L-4S		MI	1222	925	1935	628	1997	523	2002	439	1965	309	2099	164	1465
8-#7	2.14	MA	1423	925	2309	636	2429	536	2475	451	2502	319	2741	203	1687
3E		MI	1236	925	2012	621	2097	523	2124	440	2120	307	2271	181	1451
8-#7	2.14	MA	1407	925	2217	643	2309	537	2328	451	2311	322	2520	183	1699
4L-2S		MI	1267	925	2109	620	2222	518	2276	436	2323	304	2510	223	1438
8-#8	2.82	MA	1520	967	2572	657	2762	546	2880	455	3053	310	3400	227	2142
2L-4S		MI	1256	967	2000	653	2078	541	2099	448	2092	303	2243	122	1831
8-#8	2.82	MA	1470	967	2418	660	2565	554	2639	462	2726	315	3001	171	2155
3E		MI	1273	967	2101	645	2208	541	2258	450	2292	300	2465	145	1841
8-#8	2.82	MA	1449	967	2298	669	2409	555	2448	462	2477	319	2716	146	2128
4L-2S		MI	1313	967	2227	644	2370	534	2456	445	2553	296	2770	200	1827
8-#9	3.57	MA	1582	1013	2729	684	2959	565	3118	466	3377	305	3769	206	2645
2L-4S		MI	1291	1013	2070	681	2164	560	2203	459	2226	295	2393	75	2144
8-#9	3.57	MA	1520	1013	2537	687	2713	575	2818	474	2968	310	3276	135	2656
3E		MI	1313	1013	2196	671	2327	561	2402	461	2473	291	2667	102	2257
8-#9	3.57	MA	1494	1013	2385	699	2517	576	2578	474	2656	315	2923	104	2520
4L-2S		MI	1363	1013	2354	670	2529	553	2649	455	2797	286	3041	172	2242
8-#10	4.54	MA	1584	1073	2685	722	2899	601	3044	490	3270	303	3617	87	3278
3E		MI	1364	1073	2316	705	2477	586	2584	476	2699	279	2914	46	2771
8-#10	4.54	MA	1551	1073	2495	736	2653	602	2742	489	2879	309	3179	48	2999
4L-2S		MI	1426	1073	2514	704	2730	577	2892	469	3100	273	3373	135	2760
8-#11	5.57	MA	1639	1137	2824	753	3066	624	3244	502	3499	284	3845	16	3801
3E		MI	1413	1137	2424	734	2604	607	2722	483	2855	253	3047	-39	3039
10-#10	5.67	MA	1651	1143	2736	780	2962	634	3119	508	3391	303	3788	22	3703
4L-3S		MI	1444	1143	2514	749	2730	618	2892	495	3100	269	3373	11	3345

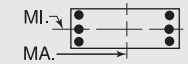
RECTANGULAR TIED COLUMNS 14" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.25	MA	1756	978	2827	683	2967	575	3007	491	3000	365	3304	305	1321
2E		MI	1350	978	2190	656	2261	552	2269	471	2218	346	2353	273	1018
4-#9	1.59	MA	1793	1002	2921	695	3084	584	3148	496	3191	362	3535	296	1629
2E		MI	1375	1002	2254	667	2340	560	2363	475	2337	340	2485	259	1241
4-#10	2.02	MA	1841	1032	3041	711	3232	594	3327	502	3433	358	3823	284	2016
2E		MI	1406	1032	2335	682	2439	570	2483	480	2486	332	2646	239	1518
4-#11	2.48	MA	1883	1064	3158	723	3368	602	3488	505	3651	350	4032	261	2403
2E		MI	1433	1064	2408	692	2522	576	2571	479	2583	315	2726	204	1790
4-#14	3.57	MA	1994	1140	3441	765	3723	632	3917	521	4222	339	4672	222	3319
2E		MI	1503	1140	2593	732	2751	604	2822	488	2905	291	3166	169	2424
4-#18	6.35	MA	2260	1334	4117	875	4571	709	4945	565	5510	298	6096	105	5490
2E		MI	1663	1334	3020	839	3237	666	3369	504	3604	218	3893	6	3870
6-#6	1.05	MA	1734	964	2767	679	2899	573	2928	491	2894	369	3187	314	1128
2L-3S		MI	1312	964	2078	654	2125	555	2106	475	2009	355	2117	256	881
6-#6	1.05	MA	1699	964	2664	681	2767	579	2768	496	2676	373	2901	283	1136
3L-2S		MI	1336	964	2150	653	2218	551	2219	472	2161	353	2297	287	875
6-#7	1.43	MA	1779	991	2878	693	3037	583	3095	496	3120	365	3471	305	1488
2L-3S		MI	1334	991	2130	668	2188	566	2181	481	2106	350	2227	230	1150
6-#7	1.43	MA	1731	991	2739	696	2859	590	2878	503	2825	370	3088	263	1501
3L-2S		MI	1366	991	2227	667	2312	560	2333	477	2309	347	2466	272	1138

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 18"

Short columns – no sidesway
Bending on major or minor axis

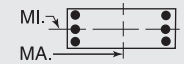


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.88	MA	1831	1022	3008	710	3199	595	3290	503	3385	361	3798	294	1906
2L-3S		MI	1360	1022	2190	684	2261	578	2269	488	2218	344	2353	199	1457
6-#8	1.88	MA	1770	1022	2827	714	2967	604	3007	511	3000	367	3304	239	1923
3L-2S		MI	1401	1022	2316	683	2423	572	2466	483	2480	341	2658	254	1439
6-#9	2.38	MA	1887	1057	3148	730	3374	608	3503	511	3673	357	4148	281	2357
2L-3S		MI	1388	1057	2254	703	2340	592	2363	496	2337	337	2485	162	1783
6-#9	2.38	MA	1811	1057	2921	734	3084	620	3148	521	3191	364	3535	211	2375
3L-2S		MI	1439	1057	2412	702	2542	584	2610	490	2661	333	2859	233	1761
6-#10	3.02	MA	1958	1102	3326	755	3597	626	3773	521	4039	352	4584	264	2925
2L-3S		MI	1423	1102	2335	727	2439	611	2483	506	2486	328	2646	115	2185
6-#10	3.02	MA	1864	1102	3041	760	3232	640	3327	533	3433	360	3823	174	2940
3L-2S		MI	1486	1102	2532	726	2692	601	2791	499	2886	322	3106	204	2160
6-#11	3.71	MA	2021	1150	3497	777	3804	641	4019	528	4373	343	4909	232	3482
2L-3S		MI	1453	1150	2408	745	2522	624	2571	509	2583	307	2726	45	2570
6-#11	3.71	MA	1911	1150	3158	782	3368	657	3488	541	3651	351	4032	122	3492
3L-2S		MI	1525	1150	2640	746	2819	614	2929	502	3041	300	3237	154	2543
6-#14	5.36	MA	2035	1265	3441	849	3723	709	3917	572	4222	338	4672	16	4629
3L-2S		MI	1629	1265	2916	810	3166	660	3310	518	3528	265	3904	104	3459
8-#6	1.40	MA	1778	988	2870	694	3031	584	3089	498	3113	367	3474	308	1462
2L-4S		MI	1332	988	2093	674	2144	566	2128	481	2045	354	2167	233	1137
8-#6	1.40	MA	1742	988	2767	697	2899	590	2928	502	2894	371	3187	277	1471
3E		MI	1342	988	2150	670	2218	566	2219	482	2161	352	2297	246	1126
8-#6	1.40	MA	1726	988	2687	703	2796	591	2802	503	2730	374	2986	261	1482
4L-2S		MI	1365	988	2222	669	2310	562	2332	478	2313	351	2477	277	1118
8-#7	1.90	MA	1837	1024	3017	714	3215	598	3312	505	3415	363	3853	297	1935
2L-4S		MI	1361	1024	2150	695	2213	580	2211	489	2154	349	2293	199	1487
8-#7	1.90	MA	1790	1024	2878	717	3037	605	3095	512	3120	368	3471	255	1946
3E		MI	1374	1024	2227	689	2312	580	2333	490	2309	347	2466	216	1472
8-#7	1.90	MA	1769	1024	2770	725	2898	607	2924	513	2897	372	3201	234	1958
4L-2S		MI	1406	1024	2324	687	2437	575	2485	486	2512	344	2705	258	1459
8-#8	2.51	MA	1906	1066	3189	738	3431	615	3573	515	3770	358	4293	283	2484
2L-4S		MI	1394	1066	2215	720	2293	598	2307	498	2280	343	2437	157	1883
8-#8	2.51	MA	1846	1066	3008	741	3199	624	3290	523	3385	364	3798	228	2497
3E		MI	1412	1066	2316	712	2423	598	2466	500	2480	339	2658	179	1867
8-#8	2.51	MA	1819	1066	2867	752	3017	626	3067	524	3094	370	3449	200	2502
4L-2S		MI	1452	1066	2442	710	2585	591	2664	495	2742	336	2963	235	1851
8-#9	3.17	MA	1981	1112	3375	764	3665	633	3858	526	4156	353	4761	267	3077
2L-4S		MI	1430	1112	2286	747	2379	616	2411	508	2414	335	2586	109	2230
8-#9	3.17	MA	1906	1112	3148	768	3374	645	3503	536	3673	360	4148	196	3088
3E		MI	1452	1112	2412	737	2542	617	2610	511	2661	330	2859	137	2288
8-#9	3.17	MA	1873	1112	2972	782	3146	647	3222	537	3308	367	3714	162	2986
4L-2S		MI	1502	1112	2570	736	2744	609	2857	505	2985	326	3234	207	2270
8-#10	4.03	MA	1983	1172	3326	804	3597	672	3773	552	4039	355	4584	155	3827
3E		MI	1503	1172	2532	771	2692	642	2791	525	2886	318	3106	80	2808
8-#10	4.03	MA	1942	1172	3103	820	3309	675	3419	553	3580	363	4044	111	3561
4L-2S		MI	1565	1172	2729	770	2945	633	3100	518	3287	312	3565	169	2792
8-#11	4.95	MA	2052	1236	3497	836	3804	696	4019	565	4373	344	4909	93	4542
3E		MI	1546	1236	2640	799	2819	663	2929	531	3041	292	3237	-5	3297
8-#11	4.95	MA	2005	1236	3231	855	3459	698	3596	564	3822	352	4282	43	4103
4L-2S		MI	1616	1236	2871	800	3116	653	3286	524	3498	285	3747	105	3283
10-#10	5.04	MA	2061	1242	3388	864	3674	706	3865	572	4186	357	4805	92	4396
4L-3S		MI	1583	1242	2729	815	2945	674	3100	544	3287	308	3565	45	3425
10-#10	5.04	MA	1979	1242	3200	869	3424	721	3553	585	3726	354	4274	39	4151
5L-2S		MI	1644	1242	2926	814	3197	664	3408	538	3688	302	4025	134	3417
10-#11	6.19	MA	2147	1323	3570	908	3894	737	4127	588	4545	345	5158	14	5100
4L-3S		MI	1645	1323	2871	853	3116	701	3286	554	3498	277	3747	-55	3733
12-#10	6.05	MA	2099	1313	3485	913	3790	752	3999	604	4333	349	5035	19	4972
5L-3S		MI	1662	1313	2926	859	3197	706	3408	564	3688	298	4025	10	3996

RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

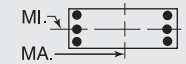
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.13	MA	2158	1077	3445	764	3626	644	3678	551	3660	413	4071	352	1492
2E		MI	1489	1077	2405	723	2476	609	2477	521	2407	385	2547	308	1035
4-#9	1.43	MA	2202	1101	3555	775	3762	652	3841	555	3881	409	4352	345	1845
2E		MI	1514	1101	2470	733	2555	616	2571	524	2525	379	2678	293	1261
4-#10	1.81	MA	2258	1131	3694	791	3935	663	4049	561	4163	405	4705	335	2291
2E		MI	1545	1131	2550	748	2654	626	2690	529	2673	371	2838	273	1541
4-#11	2.23	MA	2308	1163	3833	804	4098	671	4242	564	4422	398	4979	316	2740
2E		MI	1572	1163	2624	757	2736	631	2777	528	2769	354	2916	238	1819
4-#14	3.21	MA	2440	1239	4166	846	4514	700	4744	581	5105	388	5780	284	3805
2E		MI	1641	1239	2809	796	2965	658	3027	536	3089	329	3354	202	2460
4-#18	5.71	MA	2754	1433	4966	955	5518	777	5962	625	6749	365	7607	188	6354
2E		MI	1802	1433	3237	901	3450	719	3572	550	3786	255	4077	38	3922
6-#7	1.29	MA	2185	1090	3503	774	3706	651	3777	556	3796	413	4266	353	1683
2L-3S		MI	1473	1090	2345	735	2403	623	2389	531	2295	390	2422	265	1167
6-#7	1.29	MA	2128	1090	3344	777	3502	659	3528	563	3457	419	3810	311	1696
3L-2S		MI	1505	1090	2442	734	2528	617	2541	527	2498	387	2660	307	1156
6-#8	1.69	MA	2246	1121	3653	791	3893	664	4003	563	4103	409	4662	344	2162
2L-3S		MI	1499	1121	2405	751	2476	635	2477	538	2407	384	2547	233	1477
6-#8	1.69	MA	2173	1121	3445	795	3626	674	3678	572	3660	416	4071	289	2179
3L-2S		MI	1540	1121	2531	750	2638	629	2674	532	2668	380	2852	289	1460
6-#9	2.14	MA	2312	1156	3816	810	4097	677	4250	570	4437	405	5087	334	2681
2L-3S		MI	1527	1156	2470	769	2555	649	2571	545	2525	376	2678	197	1807
6-#9	2.14	MA	2222	1156	3555	815	3762	690	3841	582	3881	413	4352	264	2699
3L-2S		MI	1577	1156	2627	768	2757	641	2818	539	2849	372	3052	267	1785
6-#10	2.72	MA	2395	1201	4023	835	4356	695	4563	581	4863	400	5620	320	3336
2L-3S		MI	1561	1201	2550	793	2654	667	2690	555	2673	367	2838	149	2215
6-#10	2.72	MA	2284	1201	3694	842	3935	710	4049	595	4163	410	4705	231	3352
3L-2S		MI	1624	1201	2748	792	2907	658	2998	548	3073	361	3298	238	2188
6-#11	3.34	MA	2471	1249	4227	857	4602	710	4857	588	5260	391	6044	293	3988
2L-3S		MI	1591	1249	2624	810	2736	679	2777	557	2769	345	2916	78	2608
6-#11	3.34	MA	2340	1249	3833	864	4098	728	4242	604	4422	402	4979	184	3997
3L-2S		MI	1663	1249	2856	811	3033	670	3135	550	3226	338	3426	188	2577
6-#14	4.82	MA	2487	1364	4166	932	4514	781	4744	636	5105	392	5780	89	5515
3L-2S		MI	1768	1364	3133	874	3379	714	3515	566	3713	303	4092	137	3501
8-#6	1.26	MA	2183	1087	3493	775	3698	653	3769	557	3786	415	4265	356	1652
2L-4S		MI	1471	1087	2307	742	2359	624	2337	531	2234	394	2362	268	1152
8-#6	1.26	MA	2141	1087	3375	777	3547	659	3585	563	3535	419	3925	325	1661
3E		MI	1480	1087	2365	737	2433	624	2428	532	2351	392	2492	281	1142
8-#6	1.26	MA	2121	1087	3284	784	3429	661	3441	564	3348	423	3688	308	1672
4L-2S		MI	1504	1087	2437	736	2526	620	2541	529	2503	390	2673	312	1135
8-#7	1.71	MA	2252	1123	3663	794	3911	666	4027	565	4136	410	4722	348	2194
2L-4S		MI	1500	1123	2365	762	2428	638	2419	539	2343	389	2487	234	1508
8-#7	1.71	MA	2197	1123	3503	798	3706	674	3777	572	3796	416	4266	305	2206
3E		MI	1513	1123	2442	756	2528	638	2541	540	2498	386	2660	251	1492
8-#7	1.71	MA	2171	1123	3380	807	3547	677	3582	574	3542	422	3947	282	2217
4L-2S		MI	1544	1123	2539	755	2653	632	2694	536	2701	384	2899	293	1479
8-#8	2.26	MA	2333	1165	3862	818	4161	683	4329	575	4546	406	5253	337	2825
2L-4S		MI	1533	1165	2431	787	2508	655	2515	548	2468	382	2630	192	1910
8-#8	2.26	MA	2262	1165	3653	823	3893	693	4003	584	4103	413	4662	281	2838
3E		MI	1550	1165	2531	778	2638	655	2674	549	2668	379	2852	214	1891
8-#8	2.26	MA	2229	1165	3493	834	3685	697	3748	586	3770	420	4248	251	2843
4L-2S		MI	1591	1165	2658	777	2800	648	2872	544	2930	375	3157	269	1875
8-#9	2.86	MA	2421	1211	4078	845	4433	702	4659	586	4994	400	5822	323	3509
2L-4S		MI	1569	1211	2501	814	2594	673	2618	557	2602	374	2779	144	2297

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

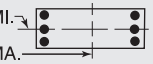
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.86	MA	2333	1211	3816	850	4097	715	4250	597	4437	409	5087	253	3520
3E		MI	1591	1211	2627	804	2757	674	2818	560	2849	369	3052	171	2316
8-#9	2.86	MA	2292	1211	3615	864	3836	718	3929	600	4019	418	4571	216	3466
4L-2S		MI	1641	1211	2785	803	2959	666	3064	554	3173	365	3427	241	2297
8-#10	3.63	MA	2423	1271	4023	886	4356	742	4563	614	4863	404	5620	216	4375
3E		MI	1641	1271	2748	837	2907	699	2998	574	3073	357	3298	114	2842
8-#10	3.63	MA	2372	1271	3768	903	4027	747	4159	617	4336	415	4975	170	4138
4L-2S		MI	1704	1271	2945	836	3159	689	3307	568	3474	351	3757	203	2823
8-#11	4.46	MA	2505	1335	4227	918	4602	766	4857	627	5260	395	6044	161	5216
3E		MI	1685	1335	2856	864	3033	718	3135	579	3226	330	3426	29	3340
8-#11	4.46	MA	2448	1335	3920	939	4206	771	4370	629	4626	406	5290	107	4781
4L-2S		MI	1755	1335	3087	865	3330	709	3492	573	3683	323	3937	138	3320
8-#14	6.43	MA	2641	1488	4288	1038	4664	841	4924	671	5390	396	6205	-24	6191
4L-2S		MI	1894	1488	3456	952	3793	770	4003	596	4336	278	4831	72	4525
10-#10	4.54	MA	2511	1341	4097	947	4448	778	4673	636	5036	409	5891	155	5105
4L-3S		MI	1721	1341	2945	881	3159	730	3307	593	3474	347	3757	79	3463
10-#10	4.54	MA	2415	1341	3882	953	4163	794	4317	650	4510	409	5253	103	4870
5L-2S		MI	1783	1341	3142	880	3412	721	3615	587	3875	342	4217	169	3450
10-#11	5.57	MA	2613	1422	4314	993	4710	809	4986	653	5463	399	6354	84	5940
4L-3S		MI	1783	1422	3087	918	3330	757	3492	602	3683	315	3937	-21	3932
12-#10	5.44	MA	2555	1412	4211	997	4584	825	4831	669	5210	403	6168	88	5836
5L-3S		MI	1801	1412	3142	925	3412	762	3615	613	3875	337	4217	44	4079

RECTANGULAR TIED COLUMNS 14" x 22"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.03	MA	2600	1177	4120	844	4347	713	4410	611	4378	460	4903	399	1663
2E		MI	1627	1177	2620	789	2691	666	2685	570	2595	425	2740	343	1052
4-#9	1.30	MA	2651	1200	4245	856	4502	721	4596	615	4630	457	5235	393	2061
2E		MI	1652	1200	2685	800	2770	673	2779	574	2713	418	2870	328	1281
4-#10	1.65	MA	2715	1230	4403	872	4699	732	4833	621	4951	453	5652	385	2565
2E		MI	1684	1230	2766	814	2869	683	2897	578	2860	410	3030	307	1564
4-#11	2.03	MA	2774	1262	4565	884	4888	739	5057	624	5252	446	5993	368	3076
2E		MI	1710	1262	2840	822	2950	686	2983	576	2954	392	3105	271	1846
4-#14	2.92	MA	2927	1338	4947	926	5366	769	5634	641	6035	436	6957	342	4291
2E		MI	1780	1338	3026	861	3179	713	3233	584	3273	367	3542	236	2495
4-#18	5.19	MA	3292	1532	5872	1036	6526	846	7040	685	7944	414	9195	263	7218
2E		MI	1940	1532	3453	964	3662	772	3775	597	3967	292	4261	70	3972
6-#7	1.17	MA	2630	1189	4185	854	4437	720	4521	616	4531	461	5126	400	1877
2L-3S		MI	1612	1189	2560	802	2619	680	2598	581	2484	429	2616	300	1183
6-#7	1.17	MA	2565	1189	4004	858	4206	729	4239	624	4148	467	4596	358	1890
3L-2S		MI	1643	1189	2657	801	2743	675	2750	576	2687	427	2855	342	1173
6-#8	1.54	MA	2701	1220	4355	871	4649	732	4778	623	4879	457	5591	393	2418
2L-3S		MI	1637	1220	2620	818	2691	692	2685	587	2595	423	2740	268	1497
6-#8	1.54	MA	2617	1220	4120	876	4347	743	4410	633	4378	465	4903	337	2435
3L-2S		MI	1678	1220	2746	817	2853	686	2882	582	2857	420	3046	324	1480
6-#9	1.95	MA	2776	1255	4541	891	4882	746	5059	630	5260	452	6092	385	3005
2L-3S		MI	1665	1255	2685	836	2770	706	2779	595	2713	416	2870	231	1830
6-#9	1.95	MA	2673	1255	4245	897	4502	759	4596	643	4630	462	5235	315	3023
3L-2S		MI	1716	1255	2843	834	2972	698	3025	589	3037	411	3245	302	1808
6-#10	2.47	MA	2872	1300	4776	916	5177	763	5416	640	5744	447	6722	374	3748
2L-3S		MI	1700	1300	2766	859	2869	724	2897	604	2860	406	3030	183	2243
6-#10	2.47	MA	2744	1300	4403	923	4699	780	4833	656	4951	459	5652	284	3763
3L-2S		MI	1763	1300	2963	858	3121	714	3206	597	3261	400	3490	273	2214
6-#11	3.04	MA	2961	1348	5013	938	5462	778	5756	648	6204	439	7247	351	4493
2L-3S		MI	1730	1348	2840	875	2950	735	2983	605	2954	384	3105	112	2644
6-#11	3.04	MA	2810	1348	4565	946	4888	798	5057	665	5252	452	5993	241	4503
3L-2S		MI	1802	1348	3072	876	3247	725	3341	598	3411	377	3616	222	2609

RECTANGULAR TIED COLUMNS 14" x 22"

Short columns – no sidesway
Bending on major or minor axis

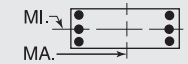


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	4.38	MA	2980	1463	4947	1014	5366	852	5634	699	6035	444	6957	155	6247
3L-2S		MI	1907	1463	3349	938	3593	769	3721	613	3897	341	4280	170	3541
6-#18	7.79	MA	3390	1753	5872	1189	6526	989	7040	783	7944	421	9195	-85	9075
3L-2S		MI	2148	1753	3989	1102	4325	866	4545	640	4953	234	5380	-73	5387
8-#6	1.14	MA	2628	1186	4172	855	4426	721	4511	617	4519	462	5113	402	1842
2L-4S		MI	1609	1186	2522	809	2575	681	2546	581	2424	434	2558	303	1167
8-#6	1.14	MA	2580	1186	4039	858	4256	728	4303	623	4235	467	4721	371	1851
3E		MI	1619	1186	2579	805	2649	681	2637	582	2540	432	2688	316	1157
8-#6	1.14	MA	2556	1186	3937	865	4124	730	4141	625	4025	472	4449	353	1862
4L-2S		MI	1643	1186	2652	804	2742	677	2750	579	2692	430	2868	347	1151
8-#7	1.56	MA	2708	1222	4365	875	4668	735	4803	625	4915	458	5656	396	2453
2L-4S		MI	1638	1222	2580	829	2644	695	2628	588	2532	429	2682	268	1526
8-#7	1.56	MA	2644	1222	4185	879	4437	744	4521	633	4531	464	5126	354	2465
3E		MI	1651	1222	2657	823	2743	695	2750	590	2687	426	2855	286	1511
8-#7	1.56	MA	2612	1222	4047	888	4258	747	4302	635	4245	471	4757	330	2477
4L-2S		MI	1683	1222	2754	822	2868	690	2902	585	2890	423	3093	328	1499
8-#8	2.05	MA	2801	1264	4591	899	4952	752	5147	635	5381	453	6278	387	3166
2L-4S		MI	1672	1264	2646	854	2723	712	2723	597	2657	422	2824	226	1934
8-#8	2.05	MA	2719	1264	4355	904	4649	763	4778	645	4879	461	5591	332	3179
3E		MI	1689	1264	2746	845	2853	712	2882	599	2857	418	3046	249	1914
8-#8	2.05	MA	2678	1264	4175	916	4416	767	4491	648	4505	470	5112	300	3184
4L-2S		MI	1729	1264	2873	844	3015	705	3080	594	3118	415	3351	304	1897
8-#9	2.60	MA	2902	1310	4837	925	5261	770	5522	645	5890	448	6949	377	3941
2L-4S		MI	1707	1310	2717	880	2809	730	2826	607	2789	413	2972	178	2362
8-#9	2.60	MA	2800	1310	4541	931	4882	784	5059	658	5260	458	6092	307	3952
3E		MI	1729	1310	2843	870	2972	731	3025	610	3037	409	3245	206	2343
8-#9	2.60	MA	2750	1310	4314	946	4587	789	4697	661	4789	468	5493	267	3937
4L-2S		MI	1779	1310	3000	869	3174	723	3272	604	3360	404	3620	276	2323
8-#10	3.30	MA	2904	1370	4776	967	5177	812	5416	675	5744	454	6722	273	4924
3E		MI	1780	1370	2963	903	3121	755	3206	623	3261	396	3490	148	2875
8-#10	3.30	MA	2841	1370	4490	986	4805	818	4960	679	5150	466	5974	224	4730
4L-2S		MI	1842	1370	3160	902	3374	746	3514	617	3661	390	3949	238	2852
8-#11	4.05	MA	3000	1434	5013	1000	5462	837	5756	689	6204	445	7247	224	5890
3E		MI	1823	1434	3072	929	3247	773	3341	628	3411	369	3616	62	3381
8-#11	4.05	MA	2929	1434	4667	1022	5014	843	5207	693	5488	458	6366	166	5475
4L-2S		MI	1894	1434	3303	930	3544	764	3699	621	3869	362	4126	172	3356
8-#14	5.84	MA	3151	1587	5090	1123	5542	915	5844	737	6367	451	7471	45	7242
4L-2S		MI	2033	1587	3672	1016	4007	825	4209	643	4521	316	5018	105	4569
10-#10	4.12	MA	3001	1440	4862	1030	5283	849	5543	698	5944	460	7044	213	5829
4L-3S		MI	1860	1440	3160	947	3374	787	3514	643	3661	386	3949	114	3499
10-#10	4.12	MA	2892	1440	4621	1037	4962	866	5142	714	5352	461	6298	162	5529
5L-2S		MI	1921	1440	3358	946	3627	777	3823	636	4062	381	4409	203	3482
10-#11	5.06	MA	3119	1521	5114	1076	5588	881	5906	716	6440	452	7620	149	6797
4L-3S		MI	1921	1521	3303	983	3544	812	3699	650	3869	353	4126	13	4110
10-#11	5.06	MA	2989	1521	4823	1084	5200	901	5423	734	5726	451	6745	86	6414
5L-2S		MI	1985	1521	3535	984	3841	803	4056	643	4326	346	4636	122	4094
12-#10	4.95	MA	3052	1511	4994	1081	5440	898	5725	733	6145	456	7369	151	6655
5L-3S		MI	1939	1511	3358	991	3627	818	3823	662	4062	376	4409	79	4118
12-#10	4.95	MA	2973	1511	4747	1099	5121	904	5328	737	5612	468	6686	95	6217
6L-2S		MI	2001	1511	3555	990	3880	809	4131	655	4463	371	4868	168	4107
12-#11	6.08	MA	3180	1607	5270	1138	5773	940	6122	757	6679	444	7999	68	7722
5L-3S		MI	2015	1607	3535	1037	3841	851	4056	673	4326	338	4636	-37	4627
14-#10	5.77	MA	3135	1581	5120	1142	5598	935	5911	756	6405	463	7756	83	7332
6L-3S		MI	2019	1581	3555	1035	3880	850	4131	681	4463	367	4868	44	4733

RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

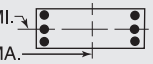
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.19	MA	3139	1299	4991	936	5303	789	5412	675	5438	504	6168	438	2277
2E		MI	1791	1299	2900	866	2985	730	2987	623	2901	458	3063	362	1299
4-#10	1.51	MA	3212	1329	5169	952	5524	800	5678	681	5798	500	6664	433	2839
2E		MI	1822	1329	2982	880	3083	739	3105	627	3047	449	3222	342	1585
4-#11	1.86	MA	3280	1361	5353	964	5740	808	5934	684	6141	493	7073	419	3413
2E		MI	1849	1361	3056	887	3164	742	3189	624	3140	431	3295	305	1873
4-#14	2.68	MA	3454	1437	5785	1006	6279	837	6585	701	7025	484	8203	397	4777
2E		MI	1919	1437	3242	925	3392	768	3438	631	3457	405	3729	269	2528
4-#18	4.76	MA	3872	1631	6834	1116	7596	915	8180	745	9190	461	10856	331	8082
2E		MI	2079	1631	3670	1026	3874	826	3978	643	4149	329	4445	103	4020
6-#7	1.07	MA	3116	1288	4922	935	5228	789	5327	676	5325	508	6015	442	2072
2L-3S		MI	1750	1288	2775	869	2834	737	2806	631	2673	469	2810	335	1198
6-#7	1.07	MA	3042	1288	4721	939	4971	792	5013	684	4897	515	5422	401	2085
3L-2S		MI	1782	1288	2872	868	2959	732	2958	626	2876	467	3049	377	1189
6-#8	1.41	MA	3195	1319	5113	952	5467	801	5615	683	5715	504	6553	437	2674
2L-3S		MI	1776	1319	2835	885	2907	749	2893	637	2783	463	2934	303	1515
6-#8	1.41	MA	3100	1319	4850	957	5130	812	5204	693	5155	513	5779	383	2691
3L-2S		MI	1817	1319	2962	884	3069	743	3091	632	3045	459	3239	358	1499
6-#9	1.79	MA	3282	1354	5322	971	5727	814	5929	690	6141	500	7142	432	3329
2L-3S		MI	1804	1354	2900	902	2985	762	2987	644	2901	455	3063	266	1852
6-#9	1.79	MA	3164	1354	4991	978	5303	829	5412	703	5438	511	6168	362	3347
3L-2S		MI	1855	1354	3058	901	3187	754	3233	638	3224	451	3438	336	1830
6-#10	2.27	MA	3390	1399	5586	996	6058	832	6330	700	6685	495	7891	425	4159
2L-3S		MI	1839	1399	2982	925	3083	780	3105	653	3047	445	3222	217	2269
6-#10	2.27	MA	3244	1399	5169	1004	5524	850	5678	717	5798	508	6664	336	4175
3L-2S		MI	1902	1399	3179	924	3336	770	3413	647	3448	439	3682	307	2240
6-#11	2.79	MA	3492	1447	5855	1018	6383	847	6718	707	7207	486	8518	406	4999
2L-3S		MI	1868	1447	3056	940	3164	790	3189	653	3140	422	3295	146	2677
6-#11	2.79	MA	3320	1447	5353	1028	5740	868	5934	727	6141	502	7073	296	5008
3L-2S		MI	1942	1447	3288	941	3461	780	3547	647	3597	415	3805	255	2640
6-#14	4.02	MA	3513	1562	5785	1097	6279	923	6585	761	7025	494	8203	216	6976
3L-2S		MI	2046	1562	3565	1002	3806	824	3926	661	4081	379	4468	204	3580
6-#18	7.14	MA	3983	1852	6834	1273	7596	1062	8180	847	9190	474	10856	-3	10850
3L-2S		MI	2287	1852	4205	1165	4537	919	4748	686	5134	271	5564	-40	5570
8-#6	1.05	MA	3113	1285	4907	936	5216	790	5315	677	5310	510	5995	443	2032
2L-4S		MI	1748	1285	2737	877	2790	739	2755	632	2613	474	2753	338	1180
8-#6	1.05	MA	3058	1285	4759	939	5026	793	5083	683	4994	515	5558	414	2041
3E		MI	1758	1285	2794	872	2864	739	2846	632	2729	472	2883	351	1172
8-#6	1.05	MA	3030	1285	4646	946	4880	799	4903	686	4760	521	5259	396	2052
4L-2S		MI	1781	1285	2866	871	2957	735	2959	629	2882	470	3063	382	1166
8-#7	1.43	MA	3203	1321	5123	955	5486	804	5641	685	5752	506	6607	438	2712
2L-4S		MI	1777	1321	2795	897	2859	752	2836	638	2721	468	2876	303	1544
8-#7	1.43	MA	3131	1321	4922	960	5228	807	5327	693	5325	513	6015	397	2724
3E		MI	1790	1321	2872	890	2959	752	2958	640	2876	466	3049	321	1529
8-#7	1.43	MA	3093	1321	4769	969	5030	816	5083	696	5007	520	5608	373	2736
4L-2S		MI	1822	1321	2969	889	3083	747	3111	635	3079	463	3288	363	1517
8-#8	1.88	MA	3309	1363	5376	979	5804	820	6026	694	6274	501	7328	432	3508
2L-4S		MI	1810	1363	2861	920	2939	768	2931	647	2845	461	3018	261	1957
8-#8	1.88	MA	3216	1363	5113	985	5467	832	5615	705	5715	510	6553	378	3520
3E		MI	1827	1363	2962	912	3069	769	3091	649	3045	458	3239	283	1936
8-#8	1.88	MA	3168	1363	4913	997	5207	837	5296	709	5299	519	6019	346	3525
4L-2S		MI	1868	1363	3088	911	3231	762	3288	644	3307	454	3544	339	1919
8-#9	2.38	MA	3423	1409	5652	1006	6151	839	6446	705	6844	496	8117	426	4373
2L-4S		MI	1846	1409	2932	947	3024	786	3034	656	2977	453	3165	213	2392

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.38	MA	3308	1409	5322	1012	5727	853	5929	719	6141	507	7142	356	4384
3E		MI	1868	1409	3058	937	3187	787	3233	659	3224	448	3438	240	2369
8-#9	2.38	MA	3248	1409	5069	1028	5400	859	5527	723	5618	518	6468	316	4369
4L-2S		MI	1918	1409	3216	935	3389	779	3480	653	3548	444	3813	310	2348
8-#10	3.02	MA	3425	1469	5586	1048	6058	881	6330	736	6685	503	7891	328	5473
3E		MI	1918	1469	3179	969	3336	811	3413	673	3448	435	3682	183	2905
8-#10	3.02	MA	3351	1469	5267	1068	5645	888	5823	741	6024	517	7037	277	5336
4L-2S		MI	1981	1469	3376	968	3589	802	3722	666	3848	430	4141	272	2881
8-#11	3.71	MA	3535	1533	5855	1082	6383	907	6718	750	7207	495	8518	283	6564
3E		MI	1962	1533	3288	994	3461	829	3547	676	3597	407	3805	96	3419
8-#11	3.71	MA	3451	1533	5470	1105	5884	914	6105	756	6409	510	7508	222	6185
4L-2S		MI	2033	1533	3520	995	3758	819	3905	669	4054	400	4316	206	3391
8-#14	5.36	MA	3701	1686	5948	1207	6481	988	6826	801	7403	505	8806	109	8192
4L-2S		MI	2172	1686	3888	1080	4221	879	4414	691	4705	354	5206	138	4612
10-#10	3.78	MA	3532	1539	5684	1112	6179	920	6475	761	6911	511	8264	269	6569
4L-3S		MI	1998	1539	3376	1013	3589	843	3722	692	3848	425	4141	148	3532
10-#10	3.78	MA	3408	1539	5417	1120	5823	938	6030	777	6253	513	7409	218	6196
5L-2S		MI	2060	1539	3573	1012	3842	833	4030	685	4249	420	4601	237	3513
10-#11	4.64	MA	3666	1620	5971	1159	6526	953	6889	779	7476	503	8953	209	7670
4L-3S		MI	2060	1620	3520	1048	3758	867	3905	698	4054	392	4316	46	4152
10-#11	4.64	MA	3519	1620	5647	1168	6095	974	6351	798	6681	505	7946	147	7279
5L-2S		MI	2124	1620	3751	1049	4055	858	4263	692	4511	385	4826	156	4132
10-#14	6.70	MA	3798	1811	6198	1297	6779	1073	7172	862	7785	495	9418	-4	9414
5L-2S		MI	2298	1811	4211	1158	4635	935	4902	721	5328	329	5944	73	5634
12-#10	4.54	MA	3589	1610	5833	1164	6358	969	6682	796	7140	508	8636	211	7457
5L-3S		MI	2078	1610	3573	1057	3842	874	4030	711	4249	415	4601	113	4154
12-#10	4.54	MA	3501	1610	5573	1170	6003	976	6241	802	6548	522	7856	152	7020
6L-2S		MI	2139	1610	3770	1056	4095	865	4338	704	4650	410	5060	202	4140
12-#11	5.57	MA	3735	1706	6148	1222	6738	1013	7135	822	7748	498	9391	134	8788
5L-3S		MI	2153	1706	3751	1102	4055	906	4263	721	4511	377	4826	-3	4879
12-#11	5.57	MA	3629	1706	5815	1243	6309	1020	6601	827	7031	513	8470	64	8132
6L-2S		MI	2215	1706	3983	1102	4352	897	4620	714	4969	370	5336	107	4866
14-#10	5.29	MA	3684	1680	5990	1214	6537	1008	6893	821	7434	516	9083	144	8271
6L-3S		MI	2158	1680	3770	1101	4095	906	4338	730	4650	406	5060	78	4773
14-#11	6.50	MA	3847	1792	6316	1297	6951	1059	7385	851	8098	506	9915	51	9638
6L-3S		MI	2246	1792	3983	1156	4352	945	4620	743	4969	361	5336	-53	5321

RECTANGULAR TIED COLUMNS 14" x 26"

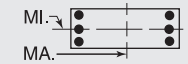
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.10	MA	3668	1398	5793	1017	6165	858	6291	735	6304	552	7136	480	2493
2E		MI	1930	1398	3116	933	3200	786	3194	672	3089	497	3256	397	1317
4-#10	1.40	MA	3750	1428	5991	1033	6410	869	6586	741	6703	548	7688	475	3113
2E		MI	1961	1428	3197	946	3298	795	3312	677	3234	488	3414	376	1606
4-#11	1.71	MA	3827	1460	6198	1045	6653	877	6872	744	7088	541	8216	467	3750
2E		MI	1988	1460	3272	952	3378	797	3395	672	3325	469	3484	339	1898
4-#14	2.47	MA	4023	1536	6679	1087	7254	906	7599	760	8072	531	9514	450	5263
2E		MI	2058	1536	3458	989	3606	822	3643	679	3641	442	3917	302	2560
4-#18	4.40	MA	4493	1730	7852	1197	8727	983	9383	805	10493	509	12587	395	8946
2E		MI	2218	1730	3886	1089	4087	879	4181	690	4330	366	4630	135	4067
6-#8	1.30	MA	3730	1418	5928	1032	6345	869	6513	742	6608	552	7559	479	2930
2L-3S		MI	1915	1418	3050	952	3122	806	3101	687	2972	502	3128	337	1532

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis

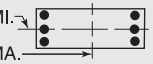


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.30	MA	3624	1418	5638	1038	5973	874	6059	754	5991	562	6704	426	2947
3L-2S		MI	1956	1418	3177	950	3284	800	3299	681	3233	499	3433	393	1518
6-#9	1.65	MA	3827	1453	6159	1051	6633	883	6862	750	7081	548	8212	474	3653
2L-3S		MI	1942	1453	3116	969	3200	819	3194	693	3089	494	3256	300	1873
6-#9	1.65	MA	3694	1453	5793	1059	6165	889	6291	764	6304	560	7136	406	3671
3L-2S		MI	1993	1453	3273	967	3402	811	3441	687	3412	490	3631	371	1851
6-#10	2.09	MA	3948	1498	6452	1077	7001	900	7306	760	7684	542	9045	467	4571
2L-3S		MI	1977	1498	3197	991	3298	836	3312	702	3234	484	3414	252	2295
6-#10	2.09	MA	3784	1498	5991	1086	6410	908	6586	778	6703	557	7688	380	4586
3L-2S		MI	2040	1498	3394	990	3551	827	3620	696	3635	478	3874	341	2265
6-#11	2.57	MA	4064	1546	6753	1099	7364	915	7741	767	8269	534	9852	458	5504
2L-3S		MI	2007	1546	3272	1005	3378	845	3395	702	3325	461	3484	179	2709
6-#11	2.57	MA	3870	1546	6198	1109	6653	938	6872	788	7088	551	8216	348	5514
3L-2S		MI	2080	1546	3504	1006	3675	836	3753	695	3782	454	3995	289	2670
6-#14	3.71	MA	4087	1661	6679	1179	7254	993	7599	823	8072	544	9514	275	7705
3L-2S		MI	2185	1661	3781	1067	4020	878	4131	709	4265	417	4655	237	3618
6-#18	6.59	MA	4616	1951	7852	1356	8727	1134	9383	911	10493	527	12587	72	12338
3L-2S		MI	2425	1951	4422	1227	4750	972	4952	733	5316	308	5748	-8	5750
8-#7	1.32	MA	3739	1420	5938	1036	6365	872	6542	745	6649	553	7616	480	2971
2L-4S		MI	1915	1420	3010	964	3074	810	3045	688	2909	508	3071	338	1560
8-#7	1.32	MA	3657	1420	5716	1040	6081	876	6195	753	6177	561	6963	440	2983
3E		MI	1929	1420	3087	957	3174	810	3167	690	3065	505	3244	356	1546
8-#7	1.32	MA	3615	1420	5548	1050	5863	886	5927	757	5828	568	6520	417	2995
4L-2S		MI	1960	1420	3184	956	3299	804	3319	685	3268	503	3482	398	1535
8-#8	1.74	MA	3857	1462	6218	1060	6717	889	6967	754	7226	548	8414	474	3849
2L-4S		MI	1949	1462	3076	987	3154	825	3139	697	3033	501	3211	296	1978
8-#8	1.74	MA	3752	1462	5928	1065	6345	894	6513	766	6608	558	7559	421	3862
3E		MI	1966	1462	3177	979	3284	826	3299	698	3233	497	3433	318	1956
8-#8	1.74	MA	3697	1462	5708	1078	6059	906	6162	770	6151	568	6976	390	3867
4L-2S		MI	2007	1462	3303	978	3446	819	3496	693	3495	494	3738	374	1940
8-#9	2.20	MA	3984	1508	6524	1086	7101	908	7433	765	7858	543	9288	468	4805
2L-4S		MI	1985	1508	3148	1013	3239	843	3242	705	3165	492	3358	247	2419
8-#9	2.20	MA	3855	1508	6159	1093	6633	914	6862	779	7081	555	8212	400	4816
3E		MI	2006	1508	3273	1003	3402	844	3441	708	3412	487	3631	275	2393
8-#9	2.20	MA	3787	1508	5881	1109	6273	929	6420	784	6505	567	7476	360	4801
4L-2S		MI	2057	1508	3431	1002	3604	836	3688	702	3736	483	4005	345	2372
8-#10	2.79	MA	3986	1568	6452	1129	7001	940	7306	797	7684	552	9045	373	6021
3E		MI	2057	1568	3394	1035	3551	868	3620	722	3635	474	3874	217	2935
8-#10	2.79	MA	3901	1568	6101	1150	6546	959	6748	803	6956	567	8112	322	5955
4L-2S		MI	2120	1568	3592	1034	3804	858	3929	715	4036	469	4333	306	2908
8-#11	3.43	MA	4111	1632	6753	1163	7364	976	7741	811	8269	544	9852	339	7238
3E		MI	2100	1632	3504	1059	3675	884	3753	724	3782	445	3995	130	3456
8-#11	3.43	MA	4013	1632	6329	1187	6814	985	7065	818	7389	561	8714	276	6910
4L-2S		MI	2172	1632	3736	1059	3972	875	4111	717	4240	438	4505	239	3424
8-#14	4.95	MA	4292	1785	6863	1290	7481	1060	7870	865	8498	557	10208	169	9159
4L-2S		MI	2311	1785	4105	1144	4434	934	4619	739	4889	392	5394	172	4654
10-#10	3.49	MA	4102	1638	6562	1194	7137	990	7468	822	7936	561	9470	314	7321
4L-3S		MI	2137	1638	3592	1079	3804	899	3929	741	4036	464	4333	182	3565
10-#10	3.49	MA	3965	1638	6269	1203	6746	998	6979	840	7213	565	8532	267	6871
5L-2S		MI	2199	1638	3789	1078	4057	890	4237	734	4436	459	4793	271	3543
10-#11	4.29	MA	4253	1719	6884	1241	7526	1024	7933	842	8571	554	10350	266	8559
4L-3S		MI	2194	1719	3736	1113	3972	923	4111	747	4240	430	4505	80	4192
10-#11	4.29	MA	4089	1719	6528	1251	7052	1046	7341	862	7695	557	9210	204	8085
5L-2S		MI	2263	1719	3967	1113	4269	913	4469	740	4697	423	5015	190	4168
10-#14	6.18	MA	4401	1910	7144	1382	7817	1147	8259	927	8929	551	10904	62	10630
5L-2S		MI	2437	1910	4428	1222	4849	990	5107	768	5513	366	6132	106	5679
12-#10	4.19	MA	4167	1709	6729	1247	7336	1029	7700	859	8193	559	9889	259	8267
5L-3S		MI	2216	1709	3789	1123	4057	931	4237	760	4436	455	4793	147	4189

RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

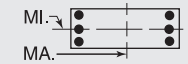
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	4.19	MA	4069	1709	6436	1252	6947	1048	7216	865	7542	574	9038	201	7840
6L-2S		MI	2278	1709	3986	1122	4309	921	4546	753	4837	449	5252	237	4172
12-#11	5.14	MA	4330	1805	7083	1305	7764	1085	8210	886	8877	550	10846	195	9771
5L-3S		MI	2291	1805	3967	1167	4269	962	4469	769	4697	415	5015	30	4922
12-#11	5.14	MA	4213	1805	6736	1312	7292	1093	7622	892	8088	567	9807	122	9091
6L-2S		MI	2354	1805	4199	1167	4566	952	4827	762	5154	408	5526	140	4905
14-#10	4.88	MA	4272	1779	6897	1296	7537	1080	7936	884	8522	568	10396	193	9228
6L-3S		MI	2296	1779	3986	1167	4309	962	4546	779	4837	445	5252	112	4810
14-#10	4.88	MA	4172	1779	6566	1312	7158	1086	7474	902	7888	583	9514	154	8784
7L-2S		MI	2357	1779	4183	1166	4562	953	4854	772	5237	439	5711	202	4797
14-#11	6.00	MA	4457	1891	7291	1366	8004	1132	8491	916	9269	560	11443	113	10766
6L-3S		MI	2384	1891	4199	1221	4566	1000	4827	792	5154	400	5526	-19	5647
16-#10	5.58	MA	4375	1849	7027	1356	7749	1117	8194	921	8868	578	10871	146	10173
7L-3S		MI	2376	1849	4183	1211	4562	994	4854	798	5237	435	5711	78	5427

RECTANGULAR TIED COLUMNS 14" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.02	MA	4236	1497	6652	1097	7088	927	7231	795	7228	600	8166	522	2709
2E		MI	2068	1497	3331	999	3415	843	3402	722	3276	536	3449	431	1334
4-#10	1.30	MA	4327	1527	6869	1113	7357	938	7555	801	7667	596	8772	517	3388
2E		MI	2100	1527	3413	1012	3513	851	3519	726	3422	527	3606	410	1626
4-#11	1.59	MA	4414	1559	7098	1125	7626	945	7873	804	8093	588	9358	509	4087
2E		MI	2126	1559	3488	1017	3592	852	3601	721	3511	507	3674	372	1923
4-#14	2.30	MA	4631	1635	7629	1167	8289	975	8674	820	9179	579	10857	498	5749
2E		MI	2196	1635	3675	1053	3819	877	3848	727	3825	480	4105	335	2592
4-#18	4.08	MA	5156	1829	8927	1277	9918	1052	10647	865	11856	557	14387	455	9810
2E		MI	2356	1829	4103	1151	4299	932	4384	736	4512	403	4814	168	4112
6-#8	1.21	MA	4305	1517	6799	1113	7284	938	7474	802	7561	600	8628	521	3186
2L-3S		MI	2053	1517	3266	1018	3337	863	3309	736	3160	542	3321	372	1549
6-#8	1.21	MA	4187	1517	6481	1119	6877	943	6977	814	6885	610	7692	469	3203
3L-2S		MI	2094	1517	3392	1017	3499	856	3507	731	3422	538	3627	428	1536
6-#9	1.53	MA	4412	1552	7052	1132	7601	951	7856	810	8079	595	9344	515	3977
2L-3S		MI	2081	1552	3331	1035	3415	876	3402	743	3276	534	3449	335	1893
6-#9	1.53	MA	4265	1552	6652	1140	7088	958	7231	824	7228	608	8166	449	3995
3L-2S		MI	2132	1552	3489	1034	3617	868	3649	737	3600	529	3824	405	1872
6-#10	1.94	MA	4547	1597	7374	1157	8004	969	8344	820	8741	590	10259	509	4982
2L-3S		MI	2116	1597	3413	1057	3513	892	3519	752	3422	523	3606	286	2319
6-#10	1.94	MA	4364	1597	6869	1167	7357	977	7555	838	7667	606	8772	424	4998
3L-2S		MI	2179	1597	3610	1056	3766	883	3828	745	3822	518	4066	375	2289
6-#11	2.39	MA	4676	1645	7708	1179	8408	984	8826	827	9390	581	11153	500	6010
2L-3S		MI	2146	1645	3488	1070	3592	901	3601	750	3511	499	3674	213	2739
6-#11	2.39	MA	4460	1645	7098	1190	7626	993	7873	849	8093	600	9358	393	6019
3L-2S		MI	2219	1645	3720	1070	3889	891	3959	743	3968	492	4184	323	2700
6-#14	3.44	MA	4702	1760	7629	1260	8289	1063	8674	884	9179	594	10857	327	8434
3L-2S		MI	2323	1760	3998	1131	4234	933	4336	756	4449	455	4843	270	3654
6-#18	6.12	MA	5291	2050	8927	1439	9918	1206	10647	974	11856	579	14387	141	13851
3L-2S		MI	2564	2050	4638	1290	4962	1026	5155	779	5497	345	5932	25	5832
8-#7	1.22	MA	4314	1519	6809	1116	7306	941	7504	804	7603	601	8689	522	3231
2L-4S		MI	2054	1519	3225	1031	3290	867	3253	738	3098	548	3265	373	1576
8-#7	1.22	MA	4224	1519	6567	1121	6995	945	7124	814	7087	609	7974	483	3242
3E		MI	2067	1519	3302	1024	3389	867	3375	739	3254	545	3438	390	1562
8-#7	1.22	MA	4175	1519	6384	1131	6758	955	6832	817	6707	617	7494	460	3254
4L-2S		MI	2099	1519	3399	1023	3514	862	3528	735	3457	543	3677	433	1552
8-#8	1.61	MA	4445	1561	7116	1140	7691	958	7970	814	8236	596	9564	516	4190
2L-4S		MI	2087	1561	3291	1054	3369	882	3348	746	3222	540	3405	330	1998
8-#8	1.61	MA	4329	1561	6799	1146	7284	963	7474	826	7561	606	8628	464	4203
3E		MI	2105	1561	3392	1046	3499	883	3507	748	3422	537	3627	353	1976

RECTANGULAR TIED COLUMNS 14" x 28"

Short columns – no sidesway
Bending on major or minor axis

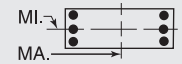


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#8	1.61	MA	4266	1561	6559	1159	6973	976	7091	831	7062	617	7997	434	4208
4L-2S		MI	2145	1561	3518	1044	3661	876	3704	743	3683	533	3932	408	1960
8-#9	2.04	MA	4586	1607	7452	1166	8113	976	8481	825	8930	591	10522	509	5237
2L-4S		MI	2123	1607	3363	1080	3455	900	3449	755	3353	531	3550	282	2444
8-#9	2.04	MA	4443	1607	7052	1174	7601	983	7856	840	8079	604	9344	443	5248
3E		MI	2145	1607	3489	1070	3617	901	3649	758	3600	527	3824	309	2417
8-#9	2.04	MA	4365	1607	6750	1191	7208	999	7374	845	7450	617	8547	404	5233
4L-2S		MI	2195	1607	3647	1068	3819	893	3895	752	3924	522	4198	379	2395
8-#10	2.59	MA	4587	1667	7374	1211	8004	1009	8344	857	8741	600	10259	417	6570
3E		MI	2196	1667	3610	1101	3766	924	3828	771	3822	513	4066	251	2962
8-#10	2.59	MA	4491	1667	6992	1231	7508	1029	7735	865	7947	616	9249	367	6514
4L-2S		MI	2258	1667	3807	1100	4019	915	4136	764	4223	508	4525	341	2935
8-#11	3.18	MA	4726	1731	7708	1244	8408	1032	8826	872	9390	593	11153	383	7912
3E		MI	2239	1731	3720	1124	3889	939	3959	772	3968	484	4184	163	3491
8-#11	3.18	MA	4614	1731	7244	1269	7806	1055	8087	880	8427	611	9919	321	7648
4L-2S		MI	2310	1731	3952	1124	4187	930	4317	766	4425	477	4695	273	3457
8-#14	4.59	MA	4923	1884	7835	1373	8543	1132	8976	928	9651	609	11643	223	10143
4L-2S		MI	2450	1884	4321	1208	4648	989	4824	786	5073	430	5581	205	4695
10-#10	3.24	MA	4713	1737	7496	1275	8155	1060	8524	884	9020	611	10736	359	8071
4L-3S		MI	2275	1737	3807	1145	4019	956	4136	790	4223	503	4525	216	3596
10-#10	3.24	MA	4561	1737	7177	1285	7729	1069	7991	902	8231	615	9716	314	7554
5L-2S		MI	2337	1737	4004	1144	4271	946	4445	783	4623	498	4985	306	3572
10-#11	3.98	MA	4881	1818	7854	1323	8587	1094	9040	904	9724	604	11714	312	9463
4L-3S		MI	2332	1818	3952	1178	4187	978	4317	795	4425	469	4695	114	4230
10-#11	3.98	MA	4699	1818	7465	1334	8070	1104	8393	925	8767	609	10474	254	8899
5L-2S		MI	2402	1818	4183	1178	4484	969	4675	788	4882	462	5205	224	4204
10-#14	5.74	MA	5044	2009	8147	1466	8916	1220	9409	992	10131	604	12423	122	11856
5L-2S		MI	2576	2009	4644	1286	5062	1045	5312	816	5697	404	6320	140	5723
12-#10	3.89	MA	4785	1808	7681	1329	8376	1100	8780	921	9305	610	11203	307	9086
5L-3S		MI	2355	1808	4004	1189	4271	987	4445	809	4623	494	4985	182	4222
12-#10	3.89	MA	4676	1808	7356	1334	7952	1120	8252	928	8596	626	10283	249	8677
6L-2S		MI	2417	1808	4202	1188	4524	978	4753	802	5024	488	5444	271	4203
12-#11	4.78	MA	4966	1904	8075	1388	8851	1142	9346	949	10064	602	12269	244	10752
5L-3S		MI	2430	1904	4183	1232	4484	1017	4675	817	4882	453	5205	64	4963
12-#11	4.78	MA	4837	1904	7687	1395	8336	1165	8705	956	9203	620	11144	172	10068
6L-2S		MI	2493	1904	4415	1232	4781	1007	5033	811	5340	446	5715	174	4943
12-#14	6.89	MA	5241	2133	8469	1554	9292	1289	9850	1036	10747	620	13362	4	13341
6L-2S		MI	2703	2133	4967	1364	5477	1100	5800	846	6320	379	7058	75	6743
14-#10	4.54	MA	4901	1878	7860	1378	8599	1151	9042	948	9669	620	11769	241	10202
6L-3S		MI	2435	1878	4202	1233	4524	1019	4753	828	5024	484	5444	147	4845
14-#10	4.54	MA	4788	1878	7499	1394	8177	1157	8538	966	8978	636	10813	204	9692
7L-2S		MI	2496	1878	4399	1232	4777	1009	5061	821	5425	478	5903	236	4830
14-#11	5.57	MA	5106	1990	8296	1449	9118	1204	9658	980	10499	613	12939	163	11912
6L-3S		MI	2523	1990	4415	1286	4781	1056	5033	840	5340	438	5715	14	5691
14-#11	5.57	MA	4974	1990	7859	1468	8616	1212	9047	1002	9660	632	11773	114	11219
7L-2S		MI	2584	1990	4647	1286	5078	1046	5391	833	5797	431	6226	124	5677
16-#10	5.18	MA	5012	1948	8004	1438	8824	1188	9327	985	10052	630	12299	197	11235
7L-3S		MI	2514	1948	4399	1277	4777	1050	5061	847	5425	474	5903	112	5465
16-#10	5.18	MA	4888	1948	7687	1445	8386	1204	8831	1003	9316	635	11251	131	10589
8L-2S		MI	2575	1948	4596	1276	5030	1041	5370	841	5825	468	6363	201	5454
16-#11	6.37	MA	5242	2077	8468	1522	9397	1251	9999	1025	10957	625	13568	105	13061
7L-3S		MI	2615	2077	4647	1340	5078	1094	5391	862	5797	423	6226	-35	6416
18-#10	5.83	MA	5113	2019	8191	1489	9033	1236	9621	1022	10389	630	12737	123	12122
8L-3S		MI	2594	2019	4596	1321	5030	1082	5370	866	5825	464	6363	77	6081

RECTANGULAR TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

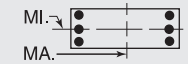
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.41	MA	1595	1005	2589	691	2711	581	2749	495	2752	364	2999	296	1314
2L-3S		MI	1555	1005	2471	694	2560	588	2564	500	2501	368	2689	254	1326
6-#8	1.85	MA	1638	1036	2698	708	2847	593	2913	501	2975	360	3259	282	1673
2L-3S		MI	1587	1036	2544	711	2650	601	2673	508	2648	364	2860	226	1691
6-#9	2.34	MA	1685	1071	2816	727	2994	606	3091	509	3217	356	3533	266	2060
2L-3S		MI	1622	1071	2624	730	2748	616	2791	517	2807	360	3040	195	2080
6-#10	2.98	MA	1744	1116	2965	752	3181	624	3317	519	3518	349	3873	243	2543
2L-3S		MI	1665	1116	2724	755	2872	636	2940	528	3007	355	3264	154	2564
6-#11	3.66	MA	1795	1164	3105	773	3348	637	3516	525	3745	332	4099	204	3014
2L-3S		MI	1704	1164	2820	776	2981	651	3069	535	3153	339	3407	94	3034
6-#14	5.27	MA	1932	1279	3455	838	3787	683	4049	551	4408	307	4826	132	4145
2L-3S		MI	1805	1279	3054	840	3273	700	3422	564	3591	317	3887	-27	3876
8-#7	1.88	MA	1644	1038	2707	712	2862	596	2933	504	3003	362	3309	286	1698
2L-4S		MI	1588	1038	2496	722	2591	604	2602	510	2561	369	2778	224	1724
8-#8	2.47	MA	1701	1080	2852	736	3044	613	3154	513	3302	357	3658	268	2168
2L-4S		MI	1630	1080	2577	748	2691	622	2722	520	2726	365	2973	187	2195
8-#9	3.13	MA	1763	1127	3009	762	3241	631	3392	524	3626	351	4026	246	2674
2L-4S		MI	1675	1127	2665	776	2799	642	2851	532	2904	361	3180	144	2609
8-#10	3.97	MA	1842	1186	3207	796	3490	655	3694	538	4029	343	4482	217	3309
2L-4S		MI	1732	1186	2775	814	2935	668	3015	546	3127	355	3435	89	3098

RECTANGULAR TIED COLUMNS 16" x 18"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#8	1.10	MA	1985	1106	3179	773	3324	652	3356	558	3318	418	3635	352	1341
2E		MI	1756	1106	2824	759	2932	640	2947	548	2897	410	3117	337	1188
4-#9	1.39	MA	2023	1129	3274	784	3441	660	3496	562	3509	415	3865	342	1652
2E		MI	1787	1129	2904	770	3030	648	3064	552	3056	406	3297	325	1457
4-#10	1.76	MA	2070	1159	3394	800	3589	670	3675	568	3750	410	4152	330	2042
2E		MI	1827	1159	3005	785	3153	658	3213	557	3255	401	3520	310	1792
4-#11	2.17	MA	2112	1191	3512	811	3725	677	3835	570	3966	402	4358	307	2434
2E		MI	1861	1191	3101	795	3263	664	3341	558	3399	387	3660	281	2127
4-#14	3.13	MA	2224	1267	3796	852	4079	706	4262	586	4535	391	4995	267	3359
2E		MI	1952	1267	3336	836	3554	692	3693	574	3836	369	4138	232	2910
4-#18	5.56	MA	2488	1461	4473	960	4926	782	5288	629	5820	349	6415	149	5545
2E		MI	2163	1461	3888	942	4244	766	4491	608	4823	313	5162	85	4734
6-#7	1.25	MA	2008	1118	3230	783	3395	660	3444	563	3439	419	3802	352	1508
2L-3S		MI	1736	1118	2750	772	2842	655	2839	559	2751	414	2948	295	1344
6-#7	1.25	MA	1960	1118	3091	786	3217	667	3227	570	3144	424	3420	310	1521
3L-2S		MI	1776	1118	2868	770	2993	648	3023	553	3002	411	3258	337	1332
6-#8	1.65	MA	2061	1149	3360	800	3556	671	3639	570	3704	415	4129	341	1929
2L-3S		MI	1768	1149	2824	789	2932	668	2947	567	2897	411	3117	267	1713
6-#8	1.65	MA	1999	1149	3179	804	3324	681	3356	578	3318	420	3635	285	1947
3L-2S		MI	1819	1149	2978	787	3129	660	3187	560	3224	407	3516	323	1695
6-#9	2.08	MA	2117	1184	3501	819	3732	685	3851	577	3991	410	4478	328	2384
2L-3S		MI	1803	1184	2904	808	3030	683	3064	575	3056	407	3297	236	2107
6-#9	2.08	MA	2040	1184	3274	823	3441	696	3496	587	3509	417	3865	257	2404
3L-2S		MI	1866	1184	3096	805	3276	673	3365	567	3465	402	3790	306	2085
6-#10	2.65	MA	2188	1229	3679	844	3954	702	4120	587	4357	405	4913	310	2955
2L-3S		MI	1846	1229	3005	833	3153	702	3213	586	3255	401	3520	194	2596
6-#10	2.65	MA	2093	1229	3394	849	3589	716	3675	599	3750	413	4152	221	2976
3L-2S		MI	1925	1229	3246	829	3462	690	3590	576	3766	395	4129	283	2572
6-#11	3.25	MA	2251	1277	3852	865	4161	716	4366	593	4689	395	5234	277	3519
2L-3S		MI	1885	1277	3101	852	3263	716	3341	592	3399	384	3660	133	3075
6-#11	3.25	MA	2140	1277	3512	870	3725	732	3835	607	3966	403	4358	168	3540
3L-2S		MI	1976	1277	3386	849	3629	703	3787	582	3991	377	4352	243	3048
6-#14	4.69	MA	2418	1392	4275	930	4693	762	5011	620	5548	380	6199	220	4874
2L-3S		MI	1986	1392	3336	916	3554	765	3693	620	3836	362	4138	13	4107
6-#14	4.69	MA	2264	1392	3796	936	4079	783	4262	637	4535	390	4995	61	4828
3L-2S		MI	2114	1392	3737	914	4068	748	4320	608	4653	352	5077	171	4188

RECTANGULAR TIED COLUMNS 16" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#7	1.67	MA	2066	1151	3369	804	3572	675	3661	572	3734	416	4185	344	1957
2L-4S		MI	1769	1151	2776	800	2873	671	2877	568	2811	415	3037	264	1746
8-#7	1.67	MA	2019	1151	3230	807	3395	682	3444	579	3439	421	3802	302	1969
3E		MI	1785	1151	2868	793	2993	670	3023	568	3002	412	3258	284	1731
8-#7	1.67	MA	1998	1151	3122	815	3255	684	3273	580	3216	426	3532	280	1983
4L-2S		MI	1825	1151	2986	791	3144	663	3208	563	3253	408	3568	326	1719
8-#8	2.19	MA	2136	1193	3541	828	3788	691	3922	582	4089	411	4623	330	2509
2L-4S		MI	1811	1193	2857	826	2973	689	2996	578	2975	411	3231	227	2224
8-#8	2.19	MA	2075	1193	3360	831	3556	700	3639	590	3704	417	4129	274	2524
3E		MI	1832	1193	2978	816	3129	688	3187	578	3224	407	3516	253	2208
8-#8	2.19	MA	2048	1193	3219	842	3374	703	3416	591	3413	423	3780	247	2536
4L-2S		MI	1882	1193	3131	814	3326	679	3428	572	3551	403	3915	308	2193
8-#9	2.78	MA	2211	1240	3728	854	4023	709	4206	592	4474	406	5091	313	3106
2L-4S		MI	1856	1240	2945	854	3081	709	3125	590	3153	407	3437	185	2712
8-#9	2.78	MA	2135	1240	3501	858	3732	721	3851	602	3991	413	4478	243	3121
3E		MI	1882	1240	3096	843	3276	708	3365	590	3465	402	3790	216	2720
8-#9	2.78	MA	2102	1240	3324	871	3503	724	3571	603	3626	420	4043	208	3089
4L-2S		MI	1945	1240	3289	840	3523	697	3666	582	3874	397	4283	287	2702
8-#10	3.53	MA	2305	1299	3964	888	4320	733	4566	606	4963	399	5674	290	3857
2L-4S		MI	1913	1299	3055	891	3216	734	3288	604	3375	400	3691	129	3192
8-#10	3.53	MA	2212	1299	3679	893	3954	748	4120	618	4357	407	4913	201	3869
3E		MI	1945	1299	3246	877	3462	733	3590	605	3766	395	4129	168	3357
8-#10	3.53	MA	2171	1299	3456	909	3666	751	3767	619	3897	415	4372	158	3676
4L-2S		MI	2023	1299	3487	873	3771	721	3967	595	4277	389	4738	257	3341
8-#11	4.33	MA	2281	1364	3852	924	4161	771	4366	630	4689	396	5234	138	4596
3E		MI	2001	1364	3386	906	3629	755	3787	615	3991	374	4352	96	3971
8-#11	4.33	MA	2235	1364	3585	942	3815	773	3943	630	4138	404	4607	88	4231
4L-2S		MI	2091	1364	3672	903	3995	741	4234	605	4583	368	5043	205	3957
8-#14	6.25	MA	2461	1516	4275	1013	4693	839	5011	671	5548	379	6199	14	6157
3E		MI	2149	1516	3737	993	4068	821	4320	654	4653	345	5077	-48	5052
10-#10	4.41	MA	2330	1370	3964	937	4320	779	4566	637	4963	402	5674	181	4755
3L-4S		MI	2013	1370	3297	935	3525	766	3665	623	3886	395	4300	103	3892
10-#10	4.41	MA	2291	1370	3741	953	4032	782	4213	639	4503	410	5133	138	4507
4L-3S		MI	2044	1370	3487	921	3771	765	3967	624	4277	389	4738	142	4111
10-#10	4.41	MA	2208	1370	3553	958	3781	797	3901	651	4044	407	4603	85	4324
5L-2S		MI	2121	1370	3728	917	4081	753	4344	615	4789	383	5347	231	4103
10-#11	5.42	MA	2377	1450	3924	996	4251	812	4474	653	4860	397	5484	59	5224
4L-3S		MI	2117	1450	3672	960	3995	793	4234	639	4583	365	5043	58	4857
12-#10	5.29	MA	2409	1440	4026	997	4397	814	4659	658	5110	404	5895	118	5347
4E		MI	2113	1440	3538	979	3835	797	4042	642	4398	389	4909	76	4598
12-#10	5.29	MA	2328	1440	3838	1002	4147	828	4347	670	4650	401	5364	65	5142
5L-3S		MI	2143	1440	3728	964	4081	796	4344	644	4789	383	5347	115	4860

RECTANGULAR TIED COLUMNS 16" x 20"

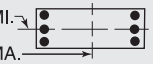
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.25	MA	2485	1242	3988	876	4204	738	4273	630	4276	469	4764	398	1868
2E		MI	1969	1242	3184	848	3312	714	3338	610	3305	452	3554	366	1477
4-#10	1.59	MA	2541	1272	4128	892	4376	749	4480	636	4557	465	5115	388	2316
2E		MI	2008	1272	3285	863	3435	724	3486	615	3503	447	3776	350	1816
4-#11	1.95	MA	2591	1304	4269	903	4539	756	4672	638	4815	457	5386	368	2771
2E		MI	2042	1304	3382	872	3544	729	3613	615	3645	432	3913	321	2156
4-#14	2.81	MA	2723	1380	4602	944	4955	784	5174	654	5496	447	6185	335	3845
2E		MI	2134	1380	3617	911	3835	756	3964	630	4081	413	4389	271	2946

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

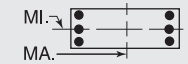
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	5.00	MA	3037	1574	5404	1052	5958	860	6388	697	7136	422	8007	238	6409
2E		MI	2345	1574	4171	1016	4523	829	4760	663	5064	357	5409	123	4786
6-#7	1.13	MA	2468	1231	3935	875	4148	738	4210	632	4193	473	4680	406	1702
2L-3S		MI	1917	1231	3029	851	3124	722	3113	617	3000	461	3206	335	1361
6-#7	1.13	MA	2411	1231	3776	879	3944	746	3960	639	3854	479	4224	364	1715
3L-2S		MI	1957	1231	3147	849	3275	716	3298	612	3252	458	3516	378	1350
6-#8	1.48	MA	2529	1263	4086	892	4335	750	4436	638	4499	469	5075	397	2185
2L-3S		MI	1949	1263	3104	867	3214	735	3221	625	3146	457	3375	308	1733
6-#8	1.48	MA	2456	1263	3878	896	4068	760	4110	647	4056	476	4484	341	2203
3L-2S		MI	2001	1263	3257	865	3411	727	3461	618	3473	453	3774	363	1716
6-#9	1.88	MA	2595	1298	4250	911	4539	763	4682	645	4833	464	5499	387	2708
2L-3S		MI	1984	1298	3184	886	3312	749	3338	633	3305	453	3554	276	2131
6-#9	1.88	MA	2505	1298	3988	916	4204	776	4273	657	4276	473	4764	316	2728
3L-2S		MI	2047	1298	3376	883	3558	739	3639	625	3714	448	4047	346	2109
6-#10	2.38	MA	2678	1342	4457	936	4798	780	4995	655	5257	459	6030	373	3366
2L-3S		MI	2027	1342	3285	910	3435	768	3486	644	3503	447	3776	234	2626
6-#10	2.38	MA	2566	1342	4128	942	4376	796	4480	669	4557	469	5115	283	3387
3L-2S		MI	2106	1342	3526	907	3744	756	3863	634	4014	441	4385	324	2599
6-#11	2.92	MA	2754	1390	4662	957	5043	794	5287	662	5652	450	6451	345	4024
2L-3S		MI	2066	1390	3382	928	3544	781	3613	649	3645	429	3913	173	3114
6-#11	2.92	MA	2623	1390	4269	964	4539	812	4672	677	4815	461	5386	235	4045
3L-2S		MI	2157	1390	3668	926	3910	768	4059	639	4237	423	4605	283	3082
6-#14	4.22	MA	2951	1505	5159	1022	5668	840	6044	688	6680	437	7658	298	5603
2L-3S		MI	2167	1505	3617	991	3835	829	3964	676	4081	406	4389	52	4250
6-#14	4.22	MA	2770	1505	4602	1030	4955	865	5174	709	5496	451	6185	140	5589
3L-2S		MI	2295	1505	4018	989	4349	812	4591	664	4898	396	5328	210	4230
6-#18	7.50	MA	3121	1795	5404	1201	5958	998	6388	789	7136	422	8007	-125	7883
3L-2S		MI	2609	1795	4844	1155	5387	929	5796	720	6388	317	6879	-7	6910
8-#7	1.50	MA	2535	1264	4095	896	4353	753	4459	641	4532	471	5136	400	2216
2L-4S		MI	1950	1264	3055	879	3156	738	3151	627	3061	462	3295	305	1767
8-#7	1.50	MA	2480	1264	3935	899	4148	761	4210	648	4193	476	4680	358	2228
3E		MI	1966	1264	3147	872	3275	737	3298	626	3252	458	3516	325	1751
8-#7	1.50	MA	2453	1264	3813	908	3989	764	4015	650	3939	482	4361	335	2242
4L-2S		MI	2006	1264	3265	869	3426	730	3482	621	3503	455	3827	367	1739
8-#8	1.98	MA	2617	1306	4294	919	4602	770	4761	650	4942	466	5665	389	2851
2L-4S		MI	1992	1306	3137	904	3255	756	3270	637	3224	458	3489	268	2251
8-#8	1.98	MA	2545	1306	4086	924	4335	780	4436	659	4499	473	5075	334	2865
3E		MI	2013	1306	3257	895	3411	754	3461	637	3473	454	3774	293	2232
8-#8	1.98	MA	2511	1306	3925	935	4127	783	4180	662	4167	480	4661	304	2877
4L-2S		MI	2064	1306	3411	892	3608	746	3702	630	3800	449	4173	349	2216
8-#9	2.50	MA	2704	1353	4511	946	4874	788	5091	661	5389	460	6234	376	3538
2L-4S		MI	2037	1353	3225	932	3362	775	3399	647	3402	453	3693	225	2765
8-#9	2.50	MA	2616	1353	4250	951	4539	801	4682	672	4833	469	5499	305	3553
3E		MI	2063	1353	3376	920	3558	774	3639	648	3714	448	4047	257	2748
8-#9	2.50	MA	2574	1353	4048	965	4278	805	4361	675	4415	477	4983	268	3553
4L-2S		MI	2126	1353	3569	918	3805	764	3939	640	4123	443	4539	327	2729
8-#10	3.17	MA	2815	1413	4786	980	5219	812	5509	674	5957	453	6946	358	4406
2L-4S		MI	2094	1413	3336	969	3498	801	3561	662	3623	446	3947	169	3282
8-#10	3.17	MA	2706	1413	4457	986	4798	828	4995	688	5257	464	6030	268	4417
3E		MI	2126	1413	3526	954	3744	800	3863	663	4014	441	4385	208	3391
8-#10	3.17	MA	2655	1413	4202	1004	4468	832	4590	691	4730	474	5386	222	4270
4L-2S		MI	2204	1413	3767	951	4053	787	4240	653	4525	435	4994	297	3371
8-#11	3.90	MA	2788	1477	4662	1017	5043	851	5287	701	5652	454	6451	213	5269
3E		MI	2182	1477	3668	982	3910	820	4059	672	4237	420	4605	135	4014

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

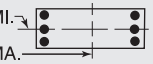
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	3.90	MA	2730	1477	4356	1038	4647	855	4800	703	5019	465	5697	158	4928
4L-2S		MI	2273	1477	3953	980	4276	807	4506	662	4829	413	5296	245	3994
8-#14	5.63	MA	3002	1629	5159	1108	5668	921	6044	743	6680	441	7658	103	7302
3E		MI	2330	1629	4018	1069	4349	885	4591	710	4898	389	5328	-9	5324
8-#14	5.63	MA	2924	1629	4724	1136	5105	925	5353	744	5781	454	6610	28	6484
4L-2S		MI	2456	1629	4419	1067	4863	868	5218	698	5714	379	6267	149	5497
10-#10	3.97	MA	2844	1483	4786	1030	5219	859	5509	708	5957	458	6946	253	5441
3L-4S		MI	2194	1483	3577	1013	3807	832	3939	681	4134	440	4556	143	3980
10-#10	3.97	MA	2794	1483	4531	1048	4890	864	5104	710	5430	469	6301	207	5233
4L-3S		MI	2225	1483	3767	998	4053	831	4240	682	4525	435	4994	182	4149
10-#10	3.97	MA	2698	1483	4316	1054	4604	880	4748	724	4905	468	5663	155	4985
5L-2S		MI	2302	1483	4008	995	4362	819	4617	672	5037	429	5603	271	4136
10-#11	4.88	MA	2896	1563	4749	1092	5151	894	5416	726	5856	458	6761	136	6082
4L-3S		MI	2298	1563	3953	1036	4276	858	4506	696	4829	410	5296	97	4906
10-#14	7.03	MA	3156	1754	5280	1214	5818	981	6223	778	6965	444	8083	-10	8073
4L-3S		MI	2493	1754	4419	1147	4863	941	5218	744	5714	372	6267	-70	6224
12-#10	4.76	MA	2932	1553	4860	1091	5311	895	5619	730	6130	463	7217	192	6203
4E		MI	2293	1553	3818	1056	4116	864	4316	700	4646	435	5165	117	4685
12-#10	4.76	MA	2838	1553	4645	1098	5026	911	5262	744	5604	462	6579	140	5974
5L-3S		MI	2324	1553	4008	1042	4362	863	4617	701	5037	429	5603	156	4902
14-#10	5.56	MA	2977	1623	4974	1142	5448	943	5777	763	6304	457	7494	125	6966
5L-4S		MI	2393	1623	4059	1100	4425	895	4693	719	5157	429	5774	90	5395

RECTANGULAR TIED COLUMNS 16" x 22"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.14	MA	2993	1355	4767	968	5037	817	5120	699	5111	523	5737	451	2084
2E		MI	2150	1355	3464	926	3593	781	3612	668	3553	498	3811	406	1497
4-#10	1.44	MA	3057	1385	4926	984	5233	827	5357	704	5432	519	6153	443	2591
2E		MI	2189	1385	3565	940	3717	790	3759	672	3750	493	4032	390	1838
4-#11	1.77	MA	3117	1417	5089	995	5423	834	5579	707	5730	511	6491	426	3108
2E		MI	2223	1417	3663	948	3825	794	3885	672	3891	478	4166	360	2183
4-#14	2.56	MA	3270	1494	5473	1036	5900	863	6155	723	6512	501	7453	399	4331
2E		MI	2315	1494	3899	987	4115	821	4235	686	4325	458	4640	310	2981
4-#18	4.55	MA	3635	1687	6399	1144	7060	939	7559	766	8417	478	9685	319	7273
2E		MI	2526	1687	4453	1090	4803	893	5029	718	5306	401	5656	162	4836
6-#7	1.02	MA	2973	1344	4705	967	4972	817	5046	700	5014	528	5631	458	1897
2L-3S		MI	2098	1344	3309	930	3406	789	3388	676	3250	508	3465	376	1377
6-#7	1.02	MA	2908	1344	4525	971	4740	825	4764	708	4631	534	5101	416	1910
3L-2S		MI	2138	1344	3427	927	3557	783	3572	670	3501	504	3775	418	1367
6-#8	1.35	MA	3043	1376	4876	984	5184	828	5303	707	5362	523	6095	452	2441
2L-3S		MI	2130	1376	3383	946	3496	802	3495	683	3396	503	3633	348	1753
6-#8	1.35	MA	2959	1376	4641	989	4882	839	4934	717	4860	532	5407	396	2459
3L-2S		MI	2182	1376	3537	943	3693	793	3735	676	3723	499	4032	404	1736
6-#9	1.70	MA	3119	1411	5063	1003	5416	841	5583	714	5741	519	6595	443	3032
2L-3S		MI	2165	1411	3464	964	3593	816	3612	691	3553	499	3811	317	2154
6-#9	1.70	MA	3015	1411	4767	1009	5037	855	5120	726	5111	529	5737	373	3052
3L-2S		MI	2228	1411	3656	961	3840	806	3912	683	3963	494	4303	387	2132
6-#10	2.16	MA	3215	1455	5299	1028	5711	859	5940	724	6225	513	7224	432	3778
2L-3S		MI	2208	1455	3565	988	3717	834	3759	701	3750	493	4032	275	2655
6-#10	2.16	MA	3086	1455	4926	1035	5233	876	5357	739	5432	526	6153	343	3798
3L-2S		MI	2287	1455	3806	984	4026	822	4136	691	4262	487	4641	364	2626
6-#11	2.66	MA	3304	1504	5537	1049	5996	873	6279	730	6682	504	7745	409	4530
2L-3S		MI	2247	1504	3663	1005	3825	846	3885	706	3891	475	4166	213	3149
6-#11	2.66	MA	3152	1504	5089	1057	5423	892	5579	748	5730	518	6491	299	4551
3L-2S		MI	2339	1504	3949	1002	4191	833	4331	695	4483	468	4858	323	3114
6-#14	3.84	MA	3532	1618	6107	1114	6713	919	7148	756	7862	491	9198	370	6332
2L-3S		MI	2348	1618	3899	1067	4115	894	4235	732	4325	451	4640	91	4302

RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

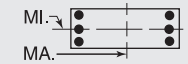
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	3.84	MA	3322	1618	5473	1124	5900	946	6155	780	6512	509	7453	212	6318
3L-2S		MI	2476	1618	4300	1065	4629	877	4862	720	5142	441	5579	249	4270
6-#18	6.82	MA	3732	1909	6399	1297	7060	1082	7559	863	8417	485	9685	-28	9646
3L-2S		MI	2791	1909	5127	1229	5667	992	6065	775	6630	360	7126	32	6967
8-#7	1.36	MA	3050	1377	4885	988	5203	831	5328	709	5398	525	6161	455	2475
2L-4S		MI	2131	1377	3334	958	3438	805	3425	685	3311	508	3554	346	1786
8-#7	1.36	MA	2986	1377	4705	992	4972	840	5046	717	5014	531	5631	412	2488
3E		MI	2147	1377	3427	950	3557	804	3572	685	3501	505	3775	366	1770
8-#7	1.36	MA	2954	1377	4567	1001	4793	843	4827	719	4728	538	5262	388	2502
4L-2S		MI	2187	1377	3545	948	3709	797	3757	679	3752	501	4085	408	1758
8-#8	1.80	MA	3144	1420	5112	1011	5486	848	5671	718	5863	520	6782	446	3192
2L-4S		MI	2173	1420	3416	983	3537	822	3544	695	3474	504	3747	308	2276
8-#8	1.80	MA	3061	1420	4876	1016	5184	859	5303	729	5362	528	6095	390	3207
3E		MI	2194	1420	3537	973	3693	821	3735	695	3723	500	4032	334	2255
8-#8	1.80	MA	3020	1420	4696	1028	4950	863	5016	732	4987	536	5616	359	3219
4L-2S		MI	2245	1420	3691	970	3890	813	3976	688	4050	496	4431	390	2238
8-#9	2.27	MA	3245	1466	5359	1038	5796	866	6046	729	6371	514	7452	435	3970
2L-4S		MI	2218	1466	3505	1010	3644	842	3672	705	3650	499	3950	266	2796
8-#9	2.27	MA	3143	1466	5063	1044	5416	880	5583	741	5741	525	6595	365	3985
3E		MI	2244	1466	3656	998	3840	840	3912	706	3963	494	4303	297	2775
8-#9	2.27	MA	3092	1466	4836	1058	5122	885	5221	745	5271	535	5996	326	3985
4L-2S		MI	2307	1466	3849	995	4086	830	4213	698	4372	490	4796	368	2755
8-#10	2.89	MA	3372	1526	5672	1072	6189	890	6523	743	7018	508	8294	421	4955
2L-4S		MI	2275	1526	3616	1046	3780	867	3835	719	3871	492	4203	209	3391
8-#10	2.89	MA	3246	1526	5299	1079	5711	907	5940	758	6225	520	7224	332	4966
3E		MI	2307	1526	3806	1032	4026	866	4136	721	4262	487	4641	248	3423
8-#10	2.89	MA	3184	1526	5012	1098	5340	913	5484	763	5631	532	6475	282	4881
4L-2S		MI	2385	1526	4047	1028	4335	853	4513	711	4773	481	5249	338	3401
8-#11	3.55	MA	3342	1590	5537	1111	5996	931	6279	771	6682	511	7745	282	5943
3E		MI	2363	1590	3949	1059	4191	885	4331	729	4483	465	4858	175	4055
8-#11	3.55	MA	3271	1590	5191	1133	5548	937	5729	775	5967	524	6863	224	5642
4L-2S		MI	2454	1590	4234	1056	4557	872	4778	719	5076	458	5549	285	4030
8-#14	5.11	MA	3589	1743	6107	1202	6713	1002	7148	814	7862	499	9198	183	8274
3E		MI	2511	1743	4300	1145	4629	950	4862	766	5142	434	5579	30	5495
8-#14	5.11	MA	3493	1743	5615	1233	6076	1009	6365	819	6844	516	7966	102	7438
4L-2S		MI	2637	1743	4701	1143	5143	933	5489	754	5959	424	6518	189	5541
10-#10	3.61	MA	3405	1596	5672	1123	6189	939	6523	777	7018	514	8294	320	6126
3L-4S		MI	2375	1596	3857	1090	4089	898	4212	738	4382	486	4812	183	4064
10-#10	3.61	MA	3343	1596	5385	1142	5818	945	6067	782	6424	527	7546	271	5975
4L-3S		MI	2406	1596	4047	1076	4335	897	4513	740	4773	481	5249	222	4185
10-#10	3.61	MA	3234	1596	5144	1149	5497	962	5666	797	5833	528	6799	221	5656
5L-2S		MI	2483	1596	4288	1072	4644	885	4891	730	5285	475	5858	311	4168
10-#11	4.43	MA	3461	1676	5639	1187	6122	976	6429	799	6919	517	8117	206	6958
4L-3S		MI	2479	1676	4234	1113	4557	924	4778	753	5076	455	5549	137	4952
10-#11	4.43	MA	3331	1676	5347	1195	5734	996	5945	816	6205	517	7243	143	6629
5L-2S		MI	2569	1676	4520	1110	4923	910	5225	742	5668	448	6240	247	4936
10-#14	6.39	MA	3760	1867	6250	1311	6889	1065	7357	852	8193	506	9712	73	9319
4L-3S		MI	2674	1867	4701	1222	5143	1006	5489	800	5959	417	6518	-30	6501
12-#10	4.33	MA	3502	1666	5758	1185	6296	976	6650	801	7218	521	8616	260	7077
4E		MI	2474	1666	4098	1134	4398	930	4589	758	4894	480	5421	157	4768
12-#10	4.33	MA	3394	1666	5517	1193	5975	993	6249	816	6626	522	7870	209	6779
5L-3S		MI	2505	1666	4288	1119	4644	929	4891	759	5285	475	5858	196	4941

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

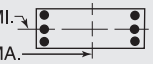
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	4.33	MA	3315	1666	5269	1211	5655	999	5852	821	6092	534	7187	153	6415
6L-2S		MI	2581	1666	4530	1116	4953	916	5268	749	5796	469	6467	285	4930
12-#11	5.32	MA	3522	1763	5794	1249	6308	1034	6645	840	7157	510	8497	126	7973
5L-3S		MI	2595	1763	4520	1167	4923	962	5225	776	5668	445	6240	99	5842
14-#10	5.05	MA	3554	1737	5889	1237	6453	1025	6832	835	7419	517	8941	198	7906
5L-4S		MI	2574	1737	4339	1178	4707	961	4966	777	5405	475	6029	131	5477
14-#10	5.05	MA	3477	1737	5642	1254	6133	1031	6435	840	6886	529	8258	142	7524
6L-3S		MI	2604	1737	4530	1163	4953	960	5268	778	5796	469	6467	170	5693
16-#10	5.77	MA	3637	1807	6015	1298	6611	1062	7018	859	7679	523	9328	131	8637
6L-4S		MI	2673	1807	4580	1222	5016	993	5343	796	5917	469	6638	104	6191

RECTANGULAR TIED COLUMNS 16" x 24"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.04	MA	3547	1468	5610	1060	5939	895	6038	767	6013	578	6771	502	2300
2E		MI	2331	1468	3744	1004	3875	847	3885	725	3802	545	4067	447	1515
4-#10	1.32	MA	3620	1498	5788	1076	6160	906	6303	773	6373	573	7265	497	2865
2E		MI	2370	1498	3845	1018	3998	856	4033	730	3998	539	4287	430	1860
4-#11	1.63	MA	3688	1530	5975	1087	6376	912	6557	775	6713	566	7670	482	3445
2E		MI	2404	1530	3944	1025	4106	859	4157	729	4137	523	4419	400	2210
4-#14	2.34	MA	3863	1607	6408	1128	6915	941	7208	791	7595	556	8797	460	4817
2E		MI	2496	1607	4180	1063	4396	885	4506	742	4570	503	4891	349	3014
4-#18	4.17	MA	4280	1800	7459	1236	8232	1017	8801	834	9756	532	11445	393	8137
2E		MI	2708	1800	4735	1164	5083	956	5298	773	5548	445	5903	200	4884
6-#8	1.23	MA	3603	1489	5731	1076	6103	907	6241	775	6291	578	7157	502	2697
2L-3S		MI	2311	1489	3663	1024	3778	868	3769	741	3645	550	3890	389	1771
6-#8	1.23	MA	3508	1489	5468	1081	5766	918	5830	786	5732	587	6383	447	2715
3L-2S		MI	2363	1489	3817	1021	3975	860	4009	734	3972	546	4289	445	1755
6-#9	1.56	MA	3689	1524	5940	1095	6363	920	6555	782	6717	573	7745	496	3356
2L-3S		MI	2346	1524	3744	1042	3875	882	3885	749	3802	545	4067	357	2176
6-#9	1.56	MA	3571	1524	5610	1102	5939	934	6038	796	6013	584	6771	427	3376
3L-2S		MI	2410	1524	3936	1039	4122	872	4186	741	4211	540	4560	427	2154
6-#10	1.98	MA	3798	1569	6205	1120	6694	937	6955	792	7260	568	8492	489	4189
2L-3S		MI	2389	1569	3845	1065	3998	900	4033	759	3998	538	4287	315	2681
6-#10	1.98	MA	3651	1569	5788	1128	6160	955	6303	809	6373	582	7265	400	4210
3L-2S		MI	2468	1569	4087	1062	4307	888	4410	749	4510	533	4896	404	2651
6-#11	2.44	MA	3900	1617	6476	1141	7019	951	7341	798	7780	559	9115	469	5035
2L-3S		MI	2428	1617	3944	1081	4106	911	4157	762	4137	520	4419	252	3183
6-#11	2.44	MA	3727	1617	5975	1150	6376	972	6557	818	6713	574	7670	359	5056
3L-2S		MI	2520	1617	4230	1079	4472	898	4603	752	4729	513	5111	362	3146
6-#14	3.52	MA	4160	1731	7120	1206	7828	997	8322	825	9111	546	10817	438	7061
2L-3S		MI	2529	1731	4180	1142	4396	958	4506	789	4570	496	4891	130	4348
6-#14	3.52	MA	3921	1731	6408	1218	6915	1026	7208	851	7595	566	8797	280	7047
3L-2S		MI	2657	1731	4581	1140	4910	941	5133	776	5387	486	5830	289	4309
6-#18	6.25	MA	4389	2022	7459	1393	8232	1164	8801	937	9756	545	11445	59	11249
3L-2S		MI	2973	2022	5409	1302	5946	1055	6334	830	6871	404	7373	70	7022
8-#7	1.25	MA	3611	1491	5740	1080	6122	910	6268	777	6330	579	7212	503	2734
2L-4S		MI	2312	1491	3613	1036	3720	872	3700	744	3560	555	3812	387	1803
8-#7	1.25	MA	3538	1491	5539	1084	5865	914	5953	786	5902	586	6620	462	2747
3E		MI	2328	1491	3706	1029	3839	871	3847	743	3751	551	4033	407	1788
8-#7	1.25	MA	3501	1491	5386	1094	5667	922	5710	789	5585	594	6213	438	2761
4L-2S		MI	2368	1491	3824	1027	3991	865	4031	738	4002	548	4344	449	1776
8-#8	1.65	MA	3717	1533	5994	1103	6440	926	6652	787	6851	574	7932	497	3533
2L-4S		MI	2354	1533	3696	1061	3819	889	3818	753	3723	550	4004	349	2298
8-#8	1.65	MA	3623	1533	5731	1109	6103	938	6241	798	6291	583	7157	442	3548
3E		MI	2375	1533	3817	1051	3975	888	4009	753	3972	546	4289	375	2277
8-#8	1.65	MA	3575	1533	5531	1121	5843	943	5922	801	5875	592	6623	411	3560
4L-2S		MI	2426	1533	3970	1049	4172	880	4250	746	4299	542	4688	430	2260

RECTANGULAR TIED COLUMNS 16" x 24"

Short columns – no sidesway
Bending on major or minor axis

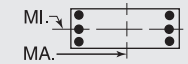


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.08	MA	3831	1579	6271	1129	6787	945	7072	797	7420	569	8719	490	4402
2L-4S		MI	2399	1579	3785	1088	3926	908	3946	763	3899	545	4207	306	2824
8-#9	2.08	MA	3715	1579	5940	1136	6363	959	6555	811	6717	580	7745	420	4417
3E		MI	2425	1579	3936	1076	4122	907	4186	764	4211	541	4560	338	2801
8-#9	2.08	MA	3656	1579	5688	1152	6036	965	6153	815	6193	591	7071	380	4417
4L-2S		MI	2488	1579	4129	1073	4368	897	4487	756	4620	536	5053	408	2780
8-#10	2.65	MA	3976	1639	6622	1164	7229	969	7607	811	8146	562	9719	481	5503
2L-4S		MI	2456	1639	3896	1124	4061	933	4108	777	4119	538	4459	250	3472
8-#10	2.65	MA	3832	1639	6205	1172	6694	987	6955	828	7260	576	8492	392	5515
3E		MI	2488	1639	4087	1109	4307	932	4410	778	4510	533	4896	289	3454
8-#10	2.65	MA	3758	1639	5887	1191	6281	994	6448	833	6599	590	7639	341	5482
4L-2S		MI	2566	1639	4328	1106	4616	920	4787	768	5021	527	5505	378	3429
8-#11	3.25	MA	3942	1703	6476	1204	7019	1011	7341	841	7780	567	9115	346	6617
3E		MI	2544	1703	4230	1135	4472	950	4603	786	4729	510	5111	215	4093
8-#11	3.25	MA	3858	1703	6091	1227	6520	1018	6728	847	6982	582	8105	286	6373
4L-2S		MI	2635	1703	4515	1132	4838	937	5050	776	5322	503	5802	324	4065
8-#14	4.69	MA	4224	1856	7120	1296	7828	1082	8322	885	9111	556	10817	257	9246
3E		MI	2692	1856	4581	1220	4910	1014	5133	823	5387	479	5830	70	5602
8-#14	4.69	MA	4108	1856	6571	1328	7117	1092	7448	892	7974	577	9401	172	8412
4L-2S		MI	2818	1856	4982	1218	5424	997	5760	810	6204	469	6769	228	5584
10-#10	3.31	MA	4011	1709	6622	1216	7229	1018	7607	847	8146	570	9719	384	6812
3L-4S		MI	2556	1709	4137	1168	4370	964	4485	796	4630	532	5067	223	4145
10-#10	3.31	MA	3939	1709	6303	1235	6816	1025	7100	852	7486	584	8865	333	6732
4L-3S		MI	2587	1709	4328	1153	4616	963	4787	797	5021	527	5505	262	4218
10-#10	3.31	MA	3815	1709	6036	1244	6460	1043	6655	869	6828	587	8010	283	6337
5L-2S		MI	2664	1709	4569	1150	4926	951	5164	787	5533	521	6114	352	4199
10-#11	4.06	MA	4073	1789	6592	1281	7163	1057	7512	870	8049	576	9550	273	7851
4L-3S		MI	2660	1789	4515	1189	4838	989	5050	809	5322	500	5802	177	4994
10-#11	4.06	MA	3926	1789	6269	1290	6732	1078	6974	889	7254	577	8543	210	7441
5L-2S		MI	2750	1789	4801	1186	5204	976	5497	799	5914	493	6493	286	4974
10-#14	5.86	MA	4411	1980	7283	1406	8030	1148	8562	926	9489	567	11421	150	10530
4L-3S		MI	2855	1980	4982	1298	5424	1070	5760	856	6204	462	6769	9	6743
10-#14	5.86	MA	4205	1980	6821	1419	7415	1177	7795	952	8356	567	10013	59	9770
5L-2S		MI	2979	1980	5383	1296	5938	1053	6387	844	7021	452	7708	167	6849
12-#10	3.97	MA	4118	1779	6720	1279	7350	1057	7751	871	8372	578	10092	325	7967
4E		MI	2655	1779	4378	1212	4680	996	4862	815	5142	526	5676	197	4848
12-#10	3.97	MA	3997	1779	6453	1287	6994	1075	7307	888	7715	581	9237	275	7594
5L-3S		MI	2686	1779	4569	1197	4926	995	5164	817	5533	521	6114	236	4977
12-#10	3.97	MA	3908	1779	6192	1293	6639	1082	6866	893	7122	595	8457	216	7244
6L-2S		MI	2762	1779	4810	1194	5235	983	5541	807	6044	515	6723	325	4963
12-#11	4.88	MA	4142	1876	6770	1344	7374	1117	7759	913	8321	570	9988	197	8955
5L-3S		MI	2776	1876	4801	1243	5204	1028	5497	833	5914	490	6493	139	5890
12-#11	4.88	MA	4036	1876	6436	1366	6945	1124	7225	918	7604	586	9067	127	8377
6L-2S		MI	2865	1876	5087	1240	5571	1014	5943	823	6506	483	7185	249	5877
12-#14	7.03	MA	4510	2105	7533	1496	8328	1233	8908	986	9871	557	12033	37	11874
5L-3S		MI	3017	2105	5383	1376	5938	1126	6387	890	7021	445	7708	-52	7674
14-#10	4.63	MA	4177	1850	6870	1331	7528	1106	7958	907	8602	575	10464	267	8855
5L-4S		MI	2755	1850	4620	1255	4989	1027	5239	834	5653	520	6285	171	5557
14-#10	4.63	MA	4090	1850	6609	1337	7174	1113	7518	913	8009	589	9684	208	8488
6L-3S		MI	2785	1850	4810	1241	5235	1026	5541	836	6044	515	6723	210	5733
14-#11	5.69	MA	4254	1962	6938	1420	7588	1163	8009	942	8671	579	10512	114	9877
6L-3S		MI	2892	1962	5087	1297	5571	1066	5943	856	6506	481	7185	101	6777
16-#10	5.29	MA	4272	1920	7026	1381	7708	1145	8169	932	8896	583	10911	200	9737
6L-4S		MI	2854	1920	4861	1299	5298	1059	5616	854	6165	515	6894	145	6270

RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

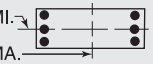
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.22	MA	4228	1612	6715	1168	7157	984	7321	841	7381	628	8398	545	3139
2E		MI	2551	1612	4126	1096	4280	923	4306	788	4246	585	4543	471	1880
4-#11	1.50	MA	4306	1644	6924	1179	7399	991	7606	843	7763	620	8922	537	3782
2E		MI	2585	1644	4225	1101	4387	925	4428	786	4383	568	4672	440	2235
4-#14	2.16	MA	4502	1720	7407	1220	8000	1020	8331	859	8745	610	10217	519	5303
2E		MI	2677	1720	4462	1138	4677	950	4777	798	4815	548	5142	389	3046
4-#18	3.85	MA	4973	1914	8584	1328	9473	1095	10113	902	11162	587	13284	463	9001
2E		MI	2889	1914	5017	1238	5362	1019	5567	828	5790	488	6150	239	4931
6-#8	1.14	MA	4209	1602	6650	1168	7092	985	7249	843	7288	632	8272	549	2953
2L-3S		MI	2492	1602	3943	1102	4060	935	4043	799	3894	596	4148	430	1788
6-#8	1.14	MA	4102	1602	6360	1174	6720	990	6795	855	6670	642	7417	496	2970
3L-2S		MI	2544	1602	4096	1100	4257	927	4283	793	4221	592	4547	485	1774
6-#9	1.44	MA	4306	1637	6882	1187	7380	998	7597	851	7759	628	8924	544	3680
2L-3S		MI	2527	1637	4024	1120	4157	949	4159	807	4051	591	4324	397	2197
6-#9	1.44	MA	4172	1637	6517	1194	6912	1005	7026	865	6982	640	7848	476	3700
3L-2S		MI	2591	1637	4216	1117	4404	939	4460	798	4460	586	4817	468	2175
6-#10	1.83	MA	4428	1682	7176	1212	7748	1016	8041	860	8361	622	9755	537	4601
2L-3S		MI	2570	1682	4126	1143	4280	966	4306	817	4246	584	4543	355	2706
6-#10	1.83	MA	4262	1682	6715	1221	7157	1023	7321	878	7381	637	8398	450	4621
3L-2S		MI	2649	1682	4367	1139	4589	954	4683	807	4758	579	5152	444	2676
6-#11	2.25	MA	4543	1730	7480	1233	8111	1030	8474	867	8944	613	10558	527	5541
2L-3S		MI	2609	1730	4225	1157	4387	976	4428	819	4383	565	4672	292	3214
6-#11	2.25	MA	4348	1730	6924	1243	7399	1052	7606	887	7763	630	8922	418	5561
3L-2S		MI	2701	1730	4511	1155	4753	963	4875	809	4976	558	5364	402	3176
6-#14	3.25	MA	4835	1844	8197	1298	9013	1075	9567	893	10426	600	12513	502	7790
2L-3S		MI	2710	1844	4462	1218	4677	1023	4777	845	4815	541	5142	170	4391
6-#14	3.25	MA	4565	1844	7407	1312	8000	1106	8331	922	8745	623	10217	344	7776
3L-2S		MI	2838	1844	4863	1216	5191	1006	5404	832	5632	531	6081	328	4347
6-#18	5.77	MA	5094	2135	8584	1488	9473	1246	10113	1009	11162	605	13284	140	12777
3L-2S		MI	3154	2135	5691	1376	6226	1118	6602	885	7113	448	7620	108	7075
8-#7	1.15	MA	4217	1604	6660	1172	7112	988	7278	846	7329	634	8331	551	2994
2L-4S		MI	2494	1604	3893	1115	4002	939	3974	802	3810	601	4071	428	1820
8-#7	1.15	MA	4136	1604	6438	1176	6828	992	6931	855	6857	641	7678	511	3006
3E		MI	2509	1604	3985	1108	4122	938	4121	802	4001	598	4292	448	1805
8-#7	1.15	MA	4093	1604	6270	1186	6610	1002	6663	858	6508	649	7234	487	3020
4L-2S		MI	2549	1604	4103	1105	4273	932	4306	796	4252	595	4602	490	1794
8-#8	1.52	MA	4336	1646	6941	1195	7464	1005	7703	855	7905	629	9127	545	3874
2L-4S		MI	2535	1646	3976	1139	4101	956	4092	811	3972	597	4262	390	2319
8-#8	1.52	MA	4230	1646	6650	1201	7092	1010	7249	867	7288	639	8272	492	3889
3E		MI	2556	1646	4096	1130	4257	955	4283	811	4221	593	4547	415	2298
8-#8	1.52	MA	4175	1646	6430	1214	6806	1022	6898	871	6830	648	7690	461	3901
4L-2S		MI	2607	1646	4250	1127	4454	947	4524	804	4548	588	4946	471	2281
8-#9	1.92	MA	4464	1692	7247	1221	7848	1023	8168	866	8536	623	10000	538	4834
2L-4S		MI	2580	1692	4065	1166	4208	975	4220	821	4148	591	4464	347	2851
8-#9	1.92	MA	4333	1692	6882	1229	7380	1029	7597	880	7759	635	8924	470	4849
3E		MI	2606	1692	4216	1154	4404	973	4460	822	4460	587	4817	378	2825
8-#9	1.92	MA	4265	1692	6605	1245	7020	1044	7155	885	7183	647	8188	431	4849
4L-2S		MI	2669	1692	4409	1151	4650	963	4760	814	4869	582	5310	448	2804
8-#10	2.44	MA	4625	1752	7637	1255	8338	1047	8762	880	9341	617	11113	530	6052
2L-4S		MI	2637	1752	4176	1201	4343	999	4381	835	4367	584	4714	290	3508
8-#10	2.44	MA	4464	1752	7176	1264	7748	1055	8041	897	8361	632	9755	443	6063
3E		MI	2669	1752	4367	1187	4589	998	4683	836	4758	578	5152	329	3483
8-#10	2.44	MA	4379	1752	6826	1285	7293	1074	7483	903	7634	646	8823	392	6031
4L-2S		MI	2748	1752	4608	1183	4898	986	5060	826	5269	573	5761	418	3457

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

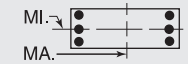
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	3.00	MA	4589	1816	7480	1297	8111	1091	8474	911	8944	623	10558	408	7291
3E		MI	2725	1816	4511	1211	4753	1015	4875	843	4976	555	5364	254	4130
8-#11	3.00	MA	4491	1816	7055	1321	7561	1099	7798	918	8064	640	9420	345	7119
4L-2S		MI	2816	1816	4796	1209	5119	1002	5322	833	5568	548	6055	364	4098
8-#14	4.33	MA	4905	1969	8197	1389	9013	1162	9567	956	10426	613	12513	327	10218
3E		MI	2873	1969	4863	1296	5191	1079	5404	879	5632	524	6081	109	5654
8-#14	4.33	MA	4770	1969	7592	1423	8228	1174	8602	964	9171	636	10911	238	9406
4L-2S		MI	2999	1969	5264	1294	5705	1062	6031	866	6448	514	7020	267	5626
8-#18	7.69	MA	5453	2356	8895	1683	9859	1362	10572	1080	11886	623	14433	-52	14349
4L-2S		MI	3418	2356	6365	1515	7090	1217	7638	941	8436	408	9090	-22	9081
10-#10	3.05	MA	4664	1822	7637	1308	8338	1086	8762	916	9341	626	11113	435	7498
3L-4S		MI	2737	1822	4418	1245	4652	1030	4758	854	4878	578	5323	264	4253
10-#10	3.05	MA	4581	1822	7286	1329	7884	1105	8203	923	8614	641	10180	385	7454
4L-3S		MI	2768	1822	4608	1231	4898	1029	5060	855	5269	572	5761	303	4250
10-#10	3.05	MA	4442	1822	6993	1338	7493	1113	7714	940	7890	645	9242	337	7026
5L-2S		MI	2846	1822	4849	1227	5207	1017	5437	845	5781	567	6370	392	4229
10-#11	3.75	MA	4731	1903	7611	1375	8273	1138	8667	941	9246	633	11056	336	8762
4L-3S		MI	2841	1903	4796	1265	5119	1054	5322	866	5568	545	6055	216	5034
10-#11	3.75	MA	4566	1903	7255	1385	7799	1160	8075	962	8370	636	9916	274	8261
5L-2S		MI	2931	1903	5082	1263	5486	1041	5769	856	6160	539	6746	326	5011
10-#14	5.41	MA	5109	2093	8382	1501	9241	1229	9838	998	10852	626	13208	221	11762
4L-3S		MI	3035	2093	5264	1374	5705	1135	6031	913	6448	507	7020	48	6874
10-#14	5.41	MA	4878	2093	7873	1515	8564	1261	8992	1026	9602	629	11607	132	11013
5L-2S		MI	3160	2093	5665	1372	6219	1117	6658	900	7265	497	7959	206	6894
12-#10	3.66	MA	4781	1893	7747	1373	8474	1137	8924	942	9594	635	11537	377	8872
4E		MI	2836	1893	4659	1289	4961	1062	5135	873	5390	572	5932	237	4925
12-#10	3.66	MA	4645	1893	7453	1382	8083	1144	8435	959	8871	639	10600	329	8417
5L-3S		MI	2867	1893	4849	1274	5207	1061	5437	874	5781	567	6370	276	5012
12-#10	3.66	MA	4546	1893	7160	1387	7694	1163	7951	966	8220	654	9749	271	8091
6L-2S		MI	2944	1893	5090	1271	5516	1049	5814	864	6292	561	6979	366	4995
12-#11	4.50	MA	4808	1989	7810	1439	8511	1199	8943	985	9551	629	11553	264	9942
5L-3S		MI	2957	1989	5082	1319	5486	1093	5769	890	6160	536	6746	178	5932
12-#11	4.50	MA	4690	1989	7462	1446	8039	1207	8356	992	8762	646	10513	192	9367
6L-2S		MI	3047	1989	5368	1317	5852	1079	6215	880	6752	529	7438	288	5916
12-#14	6.49	MA	5220	2218	8663	1593	9576	1316	10227	1060	11283	619	13903	115	13360
5L-3S		MI	3198	2218	5665	1451	6219	1190	6658	947	7265	490	7959	-13	7951
14-#10	4.27	MA	4846	1963	7914	1425	8674	1176	9155	978	9851	633	11957	322	9813
5L-4S		MI	2936	1963	4900	1333	5270	1093	5512	892	5901	566	6541	211	5633
14-#10	4.27	MA	4750	1963	7621	1431	8284	1195	8671	985	9200	648	11106	263	9472
6L-3S		MI	2966	1963	5090	1318	5516	1092	5814	893	6292	561	6979	250	5770
14-#10	4.27	MA	4650	1963	7290	1447	7905	1201	8209	1002	8566	663	10224	224	9015
7L-2S		MI	3041	1963	5331	1315	5825	1080	6191	883	6804	555	7588	339	5757
14-#11	5.25	MA	4934	2075	8018	1500	8751	1246	9224	1015	9944	640	12149	182	11034
6L-3S		MI	3073	2075	5368	1373	5852	1131	6215	913	6752	526	7438	140	6827
16-#10	4.88	MA	4952	2033	8082	1475	8875	1226	9392	1004	10180	643	12463	255	10857
6L-4S		MI	3035	2033	5141	1377	5579	1125	5889	911	6413	560	7150	185	6346
16-#10	4.88	MA	4853	2033	7751	1491	8496	1233	8929	1022	9546	658	11582	216	10415
7L-3S		MI	3064	2033	5331	1362	5825	1124	6191	912	6804	555	7588	224	6525
18-#10	5.50	MA	5055	2103	8212	1535	9086	1264	9650	1041	10526	652	12939	208	11817
7L-4S		MI	3134	2103	5382	1421	5888	1157	6266	930	6924	554	7759	159	7062

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis

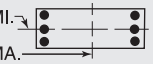


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.13	MA	4882	1725	7706	1260	8224	1062	8409	910	8456	682	9601	593	3414
2E		MI	2732	1725	4406	1173	4562	989	4579	845	4494	630	4799	511	1901
4-#11	1.39	MA	4969	1757	7938	1271	8493	1069	8725	912	8879	674	10181	585	4119
2E		MI	2766	1757	4506	1177	4668	990	4700	842	4629	613	4925	479	2260
4-#14	2.01	MA	5187	1833	8471	1312	9155	1098	9525	928	9963	664	11678	573	5789
2E		MI	2858	1833	4744	1214	4957	1014	5048	855	5059	592	5393	428	3078
4-#18	3.57	MA	5713	2027	9772	1420	10784	1174	11496	971	12635	641	15201	529	9865
2E		MI	3071	2027	5300	1312	5642	1082	5836	883	6032	532	6397	277	4976
6-#8	1.06	MA	4860	1715	7634	1260	8150	1064	8328	912	8351	687	9459	597	3209
2L-3S		MI	2673	1715	4222	1181	4342	1002	4317	858	4143	642	4406	470	1805
6-#8	1.06	MA	4741	1715	7316	1266	7743	1069	7832	923	7675	697	8524	545	3226
3L-2S		MI	2725	1715	4376	1178	4539	994	4557	851	4470	638	4805	526	1791
6-#9	1.34	MA	4967	1750	7888	1279	8467	1077	8710	919	8869	682	10174	592	4004
2L-3S		MI	2708	1750	4304	1198	4439	1015	4432	865	4299	637	4581	438	2217
6-#9	1.34	MA	4819	1750	7488	1286	7955	1083	8085	934	8018	695	8996	526	4024
3L-2S		MI	2772	1750	4496	1195	4686	1005	4733	856	4709	632	5074	508	2196
6-#10	1.70	MA	5103	1795	8211	1303	8871	1094	9198	929	9530	677	11087	585	5012
2L-3S		MI	2751	1795	4406	1220	4562	1032	4579	874	4494	630	4799	395	2730
6-#10	1.70	MA	4919	1795	7706	1313	8224	1102	8409	947	8456	693	9601	500	5033
3L-2S		MI	2831	1795	4647	1217	4871	1020	4956	864	5006	625	5408	485	2700
6-#11	2.09	MA	5232	1843	8548	1325	9274	1108	9678	935	10176	667	11977	575	6046
2L-3S		MI	2790	1843	4506	1234	4668	1042	4700	876	4629	610	4925	332	3244
6-#11	2.09	MA	5014	1843	7938	1336	8493	1117	8725	957	8879	686	10181	468	6067
3L-2S		MI	2882	1843	4792	1231	5034	1028	5147	866	5222	603	5617	442	3205
6-#14	3.01	MA	5557	1958	9339	1390	10268	1154	10882	962	11809	654	14235	559	8519
2L-3S		MI	2891	1958	4744	1294	4957	1087	5048	901	5059	585	5393	209	4432
6-#14	3.01	MA	5256	1958	8471	1405	9155	1186	9525	992	9963	680	11678	402	8505
3L-2S		MI	3019	1958	5145	1292	5471	1070	5675	889	5876	575	6332	367	4383
6-#18	5.36	MA	5845	2248	9772	1582	10784	1328	11496	1081	12635	663	15201	215	14326
3L-2S		MI	3336	2248	5973	1450	6506	1181	6871	940	7355	492	7867	147	7128
8-#7	1.07	MA	4869	1717	7643	1264	8172	1067	8359	914	8395	688	9522	598	3253
2L-4S		MI	2675	1717	4172	1194	4284	1006	4249	861	4060	648	4330	469	1835
8-#7	1.07	MA	4778	1717	7401	1269	7861	1071	7980	923	7879	696	8807	559	3265
3E		MI	2691	1717	4265	1186	4404	1005	4395	860	4251	645	4551	488	1822
8-#7	1.07	MA	4730	1717	7218	1279	7624	1081	7687	927	7498	704	8327	536	3279
4L-2S		MI	2730	1717	4383	1184	4555	999	4580	855	4502	641	4861	531	1812
8-#8	1.41	MA	5000	1759	7951	1287	8558	1083	8825	924	9027	683	10395	592	4216
2L-4S		MI	2716	1759	4255	1217	4383	1023	4366	869	4221	643	4520	430	2339
8-#8	1.41	MA	4883	1759	7634	1293	8150	1089	8328	935	8351	694	9459	541	4230
3E		MI	2737	1759	4376	1208	4539	1022	4557	870	4470	639	4805	456	2318
8-#8	1.41	MA	4821	1759	7394	1307	7839	1101	7945	940	7852	704	8829	510	4242
4L-2S		MI	2788	1759	4530	1205	4736	1013	4798	863	4797	635	5204	512	2301
8-#9	1.79	MA	5142	1805	8288	1313	8980	1102	9336	934	9719	678	11352	586	5266
2L-4S		MI	2761	1805	4345	1244	4490	1041	4493	879	4396	638	4721	387	2876
8-#9	1.79	MA	4997	1805	7888	1321	8467	1108	8710	949	8869	691	10174	520	5281
3E		MI	2787	1805	4496	1232	4686	1040	4733	880	4709	633	5074	419	2849
8-#9	1.79	MA	4919	1805	7586	1338	8075	1124	8228	955	8240	703	9377	481	5281
4L-2S		MI	2850	1805	4688	1229	4932	1030	5034	872	5118	628	5567	489	2827
8-#10	2.27	MA	5321	1865	8716	1347	9517	1126	9987	948	10603	671	12574	577	6601
2L-4S		MI	2818	1865	4457	1279	4625	1065	4654	892	4615	630	4970	330	3539
8-#10	2.27	MA	5142	1865	8211	1357	8871	1134	9198	966	9530	687	11087	493	6612
3E		MI	2850	1865	4647	1264	4871	1064	4956	893	5006	624	5408	369	3511
8-#10	2.27	MA	5045	1865	7829	1378	8375	1154	8588	973	8735	703	10077	443	6580
4L-2S		MI	2929	1865	4888	1261	5180	1052	5333	884	5517	619	6017	458	3484
8-#11	2.79	MA	5281	1929	8548	1390	9274	1156	9678	980	10176	679	11977	459	7965
3E		MI	2906	1929	4792	1288	5034	1080	5147	900	5222	600	5617	294	4165
8-#11	2.79	MA	5169	1929	8084	1414	8673	1179	8939	988	9213	697	10743	397	7881
4L-2S		MI	2997	1929	5077	1285	5401	1067	5594	889	5814	594	6308	404	4131

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

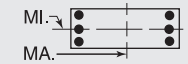
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	4.02	MA	5632	2082	9339	1483	10268	1242	10882	1026	11809	670	14235	388	11190
3E		MI	3054	2082	5145	1371	5471	1143	5675	935	5876	568	6332	148	5699
8-#14	4.02	MA	5477	2082	8677	1518	9409	1255	9827	1036	10435	695	12464	298	10417
4L-2S		MI	3180	2082	5545	1369	5985	1126	6302	923	6693	558	7271	306	5667
8-#18	7.14	MA	6234	2469	10122	1780	11216	1446	12010	1155	13443	686	16511	26	16343
4L-2S		MI	3600	2469	6647	1589	7369	1280	7907	996	8678	451	9337	17	9251
10-#10	2.83	MA	5363	1935	8716	1401	9517	1165	9987	985	10603	681	12574	485	8184
3L-4S		MI	2918	1935	4698	1323	4934	1097	5031	911	5126	624	5579	304	4301
10-#10	2.83	MA	5268	1935	8333	1422	9021	1185	9378	993	9809	697	11564	435	8139
4L-3S		MI	2949	1935	4888	1308	5180	1096	5333	913	5517	618	6017	343	4281
10-#10	2.83	MA	5115	1935	8014	1431	8595	1193	8845	1011	9020	702	10545	390	7723
5L-2S		MI	3027	1935	5129	1305	5489	1083	5710	903	6029	613	6626	432	4258
10-#11	3.48	MA	5435	2016	8693	1468	9454	1218	9892	1012	10510	690	12538	387	9687
4L-3S		MI	3022	2016	5077	1342	5401	1119	5594	923	5814	591	6308	256	5073
10-#11	3.48	MA	5253	2016	8305	1479	8937	1227	9246	1033	9553	695	11298	329	9092
5L-2S		MI	3113	2016	5363	1339	5767	1106	6041	913	6406	584	7000	366	5046
10-#14	5.02	MA	5853	2207	9544	1595	10522	1311	11184	1070	12282	685	15020	284	13013
4L-3S		MI	3216	2207	5545	1449	5985	1199	6302	969	6693	551	7271	87	6954
10-#14	5.02	MA	5598	2207	8989	1611	9782	1343	10260	1100	10915	690	13243	197	12287
5L-2S		MI	3341	2207	5946	1447	6499	1182	6929	956	7510	541	8210	246	6938
12-#10	3.40	MA	5489	2006	8838	1466	9668	1217	10167	1012	10883	692	13051	427	9699
4E		MI	3017	2006	4939	1367	5243	1128	5408	930	5638	618	6188	278	5036
12-#10	3.40	MA	5339	2006	8519	1475	9242	1225	9634	1030	10094	696	12031	383	9250
5L-3S		MI	3048	2006	5129	1352	5489	1127	5710	932	6029	612	6626	317	5045
12-#10	3.40	MA	5230	2006	8193	1480	8818	1245	9106	1037	9384	712	11111	325	8955
6L-2S		MI	3125	2006	5370	1349	5798	1115	6087	922	6540	607	7235	406	5026
12-#11	4.18	MA	5521	2102	8915	1533	9718	1266	10198	1057	10849	688	13093	320	10938
5L-3S		MI	3138	2102	5363	1396	5767	1158	6041	947	6406	581	7000	218	5974
12-#11	4.18	MA	5391	2102	8527	1540	9203	1289	9558	1065	9988	706	11968	248	10375
6L-2S		MI	3228	2102	5649	1393	6133	1145	6487	936	6998	574	7691	328	5954
12-#14	6.03	MA	5976	2331	9857	1688	10895	1399	11617	1134	12761	680	15800	183	14880
5L-3S		MI	3379	2331	5946	1527	6499	1255	6929	1003	7510	534	8210	26	8125
12-#14	6.03	MA	5794	2331	9311	1699	10158	1412	10701	1144	11531	705	14183	79	13711
6L-2S		MI	3503	2331	6347	1525	7013	1238	7556	990	8327	524	9149	185	8201
14-#10	3.97	MA	5561	2076	9023	1519	9889	1257	10423	1049	11167	691	13518	375	10781
5L-4S		MI	3117	2076	5180	1410	5552	1160	5785	950	6149	612	6797	251	5707
14-#10	3.97	MA	5455	2076	8698	1524	9465	1276	9895	1056	10458	707	12598	317	10473
6L-3S		MI	3147	2076	5370	1396	5798	1159	6087	951	6540	607	7235	290	5805
14-#10	3.97	MA	5342	2076	8336	1541	9043	1282	9392	1075	9767	723	11641	280	9936
7L-2S		MI	3223	2076	5611	1393	6107	1146	6464	941	7052	601	7844	380	5790
14-#11	4.88	MA	5660	2188	9136	1594	9984	1328	10511	1088	11285	699	13763	238	12210
6L-3S		MI	3254	2188	5649	1450	6133	1197	6487	970	6998	571	7691	180	6870
14-#11	4.88	MA	5528	2188	8699	1614	9482	1336	9899	1110	10446	718	12597	190	11625
7L-2S		MI	3343	2188	5934	1447	6499	1183	6934	960	7590	564	8382	290	6857
14-#14	7.03	MA	6175	2456	10179	1776	11271	1468	12059	1178	13377	695	16739	65	16348
6L-3S		MI	3541	2456	6347	1605	7013	1311	7556	1037	8327	517	9149	-34	9126
16-#10	4.54	MA	5678	2146	9202	1568	10112	1308	10685	1076	11532	701	14084	309	11995
6L-4S		MI	3216	2146	5421	1454	5861	1191	6163	969	6661	606	7406	225	6419
16-#10	4.54	MA	5567	2146	8841	1585	9690	1313	10181	1094	10840	717	13128	273	11473
7L-3S		MI	3245	2146	5611	1440	6107	1190	6464	970	7052	601	7844	264	6562
16-#10	4.54	MA	5442	2146	8524	1591	9252	1329	9685	1112	10104	722	12079	207	10929
8L-2S		MI	3320	2146	5853	1437	6416	1178	6841	960	7563	595	8452	353	6551

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

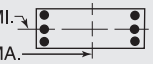
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	5.57	MA	5796	2275	9308	1668	10263	1374	10852	1133	11742	711	14392	180	13462
7L-3S		MI	3370	2275	5934	1504	6499	1235	6934	994	7590	561	8382	142	7761
18-#10	5.10	MA	5789	2217	9345	1629	10337	1345	10970	1113	11914	711	14614	265	13012
7L-4S		MI	3315	2217	5662	1498	6170	1223	6540	988	7172	600	8015	199	7135
18-#10	5.10	MA	5667	2217	9028	1635	9899	1361	10474	1131	11178	716	13566	199	12465
8L-3S		MI	3343	2217	5853	1484	6416	1222	6841	989	7563	595	8452	238	7316
20-#10	5.67	MA	5890	2287	9533	1679	10546	1392	11264	1150	12252	711	15052	191	14002
8L-4S		MI	3413	2287	5903	1542	6479	1254	6917	1007	7683	594	8623	173	7854

RECTANGULAR TIED COLUMNS 16" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.06	MA	5582	1838	8762	1351	9360	1141	9568	978	9598	737	10876	641	3688
2E		MI	2913	1838	4686	1251	4843	1055	4852	903	4742	676	5055	551	1920
4-#11	1.30	MA	5678	1870	9017	1363	9656	1148	9915	980	10063	729	11513	632	4456
2E		MI	2947	1870	4787	1254	4949	1055	4972	899	4876	658	5179	519	2284
4-#14	1.88	MA	5918	1946	9599	1404	10380	1176	10789	996	11247	719	13149	621	6275
2E		MI	3039	1946	5025	1289	5238	1079	5318	911	5304	637	5644	467	3108
4-#18	3.33	MA	6500	2140	11025	1512	12166	1252	12949	1039	14175	696	17195	592	10729
2E		MI	3252	2140	5582	1386	5921	1145	6105	938	6274	576	6644	315	5021
6-#9	1.25	MA	5675	1863	8959	1371	9624	1155	9894	987	10045	737	11497	639	4328
2L-3S		MI	2889	1863	4584	1276	4721	1081	4706	923	4548	683	4838	478	2236
6-#9	1.25	MA	5512	1863	8524	1379	9067	1162	9215	1003	9121	750	10217	575	4348
3L-2S		MI	2953	1863	4776	1273	4967	1071	5007	914	4957	678	5331	549	2216
6-#10	1.59	MA	5823	1908	9311	1395	10063	1172	10426	997	10765	731	12492	633	5424
2L-3S		MI	2932	1908	4686	1298	4843	1099	4852	932	4742	676	5055	436	2753
6-#10	1.59	MA	5621	1908	8762	1406	9360	1181	9568	1016	9598	748	10876	550	5444
3L-2S		MI	3012	1908	4927	1294	5152	1086	5229	922	5254	670	5664	525	2723
6-#11	1.95	MA	5966	1956	9680	1417	10506	1186	10952	1004	11474	722	13467	623	6552
2L-3S		MI	2971	1956	4787	1310	4949	1107	4972	933	4876	656	5179	371	3273
6-#11	1.95	MA	5727	1956	9017	1428	9656	1197	9915	1026	10063	741	11513	519	6572
3L-2S		MI	3063	1956	5073	1308	5315	1094	5419	923	5468	649	5870	481	3234
6-#14	2.81	MA	6325	2071	10545	1482	11593	1232	12268	1030	13259	709	15935	607	9248
2L-3S		MI	3072	2071	5025	1369	5238	1152	5318	957	5304	630	5644	248	4472
6-#14	2.81	MA	5992	2071	9599	1498	10380	1246	10789	1061	11247	736	13149	454	9234
3L-2S		MI	3200	2071	5426	1367	5752	1135	5946	945	6121	620	6583	406	4419
6-#18	5.00	MA	6642	2361	11025	1676	12166	1409	12949	1152	14175	721	17195	286	15622
3L-2S		MI	3517	2361	6256	1524	6785	1244	7140	995	7597	535	8114	185	7179
8-#7	1.00	MA	5567	1830	8691	1356	9302	1145	9510	983	9528	743	10785	646	3512
2L-4S		MI	2856	1830	4451	1272	4566	1073	4523	919	4310	695	4588	509	1850
8-#7	1.00	MA	5467	1830	8428	1361	8964	1150	9099	992	8968	751	10009	608	3524
3E		MI	2872	1830	4544	1265	4686	1072	4670	919	4501	691	4809	529	1837
8-#7	1.00	MA	5413	1830	8230	1371	8707	1160	8782	996	8556	759	9493	585	3538
4L-2S		MI	2911	1830	4662	1263	4837	1066	4854	913	4752	688	5119	572	1828
8-#8	1.32	MA	5710	1872	9027	1379	9721	1162	10017	992	10215	738	11735	640	4557
2L-4S		MI	2898	1872	4535	1296	4665	1090	4640	928	4471	689	4777	471	2358
8-#8	1.32	MA	5582	1872	8682	1386	9279	1167	9478	1004	9481	748	10719	589	4572
3E		MI	2918	1872	4656	1286	4821	1088	4831	928	4720	685	5062	497	2337
8-#8	1.32	MA	5511	1872	8422	1399	8942	1180	9063	1009	8941	759	10040	559	4584
4L-2S		MI	2969	1872	4809	1284	5018	1080	5072	921	5047	681	5461	552	2321
8-#9	1.67	MA	5866	1919	9393	1405	10181	1180	10574	1002	10969	732	12777	633	5698
2L-4S		MI	2942	1919	4625	1322	4772	1108	4767	937	4645	684	4977	427	2899
8-#9	1.67	MA	5707	1919	8959	1413	9624	1187	9894	1018	10045	746	11497	569	5713
3E		MI	2968	1919	4776	1310	4967	1106	5007	938	4957	679	5331	459	2871
8-#9	1.67	MA	5619	1919	8631	1430	9199	1203	9371	1024	9364	759	10639	530	5713
4L-2S		MI	3032	1919	4968	1307	5214	1096	5308	929	5366	674	5823	529	2850
8-#10	2.12	MA	6063	1978	9859	1439	10767	1204	11284	1016	11932	725	14108	625	7149
2L-4S		MI	2999	1978	4737	1356	4906	1131	4927	950	4863	676	5226	370	3569

RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

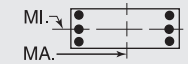
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	2.12	MA	5865	1978	9311	1449	10063	1213	10426	1035	10765	742	12492	542	7161
3E		MI	3031	1978	4927	1342	5152	1130	5229	951	5254	670	5664	409	3538
8-#10	2.12	MA	5757	1978	8896	1471	9526	1233	9765	1043	9904	759	11404	493	7128
4L-2S		MI	3110	1978	5168	1338	5462	1118	5606	941	5765	665	6273	499	3510
8-#11	2.60	MA	6019	2043	9680	1482	10506	1235	10952	1050	11474	734	13467	509	8639
3E		MI	3087	2043	5073	1364	5315	1146	5419	956	5468	646	5870	334	4198
8-#11	2.60	MA	5893	2043	9177	1508	9854	1259	10151	1058	10429	754	12138	448	8566
4L-2S		MI	3178	2043	5358	1362	5682	1132	5866	946	6060	639	6561	443	4163
8-#14	3.75	MA	6406	2195	10545	1576	11593	1302	12268	1095	13259	726	15935	440	12162
3E		MI	3235	2195	5426	1447	5752	1208	5946	991	6121	613	6583	187	5744
8-#14	3.75	MA	6231	2195	9826	1612	10660	1336	11122	1107	11767	753	14026	351	11446
4L-2S		MI	3362	2195	5827	1445	6266	1190	6573	979	6938	603	7522	346	5707
8-#18	6.67	MA	7061	2583	11412	1876	12644	1530	13518	1229	15066	747	18667	100	17975
4L-2S		MI	3782	2583	6930	1663	7649	1344	8176	1051	8920	495	9584	55	9307
10-#10	2.65	MA	6108	2049	9859	1493	10767	1244	11284	1054	11932	737	14108	535	8870
3L-4S		MI	3099	2049	4978	1400	5216	1163	5305	969	5374	670	5835	344	4334
10-#10	2.65	MA	6001	2049	9445	1515	10229	1265	10623	1062	11071	753	13020	485	8825
4L-3S		MI	3130	2049	5168	1386	5462	1162	5606	970	5765	664	6273	383	4311
10-#10	2.65	MA	5834	2049	9100	1525	9768	1274	10046	1081	10217	759	11920	443	8429
5L-2S		MI	3208	2049	5410	1382	5771	1149	5983	960	6277	659	6882	472	4287
10-#11	3.25	MA	6185	2129	9841	1562	10704	1298	11188	1082	11841	747	14093	438	10613
4L-3S		MI	3203	2129	5358	1418	5682	1184	5866	980	6060	636	6561	296	5110
10-#11	3.25	MA	5985	2129	9420	1573	10144	1308	10487	1104	10803	753	12752	383	9931
5L-2S		MI	3294	2129	5644	1416	6048	1171	6312	970	6652	629	7253	405	5081
10-#14	4.69	MA	6644	2320	10772	1690	11873	1392	12601	1141	13779	743	16812	337	14282
4L-3S		MI	3397	2320	5827	1525	6266	1263	6573	1025	6938	596	7522	126	7005
10-#14	4.69	MA	6363	2320	10170	1706	11071	1406	11599	1172	12295	750	14890	254	13447
5L-2S		MI	3523	2320	6228	1523	6780	1246	7200	1013	7755	586	8461	285	6980
12-#10	3.17	MA	6244	2119	9994	1559	10932	1296	11480	1081	12238	748	14637	478	10522
4E		MI	3198	2119	5219	1444	5525	1194	5682	988	5886	664	6444	318	5094
12-#10	3.17	MA	6079	2119	9648	1569	10471	1305	10904	1101	11384	753	13536	435	10090
5L-3S		MI	3229	2119	5410	1430	5771	1193	5983	989	6277	658	6882	357	5077
12-#10	3.17	MA	5960	2119	9290	1573	10013	1325	10333	1108	10616	770	12546	378	9755
6L-2S		MI	3306	2119	5651	1426	6080	1181	6360	979	6788	653	7490	446	5057
12-#11	3.90	MA	6279	2215	10084	1627	10994	1347	11525	1128	12215	746	14706	374	11944
5L-3S		MI	3319	2215	5644	1472	6048	1223	6312	1003	6652	626	7253	258	6014
12-#11	3.90	MA	6136	2215	9656	1634	10437	1371	10831	1137	11282	765	13495	303	11402
6L-2S		MI	3409	2215	5930	1470	6414	1210	6759	993	7244	619	7944	368	5991
12-#14	5.63	MA	6779	2444	11116	1784	12283	1461	13078	1206	14307	740	17676	241	16338
5L-3S		MI	3560	2444	6228	1603	6780	1319	7200	1059	7755	579	8461	66	8247
12-#14	5.63	MA	6579	2444	10512	1793	11485	1495	12085	1218	12973	767	15935	138	15069
6L-2S		MI	3684	2444	6629	1601	7294	1302	7827	1047	8572	569	9401	224	8246
14-#10	3.70	MA	6322	2189	10197	1613	11174	1337	11762	1120	12551	748	15152	427	11757
5L-4S		MI	3297	2189	5460	1488	5834	1226	6059	1007	6397	658	7053	292	5820
14-#10	3.70	MA	6206	2189	9838	1617	10716	1357	11190	1128	11783	765	14162	370	11436
6L-3S		MI	3328	2189	5651	1473	6080	1225	6360	1009	6788	652	7490	331	5839
14-#10	3.70	MA	6080	2189	9447	1634	10251	1362	10646	1147	11035	781	13001	320	10870
7L-2S		MI	3404	2189	5892	1470	6389	1212	6737	999	7300	647	8099	420	5822
14-#11	4.55	MA	6432	2301	10320	1688	11287	1410	11868	1160	12693	759	15449	293	13406
6L-3S		MI	3435	2301	5930	1526	6414	1262	6759	1027	7244	616	7944	220	6912
14-#11	4.55	MA	6284	2301	9845	1708	10733	1417	11206	1183	11784	778	14191	248	12739
7L-2S		MI	3524	2301	6215	1524	6780	1249	7206	1017	7836	609	8635	330	6896

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

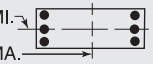
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	6.56	MA	6998	2569	11458	1871	12698	1551	13564	1252	14985	757	18721	124	17942
6L-3S		MI	3722	2569	6629	1680	7294	1375	7827	1093	8572	562	9401	5	9384
16-#10	4.23	MA	6451	2259	10387	1661	11419	1389	12048	1147	12950	759	15778	362	13120
6L-4S		MI	3397	2259	5701	1532	6143	1257	6436	1026	6909	652	7662	265	6491
16-#10	4.23	MA	6326	2259	9995	1678	10954	1394	11503	1166	12202	776	14617	312	12544
7L-3S		MI	3426	2259	5892	1517	6389	1256	6737	1028	7300	647	8099	304	6598
16-#10	4.23	MA	6189	2259	9652	1685	10480	1410	10937	1172	11405	781	13614	264	11996
8L-2S		MI	3502	2259	6133	1514	6698	1244	7115	1018	7811	641	8708	394	6585
16-#11	5.20	MA	6578	2388	10508	1762	11583	1456	12243	1206	13195	771	16145	238	14767
7L-3S		MI	3551	2388	6215	1580	6780	1300	7206	1050	7836	606	8635	182	7808
18-#10	4.76	MA	6570	2330	10544	1722	11657	1425	12361	1185	13369	770	16233	305	14220
7L-4S		MI	3496	2330	5943	1576	6452	1289	6813	1046	7420	646	8270	239	7206
18-#10	4.76	MA	6436	2330	10200	1729	11183	1442	11795	1191	12572	776	15230	256	13664
8L-3S		MI	3524	2330	6133	1561	6698	1288	7115	1047	7811	641	8708	278	7354
20-#10	5.29	MA	6680	2400	10749	1773	11886	1473	12653	1210	13740	770	16846	249	15332
8L-4S		MI	3594	2400	6184	1620	6761	1320	7190	1065	7931	640	8879	213	7925

RECTANGULAR TIED COLUMNS 16" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.22	MA	6432	1983	10159	1455	10889	1226	11176	1048	11313	783	12917	680	4793
2E		MI	3128	1983	5068	1330	5230	1120	5244	956	5122	704	5432	559	2307
4-#14	1.76	MA	6696	2059	10791	1496	11675	1255	12124	1064	12598	773	14691	668	6761
2E		MI	3220	2059	5307	1365	5519	1143	5589	967	5549	682	5895	506	3138
4-#18	3.13	MA	7333	2253	12342	1604	13617	1331	14473	1108	15782	750	19092	640	11593
2E		MI	3433	2253	5864	1460	6201	1208	6374	993	6515	620	6891	354	5064
6-#9	1.17	MA	6427	1976	10094	1463	10850	1234	11149	1056	11288	791	12892	687	4652
2L-3S		MI	3070	1976	4864	1353	5003	1148	4980	981	4797	729	5095	519	2254
6-#9	1.17	MA	6250	1976	9625	1471	10249	1241	10415	1071	10290	805	11510	624	4672
3L-2S		MI	3134	1976	5056	1350	5249	1138	5281	972	5206	725	5587	589	2235
6-#10	1.49	MA	6590	2021	10474	1487	11326	1251	11724	1065	12068	785	13968	681	5835
2L-3S		MI	3113	2021	4967	1375	5125	1165	5125	990	4990	722	5311	476	2775
6-#10	1.49	MA	6368	2021	9882	1498	10567	1260	10797	1085	10807	803	12223	599	5856
3L-2S		MI	3193	2021	5208	1372	5434	1152	5502	980	5502	716	5920	565	2746
6-#11	1.83	MA	6747	2069	10877	1508	11808	1265	12297	1072	12839	776	15030	671	7057
2L-3S		MI	3152	2069	5068	1387	5230	1172	5244	990	5122	701	5432	411	3301
6-#11	1.83	MA	6484	2069	10159	1521	10889	1276	11176	1095	11313	797	12917	569	7078
3L-2S		MI	3244	2069	5354	1384	5597	1159	5691	979	5714	694	6123	521	3261
6-#14	2.64	MA	7139	2184	11815	1574	12987	1311	13725	1098	14775	763	17707	655	9977
2L-3S		MI	3253	2184	5307	1445	5519	1216	5589	1013	5549	675	5895	287	4509
6-#14	2.64	MA	6774	2184	10791	1591	11675	1326	12124	1131	12598	792	14691	505	9963
3L-2S		MI	3381	2184	5708	1443	6033	1199	6217	1001	6366	665	6834	446	4454
6-#18	4.69	MA	7485	2474	12342	1770	13617	1454	14473	1223	15782	779	19092	341	16918
3L-2S		MI	3699	2474	6538	1598	7065	1307	7409	1050	7839	579	8361	224	7229
8-#8	1.23	MA	6466	1985	10166	1471	10954	1240	11281	1060	11471	792	13147	688	4898
2L-4S		MI	3079	1985	4815	1374	4947	1156	4914	986	4720	736	5035	512	2375
8-#8	1.23	MA	6325	1985	9794	1478	10477	1246	10699	1073	10679	803	12050	638	4913
3E		MI	3099	1985	4935	1364	5103	1155	5106	986	4969	732	5320	537	2355
8-#8	1.23	MA	6248	1985	9514	1492	10114	1259	10252	1078	10097	815	11324	608	4925
4L-2S		MI	3150	1985	5089	1362	5300	1147	5346	979	5296	727	5719	593	2340
8-#9	1.56	MA	6636	2032	10563	1497	11451	1258	11882	1071	12286	787	14273	681	6130
2L-4S		MI	3123	2032	4905	1400	5054	1174	5040	995	4893	730	5234	468	2921
8-#9	1.56	MA	6461	2032	10094	1506	10850	1266	11149	1086	11288	801	12892	618	6145
3E		MI	3149	2032	5056	1388	5249	1173	5281	996	5206	725	5587	499	2893
8-#9	1.56	MA	6365	2032	9741	1523	10392	1283	10586	1093	10555	815	11973	580	6145
4L-2S		MI	3213	2032	5248	1385	5496	1163	5581	987	5615	720	6080	570	2872

RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

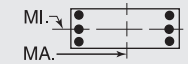
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	1.98	MA	6851	2091	11067	1531	12086	1282	12650	1085	13328	780	15714	673	7698
2L-4S		MI	3180	2091	5017	1434	5188	1197	5201	1007	5111	722	5482	411	3597
8-#10	1.98	MA	6634	2091	10474	1542	11326	1292	11724	1104	12068	797	13968	592	7709
3E		MI	3212	2091	5208	1419	5434	1196	5502	1009	5502	716	5920	450	3564
8-#10	1.98	MA	6514	2091	10029	1564	10747	1313	11012	1113	11140	815	12804	543	7677
4L-2S		MI	3291	2091	5449	1416	5743	1184	5879	999	6013	710	6529	539	3535
8-#11	2.44	MA	6803	2156	10877	1575	11808	1314	12297	1119	12839	790	15030	559	9313
3E		MI	3268	2156	5354	1441	5597	1211	5691	1013	5714	691	6123	373	4230
8-#11	2.44	MA	6663	2156	10335	1601	11105	1339	11433	1128	11713	810	13606	499	9240
4L-2S		MI	3360	2156	5640	1438	5963	1197	6138	1003	6306	684	6814	483	4194
8-#14	3.52	MA	7225	2308	11815	1668	12987	1381	13725	1165	14775	782	17707	491	13134
3E		MI	3416	2308	5708	1523	6033	1272	6217	1047	6366	658	6834	226	5787
8-#14	3.52	MA	7030	2308	11040	1705	11981	1416	12488	1178	13165	810	15660	403	12491
4L-2S		MI	3543	2308	6109	1521	6547	1255	6844	1035	7183	648	7773	385	5745
8-#18	6.25	MA	7935	2696	12767	1972	14142	1612	15097	1303	16757	808	20726	157	19628
4L-2S		MI	3963	2696	7212	1737	7929	1407	8445	1106	9162	539	9831	93	9362
10-#10	2.48	MA	6898	2162	11067	1586	12086	1323	12650	1123	13328	792	15714	584	9555
3L-4S		MI	3280	2162	5258	1478	5497	1229	5578	1027	5622	716	6091	384	4366
10-#10	2.48	MA	6780	2162	10621	1608	11507	1344	11938	1132	12400	809	14549	535	9511
4L-3S		MI	3311	2162	5449	1463	5743	1228	5879	1028	6013	710	6529	423	4340
10-#10	2.48	MA	6598	2162	10249	1618	11011	1354	11318	1152	11480	816	13367	495	9142
5L-2S		MI	3389	2162	5690	1460	6052	1216	6257	1018	6525	704	7137	513	4314
10-#11	3.05	MA	6981	2242	11052	1655	12025	1378	12554	1152	13239	804	15719	489	11455
4L-3S		MI	3384	2242	5640	1495	5963	1249	6138	1037	6306	681	6814	335	5145
10-#11	3.05	MA	6763	2242	10600	1667	11421	1389	11800	1175	12121	810	14278	436	10778
5L-2S		MI	3475	2242	5925	1492	6329	1236	6584	1027	6898	674	7506	445	5115
10-#14	4.39	MA	7480	2433	12063	1783	13293	1472	14089	1212	15343	800	18675	390	15568
4L-3S		MI	3578	2433	6109	1600	6547	1328	6844	1081	7183	641	7773	166	7051
10-#14	4.39	MA	7174	2433	11416	1800	12430	1487	13009	1244	13743	809	16609	311	14606
5L-2S		MI	3704	2433	6510	1598	7061	1311	7471	1069	7999	631	8712	324	7022
10-#18	7.81	MA	8189	2917	13413	2138	14911	1735	15991	1418	17748	801	22342	-18	22282
5L-2S		MI	4227	2917	7886	1875	8792	1506	9480	1163	10485	498	11301	-37	11284
12-#10	2.98	MA	7044	2232	11213	1651	12266	1376	12865	1151	13661	804	16295	528	11345
4E		MI	3379	2232	5499	1522	5806	1260	5955	1046	6134	710	6700	358	5128
12-#10	2.98	MA	6864	2232	10842	1662	11770	1385	12244	1171	12741	810	15112	487	10939
5L-3S		MI	3410	2232	5690	1507	6052	1259	6257	1047	6525	704	7137	397	5109
12-#10	2.98	MA	6735	2232	10451	1667	11277	1406	11630	1179	11914	828	14053	430	10557
6L-2S		MI	3487	2232	5931	1504	6361	1247	6634	1037	7036	699	7746	486	5086
12-#11	3.66	MA	7083	2328	11317	1721	12341	1428	12921	1199	13647	803	16391	427	12958
5L-3S		MI	3500	2328	5925	1548	6329	1288	6584	1060	6898	671	7506	297	6052
12-#11	3.66	MA	6928	2328	10850	1727	11741	1452	12174	1208	12642	824	15095	357	12447
6L-2S		MI	3590	2328	6211	1546	6695	1275	7031	1050	7490	664	8197	407	6027
12-#14	5.27	MA	7627	2557	12439	1878	13742	1543	14610	1278	15921	799	19625	297	17740
5L-3S		MI	3740	2557	6510	1678	7061	1384	7471	1115	7999	624	8712	105	8305
12-#14	5.27	MA	7410	2557	11778	1887	12882	1578	13540	1291	14482	827	17760	195	16430
6L-2S		MI	3865	2557	6911	1676	7575	1367	8098	1103	8816	614	9652	263	8290
14-#10	3.47	MA	7129	2302	11434	1706	12530	1417	13171	1190	14001	804	16858	479	12741
5L-4S		MI	3478	2302	5741	1565	6115	1292	6332	1065	6645	704	7308	332	5886
14-#10	3.47	MA	7003	2302	11044	1710	12036	1437	12556	1198	13175	822	15799	423	12374
6L-3S		MI	3509	2302	5931	1551	6361	1291	6634	1066	7036	698	7746	371	5872
14-#10	3.47	MA	6864	2302	10621	1728	11529	1442	11970	1218	12370	840	14553	374	11815
7L-2S		MI	3585	2302	6172	1548	6670	1279	7011	1056	7547	693	8355	460	5854

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

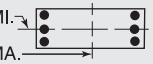
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	4.27	MA	7250	2415	11567	1781	12660	1491	13296	1232	14168	817	17208	347	14620
6L-3S		MI	3616	2415	6211	1602	6695	1327	7031	1084	7490	661	8197	259	6953
14-#11	4.27	MA	7086	2415	11055	1802	12054	1498	12583	1255	13189	837	15689	285	13854
7L-2S		MI	3705	2415	6496	1600	7061	1314	7478	1074	8082	654	8888	369	6934
14-#14	6.15	MA	7866	2682	12801	1965	14194	1634	15140	1325	16660	817	20775	181	19540
6L-3S		MI	3902	2682	6911	1756	7575	1440	8098	1149	8816	607	9652	44	9501
14-#14	6.15	MA	7637	2682	12069	1994	13337	1644	14119	1358	15259	846	18837	116	18207
7L-2S		MI	4026	2682	7311	1754	8089	1423	8725	1137	9633	597	10591	203	9552
16-#10	3.97	MA	7269	2373	11636	1754	12796	1469	13483	1217	14435	816	17544	415	14194
6L-4S		MI	3578	2373	5982	1609	6424	1323	6709	1084	7157	698	7917	306	6606
16-#10	3.97	MA	7131	2373	11214	1772	12288	1474	12897	1237	13631	834	16298	367	13627
7L-3S		MI	3607	2373	6172	1595	6670	1322	7011	1085	7547	692	8355	345	6632
16-#10	3.97	MA	6982	2373	10844	1779	11777	1491	12278	1243	12773	840	15222	320	13077
8L-2S		MI	3683	2373	6413	1592	6980	1310	7388	1075	8059	687	8964	434	6617
16-#11	4.88	MA	7406	2501	11772	1856	12973	1536	13705	1279	14715	831	17802	276	16046
7L-3S		MI	3732	2501	6496	1656	7061	1366	7478	1107	8082	652	8888	222	7850
16-#11	4.88	MA	7229	2501	11323	1864	12352	1557	12965	1286	13673	837	16489	216	15176
8L-2S		MI	3820	2501	6782	1654	7427	1352	7925	1097	8675	645	9580	331	7836
16-#14	7.03	MA	8091	2806	13092	2072	14649	1700	15720	1392	17436	836	21852	102	21296
7L-3S		MI	4064	2806	7311	1834	8089	1496	8725	1183	9633	590	10591	-17	10579
18-#10	4.46	MA	7396	2443	11806	1816	13048	1505	13823	1256	14891	828	18044	359	15441
7L-4S		MI	3676	2443	6223	1653	6734	1355	7086	1103	7668	692	8526	279	7276
18-#10	4.46	MA	7250	2443	11437	1823	12537	1523	13204	1262	14034	835	16968	312	14879
8L-3S		MI	3706	2443	6413	1639	6980	1354	7388	1105	8059	686	8964	318	7390
18-#10	4.46	MA	7116	2443	11045	1843	12047	1529	12595	1278	13239	852	15907	270	14177
9L-2S		MI	3781	2443	6654	1635	7289	1342	7765	1095	8570	681	9573	408	7378
18-#11	5.48	MA	7551	2587	12040	1918	13272	1595	14087	1310	15199	830	18602	206	17356
8L-3S		MI	3848	2587	6782	1710	7427	1404	7925	1131	8675	642	9580	184	8745
20-#10	4.96	MA	7516	2513	12029	1867	13296	1554	14131	1281	15295	829	18713	305	16681
8L-4S		MI	3775	2513	6464	1697	7043	1386	7463	1122	8179	686	9135	253	7994
20-#10	4.96	MA	7387	2513	11637	1886	12807	1561	13522	1298	14499	847	17652	262	15984
9L-3S		MI	3804	2513	6654	1683	7289	1385	7765	1124	8570	681	9573	292	8147
22-#10	5.46	MA	7656	2583	12230	1930	13566	1592	14448	1317	15760	841	19398	254	17791
9L-4S		MI	3873	2583	6705	1741	7352	1418	7840	1142	8691	680	9744	227	8715

RECTANGULAR TIED COLUMNS 18" x 18"

6-#8	1.46	MA	2290	1277	3712	890	3914	748	3988	637	4022	468	4460	387	1951
2L-3S		MI	2228	1277	3531	894	3682	757	3705	645	3637	474	3966	332	1969
6-#9	1.85	MA	2346	1312	3853	908	4089	761	4200	644	4309	463	4808	374	2409
2L-3S		MI	2269	1312	3627	913	3798	772	3845	654	3826	470	4194	304	2431
6-#10	2.35	MA	2417	1356	4032	933	4312	778	4468	653	4674	457	5242	356	2983
2L-3S		MI	2322	1356	3747	938	3946	792	4023	665	4067	465	4480	267	3008
6-#11	2.89	MA	2480	1405	4206	953	4517	791	4713	659	5004	447	5560	323	3554
2L-3S		MI	2369	1405	3866	958	4082	807	4182	672	4281	455	4684	213	3581
6-#14	4.17	MA	2647	1519	4630	1017	5049	836	5357	685	5862	431	6522	265	4917
2L-3S		MI	2493	1519	4151	1023	4435	857	4608	702	4849	441	5319	107	4922
6-#18	7.41	MA	3043	1810	5641	1184	6323	954	6902	753	7799	372	8666	90	8147
2L-3S		MI	2787	1810	4829	1189	5282	986	5632	777	6131	389	6734	-191	6619
8-#8	1.95	MA	2365	1321	3893	917	4146	768	4271	648	4407	464	4954	377	2534
2L-4S		MI	2277	1320	3571	931	3732	779	3764	658	3731	476	4111	293	2566
8-#9	2.47	MA	2440	1367	4080	943	4380	786	4554	659	4792	459	5421	360	3134
2L-4S		MI	2332	1367	3677	960	3861	800	3919	670	3944	473	4373	255	3162
8-#10	3.14	MA	2534	1427	4317	977	4677	809	4914	672	5280	452	6003	336	3889
2L-4S		MI	2400	1427	3809	998	4024	827	4115	686	4214	468	4701	204	3785

RECTANGULAR TIED COLUMNS 18" x 18"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	3.85	MA	2619	1491	4545	1007	4953	830	5244	682	5726	441	6437	294	4631
2L-4S		MI	2464	1491	3939	1030	4172	848	4289	695	4453	456	4933	134	4353
10-#10	3.92	MA	2651	1497	4602	1021	5042	841	5360	691	5887	446	6764	317	4789
2L-5S		MI	2437	1497	3906	1047	4139	872	4249	717	4361	460	4932	132	4420
10-#10	3.92	MA	2559	1497	4317	1026	4677	855	4914	704	5280	454	6003	227	4797
3L-4S		MI	2520	1497	4094	1042	4389	858	4561	705	4820	463	5462	184	4614
10-#11	4.81	MA	2650	1577	4545	1066	4953	884	5244	719	5726	442	6437	155	5699
3L-4S		MI	2606	1577	4278	1084	4608	886	4820	719	5175	449	5809	105	5343

RECTANGULAR TIED COLUMNS 18" x 20"

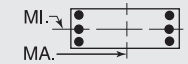
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.11	MA	2768	1384	4421	977	4646	824	4705	705	4672	529	5176	450	1889
2E		MI	2481	1384	3979	963	4156	812	4193	695	4144	520	4524	435	1693
4-#10	1.41	MA	2824	1413	4561	992	4818	835	4912	711	4952	524	5526	440	2341
2E		MI	2528	1413	4100	978	4303	822	4370	700	4384	516	4809	422	2090
4-#11	1.73	MA	2874	1446	4704	1002	4980	840	5102	712	5207	516	5794	419	2801
2E		MI	2571	1446	4220	987	4439	827	4528	701	4596	506	5009	398	2493
4-#14	2.50	MA	3006	1522	5039	1043	5395	868	5603	727	5886	505	6590	386	3882
2E		MI	2682	1522	4506	1026	4792	854	4954	715	5162	494	5642	357	3432
4-#18	4.44	MA	3321	1716	5842	1149	6398	943	6815	769	7524	480	8407	289	6462
2E		MI	2947	1716	5185	1131	5637	927	5975	756	6441	450	7053	238	5650
6-#8	1.32	MA	2812	1404	4519	993	4777	836	4868	713	4895	529	5488	450	2207
2L-3S		MI	2457	1404	3883	983	4039	834	4054	712	3955	527	4296	378	1989
6-#8	1.32	MA	2739	1404	4310	998	4510	847	4542	723	4452	536	4897	394	2225
3L-2S		MI	2519	1404	4064	980	4271	825	4337	703	4341	521	4791	434	1972
6-#9	1.67	MA	2878	1439	4683	1012	4981	849	5114	721	5228	524	5911	439	2733
2L-3S		MI	2498	1439	3979	1002	4156	849	4193	720	4144	523	4524	350	2455
6-#9	1.67	MA	2788	1439	4421	1017	4646	862	4705	732	4672	533	5176	369	2755
3L-2S		MI	2575	1439	4206	998	4447	837	4548	710	4627	516	5137	421	2433
6-#10	2.12	MA	2961	1484	4890	1036	5239	866	5426	730	5652	518	6441	425	3395
2L-3S		MI	2551	1484	4100	1027	4303	868	4370	732	4384	518	4809	313	3038
6-#10	2.12	MA	2849	1484	4561	1043	4818	882	4912	744	4952	529	5526	335	3419
3L-2S		MI	2646	1484	4385	1022	4669	854	4816	719	4991	510	5570	403	3011
6-#11	2.60	MA	3037	1532	5097	1056	5485	879	5717	736	6045	509	6858	397	4059
2L-3S		MI	2598	1532	4220	1046	4439	882	4528	737	4596	507	5009	259	3619
6-#11	2.60	MA	2906	1532	4704	1063	4980	897	5102	751	5207	520	5794	287	4086
3L-2S		MI	2710	1532	4560	1041	4874	866	5059	724	5319	499	5886	369	3588
6-#14	3.75	MA	3235	1646	5595	1120	6109	924	6473	761	7071	495	8063	349	5646
2L-3S		MI	2722	1646	4506	1110	4792	932	4954	767	5162	493	5642	152	4979
6-#14	3.75	MA	3052	1646	5039	1129	5395	949	5603	782	5886	509	6590	191	5651
3L-2S		MI	2877	1646	4985	1104	5406	910	5702	749	6176	483	6846	310	4959
6-#18	6.67	MA	3705	1937	6792	1287	7617	1042	8302	830	9541	461	10811	207	9443
2L-3S		MI	3016	1937	5185	1274	5637	1059	5975	840	6441	440	7053	-147	6970
6-#18	6.67	MA	3404	1937	5842	1298	6398	1081	6815	861	7524	479	8407	-75	8337
3L-2S		MI	3274	1937	5997	1269	6678	1027	7245	816	8110	422	8985	135	8206
8-#8	1.76	MA	2900	1448	4727	1021	5044	856	5194	725	5339	525	6078	442	2875
2L-4S		MI	2506	1448	3923	1021	4089	856	4113	725	4050	529	4441	340	2592
8-#8	1.76	MA	2828	1448	4519	1025	4777	866	4868	735	4895	533	5488	386	2891
3E		MI	2533	1448	4064	1011	4271	854	4337	723	4341	523	4791	368	2574
8-#8	1.76	MA	2794	1448	4358	1036	4569	869	4613	737	4563	540	5074	356	2907
4L-2S		MI	2595	1448	4245	1007	4503	844	4620	715	4726	517	5285	423	2557
8-#9	2.22	MA	2988	1494	4944	1046	5316	874	5523	736	5785	520	6645	428	3566
2L-4S		MI	2561	1494	4029	1050	4218	876	4267	736	4262	525	4703	301	3197

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 20"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

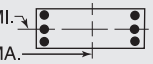
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	2.22	MA	2899	1494	4683	1052	4981	887	5114	747	5228	528	5911	358	3584
3E		MI	2594	1494	4206	1037	4447	874	4548	735	4627	518	5137	336	3180
8-#9	2.22	MA	2857	1494	4481	1066	4719	891	4793	750	4810	537	5394	321	3594
4L-2S		MI	2669	1494	4433	1032	4737	862	4903	725	5110	512	5750	406	3161
8-#10	2.82	MA	3099	1554	5219	1080	5661	898	5941	749	6352	513	7356	410	4438
2L-4S		MI	2630	1554	4162	1087	4381	903	4463	752	4531	521	5030	250	3889
8-#10	2.82	MA	2989	1554	4890	1087	5239	913	5426	763	5652	523	6441	320	4454
3E		MI	2670	1554	4385	1071	4669	900	4816	751	4991	513	5570	293	3940
8-#10	2.82	MA	2937	1554	4636	1104	4910	918	5021	766	5125	534	5797	274	4396
4L-2S		MI	2764	1554	4670	1066	5034	885	5262	738	5597	504	6331	383	3920
8-#11	3.47	MA	3200	1618	5491	1110	5989	918	6333	759	6882	502	7922	374	5305
2L-4S		MI	2693	1618	4293	1118	4529	923	4636	760	4768	508	5259	180	4469
8-#11	3.47	MA	3071	1618	5097	1117	5485	936	5717	775	6045	513	6858	264	5319
3E		MI	2739	1618	4560	1100	4874	921	5059	761	5319	500	5886	230	4688
8-#11	3.47	MA	3013	1618	4791	1137	5088	940	5231	777	5411	524	6104	210	5067
4L-2S		MI	2848	1618	4899	1095	5310	905	5590	748	6041	493	6762	339	4668
8-#14	5.00	MA	3284	1771	5595	1207	6109	1005	6473	816	7071	499	8063	154	7370
3E		MI	2919	1771	4985	1188	5406	988	5702	800	6176	482	6846	104	6461
8-#14	5.00	MA	3206	1771	5160	1235	5546	1010	5782	818	6171	513	7014	79	6648
4L-2S		MI	3070	1771	5463	1182	6019	966	6451	783	7189	472	8050	263	6469
10-#10	3.53	MA	3235	1624	5548	1124	6083	929	6455	768	7052	507	8271	395	5474
2L-5S		MI	2666	1624	4259	1136	4496	948	4597	783	4678	512	5260	178	4511
10-#10	3.53	MA	3127	1624	5219	1130	5661	945	5941	782	6352	518	7356	305	5483
3L-4S		MI	2749	1624	4447	1131	4746	934	4909	771	5137	515	5791	230	4715
10-#10	3.53	MA	3077	1624	4965	1148	5331	950	5536	785	5825	528	6712	259	5355
4L-3S		MI	2789	1624	4670	1115	5034	931	5262	770	5597	507	6331	273	4835
10-#10	3.53	MA	2981	1624	4750	1154	5046	965	5179	799	5299	527	6074	207	5093
5L-2S		MI	2881	1624	4955	1110	5400	917	5708	758	6204	499	7093	363	4822
10-#11	4.33	MA	3235	1705	5491	1171	5989	975	6333	798	6882	506	7922	242	6542
3L-4S		MI	2835	1705	4632	1172	4964	961	5167	784	5490	501	6135	150	5456
10-#11	4.33	MA	3178	1705	5184	1191	5593	979	5846	800	6248	517	7169	187	6217
4L-3S		MI	2879	1705	4899	1153	5310	959	5590	784	6041	494	6762	200	5749
10-#14	6.25	MA	3439	1895	5716	1313	6259	1065	6653	851	7356	503	8488	42	8287
4L-3S		MI	3115	1895	5463	1265	6019	1043	6451	834	7189	471	8050	57	7859
12-#10	4.23	MA	3265	1695	5548	1174	6083	976	6455	802	7052	512	8271	290	6506
3L-5S		MI	2786	1695	4544	1180	4861	980	5042	802	5284	507	6021	158	5363
12-#10	4.23	MA	3215	1695	5294	1192	5753	981	6050	804	6525	523	7627	244	6322
4E		MI	2867	1695	4732	1175	5112	966	5354	790	5744	510	6552	210	5550
12-#10	4.23	MA	3121	1695	5079	1198	5467	997	5694	818	5999	522	6989	192	6079
5L-3S		MI	2907	1695	4955	1159	5400	963	5708	789	6204	501	7093	253	5725
12-#11	5.20	MA	3343	1791	5578	1245	6097	1018	6461	824	7086	510	8233	165	7377
4E		MI	2975	1791	4972	1226	5400	1000	5698	807	6213	495	7012	121	6452
14-#10	4.94	MA	3353	1765	5623	1236	6175	1013	6565	823	7225	517	8542	229	7296
4L-5S		MI	2905	1765	4829	1224	5227	1011	5488	821	5891	501	6782	138	6218
14-#10	4.94	MA	3260	1765	5408	1242	5889	1028	6208	838	6699	516	7904	177	7069
5L-4S		MI	2986	1765	5017	1219	5477	997	5800	809	6350	504	7313	190	6390

RECTANGULAR TIED COLUMNS 18" x 22"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#9	1.01	MA	3336	1511	5289	1081	5571	912	5644	782	5593	590	6240	510	2105
2E		MI	2710	1511	4332	1053	4513	889	4542	762	4462	573	4854	482	1713
4-#10	1.28	MA	3400	1541	5448	1096	5768	923	5880	788	5912	585	6655	501	2615
2E		MI	2758	1541	4453	1067	4661	898	4718	766	4702	568	5138	469	2112
4-#11	1.58	MA	3459	1573	5614	1106	5957	929	6102	789	6209	577	6989	483	3138
2E		MI	2800	1573	4574	1075	4796	902	4875	766	4911	558	5335	443	2520
4-#14	2.27	MA	3612	1649	5999	1146	6434	957	6677	804	6988	566	7948	456	4368
2E		MI	2911	1649	4861	1113	5148	929	5299	780	5476	545	5965	403	3467

RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

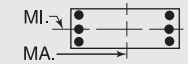
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	4.04	MA	3978	1843	6927	1253	7593	1031	8078	846	8890	542	10175	375	7326
2E		MI	3176	1843	5541	1217	5993	1000	6319	820	6752	501	7372	282	5700
6-#8	1.20	MA	3386	1531	5398	1097	5719	924	5828	790	5844	590	6599	510	2463
2L-3S		MI	2686	1531	4235	1073	4397	911	4402	778	4274	580	4627	425	2009
6-#8	1.20	MA	3301	1531	5162	1102	5417	936	5459	800	5343	598	5911	455	2481
3L-2S		MI	2748	1531	4416	1070	4629	901	4685	770	4659	574	5121	481	1992
6-#9	1.52	MA	3462	1566	5585	1115	5951	937	6107	797	6223	585	7098	502	3057
2L-3S		MI	2728	1566	4332	1092	4513	925	4542	787	4462	576	4854	397	2478
6-#9	1.52	MA	3357	1566	5289	1121	5571	951	5644	810	5593	595	6240	431	3079
3L-2S		MI	2805	1566	4558	1087	4804	913	4896	777	4945	569	5467	467	2456
6-#10	1.92	MA	3558	1611	5821	1140	6246	954	6463	807	6706	580	7725	490	3806
2L-3S		MI	2780	1611	4453	1116	4661	944	4718	798	4702	571	5138	359	3066
6-#10	1.92	MA	3428	1611	5448	1147	5768	971	5880	822	5912	592	6655	401	3831
3L-2S		MI	2876	1611	4738	1111	5026	930	5164	785	5308	563	5899	449	3037
6-#11	2.36	MA	3647	1659	6061	1160	6531	967	6801	813	7161	570	8243	466	4565
2L-3S		MI	2827	1659	4574	1133	4796	957	4875	803	4911	559	5335	304	3655
6-#11	2.36	MA	3494	1659	5614	1168	5957	987	6102	830	6209	583	6989	356	4592
3L-2S		MI	2939	1659	4914	1129	5231	941	5406	789	5634	551	6211	414	3620
6-#14	3.41	MA	3875	1774	6633	1224	7247	1012	7669	838	8338	556	9693	428	6375
2L-3S		MI	2951	1774	4861	1197	5148	1006	5299	831	5476	544	5965	197	5031
6-#14	3.41	MA	3664	1774	5999	1235	6434	1040	6677	862	6988	574	7948	269	6380
3L-2S		MI	3106	1774	5339	1191	5762	985	6048	814	6489	534	7169	355	4999
6-#18	6.06	MA	4422	2064	8016	1391	8989	1130	9781	907	11207	525	13058	310	10739
2L-3S		MI	3245	2064	5541	1360	5993	1132	6319	904	6752	490	7372	-102	7317
6-#18	6.06	MA	4073	2064	6927	1406	7593	1174	8078	944	8890	549	10175	28	10088
3L-2S		MI	3505	2064	6353	1355	7034	1100	7589	880	8420	473	9303	179	8263
8-#8	1.60	MA	3487	1575	5633	1124	6021	944	6196	802	6345	587	7287	505	3216
2L-4S		MI	2735	1575	4276	1111	4447	933	4462	791	4368	582	4772	386	2617
8-#8	1.60	MA	3404	1575	5398	1129	5719	955	5828	812	5844	595	6599	449	3232
3E		MI	2762	1575	4416	1100	4629	930	4685	790	4659	576	5121	414	2597
8-#8	1.60	MA	3363	1575	5217	1141	5485	959	5540	816	5470	603	6120	418	3248
4L-2S		MI	2824	1575	4597	1097	4861	921	4968	782	5044	571	5616	470	2580
8-#9	2.02	MA	3588	1622	5881	1150	6330	962	6570	813	6853	581	7955	494	3998
2L-4S		MI	2790	1622	4382	1139	4575	953	4616	803	4580	578	5033	347	3228
8-#9	2.02	MA	3485	1622	5585	1156	5951	976	6107	825	6223	591	7098	423	4016
3E		MI	2823	1622	4558	1126	4804	950	4896	802	4945	571	5467	382	3207
8-#9	2.02	MA	3435	1622	5357	1171	5657	981	5746	829	5752	601	6499	384	4026
4L-2S		MI	2899	1622	4785	1122	5095	938	5251	792	5428	564	6080	453	3187
8-#10	2.57	MA	3715	1681	6194	1184	6724	986	7047	826	7499	574	8796	479	4986
2L-4S		MI	2859	1681	4515	1176	4738	979	4811	818	4848	573	5358	296	3984
8-#10	2.57	MA	3588	1681	5821	1191	6246	1003	6463	842	6706	586	7725	390	5003
3E		MI	2899	1681	4738	1160	5026	975	5164	817	5308	565	5899	339	3972
8-#10	2.57	MA	3526	1681	5535	1210	5874	1009	6007	846	6112	599	6977	341	4989
4L-2S		MI	2993	1681	5023	1155	5391	961	5610	805	5914	557	6660	429	3949
8-#11	3.15	MA	3833	1746	6509	1214	7104	1006	7501	836	8113	563	9497	449	5978
2L-4S		MI	2922	1746	4647	1206	4886	998	4982	826	5083	560	5584	225	4581
8-#11	3.15	MA	3684	1746	6061	1222	6531	1026	6801	854	7161	576	8243	339	5993
3E		MI	2968	1746	4914	1187	5231	995	5406	826	5634	552	6211	275	4729
8-#11	3.15	MA	3613	1746	5715	1244	6083	1032	6251	858	6445	590	7361	281	5800
4L-2S		MI	3078	1746	5253	1183	5666	980	5937	813	6356	545	7088	385	4704
8-#14	4.55	MA	3932	1898	6633	1312	7247	1096	7669	896	8338	564	9693	240	8342
3E		MI	3148	1898	5339	1275	5762	1062	6048	865	6489	533	7169	150	6519
8-#14	4.55	MA	3835	1898	6141	1343	6610	1103	6887	900	7320	581	8462	160	7624
4L-2S		MI	3300	1898	5818	1269	6376	1040	6797	848	7502	523	8373	308	6513

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

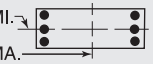
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	3.21	MA	3872	1752	6567	1227	7202	1017	7630	845	8292	568	9866	468	6160
2L-5S		MI	2895	1752	4612	1225	4853	1024	4945	849	4995	565	5589	224	4597
10-#10	3.21	MA	3747	1752	6194	1235	6724	1034	7047	861	7499	581	8796	379	6169
3L-4S		MI	2978	1752	4800	1220	5104	1010	5257	837	5455	568	6120	276	4813
10-#10	3.21	MA	3686	1752	5907	1254	6352	1040	6590	865	6905	593	8047	330	6113
4L-3S		MI	3018	1752	5023	1204	5391	1007	5610	836	5914	560	6660	320	4870
10-#10	3.21	MA	3576	1752	5666	1261	6032	1057	6190	880	6313	594	7301	279	5776
5L-2S		MI	3110	1752	5308	1199	5757	993	6056	824	6521	551	7421	409	4854
10-#11	3.94	MA	3873	1832	6509	1276	7104	1065	7501	877	8113	569	9497	322	7384
3L-4S		MI	3064	1832	4986	1260	5321	1036	5513	849	5805	553	6461	196	5565
10-#11	3.94	MA	3803	1832	6163	1298	6656	1071	6951	881	7397	583	8615	264	7111
4L-3S		MI	3108	1832	5253	1241	5666	1034	5937	850	6356	546	7088	246	5795
10-#11	3.94	MA	3673	1832	5871	1306	6269	1090	6467	899	6683	582	7741	201	6767
5L-2S		MI	3216	1832	5593	1236	6102	1018	6468	836	7079	538	7964	356	5779
10-#14	5.68	MA	4103	2023	6775	1421	7423	1159	7879	934	8670	571	10207	131	9498
4L-3S		MI	3344	2023	5818	1352	6376	1118	6797	899	7502	523	8373	102	8000
12-#10	3.85	MA	3905	1822	6567	1279	7202	1066	7630	880	8292	575	9866	368	7329
3L-5S		MI	3015	1822	4897	1269	5219	1056	5390	868	5602	559	6350	204	5448
12-#10	3.85	MA	3845	1822	6280	1297	6830	1072	7174	884	7698	587	9118	318	7211
4E		MI	3097	1822	5085	1264	5469	1042	5702	856	6061	562	6881	256	5645
12-#10	3.85	MA	3736	1822	6039	1305	6510	1089	6773	900	7107	588	8372	268	6895
5L-3S		MI	3136	1822	5308	1248	5757	1039	6056	855	6521	554	7421	300	5764
12-#10	3.85	MA	3657	1822	5792	1323	6190	1095	6376	904	6573	601	7689	211	6602
6L-2S		MI	3227	1822	5593	1243	6122	1024	6501	843	7127	546	8182	389	5753
12-#11	4.73	MA	3992	1918	6610	1352	7230	1109	7651	905	8349	576	9869	247	8432
4E		MI	3204	1918	5326	1314	5757	1075	6045	873	6528	547	7337	167	6559
12-#11	4.73	MA	3864	1918	6319	1360	6842	1129	7167	922	7635	576	8995	184	8112
5L-3S		MI	3247	1918	5593	1295	6102	1073	6468	873	7079	539	7964	217	6853
14-#10	4.49	MA	4003	1892	6653	1341	7308	1103	7757	903	8492	582	10188	307	8317
4L-5S		MI	3134	1892	5182	1313	5584	1087	5836	888	6208	554	7111	184	6302
14-#10	4.49	MA	3896	1892	6412	1349	6988	1120	7356	919	7900	583	9442	257	8019
5L-4S		MI	3215	1892	5370	1308	5834	1073	6148	875	6668	557	7642	237	6484
14-#10	4.49	MA	3819	1892	6165	1366	6668	1126	6959	923	7366	595	8759	200	7707
6L-3S		MI	3254	1892	5593	1292	6122	1070	6501	874	7127	548	8182	280	6653
14-#11	5.52	MA	4053	2004	6766	1414	7416	1168	7867	946	8587	569	10249	166	9463
5L-4S		MI	3344	2004	5666	1368	6192	1114	6576	896	7251	540	8214	138	7561
16-#10	5.13	MA	4055	1962	6785	1393	7466	1152	7939	938	8693	577	10513	245	9147
5E		MI	3253	1962	5467	1357	5949	1119	6282	907	6814	548	7872	164	7160
16-#10	5.13	MA	3979	1962	6537	1410	7146	1158	7542	942	8160	589	9830	189	8815
6L-4S		MI	3333	1962	5655	1352	6200	1105	6594	895	7274	551	8403	217	7329

RECTANGULAR TIED COLUMNS 18" x 24"

4-#10	1.18	MA	4028	1668	6408	1199	6797	1011	6928	865	6948	647	7867	561	2889
2E		MI	2987	1668	4806	1156	5018	974	5066	833	5019	621	5466	515	2134
4-#11	1.44	MA	4096	1700	6596	1209	7012	1017	7181	866	7285	638	8268	546	3475
2E		MI	3029	1700	4928	1163	5153	977	5221	831	5226	610	5661	489	2547
4-#14	2.08	MA	4271	1777	7031	1250	7551	1045	7830	881	8166	628	9392	523	4854
2E		MI	3141	1777	5215	1200	5505	1003	5645	845	5790	597	6289	448	3500
4-#18	3.70	MA	4689	1970	8085	1356	8867	1119	9421	923	10323	603	12034	455	8190
2E		MI	3405	1970	5897	1302	6348	1073	6662	883	7062	551	7691	326	5748
6-#8	1.10	MA	4011	1659	6349	1200	6740	1013	6867	867	6868	651	7762	566	2719
2L-3S		MI	2915	1659	4587	1163	4754	987	4751	845	4593	633	4958	472	2027
6-#8	1.10	MA	3915	1659	6086	1206	6402	1024	6455	878	6308	660	6987	512	2737
3L-2S		MI	2978	1659	4768	1159	4986	978	5034	837	4978	627	5452	527	2011
6-#9	1.39	MA	4097	1694	6559	1219	7000	1026	7180	874	7293	647	8348	561	3381
2L-3S		MI	2957	1694	4684	1181	4871	1001	4890	853	4780	629	5184	443	2500

RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis

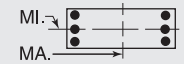


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#9	1.39	MA	3978	1694	6228	1225	6576	1040	6663	888	6589	658	7374	491	3403
3L-2S		MI	3034	1694	4911	1177	5161	990	5245	843	5263	622	5797	513	2478
6-#10	1.76	MA	4206	1738	6824	1243	7331	1043	7580	884	7834	641	9094	553	4218
2L-3S		MI	3009	1738	4806	1205	5018	1020	5066	864	5019	624	5466	406	3092
6-#10	1.76	MA	4058	1738	6408	1251	6797	1061	6928	900	6948	655	7867	464	4242
3L-2S		MI	3105	1738	5091	1200	5383	1006	5512	852	5625	615	6228	495	3063
6-#11	2.17	MA	4308	1786	7098	1263	7655	1056	7965	889	8352	631	9713	533	5070
2L-3S		MI	3056	1786	4928	1221	5153	1032	5221	868	5226	611	5661	350	3688
6-#11	2.17	MA	4134	1786	6596	1272	7012	1077	7181	909	7285	646	8268	423	5097
3L-2S		MI	3168	1786	5268	1216	5588	1016	5752	855	5949	603	6537	460	3651
6-#14	3.13	MA	4569	1901	7743	1327	8464	1101	8944	915	9681	618	11412	501	7104
2L-3S		MI	3180	1901	5215	1284	5505	1080	5645	896	5790	596	6289	242	5077
6-#14	3.13	MA	4328	1901	7031	1340	7551	1130	7830	942	8166	638	9392	343	7109
3L-2S		MI	3335	1901	5694	1278	6119	1059	6394	879	6803	586	7493	400	5038
6-#18	5.56	MA	5193	2191	9312	1494	10440	1219	11340	984	12934	586	15401	403	12035
2L-3S		MI	3474	2191	5897	1445	6348	1205	6662	967	7062	541	7691	-58	7661
6-#18	5.56	MA	4796	2191	8085	1513	8867	1267	9421	1026	10323	616	12034	121	11618
3L-2S		MI	3732	2191	6709	1440	7389	1173	7932	943	8731	523	9622	223	8318
8-#8	1.46	MA	4125	1702	6612	1228	7077	1032	7278	879	7427	648	8536	561	3558
2L-4S		MI	2965	1702	4628	1201	4804	1009	4811	858	4687	635	5103	433	2639
8-#8	1.46	MA	4030	1702	6349	1233	6740	1044	6867	890	6868	657	7762	507	3574
3E		MI	2991	1702	4768	1190	4986	1007	5034	857	4978	630	5452	461	2618
8-#8	1.46	MA	3982	1702	6149	1246	6480	1049	6547	894	6452	666	7227	475	3590
4L-2S		MI	3053	1702	4949	1187	5218	997	5317	849	5363	624	5947	517	2601
8-#9	1.85	MA	4239	1749	6889	1253	7424	1050	7697	889	7996	642	9322	554	4430
2L-4S		MI	3019	1749	4734	1229	4933	1029	4964	869	4897	631	5363	394	3256
8-#9	1.85	MA	4123	1749	6559	1260	7000	1065	7180	903	7293	653	8348	485	4448
3E		MI	3052	1749	4911	1216	5161	1026	5245	868	5263	624	5797	429	3233
8-#9	1.85	MA	4063	1749	6306	1276	6673	1070	6778	907	6769	665	7673	445	4458
4L-2S		MI	3128	1749	5138	1211	5452	1014	5600	858	5746	617	6410	499	3212
8-#10	2.35	MA	4384	1809	7241	1287	7865	1074	8232	903	8721	635	10320	546	5535
2L-4S		MI	3088	1809	4868	1265	5095	1054	5159	884	5165	626	5687	342	4022
8-#10	2.35	MA	4239	1809	6824	1295	7331	1092	7580	920	7834	649	9094	456	5551
3E		MI	3128	1809	5091	1249	5383	1051	5512	883	5625	618	6228	386	4003
8-#10	2.35	MA	4166	1809	6506	1315	6918	1099	7073	925	7174	663	8240	405	5538
4L-2S		MI	3223	1809	5376	1244	5749	1037	5958	871	6232	610	6989	475	3978
8-#11	2.89	MA	4520	1873	7599	1317	8298	1094	8749	913	9419	624	11158	520	6652
2L-4S		MI	3151	1873	5001	1294	5243	1073	5329	891	5398	612	5910	271	4688
8-#11	2.89	MA	4350	1873	7098	1326	7655	1115	7965	932	8352	640	9713	410	6667
3E		MI	3197	1873	5268	1275	5588	1070	5752	892	5949	604	6537	321	4767
8-#11	2.89	MA	4265	1873	6713	1349	7156	1123	7352	938	7554	655	8703	349	6551
4L-2S		MI	3307	1873	5608	1270	6023	1054	6284	878	6671	597	7413	431	4739
8-#14	4.17	MA	4631	2026	7743	1418	8464	1186	8944	976	9681	628	11412	320	9314
3E		MI	3377	2026	5694	1362	6119	1136	6394	930	6803	585	7493	195	6574
8-#14	4.17	MA	4516	2026	7194	1450	7753	1195	8071	982	8544	649	9995	235	8622
4L-2S		MI	3529	2026	6173	1356	6732	1115	7142	913	7816	575	8697	353	6556
8-#18	7.41	MA	5312	2413	9312	1651	10440	1366	11340	1086	12934	599	15401	69	15139
3E		MI	3805	2413	6709	1584	7389	1304	7932	1028	8731	513	9622	-161	9505
8-#18	7.41	MA	5126	2413	8359	1705	9207	1379	9826	1093	10964	629	13023	-74	12937
4L-2S		MI	4058	2413	7521	1579	8431	1272	9203	1004	10399	495	11554	121	10863
10-#10	2.94	MA	4561	1879	7658	1331	8399	1106	8884	922	9608	630	11547	538	6846
2L-5S		MI	3124	1879	4965	1314	5211	1100	5292	915	5312	618	5918	270	4680
10-#10	2.94	MA	4419	1879	7241	1339	7865	1124	8232	939	8721	643	10320	448	6854
3L-4S		MI	3207	1879	5153	1309	5461	1086	5604	903	5772	621	6448	323	4906
10-#10	2.94	MA	4347	1879	6923	1359	7452	1130	7725	944	8060	657	9467	397	6827
4L-3S		MI	3247	1879	5376	1293	5749	1083	5958	902	6232	612	6989	366	4904
10-#10	2.94	MA	4222	1879	6655	1367	7096	1149	7280	961	7403	660	8612	347	6469
5L-2S		MI	3340	1879	5661	1288	6114	1069	6404	890	6838	604	7750	455	4885

RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

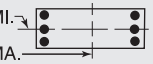
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	3.61	MA	4564	1959	7599	1380	8298	1154	8749	956	9419	633	11158	397	8226
3L-4S		MI	3293	1959	5341	1348	5678	1111	5860	915	6121	606	6786	242	5670
10-#11	3.61	MA	4481	1959	7214	1403	7799	1161	8136	961	8621	648	10148	336	8024
4L-3S		MI	3337	1959	5608	1329	6023	1109	6284	915	6671	598	7413	292	5836
10-#11	3.61	MA	4333	1959	6890	1413	7368	1183	7598	980	7826	650	9141	274	7591
5L-2S		MI	3446	1959	5947	1324	6459	1093	6815	902	7394	590	8290	401	5816
10-#14	5.21	MA	4819	2150	7906	1528	8666	1251	9185	1016	10060	639	12016	213	10732
4L-3S		MI	3573	2150	6173	1440	6732	1192	7142	964	7816	574	8697	147	8059
10-#14	5.21	MA	4611	2150	7444	1540	8051	1281	8417	1042	8926	639	10607	122	10093
5L-2S		MI	3723	2150	6652	1434	7346	1171	7891	947	8829	564	9901	306	8064
12-#10	3.53	MA	4598	1949	7658	1383	8399	1155	8884	958	9608	638	11547	440	8152
3L-5S		MI	3244	1949	5250	1358	5576	1132	5738	935	5919	612	6679	250	5529
12-#10	3.53	MA	4526	1949	7340	1403	7986	1162	8376	963	8947	652	10694	389	8114
4E		MI	3326	1949	5438	1353	5826	1117	6050	922	6378	615	7209	303	5737
12-#10	3.53	MA	4404	1949	7072	1411	7630	1180	7932	980	8290	654	9839	339	7722
5L-3S		MI	3365	1949	5661	1337	6114	1114	6404	921	6838	607	7750	346	5800
12-#10	3.53	MA	4315	1949	6812	1417	7276	1187	7491	985	7697	668	9059	280	7456
6L-2S		MI	3457	1949	5946	1332	6480	1100	6849	909	7445	598	8511	435	5786
12-#11	4.33	MA	4694	2045	7715	1457	8442	1200	8920	985	9688	641	11593	323	9507
4E		MI	3433	2045	5680	1402	6113	1150	6391	938	6843	599	7663	212	6662
12-#11	4.33	MA	4549	2045	7391	1467	8011	1221	8382	1004	8893	643	10586	261	9102
5L-3S		MI	3476	2045	5947	1383	6459	1148	6815	939	7394	591	8290	262	6900
12-#11	4.33	MA	4443	2045	7058	1488	7581	1229	7848	1009	8176	658	9665	191	8611
6L-2S		MI	3584	2045	6287	1378	6894	1132	7346	925	8117	583	9166	372	6888
12-#14	6.25	MA	4917	2274	8156	1618	8964	1336	9531	1076	10442	629	12628	100	12187
5L-3S		MI	3769	2274	6652	1517	7346	1248	7891	998	8829	563	9901	100	9537
14-#10	4.12	MA	4705	2019	7756	1447	8521	1194	9028	982	9834	646	11920	381	9355
4L-5S		MI	3363	2019	5535	1402	5941	1163	6184	954	6525	606	7440	230	6383
14-#10	4.12	MA	4584	2019	7489	1455	8165	1212	8583	999	9177	648	11065	331	8980
5L-4S		MI	3444	2019	5723	1397	6192	1149	6496	942	6985	609	7971	283	6575
14-#10	4.12	MA	4497	2019	7228	1461	7810	1218	8143	1004	8584	662	10286	272	8695
6L-3S		MI	3483	2019	5946	1381	6480	1146	6849	941	7445	601	8511	326	6694
14-#11	5.06	MA	4764	2132	7893	1520	8654	1260	9166	1027	9960	636	12031	248	10618
5L-4S		MI	3573	2132	6020	1456	6549	1189	6922	962	7566	592	8539	183	7662
14-#11	5.06	MA	4660	2132	7559	1542	8224	1267	8632	1033	9243	651	11110	178	10104
6L-3S		MI	3616	2132	6287	1437	6894	1187	7346	962	8117	584	9166	233	7957
16-#10	4.70	MA	4763	2090	7906	1499	8699	1243	9235	1018	10063	643	12292	323	10242
5E		MI	3482	2090	5820	1446	6307	1195	6630	973	7132	601	8201	211	7240
16-#10	4.70	MA	4679	2090	7645	1505	8344	1250	8794	1024	9471	657	11512	264	9939
6L-4S		MI	3562	2090	6008	1441	6557	1181	6942	961	7591	604	8732	263	7418
16-#11	5.78	MA	4877	2218	8061	1596	8867	1306	9417	1056	10310	644	12555	165	11603
6L-4S		MI	3712	2218	6359	1510	6984	1228	7453	985	8288	585	9416	154	8669
18-#10	5.29	MA	4859	2160	8062	1549	8879	1282	9446	1043	10358	651	12739	256	11186
6L-5S		MI	3600	2160	6105	1490	6672	1226	7075	992	7738	595	8962	191	8099

RECTANGULAR TIED COLUMNS 18" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.09	MA	4707	1795	7439	1303	7904	1099	8056	942	8058	708	9108	615	3164
2E		MI	3216	1795	5159	1245	5375	1050	5414	899	5336	674	5795	561	2155
4-#11	1.33	MA	4784	1827	7651	1313	8146	1105	8339	943	8437	699	9628	606	3812
2E		MI	3258	1827	5282	1250	5509	1052	5568	897	5541	662	5986	535	2572
4-#14	1.92	MA	4981	1904	8136	1353	8747	1133	9064	958	9418	689	10920	588	5340
2E		MI	3370	1904	5570	1288	5861	1077	5990	910	6103	648	6612	493	3532
4-#18	3.42	MA	5453	2097	9315	1459	10220	1207	10843	1000	11831	665	13981	531	9054
2E		MI	3634	2097	6253	1388	6704	1146	7006	947	7373	602	8009	371	5795

RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis



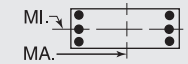
f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.01	MA	4687	1786	7373	1304	7839	1101	7985	944	7967	713	8986	620	2975
2L-3S		MI	3144	1786	4939	1253	5112	1064	5100	912	4911	686	5289	518	2044
6-#8	1.01	MA	4580	1786	7082	1310	7467	1106	7531	956	7349	722	8131	567	2992
3L-2S		MI	3207	1786	5120	1249	5344	1054	5383	904	5296	680	5783	574	2030
6-#9	1.28	MA	4784	1821	7605	1322	8127	1114	8333	951	8438	708	9636	614	3705
2L-3S		MI	3186	1821	5037	1270	5228	1078	5238	920	5098	682	5514	490	2521
6-#9	1.28	MA	4650	1821	7240	1329	7659	1120	7762	965	7661	720	8560	547	3727
3L-2S		MI	3263	1821	5264	1266	5519	1066	5593	910	5581	675	6127	560	2499
6-#10	1.63	MA	4906	1866	7900	1347	8495	1131	8776	961	9039	702	10466	607	4629
2L-3S		MI	3238	1866	5159	1294	5375	1096	5414	930	5336	676	5795	452	3118
6-#10	1.63	MA	4740	1866	7439	1356	7904	1138	8056	978	8058	717	9108	521	4654
3L-2S		MI	3334	1866	5444	1289	5741	1082	5860	918	5942	668	6556	541	3088
6-#11	2.00	MA	5022	1914	8206	1367	8858	1144	9208	966	9619	692	11264	597	5576
2L-3S		MI	3285	1914	5282	1309	5509	1107	5568	933	5541	663	5986	396	3720
6-#11	2.00	MA	4826	1914	7651	1377	8146	1166	8339	987	8437	709	9628	487	5603
3L-2S		MI	3398	1914	5622	1304	5945	1091	6099	920	6264	655	6863	505	3681
6-#14	2.88	MA	5315	2028	8926	1431	9760	1189	10299	992	11099	679	13216	571	7833
2L-3S		MI	3409	2028	5570	1371	5861	1154	5990	961	6103	647	6612	287	5120
6-#14	2.88	MA	5043	2028	8136	1445	8747	1220	9064	1021	9418	702	10920	413	7838
3L-2S		MI	3565	2028	6049	1365	6475	1133	6739	943	7116	637	7816	446	5076
6-#18	5.13	MA	6019	2319	10681	1598	11970	1307	12978	1060	14737	647	17836	490	13331
2L-3S		MI	3703	2319	6253	1531	6704	1278	7006	1031	7373	591	8009	-14	8003
6-#18	5.13	MA	5571	2319	9315	1619	10220	1358	10843	1107	11831	683	13981	208	13152
3L-2S		MI	3961	2319	7065	1526	7745	1245	8276	1007	9041	574	9941	268	8371
8-#8	1.35	MA	4814	1830	7663	1331	8211	1121	8439	956	8585	709	9841	615	3899
2L-4S		MI	3194	1830	4980	1291	5162	1086	5159	925	5005	689	5434	480	2660
8-#8	1.35	MA	4708	1830	7373	1337	7839	1126	7985	967	7967	719	8986	562	3915
3E		MI	3221	1830	5120	1280	5344	1083	5383	924	5296	683	5783	508	2639
8-#8	1.35	MA	4653	1830	7153	1350	7553	1138	7634	972	7510	729	8403	531	3931
4L-2S		MI	3282	1830	5301	1276	5576	1074	5666	916	5681	677	6277	563	2622
8-#9	1.71	MA	4943	1876	7970	1357	8595	1139	8904	966	9215	703	10712	608	4862
2L-4S		MI	3248	1876	5087	1318	5290	1105	5312	936	5215	684	5692	440	3283
8-#9	1.71	MA	4811	1876	7605	1364	8127	1145	8333	980	8438	716	9636	540	4880
3E		MI	3281	1876	5264	1305	5519	1102	5593	935	5581	677	6127	475	3257
8-#9	1.71	MA	4743	1876	7328	1380	7767	1160	7891	986	7862	728	8900	501	4890
4L-2S		MI	3357	1876	5490	1301	5810	1091	5948	925	6063	670	6740	545	3236
8-#10	2.17	MA	5105	1936	8361	1390	9085	1162	9497	980	10019	696	11823	600	6084
2L-4S		MI	3317	1936	5221	1354	5453	1130	5507	950	5482	679	6016	389	4056
8-#10	2.17	MA	4942	1936	7900	1399	8495	1170	8776	997	9039	711	10466	513	6100
3E		MI	3357	1936	5444	1338	5741	1127	5860	949	5942	671	6556	432	4032
8-#10	2.17	MA	4857	1936	7550	1420	8040	1189	8218	1004	8311	726	9533	462	6087
4L-2S		MI	3452	1936	5729	1333	6106	1113	6306	937	6549	662	7317	521	4006
8-#11	2.67	MA	5258	2000	8762	1420	9570	1182	10076	990	10801	685	12901	587	7326
2L-4S		MI	3380	2000	5355	1382	5600	1148	5676	956	5713	664	6235	317	4823
8-#11	2.67	MA	5067	2000	8206	1431	8858	1205	9208	1010	9619	702	11264	478	7341
3E		MI	3426	2000	5622	1363	5945	1145	6099	957	6264	657	6863	366	4804
8-#11	2.67	MA	4969	2000	7782	1455	8308	1213	8532	1017	8739	719	10126	415	7295
4L-2S		MI	3536	2000	5962	1358	6380	1129	6630	944	6987	649	7739	476	4772
8-#14	3.85	MA	5383	2153	8926	1522	9760	1276	10299	1054	11099	692	13216	396	10286
3E		MI	3606	2153	6049	1449	6475	1210	6739	995	7116	636	7816	240	6626
8-#14	3.85	MA	5248	2153	8320	1556	8975	1287	9335	1063	9844	715	11615	307	9640
4L-2S		MI	3759	2153	6528	1443	7089	1189	7488	977	8130	627	9020	398	6598
8-#18	6.84	MA	6151	2540	10681	1758	11970	1458	12978	1167	14737	665	17836	167	17145
3E		MI	4034	2540	7065	1669	7745	1377	8276	1091	9041	564	9941	-117	9861

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis

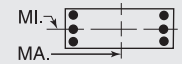


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	6.84	MA	5931	2540	9627	1815	10605	1474	11303	1178	12555	700	15130	16	15034
4L-2S		MI	4288	2540	7877	1664	8786	1345	9546	1067	10709	546	11873	165	10924
10-#10	2.71	MA	5302	2006	8822	1434	9676	1194	10217	999	10999	691	13180	592	7532
2L-5S		MI	3353	2006	5318	1403	5568	1176	5640	982	5629	670	6246	316	4758
10-#10	2.71	MA	5143	2006	8361	1443	9085	1201	9497	1017	10019	706	11823	505	7540
3L-4S		MI	3436	2006	5506	1398	5818	1162	5952	969	6089	673	6777	369	4951
10-#10	2.71	MA	5059	2006	8010	1464	8631	1220	8938	1023	9291	721	10891	455	7513
4L-3S		MI	3476	2006	5729	1382	6106	1159	6306	968	6549	665	7317	412	4936
10-#10	2.71	MA	4920	2006	7717	1473	8240	1228	8449	1041	8568	724	9953	407	7170
5L-2S		MI	3569	2006	6014	1377	6471	1145	6751	956	7155	657	8079	501	4915
10-#11	3.33	MA	5306	2086	8762	1485	9570	1243	10076	1034	10801	695	12901	468	9069
3L-4S		MI	3522	2086	5695	1436	6035	1186	6207	980	6436	658	7112	287	5771
10-#11	3.33	MA	5210	2086	8337	1509	9020	1252	9400	1041	9921	712	11763	405	8953
4L-3S		MI	3566	2086	5962	1417	6380	1184	6630	980	6987	650	7739	337	5876
10-#11	3.33	MA	5044	2086	7981	1519	8546	1274	8808	1061	9045	716	10623	343	8426
5L-2S		MI	3675	2086	6301	1412	6815	1168	7161	967	7709	642	8616	447	5853
10-#14	4.81	MA	5588	2277	9110	1634	9988	1343	10570	1097	11525	705	13911	290	11987
4L-3S		MI	3802	2277	6528	1527	7089	1266	7488	1029	8130	626	9020	193	8115
10-#14	4.81	MA	5356	2277	8601	1648	9310	1374	9724	1125	10275	708	12310	201	11364
5L-2S		MI	3953	2277	7007	1521	7702	1245	8237	1011	9143	616	10224	351	8109
12-#10	3.26	MA	5342	2076	8822	1487	9676	1233	10217	1036	10999	700	13180	497	8975
3L-5S		MI	3473	2076	5603	1447	5933	1208	6086	1001	6236	665	7007	297	5607
12-#10	3.26	MA	5259	2076	8471	1507	9221	1252	9659	1042	10272	715	12248	447	8937
4E		MI	3555	2076	5791	1442	6183	1193	6398	989	6695	668	7538	349	5826
12-#10	3.26	MA	5123	2076	8178	1516	8830	1260	9170	1060	9548	719	11310	399	8558
5L-3S		MI	3594	2076	6014	1426	6471	1190	6751	988	7155	659	8079	392	5835
12-#10	3.26	MA	5024	2076	7885	1522	8441	1278	8686	1066	8897	734	10459	341	8306
6L-2S		MI	3687	2076	6299	1421	6837	1176	7197	975	7762	651	8840	482	5818
12-#11	4.00	MA	5449	2173	8893	1563	9732	1291	10269	1064	11102	706	13399	396	10600
4E		MI	3662	2173	6034	1490	6470	1225	6738	1003	7158	651	7988	258	6762
12-#11	4.00	MA	5286	2173	8537	1573	9258	1313	9677	1085	10226	709	12259	334	10102
5L-3S		MI	3706	2173	6301	1471	6815	1223	7161	1004	7709	643	8616	308	6943
12-#11	4.00	MA	5168	2173	8189	1580	8786	1321	9089	1091	9437	726	11219	261	9629
6L-2S		MI	3813	2173	6641	1466	7251	1207	7692	991	8432	635	9492	418	6927
12-#14	5.77	MA	5698	2402	9391	1726	10323	1430	10960	1159	11956	698	14606	184	13716
5L-3S		MI	3998	2402	7007	1604	7702	1322	8237	1063	9143	615	10224	145	9598
14-#10	3.80	MA	5459	2147	8932	1551	9812	1283	10379	1061	11252	710	13605	439	10361
4L-5S		MI	3592	2147	5888	1491	6299	1239	6532	1020	6842	659	7769	277	6460
14-#10	3.80	MA	5324	2147	8638	1560	9421	1291	9890	1079	10528	713	12667	392	9950
5L-4S		MI	3673	2147	6076	1486	6549	1225	6844	1008	7302	662	8299	329	6662
14-#10	3.80	MA	5227	2147	8345	1566	9031	1310	9406	1085	9878	728	11816	333	9704
6L-3S		MI	3712	2147	6299	1470	6837	1222	7197	1007	7762	654	8840	372	6730
14-#10	3.80	MA	5128	2147	8014	1582	8652	1316	8944	1103	9243	743	10935	294	9224
7L-2S		MI	3803	2147	6584	1464	7202	1208	7643	994	8368	646	9601	462	6718
14-#11	4.67	MA	5526	2259	9092	1627	9970	1352	10545	1108	11408	702	13895	324	11783
5L-4S		MI	3802	2259	6374	1544	6906	1264	7269	1027	7881	644	8865	229	7761
14-#11	4.67	MA	5411	2259	8744	1634	9498	1360	9958	1115	10619	719	12855	252	11288
6L-3S		MI	3845	2259	6641	1525	7251	1262	7692	1028	8432	636	9492	279	8006
16-#10	4.34	MA	5524	2217	9099	1604	10011	1323	10611	1098	11509	708	14024	384	11347
5E		MI	3711	2217	6173	1535	6664	1271	6978	1039	7449	653	8530	257	7317
16-#10	4.34	MA	5430	2217	8806	1610	9622	1342	10127	1104	10858	723	13174	326	11083
6L-4S		MI	3791	2217	6361	1530	6914	1256	7290	1027	7908	656	9060	309	7504
16-#10	4.34	MA	5331	2217	8475	1626	9243	1348	9664	1122	10223	737	12292	286	10619
7L-3S		MI	3830	2217	6584	1513	7202	1253	7643	1026	8368	648	9601	352	7622
16-#11	5.33	MA	5653	2345	9300	1688	10210	1399	10826	1138	11801	712	14492	242	12954
6L-4S		MI	3941	2345	6713	1598	7341	1303	7800	1051	8603	637	9741	200	8766

RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	4.88	MA	5631	2287	9267	1654	10213	1373	10847	1124	11838	717	14531	318	12466
6L-5S		MI	3829	2287	6458	1579	7029	1302	7423	1058	8055	648	9291	237	8176
18-#10	4.88	MA	5533	2287	8936	1670	9833	1379	10385	1141	11204	732	13649	278	12016
7L-4S		MI	3909	2287	6646	1574	7280	1288	7735	1046	8515	651	9821	289	8350
20-#10	5.43	MA	5733	2358	9397	1714	10424	1411	11105	1160	12184	726	15007	271	13416
7L-5S		MI	3947	2358	6743	1623	7395	1334	7869	1077	8662	642	10052	217	9037

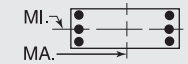
RECTANGULAR TIED COLUMNS 18" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.01	MA	5437	1923	8544	1406	9090	1187	9263	1018	9245	769	10429	669	3438
2E		MI	3445	1923	5512	1334	5733	1126	5762	965	5653	726	6124	607	2175
4-#11	1.24	MA	5524	1955	8778	1416	9359	1193	9577	1020	9665	760	11005	660	4149
2E		MI	3488	1955	5637	1338	5866	1127	5915	962	5857	714	6312	580	2597
4-#14	1.79	MA	5743	2031	9313	1456	10022	1221	10376	1035	10746	750	12499	648	5826
2E		MI	3599	2031	5925	1375	6218	1151	6336	974	6417	700	6936	538	3564
4-#18	3.17	MA	6270	2225	10618	1563	11651	1296	12345	1077	13415	726	16015	603	9918
2E		MI	3864	2225	6609	1473	7059	1219	7349	1010	7683	652	8328	415	5840
6-#9	1.19	MA	5522	1948	8724	1426	9333	1202	9565	1028	9658	769	11004	668	4029
2L-3S		MI	3415	1948	5389	1360	5585	1154	5587	986	5416	735	5843	536	2541
6-#9	1.19	MA	5374	1948	8324	1433	8821	1209	8940	1043	8808	782	9826	602	4051
3L-2S		MI	3492	1948	5616	1356	5876	1142	5941	976	5899	728	6456	606	2520
6-#10	1.51	MA	5658	1993	9048	1450	9737	1219	10052	1038	10318	763	11916	661	5041
2L-3S		MI	3467	1993	5512	1383	5733	1172	5762	996	5653	729	6124	498	3141
6-#10	1.51	MA	5473	1993	8544	1460	9090	1227	9263	1056	9245	779	10429	576	5065
3L-2S		MI	3564	1993	5797	1378	6098	1157	6208	984	6259	721	6885	587	3112
6-#11	1.86	MA	5787	2041	9388	1470	10140	1232	10530	1043	10961	753	12800	651	6081
2L-3S		MI	3514	2041	5637	1397	5866	1182	5915	999	5857	715	6312	441	3750
6-#11	1.86	MA	5569	2041	8778	1481	9359	1241	9577	1065	9665	772	11005	544	6108
3L-2S		MI	3627	2041	5976	1392	6302	1166	6446	985	6579	708	7188	551	3711
6-#14	2.68	MA	6113	2156	10181	1534	11134	1277	11733	1069	12593	740	15055	634	8562
2L-3S		MI	3638	2156	5925	1458	6218	1229	6336	1026	6417	699	6936	333	5161
6-#14	2.68	MA	5810	2156	9313	1549	10022	1310	10376	1099	10746	765	12499	477	8567
3L-2S		MI	3794	2156	6404	1452	6831	1207	7085	1008	7430	689	8139	491	5112
6-#18	4.76	MA	6898	2446	12121	1701	13578	1395	14696	1137	16615	708	20360	571	14627
2L-3S		MI	3932	2446	6609	1616	7059	1350	7349	1094	7683	642	8328	31	8245
6-#18	4.76	MA	6398	2446	10618	1725	11651	1450	12345	1187	13415	748	16015	289	14448
3L-2S		MI	4190	2446	7421	1611	8100	1318	8619	1071	9352	624	10260	312	8424
8-#8	1.25	MA	5555	1957	8787	1434	9424	1209	9680	1033	9817	770	11227	669	4240
2L-4S		MI	3423	1957	5332	1380	5519	1162	5508	992	5324	742	5764	526	2680
8-#8	1.25	MA	5438	1957	8469	1441	9017	1214	9183	1045	9142	781	10291	617	4256
3E		MI	3450	1957	5473	1370	5701	1160	5732	991	5615	736	6114	554	2659
8-#8	1.25	MA	5375	1957	8229	1454	8705	1227	8800	1050	8643	791	9660	586	4272
4L-2S		MI	3512	1957	5653	1366	5933	1151	6015	982	6000	730	6608	610	2643
8-#9	1.59	MA	5698	2003	9124	1460	9846	1227	10190	1043	10509	765	12182	662	5294
2L-4S		MI	3477	2003	5439	1407	5648	1181	5661	1002	5533	737	6022	487	3308
8-#9	1.59	MA	5552	2003	8724	1468	9333	1234	9565	1058	9658	777	11004	596	5312
3E		MI	3510	2003	5616	1394	5876	1179	5941	1001	5899	730	6456	521	3281
8-#9	1.59	MA	5474	2003	8422	1484	8941	1249	9082	1064	9030	790	10207	557	5322
4L-2S		MI	3587	2003	5843	1390	6167	1167	6296	991	6381	723	7070	592	3259
8-#10	2.02	MA	5877	2063	9553	1494	10384	1250	10841	1057	11392	758	13403	653	6632
2L-4S		MI	3546	2063	5574	1443	5810	1206	5855	1016	5800	731	6344	435	4088
8-#10	2.02	MA	5696	2063	9048	1503	9737	1259	10052	1075	10318	774	11916	569	6649
3E		MI	3586	2063	5797	1427	6098	1203	6208	1015	6259	723	6885	478	4060

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis

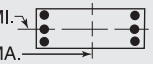


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	2.02	MA	5600	2063	8666	1524	9241	1278	9442	1082	9524	790	10906	519	6635
4L-2S		MI	3681	2063	6082	1422	6463	1189	6654	1003	6866	715	7646	567	4032
8-#11	2.48	MA	6049	2127	9997	1524	10921	1271	11483	1067	12258	747	14596	641	8000
2L-4S		MI	3609	2127	5709	1470	5956	1223	6022	1022	6028	716	6561	362	4866
8-#11	2.48	MA	5836	2127	9388	1535	10140	1280	10530	1088	10961	765	12800	534	8015
3E		MI	3655	2127	5976	1451	6302	1220	6446	1022	6579	709	7188	412	4838
8-#11	2.48	MA	5723	2127	8924	1560	9539	1303	9791	1096	9999	783	11567	472	7969
4L-2S		MI	3766	2127	6316	1446	6737	1204	6977	1009	7302	701	8065	522	4805
8-#14	3.57	MA	6187	2280	10181	1627	11134	1366	11733	1133	12593	755	15055	463	11258
3E		MI	3835	2280	6404	1536	6831	1285	7085	1059	7430	688	8139	285	6671
8-#14	3.57	MA	6032	2280	9519	1662	10276	1378	10678	1143	11219	780	13284	373	10677
4L-2S		MI	3988	2280	6883	1530	7445	1263	7834	1042	8443	678	9343	444	6639
8-#18	6.35	MA	7042	2667	12121	1864	13578	1549	14696	1247	16615	730	20360	257	19078
3E		MI	4263	2667	7421	1755	8100	1450	8619	1155	9352	614	10260	-72	10213
8-#18	6.35	MA	6788	2667	10967	1923	12083	1568	12859	1262	14222	770	17325	101	16675
4L-2S		MI	4519	2667	8233	1750	9142	1418	9890	1131	11020	596	12192	209	10979
10-#10	2.52	MA	6095	2133	10057	1538	11031	1282	11630	1076	12466	752	14889	646	8218
2L-5S		MI	3582	2133	5671	1492	5925	1252	5988	1048	5946	723	6575	363	4834
10-#10	2.52	MA	5918	2133	9553	1547	10384	1290	10841	1094	11392	768	13403	561	8226
3L-4S		MI	3665	2133	5859	1487	6175	1238	6300	1036	6406	726	7106	415	4987
10-#10	2.52	MA	5823	2133	9171	1568	9888	1310	10231	1102	10598	784	12393	511	8198
4L-3S		MI	3705	2133	6082	1471	6463	1235	6654	1035	6866	718	7646	458	4967
10-#10	2.52	MA	5669	2133	8851	1578	9462	1318	9699	1120	9809	789	11373	466	7881
5L-2S		MI	3799	2133	6367	1466	6829	1221	7099	1022	7472	709	8407	548	4944
10-#11	3.10	MA	6101	2214	9997	1589	10921	1319	11483	1112	12258	758	14596	525	9911
3L-4S		MI	3751	2214	6049	1524	6392	1261	6553	1045	6751	710	7438	333	5913
10-#11	3.10	MA	5990	2214	9533	1614	10320	1342	10744	1120	11295	776	13362	463	9850
4L-3S		MI	3795	2214	6316	1505	6737	1259	6977	1046	7302	702	8065	383	5915
10-#11	3.10	MA	5807	2214	9145	1625	9803	1351	10098	1141	10339	781	12122	405	9271
5L-2S		MI	3904	2214	6655	1500	7172	1243	7508	1033	8024	694	8941	493	5889
10-#14	4.46	MA	6408	2405	10386	1740	11388	1434	12035	1177	13065	770	15841	359	13263
4L-3S		MI	4031	2405	6883	1614	7445	1340	7834	1093	8443	677	9343	238	8169
10-#14	4.46	MA	6152	2405	9831	1755	10649	1467	11111	1207	11699	776	14064	272	12520
5L-2S		MI	4182	2405	7361	1608	8059	1319	8582	1076	9456	667	10547	396	8153
10-#18	7.94	MA	7431	2889	12471	2061	14010	1667	15211	1322	17422	752	21670	68	21211
4L-3S		MI	4593	2889	8233	1893	9142	1549	9890	1215	11020	586	12192	-175	12042
12-#10	3.02	MA	6139	2204	10057	1591	11031	1322	11630	1113	12466	762	14889	553	9798
3L-5S		MI	3702	2204	5956	1536	6290	1284	6434	1067	6553	717	7336	343	5682
12-#10	3.02	MA	6044	2204	9675	1612	10535	1342	11021	1121	11671	778	13879	503	9760
4E		MI	3784	2204	6144	1531	6541	1269	6746	1055	7013	720	7867	395	5881
12-#10	3.02	MA	5893	2204	9356	1622	10108	1350	10488	1139	10882	783	12860	459	9403
5L-3S		MI	3823	2204	6367	1515	6829	1266	7099	1054	7472	712	8407	438	5868
12-#10	3.02	MA	5784	2204	9030	1627	9685	1370	9960	1146	10173	799	11939	401	9107
6L-2S		MI	3916	2204	6652	1510	7194	1252	7545	1041	8079	704	9168	528	5849
12-#11	3.71	MA	6255	2300	10143	1668	11101	1381	11697	1143	12592	769	15157	453	11710
4E		MI	3891	2300	6388	1578	6827	1300	7084	1069	7473	703	8314	304	6858
12-#11	3.71	MA	6075	2300	9755	1679	10584	1390	11051	1165	11635	774	13917	395	11113
5L-3S		MI	3935	2300	6655	1559	7172	1298	7508	1069	8024	695	8941	354	6985
12-#11	3.71	MA	5944	2300	9367	1685	10069	1413	10410	1173	10774	792	12791	323	10666
6L-2S		MI	4043	2300	6995	1554	7608	1282	8039	1056	8747	687	9818	463	6965
12-#14	5.36	MA	6530	2529	10699	1833	11761	1522	12469	1241	13545	766	16621	258	15160
5L-3S		MI	4227	2529	7361	1691	8059	1396	8582	1127	9456	666	10547	191	9655
12-#14	5.36	MA	6347	2529	10153	1843	11025	1535	11553	1251	12314	791	15003	154	14051
6L-2S		MI	4376	2529	7840	1686	8673	1375	9331	1110	10470	656	11751	349	9659
14-#10	3.53	MA	6264	2274	10180	1656	11181	1373	11810	1140	12745	773	15366	496	11322
4L-5S		MI	3821	2274	6241	1580	6656	1315	6880	1086	7159	712	8097	323	6535
14-#10	3.53	MA	6116	2274	9860	1666	10755	1381	11277	1158	11956	777	14346	451	10930
5L-4S		MI	3902	2274	6429	1575	6906	1301	7192	1074	7619	715	8628	375	6747

RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	3.53	MA	6009	2274	9535	1671	10331	1401	10749	1165	11246	793	13426	393	10648
6L-3S		MI	3942	2274	6652	1559	7194	1298	7545	1073	8079	706	9168	418	6765
14-#10	3.53	MA	5897	2274	9173	1687	9909	1407	10246	1184	10555	809	12470	356	10166
7L-2S		MI	4033	2274	6937	1553	7559	1284	7991	1061	8685	698	9930	508	6750
14-#11	4.33	MA	6341	2386	10364	1733	11365	1429	12004	1188	12932	767	15712	385	12959
5L-4S		MI	4031	2386	6728	1632	7262	1339	7615	1092	8196	696	9191	274	7856
14-#11	4.33	MA	6214	2386	9976	1739	10850	1452	11363	1196	12071	785	14587	314	12494
6L-3S		MI	4074	2386	6995	1613	7608	1337	8039	1093	8747	688	9818	324	8050
14-#11	4.33	MA	6082	2386	9539	1759	10349	1460	10751	1218	11232	804	13420	265	11893
7L-2S		MI	4181	2386	7334	1608	8043	1321	8570	1080	9469	680	10694	434	8036
14-#14	6.25	MA	6729	2654	11021	1921	12137	1591	12910	1285	14161	781	17560	140	16677
6L-3S		MI	4422	2654	7840	1769	8673	1452	9331	1161	10470	656	11751	143	11138
16-#10	4.03	MA	6337	2344	10365	1710	11402	1413	12066	1177	13030	772	15833	443	12461
5E		MI	3940	2344	6526	1624	7021	1347	7326	1105	7766	706	8858	303	7391
16-#10	4.03	MA	6233	2344	10039	1715	10978	1433	11538	1185	12320	788	14913	385	12191
6L-4S		MI	4021	2344	6714	1619	7272	1332	7637	1093	8225	709	9389	355	7588
16-#10	4.03	MA	6121	2344	9678	1731	10556	1438	11035	1203	11629	804	13956	349	11697
7L-3S		MI	4059	2344	6937	1602	7559	1329	7991	1092	8685	701	9930	399	7659
16-#10	4.03	MA	5996	2344	9361	1738	10118	1454	10539	1221	10893	809	12907	283	11239
8L-2S		MI	4150	2344	7222	1597	7925	1315	8437	1080	9292	693	10691	488	7648
16-#11	4.95	MA	6481	2473	10586	1793	11631	1491	12316	1220	13367	779	16382	304	14326
6L-4S		MI	4171	2473	7068	1686	7698	1378	8147	1116	8918	689	10067	245	8860
16-#11	4.95	MA	6350	2473	10148	1813	11130	1498	11704	1241	12528	797	15216	256	13745
7L-3S		MI	4213	2473	7334	1667	8043	1375	8570	1116	9469	681	10694	295	9109
18-#10	4.54	MA	6455	2415	10544	1759	11625	1464	12328	1204	13394	782	16399	378	13737
6L-5S		MI	4058	2415	6811	1668	7387	1378	7771	1124	8372	700	9619	283	8250
18-#10	4.54	MA	6344	2415	10183	1775	11203	1470	11824	1222	12703	798	15443	341	13231
7L-4S		MI	4138	2415	6999	1663	7637	1364	8083	1112	8832	703	10150	335	8433
18-#10	4.54	MA	6221	2415	9866	1782	10765	1486	11328	1240	11967	803	14394	275	12768
8L-3S		MI	4177	2415	7222	1646	7925	1361	8437	1111	9292	695	10691	379	8550
18-#11	5.57	MA	6617	2559	10757	1867	11911	1537	12657	1265	13825	790	17011	246	15601
7L-4S		MI	4310	2559	7407	1739	8133	1416	8678	1139	9641	682	10943	216	9869
20-#10	5.04	MA	6565	2485	10687	1819	11850	1501	12613	1241	13776	793	16930	333	14767
7L-5S		MI	4176	2485	7096	1712	7752	1410	8217	1144	8979	695	10381	263	9111
20-#10	5.04	MA	6444	2485	10370	1825	11412	1517	12117	1259	13040	797	15881	267	14300
8L-4S		MI	4256	2485	7284	1707	8002	1395	8529	1131	9438	698	10911	316	9282
22-#10	5.54	MA	6666	2555	10875	1869	12059	1549	12907	1278	14114	792	17367	259	15833
8L-5S		MI	4294	2555	7381	1755	8117	1441	8663	1163	9585	689	11142	243	9973

RECTANGULAR TIED COLUMNS 18" x 30"

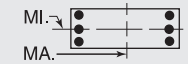
4-#11	1.16	MA	6315	2082	9978	1519	10650	1281	10895	1097	10968	822	12464	714	4486
2E		MI	3717	2082	5991	1426	6223	1202	6261	1027	6172	766	6637	626	2621
4-#14	1.67	MA	6556	2158	10562	1560	11375	1309	11768	1112	12150	811	14096	702	6312
2E		MI	3828	2158	6280	1462	6574	1226	6682	1039	6730	751	7259	583	3594
4-#18	2.96	MA	7139	2352	11993	1666	13160	1384	13926	1154	15074	787	18135	673	10782
2E		MI	4093	2352	6965	1558	7415	1292	7693	1074	7994	703	8647	460	5885
6-#9	1.11	MA	6312	2075	9916	1529	10618	1290	10876	1105	10954	830	12454	722	4353
2L-3S		MI	3644	2075	5742	1449	5943	1230	5935	1053	5734	788	6173	582	2560
6-#9	1.11	MA	6148	2075	9481	1537	10061	1297	10197	1120	10030	844	11174	657	4375
3L-2S		MI	3722	2075	5969	1445	6234	1218	6290	1043	6216	781	6786	653	2540

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis

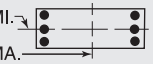


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	1.41	MA	6461	2120	10269	1553	11058	1307	11407	1115	11673	825	13447	715	5452
2L-3S		MI	3696	2120	5865	1472	6090	1248	6110	1062	5970	782	6453	544	3164
6-#10	1.41	MA	6257	2120	9720	1563	10355	1316	10549	1134	10506	841	11831	632	5477
3L-2S		MI	3793	2120	6150	1467	6455	1233	6556	1050	6577	773	7214	634	3135
6-#11	1.73	MA	6604	2168	10641	1573	11501	1320	11932	1120	12379	815	14418	704	6587
2L-3S		MI	3743	2168	5991	1485	6223	1257	6261	1064	6172	767	6637	487	3779
6-#11	1.73	MA	6363	2168	9978	1585	10650	1330	10895	1143	10968	834	12464	600	6614
3L-2S		MI	3856	2168	6330	1480	6658	1241	6792	1051	6894	760	7514	597	3739
6-#14	2.50	MA	6963	2283	11508	1638	12587	1365	13247	1146	14162	801	16882	688	9291
2L-3S		MI	3867	2283	6280	1545	6574	1303	6682	1090	6730	750	7259	378	5201
6-#14	2.50	MA	6629	2283	10562	1654	11375	1379	11768	1177	12150	828	14096	535	9296
3L-2S		MI	4023	2283	6759	1539	7188	1282	7430	1073	7744	740	8463	536	5148
6-#18	4.44	MA	7830	2573	13635	1805	15265	1483	16494	1214	18568	769	22972	648	15923
2L-3S		MI	4161	2573	6965	1702	7415	1423	7693	1158	7994	693	8647	75	8439
6-#18	4.44	MA	7278	2573	11993	1831	13160	1540	13926	1267	15074	813	18135	366	15744
3L-2S		MI	4420	2573	7777	1697	8456	1391	8963	1134	9662	675	10579	357	8475
8-#8	1.17	MA	6348	2084	9982	1538	10715	1297	11000	1110	11125	832	12694	722	4581
2L-4S		MI	3652	2084	5684	1470	5877	1239	5857	1059	5642	795	6095	573	2699
8-#8	1.17	MA	6218	2084	9638	1544	10273	1303	10461	1122	10391	842	11678	672	4597
3E		MI	3679	2084	5825	1460	6059	1237	6080	1057	5933	789	6445	601	2678
8-#8	1.17	MA	6148	2084	9378	1558	9936	1316	10046	1127	9851	853	10999	642	4613
4L-2S		MI	3741	2084	6006	1456	6291	1227	6363	1049	6318	783	6939	656	2662
8-#9	1.48	MA	6504	2131	10350	1564	11175	1315	11556	1120	11878	826	13734	716	5726
2L-4S		MI	3706	2131	5792	1497	6005	1258	6009	1069	5851	790	6352	533	3331
8-#9	1.48	MA	6343	2131	9916	1572	10618	1322	10876	1135	10954	839	12454	651	5744
3E		MI	3739	2131	5969	1484	6234	1255	6290	1068	6216	783	6786	568	3303
8-#9	1.48	MA	6256	2131	9588	1589	10193	1338	10353	1142	10273	853	11596	613	5754
4L-2S		MI	3816	2131	6195	1480	6524	1243	6645	1058	6699	776	7399	638	3282
8-#10	1.88	MA	6701	2191	10817	1597	11761	1339	12265	1134	12840	819	15063	707	7181
2L-4S		MI	3775	2191	5927	1532	6167	1282	6202	1083	6117	784	6673	481	4118
8-#10	1.88	MA	6502	2191	10269	1607	11058	1348	11407	1153	11673	836	13447	624	7197
3E		MI	3815	2191	6150	1516	6455	1279	6556	1082	6577	776	7214	524	4087
8-#10	1.88	MA	6394	2191	9855	1629	10520	1368	10746	1161	10812	853	12360	575	7184
4L-2S		MI	3911	2191	6435	1511	6821	1265	7001	1069	7183	768	7975	614	4059
8-#11	2.31	MA	6891	2255	11304	1627	12351	1359	12970	1144	13790	808	16372	695	8674
2L-4S		MI	3838	2255	6063	1558	6313	1298	6369	1087	6343	768	6887	408	4905
8-#11	2.31	MA	6656	2255	10641	1639	11501	1369	11932	1166	12379	827	14418	591	8689
3E		MI	3884	2255	6330	1539	6658	1295	6792	1088	6894	761	7514	458	4872
8-#11	2.31	MA	6529	2255	10139	1665	10848	1393	11131	1175	11334	847	13089	529	8643
4L-2S		MI	3995	2255	6670	1534	7094	1279	7323	1074	7617	753	8390	568	4837
8-#14	3.33	MA	7043	2407	11508	1732	12587	1435	13247	1211	14162	818	16882	521	12230
3E		MI	4064	2407	6759	1623	7188	1359	7430	1124	7744	740	8463	330	6716
8-#14	3.33	MA	6867	2407	10789	1768	11655	1469	12101	1223	12669	845	14973	432	11732
4L-2S		MI	4218	2407	7238	1617	7802	1337	8179	1107	8757	730	9667	489	6679
8-#18	5.93	MA	7986	2795	13635	1969	15265	1640	16494	1327	18568	795	22972	342	20806
3E		MI	4492	2795	7777	1840	8456	1523	8963	1218	9662	665	10579	-28	10562
8-#18	5.93	MA	7698	2795	12380	2031	13638	1661	14495	1344	15965	838	19607	180	18342
4L-2S		MI	4746	2795	8589	1835	9497	1491	10233	1194	11330	647	12511	254	11035
10-#10	2.35	MA	6940	2261	11366	1641	12464	1370	13123	1153	14007	813	16679	699	8903
2L-5S		MI	3811	2261	6024	1581	6282	1328	6336	1114	6264	776	6904	409	4924
10-#10	2.35	MA	6745	2261	10817	1651	11761	1379	12265	1172	12840	830	15063	617	8912
3L-4S		MI	3894	2261	6212	1576	6533	1314	6648	1102	6723	779	7434	461	5020
10-#10	2.35	MA	6638	2261	10403	1673	11223	1399	11604	1180	11979	847	13976	567	8884
4L-3S		MI	3934	2261	6435	1560	6821	1311	7001	1101	7183	770	7975	504	4997
10-#10	2.35	MA	6470	2261	10058	1683	10762	1408	11027	1199	11124	853	12875	525	8601
5L-2S		MI	4028	2261	6720	1555	7186	1296	7447	1089	7789	762	8736	594	4972
10-#11	2.89	MA	6947	2341	11304	1693	12351	1408	12970	1190	13790	820	16372	581	10754
3L-4S		MI	3980	2341	6403	1612	6749	1336	6900	1111	7066	762	7763	379	5973

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

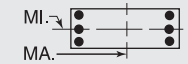
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.89	MA	6822	2341	10802	1719	11699	1432	12168	1198	12746	840	15043	520	10692
4L-3S		MI	4024	2341	6670	1593	7094	1334	7323	1111	7617	754	8390	428	5952
10-#11	2.89	MA	6621	2341	10382	1730	11138	1442	11467	1221	11708	846	13702	465	10126
5L-2S		MI	4134	2341	7009	1588	7529	1318	7854	1098	8339	746	9267	538	5923
10-#14	4.17	MA	7281	2532	11735	1846	12867	1525	13580	1257	14681	835	17759	418	14557
4L-3S		MI	4260	2532	7238	1701	7802	1415	8179	1158	8757	729	9667	283	8220
10-#14	4.17	MA	6999	2532	11134	1862	12065	1539	12578	1288	13198	842	15837	335	13687
5L-2S		MI	4412	2532	7716	1695	8415	1393	8928	1141	9770	719	10871	441	8195
10-#18	7.41	MA	8405	3016	14022	2169	15743	1761	17063	1404	19459	821	24444	156	23307
4L-3S		MI	4822	3016	8589	1978	9497	1622	10233	1279	11330	637	12511	-131	12404
10-#18	7.41	MA	7928	3016	12969	2195	14341	1818	15311	1457	16868	829	21073	-3	21066
5L-2S		MI	5072	3016	9402	1973	10538	1590	11503	1255	12998	619	14443	151	13579
12-#10	2.82	MA	6987	2331	11366	1695	12464	1411	13123	1191	14007	825	16679	609	10621
3L-5S		MI	3931	2331	6309	1625	6648	1359	6782	1133	6870	770	7665	389	5754
12-#10	2.82	MA	6881	2331	10952	1717	11927	1431	12462	1199	13146	841	15592	560	10583
4E		MI	4013	2331	6497	1620	6898	1345	7094	1121	7330	773	8195	441	5917
12-#10	2.82	MA	6715	2331	10606	1727	11465	1440	11885	1218	12292	847	14491	517	10257
5L-3S		MI	4053	2331	6720	1604	7186	1342	7447	1120	7789	765	8736	485	5900
12-#10	2.82	MA	6596	2331	10248	1731	11007	1460	11314	1226	11524	864	13501	460	9913
6L-2S		MI	4146	2331	7005	1599	7551	1328	7893	1108	8396	756	9497	574	5880
12-#11	3.47	MA	7113	2427	11465	1772	12549	1471	13205	1222	14157	833	16997	510	12741
4E		MI	4120	2427	6742	1665	7184	1375	7431	1134	7788	755	8640	349	6952
12-#11	3.47	MA	6915	2427	11045	1784	11989	1481	12505	1245	13120	839	15656	455	12133
5L-3S		MI	4164	2427	7009	1647	7529	1373	7854	1135	8339	747	9267	399	7024
12-#11	3.47	MA	6772	2427	10618	1790	11431	1505	11811	1253	12187	858	14446	384	11724
6L-2S		MI	4272	2427	7349	1642	7964	1357	8385	1121	9062	739	10143	509	7002
12-#14	5.00	MA	7415	2656	12079	1940	13278	1595	14057	1322	15210	832	18623	322	16569
5L-3S		MI	4456	2656	7716	1779	8415	1471	8928	1192	9770	718	10871	236	9710
12-#14	5.00	MA	7214	2656	11476	1949	12480	1628	13064	1334	13876	859	16882	219	15447
6L-2S		MI	4606	2656	8195	1773	9029	1449	9677	1175	10783	708	12075	394	9704
14-#10	3.29	MA	7122	2401	11500	1760	12630	1462	13320	1218	14313	836	17208	552	12282
4L-5S		MI	4050	2401	6594	1669	7013	1391	7228	1152	7477	764	8426	369	6607
14-#10	3.29	MA	6959	2401	11155	1771	12169	1471	12743	1237	13459	841	16107	509	11919
5L-4S		MI	4132	2401	6782	1664	7263	1377	7540	1140	7936	767	8957	421	6809
14-#10	3.29	MA	6842	2401	10797	1775	11710	1492	12172	1245	12691	858	15117	452	11590
6L-3S		MI	4171	2401	7005	1648	7551	1374	7893	1139	8396	759	9497	465	6799
14-#10	3.29	MA	6717	2401	10405	1792	11245	1497	11627	1264	11943	875	13957	402	11122
7L-2S		MI	4263	2401	7290	1642	7917	1359	8339	1127	9002	751	10258	554	6783
14-#11	4.04	MA	7207	2514	11708	1838	12839	1520	13542	1268	14531	832	17611	446	14146
5L-4S		MI	4260	2514	7082	1719	7619	1414	7962	1158	8511	748	9516	320	7948
14-#11	4.04	MA	7068	2514	11281	1844	12281	1544	12848	1277	13598	851	16400	375	13719
6L-3S		MI	4303	2514	7349	1701	7964	1412	8385	1158	9062	740	10143	370	8092
14-#11	4.04	MA	6920	2514	10806	1865	11727	1551	12186	1299	12689	871	15142	329	13021
7L-2S		MI	4411	2514	7689	1696	8400	1396	8917	1145	9785	732	11020	480	8075
14-#14	5.83	MA	7633	2781	12421	2027	13692	1684	14543	1368	15888	849	19668	205	18318
6L-3S		MI	4651	2781	8195	1856	9029	1526	9677	1226	10783	707	12075	188	11195
16-#10	3.76	MA	7201	2472	11703	1815	12872	1503	13601	1256	14626	836	17723	502	13585
5E		MI	4169	2472	6879	1713	7378	1423	7673	1171	8083	759	9187	349	7462
16-#10	3.76	MA	7087	2472	11345	1819	12413	1523	13030	1264	13858	853	16733	444	13270
6L-4S		MI	4250	2472	7067	1708	7629	1408	7985	1159	8543	762	9718	402	7669
16-#10	3.76	MA	6962	2472	10953	1836	11949	1529	12485	1283	13110	869	15573	394	12790
7L-3S		MI	4289	2472	7290	1691	7917	1405	8339	1158	9002	753	10258	445	7695

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

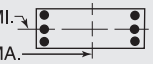
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	3.76	MA	6825	2472	10610	1843	11474	1545	11918	1289	12313	875	14570	346	12347
8L-2S		MI	4380	2472	7575	1686	8282	1391	8784	1146	9609	745	11019	534	7682
16-#11	4.62	MA	7361	2600	11944	1898	13132	1582	13885	1300	15009	844	18354	365	15720
6L-4S		MI	4400	2600	7422	1773	8054	1452	8493	1181	9234	741	10393	291	8952
16-#11	4.62	MA	7215	2600	11469	1919	12578	1589	13223	1323	14100	864	17096	320	15042
7L-3S		MI	4442	2600	7689	1755	8400	1450	8917	1182	9785	733	11020	341	9156
18-#10	4.23	MA	7330	2542	11894	1863	13116	1555	13888	1283	15025	847	18349	437	14952
6L-5S		MI	4287	2542	7164	1757	7744	1454	8119	1191	8689	753	9948	329	8321
18-#10	4.23	MA	7206	2542	11502	1880	12652	1560	13343	1302	14277	864	17189	387	14460
7L-4S		MI	4368	2542	7352	1752	7994	1440	8431	1178	9149	756	10479	382	8514
18-#10	4.23	MA	7072	2542	11159	1887	12177	1577	12776	1308	13480	869	16186	338	14014
8L-3S		MI	4406	2542	7575	1735	8282	1437	8784	1177	9609	748	11019	425	8588
18-#11	5.20	MA	7507	2686	12132	1973	13428	1628	14260	1346	15512	857	19050	310	17065
7L-4S		MI	4539	2686	7761	1827	8490	1491	9024	1205	9956	734	11269	262	9960
20-#10	4.70	MA	7449	2612	12050	1924	13355	1592	14201	1322	15444	858	18805	379	16133
7L-5S		MI	4406	2612	7449	1801	8109	1486	8565	1210	9296	748	10709	309	9182
20-#10	4.70	MA	7316	2612	11707	1931	12880	1608	13634	1328	14648	864	17802	331	15684
8L-4S		MI	4485	2612	7637	1796	8360	1471	8877	1198	9756	750	11240	362	9362
22-#10	5.17	MA	7560	2682	12256	1975	13584	1640	14492	1347	15815	858	19418	323	17356
8L-5S		MI	4524	2682	7734	1845	8475	1517	9011	1229	9902	742	11470	290	10044

RECTANGULAR TIED COLUMNS 18" x 32"

4-#11	1.08	MA	7157	2209	11250	1623	12020	1370	12292	1174	12346	883	14003	768	4823
2E		MI	3946	2209	6345	1514	6580	1277	6608	1093	6487	818	6963	672	2644
4-#14	1.56	MA	7421	2286	11884	1663	12807	1398	13240	1189	13628	872	15774	755	6798
2E		MI	4058	2286	6635	1549	6931	1300	7027	1104	7044	803	7582	629	3624
4-#18	2.78	MA	8060	2479	13440	1770	14748	1472	15586	1231	16808	848	20167	726	11646
2E		MI	4322	2479	7321	1644	7770	1365	8036	1137	8304	753	8966	504	5928
6-#9	1.04	MA	7152	2203	11179	1632	11981	1378	12267	1182	12325	891	13985	775	4677
2L-3S		MI	3873	2203	6094	1539	6300	1306	6283	1119	6051	840	6503	629	2578
6-#9	1.04	MA	6974	2203	10710	1641	11380	1386	11534	1198	11327	906	12604	712	4699
3L-2S		MI	3951	2203	6321	1534	6591	1295	6638	1109	6534	833	7116	699	2559
6-#10	1.32	MA	7315	2248	11562	1657	12457	1395	12842	1191	13103	886	15060	769	5864
2L-3S		MI	3925	2248	6218	1561	6447	1324	6458	1129	6287	834	6781	590	3186
6-#10	1.32	MA	7092	2248	10969	1667	11698	1405	11915	1211	11843	903	13315	687	5888
3L-2S		MI	4022	2248	6503	1556	6812	1309	6904	1116	6894	826	7542	680	3157
6-#11	1.63	MA	7473	2296	11967	1677	12940	1408	13414	1197	13872	876	16116	758	7092
2L-3S		MI	3973	2296	6345	1573	6580	1332	6608	1129	6487	819	6963	533	3806
6-#11	1.63	MA	7208	2296	11250	1689	12020	1419	12292	1220	12346	896	14003	656	7119
3L-2S		MI	4085	2296	6684	1568	7015	1316	7139	1116	7209	812	7840	642	3767
6-#14	2.34	MA	7865	2410	12908	1741	14119	1454	14840	1223	15806	862	18789	742	10020
2L-3S		MI	4096	2410	6635	1632	6931	1377	7027	1155	7044	802	7582	423	5238
6-#14	2.34	MA	7498	2410	11884	1758	12807	1469	13240	1256	13628	891	15774	592	10025
3L-2S		MI	4253	2410	7114	1627	7544	1356	7776	1138	8057	792	8786	581	5183
6-#18	4.17	MA	8814	2701	15220	1908	17031	1571	18370	1291	20596	831	25412	702	17219
2L-3S		MI	4390	2701	7321	1787	7770	1496	8036	1222	8304	743	8966	119	8561
6-#18	4.17	MA	8209	2701	13440	1936	14748	1595	15586	1346	16808	877	20167	427	17040
3L-2S		MI	4649	2701	8133	1782	8811	1464	9306	1198	9973	726	10898	401	8525
8-#8	1.10	MA	7191	2212	11251	1641	12085	1385	12400	1187	12509	893	14242	776	4923
2L-4S		MI	3881	2212	6036	1560	6234	1316	6206	1125	5961	848	6426	619	2717
8-#8	1.10	MA	7050	2212	10879	1648	11608	1391	11818	1199	11717	904	13145	727	4939
3E		MI	3908	2212	6177	1549	6416	1313	6429	1124	6252	842	6775	647	2696
8-#8	1.10	MA	6972	2212	10599	1662	11245	1405	11371	1205	11135	915	12419	697	4955
4L-2S		MI	3970	2212	6358	1546	6648	1304	6712	1116	6637	836	7270	703	2681

RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis



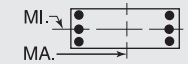
f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	1.39	MA	7361	2258	11648	1667	12582	1403	13001	1197	13323	887	15367	769	6158
2L-4S		MI	3935	2258	6144	1586	6362	1334	6357	1135	6169	843	6682	579	3353
8-#9	1.39	MA	7186	2258	11179	1676	11981	1411	12267	1213	12325	901	13985	706	6176
3E		MI	3968	2258	6321	1573	6591	1331	6638	1134	6534	836	7116	614	3325
8-#9	1.39	MA	7089	2258	10827	1693	11523	1427	11704	1220	11591	915	13067	668	6186
4L-2S		MI	4045	2258	6548	1569	6882	1320	6993	1124	7017	829	7729	685	3304
8-#10	1.76	MA	7577	2318	12154	1701	13217	1427	13768	1211	14364	880	16805	761	7730
2L-4S		MI	4004	2318	6280	1621	6525	1358	6550	1149	6434	837	7002	527	4146
8-#10	1.76	MA	7359	2318	11562	1711	12457	1436	12842	1230	13103	898	15060	680	7746
3E		MI	4045	2318	6503	1605	6812	1355	6904	1148	6894	829	7542	571	4112
8-#10	1.76	MA	7239	2318	11116	1733	11878	1457	12130	1239	12176	915	13895	631	7733
4L-2S		MI	4140	2318	6788	1600	7178	1341	7349	1136	7500	820	8304	660	4084
8-#11	2.17	MA	7786	2382	12684	1731	13859	1447	14535	1221	15398	869	18229	748	9348
2L-4S		MI	4067	2382	6417	1645	6670	1372	6715	1152	6658	820	7212	453	4942
8-#11	2.17	MA	7528	2382	11967	1743	12940	1458	13414	1244	13872	890	16116	646	9363
3E		MI	4113	2382	6684	1627	7015	1370	7139	1153	7209	813	7840	503	4904
8-#11	2.17	MA	7387	2382	11425	1769	12236	1483	12549	1253	12745	910	14693	586	9317
4L-2S		MI	4224	2382	7024	1622	7450	1354	7670	1140	7932	805	8716	613	4868
8-#14	3.13	MA	7950	2535	12908	1836	14119	1524	14840	1290	15806	881	18789	578	13202
3E		MI	4293	2535	7114	1710	7544	1433	7776	1189	8057	791	8786	376	6759
8-#14	3.13	MA	7754	2535	12133	1873	13113	1559	13604	1302	14195	909	16743	490	12805
4L-2S		MI	4447	2535	7592	1704	8158	1412	8525	1172	9070	781	9990	534	6717
8-#18	5.56	MA	8982	2922	15220	2074	17031	1695	18370	1406	20596	859	25412	403	22534
3E		MI	4721	2922	8133	1925	8811	1596	9306	1282	9973	715	10898	16	10847
8-#18	5.56	MA	8659	2922	13865	2138	15273	1754	16210	1426	17783	906	21801	243	20031
4L-2S		MI	4976	2922	8945	1921	9853	1563	10577	1258	11641	698	12830	298	11090
10-#10	2.20	MA	7837	2388	12746	1745	13976	1458	14695	1230	15625	875	18551	753	9589
2L-5S		MI	4040	2388	6376	1670	6640	1404	6684	1180	6581	828	7232	455	4994
10-#10	2.20	MA	7623	2388	12154	1755	13217	1468	13768	1249	14364	892	16805	672	9598
3L-4S		MI	4123	2388	6565	1665	6890	1390	6996	1168	7040	831	7763	507	5052
10-#10	2.20	MA	7505	2388	11708	1777	12638	1489	13056	1258	13436	910	15641	623	9570
4L-3S		MI	4163	2388	6788	1649	7178	1387	7349	1167	7500	823	8304	551	5026
10-#10	2.20	MA	7322	2388	11337	1788	12142	1498	12436	1278	12516	916	14458	583	9328
5L-2S		MI	4258	2388	7073	1644	7543	1372	7795	1155	8107	815	9065	640	5000
10-#11	2.71	MA	7845	2468	12684	1797	13859	1497	14535	1267	15398	883	18229	637	11596
3L-4S		MI	4209	2468	6757	1699	7105	1411	7246	1176	7381	814	8089	424	6014
10-#11	2.71	MA	7706	2468	12143	1823	13156	1522	13671	1277	14271	903	16806	577	11534
4L-3S		MI	4253	2468	7024	1681	7450	1409	7670	1177	7932	806	8716	474	5988
10-#11	2.71	MA	7487	2468	11691	1835	12553	1532	12916	1300	13153	910	15365	524	10990
5L-2S		MI	4363	2468	7364	1676	7886	1393	8201	1163	8654	798	9592	584	5957
10-#14	3.91	MA	8205	2659	13156	1951	14425	1615	15204	1336	16373	899	19758	476	15870
4L-3S		MI	4489	2659	7592	1788	8158	1489	8525	1223	9070	780	9990	328	8266
10-#14	3.91	MA	7898	2659	12509	1968	13561	1630	14124	1369	14773	908	17692	398	14865
5L-2S		MI	4641	2659	8071	1782	8772	1468	9274	1206	10084	770	11194	487	8237
10-#18	6.94	MA	9431	3143	15646	2276	17555	1853	18994	1486	21571	888	27047	219	25429
4L-3S		MI	5051	3143	8945	2064	9853	1695	10577	1342	11641	687	12830	-87	12762
10-#18	6.94	MA	8911	3143	14510	2304	16043	1877	17104	1541	18773	899	23417	68	23101
5L-2S		MI	5303	3143	9758	2059	10894	1663	11847	1318	13309	670	14762	195	13640
12-#10	2.65	MA	7886	2458	12746	1799	13976	1499	14695	1269	15625	886	18551	664	11444
3L-5S		MI	4160	2458	6661	1714	7005	1435	7130	1199	7187	823	7993	435	5847
12-#10	2.65	MA	7769	2458	12301	1821	13397	1520	13983	1277	14697	904	17386	616	11406
4E		MI	4242	2458	6850	1709	7255	1421	7442	1187	7647	826	8524	488	5951
12-#10	2.65	MA	7588	2458	11929	1831	12901	1530	13362	1297	13776	910	16204	575	11120
5L-3S		MI	4282	2458	7073	1693	7543	1418	7795	1186	8107	817	9065	531	5932

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis

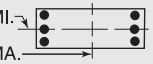


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	2.65	MA	7458	2458	11538	1836	12408	1550	12748	1305	12950	928	15145	518	10726
6L-2S		MI	4375	2458	7358	1688	7909	1404	8241	1174	8713	809	9826	620	5909
12-#11	3.25	MA	8022	2555	12860	1877	14075	1560	14792	1301	15798	896	18919	567	13752
4E		MI	4350	2555	7097	1753	7541	1450	7778	1200	8104	807	8965	395	7079
12-#11	3.25	MA	7807	2555	12408	1889	13472	1571	14038	1324	14679	903	17478	514	13163
5L-3S		MI	4393	2555	7364	1735	7886	1448	8201	1200	8654	799	9592	445	7063
12-#11	3.25	MA	7651	2555	11940	1895	12872	1596	13291	1333	13675	923	16182	444	12729
6L-2S		MI	4502	2555	7703	1730	8321	1432	8732	1187	9377	791	10469	555	7038
12-#14	4.69	MA	8351	2784	13532	2046	14873	1686	15725	1403	16951	898	20707	384	17989
5L-3S		MI	4685	2784	8071	1866	8772	1545	9274	1257	10084	769	11194	281	9763
12-#14	4.69	MA	8133	2784	12871	2055	14014	1721	14655	1416	15513	926	18843	282	16866
6L-2S		MI	4835	2784	8550	1860	9386	1523	10022	1240	11097	759	12398	439	9748
14-#10	3.09	MA	8031	2529	12893	1865	14157	1552	14909	1296	15957	898	19132	608	13242
4L-5S		MI	4279	2529	6947	1758	7370	1467	7576	1219	7794	817	8755	415	6676
14-#10	3.09	MA	7853	2529	12522	1875	13661	1561	14289	1316	15037	905	17949	567	12916
5L-4S		MI	4361	2529	7135	1753	7621	1453	7888	1206	8253	820	9285	468	6846
14-#10	3.09	MA	7726	2529	12131	1880	13167	1582	13674	1324	14211	922	16890	511	12538
6L-3S		MI	4400	2529	7358	1737	7909	1450	8241	1205	8713	812	9826	511	6832
14-#10	3.09	MA	7588	2529	11709	1897	12660	1587	13088	1344	13406	940	15644	462	12090
7L-2S		MI	4492	2529	7643	1732	8274	1435	8687	1193	9320	804	10587	600	6814
14-#11	3.79	MA	8125	2641	13125	1943	14391	1610	15160	1347	16205	896	19591	505	15342
5L-4S		MI	4489	2641	7436	1807	7976	1489	8309	1223	8826	800	9842	366	8039
14-#11	3.79	MA	7973	2641	12658	1949	13791	1635	14412	1357	15201	917	18295	435	14927
6L-3S		MI	4532	2641	7703	1789	8321	1486	8732	1224	9377	792	10469	416	8133
14-#11	3.79	MA	7810	2641	12145	1970	13185	1641	13700	1380	14222	937	16775	373	14163
7L-2S		MI	4640	2641	8043	1784	8756	1471	9263	1210	10100	784	11345	525	8113
14-#14	5.47	MA	8589	2908	13894	2132	15326	1777	16256	1450	17690	917	21858	268	19982
6L-3S		MI	4881	2908	8550	1943	9386	1601	10022	1291	11097	759	12398	234	11251
14-#14	5.47	MA	8360	2908	13162	2162	14469	1787	15235	1482	16289	945	19920	203	18785
7L-2S		MI	5029	2908	9029	1938	9999	1579	10771	1273	12110	749	13602	392	11253
16-#10	3.53	MA	8117	2599	13114	1919	14420	1593	15215	1335	16298	899	19695	559	14717
5E		MI	4398	2599	7232	1802	7736	1498	8021	1238	8400	811	9516	395	7532
16-#10	3.53	MA	7993	2599	12723	1924	13927	1614	14601	1343	15471	917	18636	503	14354
6L-4S		MI	4479	2599	7420	1797	7986	1484	8333	1225	8860	814	10046	448	7737
16-#10	3.53	MA	7855	2599	12301	1941	13419	1618	14015	1363	14666	934	17390	455	13895
7L-3S		MI	4518	2599	7643	1780	8274	1481	8687	1224	9320	806	10587	491	7730
16-#10	3.53	MA	7706	2599	11932	1949	12908	1636	13396	1369	13809	941	16314	408	13408
8L-2S		MI	4609	2599	7928	1775	8639	1467	9132	1212	9926	798	11348	580	7715
16-#11	4.33	MA	8293	2727	13375	2003	14711	1673	15534	1380	16727	910	20408	425	17129
6L-4S		MI	4629	2727	7776	1861	8411	1527	8840	1247	9549	793	10718	337	9041
16-#11	4.33	MA	8130	2727	12862	2024	14104	1680	14821	1404	15748	930	18888	363	16352
7L-3S		MI	4672	2727	8043	1843	8756	1525	9263	1247	10100	785	11345	386	9198
16-#11	4.33	MA	7952	2727	12413	2033	13484	1700	14082	1411	14706	937	17576	303	15613
8L-2S		MI	4778	2727	8382	1838	9192	1509	9794	1234	10822	777	12222	496	9184
16-#14	6.25	MA	8814	3033	14185	2240	15781	1843	16835	1516	18467	935	22935	189	21877
7L-3S		MI	5076	3033	9029	2021	9999	1657	10771	1325	12110	748	13602	186	12735
18-#10	3.97	MA	8257	2669	13316	1968	14686	1645	15527	1363	16732	911	20381	495	16172
6L-5S		MI	4516	2669	7517	1846	8101	1530	8467	1257	9007	806	10277	376	8390
18-#10	3.97	MA	8120	2669	12893	1985	14179	1650	14941	1382	15927	929	19135	447	15702
7L-4S		MI	4597	2669	7705	1841	8351	1516	8779	1245	9466	809	10808	428	8592
18-#10	3.97	MA	7974	2669	12524	1993	13668	1667	14322	1388	15070	935	18059	400	15227
8L-3S		MI	4636	2669	7928	1824	8639	1513	9132	1244	9926	801	11348	471	8624
18-#10	3.97	MA	7840	2669	12132	2012	13178	1674	13713	1404	14274	953	16998	358	14567
9L-2S		MI	4726	2669	8213	1819	9005	1498	9578	1231	10533	792	12109	561	8613
18-#11	4.88	MA	8448	2814	13580	2078	15024	1719	15943	1427	17274	923	21001	353	18544
7L-4S		MI	4768	2814	8115	1915	8847	1566	9371	1270	10271	786	11595	307	10049
18-#11	4.88	MA	8274	2814	13130	2086	14403	1739	15204	1435	16232	930	19689	294	17793
8L-3S		MI	4811	2814	8382	1897	9192	1564	9794	1271	10822	778	12222	357	10261

RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

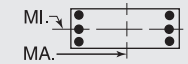
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	4.41	MA	8384	2739	13486	2029	14938	1682	15868	1401	17188	923	20881	439	17512
7L-5S		MI	4635	2739	7802	1890	8467	1562	8913	1276	9613	800	11038	356	9251
20-#10	4.41	MA	8240	2739	13116	2036	14427	1699	15249	1407	16330	929	19805	393	17044
8L-4S		MI	4715	2739	7990	1885	8717	1547	9225	1264	10073	803	11569	408	9440
20-#10	4.41	MA	8111	2739	12724	2056	13938	1705	14640	1424	15535	947	18744	350	16376
9L-3S		MI	4753	2739	8213	1868	9005	1544	9578	1263	10533	795	12109	451	9518
20-#11	5.42	MA	8593	2900	13848	2140	15322	1778	16325	1458	17758	923	21802	284	19974
8L-4S		MI	4907	2900	8455	1969	9282	1605	9902	1294	10994	779	12471	278	11061
22-#10	4.85	MA	8505	2810	13709	2080	15187	1730	16175	1426	17591	924	21550	385	18862
8L-5S		MI	4753	2810	8087	1934	8832	1593	9359	1295	10220	795	11799	336	10113
22-#10	4.85	MA	8380	2810	13317	2100	14697	1737	15566	1443	16796	941	20489	342	18184
9L-4S		MI	4832	2810	8275	1928	9082	1579	9671	1283	10679	798	12330	388	10291
24-#10	5.29	MA	8647	2880	13909	2144	15456	1768	16493	1462	18056	936	22234	334	19993
9L-5S		MI	4871	2880	8372	1977	9197	1625	9804	1314	10826	789	12560	316	10977

RECTANGULAR TIED COLUMNS 18" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.02	MA	8051	2337	12594	1726	13469	1458	13769	1250	13799	944	15624	821	5160
2E		MI	4175	2337	6699	1602	6937	1352	6954	1158	6802	870	7289	717	2667
4-#14	1.47	MA	8338	2413	13279	1767	14317	1486	14791	1266	15182	934	17534	809	7284
2E		MI	4287	2413	6990	1636	7287	1374	7373	1169	7357	854	7906	674	3652
4-#18	2.61	MA	9033	2607	14960	1873	16415	1560	17326	1308	18617	910	22279	780	12510
2E		MI	4551	2607	7677	1729	8126	1438	8380	1201	8615	804	9285	548	5970
6-#10	1.25	MA	8220	2375	12927	1760	13935	1484	14356	1268	14609	947	16754	822	6275
2L-3S		MI	4155	2375	6571	1650	6804	1399	6806	1195	6604	887	7110	637	3208
6-#10	1.25	MA	7979	2375	12291	1771	13120	1494	13361	1289	13255	965	14879	743	6300
3L-2S		MI	4251	2375	6856	1645	7170	1385	7252	1183	7211	879	7871	726	3179
6-#11	1.53	MA	8392	2423	13366	1780	14457	1497	14975	1274	15440	937	17896	812	7597
2L-3S		MI	4202	2423	6699	1661	6937	1407	6954	1195	6802	871	7289	578	3833
6-#11	1.53	MA	8105	2423	12594	1793	13469	1508	13769	1298	13799	959	15624	712	7624
3L-2S		MI	4315	2423	7038	1656	7372	1391	7485	1182	7524	864	8165	688	3794
6-#14	2.21	MA	8819	2537	14380	1844	15729	1542	16513	1300	17525	924	20778	795	10749
2L-3S		MI	4325	2537	6990	1719	7287	1452	7373	1220	7357	853	7906	468	5274
6-#14	2.21	MA	8420	2537	13279	1862	14317	1558	14791	1334	15182	953	17534	649	10754
3L-2S		MI	4482	2537	7468	1714	7901	1430	8122	1202	8371	844	9110	627	5217
6-#18	3.92	MA	9852	2828	16878	2011	18875	1660	20327	1368	22700	892	27932	756	18515
2L-3S		MI	4619	2828	7677	1873	8126	1569	8380	1285	8615	794	9285	164	8626
6-#18	3.92	MA	9192	2828	14960	2041	16415	1685	17326	1425	18617	941	22279	487	18336
3L-2S		MI	4878	2828	8489	1868	9167	1537	9650	1261	10283	776	11217	445	8574
8-#8	1.03	MA	8086	2339	12591	1745	13534	1473	13879	1264	13967	954	15871	830	5264
2L-4S		MI	4110	2339	6388	1650	6592	1392	6554	1192	6279	901	6757	666	2734
8-#8	1.03	MA	7932	2339	12192	1752	13022	1480	13254	1277	13117	966	14694	781	5280
3E		MI	4137	2339	6529	1639	6774	1390	6778	1191	6570	895	7106	694	2714
8-#8	1.03	MA	7847	2339	11893	1766	12633	1493	12776	1282	12460	970	13920	751	5296
4L-2S		MI	4199	2339	6710	1636	7006	1380	7061	1183	6955	889	7600	750	2700
8-#9	1.31	MA	8270	2385	13019	1770	14069	1491	14525	1274	14843	948	17081	823	6590
2L-4S		MI	4165	2385	6497	1676	6720	1410	6706	1202	6487	896	7012	626	3374
8-#9	1.31	MA	8080	2385	12516	1779	13423	1499	13738	1290	13772	963	15597	761	6608
3E		MI	4197	2385	6674	1663	6948	1407	6986	1201	6852	889	7446	661	3346
8-#9	1.31	MA	7974	2385	12138	1797	12933	1516	13134	1297	12985	977	14618	723	6618
4L-2S		MI	4275	2385	6900	1658	7239	1396	7341	1191	7335	882	8059	731	3325
8-#10	1.66	MA	8504	2445	13563	1804	14751	1515	15351	1288	15963	941	18629	814	8278
2L-4S		MI	4233	2445	6633	1710	6882	1434	6898	1215	6751	890	7331	574	4172
8-#10	1.66	MA	8267	2445	12927	1815	13935	1525	14356	1308	14609	960	16754	735	8295
3E		MI	4274	2445	6856	1694	7170	1431	7252	1214	7211	881	7871	617	4137
8-#10	1.66	MA	8135	2445	12449	1837	13315	1546	13593	1317	13614	978	15512	687	8281
4L-2S		MI	4369	2445	7141	1689	7535	1417	7697	1202	7817	873	8632	706	4109

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

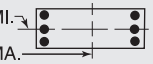
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	2.04	MA	8731	2509	14137	1834	15446	1535	16181	1298	17081	930	20168	802	10022
2L-4S		MI	4297	2509	6772	1733	7027	1447	7062	1218	6974	872	7538	499	4977
8-#11	2.04	MA	8451	2509	13366	1847	14457	1547	14975	1322	15440	952	17896	702	10037
3E		MI	4342	2509	7038	1715	7372	1445	7485	1218	7524	865	8165	549	4936
8-#11	2.04	MA	8295	2509	12785	1874	13703	1572	14047	1332	14232	973	16378	642	9991
4L-2S		MI	4454	2509	7378	1710	7807	1429	8016	1205	8247	857	9042	659	4898
8-#14	2.94	MA	8909	2662	14380	1940	15729	1614	16513	1367	17525	944	20778	635	14174
3E		MI	4522	2662	7468	1797	7901	1507	8122	1254	8371	843	9110	421	6800
8-#14	2.94	MA	8693	2662	13549	1978	14649	1649	15186	1381	15797	973	18595	548	13895
4L-2S		MI	4676	2662	7947	1791	8514	1486	8870	1236	9384	833	10314	579	6755
8-#18	5.23	MA	10031	3049	16878	2179	18875	1785	20327	1485	22700	923	27932	462	24262
3E		MI	4950	3049	8489	2011	9167	1668	9650	1345	10283	766	11217	61	11027
8-#18	5.23	MA	9672	3049	15423	2244	16986	1846	18005	1507	19676	972	24077	305	21744
4L-2S		MI	5205	3049	9302	2006	10208	1636	10920	1321	11951	748	13149	342	11144
10-#10	2.08	MA	8785	2515	14200	1848	15567	1547	16346	1307	17317	936	20503	807	10275
2L-5S		MI	4270	2515	6729	1759	6997	1480	7032	1246	6898	881	7561	501	5061
10-#10	2.08	MA	8553	2515	13563	1859	14751	1557	15351	1327	15963	954	18629	727	10283
3L-4S		MI	4353	2515	6918	1754	7247	1466	7344	1234	7357	884	8092	554	5082
10-#10	2.08	MA	8422	2515	13086	1881	14131	1578	14588	1336	14968	972	17387	679	10256
4L-3S		MI	4392	2515	7141	1738	7535	1463	7697	1233	7817	876	8632	597	5054
10-#10	2.08	MA	8224	2515	12687	1892	13600	1588	13923	1356	13983	979	16123	640	10064
5L-2S		MI	4487	2515	7426	1733	7900	1448	8143	1221	8424	867	9393	686	5027
10-#11	2.55	MA	8794	2596	14137	1901	15446	1586	16181	1345	17081	945	20168	693	12438
3L-4S		MI	4438	2596	7111	1787	7462	1486	7593	1241	7696	866	8414	470	6053
10-#11	2.55	MA	8641	2596	13556	1928	14692	1611	15253	1355	15872	966	18649	633	12377
4L-3S		MI	4482	2596	7378	1769	7807	1484	8016	1242	8247	858	9042	520	6023
10-#11	2.55	MA	8404	2596	13072	1940	14045	1622	14445	1379	14674	974	17109	582	11862
5L-2S		MI	4593	2596	7718	1764	8243	1468	8548	1229	8970	850	9918	630	5990
10-#14	3.68	MA	9181	2786	14650	2056	16061	1705	16908	1415	18140	963	21839	534	17201
4L-3S		MI	4718	2786	7947	1875	8514	1563	8870	1288	9384	832	10314	374	8311
10-#14	3.68	MA	8848	2786	13956	2074	15135	1721	15750	1449	16424	973	19629	459	16055
5L-2S		MI	4871	2786	8426	1869	9128	1542	9619	1270	10397	822	11518	532	8278
10-#18	6.54	MA	10509	3271	17342	2383	19446	1945	21006	1567	23759	955	29729	280	27575
4L-3S		MI	5280	3271	9302	2149	10208	1768	10920	1406	11951	738	13149	-42	13117
10-#18	6.54	MA	9946	3271	16124	2412	17823	1971	18977	1625	20754	969	25843	136	25154
5L-2S		MI	5534	3271	10114	2144	11249	1736	12190	1382	13619	720	15081	239	13696
12-#10	2.49	MA	8837	2586	14200	1903	15567	1588	16346	1346	17317	948	20503	719	12267
3L-5S		MI	4389	2586	7014	1803	7362	1511	7478	1266	7504	875	8322	481	5914
12-#10	2.49	MA	8708	2586	13722	1925	14946	1609	15583	1355	16323	967	19262	671	12229
4E		MI	4471	2586	7203	1798	7613	1497	7790	1253	7964	878	8853	534	5984
12-#10	2.49	MA	8513	2586	13324	1936	14415	1619	14919	1375	15337	974	17998	632	11991
5L-3S		MI	4511	2586	7426	1782	7900	1494	8143	1252	8424	870	9393	577	5962
12-#10	2.49	MA	8372	2586	12901	1940	13886	1640	14261	1384	14452	992	16867	577	11543
6L-2S		MI	4605	2586	7711	1777	8266	1480	8589	1240	9030	862	10154	666	5938
12-#11	3.06	MA	8983	2682	14327	1982	15680	1650	16459	1379	17513	959	20921	623	14763
4E		MI	4579	2682	7451	1841	7897	1525	8124	1265	8419	859	9291	441	7121
12-#11	3.06	MA	8750	2682	13843	1994	15034	1661	15651	1403	16315	967	19381	573	14201
5L-3S		MI	4622	2682	7718	1823	8243	1523	8548	1265	8970	851	9918	490	7100
12-#11	3.06	MA	8582	2682	13336	2000	14392	1687	14850	1413	15238	988	17999	503	13711
6L-2S		MI	4731	2682	8057	1818	8678	1507	9079	1252	9692	843	10795	600	7073
12-#14	4.41	MA	9339	2911	15057	2152	16547	1777	17472	1483	18767	963	22873	445	19420
5L-3S		MI	4914	2911	8426	1953	9128	1619	9619	1322	10397	821	11518	326	9815
12-#14	4.41	MA	9103	2911	14338	2160	15626	1813	16326	1497	17225	993	20886	344	18297
6L-2S		MI	5065	2911	8905	1947	9742	1598	10368	1304	11410	811	12722	485	9792

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

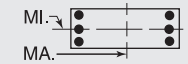
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	7.84	MA	10790	3492	18043	2551	20283	2070	21977	1685	24837	951	31496	112	30930
5L-3S		MI	5609	3492	10114	2288	11249	1867	12190	1466	13619	710	15081	-145	14948
14-#10	2.91	MA	8992	2656	14358	1969	15762	1641	16578	1374	17677	961	21137	663	14202
4L-5S		MI	4508	2656	7299	1847	7728	1543	7923	1285	8111	870	9083	462	6744
14-#10	2.91	MA	8799	2656	13960	1980	15231	1651	15914	1394	16691	968	19873	624	13922
5L-4S		MI	4590	2656	7488	1842	7978	1529	8235	1272	8570	873	9614	514	6881
14-#10	2.91	MA	8662	2656	13537	1984	14702	1672	15256	1403	15806	986	18742	569	13492
6L-3S		MI	4629	2656	7711	1826	8266	1526	8589	1271	9030	864	10154	557	6865
14-#10	2.91	MA	8510	2656	13085	2002	14153	1677	14629	1424	14944	1004	17414	522	13071
7L-2S		MI	4722	2656	7996	1821	8631	1511	9034	1259	9637	856	10916	646	6845
14-#11	3.57	MA	9094	2768	14614	2048	16023	1700	16857	1426	17956	960	21653	563	16547
5L-4S		MI	4719	2768	7790	1895	8333	1564	8655	1288	9141	852	10167	411	8185
14-#11	3.57	MA	8930	2768	14107	2054	15380	1725	16056	1437	16879	981	20271	494	16077
6L-3S		MI	4762	2768	8057	1877	8678	1561	9079	1289	9692	844	10795	461	8172
14-#11	3.57	MA	8750	2768	13557	2075	14721	1731	15293	1461	15831	1003	18647	434	15319
7L-2S		MI	4870	2768	8397	1872	9113	1545	9610	1276	10415	836	11671	571	8150
14-#14	5.15	MA	9597	3035	15440	2238	17038	1869	18048	1531	19568	983	24130	330	21645
6L-3S		MI	5110	3035	8905	2031	9742	1675	10368	1355	11410	810	12722	279	11305
14-#14	5.15	MA	9345	3035	14653	2268	16105	1878	16954	1565	18066	1013	21800	241	20437
7L-2S		MI	5258	3035	9383	2025	10356	1654	11117	1338	12424	800	13926	437	11299
16-#10	3.32	MA	9084	2726	14597	2024	16047	1682	16909	1414	18045	962	21748	617	15859
5E		MI	4627	2726	7585	1891	8093	1574	8369	1304	8717	864	9844	442	7599
16-#10	3.32	MA	8950	2726	14174	2028	15518	1703	16251	1422	17160	981	20617	561	15444
6L-4S		MI	4708	2726	7773	1886	8343	1560	8681	1292	9177	867	10375	494	7775
16-#10	3.32	MA	8799	2726	13721	2046	14969	1708	15624	1443	16298	999	19289	514	15013
7L-3S		MI	4747	2726	7996	1869	8631	1557	9034	1291	9637	859	10916	537	7764
16-#10	3.32	MA	8638	2726	13325	2054	14421	1726	14952	1448	15381	1006	18140	469	14460
8L-2S		MI	4839	2726	8281	1864	8997	1543	9480	1278	10243	851	11677	627	7747
16-#11	4.08	MA	9276	2855	14878	2108	16369	1764	17262	1460	18520	974	22543	484	18446
6L-4S		MI	4858	2855	8130	1949	8768	1602	9186	1312	9864	845	11044	382	9128
16-#11	4.08	MA	9097	2855	14328	2129	15710	1770	16499	1484	17471	996	20919	424	17677
7L-3S		MI	4901	2855	8397	1930	9113	1600	9610	1312	10415	837	11671	432	9240
16-#11	4.08	MA	8905	2855	13847	2138	15044	1791	15695	1491	16355	1003	19517	367	16932
8L-2S		MI	5008	2855	8736	1926	9549	1584	10141	1299	11137	829	12548	542	9223
16-#14	5.88	MA	9837	3160	15754	2346	17517	1934	18676	1599	20410	1003	25044	227	23764
7L-3S		MI	5305	3160	9383	2108	10356	1731	11117	1389	12424	799	13926	231	12792
18-#10	3.74	MA	9236	2796	14810	2072	16334	1735	17247	1442	18514	975	22492	554	17398
6L-5S		MI	4746	2796	7870	1935	8458	1606	8815	1323	9324	858	10606	422	8458
18-#10	3.74	MA	9086	2796	14357	2090	15785	1740	16620	1462	17652	993	21164	506	16958
7L-4S		MI	4826	2796	8058	1930	8709	1592	9127	1311	9783	861	11136	474	8666
18-#10	3.74	MA	8927	2796	13962	2098	15237	1757	15948	1467	16735	1000	20014	462	16412
8L-3S		MI	4865	2796	8281	1913	8997	1589	9480	1310	10243	853	11677	517	8660
18-#10	3.74	MA	8782	2796	13541	2117	14712	1764	15295	1484	15883	1018	18885	419	15754
9L-2S		MI	4956	2796	8566	1908	9362	1574	9926	1297	10850	845	12438	607	8646
18-#11	4.59	MA	9442	2941	15099	2183	16698	1809	17705	1508	19112	989	23191	415	20038
7L-4S		MI	4997	2941	8469	2003	9203	1641	9717	1335	10586	838	11920	353	10135
18-#11	4.59	MA	9253	2941	14618	2192	16032	1830	16901	1515	17995	997	21789	357	19277
8L-3S		MI	5040	2941	8736	1984	9549	1639	10141	1336	11137	830	12548	403	10305
20-#10	4.15	MA	9371	2867	14994	2134	16600	1771	17615	1481	19006	988	23038	499	18905
7L-5S		MI	4864	2867	8155	1979	8824	1637	9261	1342	9930	853	11367	402	9318
20-#10	4.15	MA	9215	2867	14598	2142	16053	1789	16943	1486	18089	995	21889	454	18365
8L-4S		MI	4944	2867	8343	1974	9074	1623	9573	1330	10390	856	11897	454	9516

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

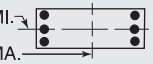
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	4.15	MA	9075	2867	14178	2161	15528	1796	16290	1503	17237	1013	20760	412	17697
9L-3S		MI	4982	2867	8566	1957	9362	1620	9926	1329	10850	848	12438	497	9554
20-#10	4.15	MA	8909	2867	13768	2167	15002	1815	15655	1521	16389	1031	19615	373	16995
10L-2S		MI	5073	2867	8851	1952	9727	1606	10372	1317	11456	839	13199	587	9543
20-#11	5.10	MA	9598	3027	15389	2246	17021	1868	18107	1538	19636	990	24061	348	21622
8L-4S		MI	5137	3027	8809	2057	9639	1680	10248	1359	11309	831	12797	324	11147
22-#10	4.57	MA	9501	2937	15234	2185	16869	1820	17938	1505	19443	989	23764	446	20318
8L-5S		MI	4982	2937	8440	2023	9189	1669	9706	1361	10537	847	12128	382	10181
22-#10	4.57	MA	9365	2937	14814	2205	16344	1828	17285	1522	18591	1007	22635	404	19640
9L-4S		MI	5062	2937	8628	2017	9439	1655	10018	1349	10996	850	12659	434	10367
22-#10	4.57	MA	9200	2937	14404	2211	15818	1847	16650	1540	17744	1025	21490	365	18930
10L-3S		MI	5100	2937	8851	2001	9727	1652	10372	1348	11456	842	13199	478	10447
24-#10	4.98	MA	9654	3007	15451	2249	17160	1859	18281	1542	19945	1002	24509	396	21583
9L-5S		MI	5100	3007	8725	2066	9555	1701	10152	1380	11143	842	12889	362	11044
24-#10	4.98	MA	9490	3007	15040	2255	16634	1878	17645	1559	19098	1019	23365	357	20864
10L-4S		MI	5179	3007	8913	2061	9805	1686	10464	1368	11603	845	13420	414	11220

RECTANGULAR TIED COLUMNS 18" x 36"

4-#14	1.39	MA	9305	2540	14745	1870	15906	1574	16421	1343	16811	995	19374	863	7770
2E		MI	4516	2540	7344	1723	7643	1449	7718	1233	7671	906	8229	719	3680
4-#18	2.47	MA	10058	2734	16552	1977	18161	1649	19145	1385	20502	971	24472	834	13374
2E		MI	4781	2734	8033	1815	8481	1511	8723	1264	8925	855	9604	593	6012
6-#10	1.18	MA	9177	2502	14365	1864	15492	1572	15950	1345	16190	1008	18529	876	6687
2L-3S		MI	4384	2502	6924	1739	7162	1475	7154	1261	6922	940	7439	683	3228
6-#10	1.18	MA	8916	2502	13684	1875	14620	1582	14886	1366	14742	1027	16525	798	6711
3L-2S		MI	4480	2502	7209	1734	7527	1461	7599	1249	7528	931	8200	772	3201
6-#11	1.44	MA	9363	2550	14836	1884	16054	1585	16615	1351	17083	998	19757	865	8103
2L-3S		MI	4431	2550	7053	1749	7293	1481	7301	1260	7117	923	7614	624	3859
6-#11	1.44	MA	9053	2550	14011	1897	14996	1597	15325	1376	15328	1021	17326	767	8130
3L-2S		MI	4544	2550	7393	1744	7729	1465	7832	1247	7840	916	8491	734	3820
6-#14	2.08	MA	9824	2665	15925	1948	17417	1630	18265	1377	19320	985	22848	849	11478
2L-3S		MI	4554	2665	7344	1806	7643	1526	7718	1285	7671	905	8229	513	5309
6-#14	2.08	MA	9392	2665	14745	1967	15906	1647	16421	1411	16811	1016	19374	705	11483
3L-2S		MI	4711	2665	7823	1801	8257	1504	8467	1267	8684	895	9433	672	5250
6-#18	3.70	MA	10942	2955	18609	2115	20798	1748	22362	1445	24879	953	30533	809	19811
2L-3S		MI	4848	2955	8033	1958	8481	1642	8723	1349	8925	844	9604	208	8686
6-#18	3.70	MA	10226	2955	16552	2146	18161	1775	19145	1504	20502	1005	24472	545	19632
3L-2S		MI	5108	2955	8845	1953	9522	1610	9993	1325	10594	827	11536	490	8622
8-#9	1.23	MA	9230	2513	14462	1874	15633	1580	16129	1351	16438	1009	18876	877	7022
2L-4S		MI	4394	2513	6849	1765	7077	1486	7054	1268	6805	949	7341	672	3394
8-#9	1.23	MA	9025	2513	13924	1883	14944	1588	15287	1367	15293	1025	17291	815	7040
3E		MI	4427	2513	7026	1752	7306	1484	7335	1267	7170	942	7776	707	3367
8-#9	1.23	MA	8909	2513	13522	1901	14420	1605	14644	1375	14409	1031	16251	778	7050
4L-2S		MI	4504	2513	7253	1748	7597	1472	7690	1257	7653	935	8389	777	3346
8-#10	1.57	MA	9482	2572	15045	1908	16364	1603	17013	1364	17637	1003	20533	868	8827
2L-4S		MI	4463	2572	6986	1799	7239	1510	7246	1281	7068	942	7659	620	4197
8-#10	1.57	MA	9226	2572	14365	1919	15492	1614	15950	1385	16190	1021	18529	790	8843
3E		MI	4503	2572	7209	1783	7527	1507	7599	1280	7528	934	8200	663	4162
8-#10	1.57	MA	9082	2572	13855	1941	14830	1635	15135	1395	15071	1029	17210	742	8830
4L-2S		MI	4598	2572	7494	1778	7892	1493	8045	1268	8134	926	8961	752	4133
8-#11	1.93	MA	9729	2637	15661	1938	17111	1624	17905	1374	18839	991	22188	856	10696
2L-4S		MI	4526	2637	7126	1821	7384	1522	7409	1283	7289	924	7864	545	5009
8-#11	1.93	MA	9425	2637	14836	1951	16054	1636	16615	1399	17083	1014	19757	757	10711
3E		MI	4571	2637	7393	1803	7729	1520	7832	1284	7840	917	8491	595	4966
8-#11	1.93	MA	9255	2637	14216	1978	15248	1661	15625	1410	15793	1036	18144	698	10664
4L-2S		MI	4683	2637	7732	1798	8164	1504	8363	1270	8562	909	9367	704	4928

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis



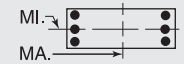
f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.78	MA	9919	2789	15925	2044	17417	1703	18265	1445	19320	1006	22848	691	15146
3E		MI	4751	2789	7823	1884	8257	1582	8467	1318	8684	894	9433	466	6840
8-#14	2.78	MA	9682	2789	15037	2083	16265	1739	16847	1460	17473	1037	20528	605	14947
4L-2S		MI	4906	2789	8302	1879	8871	1560	9216	1301	9697	884	10637	624	6792
8-#18	4.94	MA	11131	3177	18609	2284	20798	1874	22362	1564	24879	987	30533	521	25990
3E		MI	5179	3177	8845	2096	9522	1741	9993	1409	10594	816	11536	105	11204
8-#18	4.94	MA	10736	3177	17053	2351	18778	1937	19880	1588	21645	1038	26434	365	23478
4L-2S		MI	5434	3177	9658	2091	10564	1709	11264	1385	12262	799	13468	387	11197
10-#10	1.96	MA	9785	2643	15725	1951	17236	1635	18077	1384	19085	997	22537	860	10961
2L-5S		MI	4499	2643	7082	1848	7354	1556	7380	1313	7215	934	7890	548	5127
10-#10	1.96	MA	9534	2643	15045	1963	16364	1645	17013	1404	17637	1016	20533	782	10969
3L-4S		MI	4582	2643	7271	1843	7604	1541	7692	1300	7675	937	8420	600	5111
10-#10	1.96	MA	9391	2643	14535	1985	15702	1667	16199	1414	16518	1023	19214	734	10942
4L-3S		MI	4622	2643	7494	1827	7892	1538	8045	1299	8134	928	8961	643	5081
10-#10	1.96	MA	9178	2643	14107	1996	15136	1677	15491	1434	15525	1042	17870	697	10808
5L-2S		MI	4716	2643	7779	1822	8258	1524	8491	1287	8741	920	9722	732	5054
10-#11	2.41	MA	9795	2723	15661	2005	17111	1674	17905	1423	18839	1007	22188	748	13281
3L-4S		MI	4667	2723	7465	1875	7819	1561	7940	1307	8011	918	8740	516	6090
10-#11	2.41	MA	9627	2723	15042	2032	16306	1700	16915	1433	17549	1029	20575	689	13219
4L-3S		MI	4711	2723	7732	1857	8164	1559	8363	1307	8562	910	9367	565	6056
10-#11	2.41	MA	9372	2723	14526	2045	15617	1712	16053	1458	16270	1037	18934	640	12743
5L-2S		MI	4822	2723	8072	1852	8599	1543	8894	1294	9285	902	10244	675	6022
10-#14	3.47	MA	10208	2914	16216	2161	17776	1795	18691	1494	19982	1027	24001	591	18549
4L-3S		MI	4947	2914	8302	1962	8871	1638	9216	1352	9697	883	10637	419	8355
10-#14	3.47	MA	9850	2914	15476	2179	16788	1812	17456	1529	18150	1038	21647	519	17254
5L-2S		MI	5100	2914	8781	1956	9485	1616	9965	1335	10711	873	11841	577	8319
10-#18	6.17	MA	11639	3398	19110	2489	21415	2036	23097	1648	26022	1021	32494	341	29744
4L-3S		MI	5509	3398	9658	2235	10564	1841	11264	1469	12262	789	13468	2	13460
10-#18	6.17	MA	11032	3398	17811	2520	19682	2064	20929	1707	22811	1037	28351	203	27242
5L-2S		MI	5764	3398	10470	2230	11605	1809	12534	1445	13930	771	15399	284	13752
12-#10	2.35	MA	9839	2713	15725	2007	17236	1677	18077	1423	19085	1010	22537	774	13090
3L-5S		MI	4618	2713	7367	1892	7720	1587	7826	1332	7822	928	8651	528	5979
12-#10	2.35	MA	9698	2713	15216	2029	16574	1698	17263	1433	17966	1018	21219	727	13052
4E		MI	4701	2713	7556	1887	7970	1573	8138	1319	8281	931	9181	580	6016
12-#10	2.35	MA	9489	2713	14788	2040	16008	1709	16555	1453	16972	1037	19874	689	12869
5L-3S		MI	4740	2713	7779	1871	8258	1570	8491	1318	8741	923	9722	623	5991
12-#10	2.35	MA	9337	2713	14336	2045	15439	1730	15854	1463	16029	1055	18670	635	12366
6L-2S		MI	4834	2713	8064	1866	8623	1556	8937	1306	9347	915	10483	713	5967
12-#11	2.89	MA	9995	2809	15867	2086	17364	1739	18206	1457	19305	1022	23006	679	15774
4E		MI	4808	2809	7805	1929	8254	1600	8471	1330	8734	911	9617	486	7162
12-#11	2.89	MA	9745	2809	15351	2099	16675	1751	17343	1482	18025	1030	21365	631	15249
5L-3S		MI	4851	2809	8072	1910	8599	1598	8894	1331	9285	903	10244	536	7137
12-#11	2.89	MA	9563	2809	14803	2105	15990	1777	16490	1492	16877	1053	19896	562	14699
6L-2S		MI	4961	2809	8411	1906	9035	1582	9425	1317	10007	895	11120	646	7108
12-#14	4.17	MA	10378	3038	16655	2257	18300	1868	19300	1563	20658	1028	25120	505	20862
5L-3S		MI	5143	3038	8781	2040	9485	1693	9965	1386	10711	872	11841	371	9860
12-#14	4.17	MA	10124	3038	15878	2265	17318	1904	18076	1578	19013	1059	23010	405	19737
6L-2S		MI	5294	3038	9260	2034	10098	1672	10713	1369	11724	863	13045	530	9835
12-#18	7.41	MA	11942	3619	19868	2658	22319	2163	24146	1767	27188	1019	34411	178	33436
5L-3S		MI	5838	3619	10470	2373	11605	1940	12534	1530	13930	761	15399	-101	15311
12-#18	7.41	MA	11512	3619	18533	2674	20595	2226	21999	1791	24301	1071	30678	-2	30669
6L-2S		MI	6086	3619	11282	2368	12646	1908	13804	1506	15598	743	17331	181	16294

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis

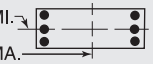


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.74	MA	10004	2783	15896	2073	17446	1730	18327	1452	19413	1012	23223	719	15162
4L-5S		MI	4737	2783	7652	1936	8085	1619	8271	1351	8428	922	9412	508	6836
14-#10	2.74	MA	9797	2783	15468	2084	16881	1740	17618	1473	18420	1031	21878	681	14937
5L-4S		MI	4819	2783	7841	1931	8335	1605	8583	1339	8888	925	9943	560	6915
14-#10	2.74	MA	9649	2783	15016	2088	16311	1761	16918	1482	17476	1050	20675	627	14451
6L-3S		MI	4858	2783	8064	1915	8623	1601	8937	1338	9347	917	10483	603	6896
14-#10	2.74	MA	9484	2783	14533	2107	15725	1766	16246	1502	16500	1057	19265	581	14064
7L-2S		MI	4951	2783	8349	1910	8989	1587	9382	1325	9954	909	11244	693	6875
14-#11	3.37	MA	10115	2896	16176	2153	17732	1790	18634	1505	19781	1023	23796	621	17761
5L-4S		MI	4948	2896	8144	1983	8690	1639	9002	1354	9456	904	10493	457	8228
14-#11	3.37	MA	9938	2896	15628	2158	17047	1816	17780	1516	18633	1046	22327	553	17232
6L-3S		MI	4991	2896	8411	1964	9035	1636	9425	1354	10007	896	11120	507	8211
14-#11	3.37	MA	9742	2896	15041	2180	16336	1821	16966	1541	17515	1068	20601	494	16488
7L-2S		MI	5099	2896	8751	1960	9470	1620	9956	1341	10730	888	11997	617	8187
14-#14	4.86	MA	10657	3163	17057	2343	18829	1960	19920	1612	21522	1049	26484	391	23323
6L-3S		MI	5339	3163	9260	2118	10098	1749	10713	1420	11724	862	13045	324	11358
14-#14	4.86	MA	10381	3163	16217	2374	17821	1969	18753	1646	19919	1080	24003	305	22060
7L-2S		MI	5488	3163	9738	2112	10712	1728	11462	1403	12737	852	14249	482	11344
16-#10	3.14	MA	10103	2853	16148	2128	17753	1772	18682	1492	19867	1025	23882	674	17008
5E		MI	4856	2853	7937	1980	8450	1650	8717	1370	9034	917	10173	488	7665
16-#10	3.14	MA	9958	2853	15697	2132	17183	1793	17981	1501	18924	1044	22679	620	16539
6L-4S		MI	4937	2853	8126	1975	8701	1636	9029	1358	9494	920	10704	540	7811
16-#10	3.14	MA	9794	2853	15214	2150	16597	1798	17310	1522	17948	1052	21269	573	16144
7L-3S		MI	4976	2853	8349	1958	8989	1633	9382	1357	9954	912	11244	583	7797
16-#10	3.14	MA	9616	2853	14792	2159	16013	1816	16589	1527	17028	1070	20047	530	15519
8L-2S		MI	5068	2853	8634	1953	9354	1619	9828	1345	10560	903	12005	673	7778
16-#11	3.85	MA	10310	2982	16453	2212	18105	1854	19070	1539	20388	1039	24758	543	19769
6L-4S		MI	5087	2982	8484	2037	9125	1677	9533	1377	10179	897	11370	428	9279
16-#11	3.85	MA	10116	2982	15866	2234	17393	1860	18257	1564	19270	1061	23032	485	19015
7L-3S		MI	5130	2982	8751	2018	9470	1675	9956	1378	10730	889	11997	478	9281
16-#11	3.85	MA	9908	2982	15353	2244	16683	1882	17388	1571	18079	1069	21540	429	18271
8L-2S		MI	5237	2982	9090	2013	9905	1659	10487	1365	11452	881	12873	587	9261
16-#14	5.56	MA	10911	3287	17396	2451	19332	2025	20597	1680	22428	1070	27476	291	25660
7L-3S		MI	5534	3287	9738	2195	10712	1805	11462	1454	12737	851	14249	277	12847
16-#14	5.56	MA	10619	3287	16660	2465	18315	2055	19367	1690	20721	1081	25333	209	23976
8L-2S		MI	5682	3287	10217	2190	11326	1784	12211	1437	13750	841	15453	435	12848
18-#10	3.53	MA	10266	2924	16377	2176	18055	1824	19045	1520	20371	1038	24683	612	18630
6L-5S		MI	4975	2924	8222	2024	8816	1682	9163	1389	9641	911	10934	468	8523
18-#10	3.53	MA	10102	2924	15894	2194	17469	1829	18374	1541	19395	1046	23273	565	18226
7L-4S		MI	5055	2924	8411	2019	9066	1668	9475	1377	10101	914	11465	520	8705
18-#10	3.53	MA	9929	2924	15472	2203	16885	1847	17652	1546	18475	1065	22051	522	17607
8L-3S		MI	5094	2924	8634	2002	9354	1665	9828	1376	10560	906	12005	564	8694
18-#10	3.53	MA	9776	2924	15020	2222	16326	1855	16957	1563	17568	1084	20854	480	16956
9L-2S		MI	5185	2924	8919	1997	9719	1650	10274	1364	11167	898	12767	653	8679
18-#11	4.33	MA	10486	3068	16691	2288	18451	1899	19547	1588	21026	1054	25463	475	21539
7L-4S		MI	5227	3068	8824	2091	9560	1716	10064	1401	10901	890	12246	399	10220
18-#11	4.33	MA	10283	3068	16178	2298	17741	1920	18678	1594	19835	1062	23971	420	20780
8L-3S		MI	5269	3068	9090	2072	9905	1714	10487	1401	11452	882	12873	448	10347
18-#11	4.33	MA	10095	3068	15633	2322	17060	1929	17831	1615	18730	1085	22502	368	19784
9L-2S		MI	5376	3068	9430	2067	10341	1698	11018	1388	12175	874	13750	558	10332
18-#14	6.25	MA	11151	3412	17839	2542	19826	2111	21211	1724	23230	1071	28807	195	27555
8L-3S		MI	5729	3412	10217	2273	11326	1861	12211	1488	13750	840	15453	229	14332
20-#10	3.92	MA	10409	2994	16574	2238	18341	1861	19438	1560	20843	1040	25278	557	20310
7L-5S		MI	5093	2994	8508	2068	9181	1713	9609	1408	10247	906	11695	448	9384
20-#10	3.92	MA	10241	2994	16152	2246	17757	1879	18716	1565	19923	1059	24055	514	19695
8L-4S		MI	5173	2994	8696	2063	9431	1699	9921	1396	10707	909	12226	500	9590
20-#10	3.92	MA	10090	2994	15700	2266	17198	1886	18020	1583	19015	1078	22858	472	19033
9L-3S		MI	5212	2994	8919	2046	9719	1696	10274	1395	11167	900	12767	544	9590

RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	3.92	MA	9910	2994	15263	2272	16637	1906	17343	1601	18041	1084	21641	435	18337
10L-2S		MI	5302	2994	9204	2041	10085	1682	10720	1383	11773	892	13528	633	9577
20-#11	4.81	MA	10655	3154	17003	2351	18798	1959	19969	1618	21590	1055	26401	410	23290
8L-4S		MI	5366	3154	9163	2145	9996	1755	10595	1424	11624	883	13123	369	11231
20-#11	4.81	MA	10474	3154	16458	2376	18118	1968	19122	1638	20485	1078	24933	358	22301
9L-3S		MI	5408	3154	9430	2126	10341	1753	11018	1425	12175	875	13750	419	11411
22-#10	4.31	MA	10549	3064	16832	2290	18629	1910	19780	1584	21370	1054	26060	506	21783
8L-5S		MI	5211	3064	8793	2112	9546	1745	10054	1428	10854	900	12457	428	10246
22-#10	4.31	MA	10402	3064	16380	2310	18070	1918	19084	1602	20463	1072	24862	464	21111
9L-4S		MI	5291	3064	8981	2106	9797	1731	10366	1415	11313	903	12987	481	10440
22-#10	4.31	MA	10223	3064	15943	2316	17509	1937	18407	1620	19489	1079	23645	427	20405
10L-3S		MI	5329	3064	9204	2090	10085	1728	10720	1414	11773	895	13528	524	10483
22-#11	5.30	MA	10850	3241	17283	2430	19175	2006	20412	1662	22241	1071	27364	349	24818
9L-4S		MI	5505	3241	9503	2199	10431	1794	11126	1448	12347	876	13999	340	12245
24-#10	4.70	MA	10712	3135	17061	2354	18942	1949	20148	1621	21910	1067	26866	457	23188
9L-5S		MI	5329	3135	9078	2155	9912	1776	10500	1447	11460	894	13218	408	11110
24-#10	4.70	MA	10534	3135	16623	2360	18381	1969	19471	1639	20936	1073	25650	419	22473
10L-4S		MI	5408	3135	9266	2150	10162	1762	10812	1434	11920	897	13748	461	11293

RECTANGULAR TIED COLUMNS 20" x 20"

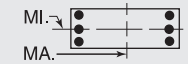
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.19	MA	3095	1546	4951	1095	5219	923	5300	789	5291	589	5901	502	2228
2L-3S		MI	3022	1546	4743	1099	4952	933	4975	798	4848	596	5310	447	2245
6-#9	1.50	MA	3161	1580	5116	1113	5422	935	5546	796	5624	584	6322	491	2757
2L-3S		MI	3070	1580	4854	1118	5087	948	5137	807	5067	593	5588	421	2779
6-#10	1.90	MA	3245	1625	5324	1137	5681	952	5858	805	6047	578	6852	477	3422
2L-3S		MI	3132	1625	4995	1143	5259	968	5343	819	5347	588	5936	388	3449
6-#11	2.34	MA	3321	1673	5532	1156	5926	964	6147	810	6437	567	7265	448	4093
2L-3S		MI	3188	1673	5139	1162	5421	982	5532	825	5600	578	6201	338	4124
6-#14	3.38	MA	3518	1788	6031	1219	6550	1008	6902	835	7462	554	8468	401	5688
2L-3S		MI	3335	1788	5475	1227	5836	1033	6032	856	6277	567	6994	242	5708
6-#18	6.00	MA	3989	2078	7230	1384	8057	1125	8729	902	9929	519	11211	257	9502
2L-3S		MI	3686	2078	6280	1395	6838	1164	7242	933	7911	536	8807	-25	8785
8-#8	1.58	MA	3183	1589	5159	1122	5486	942	5626	801	5735	585	6491	494	2899
2L-4S		MI	3077	1589	4791	1138	5011	956	5045	812	4959	600	5487	409	2934
8-#9	2.00	MA	3271	1636	5377	1147	5758	960	5955	811	6180	580	7057	481	3593
2L-4S		MI	3140	1636	4914	1167	5161	977	5224	825	5206	597	5806	373	3629
8-#10	2.54	MA	3382	1695	5653	1181	6103	983	6372	824	6747	572	7767	462	4468
2L-4S		MI	3220	1695	5069	1205	5351	1004	5453	841	5520	593	6207	326	4489
8-#11	3.12	MA	3483	1760	5926	1210	6430	1003	6763	833	7274	561	8330	426	5342
2L-4S		MI	3296	1760	5226	1237	5529	1025	5661	851	5803	582	6511	262	5200
8-#14	4.50	MA	3746	1912	6588	1297	7263	1064	7773	869	8646	544	9941	364	7441
2L-4S		MI	3489	1912	5596	1334	5987	1094	6211	891	6562	571	7419	130	6805
10-#10	3.17	MA	3519	1766	5982	1225	6524	1015	6886	843	7446	567	8682	447	5508
2L-5S		MI	3263	1766	5183	1255	5487	1051	5611	874	5694	587	6484	260	5194
10-#10	3.17	MA	3410	1766	5653	1231	6103	1031	6372	857	6747	577	7767	358	5521
3L-4S		MI	3360	1766	5398	1249	5773	1035	5967	860	6220	588	7122	311	5471
10-#11	3.90	MA	3518	1846	5926	1270	6430	1059	6763	872	7274	565	8330	293	6591
3L-4S		MI	3461	1846	5620	1291	6034	1064	6276	874	6641	576	7576	239	6346
10-#14	5.63	MA	3798	2037	6588	1383	7263	1145	7773	924	8646	547	9941	168	9152
3L-4S		MI	3721	2037	6153	1411	6700	1149	7082	925	7747	561	8892	93	8439

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.15	MA	3742	1696	5971	1208	6302	1018	6404	871	6393	652	7156	559	2639
2E		MI	3390	1696	5429	1193	5701	1006	5775	860	5741	643	6347	544	2387
4-#11	1.42	MA	3802	1728	6138	1217	6491	1023	6624	871	6687	642	7487	541	3167
2E		MI	3441	1728	5574	1201	5863	1010	5962	860	5992	633	6608	522	2857
4-#14	2.05	MA	3955	1805	6524	1256	6968	1050	7198	886	7465	631	8443	514	4404
2E		MI	3573	1805	5911	1240	6277	1036	6461	874	6668	622	7399	489	3953
4-#18	3.64	MA	4321	1998	7455	1361	8127	1124	8598	927	9363	606	10664	432	7378
2E		MI	3887	1998	6718	1343	7279	1108	7669	914	8299	594	9206	389	6564
6-#8	1.08	MA	3728	1687	5919	1210	6254	1021	6352	874	6326	657	7103	569	2484
2L-3S		MI	3305	1687	5175	1200	5394	1019	5407	873	5244	656	5723	499	2264
6-#8	1.08	MA	3644	1687	5683	1215	5952	1032	5984	884	5825	665	6415	513	2501
3L-2S		MI	3378	1687	5384	1196	5661	1009	5733	864	5688	649	6314	555	2248
6-#9	1.36	MA	3805	1722	6106	1228	6486	1033	6632	881	6704	652	7600	560	3081
2L-3S		MI	3353	1722	5288	1219	5529	1034	5569	882	5463	652	5999	473	2802
6-#9	1.36	MA	3700	1722	5810	1234	6106	1047	6169	894	6074	662	6743	490	3103
3L-2S		MI	3444	1722	5549	1214	5864	1021	5978	871	6019	644	6734	544	2780
6-#10	1.73	MA	3901	1767	6344	1252	6780	1050	6987	890	7186	646	8227	548	3834
2L-3S		MI	3415	1767	5429	1244	5701	1053	5775	894	5741	648	6347	440	3477
6-#10	1.73	MA	3770	1767	5971	1259	6302	1067	6404	906	6393	658	7156	459	3861
3L-2S		MI	3528	1767	5758	1237	6123	1038	6289	879	6441	637	7262	529	3449
6-#11	2.13	MA	3990	1815	6586	1271	7065	1062	7324	895	7639	635	8741	524	4598
2L-3S		MI	3471	1815	5574	1262	5863	1067	5962	899	5992	637	6608	390	4160
6-#11	2.13	MA	3836	1815	6138	1279	6491	1082	6624	913	6687	649	7487	414	4630
3L-2S		MI	3604	1815	5968	1255	6367	1049	6577	883	6829	626	7672	500	4125
6-#14	3.07	MA	4218	1929	7158	1334	7782	1106	8190	920	8815	622	10189	485	6417
2L-3S		MI	3618	1929	5911	1326	6277	1117	6461	929	6668	626	7399	293	5760
6-#14	3.07	MA	4006	1929	6524	1345	6968	1134	7198	944	7465	639	8443	326	6437
3L-2S		MI	3801	1929	6467	1318	6991	1092	7331	908	7852	612	8872	452	5728
6-#18	5.45	MA	4766	2220	8544	1499	9523	1223	10300	987	11680	589	13547	366	10798
2L-3S		MI	3969	2220	6718	1492	7279	1246	7669	1005	8299	594	9206	26	9132
6-#18	5.45	MA	4415	2220	7455	1514	8127	1267	8598	1025	9363	613	10664	84	10397
3L-2S		MI	4272	2220	7668	1481	8497	1208	9156	974	10317	576	11610	307	9559
8-#8	1.44	MA	3829	1731	6154	1237	6556	1040	6721	886	6827	653	7791	563	3240
2L-4S		MI	3360	1731	5223	1239	5453	1042	5477	888	5355	660	5899	461	2958
8-#8	1.44	MA	3746	1731	5919	1242	6254	1051	6352	896	6326	662	7103	508	3256
3E		MI	3394	1731	5384	1228	5661	1039	5733	885	5688	653	6314	491	2938
8-#8	1.44	MA	3705	1731	5738	1254	6020	1055	6065	899	5952	670	6624	476	3275
4L-2S		MI	3466	1731	5592	1223	5928	1029	6058	876	6131	645	6904	547	2921
8-#9	1.82	MA	3931	1777	6402	1262	6865	1058	7095	896	7334	648	8458	552	4025
2L-4S		MI	3423	1777	5347	1268	5603	1063	5656	900	5601	657	6218	425	3660
8-#9	1.82	MA	3827	1777	6106	1268	6486	1072	6632	909	6704	658	7600	482	4044
3E		MI	3465	1777	5549	1254	5864	1059	5978	897	6019	648	6734	463	3639
8-#9	1.82	MA	3777	1777	5879	1283	6191	1077	6270	912	6233	668	7002	443	4061
4L-2S		MI	3554	1777	5811	1248	6199	1046	6386	886	6576	639	7469	533	3619
8-#10	2.31	MA	4058	1837	6717	1296	7258	1081	7570	909	7979	640	9297	537	5017
2L-4S		MI	3503	1837	5503	1305	5793	1089	5884	915	5914	653	6618	378	4533
8-#10	2.31	MA	3930	1837	6344	1303	6780	1098	6987	925	7186	653	8227	448	5037
3E		MI	3554	1837	5758	1288	6123	1085	6289	913	6441	642	7262	425	4521
8-#10	2.31	MA	3868	1837	6057	1322	6409	1104	6531	929	6592	665	7478	399	5038
4L-2S		MI	3665	1837	6087	1281	6544	1069	6803	899	7141	632	8177	514	4498
8-#11	2.84	MA	4177	1901	7033	1324	7639	1101	8024	919	8591	629	9995	506	6016
2L-4S		MI	3579	1901	5661	1336	5971	1110	6091	925	6196	641	6919	313	5328
8-#11	2.84	MA	4026	1901	6586	1333	7065	1120	7324	936	7639	642	8741	397	6036
3E		MI	3636	1901	5968	1316	6367	1105	6577	923	6829	630	7672	367	5403
8-#11	2.84	MA	3956	1901	6240	1354	6617	1126	6774	940	6923	655	7859	339	5951
4L-2S		MI	3766	1901	6361	1309	6872	1087	7193	907	7667	619	8737	477	5378
8-#14	4.09	MA	4480	2054	7793	1412	8595	1162	9182	954	10165	612	11934	456	8413
2L-4S		MI	3772	2054	6032	1432	6428	1178	6640	964	6953	629	7824	181	6956

RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

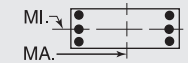
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	4.09	MA	4274	2054	7158	1422	7782	1189	8190	978	8815	629	10189	297	8405
3E		MI	3850	2054	6467	1404	6991	1173	7331	963	7852	616	8872	256	7491
8-#14	4.09	MA	4177	2054	6666	1453	7144	1197	7408	982	7797	647	8957	217	7802
4L-2S		MI	4029	2054	7024	1395	7704	1148	8202	942	9037	602	10346	415	7485
8-#18	7.27	MA	4869	2441	8544	1653	9523	1366	10300	1085	11680	596	13547	19	13482
3E		MI	4361	2441	7668	1630	8497	1346	9156	1066	10317	575	11610	-56	11543
10-#10	2.89	MA	4215	1907	7089	1339	7736	1113	8153	929	8773	635	10368	526	6193
2L-5S		MI	3546	1907	5617	1355	5929	1137	6042	949	6089	646	6895	312	5291
10-#10	2.89	MA	4090	1907	6717	1347	7258	1130	7570	944	7979	647	9297	437	6207
3L-4S		MI	3643	1907	5832	1349	6215	1121	6399	935	6614	647	7533	363	5555
10-#10	2.89	MA	4028	1907	6430	1366	6887	1136	7114	948	7386	659	8549	388	6193
4L-3S		MI	3693	1907	6087	1331	6544	1116	6803	932	7141	637	8177	410	5556
10-#10	2.89	MA	3918	1907	6189	1373	6566	1153	6714	964	6794	660	7802	337	5889
5L-2S		MI	3802	1907	6416	1325	6966	1101	7318	918	7841	626	9093	499	5539
10-#11	3.55	MA	4216	1987	7033	1387	7639	1159	8024	960	8591	635	9995	379	7434
3L-4S		MI	3744	1987	6055	1390	6475	1148	6706	948	7033	634	7983	291	6470
10-#11	3.55	MA	4146	1987	6687	1408	7191	1165	7474	964	7875	648	9113	322	7257
4L-3S		MI	3801	1987	6361	1370	6872	1144	7193	946	7667	623	8737	345	6637
10-#11	3.55	MA	4015	1987	6395	1417	6803	1185	6990	981	7161	648	8239	258	6896
5L-2S		MI	3929	1987	6755	1363	7376	1126	7808	930	8504	612	9801	455	6621
10-#14	5.11	MA	4540	2178	7793	1500	8595	1245	9182	1012	10165	619	11934	269	10367
3L-4S		MI	4004	2178	6589	1510	7141	1234	7511	998	8138	619	9297	144	8585
10-#14	5.11	MA	4445	2178	7301	1531	7958	1253	8400	1016	9146	637	10702	188	9670
4L-3S		MI	4081	2178	7024	1482	7704	1229	8202	997	9037	606	10346	219	9215
12-#10	3.46	MA	4248	1977	7089	1391	7736	1161	8153	963	8773	641	10368	426	7371
3L-5S		MI	3686	1977	5946	1399	6351	1168	6557	968	6789	641	7810	297	6273
12-#10	3.46	MA	4187	1977	6803	1409	7365	1167	7697	967	8179	654	9619	377	7339
4E		MI	3781	1977	6161	1393	6636	1153	6913	954	7314	642	8448	348	6544
12-#10	3.46	MA	4078	1977	6562	1417	7044	1184	7297	983	7587	655	8873	326	7006
5L-3S		MI	3831	1977	6416	1375	6966	1148	7318	951	7841	631	9093	395	6587
12-#10	3.46	MA	3999	1977	6314	1435	6724	1190	6899	987	7054	667	8190	269	6782
6L-2S		MI	3939	1977	6745	1369	7388	1132	7832	937	8541	621	10008	484	6576
12-#11	4.25	MA	4335	2074	7135	1462	7765	1204	8173	987	8827	642	10367	304	8575
4E		MI	3909	2074	6448	1444	6980	1187	7322	972	7871	628	9047	268	7624
12-#11	4.25	MA	4206	2074	6843	1470	7377	1224	7690	1005	8113	641	9493	241	8238
5L-3S		MI	3965	2074	6755	1424	7376	1183	7808	970	8504	617	9801	322	7864
12-#14	6.14	MA	4711	2303	7935	1609	8771	1309	9392	1050	10496	627	12448	159	11552
4E		MI	4235	2303	7145	1588	7855	1289	8381	1032	9322	610	10770	107	10228
14-#10	4.04	MA	4346	2048	7176	1453	7843	1199	8280	987	8972	648	10690	366	8442
4L-5S		MI	3825	2048	6275	1443	6772	1200	7071	987	7488	635	8725	282	7260
14-#10	4.04	MA	4238	2048	6935	1461	7522	1216	7880	1002	8381	649	9944	315	8127
5L-4S		MI	3920	2048	6490	1437	7058	1184	7428	973	8014	636	9363	333	7513
14-#10	4.04	MA	4161	2048	6687	1478	7202	1222	7482	1006	7847	661	9261	258	7881
6L-3S		MI	3969	2048	6745	1419	7388	1179	7832	970	8541	625	10008	380	7613
14-#11	4.96	MA	4396	2160	7290	1524	7950	1262	8389	1028	9065	634	10747	224	9586
5L-4S		MI	4072	2160	6842	1498	7484	1226	7937	995	8708	621	10112	245	8786
16-#10	4.62	MA	4397	2118	7307	1505	8000	1247	8463	1021	9174	643	11014	304	9253
5E		MI	3964	2118	6604	1487	7194	1231	7586	1006	8188	630	9641	267	8251
16-#10	4.62	MA	4321	2118	7060	1522	7680	1253	8066	1025	8640	656	10331	247	8986
6L-4S		MI	4057	2118	6819	1481	7480	1216	7942	992	8714	630	10279	318	8488

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis

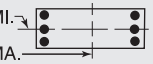


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#10	1.06	MA	4435	1838	7027	1323	7433	1116	7553	956	7523	720	8468	625	2913
2E		MI	3673	1838	5863	1294	6142	1092	6206	935	6136	703	6757	596	2408
4-#11	1.30	MA	4504	1870	7218	1332	7649	1121	7804	957	7858	710	8865	609	3504
2E		MI	3724	1870	6009	1300	6304	1095	6392	934	6385	692	7015	574	2884
4-#14	1.88	MA	4678	1946	7654	1371	8188	1148	8453	972	8736	699	9986	586	4890
2E		MI	3856	1946	6347	1338	6718	1121	6890	947	7059	680	7804	540	3986
4-#18	3.33	MA	5098	2140	8711	1476	9503	1222	10041	1012	10890	674	12622	518	8242
2E		MI	4171	2140	7155	1440	7719	1191	8096	986	8686	652	9606	440	6612
6-#9	1.25	MA	4505	1863	7177	1343	7636	1131	7806	966	7868	720	8951	625	3405
2L-3S		MI	3636	1863	5721	1320	5971	1120	6001	957	5858	712	6411	526	2824
6-#9	1.25	MA	4386	1863	6847	1349	7212	1146	7289	980	7165	731	7977	555	3427
3L-2S		MI	3727	1863	5982	1315	6306	1107	6409	946	6415	703	7146	596	2802
6-#10	1.59	MA	4614	1908	7444	1367	7967	1148	8205	976	8409	714	9695	618	4245
2L-3S		MI	3698	1908	5863	1344	6142	1139	6206	968	6136	707	6757	492	3504
6-#10	1.59	MA	4466	1908	7027	1375	7433	1166	7553	992	7523	728	8468	528	4272
3L-2S		MI	3811	1908	6191	1338	6564	1123	6720	954	6836	697	7673	581	3474
6-#11	1.95	MA	4717	1956	7719	1385	8292	1160	8588	980	8925	703	10310	596	5104
2L-3S		MI	3754	1956	6009	1361	6304	1151	6392	973	6385	696	7015	442	4193
6-#11	1.95	MA	4541	1956	7218	1395	7649	1181	7804	1000	7858	719	8865	486	5135
3L-2S		MI	3887	1956	6403	1354	6808	1133	7008	957	7222	685	8080	551	4157
6-#14	2.81	MA	4977	2071	8366	1449	9101	1204	9567	1006	10252	690	12006	564	7146
2L-3S		MI	3901	2071	6347	1425	6718	1201	6890	1002	7059	684	7804	345	5806
6-#14	2.81	MA	4735	2071	7654	1461	8188	1234	8453	1032	8736	710	9986	406	7166
3L-2S		MI	4085	2071	6904	1416	7432	1176	7760	981	8243	670	9277	503	5767
6-#18	5.00	MA	5603	2361	9938	1614	11076	1321	11960	1073	13501	657	15989	465	12094
2L-3S		MI	4251	2361	7155	1589	7719	1329	8096	1077	8686	651	9606	76	9380
6-#18	5.00	MA	5203	2361	8711	1633	9503	1369	10041	1115	10890	687	12622	184	11964
3L-2S		MI	4556	2361	8106	1578	8937	1290	9583	1046	10704	633	12010	358	9614
8-#8	1.32	MA	4532	1872	7230	1352	7713	1138	7904	972	8004	721	9140	626	3581
2L-4S		MI	3643	1872	5656	1340	5894	1129	5909	963	5751	720	6312	514	2981
8-#8	1.32	MA	4438	1872	6967	1357	7376	1150	7493	982	7444	730	8366	571	3598
3E		MI	3677	1872	5816	1329	6102	1125	6165	961	6084	712	6726	544	2960
8-#8	1.32	MA	4390	1872	6766	1370	7116	1155	7173	986	7029	740	7831	540	3616
4L-2S		MI	3749	1872	6025	1325	6369	1115	6491	951	6527	705	7317	600	2943
8-#9	1.67	MA	4647	1919	7508	1377	8060	1156	8323	982	8572	716	9925	619	4457
2L-4S		MI	3706	1919	5780	1369	6044	1149	6088	975	5997	716	6630	478	3688
8-#9	1.67	MA	4530	1919	7177	1384	7636	1170	7806	995	7868	727	8951	549	4476
3E		MI	3748	1919	5982	1354	6306	1145	6409	972	6415	708	7146	515	3665
8-#9	1.67	MA	4470	1919	6925	1400	7309	1176	7404	999	7345	738	8276	509	4493
4L-2S		MI	3838	1919	6244	1349	6641	1132	6818	961	6971	699	7881	585	3644
8-#10	2.12	MA	4792	1978	7861	1410	8502	1179	8857	995	9296	708	10922	610	5566
2L-4S		MI	3786	1978	5937	1406	6234	1175	6316	990	6309	712	7028	430	4571
8-#10	2.12	MA	4647	1978	7444	1419	7967	1197	8205	1011	8409	722	9695	520	5586
3E		MI	3837	1978	6191	1388	6564	1171	6720	987	6836	702	7673	477	4551
8-#10	2.12	MA	4573	1978	7125	1438	7554	1204	7698	1017	7749	736	8841	469	5587
4L-2S		MI	3949	1978	6520	1382	6986	1155	7235	973	7536	691	8588	566	4527
8-#11	2.60	MA	4928	2043	8221	1439	8934	1199	9373	1004	9992	697	11755	583	6690
2L-4S		MI	3862	2043	6096	1435	6412	1194	6521	998	6588	700	7326	365	5450
8-#11	2.60	MA	4757	2043	7719	1449	8292	1220	8588	1023	8925	712	10310	473	6710
3E		MI	3919	2043	6403	1415	6808	1190	7008	997	7222	689	8080	419	5441
8-#11	2.60	MA	4673	2043	7334	1472	7792	1227	7975	1029	8127	727	9300	413	6687
4L-2S		MI	4050	2043	6796	1408	7313	1172	7623	981	8059	678	9144	529	5412
8-#14	3.75	MA	5274	2195	9078	1527	10013	1260	10681	1040	11767	680	14027	542	9385
2L-4S		MI	4055	2195	6468	1531	6869	1262	7069	1037	7344	688	8229	232	7101
8-#14	3.75	MA	5039	2195	8366	1539	9101	1290	9567	1066	10252	700	12006	384	9377
3E		MI	4132	2195	6904	1502	7432	1257	7760	1036	8243	674	9277	308	7546
8-#14	3.75	MA	4923	2195	7817	1571	8389	1299	8694	1072	9115	721	10590	298	8822
4L-2S		MI	4313	2195	7460	1494	8145	1232	8631	1015	9428	660	10750	466	7528

RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

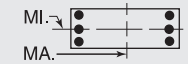
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	6.67	MA	5719	2583	9938	1771	11076	1468	11960	1175	13501	670	15989	131	15479
3E		MI	4643	2583	8106	1727	8937	1428	9583	1138	10704	633	12010	-6	12003
8-#18	6.67	MA	5533	2583	8985	1825	9843	1481	10447	1182	11531	700	13612	-12	13600
4L-2S		MI	4940	2583	9056	1717	10156	1390	11069	1106	12722	615	14414	275	12591
10-#10	2.65	MA	4970	2049	8277	1454	9036	1211	9509	1014	10183	703	12149	602	6879
2L-5S		MI	3829	2049	6051	1456	6371	1223	6474	1023	6483	706	7306	364	5383
10-#10	2.65	MA	4827	2049	7861	1463	8502	1229	8857	1031	9296	716	10922	512	6892
3L-4S		MI	3925	2049	6266	1450	6656	1207	6830	1009	7009	707	7944	415	5598
10-#10	2.65	MA	4754	2049	7542	1482	8089	1236	8350	1036	8635	730	10068	461	6879
4L-3S		MI	3976	2049	6520	1432	6986	1202	7235	1007	7536	696	8588	462	5590
10-#10	2.65	MA	4629	2049	7275	1490	7733	1254	7905	1053	7978	733	9213	411	6593
5L-2S		MI	4086	2049	6849	1426	7408	1186	7749	993	8236	686	9503	551	5570
10-#11	3.25	MA	4971	2129	8221	1503	8934	1258	9373	1047	9992	705	11755	460	8276
3L-4S		MI	4027	2129	6490	1489	6916	1233	7136	1022	7426	693	8390	342	6590
10-#11	3.25	MA	4888	2129	7835	1526	8435	1266	8760	1052	9193	720	10745	400	8188
4L-3S		MI	4084	2129	6796	1469	7313	1229	7623	1020	8059	682	9144	396	6679
10-#11	3.25	MA	4740	2129	7512	1535	8004	1287	8222	1071	8398	722	9738	337	7733
5L-2S		MI	4212	2129	7190	1462	7817	1211	8238	1004	8897	671	10208	506	6659
10-#14	4.69	MA	5340	2320	9078	1617	10013	1345	10681	1100	11767	690	14027	361	11582
3L-4S		MI	4287	2320	7025	1609	7582	1318	7940	1071	8528	678	9702	195	8726
10-#14	4.69	MA	5226	2320	8529	1649	9302	1355	9807	1106	10630	711	12610	276	10925
4L-3S		MI	4363	2320	7460	1580	8145	1313	8631	1070	9428	664	10750	270	9274
10-#14	4.69	MA	5018	2320	8067	1662	8687	1384	9040	1133	9497	711	11202	185	10396
5L-2S		MI	4540	2320	8017	1572	8859	1288	9501	1049	10612	650	12224	429	9279
12-#10	3.17	MA	5006	2119	8277	1507	9036	1260	9509	1050	10183	711	12149	504	8194
3L-5S		MI	3969	2119	6380	1500	6792	1254	6988	1043	7183	700	8221	349	6364
12-#10	3.17	MA	4934	2119	7959	1526	8623	1267	9001	1055	9522	725	11295	453	8169
4E		MI	4064	2119	6595	1493	7078	1238	7345	1029	7709	701	8859	401	6620
12-#10	3.17	MA	4811	2119	7692	1534	8267	1285	8557	1072	8865	727	10440	403	7843
5L-3S		MI	4114	2119	6849	1476	7408	1234	7749	1026	8236	691	9503	447	6623
12-#10	3.17	MA	4722	2119	7431	1540	7912	1292	8116	1077	8272	741	9660	344	7630
6L-2S		MI	4222	2119	7178	1469	7829	1218	8264	1012	8936	680	10418	536	6609
12-#11	3.90	MA	5102	2215	8337	1580	9078	1305	9544	1076	10260	713	12191	387	9667
4E		MI	4191	2215	6883	1543	7421	1272	7752	1046	8263	686	9455	320	7741
12-#11	3.90	MA	4956	2215	8013	1589	8647	1326	9006	1095	9465	715	11183	324	9240
5L-3S		MI	4247	2215	7190	1523	7817	1268	8238	1044	8897	675	10208	374	7911
12-#11	3.90	MA	4850	2215	7679	1610	8218	1333	8472	1100	8748	730	10262	254	8835
6L-2S		MI	4374	2215	7583	1516	8322	1250	8854	1028	9734	664	11273	484	7899
12-#14	5.63	MA	5528	2444	9242	1727	10215	1411	10921	1140	12146	701	14630	254	13043
4E		MI	4518	2444	7581	1686	8296	1374	8810	1105	9713	668	11175	158	10366
12-#14	5.63	MA	5324	2444	8779	1739	9600	1440	10154	1167	11012	701	13222	163	12489
5L-3S		MI	4593	2444	8017	1658	8859	1369	9501	1104	10612	654	12224	233	10997
14-#10	3.70	MA	5113	2189	8376	1570	9157	1299	9653	1074	10409	719	12522	445	9459
4L-5S		MI	4108	2189	6709	1544	7214	1286	7503	1062	7883	695	9136	334	7350
14-#10	3.70	MA	4991	2189	8108	1578	8801	1317	9208	1091	9751	721	11667	395	9099
5L-4S		MI	4203	2189	6924	1537	7500	1270	7859	1048	8409	695	9774	386	7615
14-#10	3.70	MA	4904	2189	7848	1584	8447	1324	8768	1096	9159	735	10887	336	8893
6L-3S		MI	4252	2189	7178	1520	7829	1265	8264	1045	8936	685	10418	432	7654
14-#11	4.55	MA	5171	2301	8514	1643	9290	1364	9790	1118	10532	708	12628	311	10753
5L-4S		MI	4355	2301	7277	1597	7925	1311	8367	1069	9101	679	10519	297	8901
14-#11	4.55	MA	5067	2301	8181	1664	8860	1372	9256	1124	9815	723	11707	241	10322
6L-3S		MI	4411	2301	7583	1577	8322	1306	8854	1067	9734	668	11273	351	9136

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

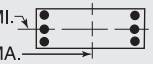
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	6.56	MA	5627	2569	9491	1817	10513	1496	11267	1201	12528	691	15242	141	14585
5L-4S		MI	4748	2569	8138	1764	9009	1429	9681	1139	10897	658	12648	121	12016
16-#10	4.23	MA	5171	2259	8525	1622	9335	1348	9860	1110	10638	716	12894	387	10358
5E		MI	4247	2259	7038	1588	7636	1317	8017	1081	8583	689	10051	319	8339
16-#10	4.23	MA	5086	2259	8264	1628	8981	1355	9419	1115	10046	730	12114	328	10132
6L-4S		MI	4340	2259	7253	1581	7921	1301	8373	1067	9109	690	10689	371	8589
16-#11	5.20	MA	5284	2388	8682	1718	9503	1411	10040	1147	10882	717	13152	228	11815
6L-4S		MI	4519	2388	7670	1651	8430	1349	8983	1093	9938	673	11583	274	10068
18-#10	4.76	MA	5266	2330	8681	1672	9515	1387	10071	1135	10933	724	13341	320	11375
6L-5S		MI	4385	2330	7367	1632	8057	1349	8531	1100	9283	683	10967	304	9332

RECTANGULAR TIED COLUMNS 20" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.20	MA	5263	2011	8378	1446	8893	1219	9073	1042	9112	778	10334	676	3841
2E		MI	4007	2011	6444	1400	6745	1179	6822	1008	6777	751	7423	626	2909
4-#14	1.73	MA	5459	2088	8864	1486	9494	1246	9796	1057	10091	767	11623	657	5376
2E		MI	4139	2088	6783	1437	7159	1205	7319	1021	7450	738	8209	591	4018
4-#18	3.08	MA	5933	2281	10047	1591	10966	1320	11573	1098	12500	742	14678	599	9106
2E		MI	4454	2281	7593	1537	8159	1274	8523	1058	9074	709	10006	490	6659
6-#9	1.15	MA	5263	2005	8329	1458	8874	1229	9068	1052	9116	788	10348	685	3729
2L-3S		MI	3919	2005	6154	1421	6412	1206	6432	1032	6254	772	6823	578	2845
6-#9	1.15	MA	5129	2005	7963	1465	8406	1235	8497	1066	8339	800	9272	617	3751
3L-2S		MI	4010	2005	6415	1416	6748	1193	6841	1021	6810	763	7558	649	2823
6-#10	1.47	MA	5385	2050	8624	1481	9242	1246	9511	1061	9716	782	11176	678	4657
2L-3S		MI	3980	2050	6296	1445	6584	1225	6637	1043	6531	767	7168	544	3529
6-#10	1.47	MA	5218	2050	8164	1490	8651	1254	8791	1079	8736	797	9819	591	4684
3L-2S		MI	4094	2050	6625	1438	7006	1209	7152	1029	7231	756	8083	633	3499
6-#11	1.80	MA	5501	2098	8933	1500	9605	1258	9941	1066	10294	772	11971	666	5609
2L-3S		MI	4037	2098	6444	1460	6745	1236	6822	1047	6777	755	7423	493	4225
6-#11	1.80	MA	5304	2098	8378	1511	8893	1280	9073	1086	9112	788	10334	557	5641
3L-2S		MI	4170	2098	6838	1454	7250	1218	7438	1031	7614	744	8487	603	4187
6-#14	2.60	MA	5794	2212	9654	1564	10507	1302	11032	1091	11772	758	13919	640	7875
2L-3S		MI	4183	2212	6783	1523	7159	1285	7319	1076	7450	742	8209	396	5849
6-#14	2.60	MA	5521	2212	8864	1578	9494	1333	9796	1119	10091	781	11623	482	7895
3L-2S		MI	4368	2212	7340	1515	7873	1261	8189	1055	8634	729	9682	554	5805
6-#18	4.62	MA	6499	2503	11412	1729	12717	1419	13709	1158	15406	725	18533	558	13390
2L-3S		MI	4534	2503	7593	1686	8159	1412	8523	1150	9074	708	10006	126	9622
6-#18	4.62	MA	6049	2503	10047	1751	10966	1470	11573	1204	12500	760	14678	276	13260
3L-2S		MI	4839	2503	8544	1675	9377	1373	10010	1118	11092	691	12410	408	9667
8-#8	1.22	MA	5293	2014	8385	1467	8958	1236	9175	1057	9264	789	10554	686	3922
2L-4S		MI	3926	2014	6088	1442	6336	1215	6342	1038	6147	780	6725	567	3002
8-#8	1.22	MA	5187	2014	8095	1473	8586	1241	8721	1068	8646	799	9699	633	3939
3E		MI	3960	2014	6249	1430	6544	1212	6597	1036	6480	772	7139	597	2980
8-#8	1.22	MA	5131	2014	7875	1486	8300	1254	8370	1073	8189	809	9116	601	3958
4L-2S		MI	4032	2014	6457	1426	6811	1201	6923	1027	6923	765	7730	652	2964
8-#9	1.54	MA	5422	2060	8694	1492	9342	1254	9639	1067	9893	784	11424	678	4889
2L-4S		MI	3989	2060	6213	1469	6486	1235	6520	1050	6392	776	7042	530	3715
8-#9	1.54	MA	5290	2060	8329	1499	8874	1260	9068	1081	9116	796	10348	611	4908
3E		MI	4030	2060	6415	1455	6748	1231	6841	1047	6810	767	7558	567	3689
8-#9	1.54	MA	5221	2060	8051	1516	8514	1275	8626	1086	8540	808	9612	571	4925
4L-2S		MI	4121	2060	6677	1450	7083	1218	7250	1036	7367	759	8292	638	3668
8-#10	1.95	MA	5584	2120	9085	1525	9832	1277	10232	1080	10696	776	12533	670	6114
2L-4S		MI	4069	2120	6371	1506	6676	1261	6747	1065	6704	772	7439	483	4605
8-#10	1.95	MA	5420	2120	8624	1534	9242	1285	9511	1098	9716	791	11176	583	6134
3E		MI	4120	2120	6625	1489	7006	1256	7152	1062	7231	761	8083	529	4580
8-#10	1.95	MA	5335	2120	8274	1555	8787	1304	8953	1104	8989	806	10244	532	6135
4L-2S		MI	4232	2120	6954	1482	7427	1240	7666	1048	7931	751	8999	618	4554

RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

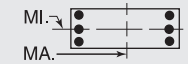
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	2.40	MA	5738	2184	9488	1554	10317	1297	10810	1089	11476	765	13607	657	7363
2L-4S		MI	4145	2184	6532	1535	6853	1279	6951	1072	6981	759	7733	416	5498
8-#11	2.40	MA	5545	2184	8933	1565	9605	1319	9941	1110	10294	782	11971	547	7384
3E		MI	4202	2184	6838	1514	7250	1275	7438	1070	7614	748	8487	471	5477
8-#11	2.40	MA	5447	2184	8509	1589	9055	1327	9266	1117	9414	799	10833	484	7361
4L-2S		MI	4333	2184	7232	1508	7754	1257	8053	1055	8452	737	9551	580	5446
8-#14	3.46	MA	6127	2337	10444	1642	11520	1358	12267	1125	13453	748	16216	623	10357
2L-4S		MI	4338	2337	6904	1629	7310	1346	7498	1111	7735	746	8634	283	7241
8-#14	3.46	MA	5861	2337	9654	1656	10507	1389	11032	1153	11772	771	13919	465	10349
3E		MI	4415	2337	7340	1601	7873	1341	8189	1110	8634	732	9682	359	7598
8-#14	3.46	MA	5726	2337	9049	1689	9722	1401	10067	1162	10517	794	12318	376	9864
4L-2S		MI	4596	2337	7896	1593	8586	1316	9060	1089	9819	719	11155	517	7570
8-#18	6.15	MA	6629	2724	11412	1889	12717	1570	13709	1265	15406	743	18533	235	17461
3E		MI	4926	2724	8544	1824	9377	1511	10010	1210	11092	690	12410	44	12262
8-#18	6.15	MA	6409	2724	10359	1946	11352	1586	12033	1276	13224	778	15827	85	15321
4L-2S		MI	5224	2724	9494	1814	10596	1472	11496	1178	13109	672	14814	326	12652
10-#10	2.44	MA	5782	2190	9546	1569	10423	1309	10952	1099	11677	771	13891	662	7565
2L-5S		MI	4112	2190	6485	1556	6812	1308	6905	1098	6878	765	7716	416	5471
10-#10	2.44	MA	5621	2190	9085	1578	9832	1317	10232	1117	10696	786	12533	575	7578
3L-4S		MI	4208	2190	6700	1550	7098	1292	7262	1084	7404	766	8354	468	5637
10-#10	2.44	MA	5537	2190	8735	1599	9378	1335	9673	1123	9969	801	11601	525	7565
4L-3S		MI	4259	2190	6954	1532	7427	1288	7666	1081	7931	756	8999	514	5622
10-#10	2.44	MA	5398	2190	8441	1608	8986	1343	9184	1141	9246	804	10663	477	7307
5L-2S		MI	4369	2190	7283	1526	7849	1272	8181	1067	8631	745	9914	604	5600
10-#11	3.00	MA	5785	2270	9488	1618	10317	1358	10810	1133	11476	775	13607	538	9118
3L-4S		MI	4310	2270	6925	1589	7358	1318	7566	1096	7818	752	8797	394	6705
10-#11	3.00	MA	5688	2270	9064	1643	9767	1366	10134	1140	10595	792	12469	475	9077
4L-3S		MI	4367	2270	7232	1568	7754	1314	8053	1094	8452	741	9551	448	6719
10-#11	3.00	MA	5522	2270	8708	1653	9293	1388	9542	1161	9720	795	11329	413	8582
5L-2S		MI	4496	2270	7625	1562	8259	1296	8669	1078	9289	730	10616	558	6695
10-#14	4.33	MA	6199	2461	10444	1733	11520	1445	12267	1187	13453	761	16216	448	12797
3L-4S		MI	4570	2461	7461	1707	8023	1402	8369	1145	8919	736	10107	246	8863
10-#14	4.33	MA	6066	2461	9839	1767	10735	1456	11303	1196	12198	784	14614	359	12203
4L-3S		MI	4646	2461	7896	1679	8586	1397	9060	1143	9819	722	11155	322	9330
10-#14	4.33	MA	5833	2461	9330	1781	10057	1487	10457	1224	10948	787	13013	270	11556
5L-2S		MI	4824	2461	8453	1670	9300	1372	9930	1122	11003	709	12628	480	9324
10-#18	7.69	MA	6989	2945	11724	2084	13102	1685	14168	1336	16129	761	19682	43	19413
4L-3S		MI	5316	2945	9494	1962	10596	1610	11496	1270	13109	672	14814	-38	14761
12-#10	2.93	MA	5821	2260	9546	1622	10423	1348	10952	1136	11677	780	13891	567	9017
3L-5S		MI	4252	2260	6814	1600	7234	1340	7420	1117	7578	760	8631	401	6450
12-#10	2.93	MA	5738	2260	9195	1642	9968	1367	10394	1142	10949	795	12958	517	8992
4E		MI	4347	2260	7028	1594	7519	1324	7776	1103	8104	761	9269	453	6663
12-#10	2.93	MA	5601	2260	8902	1651	9577	1375	9905	1160	10226	799	12020	470	8691
5L-3S		MI	4397	2260	7283	1576	7849	1319	8181	1100	8631	750	9914	499	6658
12-#10	2.93	MA	5501	2260	8609	1657	9188	1394	9421	1166	9575	814	11170	411	8434
6L-2S		MI	4506	2260	7612	1570	8271	1304	8695	1086	9330	740	10829	589	6641
12-#11	3.60	MA	5927	2357	9620	1696	10479	1405	11003	1164	11777	785	14105	465	10778
4E		MI	4474	2357	7319	1643	7862	1357	8182	1119	8656	745	9862	371	7854
12-#11	3.60	MA	5764	2357	9264	1707	10005	1427	10410	1184	10901	788	12965	403	10253
5L-3S		MI	4530	2357	7625	1622	8259	1352	8669	1118	9289	734	10616	425	7954
12-#11	3.60	MA	5645	2357	8916	1714	9533	1436	9823	1191	10112	805	11925	331	9879
6L-2S		MI	4658	2357	8019	1616	8763	1334	9284	1102	10127	723	11680	535	7938
12-#14	5.19	MA	6403	2586	10629	1845	11747	1512	12538	1230	13879	774	16910	343	14556
4E		MI	4801	2586	8018	1785	8737	1458	9239	1179	10104	726	11580	209	10499

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

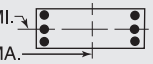
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	5.19	MA	6175	2586	10120	1859	11070	1543	11692	1258	12629	777	15310	253	13949
5L-3S		MI	4876	2586	8453	1757	9300	1453	9930	1177	11003	712	12628	285	11056
14-#10	3.42	MA	5938	2331	9656	1686	10559	1399	11114	1162	11929	789	14316	509	10419
4L-5S		MI	4391	2331	7142	1644	7655	1371	7934	1136	8278	754	9547	386	7435
14-#10	3.42	MA	5802	2331	9363	1695	10168	1406	10625	1179	11206	793	13378	462	10080
5L-4S		MI	4486	2331	7357	1638	7941	1355	8290	1122	8804	755	10185	438	7685
14-#10	3.42	MA	5705	2331	9070	1701	9778	1425	10141	1186	10555	808	12527	403	9836
6L-3S		MI	4535	2331	7612	1620	8271	1351	8695	1120	9330	744	10829	484	7690
14-#10	3.42	MA	5606	2331	8739	1717	9399	1431	9679	1203	9921	823	11645	364	9422
7L-2S		MI	4643	2331	7941	1614	8692	1335	9210	1106	10030	734	11744	574	7678
14-#11	4.20	MA	6004	2443	9819	1761	10717	1466	11279	1208	12083	781	14601	394	11931
5L-4S		MI	4638	2443	7712	1697	8367	1395	8797	1143	9493	738	10926	349	9012
14-#11	4.20	MA	5889	2443	9471	1768	10245	1474	10692	1214	11294	798	13562	321	11532
6L-3S		MI	4694	2443	8019	1676	8763	1391	9284	1141	10127	727	11680	403	9185
14-#14	6.06	MA	6514	2710	10910	1937	12083	1599	12928	1292	14309	767	17606	236	16350
5L-4S		MI	5031	2710	8574	1863	9450	1513	10110	1212	11288	716	13053	172	12147
16-#10	3.91	MA	6003	2401	9823	1739	10758	1438	11346	1198	12186	787	14735	454	11474
5E		MI	4530	2401	7471	1688	8077	1403	8448	1156	8978	749	10462	371	8424
16-#10	3.91	MA	5908	2401	9530	1745	10369	1457	10862	1205	11535	802	13884	396	11241
6L-4S		MI	4624	2401	7686	1682	8363	1387	8805	1142	9503	749	11100	423	8686
16-#10	3.91	MA	5809	2401	9199	1761	9990	1463	10399	1222	10901	817	13003	356	10812
7L-3S		MI	4673	2401	7941	1664	8692	1382	9210	1139	10030	739	11744	469	8719
16-#11	4.80	MA	6131	2529	10026	1822	10957	1513	11560	1238	12476	791	15198	312	13191
6L-4S		MI	4802	2529	8106	1751	8871	1434	9413	1166	10330	731	11990	326	10177
18-#10	4.40	MA	6109	2471	9991	1789	10960	1488	11582	1224	12516	797	15241	388	12649
6L-5S		MI	4668	2471	7800	1732	8499	1434	8963	1175	9678	743	11377	356	9416
18-#10	4.40	MA	6011	2471	9660	1805	10580	1494	11120	1241	11881	812	14360	348	12205
7L-4S		MI	4761	2471	8015	1726	8784	1419	9319	1161	10203	744	12015	408	9663
20-#10	4.88	MA	6211	2541	10121	1849	11171	1526	11840	1261	12861	806	15717	341	13600
7L-5S		MI	4806	2541	8129	1776	8921	1466	9477	1194	10378	737	12292	341	10410

RECTANGULAR TIED COLUMNS 20" x 28"

4-#11	1.11	MA	6079	2153	9618	1561	10225	1317	10430	1128	10451	846	11829	736	4178
2E		MI	4290	2153	6880	1499	7186	1264	7252	1082	7170	810	7830	677	2934
4-#14	1.61	MA	6298	2229	10155	1601	10888	1345	11227	1143	11530	836	13319	723	5862
2E		MI	4422	2229	7219	1536	7600	1289	7748	1094	7841	797	8613	642	4050
4-#18	2.86	MA	6826	2423	11463	1706	12517	1418	13194	1183	14194	810	16829	677	9970
2E		MI	4737	2423	8031	1634	8599	1356	8950	1130	9461	767	10406	540	6704
6-#9	1.07	MA	6077	2146	9560	1572	10199	1327	10419	1137	10448	856	11834	744	4053
2L-3S		MI	4202	2146	6587	1522	6854	1292	6864	1107	6649	832	7235	631	2865
6-#9	1.07	MA	5928	2146	9161	1580	9687	1334	9794	1152	9597	869	10657	678	4075
3L-2S		MI	4293	2146	6849	1516	7189	1279	7273	1096	7206	823	7970	701	2844
6-#10	1.36	MA	6213	2191	9885	1596	10603	1344	10906	1147	11107	850	12744	737	5068
2L-3S		MI	4263	2191	6730	1545	7026	1310	7069	1118	6925	826	7579	596	3553
6-#10	1.36	MA	6027	2191	9381	1606	9956	1352	10117	1165	10033	866	11258	653	5095
3L-2S		MI	4377	2191	7059	1539	7447	1295	7583	1104	7625	816	8494	686	3523
6-#11	1.67	MA	6343	2239	10228	1615	11006	1356	11383	1151	11747	840	13624	726	6115
2L-3S		MI	4320	2239	6880	1560	7186	1321	7252	1121	7170	814	7830	545	4255
6-#11	1.67	MA	6123	2239	9618	1626	10225	1365	10430	1173	10451	858	11829	619	6146
3L-2S		MI	4453	2239	7273	1553	7691	1303	7868	1105	8007	803	8894	655	4216
6-#14	2.41	MA	6669	2354	11023	1679	12001	1400	12585	1177	13376	826	15876	709	8604
2L-3S		MI	4466	2354	7219	1622	7600	1369	7748	1149	7841	801	8613	447	5890
6-#14	2.41	MA	6364	2354	10155	1694	10888	1433	11227	1207	11530	851	13319	552	8624
3L-2S		MI	4651	2354	7776	1613	8314	1345	8619	1128	9025	787	10087	605	5841

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



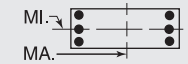
f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	4.29	MA	7455	2644	12967	1844	14444	1517	15545	1244	17394	793	21174	645	14686
2L-3S		MI	4817	2644	8031	1783	8599	1494	8950	1222	9461	766	10406	177	9717
6-#18	4.29	MA	6952	2644	11463	1868	12517	1571	13194	1293	14194	833	16829	364	14556
3L-2S		MI	5123	2644	8982	1772	9818	1456	10437	1190	11479	748	12810	458	9720
8-#8	1.13	MA	6110	2155	9622	1582	10290	1334	10535	1143	10608	857	12058	745	4264
2L-4S		MI	4209	2155	6521	1543	6778	1301	6774	1113	6544	840	7138	619	3021
8-#8	1.13	MA	5992	2155	9304	1588	9883	1340	10038	1154	9932	868	11123	693	4280
3E		MI	4242	2155	6682	1531	6986	1298	7030	1111	6876	832	7552	649	3000
8-#8	1.13	MA	5929	2155	9064	1601	9571	1352	9655	1159	9433	878	10492	663	4299
4L-2S		MI	4315	2155	6890	1527	7253	1288	7355	1102	7319	825	8143	705	2984
8-#9	1.43	MA	6253	2201	9960	1607	10712	1352	11044	1152	11298	852	13012	738	5321
2L-4S		MI	4272	2201	6647	1570	6928	1321	6952	1125	6788	836	7453	583	3740
8-#9	1.43	MA	6106	2201	9560	1615	10199	1359	10419	1167	10448	864	11834	672	5340
3E		MI	4313	2201	6849	1556	7189	1317	7273	1122	7206	827	7970	620	3713
8-#9	1.43	MA	6028	2201	9258	1631	9807	1375	9937	1173	9819	877	11037	633	5357
4L-2S		MI	4404	2201	7110	1551	7524	1304	7682	1111	7762	818	8704	690	3691
8-#10	1.81	MA	6433	2261	10390	1640	11250	1375	11695	1166	12180	844	14231	729	6663
2L-4S		MI	4352	2261	6804	1607	7118	1347	7179	1140	7098	831	7850	535	4637
8-#10	1.81	MA	6251	2261	9885	1650	10603	1384	10906	1184	11107	860	12744	645	6683
3E		MI	4403	2261	7059	1589	7447	1342	7583	1137	7625	821	8494	581	4608
8-#10	1.81	MA	6154	2261	9503	1671	10107	1403	10296	1191	10312	876	11734	595	6684
4L-2S		MI	4515	2261	7388	1583	7869	1326	8098	1123	8325	810	9409	671	4581
8-#11	2.23	MA	6605	2325	10837	1669	11788	1395	12336	1175	13044	833	15420	716	8037
2L-4S		MI	4428	2325	6967	1634	7294	1364	7381	1146	7373	818	8140	468	5540
8-#11	2.23	MA	6390	2325	10228	1680	11006	1404	11383	1196	11747	851	13624	610	8058
3E		MI	4485	2325	7273	1614	7691	1360	7868	1144	8007	807	8894	522	5512
8-#11	2.23	MA	6278	2325	9764	1705	10405	1427	10644	1204	10785	869	12391	548	8035
4L-2S		MI	4616	2325	7667	1607	8195	1342	8483	1129	8844	796	9959	632	5479
8-#14	3.21	MA	7038	2478	11890	1757	13113	1456	13942	1210	15223	816	18433	695	11329
2L-4S		MI	4621	2478	7341	1728	7751	1430	7928	1184	8126	804	9038	335	7377
8-#14	3.21	MA	6742	2478	11023	1772	12001	1489	12585	1241	13376	841	15876	539	11321
3E		MI	4698	2478	7776	1700	8314	1425	8619	1183	9025	791	10087	410	7643
8-#14	3.21	MA	6586	2478	10360	1807	11142	1501	11530	1251	12003	866	14105	448	10925
4L-2S		MI	4880	2478	8333	1691	9027	1400	9489	1162	10209	777	11560	568	7611
8-#18	5.71	MA	7596	2865	12967	2006	14444	1671	15545	1354	17394	815	21174	331	19189
3E		MI	5208	2865	8982	1921	9818	1594	10437	1282	11479	748	12810	95	12489
8-#18	5.71	MA	7343	2865	11813	2066	12949	1690	13708	1368	15002	855	18139	175	16994
4L-2S		MI	5507	2865	9932	1910	11036	1555	11923	1250	13497	730	15214	376	12707
10-#10	2.27	MA	6652	2331	10895	1684	11897	1407	12484	1185	13254	839	15718	722	8251
2L-5S		MI	4394	2331	6918	1657	7254	1394	7337	1173	7273	825	8127	468	5555
10-#10	2.27	MA	6473	2331	10390	1694	11250	1415	11695	1203	12180	855	14231	637	8264
3L-4S		MI	4491	2331	7133	1651	7539	1378	7693	1159	7798	826	8765	520	5673
10-#10	2.27	MA	6378	2331	10008	1715	10754	1435	11085	1210	11386	871	13221	587	8251
4L-3S		MI	4542	2331	7388	1633	7869	1374	8098	1156	8325	815	9409	566	5653
10-#10	2.27	MA	6224	2331	9688	1724	10328	1443	10553	1229	10597	875	12202	543	8031
5L-2S		MI	4652	2331	7717	1627	8291	1358	8612	1142	9025	805	10324	656	5630
10-#11	2.79	MA	6656	2412	10837	1734	11788	1443	12336	1220	13044	844	15420	600	9961
3L-4S		MI	4593	2412	7360	1688	7799	1403	7996	1170	8211	811	9205	445	6772
10-#11	2.79	MA	6545	2412	10373	1759	11186	1466	11597	1228	12081	862	14186	538	9920
4L-3S		MI	4649	2412	7667	1668	8195	1398	8483	1168	8844	800	9959	500	6757
10-#11	2.79	MA	6361	2412	9985	1770	10669	1475	10950	1249	11125	867	12946	480	9441
5L-2S		MI	4779	2412	8060	1661	8700	1380	9099	1152	9682	789	11023	609	6731
10-#14	4.02	MA	7116	2603	11890	1849	13113	1545	13942	1274	15223	831	18433	525	14012
3L-4S		MI	4853	2603	7897	1806	8464	1486	8798	1218	9310	794	10512	298	8995

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis

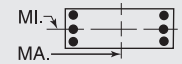


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	4.02	MA	6963	2603	11228	1885	12254	1557	12887	1285	13849	856	16661	434	13501
4L-3S		MI	4929	2603	8333	1777	9027	1481	9489	1217	10209	781	11560	373	9384
10-#14	4.02	MA	6706	2603	10673	1900	11515	1590	11963	1315	12482	861	14885	347	12729
5L-2S		MI	5107	2603	8889	1769	9741	1456	10359	1196	11394	767	13033	531	9368
10-#18	7.14	MA	7986	3087	13317	2204	14876	1789	16060	1428	18201	837	22484	143	21514
4L-3S		MI	5598	3087	9932	2059	11036	1693	11923	1342	13497	729	15214	12	15169
12-#10	2.72	MA	6694	2402	10895	1738	11897	1447	12484	1222	13254	849	15718	629	9840
3L-5S		MI	4534	2402	7247	1701	7675	1425	7851	1192	7973	819	9042	453	6534
12-#10	2.72	MA	6599	2402	10512	1759	11401	1466	11874	1230	12460	865	14708	580	9815
4E		MI	4630	2402	7462	1694	7961	1410	8207	1178	8498	820	9680	505	6704
12-#10	2.72	MA	6448	2402	10193	1768	10975	1475	11342	1248	11671	870	13688	535	9548
5L-3S		MI	4680	2402	7717	1677	8291	1405	8612	1175	9025	810	10324	551	6691
12-#10	2.72	MA	6338	2402	9867	1773	10551	1494	10814	1255	10961	886	12768	477	9244
6L-2S		MI	4790	2402	8046	1670	8712	1389	9127	1161	9725	799	11240	641	6672
12-#11	3.34	MA	6810	2498	10983	1813	11968	1505	12550	1251	13378	856	15981	529	11803
4E		MI	4757	2498	7754	1742	8303	1441	8612	1193	9048	804	10269	423	7963
12-#11	3.34	MA	6629	2498	10595	1824	11450	1514	11903	1273	12421	860	14741	470	11277
5L-3S		MI	4813	2498	8060	1722	8700	1437	9099	1191	9682	793	11023	477	7995
12-#11	3.34	MA	6498	2498	10207	1831	10935	1537	11263	1281	11560	878	13615	399	10944
6L-2S		MI	4941	2498	8454	1715	9204	1419	9714	1176	10519	782	12087	587	7976
12-#14	4.82	MA	7337	2727	12096	1962	13367	1613	14244	1319	15696	846	19218	421	16092
4E		MI	5084	2727	8454	1883	9178	1542	9668	1252	10494	785	11985	260	10628
12-#14	4.82	MA	7084	2727	11541	1977	12627	1646	13320	1349	14329	851	17441	333	15362
5L-3S		MI	5159	2727	8889	1855	9741	1537	10359	1251	11394	771	13033	336	11113
12-#14	4.82	MA	6900	2727	10995	1988	11891	1658	12404	1359	13098	876	15824	229	14377
6L-2S		MI	5335	2727	9446	1847	10454	1512	11230	1230	12578	757	14506	494	11117
14-#10	3.17	MA	6820	2472	11017	1803	12048	1498	12664	1249	13534	859	16194	572	11379
4L-5S		MI	4674	2472	7576	1745	8097	1457	8365	1211	8672	814	9957	438	7518
14-#10	3.17	MA	6670	2472	10697	1812	11622	1506	12131	1267	12744	864	15175	527	11071
5L-4S		MI	4769	2472	7791	1738	8383	1441	8722	1197	9198	814	10595	490	7728
14-#10	3.17	MA	6563	2472	10372	1817	11198	1526	11603	1274	12035	880	14254	469	10782
6L-3S		MI	4818	2472	8046	1721	8712	1437	9127	1194	9725	804	11240	536	7725
14-#10	3.17	MA	6451	2472	10011	1834	10776	1532	11099	1293	11344	896	13298	432	10385
7L-2S		MI	4926	2472	8375	1714	9134	1421	9641	1180	10425	793	12155	626	7711
14-#11	3.90	MA	6895	2584	11204	1878	12231	1553	12856	1296	13717	853	16536	461	13120
5L-4S		MI	4921	2584	8147	1796	8808	1480	9227	1217	9886	797	11333	400	9119
14-#11	3.90	MA	6768	2584	10816	1885	11717	1576	12216	1304	12856	871	15410	389	12765
6L-3S		MI	4977	2584	8454	1776	9204	1476	9714	1215	10519	786	12087	455	9229
14-#11	3.90	MA	6636	2584	10379	1904	11215	1584	11604	1326	12017	890	14244	341	12138
7L-2S		MI	5103	2584	8847	1769	9709	1458	10330	1199	11356	775	13151	564	9215
14-#14	5.63	MA	7460	2852	12409	2055	13740	1702	14677	1383	16175	841	19998	319	18003
5L-4S		MI	5314	2852	9010	1961	9891	1598	10539	1286	11679	775	13458	223	12273
14-#14	5.63	MA	7282	2852	11863	2065	13003	1714	13761	1393	14945	866	18381	215	16993
6L-3S		MI	5389	2852	9446	1933	10454	1593	11230	1285	12578	761	14506	299	12839
16-#10	3.63	MA	6892	2542	11202	1856	12268	1538	12920	1286	13818	859	16662	519	12599
5E		MI	4813	2542	7905	1789	8519	1489	8880	1230	9372	808	10872	423	8506
16-#10	3.63	MA	6787	2542	10877	1861	11845	1558	12392	1293	13109	875	15741	462	12322
6L-4S		MI	4907	2542	8120	1782	8804	1473	9236	1216	9898	809	11510	475	8751
16-#10	3.63	MA	6675	2542	10515	1878	11423	1563	11889	1312	12417	890	14785	425	11910
7L-3S		MI	4956	2542	8375	1765	9134	1468	9641	1213	10425	798	12155	521	8756
16-#10	3.63	MA	6549	2542	10198	1884	10985	1579	11393	1330	11681	895	13736	359	11528
8L-2S		MI	5063	2542	8704	1758	9556	1452	10155	1199	11125	788	13070	611	8746
16-#11	4.46	MA	7035	2671	11426	1939	12498	1615	13168	1328	14153	865	17206	380	14591
6L-4S		MI	5085	2671	8541	1850	9312	1519	9843	1240	10723	790	12398	378	10283
16-#11	4.46	MA	6904	2671	10988	1958	11996	1622	12557	1349	13314	883	16040	331	13984
7L-3S		MI	5140	2671	8847	1830	9709	1515	10330	1238	11356	779	13151	432	10457
16-#14	6.43	MA	7660	2976	12730	2143	14116	1770	15118	1427	16791	856	20937	201	19616
6L-4S		MI	5543	2976	9567	2039	10605	1653	11409	1320	12863	765	14931	186	13928

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	4.08	MA	7009	2613	11381	1905	12491	1589	13181	1313	14182	869	17228	454	13865
6L-5S		MI	4951	2613	8234	1833	8940	1520	9394	1249	10072	802	11788	408	9497
18-#10	4.08	MA	6898	2613	11020	1922	12069	1595	12678	1331	13491	885	16271	417	13439
7L-4S		MI	5044	2613	8449	1826	9226	1504	9751	1235	10598	803	12426	460	9756
18-#10	4.08	MA	6774	2613	10703	1928	11631	1611	12182	1349	12755	890	15223	351	13059
8L-3S		MI	5093	2613	8704	1809	9556	1500	10155	1233	11125	793	13070	506	9785
18-#11	5.01	MA	7171	2757	11597	2012	12777	1661	13510	1373	14610	876	17835	322	15833
7L-4S		MI	5248	2757	8934	1904	9817	1558	10458	1264	11560	783	13462	355	11452
20-#10	4.54	MA	7120	2683	11524	1965	12716	1626	13467	1350	14565	879	17758	409	14970
7L-5S		MI	5089	2683	8563	1876	9362	1552	9909	1269	10772	797	12703	393	10491
20-#10	4.54	MA	6998	2683	11207	1972	12278	1642	12971	1368	13829	884	16709	343	14584
8L-4S		MI	5182	2683	8778	1870	9648	1536	10265	1255	11298	798	13341	445	10736
22-#10	4.99	MA	7221	2753	11712	2016	12925	1674	13760	1387	14902	878	18196	335	16112
8L-5S		MI	5227	2753	8892	1920	9784	1583	10423	1288	11472	791	13618	379	11487

RECTANGULAR TIED COLUMNS 20" x 30"

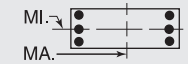
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.04	MA	6952	2294	10939	1676	11645	1415	11875	1213	11873	914	13414	795	4514
2E		MI	4573	2294	7315	1599	7628	1349	7682	1155	7562	868	8237	729	2958
4-#14	1.50	MA	7194	2371	11526	1716	12369	1443	12747	1228	13052	904	15043	783	6348
2E		MI	4705	2371	7656	1634	8041	1373	8177	1167	8232	855	9018	694	4080
4-#18	2.67	MA	7777	2564	12960	1821	14155	1516	14902	1269	15972	878	19075	753	10834
2E		MI	5020	2564	8469	1731	9039	1439	9377	1202	9849	824	10806	591	6749
6-#9	1.00	MA	6949	2288	10873	1687	11612	1425	11858	1223	11863	924	13411	804	4377
2L-3S		MI	4485	2288	7020	1623	7296	1378	7296	1182	7045	891	7647	683	2884
6-#9	1.00	MA	6785	2288	10438	1696	11055	1433	11179	1238	10939	938	12132	739	4399
3L-2S		MI	4576	2288	7282	1617	7631	1365	7705	1171	7601	883	8381	753	2864
6-#10	1.27	MA	7098	2332	11227	1711	12052	1442	12389	1232	12581	918	14403	797	5480
2L-3S		MI	4546	2332	7164	1646	7467	1396	7500	1192	7320	886	7989	648	3576
6-#10	1.27	MA	6894	2332	10678	1721	11349	1451	11531	1251	11414	935	12787	714	5507
3L-2S		MI	4660	2332	7493	1639	7889	1380	8015	1178	8020	875	8904	738	3546
6-#11	1.56	MA	7242	2381	11602	1730	12495	1454	12912	1237	13284	908	15368	786	6620
2L-3S		MI	4603	2381	7315	1659	7628	1406	7682	1195	7562	872	8237	596	4284
6-#11	1.56	MA	6999	2381	10939	1742	11645	1464	11875	1259	11873	927	13414	682	6652
3L-2S		MI	4736	2381	7708	1652	8132	1388	8298	1179	8399	862	9301	706	4245
6-#14	2.25	MA	7602	2495	12471	1794	13582	1498	14226	1262	15064	894	17829	769	9333
2L-3S		MI	4749	2495	7656	1720	8041	1453	8177	1222	8232	859	9018	498	5930
6-#14	2.25	MA	7265	2495	11526	1810	12369	1512	12747	1293	13052	920	15043	616	9353
3L-2S		MI	4934	2495	8212	1712	8755	1429	9048	1201	9416	845	10491	656	5877
6-#18	4.00	MA	8470	2786	14602	1959	16260	1615	17470	1329	19466	861	23912	728	15982
2L-3S		MI	5099	2786	8469	1880	9039	1577	9377	1294	9849	823	10806	227	9789
6-#18	4.00	MA	7914	2786	12960	1985	14155	1672	14902	1382	15972	904	19075	447	15852
3L-2S		MI	5406	2786	9419	1869	10258	1538	10864	1262	11867	806	13210	509	9771
8-#8	1.05	MA	6985	2296	10938	1697	11709	1432	11982	1228	12035	925	13652	805	4605
2L-4S		MI	4492	2296	6954	1644	7220	1388	7206	1189	6940	899	7551	672	3040
8-#8	1.05	MA	6855	2296	10593	1703	11267	1438	11443	1240	11301	936	12636	754	4621
3E		MI	4525	2296	7114	1633	7428	1384	7462	1186	7272	892	7965	702	3019
8-#8	1.05	MA	6784	2296	10334	1717	10930	1451	11028	1245	10761	947	11958	724	4640
4L-2S		MI	4598	2296	7323	1628	7695	1374	7788	1177	7716	885	8556	757	3004
8-#9	1.33	MA	7141	2343	11307	1722	12169	1450	12538	1238	12787	920	14691	798	5753
2L-4S		MI	4555	2343	7080	1671	7369	1407	7384	1200	7183	896	7865	635	3763

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis

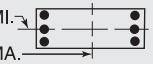


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	1.33	MA	6980	2343	10873	1730	11612	1457	11858	1253	11863	933	13411	733	5772
3E		MI	4596	2343	7282	1657	7631	1403	7705	1197	7601	887	8381	672	3735
8-#9	1.33	MA	6893	2343	10545	1747	11187	1473	11336	1260	11182	947	12554	695	5789
4L-2S		MI	4687	2343	7543	1652	7966	1390	8114	1186	8157	878	9116	743	3714
8-#10	1.69	MA	7339	2403	11775	1755	12755	1473	13247	1251	13748	912	16019	789	7212
2L-4S		MI	4635	2403	7238	1707	7559	1432	7610	1214	7493	891	8260	587	4666
8-#10	1.69	MA	7139	2403	11227	1765	12052	1482	12389	1270	12581	929	14403	706	7232
3E		MI	4686	2403	7493	1689	7889	1428	8015	1212	8020	880	8904	633	4635
8-#10	1.69	MA	7030	2403	10813	1787	11514	1503	11728	1278	11720	946	13315	657	7233
4L-2S		MI	4798	2403	7822	1683	8311	1412	8529	1198	8720	870	9820	723	4607
8-#11	2.08	MA	7530	2467	12266	1784	13345	1493	13950	1260	14695	901	17323	776	8711
2L-4S		MI	4710	2467	7402	1734	7736	1449	7811	1220	7766	877	8548	520	5579
8-#11	2.08	MA	7293	2467	11602	1796	12495	1503	12912	1283	13284	920	15368	672	8732
3E		MI	4768	2467	7708	1713	8132	1444	8298	1218	8399	866	9301	574	5546
8-#11	2.08	MA	7166	2467	11100	1821	11843	1527	12111	1292	12239	940	14040	611	8709
4L-2S		MI	4899	2467	8102	1706	8637	1426	8913	1203	9237	855	10366	684	5511
8-#14	3.00	MA	8007	2620	13417	1871	14794	1554	15705	1296	17077	884	20615	755	12301
2L-4S		MI	4904	2620	7777	1826	8191	1514	8357	1257	8517	863	9443	386	7509
8-#14	3.00	MA	7679	2620	12471	1888	13582	1568	14226	1327	15064	911	17829	602	12293
3E		MI	4981	2620	8212	1798	8755	1509	9048	1256	9416	849	10491	461	7688
8-#14	3.00	MA	7504	2620	11753	1924	12649	1602	13080	1339	13572	937	15920	513	12006
4L-2S		MI	5163	2620	8769	1790	9468	1485	9918	1235	10600	835	11965	619	7651
8-#18	5.33	MA	8623	3007	14602	2124	16260	1771	17470	1442	19466	886	23912	422	20917
3E		MI	5491	3007	9419	2018	10258	1676	10864	1354	11867	805	13210	145	12711
8-#18	5.33	MA	8334	3007	13348	2185	14633	1793	15471	1459	16863	930	20547	261	18693
4L-2S		MI	5791	3007	10370	2007	11476	1638	12350	1323	13885	787	15614	426	12763
10-#10	2.12	MA	7579	2473	12324	1799	13458	1505	14104	1270	14915	907	17635	781	8937
2L-5S		MI	4677	2473	7352	1757	7695	1480	7768	1248	7667	884	8537	520	5637
10-#10	2.12	MA	7382	2473	11775	1809	12755	1514	13247	1289	13748	924	16019	699	8950
3L-4S		MI	4774	2473	7567	1751	7981	1464	8124	1234	8193	885	9175	572	5706
10-#10	2.12	MA	7275	2473	11361	1831	12218	1534	12586	1297	12887	940	14931	650	8936
4L-3S		MI	4825	2473	7822	1733	8311	1459	8529	1231	8720	875	9820	619	5683
10-#10	2.12	MA	7106	2473	11016	1841	11757	1543	12009	1316	12032	946	13830	607	8763
5L-2S		MI	4936	2473	8151	1727	8732	1443	9044	1217	9420	864	10735	708	5658
10-#11	2.60	MA	7584	2553	12266	1850	13345	1542	13950	1306	14695	913	17323	662	10803
3L-4S		MI	4876	2553	7795	1788	8240	1488	8427	1244	8603	870	9612	497	6816
10-#11	2.60	MA	7459	2553	11763	1875	12693	1566	13148	1315	13651	933	15994	601	10762
4L-3S		MI	4932	2553	8102	1767	8637	1483	8913	1242	9237	859	10366	551	6794
10-#11	2.60	MA	7258	2553	11343	1887	12133	1576	12447	1338	12613	938	14653	546	10310
5L-2S		MI	5062	2553	8495	1760	9141	1465	9529	1226	10074	848	11430	661	6766
10-#14	3.75	MA	8090	2744	13417	1965	14794	1624	15705	1361	17077	901	20615	588	15227
3L-4S		MI	5136	2744	8333	1904	8905	1570	9227	1291	9701	853	10916	349	9123
10-#14	3.75	MA	7918	2744	12699	2002	13862	1658	14559	1373	15584	927	18706	499	14820
4L-3S		MI	5212	2744	8769	1876	9468	1565	9918	1290	10600	839	11965	424	9435
10-#14	3.75	MA	7635	2744	12097	2018	13060	1672	13557	1404	14101	934	16784	416	13914
5L-2S		MI	5391	2744	9325	1867	10182	1540	10789	1269	11785	825	13438	582	9410
10-#18	6.67	MA	9042	3228	14990	2323	16738	1892	18039	1519	20357	912	25384	236	23642
4L-3S		MI	5881	3228	10370	2156	11476	1776	12350	1414	13885	787	15614	63	15383
10-#18	6.67	MA	8564	3228	13937	2350	15336	1949	16288	1572	17767	920	22013	78	21626
5L-2S		MI	6175	3228	11320	2146	12695	1737	13836	1383	15902	769	18018	344	15739
12-#10	2.54	MA	7624	2543	12324	1853	13458	1545	14104	1309	14915	918	17635	691	10663
3L-5S		MI	4817	2543	7681	1801	8117	1511	8282	1267	8367	879	9453	506	6614
12-#10	2.54	MA	7518	2543	11910	1875	12921	1566	13443	1316	14054	935	16547	642	10638
4E		MI	4913	2543	7896	1795	8403	1495	8639	1253	8893	879	10091	557	6740
12-#10	2.54	MA	7352	2543	11564	1885	12460	1575	12867	1335	13200	940	15447	599	10415
5L-3S		MI	4963	2543	8151	1777	8732	1491	9044	1250	9420	869	10735	604	6723
12-#10	2.54	MA	7232	2543	11206	1889	12001	1595	12296	1343	12432	957	14457	542	10060
6L-2S		MI	5073	2543	8479	1771	9154	1475	9558	1236	10120	858	11650	693	6703

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis



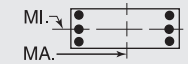
f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	3.12	MA	7750	2639	12426	1929	13543	1604	14185	1339	15062	926	17948	592	12814
4E		MI	5040	2639	8189	1841	8745	1526	9042	1267	9441	863	10676	474	8044
12-#11	3.12	MA	7552	2639	12006	1941	12983	1615	13485	1361	14025	932	16607	537	12312
5L-3S		MI	5096	2639	8495	1821	9141	1522	9529	1265	10074	852	11430	529	8035
12-#11	3.12	MA	7408	2639	11579	1947	12426	1639	12791	1370	13092	951	15396	466	11926
6L-2S		MI	5225	2639	8889	1814	9646	1504	10144	1250	10912	841	12494	638	8013
12-#14	4.50	MA	8328	2869	13644	2079	15074	1714	16038	1407	17596	918	21492	486	17649
4E		MI	5367	2869	8890	1982	9618	1626	10098	1325	10885	843	12390	312	10754
12-#14	4.50	MA	8051	2869	13043	2096	14272	1728	15036	1438	16113	925	19570	403	16788
5L-3S		MI	5442	2869	9325	1954	10182	1621	10789	1324	11785	829	13438	387	11168
12-#14	4.50	MA	7850	2869	12439	2105	13474	1761	14043	1450	14779	951	17829	300	15807
6L-2S		MI	5618	2869	9882	1945	10895	1596	11659	1303	12969	815	14911	545	11162
12-#18	8.00	MA	9277	3449	15579	2488	17441	2049	18856	1632	21261	903	26850	53	26572
5L-3S		MI	6270	3449	11320	2295	12695	1875	13836	1475	15902	768	18018	-19	17988
14-#10	2.96	MA	7760	2613	12458	1918	13624	1597	14301	1336	15221	929	18164	634	12339
4L-5S		MI	4957	2613	8010	1845	8539	1543	8797	1286	9067	873	10368	491	7597
14-#10	2.96	MA	7596	2613	12113	1929	13163	1606	13725	1355	14367	935	17063	591	12072
5L-4S		MI	5052	2613	8225	1839	8824	1527	9153	1272	9593	874	11006	542	7769
14-#10	2.96	MA	7478	2613	11755	1933	12704	1626	13154	1362	13599	952	16073	534	11733
6L-3S		MI	5101	2613	8479	1821	9154	1522	9558	1269	10120	863	11650	589	7759
14-#10	2.96	MA	7353	2613	11363	1950	12240	1632	12609	1382	12851	968	14912	484	11361
7L-2S		MI	5210	2613	8808	1815	9576	1507	10072	1255	10820	853	12565	678	7743
14-#11	3.64	MA	7844	2726	12670	1995	13833	1653	14522	1385	15436	925	18561	527	14319
5L-4S		MI	5204	2726	8583	1895	9249	1565	9657	1291	10278	856	11741	452	9224
14-#11	3.64	MA	7704	2726	12242	2001	13276	1677	13828	1393	14503	944	17350	456	13952
6L-3S		MI	5260	2726	8889	1875	9646	1561	10144	1289	10912	845	12494	506	9271
14-#11	3.64	MA	7556	2726	11767	2021	12722	1684	13166	1416	13594	964	16092	411	13289
7L-2S		MI	5387	2726	9282	1868	10150	1543	10760	1273	11749	834	13559	616	9254
14-#14	5.25	MA	8464	2993	13988	2173	15484	1783	16515	1472	18125	915	22356	389	19669
5L-4S		MI	5597	2993	9447	2060	10332	1682	10968	1359	12070	833	13863	275	12397
14-#14	5.25	MA	8269	2993	13385	2183	14686	1817	15522	1484	16791	941	20615	286	18667
6L-3S		MI	5672	2993	9882	2032	10895	1677	11659	1358	12969	819	14911	350	12896
16-#10	3.39	MA	7838	2684	12661	1972	13866	1638	14582	1374	15534	929	18679	584	13735
5E		MI	5096	2684	8339	1889	8960	1574	9311	1305	9767	867	11283	476	8585
16-#10	3.39	MA	7723	2684	12303	1977	13407	1658	14011	1382	14766	946	17689	527	13410
6L-4S		MI	5190	2684	8554	1883	9246	1558	9668	1291	10293	868	11921	527	8794
16-#10	3.39	MA	7598	2684	11911	1994	12943	1663	13467	1401	14018	963	16528	476	13023
7L-3S		MI	5239	2684	8808	1865	9576	1554	10072	1288	10820	858	12565	574	8792
16-#10	3.39	MA	7461	2684	11568	2001	12468	1680	12900	1407	13221	968	15525	428	12581
8L-2S		MI	5346	2684	9137	1859	9997	1538	10587	1274	11520	847	13481	663	8779
16-#11	4.16	MA	7997	2812	12905	2055	14126	1716	14865	1417	15914	937	19304	447	15982
6L-4S		MI	5368	2812	8976	1949	9754	1604	10273	1314	11115	849	12805	429	10386
16-#11	4.16	MA	7851	2812	12430	2075	13572	1723	14203	1439	15005	957	18046	401	15302
7L-3S		MI	5423	2812	9282	1929	10150	1599	10760	1312	11749	838	13559	484	10503
16-#14	6.00	MA	8684	3118	14330	2261	15899	1873	17001	1518	18803	932	23401	272	21533
6L-4S		MI	5827	3118	10003	2138	11045	1737	11838	1393	13254	823	15336	238	14049
18-#10	3.81	MA	7967	2754	12852	2021	14111	1689	14869	1401	15933	940	19305	519	15089
6L-5S		MI	5234	2754	8668	1933	9382	1606	9826	1324	10467	862	12198	461	9575
18-#10	3.81	MA	7843	2754	12460	2038	13646	1695	14324	1420	15185	957	18144	469	14688
7L-4S		MI	5328	2754	8883	1927	9668	1590	10182	1310	10993	863	12836	512	9816
18-#10	3.81	MA	7707	2754	12117	2045	13171	1711	13758	1426	14388	963	17141	420	14259
8L-3S		MI	5377	2754	9137	1909	9997	1585	10587	1307	11520	852	13481	559	9823

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

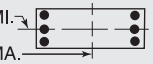
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	4.68	MA	8143	2898	13094	2129	14422	1762	15240	1463	16417	950	20000	392	17320
7L-4S		MI	5531	2898	9370	2003	10258	1642	10888	1338	11953	842	13869	407	11554
20-#10	4.23	MA	8086	2824	13009	2082	14349	1726	15182	1439	16352	952	19760	461	16356
7L-5S		MI	5372	2824	8997	1977	9804	1637	10340	1343	11167	856	13114	446	10569
20-#10	4.23	MA	7952	2824	12665	2089	13875	1743	14616	1445	15555	957	18757	413	15938
8L-4S		MI	5465	2824	9212	1971	10089	1622	10696	1329	11693	857	13752	497	10825
22-#10	4.66	MA	8196	2895	13214	2133	14578	1774	15474	1464	16723	952	20373	405	17619
8L-5S		MI	5510	2895	9326	2021	10225	1669	10855	1362	11867	851	14029	431	11564

RECTANGULAR TIED COLUMNS 20" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.41	MA	8146	2512	12977	1831	13938	1541	14355	1313	14659	972	16857	842	6834
2E		MI	4988	2512	8092	1733	8482	1457	8606	1241	8623	913	9423	745	4110
4-#18	2.50	MA	8787	2706	14538	1936	15880	1614	16699	1354	17834	946	21242	812	11698
2E		MI	5303	2706	8907	1828	9479	1522	9804	1274	10237	881	11206	641	6792
6-#10	1.19	MA	8040	2474	12649	1826	13588	1540	13960	1317	14139	986	16151	857	5891
2L-3S		MI	4829	2474	7597	1746	7909	1482	7932	1267	7715	945	8400	701	3598
6-#10	1.19	MA	7817	2474	12056	1837	12829	1549	13033	1337	12878	1004	14406	775	5918
3L-2S		MI	4943	2474	7926	1740	8331	1466	8446	1253	8415	935	9315	790	3569
6-#11	1.46	MA	8198	2522	13058	1845	14071	1552	14530	1322	14904	976	17203	845	7126
2L-3S		MI	4885	2522	7750	1759	8069	1491	8112	1269	7955	931	8644	648	4312
6-#11	1.46	MA	7933	2522	12341	1857	13151	1563	13409	1346	13378	996	15090	743	7157
3L-2S		MI	5019	2522	8144	1752	8573	1472	8728	1253	8792	920	9709	758	4272
6-#14	2.11	MA	8592	2637	14001	1909	15250	1596	15956	1347	16836	962	19872	828	10062
2L-3S		MI	5032	2637	8092	1819	8482	1537	8606	1295	8623	917	9423	549	5967
6-#14	2.11	MA	8222	2637	12977	1926	13938	1611	14355	1380	14659	990	16857	679	10082
3L-2S		MI	5217	2637	8648	1810	9196	1513	9477	1274	9807	904	10896	708	5912
6-#18	3.75	MA	9543	2927	16318	2074	18162	1713	19483	1415	21622	929	26487	788	17278
2L-3S		MI	5382	2927	8907	1977	9479	1660	9804	1366	10237	881	11206	277	9857
6-#18	3.75	MA	8933	2927	14538	2102	15880	1737	16699	1469	17834	975	21242	513	17148
3L-2S		MI	5689	2927	9857	1966	10698	1621	11290	1334	12254	863	13610	559	9821
8-#9	1.25	MA	8087	2484	12734	1837	13713	1548	14119	1323	14360	988	16460	857	6185
2L-4S		MI	4837	2484	7513	1772	7811	1493	7816	1275	7579	955	8277	687	3785
8-#9	1.25	MA	7910	2484	12265	1845	13112	1556	13386	1339	13362	1002	15079	794	6204
3E		MI	4879	2484	7715	1758	8073	1489	8137	1272	7997	947	8793	725	3757
8-#9	1.25	MA	7813	2484	11913	1863	12654	1572	12823	1346	12628	1016	14160	756	6221
4L-2S		MI	4970	2484	7976	1753	8408	1476	8546	1261	8553	938	9528	795	3736
8-#10	1.59	MA	8303	2544	13241	1870	14348	1571	14886	1337	15400	980	17897	849	7760
2L-4S		MI	4917	2544	7672	1808	8001	1518	8041	1289	7888	950	8671	639	4694
8-#10	1.59	MA	8083	2544	12649	1881	13588	1581	13960	1356	14139	998	16151	768	7780
3E		MI	4969	2544	7926	1790	8331	1513	8446	1286	8415	940	9315	686	4661
8-#10	1.59	MA	7963	2544	12203	1903	13009	1602	13248	1365	13211	1016	14987	719	7781
4L-2S		MI	5081	2544	8255	1784	8752	1498	8961	1272	9115	929	10230	775	4633
8-#11	1.95	MA	8512	2608	13775	1899	14990	1591	15652	1346	16430	969	19316	836	9385
2L-4S		MI	4993	2608	7837	1833	8177	1534	8241	1294	8158	935	8955	571	5616
8-#11	1.95	MA	8252	2608	13058	1911	14071	1602	14530	1369	14904	989	17203	734	9406
3E		MI	5051	2608	8144	1812	8573	1529	8728	1292	8792	924	9709	625	5578
8-#11	1.95	MA	8111	2608	12516	1938	13368	1626	13666	1379	13778	1010	15779	673	9383
4L-2S		MI	5183	2608	8537	1806	9078	1511	9343	1276	9629	913	10773	735	5542
8-#14	2.81	MA	9033	2761	15024	1986	16562	1652	17556	1381	19014	952	22887	815	13273
2L-4S		MI	5186	2761	8213	1925	8632	1598	8786	1331	8908	921	9848	437	7636
8-#14	2.81	MA	8675	2761	14001	2003	15250	1667	15956	1414	16836	980	19872	665	13265
3E		MI	5264	2761	8648	1897	9196	1593	9477	1329	9807	907	10896	512	7731
8-#14	2.81	MA	8479	2761	13226	2041	14244	1702	14719	1427	15226	1009	17826	577	13105
4L-2S		MI	5446	2761	9205	1888	9909	1569	10347	1308	10991	894	12369	671	7689
8-#18	5.00	MA	9707	3148	16318	2240	18162	1836	19483	1530	21622	958	26487	489	22645
3E		MI	5774	3148	9857	2115	10698	1759	11290	1426	12254	862	13610	195	12798

RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

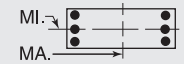
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#18	5.00	MA	9383	3148	14963	2304	16405	1895	17323	1549	18808	1004	22876	329	20417
4L-2S		MI	6074	3148	10808	2104	11916	1720	12777	1395	14272	845	16014	477	12818
10-#10	1.98	MA	8563	2614	13834	1914	15107	1603	15813	1356	16660	975	19642	841	9622
2L-5S		MI	4960	2614	7786	1858	8137	1565	8199	1322	8062	944	8948	573	5735
10-#10	1.98	MA	8348	2614	13241	1925	14348	1612	14886	1375	15400	992	17897	760	9636
3L-4S		MI	5057	2614	8001	1852	8423	1550	8556	1308	8588	945	9586	624	5738
10-#10	1.98	MA	8229	2614	12795	1946	13769	1633	14174	1384	14472	1010	16732	711	9622
4L-3S		MI	5108	2614	8255	1834	8752	1545	8961	1305	9115	934	10230	671	5712
10-#10	1.98	MA	8046	2614	12424	1957	13273	1643	13554	1404	13552	1016	15550	671	9504
5L-2S		MI	5219	2614	8584	1828	9174	1529	9475	1291	9815	924	11145	760	5686
10-#11	2.44	MA	8570	2695	13775	1965	14990	1640	15652	1393	16430	982	19316	724	11646
3L-4S		MI	5159	2695	8231	1887	8681	1572	8857	1318	8996	928	10019	549	6856
10-#11	2.44	MA	8430	2695	13233	1991	14287	1665	14787	1402	15304	1003	17892	664	11605
4L-3S		MI	5215	2695	8537	1866	9078	1568	9343	1316	9629	918	10773	603	6830
10-#11	2.44	MA	8211	2695	12781	2004	13684	1676	14033	1425	14186	1009	16451	611	11189
5L-2S		MI	5346	2695	8931	1860	9582	1550	9959	1300	10467	907	11837	713	6799
10-#14	3.52	MA	9123	2885	15024	2081	16562	1723	17556	1448	19014	970	22887	651	16442
3L-4S		MI	5418	2885	8770	2003	9346	1654	9656	1364	10092	911	11321	400	9248
10-#14	3.52	MA	8930	2885	14249	2118	15556	1758	16320	1461	17403	999	20841	563	16159
4L-3S		MI	5495	2885	9205	1974	9909	1649	10347	1363	10991	897	12369	475	9481
10-#14	3.52	MA	8622	2885	13602	2135	14692	1773	15240	1494	15804	1007	18775	485	15110
5L-2S		MI	5674	2885	9761	1966	10623	1624	11218	1342	12175	884	13843	634	9452
10-#18	6.25	MA	10156	3370	16743	2442	18687	1995	20107	1610	22597	986	28122	305	25797
4L-3S		MI	6164	3370	10808	2253	11916	1858	12777	1486	14272	844	16014	113	15593
10-#18	6.25	MA	9634	3370	15608	2470	17174	2018	18217	1665	19799	997	24492	154	23752
5L-2S		MI	6459	3370	11758	2243	13135	1820	14263	1455	16290	826	18418	395	15800
12-#10	2.38	MA	8611	2685	13834	1969	15107	1644	15813	1395	16660	987	19642	752	11486
3L-5S		MI	5100	2685	8115	1902	8559	1597	8714	1341	8762	938	9863	558	6692
12-#10	2.38	MA	8494	2685	13388	1990	14528	1665	15101	1403	15732	1004	18478	704	11461
4E		MI	5196	2685	8330	1895	8844	1581	9070	1327	9288	939	10501	609	6774
12-#10	2.38	MA	8313	2685	13016	2001	14032	1674	14480	1423	14812	1011	17295	663	11291
5L-3S		MI	5246	2685	8584	1878	9174	1577	9475	1325	9815	928	11145	656	6755
12-#10	2.38	MA	8182	2685	12625	2005	13539	1695	13866	1431	13986	1028	16236	606	10882
6L-2S		MI	5356	2685	8913	1871	9596	1561	9989	1311	10514	918	12061	745	6732
12-#11	2.92	MA	8747	2781	13950	2045	15207	1704	15909	1426	16830	996	20005	654	13825
4E		MI	5323	2781	8624	1941	9186	1611	9472	1341	9833	922	11083	526	8090
12-#11	2.92	MA	8531	2781	13498	2058	14603	1715	15154	1449	15712	1003	18564	602	13356
5L-3S		MI	5379	2781	8931	1920	9582	1607	9959	1339	10467	911	11837	580	8074
12-#11	2.92	MA	8375	2781	13031	2064	14003	1739	14407	1459	14707	1023	17268	531	12913
6L-2S		MI	5508	2781	9324	1914	10087	1589	10574	1323	11304	900	12902	690	8049
12-#14	4.22	MA	9377	3010	15273	2196	16868	1814	17920	1495	19581	989	23856	550	19227
4E		MI	5650	3010	9326	2081	10059	1710	10527	1398	11276	901	12794	363	10877
12-#14	4.22	MA	9075	3010	14625	2213	16004	1829	16840	1527	17981	997	21790	471	18225
5L-3S		MI	5725	3010	9761	2052	10623	1705	11218	1397	12175	887	13843	438	11221
12-#14	4.22	MA	8856	3010	13964	2222	15145	1864	15771	1540	16543	1026	19926	369	17261
6L-2S		MI	5902	3010	10318	2044	11336	1680	12088	1376	13360	874	15316	597	11206
12-#18	7.50	MA	10413	3591	17389	2608	19457	2118	21001	1725	23588	980	29738	130	29115
5L-3S		MI	6552	3591	11758	2392	13135	1958	14263	1547	16290	826	18418	31	18296
14-#10	2.78	MA	8757	2755	13980	2034	15288	1696	16027	1422	16993	999	20223	696	13299
4L-5S		MI	5239	2755	8444	1946	8980	1628	9228	1361	9462	933	10778	543	7674
14-#10	2.78	MA	8578	2755	13609	2045	14792	1706	15407	1442	16073	1005	19041	655	13083
5L-4S		MI	5335	2755	8659	1939	9266	1613	9585	1347	9988	933	11416	594	7806

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis

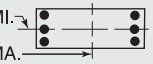


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#10	2.78	MA	8450	2755	13218	2049	14298	1727	14792	1450	15246	1023	17982	599	12691
6L-3S		MI	5385	2755	8913	1922	9596	1608	9989	1344	10514	923	12061	641	7793
14-#10	2.78	MA	8312	2755	12796	2067	13791	1731	14206	1470	14442	1040	16736	550	12350
7L-2S		MI	5493	2755	9242	1915	10017	1592	10504	1330	11214	912	12976	730	7774
14-#11	3.41	MA	8849	2867	14216	2112	15523	1753	16276	1473	17238	996	20677	592	15529
5L-4S		MI	5487	2867	9018	1995	9690	1650	10088	1365	10671	915	12148	503	9316
14-#11	3.41	MA	8697	2867	13748	2118	14923	1778	15529	1482	16233	1016	19381	522	15107
6L-3S		MI	5543	2867	9324	1974	10087	1645	10574	1363	11304	904	12902	558	9312
14-#11	3.41	MA	8533	2867	13236	2138	14316	1785	14816	1505	15255	1037	17862	460	14455
7L-2S		MI	5670	2867	9718	1968	10591	1627	11190	1347	12141	893	13966	668	9292
14-#14	4.92	MA	9525	3134	15649	2291	17316	1885	18441	1561	20159	987	24805	457	21347
5L-4S		MI	5880	3134	9883	2158	10773	1766	11397	1432	12460	891	14268	326	12517
14-#14	4.92	MA	9313	3134	14987	2300	16457	1920	17371	1574	18721	1016	22941	355	20366
6L-3S		MI	5955	3134	10318	2130	11336	1761	12088	1431	13360	877	15316	401	12952
14-#14	4.92	MA	9083	3134	14255	2329	15600	1930	16350	1607	17319	1044	21003	290	19340
7L-2S		MI	6129	3134	10875	2122	12050	1736	12958	1410	14544	864	16789	559	12954
16-#10	3.17	MA	8842	2825	14201	2089	15551	1737	16333	1461	17333	999	20786	647	14879
5E		MI	5378	2825	8773	1990	9402	1660	9743	1380	10162	927	11694	528	8661
16-#10	3.17	MA	8717	2825	13810	2093	15058	1758	15719	1469	16507	1017	19727	591	14503
6L-4S		MI	5473	2825	8988	1983	9688	1644	10099	1366	10687	928	12332	579	8835
16-#10	3.17	MA	8579	2825	13388	2111	14550	1763	15133	1489	15702	1035	18481	543	14149
7L-3S		MI	5522	2825	9242	1966	10017	1640	10504	1363	11214	917	12976	626	8827
16-#10	3.17	MA	8429	2825	13019	2118	14039	1780	14514	1495	14845	1041	17405	496	13645
8L-2S		MI	5630	2825	9571	1959	10439	1624	11018	1349	11914	907	13891	715	8812
16-#11	3.90	MA	9017	2954	14465	2172	15842	1817	16651	1506	17759	1009	21494	512	17303
6L-4S		MI	5651	2954	9411	2049	10195	1688	10703	1388	11508	908	13212	481	10486
16-#11	3.90	MA	8854	2954	13953	2192	15236	1824	15938	1529	16781	1030	19975	450	16636
7L-3S		MI	5706	2954	9718	2028	10591	1684	11190	1386	12141	897	13966	535	10546
16-#11	3.90	MA	8675	2954	13504	2201	14615	1844	15198	1536	15738	1037	18662	391	16018
8L-2S		MI	5832	2954	10111	2022	11096	1666	11805	1371	12979	886	15030	645	10532
16-#14	5.63	MA	9765	3259	16011	2378	17769	1975	18972	1608	20898	1006	25956	341	23476
6L-4S		MI	6110	3259	10439	2236	11486	1822	12267	1466	13645	881	15741	289	14168
16-#14	5.63	MA	9538	3259	15278	2407	16912	1985	17951	1641	19497	1034	24018	276	22434
7L-3S		MI	6184	3259	10875	2208	12050	1817	12958	1465	14544	868	16789	364	14679
18-#10	3.57	MA	8982	2895	14403	2137	15817	1790	16645	1489	17768	1011	21473	583	16318
6L-5S		MI	5517	2895	9101	2034	9824	1692	10257	1399	10862	921	12609	513	9651
18-#10	3.57	MA	8845	2895	13981	2155	15310	1795	16059	1508	16963	1029	20227	535	15951
7L-4S		MI	5611	2895	9316	2027	10109	1676	10613	1385	11387	922	13247	564	9859
18-#10	3.57	MA	8698	2895	13611	2162	14799	1812	15440	1514	16105	1035	19151	488	15460
8L-3S		MI	5660	2895	9571	2010	10439	1671	11018	1382	11914	912	13891	611	9859
18-#10	3.57	MA	8564	2895	13219	2181	14309	1818	14831	1530	15310	1053	18090	446	14905
9L-2S		MI	5766	2895	9900	2003	10861	1655	11533	1368	12614	901	14806	700	9847
18-#11	4.39	MA	9173	3040	14670	2246	16155	1862	17059	1552	18307	1023	22088	441	18822
7L-4S		MI	5814	3040	9805	2103	10699	1727	11318	1412	12345	901	14276	458	11653
18-#11	4.39	MA	8997	3040	14221	2255	15534	1882	16320	1560	17264	1030	20775	381	18200
8L-3S		MI	5869	3040	10111	2082	11096	1723	11805	1410	12979	890	15030	513	11778
18-#14	6.33	MA	9989	3383	16302	2485	18224	2041	19551	1675	21675	1024	27033	263	25528
7L-4S		MI	6339	3383	10996	2314	12200	1877	13138	1500	14829	871	17214	252	15826
20-#10	3.97	MA	9109	2966	14573	2198	16069	1826	16986	1527	18223	1023	21972	527	17755
7L-5S		MI	5655	2966	9430	2077	10245	1723	10772	1418	11562	916	13524	498	10644
20-#10	3.97	MA	8964	2966	14204	2206	15558	1843	16367	1533	17366	1030	20896	481	17276
8L-4S		MI	5748	2966	9645	2071	10531	1707	11128	1404	12087	916	14162	549	10881
20-#10	3.97	MA	8834	2966	13812	2225	15068	1850	15758	1550	16571	1047	19835	438	16715
9L-3S		MI	5797	2966	9900	2053	10861	1703	11533	1401	12614	906	14806	596	10890
20-#11	4.88	MA	9317	3126	14938	2309	16454	1921	17442	1583	18791	1023	22888	372	20384
8L-4S		MI	5977	3126	10198	2157	11204	1766	11934	1435	13183	894	15341	436	12826

RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	4.37	MA	9229	3036	14796	2250	16318	1875	17293	1552	18627	1024	22642	473	19094
8L-5S		MI	5793	3036	9759	2121	10667	1755	11286	1437	12262	910	14439	483	11640
22-#10	4.37	MA	9103	3036	14404	2269	15828	1881	16684	1569	17831	1042	21581	430	18525
9L-4S		MI	5885	3036	9974	2115	10953	1739	11642	1423	12787	911	15077	534	11894
24-#10	4.76	MA	9370	3106	14996	2313	16587	1913	17611	1588	19092	1036	23326	422	20334
9L-5S		MI	5931	3106	10088	2165	11089	1786	11800	1456	12961	905	15355	468	12637

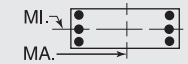
RECTANGULAR TIED COLUMNS 20" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.32	MA	9156	2653	14509	1946	15594	1639	16051	1399	16348	1040	18761	902	7320
2E		MI	5271	2653	8528	1831	8923	1541	9035	1314	9013	972	9828	796	4138
4-#18	2.35	MA	9853	2847	16196	2051	17693	1712	18584	1440	19779	1014	23498	872	12562
2E		MI	5586	2847	9345	1925	9920	1604	10231	1346	10624	939	11606	691	6834
6-#10	1.12	MA	9039	2615	14151	1941	15212	1638	15619	1403	15781	1054	17990	916	6303
2L-3S		MI	5112	2615	8031	1847	8350	1568	8363	1342	8110	1005	8810	753	3619
6-#10	1.12	MA	8796	2615	13515	1952	14396	1648	14624	1423	14427	1072	16116	837	6330
3L-2S		MI	5226	2615	8360	1840	8772	1552	8878	1328	8809	994	9726	842	3591
6-#11	1.38	MA	9211	2663	14594	1960	15734	1650	16237	1408	16609	1044	19127	905	7631
2L-3S		MI	5168	2663	8185	1858	8510	1575	8543	1343	8347	990	9052	700	4338
6-#11	1.38	MA	8923	2663	13822	1973	14746	1662	15031	1432	14968	1065	16855	805	7663
3L-2S		MI	5302	2663	8579	1851	9015	1557	9158	1327	9184	979	10116	809	4299
6-#14	1.99	MA	9639	2778	15611	2023	17006	1694	17774	1433	18692	1030	22005	888	10791
2L-3S		MI	5314	2778	8528	1917	8923	1621	9035	1369	9013	976	9828	600	6003
6-#14	1.99	MA	9237	2778	14509	2041	15594	1710	16051	1467	16348	1059	18761	742	10811
3L-2S		MI	5501	2778	9084	1909	9636	1597	9906	1348	10198	962	11301	759	5946
6-#18	3.53	MA	10675	3068	18114	2189	20152	1811	21585	1500	23861	997	29151	848	18574
2L-3S		MI	5665	3068	9345	2074	9920	1742	10231	1438	10624	938	11606	328	9922
6-#18	3.53	MA	10009	3068	16196	2218	17693	1837	18584	1557	19779	1046	23498	579	18444
3L-2S		MI	5973	3068	10295	2063	11138	1704	11717	1406	12642	920	14010	609	9870
8-#9	1.18	MA	9089	2626	14242	1952	15345	1646	15789	1409	16016	1056	18320	917	6617
2L-4S		MI	5120	2626	7946	1873	8253	1579	8248	1350	7974	1015	8689	740	3806
8-#9	1.18	MA	8897	2626	13738	1961	14699	1654	15002	1425	14945	1070	16836	855	6636
3E		MI	5162	2626	8148	1859	8514	1575	8569	1347	8392	1006	9205	777	3778
8-#9	1.18	MA	8791	2626	13361	1978	14209	1671	14398	1432	14158	1085	15857	817	6653
4L-2S		MI	5253	2626	8409	1854	8849	1562	8978	1336	8948	998	9940	847	3757
8-#10	1.49	MA	9323	2686	14787	1985	16028	1669	16615	1422	17135	1048	19865	908	8309
2L-4S		MI	5200	2686	8106	1908	8442	1604	8473	1364	8283	1010	9081	691	4721
8-#10	1.49	MA	9085	2686	14151	1996	15212	1679	15619	1442	15781	1067	17990	829	8329
3E		MI	5251	2686	8360	1890	8772	1599	8878	1361	8809	999	9726	738	4686
8-#10	1.49	MA	8952	2686	13673	2018	14591	1701	14856	1451	14786	1085	16749	781	8330
4L-2S		MI	5364	2686	8689	1884	9194	1583	9392	1347	9509	989	10641	827	4657
8-#11	1.84	MA	9551	2750	15365	2014	16723	1689	17443	1431	18249	1037	21399	895	10059
2L-4S		MI	5276	2750	8272	1932	8618	1618	8671	1368	8551	994	9362	623	5650
8-#11	1.84	MA	9269	2750	14594	2027	15734	1700	16237	1455	16609	1058	19127	795	10080
3E		MI	5333	2750	8579	1912	9015	1614	9158	1366	9184	983	10116	677	5609
8-#11	1.84	MA	9113	2750	14013	2053	14980	1726	15309	1465	15400	1079	17609	736	10057
4L-2S		MI	5466	2750	8972	1905	9519	1596	9773	1350	10022	972	11180	787	5572
8-#14	2.65	MA	10118	2902	16712	2101	18417	1750	19496	1467	21035	1020	25250	874	14245
2L-4S		MI	5469	2902	8649	2024	9073	1682	9215	1404	9298	979	10253	488	7761
8-#14	2.65	MA	9727	2902	15611	2119	17006	1766	17774	1501	18692	1049	22005	728	14237
3E		MI	5546	2902	9084	1995	9636	1677	9906	1403	10198	966	11301	563	7772
8-#14	2.65	MA	9510	2902	14779	2157	15926	1802	16447	1515	16963	1079	19822	641	14088
4L-2S		MI	5729	2902	9641	1987	10350	1653	10776	1382	11382	952	12774	722	7727

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

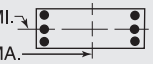


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	4.71	MA	10849	3290	18114	2357	20152	1936	21585	1617	23861	1028	29151	554	24373
3E		MI	6056	3290	10295	2212	11138	1842	11717	1498	12642	920	14010	246	12870
8-#18	4.71	MA	10489	3290	16659	2422	18264	1997	19263	1639	20837	1077	25296	397	22165
4L-2S		MI	6358	3290	11246	2201	12356	1803	13204	1467	14660	902	16414	527	12872
10-#10	1.87	MA	9605	2756	15424	2029	16843	1701	17610	1441	18489	1043	21740	901	10308
2L-5S		MI	5243	2756	8219	1958	8578	1651	8631	1397	8457	1003	9359	625	5789
10-#10	1.87	MA	9371	2756	14787	2040	16028	1711	16615	1461	17135	1061	19865	821	10321
3L-4S		MI	5340	2756	8434	1952	8864	1635	8987	1383	8982	1004	9997	676	5768
10-#10	1.87	MA	9240	2756	14310	2062	15407	1732	15851	1470	16140	1079	18623	773	10308
4L-3S		MI	5391	2756	8689	1934	9194	1631	9392	1380	9509	994	10641	723	5740
10-#10	1.87	MA	9042	2756	13912	2073	14876	1742	15187	1491	15154	1086	17360	734	10236
5L-2S		MI	5502	2756	9018	1928	9615	1615	9906	1366	10209	983	11556	812	5713
10-#11	2.29	MA	9612	2836	15365	2081	16723	1739	17443	1479	18249	1051	21399	786	12488
3L-4S		MI	5441	2836	8666	1986	9123	1657	9287	1391	9388	987	10426	600	6895
10-#11	2.29	MA	9459	2836	14784	2107	15969	1764	16515	1489	17041	1073	19881	726	12447
4L-3S		MI	5498	2836	8972	1966	9519	1653	9773	1390	10022	976	11180	654	6865
10-#11	2.29	MA	9221	2836	14300	2120	15322	1776	15707	1513	15842	1080	18340	676	12077
5L-2S		MI	5629	2836	9366	1959	10024	1635	10389	1374	10859	965	12245	764	6833
10-#14	3.31	MA	10212	3027	16712	2197	18417	1822	19496	1535	21035	1039	25250	714	17657
3L-4S		MI	5701	3027	9206	2101	9787	1738	10085	1438	10483	969	11726	451	9370
10-#14	3.31	MA	9999	3027	15880	2235	17338	1858	18169	1548	19306	1069	23066	627	17487
4L-3S		MI	5778	3027	9641	2073	10350	1733	10776	1437	11382	956	12774	526	9526
10-#14	3.31	MA	9665	3027	15187	2253	16412	1874	17011	1582	17590	1079	20856	552	16318
5L-2S		MI	5958	3027	10198	2065	11064	1709	11647	1416	12566	942	14247	685	9493
10-#18	5.88	MA	11328	3511	18577	2560	20723	2096	22264	1699	24920	1060	30949	372	27977
4L-3S		MI	6446	3511	11246	2350	12356	1941	13204	1559	14660	901	16414	163	15798
10-#18	5.88	MA	10762	3511	17360	2590	19100	2122	20235	1756	21916	1074	27062	228	25871
5L-2S		MI	6742	3511	12196	2340	13575	1902	14690	1527	16677	884	18818	445	15856
12-#10	2.24	MA	9656	2826	15424	2084	16843	1742	17610	1481	18489	1055	21740	813	12309
3L-5S		MI	5383	2826	8548	2002	9000	1683	9145	1416	9157	998	10274	610	6795
12-#10	2.24	MA	9526	2826	14946	2106	16223	1764	16847	1490	17494	1074	20498	765	12284
4E		MI	5479	2826	8763	1996	9286	1667	9502	1402	9682	998	10912	661	6807
12-#10	2.24	MA	9331	2826	14548	2117	15692	1774	16182	1510	16508	1081	19235	726	12175
5L-3S		MI	5529	2826	9018	1978	9615	1662	9906	1399	10209	988	11556	708	6785
12-#10	2.24	MA	9189	2826	14125	2121	15163	1795	15524	1519	15624	1099	18104	671	11710
6L-2S		MI	5640	2826	9347	1972	10037	1646	10421	1385	10909	977	12471	797	6761
12-#11	2.75	MA	9802	2922	15555	2161	16957	1803	17721	1513	18682	1066	22153	717	14836
4E		MI	5606	2922	9059	2040	9627	1696	9902	1415	10226	980	11491	578	8132
12-#11	2.75	MA	9568	2922	15071	2174	16311	1815	16913	1537	17483	1073	20612	666	14410
5L-3S		MI	5662	2922	9366	2020	10024	1691	10389	1413	10859	969	12245	632	8111
12-#11	2.75	MA	9399	2922	14564	2180	15668	1840	16112	1547	16407	1095	19230	597	13907
6L-2S		MI	5791	2922	9759	2013	10528	1673	11004	1397	11697	958	13309	742	8084
12-#14	3.97	MA	10484	3151	16982	2313	18750	1914	19891	1582	21649	1059	26311	613	20823
4E		MI	5933	3151	9762	2179	10500	1794	10956	1472	11667	960	13199	414	10996
12-#14	3.97	MA	10156	3151	16288	2331	17824	1930	18733	1616	19933	1069	24100	538	19674
5L-3S		MI	6008	3151	10198	2151	11064	1789	11647	1471	12566	946	14247	489	11273
12-#14	3.97	MA	9919	3151	15569	2339	16903	1965	17587	1630	18391	1099	22113	437	18739
6L-2S		MI	6186	3151	10754	2142	11777	1764	12517	1450	13751	932	15721	648	11250
12-#18	7.06	MA	11607	3732	19279	2728	21560	2221	23236	1817	25998	1056	32715	204	31651
5L-3S		MI	6835	3732	12196	2489	13575	2040	14690	1619	16677	883	18818	81	18496
14-#10	2.61	MA	9811	2896	15582	2150	17039	1795	17842	1509	18848	1068	22373	757	14259
4L-5S		MI	5522	2896	8877	2046	9422	1714	9660	1435	9857	992	11189	595	7749
14-#10	2.61	MA	9617	2896	15184	2161	16508	1805	17177	1529	17863	1075	21110	718	14102
5L-4S		MI	5618	2896	9092	2040	9707	1698	10016	1421	10382	993	11827	646	7841
14-#10	2.61	MA	9479	2896	14761	2165	15979	1826	16520	1538	16978	1093	19979	663	13655
6L-3S		MI	5668	2896	9347	2022	10037	1694	10421	1418	10909	982	12471	693	7825
14-#10	2.61	MA	9327	2896	14309	2183	15430	1831	15893	1558	16116	1112	18650	616	13353
7L-2S		MI	5777	2896	9676	2016	10459	1678	10935	1404	11609	972	13387	782	7805

RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

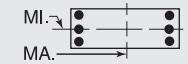
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	3.21	MA	9912	3009	15842	2228	17299	1853	18119	1560	19124	1066	22884	657	16749
5L-4S		MI	5770	3009	9453	2094	10132	1735	10518	1439	11063	974	12555	555	9364
14-#11	3.21	MA	9747	3009	15335	2234	16657	1879	17318	1570	18048	1088	21502	587	16267
6L-3S		MI	5826	3009	9759	2074	10528	1730	11004	1437	11697	963	13309	609	9352
14-#11	3.21	MA	9568	3009	14785	2255	15998	1885	16555	1594	16999	1109	19879	527	15635
7L-2S		MI	5954	3009	10153	2067	11033	1712	11620	1421	12534	952	14373	719	9330
14-#14	4.63	MA	10643	3276	17389	2408	19236	1986	20455	1650	22276	1059	27345	524	23038
5L-4S		MI	6163	3276	10319	2257	11214	1850	11826	1506	12851	950	14672	377	12635
14-#14	4.63	MA	10414	3276	16670	2417	18315	2021	19309	1664	20734	1089	25357	423	22089
6L-3S		MI	6238	3276	10754	2229	11777	1845	12517	1504	13751	936	15721	452	13006
14-#14	4.63	MA	10161	3276	15884	2447	17382	2031	18215	1698	19233	1119	23027	334	20913
7L-2S		MI	6413	3276	11311	2220	12491	1820	13388	1483	14935	922	17194	611	13000
16-#10	2.99	MA	9902	2967	15821	2205	17323	1837	18172	1548	19217	1069	22984	711	16033
5E		MI	5661	2967	9206	2090	9844	1746	10174	1455	10556	986	12104	580	8735
16-#10	2.99	MA	9767	2967	15398	2209	16794	1858	17515	1557	18332	1088	21853	655	15603
6L-4S		MI	5756	2967	9421	2084	10129	1730	10530	1440	11082	987	12742	631	8873
16-#10	2.99	MA	9616	2967	14945	2227	16245	1863	16888	1577	17470	1106	20525	608	15289
7L-3S		MI	5805	2967	9676	2066	10459	1725	10935	1438	11609	977	13387	678	8861
16-#10	2.99	MA	9455	2967	14550	2235	15698	1880	16216	1582	16552	1113	19376	563	14719
8L-2S		MI	5914	2967	10005	2060	10881	1709	11450	1424	12309	966	14302	767	8844
16-#11	3.67	MA	10093	3095	16106	2288	17646	1917	18524	1594	19688	1081	23774	577	18631
6L-4S		MI	5934	3095	9846	2148	10636	1773	11133	1462	11900	967	13619	532	10584
16-#11	3.67	MA	9915	3095	15556	2309	16986	1924	17761	1618	18640	1102	22150	518	17985
7L-3S		MI	5989	3095	10153	2128	11033	1769	11620	1460	12534	956	14373	587	10588
16-#11	3.67	MA	9721	3095	15075	2318	16321	1944	16957	1625	17523	1110	20748	460	17361
8L-2S		MI	6116	3095	10546	2121	11537	1751	12235	1444	13371	945	15437	697	10571
16-#14	5.29	MA	10904	3400	17772	2495	19727	2077	21031	1698	23078	1079	28602	409	25444
6L-4S		MI	6393	3400	10875	2335	11927	1906	12697	1540	14036	940	16146	340	14284
16-#14	5.29	MA	10654	3400	16985	2525	18794	2087	19937	1732	21576	1109	26271	320	24277
7L-3S		MI	6467	3400	11311	2306	12491	1901	13388	1538	14935	926	17194	415	14736
18-#10	3.36	MA	10054	3037	16034	2253	17610	1889	18510	1576	19686	1082	23728	648	17553
6L-5S		MI	5800	3037	9535	2134	10265	1777	10689	1474	11256	981	13019	565	9725
18-#10	3.36	MA	9903	3037	15582	2271	17061	1894	17883	1596	18824	1100	22400	600	17228
7L-4S		MI	5894	3037	9750	2128	10551	1761	11045	1460	11782	982	13657	617	9900
18-#10	3.36	MA	9744	3037	15186	2279	16513	1912	17211	1602	17907	1107	21251	556	16671
8L-3S		MI	5943	3037	10005	2110	10881	1757	11450	1457	12309	971	14302	663	9894
18-#10	3.36	MA	9599	3037	14766	2298	15989	1919	16558	1619	17055	1126	20122	513	16122
9L-2S		MI	6050	3037	10334	2104	11302	1741	11964	1443	13009	961	15217	752	9881
18-#11	4.13	MA	10259	3181	16327	2363	17975	1962	18967	1641	20281	1095	24422	508	20339
7L-4S		MI	6097	3181	10240	2202	11141	1812	11749	1486	12738	960	14684	510	11750
18-#11	4.13	MA	10069	3181	15846	2372	17309	1983	18163	1648	19164	1103	23020	451	19726
8L-3S		MI	6152	3181	10546	2182	11537	1808	12235	1484	13371	949	15437	564	11821
18-#14	5.96	MA	11142	3525	18086	2603	20206	2142	21659	1766	23919	1099	29516	307	27640
7L-4S		MI	6622	3525	11432	2413	12641	1961	13567	1574	15220	930	17619	303	15941
20-#10	3.74	MA	10189	3107	16218	2315	17877	1926	18878	1616	20178	1095	24275	593	19169
7L-5S		MI	5938	3107	9864	2178	10687	1809	11203	1493	11956	975	13935	550	10718
20-#10	3.74	MA	10032	3107	15822	2322	17329	1943	18206	1621	19261	1102	23126	548	18625
8L-4S		MI	6031	3107	10079	2172	10973	1793	11559	1479	12482	976	14573	602	10924
20-#10	3.74	MA	9892	3107	15402	2342	16805	1950	17554	1638	18409	1120	21996	505	18066
9L-3S		MI	6080	3107	10334	2154	11302	1788	11964	1476	13009	965	15217	648	10925
20-#10	3.74	MA	9726	3107	14992	2348	16279	1969	16918	1655	17561	1138	20852	467	17427
10L-2S		MI	6186	3107	10663	2148	11724	1773	12479	1462	13709	955	16132	737	10915

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

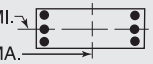
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	4.59	MA	10415	3268	16617	2426	18298	2022	19369	1672	20805	1096	25292	441	22079
8L-4S		MI	6260	3268	10633	2256	11645	1851	12364	1509	13575	953	15748	487	12921
22-#10	4.11	MA	10319	3177	16459	2366	18145	1975	19201	1640	20615	1096	25001	540	20580
8L-5S		MI	6076	3177	10193	2222	11109	1840	11717	1512	12656	970	14850	535	11713
22-#10	4.11	MA	10182	3177	16038	2386	17620	1982	18549	1657	19763	1114	23871	498	20010
9L-4S		MI	6169	3177	10408	2216	11394	1824	12074	1498	13182	970	15488	587	11946
22-#10	4.11	MA	10017	3177	15628	2392	17094	2001	17913	1675	18915	1132	22727	459	19375
10L-3S		MI	6217	3177	10663	2198	11724	1820	12479	1495	13709	960	16132	633	11956
24-#10	4.48	MA	10471	3248	16675	2430	18436	2013	19544	1676	21117	1109	25746	490	21953
9L-5S		MI	6214	3248	10522	2266	11530	1872	12232	1531	13356	964	15765	520	12710
24-#10	4.48	MA	10307	3248	16265	2436	17910	2032	18908	1694	20269	1126	24602	451	21323
10L-4S		MI	6306	3248	10737	2259	11816	1856	12588	1517	13882	965	16403	572	12962

RECTANGULAR TIED COLUMNS 20" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.25	MA	10223	2795	16122	2061	17337	1737	17836	1484	18122	1108	20755	962	7806
2E		MI	5554	2795	8964	1930	9364	1625	9464	1387	9404	1030	10233	847	4166
4-#18	2.22	MA	10978	2989	17934	2165	19593	1810	20558	1525	21807	1082	25845	932	13426
2E		MI	5869	2989	9783	2022	10360	1687	10658	1418	11012	996	12005	742	6876
6-#10	1.06	MA	10095	2757	15734	2056	16923	1736	17367	1488	17506	1122	19920	976	6714
2L-3S		MI	5395	2757	8465	1947	8792	1653	8795	1417	8504	1064	9221	805	3639
6-#10	1.06	MA	9833	2757	15054	2067	16051	1746	16303	1509	16059	1141	17915	897	6741
3L-2S		MI	5509	2757	8794	1941	9214	1638	9309	1403	9204	1054	10136	894	3612
6-#11	1.30	MA	10281	2805	16210	2075	17485	1748	18031	1493	18396	1112	21142	965	8136
2L-3S		MI	5451	2805	8620	1957	8952	1660	8973	1416	8740	1049	9459	751	4364
6-#11	1.30	MA	9969	2805	15385	2088	16427	1760	16741	1518	16641	1134	18711	866	8168
3L-2S		MI	5585	2805	9014	1951	9456	1642	9588	1401	9577	1038	10523	861	4326
6-#14	1.88	MA	10744	2919	17301	2138	18849	1792	19680	1518	20631	1098	24229	948	11520
2L-3S		MI	5597	2919	8964	2016	9364	1706	9464	1442	9404	1034	10233	652	6038
6-#14	1.88	MA	10309	2919	16122	2157	17337	1809	17836	1553	18122	1129	20755	804	11540
3L-2S		MI	5784	2919	9521	2008	10077	1681	10335	1421	10589	1020	11706	810	5979
6-#18	3.33	MA	11864	3210	19991	2304	22230	1909	23775	1585	26184	1065	31905	907	19870
2L-3S		MI	5947	3210	9783	2171	10360	1825	10658	1510	11012	995	12005	378	9982
6-#18	3.33	MA	11142	3210	17934	2335	19593	1936	20558	1644	21807	1116	25845	643	19740
3L-2S		MI	6256	3210	10733	2160	11578	1786	12144	1479	13029	978	14409	660	9918
8-#9	1.11	MA	10148	2767	15830	2067	17064	1744	17547	1494	17756	1124	20269	977	7049
2L-4S		MI	5403	2767	8379	1974	8694	1665	8680	1425	8369	1075	9101	792	3826
8-#9	1.11	MA	9941	2767	15292	2076	16374	1752	16706	1511	16611	1139	18684	916	7068
3E		MI	5445	2767	8581	1960	8956	1661	9001	1422	8788	1066	9617	829	3799
8-#9	1.11	MA	9825	2767	14889	2094	15851	1770	16062	1518	15726	1145	17644	878	7085
4L-2S		MI	5536	2767	8843	1955	9291	1649	9410	1411	9344	1057	10351	900	3778
8-#10	1.41	MA	10400	2827	16414	2100	17795	1767	18431	1508	18954	1116	21924	968	8858
2L-4S		MI	5483	2827	8539	2009	8884	1689	8904	1439	8677	1069	9492	744	4746
8-#10	1.41	MA	10143	2827	15734	2111	16923	1778	17367	1528	17506	1135	19920	890	8878
3E		MI	5534	2827	8794	1991	9214	1685	9309	1436	9204	1059	10136	790	4710
8-#10	1.41	MA	9998	2827	15224	2134	16261	1799	16553	1538	16387	1143	18601	842	8879
4L-2S		MI	5648	2827	9123	1985	9635	1669	9823	1422	9904	1048	11051	879	4682
8-#11	1.73	MA	10648	2891	17035	2129	18542	1787	19321	1517	20152	1105	23573	955	10733
2L-4S		MI	5559	2891	8707	2032	9059	1703	9101	1442	8943	1053	9769	674	5683
8-#11	1.73	MA	10342	2891	16210	2142	17485	1799	18031	1541	18396	1127	21142	857	10754
3E		MI	5616	2891	9014	2011	9456	1699	9588	1440	9577	1042	10523	729	5640
8-#11	1.73	MA	10172	2891	15590	2169	16680	1825	17041	1552	17106	1149	19529	798	10731
4L-2S		MI	5749	2891	9407	2005	9960	1681	10204	1424	10414	1031	11587	838	5602
8-#14	2.50	MA	11259	3044	18480	2216	20360	1848	21524	1552	23139	1088	27702	934	15217
2L-4S		MI	5752	3044	9085	2122	9514	1766	9644	1477	9689	1038	10657	539	7846
8-#14	2.50	MA	10837	3044	17301	2235	18849	1865	19680	1587	20631	1119	24229	790	15209
3E		MI	5829	3044	9521	2094	10077	1761	10335	1476	10589	1024	11706	615	7812

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

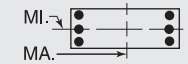
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.50	MA	10599	3044	16413	2273	17696	1902	18262	1602	18784	1150	21909	704	15060
4L-2S		MI	6013	3044	10077	2085	10791	1737	11205	1455	11773	1010	13179	773	7764
8-#18	4.44	MA	12049	3431	19991	2473	22230	2036	23775	1705	26184	1099	31905	619	26101
3E		MI	6339	3431	10733	2309	11578	1924	12144	1570	13029	977	14409	296	12939
8-#18	4.44	MA	11653	3431	18435	2539	20210	2098	21292	1728	22950	1150	27806	463	23937
4L-2S		MI	6641	3431	11684	2298	12797	1886	13631	1539	15047	959	16813	577	12925
10-#10	1.76	MA	10704	2897	17094	2144	18667	1799	19495	1527	20401	1111	23928	960	10994
2L-5S		MI	5526	2897	8653	2059	9020	1737	9062	1472	8851	1063	9769	677	5823
10-#10	1.76	MA	10451	2897	16414	2155	17795	1809	18431	1547	18954	1130	21924	882	11007
3L-4S		MI	5623	2897	8868	2053	9306	1721	9419	1458	9377	1064	10407	729	5797
10-#10	1.76	MA	10308	2897	15905	2178	17133	1831	17617	1557	17835	1137	20605	834	10994
4L-3S		MI	5673	2897	9123	2035	9635	1716	9823	1455	9904	1053	11051	775	5767
10-#10	1.76	MA	10095	2897	15477	2188	16567	1841	16908	1577	16841	1156	19260	797	10922
5L-2S		MI	5785	2897	9452	2029	10057	1701	10338	1441	10604	1043	11967	864	5740
10-#11	2.17	MA	10712	2977	17035	2196	18542	1838	19321	1565	20152	1120	23573	847	13330
3L-4S		MI	5724	2977	9101	2086	9564	1742	9717	1465	9781	1046	10834	652	6932
10-#11	2.17	MA	10544	2977	16415	2223	17737	1863	18331	1576	18862	1142	21960	788	13289
4L-3S		MI	5781	2977	9407	2065	9960	1738	10204	1463	10414	1035	11587	706	6899
10-#11	2.17	MA	10288	2977	15899	2237	17048	1875	17469	1600	17583	1150	20319	740	12974
5L-2S		MI	5912	2977	9801	2059	10465	1719	10819	1448	11252	1024	12652	816	6865
10-#14	3.13	MA	11359	3168	18480	2313	20360	1921	21524	1621	23139	1109	27702	776	18872
3L-4S		MI	5984	3168	9642	2200	10228	1822	10514	1511	10874	1028	12131	502	9489
10-#14	3.13	MA	11126	3168	17592	2351	19207	1958	20106	1636	21292	1140	25382	690	18702
4L-3S		MI	6060	3168	10077	2172	10791	1817	11205	1510	11773	1014	13179	578	9570
10-#14	3.13	MA	10766	3168	16852	2370	18220	1974	18870	1671	19460	1151	23028	618	17537
5L-2S		MI	6241	3168	10634	2163	11504	1793	12076	1489	12957	1000	14652	736	9534
10-#18	5.56	MA	12557	3652	20492	2678	22847	2198	24509	1789	27327	1132	33866	439	30181
4L-3S		MI	6729	3652	11684	2447	12797	2024	13631	1631	15047	959	16813	214	15880
10-#18	5.56	MA	11947	3652	19193	2709	21114	2225	22341	1848	24116	1149	29723	301	28028
5L-2S		MI	7026	3652	12634	2437	14015	1985	15117	1599	17065	941	19217	495	15912
12-#10	2.12	MA	10757	2968	17094	2199	18667	1841	19495	1566	20401	1124	23928	874	13132
3L-5S		MI	5666	2968	8982	2103	9442	1768	9577	1491	9551	1057	10684	662	6856
12-#10	2.12	MA	10616	2968	16585	2222	18005	1863	18681	1576	19282	1132	22609	827	13107
4E		MI	5762	2968	9197	2096	9727	1753	9933	1477	10077	1058	11322	714	6839
12-#10	2.12	MA	10405	2968	16157	2232	17439	1873	17972	1597	18289	1150	21264	789	13026
5L-3S		MI	5812	2968	9452	2079	10057	1748	10338	1474	10604	1047	11967	760	6814
12-#10	2.12	MA	10253	2968	15705	2237	16869	1894	17271	1606	17345	1169	20061	735	12544
6L-2S		MI	5923	2968	9781	2072	10479	1732	10852	1460	11304	1037	12882	849	6790
12-#11	2.60	MA	10913	3064	17240	2277	18795	1902	19622	1599	20617	1135	24391	779	15847
4E		MI	5889	3064	9495	2140	10068	1781	10332	1489	10618	1039	11898	629	8173
12-#11	2.60	MA	10661	3064	16724	2291	18106	1914	18759	1624	19338	1144	22750	730	15473
5L-3S		MI	5945	3064	9801	2119	10465	1776	10819	1487	11252	1028	12652	683	8148
12-#11	2.60	MA	10479	3064	16177	2296	17421	1940	17906	1635	18190	1166	21281	662	14906
6L-2S		MI	6075	3064	10194	2112	10969	1758	11434	1471	12089	1017	13716	793	8119
12-#14	3.75	MA	11648	3293	18771	2429	20719	2013	21950	1670	23801	1130	28856	676	22347
4E		MI	6215	3293	10198	2278	10941	1878	11385	1545	12058	1018	13604	465	11113
12-#14	3.75	MA	11295	3293	18031	2448	19731	2030	20714	1704	21969	1141	26501	604	21134
5L-3S		MI	6291	3293	10634	2249	11504	1873	12076	1544	12957	1004	14652	541	11318
12-#14	3.75	MA	11040	3293	17255	2456	18749	2067	19491	1719	20323	1172	24391	504	20239
6L-2S		MI	6469	3293	11190	2241	12218	1848	12946	1523	14141	990	16125	699	11293
12-#18	6.67	MA	12858	3874	21250	2847	23751	2324	25558	1908	28493	1131	35784	277	34225
5L-3S		MI	7118	3874	12634	2585	14015	2123	15117	1691	17065	940	19217	132	18692
12-#18	6.67	MA	12426	3874	19915	2863	22027	2387	23412	1931	25606	1182	32050	96	31345
6L-2S		MI	7410	3874	13584	2575	15234	2084	16604	1659	19083	923	21621	413	18886

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis

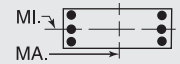


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.47	MA	10922	3038	17265	2266	18877	1894	19744	1595	20730	1126	24613	819	15219
4L-5S		MI	5805	3038	9311	2147	9863	1800	10091	1510	10251	1052	11600	647	7855
14-#10	2.47	MA	10714	3038	16837	2276	18311	1904	19036	1616	19736	1145	23269	781	15129
5L-4S		MI	5901	3038	9526	2140	10149	1784	10448	1496	10777	1052	12238	699	7875
14-#10	2.47	MA	10565	3038	16386	2281	17741	1925	18335	1625	18793	1164	22065	727	14624
6L-3S		MI	5951	3038	9781	2123	10479	1779	10852	1493	11304	1042	12882	745	7856
14-#10	2.47	MA	10400	3038	15903	2299	17156	1930	17664	1646	17817	1171	20656	681	14296
7L-2S		MI	6060	3038	10110	2116	10900	1764	11367	1479	12004	1031	13797	834	7835
14-#11	3.03	MA	11032	3150	17549	2344	19164	1953	20050	1647	21094	1137	25181	721	17978
5L-4S		MI	6053	3150	9888	2194	10573	1819	10948	1512	11456	1032	12962	607	9407
14-#11	3.03	MA	10854	3150	17002	2350	18479	1979	19196	1658	19946	1159	23712	652	17434
6L-3S		MI	6109	3150	10194	2173	10969	1815	11434	1511	12089	1021	13716	661	9390
14-#11	3.03	MA	10659	3150	16415	2371	17767	1985	18382	1683	18827	1181	21986	594	16829
7L-2S		MI	6237	3150	10588	2166	11474	1797	12050	1495	12926	1010	14780	771	9366
14-#14	4.38	MA	11819	3417	19210	2525	21243	2086	22558	1738	24478	1131	29975	590	24739
5L-4S		MI	6446	3417	10755	2356	11655	1934	12255	1579	13242	1008	15077	428	12749
14-#14	4.38	MA	11572	3417	18434	2533	20261	2123	21335	1753	22832	1162	27865	490	23828
6L-3S		MI	6521	3417	11190	2327	12218	1929	12946	1578	14141	994	16125	503	13059
14-#14	4.38	MA	11297	3417	17593	2564	19252	2131	20168	1788	21230	1193	25384	404	22502
7L-2S		MI	6697	3417	11747	2319	12931	1904	13817	1557	15326	980	17599	662	13045
14-#18	7.78	MA	13345	4095	21972	3001	24664	2486	26629	1992	29983	1165	38110	71	37586
6L-3S		MI	7506	4095	13584	2724	15234	2222	16604	1751	19083	922	21621	49	21416
16-#10	2.82	MA	11020	3108	17517	2320	19183	1936	20100	1635	21184	1139	25273	773	17196
5E		MI	5944	3108	9640	2191	10285	1831	10606	1529	10951	1046	12515	632	8808
16-#10	2.82	MA	10875	3108	17066	2325	18614	1957	19399	1644	20240	1158	24070	720	16708
6L-4S		MI	6039	3108	9855	2184	10571	1816	10962	1515	11477	1047	13153	684	8908
16-#10	2.82	MA	10711	3108	16583	2343	18028	1962	18728	1665	19264	1166	22660	673	16391
7L-3S		MI	6089	3108	10110	2167	10900	1811	11367	1512	12004	1036	13797	730	8894
16-#10	2.82	MA	10532	3108	16161	2351	17443	1980	18006	1670	18344	1184	21438	629	15804
8L-2S		MI	6197	3108	10438	2160	11322	1795	11881	1498	12704	1026	14712	820	8876
16-#11	3.47	MA	11227	3236	17827	2404	19536	2018	20486	1682	21701	1152	26143	643	19965
6L-4S		MI	6217	3236	10282	2248	11077	1858	11563	1536	12293	1025	14027	584	10638
16-#11	3.47	MA	11032	3236	17240	2425	18825	2023	19673	1706	20583	1174	24417	584	19349
7L-3S		MI	6272	3236	10588	2227	11474	1854	12050	1534	12926	1014	14780	638	10628
16-#11	3.47	MA	10824	3236	16726	2435	18114	2045	18804	1713	19392	1182	22925	529	18643
8L-2S		MI	6399	3236	10982	2220	11978	1836	12665	1518	13764	1004	15845	748	10609
16-#14	5.00	MA	12100	3542	19613	2611	21772	2179	23179	1787	25341	1152	31338	476	27416
6L-4S		MI	6676	3542	11312	2433	12368	1990	13126	1613	14426	998	16550	391	14397
16-#14	5.00	MA	11827	3542	18772	2642	20764	2187	22012	1822	23739	1183	28857	390	26104
7L-3S		MI	6750	3542	11747	2405	12931	1985	13817	1612	15326	984	17599	466	14791
16-#14	5.00	MA	11534	3542	18037	2655	19746	2217	20782	1832	22032	1194	26714	308	24644
8L-2S		MI	6924	3542	12303	2397	13645	1960	14687	1591	16510	970	19072	625	14792
18-#10	3.17	MA	11183	3178	17746	2369	19486	1988	20463	1663	21688	1152	26074	712	18795
6L-5S		MI	6083	3178	9969	2235	10707	1863	11120	1548	11651	1040	13430	617	9797
18-#10	3.17	MA	11019	3178	17263	2387	18900	1993	19792	1684	20712	1160	24664	665	18487
7L-4S		MI	6177	3178	10184	2228	10992	1847	11476	1534	12177	1041	14068	669	9940
18-#10	3.17	MA	10845	3178	16841	2395	18315	2011	19070	1689	19791	1179	23442	622	17893
8L-3S		MI	6226	3178	10438	2211	11322	1843	11881	1532	12704	1031	14712	715	9929
18-#10	3.17	MA	10692	3178	16389	2415	17756	2019	18374	1706	18884	1198	22244	580	17353
9L-2S		MI	6334	3178	10767	2204	11744	1827	12396	1517	13404	1020	15628	805	9914
18-#11	3.90	MA	11403	3323	18065	2479	19882	2062	20963	1730	22339	1167	26848	575	21871
7L-4S		MI	6380	3323	10675	2301	11582	1897	12179	1559	13130	1019	15091	561	11845
18-#11	3.90	MA	11199	3323	17551	2489	19172	2083	20094	1736	21148	1176	25355	519	21174
8L-3S		MI	6435	3323	10982	2281	11978	1892	12665	1558	13764	1008	15845	616	11863
18-#11	3.90	MA	11011	3323	17007	2513	18491	2092	19247	1757	20043	1198	23887	467	20275
9L-2S		MI	6561	3323	11375	2274	12483	1874	13281	1542	14601	997	16909	726	11848
18-#14	5.63	MA	12352	3666	19951	2720	22275	2243	23856	1856	26247	1173	32331	377	29706
7L-4S		MI	6905	3666	11868	2511	13082	2046	13996	1647	15611	988	18024	354	16052

RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	5.63	MA	12066	3666	19216	2733	21257	2273	22626	1866	24541	1184	30188	294	28225
8L-3S		MI	6979	3666	12303	2483	13645	2041	14687	1646	16510	974	19072	429	16519
20-#10	3.53	MA	11326	3249	17943	2431	19772	2025	20855	1703	22159	1154	26668	657	20586
7L-5S		MI	6221	3249	10298	2278	11128	1895	11634	1568	12351	1035	14345	602	10789
20-#10	3.53	MA	11158	3249	17521	2439	19188	2043	20134	1708	21239	1173	25446	614	19983
8L-4S		MI	6315	3249	10513	2272	11414	1879	11991	1553	12877	1035	14983	654	10965
20-#10	3.53	MA	11006	3249	17069	2458	18628	2050	19438	1726	20332	1192	24249	572	19432
9L-3S		MI	6364	3249	10767	2254	11744	1874	12396	1551	13404	1025	15628	700	10961
20-#10	3.53	MA	10826	3249	16632	2464	18068	2070	18760	1744	19358	1198	23032	535	18758
10L-2S		MI	6470	3249	11096	2248	12165	1858	12910	1537	14104	1014	16543	790	10949
20-#11	4.33	MA	11571	3409	18376	2543	20229	2122	21385	1760	22903	1169	27786	510	23706
8L-4S		MI	6544	3409	11069	2355	12086	1935	12794	1583	13968	1012	16155	539	13015
20-#11	4.33	MA	11390	3409	17832	2567	19549	2131	20538	1781	21798	1191	26318	457	22793
9L-3S		MI	6598	3409	11375	2335	12483	1931	13281	1581	14601	1001	16909	593	13095
20-#14	6.25	MA	12594	3791	20395	2811	22769	2329	24469	1900	27049	1174	33661	280	31806
8L-4S		MI	7134	3791	12425	2589	13795	2101	14867	1681	16795	978	19497	317	17715
22-#10	3.88	MA	11466	3319	18202	2483	20060	2074	21198	1727	22686	1168	27450	606	22076
8L-5S		MI	6359	3319	10627	2322	11550	1926	12149	1587	13051	1029	15260	587	11784
22-#10	3.88	MA	11318	3319	17750	2502	19500	2082	20502	1745	21779	1186	26253	564	21510
9L-4S		MI	6452	3319	10842	2316	11836	1910	12505	1573	13577	1030	15898	639	11989
22-#10	3.88	MA	11139	3319	17312	2508	18940	2101	19824	1763	20805	1192	25036	527	20841
10L-3S		MI	6501	3319	11096	2298	12165	1906	12910	1570	14104	1019	16543	685	11992
22-#11	4.77	MA	11766	3495	18657	2621	20607	2170	21828	1804	23554	1184	28749	448	25312
9L-4S		MI	6706	3495	11462	2409	12591	1974	13410	1607	14805	1005	17220	516	14190
24-#10	4.23	MA	11628	3389	18430	2546	20372	2114	21566	1764	23227	1181	28257	557	23588
9L-5S		MI	6497	3389	10956	2366	11972	1958	12663	1606	13751	1023	16176	572	12781
24-#10	4.23	MA	11450	3389	17992	2552	19812	2133	20888	1782	22253	1187	27040	519	22893
10L-4S		MI	6589	3389	11171	2360	12257	1942	13020	1592	14277	1024	16814	624	13012

RECTANGULAR TIED COLUMNS 20" x 38"

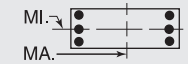
4-#14	1.18	MA	11347	2936	17815	2176	19168	1835	19709	1570	19979	1176	22840	1021	8292
2E		MI	5837	2936	9400	2028	9805	1709	9894	1460	9795	1088	10637	898	4194
4-#18	2.11	MA	12159	3130	19753	2280	21580	1908	22619	1611	23920	1151	28282	991	14290
2E		MI	6152	3130	10220	2119	10800	1770	11085	1490	11399	1053	12405	792	6916
6-#10	1.00	MA	11207	2898	17397	2171	18721	1834	19203	1574	19315	1190	21939	1036	7126
2L-3S		MI	5678	2898	8899	2048	9234	1739	9226	1491	8899	1124	9632	857	3659
6-#10	1.00	MA	10926	2898	16673	2183	17793	1845	18071	1595	17774	1209	19805	958	7153
3L-2S		MI	5792	2898	9228	2041	9655	1723	9740	1477	9599	1113	10547	947	3633
6-#11	1.23	MA	11408	2946	17907	2190	19323	1846	19914	1579	20268	1180	23247	1024	8642
2L-3S		MI	5734	2946	9056	2057	9393	1745	9403	1490	9132	1108	9866	803	4389
6-#11	1.23	MA	11073	2946	17028	2204	18196	1859	18539	1604	18398	1202	20657	928	8673
3L-2S		MI	5868	2946	9449	2050	9897	1727	10018	1475	9969	1097	10930	913	4351
6-#14	1.78	MA	11905	3061	19072	2253	20779	1890	21674	1604	22653	1166	26542	1007	12249
2L-3S		MI	5880	3061	9400	2115	9805	1790	9894	1515	9795	1092	10637	703	6071
6-#14	1.78	MA	11437	3061	17815	2273	19168	1908	19709	1639	19979	1198	22840	866	12269
3L-2S		MI	6067	3061	9957	2106	10518	1765	10764	1494	10979	1079	12111	861	6012
6-#18	3.16	MA	13111	3351	21948	2419	24394	2007	26053	1671	28591	1133	34750	967	21166
2L-3S		MI	6230	3351	10220	2267	10800	1908	11085	1582	11399	1053	12405	428	10038
6-#18	3.16	MA	12333	3351	19753	2451	21580	2036	22619	1731	23920	1186	28282	708	21036
3L-2S		MI	6539	3351	11171	2257	12018	1869	12571	1551	13417	1035	14809	710	9965

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

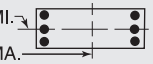


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	1.05	MA	11264	2909	17499	2182	18870	1842	19394	1580	19580	1192	22309	1036	7481
2L-4S		MI	5686	2909	8812	2075	9136	1751	9112	1500	8765	1134	9512	845	3845
8-#9	1.05	MA	11042	2909	16926	2191	18136	1851	18498	1596	18361	1207	20622	976	7500
3E		MI	5728	2909	9014	2061	9398	1747	9433	1497	9183	1126	10029	882	3818
8-#9	1.05	MA	10917	2909	16498	2209	17580	1868	17814	1604	17421	1214	19521	939	7517
4L-2S		MI	5819	2909	9276	2056	9733	1735	9842	1486	9739	1117	10763	952	3798
8-#10	1.34	MA	11535	2968	18121	2215	19649	1866	20336	1593	20856	1184	24073	1028	9406
2L-4S		MI	5766	2968	8973	2109	9326	1775	9336	1513	9072	1129	9902	796	4770
8-#10	1.34	MA	11258	2968	17397	2227	18721	1876	19203	1614	19315	1204	21939	950	9426
3E		MI	5817	2968	9228	2091	9655	1771	9740	1510	9599	1118	10547	842	4734
8-#10	1.34	MA	11101	2968	16856	2249	18018	1898	18338	1624	18126	1212	20543	903	9427
4L-2S		MI	5931	2968	9556	2085	10077	1755	10255	1496	10299	1108	11462	932	4705
8-#11	1.64	MA	11801	3033	18786	2244	20449	1885	21289	1602	22138	1173	25837	1015	11407
2L-4S		MI	5842	3033	9143	2131	9501	1788	9532	1516	9336	1112	10177	726	5714
8-#11	1.64	MA	11472	3033	17907	2258	19323	1897	19914	1627	20268	1196	23247	918	11427
3E		MI	5899	3033	9449	2111	9897	1784	10018	1514	9969	1101	10930	780	5669
8-#11	1.64	MA	11287	3033	17248	2285	18467	1924	18861	1639	18821	1205	21539	859	11405
4L-2S		MI	6032	3033	9843	2104	10402	1765	10634	1498	10807	1090	11995	890	5631
8-#14	2.37	MA	12459	3185	20328	2331	22390	1946	23640	1638	25328	1156	30245	994	16189
2L-4S		MI	6035	3185	9521	2221	9955	1850	10073	1550	10080	1096	11062	590	7892
8-#14	2.37	MA	12003	3185	19072	2350	20779	1964	21674	1673	22653	1188	26542	852	16181
3E		MI	6112	3185	9957	2192	10518	1845	10764	1549	10979	1082	12111	666	7851
8-#14	2.37	MA	11744	3185	18127	2390	19553	2001	20166	1689	20688	1220	24086	767	16032
4L-2S		MI	6296	3185	10513	2184	11232	1821	11634	1528	12164	1069	13584	824	7801
8-#18	4.21	MA	13306	3573	21948	2589	24394	2135	26053	1792	28591	1169	34750	683	27829
3E		MI	6622	3573	11171	2406	12018	2007	12571	1642	13417	1034	14809	346	13006
8-#18	4.21	MA	12874	3573	20292	2657	22244	2199	23409	1817	25147	1222	30407	529	25730
4L-2S		MI	6925	3573	12121	2395	13237	1968	14058	1611	15435	1017	17213	628	12977
10-#10	1.67	MA	11860	3039	18845	2259	20578	1897	21468	1612	22397	1179	26206	1020	11680
2L-5S		MI	5809	3039	9087	2159	9462	1823	9494	1547	9246	1122	10180	729	5854
10-#10	1.67	MA	11588	3039	18121	2270	19649	1908	20336	1633	20856	1198	24073	943	11693
3L-4S		MI	5906	3039	9302	2153	9747	1807	9850	1532	9772	1123	10818	781	5824
10-#10	1.67	MA	11433	3039	17580	2293	18946	1930	19470	1643	19667	1206	22677	895	11680
4L-3S		MI	5956	3039	9556	2135	10077	1802	10255	1530	10299	1113	11462	827	5793
10-#10	1.67	MA	11204	3039	17122	2304	18345	1940	18718	1664	18611	1226	21251	859	11608
5L-2S		MI	6069	3039	9885	2129	10499	1786	10769	1516	10999	1102	12377	917	5765
10-#11	2.05	MA	11869	3119	18786	2311	20449	1936	21289	1651	22138	1189	25837	908	14173
3L-4S		MI	6007	3119	9536	2185	10005	1827	10147	1539	10173	1105	11241	703	6968
10-#11	2.05	MA	11686	3119	18127	2339	19593	1962	20236	1662	20691	1198	24129	850	14132
4L-3S		MI	6064	3119	9843	2165	10402	1822	10634	1537	10807	1094	11995	758	6931
10-#11	2.05	MA	11412	3119	17575	2352	18861	1975	19319	1687	19407	1221	22389	803	13880
5L-2S		MI	6195	3119	10236	2158	10906	1804	11249	1522	11644	1083	13059	867	6897
10-#14	2.96	MA	12564	3310	20328	2428	22390	2020	23640	1707	25328	1178	30245	838	20087
3L-4S		MI	6267	3310	10078	2298	10669	1906	10943	1584	11264	1086	12536	553	9605
10-#14	2.96	MA	12309	3310	19384	2467	21164	2057	22132	1723	23363	1210	27789	753	19917
4L-3S		MI	6343	3310	10513	2270	11232	1901	11634	1583	12164	1072	13584	629	9613
10-#14	2.96	MA	11923	3310	18599	2487	20115	2074	20818	1758	21414	1222	25290	683	18766
5L-2S		MI	6524	3310	11070	2262	11945	1877	12505	1562	13348	1059	15057	787	9573
10-#18	5.26	MA	13844	3794	22487	2795	25059	2298	26842	1877	29818	1205	36875	505	32408
4L-3S		MI	7012	3794	12121	2544	13237	2106	14058	1703	15435	1016	17213	264	15952
10-#18	5.26	MA	13190	3794	21106	2827	23215	2327	24536	1938	26400	1223	32475	372	30222
5L-2S		MI	7309	3794	13072	2534	14455	2068	15544	1671	17453	998	19617	546	15968
12-#10	2.01	MA	11916	3109	18845	2314	20578	1939	21468	1652	22397	1193	26206	935	13955
3L-5S		MI	5948	3109	9416	2203	9883	1854	10008	1566	9946	1117	11095	714	6891
12-#10	2.01	MA	11762	3109	18304	2337	19875	1961	20603	1662	21208	1201	24811	888	13930
4E		MI	6045	3109	9631	2197	10169	1838	10365	1552	10472	1117	11733	766	6869
12-#10	2.01	MA	11537	3109	17846	2348	19274	1972	19851	1683	20152	1220	23385	851	13849
5L-3S		MI	6095	3109	9885	2179	10499	1834	10769	1549	10999	1107	12377	812	6843

RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#10	2.01	MA	11374	3109	17366	2353	18663	1993	19107	1693	19151	1239	22109	799	13383
6L-2S		MI	6206	3109	10214	2173	10920	1818	11284	1535	11699	1096	13292	902	6818
12-#11	2.46	MA	12082	3205	19006	2393	20720	2001	21610	1686	22562	1191	26719	840	16858
4E		MI	6172	3205	9930	2239	10510	1865	10762	1563	11011	1098	12305	681	8211
12-#11	2.46	MA	11812	3205	18454	2406	19988	2014	20694	1711	21277	1214	24978	793	16545
5L-3S		MI	6228	3205	10236	2219	10906	1861	11249	1561	11644	1087	13059	735	8183
12-#11	2.46	MA	11617	3205	17870	2412	19254	2039	19787	1722	20057	1237	23421	727	15912
6L-2S		MI	6358	3205	10630	2212	11411	1843	11865	1545	12482	1076	14123	845	8153
12-#14	3.55	MA	12869	3434	20641	2545	22775	2113	24097	1757	26037	1200	31491	739	23805
4E		MI	6498	3434	10635	2376	11382	1962	11814	1618	12449	1076	14009	516	11226
12-#14	3.55	MA	12491	3434	19855	2564	21726	2130	22784	1792	24089	1212	28993	669	22605
5L-3S		MI	6574	3434	11070	2348	11945	1957	12505	1617	13348	1062	15057	592	11364
12-#14	3.55	MA	12217	3434	19021	2572	20683	2168	21484	1808	22340	1244	26756	571	21741
6L-2S		MI	6753	3434	11626	2340	12659	1933	13375	1596	14532	1049	16530	750	11335
12-#18	6.32	MA	14167	4015	23301	2966	26029	2427	27970	1998	31072	1205	38943	348	36836
5L-3S		MI	7401	4015	13072	2682	14455	2206	15544	1763	17453	998	19617	182	18885
12-#18	6.32	MA	13704	4015	21864	2980	24196	2491	25686	2023	28001	1259	34991	168	33665
6L-2S		MI	7694	4015	14022	2672	15674	2167	17031	1732	19470	980	22021	463	18948
14-#10	2.34	MA	12090	3179	19028	2381	20803	1993	21735	1681	22749	1195	26944	880	16179
4L-5S		MI	6088	3179	9745	2247	10305	1886	10523	1585	10646	1111	12010	699	7922
14-#10	2.34	MA	11867	3179	18570	2392	20202	2003	20983	1702	21693	1214	25518	844	16091
5L-4S		MI	6184	3179	9960	2241	10591	1870	10879	1571	11172	1112	12648	751	7908
14-#10	2.34	MA	11708	3179	18090	2397	19592	2024	20239	1712	20692	1234	24243	791	15599
6L-3S		MI	6234	3179	10214	2223	10920	1865	11284	1568	11699	1101	13292	797	7887
14-#10	2.34	MA	11529	3179	17577	2415	18969	2030	19519	1732	19655	1242	22751	745	15237
7L-2S		MI	6343	3179	10543	2217	11342	1849	11798	1554	12398	1091	14208	887	7864
14-#11	2.87	MA	12209	3292	19333	2460	21115	2052	22069	1734	23147	1207	27568	784	19217
5L-4S		MI	6336	3292	10323	2293	11014	1904	11378	1586	11848	1091	13369	658	9449
14-#11	2.87	MA	12019	3292	18749	2466	20381	2078	21162	1746	21927	1230	26011	717	18607
6L-3S		MI	6392	3292	10630	2272	11411	1900	11865	1584	12482	1080	14123	713	9428
14-#11	2.87	MA	11806	3292	18125	2488	19623	2084	20297	1771	20665	1239	24184	659	18038
7L-2S		MI	6520	3292	11023	2266	11915	1882	12480	1569	13319	1069	15188	822	9402
14-#14	4.14	MA	13053	3559	21112	2642	23337	2186	24749	1826	26763	1202	32696	656	26452
5L-4S		MI	6729	3559	11191	2454	12096	2018	12684	1652	13633	1066	15482	479	12862
14-#14	4.14	MA	12788	3559	20278	2650	22294	2224	23450	1842	25014	1234	30459	557	25566
6L-3S		MI	6804	3559	11626	2426	12659	2013	13375	1651	14532	1052	16530	555	13110
14-#14	4.14	MA	12489	3559	19383	2681	21209	2232	22210	1878	23311	1266	27831	473	24107
7L-2S		MI	6980	3559	12183	2417	13372	1988	14246	1630	15717	1039	18003	713	13089
14-#18	7.37	MA	14690	4237	24060	3119	27011	2590	29120	2084	32672	1241	41459	144	40327
6L-3S		MI	7789	4237	14022	2821	15674	2305	17031	1823	19470	979	22021	100	21604
16-#10	2.67	MA	12195	3249	19295	2436	21130	2035	22116	1722	23234	1209	27652	836	18334
5E		MI	6227	3249	10074	2291	10727	1917	11037	1604	11346	1105	12925	684	8878
16-#10	2.67	MA	12039	3249	18814	2440	20520	2056	21372	1731	22233	1228	26376	783	17819
6L-4S		MI	6322	3249	10289	2285	11012	1901	11393	1590	11872	1106	13563	736	8943
16-#10	2.67	MA	11862	3249	18301	2459	19897	2061	20652	1751	21196	1236	24885	737	17469
7L-3S		MI	6372	3249	10543	2267	11342	1897	11798	1587	12398	1096	14208	782	8926
16-#10	2.67	MA	11670	3249	17853	2467	19277	2079	19885	1757	20219	1255	23590	695	16897
8L-2S		MI	6481	3249	10872	2261	11764	1881	12313	1573	13098	1085	15123	872	8907
16-#11	3.28	MA	12417	3378	19628	2520	21508	2117	22537	1769	23798	1223	28600	708	21306
6L-4S		MI	6500	3378	10717	2347	11519	1943	11993	1610	12685	1084	14434	636	10682
16-#11	3.28	MA	12207	3378	19004	2542	20750	2123	21672	1795	22535	1232	26774	650	20726
7L-3S		MI	6555	3378	11023	2326	11915	1938	12480	1608	13319	1073	15188	690	10668
16-#11	3.28	MA	11977	3378	18458	2552	19995	2145	20739	1801	21345	1255	25192	596	19936
8L-2S		MI	6683	3378	11417	2320	12420	1920	13095	1592	14156	1062	16252	800	10647
16-#14	4.74	MA	13353	3683	21534	2728	23905	2279	25415	1876	27688	1224	34162	543	29391
6L-4S		MI	6959	3683	11748	2532	12809	2074	13555	1686	14817	1056	16955	442	14508
16-#14	4.74	MA	13057	3683	20640	2759	22820	2288	24176	1912	25985	1256	31534	459	27947
7L-3S		MI	7033	3683	12183	2504	13372	2069	14246	1685	15717	1043	18003	518	14844

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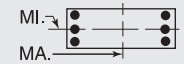
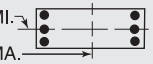


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#14	4.74	MA	12743	3683	19858	2773	21738	2319	22852	1921	24171	1268	29261	379	26473
8L-2S		MI	7207	3683	12740	2495	14086	2044	15116	1664	16901	1029	19477	676	14837
18-#10	3.01	MA	12369	3320	19538	2484	21448	2087	22504	1751	23774	1222	28510	776	20041
6L-5S		MI	6366	3320	10403	2335	11148	1949	11551	1623	12046	1100	13841	669	9867
18-#10	3.01	MA	12192	3320	19025	2503	20826	2093	21784	1771	22737	1231	27019	729	19702
7L-4S		MI	6460	3320	10618	2329	11434	1933	11908	1609	12571	1101	14479	721	9975
18-#10	3.01	MA	12005	3320	18577	2511	20205	2111	21017	1776	21760	1250	25723	687	19123
8L-3S		MI	6509	3320	10872	2311	11764	1928	12313	1606	13098	1090	15123	767	9962
18-#10	3.01	MA	11841	3320	18093	2531	19611	2119	20278	1794	20797	1269	24458	646	18593
9L-2S		MI	6617	3320	11201	2305	12185	1912	12827	1592	13798	1080	16038	857	9946
18-#11	3.69	MA	12604	3464	19883	2596	21877	2162	23047	1818	24406	1225	29364	640	23417
7L-4S		MI	6664	3464	11110	2401	12023	1982	12609	1633	13523	1077	15498	613	11910
18-#11	3.69	MA	12385	3464	19337	2606	21122	2184	22114	1824	23215	1248	27782	586	22633
8L-3S		MI	6719	3464	11417	2380	12420	1977	13095	1631	14156	1066	16252	667	11904
18-#11	3.69	MA	12183	3464	18754	2630	20398	2193	21214	1845	22041	1271	26230	535	21736
9L-2S		MI	6845	3464	11810	2374	12924	1959	13711	1616	14994	1055	17316	777	11887
18-#14	5.33	MA	13620	3808	21897	2837	24432	2344	26141	1945	28660	1246	35237	445	31787
7L-4S		MI	7188	3808	12304	2610	13523	2130	14425	1720	16002	1046	18428	405	16162
18-#14	5.33	MA	13314	3808	21115	2850	23349	2374	24817	1955	26846	1258	32964	365	30292
8L-3S		MI	7262	3808	12740	2581	14086	2125	15116	1719	16901	1033	19477	481	16575
20-#10	3.34	MA	12521	3390	19749	2547	21754	2124	22917	1790	24278	1225	29152	721	21937
7L-5S		MI	6504	3390	10732	2379	11570	1980	12066	1642	12746	1094	14756	654	10859
20-#10	3.34	MA	12340	3390	19301	2555	21133	2142	22150	1795	23301	1244	27857	679	21347
8L-4S		MI	6598	3390	10947	2373	11856	1964	12422	1628	13271	1095	15394	706	11006
20-#10	3.34	MA	12177	3390	18817	2574	20539	2150	21411	1813	22338	1264	26591	638	20813
9L-3S		MI	6647	3390	11201	2355	12185	1960	12827	1625	13798	1084	16038	752	10996
20-#10	3.34	MA	11983	3390	18352	2581	19944	2170	20691	1832	21292	1269	25302	602	20073
10L-2S		MI	6754	3390	11530	2349	12607	1944	13341	1611	14498	1074	16953	842	10982
20-#11	4.11	MA	12784	3550	20216	2659	22248	2222	23488	1848	25085	1241	30372	577	25330
8L-4S		MI	6827	3550	11504	2455	12528	2020	13224	1657	14360	1070	16562	590	13107
20-#11	4.11	MA	12589	3550	19633	2684	21525	2231	22588	1869	23912	1264	28820	525	24420
9L-3S		MI	6881	3550	11810	2434	12924	2016	13711	1655	14994	1059	17316	645	13138
20-#11	4.11	MA	12358	3550	19067	2690	20800	2255	21712	1891	22658	1271	27245	479	23464
10L-2S		MI	7006	3550	12204	2428	13429	1998	14326	1639	15831	1049	18381	755	13125
20-#14	5.92	MA	13879	3932	22372	2928	24960	2430	26783	1989	29520	1248	36667	352	34110
8L-4S		MI	7417	3932	12861	2688	14236	2185	15296	1754	17186	1036	19902	368	17823
22-#10	3.68	MA	12670	3460	20025	2599	22062	2174	23282	1815	24842	1239	29991	672	23572
8L-5S		MI	6642	3460	11061	2423	11992	2012	12580	1661	13446	1089	15671	639	11854
22-#10	3.68	MA	12511	3460	19542	2618	21468	2182	22543	1832	23879	1258	28725	630	23026
9L-4S		MI	6735	3460	11275	2416	12277	1996	12937	1647	13971	1089	16309	691	12031
22-#10	3.68	MA	12318	3460	19076	2624	20872	2202	21824	1851	22833	1264	27436	594	22291
10L-3S		MI	6784	3460	11530	2399	12607	1991	13341	1645	14498	1079	16953	737	12028
22-#10	3.68	MA	12138	3460	18627	2632	20281	2209	21081	1859	21840	1280	26186	550	21523
11L-2S		MI	6890	3460	11859	2393	13029	1976	13856	1631	15198	1068	17869	827	12017
22-#11	4.52	MA	12991	3637	20512	2737	22652	2270	23963	1893	25782	1257	31410	516	27104
9L-4S		MI	6990	3637	11897	2509	13032	2059	13840	1680	15197	1064	17627	568	14281
22-#11	4.52	MA	12761	3637	19946	2744	21927	2294	23087	1915	24528	1265	29834	469	26136
10L-3S		MI	7044	3637	12204	2488	13429	2055	14326	1679	15831	1053	18381	622	14370
24-#10	4.01	MA	12843	3531	20266	2662	22396	2213	23676	1852	25420	1252	30858	622	25239
9L-5S		MI	6780	3531	11389	2467	12413	2043	13095	1681	14145	1083	16586	624	12850
24-#10	4.01	MA	12651	3531	19801	2668	21801	2233	22956	1870	24374	1258	29570	586	24508
10L-4S		MI	6873	3531	11604	2460	12699	2027	13451	1667	14671	1084	17224	676	13055
24-#10	4.01	MA	12474	3531	19351	2676	21209	2241	22214	1878	23381	1275	28319	542	23732
11L-3S		MI	6921	3531	11859	2443	13029	2023	13856	1664	15198	1073	17869	722	13058
24-#11	4.93	MA	13162	3723	20825	2798	23054	2333	24461	1938	26399	1258	32424	460	28808
10L-4S		MI	7152	3723	12291	2563	13537	2098	14455	1704	16035	1057	18691	545	15459

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

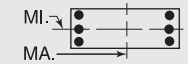
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.13	MA	12528	3078	19588	2290	21086	1933	21670	1655	21920	1244	25014	1081	8778
2E		MI	6120	3078	9836	2127	10246	1793	10323	1534	10186	1147	11042	949	4221
4-#18	2.00	MA	13398	3271	21652	2395	23655	2006	24769	1696	26116	1219	30809	1051	15154
2E		MI	6435	3271	10658	2216	11240	1852	11512	1562	11787	1111	12805	842	6956
6-#11	1.17	MA	12592	3088	19684	2305	21248	1944	21885	1664	22223	1248	25443	1084	9147
2L-3S		MI	6017	3088	9491	2156	9834	1830	9833	1564	9525	1167	10273	854	4413
6-#11	1.17	MA	12233	3088	18751	2319	20052	1957	20426	1690	20238	1271	22694	989	9179
3L-2S		MI	6151	3088	9884	2149	10338	1811	10448	1548	10362	1156	11338	964	4376
6-#14	1.69	MA	13124	3202	20923	2368	22797	1988	23757	1689	24760	1234	28947	1067	12978
2L-3S		MI	6163	3202	9836	2213	10246	1874	10323	1589	10186	1151	11042	754	6103
6-#14	1.69	MA	12622	3202	19588	2388	21086	2007	21670	1726	21920	1267	25014	927	12998
3L-2S		MI	6350	3202	10393	2205	10959	1849	11193	1568	11370	1137	12515	912	6043
6-#18	3.00	MA	14416	3493	23986	2534	26646	2105	28419	1756	31082	1201	37684	1027	22462
2L-3S		MI	6513	3493	10658	2364	11240	1990	11512	1654	11787	1110	12805	479	10092
6-#18	3.00	MA	13581	3493	21652	2567	23655	2135	24769	1818	26116	1256	30809	771	22332
3L-2S		MI	6822	3493	11609	2354	12458	1952	12998	1623	13805	1092	15209	760	10011
8-#9	1.00	MA	12437	3050	19248	2297	20764	1940	21328	1665	21487	1260	24439	1096	7913
2L-4S		MI	5969	3050	9246	2176	9578	1837	9543	1575	9160	1194	9924	897	3864
8-#9	1.00	MA	12199	3050	18640	2306	19985	1949	20379	1682	20195	1275	22650	1037	7932
3E		MI	6011	3050	9447	2162	9839	1833	9865	1572	9579	1185	10440	934	3838
8-#9	1.00	MA	12064	3050	18188	2324	19397	1967	19655	1690	19199	1282	21489	1000	7949
4L-2S		MI	6102	3050	9709	2156	10175	1821	10273	1561	10135	1177	11175	1005	3818
8-#10	1.27	MA	12726	3110	19909	2330	21591	1964	22329	1678	22842	1252	26312	1087	9955
2L-4S		MI	6049	3110	9407	2210	9767	1861	9767	1588	9467	1188	10313	848	4793
8-#10	1.27	MA	12430	3110	19141	2342	20607	1975	21128	1700	21208	1272	24049	1011	9975
3E		MI	6100	3110	9661	2192	10097	1856	10172	1585	9994	1178	10957	894	4757
8-#10	1.27	MA	12261	3110	18568	2365	19862	1997	20211	1710	19948	1281	22576	964	9976
4L-2S		MI	6214	3110	9990	2186	10519	1841	10686	1571	10693	1167	11873	984	4728
8-#11	1.56	MA	13012	3174	20617	2359	22444	1983	23344	1688	24208	1241	28191	1075	12081
2L-4S		MI	6125	3174	9578	2230	9942	1873	9962	1590	9728	1171	10584	778	5744
8-#11	1.56	MA	12659	3174	19684	2373	21248	1996	21885	1713	22223	1264	25443	979	12101
3E		MI	6182	3174	9884	2210	10338	1868	10448	1588	10362	1160	11338	832	5697
8-#11	1.56	MA	12459	3174	18986	2401	20341	2023	20769	1725	20690	1274	23640	921	12079
4L-2S		MI	6315	3174	10278	2203	10843	1850	11064	1572	11199	1149	12402	942	5659
8-#14	2.25	MA	13715	3327	22257	2446	24508	2044	25845	1723	27600	1224	32879	1053	17161
2L-4S		MI	6318	3327	9958	2319	10396	1934	10502	1624	10471	1154	11467	642	7936
8-#14	2.25	MA	13227	3327	20923	2466	22797	2062	23757	1759	24760	1257	28947	914	17153
3E		MI	6395	3327	10393	2291	10959	1930	11193	1623	11370	1141	12515	717	7888
8-#14	2.25	MA	12947	3327	19922	2506	21497	2100	22159	1776	22563	1270	26353	829	17004
4L-2S		MI	6579	3327	10949	2283	11673	1905	12064	1602	12555	1127	13989	875	7836
8-#18	4.00	MA	14620	3714	23986	2705	26646	2234	28419	1879	31082	1239	37684	747	29557
3E		MI	6904	3714	11609	2503	12458	2090	12998	1714	13805	1092	15209	397	13070
8-#18	4.00	MA	14152	3714	22229	2774	24366	2300	25614	1905	27428	1294	33098	594	27545
4L-2S		MI	7208	3714	12559	2492	13677	2051	14485	1683	15822	1074	17613	678	13028
10-#10	1.59	MA	13073	3180	20677	2374	22576	1995	23530	1698	24477	1247	28575	1080	12366
2L-5S		MI	6091	3180	9521	2260	9903	1908	9925	1621	9641	1182	10590	781	5884
10-#10	1.59	MA	12782	3180	19909	2386	21591	2006	22329	1719	22842	1267	26312	1003	12379
3L-4S		MI	6189	3180	9736	2253	10189	1892	10282	1607	10166	1182	11228	833	5851
10-#10	1.59	MA	12615	3180	19336	2409	20847	2028	21412	1729	21583	1275	24839	956	12365
4L-3S		MI	6239	3180	9990	2236	10519	1888	10686	1604	10693	1172	11873	879	5819
10-#10	1.59	MA	12371	3180	18848	2419	20211	2039	20616	1751	20466	1295	23332	921	12293
5L-2S		MI	6352	3180	10319	2230	10940	1872	11201	1590	11393	1161	12788	969	5791

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

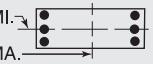


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.95	MA	13083	3260	20617	2427	22444	2034	23344	1737	24208	1257	28191	969	15015
3L-4S		MI	6290	3260	9971	2284	10446	1911	10577	1613	10566	1164	11648	755	7002
10-#11	1.95	MA	12885	3260	19919	2455	21537	2061	22228	1749	22675	1267	26389	911	14974
4L-3S		MI	6347	3260	10278	2264	10843	1907	11064	1611	11199	1153	12402	809	6963
10-#11	1.95	MA	12592	3260	19330	2468	20762	2074	21258	1774	21314	1290	24549	866	14795
5L-2S		MI	6478	3260	10671	2257	11347	1889	11679	1596	12037	1142	13466	919	6928
10-#14	2.81	MA	13825	3451	22257	2544	24508	2118	25845	1793	27600	1247	32879	900	21302
3L-4S		MI	6550	3451	10514	2397	11110	1990	11373	1658	11655	1144	12940	605	9683
10-#14	2.81	MA	13550	3451	21257	2583	23208	2156	24246	1810	25403	1260	30285	815	21132
4L-3S		MI	6626	3451	10949	2369	11673	1985	12064	1657	12555	1131	13989	680	9654
10-#14	2.81	MA	13138	3451	20419	2602	22097	2174	22855	1846	23452	1293	27643	748	20006
5L-2S		MI	6808	3451	11506	2360	12386	1961	12934	1635	13739	1117	15462	838	9612
10-#18	5.00	MA	15189	3935	24563	2912	27357	2399	29264	1966	32393	1276	39974	570	34658
4L-3S		MI	7295	3935	12559	2641	13677	2189	14485	1775	15822	1073	17613	314	16021
10-#18	5.00	MA	14489	3935	23100	2946	25404	2429	26820	2028	28769	1296	35318	442	32261
5L-2S		MI	7593	3935	13510	2630	14895	2150	15971	1743	17840	1056	20017	596	16023
12-#10	1.90	MA	13131	3250	20677	2430	22576	2038	23530	1738	24477	1261	28575	996	14778
3L-5S		MI	6231	3250	9850	2304	10325	1940	10440	1640	10341	1176	11506	766	6924
12-#10	1.90	MA	12966	3250	20104	2453	21831	2060	22614	1748	23217	1270	27102	949	14753
4E		MI	6328	3250	10065	2297	10611	1924	10796	1626	10866	1177	12144	818	6899
12-#10	1.90	MA	12725	3250	19616	2463	21196	2071	21817	1770	22100	1289	25595	914	14672
5L-3S		MI	6378	3250	10319	2280	10940	1919	11201	1624	11393	1166	12788	864	6871
12-#10	1.90	MA	12552	3250	19107	2468	20545	2091	21030	1780	21040	1309	24247	862	14227
6L-2S		MI	6489	3250	10648	2273	11362	1904	11715	1609	12093	1156	13703	954	6845
12-#11	2.34	MA	13307	3347	20852	2509	22733	2100	23688	1772	24660	1260	29138	902	17869
4E		MI	6455	3347	10365	2338	10951	1950	11192	1637	11403	1157	12712	732	8249
12-#11	2.34	MA	13019	3347	20263	2522	21958	2113	22717	1798	23299	1284	27297	857	17626
5L-3S		MI	6511	3347	10671	2318	11347	1946	11679	1635	12037	1146	13466	787	8218
12-#11	2.34	MA	12811	3347	19644	2528	21174	2138	21758	1810	22008	1307	25651	791	16923
6L-2S		MI	6641	3347	11065	2311	11852	1928	12295	1619	12874	1135	14531	896	8186
12-#14	3.38	MA	14148	3576	22591	2661	24919	2212	26333	1844	28243	1250	34217	802	25263
4E		MI	6781	3576	11071	2475	11823	2046	12243	1692	12840	1135	14414	568	11338
12-#14	3.38	MA	13743	3576	21754	2680	23808	2230	24942	1880	26292	1283	31575	734	24087
5L-3S		MI	6857	3576	11506	2447	12386	2041	12934	1690	13739	1121	15462	643	11408
12-#14	3.38	MA	13451	3576	20867	2688	22693	2267	23565	1897	24439	1316	29210	638	23175
6L-2S		MI	7036	3576	12063	2438	13100	2017	13804	1669	14923	1107	16935	801	11376
12-#18	6.00	MA	15533	4157	25434	3084	28395	2528	30469	2088	33734	1279	42193	417	39402
5L-3S		MI	7683	4157	13510	2779	14895	2288	15971	1835	17840	1055	20017	232	18962
12-#18	6.00	MA	15039	4157	23894	3098	26453	2594	28050	2115	30479	1334	38023	239	36012
6L-2S		MI	7977	4157	14460	2769	16114	2250	17458	1804	19858	1037	22421	514	19004
14-#10	2.22	MA	13315	3321	20872	2497	22816	2091	23815	1768	24851	1264	29365	941	17139
4L-5S		MI	6371	3321	10179	2348	10747	1971	10954	1660	11041	1171	12421	751	7958
14-#10	2.22	MA	13077	3321	20384	2507	22180	2102	23019	1789	23734	1284	27858	906	17051
5L-4S		MI	6467	3321	10393	2341	11032	1956	11310	1645	11566	1171	13059	803	7940
14-#10	2.22	MA	12907	3321	19875	2512	21529	2123	22231	1799	22674	1304	26510	854	16579
6L-3S		MI	6517	3321	10648	2324	11362	1951	11715	1643	12093	1161	13703	849	7917
14-#10	2.22	MA	12715	3321	19331	2531	20870	2129	21462	1819	21578	1312	24937	808	16182
7L-2S		MI	6627	3321	10977	2317	11784	1935	12230	1629	12793	1150	14618	939	7893
14-#11	2.73	MA	13443	3433	21196	2576	23154	2152	24176	1821	25285	1277	30046	847	20465
5L-4S		MI	6619	3433	10758	2392	11455	1989	11808	1660	12240	1150	13777	710	9489
14-#11	2.73	MA	13240	3433	20577	2581	22370	2177	23217	1833	23993	1300	28400	782	19786
6L-3S		MI	6675	3433	11065	2372	11852	1984	12295	1658	12874	1139	14531	764	9465
14-#11	2.73	MA	13011	3433	19915	2604	21567	2184	22292	1858	22656	1310	26473	724	19259
7L-2S		MI	6804	3433	11458	2365	12356	1966	12910	1643	13711	1128	15595	874	9437
14-#14	3.94	MA	14343	3700	23088	2758	25519	2286	27029	1914	29132	1273	35507	720	28176
5L-4S		MI	7012	3700	11627	2553	12537	2102	13113	1726	14024	1125	15887	530	12972
14-#14	3.94	MA	14060	3700	22202	2766	24404	2323	25653	1930	27279	1306	33142	624	27282
6L-3S		MI	7087	3700	12063	2524	13100	2097	13804	1724	14923	1111	16935	606	13156

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis



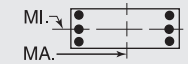
f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.94	MA	13738	3700	21254	2798	23254	2332	24339	1967	25362	1319	30370	541	25727
7L-2S		MI	7264	3700	12619	2516	13813	2072	14675	1703	16107	1097	18408	764	13132
14-#18	7.00	MA	16092	4378	26227	3236	29445	2693	31699	2175	35445	1317	44899	215	43094
6L-3S		MI	8071	4378	14460	2918	16114	2388	17458	1895	19858	1037	22421	150	21789
16-#10	2.54	MA	13427	3391	21152	2551	23165	2134	24220	1808	25369	1278	30121	898	19431
5E		MI	6510	3391	10507	2392	11168	2003	11468	1679	11741	1165	13336	736	8983
16-#10	2.54	MA	13261	3391	20643	2556	22514	2154	23433	1818	24309	1298	28773	847	18935
6L-4S		MI	6605	3391	10722	2385	11454	1987	11825	1665	12266	1166	13974	788	8977
16-#10	2.54	MA	13070	3391	20099	2575	21854	2160	22664	1838	23212	1306	27200	801	18551
7L-3S		MI	6655	3391	10977	2368	11784	1982	12230	1662	12793	1155	14618	835	8958
16-#10	2.54	MA	12864	3391	19625	2583	21197	2179	21852	1844	22178	1326	25832	760	17997
8L-2S		MI	6764	3391	11306	2361	12205	1967	12744	1648	13493	1145	15533	924	8937
16-#11	3.12	MA	13665	3519	21510	2635	23566	2216	24676	1857	25978	1293	31148	772	22652
6L-4S		MI	6783	3519	11152	2446	11960	2028	12423	1684	13078	1143	14841	687	10724
16-#11	3.12	MA	13438	3519	20848	2658	22763	2222	23751	1882	24641	1303	29222	715	22117
7L-3S		MI	6839	3519	11458	2426	12356	2023	12910	1682	13711	1132	15595	742	10707
16-#11	3.12	MA	13192	3519	20270	2668	21963	2245	22762	1888	23381	1326	27550	663	21238
8L-2S		MI	6966	3519	11852	2419	12861	2005	13526	1666	14549	1121	16659	851	10683
16-#14	4.50	MA	14664	3825	23536	2844	26115	2379	27740	1964	30119	1296	37075	610	31386
6L-4S		MI	7242	3825	12184	2630	13250	2158	13984	1759	15208	1115	17360	493	14616
16-#14	4.50	MA	14344	3825	22589	2876	24964	2388	26427	2001	28202	1309	34302	527	29806
7L-3S		MI	7316	3825	12619	2602	13813	2153	14675	1758	16107	1101	18408	569	14896
16-#14	4.50	MA	14009	3825	21760	2890	23817	2419	25010	2010	26395	1342	31900	449	28327
8L-2S		MI	7491	3825	13176	2594	14527	2128	15545	1737	17292	1087	19882	727	14883
18-#10	2.86	MA	13612	3461	21411	2600	23499	2186	24634	1837	25943	1292	31036	839	21294
6L-5S		MI	6649	3461	10836	2436	11590	2034	11983	1698	12440	1159	14251	722	9935
18-#10	2.86	MA	13422	3461	20868	2619	22839	2192	23865	1857	24846	1301	29463	793	20921
7L-4S		MI	6743	3461	11051	2429	11876	2019	12339	1684	12966	1160	14889	773	10010
18-#10	2.86	MA	13221	3461	20393	2627	22182	2210	23053	1863	23813	1321	28095	752	20356
8L-3S		MI	6793	3461	11306	2412	12205	2014	12744	1681	13493	1150	15533	820	9995
18-#10	2.86	MA	13047	3461	19878	2647	21553	2218	22270	1881	22793	1340	26762	711	19780
9L-2S		MI	6901	3461	11635	2405	12627	1998	13258	1667	14193	1139	16449	909	9977
18-#11	3.51	MA	13862	3606	21781	2712	23959	2261	25210	1905	26627	1296	31971	705	24977
7L-4S		MI	6947	3606	11545	2500	12464	2066	13039	1707	13915	1136	15905	665	11956
18-#11	3.51	MA	13628	3606	21203	2722	23159	2283	24222	1912	25366	1319	30299	653	24102
8L-3S		MI	7002	3606	11852	2480	12861	2062	13526	1705	14549	1125	16659	719	11945
18-#11	3.51	MA	13412	3606	20581	2746	22393	2293	23268	1933	24124	1343	28663	602	23215
9L-2S		MI	7128	3606	12245	2473	13365	2044	14141	1690	15386	1114	17723	829	11926
18-#14	5.06	MA	14945	3949	23923	2954	26675	2444	28514	2035	31042	1299	38234	513	33884
7L-4S		MI	7471	3949	12740	2708	13964	2214	14854	1793	16393	1105	18833	456	16269
18-#14	5.06	MA	14618	3949	23094	2968	25528	2475	27097	2043	29235	1332	35832	436	32382
8L-3S		MI	7545	3949	13176	2680	14527	2209	15545	1792	17292	1091	19882	532	16629
18-#14	5.06	MA	14313	3949	22210	3002	24430	2488	25731	2074	27453	1365	33476	361	30750
9L-2S		MI	7718	3949	13732	2672	15240	2184	16416	1771	18476	1077	21355	690	16629
20-#10	3.17	MA	13772	3531	21636	2663	23824	2223	25066	1876	26481	1295	31726	785	23293
7L-5S		MI	6787	3531	11165	2479	12012	2066	12497	1717	13140	1154	15166	707	10927
20-#10	3.17	MA	13576	3531	21161	2671	23166	2242	24254	1882	25447	1315	30358	744	22715
8L-4S		MI	6881	3531	11380	2473	12297	2050	12854	1703	13666	1154	15804	758	11042
20-#10	3.17	MA	13405	3531	20646	2690	22538	2250	23472	1901	24428	1335	29025	703	22142
9L-3S		MI	6930	3531	11635	2455	12627	2046	13258	1700	14193	1144	16449	805	11030
20-#10	3.17	MA	13197	3531	20153	2697	21907	2270	22688	1908	23311	1340	27664	668	21401
10L-2S		MI	7037	3531	11964	2449	13049	2030	13773	1686	14893	1133	17364	894	11015

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

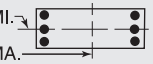
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.90	MA	14053	3692	22136	2776	24355	2322	25681	1935	27352	1313	33048	643	26965
8L-4S		MI	7110	3692	11939	2554	12969	2105	13654	1731	14753	1129	16970	642	13182
20-#11	3.90	MA	13845	3692	21514	2800	23589	2332	24727	1957	26109	1336	31412	592	26063
9L-3S		MI	7165	3692	12245	2534	13365	2101	14141	1729	15386	1118	17723	696	13180
20-#11	3.90	MA	13596	3692	20915	2807	22821	2356	23799	1980	24767	1343	29748	547	25115
10L-2S		MI	7290	3692	12639	2527	13870	2083	14756	1713	16223	1107	18788	806	13165
20-#14	5.63	MA	15221	4074	24429	3046	27239	2531	29184	2077	32074	1322	39764	422	36437
8L-4S		MI	7700	4074	13297	2786	14677	2270	15725	1827	17577	1095	20306	419	17929
20-#14	5.63	MA	14929	4074	23544	3080	26141	2544	27818	2108	30293	1355	37408	348	34786
9L-3S		MI	7773	4074	13732	2758	15240	2265	16416	1826	18476	1081	21355	495	18358
22-#10	3.49	MA	13929	3602	21929	2715	24151	2273	25456	1902	27081	1309	32621	736	25075
8L-5S		MI	6925	3602	11494	2523	12433	2097	13012	1736	13840	1148	16082	692	11922
22-#10	3.49	MA	13761	3602	21414	2734	23522	2282	24673	1920	26062	1329	31288	695	24505
9L-4S		MI	7019	3602	11709	2517	12719	2082	13368	1722	14366	1149	16720	743	12071
22-#10	3.49	MA	13553	3602	20921	2741	22892	2302	23889	1927	24945	1335	29927	660	23753
10L-3S		MI	7067	3602	11964	2499	13049	2077	13773	1719	14893	1138	17364	790	12063
22-#10	3.49	MA	13362	3602	20445	2748	22261	2309	23126	1947	23893	1352	28606	617	22993
11L-2S		MI	7174	3602	12293	2493	13470	2061	14287	1705	15593	1128	18279	879	12051
22-#11	4.29	MA	14274	3778	22447	2854	24785	2370	26186	1981	28095	1329	34161	583	28912
9L-4S		MI	7273	3778	12333	2608	13473	2144	14270	1754	15590	1122	18034	619	14370
22-#11	4.29	MA	14027	3778	21848	2861	24017	2394	25258	2003	26752	1336	32497	538	27951
10L-3S		MI	7327	3778	12639	2588	13870	2139	14756	1752	16223	1111	18788	674	14413
22-#14	6.19	MA	15539	4198	24879	3158	27852	2600	29905	2142	33132	1345	41340	334	38822
9L-4S		MI	7929	4198	13854	2864	15391	2325	16595	1861	18761	1085	21780	382	19595
24-#10	3.81	MA	14114	3672	22182	2778	24507	2313	25874	1939	27697	1324	33551	688	26867
9L-5S		MI	7063	3672	11823	2567	12855	2129	13526	1755	14540	1142	16997	677	12918
24-#10	3.81	MA	13908	3672	21689	2785	23877	2333	25091	1947	26579	1329	32190	653	26105
10L-4S		MI	7156	3672	12038	2561	13141	2113	13882	1741	15066	1143	17635	728	13096
24-#10	3.81	MA	13720	3672	21213	2792	23246	2341	24327	1966	25528	1346	30869	609	25336
11L-3S		MI	7205	3672	12293	2543	13470	2109	14287	1738	15593	1133	18279	775	13095
24-#11	4.68	MA	14454	3865	22780	2915	25213	2433	26717	2027	28738	1329	35246	528	30787
10L-4S		MI	7435	3865	12726	2662	13978	2182	14885	1778	16427	1115	19098	597	15548

RECTANGULAR TIED COLUMNS 22" x 22"

6-#9	1.24	MA	4147	1877	6628	1340	7020	1129	7156	965	7186	718	8103	618	3104
2L-3S		MI	4042	1877	6332	1346	6641	1143	6693	977	6556	729	7246	548	3126
6-#10	1.57	MA	4243	1922	6866	1364	7315	1145	7511	973	7667	712	8728	606	3860
2L-3S		MI	4113	1922	6493	1371	6837	1162	6928	989	6873	725	7658	517	3889
6-#11	1.93	MA	4332	1970	7110	1381	7599	1156	7846	977	8117	701	9238	581	4631
2L-3S		MI	4179	1970	6662	1390	7026	1176	7146	995	7165	714	7984	472	4665
6-#14	2.79	MA	4561	2085	7684	1444	8316	1200	8712	1002	9291	687	10684	542	6457
2L-3S		MI	4348	2085	7050	1455	7502	1227	7720	1026	7941	704	8938	383	6489
6-#18	4.96	MA	5109	2375	9071	1608	10056	1315	10820	1068	12153	653	14037	422	10855
2L-3S		MI	4757	2375	7983	1623	8661	1359	9117	1105	9836	677	11154	141	10696
8-#8	1.31	MA	4172	1886	6676	1350	7091	1136	7245	970	7310	720	8295	622	3262
2L-4S		MI	4047	1886	6259	1367	6555	1152	6590	983	6434	737	7128	535	3299
8-#9	1.65	MA	4273	1933	6924	1375	7400	1154	7619	980	7816	714	8961	611	4051
2L-4S		MI	4119	1933	6401	1396	6726	1172	6794	996	6715	734	7505	501	4092
8-#10	2.10	MA	4401	1992	7239	1408	7793	1177	8094	993	8460	707	9799	595	5047
2L-4S		MI	4210	1992	6580	1434	6944	1200	7055	1012	7073	731	7980	457	5081
8-#11	2.58	MA	4520	2057	7557	1435	8173	1195	8546	1001	9069	694	10492	564	6052
2L-4S		MI	4298	2057	6764	1465	7152	1221	7296	1022	7401	721	8357	396	6072
8-#14	3.72	MA	4824	2209	8318	1522	9129	1256	9704	1036	10641	677	12429	513	8457
2L-4S		MI	4519	2209	7192	1563	7679	1291	7930	1064	8273	712	9452	274	7973
10-#10	2.62	MA	4558	2063	7612	1451	8271	1208	8677	1012	9253	701	10869	584	6225
2L-5S		MI	4260	2063	6711	1485	7101	1248	7237	1047	7274	727	8304	395	5996

RECTANGULAR TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.62	MA	4432	2063	7239	1459	7793	1225	8094	1027	8460	713	9799	495	6242
3L-4S		MI	4370	2063	6952	1478	7422	1231	7638	1031	7866	726	9050	446	6241
10-#11	3.22	MA	4706	2143	8005	1489	8747	1234	9246	1024	10022	687	11747	547	7464
2L-5S		MI	4357	2143	6920	1527	7337	1279	7512	1064	7639	714	8737	316	7018
10-#11	3.22	MA	4558	2143	7557	1497	8173	1254	8546	1042	9069	701	10492	437	7479
3L-4S		MI	4488	2143	7212	1519	7725	1260	7996	1046	8353	714	9611	379	7398
10-#14	4.65	MA	4882	2334	8318	1610	9129	1339	9704	1094	10641	684	12429	326	10430
3L-4S		MI	4787	2334	7826	1641	8492	1347	8922	1098	9623	702	11198	245	9836

RECTANGULAR TIED COLUMNS 22" x 24"

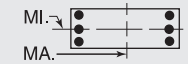
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.18	MA	4911	2040	7839	1454	8285	1226	8428	1048	8430	783	9463	673	3531
2E		MI	4487	2040	7187	1438	7560	1212	7669	1036	7643	774	8482	656	3221
4-#14	1.70	MA	5086	2116	8277	1493	8824	1252	9076	1062	9307	771	10581	650	4925
2E		MI	4640	2116	7575	1476	8037	1238	8241	1050	8418	762	9433	628	4472
4-#18	3.03	MA	5506	2310	9336	1596	10139	1324	10662	1102	11457	745	13211	580	8292
2E		MI	5007	2310	8510	1578	9194	1309	9636	1088	10309	735	11644	544	7476
6-#9	1.14	MA	4913	2033	7796	1467	8273	1237	8431	1059	8444	793	9554	689	3428
2L-3S		MI	4384	2033	6854	1459	7176	1239	7217	1061	7037	795	7749	606	3148
6-#9	1.14	MA	4793	2033	7465	1473	7849	1251	7914	1072	7741	804	8580	620	3450
3L-2S		MI	4490	2033	7150	1453	7555	1225	7680	1048	7667	785	8606	677	3126
6-#10	1.44	MA	5022	2078	8063	1490	8604	1253	8830	1067	8984	787	10297	682	4272
2L-3S		MI	4455	2078	7016	1483	7372	1258	7452	1072	7354	791	8159	575	3915
6-#10	1.44	MA	4873	2078	7646	1498	8069	1271	8178	1084	8097	801	9070	592	4300
3L-2S		MI	4586	2078	7389	1476	7850	1241	8035	1057	8147	779	9230	665	3886
6-#11	1.77	MA	5124	2126	8341	1508	8928	1264	9212	1071	9497	776	10908	660	5136
2L-3S		MI	4521	2126	7187	1500	7560	1271	7669	1078	7643	780	8482	529	4699
6-#11	1.77	MA	4949	2126	7839	1517	8285	1285	8428	1091	8430	791	9463	550	5171
3L-2S		MI	4675	2126	7634	1492	8134	1251	8369	1060	8595	767	9736	639	4662
6-#14	2.56	MA	5386	2240	8989	1570	9737	1308	10189	1096	10822	761	12601	627	7186
2L-3S		MI	4690	2240	7575	1565	8037	1321	8241	1108	8418	769	9433	441	6535
6-#14	2.56	MA	5142	2240	8277	1583	8824	1337	9076	1122	9307	782	10581	469	7218
3L-2S		MI	4904	2240	8210	1554	8850	1294	9233	1084	9768	752	11179	599	6496
6-#18	4.55	MA	6012	2531	10563	1734	11712	1423	12581	1162	14068	728	16578	528	12151
2L-3S		MI	5099	2531	8510	1731	9194	1452	9636	1186	10309	742	11644	197	10854
6-#18	4.55	MA	5610	2531	9336	1753	10139	1471	10662	1204	11457	758	13211	246	12061
3L-2S		MI	5452	2531	9599	1716	10590	1408	11339	1149	12626	717	14527	478	10910
8-#8	1.20	MA	4940	2042	7847	1476	8350	1244	8530	1064	8580	795	9745	690	3604
2L-4S		MI	4389	2042	6781	1479	7089	1248	7114	1067	6916	803	7632	593	3322
8-#8	1.20	MA	4845	2042	7585	1482	8012	1256	8118	1075	8021	804	8970	636	3620
3E		MI	4430	2042	6961	1467	7323	1244	7402	1064	7290	795	8111	625	3301
8-#8	1.20	MA	4797	2042	7384	1494	7753	1261	7799	1079	7605	813	8436	604	3641
4L-2S		MI	4514	2042	7197	1462	7625	1233	7770	1054	7792	787	8799	680	3284
8-#9	1.52	MA	5055	2088	8126	1501	8697	1262	8948	1074	9148	789	10528	683	4483
2L-4S		MI	4461	2088	6923	1508	7261	1268	7319	1079	7196	801	8007	559	4120
8-#9	1.52	MA	4937	2088	7796	1508	8273	1276	8431	1087	8444	800	9554	613	4503
3E		MI	4512	2088	7150	1493	7555	1263	7680	1076	7667	791	8606	599	4097
8-#9	1.52	MA	4878	2088	7544	1523	7946	1282	8029	1092	7921	811	8879	573	4524
4L-2S		MI	4616	2088	7446	1487	7935	1250	8143	1063	8297	781	9463	669	4076
8-#10	1.92	MA	5201	2148	8480	1534	9138	1285	9482	1087	9871	781	11523	674	5595
2L-4S		MI	4553	2148	7102	1546	7478	1295	7579	1096	7553	797	8481	515	5119
8-#10	1.92	MA	5054	2148	8063	1542	8604	1303	8830	1103	8984	795	10297	584	5618
3E		MI	4615	2148	7389	1527	7850	1289	8035	1091	8147	785	9230	564	5100

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis

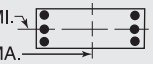


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#10	1.92	MA	4981	2148	7745	1562	8191	1310	8323	1109	8323	809	9443	533	5630
4L-2S		MI	4744	2148	7762	1520	8328	1272	8618	1076	8941	773	10300	654	5075
8-#11	2.36	MA	5336	2212	8842	1562	9571	1303	9996	1095	10564	769	12353	647	6726
2L-4S		MI	4640	2212	7288	1576	7686	1315	7819	1105	7880	787	8855	454	6124
8-#11	2.36	MA	5164	2212	8341	1571	8928	1324	9212	1114	9497	784	10908	537	6750
3E		MI	4711	2212	7634	1554	8134	1309	8369	1101	8595	773	9736	512	6115
8-#11	2.36	MA	5080	2212	7956	1594	8429	1331	8599	1120	8699	800	9898	476	6746
4L-2S		MI	4862	2212	8082	1546	8708	1290	9068	1083	9548	760	10990	622	6086
8-#14	3.41	MA	5683	2365	9701	1648	10650	1364	11303	1130	12338	752	14621	605	9429
2L-4S		MI	4862	2365	7717	1673	8213	1385	8451	1146	8750	777	9947	331	8138
8-#14	3.41	MA	5446	2365	8989	1661	9737	1393	10189	1156	10822	772	12601	447	9435
3E		MI	4958	2365	8210	1643	8850	1377	9233	1142	9768	759	11179	412	8518
8-#14	3.41	MA	5330	2365	8440	1693	9026	1403	9316	1163	9685	793	11185	361	9015
4L-2S		MI	5167	2365	8844	1632	9663	1350	10225	1118	11118	742	12925	570	8500
8-#18	6.06	MA	6126	2752	10563	1891	11712	1571	12581	1265	14068	741	16578	194	15809
3E		MI	5553	2752	9599	1870	10590	1551	11339	1246	12626	724	14527	131	14046
8-#18	6.06	MA	5940	2752	9611	1945	10478	1583	11067	1271	12097	771	14201	51	13922
4L-2S		MI	5896	2752	10688	1855	11986	1507	13042	1209	14943	699	17410	413	14319
10-#10	2.41	MA	5378	2218	8897	1578	9672	1316	10134	1106	10758	776	12750	666	6911
2L-5S		MI	4602	2218	7234	1597	7636	1344	7761	1130	7755	793	8805	453	6098
10-#10	2.41	MA	5234	2218	8480	1586	9138	1334	9482	1122	9871	790	11523	576	6928
3L-4S		MI	4713	2218	7475	1590	7956	1327	8162	1115	8347	792	9552	504	6284
10-#10	2.41	MA	5162	2218	8161	1606	8725	1341	8975	1128	9210	803	10670	525	6926
4L-3S		MI	4774	2218	7762	1571	8328	1321	8618	1111	8941	780	10300	553	6276
10-#10	2.41	MA	5037	2218	7894	1614	8369	1359	8530	1144	8553	806	9815	475	6711
5L-2S		MI	4901	2218	8134	1563	8806	1304	9201	1095	9734	767	11371	642	6256
10-#11	2.95	MA	5548	2299	9343	1616	10213	1342	10780	1118	11631	762	13798	634	8306
2L-5S		MI	4699	2299	7444	1638	7872	1374	8035	1146	8118	779	9235	374	7135
10-#11	2.95	MA	5379	2299	8842	1625	9571	1363	9996	1138	10564	777	12353	524	8322
3L-4S		MI	4830	2299	7736	1630	8260	1354	8519	1128	8832	780	10109	437	7512
10-#11	2.95	MA	5295	2299	8457	1648	9072	1370	9383	1143	9766	793	11343	463	8298
4L-3S		MI	4900	2299	8082	1608	8708	1348	9068	1125	9548	766	10990	494	7521
10-#11	2.95	MA	5147	2299	8133	1657	8641	1391	8845	1162	8971	794	10336	401	7868
5L-2S		MI	5049	2299	8529	1600	9281	1328	9768	1107	10500	753	12244	604	7501
10-#14	4.26	MA	5748	2489	9701	1738	10650	1449	11303	1190	12338	762	14621	424	11645
3L-4S		MI	5129	2489	8352	1751	9026	1440	9443	1180	10099	767	11693	302	9995
10-#14	4.26	MA	5634	2489	9152	1771	9939	1459	10430	1197	11201	783	13205	339	11111
4L-3S		MI	5224	2489	8844	1720	9663	1433	10225	1176	11118	749	12925	383	10489
10-#14	4.26	MA	5425	2489	8690	1783	9323	1488	9662	1223	10067	783	11797	249	10562
5L-2S		MI	5429	2489	9478	1710	10476	1406	11217	1152	12468	732	14670	541	10494
10-#18	7.58	MA	6457	2974	10838	2083	12052	1683	12986	1332	14708	754	17568	-2	17565
4L-3S		MI	6004	2974	10688	2008	11986	1650	13042	1307	14943	706	17410	65	17152
12-#10	2.89	MA	5555	2289	9313	1622	10207	1348	10785	1125	11645	770	13977	658	8222
2L-6S		MI	4683	2289	7359	1658	7794	1381	7947	1154	8015	800	9193	385	7032
12-#10	2.89	MA	5413	2289	8897	1630	9672	1366	10134	1142	10758	784	12750	569	8233
3L-5S		MI	4763	2289	7607	1641	8114	1375	8344	1149	8548	787	9876	442	7210
12-#10	2.89	MA	5342	2289	8578	1650	9259	1373	9626	1147	10097	798	11897	517	8220
4E		MI	4872	2289	7848	1633	8434	1358	8745	1134	9140	786	10622	493	7443
12-#10	2.89	MA	5218	2289	8311	1658	8903	1391	9182	1164	9439	800	11042	467	7959
5L-3S		MI	4933	2289	8134	1615	8806	1353	9201	1130	9734	774	11371	542	7446
12-#10	2.89	MA	5129	2289	8050	1664	8549	1398	8741	1169	8847	814	10262	408	7741
6L-2S		MI	5058	2289	8507	1607	9284	1335	9784	1114	10527	762	12442	631	7432
12-#11	3.55	MA	5592	2385	9343	1679	10213	1402	10780	1161	11631	771	13798	511	9885
3L-5S		MI	4890	2385	7892	1692	8446	1413	8734	1170	9070	772	10489	356	8473
12-#11	3.55	MA	5510	2385	8958	1702	9714	1409	10167	1167	10833	786	12788	450	9820
4E		MI	5020	2385	8183	1684	8833	1393	9218	1152	9784	773	11363	419	8843
12-#11	3.55	MA	5363	2385	8634	1711	9283	1430	9629	1186	10038	787	11781	388	9372
5L-3S		MI	5089	2385	8529	1662	9281	1387	9768	1148	10500	759	12244	477	8922

RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

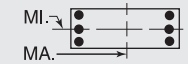
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	3.55	MA	5257	2385	8301	1733	8854	1437	9095	1191	9321	803	10860	318	9049
6L-2S		MI	5235	2385	8977	1654	9855	1367	10468	1130	11452	746	13498	587	8910
12-#14	5.11	MA	5935	2614	9864	1849	10852	1514	11544	1231	12716	773	15225	317	13222
4E		MI	5395	2614	8986	1829	9839	1496	10435	1214	11449	757	13438	273	11867
12-#14	5.11	MA	5731	2614	9402	1861	10236	1544	10776	1257	11583	773	13817	226	12711
5L-3S		MI	5489	2614	9478	1798	10476	1489	11217	1210	12468	739	14670	354	12455
14-#10	3.37	MA	5592	2359	9313	1674	10207	1397	10785	1161	11645	778	13977	561	9534
3L-6S		MI	4845	2359	7732	1702	8272	1413	8530	1173	8808	794	10264	374	8161
14-#10	3.37	MA	5521	2359	8995	1694	9794	1404	10278	1166	10984	792	13123	509	9511
4L-5S		MI	4923	2359	7980	1685	8591	1407	8927	1169	9342	782	10947	431	8329
14-#10	3.37	MA	5399	2359	8728	1702	9438	1422	9833	1183	10326	795	12268	459	9211
5L-4S		MI	5031	2359	8221	1677	8912	1390	9328	1153	9934	781	11693	482	8600
14-#10	3.37	MA	5311	2359	8467	1708	9083	1429	9393	1188	9734	808	11488	400	9006
6L-3S		MI	5091	2359	8507	1659	9284	1384	9784	1149	10527	768	12442	531	8614
14-#11	4.14	MA	5723	2471	9460	1756	10357	1448	10952	1190	11900	779	14233	437	11304
4L-5S		MI	5080	2471	8339	1746	9019	1451	9434	1193	10022	765	11743	339	9817
14-#11	4.14	MA	5578	2471	9136	1765	9926	1469	10413	1209	11105	781	13226	375	10882
5L-4S		MI	5208	2471	8631	1738	9407	1432	9918	1175	10736	766	12617	402	10163
14-#11	4.14	MA	5474	2471	8802	1787	9497	1476	9880	1215	10388	796	12305	305	10531
6L-3S		MI	5276	2471	8977	1716	9855	1426	10468	1172	11452	753	13498	460	10316
14-#14	5.97	MA	6034	2738	10114	1939	11149	1600	11890	1291	13098	763	15837	204	14867
5L-4S		MI	5660	2738	9620	1906	10652	1552	11427	1248	12799	747	15184	244	13752
16-#10	3.85	MA	5699	2429	9412	1737	10328	1436	10930	1185	11871	786	14350	502	10801
4L-6S		MI	5005	2429	8105	1746	8750	1444	9113	1192	9602	788	11334	363	9293
16-#10	3.85	MA	5579	2429	9144	1746	9972	1454	10485	1202	11213	789	13495	451	10469
5E		MI	5082	2429	8352	1729	9069	1438	9511	1188	10135	776	12017	420	9451
16-#10	3.85	MA	5493	2429	8884	1752	9617	1461	10044	1207	10621	803	12715	392	10274
6L-4S		MI	5189	2429	8594	1721	9390	1421	9911	1172	10727	775	12763	471	9755
16-#11	4.73	MA	5792	2558	9637	1819	10569	1508	11198	1233	12172	774	14671	362	12397
5E		MI	5269	2558	8787	1800	9593	1490	10134	1217	10974	759	12997	322	11166
16-#11	4.73	MA	5690	2558	9304	1841	10139	1515	10664	1238	11455	789	13750	292	12019
6L-4S		MI	5396	2558	9078	1792	9981	1470	10618	1199	11688	759	13871	385	11491
18-#10	4.33	MA	5757	2499	9561	1790	10506	1485	11137	1221	12100	783	14722	443	11730
5L-6S		MI	5165	2499	8478	1790	9228	1476	9696	1211	10395	783	12405	352	10411
18-#10	4.33	MA	5673	2499	9301	1795	10152	1492	10696	1226	11508	797	13942	384	11544
6L-5S		MI	5240	2499	8725	1773	9547	1470	10094	1207	10929	770	13088	409	10577
18-#11	5.32	MA	5906	2644	9805	1895	10782	1554	11448	1262	12522	782	15195	279	13513
6L-5S		MI	5457	2644	9234	1854	10166	1529	10834	1240	11926	752	14251	304	12518

RECTANGULAR TIED COLUMNS 22" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.09	MA	5741	2195	9104	1580	9640	1333	9807	1142	9787	858	11041	745	3868
2E		MI	4829	2195	7711	1549	8095	1307	8191	1119	8122	839	8980	714	3246
4-#14	1.57	MA	5938	2272	9592	1619	10241	1360	10529	1156	10764	846	12326	726	5411
2E		MI	4983	2272	8101	1586	8571	1332	8762	1132	8894	827	9929	685	4504
4-#18	2.80	MA	6412	2465	10778	1722	11713	1432	12304	1196	13169	820	15375	668	9156
2E		MI	5350	2465	9038	1686	9728	1401	10155	1169	10782	799	12134	600	7523
6-#9	1.05	MA	5741	2189	9052	1593	9621	1345	9804	1153	9795	868	11060	755	3752
2L-3S		MI	4726	2189	7376	1571	7710	1334	7741	1144	7519	862	8252	665	3169
6-#9	1.05	MA	5607	2189	8687	1600	9153	1351	9233	1167	9018	880	9984	687	3774
3L-2S		MI	4832	2189	7672	1565	8090	1321	8204	1132	8149	852	9109	735	3147
6-#10	1.33	MA	5864	2233	9349	1616	9988	1361	10246	1161	10394	862	11887	748	4683
2L-3S		MI	4797	2233	7538	1595	7906	1353	7975	1155	7835	857	8661	633	3940
6-#10	1.33	MA	5696	2233	8888	1625	9398	1369	9526	1179	9413	877	10529	661	4712
3L-2S		MI	4929	2233	7911	1588	8384	1336	8559	1140	8628	845	9731	723	3911
6-#11	1.64	MA	5980	2282	9660	1634	10352	1372	10675	1165	10969	851	12677	736	5642
2L-3S		MI	4863	2282	7711	1611	8095	1365	8191	1160	8122	846	8980	587	4731

RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

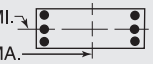
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.64	MA	5782	2282	9104	1644	9640	1394	9807	1186	9787	868	11041	626	5676
3L-2S		MI	5018	2282	8158	1603	8668	1346	8891	1142	9074	832	10234	696	4692
6-#14	2.36	MA	6274	2396	10382	1697	11254	1416	11764	1190	12445	836	14623	709	7915
2L-3S		MI	5033	2396	8101	1675	8571	1415	8762	1190	8894	834	9929	498	6578
6-#14	2.36	MA	5999	2396	9592	1711	10241	1447	10529	1218	10764	859	12326	551	7947
3L-2S		MI	5247	2396	8735	1664	9384	1388	9755	1166	10244	817	11674	656	6534
6-#18	4.20	MA	6980	2687	12144	1861	13463	1531	14439	1256	16075	803	19229	626	13447
2L-3S		MI	5441	2687	9038	1840	9728	1544	10155	1267	10782	806	12134	253	10936
6-#18	4.20	MA	6526	2687	10778	1882	11713	1583	12304	1302	13169	838	15375	345	13357
3L-2S		MI	5796	2687	10127	1825	11123	1500	11858	1229	13099	781	15017	535	10963
8-#8	1.10	MA	5771	2197	9108	1603	9705	1352	9911	1158	9943	870	11268	756	3945
2L-4S		MI	4732	2197	7302	1592	7624	1344	7639	1151	7398	870	8136	652	3343
8-#8	1.10	MA	5665	2197	8818	1608	9333	1357	9457	1169	9326	880	10412	703	3962
3E		MI	4773	2197	7482	1580	7858	1340	7926	1148	7773	862	8615	683	3322
8-#8	1.10	MA	5609	2197	8598	1621	9047	1369	9106	1174	8868	889	9830	672	3982
4L-2S		MI	4857	2197	7718	1575	8160	1329	8295	1138	8274	854	9303	739	3305
8-#9	1.40	MA	5900	2244	9417	1628	10089	1370	10375	1168	10572	864	12136	749	4915
2L-4S		MI	4804	2244	7445	1620	7795	1364	7843	1163	7678	867	8510	618	4147
8-#9	1.40	MA	5768	2244	9052	1635	9621	1376	9804	1182	9795	876	11060	681	4935
3E		MI	4854	2244	7672	1606	8090	1359	8204	1159	8149	857	9109	657	4121
8-#9	1.40	MA	5699	2244	8775	1651	9261	1391	9362	1187	9219	888	10324	642	4956
4L-2S		MI	4959	2244	7968	1599	8469	1346	8667	1147	8778	847	9966	727	4100
8-#10	1.78	MA	6063	2304	9809	1660	10579	1393	10967	1181	11374	856	13244	740	6144
2L-4S		MI	4895	2304	7625	1658	8013	1391	8102	1179	8034	864	8983	573	5154
8-#10	1.78	MA	5899	2304	9349	1669	9988	1400	10246	1198	10394	871	11887	653	6167
3E		MI	4957	2304	7911	1639	8384	1385	8559	1175	8628	851	9731	622	5129
8-#10	1.78	MA	5813	2304	8998	1690	9534	1419	9688	1205	9666	886	10954	603	6179
4L-2S		MI	5087	2304	8284	1632	8862	1368	9142	1159	9421	839	10802	712	5103
8-#11	2.18	MA	6217	2368	10215	1688	11064	1411	11544	1189	12151	844	14313	726	7399
2L-4S		MI	4983	2368	7813	1687	8220	1410	8341	1187	8358	852	9353	512	6172
8-#11	2.18	MA	6023	2368	9660	1698	10352	1433	10675	1209	10969	861	12677	617	7424
3E		MI	5053	2368	8158	1665	8668	1404	8891	1183	9074	839	10234	569	6151
8-#11	2.18	MA	5925	2368	9236	1722	9802	1442	9999	1216	10089	878	11539	554	7420
4L-2S		MI	5205	2368	8606	1657	9242	1384	9591	1166	10026	825	11488	679	6120
8-#14	3.15	MA	6607	2521	11172	1775	12266	1472	13000	1224	14126	826	16919	692	10401
2L-4S		MI	5204	2521	8243	1783	8747	1478	8972	1228	9226	842	10442	388	8297
8-#14	3.15	MA	6339	2521	10382	1789	11254	1503	11764	1252	12445	849	14623	534	10407
3E		MI	5300	2521	8735	1753	9384	1471	9755	1224	10244	824	11674	469	8570
8-#14	3.15	MA	6204	2521	9777	1822	10469	1514	10800	1261	11190	872	13021	445	10078
4L-2S		MI	5510	2521	9369	1742	10197	1444	10747	1200	11594	807	13420	627	8542
8-#18	5.59	MA	7106	2908	12144	2020	13463	1682	14439	1362	16075	820	19229	303	17562
3E		MI	5895	2908	10127	1978	11123	1644	11858	1327	13099	788	15017	187	14289
8-#18	5.59	MA	6887	2908	11090	2077	12098	1698	12763	1373	13893	856	16524	153	15597
4L-2S		MI	6240	2908	11216	1963	12519	1600	13561	1289	15416	764	17900	469	14380
10-#10	2.22	MA	6261	2374	10270	1704	11170	1424	11687	1200	12354	851	14601	732	7597
2L-5S		MI	4944	2374	7756	1709	8170	1439	8285	1213	8236	859	9307	511	6195
10-#10	2.22	MA	6100	2374	9809	1713	10579	1432	10967	1217	11374	866	13244	645	7614
3L-4S		MI	5055	2374	7998	1702	8491	1422	8686	1198	8827	858	10053	562	6323
10-#10	2.22	MA	6015	2374	9459	1734	10125	1451	10408	1224	10646	881	12311	595	7612
4L-3S		MI	5117	2374	8284	1683	8862	1416	9142	1194	9421	846	10802	611	6308
10-#10	2.22	MA	5876	2374	9166	1743	9733	1458	9919	1241	9923	884	11374	547	7437
5L-2S		MI	5244	2374	8657	1675	9340	1399	9725	1178	10215	834	11872	701	6286
10-#11	2.73	MA	6453	2454	10771	1742	11776	1450	12412	1212	13332	837	15949	717	9148
2L-5S		MI	5041	2454	7968	1749	8406	1469	8557	1228	8596	845	9733	431	7247

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

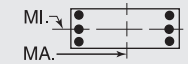
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	2.73	MA	6263	2454	10215	1752	11064	1472	11544	1233	12151	854	14313	607	9164
3L-4S		MI	5173	2454	8260	1741	8794	1449	9041	1211	9310	845	10607	494	7565
10-#11	2.73	MA	6166	2454	9791	1776	10514	1480	10868	1240	11270	871	13175	544	9140
4L-3S		MI	5243	2454	8606	1719	9242	1443	9591	1207	10026	832	11488	552	7561
10-#11	2.73	MA	6000	2454	9435	1787	10040	1503	10275	1260	10394	874	12035	482	8730
5L-2S		MI	5392	2454	9053	1711	9816	1423	10291	1189	10978	819	12742	662	7538
10-#14	3.93	MA	6677	2645	11172	1866	12266	1559	13000	1286	14126	839	16919	517	12860
3L-4S		MI	5472	2645	8877	1861	9560	1534	9964	1262	10576	832	12188	359	10149
10-#14	3.93	MA	6544	2645	10567	1900	11482	1570	12035	1295	12871	862	15317	428	12410
4L-3S		MI	5566	2645	9369	1830	10197	1527	10747	1258	11594	815	13420	440	10545
10-#14	3.93	MA	6311	2645	10058	1914	10804	1601	11190	1323	11620	866	13716	339	11738
5L-2S		MI	5772	2645	10004	1820	11011	1500	11739	1234	12944	797	15165	598	10539
10-#18	6.99	MA	7467	3129	12456	2216	13849	1797	14899	1434	16798	838	20379	111	19677
4L-3S		MI	6346	3129	11216	2116	12519	1743	13561	1387	15416	770	17900	122	17413
12-#10	2.66	MA	6459	2444	10731	1748	11760	1456	12408	1219	13335	845	15958	724	9045
2L-6S		MI	5025	2444	7882	1770	8328	1477	8471	1237	8495	866	9695	443	7123
12-#10	2.66	MA	6300	2444	10270	1757	11170	1463	11687	1237	12354	860	14601	637	9056
3L-5S		MI	5105	2444	8129	1753	8648	1471	8868	1233	9029	854	10378	500	7306
12-#10	2.66	MA	6216	2444	9920	1777	10715	1482	11129	1243	11627	875	13669	587	9043
4E		MI	5215	2444	8370	1745	8969	1454	9269	1217	9621	853	11124	551	7486
12-#10	2.66	MA	6079	2444	9626	1786	10324	1490	10640	1260	10903	879	12731	540	8817
5L-3S		MI	5276	2444	8657	1727	9340	1448	9725	1213	10215	840	11872	600	7481
12-#10	2.66	MA	5979	2444	9333	1792	9935	1509	10156	1267	10252	894	11880	481	8553
6L-2S		MI	5401	2444	9030	1719	9818	1431	10308	1197	11008	828	12943	690	7464
12-#11	3.27	MA	6501	2540	10771	1806	11776	1511	12412	1256	13332	847	15949	598	10896
3L-5S		MI	5232	2540	8416	1803	8980	1507	9257	1252	9548	838	10987	414	8583
12-#11	3.27	MA	6406	2540	10346	1830	11226	1519	11736	1263	12452	864	14811	535	10858
4E		MI	5362	2540	8708	1795	9368	1488	9741	1234	10262	838	11861	477	8953
12-#11	3.27	MA	6242	2540	9990	1841	10752	1541	11144	1284	11576	867	13671	473	10397
5L-3S		MI	5431	2540	9053	1773	9816	1482	10291	1231	10978	825	12742	535	8965
12-#11	3.27	MA	6123	2540	9642	1848	10280	1550	10557	1290	10787	884	12632	400	10113
6L-2S		MI	5578	2540	9501	1765	10389	1462	10990	1213	11930	812	13996	645	8949
12-#14	4.72	MA	6882	2770	11357	1978	12494	1626	13271	1329	14552	852	17613	412	14757
4E		MI	5738	2770	9512	1939	10373	1590	10957	1296	11926	822	13934	330	12017
12-#14	4.72	MA	6653	2770	10848	1992	11817	1657	12425	1357	13301	856	16013	322	14126
5L-3S		MI	5832	2770	10004	1908	11011	1583	11739	1291	12944	805	15165	411	12514
14-#10	3.11	MA	6499	2514	10731	1801	11760	1495	12408	1256	13335	854	15958	630	10494
3L-6S		MI	5187	2514	8255	1814	8806	1508	9054	1256	9289	860	10765	432	8251
14-#10	3.11	MA	6416	2514	10380	1821	11306	1514	11849	1262	12607	869	15026	579	10471
4L-5S		MI	5265	2514	8502	1797	9126	1502	9451	1252	9822	848	11448	489	8423
14-#10	3.11	MA	6280	2514	10087	1830	10915	1521	11360	1280	11884	873	14088	532	10204
5L-4S		MI	5373	2514	8743	1789	9447	1485	9852	1236	10414	847	12194	540	8645
14-#10	3.11	MA	6183	2514	9794	1836	10525	1540	10876	1286	11233	888	13237	473	9953
6L-3S		MI	5434	2514	9030	1771	9818	1480	10308	1232	11008	835	12943	589	8650
14-#10	3.11	MA	6083	2514	9463	1852	10146	1546	10414	1304	10598	903	12356	434	9611
7L-2S		MI	5558	2514	9403	1763	10296	1463	10891	1217	11801	822	14014	678	8638
14-#11	3.82	MA	6644	2627	10902	1884	11938	1558	12605	1287	13634	857	16447	525	12575
4L-5S		MI	5422	2627	8863	1857	9554	1546	9957	1276	10500	831	12241	397	9925
14-#11	3.82	MA	6483	2627	10546	1895	11464	1580	12012	1307	12758	860	15307	463	12071
5L-4S		MI	5551	2627	9155	1849	9941	1526	10441	1258	11214	831	13115	460	10288
14-#11	3.82	MA	6366	2627	10198	1902	10992	1588	11425	1314	11969	877	14268	391	11766
6L-3S		MI	5619	2627	9501	1827	10389	1520	10990	1254	11930	818	13996	517	10365
14-#14	5.51	MA	6992	2894	11638	2070	12830	1713	13660	1391	14982	846	18309	305	16521
5L-4S		MI	6003	2894	10146	2017	11187	1646	11949	1329	13276	812	15679	301	13898

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

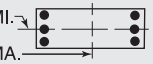
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	3.55	MA	6615	2585	10841	1865	11896	1545	12570	1281	13587	864	16383	571	11899
4L-6S		MI	5347	2585	8627	1858	9284	1540	9637	1275	10082	855	11836	421	9382
16-#10	3.55	MA	6481	2585	10548	1874	11505	1553	12081	1299	12864	867	15445	524	11595
5E		MI	5424	2585	8875	1841	9604	1534	10034	1271	10616	842	12519	478	9544
16-#10	3.55	MA	6385	2585	10254	1880	11116	1572	11597	1305	12213	882	14595	466	11356
6L-4S		MI	5532	2585	9116	1833	9925	1517	10435	1255	11207	841	13265	529	9803
16-#10	3.55	MA	6287	2585	9924	1896	10737	1578	11134	1323	11578	897	13713	426	10997
7L-3S		MI	5592	2585	9403	1815	10296	1511	10891	1251	11801	829	14014	578	9817
16-#11	4.36	MA	6722	2713	11101	1948	12176	1619	12881	1331	13940	853	16944	454	13751
5E		MI	5611	2713	9311	1911	10127	1585	10657	1299	11452	824	13495	379	11272
16-#11	4.36	MA	6608	2713	10753	1956	11704	1627	12294	1337	13151	870	15904	381	13420
6L-4S		MI	5739	2713	9603	1903	10515	1565	11140	1281	12166	825	14369	442	11613
18-#10	4.00	MA	6681	2655	11008	1918	12096	1584	12801	1318	13844	862	16803	516	12989
5L-6S		MI	5507	2655	9000	1902	9762	1571	10220	1294	10876	849	12906	410	10516
18-#10	4.00	MA	6587	2655	10715	1924	11707	1603	12317	1324	13193	877	15952	458	12762
6L-5S		MI	5583	2655	9248	1885	10082	1566	10617	1290	11409	837	13589	467	10669
18-#10	4.00	MA	6489	2655	10384	1940	11327	1610	11855	1342	12559	892	15070	418	12385
7L-4S		MI	5689	2655	9489	1877	10403	1548	11018	1275	12001	836	14335	518	10959
18-#11	4.91	MA	6849	2799	11309	2010	12416	1666	13162	1361	14332	863	17540	372	15079
6L-5S		MI	5800	2799	9758	1965	10701	1623	11356	1323	12405	817	14749	362	12624
20-#10	4.44	MA	6787	2725	11176	1968	12297	1635	13037	1343	14173	871	17309	450	14170
6E		MI	5667	2725	9373	1946	10240	1603	10803	1313	11669	843	13977	399	11651
20-#10	4.44	MA	6689	2725	10845	1983	11918	1641	12575	1361	13539	886	16428	411	13777
7L-5S		MI	5741	2725	9621	1929	10560	1597	11201	1309	12203	831	14660	456	11797

RECTANGULAR TIED COLUMNS 22" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.01	MA	6634	2351	10458	1707	11092	1441	11282	1236	11236	932	12653	811	4205
2E		MI	5172	2351	8235	1660	8629	1401	8714	1201	8600	905	9478	771	3271
4-#14	1.46	MA	6853	2427	10997	1745	11754	1468	12079	1250	12314	921	14140	798	5897
2E		MI	5325	2427	8626	1696	9105	1426	9284	1214	9371	892	10424	742	4536
4-#18	2.60	MA	7382	2621	12309	1849	13383	1539	14043	1290	14974	895	17643	752	10020
2E		MI	5693	2621	9566	1795	10261	1493	10675	1249	11255	863	12624	657	7568
6-#10	1.24	MA	6768	2389	10723	1743	11469	1469	11760	1255	11895	937	13573	813	5095
2L-3S		MI	5139	2389	8061	1707	8441	1449	8499	1239	8315	923	9162	692	3964
6-#10	1.24	MA	6582	2389	10218	1752	10822	1477	10971	1274	10822	953	12086	729	5123
3L-2S		MI	5271	2389	8434	1700	8919	1432	9082	1223	9109	911	10233	781	3935
6-#11	1.52	MA	6898	2437	11068	1761	11873	1480	12235	1259	12533	926	14448	802	6147
2L-3S		MI	5205	2437	8235	1722	8629	1460	8714	1242	8600	911	9478	644	4761
6-#11	1.52	MA	6677	2437	10458	1772	11092	1489	11282	1281	11236	944	12653	695	6182
3L-2S		MI	5360	2437	8683	1714	9203	1440	9413	1225	9552	898	10732	754	4722
6-#14	2.19	MA	7225	2552	11864	1823	12867	1524	13436	1284	14160	911	16697	784	8644
2L-3S		MI	5375	2552	8626	1785	9105	1509	9284	1272	9371	900	10424	555	6619
6-#14	2.19	MA	6919	2552	10997	1838	11754	1556	12079	1314	12314	936	14140	627	8676
3L-2S		MI	5590	2552	9261	1774	9918	1482	10276	1248	10721	882	12169	713	6570
6-#18	3.90	MA	8013	2842	13813	1987	15311	1639	16394	1350	18174	877	21988	719	14743
2L-3S		MI	5783	2842	9566	1948	10261	1637	10675	1347	11255	870	12624	310	11013
6-#18	3.90	MA	7506	2842	12309	2011	13383	1693	14043	1400	14974	917	17643	438	14653
3L-2S		MI	6139	2842	10655	1933	11657	1593	12377	1310	13572	845	15507	591	11016
8-#8	1.03	MA	6665	2353	10457	1729	11156	1460	11389	1252	11398	945	12890	822	4286
2L-4S		MI	5074	2353	7823	1705	8159	1440	8164	1235	7881	937	8640	710	3363
8-#8	1.03	MA	6547	2353	10139	1735	10749	1465	10893	1264	10723	955	11954	770	4303
3E		MI	5115	2353	8003	1693	8393	1436	8451	1232	8255	929	9119	742	3341
8-#8	1.03	MA	6484	2353	9899	1748	10437	1478	10510	1269	10224	965	11323	739	4323
4L-2S		MI	5199	2353	8239	1688	8695	1425	8819	1222	8756	920	9807	797	3325
8-#9	1.30	MA	6808	2399	10796	1754	11578	1477	11899	1262	12088	938	13842	814	5347
2L-4S		MI	5146	2399	7967	1733	8330	1460	8367	1247	8159	934	9013	676	4172

RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

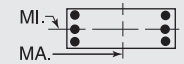
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	1.30	MA	6661	2399	10396	1762	11066	1484	11274	1276	11237	951	12664	748	5367
3E		MI	5196	2399	8194	1718	8625	1455	8729	1243	8630	924	9612	715	4145
8-#9	1.30	MA	6583	2399	10094	1778	10673	1500	10791	1282	10609	964	11867	709	5388
4L-2S		MI	5301	2399	8490	1712	9004	1441	9192	1230	9260	914	10469	786	4123
8-#10	1.65	MA	6989	2459	11227	1787	12116	1500	12549	1275	12969	931	15059	805	6693
2L-4S		MI	5237	2459	8147	1770	8548	1486	8626	1262	8515	930	9484	631	5185
8-#10	1.65	MA	6806	2459	10723	1796	11469	1509	11760	1293	11895	947	13573	721	6715
3E		MI	5300	2459	8434	1751	8919	1480	9082	1258	9109	918	10233	680	5157
8-#10	1.65	MA	6709	2459	10340	1817	10973	1528	11150	1300	11101	963	12563	671	6727
4L-2S		MI	5429	2459	8807	1744	9397	1463	9665	1242	9902	905	11303	770	5130
8-#11	2.03	MA	7161	2523	11677	1815	12654	1519	13188	1283	13829	919	16243	792	8073
2L-4S		MI	5325	2523	8337	1798	8755	1505	8864	1270	8836	918	9851	569	6214
8-#11	2.03	MA	6945	2523	11068	1826	11873	1528	12235	1305	12533	937	14448	685	8098
3E		MI	5396	2523	8683	1776	9203	1499	9413	1266	9552	904	10732	627	6186
8-#11	2.03	MA	6832	2523	10604	1850	11272	1551	11496	1312	11570	955	13215	623	8094
4L-2S		MI	5548	2523	9130	1768	9776	1479	10113	1248	10504	891	11986	737	6153
8-#14	2.92	MA	7594	2676	12732	1901	13979	1580	14793	1318	16007	901	19253	770	11373
2L-4S		MI	5546	2676	8768	1893	9281	1572	9494	1310	9703	907	10938	445	8450
8-#14	2.92	MA	7296	2676	11864	1916	12867	1612	13436	1348	14160	926	16697	614	11379
3E		MI	5642	2676	9261	1863	9918	1565	10276	1305	10721	890	12169	526	8615
8-#14	2.92	MA	7141	2676	11202	1951	12008	1625	12381	1358	12786	951	14925	523	11163
4L-2S		MI	5853	2676	9895	1852	10731	1538	11268	1281	12071	872	13915	684	8583
8-#18	5.19	MA	8151	3063	13813	2149	15311	1793	16394	1460	18174	899	21988	405	19290
3E		MI	6237	3063	10655	2086	11657	1736	12377	1408	13572	852	15507	244	14372
8-#18	5.19	MA	7897	3063	12658	2209	13815	1812	14557	1474	15781	939	18953	249	17301
4L-2S		MI	6583	3063	11743	2071	13053	1692	14080	1370	15889	828	18390	525	14435
10-#10	2.06	MA	7208	2530	11732	1831	12763	1532	13338	1294	14043	925	16546	798	8283
2L-5S		MI	5286	2530	8279	1821	8705	1535	8809	1297	8716	925	9808	569	6289
10-#10	2.06	MA	7028	2530	11227	1840	12116	1540	12549	1312	12969	941	15059	713	8299
3L-4S		MI	5397	2530	8520	1814	9026	1518	9209	1281	9308	924	10555	620	6358
10-#10	2.06	MA	6932	2530	10845	1861	11620	1560	11939	1319	12175	957	14049	663	8298
4L-3S		MI	5459	2530	8807	1795	9397	1512	9665	1277	9902	912	11303	669	6339
10-#10	2.06	MA	6778	2530	10525	1871	11194	1568	11406	1338	11386	962	13030	619	8172
5L-2S		MI	5587	2530	9179	1787	9875	1495	10249	1262	10695	900	12374	759	6316
10-#11	2.53	MA	7422	2610	12286	1869	13435	1557	14141	1306	15126	912	18039	782	9991
2L-5S		MI	5383	2610	8493	1860	8941	1563	9080	1311	9074	910	10230	489	7354
10-#11	2.53	MA	7210	2610	11677	1880	12654	1567	13188	1328	13829	930	16243	676	10007
3L-4S		MI	5515	2610	8784	1852	9329	1543	9563	1293	9788	911	11105	552	7615
10-#11	2.53	MA	7099	2610	11213	1904	12053	1590	12449	1336	12867	948	15010	614	9982
4L-3S		MI	5585	2610	9130	1830	9776	1537	10113	1289	10504	898	11986	610	7600
10-#11	2.53	MA	6916	2610	10825	1915	11535	1599	11803	1357	11910	953	13769	555	9602
5L-2S		MI	5735	2610	9578	1822	10350	1518	10813	1272	11456	884	13240	719	7573
10-#14	3.65	MA	7671	2801	12732	1994	13979	1668	14793	1382	16007	916	19253	600	14075
3L-4S		MI	5814	2801	9403	1971	10094	1628	10486	1343	11053	897	12683	416	10298
10-#14	3.65	MA	7518	2801	12070	2029	13121	1681	13738	1392	14633	941	17482	509	13731
4L-3S		MI	5909	2801	9895	1940	10731	1621	11268	1339	12071	880	13915	497	10599
10-#14	3.65	MA	7260	2801	11515	2044	12381	1713	12814	1422	13266	947	15705	422	12927
5L-2S		MI	6116	2801	10529	1930	11545	1594	12260	1315	13421	862	15660	655	10583
10-#18	6.49	MA	8541	3285	14162	2347	15743	1911	16909	1534	18981	922	23298	217	21807
4L-3S		MI	6688	3285	11743	2225	13053	1835	14080	1468	15889	835	18390	178	17668
12-#10	2.47	MA	7426	2600	12236	1875	13410	1563	14127	1313	15116	920	18033	790	9868
2L-6S		MI	5367	2600	8404	1882	8863	1572	8995	1320	8976	932	10196	502	7210
12-#10	2.47	MA	7249	2600	11732	1884	12763	1572	13338	1331	14043	936	16546	705	9879
3L-5S		MI	5447	2600	8652	1865	9183	1566	9392	1316	9510	920	10879	558	7399

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis

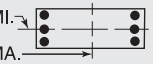


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	2.47	MA	7154	2600	11349	1905	12267	1591	12728	1338	13248	952	15536	656	9866
4E		MI	5557	2600	8893	1857	9504	1549	9792	1300	10101	919	11625	609	7527
12-#10	2.47	MA	7002	2600	11030	1915	11841	1600	12196	1357	12459	956	14517	611	9686
5L-3S		MI	5618	2600	9179	1839	9875	1544	10249	1296	10695	907	12374	658	7514
12-#10	2.47	MA	6892	2600	10704	1920	11417	1619	11668	1364	11750	972	13596	553	9372
6L-2S		MI	5744	2600	9552	1831	10353	1526	10832	1281	11489	894	13445	748	7495
12-#11	3.04	MA	7474	2696	12286	1934	13435	1606	14141	1352	15126	923	18039	666	11907
3L-5S		MI	5574	2696	8940	1914	9514	1602	9779	1334	10026	904	11484	471	8689
12-#11	3.04	MA	7365	2696	11823	1958	12834	1629	13402	1359	14163	942	16805	604	11869
4E		MI	5704	2696	9232	1906	9902	1582	10263	1317	10740	904	12359	534	9005
12-#11	3.04	MA	7184	2696	11435	1969	12317	1638	12756	1381	13207	946	15565	546	11434
5L-3S		MI	5774	2696	9578	1884	10350	1576	10813	1313	11456	891	13240	592	9006
12-#11	3.04	MA	7052	2696	11047	1976	11802	1661	12115	1389	12346	964	14439	474	11097
6L-2S		MI	5922	2696	10025	1876	10924	1556	11513	1295	12408	877	14494	702	8987
12-#14	4.38	MA	7892	2925	12938	2107	14233	1736	15095	1426	16479	931	20039	496	16314
4E		MI	6080	2925	10037	2049	10908	1684	11478	1377	12402	887	14429	387	12163
12-#14	4.38	MA	7639	2925	12383	2122	13494	1769	14171	1456	15113	937	18262	408	15554
5L-3S		MI	6174	2925	10529	2018	11545	1677	12260	1373	13421	870	15660	468	12571
12-#14	4.38	MA	7454	2925	11837	2132	12757	1782	13255	1466	13882	962	16644	304	14689
6L-2S		MI	6377	2925	11164	2008	12358	1649	13252	1349	14770	852	17406	627	12575
14-#10	2.89	MA	7469	2670	12236	1928	13410	1603	14127	1350	15116	930	18033	698	11454
3L-6S		MI	5529	2670	8777	1926	9341	1604	9578	1339	9769	926	11267	491	8337
14-#10	2.89	MA	7375	2670	11854	1949	12914	1623	13517	1358	14322	946	17023	648	11431
4L-5S		MI	5607	2670	9025	1909	9661	1598	9975	1335	10303	914	11950	547	8514
14-#10	2.89	MA	7225	2670	11535	1959	12488	1631	12985	1376	13533	951	16003	603	11206
5L-4S		MI	5716	2670	9266	1901	9982	1581	10376	1320	10895	913	12696	598	8688
14-#10	2.89	MA	7117	2670	11209	1964	12064	1651	12457	1383	12824	967	15083	545	10907
6L-3S		MI	5776	2670	9552	1883	10353	1575	10832	1315	11489	901	13445	647	8685
14-#10	2.89	MA	7005	2670	10848	1980	11642	1657	11953	1402	12132	983	14126	509	10592
7L-2S		MI	5901	2670	9925	1875	10831	1558	11415	1300	12282	889	14515	737	8671
14-#11	3.55	MA	7629	2782	12432	2012	13615	1667	14355	1383	15460	935	18600	595	13755
4L-5S		MI	5764	2782	9388	1968	10088	1641	10479	1358	10978	897	12739	454	10029
14-#11	3.55	MA	7450	2782	12044	2023	13098	1677	13709	1404	14503	939	17360	536	13273
5L-4S		MI	5893	2782	9679	1960	10476	1621	10963	1340	11693	897	13613	517	10394
14-#11	3.55	MA	7322	2782	11656	2030	12583	1700	13068	1412	13642	958	16234	465	12953
6L-3S		MI	5962	2782	10025	1938	10924	1615	11513	1336	12408	884	14494	575	10408
14-#11	3.55	MA	7190	2782	11219	2050	12081	1708	12456	1434	12803	976	15068	416	12371
7L-2S		MI	6108	2782	10473	1930	11497	1595	12213	1319	13361	870	15748	685	10395
14-#14	5.11	MA	8015	3050	13251	2200	14606	1825	15528	1490	16959	927	20819	395	18189
5L-4S		MI	6345	3050	10672	2127	11721	1740	12470	1411	13752	877	16174	359	14040
14-#14	5.11	MA	7836	3050	12704	2210	13870	1838	14612	1500	15728	952	19201	290	17297
6L-3S		MI	6438	3050	11164	2096	12358	1733	13252	1407	14770	860	17406	439	14540
16-#10	3.30	MA	7595	2740	12359	1993	13561	1654	14307	1377	15396	941	18509	640	12996
4L-6S		MI	5689	2740	9150	1970	9819	1635	10161	1358	10563	921	12337	479	9468
16-#10	3.30	MA	7447	2740	12039	2002	13135	1663	13774	1395	14607	945	17490	595	12731
5E		MI	5767	2740	9397	1953	10139	1630	10558	1354	11096	909	13020	536	9634
16-#10	3.30	MA	7341	2740	11714	2008	12711	1682	13246	1402	13897	961	16570	538	12446
6L-4S		MI	5874	2740	9639	1945	10460	1612	10959	1339	11688	908	13766	587	9848
16-#10	3.30	MA	7229	2740	11352	2024	12289	1688	12742	1421	13206	977	15613	501	12113
7L-3S		MI	5934	2740	9925	1927	10831	1607	11415	1335	12282	895	14515	636	9854
16-#10	3.30	MA	7103	2740	11035	2031	11851	1704	12247	1438	12470	982	14564	435	11720
8L-2S		MI	6057	2740	10298	1919	11309	1590	11998	1319	13075	883	15586	726	9843
16-#11	4.05	MA	7715	2869	12653	2077	13879	1716	14661	1428	15800	932	19155	527	15117
5E		MI	5954	2869	9835	2022	10662	1679	11179	1382	11931	890	13993	437	11375
16-#11	4.05	MA	7589	2869	12266	2084	13364	1739	14021	1436	14939	951	18029	455	14812
6L-4S		MI	6081	2869	10127	2014	11049	1660	11663	1364	12645	890	14867	500	11732
16-#11	4.05	MA	7459	2869	11828	2104	12862	1746	13409	1457	14100	969	16863	407	14212
7L-3S		MI	6149	2869	10473	1992	11497	1654	12213	1360	13361	877	15748	558	11805

RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	5.84	MA	8214	3174	13572	2288	14982	1893	15970	1534	17575	942	21758	276	19911
6L-4S		MI	6610	3174	11306	2204	12534	1796	13462	1445	15102	867	17920	330	15928
18-#10	3.71	MA	7667	2811	12544	2046	13782	1694	14563	1414	15680	940	18977	587	14260
5L-6S		MI	5849	2811	9523	2014	10297	1667	10744	1378	11356	915	13408	468	10601
18-#10	3.71	MA	7564	2811	12218	2051	13358	1714	14035	1421	14971	956	18056	530	13986
6L-5S		MI	5925	2811	9770	1997	10617	1661	11141	1373	11890	903	14091	525	10758
18-#10	3.71	MA	7452	2811	11857	2068	12936	1720	13532	1440	14280	972	17100	493	13638
7L-4S		MI	6032	2811	10011	1989	10938	1644	11542	1358	12481	902	14837	576	11005
18-#10	3.71	MA	7328	2811	11540	2075	12498	1736	13036	1458	13544	976	16051	427	13256
8L-3S		MI	6092	2811	10298	1971	11309	1638	11998	1354	13075	890	15586	625	11019
18-#11	4.56	MA	7855	2955	12875	2138	14145	1778	14974	1459	16235	944	19825	446	16669
6L-5S		MI	6142	2955	10283	2076	11235	1718	11879	1405	12883	883	15247	419	12726
18-#11	4.56	MA	7725	2955	12437	2157	13643	1785	14362	1481	15396	962	18659	397	16056
7L-4S		MI	6269	2955	10574	2068	11623	1698	12363	1387	13597	883	16121	483	13062
20-#10	4.12	MA	7785	2881	12723	2095	14004	1746	14824	1441	16045	950	19543	522	15530
6E		MI	6009	2881	9896	2058	10775	1698	11327	1397	12149	910	14479	457	11736
20-#10	4.12	MA	7674	2881	12362	2112	13583	1751	14321	1459	15353	966	18586	485	15165
7L-5S		MI	6084	2881	10143	2041	11095	1693	11724	1393	12683	897	15161	514	11885
20-#10	4.12	MA	7552	2881	12045	2118	13145	1767	13825	1477	14617	971	17538	419	14795
8L-4S		MI	6189	2881	10384	2033	11416	1676	12125	1377	13275	896	15908	565	12162
20-#11	5.06	MA	7991	3041	13047	2211	14425	1824	15315	1504	16693	955	20454	388	17903
7L-5S		MI	6330	3041	10730	2130	11809	1757	12579	1429	13835	876	16501	402	14079
22-#10	4.54	MA	7895	2951	12866	2156	14229	1783	15110	1478	16427	960	20073	477	16695
7L-6S		MI	6168	2951	10269	2102	11253	1730	11910	1416	12943	904	15549	446	12872
22-#10	4.54	MA	7775	2951	12549	2162	13791	1799	14614	1496	15691	965	19024	411	16335
8L-5S		MI	6241	2951	10516	2084	11573	1724	12307	1412	13476	892	16232	503	13014

RECTANGULAR TIED COLUMNS 22" x 30"

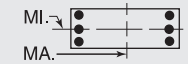
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.36	MA	7831	2583	12489	1872	13364	1576	13726	1344	13955	996	15990	864	6383
2E		MI	5668	2583	9152	1806	9639	1520	9805	1295	9848	957	10919	799	4566
4-#18	2.42	MA	8416	2776	13928	1975	15149	1647	15879	1384	16871	970	20015	833	10884
2E		MI	6035	2776	10094	1903	10795	1586	11194	1330	11728	927	13114	713	7613
6-#10	1.15	MA	7735	2545	12185	1869	13046	1577	13370	1349	13489	1011	15358	879	5506
2L-3S		MI	5482	2545	8583	1819	8976	1544	9023	1322	8796	990	9664	750	3987
6-#10	1.15	MA	7530	2545	11636	1879	12343	1586	12512	1369	12322	1028	13742	796	5535
3L-2S		MI	5614	2545	8956	1812	9454	1527	9606	1307	9589	977	10734	839	3958
6-#11	1.42	MA	7879	2593	12564	1887	13489	1588	13892	1353	14189	1000	16319	867	6653
2L-3S		MI	5547	2593	8760	1833	9164	1554	9236	1325	9078	977	9976	702	4790
6-#11	1.42	MA	7636	2593	11901	1899	12639	1598	12855	1376	12778	1020	14365	763	6687
3L-2S		MI	5703	2593	9207	1825	9737	1535	9936	1307	10030	964	11230	812	4750
6-#14	2.05	MA	8240	2707	13435	1950	14576	1631	15205	1378	15967	986	18776	850	9373
2L-3S		MI	5717	2707	9152	1895	9639	1603	9805	1353	9848	965	10919	612	6659
6-#14	2.05	MA	7901	2707	12489	1966	13364	1645	13726	1409	13955	1013	15990	697	9405
3L-2S		MI	5933	2707	9786	1884	10452	1576	10797	1329	11197	947	12665	770	6606
6-#18	3.64	MA	9110	2998	15570	2113	17254	1747	18447	1444	20365	952	24852	808	16039
2L-3S		MI	6125	2998	10094	2057	10795	1729	11194	1428	11728	934	13114	366	11085
6-#18	3.64	MA	8550	2998	13928	2140	15149	1804	15879	1496	16871	996	20015	527	15949
3L-2S		MI	6482	2998	11182	2041	12190	1685	12897	1390	14045	910	15997	647	11067
8-#9	1.21	MA	7778	2555	12264	1880	13163	1585	13520	1356	13696	1013	15648	880	5779
2L-4S		MI	5488	2555	8488	1845	8865	1556	8891	1330	8641	1000	9516	734	4195

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	1.21	MA	7616	2555	11830	1888	12606	1592	12840	1371	12772	1027	14369	815	5799
3E		MI	5539	2555	8715	1830	9159	1551	9253	1326	9111	990	10115	774	4167
8-#9	1.21	MA	7529	2555	11502	1905	12181	1609	12318	1377	12091	1040	13511	777	5820
4L-2S		MI	5644	2555	9012	1824	9539	1537	9716	1314	9741	980	10972	844	4146
8-#10	1.54	MA	7977	2615	12734	1913	13749	1608	14228	1369	14656	1006	16974	871	7241
2L-4S		MI	5580	2615	8670	1882	9082	1582	9150	1345	8995	996	9986	690	5215
8-#10	1.54	MA	7775	2615	12185	1923	13046	1617	13370	1388	13489	1023	15358	788	7264
3E		MI	5642	2615	8956	1863	9454	1576	9606	1341	9589	984	10734	739	5184
8-#10	1.54	MA	7667	2615	11771	1945	12509	1637	12709	1396	12628	1040	14271	739	7276
4L-2S		MI	5772	2615	9329	1856	9932	1559	10189	1326	10382	972	11805	828	5156
8-#11	1.89	MA	8168	2679	13227	1941	14340	1626	14930	1377	15600	993	18273	858	8747
2L-4S		MI	5667	2679	8861	1909	9289	1599	9386	1352	9314	983	10348	627	6253
8-#11	1.89	MA	7929	2679	12564	1953	13489	1637	13892	1399	14189	1013	16319	753	8772
3E		MI	5738	2679	9207	1887	9737	1593	9936	1348	10030	970	11230	684	6220
8-#11	1.89	MA	7803	2679	12061	1978	12837	1661	13091	1408	13144	1032	14990	692	8767
4L-2S		MI	5891	2679	9655	1879	10311	1573	10636	1331	10982	957	12484	794	6185
8-#14	2.73	MA	8646	2832	14381	2027	15788	1687	16684	1412	17979	976	21562	836	12345
2L-4S		MI	5888	2832	9294	2003	9815	1666	10015	1391	10179	972	11433	502	8599
8-#14	2.73	MA	8316	2832	13435	2044	14576	1701	15205	1443	15967	1003	18776	683	12351
3E		MI	5985	2832	9786	1973	10452	1659	10797	1387	11197	955	12665	583	8660
8-#14	2.73	MA	8140	2832	12716	2080	13644	1735	14059	1455	14475	1030	16867	594	12242
4L-2S		MI	6196	2832	10420	1962	11266	1632	11789	1363	12547	937	14410	742	8623
8-#18	4.85	MA	9259	3219	15570	2278	17254	1903	18447	1557	20365	978	24852	502	21018
3E		MI	6579	3219	11182	2195	12190	1829	12897	1488	14045	916	15997	300	14451
8-#18	4.85	MA	8970	3219	14315	2339	15627	1925	16448	1574	17761	1021	21487	341	19031
4L-2S		MI	6927	3219	12271	2180	13586	1785	14599	1451	16362	892	18880	582	14491
10-#10	1.92	MA	8217	2685	13282	1957	14453	1640	15086	1388	15823	1000	18590	863	8968
2L-5S		MI	5629	2685	8801	1933	9239	1630	9333	1380	9197	992	10310	628	6380
10-#10	1.92	MA	8019	2685	12734	1967	13749	1649	14228	1407	14656	1017	16974	781	8985
3L-4S		MI	5740	2685	9043	1926	9560	1613	9733	1365	9789	991	11056	678	6392
10-#10	1.92	MA	7912	2685	12319	1989	13212	1669	13567	1415	13795	1034	15887	732	8984
4L-3S		MI	5802	2685	9329	1907	9932	1608	10189	1360	10382	978	11805	728	6369
10-#10	1.92	MA	7743	2685	11974	1999	12751	1678	12990	1434	12940	1040	14786	689	8917
5L-2S		MI	5930	2685	9702	1899	10410	1590	10772	1345	11176	966	12876	817	6344
10-#11	2.36	MA	8455	2765	13890	1995	15190	1665	15967	1400	17011	987	20227	848	10833
2L-5S		MI	5725	2765	9017	1971	9475	1658	9602	1393	9552	976	10728	546	7458
10-#11	2.36	MA	8221	2765	13227	2007	14340	1675	14930	1423	15600	1006	18273	744	10849
3L-4S		MI	5857	2765	9309	1963	9863	1638	10086	1376	10267	977	11602	609	7658
10-#11	2.36	MA	8096	2765	12724	2032	13687	1699	14128	1432	14556	1026	16944	683	10825
4L-3S		MI	5927	2765	9655	1941	10311	1632	10636	1372	10982	963	12484	667	7637
10-#11	2.36	MA	7894	2765	12304	2044	13127	1710	13427	1454	13518	1031	15604	628	10485
5L-2S		MI	6078	2765	10102	1933	10884	1612	11336	1354	11935	950	13738	777	7608
10-#14	3.41	MA	8728	2956	14381	2121	15788	1757	16684	1477	17979	993	21562	669	15290
3L-4S		MI	6156	2956	9928	2081	10628	1722	11007	1425	11529	962	13178	473	10443
10-#14	3.41	MA	8555	2956	13662	2158	14856	1791	15538	1489	16487	1020	19653	580	15073
4L-3S		MI	6251	2956	10420	2050	11266	1715	11789	1421	12547	945	14410	554	10650
10-#14	3.41	MA	8271	2956	13061	2174	14054	1805	14536	1520	15004	1027	17731	497	14129
5L-2S		MI	6459	2956	11055	2040	12079	1687	12782	1397	13897	927	16156	713	10625
10-#18	6.06	MA	9679	3440	15957	2478	17732	2024	19016	1634	21255	1004	26324	316	23965
4L-3S		MI	7030	3440	12271	2333	13586	1928	14599	1549	16362	899	18880	234	17809
10-#18	6.06	MA	9199	3440	14904	2504	16330	2081	17264	1687	18665	1012	22953	158	22150
5L-2S		MI	7370	3440	13360	2318	14982	1884	16302	1511	18678	874	21763	516	17899
12-#10	2.31	MA	8456	2755	13831	2001	15156	1671	15944	1407	16990	995	20206	856	10691
2L-6S		MI	5710	2755	8927	1994	9398	1668	9518	1403	9457	998	10698	560	7293
12-#10	2.31	MA	8261	2755	13282	2011	14453	1680	15086	1426	15823	1011	18590	773	10702
3L-5S		MI	5789	2755	9174	1977	9717	1662	9916	1399	9990	986	11381	617	7488
12-#10	2.31	MA	8155	2755	12868	2032	13915	1700	14425	1434	14962	1028	17503	724	10688
4E		MI	5899	2755	9415	1969	10038	1645	10316	1384	10582	985	12127	667	7562

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

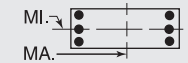
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	2.31	MA	7988	2755	12522	2043	13454	1709	13848	1453	14108	1034	16402	681	10565
5L-3S		MI	5961	2755	9702	1951	10410	1639	10772	1379	11176	973	12876	716	7546
12-#10	2.31	MA	7868	2755	12164	2047	12995	1730	13277	1461	13340	1051	15412	624	10198
6L-2S		MI	6087	2755	10075	1943	10888	1622	11355	1364	11969	961	13946	806	7526
12-#11	2.84	MA	8511	2852	13890	2061	15190	1714	15967	1447	17011	999	20227	734	12918
3L-5S		MI	5916	2852	9465	2025	10049	1696	10302	1417	10505	969	11982	529	8791
12-#11	2.84	MA	8387	2852	13388	2086	14538	1738	15165	1455	15967	1019	18898	673	12880
4E		MI	6047	2852	9756	2017	10437	1677	10786	1399	11219	970	12856	592	9055
12-#11	2.84	MA	8188	2852	12968	2098	13977	1748	14465	1478	14930	1024	17558	618	12481
5L-3S		MI	6116	2852	10102	1995	10884	1671	11336	1395	11935	956	13738	650	9046
12-#11	2.84	MA	8044	2852	12540	2104	13420	1772	13771	1486	13997	1044	16347	547	12088
6L-2S		MI	6265	2852	10550	1987	11458	1651	12035	1378	12887	943	14992	760	9023
12-#14	4.09	MA	8966	3081	14608	2235	16068	1847	17017	1523	18499	1010	22439	567	17893
4E		MI	6423	3081	10563	2159	11442	1778	11999	1459	12879	952	14924	445	12305
12-#14	4.09	MA	8687	3081	14006	2252	15267	1861	16015	1554	17016	1017	20517	484	16995
5L-3S		MI	6516	3081	11055	2128	12079	1771	12782	1455	13897	935	16156	525	12626
12-#14	4.09	MA	8485	3081	13403	2261	14469	1894	15022	1566	15681	1044	18776	381	16153
6L-2S		MI	6721	3081	11689	2118	12892	1743	13774	1431	15247	917	17901	684	12620
12-#18	7.27	MA	9913	3662	16546	2642	18435	2180	19832	1747	22159	994	27790	133	27079
5L-3S		MI	7479	3662	13360	2471	14982	2027	16302	1609	18678	881	21763	169	21033
14-#10	2.69	MA	8502	2826	13831	2055	15156	1712	15944	1445	16990	1006	20206	765	12414
3L-6S		MI	5871	2826	9300	2038	9876	1699	10101	1423	10250	993	11768	549	8420
14-#10	2.69	MA	8397	2826	13416	2076	14618	1732	15283	1453	16129	1023	19119	716	12391
4L-5S		MI	5949	2826	9547	2021	10195	1693	10499	1418	10784	980	12451	605	8602
14-#10	2.69	MA	8232	2826	13071	2087	14157	1741	14706	1472	15275	1028	18018	673	12219
5L-4S		MI	6058	2826	9788	2013	10516	1676	10899	1403	11375	979	13197	656	8729
14-#10	2.69	MA	8114	2826	12713	2091	13699	1761	14135	1480	14507	1045	17028	616	11868
6L-3S		MI	6119	2826	10075	1995	10888	1671	11355	1399	11969	967	13946	705	8720
14-#10	2.69	MA	7989	2826	12321	2108	13234	1766	13590	1499	13759	1062	15867	566	11588
7L-2S		MI	6244	2826	10448	1987	11366	1654	11939	1383	12763	955	15017	795	8703
14-#11	3.31	MA	8676	2938	14051	2140	15388	1777	16203	1479	17378	1012	20853	664	14934
4L-5S		MI	6106	2938	9912	2079	10622	1735	11002	1440	11457	962	13236	512	10130
14-#11	3.31	MA	8480	2938	13631	2152	14828	1787	15502	1501	16341	1017	19512	608	14485
5L-4S		MI	6236	2938	10204	2071	11010	1715	11485	1423	12171	963	14111	575	10446
14-#11	3.31	MA	8340	2938	13203	2158	14270	1811	14808	1510	15408	1037	18301	538	14110
6L-3S		MI	6304	2938	10550	2049	11458	1709	12035	1419	12887	949	14992	633	10450
14-#11	3.31	MA	8192	2938	12728	2178	13716	1818	14146	1533	14499	1056	17043	492	13544
7L-2S		MI	6451	2938	10997	2041	12032	1690	12735	1401	13839	936	16246	742	10434
14-#14	4.77	MA	9100	3205	14952	2329	16479	1917	17494	1588	19028	1007	23303	470	19870
5L-4S		MI	6688	3205	11197	2237	12255	1834	12991	1493	14229	942	16669	416	14179
14-#14	4.77	MA	8904	3205	14348	2339	15681	1950	16501	1600	17693	1034	21562	367	19003
6L-3S		MI	6781	3205	11689	2206	12892	1826	13774	1489	15247	925	17901	496	14597
16-#10	3.08	MA	8638	2896	13965	2120	15321	1763	16141	1472	17297	1017	20735	708	14093
4L-6S		MI	6032	2896	9673	2082	10354	1731	10685	1442	11043	987	12839	538	9550
16-#10	3.08	MA	8475	2896	13619	2130	14860	1772	15564	1491	16442	1023	19634	666	13877
5E		MI	6109	2896	9920	2065	10673	1725	11082	1437	11577	975	13522	594	9721
16-#10	3.08	MA	8360	2896	13261	2135	14402	1793	14993	1499	15674	1039	18644	609	13541
6L-4S		MI	6217	2896	10161	2057	10994	1708	11482	1422	12169	974	14268	645	9891
16-#10	3.08	MA	8235	2896	12870	2152	13937	1798	14448	1518	14926	1056	17484	558	13245
7L-3S		MI	6277	2896	10448	2039	11366	1702	11939	1418	12763	962	15017	694	9889
16-#10	3.08	MA	8097	2896	12526	2159	13462	1815	13882	1524	14129	1062	16481	510	12789
8L-2S		MI	6401	2896	10821	2031	11844	1685	12522	1402	13556	949	16087	784	9876
16-#11	3.78	MA	8771	3024	14294	2206	15678	1826	16539	1525	17752	1011	21466	599	16494
5E		MI	6296	3024	10359	2133	11196	1774	11701	1464	12409	955	14490	494	11475

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	3.78	MA	8633	3024	13867	2212	15121	1850	15845	1534	16819	1030	20255	528	16136
6L-4S		MI	6424	3024	10651	2125	11584	1754	12185	1446	13123	956	15365	557	11834
16-#11	3.78	MA	8487	3024	13392	2232	14567	1857	15183	1556	15910	1050	18997	482	15551
7L-3S		MI	6492	3024	10997	2103	12032	1748	12735	1442	13839	942	16246	615	11851
16-#14	5.45	MA	9320	3330	15294	2417	16893	2006	17980	1634	19705	1024	24348	353	21860
6L-4S		MI	6952	3330	11831	2314	13068	1890	13984	1527	15579	932	18415	387	16064
18-#10	3.46	MA	8717	2966	14168	2174	15563	1804	16422	1510	17609	1017	21250	658	15541
5L-6S		MI	6192	2966	10045	2126	10832	1762	11268	1461	11837	982	13909	527	10682
18-#10	3.46	MA	8603	2966	13810	2179	15105	1824	15851	1518	16841	1034	20260	601	15218
6L-5S		MI	6268	2966	10293	2109	11151	1757	11665	1457	12370	969	14592	583	10844
18-#10	3.46	MA	8479	2966	13418	2196	14640	1830	15306	1537	16093	1051	19100	551	14905
7L-4S		MI	6375	2966	10534	2101	11472	1740	12066	1441	12962	968	15339	634	11050
18-#10	3.46	MA	8344	2966	13075	2203	14166	1846	14739	1543	15296	1056	18097	502	14462
8L-3S		MI	6435	2966	10821	2083	11844	1734	12522	1437	13556	956	16087	683	11057
18-#11	4.25	MA	8925	3111	14530	2266	15971	1889	16883	1557	18231	1023	22209	518	18166
6L-5S		MI	6485	3111	10807	2187	11770	1813	12401	1487	13361	949	15744	477	12824
18-#11	4.25	MA	8780	3111	14055	2286	15417	1896	16220	1580	17322	1043	20951	473	17563
7L-4S		MI	6611	3111	11099	2179	12157	1793	12885	1470	14075	949	16619	540	13175
20-#10	3.85	MA	8846	3036	14358	2223	15808	1856	16709	1537	18008	1028	21876	593	16896
6E		MI	6351	3036	10418	2170	11310	1794	11851	1480	12630	976	14980	515	11817
20-#10	3.85	MA	8722	3036	13967	2240	15343	1861	16164	1556	17260	1045	20716	543	16569
7L-5S		MI	6426	3036	10666	2153	11629	1788	12248	1476	13164	964	15663	572	11970
20-#10	3.85	MA	8589	3036	13623	2247	14869	1878	15597	1562	16463	1051	19713	495	16137
8L-4S		MI	6532	3036	10907	2145	11950	1771	12649	1460	13755	963	16409	623	12208
20-#11	4.73	MA	9071	3197	14718	2340	16267	1934	17258	1603	18733	1036	22905	463	19577
7L-5S		MI	6673	3197	11254	2241	12343	1851	13101	1511	14313	942	16998	460	14177
22-#10	4.23	MA	8964	3107	14515	2284	16047	1893	17022	1576	18427	1039	22332	535	18234
7L-6S		MI	6510	3107	10791	2214	11788	1825	12434	1499	13423	970	16051	504	12953
22-#10	4.23	MA	8832	3107	14172	2291	15572	1909	16455	1582	17631	1045	21329	487	17814
8L-5S		MI	6584	3107	11038	2196	12107	1820	12831	1495	13957	958	16733	561	13098
24-#10	4.62	MA	9075	3177	14720	2335	16275	1941	17313	1601	18798	1039	22945	479	19493
8L-6S		MI	6669	3177	11164	2258	12266	1857	13017	1518	14217	965	17121	493	14090

RECTANGULAR TIED COLUMNS 22" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.28	MA	8871	2738	14070	1998	15069	1683	15471	1438	15689	1071	17939	929	6869
2E		MI	6010	2738	9677	1917	10173	1614	10327	1377	10324	1022	11414	856	4596
4-#18	2.27	MA	9513	2932	15635	2101	17011	1755	17812	1478	18859	1045	22317	899	11748
2E		MI	6378	2932	10621	2012	11328	1678	11713	1411	12201	991	13603	769	7656
6-#10	1.08	MA	8765	2700	13736	1996	14719	1684	15078	1443	15175	1086	17243	945	5918
2L-3S		MI	5824	2700	9106	1931	9510	1640	9547	1405	9276	1056	10165	808	4009
6-#10	1.08	MA	8541	2700	13143	2006	13960	1694	14151	1463	13914	1104	15498	863	5946
3L-2S		MI	5956	2700	9479	1924	9988	1623	10130	1390	10070	1044	11236	897	3980
6-#11	1.33	MA	8923	2748	14148	2013	15202	1696	15647	1447	15937	1075	18289	933	7158
2L-3S		MI	5890	2748	9284	1944	9698	1649	9759	1407	9556	1043	10474	759	4817
6-#11	1.33	MA	8657	2748	13431	2026	14283	1706	14525	1471	14411	1096	16176	831	7193
3L-2S		MI	6045	2748	9731	1936	10272	1629	10458	1390	10509	1029	11728	869	4778
6-#14	1.92	MA	9318	2863	15094	2076	16381	1739	17071	1472	17866	1061	20954	915	10102
2L-3S		MI	6059	2863	9677	2005	10173	1697	10327	1435	10324	1030	11414	669	6696
6-#14	1.92	MA	8947	2863	14070	2093	15069	1754	15471	1505	15689	1089	17939	766	10134
3L-2S		MI	6275	2863	10312	1994	10987	1670	11319	1411	11674	1012	13160	828	6641
6-#18	3.41	MA	10271	3153	17416	2240	19294	1854	20596	1538	22648	1027	27562	874	17335
2L-3S		MI	6467	3153	10621	2165	11328	1822	11713	1509	12201	998	13603	422	11153
6-#18	3.41	MA	9656	3153	15635	2268	17011	1878	17812	1593	18859	1073	22317	599	17245
3L-2S		MI	6825	3153	11710	2150	12724	1778	13416	1471	14518	974	16487	704	11117

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

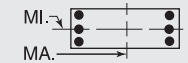
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	1.14	MA	8812	2711	13820	2007	14844	1693	15238	1450	15397	1088	17554	946	6211
2L-4S		MI	5831	2711	9010	1958	9400	1652	9416	1414	9122	1067	10019	793	4217
8-#9	1.14	MA	8635	2711	13351	2015	14243	1701	14504	1465	14399	1102	16172	882	6231
3E		MI	5881	2711	9237	1943	9694	1647	9777	1410	9593	1057	10617	832	4189
8-#9	1.14	MA	8538	2711	12999	2033	13785	1717	13941	1472	13665	1116	15253	844	6252
4L-2S		MI	5986	2711	9533	1937	10073	1633	10240	1398	10223	1047	11475	902	4168
8-#10	1.44	MA	9028	2770	14328	2040	15479	1716	16004	1463	16435	1081	18988	937	7790
2L-4S		MI	5922	2770	9192	1994	9617	1677	9674	1429	9476	1063	10487	748	5243
8-#10	1.44	MA	8808	2770	13736	2050	14719	1725	15078	1482	15175	1098	17243	856	7812
3E		MI	5984	2770	9479	1975	9988	1672	10130	1424	10070	1050	11236	797	5210
8-#10	1.44	MA	8687	2770	13290	2072	14140	1746	14366	1491	14247	1116	16078	807	7825
4L-2S		MI	6115	2770	9852	1967	10466	1654	10713	1409	10863	1038	12306	886	5181
8-#11	1.77	MA	9238	2835	14866	2067	16122	1734	16768	1471	17463	1068	20402	923	9421
2L-4S		MI	6009	2835	9386	2020	9824	1694	9908	1435	9793	1049	10846	684	6290
8-#11	1.77	MA	8977	2835	14148	2080	15202	1745	15647	1494	15937	1089	18289	821	9446
3E		MI	6080	2835	9731	1998	10272	1688	10458	1431	10509	1036	11728	742	6252
8-#11	1.77	MA	8835	2835	13607	2106	14499	1770	14782	1504	14811	1109	16865	761	9441
4L-2S		MI	6233	2835	10179	1990	10845	1668	11158	1413	11461	1022	12982	852	6216
8-#14	2.56	MA	9760	2987	16117	2154	17693	1795	18672	1506	20044	1051	23970	902	13317
2L-4S		MI	6231	2987	9819	2113	10349	1760	10537	1473	10656	1037	11928	560	8711
8-#14	2.56	MA	9399	2987	15094	2171	16381	1810	17071	1539	17866	1079	20954	752	13323
3E		MI	6327	2987	10312	2083	10987	1753	11319	1469	11674	1020	13160	640	8703
8-#14	2.56	MA	9203	2987	14319	2208	15376	1845	15835	1551	16256	1108	18908	664	13214
4L-2S		MI	6539	2987	10946	2072	11800	1725	12311	1445	13024	1002	14905	799	8661
8-#18	4.55	MA	10431	3375	17416	2406	19294	1978	20596	1653	22648	1056	27562	575	22746
3E		MI	6921	3375	11710	2303	12724	1921	13416	1569	14518	981	16487	356	14526
8-#18	4.55	MA	10107	3375	16061	2470	17536	2037	18436	1673	19834	1102	23951	415	20788
4L-2S		MI	7270	3375	12799	2288	14120	1877	15119	1531	16835	956	19370	638	14546
10-#10	1.80	MA	9290	2841	14921	2084	16238	1748	16931	1482	17696	1075	20734	929	9654
2L-5S		MI	5971	2841	9324	2045	9774	1726	9856	1463	9678	1058	10812	686	6439
10-#10	1.80	MA	9073	2841	14328	2094	15479	1757	16004	1501	16435	1093	18988	848	9671
3L-4S		MI	6082	2841	9565	2037	10095	1709	10257	1448	10269	1057	11558	737	6423
10-#10	1.80	MA	8954	2841	13882	2116	14900	1778	15292	1510	15508	1110	17824	799	9670
4L-3S		MI	6144	2841	9852	2019	10466	1703	10713	1444	10863	1045	12306	786	6397
10-#10	1.80	MA	8770	2841	13511	2126	14404	1787	14672	1530	14587	1117	16641	759	9620
5L-2S		MI	6273	2841	10225	2011	10944	1686	11296	1428	11656	1032	13377	875	6372
10-#11	2.22	MA	9550	2921	15583	2121	17041	1773	17890	1494	18989	1061	22515	914	11676
2L-5S		MI	6068	2921	9541	2082	10010	1752	10124	1476	10031	1042	11226	604	7558
10-#11	2.22	MA	9294	2921	14866	2134	16122	1784	16768	1518	17463	1082	20402	812	11691
3L-4S		MI	6200	2921	9833	2074	10397	1732	10608	1458	10745	1042	12100	667	7699
10-#11	2.22	MA	9155	2921	14324	2160	15418	1809	15904	1527	16337	1102	18978	751	11667
4L-3S		MI	6270	2921	10179	2052	10845	1726	11158	1454	11461	1029	12982	725	7673
10-#11	2.22	MA	8935	2921	13872	2172	14815	1820	15149	1551	15219	1109	17538	699	11378
5L-2S		MI	6421	2921	10626	2044	11419	1707	11858	1437	12413	1015	14236	835	7642
10-#14	3.20	MA	9848	3112	16117	2249	17693	1866	18672	1573	20044	1069	23970	738	16505
3L-4S		MI	6499	3112	10454	2191	11163	1816	11529	1507	12006	1027	13674	531	10584
10-#14	3.20	MA	9655	3112	15342	2286	16688	1901	17435	1585	18434	1098	21923	650	16372
4L-3S		MI	6593	3112	10946	2161	11800	1809	12311	1503	13024	1010	14905	611	10696
10-#14	3.20	MA	9345	3112	14695	2303	15824	1916	16355	1618	16834	1106	19857	572	15342
5L-2S		MI	6802	3112	11580	2150	12613	1781	13303	1479	14374	992	16651	770	10667
10-#18	5.68	MA	10881	3596	17841	2608	19818	2136	21221	1733	23622	1085	29197	391	26151
4L-3S		MI	7372	3596	12799	2442	14120	2020	15119	1629	16835	963	19370	291	17889
10-#18	5.68	MA	10357	3596	16706	2636	18306	2160	19330	1788	20825	1096	25567	240	24343
5L-2S		MI	7713	3596	13888	2427	15516	1976	16821	1592	19151	938	22253	572	17960

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

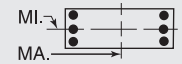


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	2.16	MA	9550	2911	15513	2127	16998	1779	17858	1501	18957	1069	22479	921	11514
2L-6S		MI	6052	2911	9449	2106	9932	1763	10042	1487	9937	1065	11199	618	7373
12-#10	2.16	MA	9337	2911	14921	2138	16238	1789	16931	1521	17696	1087	20734	840	11525
3L-5S		MI	6132	2911	9697	2089	10252	1757	10439	1482	10471	1052	11882	675	7574
12-#10	2.16	MA	9218	2911	14475	2160	15659	1809	16219	1529	16768	1105	19569	792	11511
4E		MI	6242	2911	9938	2081	10573	1740	10840	1467	11063	1051	12628	726	7597
12-#10	2.16	MA	9037	2911	14103	2170	15163	1819	15598	1549	15848	1111	18387	751	11452
5L-3S		MI	6303	2911	10225	2063	10944	1735	11296	1463	11656	1039	13377	775	7578
12-#10	2.16	MA	8906	2911	13713	2175	14670	1840	14984	1557	15021	1129	17328	694	11030
6L-2S		MI	6430	2911	10597	2055	11422	1718	11879	1447	12450	1027	14448	864	7555
12-#11	2.66	MA	9610	3007	15583	2188	17041	1823	17890	1541	18989	1075	22515	802	13929
3L-5S		MI	6259	3007	9989	2136	10583	1791	10824	1499	10983	1035	12480	587	8889
12-#11	2.66	MA	9472	3007	15041	2214	16338	1847	17026	1551	17863	1096	21091	742	13891
4E		MI	6389	3007	10281	2128	10971	1771	11308	1482	11697	1035	13354	650	9101
12-#11	2.66	MA	9255	3007	14589	2226	15735	1858	16271	1574	16745	1102	19651	689	13539
5L-3S		MI	6459	3007	10626	2106	11419	1765	11858	1478	12413	1022	14236	707	9085
12-#11	2.66	MA	9099	3007	14122	2232	15135	1883	15524	1584	15740	1123	18354	619	13086
6L-2S		MI	6608	3007	11074	2098	11992	1745	12558	1460	13365	1008	15490	817	9060
12-#14	3.84	MA	10103	3236	16366	2364	18000	1957	19036	1619	20611	1088	24939	637	19494
4E		MI	6765	3236	11088	2269	11976	1872	12521	1541	13355	1017	15419	502	12442
12-#14	3.84	MA	9799	3236	15718	2381	17136	1972	17956	1652	19012	1096	22872	558	18449
5L-3S		MI	6859	3236	11580	2238	12613	1864	13303	1537	14374	1000	16651	582	12679
12-#14	3.84	MA	9579	3236	15057	2390	16277	2007	16886	1665	17573	1125	21008	456	17641
6L-2S		MI	7064	3236	12215	2228	13426	1837	14295	1513	15723	982	18396	741	12664
12-#18	6.82	MA	11136	3817	18486	2774	20588	2259	22114	1848	24613	1078	30813	216	29712
5L-3S		MI	7822	3817	13888	2580	15516	2120	16821	1689	19151	945	22253	225	21247
14-#10	2.53	MA	9599	2981	15513	2182	16998	1820	17858	1540	18957	1081	22479	832	13374
3L-6S		MI	6213	2981	9822	2150	10410	1795	10625	1506	10731	1059	12270	607	8499
14-#10	2.53	MA	9482	2981	15067	2204	16419	1841	17145	1548	18029	1099	21315	784	13352
4L-5S		MI	6292	2981	10070	2133	10730	1789	11023	1502	11264	1047	12953	664	8687
14-#10	2.53	MA	9303	2981	14696	2214	15923	1850	16525	1568	17108	1105	20132	743	13241
5L-4S		MI	6401	2981	10311	2125	11051	1772	11423	1486	11856	1046	13699	714	8766
14-#10	2.53	MA	9174	2981	14305	2219	15429	1871	15910	1576	16282	1123	19073	687	12835
6L-3S		MI	6462	2981	10597	2107	11422	1766	11879	1482	12450	1033	14448	764	8753
14-#10	2.53	MA	9036	2981	13883	2236	14922	1876	15324	1596	15477	1140	17827	638	12572
7L-2S		MI	6587	2981	10970	2099	11900	1749	12462	1466	13243	1021	15518	853	8734
14-#11	3.10	MA	9788	3094	15758	2268	17257	1886	18147	1574	19389	1089	23204	732	16113
4L-5S		MI	6449	3094	10436	2190	11157	1830	11524	1523	11935	1028	13734	569	10227
14-#11	3.10	MA	9574	3094	15306	2280	16654	1897	17393	1598	18271	1095	21764	680	15708
5L-4S		MI	6578	3094	10728	2182	11545	1810	12008	1505	12649	1028	14608	632	10496
14-#11	3.10	MA	9421	3094	14839	2286	16054	1922	16646	1607	17266	1116	20467	609	15275
6L-3S		MI	6647	3094	11074	2160	11992	1804	12558	1501	13365	1015	15490	690	10491
14-#11	3.10	MA	9257	3094	14326	2307	15447	1928	15933	1631	16287	1136	18948	547	14732
7L-2S		MI	6794	3094	11521	2152	12566	1784	13258	1484	14317	1002	16744	800	10472
14-#14	4.47	MA	10249	3361	16742	2459	18448	2028	19556	1686	21189	1086	25888	544	21564
5L-4S		MI	7031	3361	11723	2347	12789	1928	13513	1575	14705	1008	17165	473	14314
14-#14	4.47	MA	10036	3361	16080	2467	17588	2062	18487	1699	19751	1115	24023	442	20735
6L-3S		MI	7123	3361	12215	2316	13426	1920	14295	1571	15723	990	18396	554	14653
14-#14	4.47	MA	9807	3361	15348	2497	16731	2072	17466	1732	18350	1143	22085	377	19691
7L-2S		MI	7325	3361	12849	2306	14240	1893	15287	1547	17073	973	20142	712	14655
16-#10	2.89	MA	9744	3051	15660	2248	17178	1872	18072	1567	19289	1093	23060	776	15191
4L-6S		MI	6374	3051	10195	2194	10888	1826	11208	1525	11524	1053	13340	596	9629
16-#10	2.89	MA	9567	3051	15288	2258	16682	1882	17451	1587	18369	1100	21878	735	15034
5E		MI	6451	3051	10442	2177	11208	1821	11606	1521	12058	1041	14023	653	9805
16-#10	2.89	MA	9441	3051	14897	2263	16189	1903	16837	1595	17543	1117	20819	679	14644
6L-4S		MI	6559	3051	10684	2169	11529	1803	12006	1505	12649	1040	14769	703	9932
16-#10	2.89	MA	9303	3051	14475	2280	15681	1908	16251	1615	16738	1135	19573	631	14390
7L-3S		MI	6620	3051	10970	2151	11900	1798	12462	1501	13243	1028	15518	752	9924

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

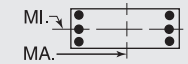


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.89	MA	9153	3051	14106	2288	15170	1925	15632	1621	15881	1141	18497	584	13870
8L-2S		MI	6744	3051	11343	2143	12378	1781	13045	1486	14037	1016	16589	842	9909
16-#11	3.55	MA	9890	3180	16023	2334	17573	1936	18514	1621	19797	1088	23877	670	17883
5E		MI	6638	3180	10884	2244	11730	1868	12224	1546	12887	1021	14988	552	11571
16-#11	3.55	MA	9741	3180	15556	2340	16973	1961	17767	1631	18792	1109	22580	600	17467
6L-4S		MI	6766	3180	11176	2235	12118	1849	12708	1529	13601	1021	15862	615	11887
16-#11	3.55	MA	9578	3180	15044	2361	16367	1967	17054	1654	17813	1129	21061	538	16907
7L-3S		MI	6835	3180	11521	2214	12566	1843	13258	1525	14317	1008	16744	673	11894
16-#11	3.55	MA	9399	3180	14595	2369	15746	1987	16315	1662	16771	1136	19748	478	16342
8L-2S		MI	6980	3180	11969	2205	13140	1823	13957	1507	15269	995	17998	783	11880
16-#14	5.11	MA	10489	3485	17104	2545	18900	2118	20087	1733	21929	1105	27039	428	23835
6L-4S		MI	7295	3485	12357	2424	13602	1984	14505	1609	16055	998	18910	444	16196
16-#14	5.11	MA	10261	3485	16371	2575	18043	2128	19066	1765	20527	1133	25100	363	22821
7L-3S		MI	7387	3485	12849	2394	14240	1976	15287	1605	17073	980	20142	525	16623
18-#10	3.25	MA	9829	3122	15881	2302	17441	1913	18378	1606	19630	1094	23623	728	16831
5L-6S		MI	6534	3122	10568	2238	11366	1858	11791	1544	12317	1048	14411	585	10761
18-#10	3.25	MA	9706	3122	15490	2307	16948	1934	17763	1615	18803	1112	22564	671	16456
6L-5S		MI	6610	3122	10815	2221	11686	1852	12189	1540	12851	1036	15094	641	10927
18-#10	3.25	MA	9569	3122	15068	2324	16441	1939	17177	1634	17998	1129	21318	623	16188
7L-4S		MI	6718	3122	11056	2213	12007	1835	12589	1524	13443	1035	15840	692	11093
18-#10	3.25	MA	9421	3122	14698	2331	15930	1956	16558	1640	17141	1136	20242	576	15679
8L-3S		MI	6777	3122	11343	2195	12378	1829	13045	1520	14037	1022	16589	741	11093
18-#10	3.25	MA	9287	3122	14306	2351	15440	1963	15949	1656	16346	1153	19181	534	15215
9L-2S		MI	6900	3122	11716	2187	12856	1812	13629	1505	14830	1010	17659	831	11082
18-#11	3.99	MA	10058	3266	16273	2394	17893	1999	18889	1654	20318	1102	24693	590	19664
6L-5S		MI	6827	3266	11331	2298	12304	1907	12924	1570	13839	1014	16242	535	12920
18-#11	3.99	MA	9897	3266	15761	2415	17286	2006	18176	1678	19339	1123	23174	528	19086
7L-4S		MI	6954	3266	11623	2289	12692	1887	13407	1552	14553	1015	17116	598	13275
18-#11	3.99	MA	9721	3266	15312	2423	16666	2026	17437	1685	18297	1129	21861	469	18537
8L-3S		MI	7022	3266	11969	2268	13140	1881	13957	1548	15269	1001	17998	656	13294
18-#14	5.75	MA	10713	3610	17395	2652	19355	2184	20667	1799	22705	1123	28116	350	25955
7L-4S		MI	7559	3610	12991	2502	14416	2039	15497	1643	17405	988	20656	415	18088
20-#10	3.61	MA	9970	3192	16082	2351	17708	1966	18690	1634	20064	1106	24310	663	18270
6E		MI	6693	3192	10941	2282	11844	1889	12375	1563	13111	1042	15482	574	11895
20-#10	3.61	MA	9833	3192	15660	2368	17200	1971	18104	1653	19259	1124	23064	615	17987
7L-5S		MI	6769	3192	11188	2265	12164	1884	12772	1559	13644	1030	16164	630	12052
20-#10	3.61	MA	9688	3192	15291	2375	16689	1988	17485	1659	18402	1130	21988	569	17491
8L-4S		MI	6875	3192	11429	2257	12485	1867	13172	1544	14236	1029	16911	681	12253
20-#10	3.61	MA	9558	3192	14899	2395	16199	1994	16876	1676	17606	1148	20927	526	17022
9L-3S		MI	6935	3192	11716	2238	12856	1861	13629	1539	14830	1017	17659	730	12262
20-#11	4.43	MA	10214	3352	16478	2469	18206	2045	19298	1701	20865	1116	25287	519	21269
7L-5S		MI	7015	3352	11779	2351	12878	1946	13623	1593	14791	1007	17496	517	14272
20-#11	4.43	MA	10041	3352	16029	2477	17585	2065	18558	1709	19823	1122	23974	459	20734
8L-4S		MI	7141	3352	12070	2343	13266	1926	14107	1576	15505	1008	18370	580	14619
22-#10	3.97	MA	10096	3262	16253	2412	17960	2002	19031	1673	20520	1118	24809	607	19789
7L-6S		MI	6852	3262	11314	2326	12322	1921	12958	1582	13904	1037	16552	563	13030
22-#10	3.97	MA	9953	3262	15883	2419	17449	2019	18411	1678	19662	1124	23733	561	19305
8L-5S		MI	6927	3262	11561	2308	12642	1915	13355	1578	14438	1024	17235	619	13180
22-#10	3.97	MA	9827	3262	15491	2439	16959	2026	17802	1695	18867	1142	22672	518	18831
9L-4S		MI	7032	3262	11802	2301	12963	1898	13756	1563	15029	1023	17981	670	13411
22-#11	4.88	MA	10359	3439	16746	2531	18504	2104	19680	1732	21349	1115	26087	449	22928
8L-5S		MI	7203	3439	12226	2405	13451	1985	14323	1617	15744	1000	18750	500	15627
24-#10	4.33	MA	10217	3333	16476	2463	18208	2051	19338	1697	20923	1119	25479	553	21120
8L-6S		MI	7011	3333	11686	2370	12800	1953	13541	1602	14697	1031	17623	551	14168
24-#10	4.33	MA	10094	3333	16084	2483	17718	2057	18729	1714	20128	1136	24418	510	20641
9L-5S		MI	7084	3333	11934	2352	13120	1947	13938	1597	15231	1019	18306	608	14311

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

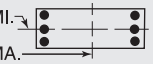
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.20	MA	9975	2894	15740	2125	16871	1791	17312	1532	17515	1145	19988	995	7355
2E		MI	6353	2894	10203	2027	10708	1708	10848	1459	10801	1087	11909	914	4624
4-#18	2.14	MA	10673	3088	17431	2228	18970	1863	19842	1572	20940	1119	24718	964	12612
2E		MI	6720	3088	11149	2120	11862	1771	12232	1491	12674	1056	14093	826	7698
6-#10	1.02	MA	9857	2856	15375	2122	16488	1792	16883	1537	16953	1161	19227	1010	6329
2L-3S		MI	6166	2856	9628	2043	10045	1736	10071	1489	9757	1122	10667	866	4031
6-#10	1.02	MA	9614	2856	14739	2133	15673	1802	15888	1558	15599	1179	17352	930	6358
3L-2S		MI	6299	2856	10001	2036	10523	1718	10654	1473	10550	1110	11737	955	4002
6-#11	1.25	MA	10030	2904	15822	2140	17011	1803	17498	1541	17777	1150	20359	998	7663
2L-3S		MI	6232	2904	9808	2055	10232	1744	10281	1490	10035	1108	10972	817	4844
6-#11	1.25	MA	9740	2904	15051	2153	16022	1815	16292	1565	16136	1171	18087	898	7698
3L-2S		MI	6388	2904	10256	2047	10806	1724	10981	1472	10987	1095	12226	927	4805
6-#14	1.80	MA	10459	3018	16841	2203	18283	1847	19034	1566	19858	1136	23232	981	10831
2L-3S		MI	6401	3018	10203	2115	10708	1791	10848	1517	10801	1095	11909	726	6732
6-#14	1.80	MA	10055	3018	15740	2220	16871	1863	17312	1600	17515	1165	19988	834	10863
3L-2S		MI	6618	3018	10837	2104	11521	1763	11840	1493	12150	1077	13655	885	6675
6-#18	3.21	MA	11497	3309	19350	2366	21430	1962	22843	1632	25023	1102	30370	940	18631
2L-3S		MI	6809	3309	11149	2273	11862	1914	12232	1589	12674	1062	14093	478	11218
6-#18	3.21	MA	10826	3309	17431	2396	18970	1988	19842	1689	20940	1151	24718	671	18541
3L-2S		MI	7168	3309	12238	2258	13258	1870	13935	1552	14991	1038	16976	760	11166
8-#9	1.07	MA	9907	2866	15465	2133	16621	1801	17053	1544	17189	1163	19558	1011	6643
2L-4S		MI	6173	2866	9532	2070	9934	1748	9940	1497	9604	1133	10522	851	4238
8-#9	1.07	MA	9715	2866	14961	2142	15976	1809	16265	1560	16118	1178	18075	949	6663
3E		MI	6223	2866	9759	2055	10229	1743	10301	1494	10074	1123	11120	890	4210
8-#9	1.07	MA	9609	2866	14584	2160	15485	1826	15662	1567	15332	1192	17095	911	6684
4L-2S		MI	6329	2866	10055	2049	10608	1729	10764	1481	10704	1113	11978	961	4189
8-#10	1.36	MA	10142	2926	16012	2166	17304	1824	17878	1557	18307	1156	21102	1002	8338
2L-4S		MI	6264	2926	9715	2106	10152	1773	10198	1512	9956	1129	10989	806	5269
8-#10	1.36	MA	9903	2926	15375	2177	16488	1834	16883	1577	16953	1174	19227	923	8361
3E		MI	6326	2926	10001	2087	10523	1767	10654	1508	10550	1117	11737	855	5235
8-#10	1.36	MA	9770	2926	14898	2199	15868	1855	16120	1586	15958	1192	17985	875	8373
4L-2S		MI	6457	2926	10374	2079	11001	1750	11237	1492	11344	1104	12808	944	5206
8-#11	1.67	MA	10371	2990	16593	2194	17999	1842	18704	1565	19418	1143	22630	989	10095
2L-4S		MI	6352	2990	9910	2131	10358	1788	10431	1517	10271	1115	11344	742	6324
8-#11	1.67	MA	10086	2990	15822	2207	17011	1854	17498	1589	17777	1164	20359	889	10120
3E		MI	6422	2990	10256	2109	10806	1782	10981	1513	10987	1101	12226	800	6283
8-#11	1.67	MA	9931	2990	15241	2233	16257	1879	16571	1599	16569	1186	18840	829	10115
4L-2S		MI	6576	2990	10703	2101	11380	1763	11681	1496	11939	1088	13480	909	6246
8-#14	2.41	MA	10938	3143	17943	2280	19694	1903	20757	1600	22201	1126	26477	967	14289
2L-4S		MI	6573	3143	10345	2223	10884	1854	11058	1555	11132	1102	12423	617	8766
8-#14	2.41	MA	10545	3143	16841	2298	18283	1919	19034	1634	19858	1155	23232	821	14295
3E		MI	6669	3143	10837	2193	11521	1847	11840	1551	12150	1085	13655	697	8744
8-#14	2.41	MA	10328	3143	16010	2336	17203	1955	17707	1648	18129	1185	21049	734	14186
4L-2S		MI	6882	3143	11472	2182	12334	1819	12832	1527	13500	1068	15401	856	8699
8-#18	4.28	MA	11667	3530	19350	2534	21430	2087	22843	1749	25023	1133	30370	646	24474
3E		MI	7263	3530	12238	2412	13258	2014	13935	1649	14991	1045	16976	413	14598
8-#18	4.28	MA	11307	3530	17895	2599	19541	2148	20522	1771	21999	1182	26515	489	22570
4L-2S		MI	7613	3530	13327	2397	14653	1970	15638	1612	17308	1020	19859	694	14600
10-#10	1.70	MA	10425	2996	16648	2210	18120	1855	18873	1576	19661	1150	22977	995	10340
2L-5S		MI	6313	2996	9846	2157	10309	1821	10380	1547	10158	1124	11313	744	6475
10-#10	1.70	MA	10189	2996	16012	2221	17304	1865	17878	1596	18307	1168	21102	915	10357
3L-4S		MI	6424	2996	10088	2149	10630	1804	10781	1531	10750	1123	12059	795	6454

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

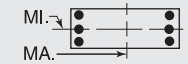
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.70	MA	10058	2996	15534	2243	16684	1886	17115	1605	17312	1186	19860	867	10355
4L-3S		MI	6486	2996	10374	2131	11001	1799	11237	1527	11344	1111	12808	844	6425
10-#10	1.70	MA	9859	2996	15136	2254	16153	1896	16450	1625	16326	1193	18596	828	10306
5L-2S		MI	6616	2996	10747	2123	11479	1782	11820	1511	12137	1099	13879	933	6399
10-#11	2.09	MA	10709	3076	17364	2248	18988	1881	19910	1588	21059	1136	24902	979	12518
2L-5S		MI	6410	3076	10066	2193	10544	1847	10647	1558	10509	1107	11724	661	7655
10-#11	2.09	MA	10431	3076	16593	2261	17999	1892	18704	1612	19418	1158	22630	879	12534
3L-4S		MI	6542	3076	10357	2185	10932	1827	11131	1541	11223	1108	12598	725	7738
10-#11	2.09	MA	10277	3076	16012	2287	17245	1918	17777	1623	18210	1179	21112	820	12510
4L-3S		MI	6612	3076	10703	2163	11380	1821	11681	1537	11939	1094	13480	782	7707
10-#11	2.09	MA	10038	3076	15528	2300	16599	1929	16969	1647	17011	1187	19571	769	12281
5L-2S		MI	6764	3076	11151	2154	11953	1801	12380	1519	12891	1081	14734	892	7675
10-#14	3.01	MA	11031	3267	17943	2376	19694	1975	20757	1668	22201	1145	26477	807	17720
3L-4S		MI	6841	3267	10979	2301	11697	1910	12050	1589	12482	1093	14169	588	10721
10-#14	3.01	MA	10817	3267	17111	2414	18615	2011	19429	1682	20472	1175	24293	720	17587
4L-3S		MI	6936	3267	11472	2271	12334	1902	12832	1585	13500	1075	15401	669	10741
10-#14	3.01	MA	10482	3267	16418	2432	17689	2026	18272	1715	18756	1185	22083	645	16568
5L-2S		MI	7145	3267	12106	2260	13147	1875	13824	1561	14850	1058	17146	827	10708
10-#18	5.35	MA	12146	3751	19813	2737	22001	2248	23522	1831	26081	1165	32168	464	28363
4L-3S		MI	7714	3751	13327	2550	14653	2113	15638	1710	17308	1027	19859	347	17966
10-#18	5.35	MA	11579	3751	18596	2767	20378	2273	21493	1888	23077	1179	28281	321	26563
5L-2S		MI	8057	3751	14415	2535	16049	2069	17341	1672	19624	1003	22742	628	18016
12-#10	2.04	MA	10706	3067	17284	2254	18936	1887	19868	1595	21015	1144	24851	987	12337
2L-6S		MI	6394	3067	9972	2218	10467	1859	10566	1570	10418	1131	11701	676	7449
12-#10	2.04	MA	10475	3067	16648	2265	18120	1897	18873	1615	19661	1163	22977	907	12348
3L-5S		MI	6474	3067	10219	2201	10787	1853	10963	1566	10951	1119	12384	733	7642
12-#10	2.04	MA	10345	3067	16170	2287	17499	1918	18110	1624	18666	1181	21735	859	12334
4E		MI	6584	3067	10460	2193	11108	1836	11364	1550	11543	1118	13130	784	7630
12-#10	2.04	MA	10148	3067	15772	2298	16968	1928	17445	1644	17680	1188	20471	820	12275
5L-3S		MI	6645	3067	10747	2175	11479	1830	11820	1546	12137	1105	13879	833	7608
12-#10	2.04	MA	10007	3067	15349	2302	16439	1949	16788	1653	16796	1206	19340	765	11867
6L-2S		MI	6773	3067	11120	2167	11957	1813	12403	1531	12930	1093	14949	922	7584
12-#11	2.50	MA	10772	3163	17364	2315	18988	1931	19910	1636	21059	1151	24902	870	14940
3L-5S		MI	6601	3163	10513	2247	11118	1886	11347	1582	11461	1100	12978	644	8985
12-#11	2.50	MA	10620	3163	16783	2341	18234	1956	18983	1646	19851	1172	23384	810	14902
4E		MI	6732	3163	10805	2238	11505	1866	11830	1564	12175	1101	13852	707	9143
12-#11	2.50	MA	10385	3163	16299	2354	17588	1968	18175	1670	18652	1180	21843	760	14607
5L-3S		MI	6801	3163	11151	2217	11953	1860	12380	1560	12891	1087	14734	765	9122
12-#11	2.50	MA	10216	3163	15792	2360	16945	1993	17374	1680	17575	1201	20462	690	14090
6L-2S		MI	6951	3163	11598	2208	12527	1840	13080	1543	13843	1074	15988	875	9095
12-#14	3.61	MA	11303	3392	18212	2492	20027	2066	21152	1715	22815	1165	27538	706	20990
4E		MI	7107	3392	11614	2379	12510	1966	13042	1623	13832	1083	15914	559	12576
12-#14	3.61	MA	10974	3392	17519	2510	19101	2082	19994	1749	21099	1175	25327	631	19915
5L-3S		MI	7201	3392	12106	2348	13147	1958	13824	1619	14850	1065	17146	640	12731
12-#14	3.61	MA	10736	3392	16800	2518	18181	2118	18847	1763	19557	1205	23340	530	19153
6L-2S		MI	7407	3392	12740	2338	13961	1931	14817	1595	16200	1048	18892	798	12708
12-#18	6.42	MA	12424	3973	20515	2905	22837	2373	24494	1949	27160	1161	33934	296	32346
5L-3S		MI	8164	3973	14415	2688	16049	2212	17341	1770	19624	1009	22742	281	21327
14-#10	2.38	MA	10758	3137	17284	2309	18936	1928	19868	1634	21015	1157	24851	899	14334
3L-6S		MI	6555	3137	10345	2262	10945	1890	11149	1589	11211	1125	12771	665	8575
14-#10	2.38	MA	10629	3137	16807	2331	18315	1950	19105	1643	20020	1175	23610	851	14312
4L-5S		MI	6634	3137	10592	2245	11265	1885	11546	1585	11745	1113	13454	722	8769
14-#10	2.38	MA	10435	3137	16409	2342	17784	1960	18441	1663	19034	1182	22346	812	14244
5L-4S		MI	6743	3137	10833	2237	11586	1867	11947	1569	12337	1112	14200	773	8802

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis

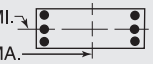


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.38	MA	10297	3137	15986	2346	17255	1981	17783	1672	18150	1200	21215	757	13808
6L-3S		MI	6804	3137	11120	2219	11957	1862	12403	1565	12930	1100	14949	822	8785
14-#10	2.38	MA	10145	3137	15533	2364	16706	1985	17156	1693	17288	1219	19887	710	13513
7L-2S		MI	6931	3137	11493	2211	12435	1845	12986	1550	13724	1087	16020	911	8765
14-#11	2.92	MA	10962	3249	17554	2395	19222	1995	20189	1670	21491	1165	25656	800	17293
4L-5S		MI	6791	3249	10961	2301	11691	1924	12046	1605	12413	1094	14232	627	10322
14-#11	2.92	MA	10730	3249	17070	2408	18576	2007	19381	1694	20293	1173	24115	750	16942
5L-4S		MI	6921	3249	11252	2292	12079	1905	12530	1588	13127	1094	15106	690	10544
14-#11	2.92	MA	10564	3249	16563	2414	17934	2032	18580	1704	19216	1194	22734	680	16446
6L-3S		MI	6989	3249	11598	2271	12527	1899	13080	1584	13843	1081	15988	748	10531
14-#11	2.92	MA	10385	3249	16013	2435	17275	2038	17817	1728	18168	1216	21110	621	15936
7L-2S		MI	7137	3249	12046	2262	13101	1879	13780	1566	14795	1067	17242	858	10509
14-#14	4.21	MA	11462	3516	18620	2587	20513	2138	21716	1783	23443	1165	28572	617	23271
5L-4S		MI	7373	3516	12248	2457	13323	2022	14034	1657	15182	1073	17660	530	14445
14-#14	4.21	MA	11230	3516	17901	2596	19592	2174	20570	1797	21901	1195	26585	516	22492
6L-3S		MI	7466	3516	12740	2426	13961	2014	14817	1653	16200	1055	18892	611	14707
14-#14	4.21	MA	10978	3516	17115	2626	18659	2183	19476	1831	20399	1225	24254	427	21302
7L-2S		MI	7669	3516	13375	2416	14774	1987	15809	1629	17550	1038	20637	769	14701
16-#10	2.72	MA	10913	3207	17443	2375	19131	1981	20100	1662	21374	1170	25485	844	16288
4L-6S		MI	6716	3207	10718	2306	11423	1922	11732	1608	12005	1120	13842	654	9704
16-#10	2.72	MA	10721	3207	17045	2386	18600	1991	19436	1683	20388	1177	24221	805	16200
5E		MI	6794	3207	10965	2289	11743	1916	12129	1604	12538	1107	14525	711	9886
16-#10	2.72	MA	10585	3207	16622	2390	18071	2012	18778	1692	19504	1195	23090	749	15752
6L-4S		MI	6902	3207	11206	2281	12064	1899	12530	1589	13130	1106	15271	762	9970
16-#10	2.72	MA	10434	3207	16170	2408	17522	2017	18151	1712	18642	1213	21762	702	15468
7L-3S		MI	6962	3207	11493	2263	12435	1893	12986	1584	13724	1094	16020	811	9958
16-#10	2.72	MA	10272	3207	15774	2416	16974	2034	17479	1717	17724	1220	20613	657	14961
8L-2S		MI	7087	3207	11866	2255	12913	1876	13569	1569	14517	1082	17090	900	9941
16-#11	3.34	MA	11072	3335	17841	2462	19565	2045	20586	1717	21934	1166	26387	740	19282
5E		MI	6980	3335	11408	2354	12265	1963	12746	1629	13365	1087	15486	609	11665
16-#11	3.34	MA	10911	3335	17334	2468	18922	2071	19786	1728	20857	1187	25005	671	18805
6L-4S		MI	7109	3335	11700	2346	12653	1943	13230	1611	14079	1087	16360	673	11937
16-#11	3.34	MA	10732	3335	16784	2489	18263	2077	19023	1752	19809	1209	23382	611	18279
7L-3S		MI	7177	3335	12046	2324	13101	1937	13780	1607	14795	1074	17242	730	11936
16-#11	3.34	MA	10538	3335	16303	2498	17598	2098	18219	1759	18692	1216	21979	554	17639
8L-2S		MI	7323	3335	12493	2316	13674	1917	14480	1590	15747	1060	18496	840	11919
16-#14	4.81	MA	11721	3641	19002	2674	21004	2230	22292	1831	24244	1185	29829	502	25836
6L-4S		MI	7638	3641	12883	2535	14137	2077	15026	1691	16532	1063	19405	501	16326
16-#14	4.81	MA	11471	3641	18216	2704	20071	2239	21198	1865	22742	1215	27498	413	24668
7L-3S		MI	7730	3641	13375	2504	14774	2070	15809	1687	17550	1045	20637	582	16680
18-#10	3.06	MA	11005	3277	17681	2430	19416	2023	20431	1702	21742	1171	26096	797	18132
5L-6S		MI	6876	3277	11090	2350	11901	1953	12315	1627	12798	1114	14912	643	10836
18-#10	3.06	MA	10871	3277	17258	2434	18887	2044	19773	1711	20858	1189	24965	742	17700
6L-5S		MI	6953	3277	11338	2333	12221	1948	12713	1623	13332	1102	15595	700	11008
18-#10	3.06	MA	10721	3277	16806	2452	18338	2048	19146	1731	19996	1207	23637	694	17425
7L-4S		MI	7060	3277	11579	2325	12542	1931	13113	1608	13923	1101	16342	750	11135
18-#10	3.06	MA	10562	3277	16410	2460	17790	2066	18474	1736	19078	1214	22488	649	16908
8L-3S		MI	7120	3277	11866	2306	12913	1925	13569	1603	14517	1089	17090	800	11129
18-#10	3.06	MA	10416	3277	15990	2479	17265	2073	17822	1753	18227	1233	21358	607	16467
9L-2S		MI	7244	3277	12238	2299	13391	1908	14152	1588	15311	1076	18161	889	11115
18-#11	3.75	MA	11255	3422	18105	2521	19911	2110	20992	1751	22498	1180	27277	661	21168
6L-5S		MI	7169	3422	11856	2408	12839	2002	13446	1652	14318	1080	16740	592	13013
18-#11	3.75	MA	11077	3422	17555	2543	19252	2116	20229	1775	21449	1202	25654	602	20626
7L-4S		MI	7297	3422	12147	2400	13226	1982	13930	1635	15032	1080	17614	655	13327
18-#11	3.75	MA	10886	3422	17074	2552	18586	2137	19425	1782	20333	1209	24251	544	20002
8L-3S		MI	7365	3422	12493	2378	13674	1976	14480	1631	15747	1067	18496	713	13337
18-#14	5.41	MA	11959	3765	19317	2782	21483	2295	22920	1899	25085	1205	30743	400	28034
7L-4S		MI	7901	3765	13517	2612	14950	2133	16019	1725	17881	1053	21151	472	18215

RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#10	3.40	MA	11157	3348	17895	2478	19702	2075	20769	1730	22212	1184	26840	734	19650
6E		MI	7036	3348	11463	2394	12379	1985	12898	1647	13591	1108	15983	632	11970
20-#10	3.40	MA	11007	3348	17442	2496	19153	2080	20142	1750	21350	1202	25512	686	19383
7L-5S		MI	7111	3348	11711	2376	12699	1979	13296	1642	14125	1096	16666	689	12133
20-#10	3.40	MA	10850	3348	17046	2503	18606	2097	19470	1755	20432	1209	24362	642	18856
8L-4S		MI	7218	3348	11952	2369	13020	1962	13696	1627	14717	1095	17412	739	12296
20-#10	3.40	MA	10709	3348	16626	2523	18081	2105	18817	1772	19581	1227	23233	599	18412
9L-3S		MI	7278	3348	12238	2350	13391	1956	14152	1623	15311	1083	18161	789	12297
20-#10	3.40	MA	10543	3348	16216	2529	17555	2124	18181	1790	18733	1245	22089	560	17779
10L-2S		MI	7400	3348	12611	2343	13869	1939	14735	1607	16104	1071	19231	878	12287
20-#11	4.17	MA	11420	3508	18326	2597	20240	2154	21435	1799	23090	1195	27926	592	22976
7L-5S		MI	7358	3508	12303	2462	13412	2040	14146	1676	15270	1073	17994	575	14364
20-#11	4.17	MA	11232	3508	17845	2606	19575	2175	20631	1806	21974	1202	26523	535	22368
8L-4S		MI	7484	3508	12595	2454	13800	2021	14630	1658	15984	1073	18868	638	14716
22-#10	3.74	MA	11291	3418	18079	2540	19969	2111	21137	1769	22704	1196	27386	679	21344
7L-6S		MI	7195	3418	11836	2438	12857	2017	13481	1666	14385	1103	17054	621	13106
22-#10	3.74	MA	11136	3418	17683	2547	19421	2129	20465	1774	21786	1203	26237	634	20806
8L-5S		MI	7269	3418	12084	2420	13177	2011	13879	1661	14918	1091	17736	677	13260
22-#10	3.74	MA	10999	3418	17263	2567	18897	2136	19812	1791	20935	1221	25108	592	20359
9L-4S		MI	7375	3418	12325	2413	13498	1994	14279	1646	15510	1090	18483	728	13455
22-#10	3.74	MA	10834	3418	16852	2573	18371	2155	19177	1809	20087	1239	23963	553	19728
10L-3S		MI	7435	3418	12611	2394	13869	1988	14735	1642	16104	1077	19231	777	13464
22-#11	4.59	MA	11577	3594	18616	2660	20563	2214	21837	1829	23614	1196	28795	525	24736
8L-5S		MI	7546	3594	12751	2516	13986	2079	14846	1699	16222	1066	19248	558	15719
24-#10	4.07	MA	11421	3488	18319	2591	20237	2161	21460	1794	23141	1198	28112	626	22758
8L-6S		MI	7353	3488	12209	2482	13335	2048	14065	1685	15178	1097	18124	610	14243
24-#10	4.07	MA	11288	3488	17899	2611	19713	2168	20807	1811	22289	1216	26983	584	22306
9L-5S		MI	7427	3488	12456	2464	13655	2042	14462	1681	15712	1085	18807	666	14390
24-#10	4.07	MA	11124	3488	17489	2616	19187	2187	20172	1828	21441	1234	25838	545	21678
10L-4S		MI	7532	3488	12698	2457	13976	2025	14862	1665	16303	1084	19553	717	14614

RECTANGULAR TIED COLUMNS 22" x 36"

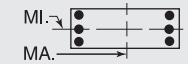
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.14	MA	11141	3049	17498	2251	18769	1899	19251	1626	19432	1220	22136	1061	7841
2E		MI	6695	3049	10728	2137	11242	1801	11369	1541	11277	1153	12405	971	4652
4-#18	2.02	MA	11897	3243	19316	2354	21024	1971	21970	1666	23113	1194	27217	1030	13476
2E		MI	7063	3243	11677	2228	12395	1863	12751	1572	13147	1120	14583	882	7740
6-#11	1.18	MA	11199	3059	17583	2266	18916	1911	19447	1635	19709	1225	22527	1064	8169
2L-3S		MI	6574	3059	10333	2166	10767	1838	10803	1572	10513	1174	11470	874	4870
6-#11	1.18	MA	10886	3059	16758	2280	17858	1923	18157	1660	17954	1247	20096	966	8204
3L-2S		MI	6730	3059	10780	2157	11340	1818	11503	1555	11465	1160	12724	984	4831
6-#14	1.70	MA	11662	3174	18677	2329	20280	1955	21095	1660	21941	1210	25609	1047	11560
2L-3S		MI	6744	3174	10728	2225	11242	1885	11369	1599	11277	1160	12405	784	6767
6-#14	1.70	MA	11225	3174	17498	2348	18769	1972	19251	1695	19432	1241	22136	903	11592
3L-2S		MI	6960	3174	11363	2214	12055	1857	12362	1575	12627	1143	14150	942	6708
6-#18	3.03	MA	12786	3464	21373	2493	23661	2070	25187	1726	27490	1177	33278	1005	19927
2L-3S		MI	7151	3464	11677	2382	12395	2007	12751	1670	13147	1127	14583	535	11278
6-#18	3.03	MA	12059	3464	19316	2524	21024	2097	21970	1785	23113	1228	27217	742	19837
3L-2S		MI	7511	3464	12766	2367	13791	1963	14454	1632	15464	1102	17466	816	11214
8-#9	1.01	MA	11065	3022	17198	2260	18494	1909	18965	1638	19073	1238	21662	1077	7075
2L-4S		MI	6515	3022	10054	2182	10469	1844	10464	1581	10085	1200	11024	909	4258

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#9	1.01	MA	10858	3022	16660	2269	17804	1917	18124	1654	17929	1253	20077	1016	7095
3E		MI	6566	3022	10281	2168	10763	1839	10826	1577	10556	1190	11623	949	4231
8-#9	1.01	MA	10742	3022	16257	2286	17281	1934	17480	1662	17044	1259	19037	978	7116
4L-2S		MI	6671	3022	10577	2161	11143	1825	11289	1565	11186	1180	12480	1019	4210
8-#10	1.28	MA	11318	3082	17783	2292	19226	1932	19849	1651	20270	1230	23314	1068	8887
2L-4S		MI	6606	3082	10237	2218	10686	1868	10721	1595	10437	1195	11490	864	5295
8-#10	1.28	MA	11060	3082	17103	2304	18353	1942	18785	1671	18822	1249	21310	990	8910
3E		MI	6669	3082	10524	2199	11058	1863	11178	1591	11031	1183	12239	913	5259
8-#10	1.28	MA	10915	3082	16594	2326	17692	1964	17970	1681	17703	1257	19992	942	8922
4L-2S		MI	6800	3082	10897	2191	11536	1846	11761	1576	11824	1171	13309	1002	5230
8-#11	1.58	MA	11566	3146	18408	2320	19974	1950	20737	1659	21465	1218	24958	1055	10769
2L-4S		MI	6694	3146	10434	2241	10893	1883	10953	1600	10749	1180	11842	799	6357
8-#11	1.58	MA	11259	3146	17583	2334	18916	1962	19447	1684	19709	1240	22527	956	10794
3E		MI	6765	3146	10780	2220	11340	1877	11503	1596	11465	1167	12724	857	6314
8-#11	1.58	MA	11088	3146	16963	2361	18111	1988	18457	1694	18419	1262	20914	897	10789
4L-2S		MI	6919	3146	11228	2211	11914	1857	12203	1578	12417	1154	13978	967	6276
8-#14	2.27	MA	12180	3298	19856	2407	21792	2011	22939	1694	24450	1200	29083	1033	15261
2L-4S		MI	6915	3298	10871	2333	11418	1948	11579	1637	11609	1168	12918	674	8818
8-#14	2.27	MA	11754	3298	18677	2425	20280	2028	21095	1729	21941	1231	25609	889	15267
3E		MI	7011	3298	11363	2303	12055	1940	12362	1633	12627	1150	14150	755	8784
8-#14	2.27	MA	11516	3298	17789	2464	19127	2064	19677	1744	20094	1262	23289	803	15158
4L-2S		MI	7225	3298	11997	2292	12868	1913	13354	1609	13977	1133	15896	913	8736
8-#18	4.04	MA	12966	3686	21373	2662	23661	2197	25187	1845	27490	1210	33278	717	26202
3E		MI	7605	3686	12766	2520	13791	2106	14454	1730	15464	1109	17466	469	14667
8-#18	4.04	MA	12570	3686	19817	2728	21642	2259	22704	1869	24256	1262	29178	561	24376
4L-2S		MI	7956	3686	13854	2505	15187	2062	16157	1693	17781	1084	20349	751	14653
10-#10	1.60	MA	11623	3152	18464	2336	20098	1963	20912	1670	21717	1225	25319	1060	11026
2L-5S		MI	6655	3152	10369	2269	10843	1917	10904	1630	10639	1191	11815	802	6509
10-#10	1.60	MA	11368	3152	17783	2348	19226	1974	19849	1690	20270	1244	23314	982	11043
3L-4S		MI	6767	3152	10610	2261	11164	1900	11304	1614	11230	1190	12561	853	6483
10-#10	1.60	MA	11225	3152	17274	2370	18564	1995	19034	1700	19151	1251	21996	934	11041
4L-3S		MI	6829	3152	10897	2243	11536	1894	11761	1610	11824	1177	13309	902	6452
10-#10	1.60	MA	11011	3152	16846	2381	17998	2005	18326	1721	18157	1270	20651	897	10992
5L-2S		MI	6958	3152	11270	2235	12014	1877	12344	1595	12618	1165	14380	991	6425
10-#11	1.97	MA	11931	3232	19233	2374	21031	1989	22028	1682	23221	1211	27389	1045	13360
2L-5S		MI	6752	3232	10590	2304	11078	1941	11169	1641	10987	1173	12222	719	7776
10-#11	1.97	MA	11629	3232	18408	2387	19974	2001	20737	1707	21465	1233	24958	947	13376
3L-4S		MI	6884	3232	10882	2295	11466	1922	11653	1623	11701	1173	13096	782	7775
10-#11	1.97	MA	11461	3232	17788	2415	19168	2027	19747	1718	20175	1255	23345	887	13352
4L-3S		MI	6954	3232	11228	2273	11914	1916	12203	1619	12417	1160	13978	840	7741
10-#11	1.97	MA	11204	3232	17273	2428	18479	2039	18885	1743	18896	1264	21704	839	13193
5L-2S		MI	7106	3232	11675	2265	12488	1896	12903	1602	13369	1147	15232	950	7707
10-#14	2.84	MA	12277	3423	19856	2503	21792	2083	22939	1763	24450	1221	29083	875	18935
3L-4S		MI	7183	3423	11505	2411	12231	2004	12571	1671	12959	1158	14664	645	10793
10-#14	2.84	MA	12043	3423	18968	2542	20639	2120	21521	1777	22603	1252	26763	789	18802
4L-3S		MI	7278	3423	11997	2381	12868	1996	13354	1667	13977	1140	15896	726	10785
10-#14	2.84	MA	11682	3423	18229	2560	19651	2137	20285	1812	20771	1264	24408	717	17805
5L-2S		MI	7488	3423	12631	2370	13681	1969	14346	1643	15327	1123	17641	884	10749
10-#18	5.05	MA	13475	3907	21874	2867	24279	2359	25921	1929	28633	1244	35239	537	30601
4L-3S		MI	8057	3907	13854	2658	15187	2205	16157	1790	17781	1091	20349	403	18040
10-#18	5.05	MA	12863	3907	20575	2898	22546	2386	23754	1988	25421	1260	31096	399	28689
5L-2S		MI	8401	3907	14943	2643	16583	2161	17860	1753	20097	1067	23232	685	18072
12-#10	1.92	MA	11926	3222	19144	2380	20970	1995	21976	1689	23165	1219	27323	1052	13160
2L-6S		MI	6736	3222	10494	2330	11002	1954	11090	1653	10898	1197	12202	734	7523
12-#10	1.92	MA	11675	3222	18464	2392	20098	2005	20912	1710	21717	1238	25319	974	13171
3L-5S		MI	6816	3222	10742	2313	11321	1949	11487	1649	11432	1185	12885	791	7679
12-#10	1.92	MA	11533	3222	17954	2414	19436	2027	20098	1719	20598	1245	24000	926	13157
4E		MI	6927	3222	10983	2305	11642	1931	11888	1634	12024	1184	13631	842	7662

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

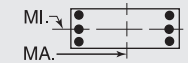
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	1.92	MA	11322	3222	17526	2425	18870	2037	19390	1740	19605	1264	22655	889	13098
5L-3S		MI	6988	3222	11270	2287	12014	1926	12344	1629	12618	1172	14380	891	7637
12-#10	1.92	MA	11170	3222	17075	2429	18300	2058	18689	1749	18662	1283	21452	835	12711
6L-2S		MI	7116	3222	11642	2279	12492	1909	12927	1614	13411	1159	15451	980	7613
12-#11	2.36	MA	11998	3318	19233	2441	21031	2039	22028	1731	23221	1226	27389	937	15951
3L-5S		MI	6943	3318	11037	2357	11652	1980	11869	1664	11939	1166	13476	702	9077
12-#11	2.36	MA	11831	3318	18614	2469	20226	2065	21038	1741	21930	1248	25775	878	15913
4E		MI	7074	3318	11329	2349	12040	1960	12353	1647	12653	1166	14350	765	9184
12-#11	2.36	MA	11578	3318	18098	2482	19537	2077	20175	1766	20651	1257	24135	829	15685
5L-3S		MI	7143	3318	11675	2327	12488	1954	12903	1643	13369	1153	15232	823	9159
12-#11	2.36	MA	11395	3318	17550	2487	18852	2103	19322	1777	19503	1279	22666	761	15101
6L-2S		MI	7294	3318	12122	2319	13061	1935	13603	1625	14321	1140	16486	932	9130
12-#14	3.41	MA	12566	3547	20148	2619	22150	2176	23365	1811	25112	1242	30237	775	22448
4E		MI	7450	3547	12139	2489	13044	2060	13564	1705	14308	1148	16410	616	12707
12-#14	3.41	MA	12212	3547	19408	2638	21163	2193	22129	1846	23279	1254	27882	703	21393
5L-3S		MI	7544	3547	12631	2458	13681	2052	14346	1701	15327	1130	17641	697	12776
12-#14	3.41	MA	11955	3547	18631	2646	20181	2229	20906	1861	21634	1285	25772	603	20653
6L-2S		MI	7751	3547	13266	2448	14495	2025	15338	1677	16677	1113	19387	855	12751
12-#18	6.06	MA	13774	4128	22632	3036	25183	2485	26971	2048	29798	1243	37156	375	34985
5L-3S		MI	8506	4128	14943	2797	16583	2305	17860	1851	20097	1074	23232	338	21405
12-#18	6.06	MA	13340	4128	21297	3051	23459	2548	24824	2072	26912	1294	33422	194	31970
6L-2S		MI	8844	4128	16032	2782	17978	2261	19563	1813	22414	1049	26115	619	21478
14-#10	2.24	MA	11980	3292	19144	2435	20970	2037	21976	1729	23165	1232	27323	966	15294
3L-6S		MI	6897	3292	10867	2374	11480	1986	11673	1672	11692	1192	13273	723	8649
14-#10	2.24	MA	11840	3292	18634	2458	20308	2058	21162	1738	22046	1240	26004	919	15272
4L-5S		MI	6976	3292	11115	2357	11799	1980	12070	1668	12225	1179	13956	780	8845
14-#10	2.24	MA	11631	3292	18206	2469	19742	2069	20454	1759	21052	1259	24659	881	15204
5L-4S		MI	7086	3292	11356	2349	12120	1963	12471	1653	12817	1178	14702	831	8836
14-#10	2.24	MA	11481	3292	17755	2473	19172	2089	19753	1768	20109	1277	23456	827	14787
6L-3S		MI	7147	3292	11642	2331	12492	1957	12927	1648	13411	1166	15451	880	8816
14-#10	2.24	MA	11316	3292	17272	2491	18586	2095	19081	1789	19133	1285	22046	780	14458
7L-2S		MI	7273	3292	12015	2323	12970	1940	13510	1633	14204	1154	16521	969	8795
14-#11	2.76	MA	12198	3405	19439	2522	21284	2104	22328	1765	23686	1242	28206	868	18472
4L-5S		MI	7133	3405	11485	2411	12226	2019	12569	1688	12892	1159	14730	684	10414
14-#11	2.76	MA	11949	3405	18923	2536	20595	2116	21466	1790	22407	1250	26566	820	18185
5L-4S		MI	7263	3405	11777	2403	12613	1999	13053	1670	13606	1160	15604	747	10587
14-#11	2.76	MA	11771	3405	18375	2541	19910	2142	20612	1800	21258	1272	25097	751	17623
6L-3S		MI	7332	3405	12122	2381	13061	1993	13603	1666	14321	1146	16486	805	10570
14-#11	2.76	MA	11575	3405	17788	2563	19198	2148	19798	1825	20140	1294	23371	693	17154
7L-2S		MI	7480	3405	12570	2373	13635	1973	14302	1649	15274	1133	17740	915	10546
14-#14	3.98	MA	12737	3672	20587	2716	22674	2249	23973	1880	25788	1244	31356	689	24990
5L-4S		MI	7716	3672	12774	2567	13858	2115	14556	1739	15658	1138	18155	587	14574
14-#14	3.98	MA	12488	3672	19810	2724	21692	2285	22750	1895	24143	1275	29246	589	24273
6L-3S		MI	7809	3672	13266	2536	14495	2108	15338	1735	16677	1120	19387	668	14760
14-#14	3.98	MA	12213	3672	18970	2755	20684	2294	21583	1930	22540	1306	26764	503	22922
7L-2S		MI	8012	3672	13900	2526	15308	2081	16330	1711	18026	1103	21132	826	14746
14-#18	7.07	MA	14259	4350	23354	3190	26096	2647	28041	2132	31289	1277	39483	169	38214
6L-3S		MI	8954	4350	16032	2935	17978	2404	19563	1911	22414	1056	26115	272	24766
16-#10	2.57	MA	12144	3363	19315	2502	21180	2090	22226	1757	23493	1234	28008	911	17385
4L-6S		MI	7058	3363	11240	2418	11958	2017	12256	1692	12485	1186	14343	712	9778
16-#10	2.57	MA	11938	3363	18887	2513	20614	2100	21517	1778	22500	1253	26664	873	17311
5E		MI	7136	3363	11487	2401	12277	2012	12653	1687	13019	1174	15026	769	9966
16-#10	2.57	MA	11791	3363	18435	2517	20044	2121	20817	1787	21557	1272	25460	820	16867
6L-4S		MI	7245	3363	11729	2393	12598	1995	13054	1672	13610	1173	15772	820	10006

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis

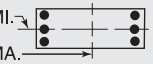


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.57	MA	11627	3363	17952	2535	19458	2126	20145	1808	20581	1279	24051	773	16549
7L-3S		MI	7305	3363	12015	2375	12970	1989	13510	1668	14204	1160	16521	869	9991
16-#10	2.57	MA	11448	3363	17530	2543	18874	2144	19424	1813	19660	1298	22828	729	16063
8L-2S		MI	7431	3363	12388	2367	13448	1972	14093	1652	14998	1148	17592	958	9973
16-#11	3.15	MA	12318	3491	19748	2590	21652	2155	22756	1813	24162	1243	28997	810	20691
5E		MI	7323	3491	11932	2465	12799	2058	13269	1711	13844	1152	15984	667	11756
16-#11	3.15	MA	12143	3491	19200	2595	20968	2181	21902	1824	23014	1265	27528	742	20150
6L-4S		MI	7452	3491	12224	2457	13187	2038	13753	1694	14558	1153	16858	730	11986
16-#11	3.15	MA	11949	3491	18613	2617	20256	2187	21089	1849	21896	1287	25802	684	19666
7L-3S		MI	7520	3491	12570	2435	13635	2032	14302	1690	15274	1139	17740	788	11976
16-#11	3.15	MA	11740	3491	18100	2626	19545	2208	20220	1855	20705	1296	24310	628	18947
8L-2S		MI	7667	3491	13017	2427	14209	2012	15002	1672	16226	1126	18994	898	11957
16-#14	4.55	MA	13016	3796	20989	2802	23204	2341	24594	1929	26651	1265	32719	575	27862
6L-4S		MI	7980	3796	13408	2645	14671	2171	15548	1773	17008	1128	19901	558	16452
16-#14	4.55	MA	12743	3796	20149	2832	22195	2350	23427	1964	25049	1296	30238	489	26526
7L-3S		MI	8073	3796	13900	2614	15308	2164	16330	1768	18026	1110	21132	639	16735
16-#14	4.55	MA	12449	3796	19413	2846	21177	2380	22196	1974	23342	1307	28095	407	25200
8L-2S		MI	8274	3796	14535	2603	16121	2137	17322	1744	19376	1093	22878	797	16736
18-#10	2.89	MA	12243	3433	19567	2557	21486	2132	22581	1797	23947	1247	28668	866	19418
5L-6S		MI	7218	3433	11613	2462	12436	2049	12839	1711	13279	1180	15414	701	10909
18-#10	2.89	MA	12100	3433	19115	2561	20916	2152	21880	1807	23004	1266	27464	812	18950
6L-5S		MI	7295	3433	11860	2445	12755	2043	13236	1706	13812	1168	16097	758	11087
18-#10	2.89	MA	11936	3433	18633	2579	20330	2158	21209	1827	22028	1274	26055	765	18643
7L-4S		MI	7403	3433	12102	2437	13076	2026	13637	1691	14404	1167	16843	809	11174
18-#10	2.89	MA	11761	3433	18211	2587	19746	2175	20488	1832	21108	1293	24833	722	18146
8L-3S		MI	7463	3433	12388	2418	13448	2020	14093	1687	14998	1155	17592	858	11163
18-#10	2.89	MA	11608	3433	17759	2607	19187	2183	19792	1850	20201	1311	23635	680	17675
9L-2S		MI	7587	3433	12761	2411	13926	2003	14676	1671	15791	1143	18662	947	11148
18-#11	3.55	MA	12514	3577	20025	2649	22025	2219	23193	1848	24770	1258	29959	732	22680
6L-5S		MI	7512	3577	12380	2519	13373	2096	13968	1735	14796	1145	17238	650	13103
18-#11	3.55	MA	12320	3577	19438	2671	21314	2225	22379	1872	23652	1280	28233	674	22181
7L-4S		MI	7639	3577	12672	2511	13761	2077	14452	1717	15510	1146	18112	713	13378
18-#11	3.55	MA	12115	3577	18925	2680	20603	2247	21510	1879	22461	1289	26740	618	21479
8L-3S		MI	7707	3577	13017	2489	14209	2071	15002	1713	16226	1132	18994	771	13379
18-#11	3.55	MA	11927	3577	18380	2704	19922	2255	20663	1899	21356	1311	25272	566	20697
9L-2S		MI	7853	3577	13465	2481	14782	2051	15702	1696	17178	1119	20248	880	13365
18-#14	5.11	MA	13269	3921	21328	2910	23706	2406	25271	1997	27558	1286	33712	476	30130
7L-4S		MI	8244	3921	14042	2722	15484	2227	16540	1807	18358	1118	21646	529	18339
18-#14	5.11	MA	12981	3921	20592	2923	22689	2436	24040	2007	25851	1297	31568	393	28784
8L-3S		MI	8336	3921	14535	2692	16121	2220	17322	1802	19376	1100	22878	610	18706
20-#10	3.21	MA	12406	3503	19796	2605	21788	2184	22944	1826	24452	1261	29469	804	21036
6E		MI	7378	3503	11986	2506	12914	2080	13422	1730	14072	1175	16485	690	12043
20-#10	3.21	MA	12244	3503	19313	2623	21202	2189	22273	1846	23476	1268	28059	757	20738
7L-5S		MI	7454	3503	12233	2488	13233	2075	13819	1726	14606	1162	17167	747	12211
20-#10	3.21	MA	12074	3503	18891	2631	20618	2207	21551	1851	22555	1287	26837	714	20232
8L-4S		MI	7561	3503	12474	2481	13554	2058	14220	1710	15197	1161	17914	798	12337
20-#10	3.21	MA	11922	3503	18439	2651	20059	2215	20856	1869	21648	1306	25639	672	19768
9L-3S		MI	7621	3503	12761	2462	13926	2052	14676	1706	15791	1149	18662	847	12333
20-#10	3.21	MA	11742	3503	18001	2657	19498	2234	20178	1887	20674	1312	24423	635	19106
10L-2S		MI	7743	3503	13134	2455	14404	2035	15259	1690	16584	1137	19733	936	12321
20-#11	3.94	MA	12689	3664	20263	2725	22371	2264	23669	1896	25407	1274	30664	664	24699
7L-5S		MI	7700	3664	12827	2573	13947	2135	14668	1758	15748	1138	18492	632	14454
20-#11	3.94	MA	12487	3664	19750	2734	21661	2285	22801	1902	24216	1282	29171	609	24014
8L-4S		MI	7827	3664	13119	2565	14334	2115	15152	1741	16462	1139	19366	696	14768
20-#11	3.94	MA	12305	3664	19205	2758	20980	2294	21954	1923	23111	1304	27703	557	23217
9L-3S		MI	7894	3664	13465	2543	14782	2109	15702	1737	17178	1126	20248	753	14780
20-#14	5.68	MA	13510	4045	21771	3001	24200	2492	25884	2041	28360	1287	35042	379	32367
8L-4S		MI	8507	4045	14677	2800	16297	2283	17532	1840	19708	1108	23392	500	20234

RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	3.53	MA	12549	3573	19993	2667	22074	2221	23337	1865	24923	1263	30063	749	22835
7L-6S		MI	7537	3573	12359	2550	13392	2112	14005	1749	14865	1169	17555	679	13179
22-#10	3.53	MA	12382	3573	19571	2675	21490	2239	22615	1870	24003	1281	28841	706	22319
8L-5S		MI	7612	3573	12606	2532	13711	2106	14403	1745	15399	1157	18238	736	13338
22-#10	3.53	MA	12234	3573	19119	2695	20931	2246	21919	1888	23096	1300	27643	664	21861
9L-4S		MI	7718	3573	12847	2525	14032	2089	14803	1729	15991	1156	18984	787	13498
22-#10	3.53	MA	12055	3573	18681	2701	20370	2266	21242	1906	22122	1306	26427	627	21190
10L-3S		MI	7778	3573	13134	2506	14404	2083	15259	1725	16584	1144	19733	836	13501
22-#11	4.33	MA	12857	3750	20575	2788	22718	2324	24091	1926	25972	1275	31602	599	26550
8L-5S		MI	7888	3750	13275	2627	14520	2174	15368	1782	16700	1132	19746	615	15808
22-#11	4.33	MA	12681	3750	20030	2812	22038	2333	23244	1946	24867	1297	30134	547	25737
9L-4S		MI	8014	3750	13567	2619	14908	2154	15852	1764	17414	1132	20620	678	16157
24-#10	3.85	MA	12689	3644	20251	2719	22362	2270	23679	1890	25450	1276	30845	698	24408
8L-6S		MI	7696	3644	12731	2594	13870	2144	14588	1768	15659	1164	18626	668	14316
24-#10	3.85	MA	12545	3644	19799	2739	21803	2278	22983	1907	24543	1295	29648	656	23954
9L-5S		MI	7770	3644	12979	2576	14189	2138	14986	1764	16192	1151	19309	725	14467
24-#10	3.85	MA	12366	3644	19362	2744	21242	2297	22306	1925	23569	1301	28431	619	23274
10L-4S		MI	7875	3644	13220	2569	14510	2121	15386	1748	16784	1150	20055	775	14658
24-#11	4.73	MA	13055	3836	20855	2866	23096	2372	24535	1970	26623	1290	32565	538	28257
9L-5S		MI	8076	3836	13722	2681	15094	2213	16068	1805	17652	1125	21000	598	17165

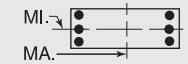
RECTANGULAR TIED COLUMNS 22" x 38"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.08	MA	12369	3205	19345	2378	20763	2007	21287	1720	21442	1295	24383	1126	8327
2E		MI	7038	3205	11254	2247	11776	1895	11891	1623	11754	1218	12900	1028	4680
4-#18	1.91	MA	13183	3399	21289	2481	23175	2079	24195	1760	25378	1269	29816	1095	14340
2E		MI	7406	3399	12204	2337	12929	1956	13271	1653	13620	1184	15073	938	7780
6-#11	1.12	MA	12431	3215	19433	2393	20917	2019	21493	1729	21734	1300	24795	1130	8674
2L-3S		MI	6916	3215	10857	2276	11301	1933	11326	1655	10991	1239	11967	932	4894
6-#11	1.12	MA	12094	3215	18554	2406	19790	2032	20118	1755	19863	1322	22205	1033	8709
3L-2S		MI	7073	3215	11304	2268	11875	1913	12026	1637	11943	1226	13221	1042	4857
6-#14	1.61	MA	12929	3330	20602	2455	22374	2063	23252	1754	24116	1285	28086	1112	12289
2L-3S		MI	7086	3330	11254	2335	11776	1978	11891	1681	11754	1225	12900	841	6800
6-#14	1.61	MA	12458	3330	19345	2475	20763	2080	21287	1790	21442	1317	24383	971	12321
3L-2S		MI	7303	3330	11888	2324	12589	1951	12883	1657	13103	1208	14645	999	6741
6-#18	2.87	MA	14138	3620	23484	2619	25989	2178	27628	1820	30049	1251	36284	1071	21223
2L-3S		MI	7493	3620	12204	2490	12929	2099	13271	1750	13620	1191	15073	591	11334
6-#18	2.87	MA	13354	3620	21289	2651	23175	2207	24195	1880	25378	1305	29816	812	21133
3L-2S		MI	7853	3620	13293	2475	14325	2055	14973	1713	15937	1166	17956	873	11261
8-#10	1.22	MA	12557	3237	19644	2419	21243	2039	21916	1745	22325	1305	25626	1134	9436
2L-4S		MI	6949	3237	10760	2330	11221	1964	11245	1679	10918	1261	11992	922	5319
8-#10	1.22	MA	12280	3237	18920	2430	20315	2050	20784	1766	20784	1324	23493	1056	9458
3E		MI	7011	3237	11046	2311	11592	1958	11701	1674	11512	1249	12740	971	5282
8-#10	1.22	MA	12123	3237	18378	2453	19611	2072	19918	1776	19595	1333	22097	1009	9470
4L-2S		MI	7142	3237	11419	2303	12070	1941	12284	1659	12305	1237	13811	1061	5254
8-#11	1.49	MA	12824	3301	20313	2447	22044	2058	22868	1753	23604	1293	27385	1120	11443
2L-4S		MI	7036	3301	10959	2352	11427	1977	11476	1682	11227	1246	12340	857	6388
8-#11	1.49	MA	12494	3301	19433	2460	20917	2070	21493	1778	21734	1316	24795	1023	11468
3E		MI	7107	3301	11304	2330	11875	1971	12026	1678	11943	1233	13221	915	6343
8-#11	1.49	MA	12308	3301	18775	2488	20061	2097	20440	1790	20287	1325	23087	965	11463
4L-2S		MI	7261	3301	11752	2322	12448	1952	12725	1660	12895	1219	14475	1025	6305
8-#14	2.15	MA	13484	3454	21859	2533	23985	2119	25218	1788	26791	1275	31789	1099	16233
2L-4S		MI	7258	3454	11396	2443	11952	2042	12101	1719	12085	1233	13414	731	8864

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.15	MA	13025	3454	20602	2552	22374	2136	23252	1823	24116	1307	28086	957	16239
3E		MI	7354	3454	11888	2413	12589	2034	12883	1715	13103	1215	14645	812	8823
8-#14	2.15	MA	12766	3454	19658	2592	21148	2173	21744	1839	22151	1339	25629	872	16130
4L-2S		MI	7567	3454	12523	2402	13402	2007	13875	1691	14453	1198	16391	970	8773
8-#18	3.83	MA	14328	3841	23484	2790	25989	2306	27628	1941	30049	1287	36284	787	27930
3E		MI	7947	3841	13293	2629	14325	2198	14973	1811	15937	1173	17956	525	14734
8-#18	3.83	MA	13896	3841	21828	2857	23839	2370	24984	1966	26605	1341	31941	633	26206
4L-2S		MI	8299	3841	14382	2614	15720	2155	16676	1773	18254	1149	20839	807	14705
10-#10	1.52	MA	12883	3307	20368	2463	22171	2071	23049	1764	23866	1300	27760	1126	11712
2L-5S		MI	6998	3307	10891	2381	11378	2013	11428	1713	11119	1257	12316	860	6540
10-#10	1.52	MA	12610	3307	19644	2474	21243	2082	21916	1785	22325	1319	25626	1049	11728
3L-4S		MI	7109	3307	11133	2373	11699	1995	11828	1698	11711	1256	13062	911	6510
10-#10	1.52	MA	12455	3307	19102	2497	20540	2104	21051	1795	21136	1327	24231	1001	11727
4L-3S		MI	7171	3307	11419	2355	12070	1990	12284	1693	12305	1244	13811	960	6479
10-#10	1.52	MA	12225	3307	18644	2508	19939	2114	20299	1816	20081	1346	22805	965	11677
5L-2S		MI	7301	3307	11792	2347	12548	1973	12868	1678	13098	1231	14882	1050	6451
10-#11	1.87	MA	13216	3388	21192	2501	23171	2096	24242	1776	25474	1286	29975	1111	14203
2L-5S		MI	7094	3388	11114	2414	11613	2036	11692	1723	11465	1239	12720	777	7836
10-#11	1.87	MA	12891	3388	20313	2514	22044	2109	22868	1802	23604	1309	27385	1014	14219
3L-4S		MI	7227	3388	11406	2406	12001	2016	12176	1705	12180	1239	13594	840	7810
10-#11	1.87	MA	12708	3388	19654	2542	21188	2135	21815	1813	22157	1318	25677	955	14194
4L-3S		MI	7297	3388	11752	2384	12448	2010	12725	1702	12895	1226	14475	897	7774
10-#11	1.87	MA	12433	3388	19102	2555	20456	2148	20898	1838	20872	1341	23936	908	14087
5L-2S		MI	7449	3388	12199	2376	13022	1990	13425	1684	13848	1212	15729	1007	7739
10-#14	2.69	MA	13587	3579	21859	2630	23985	2192	25218	1857	26791	1297	31789	943	20150
3L-4S		MI	7525	3579	12030	2521	12765	2098	13093	1753	13435	1223	15159	702	10847
10-#14	2.69	MA	13332	3579	20914	2669	22759	2229	23710	1873	24826	1329	29332	858	20017
4L-3S		MI	7620	3579	12523	2491	13402	2090	13875	1749	14453	1205	16391	783	10828
10-#14	2.69	MA	12944	3579	20129	2689	21709	2247	22396	1909	22877	1341	26833	788	19053
5L-2S		MI	7831	3579	13157	2480	14216	2063	14867	1725	15803	1188	18136	941	10788
10-#18	4.78	MA	14867	4063	24023	2996	26654	2469	28418	2026	31276	1323	38409	609	32863
4L-3S		MI	8399	4063	14382	2767	15720	2298	16676	1871	18254	1155	20839	460	18112
10-#18	4.78	MA	14210	4063	22642	3028	24810	2498	26112	2087	27858	1341	34010	476	30708
5L-2S		MI	8744	4063	15471	2752	17116	2254	18379	1834	20570	1131	23722	741	18128
12-#10	1.82	MA	13208	3378	21092	2507	23100	2103	24181	1783	25407	1294	29894	1118	13983
2L-6S		MI	7078	3378	11017	2442	11536	2050	11613	1737	11379	1264	12704	792	7595
12-#10	1.82	MA	12938	3378	20368	2518	22171	2113	23049	1804	23866	1313	27760	1041	13994
3L-5S		MI	7158	3378	11264	2425	11856	2044	12011	1732	11913	1251	13387	849	7714
12-#10	1.82	MA	12785	3378	19827	2541	21468	2135	22183	1814	22677	1321	26364	994	13980
4E		MI	7269	3378	11505	2417	12177	2027	12411	1717	12504	1250	14133	900	7692
12-#10	1.82	MA	12558	3378	19369	2552	20867	2146	21431	1835	21622	1341	24938	957	13921
5L-3S		MI	7330	3378	11792	2399	12548	2021	12868	1713	13098	1238	14882	949	7666
12-#10	1.82	MA	12395	3378	18888	2557	20257	2166	20687	1845	20620	1360	23663	905	13560
6L-2S		MI	7459	3378	12165	2391	13026	2004	13451	1697	13892	1226	15952	1038	7641
12-#11	2.24	MA	13286	3474	21192	2568	23171	2148	24242	1825	25474	1302	29975	1004	16962
3L-5S		MI	7285	3474	11562	2468	12186	2075	12392	1747	12418	1232	13974	759	9205
12-#11	2.24	MA	13104	3474	20533	2596	22315	2174	23189	1837	24028	1311	28267	946	16924
4E		MI	7416	3474	11854	2460	12574	2055	12875	1729	13132	1232	14848	822	9222
12-#11	2.24	MA	12833	3474	19981	2609	21583	2187	22273	1862	22743	1334	26526	899	16773
5L-3S		MI	7486	3474	12199	2438	13022	2049	13425	1725	13848	1219	15729	880	9194
12-#11	2.24	MA	12638	3474	19397	2615	20848	2212	21366	1873	21523	1357	24969	832	16118
6L-2S		MI	7637	3474	12647	2430	13596	2029	14125	1708	14800	1205	16983	990	9164
12-#14	3.23	MA	13892	3703	22171	2747	24370	2285	25675	1907	27500	1319	33035	844	23906
4E		MI	7792	3703	12665	2599	13578	2153	14085	1787	14785	1213	16905	673	12819
12-#14	3.23	MA	13512	3703	21386	2766	23320	2303	24362	1943	25552	1332	30536	774	22882
5L-3S		MI	7886	3703	13157	2569	14216	2146	14867	1782	15803	1195	18136	754	12822
12-#14	3.23	MA	13237	3703	20551	2774	22277	2340	23062	1958	23803	1364	28300	676	22061
6L-2S		MI	8094	3703	13791	2558	15029	2119	15859	1758	17153	1178	19882	912	12793

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

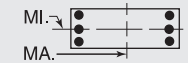
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	5.74	MA	15188	4284	24838	3166	27625	2597	29545	2147	32529	1324	40478	452	37430
5L-3S		MI	8849	4284	15471	2905	17116	2397	18379	1931	20570	1138	23722	394	21480
12-#18	5.74	MA	14723	4284	23400	3181	25791	2662	27262	2172	29459	1377	36526	272	34341
6L-2S		MI	9187	4284	16560	2890	18512	2353	20082	1894	22887	1113	26605	675	21540
14-#10	2.13	MA	13265	3448	21092	2562	23100	2145	24181	1823	25407	1308	29894	1033	16254
3L-6S		MI	7239	3448	11390	2486	12014	2081	12197	1756	12172	1258	13774	781	8720
14-#10	2.13	MA	13113	3448	20551	2585	22396	2167	23316	1833	24218	1316	28498	986	16232
4L-5S		MI	7319	3448	11637	2469	12334	2076	12594	1751	12706	1246	14457	838	8883
14-#10	2.13	MA	12889	3448	20093	2596	21796	2177	22564	1854	23163	1335	27072	950	16164
5L-4S		MI	7428	3448	11878	2461	12655	2059	12994	1736	13298	1245	15203	889	8868
14-#10	2.13	MA	12729	3448	19613	2600	21185	2198	21820	1864	22161	1354	25796	897	15772
6L-3S		MI	7489	3448	12165	2443	13026	2053	13451	1732	13892	1232	15952	938	8847
14-#10	2.13	MA	12550	3448	19099	2619	20562	2204	21100	1884	21125	1362	24305	851	15408
7L-2S		MI	7616	3448	12538	2435	13504	2036	14034	1716	14685	1220	17023	1027	8824
14-#11	2.61	MA	13498	3560	21412	2650	23441	2213	24564	1860	25898	1304	30856	936	19651
4L-5S		MI	7475	3560	12009	2522	12760	2113	13091	1770	13370	1225	15228	742	10503
14-#11	2.61	MA	13231	3560	20860	2663	22709	2225	23648	1885	24613	1327	29116	889	19438
5L-4S		MI	7605	3560	12301	2514	13148	2094	13575	1753	14084	1225	16102	805	10628
14-#11	2.61	MA	13039	3560	20276	2668	21975	2251	22741	1897	23393	1350	27558	822	18807
6L-3S		MI	7674	3560	12647	2492	13596	2088	14125	1749	14800	1212	16983	863	10607
14-#11	2.61	MA	12827	3560	19652	2691	21217	2257	21876	1922	22130	1359	25732	765	18387
7L-2S		MI	7823	3560	13094	2484	14169	2068	14825	1731	15752	1198	18237	973	10581
14-#14	3.77	MA	14075	3828	22642	2844	24932	2359	26327	1977	28226	1322	34239	761	26720
5L-4S		MI	8058	3828	13299	2677	14392	2209	15077	1821	16135	1203	18650	644	14700
14-#14	3.77	MA	13808	3828	21808	2852	23888	2396	25027	1992	26477	1354	32003	662	25931
6L-3S		MI	8151	3828	13791	2646	15029	2202	15859	1816	17153	1185	19882	725	14811
14-#14	3.77	MA	13509	3828	20914	2883	22804	2404	23788	2028	24774	1386	29375	578	24557
7L-2S		MI	8356	3828	14426	2636	15842	2175	16851	1792	18503	1168	21628	883	14790
14-#18	6.70	MA	15709	4505	25596	3319	28606	2761	30695	2233	34130	1360	42994	248	41007
6L-3S		MI	9297	4505	16560	3044	18512	2496	20082	1992	22887	1120	26605	328	24844
16-#10	2.43	MA	13439	3518	21275	2629	23325	2198	24449	1852	25759	1310	30632	978	18482
4L-6S		MI	7400	3518	11763	2530	12492	2113	12780	1775	12966	1252	14845	770	9849
16-#10	2.43	MA	13218	3518	20817	2639	22724	2209	23696	1873	24704	1329	29206	942	18408
5E		MI	7478	3518	12010	2513	12812	2107	13177	1771	13499	1240	15528	827	10043
16-#10	2.43	MA	13061	3518	20337	2644	22114	2230	22952	1883	23702	1349	27930	889	17987
6L-4S		MI	7587	3518	12251	2505	13133	2090	13578	1755	14091	1239	16274	878	10040
16-#10	2.43	MA	12883	3518	19823	2663	21491	2235	22232	1903	22665	1357	26439	843	17635
7L-3S		MI	7648	3518	12538	2487	13504	2084	14034	1751	14685	1227	17023	927	10024
16-#10	2.43	MA	12691	3518	19375	2671	20870	2253	21465	1909	21688	1376	25144	801	17175
8L-2S		MI	7774	3518	12911	2479	13982	2067	14617	1735	15478	1214	18093	1016	10004
16-#11	2.99	MA	13626	3647	21739	2717	23836	2264	25022	1909	26483	1320	31706	880	22110
5E		MI	7665	3647	12457	2576	13334	2152	13791	1794	14322	1218	16482	725	11845
16-#11	2.99	MA	13439	3647	21155	2722	23102	2290	24116	1920	25263	1343	30148	813	21501
6L-4S		MI	7794	3647	12748	2568	13722	2132	14275	1776	15036	1218	17356	788	12030
16-#11	2.99	MA	13228	3647	20531	2745	22344	2296	23251	1945	24001	1352	28322	755	21067
7L-3S		MI	7863	3647	13094	2546	14169	2126	14825	1772	15752	1205	18237	846	12016
16-#11	2.99	MA	12998	3647	19985	2754	21589	2318	22318	1951	22810	1375	26740	701	20267
8L-2S		MI	8010	3647	13542	2538	14743	2107	15525	1755	16704	1192	19491	955	11994
16-#14	4.31	MA	14374	3952	23064	2930	25500	2452	26993	2026	29151	1344	35706	648	29805
6L-4S		MI	8323	3952	13934	2755	15205	2265	16069	1854	17485	1193	20396	615	16576
16-#14	4.31	MA	14078	3952	22170	2961	24415	2460	25753	2062	27448	1376	33078	564	28400
7L-3S		MI	8415	3952	14426	2724	15842	2258	16851	1850	18503	1175	21628	696	16788
16-#14	4.31	MA	13763	3952	21388	2975	23333	2491	24429	2071	25634	1388	30805	484	27076
8L-2S		MI	8617	3952	15060	2714	16655	2230	17844	1826	19853	1158	23373	854	16781

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

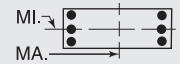


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.73	MA	13544	3588	21541	2683	23652	2240	24829	1892	26244	1324	31339	934	20652
5L-6S		MI	7560	3588	12135	2574	12970	2144	13363	1794	13759	1247	15915	759	10980
18-#10	2.73	MA	13390	3588	21061	2688	23042	2261	24085	1902	25243	1343	30064	881	20206
6L-5S		MI	7637	3588	12383	2557	13290	2139	13760	1790	14293	1234	16598	816	11163
18-#10	2.73	MA	13214	3588	20548	2707	22419	2267	23365	1922	24206	1351	28572	835	19865
7L-4S		MI	7746	3588	12624	2549	13611	2122	14161	1774	14884	1233	17345	867	11210
18-#10	2.73	MA	13026	3588	20099	2715	21798	2285	22598	1928	23229	1371	27277	793	19396
8L-3S		MI	7806	3588	12911	2530	13982	2116	14617	1770	15478	1221	18093	916	11197
18-#10	2.73	MA	12861	3588	19616	2734	21205	2293	21859	1946	22266	1390	26011	752	18870
9L-2S		MI	7930	3588	13283	2523	14460	2099	15200	1755	16272	1209	19164	1005	11180
18-#11	3.36	MA	13835	3733	22034	2776	24229	2329	25491	1944	27134	1336	32738	803	24198
6L-5S		MI	7854	3733	12904	2630	13907	2191	14491	1817	15274	1211	17736	707	13191
18-#11	3.36	MA	13626	3733	21410	2798	23471	2335	24626	1969	25871	1345	30912	746	23751
7L-4S		MI	7982	3733	13196	2622	14295	2171	14975	1800	15988	1211	18610	770	13426
18-#11	3.36	MA	13406	3733	20864	2808	22716	2356	23693	1975	24681	1368	29330	692	22968
8L-3S		MI	8050	3733	13542	2600	14743	2165	15525	1796	16704	1198	19491	828	13421
18-#11	3.36	MA	13204	3733	20281	2832	21993	2366	22793	1996	23507	1391	27778	640	22191
9L-2S		MI	8196	3733	13989	2592	15317	2145	16224	1778	17656	1185	20745	938	13404
18-#14	4.84	MA	14642	4076	23427	3039	26026	2516	27719	2096	30123	1366	36780	550	32242
7L-4S		MI	8587	4076	14568	2832	16018	2321	17061	1888	18835	1183	22141	586	18461
18-#14	4.84	MA	14334	4076	22645	3052	24944	2547	26395	2105	28309	1378	34508	470	30896
8L-3S		MI	8679	4076	15060	2802	16655	2314	17844	1884	19853	1166	23373	667	18762
20-#10	3.04	MA	13719	3659	21785	2732	23970	2293	25217	1921	26784	1338	32197	874	22428
6E		MI	7720	3659	12508	2618	13448	2176	13946	1813	14552	1241	16986	748	12114
20-#10	3.04	MA	13543	3659	21272	2751	23348	2298	24497	1941	25747	1346	30706	827	22097
7L-5S		MI	7796	3659	12756	2600	13768	2170	14343	1809	15086	1229	17669	805	12287
20-#10	3.04	MA	13359	3659	20824	2759	22727	2316	23730	1947	24770	1365	29411	785	21618
8L-4S		MI	7904	3659	12997	2593	14089	2153	14744	1793	15678	1228	18415	856	12377
20-#10	3.04	MA	13197	3659	20340	2778	22133	2324	22991	1965	23807	1384	28145	744	21099
9L-3S		MI	7963	3659	13283	2574	14460	2147	15200	1789	16272	1215	19164	905	12368
20-#10	3.04	MA	13004	3659	19875	2784	21537	2344	22272	1983	22762	1390	26856	708	20447
10L-2S		MI	8087	3659	13656	2567	14938	2130	15783	1774	17065	1203	20234	994	12354
20-#11	3.73	MA	14021	3819	22289	2852	24598	2373	26000	1992	27742	1338	33502	736	26438
7L-5S		MI	8043	3819	13352	2684	14481	2230	15191	1841	16226	1204	18990	690	14542
20-#11	3.73	MA	13805	3819	21743	2862	23843	2395	25067	1999	26551	1361	31919	682	25669
8L-4S		MI	8170	3819	13643	2676	14869	2210	15675	1823	16940	1205	19864	753	14818
20-#11	3.73	MA	13609	3819	21160	2886	23119	2404	24167	2020	25378	1384	30368	631	24876
9L-3S		MI	8237	3819	13989	2654	15317	2204	16224	1819	17656	1191	20745	811	14823
20-#11	3.73	MA	13378	3819	20594	2893	22394	2428	23291	2042	24124	1391	28792	584	23989
10L-2S		MI	8382	3819	14437	2646	15890	2184	16924	1802	18608	1178	21999	921	14810
20-#14	5.38	MA	14900	4201	23902	3130	26555	2603	28361	2139	30983	1368	38211	457	34716
8L-4S		MI	8850	4201	15202	2910	16831	2377	18053	1922	20184	1173	23887	557	20355
22-#10	3.34	MA	13870	3729	21996	2795	24276	2330	25630	1961	27288	1340	32840	820	24330
7L-6S		MI	7879	3729	12881	2662	13926	2208	14529	1832	15346	1235	18057	737	13249
22-#10	3.34	MA	13691	3729	21548	2803	23655	2348	24863	1966	26311	1359	31544	777	23842
8L-5S		MI	7955	3729	13129	2644	14246	2202	14926	1828	15879	1223	18739	794	13414
22-#10	3.34	MA	13532	3729	21064	2822	23061	2356	24124	1984	25348	1379	30279	736	23327
9L-4S		MI	8061	3729	13370	2637	14567	2185	15327	1813	16471	1222	19486	845	13540
22-#10	3.34	MA	13339	3729	20599	2828	22466	2376	23404	2003	24302	1384	28990	700	22665
10L-3S		MI	8121	3729	13656	2618	14938	2179	15783	1808	17065	1210	20234	894	13537
22-#10	3.34	MA	13159	3729	20149	2836	21875	2383	22662	2010	23309	1401	27740	655	21995
11L-2S		MI	8243	3729	14029	2611	15416	2162	16366	1793	17858	1198	21305	983	13526
22-#11	4.11	MA	14201	3906	22622	2916	24970	2434	26442	2022	28422	1354	34509	673	28368
8L-5S		MI	8231	3906	13799	2738	15055	2268	15891	1864	17178	1197	20244	673	15895
22-#11	4.11	MA	14012	3906	22039	2940	24246	2443	25542	2043	27248	1377	32957	621	27561
9L-4S		MI	8357	3906	14091	2730	15442	2249	16374	1847	17892	1198	21118	736	16209
22-#11	4.11	MA	13782	3906	21473	2947	23521	2467	24666	2065	25994	1385	31382	574	26679
10L-3S		MI	8424	3906	14437	2708	15890	2243	16924	1843	18608	1184	21999	794	16223

RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#10	3.65	MA	14019	3799	22272	2847	24584	2379	25996	1985	27852	1354	33678	770	26068
8L-6S		MI	8038	3799	13254	2706	14404	2239	15112	1851	16139	1230	19127	726	14386
24-#10	3.65	MA	13864	3799	21788	2866	23990	2387	25256	2003	26889	1373	32412	728	25556
9L-5S		MI	8113	3799	13501	2688	14724	2233	15509	1847	16673	1218	19810	783	14543
24-#10	3.65	MA	13672	3799	21323	2872	23394	2407	24537	2022	25843	1379	31123	692	24884
10L-4S		MI	8218	3799	13743	2681	15045	2216	15910	1832	17265	1216	20556	834	14700
24-#10	3.65	MA	13494	3799	20873	2879	22803	2415	23794	2030	24850	1396	29873	648	24205
11L-3S		MI	8278	3799	14029	2662	15416	2210	16366	1827	17858	1204	21305	883	14704
24-#11	4.48	MA	14412	3992	22918	2994	25373	2482	26917	2067	29118	1370	35547	612	30246
9L-5S		MI	8418	3992	14247	2792	15628	2307	16590	1888	18130	1190	21498	655	17251
24-#11	4.48	MA	14183	3992	22352	3001	24648	2506	26040	2089	27864	1378	33972	565	29370
10L-4S		MI	8544	3992	14538	2784	16016	2287	17074	1870	18845	1191	22372	719	17598

RECTANGULAR TIED COLUMNS 22" x 40"

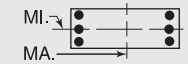
4-#14	1.02	MA	13660	3361	21280	2504	22852	2115	23420	1814	23544	1370	26729	1192	8813
2E		MI	7380	3361	11779	2357	12310	1989	12412	1705	12230	1283	13395	1085	4707
4-#18	1.82	MA	14533	3554	23350	2607	25422	2186	26516	1854	27735	1344	32515	1161	15204
2E		MI	7748	3554	12732	2445	13462	2048	13790	1733	14093	1248	15563	995	7820
6-#11	1.06	MA	13725	3371	21372	2519	23014	2127	23636	1823	23850	1374	27162	1195	9180
2L-3S		MI	7259	3371	11381	2387	11836	2027	11848	1737	11469	1305	12465	990	4918
6-#11	1.06	MA	13365	3371	20439	2533	21818	2140	22177	1849	21865	1398	24413	1100	9214
3L-2S		MI	7415	3371	11829	2379	12409	2008	12548	1719	12422	1292	13719	1099	4882
6-#14	1.53	MA	14258	3485	22615	2582	24563	2171	25507	1848	26384	1360	30662	1178	13018
2L-3S		MI	7428	3485	11779	2445	12310	2072	12412	1763	12230	1290	13395	898	6832
6-#14	1.53	MA	13754	3485	21280	2602	22852	2189	23420	1884	23544	1393	26729	1038	13050
3L-2S		MI	7646	3485	12414	2435	13123	2045	13404	1739	13580	1273	15141	1056	6772
6-#18	2.73	MA	15554	3776	25684	2745	28413	2286	30166	1914	32700	1326	39390	1137	22519
2L-3S		MI	7835	3776	12732	2599	13462	2192	13790	1831	14093	1255	15563	647	11388
6-#18	2.73	MA	14712	3776	23350	2779	25422	2316	26516	1976	27735	1382	32515	881	22429
3L-2S		MI	8196	3776	13821	2584	14858	2148	15493	1794	16410	1230	18446	929	11307
8-#10	1.15	MA	13859	3393	21593	2545	23357	2147	24081	1839	24473	1380	28038	1199	9984
2L-4S		MI	7291	3393	11282	2442	11756	2059	11769	1762	11398	1328	12493	980	5342
8-#10	1.15	MA	13562	3393	20824	2557	22372	2158	22880	1860	22838	1400	25775	1123	10007
3E		MI	7353	3393	11569	2423	12127	2054	12225	1758	11992	1315	13242	1029	5305
8-#10	1.15	MA	13393	3393	20251	2580	21627	2181	21963	1870	21579	1408	24302	1076	10019
4L-2S		MI	7485	3393	11942	2415	12605	2037	12808	1742	12786	1303	14312	1119	5277
8-#11	1.42	MA	14145	3457	22305	2573	24210	2166	25095	1847	25835	1368	29911	1186	12117
2L-4S		MI	7378	3457	11483	2463	11961	2072	11998	1764	11706	1311	12838	915	6418
8-#11	1.42	MA	13791	3457	21372	2587	23014	2179	23636	1873	23850	1391	27162	1090	12142
3E		MI	7449	3457	11829	2441	12409	2066	12548	1761	12422	1298	13719	972	6371
8-#11	1.42	MA	13591	3457	20674	2615	22107	2205	22520	1884	22317	1401	25360	1032	12137
4L-2S		MI	7604	3457	12276	2433	12983	2046	13248	1743	13374	1285	14973	1082	6333
8-#14	2.05	MA	14851	3610	23949	2660	26274	2226	27594	1882	29224	1350	34594	1164	17205
2L-4S		MI	7600	3610	11922	2553	12486	2136	12622	1801	12562	1298	13909	788	8908
8-#14	2.05	MA	14359	3610	22615	2679	24563	2245	25507	1918	26384	1383	30662	1025	17211
3E		MI	7696	3610	12414	2523	13123	2128	13404	1796	13580	1280	15141	869	8860
8-#14	2.05	MA	14079	3610	21614	2719	23264	2283	23908	1935	24187	1396	28068	940	17102
4L-2S		MI	7910	3610	13048	2512	13937	2101	14396	1772	14930	1263	16886	1027	8808
8-#18	3.64	MA	15753	3997	25684	2917	28413	2415	30166	2036	32700	1364	39390	857	29658
3E		MI	8289	3997	13821	2737	14858	2291	15493	1891	16410	1237	18446	582	14798
8-#18	3.64	MA	15284	3997	23928	2986	26133	2480	27361	2063	29046	1419	34804	704	28059
4L-2S		MI	8642	3997	14910	2722	16254	2247	17195	1854	18727	1213	21329	863	14756

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis

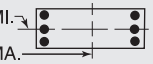


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.44	MA	14207	3463	22361	2589	24341	2179	25282	1858	26107	1374	30301	1192	12397
2L-5S		MI	7340	3463	11414	2493	11913	2108	11952	1796	11600	1323	12818	918	6570
10-#10	1.44	MA	13914	3463	21593	2601	23357	2190	24081	1879	24473	1394	28038	1115	12414
3L-4S		MI	7451	3463	11655	2485	12234	2091	12352	1781	12192	1322	13564	969	6537
10-#10	1.44	MA	13747	3463	21019	2624	22612	2212	23165	1889	23213	1403	26565	1068	12413
4L-3S		MI	7513	3463	11942	2467	12605	2085	12808	1777	12786	1310	14312	1018	6504
10-#10	1.44	MA	13502	3463	20531	2635	21976	2223	22369	1911	22096	1422	25058	1033	12363
5L-2S		MI	7643	3463	12315	2459	13083	2068	13391	1761	13579	1298	15383	1108	6477
10-#11	1.77	MA	14563	3543	23238	2627	25406	2204	26554	1870	27820	1361	32660	1176	15045
2L-5S		MI	7436	3543	11639	2525	12147	2130	12214	1806	11944	1304	13218	834	7876
10-#11	1.77	MA	14215	3543	22305	2641	24210	2217	25095	1896	25835	1384	29911	1081	15061
3L-4S		MI	7569	3543	11930	2517	12535	2111	12698	1788	12658	1305	14092	897	7844
10-#11	1.77	MA	14017	3543	21607	2669	23303	2244	23979	1908	24302	1394	28108	1022	15037
4L-3S		MI	7639	3543	12276	2495	12983	2105	13248	1784	13374	1291	14973	955	7806
10-#11	1.77	MA	13724	3543	21018	2682	22528	2257	23009	1934	22941	1417	26268	977	14929
5L-2S		MI	7792	3543	12724	2487	13556	2085	13948	1766	14326	1278	16227	1065	7770
10-#14	2.56	MA	14959	3734	23949	2757	26274	2300	27594	1952	29224	1373	34594	1011	21365
3L-4S		MI	7868	3734	12556	2631	13299	2191	13614	1834	13912	1288	15654	759	10898
10-#14	2.56	MA	14683	3734	22949	2797	24975	2338	25995	1969	27027	1386	32000	926	21232
4L-3S		MI	7963	3734	13048	2601	13937	2184	14396	1830	14930	1270	16886	840	10869
10-#14	2.56	MA	14269	3734	22111	2816	23863	2357	24604	2005	25076	1419	29358	859	20312
5L-2S		MI	8174	3734	13683	2590	14750	2157	15389	1806	16280	1253	18632	998	10827
10-#18	4.55	MA	16323	4218	26261	3124	29125	2580	31011	2123	34012	1402	41680	680	35149
4L-3S		MI	8741	4218	14910	2875	16254	2390	17195	1952	18727	1220	21329	516	18181
10-#18	4.55	MA	15620	4218	24798	3157	27171	2610	28567	2185	30387	1422	37024	552	32741
5L-2S		MI	9087	4218	15999	2860	17650	2346	18898	1914	21043	1195	24212	797	18183
12-#10	1.73	MA	14552	3533	23129	2633	25326	2210	26484	1877	27742	1369	32564	1184	14806
2L-6S		MI	7420	3533	11539	2554	12071	2145	12137	1820	11860	1330	13205	850	7679
12-#10	1.73	MA	14264	3533	22361	2645	24341	2221	25282	1898	26107	1389	30301	1107	14817
3L-5S		MI	7501	3533	11787	2537	12391	2140	12535	1816	12393	1318	13888	907	7747
12-#10	1.73	MA	14098	3533	21788	2668	23597	2244	24366	1909	24847	1397	28828	1061	14803
4E		MI	7611	3533	12028	2529	12712	2123	12935	1800	12985	1316	14634	958	7722
12-#10	1.73	MA	13857	3533	21300	2678	22961	2255	23570	1930	23730	1417	27321	1026	14744
5L-3S		MI	7673	3533	12315	2511	13083	2117	13391	1796	13579	1304	15383	1007	7694
12-#10	1.73	MA	13683	3533	20791	2684	22310	2275	22783	1940	22671	1437	25973	974	14415
6L-2S		MI	7802	3533	12687	2503	13561	2100	13974	1780	14372	1292	16454	1097	7668
12-#11	2.13	MA	14636	3630	23238	2695	25406	2256	26554	1920	27820	1377	32660	1071	17972
3L-5S		MI	7627	3630	12086	2579	12721	2169	12914	1829	12896	1297	14472	817	9280
12-#11	2.13	MA	14440	3630	22540	2723	24499	2283	25438	1932	26287	1387	30857	1013	17934
4E		MI	7759	3630	12378	2571	13109	2149	13398	1811	13610	1298	15346	880	9260
12-#11	2.13	MA	14151	3630	21951	2736	23724	2296	24468	1957	24926	1410	29017	968	17815
5L-3S		MI	7828	3630	12724	2549	13556	2143	13948	1808	14326	1284	16227	938	9229
12-#11	2.13	MA	13942	3630	21332	2742	22940	2321	23508	1969	23634	1434	27371	902	17141
6L-2S		MI	7979	3630	13171	2541	14130	2124	14647	1790	15278	1271	17481	1048	9197
12-#14	3.07	MA	15281	3859	24283	2875	26686	2394	28083	2003	29867	1376	35933	912	25364
4E		MI	8135	3859	13190	2709	14113	2247	14606	1868	15261	1278	17400	730	12874
12-#14	3.07	MA	14875	3859	23445	2894	25574	2412	26691	2039	27916	1409	33290	845	24383
5L-3S		MI	8229	3859	13683	2679	14750	2240	15389	1864	16280	1261	18632	811	12866
12-#14	3.07	MA	14582	3859	22559	2902	24459	2449	25315	2055	26063	1442	30925	749	23476
6L-2S		MI	8437	3859	14317	2668	15563	2213	16381	1840	17630	1243	20377	969	12834
12-#18	5.45	MA	16665	4440	27132	3296	30163	2709	32216	2246	35353	1404	43899	527	39888
5L-3S		MI	9191	4440	15999	3014	17650	2490	18898	2012	21043	1202	24212	450	21554
12-#18	5.45	MA	16168	4440	25592	3310	28220	2774	29797	2272	32098	1460	39729	349	36740
6L-2S		MI	9531	4440	17087	2999	19046	2446	20601	1975	23360	1177	27095	732	21596
14-#10	2.02	MA	14613	3604	23129	2689	25326	2253	26484	1918	27742	1383	32564	1100	17215
3L-6S		MI	7582	3604	11912	2598	12549	2177	12720	1839	12653	1324	14276	839	8789
14-#10	2.02	MA	14448	3604	22556	2712	24581	2275	25567	1928	26482	1391	31091	1053	17192
4L-5S		MI	7661	3604	12160	2581	12869	2171	13118	1835	13187	1312	14959	896	8918

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis



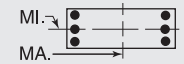
f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.02	MA	14209	3604	22068	2722	23946	2286	24771	1949	25365	1411	29584	1018	17124
5L-4S		MI	7771	3604	12401	2573	13190	2154	13518	1819	13778	1311	15705	947	8900
14-#10	2.02	MA	14039	3604	21559	2728	23295	2307	23984	1959	24305	1431	28236	966	16762
6L-3S		MI	7832	3604	12687	2555	13561	2148	13974	1815	14372	1299	16454	996	8877
14-#10	2.02	MA	13847	3604	21015	2746	22635	2312	23215	1979	23208	1440	26663	920	16361
7L-2S		MI	7959	3604	13060	2547	14039	2131	14558	1800	15166	1286	17524	1086	8853
14-#11	2.48	MA	14861	3716	23473	2777	25695	2322	26897	1955	28272	1380	33606	1003	20831
4L-5S		MI	7818	3716	12534	2633	13294	2208	13614	1853	13848	1290	15726	799	10590
14-#11	2.48	MA	14575	3716	22884	2790	24920	2334	25927	1981	26911	1403	31766	958	20701
5L-4S		MI	7948	3716	12825	2625	13682	2188	14098	1835	14562	1291	16600	863	10668
14-#11	2.48	MA	14371	3716	22265	2796	24136	2360	24967	1993	25620	1427	30119	893	19998
6L-3S		MI	8017	3716	13171	2603	14130	2182	14647	1831	15278	1277	17481	920	10644
14-#11	2.48	MA	14142	3716	21604	2818	23333	2366	24043	2017	24283	1437	28193	836	19538
7L-2S		MI	8166	3716	13619	2595	14704	2162	15347	1813	16230	1264	18735	1030	10617
14-#14	3.58	MA	15476	3983	24780	2971	27285	2468	28779	2073	30756	1399	37222	831	28462
5L-4S		MI	8400	3983	13825	2787	14926	2303	15598	1902	16611	1268	19145	701	14823
14-#14	3.58	MA	15191	3983	23894	2980	26170	2505	27402	2089	28903	1432	34857	735	27589
6L-3S		MI	8494	3983	14317	2756	15563	2296	16381	1898	17630	1251	20377	782	14857
14-#14	3.58	MA	14869	3983	22946	3011	25020	2514	26089	2125	26986	1445	32085	652	26209
7L-2S		MI	8699	3983	14951	2746	16376	2268	17373	1874	18979	1233	22123	940	14833
14-#18	6.36	MA	17222	4661	27926	3448	31212	2874	33446	2333	37063	1442	46604	325	43826
6L-3S		MI	9639	4661	17087	3152	19046	2589	20601	2072	23360	1184	27095	384	24920
16-#10	2.31	MA	14796	3674	23324	2756	25566	2307	26768	1947	28116	1386	33354	1045	19580
4L-6S		MI	7742	3674	12285	2642	13027	2208	13303	1858	13446	1319	15346	828	9918
16-#10	2.31	MA	14560	3674	22836	2766	24930	2318	25972	1968	26999	1406	31847	1010	19505
5E		MI	7821	3674	12533	2625	13347	2203	13701	1854	13980	1306	16029	885	10086
16-#10	2.31	MA	14392	3674	22327	2771	24279	2338	25185	1979	25939	1425	30499	958	19114
6L-4S		MI	7930	3674	12774	2617	13668	2186	14101	1838	14572	1305	16775	936	10074
16-#10	2.31	MA	14201	3674	21783	2790	23620	2344	24416	1998	24842	1434	28926	912	18725
7L-3S		MI	7990	3674	13060	2599	14039	2180	14558	1834	15166	1293	17524	985	10055
16-#10	2.31	MA	13995	3674	21309	2799	22962	2362	23604	2004	23809	1454	27558	872	18297
8L-2S		MI	8117	3674	13433	2591	14517	2163	15141	1819	15959	1281	18595	1074	10034
16-#11	2.84	MA	14996	3802	23817	2844	26116	2373	27386	2004	28897	1397	34514	949	23539
5E		MI	8007	3802	12981	2687	13868	2247	14314	1876	14800	1284	16980	782	11931
16-#11	2.84	MA	14797	3802	23198	2850	25332	2399	26426	2016	27605	1420	32868	883	22859
6L-4S		MI	8137	3802	13273	2679	14256	2227	14797	1859	15514	1284	17854	845	12072
16-#11	2.84	MA	14570	3802	22537	2872	24529	2405	25502	2041	26268	1430	30942	826	22414
7L-3S		MI	8205	3802	13619	2657	14704	2221	15347	1855	16230	1271	18735	903	12055
16-#11	2.84	MA	14323	3802	21959	2882	23729	2427	24513	2048	25008	1453	29270	774	21595
8L-2S		MI	8353	3802	14066	2649	15277	2201	16047	1837	17182	1257	19989	1013	12031
16-#14	4.09	MA	15795	4108	25228	3057	27881	2561	29489	2123	31743	1422	38790	721	31704
6L-4S		MI	8665	4108	14459	2865	15739	2359	16591	1936	17961	1258	20891	672	16697
16-#14	4.09	MA	15476	4108	24280	3089	26731	2570	28176	2159	29826	1435	36017	638	30290
7L-3S		MI	8758	4108	14951	2834	16376	2352	17373	1932	18979	1241	22123	753	16840
16-#14	4.09	MA	15129	4108	23452	3103	25584	2602	26760	2168	28019	1468	33615	560	28977
8L-2S		MI	8961	4108	15586	2824	17190	2324	18365	1908	20329	1223	23868	912	16827
18-#10	2.60	MA	14908	3744	23604	2810	25915	2349	27174	1987	28634	1400	34110	1002	21887
5L-6S		MI	7903	3744	12658	2686	13505	2240	13887	1877	14240	1313	16417	817	11049
18-#10	2.60	MA	14744	3744	23095	2815	25264	2370	26386	1998	27574	1420	32762	951	21468
6L-5S		MI	7980	3744	12905	2669	13825	2234	14284	1873	14773	1301	17100	874	11238
18-#10	2.60	MA	14554	3744	22551	2834	24604	2375	25617	2017	26477	1428	31189	905	21091
7L-4S		MI	8088	3744	13147	2661	14146	2217	14684	1858	15365	1300	17846	925	11245
18-#10	2.60	MA	14353	3744	22077	2843	23947	2394	24805	2023	25443	1448	29821	864	20655
8L-3S		MI	8148	3744	13433	2642	14517	2211	15141	1853	15959	1287	18595	974	11230

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis

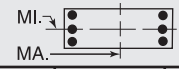


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.60	MA	14178	3744	21561	2862	23318	2402	24023	2042	24424	1468	28488	823	20073
9L-2S		MI	8274	3744	13806	2635	14995	2194	15724	1838	16752	1275	19665	1063	11212
18-#11	3.19	MA	15220	3888	24131	2904	26528	2437	27886	2040	29590	1413	35617	874	25723
6L-5S		MI	8197	3888	13429	2741	14442	2285	15013	1900	15752	1277	18234	765	13277
18-#11	3.19	MA	14994	3888	23470	2926	25725	2444	26961	2064	28253	1423	33690	817	25293
7L-4S		MI	8325	3888	13720	2733	14830	2266	15497	1882	16466	1277	19108	828	13473
18-#11	3.19	MA	14754	3888	22892	2936	24925	2466	25972	2071	26993	1446	32019	764	24460
8L-3S		MI	8393	3888	14066	2711	15277	2260	16047	1878	17182	1264	19989	886	13461
18-#11	3.19	MA	14543	3888	22270	2960	24159	2476	25019	2093	25751	1470	30383	713	23703
9L-2S		MI	8539	3888	14514	2703	15851	2240	16747	1861	18134	1250	21243	996	13442
18-#14	4.60	MA	16077	4232	25615	3167	28442	2626	30263	2193	32666	1425	39949	624	34371
7L-4S		MI	8930	4232	15093	2943	16552	2415	17583	1970	19311	1248	22637	644	18581
18-#14	4.60	MA	15748	4232	24786	3181	27295	2657	28847	2202	30859	1458	37547	546	33034
8L-3S		MI	9022	4232	15586	2912	17190	2407	18365	1966	20329	1231	23868	724	18816
18-#14	4.60	MA	15443	4232	23901	3216	26197	2671	27480	2233	29077	1491	35191	472	31452
9L-2S		MI	9222	4232	16220	2901	18003	2380	19357	1942	21679	1213	25614	883	18816
20-#10	2.89	MA	15094	3814	23863	2859	26249	2401	27587	2017	29208	1414	35025	943	23826
6E		MI	8062	3814	13031	2730	13983	2272	14470	1896	15033	1307	17488	806	12183
20-#10	2.89	MA	14905	3814	23319	2878	25589	2407	26819	2037	28111	1423	33452	897	23460
7L-5S		MI	8139	3814	13278	2712	14303	2266	14867	1892	15567	1295	18170	863	12361
20-#10	2.89	MA	14708	3814	22845	2887	24932	2426	26007	2043	27077	1442	32084	856	23014
8L-4S		MI	8246	3814	13519	2705	14624	2249	15268	1877	16158	1294	18917	914	12413
20-#10	2.89	MA	14536	3814	22329	2906	24303	2434	25224	2061	26058	1462	30751	815	22437
9L-3S		MI	8306	3814	13806	2686	14995	2243	15724	1872	16752	1282	19665	963	12402
20-#10	2.89	MA	14328	3814	21837	2912	23673	2454	24441	2068	24941	1468	29390	780	21800
10L-2S		MI	8430	3814	14179	2679	15473	2226	16307	1857	17546	1269	20736	1052	12387
20-#11	3.55	MA	15416	3975	24403	2980	26921	2483	28420	2088	30239	1416	36439	807	28173
7L-5S		MI	8385	3975	13876	2795	15015	2324	15713	1923	16704	1270	19488	748	14627
20-#11	3.55	MA	15185	3975	23825	2990	26121	2505	27431	2095	28978	1439	34767	755	27325
8L-4S		MI	8512	3975	14168	2787	15403	2304	16197	1906	17418	1270	20362	811	14867
20-#11	3.55	MA	14975	3975	23203	3014	25355	2514	26478	2116	27736	1463	33132	704	26553
9L-3S		MI	8580	3975	14514	2765	15851	2298	16747	1902	18134	1257	21243	869	14865
20-#11	3.55	MA	14727	3975	22603	3021	24587	2539	25550	2139	26394	1470	31468	659	25585
10L-2S		MI	8725	3975	14961	2757	16425	2279	17447	1884	19087	1243	22497	978	14850
20-#14	5.11	MA	16352	4357	26121	3259	29006	2713	30934	2236	33698	1448	41479	533	37091
8L-4S		MI	9193	4357	15728	3020	17366	2471	18575	2004	20661	1238	24382	615	20473
20-#14	5.11	MA	16059	4357	25236	3294	27908	2726	29568	2267	31917	1481	39123	458	35521
9L-3S		MI	9284	4357	16220	2990	18003	2463	19357	2000	21679	1221	25614	695	20788
22-#10	3.17	MA	15253	3885	24087	2922	26574	2439	28020	2056	29746	1417	35715	889	25829
7L-6S		MI	8222	3885	13404	2774	14461	2303	15053	1916	15826	1302	18558	795	13318
22-#10	3.17	MA	15061	3885	23613	2931	25916	2457	27208	2062	28712	1437	34347	848	25376
8L-5S		MI	8297	3885	13651	2756	14781	2297	15450	1911	16360	1289	19241	852	13488
22-#10	3.17	MA	14892	3885	23097	2950	25288	2465	26425	2080	27693	1457	33014	807	24801
9L-4S		MI	8404	3885	13892	2749	15101	2280	15851	1896	16952	1288	19987	903	13580
22-#10	3.17	MA	14684	3885	22605	2956	24657	2485	25642	2088	26575	1462	31652	772	24153
10L-3S		MI	8464	3885	14179	2730	15473	2274	16307	1892	17546	1276	20736	952	13572
22-#10	3.17	MA	14493	3885	22128	2963	24027	2493	24878	2107	25524	1479	30332	729	23474
11L-2S		MI	8586	3885	14552	2723	15951	2257	16890	1876	18339	1264	21807	1041	13559
22-#11	3.90	MA	15608	4061	24757	3044	27317	2544	28890	2118	30963	1432	37516	745	30190
8L-5S		MI	8573	4061	14323	2849	15589	2363	16413	1947	17657	1263	20742	730	15980
22-#11	3.90	MA	15405	4061	24136	3068	26551	2553	27937	2140	29721	1456	35880	694	29403
9L-4S		MI	8700	4061	14615	2841	15977	2343	16897	1929	18371	1263	21616	793	16259
22-#11	3.90	MA	15157	4061	23536	3075	25783	2577	27009	2162	28379	1463	34216	649	28441
10L-3S		MI	8767	4061	14961	2819	16425	2337	17447	1925	19087	1250	22497	851	16266
22-#14	5.63	MA	16669	4481	26571	3372	29619	2782	31655	2301	34756	1471	43055	445	39590
9L-4S		MI	9456	4481	16362	3098	18179	2527	19567	2038	22011	1228	26128	586	22371
24-#10	3.46	MA	15412	3955	24381	2974	26901	2489	28409	2081	30346	1431	36610	840	27739
8L-6S		MI	8381	3955	13776	2818	14939	2335	15636	1935	16620	1296	19629	784	14455

RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#10	3.46	MA	15246	3955	23866	2994	26272	2497	27627	2099	29327	1451	35277	799	27165
9L-5S		MI	8455	3955	14024	2800	15259	2329	16033	1930	17153	1284	20312	841	14616
24-#10	3.46	MA	15039	3955	23373	3000	25642	2517	26843	2107	28210	1456	33915	764	26507
10L-4S		MI	8561	3955	14265	2793	15579	2312	16434	1915	17745	1283	21058	892	14742
24-#10	3.46	MA	14850	3955	22897	3007	25011	2524	26079	2126	27158	1474	32595	721	25830
11L-3S		MI	8621	3955	14552	2774	15951	2306	16890	1911	18339	1271	21807	941	14740
24-#11	4.25	MA	15831	4147	25069	3122	27747	2592	29396	2163	31706	1449	38629	685	32253
9L-5S		MI	8761	4147	14771	2903	16163	2402	17113	1970	18609	1256	21996	713	17336
24-#11	4.25	MA	15585	4147	24469	3129	26979	2616	28468	2186	30364	1456	36965	639	31297
10L-4S		MI	8887	4147	15063	2895	16550	2382	17597	1953	19323	1256	22870	776	17650

RECTANGULAR TIED COLUMNS 22" x 42"

4-#18	1.73	MA	15945	3710	25500	2734	27765	2294	28935	1948	30184	1419	35312	1227	16068
2E		MI	8091	3710	13260	2554	13996	2141	14309	1814	14566	1312	16053	1051	7858
6-#11	1.01	MA	15082	3526	23399	2646	25207	2235	25876	1917	26058	1449	29629	1261	9685
2L-3S		MI	7601	3526	11906	2498	12370	2122	12371	1819	11948	1371	12963	1047	4942
6-#11	1.01	MA	14698	3526	22412	2660	23942	2248	24332	1944	23958	1473	26721	1167	9720
3L-2S		MI	7758	3526	12353	2490	12944	2102	13071	1802	12900	1357	14217	1157	4906
6-#14	1.46	MA	15650	3641	24716	2708	26849	2278	27859	1942	28743	1435	33337	1244	13747
2L-3S		MI	7770	3641	12305	2555	12844	2166	12934	1844	12707	1355	13890	955	6864
6-#14	1.46	MA	15112	3641	23304	2728	25038	2297	25650	1979	25738	1469	29175	1106	13779
3L-2S		MI	7988	3641	12939	2545	13657	2139	13926	1820	14057	1338	15636	1113	6804
6-#18	2.60	MA	17033	3931	27972	2872	30934	2394	32801	2008	35444	1401	42595	1202	23815
2L-3S		MI	8178	3931	13260	2707	13996	2284	14309	1912	14566	1319	16053	704	11440
6-#18	2.60	MA	16133	3931	25500	2906	27765	2425	28935	2071	30184	1458	35312	951	23725
3L-2S		MI	8539	3931	14349	2692	15392	2240	16012	1874	16883	1295	18936	985	11353
8-#10	1.10	MA	15223	3548	23630	2672	25566	2255	26343	1933	26712	1455	30548	1265	10533
2L-4S		MI	7633	3548	11805	2554	12290	2155	12293	1845	11879	1394	12995	1038	5364
8-#10	1.10	MA	14906	3548	22818	2684	24525	2266	25073	1954	24985	1475	28156	1190	10556
3E		MI	7696	3548	12091	2535	12662	2149	12749	1841	12473	1382	13743	1087	5327
8-#10	1.10	MA	14725	3548	22213	2707	23739	2289	24106	1965	23654	1484	26606	1143	10568
4L-2S		MI	7827	3548	12464	2527	13140	2132	13332	1825	13266	1369	14814	1177	5300
8-#11	1.35	MA	15529	3613	24386	2699	26472	2273	27419	1941	28158	1442	32536	1251	12791
2L-4S		MI	7721	3613	12007	2574	12496	2167	12521	1847	12184	1377	13336	972	6447
8-#11	1.35	MA	15151	3613	23399	2714	25207	2287	25876	1967	26058	1466	29629	1157	12816
3E		MI	7791	3613	12353	2552	12944	2161	13071	1843	12900	1364	14217	1030	6399
8-#11	1.35	MA	14936	3613	22662	2742	24249	2314	24697	1979	24439	1477	27732	1099	12811
4L-2S		MI	7946	3613	12800	2544	13517	2141	13770	1825	13852	1350	15471	1140	6361
8-#14	1.95	MA	16281	3765	26128	2786	28660	2334	30068	1976	31749	1425	37498	1230	18177
2L-4S		MI	7942	3765	12447	2664	13020	2229	13144	1882	13038	1363	14404	845	8950
8-#14	1.95	MA	15755	3765	24716	2806	26849	2353	27859	2013	28743	1459	33337	1092	18183
3E		MI	8038	3765	12939	2633	13657	2222	13926	1878	14057	1346	15636	926	8897
8-#14	1.95	MA	15454	3765	23659	2846	25476	2392	26169	2030	26422	1473	30607	1008	18074
4L-2S		MI	8253	3765	13574	2622	14471	2195	14918	1854	15406	1328	17381	1084	8843
8-#18	3.46	MA	17242	4153	27972	3045	30934	2524	32801	2132	35444	1440	42595	926	31386
3E		MI	8631	4153	14349	2845	15392	2383	16012	1972	16883	1301	18936	638	14860
8-#18	3.46	MA	16735	4153	26116	3114	28522	2591	29836	2160	31580	1498	37766	775	29933
4L-2S		MI	8985	4153	15437	2830	16788	2340	17715	1935	19200	1277	21819	919	14806
10-#10	1.37	MA	15592	3619	24442	2716	26607	2287	27613	1952	28440	1449	32940	1257	13083
2L-5S		MI	7682	3619	11936	2605	12447	2204	12475	1880	12081	1389	13319	976	6598
10-#10	1.37	MA	15281	3619	23630	2728	25566	2298	26343	1974	26712	1469	30548	1182	13100
3L-4S		MI	7794	3619	12178	2597	12768	2186	12876	1864	12672	1388	14065	1027	6563

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 42"

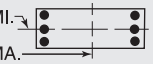
Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.37	MA	15101	3619	23025	2751	24780	2320	25376	1984	25382	1478	28999	1135	13099
4L-3S		MI	7856	3619	12464	2579	13140	2181	13332	1860	13266	1376	14814	1076	6529
10-#10	1.37	MA	14841	3619	22507	2761	24110	2332	24536	2006	24204	1499	27411	1101	13049
5L-2S		MI	7986	3619	12837	2571	13618	2164	13915	1845	14059	1364	15885	1166	6501
10-#11	1.69	MA	15973	3699	25373	2753	27737	2312	28963	1964	30258	1435	35444	1242	15888
2L-5S		MI	7779	3699	12163	2636	12682	2225	12737	1888	12422	1370	13716	892	7914
10-#11	1.69	MA	15602	3699	24386	2768	26472	2325	27419	1991	28158	1459	32536	1148	15903
3L-4S		MI	7911	3699	12455	2628	13069	2205	13220	1870	13136	1370	14590	955	7877
10-#11	1.69	MA	15389	3699	23649	2796	25514	2353	26241	2003	26539	1470	30639	1090	15879
4L-3S		MI	7981	3699	12800	2606	13517	2199	13770	1867	13852	1357	15471	1013	7837
10-#11	1.69	MA	15077	3699	23024	2809	24697	2366	25217	2029	25102	1494	28699	1046	15772
5L-2S		MI	8134	3699	13248	2598	14091	2180	14470	1849	14804	1343	16725	1122	7800
10-#14	2.44	MA	16394	3890	26128	2884	28660	2409	30068	2047	31749	1449	37498	1078	22580
3L-4S		MI	8210	3890	13081	2741	13834	2285	14136	1916	14388	1353	16150	816	10944
10-#14	2.44	MA	16096	3890	25072	2924	27287	2447	28378	2064	29427	1463	34768	994	22447
4L-3S		MI	8305	3890	13574	2711	14471	2278	14918	1912	15406	1336	17381	897	10909
10-#14	2.44	MA	15656	3890	24181	2943	26114	2466	26909	2101	27367	1496	31982	929	21581
5L-2S		MI	8517	3890	14208	2700	15284	2251	15910	1888	16756	1318	19127	1055	10865
10-#18	4.33	MA	17841	4374	28588	3253	31691	2690	33702	2220	36839	1480	45049	750	37458
4L-3S		MI	9083	4374	15437	2984	16788	2483	17715	2032	19200	1284	21819	572	18248
10-#18	4.33	MA	17093	4374	27043	3287	29628	2721	31119	2283	33008	1502	40137	627	34788
5L-2S		MI	9431	4374	16526	2969	18183	2439	19417	1995	21516	1259	24702	854	18237
12-#10	1.65	MA	15960	3689	25254	2760	27648	2318	28883	1971	30168	1444	35333	1249	15629
2L-6S		MI	7763	3689	12062	2666	12606	2241	12661	1903	12340	1396	13707	909	7746
12-#10	1.65	MA	15653	3689	24442	2772	26607	2329	27613	1993	28440	1464	32940	1174	15640
3L-5S		MI	7843	3689	12309	2649	12925	2235	13058	1899	12874	1384	14390	965	7778
12-#10	1.65	MA	15475	3689	23837	2795	25821	2352	26646	2003	27110	1473	31391	1127	15626
4E		MI	7954	3689	12551	2641	13246	2218	13459	1883	13466	1383	15136	1016	7750
12-#10	1.65	MA	15218	3689	23319	2805	25151	2363	25806	2025	25931	1493	29803	1093	15567
5L-3S		MI	8015	3689	12837	2623	13618	2212	13915	1879	14059	1370	15885	1065	7721
12-#10	1.65	MA	15033	3689	22781	2811	24459	2384	24975	2036	24813	1513	28383	1043	15275
6L-2S		MI	8144	3689	13210	2615	14096	2195	14498	1864	14853	1358	16955	1155	7695
12-#11	2.03	MA	16050	3785	25373	2822	27737	2364	28963	2014	30258	1453	35444	1138	18983
3L-5S		MI	7970	3785	12610	2690	13255	2264	13436	1912	13374	1363	14970	874	9321
12-#11	2.03	MA	15839	3785	24636	2850	26780	2391	27784	2026	28639	1463	33547	1080	18945
4E		MI	8101	3785	12902	2682	13643	2244	13920	1894	14088	1363	15844	937	9296
12-#11	2.03	MA	15531	3785	24010	2863	25962	2405	26760	2053	27202	1487	31607	1036	18826
5L-3S		MI	8171	3785	13248	2660	14091	2238	14470	1890	14804	1350	16725	995	9262
12-#11	2.03	MA	15309	3785	23356	2869	25128	2430	25747	2065	25838	1511	29872	972	18170
6L-2S		MI	8322	3785	13695	2652	14665	2218	15170	1872	15756	1337	17979	1105	9229
12-#14	2.92	MA	16733	4014	26484	3002	29097	2503	30587	2098	32433	1453	38930	980	26822
4E		MI	8477	4014	13716	2819	14647	2341	15128	1950	15738	1343	17895	787	12927
12-#14	2.92	MA	16301	4014	25593	3021	27924	2522	29118	2135	30372	1486	36143	915	25894
5L-3S		MI	8571	4014	14208	2789	15284	2334	15910	1946	16756	1326	19127	868	12910
12-#14	2.92	MA	15989	4014	24656	3029	26737	2559	27665	2152	28417	1520	33650	821	24898
6L-2S		MI	8780	4014	14842	2778	16097	2307	16902	1922	18106	1308	20872	1027	12874
12-#18	5.19	MA	18205	4595	29515	3425	32797	2820	34985	2344	38268	1484	47420	602	42359
5L-3S		MI	9533	4595	16526	3122	18183	2582	19417	2093	21516	1266	24702	506	21625
12-#18	5.19	MA	17676	4595	27872	3439	30744	2887	32429	2372	34829	1541	43024	427	39166
6L-2S		MI	9875	4595	17615	3107	19579	2538	21120	2055	23833	1242	27585	788	21653
14-#10	1.92	MA	16023	3759	25254	2816	27648	2361	28883	2012	30168	1458	35333	1166	18175
3L-6S		MI	7924	3759	12435	2710	13084	2272	13244	1922	13134	1390	14777	898	8877
14-#10	1.92	MA	15846	3759	24649	2839	26862	2384	27916	2022	28838	1467	33784	1120	18152
4L-5S		MI	8003	3759	12682	2693	13403	2267	13642	1918	13667	1378	15460	954	8952
14-#10	1.92	MA	15592	3759	24131	2849	26192	2395	27076	2044	27659	1487	32195	1086	18085
5L-4S		MI	8113	3759	12923	2685	13724	2250	14042	1903	14259	1377	16206	1005	8931
14-#10	1.92	MA	15411	3759	23593	2855	25500	2415	26245	2055	26541	1507	30775	1035	17759
6L-3S		MI	8174	3759	13210	2667	14096	2244	14498	1898	14853	1365	16955	1054	8906

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

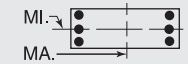
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	1.92	MA	15205	3759	23019	2873	24803	2421	25427	2074	25384	1516	29121	989	17318
7L-2S		MI	8302	3759	13583	2659	14574	2227	15081	1883	15646	1353	18026	1144	8882
14-#11	2.36	MA	16286	3871	25623	2904	28045	2430	29328	2050	30739	1456	36455	1071	22010
4L-5S		MI	8160	3871	13058	2744	13829	2303	14136	1935	14326	1356	16224	857	10720
14-#11	2.36	MA	15982	3871	24997	2917	27227	2443	28304	2076	29302	1480	34515	1027	21882
5L-4S		MI	8290	3871	13350	2736	14217	2283	14620	1917	15040	1356	17098	920	10707
14-#11	2.36	MA	15765	3871	24343	2923	26393	2469	27291	2088	27938	1504	32780	963	21194
6L-3S		MI	8359	3871	13695	2714	14665	2277	15170	1914	15756	1343	17979	978	10680
14-#11	2.36	MA	15520	3871	23644	2946	25545	2476	26306	2113	26528	1514	30753	906	20693
7L-2S		MI	8509	3871	14143	2706	15238	2257	15870	1896	16708	1330	19233	1088	10651
14-#14	3.41	MA	16940	4139	27005	3099	29735	2578	31327	2169	33378	1477	40305	901	30215
5L-4S		MI	8743	4139	14350	2897	15460	2397	16120	1984	17088	1333	19641	759	14901
14-#14	3.41	MA	16636	4139	26068	3107	28548	2614	29874	2186	31422	1510	37812	807	29252
6L-3S		MI	8836	4139	14842	2866	16097	2390	16902	1980	18106	1316	20872	839	14903
14-#14	3.41	MA	16291	4139	25066	3139	27332	2624	28475	2222	29398	1524	34895	725	27877
7L-2S		MI	9042	4139	15477	2856	16910	2362	17894	1956	19456	1298	22618	998	14876
14-#18	6.06	MA	18797	4816	30344	3577	33913	2986	36295	2432	40089	1523	50307	403	46673
6L-3S		MI	9982	4816	17615	3260	19579	2681	21120	2153	23833	1248	27585	441	24995
14-#18	6.06	MA	18208	4816	28586	3633	31779	3001	33858	2495	36741	1581	45141	254	43540
7L-2S		MI	10318	4816	18704	3245	20975	2638	22823	2116	26150	1224	30468	722	25058
16-#10	2.20	MA	16216	3829	25461	2883	27903	2415	29185	2042	30566	1461	36176	1112	20677
4L-6S		MI	8085	3829	12808	2754	13562	2304	13827	1941	13927	1385	15848	886	9985
16-#10	2.20	MA	15965	3829	24943	2893	27233	2426	28345	2063	29387	1482	34588	1078	20603
5E		MI	8163	3829	13055	2737	13881	2298	14225	1937	14461	1373	16531	943	10122
16-#10	2.20	MA	15786	3829	24405	2898	26541	2447	27515	2074	28269	1502	33168	1027	20246
6L-4S		MI	8272	3829	13296	2729	14202	2281	14625	1922	15052	1372	17277	994	10107
16-#10	2.20	MA	15582	3829	23831	2917	25844	2453	26697	2093	27112	1511	31514	982	19819
7L-3S		MI	8333	3829	13583	2711	14574	2275	15081	1917	15646	1359	18026	1043	10086
16-#10	2.20	MA	15363	3829	23331	2926	25151	2471	25840	2100	26021	1531	30073	942	19428
8L-2S		MI	8460	3829	13956	2703	15052	2258	15664	1902	16440	1347	19096	1133	10064
16-#11	2.70	MA	16430	3958	25984	2971	28492	2482	29847	2100	31402	1473	37422	1017	24939
5E		MI	8350	3958	13505	2798	14403	2341	14836	1959	15278	1349	17478	840	12016
16-#11	2.70	MA	16217	3958	25330	2977	27658	2507	28834	2112	30038	1497	35687	953	24222
6L-4S		MI	8479	3958	13797	2790	14790	2321	15320	1941	15992	1350	18352	903	12113
16-#11	2.70	MA	15974	3958	24631	3000	26810	2514	27850	2136	28628	1507	33661	897	23738
7L-3S		MI	8548	3958	14143	2768	15238	2316	15870	1937	16708	1336	19233	961	12093
16-#11	2.70	MA	15711	3958	24021	3010	25965	2537	26806	2143	27298	1531	31900	846	22930
8L-2S		MI	8696	3958	14590	2760	15812	2296	16570	1919	17660	1323	20487	1070	12068
16-#14	3.90	MA	17279	4263	27481	3185	30359	2670	32083	2220	34427	1500	41973	793	33601
6L-4S		MI	9008	4263	14985	2975	16273	2453	17112	2018	18438	1323	21386	730	16815
16-#14	3.90	MA	16936	4263	26479	3217	29143	2680	30684	2256	32403	1514	39056	711	32196
7L-3S		MI	9101	4263	15477	2944	16910	2446	17894	2014	19456	1306	22618	810	16891
16-#14	3.90	MA	16566	4263	25604	3232	27931	2712	29187	2265	30495	1548	36525	635	30902
8L-2S		MI	9304	4263	16111	2934	17724	2418	18886	1990	20806	1288	24363	969	16871
16-#18	6.93	MA	19322	5038	31058	3771	34948	3100	37724	2556	42001	1563	52424	229	50999
7L-3S		MI	10429	5038	18704	3399	20975	2781	22823	2213	26150	1231	30468	375	28360
18-#10	2.47	MA	16335	3900	25755	2937	28274	2458	29615	2082	31115	1476	36980	1070	23121
5L-6S		MI	8245	3900	13180	2798	14040	2336	14410	1961	14720	1379	16919	875	11116
18-#10	2.47	MA	16160	3900	25217	2942	27582	2478	28785	2093	29997	1496	35560	1020	22736
6L-5S		MI	8322	3900	13428	2781	14359	2330	14808	1956	15254	1367	17601	932	11290
18-#10	2.47	MA	15957	3900	24643	2961	26885	2484	27967	2113	28839	1505	33906	974	22322
7L-4S		MI	8431	3900	13669	2773	14680	2313	15208	1941	15846	1366	18348	983	11279
18-#10	2.47	MA	15742	3900	24143	2970	26192	2503	27110	2119	27749	1525	32465	934	21924
8L-3S		MI	8491	3900	13956	2754	15052	2307	15664	1937	16440	1354	19096	1032	11262

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

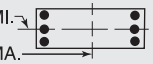


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.47	MA	15556	3900	23647	2978	25528	2512	26284	2137	26664	1545	31063	893	21284
9L-2S		MI	8617	3900	14328	2747	15530	2290	16248	1921	17233	1341	20167	1122	11243
18-#11	3.04	MA	16667	4044	26317	3031	28923	2546	30378	2135	32138	1490	38595	944	27254
6L-5S		MI	8539	4044	13953	2852	14976	2380	15536	1982	16231	1342	18732	822	13361
18-#11	3.04	MA	16425	4044	25618	3054	28075	2553	29393	2160	30728	1500	36569	887	26784
7L-4S		MI	8667	4044	14245	2844	15364	2360	16020	1964	16945	1343	19606	886	13516
18-#11	3.04	MA	16169	4044	25008	3064	27230	2576	28349	2167	29398	1524	34807	836	25961
8L-3S		MI	8736	4044	14590	2822	15812	2354	16570	1961	17660	1329	20487	943	13501
18-#11	3.04	MA	15945	4044	24347	3088	26421	2586	27343	2189	28087	1548	33088	786	25232
9L-2S		MI	8882	4044	15038	2814	16385	2334	17269	1943	18613	1316	21741	1053	13480
18-#14	4.38	MA	17576	4388	27891	3295	30954	2736	32892	2290	35409	1504	43217	697	36515
7L-4S		MI	9272	4388	15619	3053	17087	2509	18104	2052	19788	1313	23132	701	18698
18-#14	4.38	MA	17218	4388	27016	3310	29742	2768	31396	2299	33501	1538	40686	622	35196
8L-3S		MI	9364	4388	16111	3022	17724	2501	18886	2048	20806	1296	24363	781	18869
18-#14	4.38	MA	16900	4388	26075	3344	28582	2781	29953	2330	31620	1572	38209	548	33478
9L-2S		MI	9565	4388	16746	3011	18537	2474	19878	2024	22156	1278	26109	940	18862
20-#10	2.75	MA	16531	3970	26029	2986	28623	2510	30055	2112	31724	1491	37952	1012	25230
6E		MI	8405	3970	13553	2842	14518	2367	14993	1980	15514	1374	17989	864	12250
20-#10	2.75	MA	16329	3970	25455	3005	27926	2516	29237	2132	30567	1500	36298	966	24827
7L-5S		MI	8481	3970	13801	2824	14837	2361	15391	1975	16047	1361	18672	921	12434
20-#10	2.75	MA	16119	3970	24955	3014	27232	2535	28380	2138	29477	1520	34857	926	24421
8L-4S		MI	8589	3970	14042	2817	15158	2344	15791	1960	16639	1360	19418	972	12449
20-#10	2.75	MA	15936	3970	24459	3022	26569	2543	27554	2156	28392	1539	33456	886	23783
9L-3S		MI	8649	3970	14328	2798	15530	2338	16248	1956	17233	1348	20167	1021	12436
20-#10	2.75	MA	15714	3970	23887	3040	25904	2563	26727	2165	27213	1545	32022	852	23166
10L-2S		MI	8773	3970	14701	2791	16008	2321	16831	1940	18026	1336	21237	1110	12419
20-#11	3.38	MA	16873	4130	26605	3108	29340	2592	30937	2183	32828	1493	39476	878	29833
7L-5S		MI	8728	4130	14400	2906	15550	2419	16236	2006	17183	1335	19986	805	14711
20-#11	3.38	MA	16624	4130	25995	3118	28495	2614	29893	2190	31498	1517	37715	827	28992
8L-4S		MI	8855	4130	14692	2898	15938	2399	16719	1988	17897	1336	20860	868	14915
20-#11	3.38	MA	16404	4130	25334	3142	27686	2624	28886	2213	30187	1541	35996	776	28247
9L-3S		MI	8923	4130	15038	2876	16385	2393	17269	1984	18613	1322	21741	926	14906
20-#11	3.38	MA	16138	4130	24700	3149	26876	2649	27878	2222	28756	1548	34243	732	27240
10L-2S		MI	9068	4130	15485	2868	16959	2373	17969	1967	19565	1309	22995	1036	14889
20-#14	4.87	MA	17868	4512	28429	3388	31553	2824	33605	2333	36506	1528	44847	608	39490
8L-4S		MI	9536	4512	16253	3130	17900	2565	19096	2086	21137	1303	24877	672	20588
20-#14	4.87	MA	17555	4512	27487	3422	30393	2837	32161	2364	34625	1562	42370	534	37785
9L-3S		MI	9627	4512	16746	3100	18537	2557	19878	2082	22156	1286	26109	753	20843
22-#10	3.02	MA	16699	4040	26267	3049	28967	2547	30507	2151	32295	1494	38691	958	27333
7L-6S		MI	8564	4040	13926	2886	14996	2399	15577	1999	16307	1368	19060	853	13385
22-#10	3.02	MA	16494	4040	25767	3058	28273	2566	29650	2157	31205	1514	37250	918	26920
8L-5S		MI	8640	4040	14174	2868	15315	2393	15974	1995	16841	1356	19743	910	13560
22-#10	3.02	MA	16314	4040	25271	3066	27610	2575	28824	2176	30120	1534	35848	878	26283
9L-4S		MI	8747	4040	14415	2861	15636	2376	16374	1979	17432	1355	20489	961	13617
22-#10	3.02	MA	16093	4040	24699	3084	26945	2595	27997	2184	28940	1539	34415	844	25654
10L-3S		MI	8807	4040	14701	2842	16008	2370	16831	1975	18026	1342	21237	1010	13607
22-#10	3.02	MA	15889	4040	24196	3091	26275	2602	27192	2203	27831	1557	33024	802	24919
11L-2S		MI	8930	4040	15074	2835	16485	2353	17414	1959	18820	1330	22308	1099	13593
22-#11	3.71	MA	17077	4217	26982	3172	29760	2653	31436	2214	33598	1511	40623	817	32022
8L-5S		MI	8916	4217	14848	2960	16123	2457	16935	2029	18135	1328	21240	788	16064
22-#11	3.71	MA	16860	4217	26321	3196	28952	2663	30429	2236	32287	1535	38903	766	31262
9L-4S		MI	9043	4217	15140	2952	16511	2438	17419	2012	18849	1329	22114	851	16308
22-#11	3.71	MA	16595	4217	25687	3203	28141	2687	29422	2245	30856	1541	37151	723	30262
10L-3S		MI	9110	4217	15485	2930	16959	2432	17969	2008	19565	1315	22995	909	16308
22-#11	3.71	MA	16350	4217	25075	3212	27333	2697	28439	2269	29504	1562	35450	669	29201
11L-2S		MI	9254	4217	15933	2922	17533	2412	18669	1990	20517	1302	24249	1019	16295
22-#14	5.36	MA	18204	4637	28900	3500	32204	2893	34370	2398	37631	1552	46532	520	42092
9L-4S		MI	9799	4637	16888	3208	18713	2620	20088	2120	22487	1293	26623	643	22486

RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
24-#10	3.30	MA	16867	4110	26579	3102	29314	2598	30920	2176	32932	1509	39642	911	29418
8L-6S		MI	8723	4110	14299	2930	15474	2430	16160	2018	17100	1362	20130	842	14522
24-#10	3.30	MA	16690	4110	26083	3110	28651	2606	30094	2195	31847	1528	38240	870	28782
9L-5S		MI	8798	4110	14546	2912	15793	2424	16557	2014	17634	1350	20813	899	14689
24-#10	3.30	MA	16469	4110	25511	3128	27986	2626	29267	2203	30668	1534	36807	836	28143
10L-4S		MI	8904	4110	14788	2905	16114	2407	16958	1998	18226	1349	21559	950	14783
24-#10	3.30	MA	16269	4110	25008	3135	27316	2634	28461	2223	29559	1551	35417	794	27411
11L-3S		MI	8964	4110	15074	2886	16485	2401	17414	1994	18820	1337	22308	999	14776
24-#10	3.30	MA	16081	4110	24464	3155	26632	2652	27671	2243	28462	1570	33823	744	26609
12L-2S		MI	9086	4110	15447	2879	16963	2384	17997	1979	19613	1325	23379	1088	14764
24-#11	4.05	MA	17313	4303	27308	3250	30217	2702	31973	2260	34387	1528	41811	757	34277
9L-5S		MI	9104	4303	15295	3014	16697	2496	17635	2053	19087	1322	22494	771	17419
24-#11	4.05	MA	17050	4303	26674	3257	29406	2726	30965	2269	32956	1535	40058	713	33239
10L-4S		MI	9230	4303	15587	3006	17085	2476	18119	2035	19801	1322	23368	834	17700
24-#11	4.05	MA	16809	4303	26062	3266	28598	2735	29983	2293	31604	1555	38358	659	32211
11L-3S		MI	9297	4303	15933	2984	17533	2470	18669	2031	20517	1309	24249	891	17709

RECTANGULAR TIED COLUMNS 22" x 44"

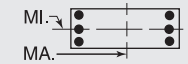
4-#18	1.65	MA	17420	3865	27739	2860	30204	2402	31452	2042	32725	1494	38209	1292	16932
2E		MI	8433	3865	13788	2662	14530	2233	14828	1895	15039	1377	16543	1107	7897
6-#14	1.39	MA	17105	3796	26906	2835	29231	2386	30308	2036	31195	1510	36111	1309	14476
2L-3S		MI	8112	3796	12830	2665	13378	2260	13455	1926	13183	1421	14385	1012	6894
6-#14	1.39	MA	16532	3796	25416	2855	27321	2405	27977	2074	28024	1544	31720	1173	14508
3L-2S		MI	8331	3796	13465	2655	14192	2233	14447	1902	14533	1403	16131	1170	6834
6-#18	2.48	MA	18575	4087	30349	2998	33550	2501	35534	2102	38279	1476	45900	1268	25111
2L-3S		MI	8520	4087	13788	2816	14530	2377	14828	1992	15039	1383	16543	760	11490
6-#18	2.48	MA	17617	4087	27739	3033	30204	2534	31452	2166	32725	1534	38209	1020	25021
3L-2S		MI	8882	4087	14876	2801	15925	2333	16531	1955	17356	1359	19426	1041	11397
8-#10	1.05	MA	16649	3704	25756	2798	27872	2363	28702	2027	29044	1530	33158	1331	11082
2L-4S		MI	7975	3704	12327	2666	12825	2250	12817	1928	12359	1460	13496	1097	5385
8-#10	1.05	MA	16313	3704	24900	2810	26775	2374	27364	2049	27223	1550	30636	1256	11104
3E		MI	8038	3704	12614	2647	13196	2245	13273	1924	12953	1448	14245	1146	5349
8-#10	1.05	MA	16120	3704	24263	2834	25947	2397	26345	2059	25822	1559	29010	1210	11116
4L-2S		MI	8170	3704	12987	2639	13674	2228	13856	1909	13747	1436	15316	1235	5322
8-#11	1.29	MA	16975	3768	26556	2826	28831	2381	29841	2035	30574	1517	35261	1317	13465
2L-4S		MI	8063	3768	12532	2685	13030	2261	13043	1929	12662	1443	13833	1030	6474
8-#11	1.29	MA	16574	3768	25515	2841	27496	2395	28213	2061	28359	1542	32194	1224	13490
3E		MI	8134	3768	12877	2663	13478	2255	13593	1925	13378	1429	14715	1087	6426
8-#11	1.29	MA	16343	3768	24739	2869	26488	2422	26972	2074	26653	1552	30203	1166	13485
4L-2S		MI	8289	3768	13325	2655	14052	2235	14293	1908	14330	1416	15969	1197	6388
8-#14	1.86	MA	17773	3921	28396	2912	31141	2442	32638	2070	34366	1500	40501	1296	19149
2L-4S		MI	8284	3921	12973	2774	13554	2323	13665	1964	13515	1428	14899	902	8990
8-#14	1.86	MA	17215	3921	26906	2933	29231	2461	30308	2108	31195	1534	36111	1159	19155
3E		MI	8380	3921	13465	2743	14192	2316	14447	1960	14533	1411	16131	983	8932
8-#14	1.86	MA	16892	3921	25793	2974	27785	2500	28528	2125	28749	1549	33245	1076	19046
4L-2S		MI	8595	3921	14099	2732	15005	2289	15439	1936	15883	1393	17876	1142	8877
8-#18	3.31	MA	18793	4308	30349	3172	33550	2633	35534	2227	38279	1517	45900	995	33114
3E		MI	8974	4308	14876	2954	15925	2476	16531	2053	17356	1366	19426	694	14915
8-#18	3.31	MA	18249	4308	28392	3242	31008	2701	32407	2256	33983	1540	40828	845	31829
4L-2S		MI	9328	4308	15965	2939	17321	2432	18234	2015	19673	1341	22309	976	14855
10-#10	1.31	MA	17041	3774	26612	2842	28970	2394	30041	2046	30865	1524	35680	1323	13769
2L-5S		MI	8024	3774	12459	2717	12982	2299	12999	1963	12561	1456	13821	1035	6625

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

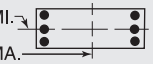


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#10	1.31	MA	16710	3774	25756	2854	27872	2406	28702	2068	29044	1545	33158	1248	13786
3L-4S		MI	8136	3774	12700	2709	13303	2282	13400	1947	13153	1455	14567	1085	6587
10-#10	1.31	MA	16518	3774	25119	2878	27045	2429	27684	2079	27644	1554	31532	1202	13784
4L-3S		MI	8198	3774	12987	2691	13674	2276	13856	1943	13747	1442	15316	1135	6554
10-#10	1.31	MA	16243	3774	24571	2888	26339	2440	26800	2101	26403	1574	29863	1169	13735
5L-2S		MI	8329	3774	13360	2683	14152	2259	14439	1928	14540	1430	16386	1224	6526
10-#11	1.61	MA	17446	3854	27597	2880	30165	2420	31469	2058	32788	1510	38328	1308	16730
2L-5S		MI	8121	3854	12687	2747	13216	2320	13259	1970	12900	1435	14213	949	7950
10-#11	1.61	MA	17051	3854	26556	2895	28831	2434	29841	2085	30574	1535	35261	1214	16746
3L-4S		MI	8253	3854	12979	2739	13604	2300	13743	1953	13614	1436	15088	1012	7909
10-#11	1.61	MA	16823	3854	25780	2923	27822	2461	28600	2098	28867	1546	33270	1157	16722
4L-3S		MI	8324	3854	13325	2717	14052	2294	14293	1949	14330	1422	15969	1070	7867
10-#11	1.61	MA	16492	3854	25117	2936	26961	2475	27522	2124	27355	1570	31230	1114	16614
5L-2S		MI	8477	3854	13772	2709	14625	2274	14993	1931	15282	1409	17223	1180	7830
10-#14	2.32	MA	17891	4045	28396	3011	31141	2517	32638	2141	34366	1524	40501	1146	23795
3L-4S		MI	8552	4045	13607	2851	14368	2379	14657	1998	14865	1418	16645	873	10989
10-#14	2.32	MA	17573	4045	27283	3052	29695	2556	30859	2159	31920	1539	37636	1062	23662
4L-3S		MI	8647	4045	14099	2821	15005	2372	15439	1994	15883	1401	17876	954	10949
10-#14	2.32	MA	17106	4045	26339	3070	28460	2576	29312	2197	29750	1574	34705	999	22861
5L-2S		MI	8860	4045	14734	2810	15818	2345	16431	1970	17233	1383	19622	1113	10902
10-#18	4.13	MA	19422	4529	31003	3381	34354	2800	36489	2316	39537	1522	48519	820	39790
4L-3S		MI	9425	4529	15965	3092	17321	2575	18234	2113	19673	1348	22309	628	18314
10-#18	4.13	MA	18628	4529	29364	3415	32181	2832	33769	2381	35722	1581	43351	701	36847
5L-2S		MI	9774	4529	17054	3077	18717	2531	19937	2075	21989	1323	25192	910	18290
12-#10	1.57	MA	17430	3844	27467	2886	30067	2426	31379	2065	32687	1518	38201	1315	16452
2L-6S		MI	8105	3844	12584	2778	13140	2336	13185	1986	12821	1462	14208	967	7811
12-#10	1.57	MA	17104	3844	26612	2898	28970	2438	30041	2087	30865	1539	35680	1240	16463
3L-5S		MI	8185	3844	12832	2761	13460	2331	13582	1982	13354	1450	14891	1024	7808
12-#10	1.57	MA	16913	3844	25975	2922	28142	2460	29022	2098	29465	1548	34054	1194	16449
4E		MI	8296	3844	13073	2753	13781	2314	13983	1967	13946	1449	15637	1074	7778
12-#10	1.57	MA	16641	3844	25427	2932	27437	2472	28139	2120	28224	1569	32384	1161	16390
5L-3S		MI	8357	3844	13360	2735	14152	2308	14439	1962	14540	1437	16386	1124	7748
12-#10	1.57	MA	16446	3844	24860	2938	26704	2492	27265	2131	27048	1589	30892	1111	16141
6L-2S		MI	8487	3844	13732	2727	14630	2291	15022	1947	15333	1424	17457	1213	7721
12-#11	1.93	MA	17525	3941	27597	2948	30165	2472	31469	2108	32788	1528	38328	1205	19994
3L-5S		MI	8312	3941	13135	2801	13790	2358	13959	1994	13852	1429	15467	932	9361
12-#11	1.93	MA	17300	3941	26821	2977	29156	2500	30228	2121	31082	1539	36336	1147	19956
4E		MI	8443	3941	13426	2793	14177	2339	14443	1976	14566	1429	16342	995	9331
12-#11	1.93	MA	16973	3941	26158	2990	28296	2514	29150	2148	29570	1563	34297	1105	19837
5L-3S		MI	8513	3941	13772	2771	14625	2333	14993	1972	15282	1416	17223	1053	9295
12-#11	1.93	MA	16738	3941	25469	2996	27411	2539	28084	2160	28135	1588	32473	1042	19206
6L-2S		MI	8665	3941	14220	2763	15199	2313	15692	1955	16234	1402	18477	1163	9262
12-#14	2.79	MA	18248	4170	28773	3129	31605	2612	33189	2193	35091	1529	42026	1048	28280
4E		MI	8819	4170	14241	2929	15181	2435	15649	2032	16215	1408	18390	845	12979
12-#14	2.79	MA	17789	4170	27829	3148	30370	2631	31642	2231	32921	1564	39096	985	27416
5L-3S		MI	8913	4170	14734	2899	15818	2428	16431	2028	17233	1391	19622	925	12952
12-#14	2.79	MA	17458	4170	26841	3157	29111	2668	30113	2248	30862	1598	36475	893	26325
6L-2S		MI	9123	4170	15368	2888	16631	2400	17424	2004	18583	1373	21368	1084	12914
12-#18	4.96	MA	19807	4751	31974	3553	35527	2931	37851	2441	41276	1563	51041	676	44843
5L-3S		MI	9876	4751	17054	3231	18717	2675	19937	2173	21989	1330	25192	563	21695
12-#18	4.96	MA	19247	4751	30240	3567	33346	2997	35159	2471	37653	1622	46417	505	41619
6L-2S		MI	10218	4751	18143	3216	20113	2631	21639	2136	24306	1306	28075	844	21709
14-#10	1.84	MA	17495	3915	27467	2942	30067	2469	31379	2106	32687	1533	38201	1233	19135
3L-6S		MI	8266	3915	12957	2822	13618	2368	13768	2005	13614	1457	15279	956	8942
14-#10	1.84	MA	17307	3915	26831	2966	29239	2492	30361	2117	31286	1543	36575	1186	19112
4L-5S		MI	8345	3915	13205	2805	13938	2362	14165	2001	14148	1444	15962	1012	8985
14-#10	1.84	MA	17038	3915	26283	2976	28534	2503	29477	2139	30046	1563	34906	1153	19045
5L-4S		MI	8455	3915	13446	2797	14259	2345	14566	1986	14740	1443	16708	1063	8961

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

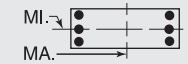
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#10	1.84	MA	16845	3915	25716	2981	27801	2524	28603	2150	28869	1584	33414	1104	18760
6L-3S		MI	8517	3915	13732	2779	14630	2339	15022	1982	15333	1431	17457	1112	8934
14-#10	1.84	MA	16627	3915	25112	3001	27068	2530	27737	2169	27652	1593	31678	1058	18279
7L-2S		MI	8645	3915	14105	2771	15108	2322	15605	1966	16127	1419	18527	1202	8909
14-#11	2.26	MA	17774	4027	27861	3031	30491	2539	31855	2145	33297	1532	39403	1138	23189
4L-5S		MI	8502	4027	13582	2855	14363	2397	14659	2018	14805	1422	16721	915	10765
14-#11	2.26	MA	17451	4027	27199	3044	29630	2552	30777	2171	31784	1556	37363	1095	23061
5L-4S		MI	8633	4027	13874	2847	14751	2377	15142	2000	15519	1422	17596	978	10745
14-#11	2.26	MA	17221	4027	26509	3050	28746	2577	29712	2184	30349	1581	35539	1032	22397
6L-3S		MI	8702	4027	14220	2825	15199	2371	15692	1996	16234	1409	18477	1036	10715
14-#11	2.26	MA	16960	4027	25773	3073	27852	2585	28667	2208	28864	1591	33413	976	21853
7L-2S		MI	8852	4027	14667	2817	15773	2352	16392	1978	17187	1395	19731	1145	10685
14-#14	3.25	MA	18466	4294	29319	3226	32281	2687	33973	2265	36092	1554	43486	971	31979
5L-4S		MI	9085	4294	14876	3007	15994	2491	16641	2066	17564	1398	20136	816	14955
14-#14	3.25	MA	18145	4294	28331	3235	31022	2724	32443	2282	34033	1588	40866	879	30916
6L-3S		MI	9179	4294	15368	2977	16631	2484	17424	2062	18583	1381	21368	896	14948
14-#14	3.25	MA	17775	4294	27276	3267	29741	2734	30957	2318	31902	1603	37804	797	29560
7L-2S		MI	9385	4294	16002	2966	17445	2456	18416	2038	19932	1363	23113	1055	14918
14-#18	5.79	MA	20436	4972	32851	3706	36692	3096	39241	2531	43207	1604	54107	480	49547
6L-3S		MI	10324	4972	18143	3369	20113	2774	21639	2234	24306	1313	28075	497	25068
14-#18	5.79	MA	19805	4972	30997	3762	34443	3112	36672	2595	39458	1628	48685	333	46378
7L-2S		MI	10661	4972	19232	3354	21508	2730	23342	2196	26623	1288	30958	778	25120
16-#10	2.10	MA	17698	3985	27687	3010	30337	2523	31700	2136	33107	1537	39097	1179	21774
4L-6S		MI	8427	3985	13330	2866	14096	2400	14351	2025	14408	1451	16349	945	10076
16-#10	2.10	MA	17432	3985	27139	3020	29631	2535	30816	2158	31867	1558	37428	1146	21700
5E		MI	8505	3985	13578	2849	14416	2394	14748	2020	14941	1439	17032	1001	10157
16-#10	2.10	MA	17243	3985	26572	3025	28899	2555	29942	2169	30690	1578	35935	1096	21383
6L-4S		MI	8615	3985	13819	2841	14737	2377	15149	2005	15533	1438	17779	1052	10139
16-#10	2.10	MA	17025	3985	25968	3044	28165	2561	29076	2188	29473	1587	34200	1051	20917
7L-3S		MI	8675	3985	14105	2823	15108	2371	15605	2001	16127	1426	18527	1101	10116
16-#10	2.10	MA	16792	3985	25441	3054	27435	2580	28173	2195	28326	1608	32686	1012	20558
8L-2S		MI	8802	3985	14478	2815	15586	2354	16188	1985	16920	1413	19598	1191	10093
16-#11	2.58	MA	17926	4113	28240	3098	30964	2591	32405	2195	33999	1549	40430	1086	26287
5E		MI	8692	4113	14030	2909	14937	2436	15358	2041	15757	1415	17975	897	12150
16-#11	2.58	MA	17700	4113	27550	3104	30080	2616	31339	2207	32564	1574	38606	1023	25592
6L-4S		MI	8822	4113	14321	2901	15325	2416	15842	2023	16471	1415	18850	960	12153
16-#11	2.58	MA	17441	4113	26814	3127	29187	2623	30295	2232	31079	1585	36480	967	25065
7L-3S		MI	8890	4113	14667	2879	15773	2410	16392	2020	17187	1402	19731	1018	12130
16-#11	2.58	MA	17161	4113	26172	3138	28297	2646	29195	2239	29680	1609	34629	917	24275
8L-2S		MI	9039	4113	15115	2871	16346	2390	17092	2002	18139	1388	20985	1128	12103
16-#14	3.72	MA	18825	4419	29821	3312	32932	2779	34774	2316	37204	1578	45256	865	35505
6L-4S		MI	9351	4419	15510	3085	16807	2547	17633	2100	18914	1388	21881	787	16926
16-#14	3.72	MA	18459	4419	28766	3345	31651	2789	33288	2352	35073	1593	42195	783	34117
7L-3S		MI	9443	4419	16002	3054	17445	2539	18416	2096	19932	1371	23113	868	16937
16-#14	3.72	MA	18066	4419	27844	3360	30375	2822	31711	2362	33064	1627	39534	710	32799
8L-2S		MI	9648	4419	16637	3044	18258	2512	19408	2072	21282	1353	24859	1026	16915
16-#18	6.61	MA	20987	5193	33607	3900	37789	3212	40754	2656	45013	1610	56375	308	54255
7L-3S		MI	10772	5193	19232	3507	21508	2873	23342	2294	26623	1295	30958	431	28436
18-#10	2.36	MA	17824	4055	27995	3064	30728	2567	32154	2177	33688	1552	39950	1138	24356
5L-6S		MI	8587	4055	13703	2910	14574	2431	14934	2044	15201	1445	17420	934	11181
18-#10	2.36	MA	17638	4055	27428	3069	29996	2587	31281	2188	32512	1573	38457	1088	24010
6L-5S		MI	8665	4055	13950	2893	14894	2425	15332	2040	15735	1433	18103	990	11326
18-#10	2.36	MA	17422	4055	26824	3088	29262	2593	30414	2208	31294	1582	36722	1043	23556
7L-4S		MI	8773	4055	14192	2885	15215	2408	15732	2024	16326	1432	18849	1041	11313

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

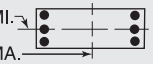


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
18-#10	2.36	MA	17194	4055	26297	3097	28532	2612	29512	2214	30147	1602	35208	1004	23202
8L-3S		MI	8834	4055	14478	2866	15586	2402	16188	2020	16920	1420	19598	1090	11294
18-#10	2.36	MA	16997	4055	25773	3105	27834	2621	28643	2233	28996	1622	33739	963	22501
9L-2S		MI	8960	4055	14851	2859	16064	2385	16771	2004	17714	1408	20668	1180	11273
18-#11	2.90	MA	18177	4200	28591	3158	31414	2655	32967	2231	34779	1567	41673	1013	28792
6L-5S		MI	8881	4200	14477	2963	15511	2475	16058	2065	16709	1408	19229	880	13443
18-#11	2.90	MA	17918	4200	27855	3181	30521	2662	31923	2255	33294	1578	39546	957	28280
7L-4S		MI	9010	4200	14769	2955	15898	2455	16542	2047	17423	1408	20104	943	13557
18-#11	2.90	MA	17646	4200	27212	3192	29631	2685	30823	2263	31894	1602	37695	907	27472
8L-3S		MI	9078	4200	15115	2933	16346	2449	17092	2043	18139	1395	20985	1001	13540
18-#11	2.90	MA	17409	4200	26579	3202	28780	2695	29763	2285	30509	1626	35892	857	26692
9L-2S		MI	9226	4200	15562	2925	16920	2429	17792	2025	19091	1382	22239	1111	13517
18-#14	4.18	MA	19137	4543	30256	3423	33562	2845	35619	2386	38244	1583	46585	769	38675
7L-4S		MI	9615	4543	16145	3163	17621	2603	18626	2134	20264	1378	23627	758	18813
18-#14	4.18	MA	18766	4543	29335	3438	32285	2878	34042	2396	36235	1618	43925	696	37367
8L-3S		MI	9707	4543	16637	3132	18258	2595	19408	2130	21282	1361	24859	839	18921
18-#14	4.18	MA	18420	4543	28337	3472	31064	2892	32522	2428	34255	1652	41327	623	35524
9L-2S		MI	9909	4543	17271	3121	19071	2568	20400	2106	22632	1343	26604	997	18907
20-#10	2.62	MA	18032	4126	28284	3113	31093	2618	32619	2207	34333	1567	40979	1080	26639
6E		MI	8747	4126	14076	2954	15052	2463	15517	2063	15994	1440	18491	923	12315
20-#10	2.62	MA	17816	4126	27680	3132	30360	2624	31753	2227	33115	1576	39244	1035	26197
7L-5S		MI	8824	4126	14323	2936	15372	2457	15915	2059	16528	1428	19173	979	12493
20-#10	2.62	MA	17592	4126	27153	3141	29629	2643	30850	2233	31968	1597	37730	996	25833
8L-4S		MI	8932	4126	14564	2929	15693	2440	16315	2043	17120	1427	19920	1030	12484
20-#10	2.62	MA	17399	4126	26629	3149	28931	2652	29981	2252	30817	1616	36260	956	25137
9L-3S		MI	8992	4126	14851	2910	16064	2434	16771	2039	17714	1414	20668	1079	12468
20-#10	2.62	MA	17162	4126	26026	3167	28232	2673	29111	2260	29576	1622	34755	923	24545
10L-2S		MI	9117	4126	15224	2903	16542	2417	17354	2024	18507	1402	21739	1169	12451
20-#11	3.22	MA	18393	4286	28896	3235	31855	2701	33550	2279	35509	1571	42613	948	31497
7L-5S		MI	9070	4286	14925	3017	16084	2513	16758	2088	17661	1401	20483	863	14793
20-#11	3.22	MA	18128	4286	28253	3246	30965	2724	32451	2286	34109	1595	40762	898	30668
8L-4S		MI	9198	4286	15216	3009	16472	2494	17242	2070	18375	1401	21358	926	14959
20-#11	3.22	MA	17895	4286	27620	3255	30114	2734	31391	2309	32724	1619	38959	848	29893
9L-3S		MI	9266	4286	15562	2987	16920	2488	17792	2067	19091	1388	22239	984	14946
20-#11	3.22	MA	17612	4286	26886	3277	29261	2759	30330	2318	31211	1626	37118	805	28866
10L-2S		MI	9412	4286	16010	2979	17494	2468	18492	2049	20043	1375	23493	1093	14927
20-#14	4.65	MA	19446	4668	30825	3516	34196	2934	36373	2430	39406	1608	48315	682	41913
8L-4S		MI	9879	4668	16779	3240	18434	2658	19618	2168	21614	1368	25372	729	20702
20-#14	4.65	MA	19113	4668	29827	3550	32974	2948	34852	2462	37426	1642	45718	609	40069
9L-3S		MI	9970	4668	17271	3210	19071	2651	20400	2164	22632	1351	26604	810	20897
22-#10	2.89	MA	18208	4196	28536	3176	31457	2656	33091	2246	34937	1571	41766	1027	28841
7L-6S		MI	8906	4196	14449	2998	15530	2494	16100	2082	16788	1434	19561	911	13451
22-#10	2.89	MA	17989	4196	28009	3185	30727	2675	32189	2252	33789	1591	40252	988	28463
8L-5S		MI	8982	4196	14696	2980	15850	2488	16498	2078	17321	1422	20244	968	13631
22-#10	2.89	MA	17799	4196	27484	3193	30029	2684	31320	2271	32639	1610	38782	948	27772
9L-4S		MI	9090	4196	14937	2973	16171	2471	16898	2062	17913	1421	20990	1019	13653
22-#10	2.89	MA	17563	4196	26882	3211	29329	2704	30450	2280	31398	1617	37277	915	27168
10L-3S		MI	9149	4196	15224	2954	16542	2465	17354	2058	18507	1409	21739	1068	13641
22-#10	2.89	MA	17348	4196	26353	3219	28619	2711	29602	2300	30230	1635	35816	873	26375
11L-2S		MI	9273	4196	15597	2947	17020	2448	17938	2043	19300	1396	22810	1158	13625
22-#11	3.55	MA	18606	4372	29294	3300	32300	2762	34079	2310	36324	1588	43829	888	33865
8L-5S		MI	9258	4372	15372	3071	16658	2552	17458	2112	18613	1394	21737	845	16145
22-#11	3.55	MA	18378	4372	28661	3309	31448	2773	33019	2332	34939	1612	42026	838	33094
9L-4S		MI	9385	4372	15664	3063	17046	2532	17942	2094	19327	1394	22612	909	16358
22-#11	3.55	MA	18096	4372	27927	3331	30595	2797	31958	2342	33426	1619	40184	796	32053
10L-3S		MI	9453	4372	16010	3041	17494	2526	18492	2090	20043	1381	23493	966	16350
22-#11	3.55	MA	17837	4372	27282	3340	29738	2806	30924	2366	32002	1641	38398	743	31001
11L-2S		MI	9598	4372	16457	3033	18067	2507	19191	2072	20995	1368	24747	1076	16335

RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

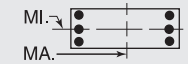
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	5.11	MA	19801	4792	31318	3628	34885	3004	37183	2495	40597	1632	50108	595	44613
9L-4S		MI	10142	4792	17413	3318	19247	2714	20610	2202	22964	1359	27118	700	22598
24-#10	3.15	MA	18384	4266	28865	3229	31824	2707	33528	2272	35611	1586	42774	981	31094
8L-6S		MI	9065	4266	14822	3042	16008	2526	16683	2101	17581	1429	20632	900	14588
24-#10	3.15	MA	18197	4266	28340	3237	31126	2715	32658	2290	34460	1605	41304	940	30407
9L-5S		MI	9141	4266	15069	3024	16328	2520	17081	2097	18115	1416	21315	957	14759
24-#10	3.15	MA	17962	4266	27738	3255	30426	2736	31788	2299	33219	1611	39798	907	29791
10L-4S		MI	9247	4266	15310	3017	16649	2503	17481	2082	18706	1415	22061	1008	14820
24-#10	3.15	MA	17750	4266	27209	3263	29716	2743	30941	2319	32051	1629	38338	866	29001
11L-3S		MI	9307	4266	15597	2998	17020	2497	17938	2077	19300	1403	22810	1057	14811
24-#10	3.15	MA	17549	4266	26635	3283	28997	2761	30110	2339	30898	1647	36666	816	28210
12L-2S		MI	9429	4266	15970	2991	17498	2480	18521	2062	20094	1391	23880	1147	14798
24-#11	3.87	MA	18858	4459	29702	3363	32783	2811	34647	2356	37153	1606	45092	828	36295
9L-5S		MI	9446	4459	15820	3125	17232	2591	18158	2135	19565	1387	22991	828	17501
24-#11	3.87	MA	18577	4459	28968	3385	31929	2836	33586	2365	35640	1612	43251	786	35240
10L-4S		MI	9572	4459	16111	3116	17619	2571	18641	2117	20279	1388	23866	891	17749
24-#11	3.87	MA	18322	4459	28323	3394	31073	2845	32552	2389	34217	1634	41465	733	34175
11L-3S		MI	9640	4459	16457	3095	18067	2565	19191	2114	20995	1374	24747	949	17752

RECTANGULAR TIED COLUMNS 24" x 24"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#9	1.04	MA	5320	2203	8414	1590	8909	1343	9057	1151	9020	867	10157	754	3450
2L-3S		MI	5200	2203	8084	1597	8485	1357	8540	1164	8316	878	9183	684	3472
6-#10	1.32	MA	5430	2248	8683	1614	9240	1358	9455	1159	9559	860	10898	746	4297
2L-3S		MI	5280	2248	8266	1622	8706	1377	8803	1176	8672	874	9671	656	4327
6-#11	1.63	MA	5532	2296	8962	1630	9564	1369	9836	1162	10069	848	11505	723	5167
2L-3S		MI	5356	2296	8461	1639	8921	1390	9051	1182	9003	864	10060	614	5204
6-#14	2.34	MA	5794	2410	9612	1692	10373	1412	10812	1186	11393	833	13196	690	7225
2L-3S		MI	5549	2410	8900	1704	9460	1441	9698	1213	9877	854	11176	532	7264
6-#18	4.17	MA	6421	2701	11189	1854	12347	1525	13201	1251	14635	799	17167	590	12206
2L-3S		MI	6017	2701	9962	1873	10774	1574	11282	1293	12024	829	13800	308	12150
8-#8	1.10	MA	5348	2212	8465	1600	8986	1350	9156	1156	9157	869	10349	755	3625
2L-4S		MI	5204	2212	8002	1618	8389	1366	8425	1171	8182	887	9040	669	3663
8-#9	1.39	MA	5463	2258	8745	1625	9333	1367	9574	1166	9723	862	11131	747	4508
2L-4S		MI	5285	2258	8162	1647	8582	1387	8655	1184	8496	885	9482	638	4552
8-#10	1.76	MA	5609	2318	9099	1657	9774	1390	10107	1178	10446	855	12125	738	5624
2L-4S		MI	5388	2318	8364	1685	8827	1415	8948	1200	8898	882	10044	597	5668
8-#11	2.17	MA	5745	2382	9464	1684	10207	1407	10620	1186	11136	841	12950	710	6760
2L-4S		MI	5487	2382	8577	1716	9065	1436	9223	1211	9271	872	10495	540	6798
8-#14	3.13	MA	6092	2535	10324	1770	11286	1468	11926	1220	12908	823	15216	668	9472
2L-4S		MI	5737	2535	9063	1815	9662	1506	9939	1253	10256	864	11779	425	9200
8-#18	5.56	MA	6924	2922	12416	1992	13920	1625	15120	1311	17246	781	20534	537	16047
2L-4S		MI	6347	2922	10236	2065	11114	1686	11687	1361	12664	842	14790	113	14161
10-#10	2.20	MA	5786	2388	9516	1701	10309	1422	10759	1198	11333	849	13352	730	6942
2L-5S		MI	5444	2388	8513	1737	9006	1465	9155	1236	9128	879	10416	539	6824
10-#10	2.20	MA	5642	2388	9099	1710	9774	1440	10107	1214	10446	863	12125	641	6961
3L-4S		MI	5569	2388	8781	1729	9362	1446	9599	1220	9785	876	11271	589	6970
10-#11	2.71	MA	5956	2468	9965	1738	10850	1446	11404	1209	12203	835	14395	697	8344
2L-5S		MI	5554	2468	8755	1780	9277	1496	9469	1253	9543	867	10933	464	7997
10-#11	2.71	MA	5786	2468	9464	1747	10207	1467	10620	1229	11136	850	12950	588	8364
3L-4S		MI	5703	2468	9078	1770	9708	1475	10007	1234	10338	865	11940	527	8355
10-#14	3.91	MA	6388	2659	11036	1848	12199	1523	13039	1254	14424	814	17236	646	11709
2L-5S		MI	5832	2659	9313	1905	9960	1592	10285	1314	10638	855	12391	312	10721
10-#14	3.91	MA	6155	2659	10324	1860	11286	1553	11926	1281	12908	834	15216	487	11704
3L-4S		MI	6041	2659	9775	1892	10575	1562	11052	1287	11771	855	13799	402	11290
10-#18	6.94	MA	7046	3143	12416	2149	13920	1772	15120	1414	17246	794	20534	203	19651
3L-4S		MI	6864	3143	11463	2203	12687	1785	13606	1421	15275	825	18157	61	17807

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

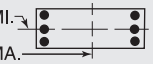
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.00	MA	6219	2379	9831	1714	10387	1447	10540	1241	10462	937	11747	815	3895
2E		MI	5726	2379	9082	1699	9558	1434	9675	1230	9575	928	10658	800	3583
4-#14	1.44	MA	6417	2455	10321	1752	10988	1473	11261	1255	11437	925	13029	795	5444
2E		MI	5902	2455	9523	1736	10096	1459	10321	1243	10448	915	11770	776	4990
4-#18	2.56	MA	6891	2649	11510	1854	12459	1544	13034	1293	13838	898	16072	736	9204
2E		MI	6322	2649	10587	1836	11410	1528	11902	1280	12590	887	14389	705	8387
6-#10	1.22	MA	6342	2417	10073	1751	10735	1476	10981	1262	11071	942	12597	818	4709
2L-3S		MI	5688	2417	8885	1745	9342	1482	9428	1268	9247	947	10273	720	4352
6-#10	1.22	MA	6174	2417	9612	1760	10145	1484	10261	1279	10091	957	11240	731	4738
3L-2S		MI	5838	2417	9302	1737	9877	1464	10080	1251	10134	933	11499	810	4322
6-#11	1.50	MA	6458	2465	10387	1768	11099	1486	11409	1265	11644	930	13383	805	5673
2L-3S		MI	5763	2465	9082	1762	9558	1494	9675	1273	9575	936	10658	677	5236
6-#11	1.50	MA	6260	2465	9831	1778	10387	1508	10540	1285	10462	947	11747	696	5710
3L-2S		MI	5940	2465	9584	1753	10200	1473	10459	1253	10642	921	12103	787	5198
6-#14	2.16	MA	6753	2580	11111	1830	12001	1529	12497	1289	13118	915	15326	778	7954
2L-3S		MI	5956	2580	9523	1826	10096	1545	10321	1303	10448	926	11770	595	7307
6-#14	2.16	MA	6477	2580	10321	1844	10988	1560	11261	1317	11437	938	13029	620	7993
3L-2S		MI	6202	2580	10235	1814	11009	1515	11434	1277	11963	905	13790	754	7263
6-#18	3.85	MA	7460	2870	12875	1992	14210	1643	15169	1354	16744	880	19926	694	13502
2L-3S		MI	6424	2870	10587	1993	11410	1676	11902	1383	12590	900	14389	371	12232
6-#18	3.85	MA	7004	2870	11510	2014	12459	1695	13034	1400	13838	916	16072	413	13446
3L-2S		MI	6829	2870	11815	1974	12983	1628	13821	1340	15201	870	17756	652	12259
8-#8	1.01	MA	6250	2381	9830	1738	10452	1468	10647	1259	10623	950	11981	826	3967
2L-4S		MI	5612	2381	8620	1743	9026	1472	9051	1263	8758	960	9644	733	3684
8-#8	1.01	MA	6143	2381	9540	1744	10080	1473	10193	1270	10005	960	11126	773	3983
3E		MI	5660	2381	8820	1730	9285	1468	9370	1260	9174	951	10178	765	3663
8-#8	1.01	MA	6087	2381	9320	1757	9794	1485	9842	1275	9548	970	10543	742	4004
4L-2S		MI	5756	2381	9083	1725	9623	1456	9781	1249	9734	942	10953	819	3646
8-#9	1.28	MA	6379	2428	10140	1763	10836	1485	11110	1268	11250	944	12848	819	4940
2L-4S		MI	5693	2428	8781	1771	9219	1493	9280	1276	9072	958	10085	702	4579
8-#9	1.28	MA	6246	2428	9775	1770	10368	1491	10539	1282	10473	956	11772	751	4961
3E		MI	5752	2428	9033	1756	9546	1488	9682	1271	9596	947	10760	742	4553
8-#9	1.28	MA	6177	2428	9498	1786	10008	1506	10097	1288	9897	968	11036	712	4984
4L-2S		MI	5871	2428	9363	1749	9969	1473	10199	1258	10299	936	11734	812	4532
8-#10	1.63	MA	6542	2488	10534	1795	11326	1508	11702	1281	12052	936	13954	810	6172
2L-4S		MI	5795	2488	8983	1809	9464	1520	9573	1292	9473	955	10646	661	5702
8-#10	1.63	MA	6377	2488	10073	1804	10735	1515	10981	1299	11071	951	12597	723	6197
3E		MI	5869	2488	9302	1789	9877	1513	10080	1287	10134	941	11499	713	5678
8-#10	1.63	MA	6291	2488	9722	1825	10281	1534	10423	1305	10344	966	11665	673	6217
4L-2S		MI	6016	2488	9719	1781	10411	1495	10732	1270	11021	928	12726	802	5651
8-#11	2.00	MA	6696	2552	10942	1822	11811	1525	12277	1288	12826	923	15019	796	7434
2L-4S		MI	5895	2552	9199	1839	9701	1540	9846	1302	9844	945	11093	603	6846
8-#11	2.00	MA	6501	2552	10387	1832	11099	1547	11409	1309	11644	940	13383	686	7463
3E		MI	5979	2552	9584	1816	10200	1533	10459	1296	10642	929	12103	664	6825
8-#11	2.00	MA	6403	2552	9962	1856	10549	1556	10733	1316	10764	957	12245	623	7472
4L-2S		MI	6153	2552	10085	1806	10843	1512	11243	1277	11709	914	13548	774	6794
8-#14	2.88	MA	7086	2704	11901	1908	13013	1585	13732	1323	14799	905	17622	762	10444
2L-4S		MI	6145	2704	9686	1936	10298	1610	10561	1344	10826	936	12374	488	9378
8-#14	2.88	MA	6817	2704	11111	1922	12001	1616	12497	1351	13118	928	15326	603	10462
3E		MI	6260	2704	10235	1904	11009	1601	11434	1337	11963	916	13790	573	9542
8-#14	2.88	MA	6682	2704	10505	1955	11216	1627	11532	1360	11863	951	13724	514	10284
4L-2S		MI	6500	2704	10947	1891	11922	1571	12548	1311	13479	895	15810	731	9514
8-#18	5.13	MA	8025	3092	14241	2130	15960	1742	17305	1414	19649	863	23781	653	17775
2L-4S		MI	6755	3092	10862	2185	11750	1788	12308	1450	13231	913	15379	175	14393

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

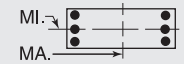


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	5.13	MA	7584	3092	12875	2152	14210	1794	15169	1460	16744	898	19926	371	17657
3E		MI	6940	3092	11815	2131	12983	1775	13821	1443	15201	883	17756	318	16017
8-#18	5.13	MA	7365	3092	11822	2209	12845	1810	13494	1471	14562	934	17221	221	15864
4L-2S		MI	7334	3092	13042	2112	14556	1727	15740	1401	17812	852	21123	600	16108
10-#10	2.04	MA	6740	2558	10994	1839	11917	1539	12422	1300	13032	931	15312	802	7628
2L-5S		MI	5851	2558	9133	1861	9642	1570	9780	1328	9702	952	11018	603	6931
10-#10	2.04	MA	6578	2558	10534	1848	11326	1547	11702	1318	12052	945	13954	715	7647
3L-4S		MI	5976	2558	9400	1853	9998	1552	10224	1311	10360	949	11873	653	7009
10-#10	2.04	MA	6494	2558	10183	1868	10872	1566	11143	1324	11324	960	13022	665	7655
4L-3S		MI	6049	2558	9719	1833	10411	1545	10732	1306	11021	936	12726	705	6994
10-#10	2.04	MA	6354	2558	9890	1877	10480	1573	10654	1342	10601	964	12084	617	7560
5L-2S		MI	6195	2558	10135	1825	10945	1527	11384	1289	11908	922	13953	794	6972
10-#11	2.50	MA	6933	2638	11497	1876	12523	1564	13146	1312	14007	916	16655	786	9186
2L-5S		MI	5961	2638	9376	1902	9913	1600	10092	1344	10116	939	11531	528	8120
10-#11	2.50	MA	6741	2638	10942	1886	11811	1586	12277	1333	12826	933	15019	677	9206
3L-4S		MI	6110	2638	9700	1893	10344	1579	10630	1325	10911	938	12538	590	8407
10-#11	2.50	MA	6644	2638	10518	1910	11261	1594	11601	1339	11945	950	13881	614	9197
4L-3S		MI	6194	2638	10085	1870	10843	1572	11243	1320	11709	922	13548	651	8404
10-#11	2.50	MA	6478	2638	10162	1920	10787	1617	11009	1360	11069	953	12741	552	8871
5L-2S		MI	6364	2638	10586	1860	11486	1550	12028	1300	12776	907	14993	761	8380
10-#14	3.61	MA	7418	2829	12691	1986	14026	1641	14968	1357	16480	895	19918	745	12924
2L-5S		MI	6239	2829	9936	2026	10596	1695	10907	1404	11208	927	12986	375	10873
10-#14	3.61	MA	7156	2829	11901	1999	13013	1672	13732	1385	14799	918	17622	586	12919
3L-4S		MI	6449	2829	10398	2014	11211	1666	11675	1378	12342	926	14394	465	11463
10-#14	3.61	MA	7022	2829	11295	2033	12228	1683	12768	1394	13544	941	16020	498	12609
4L-3S		MI	6563	2829	10947	1982	11922	1656	12548	1371	13479	906	15810	551	11760
10-#14	3.61	MA	6789	2829	10786	2047	11551	1714	11922	1422	12293	944	14420	408	11912
5L-2S		MI	6797	2829	11659	1969	12835	1627	13662	1345	14994	885	17830	709	11754
10-#18	6.41	MA	8160	3313	14241	2290	15960	1893	17305	1521	19649	881	23781	330	21866
3L-4S		MI	7272	3313	12089	2323	13323	1887	14227	1510	15842	895	18746	123	18030
10-#18	6.41	MA	7945	3313	13187	2347	14595	1910	15629	1531	17467	916	21076	180	19933
4L-3S		MI	7454	3313	13042	2269	14556	1875	15740	1503	17812	865	21123	266	19798
12-#10	2.44	MA	6938	2628	11455	1883	12507	1571	13143	1319	14012	925	16669	794	9078
2L-6S		MI	5943	2628	9289	1911	9822	1608	9991	1353	9997	960	11465	536	7944
12-#10	2.44	MA	6778	2628	10994	1892	11917	1578	12422	1337	13032	940	15312	707	9092
3L-5S		MI	6033	2628	9550	1905	10176	1601	10432	1347	10589	946	12244	595	8174
12-#10	2.44	MA	6695	2628	10644	1912	11462	1597	11864	1343	12304	955	14379	657	9089
4E		MI	6157	2628	9817	1897	10532	1583	10876	1331	11247	944	13099	646	8309
12-#10	2.44	MA	6557	2628	10350	1921	11071	1605	11375	1361	11581	958	13441	610	8938
5L-3S		MI	6229	2628	10135	1877	10945	1576	11384	1325	11908	930	13953	697	8304
12-#10	2.44	MA	6457	2628	10057	1927	10682	1624	10891	1367	10930	973	12590	551	8666
6L-2S		MI	6372	2628	10552	1869	11479	1558	12035	1309	12794	916	15180	786	8287
12-#11	3.00	MA	7168	2724	12053	1930	13235	1602	14014	1336	15189	909	18292	777	10932
2L-6S		MI	6071	2724	9544	1978	10127	1646	10343	1373	10466	948	12055	445	9377
12-#11	3.00	MA	6980	2724	11497	1940	12523	1625	13146	1356	14007	926	16655	667	10944
3L-5S		MI	6178	2724	9877	1956	10556	1639	10876	1368	11182	932	12976	515	9618
12-#11	3.00	MA	6884	2724	11073	1964	11973	1633	12470	1363	13127	943	15517	604	10919
4E		MI	6325	2724	10201	1947	10987	1618	11415	1349	11978	931	13983	577	9964
12-#11	3.00	MA	6720	2724	10717	1974	11499	1655	11877	1383	12251	946	14377	542	10535
5L-3S		MI	6407	2724	10586	1924	11486	1610	12028	1343	12776	915	14993	638	9976
12-#11	3.00	MA	6601	2724	10369	1982	11027	1664	11290	1390	11462	963	13338	470	10246
6L-2S		MI	6575	2724	11088	1914	12129	1589	12812	1324	13843	900	16438	748	9960
12-#14	4.33	MA	7492	2953	12691	2077	14026	1728	14968	1419	16480	908	19918	569	15371
3L-5S		MI	6545	2953	10648	2104	11509	1751	12021	1438	12724	917	15006	352	13014
12-#14	4.33	MA	7360	2953	12085	2111	13241	1739	14003	1428	15225	931	18316	481	14950
4E		MI	6751	2953	11110	2092	12124	1722	12789	1411	13857	917	16414	443	13564
12-#14	4.33	MA	7131	2953	11576	2125	12564	1770	13158	1456	13974	934	16716	391	14295
5L-3S		MI	6863	2953	11659	2059	12835	1712	13662	1405	14994	896	17830	528	13972

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

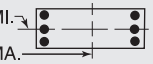


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	7.69	MA	8520	3534	14553	2485	16346	2009	17764	1592	20373	898	24930	138	24025
4E		MI	7785	3534	13316	2462	14896	1987	16146	1570	18453	878	22113	70	21690
14-#10	2.85	MA	6978	2698	11455	1936	12507	1610	13143	1356	14012	934	16669	700	10534
3L-6S		MI	6125	2698	9706	1955	10356	1640	10642	1372	10884	954	12691	528	9206
14-#10	2.85	MA	6895	2698	11105	1956	12053	1629	12584	1362	13284	949	15736	649	10520
4L-5S		MI	6214	2698	9966	1949	10711	1633	11083	1366	11476	941	13471	587	9423
14-#10	2.85	MA	6759	2698	10811	1965	11662	1636	12095	1380	12561	953	14799	602	10322
5L-4S		MI	6336	2698	10234	1940	11067	1615	11528	1350	12134	938	14326	638	9606
14-#10	2.85	MA	6661	2698	10518	1971	11272	1655	11611	1386	11910	968	13948	544	10064
6L-3S		MI	6408	2698	10552	1921	11479	1608	12035	1344	12794	924	15180	689	9610
14-#10	2.85	MA	6561	2698	10187	1987	10893	1662	11149	1404	11276	983	13066	504	9792
7L-2S		MI	6549	2698	10969	1913	12014	1590	12687	1328	13681	911	16407	778	9598
14-#11	3.50	MA	7218	2811	12053	1994	13235	1663	14014	1380	15189	919	18292	657	12674
3L-6S		MI	6288	2811	10045	2031	10769	1685	11127	1397	11533	941	13500	432	10897
14-#11	3.50	MA	7123	2811	11628	2018	12685	1672	13338	1386	14309	936	17154	595	12638
4L-5S		MI	6393	2811	10379	2010	11199	1678	11661	1391	12249	925	14421	502	11124
14-#11	3.50	MA	6961	2811	11272	2028	12211	1694	12746	1407	13433	939	16014	533	12206
5L-4S		MI	6538	2811	10703	2001	11630	1656	12199	1372	13044	924	15428	564	11518
14-#11	3.50	MA	6844	2811	10925	2036	11739	1703	12159	1413	12644	956	14974	460	11933
6L-3S		MI	6620	2811	11088	1978	12129	1649	12812	1367	13843	909	16438	625	11544
14-#14	5.05	MA	7696	3078	12875	2189	14254	1795	15239	1462	16905	921	20612	464	17304
4L-5S		MI	6848	3078	11360	2182	12422	1807	13135	1472	14239	907	17026	330	15163
14-#14	5.05	MA	7470	3078	12366	2203	13577	1826	14393	1490	15655	924	19012	374	16685
5L-4S		MI	7051	3078	11823	2169	13037	1778	13903	1445	15373	907	18434	421	15678
16-#10	3.26	MA	7094	2769	11565	2000	12643	1660	13305	1382	14265	944	17094	642	11949
4L-6S		MI	6307	2769	10122	1999	10890	1671	11294	1391	11771	949	13918	520	10472
16-#10	3.26	MA	6959	2769	11272	2009	12252	1668	12816	1399	13541	947	16156	594	11710
5E		MI	6394	2769	10383	1993	11245	1664	11735	1386	12363	935	14698	579	10677
16-#10	3.26	MA	6863	2769	10979	2015	11863	1687	12332	1405	12890	962	15305	536	11465
6L-4S		MI	6515	2769	10650	1984	11601	1646	12180	1369	13020	933	15553	630	10900
16-#10	3.26	MA	6764	2769	10648	2031	11484	1693	11869	1423	12256	977	14423	496	11173
7L-3S		MI	6586	2769	10969	1965	12014	1640	12687	1363	13681	919	16407	681	10914
16-#11	4.00	MA	7360	2897	12184	2072	13397	1711	14207	1410	15490	929	18790	585	14357
4L-6S		MI	6504	2897	10547	2085	11412	1724	11911	1420	12599	934	14945	419	12407
16-#11	4.00	MA	7200	2897	11828	2082	12923	1733	13615	1430	14614	933	17650	523	13883
5E		MI	6607	2897	10880	2064	11842	1716	12445	1415	13316	918	15866	489	12634
16-#11	4.00	MA	7086	2897	11480	2089	12451	1741	13027	1437	13825	950	16610	451	13624
6L-4S		MI	6751	2897	11204	2055	12273	1695	12983	1396	14111	917	16873	551	13070
16-#14	5.77	MA	7808	3202	13156	2281	14589	1882	15628	1524	17336	914	21308	357	19083
5E		MI	7150	3202	12072	2260	13335	1863	14249	1506	15755	897	19046	308	17318
18-#10	3.66	MA	7159	2839	11732	2053	12843	1700	13536	1418	14522	942	17513	586	13103
5L-6S		MI	6488	2839	10539	2042	11425	1703	11946	1410	12657	943	15145	513	11740
18-#10	3.66	MA	7065	2839	11439	2059	12454	1718	13052	1425	13871	957	16662	528	12869
6L-5S		MI	6573	2839	10800	2037	11779	1696	12387	1405	13250	929	15925	572	11935
18-#10	3.66	MA	6967	2839	11109	2075	12074	1725	12590	1442	13236	972	15781	489	12558
7L-4S		MI	6693	2839	11067	2028	12135	1678	12832	1388	13907	927	16780	622	12193
18-#11	4.50	MA	7439	2983	12383	2136	13635	1772	14483	1454	15796	926	19286	514	15564
5L-6S		MI	6720	2983	11048	2139	12055	1762	12695	1444	13666	927	16390	406	13892
18-#11	4.50	MA	7327	2983	12035	2143	13162	1780	13896	1461	15007	943	18246	441	15294
6L-5S		MI	6821	2983	11382	2118	12484	1755	13229	1438	14383	912	17311	476	14150
20-#10	4.07	MA	7266	2909	11900	2103	13044	1750	13772	1444	14851	951	18020	520	14275
6E		MI	6668	2909	10956	2086	11959	1734	12598	1429	13544	938	16372	505	13010
20-#10	4.07	MA	7168	2909	11569	2118	12665	1756	13310	1461	14217	966	17138	481	13947
7L-5S		MI	6751	2909	11217	2081	12313	1728	13039	1424	14136	924	17152	564	13196
20-#11	5.00	MA	7566	3070	12591	2197	13874	1819	14764	1484	16189	936	19883	432	16954
6E		MI	6934	3070	11549	2193	12698	1801	13479	1467	14733	920	17835	393	15383

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

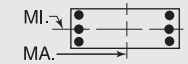
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.34	MA	7408	2625	11839	1890	12621	1591	12930	1358	13097	1007	14960	873	5930
2E		MI	6309	2625	10146	1857	10732	1563	10943	1333	11018	987	12365	839	5022
4-#18	2.38	MA	7938	2819	13154	1992	14249	1661	14892	1396	15753	980	18457	826	10068
2E		MI	6730	2819	11213	1956	12046	1631	12523	1369	13157	958	14978	767	8432
6-#10	1.13	MA	7323	2587	11560	1889	12336	1594	12614	1364	12684	1023	14401	889	5120
2L-3S		MI	6095	2587	9504	1869	9979	1587	10053	1360	9822	1020	10874	785	4376
6-#10	1.13	MA	7136	2587	11055	1899	11689	1602	11824	1383	11610	1039	12915	805	5150
3L-2S		MI	6245	2587	9921	1860	10513	1569	10705	1343	10709	1006	12101	874	4346
6-#11	1.39	MA	7453	2635	11908	1906	12739	1604	13088	1367	13319	1012	15272	877	6178
2L-3S		MI	6171	2635	9704	1884	10194	1598	10299	1364	10147	1009	11255	741	5266
6-#11	1.39	MA	7232	2635	11298	1917	11958	1613	12135	1389	12022	1030	13477	770	6215
3L-2S		MI	6348	2635	10205	1875	10837	1577	11083	1344	11214	993	12700	850	5227
6-#14	2.01	MA	7781	2750	12706	1968	13733	1647	14287	1391	14944	997	17517	859	8683
2L-3S		MI	6364	2750	10146	1948	10732	1648	10943	1394	11018	998	12365	658	7348
6-#14	2.01	MA	7473	2750	11839	1983	12621	1679	12930	1422	13097	1022	14960	702	8722
3L-2S		MI	6610	2750	10858	1935	11645	1619	12057	1367	12534	977	14385	817	7299
6-#18	3.57	MA	8570	3040	14658	2130	16177	1761	17243	1456	18953	962	22802	793	14798
2L-3S		MI	6831	3040	11213	2113	12046	1778	12523	1472	13157	971	14978	433	12309
6-#18	3.57	MA	8060	3040	13154	2154	14249	1815	14892	1506	15753	1002	18457	512	14742
3L-2S		MI	7238	3040	12440	2094	13619	1730	14442	1429	15768	941	18345	714	12312
8-#9	1.19	MA	7363	2598	11632	1901	12444	1603	12753	1371	12878	1025	14672	891	5372
2L-4S		MI	6100	2598	9399	1895	9855	1599	9906	1368	9648	1031	10688	766	4604
8-#9	1.19	MA	7215	2598	11233	1909	11932	1609	12128	1386	12027	1038	13495	825	5393
3E		MI	6159	2598	9651	1880	10182	1593	10308	1363	10172	1020	11363	806	4577
8-#9	1.19	MA	7137	2598	10930	1925	11539	1625	11645	1391	11398	1051	12698	786	5416
4L-2S		MI	6279	2598	9982	1873	10606	1579	10825	1350	10875	1009	12337	876	4555
8-#10	1.51	MA	7544	2657	12064	1933	12982	1625	13403	1384	13758	1018	15888	882	6721
2L-4S		MI	6203	2657	9603	1932	10100	1626	10198	1384	10048	1028	11247	725	5734
8-#10	1.51	MA	7360	2657	11560	1943	12336	1634	12614	1402	12684	1034	14401	797	6746
3E		MI	6276	2657	9921	1913	10513	1619	10705	1379	10709	1014	12101	777	5706
8-#10	1.51	MA	7263	2657	11177	1964	11839	1653	12004	1409	11890	1050	13391	747	6765
4L-2S		MI	6424	2657	10338	1904	11047	1601	11357	1362	11596	1001	13328	866	5678
8-#11	1.86	MA	7716	2721	12517	1960	13520	1643	14041	1391	14615	1005	17067	867	8108
2L-4S		MI	6302	2721	9820	1961	10338	1645	10470	1393	10416	1017	11690	667	6888
8-#11	1.86	MA	7499	2721	11908	1971	12739	1652	13088	1413	13319	1023	15272	761	8137
3E		MI	6386	2721	10205	1938	10837	1637	11083	1387	11214	1002	12700	728	6860
8-#11	1.86	MA	7387	2721	11444	1996	12138	1675	12349	1420	12356	1041	14039	699	8146
4L-2S		MI	6561	2721	10706	1929	11480	1616	11867	1368	12281	986	14145	837	6827
8-#14	2.68	MA	8151	2874	13574	2046	14846	1703	15644	1425	16790	987	20074	845	11416
2L-4S		MI	6552	2874	10309	2058	10934	1714	11184	1434	11397	1008	12969	551	9550
8-#14	2.68	MA	7851	2874	12706	2061	13733	1735	14287	1455	14944	1012	17517	689	11434
3E		MI	6668	2874	10858	2025	11645	1704	12057	1427	12534	988	14385	636	9587
8-#14	2.68	MA	7695	2874	12044	2096	12875	1748	13232	1466	13570	1037	15746	598	11356
4L-2S		MI	6909	2874	11570	2013	12558	1675	13171	1401	14049	967	16405	794	9555
8-#18	4.76	MA	9197	3261	16162	2268	18104	1860	19595	1516	22153	944	27147	761	19503
2L-4S		MI	7162	3261	11488	2305	12385	1890	12928	1539	13798	984	15968	238	14617
8-#18	4.76	MA	8705	3261	14658	2292	16177	1915	17243	1566	18953	984	22802	480	19385
3E		MI	7348	3261	12440	2251	13619	1877	14442	1532	15768	954	18345	380	16100
8-#18	4.76	MA	8451	3261	13504	2352	14681	1934	15406	1580	16561	1024	19767	323	17596
4L-2S		MI	7743	3261	13667	2232	15192	1829	16361	1490	18379	923	21712	662	16163
10-#10	1.89	MA	7763	2728	12569	1977	13629	1657	14192	1403	14831	1012	17375	874	8314
2L-5S		MI	6258	2728	9752	1984	10278	1675	10405	1420	10277	1025	11619	667	7035

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

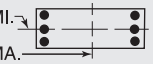


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.89	MA	7583	2728	12064	1987	12982	1665	13403	1421	13758	1028	15888	789	8333
3L-4S		MI	6384	2728	10019	1976	10634	1657	10849	1403	10935	1023	12474	718	7044
10-#10	1.89	MA	7487	2728	11682	2008	12486	1685	12793	1428	12963	1044	14878	739	8341
4L-3S		MI	6457	2728	10338	1957	11047	1650	11357	1398	11596	1009	13328	769	7025
10-#10	1.89	MA	7332	2728	11363	2017	12060	1693	12260	1447	12174	1049	13858	695	8307
5L-2S		MI	6603	2728	10755	1948	11582	1632	12009	1381	12482	995	14555	858	7001
10-#11	2.32	MA	7978	2808	13126	2014	14301	1681	14993	1415	15912	998	18862	858	10028
2L-5S		MI	6368	2808	9997	2024	10550	1704	10716	1435	10688	1012	12128	592	8238
10-#11	2.32	MA	7765	2808	12517	2025	13520	1691	14041	1436	14615	1016	17067	751	10048
3L-4S		MI	6518	2808	10321	2015	10981	1683	11254	1416	11483	1010	13136	654	8457
10-#11	2.32	MA	7654	2808	12053	2050	12919	1714	13302	1444	13653	1034	15834	689	10040
4L-3S		MI	6601	2808	10706	1992	11480	1676	11867	1411	12281	995	14145	715	8442
10-#11	2.32	MA	7470	2808	11665	2061	12402	1723	12655	1466	12696	1039	14593	631	9756
5L-2S		MI	6773	2808	11208	1983	12122	1655	12651	1391	13348	979	15590	824	8416
10-#14	3.35	MA	8519	2999	14442	2123	15958	1759	17002	1459	18637	977	22631	832	14139
2L-5S		MI	6647	2999	10559	2148	11232	1799	11530	1494	11779	999	13581	438	11019
10-#14	3.35	MA	8226	2999	13574	2139	14846	1791	15644	1489	16790	1002	20074	675	14134
3L-4S		MI	6856	2999	11021	2135	11847	1770	12298	1468	12912	998	14989	528	11630
10-#14	3.35	MA	8073	2999	12912	2174	13987	1804	14589	1500	15416	1027	18303	584	13951
4L-3S		MI	6970	2999	11570	2103	12558	1760	13171	1461	14049	978	16405	614	11814
10-#14	3.35	MA	7814	2999	12357	2189	13247	1836	13665	1530	14050	1032	16526	497	13116
5L-2S		MI	7206	2999	12282	2091	13471	1731	14285	1435	15565	957	18425	772	11798
10-#18	5.95	MA	9344	3483	16162	2431	18104	2014	19595	1626	22153	966	27147	447	24026
3L-4S		MI	7679	3483	12715	2443	13959	1990	14847	1599	16409	966	19334	185	18246
10-#18	5.95	MA	9096	3483	15008	2490	16609	2033	17758	1641	19760	1006	24112	291	22090
4L-3S		MI	7861	3483	13667	2389	15192	1977	16361	1592	18379	936	21712	328	19886
12-#10	2.27	MA	7982	2798	13074	2021	14276	1688	14981	1422	15905	1007	18861	866	9901
2L-6S		MI	6350	2798	9908	2034	10458	1714	10616	1444	10572	1033	12066	600	8038
12-#10	2.27	MA	7804	2798	12569	2031	13629	1697	14192	1440	14831	1022	17375	781	9915
3L-5S		MI	6440	2798	10169	2028	10813	1707	11057	1439	11164	1019	12846	659	8276
12-#10	2.27	MA	7709	2798	12187	2052	13133	1716	13582	1447	14037	1038	16365	732	9912
4E		MI	6564	2798	10436	2020	11169	1689	11501	1422	11822	1017	13701	710	8350
12-#10	2.27	MA	7557	2798	11867	2061	12707	1725	13049	1466	13248	1043	15345	687	9818
5L-3S		MI	6637	2798	10755	2001	11582	1682	12009	1417	12482	1003	14555	761	8337
12-#10	2.27	MA	7446	2798	11542	2066	12283	1744	12522	1473	12538	1059	14425	629	9493
6L-2S		MI	6780	2798	11172	1992	12116	1664	12660	1400	13369	989	15781	850	8318
12-#11	2.79	MA	8239	2894	13735	2068	15082	1720	15946	1438	17208	991	20658	848	11942
2L-6S		MI	6478	2894	10165	2100	10763	1751	10966	1464	11038	1020	12652	508	9489
12-#11	2.79	MA	8030	2894	13126	2079	14301	1729	14993	1460	15912	1009	18862	742	11955
3L-5S		MI	6585	2894	10499	2078	11192	1743	11500	1459	11755	1005	13573	579	9734
12-#11	2.79	MA	7920	2894	12663	2104	13700	1753	14255	1467	14949	1028	17629	680	11930
4E		MI	6732	2894	10823	2069	11623	1722	12038	1440	12550	1003	14581	641	10016
12-#11	2.79	MA	7738	2894	12275	2115	13183	1762	13608	1489	13993	1032	16388	621	11584
5L-3S		MI	6815	2894	11208	2046	12122	1715	12651	1434	13348	988	15590	702	10017
12-#11	2.79	MA	7606	2894	11887	2121	12668	1785	12967	1497	13132	1050	15263	550	11239
6L-2S		MI	6984	2894	11709	2037	12765	1694	13435	1415	14415	972	17035	811	9997
12-#14	4.02	MA	8598	3123	14442	2216	15958	1847	17002	1523	18637	992	22631	661	16829
3L-5S		MI	6952	3123	11271	2226	12145	1855	12644	1528	13294	989	15601	416	13157
12-#14	4.02	MA	8447	3123	13780	2251	15100	1860	15947	1533	17263	1017	20859	571	16528
4E		MI	7158	3123	11733	2213	12760	1825	13411	1502	14428	988	17009	506	13727
12-#14	4.02	MA	8193	3123	13225	2267	14360	1892	15023	1564	15896	1022	19082	483	15737
5L-3S		MI	7271	3123	12282	2181	13471	1816	14285	1495	15565	968	18425	591	14029
12-#14	4.02	MA	8008	3123	12679	2277	13624	1905	14107	1574	14665	1047	17465	379	14991
6L-2S		MI	7502	3123	12994	2169	14384	1787	15398	1469	17080	947	20445	750	14033
12-#18	7.14	MA	9734	3704	16511	2628	18536	2132	20109	1701	22960	988	28457	259	26607
4E		MI	8192	3704	13942	2581	15532	2089	16766	1660	19020	949	22701	133	21899
14-#10	2.65	MA	8024	2868	13074	2075	14276	1728	14981	1459	15905	1017	18861	774	11494
3L-6S		MI	6533	2868	10325	2078	10992	1745	11267	1464	11459	1028	13293	592	9299

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

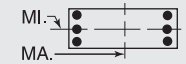
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.65	MA	7930	2868	12691	2095	13780	1748	14371	1467	15111	1033	17851	724	11480
4L-5S		MI	6621	2868	10586	2072	11347	1738	11708	1458	12051	1014	14073	651	9523
14-#10	2.65	MA	7780	2868	12372	2105	13354	1756	13839	1485	14322	1038	16832	679	11335
5L-4S		MI	6744	2868	10853	2064	11703	1720	12153	1442	12708	1011	14928	702	9649
14-#10	2.65	MA	7672	2868	12046	2110	12930	1776	13311	1492	13612	1053	15911	621	11026
6L-3S		MI	6815	2868	11172	2044	12116	1713	12660	1436	13369	998	15781	753	9645
14-#10	2.65	MA	7559	2868	11685	2127	12508	1782	12807	1510	12921	1069	14955	585	10791
7L-2S		MI	6957	2868	11588	2036	12650	1695	13312	1420	14256	984	17008	842	9631
14-#11	3.25	MA	8293	2980	13735	2133	15082	1768	15946	1483	17208	1002	20658	732	13854
3L-6S		MI	6695	2980	10667	2154	11406	1789	11750	1488	12105	1013	14097	495	11007
14-#11	3.25	MA	8184	2980	13272	2158	14481	1791	15207	1491	16246	1021	19424	670	13818
4L-5S		MI	6800	2980	11000	2132	11835	1782	12284	1482	12822	998	15018	565	11238
14-#11	3.25	MA	8004	2980	12884	2169	13964	1801	14561	1513	15289	1025	18184	612	13419
5L-4S		MI	6946	2980	11324	2123	12266	1761	12822	1463	13617	996	16026	628	11573
14-#11	3.25	MA	7876	2980	12496	2175	13449	1824	13920	1520	14428	1044	17058	540	13092
6L-3S		MI	7028	2980	11709	2100	12765	1753	13435	1458	14415	981	17035	689	11588
14-#11	3.25	MA	7744	2980	12059	2195	12948	1832	13309	1542	13589	1062	15892	492	12595
7L-2S		MI	7194	2980	12211	2091	13408	1732	14220	1438	15482	966	18481	798	11574
14-#14	4.69	MA	8819	3248	14648	2329	16212	1916	17304	1567	19109	1007	23416	557	19117
4L-5S		MI	7255	3248	11983	2303	13058	1911	13757	1562	14810	979	17621	393	15303
14-#14	4.69	MA	8569	3248	14093	2344	15472	1948	16380	1597	17743	1012	21639	470	18367
5L-4S		MI	7459	3248	12446	2291	13673	1881	14525	1536	15943	979	19029	484	15837
14-#14	4.69	MA	8389	3248	13546	2354	14736	1961	15464	1608	16512	1037	20022	365	17590
6L-3S		MI	7570	3248	12994	2259	14384	1872	15398	1529	17080	958	20445	569	16241
16-#10	3.02	MA	8150	2938	13196	2139	14427	1779	15160	1486	16184	1027	19338	716	13047
4L-6S		MI	6714	2938	10742	2122	11527	1777	11919	1483	12345	1022	14520	585	10564
16-#10	3.02	MA	8001	2938	12876	2149	14001	1788	14628	1504	15395	1032	18318	671	12857
5E		MI	6801	2938	11002	2116	11881	1770	12360	1477	12938	1008	15300	644	10775
16-#10	3.02	MA	7895	2938	12551	2154	13577	1807	14100	1511	14686	1048	17398	614	12562
6L-4S		MI	6923	2938	11270	2108	12237	1752	12805	1461	13595	1006	16155	694	10945
16-#10	3.02	MA	7784	2938	12190	2171	13155	1813	13596	1530	13995	1064	16441	577	12308
7L-3S		MI	6994	2938	11588	2088	12650	1745	13312	1455	14256	992	17008	745	10951
16-#10	3.02	MA	7657	2938	11873	2177	12717	1829	13101	1547	13259	1069	15393	511	11902
8L-2S		MI	7134	2938	12005	2080	13184	1727	13964	1439	15143	978	18235	835	10940
16-#11	3.71	MA	8447	3067	13881	2212	15262	1830	16160	1515	17542	1014	21219	661	15705
4L-6S		MI	6912	3067	11168	2208	12048	1828	12535	1511	13172	1006	15542	482	12529
16-#11	3.71	MA	8270	3067	13493	2223	14745	1840	15514	1536	16586	1018	19979	602	15260
5E		MI	7015	3067	11502	2186	12478	1821	13068	1506	13889	991	16463	552	12747
16-#11	3.71	MA	8144	3067	13106	2229	14230	1863	14873	1544	15725	1037	18853	531	14949
6L-4S		MI	7159	3067	11826	2177	12909	1799	13607	1487	14684	989	17471	615	13128
16-#11	3.71	MA	8013	3067	12668	2249	13729	1870	14262	1565	14885	1055	17687	482	14430
7L-3S		MI	7240	3067	12211	2154	13408	1792	14220	1481	15482	974	18481	676	13153
16-#14	5.36	MA	8943	3372	14960	2422	16585	2004	17737	1631	19589	1002	24196	456	21004
5E		MI	7557	3372	12695	2381	13971	1967	14871	1596	16325	969	19641	371	17455
16-#14	5.36	MA	8768	3372	14414	2432	15849	2017	16821	1642	18359	1027	22578	352	20197
6L-4S		MI	7758	3372	13158	2369	14586	1937	15639	1570	17459	969	21049	462	17958
18-#10	3.40	MA	8222	3009	13381	2193	14648	1819	15417	1523	16469	1026	19805	664	14383
5L-6S		MI	6895	3009	11159	2166	12061	1808	12571	1502	13232	1016	15747	577	11831
18-#10	3.40	MA	8118	3009	13055	2198	14224	1839	14889	1530	15760	1042	18885	606	14101
6L-5S		MI	6980	3009	11419	2160	12416	1801	13012	1496	13825	1003	16526	636	12032
18-#10	3.40	MA	8007	3009	12694	2214	13802	1845	14385	1549	15068	1058	17928	569	13828
7L-4S		MI	7101	3009	11687	2152	12772	1783	13457	1480	14482	1000	17381	686	12240
18-#10	3.40	MA	7883	3009	12377	2221	13364	1861	13890	1567	14332	1063	16879	503	13435
8L-3S		MI	7172	3009	12005	2132	13184	1776	13964	1474	15143	986	18235	737	12254

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	4.18	MA	8533	3153	14102	2277	15526	1878	16467	1560	17882	1011	21774	593	17106
5L-6S		MI	7127	3153	11669	2262	12691	1867	13319	1535	14239	999	16987	469	14054
18-#11	4.18	MA	8410	3153	13715	2283	15011	1902	15826	1567	17021	1030	20649	521	16809
6L-5S		MI	7228	3153	12003	2240	13121	1859	13853	1529	14956	984	17908	539	14261
18-#11	4.18	MA	8280	3153	13277	2303	14510	1909	15214	1589	16182	1048	19482	473	16269
7L-4S		MI	7371	3153	12327	2231	13552	1838	14391	1510	15751	982	18916	602	14681
18-#14	6.03	MA	9144	3497	15282	2510	16961	2073	18178	1676	20205	1017	25135	338	22810
6L-5S		MI	7858	3497	13407	2459	14884	2022	15985	1630	17841	959	21661	349	19614
20-#10	3.78	MA	8340	3079	13560	2242	14871	1870	15678	1550	16833	1037	20371	598	15643
6E		MI	7075	3079	11575	2210	12595	1840	13223	1521	14119	1011	16973	569	13100
20-#10	3.78	MA	8229	3079	13199	2258	14449	1876	15175	1568	16142	1053	19415	561	15352
7L-5S		MI	7159	3079	11836	2204	12950	1833	13664	1516	14711	997	17753	628	13292
20-#10	3.78	MA	8106	3079	12882	2265	14011	1892	14679	1586	15406	1057	18366	495	14970
8L-4S		MI	7279	3079	12103	2196	13306	1815	14108	1499	15369	994	18608	678	13533
20-#11	4.64	MA	8675	3239	14324	2337	15792	1940	16779	1591	18318	1023	22444	512	18672
6E		MI	7341	3239	12171	2316	13334	1905	14103	1558	15306	992	18432	456	15561
20-#11	4.64	MA	8545	3239	13887	2357	15291	1948	16167	1613	17478	1041	21278	463	18112
7L-5S		MI	7441	3239	12505	2294	13763	1898	14637	1553	16023	977	19354	526	15778
22-#10	4.16	MA	8450	3149	13703	2302	15096	1908	15964	1587	17216	1047	20901	553	16878
7L-6S		MI	7255	3149	11992	2254	13130	1871	13875	1540	15006	1005	18200	561	14371
22-#10	4.16	MA	8329	3149	13386	2309	14658	1924	15468	1605	16480	1052	19853	487	16507
8L-5S		MI	7337	3149	12253	2248	13484	1864	14315	1535	15598	991	18980	620	14555
22-#11	5.11	MA	8810	3326	14496	2411	16072	1987	17120	1636	18775	1034	23073	453	19958
7L-6S		MI	7555	3326	12672	2370	13977	1944	14887	1582	16373	986	19877	443	17053

RECTANGULAR TIED COLUMNS 24" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.25	MA	8468	2795	13453	2028	14358	1709	14705	1460	14858	1088	16937	945	6416
2E		MI	6717	2795	10769	1979	11368	1667	11566	1424	11589	1059	12960	902	5052
4-#18	2.22	MA	9054	2989	14895	2129	16144	1779	16855	1498	17769	1061	20955	913	10932
2E		MI	7138	2989	11839	2076	12681	1733	13143	1458	13724	1029	15567	829	8477
6-#10	1.06	MA	8372	2757	13143	2027	14040	1711	14352	1467	14397	1105	16314	961	5532
2L-3S		MI	6502	2757	10124	1992	10615	1693	10678	1451	10397	1093	11476	849	4399
6-#10	1.06	MA	8167	2757	12595	2037	13337	1720	13494	1486	13230	1122	14698	878	5561
3L-2S		MI	6653	2757	10541	1984	11150	1674	11330	1435	11284	1079	12702	938	4369
6-#11	1.30	MA	8516	2805	13525	2044	14484	1721	14873	1470	15094	1093	17270	949	6684
2L-3S		MI	6578	2805	10325	2007	10830	1703	10922	1455	10720	1081	11853	804	5295
6-#11	1.30	MA	8272	2805	12862	2056	13634	1732	13835	1493	13683	1113	15316	844	6721
3L-2S		MI	6755	2805	10827	1997	11473	1682	11706	1435	11787	1066	13298	914	5255
6-#14	1.88	MA	8878	2919	14398	2106	15571	1765	16184	1494	16870	1078	19723	931	9412
2L-3S		MI	6771	2919	10769	2069	11368	1752	11566	1484	11589	1070	12960	721	7388
6-#14	1.88	MA	8538	2919	13453	2122	14358	1778	14705	1525	14858	1105	16937	778	9451
3L-2S		MI	7018	2919	11481	2057	12281	1723	12680	1458	13104	1049	14980	880	7335
6-#18	3.33	MA	9750	3210	16538	2268	18249	1878	19423	1559	21263	1044	25792	889	16094
2L-3S		MI	7238	3210	11839	2232	12681	1880	13143	1561	13724	1042	15567	495	12381
6-#18	3.33	MA	9186	3210	14895	2294	16144	1935	16855	1611	17769	1087	20955	607	16038
3L-2S		MI	7646	3210	13066	2214	14254	1832	15062	1519	16335	1012	18934	777	12363
8-#9	1.11	MA	8416	2767	13221	2039	14157	1720	14502	1473	14605	1107	16605	962	5804
2L-4S		MI	6507	2767	10018	2019	10491	1704	10531	1460	10224	1104	11291	831	4627
8-#9	1.11	MA	8253	2767	12786	2047	13600	1728	13822	1489	13681	1121	15326	898	5825
3E		MI	6567	2767	10270	2003	10819	1699	10933	1456	10747	1093	11966	871	4599
8-#9	1.11	MA	8166	2767	12459	2064	13175	1744	13300	1495	13000	1134	14468	859	5848
4L-2S		MI	6686	2767	10601	1997	11242	1684	11450	1442	11451	1082	12940	940	4578
8-#10	1.41	MA	8614	2827	13692	2071	14744	1743	15210	1486	15564	1099	17930	953	7270
2L-4S		MI	6610	2827	10222	2056	10737	1731	10823	1476	10623	1101	11849	790	5764
8-#10	1.41	MA	8412	2827	13143	2081	14040	1752	14352	1505	14397	1116	16314	870	7294
3E		MI	6684	2827	10541	2036	11150	1724	11330	1471	11284	1087	12702	841	5732

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

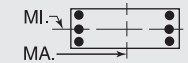
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#10	1.41	MA	8303	2827	12729	2103	13503	1772	13691	1513	13536	1133	15226	821	7314
4L-2S		MI	6832	2827	10957	2028	11684	1706	11982	1454	12171	1074	13929	930	5704
8-#11	1.73	MA	8806	2891	14188	2098	15334	1760	15910	1494	16505	1086	19224	939	8782
2L-4S		MI	6709	2891	10441	2084	10974	1749	11093	1484	10988	1089	12288	730	6927
8-#11	1.73	MA	8566	2891	13525	2110	14484	1770	14873	1516	15094	1106	17270	835	8811
3E		MI	6794	2891	10827	2060	11473	1742	11706	1478	11787	1074	13298	791	6894
8-#11	1.73	MA	8439	2891	13022	2135	13832	1794	14071	1525	14050	1125	15941	774	8820
4L-2S		MI	6969	2891	11328	2051	12116	1720	12491	1459	12854	1059	14743	901	6859
8-#14	2.50	MA	9284	3044	15344	2184	16783	1820	17663	1528	18882	1068	22509	917	12388
2L-4S		MI	6959	3044	10932	2179	11570	1817	11806	1524	11967	1080	13563	614	9624
8-#14	2.50	MA	8953	3044	14398	2200	15571	1834	16184	1559	16870	1095	19723	764	12406
3E		MI	7075	3044	11481	2147	12281	1808	12680	1518	13104	1060	14980	699	9632
8-#14	2.50	MA	8777	3044	13680	2236	14638	1868	15038	1571	15378	1122	17814	675	12328
4L-2S		MI	7317	3044	12193	2134	13194	1779	13793	1491	14620	1039	17000	857	9595
8-#18	4.44	MA	10439	3431	18180	2406	20354	1978	21991	1619	24757	1026	30630	864	21231
2L-4S		MI	7569	3431	12113	2425	13021	1993	13548	1628	14364	1055	16556	300	14835
8-#18	4.44	MA	9896	3431	16538	2432	18249	2035	19423	1671	21263	1069	25792	582	21113
3E		MI	7755	3431	13066	2371	14254	1980	15062	1621	16335	1025	18934	443	16179
8-#18	4.44	MA	9607	3431	15283	2494	16622	2056	17425	1689	18660	1113	22427	421	19357
4L-2S		MI	8152	3431	14293	2352	15827	1932	16981	1579	18946	994	22301	724	16219
10-#10	1.76	MA	8855	2897	14240	2115	15447	1774	16067	1505	16731	1094	19546	945	8999
2L-5S		MI	6666	2897	10372	2108	10915	1780	11030	1512	10852	1098	12221	731	7085
10-#10	1.76	MA	8656	2897	13692	2125	14744	1783	15210	1524	15564	1111	17930	863	9019
3L-4S		MI	6791	2897	10639	2100	11271	1762	11474	1495	11510	1096	13076	782	7078
10-#10	1.76	MA	8548	2897	13278	2147	14206	1804	14549	1532	14703	1127	16842	814	9027
4L-3S		MI	6864	2897	10957	2080	11684	1756	11982	1490	12171	1082	13929	833	7054
10-#10	1.76	MA	8379	2897	12932	2157	13745	1813	13972	1551	13848	1133	15741	771	8995
5L-2S		MI	7011	2897	11374	2072	12218	1738	12634	1473	13057	1068	15156	922	7030
10-#11	2.17	MA	9093	2977	14852	2152	16184	1799	16947	1517	17916	1079	21178	929	10871
2L-5S		MI	6776	2977	10619	2147	11186	1809	11340	1526	11260	1084	12726	655	8352
10-#11	2.17	MA	8858	2977	14188	2164	15334	1809	15910	1540	16505	1099	19224	825	10891
3L-4S		MI	6925	2977	10943	2137	11617	1788	11878	1507	12055	1082	13733	717	8500
10-#11	2.17	MA	8732	2977	13686	2189	14682	1833	15108	1548	15461	1118	17895	764	10882
4L-3S		MI	7009	2977	11328	2114	12116	1780	12491	1502	12854	1067	14743	778	8479
10-#11	2.17	MA	8530	2977	13266	2201	14122	1843	14408	1571	14423	1124	16554	709	10652
5L-2S		MI	7181	2977	11829	2105	12759	1759	13275	1482	13920	1052	16188	888	8450
10-#14	3.13	MA	9689	3168	16290	2261	17995	1876	19142	1562	20894	1058	25295	903	15354
2L-5S		MI	7054	3168	11182	2269	11868	1903	12152	1585	12349	1071	14175	501	11160
10-#14	3.13	MA	9365	3168	15344	2278	16783	1890	17663	1593	18882	1085	22509	750	15349
3L-4S		MI	7263	3168	11644	2257	12483	1873	12920	1558	13483	1070	15583	592	11792
10-#14	3.13	MA	9192	3168	14625	2314	15851	1924	16517	1605	17390	1112	20600	661	15247
4L-3S		MI	7378	3168	12193	2225	13194	1864	13793	1552	14620	1050	17000	677	11865
10-#14	3.13	MA	8907	3168	14024	2330	15049	1938	15515	1636	15907	1119	18678	578	14334
5L-2S		MI	7615	3168	12905	2212	14107	1834	14907	1525	16135	1029	19020	835	11840
10-#18	5.56	MA	10599	3652	18180	2571	20354	2134	21991	1732	24757	1052	30630	558	26186
3L-4S		MI	8086	3652	13340	2563	14594	2092	15467	1688	16976	1037	19923	247	18456
10-#18	5.56	MA	10316	3652	16925	2632	18727	2156	19993	1749	22154	1095	27264	396	24277
4L-3S		MI	8268	3652	14293	2509	15827	2079	16981	1682	18946	1007	22301	390	19969
10-#18	5.56	MA	9835	3652	15872	2658	17325	2213	18241	1801	19564	1103	23893	238	22658
5L-2S		MI	8656	3652	15520	2491	17400	2031	18900	1639	21557	976	25668	672	20059
12-#10	2.12	MA	9095	2968	14789	2159	16150	1806	16925	1524	17898	1088	21162	938	10724
2L-6S		MI	6757	2968	10528	2158	11095	1819	11241	1536	11147	1106	12667	664	8128
12-#10	2.12	MA	8899	2968	14240	2169	15447	1815	16067	1543	16731	1105	19546	855	10738
3L-5S		MI	6847	2968	10788	2152	11449	1812	11682	1531	11739	1092	13447	723	8374

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

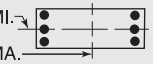


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#10	2.12	MA	8792	2968	13826	2190	14909	1835	15407	1551	15870	1122	18458	806	10735
4E		MI	6972	2968	11056	2144	11805	1794	12126	1514	12397	1090	14302	774	8385
12-#10	2.12	MA	8625	2968	13481	2201	14448	1844	14830	1570	15016	1127	17357	763	10693
5L-3S		MI	7044	2968	11374	2124	12218	1787	12634	1509	13057	1076	15156	825	8369
12-#10	2.12	MA	8504	2968	13122	2205	13990	1864	14259	1578	14248	1144	16368	706	10328
6L-2S		MI	7189	2968	11791	2116	12752	1769	13285	1492	13944	1063	16383	914	8349
12-#11	2.60	MA	9379	3064	15515	2206	17035	1838	17984	1541	19328	1072	23132	920	12953
2L-6S		MI	6885	3064	10787	2222	11399	1855	11590	1555	11610	1092	13250	572	9595
12-#11	2.60	MA	9148	3064	14852	2217	16184	1848	16947	1563	17916	1092	21178	816	12966
3L-5S		MI	6992	3064	11120	2201	11829	1848	12124	1550	12327	1077	14171	642	9846
12-#11	2.60	MA	9024	3064	14349	2243	15532	1872	16145	1572	16872	1111	19849	755	12940
4E		MI	7140	3064	11444	2191	12260	1826	12662	1531	13122	1076	15178	704	10066
12-#11	2.60	MA	8825	3064	13929	2255	14972	1882	15445	1594	15835	1117	18508	699	12644
5L-3S		MI	7223	3064	11829	2168	12759	1819	13275	1525	13920	1060	16188	765	10057
12-#11	2.60	MA	8680	3064	13501	2261	14414	1906	14751	1603	14902	1137	17297	628	12240
6L-2S		MI	7392	3064	12331	2159	13401	1798	14059	1506	14987	1045	17633	875	10034
12-#14	3.75	MA	9774	3293	16290	2355	17995	1946	19142	1627	20894	1075	25295	737	18287
3L-5S		MI	7359	3293	11894	2347	12781	1958	13266	1619	13865	1061	16195	479	13294
12-#14	3.75	MA	9603	3293	15571	2391	17063	1980	17996	1639	19402	1102	23386	648	18129
4E		MI	7566	3293	12356	2335	13396	1929	14034	1592	14998	1060	17603	569	13885
12-#14	3.75	MA	9324	3293	14970	2408	16261	1994	16994	1670	17919	1109	21464	565	17194
5L-3S		MI	7679	3293	12905	2302	14107	1920	14907	1586	16135	1040	19020	654	14084
12-#14	3.75	MA	9121	3293	14366	2417	15463	2028	16001	1682	16584	1136	19723	462	16485
6L-2S		MI	7911	3293	13617	2290	15020	1890	16021	1559	17651	1019	21040	813	14078
12-#18	6.67	MA	11018	3874	18567	2770	20832	2255	22561	1809	25648	1077	32102	372	29220
4E		MI	8600	3874	14567	2701	16167	2191	17386	1749	19587	1020	23290	195	22102
12-#18	6.67	MA	10549	3874	17514	2797	19430	2312	20809	1862	23058	1085	28730	213	27571
5L-3S		MI	8779	3874	15520	2647	17400	2178	18900	1742	21557	989	25668	338	23755
14-#10	2.47	MA	9140	3038	14789	2213	16150	1846	16925	1563	17898	1099	21162	847	12454
3L-6S		MI	6940	3038	10944	2202	11629	1850	11892	1555	12033	1101	13894	657	9388
14-#10	2.47	MA	9034	3038	14375	2234	15612	1867	16264	1570	17037	1116	20074	798	12440
4L-5S		MI	7028	3038	11205	2196	11983	1844	12333	1550	12626	1087	14674	716	9619
14-#10	2.47	MA	8869	3038	14029	2244	15151	1876	15688	1590	16183	1122	18974	755	12358
5L-4S		MI	7151	3038	11472	2187	12339	1825	12778	1533	13283	1084	15529	766	9689
14-#10	2.47	MA	8751	3038	13671	2249	14693	1896	15117	1597	15415	1139	17984	698	11995
6L-3S		MI	7223	3038	11791	2168	12752	1819	13285	1528	13944	1071	16383	817	9680
14-#10	2.47	MA	8625	3038	13279	2266	14228	1901	14572	1616	14667	1155	16823	648	11764
7L-2S		MI	7366	3038	12208	2160	13287	1801	13937	1511	14831	1057	17610	907	9663
14-#11	3.03	MA	9437	3150	15515	2271	17035	1887	17984	1587	19328	1085	23132	806	15033
3L-6S		MI	7102	3150	11288	2276	12042	1894	12374	1579	12677	1086	14695	559	11112
14-#11	3.03	MA	9314	3150	15012	2297	16382	1911	17183	1595	18283	1105	21803	745	14997
4L-5S		MI	7208	3150	11622	2255	12471	1886	12908	1573	13394	1070	15616	629	11348
14-#11	3.03	MA	9117	3150	14592	2309	15822	1921	16482	1618	17246	1110	20462	690	14643
5L-4S		MI	7354	3150	11946	2245	12902	1865	13446	1554	14189	1069	16623	691	11625
14-#11	3.03	MA	8976	3150	14165	2315	15265	1945	15788	1627	16313	1130	19252	619	14259
6L-3S		MI	7436	3150	12331	2222	13401	1858	14059	1549	14987	1053	17633	752	11630
14-#11	3.03	MA	8828	3150	13690	2335	14711	1952	15126	1649	15404	1149	17993	573	13788
7L-2S		MI	7603	3150	12832	2213	14044	1837	14843	1529	16054	1038	19078	862	11613
14-#14	4.38	MA	10012	3417	16517	2469	18275	2036	19475	1673	21414	1092	26172	634	20955
4L-5S		MI	7663	3417	12606	2425	13694	2014	14380	1653	15380	1051	18215	456	15437
14-#14	4.38	MA	9737	3417	15915	2485	17473	2050	18473	1704	19931	1099	24250	551	20063
5L-4S		MI	7867	3417	13068	2413	14309	1985	15148	1626	16514	1050	19623	547	15991
14-#14	4.38	MA	9540	3417	15312	2495	16675	2083	17480	1716	18596	1126	22509	448	19327
6L-3S		MI	7978	3417	13617	2380	15020	1976	16021	1620	17651	1030	21040	632	16298
14-#18	7.78	MA	11256	4095	19156	2935	21535	2411	23377	1922	26552	1068	33568	189	32499
5L-4S		MI	9110	4095	15795	2840	17740	2291	19305	1809	22198	1002	26657	142	25769
16-#10	2.82	MA	9276	3108	14923	2278	16316	1898	17122	1590	18204	1111	21691	790	14144
4L-6S		MI	7121	3108	11361	2246	12163	1882	12544	1575	12920	1095	15121	649	10652

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

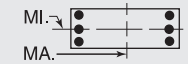


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.82	MA	9112	3108	14578	2288	15855	1907	16545	1609	17350	1116	20590	748	14014
5E		MI	7209	3108	11622	2240	12518	1875	12985	1569	13513	1081	15901	708	10870
16-#10	2.82	MA	8996	3108	14219	2293	15396	1927	15974	1617	16582	1133	19600	691	13666
6L-4S		MI	7331	3108	11889	2231	12874	1857	13430	1553	14170	1079	16756	758	10988
16-#10	2.82	MA	8871	3108	13828	2310	14931	1933	15430	1636	15834	1150	18439	640	13444
7L-3S		MI	7402	3108	12208	2212	13287	1850	13937	1547	14831	1065	17610	809	10987
16-#10	2.82	MA	8733	3108	13484	2317	14457	1949	14863	1642	15037	1155	17436	592	12987
8L-2S		MI	7543	3108	12624	2204	13821	1832	14589	1531	15718	1051	18837	899	10974
16-#11	3.47	MA	9602	3236	15675	2351	17233	1949	18220	1619	19695	1098	23757	736	17052
4L-6S		MI	7319	3236	11790	2330	12685	1932	13158	1602	13744	1079	16140	546	12633
16-#11	3.47	MA	9408	3236	15255	2363	16672	1960	17519	1641	18657	1103	22417	680	16649
5E		MI	7422	3236	12123	2309	13114	1925	13692	1597	14461	1063	17061	616	12855
16-#11	3.47	MA	9270	3236	14828	2369	16115	1984	16825	1650	17724	1123	21206	609	16282
6L-4S		MI	7567	3236	12447	2299	13545	1904	14230	1578	15256	1062	18068	678	13182
16-#11	3.47	MA	9123	3236	14353	2389	15561	1991	16163	1673	16815	1142	19947	564	15790
7L-3S		MI	7648	3236	12832	2276	14044	1897	14843	1572	16054	1046	19078	739	13199
16-#14	5.00	MA	10148	3542	16861	2563	18686	2105	19951	1738	21943	1089	27036	537	22939
5E		MI	7965	3542	13318	2503	14607	2070	15494	1686	16896	1041	20235	434	17588
16-#14	5.00	MA	9956	3542	16257	2573	17888	2139	18959	1750	20608	1116	25295	434	22175
6L-4S		MI	8166	3542	13781	2490	15222	2041	16261	1660	18029	1040	21644	525	18109
18-#10	3.17	MA	9354	3178	15126	2332	16558	1939	17403	1628	18517	1111	22206	740	15674
5L-6S		MI	7302	3178	11778	2289	12697	1913	13196	1594	13807	1089	16348	641	11918
18-#10	3.17	MA	9240	3178	14768	2337	16099	1959	16832	1636	17749	1127	21216	683	15340
6L-5S		MI	7388	3178	12039	2284	13052	1907	13637	1588	14399	1076	17128	700	12126
18-#10	3.17	MA	9116	3178	14376	2354	15634	1964	16287	1655	17001	1144	20055	633	15114
7L-4S		MI	7509	3178	12306	2275	13408	1889	14082	1572	15057	1073	17983	750	12285
18-#10	3.17	MA	8980	3178	14033	2361	15160	1981	15721	1661	16204	1150	19052	584	14656
8L-3S		MI	7580	3178	12624	2256	13821	1882	14589	1566	15718	1059	18837	801	12292
18-#11	3.90	MA	9697	3323	15919	2417	17523	1998	18557	1665	20068	1097	24371	671	18660
5L-6S		MI	7534	3323	12291	2384	13328	1971	13942	1626	14811	1072	17585	533	14157
18-#11	3.90	MA	9562	3323	15491	2423	16965	2022	17863	1674	19136	1116	23160	600	18309
6L-5S		MI	7636	3323	12625	2363	13757	1964	14476	1620	15528	1056	18506	603	14368
18-#11	3.90	MA	9416	3323	15016	2443	16411	2029	17200	1696	18227	1136	21902	554	17796
7L-4S		MI	7779	3323	12949	2353	14188	1943	15014	1601	16323	1055	19513	665	14737
18-#14	5.63	MA	10369	3666	17203	2651	19100	2195	20437	1784	22620	1106	28081	420	25031
6L-5S		MI	8266	3666	14030	2581	15520	2126	16608	1720	18411	1031	22255	412	19744
20-#10	3.53	MA	9483	3249	15316	2381	16802	1990	17690	1655	18916	1122	22832	675	17017
6E		MI	7482	3249	12195	2333	13232	1945	13848	1613	14694	1084	17575	633	13187
20-#10	3.53	MA	9359	3249	14925	2398	16338	1996	17145	1674	18168	1139	21671	625	16773
7L-5S		MI	7567	3249	12455	2327	13586	1938	14289	1607	15286	1070	18355	692	13384
20-#10	3.53	MA	9225	3249	14581	2405	15863	2012	16579	1680	17371	1144	20668	577	16327
8L-4S		MI	7687	3249	12723	2319	13942	1920	14733	1591	15944	1068	19210	742	13580
20-#11	4.33	MA	9853	3409	16154	2477	17815	2061	18900	1697	20547	1109	25114	590	20338
6E		MI	7749	3409	12792	2438	13970	2010	14727	1649	15878	1065	19030	520	15684
20-#11	4.33	MA	9708	3409	15679	2497	17262	2068	18238	1720	19638	1129	23856	545	19806
7L-5S		MI	7849	3409	13126	2416	14400	2002	15260	1644	16595	1050	19951	590	15884
22-#10	3.88	MA	9601	3319	15473	2442	17041	2027	18003	1693	19335	1133	23287	617	18435
7L-6S		MI	7662	3319	12611	2377	13766	1977	14500	1632	15581	1078	18802	625	14458
22-#10	3.88	MA	9469	3319	15130	2449	16566	2044	17437	1699	18539	1139	22284	569	18000
8L-5S		MI	7745	3319	12872	2371	14121	1970	14940	1627	16173	1064	19582	684	14646
22-#11	4.77	MA	9998	3495	16343	2551	18112	2107	19275	1743	21049	1122	25810	535	21819
7L-6S		MI	7963	3495	13294	2492	14613	2049	15511	1673	16945	1058	20475	507	17213
24-#10	4.23	MA	9712	3389	15679	2493	17269	2075	18294	1718	19706	1133	23900	561	19675
8L-6S		MI	7841	3389	13028	2421	14300	2008	15151	1651	16468	1073	20028	617	15730

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

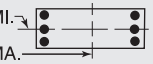
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.17	MA	9596	2965	15164	2166	16201	1826	16586	1563	16719	1170	19022	1016	6902
2E		MI	7125	2965	11392	2100	12004	1771	12188	1514	12159	1131	13554	965	5082
4-#18	2.08	MA	10239	3158	16733	2267	18143	1897	18925	1601	19885	1143	23392	985	11796
2E		MI	7546	3158	12464	2195	13317	1835	13763	1547	14291	1100	16155	891	8520
6-#11	1.22	MA	9648	2975	15239	2182	16333	1839	16763	1573	16970	1175	19376	1020	7189
2L-3S		MI	6985	2975	10947	2129	11467	1807	11546	1546	11292	1153	12450	868	5323
6-#11	1.22	MA	9381	2975	14522	2194	15414	1850	15642	1596	15444	1195	17263	918	7226
3L-2S		MI	7163	2975	11448	2120	12109	1786	12330	1526	12359	1138	13895	977	5283
6-#14	1.76	MA	10043	3089	16187	2244	17513	1882	18186	1597	18897	1160	22037	1002	10141
2L-3S		MI	7178	3089	11392	2191	12004	1856	12188	1574	12159	1142	13554	784	7425
6-#14	1.76	MA	9671	3089	15164	2261	16201	1897	16586	1629	16719	1188	19022	853	10180
3L-2S		MI	7426	3089	12104	2178	12917	1826	13302	1548	13675	1121	15574	943	7370
6-#18	3.13	MA	10999	3380	18513	2406	20425	1996	21709	1661	23673	1125	28638	960	17390
2L-3S		MI	7645	3380	12464	2352	13317	1983	13763	1650	14291	1113	16155	557	12449
6-#18	3.13	MA	10380	3380	16733	2434	18143	2020	18925	1716	19885	1172	23392	685	17334
3L-2S		MI	8055	3380	13691	2334	14890	1935	15682	1608	16902	1083	19522	839	12413
8-#9	1.04	MA	9537	2937	14906	2177	15975	1838	16356	1576	16433	1189	18647	1034	6236
2L-4S		MI	6915	2937	10636	2143	11128	1810	11157	1552	10800	1178	11894	895	4649
8-#9	1.04	MA	9359	2937	14437	2185	15374	1846	15623	1592	15436	1203	17265	971	6257
3E		MI	6974	2937	10888	2127	11455	1805	11559	1548	11323	1167	12568	935	4621
8-#9	1.04	MA	9262	2937	14084	2202	14916	1862	15060	1599	14702	1217	16347	933	6280
4L-2S		MI	7094	2937	11219	2121	11879	1790	12076	1534	12027	1155	13543	1005	4600
8-#10	1.32	MA	9753	2997	15415	2209	16610	1861	17123	1589	17471	1181	20080	1025	7818
2L-4S		MI	7017	2997	10841	2179	11373	1836	11448	1568	11198	1174	12450	854	5792
8-#10	1.32	MA	9532	2997	14823	2220	15850	1870	16196	1608	16211	1199	18334	944	7843
3E		MI	7091	2997	11160	2160	11786	1829	11955	1562	11859	1161	13304	905	5758
8-#10	1.32	MA	9411	2997	14377	2241	15271	1891	15484	1617	15283	1216	17170	895	7863
4L-2S		MI	7240	2997	11577	2151	12320	1811	12607	1546	12745	1147	14531	994	5730
8-#11	1.63	MA	9963	3061	15956	2236	17253	1878	17885	1596	18496	1168	21489	1011	9456
2L-4S		MI	7117	3061	11063	2206	11610	1853	11717	1574	11561	1162	12885	794	6964
8-#11	1.63	MA	9701	3061	15239	2248	16333	1889	16763	1619	16970	1188	19376	909	9484
3E		MI	7201	3061	11448	2183	12109	1846	12330	1569	12359	1146	13895	855	6926
8-#11	1.63	MA	9560	3061	14697	2274	15630	1913	15899	1629	15843	1209	17952	848	9494
4L-2S		MI	7376	3061	11949	2174	12752	1825	13114	1550	13426	1131	15340	964	6890
8-#14	2.34	MA	10487	3214	17210	2321	18825	1938	19787	1630	21074	1150	25052	989	13360
2L-4S		MI	7367	3214	11555	2301	12206	1921	12429	1615	12538	1152	14158	677	9683
8-#14	2.34	MA	10124	3214	16187	2339	17513	1953	18186	1663	18897	1178	22037	839	13378
3E		MI	7482	3214	12104	2268	12917	1912	13302	1608	13675	1132	15574	762	9675
8-#14	2.34	MA	9927	3214	15412	2376	16507	1988	16950	1676	17286	1207	19991	751	13300
4L-2S		MI	7725	3214	12816	2256	13830	1882	14416	1582	15190	1111	17594	921	9633
8-#18	4.17	MA	11753	3601	20294	2544	22708	2095	24494	1722	27462	1107	33883	936	22959
2L-4S		MI	7976	3601	12739	2545	13657	2095	14169	1717	14931	1126	17145	362	15048
8-#18	4.17	MA	11156	3601	18513	2572	20425	2119	21709	1776	23673	1154	28638	661	22841
3E		MI	8162	3601	13691	2491	14890	2082	15682	1710	16902	1096	19522	505	16254
8-#18	4.17	MA	10831	3601	17158	2635	18668	2178	19549	1796	20860	1200	25027	502	21146
4L-2S		MI	8561	3601	14919	2472	16463	2034	17601	1668	19513	1065	22889	786	16274
10-#10	1.65	MA	10015	3067	16008	2253	17369	1892	18049	1608	18732	1175	21825	1017	9685
2L-5S		MI	7073	3067	10991	2231	11551	1886	11655	1604	11427	1171	12822	795	7125
10-#10	1.65	MA	9798	3067	15415	2264	16610	1902	17123	1627	17471	1193	20080	936	9705
3L-4S		MI	7199	3067	11258	2223	11907	1868	12099	1587	12085	1169	13677	846	7109
10-#10	1.65	MA	9678	3067	14970	2285	16031	1922	16410	1636	16543	1211	18915	887	9713
4L-3S		MI	7272	3067	11577	2204	12320	1861	12607	1581	12745	1155	14531	897	7083

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.65	MA	9494	3067	14598	2296	15535	1932	15790	1656	15623	1217	17733	847	9681
5L-2S		MI	7419	3067	11993	2195	12855	1843	13259	1565	13632	1141	15758	986	7058
10-#11	2.03	MA	10277	3147	16673	2290	18172	1917	19007	1620	20022	1161	23602	1001	11713
2L-5S		MI	7183	3147	11240	2269	11822	1913	11963	1617	11833	1156	13323	719	8462
10-#11	2.03	MA	10019	3147	15956	2302	17253	1928	17885	1643	18496	1182	21489	899	11733
3L-4S		MI	7332	3147	11564	2260	12253	1892	12501	1598	12628	1155	14331	781	8541
10-#11	2.03	MA	9879	3147	15415	2328	16550	1952	17020	1652	17369	1202	20065	839	11724
4L-3S		MI	7416	3147	11949	2237	12752	1885	13114	1593	13426	1140	15340	842	8515
10-#11	2.03	MA	9659	3147	14963	2340	15946	1963	16266	1676	16251	1209	18624	786	11558
5L-2S		MI	7589	3147	12451	2228	13395	1864	13898	1573	14493	1124	16785	951	8484
10-#14	2.93	MA	10928	3338	18234	2399	20137	1994	21388	1664	23252	1140	28067	975	16569
2L-5S		MI	7461	3338	11804	2391	12504	2006	12775	1675	12920	1143	14770	564	11296
10-#14	2.93	MA	10573	3338	17210	2416	18825	2009	19787	1697	21074	1168	25052	825	16564
3L-4S		MI	7671	3338	12267	2379	13119	1977	13543	1649	14053	1142	16178	655	11890
10-#14	2.93	MA	10379	3338	16435	2453	17819	2044	18551	1710	19464	1197	23006	737	16462
4L-3S		MI	7785	3338	12816	2346	13830	1967	14416	1642	15190	1122	17594	740	11911
10-#14	2.93	MA	10069	3338	15788	2470	16955	2059	17471	1743	17864	1205	20940	659	15564
5L-2S		MI	8023	3338	13528	2334	14743	1938	15530	1616	16706	1101	19614	898	11882
10-#18	5.21	MA	11923	3822	20294	2710	22708	2218	24494	1837	27462	1136	33883	636	28346
3L-4S		MI	8494	3822	13966	2683	15230	2194	16088	1778	17542	1108	20512	310	18661
10-#18	5.21	MA	11606	3822	18939	2774	20950	2278	22334	1856	24648	1183	30272	477	26493
4L-3S		MI	8676	3822	14919	2629	16463	2181	17601	1771	19513	1078	22889	452	20049
10-#18	5.21	MA	11080	3822	17804	2802	19437	2301	20443	1911	21851	1194	26643	326	24907
5L-2S		MI	9065	3822	16146	2610	18036	2133	19521	1728	22124	1047	26256	734	20120
12-#10	1.98	MA	10276	3137	16600	2297	18129	1924	18976	1627	19992	1170	23571	1009	11547
2L-6S		MI	7165	3137	11147	2281	11731	1924	11866	1628	11722	1179	13269	729	8215
12-#10	1.98	MA	10062	3137	16008	2307	17369	1933	18049	1647	18732	1187	21825	928	11561
3L-5S		MI	7255	3137	11408	2275	12086	1917	12307	1623	12314	1166	14049	788	8424
12-#10	1.98	MA	9943	3137	15562	2329	16790	1954	17337	1655	17804	1205	20661	880	11558
4E		MI	7379	3137	11675	2267	12442	1899	12751	1606	12971	1163	14904	838	8420
12-#10	1.98	MA	9761	3137	15191	2340	16294	1963	16716	1675	16884	1211	19478	839	11515
5L-3S		MI	7452	3137	11993	2247	12855	1892	13259	1601	13632	1149	15758	889	8401
12-#10	1.98	MA	9630	3137	14800	2344	15801	1984	16102	1683	16057	1229	18419	782	11168
6L-2S		MI	7597	3137	12410	2239	13389	1874	13910	1584	14519	1136	16984	979	8378
12-#11	2.44	MA	10588	3234	17391	2344	19092	1955	20128	1643	21548	1154	25715	992	13964
2L-6S		MI	7292	3234	11408	2345	12035	1959	12213	1646	12183	1165	13847	635	9696
12-#11	2.44	MA	10335	3234	16673	2356	18172	1966	19007	1666	20022	1175	23602	890	13977
3L-5S		MI	7399	3234	11742	2323	12465	1952	12747	1641	12900	1150	14768	706	9954
12-#11	2.44	MA	10197	3234	16132	2382	17469	1991	18142	1676	18895	1195	22178	829	13951
4E		MI	7547	3234	12066	2314	12896	1931	13285	1622	13695	1148	15776	768	10112
12-#11	2.44	MA	9980	3234	15680	2394	16866	2002	17388	1699	17777	1202	20737	777	13715
5L-3S		MI	7630	3234	12451	2291	13395	1923	13898	1616	14493	1133	16785	829	10096
12-#11	2.44	MA	9823	3234	15212	2400	16266	2027	16640	1709	16772	1222	19441	706	13248
6L-2S		MI	7801	3234	12952	2281	14038	1902	14683	1597	15560	1117	18230	938	10071
12-#14	3.52	MA	11019	3463	18234	2494	20137	2065	21388	1731	23252	1158	28067	812	19745
3L-5S		MI	7766	3463	12517	2469	13417	2062	13889	1709	14435	1133	16790	542	13427
12-#14	3.52	MA	10828	3463	17459	2531	19131	2100	20151	1744	21641	1187	26021	724	19624
4E		MI	7973	3463	12979	2456	14032	2033	14656	1683	15569	1132	18198	632	14038
12-#14	3.52	MA	10523	3463	16811	2548	18267	2115	19071	1777	20042	1195	23955	645	18663
5L-3S		MI	8086	3463	13528	2424	14743	2023	15530	1676	16706	1112	19614	718	14137
12-#14	3.52	MA	10303	3463	16150	2557	17408	2149	18001	1789	18604	1224	22091	543	18006
6L-2S		MI	8320	3463	14240	2412	15656	1994	16643	1650	18221	1091	21634	876	14122
12-#18	6.25	MA	12372	4044	20719	2912	23232	2377	25118	1917	28436	1165	35517	453	31863
4E		MI	9007	4044	15193	2821	16803	2293	18007	1838	20153	1091	23879	257	22301

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

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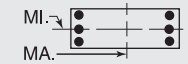
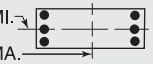


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	6.25	MA	11860	4044	19584	2940	21720	2401	23227	1972	25639	1176	31888	302	30258
5L-3S		MI	9187	4044	16146	2767	18036	2281	19521	1831	22124	1060	26256	400	23839
14-#10	2.32	MA	10324	3208	16600	2351	18129	1965	18976	1666	19992	1182	23571	920	13414
3L-6S		MI	7347	3208	11564	2325	12265	1956	12517	1647	12608	1174	14496	721	9474
14-#10	2.32	MA	10207	3208	16154	2373	17550	1985	18263	1674	19065	1199	22406	872	13400
4L-5S		MI	7436	3208	11824	2319	12620	1949	12958	1642	13201	1160	15276	780	9713
14-#10	2.32	MA	10027	3208	15783	2384	17054	1995	17643	1694	18144	1206	21224	831	13349
5L-4S		MI	7559	3208	12092	2311	12976	1931	13403	1625	13858	1157	16131	830	9726
14-#10	2.32	MA	9898	3208	15392	2388	16560	2016	17028	1702	17318	1223	20165	775	12971
6L-3S		MI	7631	3208	12410	2291	13389	1924	13910	1620	14519	1144	16984	881	9713
14-#10	2.32	MA	9760	3208	14970	2406	16053	2021	16442	1722	16513	1241	18919	726	12708
7L-2S		MI	7774	3208	12827	2283	13923	1906	14562	1603	15406	1130	18211	971	9694
14-#11	2.84	MA	10650	3320	17391	2410	19092	2005	20128	1690	21548	1168	25715	880	16212
3L-6S		MI	7509	3320	11910	2399	12678	1998	12998	1670	13250	1158	15292	622	11212
14-#11	2.84	MA	10513	3320	16849	2436	18388	2030	19264	1700	20421	1188	24291	820	16176
4L-5S		MI	7615	3320	12243	2377	13108	1991	13531	1664	13967	1143	16213	693	11454
14-#11	2.84	MA	10298	3320	16397	2448	17785	2041	18509	1723	19303	1195	22850	767	15879
5L-4S		MI	7761	3320	12567	2368	13539	1969	14070	1645	14762	1141	17221	755	11675
14-#11	2.84	MA	10145	3320	15929	2454	17185	2065	17762	1732	18299	1215	21554	697	15433
6L-3S		MI	7844	3320	12952	2345	14038	1962	14683	1640	15560	1126	18230	816	11671
14-#11	2.84	MA	9981	3320	15417	2475	16579	2072	17049	1756	17320	1236	20034	635	14998
7L-2S		MI	8012	3320	13454	2335	14681	1941	15467	1620	16627	1110	19676	925	11651
14-#14	4.10	MA	11273	3587	18482	2609	20443	2155	21752	1778	23819	1177	29036	710	22786
4L-5S		MI	8070	3587	13229	2547	14330	2118	15003	1743	15951	1123	18810	519	15568
14-#14	4.10	MA	10974	3587	17835	2626	19579	2170	20672	1811	22219	1186	26970	631	21772
5L-4S		MI	8275	3587	13691	2534	14945	2089	15770	1717	17084	1122	20218	610	16142
14-#14	4.10	MA	10759	3587	17173	2635	18720	2205	19602	1823	20781	1214	25106	529	21090
6L-3S		MI	8386	3587	14240	2502	15656	2079	16643	1710	18221	1102	21634	695	16354
14-#14	4.10	MA	10530	3587	16441	2664	17863	2215	18581	1856	19380	1242	23168	464	20011
7L-2S		MI	8616	3587	14952	2489	16569	2050	17757	1684	19737	1081	23654	854	16356
14-#18	7.29	MA	12632	4265	21364	3078	24002	2500	26012	2032	29427	1158	37133	277	35624
5L-4S		MI	9518	4265	16420	2960	18376	2393	19926	1898	22764	1073	27246	205	25962
16-#10	2.65	MA	10469	3278	16747	2417	18309	2017	19190	1693	20325	1194	24152	864	15241
4L-6S		MI	7529	3278	11981	2369	12800	1987	13169	1666	13495	1168	15723	713	10737
16-#10	2.65	MA	10291	3278	16375	2428	17813	2026	18569	1713	19405	1200	22969	823	15182
5E		MI	7616	3278	12241	2363	13154	1980	13610	1661	14088	1154	16502	772	10962
16-#10	2.65	MA	10165	3278	15985	2432	17320	2047	17955	1721	18578	1218	21910	767	14777
6L-4S		MI	7738	3278	12509	2355	13510	1962	14055	1644	14745	1152	17358	822	11029
16-#10	2.65	MA	10027	3278	15562	2450	16812	2052	17369	1741	17774	1235	20664	719	14524
7L-3S		MI	7810	3278	12827	2335	13923	1955	14562	1639	15406	1138	18211	873	11022
16-#10	2.65	MA	9877	3278	15193	2457	16301	2069	16750	1747	16916	1242	19588	672	14084
8L-2S		MI	7951	3278	13244	2327	14457	1937	15214	1622	16293	1124	19438	963	11007
16-#11	3.25	MA	10827	3406	17566	2490	19308	2068	20385	1723	21947	1181	26404	810	18400
4L-6S		MI	7726	3406	12411	2452	13321	2037	13782	1693	14317	1151	16737	609	12733
16-#11	3.25	MA	10615	3406	17114	2502	18705	2079	19631	1746	20829	1188	24963	757	18050
5E		MI	7830	3406	12745	2431	13751	2029	14316	1688	15033	1136	17658	680	12961
16-#11	3.25	MA	10465	3406	16647	2508	18105	2104	18884	1756	19825	1209	23667	687	17623
6L-4S		MI	7975	3406	13069	2422	14182	2008	14854	1669	15829	1134	18666	742	13235
16-#11	3.25	MA	10302	3406	16134	2529	17498	2111	18171	1779	18846	1229	22147	625	17167
7L-3S		MI	8056	3406	13454	2399	14681	2001	15467	1663	16627	1119	19676	803	13242
16-#11	3.25	MA	10122	3406	15685	2538	16877	2131	17432	1787	17804	1236	20835	566	16586
8L-2S		MI	8222	3406	13955	2389	15323	1980	16251	1644	17694	1104	21121	912	13228
16-#14	4.69	MA	11421	3712	18858	2704	20891	2226	22272	1844	24397	1176	29985	617	24888
5E		MI	8372	3712	13941	2624	15243	2174	16116	1777	17466	1113	20830	497	17716
16-#14	4.69	MA	11213	3712	18197	2713	20032	2261	21202	1857	22959	1204	28121	515	24182
6L-4S		MI	8574	3712	14404	2612	15858	2145	16884	1750	18600	1112	22238	588	18257
16-#14	4.69	MA	10985	3712	17464	2742	19175	2271	20181	1890	21558	1232	26183	450	23133
7L-3S		MI	8685	3712	14952	2580	16569	2135	17757	1744	19737	1092	23654	673	18567

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

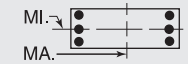


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
18-#10	2.98	MA	10555	3348	16968	2472	18572	2058	19496	1732	20665	1194	24715	816	16976
5L-6S		MI	7710	3348	12397	2413	13334	2019	13821	1686	14382	1162	16949	705	12003
18-#10	2.98	MA	10430	3348	16577	2476	18079	2079	18881	1741	19839	1212	23656	759	16586
6L-5S		MI	7796	3348	12658	2407	13688	2012	14262	1680	14974	1149	17729	764	12217
18-#10	2.98	MA	10293	3348	16155	2493	17572	2084	18296	1760	19034	1230	22410	711	16342
7L-4S		MI	7917	3348	12925	2399	14044	1994	14707	1663	15632	1146	18584	814	12328
18-#10	2.98	MA	10145	3348	15785	2501	17061	2101	17676	1766	18177	1236	21334	664	15889
8L-3S		MI	7988	3348	13244	2379	14457	1987	15214	1658	16293	1133	19438	866	12328
18-#10	2.98	MA	10011	3348	15393	2520	16571	2107	17067	1782	17382	1253	20273	622	15506
9L-2S		MI	8128	3348	13661	2371	14992	1969	15866	1641	17179	1119	20665	955	12316
18-#11	3.66	MA	10930	3492	17831	2556	19624	2118	20752	1770	22355	1181	27076	748	20226
5L-6S		MI	7941	3492	12912	2506	13964	2075	14566	1717	15384	1144	18182	596	14256
18-#11	3.66	MA	10783	3492	17364	2562	19024	2143	20005	1779	21351	1202	25780	678	19816
6L-5S		MI	8044	3492	13246	2485	14393	2068	15100	1711	16100	1129	19104	667	14472
18-#11	3.66	MA	10621	3492	16851	2583	18418	2149	19292	1803	20372	1222	24260	616	19340
7L-4S		MI	8187	3492	13570	2476	14824	2047	15638	1692	16895	1127	20111	729	14792
18-#11	3.66	MA	10444	3492	16402	2591	17797	2170	18553	1810	19330	1229	22948	556	18775
8L-3S		MI	8268	3492	13955	2453	15323	2040	16251	1687	17694	1112	21121	790	14810
18-#14	5.27	MA	11663	3836	19220	2791	21344	2317	22803	1891	25136	1194	31136	501	27280
6L-5S		MI	8673	3836	14653	2702	16156	2230	17230	1811	18982	1103	22850	475	19871
18-#14	5.27	MA	11437	3836	18488	2820	20487	2327	21782	1924	23735	1223	29198	437	26259
7L-4S		MI	8873	3836	15116	2690	16771	2200	17998	1784	20115	1102	24258	565	20381
20-#10	3.31	MA	10694	3418	17169	2520	18839	2110	19808	1760	21100	1206	25401	751	18398
6E		MI	7890	3418	12814	2457	13868	2050	14473	1705	15269	1157	18176	697	13271
20-#10	3.31	MA	10558	3418	16747	2537	18331	2115	19222	1779	20295	1224	24155	703	18162
7L-5S		MI	7975	3418	13075	2451	14223	2043	14914	1699	15861	1143	18956	756	13474
20-#10	3.31	MA	10412	3418	16378	2545	17820	2132	18603	1785	19438	1230	23079	657	17696
8L-4S		MI	8095	3418	13342	2443	14579	2025	15358	1683	16519	1141	19811	806	13624
20-#10	3.31	MA	10282	3418	15986	2564	17330	2139	17994	1802	18642	1248	22018	614	17311
9L-3S		MI	8165	3418	13661	2423	14992	2019	15866	1677	17179	1127	20665	858	13633
20-#11	4.06	MA	11099	3579	18081	2616	19943	2182	21127	1803	22877	1195	27893	668	22012
6E		MI	8156	3579	13414	2560	14607	2114	15350	1740	16450	1137	19627	583	15782
20-#11	4.06	MA	10939	3579	17569	2637	19337	2188	20414	1826	21898	1215	26373	606	21517
7L-5S		MI	8257	3579	13748	2539	15036	2107	15884	1735	17167	1122	20549	654	15987
20-#11	4.06	MA	10764	3579	17120	2645	18716	2208	19675	1834	20856	1222	25061	546	20967
8L-4S		MI	8399	3579	14071	2530	15467	2086	16422	1716	17962	1120	21556	716	16347
20-#14	5.86	MA	11885	3961	19511	2898	21799	2383	23383	1958	25913	1213	32213	423	29389
7L-5S		MI	8973	3961	15365	2780	17069	2286	18344	1845	20497	1093	24870	453	22030
22-#10	3.64	MA	10821	3489	17340	2581	19091	2147	20149	1799	21555	1218	25901	695	19984
7L-6S		MI	8070	3489	13231	2501	14402	2082	15125	1724	16156	1151	19403	689	14541
22-#10	3.64	MA	10677	3489	16970	2589	18580	2164	19529	1804	20698	1225	24825	649	19505
8L-5S		MI	8153	3489	13491	2495	14757	2075	15565	1718	16748	1138	20183	748	14735
22-#10	3.64	MA	10550	3489	16578	2608	18090	2170	18920	1821	19903	1242	23764	606	19115
9L-4S		MI	8272	3489	13759	2487	15113	2057	16010	1702	17406	1135	21038	799	14920
22-#11	4.47	MA	11254	3665	18286	2691	20256	2227	21536	1850	23424	1208	28486	597	23697
7L-6S		MI	8370	3665	13915	2614	15249	2153	16134	1764	17517	1130	21072	570	17311
22-#11	4.47	MA	11083	3665	17837	2699	19636	2247	20796	1857	22382	1215	27174	537	23162
8L-5S		MI	8469	3665	14249	2593	15679	2146	16668	1758	18234	1115	21994	641	17506
24-#10	3.97	MA	10941	3559	17563	2633	19339	2195	20456	1823	21959	1219	26570	641	21317
8L-6S		MI	8249	3559	13648	2545	14937	2113	15776	1743	17042	1146	20630	681	15813
24-#10	3.97	MA	10818	3559	17171	2652	18849	2202	19847	1840	21163	1237	25509	598	20921
9L-5S		MI	8331	3559	13908	2539	15291	2107	16217	1738	17635	1132	21410	740	15999
24-#11	4.88	MA	11399	3751	18554	2753	20555	2286	21918	1881	23908	1208	29287	527	25359
8L-6S		MI	8583	3751	14417	2668	15892	2192	16918	1787	18584	1124	22517	557	18841

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

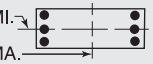
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.10	MA	10793	3134	16971	2304	18148	1944	18573	1665	18681	1251	21215	1088	7388
2E		MI	7532	3134	12014	2222	12641	1874	12811	1604	12730	1203	14149	1028	5110
4-#18	1.96	MA	11493	3328	18667	2405	20247	2014	21101	1703	22101	1224	25937	1056	12660
2E		MI	7954	3328	13090	2315	13953	1938	14384	1637	14857	1171	16744	954	8562
6-#11	1.15	MA	10848	3144	17050	2320	18288	1957	18760	1675	18946	1256	21590	1092	7695
2L-3S		MI	7393	3144	11568	2251	12103	1912	12169	1637	11864	1226	13048	931	5349
6-#11	1.15	MA	10558	3144	16279	2333	17299	1968	17554	1699	17305	1278	19318	992	7732
3L-2S		MI	7571	3144	12070	2242	12746	1890	12954	1617	12931	1210	14493	1041	5310
6-#14	1.65	MA	11278	3259	18072	2382	19560	2000	20295	1699	21024	1241	24459	1074	10870
2L-3S		MI	7585	3259	12014	2312	12641	1959	12811	1665	12730	1214	14149	848	7461
6-#14	1.65	MA	10872	3259	16971	2399	18148	2016	18573	1733	18681	1271	21215	927	10909
3L-2S		MI	7833	3259	12727	2300	13554	1930	13925	1638	14245	1193	16169	1006	7404
6-#18	2.94	MA	12318	3549	20586	2544	22707	2114	24101	1764	26184	1207	31590	1032	18686
2L-3S		MI	8052	3549	13090	2472	13953	2085	14384	1739	14857	1184	16744	620	12514
6-#18	2.94	MA	11643	3549	18667	2573	20247	2139	21101	1821	22101	1256	25937	763	18630
3L-2S		MI	8463	3549	14317	2454	15526	2037	16303	1697	17469	1154	20111	901	12462
8-#10	1.25	MA	10961	3166	17236	2347	18581	1978	19141	1691	19479	1263	22338	1096	8367
2L-4S		MI	7425	3166	11461	2303	12009	1942	12073	1660	11773	1247	13052	918	5818
8-#10	1.25	MA	10720	3166	16600	2358	17765	1988	18146	1711	18124	1281	20464	1017	8392
3E		MI	7498	3166	11779	2283	12422	1935	12580	1654	12434	1234	13905	969	5783
8-#10	1.25	MA	10587	3166	16122	2380	17144	2009	17383	1720	17130	1299	19222	969	8411
4L-2S		MI	7648	3166	12196	2275	12957	1917	13232	1638	13320	1220	15132	1058	5755
8-#11	1.53	MA	11190	3231	17821	2374	19276	1995	19966	1699	20587	1250	23862	1082	10130
2L-4S		MI	7524	3231	11684	2328	12247	1958	12341	1665	12133	1234	13483	858	6998
8-#11	1.53	MA	10904	3231	17050	2386	18288	2007	18760	1723	18946	1271	21590	982	10158
3E		MI	7609	3231	12070	2305	12746	1950	12954	1660	12931	1219	14493	918	6957
8-#11	1.53	MA	10748	3231	16469	2413	17534	2032	17833	1733	17737	1292	20071	922	10168
4L-2S		MI	7784	3231	12571	2296	13389	1929	13738	1641	13998	1204	15938	1028	6920
8-#14	2.21	MA	11759	3383	19173	2459	20971	2056	22017	1733	23367	1232	27704	1060	14332
2L-4S		MI	7774	3383	12178	2422	12842	2025	13051	1705	13109	1224	14753	740	9738
8-#14	2.21	MA	11363	3383	18072	2477	19560	2072	20295	1767	21024	1261	24459	914	14350
3E		MI	7890	3383	12727	2390	13554	2015	13925	1699	14245	1204	16169	825	9716
8-#14	2.21	MA	11146	3383	17241	2515	18481	2107	18968	1781	19295	1291	22276	827	14272
4L-2S		MI	8133	3383	13439	2378	14467	1986	15038	1672	15761	1183	18189	984	9671
8-#18	3.92	MA	13136	3771	22505	2682	25167	2213	27102	1824	30267	1189	37243	1007	24687
2L-4S		MI	8384	3771	13365	2665	14292	2197	14789	1806	15498	1197	17734	424	15255
8-#18	3.92	MA	12485	3771	20586	2712	22707	2239	24101	1881	26184	1238	31590	738	24569
3E		MI	8569	3771	14317	2611	15526	2184	16303	1800	17469	1166	20111	567	16326
8-#18	3.92	MA	12125	3771	19130	2776	20818	2300	21780	1903	23160	1287	27734	581	22960
4L-2S		MI	8970	3771	15544	2592	17099	2136	18222	1757	20080	1136	23478	849	16328
10-#10	1.56	MA	11244	3237	17872	2391	19396	2010	20137	1710	20833	1257	24213	1089	10371
2L-5S		MI	7480	3237	11610	2355	12188	1991	12280	1695	12002	1244	13423	860	7161
10-#10	1.56	MA	11007	3237	17236	2402	18581	2020	19141	1731	19479	1275	22338	1009	10390
3L-4S		MI	7606	3237	11878	2347	12544	1973	12724	1679	12660	1242	14278	910	7139
10-#10	1.56	MA	10876	3237	16758	2424	17960	2041	18378	1739	18484	1293	21097	961	10399
4L-3S		MI	7679	3237	12196	2327	12957	1966	13232	1673	13320	1228	15132	961	7111
10-#10	1.56	MA	10677	3237	16360	2435	17429	2051	17714	1760	17498	1300	19833	922	10367
5L-2S		MI	7826	3237	12613	2319	13491	1948	13884	1657	14207	1214	16359	1051	7085
10-#11	1.91	MA	11529	3317	18592	2428	20265	2034	21172	1722	22227	1243	26134	1073	12556
2L-5S		MI	7590	3317	11862	2391	12458	2018	12587	1708	12405	1229	13921	782	8569
10-#11	1.91	MA	11249	3317	17821	2440	19276	2046	19966	1746	20587	1264	23862	973	12576
3L-4S		MI	7740	3317	12186	2382	12889	1996	13125	1689	13200	1227	14928	845	8580

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.91	MA	11094	3317	17240	2467	18522	2071	19039	1756	19378	1285	22343	913	12567
4L-3S		MI	7824	3317	12571	2359	13389	1989	13738	1684	13998	1212	15938	905	8550
10-#11	1.91	MA	10856	3317	16756	2480	17876	2083	18230	1780	18180	1293	20802	862	12475
5L-2S		MI	7997	3317	13072	2350	14031	1968	14522	1664	15065	1197	17383	1015	8517
10-#14	2.76	MA	12236	3508	20274	2537	22383	2112	23739	1767	25710	1222	30948	1047	17784
2L-5S		MI	7868	3508	12427	2512	13140	2110	13398	1765	13491	1215	15365	627	11427
10-#14	2.76	MA	11850	3508	19173	2555	20971	2127	22017	1801	23367	1251	27704	900	17779
3L-4S		MI	8078	3508	12890	2500	13755	2081	14165	1739	14624	1214	16773	718	11951
10-#14	2.76	MA	11636	3508	18342	2593	19892	2163	20690	1815	21638	1281	25521	813	17677
4L-3S		MI	8193	3508	13439	2468	14467	2071	15038	1733	15761	1194	18189	803	11956
10-#14	2.76	MA	11300	3508	17648	2611	18967	2179	19532	1848	19922	1291	23310	738	16806
5L-2S		MI	8432	3508	14151	2455	15380	2042	16152	1706	17276	1173	20209	961	11923
10-#18	4.90	MA	13318	3992	22505	2850	25167	2338	27102	1941	30267	1221	37243	714	30506
3L-4S		MI	8901	3992	14592	2803	15866	2296	16708	1867	18109	1179	21101	372	18861
10-#18	4.90	MA	12965	3992	21049	2915	23278	2399	24781	1963	27243	1270	33387	557	28736
4L-3S		MI	9083	3992	15544	2749	17099	2284	18222	1860	20080	1149	23478	515	20126
10-#18	4.90	MA	12395	3992	19832	2944	21655	2425	22752	2020	24238	1283	29501	413	27031
5L-2S		MI	9474	3992	16771	2730	18672	2236	20141	1818	22691	1118	26845	796	20176
12-#10	1.87	MA	11526	3307	18509	2435	20212	2041	21132	1729	22187	1251	26088	1081	12370
2L-6S		MI	7572	3307	11766	2405	12368	2030	12491	1720	12296	1252	13870	793	8298
12-#10	1.87	MA	11293	3307	17872	2446	19396	2051	20137	1750	20833	1270	24213	1001	12384
3L-5S		MI	7662	3307	12027	2399	12722	2023	12931	1714	12889	1239	14650	852	8465
12-#10	1.87	MA	11163	3307	17394	2468	18776	2072	19373	1759	19838	1288	22971	953	12381
4E		MI	7787	3307	12294	2390	13078	2005	13376	1698	13546	1236	15505	902	8453
12-#10	1.87	MA	10966	3307	16996	2479	18245	2082	18709	1779	18852	1295	21708	914	12338
5L-3S		MI	7859	3307	12613	2371	13491	1998	13884	1692	14207	1222	16359	953	8431
12-#10	1.87	MA	10824	3307	16574	2483	17716	2103	18051	1788	17967	1313	20577	859	12015
6L-2S		MI	8005	3307	13030	2363	14025	1980	14535	1676	15094	1209	17586	1043	8407
12-#11	2.29	MA	11867	3403	19363	2482	21253	2073	22378	1746	23868	1236	28405	1063	14975
2L-6S		MI	7699	3403	12030	2467	12672	2064	12837	1737	12755	1237	14445	699	9794
12-#11	2.29	MA	11591	3403	18592	2494	20265	2084	21172	1770	22227	1257	26134	963	14988
3L-5S		MI	7807	3403	12363	2445	13101	2056	13371	1732	13472	1222	15366	769	10059
12-#11	2.29	MA	11438	3403	18011	2521	19511	2110	20245	1780	21019	1279	24615	903	14962
4E		MI	7955	3403	12687	2436	13532	2035	13909	1713	14267	1220	16373	832	10154
12-#11	2.29	MA	11203	3403	17527	2534	18865	2121	19436	1804	19820	1286	23074	853	14797
5L-3S		MI	8038	3403	13072	2413	14031	2028	14522	1707	15065	1205	17383	892	10133
12-#11	2.29	MA	11033	3403	17020	2539	18222	2147	18636	1814	18744	1307	21693	783	14263
6L-2S		MI	8209	3403	13574	2404	14674	2007	15306	1688	16132	1190	18828	1002	10106
12-#14	3.31	MA	12333	3632	20274	2633	22383	2183	23739	1835	25710	1241	30948	886	21203
3L-5S		MI	8173	3632	13140	2590	14053	2166	14511	1799	15006	1205	17385	605	13556
12-#14	3.31	MA	12122	3632	19443	2671	21304	2219	22412	1849	23981	1271	28765	799	21082
4E		MI	8381	3632	13602	2578	14668	2136	15279	1773	16139	1204	18793	696	14157
12-#14	3.31	MA	11792	3632	18749	2689	20378	2235	21255	1882	22266	1281	26555	724	20146
5L-3S		MI	8494	3632	14151	2546	15380	2127	16152	1766	17276	1184	20209	781	14189
12-#14	3.31	MA	11553	3632	18030	2697	19458	2271	20108	1896	20724	1311	24567	623	19478
6L-2S		MI	8729	3632	14863	2533	16293	2098	17266	1740	18792	1163	22229	939	14166
12-#18	5.88	MA	13796	4213	22968	3053	25738	2498	27781	2024	31325	1252	39040	532	34535
4E		MI	9415	4213	15819	2941	17439	2396	18627	1927	20720	1162	24468	319	22495
12-#18	5.88	MA	13241	4213	21751	3083	24115	2524	25752	2081	28321	1266	35154	388	32915
5L-3S		MI	9594	4213	16771	2887	18672	2383	20141	1920	22691	1131	26845	462	23919
14-#10	2.18	MA	11577	3377	18509	2490	20212	2083	21132	1769	22187	1264	26088	993	14375
3L-6S		MI	7754	3377	12183	2449	12902	2061	13142	1739	13183	1247	15097	785	9556
14-#10	2.18	MA	11448	3377	18031	2512	19592	2104	20369	1778	21192	1282	24846	945	14360
4L-5S		MI	7843	3377	12444	2443	13256	2054	13583	1734	13776	1233	15877	844	9764

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

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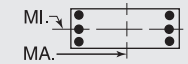
RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.18	MA	11253	3377	17633	2523	19061	2114	19704	1798	20206	1289	23583	906	14310
5L-4S		MI	7967	3377	12711	2434	13612	2036	14028	1717	14433	1231	16732	894	9762
14-#10	2.18	MA	11114	3377	17210	2527	18531	2135	19046	1807	19321	1307	22452	851	13953
6L-3S		MI	8039	3377	13030	2415	14025	2029	14535	1712	15094	1217	17586	945	9745
14-#10	2.18	MA	10962	3377	16757	2545	17982	2140	18419	1827	18460	1326	21124	804	13657
7L-2S		MI	8183	3377	13446	2407	14560	2011	15187	1695	15981	1203	18813	1035	9725
14-#11	2.68	MA	11932	3490	19363	2548	21253	2123	22378	1793	23868	1250	28405	954	17392
3L-6S		MI	7917	3490	12531	2521	13315	2102	13621	1761	13822	1230	15890	686	11309
14-#11	2.68	MA	11780	3490	18782	2575	20499	2149	21451	1803	22660	1272	26887	894	17356
4L-5S		MI	8022	3490	12865	2499	13744	2095	14155	1755	14539	1215	16811	756	11558
14-#11	2.68	MA	11548	3490	18298	2588	19853	2160	20642	1827	21461	1279	25346	843	17126
5L-4S		MI	8169	3490	13189	2490	14175	2074	14693	1736	15334	1214	17818	818	11723
14-#11	2.68	MA	11382	3490	17791	2593	19211	2185	19842	1838	20385	1301	23965	774	16614
6L-3S		MI	8251	3490	13574	2467	14674	2067	15306	1731	16132	1198	18828	879	11710
14-#11	2.68	MA	11202	3490	17241	2615	18552	2192	19079	1862	19336	1322	22341	714	16224
7L-2S		MI	8420	3490	14075	2458	15317	2045	16090	1711	17199	1183	20273	989	11688
14-#14	3.86	MA	12604	3757	20544	2748	22716	2275	24135	1883	26325	1261	32009	785	24487
4L-5S		MI	8477	3757	13852	2668	14966	2222	15625	1833	16521	1195	19405	583	15695
14-#14	3.86	MA	12280	3757	19851	2766	21790	2291	22977	1916	24609	1271	29799	710	23494
5L-4S		MI	8682	3757	14314	2656	15581	2192	16393	1807	17655	1194	20813	673	16288
14-#14	3.86	MA	12047	3757	19132	2775	20869	2327	21830	1930	23067	1301	27812	609	22855
6L-3S		MI	8794	3757	14863	2623	16293	2183	17266	1800	18792	1174	22229	758	16408
14-#14	3.86	MA	11795	3757	18345	2805	19936	2336	20736	1964	21565	1331	25481	520	21653
7L-2S		MI	9025	3757	15575	2611	17206	2154	18380	1774	20307	1153	24249	917	16402
14-#18	6.86	MA	14078	4435	23669	3221	26574	2623	28753	2141	32404	1248	40806	364	38800
5L-4S		MI	9926	4435	17046	3080	19012	2495	20546	1987	23331	1144	27835	267	26151
16-#10	2.49	MA	11732	3448	18667	2556	20407	2135	21364	1797	22546	1277	26721	938	16339
4L-6S		MI	7936	3448	12600	2492	13436	2093	13794	1758	14070	1241	16324	777	10819
16-#10	2.49	MA	11539	3448	18269	2567	19876	2145	20699	1817	21560	1284	25458	899	16281
5E		MI	8023	3448	12861	2487	13791	2086	14235	1753	14662	1227	17104	836	11052
16-#10	2.49	MA	11402	3448	17846	2571	19347	2166	20042	1826	20675	1302	24327	843	15894
6L-4S		MI	8146	3448	13128	2478	14147	2068	14680	1736	15320	1225	17959	886	11067
16-#10	2.49	MA	11251	3448	17394	2589	18798	2171	19415	1846	19814	1320	22998	796	15609
7L-3S		MI	8218	3448	13446	2459	14560	2061	15187	1731	15981	1211	18813	938	11056
16-#10	2.49	MA	11089	3448	16998	2597	18251	2189	18743	1852	18896	1327	21849	751	15191
8L-2S		MI	8360	3448	13863	2451	15094	2043	15839	1714	16868	1197	20039	1027	11039
16-#11	3.06	MA	12121	3576	19553	2629	21488	2187	22657	1827	24301	1265	29159	884	19748
4L-6S		MI	8133	3576	13032	2575	13957	2141	14405	1784	14889	1224	17335	673	12829
16-#11	3.06	MA	11891	3576	19069	2642	20842	2199	21848	1851	23102	1272	27618	834	19461
5E		MI	8237	3576	13366	2553	14387	2134	14939	1779	15606	1208	18256	743	13063
16-#11	3.06	MA	11728	3576	18562	2647	20199	2224	21048	1861	22026	1294	26237	764	18970
6L-4S		MI	8382	3576	13690	2544	14818	2113	15477	1760	16401	1207	19263	805	13285
16-#11	3.06	MA	11549	3576	18012	2669	19540	2230	20285	1885	20977	1315	24613	705	18561
7L-3S		MI	8464	3576	14075	2521	15317	2105	16090	1754	17199	1191	20273	866	13283
16-#11	3.06	MA	11355	3576	17531	2678	18874	2251	19481	1892	19860	1323	23210	647	17901
8L-2S		MI	8631	3576	14577	2512	15960	2084	16874	1735	18266	1176	21718	976	13267
16-#14	4.41	MA	12764	3881	20952	2844	23202	2347	24699	1950	26952	1261	33043	696	26851
5E		MI	8780	3881	14564	2746	15879	2278	16739	1867	18037	1185	21425	560	17841
16-#14	4.41	MA	12538	3881	20233	2853	22281	2383	23552	1964	25410	1291	31056	595	26215
6L-4S		MI	8982	3881	15027	2733	16494	2248	17507	1841	19170	1184	22833	651	18401
16-#14	4.41	MA	12288	3881	19446	2883	21348	2392	22459	1998	23908	1321	28726	506	25019
7L-3S		MI	9093	3881	15575	2701	17206	2239	18380	1834	20307	1164	24249	736	18624
18-#10	2.80	MA	11824	3518	18905	2611	20692	2177	21694	1836	22914	1278	27332	891	18252
5L-6S		MI	8117	3518	13017	2536	13970	2124	14446	1777	14957	1236	17551	769	12084
18-#10	2.80	MA	11689	3518	18483	2615	20163	2198	21037	1845	22029	1296	26201	836	17839
6L-5S		MI	8203	3518	13277	2531	14325	2117	14887	1772	15549	1222	18331	828	12305
18-#10	2.80	MA	11539	3518	18030	2633	19614	2203	20410	1865	21168	1314	24873	788	17563
7L-4S		MI	8325	3518	13545	2522	14681	2099	15332	1755	16207	1219	19186	878	12369

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
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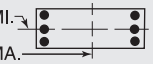
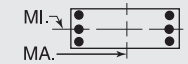


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
18-#10	2.80	MA	11379	3518	17634	2640	19066	2220	19738	1871	20250	1321	23724	743	17133
8L-3S		MI	8396	3518	13863	2503	15094	2092	15839	1750	16868	1206	20039	930	12363
18-#10	2.80	MA	11233	3518	17214	2660	18542	2227	19085	1888	19399	1340	22595	701	16703
9L-2S		MI	8537	3518	14280	2494	15628	2074	16491	1733	17754	1192	21266	1019	12350
18-#11	3.44	MA	12232	3662	19841	2696	21830	2238	23054	1875	24743	1265	29890	824	21803
5L-6S		MI	8349	3662	13534	2629	14600	2180	15190	1808	15956	1217	18780	660	14352
18-#11	3.44	MA	12072	3662	19333	2701	21188	2263	22254	1885	23666	1287	28509	755	21330
6L-5S		MI	8451	3662	13868	2607	15030	2172	15723	1802	16673	1201	19701	730	14573
18-#11	3.44	MA	11895	3662	18783	2723	20529	2269	21491	1909	22618	1308	26885	695	20901
7L-4S		MI	8595	3662	14192	2598	15461	2151	16262	1783	17468	1200	20708	792	14844
18-#11	3.44	MA	11703	3662	18302	2732	19863	2290	20687	1916	21501	1316	25482	637	20258
8L-3S		MI	8676	3662	14577	2575	15960	2144	16874	1778	18266	1184	21718	853	14854
18-#14	4.96	MA	13025	4006	21334	2930	23693	2438	25275	1998	27753	1281	34301	581	29556
6L-5S		MI	9081	4006	15276	2824	16792	2333	17853	1901	19552	1175	23445	538	19994
18-#14	4.96	MA	12777	4006	20548	2961	22760	2448	24181	2032	26251	1311	31970	492	28388
7L-4S		MI	9281	4006	15739	2811	17407	2304	18620	1875	20686	1174	24853	629	20523
20-#10	3.11	MA	11975	3588	19119	2659	20979	2229	22032	1864	23384	1291	28076	828	19786
6E		MI	8297	3588	13433	2580	14505	2156	15098	1796	15844	1230	18778	761	13352
20-#10	3.11	MA	11825	3588	18666	2677	20430	2234	21405	1885	22522	1309	26748	780	19519
7L-5S		MI	8382	3588	13694	2574	14859	2149	15539	1791	16436	1216	19558	820	13562
20-#10	3.11	MA	11667	3588	18271	2684	19882	2252	20733	1890	21604	1316	25599	736	19077
8L-4S		MI	8503	3588	13961	2566	15215	2131	15983	1774	17094	1214	20413	871	13667
20-#10	3.11	MA	11526	3588	17850	2704	19358	2259	20080	1907	20753	1334	24470	693	18657
9L-3S		MI	8574	3588	14280	2547	15628	2124	16491	1769	17754	1200	21266	922	13669
20-#10	3.11	MA	11360	3588	17440	2710	18832	2278	19445	1925	19905	1352	23325	654	18086
10L-2S		MI	8713	3588	14697	2538	16162	2106	17143	1752	18641	1186	22493	1011	13658
20-#11	3.82	MA	12415	3748	20104	2755	22176	2302	23460	1908	25307	1280	30781	745	23693
6E		MI	8563	3748	14035	2683	15243	2219	15974	1831	17023	1210	20225	647	15878
20-#11	3.82	MA	12238	3748	19554	2777	21517	2308	22697	1932	24259	1301	29157	685	23245
7L-5S		MI	8664	3748	14369	2661	15672	2211	16508	1826	17740	1194	21146	717	16087
20-#11	3.82	MA	12050	3748	19073	2786	20852	2329	21893	1939	23142	1309	27754	628	22619
8L-4S		MI	8807	3748	14693	2652	16103	2190	17046	1807	18535	1193	22153	779	16401
20-#14	5.51	MA	13262	4130	21649	3038	24172	2504	25903	2066	28595	1301	35214	479	31762
7L-5S		MI	9381	4130	15988	2902	17705	2389	18967	1935	21068	1165	25465	516	22151
22-#10	3.42	MA	12110	3658	19303	2720	21246	2266	22400	1904	23876	1303	28623	773	21477
7L-6S		MI	8477	3658	13850	2624	15039	2187	15750	1816	16731	1224	20005	753	14621
22-#10	3.42	MA	11954	3658	18907	2728	20698	2283	21728	1909	22958	1310	27474	728	21023
8L-5S		MI	8561	3658	14111	2618	15393	2180	16190	1810	17323	1211	20784	812	14822
22-#10	3.42	MA	11816	3658	18487	2748	20173	2291	21076	1926	22107	1328	26344	686	20613
9L-4S		MI	8681	3658	14378	2610	15749	2162	16635	1794	17980	1208	21639	863	14964
22-#10	3.42	MA	11652	3658	18077	2753	19647	2310	20440	1944	21259	1346	25200	647	20037
10L-3S		MI	8751	3658	14697	2591	16162	2155	17143	1788	18641	1194	22493	914	14973
22-#11	4.21	MA	12580	3835	20326	2830	22506	2347	23903	1956	25900	1294	31429	676	25593
7L-6S		MI	8777	3835	14537	2737	15886	2257	16758	1855	18090	1203	21670	634	17406
22-#11	4.21	MA	12394	3835	19844	2839	21840	2367	23099	1963	24783	1302	30026	618	24981
8L-5S		MI	8877	3835	14870	2715	16315	2250	17292	1849	18807	1187	22591	704	17605
24-#10	3.74	MA	12239	3729	19543	2772	21514	2315	22723	1928	24312	1305	29349	720	22970
8L-6S		MI	8656	3729	14267	2668	15573	2219	16401	1835	17617	1219	21231	745	15893
24-#10	3.74	MA	12105	3729	19123	2792	20989	2322	22071	1945	23461	1323	28219	678	22570
9L-5S		MI	8739	3729	14528	2662	15928	2212	16842	1829	18210	1205	22011	804	16085
24-#10	3.74	MA	11941	3729	18713	2797	20463	2341	21435	1963	22613	1341	27075	639	21987
10L-4S		MI	8858	3729	14795	2654	16284	2194	17287	1813	18867	1202	22866	855	16260
24-#11	4.59	MA	12737	3921	20615	2893	22829	2406	24305	1986	26424	1295	32298	609	27346
8L-6S		MI	8991	3921	15038	2791	16529	2296	17542	1878	19157	1196	23115	621	18935

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

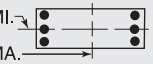
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.04	MA	12058	3304	18875	2442	20200	2062	20666	1768	20743	1333	23517	1159	7874
2E		MI	7940	3304	12637	2343	13277	1978	13433	1695	13301	1275	14743	1091	5138
4-#18	1.85	MA	12816	3498	20698	2543	22456	2132	23382	1806	24418	1306	28590	1128	13524
2E		MI	8361	3498	13716	2435	14588	2040	15004	1726	15424	1242	17333	1016	8604
6-#11	1.08	MA	12117	3314	18957	2458	20347	2074	20863	1778	21022	1338	23912	1163	8200
2L-3S		MI	7800	3314	12190	2374	12739	2016	12793	1728	12437	1298	13645	995	5375
6-#11	1.08	MA	11802	3314	18132	2471	19289	2086	19573	1802	19267	1360	21481	1065	8237
3L-2S		MI	7978	3314	12691	2364	13382	1995	13577	1708	13504	1283	15090	1105	5336
6-#14	1.56	MA	12581	3429	20054	2519	21712	2117	22510	1802	23251	1323	26990	1146	11599
2L-3S		MI	7993	3429	12637	2434	13277	2063	13433	1755	13301	1286	14743	911	7496
6-#14	1.56	MA	12142	3429	18875	2538	20200	2134	20666	1836	20743	1354	23517	1002	11638
3L-2S		MI	8241	3429	13350	2421	14190	2034	14547	1729	14816	1265	16764	1069	7437
6-#18	2.78	MA	13707	3719	22755	2682	25093	2231	26599	1866	28795	1288	34650	1103	19982
2L-3S		MI	8459	3719	13716	2592	14588	2187	15004	1828	15424	1255	17333	682	12574
6-#18	2.78	MA	12975	3719	20698	2713	22456	2258	23382	1925	24418	1340	28590	840	19926
3L-2S		MI	8871	3719	14943	2574	16161	2139	16923	1786	18035	1225	20700	963	12510
8-#10	1.18	MA	12236	3336	19153	2485	20656	2096	21266	1794	21586	1344	24705	1168	8916
2L-4S		MI	7832	3336	12080	2426	12646	2047	12698	1751	12348	1320	13653	982	5843
8-#10	1.18	MA	11977	3336	18473	2496	19784	2106	20202	1814	20139	1363	22701	1090	8940
3E		MI	7906	3336	12399	2407	13059	2040	13205	1746	13008	1307	14507	1033	5808
8-#10	1.18	MA	11832	3336	17963	2519	19122	2128	19388	1824	19020	1371	21382	1042	8960
4L-2S		MI	8055	3336	12815	2398	13593	2022	13857	1729	13895	1293	15734	1123	5779
8-#11	1.44	MA	12484	3400	19782	2512	21405	2113	22153	1801	22778	1331	26343	1154	10804
2L-4S		MI	7931	3400	12306	2451	12883	2062	12964	1756	12706	1307	14081	921	7031
8-#11	1.44	MA	12176	3400	18957	2525	20347	2125	20863	1826	21022	1353	23912	1055	10832
3E		MI	8016	3400	12691	2428	13382	2055	13577	1751	13504	1291	15090	982	6987
8-#11	1.44	MA	12005	3400	18337	2552	19542	2151	19873	1837	19732	1375	22299	996	10842
4L-2S		MI	8192	3400	13192	2418	14025	2034	14361	1732	14571	1276	16535	1092	6950
8-#14	2.08	MA	13099	3553	21233	2597	23223	2173	24353	1836	25760	1313	30464	1132	15304
2L-4S		MI	8181	3553	12801	2544	13479	2128	13674	1796	13679	1296	15347	803	9790
8-#14	2.08	MA	12671	3553	20054	2616	21712	2190	22510	1870	23251	1344	26990	988	15322
3E		MI	8297	3553	13350	2512	14190	2119	14547	1789	14816	1276	16764	888	9756
8-#14	2.08	MA	12432	3553	19166	2654	20559	2227	21092	1885	21405	1375	24670	902	15244
4L-2S		MI	8541	3553	14062	2499	15103	2090	15661	1763	16331	1255	18784	1047	9708
8-#18	3.70	MA	14589	3940	24812	2820	27730	2331	29816	1927	33172	1271	40711	1079	26415
2L-4S		MI	8791	3940	13990	2785	14928	2299	15409	1896	16065	1268	18323	487	15457
8-#18	3.70	MA	13883	3940	22755	2851	25093	2358	26599	1986	28795	1322	34650	815	26297
3E		MI	8976	3940	14943	2731	16161	2287	16923	1889	18035	1237	20700	629	16395
8-#18	3.70	MA	13487	3940	21199	2917	23074	2420	24117	2009	25561	1374	30551	660	24800
4L-2S		MI	9378	3940	16170	2712	17734	2239	18842	1846	20646	1207	24067	911	16381
10-#10	1.47	MA	12541	3406	19833	2529	21528	2127	22330	1813	23034	1339	26709	1160	11057
2L-5S		MI	7887	3406	12230	2478	12824	2096	12905	1787	12577	1317	14025	924	7194
10-#10	1.47	MA	12286	3406	19153	2540	20656	2138	21266	1834	21586	1357	24705	1082	11076
3L-4S		MI	8013	3406	12497	2470	13180	2078	13349	1771	13234	1315	14880	974	7168
10-#10	1.47	MA	12142	3406	18643	2563	19994	2159	20452	1843	20467	1365	23386	1034	11084
4L-3S		MI	8087	3406	12815	2451	13593	2072	13857	1765	13895	1301	15734	1025	7138
10-#10	1.47	MA	11928	3406	18215	2573	19428	2170	19743	1864	19474	1384	22042	997	11053
5L-2S		MI	8234	3406	13232	2442	14127	2053	14509	1749	14782	1287	16960	1115	7111
10-#11	1.81	MA	12850	3487	20607	2565	22462	2152	23444	1825	24534	1324	28774	1144	13398
2L-5S		MI	7997	3487	12483	2514	13095	2122	13210	1799	12977	1301	14518	846	8636
10-#11	1.81	MA	12547	3487	19782	2579	21405	2164	22153	1849	22778	1346	26343	1046	13418
3L-4S		MI	8147	3487	12807	2505	13526	2101	13748	1780	13773	1300	15526	908	8617

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



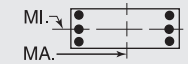
f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.81	MA	12378	3487	19162	2606	20600	2190	21163	1860	21488	1369	24730	987	13409
4L-3S		MI	8231	3487	13192	2482	14025	2093	14361	1775	14571	1284	16535	969	8583
10-#11	1.81	MA	12121	3487	18646	2619	19910	2202	20301	1885	20208	1377	23089	938	13330
5L-2S		MI	8405	3487	13694	2472	14668	2072	15146	1755	15638	1269	17980	1079	8550
10-#14	2.60	MA	13614	3678	22412	2675	24735	2229	26197	1869	28269	1303	33937	1118	18999
2L-5S		MI	8275	3678	13050	2634	13777	2214	14020	1856	14061	1287	15959	690	11554
10-#14	2.60	MA	13195	3678	21233	2694	23223	2246	24353	1904	25760	1334	30464	974	18994
3L-4S		MI	8486	3678	13513	2622	14392	2184	14788	1829	15194	1286	17367	781	12008
10-#14	2.60	MA	12960	3678	20345	2732	22070	2283	22936	1919	23913	1365	28144	888	18892
4L-3S		MI	8600	3678	14062	2589	15103	2175	15661	1823	16331	1266	18784	866	12000
10-#14	2.60	MA	12598	3678	19605	2751	21083	2299	21700	1954	22081	1376	25789	816	18061
5L-2S		MI	8840	3678	14774	2577	16016	2145	16775	1797	17847	1245	20804	1024	11964
10-#18	4.63	MA	14781	4162	24812	2989	27730	2457	29816	2046	33172	1305	40711	791	32666
3L-4S		MI	9308	4162	15217	2923	16501	2399	17328	1956	18676	1250	21690	434	19056
10-#18	4.63	MA	14393	4162	23256	3055	25711	2520	27334	2069	29938	1356	36611	635	31007
4L-3S		MI	9490	4162	16170	2869	17734	2386	18842	1949	20646	1220	24067	577	20200
10-#18	4.63	MA	13778	4162	21957	3086	23978	2547	25166	2128	26727	1372	32468	497	29079
5L-2S		MI	9883	4162	17397	2850	19307	2338	20761	1907	23257	1189	27434	859	20232
12-#10	1.76	MA	12845	3477	20513	2573	22400	2159	23394	1832	24481	1333	28714	1152	13193
2L-6S		MI	7979	3477	12386	2528	13004	2135	13116	1812	12871	1325	14472	857	8378
12-#10	1.76	MA	12593	3477	19833	2584	21528	2169	22330	1853	23034	1352	26709	1074	13207
3L-5S		MI	8069	3477	12646	2522	13358	2128	13556	1806	13464	1312	15252	916	8502
12-#10	1.76	MA	12451	3477	19324	2607	20866	2191	21516	1862	21915	1359	25391	1026	13204
4E		MI	8194	3477	12914	2514	13714	2110	14001	1790	14121	1309	16107	966	8485
12-#10	1.76	MA	12239	3477	18896	2617	20300	2201	20807	1883	20921	1378	24046	989	13161
5L-3S		MI	8267	3477	13232	2494	14127	2103	14509	1784	14782	1296	16960	1017	8460
12-#10	1.76	MA	12086	3477	18444	2622	19731	2222	20106	1892	19978	1397	22843	935	12869
6L-2S		MI	8413	3477	13649	2486	14662	2085	15160	1768	15669	1282	18187	1107	8436
12-#11	2.17	MA	13214	3573	21432	2619	23520	2191	24734	1848	26289	1317	31205	1135	15986
2L-6S		MI	8106	3573	12651	2589	13308	2168	13461	1828	13328	1310	15042	762	9888
12-#11	2.17	MA	12915	3573	20607	2633	22462	2203	23444	1873	24534	1340	28774	1036	15998
3L-5S		MI	8214	3573	12985	2568	13738	2161	13994	1823	14044	1294	15963	833	10161
12-#11	2.17	MA	12748	3573	19987	2660	21657	2229	22454	1884	23243	1362	27160	977	15973
4E		MI	8362	3573	13309	2559	14169	2139	14533	1804	14839	1293	16971	895	10194
12-#11	2.17	MA	12495	3573	19471	2673	20968	2241	21591	1908	21964	1370	25520	929	15882
5L-3S		MI	8445	3573	13694	2535	14668	2132	15146	1798	15638	1277	17980	956	10169
12-#11	2.17	MA	12312	3573	18923	2678	20283	2266	20738	1919	20816	1392	24051	860	15284
6L-2S		MI	8617	3573	14195	2526	15310	2111	15930	1779	16705	1262	19426	1066	10140
12-#14	3.13	MA	13716	3802	22412	2771	24735	2302	26197	1938	28269	1324	33937	960	22661
3L-5S		MI	8581	3802	13763	2712	14690	2270	15134	1890	15576	1277	17979	668	13681
12-#14	3.13	MA	13484	3802	21524	2810	23582	2338	24780	1953	26422	1355	31617	874	22540
4E		MI	8788	3802	14225	2699	15305	2240	15901	1863	16710	1276	19387	759	14218
12-#14	3.13	MA	13128	3802	20784	2829	22594	2355	23544	1988	24590	1366	29263	802	21640
5L-3S		MI	8902	3802	14774	2667	16016	2231	16775	1857	17847	1256	20804	844	14234
12-#14	3.13	MA	12871	3802	20007	2837	21612	2392	22321	2003	22944	1397	27153	701	20891
6L-2S		MI	9138	3802	15486	2655	16929	2201	17889	1830	19362	1235	22824	1002	14209
12-#18	5.56	MA	15290	4383	25313	3194	28348	2619	30551	2130	34315	1338	42672	611	37235
4E		MI	9822	4383	16444	3061	18074	2498	19247	2016	21287	1233	25057	382	22685
12-#18	5.56	MA	14690	4383	24014	3225	26615	2646	28383	2189	31104	1355	38528	473	35390
5L-3S		MI	10002	4383	17397	3007	19307	2485	20761	2009	23257	1202	27434	525	23997
12-#18	5.56	MA	14254	4383	22679	3240	24890	2709	26236	2212	28217	1406	34795	292	32571
6L-2S		MI	10387	4383	18624	2989	20881	2437	22680	1967	25869	1172	30801	806	24070
14-#10	2.06	MA	12898	3547	20513	2628	22400	2201	23394	1872	24481	1346	28714	1066	15335
3L-6S		MI	8161	3547	12802	2572	13538	2166	13767	1831	13758	1320	15699	849	9636

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

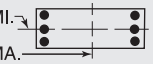


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#10	2.06	MA	12757	3547	20004	2650	21738	2222	22580	1881	23362	1354	27395	1019	15321
4L-5S		MI	8250	3547	13063	2566	13893	2160	14208	1825	14350	1306	16479	908	9805
14-#10	2.06	MA	12548	3547	19576	2661	21172	2233	21871	1902	22369	1373	26050	981	15270
5L-4S		MI	8374	3547	13330	2558	14249	2141	14653	1809	15008	1304	17334	958	9796
14-#10	2.06	MA	12398	3547	19124	2666	20603	2253	21170	1911	21426	1391	24847	927	14941
6L-3S		MI	8446	3547	13649	2538	14662	2135	15160	1803	15669	1290	18187	1010	9776
14-#10	2.06	MA	12233	3547	18641	2684	20017	2259	20499	1932	20449	1399	23437	880	14609
7L-2S		MI	8591	3547	14066	2530	15196	2117	15812	1787	16556	1276	19414	1099	9755
14-#11	2.53	MA	13282	3659	21432	2687	23520	2241	24734	1896	26289	1333	31205	1027	18571
3L-6S		MI	8324	3659	13153	2643	13951	2207	14245	1852	14394	1303	16487	749	11403
14-#11	2.53	MA	13117	3659	20812	2714	22715	2267	23744	1907	24999	1355	29591	968	18535
4L-5S		MI	8430	3659	13486	2622	14380	2199	14779	1846	15111	1287	17408	820	11658
14-#11	2.53	MA	12866	3659	20296	2727	22026	2279	22882	1932	23720	1363	27951	919	18383
5L-4S		MI	8577	3659	13810	2612	14811	2178	15317	1827	15906	1286	18416	882	11766
14-#11	2.53	MA	12687	3659	19749	2732	21341	2305	22028	1943	22571	1385	26482	851	17802
6L-3S		MI	8659	3659	14195	2589	15310	2171	15930	1822	16705	1271	19426	943	11749
14-#11	2.53	MA	12491	3659	19162	2754	20629	2311	21214	1967	21453	1407	24756	792	17424
7L-2S		MI	8829	3659	14697	2580	15953	2150	16714	1802	17771	1255	20871	1053	11725
14-#14	3.65	MA	14004	3927	22703	2888	25093	2394	26624	1987	28931	1345	35091	860	26188
4L-5S		MI	8884	3927	14475	2790	15603	2325	16248	1924	17092	1267	19999	646	15818
14-#14	3.65	MA	13654	3927	21963	2906	24106	2411	25388	2022	27099	1356	32736	788	25229
5L-4S		MI	9090	3927	14937	2777	16218	2296	17015	1897	18225	1266	21407	736	16425
14-#14	3.65	MA	13404	3927	21186	2914	23124	2448	24165	2037	25453	1387	30626	688	24511
6L-3S		MI	9202	3927	15486	2745	16929	2287	17889	1891	19362	1246	22824	821	16461
14-#14	3.65	MA	13128	3927	20346	2945	22115	2456	22998	2071	23851	1418	28145	602	23314
7L-2S		MI	9434	3927	16198	2732	17842	2257	19002	1864	20878	1225	24844	980	16447
14-#18	6.48	MA	15593	4604	26071	3363	29252	2746	31600	2249	35481	1337	44589	448	41691
5L-4S		MI	10334	4604	17671	3200	19647	2597	21166	2077	23898	1215	28424	329	26336
14-#18	6.48	MA	15174	4604	24736	3379	27528	2808	29453	2273	32594	1388	40855	267	38819
6L-3S		MI	10511	4604	18624	3146	20881	2585	22680	2070	25869	1184	30801	472	27790
16-#10	2.35	MA	13063	3617	20684	2694	22610	2254	23643	1900	24810	1348	29399	1011	17436
4L-6S		MI	8343	3617	13219	2616	14073	2198	14419	1850	14645	1314	16926	841	10898
16-#10	2.35	MA	12855	3617	20256	2705	22045	2264	22935	1921	23816	1367	28054	973	17378
5E		MI	8431	3617	13480	2610	14427	2191	14860	1845	15237	1301	17705	900	11103
16-#10	2.35	MA	12708	3617	19804	2710	21475	2285	22234	1931	22873	1386	26851	919	17018
6L-4S		MI	8554	3617	13747	2602	14783	2173	15305	1828	15895	1298	18560	950	11103
16-#10	2.35	MA	12544	3617	19322	2728	20889	2290	21563	1951	21897	1393	25441	873	16697
7L-3S		MI	8625	3617	14066	2582	15196	2166	15812	1823	16556	1284	19414	1002	11089
16-#10	2.35	MA	12364	3617	18900	2736	20305	2308	20841	1956	20977	1412	24219	829	16310
8L-2S		MI	8768	3617	14482	2574	15730	2148	16464	1806	17442	1271	20641	1091	11070
16-#11	2.89	MA	13483	3746	21637	2768	23773	2306	25034	1931	26755	1348	32022	958	21096
4L-6S		MI	8540	3746	13654	2697	14594	2245	15029	1875	15461	1296	17932	736	12922
16-#11	2.89	MA	13235	3746	21121	2781	23084	2318	24172	1955	25475	1356	30381	910	20884
5E		MI	8645	3746	13988	2676	15023	2238	15563	1870	16178	1281	18854	807	13162
16-#11	2.89	MA	13060	3746	20574	2786	22399	2344	23318	1966	24327	1378	28913	841	20325
6L-4S		MI	8790	3746	14312	2666	15454	2217	16101	1851	16973	1279	19861	869	13334
16-#11	2.89	MA	12865	3746	19987	2808	21687	2350	22505	1991	23209	1401	27187	783	19960
7L-3S		MI	8872	3746	14697	2643	15953	2210	16714	1845	17771	1264	20871	930	13324
16-#11	2.89	MA	12656	3746	19473	2818	20976	2371	21636	1997	22018	1409	25695	727	19228
8L-2S		MI	9039	3746	15198	2634	16596	2188	17498	1826	18838	1248	22316	1039	13305
16-#14	4.17	MA	14176	4051	23142	2984	25617	2467	27232	2056	29607	1346	36210	774	28826
5E		MI	9187	4051	15187	2867	16516	2381	17361	1958	18607	1257	22019	623	17962
16-#14	4.17	MA	13932	4051	22365	2992	24635	2503	26009	2070	27962	1377	34100	674	28135
6L-4S		MI	9390	4051	15649	2855	17131	2352	18129	1931	19741	1256	23427	714	18541
16-#14	4.17	MA	13659	4051	21525	3023	23626	2512	24842	2105	26360	1408	31619	588	26923
7L-3S		MI	9501	4051	16198	2823	17842	2342	19002	1925	20878	1236	24844	799	18679
16-#14	4.17	MA	13364	4051	20789	3036	22609	2542	23611	2115	24653	1419	29476	506	25736
8L-2S		MI	9730	4051	16911	2810	18755	2313	20116	1898	22393	1215	26864	958	18680
16-#18	7.41	MA	16084	4826	26793	3517	30165	2908	32670	2333	36971	1371	46916	243	45066
6L-4S		MI	10843	4826	18899	3338	21220	2697	23086	2137	26509	1197	31791	277	30004

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

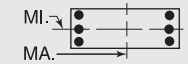
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.65	MA	13161	3688	20936	2749	22917	2296	23999	1940	25264	1361	30058	966	19486
5L-6S		MI	8524	3688	13636	2660	14607	2229	15071	1869	15532	1309	18152	833	12163
18-#10	2.65	MA	13017	3688	20485	2754	22347	2317	23298	1950	24321	1380	28855	912	19097
6L-5S		MI	8611	3688	13897	2654	14961	2223	15512	1864	16124	1295	18932	892	12391
18-#10	2.65	MA	12853	3688	20002	2772	21761	2322	22627	1970	23344	1388	27445	865	18788
7L-4S		MI	8733	3688	14164	2646	15317	2205	15956	1847	16782	1292	19787	943	12409
18-#10	2.65	MA	12678	3688	19580	2780	21177	2340	21905	1975	22424	1407	26223	821	18388
8L-3S		MI	8804	3688	14482	2626	15730	2198	16464	1842	17442	1279	20641	994	12398
18-#10	2.65	MA	12524	3688	19128	2799	20618	2347	21209	1993	21517	1425	25026	780	17908
9L-2S		MI	8945	3688	14899	2618	16265	2180	17116	1825	18329	1265	21868	1083	12382
18-#11	3.25	MA	13602	3832	21946	2835	24141	2357	25462	1979	27231	1349	32812	900	23391
5L-6S		MI	8756	3832	14155	2751	15236	2284	15813	1899	16528	1289	19377	723	14444
18-#11	3.25	MA	13430	3832	21399	2840	23456	2383	24609	1990	26083	1372	31344	832	22851
6L-5S		MI	8859	3832	14489	2730	15666	2277	16347	1893	17245	1274	20299	794	14671
18-#11	3.25	MA	13237	3832	20812	2862	22745	2388	23795	2014	24965	1394	29618	773	22478
7L-4S		MI	9003	3832	14813	2720	16097	2256	16885	1874	18040	1272	21306	856	14894
18-#11	3.25	MA	13031	3832	20298	2871	22034	2410	22926	2021	23774	1402	28125	718	21754
8L-3S		MI	9084	3832	15198	2697	16596	2248	17498	1869	18838	1257	22316	917	14896
18-#11	3.25	MA	12843	3832	19753	2896	21353	2418	22079	2042	22669	1424	26657	666	21101
9L-2S		MI	9250	3832	15700	2688	17239	2227	18282	1849	19905	1241	23761	1026	14881
18-#14	4.69	MA	14457	4175	23545	3070	26147	2559	27852	2104	30471	1367	37574	660	31764
6L-5S		MI	9488	4175	15899	2945	17429	2437	18475	1992	20123	1247	24039	601	20113
18-#14	4.69	MA	14186	4175	22704	3101	25138	2568	26686	2139	28868	1398	35092	574	30534
7L-4S		MI	9689	4175	16362	2933	18044	2408	19243	1965	21256	1246	25447	692	20661
18-#14	4.69	MA	13897	4175	21969	3114	24120	2598	25455	2149	27161	1409	32949	492	29321
8L-3S		MI	9799	4175	16911	2901	18755	2398	20116	1959	22393	1226	26864	777	20893
20-#10	2.94	MA	13324	3758	21165	2798	23219	2348	24362	1969	25768	1375	30859	904	21180
6E		MI	8705	3758	14053	2704	15141	2261	15723	1888	16419	1303	19379	825	13430
20-#10	2.94	MA	13161	3758	20682	2816	22633	2353	23691	1989	24792	1382	29450	857	20880
7L-5S		MI	8790	3758	14313	2698	15496	2254	16164	1883	17011	1289	20159	884	13647
20-#10	2.94	MA	12991	3758	20260	2824	22049	2371	22969	1994	23872	1401	28227	814	20469
8L-4S		MI	8911	3758	14581	2690	15852	2236	16608	1866	17668	1287	21014	935	13709
20-#10	2.94	MA	12838	3758	19808	2843	21490	2379	22273	2012	22964	1420	27030	772	19999
9L-3S		MI	8982	3758	14899	2670	16265	2229	17116	1861	18329	1273	21868	986	13704
20-#10	2.94	MA	12658	3758	19370	2849	20929	2398	21595	2030	21991	1426	25813	734	19438
10L-2S		MI	9122	3758	15316	2662	16799	2211	17767	1844	19216	1259	23095	1075	13692
20-#11	3.61	MA	13799	3918	22224	2894	24514	2421	25899	2013	27838	1365	33775	822	25381
6E		MI	8971	3918	14657	2805	15879	2323	16597	1922	17595	1282	20822	710	15970
20-#11	3.61	MA	13607	3918	21637	2916	23802	2427	25085	2038	26720	1387	32049	764	24990
7L-5S		MI	9072	3918	14991	2784	16309	2316	17131	1917	18312	1267	21744	781	16185
20-#11	3.61	MA	13403	3918	21123	2925	23092	2449	24217	2044	25529	1395	30556	708	24282
8L-4S		MI	9215	3918	15314	2774	16740	2294	17669	1898	19107	1265	22751	843	16453
20-#11	3.61	MA	13221	3918	20579	2950	22411	2457	23370	2065	24424	1417	29088	656	23622
9L-3S		MI	9296	3918	15700	2751	17239	2287	18282	1892	19905	1250	23761	904	16465
20-#14	5.21	MA	14709	4300	23883	3179	26649	2624	28530	2173	31377	1388	38566	561	34140
7L-5S		MI	9789	4300	16611	3023	18342	2493	19589	2026	21638	1237	26059	579	22270
20-#14	5.21	MA	14426	4300	23148	3192	25632	2654	27299	2183	29670	1400	36423	478	32906
8L-4S		MI	9988	4300	17074	3011	18957	2464	20357	1999	22771	1236	27468	669	22789
22-#10	3.23	MA	13467	3828	21362	2860	23505	2385	24754	2008	26239	1377	31454	849	22974
7L-6S		MI	8884	3828	14470	2748	15675	2292	16375	1907	17305	1297	20606	817	14699
22-#10	3.23	MA	13299	3828	20940	2868	22921	2403	24033	2013	25319	1395	30232	806	22551
8L-5S		MI	8969	3828	14730	2742	16030	2286	16815	1902	17898	1284	21386	876	14907
22-#10	3.23	MA	13150	3828	20488	2887	22362	2410	23337	2031	24412	1414	29034	764	22092
9L-4S		MI	9089	3828	14998	2734	16386	2268	17260	1885	18555	1281	22241	927	15007

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

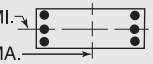
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	3.23	MA	12971	3828	20051	2893	21801	2430	22659	2049	23438	1420	27817	727	21522
10L-3S		MI	9159	3828	15316	2714	16799	2261	17767	1880	19216	1267	23095	978	15009
22-#11	3.97	MA	13974	4005	22462	2970	24860	2466	26376	2061	28476	1380	34480	754	27505
7L-6S		MI	9185	4005	15158	2859	16522	2362	17381	1946	18662	1275	22267	697	17497
22-#11	3.97	MA	13774	4005	21948	2979	24150	2487	25507	2068	27285	1388	32987	699	26813
8L-5S		MI	9285	4005	15492	2838	16952	2354	17915	1940	19379	1260	23189	768	17702
22-#11	3.97	MA	13597	4005	21404	3004	23469	2496	24660	2089	26180	1410	31519	647	26144
9L-4S		MI	9427	4005	15816	2828	17383	2333	18453	1921	20174	1258	24196	830	18010
22-#14	5.73	MA	14951	4424	24327	3269	27143	2710	29143	2217	32179	1390	39896	464	36491
8L-5S		MI	10088	4424	17323	3101	19255	2549	20703	2059	23154	1227	28079	556	24431
24-#10	3.53	MA	13606	3898	21621	2912	23793	2434	25097	2033	26767	1390	32236	798	24636
8L-6S		MI	9064	3898	14886	2792	16210	2324	17026	1927	18192	1292	21833	810	15971
24-#10	3.53	MA	13461	3898	21169	2931	23234	2442	24401	2050	25859	1409	31038	756	24186
9L-5S		MI	9147	3898	15147	2786	16564	2317	17467	1921	18785	1278	22613	869	16169
24-#10	3.53	MA	13283	3898	20731	2937	22673	2461	23723	2068	24886	1415	29822	719	23607
10L-4S		MI	9266	3898	15414	2777	16920	2299	17912	1905	19442	1276	23468	919	16304
24-#11	4.33	MA	14143	4091	22773	3033	25207	2526	26797	2091	29040	1381	35418	689	29346
8L-6S		MI	9398	4091	15660	2913	17165	2400	18166	1969	19729	1268	23712	684	19027
24-#11	4.33	MA	13971	4091	22229	3058	24527	2535	25951	2112	27935	1404	33950	637	28665
9L-5S		MI	9497	4091	15993	2891	17594	2393	18699	1964	20446	1253	24634	755	19222

RECTANGULAR TIED COLUMNS 24" x 38"

4-#18	1.75	MA	14207	3667	22825	2681	24770	2250	25770	1909	26836	1388	31351	1200	14388
2E		MI	8769	3667	14341	2555	15224	2142	15624	1815	15991	1313	17922	1078	8644
6-#11	1.03	MA	13453	3484	20960	2595	22511	2192	23072	1880	23199	1420	26343	1235	8705
2L-3S		MI	8207	3484	12811	2496	13376	2120	13417	1819	13009	1371	14243	1058	5400
6-#11	1.03	MA	13115	3484	20081	2609	21384	2205	21697	1905	21329	1442	23753	1138	8742
3L-2S		MI	8386	3484	13313	2487	14018	2099	14201	1799	14076	1355	15688	1168	5362
6-#14	1.48	MA	13952	3598	22132	2657	23968	2235	24830	1904	25579	1405	29629	1217	12328
2L-3S		MI	8400	3598	13260	2555	13913	2167	14056	1845	13871	1357	15338	974	7529
6-#14	1.48	MA	13479	3598	20875	2677	22357	2253	22864	1940	22905	1437	25926	1076	12367
3L-2S		MI	8649	3598	13973	2543	14826	2137	15170	1819	15387	1337	17358	1132	7470
6-#18	2.63	MA	15164	3889	25020	2819	27585	2349	29203	1969	31507	1370	37819	1175	21278
2L-3S		MI	8866	3889	14341	2712	15224	2290	15624	1918	15991	1326	17922	744	12630
6-#18	2.63	MA	14375	3889	22825	2852	24770	2378	25770	2029	26836	1424	31351	916	21222
3L-2S		MI	9279	3889	15568	2694	16797	2241	17543	1875	18602	1296	21289	1026	12557
8-#10	1.11	MA	13580	3506	21166	2623	22837	2213	23497	1896	23795	1426	27180	1240	9464
2L-4S		MI	8239	3506	12699	2550	13282	2152	13323	1843	12923	1394	14255	1046	5867
8-#10	1.11	MA	13301	3506	20442	2634	21908	2224	22364	1917	22254	1445	25047	1162	9489
3E		MI	8313	3506	13018	2530	13695	2145	13830	1838	13583	1380	15108	1097	5831
8-#10	1.11	MA	13144	3506	19901	2657	21205	2246	21499	1927	21064	1453	23651	1115	9508
4L-2S		MI	8463	3506	13435	2522	14230	2127	14482	1821	14470	1366	16335	1187	5803
8-#11	1.37	MA	13848	3570	21839	2649	23638	2231	24447	1904	25070	1413	28933	1225	11478
2L-4S		MI	8339	3570	12927	2573	13519	2166	13588	1847	13278	1379	14678	985	7062
8-#11	1.37	MA	13515	3570	20960	2663	22511	2243	23072	1929	23199	1436	26343	1129	11506
3E		MI	8423	3570	13313	2550	14018	2159	14201	1842	14076	1364	15688	1045	7017
8-#11	1.37	MA	13330	3570	20301	2691	21655	2270	22019	1940	21752	1445	24635	1070	11516
4L-2S		MI	8600	3570	13814	2541	14661	2138	14985	1823	15143	1348	17133	1155	6979
8-#14	1.97	MA	14508	3723	23389	2735	25579	2291	26796	1938	28254	1395	33332	1203	16276
2L-4S		MI	8589	3723	13424	2665	14115	2232	14296	1886	14250	1368	15942	866	9836
8-#14	1.97	MA	14047	3723	22132	2754	23968	2308	24830	1974	25579	1427	29629	1062	16294
3E		MI	8704	3723	13973	2633	14826	2223	15170	1879	15387	1348	17358	952	9795
8-#14	1.97	MA	13787	3723	21188	2793	22742	2346	23322	1989	23614	1459	27172	976	16216
4L-2S		MI	8949	3723	14685	2621	15739	2193	16283	1853	16902	1327	19378	1110	9745
8-#18	3.51	MA	16111	4110	27216	2958	30399	2448	32637	2029	36178	1352	44287	1151	28143
2L-4S		MI	9198	4110	14616	2904	15564	2402	16029	1985	16632	1339	18912	549	15654

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

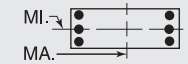
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.51	MA	15350	4110	25020	2990	27585	2477	29203	2090	31507	1406	37819	891	28025
3E		MI	9384	4110	15568	2851	16797	2389	17543	1978	18602	1308	21289	692	16462
8-#18	3.51	MA	14917	4110	23364	3058	25435	2541	26560	2115	28063	1460	33476	737	26664
4L-2S		MI	9787	4110	16795	2832	18370	2341	19462	1936	21213	1278	24656	973	16433
10-#10	1.39	MA	13907	3576	21890	2667	23765	2245	24629	1915	25336	1420	29314	1232	11743
2L-5S		MI	8295	3576	12849	2602	13461	2202	13530	1879	13152	1390	14626	988	7226
10-#10	1.39	MA	13632	3576	21166	2678	22837	2256	23497	1936	23795	1440	27180	1154	11762
3L-4S		MI	8421	3576	13116	2594	13817	2184	13974	1862	13809	1388	15481	1038	7196
10-#10	1.39	MA	13476	3576	20625	2701	22133	2278	22631	1946	22605	1448	25785	1107	11770
4L-3S		MI	8494	3576	13435	2574	14230	2177	14482	1857	14470	1374	16335	1089	7165
10-#10	1.39	MA	13247	3576	20167	2712	21533	2288	21879	1967	21550	1467	24359	1071	11738
5L-2S		MI	8642	3576	13852	2566	14764	2159	15134	1840	15357	1360	17562	1179	7137
10-#11	1.71	MA	14239	3656	22718	2703	24765	2269	25821	1927	26940	1406	31522	1216	14240
2L-5S		MI	8405	3656	13105	2636	13731	2226	13834	1890	13550	1374	15116	909	8679
10-#11	1.71	MA	13913	3656	21839	2717	23638	2282	24447	1952	25070	1429	28933	1119	14260
3L-4S		MI	8555	3656	13429	2627	14162	2205	14372	1871	14345	1372	16123	972	8653
10-#11	1.71	MA	13729	3656	21180	2745	22782	2308	23394	1964	23623	1438	27225	1060	14252
4L-3S		MI	8638	3656	13814	2604	14661	2198	14985	1866	15143	1357	17133	1032	8616
10-#11	1.71	MA	13454	3656	20629	2758	22050	2321	22477	1989	22338	1461	25484	1014	14173
5L-2S		MI	8813	3656	14315	2595	15304	2177	15769	1846	16210	1341	18578	1142	8581
10-#14	2.47	MA	15061	3847	24645	2813	27191	2347	28761	1972	30928	1385	37035	1190	20214
2L-5S		MI	8682	3847	13673	2756	14413	2317	14643	1946	14632	1359	16554	753	11678
10-#14	2.47	MA	14609	3847	23389	2832	25579	2364	26796	2008	28254	1417	33332	1048	20209
3L-4S		MI	8893	3847	14136	2743	15028	2288	15410	1920	15765	1358	17962	844	12062
10-#14	2.47	MA	14354	3847	22444	2871	24353	2402	25287	2023	26289	1449	30875	963	20107
4L-3S		MI	9007	3847	14685	2711	15739	2278	16283	1913	16902	1338	19378	929	12043
10-#14	2.47	MA	13965	3847	21659	2891	23304	2419	23974	2059	24340	1461	28377	893	19327
5L-2S		MI	9248	3847	15397	2698	16652	2249	17397	1887	18417	1317	21398	1088	12003
10-#18	4.39	MA	16314	4331	27216	3128	30399	2576	32637	2150	36178	1388	44287	867	34826
3L-4S		MI	9716	4331	15843	3043	17137	2501	17949	2045	19243	1321	22279	496	19248
10-#18	4.39	MA	15890	4331	25560	3196	28249	2640	29993	2175	32734	1442	39944	713	33302
4L-3S		MI	9898	4331	16795	2989	18370	2488	19462	2038	21213	1291	24656	639	20272
10-#18	4.39	MA	15230	4331	24179	3228	26405	2669	27687	2236	29316	1460	35544	580	31135
5L-2S		MI	10292	4331	18023	2970	19943	2440	21381	1996	23824	1260	28023	921	20288
12-#10	1.67	MA	14232	3646	22615	2711	24693	2276	25762	1935	26876	1415	31447	1224	14016
2L-6S		MI	8386	3646	13005	2652	13640	2240	13741	1904	13446	1399	15073	921	8456
12-#10	1.67	MA	13961	3646	21890	2722	23765	2287	24629	1956	25336	1434	29314	1147	14030
3L-5S		MI	8477	3646	13266	2646	13995	2233	14181	1898	14039	1385	15853	980	8537
12-#10	1.67	MA	13807	3646	21349	2745	23062	2309	23764	1965	24146	1442	27918	1099	14027
4E		MI	8602	3646	13533	2637	14351	2215	14626	1881	14696	1382	16708	1030	8515
12-#10	1.67	MA	13579	3646	20891	2756	22461	2320	23012	1987	23091	1461	26492	1063	13984
5L-3S		MI	8674	3646	13852	2618	14764	2208	15134	1876	15357	1369	17562	1082	8489
12-#10	1.67	MA	13416	3646	20411	2760	21851	2340	22268	1996	22089	1481	25217	1011	13728
6L-2S		MI	8821	3646	14268	2610	15298	2190	15785	1859	16244	1355	18789	1171	8464
12-#11	2.05	MA	14629	3743	23598	2757	25892	2308	27196	1951	28811	1399	34112	1206	16997
2L-6S		MI	8514	3743	13273	2712	13944	2272	14084	1919	13900	1382	15640	826	9979
12-#11	2.05	MA	14308	3743	22718	2771	24765	2321	25821	1976	26940	1422	31522	1109	17009
3L-5S		MI	8621	3743	13606	2690	14374	2265	14618	1914	14617	1367	16561	896	10246
12-#11	2.05	MA	14126	3743	22060	2799	23909	2347	24768	1987	25493	1431	29814	1051	16984
4E		MI	8770	3743	13930	2681	14805	2244	15156	1895	15412	1365	17568	959	10233
12-#11	2.05	MA	13854	3743	21508	2812	23177	2360	23852	2013	24208	1454	28074	1004	16893
5L-3S		MI	8853	3743	14315	2658	15304	2237	15769	1889	16210	1350	18578	1019	10205
12-#11	2.05	MA	13658	3743	20924	2817	22442	2385	22945	2024	22988	1477	26516	937	16312
6L-2S		MI	9025	3743	14817	2649	15947	2215	16553	1870	17277	1335	20023	1129	10174

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	2.96	MA	15168	3972	24645	2910	27191	2420	28761	2042	30928	1407	37035	1034	24119
3L-5S		MI	8988	3972	14386	2833	15326	2373	15756	1980	16147	1349	18574	731	13802
12-#14	2.96	MA	14915	3972	23701	2949	25965	2457	27253	2057	28963	1439	34578	949	23998
4E		MI	9196	3972	14848	2821	15941	2344	16524	1954	17280	1348	19982	822	14277
12-#14	2.96	MA	14533	3972	22916	2968	24915	2475	25939	2093	27015	1451	32080	879	23147
5L-3S		MI	9309	3972	15397	2789	16652	2334	17397	1947	18417	1328	21398	907	14280
12-#14	2.96	MA	14258	3972	22081	2976	23872	2512	24640	2108	25266	1483	29843	781	22312
6L-2S		MI	9546	3972	16109	2776	17565	2305	18511	1921	19933	1307	23418	1065	14251
12-#18	5.26	MA	16852	4553	27755	3334	31063	2740	33426	2236	37405	1424	46412	688	39961
4E		MI	10230	4553	17070	3181	18710	2600	19868	2105	21854	1304	25646	444	22871
12-#18	5.26	MA	16209	4553	26374	3366	29220	2768	31120	2296	33987	1442	42012	556	37861
5L-3S		MI	10410	4553	18023	3127	19943	2588	21381	2099	23824	1273	28023	587	24072
12-#18	5.26	MA	15742	4553	24937	3381	27386	2832	28837	2321	30916	1496	38060	376	34991
6L-2S		MI	10796	4553	19250	3109	21516	2539	23301	2056	26435	1242	31390	868	24132
14-#10	1.95	MA	14288	3717	22615	2766	24693	2319	25762	1975	26876	1428	31447	1139	16295
3L-6S		MI	8569	3717	13422	2696	14175	2272	14392	1923	14333	1393	16300	913	9713
14-#10	1.95	MA	14135	3717	22073	2789	23990	2341	24897	1985	25687	1436	30052	1092	16281
4L-5S		MI	8658	3717	13682	2690	14529	2265	14833	1917	14925	1379	17080	972	9843
14-#10	1.95	MA	13910	3717	21615	2799	23389	2351	24144	2006	24632	1456	28626	1055	16230
5L-4S		MI	8782	3717	13950	2681	14885	2247	15278	1901	15583	1377	17935	1022	9828
14-#10	1.95	MA	13750	3717	21135	2804	22779	2372	23400	2016	23630	1475	27350	1003	15936
6L-3S		MI	8854	3717	14268	2662	15298	2240	15785	1895	16244	1363	18789	1074	9807
14-#10	1.95	MA	13571	3717	20622	2823	22156	2377	22680	2036	22594	1483	25859	956	15566
7L-2S		MI	8999	3717	14685	2654	15832	2222	16437	1879	17131	1349	20016	1163	9784
14-#11	2.39	MA	14701	3829	23598	2825	25892	2359	27196	1999	28811	1415	34112	1100	19750
3L-6S		MI	8731	3829	13774	2766	14587	2311	14868	1943	14967	1375	17085	813	11493
14-#11	2.39	MA	14521	3829	22939	2853	25036	2386	26143	2011	27364	1424	32404	1041	19714
4L-5S		MI	8837	3829	14108	2744	15017	2304	15402	1937	15684	1360	18006	883	11756
14-#11	2.39	MA	14252	3829	22387	2866	24304	2398	25227	2036	26079	1447	30664	995	19613
5L-4S		MI	8984	3829	14432	2735	15448	2283	15940	1918	16479	1358	19013	946	11808
14-#11	2.39	MA	14060	3829	21803	2871	23569	2424	24320	2047	24859	1470	29106	928	18997
6L-3S		MI	9067	3829	14817	2712	15947	2275	16553	1913	17277	1343	20023	1006	11787
14-#11	2.39	MA	13848	3829	21179	2893	22812	2430	23455	2073	23596	1479	27280	870	18579
7L-2S		MI	9237	3829	15318	2702	16590	2254	17337	1893	18344	1328	21468	1116	11761
14-#14	3.45	MA	15473	4096	24958	3027	27576	2513	29219	2091	31637	1429	38281	935	27889
4L-5S		MI	9292	4096	15098	2911	16239	2429	16870	2014	17662	1339	20594	709	15937
14-#14	3.45	MA	15097	4096	24172	3046	26526	2531	27905	2127	29689	1441	35782	865	26976
5L-4S		MI	9498	4096	15560	2899	16854	2400	17638	1988	18796	1338	22002	799	16486
14-#14	3.45	MA	14829	4096	23338	3054	25483	2568	26605	2142	27940	1473	33546	767	26174
6L-3S		MI	9610	4096	16109	2866	17565	2390	18511	1981	19933	1318	23418	885	16512
14-#14	3.45	MA	14530	4096	22444	3085	24398	2576	25366	2178	26237	1505	30918	683	24987
7L-2S		MI	9843	4096	16821	2854	18478	2361	19625	1955	21448	1297	25438	1043	16491
14-#18	6.14	MA	17177	4774	28569	3505	32034	2868	34553	2357	38658	1425	48480	531	44587
5L-4S		MI	10742	4774	18297	3319	20283	2700	21787	2166	24465	1286	29013	391	26517
14-#18	6.14	MA	16728	4774	27132	3520	30201	2932	32270	2382	35588	1478	44528	352	41660
6L-3S		MI	10919	4774	19250	3265	21516	2687	23301	2159	26435	1255	31390	534	27868
16-#10	2.23	MA	14462	3787	22797	2833	24918	2372	26029	2004	27228	1431	32185	1084	18533
4L-6S		MI	8750	3787	13839	2739	14709	2303	15044	1942	15220	1387	17527	905	10974
16-#10	2.23	MA	14240	3787	22339	2843	24318	2383	25277	2025	26173	1450	30759	1048	18475
5E		MI	8838	3787	14099	2734	15063	2296	15485	1936	15812	1374	18307	964	11145
16-#10	2.23	MA	14082	3787	21859	2848	23707	2403	24533	2035	25171	1469	29484	995	18147
6L-4S		MI	8961	3787	14367	2725	15419	2278	15930	1920	16470	1371	19162	1015	11138
16-#10	2.23	MA	13904	3787	21346	2867	23084	2409	23813	2055	24135	1478	27993	949	17791
7L-3S		MI	9033	3787	14685	2706	15832	2271	16437	1914	17131	1357	20016	1066	11121
16-#10	2.23	MA	13712	3787	20898	2875	22464	2427	23046	2060	23158	1497	26697	907	17439
8L-2S		MI	9177	3787	15102	2697	16367	2253	17089	1898	18017	1344	21242	1155	11101
16-#11	2.74	MA	14914	3915	23818	2906	26163	2425	27518	2034	29234	1417	34994	1032	22444
4L-6S		MI	8947	3915	14275	2820	15230	2350	15653	1966	16034	1368	18530	800	13012

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

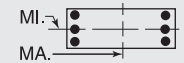
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#11	2.74	MA	14648	3915	23266	2920	25430	2437	26601	2060	27949	1440	33254	985	22316
5E		MI	9052	3915	14609	2798	15659	2342	16186	1961	16751	1353	19451	870	13259
16-#11	2.74	MA	14460	3915	22682	2925	24696	2463	25695	2071	26729	1463	31696	918	21686
6L-4S		MI	9198	3915	14933	2789	16091	2321	16725	1942	17546	1351	20458	933	13378
16-#11	2.74	MA	14249	3915	22058	2947	23939	2469	24830	2096	25467	1472	29870	861	21282
7L-3S		MI	9280	3915	15318	2766	16590	2314	17337	1936	18344	1336	21468	993	13364
16-#11	2.74	MA	14019	3915	21512	2957	23183	2491	23897	2102	24276	1495	28288	807	20567
8L-2S		MI	9448	3915	15820	2756	17232	2293	18122	1917	19411	1321	22913	1103	13342
16-#14	3.95	MA	15657	4221	25429	3124	28137	2587	29871	2161	32363	1431	39485	852	30814
5E		MI	9594	4221	15810	2989	17152	2485	17984	2048	19178	1329	22614	687	18080
16-#14	3.95	MA	15395	4221	24595	3132	27094	2624	28571	2176	30614	1463	37249	753	30040
6L-4S		MI	9798	4221	16272	2977	17767	2456	18752	2022	20311	1328	24022	777	18678
16-#14	3.95	MA	15099	4221	23700	3163	26009	2632	27331	2212	28911	1495	34621	669	28832
7L-3S		MI	9909	4221	16821	2944	18478	2446	19625	2015	21448	1308	25438	862	18732
16-#14	3.95	MA	14783	4221	22918	3177	24927	2663	26007	2221	27097	1507	32348	589	27655
8L-2S		MI	10140	4221	17534	2932	19391	2417	20739	1989	22964	1287	27458	1021	18725
16-#18	7.02	MA	17704	4995	29327	3658	33015	3031	35704	2442	40259	1461	50996	327	48329
6L-4S		MI	11251	4995	19524	3458	21856	2799	23706	2226	27076	1268	32380	339	30181
18-#10	2.51	MA	14567	3857	23064	2887	25246	2414	26409	2044	27714	1444	32893	1040	20720
5L-6S		MI	8931	3857	14255	2783	15243	2335	15696	1961	16107	1382	18754	897	12239
18-#10	2.51	MA	14412	3857	22583	2892	24636	2435	25665	2054	26712	1464	31617	987	20363
6L-5S		MI	9018	3857	14516	2777	15598	2328	16137	1956	16699	1368	19534	956	12443
18-#10	2.51	MA	14235	3857	22070	2911	24013	2441	24945	2074	25676	1472	30126	941	20017
7L-4S		MI	9140	3857	14783	2769	15954	2310	16581	1939	17357	1365	20389	1007	12444
18-#10	2.51	MA	14047	3857	21622	2919	23392	2459	24178	2079	24699	1491	28831	899	19654
8L-3S		MI	9212	3857	15102	2750	16367	2303	17089	1934	18017	1352	21242	1058	12431
18-#10	2.51	MA	13882	3857	21138	2938	22798	2467	23439	2097	23735	1511	27565	857	19122
9L-2S		MI	9354	3857	15519	2741	16901	2285	17741	1917	18904	1338	22469	1147	12415
18-#11	3.08	MA	15042	4002	24145	2974	26557	2476	27976	2083	29820	1433	35843	975	24989
5L-6S		MI	9163	4002	14777	2874	15873	2389	16437	1990	17101	1361	19975	787	14534
18-#11	3.08	MA	14857	4002	23561	2979	25823	2501	27070	2095	28599	1456	34286	909	24379
6L-5S		MI	9266	4002	15111	2852	16302	2381	16971	1984	17818	1346	20896	857	14767
18-#11	3.08	MA	14647	4002	22937	3001	25065	2508	26205	2120	27337	1465	32460	851	23989
7L-4S		MI	9411	4002	15435	2843	16733	2360	17509	1965	18613	1345	21903	920	14942
18-#11	3.08	MA	14423	4002	22391	3011	24310	2529	25272	2126	26146	1488	30877	797	23262
8L-3S		MI	9492	4002	15820	2820	17232	2353	18122	1960	19411	1329	22913	980	14937
18-#11	3.08	MA	14224	4002	21808	3035	23587	2539	24372	2147	24973	1511	29325	746	22627
9L-2S		MI	9659	4002	16321	2810	17875	2332	18906	1940	20478	1314	24358	1090	14920
18-#14	4.44	MA	15958	4345	25851	3209	28705	2680	30536	2210	33289	1453	40952	739	33911
6L-5S		MI	9896	4345	16522	3067	18065	2541	19098	2082	20693	1319	24634	664	20230
18-#14	4.44	MA	15663	4345	24957	3241	27621	2688	29297	2246	31586	1485	38324	655	32676
7L-4S		MI	10098	4345	16985	3054	18680	2511	19865	2056	21827	1318	26042	755	20796
18-#14	4.44	MA	15354	4345	24175	3254	26538	2719	27973	2255	29772	1497	36051	575	31477
8L-3S		MI	10208	4345	17534	3022	19391	2502	20739	2049	22964	1298	27458	840	20949
20-#10	2.79	MA	14741	3927	23308	2936	25564	2467	26798	2073	28253	1458	33751	980	22581
6E		MI	9112	3927	14672	2827	15778	2366	16348	1980	16993	1376	19981	889	13506
20-#10	2.79	MA	14565	3927	22794	2955	24941	2472	26078	2093	27217	1466	32260	933	22246
7L-5S		MI	9198	3927	14933	2821	16132	2359	16789	1975	17586	1362	20761	948	13730
20-#10	2.79	MA	14380	3927	22346	2963	24320	2490	25311	2099	26239	1486	30965	891	21871
8L-4S		MI	9319	3927	15200	2813	16488	2341	17233	1958	18243	1360	21616	999	13749
20-#10	2.79	MA	14218	3927	21862	2982	23727	2498	24572	2116	25276	1505	29699	850	21350
9L-3S		MI	9390	3927	15519	2794	16901	2335	17741	1953	18904	1346	22469	1050	13739
20-#10	2.79	MA	14024	3927	21397	2988	23131	2518	23852	2135	24231	1511	28410	814	20802
10L-2S		MI	9530	3927	15935	2785	17435	2316	18392	1936	19791	1332	23696	1139	13725

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

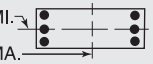


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
20-#11	3.42	MA	15252	4088	24440	3033	26950	2540	28444	2118	30470	1449	36876	899	27076
6E		MI	9378	4088	15278	2927	16516	2427	17221	2013	18168	1355	21420	774	16059
20-#11	3.42	MA	15043	4088	23816	3055	26192	2546	27579	2143	29207	1458	35049	841	26697
7L-5S		MI	9480	4088	15612	2906	16945	2420	17755	2008	18885	1339	22341	844	16280
20-#11	3.42	MA	14826	4088	23270	3065	25437	2568	26646	2149	28017	1481	33467	788	25958
8L-4S		MI	9623	4088	15936	2897	17376	2399	18293	1989	19680	1338	23348	907	16503
20-#11	3.42	MA	14630	4088	22687	3089	24714	2577	25746	2171	26843	1504	31915	736	25313
9L-3S		MI	9704	4088	16321	2874	17875	2391	18906	1983	20478	1322	24358	967	16508
20-#11	3.42	MA	14399	4088	22121	3096	23988	2601	24870	2193	25589	1511	30340	689	24432
10L-2S		MI	9869	4088	16822	2864	18518	2370	19690	1964	21545	1307	25803	1077	16495
20-#14	4.93	MA	16224	4470	26214	3319	29232	2744	31262	2280	34260	1475	42027	641	36520
7L-5S		MI	10196	4470	17234	3145	18978	2597	20212	2116	22209	1309	26654	642	22385
20-#14	4.93	MA	15920	4470	25432	3332	28150	2775	29938	2289	32446	1487	39754	561	35299
8L-4S		MI	10396	4470	17697	3132	19593	2567	20979	2089	23342	1308	28062	732	22922
22-#10	3.06	MA	14893	3998	23518	2998	25870	2504	27210	2112	28757	1461	34393	925	24476
7L-6S		MI	9292	3998	15089	2871	16312	2398	16999	1999	17880	1370	21207	882	14775
22-#10	3.06	MA	14713	3998	23070	3007	25249	2522	26444	2118	27780	1480	33098	883	24091
8L-5S		MI	9377	3998	15350	2865	16666	2391	17440	1994	18473	1357	21987	941	14989
22-#10	3.06	MA	14552	3998	22586	3026	24655	2530	25704	2136	26817	1499	31833	842	23580
9L-4S		MI	9497	3998	15617	2857	17022	2373	17885	1977	19130	1354	22842	991	15048
22-#10	3.06	MA	14359	3998	22121	3032	24059	2550	24985	2154	25772	1505	30544	806	23022
10L-3S		MI	9568	3998	15935	2838	17435	2366	18392	1972	19791	1341	23696	1042	15045
22-#10	3.06	MA	14179	3998	21672	3039	23468	2557	24242	2162	24778	1522	29293	761	22378
11L-2S		MI	9707	3998	16352	2829	17970	2348	19044	1955	20678	1327	24923	1131	15034
22-#11	3.76	MA	15437	4174	24695	3109	27319	2585	28954	2167	31078	1451	37639	832	29408
7L-6S		MI	9592	4174	15780	2981	17158	2466	18005	2037	19235	1348	22865	761	17586
22-#11	3.76	MA	15223	4174	24149	3119	26564	2607	28021	2173	29887	1474	36057	778	28657
8L-5S		MI	9693	4174	16113	2960	17588	2459	18539	2031	19951	1332	23786	831	17796
22-#11	3.76	MA	15032	4174	23566	3143	25840	2616	27121	2194	28714	1497	34505	726	27999
9L-4S		MI	9835	4174	16437	2951	18019	2438	19077	2012	20746	1331	24793	894	18062
22-#11	3.76	MA	14802	4174	23000	3150	25115	2640	26245	2216	27460	1505	32930	680	27124
10L-3S		MI	9916	4174	16822	2928	18518	2430	19690	2007	21545	1315	25803	954	18076
22-#14	5.43	MA	16483	4594	26689	3410	29761	2831	31904	2323	35120	1478	43457	548	39121
8L-5S		MI	10496	4594	17946	3222	19891	2653	21325	2150	23724	1299	28674	620	24545
24-#10	3.34	MA	15041	4068	23794	3051	26177	2553	27576	2137	29321	1474	35232	876	26312
8L-6S		MI	9471	4068	15506	2915	16846	2429	17651	2018	18767	1365	22434	874	16046
24-#10	3.34	MA	14885	4068	23311	3070	25583	2561	26837	2155	28358	1494	33966	834	25811
9L-5S		MI	9555	4068	15766	2909	17201	2423	18092	2013	19359	1351	23214	933	16251
24-#10	3.34	MA	14693	4068	22845	3076	24988	2581	26117	2173	27313	1499	32677	798	25241
10L-4S		MI	9675	4068	16034	2901	17557	2404	18537	1996	20017	1349	24069	983	16346
24-#10	3.34	MA	14515	4068	22396	3083	24397	2589	25375	2181	26319	1516	31427	754	24601
11L-3S		MI	9745	4068	16352	2881	17970	2398	19044	1991	20678	1335	24923	1034	16350
24-#11	4.11	MA	15618	4261	25028	3173	27691	2646	29396	2196	31758	1467	38647	768	31358
8L-6S		MI	9806	4261	16281	3035	17801	2505	18789	2060	20301	1341	24310	748	19116
24-#11	4.11	MA	15433	4261	24445	3197	26967	2655	28496	2218	30584	1490	37095	717	30685
9L-5S		MI	9905	4261	16615	3014	18231	2497	19323	2055	21018	1325	25231	818	19316
24-#11	4.11	MA	15204	4261	23879	3204	26242	2679	27619	2240	29330	1498	35520	670	29816
10L-4S		MI	10047	4261	16939	3005	18662	2476	19861	2036	21813	1324	26238	880	19619

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

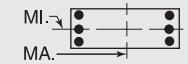
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.67	MA	15667	3837	25049	2819	27189	2367	28264	2011	29353	1469	34220	1271	15252
2E		MI	9177	3837	14967	2675	15860	2244	16245	1904	16558	1384	18511	1140	8684
6-#14	1.41	MA	15392	3768	24307	2795	26330	2353	27256	2007	28008	1486	32377	1289	13057
2L-3S		MI	8807	3768	13883	2677	14549	2270	14678	1936	14442	1429	15933	1037	7561
6-#14	1.41	MA	14885	3768	22972	2815	24619	2371	25169	2043	25168	1519	28444	1149	13096
3L-2S		MI	9056	3768	14596	2664	15462	2241	15792	1909	15957	1409	17953	1195	7501
6-#18	2.50	MA	16690	4058	27383	2957	30181	2466	31913	2071	34319	1452	41096	1247	22574
2L-3S		MI	9273	4058	14967	2832	15860	2392	16245	2007	16558	1397	18511	806	12684
6-#18	2.50	MA	15844	4058	25049	2991	27189	2496	28264	2134	29353	1507	34220	991	22518
3L-2S		MI	9687	4058	16194	2814	17433	2344	18164	1964	19169	1367	21878	1088	12603
8-#10	1.06	MA	14992	3676	23276	2761	25122	2331	25834	1999	26103	1507	29764	1311	10013
2L-4S		MI	8647	3676	13319	2673	13919	2257	13948	1935	13497	1467	14856	1110	5890
8-#10	1.06	MA	14694	3676	22508	2773	24137	2342	24632	2020	24469	1527	27501	1235	10038
3E		MI	8721	3676	13637	2654	14332	2251	14455	1930	14158	1453	15710	1161	5854
8-#10	1.06	MA	14524	3676	21935	2796	23393	2364	23716	2030	23209	1536	26028	1188	10057
4L-2S		MI	8870	3676	14054	2645	14866	2233	15107	1913	15045	1439	16937	1251	5826
8-#11	1.30	MA	15279	3740	23994	2787	25976	2348	26846	2006	27462	1494	31631	1297	12152
2L-4S		MI	8746	3740	13549	2695	14156	2271	14211	1938	13850	1451	15276	1048	7092
8-#11	1.30	MA	14923	3740	23061	2801	24780	2361	25387	2032	25477	1518	28882	1202	12180
3E		MI	8831	3740	13934	2672	14655	2263	14824	1933	14649	1436	16285	1109	7045
8-#11	1.30	MA	14723	3740	22363	2829	23873	2388	24271	2044	23943	1527	27079	1143	12190
4L-2S		MI	9007	3740	14435	2663	15297	2242	15609	1914	15715	1421	17730	1219	7007
8-#14	1.88	MA	15986	3893	25641	2873	28041	2409	29344	2041	30848	1476	36309	1275	17248
2L-4S		MI	8996	3893	14047	2787	14751	2336	14919	1976	14820	1440	16536	929	9880
8-#14	1.88	MA	15491	3893	24307	2893	26330	2427	27256	2077	28008	1509	32377	1135	17266
3E		MI	9112	3893	14596	2755	15462	2326	15792	1970	15957	1419	17953	1015	9832
8-#14	1.88	MA	15210	3893	23306	2933	25030	2465	25658	2093	25811	1522	29783	1051	17188
4L-2S		MI	9357	3893	15308	2742	16375	2297	16906	1943	17472	1399	19973	1173	9780
8-#18	3.33	MA	17703	4280	29716	3096	33172	2566	35563	2132	39285	1434	47971	1222	29871
2L-4S		MI	9606	4280	15241	3024	16199	2504	16650	2074	17198	1410	19501	611	15847
8-#18	3.33	MA	16886	4280	27383	3129	30181	2596	31913	2194	34319	1489	41096	967	29753
3E		MI	9791	4280	16194	2970	17433	2491	18164	2067	19169	1379	21878	754	16526
8-#18	3.33	MA	16416	4280	25626	3198	27900	2661	29108	2221	30665	1545	36510	814	28553
4L-2S		MI	10195	4280	17421	2952	19006	2443	20083	2025	21780	1349	25245	1036	16484
10-#10	1.32	MA	15340	3746	24044	2805	26107	2363	27035	2018	27738	1502	32027	1303	12428
2L-5S		MI	8702	3746	13468	2725	14097	2307	14155	1971	13727	1464	15228	1052	7256
10-#10	1.32	MA	15046	3746	23276	2816	25122	2374	25834	2039	26103	1522	29764	1227	12448
3L-4S		MI	8828	3746	13736	2717	14453	2289	14599	1954	14384	1461	16083	1102	7223
10-#10	1.32	MA	14878	3746	22703	2840	24377	2396	24917	2050	24844	1530	28291	1180	12456
4L-3S		MI	8901	3746	14054	2698	14866	2282	15107	1949	15045	1447	16937	1154	7190
10-#10	1.32	MA	14634	3746	22215	2850	23742	2407	24121	2071	23727	1550	26784	1145	12424
5L-2S		MI	9050	3746	14471	2689	15400	2264	15758	1932	15932	1434	18163	1243	7162
10-#11	1.63	MA	15697	3826	24927	2841	27172	2387	28305	2030	29447	1487	34379	1287	15083
2L-5S		MI	8812	3826	13726	2759	14367	2331	14457	1981	14122	1446	15713	973	8719
10-#11	1.63	MA	15348	3826	23994	2855	25976	2400	26846	2055	27462	1511	31631	1192	15103
3L-4S		MI	8962	3826	14050	2749	14798	2309	14996	1962	14917	1445	16721	1035	8687
10-#11	1.63	MA	15149	3826	23296	2883	25069	2427	25730	2067	25929	1521	29828	1134	15094
4L-3S		MI	9046	3826	14435	2726	15297	2302	15609	1957	15715	1429	17730	1096	8648
10-#11	1.63	MA	14855	3826	22707	2896	24294	2440	24760	2093	24568	1544	27988	1089	15015
5L-2S		MI	9220	3826	14937	2717	15940	2281	16393	1937	16782	1414	19176	1206	8612
10-#14	2.34	MA	16576	4017	26976	2951	29752	2464	31431	2075	33688	1466	40241	1261	21429
2L-5S		MI	9090	4017	14296	2877	15049	2421	15265	2037	15202	1431	17148	817	11799

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

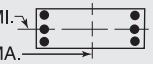


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.34	MA	16092	4017	25641	2971	28041	2483	29344	2111	30848	1499	36309	1122	21424
3L-4S		MI	9300	4017	14759	2865	15664	2392	16033	2010	16336	1430	18556	907	12113
10-#14	2.34	MA	15815	4017	24641	3010	26741	2521	27745	2127	28651	1512	33715	1037	21322
4L-3S		MI	9415	4017	15308	2832	16375	2382	16906	2004	17472	1410	19973	992	12084
10-#14	2.34	MA	15400	4017	23803	3029	25630	2539	26354	2164	26700	1545	31073	970	20604
5L-2S		MI	9656	4017	16020	2820	17288	2353	18020	1977	18988	1389	21993	1151	12042
10-#18	4.17	MA	17916	4501	29716	3267	33172	2695	35563	2254	39285	1472	47971	942	36986
3L-4S		MI	10123	4501	16469	3163	17773	2603	18569	2134	19809	1392	22868	559	19435
10-#18	4.17	MA	17456	4501	27960	3336	30892	2760	32758	2281	35630	1527	43385	790	35623
4L-3S		MI	10305	4501	17421	3109	19006	2591	20083	2127	21780	1362	25245	702	20341
10-#18	4.17	MA	16751	4501	26497	3369	28938	2791	30314	2343	32006	1547	38729	662	33195
5L-2S		MI	10701	4501	18648	3090	20579	2542	22002	2085	24391	1331	28612	983	20343
12-#10	1.59	MA	15687	3816	24812	2849	27091	2394	28236	2037	29372	1496	34290	1296	14839
2L-6S		MI	8794	3816	13624	2775	14277	2345	14366	1995	14021	1472	15675	985	8549
12-#10	1.59	MA	15397	3816	24044	2860	26107	2405	27035	2059	27738	1516	32027	1219	14853
3L-5S		MI	8884	3816	13885	2769	14631	2339	14806	1990	14613	1458	16455	1044	8570
12-#10	1.59	MA	15231	3816	23471	2883	25362	2427	26118	2069	26478	1525	30554	1172	14850
4E		MI	9009	3816	14152	2761	14987	2321	15251	1973	15271	1455	17310	1094	8545
12-#10	1.59	MA	14988	3816	22983	2894	24726	2438	25322	2090	25361	1544	29047	1137	14807
5L-3S		MI	9082	3816	14471	2741	15400	2314	15758	1968	15932	1442	18163	1146	8517
12-#10	1.59	MA	14814	3816	22474	2899	24075	2459	24535	2100	24301	1564	27699	1086	14593
6L-2S		MI	9229	3816	14888	2733	15935	2296	16410	1951	16819	1428	19390	1235	8491
12-#11	1.95	MA	16113	3912	25860	2895	28368	2426	29764	2053	31432	1481	37128	1278	18008
2L-6S		MI	8921	3912	13894	2834	14581	2377	14708	2010	14472	1455	16237	890	10067
12-#11	1.95	MA	15769	3912	24927	2909	27172	2439	28305	2079	29447	1504	34379	1182	18020
3L-5S		MI	9029	3912	14228	2813	15010	2369	15242	2005	15189	1439	17158	960	10291
12-#11	1.95	MA	15573	3912	24229	2937	26265	2466	27189	2091	27914	1514	32577	1124	17995
4E		MI	9177	3912	14552	2803	15441	2348	15780	1985	15984	1438	18166	1022	10271
12-#11	1.95	MA	15282	3912	23640	2950	25490	2479	26219	2117	26553	1537	30737	1079	17903
5L-3S		MI	9260	3912	14937	2780	15940	2341	16393	1980	16782	1422	19176	1083	10240
12-#11	1.95	MA	15073	3912	23021	2956	24706	2504	25259	2128	25261	1561	29090	1014	17347
6L-2S		MI	9433	3912	15438	2771	16583	2320	17177	1961	17849	1407	20621	1193	10208
12-#14	2.81	MA	16688	4141	26976	3048	29752	2538	31431	2145	33688	1489	40241	1108	25577
3L-5S		MI	9395	4141	15008	2955	15962	2477	16379	2071	16718	1421	19168	794	13921
12-#14	2.81	MA	16415	4141	25975	3088	28452	2576	29832	2161	31491	1503	37648	1023	25456
4E		MI	9603	4141	15471	2943	16577	2447	17147	2044	17851	1420	20577	885	14332
12-#14	2.81	MA	16007	4141	25137	3107	27341	2595	28441	2198	29540	1535	35005	956	24665
5L-3S		MI	9717	4141	16020	2910	17288	2438	18020	2038	18988	1400	21993	970	14324
12-#14	2.81	MA	15712	4141	24251	3115	26226	2631	27065	2214	27688	1568	32640	860	23740
6L-2S		MI	9955	4141	16732	2898	18201	2409	19134	2011	20503	1379	24013	1128	14292
12-#18	5.00	MA	18484	4722	30293	3474	33883	2860	36408	2341	40596	1509	50261	765	42714
4E		MI	10637	4722	17696	3301	19346	2703	20488	2195	22421	1375	26235	506	23053
12-#18	5.00	MA	17796	4722	28830	3508	31930	2890	33963	2403	36971	1530	45605	637	40346
5L-3S		MI	10817	4722	18648	3247	20579	2690	22002	2188	24391	1344	28612	649	24146
12-#18	5.00	MA	17297	4722	27290	3522	29987	2955	31544	2430	33716	1585	41435	459	37441
6L-2S		MI	11205	4722	19875	3228	22152	2642	23921	2145	27002	1313	31979	931	24188
14-#10	1.85	MA	15746	3886	24812	2904	27091	2437	28236	2078	29372	1510	34290	1212	17255
3L-6S		MI	8976	3886	14041	2819	14811	2377	15017	2014	14908	1466	16902	977	9788
14-#10	1.85	MA	15581	3886	24239	2927	26347	2459	27320	2088	28112	1519	32817	1165	17241
4L-5S		MI	9065	3886	14302	2813	15166	2370	15458	2009	15500	1452	17681	1036	9878
14-#10	1.85	MA	15341	3886	23751	2938	25711	2470	26523	2109	26995	1539	31310	1130	17190
5L-4S		MI	9189	3886	14569	2805	15522	2352	15903	1992	16158	1450	18537	1087	9860
14-#10	1.85	MA	15170	3886	23242	2943	25060	2490	25736	2120	25935	1558	29962	1078	16936
6L-3S		MI	9262	3886	14888	2785	15935	2345	16410	1987	16819	1436	19390	1138	9837
14-#10	1.85	MA	14978	3886	22699	2962	24400	2496	24967	2139	24839	1567	28389	1032	16527
7L-2S		MI	9407	3886	15304	2777	16469	2327	17062	1970	17705	1422	20617	1227	9813
14-#11	2.27	MA	16189	3999	25860	2963	28368	2478	29764	2103	31432	1497	37128	1173	20930
3L-6S		MI	9138	3999	14396	2888	15224	2415	15492	2034	15539	1448	17682	877	11581

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

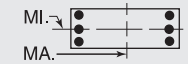
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.27	MA	15994	3999	25162	2991	27461	2504	28648	2114	29899	1507	35326	1115	20894
4L-5S		MI	9244	3999	14729	2866	15653	2408	16026	2028	16256	1432	18603	947	11851
14-#11	2.27	MA	15707	3999	24573	3004	26686	2517	27678	2140	28538	1530	33485	1070	20792
5L-4S		MI	9392	3999	15053	2857	16084	2387	16564	2009	17051	1431	19611	1009	11848
14-#11	2.27	MA	15502	3999	23954	3010	25902	2543	26718	2152	27246	1554	31839	1004	20198
6L-3S		MI	9474	3999	15438	2834	16583	2380	17177	2004	17849	1415	20621	1070	11824
14-#11	2.27	MA	15274	3999	23292	3032	25099	2549	25793	2177	25910	1563	29913	947	19738
7L-2S		MI	9645	3999	15940	2825	17226	2358	17961	1984	18916	1400	22066	1180	11796
14-#14	3.28	MA	17010	4266	27310	3166	30163	2632	31919	2195	34331	1493	41580	1009	29590
4L-5S		MI	9699	4266	15721	3033	16875	2533	17493	2104	18233	1411	21189	772	16054
14-#14	3.28	MA	16608	4266	26472	3185	29052	2650	30528	2232	32380	1526	38937	942	28736
5L-4S		MI	9905	4266	16183	3020	17490	2503	18260	2078	19366	1410	22597	863	16545
14-#14	3.28	MA	16322	4266	25586	3193	27937	2687	29152	2248	30527	1559	36572	846	27845
6L-3S		MI	10017	4266	16732	2988	18201	2494	19134	2072	20503	1390	24013	948	16558
14-#14	3.28	MA	16000	4266	24638	3225	26786	2696	27838	2284	28610	1572	33800	763	26669
7L-2S		MI	10252	4266	17444	2976	19114	2465	20247	2045	22019	1369	26033	1106	16534
14-#18	5.83	MA	18831	4944	31164	3646	34921	2989	37613	2464	41937	1512	52480	613	47497
5L-4S		MI	11149	4944	18923	3439	20919	2802	22407	2255	25032	1357	29602	454	26695
14-#18	5.83	MA	18351	4944	29624	3660	32979	3055	35193	2490	38682	1567	48310	435	44530
6L-3S		MI	11327	4944	19875	3385	22152	2789	23921	2248	27002	1326	31979	597	27944
16-#10	2.12	MA	15930	3957	25007	2971	27331	2490	28521	2107	29747	1513	35080	1157	19630
4L-6S		MI	9158	3957	14458	2863	15345	2409	15669	2034	15795	1460	18128	969	11049
16-#10	2.12	MA	15692	3957	24519	2982	26696	2501	27725	2128	28630	1533	33573	1122	19572
5E		MI	9246	3957	14719	2857	15700	2402	16110	2028	16387	1447	18908	1028	11183
16-#10	2.12	MA	15524	3957	24010	2987	26044	2522	26937	2139	27570	1553	32225	1070	19283
6L-4S		MI	9369	3957	14986	2849	16056	2384	16555	2012	17045	1444	19763	1079	11171
16-#10	2.12	MA	15333	3957	23467	3006	25385	2528	26168	2159	26473	1561	30652	1024	18888
7L-3S		MI	9441	3957	15304	2829	16469	2377	17062	2006	17705	1430	20617	1130	11152
16-#10	2.12	MA	15127	3957	22992	3014	24728	2546	25357	2164	25439	1581	29284	983	18579
8L-2S		MI	9585	3957	15721	2821	17003	2359	17714	1990	18592	1417	21844	1219	11131
16-#11	2.60	MA	16413	4085	26094	3045	28657	2543	30107	2138	31884	1500	38074	1105	23792
4L-6S		MI	9354	4085	14897	2942	15866	2454	16276	2057	16606	1441	19127	864	13099
16-#11	2.60	MA	16129	4085	25506	3058	27882	2556	29137	2164	30523	1523	36234	1060	23682
5E		MI	9459	4085	15231	2920	16296	2447	16810	2052	17323	1425	20049	934	13353
16-#11	2.60	MA	15928	4085	24887	3064	27098	2581	28177	2175	29232	1547	34588	995	23054
6L-4S		MI	9606	4085	15555	2911	16727	2426	17348	2033	18118	1424	21056	996	13420
16-#11	2.60	MA	15701	4085	24225	3086	26295	2588	27253	2200	27895	1557	32661	937	22610
7L-3S		MI	9688	4085	15940	2888	17226	2418	17961	2027	18916	1409	22066	1057	13403
16-#11	2.60	MA	15454	4085	23647	3097	25495	2610	26264	2207	26635	1580	30990	885	21918
8L-2S		MI	9856	4085	16441	2879	17869	2397	18745	2008	19983	1393	23511	1167	13379
16-#14	3.75	MA	17206	4390	27807	3263	30762	2706	32615	2265	35220	1516	42869	928	32814
5E		MI	10002	4390	16433	3111	17788	2589	18607	2138	19748	1401	23209	750	18196
16-#14	3.75	MA	16927	4390	26920	3271	29648	2743	31239	2282	33367	1549	40505	832	31954
6L-4S		MI	10206	4390	16895	3098	18403	2559	19374	2112	20882	1400	24617	840	18754
16-#14	3.75	MA	16607	4390	25972	3303	28497	2752	29926	2318	31450	1562	37732	749	30752
7L-3S		MI	10317	4390	17444	3066	19114	2550	20247	2105	22019	1380	26033	925	18784
16-#14	3.75	MA	16259	4390	25144	3317	27350	2784	28509	2327	29643	1595	35330	671	29589
8L-2S		MI	10549	4390	18156	3053	20027	2520	21361	2079	23534	1359	28053	1084	18771
16-#18	6.67	MA	19394	5165	31958	3798	35971	3154	38843	2551	43647	1550	55186	410	51620
6L-4S		MI	11659	5165	20150	3578	22492	2901	24326	2315	27643	1339	32969	401	30355
18-#10	2.38	MA	16042	4027	25288	3026	27680	2533	28926	2148	30264	1527	35836	1114	21955
5L-6S		MI	9339	4027	14875	2907	15880	2440	16321	2053	16682	1455	19355	961	12313
18-#10	2.38	MA	15876	4027	24779	3031	27029	2553	28139	2158	29204	1547	34488	1063	21634
6L-5S		MI	9426	4027	15135	2901	16234	2433	16762	2047	17274	1441	20135	1020	12484

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

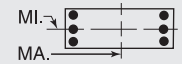


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.38	MA	15686	4027	24235	3049	26369	2559	27370	2178	28107	1556	32915	1017	21251
7L-4S		MI	9548	4027	15403	2893	16590	2415	17206	2031	17931	1439	20990	1071	12479
18-#10	2.38	MA	15484	4027	23760	3058	25712	2578	26558	2184	27074	1576	31547	976	20931
8L-3S		MI	9620	4027	15721	2873	17003	2408	17714	2025	18592	1425	21844	1122	12464
18-#10	2.38	MA	15309	4027	23245	3077	25084	2586	25775	2202	26054	1595	30214	935	20344
9L-2S		MI	9762	4027	16138	2865	17537	2390	18366	2009	19479	1411	23071	1211	12446
18-#11	2.92	MA	16549	4171	26439	3112	29078	2595	30596	2187	32509	1516	38983	1050	26572
5L-6S		MI	9570	4171	15398	2996	16509	2493	17060	2081	17673	1434	20572	851	14621
18-#11	2.92	MA	16352	4171	25820	3118	28294	2620	29636	2199	31217	1540	37336	985	25914
6L-5S		MI	9674	4171	15732	2974	16939	2486	17594	2075	18390	1419	21494	921	14861
18-#11	2.92	MA	16126	4171	25158	3140	27491	2627	28712	2224	29880	1550	35410	928	25484
7L-4S		MI	9819	4171	16056	2965	17370	2464	18132	2056	19185	1417	22501	983	14989
18-#11	2.92	MA	15885	4171	24580	3151	26691	2649	27723	2230	28620	1573	33738	876	24781
8L-3S		MI	9900	4171	16441	2942	17869	2457	18745	2051	19983	1402	23511	1044	14978
18-#11	2.92	MA	15674	4171	23958	3174	25925	2658	26770	2252	27378	1597	32103	825	24114
9L-2S		MI	10067	4171	16942	2933	18511	2436	19529	2031	21050	1386	24956	1154	14958
18-#14	4.22	MA	17527	4515	28255	3349	31359	2799	33326	2316	36207	1539	44437	818	36067
6L-5S		MI	10303	4515	17145	3188	18701	2644	19720	2172	21264	1391	25229	727	20344
18-#14	4.22	MA	17209	4515	27307	3380	30208	2808	32013	2352	34290	1552	41664	735	34835
7L-4S		MI	10506	4515	17608	3176	19316	2615	20488	2146	22397	1390	26637	818	20928
18-#14	4.22	MA	16879	4515	26478	3395	29061	2839	30596	2361	32483	1585	39262	657	33660
8L-3S		MI	10616	4515	18156	3144	20027	2606	21361	2139	23534	1370	28053	903	21003
18-#14	4.22	MA	16573	4515	25593	3429	27963	2853	29230	2392	30701	1618	36906	583	32019
9L-2S		MI	10844	4515	18869	3131	20940	2576	22475	2113	25050	1349	30073	1061	21003
20-#10	2.65	MA	16226	4097	25547	3075	28014	2585	29340	2177	30839	1542	36751	1055	23988
6E		MI	9519	4097	15291	2951	16414	2472	16973	2072	17568	1449	20582	954	13580
20-#10	2.65	MA	16037	4097	25003	3093	27354	2591	28571	2197	29742	1550	35178	1009	23616
7L-5S		MI	9605	4097	15552	2945	16768	2465	17414	2067	18161	1435	21362	1013	13782
20-#10	2.65	MA	15839	4097	24529	3102	26697	2609	27759	2203	28708	1570	33810	968	23285
8L-4S		MI	9727	4097	15819	2937	17124	2447	17858	2050	18818	1433	22217	1063	13785
20-#10	2.65	MA	15667	4097	24013	3121	26068	2617	26976	2221	27689	1590	32477	927	22710
9L-3S		MI	9798	4097	16138	2917	17537	2440	18366	2045	19479	1419	23071	1114	13774
20-#10	2.65	MA	15459	4097	23520	3128	25438	2638	26193	2229	26571	1595	31115	892	22180
10L-2S		MI	9939	4097	16555	2909	18072	2422	19017	2028	20366	1405	24298	1203	13758
20-#11	3.25	MA	16773	4258	26753	3172	29490	2659	31095	2223	33202	1533	40085	976	28777
6E		MI	9785	4258	15900	3050	17152	2532	17845	2104	18740	1427	22017	837	16145
20-#11	3.25	MA	16549	4258	26091	3194	28687	2665	30171	2247	31865	1543	38159	918	28360
7L-5S		MI	9887	4258	16233	3028	17581	2524	18378	2099	19457	1412	22939	908	16373
20-#11	3.25	MA	16316	4258	25513	3205	27887	2688	29182	2254	30605	1566	36487	866	27646
8L-4S		MI	10031	4258	16557	3019	18012	2503	18916	2080	20252	1410	23946	970	16552
20-#11	3.25	MA	16106	4258	24891	3228	27121	2697	28229	2276	29363	1590	34851	815	26984
9L-3S		MI	10112	4258	16942	2996	18511	2496	19529	2074	21050	1395	24956	1031	16550
20-#11	3.25	MA	15858	4258	24291	3236	26353	2721	27301	2298	28021	1597	33187	770	26058
10L-2S		MI	10278	4258	17444	2987	19154	2475	20314	2055	22117	1379	26401	1141	16534
20-#14	4.69	MA	17808	4639	28642	3458	31919	2864	34100	2386	37130	1542	45596	721	38918
7L-5S		MI	10604	4639	17857	3266	19614	2700	20834	2206	22779	1381	27249	705	22498
20-#14	4.69	MA	17483	4639	27813	3472	30772	2895	32684	2395	35322	1575	43194	644	37719
8L-4S		MI	10804	4639	18320	3254	20229	2671	21602	2180	23913	1380	28657	796	23052
20-#14	4.69	MA	17189	4639	26928	3507	29674	2909	31317	2426	33541	1608	40838	569	36090
9L-3S		MI	10914	4639	18869	3221	20940	2661	22475	2173	25050	1360	30073	881	23218
22-#10	2.91	MA	16386	4167	25771	3137	28339	2622	29772	2216	31376	1545	37441	1001	25983
7L-6S		MI	9699	4167	15708	2995	16948	2503	17624	2091	18455	1444	21809	946	14849
22-#10	2.91	MA	16192	4167	25297	3146	27682	2641	28960	2222	30342	1564	36073	960	25641
8L-5S		MI	9785	4167	15969	2989	17303	2496	18065	2086	19048	1430	22589	1005	15069
22-#10	2.91	MA	16023	4167	24781	3165	27053	2649	28178	2240	29323	1584	34740	919	25077
9L-4S		MI	9905	4167	16236	2981	17659	2478	18510	2069	19705	1427	23444	1055	15089
22-#10	2.91	MA	15816	4167	24288	3171	26423	2669	27394	2248	28206	1590	33378	884	24534
10L-3S		MI	9976	4167	16555	2961	18072	2471	19017	2064	20366	1414	24298	1106	15081

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	2.91	MA	15624	4167	23812	3179	25792	2677	26631	2267	27154	1607	32058	841	23861
11L-2S		MI	10116	4167	16972	2953	18606	2453	19669	2047	21253	1400	25524	1196	15068
22-#11	3.57	MA	16969	4344	27024	3248	29883	2704	31630	2271	33850	1536	40908	909	31238
7L-6S		MI	10000	4344	16401	3104	17795	2570	18629	2128	19807	1420	23462	824	17673
22-#11	3.57	MA	16740	4344	26446	3258	29083	2726	30641	2277	32590	1559	39236	856	30513
8L-5S		MI	10100	4344	16735	3082	18224	2563	19162	2122	20524	1405	24384	895	17889
22-#11	3.57	MA	16536	4344	25824	3282	28317	2736	29688	2299	31348	1583	37600	805	29854
9L-4S		MI	10243	4344	17059	3073	18655	2542	19701	2103	21319	1403	25391	957	18112
22-#11	3.57	MA	16288	4344	25224	3290	27549	2760	28760	2322	30006	1590	35936	760	28915
10L-3S		MI	10324	4344	17444	3050	19154	2535	20314	2098	22117	1388	26401	1018	18119
22-#14	5.16	MA	18084	4764	29147	3550	32483	2951	34771	2429	38162	1565	47126	630	41778
8L-5S		MI	10904	4764	18569	3344	20527	2756	21948	2240	24295	1371	29269	683	24657
22-#14	5.16	MA	17800	4764	28263	3585	31385	2964	33404	2459	36380	1598	44770	555	40161
9L-4S		MI	11102	4764	19032	3332	21142	2727	22716	2214	25428	1370	30677	773	25184
24-#10	3.17	MA	16544	4238	26065	3190	28666	2672	30162	2241	31977	1559	38336	952	27999
8L-6S		MI	9879	4238	16125	3039	17483	2535	18276	2110	19342	1438	23036	938	16119
24-#10	3.17	MA	16377	4238	25549	3209	28038	2681	29379	2259	30957	1579	37003	911	27445
9L-5S		MI	9963	4238	16386	3033	17837	2528	18717	2105	19934	1424	23816	997	16330
24-#10	3.17	MA	16171	4238	25056	3215	27407	2701	28595	2267	29840	1584	35641	876	26889
10L-4S		MI	10083	4238	16653	3024	18193	2510	19162	2088	20592	1422	24671	1047	16388
24-#10	3.17	MA	15981	4238	24580	3223	26777	2708	27832	2286	28789	1601	34321	833	26219
11L-3S		MI	10153	4238	16972	3005	18606	2503	19669	2083	21253	1408	25524	1098	16386
24-#11	3.90	MA	17161	4430	27379	3312	30279	2765	32100	2301	34575	1552	41984	847	33383
8L-6S		MI	10213	4430	16903	3158	18437	2609	19413	2151	20874	1413	24907	811	19202
24-#11	3.90	MA	16962	4430	26757	3336	29513	2775	31147	2323	33333	1576	40349	796	32724
9L-5S		MI	10313	4430	17236	3136	18867	2602	19947	2146	21591	1398	25829	882	19408
24-#11	3.90	MA	16716	4430	26157	3344	28745	2799	30219	2345	31991	1583	38685	751	31772
10L-4S		MI	10455	4430	17560	3127	19298	2581	20485	2127	22386	1396	26836	944	19671
24-#14	5.63	MA	18406	4888	29597	3663	33096	3020	35492	2493	39220	1588	48702	542	44232
9L-5S		MI	11203	4888	19282	3422	21440	2812	23062	2274	25810	1361	31289	660	26819

RECTANGULAR TIED COLUMNS 24" x 42"

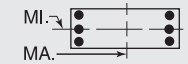
4-#18	1.59	MA	17195	4007	27369	2957	29712	2485	30863	2114	31971	1551	37198	1343	16116
2E		MI	9584	4007	15593	2795	16495	2347	16865	1993	17125	1455	19100	1203	8722
6-#14	1.34	MA	16900	3938	26578	2933	28796	2470	29789	2109	30537	1568	35232	1360	13786
2L-3S		MI	9215	3938	14506	2798	15185	2374	15301	2026	15012	1501	16527	1100	7593
6-#14	1.34	MA	16359	3938	25165	2953	26985	2489	27580	2146	27531	1602	31071	1223	13825
3L-2S		MI	9464	3938	15218	2786	16098	2345	16415	2000	16528	1481	18547	1258	7533
6-#18	2.38	MA	18286	4228	29841	3095	32881	2584	34729	2174	37231	1533	44481	1318	23870
2L-3S		MI	9681	4228	15593	2952	16495	2494	16865	2096	17125	1468	19100	869	12736
6-#18	2.38	MA	17381	4228	27369	3130	29712	2615	30863	2237	31971	1590	37198	1067	23814
3L-2S		MI	10095	4228	16820	2933	18068	2446	18784	2054	19736	1437	22467	1150	12649
8-#10	1.01	MA	16472	3845	25483	2899	27512	2449	28276	2101	28512	1589	32455	1383	10562
2L-4S		MI	9054	3845	13938	2797	14555	2363	14572	2027	14072	1540	15457	1174	5912
8-#10	1.01	MA	16154	3845	24671	2911	26471	2460	27006	2123	26785	1609	30063	1307	10586
3E		MI	9128	3845	14257	2777	14968	2356	15080	2021	14733	1526	16311	1226	5876
8-#10	1.01	MA	15973	3845	24066	2934	25685	2482	26039	2134	25455	1618	28514	1261	10606
4L-2S		MI	9278	3845	14673	2769	15503	2338	15732	2005	15620	1512	17538	1315	5848
8-#11	1.24	MA	16779	3910	26244	2925	28419	2466	29351	2109	29955	1576	34437	1369	12826
2L-4S		MI	9153	3910	14170	2818	14792	2375	14835	2029	14423	1524	15873	1112	7121
8-#11	1.24	MA	16399	3910	25257	2940	27153	2479	27807	2135	27855	1600	31529	1274	12854
3E		MI	9238	3910	14555	2795	15291	2368	15448	2024	15221	1509	16883	1172	7073

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

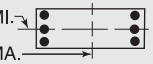


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.24	MA	16184	3910	24520	2968	26196	2506	26629	2147	26235	1610	29632	1217	12864
4L-2S		MI	9415	3910	15057	2785	15934	2347	16232	2005	16288	1493	18328	1282	7035
8-#14	1.79	MA	17532	4062	27990	3011	30607	2526	31998	2143	33542	1558	39394	1347	18220
2L-4S		MI	9403	4062	14670	2908	15387	2439	15542	2067	15391	1512	17131	993	9922
8-#14	1.79	MA	17004	4062	26578	3031	28796	2545	29789	2180	30537	1592	35232	1209	18238
3E		MI	9519	4062	15218	2876	16098	2430	16415	2060	16528	1491	18547	1078	9869
8-#14	1.79	MA	16702	4062	25521	3071	27423	2583	28100	2197	28215	1606	32503	1125	18160
4L-2S		MI	9765	4062	15931	2864	17011	2401	17529	2034	18043	1471	20567	1236	9815
8-#18	3.17	MA	19364	4450	32313	3234	36050	2683	38595	2234	42491	1516	51764	1294	31599
2L-4S		MI	10013	4450	15867	3144	16835	2606	17270	2163	17765	1481	20089	673	16036
8-#18	3.17	MA	18490	4450	29841	3268	32881	2715	34729	2298	37231	1573	44481	1042	31481
3E		MI	10198	4450	16820	3090	18068	2594	18784	2156	19736	1450	22467	816	16588
8-#18	3.17	MA	17983	4450	27985	3338	30470	2781	31763	2326	33367	1630	39652	891	30464
4L-2S		MI	10604	4450	18047	3072	19641	2545	20703	2114	22347	1420	25834	1098	16534
10-#10	1.26	MA	16842	3916	26295	2942	28553	2480	29546	2120	30240	1583	34848	1375	13114
2L-5S		MI	9109	3916	14088	2849	14734	2412	14780	2063	14302	1537	15829	1116	7284
10-#10	1.26	MA	16529	3916	25483	2955	27512	2491	28276	2142	28512	1604	32455	1300	13134
3L-4S		MI	9236	3916	14355	2840	15090	2394	15224	2046	14959	1534	16684	1166	7248
10-#10	1.26	MA	16349	3916	24878	2978	26726	2514	27309	2153	27182	1613	30906	1253	13142
4L-3S		MI	9309	3916	14673	2821	15503	2388	15732	2041	15620	1520	17538	1218	7215
10-#10	1.26	MA	16089	3916	24360	2988	26055	2525	26469	2175	26004	1633	29318	1219	13110
5L-2S		MI	9458	3916	15090	2813	16037	2369	16383	2024	16507	1507	18765	1307	7187
10-#11	1.55	MA	17224	3996	27231	2979	29684	2505	30894	2132	32055	1569	37345	1359	15925
2L-5S		MI	9219	3996	14348	2881	15004	2435	15081	2072	14695	1519	16311	1036	8757
10-#11	1.55	MA	16850	3996	26244	2994	28419	2518	29351	2158	29955	1593	34437	1265	15945
3L-4S		MI	9369	3996	14672	2872	15435	2414	15619	2053	15490	1517	17318	1099	8720
10-#11	1.55	MA	16637	3996	25507	3022	27461	2545	28172	2171	28335	1603	32540	1207	15936
4L-3S		MI	9453	3996	15057	2849	15934	2407	16232	2048	16288	1502	18328	1159	8679
10-#11	1.55	MA	16324	3996	24882	3035	26643	2559	27148	2197	26898	1627	30600	1163	15858
5L-2S		MI	9628	3996	15558	2839	16577	2385	17016	2028	17355	1486	19773	1269	8643
10-#14	2.23	MA	18160	4187	29403	3089	32417	2582	34207	2177	36548	1548	43555	1333	22644
2L-5S		MI	9497	4187	14919	2999	15685	2525	15888	2127	15773	1503	17743	880	11916
10-#14	2.23	MA	17643	4187	27990	3109	30607	2601	31998	2214	33542	1582	39394	1195	22639
3L-4S		MI	9708	4187	15382	2986	16300	2495	16655	2101	16906	1502	19151	970	12159
10-#14	2.23	MA	17345	4187	26933	3149	29234	2639	30309	2231	31221	1596	36664	1111	22537
4L-3S		MI	9822	4187	15931	2954	17011	2486	17529	2094	18043	1481	20567	1055	12124
10-#14	2.23	MA	16903	4187	26042	3168	28061	2658	28840	2268	29160	1630	33878	1046	21892
5L-2S		MI	10064	4187	16643	2942	17924	2456	18642	2068	19558	1461	22588	1214	12080
10-#18	3.97	MA	19588	4671	32313	3406	36050	2814	38595	2358	42491	1555	51764	1018	39146
3L-4S		MI	10530	4671	17094	3283	18408	2706	19189	2224	20376	1463	23456	621	19618
10-#18	3.97	MA	19091	4671	30457	3476	33639	2880	35629	2386	38627	1612	46935	866	37968
4L-3S		MI	10713	4671	18047	3229	19641	2693	20703	2217	22347	1433	25834	764	20408
10-#18	3.97	MA	18339	4671	28912	3510	31576	2912	33047	2449	34796	1634	42023	743	35269
5L-2S		MI	11110	4671	19274	3210	21215	2645	22622	2174	24958	1402	29201	1045	20397
12-#10	1.51	MA	17211	3986	27107	2986	29594	2512	30816	2140	31968	1578	37240	1367	15662
2L-6S		MI	9201	3986	14244	2899	14913	2451	14990	2087	14596	1545	16276	1049	8618
12-#10	1.51	MA	16902	3986	26295	2999	28553	2523	29546	2161	30240	1598	34848	1292	15676
3L-5S		MI	9291	3986	14504	2893	15268	2444	15431	2082	15188	1531	17056	1108	8601
12-#10	1.51	MA	16723	3986	25690	3022	27767	2546	28579	2172	28910	1607	33298	1245	15673
4E		MI	9416	3986	14772	2884	15624	2426	15876	2065	15846	1528	17911	1159	8573
12-#10	1.51	MA	16466	3986	25172	3032	27096	2557	27739	2194	27731	1627	31710	1211	15630
5L-3S		MI	9489	3986	15090	2865	16037	2419	16383	2060	16507	1515	18765	1210	8544
12-#10	1.51	MA	16280	3986	24634	3038	26405	2577	26908	2204	26613	1647	30290	1161	15464
6L-2S		MI	9636	3986	15507	2857	16571	2401	17035	2043	17394	1501	19992	1299	8518
12-#11	1.86	MA	17666	4082	28218	3033	30949	2543	32438	2156	34155	1562	40252	1350	19019
2L-6S		MI	9328	4082	14516	2956	15217	2481	15331	2101	15045	1527	16835	953	10152
12-#11	1.86	MA	17299	4082	27231	3048	29684	2557	30894	2182	32055	1586	37345	1255	19031
3L-5S		MI	9436	4082	14849	2935	15647	2474	15865	2096	15762	1512	17756	1023	10332

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



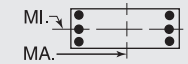
f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.86	MA	17088	4082	26494	3076	28726	2584	29716	2194	30435	1596	35448	1197	19006
4E		MI	9585	4082	15173	2926	16078	2453	16403	2076	16557	1510	18763	1086	10307
12-#11	1.86	MA	16779	4082	25869	3089	27908	2597	28692	2220	28998	1620	33508	1154	18914
5L-3S		MI	9668	4082	15558	2903	16577	2445	17016	2071	17355	1495	19773	1146	10273
12-#11	1.86	MA	16556	4082	25214	3095	27074	2622	27679	2233	27635	1644	31772	1090	18388
6L-2S		MI	9841	4082	16060	2893	17219	2424	17801	2052	18422	1479	21218	1256	10240
12-#14	2.68	MA	18277	4311	29403	3187	32417	2657	34207	2248	36548	1572	43555	1181	27035
3L-5S		MI	9802	4311	15631	3076	16598	2581	17001	2161	17288	1493	19763	857	14036
12-#14	2.68	MA	17983	4311	28346	3227	31044	2695	32518	2265	34226	1586	40825	1097	26914
4E		MI	10011	4311	16094	3064	17213	2551	17769	2135	18421	1492	21171	948	14385
12-#14	2.68	MA	17548	4311	27455	3246	29871	2714	31049	2302	32166	1620	38039	1032	26195
5L-3S		MI	10124	4311	16643	3032	17924	2542	18642	2128	19558	1472	22588	1033	14368
12-#14	2.68	MA	17235	4311	26518	3254	28684	2751	29595	2319	30210	1653	35546	938	25177
6L-2S		MI	10363	4311	17355	3019	18837	2512	19756	2102	21074	1451	24608	1191	14332
12-#18	4.76	MA	20185	4892	32929	3614	36808	2980	39495	2446	43887	1594	54218	842	45491
4E		MI	11045	4892	18321	3421	19981	2805	21108	2284	22987	1446	26823	568	23232
12-#18	4.76	MA	19452	4892	31384	3648	34745	3011	36912	2510	40056	1616	49306	718	42845
5L-3S		MI	11225	4892	19274	3367	21215	2792	22622	2277	24958	1415	29201	711	24217
12-#18	4.76	MA	18922	4892	29741	3662	32692	3077	34357	2538	36617	1673	44910	543	39918
6L-2S		MI	11615	4892	20501	3348	22788	2744	24541	2235	27569	1384	32568	993	24245
14-#10	1.76	MA	17272	4056	27107	3042	29594	2555	30816	2181	31968	1592	37240	1284	18215
3L-6S		MI	9383	4056	14661	2942	15448	2482	15642	2106	15483	1539	17503	1041	9861
14-#10	1.76	MA	17095	4056	26502	3066	28808	2577	29849	2191	30638	1601	35691	1237	18201
4L-5S		MI	9473	4056	14921	2937	15802	2475	16083	2101	16075	1525	18283	1100	9912
14-#10	1.76	MA	16840	4056	25984	3076	28137	2588	29009	2213	29459	1622	34102	1203	18150
5L-4S		MI	9597	4056	15189	2928	16158	2457	16528	2084	16733	1523	19138	1151	9891
14-#10	1.76	MA	16658	4056	25446	3081	27446	2609	28178	2223	28341	1642	32682	1153	17942
6L-3S		MI	9669	4056	15507	2909	16571	2451	17035	2079	17394	1509	19992	1202	9866
14-#10	1.76	MA	16453	4056	24872	3100	26749	2615	27360	2243	27184	1651	31028	1107	17493
7L-2S		MI	9815	4056	15924	2901	17105	2433	17687	2062	18280	1495	21219	1291	9842
14-#11	2.17	MA	17745	4168	28218	3101	30949	2596	32438	2206	34155	1579	40252	1246	22109
3L-6S		MI	9545	4168	15017	3010	15860	2520	16116	2125	16112	1520	18280	940	11666
14-#11	2.17	MA	17535	4168	27481	3130	29991	2623	31259	2218	32535	1590	38355	1188	22073
4L-5S		MI	9652	4168	15351	2989	16289	2512	16649	2119	16829	1505	19201	1010	11902
14-#11	2.17	MA	17230	4168	26855	3143	29173	2636	30235	2244	31098	1614	36415	1144	21972
5L-4S		MI	9799	4168	15675	2980	16720	2491	17188	2100	17624	1503	20208	1073	11886
14-#11	2.17	MA	17012	4168	26201	3149	28339	2661	29222	2256	29735	1638	34680	1080	21406
6L-3S		MI	9882	4168	16060	2956	17219	2484	17801	2095	18422	1488	21218	1133	11860
14-#11	2.17	MA	16767	4168	25502	3171	27491	2668	28238	2281	28324	1648	32654	1023	20902
7L-2S		MI	10053	4168	16561	2947	17862	2463	18585	2075	19489	1473	22663	1243	11831
14-#14	3.13	MA	18616	4436	29758	3305	32855	2751	34726	2299	37231	1576	44987	1084	31291
4L-5S		MI	10106	4436	16344	3154	17511	2636	18115	2195	18804	1483	21783	835	16168
14-#14	3.13	MA	18188	4436	28867	3324	31682	2770	33257	2336	35171	1610	42200	1018	30506
5L-4S		MI	10313	4436	16806	3142	18126	2607	18883	2168	19937	1482	23191	926	16602
14-#14	3.13	MA	17883	4436	27930	3332	30495	2806	31804	2353	33215	1643	39707	924	29523
6L-3S		MI	10425	4436	17355	3110	18837	2598	19756	2162	21074	1462	24608	1011	16604
14-#14	3.13	MA	17538	4436	26928	3364	29279	2816	30405	2389	31191	1657	36790	842	28368
7L-2S		MI	10661	4436	18067	3097	19750	2568	20870	2136	22589	1441	26628	1169	16577
14-#18	5.56	MA	20553	5113	33856	3787	37914	3110	40778	2570	45316	1599	56589	694	50420
5L-4S		MI	11557	5113	19548	3559	21554	2904	23027	2344	25598	1428	30190	516	26869
14-#18	5.56	MA	20043	5113	32213	3800	35861	3177	38223	2598	41877	1656	52193	519	47429
6L-3S		MI	11735	5113	20501	3505	22788	2891	24541	2337	27569	1397	32568	659	28019
14-#18	5.56	MA	19454	5113	30454	3856	33727	3192	35785	2662	38529	1713	47027	370	44526
7L-2S		MI	12118	5113	21728	3487	24361	2843	26460	2295	30180	1367	35935	940	28082

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

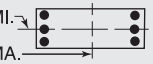


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#10	2.02	MA	17465	4126	27314	3110	29849	2609	31118	2210	32366	1596	38083	1230	20728
4L-6S		MI	9565	4126	15077	2986	15982	2514	16294	2125	16370	1533	18730	1033	11121
16-#10	2.02	MA	17213	4126	26796	3120	29178	2620	30278	2232	31187	1616	36495	1196	20670
5E		MI	9653	4126	15338	2981	16336	2507	16735	2120	16962	1520	19510	1092	11219
16-#10	2.02	MA	17034	4126	26258	3125	28487	2640	29448	2243	30069	1636	35075	1145	20425
6L-4S		MI	9777	4126	15605	2972	16692	2489	17180	2103	17620	1517	20365	1143	11204
16-#10	2.02	MA	16830	4126	25684	3144	27790	2646	28630	2262	28912	1645	33421	1100	19989
7L-3S		MI	9849	4126	15924	2953	17105	2482	17687	2098	18280	1504	21219	1194	11183
16-#10	2.02	MA	16610	4126	25184	3153	27096	2665	27773	2268	27821	1665	31980	1060	19663
8L-2S		MI	9993	4126	16341	2944	17640	2464	18339	2081	19167	1490	22445	1283	11161
16-#11	2.48	MA	17981	4255	28468	3184	31256	2661	32803	2241	34635	1583	41263	1178	25139
4L-6S		MI	9762	4255	15518	3064	16503	2559	16900	2148	17179	1513	19725	927	13184
16-#11	2.48	MA	17679	4255	27842	3197	30439	2675	31779	2267	33198	1607	39323	1135	25029
5E		MI	9867	4255	15852	3043	16932	2551	17434	2143	17895	1498	20646	997	13445
16-#11	2.48	MA	17465	4255	27188	3203	29605	2700	30766	2280	31835	1631	37588	1071	24429
6L-4S		MI	10013	4255	16176	3033	17363	2530	17972	2124	18690	1496	21653	1060	13461
16-#11	2.48	MA	17221	4255	26489	3225	28756	2707	29781	2304	30424	1641	35561	1014	23942
7L-3S		MI	10095	4255	16561	3010	17862	2523	18585	2118	19489	1481	22663	1120	13440
16-#11	2.48	MA	16958	4255	25879	3236	27911	2729	28737	2311	29094	1665	33800	963	23280
8L-2S		MI	10265	4255	17063	3001	18505	2502	19369	2099	20556	1466	24108	1230	13415
16-#14	3.57	MA	18824	4560	30280	3401	33493	2826	35466	2370	38177	1600	46362	1005	34825
5E		MI	10409	4560	17056	3232	18424	2692	19229	2229	20319	1473	23803	813	18308
16-#14	3.57	MA	18526	4560	29342	3410	32306	2862	34013	2387	36221	1634	43869	910	33875
6L-4S		MI	10614	4560	17518	3220	19039	2663	19997	2202	21452	1472	25211	903	18813
16-#14	3.57	MA	18183	4560	28341	3442	31090	2872	32614	2423	34197	1647	40952	828	32689
7L-3S		MI	10725	4560	18067	3187	19750	2653	20870	2196	22589	1452	26628	988	18835
16-#14	3.57	MA	17813	4560	27465	3457	29878	2904	31117	2432	32289	1681	38420	752	31427
8L-2S		MI	10957	4560	18779	3175	20663	2624	21984	2169	24105	1431	28648	1147	18815
16-#18	6.35	MA	21152	5335	34685	3939	39030	3276	42089	2658	47137	1638	59476	494	54940
6L-4S		MI	12067	5335	20775	3698	23127	3004	24946	2404	28209	1410	33557	464	30526
16-#18	6.35	MA	20569	5335	32926	3994	36896	3291	39651	2722	43789	1695	54310	345	51989
7L-3S		MI	12243	5335	21728	3644	24361	2991	26460	2398	30180	1380	35935	606	31816
18-#10	2.27	MA	17584	4197	27608	3164	30219	2651	31548	2251	32915	1610	38887	1188	23189
5L-6S		MI	9746	4197	15494	3030	16516	2545	16946	2145	17256	1528	19957	1026	12385
18-#10	2.27	MA	17408	4197	27070	3169	29528	2672	30718	2262	31797	1631	37467	1137	22911
6L-5S		MI	9833	4197	15755	3024	16871	2539	17387	2139	17849	1514	20737	1085	12524
18-#10	2.27	MA	17205	4197	26496	3188	28831	2678	29900	2281	30639	1639	35813	1092	22489
7L-4S		MI	9956	4197	16022	3016	17227	2520	17831	2123	18506	1512	21592	1135	12514
18-#10	2.27	MA	16989	4197	25996	3197	28137	2697	29043	2288	29549	1660	34372	1052	22171
8L-3S		MI	10027	4197	16341	2997	17640	2514	18339	2117	19167	1498	22445	1186	12497
18-#10	2.27	MA	16803	4197	25500	3205	27474	2705	28217	2306	28464	1679	32970	1011	21574
9L-2S		MI	10170	4197	16757	2988	18174	2496	18991	2101	20054	1484	23672	1275	12477
18-#11	2.79	MA	18125	4341	28829	3250	31704	2714	33322	2291	35298	1600	42231	1125	28088
5L-6S		MI	9977	4341	16020	3118	17145	2597	17684	2172	18245	1506	21170	914	14705
18-#11	2.79	MA	17915	4341	28175	3257	30870	2739	32309	2303	33935	1624	40495	1061	27455
6L-5S		MI	10081	4341	16354	3097	17575	2590	18218	2166	18962	1491	22091	984	14952
18-#11	2.79	MA	17673	4341	27476	3279	30021	2746	31325	2328	32524	1634	38469	1004	26983
7L-4S		MI	10227	4341	16677	3087	18006	2569	18756	2147	19757	1489	23098	1047	15032
18-#11	2.79	MA	17416	4341	26866	3290	29176	2768	30280	2335	31194	1658	36708	953	26311
8L-3S		MI	10308	4341	17063	3064	18505	2561	19369	2142	20556	1474	24108	1107	15017
18-#11	2.79	MA	17192	4341	26205	3314	28368	2778	29274	2357	29883	1682	34988	903	25578
9L-2S		MI	10476	4341	17564	3055	19148	2540	20153	2122	21622	1459	25553	1217	14996
18-#14	4.02	MA	19165	4685	30755	3488	34116	2918	36222	2421	39226	1624	48030	896	38230
6L-5S		MI	10711	4685	17768	3310	19337	2748	20343	2263	21834	1463	25823	790	20455
18-#14	4.02	MA	18824	4685	29753	3520	32901	2928	34823	2457	37202	1638	45113	814	37010
7L-4S		MI	10914	4685	18231	3297	19952	2719	21110	2236	22968	1462	27231	881	21022
18-#14	4.02	MA	18464	4685	28878	3535	31689	2960	33326	2466	35294	1671	42582	738	35758
8L-3S		MI	11024	4685	18779	3265	20663	2709	21984	2230	24105	1442	28648	966	21056
18-#14	4.02	MA	18146	4685	27937	3569	30529	2973	31883	2498	33413	1705	40105	665	34163
9L-2S		MI	11254	4685	19492	3253	21576	2680	23098	2203	25620	1421	30668	1125	21049

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

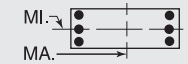
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	7.14	MA	21673	5556	35398	4133	40065	3390	43517	2782	49049	1677	61593	321	59452
7L-4S		MI	12575	5556	22003	3836	24701	3103	26866	2465	30820	1393	36924	411	34198
20-#10	2.52	MA	17780	4267	27882	3213	30568	2703	31988	2281	33524	1625	39859	1130	25401
6E		MI	9927	4267	15911	3074	17050	2577	17598	2164	18143	1522	21184	1018	13652
20-#10	2.52	MA	17577	4267	27308	3232	29872	2709	31170	2300	32367	1634	38205	1084	24990
7L-5S		MI	10013	4267	16171	3068	17405	2570	18039	2158	18736	1509	21963	1077	13824
20-#10	2.52	MA	17366	4267	26808	3241	29178	2728	30313	2307	31277	1654	36765	1044	24681
8L-4S		MI	10135	4267	16439	3060	17761	2552	18483	2142	19393	1506	22818	1127	13821
20-#10	2.52	MA	17183	4267	26312	3249	28515	2737	29487	2325	30192	1674	35363	1003	24076
9L-3S		MI	10206	4267	16757	3041	18174	2545	18991	2136	20054	1492	23672	1178	13807
20-#10	2.52	MA	16961	4267	25740	3267	27850	2757	28660	2333	29013	1679	33930	969	23563
10L-2S		MI	10348	4267	17174	3032	18708	2527	19642	2120	20941	1479	24899	1268	13790
20-#11	3.10	MA	18363	4427	29162	3311	32135	2777	33853	2327	36035	1617	43403	1051	30486
6E		MI	10193	4427	16521	3172	17788	2636	18468	2195	19312	1499	22615	901	16230
20-#11	3.10	MA	18122	4427	28463	3333	31287	2784	32868	2351	34624	1627	41377	995	30028
7L-5S		MI	10295	4427	16855	3151	18218	2629	19002	2190	20029	1484	23536	971	16463
20-#11	3.10	MA	17871	4427	27853	3344	30441	2807	31824	2358	33294	1651	39615	944	29345
8L-4S		MI	10439	4427	17179	3141	18649	2608	19540	2171	20824	1482	24543	1034	16600
20-#11	3.10	MA	17651	4427	27192	3368	29633	2817	30817	2381	31983	1675	37896	893	28614
9L-3S		MI	10520	4427	17564	3118	19148	2600	20153	2165	21622	1467	25553	1094	16591
20-#11	3.10	MA	17385	4427	26558	3375	28822	2841	29810	2390	30553	1682	36143	849	27698
10L-2S		MI	10686	4427	18065	3109	19791	2579	20937	2146	22689	1452	26998	1204	16573
20-#14	4.46	MA	19460	4809	31165	3598	34711	2983	37032	2491	40208	1628	49274	800	41332
7L-5S		MI	11012	4809	18480	3388	20250	2804	21457	2297	23350	1453	27843	768	22608
20-#14	4.46	MA	19115	4809	30290	3613	33500	3015	35535	2500	38300	1661	46743	725	40089
8L-4S		MI	11212	4809	18943	3375	20865	2775	22224	2270	24483	1452	29251	859	23180
20-#14	4.46	MA	18801	4809	29349	3647	32340	3029	34092	2532	36419	1695	44266	651	38472
9L-3S		MI	11322	4809	19492	3343	21576	2765	23098	2264	25620	1432	30668	944	23273
22-#10	2.77	MA	17949	4337	28120	3276	30913	2741	32440	2320	34095	1628	40598	1076	27493
7L-6S		MI	10107	4337	16328	3118	17585	2608	18249	2183	19030	1517	22410	1010	14920
22-#10	2.77	MA	17741	4337	27620	3285	30219	2760	31583	2326	33005	1648	39157	1036	27191
8L-5S		MI	10192	4337	16588	3112	17939	2602	18690	2178	19622	1503	23190	1069	15122
22-#10	2.77	MA	17561	4337	27124	3293	29556	2768	30757	2344	31920	1668	37755	996	26577
9L-4S		MI	10313	4337	16856	3104	18295	2584	19135	2161	20280	1500	24045	1119	15126
22-#10	2.77	MA	17340	4337	26552	3311	28891	2789	29930	2352	30741	1674	36322	962	26061
10L-3S		MI	10384	4337	17174	3084	18708	2577	19642	2156	20941	1487	24899	1170	15116
22-#10	2.77	MA	17136	4337	26049	3318	28220	2796	29125	2372	29631	1691	34932	919	25329
11L-2S		MI	10524	4337	17591	3076	19242	2559	20294	2139	21828	1473	26126	1260	15101
22-#11	3.40	MA	18569	4514	29450	3387	32552	2823	34411	2375	36724	1620	44284	985	33074
7L-6S		MI	10407	4514	17023	3226	18431	2675	19252	2219	20379	1492	24060	888	17757
22-#11	3.40	MA	18325	4514	28840	3398	31707	2846	33367	2382	35394	1644	42523	934	32381
8L-5S		MI	10508	4514	17356	3205	18860	2667	19786	2213	21096	1477	24981	958	17979
22-#11	3.40	MA	18107	4514	28179	3421	30898	2856	32361	2404	34083	1668	40804	884	31651
9L-4S		MI	10651	4514	17680	3195	19292	2646	20324	2194	21891	1476	25988	1021	18161
22-#11	3.40	MA	17842	4514	27545	3429	30087	2880	31353	2413	32653	1675	39051	840	30721
10L-3S		MI	10732	4514	18065	3172	19791	2639	20937	2189	22689	1460	26998	1081	18162
22-#11	3.40	MA	17597	4514	26933	3438	29279	2889	30371	2437	31300	1696	37351	786	29781
11L-2S		MI	10896	4514	18567	3163	20433	2618	21721	2169	23756	1445	28443	1191	18148
22-#14	4.91	MA	19753	4934	31703	3690	35310	3071	37744	2534	41305	1651	50904	711	44419
8L-5S		MI	11312	4934	19192	3466	21163	2860	22570	2331	24865	1443	29863	746	24766
22-#14	4.91	MA	19450	4934	30762	3725	34151	3085	36301	2566	39424	1685	48427	637	42702
9L-4S		MI	11511	4934	19655	3453	21778	2831	23338	2304	25999	1442	31271	836	25310

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

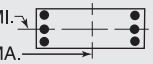
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#10	3.02	MA	18115	4407	28432	3329	31260	2791	32853	2345	34733	1643	41549	1029	29697
8L-6S		MI	10287	4407	16744	3162	18119	2640	18901	2202	19917	1511	23637	1002	16191
24-#10	3.02	MA	17938	4407	27936	3337	30597	2800	32027	2364	33648	1662	40148	988	29077
9L-5S		MI	10371	4407	17005	3156	18474	2633	19342	2197	20509	1497	24417	1061	16409
24-#10	3.02	MA	17717	4407	27364	3354	29932	2820	31200	2372	32468	1668	38714	954	28550
10L-4S		MI	10491	4407	17272	3148	18829	2615	19787	2180	21167	1495	25272	1111	16428
24-#10	3.02	MA	17516	4407	26861	3362	29261	2827	30394	2391	31359	1686	37324	912	27822
11L-3S		MI	10562	4407	17591	3128	19242	2608	20294	2175	21828	1481	26126	1162	16422
24-#10	3.02	MA	17328	4407	26317	3382	28578	2846	29604	2411	30262	1704	35730	861	27090
12L-2S		MI	10701	4407	18008	3120	19777	2590	20946	2158	22714	1467	27353	1252	16410
24-#11	3.71	MA	18773	4600	29827	3452	32972	2884	34911	2405	37494	1637	45431	925	35418
8L-6S		MI	10621	4600	17524	3280	19074	2713	20036	2242	21446	1486	25505	875	19286
24-#11	3.71	MA	18561	4600	29166	3475	32163	2894	33904	2428	36183	1661	43711	874	34687
9L-5S		MI	10721	4600	17858	3259	19503	2706	20570	2237	22163	1470	26426	945	19497
24-#11	3.71	MA	18297	4600	28532	3483	31353	2919	32897	2437	34753	1668	41959	830	33744
10L-4S		MI	10863	4600	18182	3249	19934	2685	21108	2218	22958	1469	27433	1008	19722
24-#11	3.71	MA	18055	4600	27920	3492	30545	2928	31914	2460	33400	1689	40259	776	32791
11L-3S		MI	10943	4600	18567	3226	20433	2678	21721	2212	23756	1453	28443	1068	19731
24-#14	5.36	MA	20095	5058	32174	3803	35961	3141	38509	2599	42430	1675	52589	623	47011
9L-5S		MI	11611	5058	19905	3543	22076	2916	23684	2365	26381	1433	31883	723	26928

RECTANGULAR TIED COLUMNS 24" x 44"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.52	MA	18792	4177	29786	3095	32341	2602	33568	2216	34690	1633	40284	1414	16980
2E		MI	9992	4177	16218	2915	17131	2449	17485	2083	17691	1526	19689	1265	8761
6-#14	1.28	MA	18476	4107	28945	3071	31367	2588	32427	2212	33166	1650	38196	1432	14515
2L-3S		MI	9622	4107	15129	2920	15821	2478	15924	2117	15583	1573	17122	1163	7623
6-#14	1.28	MA	17901	4107	27455	3092	29457	2607	30097	2249	29995	1684	33806	1296	14554
3L-2S		MI	9872	4107	15841	2907	16734	2448	17037	2090	17098	1553	19142	1322	7563
6-#18	2.27	MA	19950	4398	32396	3233	35687	2702	37651	2277	40244	1615	47975	1390	25166
2L-3S		MI	10088	4398	16218	3072	17131	2596	17485	2185	17691	1539	19689	931	12786
6-#18	2.27	MA	18986	4398	29786	3268	32341	2734	33568	2341	34690	1673	40284	1142	25110
3L-2S		MI	10503	4398	17445	3053	18704	2548	19404	2143	20302	1508	23056	1213	12693
8-#11	1.18	MA	18346	4079	28591	3063	30966	2584	31962	2211	32548	1658	37351	1440	13500
2L-4S		MI	9561	4079	14792	2940	15428	2479	15459	2120	14995	1596	16471	1175	7148
8-#11	1.18	MA	17943	4079	27551	3078	29632	2597	30334	2238	30333	1682	34285	1347	13528
3E		MI	9645	4079	15177	2917	15927	2472	16072	2115	15793	1581	17480	1236	7100
8-#11	1.18	MA	17713	4079	26774	3106	28623	2625	29093	2251	28627	1693	32293	1290	13537
4L-2S		MI	9823	4079	15678	2908	16570	2451	16856	2096	16860	1566	18925	1346	7062
8-#14	1.70	MA	19147	4232	30436	3149	33278	2644	34758	2246	36337	1640	42587	1418	19192
2L-4S		MI	9811	4232	15293	3030	16023	2543	16164	2157	15961	1584	17726	1056	9962
8-#14	1.70	MA	18585	4232	28945	3170	31367	2663	32427	2283	33166	1674	38196	1282	19210
3E		MI	9926	4232	15841	2998	16734	2534	17037	2151	17098	1563	19142	1141	9904
8-#14	1.70	MA	18261	4232	27832	3210	29921	2702	30648	2301	30720	1689	35330	1199	19132
4L-2S		MI	10173	4232	16554	2985	17647	2504	18151	2124	18614	1543	21162	1299	9849
8-#18	3.03	MA	21095	4619	35007	3371	39033	2801	41733	2337	45799	1597	55665	1365	33327
2L-4S		MI	10420	4619	16493	3264	17471	2709	17890	2252	18332	1552	20678	736	16221
8-#18	3.03	MA	20163	4619	32396	3407	35687	2833	37651	2401	40244	1656	47975	1117	33209
3E		MI	10605	4619	17445	3210	18704	2696	19404	2245	20302	1521	23056	879	16643
8-#18	3.03	MA	19619	4619	30440	3477	33145	2901	34524	2431	35948	1679	42903	967	32398
4L-2S		MI	11012	4619	18672	3192	20277	2648	21323	2203	22914	1491	26423	1160	16583
10-#10	1.20	MA	18412	4085	28642	3080	31104	2598	32163	2223	32843	1665	37777	1447	13800
2L-5S		MI	9517	4085	14707	2972	15370	2518	15405	2154	14876	1610	16431	1180	7310
10-#10	1.20	MA	18080	4085	27786	3093	30007	2609	30825	2245	31022	1686	35255	1372	13819
3L-4S		MI	9643	4085	14974	2964	15726	2500	15849	2138	15534	1607	17286	1231	7273
10-#10	1.20	MA	17887	4085	27149	3116	29180	2632	29806	2256	29622	1695	33629	1326	13828
4L-3S		MI	9716	4085	15293	2944	16139	2493	16357	2132	16195	1593	18139	1282	7240

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

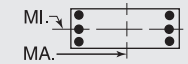
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	1.20	MA	17612	4085	26601	3126	28474	2644	28922	2278	28381	1716	31960	1293	13796
5L-2S		MI	9865	4085	15710	2936	16673	2475	17008	2116	17082	1580	19366	1371	7212
10-#11	1.48	MA	18818	4166	29632	3117	32301	2622	33590	2235	34762	1651	40418	1431	16768
2L-5S		MI	9627	4166	14969	3003	15640	2539	15705	2163	15267	1591	16908	1100	8792
10-#11	1.48	MA	18421	4166	28591	3132	30966	2636	31962	2261	32548	1675	37351	1337	16788
3L-4S		MI	9777	4166	15293	2994	16071	2518	16243	2144	16062	1589	17916	1162	8751
10-#11	1.48	MA	18193	4166	27815	3160	29958	2664	30721	2274	30842	1686	35360	1280	16779
4L-3S		MI	9861	4166	15678	2971	16570	2511	16856	2139	16860	1574	18925	1223	8709
10-#11	1.48	MA	17862	4166	27153	3173	29097	2677	29643	2301	29329	1710	33320	1238	16700
5L-2S		MI	10036	4166	16180	2962	17213	2490	17640	2119	17927	1559	20371	1333	8673
10-#14	2.13	MA	19812	4356	31926	3227	35188	2700	37088	2280	39508	1630	46977	1405	23859
2L-5S		MI	9904	4356	15542	3120	16321	2628	16510	2217	16343	1574	18338	943	12030
10-#14	2.13	MA	19262	4356	30436	3247	33278	2719	34758	2317	36337	1664	42587	1268	23854
3L-4S		MI	10115	4356	16005	3108	16936	2599	17278	2191	17477	1574	19746	1033	12204
10-#14	2.13	MA	18943	4356	29323	3288	31831	2758	32978	2335	33891	1679	39721	1185	23752
4L-3S		MI	10230	4356	16554	3076	17647	2590	18151	2184	18614	1553	21162	1119	12164
10-#14	2.13	MA	18475	4356	28378	3307	30596	2777	31431	2373	31721	1713	36791	1122	23191
5L-2S		MI	10472	4356	17266	3063	18560	2560	19265	2158	20129	1533	23182	1277	12117
10-#18	3.79	MA	21327	4841	35007	3545	39033	2933	41733	2462	45799	1638	55665	1093	41306
3L-4S		MI	10938	4841	17720	3403	19044	2808	19810	2313	20943	1534	24045	683	19798
10-#18	3.79	MA	20794	4841	33050	3616	36492	3000	38606	2491	41502	1661	50594	942	40335
4L-3S		MI	11120	4841	18672	3349	20277	2795	21323	2306	22914	1504	26423	826	20474
10-#18	3.79	MA	19996	4841	31411	3649	34318	3032	35885	2556	37687	1720	45426	822	37356
5L-2S		MI	11519	4841	19899	3330	21850	2747	23242	2263	25525	1473	29790	1108	20450
12-#10	1.44	MA	18803	4156	29498	3124	32202	2629	33502	2242	34665	1659	40299	1439	16485
2L-6S		MI	9608	4156	14863	3022	15550	2556	15615	2179	15171	1618	16878	1113	8654
12-#10	1.44	MA	18474	4156	28642	3137	31104	2641	32163	2264	32843	1680	37777	1364	16499
3L-5S		MI	9699	4156	15124	3016	15904	2549	16056	2174	15763	1604	17658	1172	8631
12-#10	1.44	MA	18283	4156	28005	3160	30277	2664	31145	2275	31443	1689	36151	1318	16496
4E		MI	9824	4156	15391	3008	16260	2531	16501	2157	16421	1602	18513	1223	8601
12-#10	1.44	MA	18011	4156	27457	3170	29571	2675	30261	2297	30202	1710	34482	1285	16453
5L-3S		MI	9897	4156	15710	2988	16673	2524	17008	2152	17082	1588	19366	1274	8571
12-#10	1.44	MA	17815	4156	26891	3176	28839	2695	29387	2308	29026	1730	32989	1235	16340
6L-2S		MI	10044	4156	16126	2980	17208	2506	17660	2135	17968	1574	20593	1363	8544
12-#11	1.77	MA	19287	4252	30673	3171	33635	2661	35217	2258	36977	1644	43485	1421	20029
2L-6S		MI	9735	4252	15137	3079	15853	2585	15955	2192	15617	1599	17432	1017	10256
12-#11	1.77	MA	18897	4252	29632	3186	32301	2675	33590	2285	34762	1668	40418	1328	20042
3L-5S		MI	9843	4252	15471	3057	16283	2578	16489	2187	16334	1584	18353	1087	10372
12-#11	1.77	MA	18670	4252	28856	3214	31292	2702	32348	2298	33056	1679	38427	1270	20017
4E		MI	9992	4252	15795	3048	16714	2557	17027	2167	17129	1582	19361	1149	10342
12-#11	1.77	MA	18343	4252	28194	3227	30431	2716	31270	2324	31544	1704	36387	1228	19925
5L-3S		MI	10075	4252	16180	3025	17213	2550	17640	2162	17927	1567	20371	1210	10306
12-#11	1.77	MA	18107	4252	27504	3233	29547	2741	30205	2337	30109	1728	34563	1165	19434
6L-2S		MI	10249	4252	16681	3016	17856	2528	18424	2143	18994	1552	21816	1320	10272
12-#14	2.56	MA	19934	4481	31926	3325	35188	2775	37088	2351	39508	1654	46977	1255	28493
3L-5S		MI	10209	4481	16254	3198	17234	2684	17624	2251	17859	1565	20358	920	14149
12-#14	2.56	MA	19619	4481	30813	3366	33742	2814	35309	2369	37062	1669	44111	1171	28372
4E		MI	10418	4481	16717	3186	17849	2655	18392	2225	18992	1564	21766	1011	14437
12-#14	2.56	MA	19158	4481	29869	3384	32507	2833	33762	2407	34892	1704	41181	1108	27735
5L-3S		MI	10532	4481	17266	3153	18560	2645	19265	2218	20129	1543	23182	1096	14410
12-#14	2.56	MA	18826	4481	28881	3393	31248	2869	32232	2424	32833	1738	38560	1015	26620
6L-2S		MI	10771	4481	17978	3141	19473	2616	20379	2192	21644	1523	25202	1255	14372
12-#18	4.55	MA	21955	5062	35660	3754	39838	3099	42689	2551	47056	1644	58284	918	48292
4E		MI	11452	5062	18947	3541	20617	2907	21729	2373	23554	1517	27412	631	23407

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

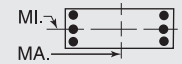


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	4.55	MA	21177	5062	34021	3788	37664	3132	39968	2616	43241	1702	53116	798	45357
5L-3S		MI	11632	5062	19899	3487	21850	2894	23242	2366	25525	1486	29790	774	24287
12-#18	4.55	MA	20614	5062	32288	3802	35484	3197	37276	2645	39618	1761	48492	627	42424
6L-2S		MI	12024	5062	21127	3468	23423	2846	25162	2324	28136	1455	33157	1055	24301
14-#10	1.68	MA	18867	4226	29498	3181	32202	2672	33502	2283	34665	1674	40299	1356	19175
3L-6S		MI	9790	4226	15280	3066	16084	2588	16267	2198	16058	1612	18105	1105	9955
14-#10	1.68	MA	18677	4226	28861	3204	31374	2695	32483	2294	33264	1684	38673	1310	19161
4L-5S		MI	9880	4226	15541	3060	16439	2581	16708	2193	16650	1598	18884	1164	9945
14-#10	1.68	MA	18407	4226	28313	3214	30669	2707	31600	2316	32024	1704	37003	1277	19110
5L-4S		MI	10004	4226	15808	3052	16795	2563	17153	2176	17308	1596	19739	1215	9921
14-#10	1.68	MA	18215	4226	27747	3220	29936	2727	30726	2327	30847	1725	35511	1227	18954
6L-3S		MI	10077	4226	16126	3032	17208	2556	17660	2171	17968	1582	20593	1266	9895
14-#10	1.68	MA	17996	4226	27142	3239	29203	2733	29859	2347	29630	1734	33776	1182	18462
7L-2S		MI	10223	4226	16543	3024	17742	2538	18312	2154	18855	1568	21820	1355	9870
14-#11	2.07	MA	19369	4338	30673	3240	33635	2713	35217	2308	36977	1661	43485	1318	23288
3L-6S		MI	9952	4338	15639	3133	16496	2624	16739	2216	16684	1592	18877	1004	11748
14-#11	2.07	MA	19145	4338	29897	3268	32626	2741	33976	2321	35271	1672	41493	1261	23252
4L-5S		MI	10059	4338	15972	3111	16926	2617	17273	2210	17401	1577	19799	1074	11944
14-#11	2.07	MA	18821	4338	29235	3281	31766	2755	32898	2348	33759	1697	39454	1218	23151
5L-4S		MI	10207	4338	16296	3102	17357	2596	17811	2191	18196	1576	20806	1136	11924
14-#11	2.07	MA	18590	4338	28545	3287	30882	2780	31832	2360	32323	1721	37630	1156	22620
6L-3S		MI	10290	4338	16681	3079	17856	2588	18424	2186	18994	1560	21816	1197	11895
14-#11	2.07	MA	18328	4338	27809	3310	29988	2787	30788	2385	30838	1732	35503	1099	22071
7L-2S		MI	10461	4338	17183	3070	18498	2567	19208	2166	20061	1545	23261	1307	11865
14-#14	2.98	MA	20290	4605	32303	3444	35652	2870	37639	2403	40233	1659	48502	1157	32992
4L-5S		MI	10514	4605	16967	3276	18147	2740	18738	2285	19374	1555	22378	898	16279
14-#14	2.98	MA	19837	4605	31359	3462	34417	2889	36093	2440	38063	1694	45572	1094	32288
5L-4S		MI	10720	4605	17429	3263	18762	2711	19505	2259	20507	1554	23786	989	16656
14-#14	2.98	MA	19513	4605	30371	3471	33158	2925	34563	2458	36004	1728	42951	1002	31209
6L-3S		MI	10833	4605	17978	3231	19473	2701	20379	2252	21644	1533	25202	1074	16649
14-#14	2.98	MA	19144	4605	29315	3504	31877	2935	33077	2494	33873	1743	39890	920	30083
7L-2S		MI	11069	4605	18690	3219	20386	2672	21492	2226	23160	1513	27222	1232	16619
14-#18	5.30	MA	22345	5283	36631	3926	41011	3231	44050	2676	48795	1685	60807	774	53358
5L-4S		MI	11965	5283	20174	3679	22190	3007	23648	2433	26165	1499	30779	578	27040
14-#18	5.30	MA	21803	5283	34898	3940	38830	3297	41358	2705	45172	1743	56182	602	50356
6L-3S		MI	12143	5283	21127	3625	23423	2994	25162	2426	28136	1468	33157	721	28092
14-#18	5.30	MA	21173	5283	33044	3997	36580	3313	38789	2770	41423	1767	50760	454	47438
7L-2S		MI	12527	5283	22354	3607	24996	2946	27081	2384	30747	1438	36524	1003	28144
16-#10	1.92	MA	19070	4296	29717	3248	32471	2727	33822	2313	35085	1678	41194	1302	21825
4L-6S		MI	9972	4296	15697	3110	16618	2619	16919	2217	16945	1607	19331	1098	11191
16-#10	1.92	MA	18802	4296	29169	3258	31766	2738	32938	2335	33845	1699	39525	1269	21767
5E		MI	10061	4296	15957	3104	16973	2612	17360	2212	17537	1593	20111	1157	11254
16-#10	1.92	MA	18612	4296	28602	3264	31033	2758	32065	2346	32668	1719	38033	1220	21572
6L-4S		MI	10184	4296	16225	3096	17329	2594	17805	2195	18194	1590	20966	1207	11236
16-#10	1.92	MA	18395	4296	27998	3283	30300	2765	31198	2366	31451	1729	36298	1174	21095
7L-3S		MI	10256	4296	16543	3076	17742	2587	18312	2190	18855	1577	21820	1258	11213
16-#10	1.92	MA	18161	4296	27471	3292	29570	2784	30296	2372	30304	1749	34784	1135	20744
8L-2S		MI	10401	4296	16960	3068	18276	2569	18964	2173	19742	1563	23047	1347	11191
16-#11	2.36	MA	19617	4425	30938	3322	33961	2780	35604	2345	37486	1665	44560	1251	26487
4L-6S		MI	10169	4425	16140	3187	17139	2663	17523	2239	17751	1586	20322	991	13266
16-#11	2.36	MA	19297	4425	30275	3335	33100	2793	34526	2371	35973	1690	42520	1209	26377
5E		MI	10274	4425	16474	3165	17568	2656	18057	2234	18468	1570	21244	1061	13513
16-#11	2.36	MA	19070	4425	29586	3341	32216	2818	33460	2384	34538	1714	40696	1146	25809
6L-4S		MI	10421	4425	16798	3156	17999	2634	18595	2215	19263	1569	22251	1123	13501
16-#11	2.36	MA	18810	4425	28850	3364	31322	2826	32416	2408	33053	1725	38570	1090	25278
7L-3S		MI	10503	4425	17183	3133	18498	2627	19208	2209	20061	1553	23261	1184	13478
16-#11	2.36	MA	18530	4425	28207	3375	30432	2849	31316	2416	31654	1749	36719	1040	24652
8L-2S		MI	10673	4425	17684	3124	19141	2606	19992	2190	21128	1538	24706	1294	13451

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

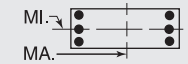
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.41	MA	20510	4730	32849	3540	36327	2945	38423	2474	41234	1684	49962	1080	36849
5E		MI	10817	4730	17679	3354	19060	2796	19852	2319	20889	1545	24398	876	18418
16-#14	3.41	MA	20195	4730	31861	3549	35068	2981	36894	2492	39175	1718	47341	988	35803
6L-4S		MI	11021	4730	18141	3341	19675	2767	20619	2293	22023	1544	25806	966	18870
16-#14	3.41	MA	19828	4730	30805	3582	33788	2991	35408	2527	37044	1733	44280	906	34642
7L-3S		MI	11133	4730	18690	3309	20386	2757	21492	2286	23160	1524	27222	1052	18881
16-#14	3.41	MA	19434	4730	29884	3597	32511	3024	33831	2538	35035	1767	41619	832	33277
8L-2S		MI	11366	4730	19402	3296	21299	2728	22606	2260	24675	1503	29242	1210	18859
16-#18	6.06	MA	22980	5505	37508	4079	42176	3396	45440	2766	50727	1726	63873	578	58288
6L-4S		MI	12475	5505	21401	3818	23763	3106	25567	2494	28776	1481	34146	526	30694
16-#18	6.06	MA	22355	5505	35654	4135	39926	3412	42871	2830	46978	1749	58451	430	55320
7L-3S		MI	12651	5505	22354	3764	24996	3093	27081	2487	30747	1451	36524	669	31892
18-#10	2.16	MA	19195	4366	30025	3302	32863	2770	34277	2355	35666	1693	42047	1262	24424
5L-6S		MI	10153	4366	16113	3154	17153	2651	17571	2236	17831	1601	20558	1090	12455
18-#10	2.16	MA	19008	4366	29458	3308	32131	2790	33403	2365	34490	1714	40555	1212	24195
6L-5S		MI	10241	4366	16374	3148	17507	2644	18012	2231	18424	1587	21338	1149	12560
18-#10	2.16	MA	18791	4366	28854	3327	31397	2796	32537	2385	33272	1723	38819	1167	23731
7L-4S		MI	10364	4366	16641	3140	17863	2626	18456	2214	19081	1585	22193	1199	12547
18-#10	2.16	MA	18562	4366	28327	3336	30667	2815	31634	2391	32125	1744	37306	1128	23389
8L-3S		MI	10435	4366	16960	3120	18276	2619	18964	2209	19742	1571	23047	1250	12528
18-#10	2.16	MA	18366	4366	27803	3344	29969	2824	30765	2410	30974	1763	35836	1087	22809
9L-2S		MI	10579	4366	17377	3112	18810	2601	19616	2192	20629	1557	24274	1340	12508
18-#11	2.66	MA	19770	4511	31316	3389	34434	2832	36154	2395	38188	1683	45587	1199	29604
5L-6S		MI	10385	4511	16641	3241	17782	2702	18308	2263	18818	1579	21767	978	14788
18-#11	2.66	MA	19547	4511	30627	3395	33550	2857	35088	2407	36753	1707	43763	1137	29003
6L-5S		MI	10489	4511	16975	3219	18211	2694	18841	2257	19535	1563	22689	1048	15041
18-#11	2.66	MA	19288	4511	29891	3418	32657	2864	34043	2432	35268	1718	41637	1080	28488
7L-4S		MI	10634	4511	17299	3210	18642	2673	19379	2238	20330	1562	23696	1110	15074
18-#11	2.66	MA	19015	4511	29248	3429	31767	2887	32944	2439	33868	1743	39786	1031	27853
8L-3S		MI	10716	4511	17684	3187	19141	2666	19992	2233	21128	1546	24706	1171	15056
18-#11	2.66	MA	18778	4511	28615	3439	30915	2898	31884	2462	32483	1767	37983	980	27050
9L-2S		MI	10884	4511	18185	3177	19784	2645	20777	2213	22195	1531	26151	1281	15033
18-#14	3.84	MA	20871	4854	33351	3627	36979	3037	39224	2526	42346	1708	51732	974	40401
6L-5S		MI	11118	4854	18391	3431	19973	2852	20965	2353	22405	1535	26418	854	20564
18-#14	3.84	MA	20507	4854	32296	3659	35698	3047	37738	2561	40215	1723	48671	892	39202
7L-4S		MI	11321	4854	18853	3419	20588	2822	21733	2327	23538	1534	27826	944	21081
18-#14	3.84	MA	20125	4854	31374	3675	34422	3079	36162	2572	38206	1757	46010	819	37847
8L-3S		MI	11432	4854	19402	3387	21299	2813	22606	2320	24675	1514	29242	1029	21108
18-#14	3.84	MA	19788	4854	30377	3709	33200	3094	34641	2603	36227	1792	43412	745	36252
9L-2S		MI	11663	4854	20115	3374	22212	2784	23720	2294	26191	1493	31262	1188	21094
18-#18	6.82	MA	23526	5726	38265	4274	43273	3511	46954	2891	52532	1731	66141	405	63201
7L-4S		MI	12984	5726	22628	3956	25336	3205	27486	2554	31387	1464	37513	473	34363
20-#10	2.41	MA	19402	4437	30314	3352	33228	2821	34742	2385	36311	1708	43076	1204	26820
6E		MI	10334	4437	16530	3198	17687	2682	18223	2256	18718	1595	21785	1082	13722
20-#10	2.41	MA	19186	4437	29710	3371	32494	2828	33875	2404	35093	1717	41341	1159	26368
7L-5S		MI	10421	4437	16791	3192	18041	2675	18664	2250	19310	1582	22565	1141	13864
20-#10	2.41	MA	18962	4437	29183	3380	31764	2847	32973	2410	33946	1738	39827	1120	26035
8L-4S		MI	10543	4437	17058	3184	18397	2657	19108	2234	19968	1579	23420	1191	13855
20-#10	2.41	MA	18768	4437	28659	3388	31066	2856	32104	2429	32795	1757	38358	1079	25445
9L-3S		MI	10614	4437	17377	3164	18810	2651	19616	2228	20629	1565	24274	1242	13840
20-#10	2.41	MA	18531	4437	28056	3406	30367	2876	31234	2438	31554	1763	36852	1046	24895
10L-2S		MI	10756	4437	17793	3156	19345	2632	20267	2212	21516	1552	25500	1332	13822
20-#11	2.95	MA	20021	4597	31668	3449	34885	2896	36716	2431	38968	1700	46830	1127	32201
6E		MI	10600	4597	17143	3295	18425	2740	19092	2286	19885	1572	23212	965	16312

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.95	MA	19764	4597	30931	3472	33991	2903	35671	2455	37483	1711	44703	1071	31700
7L-5S		MI	10703	4597	17476	3273	18854	2733	19626	2281	20602	1556	24134	1035	16552
20-#11	2.95	MA	19497	4597	30289	3483	33101	2926	34572	2463	36083	1736	42852	1021	31052
8L-4S		MI	10847	4597	17800	3264	19285	2712	20164	2262	21397	1555	25141	1097	16644
20-#11	2.95	MA	19264	4597	29656	3493	32250	2936	33512	2485	34698	1760	41049	971	30253
9L-3S		MI	10928	4597	18185	3241	19784	2705	20777	2256	22195	1540	26151	1158	16631
20-#11	2.95	MA	18980	4597	28922	3514	31396	2961	32451	2495	33185	1767	39208	928	29352
10L-2S		MI	11095	4597	18687	3231	20427	2683	21561	2237	23262	1524	27596	1268	16612
20-#14	4.26	MA	21181	4979	33786	3737	37608	3103	40069	2595	43386	1713	53061	878	43761
7L-5S		MI	11419	4979	19103	3509	20886	2908	22079	2387	23920	1525	28438	831	22716
20-#14	4.26	MA	20815	4979	32864	3752	36332	3135	38492	2605	41377	1748	50401	805	42417
8L-4S		MI	11621	4979	19566	3497	21501	2878	22847	2361	25054	1524	29846	922	23290
20-#14	4.26	MA	20481	4979	31867	3787	35111	3150	36972	2637	39397	1782	47803	732	40799
9L-3S		MI	11731	4979	20115	3465	22212	2869	23720	2354	26191	1504	31262	1007	23327
22-#10	2.65	MA	19579	4507	30566	3415	33592	2859	35214	2423	36915	1712	43863	1151	29008
7L-6S		MI	10514	4507	16947	3242	18221	2714	18874	2275	19605	1590	23012	1074	14990
22-#10	2.65	MA	19359	4507	30039	3424	32862	2878	34312	2430	35768	1732	42349	1112	28683
8L-5S		MI	10600	4507	17208	3236	18576	2707	19315	2269	20197	1576	23792	1133	15163
22-#10	2.65	MA	19168	4507	29515	3431	32163	2887	33442	2448	34617	1751	40879	1072	28082
9L-4S		MI	10721	4507	17475	3227	18932	2689	19760	2253	20855	1573	24647	1183	15162
22-#10	2.65	MA	18932	4507	28912	3449	31464	2908	32572	2457	33376	1758	39374	1039	27533
10L-3S		MI	10792	4507	17793	3208	19345	2682	20267	2247	21516	1560	25500	1234	15150
22-#10	2.65	MA	18717	4507	28383	3457	30754	2915	31725	2477	32208	1776	37914	997	26808
11L-2S		MI	10933	4507	18210	3200	19879	2664	20919	2231	22402	1546	26727	1324	15134
22-#11	3.25	MA	20237	4683	31972	3526	35325	2942	37299	2479	39697	1704	47770	1061	34914
7L-6S		MI	10814	4683	17644	3348	19067	2779	19876	2310	20952	1565	24657	952	17839
22-#11	3.25	MA	19976	4683	31330	3537	34435	2965	36200	2486	38298	1729	45919	1011	34250
8L-5S		MI	10916	4683	17978	3327	19497	2772	20410	2304	21669	1550	25579	1022	18067
22-#11	3.25	MA	19747	4683	30697	3547	33584	2975	35140	2509	36913	1753	44116	961	33456
9L-4S		MI	11060	4683	18302	3318	19928	2751	20948	2285	22464	1548	26586	1084	18211
22-#11	3.25	MA	19465	4683	29963	3568	32731	3000	34079	2518	35400	1760	42275	919	32541
10L-3S		MI	11140	4683	18687	3295	20427	2743	21561	2280	23262	1533	27596	1145	18203
22-#11	3.25	MA	19205	4683	29318	3578	31874	3009	33045	2542	33976	1781	40489	866	31620
11L-2S		MI	11305	4683	19188	3285	21070	2722	22345	2260	24329	1517	29041	1255	18188
22-#14	4.69	MA	21491	5103	34355	3830	38242	3191	40823	2639	44548	1738	54791	791	46987
8L-5S		MI	11719	5103	19815	3587	21799	2964	23193	2421	25436	1515	30458	809	24873
22-#14	4.69	MA	21169	5103	33357	3864	37021	3205	39303	2671	42568	1772	52193	718	45346
9L-4S		MI	11919	5103	20278	3575	22414	2934	23961	2395	26569	1514	31866	899	25434
24-#10	2.89	MA	19754	4577	30895	3468	33959	2910	35650	2449	37589	1727	44871	1104	31332
8L-6S		MI	10694	4577	17364	3286	18755	2745	19526	2294	20492	1584	24239	1066	16261
24-#10	2.89	MA	19566	4577	30371	3475	33261	2919	34781	2468	36438	1746	43401	1064	30718
9L-5S		MI	10779	4577	17624	3280	19110	2738	19967	2288	21084	1570	25019	1125	16461
24-#10	2.89	MA	19331	4577	29768	3493	32561	2939	33911	2476	35197	1752	41896	1031	30171
10L-4S		MI	10899	4577	17892	3271	19466	2720	20412	2272	21742	1568	25874	1175	16466
24-#10	2.89	MA	19118	4577	29239	3501	31851	2946	33063	2496	34029	1770	40435	990	29437
11L-3S		MI	10970	4577	18210	3252	19879	2714	20919	2266	22402	1554	26727	1227	16457
24-#10	2.89	MA	18918	4577	28666	3521	31131	2965	32232	2516	32876	1789	38764	940	28723
12L-2S		MI	11110	4577	18627	3244	20413	2696	21571	2250	23289	1540	27954	1316	16444
24-#11	3.55	MA	20453	4770	32371	3591	35770	3003	37827	2510	40513	1722	48986	1002	37448
8L-6S		MI	11028	4770	18146	3402	19710	2818	20660	2333	22019	1558	26103	939	19368
24-#11	3.55	MA	20227	4770	31737	3601	34918	3014	36768	2532	39127	1746	47183	952	36659
9L-5S		MI	11129	4770	18479	3381	20140	2811	21194	2328	22736	1543	27024	1009	19585
24-#11	3.55	MA	19946	4770	31003	3622	34065	3039	35707	2542	37615	1753	45341	909	35730
10L-4S		MI	11271	4770	18803	3372	20571	2789	21732	2309	23531	1541	28031	1071	19771
24-#11	3.55	MA	19690	4770	30359	3631	33208	3048	34673	2566	36191	1774	43555	857	34795
11L-3S		MI	11352	4770	19188	3349	21070	2782	22345	2303	24329	1526	29041	1132	19774
24-#14	5.11	MA	21852	5228	34847	3942	38932	3261	41633	2705	45739	1762	56584	704	49893
9L-5S		MI	12019	5228	20527	3665	22712	3019	24307	2455	26951	1505	32478	787	27034

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

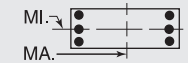
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.45	MA	20457	4346	32299	3233	35074	2720	36380	2319	37509	1714	43479	1486	17844
2E		MI	10400	4346	16844	3035	17767	2551	18106	2172	18258	1597	20277	1327	8798
6-#14	1.22	MA	20121	4277	31410	3209	34043	2706	35172	2314	35896	1731	41268	1504	15244
2L-3S		MI	10029	4277	15752	3041	16457	2581	16546	2207	16153	1645	17717	1226	7653
6-#14	1.22	MA	19512	4277	29842	3230	32033	2725	32719	2353	32559	1766	36649	1369	15283
3L-2S		MI	10279	4277	16464	3029	17370	2552	17660	2181	17669	1625	19737	1385	7593
6-#18	2.17	MA	21682	4568	35048	3371	38598	2819	40679	2379	43358	1696	51577	1461	26462
2L-3S		MI	10495	4568	16844	3192	17767	2699	18106	2274	18258	1610	20277	993	12834
6-#18	2.17	MA	20659	4568	32299	3407	35074	2852	36380	2445	37509	1756	43479	1216	26406
3L-2S		MI	10911	4568	18071	3173	19340	2651	20025	2232	20869	1579	23644	1275	12737
8-#11	1.13	MA	19982	4249	31035	3201	33619	2701	34679	2314	35241	1739	40374	1512	14173
2L-4S		MI	9968	4249	15413	3062	16065	2584	16082	2211	15568	1669	17068	1239	7174
8-#11	1.13	MA	19555	4249	29940	3216	32215	2715	32967	2341	32912	1764	37149	1420	14202
3E		MI	10053	4249	15798	3039	16564	2577	16695	2206	16366	1653	18078	1299	7126
8-#11	1.13	MA	19310	4249	29125	3245	31156	2743	31663	2354	31119	1775	35063	1362	14211
4L-2S		MI	10230	4249	16300	3030	17206	2555	17479	2187	17433	1638	19523	1409	7089
8-#14	1.63	MA	20830	4402	32978	3287	36053	2761	37624	2348	39232	1721	45888	1490	20164
2L-4S		MI	10218	4402	15915	3152	16659	2647	16787	2247	16532	1656	18320	1119	10000
8-#14	1.63	MA	20234	4402	31410	3308	34043	2781	35172	2386	35896	1756	41268	1355	20182
3E		MI	10334	4402	16464	3119	17370	2637	17660	2241	17669	1635	19737	1204	9939
8-#14	1.63	MA	19888	4402	30240	3349	32524	2821	33301	2405	33325	1772	38266	1272	20104
4L-2S		MI	10580	4402	17177	3107	18283	2608	18774	2215	19184	1615	21757	1362	9883
8-#18	2.90	MA	22894	4789	37797	3509	42121	2919	44977	2439	49206	1679	59675	1437	35055
2L-4S		MI	10828	4789	17118	3384	18106	2811	18511	2342	18899	1623	21267	798	16402
8-#18	2.90	MA	21905	4789	35048	3545	38598	2952	40679	2505	43358	1739	51577	1192	34937
3E		MI	11013	4789	18071	3330	19340	2798	20025	2335	20869	1592	23644	941	16698
8-#18	2.90	MA	21323	4789	32991	3617	35925	3020	37391	2535	38840	1763	46263	1042	34330
4L-2S		MI	11420	4789	19298	3312	20913	2750	21944	2292	23480	1562	27011	1222	16632
10-#10	1.15	MA	20051	4255	31085	3218	33760	2715	34887	2326	35547	1747	40815	1518	14486
2L-5S		MI	9924	4255	15326	3096	16006	2623	16030	2246	15451	1683	17032	1244	7336
10-#10	1.15	MA	19698	4255	30185	3231	32607	2727	33479	2348	33632	1768	38163	1444	14505
3L-4S		MI	10050	4255	15594	3087	16362	2605	16474	2230	16109	1680	17887	1295	7297
10-#10	1.15	MA	19494	4255	29517	3255	31738	2750	32410	2359	32161	1777	36461	1398	14513
4L-3S		MI	10124	4255	15912	3068	16775	2598	16982	2224	16770	1667	18741	1346	7263
10-#10	1.15	MA	19203	4255	28939	3265	30998	2762	31482	2381	30859	1798	34710	1366	14482
5L-2S		MI	10273	4255	16329	3060	17310	2580	17633	2208	17656	1653	19968	1435	7236
10-#11	1.41	MA	20481	4335	32130	3255	35022	2740	36391	2337	37571	1732	43600	1502	17610
2L-5S		MI	10034	4335	15591	3126	16276	2644	16328	2254	15839	1663	17506	1163	8826
10-#11	1.41	MA	20060	4335	31035	3270	33619	2754	34679	2364	35241	1757	40374	1410	17630
3L-4S		MI	10184	4335	15915	3116	16707	2623	16866	2235	16634	1662	18513	1226	8782
10-#11	1.41	MA	19817	4335	30220	3299	32559	2782	33375	2377	33449	1768	38289	1353	17621
4L-3S		MI	10268	4335	16300	3093	17206	2615	17479	2230	17433	1646	19523	1286	8739
10-#11	1.41	MA	19467	4335	29521	3311	31656	2796	32243	2404	31860	1793	36149	1312	17542
5L-2S		MI	10444	4335	16801	3084	17849	2594	18264	2210	18500	1631	20968	1396	8702
10-#14	2.04	MA	21533	4526	34546	3365	38064	2817	40076	2382	42569	1711	50508	1476	25074
2L-5S		MI	10311	4526	16165	3242	16957	2732	17133	2308	16914	1646	18932	1006	12142
10-#14	2.04	MA	20950	4526	32978	3386	36053	2837	37624	2420	39232	1747	45888	1341	25069
3L-4S		MI	10523	4526	16628	3229	17572	2703	17900	2281	18047	1646	20340	1096	12247
10-#14	2.04	MA	20609	4526	31808	3427	34534	2877	35754	2439	36661	1762	42886	1259	24967
4L-3S		MI	10637	4526	17177	3197	18283	2693	18774	2275	19184	1625	21757	1182	12202
10-#14	2.04	MA	20114	4526	30811	3445	33237	2896	34129	2477	34382	1797	39812	1197	24501
5L-2S		MI	10880	4526	17889	3185	19196	2664	19887	2248	20700	1605	23777	1340	12154

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

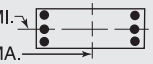


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.62	MA	23136	5010	37797	3684	42121	3051	44977	2565	49206	1721	59675	1167	43466
3L-4S		MI	11345	5010	18345	3523	19680	2910	20430	2402	21510	1605	24634	745	19974
10-#18	3.62	MA	22566	5010	35740	3755	39449	3120	41690	2596	44688	1746	54361	1018	42726
4L-3S		MI	11527	5010	19298	3469	20913	2897	21944	2395	23480	1575	27011	888	20537
10-#18	3.62	MA	21722	5010	34006	3789	37165	3153	38831	2661	40678	1806	48937	902	39457
5L-2S		MI	11927	5010	20525	3450	22486	2849	23863	2353	26091	1544	30378	1170	20502
12-#10	1.38	MA	20463	4325	31985	3262	34914	2747	36294	2345	37462	1741	43466	1510	17308
2L-6S		MI	10015	4325	15482	3146	16186	2661	16240	2271	15746	1691	17479	1177	8687
12-#10	1.38	MA	20115	4325	31085	3275	33760	2759	34887	2367	35547	1762	40815	1437	17322
3L-5S		MI	10106	4325	15743	3140	16541	2655	16681	2265	16338	1677	18259	1236	8660
12-#10	1.38	MA	19912	4325	30417	3299	32892	2782	33817	2378	34076	1772	39112	1390	17319
4E		MI	10231	4325	16010	3131	16897	2637	17126	2249	16996	1675	19114	1287	8628
12-#10	1.38	MA	19624	4325	29839	3309	32151	2794	32889	2400	32774	1793	37362	1358	17276
5L-3S		MI	10304	4325	16329	3112	17310	2630	17633	2243	17656	1661	19968	1338	8597
12-#10	1.38	MA	19417	4325	29244	3314	31378	2814	31973	2412	31539	1813	35797	1309	17167
6L-2S		MI	10452	4325	16746	3104	17844	2612	18285	2227	18543	1647	21195	1427	8570
12-#11	1.70	MA	20977	4422	33225	3309	36426	2779	38103	2361	39900	1725	46825	1493	21040
2L-6S		MI	10143	4422	15759	3201	16490	2690	16579	2283	16189	1672	18030	1080	10337
12-#11	1.70	MA	20562	4422	32130	3324	35022	2793	36391	2388	37571	1750	43600	1401	21053
3L-5S		MI	10250	4422	16092	3180	16919	2682	17112	2278	16906	1656	18951	1150	10409
12-#11	1.70	MA	20321	4422	31315	3353	33963	2821	35087	2401	35778	1762	41514	1343	21028
4E		MI	10400	4422	16416	3170	17350	2661	17651	2258	17701	1655	19958	1213	10376
12-#11	1.70	MA	19975	4422	30616	3365	33059	2835	33955	2428	34190	1787	39375	1302	20936
5L-3S		MI	10483	4422	16801	3147	17849	2654	18264	2253	18500	1640	20968	1273	10338
12-#11	1.70	MA	19726	4422	29891	3372	32125	2859	32836	2441	32683	1811	37462	1240	20488
6L-2S		MI	10657	4422	17303	3138	18492	2633	19048	2234	19566	1624	22413	1383	10304
12-#14	2.45	MA	21660	4651	34546	3463	38064	2893	40076	2454	42569	1737	50508	1328	29951
3L-5S		MI	10617	4651	16877	3320	17870	2788	18247	2342	18429	1636	20952	984	14259
12-#14	2.45	MA	21324	4651	33376	3505	36544	2932	38206	2473	39998	1752	47506	1245	29830
4E		MI	10826	4651	17340	3307	18485	2759	19014	2315	19563	1636	22360	1074	14482
12-#14	2.45	MA	20837	4651	32379	3523	35247	2952	36582	2511	37719	1787	44432	1183	29287
5L-3S		MI	10939	4651	17889	3275	19196	2749	19887	2309	20700	1615	23777	1159	14452
12-#14	2.45	MA	20486	4651	31340	3532	33916	2988	34975	2529	35556	1822	41683	1092	28071
6L-2S		MI	11179	4651	18601	3262	20109	2720	21001	2282	22215	1595	25797	1318	14411
12-#18	4.35	MA	23794	5232	38488	3893	42973	3219	45988	2656	50537	1728	62459	993	51117
4E		MI	11860	5232	19573	3661	21253	3010	22349	2462	24121	1588	28001	693	23579
12-#18	4.35	MA	22970	5232	36755	3927	40689	3252	43129	2722	46527	1788	57035	877	47883
5L-3S		MI	12040	5232	20525	3607	22486	2997	23863	2455	26091	1557	30378	836	24355
12-#18	4.35	MA	22375	5232	34931	3942	38380	3317	40301	2752	42720	1848	52183	709	44956
6L-2S		MI	12433	5232	21752	3588	24059	2949	25782	2413	28702	1526	33745	1117	24357
14-#10	1.61	MA	20529	4396	31985	3319	34914	2790	36294	2386	37462	1756	43466	1429	20135
3L-6S		MI	10198	4396	15899	3189	16720	2693	16892	2290	16633	1685	18706	1170	9995
14-#10	1.61	MA	20328	4396	31317	3342	34045	2813	35224	2397	35991	1766	41763	1383	20121
4L-5S		MI	10287	4396	16160	3184	17075	2686	17333	2285	17225	1672	19486	1229	9976
14-#10	1.61	MA	20043	4396	30739	3353	33305	2825	34297	2420	34689	1787	40013	1351	20070
5L-4S		MI	10412	4396	16427	3175	17431	2668	17778	2268	17882	1669	20341	1279	9950
14-#10	1.61	MA	19839	4396	30143	3358	32532	2845	33380	2431	33454	1808	38448	1302	19955
6L-3S		MI	10484	4396	16746	3156	17844	2661	18285	2263	18543	1655	21195	1330	9923
14-#10	1.61	MA	19606	4396	29509	3378	31761	2852	32465	2450	32176	1817	36632	1257	19435
7L-2S		MI	10631	4396	17162	3147	18378	2643	18937	2246	19430	1642	22421	1419	9897
14-#11	1.98	MA	21062	4508	33225	3378	36426	2831	38103	2411	39900	1743	46825	1391	24468
3L-6S		MI	10360	4508	16260	3255	17132	2729	17363	2307	17256	1665	19475	1067	11829
14-#11	1.98	MA	20823	4508	32410	3407	35366	2859	36799	2424	38108	1755	44740	1334	24432
4L-5S		MI	10466	4508	16594	3234	17562	2721	17897	2301	17973	1650	20396	1137	11985
14-#11	1.98	MA	20480	4508	31710	3419	34463	2873	35667	2451	36519	1780	42601	1293	24330
5L-4S		MI	10614	4508	16918	3224	17993	2700	18435	2282	18768	1648	21403	1200	11961
14-#11	1.98	MA	20236	4508	30986	3426	33529	2898	34549	2464	35013	1805	40688	1231	23840
6L-3S		MI	10697	4508	17303	3201	18492	2693	19048	2277	19566	1633	22413	1260	11929

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

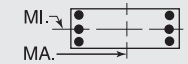
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.98	MA	19958	4508	30212	3449	32590	2906	33444	2488	33454	1816	38462	1175	23244
7L-2S		MI	10869	4508	17804	3192	19135	2672	19832	2257	20633	1617	23858	1370	11898
14-#14	2.85	MA	22033	4775	34944	3582	38554	2988	40658	2506	43335	1742	52126	1231	34693
4L-5S		MI	10921	4775	17589	3397	18783	2844	19360	2376	19945	1627	22972	961	16388
14-#14	2.85	MA	21553	4775	33947	3601	37257	3008	39034	2545	41055	1777	49052	1169	34081
5L-4S		MI	11128	4775	18052	3385	19398	2814	20128	2349	21078	1626	24380	1052	16709
14-#14	2.85	MA	21211	4775	32908	3610	35926	3044	37428	2563	38893	1813	46303	1079	32903
6L-3S		MI	11241	4775	18601	3353	20109	2805	21001	2343	22215	1605	25797	1137	16693
14-#14	2.85	MA	20818	4775	31799	3643	34580	3054	35855	2598	36655	1828	43097	997	31813
7L-2S		MI	11478	4775	19313	3340	21022	2776	22115	2316	23730	1585	27817	1295	16660
14-#18	5.07	MA	24205	5453	39503	4065	44213	3351	47428	2782	52375	1770	65133	853	56308
5L-4S		MI	12372	5453	20800	3799	22826	3109	24268	2523	26732	1570	31368	641	27209
14-#18	5.07	MA	23632	5453	37680	4080	41904	3417	44599	2812	48569	1830	60281	685	53310
6L-3S		MI	12550	5453	21752	3745	24059	3096	25782	2516	28702	1539	33745	783	28163
14-#18	5.07	MA	22960	5453	35730	4138	39538	3433	41877	2876	44629	1855	54602	538	50373
7L-2S		MI	12936	5453	22979	3727	25632	3048	27701	2473	31314	1509	37112	1065	28205
16-#10	1.84	MA	20742	4466	32216	3386	35199	2845	36632	2416	37906	1760	44414	1375	22922
4L-6S		MI	10379	4466	16316	3233	17255	2725	17544	2309	17519	1680	19933	1162	11290
16-#10	1.84	MA	20459	4466	31638	3396	34458	2857	35704	2439	36603	1781	42664	1343	22864
5E		MI	10468	4466	16577	3227	17609	2718	17985	2304	18112	1666	20713	1221	11288
16-#10	1.84	MA	20259	4466	31043	3402	33685	2877	34787	2450	35368	1802	41099	1294	22726
6L-4S		MI	10592	4466	16844	3219	17965	2700	18430	2287	18769	1663	21568	1271	11267
16-#10	1.84	MA	20027	4466	30409	3421	32915	2883	33872	2469	34091	1812	39283	1249	22205
7L-3S		MI	10664	4466	17162	3200	18378	2693	18937	2282	19430	1650	22421	1322	11243
16-#10	1.84	MA	19780	4466	29856	3431	32148	2902	32924	2476	32887	1833	37696	1211	21827
8L-2S		MI	10809	4466	17579	3191	18913	2675	19589	2265	20317	1636	23648	1412	11219
16-#11	2.26	MA	21321	4594	33504	3461	36770	2898	38511	2448	40437	1748	47965	1324	27835
4L-6S		MI	10576	4594	16761	3309	17775	2767	18147	2330	18323	1658	20920	1054	13346
16-#11	2.26	MA	20983	4594	32805	3473	35866	2912	37380	2475	38849	1773	45826	1283	27725
5E		MI	10682	4594	17095	3287	18205	2760	18681	2325	19040	1643	21841	1124	13556
16-#11	2.26	MA	20743	4594	32080	3480	34932	2937	36261	2488	37342	1798	43913	1221	27197
6L-4S		MI	10828	4594	17419	3278	18636	2739	19219	2306	19835	1641	22848	1187	13540
16-#11	2.26	MA	20466	4594	31307	3503	33993	2944	35156	2512	35783	1809	41687	1165	26619
7L-3S		MI	10911	4594	17804	3255	19135	2731	19832	2300	20633	1626	23858	1247	13514
16-#11	2.26	MA	20170	4594	30632	3514	33058	2968	34001	2520	34314	1834	39747	1117	26032
8L-2S		MI	11081	4594	18306	3246	19778	2710	20616	2281	21700	1610	25303	1357	13486
16-#14	3.26	MA	22265	4900	35515	3679	39267	3064	41486	2579	44392	1767	53672	1156	38883
5E		MI	11224	4900	18302	3475	19696	2900	20474	2410	21460	1617	24992	939	18526
16-#14	3.26	MA	21931	4900	34476	3688	37936	3100	39880	2597	42229	1803	50923	1065	37739
6L-4S		MI	11429	4900	18764	3463	20311	2870	21242	2383	22593	1616	26401	1030	18926
16-#14	3.26	MA	21541	4900	33367	3721	36590	3110	38308	2632	39992	1818	47717	984	36611
7L-3S		MI	11541	4900	19313	3430	21022	2861	22115	2377	23730	1595	27817	1115	18927
16-#14	3.26	MA	21123	4900	32399	3736	35249	3143	36651	2642	37883	1853	44927	912	35140
8L-2S		MI	11775	4900	20025	3418	21935	2831	23229	2350	25246	1575	29837	1273	18902
16-#18	5.80	MA	24876	5674	40428	4219	45427	3516	48898	2873	54417	1813	68379	660	61663
6L-4S		MI	12883	5674	22027	3937	24399	3208	26187	2583	29343	1552	34735	588	30859
16-#18	5.80	MA	24210	5674	38479	4276	43062	3533	46176	2936	50478	1837	62700	513	58690
7L-3S		MI	13059	5674	22979	3884	25632	3195	27701	2576	31314	1522	37112	731	31965
16-#18	5.80	MA	23498	5674	36775	4302	40703	3590	43263	2953	46764	1897	57772	379	54731
8L-2S		MI	13439	5674	24206	3865	27205	3147	29620	2534	33925	1491	40479	1012	32031
18-#10	2.07	MA	20874	4536	32538	3440	35612	2888	37111	2458	38518	1776	45315	1335	25658
5L-6S		MI	10561	4536	16733	3277	17789	2756	18196	2328	18406	1674	21160	1154	12524
18-#10	2.07	MA	20677	4536	31943	3446	34839	2908	36194	2469	37283	1797	43750	1286	25484
6L-5S		MI	10648	4536	16993	3271	18144	2749	18637	2323	18999	1660	21940	1213	12596

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

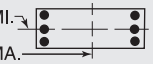


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.07	MA	20446	4536	31308	3465	34068	2915	35279	2488	36005	1806	41934	1241	24977
7L-4S		MI	10771	4536	17261	3263	18500	2731	19081	2306	19656	1658	22795	1263	12580
18-#10	2.07	MA	20204	4536	30755	3475	33302	2934	34332	2495	34802	1827	40347	1203	24609
8L-3S		MI	10843	4536	17579	3244	18913	2724	19589	2301	20317	1644	23648	1314	12559
18-#10	2.07	MA	19996	4536	30202	3482	32569	2943	33419	2514	33585	1846	38810	1163	24051
9L-2S		MI	10987	4536	17996	3235	19447	2706	20241	2284	21204	1630	24875	1404	12538
18-#11	2.54	MA	21482	4681	33900	3527	37270	2951	39092	2498	41179	1766	49052	1273	31121
5L-6S		MI	10792	4681	17263	3363	18418	2806	18931	2354	19390	1651	22365	1041	14868
18-#11	2.54	MA	21247	4681	33175	3534	36336	2975	37973	2511	39672	1791	47139	1212	30558
6L-5S		MI	10896	4681	17597	3341	18848	2799	19465	2348	20107	1636	23286	1111	15124
18-#11	2.54	MA	20972	4681	32402	3557	35397	2983	36868	2535	38113	1802	44913	1156	29996
7L-4S		MI	11042	4681	17920	3332	19279	2778	20003	2329	20902	1634	24293	1174	15114
18-#11	2.54	MA	20682	4681	31727	3568	34462	3006	35713	2543	36643	1827	42972	1107	29396
8L-3S		MI	11124	4681	18306	3309	19778	2770	20616	2324	21700	1619	25303	1234	15094
18-#11	2.54	MA	20432	4681	31058	3578	33568	3017	34600	2566	35177	1851	41086	1057	28531
9L-2S		MI	11293	4681	18807	3300	20420	2749	21400	2304	22767	1604	26748	1344	15070
18-#14	3.67	MA	22646	5024	36044	3766	39946	3156	42332	2631	45566	1793	55543	1051	42580
6L-5S		MI	11526	5024	19014	3553	20609	2955	21588	2443	22975	1607	27013	917	20671
18-#14	3.67	MA	22258	5024	34935	3799	38600	3166	40760	2666	43328	1808	52337	970	41409
7L-4S		MI	11729	5024	19476	3541	21224	2926	22356	2417	24109	1606	28421	1007	21139
18-#14	3.67	MA	21853	5024	33967	3814	37259	3199	39103	2676	41219	1843	49547	898	39949
8L-3S		MI	11840	5024	20025	3508	21935	2917	23229	2411	25246	1586	29837	1092	21159
18-#14	3.67	MA	21498	5024	33013	3828	35976	3214	37506	2709	39134	1878	46829	825	38361
9L-2S		MI	12072	5024	20737	3496	22848	2887	24343	2384	26761	1565	31857	1251	21139
18-#18	6.52	MA	25447	5896	41227	4414	46585	3632	50474	2997	56327	1820	70798	489	66990
7L-4S		MI	13392	5896	23254	4076	25972	3307	28106	2643	31954	1535	38102	536	34525
18-#18	6.52	MA	24783	5896	39524	4440	44227	3689	47562	3014	52613	1880	65870	354	63069
8L-3S		MI	13567	5896	24206	4022	27205	3295	29620	2636	33925	1504	40479	678	35764
20-#10	2.30	MA	21092	4606	32843	3490	35992	2940	37602	2488	39198	1791	46402	1278	28245
6E		MI	10741	4606	17150	3321	18323	2788	18848	2347	19293	1668	22387	1146	13790
20-#10	2.30	MA	20863	4606	32208	3509	35222	2946	36686	2507	37920	1801	44585	1233	27751
7L-5S		MI	10828	4606	17410	3315	18678	2781	19288	2342	19885	1655	23166	1205	13901
20-#10	2.30	MA	20625	4606	31655	3519	34455	2965	35739	2514	36716	1822	42999	1195	27392
8L-4S		MI	10950	4606	17678	3307	19034	2763	19733	2325	20543	1652	24021	1255	13889
20-#10	2.30	MA	20421	4606	31102	3526	33722	2974	34826	2533	35499	1840	41461	1155	26822
9L-3S		MI	11022	4606	17996	3288	19447	2756	20241	2320	21204	1638	24875	1306	13872
20-#10	2.30	MA	20169	4606	30469	3544	32988	2995	33913	2542	34196	1847	39884	1123	26232
10L-2S		MI	11164	4606	18413	3279	19981	2738	20892	2303	22091	1625	26102	1396	13853
20-#11	2.83	MA	21748	4767	34270	3588	37739	3014	39685	2535	42001	1784	50365	1202	33923
6E		MI	11007	4767	17764	3417	19061	2845	19715	2377	20457	1644	23810	1028	16392
20-#11	2.83	MA	21474	4767	33496	3611	36800	3022	38581	2559	40442	1795	48138	1146	33376
7L-5S		MI	11110	4767	18098	3395	19490	2837	20249	2372	21174	1629	24731	1098	16639
20-#11	2.83	MA	21191	4767	32822	3622	35865	3045	37425	2567	38973	1820	46198	1098	32761
8L-4S		MI	11255	4767	18422	3386	19921	2816	20787	2353	21969	1627	25738	1161	16686
20-#11	2.83	MA	20945	4767	32153	3632	34972	3056	36312	2590	37507	1844	44311	1048	31900
9L-3S		MI	11336	4767	18807	3363	20420	2809	21400	2347	22767	1612	26748	1221	16671
20-#11	2.83	MA	20644	4767	31382	3654	34076	3081	35198	2600	35918	1851	42382	1006	31021
10L-2S		MI	11504	4767	19308	3354	21063	2788	22184	2328	23834	1597	28193	1331	16650
20-#14	4.08	MA	22970	5149	36503	3877	40610	3222	43212	2700	46665	1798	56957	956	46207
7L-5S		MI	11827	5149	19726	3631	21522	3011	22702	2477	24491	1597	29033	894	22822
20-#14	4.08	MA	22577	5149	35535	3892	39269	3255	41555	2710	44556	1833	54167	884	44759
8L-4S		MI	12029	5149	20189	3618	22137	2982	23469	2451	25624	1596	30441	985	23349
20-#14	4.08	MA	22230	5149	34581	3906	37986	3270	39959	2743	42471	1868	51449	812	43146
9L-3S		MI	12139	5149	20737	3586	22848	2973	24343	2444	26761	1576	31857	1070	23380
20-#14	4.08	MA	21803	5149	33476	3937	36701	3305	38360	2757	40191	1878	48673	750	41463
10L-2S		MI	12368	5149	21450	3574	23761	2943	25456	2418	28277	1555	33877	1228	23373
20-#18	7.25	MA	26027	6117	42272	4579	47751	3788	51860	3074	58461	1862	73968	330	71407
8L-4S		MI	13899	6117	24481	4214	27545	3407	30025	2703	34565	1517	41469	483	38205

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

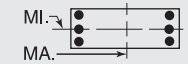
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#10	2.53	MA	21278	4677	33108	3553	36375	2978	38094	2527	39835	1795	47236	1226	30527
7L-6S		MI	10922	4677	17566	3365	18858	2819	19499	2367	20180	1663	23613	1138	15059
22-#10	2.53	MA	21044	4677	32555	3562	35609	2997	37146	2533	38631	1816	45650	1187	30177
8L-5S		MI	11008	4677	17827	3359	19212	2812	19940	2361	20772	1649	24393	1197	15204
22-#10	2.53	MA	20843	4677	32002	3570	34876	3006	36234	2552	37414	1835	44112	1147	29594
9L-4S		MI	11129	4677	18094	3351	19568	2794	20385	2345	21430	1647	25248	1247	15197
22-#10	2.53	MA	20593	4677	31369	3588	34142	3027	35320	2561	36111	1841	42535	1115	29006
10L-3S		MI	11200	4677	18413	3331	19981	2787	20892	2339	22091	1633	26102	1299	15183
22-#10	2.53	MA	20365	4677	30813	3596	33392	3034	34431	2581	34885	1860	41004	1075	28298
11L-2S		MI	11342	4677	18830	3323	20515	2769	21544	2323	22977	1619	27329	1388	15166
22-#11	3.11	MA	21974	4853	34591	3665	38204	3061	40293	2582	42772	1788	51364	1137	36758
7L-6S		MI	11222	4853	18266	3471	19704	2883	20499	2401	21524	1637	25255	1015	17919
22-#11	3.11	MA	21697	4853	33917	3676	37269	3084	39138	2590	41303	1813	49423	1088	36125
8L-5S		MI	11324	4853	18599	3449	20133	2876	21033	2395	22241	1622	26176	1085	18153
22-#11	3.11	MA	21455	4853	33248	3686	36375	3094	38025	2613	39836	1837	47537	1038	35270
9L-4S		MI	11468	4853	18923	3440	20564	2855	21571	2376	23036	1620	27183	1148	18255
22-#11	3.11	MA	21155	4853	32476	3707	35479	3119	36911	2623	38247	1844	45607	997	34375
10L-3S		MI	11548	4853	19308	3417	21063	2848	22184	2371	23834	1605	28193	1208	18244
22-#11	3.11	MA	20881	4853	31799	3717	34574	3128	35825	2647	36752	1866	43735	945	33391
11L-2S		MI	11714	4853	19810	3408	21706	2827	22969	2351	24901	1590	29638	1318	18227
22-#14	4.48	MA	23298	5273	37103	3970	41279	3311	44008	2744	47892	1823	58787	870	49568
8L-5S		MI	12127	5273	20438	3709	22435	3067	23816	2511	26006	1587	31053	872	24978
22-#14	4.48	MA	22956	5273	36149	3984	39997	3326	42411	2777	45807	1858	56069	798	47931
9L-4S		MI	12327	5273	20901	3696	23050	3038	24583	2485	27140	1586	32461	963	25556
22-#14	4.48	MA	22532	5273	35044	4015	38711	3361	40812	2791	43527	1868	53293	736	46227
10L-3S		MI	12437	5273	21450	3664	23761	3028	25456	2478	28277	1566	33877	1048	25597
24-#10	2.76	MA	21461	4747	33455	3606	36762	3029	38553	2552	40546	1810	48301	1180	32963
8L-6S		MI	11102	4747	17983	3409	19392	2851	20151	2386	21067	1657	24840	1130	16329
24-#10	2.76	MA	21263	4747	32901	3614	36030	3038	37641	2572	39329	1829	46763	1140	32366
9L-5S		MI	11187	4747	18244	3403	19746	2844	20592	2380	21659	1643	25620	1189	16503
24-#10	2.76	MA	21014	4747	32269	3632	35295	3058	36728	2580	38026	1836	45186	1107	31781
10L-4S		MI	11307	4747	18511	3395	20102	2826	21037	2364	22317	1641	26475	1239	16503
24-#10	2.76	MA	20789	4747	31713	3640	34545	3065	35838	2600	36800	1854	43655	1067	31062
11L-3S		MI	11378	4747	18830	3375	20515	2819	21544	2358	22977	1627	27329	1291	16492
24-#10	2.76	MA	20576	4747	31111	3660	33790	3084	34961	2621	35589	1873	41906	1017	30351
12L-2S		MI	11518	4747	19246	3367	21050	2801	22196	2342	23864	1614	28556	1380	16477
24-#11	3.39	MA	22200	4939	35011	3730	38672	3122	40850	2614	43632	1806	52649	1079	39489
8L-6S		MI	11436	4939	18767	3525	20346	2922	21284	2424	22591	1630	26700	1002	19448
24-#11	3.39	MA	21962	4939	34342	3740	37779	3133	39737	2637	42166	1830	50763	1029	38639
9L-5S		MI	11537	4939	19101	3503	20776	2915	21817	2419	23308	1615	27621	1072	19671
24-#11	3.39	MA	21663	4939	33571	3761	36883	3158	38623	2647	40577	1837	48833	987	37730
10L-4S		MI	11680	4939	19425	3494	21207	2894	22356	2400	24103	1614	28628	1135	19819
24-#11	3.39	MA	21393	4939	32894	3771	35977	3167	37537	2671	39082	1859	46960	936	36750
11L-3S		MI	11760	4939	19810	3471	21706	2886	22969	2394	24901	1598	29638	1195	19816
24-#11	3.39	MA	21139	4939	32160	3795	35056	3189	36473	2696	37605	1882	44815	874	35628
12L-2S		MI	11924	4939	20311	3462	22349	2865	23753	2375	25968	1583	31083	1305	19802
24-#14	4.89	MA	23677	5398	37717	4062	42007	3381	44863	2811	49144	1848	60688	784	52717
9L-5S		MI	12427	5398	21150	3786	23348	3123	24929	2545	27522	1577	33073	850	27139
24-#14	4.89	MA	23255	5398	36612	4093	40721	3417	43265	2824	46864	1858	57913	723	50991
10L-4S		MI	12625	5398	21613	3774	23963	3094	25697	2519	28655	1576	34481	940	27690

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.39	MA	22191	4516	34909	3371	37912	2838	39297	2421	40429	1796	46781	1558	18708
2E		MI	10807	4516	17469	3155	18402	2654	18726	2261	18825	1668	20866	1390	8835
6-#14	1.17	MA	21833	4447	33971	3347	36824	2823	38022	2417	38726	1813	44449	1575	15973
2L-3S		MI	10437	4447	16375	3163	17094	2685	17169	2297	16724	1717	18311	1289	7681
6-#14	1.17	MA	21190	4447	32325	3368	34714	2843	35448	2456	35224	1849	39600	1442	16012
3L-2S		MI	10687	4447	17087	3151	18007	2656	18282	2271	18239	1697	20331	1448	7622
6-#18	2.08	MA	23483	4737	37796	3509	41613	2937	43812	2482	46572	1778	55287	1533	27758
2L-3S		MI	10902	4737	17469	3312	18402	2801	18726	2363	18825	1681	20866	1056	12882
6-#18	2.08	MA	22401	4737	34909	3546	37912	2971	39297	2548	40429	1839	46781	1290	27702
3L-2S		MI	11319	4737	18697	3293	19975	2753	20645	2321	21436	1650	24233	1337	12780
8-#11	1.08	MA	21686	4419	33575	3339	36376	2819	37502	2416	38035	1821	43505	1583	14847
2L-4S		MI	10375	4419	16035	3185	16701	2688	16706	2302	16140	1741	17666	1302	7200
8-#11	1.08	MA	21236	4419	32427	3354	34903	2833	35705	2444	35591	1846	40121	1492	14876
3E		MI	10460	4419	16420	3162	17200	2681	17319	2297	16938	1726	18675	1363	7152
8-#11	1.08	MA	20975	4419	31573	3383	33793	2861	34339	2457	33712	1858	37941	1435	14885
4L-2S		MI	10638	4419	16921	3152	17843	2660	18103	2278	18005	1710	20121	1473	7115
8-#14	1.56	MA	22581	4571	35616	3425	38934	2879	40596	2451	42228	1803	49298	1562	21136
2L-4S		MI	10625	4571	16538	3273	17296	2750	17409	2338	17102	1728	18915	1182	10037
8-#14	1.56	MA	21951	4571	33971	3446	36824	2899	38022	2489	38726	1839	44449	1428	21154
3E		MI	10741	4571	17087	3241	18007	2741	18282	2331	18239	1707	20331	1267	9973
8-#14	1.56	MA	21584	4571	32745	3488	35231	2939	36061	2508	36031	1855	41311	1346	21076
4L-2S		MI	10988	4571	17799	3228	18920	2712	19396	2305	19755	1687	22351	1425	9916
8-#18	2.78	MA	24762	4959	40683	3647	45314	3036	48327	2542	52714	1760	63793	1509	36783
2L-4S		MI	11235	4959	17744	3504	18742	2913	19131	2431	19466	1694	21856	860	16580
8-#18	2.78	MA	23715	4959	37796	3684	41613	3070	43812	2609	46572	1822	55287	1266	36665
3E		MI	11420	4959	18697	3450	19975	2900	20645	2424	21436	1663	24233	1003	16752
8-#18	2.78	MA	23095	4959	35639	3756	38810	3140	40364	2640	41832	1848	49731	1117	36058
4L-2S		MI	11828	4959	19924	3432	21548	2852	22564	2382	24047	1633	27600	1285	16680
10-#10	1.10	MA	21757	4425	33625	3356	36521	2833	37716	2428	38351	1828	43961	1590	15172
2L-5S		MI	10331	4425	15946	3219	16643	2728	16655	2338	16026	1756	17634	1308	7360
10-#10	1.10	MA	21385	4425	32681	3369	35312	2845	36240	2451	36343	1850	41180	1517	15191
3L-4S		MI	10458	4425	16213	3211	16999	2710	17099	2321	16684	1753	18489	1359	7321
10-#10	1.10	MA	21168	4425	31981	3393	34401	2868	35119	2462	34802	1859	39401	1471	15199
4L-3S		MI	10531	4425	16532	3191	17412	2703	17607	2316	17345	1740	19342	1410	7287
10-#10	1.10	MA	20862	4425	31373	3403	33626	2880	34148	2485	33438	1881	37569	1439	15167
5L-2S		MI	10680	4425	16948	3183	17946	2685	18258	2299	18231	1726	20569	1499	7259
10-#11	1.35	MA	22212	4505	34724	3393	37849	2858	39298	2440	40480	1814	46890	1574	18452
2L-5S		MI	10441	4505	16212	3248	16913	2748	16952	2345	16412	1736	18103	1227	8859
10-#11	1.35	MA	21768	4505	33575	3408	36376	2872	37502	2467	38035	1839	43505	1483	18472
3L-4S		MI	10592	4505	16536	3239	17344	2727	17490	2326	17207	1734	19111	1289	8812
10-#11	1.35	MA	21509	4505	32721	3437	35266	2900	36135	2481	36156	1851	41326	1426	18464
4L-3S		MI	10676	4505	16921	3216	17843	2720	18103	2321	18005	1719	20121	1350	8768
10-#11	1.35	MA	21140	4505	31985	3450	34319	2914	34950	2508	34492	1876	39087	1385	18385
5L-2S		MI	10851	4505	17423	3206	18486	2698	18887	2301	19072	1704	21566	1460	8731
10-#14	1.95	MA	23323	4696	37262	3502	41044	2935	43170	2485	45730	1793	54147	1548	26289
2L-5S		MI	10719	4696	16788	3363	17593	2836	17755	2398	17484	1718	19527	1069	12252
10-#14	1.95	MA	22705	4696	35616	3524	38934	2955	40596	2523	42228	1829	49298	1414	26284
3L-4S		MI	10930	4696	17251	3351	18209	2806	18523	2372	18618	1718	20935	1160	12289
10-#14	1.95	MA	22343	4696	34391	3565	37341	2995	38635	2542	39533	1845	46160	1332	26182
4L-3S		MI	11045	4696	17799	3319	18920	2797	19396	2365	19755	1697	22351	1245	12240
10-#14	1.95	MA	21821	4696	33340	3584	35982	3015	36933	2581	37144	1881	42942	1272	25821
5L-2S		MI	11288	4696	18512	3306	19833	2767	20510	2339	21270	1677	24371	1403	12190
10-#18	3.47	MA	25014	5180	40683	3822	45314	3170	48327	2669	52714	1804	63793	1242	45626
3L-4S		MI	11752	5180	18971	3642	20315	3012	21050	2491	22077	1676	25223	808	20148
10-#18	3.47	MA	24406	5180	38526	3894	42511	3239	44879	2700	47975	1830	58237	1093	45004
4L-3S		MI	11935	5180	19924	3588	21548	3000	22564	2484	24047	1646	27600	951	20599
10-#18	3.47	MA	23515	5180	36698	3928	40118	3273	41882	2767	43770	1891	52557	980	41570
5L-2S		MI	12336	5180	21151	3570	23122	2952	24483	2442	26658	1615	30967	1232	20554

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

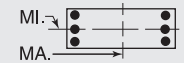
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	1.32	MA	22191	4495	34569	3400	37731	2865	39192	2447	40359	1823	46741	1582	18130
2L-6S		MI	10423	4495	16102	3269	16823	2767	16865	2363	16321	1764	18081	1242	8718
12-#10	1.32	MA	21824	4495	33625	3413	36521	2877	37716	2470	38351	1844	43961	1509	18145
3L-5S		MI	10513	4495	16362	3263	17177	2760	17306	2357	16913	1750	18861	1301	8687
12-#10	1.32	MA	21608	4495	32925	3437	35611	2900	36595	2481	36810	1854	42181	1463	18141
4E		MI	10639	4495	16630	3255	17533	2742	17751	2341	17571	1748	19716	1351	8654
12-#10	1.32	MA	21305	4495	32317	3447	34836	2912	35624	2504	35446	1875	40350	1432	18099
5L-3S		MI	10712	4495	16948	3235	17946	2735	18258	2335	18231	1734	20569	1402	8622
12-#10	1.32	MA	21087	4495	31693	3453	34022	2932	34664	2515	34153	1896	38713	1383	17990
6L-2S		MI	10860	4495	17365	3227	18480	2717	18910	2319	19118	1720	21796	1491	8595
12-#11	1.63	MA	22734	4591	35873	3447	39321	2896	41095	2464	42924	1807	50274	1564	22051
2L-6S		MI	10550	4591	16380	3323	17126	2794	17202	2374	16762	1744	18627	1144	10415
12-#11	1.63	MA	22297	4591	34724	3462	37849	2911	39298	2491	40480	1832	46890	1473	22064
3L-5S		MI	10658	4591	16714	3302	17555	2787	17736	2369	17479	1729	19548	1214	10446
12-#11	1.63	MA	22041	4591	33870	3491	36738	2939	37932	2504	38601	1844	44710	1416	22038
4E		MI	10807	4591	17038	3293	17986	2766	18274	2349	18274	1727	20556	1276	10409
12-#11	1.63	MA	21676	4591	33134	3504	35792	2953	36746	2531	36936	1869	42471	1376	21947
5L-3S		MI	10890	4591	17423	3270	18486	2758	18887	2344	19072	1712	21566	1337	10370
12-#11	1.63	MA	21413	4591	32374	3510	34808	2978	35574	2545	35358	1895	40470	1315	21546
6L-2S		MI	11065	4591	17924	3260	19128	2737	19671	2325	20139	1697	23011	1447	10335
12-#14	2.34	MA	23454	4820	37262	3602	41044	3011	43170	2557	45730	1819	54147	1401	31409
3L-5S		MI	11024	4820	17500	3441	18506	2892	18869	2432	19000	1708	21547	1047	14367
12-#14	2.34	MA	23097	4820	36037	3643	39451	3051	41209	2576	43035	1835	51009	1318	31288
4E		MI	11233	4820	17963	3429	19122	2862	19637	2406	20133	1708	22955	1137	14528
12-#14	2.34	MA	22583	4820	34986	3661	38092	3071	39507	2615	40646	1871	47791	1258	30848
5L-3S		MI	11347	4820	18512	3396	19833	2853	20510	2399	21270	1687	24371	1222	14493
12-#14	2.34	MA	22213	4820	33896	3671	36689	3107	37824	2633	38380	1907	44915	1169	29529
6L-2S		MI	11588	4820	19224	3384	20746	2823	21624	2373	22785	1667	26391	1381	14450
12-#18	4.17	MA	25701	5401	41413	4033	46212	3338	49394	2761	54118	1812	66742	1069	53958
4E		MI	12267	5401	20198	3781	21888	3112	22969	2551	24688	1659	28590	755	23748
12-#18	4.17	MA	24832	5401	39585	4066	43819	3372	46396	2827	49913	1873	61063	955	50421
5L-3S		MI	12447	5401	21151	3727	23122	3099	24483	2544	26658	1628	30967	898	24421
12-#18	4.17	MA	24204	5401	37671	4082	41382	3437	43432	2859	45923	1935	55983	791	47516
6L-2S		MI	12841	5401	22378	3708	24695	3051	26402	2502	29269	1597	34334	1180	24411
14-#10	1.54	MA	22260	4565	34569	3457	37731	2908	39192	2489	40359	1838	46741	1501	21095
3L-6S		MI	10605	4565	16519	3313	17357	2798	17517	2382	17207	1758	19307	1234	10029
14-#10	1.54	MA	22046	4565	33869	3481	36821	2931	38071	2500	38818	1848	44962	1455	21081
4L-5S		MI	10695	4565	16779	3307	17711	2791	17958	2376	17800	1745	20087	1293	10007
14-#10	1.54	MA	21746	4565	33261	3491	36046	2943	37100	2523	37454	1869	43130	1424	21030
5L-4S		MI	10819	4565	17047	3299	18067	2773	18403	2360	18457	1742	20942	1343	9978
14-#10	1.54	MA	21531	4565	32637	3497	35232	2963	36140	2534	36161	1891	41494	1376	20915
6L-3S		MI	10892	4565	17365	3279	18480	2767	18910	2354	19118	1728	21796	1394	9950
14-#10	1.54	MA	21285	4565	31972	3516	34425	2970	35176	2553	34823	1901	39596	1331	20412
7L-2S		MI	11039	4565	17782	3271	19015	2748	19562	2338	20005	1715	23023	1484	9924
14-#11	1.90	MA	22823	4678	35873	3516	39321	2949	41095	2514	42924	1826	50274	1463	25647
3L-6S		MI	10767	4678	16881	3377	17769	2833	17986	2398	17829	1737	20072	1131	11936
14-#11	1.90	MA	22569	4678	35019	3545	38211	2977	39728	2528	41045	1837	48094	1407	25611
4L-5S		MI	10874	4678	17215	3356	18198	2826	18520	2392	18546	1722	20994	1201	12025
14-#11	1.90	MA	22208	4678	34283	3557	37265	2992	38543	2555	39381	1862	45856	1366	25510
5L-4S		MI	11022	4678	17539	3347	18629	2804	19058	2373	19341	1720	22001	1263	11996
14-#11	1.90	MA	21950	4678	33523	3564	36280	3016	37371	2568	37802	1888	43854	1306	25066
6L-3S		MI	11105	4678	17924	3324	19128	2797	19671	2368	20139	1705	23011	1324	11963
14-#11	1.90	MA	21656	4678	32712	3588	35296	3024	36206	2592	36169	1899	41528	1250	24421
7L-2S		MI	11277	4678	18426	3314	19771	2776	20455	2348	21206	1690	24456	1434	11931

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

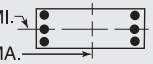


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.73	MA	23845	4945	37682	3721	41561	3107	43783	2610	46537	1825	55858	1304	36394
4L-5S		MI	11328	4945	18212	3519	19419	2947	19983	2466	20515	1698	23567	1024	16495
14-#14	2.73	MA	23338	4945	36632	3739	40202	3127	42081	2649	44148	1861	52640	1244	35885
5L-4S		MI	11536	4945	18675	3507	20035	2918	20751	2440	21649	1698	24975	1115	16760
14-#14	2.73	MA	22977	4945	35542	3749	38799	3163	40398	2667	41882	1897	49764	1155	34603
6L-3S		MI	11648	4945	19224	3474	20746	2909	21624	2433	22785	1677	26391	1200	16736
14-#14	2.73	MA	22561	4945	34379	3782	37387	3174	38740	2702	39538	1913	46414	1074	33559
7L-2S		MI	11886	4945	19936	3462	21659	2879	22738	2407	24301	1657	28412	1358	16701
14-#18	4.86	MA	26134	5623	42472	4204	47520	3472	50911	2888	56056	1856	69568	931	59272
5L-4S		MI	12780	5623	21425	3919	23461	3211	24888	2612	27299	1641	31957	703	27374
14-#18	4.86	MA	25529	5623	40558	4220	45083	3536	47947	2919	52065	1917	64488	766	56290
6L-3S		MI	12958	5623	22378	3865	24695	3198	26402	2605	29269	1610	34334	846	28232
14-#18	4.86	MA	24816	5623	38512	4278	42601	3554	45071	2982	47936	1943	58552	620	53136
7L-2S		MI	13346	5623	23605	3847	26268	3150	28321	2562	31880	1580	37701	1127	28258
16-#10	1.76	MA	22482	4636	34813	3525	38031	2963	39547	2519	40826	1843	47742	1447	24020
4L-6S		MI	10787	4636	16935	3357	17891	2830	18169	2401	18094	1753	20534	1226	11336
16-#10	1.76	MA	22185	4636	34204	3535	37256	2975	38576	2542	39462	1864	45911	1416	23962
5E		MI	10875	4636	17196	3351	18246	2823	18610	2396	18687	1739	21314	1285	11320
16-#10	1.76	MA	21973	4636	33581	3541	36442	2995	37616	2553	38169	1885	44274	1368	23842
6L-4S		MI	10999	4636	17463	3343	18602	2805	19055	2379	19344	1736	22169	1335	11297
16-#10	1.76	MA	21728	4636	32916	3560	35634	3001	36652	2572	36831	1895	42377	1323	23318
7L-3S		MI	11072	4636	17782	3323	19015	2798	19562	2374	20005	1723	23023	1386	11272
16-#10	1.76	MA	21468	4636	32336	3569	34831	3021	35659	2579	35570	1916	40717	1286	22914
8L-2S		MI	11217	4636	18199	3315	19549	2780	20214	2357	20892	1709	24250	1476	11248
16-#11	2.17	MA	23094	4764	36168	3599	39684	3016	41525	2551	43489	1830	51479	1397	29183
4L-6S		MI	10983	4764	17383	3431	18412	2872	18771	2421	18896	1730	21517	1118	13425
16-#11	2.17	MA	22737	4764	35431	3611	38737	3030	40339	2578	41825	1856	49240	1357	29073
5E		MI	11089	4764	17717	3410	18841	2864	19304	2416	19613	1715	22439	1188	13598
16-#11	2.17	MA	22484	4764	34671	3618	37753	3055	39167	2592	40247	1881	47239	1296	28590
6L-4S		MI	11236	4764	18041	3401	19272	2843	19842	2396	20408	1714	23446	1250	13577
16-#11	2.17	MA	22191	4764	33860	3642	36769	3063	38003	2616	38613	1893	44913	1241	27964
7L-3S		MI	11318	4764	18426	3378	19771	2836	20455	2391	21206	1698	24456	1311	13550
16-#11	2.17	MA	21878	4764	33154	3653	35789	3086	36792	2624	37075	1918	42883	1193	27419
8L-2S		MI	11489	4764	18927	3368	20414	2815	21240	2372	22273	1683	25901	1421	13521
16-#14	3.13	MA	24088	5069	38278	3817	42312	3183	44655	2683	47650	1851	57489	1231	40929
5E		MI	11631	5069	18925	3597	20332	3003	21097	2500	22031	1689	25587	1002	18631
16-#14	3.13	MA	23736	5069	37188	3827	40909	3219	42972	2701	45384	1887	54613	1141	39683
6L-4S		MI	11837	5069	19387	3584	20948	2974	21864	2474	23164	1688	26995	1093	18980
16-#14	3.13	MA	23322	5069	36025	3860	39497	3229	41314	2736	43040	1903	51263	1061	38595
7L-3S		MI	11949	5069	19936	3552	21659	2964	22738	2467	24301	1667	28412	1178	18972
16-#14	3.13	MA	22881	5069	35010	3876	38091	3263	39577	2747	40830	1939	48344	990	37015
8L-2S		MI	12184	5069	20648	3540	22572	2935	23851	2441	25816	1647	30432	1336	18945
16-#18	5.56	MA	26840	5844	43445	4358	48784	3636	52462	2979	58208	1899	72994	742	65064
6L-4S		MI	13291	5844	22652	4057	25034	3310	26807	2672	29910	1623	35324	650	31021
16-#18	5.56	MA	26134	5844	41399	4416	46302	3653	49586	3042	54079	1925	67058	596	61944
7L-3S		MI	13467	5844	23605	4003	26268	3298	28321	2665	31880	1593	37701	793	32038
16-#18	5.56	MA	25381	5844	39613	4443	43828	3711	46531	3060	50186	1986	61901	464	57847
8L-2S		MI	13849	5844	24832	3985	27841	3250	30240	2623	34491	1562	41068	1075	32094
18-#10	1.98	MA	22621	4706	35148	3579	38465	3006	40052	2561	41470	1858	48691	1408	26893
5L-6S		MI	10968	4706	17352	3401	18425	2861	18821	2420	18981	1747	21761	1218	12625
18-#10	1.98	MA	22413	4706	34524	3584	37651	3026	39092	2573	40177	1879	47055	1360	26769
6L-5S		MI	11056	4706	17613	3395	18780	2855	19262	2415	19573	1733	22541	1277	12630
18-#10	1.98	MA	22169	4706	33859	3604	36844	3033	38127	2592	38839	1889	45157	1315	26227
7L-4S		MI	11179	4706	17880	3387	19136	2836	19706	2398	20231	1731	23396	1327	12611
18-#10	1.98	MA	21913	4706	33280	3613	36041	3052	37135	2599	37579	1911	43498	1278	25832
8L-3S		MI	11251	4706	18199	3367	19549	2830	20214	2393	20892	1717	24250	1378	12590
18-#10	1.98	MA	21695	4706	32698	3621	35274	3062	36179	2618	36296	1929	41892	1238	25300
9L-2S		MI	11395	4706	18615	3359	20083	2812	20866	2376	21779	1703	25477	1468	12567

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

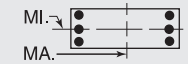
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
18-#11	2.44	MA	23263	4850	36580	3665	40210	3069	42136	2602	44269	1849	52625	1347	32637
5L-6S		MI	11199	4850	17884	3485	19054	2910	19555	2445	19963	1724	22962	1105	14946
18-#11	2.44	MA	23015	4850	35820	3672	39226	3094	40964	2615	42691	1874	50623	1287	32118
6L-5S		MI	11304	4850	18218	3464	19484	2903	20089	2439	20680	1708	23884	1175	15168
18-#11	2.44	MA	22723	4850	35009	3696	38242	3102	39799	2639	41058	1886	48297	1231	31509
7L-4S		MI	11450	4850	18542	3455	19915	2882	20627	2420	21475	1707	24891	1237	15154
18-#11	2.44	MA	22417	4850	34302	3707	37262	3125	38589	2647	39519	1911	46267	1183	30949
8L-3S		MI	11532	4850	18927	3431	20414	2875	21240	2415	22273	1691	25901	1298	15131
18-#11	2.44	MA	22153	4850	33598	3717	36326	3136	37422	2670	37972	1934	44298	1134	30020
9L-2S		MI	11701	4850	19428	3422	21057	2853	22024	2395	23340	1676	27346	1408	15106
18-#14	3.52	MA	24489	5194	38834	3904	43019	3274	45546	2735	48886	1877	59462	1128	44762
6L-5S		MI	11933	5194	19637	3675	21245	3059	22211	2534	23546	1679	27607	980	20776
18-#14	3.52	MA	24078	5194	37671	3938	41607	3285	43887	2770	46542	1893	56112	1047	43632
7L-4S		MI	12137	5194	20099	3662	21861	3030	22978	2507	24679	1678	29015	1070	21196
18-#14	3.52	MA	23649	5194	36656	3954	40201	3319	42151	2781	44332	1929	53193	977	42063
8L-3S		MI	12248	5194	20648	3630	22572	3020	23851	2501	25816	1657	30432	1156	21204
18-#14	3.52	MA	23275	5194	35651	3968	38857	3334	40477	2814	42131	1963	50354	905	40490
9L-2S		MI	12480	5194	21360	3617	23485	2991	24965	2475	27332	1637	32452	1314	21184
18-#18	6.25	MA	27438	6065	44286	4555	50003	3753	54101	3103	60222	1907	75564	571	70752
7L-4S		MI	13800	6065	23879	4196	26608	3410	28727	2732	32521	1606	38691	598	34684
18-#18	6.25	MA	26737	6065	42500	4581	47529	3810	51046	3120	56329	1969	70406	440	66606
8L-3S		MI	13975	6065	24832	4142	27841	3397	30240	2725	34491	1575	41068	741	35839
20-#10	2.20	MA	22851	4776	35468	3628	38861	3058	40568	2592	42185	1874	49835	1352	29675
6E		MI	11149	4776	17769	3445	18960	2893	19473	2439	19868	1741	22988	1210	13857
20-#10	2.20	MA	22608	4776	34803	3648	38054	3065	39603	2611	40847	1884	47938	1308	29137
7L-5S		MI	11236	4776	18030	3439	19314	2886	19913	2434	20460	1728	23768	1269	13937
20-#10	2.20	MA	22357	4776	34224	3657	37251	3084	38611	2618	39587	1905	46278	1270	28753
8L-4S		MI	11358	4776	18297	3431	19670	2868	20358	2417	21118	1725	24623	1319	13923
20-#10	2.20	MA	22141	4776	33641	3665	36483	3093	37655	2637	38304	1924	44673	1230	28207
9L-3S		MI	11430	4776	18615	3411	20083	2861	20866	2412	21779	1712	25477	1371	13904
20-#10	2.20	MA	21876	4776	32978	3683	35715	3114	36698	2646	36939	1930	43023	1199	27576
10L-2S		MI	11573	4776	19032	3403	20618	2843	21517	2395	22665	1698	26703	1460	13884
20-#11	2.71	MA	23543	4937	36969	3726	40698	3133	42760	2639	45135	1867	54008	1277	35650
6E		MI	11415	4937	18386	3539	19697	2949	20339	2468	21030	1717	24407	1092	16471
20-#11	2.71	MA	23253	4937	36158	3750	39714	3140	41596	2663	43502	1879	51682	1221	35057
7L-5S		MI	11518	4937	18719	3518	20127	2942	20873	2463	21746	1701	25329	1162	16724
20-#11	2.71	MA	22953	4937	35451	3761	38735	3164	40385	2671	41963	1904	49652	1174	34479
8L-4S		MI	11663	4937	19043	3508	20558	2921	21411	2444	22541	1700	26336	1224	16727
20-#11	2.71	MA	22694	4937	34747	3770	37798	3175	39219	2694	40416	1928	47682	1124	33556
9L-3S		MI	11744	4937	19428	3485	21057	2913	22024	2438	23340	1684	27346	1285	16709
20-#11	2.71	MA	22375	4937	33938	3793	36860	3200	38052	2704	38751	1935	45664	1084	32704
10L-2S		MI	11912	4937	19930	3476	21699	2892	22808	2419	24407	1669	28791	1395	16687
20-#14	3.91	MA	24828	5318	39316	4016	43717	3341	46461	2804	50044	1883	60961	1033	48668
7L-5S		MI	12235	5318	20349	3752	22158	3115	23324	2568	25061	1669	29627	957	22926
20-#14	3.91	MA	24412	5318	38302	4032	42311	3375	44725	2815	47834	1919	58042	963	47112
8L-4S		MI	12437	5318	20812	3740	22774	3086	24092	2541	26195	1668	31035	1048	23408
20-#14	3.91	MA	24046	5318	37297	4045	40967	3390	43051	2848	45633	1953	55203	891	45513
9L-3S		MI	12547	5318	21360	3708	23485	3076	24965	2535	27332	1648	32452	1133	23431
20-#14	3.91	MA	23594	5318	36138	4077	39620	3426	41376	2862	43243	1963	52300	831	43842
10L-2S		MI	12777	5318	22073	3695	24398	3047	26079	2508	28847	1627	34472	1292	23418
20-#18	6.94	MA	28048	6287	45387	4720	51230	3910	55561	3181	62472	1951	78912	415	75365
8L-4S		MI	14307	6287	25107	4334	28181	3509	30646	2793	35132	1588	42058	545	38362
22-#10	2.43	MA	23045	4846	35747	3692	39264	3096	41079	2630	42855	1878	50718	1300	32050
7L-6S		MI	11329	4846	18186	3489	19494	2924	20124	2458	20755	1736	24215	1202	15125

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

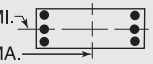


f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
22-#10	2.43	MA	22798	4846	35168	3701	38461	3116	40087	2637	41595	1899	49059	1263	31674
8L-5S		MI	11415	4846	18446	3483	19849	2918	20565	2453	21347	1722	24995	1261	15242
22-#10	2.43	MA	22586	4846	34585	3709	37693	3125	39131	2656	40312	1918	47453	1223	31114
9L-4S		MI	11537	4846	18714	3474	20205	2900	21010	2436	22005	1720	25850	1311	15231
22-#10	2.43	MA	22321	4846	33922	3727	36924	3146	38174	2665	38947	1925	45804	1191	30486
10L-3S		MI	11608	4846	19032	3455	20618	2893	21517	2431	22665	1706	26703	1363	15216
22-#10	2.43	MA	22082	4846	33340	3735	36135	3153	37243	2686	37663	1944	44203	1151	29799
11L-2S		MI	11750	4846	19449	3447	21152	2875	22169	2414	23552	1692	27930	1452	15198
22-#11	2.98	MA	23779	5023	37307	3804	41187	3179	43392	2686	45947	1872	55066	1212	38607
7L-6S		MI	11629	5023	18887	3593	20340	2988	21123	2492	22096	1710	25852	1079	17998
22-#11	2.98	MA	23486	5023	36600	3815	40207	3203	42182	2694	44408	1897	53036	1164	38009
8L-5S		MI	11731	5023	19221	3572	20769	2981	21657	2486	22813	1694	26774	1149	18238
22-#11	2.98	MA	23231	5023	35895	3824	39271	3213	41016	2717	42861	1921	51067	1115	37092
9L-4S		MI	11875	5023	19545	3562	21200	2959	22195	2467	23608	1693	27781	1211	18298
22-#11	2.98	MA	22914	5023	35087	3847	38332	3239	39848	2728	41196	1928	49048	1075	36224
10L-3S		MI	11956	5023	19930	3539	21699	2952	22808	2462	24407	1678	28791	1272	18284
22-#11	2.98	MA	22625	5023	34377	3856	37378	3247	38711	2752	39629	1951	47090	1024	35170
11L-2S		MI	12123	5023	20431	3530	22342	2931	23592	2442	25473	1662	30236	1382	18265
22-#14	4.30	MA	25169	5443	39948	4109	44421	3430	47299	2849	51336	1909	62891	949	52161
8L-5S		MI	12535	5443	21061	3830	23071	3171	24438	2602	26577	1659	31647	935	25081
22-#14	4.30	MA	24811	5443	38943	4123	43077	3446	45625	2882	49135	1943	60052	877	50536
9L-4S		MI	12735	5443	21524	3818	23687	3142	25206	2575	27710	1658	33055	1026	25618
22-#14	4.30	MA	24362	5443	37783	4155	41730	3482	43950	2896	46746	1954	57149	817	48843
10L-3S		MI	12845	5443	22073	3785	24398	3132	26079	2569	28847	1638	34472	1111	25651
24-#10	2.65	MA	23237	4917	36111	3745	39671	3147	41563	2656	43603	1894	51839	1255	34597
8L-6S		MI	11509	4917	18602	3533	20028	2956	20776	2478	21642	1730	25442	1194	16396
24-#10	2.65	MA	23028	4917	35529	3753	38903	3156	40607	2675	42320	1912	50234	1215	34021
9L-5S		MI	11594	4917	18863	3527	20383	2949	21217	2472	22234	1717	26222	1253	16544
24-#10	2.65	MA	22764	4917	34866	3771	38134	3177	39650	2684	40955	1919	48584	1183	33396
10L-4S		MI	11715	4917	19130	3518	20739	2931	21662	2456	22891	1714	27077	1304	16538
24-#10	2.65	MA	22528	4917	34284	3779	37345	3184	38719	2705	39672	1938	46984	1144	32698
11L-3S		MI	11786	4917	19449	3499	21152	2924	22169	2450	23552	1700	27930	1355	16526
24-#10	2.65	MA	22303	4917	33653	3799	36553	3203	37795	2725	38404	1957	45156	1094	31938
12L-2S		MI	11927	4917	19866	3491	21686	2906	22821	2433	24439	1687	29157	1444	16510
24-#11	3.25	MA	24016	5109	37749	3869	41680	3241	43978	2718	46852	1890	56421	1155	41539
8L-6S		MI	11843	5109	19389	3647	20983	3027	21907	2515	23163	1703	27298	1066	19527
24-#11	3.25	MA	23765	5109	37044	3878	40743	3252	42812	2741	45305	1914	54451	1105	40627
9L-5S		MI	11944	5109	19722	3626	21412	3019	22441	2510	23880	1688	28219	1136	19756
24-#11	3.25	MA	23449	5109	36236	3900	39805	3278	41645	2751	43640	1921	52433	1065	39743
10L-4S		MI	12088	5109	20046	3616	21843	2998	22979	2491	24675	1686	29226	1198	19866
24-#11	3.25	MA	23164	5109	35526	3910	38851	3286	40508	2776	42073	1944	50474	1014	38694
11L-3S		MI	12168	5109	20431	3593	22342	2991	23592	2485	25473	1671	30236	1259	19857
24-#11	3.25	MA	22895	5109	34757	3935	37885	3309	39393	2801	40526	1967	48233	953	37582
12L-2S		MI	12333	5109	20933	3584	22985	2970	24376	2466	26540	1655	31681	1369	19841
24-#14	4.69	MA	25571	5567	40589	4201	45187	3501	48199	2916	52637	1933	64901	863	55559
9L-5S		MI	12835	5567	21773	3908	23984	3227	25552	2636	28092	1649	33667	913	27241
24-#14	4.69	MA	25124	5567	39429	4233	43839	3538	46524	2930	50248	1944	61998	803	53844
10L-4S		MI	13033	5567	22236	3896	24600	3197	26320	2609	29226	1648	35075	1003	27809

RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.63	MA	4576	1868	7077	1483	8143	1197	8629	975	9117	641	10930	565	6270
2L-3S		MI	4071	1868	6419	1479	7321	1191	7653	980	7832	646	9267	474	6264
6-#14	2.34	MA	4921	2018	7941	1569	9155	1253	9818	1003	10672	612	12904	508	8786
2L-3S		MI	4220	2018	7006	1562	7998	1246	8443	1011	8864	620	10574	376	8694
6-#18	4.17	MA	5697	2400	9962	1783	11566	1394	12654	1071	14391	533	17563	346	14854
2L-3S		MI	4568	2400	8374	1769	9610	1380	10331	1084	11333	547	13663	112	13290
8-#11	2.17	MA	4861	1981	7736	1554	8965	1247	9606	1004	10402	627	12593	533	8232
2L-4S		MI	3995	1981	6578	1546	7482	1247	7848	1004	8128	637	9833	358	7728
8-#14	3.13	MA	5309	2182	8877	1671	10312	1325	11192	1044	12481	591	15233	458	11548
2L-4S		MI	4112	2182	7230	1657	8225	1325	8718	1044	9281	606	11363	208	10208
8-#18	5.56	MA	6302	2691	11551	1962	13521	1516	14978	1138	17450	488	21463	245	19560
2L-4S		MI	4395	2691	8753	1935	9992	1516	10795	1138	12038	515	14972	-191	14345
10-#11	2.71	MA	5140	2095	8395	1625	9787	1297	10582	1033	11687	613	14256	501	10180
2L-5S		MI	3956	2095	6728	1623	7708	1292	8117	1038	8450	618	10336	282	9091
10-#11	2.71	MA	4652	2095	7736	1621	8965	1292	9606	1038	10402	618	12593	410	10115
3L-4S		MI	4289	2095	7236	1617	8304	1297	8825	1033	9413	623	11496	326	9534
10-#14	3.91	MA	5686	2345	9813	1773	11469	1396	12566	1084	14290	569	17563	409	14295
2L-5S		MI	4075	2345	7441	1767	8542	1389	9096	1092	9734	576	12068	95	11683
10-#14	3.91	MA	5029	2345	8877	1766	10312	1389	11192	1092	12481	576	15233	278	14005
3L-4S		MI	4533	2345	8165	1759	9382	1396	10093	1084	11089	584	13693	159	12787
10-#18	6.94	MA	5846	2981	11551	2127	13521	1626	14978	1218	17450	456	21463	-89	20982
3L-4S		MI	5056	2981	10341	2114	11948	1639	13118	1205	15097	469	18872	-292	17688

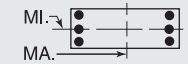
RECTANGULAR TIED COLUMNS 24" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.00	MA	5000	1882	7387	1532	8493	1247	8889	1032	9085	722	10775	665	4710
2E		MI	4590	1882	6844	1518	7794	1233	8128	1020	8270	712	9763	651	4313
4-#14	1.44	MA	5270	1982	8041	1586	9260	1283	9785	1051	10254	704	12269	630	6604
2E		MI	4828	1982	7433	1572	8472	1268	8918	1036	9301	691	11067	612	6027
4-#18	2.56	MA	5893	2236	9625	1728	11098	1376	11937	1096	13069	654	15829	530	11195
2E		MI	5376	2236	8807	1707	10084	1356	10804	1077	11767	634	14151	500	10163
6-#11	1.50	MA	5331	1995	8117	1603	9415	1298	9984	1062	10527	710	12654	637	6902
2L-3S		MI	4378	1995	6844	1585	7794	1279	8128	1054	8270	703	9763	529	6304
6-#11	1.50	MA	4769	1995	7387	1599	8493	1293	8889	1068	9085	715	10775	546	6896
3L-2S		MI	4885	1995	7502	1589	8616	1284	9104	1049	9555	698	11426	620	6299
6-#14	2.16	MA	5723	2146	9079	1688	10562	1357	11330	1093	12288	685	14909	586	9697
2L-3S		MI	4527	2146	7433	1667	8472	1332	8918	1084	9301	676	11067	431	8756
6-#14	2.16	MA	4942	2146	8041	1683	9260	1349	9785	1101	10254	692	12269	455	9605
3L-2S		MI	5232	2146	8369	1674	9629	1340	10292	1077	11110	669	13397	562	8824
6-#18	3.85	MA	6622	2527	11419	1910	13310	1503	14564	1167	16527	614	20277	440	16474
2L-3S		MI	4877	2527	8807	1873	10084	1466	10804	1157	11767	602	14151	166	13586
6-#18	3.85	MA	5356	2527	9625	1897	11098	1489	11937	1180	13069	627	15829	207	15072
3L-2S		MI	6017	2527	10395	1886	12040	1479	13128	1144	14826	589	18051	399	14911
8-#11	2.00	MA	5653	2108	8846	1674	10338	1350	11080	1093	11968	698	14532	609	9075
2L-4S		MI	4301	2108	7003	1652	7955	1334	8324	1078	8567	694	10328	413	7871
8-#11	2.00	MA	5101	2108	8117	1670	9415	1345	9984	1098	10527	703	12654	518	9036
3E		MI	4674	2108	7502	1656	8616	1329	9104	1083	9555	689	11426	497	8240
8-#11	2.00	MA	4691	2108	7565	1667	8674	1350	9109	1093	9418	709	11418	432	8625
4L-2S		MI	5172	2108	8161	1660	9438	1334	10081	1078	10840	684	13089	588	8266
8-#14	2.88	MA	6163	2309	10117	1790	11863	1430	12876	1136	14322	666	17548	542	12763
2L-4S		MI	4417	2309	7657	1762	8699	1411	9193	1117	9718	662	11856	263	10380

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

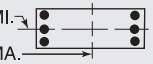


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.88	MA	5399	2309	9079	1785	10562	1423	11330	1143	12288	673	14909	411	12613
3E		MI	4933	2309	8369	1769	9629	1404	10292	1125	11110	655	13397	382	11468
8-#14	2.88	MA	4831	2309	8293	1779	9516	1430	10094	1136	10723	681	13169	288	11406
4L-2S		MI	5623	2309	9305	1776	10786	1411	11666	1117	12918	647	15726	513	11591
8-#18	5.13	MA	7311	2818	13213	2092	15522	1629	17192	1238	19985	574	24725	351	21720
2L-4S		MI	4698	2818	9186	2039	10467	1602	11268	1210	12473	570	15460	-137	15011
8-#18	5.13	MA	6095	2818	11419	2079	13310	1616	14564	1252	16527	587	20277	117	19804
3E		MI	5531	2818	10395	2052	12040	1589	13128	1224	14826	557	18051	65	17806
8-#18	5.13	MA	5177	2818	10053	2066	11531	1629	12463	1238	13866	601	17334	-93	16972
4L-2S		MI	6627	2818	11984	2065	13996	1602	15452	1210	17885	544	21952	299	19623
10-#11	2.50	MA	5968	2222	9576	1744	11260	1401	12175	1123	13410	686	16411	581	11233
2L-5S		MI	4261	2222	7154	1729	8181	1379	8592	1112	8889	675	10831	337	9234
10-#11	2.50	MA	5425	2222	8846	1741	10338	1396	11080	1128	11968	691	14532	490	11168
3L-4S		MI	4596	2222	7662	1723	8777	1385	9300	1107	9852	680	11991	381	9674
10-#11	2.50	MA	5023	2222	8295	1738	9597	1401	10204	1123	10859	696	13296	403	10630
4L-3S		MI	4962	2222	8161	1727	9438	1379	10081	1112	10840	675	13089	465	10166
10-#11	2.50	MA	4655	2222	7735	1745	8927	1396	9410	1128	9780	691	11986	360	10112
5L-2S		MI	5453	2222	8820	1731	10260	1385	11057	1107	12125	670	14752	556	10218
10-#14	3.61	MA	6593	2473	11155	1893	13165	1503	14422	1178	16356	647	20188	498	15814
2L-5S		MI	4362	2473	7869	1872	9016	1475	9571	1165	10171	633	12561	150	11943
10-#14	3.61	MA	5844	2473	10117	1887	11863	1496	12876	1186	14322	654	17548	367	15614
3L-4S		MI	4823	2473	8593	1864	9855	1483	10567	1158	11527	640	14186	213	12954
10-#14	3.61	MA	5288	2473	9331	1882	10817	1503	11640	1178	12757	662	15808	244	14273
4L-3S		MI	5342	2473	9305	1872	10786	1475	11666	1165	12918	633	15726	332	14172
10-#14	3.61	MA	4782	2473	8532	1891	9873	1496	10520	1186	11233	654	13968	182	13155
5L-2S		MI	6007	2473	10241	1879	11942	1483	13040	1158	14727	625	18056	464	14343
10-#18	6.41	MA	6807	3109	13213	2260	15522	1742	17192	1323	19985	548	24725	28	24604
3L-4S		MI	5362	3109	10774	2218	12423	1725	13592	1277	15532	525	19360	-238	18399
10-#18	6.41	MA	5926	3109	11847	2247	13743	1756	15090	1309	17324	561	21782	-182	20905
4L-3S		MI	6163	3109	11984	2231	13996	1712	15452	1291	17885	512	21952	-35	21766
12-#11	3.00	MA	6277	2335	10306	1815	12183	1453	13271	1154	14851	674	18289	553	13384
2L-6S		MI	4239	2335	7359	1795	8413	1435	8871	1136	9279	666	11415	243	10345
12-#11	3.00	MA	5742	2335	9576	1812	11260	1448	12175	1159	13410	679	16411	462	13294
3L-5S		MI	4555	2335	7812	1800	9003	1430	9568	1141	10174	661	12494	306	11076
12-#11	3.00	MA	5346	2335	9025	1809	10519	1453	11300	1154	12301	684	15175	375	12651
4E		MI	4884	2335	8320	1793	9599	1435	10276	1136	11136	666	13654	349	11493
12-#11	3.00	MA	4985	2335	8465	1816	9850	1448	10506	1159	11221	679	13865	332	12167
5L-3S		MI	5245	2335	8820	1798	10260	1430	11057	1141	12125	661	14752	434	12086
12-#11	3.00	MA	4639	2335	7965	1813	9188	1453	9723	1154	10217	684	12644	270	11347
6L-2S		MI	5729	2335	9479	1802	11082	1435	12033	1136	13410	656	16415	525	12161
12-#14	4.33	MA	6292	2636	11155	1989	13165	1569	14422	1228	16356	635	20188	323	18555
3L-5S		MI	4787	2636	8805	1975	10173	1547	10945	1206	11980	611	14891	100	14458
12-#14	4.33	MA	5756	2636	10369	1984	12119	1577	13186	1221	14791	643	18448	201	17160
4E		MI	5237	2636	9529	1967	11012	1554	11941	1198	13335	619	16515	164	15547
12-#14	4.33	MA	5263	2636	9570	1993	11175	1569	12065	1228	13267	635	16607	138	15964
5L-3S		MI	5724	2636	10241	1974	11942	1547	13040	1206	14727	611	18056	283	16727
12-#18	7.69	MA	6651	3400	13641	2429	15955	1882	17717	1381	20783	521	26230	-272	24700
4E		MI	6005	3400	12363	2397	14379	1848	15916	1344	18591	480	23261	-338	21663
14-#11	3.50	MA	6054	2449	10306	1883	12183	1499	13271	1189	14851	667	18289	434	15416
3L-6S		MI	4532	2449	8017	1866	9235	1485	9847	1165	10564	653	13078	211	12156
14-#11	3.50	MA	5664	2449	9754	1880	11442	1505	12395	1184	13742	672	17053	347	14684
4L-5S		MI	4843	2449	8471	1870	9825	1480	10545	1170	11459	647	14157	274	12849
14-#11	3.50	MA	5308	2449	9194	1887	10772	1499	11601	1189	12663	667	15743	304	14171
5L-4S		MI	5168	2449	8979	1864	10421	1485	11252	1165	12421	653	15317	318	13323
14-#11	3.50	MA	4967	2449	8695	1884	10111	1505	10818	1184	11659	672	14522	242	13363
6L-3S		MI	5523	2449	9479	1869	11082	1480	12033	1170	13410	647	16415	402	14001
14-#14	5.05	MA	6189	2800	11407	2086	13420	1650	14732	1263	16825	624	21088	157	20062
4L-5S		MI	5184	2800	9741	2077	11330	1618	12319	1246	13788	589	17220	51	16992

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	5.05	MA	5709	2800	10608	2095	12476	1643	13611	1271	15302	616	19247	94	18792
5L-4S		MI	5621	2800	10465	2069	12169	1626	13315	1239	15144	597	18845	115	18155
16-#11	4.00	MA	5976	2562	10484	1951	12364	1556	13491	1214	15184	660	18932	319	16726
4L-6S		MI	4820	2562	8676	1937	10057	1536	10823	1194	11849	639	14741	180	13977
16-#11	4.00	MA	5626	2562	9924	1958	11695	1551	12697	1219	14104	655	17622	276	16159
5E		MI	5127	2562	9130	1941	10647	1531	11521	1199	12743	633	15820	242	14633
16-#11	4.00	MA	5290	2562	9425	1954	11033	1556	11914	1214	13100	660	16401	214	15389
6L-4S		MI	5446	2562	9638	1935	11243	1536	12229	1194	13706	639	16980	286	15162
16-#14	5.77	MA	6144	2963	11646	2198	13778	1716	15157	1313	17336	597	21886	50	21635
5E		MI	5571	2963	10676	2179	12487	1690	13693	1286	15597	567	19550	2	19541
18-#11	4.50	MA	5963	2676	10654	2029	12617	1603	13792	1250	15546	643	19500	248	18156
5L-6S		MI	5123	2676	9335	2008	10879	1586	11799	1223	13134	625	16404	148	15804
18-#11	4.50	MA	5608	2675	10154	2025	11956	1608	13009	1245	14542	648	18279	185	17422
6L-5S		MI	5424	2675	9789	2012	11469	1581	12497	1228	14028	620	17483	211	16428
20-#11	5.00	MA	5946	2789	10884	2096	12878	1659	14105	1275	15983	636	20157	157	19461
6E		MI	5402	2789	9994	2079	11701	1637	12776	1252	14419	611	18067	116	17606

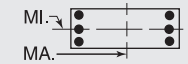
RECTANGULAR TIED COLUMNS 24" x 28"

4-#14	1.34	MA	6071	2109	9136	1705	10597	1384	11206	1137	11722	773	14055	701	7211
2E		MI	5137	2109	7861	1677	8945	1355	9393	1110	9738	747	11560	666	6058
4-#18	2.38	MA	6776	2364	10887	1848	12663	1480	13624	1187	14884	727	18090	610	12275
2E		MI	5687	2364	9240	1811	10559	1441	11278	1149	12202	690	14640	554	10210
6-#11	1.39	MA	6138	2122	9216	1722	10740	1397	11420	1149	12015	779	14468	708	7533
2L-3S		MI	4685	2122	7269	1691	8267	1366	8603	1128	8709	760	10258	584	6342
6-#11	1.39	MA	5519	2122	8415	1720	9725	1393	10205	1154	10416	784	12374	617	7528
3L-2S		MI	5194	2122	7928	1695	9089	1371	9579	1123	9994	755	11921	675	6327
6-#14	2.01	MA	6579	2273	10276	1808	12043	1459	12924	1182	13982	756	17006	662	10608
2L-3S		MI	4834	2273	7861	1772	8945	1419	9393	1158	9738	733	11560	485	8813
6-#14	2.01	MA	5717	2273	9136	1803	10597	1452	11206	1189	11722	763	14055	530	10516
3L-2S		MI	5542	2273	8797	1779	10102	1426	10767	1150	11547	725	13890	617	8860
6-#18	3.57	MA	7598	2654	12863	2029	15132	1610	16557	1261	18743	692	23089	530	18094
2L-3S		MI	5185	2654	9240	1977	10559	1551	11278	1229	12202	658	14640	220	13874
6-#18	3.57	MA	6171	2654	10887	2019	12663	1597	13624	1274	14884	705	18090	296	16905
3L-2S		MI	6336	2654	10828	1990	12515	1564	13602	1216	15261	645	18540	453	14966
8-#11	1.86	MA	6498	2236	10016	1793	11755	1449	12635	1181	13613	768	16563	683	9917
2L-4S		MI	4607	2236	7428	1758	8428	1421	8799	1152	9005	751	10823	468	8009
8-#11	1.86	MA	5889	2236	9216	1790	10740	1445	11420	1186	12015	773	14468	592	9879
3E		MI	4981	2236	7928	1762	9089	1416	9579	1157	9994	746	11921	552	8284
8-#11	1.86	MA	5440	2236	8613	1788	9926	1451	10449	1181	10784	779	13094	504	9539
4L-2S		MI	5482	2236	8586	1766	9911	1421	10556	1152	11279	741	13584	643	8298
8-#14	2.68	MA	7071	2436	11416	1910	13489	1534	14642	1226	16243	739	19957	623	13978
2L-4S		MI	4723	2436	8085	1867	9172	1498	9668	1191	10155	719	12349	317	10545
8-#14	2.68	MA	6228	2436	10276	1906	12043	1527	12924	1234	13982	747	17006	491	13828
3E		MI	5242	2436	8797	1874	10102	1490	10767	1198	11547	711	13890	436	11533
8-#14	2.68	MA	5604	2436	9415	1901	10882	1534	11551	1226	12243	754	15067	365	12624
4L-2S		MI	5937	2436	9733	1882	11259	1498	12141	1191	13355	704	16219	568	11634
8-#18	4.76	MA	8379	2945	14839	2211	17601	1739	19489	1336	22602	657	28087	450	23880
2L-4S		MI	5002	2945	9619	2143	10942	1687	11742	1283	12908	626	15949	-84	15675
8-#18	4.76	MA	7028	2945	12863	2201	15132	1726	16557	1349	18743	670	23089	216	22143
3E		MI	5844	2945	10828	2156	12515	1674	13602	1296	15261	613	18540	119	18084

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

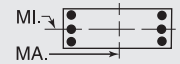


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	4.76	MA	6014	2945	11365	2190	13147	1739	14212	1336	15773	683	19792	0	19790
4L-2S		MI	6951	2945	12417	2169	14471	1687	15925	1283	18320	600	22440	353	19686
10-#11	2.32	MA	6850	2349	10817	1864	12771	1501	13850	1212	15212	758	18658	658	12286
2L-5S		MI	4566	2349	7579	1835	8654	1466	9067	1186	9327	732	11327	392	9356
10-#11	2.32	MA	6251	2349	10016	1861	11755	1497	12635	1218	13613	763	16563	567	12221
3L-4S		MI	4903	2349	8087	1828	9250	1472	9775	1181	10290	737	12486	436	9810
10-#11	2.32	MA	5809	2349	9413	1859	10941	1502	11664	1212	12383	768	15189	478	11744
4L-3S		MI	5272	2349	8586	1833	9911	1466	10556	1186	11279	732	13584	520	10215
10-#11	2.32	MA	5407	2349	8801	1867	10207	1498	10783	1218	11186	763	13728	436	11129
5L-2S		MI	5765	2349	9245	1837	10733	1472	11532	1181	12564	727	15247	611	10255
10-#14	3.35	MA	7551	2600	12556	2012	14935	1609	16359	1270	18503	722	22908	583	17333
2L-5S		MI	4665	2600	8297	1978	9490	1562	10046	1239	10608	689	13054	204	12196
10-#14	3.35	MA	6724	2600	11416	2008	13489	1601	14642	1278	16243	730	19957	452	17133
3L-4S		MI	5131	2600	9021	1970	10329	1569	11042	1231	11964	697	14679	268	13116
10-#14	3.35	MA	6114	2600	10556	2003	12328	1609	13269	1270	14503	737	18017	326	15781
4L-3S		MI	5640	2600	9733	1977	11259	1562	12141	1239	13355	689	16219	387	14243
10-#14	3.35	MA	5558	2600	9682	2014	11279	1602	12023	1278	12811	730	15960	264	14664
5L-2S		MI	6322	2600	10668	1984	12416	1569	13515	1231	15164	682	18549	518	14390
10-#18	5.95	MA	7827	3236	14839	2382	17601	1856	19489	1424	22602	635	28087	136	27449
3L-4S		MI	5668	3236	11208	2322	12898	1810	14066	1350	15966	581	19849	-184	19106
10-#18	5.95	MA	6853	3236	13340	2372	15616	1869	17144	1411	19632	648	24790	-81	24331
4L-3S		MI	6479	3236	12417	2335	14471	1797	15925	1363	18320	568	22440	19	22362
12-#11	2.79	MA	7195	2463	11617	1935	13786	1553	15065	1244	16810	747	20752	633	14647
2L-6S		MI	4543	2463	7784	1901	8886	1522	9346	1210	9718	723	11910	298	10529
12-#11	2.79	MA	6605	2463	10817	1932	12771	1548	13850	1249	15212	752	18658	542	14557
3L-5S		MI	4861	2463	8237	1905	9476	1517	10043	1215	10612	718	12989	361	11205
12-#11	2.79	MA	6170	2463	10214	1930	11957	1554	12879	1244	13981	758	17283	453	13965
4E		MI	5193	2463	8745	1899	10072	1522	10751	1210	11575	723	14149	404	11626
12-#11	2.79	MA	5774	2463	9602	1938	11222	1550	11998	1249	12785	752	15822	411	13388
5L-3S		MI	5556	2463	9245	1904	10733	1517	11532	1215	12564	718	15247	488	12138
12-#11	2.79	MA	5394	2463	9057	1935	10497	1556	11130	1244	11672	758	14459	349	12562
6L-2S		MI	6043	2463	9904	1908	11555	1522	12508	1210	13848	713	16910	580	12201
12-#14	4.02	MA	7209	2764	12556	2110	14935	1676	16359	1322	18503	713	22908	413	20434
3L-5S		MI	5093	2764	9233	2080	10647	1633	11420	1279	12417	668	15383	155	14706
12-#14	4.02	MA	6611	2764	11696	2106	13774	1684	14986	1315	16764	721	20968	287	18959
4E		MI	5547	2764	9957	2072	11486	1641	12416	1272	13772	675	17008	219	15706
12-#14	4.02	MA	6067	2764	10822	2116	12725	1676	13741	1322	15071	713	18910	225	17764
5L-3S		MI	6040	2764	10668	2079	12416	1633	13515	1279	15164	668	18549	338	16941
12-#14	4.02	MA	5544	2764	10043	2112	11688	1684	12514	1315	13497	721	16991	135	16497
6L-2S		MI	6695	2764	11604	2086	13573	1641	14889	1272	16973	660	20879	469	17135
12-#18	7.14	MA	7663	3527	15316	2553	18085	1999	20077	1485	23491	613	29789	-161	28734
4E		MI	6314	3527	12796	2501	14853	1933	16389	1417	19025	536	23749	-284	22413
14-#11	3.25	MA	6952	2576	11617	2003	13786	1600	15065	1281	16810	742	20752	517	16890
3L-6S		MI	4837	2576	8443	1972	9708	1572	10322	1239	11003	709	13573	266	12338
14-#11	3.25	MA	6524	2576	11014	2001	12972	1606	14094	1275	15580	747	19378	428	16198
4L-5S		MI	5151	2576	8896	1976	10298	1567	11020	1244	11897	704	14652	329	13060
14-#11	3.25	MA	6135	2576	10403	2009	12238	1602	13213	1281	14383	742	17917	385	15654
5L-4S		MI	5478	2576	9404	1970	10894	1572	11727	1239	12860	709	15812	373	13454
14-#11	3.25	MA	5761	2576	9857	2006	11512	1608	12345	1275	13270	747	16553	323	14781
6L-3S		MI	5836	2576	9904	1974	11555	1567	12508	1244	13848	704	16910	457	14057
14-#11	3.25	MA	5394	2576	9326	2004	10810	1603	11503	1281	12179	752	15157	240	13937
7L-2S		MI	6316	2576	10563	1979	12377	1572	13484	1239	15133	699	18573	548	14140
14-#14	4.69	MA	7126	2927	12836	2208	15220	1759	16704	1359	19024	704	23919	248	22153
4L-5S		MI	5492	2927	10168	2182	11804	1705	12794	1320	14226	646	17713	106	17234
14-#14	4.69	MA	6597	2927	11962	2219	14171	1751	15459	1367	17331	696	21861	186	20882
5L-4S		MI	5935	2927	10892	2174	12643	1712	13790	1312	15581	653	19338	170	18311
14-#14	4.69	MA	6084	2927	11183	2214	13134	1759	14232	1359	15757	704	19942	96	19574
6L-3S		MI	6415	2927	11604	2181	13573	1705	14889	1320	16973	646	20879	288	19457

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	3.71	MA	6872	2689	11815	2072	13987	1658	15309	1307	17179	736	21473	403	18441
4L-6S		MI	5126	2689	9101	2043	10530	1623	11298	1268	12287	696	15236	235	14156
16-#11	3.71	MA	6488	2689	11203	2079	13253	1654	14428	1312	15982	731	20012	360	17927
5E		MI	5435	2689	9555	2047	11120	1618	11996	1273	13182	690	16315	297	14840
16-#11	3.71	MA	6120	2689	10658	2077	12527	1659	13560	1307	14869	736	18648	298	17009
6L-4S		MI	5758	2689	10063	2041	11716	1623	12704	1268	14145	696	17475	341	15292
16-#11	3.71	MA	5760	2689	10126	2075	11825	1655	12718	1312	13778	742	17251	215	16133
7L-3S		MI	6111	2689	10563	2045	12377	1618	13484	1273	15133	690	18573	425	15973
16-#14	5.36	MA	7083	3091	13102	2321	15617	1826	17177	1411	19592	680	24812	147	24015
5E		MI	5881	3091	11104	2284	12960	1776	14168	1360	16034	624	20043	57	19779
16-#14	5.36	MA	6584	3091	12323	2316	14580	1833	15949	1403	18018	687	22892	57	22665
6L-4S		MI	6314	3091	11828	2276	13800	1784	15164	1353	17390	631	21668	120	20928
18-#11	4.18	MA	6836	2803	12004	2150	14268	1705	15643	1344	17580	721	22107	335	20129
5L-6S		MI	5432	2803	9760	2114	11352	1673	12274	1297	13572	682	16899	203	15981
18-#11	4.18	MA	6474	2803	11458	2148	13543	1711	14775	1338	16467	726	20743	273	19245
6L-5S		MI	5736	2803	10214	2118	11942	1668	12972	1302	14467	676	17978	266	16632
18-#11	4.18	MA	6118	2803	10927	2145	12840	1707	13933	1344	15376	731	19346	190	18338
7L-4S		MI	6034	2803	10722	2112	12538	1673	13680	1297	15429	682	19138	309	17137
18-#14	6.03	MA	7072	3254	13463	2419	16026	1908	17667	1448	20278	670	25843	18	25769
6L-5S		MI	6263	3254	12040	2386	14117	1848	15542	1400	17843	602	22372	7	22337
20-#11	4.64	MA	6822	2916	12259	2219	14558	1763	15990	1370	18066	715	22837	248	21488
6E		MI	5712	2916	10419	2185	12174	1724	13251	1326	14857	668	18562	171	17813
20-#11	4.64	MA	6471	2916	11728	2216	13856	1759	15148	1375	16975	720	21441	165	20551
7L-5S		MI	6010	2916	10873	2189	12764	1719	13949	1331	15752	663	19641	234	18432
22-#11	5.11	MA	6820	3030	12528	2287	14871	1811	16363	1407	18574	710	23535	139	22744
7L-6S		MI	5987	3030	11078	2256	12996	1774	14227	1355	16142	654	20225	140	19647

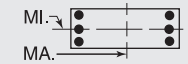
RECTANGULAR TIED COLUMNS 24" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.25	MA	6925	2237	10290	1825	11979	1483	12708	1224	13268	841	15933	771	7819
2E		MI	5445	2237	8289	1782	9419	1441	9867	1183	10175	804	12053	721	6087
4-#18	2.22	MA	7712	2491	12209	1967	14304	1583	15393	1276	16778	799	20444	688	13355
2E		MI	5998	2491	9673	1915	11034	1527	11752	1222	12636	746	15128	608	10253
6-#11	1.30	MA	6997	2250	10374	1841	12131	1496	12936	1236	13580	847	16374	778	8165
2L-3S		MI	4991	2250	7694	1797	8740	1453	9078	1202	9148	817	10753	639	6376
6-#11	1.30	MA	6320	2250	9503	1840	11026	1492	11601	1241	11824	852	14062	687	8160
3L-2S		MI	5502	2250	8353	1801	9562	1458	10054	1197	10432	811	12416	730	6355
6-#14	1.88	MA	7488	2400	11533	1927	13555	1557	14598	1270	15755	826	19196	735	11520
2L-3S		MI	5141	2400	8289	1877	9419	1505	9867	1231	10175	789	12053	540	8865
6-#14	1.88	MA	6544	2400	10290	1924	11979	1551	12708	1277	13268	833	15933	604	11428
3L-2S		MI	5852	2400	9225	1884	10576	1513	11241	1224	11984	782	14383	671	8895
6-#18	3.33	MA	8625	2782	14367	2149	17031	1716	18631	1354	21039	768	25996	615	19714
2L-3S		MI	5494	2782	9673	2081	11034	1636	11752	1302	12636	714	15128	274	14156
6-#18	3.33	MA	7059	2782	12209	2140	14304	1702	15393	1367	16778	781	20444	382	18787
3L-2S		MI	6653	2782	11262	2094	12990	1650	14075	1289	15695	700	19028	507	15020
8-#11	1.73	MA	7395	2363	11246	1912	13236	1547	14270	1268	15336	838	18685	755	10759
2L-4S		MI	4913	2363	7853	1863	8901	1508	9274	1226	9444	808	11319	523	8142
8-#11	1.73	MA	6730	2363	10374	1910	12131	1544	12936	1273	13580	843	16374	664	10721
3E		MI	5289	2363	8353	1868	9562	1503	10054	1231	10432	803	12416	607	8324
8-#11	1.73	MA	6240	2363	9720	1909	11248	1550	11869	1268	12186	838	14860	574	10470
4L-2S		MI	5792	2363	9011	1872	10384	1508	11031	1226	11717	798	14079	698	8329

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

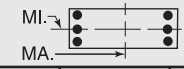


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.50	MA	8033	2564	12775	2029	15131	1632	16488	1316	18242	811	22458	700	15193
2L-4S		MI	5028	2564	8513	1973	9646	1584	10142	1264	10593	775	12842	372	10706
8-#14	2.50	MA	7109	2564	11533	2026	13555	1626	14598	1323	15755	819	19196	569	15043
3E		MI	5551	2564	9225	1980	10576	1577	11241	1272	11984	768	14383	491	11593
8-#14	2.50	MA	6429	2564	10598	2023	12293	1635	13087	1316	13840	826	17056	440	13862
4L-2S		MI	6249	2564	10161	1987	11733	1584	12615	1264	13793	760	16712	622	11675
8-#18	4.44	MA	9504	3073	16524	2330	19758	1848	21869	1431	25299	737	31547	543	26040
2L-4S		MI	5306	3073	10052	2246	11416	1773	12216	1356	13342	682	16437	-30	16339
8-#18	4.44	MA	7986	3073	14367	2322	17031	1835	18631	1445	21039	750	25996	309	24534
3E		MI	6156	3073	11262	2260	12990	1759	14075	1369	15695	669	19028	173	18356
8-#18	4.44	MA	6866	3073	12736	2314	14840	1848	16043	1431	17760	763	22344	88	21763
4L-2S		MI	7274	3073	12850	2273	14946	1773	16399	1356	18754	655	22929	407	19746
10-#11	2.17	MA	7784	2476	12117	1983	14342	1599	15605	1301	17092	828	20997	733	13339
2L-5S		MI	4871	2476	8004	1940	9127	1554	9542	1260	9766	789	11822	447	9472
10-#11	2.17	MA	7129	2476	11246	1981	13236	1596	14270	1306	15336	833	18685	642	13274
3L-4S		MI	5210	2476	8512	1934	9723	1559	10250	1255	10729	794	12982	491	9940
10-#11	2.17	MA	6648	2476	10591	1980	12353	1602	13204	1301	13942	828	17172	551	12874
4L-3S		MI	5581	2476	9011	1939	10384	1554	11031	1260	11717	789	14079	575	10260
10-#11	2.17	MA	6210	2476	9928	1988	11556	1599	12236	1306	12670	833	15560	509	12155
5L-2S		MI	6077	2476	9670	1943	11206	1559	12007	1255	13002	784	15742	666	10290
10-#14	3.13	MA	8564	2727	14018	2131	16707	1707	18378	1361	20729	796	25721	665	18851
2L-5S		MI	4969	2727	8725	2083	9963	1648	10520	1312	11046	746	13547	259	12443
10-#14	3.13	MA	7658	2727	12775	2128	15131	1701	16488	1369	18242	804	22458	533	18652
3L-4S		MI	5438	2727	9449	2075	10803	1656	11516	1305	12401	753	15172	323	13273
10-#14	3.13	MA	6992	2727	11840	2125	13869	1710	14978	1361	16327	811	20319	405	17310
4L-3S		MI	5951	2727	10161	2082	11733	1648	12615	1312	13793	746	16712	442	14309
10-#14	3.13	MA	6387	2727	10892	2137	12730	1704	13607	1369	14466	804	18043	344	16208
5L-2S		MI	6637	2727	11096	2089	12890	1656	13990	1305	15601	738	19042	573	14435
10-#18	5.56	MA	8903	3363	16524	2504	19758	1967	21869	1522	25299	719	31547	237	30348
3L-4S		MI	5975	3363	11641	2425	13372	1896	14539	1422	16401	637	20337	-130	19809
10-#18	5.56	MA	7835	3363	14894	2495	17567	1980	19281	1509	22020	732	27895	15	27790
4L-3S		MI	6795	3363	12850	2439	14946	1882	16399	1436	18754	623	22929	73	22626
10-#18	5.56	MA	6849	3363	13238	2513	15589	1967	16933	1522	18830	719	24023	-95	23629
5L-2S		MI	7877	3363	14438	2452	16902	1896	18722	1422	21813	610	26829	307	24449
12-#11	2.60	MA	8166	2590	12988	2054	15447	1651	16940	1333	18848	819	23308	710	15911
2L-6S		MI	4847	2590	8209	2007	9359	1609	9821	1284	10156	780	12405	353	10708
12-#11	2.60	MA	7520	2590	12117	2052	14342	1647	15605	1338	17092	824	20997	619	15821
3L-5S		MI	5167	2590	8662	2011	9949	1604	10518	1289	11051	775	13485	416	11321
12-#11	2.60	MA	7046	2590	11463	2050	13458	1654	14539	1333	15698	819	19483	529	15295
4E		MI	5501	2590	9171	2005	10545	1609	11226	1284	12013	780	14645	459	11754
12-#11	2.60	MA	6616	2590	10799	2059	12662	1651	13571	1338	14426	824	17871	487	14619
5L-3S		MI	5867	2590	9670	2009	11206	1604	12007	1289	13002	775	15742	543	12188
12-#11	2.60	MA	6202	2590	10208	2057	11874	1657	12618	1333	13203	829	16259	410	13798
6L-2S		MI	6356	2590	10329	2014	12028	1609	12983	1284	14287	770	17405	635	12239
12-#14	3.75	MA	8195	2891	14018	2230	16707	1776	18378	1415	20729	789	25721	498	22257
3L-5S		MI	5399	2891	9661	2185	11120	1720	11894	1353	12854	724	15876	210	14947
12-#14	3.75	MA	7542	2891	13083	2227	15444	1784	16868	1407	18814	797	23582	370	20778
4E		MI	5858	2891	10385	2177	11960	1727	12890	1345	14210	732	17501	273	15860
12-#14	3.75	MA	6949	2891	12134	2239	14306	1778	15498	1415	16953	789	21306	309	19600
5L-3S		MI	6355	2891	11096	2184	12890	1720	13990	1353	15601	724	19042	392	17018
12-#14	3.75	MA	6379	2891	11289	2236	13181	1787	14147	1407	15221	797	19181	219	18236
6L-2S		MI	7016	2891	12032	2191	14047	1727	15364	1345	17410	717	21371	524	17183
12-#18	6.67	MA	8733	3654	17051	2677	20294	2112	22519	1587	26281	701	33446	-57	33002
4E		MI	6623	3654	13229	2604	15328	2019	16863	1489	19460	591	24238	-230	23158
12-#18	6.67	MA	7785	3654	15395	2695	18316	2099	20171	1600	23090	688	29575	-168	28647
5L-3S		MI	7416	3654	14438	2618	16902	2005	18722	1503	21813	578	26829	-27	26666
14-#11	3.03	MA	7904	2703	12988	2123	15447	1699	16940	1371	18848	815	23308	596	18364
3L-6S		MI	5142	2703	8868	2078	10181	1660	10797	1313	11441	766	14068	321	12514

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	3.03	MA	7437	2703	12334	2121	14563	1706	15873	1366	17454	810	21795	506	17730
4L-5S		MI	5458	2703	9321	2082	10771	1654	11495	1318	12336	761	15148	384	13177
14-#11	3.03	MA	7014	2703	11671	2130	13767	1702	14906	1371	16182	815	20183	464	17090
5L-4S		MI	5787	2703	9829	2076	11367	1660	12202	1313	13298	766	16308	428	13581
14-#11	3.03	MA	6607	2703	11079	2128	12980	1709	13952	1366	14959	820	18570	388	16220
6L-3S		MI	6148	2703	10329	2080	12028	1654	12983	1318	14287	761	17405	512	14110
14-#11	3.03	MA	6208	2703	10504	2126	12219	1706	13027	1371	13718	815	17140	317	15373
7L-2S		MI	6631	2703	10988	2084	12850	1660	13960	1313	15572	756	19068	603	14181
14-#14	4.38	MA	8080	3054	14325	2329	17020	1859	18758	1453	21301	782	26844	335	24264
4L-5S		MI	5800	3054	10596	2287	12277	1791	13268	1393	14663	702	18206	160	17471
14-#14	4.38	MA	7498	3054	13377	2341	15882	1853	17388	1461	19440	774	24569	273	23009
5L-4S		MI	6248	3054	11320	2279	13117	1799	14265	1386	16018	710	19831	224	18463
14-#14	4.38	MA	6940	3054	12531	2338	14756	1862	16038	1453	17708	782	22444	184	21678
6L-3S		MI	6733	3054	12032	2286	14047	1791	15364	1393	17410	702	21371	343	19662
14-#18	7.78	MA	8691	3945	17553	2877	21042	2231	23409	1678	27351	657	35126	-240	33488
5L-4S		MI	7256	3945	14817	2783	17284	2142	19187	1556	22519	546	28138	-331	26394
16-#11	3.47	MA	7822	2817	13206	2192	15668	1758	17208	1398	19210	800	24106	484	20175
4L-6S		MI	5432	2817	9526	2149	11003	1710	11773	1342	12726	752	15731	290	14329
16-#11	3.47	MA	7404	2817	12542	2201	14872	1754	16241	1403	17938	806	22494	441	19568
5E		MI	5744	2817	9980	2153	11593	1705	12471	1347	13620	747	16811	352	15038
16-#11	3.47	MA	7003	2817	11951	2199	14085	1761	15287	1398	16715	811	20882	365	18652
6L-4S		MI	6069	2817	10488	2147	12189	1710	13179	1342	14583	752	17970	396	15417
16-#11	3.47	MA	6611	2817	11375	2197	13324	1757	14362	1403	15474	806	19452	295	17773
7L-3S		MI	6425	2817	10988	2151	12850	1705	13960	1347	15572	747	19068	480	16029
16-#14	5.00	MA	8037	3218	14619	2443	17457	1928	19278	1506	21927	760	27832	238	26434
5E		MI	6191	3218	11532	2389	13434	1863	14642	1433	16471	680	20536	111	20011
16-#14	5.00	MA	7489	3218	13774	2440	16332	1937	17928	1499	20195	767	25707	149	25063
6L-4S		MI	6629	3218	12256	2382	14274	1870	15639	1426	17827	688	22161	175	21078
18-#11	3.90	MA	7788	2930	13413	2272	15977	1806	17575	1436	19694	796	24806	419	22052
5L-6S		MI	5718	2930	10185	2220	11825	1760	12749	1371	14011	739	17394	258	16152
18-#11	3.90	MA	7393	2930	12822	2270	15190	1813	16622	1431	18471	801	23193	343	21091
6L-5S		MI	6026	2930	10639	2224	12415	1755	13447	1376	14905	733	18474	321	16830
18-#11	3.90	MA	7006	2930	12246	2268	14429	1809	15697	1436	17230	796	21763	272	20182
7L-4S		MI	6347	2930	11147	2218	13011	1760	14155	1371	15868	739	19633	364	17261
18-#14	5.63	MA	8072	3382	15016	2542	17908	2012	19818	1545	22682	752	28970	113	28460
6L-5S		MI	6575	3382	12468	2492	14591	1934	16017	1474	18280	659	22865	62	22565
20-#11	4.33	MA	7777	3043	13694	2341	16295	1865	17957	1463	20227	792	25505	320	23537
6E		MI	6022	3043	10844	2291	12647	1811	13726	1400	15296	725	19057	226	17981
20-#11	4.33	MA	7396	3043	13118	2339	15534	1861	17032	1468	18986	787	24075	249	22597
7L-5S		MI	6324	3043	11298	2295	13237	1806	14424	1405	16190	719	20137	289	18627
22-#11	4.77	MA	7780	3157	13989	2410	16639	1913	18366	1501	20742	778	26387	227	25019
7L-6S		MI	6299	3157	11503	2362	13469	1861	14702	1429	16580	711	20720	194	19817

RECTANGULAR TIED COLUMNS 24" x 32"

4-#14	1.17	MA	7831	2364	11505	1944	13437	1581	14289	1310	14891	908	17901	839	8426
2E		MI	5752	2364	8717	1887	9893	1528	10342	1257	10613	860	12546	775	6115
4-#18	2.08	MA	8701	2618	13591	2086	15986	1683	17242	1365	18750	870	22891	763	14435
2E		MI	6308	2618	10106	2019	11509	1612	12225	1294	13071	801	15617	661	10296
6-#11	1.22	MA	7907	2377	11592	1961	13598	1594	14511	1320	15222	914	18370	846	8797
2L-3S		MI	5298	2377	8119	1903	9213	1540	9553	1276	9586	873	11248	694	6408
6-#11	1.22	MA	7173	2377	10650	1960	12403	1591	13063	1326	13309	919	15841	755	8791
3L-2S		MI	5810	2377	8778	1907	10035	1545	10529	1271	10871	868	12911	785	6382
6-#14	1.76	MA	8449	2527	12849	2046	15142	1656	16352	1357	17605	895	21476	808	12431
2L-3S		MI	5448	2527	8717	1983	9893	1592	10342	1305	10613	846	12546	595	8915

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

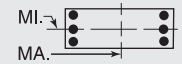
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.76	MA	7423	2527	11505	2044	13437	1651	14289	1365	14891	903	17901	676	12339
3L-2S		MI	6162	2527	9653	1990	11050	1599	11716	1297	12421	838	14876	726	8929
6-#18	3.13	MA	9707	2909	15930	2268	18953	1816	20787	1445	23414	842	28997	698	21334
2L-3S		MI	5802	2909	10106	2184	11509	1722	12225	1374	13071	769	15617	328	14430
6-#18	3.13	MA	8000	2909	13591	2261	15986	1804	17242	1458	18750	855	22891	464	20715
3L-2S		MI	6970	2909	11695	2198	13465	1735	14549	1361	16130	756	19517	561	15072
8-#11	1.63	MA	8344	2490	12535	2032	14793	1646	15959	1353	17136	906	20898	826	11602
2L-4S		MI	5219	2490	8278	1969	9374	1595	9749	1300	9882	865	11814	578	8271
8-#11	1.63	MA	7622	2490	11592	2030	13598	1643	14511	1359	15222	911	18370	735	11563
3E		MI	5597	2490	8778	1974	10035	1590	10529	1305	10871	860	12911	662	8363
8-#11	1.63	MA	7092	2490	10887	2029	12644	1650	13355	1354	13703	906	16714	644	11400
4L-2S		MI	6102	2490	9437	1978	10857	1595	11506	1300	12156	854	14574	753	8360
8-#14	2.34	MA	9048	2691	14194	2149	16848	1730	18415	1404	20319	882	25052	776	16408
2L-4S		MI	5334	2691	8941	2078	10120	1671	10617	1338	11030	832	13335	426	10861
8-#14	2.34	MA	8043	2691	12849	2146	15142	1725	16352	1412	17605	890	21476	644	16258
3E		MI	5859	2691	9653	2085	11050	1663	11716	1345	12421	824	14876	545	11649
8-#14	2.34	MA	7306	2691	11840	2144	13780	1735	14704	1404	15450	882	19136	514	15118
4L-2S		MI	6561	2691	10588	2092	12207	1671	13090	1338	14230	817	17205	677	11714
8-#18	4.17	MA	10677	3200	18269	2450	21920	1949	24331	1525	28077	814	35102	632	28200
2L-4S		MI	5610	3200	10485	2350	11891	1858	12689	1428	13777	738	16926	24	16798
8-#18	4.17	MA	9019	3200	15930	2443	18953	1937	20787	1539	23414	828	28997	398	26973
3E		MI	6468	3200	11695	2363	13465	1845	14549	1441	16130	724	19517	227	18622
8-#18	4.17	MA	7803	3200	14168	2437	16574	1952	17954	1525	19824	841	24989	172	23759
4L-2S		MI	7595	3200	13283	2377	15421	1858	16872	1428	19189	711	23417	461	19805
10-#11	2.03	MA	8772	2604	13477	2102	15988	1697	17406	1386	19049	898	23427	806	14392
2L-5S		MI	5177	2604	8429	2046	9600	1641	10017	1334	10204	846	12317	502	9584
10-#11	2.03	MA	8060	2604	12535	2101	14793	1695	15959	1391	17136	903	20898	715	14327
3L-4S		MI	5517	2604	8937	2040	10196	1646	10725	1329	11167	851	13477	546	10067
10-#11	2.03	MA	7538	2604	11829	2100	13839	1702	14803	1387	15617	898	19243	623	14021
4L-3S		MI	5889	2604	9437	2044	10857	1641	11506	1334	12156	846	14574	630	10303
10-#11	2.03	MA	7065	2604	11113	2109	12981	1699	13756	1392	14231	903	17482	581	13192
5L-2S		MI	6388	2604	10095	2049	11679	1646	12482	1329	13441	841	16237	721	10325
10-#14	2.93	MA	9632	2855	15539	2251	18553	1805	20478	1451	23033	869	28628	744	20370
2L-5S		MI	5274	2855	9153	2188	10437	1735	10995	1386	11483	802	14040	314	12683
10-#14	2.93	MA	8646	2855	14194	2248	16848	1800	18415	1459	20319	876	25052	612	20171
3L-4S		MI	5745	2855	9877	2180	11276	1742	11991	1378	12838	810	15665	377	13425
10-#14	2.93	MA	7924	2855	13185	2246	15485	1810	16767	1451	18164	869	22712	482	18857
4L-3S		MI	6261	2855	10588	2187	12207	1735	13090	1386	14230	802	17205	496	14371
10-#14	2.93	MA	7268	2855	12162	2259	14257	1805	15272	1459	16199	876	20218	421	17787
5L-2S		MI	6951	2855	11524	2194	13364	1742	14464	1378	16038	795	19535	628	14478
10-#18	5.21	MA	10036	3491	18269	2625	21920	2070	24331	1619	28077	800	35102	333	33298
3L-4S		MI	6282	3491	12074	2529	13847	1981	15013	1495	16836	692	20826	-76	20509
10-#18	5.21	MA	8873	3491	16507	2618	19540	2085	21498	1606	24488	813	31095	106	30308
4L-3S		MI	7110	3491	13283	2542	15421	1968	16872	1508	19189	679	23417	127	22884
10-#18	5.21	MA	7800	3491	14718	2638	17393	2073	18929	1619	20997	800	26837	-3	26823
5L-2S		MI	8203	3491	14871	2556	17377	1981	19196	1495	22248	666	27318	360	24514
12-#11	2.44	MA	9190	2717	14419	2173	17183	1749	18854	1419	20963	890	25956	785	17174
2L-6S		MI	5151	2717	8634	2113	9832	1696	10296	1358	10595	837	12901	408	10881
12-#11	2.44	MA	8489	2717	13477	2172	15988	1746	17406	1424	19049	895	23427	694	17084
3L-5S		MI	5474	2717	9088	2117	10422	1691	10993	1363	11489	832	13980	471	11432
12-#11	2.44	MA	7975	2717	12771	2171	15034	1754	16251	1420	17531	890	21772	603	16643
4E		MI	5809	2717	9596	2111	11018	1696	11701	1358	12452	837	15140	514	11879

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

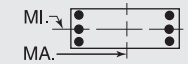


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.44	MA	7509	2717	12056	2180	14176	1751	15204	1425	16145	895	20011	561	15860
5L-3S		MI	6177	2717	10095	2115	11679	1691	12482	1363	13441	832	16237	598	12235
12-#11	2.44	MA	7062	2717	11419	2179	13328	1758	14172	1421	14812	900	18246	485	15054
6L-2S		MI	6669	2717	10754	2120	12501	1696	13458	1358	14725	827	17900	690	12277
12-#14	3.52	MA	9234	3018	15539	2351	18553	1875	20478	1506	23033	863	28628	580	24079
3L-5S		MI	5684	3018	10088	2290	11594	1806	12369	1426	13291	781	16369	264	15183
12-#14	3.52	MA	8527	3018	14530	2348	17190	1885	18830	1499	20878	856	26287	450	22618
4E		MI	6147	3018	10812	2282	12433	1814	13365	1419	14647	788	17994	328	16010
12-#14	3.52	MA	7884	3018	13506	2361	15962	1880	17335	1506	18913	863	23794	389	21470
5L-3S		MI	6655	3018	11524	2289	13364	1806	14464	1426	16038	781	19535	447	17086
12-#14	3.52	MA	7267	3018	12595	2359	14749	1890	15861	1499	17023	871	21299	279	19902
6L-2S		MI	7336	3018	12460	2296	14520	1814	15838	1419	17847	773	21864	578	17231
12-#18	6.25	MA	9860	3781	18846	2800	22507	2218	25043	1686	29151	786	37200	41	36890
4E		MI	6933	3781	13662	2708	15803	2104	17337	1562	19895	647	24726	-177	23897
12-#18	6.25	MA	8828	3781	17057	2820	20360	2206	22474	1699	25660	772	32942	-69	32518
5L-3S		MI	7735	3781	14871	2721	17377	2091	19196	1575	22248	634	27318	26	27200
14-#11	2.84	MA	8909	2831	14419	2243	17183	1798	18854	1457	20963	887	25956	674	19839
3L-6S		MI	5447	2831	9293	2184	10654	1747	11272	1387	11880	823	14564	376	12684
14-#11	2.84	MA	8404	2831	13714	2242	16230	1806	17699	1453	19444	882	24301	583	19278
4L-5S		MI	5765	2831	9746	2188	11244	1742	11970	1392	12774	818	15643	439	13287
14-#11	2.84	MA	7945	2831	12998	2251	15371	1803	16651	1458	18058	887	22540	540	18536
5L-4S		MI	6097	2831	10254	2182	11840	1747	12678	1387	13737	823	16803	483	13704
14-#11	2.84	MA	7505	2831	12361	2250	14523	1810	15619	1454	16726	892	20775	464	17680
6L-3S		MI	6459	2831	10754	2186	12501	1742	13458	1392	14725	818	17900	567	14161
14-#11	2.84	MA	7074	2831	11741	2249	13703	1807	14618	1459	15374	887	19213	393	16839
7L-2S		MI	6946	2831	11413	2190	13323	1747	14435	1387	16010	813	19563	658	14221
14-#14	4.10	MA	9116	3182	15874	2451	18896	1960	20893	1546	23592	843	29863	418	26396
4L-5S		MI	6108	3182	11024	2392	12751	1878	13743	1467	15100	759	18699	215	17702
14-#14	4.10	MA	8486	3182	14851	2463	17668	1955	19398	1553	21627	850	27370	357	25172
5L-4S		MI	6560	3182	11748	2385	13590	1885	14739	1459	16456	766	20324	279	18610
14-#14	4.10	MA	7881	3182	13940	2461	16454	1965	17924	1546	19737	858	24875	248	23669
6L-3S		MI	7050	3182	12460	2392	14520	1878	15838	1467	17847	759	21864	398	19795
14-#14	4.10	MA	7289	3182	13052	2458	15281	1960	16494	1553	17819	850	22664	145	21839
7L-2S		MI	7703	3182	13396	2399	15677	1885	17212	1459	19656	751	24194	529	19974
14-#18	7.29	MA	9823	4072	19397	3002	23327	2339	26018	1780	30323	745	39048	-134	38023
5L-4S		MI	7568	4072	15250	2887	17759	2227	19660	1629	22953	602	28627	-277	27172
16-#11	3.25	MA	8825	2944	14656	2313	17425	1858	19147	1485	21358	873	26830	562	21925
4L-6S		MI	5738	2944	9952	2255	11476	1797	12248	1416	13164	809	16227	345	14497
16-#11	3.25	MA	8373	2944	13940	2322	16566	1855	18099	1491	19972	879	25069	520	21220
5E		MI	6053	2944	10405	2259	12066	1792	12946	1421	14059	804	17306	407	15148
16-#11	3.25	MA	7939	2944	13304	2321	15718	1862	17067	1486	18639	884	23304	444	20315
6L-4S		MI	6380	2944	10913	2253	12662	1797	13654	1416	15022	809	18466	451	15538
16-#11	3.25	MA	7514	2944	12683	2320	14898	1859	16066	1492	17287	879	21741	373	19444
7L-3S		MI	6738	2944	11413	2257	13323	1792	14435	1421	16010	804	19563	535	16082
16-#11	3.25	MA	7095	2944	12073	2319	14094	1856	15062	1487	15983	884	20098	323	18359
8L-2S		MI	7219	2944	12072	2261	14145	1797	15411	1416	17295	799	21226	626	16160
16-#14	4.69	MA	9076	3345	16196	2565	19373	2029	21461	1600	24341	837	30946	325	28890
5E		MI	6502	3345	11960	2495	13908	1949	15117	1507	16909	737	21029	166	20238
16-#14	4.69	MA	8482	3345	15284	2563	18159	2039	19987	1593	22451	845	28451	216	27447
6L-4S		MI	6944	3345	12684	2487	14747	1957	16113	1500	18264	744	22653	229	21223
16-#14	4.69	MA	7901	3345	14396	2561	16986	2034	18557	1600	20533	837	26240	113	25579
7L-3S		MI	7424	3345	13396	2494	15677	1949	17212	1507	19656	737	24194	348	22390
18-#11	3.66	MA	8794	3057	14883	2393	17761	1907	19547	1524	21885	870	27598	500	23909
5L-6S		MI	6025	3057	10610	2326	12298	1848	13225	1445	14449	795	17890	313	16318
18-#11	3.66	MA	8366	3057	14246	2392	16913	1914	18515	1519	20553	876	25833	424	22958
6L-5S		MI	6336	3057	11064	2330	12888	1842	13922	1450	15344	790	18969	376	17014
18-#11	3.66	MA	7948	3057	13626	2391	16093	1911	17514	1525	19201	870	24270	352	22056
7L-4S		MI	6659	3057	11572	2324	13484	1848	14630	1445	16307	795	20129	419	17381

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	3.66	MA	7534	3057	13015	2389	15289	1908	16510	1520	17897	876	22627	303	21003
8L-3S		MI	7013	3057	12072	2328	14145	1842	15411	1450	17295	790	21226	503	18001
18-#14	5.27	MA	9126	3509	16629	2665	19865	2114	22050	1640	25165	832	32027	184	31200
6L-5S		MI	6887	3509	12896	2597	15065	2021	16491	1547	18717	715	23358	117	22788
18-#14	5.27	MA	8501	3509	15741	2663	18691	2109	20620	1647	23247	824	29816	81	29329
7L-4S		MI	7320	3509	13620	2589	15904	2028	17487	1540	20073	723	24983	180	23847
20-#11	4.06	MA	8787	3171	15188	2463	18108	1966	19963	1552	22466	867	28362	403	25608
6E		MI	6308	3171	11269	2397	13120	1898	14201	1474	15734	782	19552	281	18145
20-#11	4.06	MA	8374	3171	14568	2461	17288	1963	18962	1558	21114	862	26799	332	24676
7L-5S		MI	6615	3171	11723	2401	13710	1893	14899	1479	16629	776	20632	344	18817
20-#11	4.06	MA	7966	3171	13957	2460	16484	1960	17958	1553	19811	867	25156	282	23646
8L-4S		MI	6935	3171	12231	2395	14306	1898	15606	1474	17591	782	21792	388	19230
20-#14	5.86	MA	9147	3672	17086	2765	20397	2184	22683	1695	25961	811	33392	50	33089
7L-5S		MI	7266	3672	13831	2699	16222	2093	17865	1588	20526	693	25688	67	25351
22-#11	4.47	MA	8794	3284	15510	2532	18483	2015	20409	1591	23028	854	29328	311	27302
7L-6S		MI	6611	3284	11928	2467	13942	1948	15177	1503	17019	768	21215	249	19979
22-#11	4.47	MA	8392	3284	14900	2531	17679	2012	19406	1586	21724	859	27685	262	26254
8L-5S		MI	6910	3284	12382	2472	14532	1943	15875	1508	17914	762	22295	312	20620
24-#11	4.88	MA	8811	3398	15842	2602	18874	2064	20854	1619	23638	851	30214	242	28868
8L-6S		MI	6885	3398	12587	2538	14764	1999	16153	1532	18304	754	22878	218	21818

RECTANGULAR TIED COLUMNS 24" x 34"

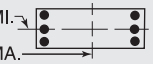
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.10	MA	8789	2491	12779	2063	14970	1679	15925	1394	16591	975	19959	907	9034
2E		MI	6060	2491	9145	1993	10367	1614	10816	1330	11050	917	13039	830	6143
4-#18	1.96	MA	9744	2746	15032	2206	17724	1781	19172	1453	20800	940	25430	837	15515
2E		MI	6618	2746	10539	2122	11984	1697	12699	1367	13505	857	16105	715	10337
6-#11	1.15	MA	8870	2504	12870	2080	15139	1692	16153	1403	16942	981	20456	914	9429
2L-3S		MI	5604	2504	8544	2009	9686	1627	10028	1350	10025	930	11743	748	6438
6-#11	1.15	MA	8077	2504	11857	2079	13854	1690	14596	1410	14871	986	17709	823	9423
3L-2S		MI	6117	2504	9203	2013	10508	1632	11004	1345	11309	925	13406	840	6408
6-#14	1.65	MA	9463	2655	14225	2166	16805	1754	18148	1441	19532	964	23848	878	13342
2L-3S		MI	5755	2655	9145	2088	10367	1678	10816	1378	11050	902	13039	649	8961
6-#14	1.65	MA	8354	2655	12779	2164	14970	1750	15925	1450	16591	971	19959	747	13250
3L-2S		MI	6471	2655	10080	2095	11523	1686	12190	1371	12858	895	15368	781	8962
6-#18	2.94	MA	10842	3036	17553	2387	20921	1914	23023	1535	25867	915	32091	777	22954
2L-3S		MI	6111	3036	10539	2288	11984	1807	12699	1447	13505	825	16105	381	14699
6-#18	2.94	MA	8994	3036	15032	2382	17724	1905	19172	1548	20800	928	25430	543	22384
3L-2S		MI	7286	3036	12128	2301	13940	1820	15022	1434	16564	812	20005	615	15123
8-#11	1.53	MA	9346	2618	13883	2151	16424	1744	17709	1436	19013	974	23202	896	12444
2L-4S		MI	5525	2618	8703	2075	9847	1683	10224	1374	10321	922	12309	633	8353
8-#11	1.53	MA	8565	2618	12870	2150	15139	1741	16153	1443	16942	979	20456	805	12406
3E		MI	5904	2618	9203	2079	10508	1677	11004	1379	11309	916	13406	717	8400
8-#11	1.53	MA	7995	2618	12113	2150	14116	1750	14913	1439	15298	974	18654	713	12243
4L-2S		MI	6411	2618	9862	2084	11330	1683	11981	1374	12594	911	15069	808	8389
8-#14	2.21	MA	10116	2818	15672	2268	18640	1829	20371	1489	22473	952	27737	849	17623
2L-4S		MI	5640	2818	9369	2183	10593	1757	11091	1411	11467	888	13828	481	11012
8-#14	2.21	MA	9029	2818	14225	2266	16805	1825	18148	1497	19532	960	23848	718	17473
3E		MI	6168	2818	10080	2190	11523	1750	12190	1419	12858	881	15368	600	11703
8-#14	2.21	MA	8235	2818	13142	2265	15342	1835	16375	1490	17197	952	21301	587	16393
4L-2S		MI	6872	2818	11016	2197	12680	1757	13565	1411	14667	873	17698	731	11753

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

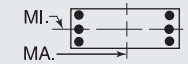


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.92	MA	11902	3327	20074	2569	24118	2047	26875	1618	30934	890	38752	717	30360
2L-4S		MI	5915	3327	10919	2454	12366	1943	13163	1501	14211	793	17414	78	16999
8-#18	3.92	MA	10106	3327	17553	2564	20921	2038	23023	1631	25867	904	32091	484	29459
3E		MI	6779	3327	12128	2467	13940	1930	15022	1514	16564	780	20005	281	18883
8-#18	3.92	MA	8792	3327	15659	2559	18363	2054	19946	1618	21845	890	27727	254	25778
4L-2S		MI	7916	3327	13716	2480	15896	1943	17346	1501	19623	767	23906	515	19862
10-#11	1.91	MA	9812	2731	14897	2222	17709	1796	19266	1469	21085	967	25949	877	15445
2L-5S		MI	5482	2731	8854	2152	10073	1728	10492	1408	10643	903	12812	557	9692
10-#11	1.91	MA	9042	2731	13883	2221	16424	1793	17709	1476	19013	972	23202	786	15380
3L-4S		MI	5824	2731	9362	2146	10669	1733	11200	1403	11606	908	13972	601	10190
10-#11	1.91	MA	8481	2731	13126	2221	15401	1801	16470	1472	17369	967	21401	695	15183
4L-3S		MI	6198	2731	9862	2150	11330	1728	11981	1408	12594	903	15069	685	10344
10-#11	1.91	MA	7971	2731	12359	2230	14480	1799	15346	1478	15869	972	19495	652	14238
5L-2S		MI	6698	2731	10520	2155	12152	1733	12957	1403	13879	897	16732	776	10357
10-#14	2.76	MA	10752	2982	17119	2370	20475	1903	22594	1536	25415	941	31627	820	21889
2L-5S		MI	5578	2982	9580	2293	10911	1821	11469	1459	11920	859	14533	368	12918
10-#14	2.76	MA	9686	2982	15672	2369	18640	1899	20371	1544	22473	948	27737	689	21689
3L-4S		MI	6052	2982	10304	2285	11750	1829	12466	1452	13276	866	16158	432	13573
10-#14	2.76	MA	8908	2982	14589	2367	17177	1910	18598	1538	20139	941	25191	558	20424
4L-3S		MI	6571	2982	11016	2292	12680	1821	13565	1459	14667	859	17698	551	14430
10-#14	2.76	MA	8201	2982	13491	2380	15859	1906	16990	1546	18009	948	22484	496	19283
5L-2S		MI	7264	2982	11952	2299	13837	1829	14939	1452	16476	851	20028	682	14521
10-#18	4.90	MA	11183	3618	20074	2746	24118	2171	26875	1714	30934	879	38752	424	36298
3L-4S		MI	6589	3618	12507	2633	14322	2066	15487	1567	17270	748	21314	-22	21220
10-#18	4.90	MA	9906	3618	18180	2741	21560	2187	23797	1700	26911	866	34388	194	32851
4L-3S		MI	7425	3618	13716	2646	15896	2053	17346	1581	19623	735	23906	181	23137
10-#18	4.90	MA	8747	3618	16258	2762	19254	2177	21006	1714	23242	879	29743	85	29278
5L-2S		MI	8527	3618	15304	2659	17851	2066	19670	1567	22682	722	27806	414	24576
12-#11	2.29	MA	10268	2844	15910	2293	18994	1847	20823	1502	23156	960	28695	859	18438
2L-6S		MI	5455	2844	9059	2219	10305	1783	10771	1432	11033	894	13396	463	11049
12-#11	2.29	MA	9509	2844	14897	2292	17709	1845	19266	1508	21085	965	25949	768	18348
3L-5S		MI	5780	2844	9513	2223	10895	1778	11468	1437	11928	889	14475	526	11539
12-#11	2.29	MA	8957	2844	14139	2291	16686	1853	18026	1505	19441	960	24148	677	18006
4E		MI	6117	2844	10021	2217	11491	1783	12176	1432	12890	894	15635	569	12000
12-#11	2.29	MA	8455	2844	13372	2301	15765	1851	16903	1511	17941	965	22241	633	17110
5L-3S		MI	6487	2844	10520	2221	12152	1778	12957	1437	13879	889	16732	653	12280
12-#11	2.29	MA	7974	2844	12690	2300	14856	1859	15796	1507	16498	970	20324	558	16331
6L-2S		MI	6981	2844	11179	2225	12974	1783	13933	1432	15164	884	18395	745	12313
12-#14	3.31	MA	10327	3145	17119	2471	20475	1974	22594	1592	25415	936	31627	660	25902
3L-5S		MI	5989	3145	10516	2395	12068	1893	12843	1500	13729	837	16862	319	15413
12-#14	3.31	MA	9564	3145	16036	2469	19012	1985	20821	1585	23080	929	29080	529	24477
4E		MI	6456	3145	11240	2387	12907	1900	13840	1492	15084	844	18487	383	16155
12-#14	3.31	MA	8872	3145	14938	2483	17694	1981	19213	1594	20950	936	26373	467	23375
5L-3S		MI	6967	3145	11952	2395	13837	1893	14939	1500	16476	837	20028	502	17150
12-#14	3.31	MA	8207	3145	13961	2481	16392	1992	17629	1587	18902	944	23659	358	21591
6L-2S		MI	7649	3145	12888	2402	14994	1900	16313	1492	18284	830	22357	633	17277
12-#18	5.88	MA	11043	3909	20701	2923	24758	2320	27649	1783	31978	841	41049	134	39958
4E		MI	7242	3909	14095	2812	16278	2189	17810	1634	20329	703	25215	-123	24631
12-#18	5.88	MA	9926	3909	18779	2944	22451	2310	24857	1796	28308	854	36404	25	36259
5L-3S		MI	8053	3909	15304	2825	17851	2176	19670	1648	22682	690	27806	80	27446
14-#11	2.68	MA	9968	2958	15910	2363	18994	1897	20823	1541	23156	958	28695	749	21313
3L-6S		MI	5752	2958	9718	2290	11127	1834	11747	1461	12318	880	15059	431	12850
14-#11	2.68	MA	9423	2958	15153	2362	17971	1905	19583	1537	21512	952	26894	658	20843
4L-5S		MI	6073	2958	10171	2294	11717	1829	12445	1466	13213	875	16138	494	13394
14-#11	2.68	MA	8929	2958	14386	2372	17050	1903	18460	1544	20012	958	24988	615	19992
5L-4S		MI	6406	2958	10680	2288	12313	1834	13153	1461	14175	880	17298	538	13823
14-#11	2.68	MA	8455	2958	13703	2371	16141	1911	17353	1540	18569	963	23071	539	19160
6L-3S		MI	6771	2958	11179	2292	12974	1829	13933	1466	15164	875	18395	622	14209

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

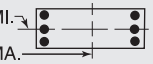


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.68	MA	7991	2958	13038	2371	15262	1909	16280	1546	17106	958	21371	468	18264
7L-2S		MI	7259	2958	11838	2296	13796	1834	14910	1461	16449	870	20058	713	14260
14-#14	3.86	MA	10206	3309	17483	2571	20847	2060	23044	1633	26021	917	32969	500	28548
4L-5S		MI	6416	3309	11452	2498	13225	1964	14218	1540	15537	815	19192	270	17927
14-#14	3.86	MA	9527	3309	16385	2585	19529	2056	21436	1641	23891	925	30262	438	27370
5L-4S		MI	6872	3309	12176	2490	14064	1972	15214	1533	16893	823	20817	333	18753
14-#14	3.86	MA	8875	3309	15408	2583	18227	2067	19852	1634	21843	932	27549	329	25654
6L-3S		MI	7367	3309	12888	2497	14994	1964	16313	1540	18284	815	22357	452	19863
14-#14	3.86	MA	8237	3309	14456	2582	16969	2063	18315	1643	19765	925	25145	226	23773
7L-2S		MI	8025	3309	13823	2504	16151	1972	17687	1533	20093	808	24687	584	20023
14-#18	6.86	MA	11011	4200	21300	3126	25648	2443	28708	1879	33375	829	43065	-34	42776
5L-4S		MI	7880	4200	15683	2991	18234	2312	20134	1701	23388	658	29115	-223	27945
16-#11	3.06	MA	9881	3071	16166	2433	19256	1957	21140	1570	23583	945	29641	640	23692
4L-6S		MI	6045	3071	10377	2361	11949	1884	12723	1490	13603	866	16722	400	14660
16-#11	3.06	MA	9395	3071	15399	2443	18335	1955	20016	1577	22083	950	27734	596	22881
5E		MI	6361	3071	10830	2365	12539	1879	13421	1495	14498	861	17801	462	15255
16-#11	3.06	MA	8928	3071	14716	2442	17426	1963	18910	1573	20641	956	25818	521	21999
6L-4S		MI	6690	3071	11338	2359	13135	1884	14129	1490	15460	866	18961	506	15656
16-#11	3.06	MA	8471	3071	14052	2442	16547	1961	17836	1579	19178	950	24118	449	21134
7L-3S		MI	7050	3071	11838	2363	13796	1879	14910	1495	16449	861	20058	590	16134
16-#11	3.06	MA	8019	3071	13397	2441	15686	1958	16761	1575	17766	956	22338	399	19917
8L-2S		MI	7534	3071	12497	2367	14618	1884	15886	1490	17734	856	21721	681	16201
16-#14	4.41	MA	10169	3473	17832	2687	21364	2131	23659	1688	26833	913	34152	409	31381
5E		MI	6812	3473	12388	2600	14382	2036	15592	1580	17346	793	21521	220	20459
16-#14	4.41	MA	9529	3473	16855	2686	20062	2141	22075	1682	24784	921	31438	300	29728
6L-4S		MI	7258	3473	13112	2592	15221	2043	16588	1573	18701	801	23146	284	21365
16-#14	4.41	MA	8902	3473	15903	2684	18804	2137	20538	1690	22706	913	29034	197	27809
7L-3S		MI	7742	3473	13823	2599	16151	2036	17687	1580	20093	793	24687	403	22571
18-#11	3.44	MA	9852	3185	16412	2514	19620	2007	21573	1610	24155	943	30481	578	25776
5L-6S		MI	6333	3185	11035	2432	12771	1935	13700	1519	14888	852	18385	368	16479
18-#11	3.44	MA	9392	3185	15730	2513	18711	2015	20467	1606	22712	948	28564	502	24846
6L-5S		MI	6645	3185	11489	2436	13361	1929	14397	1524	15782	847	19464	431	17120
18-#11	3.44	MA	8942	3185	15065	2512	17832	2012	19393	1612	21249	943	26864	431	23961
7L-4S		MI	6971	3185	11997	2430	13957	1935	15105	1519	16745	852	20624	474	17498
18-#11	3.44	MA	8496	3185	14410	2512	16971	2010	18318	1608	19838	948	25085	380	22767
8L-3S		MI	7327	3185	12497	2434	14618	1929	15886	1524	17734	847	21721	558	18055
18-#14	4.96	MA	10171	3636	18302	2788	21897	2216	24298	1729	27726	909	35327	271	33813
6L-5S		MI	7199	3636	13323	2702	15538	2108	16966	1621	19154	772	23851	171	23006
18-#14	4.96	MA	9555	3636	17350	2786	20639	2212	22762	1738	25648	902	32923	168	31856
7L-4S		MI	7636	3636	14047	2694	16378	2115	17962	1613	20510	779	25476	235	23987
20-#11	3.82	MA	9849	3298	16743	2584	19996	2067	22023	1638	24783	941	31311	484	27701
6E		MI	6617	3298	11694	2502	13593	1985	14676	1548	16173	838	20048	336	18304
20-#11	3.82	MA	9405	3298	16078	2583	19117	2064	20950	1645	23320	936	29611	412	26785
7L-5S		MI	6926	3298	12148	2507	14183	1980	15374	1553	17067	833	21127	399	18990
20-#11	3.82	MA	8966	3298	15424	2583	18256	2062	19874	1641	21909	941	27832	362	25623
8L-4S		MI	7248	3298	12656	2500	14780	1985	16081	1548	18030	838	22287	443	19346
20-#14	5.51	MA	10197	3800	18797	2888	22474	2287	24985	1785	28589	890	36813	139	35912
7L-5S		MI	7580	3800	14259	2804	16695	2179	18340	1661	20963	750	26181	122	25566
22-#11	4.21	MA	9862	3411	17091	2654	20402	2116	22507	1678	25392	929	32357	394	29615
7L-6S		MI	6922	3411	12353	2573	14415	2035	15652	1577	17457	825	21711	304	20136
22-#11	4.21	MA	9428	3411	16437	2654	19541	2114	21431	1674	23980	934	30578	343	28484
8L-5S		MI	7224	3411	12807	2577	15005	2030	16350	1582	18352	819	22790	367	20804
24-#11	4.59	MA	9885	3525	17450	2724	20826	2166	22988	1707	26052	927	33325	325	31349
8L-6S		MI	7198	3525	13012	2644	15237	2086	16628	1606	18742	811	23374	273	21974

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



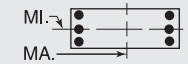
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.04	MA	9798	2618	14112	2183	16578	1777	17634	1477	18368	1042	22107	974	9641
2E		MI	6367	2618	9573	2098	10840	1701	11291	1404	11487	973	13532	885	6170
4-#18	1.85	MA	10839	2873	16533	2325	19537	1880	21170	1539	22928	1009	28060	909	16595
2E		MI	6927	2873	10973	2226	12458	1783	13173	1439	13940	913	16593	769	10377
6-#11	1.08	MA	9884	2632	14208	2199	16756	1790	17874	1487	18739	1048	22632	981	10061
2L-3S		MI	5910	2632	8969	2114	10159	1714	10503	1424	10463	987	12238	803	6467
6-#11	1.08	MA	9032	2632	13124	2199	15381	1788	16208	1494	16509	1053	19667	890	10055
3L-2S		MI	6425	2632	9628	2119	10981	1719	11479	1419	11748	982	13901	895	6433
6-#14	1.56	MA	10528	2782	15661	2285	18543	1852	20014	1525	21537	1032	26310	948	14253
2L-3S		MI	6061	2782	9573	2193	10840	1765	11291	1452	11487	959	13532	704	9004
6-#14	1.56	MA	9336	2782	14112	2284	16578	1849	17634	1534	18368	1039	22107	817	14161
3L-2S		MI	6780	2782	10508	2200	11997	1772	12665	1444	13296	951	15861	835	8994
6-#18	2.78	MA	12032	3164	19236	2507	22965	2013	25323	1623	28399	987	35278	854	24574
2L-3S		MI	6400	3164	10973	2392	12458	1893	13173	1519	13940	881	16593	435	14946
6-#18	2.78	MA	10040	3164	16533	2503	19537	2004	21170	1637	22928	1000	28060	621	24004
3L-2S		MI	7596	3164	12561	2405	14414	1906	15496	1506	16999	868	20494	669	15173
8-#11	1.44	MA	10399	2745	15292	2270	18131	1842	19539	1520	20968	1042	25596	964	13287
2L-4S		MI	5831	2745	9128	2181	10320	1770	10699	1448	10759	978	12804	688	8402
8-#11	1.44	MA	9561	2745	14208	2270	16756	1840	17874	1527	18739	1047	22632	873	13248
3E		MI	6211	2745	9628	2185	10981	1765	11479	1453	11748	973	13901	772	8434
8-#11	1.44	MA	8949	2745	13399	2270	15663	1849	16550	1524	16970	1042	20684	782	13085
4L-2S		MI	6719	2745	10287	2190	11803	1770	12456	1448	13033	968	15564	863	8418
8-#14	2.08	MA	11237	2946	17210	2387	20507	1927	22394	1572	24706	1021	30514	922	18838
2L-4S		MI	5946	2946	9797	2288	11067	1844	11566	1485	11904	945	14321	536	11158
8-#14	2.08	MA	10068	2946	15661	2386	18543	1924	20014	1581	21537	1029	26310	790	18688
3E		MI	6476	2946	10508	2295	11997	1836	12665	1492	13296	937	15861	655	11753
8-#14	2.08	MA	9215	2946	14504	2386	16979	1935	18119	1576	19022	1021	23553	659	17685
4L-2S		MI	7183	2946	11444	2302	13154	1844	14039	1485	15104	930	18191	786	11790
8-#18	3.70	MA	13182	3454	21939	2688	26392	2146	29476	1708	33869	965	42496	800	32520
2L-4S		MI	6220	3454	11352	2558	12841	2029	13637	1573	14646	849	17903	132	17194
8-#18	3.70	MA	11246	3454	19236	2685	22965	2137	25323	1721	28399	978	35278	566	31810
3E		MI	7091	3454	12561	2571	14414	2016	15496	1586	16999	836	20494	335	19138
8-#18	3.70	MA	9835	3454	17210	2681	20228	2156	22007	1708	24056	965	30556	333	27821
4L-2S		MI	8235	3454	14149	2584	16370	2029	17820	1573	20058	822	24394	569	19918
10-#11	1.81	MA	10904	2858	16376	2341	19506	1894	21205	1553	23197	1035	28561	948	16498
2L-5S		MI	5787	2858	9279	2258	10546	1815	10967	1482	11081	959	13307	612	9796
10-#11	1.81	MA	10077	2858	15292	2341	18131	1892	19539	1560	20968	1040	25596	857	16433
3L-4S		MI	6131	2858	9787	2252	11142	1820	11675	1477	12044	965	14467	656	10309
10-#11	1.81	MA	9475	2858	14483	2341	17038	1901	18215	1556	19199	1035	23649	765	16236
4L-3S		MI	6506	2858	10287	2256	11803	1815	12456	1482	13033	959	15564	740	10384
10-#11	1.81	MA	8930	2858	13664	2351	16055	1899	17016	1563	17584	1040	21597	721	15292
5L-2S		MI	7008	2858	10946	2260	12625	1820	13432	1477	14318	954	17227	831	10389
10-#14	2.60	MA	11927	3109	18760	2489	22472	2002	24774	1619	27875	1011	34717	895	23408
2L-5S		MI	5883	3109	10008	2398	11385	1908	11944	1533	12357	915	15026	423	13125
10-#14	2.60	MA	10779	3109	17210	2489	20507	1998	22394	1629	24706	1019	30514	764	23208
3L-4S		MI	6359	3109	10732	2390	12224	1915	12940	1525	13713	923	16650	486	13716
10-#14	2.60	MA	9944	3109	16053	2488	18943	2010	20499	1623	22191	1011	27757	633	22008
4L-3S		MI	6881	3109	11444	2397	13154	1908	14039	1533	15104	915	18191	605	14487
10-#14	2.60	MA	9187	3109	14880	2502	17536	2007	18782	1633	19896	1019	24840	570	20727
5L-2S		MI	7577	3109	12380	2404	14311	1915	15413	1525	16913	908	20521	737	14563
10-#18	4.63	MA	12414	3745	21939	2867	26392	2270	29476	1805	33869	956	42496	512	39344
3L-4S		MI	6896	3745	12940	2737	14797	2152	15960	1640	17705	804	21803	32	21628

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

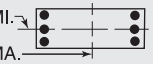


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	4.63	MA	11041	3745	19912	2863	23655	2289	26160	1793	29527	943	37774	278	35419
4L-3S		MI	7740	3745	14149	2750	16370	2139	17820	1653	20058	791	24394	235	23385
10-#18	4.63	MA	9796	3745	17858	2886	21190	2280	23151	1806	25565	956	32741	170	31745
5L-2S		MI	8851	3745	15737	2763	18326	2152	20143	1640	23117	777	28295	468	24637
12-#11	2.17	MA	11398	2972	17460	2412	20881	1946	22871	1585	25426	1029	31525	931	19702
2L-6S		MI	5760	2972	9484	2325	10778	1871	11246	1506	11472	951	13891	518	11213
12-#11	2.17	MA	10583	2972	16376	2412	19506	1944	21205	1593	23197	1034	28561	840	19612
3L-5S		MI	6086	2972	9938	2329	11368	1865	11943	1511	12366	946	14970	581	11643
12-#11	2.17	MA	9990	2972	15567	2412	18413	1953	19881	1589	21428	1029	26614	749	19384
4E		MI	6425	2972	10446	2323	11964	1871	12651	1506	13329	951	16130	624	12118
12-#11	2.17	MA	9453	2972	14748	2422	17430	1951	18682	1596	19814	1034	24562	704	18370
5L-3S		MI	6796	2972	10946	2327	12625	1865	13432	1511	14318	946	17227	708	12323
12-#11	2.17	MA	8937	2972	14020	2422	16460	1959	17501	1593	18261	1039	22492	629	17626
6L-2S		MI	7292	2972	11604	2331	13447	1871	14408	1506	15603	940	18890	800	12348
12-#14	3.13	MA	11474	3273	18760	2591	22472	2073	24774	1676	27875	1008	34717	738	27724
3L-5S		MI	6295	3273	10944	2501	12541	1979	13318	1573	14166	894	17355	374	15637
12-#14	3.13	MA	10655	3273	17602	2590	20908	2085	22879	1671	25360	1001	31960	606	26354
4E		MI	6765	3273	11668	2493	13381	1987	14314	1566	15521	901	18980	437	16296
12-#14	3.13	MA	9912	3273	16430	2604	19501	2082	21162	1680	23065	1008	29043	543	25139
5L-3S		MI	7278	3273	12380	2500	14311	1979	15413	1573	16913	894	20521	556	17210
12-#14	3.13	MA	9200	3273	15387	2603	18111	2093	19471	1674	20858	1016	26110	434	23304
6L-2S		MI	7964	3273	13316	2507	15468	1987	16787	1566	18721	886	22850	688	17322
12-#18	5.56	MA	12282	4036	22615	3045	27083	2422	30312	1877	34997	920	44992	223	43051
4E		MI	7552	4036	14528	2916	16753	2275	18284	1707	20764	759	25703	-69	25361
12-#18	5.56	MA	11078	4036	20561	3068	24617	2413	27304	1891	31036	934	39959	116	39253
5L-3S		MI	8371	4036	15737	2929	18326	2261	20143	1720	23117	745	28295	134	27688
12-#18	5.56	MA	9906	4036	18732	3064	22181	2432	24340	1878	27226	947	34923	-79	34519
6L-2S		MI	9453	4036	17326	2942	20282	2275	22467	1707	26176	732	32195	368	29339
14-#11	2.53	MA	11079	3085	17460	2483	20881	1996	22871	1625	25426	1028	31525	823	22787
3L-6S		MI	6058	3085	10143	2396	11600	1921	12222	1535	12757	937	15554	486	13011
14-#11	2.53	MA	10495	3085	16651	2483	19788	2004	21547	1622	23657	1022	29578	732	22423
4L-5S		MI	6380	3085	10597	2400	12190	1916	12920	1540	13651	932	16633	549	13497
14-#11	2.53	MA	9966	3085	15833	2493	18805	2003	20347	1629	22043	1028	27526	688	21457
5L-4S		MI	6715	3085	11105	2394	12786	1921	13628	1535	14614	937	17793	593	13939
14-#11	2.53	MA	9458	3085	15105	2493	17835	2011	19166	1626	20490	1033	25457	612	20660
6L-3S		MI	7081	3085	11604	2398	13447	1916	14408	1540	15603	932	18890	677	14255
14-#11	2.53	MA	8961	3085	14396	2492	16897	2010	18021	1633	18916	1028	23620	541	19656
7L-2S		MI	7572	3085	12263	2402	14269	1921	15385	1535	16887	927	20553	768	14298
14-#14	3.65	MA	11350	3436	19151	2692	22873	2160	25259	1718	28529	991	36163	580	30718
4L-5S		MI	6700	3436	11880	2603	13698	2051	14692	1614	15974	872	19685	324	18148
14-#14	3.65	MA	10621	3436	17979	2706	21466	2157	23542	1727	26234	998	33247	517	29561
5L-4S		MI	7184	3436	12604	2595	14538	2058	15688	1606	17330	879	21310	388	18893
14-#14	3.65	MA	9922	3436	16936	2705	20076	2168	21851	1722	24027	1006	30313	408	27663
6L-3S		MI	7683	3436	13316	2602	15468	2051	16787	1614	18721	872	22850	507	19927
14-#14	3.65	MA	9237	3436	15920	2705	18732	2165	20210	1731	21788	998	27712	305	25740
7L-2S		MI	8345	3436	14251	2609	16625	2058	18162	1606	20530	864	25180	638	20071
14-#18	6.48	MA	12254	4327	23263	3249	28045	2546	31457	1975	36506	912	47177	61	46789
5L-4S		MI	8192	4327	16117	3095	18709	2398	20607	1774	23823	713	29604	-169	28711
14-#18	6.48	MA	11124	4327	21434	3246	25609	2565	28492	1962	32696	925	42141	-134	41265
6L-3S		MI	8988	4327	17326	3108	20282	2384	22467	1787	26176	700	32195	34	32035
16-#11	2.89	MA	10990	3199	17735	2553	21163	2056	23212	1655	25887	1016	32543	715	25474
4L-6S		MI	6351	3199	10802	2467	12422	1971	13198	1564	14041	923	17217	454	14819
16-#11	2.89	MA	10469	3199	16917	2564	20180	2055	22013	1662	24272	1021	30491	671	24551
5E		MI	6669	3199	11255	2471	13012	1966	13896	1569	14936	918	18296	517	15358
16-#11	2.89	MA	9969	3199	16189	2563	19210	2063	20832	1659	22720	1026	28421	595	23703
6L-4S		MI	7000	3199	11763	2465	13609	1971	14604	1564	15899	923	19456	561	15771
16-#11	2.89	MA	9479	3199	15480	2563	18272	2061	19687	1666	21145	1021	26585	524	22731
7L-3S		MI	7363	3199	12263	2469	14269	1966	15385	1569	16887	918	20553	645	16183

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

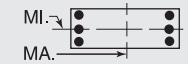
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.89	MA	8995	3199	14782	2563	17353	2060	18539	1663	19626	1026	24669	473	21499
8L-2S		MI	7848	3199	12922	2473	15091	1971	16361	1564	18172	913	22216	736	16241
16-#14	4.17	MA	11316	3600	19528	2809	23430	2231	25922	1775	29403	988	37450	491	33906
5E		MI	7122	3600	12816	2705	14855	2123	16066	1654	17783	850	22014	275	20676
16-#14	4.17	MA	10630	3600	18485	2808	22040	2243	24231	1769	27196	995	34517	382	32034
6L-4S		MI	7572	3600	13540	2697	15695	2130	17062	1647	19139	857	23639	339	21503
16-#14	4.17	MA	9957	3600	17469	2807	20697	2240	22590	1779	24957	988	31915	279	30074
7L-3S		MI	8060	3600	14251	2704	16625	2123	18162	1654	20530	850	25180	458	22640
16-#14	4.17	MA	9292	3600	16469	2806	19380	2237	20946	1773	22798	995	29193	206	28087
8L-2S		MI	8711	3600	15187	2711	17782	2130	19536	1647	22339	842	27509	589	22813
16-#18	7.41	MA	12305	4618	24137	3428	29037	2698	32645	2046	38167	903	49359	-188	47867
6L-4S		MI	8820	4618	17705	3274	20665	2521	22931	1841	26882	668	33504	-269	31958
18-#11	3.25	MA	10964	3312	18001	2634	21555	2106	23679	1695	26501	1015	33455	654	27652
5L-6S		MI	6640	3312	11460	2537	13244	2022	14175	1593	15326	909	18880	423	16636
18-#11	3.25	MA	10471	3312	17273	2634	20585	2115	22498	1692	24949	1020	31386	579	26755
6L-5S		MI	6955	3312	11914	2542	13834	2017	14872	1598	16221	904	19959	485	17223
18-#11	3.25	MA	9988	3312	16564	2634	19647	2113	21352	1699	23374	1015	29549	507	25813
7L-4S		MI	7282	3312	12422	2535	14431	2022	15580	1593	17184	909	21119	529	17612
18-#11	3.25	MA	9511	3312	15866	2634	18728	2112	20205	1695	21855	1020	27634	456	24555
8L-3S		MI	7640	3312	12922	2540	15091	2017	16361	1598	18172	904	22216	613	18106
18-#11	3.25	MA	9037	3312	15095	2644	17781	2120	19075	1703	20351	1025	25758	397	23306
9L-2S		MI	8121	3312	13581	2544	15913	2022	17337	1593	19457	899	23879	704	18180
18-#14	4.69	MA	11324	3763	20034	2910	24005	2318	26611	1817	30365	985	38720	355	36415
6L-5S		MI	7511	3763	13751	2807	16012	2194	17440	1694	19592	828	24344	226	23219
18-#14	4.69	MA	10663	3763	19018	2909	22662	2315	24970	1826	28126	978	36118	252	34418
7L-4S		MI	7952	3763	14475	2799	16851	2202	18437	1687	20947	836	25969	289	24123
18-#14	4.69	MA	10010	3763	18018	2908	21345	2311	23326	1820	25967	985	33396	180	32406
8L-3S		MI	8432	3763	15187	2806	17782	2194	19536	1694	22339	828	27509	408	25309
20-#11	3.61	MA	10965	3425	18357	2705	21960	2167	24163	1724	27178	1014	34351	562	29814
6E		MI	6925	3425	12119	2608	14066	2072	15151	1622	16611	895	20543	391	18460
20-#11	3.61	MA	10489	3425	17648	2705	21022	2165	23018	1732	25604	1009	32514	491	28901
7L-5S		MI	7236	3425	12573	2613	14656	2067	15849	1627	17506	890	21622	454	19093
20-#11	3.61	MA	10018	3425	16950	2705	20103	2164	21870	1728	24085	1014	30598	439	27616
8L-4S		MI	7560	3425	13081	2606	15253	2072	16556	1622	18468	895	22782	498	19459
20-#11	3.61	MA	9551	3425	16179	2715	19156	2172	20741	1735	22580	1019	28722	380	26348
9L-3S		MI	7915	3425	13581	2611	15913	2067	17337	1627	19457	890	23879	582	20027
20-#14	5.21	MA	11357	3927	20567	3011	24626	2389	27351	1873	31295	967	40322	226	38771
7L-5S		MI	7894	3927	14687	2909	17169	2266	18815	1735	21400	806	26674	177	25776
20-#14	5.21	MA	10714	3927	19567	3010	23310	2386	25707	1868	29136	975	37599	153	36733
8L-4S		MI	8327	3927	15411	2902	18008	2273	19811	1727	22756	814	28299	240	26752
22-#11	3.97	MA	10983	3539	18732	2776	22397	2217	24684	1764	27833	1002	35478	474	31959
7L-6S		MI	7207	3539	12778	2679	14888	2123	16127	1651	17896	881	22206	359	20290
22-#11	3.97	MA	10518	3539	18034	2776	21478	2215	23536	1761	26314	1007	33563	423	30683
8L-5S		MI	7515	3539	13232	2683	15478	2117	16825	1656	18791	876	23285	422	20965
22-#11	3.97	MA	10057	3539	17264	2786	20531	2224	22407	1768	24810	1013	31687	364	29396
9L-4S		MI	7836	3539	13740	2677	16075	2123	17533	1651	19753	881	24445	466	21313
22-#14	5.73	MA	11407	4091	21116	3113	25274	2461	28087	1915	32305	965	41803	127	41068
8L-5S		MI	8271	4091	15623	3012	18326	2337	20189	1775	23209	785	29003	127	28343
24-#11	4.33	MA	11011	3652	19118	2847	22852	2267	25202	1794	28543	1001	36527	406	33755
8L-6S		MI	7510	3652	13437	2750	15710	2173	17103	1680	19181	868	23869	328	22126
24-#11	4.33	MA	10555	3652	18348	2857	21905	2276	24072	1801	27039	1006	34651	347	32448
9L-5S		MI	7811	3652	13891	2754	16300	2168	17801	1685	20075	862	24948	390	22789

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

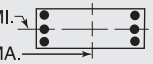


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.75	MA	11986	3000	18094	2444	21425	1978	23204	1623	25134	1078	30781	980	17675
2E		MI	7236	3000	11406	2330	12933	1868	13646	1512	14374	969	17082	823	10416
6-#11	1.03	MA	10949	2759	15605	2319	18448	1888	19674	1570	20612	1114	24898	1048	10692
2L-3S		MI	6216	2759	9394	2220	10632	1801	10978	1498	10902	1044	12733	858	6494
6-#11	1.03	MA	10039	2759	14450	2319	16983	1887	17900	1578	18225	1119	21715	957	10687
3L-2S		MI	6732	2759	10053	2225	11454	1806	11954	1493	12186	1039	14396	950	6458
6-#14	1.48	MA	11646	2909	17157	2404	20356	1950	21959	1608	23619	1099	28863	1017	15165
2L-3S		MI	6368	2909	10000	2298	11314	1851	11766	1525	11924	1015	14025	759	9045
6-#14	1.48	MA	10370	2909	15505	2404	18261	1948	19422	1618	20222	1107	24345	886	15073
3L-2S		MI	7089	2909	10936	2305	12471	1859	13140	1518	13733	1008	16354	890	9026
6-#18	2.63	MA	13275	3291	20978	2626	25083	2111	27636	1707	31009	1058	38556	930	26194
2L-3S		MI	6707	3291	11406	2496	12933	1978	13646	1592	14374	937	17082	489	15029
6-#18	2.63	MA	11139	3291	18094	2624	21425	2104	23204	1722	25134	1071	30781	696	25624
3L-2S		MI	7908	3291	12994	2509	14889	1991	15970	1579	17433	923	20982	723	15221
8-#11	1.37	MA	11505	2872	16760	2390	19913	1940	21449	1603	22999	1109	28081	1032	14129
2L-4S		MI	6137	2872	9553	2287	10793	1857	11174	1522	11198	1035	13299	743	8447
8-#11	1.37	MA	10608	2872	15605	2390	18448	1939	19674	1611	20612	1114	24898	941	14091
3E		MI	6518	2872	10053	2291	11454	1852	11954	1527	12186	1030	14396	827	8467
8-#11	1.37	MA	9956	2872	14745	2390	17286	1948	18266	1608	18718	1109	22804	850	13928
4L-2S		MI	7028	2872	10712	2295	12276	1857	12931	1522	13471	1025	16059	918	8446
8-#14	1.97	MA	12410	3073	18808	2507	22450	2025	24496	1655	27015	1090	33381	993	20053
2L-4S		MI	6252	3073	10224	2393	11541	1930	12041	1558	12341	1001	14814	590	11301
8-#14	1.97	MA	11158	3073	17157	2506	20356	2022	21959	1666	23619	1098	28863	861	19903
3E		MI	6784	3073	10936	2400	12471	1923	13140	1566	13733	994	16354	709	11801
8-#14	1.97	MA	10248	3073	15925	2506	18691	2035	19942	1661	20923	1090	25895	730	18994
4L-2S		MI	7493	3073	11872	2407	13628	1930	14514	1558	15542	986	18684	841	11825
8-#18	3.51	MA	14517	3582	23863	2808	28742	2244	32068	1791	36884	1038	46332	880	34680
2L-4S		MI	6525	3582	11785	2662	13316	2114	14110	1646	15080	905	18391	186	17385
8-#18	3.51	MA	12440	3582	20978	2805	25083	2237	27636	1806	31009	1051	38556	646	33970
3E		MI	7402	3582	12994	2675	14889	2101	15970	1659	17433	891	20982	389	19387
8-#18	3.51	MA	10930	3582	18820	2803	22168	2257	24103	1795	26346	1038	33462	413	29887
4L-2S		MI	8553	3582	14582	2688	16845	2114	18293	1646	20492	878	24883	622	19973
10-#11	1.71	MA	12048	2986	17915	2460	21378	1992	23223	1636	25387	1103	31263	1017	17551
2L-5S		MI	6093	2986	9704	2364	11019	1902	11442	1556	11520	1016	13802	667	9896
10-#11	1.71	MA	11164	2986	16760	2461	19913	1991	21449	1644	22999	1108	28081	926	17486
3L-4S		MI	6437	2986	10212	2358	11615	1907	12150	1551	12483	1021	14962	711	10374
10-#11	1.71	MA	10521	2986	15900	2461	18750	2000	20040	1641	21105	1103	25987	835	17289
4L-3S		MI	6814	2986	10712	2362	12276	1902	12931	1556	13471	1016	16059	795	10421
10-#11	1.71	MA	9939	2986	15029	2471	17706	1999	18765	1649	19376	1108	23789	790	16356
5L-2S		MI	7318	2986	11371	2366	13098	1907	13907	1551	14756	1011	17722	886	10419
10-#14	2.47	MA	13154	3236	20459	2609	24544	2100	27034	1703	30412	1081	37899	969	24926
2L-5S		MI	6187	3236	10436	2503	11858	1994	12418	1606	12794	972	15518	477	13253
10-#14	2.47	MA	11925	3236	18808	2609	22450	2097	24496	1713	27015	1088	33381	837	24727
3L-4S		MI	6666	3236	11160	2496	12698	2002	13415	1599	14150	979	17143	541	13857
10-#14	2.47	MA	11033	3236	17577	2608	20785	2110	22480	1708	24320	1081	30413	706	23610
4L-3S		MI	7190	3236	11872	2503	13628	1994	14514	1606	15542	972	18684	660	14540
10-#14	2.47	MA	10224	3236	16329	2623	19289	2107	20653	1719	21860	1088	27286	642	22182
5L-2S		MI	7889	3236	12808	2510	14785	2002	15888	1599	17350	964	21014	791	14603
10-#18	4.39	MA	13699	3873	23863	2987	28742	2370	32068	1891	36884	1031	46332	596	42321
3L-4S		MI	7204	3873	13373	2841	15272	2237	16434	1713	18139	860	22291	85	21815
10-#18	4.39	MA	12230	3873	21705	2985	25826	2390	28535	1880	32221	1018	41238	363	38010
4L-3S		MI	8054	3873	14582	2854	16845	2224	18293	1726	20492	846	24883	288	23628
10-#18	4.39	MA	10899	3873	19517	3009	23201	2383	25332	1895	27966	1031	35831	253	34253
5L-2S		MI	9173	3873	16171	2867	18801	2237	20617	1713	23551	833	28783	522	24697
12-#11	2.05	MA	12580	3099	19070	2531	22842	2044	24998	1669	27774	1097	34446	1002	20965
2L-6S		MI	6065	3099	9909	2431	11251	1958	11721	1580	11910	1008	14386	573	11372

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

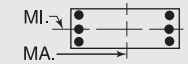
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.05	MA	11708	3099	17915	2532	21378	2043	23223	1676	25387	1103	31263	911	20875
3L-5S		MI	6392	3099	10363	2435	11841	1952	12419	1585	12805	1002	15465	636	11743
12-#11	2.05	MA	11075	3099	17055	2532	20215	2052	21815	1674	23493	1097	29170	820	20650
4E		MI	6733	3099	10871	2429	12438	1958	13126	1580	13768	1008	16625	679	12232
12-#11	2.05	MA	10502	3099	16184	2542	19170	2051	20540	1681	21764	1103	26972	775	19639
5L-3S		MI	7105	3099	11371	2433	13098	1952	13907	1585	14756	1002	17722	763	12364
12-#11	2.05	MA	9952	3099	15411	2543	18139	2060	19284	1679	20101	1108	24750	699	18940
6L-2S		MI	7603	3099	12029	2437	13920	1958	14883	1580	16041	997	19385	855	12383
12-#14	2.96	MA	12674	3400	20459	2711	24544	2172	27034	1760	30412	1079	37899	813	29547
3L-5S		MI	6601	3400	11372	2606	13015	2066	13793	1647	14603	950	17848	428	15857
12-#14	2.96	MA	11798	3400	19228	2711	22880	2185	25017	1756	27717	1072	34931	682	28249
4E		MI	7073	3400	12096	2598	13854	2073	14789	1639	15959	957	19473	492	16434
12-#14	2.96	MA	11005	3400	17981	2725	21383	2182	23190	1766	25257	1079	31804	618	26891
5L-3S		MI	7589	3400	12808	2605	14785	2066	15888	1647	17350	950	21014	611	17268
12-#14	2.96	MA	10244	3400	16872	2725	19905	2195	21392	1761	22891	1087	28651	509	25038
6L-2S		MI	8278	3400	13743	2612	15942	2073	17262	1639	19159	943	23343	742	17365
12-#18	5.26	MA	13494	4163	24589	3167	29484	2523	32967	1964	38096	998	49014	313	46168
4E		MI	7862	4163	14961	3020	17227	2360	18757	1779	21198	814	26192	-15	26117
12-#18	5.26	MA	12198	4163	22402	3191	26859	2516	29763	1979	33841	1012	43607	203	42288
5L-3S		MI	8688	4163	16171	3033	18801	2347	20617	1793	23551	801	28783	188	27925
12-#18	5.26	MA	10954	4163	20456	3188	24266	2536	26608	1968	29750	1025	38181	8	38143
6L-2S		MI	9778	4163	17759	3046	20757	2360	22941	1779	26610	788	32683	422	29404
14-#11	2.39	MA	12242	3212	19070	2602	22842	2094	24998	1709	27774	1097	34446	895	24261
3L-6S		MI	6363	3212	10568	2502	12073	2008	12697	1609	13195	994	16049	541	13168
14-#11	2.39	MA	11619	3212	18210	2603	21680	2104	23589	1707	25880	1092	32353	804	24011
4L-5S		MI	6687	3212	11022	2506	12663	2003	13395	1614	14090	989	17128	604	13597
14-#11	2.39	MA	11054	3212	17339	2613	20635	2102	22314	1714	24151	1097	30155	759	22931
5L-4S		MI	7023	3212	11530	2500	13260	2008	14103	1609	15052	994	18288	648	14052
14-#11	2.39	MA	10512	3212	16566	2613	19604	2112	21059	1712	22488	1102	27933	684	22179
6L-3S		MI	7392	3212	12029	2504	13920	2003	14883	1614	16041	989	19385	732	14300
14-#11	2.39	MA	9982	3212	15812	2614	18607	2110	19842	1719	20803	1097	25959	613	21061
7L-2S		MI	7884	3212	12688	2508	14742	2008	15860	1609	17326	983	21048	823	14335
14-#14	3.45	MA	12547	3564	20879	2813	24974	2259	27554	1803	31114	1063	39449	658	32907
4L-5S		MI	7007	3564	12308	2708	14172	2138	15167	1687	16412	928	20178	379	18364
14-#14	3.45	MA	11769	3564	19632	2827	23477	2257	25728	1813	28654	1070	36322	594	31611
5L-4S		MI	7472	3564	13032	2700	15011	2145	16163	1680	17767	936	21803	443	19029
14-#14	3.45	MA	11022	3564	18523	2827	22000	2269	23929	1809	26288	1078	33169	485	29694
6L-3S		MI	7981	3564	13743	2707	15942	2138	17262	1687	19159	928	23343	562	19989
14-#14	3.45	MA	10290	3564	17444	2827	20571	2267	22184	1819	23889	1070	30369	382	27740
7L-2S		MI	8661	3564	14679	2714	17098	2145	18636	1680	20967	921	25673	693	20118
14-#18	6.14	MA	13553	4454	25286	3372	30517	2649	34195	2063	39716	992	51382	153	50352
5L-4S		MI	8505	4454	16550	3199	19183	2483	21081	1846	24257	769	30092	-115	29472
14-#18	6.14	MA	12341	4454	23340	3370	27924	2669	31040	2052	35624	1005	45957	-42	45660
6L-3S		MI	9308	4454	17759	3212	20757	2470	22941	1860	26610	756	32683	88	32267
16-#11	2.74	MA	12152	3326	19365	2674	23145	2155	25364	1740	28267	1086	35535	789	27273
4L-6S		MI	6657	3326	11227	2572	12895	2058	13673	1638	14480	980	17712	509	14974
16-#11	2.74	MA	11596	3326	18494	2684	22100	2154	24089	1747	26538	1091	33338	744	26231
5E		MI	6977	3326	11680	2577	13485	2053	14371	1643	15375	975	18791	572	15458
16-#11	2.74	MA	11062	3326	17721	2684	21069	2163	22834	1744	24876	1097	31116	669	25427
6L-4S		MI	7310	3326	12188	2571	14082	2058	15079	1638	16337	980	19951	616	15883
16-#11	2.74	MA	10539	3326	16967	2685	20072	2162	21616	1752	23190	1091	29142	598	24343
7L-3S		MI	7674	3326	12688	2575	14742	2053	15860	1643	17326	975	21048	700	16230
16-#11	2.74	MA	10022	3326	16226	2685	19095	2161	20397	1749	21563	1097	27090	546	23102
8L-2S		MI	8162	3326	13347	2579	15564	2058	16836	1638	18611	970	22711	791	16281

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.95	MA	12516	3727	21283	2930	25572	2332	28265	1861	32050	1061	40840	570	36341
5E		MI	7432	3727	13243	2810	15329	2209	16541	1727	18220	906	22507	330	20888
16-#14	3.95	MA	11783	3727	20175	2930	24094	2344	26466	1856	29685	1069	37686	461	34362
6L-4S		MI	7885	3727	13967	2802	16168	2217	17537	1720	19576	914	24132	393	21637
16-#14	3.95	MA	11065	3727	19095	2929	22666	2342	24722	1866	27286	1061	34887	358	32372
7L-3S		MI	8378	3727	14679	2809	17098	2209	18636	1727	20967	906	25673	512	22705
16-#14	3.95	MA	10354	3727	18032	2929	21266	2339	22974	1862	24971	1069	31968	284	30335
8L-2S		MI	9033	3727	15615	2816	18255	2217	20010	1720	22776	899	28002	644	22863
16-#18	7.02	MA	13614	4745	26225	3552	31583	2802	35472	2137	41499	985	53732	-92	52942
6L-4S		MI	9134	4745	18138	3378	21139	2606	23405	1913	27316	724	33992	-216	32754
18-#11	3.08	MA	12129	3439	19649	2755	23565	2206	25864	1780	28926	1086	36521	729	29537
5L-6S		MI	6947	3439	11886	2643	13717	2109	14650	1667	15765	966	19375	478	16789
18-#11	3.08	MA	11602	3439	18876	2755	22533	2215	24608	1777	27263	1091	34299	653	28683
6L-5S		MI	7264	3439	12339	2648	14307	2104	15347	1672	16659	961	20454	540	17323
18-#11	3.08	MA	11087	3439	18122	2755	21537	2214	23391	1785	25577	1086	32324	582	27631
7L-4S		MI	7593	3439	12847	2641	14904	2109	16055	1667	17622	966	21614	584	17723
18-#11	3.08	MA	10577	3439	17381	2756	20560	2213	22171	1782	23950	1091	30272	530	26364
8L-3S		MI	7953	3439	13347	2646	15564	2104	16836	1672	18611	961	22711	668	18156
18-#11	3.08	MA	10071	3439	16562	2766	19554	2222	20971	1790	22339	1096	28257	471	25101
9L-2S		MI	8436	3439	14006	2650	16386	2109	17812	1667	19896	956	24374	759	18221
18-#14	4.44	MA	12530	3891	21826	3032	26188	2419	29003	1903	33081	1060	42204	437	39040
6L-5S		MI	7823	3891	14179	2912	16486	2281	17915	1768	20029	885	24837	280	23428
18-#14	4.44	MA	11824	3891	20746	3032	24760	2417	27259	1914	30683	1052	39405	334	37014
7L-4S		MI	8268	3891	14903	2905	17325	2288	18911	1760	21384	892	26462	344	24256
18-#14	4.44	MA	11126	3891	19683	3031	23360	2414	25511	1909	28368	1060	36486	260	34953
8L-3S		MI	8751	3891	15615	2912	18255	2281	20010	1768	22776	885	28002	463	25417
20-#11	3.42	MA	12134	3553	20031	2826	23998	2267	26383	1810	29650	1085	37481	638	31946
6E		MI	7234	3553	12544	2714	14539	2159	15626	1696	17050	952	21038	446	18611
20-#11	3.42	MA	11626	3553	19277	2826	23002	2266	25165	1818	27965	1080	35507	567	30925
7L-5S		MI	7547	3553	12998	2718	15129	2154	16324	1701	17944	947	22117	509	19192
20-#11	3.42	MA	11123	3553	18536	2827	22025	2265	23946	1815	26338	1085	33455	515	29632
8L-4S		MI	7872	3553	13506	2712	15726	2159	17032	1696	18907	952	23277	553	19569
20-#11	3.42	MA	10624	3553	17717	2837	21019	2274	22746	1823	24727	1091	31440	456	28350
9L-3S		MI	8229	3553	14006	2716	16386	2154	17812	1701	19896	947	24374	637	20079
20-#11	3.42	MA	10126	3553	16978	2837	20049	2273	21540	1820	23070	1085	29485	390	27029
10L-2S		MI	8708	3553	14665	2721	17208	2159	18789	1696	21180	942	26037	728	20158
20-#14	4.93	MA	12570	4054	22398	3134	26854	2491	29796	1961	34079	1043	43923	310	41665
7L-5S		MI	8207	4054	15115	3015	17643	2352	19289	1808	21837	863	27166	231	25981
20-#14	4.93	MA	11883	4054	21334	3134	25454	2489	28048	1956	31765	1050	41004	236	39579
8L-4S		MI	8644	4054	15839	3007	18482	2360	20285	1801	23193	870	28791	295	26884
22-#11	3.76	MA	12157	3666	20432	2897	24466	2318	26940	1851	30352	1075	38690	552	34224
7L-6S		MI	7517	3666	13203	2785	15361	2210	16602	1725	18335	938	22701	414	20440
22-#11	3.76	MA	11661	3666	19691	2897	23490	2317	25720	1848	28725	1080	36638	500	32905
8L-5S		MI	7826	3666	13657	2789	15951	2205	17300	1730	19229	933	23780	477	21065
22-#11	3.76	MA	11168	3666	18872	2908	22483	2326	24520	1856	27114	1085	34623	441	31604
9L-4S		MI	8149	3666	14165	2783	16548	2210	18008	1725	20192	938	24940	521	21422
22-#11	3.76	MA	10677	3666	18133	2908	21513	2324	23314	1853	25458	1080	32668	375	30271
10L-3S		MI	8502	3666	14665	2787	17208	2205	18789	1730	21180	933	26037	605	21999
22-#14	5.43	MA	12629	4218	22986	3236	27549	2564	30585	2004	35162	1041	45521	212	44213
8L-5S		MI	8586	4218	16051	3117	18800	2424	20663	1849	23646	841	29496	182	28546
24-#11	4.11	MA	12191	3779	20846	2968	24955	2368	27495	1881	31112	1074	39821	484	36183
8L-6S		MI	7797	3779	13862	2856	16183	2260	17578	1754	19619	924	24364	383	22274
24-#11	4.11	MA	11704	3779	20027	2979	23948	2378	26295	1889	29501	1079	37806	426	34863
9L-5S		MI	8103	3779	14316	2860	16773	2255	18276	1759	20514	919	25443	445	22940
24-#11	4.11	MA	11220	3779	19288	2979	22978	2376	25089	1886	27845	1074	35851	360	33516
10L-4S		MI	8423	3779	14824	2854	17370	2260	18984	1754	21477	924	26603	489	23280

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

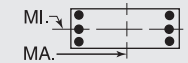
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.67	MA	13185	3127	19714	2564	23388	2076	25316	1706	27417	1146	33592	1050	18755
2E		MI	7545	3127	11839	2434	13408	1954	14120	1584	14809	1024	17570	877	10454
6-#14	1.41	MA	12815	3037	18712	2524	22244	2048	23984	1691	25778	1166	31506	1085	16076
2L-3S		MI	6674	3037	10428	2403	11788	1938	12240	1599	12362	1072	14518	813	9085
6-#14	1.41	MA	11455	3037	16958	2524	20020	2047	21290	1702	22153	1174	26673	954	15984
3L-2S		MI	7397	3037	11364	2410	12945	1945	13614	1591	14170	1064	16847	945	9056
6-#18	2.50	MA	14571	3418	22780	2745	27277	2209	30027	1790	33696	1128	41926	1004	27814
2L-3S		MI	7015	3418	11839	2600	13408	2063	14120	1664	14809	992	17570	543	15107
6-#18	2.50	MA	12291	3418	19714	2744	23388	2204	25316	1807	27417	1141	33592	771	27244
3L-2S		MI	8219	3418	13427	2613	15364	2077	16443	1651	17868	979	21471	777	15269
8-#11	1.30	MA	12662	3000	18288	2509	21770	2038	23438	1687	25091	1174	30655	1100	14971
2L-4S		MI	6442	3000	9978	2393	11266	1944	11649	1596	11636	1092	13794	798	8490
8-#11	1.30	MA	11706	3000	17062	2510	20215	2038	21554	1695	22549	1180	27254	1009	14933
3E		MI	6825	3000	10478	2397	11927	1939	12429	1601	12625	1087	14891	882	8498
8-#11	1.30	MA	11013	3000	16150	2510	18983	2047	20061	1693	20534	1175	25013	918	14770
4L-2S		MI	7336	3000	11137	2401	12749	1944	13406	1596	13910	1082	16554	973	8473
8-#14	1.88	MA	13635	3200	20466	2626	24468	2123	26678	1739	29402	1158	36339	1063	21268
2L-4S		MI	6557	3200	10652	2499	12014	2017	12515	1632	12779	1058	15307	645	11440
8-#14	1.88	MA	12301	3200	18712	2626	22244	2121	23984	1750	25778	1166	31506	932	21118
3E		MI	7091	3200	11364	2506	12945	2009	13614	1639	14170	1050	16847	764	11847
8-#14	1.88	MA	11332	3200	17406	2627	20479	2135	21845	1746	22902	1158	28327	800	20320
4L-2S		MI	7803	3200	12300	2513	14101	2017	14988	1632	15979	1043	19177	895	11860
8-#18	3.33	MA	15905	3709	25847	2927	31166	2342	34739	1874	39976	1110	50261	958	36840
2L-4S		MI	6830	3709	12218	2765	13790	2200	14584	1718	15515	960	18880	240	17571
8-#18	3.33	MA	13687	3709	22780	2926	27277	2337	30027	1891	33696	1124	41926	725	36130
3E		MI	7713	3709	13427	2779	15364	2186	16443	1731	17868	947	21471	443	19633
8-#18	3.33	MA	12077	3709	20490	2925	24183	2358	26278	1882	28713	1110	36458	491	31974
4L-2S		MI	8871	3709	15015	2792	17320	2200	18767	1718	20927	934	25371	676	20027
10-#11	1.63	MA	13244	3113	19514	2580	23324	2090	25321	1719	27632	1169	34056	1086	18604
2L-5S		MI	6398	3113	10129	2470	11492	1989	11917	1630	11959	1073	14297	722	9994
10-#11	1.63	MA	12302	3113	18288	2580	21770	2089	23438	1728	25091	1175	30655	995	18539
3L-4S		MI	6744	3113	10637	2464	12089	1994	12625	1625	12921	1078	15457	766	10422
10-#11	1.63	MA	11619	3113	17376	2581	20538	2099	21945	1725	23075	1170	28415	904	18342
4L-3S		MI	7122	3113	11137	2468	12749	1989	13406	1630	13910	1073	16554	850	10458
10-#11	1.63	MA	11000	3113	16454	2592	19431	2098	20594	1734	21236	1175	26071	858	17429
5L-2S		MI	7627	3113	11796	2472	13571	1994	14382	1625	15195	1068	18217	941	10450
10-#14	2.34	MA	14434	3364	22219	2728	26692	2198	29373	1786	33027	1150	41171	1041	26445
2L-5S		MI	6492	3364	10864	2609	12332	2081	12893	1680	13232	1028	16011	532	13377
10-#14	2.34	MA	13123	3364	20466	2728	24468	2196	26678	1797	29402	1158	36339	910	26246
3L-4S		MI	6973	3364	11588	2601	13171	2088	13889	1672	14587	1036	17636	596	13993
10-#14	2.34	MA	12174	3364	19160	2729	22703	2209	24540	1793	26526	1150	33159	778	25229
4L-3S		MI	7499	3364	12300	2608	14101	2081	14988	1680	15979	1028	19177	715	14591
10-#14	2.34	MA	11313	3364	17838	2744	21117	2208	22604	1804	23901	1158	29823	713	23647
5L-2S		MI	8201	3364	13235	2615	15258	2088	16363	1672	17787	1021	21506	846	14643
10-#18	4.17	MA	15039	4000	25847	3108	31166	2470	34739	1976	39976	1106	50261	679	45021
3L-4S		MI	7512	4000	13806	2944	15746	2323	16907	1785	18574	915	22780	139	21997
10-#18	4.17	MA	13473	4000	23557	3106	28071	2491	30989	1966	34992	1093	44792	445	40624
4L-3S		MI	8367	4000	15015	2958	17320	2309	18767	1798	20927	902	25371	342	23866
10-#18	4.17	MA	12054	4000	21237	3132	25287	2485	27591	1983	30444	1106	39012	333	36800
5L-2S		MI	9494	4000	16604	2971	19276	2323	21091	1785	23986	889	29271	576	24756
12-#11	1.95	MA	13815	3226	20739	2651	24879	2142	27205	1752	30173	1164	37457	1072	22229
2L-6S		MI	6370	3226	10334	2537	11724	2045	12196	1654	12349	1064	14881	628	11528

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

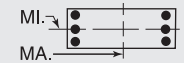


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.95	MA	12885	3226	19514	2651	23324	2141	25321	1760	27632	1170	34056	981	22139
3L-5S		MI	6698	3226	10788	2541	12314	2040	12894	1659	13243	1059	15960	691	11840
12-#11	1.95	MA	12213	3226	18602	2652	22092	2151	23828	1758	25617	1165	31816	890	21914
4E		MI	7040	3226	11296	2535	12911	2045	13601	1654	14206	1064	17120	734	12344
12-#11	1.95	MA	11603	3226	17680	2663	20986	2150	22477	1766	23778	1170	29472	844	20916
5L-3S		MI	7414	3226	11796	2539	13571	2040	14382	1659	15195	1059	18217	818	12404
12-#11	1.95	MA	11019	3226	16861	2663	19893	2160	21148	1764	22009	1175	27098	769	20195
6L-2S		MI	7914	3226	12454	2543	14393	2045	15358	1654	16480	1054	19880	909	12416
12-#14	2.81	MA	13926	3527	22219	2831	26692	2271	29373	1845	33027	1150	41171	888	31369
3L-5S		MI	6907	3527	11800	2711	13489	2153	14267	1720	15040	1006	18341	483	16000
12-#14	2.81	MA	12994	3527	20913	2831	24927	2284	27234	1841	30151	1142	37992	756	30162
4E		MI	7381	3527	12524	2703	14328	2160	15263	1713	16396	1014	19966	546	16569
12-#14	2.81	MA	12150	3527	19592	2846	23341	2282	25298	1852	27526	1150	34655	691	28654
5L-3S		MI	7900	3527	13235	2710	15258	2153	16363	1720	17787	1006	21506	665	17324
12-#14	2.81	MA	11341	3527	18417	2847	21775	2296	23392	1848	25002	1157	31282	583	26794
6L-2S		MI	8592	3527	14171	2717	16415	2160	17737	1713	19596	999	23836	797	17408
12-#18	5.00	MA	14828	4291	26623	3288	31960	2624	35700	2050	41272	1075	53126	399	49308
4E		MI	8173	4291	15394	3123	17702	2446	19231	1852	21633	870	26680	39	26456
12-#18	5.00	MA	13447	4291	24303	3313	29176	2618	32303	2067	36724	1088	47346	287	45364
5L-3S		MI	9005	4291	16604	3137	19276	2432	21091	1865	23986	857	29271	242	28157
12-#18	5.00	MA	12121	4291	22240	3312	26427	2639	28957	2058	32351	1101	41530	93	41086
6L-2S		MI	10103	4291	18192	3150	21232	2446	23414	1852	27045	844	33172	476	29467
14-#11	2.27	MA	13458	3340	20739	2722	24879	2193	27205	1793	30173	1164	37457	967	25735
3L-6S		MI	6669	3340	10993	2607	12546	2095	13172	1683	13634	1051	16544	596	13322
14-#11	2.27	MA	12795	3340	19828	2723	23647	2203	25712	1791	28158	1159	35217	876	25485
4L-5S		MI	6994	3340	11447	2612	13136	2090	13870	1688	14528	1045	17623	659	13694
14-#11	2.27	MA	12194	3340	18906	2734	22540	2202	24361	1799	26319	1165	32874	830	24414
5L-4S		MI	7332	3340	11955	2606	13733	2095	14578	1683	15491	1051	18783	703	14163
14-#11	2.27	MA	11619	3340	18087	2734	21448	2211	23031	1797	24550	1170	30499	755	23715
6L-3S		MI	7702	3340	12454	2610	14393	2090	15358	1688	16480	1045	19880	787	14343
14-#11	2.27	MA	11055	3340	17289	2735	20393	2211	21742	1805	22757	1165	28387	684	22480
7L-2S		MI	8196	3340	13113	2614	15215	2095	16335	1683	17764	1040	21543	878	14371
14-#14	3.28	MA	13797	3691	22667	2933	27151	2359	29928	1888	33776	1134	42825	734	35114
4L-5S		MI	7314	3691	12735	2813	14646	2224	15641	1761	16849	985	20671	434	18575
14-#14	3.28	MA	12968	3691	21345	2948	25565	2357	27992	1899	31151	1142	39488	669	33672
5L-4S		MI	7782	3691	13459	2805	15485	2232	16638	1753	18204	992	22296	497	19162
14-#14	3.28	MA	12174	3691	20171	2949	23999	2370	26086	1895	28626	1149	36114	561	31748
6L-3S		MI	8293	3691	14171	2812	16415	2224	17737	1761	19596	985	23836	616	20049
14-#14	3.28	MA	11395	3691	19027	2949	22486	2369	24238	1906	26067	1142	33117	458	29851
7L-2S		MI	8977	3691	15107	2819	17572	2232	19111	1753	21404	977	26166	748	20164
14-#18	5.83	MA	14804	4581	27369	3495	33065	2751	37014	2152	43004	1070	55680	241	53957
5L-4S		MI	8817	4581	16983	3302	19658	2568	21555	1919	24692	825	30581	-61	30228
14-#18	5.83	MA	13511	4581	25306	3494	30315	2772	33668	2142	38630	1083	49864	47	49628
6L-3S		MI	9628	4581	18192	3316	21232	2555	23414	1932	27045	812	33172	142	32494
16-#11	2.60	MA	13367	3453	21054	2794	25202	2255	27595	1824	30699	1154	38619	862	29056
4L-6S		MI	6964	3453	11652	2678	13368	2146	14148	1712	14918	1037	18207	564	15125
16-#11	2.60	MA	12775	3453	20132	2805	24095	2254	26244	1832	28860	1160	36275	816	27919
5E		MI	7285	3453	12106	2683	13958	2140	14846	1717	15813	1032	19286	627	15554
16-#11	2.60	MA	12207	3453	19312	2805	23003	2263	24915	1830	27091	1165	33900	741	27168
6L-4S		MI	7620	3453	12614	2676	14555	2146	15554	1712	16776	1037	20446	671	15993
16-#11	2.60	MA	11652	3453	18515	2806	21947	2263	23625	1838	25298	1160	31789	670	25968
7L-3S		MI	7985	3453	13113	2681	15215	2140	16335	1717	17764	1032	21543	755	16276
16-#11	2.60	MA	11102	3453	17730	2806	20913	2262	22334	1836	23568	1166	29600	617	24726
8L-2S		MI	8475	3453	13772	2685	16037	2146	17311	1712	19049	1026	23206	846	16319
16-#14	3.75	MA	13770	3854	23099	3051	27788	2432	30687	1947	34776	1134	44321	647	38700
5E		MI	7741	3854	13671	2915	15803	2296	17015	1801	18657	963	23000	384	21096
16-#14	3.75	MA	12989	3854	21924	3051	26223	2445	28781	1943	32251	1141	40947	539	36713
6L-4S		MI	8198	3854	14395	2907	16642	2303	18012	1794	20013	970	24625	448	21769

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

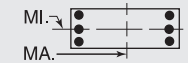
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.75	MA	12225	3854	20781	3051	24710	2443	26933	1954	29692	1134	37949	436	34702
7L-3S		MI	8694	3854	15107	2915	17572	2296	19111	1801	21404	963	26166	567	22768
16-#14	3.75	MA	11469	3854	19655	3052	23227	2442	25081	1950	27222	1141	34834	361	32624
8L-2S		MI	9354	3854	16043	2922	18729	2303	20485	1794	23213	955	28495	698	22911
16-#18	6.67	MA	14978	4872	28372	3676	34204	2905	38379	2226	44910	1066	58198	1	58192
6L-4S		MI	9449	4872	18571	3481	21614	2691	23878	1986	27751	780	34481	-162	33544
18-#11	2.92	MA	13346	3567	21358	2875	25650	2306	28128	1865	31401	1155	39676	802	31432
5L-6S		MI	7255	3567	12311	2749	14190	2196	15125	1741	16203	1023	19870	533	16938
18-#11	2.92	MA	12786	3567	20538	2876	24557	2315	26798	1863	29632	1160	37302	727	30630
6L-5S		MI	7573	3567	12764	2753	14780	2191	15822	1746	17098	1018	20949	595	17419
18-#11	2.92	MA	12238	3567	19741	2877	23502	2314	25509	1871	27839	1155	35190	656	29463
7L-4S		MI	7903	3567	13272	2747	15377	2196	16530	1741	18061	1023	22109	639	17831
18-#11	2.92	MA	11696	3567	18956	2877	22468	2314	24217	1869	26109	1160	33001	603	28195
8L-3S		MI	8265	3567	13772	2751	16037	2191	17311	1746	19049	1018	23206	723	18204
18-#11	2.92	MA	11158	3567	18089	2888	21402	2323	22946	1877	24396	1166	30847	544	26924
9L-2S		MI	8751	3567	14431	2756	16859	2196	18287	1741	20334	1013	24869	814	18262
18-#14	4.22	MA	13790	4018	23678	3153	28447	2520	31475	1990	35876	1133	45780	517	41688
6L-5S		MI	8134	4018	14607	3018	16960	2367	18390	1841	20466	941	25330	335	23633
18-#14	4.22	MA	13038	4018	22534	3154	26934	2518	29627	2001	33316	1125	42782	414	39642
7L-4S		MI	8583	4018	15331	3010	17799	2375	19386	1834	21822	949	26955	399	24386
18-#14	4.22	MA	12295	4018	21408	3154	25451	2516	27775	1997	30846	1133	39666	339	37542
8L-3S		MI	9070	4018	16043	3017	18729	2367	20485	1841	23213	941	28495	518	25483
18-#14	4.22	MA	11556	4018	20165	3169	23923	2530	25953	2008	28400	1140	36607	254	35237
9L-2S		MI	9720	4018	16978	3024	19886	2375	21859	1834	25022	934	30825	649	25652
20-#11	3.25	MA	13356	3680	21764	2947	26112	2367	28682	1896	32173	1155	40703	713	34098
6E		MI	7542	3680	12969	2820	15012	2246	16101	1770	17488	1009	21533	501	18759
20-#11	3.25	MA	12815	3680	20967	2948	25057	2366	27392	1904	30381	1150	38591	642	32963
7L-5S		MI	7857	3680	13423	2824	15602	2241	16799	1775	18383	1004	22612	564	19289
20-#11	3.25	MA	12280	3680	20181	2948	24023	2365	26101	1902	28650	1155	36403	589	31670
8L-4S		MI	8184	3680	13931	2818	16199	2246	17507	1770	19345	1009	23772	607	19677
20-#11	3.25	MA	11749	3680	19315	2959	22957	2375	24830	1910	26937	1161	34248	531	30381
9L-3S		MI	8543	3680	14431	2822	16859	2241	18287	1775	20334	1004	24869	692	20129
20-#11	3.25	MA	11220	3680	18532	2960	21930	2374	23553	1908	25175	1156	32019	450	28974
10L-2S		MI	9023	3680	15090	2827	17681	2246	19264	1770	21619	999	26532	783	20200
20-#14	4.69	MA	13837	4182	24288	3256	29158	2593	32321	2049	36941	1117	47615	392	44592
7L-5S		MI	8520	4182	15543	3120	18116	2439	19764	1882	22275	919	27659	286	26183
20-#14	4.69	MA	13106	4182	23162	3256	27675	2591	30469	2045	34471	1125	44499	317	42467
8L-4S		MI	8961	4182	16267	3112	18956	2446	20760	1874	23630	927	29284	349	27013
20-#14	4.69	MA	12379	4182	21919	3271	26147	2604	28647	2056	32025	1132	41439	232	40205
9L-3S		MI	9440	4182	16978	3119	19886	2439	21859	1882	25022	919	30825	468	28195
22-#11	3.57	MA	13384	3793	22192	3018	26611	2418	29276	1937	32922	1145	41992	628	36469
7L-6S		MI	7826	3793	13628	2891	15835	2297	17077	1799	18773	995	23196	469	20586
22-#11	3.57	MA	12856	3793	21407	3019	25577	2417	27984	1935	31192	1150	39804	575	35149
8L-5S		MI	8137	3793	14082	2895	16424	2292	17775	1804	19668	990	24275	532	21162
22-#11	3.57	MA	12332	3793	20541	3030	24512	2427	26713	1943	29478	1156	37649	517	33842
9L-4S		MI	8462	3793	14590	2889	17021	2297	18483	1799	20630	995	25435	576	21529
22-#11	3.57	MA	11809	3793	19758	3031	23485	2426	25436	1941	27716	1151	35421	436	32460
10L-3S		MI	8817	3793	15090	2893	17681	2292	19264	1804	21619	990	26532	660	22051
22-#14	5.16	MA	13904	4345	24915	3358	29899	2666	33164	2092	38096	1117	49332	295	47401
8L-5S		MI	8901	4345	16478	3222	19273	2510	21138	1922	24083	898	29989	237	28745
22-#14	5.16	MA	13188	4345	23673	3374	28371	2679	31342	2103	35650	1124	46272	210	45160
9L-4S		MI	9334	4345	17202	3214	20113	2518	22134	1915	25439	905	31614	300	29647

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

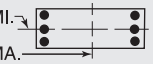
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	3.90	MA	13424	3907	22633	3090	27132	2469	29868	1967	33733	1145	43205	561	38634
8L-6S		MI	8107	3907	14287	2962	16657	2347	18054	1828	20058	981	24859	438	22419
24-#11	3.90	MA	12906	3907	21766	3101	26066	2479	28597	1976	32019	1150	41050	503	37308
9L-5S		MI	8416	3907	14741	2966	17246	2342	18751	1833	20952	976	25938	500	23037
24-#11	3.90	MA	12390	3907	20984	3101	25039	2478	27320	1973	30258	1145	38822	422	35945
10L-4S		MI	8737	3907	15249	2960	17843	2347	19459	1828	21915	981	27098	544	23386
24-#14	5.63	MA	13985	4509	25426	3476	30595	2754	34036	2150	39275	1116	51104	188	50085
9L-5S		MI	9276	4509	17414	3324	20430	2582	22512	1963	25892	876	32319	187	31318

RECTANGULAR TIED COLUMNS 24" x 42"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.59	MA	14437	3255	21394	2683	25427	2174	27508	1789	29777	1214	36494	1120	19835
2E		MI	7853	3255	12272	2538	13883	2039	14593	1657	15244	1080	18059	931	10492
6-#14	1.34	MA	14036	3164	20327	2643	24207	2146	26088	1775	27996	1232	34239	1153	16987
2L-3S		MI	6981	3164	10856	2509	12261	2024	12715	1672	12799	1128	15011	868	9121
6-#14	1.34	MA	12592	3164	18471	2644	21853	2145	23237	1787	24149	1240	29091	1021	16895
3L-2S		MI	7705	3164	11792	2516	13418	2032	14089	1665	14607	1121	17340	999	9086
6-#18	2.38	MA	15919	3546	24642	2865	29546	2307	32499	1874	36461	1198	45387	1077	29434
2L-3S		MI	7322	3546	12272	2703	13883	2149	14593	1737	15244	1048	18059	597	15180
6-#18	2.38	MA	13494	3546	21394	2864	25427	2303	27508	1892	29777	1211	36494	844	28864
3L-2S		MI	8530	3546	13860	2717	15839	2162	16917	1724	18302	1035	21959	831	15315
8-#11	1.24	MA	13870	3127	19875	2628	23702	2136	25506	1770	27231	1239	33319	1167	15814
2L-4S		MI	6748	3127	10403	2499	11740	2031	12124	1670	12075	1149	14289	853	8529
8-#11	1.24	MA	12856	3127	18578	2629	22058	2136	23514	1779	24543	1245	29699	1075	15775
3E		MI	7132	3127	10903	2503	12400	2026	12904	1675	13064	1144	15387	937	8528
8-#11	1.24	MA	12121	3127	17616	2630	20756	2146	21936	1777	22413	1240	27312	984	15612
4L-2S		MI	7644	3127	11562	2507	13222	2031	13881	1670	14348	1139	17050	1028	8500
8-#14	1.79	MA	14912	3327	22183	2745	26561	2221	28939	1822	31843	1225	39386	1132	22483
2L-4S		MI	6863	3327	11080	2604	12488	2103	12990	1705	13216	1114	15800	700	11576
8-#14	1.79	MA	13495	3327	20327	2746	24207	2220	26088	1834	27996	1233	34239	1001	22333
3E		MI	7399	3327	11792	2611	13418	2096	14089	1713	14607	1107	17340	819	11891
8-#14	1.79	MA	12467	3327	18947	2747	22342	2234	23828	1831	24945	1225	30848	869	21661
4L-2S		MI	8113	3327	12728	2618	14575	2103	15463	1705	16416	1099	19670	950	11894
8-#18	3.17	MA	17348	3836	27890	3046	33665	2440	37489	1958	43146	1182	54281	1035	39000
2L-4S		MI	7136	3836	12651	2869	14265	2285	15057	1791	15949	1016	19368	294	17753
8-#18	3.17	MA	14988	3836	24642	3046	29546	2436	32499	1976	36461	1195	45387	801	38290
3E		MI	8023	3836	13860	2882	15839	2272	16917	1804	18302	1003	21959	497	19837
8-#18	3.17	MA	13277	3836	22220	3046	26273	2458	28532	1968	31157	1182	39544	568	34083
4L-2S		MI	9188	3836	15448	2896	17795	2285	19241	1791	21361	990	25860	730	20079
10-#11	1.55	MA	14492	3240	21172	2699	25347	2188	27498	1803	29919	1233	36939	1154	19657
2L-5S		MI	6704	3240	10554	2576	11965	2076	12392	1704	12397	1130	14792	777	10089
10-#11	1.55	MA	13492	3240	19875	2700	23702	2188	25506	1811	27231	1239	33319	1063	19592
3L-4S		MI	7050	3240	11062	2570	12562	2081	13100	1699	13360	1135	15952	821	10467
10-#11	1.55	MA	12768	3240	18912	2701	22400	2198	23928	1810	25102	1235	30932	972	19395
4L-3S		MI	7430	3240	11562	2574	13222	2076	13881	1704	14348	1130	17050	905	10493
10-#11	1.55	MA	12113	3240	17939	2712	21232	2198	22502	1818	23159	1241	28443	925	18509
5L-2S		MI	7936	3240	12221	2578	14044	2081	14857	1699	15633	1125	18713	996	10479
10-#14	2.23	MA	15766	3491	24038	2847	28914	2296	31791	1870	35690	1217	44534	1112	27964
2L-5S		MI	6797	3491	11292	2714	12806	2168	13368	1753	13669	1085	16504	587	13498
10-#14	2.23	MA	14373	3491	22183	2848	26561	2295	28939	1881	31843	1225	39386	981	27764
3L-4S		MI	7280	3491	12016	2706	13645	2175	14364	1746	15024	1092	18129	650	14127
10-#14	2.23	MA	13366	3491	20803	2849	24695	2309	26679	1878	28792	1218	35996	849	26864
4L-3S		MI	7808	3491	12728	2713	14575	2168	15463	1753	16416	1085	19670	769	14641
10-#14	2.23	MA	12454	3491	19407	2865	23020	2308	24634	1890	26008	1226	32449	784	25122
5L-2S		MI	8512	3491	13663	2720	15732	2175	16837	1746	18225	1077	21999	901	14682
10-#18	3.97	MA	16432	4127	27890	3228	33665	2569	37489	2060	43146	1179	54281	759	47721
3L-4S		MI	7819	4127	14239	3048	16221	2408	17381	1858	19008	971	23268	193	22175

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

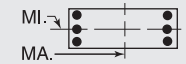
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.97	MA	14769	4127	25468	3228	30392	2591	33523	2052	37841	1166	48437	525	43260
4L-3S		MI	8681	4127	15448	3061	17795	2395	19241	1871	21361	958	25860	396	24100
10-#18	3.97	MA	13262	4127	23016	3254	27449	2587	29931	2071	33000	1179	42284	412	39385
5L-2S		MI	9815	4127	17037	3075	19751	2408	21564	1858	24420	944	29760	630	24814
12-#11	1.86	MA	15102	3354	22469	2770	26991	2240	29491	1836	32607	1228	40559	1141	23492
2L-6S		MI	6675	3354	10759	2642	12197	2132	12671	1728	12787	1121	15376	683	11665
12-#11	1.86	MA	14115	3354	21172	2771	25347	2240	27498	1844	29919	1234	36939	1050	23402
3L-5S		MI	7005	3354	11213	2647	12787	2127	13369	1733	13682	1116	16455	745	11934
12-#11	1.86	MA	13401	3354	20209	2772	24045	2250	25921	1843	27790	1230	34552	959	23177
4E		MI	7348	3354	11721	2641	13384	2132	14076	1728	14645	1121	17615	789	12394
12-#11	1.86	MA	12756	3354	19235	2783	22876	2249	24494	1851	25847	1236	32063	913	22202
5L-3S		MI	7723	3354	12221	2645	14044	2127	14857	1733	15633	1116	18713	873	12443
12-#11	1.86	MA	12137	3354	18370	2784	21723	2259	23090	1850	23980	1242	29535	837	21417
6L-2S		MI	8224	3354	12880	2649	14866	2132	15833	1728	16918	1111	20376	964	12447
12-#14	2.68	MA	15231	3655	24038	2951	28914	2370	31791	1929	35690	1218	44534	961	33192
3L-5S		MI	7213	3655	12228	2816	13963	2239	14742	1794	15478	1063	18834	537	16120
12-#14	2.68	MA	14242	3655	22659	2951	27049	2384	29530	1926	32639	1211	41144	829	32091
4E		MI	7689	3655	12952	2808	14802	2247	15738	1786	16833	1070	20459	601	16700
12-#14	2.68	MA	13347	3655	21262	2967	25373	2382	27485	1937	29855	1218	37597	763	30427
5L-3S		MI	8210	3655	13663	2815	15732	2239	16837	1794	18225	1063	21999	720	17378
12-#14	2.68	MA	12489	3655	20022	2968	23719	2396	25472	1934	27177	1226	34003	655	28571
6L-2S		MI	8905	3655	14599	2822	16889	2247	18211	1786	20033	1056	24329	851	17450
12-#18	4.76	MA	16217	4418	28716	3409	34512	2724	38513	2137	44526	1150	57331	483	52471
4E		MI	8483	4418	15828	3227	18177	2531	19705	1925	22067	926	27169	93	26631
12-#18	4.76	MA	14749	4418	26264	3436	31568	2720	34921	2155	39685	1163	51178	369	48480
5L-3S		MI	9321	4418	17037	3240	19751	2518	21564	1938	24420	913	29760	296	28386
12-#18	4.76	MA	13341	4418	24084	3435	28663	2742	31385	2147	35029	1176	44970	176	44080
6L-2S		MI	10427	4418	18625	3254	21707	2531	23888	1925	27479	899	33660	530	29528
14-#11	2.17	MA	14726	3467	22469	2842	26991	2292	29491	1877	32607	1229	40559	1037	27210
3L-6S		MI	6975	3467	11418	2713	13019	2182	13647	1757	14072	1107	17039	651	13471
14-#11	2.17	MA	14023	3467	21506	2843	25690	2302	27913	1875	30478	1225	38172	946	26959
4L-5S		MI	7301	3467	11872	2718	13609	2177	14345	1762	14967	1102	18118	714	13788
14-#11	2.17	MA	13387	3467	20532	2854	24521	2301	26487	1884	28535	1231	35683	900	25905
5L-4S		MI	7640	3467	12380	2711	14206	2182	15053	1757	15929	1107	19278	758	14271
14-#11	2.17	MA	12777	3467	19667	2855	23368	2311	25083	1882	26668	1237	33155	825	25147
6L-3S		MI	8011	3467	12880	2716	14866	2177	15833	1762	16918	1102	20376	842	14384
14-#11	2.17	MA	12179	3467	18825	2856	22253	2311	23722	1891	24775	1232	30906	754	23912
7L-2S		MI	8508	3467	13538	2720	15688	2182	16810	1757	18203	1097	22039	933	14407
14-#14	3.13	MA	15099	3818	24514	3054	29402	2458	32382	1973	36486	1203	46292	809	37337
4L-5S		MI	7622	3818	13163	2918	15119	2311	16116	1834	17286	1041	21164	488	18752
14-#14	3.13	MA	14221	3818	23118	3069	27727	2457	30337	1985	33702	1211	42744	743	35743
5L-4S		MI	8091	3818	13887	2910	15959	2318	17112	1827	18642	1049	22788	552	19292
14-#14	3.13	MA	13378	3818	21878	3070	26073	2471	28324	1982	31024	1219	39151	635	33822
6L-3S		MI	8605	3818	14599	2917	16889	2311	18211	1834	20033	1041	24329	671	20107
14-#14	3.13	MA	12552	3818	20670	3071	24475	2470	26372	1993	28310	1212	35955	532	31918
7L-2S		MI	9291	3818	15535	2925	18046	2318	19585	1827	21842	1034	26659	802	20208
14-#18	5.56	MA	16198	4709	29512	3617	35688	2853	39912	2239	46370	1147	60071	327	57602
5L-4S		MI	9130	4709	17416	3406	20133	2654	22028	1991	25126	881	31069	-7	31027
14-#18	5.56	MA	14824	4709	27332	3617	32782	2875	36375	2231	41714	1160	53863	133	53156
6L-3S		MI	9947	4709	18625	3419	21707	2641	23888	2005	27479	867	33660	196	32718
14-#18	5.56	MA	13477	4709	25209	3617	29973	2871	32945	2250	36993	1147	48352	-49	48037
7L-2S		MI	11028	4709	20213	3433	23663	2654	26211	1991	30538	854	37561	429	34229

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

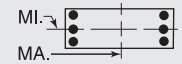


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.48	MA	14633	3580	22803	2914	27334	2354	29906	1908	33166	1220	41792	933	30741
4L-6S		MI	7270	3580	12077	2784	13841	2233	14623	1786	15357	1094	18702	619	15273
16-#11	2.48	MA	14006	3580	21829	2925	26165	2353	28479	1917	31223	1226	39303	887	29617
5E		MI	7593	3580	12531	2788	14431	2228	15321	1791	16252	1088	19781	682	15648
16-#11	2.48	MA	13405	3580	20964	2926	25012	2363	27075	1915	29356	1232	36775	812	28883
6L-4S		MI	7929	3580	13039	2782	15028	2233	16029	1786	17214	1094	20941	726	16099
16-#11	2.48	MA	12816	3580	20122	2927	23898	2363	25714	1924	27463	1227	34526	741	27607
7L-3S		MI	8296	3580	13538	2786	15688	2228	16810	1791	18203	1088	22039	810	16320
16-#11	2.48	MA	12233	3580	19294	2928	22806	2362	24350	1922	25636	1233	32201	688	26415
8L-2S		MI	8788	3580	14197	2791	16510	2233	17786	1786	19488	1083	23702	901	16356
16-#14	3.57	MA	15076	3982	24974	3172	30081	2532	33188	2032	37549	1203	47892	723	41070
5E		MI	8024	3982	14099	3021	16276	2382	17490	1874	19095	1019	23493	439	21301
16-#14	3.57	MA	14248	3982	23734	3172	28427	2546	31175	2029	34871	1211	44298	615	39085
6L-4S		MI	8487	3982	14823	3013	17116	2390	18486	1867	20450	1027	25118	503	21897
16-#14	3.57	MA	13437	3982	22526	3173	26829	2545	29223	2041	32157	1204	41102	512	37144
7L-3S		MI	9010	3982	15535	3020	18046	2382	19585	1874	21842	1019	26659	622	22829
16-#14	3.57	MA	12635	3982	21337	3174	25263	2543	27267	2038	29537	1212	37790	436	34904
8L-2S		MI	9674	3982	16471	3027	19203	2390	20960	1867	23650	1012	28988	753	22958
16-#18	6.35	MA	16273	4999	30580	3799	36901	3008	41365	2315	48399	1144	62757	91	62254
6L-4S		MI	9764	4999	19004	3585	22089	2777	24352	2058	28185	835	34969	-108	34327
16-#18	6.35	MA	14958	4999	28456	3799	34093	3004	37935	2334	43678	1131	57245	-92	56525
7L-3S		MI	10561	4999	20213	3598	23663	2764	26211	2072	30538	822	37561	95	37087
18-#11	2.79	MA	14615	3694	23125	2996	27810	2405	30471	1950	33911	1220	42922	874	33335
5L-6S		MI	7562	3694	12736	2855	14664	2283	15600	1815	16642	1080	20365	588	17084
18-#11	2.79	MA	14022	3694	22261	2997	26657	2415	29068	1948	32044	1226	40395	799	32595
6L-5S		MI	7881	3694	13189	2859	15253	2278	16297	1820	17536	1075	21444	650	17513
18-#11	2.79	MA	13441	3694	21419	2998	25543	2415	27706	1957	30151	1222	38145	728	31308
7L-4S		MI	8214	3694	13697	2853	15850	2283	17005	1815	18499	1080	22604	694	17937
18-#11	2.79	MA	12867	3694	20590	2999	24451	2414	26343	1955	28324	1228	35820	675	30047
8L-3S		MI	8577	3694	14197	2857	16510	2278	17786	1820	19488	1075	23702	778	18251
18-#11	2.79	MA	12296	3694	19675	3010	23326	2424	25001	1964	26515	1234	33526	616	28775
9L-2S		MI	9065	3694	14856	2862	17332	2283	18762	1815	20773	1069	25365	869	18301
18-#14	4.02	MA	15102	4145	25589	3275	30780	2621	34026	2076	38718	1204	49446	594	44358
6L-5S		MI	8445	4145	15035	3123	17433	2454	18864	1915	20903	998	25823	390	23834
18-#14	4.02	MA	14305	4145	24382	3275	29183	2619	32074	2088	36004	1197	46250	492	42303
7L-4S		MI	8897	4145	15759	3115	18273	2461	19860	1907	22259	1005	27448	453	24514
18-#14	4.02	MA	13516	4145	23193	3276	27617	2618	30119	2085	33384	1204	42938	416	40171
8L-3S		MI	9388	4145	16471	3122	19203	2454	20960	1915	23650	998	28988	572	25547
18-#14	4.02	MA	12732	4145	21881	3292	26003	2632	28194	2097	30790	1212	39676	331	37641
9L-2S		MI	10042	4145	17406	3129	20360	2461	22334	1907	25459	990	31318	704	25702
18-#18	7.14	MA	16537	5290	31704	3980	38212	3137	42926	2418	50363	1115	66138	-134	64896
7L-4S		MI	10387	5290	20592	3764	24045	2900	26676	2125	31244	790	38870	-208	37583
20-#11	3.10	MA	14630	3807	23557	3068	28301	2467	31060	1981	34732	1221	44015	787	36269
6E		MI	7850	3807	13395	2926	15486	2334	16576	1844	17927	1066	22028	556	18903
20-#11	3.10	MA	14057	3807	22716	3068	27187	2466	29699	1990	32839	1217	41765	716	35015
7L-5S		MI	8166	3807	13848	2930	16075	2328	17274	1849	18821	1061	23107	619	19383
20-#11	3.10	MA	13490	3807	21887	3069	26095	2466	28335	1988	31012	1223	39440	662	33729
8L-4S		MI	8496	3807	14356	2924	16672	2334	17982	1844	19784	1066	24267	662	19782
20-#11	3.10	MA	12927	3807	20972	3081	24971	2476	26993	1997	29203	1229	37146	604	32439
9L-3S		MI	8856	3807	14856	2928	17332	2328	18762	1849	20773	1061	25365	747	20178
20-#11	3.10	MA	12366	3807	20146	3082	23886	2476	25645	1995	27343	1225	34773	523	30898
10L-2S		MI	9339	3807	15515	2932	18154	2334	19739	1844	22057	1056	27028	838	20241
20-#14	4.46	MA	15157	4309	26238	3378	31536	2694	34926	2135	39851	1189	51398	472	47551
7L-5S		MI	8833	4309	15971	3225	18590	2525	20238	1955	22712	976	28152	340	26381
20-#14	4.46	MA	14381	4309	25049	3379	29970	2693	32970	2132	37231	1197	48085	396	45396
8L-4S		MI	9277	4309	16695	3217	19429	2533	21235	1948	24067	983	29777	404	27140
20-#14	4.46	MA	13610	4309	23737	3394	28357	2707	31046	2144	34637	1205	44824	311	42910
9L-3S		MI	9760	4309	17406	3224	20360	2525	22334	1955	25459	976	31318	523	28262

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.40	MA	14663	3921	24012	3139	28832	2518	31691	2022	35527	1212	45385	703	38728
7L-6S		MI	8135	3921	14053	2997	16308	2384	17552	1873	19212	1052	23691	524	20729
22-#11	3.40	MA	14104	3921	23184	3140	27740	2518	30327	2021	33700	1218	43060	649	37415
8L-5S		MI	8448	3921	14507	3001	16897	2379	18250	1878	20106	1047	24770	587	21256
22-#11	3.40	MA	13548	3921	22269	3152	26615	2528	28986	2029	31891	1224	40766	591	36108
9L-4S		MI	8774	3921	15015	2995	17494	2384	18958	1873	21069	1052	25930	631	21634
22-#11	3.40	MA	12994	3921	21443	3152	25531	2527	27638	2028	30031	1220	38393	511	34592
10L-3S		MI	9131	3921	15515	2999	18154	2379	19739	1878	22057	1047	27028	715	22102
22-#11	3.40	MA	12399	3921	20624	3153	24419	2537	26304	2036	28230	1226	36108	454	32983
11L-2S		MI	9610	3921	16174	3003	18977	2384	20715	1873	23342	1042	28690	806	22178
22-#14	4.91	MA	15232	4472	26905	3481	32324	2768	35821	2180	41078	1189	53233	375	50629
8L-5S		MI	9215	4472	16906	3327	19747	2597	21612	1996	24520	954	30482	291	28941
22-#14	4.91	MA	14473	4472	25592	3497	30710	2782	33897	2191	38484	1197	49972	291	48186
9L-4S		MI	9652	4472	17630	3319	20586	2604	22609	1988	25876	961	32107	355	29773
24-#11	3.71	MA	14709	4034	24480	3211	29385	2570	32320	2054	36388	1213	46680	637	41106
8L-6S		MI	8417	4034	14712	3068	17130	2434	18529	1902	20496	1038	25354	493	22561
24-#11	3.71	MA	14160	4034	23565	3222	28260	2580	30978	2062	34580	1219	44386	578	39782
9L-5S		MI	8727	4034	15166	3072	17719	2429	19226	1907	21391	1033	26433	555	23132
24-#11	3.71	MA	13608	4034	22740	3223	27176	2579	29630	2061	32719	1214	42013	498	38289
10L-4S		MI	9050	4034	15674	3066	18316	2434	19934	1902	22354	1038	27593	599	23490
24-#11	3.71	MA	13021	4034	21920	3224	26063	2589	28297	2069	30918	1220	39728	442	36667
11L-3S		MI	9404	4034	16174	3070	18977	2429	20715	1907	23342	1033	28690	683	24024
24-#14	5.36	MA	15323	4636	27448	3599	33064	2856	36749	2239	42331	1190	55120	271	53468
9L-5S		MI	9592	4636	17842	3429	20904	2668	22987	2036	26329	932	32812	242	31511

RECTANGULAR TIED COLUMNS 24" x 44"

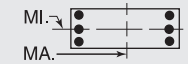
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.52	MA	15740	3382	23134	2802	27541	2272	29780	1873	32214	1281	39486	1188	20915
2E		MI	8162	3382	12705	2641	14358	2124	15067	1729	15678	1136	18547	985	10529
6-#14	1.28	MA	15309	3291	22001	2762	26245	2245	28272	1858	30260	1296	37061	1219	17898
2L-3S		MI	7287	3291	11284	2614	12735	2111	13189	1746	13236	1185	15504	922	9156
6-#14	1.28	MA	13780	3291	20043	2764	23762	2244	25263	1871	26201	1305	31598	1088	17806
3L-2S		MI	8013	3291	12220	2621	13892	2118	14563	1738	15045	1177	17833	1054	9116
6-#18	2.27	MA	17321	3673	26564	2984	31891	2405	35049	1957	39304	1267	48939	1149	31054
2L-3S		MI	7629	3673	12705	2807	14358	2234	15067	1810	15678	1104	18547	651	15250
6-#18	2.27	MA	14749	3673	23134	2985	27541	2402	29780	1977	32214	1280	39486	915	30484
3L-2S		MI	8841	3673	14293	2820	16314	2247	17391	1796	18737	1091	22448	884	15358
8-#11	1.18	MA	15130	3254	21522	2748	25710	2235	27654	1853	29447	1303	36073	1233	16656
2L-4S		MI	7054	3254	10828	2605	12213	2118	12599	1744	12513	1206	14784	908	8567
8-#11	1.18	MA	14057	3254	20155	2749	23975	2235	25552	1862	26613	1309	32234	1142	16618
3E		MI	7439	3254	11328	2609	12873	2113	13379	1749	13502	1201	15882	992	8557
8-#11	1.18	MA	13281	3254	19141	2750	22604	2245	23890	1861	24369	1305	29700	1051	16455
4L-2S		MI	7951	3254	11987	2613	13695	2118	14356	1744	14787	1196	17545	1083	8526
8-#14	1.70	MA	16242	3455	23959	2865	28729	2319	31280	1906	34319	1289	42524	1201	23698
2L-4S		MI	7169	3455	11508	2709	12962	2190	13464	1779	13653	1171	16293	754	11709
8-#14	1.70	MA	14740	3455	22001	2866	26245	2319	28272	1918	30260	1298	37061	1070	23548
3E		MI	7706	3455	12220	2716	13892	2183	14563	1786	15045	1163	17833	873	11933
8-#14	1.70	MA	13655	3455	20547	2867	24280	2333	25889	1915	27044	1291	33459	938	23019
4L-2S		MI	8422	3455	13155	2723	15049	2190	15938	1779	16853	1156	20163	1005	11928
8-#18	3.03	MA	18844	3964	29993	3166	36240	2538	40319	2041	46394	1253	58392	1110	41160
2L-4S		MI	7441	3964	13084	2973	14740	2370	15531	1863	16384	1072	19857	348	17931
8-#18	3.03	MA	16340	3964	26564	3166	31891	2535	35049	2061	39304	1266	48939	876	40450
3E		MI	8333	3964	14293	2986	16314	2357	17391	1876	18737	1059	22448	550	19917

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

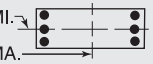


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.03	MA	14529	3964	24010	3167	28439	2559	30866	2054	33678	1253	42721	643	36213
4L-2S		MI	9504	3964	15882	2999	18270	2370	19714	1863	21796	1045	26348	784	20130
10-#11	1.48	MA	15792	3368	22890	2818	27444	2287	29755	1886	32282	1297	39911	1221	20710
2L-5S		MI	7009	3368	10979	2682	12438	2163	12867	1778	12836	1187	15288	832	10181
10-#11	1.48	MA	14733	3368	21522	2820	25710	2286	27654	1895	29447	1304	36073	1130	20645
3L-4S		MI	7357	3368	11487	2676	13035	2169	13575	1773	13798	1192	16447	876	10509
10-#11	1.48	MA	13969	3368	20508	2821	24338	2297	25992	1894	27204	1300	33539	1039	20448
4L-3S		MI	7737	3368	11987	2680	13695	2163	14356	1778	14787	1187	17545	960	10525
10-#11	1.48	MA	13277	3368	19483	2832	23108	2297	24489	1903	25159	1307	30904	992	19599
5L-2S		MI	8245	3368	12646	2684	14517	2169	15332	1773	16072	1182	19208	1051	10508
10-#14	2.13	MA	17151	3618	25917	2967	31212	2394	34289	1953	38378	1281	47987	1182	29483
2L-5S		MI	7102	3618	11720	2819	13279	2254	13842	1827	14106	1141	16997	641	13614
10-#14	2.13	MA	15675	3618	23959	2968	28729	2394	31280	1965	34319	1290	42524	1051	29283
3L-4S		MI	7587	3618	12444	2811	14119	2262	14838	1819	15462	1149	18622	705	14257
10-#14	2.13	MA	14610	3618	22505	2969	26763	2408	28898	1963	31103	1284	38923	920	28516
4L-3S		MI	8117	3618	13155	2818	15049	2254	15938	1827	16853	1141	20163	824	14688
10-#14	2.13	MA	13646	3618	21035	2986	24998	2407	26743	1975	28170	1292	35165	853	26607
5L-2S		MI	8823	3618	14091	2825	16206	2262	17312	1819	18662	1134	22492	955	14719
10-#18	3.79	MA	17879	4254	29993	3348	36240	2668	40319	2145	46394	1251	58392	837	50421
3L-4S		MI	8127	4254	14672	3152	16696	2493	17855	1930	19443	1027	23757	247	22350
10-#18	3.79	MA	16117	4254	27440	3349	32788	2692	36136	2138	40768	1238	52174	604	45917
4L-3S		MI	8994	4254	15882	3165	18270	2480	19714	1943	21796	1013	26348	450	24331
10-#18	3.79	MA	14522	4254	24855	3376	29686	2689	32350	2158	35633	1251	45647	488	42008
5L-2S		MI	10134	4254	17470	3178	20225	2493	22038	1930	24855	1000	30248	684	24870
12-#11	1.77	MA	16441	3481	24258	2889	29178	2338	31856	1919	35117	1292	43750	1210	24756
2L-6S		MI	6980	3481	11184	2748	12670	2219	13146	1802	13226	1178	15871	738	11755
12-#11	1.77	MA	15396	3481	22890	2891	27444	2338	29755	1928	32282	1299	39911	1118	24666
3L-5S		MI	7311	3481	11638	2753	13260	2214	13844	1807	14120	1173	16951	800	12025
12-#11	1.77	MA	14642	3481	21876	2892	26073	2349	28093	1927	30039	1295	37378	1027	24441
4E		MI	7655	3481	12146	2746	13857	2219	14551	1802	15083	1178	18110	844	12441
12-#11	1.77	MA	13960	3481	20850	2903	24842	2349	26591	1936	27994	1302	34742	981	23497
5L-3S		MI	8031	3481	12646	2751	14517	2214	15332	1807	16072	1173	19208	928	12480
12-#11	1.77	MA	13306	3481	19940	2905	23628	2359	25112	1935	26027	1308	32062	906	22645
6L-2S		MI	8534	3481	13305	2755	15339	2219	16308	1802	17357	1168	20871	1019	12479
12-#14	2.56	MA	16589	3782	25917	3070	31212	2468	34289	2013	38378	1283	47987	1032	35014
3L-5S		MI	7519	3782	12655	2921	14436	2326	15216	1867	15915	1119	19327	592	16236
12-#14	2.56	MA	15543	3782	24463	3072	29246	2483	31906	2010	35162	1276	44386	901	34037
4E		MI	7997	3782	13379	2913	15276	2333	16213	1860	17270	1127	20952	656	16829
12-#14	2.56	MA	14596	3782	22993	3088	27481	2482	29752	2023	32229	1285	40628	834	32210
5L-3S		MI	8520	3782	14091	2920	16206	2326	17312	1867	18662	1119	22492	775	17429
12-#14	2.56	MA	13689	3782	21687	3089	25740	2496	27632	2020	29409	1294	36814	726	30369
6L-2S		MI	9217	3782	15027	2927	17363	2333	18686	1860	20470	1112	24822	906	17492
12-#18	4.55	MA	17659	4545	30869	3530	37138	2825	41406	2223	47858	1224	61627	564	55656
4E		MI	8793	4545	16261	3331	18652	2616	20178	1997	22502	982	27657	147	26803
12-#18	4.55	MA	16105	4545	28284	3558	34036	2822	37620	2242	42723	1237	55100	449	51633
5L-3S		MI	9637	4545	17470	3344	20225	2603	22038	2010	24855	968	30248	350	28611
12-#18	4.55	MA	14613	4545	25987	3558	30974	2845	33892	2235	37785	1250	48501	256	47343
6L-2S		MI	10750	4545	19058	3357	22181	2616	24361	1997	27914	955	34149	583	29589
14-#11	2.07	MA	16046	3594	24258	2961	29178	2390	31856	1961	35117	1294	43750	1107	28684
3L-6S		MI	7280	3594	11843	2819	13492	2269	14122	1831	14511	1164	17534	706	13618
14-#11	2.07	MA	15303	3594	23243	2963	27807	2401	30194	1960	32874	1290	41217	1016	28433
4L-5S		MI	7608	3594	12297	2823	14082	2264	14820	1836	15405	1159	18613	769	13879
14-#11	2.07	MA	14630	3594	22218	2974	26577	2401	28692	1969	30829	1296	38581	969	27405
5L-4S		MI	7948	3594	12805	2817	14679	2269	15528	1831	16368	1164	19773	813	14367
14-#11	2.07	MA	13986	3594	21307	2975	25362	2411	27214	1967	28862	1303	35901	894	26583
6L-3S		MI	8321	3594	13305	2822	15339	2264	16308	1836	17357	1159	20871	897	14424
14-#11	2.07	MA	13355	3594	20421	2977	24189	2411	25781	1977	26869	1299	33513	823	25357
7L-2S		MI	8818	3594	13963	2826	16161	2269	17285	1831	18641	1154	22534	988	14441

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

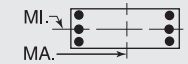
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.98	MA	16455	3945	26421	3174	31729	2558	34915	2058	39221	1269	49849	883	39578
4L-5S		MI	7929	3945	13591	3024	15593	2397	16591	1908	17723	1098	21656	543	18868
14-#14	2.98	MA	15525	3945	24951	3190	29965	2557	32760	2070	36288	1277	46091	816	37825
5L-4S		MI	8401	3945	14315	3016	16432	2405	17587	1900	19079	1105	23281	606	19419
14-#14	2.98	MA	14634	3945	23645	3191	28223	2571	30640	2068	33468	1286	42277	708	35918
6L-3S		MI	8917	3945	15027	3023	17363	2397	18686	1908	20470	1098	24822	725	20162
14-#14	2.98	MA	13761	3945	22373	3193	26540	2571	28584	2080	30609	1280	38882	605	34015
7L-2S		MI	9606	3945	15963	3030	18519	2405	20060	1900	22279	1090	27152	857	20252
14-#18	5.30	MA	17646	4836	31714	3739	38386	2955	42889	2326	49813	1223	64553	410	61286
5L-4S		MI	9442	4836	17849	3510	20608	2739	22502	2064	25561	936	31558	46	31282
14-#18	5.30	MA	16191	4836	29417	3740	35323	2978	39162	2320	44875	1236	57954	217	56736
6L-3S		MI	10265	4836	19058	3523	22181	2726	24361	2077	27914	923	34149	249	32938
14-#18	5.30	MA	14765	4836	27180	3741	32364	2975	35547	2339	39869	1223	52090	35	51956
7L-2S		MI	11354	4836	20646	3536	24137	2739	26685	2064	30973	910	38049	483	34294
16-#11	2.36	MA	15952	3708	24611	3034	29542	2452	32296	1993	35709	1285	45055	1004	32426
4L-6S		MI	7577	3708	12502	2890	14315	2320	15098	1860	15796	1150	19197	674	15418
16-#11	2.36	MA	15289	3708	23585	3045	28311	2452	30793	2002	33664	1291	42420	957	31322
5E		MI	7901	3708	12956	2894	14904	2315	15796	1865	16690	1145	20276	737	15739
16-#11	2.36	MA	14654	3708	22675	3046	27097	2463	29315	2000	31697	1298	39739	882	30526
6L-4S		MI	8238	3708	13464	2888	15501	2320	16504	1860	17653	1150	21436	781	16204
16-#11	2.36	MA	14031	3708	21789	3048	25924	2463	27882	2009	29704	1294	37352	811	29259
7L-3S		MI	8607	3708	13963	2892	16161	2315	17285	1865	18641	1145	22534	865	16363
16-#11	2.36	MA	13416	3708	20917	3049	24775	2463	26446	2008	27781	1301	34891	757	28083
8L-2S		MI	9100	3708	14622	2897	16983	2320	18261	1860	19926	1140	24197	956	16393
16-#14	3.41	MA	16436	4109	26909	3292	32448	2632	35769	2117	40347	1270	51554	797	43450
5E		MI	8332	4109	14527	3126	16750	2469	17965	1948	19532	1076	23986	494	21501
16-#14	3.41	MA	15560	4109	25603	3294	30706	2646	33649	2115	37527	1279	47740	689	41479
6L-4S		MI	8798	4109	15251	3118	17589	2476	18961	1941	20887	1083	25611	557	22023
16-#14	3.41	MA	14702	4109	24331	3295	29023	2645	31593	2127	34668	1272	44345	587	39540
7L-3S		MI	9308	4109	15963	3125	18519	2469	20060	1948	22279	1076	27152	676	22888
16-#14	3.41	MA	13853	4109	23080	3296	27375	2645	29533	2125	31909	1281	40836	510	37099
8L-2S		MI	9989	4109	16898	3132	19676	2476	21434	1941	24088	1068	29481	808	23005
16-#18	6.06	MA	17732	5127	32847	3922	39673	3111	44431	2404	51965	1222	67407	178	66368
6L-4S		MI	10078	5127	19437	3689	22564	2862	24826	2131	28620	891	35458	-54	35121
16-#18	6.06	MA	16339	5127	30610	3922	36714	3108	40817	2424	46959	1209	61543	-4	61506
7L-3S		MI	10882	5127	20646	3702	24137	2849	26685	2144	30973	878	38049	149	37303
18-#11	2.66	MA	15937	3821	24953	3116	30045	2504	32895	2034	36499	1286	46259	946	35247
5L-6S		MI	7869	3821	13161	2961	15137	2370	16075	1889	17080	1137	20860	643	17227
18-#11	2.66	MA	15310	3821	24043	3117	28831	2515	31416	2033	34532	1293	43578	871	34474
6L-5S		MI	8190	3821	13614	2965	15726	2365	16772	1894	17975	1131	21939	705	17605
18-#11	2.66	MA	14696	3821	23157	3118	27658	2515	29983	2042	32539	1289	41191	800	33167
7L-4S		MI	8524	3821	14123	2959	16323	2370	17480	1889	18938	1137	23099	749	18041
18-#11	2.66	MA	14089	3821	22285	3120	26509	2514	28548	2041	30616	1296	38729	746	31964
8L-3S		MI	8889	3821	14622	2963	16983	2365	18261	1894	19926	1131	24197	833	18296
18-#11	2.66	MA	13486	3821	21321	3131	25325	2525	27135	2050	28711	1302	36295	687	30539
9L-2S		MI	9378	3821	15281	2967	17806	2370	19237	1889	21211	1126	25860	924	18340
18-#14	3.84	MA	16468	4273	27561	3396	33189	2721	36657	2162	41586	1271	53203	671	47050
6L-5S		MI	8756	4273	15463	3228	17907	2540	19339	1988	21340	1054	26316	444	24031
18-#14	3.84	MA	15624	4273	26289	3397	31507	2720	34601	2175	38727	1265	49808	568	45075
7L-4S		MI	9211	4273	16187	3220	18746	2548	20335	1981	22696	1062	27941	508	24638
18-#14	3.84	MA	14790	4273	25038	3398	29858	2720	32542	2172	35968	1274	46299	491	42686
8L-3S		MI	9705	4273	16898	3227	19676	2540	21434	1988	24088	1054	29481	627	25609
18-#14	3.84	MA	13960	4273	23656	3415	28159	2734	30515	2185	33236	1282	42836	407	40078
9L-2S		MI	10363	4273	17834	3234	20833	2548	22808	1981	25896	1047	31811	758	25751

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

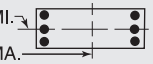
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	6.82	MA	18023	5418	34040	4104	41064	3241	46086	2508	54049	1194	70996	-44	70565
7L-4S		MI	10703	5418	21026	3868	24520	2985	27149	2198	31679	846	39358	-154	38392
20-#11	2.95	MA	15956	3935	25410	3188	30566	2566	33518	2066	37367	1288	47417	859	38426
6E		MI	8158	3935	13820	3032	15959	2421	17051	1918	18365	1123	22523	611	19045
20-#11	2.95	MA	15350	3935	24524	3189	29393	2566	32085	2075	35374	1284	45030	788	37081
7L-5S		MI	8476	3935	14273	3036	16548	2415	17749	1923	19260	1118	23602	674	19474
20-#11	2.95	MA	14751	3935	23652	3191	28244	2566	30649	2074	33451	1290	42568	734	35808
8L-4S		MI	8807	3935	14781	3030	17145	2421	18457	1918	20222	1123	24762	717	19885
20-#11	2.95	MA	14156	3935	22689	3202	27059	2577	29236	2083	31546	1297	40133	676	34454
9L-3S		MI	9168	3935	15281	3034	17806	2415	19237	1923	21211	1118	25860	802	20225
20-#11	2.95	MA	13559	3935	21820	3203	25918	2577	27817	2082	29588	1293	37617	596	32844
10L-2S		MI	9653	3935	15940	3038	18628	2421	20214	1918	22496	1112	27523	893	20282
20-#14	4.26	MA	16531	4436	28247	3499	33990	2795	37610	2222	42785	1257	55272	550	50541
7L-5S		MI	9146	4436	16398	3330	19064	2612	20713	2029	23149	1032	28645	395	26576
20-#14	4.26	MA	15710	4436	26996	3501	32341	2795	35550	2220	40027	1266	51762	473	48280
8L-4S		MI	9593	4436	17122	3322	19903	2619	21709	2021	24505	1040	30270	459	27263
20-#14	4.26	MA	14893	4436	25614	3517	30642	2809	33524	2232	37295	1275	48299	388	45648
9L-3S		MI	10079	4436	17834	3329	20833	2612	22808	2029	25896	1032	31811	578	28326
22-#11	3.25	MA	15995	4048	25892	3260	31127	2618	34186	2108	38209	1279	48868	776	41000
7L-6S		MI	8444	4048	14478	3103	16781	2471	18027	1947	19650	1109	24186	579	20869
22-#11	3.25	MA	15404	4048	25020	3261	29978	2618	32750	2107	36286	1285	46407	722	39702
8L-5S		MI	8759	4048	14932	3107	17370	2466	18725	1952	20545	1104	25265	642	21347
22-#11	3.25	MA	14816	4048	24057	3273	28794	2629	31338	2116	34381	1292	43972	664	38372
9L-4S		MI	9086	4048	15440	3101	17967	2471	19433	1947	21507	1109	26425	686	21736
22-#11	3.25	MA	14222	4048	23188	3274	27653	2629	29919	2114	32423	1288	41455	584	36746
10L-3S		MI	9445	4048	15940	3105	18628	2466	20214	1952	22496	1104	27523	770	22152
22-#11	3.25	MA	13593	4048	22325	3275	26482	2639	28515	2124	30527	1295	39036	527	35112
11L-2S		MI	9926	4048	16599	3109	19450	2471	21190	1947	23781	1098	29186	861	22220
22-#14	4.69	MA	16614	4600	28954	3603	34825	2869	38559	2267	44086	1259	57225	454	53881
8L-5S		MI	9529	4600	17334	3432	20221	2683	22087	2069	24958	1011	30975	346	29133
22-#14	4.69	MA	15811	4600	27572	3619	33126	2884	36532	2279	41354	1267	53762	370	51224
9L-4S		MI	9969	4600	18058	3425	21060	2691	23083	2062	26313	1018	32600	409	29896
24-#11	3.55	MA	16047	4161	26387	3332	31713	2670	34851	2140	39121	1280	50246	711	43600
8L-6S		MI	8727	4161	15137	3174	17603	2521	19004	1976	20935	1095	25849	548	22700
24-#11	3.55	MA	15467	4161	25424	3344	30528	2680	33439	2149	37216	1287	47811	652	42283
9L-5S		MI	9039	4161	15591	3178	18193	2516	19701	1981	21830	1090	26928	610	23223
24-#11	3.55	MA	14875	4161	24555	3345	29387	2680	32020	2147	35258	1283	45294	572	40652
10L-4S		MI	9363	4161	16099	3172	18789	2521	20409	1976	22792	1095	28088	654	23592
24-#11	3.55	MA	14253	4161	23693	3346	28216	2691	30616	2156	33362	1289	42875	515	39005
11L-3S		MI	9719	4161	16599	3176	19450	2516	21190	1981	23781	1090	29186	738	24075
24-#14	5.11	MA	16713	4763	29530	3721	35609	2958	39541	2327	45413	1260	59226	351	56807
9L-5S		MI	9908	4763	18270	3535	21378	2755	23461	2110	26766	989	33304	297	31700

RECTANGULAR TIED COLUMNS 24" x 46"

4-#18	1.45	MA	17095	3509	24933	2922	29730	2371	32130	1956	34709	1347	42568	1256	21995
2E		MI	8470	3509	13138	2745	14832	2210	15541	1802	16113	1192	19036	1039	10565
6-#14	1.22	MA	16633	3419	23735	2882	28359	2343	30534	1942	32600	1360	39974	1286	18810
2L-3S		MI	7594	3419	11712	2719	13209	2198	13664	1819	13673	1241	15996	977	9189
6-#14	1.22	MA	15019	3419	21675	2883	25746	2343	27369	1955	28329	1370	34195	1155	18718
3L-2S		MI	8321	3419	12647	2726	14366	2205	15038	1812	15482	1234	18326	1108	9145
6-#18	2.17	MA	18775	3800	28545	3103	34310	2504	37679	2040	42196	1334	52582	1220	32674
2L-3S		MI	7935	3800	13138	2911	14832	2319	15541	1882	16113	1160	19036	705	15317
6-#18	2.17	MA	16056	3800	24933	3105	29730	2501	32130	2061	34709	1348	42568	986	32104
3L-2S		MI	9152	3800	14726	2924	16788	2333	17864	1869	19172	1146	22936	938	15401

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

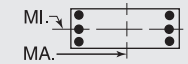
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.13	MA	16442	3381	23229	2867	27792	2333	29881	1937	31741	1367	38916	1299	17499
2L-4S		MI	7360	3381	11254	2711	12686	2205	13074	1818	12952	1263	15280	963	8602
8-#11	1.13	MA	15310	3381	21791	2868	25968	2333	27670	1946	28759	1374	34858	1208	17460
3E		MI	7745	3381	11753	2715	13346	2200	13854	1823	13941	1258	16377	1047	8585
8-#11	1.13	MA	14492	3381	20725	2870	24527	2344	25924	1945	26402	1371	32178	1116	17297
4L-2S		MI	8259	3381	12412	2719	14168	2205	14831	1818	15225	1252	18040	1138	8552
8-#14	1.63	MA	17623	3582	25796	2984	30972	2418	33700	1989	36871	1353	45752	1269	24913
2L-4S		MI	7475	3582	11936	2814	13435	2277	13939	1852	14090	1227	16785	809	11840
8-#14	1.63	MA	16038	3582	23735	2986	28359	2418	30534	2002	32600	1362	39974	1138	24763
3E		MI	8014	3582	12647	2821	14366	2269	15038	1860	15482	1220	18326	928	11974
8-#14	1.63	MA	14893	3582	22207	2987	26293	2432	28030	2000	29220	1357	36160	1006	24261
4L-2S		MI	8731	3582	13583	2828	15522	2277	16412	1852	17290	1212	20656	1059	11960
8-#18	2.90	MA	20394	4091	32156	3285	38890	2637	43228	2125	49682	1321	62595	1184	43320
2L-4S		MI	7723	4091	13517	3077	15215	2456	16005	1936	16819	1128	20345	401	18105
8-#18	2.90	MA	17746	4091	28545	3287	34310	2634	37679	2145	42196	1335	52582	950	42610
3E		MI	8643	4091	14726	3090	16788	2442	17864	1949	19172	1114	22936	604	19992
8-#18	2.90	MA	15834	4091	25859	3288	30680	2659	33280	2140	36258	1322	45987	717	38364
4L-2S		MI	9819	4091	16315	3103	18744	2456	20188	1936	22230	1101	26837	838	20181
10-#11	1.41	MA	17144	3495	24668	2938	29617	2385	32091	1970	34723	1362	42974	1288	21763
2L-5S		MI	7315	3495	11404	2788	12911	2251	13342	1852	13274	1244	15783	887	10270
10-#11	1.41	MA	16026	3495	23229	2939	27792	2385	29881	1979	31741	1369	38916	1197	21698
3L-4S		MI	7663	3495	11912	2781	13508	2256	14050	1847	14237	1249	16943	931	10549
10-#11	1.41	MA	15220	3495	22164	2941	26351	2396	28134	1978	29383	1365	36235	1106	21501
4L-3S		MI	8044	3495	12412	2786	14168	2251	14831	1852	15225	1244	18040	1015	10557
10-#11	1.41	MA	14492	3495	21086	2953	25059	2396	26556	1988	27235	1372	33454	1059	20696
5L-2S		MI	8553	3495	13071	2790	14990	2256	15807	1847	16510	1239	19703	1106	10536
10-#14	2.04	MA	18589	3746	27856	3086	33585	2492	36866	2036	41142	1346	51531	1252	31001
2L-5S		MI	7407	3746	12147	2924	13753	2341	14317	1900	14543	1198	17490	696	13728
10-#14	2.04	MA	17030	3746	25796	3088	30972	2492	33700	2049	36871	1355	45752	1120	30802
3L-4S		MI	7894	3746	12871	2916	14592	2348	15313	1893	15899	1205	19115	760	14385
10-#14	2.04	MA	15906	3746	24268	3090	28906	2507	31196	2047	33491	1349	41939	989	30183
4L-3S		MI	8426	3746	13583	2923	15522	2341	16412	1900	17290	1198	20656	879	14734
10-#14	2.04	MA	14890	3746	22722	3106	27052	2507	28932	2060	30409	1359	37971	922	28102
5L-2S		MI	9134	3746	14519	2930	16679	2348	17786	1893	19099	1190	22985	1010	14755
10-#18	3.62	MA	19380	4382	32156	3468	38890	2767	43228	2230	49682	1321	62595	914	53121
3L-4S		MI	8435	4382	15105	3256	17171	2579	18328	2003	19877	1082	24245	301	22521
10-#18	3.62	MA	17519	4382	29471	3470	35260	2792	38829	2224	43744	1308	56001	680	48595
4L-3S		MI	9307	4382	16315	3269	18744	2565	20188	2016	22230	1069	26837	504	24557
10-#18	3.62	MA	15834	4382	26753	3498	31999	2790	34848	2245	38325	1322	49100	564	44667
5L-2S		MI	10453	4382	17903	3282	20700	2579	22511	2003	25289	1056	30737	738	24925
12-#11	1.70	MA	17832	3608	26106	3009	31441	2437	34301	2002	37705	1356	47031	1277	26020
2L-6S		MI	7285	3608	11609	2854	13144	2306	13621	1876	13664	1235	16366	793	11841
12-#11	1.70	MA	16728	3608	24668	3010	29617	2437	32091	2012	34723	1363	42974	1186	25930
3L-5S		MI	7617	3608	12063	2858	13733	2301	14319	1881	14559	1230	17446	855	12115
12-#11	1.70	MA	15934	3608	23602	3012	28176	2447	30344	2011	32365	1360	40293	1095	25704
4E		MI	7962	3608	12571	2852	14330	2306	15026	1876	15522	1235	18606	899	12486
12-#11	1.70	MA	15216	3608	22525	3023	26883	2448	28766	2020	30217	1367	37512	1048	24799
5L-3S		MI	8339	3608	13071	2857	14990	2301	15807	1881	16510	1230	19703	983	12516
12-#11	1.70	MA	14527	3608	21569	3025	25608	2458	27214	2020	28151	1374	34678	973	23879
6L-2S		MI	8843	3608	13730	2861	15812	2306	16783	1876	17795	1225	21366	1074	12509
12-#14	2.45	MA	17998	3909	27856	3190	33585	2567	36866	2097	41142	1347	51531	1103	36837
3L-5S		MI	7825	3909	13083	3026	14910	2412	15691	1941	16352	1176	19820	647	16349
12-#14	2.45	MA	16895	3909	26328	3192	31519	2582	34361	2095	37762	1342	47717	972	35999
4E		MI	8305	3909	13807	3019	15749	2420	16687	1933	17707	1183	21445	710	16955

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	2.45	MA	15897	3909	24783	3208	29665	2582	32098	2108	34680	1351	43749	905	34003
5L-3S		MI	8830	3909	14519	3026	16679	2412	17786	1941	19099	1176	22985	829	17479
12-#14	2.45	MA	14940	3909	23411	3210	27835	2597	29870	2106	31717	1361	39714	797	32186
6L-2S		MI	9529	3909	15455	3033	17836	2420	19160	1933	20908	1168	25315	961	17532
12-#18	4.35	MA	19154	4673	33082	3651	39840	2925	44378	2308	51231	1295	66014	644	58863
4E		MI	9102	4673	16694	3435	19127	2702	20652	2070	22936	1037	28146	201	26972
12-#18	4.35	MA	17513	4673	30365	3679	36579	2923	40397	2329	45812	1309	59113	528	54824
5L-3S		MI	9952	4673	17903	3448	20700	2688	22511	2083	25289	1024	30737	404	28832
12-#18	4.35	MA	15938	4673	27951	3681	33360	2947	36479	2323	40600	1323	52122	335	50448
6L-2S		MI	11072	4673	19491	3461	22656	2702	24835	2070	28348	1011	34637	637	29649
14-#11	1.98	MA	17418	3722	26106	3081	31441	2489	34301	2045	37705	1358	47031	1176	30158
3L-6S		MI	7586	3722	12268	2925	13966	2357	14597	1905	14949	1221	18029	761	13711
14-#11	1.98	MA	16634	3722	25041	3083	30000	2499	32555	2044	35347	1355	44351	1085	29907
4L-5S		MI	7915	3722	12722	2929	14555	2351	15295	1910	15844	1216	19109	824	13968
14-#11	1.98	MA	15926	3722	23963	3094	28707	2500	30977	2053	33199	1362	41570	1037	28913
5L-4S		MI	8256	3722	13230	2923	15152	2357	16003	1905	16806	1221	20269	867	14415
14-#11	1.98	MA	15247	3722	23007	3096	27432	2510	29424	2052	31133	1369	38736	962	28024
6L-3S		MI	8630	3722	13730	2927	15812	2351	16783	1910	17795	1216	21366	952	14463
14-#11	1.98	MA	14582	3722	22077	3097	26201	2511	27919	2062	29040	1366	36211	892	26814
7L-2S		MI	9129	3722	14389	2932	16635	2357	17760	1905	19080	1211	23029	1043	14474
14-#14	2.85	MA	17862	4073	28388	3294	34132	2657	37527	2142	42033	1334	53496	955	41834
4L-5S		MI	8236	4073	14019	3129	16067	2484	17065	1981	18161	1154	22149	597	18981
14-#14	2.85	MA	16882	4073	26843	3311	32277	2657	35263	2155	38951	1344	49528	888	39916
5L-4S		MI	8710	4073	14743	3121	16906	2491	18061	1974	19516	1162	23774	661	19543
14-#14	2.85	MA	15943	4073	25471	3312	30448	2671	33036	2153	35988	1353	45493	780	38034
6L-3S		MI	9228	4073	15455	3128	17836	2484	19160	1981	20908	1154	25315	780	20216
14-#14	2.85	MA	15022	4073	24136	3314	28680	2671	30877	2166	32984	1348	41900	677	36065
7L-2S		MI	9919	4073	16390	3135	18993	2491	20535	1974	22716	1147	27644	911	20296
14-#18	5.07	MA	19148	4963	33976	3861	41159	3056	45946	2413	53298	1296	69126	491	65008
5L-4S		MI	9754	4963	18282	3614	21083	2825	22976	2136	25995	992	32046	100	31449
14-#18	5.07	MA	17612	4963	31562	3863	37940	3080	42028	2408	48087	1309	62136	299	60366
6L-3S		MI	10583	4963	19491	3627	22656	2811	24835	2150	28348	979	34637	303	33154
14-#18	5.07	MA	16105	4963	29212	3864	34831	3078	38229	2428	42803	1297	55919	117	55183
7L-2S		MI	11679	4963	21080	3640	24612	2825	27159	2136	31407	966	38538	537	34357
16-#11	2.26	MA	17323	3835	26479	3153	31824	2551	34765	2077	38329	1350	48409	1074	34110
4L-6S		MI	7883	3835	12927	2996	14788	2407	15573	1934	16234	1207	19692	729	15559
16-#11	2.26	MA	16624	3835	25402	3165	30532	2552	33187	2086	36180	1357	45627	1027	33037
5E		MI	8208	3835	13381	3000	15377	2402	16271	1939	17129	1202	20772	792	15828
16-#11	2.26	MA	15954	3835	24446	3167	29257	2562	31634	2085	34115	1364	42794	952	32175
6L-4S		MI	8547	3835	13889	2994	15974	2407	16979	1934	18091	1207	21931	836	16306
16-#11	2.26	MA	15299	3835	23516	3168	28025	2562	30129	2095	32022	1361	40268	881	30923
7L-3S		MI	8917	3835	14389	2998	16635	2402	17760	1939	19080	1202	23029	920	16404
16-#11	2.26	MA	14650	3835	22600	3170	26818	2563	28622	2094	30002	1368	37670	826	29770
8L-2S		MI	9412	3835	15047	3002	17457	2407	18736	1934	20365	1197	24692	1011	16429
16-#14	3.26	MA	17847	4236	28903	3413	34890	2731	38429	2203	43222	1336	55307	871	45840
5E		MI	8640	4236	14955	3231	17224	2555	18439	2022	19969	1132	24479	548	21621
16-#14	3.26	MA	16924	4236	27531	3415	33061	2746	36202	2201	40259	1346	51272	763	43893
6L-4S		MI	9108	4236	15679	3223	18063	2563	19435	2014	21325	1140	26104	612	22146
16-#14	3.26	MA	16019	4236	26196	3416	31293	2746	34042	2214	37255	1340	47678	660	41966
7L-3S		MI	9620	4236	16390	3230	18993	2555	20535	2022	22716	1132	27644	731	22945
16-#14	3.26	MA	15123	4236	24882	3418	29562	2746	31879	2212	34357	1350	43972	583	39318
8L-2S		MI	10304	4236	17326	3237	20150	2563	21909	2014	24525	1125	29974	862	23051
16-#18	5.80	MA	19245	5254	35174	4044	42521	3213	47577	2492	55573	1296	72149	262	70533
6L-4S		MI	10392	5254	19870	3793	23039	2948	25299	2203	29054	947	35946	0	35946
16-#18	5.80	MA	17773	5254	32823	4046	39411	3211	43778	2513	50290	1283	65932	80	65465
7L-3S		MI	11203	5254	21080	3806	24612	2934	27159	2217	31407	934	38538	203	37515
16-#18	5.80	MA	16315	5254	30510	4047	36363	3209	39971	2507	45191	1297	59488	-55	59107
8L-2S		MI	12276	5254	22668	3819	26568	2948	29482	2203	34466	920	42438	437	39054

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.54	MA	17311	3948	26840	3236	32356	2603	35397	2119	39162	1352	49685	1016	37168
5L-6S		MI	8176	3948	13586	3067	15610	2457	16550	1963	17519	1193	21355	698	17367
18-#11	2.54	MA	16650	3948	25884	3238	31081	2614	33845	2118	37097	1359	46851	941	36331
6L-5S		MI	8499	3948	14040	3071	16199	2452	17248	1968	18414	1188	22435	760	17694
18-#11	2.54	MA	16003	3948	24954	3239	29849	2614	32340	2128	35004	1356	44326	870	35038
7L-4S		MI	8834	3948	14548	3065	16796	2457	17955	1963	19376	1193	23594	804	18142
18-#11	2.54	MA	15363	3948	24039	3241	28643	2615	30832	2127	32984	1363	41728	816	33858
8L-3S		MI	9200	3948	15047	3069	17457	2452	18736	1968	20365	1188	24692	888	18340
18-#11	2.54	MA	14727	3948	23027	3252	27399	2625	29349	2136	30984	1370	39153	757	32315
9L-2S		MI	9691	3948	15706	3073	18279	2457	19712	1963	21650	1183	26355	979	18378
18-#14	3.67	MA	17886	4400	29592	3517	35674	2821	39367	2248	44530	1338	57050	745	49762
6L-5S		MI	9067	4400	15890	3333	18381	2627	19813	2062	21778	1111	26809	499	24225
18-#14	3.67	MA	16996	4400	28257	3518	33906	2821	37208	2261	41526	1333	53457	643	47800
7L-4S		MI	9525	4400	16614	3325	19220	2634	20810	2054	23133	1118	28434	563	24761
18-#14	3.67	MA	16116	4400	26942	3520	32175	2821	35044	2259	38628	1342	49751	566	45205
8L-3S		MI	10022	4400	17326	3332	20150	2627	21909	2062	24525	1111	29974	682	25669
18-#14	3.67	MA	15240	4400	25491	3537	30390	2836	32916	2272	35759	1352	46086	481	42545
9L-2S		MI	10684	4400	18262	3339	21307	2634	23283	2054	26333	1103	32304	813	25799
18-#18	6.52	MA	19405	5545	36435	4227	43991	3344	49327	2597	57776	1270	75945	44	75745
7L-4S		MI	11020	5545	21459	3972	24995	3071	27623	2270	32113	902	39847	-100	39196
18-#18	6.52	MA	17979	5545	34121	4229	40943	3342	45520	2591	52678	1284	69502	-91	68705
8L-3S		MI	11813	5545	22668	3985	26568	3057	29482	2284	34466	888	42438	103	41907
20-#11	2.83	MA	17335	4062	27323	3308	32905	2666	36055	2151	40079	1354	50909	930	40491
6E		MI	8466	4062	14245	3138	16432	2508	17526	1992	18804	1180	23018	666	19183
20-#11	2.83	MA	16696	4062	26393	3310	31674	2666	34550	2160	37986	1350	48384	860	39159
7L-5S		MI	8785	4062	14698	3142	17021	2503	18224	1997	19698	1174	24098	729	19564
20-#11	2.83	MA	16065	4062	25477	3311	30467	2666	33042	2159	35966	1357	45786	805	37952
8L-4S		MI	9117	4062	15206	3136	17618	2508	18932	1992	20661	1180	25257	772	19986
20-#11	2.83	MA	15437	4062	24466	3323	29224	2677	31559	2169	33966	1365	43211	747	36438
9L-3S		MI	9481	4062	15706	3140	18279	2503	19712	1997	21650	1174	26355	857	20271
20-#11	2.83	MA	14800	4062	23554	3325	28025	2677	30069	2168	31910	1361	40550	667	34813
10L-2S		MI	9967	4062	16365	3144	19101	2508	20689	1992	22935	1169	28018	948	20321
20-#14	4.08	MA	17957	4563	30317	3621	36519	2896	40373	2308	45797	1325	59236	626	53644
7L-5S		MI	9458	4563	16826	3435	19538	2698	21188	2102	23586	1089	29138	450	26767
20-#14	4.08	MA	17090	4563	29003	3622	34788	2896	38210	2306	42899	1335	55529	549	51099
8L-4S		MI	9908	4563	17550	3427	20377	2706	22184	2095	24942	1096	30763	513	27385
20-#14	4.08	MA	16229	4563	27551	3639	33003	2910	36082	2319	40029	1344	51865	464	48417
9L-3S		MI	10398	4563	18262	3435	21307	2698	23283	2102	26333	1089	32304	632	28389
20-#14	4.08	MA	15343	4563	26242	3641	31283	2910	33943	2318	37079	1339	48076	349	45688
10L-2S		MI	11051	4563	19198	3442	22464	2706	24657	2095	28142	1081	34633	764	28541
20-#18	7.25	MA	19774	5836	37733	4411	45524	3475	51069	2675	60164	1271	79515	-127	78178
8L-4S		MI	11638	5836	23047	4151	26951	3194	29946	2337	35172	856	43747	-201	42426
22-#11	3.11	MA	17380	4175	27831	3381	33498	2718	36760	2193	40968	1345	52442	849	43286
7L-6S		MI	8753	4175	14904	3209	17254	2558	18502	2021	20089	1166	24681	634	21006
22-#11	3.11	MA	16756	4175	26916	3382	32291	2718	35252	2192	38948	1352	49843	794	42051
8L-5S		MI	9069	4175	15357	3213	17844	2553	19200	2026	20983	1161	25761	697	21437
22-#11	3.11	MA	16136	4175	25904	3394	31048	2729	33769	2202	36948	1359	47269	736	40565
9L-4S		MI	9398	4175	15865	3207	18440	2558	19908	2021	21946	1166	26920	741	21836
22-#11	3.11	MA	15502	4175	24992	3396	29850	2729	32279	2201	34892	1356	44608	656	38924
10L-3S		MI	9758	4175	16365	3211	19101	2553	20689	2026	22935	1161	28018	825	22200
22-#11	3.11	MA	14839	4175	24087	3397	28620	2740	30805	2210	32900	1363	42054	599	37269
11L-2S		MI	10241	4175	17024	3215	19923	2558	21665	2021	24219	1155	29681	916	22261
22-#14	4.48	MA	18049	4727	31063	3725	37400	2970	41375	2354	47170	1327	61308	532	57000
8L-5S		MI	9843	4727	17762	3538	20694	2770	22562	2143	25395	1067	31468	400	29322

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

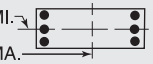
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	4.48	MA	17201	4727	29611	3741	35616	2985	39247	2367	44300	1337	57643	447	54295
9L-4S		MI	10286	4727	18486	3530	21534	2777	23558	2135	26750	1074	33093	464	30017
22-#14	4.48	MA	16319	4727	28302	3743	33896	2985	37109	2365	41349	1331	53855	332	51550
10L-3S		MI	10768	4727	19198	3537	22464	2770	24657	2143	28142	1067	34633	583	31105
24-#11	3.39	MA	17438	4289	28354	3453	34116	2770	37463	2225	41930	1347	53901	784	46114
8L-6S		MI	9036	4289	15562	3280	18076	2609	19479	2050	21373	1152	26344	603	22836
24-#11	3.39	MA	16825	4289	27343	3465	32872	2781	35979	2235	39930	1354	51326	725	44695
9L-5S		MI	9350	4289	16016	3284	18666	2603	20176	2055	22268	1147	27424	665	23313
24-#11	3.39	MA	16194	4289	26431	3467	31674	2781	34489	2234	37874	1351	48665	645	43038
10L-4S		MI	9676	4289	16524	3278	19262	2609	20884	2050	23231	1152	28583	709	23692
24-#11	3.39	MA	15538	4289	25525	3468	30445	2792	33015	2243	35882	1358	46112	588	41371
11L-3S		MI	10033	4289	17024	3282	19923	2603	21665	2055	24219	1147	29681	793	24125
24-#11	3.39	MA	14891	4289	24625	3469	29250	2792	31534	2242	33900	1365	43557	530	39598
12L-2S		MI	10512	4289	17683	3286	20745	2609	22641	2050	25504	1141	31344	884	24198
24-#14	4.89	MA	18157	4891	31672	3843	38229	3060	42413	2414	48571	1329	63422	430	60178
9L-5S		MI	10223	4891	18698	3640	21851	2841	23936	2183	27203	1045	33797	351	31887
24-#14	4.89	MA	17279	4891	30363	3845	36509	3060	40274	2412	45620	1324	59634	315	57418
10L-4S		MI	10659	4891	19422	3632	22691	2849	24932	2176	28559	1053	35422	415	32655

RECTANGULAR TIED COLUMNS 24" x 48"

4-#18	1.39	MA	18502	3637	26792	3041	31994	2469	34560	2039	37242	1411	45740	1323	23075
2E		MI	8778	3637	13571	2849	15307	2295	16014	1874	16547	1247	19524	1093	10600
6-#14	1.17	MA	18009	3546	25529	3001	30548	2441	32877	2025	35017	1425	42976	1352	19721
2L-3S		MI	7900	3546	12140	2824	13682	2284	14139	1893	14110	1298	16489	1032	9222
6-#14	1.17	MA	16310	3546	23367	3003	27805	2441	29554	2038	30535	1435	36881	1221	19629
3L-2S		MI	8628	3546	13075	2831	14839	2291	15513	1885	15919	1290	18819	1163	9173
6-#18	2.08	MA	20282	3927	30586	3223	36805	2602	40388	2124	45105	1398	56314	1290	34294
2L-3S		MI	8242	3927	13571	3015	15307	2405	16014	1955	16547	1215	19524	759	15380
6-#18	2.08	MA	17415	3927	26792	3225	31994	2600	34560	2146	37242	1413	45740	1056	33724
3L-2S		MI	9462	3927	15160	3028	17263	2418	18338	1941	19606	1202	23425	992	15443
8-#11	1.08	MA	17805	3509	24996	2986	29950	2431	32187	2020	34111	1431	41849	1364	18341
2L-4S		MI	7666	3509	11679	2816	13159	2292	13549	1892	13390	1320	15775	1018	8635
8-#11	1.08	MA	16613	3509	23486	2988	28036	2432	29868	2030	30982	1438	37572	1273	18303
3E		MI	8052	3509	12178	2821	13819	2287	14330	1897	14379	1314	16872	1102	8612
8-#11	1.08	MA	15755	3509	22369	2990	26525	2443	28037	2029	28510	1436	34745	1182	18140
4L-2S		MI	8566	3509	12837	2825	14641	2292	15306	1892	15664	1309	18535	1193	8577
8-#14	1.56	MA	19056	3709	27692	3103	33291	2516	36199	2072	39500	1417	49070	1336	26128
2L-4S		MI	7781	3709	12364	2919	13909	2363	14414	1926	14527	1283	17278	863	11954
8-#14	1.56	MA	17387	3709	25529	3105	30548	2516	32877	2086	35017	1427	42976	1205	25978
3E		MI	8321	3709	13075	2926	14839	2356	15513	1933	15919	1276	18819	982	12013
8-#14	1.56	MA	16183	3709	23927	3107	28381	2531	30251	2084	31473	1422	38950	1074	25476
4L-2S		MI	9040	3709	14011	2933	15996	2363	16887	1926	17728	1269	21149	1114	11992
8-#18	2.78	MA	21997	4218	34379	3404	41615	2735	46217	2208	52968	1385	66888	1257	45480
2L-4S		MI	8028	4218	13950	3180	15690	2541	16478	2008	17253	1183	20833	455	18276
8-#18	2.78	MA	19204	4218	30586	3407	36805	2733	40388	2230	45105	1400	56314	1023	44770
3E		MI	8931	4218	15160	3194	17263	2528	18338	2022	19606	1170	23425	658	20065
8-#18	2.78	MA	17190	4218	27768	3409	32996	2759	35772	2225	38875	1389	49344	789	40534
4L-2S		MI	10127	4218	16748	3207	19219	2541	20661	2008	22665	1157	27325	892	20230
10-#11	1.35	MA	18547	3622	26505	3057	31864	2483	34506	2053	37239	1426	46126	1355	22816
2L-5S		MI	7620	3622	11829	2893	13384	2338	13817	1926	13713	1301	16278	942	10358
10-#11	1.35	MA	17370	3622	24996	3059	29950	2483	32187	2063	34111	1433	41849	1263	22751
3L-4S		MI	7970	3622	12337	2887	13981	2343	14525	1921	14675	1306	17438	986	10588
10-#11	1.35	MA	16524	3622	23879	3061	28440	2494	30356	2062	31639	1430	39021	1172	22554
4L-3S		MI	8352	3622	12837	2892	14641	2338	15306	1926	15664	1301	18535	1070	10588
10-#11	1.35	MA	15758	3622	22750	3073	27085	2495	28703	2072	29387	1438	36094	1125	21801
5L-2S		MI	8862	3622	13496	2896	15464	2343	16282	1921	16949	1295	20198	1161	10564

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



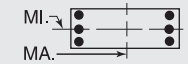
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.95	MA	20078	3873	29854	3205	36033	2591	39522	2120	43983	1410	55164	1321	32520
2L-5S		MI	7713	3873	12575	3029	14227	2427	14791	1974	14981	1254	17983	750	13838
10-#14	1.95	MA	18436	3873	27692	3208	33291	2591	36199	2133	39500	1420	49070	1189	32321
3L-4S		MI	8201	3873	13299	3022	15066	2435	15788	1966	16336	1262	19608	814	14510
10-#14	1.95	MA	17254	3873	26090	3210	31124	2606	33573	2132	35956	1415	45045	1058	31768
4L-3S		MI	8734	3873	14011	3029	15996	2427	16887	1974	17728	1254	21149	933	14778
10-#14	1.95	MA	16185	3873	24470	3227	29180	2607	31201	2145	32725	1425	40866	990	29606
5L-2S		MI	9444	3873	14947	3036	17153	2435	18261	1966	19536	1247	23478	1065	14791
10-#18	3.47	MA	20933	4509	34379	3588	41615	2866	46217	2314	52968	1387	66888	990	55821
3L-4S		MI	8742	4509	15539	3359	17646	2664	18802	2075	20312	1138	24734	355	22689
10-#18	3.47	MA	18973	4509	31562	3591	37806	2892	41601	2309	46738	1375	59918	756	51294
4L-3S		MI	9619	4509	16748	3373	19219	2651	20661	2088	22665	1125	27325	558	24728
10-#18	3.47	MA	17199	4509	28712	3619	34386	2891	37426	2331	41055	1390	52643	638	47361
5L-2S		MI	10771	4509	18336	3386	21175	2664	22985	2075	25724	1112	31225	792	24980
12-#11	1.63	MA	19275	3736	28014	3128	33779	2535	36825	2086	40368	1420	50402	1345	27283
2L-6S		MI	7590	3736	12035	2960	13617	2393	14096	1950	14103	1292	16862	848	11926
12-#11	1.63	MA	18113	3736	26505	3130	31864	2535	34506	2096	37239	1428	46126	1254	27193
3L-5S		MI	7923	3736	12488	2964	14206	2388	14794	1955	14997	1287	17941	910	12202
12-#11	1.63	MA	17277	3736	25388	3131	30354	2546	32675	2095	34768	1425	43298	1163	26968
4E		MI	8269	3736	12996	2958	14803	2393	15501	1950	15960	1292	19101	954	12528
12-#11	1.63	MA	16523	3736	24259	3144	28999	2547	31022	2105	32516	1433	40371	1115	26110
5L-3S		MI	8647	3736	13496	2962	15464	2388	16282	1955	16949	1287	20198	1038	12551
12-#11	1.63	MA	15799	3736	23258	3145	27663	2558	29395	2104	30352	1440	37384	1040	25117
6L-2S		MI	9152	3736	14155	2967	16286	2393	17258	1950	18234	1282	21861	1129	12539
12-#14	2.34	MA	19460	4036	29854	3310	36033	2666	39522	2181	43983	1412	55164	1174	38659
3L-5S		MI	8131	4037	13511	3132	15384	2499	16166	2014	16789	1232	20313	701	16459
12-#14	2.34	MA	18299	4036	28252	3312	33867	2681	36896	2179	40438	1407	51139	1042	37976
4E		MI	8613	4037	14235	3124	16223	2506	17162	2007	18145	1240	21938	765	17078
12-#14	2.34	MA	17250	4037	26632	3329	31923	2681	34523	2193	37207	1417	46961	974	35805
5L-3S		MI	9139	4037	14947	3131	17153	2499	18261	2014	19536	1232	23478	884	17528
12-#14	2.34	MA	16243	4037	25195	3331	30005	2697	32189	2191	34102	1428	42705	866	34023
6L-2S		MI	9841	4036	15883	3138	18310	2506	19635	2007	21345	1225	25808	1015	17572
12-#18	4.17	MA	20703	4800	35355	3772	42617	3025	47429	2394	54601	1362	70492	723	62090
4E		MI	9412	4800	17127	3538	19602	2787	21126	2142	23371	1093	28634	255	27137
12-#18	4.17	MA	18975	4800	32505	3801	39197	3024	43254	2416	48918	1377	63217	604	58051
5L-3S		MI	10267	4800	18336	3552	21175	2774	22985	2155	25724	1080	31225	458	29050
12-#18	4.17	MA	17316	4800	29974	3803	35822	3049	39146	2411	43453	1392	55834	412	53391
6L-2S		MI	11393	4800	19924	3565	23131	2787	25309	2142	28783	1066	35126	691	29707
14-#11	1.90	MA	18842	3849	28014	3201	33779	2587	36825	2128	40368	1423	50402	1244	31632
3L-6S		MI	7892	3849	12693	3031	14439	2444	15072	1979	15388	1278	18525	816	13795
14-#11	1.90	MA	18018	3849	26897	3202	32268	2598	34994	2128	37897	1420	47575	1153	31382
4L-5S		MI	8221	3849	13147	3035	15028	2438	15770	1984	16282	1273	19604	879	14055
14-#11	1.90	MA	17273	3849	25769	3214	30914	2599	33341	2138	35645	1428	44648	1105	30430
5L-4S		MI	8564	3849	13655	3029	15625	2444	16478	1979	17245	1278	20764	922	14461
14-#11	1.90	MA	16560	3849	24767	3216	29577	2610	31714	2137	33481	1435	41661	1030	29470
6L-3S		MI	8939	3849	14155	3033	16286	2438	17258	1984	18234	1273	21861	1007	14501
14-#11	1.90	MA	15861	3849	23793	3218	28287	2610	30137	2147	31287	1432	38998	960	28284
7L-2S		MI	9439	3849	14814	3037	17108	2444	18235	1979	19518	1268	23524	1098	14506
14-#14	2.73	MA	19322	4200	30415	3414	36609	2756	40219	2227	44921	1400	57234	1027	44107
4L-5S		MI	8543	4200	14447	3234	16540	2570	17540	2055	18598	1211	22642	652	19091
14-#14	2.73	MA	18291	4200	28795	3431	34666	2756	37846	2240	41690	1410	53055	959	42017
5L-4S		MI	9019	4200	15171	3226	17380	2578	18536	2047	19953	1218	24267	716	19665
14-#14	2.73	MA	17303	4200	27357	3433	32748	2771	35511	2239	38585	1420	48799	851	40169
6L-3S		MI	9539	4200	15883	3233	18310	2570	19635	2055	21345	1211	25808	835	20268

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

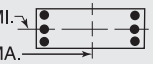


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.73	MA	16334	4200	25959	3435	30896	2772	33248	2252	35437	1415	45007	748	38044
7L-2S		MI	10232	4200	16818	3240	19467	2578	21009	2047	23153	1203	28137	966	20338
14-#18	4.86	MA	20704	5091	36298	3983	44008	3157	49082	2500	56781	1364	73791	571	68767
5L-4S		MI	10066	5091	18715	3718	21557	2910	23449	2209	26430	1048	32535	154	31612
14-#18	4.86	MA	19085	5091	33767	3985	40633	3182	44974	2495	51316	1379	66408	378	64244
6L-3S		MI	10900	5091	19924	3731	23131	2897	25309	2222	28783	1035	35126	357	33367
14-#18	4.86	MA	17497	5091	31303	3987	37372	3181	40990	2517	45776	1368	59839	197	58432
7L-2S		MI	12003	5091	21513	3744	25087	2910	27632	2209	31842	1021	39026	591	34419
16-#11	2.17	MA	18746	3962	28407	3273	34182	2650	37313	2161	41026	1415	51852	1143	35795
4L-6S		MI	8189	3962	13352	3102	15261	2494	16048	2008	16673	1264	20188	784	15669
16-#11	2.17	MA	18011	3962	27278	3285	32828	2651	35660	2171	38774	1422	48924	1095	34759
5E		MI	8516	3962	13806	3106	15850	2489	16746	2013	17567	1259	21267	847	15915
16-#11	2.17	MA	17307	3962	26277	3287	31492	2662	34033	2170	36610	1430	45937	1020	33829
6L-4S		MI	8855	3962	14314	3100	16447	2494	17454	2008	18530	1264	22427	891	16388
16-#11	2.17	MA	16618	3962	25302	3289	30201	2662	32456	2180	34416	1427	43274	950	32600
7L-3S		MI	9227	3962	14814	3104	17108	2489	18235	2013	19518	1259	23524	975	16445
16-#11	2.17	MA	15936	3962	24343	3290	28937	2663	30877	2179	32300	1435	40539	895	31414
8L-2S		MI	9723	3962	15472	3108	17930	2494	19211	2008	20803	1254	25187	1066	16465
16-#14	3.13	MA	19312	4364	30957	3533	37408	2831	41169	2288	46173	1403	59150	943	48240
5E		MI	8948	4364	15383	3336	17697	2642	18914	2095	20406	1189	24972	603	21732
16-#14	3.13	MA	18340	4364	29520	3535	35490	2846	38834	2286	43067	1413	54894	835	46327
6L-4S		MI	9418	4364	16107	3328	18537	2649	19910	2088	21762	1196	26597	666	22267
16-#14	3.13	MA	17388	4364	28121	3537	33638	2847	36571	2300	39919	1408	51101	733	44255
7L-3S		MI	9932	4364	16818	3335	19467	2642	21009	2095	23153	1189	28137	785	23000
16-#14	3.13	MA	16445	4364	26744	3539	31824	2847	34304	2298	36882	1418	47198	654	41559
8L-2S		MI	10619	4364	17754	3342	20624	2649	22383	2088	24962	1181	30467	917	23095
16-#18	5.56	MA	20811	5381	37560	4167	45443	3315	50802	2579	59179	1366	76982	345	74748
6L-4S		MI	10706	5381	20304	3897	23513	3033	25773	2276	29489	1003	36435	54	36108
16-#18	5.56	MA	19260	5381	35097	4169	42183	3314	46818	2601	53639	1354	70412	163	69250
7L-3S		MI	11522	5381	21513	3910	25087	3020	27632	2289	31842	989	39026	257	37724
16-#18	5.56	MA	17724	5381	32671	4171	38988	3312	42827	2597	48293	1369	63618	27	63443
8L-2S		MI	12603	5381	23101	3923	27043	3033	29956	2276	34901	976	42926	490	39119
18-#11	2.44	MA	18737	4076	28787	3356	34742	2702	37979	2203	41903	1417	53201	1086	39096
5L-6S		MI	8483	4076	14011	3173	16083	2544	17025	2037	17957	1250	21851	753	17504
18-#11	2.44	MA	18042	4076	27786	3358	33406	2713	36352	2203	39739	1425	50214	1011	38193
6L-5S		MI	8807	4076	14465	3177	16673	2539	17723	2042	18852	1245	22930	815	17781
18-#11	2.44	MA	17362	4076	26811	3360	32116	2714	34775	2213	37545	1422	47551	940	36923
7L-4S		MI	9143	4076	14973	3171	17269	2544	18430	2037	19815	1250	24090	859	18242
18-#11	2.44	MA	16689	4076	25852	3361	30852	2715	33196	2212	35429	1429	44816	885	35763
8L-3S		MI	9511	4076	15472	3175	17930	2539	19211	2042	20803	1245	25187	943	18383
18-#11	2.44	MA	16020	4076	24793	3373	29549	2726	31642	2222	33334	1437	42101	827	34107
9L-2S		MI	10003	4076	16131	3179	18752	2544	20187	2037	22088	1240	26850	1034	18415
18-#14	3.52	MA	19357	4527	31682	3638	38233	2921	42157	2334	47550	1405	60988	819	52495
6L-5S		MI	9348	4527	16318	3438	18854	2713	20288	2135	22215	1167	27301	554	24378
18-#14	3.52	MA	18421	4527	30284	3640	36381	2921	39894	2347	44402	1400	57196	717	50474
7L-4S		MI	9813	4527	17042	3430	19694	2721	21284	2128	23570	1175	28926	617	24881
18-#14	3.52	MA	17494	4527	28907	3642	34566	2922	37626	2346	41365	1410	53292	639	47747
8L-3S		MI	10321	4527	17754	3437	20624	2713	22383	2135	24962	1167	30467	736	25727
18-#14	3.52	MA	16573	4527	27386	3659	32697	2937	35396	2359	38358	1420	49426	554	45044
9L-2S		MI	11004	4527	18690	3445	21781	2721	23757	2128	26771	1160	32797	868	25846
18-#18	6.25	MA	20985	5672	38890	4351	46993	3447	52647	2686	61502	1341	80986	130	80083
7L-4S		MI	11336	5672	21892	4076	25469	3156	28096	2343	32548	957	40335	-46	40024
18-#18	6.25	MA	19482	5672	36465	4353	43798	3445	48655	2681	56156	1356	74192	-7	74129
8L-3S		MI	12135	5672	23101	4089	27043	3143	29956	2356	34901	944	42926	157	42113
20-#11	2.71	MA	18766	4189	29295	3429	35320	2765	38671	2236	42867	1420	54491	1001	42562
6E		MI	8774	4189	14670	3244	16905	2595	18001	2066	19242	1236	23513	721	19319
20-#11	2.71	MA	18094	4189	28321	3431	34030	2766	37094	2246	40674	1417	51828	930	41251
7L-5S		MI	9094	4189	15123	3248	17495	2590	18699	2071	20137	1231	24593	784	19651

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

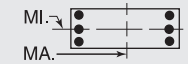
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.71	MA	17430	4189	27362	3432	32766	2766	35515	2245	38558	1424	49093	875	40073
8L-4S		MI	9428	4189	15632	3242	18091	2595	19407	2066	21100	1236	25753	827	20085
20-#11	2.71	MA	16770	4189	26302	3444	31463	2777	33961	2255	36463	1432	46378	817	38438
9L-3S		MI	9792	4189	16131	3246	18752	2590	20187	2071	22088	1231	26850	912	20316
20-#11	2.71	MA	16092	4189	25347	3446	30208	2778	32400	2254	34308	1429	43573	737	36804
10L-2S		MI	10281	4189	16790	3250	19574	2595	21164	2066	23373	1226	28513	1003	20360
20-#14	3.91	MA	19436	4691	32446	3742	39124	2996	43216	2394	48885	1393	63290	702	56698
7L-5S		MI	9770	4691	17254	3541	20011	2785	21662	2176	24024	1145	29631	504	26955
20-#14	3.91	MA	18524	4691	31069	3744	37309	2997	40949	2393	45848	1403	59387	623	53942
8L-4S		MI	10223	4691	17978	3533	20851	2792	22658	2168	25379	1153	31256	568	27504
20-#14	3.91	MA	17617	4691	29548	3761	35439	3012	38719	2407	42841	1413	55520	539	51217
9L-3S		MI	10716	4691	18690	3540	21781	2785	23757	2176	26771	1145	32797	687	28449
20-#14	3.91	MA	16673	4691	28177	3763	33637	3012	36478	2405	39748	1408	51524	423	48432
10L-2S		MI	11372	4691	19626	3547	22938	2792	25132	2168	28579	1138	35126	818	28590
20-#18	6.94	MA	21205	5963	40258	4534	48609	3578	54484	2765	64019	1343	84766	-40	84318
8L-4S		MI	11956	5963	23480	4255	27425	3279	30420	2410	35607	912	44236	-147	43253
22-#11	2.98	MA	18816	4303	29830	3501	35944	2818	39414	2278	43803	1412	56105	920	45584
7L-6S		MI	9061	4303	15329	3315	17727	2645	18977	2095	20527	1223	25176	689	21141
22-#11	2.98	MA	18160	4303	28871	3503	34680	2818	37834	2278	41687	1419	53370	865	44380
8L-5S		MI	9379	4303	15782	3319	18317	2640	19675	2100	21422	1217	26256	752	21524
22-#11	2.98	MA	17508	4303	27811	3515	33377	2829	36280	2288	39591	1427	50655	807	42773
9L-4S		MI	9710	4303	16290	3313	18913	2645	20383	2095	22384	1223	27416	796	21935
22-#11	2.98	MA	16834	4303	26856	3517	32122	2830	34719	2287	37437	1424	47849	727	41123
10L-3S		MI	10071	4303	16790	3317	19574	2640	21164	2100	23373	1217	28513	880	22246
22-#11	2.98	MA	16136	4303	25908	3519	30834	2841	33175	2297	35351	1431	45161	669	39454
11L-2S		MI	10556	4303	17449	3321	20396	2645	22140	2095	24658	1212	30176	971	22302
22-#14	4.30	MA	19536	4854	33232	3846	40052	3071	44272	2440	50331	1395	65481	607	60143
8L-5S		MI	10157	4854	18190	3643	21168	2856	23036	2216	25832	1123	31961	455	29507
22-#14	4.30	MA	18643	4854	31711	3863	38182	3087	42041	2454	47323	1406	61615	523	57396
9L-4S		MI	10603	4854	18914	3635	22007	2864	24032	2209	27188	1131	33586	519	30135
22-#14	4.30	MA	17704	4854	30339	3865	36380	3087	39801	2453	44231	1401	57618	408	54597
10L-3S		MI	11088	4854	19626	3642	22938	2856	25132	2216	28579	1123	35126	638	31168
24-#11	3.25	MA	18880	4416	30380	3574	36594	2870	40153	2311	44815	1414	57646	856	48691
8L-6S		MI	9346	4416	15987	3385	18549	2696	19954	2124	21812	1209	26839	658	22969
24-#11	3.25	MA	18236	4416	29321	3586	35291	2881	38599	2320	42720	1421	54932	797	47112
9L-5S		MI	9661	4416	16441	3390	19139	2691	20651	2129	22707	1204	27919	720	23400
24-#11	3.25	MA	17565	4416	28366	3588	34036	2882	37038	2320	40566	1419	52126	718	45445
10L-4S		MI	9989	4416	16949	3383	19735	2696	21359	2124	23669	1209	29079	764	23790
24-#11	3.25	MA	16875	4416	27417	3590	32748	2893	35494	2330	38479	1426	49438	660	43765
11L-3S		MI	10347	4416	17449	3388	20396	2691	22140	2129	24658	1204	30176	848	24173
24-#11	3.25	MA	16194	4416	26474	3591	31497	2893	33942	2329	36343	1423	46745	602	41995
12L-2S		MI	10828	4416	18108	3392	21218	2696	23116	2124	25943	1198	31839	939	24240
24-#14	4.69	MA	19654	5018	33873	3965	40924	3161	45364	2501	51806	1398	67709	507	63581
9L-5S		MI	10538	5018	19126	3745	22325	2928	24410	2257	27641	1102	34290	406	32070
24-#14	4.69	MA	18719	5018	32502	3967	39122	3162	43123	2500	48714	1393	63712	392	60767
10L-4S		MI	10978	5018	19850	3737	23164	2935	25407	2249	28996	1109	35915	469	32773

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.38	MA	5693	2133	8611	1718	9969	1394	10543	1143	11044	772	13239	697	6931
2L-3S		MI	5129	2133	7881	1715	9047	1388	9447	1149	9602	778	11360	606	6936
6-#14	2.00	MA	6088	2283	9576	1803	11116	1451	11888	1174	12804	747	15491	646	9736
2L-3S		MI	5303	2283	8538	1798	9815	1444	10342	1181	10770	754	12852	514	9667
6-#18	3.55	MA	6997	2665	11922	2024	13866	1596	15121	1247	17039	675	20855	499	16531
2L-3S		MI	5719	2665	10128	2011	11654	1583	12494	1260	13581	688	16407	266	15410
8-#11	1.85	MA	6018	2246	9340	1789	10892	1445	11638	1174	12485	760	15117	669	9109
2L-4S		MI	5051	2246	8059	1783	9228	1445	9667	1174	9934	771	12003	492	8784
8-#14	2.66	MA	6532	2447	10614	1906	12418	1525	13434	1216	14838	728	18131	602	12806
2L-4S		MI	5190	2447	8790	1895	10070	1525	10652	1216	11238	743	13751	348	11597
8-#18	4.73	MA	7693	2956	13716	2205	16078	1723	17749	1318	20498	635	25303	410	21783
2L-4S		MI	5534	2956	10556	2179	12087	1723	13019	1318	14379	662	17911	-34	17774
10-#11	2.31	MA	6335	2360	10070	1860	11814	1497	12734	1204	13927	748	16995	641	11271
2L-5S		MI	5014	2360	8229	1861	9481	1492	9968	1209	10296	753	12571	420	10251
10-#11	2.31	MA	5789	2360	9340	1857	10892	1492	11638	1209	12485	753	15117	550	11219
3L-4S		MI	5383	2360	8789	1854	10151	1497	10762	1204	11376	759	13881	464	10786
10-#14	3.33	MA	6964	2611	11652	2008	13719	1598	14979	1259	16872	709	20770	558	15862
2L-5S		MI	5139	2611	9029	2006	10428	1591	11077	1266	11749	716	14550	241	13450
10-#14	3.33	MA	6210	2611	10614	2002	12418	1591	13434	1266	14838	716	18131	427	15691
3L-4S		MI	5649	2611	9828	1997	11372	1598	12198	1259	13273	724	16391	304	14460
10-#18	5.92	MA	7180	3247	13716	2374	16078	1836	17749	1402	20498	609	25303	87	24919
3L-4S		MI	6287	3247	12350	2361	14299	1849	15647	1389	17837	622	22359	-123	21763

RECTANGULAR TIED COLUMNS 26" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.24	MA	6491	2258	9707	1830	11239	1487	11854	1225	12322	840	14735	766	7242
2E		MI	5993	2258	9035	1816	10370	1473	10900	1211	11285	828	13434	749	6665
4-#18	2.20	MA	7200	2512	11465	1971	13306	1582	14271	1273	15481	793	18764	674	12323
2E		MI	6624	2512	10631	1956	12210	1563	13050	1255	14094	776	16984	648	11290
6-#11	1.29	MA	6558	2271	9783	1848	11381	1501	12068	1237	12616	846	15150	774	7563
2L-3S		MI	5489	2271	8375	1831	9601	1484	10005	1229	10119	840	11945	667	6973
6-#11	1.29	MA	5936	2271	8983	1845	10366	1496	10853	1242	11018	852	13056	682	7568
3L-2S		MI	6055	2271	9105	1834	10523	1489	11101	1224	11561	835	13823	758	6959
6-#14	1.85	MA	7002	2421	10847	1933	12685	1562	13571	1269	14583	823	17686	727	10647
2L-3S		MI	5664	2421	9035	1913	10370	1539	10900	1261	11285	816	13434	574	9724
6-#14	1.85	MA	6136	2421	9707	1928	11239	1555	11854	1277	12322	831	14735	595	10578
3L-2S		MI	6453	2421	10073	1919	11671	1546	12446	1254	13319	809	16074	706	9772
6-#18	3.30	MA	8028	2803	13441	2153	15775	1712	17203	1348	19340	758	23763	594	18151
2L-3S		MI	6060	2803	10631	2124	12210	1676	13050	1339	14094	749	16984	325	15739
6-#18	3.30	MA	6591	2803	11465	2142	13306	1698	14271	1361	15481	772	18764	361	17287
3L-2S		MI	7367	2803	12425	2137	14422	1690	15678	1326	17552	736	21433	559	16586
8-#11	1.71	MA	6920	2384	10584	1919	12397	1553	13283	1269	14215	836	17245	748	9951
2L-4S		MI	5410	2384	8553	1899	9782	1540	10225	1255	10451	833	12588	552	8938
8-#11	1.71	MA	6309	2384	9783	1916	11381	1548	12068	1274	12616	841	15150	657	9925
3E		MI	5824	2384	9105	1902	10523	1535	11101	1260	11561	828	13823	638	9126
8-#11	1.71	MA	5857	2384	9180	1914	10567	1554	11097	1269	11386	846	13776	569	9716
4L-2S		MI	6382	2384	9834	1905	11446	1540	12196	1255	13002	823	15702	729	9141
8-#14	2.47	MA	7498	2585	11987	2035	14131	1637	15289	1314	16843	806	20636	687	14021
2L-4S		MI	5550	2585	9287	2010	10625	1619	11210	1297	11754	804	14334	408	11781
8-#14	2.47	MA	6649	2585	10847	2031	12685	1630	13571	1321	14583	814	17686	556	13898
3E		MI	6125	2585	10073	2015	11671	1612	12446	1304	13319	797	16074	530	12748
8-#14	2.47	MA	6021	2585	9987	2026	11524	1637	12198	1314	12843	821	15746	430	12835
4L-2S		MI	6899	2585	11111	2021	12973	1619	13992	1297	15353	789	18713	662	12849
8-#18	4.40	MA	8822	3094	15416	2335	18244	1841	20136	1422	23199	723	28762	514	23943
2L-4S		MI	5892	3094	11059	2293	12643	1816	13576	1397	14891	723	18489	25	18346
8-#18	4.40	MA	7456	3094	13441	2324	15775	1828	17203	1436	19340	737	23763	280	22512
3E		MI	6831	3094	12425	2306	14422	1803	15678	1411	17552	710	21433	235	20449

RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis

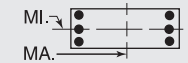
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	4.40	MA	6430	3094	11943	2314	13791	1841	14859	1422	16371	750	20466	64	20072
4L-2S		MI	8074	3094	14219	2319	16634	1816	18305	1397	21010	696	25881	469	21846
10-#11	2.14	MA	7275	2498	11384	1990	13412	1605	14498	1300	15813	825	19340	723	12324
2L-5S		MI	5372	2498	8723	1977	10035	1587	10526	1290	10813	816	13156	481	10384
10-#11	2.14	MA	6672	2498	10584	1987	12397	1600	13283	1305	14215	830	17245	632	12272
3L-4S		MI	5744	2498	9283	1970	10705	1592	11321	1285	11893	821	14466	524	10936
10-#11	2.14	MA	6228	2498	9981	1985	11583	1606	12312	1300	12984	836	15871	544	11916
4L-3S		MI	6152	2498	9834	1973	11446	1587	12196	1290	13002	816	15702	610	11268
10-#11	2.14	MA	5822	2498	9369	1993	10848	1601	11431	1305	11788	830	14410	501	11279
5L-2S		MI	6701	2498	10564	1976	12368	1592	13292	1285	14444	811	17580	701	11308
10-#14	3.09	MA	7982	2748	13128	2137	15577	1712	17007	1358	19103	790	23587	648	17381
2L-5S		MI	5496	2748	9526	2121	10983	1685	11635	1347	12264	778	15133	301	13736
10-#14	3.09	MA	7149	2748	11987	2133	14131	1704	15289	1365	16843	797	20636	517	17209
3L-4S		MI	6011	2748	10325	2112	11927	1693	12756	1339	13788	785	16973	364	14640
10-#14	3.09	MA	6533	2748	11127	2129	12970	1712	13916	1358	15103	805	18697	391	15987
4L-3S		MI	6575	2748	11111	2117	12973	1685	13992	1347	15353	778	18713	487	15762
10-#14	3.09	MA	5973	2748	10253	2139	11921	1704	12671	1365	13411	797	16639	329	14995
5L-2S		MI	7335	2748	12149	2123	14274	1693	15537	1339	17387	770	21353	618	15908
10-#18	5.49	MA	8260	3385	15416	2506	18244	1957	20136	1510	23199	701	28762	200	27806
3L-4S		MI	6648	3385	12853	2475	14855	1943	16204	1468	18350	683	22937	-64	22616
10-#18	5.49	MA	7273	3385	13918	2495	16260	1971	17791	1497	20230	715	25464	-16	25361
4L-3S		MI	7553	3385	14219	2488	16634	1930	18305	1482	21010	670	25881	146	25227
12-#11	2.57	MA	7623	2611	12185	2060	14427	1656	15713	1332	17412	815	21434	698	14688
2L-6S		MI	5353	2611	8953	2044	10296	1644	10839	1315	11251	809	13813	390	11766
12-#11	2.57	MA	7029	2611	11384	2058	13412	1652	14498	1337	15813	820	19340	607	14613
3L-5S		MI	5705	2611	9453	2048	10958	1638	11622	1321	12255	804	15035	452	12436
12-#11	2.57	MA	6591	2611	10782	2056	12598	1658	13527	1332	14583	825	17965	519	14133
4E		MI	6071	2611	10013	2040	11627	1644	12416	1315	13334	809	16345	496	12951
12-#11	2.57	MA	6192	2611	10170	2063	11864	1653	12646	1337	13386	820	16504	476	13537
5L-3S		MI	6473	2611	10564	2044	12368	1638	13292	1321	14444	804	17580	582	13402
12-#11	2.57	MA	5809	2611	9625	2061	11138	1659	11778	1332	12273	825	15141	414	12798
6L-2S		MI	7015	2611	11294	2047	13291	1644	14387	1315	15885	798	19459	673	13464
12-#14	3.71	MA	7637	2912	13128	2235	15577	1779	17007	1410	19103	780	23587	478	20516
3L-5S		MI	5956	2912	10564	2223	12284	1759	13181	1389	14298	759	17772	257	16533
12-#14	3.71	MA	7033	2912	12267	2231	14416	1787	15634	1402	17364	788	21648	352	19160
4E		MI	6461	2912	11363	2214	13228	1766	14301	1382	15822	766	19613	320	17519
12-#14	3.71	MA	6484	2912	11393	2241	13367	1779	14389	1410	15671	780	19590	290	18088
5L-3S		MI	7015	2912	12149	2220	14274	1759	15537	1389	17387	759	21353	443	18770
12-#14	3.71	MA	5956	2912	10614	2237	12330	1787	13161	1402	14097	788	17670	200	16876
6L-2S		MI	7762	2912	13187	2225	15576	1766	17083	1382	19422	751	23992	574	18957
12-#18	6.59	MA	8088	3675	15894	2677	18729	2100	20723	1572	24088	680	30463	-97	29820
4E		MI	7380	3675	14647	2657	17067	2069	18831	1540	21808	644	27385	-154	26520
14-#11	3.00	MA	7378	2724	12185	2129	14427	1704	15713	1368	17412	809	21434	582	16950
3L-6S		MI	5684	2724	9683	2115	11219	1695	11935	1346	12693	797	15692	362	13776
14-#11	3.00	MA	6947	2724	11582	2126	13613	1710	14742	1363	16182	814	20060	493	16363
4L-5S		MI	6031	2724	10182	2118	11880	1690	12717	1351	13696	792	16913	424	14496
14-#11	3.00	MA	6554	2724	10970	2134	12879	1705	13861	1368	14985	809	18599	451	15802
5L-4S		MI	6392	2724	10742	2111	12550	1695	13512	1346	14776	797	18223	467	14978
14-#11	3.00	MA	6177	2724	10425	2132	12153	1711	12993	1363	13872	814	17235	389	15013
6L-3S		MI	6789	2724	11294	2115	13291	1690	14387	1351	15885	792	19459	554	15532
14-#11	3.00	MA	5807	2724	9894	2129	11451	1707	12151	1368	12781	820	15839	305	14249
7L-2S		MI	7324	2724	12023	2118	14213	1695	15483	1346	17327	786	21337	645	15614

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

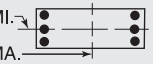
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	4.33	MA	7523	3076	13407	2333	15862	1861	17352	1447	19624	771	24598	313	22350
4L-5S		MI	6434	3076	11602	2326	13586	1832	14727	1432	16332	740	20412	214	19350
14-#14	4.33	MA	6984	3076	12534	2344	14813	1854	16106	1454	17931	764	22540	251	21199
5L-4S		MI	6926	3076	12401	2316	14530	1839	15847	1424	17856	747	22253	276	20414
14-#14	4.33	MA	6466	3076	11754	2339	13776	1862	14879	1447	16358	771	20621	161	19990
6L-3S		MI	7461	3076	13187	2322	15576	1832	17083	1432	19422	740	23992	399	21774
16-#11	3.43	MA	7297	2838	12383	2197	14629	1762	15957	1395	17780	804	22155	468	18604
4L-6S		MI	6010	2838	10413	2186	12141	1747	13030	1376	14134	785	17570	334	15794
16-#11	3.43	MA	6910	2838	11771	2205	13894	1757	15076	1400	16583	799	20694	426	18073
5E		MI	6352	2838	10912	2189	12803	1742	13813	1381	15138	779	18792	396	16562
16-#11	3.43	MA	6538	2838	11226	2203	13168	1763	14208	1395	15470	804	19330	364	17238
6L-4S		MI	6708	2838	11472	2182	13472	1747	14607	1376	16217	785	20102	439	17016
16-#11	3.43	MA	6174	2838	10694	2200	12466	1758	13366	1400	14379	809	17933	280	16441
7L-3S		MI	7099	2838	12023	2185	14213	1742	15483	1381	17327	779	21337	526	17658
16-#14	4.95	MA	7508	3239	13674	2446	16259	1929	17824	1498	20192	747	25491	212	24327
5E		MI	6875	3239	12640	2428	14887	1905	16272	1474	18367	721	23051	170	22182
16-#14	4.95	MA	7002	3239	12894	2442	15222	1936	16597	1491	18618	754	23572	122	23075
6L-4S		MI	7355	3239	13439	2419	15831	1913	17393	1467	19890	728	24892	233	23322
18-#11	3.86	MA	7260	2951	12572	2276	14910	1809	16291	1431	18182	788	22789	400	20350
5L-6S		MI	6330	2951	11142	2257	13064	1798	14126	1406	15576	773	19449	306	17821
18-#11	3.86	MA	6893	2951	12026	2274	14184	1815	15423	1426	17069	793	21425	338	19470
6L-5S		MI	6668	2951	11642	2260	13725	1793	14908	1412	16579	767	20670	368	18623
18-#11	3.86	MA	6535	2951	11495	2271	13482	1810	14581	1431	15978	799	20028	255	18642
7L-4S		MI	7020	2951	12202	2253	14395	1798	15703	1406	17659	773	21980	411	19063
18-#14	5.56	MA	7493	3403	14035	2544	16668	2011	18315	1535	20878	738	26523	83	26172
6L-5S		MI	7306	3403	13678	2530	16189	1979	17818	1517	20401	702	25691	126	25029
20-#11	4.29	MA	7244	3065	12827	2345	15199	1867	16638	1458	18667	783	23519	313	21709
6E		MI	6647	3065	11872	2328	13986	1850	15221	1437	17017	760	21327	278	19855
20-#11	4.29	MA	6890	3065	12295	2342	14497	1862	15796	1463	17577	788	22123	230	20849
7L-5S		MI	6980	3065	12371	2331	14648	1845	16004	1442	18021	755	22548	340	20622
22-#11	4.71	MA	7240	3178	13096	2413	15512	1914	17011	1495	19175	777	24217	205	23064
7L-6S		MI	6987	3178	12602	2399	14909	1902	16317	1467	18459	748	23206	249	21895

RECTANGULAR TIED COLUMNS 26" x 30"

4-#14	1.15	MA	7407	2396	10941	1960	12715	1594	13451	1318	13959	913	16717	841	7850
2E		MI	6354	2396	9532	1931	10924	1567	11458	1292	11800	889	14017	809	6694
4-#18	2.05	MA	8199	2650	12867	2101	15042	1693	16136	1369	17466	871	21223	757	13403
2E		MI	6988	2650	11134	2069	12766	1657	13607	1334	14607	837	17562	707	11333
6-#11	1.20	MA	7478	2409	11021	1977	12866	1607	13680	1330	14273	920	17160	848	8194
2L-3S		MI	5849	2409	8869	1947	10155	1579	10563	1310	10636	902	12530	727	7008
6-#11	1.20	MA	6799	2409	10149	1975	11761	1604	12345	1336	12517	925	14849	757	8200
3L-2S		MI	6417	2409	9599	1950	11077	1584	11659	1305	12077	897	14408	818	6987
6-#14	1.73	MA	7973	2559	12183	2062	14291	1668	15342	1364	16446	898	19979	806	11558
2L-3S		MI	6024	2559	9532	2028	10924	1633	11458	1342	11800	878	14017	634	9777
6-#14	1.73	MA	7024	2559	10941	2059	12715	1662	13451	1372	13959	906	16717	674	11490
3L-2S		MI	6816	2559	10570	2034	12226	1641	13004	1334	13835	870	16656	765	9806
6-#18	3.08	MA	9119	2941	15024	2282	17769	1826	19374	1447	21727	840	26774	685	19771
2L-3S		MI	6421	2941	11134	2238	12766	1770	13607	1419	14607	810	17562	384	16060
6-#18	3.08	MA	7541	2941	12867	2274	15042	1812	16136	1460	17466	853	21223	451	19215
3L-2S		MI	7737	2941	12928	2251	14978	1783	16235	1406	18065	797	22010	618	16640
8-#11	1.60	MA	7880	2522	11892	2048	13971	1659	15015	1363	16028	910	19472	826	10793
2L-4S		MI	5769	2522	9047	2015	10336	1636	10783	1336	10968	895	13173	612	9086
8-#11	1.60	MA	7211	2522	11021	2046	12866	1655	13680	1368	14273	916	17160	735	10768
3E		MI	6185	2522	9599	2018	11077	1631	11659	1341	12077	890	14408	699	9167

RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

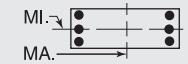
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.60	MA	6718	2522	10366	2044	11982	1662	12613	1363	12879	910	15647	644	10637
4L-2S		MI	6745	2522	10328	2021	12000	1636	12754	1336	13519	885	16287	790	9172
8-#14	2.31	MA	8523	2723	13426	2164	15867	1743	17232	1410	18933	884	23242	770	15236
2L-4S		MI	5909	2723	9784	2125	11180	1714	11768	1377	12269	866	14916	468	11959
8-#14	2.31	MA	7593	2723	12183	2161	14291	1737	15342	1417	16446	891	19979	639	15113
3E		MI	6488	2723	10570	2130	12226	1707	13004	1384	13835	859	16656	590	12808
8-#14	2.31	MA	6908	2723	11248	2158	13029	1746	13831	1410	14532	899	17840	511	14094
4L-2S		MI	7265	2723	11608	2136	13527	1714	14549	1377	15869	851	19296	722	12890
8-#18	4.10	MA	10008	3232	17182	2464	20495	1958	22612	1525	25987	808	32325	612	26103
2L-4S		MI	6250	3232	11562	2407	13199	1910	14133	1477	15404	784	19067	84	18582
8-#18	4.10	MA	8474	3232	15024	2456	17769	1945	19374	1538	21727	822	26774	379	24947
3E		MI	7198	3232	12928	2420	14978	1897	16235	1490	18065	771	22010	295	20759
8-#18	4.10	MA	7343	3232	13394	2447	15578	1958	16786	1525	18448	835	23122	157	22070
4L-2S		MI	8452	3232	14722	2433	17190	1910	18862	1477	21523	757	26458	528	21906
10-#11	2.00	MA	8272	2636	12764	2119	15076	1711	16349	1396	17784	901	21783	803	13377
2L-5S		MI	5730	2636	9217	2093	10589	1682	11085	1371	11330	878	13741	541	10511
10-#11	2.00	MA	7613	2636	11892	2117	13971	1707	15015	1401	16028	906	19472	712	13325
3L-4S		MI	6104	2636	9777	2085	11259	1687	11879	1366	12410	883	15051	584	11081
10-#11	2.00	MA	7128	2636	11238	2115	13087	1714	13948	1396	14634	901	17958	622	13063
4L-3S		MI	6514	2636	10328	2089	12000	1682	12754	1371	13519	878	16287	670	11313
10-#11	2.00	MA	6687	2636	10574	2124	12291	1710	12981	1401	13363	906	16346	580	12318
5L-2S		MI	7067	2636	11058	2092	12922	1687	13850	1366	14961	873	18165	761	11343
10-#14	2.88	MA	9058	2886	14668	2266	17442	1818	19122	1456	21420	869	26505	735	18899
2L-5S		MI	5853	2886	10023	2236	11537	1780	12193	1427	12780	840	15715	361	14015
10-#14	2.88	MA	8146	2886	13426	2263	15867	1812	17232	1463	18933	876	23242	604	18728
3L-4S		MI	6372	2886	10822	2227	12481	1787	13313	1420	14303	847	17556	424	14814
10-#14	2.88	MA	7474	2886	12491	2260	14604	1821	15722	1456	17019	884	21103	475	17536
4L-3S		MI	6940	2886	11608	2233	13527	1780	14549	1427	15869	840	19296	546	15828
10-#14	2.88	MA	6864	2886	11542	2272	13466	1815	14351	1463	15157	876	18827	414	16577
5L-2S		MI	7704	2886	12646	2238	14829	1787	16095	1420	17903	832	21935	678	15953
10-#18	5.13	MA	9402	3522	17182	2637	20495	2077	22612	1616	25987	791	32325	306	30749
3L-4S		MI	7010	3522	13356	2589	15411	2036	16760	1548	18862	744	23515	-5	23488
10-#18	5.13	MA	8319	3522	15552	2629	18305	2090	20024	1603	22708	804	28673	85	28087
4L-3S		MI	7924	3522	14722	2602	17190	2023	18862	1561	21523	731	26458	205	25528
10-#18	5.13	MA	7320	3522	13896	2647	16327	2077	17676	1616	19518	791	24802	-26	24697
5L-2S		MI	9139	3522	16516	2615	19402	2036	21490	1548	24981	718	30906	439	27149
12-#11	2.40	MA	8657	2749	13635	2190	16181	1763	17684	1428	19540	892	24095	781	15952
2L-6S		MI	5710	2749	9447	2160	10850	1739	11397	1396	11768	871	14398	450	11965
12-#11	2.40	MA	8007	2749	12764	2188	15076	1759	16349	1433	17784	897	21783	689	15877
3L-5S		MI	6064	2749	9947	2163	11512	1734	12180	1402	12772	866	15619	513	12562
12-#11	2.40	MA	7529	2749	12109	2186	14193	1766	15283	1428	16390	892	20270	599	15480
4E		MI	6433	2749	10507	2156	12181	1739	12974	1396	13851	871	16930	556	13093
12-#11	2.40	MA	7095	2749	11446	2195	13396	1762	14315	1433	15119	897	18658	557	14779
5L-3S		MI	6837	2749	11058	2160	12922	1734	13850	1402	14961	866	18165	642	13452
12-#11	2.40	MA	6679	2749	10855	2193	12609	1769	13362	1428	13896	902	17045	481	14058
6L-2S		MI	7382	2749	11788	2163	13845	1739	14945	1396	16402	861	20044	733	13503
12-#14	3.46	MA	8686	3050	14668	2365	17442	1887	19122	1509	21420	862	26505	568	22339
3L-5S		MI	6315	3050	11061	2339	12839	1853	13739	1470	14814	821	18355	317	16806
12-#14	3.46	MA	8027	3050	13733	2362	16180	1896	17612	1502	19506	869	24365	440	20999
4E		MI	6824	3050	11860	2329	13783	1861	14859	1462	16338	828	20196	380	17689
12-#14	3.46	MA	7428	3050	12785	2374	15042	1889	16242	1509	17644	862	22090	379	19961
5L-3S		MI	7382	3050	12646	2335	14829	1853	16095	1470	17903	821	21935	503	18841
12-#14	3.46	MA	6853	3050	11939	2371	13916	1898	14891	1502	15912	869	19965	289	18546
6L-2S		MI	8134	3050	13684	2340	16131	1861	17641	1462	19937	813	24575	634	19006

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis

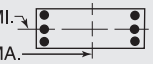


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	6.15	MA	9223	3813	17709	2811	21031	2222	23262	1680	26969	773	34224	12	34137
4E		MI	7745	3813	15150	2770	17623	2163	19388	1619	22321	705	27963	-95	27419
12-#18	6.15	MA	8261	3813	16053	2829	19053	2209	20914	1694	23778	760	30353	-98	29820
5L-3S		MI	8630	3813	16516	2783	19402	2150	21490	1632	24981	691	30906	116	30353
14-#11	2.80	MA	8393	2862	13635	2259	16181	1811	17684	1466	19540	888	24095	667	18424
3L-6S		MI	6043	2862	10177	2231	11773	1791	12493	1427	13209	859	16277	422	13972
14-#11	2.80	MA	7923	2862	12981	2257	15298	1818	16618	1461	18146	883	22581	577	17911
4L-5S		MI	6392	2862	10676	2234	12434	1785	13276	1432	14213	854	17498	484	14621
14-#11	2.80	MA	7495	2862	12317	2266	14501	1814	15650	1466	16875	888	20969	534	17249
5L-4S		MI	6756	2862	11236	2227	13104	1791	14070	1427	15293	859	18808	528	15119
14-#11	2.80	MA	7085	2862	11726	2264	13714	1821	14697	1461	15652	893	19357	458	16476
6L-3S		MI	7155	2862	11788	2230	13845	1785	14945	1432	16402	854	20044	614	15585
14-#11	2.80	MA	6683	2862	11150	2262	12953	1817	13772	1466	14411	888	17927	388	15720
7L-2S		MI	7693	2862	12517	2234	14767	1791	16041	1427	17844	849	21922	705	15655
14-#14	4.04	MA	8568	3214	14976	2464	17756	1970	19502	1548	21993	854	27628	405	24480
4L-5S		MI	6767	3214	12099	2441	14140	1927	15284	1512	16848	802	20994	273	19617
14-#14	4.04	MA	7981	3214	14027	2476	16617	1964	18132	1555	20131	847	25353	343	23363
5L-4S		MI	7268	3214	12898	2431	15085	1934	16405	1505	18372	809	22835	336	20581
14-#14	4.04	MA	7416	3214	13182	2473	15492	1973	16781	1548	18399	854	23228	254	22011
6L-3S		MI	7817	3214	13684	2437	16131	1927	17641	1512	19937	802	24575	459	21849
14-#18	7.18	MA	9172	4104	18211	3011	21780	2341	24152	1771	28039	728	35904	-171	34763
5L-4S		MI	8462	4104	16944	2952	19835	2290	22015	1690	25779	665	32411	-184	31248
16-#11	3.20	MA	8310	2976	13852	2328	16403	1870	17952	1493	19902	873	24893	554	20353
4L-6S		MI	6370	2976	10907	2302	12695	1842	13588	1457	14651	847	18155	394	15987
16-#11	3.20	MA	7888	2976	13189	2337	15607	1866	16985	1498	18631	878	23281	512	19725
5E		MI	6715	2976	11406	2305	13357	1837	14371	1462	15655	842	19376	456	16686
16-#11	3.20	MA	7484	2976	12598	2335	14820	1873	16032	1493	17408	884	21668	436	18903
6L-4S		MI	7074	2976	11966	2298	14026	1842	15165	1457	16734	847	20686	499	17155
16-#11	3.20	MA	7087	2976	12022	2333	14058	1869	15106	1498	16167	878	20239	365	18115
7L-3S		MI	7467	2976	12517	2301	14767	1837	16041	1462	17844	842	21922	586	17714
16-#14	4.62	MA	8522	3377	15270	2578	18193	2039	20022	1601	22618	832	28616	308	26781
5E		MI	7240	3377	13137	2543	15442	2000	16830	1555	18882	783	23634	230	22445
16-#14	4.62	MA	7968	3377	14424	2575	17068	2048	18672	1593	20886	840	26491	219	25489
6L-4S		MI	7726	3377	13936	2534	16386	2008	17951	1547	20406	790	25475	292	23487
18-#11	3.60	MA	8275	3089	14060	2407	16712	1918	18320	1531	20387	869	25593	489	22207
5L-6S		MI	6692	3089	11636	2373	13618	1894	14684	1487	16092	835	20034	366	18011
18-#11	3.60	MA	7876	3089	13469	2406	15925	1925	17366	1526	19164	874	23980	413	21338
6L-5S		MI	7032	3089	12136	2376	14279	1889	15467	1493	17096	830	21255	428	18757
18-#11	3.60	MA	7485	3089	12893	2404	15164	1921	16441	1531	17923	869	22550	343	20518
7L-4S		MI	7387	3089	12696	2369	14949	1894	16261	1487	18176	835	22565	471	19199
18-#14	5.19	MA	8556	3541	15667	2677	18643	2123	20562	1639	23373	825	29754	183	28912
6L-5S		MI	7674	3541	14175	2645	16743	2073	18376	1597	20916	764	26273	186	25287
20-#11	4.00	MA	8262	3203	14340	2477	17030	1976	18701	1558	20920	865	26291	391	23781
6E		MI	7010	3203	12366	2444	14540	1945	15779	1518	17534	823	21912	338	20043
20-#11	4.00	MA	7877	3203	13765	2475	16269	1973	17776	1563	19679	860	24862	320	22929
7L-5S		MI	7346	3203	12865	2447	15202	1940	16562	1523	18538	818	23133	400	20831
22-#11	4.40	MA	8263	3316	14636	2546	17374	2025	19111	1596	21435	851	27173	297	25347
7L-6S		MI	7323	3316	13096	2515	15463	1997	16875	1548	18975	811	23791	310	22080

RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis



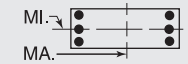
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.08	MA	8379	2534	12239	2089	14273	1700	15136	1411	15679	986	18796	915	8457
2E		MI	6715	2534	10029	2047	11479	1662	12016	1372	12316	951	14599	869	6723
4-#18	1.92	MA	9255	2788	14333	2230	16824	1801	18089	1465	19536	947	23781	838	14483
2E		MI	7352	2788	11637	2183	13322	1750	14164	1414	15119	898	18140	766	11376
6-#11	1.13	MA	8455	2547	12323	2106	14432	1714	15358	1422	16012	992	19268	922	8826
2L-3S		MI	6208	2547	9363	2063	10709	1674	11122	1391	11153	964	13115	787	7040
6-#11	1.13	MA	7718	2547	11380	2105	13237	1711	13910	1428	14099	998	16739	831	8832
3L-2S		MI	6778	2547	10092	2066	11631	1679	12217	1386	12594	959	14993	878	7013
6-#14	1.62	MA	9001	2697	13584	2191	15978	1775	17199	1458	18393	973	22372	883	12469
2L-3S		MI	6384	2697	10029	2143	11479	1728	12016	1422	12316	940	14599	694	9826
6-#14	1.62	MA	7969	2697	12239	2189	14273	1770	15136	1466	15679	980	18796	751	12401
3L-2S		MI	7179	2697	11067	2149	12781	1736	13561	1415	14350	932	17239	825	9840
6-#18	2.88	MA	10268	3079	16673	2412	19791	1934	21633	1545	24199	919	29887	772	21391
2L-3S		MI	6782	3079	11637	2352	13322	1864	14164	1498	15119	871	18140	443	16373
6-#18	2.88	MA	8549	3079	14333	2405	16824	1923	18089	1559	19536	932	23781	538	20902
3L-2S		MI	8105	3079	13431	2365	15534	1877	16792	1485	18577	858	22588	677	16692
8-#11	1.50	MA	8895	2660	13265	2177	15627	1765	16806	1455	17926	984	21797	902	11636
2L-4S		MI	6128	2660	9541	2130	10890	1731	11341	1417	11485	957	13757	672	9143
8-#11	1.50	MA	8169	2660	12323	2176	14432	1762	15358	1460	16012	989	19268	811	11610
3E		MI	6546	2660	10092	2134	11631	1726	12217	1422	12594	952	14993	759	9205
8-#11	1.50	MA	7636	2660	11617	2175	13479	1770	14203	1456	14494	984	17613	719	11479
4L-2S		MI	7108	2660	10822	2137	12554	1731	13313	1417	14036	947	16872	850	9202
8-#14	2.16	MA	9604	2861	14929	2293	17683	1850	19262	1506	21107	960	25948	851	16451
2L-4S		MI	6268	2861	10281	2240	11735	1809	12325	1457	12785	928	15499	527	12132
8-#14	2.16	MA	8593	2861	13584	2291	15978	1845	17199	1513	18393	967	22372	720	16328
3E		MI	6850	2861	11067	2245	12781	1801	13561	1465	14350	921	17239	650	12864
8-#14	2.16	MA	7851	2861	12575	2289	14615	1855	15551	1506	16239	960	20032	589	15372
4L-2S		MI	7631	2861	12105	2251	14082	1809	15107	1457	16384	913	19878	781	12929
8-#18	3.85	MA	11246	3370	19012	2593	22757	2067	25177	1626	28862	891	35992	706	28263
2L-4S		MI	6608	3370	12065	2521	13756	2003	14690	1556	15917	845	19645	143	18811
8-#18	3.85	MA	9574	3370	16673	2587	19791	2056	21633	1639	24199	905	29887	473	27434
3E		MI	7565	3370	13431	2534	15534	1990	16792	1569	18577	832	22588	354	21062
8-#18	3.85	MA	8346	3370	14910	2580	17411	2070	18800	1626	20610	918	25879	247	24094
4L-2S		MI	8829	3370	15225	2547	17746	2003	19419	1556	22036	819	27036	587	21965
10-#11	1.87	MA	9326	2773	14207	2248	16822	1817	18254	1488	19840	976	24326	881	14430
2L-5S		MI	6089	2773	9711	2208	11143	1777	11643	1452	11847	940	14326	601	10633
10-#11	1.87	MA	8610	2773	13265	2247	15627	1814	16806	1493	17926	981	21797	790	14378
3L-4S		MI	6465	2773	10271	2201	11813	1783	12437	1447	12926	945	15636	644	11222
10-#11	1.87	MA	8085	2773	12559	2246	14674	1822	15651	1489	16407	976	20142	699	14215
4L-3S		MI	6877	2773	10822	2204	12554	1777	13313	1452	14036	940	16872	731	11356
10-#11	1.87	MA	7608	2773	11844	2255	13815	1819	14603	1494	15021	981	18381	657	13367
5L-2S		MI	7431	2773	11552	2208	13476	1783	14408	1447	15477	935	18750	822	11378
10-#14	2.70	MA	10193	3024	16273	2396	19389	1924	21325	1553	23821	947	29524	819	20418
2L-5S		MI	6211	3024	10520	2351	12092	1875	12751	1507	13295	902	16297	421	14287
10-#14	2.70	MA	9200	3024	14929	2393	17683	1919	19262	1560	21107	954	25948	688	20247
3L-4S		MI	6732	3024	11319	2342	13036	1882	13871	1500	14819	909	18138	484	14982
10-#14	2.70	MA	8472	3024	13919	2391	16321	1929	17614	1553	18953	947	23607	557	19104
4L-3S		MI	7304	3024	12105	2348	14082	1875	15107	1507	16384	902	19878	606	15890
10-#14	2.70	MA	7811	3024	12896	2404	15092	1924	16119	1560	16987	954	21114	496	18074
5L-2S		MI	8073	3024	13143	2353	15384	1882	16653	1500	18418	894	22518	738	15997
10-#18	4.81	MA	10604	3660	19012	2768	22757	2189	25177	1719	28862	877	35992	407	33745
3L-4S		MI	7372	3660	13859	2702	15968	2130	17317	1627	19375	805	24093	54	23769

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis

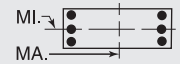


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	4.81	MA	9425	3660	17250	2762	20378	2203	22345	1706	25273	890	31985	181	30633
4L-3S		MI	8295	3660	15225	2715	17746	2117	19419	1641	22036	792	27036	264	25822
10-#18	4.81	MA	8338	3660	15461	2782	18231	2191	19775	1719	21782	877	27727	71	27358
5L-2S		MI	9521	3660	17019	2728	19958	2130	22046	1627	25494	779	31484	498	27214
12-#11	2.25	MA	9748	2887	15150	2319	18017	1869	19702	1520	21753	968	26855	861	17215
2L-6S		MI	6068	2887	9941	2276	11404	1834	11955	1477	12285	933	14983	510	12158
12-#11	2.25	MA	9042	2887	14207	2318	16822	1866	18254	1526	19840	973	24326	770	17140
3L-5S		MI	6424	2887	10441	2279	12066	1829	12738	1482	13288	928	16204	573	12683
12-#11	2.25	MA	8525	2887	13502	2317	15869	1874	17098	1521	18321	968	22671	679	16844
4E		MI	6795	2887	11001	2272	12735	1834	13532	1477	14368	933	17514	616	13232
12-#11	2.25	MA	8055	2887	12786	2326	15010	1871	16051	1527	16935	973	20910	636	16032
5L-3S		MI	7201	2887	11552	2275	13476	1829	14408	1482	15477	928	18750	702	13499
12-#11	2.25	MA	7605	2887	12150	2325	14162	1878	15019	1522	15602	978	19145	560	15339
6L-2S		MI	7749	2887	12282	2279	14399	1834	15504	1477	16919	923	20629	794	13540
12-#14	3.25	MA	9793	3188	16273	2496	19389	1994	21325	1607	23821	941	29524	656	24161
3L-5S		MI	6674	3188	11558	2454	13394	1948	14296	1550	15329	883	18937	377	17073
12-#14	3.25	MA	9079	3188	15264	2493	18026	2004	19677	1600	21667	934	27183	525	22859
4E		MI	7187	3188	12357	2444	14338	1956	15417	1543	16853	890	20778	440	17855
12-#14	3.25	MA	8430	3188	14241	2506	16798	1999	18182	1607	19701	941	24690	464	21870
5L-3S		MI	7749	3188	13143	2450	15384	1948	16653	1550	18418	883	22518	562	18908
12-#14	3.25	MA	7808	3188	13330	2504	15584	2009	16708	1600	17811	949	22195	355	20241
6L-2S		MI	8506	3188	14181	2455	16685	1956	18198	1543	20453	875	25157	694	19053
12-#18	5.77	MA	10419	3951	19589	2944	23345	2336	25889	1786	29936	863	38090	115	37206
4E		MI	8110	3951	15653	2884	18180	2257	19945	1699	22833	766	28541	-36	28317
12-#18	5.77	MA	9372	3951	17800	2964	21198	2324	23320	1800	26445	849	33832	6	33801
5L-3S		MI	9005	3951	17019	2897	19958	2243	22046	1712	25494	752	31484	175	30639
14-#11	2.63	MA	9465	3000	15150	2389	18017	1918	19702	1559	21753	965	26855	749	19898
3L-6S		MI	6402	3000	10671	2347	12327	1886	13051	1508	13726	921	16861	482	14161
14-#11	2.63	MA	8956	3000	14444	2388	17064	1926	18546	1554	20234	960	25199	658	19476
4L-5S		MI	6753	3000	11170	2350	12988	1881	13834	1513	14730	916	18083	545	14741
14-#11	2.63	MA	8494	3000	13729	2397	16205	1923	17499	1560	18848	965	23438	616	18706
5L-4S		MI	7119	3000	11730	2343	13658	1886	14628	1508	15810	921	19393	588	15255
14-#11	2.63	MA	8050	3000	13092	2396	15357	1930	16467	1555	17516	970	21674	540	17960
6L-3S		MI	7520	3000	12282	2346	14399	1881	15504	1513	16919	916	20629	674	15635
14-#11	2.63	MA	7615	3000	12472	2394	14537	1927	15465	1561	16164	965	20111	469	17145
7L-2S		MI	8062	3000	13011	2350	15321	1886	16599	1508	18360	911	22507	765	15695
14-#14	3.79	MA	9672	3351	16609	2595	19731	2079	21740	1647	24381	921	30759	493	26632
4L-5S		MI	7128	3351	12596	2556	14695	2021	15842	1593	17363	863	21577	333	19878
14-#14	3.79	MA	9035	3351	15586	2608	18503	2074	20245	1654	22415	928	28265	433	25564
5L-4S		MI	7633	3351	13395	2547	15639	2029	16963	1585	18887	871	23418	396	20744
14-#14	3.79	MA	8424	3351	14674	2606	17290	2084	18771	1647	20525	936	25771	323	24002
6L-3S		MI	8186	3351	14181	2552	16685	2021	18198	1593	20453	863	25157	519	21921
14-#14	3.79	MA	7826	3351	13786	2603	16116	2079	17341	1654	18607	928	23560	221	22285
7L-2S		MI	8932	3351	15219	2558	17987	2029	19744	1585	22487	856	27797	650	22100
14-#18	6.73	MA	10372	4242	20139	3145	24165	2457	26864	1880	31109	822	39938	-60	39491
5L-4S		MI	8830	4242	17447	3066	20392	2383	22572	1770	26292	726	32989	-125	32188
16-#11	3.00	MA	9380	3114	15386	2458	18259	1977	19994	1587	22148	952	27728	638	22119
4L-6S		MI	6730	3114	11400	2418	13249	1937	14146	1538	15168	909	18740	454	16175
16-#11	3.00	MA	8924	3114	14671	2468	17400	1974	18947	1593	20762	957	25967	596	21388
5E		MI	7077	3114	11900	2421	13911	1932	14929	1543	16172	904	19961	516	16806
16-#11	3.00	MA	8486	3114	14034	2466	16552	1982	17915	1588	19429	962	24203	520	20591
6L-4S		MI	7438	3114	12460	2414	14580	1937	15723	1538	17251	909	21271	560	17289
16-#11	3.00	MA	8058	3114	13414	2465	15732	1979	16913	1594	18078	957	22640	448	19805
7L-3S		MI	7835	3114	13011	2417	15321	1932	16599	1543	18360	904	22507	646	17767
16-#11	3.00	MA	7634	3114	12803	2464	14928	1976	15910	1589	16774	962	20997	399	18699
8L-2S		MI	8370	3114	13741	2420	16244	1937	17695	1538	19802	899	24385	737	17845
16-#14	4.33	MA	9629	3515	16930	2710	20208	2149	22308	1702	25129	915	31841	401	29274
5E		MI	7605	3515	13634	2658	15997	2095	17388	1635	19398	844	24216	289	22701

RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

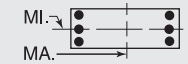
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	4.33	MA	9029	3515	16019	2708	18995	2159	20834	1694	23239	923	29347	291	27774
6L-4S		MI	8095	3515	14433	2649	16941	2102	18508	1628	20921	852	26057	352	23648
16-#14	4.33	MA	8441	3515	15131	2706	17821	2154	19404	1702	21321	915	27136	189	26017
7L-3S		MI	8629	3515	15219	2654	17987	2095	19744	1635	22487	844	27797	475	24930
18-#11	3.37	MA	9347	3227	15613	2539	18596	2026	20394	1626	22675	949	28496	575	24075
5L-6S		MI	7053	3227	12130	2489	14172	1989	15242	1568	16609	897	20618	426	18196
18-#11	3.37	MA	8916	3227	14977	2537	17747	2034	19362	1621	21343	954	26732	499	23229
6L-5S		MI	7396	3227	12630	2492	14833	1984	16025	1574	17613	892	21840	488	18876
18-#11	3.37	MA	8493	3227	14356	2536	16927	2031	18361	1627	19991	949	25169	428	22428
7L-4S		MI	7753	3227	13190	2485	15503	1989	16819	1568	18693	897	23150	531	19332
18-#11	3.37	MA	8075	3227	13745	2535	16123	2028	17357	1622	18687	954	23526	378	21338
8L-3S		MI	8145	3227	13741	2488	16244	1984	17695	1574	19802	892	24385	618	19896
18-#14	4.87	MA	9622	3679	17364	2810	20700	2233	22897	1741	25953	910	32922	259	31557
6L-5S		MI	8041	3679	14672	2760	17298	2168	18934	1678	21432	825	26856	246	25539
18-#14	4.87	MA	9044	3679	16476	2808	19527	2228	21467	1749	24035	902	30712	157	29761
7L-4S		MI	8522	3679	15471	2751	18242	2176	20054	1670	22956	833	28697	308	26562
20-#11	3.75	MA	9339	3341	15919	2608	18942	2086	20810	1654	23256	946	29260	479	25875
6E		MI	7372	3341	12860	2559	15094	2041	16337	1599	18051	885	22497	398	20225
20-#11	3.75	MA	8922	3341	15299	2607	18122	2083	19809	1660	21905	940	27698	407	25042
7L-5S		MI	7711	3341	13359	2563	15756	2035	17120	1604	19055	880	23718	460	20950
20-#11	3.75	MA	8510	3341	14688	2606	17318	2080	18805	1655	20601	946	26055	358	23984
8L-4S		MI	8064	3341	13919	2556	16425	2041	17914	1599	20134	885	25028	503	21382
20-#14	5.41	MA	9696	3842	17820	2910	21232	2303	23530	1796	26750	889	34288	125	33514
7L-5S		MI	8470	3842	15710	2863	18600	2241	20479	1720	23466	806	29495	202	28390
22-#11	4.13	MA	9344	3454	16241	2678	19318	2135	21257	1692	23818	932	30227	387	27664
7L-6S		MI	7687	3454	13590	2630	16017	2092	17433	1629	19492	873	24375	370	22260
22-#11	4.13	MA	8937	3454	15630	2677	18514	2132	20253	1688	22514	937	28583	338	26634
8L-5S		MI	8022	3454	14089	2634	16678	2087	18216	1634	20496	868	25597	432	23027
24-#11	4.50	MA	9360	3567	16572	2748	19709	2184	21701	1721	24428	929	31112	317	29290
8L-6S		MI	8030	3567	14319	2701	16939	2144	18529	1659	20934	861	26254	342	24301

RECTANGULAR TIED COLUMNS 26" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.02	MA	9406	2672	13602	2218	15912	1806	16881	1502	17483	1058	20974	988	9065
2E		MI	7076	2672	10526	2162	12034	1757	12573	1453	12831	1013	15181	929	6750
4-#18	1.81	MA	10368	2926	15865	2359	18668	1908	20128	1560	21689	1022	26439	917	15563
2E		MI	7716	2926	12140	2297	13878	1844	14721	1493	15632	959	18718	825	11417
6-#11	1.06	MA	9488	2685	13689	2236	16080	1820	17109	1512	17836	1065	21474	995	9458
2L-3S		MI	6568	2685	9857	2179	11263	1770	11680	1472	11670	1026	13699	847	7070
6-#11	1.06	MA	8692	2685	12676	2235	14795	1818	15553	1519	15765	1070	18727	904	9463
3L-2S		MI	7139	2685	10586	2182	12185	1775	12775	1467	13111	1021	15578	938	7039
6-#14	1.53	MA	10085	2835	15049	2321	17747	1881	19104	1549	20424	1047	24863	959	13381
2L-3S		MI	6744	2835	10526	2258	12034	1823	12573	1503	12831	1001	15181	753	9872
6-#14	1.53	MA	8970	2835	13602	2319	15912	1877	16881	1558	17483	1054	20974	827	13312
3L-2S		MI	7542	2835	11564	2264	13335	1830	14119	1495	14866	994	17821	885	9873
6-#18	2.71	MA	11475	3217	18386	2541	21865	2041	23979	1642	26756	997	33100	857	23011
2L-3S		MI	7143	3217	12140	2466	13878	1957	14721	1578	15632	933	18718	502	16477
6-#18	2.71	MA	9614	3217	15865	2536	18668	2031	20128	1656	21689	1011	26439	623	22522
3L-2S		MI	8472	3217	13934	2479	16090	1970	17348	1565	19090	919	23166	736	16743
8-#11	1.41	MA	9967	2798	14703	2307	17365	1872	18666	1545	19907	1058	24220	977	12478
2L-4S		MI	6487	2798	10035	2246	11444	1826	11900	1498	12002	1020	14342	732	9196
8-#11	1.41	MA	9183	2798	13689	2306	16080	1869	17109	1551	17836	1063	21474	885	12452
3E		MI	6907	2798	10586	2249	12185	1821	12775	1503	13111	1014	15578	819	9242
8-#11	1.41	MA	8610	2798	12932	2305	15056	1878	15870	1548	16192	1058	19672	794	12322
4L-2S		MI	7470	2798	11316	2253	13108	1826	13871	1498	14553	1009	17456	910	9231

RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

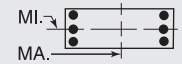
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.04	MA	10743	2999	16496	2423	19582	1956	21327	1597	23366	1035	28752	930	17666
2L-4S		MI	6627	2999	10778	2355	12289	1904	12883	1538	13300	990	16081	587	12300
8-#14	2.04	MA	9650	2999	15049	2421	17747	1952	19104	1605	20424	1043	24863	798	17543
3E		MI	7212	2999	11564	2361	13335	1896	14119	1545	14866	982	17821	710	12918
8-#14	2.04	MA	8850	2999	13966	2420	16283	1963	17331	1599	18090	1035	22316	667	16669
4L-2S		MI	7996	2999	12602	2366	14637	1904	15665	1538	16900	975	20461	841	12968
8-#18	3.62	MA	12544	3508	20907	2723	25063	2174	27830	1725	31823	973	39761	797	30423
2L-4S		MI	6967	3508	12568	2634	14312	2097	15247	1636	16429	906	20222	202	19034
8-#18	3.62	MA	10733	3508	18386	2718	21865	2164	23979	1738	26756	986	33100	563	29798
3E		MI	7931	3508	13934	2647	16090	2084	17348	1649	19090	893	23166	413	21358
8-#18	3.62	MA	9407	3508	16491	2713	19307	2180	20902	1725	22734	973	28736	333	26143
4L-2S		MI	9205	3508	15728	2660	18302	2097	19976	1636	22548	880	27614	646	22022
10-#11	1.76	MA	10436	2911	15716	2377	18650	1924	20223	1578	21979	1050	26967	958	15483
2L-5S		MI	6447	2911	10205	2324	11697	1873	12201	1533	12364	1002	14911	661	10750
10-#11	1.76	MA	9663	2911	14703	2377	17365	1921	18666	1584	19907	1056	24220	867	15431
3L-4S		MI	6825	2911	10765	2317	12367	1878	12995	1528	13443	1007	16221	704	11322
10-#11	1.76	MA	9098	2911	13945	2376	16341	1929	17426	1580	18263	1050	22419	776	15268
4L-3S		MI	7239	2911	11316	2320	13108	1873	13871	1533	14553	1002	17456	791	11397
10-#11	1.76	MA	8585	2911	13178	2386	15421	1927	16303	1587	16763	1056	20513	732	14425
5L-2S		MI	7795	2911	12046	2324	14030	1878	14966	1528	15994	997	19335	882	11410
10-#14	2.55	MA	11385	3162	17943	2525	21417	2031	23551	1644	26307	1024	32642	901	21937
2L-5S		MI	6569	3162	11017	2467	12647	1969	13308	1588	13811	963	16880	481	14440
10-#14	2.55	MA	10311	3162	16496	2523	19582	2027	21327	1653	23366	1031	28752	769	21766
3L-4S		MI	7093	3162	11816	2457	13591	1977	14429	1580	15334	971	18721	543	15146
10-#14	2.55	MA	9527	3162	15413	2522	18118	2038	19554	1646	21031	1024	26206	638	20692
4L-3S		MI	7668	3162	12602	2463	14637	1969	15665	1588	16900	963	20461	666	15949
10-#14	2.55	MA	8815	3162	14315	2535	16801	2034	17946	1654	18901	1031	23499	577	19523
5L-2S		MI	8440	3162	13640	2468	15938	1977	17211	1580	18934	956	23100	797	16040
10-#18	4.52	MA	11817	3798	20907	2899	25063	2297	27830	1821	31823	961	39761	504	36792
3L-4S		MI	7734	3798	14362	2816	16524	2223	17874	1707	19888	866	24670	113	23987
10-#18	4.52	MA	10527	3798	19012	2894	22504	2313	24753	1808	27800	948	35397	274	33205
4L-3S		MI	8666	3798	15728	2829	18302	2210	19976	1720	22548	853	27614	323	26110
10-#18	4.52	MA	9355	3798	17091	2916	20198	2303	21962	1821	24131	961	30752	165	29836
5L-2S		MI	9902	3798	17522	2842	20514	2223	22603	1707	26007	840	32062	557	27276
12-#11	2.12	MA	10896	3025	16729	2448	19935	1975	21780	1611	24050	1043	29713	940	18479
2L-6S		MI	6426	3025	10435	2392	11958	1930	12514	1558	12802	995	15568	571	12346
12-#11	2.12	MA	10133	3025	15716	2448	18650	1973	20223	1617	21979	1048	26967	848	18404
3L-5S		MI	6784	3025	10935	2395	12620	1924	13296	1563	13805	990	16789	633	12799
12-#11	2.12	MA	9577	3025	14959	2447	17626	1981	18983	1613	20335	1043	25166	757	18212
4E		MI	7156	3025	11495	2388	13289	1930	14091	1558	14885	995	18099	676	13366
12-#11	2.12	MA	9072	3025	14192	2457	16706	1979	17860	1620	18835	1048	23259	714	17295
5L-3S		MI	7565	3025	12046	2391	14030	1924	14966	1563	15994	990	19335	763	13544
12-#11	2.12	MA	8587	3025	13509	2456	15797	1987	16753	1616	17392	1054	21342	638	16641
6L-2S		MI	8115	3025	12776	2394	14953	1930	16062	1558	17436	985	21213	854	13577
12-#14	3.05	MA	10957	3326	17943	2626	21417	2102	23551	1700	26307	1020	32642	741	25984
3L-5S		MI	7034	3326	12055	2569	13948	2043	14854	1630	15845	944	19520	437	17332
12-#14	3.05	MA	10188	3326	16860	2624	19953	2112	21777	1693	23972	1012	30095	609	24739
4E		MI	7550	3326	12854	2559	14893	2050	15975	1623	17369	952	21361	500	18016
12-#14	3.05	MA	9489	3326	15762	2638	18636	2108	20170	1702	21842	1020	27388	548	23632
5L-3S		MI	8115	3326	13640	2565	15938	2043	17211	1630	18934	944	23100	622	18972
12-#14	3.05	MA	8818	3326	14785	2636	17334	2119	18586	1695	19794	1027	24674	438	21961
6L-2S		MI	8876	3326	14678	2571	17240	2050	18756	1623	20968	937	25740	754	19099
12-#18	5.43	MA	11675	4089	21533	3076	25702	2446	28604	1890	32867	923	42058	214	40301
4E		MI	8476	4089	16156	2998	18736	2350	20502	1778	23346	827	29119	24	28972

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

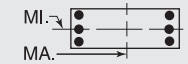
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	5.43	MA	10542	4089	19612	3098	23395	2436	25813	1904	29197	937	37413	105	36803
5L-3S		MI	9379	4089	17522	3011	20514	2337	22603	1791	26007	814	32062	234	30919
14-#11	2.47	MA	10595	3138	16729	2519	19935	2025	21780	1650	24050	1041	29713	830	21372
3L-6S		MI	6760	3138	11165	2463	12881	1981	13609	1589	14243	983	17446	542	14346
14-#11	2.47	MA	10046	3138	15972	2518	18911	2033	20540	1646	22406	1036	27912	739	21058
4L-5S		MI	7114	3138	11664	2466	13542	1976	14392	1594	15247	978	18668	605	14857
14-#11	2.47	MA	9548	3138	15205	2528	17991	2031	19417	1653	20906	1041	26006	696	20174
5L-4S		MI	7482	3138	12224	2459	14212	1981	15186	1589	16326	983	19978	648	15387
14-#11	2.47	MA	9071	3138	14522	2527	17082	2039	18310	1649	19463	1046	24089	620	19466
6L-3S		MI	7885	3138	12776	2462	14953	1976	16062	1594	17436	978	21213	734	15683
14-#11	2.47	MA	8603	3138	13858	2526	16203	2037	17237	1655	18000	1041	22389	549	18542
7L-2S		MI	8429	3138	13505	2465	15875	1981	17157	1589	18877	973	23092	826	15734
14-#14	3.56	MA	10834	3489	18307	2726	21788	2187	24001	1741	26914	1001	33984	580	28804
4L-5S		MI	7489	3489	13093	2671	15250	2116	16400	1673	17879	925	22159	393	20133
14-#14	3.56	MA	10148	3489	17209	2740	20471	2183	22393	1749	24784	1008	31277	519	27753
5L-4S		MI	7997	3489	13892	2662	16194	2124	17520	1666	19403	933	24000	456	20902
14-#14	3.56	MA	9490	3489	16232	2738	19169	2194	20809	1743	22735	1016	28564	409	26017
6L-3S		MI	8554	3489	14678	2667	17240	2116	18756	1673	20968	925	25740	578	21989
14-#14	3.56	MA	8845	3489	15280	2737	17910	2190	19272	1751	20657	1008	26160	306	24263
7L-2S		MI	9304	3489	15716	2673	18542	2124	20302	1666	23002	918	28379	710	22149
14-#18	6.33	MA	11633	4380	22133	3279	26592	2569	29664	1986	34264	912	44074	45	43800
5L-4S		MI	9199	4380	17950	3180	20948	2477	23129	1849	26804	787	33567	-66	33121
16-#11	2.82	MA	10508	3252	16985	2589	20196	2085	22097	1679	24477	1029	30659	720	23903
4L-6S		MI	7090	3252	11894	2534	13803	2033	14705	1619	15685	971	19325	514	16356
16-#11	2.82	MA	10017	3252	16218	2598	19276	2083	20973	1685	22977	1034	28752	677	23060
5E		MI	7439	3252	12394	2537	14465	2028	15487	1624	16688	966	20546	577	16921
16-#11	2.82	MA	9546	3252	15536	2598	18367	2091	19867	1682	21535	1039	26836	601	22300
6L-4S		MI	7803	3252	12954	2530	15134	2033	16282	1619	17768	971	21856	620	17419
16-#11	2.82	MA	9084	3252	14871	2597	17488	2089	18793	1688	20072	1034	25136	530	21407
7L-3S		MI	8201	3252	13505	2533	15875	2028	17157	1624	18877	966	23092	706	17818
16-#11	2.82	MA	8629	3252	14216	2597	16626	2086	17718	1684	18660	1039	23356	480	20289
8L-2S		MI	8739	3252	14235	2536	16798	2033	18253	1619	20319	961	24970	797	17886
16-#14	4.07	MA	10794	3653	18656	2842	22306	2258	24616	1797	27725	997	35167	490	31804
5E		MI	7937	3653	14131	2773	16551	2189	17946	1716	19913	906	24799	349	22951
16-#14	4.07	MA	10147	3653	17678	2840	21004	2269	23032	1790	25677	1004	32453	380	30085
6L-4S		MI	8438	3653	14930	2764	17496	2197	19066	1708	21437	914	26640	412	23804
16-#14	4.07	MA	9513	3653	16727	2839	19745	2265	21495	1798	23599	997	30049	277	28291
7L-3S		MI	8987	3653	15716	2770	18542	2189	20302	1716	23002	906	28379	535	25001
18-#11	3.18	MA	10477	3365	17231	2669	20561	2135	22530	1718	25049	1027	31499	659	25953
5L-6S		MI	7415	3365	12624	2604	14726	2084	15800	1649	17126	959	21203	486	18375
18-#11	3.18	MA	10013	3365	16549	2669	19652	2143	21424	1714	23606	1032	29582	583	25142
6L-5S		MI	7760	3365	13124	2608	15387	2079	16583	1654	18130	954	22425	548	18990
18-#11	3.18	MA	9558	3365	15884	2668	18773	2140	20350	1721	22143	1027	27882	512	24279
7L-4S		MI	8119	3365	13684	2601	16057	2084	17377	1649	19209	959	23735	592	19461
18-#11	3.18	MA	9108	3365	15230	2667	17911	2138	19274	1717	20732	1032	26103	461	23133
8L-3S		MI	8513	3365	14235	2604	16798	2079	18253	1654	20319	954	24970	678	19950
18-#14	4.58	MA	10793	3816	19125	2943	22839	2344	25255	1837	28618	992	36342	351	34163
6L-5S		MI	8408	3816	15169	2876	17853	2263	19491	1758	21947	887	27438	305	25785
18-#14	4.58	MA	10170	3816	18173	2941	21580	2340	23718	1846	26540	985	33938	249	32331
7L-4S		MI	8893	3816	15968	2866	18797	2270	20612	1751	23471	895	29279	368	26716
20-#11	3.53	MA	10473	3478	17562	2740	20937	2195	22980	1747	25677	1025	32329	564	27992
6E		MI	7735	3478	13354	2675	15648	2136	16896	1680	18568	947	23082	458	20402

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

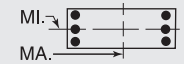
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.53	MA	10024	3478	16897	2739	20058	2192	21907	1754	24214	1020	30629	493	27157
7L-5S		MI	8076	3478	13853	2679	16310	2131	17678	1685	19571	942	24303	520	21064
20-#11	3.53	MA	9580	3478	16243	2738	19196	2190	20831	1750	22803	1025	28850	443	25984
8L-4S		MI	8432	3478	14413	2671	16979	2136	18473	1680	20651	947	25613	563	21510
20-#14	5.09	MA	10815	3980	19620	3043	23415	2414	25941	1893	29481	973	37828	220	36380
7L-5S		MI	8839	3980	16207	2978	19154	2336	21037	1801	23981	868	30078	262	28632
22-#11	3.88	MA	10483	3592	17911	2810	21343	2244	23464	1786	26286	1012	33375	475	30013
7L-6S		MI	8051	3592	14084	2746	16571	2187	17991	1710	20009	935	24960	430	22435
22-#11	3.88	MA	10045	3592	17256	2809	20481	2242	22388	1783	24874	1018	31596	424	28840
8L-5S		MI	8389	3592	14583	2749	17232	2182	18774	1715	21013	930	26182	492	23141
24-#11	4.24	MA	10504	3705	18269	2880	21766	2294	23945	1815	26946	1010	34343	406	31701
8L-6S		MI	8364	3705	14813	2817	17493	2239	19087	1740	21451	923	26839	402	24474

RECTANGULAR TIED COLUMNS 26" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.71	MA	11538	3064	17460	2488	20594	2014	22243	1653	23927	1097	29195	994	16643
2E		MI	8079	3064	12643	2411	14434	1937	15278	1573	16145	1020	19295	884	11457
6-#11	1.00	MA	10577	2822	15121	2365	17809	1926	18947	1603	19743	1137	23777	1067	10090
2L-3S		MI	6927	2822	10351	2294	11817	1865	12238	1553	12187	1089	14284	907	7098
6-#11	1.00	MA	9722	2822	14037	2365	16434	1925	17281	1610	17514	1142	20812	976	10095
3L-2S		MI	7499	2822	11080	2298	12739	1870	13333	1548	13628	1083	16163	998	7065
6-#14	1.44	MA	11225	2973	16579	2450	19597	1988	21087	1640	22539	1120	27452	1034	14292
2L-3S		MI	7104	2973	11023	2373	12589	1917	13131	1583	13347	1063	15764	813	9915
6-#14	1.44	MA	10027	2973	15030	2449	17632	1984	18706	1649	19370	1128	23249	902	14223
3L-2S		MI	7904	2973	12061	2379	13890	1925	14677	1576	15381	1056	18404	945	9905
6-#18	2.56	MA	12741	3355	20163	2670	24021	2147	26395	1738	29398	1075	36413	939	24631
2L-3S		MI	7504	3355	12643	2579	14434	2051	15278	1657	16145	994	19295	561	16566
6-#18	2.56	MA	10736	3355	17460	2667	20594	2139	22243	1751	23927	1088	29195	706	24142
3L-2S		MI	8839	3355	14437	2592	16646	2064	17905	1644	19603	980	23744	795	16793
8-#11	1.33	MA	11096	2936	16205	2436	19183	1978	20612	1635	21972	1130	26741	1050	13321
2L-4S		MI	6847	2936	10529	2362	11998	1922	12458	1578	12519	1082	14927	792	9245
8-#11	1.33	MA	10253	2936	15121	2436	17809	1976	18947	1642	19743	1136	23777	959	13295
3E		MI	7267	2936	11080	2365	12739	1916	13333	1584	13628	1077	16163	879	9277
8-#11	1.33	MA	9639	2936	14312	2435	16716	1985	17623	1639	17974	1130	21829	868	13164
4L-2S		MI	7832	2936	11810	2369	13662	1922	14429	1578	15070	1071	18041	970	9260
8-#14	1.92	MA	11939	3137	18128	2552	21561	2062	23467	1687	25708	1110	31655	1007	18881
2L-4S		MI	6986	3137	11275	2470	12844	1998	13441	1618	13816	1052	16664	647	12463
8-#14	1.92	MA	10763	3137	16579	2551	19597	2059	21087	1697	22539	1117	27452	876	18758
3E		MI	7573	3137	12061	2476	13890	1991	14677	1626	15381	1044	18404	769	12968
8-#14	1.92	MA	9905	3137	15422	2550	18033	2071	19192	1691	20024	1110	24695	744	17984
4L-2S		MI	8361	3137	13099	2481	15192	1998	16223	1618	17415	1037	21043	901	13005
8-#18	3.42	MA	13901	3645	22866	2852	27449	2280	30548	1822	34868	1053	43631	885	32583
2L-4S		MI	7297	3645	13071	2748	14868	2190	15804	1715	16942	967	20800	261	19251
8-#18	3.42	MA	11949	3645	20163	2848	24021	2272	26395	1835	29398	1066	36413	651	31958
3E		MI	8272	3645	14437	2761	16646	2177	17905	1728	19603	954	23744	472	21648
8-#18	3.42	MA	10524	3645	18137	2845	21284	2290	23079	1823	25055	1053	31692	418	28216
4L-2S		MI	9577	3645	16231	2774	18858	2190	20533	1715	23061	941	28192	705	22078
10-#11	1.67	MA	11604	3049	17289	2507	20558	2030	22278	1668	24201	1124	29706	1034	16536
2L-5S		MI	6806	3049	10699	2440	12251	1968	12759	1614	12881	1065	15496	721	10863
10-#11	1.67	MA	10773	3049	16205	2506	19183	2028	20612	1675	21972	1129	26741	943	16484
3L-4S		MI	7185	3049	11259	2433	12921	1973	13553	1609	13960	1070	16806	764	11376
10-#11	1.67	MA	10167	3049	15396	2506	18091	2037	19288	1672	20203	1124	24794	851	16321
4L-3S		MI	7600	3049	11810	2436	13662	1968	14429	1614	15070	1065	18041	851	11437
10-#11	1.67	MA	9618	3049	14577	2516	17108	2035	18089	1679	18589	1129	22742	807	15493
5L-2S		MI	8159	3049	12540	2439	14584	1973	15524	1609	16511	1059	19920	942	11442

RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

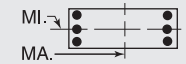
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.40	MA	12635	3300	19677	2654	23526	2137	25847	1735	28877	1100	35859	981	23456
2L-5S		MI	6927	3300	11514	2582	13202	2064	13866	1668	14326	1025	17462	540	14585
10-#14	2.40	MA	11480	3300	18128	2653	21561	2134	23467	1744	25708	1107	31655	850	23284
3L-4S		MI	7454	3300	12313	2572	14146	2072	14987	1661	15850	1033	19303	603	15306
10-#14	2.40	MA	10639	3300	16971	2653	19997	2146	21572	1738	23193	1100	28898	718	22299
4L-3S		MI	8031	3300	13099	2578	15192	2064	16223	1668	17415	1025	21043	726	16005
10-#14	2.40	MA	9875	3300	15798	2667	18590	2143	19854	1748	20898	1107	25982	655	20982
5L-2S		MI	8807	3300	14137	2583	16493	2072	17768	1661	19449	1018	23683	857	16081
10-#18	4.27	MA	13125	3936	22866	3030	27449	2405	30548	1920	34868	1044	43631	596	39776
3L-4S		MI	8096	3936	14865	2930	17080	2317	18431	1786	20400	928	25248	172	24199
10-#18	4.27	MA	11738	3936	20840	3026	24712	2423	27232	1907	30526	1030	38910	363	35802
4L-3S		MI	9035	3936	16231	2943	18858	2304	20533	1800	23061	914	28192	382	26392
10-#18	4.27	MA	10480	3936	18785	3049	22246	2415	24223	1921	26564	1044	33877	255	32357
5L-2S		MI	10282	3936	18025	2956	21070	2317	23160	1786	26519	901	32640	616	27337
12-#11	2.00	MA	12102	3163	18373	2578	21933	2082	23944	1701	26431	1118	32670	1017	19743
2L-6S		MI	6784	3163	10929	2508	12512	2025	13072	1639	13318	1058	16153	631	12528
12-#11	2.00	MA	11281	3163	17289	2577	20558	2080	22278	1708	24201	1123	29706	926	19668
3L-5S		MI	7143	3163	11429	2511	13174	2020	13855	1644	14322	1052	17374	693	12911
12-#11	2.00	MA	10685	3163	16480	2577	19466	2089	20954	1705	22432	1118	27758	835	19476
4E		MI	7518	3163	11988	2504	13843	2025	14649	1639	15402	1058	18684	736	13496
12-#11	2.00	MA	10144	3163	15661	2587	18483	2087	19755	1712	20818	1123	25706	790	18567
5L-3S		MI	7928	3163	12540	2507	14584	2020	15524	1644	16511	1052	19920	823	13587
12-#11	2.00	MA	9625	3163	14933	2587	17513	2096	18574	1709	19265	1128	23637	715	17963
6L-2S		MI	8480	3163	13269	2510	15507	2025	16620	1639	17953	1047	21798	914	13612
12-#14	2.88	MA	12180	3464	19677	2756	23526	2209	25847	1791	28877	1097	35859	823	27806
3L-5S		MI	7393	3464	12552	2684	14503	2138	15412	1711	16360	1006	20102	497	17502
12-#14	2.88	MA	11354	3464	18520	2755	21962	2221	23952	1786	26362	1089	33102	692	26638
4E		MI	7912	3464	13351	2675	15447	2145	16532	1703	17884	1014	21943	559	18172
12-#14	2.88	MA	10605	3464	17347	2769	20555	2217	22235	1795	24067	1097	30185	629	25389
5L-3S		MI	8480	3464	14137	2680	16493	2138	17768	1711	19449	1006	23683	682	19033
12-#14	2.88	MA	9886	3464	16304	2768	19165	2229	20543	1790	21860	1104	27252	520	23705
6L-2S		MI	9245	3464	15175	2686	17795	2145	19314	1703	21483	999	26322	813	19144
12-#18	5.13	MA	12991	4227	23542	3208	28140	2556	31384	1991	35996	1008	46128	308	43423
4E		MI	8841	4227	16659	3112	19292	2444	21058	1857	23859	888	29696	83	29180
12-#18	5.13	MA	11692	4227	21488	3231	25674	2548	28376	2005	32035	1022	41094	201	39850
5L-3S		MI	9753	4227	18025	3125	21070	2430	23160	1871	26519	875	32640	293	31193
12-#18	5.13	MA	10515	4227	19659	3228	23238	2566	25412	1992	28225	1035	36059	6	36033
6L-2S		MI	10966	4227	19819	3138	23282	2444	25788	1857	29978	861	37088	527	32579
14-#11	2.33	MA	11781	3276	18373	2648	21933	2132	23944	1741	26431	1117	32670	909	22846
3L-6S		MI	7119	3276	11659	2579	13435	2076	14167	1670	14760	1046	18031	603	14526
14-#11	2.33	MA	11193	3276	17564	2648	20840	2141	22620	1738	24662	1111	30723	818	22630
4L-5S		MI	7475	3276	12158	2582	14096	2071	14950	1675	15764	1040	19252	665	14968
14-#11	2.33	MA	10660	3276	16746	2658	19858	2139	21420	1745	23047	1117	28671	774	21651
5L-4S		MI	7845	3276	12718	2575	14766	2076	15744	1670	16843	1046	20563	708	15515
14-#11	2.33	MA	10148	3276	16018	2658	18888	2148	20239	1742	21495	1122	26602	698	20991
6L-3S		MI	8250	3276	13269	2578	15507	2071	16620	1675	17953	1040	21798	795	15730
14-#11	2.33	MA	9647	3276	15309	2658	17950	2146	19094	1749	19920	1117	24765	627	19954
7L-2S		MI	8796	3276	13999	2581	16429	2076	17715	1670	19394	1035	23677	886	15772
14-#14	3.37	MA	12054	3627	20069	2857	23927	2295	26332	1833	29531	1079	37305	665	30996
4L-5S		MI	7850	3627	13590	2786	15805	2211	16958	1753	18394	987	22742	453	20382
14-#14	3.37	MA	11318	3627	18896	2871	22520	2292	24615	1843	27236	1087	34388	603	29807
5L-4S		MI	8361	3627	14389	2777	16749	2218	18078	1746	19918	995	24583	515	21057
14-#14	3.37	MA	10612	3627	17853	2870	21130	2304	22924	1837	25029	1094	31455	494	28057
6L-3S		MI	8922	3627	15175	2782	17795	2211	19314	1753	21483	987	26322	638	22054

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis

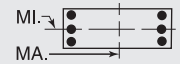


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.37	MA	9920	3627	16838	2869	19786	2301	21283	1846	22791	1087	28853	391	26344
7L-2S		MI	9676	3627	16213	2788	19096	2218	20860	1746	23518	980	28962	770	22197
14-#18	5.98	MA	12954	4518	24191	3413	29102	2681	32529	2089	37505	999	48312	146	47373
5L-4S		MI	9567	4518	18453	3293	21504	2570	23686	1929	27317	848	34144	-7	34096
14-#18	5.98	MA	11807	4518	22362	3409	26666	2699	29564	2076	33695	1013	43276	-49	42961
6L-3S		MI	10454	4518	19819	3306	23282	2557	25788	1942	29978	835	37088	203	36042
16-#11	2.67	MA	11692	3390	18648	2719	22215	2193	24285	1771	26891	1105	33688	801	25703
4L-6S		MI	7450	3390	12388	2649	14357	2128	15263	1700	16201	1033	19910	574	16533
16-#11	2.67	MA	11166	3390	17830	2729	21233	2191	23086	1778	25276	1110	31636	757	24742
5E		MI	7801	3390	12888	2653	15019	2123	16046	1705	17205	1028	21131	637	17032
16-#11	2.67	MA	10662	3390	17102	2729	20262	2199	21905	1774	23724	1115	29566	681	24029
6L-4S		MI	8167	3390	13448	2646	15688	2128	16840	1700	18285	1033	22441	680	17546
16-#11	2.67	MA	10168	3390	16393	2729	19325	2198	20760	1782	22149	1110	27729	610	23025
7L-3S		MI	8567	3390	13999	2649	16429	2123	17715	1705	19394	1028	23677	766	17868
16-#11	2.67	MA	9679	3390	15695	2729	18406	2196	19612	1778	20630	1115	25814	559	21901
8L-2S		MI	9108	3390	14729	2652	17352	2128	18811	1700	20836	1023	25555	858	17926
16-#14	3.85	MA	12017	3791	20446	2973	24484	2367	26995	1890	30405	1076	38592	576	34235
5E		MI	8300	3791	14628	2888	17106	2284	18503	1796	20429	968	25381	409	23196
16-#14	3.85	MA	11323	3791	19403	2973	23094	2379	25304	1884	28198	1084	35658	467	32420
6L-4S		MI	8804	3791	15427	2879	18050	2292	19624	1789	21952	976	27222	472	23956
16-#14	3.85	MA	10644	3791	18387	2972	21751	2375	23663	1894	25960	1076	33057	364	30601
7L-3S		MI	9356	3791	16213	2885	19096	2284	20860	1796	23518	968	28962	594	25070
16-#14	3.85	MA	9972	3791	17386	2971	20434	2372	22019	1888	23801	1084	30334	292	28736
8L-2S		MI	10101	3791	17251	2890	20398	2292	22405	1789	25552	961	31601	726	25243
16-#18	6.84	MA	12995	4809	25064	3591	30094	2832	33717	2160	39166	990	50494	-103	49687
6L-4S		MI	10278	4809	20247	3475	23716	2697	26313	2000	30775	809	38592	-96	37900
18-#11	3.00	MA	11665	3503	18914	2800	22608	2243	24752	1811	27506	1104	34600	740	27841
5L-6S		MI	7776	3503	13118	2720	15280	2180	16358	1730	17643	1021	21788	546	18550
18-#11	3.00	MA	11167	3503	18186	2800	21637	2251	23571	1807	25953	1109	32531	665	27075
6L-5S		MI	8123	3503	13618	2724	15941	2174	17141	1735	18647	1016	23009	609	19101
18-#11	3.00	MA	10679	3503	17477	2800	20700	2250	22425	1814	24379	1104	30694	593	26103
7L-4S		MI	8485	3503	14178	2716	16611	2180	17935	1730	19726	1021	24319	652	19586
18-#11	3.00	MA	10198	3503	16779	2799	19780	2248	21278	1811	22860	1109	28778	542	24952
8L-3S		MI	8881	3503	14729	2720	17352	2174	18811	1735	20836	1016	25555	738	20002
18-#11	3.00	MA	9719	3503	16008	2810	18833	2256	20148	1818	21355	1114	26903	483	23803
9L-2S		MI	9416	3503	15459	2723	18274	2180	19907	1730	22277	1011	27434	829	20075
18-#14	4.33	MA	12021	3954	20952	3075	25059	2453	27684	1932	31367	1074	39862	441	36795
6L-5S		MI	8775	3954	15666	2991	18408	2358	20049	1839	22463	949	28021	365	26026
18-#14	4.33	MA	11353	3954	19936	3074	23716	2450	26043	1941	29129	1066	37260	338	34937
7L-4S		MI	9265	3954	16465	2981	19352	2365	21170	1831	23986	957	29862	428	26866
18-#14	4.33	MA	10692	3954	18936	3073	22399	2447	24399	1936	26969	1074	34538	265	33046
8L-3S		MI	9798	3954	17251	2987	20398	2358	22405	1839	25552	949	31601	551	28082
20-#11	3.33	MA	11665	3616	19270	2871	23012	2303	25236	1840	28182	1103	35495	648	30129
6E		MI	8097	3616	13848	2791	16202	2231	17454	1761	19085	1009	23667	518	20574
20-#11	3.33	MA	11183	3616	18561	2871	22074	2301	24091	1847	26608	1098	33659	577	29186
7L-5S		MI	8441	3616	14347	2794	16864	2226	18237	1766	20088	1004	24888	580	21175
20-#11	3.33	MA	10708	3616	17863	2870	21155	2300	22943	1844	25089	1103	31743	525	28008
8L-4S		MI	8798	3616	14907	2787	17533	2231	19031	1761	21168	1009	26198	624	21634
20-#11	3.33	MA	10236	3616	17092	2881	20208	2308	21814	1851	23585	1108	29867	466	26840
9L-3S		MI	9191	3616	15459	2791	18274	2226	19907	1766	22277	1004	27434	710	22133
20-#14	4.81	MA	12051	4118	21485	3176	25680	2525	28423	1988	32298	1056	41463	312	39283
7L-5S		MI	9208	4118	16704	3093	19709	2431	21595	1881	24497	930	30660	321	28869
20-#14	4.81	MA	11400	4118	20485	3175	24364	2522	26779	1983	30138	1063	38741	239	37365
8L-4S		MI	9689	4118	17503	3084	20653	2438	22715	1874	26021	937	32501	384	29787
22-#11	3.67	MA	11680	3730	19645	2941	23449	2353	25757	1880	28837	1091	36623	560	32275
7L-6S		MI	8415	3730	14577	2862	17125	2283	18549	1791	20526	997	25545	490	22606

RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.67	MA	11211	3730	18947	2941	22530	2352	24609	1877	27318	1096	34708	509	31070
8L-5S		MI	8755	3730	15077	2865	17786	2278	19332	1796	21530	992	26766	552	23252
22-#11	3.67	MA	10744	3730	18176	2951	21583	2360	23480	1884	25814	1102	32832	450	29882
9L-4S		MI	9109	3730	15637	2858	18456	2283	20126	1791	22609	997	28076	595	23688
22-#14	5.29	MA	12097	4281	22034	3278	26328	2597	29160	2030	33307	1053	42944	212	41692
8L-5S		MI	9634	4281	17742	3195	21011	2504	23140	1924	26531	911	33300	278	31724
24-#11	4.00	MA	11707	3843	20031	3012	23905	2403	26275	1910	29547	1090	37672	492	34136
8L-6S		MI	8729	3843	15307	2933	18047	2334	19645	1821	21968	985	27424	462	24643
24-#11	4.00	MA	11246	3843	19261	3022	22958	2412	25145	1917	28043	1095	35796	433	32928
9L-5S		MI	9066	3843	15807	2936	18709	2329	20428	1827	22971	980	28645	524	25332

RECTANGULAR TIED COLUMNS 26" x 38"

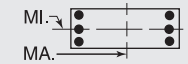
4-#18	1.62	MA	12764	3202	19121	2618	22601	2120	24399	1744	26249	1171	32050	1070	17723
2E		MI	8442	3202	13146	2524	14991	2031	15835	1652	16657	1081	19873	943	11496
6-#14	1.37	MA	12422	3111	18174	2579	21528	2094	23155	1730	24738	1193	30139	1108	15203
2L-3S		MI	7464	3111	11520	2489	13143	2012	13689	1664	13862	1125	16346	873	9957
6-#14	1.37	MA	11140	3111	16522	2579	19434	2091	20618	1740	21341	1201	25621	976	15135
3L-2S		MI	8266	3111	12558	2494	14445	2020	15235	1656	15897	1118	18986	1004	9937
6-#18	2.43	MA	14064	3493	22005	2799	26259	2253	28831	1828	32124	1151	39826	1020	26251
2L-3S		MI	7865	3493	13146	2693	14991	2144	15835	1737	16657	1055	19873	620	16649
6-#18	2.43	MA	11914	3493	19121	2797	22601	2247	24399	1843	26249	1164	32050	787	25762
3L-2S		MI	9205	3493	14940	2706	17203	2157	18462	1723	20115	1041	24321	854	16841
8-#11	1.26	MA	12280	3074	17772	2565	21084	2084	22645	1726	24120	1203	29360	1124	14163
2L-4S		MI	7206	3074	11023	2478	12552	2017	13016	1659	13036	1144	15512	853	9290
8-#11	1.26	MA	11379	3074	16617	2565	19619	2083	20870	1733	21733	1208	26177	1032	14137
3E		MI	7627	3074	11574	2481	13293	2012	13892	1665	14145	1139	16748	939	9309
8-#11	1.26	MA	10723	3074	15757	2566	18457	2092	19462	1731	19839	1203	24083	941	14007
4L-2S		MI	8194	3074	12304	2484	14216	2017	14987	1659	15586	1134	18626	1030	9288
8-#14	1.82	MA	13191	3274	19825	2681	23623	2169	25692	1777	28135	1184	34657	1084	20096
2L-4S		MI	7345	3274	11772	2585	13399	2093	13999	1699	14331	1114	17246	707	12621
8-#14	1.82	MA	11933	3274	18174	2681	21528	2166	23155	1788	24738	1191	30139	952	19973
3E		MI	7935	3274	12558	2591	14445	2086	15235	1706	15897	1106	18986	829	13016
8-#14	1.82	MA	11017	3274	16942	2681	19864	2179	21138	1783	22042	1184	27171	821	19318
4L-2S		MI	8725	3274	13596	2596	15746	2093	16780	1699	17931	1099	21626	961	13040
8-#18	3.24	MA	15317	3783	24890	2981	29917	2386	33263	1912	37999	1131	47601	970	34743
2L-4S		MI	7655	3783	13574	2862	15424	2284	16360	1795	17455	1028	21378	320	19463
8-#18	3.24	MA	13223	3783	22005	2979	26259	2380	28831	1928	32124	1144	39826	736	34118
3E		MI	8636	3783	14940	2875	17203	2271	18462	1808	20115	1015	24321	531	21826
8-#18	3.24	MA	11699	3783	19847	2976	23343	2400	25298	1916	27461	1131	34731	503	30314
4L-2S		MI	9946	3783	16734	2888	19415	2284	21090	1795	23574	1002	28769	764	22133
10-#11	1.58	MA	12827	3187	18927	2636	22549	2136	24419	1759	26508	1197	32543	1108	17589
2L-5S		MI	7165	3187	11193	2556	12805	2063	13317	1695	13398	1127	16080	781	10973
10-#11	1.58	MA	11938	3187	17772	2636	21084	2135	22645	1766	24120	1202	29360	1017	17537
3L-4S		MI	7545	3187	11753	2549	13475	2069	14111	1690	14477	1132	17390	824	11427
10-#11	1.58	MA	11292	3187	16912	2636	19921	2144	21236	1764	22226	1197	27266	926	17374
4L-3S		MI	7962	3187	12304	2552	14216	2063	14987	1695	15586	1127	18626	911	11474
10-#11	1.58	MA	10707	3187	16041	2647	18877	2143	19961	1771	20497	1202	25068	881	16571
5L-2S		MI	8522	3187	13034	2555	15138	2069	16083	1690	17028	1122	20505	1002	11472
10-#14	2.28	MA	13942	3438	21476	2784	25717	2244	28229	1825	31531	1175	39175	1060	24974
2L-5S		MI	7285	3438	12011	2697	13756	2159	14424	1749	14842	1087	18045	600	14724

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis

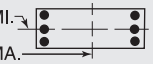


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.28	MA	12705	3438	19825	2783	23623	2241	25692	1835	28135	1182	34657	928	24803
3L-4S		MI	7815	3438	12810	2688	14700	2166	15544	1741	16365	1094	19886	663	15461
10-#14	2.28	MA	11806	3438	18593	2783	21958	2254	23675	1830	25439	1175	31689	797	23925
4L-3S		MI	8395	3438	13596	2693	15746	2159	16780	1749	17931	1087	21626	785	16059
10-#14	2.28	MA	10991	3438	17346	2798	20461	2251	21849	1841	22979	1182	28562	733	22453
5L-2S		MI	9173	3438	14634	2699	17048	2166	18326	1741	19965	1080	24265	917	16122
10-#18	4.05	MA	14491	4074	24890	3161	29917	2513	33263	2012	37999	1125	47601	686	42476
3L-4S		MI	8458	4074	15368	3044	17636	2411	18988	1866	20913	989	25826	231	24405
10-#18	4.05	MA	13008	4074	22732	3158	27002	2533	29730	2001	33336	1111	42507	453	38424
4L-3S		MI	9405	4074	16734	3057	19415	2397	21090	1879	23574	975	28769	441	26668
10-#18	4.05	MA	11662	4074	20544	3182	24377	2526	26527	2016	29081	1125	37100	343	34920
5L-2S		MI	10660	4074	18528	3070	21627	2411	23717	1866	27032	962	33217	675	27397
12-#11	1.89	MA	13364	3301	20082	2707	24013	2188	26194	1791	28895	1192	35725	1093	21006
2L-6S		MI	7142	3301	11423	2623	13066	2120	13630	1720	13835	1120	16738	691	12698
12-#11	1.89	MA	12486	3301	18927	2707	22549	2187	24419	1799	26508	1197	32543	1002	20931
3L-5S		MI	7503	3301	11922	2627	13728	2115	14413	1725	14839	1115	17959	753	13020
12-#11	1.89	MA	11849	3301	18067	2707	21386	2196	23011	1796	24613	1192	30449	911	20740
4E		MI	7879	3301	12482	2620	14397	2120	15207	1720	15919	1120	19269	796	13557
12-#11	1.89	MA	11272	3301	17196	2718	20342	2195	21736	1804	22885	1197	28251	866	19849
5L-3S		MI	8290	3301	13034	2623	15138	2115	16083	1725	17028	1115	20505	883	13628
12-#11	1.89	MA	10719	3301	16422	2718	19310	2204	20480	1801	21222	1202	26029	790	19186
6L-2S		MI	8845	3301	13763	2626	16061	2120	17178	1720	18469	1109	22383	974	13647
12-#14	2.73	MA	13459	3602	21476	2886	25717	2316	28229	1883	31531	1173	39175	904	29629
3L-5S		MI	7753	3602	13049	2799	15058	2232	15970	1791	16876	1068	20685	556	17640
12-#14	2.73	MA	12577	3602	20245	2885	24052	2328	26212	1878	28836	1166	36207	773	28556
4E		MI	8274	3602	13848	2790	16002	2240	17090	1784	18400	1075	22525	619	18325
12-#14	2.73	MA	11777	3602	18998	2900	22556	2326	24386	1888	26376	1173	33080	709	27157
5L-3S		MI	8846	3602	14634	2795	17048	2232	18326	1791	19965	1068	24265	742	19091
12-#14	2.73	MA	11009	3602	17889	2900	21078	2338	22587	1883	24010	1181	29927	600	25472
6L-2S		MI	9613	3602	15672	2801	18350	2240	19872	1784	21999	1061	26905	873	19188
12-#18	4.86	MA	14279	4365	25616	3340	30660	2666	34161	2085	39211	1091	50283	403	46570
4E		MI	9206	4365	17162	3225	19848	2537	21615	1937	24371	949	30274	142	29383
12-#18	4.86	MA	12967	4365	23429	3364	28035	2659	30958	2100	34956	1105	44876	293	42940
5L-3S		MI	10126	4365	18528	3238	21627	2524	23717	1950	27032	936	33217	352	31462
12-#18	4.86	MA	11709	4365	21483	3362	25442	2679	27803	2089	30865	1118	39450	99	38998
6L-2S		MI	11349	4365	20322	3251	23839	2537	26344	1937	30490	922	37665	586	32644
14-#11	2.21	MA	13024	3414	20082	2778	24013	2239	26194	1832	28895	1191	35725	987	24321
3L-6S		MI	7478	3414	12153	2694	13989	2172	14725	1750	15277	1108	18616	663	14701
14-#11	2.21	MA	12396	3414	19222	2778	22851	2248	24785	1829	27001	1186	33632	895	24104
4L-5S		MI	7835	3414	12652	2698	14650	2167	15508	1756	16281	1103	19837	725	15076
14-#11	2.21	MA	11827	3414	18351	2789	21806	2247	23510	1837	25272	1191	31434	851	23138
5L-4S		MI	8207	3414	13212	2691	15320	2172	16302	1750	17360	1108	21147	768	15641
14-#11	2.21	MA	11281	3414	17577	2789	20775	2256	22255	1834	23609	1196	29212	775	22499
6L-3S		MI	8614	3414	13763	2694	16061	2167	17178	1756	18469	1103	22383	855	15774
14-#11	2.21	MA	10747	3414	16824	2789	19778	2255	21038	1842	21923	1191	27238	704	21380
7L-2S		MI	9162	3414	14493	2697	16983	2172	18274	1750	19911	1097	24262	946	15809
14-#14	3.19	MA	13330	3765	21896	2988	26147	2403	28750	1925	32233	1157	40724	749	33207
4L-5S		MI	8211	3765	14087	2901	16359	2306	17515	1834	18910	1049	23324	513	20567
14-#14	3.19	MA	12545	3765	20649	3002	24650	2401	26923	1936	29773	1164	37598	685	31873
5L-4S		MI	8725	3765	14886	2892	17304	2313	18636	1826	20434	1056	25165	575	21207
14-#14	3.19	MA	11791	3765	19540	3002	23172	2413	25124	1931	27407	1172	34444	576	30120
6L-3S		MI	9289	3765	15672	2898	18350	2306	19872	1834	21999	1049	26905	698	22116
14-#14	3.19	MA	11052	3765	18460	3002	21744	2411	23380	1941	25008	1164	31645	473	28395
7L-2S		MI	10047	3765	16710	2903	19651	2313	21417	1826	24033	1042	29544	829	22244
14-#18	5.67	MA	14240	4656	26313	3546	31693	2792	35390	2185	40831	1085	52652	243	50990
5L-4S		MI	9935	4656	18956	3407	22060	2664	24243	2008	27830	909	34722	52	34387
14-#18	5.67	MA	13012	4656	24367	3543	29100	2812	32235	2174	36740	1098	47226	48	46992
6L-3S		MI	10830	4656	20322	3420	23839	2651	26344	2021	30490	896	37665	263	36305

RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

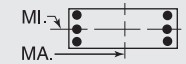
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.53	MA	12934	3527	20377	2849	24316	2300	26560	1862	29388	1181	36814	880	27468
4L-6S		MI	7810	3527	12882	2765	14911	2223	15821	1781	16718	1096	20495	635	16706
16-#11	2.53	MA	12372	3527	19506	2860	23271	2299	25285	1870	27659	1186	34617	835	26434
5E		MI	8163	3527	13382	2768	15573	2218	16604	1786	17722	1090	21716	697	17139
16-#11	2.53	MA	11834	3527	18732	2860	22240	2308	24030	1867	25997	1191	32395	760	25779
6L-4S		MI	8530	3527	13942	2761	16242	2223	17398	1781	18802	1096	23026	740	17670
16-#11	2.53	MA	11307	3527	17979	2860	21243	2307	22812	1875	24311	1186	30421	689	24658
7L-3S		MI	8933	3527	14493	2765	16983	2218	18274	1786	19911	1090	24262	827	17915
16-#11	2.53	MA	10786	3527	17238	2860	20267	2305	21592	1872	22684	1191	28369	637	23575
8L-2S		MI	9476	3527	15223	2768	17906	2223	19369	1781	21353	1085	26140	918	17965
16-#14	3.64	MA	13297	3929	22300	3105	26744	2476	29460	1983	33169	1155	42116	661	36599
5E		MI	8663	3929	15125	3004	17661	2379	19061	1876	20944	1030	25964	469	23436
16-#14	3.64	MA	12556	3929	21192	3104	25267	2488	27662	1978	30804	1163	38962	552	34780
6L-4S		MI	9170	3929	15924	2994	18605	2386	20182	1869	22468	1037	27805	531	24104
16-#14	3.64	MA	11831	3929	20112	3104	23838	2486	25917	1989	28405	1155	36163	449	33015
7L-3S		MI	9725	3929	16710	3000	19651	2379	21417	1876	24033	1030	29544	654	25135
16-#14	3.64	MA	11113	3929	19049	3104	22439	2483	24169	1984	26090	1163	33244	375	31043
8L-2S		MI	10474	3929	17748	3005	20953	2386	22963	1869	26067	1022	32184	786	25293
16-#18	6.48	MA	14386	4946	27252	3725	32758	2945	36667	2258	42615	1078	55001	-2	54987
6L-4S		MI	10649	4946	20750	3589	24272	2790	26870	2079	31288	870	39170	-37	38880
18-#11	2.84	MA	12909	3641	20661	2931	24736	2350	27059	1903	30047	1180	37800	820	29738
5L-6S		MI	8137	3641	13612	2836	15834	2275	16916	1811	18160	1084	22373	606	18720
18-#11	2.84	MA	12378	3641	19887	2931	23705	2360	25804	1900	28384	1185	35578	745	29029
6L-5S		MI	8486	3641	14112	2839	16495	2270	17699	1816	19164	1078	23594	669	19208
18-#11	2.84	MA	11858	3641	19134	2931	22708	2358	24587	1908	26698	1180	33604	674	27941
7L-4S		MI	8849	3641	14672	2832	17165	2275	18493	1811	20243	1084	24904	712	19708
18-#11	2.84	MA	11343	3641	18392	2931	21731	2357	23367	1905	25071	1185	31552	621	26830
8L-3S		MI	9248	3641	15223	2836	17906	2270	19369	1816	21353	1078	26140	798	20052
18-#11	2.84	MA	10833	3641	17574	2942	20725	2366	22167	1913	23460	1190	29536	563	25641
9L-2S		MI	9786	3641	15953	2839	18828	2275	20465	1811	22794	1073	28018	890	20117
18-#14	4.10	MA	13308	4092	22843	3207	27361	2563	30199	2026	34201	1153	43480	528	39451
6L-5S		MI	9107	4092	16163	3106	18962	2452	20607	1919	22978	1011	28603	425	26262
18-#14	4.10	MA	12594	4092	21763	3206	25933	2560	28455	2036	31802	1146	40680	425	37579
7L-4S		MI	9607	4092	16962	3096	19907	2460	21727	1912	24502	1018	30444	488	27013
18-#14	4.10	MA	11888	4092	20700	3206	24533	2558	26707	2031	29487	1153	37762	351	35652
8L-3S		MI	10156	4092	17748	3102	20953	2452	22963	1919	26067	1011	32184	610	28151
20-#11	3.16	MA	12913	3754	21042	3002	25169	2411	27579	1933	30771	1180	38761	729	32288
6E		MI	8460	3754	14342	2907	16756	2326	18012	1842	19601	1072	24251	578	20743
20-#11	3.16	MA	12400	3754	20289	3002	24173	2410	26361	1941	29085	1175	36786	658	31231
7L-5S		MI	8805	3754	14841	2910	17418	2321	18795	1847	20605	1066	25473	641	21282
20-#11	3.16	MA	11892	3754	19547	3002	23196	2409	25142	1938	27459	1180	34734	606	30056
8L-4S		MI	9165	3754	15401	2903	18087	2326	19589	1842	21685	1072	26783	684	21755
20-#11	3.16	MA	11388	3754	18729	3013	22190	2418	23941	1945	25848	1185	32719	547	28884
9L-3S		MI	9559	3754	15953	2906	18828	2321	20465	1847	22794	1066	28018	770	22185
20-#11	3.16	MA	10886	3754	17990	3013	21220	2417	22736	1943	24191	1180	30764	481	27566
10L-2S		MI	10092	3754	16682	2910	19751	2326	21560	1842	24236	1061	29897	861	22264
20-#14	4.55	MA	13344	4256	23415	3309	28027	2635	30992	2083	35198	1137	45198	401	42222
7L-5S		MI	9576	4256	17201	3208	20264	2526	22153	1962	25012	992	31243	381	29101
20-#14	4.55	MA	12650	4256	22351	3308	26627	2633	29244	2079	32884	1144	42279	327	40269
8L-4S		MI	10061	4256	18000	3199	21208	2533	23273	1954	26536	999	33084	444	29932
22-#11	3.47	MA	12934	3868	21444	3073	25638	2462	28136	1973	31473	1169	39969	643	34526
7L-6S		MI	8779	3868	15071	2978	17679	2378	19107	1872	21043	1059	26130	550	22772

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

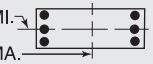
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.47	MA	12433	3868	20702	3073	24661	2461	26916	1971	29846	1174	37917	591	33323
8L-5S		MI	9121	3868	15571	2981	18340	2373	19890	1877	22047	1054	27351	613	23359
22-#11	3.47	MA	11935	3868	19884	3084	23655	2470	25716	1978	28235	1179	35902	532	32132
9L-4S		MI	9477	3868	16131	2974	19010	2378	20684	1872	23126	1059	28661	656	23808
22-#11	3.47	MA	11439	3868	19145	3084	22685	2469	24510	1976	26578	1174	33947	466	30838
10L-3S		MI	9867	3868	16682	2977	19751	2373	21560	1877	24236	1054	29897	742	24316
22-#14	5.01	MA	13399	4419	24003	3411	28722	2708	31781	2126	36281	1135	46797	303	44895
8L-5S		MI	10005	4419	18239	3310	21566	2599	23698	2004	27046	973	33882	337	31953
24-#11	3.79	MA	12966	3981	21857	3144	26126	2513	28691	2004	32233	1169	41100	576	36596
8L-6S		MI	9094	3981	15801	3049	18601	2430	20203	1902	22484	1047	28008	522	24807
24-#11	3.79	MA	12474	3981	21039	3154	25119	2522	27491	2011	30622	1174	39085	517	35385
9L-5S		MI	9433	3981	16301	3052	19263	2424	20986	1907	23488	1042	29230	584	25439
24-#11	3.79	MA	11985	3981	20300	3155	24149	2521	26285	2009	28966	1169	37130	451	34115
10L-4S		MI	9785	3981	16861	3045	19932	2430	21780	1902	24568	1047	30540	628	25867

RECTANGULAR TIED COLUMNS 26" x 40"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.54	MA	14047	3340	20846	2747	24689	2227	26641	1834	28655	1244	35003	1146	18803
2E		MI	8804	3340	13649	2638	15547	2124	16391	1732	17170	1142	20451	1002	11534
6-#14	1.30	MA	13674	3249	19833	2708	23541	2200	25309	1820	27020	1266	32923	1181	16114
2L-3S		MI	7824	3249	12017	2604	13698	2107	14247	1744	14378	1187	16929	933	9996
6-#14	1.30	MA	12308	3249	18079	2709	21317	2199	22615	1832	23395	1273	28091	1050	16046
3L-2S		MI	8628	3249	13055	2609	15000	2114	15792	1737	16412	1179	19569	1064	9968
6-#18	2.31	MA	15444	3630	23912	2929	28578	2360	31352	1918	34934	1227	43337	1099	27871
2L-3S		MI	8225	3630	13649	2807	15547	2238	16391	1816	17170	1116	20451	679	16727
6-#18	2.31	MA	13149	3630	20846	2927	24689	2354	26641	1935	28655	1240	35003	866	27382
3L-2S		MI	9571	3630	15443	2820	17759	2251	19019	1803	20628	1103	24899	913	16889
8-#11	1.20	MA	13520	3212	19403	2694	23066	2191	24763	1816	26334	1274	32076	1196	15005
2L-4S		MI	7565	3212	11517	2594	13106	2112	13574	1740	13552	1206	16097	913	9332
8-#11	1.20	MA	12560	3212	18177	2695	21511	2190	22880	1824	23793	1279	28674	1105	14980
3E		MI	7988	3212	12068	2597	13847	2107	14450	1746	14662	1201	17333	999	9340
8-#11	1.20	MA	11864	3212	17266	2696	20279	2200	21386	1822	21778	1275	26434	1014	14849
4L-2S		MI	8555	3212	12798	2600	14770	2112	15545	1740	16103	1196	19211	1090	9316
8-#14	1.73	MA	14500	3412	21586	2811	25765	2275	28003	1868	30644	1258	37756	1159	21311
2L-4S		MI	7704	3412	12269	2700	13954	2188	14556	1779	14847	1175	17829	766	12776
8-#14	1.73	MA	13159	3412	19833	2811	23541	2273	25309	1879	27020	1265	32923	1028	21188
3E		MI	8296	3412	13055	2706	15000	2180	15792	1787	16412	1168	19569	889	13062
8-#14	1.73	MA	12184	3412	18527	2811	21776	2286	23170	1875	24144	1258	29744	896	20668
4L-2S		MI	9088	3412	14093	2712	16301	2188	17338	1779	18446	1160	22208	1020	13075
8-#18	3.08	MA	16791	3921	26978	3110	32467	2493	36063	2003	41214	1209	51671	1053	36903
2L-4S		MI	8014	3921	14077	2976	15980	2378	16917	1874	17967	1089	21956	379	19670
8-#18	3.08	MA	14555	3921	23912	3109	28578	2487	31352	2020	34934	1222	43337	820	36278
3E		MI	8999	3921	15443	2989	17759	2364	19019	1887	20628	1076	24899	590	21914
8-#18	3.08	MA	12930	3921	21622	3108	25484	2509	27602	2010	29951	1209	37868	586	32434
4L-2S		MI	10316	3921	17237	3002	19971	2378	21646	1874	24086	1063	29347	823	22187
10-#11	1.50	MA	14107	3325	20629	2765	24620	2243	26647	1849	28876	1269	35477	1182	18642
2L-5S		MI	7523	3325	11687	2672	13359	2159	13875	1776	13914	1189	16665	841	11079
10-#11	1.50	MA	13159	3325	19403	2766	23066	2242	24763	1857	26334	1274	32076	1091	18590
3L-4S		MI	7905	3325	12247	2665	14028	2164	14670	1771	14994	1194	17975	885	11475
10-#11	1.50	MA	12473	3325	18492	2766	21834	2251	23270	1855	24319	1269	29835	1000	18427
4L-3S		MI	8323	3325	12798	2668	14770	2159	15545	1776	16103	1189	19211	971	11511
10-#11	1.50	MA	11851	3325	17569	2777	20727	2251	21919	1863	22480	1275	27492	954	17657
5L-2S		MI	8885	3325	13528	2671	15692	2164	16641	1771	17545	1184	21089	1062	11503
10-#14	2.16	MA	15306	3576	23340	2913	27989	2350	30698	1915	34269	1249	42588	1137	26493
2L-5S		MI	7643	3576	12508	2812	14311	2254	14982	1829	15357	1149	18627	660	14859
10-#14	2.16	MA	13987	3576	21586	2913	25765	2348	28003	1926	30644	1257	37756	1006	26322
3L-4S		MI	8175	3576	13307	2803	15255	2261	16102	1822	16881	1156	20468	723	15613

RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

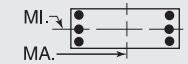
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.16	MA	13030	3576	20281	2914	24000	2361	25865	1922	27768	1249	34577	874	25568
4L-3S		MI	8757	3576	14093	2808	16301	2254	17338	1829	18446	1149	22208	845	16110
10-#14	2.16	MA	12163	3576	18959	2929	22414	2360	23929	1933	25143	1257	31240	809	23935
5L-2S		MI	9539	3576	15131	2814	17603	2261	18884	1822	20480	1141	24848	977	16162
10-#18	3.85	MA	15916	4212	26978	3291	32467	2620	36063	2104	41214	1204	51671	774	45176
3L-4S		MI	8820	4212	15871	3157	18192	2504	19545	1945	21426	1050	26404	290	24607
10-#18	3.85	MA	14334	4212	24688	3290	29372	2642	32313	2094	36230	1191	46202	540	41069
4L-3S		MI	9773	4212	17237	3170	19971	2491	21646	1959	24086	1036	29347	500	26939
10-#18	3.85	MA	12901	4212	22369	3315	26588	2636	28916	2111	31683	1204	40423	428	37525
5L-2S		MI	11037	4212	19031	3183	22183	2504	24274	1945	27545	1023	33795	734	27456
12-#11	1.80	MA	14682	3439	21855	2836	26175	2295	28530	1882	31417	1264	38878	1168	22270
2L-6S		MI	7500	3439	11917	2739	13620	2215	14188	1801	14352	1182	17322	751	12802
12-#11	1.80	MA	13747	3439	20629	2837	24620	2294	26647	1890	28876	1269	35477	1077	22195
3L-5S		MI	7862	3439	12416	2743	14282	2210	14971	1806	15356	1177	18544	813	13125
12-#11	1.80	MA	13070	3439	19718	2837	23388	2303	25153	1888	26860	1264	33237	986	22003
4E		MI	8240	3439	12976	2735	14951	2215	15765	1801	16435	1182	19854	856	13609
12-#11	1.80	MA	12457	3439	18795	2848	22282	2303	23803	1896	25021	1270	30893	940	21140
5L-3S		MI	8653	3439	13528	2739	15692	2210	16641	1806	17545	1177	21089	943	13668
12-#11	1.80	MA	11868	3439	17976	2849	21189	2312	22473	1894	23253	1275	28519	865	20413
6L-2S		MI	9209	3439	14257	2742	16615	2215	17736	1801	18986	1172	22968	1034	13679
12-#14	2.60	MA	14796	3739	23340	3015	27989	2423	30698	1974	34269	1249	42588	983	31451
3L-5S		MI	8112	3739	13546	2914	15613	2327	16527	1872	17391	1130	21267	616	17774
12-#14	2.60	MA	13856	3739	22034	3016	26224	2436	28559	1970	31393	1241	39409	852	30492
4E		MI	8636	3739	14345	2905	16557	2334	17648	1864	18915	1137	23108	679	18474
12-#14	2.60	MA	13005	3739	20713	3031	24638	2434	26623	1981	28768	1249	36073	787	28936
5L-3S		MI	9210	3739	15131	2910	17603	2327	18884	1872	20480	1130	24848	801	19147
12-#14	2.60	MA	12189	3739	19538	3031	23072	2448	24717	1977	26244	1256	32699	679	27262
6L-2S		MI	9981	3739	16169	2916	18904	2334	20430	1864	22514	1122	27487	933	19231
12-#18	4.62	MA	15699	4503	27755	3471	33261	2775	37025	2178	42510	1173	54537	494	49741
4E		MI	9571	4503	17665	3339	20404	2631	22172	2016	24884	1010	30852	201	29581
12-#18	4.62	MA	14301	4503	25435	3497	30477	2769	33627	2195	37962	1186	48757	382	46073
5L-3S		MI	10498	4503	19031	3352	22183	2618	24274	2030	27545	997	33795	411	31727
12-#18	4.62	MA	12960	4503	23372	3495	27728	2790	30281	2186	33589	1200	42940	188	42210
6L-2S		MI	11730	4503	20825	3365	24395	2631	26901	2016	31003	983	38243	645	32707
14-#11	2.10	MA	14324	3552	21855	2908	26175	2346	28530	1923	31417	1264	38878	1063	25795
3L-6S		MI	7837	3552	12647	2810	14543	2267	15284	1831	15794	1170	19201	723	14871
14-#11	2.10	MA	13656	3552	20943	2908	24943	2355	27037	1921	29401	1259	36638	972	25578
4L-5S		MI	8196	3552	13146	2813	15204	2262	16066	1837	16797	1165	20422	785	15181
14-#11	2.10	MA	13051	3552	20021	2919	23836	2354	25686	1929	27562	1264	34295	926	24633
5L-4S		MI	8569	3552	13706	2806	15874	2267	16861	1831	17877	1170	21732	828	15738
14-#11	2.10	MA	12471	3552	19202	2920	22744	2364	24356	1927	25794	1270	31920	851	23933
6L-3S		MI	8978	3552	14257	2810	16615	2262	17736	1837	18986	1165	22968	915	15817
14-#11	2.10	MA	11903	3552	18404	2920	21689	2363	23067	1935	24001	1265	29808	780	22821
7L-2S		MI	9528	3552	14987	2813	17537	2267	18832	1831	20428	1160	24846	1006	15845
14-#14	3.03	MA	14665	3903	23788	3118	28448	2511	31253	2017	35018	1233	44242	830	35436
4L-5S		MI	8572	3903	14584	3016	16914	2400	18073	1914	19425	1111	23907	572	20700
14-#14	3.03	MA	13828	3903	22466	3133	26862	2509	29317	2028	32393	1241	40905	765	33949
5L-4S		MI	9089	3903	15383	3007	17858	2408	19194	1907	20949	1118	25748	635	21354
14-#14	3.03	MA	13026	3903	21292	3134	25296	2522	27412	2024	29868	1248	37532	657	32206
6L-3S		MI	9655	3903	16169	3013	18904	2400	20430	1914	22514	1111	27487	758	22175
14-#14	3.03	MA	12241	3903	20148	3134	23783	2521	25563	2035	27309	1241	34534	554	30480
7L-2S		MI	10417	3903	17207	3018	20206	2408	21975	1907	24549	1103	30127	889	22290
14-#18	5.38	MA	15666	4794	28501	3678	34366	2902	38338	2280	44242	1169	57091	336	54650
5L-4S		MI	10303	4794	19459	3521	22616	2757	24799	2088	28342	970	35300	111	34582

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis

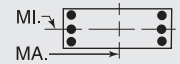


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	5.38	MA	14356	4794	26438	3677	31616	2923	34992	2270	39868	1182	51274	142	50544
6L-3S		MI	11206	4794	20825	3534	24395	2744	26901	2101	31003	957	38243	322	36563
16-#11	2.40	MA	14232	3665	22169	2979	26498	2407	28920	1954	31943	1254	40039	958	29153
4L-6S		MI	8170	3665	13376	2881	15465	2319	16379	1862	17235	1158	21079	695	16874
16-#11	2.40	MA	13635	3665	21247	2990	25391	2406	27570	1962	30104	1259	37696	912	28136
5E		MI	8525	3665	13876	2884	16127	2313	17162	1867	18239	1153	22301	757	17244
16-#11	2.40	MA	13063	3665	20428	2991	24299	2416	26240	1960	28335	1265	35321	837	27458
6L-4S		MI	8894	3665	14436	2877	16796	2319	17956	1862	19319	1158	23611	800	17790
16-#11	2.40	MA	12503	3665	19630	2991	23243	2415	24951	1968	26542	1260	33209	766	26305
7L-3S		MI	9298	3665	14987	2880	17537	2313	18832	1867	20428	1153	24846	887	17961
16-#11	2.40	MA	11949	3665	18845	2992	22209	2414	23659	1966	24812	1265	31021	713	25235
8L-2S		MI	9843	3665	15717	2884	18460	2319	19927	1862	21869	1148	26725	978	18004
16-#14	3.46	MA	14635	4067	24220	3235	29086	2584	32012	2076	36018	1233	45738	743	38973
5E		MI	9025	4067	15622	3119	18216	2474	19619	1957	21460	1092	26546	529	23634
16-#14	3.46	MA	13847	4067	23045	3236	27520	2597	30106	2072	33493	1240	42364	634	37163
6L-4S		MI	9535	4067	16421	3109	19160	2481	20739	1949	22983	1099	28387	591	24249
16-#14	3.46	MA	13074	4067	21902	3236	26007	2595	28258	2083	30933	1233	39367	532	35397
7L-3S		MI	10094	4067	17207	3115	20206	2474	21975	1957	24549	1092	30127	714	25198
16-#14	3.46	MA	12310	4067	20776	3237	24524	2594	26406	2079	28463	1240	36251	457	33291
8L-2S		MI	10846	4067	18245	3120	21507	2481	23521	1949	26583	1084	32766	845	25341
16-#18	6.15	MA	15836	5084	29504	3859	35505	3056	39704	2354	46148	1164	59608	96	59093
6L-4S		MI	11020	5084	21253	3702	24828	2884	27427	2159	31800	931	39748	22	39604
18-#11	2.70	MA	14210	3779	22473	3061	26946	2458	29453	1995	32645	1254	41097	898	31645
5L-6S		MI	8498	3779	14106	2952	16388	2370	17475	1892	18677	1146	22958	667	18886
18-#11	2.70	MA	13645	3779	21654	3061	25853	2468	28123	1992	30876	1260	38723	823	30988
6L-5S		MI	8849	3779	14606	2955	17049	2365	18257	1897	19680	1141	24179	729	19312
18-#11	2.70	MA	13092	3779	20856	3062	24798	2467	26834	2001	29083	1255	36611	752	29794
7L-4S		MI	9214	3779	15165	2948	17719	2370	19052	1892	20760	1146	25489	772	19828
18-#11	2.70	MA	12546	3779	20071	3063	23764	2466	25542	1998	27353	1260	34422	699	28696
8L-3S		MI	9614	3779	15717	2951	18460	2365	19927	1897	21869	1141	26725	859	20100
18-#11	2.70	MA	12002	3779	19204	3074	22698	2476	24272	2007	25640	1265	32267	641	27465
9L-2S		MI	10154	3779	16446	2955	19382	2370	21023	1892	23311	1135	28603	950	20157
18-#14	3.89	MA	14652	4230	24799	3338	29744	2672	32800	2119	37118	1232	47197	612	42131
6L-5S		MI	9471	4230	16660	3221	19517	2547	21165	1999	23494	1073	29186	485	26493
18-#14	3.89	MA	13892	4230	23655	3338	28231	2670	30952	2130	34558	1225	44199	510	40325
7L-4S		MI	9974	4230	17459	3212	20461	2554	22285	1992	25017	1080	31027	547	27156
18-#14	3.89	MA	13141	4230	22529	3339	26748	2668	29100	2126	32088	1232	41084	435	38270
8L-3S		MI	10526	4230	18245	3217	21507	2547	23521	1999	26583	1073	32766	670	28217
18-#14	3.89	MA	12394	4230	21286	3354	25220	2682	27278	2137	29642	1240	38024	350	35916
9L-2S		MI	11270	4230	19283	3223	22809	2554	25067	1992	28617	1065	35406	802	28386
20-#11	3.00	MA	14219	3892	22880	3132	27408	2520	30007	2025	33417	1254	42124	809	34466
6E		MI	8822	3892	14836	3023	17310	2422	18570	1923	20118	1134	24836	638	20907
20-#11	3.00	MA	13673	3892	22082	3133	26353	2519	28718	2033	31624	1249	40012	738	33290
7L-5S		MI	9169	3892	15335	3026	17972	2417	19353	1928	21122	1129	26058	701	21386
20-#11	3.00	MA	13133	3892	21297	3134	25319	2518	27426	2031	29894	1255	37824	686	32163
8L-4S		MI	9531	3892	15895	3019	18641	2422	20147	1923	22202	1134	27368	744	21873
20-#11	3.00	MA	12597	3892	20430	3145	24253	2528	26155	2039	28181	1260	35669	627	30958
9L-3S		MI	9927	3892	16446	3022	19382	2417	21023	1928	23311	1129	28603	830	22235
20-#11	3.00	MA	12063	3892	19648	3145	23226	2527	24878	2037	26419	1255	33440	547	29504
10L-2S		MI	10462	3892	17176	3025	20305	2422	22118	1923	24752	1123	30482	922	22306
20-#14	4.33	MA	14696	4394	25409	3441	30455	2745	33646	2178	38183	1217	49032	488	45195
7L-5S		MI	9945	4394	17698	3323	20819	2620	22710	2042	25528	1054	31825	441	29329
20-#14	4.33	MA	13956	4394	24283	3441	28972	2743	31794	2174	35713	1224	45916	413	43218
8L-4S		MI	10434	4394	18497	3314	21763	2628	23831	2035	27052	1061	33666	504	30073
20-#14	4.33	MA	13221	4394	23040	3456	27444	2756	29972	2185	33267	1232	42857	328	40876
9L-3S		MI	10966	4394	19283	3319	22809	2620	25067	2042	28617	1054	35406	626	31233

RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

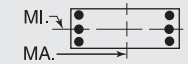
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.30	MA	14245	4006	23308	3204	27907	2571	30601	2066	34166	1244	43413	724	36791
7L-6S		MI	9142	4006	15565	3094	18233	2473	19666	1953	21560	1122	26715	610	22934
22-#11	3.30	MA	13712	4006	22523	3204	26873	2570	29309	2064	32435	1250	41225	672	35600
8L-5S		MI	9486	4006	16065	3097	18894	2468	20448	1958	22564	1116	27936	673	23463
22-#11	3.30	MA	13183	4006	21656	3215	25808	2579	28039	2072	30722	1255	39070	613	34413
9L-4S		MI	9844	4006	16625	3090	19564	2473	21243	1953	23643	1122	29246	716	23926
22-#11	3.30	MA	12655	4006	20874	3216	24780	2579	26762	2070	28960	1250	36841	533	32984
10L-3S		MI	10237	4006	17176	3093	20305	2468	22118	1958	24752	1116	30482	802	24368
22-#14	4.76	MA	14759	4557	26036	3543	31196	2818	34489	2221	39338	1216	50749	391	48143
8L-5S		MI	10375	4557	18736	3425	22120	2694	24256	2085	27562	1035	34465	397	32177
22-#14	4.76	MA	14035	4557	24793	3558	29668	2831	32667	2232	36892	1224	47689	306	45843
9L-4S		MI	10856	4557	19535	3416	23064	2701	25377	2077	29086	1042	36306	460	32999
24-#11	3.60	MA	14283	4119	23749	3275	28428	2622	31193	2097	34976	1245	44626	658	39079
8L-6S		MI	9458	4119	16295	3165	19155	2525	20761	1983	23001	1110	28593	582	24968
24-#11	3.60	MA	13760	4119	22882	3286	27362	2631	29922	2105	33263	1250	42471	599	37873
9L-5S		MI	9799	4119	16795	3168	19817	2520	21544	1988	24005	1104	29815	645	25543
24-#11	3.60	MA	13239	4119	22100	3287	26335	2631	28645	2103	31501	1245	40243	519	36468
10L-4S		MI	10154	4119	17355	3161	20486	2525	22338	1983	25085	1110	31125	688	25984
24-#14	5.19	MA	14836	4721	26547	3661	31892	2906	35361	2280	40517	1215	52522	284	50816
9L-5S		MI	10799	4721	19774	3528	23422	2767	25802	2127	29596	1016	37104	353	35037

RECTANGULAR TIED COLUMNS 26" x 42"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.47	MA	15386	3478	22636	2876	26859	2333	28969	1924	31144	1318	38053	1220	19883
2E		MI	9166	3478	14152	2752	16103	2218	16948	1811	17683	1203	21029	1061	11572
6-#14	1.24	MA	14983	3387	21557	2838	25636	2307	27549	1911	29367	1337	35805	1254	17026
2L-3S		MI	8183	3387	12514	2719	14253	2202	14804	1825	14893	1249	17511	993	10032
6-#14	1.24	MA	13532	3387	19701	2839	23282	2305	24698	1923	25520	1345	30657	1122	16957
3L-2S		MI	8990	3387	13552	2724	15554	2209	16350	1817	16928	1241	20151	1124	9998
6-#18	2.20	MA	16881	3768	25884	3058	30979	2466	33959	2009	37828	1302	46946	1178	29491
2L-3S		MI	8586	3768	14152	2921	16103	2331	16948	1896	17683	1177	21029	738	16800
6-#18	2.20	MA	14440	3768	22636	3058	26859	2462	28969	2027	31144	1315	38053	944	29002
3L-2S		MI	9936	3768	15946	2934	18315	2345	19576	1882	21141	1164	25477	972	16935
8-#11	1.14	MA	14816	3350	21099	2824	25129	2297	26967	1906	28604	1343	34889	1268	15848
2L-4S		MI	7924	3350	12011	2710	13660	2208	14132	1821	14069	1268	16682	973	9372
8-#11	1.14	MA	13797	3350	19802	2825	23485	2297	24975	1915	25916	1349	31269	1177	15822
3E		MI	8348	3350	12562	2713	14401	2202	15008	1826	15179	1263	17917	1059	9370
8-#11	1.14	MA	13060	3350	18840	2825	22183	2307	23397	1913	23787	1345	28882	1086	15691
4L-2S		MI	8917	3350	13292	2716	15324	2208	16103	1821	16620	1258	19796	1150	9342
8-#14	1.65	MA	15866	3550	23413	2940	27989	2381	30401	1958	33214	1329	40953	1233	22526
2L-4S		MI	8063	3550	12766	2816	14508	2282	15114	1860	15362	1237	18411	826	12927
8-#14	1.65	MA	14440	3550	21557	2941	25636	2380	27549	1970	29367	1337	35805	1102	22403
3E		MI	8657	3550	13552	2821	15554	2275	16350	1867	16928	1230	20151	949	13106
8-#14	1.65	MA	13407	3550	20177	2942	23770	2394	25289	1967	26316	1330	32415	971	21976
4L-2S		MI	9451	3550	14590	2827	16856	2282	17896	1860	18962	1222	22791	1080	13109
8-#18	2.93	MA	18323	4059	29132	3240	35098	2599	38950	2093	44513	1286	55840	1135	39063
2L-4S		MI	8372	4059	14580	3089	16536	2471	17474	1954	18480	1150	22533	439	19872
8-#18	2.93	MA	15943	4059	25884	3239	30979	2595	33959	2111	37828	1299	46946	902	38438
3E		MI	9362	4059	15946	3102	18315	2458	19576	1967	21141	1137	25477	649	21997
8-#18	2.93	MA	14218	4059	23462	3239	27706	2617	29993	2103	32524	1286	41103	668	34576
4L-2S		MI	10684	4059	17740	3115	20527	2471	22203	1954	24599	1124	29925	882	22239
10-#11	1.43	MA	15442	3463	22396	2895	26774	2349	28960	1939	31292	1338	38509	1255	19695
2L-5S		MI	7882	3463	12181	2788	13913	2254	14434	1857	14431	1251	17250	902	11183
10-#11	1.43	MA	14437	3463	21099	2895	25129	2349	26967	1948	28604	1344	34889	1164	19643
3L-4S		MI	8265	3463	12741	2780	14582	2259	15228	1852	15511	1256	18560	945	11520
10-#11	1.43	MA	13709	3463	20136	2896	23827	2359	25390	1946	26475	1340	32502	1073	19480
4L-3S		MI	8684	3463	13292	2784	15324	2254	16103	1857	16620	1251	19796	1031	11546

RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

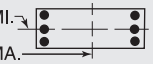
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.43	MA	13050	3463	19163	2908	22659	2358	23963	1955	24532	1346	30013	1027	18752
5L-2S		MI	9247	3463	14022	2787	16246	2259	17199	1852	18062	1246	21674	1122	11532
10-#14	2.06	MA	16727	3714	25268	3042	30343	2456	33252	2006	37061	1322	46100	1213	28012
2L-5S		MI	8001	3714	13005	2927	14866	2348	15539	1910	15873	1211	19210	720	14989
10-#14	2.06	MA	15325	3714	23413	3043	27989	2455	30401	2017	33214	1330	40953	1082	27841
3L-4S		MI	8535	3714	13804	2918	15810	2356	16660	1902	17396	1218	21051	782	15761
10-#14	2.06	MA	14310	3714	22033	3044	26124	2469	28140	2014	30163	1323	37562	950	27228
4L-3S		MI	9120	3714	14590	2923	16856	2348	17896	1910	18962	1211	22791	905	16159
10-#14	2.06	MA	13391	3714	20636	3060	24449	2468	26095	2026	27379	1330	34015	885	25427
5L-2S		MI	9904	3714	15628	2929	18157	2356	19442	1902	20996	1203	25430	1036	16201
10-#18	3.66	MA	17399	4350	29132	3421	35098	2728	38950	2196	44513	1283	55840	859	47876
3L-4S		MI	9181	4350	16374	3271	18748	2598	20101	2025	21938	1111	26981	349	24805
10-#18	3.66	MA	15719	4350	26710	3421	31825	2750	34983	2187	39209	1270	49996	626	43737
4L-3S		MI	10141	4350	17740	3284	20527	2584	22203	2038	24599	1097	29925	559	27178
10-#18	3.66	MA	14196	4350	24257	3447	28882	2746	31392	2206	34368	1283	43843	512	40169
5L-2S		MI	11413	4350	19534	3297	22739	2598	24831	2025	28057	1084	34373	793	27514
12-#11	1.71	MA	16057	3576	23693	2965	28418	2401	30952	1972	33980	1333	42129	1243	23533
2L-6S		MI	7858	3576	12411	2855	14174	2311	14746	1882	14869	1244	17907	811	12902
12-#11	1.71	MA	15064	3576	22396	2966	26774	2401	28960	1981	31292	1339	38509	1151	23458
3L-5S		MI	8222	3576	12910	2858	14836	2306	15529	1887	15873	1239	19129	873	13228
12-#11	1.71	MA	14346	3576	21433	2967	25472	2411	27382	1979	29163	1335	36122	1060	23267
4E		MI	8600	3576	13470	2851	15505	2311	16323	1882	16952	1244	20439	917	13658
12-#11	1.71	MA	13697	3576	20459	2979	24303	2410	25956	1988	27221	1341	33633	1014	22440
5L-3S		MI	9015	3576	14022	2855	16246	2306	17199	1887	18062	1239	21674	1003	13706
12-#11	1.71	MA	13073	3576	19595	2979	23150	2420	24552	1986	25353	1347	31105	939	21645
6L-2S		MI	9572	3576	14751	2858	17169	2311	18294	1882	19503	1234	23553	1094	13711
12-#14	2.47	MA	16189	3877	25268	3145	30343	2530	33252	2065	37061	1322	46100	1062	33274
3L-5S		MI	8472	3877	14043	3029	16167	2422	17085	1952	17907	1192	21850	676	17903
12-#14	2.47	MA	15192	3877	23889	3146	28478	2544	30992	2062	34010	1315	42710	930	32445
4E		MI	8998	3877	14842	3020	17112	2429	18206	1945	19431	1199	23690	739	18619
12-#14	2.47	MA	14290	3877	22492	3162	26802	2543	28946	2073	31226	1323	39163	864	30726
5L-3S		MI	9574	3877	15628	3026	18157	2422	19442	1952	20996	1192	25430	861	19200
12-#14	2.47	MA	13424	3877	21252	3163	25148	2556	26933	2070	28548	1331	35569	756	29073
6L-2S		MI	10348	3877	16666	3031	19459	2429	20987	1945	23030	1184	28070	993	19273
12-#18	4.40	MA	17176	4641	29958	3603	35944	2883	39974	2272	45893	1254	58890	583	52935
4E		MI	9936	4641	18168	3453	20960	2724	22729	2096	25397	1071	31429	260	29775
12-#18	4.40	MA	15692	4641	27505	3629	33001	2879	36382	2290	41052	1267	52737	470	49246
5L-3S		MI	10870	4641	19534	3466	22739	2711	24831	2109	28057	1058	34373	470	31986
12-#18	4.40	MA	14268	4641	25325	3629	30095	2901	32845	2282	36397	1280	46529	276	45295
6L-2S		MI	12110	4641	21328	3479	24951	2724	27458	2096	31516	1045	38821	704	32768
14-#11	2.00	MA	15680	3690	23693	3037	28418	2452	30952	2014	33980	1334	42129	1139	27269
3L-6S		MI	8196	3690	13141	2926	15097	2362	15842	1912	16311	1232	19786	783	14974
14-#11	2.00	MA	14971	3690	22730	3038	27117	2462	29375	2012	31851	1330	39742	1048	27053
4L-5S		MI	8556	3690	13640	2929	15758	2357	16625	1918	17314	1227	21007	845	15283
14-#11	2.00	MA	14331	3690	21756	3049	25948	2462	27948	2021	29909	1336	37252	1001	26138
5L-4S		MI	8931	3690	14200	2922	16427	2362	17419	1912	18394	1232	22317	888	15791
14-#11	2.00	MA	13716	3690	20891	3050	24795	2472	26544	2019	28041	1342	34725	926	25373
6L-3S		MI	9341	3690	14751	2925	17169	2357	18294	1918	19503	1227	23553	975	15858
14-#11	2.00	MA	13114	3690	20049	3051	23680	2472	25183	2028	26148	1337	32475	855	24276
7L-2S		MI	9893	3690	15481	2929	18091	2362	19390	1912	20945	1222	25431	1066	15881
14-#14	2.88	MA	16056	4041	25744	3248	30831	2618	33843	2109	37857	1308	47858	910	37683
4L-5S		MI	8933	4041	15081	3132	17469	2495	18631	1995	19941	1173	24489	632	20829
14-#14	2.88	MA	15169	4041	24348	3264	29156	2617	31798	2121	35073	1315	44311	844	36037
5L-4S		MI	9452	4041	15880	3122	18413	2502	19751	1987	21465	1180	26330	695	21497

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

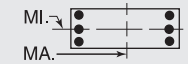
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.88	MA	14318	4041	23108	3265	27502	2631	29785	2118	32395	1323	40717	736	34315
6L-3S		MI	10021	4041	16666	3128	19459	2495	20987	1995	23030	1173	28070	817	22233
14-#14	2.88	MA	13485	4041	21900	3266	25904	2630	27833	2129	29681	1316	37521	633	32596
7L-2S		MI	10786	4041	17704	3133	20761	2502	22533	1987	25064	1165	30709	949	22335
14-#18	5.13	MA	17149	4931	30753	3811	37120	3012	41372	2374	47737	1251	61630	427	58352
5L-4S		MI	10671	4931	19962	3634	23172	2851	25356	2167	28855	1031	35878	170	34772
14-#18	5.13	MA	15759	4931	28573	3810	34214	3034	37836	2366	43081	1264	55422	234	54346
6L-3S		MI	11581	4931	21328	3647	24951	2838	27458	2180	31516	1018	38821	381	36816
14-#18	5.13	MA	14396	4931	26450	3810	31406	3030	34405	2385	38361	1251	49911	51	49651
7L-2S		MI	12794	4931	23122	3660	27163	2851	30085	2167	34974	1005	43269	614	38009
16-#11	2.29	MA	15586	3803	24027	3109	28761	2514	31367	2045	34539	1324	43362	1035	30838
4L-6S		MI	8530	3803	13870	2997	16019	2414	16937	1943	17752	1220	21664	755	17039
16-#11	2.29	MA	14954	3803	23053	3120	27592	2514	29940	2053	32597	1331	40872	989	29846
5E		MI	8886	3803	14370	3000	16681	2409	17720	1948	18756	1215	22886	817	17345
16-#11	2.29	MA	14348	3803	22188	3121	26439	2524	28536	2052	30729	1337	38345	913	29106
6L-4S		MI	9257	3803	14930	2993	17350	2414	18514	1943	19835	1220	24196	860	17908
16-#11	2.29	MA	13754	3803	21346	3122	25325	2523	27175	2060	28836	1332	36095	843	27965
7L-3S		MI	9663	3803	15481	2996	18091	2409	19390	1948	20945	1215	25431	947	18005
16-#11	2.29	MA	13167	3803	20518	3123	24233	2523	25812	2059	27009	1338	33770	789	26916
8L-2S		MI	10210	3803	16211	3000	19014	2414	20485	1943	22386	1210	27310	1038	18041
16-#14	3.30	MA	16030	4205	26204	3366	31509	2692	34649	2168	38920	1308	49459	824	41359
5E		MI	9387	4205	16119	3234	18770	2568	20177	2037	21975	1154	27129	588	23763
16-#14	3.30	MA	15194	4205	24964	3367	29856	2706	32636	2165	36242	1316	45865	716	39569
6L-4S		MI	9900	4205	16918	3224	19715	2576	21297	2030	23499	1161	28970	651	24390
16-#14	3.30	MA	14375	4205	23756	3368	28258	2705	30684	2177	33528	1309	42669	613	37812
7L-3S		MI	10461	4205	17704	3230	20761	2568	22533	2037	25064	1154	30709	774	25259
16-#14	3.30	MA	13564	4205	22567	3369	26692	2704	28728	2174	30908	1316	39356	537	35503
8L-2S		MI	11217	4205	18742	3236	22062	2576	24079	2030	27098	1146	33349	905	25388
16-#18	5.86	MA	17215	5222	31821	3992	38333	3167	42826	2450	49766	1248	64316	191	63233
6L-4S		MI	11390	5222	21757	3816	25384	2977	27984	2238	32313	992	40326	81	39792
16-#18	5.86	MA	15883	5222	29698	3992	35525	3163	39396	2469	45045	1235	58804	9	58769
7L-3S		MI	12279	5222	23122	3829	27163	2964	30085	2251	34974	978	43269	291	41687
18-#11	2.57	MA	15568	3917	24349	3191	29237	2566	31933	2086	35285	1325	44492	976	33561
5L-6S		MI	8859	3917	14600	3068	16942	2465	18033	1973	19194	1208	23543	727	19049
18-#11	2.57	MA	14969	3917	23485	3192	28084	2576	30529	2085	33417	1331	41965	901	32844
6L-5S		MI	9211	3917	15099	3071	17603	2460	18816	1978	20197	1203	24764	789	19414
18-#11	2.57	MA	14383	3917	22643	3193	26970	2575	29168	2093	31524	1327	39715	830	31662
7L-4S		MI	9578	3917	15659	3064	18273	2465	19610	1973	21277	1208	26074	832	19944
18-#11	2.57	MA	13804	3917	21814	3194	25878	2575	27804	2092	29697	1333	37390	776	30584
8L-3S		MI	9980	3917	16211	3067	19014	2460	20485	1978	22386	1203	27310	919	20146
18-#11	2.57	MA	13228	3917	20899	3205	24753	2585	26462	2100	27889	1339	35096	718	29238
9L-2S		MI	10523	3917	16940	3070	19936	2465	21581	1973	23828	1198	29188	1010	20196
18-#14	3.71	MA	16054	4368	26819	3469	32209	2781	35487	2212	40089	1308	51012	695	44834
6L-5S		MI	9835	4368	17157	3336	20072	2642	21722	2080	24009	1135	29768	545	26704
18-#14	3.71	MA	15247	4368	25612	3470	30611	2780	33536	2224	37375	1301	47816	593	43038
7L-4S		MI	10341	4368	17956	3327	21016	2649	22843	2072	25533	1142	31609	607	27296
18-#14	3.71	MA	14450	4368	24423	3471	29046	2778	31580	2221	34755	1309	44504	517	40781
8L-3S		MI	10896	4368	18742	3332	22062	2642	24079	2080	27098	1135	33349	730	28281
18-#14	3.71	MA	13658	4368	23111	3487	27432	2792	29656	2233	32161	1317	41243	432	38374
9L-2S		MI	11643	4368	19780	3338	23364	2649	25624	2072	29132	1127	35988	861	28436
18-#18	6.59	MA	17473	5513	32946	4174	39644	3296	44386	2553	51730	1219	67697	-34	67389
7L-4S		MI	12097	5513	23551	3998	27596	3104	30611	2309	35771	952	44774	-8	44703

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

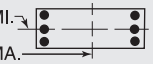
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.86	MA	15581	4030	24781	3263	29728	2628	32521	2117	36105	1326	45585	888	36586
6E		MI	9184	4030	15330	3139	17864	2517	19128	2003	20635	1196	25421	699	21067
20-#11	2.86	MA	15002	4030	23940	3264	28614	2627	31160	2126	34212	1322	43335	817	35364
7L-5S		MI	9533	4030	15829	3142	18526	2512	19911	2009	21639	1191	26642	761	21487
20-#11	2.86	MA	14430	4030	23111	3265	27522	2627	29796	2124	32385	1328	41010	764	34257
8L-4S		MI	9896	4030	16389	3135	19195	2517	20705	2003	22718	1196	27953	804	21989
20-#11	2.86	MA	13862	4030	22196	3276	26397	2637	28455	2133	30577	1334	38716	705	32939
9L-3S		MI	10294	4030	16940	3138	19936	2512	21581	2009	23828	1191	29188	891	22284
20-#11	2.86	MA	13296	4030	21370	3277	25313	2636	27107	2131	28717	1330	36343	625	31467
10L-2S		MI	10832	4030	17670	3141	20859	2517	22677	2003	25269	1186	31067	982	22347
20-#14	4.12	MA	16105	4532	27468	3572	32965	2854	36387	2272	41222	1294	52964	573	48273
7L-5S		MI	10277	4532	18195	3438	21373	2715	23268	2122	26043	1116	32408	501	29552
20-#14	4.12	MA	15320	4532	26279	3573	31399	2853	34431	2268	38602	1302	49652	497	46066
8L-4S		MI	10777	4532	18994	3429	22318	2722	24389	2115	27567	1123	34249	563	30212
20-#14	4.12	MA	14540	4532	24967	3589	29786	2867	32507	2280	36008	1309	46390	412	43634
9L-3S		MI	11325	4532	19780	3434	23364	2715	25624	2122	29132	1116	35988	686	31299
22-#11	3.14	MA	15613	4143	25236	3335	30259	2679	33153	2159	36900	1317	46955	804	39071
7L-6S		MI	9505	4143	16059	3210	18787	2569	20224	2034	22077	1184	27300	670	23093
22-#11	3.14	MA	15048	4143	24408	3336	29167	2679	31789	2157	35074	1323	44630	751	37936
8L-5S		MI	9851	4143	16559	3213	19448	2563	21007	2039	23080	1179	28521	733	23564
22-#11	3.14	MA	14486	4143	23493	3347	28042	2689	30447	2166	33265	1329	42336	692	36644
9L-4S		MI	10211	4143	17119	3206	20118	2569	21801	2034	24160	1184	29831	776	24040
22-#11	3.14	MA	13927	4143	22667	3348	26958	2688	29099	2164	31405	1324	39963	612	35154
10L-3S		MI	10605	4143	17670	3209	20859	2563	22677	2039	25269	1179	31067	862	24419
22-#11	3.14	MA	13331	4143	21848	3349	25846	2698	27766	2173	29603	1331	37678	556	33655
11L-2S		MI	11138	4143	18400	3212	21781	2569	23772	2034	26711	1173	32945	954	24495
22-#14	4.53	MA	16176	4695	28135	3675	33753	2928	37283	2316	42449	1294	54799	477	51359
8L-5S		MI	10745	4695	19233	3541	22675	2788	24814	2165	28077	1096	35047	457	32397
22-#14	4.53	MA	15408	4695	26822	3691	32139	2942	35358	2328	39855	1302	51538	392	48901
9L-4S		MI	11229	4695	20032	3531	23619	2796	25934	2158	29601	1104	36888	520	33137
24-#11	3.43	MA	15657	4257	25704	3407	30812	2731	33781	2190	37762	1318	48250	738	41620
8L-6S		MI	9823	4257	16789	3280	19709	2620	21319	2064	23518	1172	29178	642	25125
24-#11	3.43	MA	15102	4257	24789	3418	29687	2740	32440	2199	35953	1324	45956	680	40354
9L-5S		MI	10165	4257	17289	3284	20371	2615	22102	2069	24522	1167	30399	705	25644
24-#11	3.43	MA	14549	4257	23964	3419	28603	2740	31092	2197	34093	1319	43583	599	38846
10L-4S		MI	10522	4257	17849	3277	21040	2620	22896	2064	25601	1172	31709	748	26098
24-#11	3.43	MA	13956	4257	23144	3420	27490	2750	29758	2206	32291	1325	41298	543	37334
11L-3S		MI	10913	4257	18400	3280	21781	2615	23772	2069	26711	1167	32945	834	26551
24-#14	4.95	MA	16262	4859	28678	3793	34493	3017	38210	2375	43702	1294	56686	372	54174
9L-5S		MI	11171	4859	20271	3643	23977	2862	26359	2208	30112	1077	37687	413	35254

RECTANGULAR TIED COLUMNS 26" x 44"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.40	MA	16781	3615	24490	3006	29111	2440	31383	2015	33716	1390	41201	1294	20963
2E		MI	9528	3615	14655	2866	16659	2312	17505	1891	18195	1264	21606	1120	11609
6-#14	1.18	MA	16347	3525	23345	2967	27812	2413	29875	2001	31767	1406	38784	1326	17937
2L-3S		MI	8543	3525	13011	2834	14808	2296	15362	1905	15409	1311	18094	1052	10067
6-#14	1.18	MA	14812	3525	21387	2968	25328	2412	26867	2014	27708	1415	33321	1194	17868
3L-2S		MI	9351	3525	14049	2840	16109	2304	16908	1898	17443	1303	20734	1184	10027
6-#18	2.10	MA	18375	3906	27920	3187	33461	2573	36653	2099	40806	1376	50654	1255	31111
2L-3S		MI	8946	3906	14655	3034	16659	2425	17505	1975	18195	1238	21606	797	16870
6-#18	2.10	MA	15787	3906	24490	3188	29111	2569	31383	2119	33716	1389	41201	1021	30622
3L-2S		MI	10300	3906	16449	3047	18871	2438	20133	1962	21653	1225	26054	1031	16978
8-#11	1.09	MA	16167	3488	22860	2953	27274	2404	29258	1997	30956	1413	37799	1339	16690
2L-4S		MI	8283	3488	12505	2825	14214	2303	14690	1902	14586	1331	17267	1033	9409
8-#11	1.09	MA	15090	3488	21492	2954	25539	2404	27156	2006	28121	1419	33960	1248	16664
3E		MI	8707	3488	13056	2829	14955	2298	15566	1907	15695	1325	18502	1120	9399

RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis



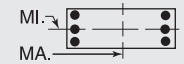
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.09	MA	14311	3488	20478	2955	24168	2414	25494	2005	25878	1416	31427	1157	16534
4L-2S		MI	9278	3488	13786	2832	15878	2303	16662	1902	17137	1320	20381	1211	9369
8-#14	1.57	MA	17287	3688	25303	3069	30295	2488	32884	2049	35826	1399	44247	1307	23741
2L-4S		MI	8423	3688	13263	2931	15063	2377	15672	1940	15878	1299	18994	886	13055
8-#14	1.57	MA	15778	3688	23345	3070	27812	2487	29875	2061	31767	1407	38784	1176	23618
3E		MI	9017	3688	14049	2936	16109	2370	16908	1948	17443	1292	20734	1009	13148
8-#14	1.57	MA	14685	3688	21891	3072	25846	2502	27493	2058	28551	1401	35182	1044	23191
4L-2S		MI	9814	3688	15087	2942	17411	2377	18454	1940	19477	1284	23373	1140	13143
8-#18	2.80	MA	19913	4197	31350	3369	37810	2706	41922	2183	47896	1362	60107	1215	41223
2L-4S		MI	8731	4197	15083	3203	17092	2565	18031	2033	18993	1212	23111	498	20069
8-#18	2.80	MA	17389	4197	27920	3370	33461	2702	36653	2203	40806	1375	50654	982	40598
3E		MI	9724	4197	16449	3216	18871	2551	20133	2046	21653	1198	26054	708	22077
8-#18	2.80	MA	15562	4197	25366	3370	30009	2726	32470	2196	35181	1362	44436	748	36740
4L-2S		MI	11052	4197	18243	3229	21083	2565	22760	2033	25112	1185	30503	942	22290
10-#11	1.36	MA	16834	3601	24228	3024	29008	2455	31359	2030	33791	1408	41638	1328	20748
2L-5S		MI	8241	3601	12675	2903	14467	2349	14992	1938	14948	1313	17835	962	11283
10-#11	1.36	MA	15770	3601	22860	3025	27274	2455	29258	2039	30956	1414	37799	1237	20696
3L-4S		MI	8625	3601	13235	2896	15136	2354	15786	1933	16028	1319	19145	1005	11562
10-#11	1.36	MA	15001	3601	21846	3026	25903	2466	27596	2037	28713	1411	35265	1146	20533
4L-3S		MI	9045	3601	13786	2900	15878	2349	16662	1938	17137	1313	20381	1091	11578
10-#11	1.36	MA	14306	3601	20820	3038	24672	2466	26093	2047	26668	1417	32630	1099	19856
5L-2S		MI	9609	3601	14516	2903	16800	2354	17757	1933	18579	1308	22259	1183	11561
10-#14	1.97	MA	18204	3852	27261	3171	32778	2563	35892	2096	39885	1391	49710	1289	29531
2L-5S		MI	8360	3852	13502	3042	15421	2443	16097	1990	16388	1273	19792	779	15116
10-#14	1.97	MA	16719	3852	25303	3173	30295	2562	32884	2108	35826	1400	44247	1157	29359
3L-4S		MI	8896	3852	14301	3033	16365	2451	17218	1983	17912	1280	21633	842	15906
10-#14	1.97	MA	15647	3852	23849	3174	28329	2576	30502	2106	32610	1394	40645	1026	28881
4L-3S		MI	9482	3852	15087	3038	17411	2443	18454	1990	19477	1273	23373	965	16207
10-#14	1.97	MA	14675	3852	22379	3190	26564	2576	28347	2118	29677	1402	36888	959	26930
5L-2S		MI	10269	3852	16125	3044	18712	2451	19999	1983	21511	1265	26013	1096	16238
10-#18	3.50	MA	18940	4488	31350	3551	37810	2835	41922	2287	47896	1361	60107	943	50576
3L-4S		MI	9543	4488	16877	3385	19304	2691	20658	2104	22451	1172	27559	408	24998
10-#18	3.50	MA	17160	4488	28796	3552	34359	2859	37739	2280	42271	1347	53889	709	46428
4L-3S		MI	10483	4488	18243	3398	21083	2678	22760	2117	25112	1159	30503	618	27265
10-#18	3.50	MA	15549	4488	26211	3579	31256	2856	33953	2300	37136	1361	47362	594	42852
5L-2S		MI	11786	4488	20037	3411	23295	2691	25387	2104	28570	1145	34951	852	27570
12-#11	1.64	MA	17488	3714	25595	3095	30743	2507	33460	2062	36626	1403	45477	1316	24797
2L-6S		MI	8216	3714	12905	2971	14728	2406	15304	1963	15386	1306	18492	871	12998
12-#11	1.64	MA	16437	3714	24228	3096	29008	2507	31359	2072	33791	1409	41638	1225	24722
3L-5S		MI	8581	3714	13404	2974	15390	2401	16087	1968	16390	1301	19713	934	13327
12-#11	1.64	MA	15678	3714	23213	3097	27637	2518	29697	2070	31548	1405	39104	1134	24530
4E		MI	8961	3714	13964	2967	16059	2406	16881	1963	17469	1306	21024	977	13705
12-#11	1.64	MA	14992	3714	22188	3109	26406	2518	28195	2079	29503	1412	36469	1087	23748
5L-3S		MI	9377	3714	14516	2970	16800	2401	17757	1968	18579	1301	22259	1063	13743
12-#11	1.64	MA	14334	3714	21278	3110	25192	2528	26716	2078	27536	1419	33788	1012	22884
6L-2S		MI	9936	3714	15245	2974	17723	2406	18853	1963	20020	1296	24138	1154	13742
12-#14	2.36	MA	17639	4015	27261	3275	32778	2637	35892	2156	39885	1393	49710	1139	35096
3L-5S		MI	8831	4015	14540	3145	16722	2516	17643	2033	18422	1253	22432	736	18029
12-#14	2.36	MA	16585	4015	25807	3276	30813	2651	33510	2153	36669	1386	46108	1007	34416
4E		MI	9360	4015	15339	3135	17666	2524	18763	2025	19946	1261	24273	798	18762
12-#14	2.36	MA	15631	4015	24337	3292	29048	2651	31356	2166	33736	1395	42351	941	32526
5L-3S		MI	9938	4015	16125	3141	18712	2516	19999	2033	21511	1253	26013	921	19252
12-#14	2.36	MA	14716	4015	23031	3294	27306	2665	29235	2163	30916	1403	38536	832	30906
6L-2S		MI	10715	4015	17163	3146	20014	2524	21545	2025	23545	1246	28652	1052	19314

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

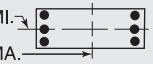


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	4.20	MA	18712	4779	32226	3734	38708	2992	43009	2365	49361	1333	63342	670	56153
4E		MI	10301	4779	18671	3566	21516	2818	23286	2175	25909	1132	32007	319	29964
12-#18	4.20	MA	17141	4779	29641	3761	35606	2989	39223	2384	44226	1346	56815	555	52460
5L-3S		MI	11241	4779	20037	3579	23295	2805	25387	2189	28570	1119	34951	529	32241
12-#18	4.20	MA	15633	4779	27344	3761	32544	3012	35495	2377	39288	1360	50216	361	48385
6L-2S		MI	12489	4779	21831	3592	25507	2818	28015	2175	32028	1106	39399	763	32829
14-#11	1.91	MA	17092	3828	25595	3167	30743	2559	33460	2104	36626	1404	45477	1213	28743
3L-6S		MI	8555	3828	13635	3042	15651	2458	16400	1993	16827	1294	20371	843	15071
14-#11	1.91	MA	16343	3828	24581	3168	29372	2569	31798	2103	34383	1400	42943	1122	28527
4L-5S		MI	8917	3828	14134	3045	16312	2452	17183	1998	17831	1289	21592	905	15382
14-#11	1.91	MA	15666	3828	23556	3180	28141	2569	30296	2112	32338	1407	40308	1076	27652
5L-4S		MI	9292	3828	14694	3038	16981	2458	17977	1993	18911	1294	22902	949	15841
14-#11	1.91	MA	15017	3828	22645	3181	26927	2580	28818	2111	30371	1413	37627	1001	26819
6L-3S		MI	9704	3828	15245	3041	17723	2452	18853	1998	20020	1289	24138	1035	15899
14-#11	1.91	MA	14382	3828	21759	3182	25754	2580	27385	2120	28378	1410	35240	930	25744
7L-2S		MI	10258	3828	15975	3045	18645	2458	19948	1993	21462	1284	26016	1126	15915
14-#14	2.75	MA	17503	4179	27765	3378	33296	2726	36519	2201	40728	1379	51571	989	39948
4L-5S		MI	9294	4179	15578	3247	18024	2590	19189	2075	20456	1234	25072	692	20954
14-#14	2.75	MA	16566	4179	26295	3395	31531	2725	34364	2213	37795	1387	47814	922	38135
5L-4S		MI	9816	4179	16377	3237	18968	2597	20309	2068	21980	1242	26913	755	21637
14-#14	2.75	MA	15667	4179	24989	3396	29789	2740	32244	2210	34975	1396	43999	814	36445
6L-3S		MI	10387	4179	17163	3243	20014	2590	21545	2075	23545	1234	28652	877	22288
14-#14	2.75	MA	14786	4179	23717	3397	28107	2739	30188	2223	32116	1390	40605	712	34581
7L-2S		MI	11154	4179	18201	3248	21315	2597	23091	2068	25580	1227	31292	1009	22379
14-#18	4.90	MA	18692	5069	33070	3943	39956	3122	44493	2468	51316	1332	66268	516	62096
5L-4S		MI	11039	5069	20466	3748	23728	2944	25913	2247	29368	1092	36455	229	34959
14-#18	4.90	MA	17219	5069	30773	3943	36893	3145	40765	2462	46378	1345	59669	322	58017
6L-3S		MI	11956	5069	21831	3761	25507	2931	28015	2260	32028	1079	39399	440	37066
14-#18	4.90	MA	15775	5069	28537	3944	33934	3142	37150	2481	41372	1332	53805	140	52889
7L-2S		MI	13177	5069	23625	3774	27719	2944	30642	2247	35486	1066	43847	673	38074
16-#11	2.18	MA	16997	3941	25949	3239	31106	2621	33900	2136	37218	1395	46782	1111	32523
4L-6S		MI	8890	3941	14364	3113	16573	2509	17495	2024	18269	1282	22249	815	17148
16-#11	2.18	MA	16329	3941	24923	3250	29875	2621	32397	2145	35173	1402	44146	1064	31565
5E		MI	9247	3941	14864	3116	17235	2504	18278	2029	19273	1277	23470	877	17444
16-#11	2.18	MA	15689	3941	24013	3252	28661	2632	30919	2144	33206	1408	41466	989	30759
6L-4S		MI	9619	3941	15424	3109	17904	2509	19072	2024	20352	1282	24780	920	17972
16-#11	2.18	MA	15061	3941	23127	3253	27488	2632	29486	2153	31213	1404	39079	918	29640
7L-3S		MI	10027	3941	15975	3112	18645	2504	19948	2029	21462	1277	26016	1007	18047
16-#11	2.18	MA	14441	3941	22255	3254	26339	2632	28050	2152	29290	1411	36617	864	28600
8L-2S		MI	10576	3941	16705	3115	19568	2509	21044	2024	22903	1272	27895	1098	18078
16-#14	3.15	MA	17482	4342	28253	3497	34014	2800	37373	2260	41854	1380	53277	904	43755
5E		MI	9749	4342	16616	3349	19325	2663	20734	2118	22490	1215	27711	648	23888
16-#14	3.15	MA	16598	4342	26947	3498	32272	2814	35252	2258	39034	1389	49463	795	41996
6L-4S		MI	10265	4342	17415	3340	20269	2671	21855	2110	24014	1223	29552	711	24529
16-#14	3.15	MA	15732	4342	25675	3499	30590	2814	33197	2270	36174	1382	46068	693	40184
7L-3S		MI	10829	4342	18201	3345	21315	2663	23091	2118	25580	1215	31292	833	25318
16-#14	3.15	MA	14875	4342	24424	3501	28941	2813	31137	2268	33416	1391	42559	616	37740
8L-2S		MI	11588	4342	19239	3351	22617	2671	24636	2110	27614	1208	33931	965	25435
16-#18	5.59	MA	18768	5360	34203	4125	41243	3278	46035	2546	53468	1331	69122	283	67624
6L-4S		MI	11761	5360	22260	3930	25940	3071	28541	2318	32826	1053	40903	140	39976
16-#18	5.59	MA	17357	5360	31966	4126	38284	3275	42420	2566	48462	1318	63258	101	62619
7L-3S		MI	12657	5360	23625	3943	27719	3058	30642	2331	35486	1040	43847	350	41931
18-#11	2.45	MA	16982	4055	26291	3321	31610	2673	34499	2178	38008	1396	47985	1052	35486
5L-6S		MI	9220	4055	15094	3184	17496	2561	18591	2054	19710	1270	24128	787	19208
18-#11	2.45	MA	16349	4055	25380	3323	30395	2683	33020	2177	36041	1403	45305	977	34705
6L-5S		MI	9574	4055	15593	3187	18157	2556	19374	2059	20714	1265	25349	849	19512
18-#11	2.45	MA	15730	4055	24494	3324	29223	2683	31587	2186	34048	1399	42917	906	33543
7L-4S		MI	9942	4055	16153	3180	18826	2561	20168	2054	21794	1270	26659	892	20059

RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

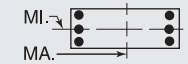


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.45	MA	15118	4055	23622	3325	28074	2683	30152	2184	32125	1406	40456	852	32493
8L-3S		MI	10346	4055	16705	3183	19568	2556	21044	2059	22903	1265	27895	979	20191
18-#11	2.45	MA	14510	4055	22659	3337	26889	2694	28739	2194	30220	1412	38021	794	31027
9L-2S		MI	10890	4055	17434	3186	20490	2561	22139	2054	24345	1260	29773	1070	20235
18-#14	3.54	MA	17512	4506	28905	3600	34756	2889	38261	2305	43093	1381	54926	777	47559
6L-5S		MI	10199	4506	17654	3451	20627	2736	22280	2160	24525	1196	30351	604	26829
18-#14	3.54	MA	16660	4506	27633	3602	33073	2889	36205	2318	40233	1375	51531	675	45783
7L-4S		MI	10707	4506	18453	3442	21571	2744	23401	2153	26048	1204	32192	667	27433
18-#14	3.54	MA	15816	4506	26382	3603	31424	2888	34146	2315	37475	1383	48022	598	43318
8L-3S		MI	11265	4506	19239	3447	22617	2736	24636	2160	27614	1196	33931	790	28343
18-#14	3.54	MA	14978	4506	25000	3619	29725	2902	32119	2328	34743	1392	44559	513	40865
9L-2S		MI	12016	4506	20277	3453	23918	2744	26182	2153	29648	1189	36571	921	28485
18-#18	6.29	MA	18905	5651	35396	4307	42634	3408	47690	2650	55552	1303	72711	62	72364
7L-4S		MI	12470	5651	24054	4112	28152	3198	31168	2389	36284	1013	45351	51	45012
20-#11	2.73	MA	17000	4168	26748	3393	32130	2735	35122	2210	38876	1398	49143	966	38655
6E		MI	9545	4168	15824	3254	18418	2612	19686	2084	21152	1258	26006	759	21224
20-#11	2.73	MA	16388	4168	25862	3395	30957	2735	33689	2219	36883	1394	46756	895	37451
7L-5S		MI	9896	4168	16323	3258	19080	2607	20469	2090	22156	1253	27227	821	21585
20-#11	2.73	MA	15784	4168	24990	3396	29808	2735	32253	2217	34960	1401	44295	841	36373
8L-4S		MI	10261	4168	16883	3251	19749	2612	21263	2084	23235	1258	28537	864	22102
20-#11	2.73	MA	15183	4168	24027	3407	28624	2746	30841	2226	33055	1407	41860	782	34936
9L-3S		MI	10661	4168	17434	3254	20490	2607	22139	2090	24345	1253	29773	951	22331
20-#11	2.73	MA	14585	4168	23158	3409	27483	2746	29421	2225	31097	1403	39343	702	33453
10L-2S		MI	11201	4168	18164	3257	21413	2612	23235	2084	25786	1248	31652	1042	22388
20-#14	3.93	MA	17571	4670	29591	3704	35556	2963	39214	2365	44292	1367	56994	656	51317
7L-5S		MI	10642	4670	18692	3553	21928	2810	23826	2203	26559	1177	32990	561	29771
20-#14	3.93	MA	16741	4670	28340	3705	33908	2963	37154	2363	41534	1376	53485	579	48903
8L-4S		MI	11145	4670	19491	3544	22872	2817	24946	2195	28083	1185	34831	623	30348
20-#14	3.93	MA	15916	4670	26958	3721	32209	2977	35128	2375	38802	1385	50022	494	46426
9L-3S		MI	11696	4670	20277	3550	23918	2810	26182	2203	29648	1177	36571	746	31364
22-#11	3.00	MA	17038	4281	27230	3466	32692	2787	35790	2251	39718	1389	50595	883	41365
7L-6S		MI	9868	4281	16553	3325	19341	2664	20782	2115	22593	1246	27885	731	23248
22-#11	3.00	MA	16440	4281	26357	3467	31542	2787	34354	2250	37795	1395	48133	829	40259
8L-5S		MI	10215	4281	17053	3329	20002	2659	21565	2120	23597	1241	29106	793	23662
22-#11	3.00	MA	15847	4281	25394	3478	30358	2797	32942	2259	35890	1402	45699	771	38849
9L-4S		MI	10577	4281	17613	3322	20672	2664	22359	2115	24677	1246	30416	836	24153
22-#11	3.00	MA	15251	4281	24525	3480	29217	2797	31523	2258	33932	1398	43182	690	37349
10L-3S		MI	10973	4281	18164	3325	21413	2659	23235	2120	25786	1241	31652	923	24468
22-#11	3.00	MA	14617	4281	23663	3481	28046	2808	30119	2267	32036	1405	40763	634	35834
11L-2S		MI	11509	4281	18894	3328	22335	2664	24330	2115	27228	1236	33530	1014	24537
22-#14	4.33	MA	17651	4833	30298	3807	36391	3038	40163	2410	45593	1369	58948	561	54495
8L-5S		MI	11114	4833	19730	3656	23230	2883	25372	2245	28593	1158	35630	517	32614
22-#14	4.33	MA	16838	4833	28916	3824	34692	3052	38136	2422	42861	1377	55485	476	51993
9L-4S		MI	11602	4833	20529	3646	24174	2891	26492	2238	30117	1166	37471	579	33271
24-#11	3.27	MA	17088	4395	27725	3538	33277	2839	36456	2283	40630	1390	51972	817	44149
8L-6S		MI	10187	4395	17283	3396	20263	2716	21877	2145	24035	1234	29763	702	25279
24-#11	3.27	MA	16501	4395	26762	3549	32093	2849	35043	2292	38725	1397	49537	759	42766
9L-5S		MI	10531	4395	17783	3400	20925	2710	22660	2150	25039	1229	30984	765	25742
24-#11	3.27	MA	15908	4395	25893	3550	30951	2849	33624	2291	36767	1393	47021	679	41248
10L-4S		MI	10889	4395	18342	3392	21594	2716	23454	2145	26118	1234	32294	808	26209
24-#11	3.27	MA	15280	4395	25031	3552	29781	2860	32220	2300	34871	1400	44601	622	39721
11L-3S		MI	11282	4395	18894	3396	22335	2710	24330	2150	27228	1229	33530	894	26602
24-#14	4.72	MA	17746	4997	30874	3926	37175	3127	41145	2470	46920	1370	60948	457	57567
9L-5S		MI	11542	4997	20768	3758	24531	2956	26917	2288	30627	1139	38269	473	35468

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis

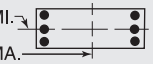


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.34	MA	18233	3753	26409	3135	31444	2546	33883	2105	36354	1462	44447	1367	22043
2E		MI	9889	3753	15158	2979	17215	2405	18062	1970	18708	1325	22184	1179	11645
6-#14	1.13	MA	17767	3662	25198	3096	30069	2519	32288	2091	34249	1476	41860	1397	18848
2L-3S		MI	8902	3662	13509	2949	15362	2391	15920	1986	15924	1372	18676	1112	10101
6-#14	1.13	MA	16147	3662	23138	3098	27456	2519	29122	2104	29978	1485	36081	1266	18780
3L-2S		MI	9712	3662	14547	2955	16664	2399	17466	1978	17958	1365	21316	1244	10056
6-#18	2.01	MA	19926	4044	30021	3317	36024	2679	39432	2189	43840	1449	54460	1331	32731
2L-3S		MI	9307	4044	15158	3148	17215	2518	18062	2055	18708	1299	22184	856	16937
6-#18	2.01	MA	17190	4044	26409	3318	31444	2677	33883	2210	36354	1462	44447	1097	32242
3L-2S		MI	10665	4044	16952	3161	19427	2532	20689	2041	22166	1286	26632	1090	17021
8-#11	1.04	MA	17575	3625	24685	3082	29500	2510	31634	2087	33392	1482	40806	1411	17533
2L-4S		MI	8642	3625	12999	2941	14768	2398	15248	1983	15103	1393	17851	1093	9445
8-#11	1.04	MA	16438	3625	23247	3084	27676	2510	29424	2097	30410	1489	36749	1319	17507
3E		MI	9067	3625	13550	2944	15509	2393	16124	1988	16212	1388	19087	1180	9427
8-#11	1.04	MA	15617	3625	22181	3085	26235	2521	27677	2096	28053	1486	34068	1228	17376
4L-2S		MI	9639	3625	14280	2948	16432	2398	17220	1983	17654	1382	20966	1271	9394
8-#14	1.51	MA	18765	3826	27259	3198	32682	2594	35453	2139	38520	1468	47639	1380	24956
2L-4S		MI	8782	3826	13760	3046	15618	2472	16230	2021	16393	1361	19576	946	13114
8-#14	1.51	MA	17171	3826	25198	3200	30069	2594	32288	2152	34249	1478	41860	1249	24833
3E		MI	9378	3826	14547	3051	16664	2464	17466	2028	17958	1353	21316	1068	13189
8-#14	1.51	MA	16020	3826	23670	3202	28003	2609	29783	2150	30869	1472	38047	1118	24406
4L-2S		MI	10177	3826	15585	3057	17965	2472	19011	2021	19993	1346	23956	1200	13175
8-#18	2.68	MA	21560	4335	33632	3498	40604	2812	44981	2274	51327	1435	64473	1295	43383
2L-4S		MI	9089	4335	15586	3317	17648	2658	18588	2113	19506	1273	23689	557	20263
8-#18	2.68	MA	18891	4335	30021	3500	36024	2810	39432	2294	43840	1449	54460	1061	42758
3E		MI	10087	4335	16952	3330	19427	2645	20689	2126	22166	1259	26632	767	22152
8-#18	2.68	MA	16963	4335	27335	3501	32394	2834	35032	2289	37903	1436	47866	827	38926
4L-2S		MI	11419	4335	18746	3343	21639	2658	23317	2113	25624	1246	31080	1001	22341
10-#11	1.30	MA	18282	3739	26124	3153	31325	2562	33844	2120	36374	1477	44864	1400	21801
2L-5S		MI	8599	3739	13169	3019	15021	2445	15550	2019	15465	1376	18420	1022	11381
10-#11	1.30	MA	17159	3739	24685	3155	29500	2562	31634	2129	33392	1484	40806	1309	21749
3L-4S		MI	8984	3739	13729	3012	15690	2450	16344	2014	16545	1381	19730	1065	11602
10-#11	1.30	MA	16349	3739	23620	3156	28059	2573	29888	2129	31035	1481	38126	1218	21586
4L-3S		MI	9405	3739	14280	3015	16432	2445	17220	2019	17654	1376	20966	1152	11610
10-#11	1.30	MA	15616	3739	22543	3168	26767	2573	28310	2138	28886	1488	35345	1170	20968
5L-2S		MI	9971	3739	15010	3019	17354	2450	18315	2014	19095	1370	22844	1243	11589
10-#14	1.88	MA	19738	3990	29319	3301	35295	2669	38619	2186	42791	1461	53417	1363	31049
2L-5S		MI	8718	3990	13999	3157	15975	2538	16655	2071	16904	1334	20375	839	15239
10-#14	1.88	MA	18170	3990	27259	3302	32682	2669	35453	2199	38520	1470	47639	1232	30878
3L-4S		MI	9256	3990	14798	3148	16919	2545	17775	2063	18427	1342	22216	902	16048
10-#14	1.88	MA	17039	3990	25731	3304	30616	2684	32949	2197	35140	1465	43825	1100	30400
4L-3S		MI	9844	3990	15585	3154	17965	2538	19011	2071	19993	1334	23956	1025	16252
10-#14	1.88	MA	16015	3990	24185	3321	28762	2684	30685	2210	32058	1474	39857	1033	28442
5L-2S		MI	10633	3990	16623	3159	19267	2545	20557	2063	22027	1327	26595	1156	16274
10-#18	3.34	MA	20538	4626	33632	3681	40604	2943	44981	2379	51327	1436	64473	1025	53276
3L-4S		MI	9869	4626	17380	3498	19861	2785	21215	2184	22964	1233	28137	467	25188
10-#18	3.34	MA	18659	4626	30947	3683	36974	2967	40581	2373	45389	1423	57879	791	49141
4L-3S		MI	10848	4626	18746	3511	21639	2772	23317	2197	25624	1220	31080	678	27348
10-#18	3.34	MA	16958	4626	28229	3711	33713	2965	36601	2394	39970	1437	50979	674	45574
5L-2S		MI	12156	4626	20540	3524	23851	2785	25944	2184	29083	1206	35528	911	27625
12-#11	1.57	MA	18976	3852	27562	3224	33149	2614	36054	2153	39356	1472	48922	1389	26061
2L-6S		MI	8574	3852	13399	3087	15282	2501	15863	2044	15903	1369	19077	931	13091
12-#11	1.57	MA	17866	3852	26124	3225	31325	2614	33844	2162	36374	1479	44864	1298	25986
3L-5S		MI	8941	3852	13898	3090	15944	2496	16645	2049	16906	1363	20298	994	13425
12-#11	1.57	MA	17066	3852	25058	3227	29884	2625	32098	2161	34016	1476	42184	1207	25794
4E		MI	9321	3852	14458	3083	16613	2501	17440	2044	17986	1369	21608	1037	13749

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis



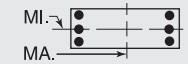
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.57	MA	16344	3852	23981	3239	28591	2625	30520	2171	31868	1483	39402	1160	25065
5L-3S		MI	9738	3852	15010	3086	17354	2496	18315	2049	19095	1363	22844	1123	13779
12-#11	1.57	MA	15651	3852	23025	3240	27316	2636	28967	2170	29803	1490	36569	1085	24128
6L-2S		MI	10299	3852	15739	3089	18277	2501	19411	2044	20537	1358	24723	1215	13773
12-#14	2.26	MA	19146	4153	29319	3405	35295	2744	38619	2247	42791	1463	53417	1215	36919
3L-5S		MI	9191	4153	15037	3260	17277	2611	18201	2113	18938	1315	23015	795	18152
12-#14	2.26	MA	18034	4153	27791	3406	33229	2758	36115	2245	39411	1457	49604	1083	36396
4E		MI	9721	4153	15836	3250	18221	2619	19321	2106	20461	1323	24855	858	18901
12-#14	2.26	MA	17028	4153	26246	3423	31375	2758	33851	2258	36329	1467	45636	1016	34336
5L-3S		MI	10302	4153	16623	3256	19267	2611	20557	2113	22027	1315	26595	981	19302
12-#14	2.26	MA	16064	4153	24874	3425	29545	2773	31624	2256	33366	1476	41601	908	32759
6L-2S		MI	11081	4153	17660	3261	20569	2619	22103	2106	24061	1308	29235	1112	19355
12-#18	4.01	MA	20306	4916	34558	3865	41554	3100	46130	2457	52875	1410	67892	755	59393
4E		MI	10665	4916	19175	3680	22073	2911	23843	2255	26422	1193	32585	378	30150
12-#18	4.01	MA	18647	4916	31841	3893	38293	3098	42150	2478	47456	1423	60992	638	55712
5L-3S		MI	11611	4916	20540	3693	23851	2898	25944	2268	29083	1180	35528	588	32492
12-#18	4.01	MA	17054	4916	29427	3894	35074	3122	38232	2472	42245	1437	54001	445	51273
6L-2S		MI	12867	4916	22334	3706	26063	2911	28572	2255	32541	1167	39976	822	32889
14-#11	1.83	MA	18560	3966	27562	3296	33149	2666	36054	2195	39356	1474	48922	1287	30217
3L-6S		MI	8914	3966	14129	3158	16205	2553	16958	2074	17344	1357	20955	903	15164
14-#11	1.83	MA	17771	3966	26497	3298	31708	2676	34308	2194	36998	1471	46241	1196	30001
4L-5S		MI	9277	3966	14628	3161	16866	2548	17741	2079	18348	1351	22177	966	15478
14-#11	1.83	MA	17058	3966	25420	3310	30415	2677	32730	2204	34850	1478	43460	1149	29175
5L-4S		MI	9654	3966	15188	3154	17535	2553	18535	2074	19428	1357	23487	1009	15889
14-#11	1.83	MA	16374	3966	24464	3311	29140	2687	31177	2203	32784	1485	40626	1074	28270
6L-3S		MI	10067	3966	15739	3157	18277	2548	19411	2079	20537	1351	24723	1095	15938
14-#11	1.83	MA	15705	3966	23533	3313	27909	2688	29673	2212	30691	1481	38101	1003	27225
7L-2S		MI	10622	3966	16469	3160	19199	2553	20506	2074	21978	1346	26601	1186	15948
14-#14	2.63	MA	19008	4317	29851	3509	35842	2833	39280	2292	43682	1450	55383	1066	42229
4L-5S		MI	9655	4317	16075	3362	18578	2684	19746	2156	20972	1296	25654	752	21076
14-#14	2.63	MA	18019	4317	28306	3525	33987	2833	37017	2305	40600	1459	51415	999	40243
5L-4S		MI	10178	4317	16874	3353	19523	2692	20867	2148	22496	1304	27495	814	21775
14-#14	2.63	MA	17071	4317	26934	3527	32158	2848	34789	2303	37637	1468	47379	891	38596
6L-3S		MI	10752	4317	17660	3358	20569	2684	22103	2156	24061	1296	29235	937	22342
14-#14	2.63	MA	16142	4317	25599	3529	30390	2848	32630	2316	34633	1463	43786	789	36573
7L-2S		MI	11522	4317	18698	3364	21870	2692	23649	2148	26095	1289	31874	1068	22422
14-#18	4.68	MA	20292	5207	35452	4074	42873	3231	47699	2562	54943	1410	71005	602	65878
5L-4S		MI	11406	5207	20969	3862	24285	3038	26470	2326	29880	1154	37033	288	35142
14-#18	4.68	MA	18737	5207	33038	4076	39654	3255	43781	2557	49731	1424	64014	409	61576
6L-3S		MI	12329	5207	22334	3875	26063	3025	28572	2339	32541	1140	39976	499	37311
14-#18	4.68	MA	17212	5207	30688	4077	36545	3253	39982	2577	44448	1411	57798	227	56167
7L-2S		MI	13559	5207	24128	3888	28275	3038	31199	2326	35999	1127	44424	732	38137
16-#11	2.09	MA	18465	4079	27935	3369	33532	2728	36518	2227	39980	1465	50299	1186	34208
4L-6S		MI	9249	4079	14858	3229	17127	2604	18054	2105	18786	1344	22834	875	17242
16-#11	2.09	MA	17760	4079	26858	3381	32240	2729	34940	2237	37832	1473	47518	1138	33293
5E		MI	9608	4079	15358	3232	17789	2599	18836	2110	19790	1339	24055	937	17540
16-#11	2.09	MA	17086	4079	25902	3382	30964	2739	33388	2236	35766	1480	44684	1063	32418
6L-4S		MI	9982	4079	15918	3225	18458	2604	19631	2105	20869	1344	25365	981	18023
16-#11	2.09	MA	16425	4079	24972	3383	29733	2740	31883	2245	33673	1476	42159	993	31328
7L-3S		MI	10391	4079	16469	3228	19199	2599	20506	2110	21978	1339	26601	1067	18089
16-#11	2.09	MA	15771	4079	24056	3385	28526	2740	30375	2244	31653	1483	39561	938	30204
8L-2S		MI	10941	4079	17199	3231	20122	2604	21602	2105	23420	1334	28479	1158	18114
16-#14	3.01	MA	18991	4480	30366	3627	36600	2908	40182	2352	44871	1452	57193	982	46161
5E		MI	10112	4480	17113	3464	19880	2758	21292	2198	23006	1277	28294	708	24010

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis

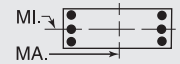


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.01	MA	18058	4480	28994	3629	34771	2923	37955	2351	41908	1461	53158	874	44446
6L-4S		MI	10629	4480	17912	3455	20824	2765	22413	2191	24530	1285	30135	771	24665
16-#14	3.01	MA	17145	4480	27659	3631	33003	2923	35795	2364	38904	1455	49565	772	42475
7L-3S		MI	11196	4480	18698	3460	21870	2758	23649	2198	26095	1277	31874	893	25375
16-#14	3.01	MA	16241	4480	26345	3632	31272	2923	33632	2362	36006	1465	45859	694	40001
8L-2S		MI	11958	4480	19736	3466	23172	2765	25194	2191	28129	1270	34514	1025	25481
16-#18	5.35	MA	20379	5498	36650	4257	44235	3388	49330	2641	57218	1411	74027	373	71882
6L-4S		MI	12131	5498	22763	4044	26497	3165	29097	2397	33338	1114	41481	199	40157
16-#18	5.35	MA	18889	5498	34299	4259	41125	3386	45530	2662	51935	1398	67811	191	66432
7L-3S		MI	13033	5498	24128	4057	28275	3151	31199	2410	35999	1101	44424	409	42171
16-#18	5.35	MA	17413	5498	31986	4260	38077	3384	41724	2656	46836	1412	61367	56	61010
8L-2S		MI	14238	5498	25922	4070	30487	3165	33827	2397	39457	1087	48873	643	43374
18-#11	2.35	MA	18452	4192	28297	3451	34064	2781	37150	2269	40814	1467	51575	1128	37420
5L-6S		MI	9580	4192	15588	3299	18050	2656	19149	2135	20227	1332	24712	847	19323
18-#11	2.35	MA	17786	4192	27341	3453	32789	2791	35598	2269	38748	1474	48742	1053	36572
6L-5S		MI	9936	4192	16087	3303	18711	2651	19932	2140	21231	1327	25934	909	19608
18-#11	2.35	MA	17133	4192	26410	3454	31557	2791	34093	2278	36655	1471	46217	982	35437
7L-4S		MI	10306	4192	16647	3296	19380	2656	20726	2135	22311	1332	27244	952	20154
18-#11	2.35	MA	16488	4192	25495	3456	30351	2792	32585	2277	34635	1478	43618	928	34339
8L-3S		MI	10711	4192	17199	3299	20122	2651	21602	2140	23420	1327	28479	1039	20235
18-#11	2.35	MA	15847	4192	24483	3468	29107	2802	31102	2287	32635	1485	41044	869	32834
9L-2S		MI	11257	4192	17928	3302	21044	2656	22697	2135	24861	1322	30358	1130	20273
18-#14	3.39	MA	19027	4644	31055	3731	37384	2998	41120	2398	46179	1454	58937	857	50306
6L-5S		MI	10562	4644	18151	3566	21181	2831	22838	2241	25040	1258	30933	664	26951
18-#14	3.39	MA	18128	4644	29719	3733	35616	2997	38961	2411	43175	1448	55344	755	48386
7L-4S		MI	11073	4644	18950	3557	22126	2839	23958	2233	26564	1266	32774	727	27568
18-#14	3.39	MA	17239	4644	28405	3735	33885	2997	36798	2409	40277	1457	51637	677	45879
8L-3S		MI	11634	4644	19736	3563	23172	2831	25194	2241	28129	1258	34514	849	28403
18-#14	3.39	MA	16354	4644	26954	3751	32100	3012	34669	2422	37407	1467	47973	593	43389
9L-2S		MI	12387	4644	20774	3568	24473	2839	26740	2233	30163	1251	37153	981	28532
18-#18	6.02	MA	20529	5789	37911	4441	45705	3519	51079	2746	59421	1385	77824	155	76712
7L-4S		MI	12842	5789	24557	4225	28709	3291	31725	2468	36797	1074	45929	110	45191
18-#18	6.02	MA	19084	5789	35597	4442	42657	3517	47273	2740	54322	1398	71380	20	71250
8L-3S		MI	13726	5789	25922	4238	30487	3278	33827	2482	39457	1061	48873	320	47066
20-#11	2.61	MA	18475	4306	28779	3524	34613	2843	37808	2301	41730	1469	52799	1042	40729
6E		MI	9907	4306	16318	3370	18972	2708	20245	2165	21669	1320	26591	819	21378
20-#11	2.61	MA	17831	4306	27849	3525	33382	2843	36303	2311	39637	1466	50274	971	39552
7L-5S		MI	10259	4306	16817	3374	19634	2702	21027	2171	22673	1315	27812	881	21681
20-#11	2.61	MA	17193	4306	26933	3527	32175	2844	34796	2310	37617	1473	47676	917	38479
8L-4S		MI	10626	4306	17377	3366	20303	2708	21822	2165	23752	1320	29122	924	22213
20-#11	2.61	MA	16560	4306	25922	3539	30931	2854	33312	2319	35617	1480	45101	858	36950
9L-3S		MI	11028	4306	17928	3370	21044	2702	22697	2171	24861	1315	30358	1011	22377
20-#11	2.61	MA	15921	4306	25010	3540	29733	2855	31822	2318	33561	1477	42440	778	35463
10L-2S		MI	11569	4306	18658	3373	21967	2708	23793	2165	26303	1310	32236	1102	22427
20-#14	3.76	MA	19095	4807	31780	3835	38229	3072	42126	2458	47446	1441	61122	738	54304
7L-5S		MI	11007	4807	19189	3669	22483	2904	24384	2283	27074	1239	33573	620	29897
20-#14	3.76	MA	18219	4807	30466	3837	36498	3072	39963	2456	44548	1450	57416	660	51764
8L-4S		MI	11512	4807	19988	3659	23427	2912	25504	2276	28598	1247	35414	683	30481
20-#14	3.76	MA	17348	4807	29014	3854	34713	3087	37835	2469	41678	1459	53751	576	49251
9L-3S		MI	12066	4807	20774	3665	24473	2904	26740	2283	30163	1239	37153	806	31426
20-#14	3.76	MA	16459	4807	27705	3855	32994	3087	35697	2467	38728	1454	49963	460	46677
10L-2S		MI	12813	4807	21812	3670	25775	2912	28286	2276	32197	1232	39793	937	31579
20-#18	6.69	MA	20723	6080	39208	4624	47238	3650	52822	2824	61809	1385	81393	-16	81224
8L-4S		MI	13543	6080	26351	4407	30921	3418	34352	2540	40255	1035	50377	20	50239
22-#11	2.87	MA	18519	4419	29287	3596	35206	2895	38513	2344	42619	1461	54332	961	43673
7L-6S		MI	10230	4419	17047	3441	19895	2759	21340	2196	23110	1308	28469	791	23401
22-#11	2.87	MA	17889	4419	28372	3598	33999	2895	37006	2343	40599	1468	51734	906	42602
8L-5S		MI	10579	4419	17547	3444	20556	2754	22123	2201	24114	1303	29691	853	23758

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.87	MA	17263	4419	27360	3609	32756	2906	35523	2352	38599	1475	49159	848	41071
9L-4S		MI	10943	4419	18107	3437	21225	2759	22917	2196	25194	1308	31001	896	24263
22-#11	2.87	MA	16627	4419	26448	3611	31558	2906	34033	2351	36543	1472	46498	768	39567
10L-3S		MI	11341	4419	18658	3441	21967	2754	23793	2201	26303	1303	32236	983	24516
22-#11	2.87	MA	15958	4419	25543	3612	30328	2917	32559	2361	34551	1479	43944	710	38042
11L-2S		MI	11878	4419	19388	3444	22889	2759	24888	2196	27745	1298	34115	1074	24578
22-#14	4.14	MA	19183	4971	32526	3939	39110	3147	43129	2504	48819	1442	63195	643	57656
8L-5S		MI	11446	4971	20227	3771	23785	2978	25929	2326	29108	1220	36212	577	32826
22-#14	4.14	MA	18325	4971	31074	3956	37326	3162	41000	2517	45949	1452	59530	559	55119
9L-4S		MI	11946	4971	21026	3761	24729	2985	27050	2318	30632	1228	38053	639	33404
22-#14	4.14	MA	17440	4971	29765	3957	35606	3162	38862	2515	42998	1446	55741	443	52529
10L-3S		MI	12495	4971	21812	3767	25775	2978	28286	2326	32197	1220	39793	762	34446
24-#11	3.13	MA	18575	4533	29810	3668	35824	2947	39216	2376	43581	1463	55791	896	46700
8L-6S		MI	10550	4533	17777	3512	20817	2811	22436	2226	24552	1296	30348	763	25430
24-#11	3.13	MA	17957	4533	28799	3680	34580	2958	37733	2385	41581	1470	53217	837	45196
9L-5S		MI	10896	4533	18276	3515	21479	2806	23218	2231	25556	1291	31569	825	25838
24-#11	3.13	MA	17323	4533	27887	3682	33382	2958	36243	2384	39525	1467	50556	757	43674
10L-4S		MI	11256	4533	18836	3508	22148	2811	24013	2226	26635	1296	32879	868	26319
24-#11	3.13	MA	16661	4533	26981	3683	32153	2969	34769	2394	37533	1474	48002	700	42138
11L-3S		MI	11651	4533	19388	3511	22889	2806	24888	2231	27745	1291	34115	955	26652
24-#11	3.13	MA	16008	4533	26081	3685	30958	2969	33287	2393	35551	1481	45448	642	40445
12L-2S		MI	12184	4533	20117	3515	23812	2811	25984	2226	29186	1286	35993	1046	26725
24-#14	4.52	MA	19287	5135	33135	4058	39939	3237	44166	2564	50220	1444	65309	542	60993
9L-5S		MI	11913	5135	21265	3873	25086	3051	27475	2368	31143	1201	38852	533	35677
24-#14	4.52	MA	18406	5135	31825	4060	38219	3237	42028	2562	47269	1439	61520	426	58387
10L-4S		MI	12397	5135	22064	3864	26030	3059	28596	2361	32666	1209	40693	595	36334

RECTANGULAR TIED COLUMNS 26" x 48"

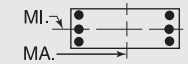
4-#18	1.28	MA	19740	3891	28393	3264	33858	2652	36469	2195	39035	1531	47790	1439	23123
2E		MI	10251	3891	15661	3093	17771	2499	18619	2050	19221	1386	22762	1238	11680
6-#14	1.08	MA	19243	3800	27116	3226	32408	2626	34786	2182	36815	1545	45033	1469	19759
2L-3S		MI	9262	3800	14006	3064	15917	2486	16478	2066	16440	1434	19259	1172	10133
6-#14	1.08	MA	17537	3800	24954	3228	29666	2626	31463	2195	32332	1555	38939	1337	19691
3L-2S		MI	10073	3800	15044	3070	17219	2493	18023	2059	18474	1427	21899	1303	10084
6-#18	1.92	MA	21534	4182	32186	3446	38669	2785	42297	2280	46898	1518	58364	1406	34351
2L-3S		MI	9667	4182	15661	3262	17771	2612	18619	2134	19221	1360	22762	915	17000
6-#18	1.92	MA	18650	4182	28393	3448	33858	2784	36469	2302	39035	1533	47790	1172	33862
3L-2S		MI	11029	4182	17455	3275	19983	2625	21246	2121	22679	1347	27210	1149	17063
8-#11	1.00	MA	19038	3763	26575	3211	31808	2616	34096	2177	35910	1552	43911	1481	18375
2L-4S		MI	9000	3763	13493	3057	15322	2493	15807	2064	15620	1455	18436	1153	9478
8-#11	1.00	MA	17842	3763	25066	3213	29894	2617	31777	2187	32781	1559	39634	1390	18349
3E		MI	9427	3763	14044	3060	16063	2488	16682	2069	16729	1450	19672	1240	9454
8-#11	1.00	MA	16979	3763	23949	3215	28383	2628	29946	2187	30310	1556	36806	1299	18219
4L-2S		MI	9999	3763	14774	3064	16986	2493	17778	2064	18171	1445	21550	1331	9420
8-#14	1.44	MA	20298	3964	29279	3328	35151	2701	38108	2229	41297	1538	51128	1453	26171
2L-4S		MI	9141	3964	14257	3161	16173	2567	16787	2101	16909	1423	20159	1006	13169
8-#14	1.44	MA	18620	3964	27116	3330	32408	2701	34786	2243	36815	1548	45033	1322	26048
3E		MI	9739	3964	15044	3167	17219	2559	18023	2109	18474	1415	21899	1128	13228
8-#14	1.44	MA	17409	3964	25514	3332	30242	2716	32160	2241	33270	1543	41008	1190	25621
4L-2S		MI	10539	3964	16082	3172	18520	2567	19569	2101	20508	1408	24538	1260	13207
8-#18	2.56	MA	23265	4473	35979	3628	43480	2918	48125	2364	54761	1505	68937	1373	45543
2L-4S		MI	9448	4473	16089	3430	18205	2752	19145	2192	20018	1334	24267	616	20452

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	2.56	MA	20450	4473	32186	3630	38669	2917	42297	2386	46898	1520	58364	1139	44918
3E		MI	10449	4473	17455	3443	19983	2739	21246	2205	22679	1320	27210	826	22225
8-#18	2.56	MA	18420	4473	29369	3632	34860	2942	37681	2381	40668	1508	51394	905	41132
4L-2S		MI	11785	4473	19249	3456	22195	2752	23874	2192	26137	1307	31658	1060	22390
10-#11	1.25	MA	19785	3877	28085	3282	33722	2668	36415	2210	39039	1547	48187	1471	22854
2L-5S		MI	8958	3877	13663	3135	15575	2540	16108	2100	15982	1438	19005	1082	11476
10-#11	1.25	MA	18603	3877	26575	3284	31808	2669	34096	2220	35910	1554	43911	1380	22802
3L-4S		MI	9344	3877	14223	3128	16244	2545	16902	2094	17061	1443	20315	1125	11641
10-#11	1.25	MA	17752	3877	25459	3286	30297	2680	32265	2220	33439	1551	41083	1289	22639
4L-3S		MI	9766	3877	14774	3131	16986	2540	17778	2100	18171	1438	21550	1212	11641
10-#11	1.25	MA	16982	3877	24330	3298	28943	2680	30612	2229	31187	1559	38156	1242	22088
5L-2S		MI	10333	3877	15504	3134	17908	2545	18873	2094	19612	1433	23429	1303	11617
10-#14	1.80	MA	21329	4128	31441	3430	37893	2775	41431	2277	45780	1530	57222	1437	32568
2L-5S		MI	9077	4128	14496	3273	16530	2632	17213	2151	17419	1396	20957	899	15360
10-#14	1.80	MA	19676	4128	29279	3432	35151	2776	38108	2290	41297	1540	51128	1306	32397
3L-4S		MI	9616	4128	15295	3263	17474	2640	18333	2144	18943	1404	22798	962	16186
10-#14	1.80	MA	18486	4128	27677	3434	32984	2791	35483	2289	37753	1535	47102	1174	31919
4L-3S		MI	10206	4128	16082	3269	18520	2632	19569	2151	20508	1396	24538	1084	16297
10-#14	1.80	MA	17410	4128	26057	3451	31040	2791	33110	2302	34522	1546	42924	1106	29965
5L-2S		MI	10997	4128	17120	3274	19822	2640	21115	2144	22542	1389	27178	1216	16309
10-#18	3.21	MA	22194	4764	35979	3811	43480	3050	48125	2470	54761	1507	68937	1105	55976
3L-4S		MI	10230	4764	17883	3612	20417	2878	21772	2263	23476	1294	28715	526	25373
10-#18	3.21	MA	20214	4764	33162	3814	39671	3075	43509	2465	48531	1495	61967	872	51874
4L-3S		MI	11213	4764	19249	3625	22195	2865	23874	2276	26137	1281	31658	737	27428
10-#18	3.21	MA	18423	4764	30312	3842	36251	3074	39335	2487	42848	1510	54693	754	48332
5L-2S		MI	12525	4764	21043	3638	24407	2878	26501	2263	29595	1267	36106	970	27680
12-#11	1.50	MA	20519	3990	29594	3353	35636	2720	38734	2243	42168	1541	52464	1462	27324
2L-6S		MI	8933	3990	13893	3203	15836	2597	16421	2125	16420	1431	19662	992	13181
12-#11	1.50	MA	19350	3990	28085	3355	33722	2721	36415	2253	39039	1549	48187	1371	27249
3L-5S		MI	9300	3990	14392	3206	16498	2591	17204	2130	17423	1426	20883	1054	13519
12-#11	1.50	MA	18510	3990	26968	3357	32212	2732	34585	2252	36568	1546	45360	1279	27058
4E		MI	9682	3990	14952	3199	17167	2597	17998	2125	18503	1431	22193	1097	13792
12-#11	1.50	MA	17751	3990	25839	3369	30857	2732	32931	2262	34316	1554	42433	1232	26391
5L-3S		MI	10100	3990	15504	3202	17908	2591	18873	2130	19612	1426	23429	1184	13814
12-#11	1.50	MA	17023	3990	24838	3371	29521	2743	31304	2262	32152	1561	39446	1157	25378
6L-2S		MI	10662	3990	16233	3205	18831	2597	19969	2125	21054	1421	25307	1275	13803
12-#14	2.16	MA	20709	4291	31441	3534	37893	2850	41431	2338	45780	1533	57222	1290	38741
3L-5S		MI	9550	4291	15534	3375	17832	2706	18758	2194	19453	1377	23597	855	18271
12-#14	2.16	MA	19539	4291	29839	3536	35727	2866	38805	2336	42236	1528	53197	1159	38218
4E		MI	10082	4291	16333	3365	18776	2713	19879	2186	20977	1385	25438	918	19038
12-#14	2.16	MA	18481	4291	28219	3553	33783	2866	36432	2350	39005	1538	49018	1091	36156
5L-3S		MI	10665	4291	17120	3371	19822	2706	21115	2194	22542	1377	27178	1041	19350
12-#14	2.16	MA	17467	4291	26782	3555	31865	2881	34098	2348	35899	1548	44762	983	34633
6L-2S		MI	11447	4291	18158	3377	21123	2713	22661	2186	24576	1370	29817	1172	19394
12-#18	3.85	MA	21957	5054	36955	3995	44482	3208	49337	2550	56394	1482	72541	838	62654
4E		MI	11029	5054	19678	3794	22629	3005	24399	2334	26935	1254	33163	437	30333
12-#18	3.85	MA	20209	5054	34105	4024	41062	3207	45163	2572	50711	1497	65266	720	59002
5L-3S		MI	11981	5054	21043	3807	24407	2992	26501	2348	29595	1241	36106	647	32618
12-#18	3.85	MA	18532	5054	31574	4026	37686	3232	41054	2567	45246	1512	57884	528	54189
6L-2S		MI	13244	5054	22837	3820	26619	3005	29129	2334	33054	1228	40554	881	32947
14-#11	1.75	MA	20085	4104	29594	3426	35636	2772	38734	2286	42168	1544	52464	1361	31692
3L-6S		MI	9273	4104	14622	3274	16758	2648	17516	2155	17861	1419	21540	963	15255
14-#11	1.75	MA	19255	4104	28477	3428	34126	2783	36904	2285	39697	1541	49637	1270	31475
4L-5S		MI	9637	4104	15122	3277	17420	2643	18299	2160	18865	1414	22762	1026	15573
14-#11	1.75	MA	18505	4104	27348	3440	32771	2784	35250	2295	37445	1548	46709	1222	30705
5L-4S		MI	10015	4104	15682	3270	18089	2648	19093	2155	19944	1419	24072	1069	15935
14-#11	1.75	MA	17787	4104	26347	3441	31435	2795	33623	2295	35281	1556	43722	1147	29727
6L-3S		MI	10429	4104	16233	3273	18831	2643	19969	2160	21054	1414	25307	1155	15975

RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

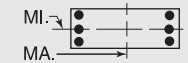
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.75	MA	17083	4104	25373	3443	30145	2796	32046	2304	33087	1553	41059	1076	28719
7L-2S		MI	10986	4104	16963	3276	19753	2648	21064	2155	22495	1408	27186	1247	15980
14-#14	2.52	MA	20569	4455	32002	3639	38469	2941	42128	2384	46719	1521	59291	1143	44521
4L-5S		MI	10015	4455	16572	3477	19133	2779	20304	2236	21487	1358	26237	811	21195
14-#14	2.52	MA	19529	4455	30382	3656	36526	2941	39755	2397	43488	1531	55113	1075	42361
5L-4S		MI	10541	4455	17371	3468	20077	2787	21425	2229	23011	1366	28078	874	21910
14-#14	2.52	MA	18532	4455	28944	3658	34608	2956	37420	2396	40382	1541	50857	967	40768
6L-3S		MI	11117	4455	18158	3473	21123	2779	22661	2236	24576	1358	29817	997	22394
14-#14	2.52	MA	17555	4455	27545	3660	32756	2957	35157	2409	37234	1536	47065	865	38580
7L-2S		MI	11890	4455	19196	3479	22425	2787	24206	2229	26611	1351	32457	1128	22464
14-#18	4.49	MA	21949	5345	37899	4206	45872	3340	50991	2656	58574	1484	75840	687	69700
5L-4S		MI	11773	5345	21472	3976	24841	3132	27027	2405	30393	1215	37611	347	35322
14-#18	4.49	MA	20312	5345	35368	4208	42497	3365	46882	2651	53109	1499	68457	494	65026
6L-3S		MI	12702	5345	22837	3989	26619	3118	29129	2419	33054	1201	40554	558	37553
14-#18	4.49	MA	18705	5345	32904	4210	39237	3364	42899	2673	47569	1487	61888	312	59484
7L-2S		MI	13939	5345	24631	4002	28831	3132	31756	2405	36512	1188	45002	791	38199
16-#11	2.00	MA	19988	4217	29987	3498	36040	2835	39223	2318	42825	1536	53914	1260	35892
4L-6S		MI	9609	4217	15352	3344	17681	2700	18612	2186	19303	1407	23419	935	17333
16-#11	2.00	MA	19248	4217	28858	3511	34686	2836	37569	2328	40574	1543	50986	1212	35030
5E		MI	9969	4217	15852	3348	18343	2695	19395	2191	20306	1402	24640	998	17634
16-#11	2.00	MA	18538	4217	27856	3512	33349	2847	35942	2327	38409	1551	47999	1137	34083
6L-4S		MI	10344	4217	16412	3341	19012	2700	20189	2186	21386	1407	25950	1041	18073
16-#11	2.00	MA	17844	4217	26882	3514	32059	2847	34366	2337	36216	1548	45336	1067	33029
7L-3S		MI	10754	4217	16963	3344	19753	2695	21064	2191	22495	1402	27186	1127	18129
16-#11	2.00	MA	17157	4217	25923	3516	30795	2848	32786	2337	34100	1556	42601	1012	31818
8L-2S		MI	11306	4217	17693	3347	20676	2700	22160	2186	23937	1396	29064	1218	18149
16-#14	2.88	MA	20556	4618	32544	3758	39268	3016	43078	2444	47970	1523	61207	1060	48578
5E		MI	10473	4618	17610	3579	20435	2853	21850	2279	23521	1339	28876	768	24128
16-#14	2.88	MA	19575	4618	31107	3760	37350	3031	40743	2443	44865	1533	56951	951	46916
6L-4S		MI	10993	4618	18409	3570	21379	2860	22970	2271	25045	1347	30717	830	24798
16-#14	2.88	MA	18614	4618	29708	3762	35498	3031	38480	2457	41717	1528	53159	849	44782
7L-3S		MI	11562	4618	19196	3575	22425	2853	24206	2279	26611	1339	32457	953	25430
16-#14	2.88	MA	17663	4618	28331	3764	33684	3032	36213	2455	38680	1538	49256	771	42287
8L-2S		MI	12327	4618	20234	3581	23726	2860	25752	2271	28645	1332	35096	1084	25525
16-#18	5.13	MA	22048	5636	39161	4390	47308	3498	52711	2735	60972	1486	79031	461	75880
6L-4S		MI	12500	5636	23266	4157	27053	3258	29654	2477	33851	1175	42059	258	40335
16-#18	5.13	MA	20478	5636	36697	4392	44047	3497	48727	2757	55432	1474	72462	279	70285
7L-3S		MI	13409	5636	24631	4170	28831	3245	31756	2490	36512	1162	45002	468	42408
16-#18	5.13	MA	18922	5636	34272	4394	40852	3496	44736	2753	50086	1489	65668	142	64708
8L-2S		MI	14622	5636	26425	4183	31043	3258	34383	2477	39970	1148	49450	702	43439
18-#11	2.25	MA	19979	4330	30367	3581	36600	2888	39888	2361	43702	1538	55263	1202	39363
5L-6S		MI	9941	4330	16082	3415	18604	2751	19707	2216	20744	1395	25297	907	19414
18-#11	2.25	MA	19278	4330	29366	3583	35264	2899	38261	2360	41538	1546	52276	1128	38444
6L-5S		MI	10298	4330	16581	3419	19265	2746	20490	2221	21748	1389	26519	970	19702
18-#11	2.25	MA	18592	4330	28391	3585	33973	2899	36685	2370	39345	1543	49613	1057	37345
7L-4S		MI	10669	4330	17141	3411	19934	2751	21284	2216	22827	1395	27829	1013	20206
18-#11	2.25	MA	17914	4330	27432	3587	32709	2900	35105	2370	37228	1550	46878	1002	36161
8L-3S		MI	11076	4330	17693	3415	20676	2746	22160	2221	23937	1389	29064	1099	20278
18-#11	2.25	MA	17240	4330	26373	3599	31407	2911	33551	2379	35133	1558	44163	944	34657
9L-2S		MI	11623	4330	18422	3418	21598	2751	23255	2216	25378	1384	30943	1190	20310
18-#14	3.25	MA	20600	4782	33269	3862	40093	3106	44066	2490	49348	1526	63046	936	53074
6L-5S		MI	10925	4782	18648	3681	21736	2926	23396	2321	25556	1320	31516	724	27069
18-#14	3.25	MA	19653	4782	31870	3864	38241	3106	41803	2504	46200	1521	59254	834	50993
7L-4S		MI	11439	4782	19447	3672	22680	2933	24516	2314	27079	1327	33357	787	27699

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

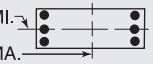


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	3.25	MA	18717	4782	30493	3866	36427	3106	39536	2503	43162	1531	55350	755	48465
8L-3S		MI	12002	4782	20234	3678	23726	2926	25752	2321	28645	1320	35096	909	28461
18-#14	3.25	MA	17787	4782	28972	3883	34557	3122	37305	2516	40155	1541	51484	671	45946
9L-2S		MI	12758	4782	21271	3683	25028	2933	27298	2314	30679	1313	37736	1041	28580
18-#18	5.77	MA	22212	5927	40490	4574	48858	3630	54555	2842	63295	1461	83036	246	81101
7L-4S		MI	13215	5927	25060	4339	29265	3385	32282	2548	37309	1135	46507	169	45366
18-#18	5.77	MA	20689	5927	38065	4576	45663	3629	50564	2837	57949	1476	76241	109	75486
8L-3S		MI	14105	5927	26425	4352	31043	3371	34383	2561	39970	1122	49450	379	47298
20-#11	2.50	MA	20007	4444	30875	3654	37178	2951	40580	2393	44667	1540	56553	1118	42810
6E		MI	10269	4444	16812	3486	19526	2803	20803	2246	22186	1383	27176	879	21499
20-#11	2.50	MA	19329	4444	29901	3656	35888	2951	39004	2403	42473	1538	53890	1047	41667
7L-5S		MI	10622	4444	17311	3489	20188	2798	21586	2251	23189	1377	28397	941	21774
20-#11	2.50	MA	18659	4444	28942	3657	34624	2952	37424	2402	40357	1545	51155	992	40509
8L-4S		MI	10990	4444	17871	3482	20857	2803	22380	2246	24269	1383	29707	985	22322
20-#11	2.50	MA	17993	4444	27882	3670	33321	2963	35870	2412	38262	1553	48440	934	38981
9L-3S		MI	11393	4444	18422	3486	21598	2798	23255	2251	25378	1377	30943	1071	22422
20-#11	2.50	MA	17314	4444	26927	3671	32066	2963	34309	2412	36107	1550	45635	854	37496
10L-2S		MI	11937	4444	19152	3489	22521	2803	24351	2246	26820	1372	32821	1162	22466
20-#14	3.61	MA	20675	4945	34033	3966	40984	3181	45125	2551	50682	1513	65348	818	57210
7L-5S		MI	11371	4945	19686	3784	23038	2999	24941	2364	27590	1301	34155	680	30016
20-#14	3.61	MA	19753	4945	32656	3968	39169	3181	42858	2550	47645	1524	61445	740	54650
8L-4S		MI	11879	4945	20485	3774	23982	3007	26062	2356	29114	1308	35996	743	30612
20-#14	3.61	MA	18837	4945	31135	3985	37299	3197	40628	2563	44638	1534	57578	655	52109
9L-3S		MI	12436	4945	21271	3780	25028	2999	27298	2364	30679	1301	37736	865	31487
20-#14	3.61	MA	17890	4945	29763	3988	35497	3197	38387	2562	41546	1529	53581	540	49491
10L-2S		MI	13185	4945	22309	3785	26329	3007	28843	2356	32713	1294	40375	997	31628
20-#18	6.41	MA	22420	6218	41858	4758	50474	3762	56392	2921	65812	1463	86815	76	86278
8L-4S		MI	13918	6218	26854	4521	31477	3511	34909	2619	40768	1096	50955	79	50413
22-#11	2.75	MA	20056	4557	31410	3727	37802	3003	41323	2436	45602	1533	58167	1037	45994
7L-6S		MI	10593	4557	17541	3557	20449	2855	21898	2277	23627	1370	29054	851	23550
22-#11	2.75	MA	19394	4557	30451	3728	36538	3004	39743	2435	43486	1540	55431	982	44860
8L-5S		MI	10943	4557	18041	3560	21110	2849	22681	2282	24631	1365	30276	913	23851
22-#11	2.75	MA	18736	4557	29391	3740	35235	3015	38189	2445	41391	1548	52717	924	43310
9L-4S		MI	11308	4557	18601	3553	21779	2855	23475	2277	25711	1370	31586	956	24371
22-#11	2.75	MA	18059	4557	28436	3742	33980	3015	36628	2444	39236	1545	49911	844	41807
10L-3S		MI	11708	4557	19152	3556	22521	2849	24351	2282	26820	1365	32821	1043	24563
22-#11	2.75	MA	17356	4557	27488	3744	32692	3026	35084	2454	37150	1552	47223	786	40240
11L-2S		MI	12247	4557	19882	3560	23443	2855	25447	2277	28261	1360	34700	1134	24619
22-#14	3.97	MA	20772	5109	34818	4071	41912	3256	46181	2597	52128	1516	67539	724	60842
8L-5S		MI	11812	5109	20724	3886	24339	3073	26487	2406	29624	1282	36795	636	32968
22-#14	3.97	MA	19869	5109	33297	4088	40042	3271	43951	2611	49121	1526	63672	640	58278
9L-4S		MI	12315	5109	21523	3877	25283	3080	27608	2399	31148	1289	38636	699	33533
22-#14	3.97	MA	18927	5109	31926	4090	38240	3272	41710	2609	46028	1521	59676	524	55646
10L-3S		MI	12866	5109	22309	3882	26329	3073	28843	2406	32713	1282	40375	822	34509
24-#11	3.00	MA	20119	4671	31960	3799	38452	3055	42062	2468	46615	1535	59708	973	49216
8L-6S		MI	10914	4671	18271	3628	21371	2906	22994	2307	25069	1358	30933	823	25578
24-#11	3.00	MA	19468	4671	30901	3811	37149	3066	40509	2478	44520	1542	56994	914	47643
9L-5S		MI	11261	4671	18770	3631	22033	2901	23777	2312	26072	1353	32154	885	25932
24-#11	3.00	MA	18794	4671	29945	3813	35894	3067	38947	2477	42365	1540	54188	834	46123
10L-4S		MI	11623	4671	19330	3624	22702	2906	24571	2307	27152	1358	33464	928	26426
24-#11	3.00	MA	18098	4671	28997	3815	34606	3078	37403	2487	40279	1547	51500	777	44577
11L-3S		MI	12020	4671	19882	3627	23443	2901	25447	2312	28261	1353	34700	1015	26701
24-#11	3.00	MA	17411	4671	28054	3816	33355	3079	35851	2487	38142	1544	48807	719	42756
12L-2S		MI	12555	4671	20611	3631	24366	2906	26542	2307	29703	1348	36578	1106	26767
24-#14	4.33	MA	20885	5272	35460	4190	42784	3346	47273	2658	53604	1519	69767	624	64452
9L-5S		MI	12283	5272	21762	3988	25641	3146	28033	2449	31658	1263	39434	592	35884
24-#14	4.33	MA	19948	5272	34088	4192	40982	3346	45032	2657	50511	1514	65770	509	61806
10L-4S		MI	12771	5272	22561	3979	26585	3153	29153	2441	33182	1270	41275	655	36462

RECTANGULAR TIED COLUMNS 28" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.19	MA	6977	2419	10351	1974	12022	1604	12716	1325	13218	914	15832	839	7591
2L-3S		MI	6354	2419	9551	1971	11007	1600	11501	1330	11619	919	13738	748	7605
6-#14	1.72	MA	7424	2570	11418	2058	13327	1665	14219	1357	15183	890	18365	792	10683
2L-3S		MI	6554	2570	10278	2053	11881	1658	12501	1364	12922	898	15414	660	10635
6-#18	3.06	MA	8458	2952	14019	2277	16419	1813	17850	1434	19937	825	24437	658	18206
2L-3S		MI	7010	2952	12043	2266	13950	1800	14918	1447	16078	838	19439	425	17659
8-#11	1.59	MA	7342	2533	11152	2044	13038	1656	13931	1357	14816	903	17927	814	9983
2L-4S		MI	6273	2533	9748	2040	11208	1658	11745	1357	11987	914	14458	634	9865
8-#14	2.30	MA	7924	2733	12559	2160	14773	1740	15937	1401	17443	874	21316	752	14064
2L-4S		MI	6438	2733	10558	2151	12166	1740	12846	1401	13443	888	16426	495	13039
8-#18	4.08	MA	9263	3242	15994	2458	18888	1943	20782	1509	23796	790	29436	578	24006
2L-4S		MI	6846	3242	12521	2437	14435	1943	15505	1509	16968	816	21140	128	20342
10-#11	1.99	MA	7699	2646	11952	2115	14053	1708	15146	1388	16415	893	20022	789	12361
2L-5S		MI	6238	2646	9937	2118	11489	1705	12079	1393	12389	898	15092	566	11423
10-#11	1.99	MA	7093	2646	11152	2113	13038	1704	13931	1393	14816	898	17927	697	12321
3L-4S		MI	6646	2646	10549	2110	12224	1709	12960	1388	13586	903	16553	609	12082
10-#14	2.87	MA	8411	2897	13699	2262	16219	1815	17655	1445	19703	857	24267	713	17427
2L-5S		MI	6388	2897	10824	2264	12563	1807	13318	1453	14011	864	17318	394	15316
10-#14	2.87	MA	7572	2897	12559	2258	14773	1807	15937	1453	17443	864	21316	582	17280
3L-4S		MI	6952	2897	11698	2254	13612	1815	14564	1445	15703	872	19376	456	16186
10-#18	5.10	MA	8693	3533	15994	2630	18888	2059	20782	1597	23796	768	29436	264	28154
3L-4S		MI	7694	3533	14496	2619	16904	2072	18438	1584	20827	781	26139	48	25830

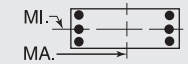
RECTANGULAR TIED COLUMNS 28" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.07	MA	7888	2555	11591	2095	13451	1705	14195	1413	14650	986	17500	911	7880
2E		MI	7329	2555	10850	2081	12523	1693	13149	1400	13522	974	16094	896	7302
4-#18	1.90	MA	8684	2809	13525	2234	15780	1803	16879	1463	18154	942	22001	827	13450
2E		MI	8046	2809	12621	2219	14594	1785	15564	1446	16675	926	20113	803	12413
6-#11	1.11	MA	7960	2568	11667	2113	13600	1719	14424	1425	14965	993	17947	919	8223
2L-3S		MI	6771	2568	10118	2097	11648	1703	12149	1418	12221	987	14420	813	7640
6-#11	1.11	MA	7278	2568	10796	2111	12495	1715	13089	1431	13209	998	15635	828	8237
3L-2S		MI	7396	2568	10919	2099	12664	1708	13364	1413	13819	982	16514	904	7619
6-#14	1.61	MA	8457	2718	12834	2197	15027	1780	16086	1458	17137	971	20763	876	11594
2L-3S		MI	6972	2718	10850	2179	12523	1760	13149	1451	13522	965	16094	725	10688
6-#14	1.61	MA	7504	2718	11591	2194	13451	1773	14195	1466	14650	978	17500	744	11547
3L-2S		MI	7846	2718	11990	2183	13969	1768	14866	1444	15783	957	19045	857	10718
6-#18	2.86	MA	9611	3100	15682	2416	18506	1936	20117	1540	22415	911	27553	754	19826
2L-3S		MI	7430	3100	12621	2390	14594	1902	15564	1534	16675	904	20113	489	17898
6-#18	2.86	MA	8023	3100	13525	2407	15780	1922	16879	1554	18154	925	22001	520	19406
3L-2S		MI	8885	3100	14597	2400	17063	1915	18497	1521	20534	891	25112	723	18260
8-#11	1.49	MA	8363	2681	12539	2184	14706	1771	15759	1458	16721	983	20258	896	10825
2L-4S		MI	6690	2681	10316	2165	11850	1761	12393	1444	12589	981	15140	699	9928
8-#11	1.49	MA	7692	2681	11667	2182	13600	1767	14424	1463	14965	988	17947	805	10811
3E		MI	7146	2681	10919	2168	12664	1755	13364	1450	13819	976	16514	788	10009
8-#11	1.49	MA	7197	2681	11013	2180	12717	1774	13358	1458	13571	983	16433	715	10707
4L-2S		MI	7763	2681	11720	2170	13679	1760	14579	1444	15418	971	18609	879	10014
8-#14	2.14	MA	9011	2882	14076	2299	16602	1854	17976	1504	19624	956	24026	840	15279
2L-4S		MI	6854	2882	11129	2276	12808	1843	13493	1488	14043	956	17105	560	13236
8-#14	2.14	MA	8076	2882	12834	2296	15027	1848	16086	1512	17137	964	20763	709	15178
3E		MI	7490	2882	11990	2281	13969	1835	14866	1496	15783	948	19045	686	14023

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis

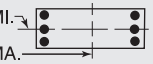


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.14	MA	7386	2882	11899	2293	13764	1857	14575	1504	15223	971	18624	581	14318
4L-2S		MI	8348	2882	13130	2285	15415	1843	16584	1488	18043	941	21995	817	14105
8-#18	3.81	MA	10507	3391	17840	2598	21233	2068	23355	1618	26675	880	33104	682	26166
2L-4S		MI	7228	3391	13099	2561	15079	2045	16152	1595	17565	883	21815	192	20603
8-#18	3.81	MA	8961	3391	15682	2589	18506	2054	20117	1631	22415	893	27553	448	25350
3E		MI	8309	3391	14597	2572	17063	2031	18497	1608	20534	869	25112	409	23222
8-#18	3.81	MA	7820	3391	14052	2581	16316	2068	17529	1618	19136	907	23901	226	22366
4L-2S		MI	9702	3391	16572	2582	19532	2045	21429	1595	24393	856	30110	642	24066
10-#11	1.86	MA	8758	2795	13410	2255	15811	1823	17094	1490	18477	974	22570	874	13414
2L-5S		MI	6654	2795	10505	2244	12131	1808	12727	1481	12991	966	15774	632	11561
10-#11	1.86	MA	8096	2795	12539	2253	14706	1819	15759	1496	16721	979	20258	783	13374
3L-4S		MI	7064	2795	11117	2236	12865	1813	13608	1476	14188	971	17235	674	12242
10-#11	1.86	MA	7609	2795	11884	2251	13822	1826	14692	1490	15327	974	18745	692	13238
4L-3S		MI	7514	2795	11720	2239	13679	1807	14579	1481	15418	966	18609	763	12366
10-#11	1.86	MA	7165	2795	11221	2260	13026	1822	13725	1496	14055	979	17133	650	12473
5L-2S		MI	8122	2795	12520	2241	14694	1812	15794	1476	17017	960	20704	854	12396
10-#14	2.68	MA	9551	3046	15319	2401	18178	1929	19866	1550	22111	941	27289	805	18946
2L-5S		MI	6803	3046	11396	2389	13205	1910	13966	1540	14611	931	17998	459	15573
10-#14	2.68	MA	8632	3046	14076	2398	16602	1923	17976	1558	19624	949	24026	674	18799
3L-4S		MI	7371	3046	12269	2379	14254	1918	15211	1533	16304	939	20056	521	16378
10-#14	2.68	MA	7956	3046	13141	2395	15340	1932	16465	1550	17710	956	21886	545	17754
4L-3S		MI	7995	3046	13130	2383	15415	1910	16584	1540	18043	931	21995	647	17347
10-#14	2.68	MA	7340	3046	12193	2407	14201	1926	15095	1558	15848	949	19611	484	16836
5L-2S		MI	8839	3046	14270	2387	16861	1918	18302	1533	20303	924	24946	778	17472
10-#18	4.76	MA	9899	3682	17840	2771	21233	2187	23355	1709	26675	862	33104	376	31139
3L-4S		MI	8115	3682	15074	2743	17547	2174	19084	1670	21424	848	26813	112	26084
10-#18	4.76	MA	8804	3682	16209	2763	19042	2200	20767	1696	23397	876	29452	154	28375
4L-3S		MI	9125	3682	16572	2753	19532	2161	21429	1683	24393	834	30110	329	28494
10-#18	4.76	MA	7793	3682	14554	2781	17064	2187	18420	1709	20206	862	25580	43	25370
5L-2S		MI	10473	3682	18548	2764	22001	2174	24361	1670	28252	821	35109	562	29849
12-#11	2.23	MA	9146	2908	14282	2325	16916	1874	18428	1523	20233	965	24881	851	15991
2L-6S		MI	6639	2908	10760	2313	12420	1866	13074	1508	13476	960	16505	544	13247
12-#11	2.23	MA	8492	2908	13410	2324	15811	1871	17094	1528	18477	970	22570	760	15929
3L-5S		MI	7027	2908	11305	2315	13146	1860	13942	1513	14589	955	17868	607	13815
12-#11	2.23	MA	8012	2908	12756	2322	14927	1878	16027	1523	17083	965	21056	670	15658
4E		MI	7431	2908	11917	2307	13880	1865	14823	1508	15786	960	19329	649	14453
12-#11	2.23	MA	7575	2908	12092	2331	14131	1874	15060	1528	15811	970	19444	628	14932
5L-3S		MI	7874	2908	12520	2310	14694	1859	15794	1513	17017	955	20704	738	14715
12-#11	2.23	MA	7155	2908	11501	2329	13344	1881	14106	1523	14589	975	17832	551	14309
6L-2S		MI	8475	2908	13321	2312	15710	1863	17009	1508	18615	950	22798	829	14766
12-#14	3.21	MA	10079	3209	16561	2504	19754	2004	21757	1596	24598	927	30552	770	22602
2L-6S		MI	6782	3209	11757	2487	13614	1993	14456	1577	15297	922	19029	330	17411
12-#14	3.21	MA	9176	3209	15319	2500	18178	1998	19866	1603	22111	934	27289	638	22415
3L-5S		MI	7318	3209	12536	2492	14651	1985	15684	1584	16871	915	20949	420	18709
12-#14	3.21	MA	8512	3209	14384	2497	16916	2007	18356	1596	20197	942	25149	510	21212
4E		MI	7877	3209	13410	2481	15700	1992	16929	1577	18564	922	23007	482	19542
12-#14	3.21	MA	7908	3209	13435	2509	15777	2001	16986	1603	18335	934	22874	449	20311
5L-3S		MI	8490	3209	14270	2485	16861	1985	18302	1584	20303	915	24946	608	20663
12-#14	3.21	MA	7328	3209	12590	2506	14652	2009	15635	1596	16603	942	20749	359	18845
6L-2S		MI	9320	3209	15410	2490	18308	1992	20020	1577	22564	907	27897	739	20828
12-#18	5.71	MA	9713	3972	18367	2944	21769	2332	24005	1774	27657	845	35003	82	34417
4E		MI	8939	3972	17050	2925	20016	2304	22017	1745	25283	813	31812	32	31599
12-#18	5.71	MA	8738	3972	16711	2962	19791	2319	21658	1787	24466	831	31132	-29	30977
5L-3S		MI	9916	3972	18548	2935	22001	2291	24361	1758	28252	799	35109	248	33823
14-#11	2.60	MA	9527	3022	15153	2396	18021	1926	19763	1555	21989	955	27193	828	18563
2L-7S		MI	6635	3022	11029	2381	12733	1914	13447	1544	13984	955	17203	436	14807
14-#11	2.60	MA	8881	3022	14282	2395	16916	1923	18428	1561	20233	961	24881	737	18480
3L-6S		MI	7010	3022	11561	2383	13435	1918	14289	1539	15075	950	18599	519	15454

RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

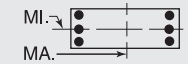
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.60	MA	8408	3022	13627	2393	16032	1929	17362	1555	18839	955	23368	647	18086
4L-5S		MI	7392	3022	12106	2386	14161	1912	15157	1544	16188	944	19963	581	16077
14-#11	2.60	MA	7977	3022	12964	2401	15236	1926	16394	1561	17567	961	21756	605	17400
5L-4S		MI	7791	3022	12718	2378	14896	1917	16038	1539	17385	950	21424	624	16677
14-#11	2.60	MA	7563	3022	12373	2400	14449	1932	15441	1555	16345	966	20143	529	16723
6L-3S		MI	8228	3022	13321	2380	15710	1911	17009	1544	18615	944	22798	712	17059
14-#11	2.60	MA	7158	3022	11797	2398	13688	1929	14516	1561	15104	961	18714	458	15990
7L-2S		MI	8822	3022	14121	2383	16725	1915	18224	1539	20214	939	24893	804	17130
14-#14	3.75	MA	9709	3373	16561	2603	19754	2073	21757	1649	24598	919	30552	603	26026
3L-6S		MI	7295	3373	12897	2589	15060	2067	16174	1621	17558	905	21980	291	20572
14-#14	3.75	MA	9056	3373	15626	2599	18491	2081	20246	1642	22684	927	28412	475	24689
4L-5S		MI	7823	3373	13676	2594	16097	2060	17402	1629	19132	898	23899	381	21808
14-#14	3.75	MA	8463	3373	14678	2611	17353	2075	18876	1649	20822	919	26137	414	23706
5L-4S		MI	8372	3373	14550	2583	17146	2067	18647	1621	20824	905	25957	443	22724
14-#14	3.75	MA	7893	3373	13832	2608	16228	2084	17525	1642	19090	927	24012	324	22305
6L-3S		MI	8975	3373	15410	2587	18308	2060	20020	1629	22564	898	27897	568	23976
14-#18	6.67	MA	9653	4263	18869	3144	22518	2451	24896	1865	28727	800	36683	-101	36018
5L-4S		MI	9740	4263	19026	3106	22485	2433	24949	1819	29142	777	36810	-48	36420
16-#11	2.97	MA	9264	3135	15153	2465	18021	1975	19763	1593	21989	951	27193	715	21027
3L-7S		MI	7004	3135	11830	2452	13749	1965	14662	1576	15583	944	19297	411	17029
16-#11	2.97	MA	8797	3135	14499	2464	17138	1981	18697	1588	20595	946	25679	625	20525
4L-6S		MI	7374	3135	12361	2454	14451	1970	15504	1571	16673	939	20694	494	17672
16-#11	2.97	MA	8372	3135	13835	2472	16341	1978	17729	1593	19323	951	24068	582	19875
5E		MI	7752	3135	12907	2457	15177	1964	16372	1576	17787	934	22058	556	18347
16-#11	2.97	MA	7964	3135	13244	2471	15554	1984	16776	1588	18100	957	22455	506	19146
6L-4S		MI	8145	3135	13518	2449	15911	1969	17253	1571	18983	939	23519	599	18913
16-#11	2.97	MA	7565	3135	12668	2469	14793	1981	15851	1593	16860	951	21025	436	18442
7L-3S		MI	8577	3135	14121	2451	16725	1963	18224	1576	20214	934	24893	687	19399
16-#14	4.29	MA	9591	3536	16869	2702	20067	2156	22136	1688	25171	912	31675	440	28180
4L-6S		MI	7799	3536	14037	2692	16506	2142	17892	1666	19818	889	24931	252	23746
16-#14	4.29	MA	9007	3536	15920	2713	18929	2150	20766	1695	23309	905	29400	378	27118
5E		MI	8318	3536	14816	2696	17543	2135	19119	1673	21392	881	26850	342	24924
16-#14	4.29	MA	8447	3536	15075	2710	17803	2159	19416	1688	21577	912	27275	289	25777
6L-4S		MI	8859	3536	15690	2685	18592	2142	20365	1666	23084	889	28908	404	25921
18-#11	3.34	MA	9180	3248	15370	2535	18243	2033	20031	1620	22351	937	27991	602	22974
4L-7S		MI	7368	3248	12630	2523	14764	2017	15877	1607	17181	934	21392	386	19221
18-#11	3.34	MA	8761	3248	14707	2543	17446	2029	19064	1626	21079	942	26379	560	22356
5L-6S		MI	7733	3248	13162	2525	15466	2022	16719	1602	18272	928	22789	469	19897
18-#11	3.34	MA	8358	3248	14116	2541	16659	2036	18111	1620	19856	947	24767	484	21577
6L-5S		MI	8106	3248	13707	2528	16192	2016	17587	1607	19385	923	24153	531	20622
18-#11	3.34	MA	7964	3248	13540	2540	15898	2033	17185	1626	18616	942	23337	413	20845
7L-4S		MI	8494	3248	14319	2520	16926	2020	18468	1602	20582	928	25613	574	21158
18-#14	4.82	MA	9543	3700	17162	2816	20504	2225	22656	1741	25796	890	32663	343	30545
5L-6S		MI	8336	3700	15177	2794	17952	2217	19610	1710	22078	872	27882	213	26931
18-#14	4.82	MA	8992	3700	16317	2812	19379	2234	21306	1734	24064	897	30537	254	29260
6L-5S		MI	8842	3700	15956	2798	18989	2209	20837	1717	23652	865	29801	302	28055
20-#11	3.71	MA	9144	3362	15578	2614	18552	2081	20399	1658	22835	933	28691	537	24842
5L-7S		MI	7726	3362	13431	2594	15779	2069	17092	1639	18780	923	23487	360	21421
20-#11	3.71	MA	8747	3362	14987	2612	17765	2088	19445	1653	21612	938	27078	461	24016
6E		MI	8087	3362	13962	2596	16481	2074	17934	1634	19871	918	24883	444	22131
20-#11	3.71	MA	8358	3362	14411	2611	17003	2084	18520	1658	20372	933	25648	390	23251
7L-5S		MI	8455	3362	14508	2599	17207	2068	18802	1639	20984	913	26247	506	22901

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

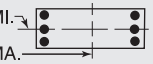
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	5.36	MA	9576	3863	17560	2915	20955	2309	23196	1779	26551	883	33800	218	32749
6E		MI	8822	3863	16317	2896	19398	2292	21328	1754	24339	855	30832	173	30048
22-#11	4.09	MA	9130	3475	15859	2683	18870	2140	20780	1685	23368	929	29390	438	26462
6L-7S		MI	8080	3475	14232	2665	16795	2121	18307	1670	20378	912	25581	335	23628
22-#11	4.09	MA	8746	3475	15283	2681	18109	2136	19855	1691	22128	924	27960	368	25665
7L-6S		MI	8436	3475	14763	2667	17497	2126	19149	1665	21469	907	26978	419	24371
24-#11	4.46	MA	9129	3589	16154	2752	19214	2188	21190	1723	23883	914	30271	345	28085
7E		MI	8429	3589	15032	2735	17810	2173	19522	1702	21977	902	27676	310	25842

RECTANGULAR TIED COLUMNS 28" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.00	MA	8926	2703	12974	2234	15108	1819	15983	1513	16468	1064	19692	990	8488
2E		MI	7747	2703	11421	2206	13165	1796	13796	1487	14123	1041	16773	961	7330
4-#18	1.79	MA	9807	2958	15076	2373	17662	1920	18935	1565	20321	1024	24671	912	14530
2E		MI	8468	2958	13199	2342	15238	1887	16211	1532	17273	993	20788	867	12456
6-#11	1.04	MA	9003	2716	13053	2252	15266	1833	16205	1524	16803	1071	20167	998	8855
2L-3S		MI	7188	2716	10686	2223	12289	1807	12797	1506	12822	1054	15102	878	7671
6-#11	1.04	MA	8263	2716	12111	2251	14071	1830	14757	1529	14889	1076	17638	907	8869
3L-2S		MI	7815	2716	11487	2225	13305	1811	14012	1501	14421	1049	17196	970	7645
6-#14	1.51	MA	9551	2867	14318	2336	16814	1894	18046	1560	19182	1051	23268	958	12505
2L-3S		MI	7389	2867	11421	2304	13165	1863	13796	1539	14123	1032	16773	790	10737
6-#14	1.51	MA	8516	2867	12974	2334	15108	1889	15983	1567	16468	1058	19692	827	12458
3L-2S		MI	8267	2867	12561	2308	14611	1871	15514	1531	16383	1025	19724	922	10752
6-#18	2.68	MA	10828	3249	17415	2555	20628	2052	22479	1646	24984	996	30777	847	21446
2L-3S		MI	7849	3249	13199	2513	15238	2003	16211	1620	17273	971	20788	553	18001
6-#18	2.68	MA	9098	3249	15076	2549	17662	2041	18935	1659	20321	1010	24671	613	21026
3L-2S		MI	9312	3249	15175	2524	17707	2017	19143	1607	21131	958	25786	787	18312
8-#11	1.39	MA	9445	2830	13995	2323	16461	1885	17653	1557	18716	1063	22696	977	11668
2L-4S		MI	7107	2830	10884	2291	12491	1865	13041	1532	13191	1049	15822	765	9986
8-#11	1.39	MA	8716	2830	13053	2322	15266	1882	16205	1562	16803	1068	20167	886	11653
3E		MI	7565	2830	11487	2294	13305	1859	14012	1538	14421	1044	17196	853	10048
8-#11	1.39	MA	8181	2830	12347	2321	14313	1890	15050	1558	15284	1063	18511	795	11550
4L-2S		MI	8184	2830	12287	2296	14320	1863	15227	1532	16020	1038	19291	944	10044
8-#14	2.01	MA	10159	3030	15663	2438	18519	1969	20109	1607	21896	1038	26844	926	16494
2L-4S		MI	7271	3030	11701	2402	13450	1946	14141	1576	14643	1023	17785	625	13426
8-#14	2.01	MA	9142	3030	14318	2436	16814	1964	18046	1614	19182	1045	23268	795	16393
3E		MI	7910	3030	12561	2406	14611	1938	15514	1583	16383	1015	19724	751	14079
8-#14	2.01	MA	8396	3030	13309	2434	15451	1974	16398	1607	17027	1038	20927	664	15617
4L-2S		MI	8772	3030	13701	2410	16057	1946	17232	1576	18643	1008	22675	882	14144
8-#18	3.57	MA	11814	3539	19755	2737	23595	2185	26023	1726	29648	969	36882	781	28326
2L-4S		MI	7643	3539	13677	2685	15722	2146	16799	1682	18162	949	22489	257	20856
8-#18	3.57	MA	10129	3539	17415	2730	20628	2174	22479	1739	24984	982	30777	547	27772
3E		MI	8703	3539	15175	2695	17707	2133	19143	1695	21131	936	25786	473	23564
8-#18	3.57	MA	8890	3539	15653	2724	18249	2188	19646	1726	21395	995	26769	321	24417
4L-2S		MI	10131	3539	17150	2706	20176	2146	22076	1682	24990	923	30785	707	24125
10-#11	1.74	MA	9879	2943	14938	2394	17657	1937	19101	1589	20630	1054	25224	957	14467
2L-5S		MI	7070	2943	11073	2370	12772	1912	13375	1569	13592	1033	16456	697	11693
10-#11	1.74	MA	9159	2943	13995	2393	16461	1934	17653	1595	18716	1060	22696	866	14427
3L-4S		MI	7482	2943	11685	2362	13506	1916	14256	1564	14789	1038	17917	740	12317
10-#11	1.74	MA	8632	2943	13290	2391	15508	1942	16498	1590	17197	1054	21040	775	14291
4L-3S		MI	7934	2943	12287	2364	14320	1911	15227	1569	16020	1033	19291	828	12409
10-#11	1.74	MA	8152	2943	12574	2401	14649	1939	15450	1596	15811	1060	19279	732	13534
5L-2S		MI	8545	2943	13088	2367	15335	1915	16442	1564	17618	1028	21386	919	12431
10-#14	2.51	MA	10752	3194	17008	2541	20224	2044	22172	1654	24610	1025	30419	894	20465
2L-5S		MI	7218	3194	11967	2514	13847	2013	14613	1628	15211	999	18677	524	15742

RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

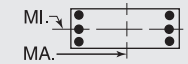
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.51	MA	9753	3194	15663	2538	18519	2039	20109	1661	21896	1032	26844	763	20318
3L-4S		MI	7790	3194	12841	2504	14896	2021	15859	1620	16904	1006	20735	586	16564
10-#14	2.51	MA	9020	3194	14654	2536	17156	2049	18461	1654	19741	1025	24503	632	19343
4L-3S		MI	8418	3194	13701	2508	16057	2013	17232	1628	18643	999	22675	712	17409
10-#14	2.51	MA	8354	3194	13631	2549	15928	2044	16965	1661	17776	1032	22010	572	18287
5L-2S		MI	9266	3194	14841	2512	17504	2020	18950	1620	20904	991	25625	843	17516
10-#18	4.46	MA	11129	3830	19755	2912	23595	2307	26023	1820	29648	954	36882	482	34179
3L-4S		MI	8535	3830	15652	2866	18191	2276	19731	1756	22021	914	27488	176	26331
10-#18	4.46	MA	9922	3830	17992	2905	21216	2321	23191	1806	26058	967	32875	256	30947
4L-3S		MI	9555	3830	17150	2877	20176	2263	22076	1770	24990	901	30785	393	28826
10-#18	4.46	MA	8826	3830	16203	2925	19069	2309	20621	1820	22567	954	28617	146	27851
5L-2S		MI	10917	3830	19126	2887	22645	2276	25008	1756	28849	887	35783	626	29914
12-#11	2.09	MA	10304	3057	15880	2465	18852	1989	20549	1622	22543	1046	27753	937	17255
2L-6S		MI	7054	3057	11328	2438	13061	1970	13722	1595	14078	1028	17187	610	13461
12-#11	2.09	MA	9594	3057	14938	2463	17657	1986	19101	1628	20630	1051	25224	845	17193
3L-5S		MI	7444	3057	11873	2441	13787	1964	14590	1601	15191	1023	18550	672	13946
12-#11	2.09	MA	9074	3057	14232	2462	16703	1994	17946	1623	19111	1046	23569	754	17030
4E		MI	7850	3057	12485	2433	14521	1968	15471	1595	16388	1028	20011	714	14605
12-#11	2.09	MA	8601	3057	13517	2472	15845	1991	16898	1629	17725	1051	21808	712	16197
5L-3S		MI	8296	3057	13088	2435	15335	1962	16442	1601	17618	1023	21386	803	14762
12-#11	2.09	MA	8147	3057	12880	2470	14996	1998	15866	1624	16392	1057	20044	636	15615
6L-2S		MI	8900	3057	13888	2438	16351	1967	17657	1595	19217	1017	23480	894	14804
12-#14	3.01	MA	11333	3358	18352	2643	21930	2119	24235	1701	27324	1012	33995	862	24425
2L-6S		MI	7195	3358	12328	2612	14256	2095	15104	1664	15898	989	19709	395	17667
12-#14	3.01	MA	10350	3358	17008	2641	20224	2114	22172	1709	24610	1019	30419	731	24237
3L-5S		MI	7735	3358	13107	2617	15293	2088	16331	1672	17471	982	21628	485	18956
12-#14	3.01	MA	9630	3358	15999	2638	18861	2123	20524	1701	22455	1012	28079	600	23092
4E		MI	8298	3358	13981	2606	16342	2095	17577	1664	19164	989	23686	547	19725
12-#14	3.01	MA	8976	3358	14975	2651	17633	2118	19028	1709	20490	1019	25585	540	22097
5L-3S		MI	8915	3358	14841	2610	17504	2088	18950	1672	20904	982	25625	673	20731
12-#14	3.01	MA	8348	3358	14064	2648	16420	2128	17555	1701	18600	1027	23091	430	20569
6L-2S		MI	9750	3358	15982	2615	18950	2095	20667	1664	23164	974	28576	804	20876
12-#18	5.36	MA	10977	4121	20332	3087	24183	2454	26735	1887	30722	940	38980	190	37511
4E		MI	9364	4121	17628	3048	20660	2406	22663	1831	25880	879	32486	96	31840
12-#18	5.36	MA	9916	4121	18543	3107	22036	2442	24166	1900	27231	926	34722	80	34282
5L-3S		MI	10352	4121	19126	3059	22645	2392	25008	1844	28849	866	35783	313	34145
14-#11	2.44	MA	10722	3170	16822	2536	20047	2041	21997	1655	24457	1038	30282	916	20037
2L-7S		MI	7049	3170	11597	2507	13374	2017	14095	1632	14586	1022	17885	501	15000
14-#11	2.44	MA	10020	3170	15880	2534	18852	2038	20549	1661	22543	1043	27753	825	19954
3L-6S		MI	7426	3170	12129	2509	14077	2022	14937	1627	15676	1017	19281	585	15665
14-#11	2.44	MA	9507	3170	15174	2533	17898	2045	19394	1656	21024	1038	26098	734	19667
4L-5S		MI	7811	3170	12674	2512	14802	2016	15805	1632	16790	1012	20645	647	16207
14-#11	2.44	MA	9041	3170	14459	2542	17040	2042	18346	1662	19639	1043	24337	692	18869
5L-4S		MI	8212	3170	13286	2504	15537	2020	16686	1627	17986	1017	22106	689	16827
14-#11	2.44	MA	8594	3170	13822	2541	16192	2050	17314	1657	18306	1048	22572	616	18231
6L-3S		MI	8652	3170	13888	2506	16351	2014	17657	1632	19217	1012	23480	778	17109
14-#11	2.44	MA	8156	3170	13202	2540	15371	2047	16312	1663	16954	1043	21010	544	17391
7L-2S		MI	9249	3170	14689	2509	17366	2019	18872	1627	20815	1007	25575	869	17169
14-#14	3.52	MA	10935	3521	18352	2743	21930	2188	24235	1756	27324	1006	33995	699	28153
3L-6S		MI	7711	3521	13468	2715	15702	2170	16822	1709	18158	973	22660	356	20823
14-#14	3.52	MA	10227	3521	17343	2740	20567	2198	22587	1748	25169	999	31655	569	26860
4L-5S		MI	8242	3521	14247	2719	16739	2163	18049	1716	19732	965	24579	446	22100
14-#14	3.52	MA	9585	3521	16320	2753	19339	2193	21092	1756	23204	1006	29161	508	25917
5L-4S		MI	8795	3521	15121	2708	17788	2170	19294	1709	21424	973	26637	508	22904

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis

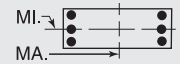


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.52	MA	8968	3521	15409	2751	18125	2203	19618	1748	21314	1014	26667	398	24323
6L-3S		MI	9403	3521	15982	2713	18950	2163	20667	1716	23164	965	28576	633	24047
14-#14	3.52	MA	8364	3521	14521	2748	16952	2198	18188	1756	19396	1006	24456	296	22777
7L-2S		MI	10226	3521	17122	2717	20396	2170	22385	1709	25424	958	31527	765	24227
14-#18	6.25	MA	10923	4412	20882	3289	25002	2575	27710	1980	31894	899	40828	15	40744
5L-4S		MI	10170	4412	19604	3230	23129	2535	25595	1906	29739	844	37485	16	37376
16-#11	2.79	MA	10440	3283	16822	2605	20047	2090	21997	1694	24457	1035	30282	805	22712
3L-7S		MI	7420	3283	12398	2578	14390	2069	15310	1664	16184	1012	19979	476	17242
16-#11	2.79	MA	9934	3283	16117	2604	19093	2097	20841	1689	22938	1030	28627	714	22307
4L-6S		MI	7792	3283	12929	2580	15092	2073	16152	1658	17275	1007	21376	559	17879
16-#11	2.79	MA	9474	3283	15401	2613	18235	2094	19794	1695	21552	1035	26866	671	21548
5E		MI	8172	3283	13474	2583	15818	2068	17020	1664	18388	1001	22740	622	18475
16-#11	2.79	MA	9033	3283	14765	2612	17387	2102	18762	1690	20219	1040	25101	595	20856
6L-4S		MI	8568	3283	14086	2575	16552	2072	17901	1658	19585	1007	24201	664	19060
16-#11	2.79	MA	8601	3283	14144	2611	16567	2099	17760	1696	18868	1035	23539	524	20047
7L-3S		MI	9003	3283	14689	2577	17366	2066	18872	1664	20815	1001	25575	753	19452
16-#11	2.79	MA	8174	3283	13533	2610	15763	2096	16757	1691	17564	1040	21895	474	19058
8L-2S		MI	9593	3283	15490	2579	18381	2071	20087	1658	22414	996	27670	844	19530
16-#14	4.02	MA	10814	3685	18688	2843	22272	2273	24650	1795	27883	986	35231	537	30643
4L-6S		MI	8217	3685	14608	2817	17148	2245	18539	1753	20418	956	25610	317	23993
16-#14	4.02	MA	10182	3685	17665	2855	21044	2268	23155	1803	25918	993	32737	476	29647
5E		MI	8740	3685	15388	2821	18185	2238	19767	1761	21992	948	27530	406	25211
16-#14	4.02	MA	9575	3685	16754	2853	19830	2278	21681	1795	24028	1001	30242	366	28090
6L-4S		MI	9284	3685	16261	2810	19234	2245	21012	1753	23685	956	29588	468	26097
16-#14	4.02	MA	8981	3685	15866	2851	18657	2273	20251	1803	22110	993	28032	264	26444
7L-3S		MI	9883	3685	17122	2815	20396	2237	22385	1761	25424	948	31527	594	27360
18-#11	3.13	MA	10354	3397	17059	2675	20288	2149	22289	1722	24851	1022	31156	693	24957
4L-7S		MI	7785	3397	13198	2649	15405	2121	16525	1695	17783	1001	22074	451	19491
18-#11	3.13	MA	9900	3397	16344	2684	19430	2146	21242	1727	23466	1027	29395	651	24234
5L-6S		MI	8153	3397	13730	2651	16107	2125	17367	1690	18874	996	23471	534	20102
18-#11	3.13	MA	9465	3397	15707	2683	18582	2154	20210	1723	22133	1032	27630	575	23491
6L-5S		MI	8528	3397	14275	2653	16833	2119	18235	1695	19987	991	24835	596	20750
18-#11	3.13	MA	9039	3397	15087	2682	17762	2151	19208	1729	20781	1027	26067	503	22710
7L-4S		MI	8919	3397	14887	2646	17567	2124	19116	1690	21184	996	26295	639	21304
18-#11	3.13	MA	8617	3397	14476	2681	16958	2148	18205	1724	19477	1032	24424	454	21662
8L-3S		MI	9349	3397	15490	2648	18381	2118	20087	1695	22414	991	27670	728	21792
18-#14	4.52	MA	10769	3848	19009	2958	22749	2343	25218	1850	28632	980	36313	444	33365
5L-6S		MI	8714	3848	15748	2919	18594	2320	20257	1797	22678	939	28561	278	27173
18-#14	4.52	MA	10172	3848	18098	2955	21536	2353	23744	1843	26742	987	33818	334	31867
6L-5S		MI	9269	3848	16528	2923	19631	2312	21485	1805	24252	932	30480	367	28337
18-#14	4.52	MA	9587	3848	17210	2953	20362	2348	22314	1850	24824	980	31608	232	30180
7L-4S		MI	9798	3848	17402	2913	20680	2320	22730	1797	25945	939	32538	429	29303
20-#11	3.48	MA	10320	3510	17286	2755	20625	2198	22690	1760	25379	1019	31924	630	26925
5L-7S		MI	8145	3510	13999	2719	16420	2173	17740	1727	19381	991	24169	426	21696
20-#11	3.48	MA	9890	3510	16649	2754	19777	2206	21658	1756	24047	1024	30159	555	26133
6E		MI	8508	3510	14530	2722	17123	2177	18582	1722	20472	985	25565	509	22332
20-#11	3.48	MA	9469	3510	16029	2753	18957	2203	20656	1761	22695	1019	28596	483	25379
7L-5S		MI	8879	3510	15076	2724	17848	2171	19450	1727	21585	980	26929	571	23028
20-#11	3.48	MA	9053	3510	15418	2752	18153	2200	19653	1757	21391	1024	26953	434	24303
8L-4S		MI	9266	3510	15687	2716	18583	2176	20331	1722	22782	985	28390	614	23555
20-#14	5.02	MA	10759	4012	19443	3057	23241	2428	25807	1890	29456	974	37394	302	35654
6E		MI	9246	4012	16889	3021	20040	2395	21975	1842	24939	922	31512	238	30364
20-#14	5.02	MA	10184	4012	18555	3055	22068	2423	24377	1897	27538	967	35183	200	33927
7L-5S		MI	9748	4012	17668	3025	21077	2387	23203	1849	26513	915	33431	328	31477
22-#11	3.83	MA	10310	3624	17592	2825	20972	2257	23105	1789	25960	1016	32688	534	28782
6L-7S		MI	8500	3624	14799	2790	17436	2225	18955	1758	20980	980	26263	401	23899

RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.83	MA	9894	3624	16971	2824	20152	2254	22104	1794	24608	1011	31125	463	28015
7L-6S		MI	8859	3624	15331	2793	18138	2229	19797	1753	22071	975	27660	484	24569
22-#11	3.83	MA	9483	3624	16360	2822	19348	2252	21100	1790	23304	1016	29482	413	26950
8L-5S		MI	9226	3624	15876	2795	18864	2223	20665	1758	23184	970	29024	546	25311
22-#14	5.52	MA	10834	4175	19900	3157	23773	2497	26440	1944	30252	954	38759	168	37682
7L-6S		MI	9727	4175	18029	3123	21486	2469	23693	1886	27199	906	34463	199	33523
24-#11	4.18	MA	10314	3737	17914	2895	21347	2306	23552	1827	26522	1002	33654	442	30638
7E		MI	8850	3737	15600	2861	18451	2276	20170	1790	22579	969	28358	376	26109
24-#11	4.18	MA	9908	3737	17303	2893	20543	2303	22548	1822	25218	1008	32011	393	29601
8L-6S		MI	9206	3737	16131	2864	19153	2281	21012	1785	23669	964	29755	459	26813

RECTANGULAR TIED COLUMNS 28" x 34"

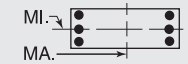
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.68	MA	10991	3106	16697	2513	19612	2034	21084	1667	22578	1105	27448	996	15610
2E		MI	8889	3106	13777	2466	15881	1989	16858	1619	17870	1059	21462	931	12497
6-#14	1.42	MA	10706	3015	15873	2475	18688	2009	20061	1658	21317	1130	25878	1039	13417
2L-3S		MI	7807	3015	11992	2429	13807	1966	14444	1626	14723	1099	17453	855	10783
6-#14	1.42	MA	9587	3015	14426	2474	16853	2005	17838	1666	18375	1137	21989	908	13369
3L-2S		MI	8687	3015	13132	2433	15254	1974	16161	1619	16983	1092	20404	986	10785
6-#18	2.52	MA	12107	3397	19218	2694	22809	2167	24935	1750	27645	1080	34109	936	23066
2L-3S		MI	8268	3397	13777	2637	15881	2105	16858	1707	17870	1037	21462	617	18097
6-#18	2.52	MA	10233	3397	16697	2689	19612	2157	21084	1763	22578	1093	27448	703	22646
3L-2S		MI	9738	3397	15753	2648	18350	2118	19790	1693	21729	1024	26461	851	18363
8-#11	1.31	MA	10588	2978	15522	2462	18305	2000	19623	1654	20801	1141	25238	1057	12510
2L-4S		MI	7523	2978	11452	2417	13132	1968	13689	1620	13792	1116	16504	830	10038
8-#11	1.31	MA	9800	2978	14509	2461	17020	1998	18066	1660	18730	1146	22492	966	12496
3E		MI	7983	2978	12055	2419	13946	1962	14660	1625	15023	1111	17878	919	10084
8-#11	1.31	MA	9224	2978	13751	2461	15997	2006	16827	1656	17086	1141	20690	875	12392
4L-2S		MI	8604	2978	12855	2422	14961	1967	15875	1620	16621	1106	19973	1010	10074
8-#14	1.89	MA	11369	3179	17320	2578	20523	2083	22284	1705	24258	1118	29767	1010	17709
2L-4S		MI	7688	3179	12272	2527	14092	2049	14788	1663	15244	1090	18464	690	13612
8-#14	1.89	MA	10270	3179	15873	2576	18688	2079	20061	1713	21317	1126	25878	879	17608
3E		MI	8330	3179	13132	2531	15254	2041	16161	1671	16983	1082	20404	816	14133
8-#14	1.89	MA	9465	3179	14790	2575	17225	2090	18288	1707	18982	1118	23331	747	16936
4L-2S		MI	9195	3179	14273	2535	16700	2049	17879	1663	19243	1075	23354	947	14183
8-#18	3.36	MA	13184	3688	21739	2876	26007	2300	28786	1832	32712	1055	40770	877	30486
2L-4S		MI	8059	3688	14254	2808	16366	2248	17445	1768	18759	1015	23164	321	21102
8-#18	3.36	MA	11359	3688	19218	2871	22809	2290	24935	1846	27645	1068	34109	643	29932
3E		MI	9126	3688	15753	2819	18350	2235	19790	1781	21729	1002	26461	537	23794
8-#18	3.36	MA	10022	3688	17324	2866	20251	2307	21858	1832	23623	1055	29745	413	26495
4L-2S		MI	10561	3688	17728	2829	20819	2248	22722	1768	25588	989	31459	771	24182
10-#11	1.64	MA	11060	3092	16535	2533	19590	2052	21180	1687	22873	1134	27985	1039	15520
2L-5S		MI	7486	3092	11641	2496	13413	2015	14023	1657	14194	1101	17138	762	11820
10-#11	1.64	MA	10283	3092	15522	2532	18305	2049	19623	1693	20801	1139	25238	948	15480
3L-4S		MI	7900	3092	12252	2488	14147	2020	14904	1652	15391	1106	18599	805	12375
10-#11	1.64	MA	9715	3092	14765	2532	17282	2057	18383	1689	19157	1134	23437	857	15344
4L-3S		MI	8353	3092	12855	2490	14961	2014	15875	1657	16621	1101	19973	893	12450
10-#11	1.64	MA	9199	3092	13998	2541	16361	2055	17260	1696	17657	1139	21531	813	14605
5L-2S		MI	8967	3092	13656	2493	15977	2018	17090	1652	18220	1095	22068	985	12463
10-#14	2.36	MA	12016	3343	18767	2680	22358	2158	24507	1752	27199	1107	33657	981	21983
2L-5S		MI	7634	3343	12538	2639	14489	2116	15261	1715	15811	1066	19357	589	15904

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.36	MA	10935	3343	17320	2678	20523	2154	22284	1761	24258	1114	29767	850	21837
3L-4S		MI	8209	3343	13412	2629	15538	2123	16506	1707	17504	1073	21415	651	16745
10-#14	2.36	MA	10146	3343	16237	2677	19060	2165	20511	1754	21923	1107	27221	718	20952
4L-3S		MI	8840	3343	14273	2633	16700	2116	17879	1715	19243	1066	23354	777	17468
10-#14	2.36	MA	9428	3343	15139	2690	17742	2161	18903	1763	19793	1114	24514	657	19750
5L-2S		MI	9692	3343	15413	2637	18146	2123	19597	1707	21504	1058	26305	908	17559
10-#18	4.20	MA	12450	3979	21739	3053	26007	2423	28786	1928	32712	1044	40770	583	37218
3L-4S		MI	8956	3979	16230	2990	18835	2378	20378	1843	22618	980	28162	241	26570
10-#18	4.20	MA	11147	3979	19845	3048	23449	2440	25709	1915	28689	1030	36406	353	33546
4L-3S		MI	9985	3979	17728	3001	20819	2364	22722	1856	25588	967	31459	457	29150
10-#18	4.20	MA	9964	3979	17923	3069	21142	2430	22917	1928	25020	1044	31761	245	30379
5L-2S		MI	11358	3979	19704	3011	23288	2378	25655	1843	29447	954	36458	691	29976
12-#11	1.97	MA	11523	3205	17548	2604	20875	2104	22737	1720	24944	1127	30731	1020	18519
2L-6S		MI	7469	3205	11896	2564	13702	2073	14370	1683	14679	1095	17869	675	13668
12-#11	1.97	MA	10756	3205	16535	2603	19590	2101	21180	1726	22873	1132	27985	929	18456
3L-5S		MI	7861	3205	12441	2567	14428	2067	15238	1688	15793	1090	19232	737	14071
12-#11	1.97	MA	10196	3205	15778	2603	18567	2109	19940	1722	21229	1127	26184	838	18293
4E		MI	8269	3205	13053	2559	15163	2072	16119	1683	16989	1095	20693	780	14707
12-#11	1.97	MA	9688	3205	15011	2612	17646	2107	18817	1728	19729	1132	24277	795	17471
5L-3S		MI	8717	3205	13656	2561	15977	2066	17090	1688	18220	1090	22068	868	14807
12-#11	1.97	MA	9200	3205	14328	2612	16737	2115	17710	1725	18286	1137	22360	719	16927
6L-2S		MI	9324	3205	14456	2564	16992	2070	18305	1683	19818	1085	24162	959	14840
12-#14	2.84	MA	12649	3506	20214	2782	24193	2233	26730	1800	30141	1095	37546	952	26247
2L-6S		MI	7609	3506	12899	2737	14898	2198	15751	1752	16498	1056	20388	460	17915
12-#14	2.84	MA	11586	3506	18767	2781	22358	2229	24507	1808	27199	1103	33657	821	26060
3L-5S		MI	8153	3506	13678	2742	15935	2191	16979	1759	18072	1049	22308	550	19116
12-#14	2.84	MA	10810	3506	17683	2779	20895	2240	22734	1802	24865	1095	31110	690	24992
4E		MI	8718	3506	14552	2731	16984	2198	18224	1752	19764	1056	24366	612	19902
12-#14	2.84	MA	10106	3506	16585	2792	19577	2236	21126	1810	22735	1103	28403	628	23856
5L-3S		MI	9339	3506	15413	2735	18146	2191	19597	1759	21504	1049	26305	737	20795
12-#14	2.84	MA	9430	3506	15608	2791	18276	2247	19542	1803	20686	1110	25689	519	22319
6L-2S		MI	10179	3506	16553	2740	19592	2198	21315	1752	23764	1042	29256	869	20922
12-#18	5.04	MA	12242	4269	22366	3230	26646	2573	29560	1998	33756	1006	43067	293	40634
4E		MI	9789	4269	18206	3172	21304	2507	23310	1918	26477	945	33161	160	32074
12-#18	5.04	MA	11088	4269	20444	3251	24339	2563	26769	2011	30086	1019	38422	185	37333
5L-3S		MI	10787	4269	19704	3182	23288	2494	25655	1931	29447	932	36458	377	34461
14-#11	2.29	MA	11979	3319	18561	2675	22160	2155	24293	1752	27015	1120	33478	1002	21511
2L-7S		MI	7464	3319	12165	2633	14016	2121	14743	1720	15187	1090	18567	567	15186
14-#11	2.29	MA	11221	3319	17548	2674	20875	2153	22737	1759	24944	1125	30731	911	21428
3L-6S		MI	7843	3319	12696	2635	14718	2125	15585	1715	16278	1085	19963	650	15869
14-#11	2.29	MA	10668	3319	16791	2673	19852	2161	21497	1755	23300	1120	28930	820	21241
4L-5S		MI	8230	3319	13242	2637	15444	2119	16453	1720	17391	1080	21327	712	16332
14-#11	2.29	MA	10167	3319	16024	2683	18931	2159	20373	1761	21800	1125	27024	776	20347
5L-4S		MI	8633	3319	13853	2630	16178	2124	17334	1715	18588	1085	22788	755	16972
14-#11	2.29	MA	9686	3319	15342	2683	18022	2167	19267	1757	20357	1130	25107	701	19760
6L-3S		MI	9075	3319	14456	2632	16992	2118	18305	1720	19818	1080	24162	843	17158
14-#11	2.29	MA	9215	3319	14677	2682	17143	2165	18193	1764	18894	1125	23407	629	18807
7L-2S		MI	9675	3319	15257	2634	18007	2122	19520	1715	21417	1074	26257	934	17208
14-#14	3.31	MA	12223	3670	20214	2883	24193	2304	26730	1856	30141	1091	37546	792	30279
3L-6S		MI	8127	3670	14039	2840	16344	2273	17469	1796	18758	1040	23339	421	21067
14-#14	3.31	MA	11460	3670	19130	2881	22730	2315	24957	1849	27806	1084	34999	661	29052
4L-5S		MI	8661	3670	14819	2844	17381	2266	18697	1804	20332	1032	25258	511	22339
14-#14	3.31	MA	10768	3670	18032	2895	21412	2311	23349	1857	25676	1091	32292	599	27974
5L-4S		MI	9218	3670	15692	2833	18430	2273	19942	1796	22024	1040	27316	573	23078
14-#14	3.31	MA	10104	3670	17055	2893	20111	2322	21765	1851	23628	1099	29579	490	26368
6L-3S		MI	9830	3670	16553	2838	19592	2266	21315	1804	23764	1032	29256	698	24115
14-#14	3.31	MA	9454	3670	16103	2892	18852	2318	20228	1859	21550	1091	27175	387	24801
7L-2S		MI	10658	3670	17693	2842	21038	2273	23033	1796	26024	1025	32206	830	24276

RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	5.88	MA	12256	4560	22965	3433	27537	2696	30620	2094	35153	994	45083	125	44318
5L-4S		MI	10599	4560	20182	3354	23773	2637	26242	1992	30336	910	38159	80	37605
16-#11	2.62	MA	11678	3432	18561	2745	22160	2205	24293	1792	27015	1118	33478	892	24397
3L-7S		MI	7835	3432	12965	2703	15031	2172	15958	1752	16786	1079	20661	541	17426
16-#11	2.62	MA	11133	3432	17804	2744	21137	2213	23054	1788	25371	1112	31677	801	24107
4L-6S		MI	8210	3432	13497	2706	15733	2177	16800	1746	17877	1074	22058	625	18080
16-#11	2.62	MA	10638	3432	17037	2754	20216	2211	21930	1794	23871	1118	29770	758	23232
5E		MI	8592	3432	14042	2708	16459	2171	17668	1752	18990	1069	23422	687	18599
16-#11	2.62	MA	10163	3432	16355	2753	19307	2219	20824	1790	22429	1123	27854	682	22589
6L-4S		MI	8991	3432	14654	2700	17193	2175	18549	1746	20186	1074	24883	729	19204
16-#11	2.62	MA	9698	3432	15690	2753	18428	2217	19750	1797	20966	1118	26154	611	21669
7L-3S		MI	9428	3432	15257	2703	18007	2170	19520	1752	21417	1069	26257	818	19503
16-#11	2.62	MA	9239	3432	15036	2752	17566	2214	18675	1793	19554	1123	24374	560	20679
8L-2S		MI	10021	3432	16057	2705	19023	2174	20735	1746	23015	1064	28352	909	19571
16-#14	3.78	MA	12099	3833	20577	2984	24565	2390	27180	1896	30747	1072	38889	632	33128
4L-6S		MI	8634	3833	15180	2942	17790	2348	19187	1840	21018	1023	26290	382	24232
16-#14	3.78	MA	11418	3833	19479	2997	23247	2385	25572	1905	28617	1080	36182	570	32101
5E		MI	9161	3833	15959	2946	18827	2340	20414	1848	22592	1016	28209	471	25492
16-#14	3.78	MA	10765	3833	18502	2995	21946	2396	23988	1898	26569	1087	33468	461	30429
6L-4S		MI	9710	3833	16833	2936	19876	2348	21660	1840	24285	1023	30267	533	26269
16-#14	3.78	MA	10125	3833	17550	2994	20687	2392	22452	1907	24491	1080	31064	358	28819
7L-3S		MI	10313	3833	17693	2940	21038	2340	23033	1848	26024	1016	32206	659	27431
18-#11	2.95	MA	11590	3545	18817	2815	22422	2265	24610	1821	27443	1105	34423	783	26959
4L-7S		MI	8202	3545	13766	2774	16046	2224	17173	1783	18384	1069	22756	516	19673
18-#11	2.95	MA	11102	3545	18050	2825	21501	2263	23487	1827	25943	1110	32517	739	26123
5L-6S		MI	8572	3545	14298	2777	16748	2229	18015	1778	19475	1064	24153	600	20300
18-#11	2.95	MA	10633	3545	17368	2824	20592	2271	22380	1823	24500	1116	30600	664	25427
6L-5S		MI	8950	3545	14843	2779	17474	2223	18883	1783	20588	1058	25517	662	20873
18-#11	2.95	MA	10174	3545	16703	2824	19713	2268	21307	1830	23037	1110	28900	592	24537
7L-4S		MI	9344	3545	15455	2771	18209	2227	19764	1778	21785	1064	26977	704	21445
18-#11	2.95	MA	9721	3545	16049	2823	18851	2266	20231	1826	21626	1116	27121	542	23517
8L-3S		MI	9776	3545	16057	2774	19023	2221	20735	1783	23015	1058	28352	793	21845
18-#14	4.25	MA	12057	3997	20926	3099	25082	2460	27795	1952	31559	1068	40071	541	36225
5L-6S		MI	9134	3997	16320	3044	19236	2423	20905	1885	23279	1006	29241	342	27409
18-#14	4.25	MA	11414	3997	19949	3098	23781	2471	26212	1946	29510	1076	37357	432	34502
6L-5S		MI	9653	3997	17099	3048	20273	2415	22132	1892	24853	999	31160	432	28613
18-#14	4.25	MA	10785	3997	18997	3096	22522	2467	24675	1954	27432	1068	34953	329	32792
7L-4S		MI	10194	3997	17973	3038	21322	2423	23378	1885	26545	1006	33218	494	29472
20-#11	3.28	MA	11559	3659	19064	2896	22786	2315	25044	1860	28014	1103	35263	721	29019
5L-7S		MI	8563	3659	14567	2845	17062	2276	18388	1815	19983	1058	24851	491	21925
20-#11	3.28	MA	11096	3659	18381	2895	21877	2323	23937	1856	26571	1108	33347	645	28272
6E		MI	8929	3659	15098	2848	17764	2281	19230	1809	21074	1053	26247	575	22528
20-#11	3.28	MA	10643	3659	17717	2895	20998	2320	22864	1862	25108	1103	31647	574	27412
7L-5S		MI	9303	3659	15643	2850	18490	2275	20098	1815	22187	1048	27611	637	23151
20-#11	3.28	MA	10195	3659	17062	2894	20136	2318	21788	1858	23697	1108	29868	524	26332
8L-4S		MI	9692	3659	16255	2842	19224	2279	20979	1809	23384	1053	29072	679	23695
20-#14	4.73	MA	12053	4160	21396	3200	25616	2546	28435	1993	32452	1064	41247	403	38584
6E		MI	9670	4160	17460	3146	20682	2498	22623	1929	25539	990	32191	303	30596
20-#14	4.73	MA	11433	4160	20444	3198	24357	2542	26898	2001	30374	1057	38843	300	36834
7L-5S		MI	10177	4160	18239	3151	21719	2490	23850	1937	27113	982	34111	393	31749
22-#11	3.61	MA	11552	3772	19394	2966	23162	2374	25494	1889	28643	1101	36093	627	31125
6L-7S		MI	8919	3772	15367	2916	18077	2328	19603	1846	21581	1048	26945	466	24164

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

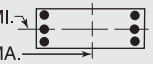
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.61	MA	11105	3772	18730	2965	22283	2372	24421	1895	27180	1096	34393	556	30291
7L-6S		MI	9281	3772	15899	2919	18779	2332	20445	1841	22672	1042	28342	549	24763
22-#11	3.61	MA	10663	3772	18075	2965	21421	2370	23345	1891	25768	1101	32614	505	29184
8L-5S		MI	9651	3772	16444	2921	19505	2327	21313	1846	23786	1037	29706	611	25434
22-#14	5.20	MA	12072	4324	21891	3301	26192	2617	29121	2049	33315	1045	42732	271	40885
7L-6S		MI	10154	4324	18600	3248	22128	2572	24340	1973	27799	973	35142	264	33792
24-#11	3.93	MA	11561	3886	19743	3036	23568	2424	25977	1928	29251	1089	37140	537	33175
7E		MI	9272	3886	16168	2987	19092	2380	20818	1878	23180	1037	29040	441	26370
24-#11	3.93	MA	11124	3886	19088	3036	22706	2422	24902	1924	27840	1094	35361	487	32040
8L-6S		MI	9630	3886	16699	2989	19794	2384	21660	1872	24271	1032	30437	524	27004

RECTANGULAR TIED COLUMNS 28" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.59	MA	12236	3255	18388	2652	21651	2149	23315	1768	24926	1185	30331	1079	16690
2E		MI	9310	3255	14355	2590	16525	2091	17504	1705	18467	1125	22137	995	12537
6-#14	1.34	MA	11921	3164	17497	2615	20651	2123	22159	1755	23542	1209	28594	1119	14328
2L-3S		MI	8224	3164	12563	2554	14450	2069	15091	1714	15323	1166	18132	920	10827
6-#14	1.34	MA	10718	3164	15948	2614	18686	2120	19779	1764	20373	1216	24390	988	14280
3L-2S		MI	9107	3164	13704	2558	15896	2077	16809	1706	17583	1159	21083	1051	10817
6-#18	2.38	MA	13447	3546	21090	2834	25078	2282	27467	1852	30397	1162	37549	1024	24686
2L-3S		MI	8687	3546	14355	2761	16525	2207	17504	1793	18467	1104	22137	682	18186
6-#18	2.38	MA	11430	3546	18388	2830	21651	2273	23315	1865	24926	1176	30331	791	24266
3L-2S		MI	10163	3546	16330	2771	18994	2220	20437	1780	22326	1090	27135	915	18413
8-#11	1.24	MA	11791	3127	17118	2601	20236	2114	21686	1751	22976	1219	27886	1136	13353
2L-4S		MI	7940	3127	12020	2543	13773	2071	14336	1708	14394	1184	17186	895	10087
8-#11	1.24	MA	10945	3127	16034	2601	18861	2113	20020	1758	20747	1225	24922	1045	13338
3E		MI	8401	3127	12622	2545	14587	2066	15307	1713	15624	1179	18560	984	10119
8-#11	1.24	MA	10328	3127	15225	2601	17768	2121	18696	1755	18978	1219	22974	954	13234
4L-2S		MI	9023	3127	13423	2548	15602	2070	16522	1708	17223	1174	20655	1075	10103
8-#14	1.79	MA	12640	3327	19046	2717	22615	2198	24540	1802	26711	1198	32797	1093	18924
2L-4S		MI	8105	3327	12843	2652	14734	2152	15436	1751	15844	1157	19144	755	13792
8-#14	1.79	MA	11458	3327	17497	2716	20651	2195	22159	1812	23542	1206	28594	961	18823
3E		MI	8749	3327	13704	2656	15896	2144	16809	1758	17583	1150	21083	881	14183
8-#14	1.79	MA	10595	3327	16339	2715	19087	2207	20264	1806	21027	1198	25837	830	18273
4L-2S		MI	9618	3327	14844	2660	17342	2151	18527	1751	19843	1142	24034	1012	14220
8-#18	3.17	MA	14617	3836	23793	3015	28506	2415	31620	1936	35867	1140	44766	970	32646
2L-4S		MI	8475	3836	14832	2932	17010	2350	18092	1854	19356	1082	23838	385	21342
8-#18	3.17	MA	12651	3836	21090	3012	25078	2406	27467	1950	30397	1154	37549	736	32092
3E		MI	9548	3836	16330	2943	18994	2337	20437	1868	22326	1069	27135	601	23893
8-#18	3.17	MA	11214	3836	19064	3008	22341	2425	24151	1937	26054	1140	32827	502	28598
4L-2S		MI	10991	3836	18306	2953	21463	2350	23369	1854	26185	1055	32134	835	24238
10-#11	1.55	MA	12302	3240	18202	2672	21611	2166	23351	1784	25206	1213	30851	1120	16573
2L-5S		MI	7902	3240	12208	2621	14054	2119	14671	1745	14796	1168	17820	828	11943
10-#11	1.55	MA	11467	3240	17118	2672	20236	2164	21686	1791	22976	1218	27886	1028	16533
3L-4S		MI	8317	3240	12820	2614	14789	2123	15551	1740	15992	1173	19281	870	12429
10-#11	1.55	MA	10859	3240	16309	2672	19143	2173	20361	1788	21207	1213	25939	937	16397
4L-3S		MI	8773	3240	13423	2616	15602	2117	16522	1745	17223	1168	20655	959	12490
10-#11	1.55	MA	10307	3240	15490	2682	18161	2171	19162	1795	19593	1218	23887	893	15685
5L-2S		MI	9388	3240	14224	2618	16618	2122	17737	1740	18821	1163	22750	1050	12495
10-#14	2.23	MA	13341	3491	20595	2819	24580	2273	26920	1850	29880	1188	37001	1067	23502
2L-5S		MI	8049	3491	13109	2765	15131	2219	15908	1802	16411	1133	20036	654	16060
10-#14	2.23	MA	12179	3491	19046	2818	22615	2270	24540	1859	26711	1196	32797	935	23355
3L-4S		MI	8627	3491	13983	2754	16180	2226	17154	1795	18104	1140	22094	716	16921
10-#14	2.23	MA	11332	3491	17889	2817	21052	2281	22644	1854	24196	1188	30040	804	22580
4L-3S		MI	9261	3491	14844	2758	17342	2219	18527	1802	19843	1133	24034	842	17524
10-#14	2.23	MA	10563	3491	16716	2832	19644	2278	20927	1863	21901	1196	27123	741	21225
5L-2S		MI	10117	3491	15984	2763	18788	2226	20245	1795	22104	1125	26984	973	17600

RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

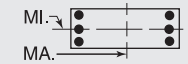
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.97	MA	13834	4127	23793	3193	28506	2539	31620	2034	35867	1131	44766	681	39918
3L-4S		MI	9377	4127	16808	3114	19479	2479	21024	1929	23215	1047	28837	305	26804
10-#18	3.97	MA	12435	4127	21767	3190	25769	2558	28304	2021	31525	1118	40045	448	36172
4L-3S		MI	10415	4127	18306	3124	21463	2466	23369	1942	26185	1034	32134	521	29468
10-#18	3.97	MA	11164	4127	19712	3213	23303	2549	25295	2035	27563	1131	35012	340	32952
5L-2S		MI	11798	4127	20282	3135	23932	2479	26301	1929	30044	1020	37132	755	30037
12-#11	1.86	MA	12804	3354	19286	2743	22986	2218	25017	1817	27435	1207	33815	1103	19782
2L-6S		MI	7885	3354	12464	2690	14344	2177	15018	1771	15281	1163	18551	740	13817
12-#11	1.86	MA	11979	3354	18202	2743	21611	2216	23351	1824	25206	1212	30851	1012	19720
3L-5S		MI	8279	3354	13009	2692	15069	2171	15886	1776	16394	1158	19914	802	14193
12-#11	1.86	MA	11379	3354	17393	2743	20518	2225	22027	1821	23437	1207	28903	921	19557
4E		MI	8688	3354	13621	2684	15804	2175	16767	1771	17591	1163	21375	845	14765
12-#11	1.86	MA	10835	3354	16574	2753	19536	2223	20828	1828	21822	1212	26851	876	18756
5L-3S		MI	9138	3354	14224	2687	16618	2169	17737	1776	18821	1158	22750	934	14850
12-#11	1.86	MA	10312	3354	15846	2753	18565	2232	19647	1824	20270	1217	24782	801	18151
6L-2S		MI	9747	3354	15024	2689	17633	2174	18952	1771	20420	1152	24844	1025	14876
12-#14	2.68	MA	14028	3655	22144	2921	26545	2348	29300	1897	33049	1178	41204	1040	28070
2L-6S		MI	8024	3655	13470	2862	15540	2301	16399	1839	17098	1124	21068	525	18156
12-#14	2.68	MA	12884	3655	20595	2921	24580	2344	26920	1906	29880	1185	37001	909	27882
3L-5S		MI	8570	3655	14250	2867	16577	2294	17626	1847	18672	1116	22987	615	19270
12-#14	2.68	MA	12051	3655	19438	2920	23016	2356	25025	1901	27365	1178	34243	777	26912
4E		MI	9139	3655	15123	2856	17626	2301	18872	1839	20364	1124	25045	677	20074
12-#14	2.68	MA	11296	3655	18265	2934	21609	2353	23307	1910	25070	1185	31327	715	25628
5L-3S		MI	9763	3655	15984	2860	18788	2294	20245	1847	22104	1116	26984	802	20855
12-#14	2.68	MA	10572	3655	17222	2933	20219	2365	21616	1905	22863	1193	28393	606	24093
6L-2S		MI	10607	3655	17124	2865	20234	2301	21962	1839	24364	1109	29935	934	20967
12-#18	4.76	MA	13621	4418	24470	3372	29197	2691	32457	2105	36995	1096	47263	393	43783
4E		MI	10213	4418	18784	3296	21948	2609	23956	2004	27074	1012	33835	225	32302
12-#18	4.76	MA	12382	4418	22415	3395	26731	2682	29448	2119	33033	1109	42230	286	40431
5L-3S		MI	11220	4418	20282	3306	23932	2596	26301	2017	30044	999	37132	441	34771
12-#18	4.76	MA	11193	4418	20586	3391	24295	2701	26484	2106	29224	1123	37194	91	36961
6L-2S		MI	12568	4418	22258	3317	26401	2609	29234	2004	33903	985	42131	675	35819
14-#11	2.17	MA	13298	3467	20370	2814	24361	2270	26683	1850	29664	1200	36780	1086	22985
2L-7S		MI	7878	3467	12733	2758	14657	2224	15391	1808	15789	1157	19249	632	15367
14-#11	2.17	MA	12482	3467	19286	2814	22986	2268	25017	1857	27435	1205	33815	995	22903
3L-6S		MI	8259	3467	13264	2761	15359	2228	16233	1803	16880	1152	20645	715	16068
14-#11	2.17	MA	11890	3467	18477	2814	21893	2277	23693	1853	25666	1200	31868	904	22715
4L-5S		MI	8648	3467	13809	2763	16085	2223	17101	1808	17993	1147	22009	777	16452
14-#11	2.17	MA	11353	3467	17658	2824	20910	2275	22493	1861	24051	1205	29816	860	21836
5L-4S		MI	9053	3467	14421	2755	16819	2227	17982	1803	19189	1152	23470	820	17097
14-#11	2.17	MA	10838	3467	16930	2824	19940	2284	21312	1857	22499	1211	27747	784	21255
6L-3S		MI	9498	3467	15024	2758	17633	2221	18952	1808	20420	1147	24844	908	17204
14-#11	2.17	MA	10333	3467	16222	2823	19002	2282	20167	1864	20924	1205	25910	713	20239
7L-2S		MI	10100	3467	15825	2760	18648	2226	20168	1803	22018	1142	26939	1000	17246
14-#14	3.13	MA	13574	3818	22144	3023	26545	2419	29300	1954	33049	1175	41204	882	32405
3L-6S		MI	8542	3818	14611	2965	16986	2376	18117	1884	19358	1107	24019	486	21304
14-#14	3.13	MA	12756	3818	20987	3022	24981	2431	27405	1948	30534	1168	38447	751	31264
4L-5S		MI	9081	3818	15390	2969	18023	2369	19344	1891	20932	1099	25938	576	22492
14-#14	3.13	MA	12014	3818	19814	3036	23574	2428	25688	1958	28239	1175	35530	688	30042
5L-4S		MI	9641	3818	16264	2958	19072	2376	20589	1884	22625	1107	27996	638	23247
14-#14	3.13	MA	11301	3818	18771	3035	22184	2439	23996	1952	26032	1183	32597	579	28437
6L-3S		MI	10256	3818	17124	2963	20234	2368	21962	1891	24364	1099	29935	763	24180
14-#14	3.13	MA	10604	3818	17755	3034	20841	2436	22356	1962	23793	1175	29995	476	26862
7L-2S		MI	11089	3818	18264	2967	21680	2376	23680	1884	26624	1092	32886	895	24323

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis

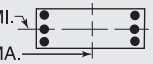


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	5.56	MA	13655	4709	25118	3576	30159	2815	33601	2203	38504	1087	49448	231	47941
5L-4S		MI	11027	4709	20760	3477	24417	2739	26889	2079	30933	977	38834	144	37829
14-#18	5.56	MA	12492	4709	23289	3573	27723	2834	30636	2190	34694	1100	44412	36	44245
6L-3S		MI	12007	4709	22258	3488	26401	2725	29234	2092	33903	963	42131	361	40122
16-#11	2.48	MA	12977	3580	20370	2885	24361	2320	26683	1890	29664	1199	36780	978	26082
3L-7S		MI	8251	3580	13533	2829	15672	2276	16606	1839	17387	1147	21343	607	17604
16-#11	2.48	MA	12393	3580	19561	2885	23268	2329	25358	1886	27895	1194	34832	887	25872
4L-6S		MI	8628	3580	14065	2832	16374	2280	17448	1834	18478	1142	22740	690	18276
16-#11	2.48	MA	11863	3580	18743	2895	22285	2327	24159	1893	26281	1199	32780	843	24926
5E		MI	9012	3580	14610	2834	17100	2274	18316	1839	19591	1136	24104	752	18719
16-#11	2.48	MA	11354	3580	18015	2895	21315	2336	22978	1890	24728	1204	30711	767	24343
6L-4S		MI	9413	3580	15222	2826	17834	2279	19197	1834	20788	1142	25565	795	19343
16-#11	2.48	MA	10856	3580	17306	2894	20377	2334	21833	1897	23154	1199	28874	696	23307
7L-3S		MI	9852	3580	15825	2829	18648	2273	20168	1839	22018	1136	26939	883	19552
16-#11	2.48	MA	10364	3580	16608	2894	19458	2332	20685	1894	21635	1204	26959	645	22324
8L-2S		MI	10448	3580	16625	2831	19664	2278	21383	1834	23617	1131	29034	974	19611
16-#14	3.57	MA	13447	3982	22536	3124	26946	2506	29785	1996	33703	1157	42650	725	35633
4L-6S		MI	9052	3982	15751	3067	18432	2451	19835	1928	21618	1090	26969	447	24466
16-#14	3.57	MA	12717	3982	21363	3138	25538	2503	28068	2005	31408	1165	39733	662	34467
5E		MI	9582	3982	16530	3071	19469	2443	21062	1935	23192	1083	28889	536	25723
16-#14	3.57	MA	12017	3982	20320	3137	24149	2514	26377	2000	29201	1172	36800	553	32794
6L-4S		MI	10135	3982	17404	3061	20518	2451	22307	1928	24885	1090	30947	598	26436
16-#14	3.57	MA	11331	3982	19305	3137	22805	2511	24736	2009	26962	1165	34198	450	31176
7L-3S		MI	10741	3982	18264	3065	21680	2443	23680	1935	26624	1083	32886	724	27500
16-#14	3.57	MA	10652	3982	18304	3136	21488	2508	23092	2003	24803	1172	31476	377	29367
8L-2S		MI	11564	3982	19405	3069	23126	2451	25398	1928	28885	1075	35837	855	27673
16-#18	6.35	MA	13687	4999	25992	3754	31150	2967	34789	2275	40165	1078	51630	-19	51487
6L-4S		MI	11823	4999	22736	3659	26886	2868	29821	2153	34792	942	43832	64	43378
18-#11	2.79	MA	12887	3694	20645	2955	24643	2381	27024	1919	30124	1188	37797	870	28978
4L-7S		MI	8619	3694	14334	2900	16687	2328	17821	1871	18986	1136	23438	582	19849
18-#11	2.79	MA	12364	3694	19827	2966	23660	2379	25825	1926	28510	1193	35745	826	28022
5L-6S		MI	8991	3694	14865	2903	17390	2332	18663	1866	20077	1131	24835	665	20493
18-#11	2.79	MA	11862	3694	19099	2965	22690	2387	24644	1923	26957	1198	33676	751	27385
6L-5S		MI	9371	3694	15411	2905	18115	2326	19531	1871	21190	1126	26199	727	20992
18-#11	2.79	MA	11371	3694	18390	2965	21752	2386	23498	1930	25383	1193	31839	679	26380
7L-4S		MI	9767	3694	16022	2897	18850	2331	20412	1866	22387	1131	27659	770	21583
18-#11	2.79	MA	10885	3694	17692	2965	20833	2384	22351	1927	23864	1198	29923	628	25368
8L-3S		MI	10202	3694	16625	2899	19664	2325	21383	1871	23617	1126	29034	858	21897
18-#11	2.79	MA	10403	3694	16921	2975	19886	2393	21221	1934	22360	1203	28048	569	24285
9L-2S		MI	10792	3694	17426	2902	20679	2329	22598	1866	25216	1121	31129	949	21971
18-#14	4.02	MA	13408	4145	22913	3240	27503	2577	30448	2052	34577	1155	43937	636	38900
5L-6S		MI	9553	4145	16891	3169	19878	2526	21552	1972	23879	1073	29920	407	27639
18-#14	4.02	MA	12719	4145	21870	3240	26113	2589	28757	2047	32370	1162	41003	526	37162
6L-5S		MI	10076	4145	17670	3173	20915	2518	22780	1980	25453	1066	31839	497	28883
18-#14	4.02	MA	12044	4145	20854	3239	24770	2586	27116	2056	30131	1155	38402	424	35501
7L-4S		MI	10621	4145	18544	3163	21964	2526	24025	1972	27145	1073	33897	559	29637
18-#14	4.02	MA	11376	4145	19853	3238	23453	2583	25472	2051	27972	1162	35679	351	33669
8L-3S		MI	11220	4145	19405	3167	23126	2518	25398	1980	28885	1066	35837	685	30816
20-#11	3.10	MA	12859	3807	20911	3036	25035	2431	27490	1959	30739	1186	38709	809	31124
5L-7S		MI	8981	3807	15134	2971	17703	2380	19036	1902	20584	1126	25533	556	22100
20-#11	3.10	MA	12363	3807	20183	3036	24065	2439	26310	1956	29187	1192	36640	734	30434
6E		MI	9350	3807	15666	2973	18405	2384	19878	1897	21675	1121	26929	640	22718
20-#11	3.10	MA	11877	3807	19474	3036	23127	2438	25164	1963	27612	1186	34803	663	29460
7L-5S		MI	9726	3807	16211	2976	19131	2378	20746	1902	22789	1115	28293	702	23270
20-#11	3.10	MA	11398	3807	18776	3036	22208	2436	24016	1960	26093	1192	32888	611	28418
8L-4S		MI	10117	3807	16823	2968	19865	2383	21627	1897	23985	1121	29754	744	23831
20-#11	3.10	MA	10921	3807	18005	3046	21261	2445	22887	1967	24589	1197	31012	552	27316
9L-3S		MI	10548	3807	17426	2970	20679	2377	22598	1902	25216	1115	31129	833	24239

RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	4.46	MA	13410	4309	23419	3342	28078	2664	31137	2094	35539	1152	45207	500	41540
6E		MI	10047	4309	18031	3271	21324	2600	23270	2017	26139	1057	32871	368	30823
20-#14	4.46	MA	12745	4309	22403	3341	26735	2661	29496	2104	33300	1144	42605	397	39779
7L-5S		MI	10605	4309	18811	3276	22362	2593	24498	2024	27713	1049	34790	458	32014
20-#14	4.46	MA	12088	4309	21403	3340	25418	2658	27852	2098	31141	1152	39883	324	37980
8L-4S		MI	11135	4309	19684	3265	23410	2600	25743	2017	29405	1057	36848	520	32849
22-#11	3.40	MA	12857	3921	21267	3107	25440	2491	27975	1989	31416	1185	39605	717	33490
6L-7S		MI	9339	3921	15935	3042	18718	2431	20251	1934	22183	1115	27628	531	24355
22-#11	3.40	MA	12377	3921	20558	3107	24502	2490	26830	1996	29841	1180	37768	646	32545
7L-6S		MI	9704	3921	16466	3044	19420	2436	21093	1929	23274	1110	29024	615	24951
22-#11	3.40	MA	11903	3921	19860	3107	23583	2488	25682	1993	28322	1185	35852	595	31443
8L-5S		MI	10076	3921	17012	3047	20146	2430	21961	1934	24387	1105	30388	677	25552
22-#11	3.40	MA	11432	3921	19089	3117	22636	2496	24553	2000	26818	1190	33977	535	30352
9L-4S		MI	10463	3921	17624	3039	20880	2435	22842	1929	25584	1110	31849	719	26087
22-#14	4.91	MA	13435	4472	23952	3443	28699	2736	31876	2151	36469	1134	46808	371	44127
7L-6S		MI	10580	4472	19171	3374	22771	2675	24988	2061	28399	1040	35822	329	34016
22-#14	4.91	MA	12788	4472	22952	3442	27382	2732	30232	2146	34310	1142	44086	298	42299
8L-5S		MI	11082	4472	19951	3378	23808	2668	26215	2068	29973	1033	37741	419	35157
24-#11	3.71	MA	12870	4034	21642	3178	25877	2541	28495	2029	32071	1174	40732	629	35635
7E		MI	9693	4034	16736	3113	19733	2483	21466	1966	23782	1105	29722	506	26616
24-#11	3.71	MA	12402	4034	20944	3178	24958	2540	27348	2025	30552	1179	38817	578	34505
8L-6S		MI	10054	4034	17267	3115	20436	2488	22308	1960	24873	1099	31119	590	27190
24-#11	3.71	MA	11937	4034	20174	3188	24011	2548	26218	2032	29047	1184	36941	519	33394
9L-5S		MI	10422	4034	17812	3118	21161	2482	23176	1966	25986	1094	32483	652	27837
24-#14	5.36	MA	13478	4636	24501	3545	29347	2807	32613	2193	37479	1131	48289	272	46627
8L-6S		MI	11058	4636	20312	3476	24217	2750	26706	2105	30660	1023	38772	290	37217

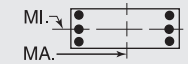
RECTANGULAR TIED COLUMNS 28" x 38"

4-#18	1.50	MA	13541	3403	20148	2791	23777	2263	25594	1865	27364	1264	33319	1160	17770
2E		MI	9730	3403	14933	2713	17169	2192	18151	1791	19064	1192	22811	1060	12576
6-#14	1.27	MA	13197	3312	19191	2754	22701	2238	24350	1852	25857	1287	31415	1198	15239
2L-3S		MI	8642	3312	13135	2679	15092	2172	15739	1801	15923	1234	18812	985	10868
6-#14	1.27	MA	11910	3312	17539	2754	20607	2235	21813	1863	22460	1294	26897	1067	15192
3L-2S		MI	9527	3312	14275	2683	16538	2180	17456	1794	18183	1226	21762	1116	10848
6-#18	2.26	MA	14850	3694	23032	2973	27435	2396	30026	1949	33239	1244	41095	1110	26306
2L-3S		MI	9105	3694	14933	2885	17169	2309	18151	1879	19064	1170	22811	746	18269
6-#18	2.26	MA	12687	3694	20148	2970	23777	2389	25594	1965	27364	1257	33319	877	25886
3L-2S		MI	10588	3694	16908	2895	19638	2322	21083	1866	22923	1157	27809	979	18461
8-#11	1.17	MA	13054	3275	18783	2741	22255	2229	23841	1848	25241	1297	30639	1215	14195
2L-4S		MI	8356	3275	12587	2668	14414	2175	14984	1796	14995	1251	17868	961	10132
8-#11	1.17	MA	12149	3275	17628	2741	20790	2228	22066	1856	22854	1302	27456	1124	14181
3E		MI	8819	3275	13190	2671	15228	2169	15955	1801	16226	1246	19242	1049	10152
8-#11	1.17	MA	11491	3275	16768	2741	19628	2237	20657	1853	20960	1297	25362	1032	14077
4L-2S		MI	9443	3275	13991	2673	16244	2174	17170	1796	17824	1241	21337	1140	10131
8-#14	1.69	MA	13972	3476	20842	2856	24795	2313	26888	1900	29254	1278	35933	1174	20139
2L-4S		MI	8521	3476	13414	2777	15376	2254	16083	1838	16444	1224	19823	820	13967
8-#14	1.69	MA	12707	3476	19191	2856	22701	2310	24350	1910	25857	1285	31415	1043	20038
3E		MI	9168	3476	14275	2781	16538	2247	17456	1845	18183	1217	21762	946	14231
8-#14	1.69	MA	11785	3476	17959	2856	21037	2323	22334	1905	23161	1278	28447	912	19629
4L-2S		MI	10040	3476	15415	2785	17984	2254	19174	1838	20444	1209	24713	1077	14255

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

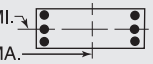


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.01	MA	16114	3985	25917	3155	31093	2529	34458	2033	39114	1224	48870	1060	34806
2L-4S		MI	8891	3985	15410	3056	17653	2452	18739	1941	19954	1148	24512	449	21575
8-#18	3.01	MA	14005	3985	23032	3152	27435	2522	30026	2049	33239	1238	41095	826	34252
3E		MI	9969	3985	16908	3066	19638	2438	21083	1954	22923	1135	27809	666	23986
8-#18	3.01	MA	12468	3985	20874	3150	24519	2542	26493	2038	28576	1224	36001	593	30726
4L-2S		MI	11420	3985	18884	3077	22107	2452	24016	1941	26782	1122	32808	899	24293
10-#11	1.47	MA	13605	3389	19938	2811	23720	2281	25615	1881	27629	1292	33822	1199	17626
2L-5S		MI	8318	3389	12776	2747	14695	2222	15319	1833	15397	1236	18502	893	12062
10-#11	1.47	MA	12711	3389	18783	2812	22255	2280	23841	1889	25241	1297	30639	1108	17586
3L-4S		MI	8735	3389	13388	2739	15430	2227	16199	1828	16594	1241	19963	936	12480
10-#11	1.47	MA	12062	3389	17923	2812	21093	2289	22432	1886	23347	1292	28545	1017	17450
4L-3S		MI	9192	3389	13991	2742	16244	2221	17170	1833	17824	1236	21337	1024	12527
10-#11	1.47	MA	11474	3389	17053	2823	20048	2287	21157	1894	21618	1297	26348	972	16776
5L-2S		MI	9809	3389	14791	2744	17259	2225	18385	1828	19423	1231	23432	1115	12525
10-#14	2.11	MA	14728	3640	22493	2958	26890	2387	29425	1947	32650	1269	40450	1150	25021
2L-5S		MI	8465	3640	13681	2890	15773	2322	16556	1890	17012	1200	20716	719	16210
10-#14	2.11	MA	13484	3640	20842	2958	24795	2385	26888	1957	29254	1276	35933	1019	24874
3L-4S		MI	9046	3640	14555	2879	16822	2329	17801	1882	18704	1208	22774	781	17092
10-#14	2.11	MA	12579	3640	19610	2958	23131	2397	24871	1953	26558	1269	32965	887	24228
4L-3S		MI	9682	3640	15415	2883	17984	2322	19174	1890	20444	1200	24713	907	17578
10-#14	2.11	MA	11758	3640	18363	2973	21634	2395	23044	1963	24098	1276	29838	824	22712
5L-2S		MI	10542	3640	16555	2888	19430	2329	20892	1882	22704	1193	27664	1038	17641
10-#18	3.76	MA	15282	4276	25917	3334	31093	2655	34458	2133	39114	1218	48870	776	42618
3L-4S		MI	9755	4276	17386	3237	20122	2581	21671	2016	23813	1113	29511	369	27032
10-#18	3.76	MA	13784	4276	23759	3332	28177	2675	30925	2122	34451	1204	43776	543	38823
4L-3S		MI	10843	4276	18884	3248	22107	2568	24016	2029	26782	1100	32808	585	29692
10-#18	3.76	MA	12426	4276	21572	3356	25552	2668	27721	2137	30197	1218	38369	433	35569
5L-2S		MI	12236	4276	20860	3258	24576	2581	26948	2016	30641	1087	37807	819	30097
12-#11	1.76	MA	14145	3502	21093	2882	25185	2333	27390	1914	30016	1286	37005	1184	21046
2L-6S		MI	8300	3502	13031	2816	14985	2280	15666	1859	15883	1230	19233	806	13932
12-#11	1.76	MA	13263	3502	19938	2883	23720	2331	25615	1922	27629	1291	33822	1093	20984
3L-5S		MI	8696	3502	13577	2818	15711	2274	16534	1864	16996	1225	20596	868	14311
12-#11	1.76	MA	12622	3502	19078	2883	22557	2341	24207	1919	25734	1286	31728	1002	20820
4E		MI	9107	3502	14189	2810	16445	2279	17414	1859	18192	1230	22057	910	14821
12-#11	1.76	MA	12042	3502	18208	2893	21513	2339	22932	1927	24005	1291	29530	957	20050
5L-3S		MI	9559	3502	14791	2813	17259	2273	18385	1864	19423	1225	23432	999	14892
12-#11	1.76	MA	11485	3502	17434	2894	20481	2348	21676	1924	22343	1296	27309	882	19381
6L-2S		MI	10169	3502	15592	2815	18274	2277	19600	1859	21021	1220	25526	1090	14910
12-#14	2.54	MA	15469	3803	24145	3061	28984	2462	31962	1994	36047	1260	44968	1126	29892
2L-6S		MI	8438	3803	14042	2987	16182	2404	17046	1927	17698	1191	21747	590	18392
12-#14	2.54	MA	14243	3803	22493	3060	26890	2460	29425	2005	32650	1267	40450	995	29705
3L-5S		MI	8987	3803	14821	2992	17219	2397	18274	1934	19272	1183	23667	680	19419
12-#14	2.54	MA	13354	3803	21262	3060	25225	2472	27408	2000	29955	1260	37482	863	28852
4E		MI	9559	3803	15695	2981	18268	2404	19519	1927	20964	1191	25725	742	20243
12-#14	2.54	MA	12548	3803	20015	3075	23729	2470	25581	2010	27495	1267	34356	800	27411
5L-3S		MI	10186	3803	16555	2986	19430	2397	20892	1934	22704	1183	27664	867	20913
12-#14	2.54	MA	11774	3803	18906	3075	22251	2482	23783	2006	25129	1275	31202	691	25891
6L-2S		MI	11034	3803	17695	2990	20876	2404	22610	1927	24964	1176	30615	999	21010
12-#18	4.51	MA	15063	4566	26643	3513	31835	2808	35356	2206	40326	1185	51552	493	46958
4E		MI	10638	4566	19362	3419	22591	2711	24603	2090	27672	1078	34510	289	32525
12-#18	4.51	MA	13738	4566	24456	3537	29211	2801	32153	2222	36072	1198	46145	383	43574
5L-3S		MI	11653	4566	20860	3430	24576	2698	26948	2104	30641	1065	37807	505	35074
12-#18	4.51	MA	12466	4566	22510	3535	26618	2821	28998	2210	31980	1211	40719	189	40009
6L-2S		MI	13012	4566	22836	3440	27045	2711	29880	2090	34500	1052	42805	739	35884
14-#11	2.05	MA	14677	3616	22248	2953	26649	2384	29164	1947	32403	1280	40187	1169	24459
2L-7S		MI	8293	3616	13300	2884	15298	2327	16038	1896	16390	1225	19931	697	15542
14-#11	2.05	MA	13805	3616	21093	2953	25185	2383	27390	1955	30016	1286	37005	1078	24377
3L-6S		MI	8676	3616	13832	2887	16000	2332	16881	1891	17481	1220	21327	781	16208

RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

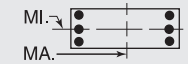
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.05	MA	13172	3616	20233	2954	24022	2392	25981	1952	28122	1280	34911	987	24189
4L-5S		MI	9067	3616	14377	2889	16726	2326	17749	1896	18594	1215	22691	843	16569
14-#11	2.05	MA	12600	3616	19363	2964	22977	2391	24706	1960	26393	1286	32713	942	23335
5L-4S		MI	9473	3616	14989	2881	17460	2331	18629	1891	19791	1220	24152	885	17156
14-#11	2.05	MA	12050	3616	18589	2964	21946	2400	23451	1957	24730	1291	30491	866	22692
6L-3S		MI	9920	3616	15592	2884	18274	2325	19600	1896	21021	1215	25526	974	17248
14-#11	2.05	MA	11512	3616	17836	2965	20950	2399	22233	1965	23044	1286	28517	795	21687
7L-2S		MI	10524	3616	16393	2886	19290	2329	20815	1891	22620	1209	27621	1065	17283
14-#14	2.96	MA	14987	3967	24145	3163	28984	2535	31962	2052	36047	1258	44968	971	34531
3L-6S		MI	8958	3967	15182	3090	17628	2479	18764	1971	19958	1174	24698	551	21536
14-#14	2.96	MA	14112	3967	22913	3162	27320	2547	29945	2047	33352	1251	42000	839	33496
4L-5S		MI	9500	3967	15961	3094	18665	2471	19992	1978	21532	1167	26617	640	22640
14-#14	2.96	MA	13320	3967	21666	3177	25823	2545	28119	2058	30892	1258	38874	776	32122
5L-4S		MI	10063	3967	16835	3083	19714	2479	21237	1971	23225	1174	28675	702	23412
14-#14	2.96	MA	12560	3967	20557	3177	24345	2557	26320	2053	28526	1266	35720	667	30531
6L-3S		MI	10682	3967	17695	3088	20876	2471	22610	1978	24964	1167	30615	828	24242
14-#14	2.96	MA	11815	3967	19477	3177	22917	2555	24576	2063	26127	1258	32921	564	28958
7L-2S		MI	11518	3967	18836	3092	22322	2479	24328	1971	27225	1159	33565	960	24370
14-#18	5.26	MA	15017	4857	27341	3719	32869	2934	36585	2306	41946	1178	53921	333	51610
5L-4S		MI	11455	4857	21338	3601	25060	2840	27535	2165	31530	1043	39508	209	38048
14-#18	5.26	MA	13775	4857	25394	3717	30276	2954	33430	2295	37855	1191	48495	138	47981
6L-3S		MI	12444	4857	22836	3611	27045	2827	29880	2178	34500	1030	42805	425	40418
16-#11	2.35	MA	14338	3729	22248	3024	26649	2435	29164	1987	32403	1280	40187	1062	27766
3L-7S		MI	8667	3729	14101	2955	16313	2379	17253	1927	17989	1214	22025	672	17777
16-#11	2.35	MA	13714	3729	21388	3025	25487	2444	27756	1985	30509	1275	38094	971	27557
4L-6S		MI	9046	3729	14633	2957	17015	2384	18096	1922	19080	1209	23422	755	18467
16-#11	2.35	MA	13148	3729	20518	3035	24442	2443	26481	1992	28780	1280	35896	926	26629
5E		MI	9432	3729	15178	2960	17741	2378	18964	1927	20193	1204	24786	817	18835
16-#11	2.35	MA	12606	3729	19744	3035	23411	2452	25225	1990	27117	1285	33674	851	26008
6L-4S		MI	9834	3729	15790	2952	18476	2382	19844	1922	21390	1209	26247	860	19479
16-#11	2.35	MA	12075	3729	18991	3036	22414	2451	24008	1997	25432	1280	31700	780	24959
7L-3S		MI	10276	3729	16393	2954	19290	2377	20815	1927	22620	1204	27621	949	19600
16-#11	2.35	MA	11550	3729	18249	3036	21438	2450	22788	1995	23805	1285	29648	728	23993
8L-2S		MI	10875	3729	17193	2957	20305	2381	22030	1922	24219	1199	29716	1040	19650
16-#14	3.38	MA	14857	4130	24564	3265	29414	2622	32483	2095	36748	1241	46518	815	38158
4L-6S		MI	9469	4130	16322	3192	19074	2554	20482	2015	22219	1157	27649	512	24694
16-#14	3.38	MA	14077	4130	23317	3279	27917	2619	30656	2105	34288	1249	43391	751	36844
5E		MI	10003	4130	17101	3196	20111	2546	21709	2023	23792	1150	29568	601	25870
16-#14	3.38	MA	13330	4130	22208	3279	26439	2632	28857	2100	31923	1256	40238	643	35184
6L-4S		MI	10559	4130	17975	3186	21160	2554	22955	2015	25485	1157	31626	663	26598
16-#14	3.38	MA	12597	4130	21129	3279	25011	2629	27113	2111	29524	1249	37438	540	33569
7L-3S		MI	11169	4130	18836	3190	22322	2546	24328	2023	27225	1150	33565	789	27565
16-#14	3.38	MA	11873	4130	20066	3279	23611	2627	25365	2106	27209	1256	34520	466	31605
8L-2S		MI	11996	4130	19976	3194	23768	2554	26046	2015	29485	1142	36516	920	27723
16-#18	6.02	MA	15159	5148	28279	3899	33934	3087	37862	2379	43730	1171	56270	88	55816
6L-4S		MI	12255	5148	23313	3783	27529	2970	30468	2240	35389	1008	44507	128	43593
18-#11	2.64	MA	14246	3842	22543	3095	26952	2496	29530	2018	32896	1269	41276	956	30924
4L-7S		MI	9036	3842	14902	3026	17329	2431	18468	1959	19587	1204	24120	647	20020
18-#11	2.64	MA	13688	3842	21673	3106	25907	2495	28255	2025	31167	1274	39079	911	29931
5L-6S		MI	9410	3842	15433	3028	18031	2436	19311	1954	20678	1199	25517	730	20681
18-#11	2.64	MA	13153	3842	20899	3106	24876	2504	27000	2023	29505	1280	36857	836	29329
6L-5S		MI	9792	3842	15978	3031	18757	2430	20179	1959	21792	1193	26881	792	21107
18-#11	2.64	MA	12628	3842	20146	3106	23879	2503	25783	2030	27819	1274	34883	765	28239
7L-4S		MI	10190	3842	16590	3023	19491	2434	21059	1954	22988	1199	28341	835	21717

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

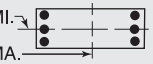


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.64	MA	12110	3842	19404	3107	22902	2502	24563	2028	26192	1280	32831	713	27242
8L-3S		MI	10628	3842	17193	3025	20305	2428	22030	1959	24219	1193	29716	923	21947
18-#11	2.64	MA	11595	3842	18586	3117	21896	2511	23363	2035	24581	1285	30815	654	26096
9L-2S		MI	11220	3842	17994	3028	21320	2433	23245	1954	25817	1188	31811	1015	22012
18-#14	3.81	MA	14822	4294	24969	3382	30011	2694	33193	2152	37685	1240	47909	727	41575
5L-6S		MI	9973	4294	17462	3294	20521	2629	22200	2060	24479	1141	30600	472	27864
18-#14	3.81	MA	14085	4294	23860	3381	28534	2707	31395	2148	35320	1247	44756	618	39848
6L-5S		MI	10499	4294	18242	3298	21558	2621	23427	2067	26053	1133	32519	562	29108
18-#14	3.81	MA	13364	4294	22780	3381	27105	2704	29650	2158	32921	1240	41956	516	38191
7L-4S		MI	11048	4294	19115	3288	22606	2628	24673	2060	27745	1141	34577	624	29797
18-#14	3.81	MA	12652	4294	21717	3381	25706	2702	27902	2153	30606	1247	39037	442	36278
8L-3S		MI	11650	4294	19976	3292	23768	2621	26046	2067	29485	1133	36516	750	30885
20-#11	2.93	MA	14220	3956	22828	3177	27372	2547	30030	2058	33555	1269	42262	896	33238
5L-7S		MI	9399	3956	15702	3097	18344	2483	19683	1990	21186	1193	26215	622	22269
20-#11	2.93	MA	13691	3956	22054	3177	26340	2556	28775	2055	31892	1274	40040	820	32617
6E		MI	9770	3956	16234	3099	19046	2488	20526	1985	22277	1188	27611	705	22904
20-#11	2.93	MA	13173	3956	21301	3177	25344	2555	27557	2063	30206	1269	38065	749	31524
7L-5S		MI	10148	3956	16779	3102	19772	2482	21394	1990	23390	1183	28975	767	23385
20-#11	2.93	MA	12661	3956	20559	3178	24367	2553	26337	2060	28579	1274	36013	697	30498
8L-4S		MI	10542	3956	17391	3094	20506	2486	22274	1985	24587	1188	30436	810	23964
20-#11	2.93	MA	12153	3956	19741	3188	23361	2563	25137	2068	26968	1279	33998	638	29378
9L-3S		MI	10975	3956	17994	3096	21320	2480	23245	1990	25817	1183	31811	898	24291
20-#11	2.93	MA	11647	3956	19002	3188	22391	2561	23932	2065	25312	1274	32043	572	28040
10L-2S		MI	11562	3956	18794	3099	22335	2485	24460	1985	27416	1178	33905	989	24370
20-#14	4.23	MA	14829	4457	25511	3484	30628	2781	33932	2195	38716	1238	49274	594	44522
6E		MI	10469	4457	18602	3396	21967	2703	23918	2104	26739	1124	33550	433	31044
20-#14	4.23	MA	14119	4457	24431	3483	29200	2779	32187	2205	36317	1231	46474	492	42823
7L-5S		MI	10989	4457	19382	3401	23004	2696	25145	2111	28313	1116	35470	523	32274
20-#14	4.23	MA	13417	4457	23368	3483	27800	2777	30439	2201	34003	1238	43555	418	40941
8L-4S		MI	11530	4457	20256	3390	24052	2703	26390	2104	30006	1124	37527	585	33007
22-#11	3.23	MA	14223	4069	23209	3248	27805	2608	30549	2088	34279	1268	43223	805	35878
6L-7S		MI	9759	4069	16503	3168	19359	2535	20899	2022	22785	1183	28310	597	24523
22-#11	3.23	MA	13711	4069	22456	3248	26809	2607	29332	2096	32594	1263	41248	734	34815
7L-6S		MI	10125	4069	17034	3170	20061	2539	21741	2017	23876	1177	29706	680	25134
22-#11	3.23	MA	13205	4069	21714	3248	25832	2605	28112	2093	30967	1268	39196	682	33759
8L-5S		MI	10500	4069	17580	3173	20787	2534	22609	2022	24989	1172	31070	742	25666
22-#11	3.23	MA	12703	4069	20895	3259	24826	2614	26912	2101	29356	1274	37181	623	32644
9L-4S		MI	10890	4069	18191	3165	21522	2538	23490	2017	26185	1177	32531	785	26218
22-#11	3.23	MA	12202	4069	20157	3259	23856	2613	25706	2098	27699	1268	35226	557	31308
10L-3S		MI	11318	4069	18794	3167	22335	2532	24460	2022	27416	1172	33905	873	26632
22-#14	4.65	MA	14862	4621	26083	3586	31294	2854	34725	2253	39714	1222	50992	468	47406
7L-6S		MI	11005	4621	19743	3499	23413	2778	25636	2148	28999	1107	36501	394	34234
22-#14	4.65	MA	14170	4621	25020	3585	29894	2851	32977	2248	37400	1229	48073	394	45559
8L-5S		MI	11512	4621	20522	3503	24450	2771	26863	2156	30573	1100	38420	484	35413
24-#11	3.52	MA	14241	4183	23611	3319	28273	2658	31106	2129	34981	1258	44431	719	38111
7E		MI	10114	4183	17303	3239	20375	2587	22114	2053	24383	1172	30404	571	26782
24-#11	3.52	MA	13741	4183	22869	3319	27297	2657	29887	2126	33354	1263	42379	667	36995
8L-6S		MI	10477	4183	17835	3241	21077	2591	22956	2048	25474	1167	31801	655	27371
24-#11	3.52	MA	13245	4183	22050	3330	26290	2666	28687	2134	31743	1268	40364	608	35891
9L-5S		MI	10848	4183	18380	3243	21803	2585	23824	2053	26587	1162	33165	717	27952
24-#11	3.52	MA	12750	4183	21312	3330	25320	2665	27481	2131	30087	1263	38409	542	34579
10L-4S		MI	11234	4183	18992	3235	22537	2590	24705	2048	27784	1167	34626	760	28479
24-#14	5.08	MA	14912	4785	26671	3688	31989	2926	35514	2296	40796	1220	52591	370	50184
8L-6S		MI	11486	4785	20883	3601	24859	2853	27353	2193	31260	1091	39452	355	37433

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

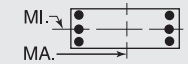
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.43	MA	14907	3552	21978	2930	25990	2378	27965	1962	29893	1343	36413	1241	18850
2E		MI	10150	3552	15511	2837	17813	2294	18798	1878	19661	1258	23485	1124	12614
6-#14	1.21	MA	14532	3461	20954	2893	24839	2352	26634	1950	28262	1365	34341	1277	16150
2L-3S		MI	9059	3461	13706	2804	15734	2275	16386	1888	16523	1301	19491	1050	10907
6-#14	1.21	MA	13161	3461	19200	2893	22615	2351	23940	1961	24637	1372	29508	1145	16103
3L-2S		MI	9946	3461	14846	2808	17180	2282	18104	1881	18783	1293	22442	1181	10879
6-#18	2.14	MA	16315	3843	25044	3112	29879	2511	32676	2046	36172	1325	44747	1195	27926
2L-3S		MI	9524	3843	15511	3008	17813	2410	18798	1966	19661	1236	23485	810	18347
6-#18	2.14	MA	14006	3843	21978	3111	25990	2505	27965	2063	29893	1338	36413	961	27506
3L-2S		MI	11012	3843	17486	3019	20282	2424	21730	1953	23520	1223	28484	1044	18509
8-#11	1.11	MA	14377	3424	20518	2880	24362	2343	26088	1946	27578	1374	33496	1292	15037
2L-4S		MI	8773	3424	13155	2794	15056	2278	15632	1884	15597	1319	18550	1026	10174
8-#11	1.11	MA	13414	3424	19293	2880	22807	2343	24205	1954	25037	1379	30095	1201	15023
3E		MI	9236	3424	13758	2797	15869	2273	16603	1889	16827	1314	19924	1114	10183
8-#11	1.11	MA	12714	3424	18381	2881	21575	2352	22712	1952	23022	1374	27855	1110	14919
4L-2S		MI	9862	3424	14559	2799	16885	2277	17818	1884	18426	1309	22019	1206	10158
8-#14	1.61	MA	15364	3625	22707	2995	27063	2427	29328	1997	31886	1357	39173	1255	21354
2L-4S		MI	8938	3625	13986	2902	16018	2357	16731	1925	17044	1291	20503	885	14138
8-#14	1.61	MA	14016	3625	20954	2996	24839	2425	26634	2008	28262	1364	34341	1123	21253
3E		MI	9587	3625	14846	2906	17180	2350	18104	1933	18783	1284	22442	1011	14277
8-#14	1.61	MA	13036	3625	19648	2996	23074	2438	24495	2004	25385	1357	31162	992	20888
4L-2S		MI	10461	3625	15986	2910	18626	2357	19822	1925	21044	1277	25393	1142	14290
8-#18	2.86	MA	17673	4133	28110	3294	33768	2644	37388	2131	42452	1307	53081	1149	36966
2L-4S		MI	9307	4133	15988	3179	18297	2553	19385	2027	20551	1215	25187	513	21803
8-#18	2.86	MA	15421	4133	25044	3293	29879	2638	32676	2148	36172	1321	44747	915	36412
3E		MI	10391	4133	17486	3190	20282	2540	21730	2041	23520	1201	28484	730	24074
8-#18	2.86	MA	13783	4133	22754	3291	26785	2659	28927	2138	31189	1307	39279	681	32877
4L-2S		MI	11847	4133	19462	3200	22751	2553	24662	2027	27379	1188	33482	963	24347
10-#11	1.39	MA	14968	3537	21744	2951	25916	2395	27972	1979	30119	1368	36898	1278	18679
2L-5S		MI	8735	3537	13344	2873	15337	2326	15967	1921	15999	1303	19184	958	12178
10-#11	1.39	MA	14016	3537	20518	2951	24362	2395	26088	1987	27578	1374	33496	1187	18639
3L-4S		MI	9152	3537	13956	2865	16071	2330	16847	1915	17195	1308	20645	1001	12528
10-#11	1.39	MA	13326	3537	19607	2952	23130	2404	24595	1985	25563	1369	31256	1096	18503
4L-3S		MI	9611	3537	14559	2868	16885	2324	17818	1921	18426	1303	22019	1089	12564
10-#11	1.39	MA	12701	3537	18685	2963	22023	2403	23244	1993	23724	1374	28913	1051	17875
5L-2S		MI	10230	3537	15359	2870	17900	2329	19033	1915	20024	1298	24114	1180	12556
10-#14	2.01	MA	16176	3788	24461	3098	29287	2502	32023	2044	35511	1349	44006	1233	26540
2L-5S		MI	8881	3788	14252	3015	16415	2425	17204	1977	17612	1267	21395	784	16356
10-#14	2.01	MA	14849	3788	22707	3098	27063	2500	29328	2055	31886	1356	39173	1101	26393
3L-4S		MI	9464	3788	15126	3004	17464	2432	18449	1970	19304	1275	23453	846	17260
10-#14	2.01	MA	13886	3788	21402	3098	25298	2513	27190	2052	29010	1349	35994	970	25894
4L-3S		MI	10103	3788	15986	3008	18626	2425	19822	1977	21044	1267	25393	971	17629
10-#14	2.01	MA	13014	3788	20080	3114	23712	2512	25254	2063	26385	1356	32657	905	24210
5L-2S		MI	10965	3788	17127	3013	20072	2432	21540	1970	23304	1260	28343	1103	17681
10-#18	3.57	MA	16791	4424	28110	3474	33768	2771	37388	2232	42452	1303	53081	869	45318
3L-4S		MI	10174	4424	17964	3361	20766	2683	22317	2102	24410	1180	30185	433	27255
10-#18	3.57	MA	15195	4424	25820	3473	30673	2792	33638	2222	37468	1289	47613	635	41499
4L-3S		MI	11235	4424	19462	3372	22751	2670	24662	2115	27379	1166	33482	650	29787
10-#18	3.57	MA	13748	4424	23500	3498	27889	2787	30240	2239	32921	1303	41833	524	38229
5L-2S		MI	12663	4424	21438	3382	25220	2683	27595	2102	31238	1153	38481	883	30156
12-#11	1.67	MA	15547	3651	22970	3022	27471	2447	29855	2011	32661	1363	40299	1264	22309
2L-6S		MI	8716	3651	13599	2941	15626	2384	16314	1947	16484	1298	19915	871	14042

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis

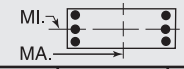


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.67	MA	14607	3651	21744	3022	25916	2446	27972	2020	30119	1369	36898	1173	22247
3L-5S		MI	9113	3651	14145	2944	16352	2378	17182	1952	17597	1293	21279	933	14425
12-#11	1.67	MA	13926	3651	20833	3023	24684	2456	26479	2017	28104	1364	34658	1082	22084
4E		MI	9526	3651	14756	2936	17086	2382	18062	1947	18794	1298	22739	976	14873
12-#11	1.67	MA	13309	3651	19911	3034	23578	2455	25128	2026	26265	1369	32314	1037	21354
5L-3S		MI	9979	3651	15359	2938	17900	2376	19033	1952	20024	1293	24114	1064	14931
12-#11	1.67	MA	12718	3651	19091	3034	22485	2465	23798	2023	24497	1375	29939	961	20617
6L-2S		MI	10591	3651	16160	2941	18915	2381	20248	1947	21623	1288	26208	1155	14943
12-#14	2.41	MA	16971	3952	26215	3200	31511	2577	34717	2092	39136	1341	48838	1211	31715
2L-6S		MI	8853	3952	14613	3113	16824	2507	17694	2014	18298	1258	22427	655	18622
12-#14	2.41	MA	15663	3952	24461	3200	29287	2575	32023	2103	35511	1348	44006	1079	31527
3L-5S		MI	9405	3952	15392	3117	17861	2500	18921	2021	19872	1251	24346	745	19564
12-#14	2.41	MA	14717	3952	23155	3200	27522	2588	29884	2099	32635	1341	40827	948	30810
4E		MI	9979	3952	16266	3106	18910	2507	20167	2014	21564	1258	26404	807	20407
12-#14	2.41	MA	13860	3952	21834	3216	25936	2586	27948	2110	30010	1348	37490	883	29205
5L-3S		MI	10609	3952	17127	3111	20072	2499	21540	2021	23304	1251	28343	932	20969
12-#14	2.41	MA	13037	3952	20659	3216	24370	2599	26042	2106	27485	1356	34116	774	27713
6L-2S		MI	11460	3952	18267	3115	21518	2507	23258	2014	25564	1243	31294	1064	21053
12-#18	4.29	MA	16568	4715	28886	3655	34562	2925	38349	2307	43748	1272	55947	589	50159
4E		MI	11062	4715	19940	3543	23235	2813	25250	2177	28269	1145	35184	353	32743
12-#18	4.29	MA	15156	4715	26567	3680	31778	2920	34952	2324	39200	1285	50167	478	46762
5L-3S		MI	12085	4715	21438	3553	25220	2799	27595	2190	31238	1131	38481	569	35372
12-#18	4.29	MA	13801	4715	24503	3679	29029	2941	31606	2314	34827	1298	44351	284	43115
6L-2S		MI	13454	4715	23414	3564	27688	2813	30527	2177	35097	1118	43480	803	35947
14-#11	1.95	MA	16118	3764	24196	3092	29026	2499	31739	2044	35202	1358	43700	1251	25934
2L-7S		MI	8708	3764	13868	3010	15939	2431	16686	1984	16992	1292	20613	762	15712
14-#11	1.95	MA	15188	3764	22970	3093	27471	2498	29855	2052	32661	1364	40299	1159	25851
3L-6S		MI	9092	3764	14400	3012	16641	2435	17529	1979	18083	1287	22009	846	16319
14-#11	1.95	MA	14515	3764	22059	3094	26239	2508	28362	2050	30645	1359	38059	1068	25663
4L-5S		MI	9485	3764	14945	3015	17367	2430	18397	1984	19196	1282	23373	908	16682
14-#11	1.95	MA	13907	3764	21137	3105	25132	2507	27011	2058	28806	1364	35715	1023	24844
5L-4S		MI	9893	3764	15557	3007	18101	2434	19277	1979	20393	1287	24834	951	17212
14-#11	1.95	MA	13323	3764	20317	3105	24040	2517	25682	2056	27038	1369	33341	947	24135
6L-3S		MI	10342	3764	16160	3009	18915	2428	20248	1984	21623	1282	26208	1039	17291
14-#11	1.95	MA	12751	3764	19520	3106	22985	2516	24393	2064	25245	1365	31229	876	23149
7L-2S		MI	10948	3764	16960	3012	19931	2433	21463	1979	23222	1277	28303	1130	17319
14-#14	2.81	MA	16462	4115	26215	3302	31511	2650	34717	2150	39136	1340	48838	1057	36658
3L-6S		MI	9374	4115	15753	3215	18270	2582	19412	2058	20558	1241	25378	616	21762
14-#14	2.81	MA	15531	4115	24909	3303	29746	2663	32578	2146	36260	1333	45659	926	35747
4L-5S		MI	9919	4115	16532	3219	19308	2574	20639	2066	22132	1234	27297	705	22783
14-#14	2.81	MA	14688	4115	23587	3318	28160	2661	30643	2157	33635	1340	42323	861	34214
5L-4S		MI	10485	4115	17406	3209	20356	2582	21884	2058	23825	1241	29355	767	23574
14-#14	2.81	MA	13879	4115	22413	3318	26594	2674	28737	2153	31110	1348	38949	752	32649
6L-3S		MI	11107	4115	18267	3213	21518	2574	23258	2066	25564	1234	31294	893	24302
14-#14	2.81	MA	13087	4115	21269	3319	25081	2673	26888	2165	28551	1340	35951	650	31050
7L-2S		MI	11947	4115	19407	3217	22964	2582	24975	2058	27825	1226	34245	1025	24416
14-#18	5.00	MA	16528	5006	29633	3862	35667	3053	39663	2408	45480	1267	58501	431	55324
5L-4S		MI	11883	5006	21916	3725	25704	2942	28182	2252	32128	1110	40182	273	38262
14-#18	5.00	MA	15204	5006	27570	3860	32917	3074	36317	2398	41107	1280	52685	238	51618
6L-3S		MI	12880	5006	23414	3735	27688	2929	30527	2265	35097	1096	43480	489	40709
16-#11	2.23	MA	15760	3877	24196	3164	29026	2550	31739	2085	35202	1358	43700	1145	29451
3L-7S		MI	9083	3877	14669	3081	16954	2483	17901	2015	18590	1282	22707	737	17945
16-#11	2.23	MA	15095	3877	23285	3165	27794	2560	30246	2083	33186	1353	41460	1054	29242
4L-6S		MI	9463	3877	15200	3083	17657	2487	18744	2010	19681	1277	24104	821	18601
16-#11	2.23	MA	14494	3877	22362	3175	26687	2559	28895	2091	31347	1359	39117	1009	28343
5E		MI	9851	3877	15746	3086	18382	2481	19612	2015	20795	1272	25468	883	18947
16-#11	2.23	MA	13918	3877	21543	3176	25595	2568	27565	2089	29579	1364	36742	933	27659
6L-4S		MI	10256	3877	16357	3078	19117	2486	20492	2010	21991	1277	26929	925	19547

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.23	MA	13353	3877	20746	3177	24539	2568	26276	2097	27786	1359	34630	863	26627
7L-3S		MI	10699	3877	16960	3080	19931	2480	21463	2015	23222	1272	28303	1014	19645
16-#11	2.23	MA	12796	3877	19961	3177	23505	2567	24984	2095	26056	1365	32442	810	25685
8L-2S		MI	11300	3877	17761	3083	20946	2484	22678	2010	24820	1266	30398	1105	19689
16-#14	3.21	MA	16329	4279	26662	3405	31970	2738	35273	2194	39885	1325	50492	904	40702
4L-6S		MI	9887	4279	16893	3317	19717	2657	21130	2103	22819	1225	28328	576	24916
16-#14	3.21	MA	15499	4279	25341	3420	30384	2736	33337	2205	37260	1332	47155	839	39234
5E		MI	10424	4279	17673	3321	20754	2649	22357	2110	24393	1217	30248	666	26012
16-#14	3.21	MA	14704	4279	24166	3421	28818	2749	31431	2201	34735	1339	43782	730	37598
6L-4S		MI	10983	4279	18546	3311	21802	2657	23602	2103	26085	1225	32305	728	26757
16-#14	3.21	MA	13924	4279	23023	3421	27305	2747	29583	2212	32175	1332	40784	628	35997
7L-3S		MI	11596	4279	19407	3315	22964	2649	24975	2110	27825	1217	34245	854	27628
16-#14	3.21	MA	13154	4279	21897	3421	25822	2746	27731	2208	29705	1339	37669	553	33830
8L-2S		MI	12427	4279	20547	3319	24410	2656	26693	2103	30085	1210	37196	985	27771
16-#18	5.71	MA	16575	5297	30636	4042	36806	3207	41028	2483	47386	1263	61019	192	60144
6L-4S		MI	12686	5297	23891	3906	28173	3072	31114	2326	35987	1075	45181	193	43804
18-#11	2.51	MA	15667	3991	24510	3235	29348	2612	32129	2116	35728	1348	44861	1040	32819
4L-7S		MI	9453	3991	15469	3152	17970	2535	19116	2047	20189	1271	24802	712	20186
18-#11	2.51	MA	15073	3991	23588	3246	28242	2611	30778	2124	33889	1354	42518	995	31849
5L-6S		MI	9829	3991	16001	3154	18672	2539	19959	2042	21280	1266	26199	796	20865
18-#11	2.51	MA	14504	3991	22769	3247	27149	2620	29449	2122	32120	1359	40143	920	31187
6L-5S		MI	10213	3991	16546	3157	19398	2533	20827	2047	22393	1261	27563	858	21219
18-#11	2.51	MA	13946	3991	21972	3248	26094	2620	28160	2130	30327	1354	38032	849	30112
7L-4S		MI	10613	3991	17158	3149	20132	2538	21707	2042	23590	1266	29023	900	21848
18-#11	2.51	MA	13395	3991	21186	3248	25060	2619	26868	2128	28597	1360	35843	796	29140
8L-3S		MI	11052	3991	17761	3151	20946	2532	22678	2047	24820	1261	30398	989	21995
18-#11	2.51	MA	12848	3991	20320	3259	23994	2628	25597	2136	26884	1365	33688	737	27878
9L-2S		MI	11648	3991	18561	3153	21961	2536	23893	2042	26419	1256	32493	1080	22052
18-#14	3.62	MA	16297	4442	27094	3522	32608	2811	36031	2252	40884	1324	51988	817	44262
5L-6S		MI	10392	4442	18034	3419	21163	2731	22847	2147	25079	1208	31279	537	28083
18-#14	3.62	MA	15514	4442	25920	3523	31042	2824	34125	2248	38360	1331	48614	708	42559
6L-5S		MI	10922	4442	18813	3424	22200	2724	24075	2154	26653	1200	33198	627	29249
18-#14	3.62	MA	14747	4442	24776	3523	29529	2822	32277	2259	35800	1324	45617	606	40917
7L-4S		MI	11474	4442	19687	3413	23248	2731	25320	2147	28345	1208	35256	689	29954
18-#14	3.62	MA	13988	4442	23650	3523	28046	2820	30425	2255	33330	1331	42501	531	38800
8L-3S		MI	12080	4442	20547	3417	24410	2724	26693	2154	30085	1200	37196	815	30951
18-#14	3.62	MA	13234	4442	22407	3539	26518	2834	28603	2267	30884	1339	39441	446	36575
9L-2S		MI	12901	4442	21687	3422	25856	2731	28411	2147	32345	1193	40146	946	31120
20-#11	2.79	MA	15643	4104	24814	3317	29796	2663	32662	2157	36430	1349	45919	981	35363
5L-7S		MI	9818	4104	16270	3223	18985	2587	20331	2078	21788	1261	26897	687	22433
20-#11	2.79	MA	15081	4104	23995	3318	28704	2672	31332	2155	34661	1354	43545	906	34720
6E		MI	10190	4104	16802	3225	19687	2591	21174	2073	22879	1256	28293	770	23085
20-#11	2.79	MA	14530	4104	23197	3318	27649	2671	30043	2163	32868	1349	41433	835	33604
7L-5S		MI	10570	4104	17347	3227	20413	2585	22042	2078	23992	1250	29657	832	23496
20-#11	2.79	MA	13986	4104	22412	3319	26614	2671	28751	2161	31138	1354	39244	782	32601
8L-4S		MI	10966	4104	17959	3219	21147	2590	22922	2073	25188	1256	31118	875	24093
20-#11	2.79	MA	13445	4104	21545	3330	25549	2680	27480	2169	29425	1360	37089	723	31366
9L-3S		MI	11401	4104	18561	3222	21961	2584	23893	2078	26419	1250	32493	964	24341
20-#11	2.79	MA	12907	4104	20763	3331	24522	2679	26203	2167	27663	1355	34861	643	30015
10L-2S		MI	11991	4104	19362	3224	22977	2588	25108	2073	28017	1245	34587	1055	24412
20-#14	4.02	MA	16311	4606	27673	3625	33266	2899	36820	2296	41985	1323	53447	686	47529
6E		MI	10890	4606	19174	3521	22609	2806	24565	2191	27339	1191	34230	498	31260
20-#14	4.02	MA	15555	4606	26530	3625	31753	2897	34971	2307	39425	1316	50449	584	45846
7L-5S		MI	11413	4606	19953	3526	23646	2799	25793	2199	28913	1184	36149	588	32493

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	4.02	MA	14808	4606	25404	3626	30270	2895	33119	2303	36955	1323	47334	509	43779
8L-4S		MI	11958	4606	20827	3515	24695	2806	27038	2191	30606	1191	38207	650	33162
20-#14	4.02	MA	14065	4606	24161	3641	28742	2908	31297	2314	34509	1331	44274	424	41527
9L-3S		MI	12557	4606	21687	3519	25856	2799	28411	2199	32345	1184	40146	776	34270
22-#11	3.06	MA	15650	4218	25221	3389	30259	2724	33216	2188	37202	1349	46946	892	38257
6L-7S		MI	10178	4218	17071	3293	20000	2638	21546	2110	23386	1250	28992	662	24686
22-#11	3.06	MA	15106	4218	24423	3389	29203	2723	31927	2196	35409	1344	44834	821	37100
7L-6S		MI	10547	4218	17602	3296	20703	2643	22389	2105	24477	1245	30388	745	25314
22-#11	3.06	MA	14568	4218	23638	3390	28169	2722	30635	2194	33679	1349	42646	768	36068
8L-5S		MI	10924	4218	18147	3298	21428	2637	23257	2110	25590	1240	31752	807	25778
22-#11	3.06	MA	14034	4218	22771	3401	27103	2732	29364	2202	31966	1355	40491	709	34860
9L-4S		MI	11316	4218	18759	3290	22163	2641	24137	2105	26787	1245	33213	850	26346
22-#11	3.06	MA	13501	4218	21989	3401	26076	2731	28087	2200	30204	1350	38262	629	33490
10L-3S		MI	11746	4218	19362	3293	22977	2636	25108	2110	28017	1240	34587	938	26685
22-#14	4.42	MA	16351	4769	28283	3728	33977	2972	37666	2354	43050	1308	55282	562	50784
7L-6S		MI	11381	4769	20314	3624	24055	2881	26283	2236	29600	1174	37181	459	34448
22-#14	4.42	MA	15614	4769	27157	3728	32494	2970	35814	2350	40580	1315	52166	487	48765
8L-5S		MI	11942	4769	21093	3628	25092	2874	27510	2243	31174	1167	39100	549	35664
22-#14	4.42	MA	14882	4769	25914	3743	30966	2983	33992	2361	38134	1323	49107	402	46486
9L-4S		MI	12471	4769	21967	3617	26141	2881	28756	2236	32866	1174	41158	611	36380
24-#11	3.34	MA	15674	4331	25649	3460	30758	2775	33810	2229	37951	1339	48235	807	40602
7E		MI	10535	4331	17871	3364	21016	2690	22761	2141	24985	1240	31086	637	26944
24-#11	3.34	MA	15142	4331	24864	3461	29724	2774	32518	2227	36220	1344	46047	754	39541
8L-6S		MI	10900	4331	18403	3367	21718	2695	23604	2136	26076	1234	32483	720	27548
24-#11	3.34	MA	14614	4331	23997	3472	28658	2784	31247	2235	34507	1350	43892	695	38357
9L-5S		MI	11273	4331	18948	3369	22444	2689	24472	2141	27189	1229	33847	782	28063
24-#11	3.34	MA	14088	4331	23215	3472	27631	2783	29970	2233	32745	1345	41663	615	36968
10L-4S		MI	11661	4331	19560	3361	23178	2693	25352	2136	28386	1234	35308	825	28606
24-#14	4.82	MA	16409	4933	28911	3830	34718	3045	38508	2398	44205	1307	56999	465	53757
8L-6S		MI	11914	4933	21454	3726	25501	2956	28001	2280	31860	1158	40131	420	37643
24-#14	4.82	MA	15688	4933	27668	3845	33190	3058	36686	2409	41759	1315	53939	380	51451
9L-5S		MI	12417	4933	22233	3730	26538	2948	29228	2287	33434	1150	42051	509	38812

RECTANGULAR TIED COLUMNS 28" x 42"

4-#18	1.36	MA	16334	3700	23877	3070	28292	2492	30429	2059	32511	1421	39612	1320	19930
2E		MI	10570	3700	16089	2961	18456	2396	19444	1964	20258	1325	24160	1188	12652
6-#14	1.15	MA	15928	3609	22787	3032	27065	2467	29010	2047	30739	1441	37371	1355	17062
2L-3S		MI	9476	3609	14277	2929	16376	2378	17034	1976	17123	1368	20171	1115	10944
6-#14	1.15	MA	14472	3609	20931	3033	24711	2466	26159	2059	26891	1449	32223	1223	17014
3L-2S		MI	10365	3609	15417	2933	17822	2385	18752	1968	19384	1360	23121	1246	10909
6-#18	2.04	MA	17840	3991	27125	3251	32411	2625	35420	2144	39196	1405	48505	1278	29546
2L-3S		MI	9942	3991	16089	3132	18456	2512	19444	2052	20258	1303	24160	874	18420
6-#18	2.04	MA	15384	3991	23877	3251	28292	2621	30429	2162	32511	1419	39612	1044	29126
3L-2S		MI	11435	3991	18064	3142	20925	2525	22377	2039	24117	1290	29158	1108	18555
8-#11	1.06	MA	15760	3572	22323	3019	26556	2458	28429	2043	29977	1448	36459	1369	15880
2L-4S		MI	9189	3572	13723	2920	15697	2382	16280	1972	16198	1387	19232	1091	10214
8-#11	1.06	MA	14738	3572	21027	3020	24912	2458	26436	2052	27289	1454	32839	1278	15865
3E		MI	9654	3572	14326	2922	16511	2376	17251	1977	17429	1381	20606	1180	10212
8-#11	1.06	MA	13997	3572	20064	3021	23610	2468	24859	2050	25160	1450	30452	1187	15762
4L-2S		MI	10280	3572	15126	2925	17526	2381	18466	1972	19027	1376	22701	1271	10185
8-#14	1.53	MA	16817	3773	24642	3135	29418	2542	31862	2094	34586	1434	42519	1335	22569
2L-4S		MI	9354	3773	14557	3027	16660	2460	17378	2013	17644	1359	21182	950	14207
8-#14	1.53	MA	15385	3773	22787	3135	27065	2540	29010	2106	30739	1442	37371	1203	22468
3E		MI	10005	3773	15417	3031	17822	2453	18752	2020	19384	1351	23121	1076	14321
8-#14	1.53	MA	14346	3773	21407	3136	25199	2554	26750	2103	27688	1435	33981	1072	22103
4L-2S		MI	10882	3773	16558	3036	19268	2460	20469	2013	21644	1344	26072	1207	14324

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

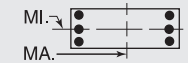
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	2.72	MA	19294	4282	30373	3433	36530	2758	40410	2228	45880	1389	57399	1236	39126
2L-4S		MI	9723	4282	16566	3303	18941	2655	20032	2114	21148	1281	25861	578	22026
8-#18	2.72	MA	16898	4282	27125	3433	32411	2754	35420	2246	39196	1403	48505	1002	38572
3E		MI	10812	4282	18064	3314	20925	2642	22377	2127	24117	1268	29158	794	24157
8-#18	2.72	MA	15159	4282	24703	3432	29138	2776	31454	2238	33891	1389	42662	768	35052
4L-2S		MI	12274	4282	20040	3324	23394	2655	25309	2114	27976	1255	34157	1028	24399
10-#11	1.33	MA	16391	3686	23620	3090	28201	2510	30421	2076	32665	1443	40079	1357	19732
2L-5S		MI	9151	3686	13912	2999	15978	2429	16614	2009	16600	1371	19866	1024	12290
10-#11	1.33	MA	15381	3686	22323	3091	26556	2509	28429	2084	29977	1449	36459	1266	19692
3L-4S		MI	9570	3686	14524	2991	16712	2434	17495	2003	17797	1376	21327	1066	12572
10-#11	1.33	MA	14650	3686	21360	3092	25254	2519	26851	2083	27848	1445	34072	1174	19556
4L-3S		MI	10029	3686	15126	2993	17526	2428	18466	2009	19027	1371	22701	1155	12599
10-#11	1.33	MA	13988	3686	20387	3103	24086	2519	25425	2091	25906	1451	31583	1128	18984
5L-2S		MI	10650	3686	15927	2996	18541	2432	19681	2003	20626	1366	24796	1246	12585
10-#14	1.91	MA	17685	3937	26498	3237	31772	2616	34713	2142	38433	1426	47667	1314	28058
2L-5S		MI	9297	3937	14823	3140	17057	2528	17851	2065	18212	1334	22075	849	16497
10-#14	1.91	MA	16275	3937	24642	3238	29418	2615	31862	2153	34586	1434	42519	1183	27912
3L-4S		MI	9882	3937	15697	3129	18106	2535	19096	2057	19904	1342	24133	911	17423
10-#14	1.91	MA	15254	3937	23263	3238	27553	2629	29601	2150	31535	1427	39129	1051	27496
4L-3S		MI	10523	3937	16558	3133	19268	2528	20469	2065	21644	1334	26072	1036	17678
10-#14	1.91	MA	14329	3937	21866	3254	25877	2628	27556	2162	28750	1435	35582	986	25718
5L-2S		MI	11388	3937	17698	3138	20714	2535	22187	2057	23904	1327	29023	1168	17719
10-#18	3.40	MA	18363	4573	30373	3614	36530	2887	40410	2331	45880	1387	57399	960	48018
3L-4S		MI	10593	4573	18542	3485	21410	2785	22964	2188	25007	1246	30860	497	27472
10-#18	3.40	MA	16668	4573	27951	3614	33257	2909	36444	2322	40576	1373	51555	726	44199
4L-3S		MI	11659	4573	20040	3495	23394	2771	25309	2202	27976	1233	34157	714	29878
10-#18	3.40	MA	15132	4573	25499	3640	30314	2905	32852	2341	35735	1387	45402	612	40931
5L-2S		MI	13094	4573	22016	3506	25863	2785	28241	2188	31835	1220	39155	947	30214
12-#11	1.59	MA	17010	3799	24917	3161	29845	2562	32414	2109	35353	1438	43699	1344	23573
2L-6S		MI	9131	3799	14167	3067	16267	2487	16961	2035	17086	1365	20597	936	14148
12-#11	1.59	MA	16012	3799	23620	3162	28201	2561	30421	2117	32665	1444	40079	1253	23511
3L-5S		MI	9530	3799	14712	3070	16993	2481	17829	2040	18199	1360	21961	998	14536
12-#11	1.59	MA	15290	3799	22657	3163	26899	2571	28844	2116	30536	1440	37692	1162	23348
4E		MI	9944	3799	15324	3062	17727	2486	18710	2035	19396	1365	23421	1041	14922
12-#11	1.59	MA	14637	3799	21683	3174	25730	2571	27417	2124	28594	1446	35202	1116	22667
5L-3S		MI	10399	3799	15927	3064	18541	2480	19681	2040	20626	1360	24796	1129	14970
12-#11	1.59	MA	14010	3799	20819	3175	24577	2581	26013	2123	26726	1452	32675	1040	21860
6L-2S		MI	11013	3799	16728	3067	19557	2484	20896	2035	22225	1355	26890	1221	14975
12-#14	2.30	MA	18535	4100	28354	3339	34125	2691	37565	2189	42280	1419	52814	1294	33537
2L-6S		MI	9268	4100	15184	3238	17466	2610	18341	2101	18898	1325	23106	720	18846
12-#14	2.30	MA	17145	4100	26498	3340	31772	2690	34713	2201	38433	1427	47667	1163	33350
3L-5S		MI	9822	4100	15963	3242	18504	2602	19569	2109	20472	1318	25026	810	19704
12-#14	2.30	MA	16141	4100	25118	3341	29907	2704	32453	2198	35382	1420	44276	1031	32787
4E		MI	10399	4100	16837	3231	19552	2610	20814	2101	22165	1325	27083	872	20567
12-#14	2.30	MA	15232	4100	23722	3356	28231	2703	30408	2209	32597	1427	40729	966	31011
5L-3S		MI	11031	4100	17698	3236	20714	2602	22187	2109	23904	1318	29023	997	21023
12-#14	2.30	MA	14360	4100	22482	3357	26577	2716	28394	2206	29920	1435	37135	857	29557
6L-2S		MI	11886	4100	18838	3240	22160	2610	23905	2101	26164	1310	31974	1129	21095
12-#18	4.08	MA	18135	4863	31199	3796	37376	3042	41434	2407	47261	1357	60449	684	53384
4E		MI	11486	4863	20518	3667	23879	2914	25896	2263	28866	1211	35858	417	32956
12-#18	4.08	MA	16636	4863	28747	3822	34433	3038	37843	2425	42420	1371	54296	570	49992
5L-3S		MI	12517	4863	22016	3677	25863	2901	28241	2276	31835	1198	39155	634	35590
12-#18	4.08	MA	15197	4863	26567	3822	31527	3060	34306	2417	37764	1384	48088	376	46158
6L-2S		MI	13894	4863	23992	3688	28332	2914	31173	2263	35694	1185	44154	867	36008

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis

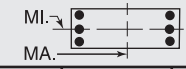


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.86	MA	17619	3913	26213	3232	31490	2614	34406	2142	38041	1433	47319	1331	27408
2L-7S		MI	9123	3913	14436	3136	16580	2534	17334	2072	17593	1360	21295	828	15877
14-#11	1.86	MA	16632	3913	24917	3233	29845	2613	32414	2150	35353	1439	43699	1240	27325
3L-6S		MI	9509	3913	14968	3138	17282	2539	18176	2066	18684	1355	22691	911	16425
14-#11	1.86	MA	15919	3913	23954	3234	28544	2623	30836	2148	33224	1435	41312	1149	27138
4L-5S		MI	9903	3913	15513	3141	18008	2533	19044	2072	19797	1350	24055	973	16792
14-#11	1.86	MA	15274	3913	22980	3245	27375	2623	29409	2157	31282	1441	38822	1103	26362
5L-4S		MI	10313	3913	16125	3133	18743	2538	19925	2066	20994	1355	25516	1016	17265
14-#11	1.86	MA	14656	3913	22115	3246	26222	2633	28005	2155	29414	1447	36295	1028	25585
6L-3S		MI	10763	3913	16728	3135	19557	2532	20896	2072	22225	1350	26890	1104	17333
14-#11	1.86	MA	14050	3913	21273	3247	25107	2632	26644	2164	27521	1442	34045	957	24625
7L-2S		MI	11371	3913	17528	3138	20572	2536	22111	2066	23823	1345	28985	1195	17355
14-#14	2.68	MA	17998	4264	28354	3442	34125	2765	37565	2248	42280	1419	52814	1143	38784
3L-6S		MI	9791	4264	16324	3340	18913	2685	20059	2146	21159	1308	26057	681	21982
14-#14	2.68	MA	17010	4264	26974	3443	32260	2779	35304	2245	39229	1412	49424	1011	38017
4L-5S		MI	10337	4264	17104	3344	19950	2677	21287	2153	22732	1301	27976	770	22922
14-#14	2.68	MA	16116	4264	25578	3459	30585	2778	33259	2257	36444	1420	45877	945	36317
5L-4S		MI	10907	4264	17978	3334	20998	2685	22532	2146	24425	1308	30034	832	23732
14-#14	2.68	MA	15259	4264	24338	3460	28931	2791	31246	2254	33767	1428	42283	837	34790
6L-3S		MI	11531	4264	18838	3338	22160	2677	23905	2153	26164	1301	31974	958	24359
14-#14	2.68	MA	14419	4264	23130	3460	27333	2790	29294	2265	31052	1421	39087	734	33036
7L-2S		MI	12375	4264	19978	3342	23606	2685	25623	2146	28425	1294	34924	1089	24461
14-#18	4.76	MA	18101	5154	31995	4004	38552	3171	42833	2509	49104	1355	63189	527	59082
5L-4S		MI	12311	5154	22494	3848	26348	3044	28829	2338	32725	1176	40857	337	38471
14-#18	4.76	MA	16695	5154	29815	4004	35646	3193	39296	2501	44449	1368	56981	334	55312
6L-3S		MI	13316	5154	23992	3859	28332	3031	31173	2351	35694	1163	44154	553	40994
14-#18	4.76	MA	15317	5154	27692	4003	32838	3189	35866	2520	39728	1355	51470	151	50478
7L-2S		MI	14663	5154	25967	3869	30801	3044	34106	2338	39553	1149	49152	787	41789
16-#11	2.12	MA	17242	4026	26213	3303	31490	2665	34406	2183	38041	1434	47319	1227	31136
3L-7S		MI	9499	4026	15237	3207	17596	2586	18549	2103	19192	1349	23389	803	18109
16-#11	2.12	MA	16538	4026	25251	3304	30188	2675	32828	2181	35912	1429	44932	1136	30926
4L-6S		MI	9881	4026	15768	3209	18298	2591	19391	2098	20283	1344	24786	886	18707
16-#11	2.12	MA	15901	4026	24277	3316	29019	2675	31402	2190	33970	1435	42442	1090	30066
5E		MI	10271	4026	16314	3211	19024	2585	20260	2103	21396	1339	26150	948	19057
16-#11	2.12	MA	15290	4026	23412	3317	27866	2685	29998	2188	32102	1441	39915	1015	29316
6L-4S		MI	10676	4026	16925	3204	19758	2589	21140	2098	22593	1344	27611	991	19603
16-#11	2.12	MA	14692	4026	22570	3318	26752	2684	28637	2197	30209	1437	37665	944	28309
7L-3S		MI	11122	4026	17528	3206	20572	2583	22111	2103	23823	1339	28985	1079	19690
16-#11	2.12	MA	14101	4026	21742	3318	25660	2684	27273	2195	28383	1443	35340	891	27334
8L-2S		MI	11725	4026	18329	3208	21587	2588	23326	2098	25422	1334	31080	1170	19726
16-#14	3.06	MA	17863	4427	28830	3545	34614	2853	38155	2292	43076	1405	54572	991	43266
4L-6S		MI	10305	4427	17465	3442	20359	2760	21777	2190	23419	1292	29008	641	25133
16-#14	3.06	MA	16983	4427	27434	3561	32938	2852	36110	2304	40291	1413	51025	925	41634
5E		MI	10845	4427	18244	3446	21396	2752	23005	2198	24993	1284	30927	731	26151
16-#14	3.06	MA	16139	4427	26194	3562	31284	2866	34097	2301	37614	1420	47431	817	40036
6L-4S		MI	11406	4427	19118	3436	22444	2759	24250	2190	26685	1292	32985	793	26913
16-#14	3.06	MA	15313	4427	24986	3563	29687	2865	32145	2313	34899	1413	44235	714	38333
7L-3S		MI	12023	4427	19978	3440	23606	2752	25623	2198	28425	1284	34924	919	27689
16-#14	3.06	MA	14495	4427	23797	3563	28121	2864	30190	2310	32280	1421	40922	638	36081
8L-2S		MI	12857	4427	21118	3444	25052	2759	27341	2190	30685	1277	37875	1050	27818
16-#18	5.44	MA	18159	5445	33063	4185	39766	3326	44287	2585	51133	1352	65875	292	64370
6L-4S		MI	13117	5445	24469	4030	28817	3173	31761	2413	36584	1141	45855	257	44009
16-#18	5.44	MA	16811	5445	30940	4185	36957	3322	40856	2604	46412	1339	60363	109	59659
7L-3S		MI	14099	5445	25967	4041	30801	3160	34106	2426	39553	1128	49152	473	46367
18-#11	2.39	MA	17148	4139	26547	3375	31833	2727	34821	2214	38600	1424	48552	1124	34715
4L-7S		MI	9870	4139	16037	3277	18611	2638	19764	2135	20791	1339	25484	777	20348
18-#11	2.39	MA	16518	4139	25573	3387	30664	2726	33394	2223	36658	1430	46062	1077	33778
5L-6S		MI	10248	4139	16569	3280	19313	2643	20606	2129	21881	1334	26881	861	20993

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

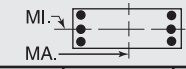
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.39	MA	15915	4139	24709	3387	29511	2736	31990	2221	34790	1436	43535	1002	33052
6L-5S		MI	10634	4139	17114	3282	20039	2637	21475	2135	22995	1329	28245	923	21328
18-#11	2.39	MA	15325	4139	23867	3388	28397	2736	30629	2230	32897	1432	41285	931	32000
7L-4S		MI	11035	4139	17726	3274	20773	2641	22355	2129	24191	1334	29705	966	21939
18-#11	2.39	MA	14741	4139	23038	3389	27305	2736	29265	2228	31071	1438	38960	878	31050
8L-3S		MI	11476	4139	18329	3277	21587	2635	23326	2135	25422	1329	31080	1054	22042
18-#11	2.39	MA	14161	4139	22123	3401	26180	2746	27924	2237	29262	1444	36666	819	29678
9L-2S		MI	12074	4139	19129	3279	22603	2640	24541	2129	27020	1323	33175	1145	22092
18-#14	3.44	MA	17835	4591	29290	3663	35292	2927	38962	2352	44138	1405	56173	905	46961
5L-6S		MI	10811	4591	18605	3544	21805	2834	23495	2234	25679	1275	31959	602	28297
18-#14	3.44	MA	17004	4591	28049	3664	33638	2941	36949	2348	41461	1413	52579	797	45293
6L-5S		MI	11344	4591	19384	3549	22842	2827	24722	2242	27253	1268	33878	692	29387
18-#14	3.44	MA	16190	4591	26842	3665	32040	2940	34997	2360	38746	1406	49383	694	43638
7L-4S		MI	11899	4591	20258	3538	23891	2834	25968	2234	28946	1275	35936	754	30108
18-#14	3.44	MA	15385	4591	25653	3666	30474	2939	33041	2357	36127	1414	46070	618	41351
8L-3S		MI	12508	4591	21118	3542	25052	2827	27341	2242	30685	1268	37875	880	31015
18-#14	3.44	MA	14585	4591	24341	3681	28861	2952	31117	2369	33533	1421	42809	533	39085
9L-2S		MI	13333	4591	22259	3547	26498	2834	29059	2234	32945	1260	40826	1011	31170
18-#18	6.12	MA	18273	5736	34187	4367	41077	3455	45847	2688	53097	1323	69256	67	68856
7L-4S		MI	13909	5736	26445	4212	31286	3303	34693	2487	40443	1106	50854	177	49568
20-#11	2.65	MA	17127	4253	26870	3457	32309	2778	35387	2256	39346	1425	49682	1065	37497
5L-7S		MI	10236	4253	16838	3348	19626	2690	20979	2166	22389	1328	27579	752	22593
20-#11	2.65	MA	16531	4253	26005	3458	31155	2788	33983	2254	37478	1431	47155	989	36792
6E		MI	10610	4253	17369	3351	20328	2695	21822	2161	23480	1323	28975	836	23263
20-#11	2.65	MA	15947	4253	25164	3459	30041	2788	32621	2263	35585	1427	44905	919	35698
7L-5S		MI	10992	4253	17915	3353	21054	2689	22690	2166	24593	1318	30339	898	23605
20-#11	2.65	MA	15371	4253	24335	3460	28949	2788	31258	2261	33759	1433	42580	865	34728
8L-4S		MI	11390	4253	18526	3345	21789	2693	23570	2161	25790	1323	31800	940	24220
20-#11	2.65	MA	14798	4253	23420	3471	27824	2797	29916	2270	31950	1439	40286	807	33374
9L-3S		MI	11827	4253	19129	3348	22603	2687	24541	2166	27020	1318	33175	1029	24390
20-#11	2.65	MA	14227	4253	22595	3472	26740	2797	28568	2268	30090	1435	37913	726	32016
10L-2S		MI	12420	4253	19930	3350	23618	2692	25756	2161	28619	1313	35269	1120	24453
20-#14	3.83	MA	17854	4754	29905	3766	35992	3016	39800	2396	45308	1405	57726	776	50560
6E		MI	11311	4754	19745	3647	23251	2909	25213	2279	27939	1258	34909	563	31472
20-#14	3.83	MA	17053	4754	28698	3767	34394	3015	37848	2408	42593	1398	54530	674	48903
7L-5S		MI	11837	4754	20524	3651	24288	2902	26440	2286	29513	1251	36829	653	32630
20-#14	3.83	MA	16260	4754	27509	3768	32828	3013	35892	2404	39974	1406	51218	598	46628
8L-4S		MI	12385	4754	21398	3640	25337	2909	27685	2279	31206	1258	38886	715	33314
20-#14	3.83	MA	15472	4754	26196	3784	31215	3027	33968	2416	37380	1414	47957	513	44336
9L-3S		MI	12988	4754	22259	3645	26498	2902	29059	2286	32945	1251	40826	840	34337
22-#11	2.92	MA	17139	4366	27302	3529	32800	2840	35975	2287	40167	1426	50775	977	40536
6L-7S		MI	10597	4366	17638	3419	20642	2742	22194	2198	23988	1318	29674	727	24845
22-#11	2.92	MA	16562	4366	26460	3530	31686	2840	34614	2296	38273	1422	48525	906	39401
7L-6S		MI	10968	4366	18170	3422	21344	2746	23037	2193	25079	1313	31070	811	25489
22-#11	2.92	MA	15992	4366	25632	3531	30594	2839	33250	2294	36447	1428	46200	852	38401
8L-5S		MI	11347	4366	18715	3424	22070	2740	23905	2198	26192	1307	32434	873	25886
22-#11	2.92	MA	15425	4366	24717	3542	29469	2849	31908	2302	34638	1434	43906	794	37074
9L-4S		MI	11741	4366	19327	3416	22804	2745	24785	2193	27389	1313	33895	915	26472
22-#11	2.92	MA	14861	4366	23891	3543	28385	2849	30561	2301	32778	1429	41533	714	35697
10L-3S		MI	12174	4366	19930	3419	23618	2739	25756	2198	28619	1307	35269	1004	26735
22-#11	2.92	MA	14263	4366	23072	3544	27273	2859	29227	2309	30977	1435	39248	657	34307
11L-2S		MI	12762	4366	20730	3421	24633	2744	26971	2193	30217	1302	37364	1095	26811
22-#14	4.21	MA	17902	4918	30553	3869	36747	3089	40699	2455	46440	1391	59678	654	54139
7L-6S		MI	11804	4918	20885	3749	24697	2984	26931	2323	30200	1242	37860	524	34656

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

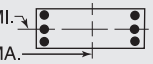
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	4.21	MA	17120	4918	29365	3870	35182	3088	38744	2452	43821	1399	56366	578	51913
8L-5S		MI	12324	4918	21665	3753	25734	2976	28158	2331	31774	1234	39779	614	35878
22-#14	4.21	MA	16344	4918	28052	3886	33568	3102	36820	2464	41227	1406	53104	493	49595
9L-4S		MI	12866	4918	22538	3742	26783	2984	29403	2323	33466	1242	41837	676	36530
24-#11	3.18	MA	17168	4480	27757	3601	33330	2892	36606	2328	40961	1416	52145	893	43109
7E		MI	10955	4480	18439	3490	21657	2794	23409	2229	25586	1307	31768	702	27101
24-#11	3.18	MA	16604	4480	26928	3602	32239	2891	35243	2327	39135	1423	49820	840	42080
8L-6S		MI	11322	4480	18971	3493	22359	2798	24252	2224	26677	1302	33165	785	27722
24-#11	3.18	MA	16044	4480	26013	3613	31114	2901	33901	2335	37326	1429	47525	781	40779
9L-5S		MI	11697	4480	19516	3495	23085	2792	25120	2229	27790	1297	34529	847	28171
24-#11	3.18	MA	15487	4480	25188	3614	30030	2901	32553	2334	35466	1424	45153	701	39383
10L-4S		MI	12088	4480	20128	3487	23819	2797	26000	2224	28987	1302	35990	890	28730
24-#11	3.18	MA	14891	4480	24368	3615	28917	2911	31219	2342	33665	1430	42868	645	37979
11L-3S		MI	12517	4480	20730	3489	24633	2791	26971	2229	30217	1297	37364	979	29078
24-#14	4.59	MA	17969	5082	31221	3972	37535	3163	41595	2499	47668	1391	61513	557	57204
8L-6S		MI	12341	5082	22025	3851	26143	3059	28648	2367	32460	1225	40811	485	37850
24-#14	4.59	MA	17203	5082	29908	3988	35922	3177	39671	2511	45074	1399	58252	473	54860
9L-5S		MI	12848	5082	22805	3855	27180	3051	29876	2375	34034	1217	42730	574	39055

RECTANGULAR TIED COLUMNS 28" x 44"

4-#18	1.30	MA	17821	3849	25846	3209	30681	2607	32986	2157	35219	1499	42916	1399	21010
2E		MI	10989	3849	16666	3084	19100	2498	20091	2051	20856	1391	24834	1252	12689
6-#14	1.10	MA	17384	3758	24689	3172	29378	2581	31479	2144	33274	1516	40507	1432	17973
2L-3S		MI	9893	3758	14848	3054	17018	2481	17681	2063	17723	1435	20850	1180	10978
6-#14	1.10	MA	15843	3758	22731	3173	26895	2581	28471	2157	29215	1525	35043	1301	17925
3L-2S		MI	10784	3758	15989	3058	18464	2488	19399	2056	19984	1428	23801	1311	10938
6-#18	1.95	MA	19427	4140	29276	3390	35031	2740	38256	2241	42309	1485	52369	1360	31166
2L-3S		MI	10360	4140	16666	3256	19100	2614	20091	2139	20856	1369	24834	938	18490
6-#18	1.95	MA	16823	4140	25846	3391	30681	2737	32986	2261	35219	1498	42916	1126	30746
3L-2S		MI	11857	4140	18642	3266	21569	2627	23023	2125	24714	1356	29833	1172	18598
8-#11	1.01	MA	17203	3721	24198	3158	28838	2573	30862	2140	32465	1523	39526	1446	16722
2L-4S		MI	9605	3721	14291	3046	16338	2485	16928	2060	16800	1454	19914	1157	10252
8-#11	1.01	MA	16122	3721	22830	3159	27104	2572	28760	2149	29630	1530	35687	1355	16708
3E		MI	10071	3721	14894	3048	17152	2480	17899	2065	18030	1449	21288	1245	10241
8-#11	1.01	MA	15340	3721	21816	3161	25732	2583	27098	2148	27387	1526	33153	1264	16604
4L-2S		MI	10699	3721	15694	3051	18167	2484	19114	2060	19629	1444	23383	1336	10211
8-#14	1.46	MA	18330	3922	26647	3274	31861	2656	34488	2192	37333	1509	45970	1413	23784
2L-4S		MI	9771	3922	15128	3152	17302	2563	18026	2100	18244	1426	21861	1015	14270
8-#14	1.46	MA	16814	3922	24689	3275	29378	2656	31479	2204	33274	1517	40507	1282	23683
3E		MI	10424	3922	15989	3156	18464	2556	19399	2108	19984	1418	23801	1141	14363
8-#14	1.46	MA	15716	3922	23235	3276	27412	2670	29097	2201	30058	1511	36905	1151	23318
4L-2S		MI	11303	3922	17129	3161	19910	2563	21117	2100	22244	1411	26752	1272	14358
8-#18	2.60	MA	20977	4430	32706	3572	39380	2873	43526	2325	49399	1471	61822	1321	41286
2L-4S		MI	10140	4430	17144	3427	19585	2757	20679	2200	21745	1348	26536	642	22244
8-#18	2.60	MA	18436	4430	29276	3573	35031	2870	38256	2345	42309	1484	52369	1087	40732
3E		MI	11233	4430	18642	3437	21569	2744	23023	2213	24714	1334	29833	858	24237
8-#18	2.60	MA	16595	4430	26722	3573	31579	2893	34073	2338	36683	1471	46151	854	37249
4L-2S		MI	12701	4430	20618	3448	24038	2757	25956	2200	28573	1321	34831	1092	24450
10-#11	1.27	MA	17874	3834	25565	3229	30573	2624	32963	2173	35300	1518	43364	1434	20785
2L-5S		MI	9567	3834	14480	3125	16619	2533	17262	2096	17202	1438	20548	1089	12399
10-#11	1.27	MA	16805	3834	24198	3230	28838	2624	30862	2182	32465	1525	39526	1343	20745
3L-4S		MI	9987	3834	15091	3117	17353	2537	18143	2091	18399	1444	22009	1131	12615
10-#11	1.27	MA	16033	3834	23184	3232	27467	2635	29200	2181	30222	1521	36992	1252	20609
4L-3S		MI	10447	3834	15694	3119	18167	2531	19114	2096	19629	1438	23383	1220	12631
10-#11	1.27	MA	15334	3834	22158	3243	26236	2635	27697	2190	28177	1527	34357	1205	20101
5L-2S		MI	11069	3834	16495	3122	19182	2536	20329	2091	21228	1433	25478	1311	12614

RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis



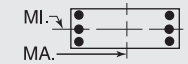
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.83	MA	19255	4085	28605	3376	34345	2731	37496	2239	41392	1501	51433	1395	29577
2L-5S		MI	9713	4085	15395	3265	17700	2631	18499	2152	18812	1402	22754	914	16635
10-#14	1.83	MA	17761	4085	26647	3377	31861	2730	34488	2251	37333	1510	45970	1264	29430
3L-4S		MI	10300	4085	16268	3254	18748	2638	19744	2145	20504	1409	24812	976	17583
10-#14	1.83	MA	16682	4085	25193	3379	29896	2745	32105	2249	34117	1504	42368	1132	29014
4L-3S		MI	10943	4085	17129	3259	19910	2630	21117	2152	22244	1402	26752	1101	17725
10-#14	1.83	MA	15705	4085	23723	3395	28131	2744	29951	2261	31184	1512	38610	1066	27237
5L-2S		MI	11811	4085	18269	3263	21356	2638	22835	2145	24504	1394	29702	1233	17757
10-#18	3.25	MA	19997	4721	32706	3755	39380	3003	43526	2429	49399	1470	61822	1048	50718
3L-4S		MI	11012	4721	19120	3608	22054	2886	23611	2275	25604	1312	31534	562	27685
10-#18	3.25	MA	18202	4721	30152	3755	35929	3026	39343	2422	43774	1457	55604	815	46922
4L-3S		MI	12083	4721	20618	3619	24038	2873	25956	2288	28573	1299	34831	778	29965
10-#18	3.25	MA	16576	4721	27567	3782	32827	3023	35557	2442	38639	1470	49077	699	43673
5L-2S		MI	13524	4721	22594	3630	26507	2886	28888	2275	32432	1286	39830	1012	30270
12-#11	1.52	MA	18533	3948	26933	3300	32307	2676	35064	2206	38135	1513	47203	1423	24837
2L-6S		MI	9547	3948	14735	3193	16908	2591	17609	2123	17687	1433	21279	1002	14251
12-#11	1.52	MA	17476	3948	25565	3301	30573	2676	32963	2215	35300	1519	43364	1332	24774
3L-5S		MI	9947	3948	15280	3195	17634	2585	18477	2128	18800	1428	22643	1064	14644
12-#11	1.52	MA	16714	3948	24551	3302	29201	2687	31301	2214	33057	1516	40831	1241	24611
4E		MI	10362	3948	15892	3188	18369	2589	19358	2123	19997	1433	24103	1106	14968
12-#11	1.52	MA	16024	3948	23526	3314	27971	2687	29799	2223	31012	1522	38195	1194	23989
5L-3S		MI	10818	3948	16495	3190	19182	2583	20329	2128	21228	1428	25478	1195	15007
12-#11	1.52	MA	15362	3948	22615	3315	26756	2697	28320	2222	29045	1529	35515	1119	23108
6L-2S		MI	11434	3948	17295	3192	20198	2588	21544	2123	22826	1423	27572	1286	15006
12-#14	2.19	MA	20160	4249	30563	3478	36828	2806	40505	2286	45451	1494	56896	1376	35360
2L-6S		MI	9683	4249	15755	3363	18109	2713	18989	2189	19498	1392	23786	785	19066
12-#14	2.19	MA	18687	4249	28605	3480	34345	2805	37496	2299	41392	1502	51433	1245	35172
3L-5S		MI	10239	4249	16535	3367	19146	2705	20216	2196	21072	1385	25705	875	19840
12-#14	2.19	MA	17626	4249	27151	3481	32379	2819	35114	2296	38176	1496	47831	1114	34712
4E		MI	10818	4249	17409	3356	20194	2713	21462	2189	22765	1392	27763	936	20724
12-#14	2.19	MA	16665	4249	25681	3497	30614	2819	32960	2309	35243	1505	44073	1047	32827
5L-3S		MI	11453	4249	18269	3361	21356	2705	22835	2196	24504	1385	29702	1062	21074
12-#14	2.19	MA	15744	4249	24374	3498	28872	2833	30839	2306	32423	1513	40259	939	31423
6L-2S		MI	12310	4249	19409	3365	22802	2713	24553	2189	26765	1377	32653	1194	21137
12-#18	3.90	MA	19764	5012	33582	3937	40278	3159	44612	2507	50864	1442	65057	776	56632
4E		MI	11909	5012	21096	3790	24523	3016	26543	2350	29463	1277	36533	481	33165
12-#18	3.90	MA	18177	5012	30997	3964	37176	3156	40826	2526	45729	1455	58530	660	53263
5L-3S		MI	12947	5012	22594	3801	26507	3003	28888	2363	32432	1264	39830	698	35683
12-#18	3.90	MA	16654	5012	28700	3965	34114	3179	37099	2519	40791	1469	51931	467	49064
6L-2S		MI	14333	5012	24570	3811	28976	3016	31820	2350	36291	1251	44828	931	36069
14-#11	1.77	MA	19182	4061	28300	3371	34042	2728	37166	2239	40970	1508	51042	1411	28882
2L-7S		MI	9538	4061	15004	3261	17221	2638	17982	2159	18195	1428	21977	893	16038
14-#11	1.77	MA	18136	4061	26933	3372	32307	2728	35064	2248	38135	1514	47203	1320	28799
3L-6S		MI	9925	4061	15535	3264	17924	2642	18824	2154	19286	1422	23373	976	16528
14-#11	1.77	MA	17383	4061	25919	3373	30936	2738	33402	2247	35892	1510	44669	1229	28612
4L-5S		MI	10321	4061	16081	3266	18650	2637	19692	2159	20399	1417	24737	1039	16899
14-#11	1.77	MA	16701	4061	24893	3385	29705	2738	31900	2256	33847	1517	42034	1182	27889
5L-4S		MI	10732	4061	16693	3258	19384	2641	20573	2154	21596	1422	26198	1081	17315
14-#11	1.77	MA	16048	4061	23983	3386	28491	2749	30422	2254	31880	1524	39354	1107	27040
6L-3S		MI	11183	4061	17295	3261	20198	2635	21544	2159	22826	1417	27572	1170	17373
14-#11	1.77	MA	15409	4061	23097	3387	27318	2749	28989	2264	29887	1520	36966	1036	26115
7L-2S		MI	11794	4061	18096	3263	21213	2640	22759	2154	24425	1412	29667	1261	17390
14-#14	2.56	MA	19596	4412	30563	3582	36828	2880	40505	2346	45451	1495	56896	1226	40910
3L-6S		MI	10207	4412	16896	3465	19555	2788	20707	2233	21759	1376	26737	746	22198

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

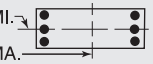


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.56	MA	18550	4412	29109	3583	34862	2894	38122	2344	42235	1489	53294	1095	40305
4L-5S		MI	10756	4412	17675	3469	20592	2780	21934	2241	23333	1368	28656	835	23057
14-#14	2.56	MA	17605	4412	27639	3599	33097	2894	35968	2356	39302	1497	49537	1028	38431
5L-4S		MI	11328	4412	18549	3459	21641	2788	23180	2233	25025	1376	30714	897	23886
14-#14	2.56	MA	16699	4412	26333	3601	31355	2908	33848	2353	36482	1506	45722	920	36954
6L-3S		MI	11955	4412	19409	3463	22802	2780	24553	2241	26765	1368	32653	1023	24415
14-#14	2.56	MA	15811	4412	25061	3602	29673	2907	31792	2366	33622	1500	42328	818	35039
7L-2S		MI	12802	4412	20550	3467	24248	2787	26270	2233	29025	1361	35604	1154	24505
14-#18	4.55	MA	19737	5303	34427	4146	41526	3289	46096	2610	52819	1441	67983	621	62883
5L-4S		MI	12738	5303	23072	3972	26992	3146	29475	2424	33322	1242	41531	401	38676
14-#18	4.55	MA	18248	5303	32129	4146	38464	3312	42368	2604	47881	1454	61384	428	58819
6L-3S		MI	13750	5303	24570	3982	28976	3132	31820	2438	36291	1229	44828	618	41275
14-#18	4.55	MA	16789	5303	29893	4147	35505	3309	38754	2623	42875	1441	55520	246	53780
7L-2S		MI	15106	5303	26545	3993	31445	3146	34752	2424	40150	1216	49827	851	41854
16-#11	2.03	MA	18786	4175	28300	3443	34042	2780	37166	2281	40970	1509	51042	1308	32821
3L-7S		MI	9915	4175	15805	3332	18237	2690	19197	2191	19794	1417	24071	868	18268
16-#11	2.03	MA	18041	4175	27286	3444	32670	2790	35504	2279	38727	1505	48508	1217	32611
4L-6S		MI	10298	4175	16336	3335	18939	2694	20039	2186	20884	1412	25468	951	18810
16-#11	2.03	MA	17368	4175	26261	3456	31440	2790	34001	2289	36682	1512	45873	1170	31798
5E		MI	10690	4175	16881	3337	19665	2688	20907	2191	21998	1407	26832	1013	19163
16-#11	2.03	MA	16723	4175	25350	3457	30225	2801	32523	2287	34715	1518	43192	1095	30978
6L-4S		MI	11097	4175	17493	3329	20399	2693	21788	2186	23194	1412	28293	1056	19657
16-#11	2.03	MA	16092	4175	24464	3458	29053	2801	31090	2296	32722	1515	40805	1025	30005
7L-3S		MI	11544	4175	18096	3332	21213	2687	22759	2191	24425	1407	29667	1145	19732
16-#11	2.03	MA	15467	4175	23592	3459	27903	2800	29654	2295	30799	1521	38343	971	28946
8L-2S		MI	12149	4175	18897	3334	22228	2691	23974	2186	26023	1402	31762	1236	19763
16-#14	2.92	MA	19458	4576	31067	3685	37345	2969	41131	2391	46294	1481	58757	1077	45847
4L-6S		MI	10723	4576	18036	3567	21001	2862	22425	2277	24019	1359	29687	706	25346
16-#14	2.92	MA	18527	4576	29597	3702	35580	2968	38977	2403	43361	1490	55000	1010	44046
5E		MI	11265	4576	18815	3571	22038	2855	23652	2285	25593	1351	31607	796	26285
16-#14	2.92	MA	17635	4576	28291	3703	33839	2983	36856	2401	40540	1498	51185	902	42496
6L-4S		MI	11829	4576	19689	3561	23087	2862	24897	2277	27285	1359	33664	858	27065
16-#14	2.92	MA	16761	4576	27019	3704	32156	2982	34801	2413	37681	1492	47791	799	40635
7L-3S		MI	12449	4576	20550	3565	24248	2855	26270	2285	29025	1351	35604	984	27748
16-#14	2.92	MA	15897	4576	25768	3705	30507	2982	32741	2411	34923	1501	44281	722	38358
8L-2S		MI	13287	4576	21690	3569	25694	2862	27988	2277	31285	1344	38555	1115	27865
16-#18	5.19	MA	19806	5594	35559	4328	42813	3445	47638	2688	54971	1440	70837	389	68593
6L-4S		MI	13548	5594	25047	4154	29461	3275	32408	2499	37181	1207	46530	321	44211
16-#18	5.19	MA	18378	5594	33322	4329	39854	3442	44023	2708	49965	1427	64973	207	63494
7L-3S		MI	14537	5594	26545	4164	31445	3262	34752	2512	40150	1194	49827	537	46641
18-#11	2.28	MA	18690	4288	28654	3515	34405	2842	37605	2312	41562	1500	52347	1206	36610
4L-7S		MI	10287	4288	16605	3403	19252	2742	20412	2223	21392	1406	26166	843	20505
18-#11	2.28	MA	18025	4288	27628	3527	33174	2842	36103	2321	39517	1507	49712	1159	35715
5L-6S		MI	10666	4288	17137	3406	19954	2746	21254	2217	22483	1401	27563	926	21096
18-#11	2.28	MA	17387	4288	26718	3528	31960	2852	34624	2320	37550	1513	47031	1084	34922
6L-5S		MI	11054	4288	17682	3408	20680	2740	22122	2223	23596	1396	28927	988	21434
18-#11	2.28	MA	16763	4288	25832	3529	30787	2852	33191	2329	35557	1510	44644	1013	33903
7L-4S		MI	11457	4288	18294	3400	21414	2745	23003	2217	24793	1401	30387	1031	21995
18-#11	2.28	MA	16147	4288	24960	3530	29638	2852	31756	2328	33634	1516	42182	959	32869
8L-3S		MI	11900	4288	18897	3403	22228	2739	23974	2223	26023	1396	31762	1119	22087
18-#11	2.28	MA	15534	4288	23997	3542	28454	2863	30343	2337	31729	1523	39748	900	31496
9L-2S		MI	12500	4288	19697	3405	23244	2743	25189	2217	27622	1391	33857	1210	22131
18-#14	3.29	MA	19434	4739	31555	3804	38064	3043	41985	2451	47420	1482	60463	991	49671
5L-6S		MI	11231	4739	19176	3669	22447	2937	24142	2322	26279	1342	32638	667	28507
18-#14	3.29	MA	18555	4739	30249	3805	36322	3058	39865	2448	44599	1491	56648	883	48051
6L-5S		MI	11766	4739	19955	3674	23484	2930	25370	2329	27853	1335	34557	757	29521
18-#14	3.29	MA	17694	4739	28977	3806	34639	3057	37809	2461	41740	1485	53254	781	46239
7L-4S		MI	12324	4739	20829	3663	24533	2937	26615	2322	29546	1342	36615	819	30258

RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

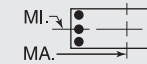


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	3.29	MA	16843	4739	27726	3808	32991	3056	35749	2458	38982	1493	49744	704	43927
8L-3S		MI	12936	4739	21690	3667	25694	2930	27988	2329	31285	1335	38555	945	31076
18-#14	3.29	MA	15997	4739	26344	3824	31292	3071	33723	2471	36250	1502	46282	619	41629
9L-2S		MI	13765	4739	22830	3672	27140	2937	29706	2322	33546	1327	41505	1076	31218
18-#18	5.84	MA	19933	5884	36752	4511	44204	3575	49293	2792	57055	1413	74426	168	73225
7L-4S		MI	14343	5884	27023	4335	31929	3405	35340	2574	41040	1172	51528	241	49767
20-#11	2.53	MA	18672	4401	28996	3598	34909	2894	38204	2354	42352	1502	53550	1147	39640
5L-7S		MI	10654	4401	17406	3474	20267	2794	21627	2254	22991	1396	28261	818	22749
20-#11	2.53	MA	18042	4401	28086	3599	33694	2904	36726	2353	40385	1508	50870	1072	38870
6E		MI	11030	4401	17937	3477	20970	2798	22469	2249	24082	1391	29657	901	23386
20-#11	2.53	MA	17426	4401	27200	3600	32521	2904	35293	2362	38392	1504	48483	1001	37807
7L-5S		MI	11414	4401	18482	3479	21695	2792	23337	2254	25195	1386	31021	963	23710
20-#11	2.53	MA	16816	4401	26327	3601	31372	2904	33857	2361	36469	1511	46021	947	36797
8L-4S		MI	11813	4401	19094	3471	22430	2797	24218	2249	26392	1391	32482	1006	24330
20-#11	2.53	MA	16211	4401	25364	3613	30188	2915	32445	2370	34564	1518	43586	889	35399
9L-3S		MI	12252	4401	19697	3473	23244	2791	25189	2254	27622	1386	33857	1094	24437
20-#11	2.53	MA	15607	4401	24495	3614	29047	2915	31026	2369	32606	1514	41070	809	34041
10L-2S		MI	12847	4401	20498	3476	24259	2795	26404	2249	29220	1380	35951	1185	24494
20-#14	3.65	MA	19460	4903	32207	3907	38805	3132	42873	2496	48658	1484	62111	865	53615
6E		MI	11732	4903	20316	3772	23893	3012	25860	2366	28540	1325	35589	628	31679
20-#14	3.65	MA	18612	4903	30935	3909	37123	3132	40817	2508	45799	1477	58717	762	51851
7L-5S		MI	12261	4903	21096	3776	24930	3005	27088	2374	30113	1318	37508	718	32763
20-#14	3.65	MA	17773	4903	29684	3910	35474	3131	38758	2506	43041	1486	55208	685	49504
8L-4S		MI	12812	4903	21969	3765	25979	3012	28333	2366	31806	1325	39566	780	33463
20-#14	3.65	MA	16940	4903	28302	3926	33775	3146	36732	2518	40309	1494	51745	601	47181
9L-3S		MI	13418	4903	22830	3770	27140	3004	29706	2374	33546	1318	41505	905	34401
22-#11	2.79	MA	18688	4515	29453	3670	35429	2956	38827	2386	43220	1503	54709	1061	42822
6L-7S		MI	11017	4515	18206	3545	21283	2845	22842	2286	24589	1385	30356	792	24999
22-#11	2.79	MA	18079	4515	28567	3671	34256	2956	37394	2395	41227	1499	52321	990	41716
7L-6S		MI	11389	4515	18738	3547	21985	2850	23684	2280	25680	1380	31752	876	25660
22-#11	2.79	MA	17476	4515	27695	3672	33107	2956	35958	2394	39304	1506	49860	936	40729
8L-5S		MI	11770	4515	19283	3550	22711	2844	24552	2286	26793	1375	33116	938	25991
22-#11	2.79	MA	16878	4515	26732	3684	31922	2966	34546	2403	37399	1512	47425	877	39307
9L-4S		MI	12165	4515	19895	3542	23445	2848	25433	2280	27990	1380	34577	981	26595
22-#11	2.79	MA	16280	4515	25863	3685	30781	2966	33127	2401	35441	1509	44908	797	37930
10L-3S		MI	12600	4515	20498	3544	24259	2843	26404	2286	29220	1375	35951	1069	26785
22-#11	2.79	MA	15641	4515	25001	3686	29611	2977	31723	2411	33545	1515	42489	740	36534
11L-2S		MI	13191	4515	21298	3547	25274	2847	27619	2280	30819	1370	38046	1160	26853
22-#14	4.02	MA	19515	5066	32893	4011	39606	3207	43826	2555	49858	1470	64180	744	57469
7L-6S		MI	12226	5066	21457	3874	25339	3087	27578	2410	30800	1309	38540	589	34861
22-#14	4.02	MA	18688	5066	31642	4012	37957	3206	41766	2553	47099	1478	60671	667	55088
8L-5S		MI	12750	5066	22236	3878	26376	3079	28806	2418	32374	1301	40459	679	36011
22-#14	4.02	MA	17866	5066	30260	4028	36258	3220	39740	2565	44368	1487	57208	582	52739
9L-4S		MI	13295	5066	23110	3868	27425	3087	30051	2410	34066	1309	42517	741	36677
24-#11	3.04	MA	18723	4628	29935	3742	35990	3008	39495	2428	44062	1494	56160	978	45630
7E		MI	11375	4628	19007	3616	22298	2897	24057	2317	26188	1375	32450	767	27255
24-#11	3.04	MA	18127	4628	29063	3743	34841	3008	38060	2426	42139	1501	53699	924	44641
8L-6S		MI	11745	4628	19538	3618	23000	2902	24899	2312	27279	1370	33847	851	27891
24-#11	3.04	MA	17536	4628	28099	3755	33657	3018	36647	2436	40234	1507	51264	866	43219
9L-5S		MI	12122	4628	20084	3621	23726	2896	25767	2317	28392	1364	35211	913	28276
24-#11	3.04	MA	16940	4628	27231	3756	32516	3018	35228	2434	38276	1503	48747	785	41823
10L-4S		MI	12514	4628	20695	3613	24460	2900	26648	2312	29589	1370	36672	955	28852
24-#11	3.04	MA	16308	4628	26368	3757	31345	3029	33824	2443	36380	1510	46328	729	40414
11L-3S		MI	12945	4628	21298	3615	25274	2894	27619	2317	30819	1364	38046	1044	29129
24-#14	4.38	MA	19590	5230	33600	4114	40440	3281	44775	2600	51158	1471	66134	648	60678
8L-6S		MI	12716	5230	22597	3976	26785	3162	29296	2455	33060	1292	41490	550	38052
24-#14	4.38	MA	18779	5230	32218	4131	38741	3295	42749	2613	48427	1480	62671	564	58304
9L-5S		MI	13233	5230	23376	3980	27822	3154	30523	2462	34634	1285	43410	639	39264

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis



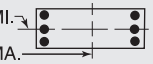
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.24	MA	19368	3997	27885	3348	33158	2721	35636	2254	37999	1576	46325	1477	22090
2E		MI	11409	3997	17244	3208	19744	2599	20738	2137	21453	1458	25509	1317	12725
6-#14	1.05	MA	18900	3906	26661	3311	31779	2696	34041	2241	35898	1591	43746	1509	18884
2L-3S		MI	10310	3906	15420	3179	17660	2584	18329	2151	18323	1502	21530	1245	11012
6-#14	1.05	MA	17274	3906	24601	3313	29166	2696	30875	2254	31627	1600	37968	1377	18837
3L-2S		MI	11203	3906	16560	3183	19106	2591	20047	2143	20584	1495	24480	1376	10967
6-#18	1.86	MA	21074	4288	31497	3530	37738	2854	41185	2338	45485	1563	56339	1441	32786
2L-3S		MI	10778	4288	17244	3379	19744	2716	20738	2225	21453	1436	25509	1003	18557
6-#18	1.86	MA	18323	4288	27885	3531	33158	2852	35636	2359	37999	1577	46325	1208	32366
3L-2S		MI	12280	4288	19220	3390	22213	2729	23670	2212	25312	1422	30507	1236	18641
8-#14	1.40	MA	19904	4070	28722	3413	34392	2771	37206	2289	40169	1583	49525	1492	24999
2L-4S		MI	10188	4070	15699	3277	17944	2666	18674	2188	18844	1493	22541	1080	14329
8-#14	1.40	MA	18303	4070	26661	3415	31779	2771	34041	2302	35898	1593	43746	1360	24898
3E		MI	10842	4070	16560	3281	19106	2658	20047	2195	20584	1485	24480	1206	14404
8-#14	1.40	MA	17146	4070	25133	3416	29713	2785	31537	2300	32518	1587	39933	1229	24533
4L-2S		MI	11723	4070	17700	3286	20552	2666	21764	2188	22844	1478	27431	1337	14390
8-#18	2.48	MA	22722	4579	35108	3711	42318	2987	46733	2423	52971	1550	66352	1405	43446
2L-4S		MI	10556	4579	17722	3550	20228	2859	21325	2287	22342	1414	27210	706	22458
8-#18	2.48	MA	20035	4579	31497	3713	37738	2985	41185	2443	45485	1563	56339	1172	42892
3E		MI	11653	4579	19220	3561	22213	2845	23670	2300	25312	1401	30507	922	24312
8-#18	2.48	MA	18092	4579	28811	3714	34108	3010	36785	2438	39547	1551	49745	938	39468
4L-2S		MI	13126	4579	21196	3571	24682	2859	26602	2287	29171	1387	35506	1156	24501
10-#11	1.21	MA	19418	3983	27580	3368	33032	2739	35597	2270	38025	1593	46754	1512	21838
2L-5S		MI	9983	3983	15047	3250	17260	2636	17910	2184	17803	1506	21230	1154	12506
10-#11	1.21	MA	18290	3983	26142	3370	31208	2739	33387	2280	35043	1600	42697	1421	21798
3L-4S		MI	10404	3983	15659	3242	17994	2641	18791	2179	19000	1511	22691	1197	12655
10-#11	1.21	MA	17476	3983	25076	3371	29767	2750	31641	2279	32686	1597	40016	1329	21662
4L-3S		MI	10866	3983	16262	3245	18808	2635	19762	2184	20231	1506	24065	1285	12663
10-#11	1.21	MA	16741	3983	23999	3383	28475	2750	30063	2288	30537	1604	37235	1282	21228
5L-2S		MI	11489	3983	17063	3247	19824	2639	20977	2179	21829	1501	26160	1376	12642
10-#14	1.75	MA	20885	4234	30782	3515	37005	2846	40372	2336	44440	1576	55304	1475	31096
2L-5S		MI	10128	4234	15966	3390	18342	2733	19146	2239	19412	1469	23434	979	16768
10-#14	1.75	MA	19308	4234	28722	3517	34392	2845	37206	2349	40169	1585	49525	1343	30949
3L-4S		MI	10717	4234	16840	3379	19390	2741	20391	2232	21105	1476	25492	1041	17652
10-#14	1.75	MA	18170	4234	27194	3519	32326	2860	34702	2347	36789	1580	45712	1212	30533
4L-3S		MI	11363	4234	17700	3384	20552	2733	21764	2239	22844	1469	27431	1166	17771
10-#14	1.75	MA	17140	4234	25648	3535	30472	2860	32439	2360	33707	1589	41744	1145	28767
5L-2S		MI	12233	4234	18840	3388	21998	2741	23482	2232	25104	1461	30382	1298	17793
10-#18	3.11	MA	21693	4870	35108	3895	42318	3118	46733	2528	52971	1550	66352	1135	53418
3L-4S		MI	11430	4870	19698	3732	22697	2988	24257	2361	26201	1379	32209	626	27894
10-#18	3.11	MA	19798	4870	32423	3896	38688	3143	42334	2522	47034	1537	59758	902	49667
4L-3S		MI	12507	4870	21196	3743	24682	2975	26602	2375	29171	1366	35506	842	30048
10-#18	3.11	MA	18082	4870	29705	3924	35427	3140	38354	2543	41615	1551	52857	785	46454
5L-2S		MI	13953	4870	23172	3753	27151	2988	29534	2361	33030	1352	40504	1076	30325
12-#11	1.45	MA	20117	4096	29019	3439	34857	2791	37808	2303	41007	1588	50812	1501	26100
2L-6S		MI	9963	4096	15303	3319	17549	2694	18257	2211	18289	1501	21961	1067	14350
12-#11	1.45	MA	19001	4096	27580	3441	33032	2791	35597	2313	38025	1595	46754	1410	26038
3L-5S		MI	10363	4096	15848	3321	18275	2688	19125	2216	19402	1495	23325	1129	14749
12-#11	1.45	MA	18198	4096	26515	3442	31592	2802	33851	2312	35668	1591	44074	1319	25875
4E		MI	10780	4096	16460	3313	19010	2693	20006	2211	20599	1501	24785	1172	15013
12-#11	1.45	MA	17471	4096	25437	3454	30299	2802	32273	2321	33519	1598	41293	1271	25320
5L-3S		MI	11237	4096	17063	3316	19824	2687	20977	2216	21829	1495	26160	1260	15043

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

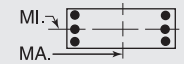
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.45	MA	16774	4096	24482	3456	29024	2813	30721	2320	31454	1606	38459	1197	24363
6L-2S		MI	11855	4096	17863	3318	20839	2691	22192	2211	23428	1490	28255	1351	15037
12-#14	2.10	MA	21846	4397	32842	3618	39618	2920	43537	2384	48711	1569	61083	1458	37182
2L-6S		MI	10098	4397	16327	3488	18751	2816	19636	2276	20098	1460	24465	850	19281
12-#14	2.10	MA	20290	4397	30782	3619	37005	2920	40372	2397	44440	1578	55304	1326	36995
3L-5S		MI	10656	4397	17106	3492	19788	2808	20864	2284	21672	1452	26385	939	19972
12-#14	2.10	MA	19171	4397	29254	3621	34939	2935	37868	2395	41060	1572	51490	1195	36534
4E		MI	11237	4397	17980	3481	20837	2816	22109	2276	23365	1460	28442	1001	20877
12-#14	2.10	MA	18158	4397	27709	3638	33085	2935	35604	2408	37978	1582	47522	1128	34654
5L-3S		MI	11875	4397	18840	3486	21998	2808	23482	2284	25104	1452	30382	1127	21124
12-#14	2.10	MA	17187	4397	26337	3639	31255	2950	33377	2406	35015	1591	43487	1019	33311
6L-2S		MI	12735	4397	19981	3490	23444	2816	25200	2276	27365	1445	33333	1259	21177
12-#18	3.73	MA	21455	5160	36034	4078	43268	3276	47883	2606	54520	1524	69771	866	59904
4E		MI	12285	5160	21674	3914	25166	3118	27190	2436	30060	1344	37207	546	33370
12-#18	3.73	MA	19780	5160	33317	4106	40007	3273	43903	2627	49101	1538	62870	749	56575
5L-3S		MI	13377	5160	23172	3924	27151	3105	29534	2449	33030	1331	40504	762	35772
12-#18	3.73	MA	18172	5160	30902	4107	36788	3298	39984	2621	43890	1552	55880	556	51998
6L-2S		MI	14771	5160	25148	3935	29620	3118	32467	2436	36888	1317	45503	996	36129
14-#11	1.70	MA	20804	4210	30457	3510	36681	2843	40018	2336	43989	1582	54870	1490	30356
2L-7S		MI	9953	4210	15572	3387	17863	2741	18630	2247	18797	1495	22659	958	16196
14-#11	1.70	MA	19701	4210	29019	3512	34857	2843	37808	2346	41007	1589	50812	1399	30274
3L-6S		MI	10342	4210	16103	3390	18565	2746	19472	2242	19887	1490	24055	1042	16627
14-#11	1.70	MA	18907	4210	27953	3513	33416	2854	36061	2345	38649	1586	48132	1308	30086
4L-5S		MI	10739	4210	16649	3392	19291	2740	20340	2247	21001	1485	25419	1104	17004
14-#11	1.70	MA	18189	4210	26876	3525	32123	2854	34483	2354	36501	1593	45350	1261	29425
5L-4S		MI	11151	4210	17260	3384	20025	2744	21221	2242	22197	1490	26880	1146	17363
14-#11	1.70	MA	17501	4210	25920	3526	30848	2865	32931	2353	34436	1600	42517	1186	28502
6L-3S		MI	11604	4210	17863	3387	20839	2739	22192	2247	23428	1485	28255	1235	17412
14-#11	1.70	MA	16828	4210	24990	3528	29616	2865	31426	2363	32342	1597	39992	1115	27619
7L-2S		MI	12216	4210	18664	3389	21854	2743	23407	2242	25026	1480	30349	1326	17422
14-#14	2.45	MA	21254	4561	32842	3721	39618	2995	43537	2444	48711	1570	61083	1309	43036
3L-6S		MI	10623	4561	17467	3590	20197	2891	21354	2321	22359	1443	27416	811	22410
14-#14	2.45	MA	20152	4561	31314	3723	37552	3010	41033	2442	45331	1565	57269	1178	42537
4L-5S		MI	11175	4561	18246	3594	21234	2883	22582	2328	23933	1435	29335	900	23189
14-#14	2.45	MA	19155	4561	29769	3740	35697	3010	38770	2455	42249	1574	53301	1111	40555
5L-4S		MI	11749	4561	19120	3584	22283	2890	23827	2321	25625	1443	31393	962	24037
14-#14	2.45	MA	18200	4561	28397	3741	33868	3025	36542	2453	39286	1584	49266	1002	39139
6L-3S		MI	12378	4561	19981	3588	23444	2883	25200	2328	27365	1435	33333	1088	24468
14-#14	2.45	MA	17263	4561	27062	3743	32100	3024	34383	2466	36282	1578	45673	900	37058
7L-2S		MI	13228	4561	21121	3592	24890	2890	26918	2321	29625	1428	36283	1219	24548
14-#18	4.35	MA	21435	5451	36928	4287	44587	3406	49451	2711	56587	1525	72883	713	66724
5L-4S		MI	13165	5451	23650	4096	27635	3247	30122	2511	33919	1309	42206	465	38877
14-#18	4.35	MA	19863	5451	34514	4289	41369	3431	45533	2706	51376	1538	65893	520	62286
6L-3S		MI	14184	5451	25148	4106	29620	3234	32467	2524	36888	1296	45503	682	41489
14-#18	4.35	MA	18322	5451	32164	4290	38259	3429	41734	2726	46093	1526	59676	338	57123
7L-2S		MI	15549	5451	27123	4117	32089	3247	35399	2511	40747	1282	50501	915	41917
16-#11	1.94	MA	20389	4323	30457	3582	36681	2895	40018	2378	43989	1584	54870	1389	34506
3L-7S		MI	10331	4323	16372	3458	18878	2793	19845	2279	20395	1485	24753	933	18423
16-#11	1.94	MA	19604	4323	29392	3584	35240	2905	38271	2378	41631	1581	52189	1297	34296
4L-6S		MI	10716	4323	16904	3461	19580	2798	20687	2274	21486	1479	26150	1017	18910
16-#11	1.94	MA	18895	4323	28314	3596	33948	2906	36694	2387	39483	1588	49408	1250	33539
5E		MI	11109	4323	17449	3463	20306	2792	21555	2279	22599	1474	27514	1079	19267
16-#11	1.94	MA	18216	4323	27359	3597	32672	2916	35141	2386	37417	1595	46574	1175	32647
6L-4S		MI	11517	4323	18061	3455	21040	2796	22436	2274	23796	1479	28975	1121	19708

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis

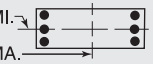


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.94	MA	17551	4323	26428	3599	31441	2917	33636	2396	35324	1592	44049	1104	31716
7L-3S		MI	11966	4323	18664	3458	21854	2790	23407	2279	25026	1474	30349	1210	19774
16-#11	1.94	MA	16893	4323	25513	3600	30234	2917	32128	2395	33304	1599	41451	1050	30568
8L-2S		MI	12573	4323	19464	3460	22870	2795	24622	2274	26625	1469	32444	1301	19799
16-#14	2.80	MA	21114	4724	33374	3825	40165	3085	44199	2489	49602	1558	63048	1161	48447
4L-6S		MI	11140	4724	18607	3692	21643	2965	23072	2365	24619	1426	30367	771	25554
16-#14	2.80	MA	20133	4724	31829	3842	38310	3085	41935	2502	46520	1567	59080	1094	46468
5E		MI	11685	4724	19386	3697	22680	2958	24300	2372	26193	1419	32286	861	26416
16-#14	2.80	MA	19192	4724	30457	3844	36481	3099	39708	2501	43557	1576	55045	985	44979
6L-4S		MI	12252	4724	20260	3686	23729	2965	25545	2365	27885	1426	34344	923	27214
16-#14	2.80	MA	18271	4724	29122	3845	34713	3099	37548	2514	40553	1571	51451	883	42953
7L-3S		MI	12874	4724	21121	3690	24890	2958	26918	2372	29625	1419	36283	1049	27805
16-#14	2.80	MA	17359	4724	27808	3847	32982	3099	35385	2512	37655	1580	47745	805	40661
8L-2S		MI	13715	4724	22261	3695	26336	2965	28636	2365	31885	1411	39234	1180	27911
16-#18	4.97	MA	21515	5742	38125	4471	45949	3564	51082	2790	58863	1525	75906	484	72592
6L-4S		MI	13978	5742	25625	4277	30104	3377	33054	2586	37778	1274	47204	385	44409
16-#18	4.97	MA	20007	5742	35775	4472	42839	3562	47283	2811	53579	1512	69689	302	67372
7L-3S		MI	14975	5742	27123	4288	32089	3364	35399	2599	40747	1261	50501	602	46912
16-#18	4.97	MA	18514	5742	33461	4474	39791	3560	43477	2805	48481	1526	63245	167	62159
8L-2S		MI	16312	5742	29099	4298	34558	3377	38331	2586	44606	1247	55500	835	47694
18-#11	2.18	MA	20292	4436	30830	3655	37065	2957	40482	2410	44613	1576	56247	1287	38505
4L-7S		MI	10704	4436	17173	3529	19893	2845	21060	2310	21994	1474	26848	908	20659
18-#11	2.18	MA	19591	4436	29753	3667	35772	2958	38904	2420	42465	1583	53466	1239	37662
5L-6S		MI	11085	4436	17704	3531	20595	2850	21902	2305	23085	1469	28245	992	21196
18-#11	2.18	MA	18920	4436	28797	3668	34497	2968	37351	2419	40399	1590	50632	1165	36798
6L-5S		MI	11474	4436	18250	3534	21321	2844	22770	2310	24198	1464	29609	1054	21537
18-#11	2.18	MA	18263	4436	27867	3670	33265	2969	35846	2428	38306	1587	48107	1094	35819
7L-4S		MI	11879	4436	18862	3526	22056	2848	23651	2305	25395	1469	31069	1096	22049
18-#11	2.18	MA	17613	4436	26951	3671	32059	2969	34339	2428	36286	1594	45509	1039	34699
8L-3S		MI	12323	4436	19464	3528	22870	2842	24622	2310	26625	1464	32444	1185	22131
18-#11	2.18	MA	16967	4436	25940	3683	30815	2979	32856	2437	34286	1601	42934	981	33332
9L-2S		MI	12925	4436	20265	3531	23885	2847	25837	2305	28223	1458	34539	1276	22168
18-#14	3.14	MA	21094	4888	33889	3944	40923	3159	45101	2550	50790	1559	64858	1077	52391
5L-6S		MI	11650	4888	19747	3794	23089	3040	24790	2409	26879	1409	33318	732	28712
18-#14	3.14	MA	20167	4888	32518	3946	39094	3174	42873	2548	47828	1569	60823	968	50831
6L-5S		MI	12188	4888	20527	3799	24126	3033	26017	2417	28453	1402	35237	822	29651
18-#14	3.14	MA	19260	4888	31182	3948	37326	3174	40714	2561	44824	1563	57230	866	48856
7L-4S		MI	12748	4888	21400	3788	25175	3040	27263	2409	30146	1409	37295	884	30405
18-#14	3.14	MA	18362	4888	29868	3949	35595	3174	38551	2559	41926	1573	53524	788	46530
8L-3S		MI	13363	4888	22261	3792	26336	3033	28636	2417	31885	1402	39234	1010	31136
18-#14	3.14	MA	17470	4888	28417	3966	33810	3189	36422	2572	39056	1582	49859	704	44207
9L-2S		MI	14196	4888	23401	3797	27782	3040	30354	2409	34146	1394	42185	1141	31266
18-#18	5.59	MA	21656	6033	39387	4654	47419	3695	52832	2895	61066	1499	79702	266	77637
7L-4S		MI	14776	6033	27601	4459	32573	3507	35987	2660	41637	1239	52203	305	49962
18-#18	5.59	MA	20193	6033	37073	4655	44372	3693	49026	2889	55967	1513	73259	130	72384
8L-3S		MI	15751	6033	29099	4470	34558	3493	38331	2673	44606	1225	55500	521	52309
20-#11	2.42	MA	20278	4550	31191	3738	37596	3009	41114	2453	45447	1578	57524	1229	41792
5L-7S		MI	11072	4550	17973	3600	20909	2897	22275	2342	23592	1463	28943	883	22902
20-#11	2.42	MA	19614	4550	30235	3739	36321	3020	39561	2452	43381	1585	54690	1154	40954
6E		MI	11449	4550	18505	3602	21611	2901	23117	2337	24683	1458	30340	966	23486
20-#11	2.42	MA	18964	4550	29305	3741	35090	3020	38056	2461	41288	1582	52165	1083	39929
7L-5S		MI	11835	4550	19050	3605	22337	2896	23985	2342	25796	1453	31703	1028	23813
20-#11	2.42	MA	18322	4550	28390	3742	33883	3021	36549	2460	39268	1589	49566	1029	38834
8L-4S		MI	12236	4550	19662	3597	23071	2900	24866	2337	26993	1458	33164	1071	24387
20-#11	2.42	MA	17684	4550	27378	3754	32639	3031	35066	2470	37268	1596	46992	970	37442
9L-3S		MI	12677	4550	20265	3599	23885	2894	25837	2342	28223	1453	34539	1160	24483
20-#11	2.42	MA	17043	4550	26466	3755	31441	3032	33576	2469	35212	1592	44331	890	36090
10L-2S		MI	13274	4550	21065	3602	24900	2899	27052	2337	29822	1448	36633	1251	24533

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

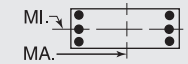
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	3.49	MA	21126	5051	34578	4048	41707	3249	46039	2595	52098	1561	66602	951	56693
6E		MI	12152	5051	20888	3897	24535	3115	26508	2454	29140	1393	36268	693	31882
20-#14	3.49	MA	20232	5051	33243	4050	39939	3249	43880	2608	49095	1556	63009	849	54767
7L-5S		MI	12684	5051	21667	3901	25572	3107	27735	2461	30714	1385	38188	783	32893
20-#14	3.49	MA	19347	5051	31928	4052	38208	3249	41716	2606	46197	1565	59302	771	52406
8L-4S		MI	13238	5051	22541	3890	26621	3115	28981	2454	32406	1393	40245	845	33608
20-#14	3.49	MA	18468	5051	30477	4068	36423	3264	39588	2619	43327	1575	55638	687	50060
9L-3S		MI	13847	5051	23401	3895	27782	3107	30354	2461	34146	1385	42185	970	34464
20-#14	3.49	MA	17577	5051	29168	4070	34704	3263	37450	2617	40377	1569	51849	571	47638
10L-2S		MI	14671	5051	24541	3899	29228	3115	32071	2454	36406	1378	45136	1102	34616
20-#18	6.21	MA	21839	6324	40684	4837	48952	3826	54574	2973	63454	1499	83272	94	82623
8L-4S		MI	15561	6324	29577	4641	35042	3636	38919	2735	45496	1204	57201	225	55531
22-#11	2.66	MA	20299	4663	31674	3810	38145	3072	41772	2485	46363	1580	58748	1143	45114
6L-7S		MI	11436	4663	18774	3671	21924	2949	23490	2373	25191	1453	31038	858	25150
22-#11	2.66	MA	19656	4663	30744	3811	36914	3072	40267	2494	44270	1576	56222	1073	44045
7L-6S		MI	11810	4663	19306	3673	22626	2953	24332	2368	26282	1448	32434	941	25778
22-#11	2.66	MA	19021	4663	29828	3813	35707	3073	38759	2493	42250	1584	53624	1018	42974
8L-5S		MI	12192	4663	19851	3676	23352	2947	25200	2373	27395	1443	33798	1003	26094
22-#11	2.66	MA	18390	4663	28817	3825	34464	3083	37276	2503	40250	1591	51050	960	41557
9L-4S		MI	12590	4663	20463	3668	24086	2952	26081	2368	28592	1448	35259	1046	26715
22-#11	2.66	MA	17752	4663	27905	3826	33266	3084	35786	2502	38194	1587	48388	880	40187
10L-3S		MI	13026	4663	21065	3670	24900	2946	27052	2373	29822	1443	36633	1134	26833
22-#11	2.66	MA	17078	4663	26999	3828	32036	3094	34312	2511	36203	1594	45835	822	38694
11L-2S		MI	13619	4663	21866	3673	25916	2951	28267	2368	31421	1437	38728	1225	26895
22-#14	3.84	MA	21189	5215	35303	4152	42552	3324	47045	2656	53366	1548	68787	832	60685
7L-6S		MI	12649	5215	22028	3999	25981	3190	28226	2498	31400	1376	39219	654	35061
22-#14	3.84	MA	20317	5215	33989	4154	40821	3324	44882	2654	50468	1558	65081	754	58289
8L-5S		MI	13175	5215	22807	4003	27018	3182	29453	2505	32974	1368	41138	743	36141
22-#14	3.84	MA	19450	5215	32537	4170	39036	3338	42754	2667	47598	1567	61416	670	55919
9L-4S		MI	13723	5215	23681	3993	28067	3190	30698	2498	34666	1376	43196	805	36821
22-#14	3.84	MA	18563	5215	31228	4172	37316	3338	40615	2665	44647	1562	57628	554	53481
10L-3S		MI	14325	5215	24541	3997	29228	3182	32071	2505	36406	1368	45136	931	37787
24-#11	2.91	MA	20339	4777	32182	3882	38738	3124	42477	2527	47252	1571	60280	1062	48166
7E		MI	11796	4777	19575	3742	22939	3001	24705	2405	26790	1442	33132	833	27404
24-#11	2.91	MA	19711	4777	31267	3884	37532	3124	40969	2526	45232	1578	57682	1007	47117
8L-6S		MI	12167	4777	20106	3744	23641	3005	25547	2400	27880	1437	34529	916	28057
24-#11	2.91	MA	19087	4777	30255	3896	36288	3135	39486	2536	43232	1585	55107	949	45677
9L-5S		MI	12545	4777	20651	3746	24367	2999	26415	2405	28994	1432	35893	978	28378
24-#11	2.91	MA	18452	4777	29343	3897	35090	3135	37996	2535	41176	1582	52446	869	44288
10L-4S		MI	12940	4777	21263	3739	25102	3004	27296	2400	30190	1437	37354	1021	28971
24-#11	2.91	MA	17785	4777	28438	3899	33861	3146	36522	2544	39184	1589	49892	812	42816
11L-3S		MI	13373	4777	21866	3741	25916	2998	28267	2405	31421	1432	38728	1109	29179
24-#11	2.91	MA	17126	4777	27537	3900	32666	3146	35041	2543	37203	1596	47338	754	41135
12L-2S		MI	13961	4777	22667	3743	26931	3002	29482	2400	33019	1427	40823	1200	29253
24-#14	4.19	MA	21273	5379	36049	4256	43433	3398	48047	2701	54739	1550	70860	737	64179
8L-6S		MI	13139	5379	23168	4101	27427	3265	29943	2542	33660	1359	42170	615	38250
24-#14	4.19	MA	20418	5379	34598	4273	41649	3413	45919	2714	51869	1560	67195	653	61784
9L-5S		MI	13660	5379	23947	4105	28464	3257	31171	2550	35234	1352	44089	704	39393
24-#14	4.19	MA	19534	5379	33288	4274	39929	3413	43781	2712	48918	1554	63406	537	59330
10L-4S		MI	14203	5379	24821	4095	29513	3264	32416	2542	36927	1359	46147	766	40043

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

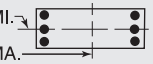


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.19	MA	20976	4146	29993	3487	35723	2836	38378	2351	40828	1651	49839	1555	23170
2E		MI	11828	4146	17822	3332	20388	2701	21384	2224	22050	1524	26183	1381	12760
6-#14	1.00	MA	20476	4055	28703	3450	34268	2810	36695	2339	38612	1666	47091	1585	19795
2L-3S		MI	10727	4055	15991	3304	18302	2687	18976	2238	18924	1569	22209	1310	11044
6-#14	1.00	MA	18764	4055	26540	3452	31526	2811	33372	2352	34129	1676	40996	1454	19748
3L-2S		MI	11621	4055	17131	3309	19748	2694	20694	2231	21184	1562	25160	1441	10995
6-#18	1.79	MA	22782	4437	33787	3669	40533	2969	44206	2436	48691	1638	60413	1522	34406
2L-3S		MI	11196	4437	17822	3503	20388	2817	21384	2312	22050	1502	26183	1067	18620
6-#18	1.79	MA	19883	4437	29993	3671	35723	2968	38378	2457	40828	1653	49839	1288	33986
3L-2S		MI	12701	4437	19798	3513	22856	2831	24317	2298	25909	1489	31182	1301	18683
8-#14	1.34	MA	21538	4219	30865	3552	37011	2885	40017	2386	43095	1658	53185	1570	26214
2L-4S		MI	10604	4219	16271	3402	18586	2769	19321	2275	19444	1560	23220	1145	14384
8-#14	1.34	MA	19852	4219	28703	3554	34268	2886	36695	2400	38612	1668	47091	1438	26113
3E		MI	11260	4219	17131	3406	19748	2761	20694	2282	21184	1553	25160	1270	14443
8-#14	1.34	MA	18636	4219	27101	3556	32102	2901	34069	2398	35068	1663	43066	1307	25748
4L-2S		MI	12143	4219	18271	3411	21194	2769	22412	2275	23444	1545	28111	1402	14422
8-#18	2.38	MA	24528	4727	37580	3851	45344	3102	50034	2520	56554	1625	70987	1488	45606
2L-4S		MI	10973	4727	18300	3674	20872	2960	21972	2373	22939	1480	27885	770	22667
8-#18	2.38	MA	21695	4727	33787	3853	40533	3101	44206	2542	48691	1640	60413	1255	45052
3E		MI	12074	4727	19798	3685	22856	2947	24317	2386	25909	1467	31182	987	24385
8-#18	2.38	MA	19649	4727	30969	3855	36725	3126	39590	2537	42461	1628	53443	1021	41709
4L-2S		MI	13551	4727	21774	3695	25325	2960	27249	2373	29768	1454	36180	1220	24550
10-#11	1.16	MA	21021	4131	29665	3508	35580	2853	38325	2368	40839	1668	50249	1588	22891
2L-5S		MI	10399	4131	15615	3376	17901	2740	18558	2272	18405	1573	21912	1219	12610
10-#11	1.16	MA	19834	4131	28155	3509	33666	2854	36005	2378	37710	1675	45972	1497	22851
3L-4S		MI	10821	4131	16227	3368	18636	2744	19439	2267	19602	1579	23373	1262	12694
10-#11	1.16	MA	18980	4131	27038	3511	32155	2865	34175	2377	35238	1672	43145	1406	22715
4L-3S		MI	11284	4131	16830	3371	19449	2738	20410	2272	20832	1573	24747	1351	12694
10-#11	1.16	MA	18207	4131	25910	3523	30801	2866	32521	2387	32987	1680	40218	1358	22362
5L-2S		MI	11908	4131	17630	3373	20465	2743	21625	2267	22431	1568	26842	1442	12670
10-#14	1.67	MA	22576	4382	33028	3655	39753	2960	43340	2433	47578	1651	59280	1554	32615
2L-5S		MI	10544	4382	16537	3515	18984	2836	19794	2327	20012	1536	24113	1044	16899
10-#14	1.67	MA	20915	4382	30865	3657	37011	2960	40017	2447	43095	1661	53185	1422	32468
3L-4S		MI	11135	4382	17411	3504	20033	2844	21039	2319	21705	1543	26171	1106	17713
10-#14	1.67	MA	19718	4382	29263	3659	34844	2976	37392	2446	39550	1656	49160	1291	32052
4L-3S		MI	11783	4382	18271	3509	21194	2836	22412	2327	23444	1536	28111	1231	17815
10-#14	1.67	MA	18635	4382	27644	3676	32900	2976	35019	2459	36320	1666	44982	1223	30307
5L-2S		MI	12655	4382	19412	3513	22640	2844	24130	2319	25705	1528	31061	1363	17828
10-#18	2.98	MA	23450	5018	37580	4035	45344	3234	50034	2626	56554	1626	70987	1221	56118
3L-4S		MI	11849	5018	20276	3856	23341	3090	24904	2448	26798	1445	32883	690	28098
10-#18	2.98	MA	21454	5018	34763	4037	41535	3259	45418	2621	50324	1615	64017	988	52435
4L-3S		MI	12930	5018	21774	3866	25325	3077	27249	2461	29768	1432	36180	906	30128
10-#18	2.98	MA	19647	5018	31913	4065	38115	3258	41243	2643	44641	1630	56742	870	49140
5L-2S		MI	14381	5018	23750	3877	27794	3090	30181	2448	33627	1419	41179	1140	30380
12-#11	1.39	MA	21760	4245	31174	3578	37494	2905	40644	2401	43967	1662	54526	1579	27364
2L-6S		MI	10379	4245	15871	3445	18191	2797	18905	2299	18890	1568	22643	1132	14446
12-#11	1.39	MA	20586	4245	29665	3580	35580	2906	38325	2410	40839	1670	50249	1488	27302
3L-5S		MI	10780	4245	16416	3447	18917	2792	19773	2304	20004	1563	24007	1194	14852
12-#11	1.39	MA	19741	4245	28548	3582	34069	2917	36494	2410	38367	1667	47422	1396	27138
4E		MI	11198	4245	17028	3439	19651	2796	20654	2299	21200	1568	25467	1237	15056
12-#11	1.39	MA	18978	4245	27419	3594	32715	2917	34840	2420	36115	1675	44494	1349	26660
5L-3S		MI	11656	4245	17630	3442	20465	2790	21625	2304	22431	1563	26842	1325	15078
12-#11	1.39	MA	18246	4245	26418	3596	31379	2928	33213	2419	33951	1682	41507	1274	25623
6L-2S		MI	12275	4245	18431	3444	21480	2795	22840	2299	24029	1558	28937	1417	15067
12-#14	2.01	MA	23593	4546	35190	3757	42496	3035	46663	2481	52060	1643	65374	1538	39005
2L-6S		MI	10513	4546	16898	3613	19393	2919	20284	2364	20699	1527	25145	915	19491

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

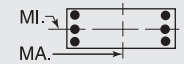
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	2.01	MA	21954	4546	33028	3759	39753	3035	43340	2494	47578	1653	59280	1407	38817
3L-5S		MI	11073	4546	17677	3617	20430	2911	21511	2371	22272	1519	27064	1004	20101
12-#14	2.01	MA	20776	4546	31426	3761	37587	3050	40714	2493	44033	1649	55255	1275	38357
4E		MI	11657	4546	18551	3607	21479	2919	22757	2364	23965	1527	29122	1066	21027
12-#14	2.01	MA	19711	4546	29806	3778	35643	3051	38341	2507	40802	1659	51076	1207	36492
5L-3S		MI	12296	4546	19412	3611	22640	2911	24130	2371	25705	1519	31061	1192	21173
12-#14	2.01	MA	18690	4546	28369	3780	33725	3066	36007	2505	37697	1669	46820	1099	35142
6L-2S		MI	13158	4546	20552	3615	24086	2918	25848	2364	27965	1512	34012	1323	21217
12-#18	3.57	MA	23208	5309	38556	4219	46346	3392	51246	2706	58187	1602	74590	954	63199
4E		MI	12706	5309	22252	4038	25810	3220	27836	2522	30657	1410	37882	610	33570
12-#18	3.57	MA	21444	5309	35706	4247	42926	3391	47072	2727	52504	1617	67316	836	59926
5L-3S		MI	13767	5309	23750	4048	27794	3206	30181	2536	33627	1397	41179	826	35858
12-#18	3.57	MA	19751	5309	33175	4249	39551	3416	42963	2723	47039	1632	59933	644	54961
6L-2S		MI	15196	5309	25726	4059	30263	3220	33113	2522	37486	1384	46177	1060	36187
14-#11	1.63	MA	22488	4358	32683	3649	39408	2957	42963	2433	47096	1657	58803	1569	31830
2L-7S		MI	10369	4358	16140	3513	18504	2845	19278	2335	19398	1563	23341	1024	16349
14-#11	1.63	MA	21325	4358	31174	3651	37494	2958	40644	2443	43967	1665	54526	1478	31748
3L-6S		MI	10758	4358	16671	3515	19206	2849	20120	2330	20489	1558	24737	1107	16724
14-#11	1.63	MA	20491	4358	30057	3653	35984	2969	38813	2443	41496	1662	51699	1387	31560
4L-5S		MI	11156	4358	17216	3518	19932	2843	20988	2335	21602	1552	26101	1169	17105
14-#11	1.63	MA	19737	4358	28928	3665	34629	2969	37159	2452	39244	1669	48771	1339	30969
5L-4S		MI	11570	4358	17828	3510	20666	2848	21869	2330	22799	1558	27562	1212	17409
14-#11	1.63	MA	19014	4358	27927	3667	33293	2980	35532	2452	37080	1677	45784	1264	29969
6L-3S		MI	12024	4358	18431	3512	21480	2842	22840	2335	24029	1552	28937	1300	17450
14-#11	1.63	MA	18306	4358	26952	3668	32003	2981	33956	2462	34887	1674	43121	1193	29136
7L-2S		MI	12638	4358	19232	3515	22495	2847	24055	2330	25628	1547	31031	1391	17455
14-#14	2.34	MA	22974	4709	35190	3861	42496	3110	46663	2542	52060	1646	65374	1391	45163
3L-6S		MI	11040	4709	18038	3715	20839	2993	22002	2408	22959	1510	28096	875	22617
14-#14	2.34	MA	21813	4709	33588	3863	40329	3125	44037	2540	48516	1641	61349	1260	44663
4L-5S		MI	11593	4709	18818	3719	21876	2986	23229	2415	24533	1503	30015	965	23317
14-#14	2.34	MA	20765	4709	31969	3880	38386	3126	41664	2554	45285	1651	57170	1192	42690
5L-4S		MI	12169	4709	19691	3709	22925	2993	24475	2408	26225	1510	32073	1027	24185
14-#14	2.34	MA	19760	4709	30531	3882	36468	3141	39329	2553	42179	1661	52914	1084	41346
6L-3S		MI	12801	4709	20552	3713	24086	2986	25848	2415	27965	1503	34012	1153	24520
14-#14	2.34	MA	18776	4709	29132	3884	34616	3141	37066	2566	39031	1656	49122	982	39093
7L-2S		MI	13654	4709	21692	3717	25532	2993	27565	2408	30225	1495	36963	1284	24590
14-#18	4.17	MA	23194	5600	39499	4429	47737	3524	52900	2812	60367	1603	77889	803	70606
5L-4S		MI	13591	5600	24227	4219	28279	3349	30769	2597	34516	1375	42880	530	39074
14-#18	4.17	MA	21539	5600	36968	4431	44361	3549	48791	2807	54902	1619	70507	610	65781
6L-3S		MI	14617	5600	25726	4230	30263	3336	33113	2610	37486	1362	46177	746	41580
14-#18	4.17	MA	19916	5600	34504	4433	41101	3548	44808	2829	49362	1607	63938	428	60507
7L-2S		MI	15990	5600	27701	4240	32732	3349	36046	2597	41345	1349	51176	980	41979
16-#11	1.86	MA	22054	4472	32683	3722	39408	3010	42963	2476	47096	1660	58803	1468	36190
3L-7S		MI	10747	4472	16940	3584	19519	2897	20493	2367	20997	1552	25435	999	18575
16-#11	1.86	MA	21228	4472	31567	3724	37898	3021	41132	2476	44625	1657	55975	1377	35981
4L-6S		MI	11133	4472	17472	3586	20221	2901	21335	2362	22088	1547	26832	1082	19006
16-#11	1.86	MA	20483	4472	30438	3736	36543	3021	39478	2485	42373	1664	53048	1329	35289
5E		MI	11527	4472	18017	3589	20947	2895	22203	2367	23201	1542	28196	1144	19368
16-#11	1.86	MA	19769	4472	29436	3737	35207	3032	37851	2485	40209	1672	50061	1254	34322
6L-4S		MI	11937	4472	18629	3581	21682	2900	23084	2362	24398	1547	29657	1187	19757
16-#11	1.86	MA	19070	4472	28462	3739	33917	3033	36275	2495	38015	1669	47398	1184	33439
7L-3S		MI	12387	4472	19232	3583	22495	2894	24055	2367	25628	1542	31031	1275	19814
16-#11	1.86	MA	18379	4472	27503	3741	32653	3033	34695	2494	35899	1677	44663	1129	32201
8L-2S		MI	12996	4472	20032	3586	23511	2898	25270	2362	27226	1537	33126	1366	19834

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

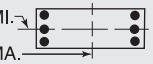


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	2.68	MA	22832	4873	35751	3965	43072	3200	47360	2588	52999	1634	67443	1244	50971
4L-6S		MI	11558	4873	19178	3817	22285	3068	23720	2452	25219	1493	31046	836	25758
16-#14	2.68	MA	21799	4873	34131	3982	41128	3200	44987	2601	49768	1644	63265	1176	48901
5E		MI	12105	4873	19958	3822	23322	3061	24947	2460	26793	1486	32966	926	26543
16-#14	2.68	MA	20810	4873	32694	3984	39211	3216	42652	2600	46662	1654	59009	1068	47484
6L-4S		MI	12674	4873	20832	3811	24371	3068	26192	2452	28486	1493	35023	988	27360
16-#14	2.68	MA	19841	4873	31295	3986	37359	3216	40389	2613	43514	1649	55217	966	45287
7L-3S		MI	13299	4873	21692	3815	25532	3061	27565	2460	30225	1486	36963	1114	27860
16-#14	2.68	MA	18882	4873	29918	3989	35544	3216	38122	2612	40477	1659	51313	887	42989
8L-2S		MI	14143	4873	22832	3820	26978	3068	29283	2452	32485	1478	39914	1245	27955
16-#18	4.76	MA	23286	5891	40761	4613	49172	3682	54619	2891	62765	1605	81080	577	76621
6L-4S		MI	14408	5891	26203	4401	30748	3479	33701	2672	38375	1340	47879	449	44603
16-#18	4.76	MA	21697	5891	38298	4615	45912	3681	50636	2913	57225	1594	74511	395	71292
7L-3S		MI	15411	5891	27701	4412	32732	3465	36046	2685	41345	1327	51176	666	47177
16-#18	4.76	MA	20125	5891	35872	4617	42717	3679	46645	2909	51879	1609	67717	258	65942
8L-2S		MI	16757	5891	29677	4422	35201	3479	38978	2672	45204	1314	56174	899	47759
18-#11	2.09	MA	21955	4585	33076	3795	39812	3072	43451	2508	47754	1652	60252	1367	40401
4L-7S		MI	11121	4585	17741	3655	20534	2949	21708	2398	22595	1542	27530	973	20809
18-#11	2.09	MA	21219	4585	31947	3807	38458	3073	41797	2518	45502	1659	57325	1319	39618
5L-6S		MI	11503	4585	18272	3657	21237	2953	22550	2393	23686	1536	28927	1057	21293
18-#11	2.09	MA	20513	4585	30946	3808	37121	3084	40171	2518	43338	1667	54338	1245	38680
6L-5S		MI	11894	4585	18818	3660	21962	2947	23418	2398	24799	1531	30291	1119	21638
18-#11	2.09	MA	19822	4585	29971	3810	35831	3085	38594	2527	41144	1664	51675	1174	37749
7L-4S		MI	12300	4585	19429	3652	22697	2952	24299	2393	25996	1536	31751	1161	22101
18-#11	2.09	MA	19139	4585	29012	3812	34567	3085	37014	2527	39028	1671	48940	1119	36539
8L-3S		MI	12746	4585	20032	3654	23511	2946	25270	2398	27226	1531	33126	1250	22173
18-#11	2.09	MA	18460	4585	27952	3824	33264	3096	35460	2537	36933	1679	46225	1061	35184
9L-2S		MI	13350	4585	20833	3657	24526	2950	26485	2393	28825	1526	35221	1341	22206
18-#14	3.01	MA	22816	5036	36294	4085	43871	3275	48309	2649	54251	1636	69359	1160	55122
5L-6S		MI	12069	5036	20319	3920	23731	3143	25438	2497	27479	1477	33997	797	28914
18-#14	3.01	MA	21841	5036	34856	4087	41953	3290	45975	2647	51145	1646	65103	1052	53633
6L-5S		MI	12609	5036	21098	3924	24768	3136	26665	2504	29053	1469	35916	887	29778
18-#14	3.01	MA	20886	5036	33457	4089	40101	3291	43712	2661	47997	1642	61311	950	51490
7L-4S		MI	13172	5036	21972	3913	25817	3143	27910	2497	30746	1477	37974	949	30549
18-#14	3.01	MA	19941	5036	32080	4091	38287	3291	41445	2659	44960	1652	57408	872	49157
8L-3S		MI	13790	5036	22832	3918	26978	3135	29283	2504	32485	1469	39914	1074	31194
18-#14	3.01	MA	19003	5036	30559	4108	36417	3306	39214	2673	41953	1662	53541	788	46819
9L-2S		MI	14625	5036	23972	3922	28424	3143	31001	2497	34746	1462	42864	1206	31313
18-#18	5.36	MA	23440	6181	42091	4797	50722	3814	56464	2997	65088	1581	85085	362	82092
7L-4S		MI	15209	6181	28179	4583	33217	3608	36633	2747	42234	1305	52877	369	50153
18-#18	5.36	MA	21900	6181	39666	4799	47527	3812	52473	2993	59742	1596	78291	225	76704
8L-3S		MI	16191	6181	29677	4593	35201	3595	38978	2760	45204	1292	56174	586	52570
20-#11	2.32	MA	21944	4698	33456	3878	40372	3125	44116	2551	48631	1654	61601	1310	43954
5L-7S		MI	11490	4698	18541	3726	21550	3000	22923	2430	24194	1531	29625	948	23051
20-#11	2.32	MA	21246	4698	32455	3879	39036	3136	42490	2550	46467	1661	58615	1235	43044
6E		MI	11869	4698	19073	3728	22252	3005	23765	2425	25285	1526	31022	1032	23583
20-#11	2.32	MA	20563	4698	31480	3881	37745	3136	40913	2560	44273	1659	55952	1164	42066
7L-5S		MI	12256	4698	19618	3731	22978	2999	24633	2430	26398	1521	32385	1094	23914
20-#11	2.32	MA	19888	4698	30521	3883	36481	3137	39333	2560	42157	1666	53217	1109	40882
8L-4S		MI	12658	4698	20230	3723	23712	3004	25514	2425	27595	1526	33846	1136	24441
20-#11	2.32	MA	19217	4698	29462	3895	35179	3148	37780	2570	40062	1674	50502	1051	39503
9L-3S		MI	13101	4698	20833	3725	24526	2998	26485	2430	28825	1521	35221	1225	24528
20-#11	2.32	MA	18536	4698	28507	3897	33923	3149	36218	2569	37907	1671	47696	971	38163
10L-2S		MI	13700	4698	21633	3727	25541	3002	27700	2425	30424	1515	37315	1316	24572
20-#14	3.35	MA	22855	5200	37019	4189	44696	3365	49297	2695	55628	1639	71198	1037	59793
6E		MI	12573	5200	21459	4022	25177	3218	27155	2541	29740	1460	36948	758	32080
20-#14	3.35	MA	21914	5200	35620	4191	42844	3366	47034	2708	52480	1634	67406	935	57700
7L-5S		MI	13107	5200	22238	4026	26214	3210	28383	2548	31314	1452	38867	848	33019

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

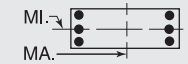
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	3.35	MA	20983	5200	34243	4193	41029	3366	44767	2707	49443	1644	63502	856	55334
8L-4S		MI	13664	5200	23112	4015	27263	3218	29628	2541	33006	1460	40925	910	33751
20-#14	3.35	MA	20057	5200	32722	4210	39159	3381	42537	2720	46435	1654	59636	772	52972
9L-3S		MI	14275	5200	23972	4020	28424	3210	31001	2548	34746	1452	42864	1035	34524
20-#14	3.35	MA	19108	5200	31350	4212	37357	3382	40296	2719	43343	1649	55639	657	50421
10L-2S		MI	15103	5200	25113	4024	29870	3218	32719	2541	37006	1445	45815	1167	34665
20-#18	5.95	MA	23639	6472	43459	4981	52338	3945	58301	3077	67605	1582	88865	191	87480
8L-4S		MI	15997	6472	30155	4765	35686	3738	39566	2821	46093	1270	57876	289	55721
22-#11	2.55	MA	21970	4812	33964	3950	40950	3188	44809	2583	49596	1656	62891	1225	47412
6L-7S		MI	11855	4812	19342	3797	22565	3052	24138	2461	25793	1520	31720	923	25298
22-#11	2.55	MA	21294	4812	32990	3952	39660	3188	43232	2593	47402	1653	60228	1154	46388
7L-6S		MI	12230	4812	19873	3799	23267	3057	24980	2456	26883	1515	33116	1007	25876
22-#11	2.55	MA	20627	4812	32031	3954	38396	3189	41652	2593	45286	1661	57493	1099	45229
8L-5S		MI	12614	4812	20419	3801	23993	3051	25848	2461	27997	1510	34480	1069	26194
22-#11	2.55	MA	19963	4812	30971	3966	37093	3200	40099	2602	43191	1669	54779	1041	43825
9L-4S		MI	13013	4812	21030	3793	24727	3055	26729	2456	29193	1515	35941	1111	26779
22-#11	2.55	MA	19285	4812	30016	3967	35838	3200	38538	2602	41036	1666	51973	961	42468
10L-3S		MI	13452	4812	21633	3796	25541	3050	27700	2461	30424	1510	37315	1200	26879
22-#11	2.55	MA	18576	4812	29068	3969	34550	3211	36993	2612	38950	1673	49285	903	40856
11L-2S		MI	14046	4812	22434	3798	26557	3054	28915	2456	32022	1505	39410	1291	26935
22-#14	3.68	MA	22925	5364	37782	4293	45586	3440	50357	2756	56962	1627	73500	919	63918
7L-6S		MI	13071	5364	22599	4124	26623	3293	28873	2585	32000	1443	39898	719	35258
22-#14	3.68	MA	22008	5364	36405	4295	43772	3441	48090	2754	53925	1637	69597	841	61517
8L-5S		MI	13600	5364	23378	4128	27660	3285	30101	2593	33574	1436	41818	808	36267
22-#14	3.68	MA	21095	5364	34884	4312	41902	3456	45860	2768	50918	1647	65730	756	59132
9L-4S		MI	14151	5364	24252	4118	28709	3293	31346	2585	35267	1443	43876	870	36963
22-#14	3.68	MA	20150	5364	33513	4314	40100	3456	43619	2766	47826	1642	61733	641	56618
10L-3S		MI	14755	5364	25113	4122	29870	3285	32719	2593	37006	1436	45815	996	37850
24-#11	2.79	MA	22016	4925	34499	4023	41574	3240	45551	2626	50531	1648	64505	1145	50716
7E		MI	12216	4925	20142	3867	23580	3104	25353	2493	27391	1510	33814	898	27551
24-#11	2.79	MA	21356	4925	33540	4024	40310	3241	43972	2625	48415	1656	61770	1090	49581
8L-6S		MI	12588	4925	20674	3870	24283	3109	26195	2488	28482	1505	35211	981	28171
24-#11	2.79	MA	20700	4925	32481	4037	39007	3252	42418	2635	46319	1663	59055	1031	48152
9L-5S		MI	12969	4925	21219	3872	25008	3103	27063	2493	29595	1499	36575	1043	28479
24-#11	2.79	MA	20024	4925	31525	4038	37752	3252	40857	2635	44165	1661	56250	951	46777
10L-4S		MI	13365	4925	21831	3864	25743	3107	27944	2488	30792	1505	38036	1086	29088
24-#11	2.79	MA	19322	4925	30577	4040	36464	3263	39313	2645	42079	1668	53562	893	45187
11L-3S		MI	13800	4925	22434	3867	26557	3101	28915	2493	32022	1499	39410	1175	29228
24-#11	2.79	MA	18630	4925	29634	4042	35212	3264	37761	2644	39942	1665	50868	836	43491
12L-2S		MI	14390	4925	23234	3869	27572	3106	30130	2488	33621	1494	41505	1266	29295
24-#14	4.02	MA	23018	5527	38568	4397	46514	3516	51413	2802	58408	1629	75691	825	67706
8L-6S		MI	13563	5527	23739	4226	28069	3367	30591	2630	34260	1426	42849	679	38444
24-#14	4.02	MA	22117	5527	37047	4414	44644	3531	49182	2815	55401	1639	71825	741	65298
9L-5S		MI	14087	5527	24519	4231	29106	3360	31818	2637	35834	1419	44769	769	39519
24-#14	4.02	MA	21177	5527	35675	4417	42843	3531	46942	2814	52309	1634	67828	625	62816
10L-4S		MI	14632	5527	25392	4220	30155	3367	33064	2630	37527	1426	46826	831	40183

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

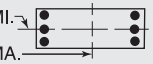
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.04	MA	8441	2727	12314	2249	14335	1830	15168	1520	15658	1065	18733	989	8250
2L-3S		MI	7757	2727	11443	2247	13230	1827	13834	1525	13902	1071	16422	898	8272
6-#14	1.50	MA	8941	2877	13484	2332	15762	1891	16830	1553	17828	1043	21547	946	11629
2L-3S		MI	7984	2877	12242	2329	14187	1885	14939	1560	15341	1051	18284	814	11599
6-#18	2.67	MA	10102	3259	16340	2549	19244	2045	20860	1634	23103	983	28331	823	19880
2L-3S		MI	8505	3259	14182	2541	16517	2032	17622	1647	18842	996	22780	590	19518
8-#11	1.39	MA	8846	2840	13185	2319	15440	1882	16503	1553	17414	1056	21045	967	10857
2L-4S		MI	7675	2840	11660	2316	13451	1885	14102	1553	14264	1056	17220	785	10770
8-#14	2.00	MA	9498	3041	14727	2434	17338	1965	18720	1599	20315	1029	24810	910	15320
2L-4S		MI	7865	3041	12549	2428	14500	1968	15319	1599	15914	1044	19407	651	14534
8-#18	3.56	MA	11004	3550	18498	2731	21970	2178	24098	1712	27363	952	33882	751	26226
2L-4S		MI	8298	3550	14710	2714	17053	2178	18272	1712	19824	978	24679	296	22653
10-#11	1.73	MA	9244	2954	14057	2390	16546	1934	17838	1585	19170	1047	23357	944	13449
2L-5S		MI	7643	2954	11868	2395	13760	1934	14469	1590	14748	1052	17919	721	12622
10-#11	1.73	MA	8578	2954	13185	2389	15440	1931	16503	1590	17414	1052	21045	853	13419
3L-4S		MI	8089	2954	12531	2387	14557	1937	15437	1585	16020	1047	19531	763	13307
10-#14	2.50	MA	10041	3205	15969	2536	18914	2040	20610	1645	22802	1014	28073	875	18991
2L-5S		MI	7818	3205	12843	2542	14937	2037	15839	1652	16539	1021	20395	554	17025
10-#14	2.50	MA	9117	3205	14727	2533	17338	2034	18720	1652	20315	1021	24810	744	18865
3L-4S		MI	8437	3205	13792	2530	16076	2043	17209	1645	18401	1029	22670	616	17965
10-#18	4.44	MA	11880	3841	20655	2913	24697	2310	27336	1789	31624	921	39433	679	32549
2L-5S		MI	8266	3841	15211	2914	17802	2297	19163	1803	20894	934	26359	113	25804
10-#18	4.44	MA	10395	3841	18498	2905	21970	2297	24098	1803	27363	934	33882	445	31520
3L-4S		MI	9242	3841	16867	2896	19780	2310	21510	1789	24085	947	30230	223	28653

RECTANGULAR TIED COLUMNS 30" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.67	MA	10358	3127	15819	2517	18499	2038	19781	1666	21106	1101	25561	987	14573
2E		MI	9653	3127	14840	2501	17255	2023	18365	1649	19530	1086	23559	965	13536
6-#14	1.41	MA	10101	3037	15053	2481	17649	2013	18893	1661	19970	1129	24164	1033	12540
2L-3S		MI	8464	3037	12892	2464	14922	1996	15683	1655	16032	1123	19068	884	11648
6-#14	1.41	MA	9061	3037	13708	2479	15944	2008	16830	1668	17256	1136	20588	902	12510
3L-2S		MI	9424	3037	14135	2467	16498	2002	17574	1647	18519	1116	22331	1016	11663
6-#18	2.50	MA	11386	3418	18158	2699	21466	2171	23325	1746	25769	1073	31667	921	21500
2L-3S		MI	8986	3418	14840	2675	17255	2142	18365	1740	19530	1068	23559	659	19621
6-#18	2.50	MA	9646	3418	15819	2692	18499	2159	19781	1759	21106	1087	25561	688	21138
3L-2S		MI	10592	3418	16998	2683	19981	2155	21603	1727	23791	1055	29110	893	19932
8-#11	1.30	MA	9995	3000	14726	2469	17296	2005	18500	1658	19506	1141	23594	1053	11699
2L-4S		MI	8154	3000	12306	2452	14186	1997	14846	1648	14957	1129	18006	856	10828
8-#11	1.30	MA	9262	3000	13784	2467	16101	2002	17052	1664	17593	1146	21065	962	11694
3E		MI	8652	3000	12961	2453	15070	1990	15913	1653	16351	1134	19520	946	10890
8-#11	1.30	MA	8725	3000	13078	2466	15147	2010	15897	1659	16074	1141	19410	871	11613
4L-2S		MI	9329	3000	13832	2455	16175	1994	17247	1648	18106	1129	21832	1037	10887
8-#14	1.88	MA	10713	3200	16398	2583	19354	2088	20956	1708	22684	1116	27739	1001	16535
2L-4S		MI	8344	3200	13200	2563	15236	2079	16063	1693	16605	1116	20191	721	14744
8-#14	1.88	MA	9691	3200	15053	2581	17649	2083	18893	1716	19970	1123	24164	870	16453
3E		MI	9040	3200	14135	2566	16498	2070	17574	1700	18519	1109	22331	849	15294
8-#14	1.88	MA	8940	3200	14044	2579	16286	2093	17245	1708	17816	1116	21823	740	15853
4L-2S		MI	9984	3200	15377	2569	18074	2077	19464	1693	21006	1101	25594	981	15359
8-#18	3.33	MA	12379	3709	20497	2880	24433	2304	26869	1826	30433	1046	37772	855	28386
2L-4S		MI	8776	3709	15368	2848	17791	2288	19015	1805	20512	1050	25458	365	22931
8-#18	3.33	MA	10682	3709	18158	2874	21466	2292	23325	1840	25769	1059	31667	622	27895
3E		MI	9933	3709	16998	2856	19981	2274	21603	1818	23791	1037	29110	587	25849
8-#18	3.33	MA	9434	3709	16396	2867	19087	2306	20493	1826	22180	1072	27659	396	24731
4L-2S		MI	11500	3709	19155	2865	22708	2288	24841	1805	28052	1024	34661	820	26285

RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

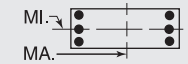
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.63	MA	10431	3113	15668	2539	18491	2057	19948	1691	21420	1133	26123	1033	14502
2L-5S		MI	8121	3113	12514	2531	14495	2045	15213	1685	15441	1125	18706	791	12765
10-#11	1.63	MA	9708	3113	14726	2538	17296	2054	18500	1697	19506	1138	23594	941	14472
3L-4S		MI	8568	3113	13178	2522	15291	2049	16181	1680	16712	1120	20318	833	13370
10-#11	1.63	MA	9178	3113	14020	2537	16342	2061	17345	1692	17987	1133	21939	850	14360
4L-3S		MI	9060	3113	13832	2524	16175	2042	17247	1685	18106	1125	21832	923	13462
10-#11	1.63	MA	8696	3113	13305	2546	15484	2059	16298	1698	16602	1138	20178	808	13694
5L-2S		MI	9728	3113	14704	2526	17280	2046	18582	1680	19862	1120	24143	1015	13484
10-#14	2.34	MA	11310	3364	17742	2686	21060	2163	23019	1755	25398	1103	31315	970	20510
2L-5S		MI	8295	3364	13494	2677	15673	2148	16583	1746	17230	1094	21179	624	17207
10-#14	2.34	MA	10305	3364	16398	2683	19354	2158	20956	1763	22684	1110	27739	838	20384
3L-4S		MI	8918	3364	14442	2665	16811	2154	17953	1739	19092	1101	23454	686	18169
10-#14	2.34	MA	9568	3364	15389	2681	17992	2168	19308	1755	20530	1103	25399	708	19573
4L-3S		MI	9602	3364	15377	2668	18074	2145	19464	1746	21006	1094	25594	814	18928
10-#14	2.34	MA	8897	3364	14365	2694	16763	2163	17812	1763	18564	1110	22905	647	18490
5L-2S		MI	10531	3364	16619	2671	19649	2151	21354	1739	23493	1086	28857	945	19035
10-#18	4.17	MA	13346	4000	22837	3062	27400	2437	30414	1907	35096	1018	43878	790	35249
2L-5S		MI	8696	4000	15869	3048	18539	2406	19906	1896	21582	1006	27137	182	26227
10-#18	4.17	MA	11688	4000	20497	3056	24433	2425	26869	1920	30433	1031	37772	556	34603
3L-4S		MI	9724	4000	17525	3030	20517	2420	22253	1883	24773	1019	31009	293	28924
10-#18	4.17	MA	10471	4000	18735	3049	22054	2439	24037	1907	26844	1044	33765	330	31251
4L-3S		MI	10853	4000	19155	3038	22708	2406	24841	1896	28052	1006	34661	514	31891
10-#18	4.17	MA	9365	4000	16946	3069	19907	2428	21468	1920	23352	1031	29507	221	28332
5L-2S		MI	12385	4000	21313	3047	25435	2420	28079	1883	32312	993	40212	748	32614
12-#11	1.95	MA	10859	3226	16611	2610	19686	2109	21396	1724	23333	1124	28652	1012	17294
2L-6S		MI	8109	3226	12795	2600	14813	2104	15595	1713	15974	1121	19405	692	14788
12-#11	1.95	MA	10145	3226	15668	2609	18491	2106	19948	1730	21420	1130	26123	921	17242
3L-5S		MI	8533	3226	13386	2602	15600	2097	16548	1718	17197	1116	21018	768	15220
12-#11	1.95	MA	9622	3226	14963	2608	17537	2113	18793	1725	19901	1124	24468	830	17103
4E		MI	8975	3226	14049	2593	16397	2101	17516	1713	18468	1111	22630	811	15907
12-#11	1.95	MA	9147	3226	14247	2617	16679	2110	17745	1731	18515	1130	22707	788	16354
5L-3S		MI	9461	3226	14704	2595	17280	2094	18582	1718	19862	1116	24143	901	16026
12-#11	1.95	MA	8690	3226	13610	2616	15831	2118	16713	1726	17183	1135	20942	712	15867
6L-2S		MI	10121	3226	15575	2597	18385	2098	19917	1713	21618	1111	26455	992	16067
12-#14	2.81	MA	11895	3527	19087	2788	22765	2238	25082	1802	28112	1090	34891	938	24473
2L-6S		MI	8279	3527	13891	2776	16123	2231	17123	1785	17986	1087	22317	500	19417
12-#14	2.81	MA	10905	3527	17742	2786	21060	2233	23019	1810	25398	1097	31315	806	24308
3L-5S		MI	8867	3527	14736	2779	17249	2223	18473	1792	19717	1079	24442	589	20715
12-#14	2.81	MA	10181	3527	16733	2783	19697	2243	21371	1802	23244	1090	28975	676	23317
4E		MI	9479	3527	15685	2767	18387	2229	19844	1785	21579	1087	26717	650	21618
12-#14	2.81	MA	9522	3527	15710	2796	18469	2238	19875	1810	21278	1097	26481	615	22297
5L-3S		MI	10152	3527	16619	2770	19649	2220	21354	1792	23493	1079	28857	779	22553
12-#14	2.81	MA	8890	3527	14799	2793	17255	2248	18402	1802	19388	1104	23987	505	20887
6L-2S		MI	11067	3527	17862	2774	21225	2226	23244	1785	25980	1072	32120	910	22698
12-#18	5.00	MA	12702	4291	22837	3237	27400	2558	30414	2000	35096	1004	43878	491	40946
3L-5S		MI	9694	4291	18027	3230	21266	2539	23144	1974	25842	975	32689	110	32115
12-#18	5.00	MA	11535	4291	21074	3231	25020	2572	27581	1987	31507	1017	39870	264	37807
4E		MI	10691	4291	19683	3212	23244	2552	25491	1960	29033	988	36560	220	34952
12-#18	5.00	MA	10462	4291	19285	3251	22873	2561	25012	2000	28016	1004	35612	155	34751
5L-3S		MI	11774	4291	21313	3220	25435	2539	28079	1974	32312	975	40212	442	37716
14-#11	2.27	MA	11280	3340	17553	2681	20881	2161	22844	1757	25247	1116	31181	992	20078
2L-7S		MI	8110	3340	13090	2669	15157	2152	16004	1750	16489	1106	20287	599	16419
14-#11	2.27	MA	10574	3340	16611	2680	19686	2158	21396	1763	23333	1121	28652	901	20007
3L-6S		MI	8520	3340	13666	2671	15918	2156	16930	1745	17730	1112	21717	670	17193

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.27	MA	10058	3340	15905	2679	18733	2165	20241	1758	21815	1116	26997	810	19844
4L-5S		MI	8939	3340	14257	2673	16705	2149	17883	1750	18953	1106	23329	746	17685
14-#11	2.27	MA	9589	3340	15189	2688	17874	2162	19193	1764	20429	1121	25236	767	19024
5L-4S		MI	9375	3340	14921	2664	17502	2153	18851	1745	20224	1101	24941	788	18419
14-#11	2.27	MA	9139	3340	14553	2687	17026	2170	18161	1759	19096	1127	23471	691	18492
6L-3S		MI	9854	3340	15575	2666	18385	2146	19917	1750	21618	1106	26455	878	18584
14-#11	2.27	MA	8698	3340	13932	2686	16206	2167	17160	1765	17744	1121	21908	620	17627
7L-2S		MI	10507	3340	16446	2668	19491	2150	21252	1745	23374	1101	28766	969	18644
14-#14	3.28	MA	11494	3691	19087	2888	22765	2308	25082	1857	28112	1084	34891	774	28228
3L-6S		MI	8848	3691	15133	2878	17699	2306	19013	1831	20473	1072	25579	464	22866
14-#14	3.28	MA	10781	3691	18078	2885	21402	2317	23434	1850	25958	1076	32550	644	27080
4L-5S		MI	9427	3691	15979	2881	18824	2297	20364	1838	22204	1064	27705	554	24236
14-#14	3.28	MA	10134	3691	17055	2898	20174	2312	21938	1857	23992	1084	30057	583	26115
5L-4S		MI	10029	3691	16927	2869	19963	2304	21734	1831	24066	1072	29980	615	25087
14-#14	3.28	MA	9512	3691	16144	2896	18961	2322	20465	1850	22102	1091	27562	473	24635
6L-3S		MI	10692	3691	17862	2873	21225	2295	23244	1838	25980	1064	32120	743	26173
14-#14	3.28	MA	8903	3691	15256	2893	17787	2317	19035	1857	20185	1084	25352	371	23196
7L-2S		MI	11594	3691	19104	2876	22801	2301	25135	1831	28467	1057	35383	875	26353
14-#18	5.83	MA	12513	4581	23413	3412	27987	2705	31126	2067	36170	989	45975	199	44393
4L-5S		MI	10619	4581	20184	3411	23993	2671	26382	2051	30103	944	38240	37	38037
14-#18	5.83	MA	11473	4581	21625	3432	25840	2694	28556	2081	32679	976	41718	89	41202
5L-4S		MI	11585	4581	21840	3393	25971	2684	28729	2038	33294	957	42111	148	41009
16-#11	2.60	MA	10997	3453	17553	2751	20881	2210	22844	1795	25247	1113	31181	880	22768
3L-7S		MI	8519	3453	13962	2740	16262	2204	17339	1783	18245	1097	22598	577	18865
16-#11	2.60	MA	10487	3453	16847	2750	19928	2217	21689	1791	23728	1108	29525	789	22488
4L-6S		MI	8924	3453	14538	2742	17023	2208	18264	1778	19486	1102	24028	647	19609
16-#11	2.60	MA	10024	3453	16132	2759	19069	2214	20641	1796	22342	1113	27764	747	21702
5E		MI	9338	3453	15129	2744	17810	2201	19218	1783	20709	1097	25641	723	20157
16-#11	2.60	MA	9580	3453	15495	2758	18221	2222	19609	1792	21010	1118	26000	671	21114
6L-4S		MI	9769	3453	15792	2735	18607	2205	20185	1778	21980	1092	27253	766	20853
16-#11	2.60	MA	9145	3453	14875	2757	17401	2219	18608	1797	19658	1113	24437	600	20281
7L-3S		MI	10242	3453	16446	2737	19491	2198	21252	1783	23374	1097	28766	856	21137
16-#11	2.60	MA	8715	3453	14264	2756	16597	2216	17604	1793	18354	1118	22794	550	19375
8L-2S		MI	10888	3453	17318	2739	20596	2201	22586	1778	25130	1092	31078	947	21214
16-#14	3.75	MA	11371	3854	19423	2988	23108	2392	25497	1897	28672	1063	36126	612	30860
4L-6S		MI	9407	3854	16376	2980	19275	2381	20904	1876	22960	1057	28842	429	26328
16-#14	3.75	MA	10734	3854	18399	3000	21880	2387	24002	1904	26706	1071	33633	551	29943
5E		MI	9977	3854	17221	2983	20400	2372	22254	1884	24691	1050	30968	518	27765
16-#14	3.75	MA	10122	3854	17488	2998	20666	2397	22528	1897	24816	1078	31138	441	28396
6L-4S		MI	10570	3854	18170	2972	21539	2378	23624	1876	26553	1057	33243	580	28572
16-#14	3.75	MA	9523	3854	16600	2996	19493	2392	21098	1904	22899	1071	28927	339	26912
7L-3S		MI	11223	3854	19104	2975	22801	2370	25135	1884	28467	1050	35383	708	29790
16-#18	6.67	MA	12458	4872	23964	3614	28807	2827	32101	2161	37342	948	47823	24	47682
5E		MI	11519	4872	22342	3593	26719	2803	29620	2129	34364	913	43791	-35	43531
18-#11	2.92	MA	10910	3567	17790	2821	21123	2269	23137	1824	25642	1100	32054	769	25136
4L-7S		MI	8922	3567	14833	2811	17368	2256	18674	1815	20001	1088	24910	554	21317
18-#11	2.92	MA	10452	3567	17074	2830	20264	2266	22089	1829	24256	1105	30293	726	24387
5L-6S		MI	9322	3567	15409	2813	18129	2260	19599	1810	21242	1093	26340	625	22033
18-#11	2.92	MA	10014	3567	16437	2829	19416	2273	21057	1825	22923	1110	28529	651	23744
6L-5S		MI	9731	3567	16000	2815	18916	2253	20552	1815	22465	1088	27952	701	22636
18-#11	2.92	MA	9584	3567	15817	2828	18596	2271	20055	1830	21571	1105	26966	579	22941
7L-4S		MI	10156	3567	16664	2806	19712	2256	21520	1810	23736	1083	29564	743	23297
18-#11	2.92	MA	9160	3567	15206	2826	17792	2268	19052	1826	20267	1110	25323	530	22004
8L-3S		MI	10625	3567	17318	2808	20596	2250	22586	1815	25130	1088	31078	833	23687
18-#14	4.22	MA	11324	4018	19744	3102	23585	2462	26065	1951	29420	1058	37209	519	33722
5L-6S		MI	9957	4018	17618	3082	20850	2456	22794	1922	25446	1042	32105	394	29802
18-#14	4.22	MA	10721	4018	18833	3100	22371	2472	24591	1944	27530	1065	34714	410	32168
6L-5S		MI	10518	4018	18463	3086	21976	2447	24144	1930	27178	1035	34230	483	31182

RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	4.22	MA	10132	4018	17945	3098	21198	2467	23161	1951	25613	1058	32503	307	30588
7L-4S		MI	11103	4018	19412	3074	23114	2453	25514	1922	29040	1042	36506	545	32069
20-#11	3.25	MA	10875	3680	18016	2901	21459	2318	23537	1862	26169	1097	32822	706	27076
5L-7S		MI	9319	3680	15704	2882	18473	2308	20009	1848	21757	1079	27221	531	23776
20-#11	3.25	MA	10441	3680	17380	2900	20611	2325	22505	1857	24837	1102	31058	630	26382
6E		MI	9715	3680	16280	2884	19234	2311	20934	1843	22998	1084	28651	602	24466
20-#11	3.25	MA	10017	3680	16759	2898	19791	2322	21503	1863	23485	1097	29495	559	25606
7L-5S		MI	10118	3680	16871	2885	20021	2305	21887	1848	24220	1079	30264	678	25119
20-#11	3.25	MA	9598	3680	16149	2897	18987	2320	20500	1858	22181	1102	27852	509	24639
8L-4S		MI	10539	3680	17535	2877	20817	2308	22855	1843	25492	1073	31876	720	25749
20-#14	4.69	MA	11312	4182	20178	3202	24077	2547	26654	1991	30244	1052	38290	378	35950
6E		MI	10498	4182	18861	3185	22426	2531	24684	1968	27933	1028	35368	359	33286
20-#14	4.69	MA	10730	4182	19290	3200	22903	2542	25224	1999	28327	1045	36079	275	34329
7L-5S		MI	11051	4182	19706	3188	23551	2522	26035	1976	29665	1020	37493	448	34611
22-#11	3.57	MA	10864	3793	18322	2970	21806	2377	23953	1890	26750	1094	33586	610	29028
6L-7S		MI	9711	3793	16576	2953	19578	2360	21343	1880	23513	1069	29533	509	26240
22-#11	3.57	MA	10444	3793	17702	2969	20986	2374	22951	1896	25398	1089	32024	538	28277
7L-6S		MI	10102	3793	17152	2955	20339	2363	22269	1875	24754	1074	30963	579	26905
22-#11	3.57	MA	10030	3793	17091	2968	20182	2371	21948	1891	24095	1094	30381	489	27255
8L-5S		MI	10501	3793	17743	2956	21126	2357	23222	1880	25976	1069	32575	656	27608
22-#14	5.16	MA	11321	4345	20634	3302	24609	2617	27287	2046	31041	1032	39655	243	38079
7L-6S		MI	11032	4345	20103	3287	24002	2606	26574	2014	30420	1013	38631	323	36779
24-#11	3.90	MA	10866	3907	18644	3040	22181	2426	24399	1929	27312	1081	34553	518	30953
7E		MI	10098	3907	17447	3024	20683	2411	22678	1913	25269	1060	31844	486	28687
24-#11	3.90	MA	10456	3907	18033	3039	21377	2423	23396	1924	26008	1086	32909	469	29903
8L-6S		MI	10485	3907	18023	3025	21444	2415	23603	1908	26510	1065	33274	557	29351

RECTANGULAR TIED COLUMNS 30" x 34"

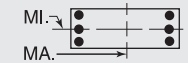
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.57	MA	11613	3287	17530	2666	20556	2160	22040	1774	23467	1187	28457	1076	15653
2E		MI	10137	3287	15498	2635	17992	2133	19108	1743	20218	1158	24337	1035	13577
6-#14	1.32	MA	11326	3196	16697	2630	19630	2136	21017	1766	22209	1213	26893	1120	13451
2L-3S		MI	8943	3196	13543	2599	15658	2107	16427	1749	16723	1196	19852	955	11694
6-#14	1.32	MA	10203	3196	15250	2629	17795	2132	18794	1774	19268	1221	23004	988	13422
3L-2S		MI	9906	3196	14785	2602	17234	2113	18317	1742	19210	1188	23115	1086	11696
6-#18	2.35	MA	12736	3577	20051	2848	23754	2293	25891	1857	28534	1162	35118	1016	23120
2L-3S		MI	9467	3577	15498	2808	17992	2252	19108	1834	20218	1140	24337	729	19717
6-#18	2.35	MA	10852	3577	17530	2843	20556	2283	22040	1870	23467	1176	28457	783	22758
3L-2S		MI	11080	3577	17656	2817	20719	2265	22346	1821	24479	1127	29888	962	19983
8-#11	1.22	MA	11207	3159	16341	2618	19245	2128	20580	1763	21695	1225	26256	1138	12541
2L-4S		MI	8632	3159	12953	2587	14921	2109	15591	1742	15649	1202	18793	926	10881
8-#11	1.22	MA	10417	3159	15328	2617	17960	2126	19023	1769	19624	1230	23510	1047	12536
3E		MI	9132	3159	13607	2589	15804	2102	16657	1748	17043	1207	20307	1017	10927
8-#11	1.22	MA	9839	3159	14571	2616	16937	2134	17783	1765	17980	1225	21708	956	12455
4L-2S		MI	9811	3159	14479	2591	16910	2106	17992	1742	18799	1202	22618	1108	10916
8-#14	1.76	MA	11993	3359	18144	2733	21465	2211	23241	1813	25150	1202	30782	1091	17750
2L-4S		MI	8822	3359	13850	2698	15971	2190	16807	1787	17296	1189	20975	791	14947
8-#14	1.76	MA	10889	3359	16697	2731	19630	2207	21017	1822	22209	1209	26893	959	17668
3E		MI	9522	3359	14785	2701	17234	2181	18317	1795	19210	1181	23115	919	15348
8-#14	1.76	MA	10080	3359	15613	2730	18167	2218	19244	1815	19874	1202	24346	828	17193
4L-2S		MI	10469	3359	16027	2704	18809	2188	20208	1787	21697	1174	26378	1051	15398

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis

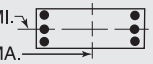


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.14	MA	13821	3868	22572	3030	26951	2426	29742	1940	33601	1138	41779	956	30546
2L-4S		MI	9254	3868	16025	2982	18528	2397	19758	1898	21200	1122	26236	435	23201
8-#18	3.14	MA	11984	3868	20051	3025	23754	2416	25891	1953	28534	1151	35118	723	30055
3E		MI	10419	3868	17656	2990	20719	2384	22346	1912	24479	1109	29888	656	25954
8-#18	3.14	MA	10637	3868	18156	3020	21195	2433	22814	1940	24511	1138	30754	493	26836
4L-2S		MI	11994	3868	19813	2998	23446	2397	25584	1898	28740	1095	35439	890	26342
10-#11	1.53	MA	11682	3272	17354	2689	20530	2180	22137	1795	23767	1218	29003	1120	15555
2L-5S		MI	8598	3272	13161	2667	15229	2157	15958	1780	16133	1198	19493	862	12903
10-#11	1.53	MA	10902	3272	16341	2688	19245	2177	20580	1802	21695	1223	26256	1029	15525
3L-4S		MI	9048	3272	13824	2658	16026	2161	16925	1775	17405	1193	21105	904	13428
10-#11	1.53	MA	10332	3272	15584	2687	18222	2185	19340	1798	20051	1218	24455	937	15413
4L-3S		MI	9542	3272	14479	2660	16910	2154	17992	1780	18799	1198	22618	994	13503
10-#11	1.53	MA	9813	3272	14817	2697	17302	2183	18217	1804	18551	1223	22549	894	14777
5L-2S		MI	10212	3272	15350	2662	18015	2158	19326	1775	20555	1193	24930	1085	13516
10-#14	2.21	MA	12645	3523	19590	2835	23300	2286	25464	1861	28092	1190	34672	1062	22028
2L-5S		MI	8772	3523	14144	2812	16409	2259	17327	1841	17922	1166	21963	694	17381
10-#14	2.21	MA	11558	3523	18144	2833	21465	2282	23241	1869	25150	1198	30782	930	21903
3L-4S		MI	9399	3523	15093	2800	17547	2265	18697	1833	19783	1174	24238	756	18368
10-#14	2.21	MA	10764	3523	17060	2832	20002	2293	21467	1863	22816	1190	28236	799	21203
4L-3S		MI	10086	3523	16027	2803	18809	2256	20208	1841	21697	1166	26378	884	18987
10-#14	2.21	MA	10042	3523	15962	2845	18684	2288	19860	1871	20686	1198	25529	738	19968
5L-2S		MI	11019	3523	17270	2806	20385	2262	22098	1833	24184	1159	29641	1015	19077
10-#18	3.92	MA	14877	4159	25093	3211	30148	2559	33593	2022	38667	1113	48440	897	37949
2L-5S		MI	9170	4159	16527	3182	19277	2516	20649	1989	22270	1078	27916	252	26642
10-#18	3.92	MA	13081	4159	22572	3206	26951	2549	29742	2036	33601	1126	41779	663	37349
3L-4S		MI	10205	4159	18183	3163	21255	2530	22996	1976	25461	1091	31787	362	29187
10-#18	3.92	MA	11768	4159	20677	3201	24393	2566	26665	2022	29578	1113	37415	433	33877
4L-3S		MI	11343	4159	19813	3172	23446	2516	25584	1989	28740	1078	35439	584	32184
10-#18	3.92	MA	10574	4159	18756	3223	22086	2556	23873	2036	25909	1126	32770	324	30908
5L-2S		MI	12885	4159	21971	3180	26172	2530	28822	1976	33000	1064	40990	817	32676
12-#11	1.84	MA	12149	3385	18367	2759	21815	2232	23693	1828	25838	1210	31749	1101	18557
2L-6S		MI	8586	3385	13441	2736	15548	2216	16339	1807	16667	1194	20192	763	14923
12-#11	1.84	MA	11378	3385	17354	2759	20530	2229	22137	1835	23767	1216	29003	1010	18506
3L-5S		MI	9013	3385	14032	2738	16335	2209	17293	1813	17889	1189	21804	839	15356
12-#11	1.84	MA	10815	3385	16597	2758	19507	2237	20897	1831	22123	1210	27202	919	18367
4E		MI	9456	3385	14696	2729	17131	2212	18260	1807	19161	1183	23416	881	15970
12-#11	1.84	MA	10304	3385	15830	2768	18586	2235	19773	1837	20623	1216	25295	876	17640
5L-3S		MI	9944	3385	15350	2731	18015	2206	19326	1813	20555	1189	24930	971	16071
12-#11	1.84	MA	9813	3385	15148	2767	17677	2243	18667	1833	19180	1221	23378	800	17093
6L-2S		MI	10607	3385	16222	2733	19120	2209	20661	1807	22311	1183	27241	1062	16104
12-#14	2.65	MA	13283	3686	21037	2937	25135	2361	27687	1908	31033	1179	38561	1033	26296
2L-6S		MI	8755	3686	14541	2911	16859	2343	17867	1879	18677	1159	23100	570	19690
12-#14	2.65	MA	12213	3686	19590	2935	23300	2356	25464	1916	28092	1186	34672	901	26131
3L-5S		MI	9346	3686	15387	2914	17984	2334	19217	1887	20409	1152	25226	659	20888
12-#14	2.65	MA	11432	3686	18507	2934	21837	2367	23691	1910	25757	1179	32125	770	25237
4E		MI	9962	3686	16335	2902	19123	2340	20588	1879	22270	1159	27501	720	21813
12-#14	2.65	MA	10722	3686	17409	2947	20519	2363	22083	1918	23627	1186	29418	709	24070
5L-3S		MI	10639	3686	17270	2905	20385	2331	22098	1887	24184	1152	29641	849	22617
12-#14	2.65	MA	10042	3686	16432	2946	19217	2374	20499	1912	21579	1193	26704	599	22665
6L-2S		MI	11559	3686	18512	2909	21961	2337	23988	1879	26671	1144	32904	980	22744
12-#18	4.71	MA	14152	4450	25093	3388	30148	2682	33593	2118	38667	1101	48440	603	44594
3L-5S		MI	10173	4450	18685	3363	22004	2649	23887	2067	26531	1047	33467	179	32520
12-#18	4.71	MA	12868	4450	23198	3383	27590	2699	30516	2105	34645	1088	44076	373	40956
4E		MI	11180	4450	20340	3345	23982	2662	26234	2054	29721	1060	37339	290	35209
12-#18	4.71	MA	11703	4450	21277	3405	25283	2689	27724	2118	30975	1101	39431	265	37850
5L-3S		MI	12274	4450	21971	3354	26172	2649	28822	2067	33000	1047	40990	511	38070
14-#11	2.14	MA	12608	3499	19381	2830	23100	2283	25250	1861	27909	1203	34496	1083	21552
2L-7S		MI	8586	3499	13737	2805	15892	2264	16749	1845	17182	1179	21073	670	16622

RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

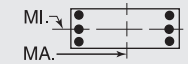
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.14	MA	11845	3499	18367	2830	21815	2281	23693	1868	25838	1208	31749	992	21481
3L-6S		MI	8999	3499	14313	2807	16653	2267	17674	1840	18423	1184	22503	740	17406
14-#11	2.14	MA	11289	3499	17610	2829	20792	2289	22454	1864	24194	1203	29948	900	21319
4L-5S		MI	9420	3499	14904	2809	17440	2261	18627	1845	19645	1179	24116	816	17819
14-#11	2.14	MA	10785	3499	16843	2839	19871	2287	21330	1870	22694	1208	28042	857	20514
5L-4S		MI	9858	3499	15567	2800	18236	2264	19595	1840	20917	1174	25728	859	18509
14-#11	2.14	MA	10301	3499	16161	2838	18962	2295	20224	1866	21251	1213	26125	781	19989
6L-3S		MI	10340	3499	16222	2802	19120	2258	20661	1845	22311	1179	27241	949	18632
14-#11	2.14	MA	9827	3499	15496	2838	18083	2293	19150	1873	19788	1208	24425	710	19063
7L-2S		MI	10996	3499	17093	2803	20225	2261	21996	1840	24067	1174	29553	1040	18683
14-#14	3.09	MA	12855	3850	21037	3038	25135	2431	27687	1964	31033	1174	38561	872	30354
3L-6S		MI	9326	3850	15784	3013	18435	2417	19757	1925	21164	1144	26363	534	23134
14-#14	3.09	MA	12086	3850	19954	3036	23672	2442	25914	1957	28698	1167	36014	741	29291
4L-5S		MI	9909	3850	16629	3016	19560	2409	21108	1932	22895	1137	28489	624	24406
14-#14	3.09	MA	11388	3850	18856	3050	22354	2438	24306	1966	26568	1174	33307	680	28185
5L-4S		MI	10515	3850	17578	3004	20698	2415	22478	1925	24757	1144	30764	685	25278
14-#14	3.09	MA	10719	3850	17879	3048	21052	2449	22722	1959	24520	1182	30594	570	26707
6L-3S		MI	11182	3850	18512	3008	21961	2406	23988	1932	26671	1137	32904	813	26241
14-#14	3.09	MA	10063	3850	16927	3047	19794	2445	21185	1967	22442	1174	28190	467	25261
7L-2S		MI	12089	3850	19755	3011	23536	2412	25879	1925	29158	1129	36167	945	26402
14-#18	5.49	MA	14005	4741	25719	3565	30787	2832	34367	2188	39711	1063	50737	313	48064
4L-5S		MI	11102	4741	20842	3545	24730	2781	27125	2145	30791	1015	39018	107	38433
14-#18	5.49	MA	12880	4741	23798	3586	28481	2822	31576	2201	36042	1077	46092	205	44824
5L-4S		MI	12079	4741	22498	3527	26708	2794	29472	2132	33982	1029	42890	217	41260
16-#11	2.45	MA	12306	3612	19381	2901	23100	2333	25250	1900	27909	1201	34496	973	24453
3L-7S		MI	8997	3612	14608	2876	16997	2316	18083	1878	18938	1170	23385	647	19065
16-#11	2.45	MA	11757	3612	18623	2900	22077	2341	24010	1896	26265	1196	32695	882	24269
4L-6S		MI	9404	3612	15184	2878	17758	2319	19009	1872	20178	1175	24815	718	19830
16-#11	2.45	MA	11258	3612	17856	2910	21156	2339	22887	1903	24765	1201	30788	839	23396
5E		MI	9820	3612	15775	2879	18545	2313	19962	1878	21401	1170	26427	794	20290
16-#11	2.45	MA	10781	3612	17174	2909	20247	2347	21780	1899	23323	1206	28872	763	22869
6L-4S		MI	10253	3612	16439	2871	19342	2316	20930	1872	22673	1165	28039	836	21009
16-#11	2.45	MA	10312	3612	16509	2908	19368	2345	20707	1905	21860	1201	27172	692	21921
7L-3S		MI	10730	3612	17093	2873	20225	2310	21996	1878	24067	1170	29553	926	21188
16-#11	2.45	MA	9850	3612	15855	2908	18507	2342	19631	1902	20448	1206	25392	641	21024
8L-2S		MI	11379	3612	17965	2874	21330	2313	23331	1872	25823	1165	31864	1017	21256
16-#14	3.53	MA	12728	4014	21401	3138	25507	2517	28137	2005	31640	1155	39904	712	33363
4L-6S		MI	9887	4014	17026	3115	20010	2492	21647	1971	23651	1130	29626	499	26592
16-#14	3.53	MA	12042	4014	20303	3152	24189	2513	26529	2013	29510	1163	37197	651	32309
5E		MI	10461	4014	17871	3118	21136	2483	22998	1978	25382	1122	31751	589	27934
16-#14	3.53	MA	11383	4014	19326	3150	22887	2524	24945	2006	27461	1170	34483	541	30762
6L-4S		MI	11059	4014	18820	3107	22274	2490	24368	1971	27244	1130	34027	650	28759
16-#14	3.53	MA	10738	4014	18374	3149	21629	2520	23408	2015	25383	1163	32079	438	29272
7L-3S		MI	11716	4014	19755	3110	23536	2481	25879	1978	29158	1122	36167	778	29861
16-#18	6.27	MA	13955	5031	26319	3768	31678	2955	35427	2283	41109	1052	52753	145	51826
5E		MI	12007	5031	23000	3727	27457	2913	30363	2223	35052	984	44569	34	44375
18-#11	2.75	MA	12217	3726	19637	2971	23362	2393	25567	1929	28337	1189	35441	864	27153
4L-7S		MI	9401	3726	15480	2947	18102	2368	19418	1910	20694	1161	25696	624	21515
18-#11	2.75	MA	11725	3726	18870	2981	22441	2391	24444	1936	26837	1194	33535	820	26286
5L-6S		MI	9804	3726	16056	2949	18863	2371	20343	1905	21934	1166	27126	695	22251
18-#11	2.75	MA	11253	3726	18187	2980	21532	2399	23337	1932	25394	1199	31618	745	25703
6L-5S		MI	10215	3726	16647	2950	19650	2364	21297	1910	23157	1161	28739	771	22768
18-#11	2.75	MA	10790	3726	17523	2979	20653	2396	22264	1938	23931	1194	29918	673	24786
7L-4S		MI	10643	3726	17310	2942	20447	2368	22264	1905	24429	1156	30351	813	23451

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

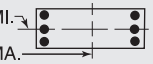
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.75	MA	10334	3726	16868	2979	19792	2394	21188	1934	22520	1199	28139	623	23858
8L-3S		MI	11114	3726	17965	2943	21330	2361	23331	1910	25823	1161	31864	904	23741
18-#14	3.97	MA	12684	4177	21750	3254	26024	2588	28752	2060	32451	1151	41086	622	36442
5L-6S		MI	10439	4177	18269	3217	21586	2567	23538	2017	26138	1115	32889	464	30061
18-#14	3.97	MA	12035	4177	20773	3252	24722	2599	27168	2054	30403	1159	38372	512	34829
6L-5S		MI	11005	4177	19114	3221	22711	2558	24888	2024	27869	1107	35014	553	31469
18-#14	3.97	MA	11400	4177	19821	3251	23464	2595	25631	2062	28325	1151	35968	409	33294
7L-4S		MI	11594	4177	20062	3209	23850	2564	26258	2017	29731	1115	37290	615	32254
20-#11	3.06	MA	12184	3839	19883	3051	23726	2443	26001	1969	28908	1187	36281	802	29181
5L-7S		MI	9800	3839	16351	3018	19207	2419	20753	1943	22450	1151	28008	602	23972
20-#11	3.06	MA	11718	3839	19200	3051	22817	2451	24894	1965	27465	1192	34365	726	28544
6E		MI	10198	3839	16927	3019	19968	2423	21678	1937	23690	1157	29438	672	24681
20-#11	3.06	MA	11261	3839	18536	3050	21938	2448	23821	1971	26002	1187	32665	655	27657
7L-5S		MI	10605	3839	17518	3021	20756	2416	22632	1943	24913	1151	31050	749	25251
20-#11	3.06	MA	10810	3839	17881	3050	21077	2446	22745	1967	24591	1192	30886	604	26698
8L-4S		MI	11028	3839	18182	3013	21552	2420	23599	1937	26185	1146	32662	791	25902
20-#14	4.41	MA	12677	4341	22220	3355	26557	2673	29391	2101	33344	1147	42262	483	38907
6E		MI	10983	4341	19511	3320	23162	2642	25428	2062	28625	1100	36152	429	33541
20-#14	4.41	MA	12051	4341	21268	3353	25299	2669	27854	2110	31266	1140	39858	380	37327
7L-5S		MI	11541	4341	20356	3323	24287	2633	26778	2070	30356	1093	38277	518	34913
22-#11	3.36	MA	12177	3953	20214	3122	24102	2502	26451	1998	29537	1185	37111	708	31393
6L-7S		MI	10194	3953	17223	3089	20313	2471	22088	1975	24206	1142	30320	579	26433
22-#11	3.36	MA	11726	3953	19549	3121	23223	2500	25377	2004	28074	1180	35411	636	30533
7L-6S		MI	10587	3953	17799	3090	21074	2475	23013	1970	25446	1147	31749	650	27118
22-#11	3.36	MA	11280	3953	18894	3120	22362	2498	24302	2000	26662	1185	33632	586	29543
8L-5S		MI	10989	3953	18390	3092	21861	2468	23966	1975	26669	1142	33362	726	27738
22-#14	4.85	MA	12693	4504	22715	3455	27134	2744	30077	2157	34207	1128	43747	351	41321
7L-6S		MI	11519	4504	20753	3422	24737	2717	27318	2108	31112	1085	39415	393	37031
24-#11	3.67	MA	12184	4066	20562	3192	24508	2552	26934	2037	30145	1172	38158	618	33414
7E		MI	10582	4066	18094	3159	21418	2523	23422	2008	25961	1133	32631	557	28900
24-#11	3.67	MA	11743	4066	19908	3191	23647	2550	25859	2033	28734	1177	36379	567	32369
8L-6S		MI	10972	4066	18670	3161	22179	2527	24348	2002	27202	1138	34061	627	29561

RECTANGULAR TIED COLUMNS 30" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.48	MA	12932	3446	19315	2815	22707	2283	24387	1882	25925	1272	31466	1164	16733
2E		MI	10620	3446	16156	2769	18730	2243	19852	1836	20906	1229	25116	1104	13617
6-#14	1.25	MA	12616	3355	18415	2780	21705	2259	23232	1870	24544	1297	29735	1205	14363
2L-3S		MI	9422	3355	14193	2734	16394	2218	17171	1843	17415	1268	20636	1025	11738
6-#14	1.25	MA	11409	3355	16866	2779	19740	2256	20852	1880	21375	1305	25532	1073	14333
3L-2S		MI	10388	3355	15435	2737	17969	2224	19061	1836	19902	1261	23899	1156	11728
6-#18	2.22	MA	14152	3737	22018	2997	26135	2416	28539	1966	31396	1250	38684	1109	24740
2L-3S		MI	9948	3737	16156	2942	18730	2362	19852	1927	20906	1212	25116	798	19806
6-#18	2.22	MA	12124	3737	19315	2993	22707	2408	24387	1980	25925	1264	31466	875	24378
3L-2S		MI	11568	3737	18314	2950	21457	2375	23090	1914	25167	1198	30667	1032	20033
8-#11	1.16	MA	12485	3318	18031	2767	21289	2251	22759	1867	23981	1308	29031	1222	13384
2L-4S		MI	9110	3318	13600	2723	15655	2220	16335	1837	16342	1275	19580	997	10929
8-#11	1.16	MA	11636	3318	16947	2767	19914	2249	21093	1874	21751	1313	26066	1131	13379
3E		MI	9612	3318	14254	2725	16539	2214	17401	1842	17736	1280	21093	1087	10962
8-#11	1.16	MA	11017	3318	16138	2767	18821	2257	19769	1871	19982	1308	24119	1040	13298
4L-2S		MI	10292	3318	15125	2727	17644	2217	18736	1837	19492	1275	23405	1178	10945
8-#14	1.67	MA	13339	3518	19964	2882	23670	2334	25612	1918	27713	1287	33939	1179	18965
2L-4S		MI	9301	3518	14501	2833	16707	2301	17551	1882	17987	1261	21759	861	15145
8-#14	1.67	MA	12152	3518	18415	2881	21705	2330	23232	1927	24544	1294	29735	1047	18883
3E		MI	10003	3518	15435	2836	17969	2293	19061	1889	19902	1254	23899	989	15398

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

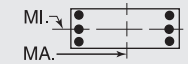
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.67	MA	11285	3518	17257	2880	20141	2342	21337	1921	22029	1287	26978	916	18552
4L-2S		MI	10954	3518	16678	2839	19545	2299	20952	1882	22388	1246	27162	1121	15435
8-#18	2.96	MA	15331	4027	24721	3179	29563	2549	32692	2050	36866	1228	45902	1054	32706
2L-4S		MI	9732	4027	16683	3115	19266	2507	20501	1992	21888	1194	27015	504	23464
8-#18	2.96	MA	13352	4027	22018	3175	26135	2541	28539	2064	31396	1241	38684	821	32215
3E		MI	10904	4027	18314	3124	21457	2494	23090	2005	25167	1181	30667	726	26053
8-#18	2.96	MA	11905	4027	19991	3172	23398	2559	25223	2051	27053	1228	33962	587	28968
4L-2S		MI	12487	4027	20471	3132	24183	2507	26328	1992	29428	1167	36218	959	26398
10-#11	1.44	MA	12999	3431	19115	2838	22664	2302	24424	1900	26210	1302	31996	1206	16608
2L-5S		MI	9076	3431	13807	2803	15964	2269	16702	1875	16826	1271	20279	932	13036
10-#11	1.44	MA	12161	3431	18031	2838	21289	2301	22759	1907	23981	1307	29031	1114	16578
3L-4S		MI	9527	3431	14471	2794	16761	2272	17670	1870	18098	1266	21891	974	13482
10-#11	1.44	MA	11550	3431	17222	2837	20196	2309	21434	1903	22212	1302	27084	1023	16466
4L-3S		MI	10023	3431	15125	2796	17644	2266	18736	1875	19492	1271	23405	1064	13543
10-#11	1.44	MA	10995	3431	16403	2848	19213	2308	20235	1911	20597	1307	25032	979	15869
5L-2S		MI	10696	3431	15997	2797	18749	2269	20071	1870	21248	1266	25716	1156	13548
10-#14	2.08	MA	14046	3682	21513	2984	25634	2408	27993	1965	30882	1277	38142	1152	23547
2L-5S		MI	9250	3682	14795	2947	17144	2370	18071	1935	18613	1239	22747	764	17549
10-#14	2.08	MA	12877	3682	19964	2983	23670	2405	25612	1974	27713	1284	33939	1021	23422
3L-4S		MI	9879	3682	15743	2935	18283	2376	19441	1928	20474	1246	25022	826	18561
10-#14	2.08	MA	12025	3682	18806	2982	22106	2417	23717	1969	25198	1277	31182	889	22852
4L-3S		MI	10570	3682	16678	2938	19545	2367	20952	1935	22388	1239	27162	954	19043
10-#14	2.08	MA	11252	3682	17634	2996	20698	2414	22000	1978	22903	1284	28265	827	21457
5L-2S		MI	11507	3682	17920	2942	21121	2373	22842	1928	24875	1231	30425	1086	19119
10-#18	3.70	MA	16477	4318	27423	3361	32991	2682	36845	2135	42337	1206	53120	1000	40649
2L-5S		MI	9644	4318	17185	3315	20015	2626	21392	2083	22958	1149	28694	321	27047
10-#18	3.70	MA	14542	4318	24721	3357	29563	2674	32692	2148	36866	1219	45902	766	40049
3L-4S		MI	10687	4318	18841	3297	21993	2640	23739	2069	26149	1163	32566	432	29443
10-#18	3.70	MA	13131	4318	22694	3353	26826	2692	29376	2135	32524	1206	41180	533	36531
4L-3S		MI	11832	4318	20471	3305	24183	2626	26328	2083	29428	1149	36218	653	32291
10-#18	3.70	MA	11849	4318	20640	3376	24360	2684	26367	2149	28562	1219	36147	425	33532
5L-2S		MI	13383	4318	22629	3314	26910	2640	29566	2069	33688	1136	41769	887	32737
12-#11	1.73	MA	13505	3545	20199	2909	24038	2354	26090	1933	28439	1296	34960	1189	19821
2L-6S		MI	9063	3545	14088	2872	16282	2327	17083	1902	17359	1267	20978	833	15051
12-#11	1.73	MA	12676	3545	19115	2908	22664	2353	24424	1940	26210	1301	31996	1098	19770
3L-5S		MI	9492	3545	14679	2873	17069	2321	18037	1907	18582	1261	22591	909	15487
12-#11	1.73	MA	12072	3545	18306	2908	21571	2361	23100	1936	24441	1296	30048	1007	19630
4E		MI	9937	3545	15343	2865	17866	2324	19004	1902	19854	1256	24203	952	16029
12-#11	1.73	MA	11525	3545	17487	2918	20588	2359	21901	1943	22826	1301	27996	962	18937
5L-3S		MI	10427	3545	15997	2867	18749	2317	20071	1907	21248	1261	25716	1042	16114
12-#11	1.73	MA	11000	3545	16759	2918	19618	2368	20720	1940	21274	1306	25927	887	18326
6L-2S		MI	11093	3545	16868	2868	19855	2321	21405	1902	23004	1256	28028	1133	16139
12-#14	2.50	MA	14737	3846	23062	3086	27599	2483	30373	2012	34051	1267	42346	1126	28118
2L-6S		MI	9231	3846	15192	3046	17595	2454	18611	1973	19368	1232	23884	640	19956
12-#14	2.50	MA	13586	3846	21513	3085	25634	2480	27993	2022	30882	1274	38142	994	27953
3L-5S		MI	9826	3846	16037	3049	18720	2445	19961	1981	21100	1224	26010	729	21053
12-#14	2.50	MA	12748	3846	20356	3085	24070	2492	26097	2016	28367	1267	35385	863	27177
4E		MI	10445	3846	16986	3037	19858	2451	21331	1973	22961	1232	28285	791	22002
12-#14	2.50	MA	11988	3846	19183	3099	22663	2489	24380	2026	26072	1274	32468	800	25856
5L-3S		MI	11126	3846	17920	3040	21121	2442	22842	1981	24875	1224	30425	919	22678
12-#14	2.50	MA	11258	3846	18140	3098	21273	2500	22689	2020	23865	1281	29535	691	24468
6L-2S		MI	12050	3846	19163	3044	22696	2448	24732	1973	27362	1217	33688	1050	22789
12-#18	4.44	MA	15703	4609	27423	3539	32991	2807	36845	2232	42337	1197	53120	712	47883
3L-5S		MI	10597	4609	19342	3497	22741	2759	24630	2160	27219	1118	34246	249	32917

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis

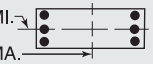


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	4.44	MA	14324	4609	25397	3535	30253	2825	33529	2220	37994	1184	48398	478	44132
4E		MI	11618	4609	20998	3479	24719	2772	26977	2147	30409	1132	38117	359	35459
12-#18	4.44	MA	13073	4609	23342	3558	27788	2817	30520	2233	34032	1197	43365	370	40998
5L-3S		MI	12772	4609	22629	3487	26910	2759	29566	2160	33688	1118	41769	581	38416
12-#18	4.44	MA	11872	4609	21513	3554	25352	2835	27556	2220	30223	1210	38329	176	37703
6L-2S		MI	14256	4609	24786	3496	29637	2772	32804	2147	37949	1105	47320	814	39059
14-#11	2.02	MA	14002	3658	21283	2980	25413	2406	27756	1965	30668	1289	37925	1172	23026
2L-7S		MI	9063	3658	14383	2941	16626	2375	17493	1940	17874	1252	21860	740	16818
14-#11	2.02	MA	13182	3658	20199	2979	24038	2404	26090	1972	28439	1294	34960	1081	22956
3L-6S		MI	9477	3658	14959	2943	17387	2379	18418	1935	19115	1257	23290	811	17533
14-#11	2.02	MA	12586	3658	19390	2979	22946	2413	24766	1969	26670	1289	33013	990	22793
4L-5S		MI	9900	3658	15550	2944	18175	2372	19372	1940	20338	1252	24902	887	17949
14-#11	2.02	MA	12046	3658	18571	2989	21963	2411	23566	1976	25056	1294	30961	946	22014
5L-4S		MI	10341	3658	16214	2936	18971	2376	20339	1935	21610	1247	26514	929	18571
14-#11	2.02	MA	11528	3658	17843	2989	20993	2420	22386	1973	23503	1300	28892	870	21428
6L-3S		MI	10825	3658	16868	2937	19855	2369	21405	1940	23004	1252	28028	1019	18678
14-#11	2.02	MA	11020	3658	17134	2989	20055	2418	21240	1980	21929	1294	27055	799	20514
7L-2S		MI	11483	3658	17740	2939	20960	2373	22740	1935	24760	1247	30339	1110	18720
14-#14	2.92	MA	14281	4009	23062	3188	27599	2555	30373	2069	34051	1264	42346	968	32481
3L-6S		MI	9804	4009	16434	3148	19170	2528	20501	2019	21855	1217	27147	605	23395
14-#14	2.92	MA	13457	4009	21905	3187	26035	2567	28478	2064	31536	1256	39588	837	31524
4L-5S		MI	10390	4009	17279	3151	20296	2520	21851	2027	23587	1209	29272	694	24570
14-#14	2.92	MA	12709	4009	20732	3201	24628	2563	26760	2073	29241	1264	36672	774	30267
5L-4S		MI	11000	4009	18228	3139	21434	2526	23222	2019	25448	1217	31548	755	25464
14-#14	2.92	MA	11991	4009	19689	3200	23238	2575	25069	2067	27034	1271	33738	665	28805
6L-3S		MI	11671	4009	19163	3143	22696	2517	24732	2027	27362	1209	33688	884	26306
14-#14	2.92	MA	11288	4009	18673	3199	21895	2572	23428	2077	24796	1264	31137	562	27365
7L-2S		MI	12583	4009	20405	3146	24272	2523	26623	2019	29849	1202	36951	1015	26450
14-#18	5.19	MA	15567	4900	28100	3717	33681	2958	37681	2304	43465	1162	55616	423	51763
4L-5S		MI	11585	4900	21500	3679	25468	2891	27868	2238	31479	1087	39797	176	38820
14-#18	5.19	MA	14266	4900	26045	3740	31215	2950	34673	2317	39503	1175	50583	316	48495
5L-4S		MI	12572	4900	23156	3661	27446	2904	30215	2225	34670	1100	43668	287	41505
14-#18	5.19	MA	13092	4900	24216	3736	28779	2968	31708	2305	35693	1188	45547	121	45131
6L-3S		MI	13646	4900	24786	3669	29637	2891	32804	2238	37949	1087	47320	508	44272
16-#11	2.31	MA	13680	3771	21283	3050	25413	2456	27756	2005	30668	1288	37925	1064	26138
3L-7S		MI	9475	3771	15255	3012	17732	2427	18828	1972	19630	1243	24171	718	19259
16-#11	2.31	MA	13092	3771	20474	3050	24321	2465	26431	2002	28899	1283	35977	973	25953
4L-6S		MI	9884	3771	15831	3013	18493	2431	19753	1967	20871	1248	25601	788	20020
16-#11	2.31	MA	12558	3771	19656	3060	23338	2463	25232	2009	27285	1288	33925	929	25101
5E		MI	10302	3771	16422	3015	19280	2424	20706	1972	22094	1243	27214	864	20419
16-#11	2.31	MA	12046	3771	18928	3060	22368	2472	24051	2006	25732	1293	31856	853	24536
6L-4S		MI	10738	3771	17085	3007	20076	2428	21674	1967	23366	1238	28826	906	21111
16-#11	2.31	MA	11545	3771	18219	3060	21430	2470	22906	2013	24158	1288	30019	782	23577
7L-3S		MI	11217	3771	17740	3008	20960	2421	22740	1972	24760	1243	30339	997	21237
16-#11	2.31	MA	11050	3771	17520	3060	20511	2468	21758	2010	22639	1293	28104	731	22699
8L-2S		MI	11869	3771	18611	3010	22065	2425	24075	1967	26516	1238	32651	1088	21296
16-#14	3.33	MA	14152	4173	23454	3289	28000	2641	30858	2111	34705	1246	43792	810	35887
4L-6S		MI	10367	4173	17677	3250	20746	2603	22391	2065	24342	1202	30410	569	26848
16-#14	3.33	MA	13416	4173	22281	3303	26592	2638	29141	2120	32410	1253	40875	748	34688
5E		MI	10945	4173	18522	3253	21871	2594	23742	2073	26074	1195	32535	659	28097
16-#14	3.33	MA	12710	4173	21238	3302	25203	2650	27449	2115	30203	1261	37942	638	33156
6L-4S		MI	11546	4173	19470	3242	23010	2601	25112	2065	27935	1202	34811	720	28942
16-#14	3.33	MA	12018	4173	20222	3301	23859	2647	25809	2124	27965	1253	35340	536	31671
7L-3S		MI	12208	4173	20405	3245	24272	2592	26623	2073	29849	1195	36951	848	29930
16-#14	3.33	MA	11334	4173	19222	3301	22542	2644	24165	2119	25805	1261	32618	463	29856
8L-2S		MI	13109	4173	21648	3248	25848	2598	28513	2065	32336	1187	40213	980	30103
16-#18	5.93	MA	15521	5190	28748	3921	34643	3083	38826	2402	44973	1153	57801	261	56021
5E		MI	12494	5190	23657	3860	28195	3023	31106	2316	35740	1056	45348	104	44754

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

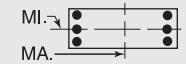
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	5.93	MA	14380	5190	26919	3918	32207	3101	35861	2389	41164	1166	52765	66	52585
6L-4S		MI	13455	5190	25313	3842	30173	3036	33453	2303	38931	1069	49219	214	47575
18-#11	2.60	MA	13590	3885	21558	3121	25695	2517	28097	2035	31129	1277	38942	956	29113
4L-7S		MI	9880	3885	16126	3083	18837	2479	20162	2005	21386	1234	26483	695	21707
18-#11	2.60	MA	13063	3885	20740	3131	24713	2515	26898	2042	29514	1282	36890	912	28195
5L-6S		MI	10285	3885	16702	3084	19598	2483	21088	2000	22627	1239	27913	766	22464
18-#11	2.60	MA	12557	3885	20012	3131	23742	2524	25717	2039	27962	1287	34821	837	27649
6L-5S		MI	10699	3885	17293	3086	20385	2476	22041	2005	23850	1234	29525	842	22895
18-#11	2.60	MA	12062	3885	19303	3131	22805	2522	24572	2046	26387	1282	32984	765	26647
7L-4S		MI	11130	3885	17957	3077	21181	2480	23009	2000	25122	1228	31137	884	23602
18-#11	2.60	MA	11573	3885	18605	3131	21886	2520	23424	2043	24868	1287	31068	714	25737
8L-3S		MI	11603	3885	18611	3079	22065	2473	24075	2005	26516	1234	32651	974	23793
18-#11	2.60	MA	11087	3885	17834	3141	20939	2529	22294	2050	23364	1292	29192	655	24678
9L-2S		MI	12249	3885	19483	3081	23170	2477	25410	2000	28272	1228	34962	1065	23866
18-#14	3.75	MA	14111	4336	23830	3405	28557	2713	31521	2168	35579	1243	45079	721	39119
5L-6S		MI	10921	4336	18919	3352	22322	2678	24282	2111	26829	1187	33673	534	30314
18-#14	3.75	MA	13416	4336	22787	3404	27167	2725	29829	2162	33372	1251	42145	612	37518
6L-5S		MI	11491	4336	19764	3356	23447	2669	25632	2118	28561	1180	35798	623	31631
18-#14	3.75	MA	12734	4336	21772	3404	25824	2722	28189	2172	31134	1243	39543	509	35989
7L-4S		MI	12084	4336	20713	3344	24586	2675	27002	2111	30422	1187	38074	685	32434
18-#14	3.75	MA	12061	4336	20771	3403	24507	2718	26545	2166	28974	1251	36821	436	34224
8L-3S		MI	12737	4336	21648	3347	25848	2667	28513	2118	32336	1180	40213	813	33550
18-#18	6.67	MA	15550	5481	29622	4100	35635	3234	40014	2473	46634	1144	59983	12	59923
6L-5S		MI	13384	5481	25815	4042	30921	3155	34344	2394	40001	1025	50899	31	50715
20-#11	2.89	MA	13560	3998	21824	3202	26088	2567	28564	2075	31743	1275	39854	895	31295
5L-7S		MI	10281	3998	16998	3153	19942	2531	21497	2037	23142	1224	28795	672	24161
20-#11	2.89	MA	13060	3998	21096	3202	25117	2576	27383	2072	30191	1281	37785	820	30729
6E		MI	10681	3998	17574	3155	20703	2535	22422	2032	24383	1230	30224	743	24890
20-#11	2.89	MA	12571	3998	20387	3202	24180	2574	26237	2079	28616	1275	35948	749	29723
7L-5S		MI	11090	3998	18165	3157	21490	2528	23376	2037	25606	1224	31837	819	25378
20-#11	2.89	MA	12088	3998	19689	3201	23261	2572	25089	2075	27097	1281	34033	697	28782
8L-4S		MI	11516	3998	18828	3148	22287	2532	24343	2032	26878	1219	33449	861	26050
20-#11	2.89	MA	11608	3998	18918	3212	22313	2581	23960	2082	25593	1286	32157	638	27749
9L-3S		MI	11985	3998	19483	3150	23170	2525	25410	2037	28272	1224	34962	951	26345
20-#14	4.17	MA	14110	4500	24337	3507	29132	2800	32210	2210	36541	1240	46348	586	41890
6E		MI	11467	4500	20161	3455	23897	2753	26172	2157	29316	1173	36936	499	33790
20-#14	4.17	MA	13439	4500	23321	3506	27789	2796	30569	2219	34303	1233	43747	483	40318
7L-5S		MI	12029	4500	21007	3458	25023	2744	27522	2164	31048	1165	39061	588	35172
20-#14	4.17	MA	12776	4500	22320	3505	26472	2793	28925	2213	32143	1240	41024	410	38580
8L-4S		MI	12615	4500	21955	3446	26161	2750	28893	2157	32909	1173	41337	649	35937
22-#11	3.18	MA	13557	4112	22180	3273	26492	2627	29048	2104	32420	1274	40750	803	33781
6L-7S		MI	10676	4112	17869	3224	21047	2583	22832	2070	24898	1215	31106	650	26621
22-#11	3.18	MA	13073	4112	21471	3273	25555	2626	27903	2112	30846	1269	38913	732	32805
7L-6S		MI	11072	4112	18445	3226	21808	2587	23757	2065	26139	1220	32536	720	27324
22-#11	3.18	MA	12596	4112	20773	3272	24635	2624	26755	2108	29327	1274	36997	680	31833
8L-5S		MI	11477	4112	19036	3228	22595	2580	24711	2070	27362	1215	34149	796	27865
22-#11	3.18	MA	12121	4112	20002	3283	23688	2633	25626	2115	27822	1279	35121	621	30809
9L-4S		MI	11899	4112	19700	3219	23392	2583	25678	2065	28633	1210	35760	839	28507
22-#14	4.58	MA	14133	4663	24870	3608	29753	2871	32949	2266	37472	1223	47950	457	44656
7L-6S		MI	12006	4663	21404	3557	25473	2828	28062	2203	31803	1158	40199	463	37276
22-#14	4.58	MA	13479	4663	23869	3607	28436	2868	31305	2261	35312	1230	45228	384	42892
8L-5S		MI	12561	4663	22249	3560	26598	2819	29413	2210	33535	1150	42324	553	38641

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

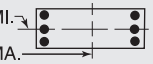
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	3.47	MA	13569	4225	22555	3343	26929	2678	29569	2144	33075	1263	41877	715	35892
7E		MI	11066	4225	18741	3295	22152	2635	24167	2102	26654	1206	33418	627	29086
24-#11	3.47	MA	13097	4225	21857	3343	26010	2676	28421	2141	31556	1268	39962	664	34889
8L-6S		MI	11459	4225	19317	3297	22914	2638	25092	2097	27895	1211	34848	698	29765
24-#11	3.47	MA	12628	4225	21086	3353	25063	2684	27291	2148	30052	1273	38086	605	33846
9L-5S		MI	11859	4225	19908	3299	23701	2632	26045	2102	29118	1206	36460	774	30355
24-#14	5.00	MA	14173	4827	25419	3710	30401	2943	33685	2308	38481	1220	49431	357	47213
8L-6S		MI	12538	4827	22646	3659	27049	2902	29953	2249	34290	1143	43462	428	40771

RECTANGULAR TIED COLUMNS 30" x 38"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.40	MA	14317	3605	21175	2964	24952	2406	26789	1986	28480	1357	34588	1250	17813
2E		MI	11102	3605	16814	2902	19468	2353	20595	1930	21594	1301	25894	1173	13656
6-#14	1.18	MA	13970	3514	20207	2929	23874	2382	25546	1974	26976	1381	32690	1289	15274
2L-3S		MI	9901	3514	14844	2869	17129	2329	17915	1938	18106	1341	21420	1095	11779
6-#14	1.18	MA	12679	3514	18556	2928	21779	2379	23009	1985	23579	1388	28173	1158	15244
3L-2S		MI	10870	3514	16086	2872	18705	2335	19805	1930	20593	1333	24683	1226	11759
6-#18	2.11	MA	15635	3896	24060	3146	28611	2539	31221	2070	34355	1337	42364	1200	26360
2L-3S		MI	10429	3896	16814	3076	19468	2472	20595	2021	21594	1283	25894	867	19889
6-#18	2.11	MA	13460	3896	21175	3144	24952	2532	26789	2086	28480	1351	34588	967	25998
3L-2S		MI	12055	3896	18971	3084	22194	2485	23833	2007	25855	1270	31445	1101	20081
8-#11	1.09	MA	13827	3477	19795	2916	23426	2373	25037	1971	26362	1391	31918	1306	14226
2L-4S		MI	9588	3477	14246	2859	16390	2332	17079	1932	17035	1348	20366	1067	10975
8-#11	1.09	MA	12919	3477	18640	2916	21961	2372	23262	1979	23975	1397	28735	1215	14221
3E		MI	10091	3477	14901	2861	17274	2325	18145	1937	18429	1353	21880	1157	10994
8-#11	1.09	MA	12259	3477	17780	2917	20799	2381	21853	1976	22080	1391	26642	1124	14140
4L-2S		MI	10773	3477	15772	2862	18379	2329	19480	1932	20184	1348	24191	1249	10973
8-#14	1.58	MA	14750	3678	21859	3031	25968	2456	28083	2022	30373	1372	37208	1265	20180
2L-4S		MI	9779	3678	15151	2968	17443	2412	18295	1976	18679	1334	22543	931	15284
8-#14	1.58	MA	13480	3678	20207	3031	23874	2454	25546	2032	26976	1379	32690	1134	20098
3E		MI	10484	3678	16086	2971	18705	2404	19805	1984	20593	1326	24683	1060	15446
8-#14	1.58	MA	12554	3678	18976	3031	22209	2466	23529	2027	24280	1372	29723	1002	19787
4L-2S		MI	11438	3678	17328	2974	20281	2410	21696	1976	23080	1319	27946	1191	15470
8-#18	2.81	MA	16908	4186	26944	3328	32269	2672	35652	2155	40230	1317	50139	1150	34866
2L-4S		MI	10210	4186	17341	3249	20004	2617	21244	2085	22576	1266	27793	573	23721
8-#18	2.81	MA	14785	4186	24060	3326	28611	2665	31221	2170	34355	1331	42364	917	34375
3E		MI	11388	4186	18971	3257	22194	2604	23833	2098	25855	1252	31445	795	26146
8-#18	2.81	MA	13238	4186	21901	3323	25695	2685	27688	2159	29692	1317	37270	683	31125
4L-2S		MI	12979	4186	21129	3266	24921	2617	27071	2085	30116	1239	36996	1029	26453
10-#11	1.37	MA	14381	3590	20950	2987	24891	2425	26811	2004	28749	1386	35101	1291	17661
2L-5S		MI	9554	3590	14454	2938	16699	2380	17446	1970	17519	1344	21066	1002	13165
10-#11	1.37	MA	13484	3590	19795	2987	23426	2424	25037	2012	26362	1391	31918	1199	17631
3L-4S		MI	10007	3590	15118	2930	17495	2384	18414	1965	18791	1338	22678	1045	13533
10-#11	1.37	MA	12832	3590	18935	2987	22264	2433	23628	2009	24468	1386	29824	1108	17519
4L-3S		MI	10504	3590	15772	2931	18379	2377	19480	1970	20184	1344	24191	1135	13580
10-#11	1.37	MA	12241	3590	18064	2998	21219	2432	22353	2017	22739	1391	27627	1063	16972
5L-2S		MI	11179	3590	16643	2933	19484	2381	20815	1965	21940	1338	26503	1226	13578
10-#14	1.97	MA	15512	3841	23510	3133	28062	2531	30621	2069	33769	1363	41726	1241	25066
2L-5S		MI	9727	3841	15445	3082	17880	2481	18815	2029	19304	1311	23531	835	17711
10-#14	1.97	MA	14261	3841	21859	3133	25968	2529	28083	2079	30373	1370	37208	1110	24940
3L-4S		MI	10359	3841	16394	3070	19018	2487	20185	2022	21165	1319	25806	896	18749
10-#14	1.97	MA	13351	3841	20627	3133	24304	2541	26066	2075	27677	1363	34240	978	24521
4L-3S		MI	11053	3841	17328	3073	20281	2478	21696	2029	23080	1311	27946	1024	19096
10-#14	1.97	MA	12526	3841	19380	3147	22807	2539	24240	2085	25217	1370	31114	914	22959
5L-2S		MI	11994	3841	18571	3077	21856	2485	23586	2022	25567	1304	31209	1156	19160
10-#18	3.51	MA	18146	4477	29829	3510	35927	2805	40084	2239	46104	1298	57915	1100	43349
2L-5S		MI	10119	4477	17843	3449	20752	2736	22135	2176	23646	1221	29473	390	27445

RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis



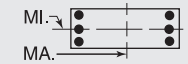
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.51	MA	16070	4477	26944	3507	32269	2798	35652	2254	40230	1311	50139	866	42749
3L-4S		MI	11168	4477	19499	3431	22730	2750	24482	2163	26837	1234	33344	501	29693
10-#18	3.51	MA	14560	4477	24786	3505	29353	2818	32119	2243	35567	1298	45045	633	39210
4L-3S		MI	12320	4477	21129	3439	24921	2736	27071	2176	30116	1221	36996	723	32392
10-#18	3.51	MA	13190	4477	22599	3529	26728	2811	28916	2258	31312	1311	39639	523	36202
5L-2S		MI	13879	4477	23286	3447	27648	2750	30309	2163	34376	1208	42547	956	32797
12-#11	1.64	MA	14925	3704	22105	3058	26356	2477	28586	2037	31137	1380	38284	1275	21084
2L-6S		MI	9541	3704	14735	3007	17017	2439	17828	1997	18052	1340	21765	904	15173
12-#11	1.64	MA	14039	3704	20950	3058	24891	2476	26811	2044	28749	1385	35101	1184	21033
3L-5S		MI	9970	3704	15326	3009	17804	2432	18781	2002	19275	1334	23377	980	15614
12-#11	1.64	MA	13395	3704	20090	3058	23729	2485	25402	2042	26855	1380	33007	1093	20894
4E		MI	10418	3704	15989	3001	18600	2436	19749	1997	20546	1329	24989	1022	16084
12-#11	1.64	MA	12811	3704	19219	3069	22684	2484	24127	2049	25126	1385	30809	1048	20243
5L-3S		MI	10910	3704	16643	3002	19484	2429	20815	2002	21940	1334	26503	1112	16155
12-#11	1.64	MA	12251	3704	18446	3069	21652	2493	22872	2047	23464	1391	28588	973	19565
6L-2S		MI	11577	3704	17515	3004	20589	2433	22150	1997	23696	1329	28814	1203	16174
12-#14	2.37	MA	16258	4005	25162	3235	30157	2606	33158	2117	37166	1354	46244	1217	29941
2L-6S		MI	9707	4005	15842	3181	18330	2565	19355	2068	20059	1304	24668	710	20215
12-#14	2.37	MA	15025	4005	23510	3235	28062	2604	30621	2127	33769	1361	41726	1086	29776
3L-5S		MI	10305	4005	16687	3184	19456	2556	20705	2075	21791	1297	26793	799	21214
12-#14	2.37	MA	14130	4005	22279	3235	26398	2616	28604	2122	31074	1354	38758	954	29138
4E		MI	10927	4005	17636	3172	20594	2562	22075	2068	23652	1304	29069	861	22186
12-#14	2.37	MA	13319	4005	21031	3250	24901	2614	26777	2132	28614	1361	35632	890	27653
5L-3S		MI	11611	4005	18571	3176	21856	2553	23586	2075	25567	1297	31209	989	22736
12-#14	2.37	MA	12540	4005	19923	3249	23423	2626	24978	2128	26248	1368	32478	781	26297
6L-2S		MI	12539	4005	19813	3179	23432	2559	25476	2068	28054	1289	34472	1120	22833
12-#18	4.21	MA	17322	4768	29829	3689	35927	2931	40084	2338	46104	1291	57915	816	51123
3L-5S		MI	11075	4768	20000	3631	23479	2868	25373	2254	27907	1190	35024	318	33305
12-#18	4.21	MA	15846	4768	27670	3687	33011	2951	36551	2327	41442	1278	52821	583	47334
4E		MI	12103	4768	21656	3612	25457	2882	27720	2241	31097	1203	38896	429	35703
12-#18	4.21	MA	14508	4768	25483	3711	30386	2944	33348	2343	37187	1291	47414	473	44193
5L-3S		MI	13232	4768	23286	3621	27648	2868	30309	2254	34376	1190	42547	650	38631
12-#18	4.21	MA	13225	4768	23537	3709	27793	2964	30193	2332	33096	1304	41988	279	40821
6L-2S		MI	14762	4768	25444	3629	30374	2882	33547	2241	38637	1177	48099	884	39124
14-#11	1.92	MA	15461	3817	23260	3129	27820	2529	30360	2070	33524	1375	41466	1260	24501
2L-7S		MI	9539	3817	15030	3077	17361	2487	18237	2035	18567	1325	22646	811	17009
14-#11	1.92	MA	14584	3817	22105	3129	26356	2528	28586	2077	31137	1380	38284	1169	24430
3L-6S		MI	9955	3817	15606	3078	18122	2491	19162	2030	19808	1330	24076	881	17655
14-#11	1.92	MA	13948	3817	21245	3129	25193	2537	27177	2075	29242	1375	36190	1078	24267
4L-5S		MI	10380	3817	16197	3080	18909	2484	20116	2035	21031	1325	25689	957	18075
14-#11	1.92	MA	13372	3817	20374	3140	24149	2536	25902	2082	27514	1380	33992	1033	23525
5L-4S		MI	10823	3817	16861	3071	19706	2488	21083	2030	22302	1320	27301	1000	18630
14-#11	1.92	MA	12819	3817	19601	3140	23117	2545	24647	2080	25851	1385	31770	957	22874
6L-3S		MI	11309	3817	17515	3073	20589	2481	22150	2035	23696	1325	28814	1090	18723
14-#11	1.92	MA	12278	3817	18847	3140	22121	2543	23429	2087	24165	1380	29796	886	21981
7L-2S		MI	11970	3817	18386	3075	21694	2485	23484	2030	25452	1320	31126	1181	18757
14-#14	2.76	MA	15774	4168	25162	3337	30157	2678	33158	2174	37166	1352	46244	1062	34607
3L-6S		MI	10282	4168	17085	3283	19906	2640	21245	2114	22546	1289	27931	675	23650
14-#14	2.76	MA	14893	4168	23930	3337	28492	2691	31141	2170	34471	1344	43276	930	33776
4L-5S		MI	10872	4168	17930	3286	21031	2631	22595	2121	24278	1282	30056	764	24729
14-#14	2.76	MA	14095	4168	22683	3352	26996	2688	29314	2180	32011	1352	40149	866	32361
5L-4S		MI	11485	4168	18878	3275	22170	2637	23966	2114	26139	1289	32332	825	25644
14-#14	2.76	MA	13329	4168	21574	3352	25518	2701	27516	2175	29645	1359	36996	757	30929
6L-3S		MI	12159	4168	19813	3278	23432	2628	25476	2121	28054	1282	34472	954	26368

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis

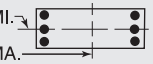


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.76	MA	12578	4168	20494	3351	24090	2698	25771	2185	27246	1352	34196	655	29446
7L-2S		MI	13076	4168	21056	3281	25008	2634	27366	2114	30541	1274	37734	1085	26497
14-#18	4.91	MA	17103	5059	30555	3868	36669	3084	40983	2412	47316	1258	60597	533	55490
4L-5S		MI	12068	5059	22158	3812	26205	3001	28611	2332	32167	1159	40575	246	39201
14-#18	4.91	MA	15794	5059	28368	3893	34044	3077	37780	2427	43062	1271	55190	423	52215
5L-4S		MI	13064	5059	23814	3794	28183	3014	30958	2318	35358	1172	44447	356	41744
14-#18	4.91	MA	14539	5059	26421	3890	31452	3097	34625	2416	38970	1284	49764	228	48779
6L-3S		MI	14148	5059	25444	3803	30374	3001	33547	2332	38637	1159	48099	578	44603
16-#11	2.19	MA	15121	3931	23260	3200	27820	2580	30360	2110	33524	1374	41466	1154	27823
3L-7S		MI	9952	3931	15901	3147	18466	2539	19572	2067	20323	1316	24958	788	19447
16-#11	2.19	MA	14492	3931	22400	3200	26658	2589	28952	2107	31630	1369	39373	1062	27638
4L-6S		MI	10364	3931	16477	3149	19227	2543	20497	2062	21564	1321	26388	859	20142
16-#11	2.19	MA	13923	3931	21529	3211	25613	2587	27677	2115	29901	1374	37175	1018	26816
5E		MI	10784	3931	17068	3151	20014	2536	21451	2067	22787	1316	28000	935	20543
16-#11	2.19	MA	13377	3931	20756	3211	24582	2597	26421	2112	28238	1379	34953	942	26189
6L-4S		MI	11222	3931	17732	3142	20811	2540	22418	2062	24058	1311	29612	977	21173
16-#11	2.19	MA	12842	3931	20002	3211	23586	2595	25204	2120	26552	1374	32979	871	25249
7L-3S		MI	11703	3931	18386	3144	21694	2533	23484	2067	25452	1316	31126	1067	21285
16-#11	2.19	MA	12314	3931	19261	3211	22609	2594	23984	2117	24926	1379	30927	819	24398
8L-2S		MI	12357	3931	19258	3146	22800	2536	24819	2062	27208	1311	33438	1158	21335
16-#14	3.16	MA	15643	4332	25581	3439	30587	2766	33678	2217	37867	1335	47794	906	38432
4L-6S		MI	10847	4332	18327	3385	21482	2714	23135	2159	25033	1275	31194	639	27099
16-#14	3.16	MA	14856	4332	24334	3454	29090	2763	31852	2227	35408	1343	44667	842	37079
5E		MI	11428	4332	19172	3388	22607	2706	24486	2167	26765	1267	33319	729	28254
16-#14	3.16	MA	14102	4332	23225	3454	27612	2776	30053	2223	33042	1350	41514	733	35575
6L-4S		MI	12034	4332	20121	3377	23746	2712	25856	2159	28626	1275	35595	790	29120
16-#14	3.16	MA	13364	4332	22146	3454	26184	2773	28308	2233	30643	1343	38714	631	34108
7L-3S		MI	12699	4332	21056	3380	25008	2703	27366	2167	30541	1267	37734	918	29995
16-#14	3.16	MA	12634	4332	21082	3453	24784	2771	26560	2228	28328	1350	35795	557	32089
8L-2S		MI	13604	4332	22298	3383	26583	2709	29257	2159	33027	1260	40997	1050	30153
16-#18	5.61	MA	17053	5350	31252	4074	37703	3210	42212	2511	48937	1251	62965	373	60266
5E		MI	12982	5350	24315	3994	28932	3133	31849	2409	36428	1128	46126	173	45127
16-#18	5.61	MA	15824	5350	29306	4072	35110	3230	39057	2500	44845	1265	57540	178	56761
6L-4S		MI	13952	5350	25971	3976	30910	3146	34196	2396	39619	1141	49998	284	47810
18-#11	2.46	MA	15028	4044	23555	3271	28123	2640	30726	2140	34017	1363	42556	1047	31008
4L-7S		MI	10359	4044	16773	3218	19571	2591	20907	2100	22079	1307	27270	765	21893
18-#11	2.46	MA	14466	4044	22684	3282	27078	2639	29451	2148	32288	1369	40358	1002	30115
5L-6S		MI	10767	4044	17349	3220	20333	2594	21832	2095	23320	1312	28699	836	22634
18-#11	2.46	MA	13927	4044	21911	3282	26047	2648	28196	2145	30626	1374	38136	927	29509
6L-5S		MI	11182	4044	17940	3222	21120	2588	22785	2100	24543	1307	30312	912	23019
18-#11	2.46	MA	13398	4044	21157	3282	25050	2647	26979	2153	28940	1369	36162	856	28525
7L-4S		MI	11615	4044	18604	3213	21916	2591	23753	2095	25814	1301	31924	954	23713
18-#11	2.46	MA	12877	4044	20416	3282	24074	2646	25759	2150	27313	1374	34110	804	27642
8L-3S		MI	12091	4044	19258	3215	22800	2585	24819	2100	27208	1307	33438	1045	23842
18-#11	2.46	MA	12358	4044	19597	3293	23067	2655	24559	2158	25702	1379	32095	745	26466
9L-2S		MI	12740	4044	20129	3217	23905	2588	26154	2095	28964	1301	35749	1136	23907
18-#14	3.55	MA	15605	4495	25985	3556	31184	2838	34389	2275	38804	1334	49185	818	41807
5L-6S		MI	11403	4495	19569	3487	23057	2789	25026	2205	27520	1260	34457	604	30561
18-#14	3.55	MA	14862	4495	24877	3556	29706	2850	32590	2270	36439	1341	46032	709	40232
6L-5S		MI	11977	4495	20415	3491	24183	2780	26376	2213	29252	1252	36582	693	31787
18-#14	3.55	MA	14135	4495	23797	3556	28278	2848	30846	2280	34040	1334	43232	607	38722
7L-4S		MI	12574	4495	21363	3479	25321	2786	27746	2205	31113	1260	38858	755	32609
18-#14	3.55	MA	13416	4495	22734	3556	26878	2846	29098	2276	31725	1341	40313	533	36754
8L-3S		MI	13231	4495	22298	3482	26583	2778	29257	2213	33027	1252	40997	883	33619
18-#18	6.32	MA	17195	5640	32190	4254	38768	3363	43489	2584	50720	1245	65315	128	64766
6L-5S		MI	13875	5640	26473	4176	31659	3265	35087	2487	40689	1097	51678	101	51080
20-#11	2.74	MA	15001	4157	23839	3352	28543	2691	31226	2181	34676	1363	43541	987	33421
5L-7S		MI	10761	4157	17644	3289	20677	2643	22242	2132	23835	1297	29581	743	24345

RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
20-#11	2.74	MA	14468	4157	23066	3353	27512	2700	29970	2178	33013	1368	41319	912	32833
6E		MI	11164	4157	18220	3291	21438	2646	23167	2127	25076	1302	31011	813	25094
20-#11	2.74	MA	13946	4157	22312	3353	26515	2699	28753	2186	31327	1363	39345	841	31806
7L-5S		MI	11575	4157	18811	3293	22225	2640	24120	2132	26298	1297	32624	890	25501
20-#11	2.74	MA	13430	4157	21571	3353	25538	2698	27533	2183	29700	1368	37293	788	30892
8L-4S		MI	12004	4157	19475	3284	23021	2643	25088	2127	27570	1292	34235	932	26195
20-#11	2.74	MA	12918	4157	20752	3364	24532	2707	26333	2191	28089	1373	35277	730	29744
9L-3S		MI	12475	4157	20129	3286	23905	2637	26154	2132	28964	1297	35749	1022	26397
20-#11	2.74	MA	12408	4157	20013	3364	23562	2706	25127	2188	26433	1368	33322	663	28500
10L-2S		MI	13118	4157	21001	3288	25010	2640	27489	2127	30720	1292	38061	1113	26476
20-#14	3.95	MA	15610	4659	26528	3658	31801	2925	35128	2317	39835	1332	50549	685	44901
6E		MI	11951	4659	20812	3590	24633	2864	26916	2251	30007	1245	37720	569	34033
20-#14	3.95	MA	14893	4659	25448	3658	30372	2923	33383	2328	37436	1325	47750	583	43347
7L-5S		MI	12517	4659	21657	3593	25758	2855	28266	2259	31739	1238	39845	658	35328
20-#14	3.95	MA	14184	4659	24385	3658	28973	2920	31635	2323	35122	1332	44831	508	41428
8L-4S		MI	13107	4659	22606	3581	26897	2861	29637	2251	33600	1245	42120	720	36110
22-#11	3.01	MA	15003	4271	24221	3424	28976	2752	31745	2211	35400	1363	44502	896	36161
6L-7S		MI	11158	4271	18516	3360	21782	2695	23576	2165	25591	1288	31893	720	26803
22-#11	3.01	MA	14487	4271	23467	3424	27980	2751	30528	2219	33714	1357	42527	825	35094
7L-6S		MI	11556	4271	19092	3362	22543	2698	24501	2160	26832	1293	33323	791	27526
22-#11	3.01	MA	13977	4271	22726	3424	27003	2750	29308	2216	32088	1363	40475	773	34148
8L-5S		MI	11964	4271	19683	3364	23330	2692	25455	2165	28054	1288	34935	867	27987
22-#11	3.01	MA	13470	4271	21907	3435	25997	2759	28108	2224	30477	1368	38460	714	33026
9L-4S		MI	12388	4271	20346	3355	24126	2695	26422	2160	29326	1283	36547	909	28650
22-#11	3.01	MA	12966	4271	21168	3435	25027	2758	26902	2221	28820	1363	36505	648	31762
10L-3S		MI	12855	4271	21001	3357	25010	2688	27489	2165	30720	1288	38061	999	28949
22-#14	4.34	MA	15640	4823	27100	3760	32467	2998	35920	2375	40833	1316	52268	558	47981
7L-6S		MI	12492	4823	22054	3692	26209	2939	28806	2297	32494	1230	40983	534	37516
22-#14	4.34	MA	14941	4823	26036	3760	31067	2995	34172	2370	38519	1323	49349	484	46108
8L-5S		MI	13051	4823	22900	3695	27334	2930	30157	2304	34226	1223	43108	623	38874
24-#11	3.28	MA	15020	4384	24622	3495	29445	2803	32302	2252	36102	1352	45710	810	38386
7E		MI	11550	4384	19387	3431	22887	2746	24911	2197	27347	1279	34204	698	29266
24-#11	3.28	MA	14516	4384	23881	3495	28468	2802	31083	2249	34475	1357	43658	758	37410
8L-6S		MI	11945	4384	19963	3433	23648	2750	25836	2192	28588	1284	35634	768	29964
24-#11	3.28	MA	14015	4384	23062	3505	27462	2811	29882	2256	32864	1362	41643	699	36312
9L-5S		MI	12348	4384	20554	3434	24435	2743	26790	2197	29810	1279	37247	844	30477
24-#11	3.28	MA	13516	4384	22323	3506	26492	2809	28677	2254	31207	1357	39688	633	35029
10L-4S		MI	12768	4384	21218	3426	25232	2747	27757	2192	31082	1273	38859	887	31112
24-#14	4.74	MA	15688	4986	27688	3862	33161	3070	36710	2418	41915	1314	53867	460	50796
8L-6S		MI	13027	4986	23297	3794	27785	3014	30696	2343	34981	1216	44246	498	41007

RECTANGULAR TIED COLUMNS 30" x 40"

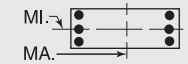
4-#18	1.33	MA	15767	3764	23110	3114	27291	2529	29290	2090	31131	1441	37823	1336	18893
2E		MI	11584	3764	17472	3036	20205	2463	21338	2023	22282	1373	26673	1243	13694
6-#14	1.13	MA	15389	3673	22075	3078	26137	2504	27959	2079	29504	1464	35758	1373	16185
2L-3S		MI	10380	3673	15494	3004	17865	2440	18659	2032	18797	1413	22204	1165	11819
6-#14	1.13	MA	14013	3673	20321	3078	23913	2503	25265	2090	25879	1472	30925	1241	16155
3L-2S		MI	11351	3673	16736	3007	19441	2446	20549	2025	21284	1406	25467	1296	11790
6-#18	2.00	MA	17183	4055	26176	3295	31180	2662	34001	2175	37410	1424	46157	1290	27980
2L-3S		MI	10909	4055	17472	3209	20205	2582	21338	2114	22282	1355	26673	937	19967
6-#18	2.00	MA	14862	4055	23110	3294	27291	2656	29290	2192	31131	1437	37823	1056	27618
3L-2S		MI	12541	4055	19629	3218	22932	2595	24576	2101	26543	1342	32224	1170	20129

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis

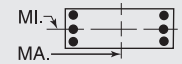


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#11	1.04	MA	15233	3636	21634	3065	25658	2496	27414	2075	28822	1473	34917	1389	15069
2L-4S		MI	10066	3636	14893	2995	17125	2444	17823	2027	17727	1421	21153	1138	11017
8-#11	1.04	MA	14267	3636	20408	3066	24103	2495	25530	2083	26281	1479	31516	1297	15064
3E		MI	10571	3636	15547	2996	18008	2437	18890	2032	19121	1426	22666	1228	11025
8-#11	1.04	MA	13565	3636	19497	3066	22871	2505	24037	2081	24266	1474	29276	1206	14982
4L-2S		MI	11254	3636	16419	2998	19113	2441	20225	2027	20877	1421	24978	1319	11000
8-#14	1.50	MA	16226	3837	23828	3180	28361	2579	30654	2126	33128	1456	40590	1351	21395
2L-4S		MI	10257	3837	15802	3103	18178	2524	19039	2070	19370	1406	23327	1001	15356
8-#14	1.50	MA	14872	3837	22075	3180	26137	2577	27959	2137	29504	1463	35758	1219	21313
3E		MI	10964	3837	16736	3106	19441	2515	20549	2078	21284	1399	25467	1130	15492
8-#14	1.50	MA	13887	3837	20769	3181	24372	2590	25820	2133	26627	1456	32579	1088	21002
4L-2S		MI	11921	3837	17979	3109	21016	2521	22439	2070	23771	1391	28730	1261	15505
8-#18	2.67	MA	18551	4346	29242	3477	35069	2794	38712	2259	43690	1406	54492	1244	37026
2L-4S		MI	10688	4346	17999	3383	20741	2727	21987	2178	23264	1337	28572	643	23971
8-#18	2.67	MA	16285	4346	26176	3476	31180	2789	34001	2276	37410	1419	46157	1010	36535
3E		MI	11872	4346	19629	3391	22932	2714	24576	2192	26543	1324	32224	864	26234
8-#18	2.67	MA	14636	4346	23886	3475	28085	2810	30251	2266	32427	1406	40689	777	33306
4L-2S		MI	13469	4346	21787	3399	25658	2727	27814	2178	30804	1311	37775	1098	26507
10-#11	1.30	MA	15827	3749	22860	3136	27212	2548	29297	2108	31363	1468	38319	1375	18714
2L-5S		MI	10032	3749	15101	3074	17433	2492	18191	2065	18211	1417	21852	1073	13290
10-#11	1.30	MA	14872	3749	21634	3137	25658	2547	27414	2116	28822	1473	34917	1284	18684
3L-4S		MI	10486	3749	15764	3065	18230	2496	19158	2059	19483	1411	23464	1115	13581
10-#11	1.30	MA	14179	3749	20722	3137	24426	2557	25921	2114	26807	1469	32677	1192	18572
4L-3S		MI	10984	3749	16419	3067	19113	2489	20225	2065	20877	1417	24978	1205	13617
10-#11	1.30	MA	13551	3749	19800	3148	23319	2556	24570	2122	24968	1474	30334	1147	18085
5L-2S		MI	11661	3749	17290	3069	20219	2493	21559	2059	22633	1411	27289	1296	13609
10-#14	1.88	MA	17044	4000	25582	3282	30585	2654	33348	2173	36753	1448	45423	1329	26585
2L-5S		MI	10205	4000	16095	3217	18616	2592	19559	2124	19995	1384	24314	905	17869
10-#14	1.88	MA	15710	4000	23828	3283	28361	2652	30654	2184	33128	1455	40590	1197	26459
3L-4S		MI	10839	4000	17044	3205	19754	2598	20929	2116	21857	1391	26590	966	18933
10-#14	1.88	MA	14742	4000	22523	3283	26596	2665	28515	2181	30252	1448	37411	1066	26097
4L-3S		MI	11536	4000	17979	3208	21016	2590	22439	2124	23771	1384	28730	1094	19148
10-#14	1.88	MA	13864	4000	21201	3298	25010	2664	26579	2192	27627	1455	34075	1001	24472
5L-2S		MI	12480	4000	19221	3212	22592	2596	24330	2116	26258	1376	31993	1226	19199
10-#18	3.33	MA	19882	4636	32308	3659	38957	2927	43423	2343	49970	1388	62826	1198	46049
2L-5S		MI	10595	4636	18501	3582	21490	2846	22878	2269	24334	1293	30251	460	27834
10-#18	3.33	MA	17664	4636	29242	3658	35069	2922	38712	2360	43690	1401	54492	964	45449
3L-4S		MI	11650	4636	20156	3564	23468	2859	25225	2256	27525	1306	34123	570	29937
10-#18	3.33	MA	16055	4636	26952	3656	31974	2943	34962	2350	38707	1388	49023	731	41915
4L-3S		MI	12808	4636	21787	3573	25658	2846	27814	2269	30804	1293	37775	792	32487
10-#18	3.33	MA	14596	4636	24632	3682	29190	2938	31565	2367	34159	1401	43243	619	38915
5L-2S		MI	14375	4636	23944	3581	28385	2859	31052	2256	35064	1280	43326	1026	32856
12-#11	1.56	MA	16411	3863	24086	3207	28767	2600	31181	2141	33904	1463	41720	1361	22348
2L-6S		MI	10018	3863	15381	3143	17752	2551	18572	2092	18745	1412	22551	974	15291
12-#11	1.56	MA	15466	3863	22860	3208	27212	2599	29297	2149	31363	1468	38319	1270	22297
3L-5S		MI	10449	3863	15972	3145	18539	2544	19525	2097	19967	1407	24164	1050	15738
12-#11	1.56	MA	14782	3863	21948	3208	25980	2609	27804	2147	29348	1463	36078	1179	22158
4E		MI	10898	3863	16636	3136	19335	2547	20493	2092	21239	1402	25776	1093	16136
12-#11	1.56	MA	14162	3863	21026	3219	24874	2608	26453	2155	27509	1469	33735	1133	21559
5L-3S		MI	11392	3863	17290	3138	20219	2541	21559	2097	22633	1407	27289	1183	16195
12-#11	1.56	MA	13567	3863	20207	3220	23781	2617	25124	2153	25740	1474	31360	1058	20810
6L-2S		MI	12061	3863	18162	3140	21324	2544	22894	2092	24389	1402	29601	1274	16206
12-#14	2.25	MA	17844	4164	27335	3385	32808	2729	36042	2221	40378	1440	50256	1307	31763
2L-6S		MI	10184	4164	16493	3316	19066	2676	20099	2162	20750	1377	25452	780	20467
12-#14	2.25	MA	16529	4164	25582	3385	30585	2727	33348	2232	36753	1447	45423	1175	31598
3L-5S		MI	10784	4164	17338	3319	20191	2667	21449	2170	22482	1369	27577	869	21369
12-#14	2.25	MA	15577	4164	24276	3385	28820	2740	31209	2228	33877	1440	42244	1044	31118
4E		MI	11410	4164	18286	3307	21330	2673	22819	2162	24344	1377	29853	931	22366

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis



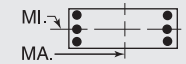
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	2.25	MA	14714	4164	22954	3401	27234	2738	29273	2239	31252	1447	38907	979	29463
5L-3S		MI	12096	4164	19221	3311	22592	2664	24330	2170	26258	1369	31993	1059	22792
12-#14	2.25	MA	13886	4164	21780	3401	25668	2751	27367	2235	28727	1455	35534	870	28149
6L-2S		MI	13028	4164	20464	3314	24168	2670	26220	2162	28745	1362	35255	1190	22876
12-#18	4.00	MA	19008	4927	32308	3839	38957	3055	43423	2444	49970	1383	62826	918	54363
3L-5S		MI	11554	4927	20658	3764	24216	2978	26116	2347	28595	1262	35803	387	33686
12-#18	4.00	MA	17436	4927	30018	3838	35863	3076	39674	2435	44986	1370	57357	685	50564
4E		MI	12588	4927	22314	3746	26194	2992	28463	2334	31786	1275	39674	498	35942
12-#18	4.00	MA	16011	4927	27698	3863	33079	3071	36276	2452	40438	1383	51577	573	47433
5L-3S		MI	13723	4927	23944	3754	28385	2978	31052	2347	35064	1262	43326	720	38733
12-#18	4.00	MA	14643	4927	25635	3862	30329	3092	32930	2442	36065	1397	45761	379	43854
6L-2S		MI	15262	4927	26102	3763	31112	2992	34290	2334	39325	1249	48877	953	39187
14-#11	1.82	MA	16985	3976	25311	3278	30322	2652	33064	2174	36446	1458	45121	1347	25975
2L-7S		MI	10016	3976	15677	3212	18096	2599	18982	2130	19260	1398	23433	881	17194
14-#11	1.82	MA	16050	3976	24086	3278	28767	2651	31181	2182	33904	1463	41720	1256	25904
3L-6S		MI	10434	3976	16253	3214	18857	2602	19907	2124	20501	1403	24863	952	17772
14-#11	1.82	MA	15374	3976	23174	3279	27535	2660	29688	2180	31889	1458	39480	1165	25741
4L-5S		MI	10860	3976	16844	3216	19644	2596	20860	2130	21723	1398	26476	1028	18197
14-#11	1.82	MA	14762	3976	22252	3290	26428	2660	28337	2188	30050	1464	37136	1119	25046
5L-4S		MI	11305	3976	17507	3207	20440	2599	21828	2124	22995	1393	28087	1070	18686
14-#11	1.82	MA	14175	3976	21433	3291	25336	2669	27007	2186	28282	1469	34762	1044	24326
6L-3S		MI	11793	3976	18162	3209	21324	2593	22894	2130	24389	1398	29601	1160	18765
14-#11	1.82	MA	13600	3976	20635	3291	24281	2668	25718	2194	26489	1464	32650	973	23463
7L-2S		MI	12456	3976	19033	3211	22429	2596	24229	2124	26145	1393	31913	1251	18794
14-#14	2.63	MA	17333	4327	27335	3487	32808	2802	36042	2279	40378	1439	50256	1153	36733
3L-6S		MI	10761	4327	17735	3418	20642	2751	21989	2208	23237	1362	28715	745	23898
14-#14	2.63	MA	16395	4327	26030	3487	31044	2815	33903	2275	37502	1432	47077	1022	36049
4L-5S		MI	11353	4327	18580	3421	21767	2742	23339	2215	24969	1354	30840	834	24883
14-#14	2.63	MA	15546	4327	24708	3503	29457	2813	31968	2286	34877	1439	43740	957	34467
5L-4S		MI	11969	4327	19529	3410	22905	2748	24710	2208	26831	1362	33116	895	25821
14-#14	2.63	MA	14731	4327	23533	3503	27892	2826	30062	2283	32352	1447	40366	848	33078
6L-3S		MI	12647	4327	20464	3413	24168	2739	26220	2215	28745	1354	35255	1024	26428
14-#14	2.63	MA	13933	4327	22390	3503	26379	2825	28213	2294	29793	1439	37369	746	31440
7L-2S		MI	13567	4327	21706	3416	25743	2745	28110	2208	31232	1347	38518	1155	26542
14-#18	4.67	MA	18784	5218	33084	4020	39752	3209	44385	2519	51266	1352	65691	639	59244
4L-5S		MI	12552	5218	22816	3946	26943	3111	29354	2425	32855	1231	41354	315	39574
14-#18	4.67	MA	17390	5218	30765	4045	36968	3204	40987	2536	46718	1366	59912	527	55982
5L-4S		MI	13556	5218	24471	3928	28921	3124	31701	2412	36046	1244	45225	426	41978
14-#18	4.67	MA	16052	5218	28701	4044	34218	3225	37641	2526	42345	1379	54095	333	52487
6L-3S		MI	14649	5218	26102	3936	31112	3111	34290	2425	39325	1231	48877	647	44928
16-#11	2.08	MA	16626	4090	25311	3349	30322	2703	33064	2215	36446	1458	45121	1242	29507
3L-7S		MI	10430	4090	16548	3283	19201	2651	20316	2162	21016	1389	25745	858	19630
16-#11	2.08	MA	15957	4090	24400	3350	29090	2712	31571	2213	34430	1453	42881	1151	29323
4L-6S		MI	10843	4090	17124	3285	19962	2654	21241	2157	22256	1394	27175	929	20259
16-#11	2.08	MA	15352	4090	23478	3361	27983	2711	30220	2221	32591	1458	40537	1105	28541
5E		MI	11266	4090	17715	3287	20749	2648	22195	2162	23479	1389	28787	1005	20664
16-#11	2.08	MA	14772	4090	22659	3362	26891	2721	28891	2219	30823	1464	38163	1030	27848
6L-4S		MI	11705	4090	18379	3278	21545	2651	23162	2157	24751	1384	30399	1047	21232
16-#11	2.08	MA	14204	4090	21861	3362	25835	2720	27601	2227	29030	1459	36051	959	26937
7L-3S		MI	12188	4090	19033	3280	22429	2644	24229	2162	26145	1389	31913	1138	21330
16-#11	2.08	MA	13643	4090	21076	3363	24801	2719	26310	2225	27300	1464	33863	906	26029
8L-2S		MI	12845	4090	19904	3282	23534	2648	25564	2157	27901	1384	34224	1229	21373
16-#14	3.00	MA	17199	4491	27783	3590	33268	2890	36598	2323	41127	1424	51909	1000	40997
4L-6S		MI	11327	4491	18977	3520	22217	2825	23879	2254	25724	1347	31978	710	27343

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis

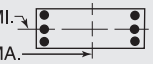


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.00	MA	16362	4491	26462	3605	31681	2888	34662	2334	38502	1431	48573	935	39483
5E		MI	11912	4491	19823	3523	23343	2817	25230	2261	27456	1340	34103	799	28407
16-#14	3.00	MA	15560	4491	25287	3605	30116	2901	32756	2330	35977	1439	45199	826	38019
6L-4S		MI	12520	4491	20771	3512	24481	2823	26600	2254	29318	1347	36379	860	29294
16-#14	3.00	MA	14775	4491	24143	3606	28603	2899	30908	2341	33417	1431	42201	724	36431
7L-3S		MI	13189	4491	21706	3515	25743	2814	28110	2261	31232	1340	38518	989	30058
16-#14	3.00	MA	13998	4491	23017	3606	27120	2898	29056	2337	30947	1439	39086	649	34351
8L-2S		MI	14099	4491	22949	3518	27319	2820	30001	2254	33719	1332	41781	1120	30201
16-#18	5.33	MA	18740	5509	33831	4227	40856	3337	45699	2620	52998	1348	68246	481	64558
5E		MI	13469	5509	24973	4128	29670	3243	32592	2503	37116	1200	46905	242	45493
16-#18	5.33	MA	17430	5509	31768	4226	38107	3358	42352	2611	48624	1361	62429	287	61000
6L-4S		MI	14448	5509	26629	4110	31648	3256	34939	2489	40307	1213	50776	353	48040
18-#11	2.34	MA	16532	4203	25626	3421	30644	2764	33455	2246	36971	1448	46282	1137	32904
4L-7S		MI	10838	4203	17420	3354	20306	2703	21651	2195	22772	1379	28056	836	22073
18-#11	2.34	MA	15934	4203	24704	3432	29538	2763	32104	2254	35132	1453	43939	1091	32045
5L-6S		MI	11248	4203	17996	3356	21067	2706	22576	2189	24012	1385	29486	906	22751
18-#11	2.34	MA	15361	4203	23884	3432	28445	2773	30774	2252	33364	1459	41564	1016	31376
6L-5S		MI	11665	4203	18587	3357	21854	2699	23530	2195	25235	1379	31099	983	23139
18-#11	2.34	MA	14800	4203	23087	3433	27390	2772	29485	2260	31571	1454	39452	945	30418
7L-4S		MI	12100	4203	19250	3349	22651	2703	24497	2189	26507	1374	32711	1025	23775
18-#11	2.34	MA	14245	4203	22302	3434	26356	2771	28193	2258	29841	1459	37264	892	29534
8L-3S		MI	12578	4203	19904	3351	23534	2696	25564	2195	27901	1379	34224	1115	23890
18-#11	2.34	MA	13694	4203	21435	3445	25290	2781	26922	2266	28127	1465	35109	833	28275
9L-2S		MI	13230	4203	20776	3352	24640	2700	26898	2189	29657	1374	36536	1206	23948
18-#14	3.38	MA	17165	4654	28215	3707	33905	2963	37356	2381	42126	1423	53405	913	44508
5L-6S		MI	11885	4654	20220	3622	23793	2900	25769	2300	28211	1332	35241	674	30801
18-#14	3.38	MA	16375	4654	27041	3708	32340	2976	35450	2377	39602	1431	50032	804	42973
6L-5S		MI	12462	4654	21065	3626	24918	2891	27120	2307	29943	1325	37366	764	31939
18-#14	3.38	MA	15601	4654	25897	3708	30827	2974	33602	2388	37042	1423	47034	702	41432
7L-4S		MI	13063	4654	22014	3614	26057	2898	28490	2300	31804	1332	39641	825	32780
18-#14	3.38	MA	14836	4654	24771	3708	29344	2972	31750	2385	34572	1431	43918	627	39314
8L-3S		MI	13723	4654	22949	3617	27319	2889	30001	2307	33719	1325	41781	953	33685
18-#14	3.38	MA	14075	4654	23528	3723	27816	2986	29928	2396	32126	1438	40859	542	37216
9L-2S		MI	14623	4654	24191	3620	28895	2895	31891	2300	36206	1318	45044	1085	33854
18-#18	6.00	MA	18909	5799	34834	4407	41996	3491	47064	2695	54904	1343	70763	241	69534
6L-5S		MI	14366	5799	27131	4309	32396	3375	35830	2580	41377	1169	52456	170	51439
20-#11	2.60	MA	16508	4316	25929	3503	31092	2815	33987	2287	37674	1448	47340	1077	35556
5L-7S		MI	11241	4316	18291	3425	21411	2754	22986	2227	24528	1370	30368	813	24524
20-#11	2.60	MA	15941	4316	25110	3503	30000	2825	32658	2284	35905	1454	44965	1002	34907
6E		MI	11646	4316	18867	3427	22172	2758	23911	2222	25768	1375	31798	884	25246
20-#11	2.60	MA	15387	4316	24313	3504	28945	2824	31368	2293	34112	1449	42854	931	33905
7L-5S		MI	12060	4316	19458	3428	22959	2751	24864	2227	26991	1370	33410	960	25620
20-#11	2.60	MA	14838	4316	23528	3504	27910	2823	30077	2290	32382	1454	40665	878	33026
8L-4S		MI	12491	4316	20122	3420	23756	2755	25832	2222	28263	1365	35022	1002	26316
20-#11	2.60	MA	14294	4316	22661	3515	26845	2833	28806	2299	30669	1459	38510	819	31759
9L-3S		MI	12964	4316	20776	3422	24640	2748	26898	2227	29657	1370	36536	1092	26447
20-#11	2.60	MA	13751	4316	21879	3516	25818	2832	27529	2296	28907	1455	36282	739	30510
10L-2S		MI	13610	4316	21647	3423	25745	2752	28233	2222	31413	1365	38847	1184	26518
20-#14	3.75	MA	17176	4818	28794	3810	34564	3051	38145	2425	43227	1423	54864	782	47937
6E		MI	12435	4818	21462	3725	25369	2975	27660	2346	30698	1318	38504	639	34271
20-#14	3.75	MA	16413	4818	27651	3810	33051	3049	36296	2436	40667	1415	51867	680	46413
7L-5S		MI	13005	4818	22308	3728	26494	2966	29010	2353	32430	1310	40629	728	35478
20-#14	3.75	MA	15659	4818	26525	3810	31568	3047	34445	2432	38197	1423	48751	605	44285
8L-4S		MI	13598	4818	23256	3716	27633	2972	30380	2346	34291	1318	42904	790	36279
20-#14	3.75	MA	14910	4818	25282	3826	30040	3060	32622	2443	35751	1430	45691	520	42160
9L-3S		MI	14251	4818	24191	3719	28895	2964	31891	2353	36206	1310	45044	918	37308
22-#11	2.86	MA	16514	4430	26336	3574	31555	2877	34541	2317	38446	1448	48367	988	38442
6L-7S		MI	11639	4430	19162	3496	22516	2806	24321	2260	26284	1361	32679	791	26980

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

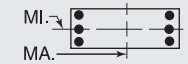
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.86	MA	15966	4430	25539	3575	30499	2876	33252	2325	36653	1443	46255	917	37398
7L-6S		MI	12040	4430	19738	3498	23278	2810	25246	2254	27524	1366	34109	861	27723
22-#11	2.86	MA	15423	4430	24753	3575	29465	2875	31960	2323	34923	1449	44066	864	36488
8L-5S		MI	12450	4430	20329	3499	24065	2803	26199	2260	28747	1361	35722	937	28106
22-#11	2.86	MA	14885	4430	23887	3586	28399	2885	30689	2332	33210	1454	41912	805	35247
9L-4S		MI	12877	4430	20993	3491	24861	2807	27167	2254	30019	1356	37334	980	28790
22-#11	2.86	MA	14348	4430	23104	3587	27372	2884	29412	2329	31448	1449	39683	725	33979
10L-3S		MI	13346	4430	21647	3492	25745	2800	28233	2260	31413	1361	38847	1070	29001
22-#14	4.13	MA	17214	4982	29404	3912	35274	3124	38991	2483	44292	1407	56699	658	51344
7L-6S		MI	12978	4982	22705	3827	26944	3050	29550	2391	33185	1303	41767	604	37750
22-#14	4.13	MA	16470	4982	28278	3913	33792	3122	37139	2479	41822	1414	53584	583	49264
8L-5S		MI	13541	4982	23550	3830	28070	3041	30900	2399	34917	1295	43892	693	39024
22-#14	4.13	MA	15731	4982	27035	3928	32264	3135	35317	2490	39376	1422	50524	498	47111
9L-4S		MI	14128	4982	24499	3818	29208	3047	32271	2391	36778	1303	46167	754	39788
24-#11	3.12	MA	16537	4543	26764	3646	32054	2928	35135	2358	39194	1438	49656	903	40896
7E		MI	12033	4543	20034	3567	23622	2858	25655	2292	28040	1352	34991	768	29441
24-#11	3.12	MA	16001	4543	25979	3646	31020	2927	33844	2356	37464	1444	47468	850	39955
8L-6S		MI	12430	4543	20610	3568	24383	2862	26580	2287	29280	1357	36421	839	30159
24-#11	3.12	MA	15468	4543	25112	3657	29954	2936	32573	2364	35751	1449	45313	792	38740
9L-5S		MI	12836	4543	21201	3570	25170	2855	27534	2292	30503	1352	38033	915	30596
24-#11	3.12	MA	14938	4543	24330	3658	28927	2936	31296	2362	33989	1444	43084	711	37452
10L-4S		MI	13258	4543	21865	3562	25966	2859	28501	2287	31775	1346	39645	957	31251
24-#14	4.50	MA	17269	5145	30032	4015	36016	3197	39833	2527	45446	1406	58416	561	54250
8L-6S		MI	13515	5145	23947	3929	28520	3125	31440	2437	35672	1288	45030	568	41239
24-#14	4.50	MA	16540	5145	28789	4030	34488	3210	38011	2538	43001	1414	55356	476	52069
9L-5S		MI	14071	5145	24793	3932	29645	3116	32791	2445	37404	1281	47155	658	42574

RECTANGULAR TIED COLUMNS 30" x 42"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.27	MA	17281	3923	25119	3263	29724	2651	31890	2195	33878	1525	41171	1421	19973
2E		MI	12066	3923	18129	3169	20943	2573	22081	2116	22970	1445	27451	1312	13732
6-#14	1.07	MA	16873	3832	24017	3227	28493	2627	30472	2183	32110	1546	38937	1456	17096
2L-3S		MI	10859	3832	16144	3139	18601	2551	19403	2126	19488	1486	22988	1235	11855
6-#14	1.07	MA	15411	3832	22161	3228	26140	2626	27620	2195	28263	1554	33790	1324	17067
3L-2S		MI	11832	3832	17387	3142	20176	2557	21293	2119	21975	1478	26251	1366	11820
6-#18	1.90	MA	18797	4214	28367	3445	33843	2784	36880	2279	40563	1509	50064	1378	29600
2L-3S		MI	11390	4214	18129	3343	20943	2692	22081	2207	22970	1427	27451	1006	20040
6-#18	1.90	MA	16328	4214	25119	3444	29724	2780	31890	2297	33878	1522	41171	1145	29238
3L-2S		MI	13027	4214	20287	3351	23669	2705	25319	2194	27231	1414	33002	1240	20175
8-#14	1.43	MA	17767	3996	25872	3329	30847	2702	33323	2230	35957	1539	44085	1436	22610
2L-4S		MI	10736	3996	16452	3238	18914	2635	19783	2165	20061	1479	24111	1071	15422
8-#14	1.43	MA	16328	3996	24017	3330	28493	2701	30472	2242	32110	1546	38937	1304	22528
3E		MI	11445	3996	17387	3241	20176	2626	21293	2172	21975	1471	26251	1200	15536
8-#14	1.43	MA	15285	3996	22637	3331	26628	2714	28211	2239	29059	1539	35547	1173	22217
4L-2S		MI	12404	3996	18629	3244	21752	2632	23183	2165	24462	1464	29514	1331	15539
8-#18	2.54	MA	20261	4505	31615	3626	37963	2917	41871	2363	47248	1493	58958	1336	39186
2L-4S		MI	11167	4505	18657	3516	21479	2837	22730	2272	23952	1409	29350	712	24216
8-#18	2.54	MA	17850	4505	28367	3626	33843	2913	36880	2381	40563	1506	50064	1102	38695
3E		MI	12355	4505	20287	3525	23669	2824	25319	2285	27231	1396	33002	934	26317
8-#18	2.54	MA	16100	4505	25945	3626	30570	2935	32914	2373	35258	1493	44221	869	35512
4L-2S		MI	13959	4505	22445	3533	26396	2837	28557	2272	31492	1383	38553	1167	26559
10-#11	1.24	MA	17338	3909	24844	3285	29628	2671	31882	2212	34038	1548	41649	1458	19767
2L-5S		MI	10509	3909	15747	3210	18168	2604	18935	2159	18904	1489	22639	1143	13411
10-#11	1.24	MA	16324	3909	23547	3286	27983	2670	29890	2221	31350	1554	38029	1367	19737
3L-4S		MI	10965	3909	16411	3201	18964	2607	19902	2154	20176	1484	24251	1186	13625
10-#11	1.24	MA	15590	3909	22584	3287	26681	2680	28313	2219	29221	1550	35642	1276	19625
4L-3S		MI	11465	3909	17065	3203	19848	2601	20969	2159	21570	1489	25765	1276	13652

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

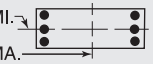
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.24	MA	14925	3909	21611	3298	25513	2680	26886	2228	27279	1556	33152	1230	19206
5L-2S		MI	12143	3909	17937	3205	20953	2604	22304	2154	23326	1484	28076	1367	13638
10-#14	1.79	MA	18640	4159	27728	3432	33201	2777	36174	2278	39804	1531	49233	1415	28103
2L-5S		MI	10682	4159	16746	3352	19351	2703	20303	2218	20686	1456	25098	975	18021
10-#14	1.79	MA	17223	4159	25872	3432	30847	2775	33323	2289	35957	1539	44085	1284	27978
3L-4S		MI	11319	4159	17694	3340	20490	2709	21673	2211	22548	1464	27374	1036	19037
10-#14	1.79	MA	16197	4159	24493	3433	28982	2789	31062	2286	32906	1532	40695	1153	27615
4L-3S		MI	12018	4159	18629	3343	21752	2701	23183	2218	24462	1456	29514	1164	19197
10-#14	1.79	MA	15267	4159	23096	3449	27306	2788	29017	2298	30121	1539	37148	1087	25997
5L-2S		MI	12965	4159	19872	3347	23328	2707	25074	2211	26949	1449	32776	1296	19238
10-#18	3.17	MA	21685	4795	34863	3808	42082	3050	46861	2447	53932	1477	67851	1294	48749
2L-5S		MI	11070	4795	19158	3716	22227	2956	23621	2363	25022	1365	31030	529	28217
10-#18	3.17	MA	19325	4795	31615	3808	37963	3046	41871	2466	47248	1491	58958	1060	48149
3L-4S		MI	12131	4795	20814	3698	24205	2969	25968	2350	28213	1378	34901	640	30175
10-#18	3.17	MA	17617	4795	29193	3807	34689	3068	37905	2458	41943	1477	53114	826	44645
4L-3S		MI	13295	4795	22445	3706	26396	2956	28557	2363	31492	1365	38553	861	32578
10-#18	3.17	MA	16068	4795	26740	3834	31746	3064	34313	2476	37102	1491	46961	713	41672
5L-2S		MI	14869	4795	24602	3715	29123	2969	31795	2350	35752	1351	44104	1095	32914
12-#11	1.49	MA	17961	4022	26141	3356	31272	2722	33875	2245	36727	1543	45269	1445	23612
2L-6S		MI	10495	4022	16028	3279	18486	2662	19316	2187	19437	1485	23338	1045	15404
12-#11	1.49	MA	16958	4022	24844	3357	29628	2722	31882	2254	34038	1549	41649	1354	23560
3L-5S		MI	10928	4022	16619	3281	19273	2656	20270	2192	20660	1480	24951	1121	15857
12-#11	1.49	MA	16233	4022	23881	3358	28326	2732	30305	2252	31909	1545	39262	1263	23421
4E		MI	11379	4022	17282	3272	20070	2659	21237	2187	21932	1475	26562	1163	16185
12-#11	1.49	MA	15576	4022	22907	3369	27157	2732	28878	2261	29967	1551	36772	1217	22885
5L-3S		MI	11873	4022	17937	3274	20953	2652	22304	2192	23326	1480	28076	1253	16233
12-#11	1.49	MA	14947	4022	22043	3370	26004	2742	27474	2259	28099	1557	34245	1142	22063
6L-2S		MI	12545	4022	18808	3275	22059	2656	23638	2187	25082	1475	30388	1344	16238
12-#14	2.14	MA	19496	4323	29584	3534	35554	2851	39026	2325	43651	1524	54381	1395	33586
2L-6S		MI	10660	4323	17143	3451	19802	2787	20843	2256	21441	1449	26236	850	20714
12-#14	2.14	MA	18099	4323	27728	3535	33201	2850	36174	2337	39804	1531	49233	1264	33421
3L-5S		MI	11263	4323	17988	3454	20927	2778	22193	2264	23173	1442	28361	940	21520
12-#14	2.14	MA	17089	4323	26348	3535	31335	2864	33914	2334	36753	1524	45843	1132	33014
4E		MI	11891	4323	18937	3442	22065	2784	23563	2256	25035	1449	30637	1001	22542
12-#14	2.14	MA	16174	4323	24952	3551	29660	2863	31869	2345	33969	1532	42296	1067	31284
5L-3S		MI	12581	4323	19872	3446	23328	2775	25074	2264	26949	1442	32776	1129	22845
12-#14	2.14	MA	15296	4323	23712	3552	28006	2877	29856	2342	31291	1540	38702	958	30025
6L-2S		MI	13516	4323	21114	3449	24903	2782	26964	2256	29436	1434	36039	1261	22918
12-#18	3.81	MA	20762	5086	34863	3990	42082	3179	46861	2550	53932	1475	67851	1018	57603
3L-5S		MI	12032	5086	21316	3898	24954	3088	26859	2441	29283	1334	36581	457	34060
12-#18	3.81	MA	19092	5086	32441	3989	38809	3201	42895	2542	48628	1461	62008	784	53818
4E		MI	13072	5086	22972	3880	26932	3102	29206	2427	32474	1347	40453	567	36175
12-#18	3.81	MA	17579	5086	29988	4015	35866	3197	39303	2560	43787	1475	55855	670	50718
5L-3S		MI	14214	5086	24602	3888	29123	3088	31795	2441	35752	1334	44104	789	38830
12-#18	3.81	MA	16127	5086	27808	4015	32960	3219	35766	2552	39131	1488	49647	477	46773
6L-2S		MI	15761	5086	26760	3896	31849	3102	35033	2427	40013	1320	49656	1023	39248
14-#11	1.73	MA	18575	4135	27437	3427	32917	2774	35867	2278	39415	1538	48888	1433	27449
2L-7S		MI	10493	4135	16323	3348	18830	2710	19726	2224	19952	1471	24220	952	17374
14-#11	1.73	MA	17582	4135	26141	3428	31272	2774	33875	2287	36727	1544	45269	1342	27378
3L-6S		MI	10912	4135	16899	3350	19591	2714	20651	2219	21193	1476	25650	1022	17885
14-#11	1.73	MA	16865	4135	25178	3429	29971	2784	32297	2285	34597	1540	42882	1250	27215
4L-5S		MI	11340	4135	17490	3351	20378	2707	21604	2224	22416	1471	27262	1098	18315
14-#11	1.73	MA	16217	4135	24204	3440	28802	2784	30871	2294	32655	1546	40392	1204	26576
5L-4S		MI	11786	4135	18154	3343	21175	2711	22572	2219	23688	1466	28874	1140	18739

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

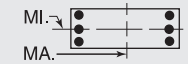
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.73	MA	15595	4135	23339	3441	27649	2793	29467	2292	30788	1552	37865	1129	25785
6L-3S		MI	12276	4135	18808	3345	22059	2704	23638	2224	25082	1471	30388	1231	18807
14-#11	1.73	MA	14986	4135	22497	3442	26534	2793	28106	2301	28894	1547	35615	1058	24960
7L-2S		MI	12941	4135	19680	3346	23164	2708	24973	2219	26838	1466	32699	1322	18829
14-#14	2.50	MA	18958	4486	29584	3637	35554	2925	39026	2384	43651	1524	54381	1244	38859
3L-6S		MI	11239	4486	18385	3553	21377	2862	22733	2302	23928	1434	29499	815	24141
14-#14	2.50	MA	17963	4486	28204	3638	33689	2939	36765	2381	40600	1517	50990	1112	38340
4L-5S		MI	11834	4486	19231	3556	22503	2853	24083	2310	25660	1427	31624	904	25032
14-#14	2.50	MA	17062	4486	26808	3653	32013	2938	34720	2393	37816	1525	47443	1046	36585
5L-4S		MI	12453	4486	20179	3545	23641	2859	25453	2302	27522	1434	33900	966	25994
14-#14	2.50	MA	16199	4486	25568	3654	30360	2951	32707	2390	35138	1532	43849	938	35250
6L-3S		MI	13134	4486	21114	3548	24903	2850	26964	2310	29436	1427	36039	1094	26485
14-#14	2.50	MA	15353	4486	24360	3655	28762	2950	30755	2401	32423	1525	40653	836	33451
7L-2S		MI	14058	4486	22357	3551	26479	2856	28854	2302	31923	1420	39302	1225	26587
14-#18	4.44	MA	20532	5377	35689	4171	42928	3334	47885	2626	55312	1445	70901	741	63024
4L-5S		MI	12973	5377	23473	4080	27681	3220	30097	2518	33543	1302	42132	384	39940
14-#18	4.44	MA	19052	5377	33236	4197	39985	3330	44294	2644	50471	1459	64748	628	59794
5L-4S		MI	13994	5377	25129	4061	29659	3234	32444	2505	36734	1316	46004	495	42207
14-#18	4.44	MA	17632	5377	31056	4197	37079	3352	40757	2636	45816	1472	58540	434	55983
6L-3S		MI	15149	5377	26760	4070	31849	3220	35033	2518	40013	1302	49656	717	45076
14-#18	4.44	MA	16240	5377	28933	4197	34271	3348	37327	2655	41095	1459	53029	252	51285
7L-2S		MI	16632	5377	28917	4078	34576	3234	38271	2505	44274	1289	55207	950	45569
16-#11	1.98	MA	18196	4249	27437	3499	32917	2826	35867	2320	39415	1539	48888	1329	31192
3L-7S		MI	10908	4249	17195	3419	19935	2762	21061	2257	21708	1462	26531	929	19808
16-#11	1.98	MA	17488	4249	26475	3500	31615	2836	34290	2318	37285	1534	46502	1238	31008
4L-6S		MI	11323	4249	17771	3421	20697	2766	21986	2252	22949	1467	27961	1000	20372
16-#11	1.98	MA	16847	4249	25501	3511	30446	2835	32863	2327	35343	1540	44012	1191	30276
5E		MI	11747	4249	18362	3422	21484	2759	22939	2257	24172	1462	29574	1076	20782
16-#11	1.98	MA	16232	4249	24636	3512	29293	2845	31459	2325	33476	1546	41485	1116	29514
6L-4S		MI	12188	4249	19025	3414	22280	2763	23907	2252	25444	1456	31186	1118	21288
16-#11	1.98	MA	15631	4249	23794	3513	28179	2845	30098	2333	31582	1542	39235	1045	28640
7L-3S		MI	12673	4249	19680	3415	23164	2756	24973	2257	26838	1462	32699	1208	21374
16-#11	1.98	MA	15036	4249	22966	3514	27087	2845	28734	2332	29756	1548	36910	992	27647
8L-2S		MI	13332	4249	20551	3417	24269	2760	26308	2252	28594	1456	35011	1299	21411
16-#14	2.86	MA	18821	4650	30060	3740	36043	3014	39617	2428	44447	1509	56138	1092	43582
4L-6S		MI	11807	4650	19628	3655	22953	2937	24623	2348	26415	1420	32762	780	27582
16-#14	2.86	MA	17934	4650	28664	3756	34367	3012	37572	2440	41663	1517	52591	1026	41898
5E		MI	12395	4650	20473	3658	24078	2928	25974	2356	28147	1412	34887	869	28555
16-#14	2.86	MA	17084	4650	27423	3756	32713	3026	35558	2437	38985	1525	48997	918	40488
6L-4S		MI	13006	4650	21422	3647	25217	2934	27344	2348	30009	1420	37162	930	29463
16-#14	2.86	MA	16251	4650	26216	3757	31115	3025	33606	2449	36270	1518	45801	815	38741
7L-3S		MI	13678	4650	22357	3650	26479	2925	28854	2356	31923	1412	39302	1059	30119
16-#14	2.86	MA	15427	4650	25027	3758	29550	3024	31651	2446	33651	1526	42489	739	36640
8L-2S		MI	14592	4650	23599	3653	28055	2931	30745	2348	34410	1405	42565	1190	30248
16-#18	5.08	MA	20494	5668	36484	4379	44104	3463	49284	2729	57156	1443	73641	585	68897
5E		MI	13956	5668	25631	4261	30407	3353	33335	2596	37804	1271	47683	312	45852
16-#18	5.08	MA	19103	5668	34304	4379	41198	3485	45747	2721	52501	1456	67434	392	65213
6L-4S		MI	14943	5668	27287	4243	32385	3366	35682	2583	40995	1285	51555	423	48264
16-#18	5.08	MA	17741	5668	32181	4378	38390	3481	42317	2739	47780	1443	61922	209	60451
7L-3S		MI	16019	5668	28917	4252	34576	3353	38271	2596	44274	1271	55207	644	51124
18-#11	2.23	MA	18101	4362	27771	3571	33260	2888	36282	2351	39973	1529	50122	1225	34799
4L-7S		MI	11317	4362	18066	3490	21041	2814	22395	2289	23464	1452	28843	906	22249
18-#11	2.23	MA	17468	4362	26798	3582	32091	2887	34856	2359	38031	1535	47632	1179	33985
5L-6S		MI	11728	4362	18642	3491	21802	2818	23320	2284	24705	1457	30273	977	22864

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis

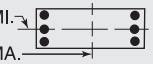


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.23	MA	16860	4362	25933	3583	30938	2897	33452	2358	36164	1541	45105	1104	33248
6L-5S		MI	12148	4362	19233	3493	22589	2811	24274	2289	25928	1452	31885	1053	23256
18-#11	2.23	MA	16266	4362	25091	3584	29824	2897	32090	2366	34271	1537	42855	1033	32326
7L-4S		MI	12585	4362	19897	3485	23385	2815	25241	2284	27200	1447	33497	1095	23834
18-#11	2.23	MA	15678	4362	24262	3585	28732	2896	30727	2365	32444	1543	40530	979	31358
8L-3S		MI	13065	4362	20551	3486	24269	2808	26308	2289	28594	1452	35011	1185	23937
18-#11	2.23	MA	15094	4362	23347	3596	27607	2906	29385	2373	30635	1549	38236	921	30102
9L-2S		MI	13719	4362	21423	3488	25374	2812	27643	2284	30350	1447	37322	1277	23987
18-#14	3.21	MA	18791	4814	30520	3858	36721	3087	40423	2488	45510	1510	57739	1006	47221
5L-6S		MI	12367	4814	20870	3757	24529	3011	26513	2394	28902	1405	36025	744	31037
18-#14	3.21	MA	17953	4814	29279	3859	35067	3101	38410	2484	42832	1517	54145	898	45738
6L-5S		MI	12947	4814	21716	3761	25654	3003	27864	2401	30634	1397	38150	834	32086
18-#14	3.21	MA	17132	4814	28072	3860	33469	3100	36458	2496	40117	1510	50949	795	44040
7L-4S		MI	13551	4814	22664	3749	26793	3009	29234	2394	32496	1405	40425	895	32948
18-#14	3.21	MA	16321	4814	26883	3860	31903	3099	34502	2493	37498	1518	47637	719	41902
8L-3S		MI	14215	4814	23599	3752	28055	3000	30745	2401	34410	1397	42565	1023	33748
18-#14	3.21	MA	15514	4814	25571	3876	30290	3113	32578	2505	34904	1526	44375	634	39775
9L-2S		MI	15119	4814	24841	3755	29631	3006	32635	2394	36897	1390	45828	1155	33903
18-#18	5.71	MA	20545	5959	37552	4560	45317	3618	50738	2805	59185	1440	76327	350	74364
6L-5S		MI	14857	5959	27789	4443	33134	3485	36573	2674	42065	1240	53235	239	51791
18-#18	5.71	MA	19210	5959	35429	4560	42509	3614	47307	2823	54464	1427	70815	167	69636
7L-4S		MI	15822	5959	29444	4425	35112	3498	38920	2661	45256	1254	57106	350	54343
20-#11	2.48	MA	18080	4476	28094	3653	33736	2939	36848	2392	40719	1530	51252	1166	37702
5L-7S		MI	11722	4476	18938	3561	22146	2866	23730	2322	25220	1443	31154	884	24698
20-#11	2.48	MA	17480	4476	27229	3654	32582	2949	35444	2391	38852	1536	48725	1091	36987
6E		MI	12129	4476	19514	3562	22907	2870	24655	2317	26461	1448	32584	954	25359
20-#11	2.48	MA	16892	4476	26388	3655	31468	2949	34083	2399	36959	1532	46475	1020	36019
7L-5S		MI	12544	4476	20105	3564	23694	2863	25609	2322	27684	1443	34197	1030	25736
20-#11	2.48	MA	16311	4476	25559	3656	30376	2948	32719	2398	35132	1538	44150	967	35075
8L-4S		MI	12977	4476	20768	3556	24491	2867	26576	2317	28956	1438	35809	1073	26377
20-#11	2.48	MA	15734	4476	24644	3667	29251	2958	31377	2406	33323	1544	41855	908	33792
9L-3S		MI	13453	4476	21423	3557	25374	2860	27643	2322	30350	1443	37322	1163	26496
20-#11	2.48	MA	15159	4476	23819	3668	28167	2958	30029	2404	31463	1540	39483	828	32547
10L-2S		MI	14101	4476	22294	3559	26479	2864	28977	2317	32105	1438	39634	1254	26559
20-#14	3.57	MA	18809	4977	31135	3961	37420	3176	41261	2532	46679	1510	59293	877	50998
6E		MI	12919	4977	22113	3860	26104	3086	28404	2440	31389	1390	39288	709	34503
20-#14	3.57	MA	17999	4977	29928	3962	35823	3175	39309	2544	43964	1503	56097	775	49346
7L-5S		MI	13492	4977	22958	3863	27230	3077	29754	2447	33121	1383	41413	798	35625
20-#14	3.57	MA	17199	4977	28739	3963	34257	3174	37353	2540	41345	1511	52784	699	47172
8L-4S		MI	14089	4977	23907	3851	28368	3083	31124	2440	34983	1390	43688	860	36445
20-#14	3.57	MA	16405	4977	27426	3978	32643	3187	35429	2552	38751	1518	49523	614	45019
9L-3S		MI	14745	4977	24841	3854	29631	3075	32635	2447	36897	1383	45828	988	37374
20-#18	6.35	MA	20652	6249	38677	4742	46628	3747	52298	2907	61149	1411	79708	125	78836
7L-5S		MI	15742	6249	29946	4625	35861	3617	39811	2752	46325	1209	58786	167	57755
22-#11	2.72	MA	18091	4589	28526	3725	34227	3001	37436	2423	41540	1531	52345	1078	40730
6L-7S		MI	12121	4589	19809	3631	23251	2918	25065	2355	26976	1434	33466	861	27152
22-#11	2.72	MA	17510	4589	27684	3726	33113	3001	36075	2432	39647	1527	50095	1007	39718
7L-6S		MI	12524	4589	20385	3633	24012	2922	25990	2349	28217	1439	34896	932	27857
22-#11	2.72	MA	16935	4589	26856	3726	32021	3000	34712	2430	37820	1533	47770	954	38796
8L-5S		MI	12936	4589	20976	3635	24799	2915	26943	2355	29440	1434	36508	1008	28222
22-#11	2.72	MA	16364	4589	25941	3738	30896	3010	33370	2439	36011	1539	45475	895	37488
9L-4S		MI	13364	4589	21640	3626	25596	2918	27911	2349	30711	1429	38120	1050	28919
22-#11	2.72	MA	15796	4589	25115	3739	29812	3010	32022	2437	34151	1534	43103	815	36223
10L-3S		MI	13836	4589	22294	3628	26479	2912	28977	2355	32105	1434	39634	1140	29052
22-#11	2.72	MA	15197	4589	24296	3740	28700	3020	30688	2446	32350	1540	40818	759	34924
11L-2S		MI	14479	4589	23165	3630	27585	2915	30312	2349	33861	1429	41945	1231	29128
22-#14	3.93	MA	18854	5141	31783	4064	38176	3250	42161	2591	47811	1495	61244	755	54660
7L-6S		MI	13464	5141	23355	3962	27680	3161	30294	2486	33876	1375	42551	674	37979

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.93	MA	18065	5141	30595	4065	36610	3248	40205	2588	45192	1503	57932	679	52449
8L-5S		MI	14030	5141	24201	3965	28805	3152	31644	2493	35608	1368	44676	763	39169
22-#14	3.93	MA	17281	5141	29282	4081	34997	3262	38281	2600	42598	1511	54671	594	50269
9L-4S		MI	14620	5141	25149	3953	29944	3158	33015	2486	37470	1375	46951	824	39952
24-#11	2.97	MA	18119	4702	28981	3796	34757	3052	38068	2465	42335	1521	53715	995	43422
7E		MI	12516	4702	20681	3702	24356	2970	26400	2387	28732	1424	35777	839	29612
24-#11	2.97	MA	17551	4702	28152	3797	33666	3052	36704	2463	40508	1527	51390	941	42521
8L-6S		MI	12915	4702	21257	3704	25117	2973	27325	2382	29973	1430	37207	909	30349
24-#11	2.97	MA	16986	4702	27237	3809	32541	3062	35362	2472	38699	1533	49095	882	41188
9L-5S		MI	13323	4702	21848	3706	25904	2967	28278	2387	31196	1424	38820	985	30711
24-#11	2.97	MA	16424	4702	26412	3810	31456	3062	34014	2470	36839	1529	46723	802	39903
10L-4S		MI	13748	4702	22511	3697	26701	2970	29246	2382	32467	1419	40432	1027	31386
24-#11	2.97	MA	15827	4702	25592	3810	30344	3072	32681	2479	35038	1535	44438	746	38606
11L-3S		MI	14215	4702	23165	3699	27585	2964	30312	2387	33861	1424	41945	1118	31605
24-#14	4.29	MA	18917	5304	32450	4167	38964	3323	43056	2635	49039	1496	63080	659	57734
8L-6S		MI	14002	5304	24598	4064	29256	3236	32184	2532	36363	1361	45813	639	41465
24-#14	4.29	MA	18144	5304	31138	4183	37351	3337	41132	2647	46445	1503	59818	574	55526
9L-5S		MI	14563	5304	25443	4067	30381	3227	33535	2539	38095	1353	47939	728	42719

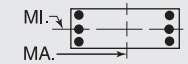
RECTANGULAR TIED COLUMNS 30" x 44"

4-#18	1.21	MA	18859	4082	27203	3412	32251	2774	34590	2299	36722	1609	44631	1505	21053
2E		MI	12547	4082	18787	3303	21680	2683	22824	2210	23658	1516	28230	1382	13769
6-#14	1.02	MA	18420	3991	26033	3376	30944	2750	33083	2287	34781	1626	42229	1538	18008
2L-3S		MI	11338	3991	16795	3274	19336	2662	20147	2221	20179	1558	23772	1305	11890
6-#14	1.02	MA	16874	3991	24075	3378	28461	2749	30075	2300	30722	1635	36766	1407	17978
3L-2S		MI	12312	3991	18037	3277	20912	2668	22037	2213	22666	1551	27035	1437	11850
6-#18	1.82	MA	20475	4373	30632	3594	36601	2907	39859	2383	43812	1594	54084	1466	31220
2L-3S		MI	11870	4373	18787	3476	21680	2802	22824	2301	23658	1499	28230	1076	20110
6-#18	1.82	MA	17859	4373	27203	3594	32251	2904	34590	2403	36722	1608	44631	1232	30858
3L-2S		MI	13511	4373	20945	3485	24407	2815	26062	2287	27919	1485	33781	1309	20218
8-#14	1.36	MA	19372	4155	27991	3478	33428	2825	36092	2335	38840	1619	47692	1520	23825
2L-4S		MI	11214	4155	17102	3373	19650	2746	20526	2259	20752	1551	24895	1142	15485
8-#14	1.36	MA	17849	4155	26033	3480	30944	2824	33083	2347	34781	1627	42229	1388	23743
3E		MI	11925	4155	18037	3376	20912	2737	22037	2267	22666	1544	27035	1270	15578
8-#14	1.36	MA	16746	4155	24579	3481	28979	2838	30701	2344	31565	1621	38627	1257	23432
4L-2S		MI	12887	4155	19280	3379	22488	2743	23927	2259	25153	1536	30297	1401	15573
8-#18	2.42	MA	22037	4664	34062	3775	40951	3040	45129	2467	50902	1580	63537	1427	41346
2L-4S		MI	11645	4664	19315	3650	22216	2947	23474	2365	24640	1481	30129	781	24455
8-#18	2.42	MA	19481	4664	30632	3776	36601	3037	39859	2487	43812	1593	54084	1193	40855
3E		MI	12838	4664	20945	3658	24407	2934	26062	2378	27919	1468	33781	1003	26397
8-#18	2.42	MA	17628	4664	28079	3777	33149	3060	35676	2480	38186	1580	47866	959	37741
4L-2S		MI	14448	4664	23102	3667	27134	2947	29300	2365	32180	1454	39332	1237	26610
10-#11	1.18	MA	18913	4068	26903	3434	32137	2793	34567	2317	36809	1628	45091	1541	20820
2L-5S		MI	10987	4068	16394	3345	18903	2715	19679	2254	19597	1562	23426	1214	13529
10-#11	1.18	MA	17840	4068	25535	3436	30403	2793	32466	2326	33974	1635	41252	1450	20790
3L-4S		MI	11444	4068	17058	3337	19699	2719	20647	2249	20869	1557	25038	1256	13668
10-#11	1.18	MA	17065	4068	24521	3437	29031	2804	30804	2324	31731	1631	38718	1359	20678
4L-3S		MI	11945	4068	17712	3339	20583	2712	21713	2254	22263	1562	26551	1346	13684
10-#11	1.18	MA	16363	4068	23496	3448	27801	2804	29302	2333	29686	1638	36083	1312	20337
5L-2S		MI	12625	4068	18583	3340	21688	2716	23048	2249	24018	1557	28863	1437	13667

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

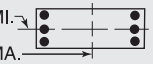


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.70	MA	20302	4318	29949	3581	35911	2899	39100	2382	42899	1611	53155	1501	29622
2L-5S		MI	11160	4318	17396	3487	20087	2814	21047	2312	21377	1529	25882	1045	18170
10-#14	1.70	MA	18801	4318	27991	3582	33428	2899	36092	2394	38840	1620	47692	1370	29497
3L-4S		MI	11799	4318	18345	3475	21225	2820	22417	2305	23239	1536	28158	1106	19105
10-#14	1.70	MA	17716	4318	26537	3583	31462	2913	33709	2392	35624	1613	44091	1238	29134
4L-3S		MI	12500	4318	19280	3478	22488	2812	23927	2312	25153	1529	30297	1235	19244
10-#14	1.70	MA	16734	4318	25066	3599	29697	2912	31555	2404	32691	1622	40333	1172	27532
5L-2S		MI	13450	4318	20522	3482	24063	2818	25818	2305	27640	1522	33560	1366	19276
10-#18	3.03	MA	23556	4955	37492	3957	45300	3173	50399	2551	57992	1566	72990	1387	51449
2L-5S		MI	11546	4955	19816	3850	22965	3066	24364	2456	25710	1436	31809	598	28592
10-#18	3.03	MA	21052	4955	34062	3958	40951	3170	45129	2571	50902	1579	63537	1154	50849
3L-4S		MI	12612	4955	21472	3832	24943	3079	26712	2443	28901	1450	35680	709	30409
10-#18	3.03	MA	19243	4955	31508	3958	37499	3193	40946	2564	45276	1566	57319	920	47399
4L-3S		MI	13782	4955	23102	3840	27134	3066	29300	2456	32180	1436	39332	931	32665
10-#18	3.03	MA	17604	4955	28923	3986	34397	3190	37160	2584	40142	1579	50792	805	44471
5L-2S		MI	15362	4955	25260	3848	29860	3079	32538	2443	36440	1423	44883	1164	32970
12-#11	1.42	MA	19576	4181	28270	3505	33871	2845	36668	2349	39644	1623	48929	1529	24875
2L-6S		MI	10973	4181	16674	3415	19221	2774	20060	2282	20130	1558	24125	1115	15513
12-#11	1.42	MA	18514	4181	26903	3507	32137	2845	34567	2359	36809	1630	45091	1438	24824
3L-5S		MI	11407	4181	17265	3416	20008	2767	21014	2287	21353	1553	25737	1191	15974
12-#11	1.42	MA	17748	4181	25889	3508	30766	2855	32905	2357	34566	1626	42557	1347	24685
4E		MI	11858	4181	17929	3408	20804	2771	21981	2282	22624	1548	27349	1234	16232
12-#11	1.42	MA	17055	4181	24863	3519	29535	2855	31403	2366	32521	1632	39922	1300	24220
5L-3S		MI	12355	4181	18583	3409	21688	2764	23048	2287	24018	1553	28863	1324	16271
12-#11	1.42	MA	16390	4181	23953	3521	28321	2866	29925	2365	30554	1639	37241	1225	23321
6L-2S		MI	13028	4181	19455	3411	22793	2768	24383	2282	25774	1548	31174	1415	16269
12-#14	2.05	MA	21214	4482	31907	3683	38394	2974	42109	2429	46957	1604	58619	1483	35408
2L-6S		MI	11137	4482	17794	3586	20537	2898	21586	2351	22132	1522	27020	920	20956
12-#14	2.05	MA	19733	4482	29949	3684	35911	2974	39100	2442	42899	1612	53155	1351	35243
3L-5S		MI	11743	4482	18639	3589	21663	2889	22937	2358	23864	1514	29145	1010	21666
12-#14	2.05	MA	18665	4482	28495	3685	33945	2988	36718	2439	39683	1606	49554	1220	34837
4E		MI	12373	4482	19587	3577	22801	2895	24307	2351	25726	1522	31421	1071	22714
12-#14	2.05	MA	17698	4482	27024	3702	32180	2987	34563	2452	36750	1615	45796	1153	33116
5L-3S		MI	13065	4482	20522	3581	24063	2886	25818	2358	27640	1514	33560	1199	22897
12-#14	2.05	MA	16771	4482	25718	3703	30438	3002	32443	2449	33930	1623	41982	1045	31924
6L-2S		MI	14003	4482	21765	3584	25639	2893	27708	2351	30127	1507	36823	1331	22959
12-#18	3.64	MA	22584	5245	37492	4140	45300	3303	50399	2655	57992	1565	72990	1115	60843
3L-5S		MI	12511	5245	21974	4031	25692	3198	27602	2534	29971	1405	37360	526	34428
12-#18	3.64	MA	20814	5245	34938	4140	41849	3326	46216	2649	52366	1551	66772	881	57097
4E		MI	13556	5245	23630	4013	27670	3211	29950	2521	33162	1419	41231	637	36403
12-#18	3.64	MA	19213	5245	32353	4167	38746	3323	42430	2668	47232	1565	60245	766	54045
5L-3S		MI	14704	5245	25260	4022	29860	3198	32538	2534	36440	1405	44883	858	38923
12-#18	3.64	MA	17676	5245	30056	4168	35684	3347	38702	2661	42294	1578	53646	573	49722
6L-2S		MI	16258	5245	27417	4030	32587	3211	35776	2521	40701	1392	50434	1092	39309
14-#11	1.65	MA	20229	4294	29638	3576	35606	2897	38770	2382	42479	1618	52768	1518	28923
2L-7S		MI	10970	4294	16970	3484	19565	2822	20470	2319	20645	1544	25006	1022	17550
14-#11	1.65	MA	19178	4294	28270	3577	33871	2897	36668	2391	39644	1625	48929	1427	28852
3L-6S		MI	11390	4294	17546	3485	20326	2826	21395	2314	21886	1549	26436	1093	17994
14-#11	1.65	MA	18421	4294	27256	3579	32500	2907	35006	2390	37401	1621	46396	1335	28690
4L-5S		MI	11820	4294	18137	3487	21113	2819	22349	2319	23109	1544	28049	1169	18431
14-#11	1.65	MA	17736	4294	26231	3590	31270	2907	33504	2399	35356	1627	43761	1289	28116
5L-4S		MI	12267	4294	18801	3479	21910	2823	23316	2314	24380	1539	29661	1211	18789
14-#11	1.65	MA	17079	4294	25320	3591	30055	2918	32026	2398	33389	1634	41080	1214	27250
6L-3S		MI	12759	4294	19455	3480	22793	2816	24383	2319	25774	1544	31174	1301	18847
14-#11	1.65	MA	16436	4294	24434	3593	28882	2918	30593	2407	31396	1630	38693	1143	26472
7L-2S		MI	13426	4294	20326	3482	23898	2820	25717	2314	27530	1539	33486	1392	18864
14-#14	2.39	MA	20648	4646	31907	3786	38394	3048	42109	2489	46957	1605	58619	1333	40986
3L-6S		MI	11717	4646	19036	3688	22113	2973	23477	2397	24619	1507	30283	885	24378

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis



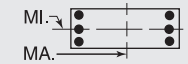
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.39	MA	19595	4646	30453	3788	36428	3063	39726	2487	43742	1599	55017	1201	40540
4L-5S		MI	12315	4646	19881	3691	23238	2964	24827	2404	26351	1499	32408	974	25177
14-#14	2.39	MA	18644	4646	28983	3804	34663	3062	37572	2499	40809	1607	51259	1135	38714
5L-4S		MI	12937	4646	20830	3680	24377	2970	26197	2397	28213	1507	34683	1036	26163
14-#14	2.39	MA	17731	4646	27676	3805	32922	3076	35452	2496	37988	1616	47445	1026	37446
6L-3S		MI	13620	4646	21765	3683	25639	2961	27708	2404	30127	1499	36823	1164	26541
14-#14	2.39	MA	16837	4646	26405	3807	31239	3076	33396	2509	35129	1610	44050	924	35479
7L-2S		MI	14548	4646	23007	3686	27215	2967	29598	2397	32614	1492	40086	1295	26631
14-#18	4.24	MA	22348	5536	38368	4322	46198	3459	51485	2733	59456	1537	76225	842	66828
4L-5S		MI	13454	5536	24131	4213	28418	3330	30840	2612	34231	1374	42911	454	40301
14-#18	4.24	MA	20781	5536	35783	4349	43096	3456	47699	2752	54322	1550	69698	727	63650
5L-4S		MI	14482	5536	25787	4195	30396	3344	33188	2598	37422	1388	46782	564	42431
14-#18	4.24	MA	19278	5536	33486	4350	40034	3480	43972	2746	49384	1564	63099	533	59463
6L-3S		MI	15610	5536	27417	4203	32587	3330	35776	2612	40701	1374	50434	786	45174
14-#18	4.24	MA	17805	5536	31249	4350	37075	3476	40357	2765	44377	1550	57235	351	54648
7L-2S		MI	17139	5536	29575	4212	35314	3344	39014	2598	44962	1361	55985	1020	45634
16-#11	1.89	MA	19832	4408	29638	3648	35606	2949	38770	2424	42479	1619	52768	1415	32877
3L-7S		MI	11386	4408	17841	3555	20670	2874	21805	2352	22401	1534	27318	999	19981
16-#11	1.89	MA	19083	4408	28624	3650	34235	2959	37108	2423	40236	1616	50235	1324	32693
4L-6S		MI	11802	4408	18417	3556	21431	2878	22730	2347	23642	1540	28748	1070	20481
16-#11	1.89	MA	18406	4408	27598	3661	33004	2959	35605	2432	38191	1622	47599	1277	32021
5E		MI	12228	4408	19008	3558	22218	2871	23683	2352	24865	1534	30360	1146	20897
16-#11	1.89	MA	17757	4408	26688	3662	31790	2969	34127	2431	36224	1629	44919	1202	31186
6L-4S		MI	12671	4408	19672	3549	23015	2875	24651	2347	26136	1529	31972	1188	21342
16-#11	1.89	MA	17122	4408	25802	3664	30617	2969	32694	2440	34231	1625	42532	1131	30357
7L-3S		MI	13157	4408	20326	3551	23898	2868	25717	2352	27530	1534	33486	1279	21417
16-#11	1.89	MA	16493	4408	24930	3665	29468	2969	31258	2439	32308	1632	40070	1077	29275
8L-2S		MI	13819	4408	21198	3553	25004	2871	27052	2347	29286	1529	35797	1370	21448
16-#14	2.73	MA	20509	4809	32411	3890	38912	3137	42735	2534	47801	1591	60480	1183	46186
4L-6S		MI	12287	4809	20278	3790	23689	3048	25367	2443	27106	1492	33546	850	27816
16-#14	2.73	MA	19571	4809	30941	3906	37147	3137	40580	2546	44868	1600	56722	1116	44324
5E		MI	12877	4809	21124	3793	24814	3039	26717	2450	28838	1485	35671	939	28699
16-#14	2.73	MA	18672	4809	29634	3907	35405	3151	38460	2544	42047	1608	52908	1008	42980
6L-4S		MI	13492	4809	22072	3782	25953	3045	28088	2443	30700	1492	37946	1000	29630
16-#14	2.73	MA	17791	4809	28363	3909	33722	3151	36404	2556	39188	1602	49513	906	41068
7L-3S		MI	14167	4809	23007	3785	27215	3036	29598	2450	32614	1485	40086	1129	30178
16-#14	2.73	MA	16920	4809	27112	3910	32074	3150	34345	2554	36430	1611	46004	829	38956
8L-2S		MI	15084	4809	24249	3788	28790	3042	31488	2443	35101	1477	43349	1260	30295
16-#18	4.85	MA	22316	5827	39213	4531	47446	3589	52969	2837	61412	1536	79151	688	73281
5E		MI	14443	5827	26289	4395	31145	3463	34078	2689	38492	1343	48462	381	46205
16-#18	4.85	MA	20843	5827	36915	4531	44383	3613	49241	2830	56474	1549	72552	494	69224
6L-4S		MI	15438	5827	27945	4377	33123	3476	36426	2676	41683	1356	52333	492	48485
16-#18	4.85	MA	19401	5827	34679	4532	41424	3609	45627	2850	51467	1536	66688	312	64348
7L-3S		MI	16522	5827	29575	4385	35314	3463	39014	2689	44962	1343	55985	714	51421
18-#11	2.13	MA	19736	4521	29992	3720	35969	3011	39209	2456	43071	1610	54073	1312	36695
4L-7S		MI	11796	4521	18713	3625	21775	2926	23140	2384	24157	1525	29629	977	22421
18-#11	2.13	MA	19066	4521	28966	3732	34738	3011	37707	2465	41026	1617	51438	1265	35935
5L-6S		MI	12209	4521	19289	3627	22536	2929	24065	2379	25398	1530	31059	1047	22973
18-#11	2.13	MA	18425	4521	28056	3733	33524	3021	36228	2464	39059	1624	48758	1190	35128
6L-5S		MI	12630	4521	19880	3629	23323	2923	25018	2384	26621	1525	32672	1124	23370
18-#11	2.13	MA	17797	4521	27170	3734	32351	3021	34795	2473	37066	1620	46370	1120	34250
7L-4S		MI	13069	4521	20543	3620	24120	2926	25986	2379	27892	1520	34284	1166	23890
18-#11	2.13	MA	17176	4521	26298	3736	31202	3021	33360	2471	35143	1626	43909	1066	33195
8L-3S		MI	13551	4521	21198	3622	25004	2920	27052	2384	29286	1525	35797	1256	23982

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

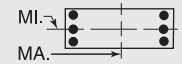


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.13	MA	16559	4521	25334	3747	30018	3032	31947	2480	33238	1633	41474	1007	31947
9L-2S		MI	14207	4521	22069	3624	26109	2923	28387	2379	31042	1520	38109	1347	24026
18-#14	3.07	MA	20483	4973	32899	4008	39630	3212	43589	2594	48927	1592	62185	1098	49945
5L-6S		MI	12849	4973	21521	3892	25264	3122	27257	2488	29593	1477	36809	814	31267
18-#14	3.07	MA	19597	4973	31593	4010	37888	3226	41469	2591	46106	1601	58371	989	48526
6L-5S		MI	13432	4973	22366	3896	26390	3114	28608	2496	31325	1470	38934	904	32229
18-#14	3.07	MA	18729	4973	30321	4011	36206	3225	39413	2604	43247	1595	54976	887	46665
7L-4S		MI	14039	4973	23315	3884	27528	3120	29978	2488	33187	1477	41209	965	33112
18-#14	3.07	MA	17871	4973	29070	4012	34557	3225	37353	2601	40488	1603	51467	810	44517
8L-3S		MI	14706	4973	24249	3887	28790	3111	31488	2496	35101	1470	43349	1093	33810
18-#14	3.07	MA	17018	4973	27688	4028	32858	3239	35327	2614	37757	1612	48004	726	42371
9L-2S		MI	15614	4973	25492	3891	30366	3117	33379	2488	37588	1463	46612	1225	33952
18-#18	5.45	MA	22378	6118	40345	4713	48733	3746	54511	2914	63564	1535	82005	455	79004
6L-5S		MI	15348	6118	28446	4577	33872	3595	37316	2767	42753	1312	54013	309	52138
18-#18	5.45	MA	20963	6118	38108	4714	45774	3742	50896	2934	58557	1522	76141	273	74065
7L-4S		MI	16320	6118	30102	4558	35850	3608	39663	2754	45944	1325	57885	420	54560
20-#11	2.36	MA	19717	4635	30334	3803	36473	3063	39808	2498	43861	1612	55277	1254	39857
5L-7S		MI	12202	4635	19584	3696	22881	2978	24474	2417	25913	1516	31941	954	24867
20-#11	2.36	MA	19083	4635	29423	3804	35259	3073	38330	2496	41894	1618	52596	1179	39074
6E		MI	12610	4635	20160	3698	23642	2981	25399	2412	27154	1521	33371	1025	25468
20-#11	2.36	MA	18462	4635	28537	3805	34086	3073	36897	2506	39901	1615	50209	1108	38148
7L-5S		MI	13028	4635	20751	3700	24429	2975	26353	2417	28377	1516	34983	1101	25850
20-#11	2.36	MA	17848	4635	27665	3807	32937	3073	35461	2504	37978	1621	47747	1054	37118
8L-4S		MI	13462	4635	21415	3691	25225	2978	27320	2412	29648	1511	36595	1143	26436
20-#11	2.36	MA	17238	4635	26702	3818	31752	3083	34049	2513	36073	1628	45313	995	35845
9L-3S		MI	13940	4635	22069	3693	26109	2972	28387	2417	31042	1516	38109	1233	26543
20-#11	2.36	MA	16631	4635	25833	3819	30611	3083	32630	2512	34115	1624	42796	915	34609
10L-2S		MI	14591	4635	22941	3695	27214	2975	29722	2412	32798	1511	40420	1324	26600
20-#14	3.41	MA	20507	5136	33551	4112	40371	3301	44477	2639	50165	1593	63834	971	54084
6E		MI	13403	5136	22763	3995	26840	3197	29148	2534	32080	1463	40072	779	34730
20-#14	3.41	MA	19651	5136	32279	4113	38689	3300	42421	2651	47306	1587	60440	869	52271
7L-5S		MI	13979	5136	23609	3998	27965	3188	30498	2542	33812	1455	42197	869	35767
20-#14	3.41	MA	18805	5136	31028	4114	37040	3300	40362	2649	44547	1596	56930	792	50086
8L-4S		MI	14579	5136	24557	3986	29104	3195	31868	2534	35674	1463	44472	930	36607
20-#14	3.41	MA	17964	5136	29646	4131	35341	3314	38335	2661	41816	1604	53467	707	47914
9L-3S		MI	15239	5136	25492	3989	30366	3186	33379	2542	37588	1455	46612	1058	37439
20-#18	6.06	MA	22497	6408	41538	4896	50124	3875	56166	3018	65647	1507	85594	234	83798
7L-5S		MI	16236	6408	30604	4758	36598	3727	40554	2845	47014	1281	59564	236	58095
22-#11	2.60	MA	19733	4748	30791	3875	36993	3125	40431	2529	44729	1613	56435	1167	43025
6L-7S		MI	12602	4748	20456	3767	23986	3030	25809	2449	27669	1507	34252	932	27320
22-#11	2.60	MA	19119	4748	29905	3876	35820	3125	38998	2538	42736	1609	54048	1096	42053
7L-6S		MI	13007	4748	21032	3769	24747	3033	26734	2444	28910	1512	35682	1002	27966
22-#11	2.60	MA	18511	4748	29033	3877	34671	3125	37562	2537	40813	1616	51586	1042	41047
8L-5S		MI	13421	4748	21623	3771	25534	3026	27688	2449	30132	1507	37295	1078	28334
22-#11	2.60	MA	17908	4748	28069	3889	33487	3135	36150	2546	38908	1623	49152	984	39748
9L-4S		MI	13852	4748	22286	3762	26330	3030	28655	2444	31404	1501	38907	1121	28980
22-#11	2.60	MA	17308	4748	27201	3890	32346	3135	34731	2545	36950	1619	46635	904	38492
10L-3S		MI	14325	4748	22941	3764	27214	3023	29722	2449	32798	1507	40420	1211	29101
22-#11	2.60	MA	16666	4748	26338	3891	31175	3146	33327	2554	35054	1625	44216	847	37079
11L-2S		MI	14971	4748	23812	3766	28319	3027	31056	2444	34554	1501	42732	1302	29170
22-#14	3.75	MA	20560	5300	34237	4215	41172	3375	45430	2698	51365	1580	65903	850	57883
7L-6S		MI	13949	5300	24006	4097	28416	3272	31038	2580	34567	1448	43334	744	38204
22-#14	3.75	MA	19725	5300	32986	4217	39523	3374	43370	2696	48606	1588	62393	773	55662
8L-5S		MI	14519	5300	24851	4100	29541	3263	32388	2588	36299	1441	45460	833	39311
22-#14	3.75	MA	18896	5300	31604	4233	37824	3389	41344	2708	45875	1597	58930	688	53464
9L-4S		MI	15112	5300	25800	4088	30680	3269	33759	2580	38161	1448	47735	895	40112
24-#11	2.84	MA	19767	4862	31272	3947	37555	3177	41099	2571	45571	1604	57887	1085	45964
7E		MI	12999	4862	21327	3838	25091	3081	27144	2482	29425	1497	36564	909	29778

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.84	MA	19166	4862	30400	3948	36405	3177	39664	2570	43648	1611	55425	1031	44979
8L-6S		MI	13400	4862	21903	3840	25852	3085	28069	2477	30666	1503	37994	980	30467
24-#11	2.84	MA	18570	4862	29437	3960	35221	3187	38251	2579	41743	1617	52990	972	43655
9L-5S		MI	13810	4862	22494	3842	26639	3078	29022	2482	31888	1497	39606	1056	30823
24-#11	2.84	MA	17973	4862	28568	3961	34080	3187	36832	2578	39785	1614	50474	892	42380
10L-4S		MI	14237	4862	23158	3833	27436	3082	29990	2477	33160	1492	41218	1098	31519
24-#11	2.84	MA	17336	4862	27706	3962	32909	3197	35428	2587	37889	1620	48054	835	40988
11L-3S		MI	14707	4862	23812	3835	28319	3075	31056	2482	34554	1497	42732	1188	31657
24-#14	4.09	MA	20632	5463	34944	4319	42007	3449	46379	2743	52665	1581	67856	755	61245
8L-6S		MI	14490	5463	25248	4199	29992	3347	32928	2626	37054	1433	46597	709	41686
24-#14	4.09	MA	19813	5463	33562	4335	40308	3463	44352	2756	49933	1589	64394	670	59021
9L-5S		MI	15053	5463	26093	4202	31117	3338	34279	2633	38786	1426	48723	798	42861

RECTANGULAR TIED COLUMNS 30" x 46"

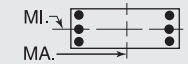
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.16	MA	20502	4241	29361	3561	34872	2897	37388	2403	39643	1691	48204	1588	22133
2E		MI	13028	4241	19445	3437	22418	2793	23567	2303	24346	1588	29008	1451	13805
6-#18	1.74	MA	22219	4532	32972	3743	39452	3030	42937	2487	47130	1677	58217	1552	32840
2L-3S		MI	12350	4532	19445	3610	22418	2912	23567	2394	24346	1570	29008	1145	20177
6-#18	1.74	MA	19455	4532	29361	3744	34872	3028	37388	2508	39643	1691	48204	1318	32478
3L-2S		MI	13996	4532	21603	3618	25145	2925	26805	2381	28607	1557	34559	1379	20261
8-#14	1.30	MA	21042	4314	30184	3628	36102	2947	38959	2439	41818	1699	51412	1603	25040
2L-4S		MI	11692	4314	17753	3508	20385	2857	21270	2353	21443	1624	25679	1212	15544
8-#14	1.30	MA	19434	4314	28124	3629	33489	2947	35794	2452	37547	1708	45633	1472	24958
3E		MI	12405	4314	18688	3511	21648	2848	22781	2361	23357	1616	27818	1340	15619
8-#14	1.30	MA	18272	4314	26596	3631	31423	2962	33290	2450	34167	1703	41820	1340	24647
4L-2S		MI	13369	4314	19930	3514	23223	2854	24671	2353	25844	1609	31081	1471	15605
8-#18	2.32	MA	23879	4823	36584	3925	44033	3163	48486	2571	54616	1664	68230	1516	43506
2L-4S		MI	12124	4823	19972	3783	22954	3057	24217	2459	25328	1553	30907	851	24689
8-#18	2.32	MA	21176	4823	32972	3926	39452	3161	42937	2592	47130	1678	58217	1282	43015
3E		MI	13321	4823	21603	3792	25145	3044	26805	2472	28607	1539	34559	1072	26472
8-#18	2.32	MA	19221	4823	30287	3928	35822	3185	38538	2587	41192	1665	51623	1049	39993
4L-2S		MI	14936	4823	23760	3800	27871	3057	30043	2459	32868	1526	40110	1306	26661
10-#11	1.13	MA	20552	4227	29036	3584	34740	2916	37351	2421	39676	1708	48645	1623	21873
2L-5S		MI	11465	4227	17041	3481	19637	2827	20423	2349	20289	1635	24212	1284	13642
10-#11	1.13	MA	19420	4227	27598	3585	32916	2916	35141	2430	36694	1715	44587	1532	21843
3L-4S		MI	11922	4227	17704	3473	20434	2831	21391	2344	21561	1630	25824	1327	13708
10-#11	1.13	MA	18604	4227	26532	3587	31475	2927	33394	2429	34337	1712	41907	1441	21731
4L-3S		MI	12425	4227	18359	3474	21317	2824	22457	2349	22955	1635	27338	1417	13716
10-#11	1.13	MA	17865	4227	25455	3598	30183	2927	31816	2439	32188	1719	39125	1394	21464
5L-2S		MI	13106	4227	19230	3476	22423	2828	23792	2344	24711	1630	29649	1508	13695
10-#14	1.63	MA	22029	4478	32245	3730	38715	3022	42125	2486	46089	1691	57190	1586	31141
2L-5S		MI	11638	4478	18047	3622	20823	2925	21790	2407	22068	1601	26666	1115	18314
10-#14	1.63	MA	20444	4478	30184	3732	36102	3022	38959	2499	41818	1701	51412	1455	31015
3L-4S		MI	12279	4478	18995	3610	21961	2932	23161	2399	23930	1609	28942	1176	19170
10-#14	1.63	MA	19300	4478	28656	3733	34036	3037	36455	2497	38438	1695	47598	1323	30653
4L-3S		MI	12982	4478	19930	3613	23223	2923	24671	2407	25844	1601	31081	1305	19290
10-#14	1.63	MA	18265	4478	27111	3750	32182	3037	34192	2510	35356	1704	43630	1256	29079
5L-2S		MI	13934	4478	21173	3617	24799	2929	26562	2399	28331	1594	34344	1436	19312
10-#18	2.90	MA	25493	5114	40195	4106	48613	3296	54035	2656	62103	1651	78243	1480	54149
2L-5S		MI	12022	5114	20474	3983	23703	3176	25107	2550	26398	1508	32587	668	28961
10-#18	2.90	MA	22845	5114	36584	4108	44033	3294	48486	2677	54616	1665	68230	1246	53549
3L-4S		MI	13093	5114	22130	3965	25681	3189	27455	2536	29589	1521	36458	778	30637

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

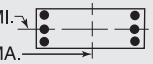


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	2.90	MA	20935	5114	33898	4109	40402	3318	44087	2671	48678	1652	61636	1013	50176
4L-3S		MI	14268	5114	23760	3974	27871	3176	30043	2550	32868	1508	40110	1000	32748
10-#18	2.90	MA	19206	5114	31181	4137	37141	3316	40106	2692	43259	1666	54736	896	47073
5L-2S		MI	15855	5114	25918	3982	30598	3189	33281	2536	37129	1495	45662	1234	33025
12-#11	1.36	MA	21255	4340	30475	3655	36565	2968	39561	2454	42658	1703	52703	1613	26139
2L-6S		MI	11450	4340	17321	3550	19955	2886	20805	2376	20823	1631	24911	1186	15619
12-#11	1.36	MA	20135	4340	29036	3656	34740	2968	37351	2463	39676	1710	48645	1522	26088
3L-5S		MI	11885	4340	17912	3552	20742	2879	21758	2382	22045	1626	26524	1262	16088
12-#11	1.36	MA	19328	4340	27971	3658	33299	2979	35604	2462	37319	1707	45964	1431	25948
4E		MI	12338	4340	18576	3543	21539	2882	22726	2376	23317	1621	28136	1304	16277
12-#11	1.36	MA	18598	4340	26894	3669	32007	2979	34026	2472	35170	1714	43183	1383	25565
5L-3S		MI	12836	4340	19230	3545	22423	2876	23792	2382	24711	1626	29649	1394	16307
12-#11	1.36	MA	17898	4340	25938	3671	30732	2990	32474	2471	33105	1721	40349	1308	24585
6L-2S		MI	13511	4340	20101	3547	23528	2879	25127	2376	26467	1621	31961	1485	16300
12-#14	1.96	MA	22997	4641	34305	3832	41328	3097	45291	2534	50360	1684	62969	1569	37231
2L-6S		MI	11614	4641	18444	3721	21273	3009	22330	2445	22824	1594	27804	990	21192
12-#14	1.96	MA	21433	4641	32245	3834	38715	3097	42125	2547	46089	1693	57190	1438	37066
3L-5S		MI	12222	4641	19289	3724	22398	3000	23681	2453	24555	1587	29929	1080	21809
12-#14	1.96	MA	20306	4641	30717	3835	36649	3112	39621	2545	42709	1688	53377	1306	36659
4E		MI	12854	4641	20238	3712	23537	3006	25051	2445	26417	1594	32204	1141	22789
12-#14	1.96	MA	19288	4641	29171	3852	34795	3111	37357	2558	39627	1697	49409	1239	34959
5L-3S		MI	13549	4641	21173	3716	24799	2998	26562	2453	28331	1587	34344	1269	22947
12-#14	1.96	MA	18310	4641	27800	3854	32965	3126	35130	2556	36664	1706	45374	1131	33695
6L-2S		MI	14490	4641	22415	3719	26375	3004	28452	2445	30818	1579	37607	1401	23000
12-#18	3.48	MA	24471	5404	40195	4290	48613	3427	54035	2761	62103	1651	78243	1210	64083
3L-5S		MI	12989	5404	22632	4165	26429	3308	28345	2627	30659	1477	38138	595	34789
12-#18	3.48	MA	22603	5404	37510	4291	44982	3451	49636	2755	56165	1639	71649	976	60400
4E		MI	14040	5404	24287	4147	28407	3321	30693	2614	33850	1490	42010	706	36627
12-#18	3.48	MA	20913	5404	34792	4319	41721	3449	45655	2776	50746	1652	64749	860	57415
5L-3S		MI	15194	5404	25918	4155	30598	3308	33281	2627	37129	1477	45662	928	39012
12-#18	3.48	MA	19291	5404	32378	4320	38503	3473	41737	2770	45534	1666	57758	667	52700
6L-2S		MI	16755	5404	28075	4164	33325	3321	36519	2614	41389	1464	51213	1161	39369
14-#11	1.58	MA	21948	4454	31913	3725	38389	3020	41771	2487	45640	1698	56760	1602	30397
2L-7S		MI	11447	4454	17617	3619	20300	2934	21214	2414	21338	1617	25793	1092	17721
14-#11	1.58	MA	20839	4454	30475	3727	36565	3020	39561	2496	42658	1705	52703	1511	30327
3L-6S		MI	11869	4454	18193	3621	21061	2937	22140	2409	22579	1622	27223	1163	18100
14-#11	1.58	MA	20041	4454	29409	3728	35124	3031	37815	2495	40301	1702	50022	1420	30164
4L-5S		MI	12300	4454	18784	3623	21848	2931	23093	2414	23801	1617	28835	1239	18543
14-#11	1.58	MA	19319	4454	28332	3740	33831	3031	36237	2505	38152	1709	47241	1373	29665
5L-4S		MI	12748	4454	19447	3614	22644	2934	24060	2409	25073	1611	30447	1281	18837
14-#11	1.58	MA	18628	4454	27376	3742	32556	3042	34684	2504	36087	1716	44407	1298	28722
6L-3S		MI	13241	4454	20101	3616	23528	2928	25127	2414	26467	1617	31961	1372	18886
14-#11	1.58	MA	17951	4454	26446	3743	31324	3042	33179	2513	33993	1713	41882	1227	27998
7L-2S		MI	13910	4454	20973	3618	24633	2931	26462	2409	28223	1611	34272	1463	18897
14-#14	2.28	MA	22403	4805	34305	3936	41328	3172	45291	2594	50360	1686	62969	1421	43112
3L-6S		MI	12195	4805	19686	3823	22849	3084	24221	2491	25311	1579	31067	955	24611
14-#14	2.28	MA	21293	4805	32777	3938	39262	3186	42786	2592	46980	1680	59156	1289	42666
4L-5S		MI	12795	4805	20532	3826	23974	3075	25571	2498	27042	1572	33192	1044	25318
14-#14	2.28	MA	20290	4805	31232	3954	37408	3186	40523	2605	43898	1690	55188	1222	40854
5L-4S		MI	13420	4805	21480	3815	25113	3081	26941	2491	28904	1579	35467	1106	26328
14-#14	2.28	MA	19328	4805	29860	3956	35578	3201	38295	2603	40935	1699	51152	1114	39631
6L-3S		MI	14106	4805	22415	3818	26375	3072	28452	2498	30818	1572	37607	1234	26594
14-#14	2.28	MA	18385	4805	28525	3958	33811	3201	36136	2616	37931	1693	47559	1012	37524
7L-2S		MI	15037	4805	23658	3821	27950	3079	30342	2491	33305	1565	40870	1366	26674
14-#18	4.06	MA	24231	5695	41121	4473	49563	3584	55185	2839	63651	1625	81662	940	70658
4L-5S		MI	13936	5695	24789	4347	29156	3440	31583	2705	34919	1446	43689	523	40655
14-#18	4.06	MA	22577	5695	38404	4501	46301	3582	51204	2860	58232	1639	74762	824	67548
5L-4S		MI	14969	5695	26445	4329	31134	3454	33931	2692	38110	1459	47561	634	42650

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis



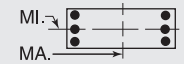
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	4.06	MA	20990	5695	35990	4502	43083	3606	47286	2855	53021	1653	67771	631	62973
6L-3S		MI	16103	5695	28075	4337	33325	3440	36519	2705	41389	1446	51213	855	45269
14-#18	4.06	MA	19434	5695	33640	4504	39973	3604	43487	2875	47738	1640	61555	449	58054
7L-2S		MI	17639	5695	30233	4345	36051	3454	39757	2692	45650	1433	56764	1089	45697
16-#11	1.81	MA	21532	4567	31913	3798	38389	3072	41771	2529	45640	1700	56760	1500	34562
3L-7S		MI	11864	4567	18488	3690	21405	2986	22549	2447	23094	1607	28104	1070	20150
16-#11	1.81	MA	20742	4567	30848	3799	36948	3083	40025	2528	43282	1697	54080	1409	34377
4L-6S		MI	12282	4567	19064	3692	22166	2989	23474	2441	24335	1613	29534	1141	20587
16-#11	1.81	MA	20029	4567	29771	3811	35656	3083	38447	2537	41134	1704	51299	1362	33775
5E		MI	12709	4567	19655	3694	22953	2983	24428	2447	25557	1607	31147	1217	21008
16-#11	1.81	MA	19346	4567	28815	3813	34380	3094	36894	2537	39069	1711	48465	1287	32864
6L-4S		MI	13153	4567	20319	3685	23749	2986	25395	2441	26829	1602	32759	1259	21393
16-#11	1.81	MA	18677	4567	27885	3814	33149	3094	35389	2546	36975	1708	45940	1216	32089
7L-3S		MI	13641	4567	20973	3687	24633	2979	26462	2447	28223	1607	34272	1349	21459
16-#11	1.81	MA	18015	4567	26969	3816	31942	3094	33882	2545	34955	1715	43341	1162	30915
8L-2S		MI	14305	4567	21844	3689	25738	2983	27796	2441	29979	1602	36584	1440	21484
16-#14	2.61	MA	22262	4968	34837	4040	41875	3261	45952	2639	51251	1673	64934	1272	48674
4L-6S		MI	12767	4968	20929	3925	24424	3159	26111	2537	27798	1565	34330	920	28045
16-#14	2.61	MA	21273	4968	33292	4057	40020	3261	43688	2652	48169	1682	60966	1205	46762
5E		MI	13360	4968	21774	3928	25550	3150	27461	2544	29529	1557	36455	1009	28839
16-#14	2.61	MA	20325	4968	31920	4058	38191	3276	41461	2650	45206	1692	56931	1097	45496
6L-4S		MI	13977	4968	22723	3917	26688	3156	28832	2537	31391	1565	38730	1071	29792
16-#14	2.61	MA	19397	4968	30585	4060	36423	3276	39302	2663	42202	1686	53338	995	43412
7L-3S		MI	14655	4968	23658	3920	27950	3147	30342	2544	33305	1557	40870	1199	30235
16-#14	2.61	MA	18479	4968	29271	4062	34692	3276	37138	2662	39304	1695	49631	917	41299
8L-2S		MI	15576	4968	24900	3923	29526	3153	32232	2537	35792	1550	44133	1330	30341
16-#18	4.64	MA	24204	5986	42015	4682	50882	3715	56753	2944	65719	1626	84775	787	77708
5E		MI	14930	5986	26947	4528	31883	3573	34821	2783	39180	1415	49240	451	46553
16-#18	4.64	MA	22650	5986	39601	4684	47663	3739	52835	2939	60507	1640	77784	594	73266
6L-4S		MI	15933	5986	28602	4510	33860	3586	37169	2770	42371	1428	53112	561	48701
16-#18	4.64	MA	21127	5986	37251	4685	44553	3737	49036	2960	55224	1627	71568	412	68288
7L-3S		MI	17025	5986	30233	4519	36051	3573	39757	2783	45650	1415	56764	783	51520
16-#18	4.64	MA	19619	5986	34937	4687	41506	3735	45229	2954	50126	1640	65124	277	63282
8L-2S		MI	18498	5986	32390	4527	38778	3586	42995	2770	49911	1402	62315	1017	52014
18-#11	2.03	MA	21435	4680	32286	3870	38772	3134	42235	2561	46264	1692	58138	1399	38590
4L-7S		MI	12275	4680	19360	3761	22510	3038	23884	2479	24850	1598	30416	1047	22588
18-#11	2.03	MA	20729	4680	31209	3882	37480	3135	40657	2570	44116	1699	55356	1351	37894
5L-6S		MI	12689	4680	19935	3763	23271	3041	24809	2474	26090	1603	31846	1118	23078
18-#11	2.03	MA	20053	4680	30253	3883	36205	3145	39104	2569	42050	1706	52523	1276	37013
6L-5S		MI	13112	4680	20526	3765	24058	3034	25762	2479	27313	1598	33458	1194	23481
18-#11	2.03	MA	19392	4680	29323	3885	34973	3146	37600	2579	39957	1702	49997	1206	36187
7L-4S		MI	13552	4680	21190	3756	24855	3038	26730	2474	28585	1593	35070	1236	23944
18-#11	2.03	MA	18738	4680	28407	3886	33766	3146	36092	2578	37937	1709	47399	1151	35042
8L-3S		MI	14036	4680	21844	3758	25738	3031	27796	2479	29979	1598	36584	1326	24026
18-#11	2.03	MA	18088	4680	27396	3898	32523	3157	34609	2587	35938	1717	44825	1093	33811
9L-2S		MI	14695	4680	22716	3760	26843	3035	29131	2474	31735	1593	38895	1418	24064
18-#14	2.93	MA	22240	5132	35352	4159	42633	3336	46854	2700	52439	1675	66745	1188	52680
5L-6S		MI	13330	5132	22171	4027	26000	3233	28001	2583	30284	1550	37593	885	31493
18-#14	2.93	MA	21306	5132	33980	4160	40804	3351	44627	2698	49477	1684	62710	1080	51339
6L-5S		MI	13916	5132	23017	4031	27125	3225	29352	2590	32016	1543	39718	974	32368
18-#14	2.93	MA	20391	5132	32645	4162	39036	3351	42467	2711	46473	1679	59117	978	49308
7L-4S		MI	14526	5132	23965	4019	28264	3231	30722	2583	33878	1550	41993	1035	33272
18-#14	2.93	MA	19486	5132	31331	4164	37305	3350	40304	2709	43575	1688	55410	900	47159
8L-3S		MI	15196	5132	24900	4022	29526	3222	32232	2590	35792	1543	44133	1164	33870

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

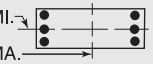


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.93	MA	18587	5132	29880	4180	35520	3365	38176	2722	40705	1697	51745	815	45002
9L-2S		MI	16108	5132	26142	4026	31102	3228	34123	2583	38279	1535	47396	1295	34000
18-#18	5.22	MA	24277	6277	43213	4866	52243	3872	58384	3023	67994	1626	87797	558	83577
6L-5S		MI	15838	6277	29104	4710	34609	3705	38059	2861	43441	1384	54792	378	52479
18-#18	5.22	MA	22783	6277	40862	4867	49133	3870	54585	3044	62710	1614	81581	376	78539
7L-4S		MI	16819	6277	30760	4692	36587	3718	40407	2847	46632	1397	58663	489	54773
18-#18	5.22	MA	21305	6277	38549	4868	46086	3868	50778	3038	57612	1627	75137	241	73492
8L-3S		MI	17888	6277	32390	4700	38778	3705	42995	2861	49911	1384	62315	710	57634
20-#11	2.26	MA	21420	4794	32648	3953	39304	3187	42867	2603	47098	1693	59414	1341	42021
5L-7S		MI	12682	4794	20231	3832	23615	3089	25219	2512	26606	1589	32727	1025	25033
20-#11	2.26	MA	20751	4794	31692	3954	38029	3197	41315	2602	45032	1700	56580	1266	41167
6E		MI	13092	4794	20807	3834	24376	3093	26144	2507	27846	1594	34157	1095	25574
20-#11	2.26	MA	20097	4794	30761	3956	36797	3198	39810	2612	42939	1697	54055	1195	40292
7L-5S		MI	13511	4794	21398	3836	25163	3086	27097	2512	29069	1589	35770	1171	25960
20-#11	2.26	MA	19450	4794	29846	3957	35591	3198	38302	2611	40919	1704	51457	1140	39173
8L-4S		MI	13947	4794	22062	3827	25960	3090	28065	2507	30341	1584	37382	1214	26493
20-#11	2.26	MA	18807	4794	28834	3969	34347	3208	36819	2620	38919	1711	48882	1082	37916
9L-3S		MI	14427	4794	22716	3829	26843	3083	29131	2512	31735	1589	38895	1304	26589
20-#11	2.26	MA	18166	4794	27922	3971	33149	3209	35329	2619	36863	1708	46221	1002	36686
10L-2S		MI	15080	4794	23587	3830	27949	3087	30466	2507	33491	1584	41207	1395	26639
20-#14	3.26	MA	22271	5295	36041	4263	43417	3425	47792	2745	53747	1677	68488	1063	57193
6E		MI	13886	5295	23414	4130	27576	3308	29892	2629	32771	1535	40855	849	34953
20-#14	3.26	MA	21368	5295	34706	4264	41649	3425	45633	2758	50744	1671	64895	961	55212
7L-5S		MI	14465	5295	24259	4133	28701	3299	31242	2636	34503	1528	42981	939	35906
20-#14	3.26	MA	20476	5295	33391	4266	39918	3425	43469	2756	47846	1680	61189	883	53027
8L-4S		MI	15068	5295	25208	4121	29840	3306	32612	2629	36365	1535	45256	1000	36765
20-#14	3.26	MA	19589	5295	31940	4283	38133	3440	41341	2769	44976	1690	57524	798	50845
9L-3S		MI	15731	5295	26142	4125	31102	3297	34123	2636	38279	1528	47396	1128	37501
20-#14	3.26	MA	18695	5295	30631	4284	36414	3440	39203	2767	42026	1684	53736	683	48419
10L-2S		MI	16634	5295	27385	4128	32678	3303	36013	2629	40766	1520	50659	1260	37654
20-#18	5.80	MA	24409	6568	44474	5049	53713	4003	60134	3128	70197	1600	91594	340	88805
7L-5S		MI	16730	6568	31262	4892	37336	3837	41297	2938	47702	1353	60343	306	58431
20-#18	5.80	MA	22959	6568	42160	5050	50666	4001	56327	3122	65098	1614	85150	205	83716
8L-4S		MI	17689	6568	32918	4874	39314	3850	43645	2925	50892	1366	64214	416	60863
22-#11	2.49	MA	21440	4907	33130	4025	39853	3249	43525	2635	48014	1695	60638	1255	45325
6L-7S		MI	13084	4907	21102	3903	24720	3141	26553	2544	28362	1580	35039	1002	27484
22-#11	2.49	MA	20793	4907	32200	4027	38622	3249	42020	2645	45921	1692	58113	1184	44403
7L-6S		MI	13490	4907	21678	3905	25481	3145	27479	2539	29602	1585	36469	1073	28072
22-#11	2.49	MA	20153	4907	31284	4028	37415	3250	40512	2644	43901	1699	55515	1130	43309
8L-5S		MI	13906	4907	22269	3906	26269	3138	28432	2544	30825	1580	38081	1149	28444
22-#11	2.49	MA	19517	4907	30273	4040	36172	3260	39029	2653	41901	1706	52940	1071	42026
9L-4S		MI	14338	4907	22933	3898	27065	3142	29399	2539	32097	1574	39693	1191	29039
22-#11	2.49	MA	18878	4907	29361	4041	34974	3261	37539	2652	39845	1703	50279	991	40787
10L-3S		MI	14814	4907	23587	3900	27949	3135	30466	2544	33491	1580	41207	1281	29149
22-#11	2.49	MA	18199	4907	28456	4043	33744	3271	36065	2662	37854	1710	47725	934	39254
11L-2S		MI	15462	4907	24459	3901	29054	3139	31801	2539	35247	1574	43519	1372	29211
22-#14	3.59	MA	22331	5459	36766	4367	44262	3500	48798	2806	55015	1664	70674	944	61124
7L-6S		MI	14434	5459	24656	4232	29151	3383	31782	2674	35258	1520	44118	814	38424
22-#14	3.59	MA	21451	5459	35452	4368	42531	3500	46635	2804	52117	1673	66968	866	58903
8L-5S		MI	15007	5459	25501	4235	30277	3374	33132	2682	36990	1513	46244	903	39449
22-#14	3.59	MA	20576	5459	34000	4385	40746	3515	44507	2817	49247	1682	63303	781	56696
9L-4S		MI	15604	5459	26450	4223	31415	3380	34502	2674	38852	1520	48519	965	40269
22-#14	3.59	MA	19686	5459	32691	4387	39027	3515	42368	2815	46296	1677	59514	666	54307
10L-3S		MI	16260	5459	27385	4227	32678	3372	36013	2682	40766	1513	50659	1093	41129
22-#18	6.38	MA	24584	6858	45772	5232	55246	4134	61876	3207	72585	1601	95163	169	93954
8L-5S		MI	17607	6858	33419	5074	40062	3969	44535	3016	51962	1322	65894	233	64405
24-#11	2.71	MA	21480	5021	33638	4098	40446	3301	44230	2677	48903	1687	62171	1174	48520
7E		MI	13481	5021	21974	3974	25826	3193	27888	2577	30118	1570	37351	980	29941

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.71	MA	20847	5021	32723	4099	39239	3302	42723	2677	46883	1694	59572	1119	47449
8L-6S		MI	13884	5021	22550	3976	26587	3197	28813	2572	31358	1575	38780	1050	30574
24-#11	2.71	MA	20218	5021	31711	4111	37996	3312	41239	2686	44883	1701	56998	1061	46140
9L-5S		MI	14296	5021	23141	3977	27374	3190	29767	2577	32581	1570	40393	1126	30933
24-#11	2.71	MA	19581	5021	30799	4112	36798	3312	39749	2685	42827	1698	54337	981	44882
10L-4S		MI	14725	5021	23804	3969	28170	3194	30734	2572	33853	1565	42005	1168	31583
24-#11	2.71	MA	18909	5021	29894	4114	35569	3323	38275	2695	40836	1705	51783	923	43371
11L-3S		MI	15197	5021	24459	3970	29054	3187	31801	2577	35247	1570	43519	1259	31706
24-#11	2.71	MA	18246	5021	28993	4115	34374	3323	36794	2694	38854	1712	49229	865	41803
12L-2S		MI	15840	5021	25330	3972	30159	3191	33135	2572	37003	1565	45830	1350	31780
24-#14	3.91	MA	22412	5623	37512	4471	45143	3575	49801	2851	56388	1666	72746	849	64785
8L-6S		MI	14977	5623	25899	4334	30727	3458	33672	2720	37745	1506	47381	779	41904
24-#14	3.91	MA	21549	5623	36060	4487	43359	3590	47672	2864	53518	1675	69082	764	62552
9L-5S		MI	15544	5623	26744	4337	31853	3449	35023	2728	39477	1498	49506	868	42998
24-#14	3.91	MA	20663	5623	34751	4489	41639	3590	45534	2862	50567	1669	65293	649	60200
10L-4S		MI	16134	5623	27692	4326	32991	3455	36393	2720	41339	1506	51782	929	43782

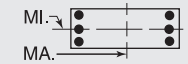
RECTANGULAR TIED COLUMNS 30" x 48"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.11	MA	22210	4400	31594	3710	37587	3019	40286	2507	42621	1771	51889	1671	23213
2E		MI	13509	4400	20103	3570	23156	2903	24310	2396	25034	1660	29787	1520	13840
6-#18	1.67	MA	24028	4691	35387	3892	42398	3152	46114	2591	50484	1758	62462	1638	34460
2L-3S		MI	12829	4691	20103	3744	23156	3022	24310	2487	25034	1642	29787	1214	20240
6-#18	1.67	MA	21115	4691	31594	3894	37587	3151	40286	2613	42621	1773	51889	1404	34098
3L-2S		MI	14480	4691	22260	3752	25882	3035	27548	2474	29295	1629	35338	1448	20303
8-#14	1.25	MA	22776	4473	32452	3777	38871	3070	41927	2543	44892	1779	55243	1686	26255
2L-4S		MI	12170	4473	18403	3643	21121	2968	22014	2448	22134	1696	26463	1282	15599
8-#14	1.25	MA	21083	4473	30290	3779	36128	3070	38604	2557	40410	1789	49149	1555	26173
3E		MI	12885	4473	19338	3646	22383	2959	23525	2455	24048	1689	28602	1410	15658
8-#14	1.25	MA	19861	4473	28688	3781	33962	3086	35978	2555	36865	1784	45123	1423	25862
4L-2S		MI	13851	4473	20581	3649	23959	2965	25415	2448	26535	1681	31865	1541	15637
8-#18	2.22	MA	25787	4982	39180	4074	47208	3285	51943	2676	58347	1744	73036	1604	45666
2L-4S		MI	12602	4982	20630	3917	23692	3167	24960	2552	26016	1624	31686	920	24919
8-#18	2.22	MA	22937	4982	35387	4076	42398	3284	46114	2698	50484	1759	62462	1371	45175
3E		MI	13804	4982	22260	3925	25882	3154	27548	2565	29295	1611	35338	1142	26545
8-#18	2.22	MA	20878	4982	32570	4078	38589	3309	41498	2693	44254	1748	55492	1137	42267
4L-2S		MI	15424	4982	24418	3934	28609	3167	30786	2552	33556	1598	40889	1376	26710
10-#11	1.08	MA	22256	4386	31244	3733	37438	3039	40234	2525	42638	1788	52311	1705	22926
2L-5S		MI	11942	4386	17687	3617	20372	2939	21168	2444	20982	1708	24999	1355	13694
10-#11	1.08	MA	21065	4386	29735	3735	35523	3039	37915	2535	39509	1796	48034	1614	22896
3L-4S		MI	12401	4386	18351	3608	21168	2942	22135	2439	22254	1703	26611	1397	13747
10-#11	1.08	MA	20207	4386	28618	3736	34013	3050	36084	2534	37038	1793	45207	1523	22784
4L-3S		MI	12905	4386	19005	3610	22052	2936	23202	2444	23648	1708	28124	1487	13747
10-#11	1.08	MA	19431	4386	27489	3748	32658	3051	34430	2544	34786	1801	42279	1475	22517
5L-2S		MI	13587	4386	19877	3612	23157	2939	24536	2439	25404	1703	30436	1578	13723
10-#14	1.56	MA	23820	4637	34615	3879	41613	3145	45249	2590	49375	1771	61337	1670	32660
2L-5S		MI	12115	4637	18697	3757	21558	3037	22534	2501	22760	1674	27450	1185	18455
10-#14	1.56	MA	22151	4637	32452	3881	38871	3145	41927	2604	44892	1781	55243	1539	32534
3L-4S		MI	12758	4637	19646	3745	22697	3043	23905	2494	24621	1681	29725	1246	19232
10-#14	1.56	MA	20948	4637	30850	3883	36704	3160	39301	2603	41348	1777	51218	1408	32172
4L-3S		MI	13463	4637	20581	3748	23959	3034	25415	2501	26535	1674	31865	1375	19334
10-#14	1.56	MA	19860	4637	29230	3900	34760	3161	36928	2616	38117	1787	47039	1340	30635
5L-2S		MI	14418	4637	21823	3752	25535	3040	27305	2494	29022	1667	35128	1506	19347

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	2.78	MA	27496	5273	42974	4256	52019	3418	57771	2760	66211	1731	83610	1571	56849
2L-5S		MI	12499	5273	21132	4117	24440	3286	25850	2643	27086	1580	33366	737	29324
10-#18	2.78	MA	24704	5273	39180	4258	47208	3417	51943	2782	58347	1746	73036	1337	56249
3L-4S		MI	13574	5273	22788	4099	26418	3299	28198	2630	30277	1593	37237	848	30861
10-#18	2.78	MA	22693	5273	36363	4260	43400	3442	47327	2777	52117	1735	66066	1104	52977
4L-3S		MI	14754	5273	24418	4107	28609	3286	30786	2643	33556	1580	40889	1069	32828
10-#18	2.78	MA	20872	5273	33513	4289	39980	3441	43152	2799	46434	1750	58792	985	49619
5L-2S		MI	16346	5273	26576	4116	31335	3299	34024	2630	37817	1567	46440	1303	33080
12-#11	1.30	MA	22999	4499	32754	3804	39352	3091	42553	2558	45767	1783	56588	1696	27402
2L-6S		MI	11927	4499	17968	3686	20690	2997	21549	2471	21515	1704	25698	1256	15721
12-#11	1.30	MA	21820	4499	31244	3805	37438	3091	40234	2568	42638	1791	52311	1604	27351
3L-5S		MI	12364	4499	18559	3688	21477	2990	22502	2476	22738	1699	27310	1332	16199
12-#11	1.30	MA	20972	4499	30128	3807	35927	3102	38403	2567	40167	1788	49484	1513	27212
4E		MI	12818	4499	19222	3679	22274	2994	23470	2471	24010	1694	28922	1374	16319
12-#11	1.30	MA	20205	4499	28999	3819	34573	3103	36749	2577	37915	1796	46556	1466	26918
5L-3S		MI	13317	4499	19877	3681	23157	2987	24536	2476	25404	1699	30436	1465	16342
12-#11	1.30	MA	19470	4499	27997	3821	33237	3114	35122	2576	35751	1803	43569	1391	25856
6L-2S		MI	13993	4499	20748	3683	24262	2991	25871	2471	27160	1694	32747	1556	16330
12-#14	1.88	MA	24845	4800	36777	3981	44356	3220	48572	2638	53858	1764	67432	1655	39053
2L-6S		MI	12091	4800	19094	3856	22009	3120	23074	2540	23515	1667	28588	1060	21356
12-#14	1.88	MA	23197	4800	34615	3983	41613	3220	45249	2651	49375	1774	61337	1523	38888
3L-5S		MI	12701	4800	19940	3859	23134	3111	24425	2547	25247	1659	30713	1150	21948
12-#14	1.88	MA	22012	4800	33013	3985	39447	3235	42623	2650	45831	1769	57312	1392	38482
4E		MI	13335	4800	20888	3847	24272	3117	25795	2540	27108	1667	32988	1211	22855
12-#14	1.88	MA	20941	4800	31393	4002	37503	3236	40251	2663	42600	1779	53134	1324	36813
5L-3S		MI	14032	4800	21823	3851	25535	3109	27305	2547	29022	1659	35128	1339	22995
12-#14	1.88	MA	19914	4800	29955	4004	35585	3251	37916	2662	39494	1789	48878	1216	35455
6L-2S		MI	14976	4800	23066	3854	27110	3115	29196	2540	31509	1652	38391	1471	23039
12-#18	3.33	MA	26426	5564	42974	4439	52019	3550	57771	2866	66211	1733	83610	1304	67323
3L-5S		MI	13468	5564	23289	4299	27167	3418	29088	2721	31347	1549	38917	665	35144
12-#18	3.33	MA	24457	5564	40156	4442	48210	3575	53155	2861	59980	1721	76640	1070	63726
4E		MI	14524	5564	24945	4280	29145	3431	31436	2707	34538	1562	42788	775	36847
12-#18	3.33	MA	22678	5564	37306	4470	44790	3574	48980	2883	54297	1737	69365	952	60511
5L-3S		MI	15683	5564	26576	4289	31335	3418	34024	2721	37817	1549	46440	997	39098
12-#18	3.33	MA	20970	5564	34775	4472	41415	3599	44872	2879	48832	1752	61983	759	55708
6L-2S		MI	17250	5564	28733	4297	34062	3431	37262	2707	42077	1536	51991	1231	39427
14-#11	1.52	MA	23732	4613	34263	3875	41266	3142	44872	2591	48896	1778	60865	1686	31872
2L-7S		MI	11924	4613	18263	3755	21034	3045	21959	2509	22031	1690	26579	1163	17888
14-#11	1.52	MA	22564	4613	32754	3876	39352	3143	42553	2601	45767	1786	56588	1595	31801
3L-6S		MI	12347	4613	18839	3757	21795	3049	22884	2504	23271	1695	28009	1234	18202
14-#11	1.52	MA	21725	4613	31637	3878	37841	3154	40722	2600	43296	1783	53760	1504	31638
4L-5S		MI	12779	4613	19430	3759	22582	3042	23837	2509	24494	1690	29622	1310	18653
14-#11	1.52	MA	20967	4613	30508	3890	36487	3155	39068	2610	41044	1790	50833	1456	31223
5L-4S		MI	13229	4613	20094	3750	23379	3046	24805	2504	25766	1684	31234	1352	18884
14-#11	1.52	MA	20240	4613	29507	3892	35151	3166	37442	2609	38880	1798	47846	1381	30199
6L-3S		MI	13723	4613	20748	3752	24262	3039	25871	2509	27160	1690	32747	1442	18924
14-#11	1.52	MA	19529	4613	28532	3894	33860	3166	35865	2619	36686	1795	45183	1310	29480
7L-2S		MI	14394	4613	21620	3754	25368	3043	27206	2504	28916	1684	35059	1533	18929
14-#14	2.19	MA	24224	4964	36777	4086	44356	3295	48572	2699	53858	1767	67432	1508	45238
3L-6S		MI	12673	4964	20337	3958	23584	3195	24965	2585	26002	1652	31851	1025	24838
14-#14	2.19	MA	23056	4964	35175	4088	42189	3310	45946	2697	50313	1762	63407	1376	44792
4L-5S		MI	13276	4964	21182	3961	24710	3186	26315	2593	27734	1645	33976	1115	25456
14-#14	2.19	MA	22000	4964	33555	4105	40246	3310	43573	2711	47082	1772	59228	1308	43006
5L-4S		MI	13903	4964	22131	3950	25848	3192	27685	2585	29595	1652	36251	1176	26473
14-#14	2.19	MA	20989	4964	32118	4107	38328	3326	41239	2709	43977	1782	54972	1200	41692
6L-3S		MI	14591	4964	23066	3953	27110	3183	29196	2593	31509	1645	38391	1304	26646
14-#14	2.19	MA	19998	4964	30719	4109	36476	3326	38976	2723	40829	1777	51180	1098	39586
7L-2S		MI	15525	4964	24308	3956	28686	3190	31086	2585	33996	1637	41654	1436	26717

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

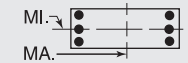
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.89	MA	26180	5854	43950	4623	53021	3708	58983	2946	67843	1708	87213	1037	74511
4L-5S		MI	14417	5854	25447	4480	29893	3550	32326	2798	35608	1518	44468	592	41003
14-#18	3.89	MA	24438	5854	41100	4652	49601	3707	54808	2968	62160	1723	79939	919	71424
5L-4S		MI	15455	5854	27103	4462	31871	3564	34674	2785	38798	1531	48339	703	42866
14-#18	3.89	MA	22767	5854	38569	4654	46226	3732	50700	2963	56695	1738	72556	726	66514
6L-3S		MI	16595	5854	28733	4471	34062	3550	37262	2798	42077	1518	51991	925	45360
14-#18	3.89	MA	21129	5854	36105	4656	42965	3731	46716	2985	51155	1727	65987	544	61503
7L-2S		MI	18138	5854	30891	4479	36789	3564	40500	2785	46338	1505	57542	1158	45759
16-#11	1.73	MA	23297	4726	34263	3947	41266	3195	44872	2633	48896	1781	60865	1585	36247
3L-7S		MI	12342	4726	19135	3826	22139	3097	23293	2542	23786	1680	28891	1140	20316
16-#11	1.73	MA	22467	4726	33146	3949	39756	3206	43041	2633	46425	1778	58037	1494	36062
4L-6S		MI	12761	4726	19711	3828	22900	3101	24219	2536	25027	1685	30321	1211	20689
16-#11	1.73	MA	21717	4726	32018	3961	38401	3206	41387	2643	44173	1785	55110	1446	35538
5E		MI	13189	4726	20302	3830	23688	3094	25172	2542	26250	1680	31933	1287	21117
16-#11	1.73	MA	20999	4726	31016	3963	37065	3217	39761	2642	42009	1793	52123	1371	34549
6L-4S		MI	13635	4726	20965	3821	24484	3098	26139	2536	27522	1675	33545	1329	21442
16-#11	1.73	MA	20296	4726	30042	3964	35775	3218	38184	2652	39815	1790	49460	1301	33834
7L-3S		MI	14125	4726	21620	3823	25368	3091	27206	2542	28916	1680	35059	1419	21499
16-#11	1.73	MA	19601	4726	29083	3966	34511	3219	36604	2651	37699	1797	46725	1246	32566
8L-2S		MI	14790	4726	22491	3824	26473	3095	28541	2536	30672	1675	37370	1511	21519
16-#14	2.50	MA	24081	5127	37338	4190	44932	3385	49269	2745	54796	1754	69501	1361	51104
4L-6S		MI	13247	5127	21579	4060	25160	3270	26855	2631	28489	1637	35114	990	28269
16-#14	2.50	MA	23040	5127	35718	4207	42988	3385	46896	2758	51565	1764	65323	1293	49211
5E		MI	13842	5127	22425	4064	26285	3261	28205	2639	30220	1630	37239	1079	28975
16-#14	2.50	MA	22044	5127	34280	4209	41071	3400	44561	2757	48460	1774	61067	1185	47936
6L-4S		MI	14461	5127	23373	4052	27424	3267	29575	2631	32082	1637	39514	1141	29952
16-#14	2.50	MA	21067	5127	32881	4211	39219	3401	42298	2770	45312	1770	57275	1083	45773
7L-3S		MI	15142	5127	24308	4055	28686	3258	31086	2639	33996	1630	41654	1269	30290
16-#14	2.50	MA	20101	5127	31505	4213	37404	3401	40031	2769	42275	1780	53371	1004	43668
8L-2S		MI	16066	5127	25550	4058	30262	3264	32976	2631	36483	1622	44917	1400	30385
16-#18	4.44	MA	26160	6145	44893	4834	54412	3840	60637	3052	70023	1710	90513	885	82178
5E		MI	15349	6145	27604	4662	32620	3682	35564	2876	39868	1487	50019	520	46895
16-#18	4.44	MA	24523	6145	42362	4836	51036	3865	56528	3047	64558	1725	83130	693	77339
6L-4S		MI	16371	6145	29260	4644	34598	3696	37912	2863	43059	1500	53890	631	48912
16-#18	4.44	MA	22919	6145	39898	4838	47776	3864	52544	3069	59018	1714	76561	511	72272
7L-3S		MI	17526	6145	30891	4652	36789	3682	40500	2876	46338	1487	57542	852	51615
16-#18	4.44	MA	21330	6145	37473	4840	44581	3863	48553	3064	53672	1729	69767	374	67146
8L-2S		MI	19008	6145	33048	4661	39515	3696	43738	2863	50599	1473	63093	1086	52079
18-#11	1.95	MA	23198	4840	34656	4020	41670	3258	45360	2666	49553	1773	62314	1484	40485
4L-7S		MI	12754	4840	20006	3897	23245	3149	24628	2574	25542	1671	31203	1118	22751
18-#11	1.95	MA	22457	4840	33527	4032	40315	3258	43707	2676	47302	1780	59387	1436	39863
5L-6S		MI	13170	4840	20582	3899	24006	3153	25553	2569	26783	1676	32632	1188	23181
18-#11	1.95	MA	21746	4840	32525	4034	38979	3269	42080	2675	45137	1788	56400	1362	38905
6L-5S		MI	13594	4840	21173	3900	24793	3146	26507	2574	28006	1671	34245	1264	23589
18-#11	1.95	MA	21051	4840	31551	4035	37689	3270	40503	2685	42944	1785	53737	1291	38139
7L-4S		MI	14036	4840	21837	3892	25589	3150	27474	2569	29278	1666	35857	1307	23996
18-#11	1.95	MA	20364	4840	30592	4037	36425	3270	38923	2684	40828	1792	51002	1236	36900
8L-3S		MI	14521	4840	22491	3894	26473	3143	28541	2574	30672	1671	37370	1397	24069
18-#11	1.95	MA	19681	4840	29532	4049	35122	3281	37370	2694	38732	1800	48287	1178	35732
9L-2S		MI	15182	4840	23362	3895	27578	3147	29875	2569	32428	1666	39682	1488	24101
18-#14	2.81	MA	24063	5291	37880	4309	45731	3460	50218	2806	56048	1757	71417	1277	55427
5L-6S		MI	13812	5291	22822	4162	26736	3345	28745	2677	30976	1622	38376	955	31714
18-#14	2.81	MA	23080	5291	36443	4311	43813	3475	47884	2804	52942	1767	67161	1169	54174
6L-5S		MI	14400	5291	23667	4166	27861	3336	30096	2685	32707	1615	40502	1044	32504

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

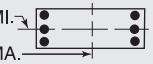


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.81	MA	22118	5291	35044	4313	41961	3476	45621	2818	49794	1762	63369	1067	51968
7L-4S		MI	15013	5291	24616	4154	29000	3342	31466	2677	34569	1622	42777	1105	33430
18-#14	2.81	MA	21166	5291	33667	4315	40147	3476	43354	2816	46757	1772	59465	988	49828
8L-3S		MI	15686	5291	25550	4157	30262	3333	32976	2685	36483	1615	44917	1234	33928
18-#14	2.81	MA	20220	5291	32146	4332	38277	3491	41123	2830	43750	1782	55599	904	47663
9L-2S		MI	16601	5291	26793	4161	31838	3339	34867	2677	38970	1608	48180	1365	34047
18-#18	5.00	MA	26244	6436	46155	5018	55847	3998	62356	3131	72421	1712	93704	659	88182
6L-5S		MI	16329	6436	29762	4844	35347	3815	38802	2954	44129	1456	55570	448	52815
18-#18	5.00	MA	24670	6436	43691	5020	52587	3997	58373	3153	66881	1700	87134	477	83057
7L-4S		MI	17316	6436	31418	4826	37325	3828	41150	2941	47320	1469	59442	558	54981
18-#18	5.00	MA	23113	6436	41266	5022	49392	3996	54381	3149	61535	1716	80340	341	77893
8L-3S		MI	18393	6436	33048	4834	39515	3815	43738	2954	50599	1456	63093	780	57867
20-#11	2.17	MA	23187	4953	35036	4103	42230	3310	46026	2708	50430	1775	63663	1427	44195
5L-7S		MI	13162	4953	20878	3968	24350	3201	25963	2607	27298	1662	33514	1095	25195
20-#11	2.17	MA	22484	4953	34035	4104	40893	3321	44399	2708	48266	1782	60676	1352	43266
6E		MI	13574	4953	21454	3970	25111	3205	26888	2601	28539	1667	34944	1166	25676
20-#11	2.17	MA	21796	4953	33060	4106	39603	3322	42822	2718	46073	1780	58013	1281	42450
7L-5S		MI	13994	4953	22045	3971	25898	3198	27841	2607	29762	1662	36557	1242	26068
20-#11	2.17	MA	21116	4953	32101	4108	38339	3322	41243	2717	43957	1787	55278	1226	41238
8L-4S		MI	14432	4953	22708	3963	26694	3202	28809	2601	31034	1657	38168	1284	26547
20-#11	2.17	MA	20441	4953	31042	4120	37036	3333	39689	2727	41861	1795	52564	1168	40043
9L-3S		MI	14914	4953	23362	3964	27578	3195	29875	2607	32428	1662	39682	1374	26634
20-#11	2.17	MA	19758	4953	30086	4122	35781	3334	38128	2726	39707	1792	49758	1088	38680
10L-2S		MI	15569	4953	24234	3966	28683	3198	31210	2601	34183	1657	41994	1465	26678
20-#14	3.13	MA	24100	5455	38605	4413	46556	3550	51206	2852	57425	1759	73255	1153	60325
6E		MI	14369	5455	24064	4265	28311	3419	30635	2723	33463	1608	41639	919	35171
20-#14	3.13	MA	23151	5455	37206	4415	44704	3550	48943	2865	54277	1755	69463	1051	58171
7L-5S		MI	14951	5455	24909	4268	29437	3411	31986	2730	35194	1600	43765	1009	36041
20-#14	3.13	MA	22212	5455	35830	4418	42889	3551	46676	2864	51240	1765	65560	973	55995
8L-4S		MI	15557	5455	25858	4256	30575	3417	33356	2723	37056	1608	46040	1070	36921
20-#14	3.13	MA	21279	5455	34309	4434	41019	3566	44446	2877	48233	1775	61693	889	53811
9L-3S		MI	16223	5455	26793	4260	31838	3408	34867	2730	38970	1600	48180	1198	37562
20-#14	3.13	MA	20327	5455	32937	4437	39217	3566	42205	2876	45140	1770	57697	773	51189
10L-2S		MI	17129	5455	28035	4263	33413	3414	36757	2723	41457	1593	51443	1330	37703
20-#18	5.56	MA	26389	6727	47484	5202	57397	4130	64201	3238	74744	1687	97708	444	93857
7L-5S		MI	17223	6727	31920	5026	38073	3947	42040	3032	48390	1424	61121	375	58761
20-#18	5.56	MA	24861	6727	45059	5204	54202	4129	60210	3233	69398	1702	90914	307	88654
8L-4S		MI	18191	6727	33575	5007	40051	3960	44388	3018	51580	1438	64993	486	61069
22-#11	2.38	MA	23212	5066	35544	4175	42808	3373	46718	2741	51395	1777	64953	1342	47632
6L-7S		MI	13565	5066	21749	4039	25455	3253	27298	2639	29054	1652	35826	1073	27644
22-#11	2.38	MA	22531	5066	34570	4177	41517	3374	45141	2751	49201	1774	62290	1271	46768
7L-6S		MI	13973	5066	22325	4040	26216	3257	28223	2634	30295	1658	37255	1143	28175
22-#11	2.38	MA	21859	5066	33611	4179	40253	3374	43562	2750	47085	1782	59555	1216	45582
8L-5S		MI	14390	5066	22916	4042	27003	3250	29176	2639	31518	1652	38868	1219	28552
22-#11	2.38	MA	21191	5066	32551	4191	38951	3385	42008	2760	44990	1789	56840	1158	44322
9L-4S		MI	14824	5066	23580	4034	27800	3253	30144	2634	32789	1647	40480	1262	29096
22-#11	2.38	MA	20511	5066	31596	4193	37695	3386	40447	2759	42835	1787	54035	1078	43019
10L-3S		MI	15302	5066	24234	4035	28683	3247	31210	2639	34183	1652	41994	1352	29196
22-#11	2.38	MA	19797	5066	30647	4194	36408	3397	38903	2769	40749	1794	51347	1020	41451
11L-2S		MI	15952	5066	25105	4037	29788	3250	32545	2634	35939	1647	44305	1443	29252
22-#14	3.44	MA	24169	5618	39369	4518	47446	3625	52266	2913	58760	1747	75558	1036	64382
7L-6S		MI	14919	5618	25307	4367	29887	3494	32526	2769	35950	1593	44902	884	38639
22-#14	3.44	MA	23243	5618	37992	4520	45632	3626	49999	2911	55723	1757	71654	957	62170
8L-5S		MI	15495	5618	26152	4370	31012	3485	33876	2776	37681	1586	47027	973	39584
22-#14	3.44	MA	22322	5618	36471	4537	43762	3641	47769	2925	52716	1767	67788	873	59962
9L-4S		MI	16094	5618	27100	4359	32151	3491	35246	2769	39543	1593	49303	1035	40423
22-#14	3.44	MA	21374	5618	35100	4539	41960	3641	45528	2923	49623	1762	63791	757	57377
10L-3S		MI	16754	5618	28035	4362	33413	3483	36757	2776	41457	1586	51443	1163	41192

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#18	6.11	MA	26578	7018	48852	5386	59013	4262	66038	3317	77261	1689	101488	274	99428
8L-5S		MI	18104	7018	34077	5207	40800	4079	45278	3109	52650	1393	66672	303	64729
24-#11	2.60	MA	23258	5180	36079	4248	43432	3425	47460	2783	52330	1769	66567	1262	51091
7E		MI	13963	5180	22621	4110	26560	3305	28632	2672	30810	1643	38137	1050	30100
24-#11	2.60	MA	22592	5180	35120	4250	42168	3426	45881	2783	50214	1777	63832	1207	49929
8L-6S		MI	14368	5180	23196	4111	27321	3308	29558	2666	32051	1648	39567	1121	30677
24-#11	2.60	MA	21931	5180	34060	4262	40865	3437	44327	2793	48119	1784	61117	1148	48643
9L-5S		MI	14782	5180	23787	4113	28108	3302	30511	2672	33274	1643	41180	1197	31040
24-#11	2.60	MA	21253	5180	33105	4263	39610	3438	42766	2792	45964	1781	58312	1068	47362
10L-4S		MI	15213	5180	24451	4104	28905	3305	31478	2666	34545	1638	42792	1239	31642
24-#11	2.60	MA	20546	5180	32157	4265	38322	3449	41222	2802	43878	1789	55623	1010	45776
11L-3S		MI	15686	5180	25105	4106	29788	3299	32545	2672	35939	1643	44305	1329	31755
24-#11	2.60	MA	19831	5180	31214	4267	37070	3449	39670	2801	41742	1786	52930	953	44202
12L-2S		MI	16332	5180	25977	4108	30894	3302	33880	2666	37695	1638	46617	1420	31822
24-#14	3.75	MA	24258	5782	40155	4622	48374	3700	53322	2959	60206	1750	77749	941	68351
8L-6S		MI	15463	5782	26549	4469	31463	3569	34416	2815	38437	1578	48165	849	42117
24-#14	3.75	MA	23349	5782	38634	4639	46504	3716	51091	2972	57198	1760	73882	857	66119
9L-5S		MI	16033	5782	27394	4472	32588	3560	35766	2822	40168	1571	50290	938	43132
24-#14	3.75	MA	22406	5782	37262	4641	44703	3716	48851	2971	54106	1755	69886	742	63571
10L-4S		MI	16627	5782	28343	4461	33727	3566	37137	2815	42030	1578	52566	1000	43934

RECTANGULAR TIED COLUMNS 32" x 32"

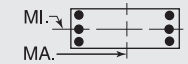
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.32	MA	10650	3206	15788	2626	18485	2133	19740	1762	20759	1207	25059	1109	12574
2L-3S		MI	9607	3206	14443	2624	16779	2128	17677	1770	18045	1214	21483	977	12560
6-#18	2.34	MA	11942	3588	18901	2842	22304	2289	24171	1846	26555	1150	32557	996	21552
2L-3S		MI	10194	3588	16561	2836	19337	2277	20627	1859	21891	1164	26451	762	21241
8-#11	1.22	MA	10543	3169	15456	2614	18130	2125	19348	1760	20296	1219	24493	1129	11729
2L-4S		MI	9269	3169	13808	2612	15982	2129	16745	1761	16864	1219	20309	946	11670
8-#14	1.76	MA	11265	3370	17132	2728	20190	2207	21803	1809	23473	1193	28635	1077	16574
2L-4S		MI	9485	3370	14779	2724	17122	2212	18092	1809	18604	1193	22719	815	16083
8-#18	3.13	MA	12942	3879	21240	3024	25271	2422	27716	1927	31218	1123	38662	930	28445
2L-4S		MI	9979	3879	17138	3011	19925	2425	21339	1927	22966	1149	28549	470	25035
10-#11	1.52	MA	10982	3283	16399	2685	19325	2177	20795	1793	22210	1211	27022	1108	14537
2L-5S		MI	9240	3283	14035	2692	16318	2178	17145	1800	17392	1216	21076	884	13848
10-#11	1.52	MA	10256	3283	15456	2684	18130	2174	19348	1799	20296	1216	24493	1017	14515
3L-4S		MI	9724	3283	14751	2683	17177	2181	18192	1794	18778	1211	22837	926	14423
10-#14	2.20	MA	11866	3533	18477	2831	21895	2282	23866	1857	26187	1180	32211	1045	20553
2L-5S		MI	9441	3533	15100	2839	17599	2282	18659	1864	19353	1188	23801	722	18685
10-#14	2.20	MA	10856	3533	17132	2828	20190	2277	21803	1864	23473	1188	28635	913	20446
3L-4S		MI	10115	3533	16123	2826	18827	2287	20155	1857	21318	1180	26295	783	19796
10-#18	3.91	MA	13916	4170	23579	3206	28237	2555	31260	2007	35881	1095	44768	864	35314
2L-5S		MI	9905	4170	17689	3213	20744	2546	22314	2020	24138	1108	30397	295	28801
10-#18	3.91	MA	12246	4170	21240	3199	25271	2543	27716	2020	31218	1108	38662	631	34771
3L-4S		MI	11020	4170	19478	3193	22891	2558	24883	2007	27629	1122	34655	405	31546

RECTANGULAR TIED COLUMNS 32" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.47	MA	12234	3467	18362	2820	21500	2287	22995	1882	24356	1270	29466	1156	15696
2E		MI	11458	3467	17304	2804	20175	2274	21473	1866	22677	1255	27341	1136	14657
6-#14	1.24	MA	11946	3376	17520	2785	20572	2264	21974	1874	23101	1296	27908	1200	13485
2L-3S		MI	10152	3376	15178	2769	17615	2247	18524	1871	18833	1292	22379	1052	12606
6-#14	1.24	MA	10819	3376	16073	2784	18737	2259	19751	1883	20160	1304	24019	1069	13471
3L-2S		MI	11199	3376	16522	2771	19320	2252	20587	1864	21547	1284	25955	1184	12607
6-#18	2.21	MA	13364	3758	20883	3001	24698	2420	26847	1964	29423	1245	36127	1096	23172
2L-3S		MI	10741	3758	17304	2979	20175	2395	21473	1960	22677	1241	27341	837	21337

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

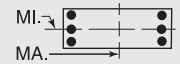
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	2.21	MA	11471	3758	18362	2996	21500	2410	22995	1978	24356	1258	29466	862	22861
3L-2S		MI	12498	3758	19643	2986	23142	2407	25017	1947	27340	1228	33447	1070	21603
8-#11	1.15	MA	11826	3339	17160	2773	20186	2256	21537	1871	22589	1308	27274	1219	12572
2L-4S		MI	9813	3339	14539	2758	16816	2249	17592	1863	17654	1297	21207	1022	11723
8-#11	1.15	MA	11034	3339	16147	2773	18901	2254	19980	1878	20518	1313	24528	1128	12575
3E		MI	10354	3339	15244	2759	17769	2242	18747	1868	19173	1302	22863	1113	11769
8-#11	1.15	MA	10453	3339	15390	2772	17878	2262	18740	1874	18874	1308	22727	1037	12513
4L-2S		MI	11091	3339	16187	2760	18964	2245	20195	1862	21087	1297	25391	1204	11759
8-#14	1.65	MA	12617	3540	18967	2887	22407	2338	24197	1922	26043	1285	31797	1171	17789
2L-4S		MI	10030	3540	15513	2869	17957	2332	18939	1911	19393	1271	23615	890	16305
8-#14	1.65	MA	11508	3540	17520	2886	20572	2334	21974	1930	23101	1292	27908	1040	17724
3E		MI	10787	3540	16522	2871	19320	2322	20587	1918	21547	1279	25955	1021	16563
8-#14	1.65	MA	10695	3540	16437	2884	19108	2345	20201	1923	20767	1285	25361	908	17442
4L-2S		MI	11817	3540	17867	2873	21026	2327	22650	1911	24261	1271	29531	1152	16613
8-#18	2.94	MA	14456	4049	23404	3183	27895	2553	30698	2047	34490	1220	42788	1036	30605
2L-4S		MI	10523	4049	17881	3154	20762	2543	22185	2027	23751	1226	29439	545	25330
8-#18	2.94	MA	12608	4049	20883	3178	24698	2543	26847	2060	29423	1233	36127	802	30169
3E		MI	11788	4049	19643	3161	23142	2528	25017	2040	27340	1213	33447	771	28114
8-#18	2.94	MA	11252	4049	18989	3173	22140	2559	23769	2047	25400	1220	31763	572	27167
4L-2S		MI	13504	4049	21983	3168	26108	2540	28562	2027	32003	1200	39552	1005	28502
10-#11	1.43	MA	12304	3452	18173	2844	21471	2308	23093	1904	24661	1301	30021	1200	15590
2L-5S		MI	9783	3452	14766	2838	17153	2298	17992	1901	18182	1294	21975	959	13996
10-#11	1.43	MA	11521	3452	17160	2844	20186	2305	21537	1911	22589	1306	27274	1109	15568
3L-4S		MI	10269	3452	15481	2828	18011	2301	19040	1896	19568	1289	23736	1002	14481
10-#11	1.43	MA	10948	3452	16403	2843	19163	2314	20297	1907	20945	1301	25473	1018	15476
4L-3S		MI	10804	3452	16187	2830	18964	2294	20195	1900	21087	1294	25391	1093	14556
10-#11	1.43	MA	10427	3452	15636	2853	18242	2311	19174	1913	19445	1306	23567	975	14942
5L-2S		MI	11532	3452	17129	2831	20160	2297	21643	1895	23000	1289	27920	1184	14569
10-#14	2.07	MA	13272	3703	20414	2990	24242	2413	26420	1969	28984	1273	35687	1142	22072
2L-5S		MI	9984	3703	15835	2983	18435	2401	19506	1965	20141	1266	24697	797	18872
10-#14	2.07	MA	12181	3703	18967	2988	22407	2409	24197	1977	26043	1281	31797	1011	21965
3L-4S		MI	10662	3703	16858	2971	19663	2406	21002	1958	22107	1258	27190	858	20013
10-#14	2.07	MA	11382	3703	17884	2987	20943	2420	22424	1971	23708	1273	29251	879	21446
4L-3S		MI	11407	3703	17867	2973	21026	2396	22650	1965	24261	1266	29531	989	20505
10-#14	2.07	MA	10656	3703	16786	3000	19626	2416	20816	1979	21578	1281	26544	818	20176
5L-2S		MI	12422	3703	19212	2976	22731	2401	24713	1958	26975	1258	33107	1120	20596
10-#18	3.68	MA	15520	4339	25925	3365	31092	2686	34549	2130	39556	1195	49449	976	38014
2L-5S		MI	10446	4339	18431	3356	21582	2664	23160	2121	24923	1185	31287	370	29260
10-#18	3.68	MA	13712	4339	23404	3360	27895	2676	30698	2143	34490	1209	42788	743	37471
3L-4S		MI	11569	4339	20220	3336	23729	2676	25729	2107	28414	1199	35545	479	31834
10-#18	3.68	MA	12388	4339	21510	3355	25337	2692	27621	2130	30467	1195	38424	513	34199
4L-3S		MI	12804	4339	21983	3343	26108	2661	28562	2121	32003	1185	39552	705	34884
10-#18	3.68	MA	11185	4339	19588	3376	23030	2682	24829	2143	26798	1209	33779	404	31425
5L-2S		MI	14484	4339	24322	3349	29075	2673	32106	2107	36667	1172	45658	939	35376
12-#11	1.72	MA	12773	3566	19187	2915	22756	2360	24650	1937	26732	1294	32767	1182	18595
2L-6S		MI	9776	3566	15071	2907	17499	2358	18408	1930	18763	1291	22739	863	16158
12-#11	1.72	MA	11999	3566	18173	2914	21471	2357	23093	1943	24661	1299	30021	1091	18553
3L-5S		MI	10237	3566	15708	2909	18348	2350	19440	1934	20095	1286	24504	939	16652
12-#11	1.72	MA	11433	3566	17416	2914	20447	2365	21854	1940	23017	1294	28220	1000	18435
4E		MI	10717	3566	16423	2899	19206	2353	20488	1929	21481	1281	26265	981	17234
12-#11	1.72	MA	10919	3566	16649	2924	19527	2363	20730	1946	21517	1299	26313	956	17803
5L-3S		MI	11245	3566	17129	2901	20160	2346	21643	1933	23000	1286	27920	1072	17334

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis



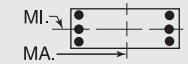
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.72	MA	10426	3566	15967	2923	18618	2371	19624	1942	20074	1304	24396	881	17250
6L-2S		MI	11965	3566	18071	2902	21355	2349	23091	1928	24914	1281	30449	1163	17367
12-#14	2.48	MA	13915	3867	21861	3092	26077	2488	28643	2016	31925	1262	39576	1113	26343
2L-6S		MI	9974	3867	16268	3083	18926	2486	20096	2005	20965	1260	25778	656	21494
12-#14	2.48	MA	12839	3867	20414	3090	24242	2484	26420	2025	28984	1269	35687	982	26198
3L-5S		MI	10614	3867	17179	3086	20140	2476	21569	2013	22855	1253	28273	765	22673
12-#14	2.48	MA	12053	3867	19331	3089	22778	2495	24647	2018	26649	1262	33140	850	25474
4E		MI	11281	3867	18203	3073	21368	2481	23065	2005	24821	1245	30766	826	23747
12-#14	2.48	MA	11339	3867	18233	3102	21461	2491	23039	2027	24519	1269	30433	789	24275
5L-3S		MI	12014	3867	19212	3075	22731	2471	24713	2013	26975	1253	33107	957	24440
12-#14	2.48	MA	10654	3867	17256	3101	20159	2502	21455	2020	22471	1277	27719	680	23000
6L-2S		MI	13014	3867	20556	3078	24436	2476	26776	2005	29689	1245	36682	1088	24567
12-#18	4.41	MA	14788	4630	25925	3542	31092	2809	34549	2225	39556	1184	49449	683	44771
3L-5S		MI	11489	4630	20771	3538	24549	2797	26704	2201	29586	1158	37392	304	35658
12-#18	4.41	MA	13494	4630	24031	3537	28534	2825	31472	2212	35534	1171	45085	453	41268
4E		MI	12587	4630	22560	3518	26696	2809	29274	2188	33078	1171	41650	414	38375
12-#18	4.41	MA	12319	4630	22109	3558	26228	2815	28680	2225	31864	1184	40440	344	38355
5L-3S		MI	13796	4630	24322	3524	29075	2794	32106	2201	36667	1158	45658	640	41650
14-#11	2.01	MA	13235	3679	20200	2986	24041	2411	26207	1970	28803	1287	35514	1164	21592
2L-7S		MI	9782	3679	15393	2977	17875	2407	18854	1968	19325	1278	23705	771	18075
14-#11	2.01	MA	12469	3679	19187	2985	22756	2409	24650	1976	26732	1292	32767	1072	21532
3L-6S		MI	10228	3679	16014	2978	18695	2409	19856	1963	20676	1283	25268	843	18846
14-#11	2.01	MA	11910	3679	18429	2985	21732	2417	23411	1972	25088	1287	30966	981	21390
4L-5S		MI	10683	3679	16650	2979	19543	2402	20888	1967	22009	1278	27033	918	19318
14-#11	2.01	MA	11403	3679	17662	2994	20812	2415	22287	1979	23588	1292	29060	938	20674
5L-4S		MI	11157	3679	17366	2970	20401	2405	21935	1961	23395	1273	28794	961	19983
14-#11	2.01	MA	10916	3679	16980	2994	19903	2423	21181	1975	22145	1297	27143	862	20145
6L-3S		MI	11679	3679	18071	2971	21355	2397	23091	1966	24914	1278	30449	1052	20106
14-#11	2.01	MA	10439	3679	16315	2993	19024	2421	20107	1981	20682	1292	25443	791	19309
7L-2S		MI	12391	3679	19014	2973	22550	2400	24538	1960	26827	1273	32978	1143	20157
14-#14	2.90	MA	14546	4030	23308	3194	27912	2563	30866	2064	34867	1250	43465	1084	30605
2L-7S		MI	9983	4030	16725	3183	19458	2556	20729	2060	21762	1240	27143	522	24003
14-#14	2.90	MA	13484	4030	21861	3193	26077	2559	28643	2072	31925	1258	39576	953	30426
3L-6S		MI	10600	4030	17613	3186	20632	2561	22159	2052	23679	1247	29354	624	25231
14-#14	2.90	MA	12710	4030	20778	3191	24613	2570	26870	2066	29591	1250	37029	821	29524
4L-5S		MI	11231	4030	18524	3188	21845	2551	23632	2060	25569	1240	31848	734	26487
14-#14	2.90	MA	12008	4030	19680	3204	23296	2566	25262	2074	27461	1258	34323	760	28387
5L-4S		MI	11887	4030	19547	3175	23073	2556	25128	2052	27535	1232	34342	794	27502
14-#14	2.90	MA	11334	4030	18703	3203	21994	2576	23678	2067	25412	1265	31609	651	27036
6L-3S		MI	12610	4030	20556	3178	24436	2546	26776	2060	29689	1240	36682	925	28368
14-#14	2.90	MA	10673	4030	17751	3201	20735	2572	22141	2076	23334	1258	29205	548	25710
7L-2S		MI	13597	4030	21901	3180	26142	2551	28839	2052	32403	1232	40258	1056	28528
14-#18	5.15	MA	14576	4921	26552	3718	31731	2958	35323	2295	40600	1146	51746	393	48369
4L-5S		MI	12576	4921	23110	3720	27515	2930	30249	2281	34250	1130	43498	238	42089
14-#18	5.15	MA	13425	4921	24630	3740	29425	2948	32531	2308	36931	1159	47101	285	45318
5L-4S		MI	13639	4921	24899	3700	29663	2942	32818	2268	37741	1143	47756	348	44948
16-#11	2.29	MA	13690	3793	21213	3057	25326	2463	27764	2003	30875	1280	38260	1145	24584
2L-8S		MI	9797	3793	15725	3047	18266	2455	19299	1996	19934	1275	24591	701	19979
16-#11	2.29	MA	12932	3793	20200	3056	24041	2461	26207	2009	28803	1285	35514	1054	24506
3L-7S		MI	10232	3793	16336	3048	19070	2458	20302	2001	21238	1270	26234	751	20722
16-#11	2.29	MA	12380	3793	19443	3056	23017	2469	24967	2005	27159	1280	33713	963	24344
4L-6S		MI	10672	3793	16956	3049	19890	2461	21304	1995	22590	1275	27797	822	21540
16-#11	2.29	MA	11878	3793	18676	3065	22097	2467	23844	2012	25659	1285	31806	919	23555
5E		MI	11122	3793	17593	3050	20738	2454	22336	2000	23923	1270	29562	898	21993

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis

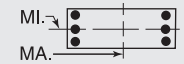


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.29	MA	11398	3793	17993	3065	21188	2475	22737	2008	24217	1290	29890	844	23046
6L-4S		MI	11591	3793	18308	3041	21596	2457	23383	1994	25308	1265	31323	940	22730
16-#11	2.29	MA	10927	3793	17329	3064	20309	2473	21664	2014	22754	1285	28190	773	22163
7L-3S		MI	12106	3793	19014	3042	22550	2449	24538	1999	26827	1270	32978	1032	22873
16-#11	2.29	MA	10461	3793	16674	3063	19447	2470	20588	2010	21342	1290	26411	722	21358
8L-2S		MI	12812	3793	19956	3043	23745	2452	25986	1993	28741	1265	35507	1123	22940
16-#14	3.31	MA	14119	4194	23308	3295	27912	2634	30866	2119	34867	1246	43465	924	34650
3L-7S		MI	10607	4194	18069	3286	21164	2631	22792	2107	24476	1227	30719	490	27706
16-#14	3.31	MA	13357	4194	22225	3293	26448	2644	29093	2113	32532	1239	40919	792	33591
4L-6S		MI	11216	4194	18957	3288	22337	2636	24222	2099	26393	1234	32930	592	28981
16-#14	3.31	MA	12665	4194	21127	3307	25131	2640	27485	2121	30402	1246	38212	731	32509
5E		MI	11836	4194	19869	3290	23551	2626	25695	2107	28283	1227	35424	702	30311
16-#14	3.31	MA	12001	4194	20150	3305	23829	2651	25901	2115	28354	1254	35498	622	31086
6L-4S		MI	12483	4194	20892	3278	24779	2631	27191	2099	30249	1219	37918	762	31274
16-#14	3.31	MA	11351	4194	19198	3304	22570	2647	24365	2123	26276	1246	33094	519	29714
7L-3S		MI	13196	4194	21901	3280	26142	2621	28839	2107	32403	1227	40258	893	32291
16-#18	5.88	MA	14584	5212	27151	3922	32622	3081	36383	2391	41998	1134	53762	225	52310
5E		MI	13571	5212	25449	3901	30482	3063	33793	2362	38913	1102	49603	173	48550
18-#11	2.58	MA	13389	3906	21213	3127	25326	2513	27764	2042	30875	1277	38260	1035	27478
3L-8S		MI	10245	3906	16667	3118	19461	2507	20746	2029	21848	1267	27120	681	22600
18-#11	2.58	MA	12843	3906	20456	3126	24302	2521	26524	2038	29231	1272	36459	944	27296
4L-7S		MI	10675	3906	17278	3119	20265	2510	21750	2034	23152	1262	28763	730	23377
18-#11	2.58	MA	12347	3906	19689	3136	23382	2519	25401	2045	27731	1277	34553	901	26442
5L-6S		MI	11110	3906	17898	3120	21085	2513	22751	2028	24503	1267	30326	802	24228
18-#11	2.58	MA	11872	3906	19006	3136	22473	2527	24294	2041	26288	1283	32636	825	25951
6L-5S		MI	11555	3906	18535	3121	21933	2506	23784	2033	25836	1262	32090	878	24675
18-#11	2.58	MA	11407	3906	18342	3135	21594	2524	23221	2047	24825	1277	30936	754	25025
7L-4S		MI	12018	3906	19250	3112	22792	2509	24831	2027	27222	1256	33851	920	25474
18-#11	2.58	MA	10947	3906	17687	3134	20732	2522	22145	2043	23414	1283	29157	704	24187
8L-3S		MI	12528	3906	19956	3113	23745	2501	25986	2032	28741	1262	35507	1011	25636
18-#14	3.72	MA	13992	4357	23672	3396	28283	2719	31316	2160	35473	1227	44808	764	37672
4L-7S		MI	11221	4357	19414	3388	22869	2706	24855	2154	27190	1214	34295	458	31422
18-#14	3.72	MA	13310	4357	22574	3409	26966	2715	29709	2169	33343	1235	42101	702	36640
5L-6S		MI	11820	4357	20302	3390	24042	2711	26285	2147	29107	1221	36505	560	32744
18-#14	3.72	MA	12656	4357	21596	3407	25664	2726	28125	2162	31295	1242	39387	593	35147
6L-5S		MI	12432	4357	21213	3392	25256	2701	27758	2154	30997	1214	39000	670	34143
18-#14	3.72	MA	12016	4357	20645	3406	24405	2722	26588	2171	29217	1235	36983	490	33729
7L-4S		MI	13070	4357	22237	3380	26484	2706	29254	2147	32963	1206	41494	731	35060
20-#11	2.87	MA	13299	4019	21469	3197	25587	2573	28081	2071	31302	1265	39206	926	30196
4L-8S		MI	10686	4019	17609	3189	20656	2559	22194	2062	23761	1259	29649	661	25228
20-#11	2.87	MA	12809	4019	20702	3207	24667	2571	26957	2077	29802	1270	37299	883	29336
5L-7S		MI	11112	4019	18220	3190	21460	2562	23198	2067	25065	1253	31292	710	26037
20-#11	2.87	MA	12340	4019	20020	3206	23758	2579	25851	2073	28359	1275	35383	807	28808
6E		MI	11542	4019	18841	3191	22280	2565	24199	2061	26417	1259	32855	781	26860
20-#11	2.87	MA	11880	4019	19355	3206	22879	2576	24777	2080	26896	1270	33683	736	27893
7L-5S		MI	11982	4019	19477	3192	23128	2558	25231	2066	27750	1253	34619	857	27362
20-#11	2.87	MA	11425	4019	18700	3205	22017	2574	23702	2076	25485	1275	31904	685	27023
8L-4S		MI	12440	4019	20193	3183	23987	2560	26279	2060	29135	1248	36380	900	28129
20-#14	4.14	MA	13947	4521	24021	3511	28801	2790	31932	2216	36285	1223	45991	673	40778
5L-7S		MI	11825	4521	20759	3490	24574	2780	26918	2201	29904	1201	37871	426	35148
20-#14	4.14	MA	13302	4521	23043	3510	27499	2801	30348	2210	34236	1230	43277	564	39220
6E		MI	12416	4521	21647	3492	25748	2785	28348	2194	31821	1208	40081	528	36518
20-#14	4.14	MA	12670	4521	22091	3508	26240	2797	28811	2218	32158	1223	40873	461	37756
7L-5S		MI	13020	4521	22558	3495	26961	2775	29821	2201	33711	1201	42576	638	37982
22-#11	3.15	MA	13266	4133	21715	3278	25952	2622	28514	2110	31873	1263	40046	864	32234
5L-8S		MI	11122	4133	18552	3259	21851	2611	23642	2095	25675	1250	32178	640	27862
22-#11	3.15	MA	12801	4133	21033	3277	25043	2630	27408	2106	30431	1268	38129	788	31653
6L-7S		MI	11543	4133	19163	3261	22655	2614	24646	2100	26979	1245	33821	690	28703

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.15	MA	12346	4133	20368	3277	24164	2628	26334	2113	28968	1263	36429	717	30766
7L-6S		MI	11968	4133	19783	3262	23475	2617	25647	2094	28331	1250	35384	761	29499
22-#11	3.15	MA	11897	4133	19714	3276	23302	2626	25259	2109	27556	1268	34650	667	29865
8L-5S		MI	12403	4133	20420	3263	24323	2609	26679	2099	29663	1245	37148	837	30055
22-#14	4.55	MA	13938	4685	24490	3612	29334	2876	32571	2257	37178	1219	47166	535	43302
6L-7S		MI	12420	4685	22103	3592	26280	2855	28981	2248	32618	1187	41446	394	38885
22-#14	4.55	MA	13315	4685	23538	3610	28075	2872	31034	2265	35100	1211	44762	432	41793
7L-6S		MI	13004	4685	22991	3595	27453	2860	30411	2241	34535	1195	43657	496	40301
24-#11	3.44	MA	13257	4246	22046	3348	26328	2682	28964	2139	32502	1261	40876	770	34505
6L-8S		MI	11552	4246	19494	3330	23046	2663	25090	2128	27588	1242	34707	620	30502
24-#11	3.44	MA	12807	4246	21381	3348	25449	2680	27891	2146	31039	1256	39176	699	33645
7E		MI	11968	4246	20105	3332	23850	2666	26094	2132	28892	1237	36350	669	31375
24-#11	3.44	MA	12363	4246	20727	3347	24587	2678	26815	2142	29628	1261	37397	648	32713
8L-6S		MI	12390	4246	20725	3333	24670	2669	27095	2127	30244	1242	37913	741	32145
24-#14	4.96	MA	13951	4848	24985	3713	29910	2946	33257	2313	38041	1200	48651	403	45838
7E		MI	13008	4848	23448	3694	27985	2930	31044	2295	35332	1174	45022	362	42631

RECTANGULAR TIED COLUMNS 32" x 36"

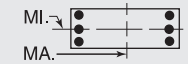
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.39	MA	13628	3637	20242	2979	23764	2418	25459	1996	26924	1360	32601	1249	16776
2E		MI	12008	3637	18047	2948	21013	2392	22319	1967	23462	1332	28232	1210	14697
6-#14	1.17	MA	13310	3546	19333	2944	22759	2394	24305	1985	25547	1386	30877	1290	14397
2L-3S		MI	10697	3546	15912	2914	18450	2366	19371	1972	19622	1370	23275	1128	12649
6-#14	1.17	MA	12099	3546	17783	2944	20794	2391	21925	1995	22378	1393	26674	1159	14382
3L-2S		MI	11747	3546	17257	2916	20156	2371	21434	1965	22336	1362	26851	1259	12639
6-#18	2.08	MA	14856	3927	22945	3160	27192	2551	29611	2080	32395	1338	39819	1194	24792
2L-3S		MI	11288	3927	18047	3123	21013	2513	22319	2060	23462	1318	28232	911	21426
6-#18	2.08	MA	12817	3927	20242	3157	23764	2542	25459	2094	26924	1351	32601	960	24481
3L-2S		MI	13052	3927	20386	3129	23979	2525	25864	2047	28125	1305	34337	1145	21653
8-#11	1.08	MA	13178	3509	18944	2932	22341	2387	23832	1982	24985	1397	30176	1308	13414
2L-4S		MI	10357	3509	15269	2903	17650	2369	18439	1965	18444	1375	22106	1098	11772
8-#11	1.08	MA	12327	3509	17860	2932	20966	2385	22166	1990	22756	1402	27211	1217	13417
3E		MI	10900	3509	15975	2904	18604	2362	19594	1969	19963	1381	23761	1189	11804
8-#11	1.08	MA	11705	3509	17051	2932	19874	2394	20842	1986	20987	1397	25264	1126	13355
4L-2S		MI	11639	3509	16917	2906	19799	2365	21042	1964	21877	1375	26290	1280	11787
8-#14	1.56	MA	14037	3709	20882	3047	24724	2469	26685	2033	28716	1376	35081	1264	19004
2L-4S		MI	10574	3709	16248	3014	18793	2451	19785	2012	20181	1349	24510	965	16421
8-#14	1.56	MA	12845	3709	19333	3046	22759	2466	24305	2042	25547	1383	30877	1133	18939
3E		MI	11335	3709	17257	3016	20156	2441	21434	2020	22336	1357	26851	1096	16613
8-#14	1.56	MA	11975	3709	18175	3045	21195	2478	22410	2037	23032	1376	28120	1001	18674
4L-2S		MI	12368	3709	18602	3018	21861	2446	23497	2012	25050	1349	30427	1227	16650
8-#18	2.78	MA	16042	4218	25648	3342	30620	2684	33764	2164	37865	1316	47037	1139	32765
2L-4S		MI	11068	4218	18624	3298	21600	2661	23031	2127	24536	1303	30329	619	25618
8-#18	2.78	MA	14051	4218	22945	3339	27192	2675	29611	2178	32395	1329	39819	906	32329
3E		MI	12339	4218	20386	3305	23979	2646	25864	2141	28125	1290	34337	845	28213
8-#18	2.78	MA	12595	4218	20919	3335	24455	2694	26295	2165	28052	1316	35098	672	29326
4L-2S		MI	14064	4218	22725	3311	26946	2658	29408	2127	32789	1277	40442	1079	28558
10-#11	1.35	MA	13696	3622	20028	3003	23716	2439	25497	2015	27214	1391	33140	1292	16643
2L-5S		MI	10327	3622	15496	2983	17987	2418	18839	2003	18972	1372	22874	1035	14140
10-#11	1.35	MA	12854	3622	18944	3003	22341	2437	23832	2022	24985	1396	30176	1200	16621
3L-4S		MI	10815	3622	16211	2974	18845	2421	19887	1998	20358	1367	24635	1077	14535

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

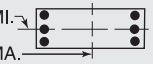


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.35	MA	12240	3622	18135	3003	21249	2446	22507	2019	23216	1391	28228	1109	16529
4L-3S		MI	11351	3622	16917	2975	19799	2414	21042	2002	21877	1372	26290	1168	14596
10-#11	1.35	MA	11683	3622	17316	3013	20266	2444	21308	2026	21601	1396	26176	1065	16047
5L-2S		MI	12081	3622	17860	2976	20994	2416	22490	1997	23790	1367	28819	1260	14601
10-#14	1.95	MA	14748	3873	22431	3149	26688	2544	29065	2080	31885	1365	39284	1238	23591
2L-5S		MI	10528	3873	16569	3128	19270	2521	20353	2067	20930	1344	25593	873	19053
10-#14	1.95	MA	13574	3873	20882	3148	24724	2541	26685	2090	28716	1373	35081	1106	23484
3L-4S		MI	11209	3873	17592	3116	20498	2526	21849	2059	22895	1336	28086	933	20224
10-#14	1.95	MA	12718	3873	19724	3147	23160	2553	24790	2084	26201	1365	32323	975	23115
4L-3S		MI	11957	3873	18602	3118	21861	2516	23497	2067	25050	1344	30427	1064	20562
10-#14	1.95	MA	11940	3873	18552	3161	21752	2549	23073	2093	23906	1373	29407	912	21680
5L-2S		MI	12976	3873	19946	3121	23566	2521	25560	2059	27764	1336	34002	1195	20638
10-#18	3.47	MA	17197	4509	28351	3524	34047	2817	37917	2249	43336	1294	54255	1085	40714
2L-5S		MI	10987	4509	19174	3500	22420	2782	24006	2221	25708	1263	32177	444	29709
10-#18	3.47	MA	15248	4509	25648	3520	30620	2808	33764	2262	37865	1307	47037	851	40171
3L-4S		MI	12117	4509	20963	3480	24567	2794	26575	2208	29200	1276	36435	554	32113
10-#18	3.47	MA	13827	4509	23621	3517	27883	2827	30448	2250	33523	1294	42316	618	36879
4L-3S		MI	13360	4509	22725	3486	26946	2779	29408	2221	32789	1263	40442	780	34991
10-#18	3.47	MA	12535	4509	21567	3540	25417	2818	27439	2263	29561	1307	37283	510	34098
5L-2S		MI	15050	4509	25065	3493	29913	2791	32952	2208	37452	1249	46548	1013	35437
12-#11	1.63	MA	14204	3736	21112	3074	25091	2490	27163	2048	29443	1384	36105	1275	19858
2L-6S		MI	10320	3736	15802	3053	18334	2477	19255	2031	19553	1369	23638	939	16293
12-#11	1.63	MA	13371	3736	20028	3074	23716	2489	25497	2055	27214	1390	33140	1184	19817
3L-5S		MI	10782	3736	16438	3054	19182	2470	20287	2036	20886	1364	25402	1014	16793
12-#11	1.63	MA	12765	3736	19219	3074	22623	2497	24173	2052	25445	1384	31193	1093	19698
4E		MI	11264	3736	17154	3045	20041	2473	21335	2030	22271	1359	27163	1057	17293
12-#11	1.63	MA	12215	3736	18400	3084	21641	2496	22974	2059	23831	1390	29141	1048	19111
5L-3S		MI	11794	3736	17860	3046	20994	2465	22490	2035	23790	1364	28819	1148	17377
12-#11	1.63	MA	11688	3736	17672	3084	20670	2504	21793	2056	22278	1395	27072	973	18491
6L-2S		MI	12517	3736	18802	3047	22189	2468	23938	2029	25704	1359	31348	1239	17403
12-#14	2.34	MA	15445	4036	23980	3251	28653	2619	31445	2128	35054	1355	43487	1211	28166
2L-6S		MI	10516	4037	17003	3228	19762	2605	20943	2106	21754	1338	26674	731	21785
12-#14	2.34	MA	14287	4037	22431	3250	26688	2616	29065	2137	31885	1362	39284	1080	28021
3L-5S		MI	11160	4037	17914	3231	20975	2595	22416	2114	23644	1331	29168	841	22851
12-#14	2.34	MA	13444	4037	21273	3249	25124	2627	27170	2131	29370	1355	36527	949	27435
4E		MI	11830	4036	18937	3218	22204	2600	23912	2106	25609	1323	31662	902	23954
12-#14	2.34	MA	12679	4037	20101	3263	23717	2624	25453	2141	27075	1362	33610	886	26074
5L-3S		MI	12567	4036	19946	3220	23566	2591	25560	2114	27764	1331	34002	1032	24500
12-#14	2.34	MA	11945	4037	19058	3263	22327	2636	23762	2135	24868	1370	30677	777	24832
6L-2S		MI	13572	4036	21291	3223	25272	2596	27623	2106	30478	1323	37578	1163	24612
12-#18	4.17	MA	16416	4800	28351	3702	34047	2941	37917	2347	43336	1285	54255	796	48011
3L-5S		MI	12034	4800	21513	3681	25386	2915	27550	2301	30372	1235	38282	379	36096
12-#18	4.17	MA	15025	4800	26324	3699	31310	2960	34601	2334	38993	1272	49534	563	44470
4E		MI	13140	4800	23302	3661	27534	2927	30120	2288	33863	1248	42540	488	38648
12-#18	4.17	MA	13764	4800	24270	3721	28845	2951	31592	2347	35031	1285	44501	455	41551
5L-3S		MI	14357	4800	25065	3668	29913	2912	32952	2301	37452	1235	46548	714	41764
12-#18	4.17	MA	12553	4800	22441	3718	26408	2970	28628	2335	31222	1298	39465	260	38428
6L-2S		MI	16015	4800	27404	3675	32880	2924	36497	2288	42115	1222	52653	948	42299
14-#11	1.90	MA	14704	3849	22196	3145	26466	2542	28829	2081	31673	1378	39069	1258	23066
2L-7S		MI	10325	3849	16124	3123	18709	2526	19702	2070	20115	1356	24604	847	18288
14-#11	1.90	MA	13881	3849	21112	3145	25091	2541	27163	2088	29443	1383	36105	1167	23006
3L-6S		MI	10773	3849	16744	3124	19529	2529	20703	2064	21467	1361	26167	918	18981
14-#11	1.90	MA	13282	3849	20303	3145	23998	2549	25839	2085	27674	1378	34158	1076	22865
4L-5S		MI	11230	3849	17381	3125	20377	2522	21735	2069	22799	1356	27931	994	19458
14-#11	1.90	MA	12738	3849	19484	3155	23016	2548	24640	2092	26060	1383	32106	1032	22186
5L-4S		MI	11706	3849	18096	3116	21236	2525	22783	2063	24185	1351	29692	1036	20046
14-#11	1.90	MA	12217	3849	18756	3155	22045	2556	23459	2089	24507	1388	30036	956	21593
6L-3S		MI	12230	3849	18802	3117	22189	2517	23938	2068	25704	1356	31348	1128	20152

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

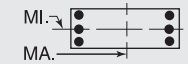
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.90	MA	11707	3849	18047	3155	21108	2554	22313	2096	22933	1383	28199	885	20779
7L-2S		MI	12945	3849	19744	3118	23384	2520	25386	2062	27617	1351	33877	1219	20195
14-#14	2.73	MA	16129	4200	25529	3353	30618	2694	33826	2175	38223	1345	47691	1185	32732
2L-7S		MI	10524	4200	17459	3328	20294	2675	21576	2161	22550	1318	28039	597	24392
14-#14	2.73	MA	14987	4200	23980	3352	28653	2690	31445	2184	35054	1352	43487	1054	32552
3L-6S		MI	11145	4200	18347	3331	21467	2680	23006	2154	24468	1325	30250	699	25516
14-#14	2.73	MA	14157	4200	22822	3352	27089	2702	29550	2179	32539	1345	40730	922	31775
4L-5S		MI	11779	4200	19259	3333	22681	2670	24479	2161	26358	1318	32744	809	26663
14-#14	2.73	MA	13404	4200	21650	3366	25682	2699	27833	2188	30244	1352	37813	860	30482
5L-4S		MI	12439	4200	20282	3320	23909	2675	25975	2154	28323	1310	35238	870	27705
14-#14	2.73	MA	12681	4200	20607	3365	24292	2711	26142	2183	28037	1360	34880	750	29163
6L-3S		MI	13166	4200	21291	3323	25272	2665	27623	2161	30478	1318	37578	1000	28432
14-#14	2.73	MA	11973	4200	19591	3364	22949	2708	24501	2192	25798	1352	32278	648	27799
7L-2S		MI	14158	4200	22636	3325	26977	2670	29686	2154	33192	1310	41154	1132	28576
14-#18	4.86	MA	16197	5091	29027	3880	34738	3093	38753	2418	44464	1249	56752	508	52094
4L-5S		MI	13127	5091	23853	3863	28353	3048	31095	2382	35035	1207	44388	313	42519
14-#18	4.86	MA	14962	5091	26973	3903	32272	3084	35745	2432	40502	1263	51718	401	49037
5L-4S		MI	14200	5091	25641	3843	30500	3060	33664	2368	38526	1220	48646	422	45215
14-#18	4.86	MA	13777	5091	25143	3900	29836	3103	32781	2419	36692	1276	46683	206	45844
6L-3S		MI	15370	5091	27404	3850	32880	3045	36497	2382	42115	1207	52653	648	48489
16-#11	2.17	MA	15197	3962	23280	3216	27841	2594	30494	2114	33902	1372	42034	1241	26269
2L-8S		MI	10339	3962	16455	3193	19100	2575	20146	2098	20724	1353	25490	777	20269
16-#11	2.17	MA	14382	3962	22196	3216	26466	2592	28829	2121	31673	1377	39069	1150	26191
3L-7S		MI	10776	3962	17066	3194	19904	2578	21149	2103	22028	1348	27133	826	20932
16-#11	2.17	MA	13790	3962	21387	3216	25373	2601	27504	2118	29904	1372	37122	1059	26029
4L-6S		MI	11219	3962	17686	3195	20724	2581	22151	2097	23380	1353	28696	898	21674
16-#11	2.17	MA	13253	3962	20568	3226	24391	2599	26305	2125	28289	1377	35070	1015	25270
5E		MI	11671	3962	18323	3196	21572	2574	23183	2102	24713	1348	30460	974	22131
16-#11	2.17	MA	12738	3962	19840	3226	23420	2608	25124	2122	26737	1382	33001	939	24700
6L-4S		MI	12141	3962	19038	3187	22431	2577	24231	2096	26098	1343	32221	1016	22796
16-#11	2.17	MA	12234	3962	19132	3225	22482	2606	23979	2129	25162	1377	31164	868	23838
7L-3S		MI	12660	3962	19744	3188	23384	2569	25386	2101	27617	1348	33877	1107	22922
16-#11	2.17	MA	11736	3962	18433	3225	21563	2605	22831	2125	23643	1382	29248	817	23061
8L-2S		MI	13368	3962	20687	3189	24579	2572	26834	2095	29531	1343	36405	1198	22981
16-#14	3.13	MA	15675	4364	25529	3455	30618	2765	33826	2232	38223	1342	47691	1027	37080
3L-7S		MI	11150	4364	18804	3430	21999	2750	23639	2208	25264	1304	31615	565	28089
16-#14	3.13	MA	14856	4364	24372	3454	29054	2777	31931	2226	35708	1335	44933	896	36134
4L-6S		MI	11762	4364	19692	3433	23173	2755	25069	2201	27182	1312	33825	667	29262
16-#14	3.13	MA	14114	4364	23199	3468	27646	2774	30213	2235	33413	1342	42017	833	34901
5E		MI	12387	4364	20603	3435	24386	2745	26542	2208	29072	1304	36320	777	30485
16-#14	3.13	MA	13403	4364	22156	3467	26257	2786	28522	2230	31206	1349	39083	724	33507
6L-4S		MI	13038	4364	21626	3423	25614	2750	28038	2201	31037	1297	38813	838	31473
16-#14	3.13	MA	12706	4364	21140	3466	24913	2782	26881	2239	28967	1342	36482	621	32153
7L-3S		MI	13755	4364	22636	3425	26977	2740	29686	2208	33192	1304	41154	968	32360
16-#14	3.13	MA	12017	4364	20140	3465	23596	2779	25237	2234	26808	1349	33759	548	30291
8L-2S		MI	14735	4364	23980	3427	28682	2745	31749	2201	35906	1297	44730	1100	32533
16-#18	5.56	MA	16228	5381	29675	4085	35700	3217	39898	2516	45972	1241	58936	346	56552
5E		MI	14127	5381	26192	4045	31320	3181	34639	2462	39698	1179	50493	247	48971
16-#18	5.56	MA	15073	5381	27846	4081	33264	3236	36933	2503	42163	1254	53900	151	53287
6L-4S		MI	15172	5381	27981	4025	33467	3193	37208	2449	43190	1193	54751	357	51806
18-#11	2.44	MA	14876	4076	23280	3287	27841	2644	30494	2154	33902	1371	42034	1133	29373
3L-8S		MI	10788	4076	17398	3263	20295	2627	21594	2131	22638	1345	28019	757	22886
18-#11	2.44	MA	14291	4076	22471	3287	26748	2653	29170	2151	32133	1365	40087	1042	29191
4L-7S		MI	11220	4076	18008	3265	21099	2630	22597	2136	23942	1340	29662	806	23584

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

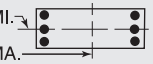


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.44	MA	13760	4076	21653	3297	25765	2651	27971	2158	30518	1371	38035	998	28362
5L-6S		MI	11658	4076	18629	3266	21919	2633	23599	2130	25294	1345	31225	877	24372
18-#11	2.44	MA	13251	4076	20925	3297	24795	2660	26790	2154	28966	1376	35965	922	27812
6L-5S		MI	12105	4076	19265	3267	22767	2626	24631	2135	26626	1340	32989	953	24811
18-#11	2.44	MA	12753	4076	20216	3296	23857	2658	25645	2161	27391	1371	34129	851	26904
7L-4S		MI	12571	4076	19981	3258	23626	2628	25678	2129	28012	1335	34750	996	25543
18-#11	2.44	MA	12260	4076	19518	3296	22938	2656	24497	2158	25872	1376	32213	800	26095
8L-3S		MI	13084	4076	20687	3259	24579	2621	26834	2134	29531	1340	36405	1087	25688
18-#11	2.44	MA	11771	4076	18747	3306	21991	2665	23368	2165	24368	1381	30337	741	25011
9L-2S		MI	13786	4076	21629	3260	25774	2624	28281	2128	31444	1335	38934	1178	25762
18-#14	3.52	MA	15545	4527	25921	3556	31018	2852	34311	2274	38877	1324	49137	869	40508
4L-7S		MI	11766	4527	20149	3533	23704	2825	25702	2255	27978	1291	35190	533	31799
18-#14	3.52	MA	14814	4527	24748	3570	29611	2849	32594	2283	36582	1332	46220	807	39329
5L-6S		MI	12369	4527	21037	3535	24878	2830	27132	2248	29896	1299	37401	635	33021
18-#14	3.52	MA	14112	4527	23705	3569	28221	2860	30902	2277	34375	1339	43287	698	37863
6L-5S		MI	12986	4527	21948	3537	26092	2820	28605	2255	31786	1291	39896	745	34315
18-#14	3.52	MA	13425	4527	22689	3569	26878	2857	29262	2287	32136	1332	40685	595	36465
7L-4S		MI	13628	4527	22971	3525	27320	2825	30101	2248	33751	1284	42389	806	35256
18-#14	3.52	MA	12747	4527	21689	3568	25561	2854	27617	2281	29977	1339	37963	522	34652
8L-3S		MI	14336	4527	23980	3527	28682	2815	31749	2255	35906	1291	44730	936	36284
18-#18	6.25	MA	16250	5672	30549	4263	36692	3369	41086	2587	47633	1232	61118	97	60753
6L-5S		MI	15105	5672	28531	4227	34287	3314	38183	2542	44362	1152	56599	182	55450
20-#11	2.71	MA	14785	4189	23555	3357	28123	2705	30836	2183	34362	1359	43051	1025	32353
4L-8S		MI	11231	4189	18340	3334	21490	2679	23042	2164	24551	1337	30547	736	25510
20-#11	2.71	MA	14260	4189	22737	3368	27140	2703	29637	2191	32748	1364	40999	981	31461
5L-7S		MI	11659	4189	18951	3335	22294	2682	24045	2169	25855	1332	32191	786	26242
20-#11	2.71	MA	13757	4189	22009	3367	26170	2712	28456	2187	31195	1369	38930	906	30928
6E		MI	12092	4189	19571	3337	23114	2685	25047	2163	27207	1337	33753	857	27073
20-#11	2.71	MA	13264	4189	21300	3367	25232	2710	27310	2194	29621	1364	37093	835	29977
7L-5S		MI	12534	4189	20208	3338	23962	2677	26079	2168	28540	1332	35518	933	27498
20-#11	2.71	MA	12778	4189	20602	3367	24313	2708	26163	2191	28102	1369	35178	783	29136
8L-4S		MI	12995	4189	20923	3329	24821	2680	27126	2162	29926	1326	37279	975	28289
20-#11	2.71	MA	12294	4189	19831	3377	23366	2717	25033	2198	26597	1375	33302	724	28078
9L-3S		MI	13503	4189	21629	3330	25774	2673	28281	2166	31444	1332	38934	1066	28451
20-#14	3.91	MA	15502	4691	26297	3672	31576	2923	34974	2330	39751	1321	50424	780	43764
5L-7S		MI	12372	4691	21493	3635	25410	2900	27765	2302	30692	1278	38766	501	35520
20-#14	3.91	MA	14810	4691	25254	3672	30186	2935	33282	2325	37544	1329	47490	671	42230
6E		MI	12968	4691	22381	3637	26583	2905	29195	2295	32610	1286	40977	603	36790
20-#14	3.91	MA	14133	4691	24238	3671	28843	2932	31642	2334	35305	1321	44888	569	40786
7L-5S		MI	13576	4691	23293	3640	27797	2895	30668	2302	34500	1278	43472	713	38153
20-#14	3.91	MA	13464	4691	23238	3670	27526	2929	29998	2329	33146	1329	42166	496	39021
8L-4S		MI	14210	4691	24316	3627	29025	2900	32164	2295	36465	1271	45965	774	39051
22-#11	2.98	MA	14754	4303	23821	3438	28515	2755	31302	2223	34977	1358	43964	964	34565
5L-8S		MI	11668	4303	19282	3405	22685	2731	24489	2197	26465	1329	33076	716	28141
22-#11	2.98	MA	14257	4303	23093	3438	27545	2764	30121	2220	33424	1363	41895	889	34047
6L-7S		MI	12092	4303	19893	3406	23489	2734	25493	2201	27769	1323	34719	765	28906
22-#11	2.98	MA	13769	4303	22384	3438	26607	2762	28976	2227	31850	1358	40058	818	33056
7L-6S		MI	12520	4303	20513	3407	24309	2737	26494	2196	29121	1329	36282	837	29725
22-#11	2.98	MA	13288	4303	21686	3438	25688	2760	27828	2224	30331	1363	38142	766	32182
8L-5S		MI	12958	4303	21150	3409	25158	2729	27527	2200	30453	1323	38047	913	30190
22-#11	2.98	MA	12810	4303	20915	3448	24741	2769	26699	2231	28827	1368	36266	707	31150
9L-4S		MI	13414	4303	21865	3399	26016	2732	28574	2195	31839	1318	39808	955	30949
22-#14	4.30	MA	15499	4854	26803	3774	32151	3010	35663	2372	40713	1319	51693	645	46607
6L-7S		MI	12970	4854	22838	3737	27115	2974	29828	2350	33406	1265	42342	469	39252
22-#14	4.30	MA	14831	4854	25788	3773	30807	3007	34022	2381	38474	1311	49092	542	45118
7L-6S		MI	13558	4854	23726	3739	28289	2979	31258	2342	35324	1273	44553	572	40569
22-#14	4.30	MA	14171	4854	24787	3772	29490	3004	32378	2376	36315	1319	46369	469	43398
8L-5S		MI	14159	4854	24637	3742	29502	2969	32731	2350	37214	1265	47047	681	41997

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	3.25	MA	14750	4416	24177	3509	28920	2815	31787	2253	35654	1357	44859	872	37119
6L-8S		MI	12100	4416	20225	3476	23880	2783	25937	2230	28379	1320	35605	695	30778
24-#11	3.25	MA	14268	4416	23468	3509	27982	2814	30642	2260	34079	1352	43022	801	36140
7E		MI	12519	4416	20835	3477	24684	2786	26941	2234	29682	1315	37248	745	31575
24-#11	3.25	MA	13791	4416	22770	3509	27063	2812	29494	2257	32560	1357	41107	750	35234
8L-6S		MI	12943	4416	21456	3478	25504	2789	27942	2229	31034	1320	38811	816	32368
24-#11	3.25	MA	13318	4416	21999	3519	26116	2821	28365	2264	31056	1362	39231	691	34226
9L-5S		MI	13377	4416	22092	3479	26353	2781	28974	2233	32367	1315	40576	892	32886
24-#14	4.69	MA	15519	5018	27337	3875	32772	3082	36402	2429	41643	1301	53295	516	49459
7E		MI	13560	5018	24183	3839	28821	3049	31891	2397	36120	1252	45918	437	42993
24-#14	4.69	MA	14868	5018	26336	3874	31455	3078	34758	2423	39484	1308	50573	443	47783
8L-6S		MI	14141	5018	25071	3842	29994	3054	33321	2389	38038	1260	48129	540	44357

RECTANGULAR TIED COLUMNS 32" x 38"

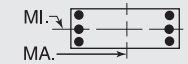
4-#18	1.32	MA	15092	3806	22202	3138	26128	2548	27984	2107	29595	1450	35857	1340	17856
2E		MI	12556	3806	18789	3091	21850	2510	23165	2067	24247	1409	29122	1285	14736
6-#14	1.11	MA	14743	3716	21224	3103	25046	2525	26742	2097	28095	1475	33966	1380	15308
2L-3S		MI	11242	3716	16647	3059	19286	2485	20218	2074	20410	1448	24171	1203	12690
6-#14	1.11	MA	13448	3716	19573	3103	22952	2523	24204	2107	24698	1482	29448	1249	15293
3L-2S		MI	12294	3716	17991	3061	20991	2490	22281	2066	23124	1440	27747	1334	12671
6-#18	1.97	MA	16418	4097	25087	3320	29786	2681	32416	2191	35470	1430	43633	1290	26412
2L-3S		MI	11835	4097	18789	3266	21850	2631	23165	2160	24247	1395	29122	986	21509
6-#18	1.97	MA	14233	4097	22202	3317	26128	2675	27984	2207	29595	1444	35857	1057	26101
3L-2S		MI	13606	4097	21129	3273	24817	2643	26710	2147	28911	1382	35227	1219	21701
8-#11	1.03	MA	14599	3678	20807	3092	24597	2518	26232	2094	27483	1486	33197	1397	14256
2L-4S		MI	10901	3678	16000	3049	18485	2489	19286	2067	19235	1454	23004	1173	11817
8-#11	1.03	MA	13689	3678	19652	3092	23133	2516	24458	2101	25096	1491	30014	1306	14260
3E		MI	11445	3678	16705	3050	19438	2482	20441	2071	20753	1459	24660	1264	11836
8-#11	1.03	MA	13026	3678	18792	3092	21970	2526	23049	2099	23201	1486	27921	1215	14198
4L-2S		MI	12186	3678	17648	3051	20633	2484	21889	2065	22667	1454	27189	1356	11815
8-#14	1.48	MA	15528	3879	22876	3206	27141	2600	29279	2144	31492	1466	38484	1356	20219
2L-4S		MI	11119	3879	16982	3159	19628	2570	20632	2113	20970	1427	25406	1041	16499
8-#14	1.48	MA	14252	3879	21224	3206	25046	2598	26742	2154	28095	1473	33966	1224	20154
3E		MI	11882	3879	17991	3161	20991	2560	22281	2121	23124	1434	27747	1171	16661
8-#14	1.48	MA	13322	3879	19993	3205	23382	2610	24725	2150	25399	1466	30998	1093	19889
4L-2S		MI	12918	3879	19336	3163	22697	2565	24344	2113	25838	1427	31322	1303	16685
8-#18	2.63	MA	17699	4388	27971	3501	33444	2814	36847	2276	41345	1411	51409	1240	34925
2L-4S		MI	11612	4388	19366	3442	22438	2779	23877	2228	25322	1381	31219	694	25898
8-#18	2.63	MA	15565	4388	25087	3499	29786	2808	32416	2291	35470	1424	43633	1007	34489
3E		MI	12890	4388	21129	3448	24817	2764	26710	2241	28911	1367	35227	920	28306
8-#18	2.63	MA	14007	4388	22928	3497	26870	2827	28883	2280	30807	1411	38539	773	31511
4L-2S		MI	14623	4388	23468	3455	27784	2776	30254	2228	33574	1354	41332	1154	28613
10-#11	1.28	MA	15156	3792	21962	3162	26062	2570	28007	2127	29870	1480	36380	1382	17696
2L-5S		MI	10871	3792	16227	3129	18821	2538	19687	2105	19762	1451	23772	1111	14279
10-#11	1.28	MA	14256	3792	20807	3163	24597	2568	26232	2134	27483	1485	33197	1291	17674
3L-4S		MI	11360	3792	16942	3120	19680	2541	20734	2099	21148	1446	25533	1153	14586
10-#11	1.28	MA	13602	3792	19947	3163	23435	2577	24824	2132	25589	1480	31103	1199	17582
4L-3S		MI	11898	3792	17648	3121	20633	2533	21889	2104	22667	1451	27189	1244	14633
10-#11	1.28	MA	13008	3792	19076	3174	22390	2576	23549	2139	23860	1485	28906	1154	17161
5L-2S		MI	12630	3792	18590	3122	21828	2536	23337	2098	24580	1446	29717	1335	14631
10-#14	1.85	MA	16294	4043	24527	3308	29235	2675	31816	2191	34888	1457	43002	1332	25110
2L-5S		MI	11072	4043	17304	3273	20106	2640	21200	2168	21718	1421	26488	948	19227

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

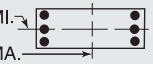


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.85	MA	15037	4043	22876	3308	27141	2673	29279	2202	31492	1464	38484	1200	25003
3L-4S		MI	11755	4043	18327	3261	21334	2645	22695	2161	23684	1414	28982	1009	20404
10-#14	1.85	MA	14123	4043	21644	3308	25476	2685	27262	2197	28796	1457	35516	1069	24686
4L-3S		MI	12507	4043	19336	3263	22697	2635	24344	2168	25838	1421	31322	1139	20615
10-#14	1.85	MA	13293	4043	20397	3322	23980	2683	25435	2207	26336	1464	32389	1005	23196
5L-2S		MI	13529	4043	20681	3265	24402	2640	26407	2161	28552	1414	34898	1271	20678
10-#18	3.29	MA	18946	4679	30856	3683	37103	2947	41279	2360	47220	1391	59184	1190	43414
2L-5S		MI	11528	4679	19917	3643	23257	2900	24852	2321	26494	1340	33067	519	30148
10-#18	3.29	MA	16857	4679	27971	3681	33444	2941	36847	2375	41345	1404	51409	956	42871
3L-4S		MI	12666	4679	21706	3623	25405	2912	27421	2308	29985	1353	37325	628	32386
10-#18	3.29	MA	15336	4679	25813	3678	30529	2960	33314	2364	36682	1391	46314	723	39586
4L-3S		MI	13916	4679	23468	3630	27784	2897	30254	2321	33574	1340	41332	854	35092
10-#18	3.29	MA	13955	4679	23626	3703	27904	2954	30111	2380	32427	1404	40908	613	36818
5L-2S		MI	15614	4679	25807	3636	30751	2909	33798	2308	38237	1326	47438	1088	35497
12-#11	1.54	MA	15704	3905	23117	3233	27527	2621	29782	2159	32258	1474	39563	1366	21122
2L-6S		MI	10863	3905	16532	3199	19168	2597	20102	2133	20343	1448	24537	1014	16423
12-#11	1.54	MA	14813	3905	21962	3234	26062	2620	28007	2167	29870	1480	36380	1275	21080
3L-5S		MI	11327	3905	17169	3200	20016	2590	21134	2138	21676	1443	26301	1090	16930
12-#11	1.54	MA	14167	3905	21102	3234	24900	2629	26598	2164	27976	1474	34286	1184	20962
4E		MI	11811	3905	17884	3191	20875	2593	22182	2132	23062	1437	28062	1133	17348
12-#11	1.54	MA	13580	3905	20231	3244	23855	2628	25323	2172	26247	1480	32089	1139	20429
5L-3S		MI	12343	3905	18590	3192	21828	2585	23337	2137	24580	1443	29717	1224	17419
12-#11	1.54	MA	13018	3905	19457	3245	22824	2637	24068	2169	24584	1485	29867	1064	19739
6L-2S		MI	13068	3905	19532	3193	23023	2588	24785	2131	26494	1437	32246	1315	17437
12-#14	2.22	MA	17045	4206	26178	3410	31329	2750	34353	2239	38285	1447	47520	1308	29988
2L-6S		MI	11058	4206	17737	3373	20597	2725	21790	2208	22542	1416	27570	806	22068
12-#14	2.22	MA	15806	4206	24527	3410	29235	2747	31816	2249	34888	1455	43002	1176	29843
3L-5S		MI	11705	4206	18648	3376	21811	2715	23263	2215	24432	1408	30064	916	23023
12-#14	2.22	MA	14905	4206	23295	3410	27571	2760	29799	2244	32193	1447	40034	1045	29416
4E		MI	12379	4206	19672	3363	23039	2720	24759	2208	26398	1401	32558	977	24155
12-#14	2.22	MA	14089	4206	22048	3424	26074	2757	27973	2255	29733	1455	36907	981	27886
5L-3S		MI	13119	4206	20681	3365	24402	2710	26407	2215	28552	1408	34898	1107	24558
12-#14	2.22	MA	13306	4206	20940	3424	24596	2770	26174	2250	27367	1462	33754	872	26690
6L-2S		MI	14129	4206	22025	3368	26107	2715	28470	2208	31266	1401	38474	1239	24655
12-#18	3.95	MA	18116	4970	30856	3862	37103	3074	41279	2460	47220	1384	59184	906	51251
3L-5S		MI	12579	4970	22256	3825	26224	3033	28397	2402	31157	1312	39172	453	36527
12-#18	3.95	MA	16628	4970	28697	3860	34187	3093	37746	2448	42557	1371	54090	673	47700
4E		MI	13693	4970	24045	3805	28371	3045	30966	2388	34648	1325	43430	563	38915
12-#18	3.95	MA	15279	4970	26510	3884	31562	3087	34543	2464	38302	1384	48683	563	44796
5L-3S		MI	14918	4970	25807	3812	30751	3030	33798	2402	38237	1312	47438	789	41871
12-#18	3.95	MA	13985	4970	24564	3882	28969	3107	31388	2453	34211	1397	43257	369	41483
6L-2S		MI	16585	4970	28147	3818	33717	3042	37343	2388	42901	1299	53543	1022	42364
14-#11	1.80	MA	16243	4019	24272	3304	28992	2673	31556	2192	34645	1469	42746	1351	24540
2L-7S		MI	10867	4019	16854	3268	19543	2646	20549	2172	20905	1434	25503	922	18495
14-#11	1.80	MA	15361	4019	23117	3304	27527	2672	29782	2200	32258	1474	39563	1260	24480
3L-6S		MI	11317	4019	17475	3270	20363	2649	21550	2166	22257	1440	27065	994	19110
14-#11	1.80	MA	14722	4019	22257	3305	26364	2681	28373	2197	30363	1469	37469	1169	24339
4L-5S		MI	11776	4019	18111	3271	21211	2642	22582	2171	23589	1434	28830	1070	19593
14-#11	1.80	MA	14143	4019	21386	3315	25320	2680	27098	2205	28634	1474	35271	1124	23708
5L-4S		MI	12254	4019	18827	3262	22070	2645	23630	2165	24975	1429	30591	1112	20105
14-#11	1.80	MA	13587	4019	20612	3316	24288	2689	25843	2202	26972	1479	33050	1049	23047
6L-3S		MI	12781	4019	19532	3263	23023	2637	24785	2170	26494	1434	32246	1203	20197
14-#11	1.80	MA	13043	4019	19859	3316	23292	2688	24625	2210	25286	1474	31075	977	22265
7L-2S		MI	13499	4019	20475	3264	24219	2640	26233	2164	28407	1429	34775	1294	20232
14-#14	2.59	MA	17783	4370	27830	3512	33424	2825	36891	2286	41682	1438	52038	1284	34858
2L-7S		MI	11065	4370	18194	3473	21129	2794	22423	2262	23339	1395	28935	672	24655
14-#14	2.59	MA	16560	4370	26178	3512	31329	2822	34353	2296	38285	1446	47520	1152	34678
3L-6S		MI	11689	4370	19082	3476	22303	2799	23853	2255	25256	1403	31145	774	25795

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis



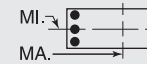
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.59	MA	15673	4370	24947	3512	29665	2835	32337	2292	35590	1438	44552	1021	34048
4L-5S		MI	12327	4370	19993	3478	23516	2790	25326	2262	27146	1395	33640	884	26833
14-#14	2.59	MA	14869	4370	23700	3527	28168	2832	30510	2302	33130	1446	41425	957	32590
5L-4S		MI	12991	4370	21016	3465	24744	2795	26822	2255	29112	1388	36133	945	27902
14-#14	2.59	MA	14098	4370	22591	3526	26690	2845	28711	2297	30764	1453	38272	848	31315
6L-3S		MI	13721	4370	22025	3468	26107	2785	28470	2262	31266	1395	38474	1075	28495
14-#14	2.59	MA	13342	4370	21511	3526	25262	2842	26967	2308	28365	1446	35472	746	29797
7L-2S		MI	14718	4370	23370	3470	27813	2790	30533	2255	33980	1388	42050	1207	28623
14-#18	4.61	MA	17892	5260	31582	4042	37845	3226	42178	2533	48432	1351	61866	623	55847
4L-5S		MI	13605	5260	24595	4007	29191	3166	31941	2482	35820	1284	45278	387	42940
14-#18	4.61	MA	16571	5260	29395	4066	35220	3220	38975	2548	44177	1364	56459	513	52806
5L-4S		MI	14761	5260	26384	3987	31338	3178	34510	2469	39312	1297	49536	497	45475
14-#18	4.61	MA	15304	5260	27449	4064	32627	3240	35820	2537	40086	1378	51033	319	49559
6L-3S		MI	15941	5260	28147	3993	33717	3163	37343	2482	42901	1284	53543	723	48646
16-#11	2.05	MA	16774	4132	25427	3375	30456	2725	33331	2225	37032	1463	45928	1336	27954
2L-8S		MI	10880	4132	17186	3338	19934	2695	20993	2200	21515	1431	26388	853	20507
16-#11	2.05	MA	15902	4132	24272	3375	28992	2724	31556	2233	34645	1468	42746	1245	27876
3L-7S		MI	11320	4132	17797	3339	20738	2698	21997	2205	22818	1426	28031	902	21136
16-#11	2.05	MA	15269	4132	23412	3376	27829	2733	30148	2230	32751	1463	40652	1154	27714
4L-6S		MI	11765	4132	18417	3340	21558	2701	22998	2199	24170	1431	29594	973	21803
16-#11	2.05	MA	14697	4132	22541	3386	26784	2732	28872	2238	31022	1468	38454	1109	26996
5E		MI	12219	4132	19054	3342	22407	2694	24030	2204	25503	1426	31359	1049	22265
16-#11	2.05	MA	14148	4132	21767	3386	25753	2741	27617	2235	29359	1474	36232	1033	26361
6L-4S		MI	12692	4132	19769	3332	23265	2696	25078	2198	26889	1421	33120	1092	22858
16-#11	2.05	MA	13610	4132	21014	3387	24757	2740	26400	2243	27673	1468	34258	962	25529
7L-3S		MI	13212	4132	20475	3334	24219	2689	26233	2203	28407	1426	34775	1183	22969
16-#11	2.05	MA	13079	4132	20273	3387	23780	2738	25180	2240	26046	1474	32206	910	24689
8L-2S		MI	13924	4132	21417	3335	25414	2692	27681	2197	30321	1421	37304	1274	23020
16-#14	2.96	MA	17301	4533	27830	3614	33424	2897	36891	2344	41682	1437	52038	1128	39510
3L-7S		MI	11693	4533	19539	3575	22835	2869	24486	2309	26053	1382	32510	640	28440
16-#14	2.96	MA	16426	4533	26598	3614	31759	2909	34874	2339	38986	1429	49070	997	38698
4L-6S		MI	12309	4533	20427	3578	24008	2874	25916	2302	27970	1390	34721	743	29536
16-#14	2.96	MA	15634	4533	25351	3629	30263	2907	33047	2349	36527	1437	45943	933	37305
5E		MI	12937	4533	21338	3580	25222	2864	27389	2309	29860	1382	37216	852	30653
16-#14	2.96	MA	14875	4533	24242	3629	28785	2919	31249	2345	34161	1444	42790	824	35954
6L-4S		MI	13592	4533	22361	3568	26450	2869	28885	2302	31826	1375	39709	913	31667
16-#14	2.96	MA	14131	4533	23162	3629	27357	2917	29504	2355	31762	1437	39990	721	34485
7L-3S		MI	14313	4533	23370	3570	27813	2859	30533	2309	33980	1382	42050	1044	32425
16-#14	2.96	MA	13395	4533	22099	3628	25957	2915	27756	2350	29447	1444	37071	647	32558
8L-2S		MI	15298	4533	24715	3572	29518	2864	32596	2302	36694	1375	45626	1175	32583
16-#18	5.26	MA	17836	5551	32279	4248	38878	3353	43407	2632	50052	1344	64235	463	60845
5E		MI	14683	5551	26935	4188	32158	3299	35485	2562	40484	1257	51383	322	49384
16-#18	5.26	MA	16595	5551	30333	4245	36286	3373	40252	2621	45961	1358	58809	268	57529
6L-4S		MI	15738	5551	28723	4168	34305	3311	38055	2549	43975	1270	55641	431	52062
18-#11	2.31	MA	16434	4245	25427	3446	30456	2776	33331	2266	37032	1463	45928	1229	31269
3L-8S		MI	11331	4245	18128	3409	21130	2747	22441	2233	23428	1423	28917	832	23165
18-#11	2.31	MA	15809	4245	24567	3446	29294	2785	31922	2263	35138	1458	43835	1138	31087
4L-7S		MI	11766	4245	18739	3410	21933	2750	23445	2237	24732	1418	30560	882	23785
18-#11	2.31	MA	15243	4245	23696	3457	28249	2784	30647	2271	33409	1463	41637	1093	30293
5L-6S		MI	12206	4245	19359	3411	22754	2753	24446	2232	26084	1423	32123	953	24500
18-#11	2.31	MA	14700	4245	22922	3457	27218	2793	29392	2268	31746	1468	39415	1018	29680
6L-5S		MI	12655	4245	19996	3413	23602	2745	25478	2236	27416	1418	33888	1029	24944
18-#11	2.31	MA	14169	4245	22169	3457	26221	2792	28174	2276	30061	1463	37441	947	28801
7L-4S		MI	13123	4245	20711	3403	24460	2748	26526	2231	28802	1413	35649	1071	25608

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

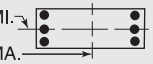


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.31	MA	13643	4245	21427	3458	25245	2790	26955	2273	28434	1468	35389	895	27984
8L-3S		MI	13639	4245	21417	3404	25414	2741	27681	2235	30321	1418	37304	1162	25738
18-#11	2.31	MA	13122	4245	20609	3468	24238	2799	25755	2281	26823	1473	33374	836	26824
9L-2S		MI	14344	4245	22359	3406	26609	2744	29129	2230	32235	1413	39833	1254	25803
18-#14	3.33	MA	17168	4697	28250	3716	33854	2984	37411	2386	42383	1420	53587	973	43365
4L-7S		MI	12311	4697	20883	3678	24540	2944	26549	2357	28767	1369	36086	608	32169
18-#14	3.33	MA	16387	4697	27002	3731	32357	2982	35585	2397	39923	1428	50461	909	42030
5L-6S		MI	12918	4697	21771	3680	25714	2949	27979	2349	30684	1377	38297	711	33290
18-#14	3.33	MA	15639	4697	25894	3731	30879	2994	33786	2392	37558	1435	47307	800	40606
6L-5S		MI	13539	4697	22682	3682	26927	2939	29452	2357	32574	1369	40792	820	34482
18-#14	3.33	MA	14905	4697	24814	3731	29451	2992	32041	2402	35159	1428	44508	697	39183
7L-4S		MI	14185	4697	23706	3670	28155	2944	30948	2349	34540	1362	43285	881	35447
18-#14	3.33	MA	14180	4697	23751	3731	28051	2989	30293	2398	32844	1435	41589	623	37217
8L-3S		MI	14897	4697	24715	3672	29518	2934	32596	2357	36694	1369	45626	1012	36352
18-#18	5.92	MA	17976	5842	33217	4427	39944	3506	44684	2706	51835	1338	66584	218	65523
6L-5S		MI	15665	5842	29274	4370	35124	3432	39030	2643	45147	1229	57489	256	55855
20-#11	2.57	MA	16341	4359	25721	3517	30759	2837	33697	2296	37525	1452	47017	1123	34459
4L-8S		MI	11775	4359	19070	3480	22325	2799	23889	2266	25342	1415	31446	812	25786
20-#11	2.57	MA	15781	4359	24851	3528	29714	2836	32422	2303	35796	1457	44820	1078	33596
5L-7S		MI	12206	4359	19681	3481	23129	2802	24892	2270	26645	1410	33089	861	26441
20-#11	2.57	MA	15244	4359	24077	3528	28683	2845	31166	2301	34134	1462	42598	1003	33003
6E		MI	12641	4359	20302	3482	23949	2805	25894	2265	27997	1415	34652	933	27202
20-#11	2.57	MA	14719	4359	23324	3528	27686	2843	29949	2308	32448	1457	40624	932	32079
7L-5S		MI	13086	4359	20938	3483	24797	2797	26926	2269	29330	1410	36416	1009	27630
20-#11	2.57	MA	14200	4359	22582	3529	26710	2842	28729	2306	30821	1462	38572	880	31274
8L-4S		MI	13549	4359	21654	3474	25655	2800	27974	2264	30716	1405	38177	1051	28357
20-#11	2.57	MA	13684	4359	21764	3539	25703	2851	27529	2313	29210	1468	36556	821	30097
9L-3S		MI	14060	4359	22359	3475	26609	2793	29129	2268	32235	1410	39833	1142	28503
20-#11	2.57	MA	13170	4359	21025	3539	24733	2850	26323	2311	27554	1462	34602	755	28945
10L-2S		MI	14758	4359	23302	3477	27804	2796	30577	2263	34148	1405	42362	1233	28582
20-#14	3.70	MA	17129	4860	28654	3833	34451	3057	38122	2444	43320	1419	54979	885	46763
5L-7S		MI	12919	4860	22228	3780	26245	3019	28612	2404	31481	1356	39662	576	35885
20-#14	3.70	MA	16390	4860	27545	3833	32973	3069	36323	2439	40954	1426	51825	776	45268
6E		MI	13519	4860	23116	3782	27419	3024	30042	2396	33398	1364	41873	679	37056
20-#14	3.70	MA	15667	4860	26465	3833	31545	3067	34579	2450	38555	1419	49026	673	43856
7L-5S		MI	14132	4860	24027	3785	28632	3014	31515	2404	35288	1356	44367	788	38319
20-#14	3.70	MA	14953	4860	25402	3833	30145	3064	32831	2445	36241	1426	46107	599	41884
8L-4S		MI	14770	4860	25050	3772	29861	3019	33011	2396	37254	1349	46861	849	39239
22-#11	2.82	MA	16313	4472	26006	3599	31179	2887	34196	2336	38184	1452	48003	1063	36906
5L-8S		MI	12214	4472	20013	3551	23520	2851	25337	2299	27255	1407	33975	791	28413
22-#11	2.82	MA	15782	4472	25232	3599	30148	2897	32941	2334	36521	1457	45781	987	36330
6L-7S		MI	12640	4472	20624	3552	24324	2854	26340	2303	28559	1402	35618	841	29103
22-#11	2.82	MA	15262	4472	24479	3599	29151	2895	31724	2341	34835	1452	43806	916	35362
7L-6S		MI	13071	4472	21244	3553	25144	2857	27342	2298	29911	1407	37181	912	29906
22-#11	2.82	MA	14748	4472	23737	3599	28174	2894	30504	2339	33208	1457	41755	864	34525
8L-5S		MI	13512	4472	21881	3554	25992	2849	28374	2302	31243	1402	38945	988	30320
22-#11	2.82	MA	14238	4472	22919	3610	27168	2903	29304	2346	31598	1462	39739	805	33375
9L-4S		MI	13970	4472	22596	3545	26850	2852	29421	2296	32629	1396	40706	1031	31104
22-#11	2.82	MA	13730	4472	22180	3610	26198	2902	28098	2344	29941	1457	37784	739	32203
10L-3S		MI	14476	4472	23302	3546	27804	2845	30577	2301	34148	1402	42362	1122	31265
22-#14	4.07	MA	17131	5024	29196	3935	35068	3144	38860	2487	44351	1417	56343	752	49940
6L-7S		MI	13519	5024	23573	3882	27951	3094	30675	2451	34195	1343	43238	545	39611
22-#14	4.07	MA	16418	5024	28117	3935	33640	3141	37116	2497	41952	1409	53544	649	48484
7L-6S		MI	14112	5024	24461	3884	29124	3099	32105	2443	36112	1351	45449	647	40831
22-#14	4.07	MA	15713	5024	27053	3935	32240	3139	35368	2492	39638	1417	50625	575	46558
8L-5S		MI	14717	5024	25372	3887	30338	3089	33578	2451	38002	1343	47943	757	42162
24-#11	3.08	MA	16313	4586	26387	3670	31612	2948	34715	2366	38908	1451	48964	972	39660
6L-8S		MI	12648	4586	20955	3622	24715	2903	26785	2331	29169	1399	36504	771	31047

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	3.08	MA	15799	4586	25634	3670	30616	2947	33498	2374	37223	1446	46989	901	38652
7E		MI	13070	4586	21566	3623	25519	2906	27788	2336	30473	1393	38147	821	31770
24-#11	3.08	MA	15290	4586	24892	3670	29639	2946	32278	2371	35596	1451	44937	849	37783
8L-6S		MI	13496	4586	22186	3624	26339	2908	28790	2330	31824	1399	39710	892	32586
24-#11	3.08	MA	14786	4586	24074	3681	28633	2955	31078	2379	33985	1456	42922	790	36658
9L-5S		MI	13933	4586	22823	3625	27187	2901	29822	2335	33157	1393	41474	968	33016
24-#11	3.08	MA	14283	4586	23335	3681	27663	2954	29872	2376	32328	1451	40967	724	35465
10L-4S		MI	14387	4586	23538	3616	28046	2904	30869	2329	34543	1388	43235	1010	33768
24-#14	4.44	MA	17159	5188	29768	4037	35734	3216	39653	2545	45349	1400	58061	625	53120
7E		MI	14112	5188	24917	3984	29656	3168	32738	2498	36909	1330	46814	513	43348
24-#14	4.44	MA	16463	5188	28705	4037	34334	3214	37905	2540	43034	1408	55143	551	51240
8L-6S		MI	14697	5188	25805	3987	30830	3173	34168	2491	38826	1338	49024	615	44616

RECTANGULAR TIED COLUMNS 32" x 40"

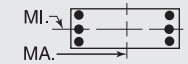
4-#18	1.25	MA	16625	3976	24241	3297	28592	2679	30614	2218	32369	1540	39234	1431	18936
2E		MI	13104	3976	19532	3235	22688	2628	24011	2167	25033	1487	30012	1360	14774
6-#14	1.05	MA	16245	3885	23196	3263	27434	2656	29284	2208	30746	1563	37175	1469	16219
2L-3S		MI	11787	3885	17381	3204	20121	2605	21064	2175	21199	1525	25066	1278	12730
6-#14	1.05	MA	14865	3885	21442	3263	25210	2654	26590	2219	27121	1571	32343	1337	16205
3L-2S		MI	12841	3885	18726	3206	21827	2610	23128	2167	23913	1518	28642	1410	12701
6-#18	1.88	MA	18050	4267	27308	3479	32481	2812	35325	2303	38649	1522	47568	1385	28032
2L-3S		MI	12382	4267	19532	3410	22688	2749	24011	2261	25033	1472	30012	1060	21587
6-#18	1.88	MA	15718	4267	24241	3477	28592	2807	30614	2320	32369	1535	39234	1151	27721
3L-2S		MI	14159	4267	21871	3416	25655	2761	27556	2248	29696	1459	36117	1294	21749
8-#14	1.41	MA	17087	4049	24949	3365	29658	2731	31979	2255	34370	1555	42008	1447	21434
2L-4S		MI	11663	4049	17717	3304	20464	2689	21479	2215	21758	1505	26302	1116	16571
8-#14	1.41	MA	15727	4049	23196	3365	27434	2729	29284	2266	30746	1563	37175	1315	21369
3E		MI	12428	4049	18726	3306	21827	2679	23128	2222	23913	1512	28642	1246	16707
8-#14	1.41	MA	14738	4049	21890	3366	25669	2742	27146	2262	27869	1555	33996	1184	21104
4L-2S		MI	13468	4049	20071	3308	23532	2684	25191	2215	26627	1505	32218	1378	16720
8-#18	2.50	MA	19427	4558	30374	3660	36370	2945	40037	2387	44928	1504	55902	1339	37085
2L-4S		MI	12157	4558	20109	3585	23276	2897	24723	2328	26107	1458	32109	768	26171
8-#18	2.50	MA	17148	4558	27308	3659	32481	2940	35325	2404	38649	1517	47568	1105	36649
3E		MI	13441	4558	21871	3592	25655	2882	27556	2341	29696	1444	36117	995	28394
8-#18	2.50	MA	15489	4558	25018	3658	29386	2961	31576	2394	33665	1504	42099	872	33722
4L-2S		MI	15181	4558	24211	3598	28622	2894	31100	2328	34359	1431	42222	1228	28667
10-#11	1.22	MA	16685	3962	23975	3322	28508	2700	30623	2238	32607	1568	39739	1471	18749
2L-5S		MI	11414	3962	16957	3275	19656	2658	20534	2207	20552	1529	24671	1186	14414
10-#11	1.22	MA	15727	3962	22749	3322	26954	2700	28739	2246	30066	1573	36338	1380	18727
3L-4S		MI	11905	3962	17672	3265	20514	2661	21581	2201	21938	1524	26432	1229	14634
10-#11	1.22	MA	15031	3962	21838	3323	25721	2709	27246	2244	28051	1568	34098	1289	18635
4L-3S		MI	12444	3962	18378	3267	21468	2653	22737	2206	23457	1529	28087	1320	14670
10-#11	1.22	MA	14401	3962	20916	3334	24615	2708	25895	2252	26212	1574	31754	1243	18286
5L-2S		MI	13179	3962	19320	3268	22663	2656	24184	2200	25371	1524	30616	1411	14662
10-#14	1.76	MA	17909	4212	26703	3467	31882	2806	34673	2303	37995	1547	46840	1425	26628
2L-5S		MI	11615	4212	18038	3418	20941	2759	22047	2269	22507	1499	27384	1023	19396
10-#14	1.76	MA	16569	4212	24949	3467	29658	2804	31979	2314	34370	1555	42008	1293	26521
3L-4S		MI	12301	4212	19062	3406	22169	2764	23542	2262	24472	1492	29878	1084	20482
10-#14	1.76	MA	15596	4212	23644	3468	27893	2817	29840	2310	31494	1547	38829	1162	26205
4L-3S		MI	13056	4212	20071	3408	23532	2754	25191	2269	26627	1499	32218	1215	20666
10-#14	1.76	MA	14714	4212	22322	3483	26307	2816	27904	2321	28869	1555	35492	1097	24724
5L-2S		MI	14082	4212	21415	3410	25237	2759	27254	2262	29341	1492	35794	1346	20718

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

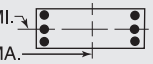


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.13	MA	20768	4848	33440	3842	40258	3078	44748	2471	51208	1486	64236	1293	46114
2L-5S		MI	12070	4848	20660	3787	24095	3018	25698	2422	27279	1417	33957	593	30579
10-#18	3.13	MA	18536	4848	30374	3841	36370	3073	40037	2488	44928	1500	55902	1059	45571
3L-4S		MI	13214	4848	22448	3767	26242	3030	28268	2408	30770	1430	38215	703	32652
10-#18	3.13	MA	16915	4848	28084	3840	33275	3094	36287	2479	39945	1486	50433	826	42319
4L-3S		MI	14471	4848	24211	3773	28622	3015	31100	2422	34359	1417	42222	929	35187
10-#18	3.13	MA	15445	4848	25764	3865	30491	3089	32889	2496	35397	1500	44654	714	39584
5L-2S		MI	16178	4848	26550	3780	31588	3027	34645	2408	39023	1403	48328	1163	35556
12-#11	1.46	MA	17273	4075	25201	3392	30063	2752	32506	2271	35148	1562	43141	1457	22385
2L-6S		MI	11406	4075	17263	3344	20003	2717	20950	2235	21133	1526	25435	1090	16547
12-#11	1.46	MA	16324	4075	23975	3393	28508	2752	30623	2279	32607	1568	39739	1366	22344
3L-5S		MI	11872	4075	17899	3346	20851	2710	21982	2240	22466	1521	27200	1166	17063
12-#11	1.46	MA	15636	4075	23064	3394	27276	2761	29129	2277	30592	1563	37499	1275	22225
4E		MI	12357	4075	18615	3336	21709	2713	23029	2234	23852	1516	28961	1208	17400
12-#11	1.46	MA	15014	4075	22141	3405	26169	2760	27779	2285	28753	1568	35156	1229	21757
5L-3S		MI	12891	4075	19320	3338	22663	2705	24184	2239	25371	1521	30616	1299	17459
12-#11	1.46	MA	14416	4075	21322	3405	25077	2770	26449	2283	26984	1574	32781	1154	20994
6L-2S		MI	13618	4075	20263	3339	23858	2708	25632	2233	27284	1516	33145	1390	17470
12-#14	2.11	MA	18716	4376	28456	3569	34106	2881	37367	2350	41620	1539	51673	1403	31811
2L-6S		MI	11601	4376	18472	3518	21433	2844	22636	2309	23331	1494	28465	882	22345
12-#14	2.11	MA	17394	4376	26703	3570	31882	2879	34673	2361	37995	1547	46840	1271	31666
3L-5S		MI	12251	4376	19383	3521	22646	2834	24110	2316	25221	1486	30960	991	23190
12-#14	2.11	MA	16436	4376	25397	3570	30117	2892	32534	2357	35119	1539	43661	1140	31305
4E		MI	12927	4376	20406	3508	23875	2839	25605	2309	27186	1479	33453	1052	24351
12-#14	2.11	MA	15568	4376	24075	3585	28531	2890	30598	2368	32494	1547	40325	1075	29710
5L-3S		MI	13671	4376	21415	3510	25237	2829	27254	2316	29341	1486	35794	1183	24614
12-#14	2.11	MA	14735	4376	22901	3586	26965	2903	28692	2364	29969	1554	36951	966	28572
6L-2S		MI	14684	4376	22760	3513	26943	2834	29317	2309	32055	1479	39370	1314	24698
12-#18	3.75	MA	19888	5139	33440	4023	40258	3206	44748	2572	51208	1482	64236	1013	54491
3L-5S		MI	13124	5139	22999	3969	27062	3151	29243	2502	31942	1389	40062	528	36948
12-#18	3.75	MA	18302	5139	31150	4021	37164	3227	40998	2563	46224	1469	58768	780	50957
4E		MI	14244	5139	24788	3949	29209	3163	31812	2489	35434	1402	44320	637	39175
12-#18	3.75	MA	16866	5139	28830	4047	34380	3222	37601	2580	41677	1482	52988	668	48088
5L-3S		MI	15477	5139	26550	3955	31588	3148	34645	2502	39023	1389	48328	863	41973
12-#18	3.75	MA	15487	5139	26767	4045	31630	3243	34255	2570	37303	1495	47171	474	44410
6L-2S		MI	17154	5139	28889	3962	34555	3160	38189	2489	43686	1376	54433	1097	42427
14-#11	1.71	MA	17851	4188	26427	3463	31618	2804	34389	2303	37689	1557	46542	1443	26015
2L-7S		MI	11410	4188	17585	3414	20378	2766	21396	2274	21695	1513	26401	998	18696
14-#11	1.71	MA	16912	4188	25201	3464	30063	2803	32506	2312	35148	1563	43141	1352	25955
3L-6S		MI	11861	4188	18205	3415	21198	2769	22397	2268	23047	1518	27964	1069	19234
14-#11	1.71	MA	16232	4188	24289	3465	28831	2813	31013	2309	33133	1558	40900	1261	25813
4L-5S		MI	12322	4188	18842	3416	22046	2762	23430	2273	24379	1513	29729	1145	19724
14-#11	1.71	MA	15616	4188	23367	3475	27724	2812	29662	2318	31294	1563	38557	1215	25240
5L-4S		MI	12802	4188	19557	3407	22904	2764	24477	2267	25765	1507	31489	1188	20160
14-#11	1.71	MA	15026	4188	22548	3476	26632	2822	28332	2315	29525	1569	36182	1140	24508
6L-3S		MI	13331	4188	20263	3408	23858	2757	25632	2272	27284	1513	33145	1279	20240
14-#11	1.71	MA	14448	4188	21751	3477	25576	2821	27043	2324	27733	1564	34071	1069	23767
7L-2S		MI	14051	4188	21205	3410	25053	2760	27080	2266	29198	1507	35674	1370	20268
14-#14	2.46	MA	19508	4540	30210	3672	36330	2955	40062	2397	45245	1531	56506	1381	36984
2L-7S		MI	11606	4540	18929	3618	21965	2914	23270	2364	24127	1473	29830	747	24903
14-#14	2.46	MA	18203	4540	28456	3672	34106	2954	37367	2408	41620	1538	51673	1249	36805
3L-6S		MI	12234	4540	19817	3621	23138	2919	24699	2356	26045	1481	32041	850	26067
14-#14	2.46	MA	17259	4540	27151	3672	32341	2967	35229	2404	38744	1531	48494	1118	36341
4L-5S		MI	12874	4540	20728	3623	24352	2909	26173	2364	27935	1473	34536	959	26997
14-#14	2.46	MA	16404	4540	25829	3687	30755	2965	33293	2416	36119	1538	45157	1053	34710
5L-4S		MI	13542	4540	21751	3610	25580	2914	27668	2356	29900	1466	37029	1020	28095
14-#14	2.46	MA	15584	4540	24654	3688	29189	2978	31387	2412	33594	1546	41784	944	33493
6L-3S		MI	14276	4540	22760	3613	26943	2904	29317	2364	32055	1473	39370	1151	28554

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis



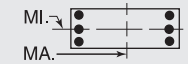
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.46	MA	14780	4540	23511	3688	27676	2977	29539	2423	31035	1538	38786	842	31814
7L-2S		MI	15276	4540	24105	3615	28648	2909	31380	2356	34769	1466	42945	1282	28669
14-#18	4.38	MA	19658	5430	34216	4203	41053	3360	45709	2647	52504	1451	67102	734	59627
4L-5S		MI	14154	5430	25338	4150	30029	3284	32787	2582	36606	1361	46168	462	43353
14-#18	4.38	MA	18251	5430	31896	4228	38268	3355	42312	2664	47956	1464	61322	622	56623
5L-4S		MI	15254	5430	27127	4130	32176	3296	35356	2569	40097	1375	50426	571	45730
14-#18	4.38	MA	16902	5430	29833	4227	35519	3376	38966	2655	43583	1477	55505	428	53078
6L-3S		MI	16464	5430	28889	4137	34555	3281	38189	2582	43686	1361	54433	798	48753
16-#11	1.95	MA	18420	4302	27653	3534	33172	2856	36273	2336	40230	1552	49943	1429	29638
2L-8S		MI	11422	4302	17916	3484	20769	2815	21840	2302	22305	1510	27287	928	20696
16-#11	1.95	MA	17491	4302	26427	3535	31618	2855	34389	2344	37689	1558	46542	1338	29561
3L-7S		MI	11864	4302	18527	3485	21573	2818	22844	2306	23609	1504	28930	978	21334
16-#11	1.95	MA	16818	4302	25515	3535	30385	2865	32896	2342	35674	1553	44302	1247	29398
4L-6S		MI	12310	4302	19147	3486	22393	2821	23845	2301	24960	1510	30493	1049	21927
16-#11	1.95	MA	16210	4302	24593	3546	29279	2864	31546	2350	33835	1558	41958	1201	28733
5E		MI	12766	4302	19784	3487	23241	2813	24877	2305	26293	1504	32257	1125	22395
16-#11	1.95	MA	15626	4302	23774	3547	28186	2874	30216	2348	32067	1563	39584	1126	28029
6L-4S		MI	13241	4302	20499	3478	24099	2816	25925	2300	27679	1499	34018	1167	22917
16-#11	1.95	MA	15055	4302	22976	3548	27131	2873	28927	2357	30274	1559	37472	1055	27236
7L-3S		MI	13764	4302	21205	3479	25053	2809	27080	2304	29198	1504	35674	1258	23015
16-#11	1.95	MA	14491	4302	22191	3548	26097	2872	27635	2354	28543	1564	35283	1002	26311
8L-2S		MI	14478	4302	22147	3480	26248	2812	28528	2299	31111	1499	38203	1350	23058
16-#14	2.81	MA	18998	4703	30210	3774	36330	3029	40062	2456	45245	1530	56506	1227	41940
3L-7S		MI	12236	4703	20273	3720	23670	2988	25333	2411	26841	1460	33406	716	28685
16-#14	2.81	MA	18067	4703	28904	3774	34565	3042	37923	2452	42368	1523	53327	1096	41284
4L-6S		MI	12855	4703	21161	3723	24844	2994	26763	2403	28759	1468	35617	818	29804
16-#14	2.81	MA	17224	4703	27583	3790	32979	3040	35987	2463	39743	1530	49990	1031	39722
5E		MI	13487	4703	22072	3725	26057	2984	28236	2411	30649	1460	38111	927	30816
16-#14	2.81	MA	16416	4703	26408	3790	31413	3053	34081	2459	37219	1538	46616	922	38428
6L-4S		MI	14146	4703	23096	3712	27285	2989	29732	2403	32614	1453	40605	988	31856
16-#14	2.81	MA	15625	4703	25264	3790	29900	3051	32233	2470	34659	1530	43619	820	36800
7L-3S		MI	14871	4703	24105	3715	28648	2979	31380	2411	34769	1460	42945	1119	32488
16-#14	2.81	MA	14843	4703	24138	3791	28417	3050	30381	2466	32189	1538	40503	745	34856
8L-2S		MI	15860	4703	25449	3717	30354	2984	33443	2403	37483	1453	46521	1250	32631
16-#18	5.00	MA	19608	5721	34963	4410	42157	3488	47023	2748	54236	1446	69656	576	65187
5E		MI	15238	5721	27677	4332	32995	3417	36331	2663	41269	1334	52273	396	49789
16-#18	5.00	MA	18286	5721	32899	4409	39408	3509	43677	2739	49862	1460	63840	382	61766
6L-4S		MI	16303	5721	29466	4312	35143	3429	38901	2649	44760	1347	56531	506	52312
18-#11	2.19	MA	18062	4415	27653	3606	33172	2907	36273	2377	40230	1552	49943	1324	33164
3L-8S		MI	11874	4415	18858	3555	21964	2867	23288	2335	24218	1501	29816	908	23364
18-#11	2.19	MA	17396	4415	26741	3606	31940	2917	34780	2375	38215	1547	47703	1233	32982
4L-7S		MI	12311	4415	19469	3556	22768	2870	24292	2339	25522	1496	31459	957	23981
18-#11	2.19	MA	16795	4415	25819	3617	30833	2916	33429	2383	36376	1553	45360	1187	32234
5L-6S		MI	12753	4415	20090	3557	23588	2873	25293	2334	26874	1501	33022	1029	24624
18-#11	2.19	MA	16218	4415	25000	3618	29741	2925	32099	2381	34608	1558	42985	1112	31554
6L-5S		MI	13204	4415	20726	3558	24436	2865	26325	2338	28206	1496	34786	1105	25073
18-#11	2.19	MA	15653	4415	24202	3618	28686	2925	30810	2389	32815	1553	40873	1041	30713
7L-4S		MI	13675	4415	21442	3549	25295	2868	27373	2333	29592	1491	36547	1147	25670
18-#11	2.19	MA	15095	4415	23417	3619	27652	2924	29518	2387	31085	1559	38685	988	29813
8L-3S		MI	14192	4415	22147	3550	26248	2861	28528	2337	31111	1496	38203	1238	25786
18-#11	2.19	MA	14541	4415	22550	3630	26586	2933	28248	2395	29371	1564	36530	930	28658
9L-2S		MI	14900	4415	23090	3551	27443	2864	29976	2332	33025	1491	40731	1329	25843
18-#14	3.16	MA	18862	4867	30658	3877	36789	3116	40617	2499	45993	1515	58159	1074	46243
4L-7S		MI	12856	4867	21618	3823	25376	3063	27396	2458	29555	1447	36982	684	32477

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

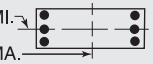


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	3.16	MA	18032	4867	29336	3892	35203	3115	38681	2510	43368	1522	54823	1009	44744
5L-6S		MI	13467	4867	22506	3825	26549	3068	28826	2450	31473	1455	39193	786	33554
18-#14	3.16	MA	17235	4867	28162	3892	33637	3128	36775	2506	40844	1530	51449	900	43374
6L-5S		MI	14091	4867	23417	3827	27763	3058	30299	2458	33363	1447	41687	896	34644
18-#14	3.16	MA	16455	4867	27018	3893	32124	3126	34927	2518	38284	1522	48451	798	41795
7L-4S		MI	14741	4867	24440	3815	28991	3063	31795	2450	35329	1440	44181	956	35633
18-#14	3.16	MA	15684	4867	25892	3893	30641	3124	33075	2514	35814	1530	45336	723	39812
8L-3S		MI	15457	4867	25449	3817	30354	3054	33443	2458	37483	1447	46521	1087	36418
18-#14	3.16	MA	14918	4867	24649	3908	29113	3138	31253	2525	33368	1537	42276	638	37839
9L-2S		MI	16436	4867	26794	3819	32059	3059	35506	2450	40197	1440	50097	1218	36587
18-#18	5.63	MA	19643	6012	35966	4591	43297	3642	48388	2823	56142	1442	72174	336	70359
6L-5S		MI	16225	6012	30017	4514	35962	3550	39876	2743	45932	1306	58379	331	56252
20-#11	2.44	MA	17967	4529	27967	3677	33495	2969	36663	2408	40756	1542	51104	1219	36565
4L-8S		MI	12320	4529	19801	3626	23159	2919	24736	2367	26132	1493	32345	887	26037
20-#11	2.44	MA	17372	4529	27045	3688	32388	2968	35313	2416	38917	1548	48761	1173	35743
5L-7S		MI	12752	4529	20412	3627	23963	2922	25740	2372	27436	1488	33988	937	26635
20-#11	2.44	MA	16801	4529	26226	3689	31296	2977	33983	2414	37149	1553	46386	1098	35085
6E		MI	13190	4529	21032	3628	24783	2925	26741	2366	28787	1493	35551	1008	27325
20-#11	2.44	MA	16243	4529	25428	3689	30240	2977	32694	2422	35356	1548	44274	1027	34196
7L-5S		MI	13637	4529	21669	3629	25631	2917	27773	2371	30120	1488	37315	1084	27757
20-#11	2.44	MA	15691	4529	24643	3690	29206	2976	31402	2420	33626	1554	42086	974	33319
8L-4S		MI	14103	4529	22384	3620	26490	2920	28821	2365	31506	1483	39076	1127	28422
20-#11	2.44	MA	15142	4529	23776	3701	28141	2985	30131	2428	31912	1559	39931	916	32137
9L-3S		MI	14616	4529	23090	3621	27443	2913	29976	2370	33025	1488	40731	1218	28553
20-#11	2.44	MA	14596	4529	22994	3701	27114	2985	28854	2426	30151	1554	37703	835	30990
10L-2S		MI	15317	4529	24032	3622	28638	2915	31424	2364	34938	1483	43260	1309	28624
20-#14	3.52	MA	18827	5030	31090	3994	37427	3190	41376	2558	46993	1514	59655	987	49775
5L-7S		MI	13467	5030	22963	3925	27081	3138	29459	2505	32269	1434	40558	652	36241
20-#14	3.52	MA	18041	5030	29915	3995	35861	3203	39470	2554	44468	1522	56282	878	48332
6E		MI	14070	5030	23851	3927	28254	3143	30889	2498	34187	1442	42768	754	37315
20-#14	3.52	MA	17272	5030	28772	3995	34348	3201	37622	2565	41909	1514	53284	776	46798
7L-5S		MI	14686	5030	24762	3930	29468	3133	32362	2505	36077	1434	45263	864	38479
20-#14	3.52	MA	16511	5030	27646	3995	32865	3199	35770	2561	39439	1522	50168	701	44777
8L-4S		MI	15329	5030	25785	3917	30696	3138	33858	2498	38043	1427	47757	924	39423
20-#14	3.52	MA	15756	5030	26403	4010	31337	3212	33947	2572	36993	1529	47109	616	42776
9L-3S		MI	16036	5030	26794	3919	32059	3128	35506	2505	40197	1434	50097	1055	40345
22-#11	2.68	MA	17942	4642	28271	3759	33943	3020	37196	2449	41459	1543	52162	1159	39257
5L-8S		MI	12760	4642	20743	3696	24354	2971	26184	2400	28045	1485	34873	867	28679
22-#11	2.68	MA	17377	4642	27451	3760	32850	3029	35866	2447	39690	1548	49788	1084	38619
6L-7S		MI	13188	4642	21354	3698	25158	2974	27188	2405	29349	1480	36517	917	29295
22-#11	2.68	MA	16825	4642	26654	3760	31795	3028	34577	2455	37897	1543	47676	1013	37685
7L-6S		MI	13622	4642	21974	3699	25978	2976	28189	2399	30701	1485	38079	988	30030
22-#11	2.68	MA	16278	4642	25869	3761	30761	3028	33285	2453	36167	1548	45487	960	36830
8L-5S		MI	14065	4642	22611	3700	26826	2969	29221	2404	32034	1480	39844	1064	30447
22-#11	2.68	MA	15736	4642	25002	3772	29695	3037	32014	2461	34454	1554	43332	902	35621
9L-4S		MI	14526	4642	23326	3691	27685	2972	30269	2398	33419	1475	41605	1106	31171
22-#11	2.68	MA	15196	4642	24220	3772	28668	3036	30738	2459	32692	1549	41104	821	34454
10L-3S		MI	15034	4642	24032	3692	28638	2964	31424	2403	34938	1480	43260	1197	31318
22-#14	3.87	MA	18835	5194	31669	4097	38085	3278	42164	2601	48093	1514	61114	856	53300
6L-7S		MI	14069	5194	24307	4027	28786	3213	31522	2552	34983	1421	44134	620	39963
22-#14	3.87	MA	18076	5194	30525	4097	36572	3276	40316	2612	45534	1506	58117	754	51809
7L-6S		MI	14665	5194	25195	4029	29960	3218	32952	2545	36901	1428	46344	722	41087
22-#14	3.87	MA	17326	5194	29399	4097	35089	3274	38464	2608	43064	1514	55001	679	49749
8L-5S		MI	15274	5194	26106	4032	31173	3208	34425	2552	38791	1421	48839	832	42321
22-#14	3.87	MA	16580	5194	28156	4113	33561	3287	36642	2619	40618	1521	51941	594	47720
9L-4S		MI	15909	5194	27130	4019	32401	3213	35921	2545	40757	1414	51332	893	43224
24-#11	2.92	MA	17946	4755	28677	3830	34405	3081	37750	2480	42231	1543	53189	1070	42157
6L-8S		MI	13195	4755	21685	3767	25549	3022	27632	2433	29959	1477	37402	847	31309

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.92	MA	17399	4755	27880	3831	33350	3080	36461	2488	40438	1538	51077	999	41180
7E		MI	13620	4755	22296	3769	26353	3025	28635	2438	31263	1472	39046	896	31960
24-#11	2.92	MA	16859	4755	27095	3832	32316	3079	35169	2486	38708	1543	48889	947	40345
8L-6S		MI	14049	4755	22917	3770	27173	3028	29637	2432	32614	1477	40608	968	32737
24-#11	2.92	MA	16322	4755	26228	3843	31250	3089	33898	2494	36995	1549	46734	888	39110
9L-5S		MI	14487	4755	23553	3771	28021	3021	30669	2437	33947	1472	42373	1043	33142
24-#11	2.92	MA	15788	4755	25446	3843	30223	3088	32621	2492	35233	1544	44505	808	37922
10L-4S		MI	14944	4755	24269	3762	28880	3024	31717	2431	35333	1467	44134	1086	33918
24-#14	4.22	MA	18870	5357	32279	4199	38796	3351	43010	2660	49158	1498	62949	732	56821
7E		MI	14664	5357	25652	4129	30492	3288	33585	2599	37697	1408	47709	588	43696
24-#14	4.22	MA	18129	5357	31153	4200	37313	3349	41158	2656	46688	1506	59834	657	54729
8L-6S		MI	15253	5357	26540	4132	31665	3293	35015	2592	39615	1415	49920	690	44869
24-#14	4.22	MA	17393	5357	29910	4215	35785	3362	39336	2667	44242	1513	56774	572	52671
9L-5S		MI	15855	5357	27451	4134	32879	3283	36488	2599	41505	1408	52415	800	46169

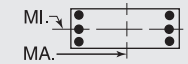
RECTANGULAR TIED COLUMNS 32" x 42"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.19	MA	18226	4146	26360	3456	31157	2810	33351	2330	35246	1629	42730	1521	20016
2E		MI	13652	4146	20275	3378	23526	2746	24858	2267	25818	1564	30902	1434	14812
6-#14	1.00	MA	17816	4055	25247	3422	29922	2787	31933	2319	33481	1651	40504	1557	17130
2L-3S		MI	12332	4055	18116	3349	20957	2724	21911	2276	21988	1603	25962	1354	12766
6-#14	1.00	MA	16350	4055	23391	3423	27569	2786	29081	2331	29634	1658	35356	1425	17116
3L-2S		MI	13388	4055	19461	3351	22662	2729	23974	2269	24702	1596	29538	1485	12731
6-#18	1.79	MA	19751	4437	29608	3638	35276	2943	38341	2414	41930	1613	51623	1479	29652
2L-3S		MI	12928	4437	20275	3553	23526	2867	24858	2361	25818	1549	30902	1135	21660
6-#18	1.79	MA	17272	4437	26360	3638	31157	2939	33351	2432	35246	1626	42730	1245	29341
3L-2S		MI	14711	4437	22614	3560	26493	2879	28402	2348	30481	1536	37007	1368	21795
8-#14	1.34	MA	18715	4219	27102	3524	32276	2862	34784	2366	37328	1643	45652	1537	22649
2L-4S		MI	12207	4219	18452	3449	21299	2809	22326	2316	22547	1583	27197	1191	16637
8-#14	1.34	MA	17271	4219	25247	3525	29922	2861	31933	2378	33481	1651	40504	1405	22584
3E		MI	12975	4219	19461	3451	22662	2799	23974	2323	24702	1590	29538	1322	16751
8-#14	1.34	MA	16223	4219	23867	3526	28057	2875	29672	2375	30430	1644	37113	1274	22319
4L-2S		MI	14017	4219	20805	3453	24368	2804	26037	2316	27416	1583	33114	1453	16754
8-#18	2.38	MA	21226	4727	32856	3820	39395	3076	43331	2498	48615	1597	60517	1436	39245
2L-4S		MI	12702	4727	20852	3729	24113	3015	25569	2428	26892	1535	32999	843	26438
8-#18	2.38	MA	18801	4727	29608	3819	35276	3072	38341	2516	41930	1610	51623	1203	38809
3E		MI	13991	4727	22614	3735	26493	3000	28402	2441	30481	1522	37007	1069	28477
8-#18	2.38	MA	17040	4727	27186	3819	32003	3094	34375	2508	36626	1597	45780	969	35958
4L-2S		MI	15738	4727	24953	3742	29459	3012	31946	2428	35145	1508	43113	1303	28719
10-#11	1.16	MA	18283	4131	26068	3481	31055	2831	33344	2349	35412	1653	43219	1560	19802
2L-5S		MI	11958	4131	17687	3420	20490	2778	21381	2309	21343	1607	25569	1262	14545
10-#11	1.16	MA	17266	4131	24771	3482	29410	2831	31351	2358	32724	1659	39599	1468	19780
3L-4S		MI	12450	4131	18403	3411	21349	2781	22429	2303	22728	1602	27330	1304	14678
10-#11	1.16	MA	16529	4131	23809	3483	28108	2841	29774	2356	30594	1655	37212	1377	19688
4L-3S		MI	12991	4131	19109	3412	22302	2773	23584	2308	24247	1607	28986	1395	14705
10-#11	1.16	MA	15862	4131	22835	3494	26940	2841	28347	2365	28652	1661	34722	1331	19421
5L-2S		MI	13727	4131	20051	3413	23497	2776	25032	2302	26161	1602	31515	1486	14691
10-#14	1.67	MA	19594	4382	28958	3626	34630	2937	37636	2414	41175	1636	50799	1517	28147
2L-5S		MI	12159	4382	18773	3563	21777	2878	22894	2371	23295	1577	28280	1098	19561
10-#14	1.67	MA	18170	4382	27102	3627	32276	2936	34784	2425	37328	1643	45652	1385	28040
3L-4S		MI	12847	4382	19796	3551	23005	2883	24389	2363	25261	1570	30773	1159	20555
10-#14	1.67	MA	17139	4382	25723	3628	30411	2949	32524	2422	34277	1636	42261	1254	27724
4L-3S		MI	13604	4382	20805	3553	24368	2874	26037	2371	27416	1577	33114	1290	20716

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

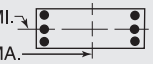


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.67	MA	16204	4382	24326	3644	28735	2948	30478	2434	31493	1644	38714	1188	26264
5L-2S		MI	14634	4382	22150	3555	26073	2879	28101	2363	30130	1570	36690	1421	20757
10-#18	2.98	MA	22660	5018	36104	4001	43514	3209	48322	2582	55300	1581	69410	1394	48814
2L-5S		MI	12612	5018	21402	3930	24933	3136	26544	2522	28064	1494	34847	668	31002
10-#18	2.98	MA	20285	5018	32856	4001	39395	3205	43331	2601	48615	1594	60517	1160	48271
3L-4S		MI	13762	5018	23191	3910	27080	3148	29114	2509	31555	1507	39105	777	32913
10-#18	2.98	MA	18564	5018	30434	4001	36122	3227	39365	2593	43310	1581	54673	927	45078
4L-3S		MI	15025	5018	24953	3917	29459	3133	31946	2522	35145	1494	43113	1003	35278
10-#18	2.98	MA	17004	5018	27982	4027	33179	3223	35773	2611	38469	1594	48520	813	42395
5L-2S		MI	16739	5018	27293	3924	32426	3145	35491	2509	39808	1481	49218	1237	35614
12-#11	1.39	MA	18910	4245	27365	3552	32699	2883	35336	2382	38100	1648	46838	1547	23649
2L-6S		MI	11949	4245	17993	3490	20837	2837	21797	2337	21923	1604	26334	1166	16668
12-#11	1.39	MA	17903	4245	26068	3553	31055	2883	33344	2390	35412	1654	43219	1456	23608
3L-5S		MI	12417	4245	18630	3491	21685	2829	22829	2341	23256	1599	28098	1241	17192
12-#11	1.39	MA	17175	4245	25105	3553	29753	2893	31766	2389	33282	1650	40832	1365	23489
4E		MI	12903	4245	19345	3482	22544	2832	23877	2336	24642	1594	29859	1284	17449
12-#11	1.39	MA	16515	4245	24131	3565	28584	2892	30340	2397	31340	1656	38342	1318	23095
5L-3S		MI	13439	4245	20051	3483	23497	2825	25032	2340	26161	1599	31515	1375	17497
12-#11	1.39	MA	15883	4245	23267	3566	27431	2902	28936	2396	29473	1662	35815	1243	22255
6L-2S		MI	14168	4245	20993	3484	24692	2828	26480	2335	28074	1594	34043	1466	17502
12-#14	2.01	MA	20456	4546	30814	3728	36983	3012	40487	2461	45022	1628	55947	1496	33633
2L-6S		MI	12144	4546	19206	3663	22269	2963	23483	2410	24119	1572	29361	957	22615
12-#14	2.01	MA	19051	4546	28958	3729	34630	3010	37636	2473	41175	1636	50799	1365	33488
3L-5S		MI	12796	4546	20118	3666	23482	2953	24957	2418	26009	1564	31856	1067	23352
12-#14	2.01	MA	18035	4546	27578	3730	32764	3024	35375	2470	38124	1629	47409	1233	33128
4E		MI	13475	4546	21141	3653	24710	2958	26452	2410	27975	1557	34349	1127	24467
12-#14	2.01	MA	17115	4546	26182	3746	31089	3023	33330	2481	35340	1637	43862	1168	31546
5L-3S		MI	14222	4546	22150	3655	26073	2948	28101	2418	30130	1564	36690	1258	24668
12-#14	2.01	MA	16232	4546	24942	3747	29435	3037	31317	2478	32662	1644	40268	1059	30457
6L-2S		MI	15239	4546	23495	3658	27778	2953	30164	2410	32844	1557	40265	1389	24740
12-#18	3.57	MA	21732	5309	36104	4183	43514	3338	48322	2685	55300	1578	69410	1118	57731
3L-5S		MI	13669	5309	23741	4112	27900	3269	30089	2602	32728	1466	40952	602	37362
12-#18	3.57	MA	20047	5309	33682	4183	40241	3360	44356	2677	49995	1565	63567	884	54240
4E		MI	14796	5309	25530	4092	30047	3281	32658	2589	36219	1479	45210	712	39429
12-#18	3.57	MA	18522	5309	31230	4209	37298	3356	40764	2695	45154	1578	57413	771	51426
5L-3S		MI	16035	5309	27293	4099	32426	3266	35491	2602	39808	1466	49218	938	42070
12-#18	3.57	MA	17058	5309	29050	4209	34392	3379	37227	2687	40499	1592	51206	577	47369
6L-2S		MI	17720	5309	29632	4105	35393	3278	39035	2589	44471	1453	55323	1171	42488
14-#11	1.63	MA	19528	4358	28661	3622	34344	2935	37329	2415	40788	1643	50458	1534	27489
2L-7S		MI	11953	4358	18315	3560	21212	2886	22243	2375	22485	1591	27300	1074	18891
14-#11	1.63	MA	18531	4358	27365	3623	32699	2935	35336	2423	38100	1649	46838	1443	27429
3L-6S		MI	12406	4358	18935	3561	22032	2889	23245	2370	23837	1596	28863	1145	19354
14-#11	1.63	MA	17810	4358	26402	3624	31397	2945	33759	2422	35970	1644	44452	1352	27287
4L-5S		MI	12868	4358	19572	3562	22880	2881	24277	2374	25170	1591	30627	1221	19852
14-#11	1.63	MA	17159	4358	25428	3636	30229	2944	32332	2430	34028	1650	41962	1306	26782
5L-4S		MI	13350	4358	20287	3553	23739	2884	25324	2369	26555	1586	32388	1263	20213
14-#11	1.63	MA	16534	4358	24563	3636	29076	2954	30928	2429	32161	1657	39435	1231	25976
6L-3S		MI	13880	4358	20993	3554	24692	2877	26480	2373	28074	1591	34043	1355	20281
14-#11	1.63	MA	15922	4358	23722	3637	27961	2954	29567	2437	30268	1652	37185	1160	25284
7L-2S		MI	14603	4358	21936	3555	25887	2880	27927	2368	29988	1586	36572	1446	20303
14-#14	2.34	MA	21302	4709	32670	3831	39337	3086	43338	2508	48869	1621	61095	1476	39110
2L-7S		MI	12148	4709	19663	3763	22800	3033	24116	2465	24916	1551	30726	823	25144
14-#14	2.34	MA	19915	4709	30814	3831	36983	3085	40487	2520	45022	1628	55947	1345	38931
3L-6S		MI	12778	4709	20551	3765	23974	3038	25546	2457	26833	1559	32937	925	26332
14-#14	2.34	MA	18914	4709	29434	3832	35118	3099	38226	2517	41971	1621	52557	1213	38532
4L-5S		MI	13422	4709	21462	3768	25187	3028	27020	2465	28723	1551	35431	1035	27157
14-#14	2.34	MA	18008	4709	28038	3848	33442	3098	36181	2529	39187	1629	49010	1148	36843
5L-4S		MI	14092	4709	22486	3755	26416	3033	28515	2457	30689	1544	37925	1095	28283

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

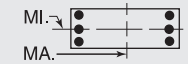
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.34	MA	17139	4709	26798	3849	31788	3112	34168	2526	36509	1637	45416	1039	35696
6L-3S		MI	14829	4709	23495	3758	27778	3023	30164	2465	32844	1551	40265	1226	28612
14-#14	2.34	MA	16287	4709	25590	3850	30191	3110	32216	2537	33795	1630	42220	937	33850
7L-2S		MI	15834	4709	24839	3760	29484	3028	32227	2457	35558	1544	43841	1357	28713
14-#18	4.17	MA	21496	5600	36930	4364	44360	3493	49346	2761	56680	1549	72460	842	63435
4L-5S		MI	14702	5600	26081	4294	30866	3402	33633	2683	37391	1438	47058	536	43758
14-#18	4.17	MA	20003	5600	34478	4391	41417	3489	45754	2779	51839	1562	66307	728	60488
5L-4S		MI	15809	5600	27870	4274	33013	3414	36202	2669	40882	1452	51316	646	45979
14-#18	4.17	MA	18570	5600	32298	4390	38511	3511	42217	2771	47183	1576	60099	535	56567
6L-3S		MI	17026	5600	29632	4280	35393	3399	39035	2683	44471	1438	55323	872	48856
14-#18	4.17	MA	17166	5600	30175	4390	35703	3507	38787	2790	42462	1562	54588	352	52071
7L-2S		MI	18684	5600	31971	4287	38360	3411	42579	2669	49135	1425	61429	1106	49349
16-#11	1.86	MA	20136	4472	29958	3693	35988	2987	39321	2447	43476	1638	54078	1521	31323
2L-8S		MI	11965	4472	18647	3630	21603	2935	22688	2404	23095	1588	28185	1004	20878
16-#11	1.86	MA	19149	4472	28661	3694	34344	2987	37329	2456	40788	1644	50458	1430	31246
3L-7S		MI	12408	4472	19257	3631	22407	2938	23691	2408	24399	1583	29829	1053	21527
16-#11	1.86	MA	18436	4472	27699	3695	33042	2997	35751	2454	38659	1639	48072	1339	31083
4L-6S		MI	12856	4472	19878	3632	23227	2941	24693	2403	25751	1588	31391	1125	22046
16-#11	1.86	MA	17792	4472	26725	3706	31873	2996	34325	2463	36716	1645	45582	1293	30479
5E		MI	13314	4472	20514	3633	24075	2933	25725	2407	27083	1583	33156	1201	22521
16-#11	1.86	MA	17174	4472	25860	3707	30720	3006	32921	2461	34849	1651	43055	1218	29703
6L-4S		MI	13791	4472	21230	3624	24934	2936	26772	2402	28469	1577	34917	1243	22973
16-#11	1.86	MA	16569	4472	25018	3708	29606	3006	31559	2470	32956	1647	40805	1147	28959
7L-3S		MI	14316	4472	21936	3625	25887	2929	27927	2406	29988	1583	36572	1334	23059
16-#11	1.86	MA	15971	4472	24190	3709	28514	3005	30196	2468	31129	1653	38480	1094	27945
8L-2S		MI	15032	4472	22878	3626	27082	2932	29375	2400	31901	1577	39101	1425	23096
16-#14	2.68	MA	20765	4873	32670	3934	39337	3160	43338	2568	48869	1621	61095	1325	44370
3L-7S		MI	12780	4873	21008	3865	24506	3108	26180	2512	27630	1538	34302	791	28923
16-#14	2.68	MA	19777	4873	31290	3935	37471	3174	41078	2564	45818	1614	57704	1193	43889
4L-6S		MI	13402	4873	21896	3868	25679	3113	27609	2505	29547	1545	36513	893	30065
16-#14	2.68	MA	18884	4873	29894	3950	35796	3173	39033	2576	43034	1622	54157	1127	42151
5E		MI	14037	4873	22807	3870	26893	3103	29083	2512	31437	1538	39007	1003	30974
16-#14	2.68	MA	18028	4873	28653	3951	34142	3186	37020	2573	40356	1629	50563	1019	40926
6L-4S		MI	14699	4873	23830	3857	28121	3108	30578	2505	33403	1531	41501	1064	32041
16-#14	2.68	MA	17189	4873	27446	3952	32544	3185	35068	2585	37642	1622	47367	916	39133
7L-3S		MI	15427	4873	24839	3860	29484	3098	32227	2512	35558	1538	43841	1194	32549
16-#14	2.68	MA	16359	4873	26257	3953	30979	3184	33112	2582	35022	1630	44055	840	37182
8L-2S		MI	16421	4873	26184	3862	31189	3103	34290	2505	38272	1531	47417	1326	32678
16-#18	4.76	MA	21452	5891	37726	4572	45536	3622	50745	2864	58523	1546	75200	686	69578
5E		MI	15794	5891	28420	4476	33833	3535	37178	2763	42054	1411	53163	471	50186
16-#18	4.76	MA	20048	5891	35546	4572	42630	3644	47208	2856	53868	1560	68992	492	65786
6L-4S		MI	16867	5891	30209	4456	35980	3547	39747	2750	45545	1424	57421	580	52556
16-#18	4.76	MA	18672	5891	33423	4572	39822	3640	43778	2874	49147	1546	63481	310	61225
7L-3S		MI	18038	5891	31971	4462	38360	3532	42579	2763	49135	1411	61429	806	55638
18-#11	2.09	MA	19759	4585	29958	3765	35988	3038	39321	2489	43476	1638	54078	1418	35059
3L-8S		MI	12417	4585	19589	3700	22798	2987	24135	2436	25008	1580	30714	984	23545
18-#11	2.09	MA	19053	4585	28995	3766	34687	3048	37743	2487	41347	1634	51691	1326	34878
4L-7S		MI	12856	4585	20200	3702	23602	2990	25139	2441	26312	1574	32358	1033	24172
18-#11	2.09	MA	18416	4585	28022	3777	33518	3048	36317	2496	39404	1640	49202	1280	34186
5L-6S		MI	13300	4585	20820	3703	24422	2993	26140	2435	27664	1580	33920	1104	24743
18-#11	2.09	MA	17805	4585	27157	3778	32365	3058	34913	2494	37537	1646	46675	1205	33436
6L-5S		MI	13753	4585	21457	3704	25270	2985	27173	2440	28997	1574	35685	1180	25198
18-#11	2.09	MA	17207	4585	26315	3779	31251	3058	33552	2503	35644	1642	44425	1134	32641
7L-4S		MI	14226	4585	22172	3695	26129	2988	28220	2434	30382	1569	37446	1223	25729

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

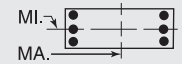


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.09	MA	16615	4585	25486	3780	30159	3057	32188	2501	33817	1648	42100	1081	31654
8L-3S		MI	14746	4585	22878	3696	27082	2981	29375	2439	31901	1574	39101	1314	25832
18-#11	2.09	MA	16028	4585	24571	3791	29034	3067	30846	2510	32008	1654	39805	1022	30545
9L-2S		MI	15456	4585	23820	3697	28277	2983	30823	2433	33815	1569	41630	1405	25883
18-#14	3.01	MA	20627	5036	33146	4037	39825	3249	43929	2612	49665	1606	62852	1173	49141
4L-7S		MI	13401	5036	22353	3968	26211	3183	28243	2559	30344	1525	37878	759	32712
18-#14	3.01	MA	19746	5036	31750	4053	38150	3247	41884	2624	46881	1614	59305	1107	47471
5L-6S		MI	14016	5036	23240	3970	27385	3188	29672	2552	32261	1532	40088	861	33811
18-#14	3.01	MA	18902	5036	30509	4053	36496	3261	39871	2620	44203	1622	55711	999	46169
6L-5S		MI	14643	5036	24152	3972	28598	3178	31146	2559	34151	1525	42583	971	34801
18-#14	3.01	MA	18075	5036	29302	4054	34898	3260	37919	2632	41489	1615	52515	896	44426
7L-4S		MI	15297	5036	25175	3960	29826	3183	32641	2552	36117	1518	45077	1032	35815
18-#14	3.01	MA	17257	5036	28113	4055	33332	3259	35963	2629	38869	1623	49203	820	42436
8L-3S		MI	16016	5036	26184	3962	31189	3173	34290	2559	38272	1525	47417	1162	36482
18-#14	3.01	MA	16444	5036	26801	4071	31719	3273	34039	2641	36275	1630	45941	735	40447
9L-2S		MI	16999	5036	27529	3964	32894	3178	36353	2552	40986	1518	50993	1294	36637
18-#18	5.36	MA	21497	6181	38794	4754	46750	3777	52198	2940	60552	1544	77886	450	75023
6L-5S		MI	16785	6181	30759	4657	36800	3668	40722	2843	46718	1383	59269	405	56642
18-#18	5.36	MA	20147	6181	36671	4753	43941	3773	48768	2958	55832	1530	72374	267	70396
7L-4S		MI	17834	6181	32548	4637	38947	3680	43291	2830	50209	1396	63527	515	59156
20-#11	2.32	MA	19663	4698	30292	3837	36331	3100	39736	2520	44035	1629	55311	1314	38671
4L-8S		MI	12865	4698	20531	3771	23993	3039	25583	2469	26922	1571	33243	963	26216
20-#11	2.32	MA	19032	4698	29318	3848	35162	3100	38309	2529	42092	1635	52822	1267	37899
5L-7S		MI	13299	4698	21142	3772	24797	3041	26587	2474	28226	1566	34886	1013	26823
20-#11	2.32	MA	18427	4698	28453	3849	34009	3110	36905	2527	40225	1641	50295	1192	37173
6E		MI	13739	4698	21762	3774	25617	3044	27588	2468	29578	1571	36449	1084	27444
20-#11	2.32	MA	17836	4698	27612	3850	32895	3109	35544	2536	38332	1637	48045	1121	36330
7L-5S		MI	14188	4698	22399	3775	26465	3037	28620	2473	30910	1566	38214	1160	27882
20-#11	2.32	MA	17251	4698	26783	3851	31803	3109	34181	2534	36505	1643	45720	1068	35367
8L-4S		MI	14656	4698	23114	3766	27324	3040	29668	2467	32296	1561	39975	1202	28483
20-#11	2.32	MA	16670	4698	25868	3862	30678	3119	32839	2543	34696	1649	43425	1009	34197
9L-3S		MI	15171	4698	23820	3767	28277	3032	30823	2472	33815	1566	41630	1293	28602
20-#11	2.32	MA	16091	4698	25043	3863	29594	3119	31491	2541	32836	1644	41053	929	33062
10L-2S		MI	15875	4698	24763	3768	29473	3035	32271	2466	35728	1561	44159	1384	28665
20-#14	3.35	MA	20595	5200	33605	4155	40503	3322	44735	2671	50728	1607	64453	1087	52799
5L-7S		MI	14014	5200	23697	4070	27916	3257	30306	2606	33058	1512	41454	727	36510
20-#14	3.35	MA	19762	5200	32365	4156	38849	3336	42722	2668	48050	1615	60859	979	51423
6E		MI	14621	5200	24585	4072	29090	3262	31736	2599	34975	1519	43664	829	37569
20-#14	3.35	MA	18946	5200	31158	4156	37252	3335	40770	2680	45336	1607	57663	876	49728
7L-5S		MI	15241	5200	25496	4074	30303	3252	33209	2606	36865	1512	46159	939	38635
20-#14	3.35	MA	18139	5200	29969	4157	35686	3334	38815	2677	42716	1615	54351	800	47699
8L-4S		MI	15887	5200	26520	4062	31532	3257	34705	2599	38831	1504	48652	1000	39603
20-#14	3.35	MA	17338	5200	28656	4173	34072	3347	36890	2688	40122	1623	51089	715	45683
9L-3S		MI	16598	5200	27529	4064	32894	3248	36353	2606	40986	1512	50993	1130	40412
20-#18	5.95	MA	21596	6472	39919	4935	48061	3906	53758	3043	62516	1515	81267	225	79584
7L-5S		MI	17757	6472	33099	4839	39767	3801	44266	2924	51381	1355	65374	340	63123
22-#11	2.55	MA	19640	4812	30615	3919	36807	3152	40302	2562	44780	1630	56442	1255	41619
5L-8S		MI	13306	4812	21473	3842	25188	3090	27031	2502	28835	1563	35772	943	28893
22-#11	2.55	MA	19042	4812	29750	3920	35654	3162	38898	2560	42913	1636	53914	1180	40915
6L-7S		MI	13737	4812	22084	3843	25992	3093	28035	2507	30139	1558	37415	992	29481
22-#11	2.55	MA	18456	4812	28908	3921	34540	3161	37537	2569	41020	1632	51665	1109	40024
7L-6S		MI	14172	4812	22705	3844	26812	3096	29036	2501	31491	1563	38978	1064	30149
22-#11	2.55	MA	17878	4812	28080	3922	33448	3161	36173	2567	39193	1638	49340	1055	39085
8L-5S		MI	14617	4812	23341	3846	27661	3089	30068	2506	32824	1558	40743	1139	30571
22-#11	2.55	MA	17303	4812	27165	3933	32323	3171	34831	2576	37384	1644	47045	997	37887
9L-4S		MI	15081	4812	24057	3836	28519	3092	31116	2500	34210	1553	42503	1182	31235
22-#11	2.55	MA	16731	4812	26339	3934	31239	3170	33483	2574	35524	1639	44673	917	36732
10L-3S		MI	15591	4812	24763	3838	29473	3084	32271	2505	35728	1558	44159	1273	31369

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.55	MA	16130	4812	25520	3935	30127	3180	32150	2583	33723	1645	42388	860	35402
11L-2S		MI	16290	4812	25705	3839	30668	3087	33719	2499	37642	1553	46688	1364	31444
22-#14	3.68	MA	20610	5364	34221	4258	41203	3411	45574	2715	51897	1607	66007	958	56687
6L-7S		MI	14618	5364	25042	4172	29622	3332	32369	2654	35772	1499	45029	695	40309
22-#14	3.68	MA	19805	5364	33013	4259	39605	3410	43622	2727	49183	1600	62811	856	55036
7L-6S		MI	15218	5364	25930	4174	30795	3337	33799	2646	37690	1506	47240	797	41338
22-#14	3.68	MA	19009	5364	31825	4260	38039	3409	41666	2724	46563	1608	59498	780	52970
8L-5S		MI	15831	5364	26841	4177	32009	3327	35272	2654	39579	1499	49735	907	42476
22-#14	3.68	MA	18218	5364	30512	4275	36426	3422	39742	2736	43969	1616	56237	695	50926
9L-4S		MI	16470	5364	27864	4164	33237	3332	36768	2646	41545	1491	52228	968	43401
24-#11	2.79	MA	19649	4925	31047	3991	37298	3214	40890	2593	45601	1631	57534	1167	44660
6L-8S		MI	13743	4925	22416	3913	26384	3142	28479	2535	30749	1555	38301	922	31566
24-#11	2.79	MA	19070	4925	30205	3992	36184	3213	39529	2601	43708	1626	55285	1096	43725
7E		MI	14169	4925	23027	3914	27187	3145	29483	2540	32053	1550	39944	972	32144
24-#11	2.79	MA	18497	4925	29376	3993	35093	3213	38165	2600	41881	1632	52960	1043	42807
8L-6S		MI	14601	4925	23647	3915	28008	3148	30484	2534	33405	1555	41507	1043	32856
24-#11	2.79	MA	17928	4925	28461	4004	33968	3223	36824	2608	40072	1638	50665	984	41583
9L-5S		MI	15042	4925	24284	3916	28856	3141	31516	2539	34737	1550	43271	1119	33265
24-#11	2.79	MA	17362	4925	27636	4005	32883	3222	35476	2607	38212	1634	48293	904	40408
10L-4S		MI	15501	4925	24999	3907	29714	3144	32564	2533	36123	1545	45032	1161	33986
24-#11	2.79	MA	16763	4925	26816	4006	31771	3232	34142	2615	36411	1640	46008	847	39098
11L-3S		MI	16007	4925	25705	3908	30668	3136	33719	2538	37642	1550	46688	1253	34133
24-#14	4.02	MA	20652	5527	34869	4361	41959	3484	46473	2774	53030	1592	67958	836	60352
7E		MI	15215	5527	26387	4274	31327	3407	34432	2701	38486	1486	48605	663	44036
24-#14	4.02	MA	19866	5527	33680	4362	40393	3483	44517	2771	50410	1600	64646	760	58248
8L-6S		MI	15808	5527	27274	4277	32501	3412	35862	2693	40404	1493	50816	765	45116
24-#14	4.02	MA	19085	5527	32368	4378	38779	3497	42593	2783	47816	1608	61385	675	56176
9L-5S		MI	16414	5527	28186	4279	33714	3402	37335	2701	42293	1486	53310	875	46323

RECTANGULAR TIED COLUMNS 32" x 44"

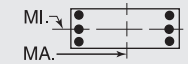
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.14	MA	19896	4316	28559	3615	33821	2941	36193	2441	38225	1718	46346	1610	21096
2E		MI	14199	4316	21018	3522	24364	2864	25704	2368	26603	1641	31792	1509	14849
6-#18	1.70	MA	21522	4606	31989	3797	38171	3074	41463	2525	45315	1703	55799	1571	31272
2L-3S		MI	13474	4606	21018	3697	24364	2986	25704	2461	26603	1626	31792	1209	21730
6-#18	1.70	MA	18894	4606	28559	3798	33821	3071	36193	2545	38225	1717	46346	1337	30961
3L-2S		MI	15262	4606	23357	3704	27330	2997	29248	2448	31267	1613	37897	1443	21838
8-#14	1.28	MA	20412	4388	29335	3683	34994	2993	37695	2478	40347	1729	49415	1626	23864
2L-4S		MI	12751	4388	19186	3593	22135	2928	23173	2417	23336	1661	28093	1266	16700
8-#14	1.28	MA	18883	4388	27377	3684	32511	2992	34687	2490	36288	1737	43952	1495	23799
3E		MI	13521	4388	20195	3596	23498	2918	24821	2425	25490	1668	30434	1397	16793
8-#14	1.28	MA	17776	4388	25923	3686	30545	3007	32305	2487	33072	1731	40350	1363	23534
4L-2S		MI	14566	4388	21540	3598	25203	2923	26884	2417	28204	1661	34010	1528	16788
8-#18	2.27	MA	23095	4897	35418	3979	42521	3207	46732	2609	52405	1689	65252	1532	41405
2L-4S		MI	13246	4897	21594	3872	24951	3133	26416	2529	27677	1612	33889	918	26700
8-#18	2.27	MA	20524	4897	31989	3979	38171	3204	41463	2629	45315	1702	55799	1298	40969
3E		MI	14541	4897	23357	3879	27330	3119	29248	2542	31267	1599	37897	1144	28557
8-#18	2.27	MA	18660	4897	29435	3980	34719	3227	37280	2622	39689	1689	49581	1065	38218
4L-2S		MI	16294	4897	25696	3885	30297	3130	32792	2529	35930	1585	44003	1377	28770
10-#11	1.11	MA	19950	4301	28241	3640	33701	2962	36171	2460	38318	1739	46817	1648	20855
2L-5S		MI	12501	4301	18418	3566	21324	2897	22228	2410	22133	1685	26468	1337	14639

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

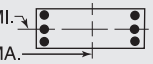


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.11	MA	18874	4301	26873	3641	31967	2962	34070	2469	35483	1745	42978	1557	20833
3L-4S		MI	12995	4301	19133	3557	22183	2900	23276	2405	23518	1680	28229	1380	14721
10-#11	1.11	MA	18096	4301	25859	3642	30596	2973	32408	2468	33240	1741	40445	1465	20741
4L-3S		MI	13537	4301	19839	3558	23136	2893	24431	2409	25037	1685	29884	1471	14737
10-#11	1.11	MA	17391	4301	24833	3654	29365	2972	30906	2477	31195	1748	37810	1419	20513
5L-2S		MI	14275	4301	20781	3559	24331	2896	25879	2404	26951	1680	32413	1562	14720
10-#14	1.60	MA	21348	4552	31293	3785	37477	3068	40704	2525	44405	1721	54878	1607	29666
2L-5S		MI	12702	4552	19508	3708	22612	2998	23741	2472	24084	1655	29176	1174	19720
10-#14	1.60	MA	19840	4552	29335	3787	34994	3067	37695	2537	40347	1730	49415	1476	29559
3L-4S		MI	13393	4552	20531	3696	23840	3003	25236	2464	26050	1648	31669	1235	20624
10-#14	1.60	MA	18750	4552	27881	3788	33028	3081	35313	2535	37131	1723	45813	1345	29242
4L-3S		MI	14153	4552	21540	3698	25203	2993	26884	2472	28204	1655	34010	1365	20763
10-#14	1.60	MA	17763	4552	26410	3804	31263	3081	33159	2547	34198	1732	42056	1278	27815
5L-2S		MI	15185	4552	22885	3700	26909	2998	28947	2464	30918	1648	37585	1496	20794
10-#18	2.84	MA	24624	5188	38848	4160	46870	3340	52002	2693	59495	1675	74705	1493	51514
2L-5S		MI	13154	5188	22145	4074	25771	3254	27391	2622	28850	1571	35737	742	31417
10-#18	2.84	MA	22105	5188	35418	4161	42521	3337	46732	2713	52405	1688	65252	1259	50971
3L-4S		MI	14309	5188	23934	4054	27918	3266	29960	2609	32341	1584	39995	852	33167
10-#18	2.84	MA	20283	5188	32865	4162	39069	3360	42549	2706	46779	1675	59034	1026	47862
4L-3S		MI	15578	5188	25696	4061	30297	3251	32792	2622	35930	1571	44003	1078	35365
10-#18	2.84	MA	18633	5188	30280	4189	35967	3357	38763	2726	41645	1688	52507	910	44956
5L-2S		MI	17300	5188	28035	4067	33264	3263	36337	2609	40593	1558	50108	1312	35670
12-#11	1.33	MA	20617	4414	29608	3711	35436	3014	38272	2493	41153	1733	50656	1636	24913
2L-6S		MI	12492	4414	18724	3636	21671	2957	22644	2439	22714	1682	27232	1241	16784
12-#11	1.33	MA	19551	4414	28241	3712	33701	3014	36171	2502	38318	1740	46817	1545	24871
3L-5S		MI	12961	4414	19360	3637	22519	2949	23676	2443	24046	1677	28997	1317	17318
12-#11	1.33	MA	18782	4414	27226	3713	32330	3024	34509	2501	36075	1736	44284	1454	24753
4E		MI	13449	4414	20076	3628	23378	2952	24724	2438	25432	1672	30758	1359	17496
12-#11	1.33	MA	18086	4414	26201	3725	31099	3024	33007	2510	34030	1743	41648	1407	24443
5L-3S		MI	13986	4414	20781	3629	24331	2945	25879	2442	26951	1677	32413	1451	17534
12-#11	1.33	MA	17418	4414	25291	3726	29885	3035	31529	2509	32063	1749	38968	1332	23523
6L-2S		MI	14717	4414	21724	3630	25526	2948	27327	2437	28864	1672	34942	1542	17533
12-#14	1.92	MA	22266	4715	33251	3888	39960	3142	43712	2572	48464	1714	60341	1589	35456
2L-6S		MI	12687	4715	19941	3808	23104	3082	24330	2512	24908	1649	30257	1032	22838
12-#14	1.92	MA	20778	4715	31293	3889	37477	3142	40704	2585	44405	1722	54878	1457	35311
3L-5S		MI	13341	4715	20852	3811	24318	3073	25804	2519	26798	1642	32751	1142	23509
12-#14	1.92	MA	19704	4715	29839	3890	35511	3156	38322	2582	41190	1716	51276	1326	34950
4E		MI	14023	4715	21876	3798	25546	3078	27299	2512	28764	1634	35245	1203	24541
12-#14	1.92	MA	18731	4715	28368	3906	33747	3156	36167	2595	38257	1725	47519	1259	33393
5L-3S		MI	14772	4715	22885	3800	26909	3068	28947	2519	30918	1642	37585	1333	24719
12-#14	1.92	MA	17799	4715	27062	3908	32005	3170	34047	2592	35436	1733	43704	1151	32215
6L-2S		MI	15793	4715	24229	3803	28614	3073	31011	2512	33632	1634	41161	1465	24782
12-#18	3.41	MA	23646	5479	38848	4343	46870	3470	52002	2797	59495	1674	74705	1220	60971
3L-5S		MI	14214	5479	24484	4256	28737	3387	30935	2703	33513	1543	41843	677	37769
12-#18	3.41	MA	21863	5479	36294	4343	43419	3493	47819	2791	53869	1660	68487	987	57548
4E		MI	15347	5479	26273	4236	30884	3399	33504	2689	37004	1556	46100	786	39678
12-#18	3.41	MA	20249	5479	33709	4371	40317	3490	44033	2810	48735	1674	61960	871	54775
5L-3S		MI	16593	5479	28035	4242	33264	3384	36337	2703	40593	1543	50108	1012	42163
12-#18	3.41	MA	18700	5479	31412	4371	37254	3514	40305	2803	43797	1687	55361	678	50360
6L-2S		MI	18286	5479	30375	4249	36231	3396	39881	2689	45257	1530	56213	1246	42549
14-#11	1.55	MA	21274	4528	30976	3782	37170	3066	40374	2526	43988	1728	54495	1624	28963
2L-7S		MI	12496	4528	19046	3705	22046	3006	23091	2477	23275	1669	28198	1149	19082
14-#11	1.55	MA	20219	4528	29608	3783	35436	3066	38272	2535	41153	1735	50656	1533	28903
3L-6S		MI	12950	4528	19666	3707	22866	3009	24092	2471	24627	1674	29761	1221	19469
14-#11	1.55	MA	19458	4528	28594	3784	34064	3076	36610	2534	38910	1731	48122	1442	28761
4L-5S		MI	13414	4528	20303	3708	23715	3001	25124	2476	25960	1669	31526	1297	19976
14-#11	1.55	MA	18769	4528	27568	3796	32834	3076	35108	2543	36865	1738	45487	1395	28334
5L-4S		MI	13897	4528	21018	3699	24573	3004	26172	2470	27346	1664	33287	1339	20263

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

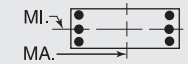
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.55	MA	18109	4528	26658	3797	31620	3087	33630	2541	34898	1744	42806	1320	27450
6L-3S		MI	14429	4528	21724	3700	25526	2997	27327	2475	28864	1669	34942	1430	20321
14-#11	1.55	MA	17463	4528	25772	3798	30447	3087	32197	2550	32905	1740	40419	1250	26816
7L-2S		MI	15154	4528	22666	3701	26722	3000	28775	2469	30778	1664	37471	1521	20338
14-#14	2.24	MA	23167	4879	35209	3990	42444	3217	46721	2620	52523	1706	65804	1570	41237
2L-7S		MI	12690	4879	20398	3908	23636	3152	24963	2566	25704	1629	31622	898	25380
14-#14	2.24	MA	21698	4879	33251	3991	39960	3217	43712	2632	48464	1715	60341	1439	41057
3L-6S		MI	13323	4879	21286	3910	24809	3157	26393	2559	27622	1636	33833	1000	26592
14-#14	2.24	MA	20639	4879	31797	3992	37995	3231	41330	2630	45249	1708	56739	1308	40658
4L-5S		MI	13969	4879	22197	3913	26023	3147	27867	2566	29512	1629	36327	1110	27313
14-#14	2.24	MA	19681	4879	30326	4009	36230	3230	39176	2642	42316	1717	52982	1241	38987
5L-4S		MI	14642	4879	23220	3900	27251	3152	29362	2559	31478	1621	38821	1171	28454
14-#14	2.24	MA	18762	4879	29020	4010	34488	3245	37055	2639	39495	1726	49167	1133	37848
6L-3S		MI	15382	4879	24229	3903	28614	3142	31011	2566	33632	1629	41161	1301	28667
14-#14	2.24	MA	17863	4879	27749	4011	32805	3244	35000	2652	36636	1719	45773	1030	35903
7L-2S		MI	16391	4879	25574	3905	30319	3147	33074	2559	36346	1621	44737	1433	28757
14-#18	3.98	MA	23406	5770	39724	4525	47768	3626	53089	2875	60959	1646	77940	947	67268
4L-5S		MI	15251	5770	26823	4437	31704	3520	34479	2783	38176	1516	47948	611	44157
14-#18	3.98	MA	21825	5770	37139	4552	44666	3623	49303	2895	55825	1659	71413	832	64397
5L-4S		MI	16364	5770	28612	4417	33851	3532	37049	2770	41667	1529	52206	721	46223
14-#18	3.98	MA	20309	5770	34842	4553	41604	3647	45575	2888	50887	1673	64814	639	60088
6L-3S		MI	17588	5770	30375	4424	36231	3517	39881	2783	45257	1516	56213	947	48954
14-#18	3.98	MA	18822	5770	32605	4554	38645	3644	41960	2907	45880	1659	58950	457	55494
7L-2S		MI	19254	5770	32714	4431	39197	3529	43426	2770	49920	1502	62319	1180	49414
16-#11	1.77	MA	21922	4641	32343	3852	38905	3118	42475	2559	46823	1723	58333	1613	33008
2L-8S		MI	12507	4641	19377	3775	22437	3055	23535	2505	23885	1666	29084	1080	21055
16-#11	1.77	MA	20876	4641	30976	3854	37170	3118	40374	2568	43988	1730	54495	1522	32930
3L-7S		MI	12951	4641	19988	3776	23241	3058	24538	2510	25189	1661	30727	1129	21715
16-#11	1.77	MA	20123	4641	29962	3855	35799	3128	38712	2566	41745	1726	51961	1430	32768
4L-6S		MI	13401	4641	20608	3778	24061	3061	25540	2504	26541	1666	32290	1200	22161
16-#11	1.77	MA	19442	4641	28936	3866	34568	3128	37209	2576	39700	1732	49326	1384	32236
5E		MI	13861	4641	21245	3779	24910	3053	26572	2509	27873	1661	34055	1276	22644
16-#11	1.77	MA	18790	4641	28026	3868	33354	3138	35731	2574	37733	1739	46645	1309	31384
6L-4S		MI	14340	4641	21960	3769	25768	3056	27620	2503	29259	1656	35815	1319	23027
16-#11	1.77	MA	18151	4641	27140	3869	32181	3138	34298	2583	35740	1735	44258	1238	30696
7L-3S		MI	14866	4641	22666	3771	26722	3049	28775	2508	30778	1661	37471	1410	23102
16-#11	1.77	MA	17520	4641	26268	3870	31032	3138	32862	2582	33817	1742	41796	1184	29591
8L-2S		MI	15585	4641	23608	3772	27917	3051	30223	2502	32691	1656	40000	1501	23132
16-#14	2.56	MA	22603	5043	35209	4093	42444	3291	46721	2679	52523	1707	65804	1420	46800
3L-7S		MI	13323	5043	21743	4010	25341	3227	27026	2613	28418	1616	35198	866	29155
16-#14	2.56	MA	21558	5043	33755	4095	40478	3306	44339	2677	49308	1701	62203	1289	46366
4L-6S		MI	13948	5043	22630	4013	26515	3232	28456	2606	30336	1623	37408	968	30321
16-#14	2.56	MA	20613	5043	32284	4111	38713	3305	42184	2689	46375	1710	58445	1222	44592
5E		MI	14586	5043	23542	4015	27728	3222	29930	2613	32226	1616	39903	1078	31129
16-#14	2.56	MA	19708	5043	30978	4112	36971	3320	40064	2687	43554	1718	54631	1114	43449
6L-4S		MI	15251	5043	24565	4002	28956	3227	31425	2606	34192	1608	42396	1139	32222
16-#14	2.56	MA	18821	5043	29707	4113	35289	3319	38008	2699	40695	1712	51236	1012	41485
7L-3S		MI	15982	5043	25574	4005	30319	3217	33074	2613	36346	1616	44737	1269	32608
16-#14	2.56	MA	17945	5043	28456	4115	33640	3318	35949	2697	37936	1721	47727	935	39536
8L-2S		MI	16980	5043	26919	4007	32025	3222	35137	2606	39060	1608	48313	1401	32725
16-#18	4.55	MA	23368	6060	40569	4734	49016	3756	54572	2979	62915	1645	80866	793	74014
5E		MI	16268	6060	29163	4619	34671	3653	38024	2863	42840	1488	54053	545	50577
16-#18	4.55	MA	21881	6060	38272	4735	45954	3780	50845	2972	57977	1658	74267	600	69837
6L-4S		MI	17431	6060	30951	4599	36818	3665	40593	2850	46331	1501	58311	655	52795

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	4.55	MA	20425	6060	36035	4735	42994	3777	47230	2992	52970	1645	68403	418	65180
7L-3S		MI	18611	6060	32714	4606	39197	3650	43426	2863	49920	1488	62319	881	55741
18-#11	1.99	MA	21525	4755	32343	3925	38905	3170	42475	2601	46823	1724	58333	1510	36955
3L-8S		MI	12961	4755	20319	3846	23633	3107	24983	2538	25798	1658	31613	1059	23720
18-#11	1.99	MA	20780	4755	31329	3926	37533	3180	40813	2599	44580	1721	55800	1419	36773
4L-7S		MI	13401	4755	20930	3847	24437	3109	25986	2543	27102	1653	33256	1109	24357
18-#11	1.99	MA	20106	4755	30304	3937	36303	3180	39311	2608	42535	1727	53165	1372	36147
5L-6S		MI	13847	4755	21551	3848	25257	3112	26988	2537	28454	1658	34819	1180	24858
18-#11	1.99	MA	19461	4755	29393	3939	35088	3190	37832	2607	40568	1734	50484	1297	35324
6L-5S		MI	14302	4755	22187	3850	26105	3105	28020	2542	29787	1653	36583	1256	25320
18-#11	1.99	MA	18829	4755	28507	3940	33916	3190	36399	2616	38575	1730	48097	1226	34584
7L-4S		MI	14776	4755	22903	3840	26963	3108	29067	2536	31173	1648	38344	1298	25786
18-#11	1.99	MA	18205	4755	27635	3941	32766	3190	34964	2615	36652	1737	45635	1172	33506
8L-3S		MI	15298	4755	23608	3841	27917	3100	30223	2541	32691	1653	40000	1389	25878
18-#11	1.99	MA	17584	4755	26672	3953	31582	3201	33551	2624	34747	1743	43201	1114	32418
9L-2S		MI	16011	4755	24551	3843	29112	3103	31670	2535	34605	1648	42529	1480	25921
18-#14	2.88	MA	22462	5206	35713	4197	42961	3381	47347	2724	53367	1694	67666	1271	52059
4L-7S		MI	13946	5206	23087	4113	27047	3302	29089	2661	31132	1603	38773	834	32941
18-#14	2.88	MA	21530	5206	34243	4213	41196	3380	45193	2737	50434	1702	63908	1204	50209
5L-6S		MI	14564	5206	23975	4115	28220	3307	30519	2653	33050	1610	40984	936	34063
18-#14	2.88	MA	20638	5206	32936	4214	39455	3394	43072	2734	47613	1711	60094	1096	48988
6L-5S		MI	15194	5206	24886	4117	29434	3297	31993	2661	34940	1603	43479	1046	34954
18-#14	2.88	MA	19763	5206	31665	4216	37772	3394	41017	2747	44754	1704	56699	993	47076
7L-4S		MI	15851	5206	25910	4105	30662	3302	33488	2653	36906	1595	45972	1107	35994
18-#14	2.88	MA	18899	5206	30414	4217	36123	3393	38957	2744	41995	1713	53190	916	45089
8L-3S		MI	16574	5206	26919	4107	32025	3292	35137	2661	39060	1603	48313	1237	36544
18-#14	2.88	MA	18040	5206	29032	4233	34424	3407	36931	2757	39264	1722	49727	832	43092
9L-2S		MI	17562	5206	28263	4109	33730	3297	37200	2653	41774	1595	51889	1369	36686
18-#18	5.11	MA	23423	6351	41701	4916	50303	3913	56114	3056	65067	1644	83720	561	79605
6L-5S		MI	17344	6351	31502	4801	37638	3786	41568	2944	47503	1460	60159	480	57026
18-#18	5.11	MA	21994	6351	39465	4917	47344	3910	52500	3076	60060	1631	77856	379	74884
7L-4S		MI	18402	6351	33291	4781	39785	3798	44137	2930	50994	1473	64417	589	59391
20-#11	2.22	MA	21428	4868	32697	3997	39268	3232	42914	2632	47415	1715	59639	1407	40777
4L-8S		MI	13409	4868	21262	3917	24828	3158	26431	2571	27712	1650	34142	1039	26390
20-#11	2.22	MA	20761	4868	31671	4008	38037	3232	41412	2641	45369	1722	57003	1360	40066
5L-7S		MI	13845	4868	21873	3918	25632	3161	27434	2576	29016	1645	35785	1088	27007
20-#11	2.22	MA	20123	4868	30761	4009	36823	3242	39934	2640	43403	1729	54323	1285	39268
6E		MI	14287	4868	22493	3919	26452	3164	28436	2570	30368	1650	37348	1160	27559
20-#11	2.22	MA	19498	4868	29875	4011	35650	3242	38501	2649	41410	1725	51936	1215	38478
7L-5S		MI	14738	4868	23130	3920	27300	3157	29468	2575	31700	1645	39112	1235	28003
20-#11	2.22	MA	18880	4868	29003	4012	34501	3242	37065	2648	39487	1731	49474	1161	37427
8L-4S		MI	15208	4868	23845	3911	28158	3160	30515	2569	33086	1639	40873	1278	28542
20-#11	2.22	MA	18266	4868	28040	4023	33317	3252	35653	2657	37582	1738	47039	1102	36309
9L-3S		MI	15725	4868	24551	3912	29112	3152	31670	2574	34605	1645	42529	1369	28649
20-#11	2.22	MA	17655	4868	27171	4025	32176	3252	34234	2656	35624	1734	44522	1022	35117
10L-2S		MI	16432	4868	25493	3914	30307	3155	33118	2568	36519	1639	45057	1460	28706
20-#14	3.20	MA	22434	5370	36201	4315	43680	3455	48201	2784	54493	1695	69371	1185	55835
5L-7S		MI	14561	5370	24432	4215	28752	3377	31153	2708	33846	1590	42349	802	36736
20-#14	3.20	MA	21553	5370	34895	4317	41938	3469	46081	2782	51672	1703	65557	1077	54538
6E		MI	15171	5370	25320	4217	29925	3382	32582	2700	35764	1597	44560	905	37818
20-#14	3.20	MA	20690	5370	33623	4318	40255	3469	44025	2794	48813	1697	62162	975	52676
7L-5S		MI	15794	5370	26231	4219	31139	3372	34056	2708	37654	1590	47055	1014	38787
20-#14	3.20	MA	19837	5370	32372	4319	38607	3468	41966	2792	46054	1706	58653	898	50651
8L-4S		MI	16444	5370	27254	4207	32367	3377	35551	2700	39620	1582	49548	1075	39779
20-#14	3.20	MA	18990	5370	30990	4335	36908	3482	39939	2804	43323	1714	55190	813	48628
9L-3S		MI	17159	5370	28263	4209	33730	3367	37200	2708	41774	1590	51889	1206	40476
20-#18	5.68	MA	23535	6642	42894	5099	51694	4043	57769	3160	67150	1617	87309	339	84604
7L-5S		MI	18321	6642	33841	4983	40604	3919	45112	3024	52166	1432	66264	414	63500

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.44	MA	21408	4981	33039	4079	39772	3284	43513	2674	48204	1717	60842	1349	43991
5L-8S		MI	13852	4981	22204	3988	26023	3210	27878	2604	29626	1642	36671	1018	29065
22-#11	2.44	MA	20776	4981	32129	4080	38557	3294	42035	2673	46238	1723	58162	1274	43217
6L-7S		MI	14284	4981	22815	3989	26827	3213	28882	2609	30929	1636	38314	1068	29663
22-#11	2.44	MA	20158	4981	31243	4082	37385	3294	40602	2682	44245	1720	55774	1203	42379
7L-6S		MI	14722	4981	23435	3990	27647	3216	29883	2603	32281	1642	39877	1139	30264
22-#11	2.44	MA	19546	4981	30370	4083	36235	3294	39166	2681	42322	1726	53313	1149	41352
8L-5S		MI	15169	4981	24072	3991	28495	3209	30916	2608	33614	1636	41641	1215	30691
22-#11	2.44	MA	18939	4981	29407	4094	35051	3304	37754	2690	40417	1733	50878	1090	40173
9L-4S		MI	15634	4981	24787	3982	29354	3212	31963	2602	35000	1631	43402	1257	31297
22-#11	2.44	MA	18334	4981	28538	4096	33910	3304	36335	2688	38459	1729	48361	1010	39036
10L-3S		MI	16147	4981	25493	3983	30307	3204	33118	2607	36519	1636	45057	1349	31418
22-#11	2.44	MA	17691	4981	27676	4097	32739	3315	34931	2697	36563	1736	45942	953	37588
11L-2S		MI	16849	4981	26435	3984	31502	3207	34566	2601	38432	1631	47586	1440	31487
22-#14	3.52	MA	22455	5533	36853	4419	44421	3544	49089	2829	55731	1696	71020	1059	60099
6L-7S		MI	15167	5533	25777	4317	30457	3451	33216	2755	36560	1577	45925	770	40539
22-#14	3.52	MA	21603	5533	35581	4420	42738	3543	47034	2841	52872	1690	67625	956	58283
7L-6S		MI	15771	5533	26664	4319	31631	3456	34646	2747	38478	1584	48136	873	41583
22-#14	3.52	MA	20762	5533	34330	4421	41090	3543	44974	2839	50113	1698	64116	879	56220
8L-5S		MI	16387	5533	27576	4322	32844	3447	36119	2755	40368	1577	50630	982	42627
22-#14	3.52	MA	19925	5533	32948	4438	39391	3557	42948	2851	47381	1707	60653	795	54170
9L-4S		MI	17029	5533	28599	4309	34073	3452	37615	2747	42334	1569	53124	1043	43575
24-#11	2.66	MA	21422	5095	33496	4151	40292	3346	44136	2706	49073	1718	62000	1262	47170
6L-8S		MI	14290	5095	23146	4059	27218	3262	29326	2637	31539	1633	39199	998	31745
24-#11	2.66	MA	20810	5095	32610	4152	39119	3346	42703	2715	47080	1715	59613	1191	46285
7E		MI	14719	5095	23757	4060	28022	3265	30330	2641	32843	1628	40843	1047	32324
24-#11	2.66	MA	20204	5095	31738	4154	37970	3346	41268	2713	45157	1721	57151	1137	45281
8L-6S		MI	15152	5095	24377	4061	28842	3268	31331	2636	34195	1633	42405	1119	32972
24-#11	2.66	MA	19603	5095	30775	4165	36786	3356	39855	2723	43252	1728	54717	1079	44075
9L-5S		MI	15595	5095	25014	4062	29690	3261	32363	2640	35527	1628	44170	1195	33385
24-#11	2.66	MA	19005	5095	29906	4166	35644	3356	38436	2721	41294	1724	52200	999	42920
10L-4S		MI	16057	5095	25730	4053	30549	3263	33411	2635	36913	1623	45931	1237	34049
24-#11	2.66	MA	18364	5095	29044	4168	34474	3366	37032	2730	39398	1731	49781	942	41492
11L-3S		MI	16565	5095	26435	4054	31502	3256	34566	2639	38432	1628	47586	1328	34184
24-#14	3.84	MA	22504	5697	37539	4522	45222	3618	50042	2889	56931	1682	73088	938	63897
7E		MI	15766	5697	27121	4419	32163	3526	35279	2802	39274	1564	49501	738	44349
24-#14	3.84	MA	21673	5697	36288	4524	43573	3618	47983	2886	54172	1691	69579	861	61796
8L-6S		MI	16363	5697	28009	4422	33336	3531	36709	2795	41192	1571	51712	841	45358
24-#14	3.84	MA	20847	5697	34906	4540	41874	3632	45956	2899	51440	1699	66116	776	59719
9L-5S		MI	16973	5697	28920	4424	34550	3521	38182	2802	43082	1564	54206	950	46473

RECTANGULAR TIED COLUMNS 32" x 46"

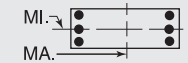
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.09	MA	21635	4485	30837	3774	36586	3072	39141	2552	41288	1805	50083	1699	22176
2E		MI	14747	4485	21760	3665	25201	2982	26550	2468	27389	1718	32682	1583	14885
6-#18	1.63	MA	23362	4776	34448	3956	41166	3205	44690	2636	48774	1792	60096	1663	32892
2L-3S		MI	14020	4776	21760	3841	25201	3104	26550	2562	27389	1703	32682	1284	21797
6-#18	1.63	MA	20586	4776	30837	3958	36586	3203	39141	2657	41288	1806	50083	1429	32581
3L-2S		MI	15813	4776	24099	3847	28168	3115	30094	2548	32052	1690	38787	1517	21881
8-#14	1.22	MA	22177	4558	31647	3842	37812	3124	40713	2589	43467	1814	53298	1715	25079
2L-4S		MI	13296	4558	19921	3738	22971	3047	24020	2519	24124	1738	28989	1342	16759
8-#14	1.22	MA	20564	4558	29587	3844	35199	3124	37547	2602	39196	1823	47519	1583	25014
3E		MI	14067	4558	20930	3741	24333	3037	25668	2526	26279	1746	31330	1472	16834

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.22	MA	19397	4558	28059	3846	33133	3138	35043	2600	35816	1818	43706	1452	24749
4L-2S		MI	15114	4558	22275	3743	26039	3042	27731	2519	28993	1738	34905	1604	16820
8-#18	2.17	MA	25034	5067	38060	4138	45747	3338	50239	2720	56261	1779	70109	1627	43565
2L-4S		MI	13791	5067	22337	4016	25789	3251	27262	2629	28463	1689	34779	992	26955
8-#18	2.17	MA	22316	5067	34448	4139	41166	3336	44690	2741	48774	1792	60096	1393	43129
3E		MI	15090	5067	24099	4022	28168	3237	30094	2642	32052	1676	38787	1218	28632
8-#18	2.17	MA	20349	5067	31763	4141	37536	3360	40290	2736	42837	1780	53502	1159	40501
4L-2S		MI	16849	5067	26439	4029	31135	3248	33639	2629	36715	1662	44893	1452	28821
10-#11	1.06	MA	21685	4471	30493	3799	36448	3093	39104	2571	41327	1824	50535	1735	21908
2L-5S		MI	13045	4471	19148	3712	22159	3017	23076	2512	22923	1764	27367	1413	14695
10-#11	1.06	MA	20550	4471	29054	3800	34624	3093	36894	2581	38345	1831	46478	1644	21886
3L-4S		MI	13539	4471	19864	3702	23017	3020	24123	2507	24309	1758	29128	1455	14761
10-#11	1.06	MA	19730	4471	27989	3802	33183	3104	35147	2580	35988	1828	43797	1553	21794
4L-3S		MI	14083	4471	20569	3704	23971	3013	25278	2511	25827	1764	30783	1547	14769
10-#11	1.06	MA	18989	4471	26912	3814	31890	3104	33570	2589	33839	1835	41016	1506	21566
5L-2S		MI	14822	4471	21512	3705	25166	3016	26726	2506	27741	1758	33312	1638	14748
10-#14	1.53	MA	23171	4722	33708	3944	40425	3199	43878	2636	47738	1807	59077	1698	31185
2L-5S		MI	13246	4722	20242	3853	23448	3117	24588	2573	24873	1733	30071	1249	19876
10-#14	1.53	MA	21579	4722	31647	3946	37812	3198	40713	2649	43467	1816	53298	1566	31078
3L-4S		MI	13939	4722	21266	3841	24676	3122	26083	2566	26838	1725	32565	1310	20689
10-#14	1.53	MA	20430	4722	30119	3948	35746	3213	38209	2647	40087	1810	49485	1435	30761
4L-3S		MI	14700	4722	22275	3843	26039	3112	27731	2573	28993	1733	34905	1440	20809
10-#14	1.53	MA	19390	4722	28574	3964	33892	3213	35945	2660	37005	1820	45517	1367	29378
5L-2S		MI	15735	4722	23619	3845	27744	3117	29794	2566	31707	1725	38481	1572	20830
10-#18	2.72	MA	26659	5358	41671	4320	50327	3471	55788	2805	63747	1765	80122	1590	54214
2L-5S		MI	13697	5358	22888	4217	26608	3372	28237	2722	29635	1648	36627	817	31729
10-#18	2.72	MA	23995	5358	38060	4321	45747	3469	50239	2826	56261	1779	70109	1357	53671
3L-4S		MI	14857	5358	24676	4198	28755	3384	30806	2709	33126	1661	40885	926	33417
10-#18	2.72	MA	22072	5358	35374	4322	42116	3493	45839	2820	50323	1766	63515	1123	50670
4L-3S		MI	16131	5358	26439	4204	31135	3370	33639	2722	36715	1648	44893	1153	35448
10-#18	2.72	MA	20331	5358	32657	4350	38855	3491	41859	2841	44904	1780	56614	1006	47509
5L-2S		MI	17860	5358	28778	4211	34101	3381	37183	2709	41379	1635	50998	1386	35725
12-#11	1.27	MA	22392	4584	31931	3870	38273	3145	41314	2604	44309	1819	54593	1725	26176
2L-6S		MI	13036	4584	19454	3781	22506	3077	23491	2540	23504	1761	28131	1317	16896
12-#11	1.27	MA	21268	4584	30493	3871	36448	3145	39104	2614	41327	1826	50535	1633	26135
3L-5S		MI	13506	4584	20091	3783	23354	3069	24523	2545	24836	1755	29895	1393	17440
12-#11	1.27	MA	20457	4584	29427	3873	35007	3156	37358	2613	38970	1823	47855	1542	26016
4E		MI	13995	4584	20806	3773	24212	3072	25571	2539	26222	1750	31656	1435	17540
12-#11	1.27	MA	19724	4584	28350	3885	33715	3156	35780	2622	36821	1830	45074	1495	25762
5L-3S		MI	14533	4584	21512	3775	25166	3065	26726	2544	27741	1755	33312	1526	17570
12-#11	1.27	MA	19022	4584	27394	3886	32440	3167	34227	2621	34756	1837	42240	1420	24797
6L-2S		MI	15266	4584	22454	3776	26361	3068	28174	2538	29655	1750	35841	1617	17564
12-#14	1.83	MA	24145	4885	35768	4047	43038	3273	47044	2683	52009	1799	64855	1681	37278
2L-6S		MI	13229	4885	20676	3953	23940	3202	25177	2613	25697	1727	31152	1107	22988
12-#14	1.83	MA	22574	4885	33708	4048	40425	3273	43878	2696	47738	1808	59077	1549	37133
3L-5S		MI	13886	4885	21587	3956	25153	3192	26651	2620	27587	1720	33647	1217	23662
12-#14	1.83	MA	21441	4885	32180	4050	38359	3288	41374	2695	44358	1803	55263	1418	36773
4E		MI	14571	4885	22610	3943	26381	3197	28146	2613	29552	1712	36141	1278	24611
12-#14	1.83	MA	20416	4885	30634	4067	36505	3288	39110	2708	41276	1812	51295	1350	35252
5L-3S		MI	15323	4885	23619	3945	27744	3187	29794	2620	31707	1720	38481	1408	24769
12-#14	1.83	MA	19434	4885	29263	4068	34675	3303	36883	2706	38313	1822	47260	1242	33980
6L-2S		MI	16346	4885	24964	3948	29449	3192	31857	2613	34421	1712	42057	1540	24822
12-#18	3.26	MA	25632	5648	41671	4503	50327	3602	55788	2910	63747	1766	80122	1321	64211
3L-5S		MI	14759	5648	25227	4399	29575	3505	31781	2803	34298	1620	42733	751	38168
12-#18	3.26	MA	23749	5648	38986	4504	46697	3626	51388	2904	57809	1753	73528	1087	60881
4E		MI	15898	5648	27016	4379	31722	3517	34350	2790	37789	1634	46990	861	39922
12-#18	3.26	MA	22045	5648	36268	4532	43435	3624	47408	2925	52391	1767	66627	970	57860
5L-3S		MI	17150	5648	28778	4386	34101	3503	37183	2803	41379	1620	50998	1087	42252

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

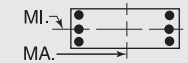
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	3.26	MA	20411	5648	33854	4534	40217	3649	43490	2919	47179	1781	59637	777	53382
6L-2S		MI	18850	5648	31117	4392	37068	3514	40727	2790	46042	1607	57103	1321	42609
14-#11	1.48	MA	23089	4698	33370	3941	40097	3197	43524	2637	47291	1814	58651	1714	30437
2L-7S		MI	13038	4698	19776	3851	22881	3126	23938	2579	24065	1747	29097	1225	19238
14-#11	1.48	MA	21975	4698	31931	3942	38273	3197	41314	2646	44309	1821	54593	1623	30377
3L-6S		MI	13494	4698	20396	3852	23701	3128	24939	2573	25417	1752	30660	1296	19581
14-#11	1.48	MA	21173	4698	30866	3944	36832	3208	39568	2646	41952	1817	51913	1532	30236
4L-5S		MI	13960	4698	21033	3853	24549	3121	25971	2578	26750	1747	32424	1372	20097
14-#11	1.48	MA	20449	4698	29788	3955	35539	3208	37990	2655	39803	1825	49131	1484	29896
5L-4S		MI	14445	4698	21748	3844	25407	3124	27019	2572	28136	1742	34185	1415	20312
14-#11	1.48	MA	19754	4698	28833	3957	34264	3219	36437	2654	37738	1832	46298	1409	28931
6L-3S		MI	14978	4698	22454	3845	26361	3117	28174	2577	29655	1747	35841	1506	20360
14-#11	1.48	MA	19073	4698	27902	3958	33032	3219	34932	2664	35644	1828	43772	1339	28263
7L-2S		MI	15704	4698	23396	3847	27556	3119	29622	2571	31568	1742	38369	1597	20371
14-#14	2.14	MA	25102	5049	37828	4149	45651	3348	50209	2731	56280	1792	70634	1664	43363
2L-7S		MI	13232	5049	21132	4053	24471	3271	25810	2667	26493	1707	32518	973	25609
14-#14	2.14	MA	23550	5049	35768	4151	43038	3348	47044	2744	52009	1801	64855	1532	43183
3L-6S		MI	13867	5049	22020	4055	25645	3276	27240	2660	28411	1714	34728	1076	26820
14-#14	2.14	MA	22433	5049	34240	4152	40972	3363	44540	2742	48629	1795	61042	1401	42784
4L-5S		MI	14516	5049	22932	4058	26858	3267	28714	2667	30301	1707	37223	1185	27464
14-#14	2.14	MA	21423	5049	32695	4169	39118	3363	42276	2755	45547	1805	57074	1333	41142
5L-4S		MI	15191	5049	23955	4045	28087	3272	30209	2660	32266	1699	39716	1246	28528
14-#14	2.14	MA	20455	5049	31323	4171	37288	3378	40049	2753	42584	1814	53039	1225	39912
6L-3S		MI	15934	5049	24964	4047	29449	3262	31857	2667	34421	1707	42057	1377	28721
14-#14	2.14	MA	19507	5049	29988	4172	35521	3377	37889	2766	39580	1809	49446	1123	37974
7L-2S		MI	16946	5049	26309	4050	31155	3267	33920	2660	37135	1699	45633	1508	28801
14-#18	3.80	MA	25387	5939	42597	4686	51277	3759	56937	2988	65296	1740	83541	1051	71126
4L-5S		MI	15799	5939	27566	4581	32542	3638	35325	2883	38962	1593	48838	686	44548
14-#18	3.80	MA	23718	5939	39880	4714	48016	3757	52957	3009	59877	1754	76640	934	68231
5L-4S		MI	16918	5939	29355	4561	34689	3650	37895	2870	42453	1606	53096	795	46462
14-#18	3.80	MA	22117	5939	37466	4715	44797	3782	49039	3003	54666	1767	69650	741	63641
6L-3S		MI	18149	5939	31117	4568	37068	3636	40727	2883	46042	1593	57103	1021	49049
14-#18	3.80	MA	20548	5939	35115	4717	41687	3779	45240	3024	49382	1755	63433	559	58962
7L-2S		MI	19823	5939	33457	4574	40035	3647	44272	2870	50705	1579	63209	1255	49477
16-#11	1.70	MA	23776	4811	34808	4012	41921	3249	45735	2670	50273	1808	62708	1703	34693
2L-8S		MI	13049	4811	20107	3921	23272	3175	24382	2607	24675	1744	29983	1155	21227
16-#11	1.70	MA	22673	4811	33370	4013	40097	3249	43524	2679	47291	1816	58651	1612	34615
3L-7S		MI	13495	4811	20718	3922	24076	3177	25386	2612	25979	1739	31626	1205	21899
16-#11	1.70	MA	21879	4811	32304	4015	38656	3260	41778	2678	44934	1812	55970	1521	34453
4L-6S		MI	13947	4811	21339	3923	24896	3180	26387	2606	27331	1744	33189	1276	22273
16-#11	1.70	MA	21162	4811	31227	4026	37363	3260	40200	2688	42785	1819	53189	1474	34002
5E		MI	14408	4811	21975	3924	25744	3173	27419	2611	28663	1739	34953	1352	22764
16-#11	1.70	MA	20475	4811	30271	4028	36088	3271	38648	2687	40720	1826	50355	1399	33071
6L-4S		MI	14888	4811	22691	3915	26603	3176	28467	2605	30049	1734	36714	1394	23078
16-#11	1.70	MA	19802	4811	29341	4029	34857	3271	37143	2696	38626	1823	47830	1328	32419
7L-3S		MI	15416	4811	23396	3916	27556	3168	29622	2610	31568	1739	38369	1485	23143
16-#11	1.70	MA	19137	4811	28425	4031	33650	3271	35635	2696	36606	1830	45232	1274	31248
8L-2S		MI	16137	4811	24339	3917	28751	3171	31070	2604	33482	1734	40898	1577	23168
16-#14	2.45	MA	24510	5212	37828	4253	45651	3423	50209	2791	56280	1794	70634	1515	49230
3L-7S		MI	13866	5212	22477	4155	26177	3346	27873	2715	29207	1694	36093	941	29382
16-#14	2.45	MA	23408	5212	36300	4255	43585	3438	47705	2789	52900	1788	66821	1384	48796
4L-6S		MI	14494	5212	23365	4158	27350	3351	29303	2707	31125	1701	38304	1044	30571
16-#14	2.45	MA	22412	5212	34755	4271	41730	3438	45442	2802	49818	1797	62853	1316	47045
5E		MI	15135	5212	24276	4160	28564	3341	30777	2715	33015	1694	40799	1153	31279

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

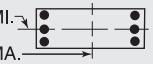


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	2.45	MA	21458	5212	33383	4273	39901	3452	43214	2800	46855	1807	58818	1208	45853
6L-4S		MI	15803	5212	25300	4147	29792	3346	32272	2707	34980	1686	43292	1214	32399
16-#14	2.45	MA	20523	5212	32048	4275	38133	3452	41055	2813	43851	1801	55224	1106	43854
7L-3S		MI	16537	5212	26309	4150	31155	3336	33920	2715	37135	1694	45633	1345	32665
16-#14	2.45	MA	19599	5212	30734	4276	36402	3452	38891	2811	40953	1811	51518	1028	41988
8L-2S		MI	17539	5212	27653	4152	32860	3341	35984	2707	39849	1686	49209	1476	32771
16-#18	4.35	MA	25355	6230	43491	4896	52596	3890	58506	3093	67363	1740	86653	898	78496
5E		MI	16820	6230	29905	4763	35509	3771	38870	2964	43625	1565	54943	620	50961
16-#18	4.35	MA	23786	6230	41077	4897	49377	3915	54588	3088	62152	1754	79663	705	73921
6L-4S		MI	17921	6230	31694	4743	37656	3783	41439	2950	47116	1578	59201	729	53030
16-#18	4.35	MA	22248	6230	38727	4898	46267	3912	50789	3109	56869	1741	73446	523	69182
7L-3S		MI	19132	6230	33457	4749	40035	3769	44272	2964	50705	1565	63209	956	55840
16-#18	4.35	MA	20726	6230	36413	4900	43220	3910	46982	3103	51770	1755	67003	388	64380
8L-2S		MI	20782	6230	35796	4756	43002	3780	47816	2950	55369	1552	69314	1189	56334
18-#11	1.91	MA	23361	4924	34808	4084	41921	3301	45735	2712	50273	1810	62708	1601	38850
3L-8S		MI	13504	4924	21050	3992	24467	3226	25830	2640	26589	1736	32512	1135	23890
18-#11	1.91	MA	22575	4924	33743	4085	40480	3312	43988	2711	47915	1807	60028	1510	38669
4L-7S		MI	13946	4924	21661	3993	25271	3229	26834	2645	27893	1731	34155	1184	24539
18-#11	1.91	MA	21865	4924	32665	4097	39188	3312	42410	2721	45767	1814	57247	1463	38118
5L-6S		MI	14394	4924	22281	3994	26091	3232	27835	2639	29244	1736	35717	1256	24970
18-#11	1.91	MA	21186	4924	31710	4099	37913	3322	40858	2720	43702	1821	54413	1388	37218
6L-5S		MI	14850	4924	22918	3995	26939	3225	28867	2644	30577	1731	37482	1332	25439
18-#11	1.91	MA	20520	4924	30779	4100	36681	3323	39353	2729	41608	1818	51888	1317	36542
7L-4S		MI	15326	4924	23633	3986	27798	3228	29915	2638	31963	1726	39243	1374	25840
18-#11	1.91	MA	19862	4924	29864	4102	35474	3323	37845	2728	39588	1825	49290	1263	35370
8L-3S		MI	15850	4924	24339	3987	28751	3220	31070	2643	33482	1731	40898	1465	25921
18-#11	1.91	MA	19209	4924	28852	4114	34231	3334	36362	2738	37589	1832	46715	1204	34310
9L-2S		MI	16565	4924	25281	3988	29946	3223	32518	2637	35395	1726	43427	1556	25959
18-#14	2.75	MA	24367	5376	38360	4357	46198	3513	50871	2837	57171	1781	72599	1367	54808
4L-7S		MI	14492	5376	23822	4258	27882	3421	29936	2762	31921	1681	39669	909	33165
18-#14	2.75	MA	23385	5376	36815	4373	44343	3512	48607	2850	54088	1790	68631	1299	52959
5L-6S		MI	15112	5376	24710	4260	29056	3426	31366	2754	33839	1688	41880	1012	34310
18-#14	2.75	MA	22443	5376	35443	4375	42514	3527	46380	2848	51125	1799	64596	1191	51801
6L-5S		MI	15745	5376	25621	4262	30269	3416	32840	2762	35729	1681	44375	1121	35103
18-#14	2.75	MA	21522	5376	34108	4377	40746	3527	44220	2861	48122	1794	61003	1089	49744
7L-4S		MI	16405	5376	26644	4250	31497	3421	34335	2754	37694	1673	46868	1182	36168
18-#14	2.75	MA	20610	5376	32794	4378	39015	3527	42057	2859	45224	1803	57297	1011	47770
8L-3S		MI	17132	5376	27653	4252	32860	3411	35984	2762	39849	1681	49209	1313	36604
18-#14	2.75	MA	19704	5376	31342	4395	37230	3542	39929	2872	42354	1813	53632	927	45719
9L-2S		MI	18123	5376	28998	4254	34566	3416	38047	2754	42563	1673	52784	1444	36734
18-#18	4.89	MA	25421	6521	44689	5079	53957	4048	60137	3172	69638	1741	89676	669	84220
6L-5S		MI	17903	6521	32245	4944	38475	3904	42414	3044	48288	1537	61049	554	57403
18-#18	4.89	MA	23912	6521	42338	5080	50847	4045	56337	3193	64355	1728	83460	487	79418
7L-4S		MI	18969	6521	34033	4924	40622	3916	44983	3031	51779	1550	65307	664	59622
18-#18	4.89	MA	22419	6521	40025	5082	47800	4043	52531	3187	59257	1742	77016	352	74576
8L-3S		MI	20133	6521	35796	4931	43002	3902	47816	3044	55369	1537	69314	890	62627
20-#11	2.12	MA	23262	5038	35181	4156	42305	3363	46198	2744	50897	1802	64086	1500	42883
4L-8S		MI	13954	5038	21992	4063	25662	3278	27278	2673	28502	1728	35040	1114	26559
20-#11	2.12	MA	22560	5038	34104	4168	41012	3364	44621	2754	48749	1809	61304	1452	42242
5L-7S		MI	14392	5038	22603	4064	26466	3281	28281	2678	29806	1723	36684	1164	27186
20-#11	2.12	MA	21887	5038	33148	4170	39737	3374	43068	2753	46683	1816	58471	1377	41370
6E		MI	14835	5038	23223	4065	27286	3284	29283	2672	31158	1728	38246	1235	27671
20-#11	2.12	MA	21229	5038	32218	4171	38505	3375	41563	2762	44590	1813	55946	1307	40642
7L-5S		MI	15288	5038	23860	4066	28134	3277	30315	2676	32490	1723	40011	1311	28121
20-#11	2.12	MA	20578	5038	31302	4173	37299	3375	40055	2761	42570	1820	53347	1252	39498
8L-4S		MI	15759	5038	24575	4057	28993	3280	31363	2671	33876	1718	41772	1353	28599
20-#11	2.12	MA	19931	5038	30291	4184	36055	3386	38572	2771	40571	1827	50773	1194	38408
9L-3S		MI	16279	5038	25281	4058	29946	3272	32518	2675	35395	1723	43427	1445	28695

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

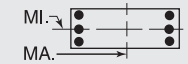
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.12	MA	19287	5038	29379	4186	34857	3386	37082	2770	38514	1824	48112	1114	37119
10L-2S		MI	16988	5038	26223	4059	31141	3275	33966	2670	37309	1718	45956	1536	28745
20-#14	3.06	MA	24343	5539	38875	4476	46956	3587	51773	2897	58359	1782	74410	1282	58882
5L-7S		MI	15108	5539	25166	4360	29588	3496	31999	2809	34635	1668	43245	878	36957
20-#14	3.06	MA	23414	5539	37504	4477	45127	3602	49545	2895	55396	1792	70375	1174	57678
6E		MI	15721	5539	26054	4362	30761	3501	33429	2802	36553	1675	45456	980	38061
20-#14	3.06	MA	22504	5539	36168	4479	43359	3602	47386	2908	52393	1786	66782	1072	55642
7L-5S		MI	16348	5539	26966	4364	31975	3491	34903	2809	38443	1668	47950	1090	38935
20-#14	3.06	MA	21605	5539	34854	4481	41628	3602	45223	2906	49495	1796	63075	994	53630
8L-4S		MI	17000	5539	27989	4352	33203	3496	36398	2802	40408	1660	50444	1150	39951
20-#14	3.06	MA	20711	5539	33403	4497	39843	3617	43094	2919	46625	1805	59411	910	51610
9L-3S		MI	17719	5539	28998	4354	34566	3486	38047	2809	42563	1668	52784	1281	40539
20-#14	3.06	MA	19815	5539	32094	4499	38124	3616	40956	2917	43675	1800	55622	794	49118
10L-2S		MI	18701	5539	30343	4357	36271	3491	40110	2802	45277	1660	56360	1412	40691
20-#18	5.43	MA	25546	6812	45950	5262	55428	4178	61886	3277	71841	1715	93473	451	89671
7L-5S		MI	18884	6812	34584	5126	41442	4037	45958	3124	52952	1510	67154	489	63871
20-#18	5.43	MA	24080	6812	43636	5263	52380	4176	58080	3271	66743	1728	87029	316	84787
8L-4S		MI	19927	6812	36373	5106	43589	4049	48528	3111	56443	1523	71412	598	66234
22-#11	2.33	MA	23246	5151	35542	4239	42836	3416	46831	2786	51731	1804	65362	1442	46373
5L-8S		MI	14398	5151	22934	4134	26857	3330	28726	2706	30416	1720	37569	1094	29233
22-#11	2.33	MA	22580	5151	34586	4240	41561	3426	45278	2786	49665	1811	62528	1367	45526
6L-7S		MI	14832	5151	23545	4135	27661	3333	29729	2710	31720	1715	39212	1143	29840
22-#11	2.33	MA	21928	5151	33656	4242	40330	3427	43773	2795	47572	1808	60003	1296	44749
7L-6S		MI	15271	5151	24166	4136	28481	3336	30731	2705	33071	1720	40775	1215	30376
22-#11	2.33	MA	21284	5151	32741	4243	39123	3427	42266	2794	45552	1815	57405	1242	43630
8L-5S		MI	15720	5151	24802	4137	29329	3329	31763	2709	34404	1715	42540	1291	30809
22-#11	2.33	MA	20644	5151	31729	4255	37880	3437	40783	2804	43552	1822	54830	1183	42512
9L-4S		MI	16188	5151	25518	4128	30188	3331	32810	2704	35790	1709	44301	1333	31355
22-#11	2.33	MA	20003	5151	30817	4257	36681	3438	39292	2803	41496	1819	52169	1103	41246
10L-3S		MI	16703	5151	26223	4129	31141	3324	33966	2708	37309	1715	45956	1424	31466
22-#11	2.33	MA	19320	5151	29912	4258	35452	3448	37819	2812	39505	1826	49616	1046	39795
11L-2S		MI	17407	5151	27166	4130	32336	3327	35413	2703	39222	1709	48485	1515	31528
22-#14	3.36	MA	24370	5703	39564	4580	47740	3677	52711	2943	59667	1784	76154	1157	63535
6L-7S		MI	15716	5703	26511	4462	31293	3571	34063	2856	37349	1655	46821	846	40758
22-#14	3.36	MA	23472	5703	38229	4581	45972	3677	50551	2956	56664	1779	72560	1055	61548
7L-6S		MI	16323	5703	27399	4464	32466	3576	35492	2849	39267	1662	49032	948	41823
22-#14	3.36	MA	22585	5703	36914	4583	44241	3677	48388	2954	53766	1788	68854	977	59498
8L-5S		MI	16942	5703	28310	4467	33680	3566	36966	2856	41157	1655	51526	1058	42774
22-#14	3.36	MA	21702	5703	35463	4600	42456	3691	46260	2967	50896	1798	65189	893	57452
9L-4S		MI	17588	5703	29334	4454	34908	3571	38461	2849	43122	1647	54020	1118	43745
22-#14	3.36	MA	20810	5703	34154	4601	40737	3691	44122	2965	47945	1792	61401	777	54998
10L-3S		MI	18299	5703	30343	4456	36271	3561	40110	2856	45277	1655	56360	1249	44470
22-#18	5.98	MA	25712	7102	47248	5445	56960	4309	63629	3356	74229	1715	97042	280	95011
8L-5S		MI	19848	7102	36923	5308	44409	4170	49503	3205	57615	1482	73260	423	70361
24-#11	2.54	MA	23264	5265	36025	4311	43386	3478	47488	2818	52647	1806	66586	1356	49687
6L-8S		MI	14837	5265	23877	4204	28052	3382	30174	2739	32329	1712	40098	1074	31911
24-#11	2.54	MA	22619	5265	35095	4313	42154	3478	45983	2828	50554	1802	64061	1285	48861
7E		MI	15268	5265	24488	4206	28856	3385	31177	2743	33633	1706	41741	1123	32500
24-#11	2.54	MA	21981	5265	34179	4314	40947	3479	44476	2827	48534	1810	61463	1231	47766
8L-6S		MI	15703	5265	25108	4207	29676	3388	32179	2738	34985	1712	43304	1194	33083
24-#11	2.54	MA	21348	5265	33168	4326	39704	3489	42993	2836	46534	1817	58888	1172	46619
9L-5S		MI	16148	5265	25745	4208	30524	3380	33211	2742	36318	1706	45069	1270	33502
24-#11	2.54	MA	20710	5265	32256	4328	38506	3490	41503	2836	44478	1813	56227	1092	45376
10L-4S		MI	16612	5265	26460	4199	31383	3383	34258	2737	37703	1701	46830	1313	34110

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

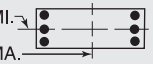
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.54	MA	20033	5265	31350	4329	37276	3500	40029	2845	42487	1820	53673	1035	43907
11L-3S		MI	17123	5265	27166	4200	32336	3376	35413	2741	39222	1706	48485	1404	34234
24-#11	2.54	MA	19349	5265	30450	4331	36082	3501	38547	2844	40505	1828	51119	977	42451
12L-2S		MI	17822	5265	28108	4201	33531	3379	36861	2735	41136	1701	51014	1495	34307
24-#14	3.67	MA	24427	5867	40289	4683	48585	3752	53717	3003	60934	1771	78339	1038	67460
7E		MI	16317	5867	27856	4564	32998	3646	36126	2903	40063	1642	50397	814	44565
24-#14	3.67	MA	23551	5867	38975	4685	46853	3751	51554	3001	58037	1781	74633	960	65372
8L-6S		MI	16917	5867	28744	4567	34172	3651	37555	2896	41981	1649	52607	916	45595
24-#14	3.67	MA	22679	5867	37523	4702	45069	3766	49425	3014	55167	1790	70968	876	63300
9L-5S		MI	17530	5867	29655	4569	35385	3641	39029	2903	43871	1642	55102	1026	46620
24-#14	3.67	MA	21791	5867	36214	4703	43349	3766	47287	3012	52216	1785	67179	760	60884
10L-4S		MI	18169	5867	30678	4556	36613	3646	40524	2896	45836	1634	57595	1086	47550

RECTANGULAR TIED COLUMNS 32" x 48"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.04	MA	23443	4655	33194	3933	39451	3203	42195	2663	44414	1891	53938	1787	23256
2E		MI	15293	4655	22503	3809	26039	3101	27396	2568	28174	1795	33572	1658	14920
6-#18	1.56	MA	25272	4946	36988	4115	44262	3336	48023	2747	52277	1877	64512	1753	34512
2L-3S		MI	14566	4946	22503	3984	26039	3222	27396	2662	28174	1781	33572	1358	21860
6-#18	1.56	MA	22346	4946	33194	4117	39451	3335	42195	2769	44414	1893	53938	1520	34201
3L-2S		MI	16363	4946	24842	3991	29006	3234	30940	2649	32837	1767	39677	1592	21923
8-#14	1.17	MA	24012	4728	34039	4001	40731	3255	43836	2700	46690	1899	57301	1803	26294
2L-4S		MI	13840	4728	20655	3883	23806	3166	24867	2620	24913	1816	29885	1417	16814
8-#14	1.17	MA	22313	4728	31877	4003	37988	3255	40513	2713	42207	1909	51206	1671	26229
3E		MI	14613	4728	21665	3886	25169	3157	26515	2627	27067	1824	32225	1547	16873
8-#14	1.17	MA	21087	4728	30275	4005	35822	3270	37887	2712	38663	1905	47181	1540	25964
4L-2S		MI	15662	4728	23009	3888	26874	3162	28578	2620	29781	1816	35801	1679	16852
8-#18	2.08	MA	27042	5237	40781	4297	49073	3469	53851	2832	60140	1864	75086	1720	45725
2L-4S		MI	14335	5237	23080	4159	26626	3369	28108	2729	29248	1766	35669	1067	27206
8-#18	2.08	MA	24177	5237	36988	4299	44262	3468	48023	2854	52277	1879	64512	1486	45289
3E		MI	15639	5237	24842	4166	29006	3355	30940	2742	32837	1753	39677	1293	28705
8-#18	2.08	MA	22107	5237	34170	4301	40453	3493	43407	2849	46047	1868	57542	1253	42808
4L-2S		MI	17403	5237	27181	4172	31972	3367	34485	2729	37501	1740	45783	1526	28870
10-#11	1.02	MA	23489	4641	32824	3958	39295	3224	42143	2682	44438	1909	54373	1822	22961
2L-5S		MI	13589	4641	19879	3857	22993	3137	23923	2614	23713	1842	28265	1489	14747
10-#11	1.02	MA	22294	4640	31315	3960	37381	3225	39824	2692	41309	1917	50096	1731	22939
3L-4S		MI	14084	4641	20594	3848	23852	3140	24970	2608	25099	1837	30026	1531	14800
10-#11	1.02	MA	21433	4640	30198	3962	35871	3236	37993	2692	38838	1914	47269	1640	22847
4L-3S		MI	14628	4640	21300	3849	24805	3133	26126	2613	26618	1842	31681	1622	14800
10-#11	1.02	MA	20654	4641	29069	3974	34516	3236	36339	2702	36586	1922	44341	1592	22619
5L-2S		MI	15369	4641	22242	3850	26000	3136	27573	2607	28531	1837	34210	1713	14776
10-#14	1.46	MA	25063	4891	36202	4104	43473	3329	47158	2747	51173	1892	63395	1787	32703
2L-5S		MI	13790	4891	20977	3998	24283	3236	25435	2674	25661	1811	30967	1324	20027
10-#14	1.46	MA	23387	4891	34039	4106	40731	3330	43836	2761	46690	1902	57301	1656	32596
3L-4S		MI	14485	4891	22000	3986	25511	3241	26930	2667	27627	1803	33461	1385	20751
10-#14	1.46	MA	22178	4891	32437	4108	38564	3345	41210	2759	43145	1897	53275	1524	32280
4L-3S		MI	15248	4891	23009	3988	26874	3231	28578	2674	29781	1811	35801	1516	20853
10-#14	1.46	MA	21085	4891	30817	4125	36621	3345	38837	2773	39914	1907	49097	1456	30951
5L-2S		MI	16285	4891	24354	3990	28580	3236	30641	2667	32495	1803	39377	1647	20866
10-#18	2.60	MA	28765	5527	44574	4479	53884	3602	59679	2916	68004	1851	85659	1687	56914
2L-5S		MI	14240	5527	23630	4361	27446	3491	29083	2823	30420	1725	37517	891	31951
10-#18	2.60	MA	25955	5527	40781	4481	49073	3601	53851	2938	60140	1866	75086	1453	56371
3L-4S		MI	15404	5527	25419	4341	29593	3502	31652	2810	33911	1738	41775	1001	33661
10-#18	2.60	MA	23930	5527	37964	4483	45264	3626	49235	2933	53910	1855	68116	1219	53502
4L-3S		MI	16684	5527	27181	4348	31972	3488	34485	2823	37501	1725	45783	1227	35528
10-#18	2.60	MA	22097	5527	35114	4512	41844	3625	45061	2955	48227	1870	60841	1101	50077
5L-2S		MI	18418	5527	29521	4354	34939	3500	38029	2810	42164	1712	51888	1461	35780

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

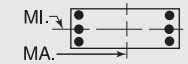
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.22	MA	24237	4754	34334	4029	41210	3276	44462	2715	47567	1904	58650	1813	27440
2L-6S		MI	13579	4754	20184	3927	23340	3196	24339	2642	24294	1839	29029	1392	17005
12-#11	1.22	MA	23053	4754	32824	4031	39295	3277	42143	2725	44438	1912	54373	1721	27398
3L-5S		MI	14050	4754	20821	3928	24188	3189	25371	2647	25626	1834	30794	1468	17506
12-#11	1.22	MA	22201	4754	31707	4032	37785	3287	40312	2725	41967	1909	51545	1630	27280
4E		MI	14541	4754	21536	3919	25047	3192	26418	2641	27012	1828	32555	1511	17583
12-#11	1.22	MA	21431	4754	30579	4044	36430	3288	38659	2734	39715	1917	48618	1583	27026
5L-3S		MI	15080	4754	22242	3920	26000	3184	27573	2646	28531	1834	34210	1602	17605
12-#11	1.22	MA	20693	4754	29577	4046	35094	3299	37032	2734	37551	1924	45631	1508	26078
6L-2S		MI	15815	4754	23185	3921	27195	3187	29021	2640	30445	1828	36739	1693	17594
12-#14	1.76	MA	26094	5055	38364	4206	46216	3404	50481	2795	55655	1885	69490	1771	39101
2L-6S		MI	13772	5055	21410	4098	24775	3321	26024	2714	26485	1805	32048	1183	23134
12-#14	1.76	MA	24438	5055	36202	4208	43473	3405	47158	2808	51173	1895	63395	1640	38956
3L-5S		MI	14431	5055	22322	4100	25989	3311	27498	2722	28375	1798	34543	1292	23812
12-#14	1.76	MA	23247	5055	34600	4210	41307	3420	44532	2807	47628	1890	59370	1509	38595
4E		MI	15118	5055	23345	4088	27217	3316	28993	2714	30341	1790	37036	1353	24678
12-#14	1.76	MA	22170	5055	32980	4227	39363	3420	42160	2820	44397	1900	55191	1441	37122
5L-3S		MI	15872	5055	24354	4090	28580	3306	30641	2722	32495	1798	39377	1484	24818
12-#14	1.76	MA	21137	5055	31542	4229	37445	3436	39825	2819	41292	1910	50935	1333	35752
6L-2S		MI	16898	5055	25699	4093	30285	3311	32704	2714	35209	1790	42953	1615	24862
12-#18	3.13	MA	27688	5818	44574	4663	53884	3734	59679	3022	68004	1853	85659	1420	67451
3L-5S		MI	15305	5818	25969	4543	30413	3624	32627	2903	35083	1697	43623	826	38556
12-#18	3.13	MA	25705	5818	41757	4665	50075	3759	55063	3017	61773	1841	78689	1186	64238
4E		MI	16449	5818	27758	4523	32560	3635	35197	2890	38575	1711	47880	935	40161
12-#18	3.13	MA	23911	5818	38907	4693	46655	3758	50889	3039	56090	1856	71415	1068	60960
5L-3S		MI	17706	5818	29521	4529	34939	3621	38029	2903	42164	1697	51888	1161	42338
12-#18	3.13	MA	22191	5818	36376	4696	43279	3783	46780	3035	50625	1872	64032	875	56433
6L-2S		MI	19413	5818	31860	4536	37906	3633	41573	2890	46827	1684	57993	1395	42667
14-#11	1.42	MA	24973	4867	35843	4100	43124	3328	46781	2748	50696	1899	62926	1803	31911
2L-7S		MI	13581	4867	20506	3997	23715	3245	24785	2681	24856	1825	29996	1301	19349
14-#11	1.42	MA	23801	4867	34334	4102	41210	3328	44462	2758	47567	1907	58650	1712	31851
3L-6S		MI	14039	4867	21127	3998	24535	3248	25786	2675	26207	1831	31558	1372	19690
14-#11	1.42	MA	22958	4867	33217	4103	39699	3339	42631	2757	45095	1904	55822	1621	31710
4L-5S		MI	14505	4867	21763	3999	25383	3241	26819	2680	27540	1825	33323	1448	20215
14-#11	1.42	MA	22196	4867	32088	4115	38345	3340	40978	2767	42843	1911	52895	1573	31433
5L-4S		MI	14991	4867	22479	3990	26242	3244	27866	2674	28926	1820	35084	1490	20358
14-#11	1.42	MA	21466	4867	31087	4117	37009	3351	39351	2767	40679	1919	49908	1498	30418
6L-3S		MI	15526	4867	23185	3991	27195	3236	29021	2679	30445	1825	36739	1581	20398
14-#11	1.42	MA	20752	4867	30112	4119	35718	3351	37774	2777	38486	1916	47245	1427	29704
7L-2S		MI	16254	4867	24127	3992	28390	3239	30469	2673	32358	1820	39268	1673	20403
14-#14	2.05	MA	27107	5218	40527	4308	48958	3479	53804	2842	60138	1877	75584	1756	45489
2L-7S		MI	13774	5218	21867	4198	25307	3391	26657	2769	27282	1785	33413	1049	25833
14-#14	2.05	MA	25471	5218	38364	4310	46216	3479	50481	2856	55655	1887	69490	1624	45310
3L-6S		MI	14411	5218	22755	4200	26480	3396	28087	2761	29199	1792	35624	1151	26965
14-#14	2.05	MA	24296	5218	36762	4312	44049	3495	47855	2854	52111	1882	65464	1493	44910
4L-5S		MI	15063	5218	23666	4203	27694	3386	29561	2769	31089	1785	38119	1260	27612
14-#14	2.05	MA	23234	5218	35142	4329	42106	3495	45482	2868	48880	1892	61286	1425	43309
5L-4S		MI	15741	5218	24689	4190	28922	3391	31056	2761	33055	1777	40612	1321	28599
14-#14	2.05	MA	22217	5218	33705	4331	40188	3510	43148	2866	45774	1902	57030	1317	41984
6L-3S		MI	16486	5218	25699	4192	30285	3381	32704	2769	35209	1785	42953	1452	28773
14-#14	2.05	MA	21220	5218	32306	4333	38336	3511	40885	2880	42626	1898	53238	1215	40062
7L-2S		MI	17501	5218	27043	4195	31990	3386	34767	2761	37923	1777	46528	1583	28843
14-#18	3.65	MA	27438	6109	45550	4846	54885	3892	60892	3102	69636	1828	89263	1153	75010
4L-5S		MI	16348	6109	28309	4725	33380	3757	36172	2984	39747	1670	49728	760	44933

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

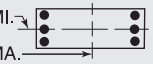


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.65	MA	25681	6109	42700	4875	51465	3891	56717	3124	63953	1843	81988	1034	71863
5L-4S		MI	17472	6109	30098	4705	35527	3768	38741	2970	43238	1683	53986	870	46696
14-#18	3.65	MA	23996	6109	40169	4877	48090	3916	52608	3119	58488	1858	74606	842	67224
6L-3S		MI	18709	6109	31860	4711	37906	3754	41573	2984	46827	1670	57993	1096	49140
14-#18	3.65	MA	22344	6109	37705	4880	44830	3915	48625	3141	52948	1847	68036	660	62474
7L-2S		MI	20391	6109	34199	4718	40873	3766	45118	2970	51490	1656	64099	1329	49539
16-#11	1.63	MA	25700	4981	37352	4171	45038	3380	49100	2781	53824	1894	67203	1793	36378
2L-8S		MI	13592	4981	20838	4067	24106	3294	25229	2709	25465	1822	30881	1231	21395
16-#11	1.63	MA	24538	4981	35843	4172	43124	3380	46781	2791	50696	1901	62926	1702	36300
3L-7S		MI	14039	4981	21449	4068	24910	3297	26233	2714	26769	1817	32524	1280	22051
16-#11	1.63	MA	23704	4981	34726	4174	41613	3391	44950	2790	48224	1899	60099	1611	36138
4L-6S		MI	14492	4981	22069	4069	25730	3300	27234	2708	28121	1822	34087	1352	22381
16-#11	1.63	MA	22950	4981	33597	4186	40259	3392	43297	2800	45972	1906	57172	1563	35778
5E		MI	14955	4981	22706	4070	26578	3293	28266	2713	29454	1817	35852	1428	22881
16-#11	1.63	MA	22228	4981	32596	4188	38923	3403	41670	2800	43808	1914	54185	1488	34765
6L-4S		MI	15436	4981	23421	4061	27437	3296	29314	2707	30839	1812	37613	1470	23127
16-#11	1.63	MA	21521	4981	31621	4190	37632	3403	40093	2809	41615	1911	51522	1418	34069
7L-3S		MI	15966	4981	24127	4062	28390	3288	30469	2712	32358	1817	39268	1561	23184
16-#11	1.63	MA	20823	4981	30662	4191	36368	3404	38514	2809	39498	1918	48787	1363	32916
8L-2S		MI	16689	4981	25069	4063	29585	3291	31917	2706	34272	1812	41797	1652	23204
16-#14	2.34	MA	26487	5382	40527	4412	48958	3554	53804	2903	60138	1880	75584	1609	51660
3L-7S		MI	14410	5382	23212	4300	27012	3466	28720	2816	29996	1772	36989	1017	29602
16-#14	2.34	MA	25327	5382	38925	4414	46792	3570	51178	2902	56594	1875	71559	1477	51226
4L-6S		MI	15040	5382	24100	4303	28186	3471	30150	2808	31913	1779	39200	1119	30804
16-#14	2.34	MA	24280	5382	37305	4431	44848	3570	48805	2915	53363	1885	67380	1409	49509
5E		MI	15684	5382	25011	4305	29399	3461	31624	2816	33803	1772	41694	1229	31425
16-#14	2.34	MA	23276	5382	35867	4433	42931	3585	46470	2914	50257	1895	63124	1301	48225
6L-4S		MI	16354	5382	26034	4292	30628	3466	33119	2808	35769	1764	44188	1289	32516
16-#14	2.34	MA	22294	5382	34468	4436	41079	3585	44207	2927	47109	1890	59332	1199	46241
7L-3S		MI	17091	5382	27043	4295	31990	3456	34767	2816	37923	1772	46528	1420	32720
16-#14	2.34	MA	21322	5382	33091	4438	39264	3586	41940	2926	44072	1900	55429	1121	44399
8L-2S		MI	18096	5382	28388	4297	33696	3461	36830	2808	40637	1764	50104	1551	32815
16-#18	4.17	MA	27413	6400	46493	5057	56276	4024	62545	3208	71816	1830	92562	1001	82784
5E		MI	17371	6400	30648	4906	36346	3889	39716	3064	44410	1642	55833	694	51339
16-#18	4.17	MA	25760	6400	43962	5059	52901	4049	58437	3203	66351	1845	85179	808	78036
6L-4S		MI	18478	6400	32437	4886	38493	3901	42285	3051	47901	1655	60091	804	53260
16-#18	4.17	MA	24141	6400	41499	5061	49640	4048	54453	3225	60811	1834	78610	627	73228
7L-3S		MI	19696	6400	34199	4893	40873	3887	45118	3064	51490	1642	64099	1030	55935
16-#18	4.17	MA	22538	6400	39073	5063	46445	4047	50462	3220	55465	1849	71816	490	68324
8L-2S		MI	21353	6400	36538	4899	43839	3899	48662	3051	56154	1629	70204	1264	56399
18-#11	1.83	MA	25266	5094	37352	4243	45038	3432	49100	2824	53824	1896	67203	1692	40746
3L-8S		MI	14048	5094	21780	4137	25301	3346	26677	2742	27379	1814	33410	1210	24056
18-#11	1.83	MA	24439	5094	36236	4245	43528	3443	47269	2823	51353	1893	64376	1601	40564
4L-7S		MI	14491	5094	22391	4139	26105	3349	27681	2746	28683	1809	35053	1260	24716
18-#11	1.83	MA	23694	5094	35107	4257	42173	3444	45616	2833	49101	1901	61448	1553	40099
5L-6S		MI	14940	5094	23011	4140	26925	3352	28682	2741	30034	1814	36616	1331	25078
18-#11	1.83	MA	22979	5094	34105	4259	40837	3455	43989	2832	46937	1909	58461	1479	39118
6L-5S		MI	15398	5094	23648	4141	27773	3345	29714	2745	31367	1809	38381	1407	25555
18-#11	1.83	MA	22280	5094	33131	4261	39547	3455	42412	2842	44743	1906	55798	1408	38438
7L-4S		MI	15876	5094	24363	4132	28632	3348	30762	2740	32753	1804	40142	1450	25892
18-#11	1.83	MA	21589	5094	32172	4262	38283	3456	40833	2842	42627	1913	53063	1353	37245
8L-3S		MI	16401	5094	25069	4133	29585	3340	31917	2744	34272	1809	41797	1541	25964
18-#11	1.83	MA	20902	5094	31112	4274	36980	3467	39279	2851	40532	1921	50349	1295	36221
9L-2S		MI	17118	5094	26012	4134	30781	3343	33365	2739	36185	1804	44326	1632	25996
18-#14	2.64	MA	26342	5546	41087	4517	49534	3644	54500	2949	61076	1867	77653	1462	57542
4L-7S		MI	15037	5546	24556	4402	28718	3540	30783	2863	32710	1759	40565	985	33383
18-#14	2.64	MA	25308	5546	39467	4534	47591	3645	52128	2962	57845	1877	73475	1394	55720
5L-6S		MI	15660	5546	25444	4405	29891	3545	32213	2856	34627	1766	42776	1087	34552

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

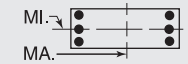
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.64	MA	24318	5546	38030	4536	45673	3660	49793	2961	54740	1888	69219	1286	54473
6L-5S		MI	16296	5546	26356	4407	31105	3535	33687	2863	36517	1759	45270	1197	35248
18-#14	2.64	MA	23349	5546	36631	4538	43821	3660	47530	2975	51592	1883	65427	1183	52429
7L-4S		MI	16959	5546	27379	4395	32333	3540	35182	2856	38483	1751	47764	1257	36339
18-#14	2.64	MA	22390	5546	35254	4540	42007	3661	45263	2973	48555	1893	61523	1105	50548
8L-3S		MI	17688	5546	28388	4397	33696	3531	36830	2863	40637	1759	50104	1388	36662
18-#14	2.64	MA	21437	5546	33733	4557	40137	3676	43032	2987	45547	1903	57657	1021	48262
9L-2S		MI	18683	5546	29733	4399	35401	3536	38894	2856	43351	1751	53680	1519	36781
18-#18	4.69	MA	27490	6691	47756	5241	57712	4182	64265	3287	74214	1832	95753	775	88866
6L-5S		MI	18462	6691	32987	5088	39313	4022	43260	3144	49073	1614	61939	629	57775
18-#18	4.69	MA	25901	6691	45292	5243	54451	4181	60281	3309	68674	1820	89184	593	83998
7L-4S		MI	19535	6691	34776	5068	41460	4034	45830	3131	52565	1628	66197	738	59849
18-#18	4.69	MA	24328	6691	42867	5245	51256	4180	56290	3305	63328	1835	82390	457	79056
8L-3S		MI	20708	6691	36538	5075	43839	4020	48662	3144	56154	1614	70204	964	62727
20-#11	2.03	MA	25166	5208	37745	4316	45442	3495	49589	2856	54482	1888	68653	1591	44989
4L-8S		MI	14498	5208	22722	4208	26496	3398	28125	2775	29292	1806	35939	1190	26724
20-#11	2.03	MA	24427	5208	36616	4328	44087	3496	47935	2866	52230	1896	65725	1544	44428
5L-7S		MI	14938	5208	23333	4209	27300	3401	29129	2779	30596	1801	37582	1239	27361
20-#11	2.03	MA	23720	5208	35615	4330	42751	3506	46308	2865	50066	1903	62738	1469	43477
6E		MI	15383	5208	23954	4211	28120	3404	30130	2774	31948	1806	39145	1311	27779
20-#11	2.03	MA	23028	5208	34640	4331	41461	3507	44731	2875	47872	1901	60075	1398	42810
7L-5S		MI	15837	5208	24590	4212	28969	3396	31162	2778	33281	1801	40909	1387	28236
20-#11	2.03	MA	22344	5208	33681	4333	40197	3508	43152	2875	45756	1908	57340	1343	41580
8L-4S		MI	16310	5208	25306	4203	29827	3399	32210	2773	34666	1796	42670	1429	28653
20-#11	2.03	MA	21665	5208	32621	4345	38894	3519	41598	2884	43661	1916	54626	1285	40526
9L-3S		MI	16831	5208	26012	4204	30781	3392	33365	2777	36185	1801	44326	1520	28740
20-#11	2.03	MA	20981	5208	31666	4347	37639	3519	40037	2884	41506	1913	51820	1205	39137
10L-2S		MI	17543	5208	26954	4205	31976	3395	34813	2772	38099	1796	46855	1611	28784
20-#14	2.93	MA	26322	5709	41630	4636	50333	3719	55450	3010	62328	1870	79569	1378	61941
5L-7S		MI	15655	5709	25901	4505	30423	3615	32846	2910	35424	1745	44141	953	37173
20-#14	2.93	MA	25344	5709	40192	4638	48416	3735	53116	3008	59223	1880	75313	1270	60728
6E		MI	16271	5709	26789	4507	31597	3620	34276	2903	37341	1753	46351	1055	38299
20-#14	2.93	MA	24388	5709	38793	4640	46564	3735	50853	3022	56075	1875	71521	1168	58626
7L-5S		MI	16900	5709	27700	4509	32810	3610	35750	2910	39231	1745	48846	1165	39079
20-#14	2.93	MA	23441	5709	37416	4642	44749	3735	48585	3021	53037	1885	67618	1089	56704
8L-4S		MI	17556	5709	28723	4497	34038	3615	37245	2903	41197	1738	51340	1226	40120
20-#14	2.93	MA	22501	5709	35895	4659	42879	3751	46355	3034	50030	1895	63751	1005	54462
9L-3S		MI	18278	5709	29733	4499	35401	3605	38894	2910	43351	1745	53680	1356	40599
20-#14	2.93	MA	21547	5709	34524	4661	41077	3751	44114	3033	46938	1891	59754	890	51933
10L-2S		MI	19263	5709	31077	4501	37106	3610	40957	2903	46065	1738	57256	1488	40740
20-#18	5.21	MA	27628	6981	49085	5425	59262	4314	66109	3393	76537	1807	99757	560	94784
7L-5S		MI	19446	6981	35327	5270	42280	4155	46805	3225	53737	1587	68044	563	64236
20-#18	5.21	MA	26084	6981	46660	5427	56067	4313	62118	3389	71191	1822	92963	423	89803
8L-4S		MI	20498	6981	37115	5250	44427	4167	49374	3211	57228	1600	72302	673	66457
22-#11	2.23	MA	25153	5321	38125	4399	46002	3547	50254	2899	55359	1891	70002	1534	48764
5L-8S		MI	14943	5321	23665	4279	27692	3450	29573	2807	31206	1798	38468	1170	29396
22-#11	2.23	MA	24452	5321	37124	4401	44665	3558	48627	2898	53195	1898	67015	1459	47841
6L-7S		MI	15379	5321	24276	4280	28495	3453	30577	2812	32510	1793	40111	1219	30014
22-#11	2.23	MA	23767	5321	36150	4402	43375	3559	47050	2908	51001	1895	64352	1388	47134
7L-6S		MI	15821	5321	24896	4281	29315	3456	31578	2806	33862	1798	41674	1290	30484
22-#11	2.23	MA	23090	5321	35190	4404	42111	3559	45471	2907	48885	1903	61617	1333	45919
8L-5S		MI	16271	5321	25533	4283	30164	3448	32610	2811	35194	1793	43438	1366	30923
22-#11	2.23	MA	22418	5321	34131	4416	40808	3570	43917	2917	46790	1910	58902	1275	44836
9L-4S		MI	16741	5321	26248	4273	31022	3451	33658	2805	36580	1788	45199	1409	31412

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

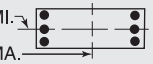
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.23	MA	21736	5321	33176	4418	39553	3571	42356	2917	44635	1908	56097	1195	43471
10L-3S		MI	17257	5321	26954	4275	31976	3444	34813	2810	38099	1793	46855	1500	31513
22-#11	2.23	MA	21004	5321	32227	4420	38265	3582	40812	2926	42549	1915	53408	1137	42025
11L-2S		MI	17964	5321	27896	4276	33171	3447	36261	2804	40012	1788	49383	1591	31568
22-#14	3.22	MA	26356	5873	42355	4740	51158	3810	56438	3056	63705	1873	81408	1254	66988
6L-7S		MI	16265	5873	27246	4607	32128	3690	34909	2957	38138	1732	47717	921	40971
22-#14	3.22	MA	25411	5873	40956	4742	49306	3810	54175	3069	60557	1868	77616	1152	64830
7L-6S		MI	16875	5873	28134	4609	33302	3695	36339	2950	40055	1740	49927	1023	42059
22-#14	3.22	MA	24477	5873	39579	4744	47492	3810	51908	3068	57520	1878	73712	1074	62803
8L-5S		MI	17497	5873	29045	4612	34515	3685	37813	2957	41945	1732	52422	1133	42918
22-#14	3.22	MA	23549	5873	38058	4761	45622	3825	49678	3082	54513	1888	69846	989	60668
9L-4S		MI	18146	5873	30068	4599	35744	3690	39308	2950	43911	1725	54915	1194	43912
22-#14	3.22	MA	22599	5873	36686	4763	43820	3826	47437	3080	51421	1883	65849	874	58113
10L-3S		MI	18860	5873	31077	4601	37106	3680	40957	2957	46065	1732	57256	1324	44533
22-#18	5.73	MA	27809	7272	50453	5609	60877	4446	67946	3473	79054	1809	103537	390	100562
8L-5S		MI	20415	7272	37666	5451	45247	4288	50349	3305	58400	1559	74150	497	70721
24-#11	2.44	MA	25176	5434	38633	4471	46580	3610	50946	2931	56324	1893	71292	1449	52209
6L-8S		MI	15384	5434	24607	4350	28887	3502	31021	2840	33119	1790	40997	1149	32073
24-#11	2.44	MA	24498	5434	37659	4473	45289	3611	49370	2941	54130	1890	68629	1379	51452
7E		MI	15816	5434	25218	4351	29691	3505	32024	2845	34423	1785	42640	1199	32672
24-#11	2.44	MA	23827	5434	36700	4475	44025	3611	47790	2940	52014	1898	65894	1324	50263
8L-6S		MI	16254	5434	25838	4352	30511	3508	33026	2839	35775	1790	44203	1270	33192
24-#11	2.44	MA	23161	5434	35640	4487	42723	3622	46236	2950	49919	1905	63179	1265	49151
9L-5S		MI	16701	5434	26475	4354	31359	3500	34058	2844	37108	1785	45967	1346	33616
24-#11	2.44	MA	22482	5434	34685	4489	41467	3623	44675	2950	47764	1902	60373	1185	47809
10L-4S		MI	17166	5434	27190	4344	32217	3503	35106	2838	38493	1779	47728	1388	34169
24-#11	2.44	MA	21771	5434	33737	4490	40180	3634	43131	2959	45678	1910	57685	1127	46345
11L-3S		MI	17679	5434	27896	4345	33171	3496	36261	2843	40012	1785	49383	1479	34282
24-#11	2.44	MA	21051	5434	32793	4492	38928	3634	41579	2959	43541	1907	54992	1070	44891
12L-2S		MI	18381	5434	28839	4347	34366	3499	37709	2837	41926	1779	51912	1571	34349
24-#14	3.52	MA	26421	6036	43118	4844	52049	3885	57498	3117	65040	1860	83710	1137	71042
7E		MI	16868	6036	28590	4709	33834	3765	36972	3005	40852	1719	51292	889	44777
24-#14	3.52	MA	25498	6036	41741	4846	50234	3885	55231	3115	62003	1870	79806	1058	68977
8L-6S		MI	17471	6036	29478	4712	35007	3770	38402	2997	42769	1727	53503	991	45828
24-#14	3.52	MA	24581	6036	40220	4863	48364	3900	53000	3129	58996	1880	75940	974	66879
9L-5S		MI	18088	6036	30390	4714	36221	3760	39876	3005	44659	1719	55998	1101	46762
24-#14	3.52	MA	23636	6036	38849	4866	46563	3901	50760	3128	55903	1876	71943	858	64300
10L-4S		MI	18730	6036	31413	4701	37449	3765	41371	2997	46625	1712	58491	1162	47715

RECTANGULAR TIED COLUMNS 34" x 34"

6-#14	1.17	MA	12565	3556	18344	2940	21513	2391	22930	1982	23994	1380	28923	1281	13518
2L-3S		MI	11434	3556	16897	2939	19678	2387	20707	1991	21052	1387	25034	1149	13517
6-#18	2.08	MA	13990	3938	21716	3155	25642	2546	27802	2072	30312	1327	37136	1176	23223
2L-3S		MI	12089	3938	19195	3150	22445	2536	23951	2085	25245	1341	30475	942	22957
8-#11	1.08	MA	12445	3519	17979	2929	21126	2384	22494	1980	23483	1392	28292	1300	12601
2L-4S		MI	11067	3519	16209	2928	18818	2390	19697	1983	19768	1392	23745	1117	12565
8-#14	1.56	MA	13239	3720	19791	3042	23348	2466	25154	2030	26935	1368	32812	1252	17828
2L-4S		MI	11310	3720	17261	3039	20050	2473	21157	2032	21659	1368	26376	989	17551
8-#18	2.77	MA	15090	4229	24237	3337	28839	2679	31654	2154	35378	1302	43797	1116	30662
2L-4S		MI	11867	4229	19821	3327	23084	2686	24725	2154	26289	1302	32772	652	27488
10-#11	1.35	MA	12925	3633	18993	3000	22411	2436	24050	2013	25555	1385	31039	1281	15622
2L-5S		MI	11041	3633	16455	3008	19182	2439	20130	2022	20339	1390	24585	1056	15102
10-#11	1.35	MA	12139	3633	17979	2999	21126	2433	22494	2019	23483	1390	28292	1190	15609
3L-4S		MI	11564	3633	17222	2999	20103	2442	21254	2015	21839	1385	26491	1099	15534
10-#14	1.95	MA	13899	3884	21238	3145	25183	2541	27377	2077	29876	1356	36702	1223	22115
2L-5S		MI	11270	3884	17610	3155	20567	2543	21773	2087	22470	1364	27559	898	20377

RECTANGULAR TIED COLUMNS 34" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.95	MA	12802	3884	19791	3143	23348	2537	25154	2086	26935	1364	32812	1091	22024
3L-4S		MI	11999	3884	18708	3142	21885	2547	23380	2079	24600	1356	30266	960	21682
10-#18	3.46	MA	16160	4520	26758	3518	32036	2812	35505	2237	40445	1278	50458	1056	38076
2L-5S		MI	11797	4520	20421	3530	23974	2809	25785	2250	27687	1291	34788	484	31930
10-#18	3.46	MA	14341	4520	24237	3513	28839	2802	31654	2250	35378	1291	43797	822	37584
3L-4S		MI	13008	4520	22342	3508	26281	2819	28576	2237	31356	1278	39433	592	34511

RECTANGULAR TIED COLUMNS 34" x 36"

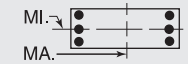
4-#18	1.31	MA	14323	3828	21170	3142	24821	2552	26531	2110	27923	1448	33737	1333	16817
2E		MI	13474	3828	20027	3127	23389	2539	24907	2096	26134	1434	31484	1315	15777
6-#14	1.10	MA	14004	3737	20250	3109	23813	2530	25378	2101	26549	1474	32019	1376	14430
2L-3S		MI	12049	3737	17721	3094	20620	2514	21664	2099	21945	1470	26049	1230	13560
6-#14	1.10	MA	12789	3737	18701	3108	21848	2527	22997	2110	23380	1482	27815	1245	14428
3L-2S		MI	13183	3737	19168	3095	22455	2518	23887	2091	24886	1463	29938	1361	13550
6-#18	1.96	MA	15557	4118	23872	3324	28249	2685	30684	2194	33394	1426	40955	1279	24843
2L-3S		MI	12706	4118	20027	3303	23389	2662	24907	2192	26134	1423	31484	1022	23046
6-#18	1.96	MA	13510	4118	21170	3320	24821	2677	26531	2208	27923	1439	33737	1045	24577
3L-2S		MI	14616	4118	22548	3308	26586	2672	28758	2179	31201	1410	38145	1255	23273
8-#11	1.02	MA	13871	3700	19857	3098	23394	2523	24905	2098	25989	1486	31321	1394	13443
2L-4S		MI	11682	3700	17028	3083	19758	2518	20654	2091	20662	1475	24763	1198	12614
8-#11	1.02	MA	13018	3700	18773	3098	22019	2521	23239	2105	23760	1491	28356	1303	13454
3E		MI	12265	3700	17785	3084	20781	2510	21894	2095	22306	1481	26564	1289	12646
8-#11	1.02	MA	12394	3700	17964	3098	20926	2530	21915	2102	21991	1486	26409	1212	13408
4L-2S		MI	13063	3700	18799	3085	22066	2512	23450	2089	24377	1475	29310	1381	12630
8-#14	1.47	MA	14735	3900	21800	3211	25778	2605	27758	2148	29718	1464	36222	1350	19043
2L-4S		MI	11925	3900	18085	3194	20992	2600	22114	2140	22551	1451	27391	1069	17636
8-#14	1.47	MA	13538	3900	20250	3211	23813	2602	25378	2157	26549	1472	32019	1218	18993
3E		MI	12744	3900	19168	3196	22455	2589	23887	2146	24886	1459	29938	1201	17828
8-#14	1.47	MA	12664	3900	19093	3210	22249	2613	23483	2152	24034	1464	29262	1087	18766
4L-2S		MI	13861	3900	20615	3197	24290	2593	26110	2138	27827	1451	33827	1332	17865
8-#18	2.61	MA	16752	4409	26575	3506	31676	2818	34836	2279	38864	1404	48172	1224	32822
2L-4S		MI	12482	4409	20654	3480	24028	2812	25681	2261	27178	1385	33781	732	27801
8-#18	2.61	MA	14750	4409	23872	3502	28249	2810	30684	2292	33394	1417	40955	991	32434
3E		MI	13854	4409	22548	3485	26586	2795	28758	2275	31201	1398	38145	962	30373
8-#18	2.61	MA	13285	4409	21846	3498	25512	2828	27367	2279	29051	1404	36233	757	29674
4L-2S		MI	15722	4409	25069	3490	29783	2805	32609	2261	36267	1385	44806	1196	30718
10-#11	1.27	MA	14391	3813	20941	3169	24769	2575	26570	2131	28218	1480	34285	1378	16675
2L-5S		MI	11655	3813	17274	3164	20123	2567	21087	2131	21233	1473	25603	1136	15256
10-#11	1.27	MA	13547	3813	19857	3169	23394	2573	24905	2138	25989	1485	31321	1286	16662
3L-4S		MI	12179	3813	18041	3154	21043	2570	22211	2124	22733	1468	27509	1180	15588
10-#11	1.27	MA	12931	3813	19048	3169	22301	2582	23580	2135	24220	1480	29373	1195	16587
4L-3S		MI	12756	3813	18799	3155	22066	2561	23450	2128	24377	1473	29310	1271	15649
10-#11	1.27	MA	12372	3813	18229	3179	21318	2580	22381	2142	22606	1485	27321	1151	16217
5L-2S		MI	13545	3813	19812	3155	23351	2564	25007	2122	26449	1468	32057	1362	15654
10-#14	1.84	MA	15450	4064	23349	3314	27742	2680	30138	2195	32887	1454	40426	1323	23634
2L-5S		MI	11884	4064	18433	3310	21509	2671	22729	2196	23363	1447	28574	979	20570
10-#14	1.84	MA	14270	4064	21800	3313	25778	2676	27758	2205	29718	1461	36222	1192	23543
3L-4S		MI	12616	4064	19531	3296	22827	2675	24337	2187	25493	1440	31281	1040	21838
10-#14	1.84	MA	13410	4064	20642	3312	24214	2688	25863	2199	27203	1454	33465	1061	23266
4L-3S		MI	13423	4064	20615	3298	24290	2664	26110	2194	27827	1447	33827	1172	22080
10-#14	1.84	MA	12628	4064	19470	3326	22806	2685	24146	2209	24908	1461	30548	998	21894
5L-2S		MI	14524	4064	22062	3300	26125	2668	28333	2185	30769	1440	37717	1303	22156

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

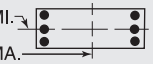


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.27	MA	17914	4700	29278	3687	35104	2951	38989	2363	44335	1382	55390	1170	40776
2L-5S		MI	12408	4700	21253	3683	24919	2935	26741	2357	28575	1373	35797	564	32424
10-#18	3.27	MA	15954	4700	26575	3684	31676	2943	34836	2377	38864	1395	48172	936	40284
3L-4S		MI	13627	4700	23175	3662	27225	2945	29532	2344	32245	1360	40442	672	34815
10-#18	3.27	MA	14522	4700	24549	3680	28939	2961	31520	2364	34522	1382	43451	702	37217
4L-3S		MI	14969	4700	25069	3667	29783	2928	32609	2357	36267	1373	44806	902	37691
10-#18	3.27	MA	13222	4700	22494	3703	26474	2953	28512	2377	30560	1395	38418	595	34651
5L-2S		MI	16799	4700	27590	3672	32980	2938	36461	2344	41334	1360	51467	1136	38137
12-#11	1.53	MA	14902	3926	22025	3240	26144	2627	28236	2164	30448	1473	37250	1361	19895
2L-6S		MI	11653	3926	17605	3234	20498	2627	21537	2160	21862	1471	26432	1042	17543
12-#11	1.53	MA	14066	3926	20941	3240	24769	2625	26570	2171	28218	1479	34285	1270	19862
3L-5S		MI	12150	3926	18288	3235	21408	2619	22644	2163	23305	1466	28349	1118	18111
12-#11	1.53	MA	13458	3926	20132	3239	23676	2634	25246	2168	26449	1473	32338	1178	19761
4E		MI	12668	3926	19055	3225	22328	2621	23767	2157	24805	1461	30256	1161	18556
12-#11	1.53	MA	12905	3926	19313	3250	22693	2632	24047	2175	24835	1479	30286	1134	19278
5L-3S		MI	13239	3926	19812	3226	23351	2613	25007	2161	26449	1466	32057	1252	18641
12-#11	1.53	MA	12375	3926	18585	3249	21723	2641	22866	2172	23282	1484	28217	1059	18649
6L-2S		MI	14019	3926	20825	3226	24636	2616	26564	2154	28520	1461	34803	1344	18666
12-#14	2.21	MA	16151	4227	24898	3416	29707	2754	32518	2243	36056	1444	44629	1297	28212
2L-6S		MI	11879	4227	18903	3411	22042	2757	23368	2236	24255	1443	29749	841	23643
12-#14	2.21	MA	14987	4227	23349	3415	27742	2751	30138	2252	32887	1451	40426	1166	28085
3L-5S		MI	12572	4227	19880	3412	23344	2746	24952	2243	26304	1436	32463	950	24663
12-#14	2.21	MA	14140	4227	22191	3414	26178	2763	28243	2247	30372	1444	37668	1034	27684
4E		MI	13293	4227	20978	3399	24662	2750	26560	2235	28434	1428	35170	1011	25929
12-#14	2.21	MA	13371	4227	21019	3428	24771	2760	26526	2256	28077	1451	34752	971	26285
5L-3S		MI	14087	4227	22062	3400	26125	2739	28333	2241	30769	1436	37717	1143	26323
12-#14	2.21	MA	12632	4227	19976	3428	23381	2772	24834	2250	25870	1458	31818	862	25185
6L-2S		MI	15174	4227	23508	3402	27960	2743	30556	2233	33710	1428	41606	1274	26434
12-#18	3.92	MA	17128	4991	29278	3866	35104	3076	38989	2461	44335	1373	55390	881	48130
3L-5S		MI	13550	4991	23774	3865	28116	3068	30592	2440	33642	1349	42458	504	39332
12-#18	3.92	MA	15726	4991	27252	3862	32367	3094	35673	2448	39992	1359	50669	648	44800
4E		MI	14743	4991	25696	3844	30422	3078	33383	2427	37312	1335	47103	612	41869
12-#18	3.92	MA	14455	4991	25197	3885	29901	3086	32664	2462	36030	1373	45636	540	42092
5L-3S		MI	16057	4991	27590	3849	32980	3061	36461	2440	41334	1349	51467	842	45004
12-#18	3.92	MA	13234	4991	23368	3881	27465	3104	29700	2449	32221	1386	40600	345	39055
6L-2S		MI	17853	4991	30111	3854	36178	3071	40312	2427	46401	1335	58128	1076	45539
14-#11	1.78	MA	15405	4040	23109	3311	27519	2679	29902	2197	32677	1467	40214	1344	23105
2L-7S		MI	11664	4040	17954	3304	20904	2677	22021	2199	22470	1459	27479	953	19776
14-#11	1.78	MA	14578	4040	22025	3310	26144	2677	28236	2204	30448	1472	37250	1253	23054
3L-6S		MI	12146	4040	18618	3305	21783	2679	23094	2192	23933	1464	29179	1024	20436
14-#11	1.78	MA	13976	4040	21216	3310	25051	2685	26912	2201	28679	1467	35302	1162	22931
4L-5S		MI	12637	4040	19301	3306	22693	2671	24201	2196	25376	1459	31096	1100	20979
14-#11	1.78	MA	13430	4040	20397	3320	24068	2684	25713	2208	27064	1472	33250	1118	22351
5L-4S		MI	13149	4040	20068	3296	23613	2673	25324	2190	26876	1454	33002	1143	21520
14-#11	1.78	MA	12907	4040	19669	3320	23098	2692	24532	2204	25512	1477	31181	1042	21750
6L-3S		MI	13713	4040	20825	3297	24636	2665	26564	2194	28520	1459	34803	1234	21627
14-#11	1.78	MA	12394	4040	18960	3320	22160	2691	23386	2211	23937	1472	29344	971	21035
7L-2S		MI	14486	4040	21838	3297	25921	2667	28121	2187	30591	1454	37550	1325	21669
14-#14	2.57	MA	16839	4391	26447	3518	31672	2829	34898	2290	39225	1433	48832	1271	32781
2L-7S		MI	11895	4391	19398	3511	22619	2827	24055	2292	25119	1424	31235	709	26399
14-#14	2.57	MA	15691	4391	24898	3517	29707	2826	32518	2299	36056	1441	44629	1139	32620
3L-6S		MI	12564	4391	20350	3513	23877	2831	25591	2284	27197	1431	33639	812	27667
14-#14	2.57	MA	14856	4391	23740	3516	28143	2838	30623	2294	33541	1433	41872	1008	32020
4L-5S		MI	13246	4391	21327	3514	25179	2820	27175	2290	29245	1424	36353	921	28769
14-#14	2.57	MA	14098	4391	22568	3531	26736	2835	28906	2303	31246	1441	38955	945	30690
5L-4S		MI	13957	4391	22425	3501	26497	2824	28783	2282	31375	1417	39059	982	29970
14-#14	2.57	MA	13371	4391	21525	3530	25346	2846	27215	2298	29039	1448	36022	836	29510
6L-3S		MI	14740	4391	23508	3502	27960	2814	30556	2289	33710	1424	41606	1114	30559

RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis



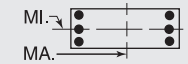
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.57	MA	12659	4391	20509	3529	24003	2843	25574	2307	26801	1441	33420	733	28115
7L-2S		MI	15813	4391	24955	3504	29795	2818	32780	2280	36651	1417	45495	1245	30702
14-#18	4.58	MA	16904	5282	29954	4044	35795	3227	39825	2532	45463	1337	57887	593	52415
4L-5S		MI	14665	5282	26295	4047	31313	3201	34443	2523	38709	1324	49119	444	46274
14-#18	4.58	MA	15659	5282	27900	4067	33329	3219	36817	2546	41501	1350	52854	485	49566
5L-4S		MI	15835	5282	28217	4025	33620	3211	37235	2509	42378	1311	53764	552	48956
14-#18	4.58	MA	14463	5282	26071	4063	30893	3237	33853	2533	37691	1364	47818	291	46543
6L-3S		MI	17123	5282	30111	4030	36178	3194	40312	2523	46401	1324	58128	782	52314
16-#11	2.04	MA	15901	4153	24193	3382	28893	2730	31567	2230	34906	1461	43179	1327	26310
2L-8S		MI	11685	4153	18312	3375	21328	2726	22502	2228	23130	1457	28447	884	21924
16-#11	2.04	MA	15082	4153	23109	3381	27519	2729	29902	2237	32677	1466	40214	1236	26243
3L-7S		MI	12155	4153	18967	3375	22189	2729	23578	2232	24542	1452	30226	934	22624
16-#11	2.04	MA	14487	4153	22300	3381	26426	2737	28578	2233	30908	1461	38267	1145	26099
4L-6S		MI	12631	4153	19632	3376	23068	2731	24651	2225	26005	1457	31926	1005	23336
16-#11	2.04	MA	13947	4153	21481	3391	25443	2736	27378	2241	29293	1466	36215	1101	25433
5E		MI	13117	4153	20314	3377	23978	2723	25758	2229	27447	1452	33842	1081	23855
16-#11	2.04	MA	13430	4153	20753	3391	24473	2744	26197	2237	27741	1471	34146	1025	24856
6L-4S		MI	13623	4153	21081	3367	24898	2725	26881	2223	28947	1447	35749	1124	24480
16-#11	2.04	MA	12923	4153	20044	3391	23535	2743	25052	2244	26166	1466	32309	954	24090
7L-3S		MI	14182	4153	21838	3367	25921	2717	28121	2227	30591	1452	37550	1216	24607
16-#11	2.04	MA	12422	4153	19346	3391	22616	2741	23904	2241	24647	1471	30393	903	23320
8L-2S		MI	14947	4153	22852	3368	27206	2719	29677	2220	32663	1447	40296	1307	24665
16-#14	2.94	MA	16383	4555	26447	3620	31672	2901	34898	2347	39225	1431	48832	1113	37151
3L-7S		MI	12577	4555	20845	3613	24454	2902	26278	2340	28060	1412	35124	680	30485
16-#14	2.94	MA	15559	4555	25289	3619	30108	2913	33003	2341	36710	1423	46075	981	36374
4L-6S		MI	13236	4555	21797	3615	25712	2906	27815	2331	30138	1420	37528	783	31706
16-#14	2.94	MA	14812	4555	24117	3633	28700	2909	31286	2351	34415	1431	43159	919	35105
5E		MI	13909	4555	22774	3617	27014	2895	29399	2338	32187	1412	40242	892	32887
16-#14	2.94	MA	14096	4555	23074	3632	27311	2921	29595	2345	32208	1438	40225	810	33848
6L-4S		MI	14610	4555	23872	3603	28332	2899	31006	2329	34317	1405	42949	953	34028
16-#14	2.94	MA	13394	4555	22058	3631	25967	2918	27954	2355	29970	1431	37623	707	32501
7L-3S		MI	15382	4555	24955	3605	29795	2888	32780	2336	36651	1412	45495	1085	34790
16-#14	2.94	MA	12700	4555	21058	3630	24651	2915	26310	2349	27810	1438	34901	634	30712
8L-2S		MI	16442	4555	26402	3606	31630	2892	35003	2328	39593	1405	49385	1216	34963
16-#18	5.23	MA	16934	5572	30603	4248	36757	3352	40970	2630	46971	1328	60072	431	57070
5E		MI	15759	5572	28816	4229	34510	3334	38294	2605	43775	1299	55780	384	53246
16-#18	5.23	MA	15666	5572	28774	4245	34321	3370	38005	2617	43162	1342	55036	236	53974
6L-4S		MI	16906	5572	30738	4207	36817	3344	41086	2592	47445	1286	60425	493	56070
18-#11	2.29	MA	15580	4267	24193	3452	28893	2781	31567	2270	34906	1460	43179	1219	29427
3L-8S		MI	12173	4267	19326	3446	22613	2778	24059	2261	25202	1450	31193	865	24802
18-#11	2.29	MA	14991	4267	23384	3452	27801	2789	30243	2266	33137	1454	41231	1128	29265
4L-7S		MI	12638	4267	19980	3446	23474	2781	25134	2265	26613	1445	32972	916	25480
18-#11	2.29	MA	14457	4267	22566	3462	26818	2787	29044	2273	31523	1460	39180	1084	28523
5L-6S		MI	13109	4267	20645	3447	24353	2783	26208	2258	28076	1450	34672	987	26240
18-#11	2.29	MA	13945	4267	21838	3462	25848	2796	27863	2270	29970	1465	37110	1008	27967
6L-5S		MI	13590	4267	21327	3447	25263	2775	27314	2262	29519	1445	36589	1063	26740
18-#11	2.29	MA	13444	4267	21129	3462	24910	2794	26718	2277	28396	1460	35273	937	27153
7L-4S		MI	14091	4267	22094	3438	26183	2777	28438	2256	31019	1439	38495	1106	27439
18-#11	2.29	MA	12948	4267	20430	3462	23991	2793	25570	2274	26877	1465	33358	886	26405
8L-3S		MI	14643	4267	22852	3438	27206	2769	29677	2259	32663	1445	40296	1197	27583
18-#11	2.29	MA	12456	4267	19660	3472	23044	2801	24441	2281	25372	1470	31482	827	25333
9L-2S		MI	15402	4267	23865	3439	28491	2771	31234	2253	34734	1439	43043	1288	27657
18-#14	3.31	MA	16251	4718	26839	3721	32072	2987	35384	2389	39879	1413	50279	955	40743
4L-7S		MI	13247	4718	22292	3716	26289	2977	28501	2387	31002	1401	39013	651	34568

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

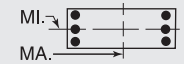


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	3.31	MA	15515	4718	25666	3735	30665	2984	33666	2398	37584	1420	47362	892	39531
5L-6S		MI	13897	4718	23244	3717	27547	2981	30038	2379	33080	1408	41417	754	35758
18-#14	3.31	MA	14808	4718	24623	3734	29275	2996	31975	2393	35377	1428	44428	783	38199
6L-5S		MI	14561	4718	24221	3719	28849	2970	31622	2385	35128	1401	44131	863	37014
18-#14	3.31	MA	14116	4718	23607	3733	27932	2993	30334	2402	33139	1420	41827	680	36897
7L-4S		MI	15253	4718	25319	3705	30167	2974	33230	2377	37258	1393	46838	924	38102
18-#14	3.31	MA	13433	4718	22607	3733	26615	2990	28690	2396	30979	1428	39104	608	35067
8L-3S		MI	16015	4718	26402	3707	31630	2963	35003	2383	39593	1401	49385	1056	39017
18-#18	5.88	MA	16950	5863	31476	4427	37748	3503	42158	2701	48632	1319	62254	181	61429
6L-5S		MI	16910	5863	31337	4410	37708	3467	42146	2688	48842	1274	62441	324	60246
20-#11	2.55	MA	15488	4380	24468	3523	29176	2841	31909	2299	35366	1448	44196	1111	32429
4L-8S		MI	12655	4380	20339	3516	23898	2830	25616	2293	27273	1443	33940	847	27647
20-#11	2.55	MA	14960	4380	23650	3533	28193	2839	30710	2306	33752	1453	42144	1067	31620
5L-7S		MI	13115	4380	20993	3517	24759	2832	26691	2297	28684	1437	35719	897	28342
20-#11	2.55	MA	14453	4380	22922	3533	27223	2848	29529	2303	32199	1458	40075	992	31082
6E		MI	13581	4380	21658	3518	25638	2835	27765	2291	30147	1443	37419	968	29148
20-#11	2.55	MA	13958	4380	22213	3533	26285	2846	28383	2310	30625	1453	38238	921	30223
7L-5S		MI	14057	4380	22340	3518	26548	2827	28871	2295	31590	1437	39335	1044	29630
20-#11	2.55	MA	13468	4380	21515	3533	25366	2845	27236	2307	29106	1458	36322	869	29479
8L-4S		MI	14553	4380	23108	3509	27468	2829	29995	2288	33090	1432	41242	1087	30395
20-#11	2.55	MA	12981	4380	20744	3543	24419	2853	26106	2314	27602	1464	34447	810	28396
9L-3S		MI	15100	4380	23865	3509	28491	2821	31234	2292	34734	1437	43043	1179	30557
20-#14	3.68	MA	16207	4882	27215	3837	32630	3059	36047	2445	40753	1410	51565	866	43964
5L-7S		MI	13907	4882	23739	3818	28124	3052	30724	2434	33943	1389	42903	622	38583
20-#14	3.68	MA	15510	4882	26172	3836	31240	3071	34355	2440	38546	1417	48632	757	42560
6E		MI	14548	4882	24691	3819	29382	3056	32261	2426	36021	1397	45307	725	39821
20-#14	3.68	MA	14827	4882	25156	3836	29897	3068	32715	2449	36308	1410	46030	654	41243
7L-5S		MI	15203	4882	25668	3821	30684	3045	33845	2433	38069	1389	48021	834	41148
20-#14	3.68	MA	14153	4882	24156	3835	28580	3064	31070	2444	34148	1417	43308	581	39431
8L-4S		MI	15886	4882	26766	3808	32002	3049	35453	2424	40199	1382	50727	895	42190
22-#11	2.80	MA	15456	4494	24734	3604	29568	2891	32375	2339	35981	1447	45109	1050	34723
5L-8S		MI	13131	4494	21352	3587	25183	2882	27172	2326	29344	1435	36686	828	30482
22-#11	2.80	MA	14955	4494	24006	3604	28597	2900	31194	2336	34429	1452	43039	975	34201
6L-7S		MI	13586	4494	22007	3588	26044	2884	28248	2330	30756	1430	38465	879	31211
22-#11	2.80	MA	14465	4494	23297	3604	27660	2898	30049	2343	32854	1447	41202	904	33298
7L-6S		MI	14047	4494	22671	3589	26923	2887	29321	2324	32219	1435	40165	950	32059
22-#11	2.80	MA	13980	4494	22599	3603	26741	2896	28901	2340	31335	1452	39287	852	32521
8L-5S		MI	14518	4494	23354	3589	27833	2878	30428	2328	33661	1430	42082	1026	32527
22-#11	2.80	MA	13498	4494	21828	3614	25794	2905	27772	2347	29831	1457	37411	793	31464
9L-4S		MI	15009	4494	24121	3579	28753	2881	31551	2321	35161	1425	43988	1069	33350
22-#14	4.04	MA	16202	5045	27721	3939	33205	3146	36735	2487	41715	1407	52835	731	46932
6L-7S		MI	14558	5045	25186	3920	29959	3127	32947	2482	36884	1378	46792	593	42609
22-#14	4.04	MA	15528	5045	26705	3938	31861	3142	35095	2497	39477	1400	50233	628	45569
7L-6S		MI	15191	5045	26138	3922	31217	3131	34484	2473	38962	1385	49196	696	43894
22-#14	4.04	MA	14862	5045	25705	3937	30545	3139	33451	2491	37317	1407	47511	555	43803
8L-5S		MI	15838	5045	27115	3923	32519	3120	36068	2480	41011	1378	51910	805	45290
24-#11	3.06	MA	15451	4607	25090	3675	29972	2952	32860	2369	36658	1446	46004	958	37323
6L-8S		MI	13601	4607	22365	3658	26468	2934	28729	2359	31416	1428	39433	810	33322
24-#11	3.06	MA	14966	4607	24381	3675	29035	2950	31715	2376	35083	1440	44167	887	36379
7E		MI	14052	4607	23020	3659	27329	2936	29805	2363	32827	1423	41212	860	34084
24-#11	3.06	MA	14486	4607	23683	3674	28116	2948	30567	2372	33564	1446	42251	836	35570
8L-6S		MI	14508	4607	23684	3659	28208	2938	30878	2357	34290	1428	42912	932	34974
24-#11	3.06	MA	14009	4607	22912	3685	27168	2957	29438	2380	32060	1451	40376	777	34537
9L-5S		MI	14974	4607	24367	3660	29118	2930	31985	2361	35733	1423	44828	1007	35428
24-#14	4.41	MA	16220	5209	28255	4040	33826	3217	37475	2544	42646	1390	54437	601	49904
7E		MI	15200	5209	26633	4022	31794	3201	35170	2529	39826	1366	50681	564	46643
24-#14	4.41	MA	15562	5209	27254	4039	32509	3214	35831	2539	40486	1397	51715	529	48182
8L-6S		MI	15825	5209	27585	4024	33052	3205	36707	2521	41904	1374	53085	667	47976

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

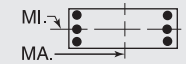
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.24	MA	15866	4008	23229	3311	27304	2691	29179	2228	30711	1543	37127	1430	17897
2E		MI	14093	4008	20860	3280	24333	2666	25863	2203	27023	1517	32493	1395	15816
6-#14	1.04	MA	15516	3917	22241	3278	26219	2669	27937	2219	29214	1569	35242	1471	15341
2L-3S		MI	12665	3917	18545	3248	21562	2642	22620	2207	22837	1553	27064	1310	13602
6-#14	1.04	MA	14216	3917	20590	3278	24125	2667	25400	2229	25817	1576	30724	1339	15339
3L-2S		MI	13801	3917	19992	3250	23397	2646	24844	2199	25778	1546	30953	1441	13582
6-#18	1.86	MA	17199	4299	26114	3493	30962	2824	33610	2313	36585	1524	44902	1380	26463
2L-3S		MI	13324	4299	20860	3457	24333	2789	25863	2299	27023	1505	32493	1101	23129
6-#18	1.86	MA	15005	4299	23229	3491	27304	2817	29179	2328	30711	1537	37127	1147	26197
3L-2S		MI	15240	4299	23381	3462	27530	2798	29714	2286	32090	1492	39154	1335	23321
8-#14	1.39	MA	16304	4081	23893	3381	28313	2744	30475	2266	32611	1559	39760	1447	20258
2L-4S		MI	12540	4081	18908	3349	21933	2728	23070	2248	23444	1534	28406	1150	17714
8-#14	1.39	MA	15024	4081	22241	3380	26219	2742	27937	2276	29214	1567	35242	1315	20208
3E		MI	13361	4081	19992	3351	23397	2717	24844	2255	25778	1542	30953	1281	17876
8-#14	1.39	MA	14090	4081	21010	3380	24555	2754	25920	2272	26518	1559	32274	1184	19981
4L-2S		MI	14481	4081	21438	3352	25232	2721	27067	2246	28720	1534	34842	1412	17900
8-#18	2.48	MA	18489	4590	28998	3675	34620	2957	38042	2397	42460	1504	52678	1330	34982
2L-4S		MI	13097	4590	21486	3634	24972	2938	26637	2369	28067	1467	34790	812	28105
8-#18	2.48	MA	16343	4590	26114	3672	30962	2950	33610	2412	36585	1517	44902	1097	34594
3E		MI	14476	4590	23381	3639	27530	2922	29714	2382	32090	1481	39154	1042	30466
8-#18	2.48	MA	14776	4590	23955	3670	28046	2970	30077	2401	31923	1504	39808	863	31887
4L-2S		MI	16352	4590	25902	3644	30727	2931	33565	2369	37156	1467	45815	1275	30773
10-#11	1.21	MA	15930	3993	22973	3338	27233	2714	29203	2249	30991	1574	37659	1473	17728
2L-5S		MI	12269	3993	18094	3320	21063	2695	22044	2239	22127	1557	26621	1217	15405
10-#11	1.21	MA	15027	3993	21818	3338	25768	2713	27428	2257	28604	1579	34476	1382	17715
3L-4S		MI	12795	3993	18861	3310	21984	2698	23168	2233	23627	1552	28527	1261	15639
10-#11	1.21	MA	14371	3993	20958	3338	24606	2722	26020	2254	26709	1574	32383	1291	17640
4L-3S		MI	13373	3993	19618	3310	23007	2689	24407	2237	25271	1557	30328	1352	15686
10-#11	1.21	MA	13775	3993	20088	3349	23561	2721	24745	2262	24981	1579	30185	1246	17344
5L-2S		MI	14164	3993	20631	3311	24292	2692	25964	2230	27343	1552	33075	1443	15684
10-#14	1.74	MA	17075	4244	25544	3483	30408	2819	33012	2313	36007	1550	44278	1423	25152
2L-5S		MI	12498	4244	19257	3465	22451	2798	23686	2304	24255	1530	29589	1059	20757
10-#14	1.74	MA	15812	4244	23893	3483	28313	2816	30475	2324	32611	1558	39760	1291	25062
3L-4S		MI	13233	4244	20355	3451	23768	2802	25294	2296	26385	1523	32296	1121	21922
10-#14	1.74	MA	14894	4244	22661	3482	26649	2829	28458	2319	29915	1550	36792	1160	24785
4L-3S		MI	14043	4244	21438	3453	25232	2791	27067	2302	28720	1530	34842	1252	22134
10-#14	1.74	MA	14060	4244	21414	3497	25152	2826	26631	2329	27455	1558	33665	1096	23425
5L-2S		MI	15148	4244	22885	3454	27067	2795	29290	2294	31661	1523	38732	1383	22197
10-#18	3.10	MA	19744	4880	31883	3856	38278	3090	42474	2481	48335	1484	60453	1280	43476
2L-5S		MI	13020	4880	22086	3837	25863	3061	27696	2465	29464	1456	36806	643	32908
10-#18	3.10	MA	17642	4880	28998	3854	34620	3083	38042	2497	42460	1497	52678	1046	42984
3L-4S		MI	14247	4880	24007	3815	28169	3071	30488	2451	33134	1443	41451	752	35111
10-#18	3.10	MA	16111	4880	26840	3852	31704	3103	34509	2485	37797	1484	47584	813	39951
4L-3S		MI	15596	4880	25902	3820	30727	3055	33565	2465	37156	1456	45815	982	37792
10-#18	3.10	MA	14721	4880	24653	3876	29079	3096	31306	2501	33543	1497	42177	703	37420
5L-2S		MI	17435	4880	28423	3825	33925	3064	37416	2451	42223	1443	52476	1215	38197
12-#11	1.45	MA	16481	4107	24128	3409	28698	2766	30977	2282	33378	1569	40842	1458	21158
2L-6S		MI	12266	4107	18424	3390	21439	2755	22494	2268	22756	1555	27450	1123	17680
12-#11	1.45	MA	15587	4107	22973	3409	27233	2765	29203	2290	30991	1574	37659	1366	21125
3L-5S		MI	12765	4107	19107	3390	22348	2747	23601	2272	24199	1550	29367	1199	18258
12-#11	1.45	MA	14938	4107	22113	3409	26071	2774	27794	2287	29097	1569	35565	1275	21025
4E		MI	13285	4107	19874	3381	23269	2749	24724	2266	25699	1545	31274	1242	18611

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

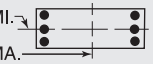


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.45	MA	14349	4107	21243	3420	25026	2772	26519	2295	27368	1574	33368	1230	20608
5L-3S		MI	13858	4107	20631	3381	24292	2741	25964	2270	27343	1550	33075	1333	18682
12-#11	1.45	MA	13784	4107	20469	3420	23995	2782	25264	2292	25705	1579	31146	1155	19906
6L-2S		MI	14641	4107	21644	3382	25577	2744	27521	2263	29414	1545	35821	1424	18701
12-#14	2.09	MA	17831	4408	27195	3585	32502	2894	35549	2361	39404	1541	48796	1399	30034
2L-6S		MI	12492	4408	19727	3565	22984	2884	24325	2345	25148	1526	30764	921	23952
12-#14	2.09	MA	16585	4408	25544	3585	30408	2891	33012	2371	36007	1549	44278	1267	29907
3L-5S		MI	13188	4408	20704	3567	24286	2873	25909	2351	27196	1519	33478	1030	24847
12-#14	2.09	MA	15680	4408	24312	3585	28743	2904	30995	2366	33312	1541	41310	1136	29587
4E		MI	13913	4408	21802	3554	25603	2877	27517	2343	29326	1511	36185	1092	26128
12-#14	2.09	MA	14859	4408	23065	3599	27247	2901	29168	2377	30852	1549	38183	1072	28111
5L-3S		MI	14711	4408	22885	3555	27067	2866	29290	2349	31661	1519	38732	1223	26381
12-#14	2.09	MA	14071	4408	21956	3599	25769	2914	27370	2372	28486	1556	35030	963	27071
6L-2S		MI	15801	4408	24332	3557	28902	2870	31513	2341	34602	1511	42621	1355	26478
12-#18	3.72	MA	18909	5171	31883	4036	38278	3216	42474	2581	48335	1477	60453	996	51370
3L-5S		MI	14166	5171	24607	4019	29060	3194	31548	2547	34531	1431	43467	583	39805
12-#18	3.72	MA	17410	5171	29724	4034	35363	3236	38941	2570	43672	1464	55359	763	48055
4E		MI	15367	5171	26528	3997	31366	3204	34339	2534	38200	1418	48112	692	42158
12-#18	3.72	MA	16050	5171	27537	4058	32738	3229	35738	2585	39418	1477	49952	653	45385
5L-3S		MI	16689	5171	28423	4002	33925	3188	37416	2547	42223	1431	52476	922	45111
12-#18	3.72	MA	14746	5171	25591	4055	30145	3249	32583	2574	35326	1490	44527	459	41986
6L-2S		MI	18496	5171	30944	4007	37122	3197	41268	2534	47290	1418	59137	1156	45604
14-#11	1.69	MA	17023	4220	25283	3480	30163	2818	32752	2315	35766	1563	44025	1442	24579
2L-7S		MI	12277	4220	18773	3460	21845	2805	22978	2308	23364	1543	28497	1033	20000
14-#11	1.69	MA	16138	4220	24128	3480	28698	2816	30977	2323	33378	1568	40842	1351	24529
3L-6S		MI	12760	4220	19438	3461	22724	2807	24051	2301	24827	1548	30197	1105	20573
14-#11	1.69	MA	15496	4220	23268	3480	27536	2826	29569	2320	31484	1563	38748	1260	24406
4L-5S		MI	13254	4220	20120	3461	23633	2799	25158	2305	26270	1543	32114	1180	21123
14-#11	1.69	MA	14914	4220	22398	3491	26491	2824	28294	2328	29755	1568	36551	1215	23884
5L-4S		MI	13768	4220	20887	3452	24554	2801	26281	2299	27770	1537	34020	1224	21579
14-#11	1.69	MA	14356	4220	21624	3491	25460	2833	27038	2325	28093	1573	34329	1140	23212
6L-3S		MI	14335	4220	21644	3452	25577	2793	27521	2303	29414	1543	35821	1315	21671
14-#11	1.69	MA	13809	4220	20871	3491	24463	2832	25821	2333	26407	1568	32354	1069	22539
7L-2S		MI	15110	4220	22658	3453	26862	2796	29078	2296	31485	1537	38568	1406	21706
14-#14	2.44	MA	18573	4571	28847	3687	34596	2968	38086	2408	42801	1532	53313	1374	34907
2L-7S		MI	12507	4571	20222	3666	23560	2955	25011	2400	26011	1507	32250	789	26675
14-#14	2.44	MA	17343	4571	27195	3687	32502	2966	35549	2419	39404	1540	48796	1243	34746
3L-6S		MI	13179	4571	21174	3668	24819	2959	26548	2392	28089	1515	34654	892	27971
14-#14	2.44	MA	16451	4571	25964	3687	30838	2978	33532	2414	36709	1532	45828	1112	34312
4L-5S		MI	13865	4571	22151	3669	26121	2948	28132	2399	30138	1507	37368	1001	28951
14-#14	2.44	MA	15642	4571	24717	3701	29341	2976	31706	2424	34249	1540	42701	1048	32811
5L-4S		MI	14579	4571	23249	3656	27438	2952	29740	2390	32268	1500	40074	1063	30184
14-#14	2.44	MA	14867	4571	23608	3701	27863	2988	29907	2419	31883	1547	39548	939	31690
6L-3S		MI	15367	4571	24332	3657	28902	2941	31513	2397	34602	1507	42621	1194	30621
14-#14	2.44	MA	14107	4571	22528	3701	26435	2986	28162	2430	29484	1540	36748	836	30136
7L-2S		MI	16444	4571	25779	3659	30737	2945	33736	2388	37544	1500	46510	1326	30749
14-#18	4.33	MA	18679	5462	32609	4215	39021	3369	43373	2654	49547	1444	63135	713	56194
4L-5S		MI	15286	5462	27128	4200	32257	3327	35399	2630	39598	1406	50128	524	46738
14-#18	4.33	MA	17348	5462	30422	4239	36396	3362	40170	2669	45292	1457	57728	603	53383
5L-4S		MI	16464	5462	29049	4179	34564	3337	38191	2617	43267	1393	54773	632	49239
14-#18	4.33	MA	16070	5462	28476	4237	33803	3382	37015	2658	41201	1471	52302	409	50113
6L-3S		MI	17761	5462	30944	4184	37122	3321	41268	2630	47290	1406	59137	862	52426
16-#11	1.93	MA	17558	4334	26438	3551	31628	2870	34527	2348	38153	1558	47207	1427	27995
2L-8S		MI	12297	4334	19132	3530	22268	2854	23459	2336	24024	1541	29465	964	22133
16-#11	1.93	MA	16681	4334	25283	3551	30163	2868	32752	2355	35766	1563	44025	1336	27927
3L-7S		MI	12769	4334	19786	3531	23130	2857	24534	2340	25436	1535	31244	1015	22845
16-#11	1.93	MA	16046	4334	24423	3551	29000	2877	31343	2353	33871	1558	41931	1245	27784
4L-6S		MI	13247	4334	20451	3532	24009	2859	25608	2334	26899	1541	32944	1086	23471

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

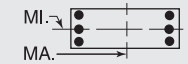
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.93	MA	15470	4334	23553	3562	27956	2876	30068	2360	32143	1563	39733	1200	27170
5E		MI	13736	4334	21133	3532	24918	2851	26714	2338	28341	1535	34860	1162	23998
16-#11	1.93	MA	14918	4334	22779	3562	26924	2885	28813	2358	30480	1568	37511	1124	26525
6L-4S		MI	14244	4334	21900	3522	25839	2853	27838	2331	29841	1530	36767	1205	24543
16-#11	1.93	MA	14378	4334	22026	3562	25928	2884	27596	2365	28794	1563	35537	1053	25799
7L-3S		MI	14805	4334	22658	3523	26862	2845	29078	2335	31485	1535	38568	1296	24654
16-#11	1.93	MA	13844	4334	21284	3562	24951	2883	26376	2363	27167	1568	33485	1001	24945
8L-2S		MI	15573	4334	23671	3524	28147	2847	30634	2329	33557	1530	41314	1387	24705
16-#14	2.79	MA	18089	4735	28847	3789	34596	3041	38086	2466	42801	1531	53313	1219	39581
3L-7S		MI	13191	4735	21669	3768	25395	3030	27234	2448	28953	1496	36139	760	30756
16-#14	2.79	MA	17209	4735	27615	3789	32932	3053	36069	2461	40105	1523	50345	1088	38957
4L-6S		MI	13853	4735	22621	3770	26654	3034	28771	2439	31031	1503	38543	863	32005
16-#14	2.79	MA	16412	4735	26368	3804	31435	3051	34243	2472	37646	1531	47219	1024	37523
5E		MI	14530	4735	23598	3771	27956	3023	30355	2446	33079	1496	41257	972	33067
16-#14	2.79	MA	15647	4735	25259	3804	29957	3063	32444	2467	35280	1538	44065	915	36323
6L-4S		MI	15235	4735	24696	3758	29273	3027	31963	2438	35209	1488	43964	1034	34239
16-#14	2.79	MA	14898	4735	24179	3803	28529	3061	30700	2477	32881	1531	41266	812	34819
7L-3S		MI	16012	4735	25779	3760	30737	3016	33736	2444	37544	1496	46510	1165	34855
16-#14	2.79	MA	14158	4735	23116	3803	27129	3058	28952	2472	30566	1538	38347	738	33014
8L-2S		MI	17077	4735	27226	3761	32572	3020	35959	2436	40485	1488	50400	1297	35013
16-#18	4.95	MA	18619	5753	33306	4421	40054	3495	44602	2754	51167	1438	65504	553	61411
5E		MI	16383	5753	29649	4382	35454	3460	39250	2713	44664	1382	56789	464	53701
16-#18	4.95	MA	17366	5753	31360	4419	37461	3515	41447	2742	47076	1451	60078	358	58263
6L-4S		MI	17540	5753	31570	4361	37761	3470	42042	2699	48334	1368	61434	572	56347
18-#11	2.17	MA	17217	4447	26438	3622	31628	2920	34527	2388	38153	1557	47207	1321	31322
3L-8S		MI	12787	4447	20145	3601	23553	2906	25016	2369	26096	1533	32211	946	25009
18-#11	2.17	MA	16588	4447	25578	3622	30465	2929	33118	2386	36259	1552	45114	1229	31160
4L-7S		MI	13254	4447	20799	3602	24415	2909	26091	2373	27507	1528	33990	996	25697
18-#11	2.17	MA	16019	4447	24708	3633	29420	2928	31843	2393	34530	1557	42916	1184	30464
5L-6S		MI	13727	4447	21464	3602	25294	2911	27165	2367	28970	1533	35690	1068	26375
18-#11	2.17	MA	15473	4447	23934	3633	28389	2937	30588	2391	32867	1562	40694	1109	29842
6L-5S		MI	14211	4447	22146	3603	26203	2903	28271	2371	30413	1528	37607	1143	26881
18-#11	2.17	MA	14938	4447	23181	3633	27393	2936	29370	2398	31181	1557	38720	1038	29067
7L-4S		MI	14714	4447	22914	3593	27124	2905	29395	2364	31913	1523	39513	1187	27504
18-#11	2.17	MA	14410	4447	22439	3633	26416	2935	28151	2396	29555	1562	36668	986	28237
8L-3S		MI	15269	4447	23671	3594	28147	2897	30634	2368	33557	1528	41314	1278	27633
18-#11	2.17	MA	13885	4447	21621	3644	25410	2944	26950	2403	27944	1567	34653	927	27200
9L-2S		MI	16031	4447	24684	3595	29432	2899	32191	2362	35628	1523	44061	1369	27698
18-#14	3.13	MA	17955	4898	29266	3891	35026	3128	38607	2509	43502	1514	54863	1063	43619
4L-7S		MI	13863	4898	23116	3871	27230	3104	29457	2495	31894	1484	40028	731	34847
18-#14	3.13	MA	17169	4898	28019	3906	33530	3126	36780	2519	41042	1521	51737	1000	42245
5L-6S		MI	14517	4898	24068	3872	28489	3108	30994	2487	33972	1492	42432	834	36052
18-#14	3.13	MA	16414	4898	26910	3906	32052	3138	34981	2514	38677	1529	48583	891	40968
6L-5S		MI	15185	4898	25045	3874	29791	3098	32578	2493	36020	1484	45146	943	37192
18-#14	3.13	MA	15676	4898	25831	3906	30624	3136	33237	2525	36278	1521	45784	788	39511
7L-4S		MI	15881	4898	26143	3860	31108	3102	34186	2485	38150	1477	47853	1005	38309
18-#14	3.13	MA	14946	4898	24768	3905	29224	3133	31489	2520	33963	1529	42865	714	37666
8L-3S		MI	16648	4898	27226	3862	32572	3091	35959	2492	40485	1484	50400	1136	39086
18-#18	5.57	MA	18637	6043	34245	4601	41120	3648	45879	2827	52951	1431	67853	308	66264
6L-5S		MI	17544	6043	32170	4564	38652	3593	43101	2795	49731	1357	63450	404	60691
20-#11	2.41	MA	17123	4560	26733	3693	31930	2981	34893	2418	38646	1546	48297	1214	34535
4L-8S		MI	13270	4560	21158	3672	24838	2958	26572	2402	28167	1526	34958	928	27889
20-#11	2.41	MA	16560	4560	25863	3703	30885	2980	33618	2426	36917	1552	46099	1169	33766
5L-7S		MI	13733	4560	21813	3673	25700	2960	27648	2406	29578	1521	36737	978	28557

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

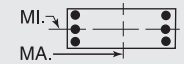


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.41	MA	16020	4560	25089	3704	29854	2989	32362	2423	35255	1557	43877	1094	33165
6E		MI	14201	4560	22477	3673	26579	2963	28721	2400	31041	1526	38437	1049	29283
20-#11	2.41	MA	15491	4560	24336	3704	28857	2988	31145	2431	33569	1552	41903	1023	32342
7L-5S		MI	14679	4560	23160	3674	27488	2955	29828	2404	32484	1521	40353	1125	29771
20-#11	2.41	MA	14969	4560	23594	3704	27881	2987	29925	2428	31942	1557	39851	971	31534
8L-4S		MI	15178	4560	23927	3664	28409	2957	30951	2397	33984	1516	42260	1168	30463
20-#11	2.41	MA	14450	4560	22776	3715	26874	2996	28725	2436	30331	1562	37836	912	30439
9L-3S		MI	15728	4560	24684	3665	29432	2949	32191	2401	35628	1521	44061	1259	30609
20-#11	2.41	MA	13933	4560	22037	3715	25904	2994	27519	2433	28674	1557	35881	846	29378
10L-2S		MI	16483	4560	25697	3665	30717	2951	33748	2395	37699	1516	46808	1351	30688
20-#14	3.48	MA	17914	5062	29671	4008	35624	3200	39317	2566	44439	1512	56254	976	46976
5L-7S		MI	14525	5062	24563	3973	29065	3179	31680	2543	34835	1473	43918	702	38947
20-#14	3.48	MA	17170	5062	28562	4008	34146	3213	37519	2562	42073	1520	53101	867	45625
6E		MI	15171	5062	25515	3974	30324	3183	33217	2534	36913	1480	46322	805	40110
20-#14	3.48	MA	16441	5062	27482	4008	32718	3210	35774	2572	39675	1512	50302	764	44212
7L-5S		MI	15831	5062	26492	3976	31626	3172	34801	2541	38962	1473	49036	915	41325
20-#14	3.48	MA	15721	5062	26419	4008	31318	3208	34026	2567	37360	1520	47383	690	42327
8L-4S		MI	16518	5062	27590	3963	32943	3176	36409	2532	41092	1465	51742	976	42393
22-#11	2.66	MA	17095	4674	27018	3774	32350	3032	35392	2459	39305	1546	49282	1154	37074
5L-8S		MI	13748	4674	22171	3743	26123	3010	28129	2435	30238	1519	37704	909	30774
22-#11	2.66	MA	16560	4674	26244	3775	31319	3041	34137	2456	37642	1551	47060	1079	36491
6L-7S		MI	14206	4674	22826	3744	26985	3012	29205	2439	31650	1514	39483	960	31423
22-#11	2.66	MA	16037	4674	25491	3775	30322	3040	32919	2464	35956	1546	45086	1008	35622
7L-6S		MI	14669	4674	23490	3744	27864	3015	30278	2433	33113	1519	41183	1031	32194
22-#11	2.66	MA	15520	4674	24749	3775	29345	3038	31700	2461	34329	1551	43034	955	34835
8L-5S		MI	15143	4674	24173	3745	28773	3006	31385	2436	34555	1514	43100	1106	32666
22-#11	2.66	MA	15006	4674	23930	3786	28339	3048	30500	2469	32718	1556	41018	897	33713
9L-4S		MI	15637	4674	24940	3735	29694	3009	32508	2430	36055	1509	45006	1150	33421
22-#11	2.66	MA	14495	4674	23192	3786	27369	3046	29294	2466	31062	1551	39063	830	32631
10L-3S		MI	16181	4674	25697	3736	30717	3001	33748	2434	37699	1514	46808	1241	33582
22-#14	3.83	MA	17915	5226	30213	4110	36240	3288	40056	2609	45470	1511	57619	843	50292
6L-7S		MI	15179	5226	26010	4075	30900	3254	33904	2590	37777	1461	47807	673	43003
22-#14	3.83	MA	17195	5226	29133	4110	34812	3285	38312	2619	43071	1503	54819	740	48920
7L-6S		MI	15816	5226	26961	4077	32159	3258	35440	2582	39855	1468	50211	776	44179
22-#14	3.83	MA	16485	5226	28070	4110	33412	3283	36564	2615	40757	1511	51900	666	46996
8L-5S		MI	16468	5226	27939	4078	33461	3247	37024	2588	41903	1461	52925	886	45465
24-#11	2.90	MA	17094	4787	27399	3845	32783	3093	35911	2489	40029	1546	50243	1063	39820
6L-8S		MI	14219	4787	23185	3814	27408	3062	29686	2468	32310	1512	40451	891	33615
24-#11	2.90	MA	16576	4787	26646	3846	31787	3092	34694	2497	38343	1540	48268	992	38909
7E		MI	14673	4787	23839	3814	28270	3064	30762	2472	33721	1507	42230	941	34294
24-#11	2.90	MA	16064	4787	25904	3846	30810	3090	33474	2494	36717	1546	46216	940	38141
8L-6S		MI	15132	4787	24504	3815	29149	3066	31835	2465	35184	1512	43930	1012	35109
24-#11	2.90	MA	15556	4787	25085	3856	29804	3099	32274	2502	35106	1551	44201	881	36992
9L-5S		MI	15601	4787	25186	3816	30058	3058	32942	2469	36627	1507	45846	1088	35566
24-#11	2.90	MA	15050	4787	24347	3857	28834	3098	31068	2499	33449	1546	42246	815	35888
10L-4S		MI	16090	4787	25953	3806	30979	3061	34065	2463	38127	1501	47753	1131	36377
24-#14	4.18	MA	17940	5389	30785	4212	36907	3360	40849	2667	46468	1494	59337	716	53604
7E		MI	15823	5389	27456	4177	32735	3329	36127	2637	40718	1449	51696	644	47033
24-#14	4.18	MA	17238	5389	29722	4212	35507	3358	39101	2662	44153	1502	56418	642	51672
8L-6S		MI	16454	5389	28408	4179	33994	3333	37664	2629	42796	1457	54100	747	48258

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

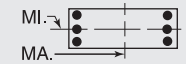
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.18	MA	17482	4188	25373	3480	29893	2830	31939	2347	33607	1638	40644	1526	18977
2E		MI	14711	4188	21692	3434	25277	2792	26819	2311	27912	1599	33502	1475	15854
6-#18	1.76	MA	18914	4479	28440	3662	33782	2963	36650	2431	39887	1620	48978	1480	28083
2L-3S		MI	13941	4479	21692	3610	25277	2915	26819	2407	27912	1588	33502	1181	23207
6-#18	1.76	MA	16573	4479	25373	3661	29893	2958	31939	2448	33607	1634	40644	1247	27817
3L-2S		MI	15864	4479	24213	3615	28474	2925	30670	2393	32979	1575	40163	1415	23369
8-#14	1.32	MA	17946	4261	26070	3550	30956	2883	33304	2384	35612	1654	43425	1543	21473
2L-4S		MI	13154	4261	19732	3504	22875	2855	24027	2356	24336	1618	29421	1230	17786
8-#14	1.32	MA	16582	4261	24317	3550	28732	2881	30609	2395	31987	1662	38593	1411	21423
3E		MI	13978	4261	20815	3506	24338	2844	25800	2363	26671	1625	31968	1361	17922
8-#14	1.32	MA	15589	4261	23011	3550	26967	2894	28471	2391	29111	1654	35414	1280	21196
4L-2S		MI	15102	4261	22262	3507	26173	2848	28023	2355	29612	1618	35857	1493	17935
8-#18	2.35	MA	20301	4770	31506	3844	37671	3096	41361	2515	46166	1603	57312	1434	37142
2L-4S		MI	13713	4770	22319	3787	25916	3064	27593	2476	28956	1550	35799	891	28403
8-#18	2.35	MA	18010	4770	28440	3843	33782	3091	36650	2532	39887	1616	48978	1201	36754
3E		MI	15097	4770	24213	3792	28474	3048	30670	2489	32979	1563	40163	1121	30554
8-#18	2.35	MA	16342	4770	26149	3841	30687	3112	32900	2522	34903	1603	43510	967	34126
4L-2S		MI	16981	4770	26734	3797	31671	3058	34521	2476	38045	1550	46824	1355	30827
10-#11	1.15	MA	17543	4174	25090	3507	29804	2853	31948	2367	33851	1667	41160	1567	18781
2L-5S		MI	12882	4174	18913	3475	22003	2823	23001	2348	23021	1641	27639	1298	15550
10-#11	1.15	MA	16581	4174	23865	3508	28249	2852	30064	2376	31310	1673	37759	1476	18768
3L-4S		MI	13410	4174	19680	3465	22924	2826	24124	2342	24521	1635	29545	1341	15687
10-#11	1.15	MA	15883	4174	22953	3508	27017	2862	28571	2373	29295	1668	35519	1385	18693
4L-3S		MI	13990	4174	20437	3466	23947	2818	25364	2346	26165	1641	31346	1433	15723
10-#11	1.15	MA	15250	4174	22031	3519	25911	2861	27220	2382	27456	1673	33175	1339	18481
5L-2S		MI	14783	4174	21450	3467	25232	2820	26921	2339	28237	1635	34093	1524	15715
10-#14	1.65	MA	18773	4425	27824	3652	33180	2958	35998	2432	39237	1646	48258	1521	26671
2L-5S		MI	13111	4425	20081	3620	23392	2926	24642	2412	25147	1614	30604	1140	20939
10-#14	1.65	MA	17428	4425	26070	3652	30956	2956	33304	2443	35612	1654	43425	1389	26580
3L-4S		MI	13850	4425	21179	3606	24710	2930	26250	2404	27277	1606	33311	1201	22001
10-#14	1.65	MA	16451	4425	24764	3653	29191	2969	31165	2439	32736	1646	40246	1258	26304
4L-3S		MI	14662	4425	22262	3608	26173	2919	28023	2410	29612	1614	35857	1333	22185
10-#14	1.65	MA	15564	4425	23443	3668	27605	2967	29229	2450	30111	1654	36909	1193	24967
5L-2S		MI	15771	4425	23709	3609	28008	2923	30246	2402	32553	1606	39747	1464	22237
10-#18	2.94	MA	21650	5061	34572	4026	41559	3229	46072	2599	52446	1585	65646	1388	46176
2L-5S		MI	13633	5061	22918	3990	26807	3188	28652	2572	30353	1538	37815	723	33381
10-#18	2.94	MA	19405	5061	31506	4024	37671	3224	41361	2616	46166	1598	57312	1155	45684
3L-4S		MI	14866	5061	24840	3969	29113	3197	31444	2559	34023	1525	42460	831	35401
10-#18	2.94	MA	17774	5061	29216	4023	34576	3245	37611	2607	41183	1585	51844	921	42712
4L-3S		MI	16222	5061	26734	3974	31671	3181	34521	2572	38045	1538	46824	1061	37887
10-#18	2.94	MA	16294	5061	26896	4048	31792	3240	34214	2624	36635	1598	46064	809	40237
5L-2S		MI	18070	5061	29255	3979	34869	3191	38372	2559	43112	1525	53485	1295	38256
12-#11	1.38	MA	18133	4287	26316	3578	31359	2905	33831	2400	36392	1662	44561	1553	22422
2L-6S		MI	12880	4287	19244	3545	22379	2883	23451	2377	23650	1639	28468	1204	17812
12-#11	1.38	MA	17181	4287	25090	3579	29804	2904	31948	2408	33851	1667	41160	1462	22389
3L-5S		MI	13380	4287	19926	3546	23288	2875	24558	2381	25093	1633	30385	1280	18401
12-#11	1.38	MA	16491	4287	24179	3579	28572	2914	30455	2406	31836	1663	38920	1371	22288
4E		MI	13902	4287	20693	3536	24209	2877	25681	2374	26593	1628	32292	1323	18663
12-#11	1.38	MA	15865	4287	23257	3590	27465	2913	29104	2414	29997	1668	36577	1325	21948
5L-3S		MI	14476	4287	21450	3537	25232	2869	26921	2378	28237	1633	34093	1414	18722
12-#11	1.38	MA	15266	4287	22438	3591	26373	2922	27774	2412	28228	1673	34202	1250	21169
6L-2S		MI	15261	4287	22464	3538	26517	2872	28478	2372	30308	1628	36839	1505	18734

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis

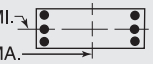


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.99	MA	19585	4588	29577	3754	35404	3033	38692	2479	42862	1638	53090	1499	31857
2L-6S		MI	13105	4588	20551	3720	23926	3011	25281	2453	26040	1609	31779	1001	24253
12-#14	1.99	MA	18257	4588	27824	3754	33180	3031	35998	2490	39237	1646	48258	1367	31730
3L-5S		MI	13804	4588	21528	3722	25227	3001	26865	2460	28089	1602	34493	1111	25026
12-#14	1.99	MA	17294	4588	26518	3755	31415	3044	33859	2486	36361	1638	45079	1236	31409
4E		MI	14532	4588	22626	3709	26545	3005	28473	2451	30219	1595	37200	1172	26211
12-#14	1.99	MA	16421	4588	25196	3770	29829	3042	31923	2497	33736	1646	41742	1171	29949
5L-3S		MI	15333	4588	23709	3710	28008	2994	30246	2458	32553	1602	39747	1304	26437
12-#14	1.99	MA	15584	4588	24022	3770	28263	3055	30017	2493	31211	1653	38368	1062	28945
6L-2S		MI	16428	4588	25156	3712	29843	2998	32469	2449	35495	1595	43636	1435	26521
12-#18	3.53	MA	20766	5351	34572	4206	41559	3357	46072	2700	52446	1580	65646	1109	54610
3L-5S		MI	14782	5351	25439	4172	30004	3321	32503	2654	35420	1514	44476	663	40269
12-#18	3.53	MA	19168	5351	32282	4205	38465	3378	42323	2691	47462	1567	60178	875	51339
4E		MI	15991	5351	27361	4151	32311	3330	35295	2641	39089	1500	49121	772	42441
12-#18	3.53	MA	17721	5351	29962	4230	35681	3373	38925	2708	42915	1580	54398	763	48728
5L-3S		MI	17321	5351	29255	4156	34869	3314	38372	2654	43112	1514	53485	1002	45213
12-#18	3.53	MA	16331	5351	27899	4229	32931	3394	35579	2698	38541	1594	48582	569	44951
6L-2S		MI	19137	5351	31776	4161	38066	3324	42223	2641	48179	1500	60146	1235	45667
14-#11	1.61	MA	18714	4401	27542	3649	32913	2957	35715	2433	38933	1657	47963	1539	26054
2L-7S		MI	12890	4401	19592	3616	22785	2933	23935	2416	24258	1626	29515	1114	20217
14-#11	1.61	MA	17772	4401	26316	3649	31359	2956	33831	2441	36392	1662	44561	1448	26003
3L-6S		MI	13375	4401	20257	3616	23664	2935	25008	2410	25721	1631	31215	1185	20704
14-#11	1.61	MA	17089	4401	25405	3650	30127	2966	32338	2439	34377	1657	42321	1357	25880
4L-5S		MI	13871	4401	20939	3617	24573	2927	26114	2414	27164	1626	33132	1261	21264
14-#11	1.61	MA	16471	4401	24483	3661	29020	2965	30987	2447	32538	1663	39978	1312	25427
5L-4S		MI	14387	4401	21706	3607	25494	2929	27238	2407	28664	1621	35038	1304	21634
14-#11	1.61	MA	15878	4401	23663	3662	27928	2974	29658	2445	30769	1668	37603	1236	24682
6L-3S		MI	14955	4401	22464	3608	26517	2921	28478	2411	30308	1626	36839	1396	21714
14-#11	1.61	MA	15297	4401	22866	3662	26872	2974	28369	2453	28976	1663	35491	1165	24060
7L-2S		MI	15733	4401	23477	3608	27802	2924	30034	2405	32379	1621	39586	1487	21742
14-#14	2.32	MA	20382	4752	31331	3856	37628	3107	41387	2526	46487	1630	57923	1477	37033
2L-7S		MI	13118	4752	21046	3821	24502	3082	25968	2509	26904	1590	33265	869	26943
14-#14	2.32	MA	19070	4752	29577	3857	35404	3106	38692	2537	42862	1638	53090	1345	36873
3L-6S		MI	13794	4752	21998	3823	25761	3086	27504	2500	28982	1598	35669	972	28267
14-#14	2.32	MA	18121	4752	28272	3857	33639	3119	36554	2534	39986	1630	49911	1214	36514
4L-5S		MI	14483	4752	22975	3824	27062	3075	29088	2507	31030	1590	38383	1082	29127
14-#14	2.32	MA	17261	4752	26950	3872	32053	3117	34618	2545	37361	1638	46575	1149	34945
5L-4S		MI	15201	4752	24073	3811	28380	3079	30696	2499	33160	1583	41089	1143	30393
14-#14	2.32	MA	16436	4752	25775	3873	30487	3130	32712	2541	34836	1645	43201	1040	33897
6L-3S		MI	15992	4752	25156	3812	29843	3068	32469	2505	35495	1590	43636	1275	30680
14-#14	2.32	MA	15628	4752	24632	3873	28974	3129	30864	2552	32276	1638	40203	938	32176
7L-2S		MI	17074	4752	26603	3814	31678	3073	34693	2497	38436	1583	47525	1406	30795
14-#18	4.12	MA	20531	5642	35348	4387	42353	3511	47034	2775	53742	1549	68512	829	60000
4L-5S		MI	15906	5642	27960	4354	33201	3453	36355	2737	40487	1489	51137	603	47192
14-#18	4.12	MA	19113	5642	33028	4412	39569	3505	43636	2792	49194	1563	62732	717	57250
5L-4S		MI	17092	5642	29882	4332	35508	3463	39146	2724	44156	1476	55782	712	49515
14-#18	4.12	MA	17752	5642	30965	4411	36820	3527	40290	2783	44821	1576	56916	523	53607
6L-3S		MI	18397	5642	31776	4337	38066	3447	42223	2737	48179	1489	60146	942	52533
16-#11	1.84	MA	19288	4514	28768	3720	34468	3009	37598	2466	41474	1652	51364	1525	29680
2L-8S		MI	12909	4514	19951	3686	23209	2982	24416	2445	24918	1624	30483	1045	22335
16-#11	1.84	MA	18354	4514	27542	3720	32913	3008	35715	2474	38933	1657	47963	1434	29612
3L-7S		MI	13383	4514	20605	3687	24070	2985	25491	2449	26330	1619	32262	1096	23059
16-#11	1.84	MA	17678	4514	26631	3721	31681	3017	34222	2472	36918	1652	45723	1343	29469
4L-6S		MI	13864	4514	21270	3687	24949	2987	26565	2443	27793	1624	33962	1167	23602
16-#11	1.84	MA	17067	4514	25708	3732	30575	3017	32871	2480	35079	1658	43379	1298	28918
5E		MI	14354	4514	21952	3688	25858	2979	27671	2447	29235	1619	35878	1243	24137
16-#11	1.84	MA	16480	4514	24889	3732	29482	3026	31541	2478	33310	1663	41004	1222	28200
6L-4S		MI	14865	4514	22720	3678	26779	2981	28795	2440	30735	1614	37785	1286	24602

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

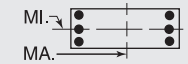
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.84	MA	15906	4514	24092	3733	28427	3025	30252	2486	31518	1658	38893	1151	27525
7L-3S		MI	15427	4514	23477	3679	27802	2973	30034	2444	32379	1619	39586	1377	24700
16-#11	1.84	MA	15338	4514	23307	3734	27393	3025	28960	2484	29787	1664	36704	1099	26582
8L-2S		MI	16199	4514	24490	3679	29087	2975	31591	2438	34451	1614	42332	1468	24743
16-#14	2.65	MA	19870	4915	31331	3959	37628	3181	41387	2585	46487	1630	57923	1323	42011
3L-7S		MI	13804	4915	22493	3923	26337	3157	28191	2556	29845	1579	37154	841	31020
16-#14	2.65	MA	18934	4915	30025	3959	35863	3194	39248	2581	43610	1622	54744	1192	41562
4L-6S		MI	14471	4915	23445	3925	27596	3161	29728	2548	31923	1586	39558	943	32296
16-#14	2.65	MA	18086	4915	28704	3974	34277	3192	37312	2592	40985	1630	51407	1127	39953
5E		MI	15151	4915	24422	3926	28897	3150	31312	2554	33971	1579	42272	1053	33241
16-#14	2.65	MA	17272	4915	27529	3975	32711	3205	35406	2588	38461	1637	48034	1018	38824
6L-4S		MI	15860	4915	25520	3913	30215	3154	32919	2546	36101	1571	44979	1114	34444
16-#14	2.65	MA	16476	4915	26385	3975	31198	3203	33558	2599	35901	1630	45036	916	37156
7L-3S		MI	16641	4915	26603	3915	31678	3143	34693	2552	38436	1579	47525	1246	34918
16-#14	2.65	MA	15688	4915	25259	3975	29715	3202	31706	2595	33431	1637	41920	841	35347
8L-2S		MI	17711	4915	28050	3916	33513	3147	36916	2544	41377	1571	51415	1377	35061
16-#18	4.71	MA	20476	5933	36095	4594	43458	3638	48347	2876	55474	1545	71066	671	65802
5E		MI	17007	5933	30481	4536	36399	3586	40206	2820	45553	1464	57798	544	54147
16-#18	4.71	MA	19142	5933	34031	4592	40709	3660	45001	2867	51101	1558	65250	477	62285
6L-4S		MI	18172	5933	32403	4514	38705	3596	42998	2807	49223	1451	62443	652	56618
18-#11	2.06	MA	18928	4627	28768	3791	34468	3060	37598	2507	41474	1652	51364	1420	33218
3L-8S		MI	13400	4627	20964	3757	24494	3034	25972	2478	26990	1617	33229	1027	25208
18-#11	2.06	MA	18259	4627	27857	3792	33236	3069	36105	2505	39459	1647	49124	1329	33056
4L-7S		MI	13870	4627	21619	3757	25355	3037	27048	2482	28401	1612	35008	1077	25909
18-#11	2.06	MA	17654	4627	26934	3803	32129	3068	34754	2513	37620	1652	46780	1284	32416
5L-6S		MI	14345	4627	22283	3758	26234	3039	28121	2476	29864	1617	36708	1149	26505
18-#11	2.06	MA	17074	4627	26115	3803	31037	3078	33425	2511	35852	1658	44406	1208	31725
6L-5S		MI	14831	4627	22966	3759	27143	3031	29228	2479	31307	1612	38625	1224	27019
18-#11	2.06	MA	16506	4627	25318	3804	29982	3077	32135	2519	34059	1653	42294	1137	30998
7L-4S		MI	15336	4627	23733	3749	28064	3033	30351	2473	32807	1607	40531	1268	27566
18-#11	2.06	MA	15945	4627	24532	3804	28948	3076	30844	2517	32328	1658	40106	1085	30081
8L-3S		MI	15894	4627	24490	3750	29087	3025	31591	2477	34451	1612	42332	1359	27681
18-#11	2.06	MA	15387	4627	23666	3815	27882	3086	29573	2525	30615	1664	37951	1026	29059
9L-2S		MI	16658	4627	25503	3750	30372	3027	33148	2471	36522	1607	45079	1450	27739
18-#14	2.98	MA	19734	5079	31779	4061	38087	3268	41942	2628	47235	1614	59577	1170	46516
4L-7S		MI	14479	5079	23940	4026	28172	3232	30414	2604	32786	1567	41043	812	35108
18-#14	2.98	MA	18897	5079	30457	4077	36501	3267	40006	2639	44610	1622	56240	1105	44972
5L-6S		MI	15137	5079	24891	4027	29431	3236	31951	2595	34864	1575	43447	915	36339
18-#14	2.98	MA	18095	5079	29283	4077	34935	3280	38101	2636	42086	1629	52866	996	43765
6L-5S		MI	15808	5079	25869	4029	30732	3225	33535	2602	36913	1567	46161	1024	37364
18-#14	2.98	MA	17309	5079	28139	4077	33422	3278	36252	2647	39526	1622	49869	894	42146
7L-4S		MI	16509	5079	26966	4015	32050	3229	35143	2593	39043	1560	48868	1085	38512
18-#14	2.98	MA	16533	5079	27013	4078	31939	3276	34400	2643	37056	1629	46753	819	40296
8L-3S		MI	17280	5079	28050	4017	33513	3218	36916	2600	41377	1567	51415	1217	39152
18-#14	2.98	MA	15761	5079	25770	4093	30411	3290	32578	2654	34610	1636	43693	734	38447
9L-2S		MI	18338	5079	29497	4018	35348	3222	39139	2591	44319	1560	55304	1348	39321
18-#18	5.29	MA	20505	6224	37098	4774	44597	3793	49713	2951	57380	1540	73584	431	70983
6L-5S		MI	18177	6224	33002	4717	39596	3719	44057	2902	50620	1439	64459	484	61129
20-#11	2.29	MA	18833	4741	29082	3863	34791	3121	37989	2538	42000	1642	52525	1315	36641
4L-8S		MI	13885	4741	21977	3828	25779	3086	27529	2511	29061	1610	35976	1008	28087
20-#11	2.29	MA	18234	4741	28160	3874	33684	3120	36638	2546	40161	1647	50182	1270	35923
5L-7S		MI	14350	4741	22632	3828	26640	3088	28605	2515	30472	1605	37755	1059	28766
20-#11	2.29	MA	17660	4741	27341	3874	32592	3130	35308	2544	38393	1653	47807	1194	35254
6E		MI	14821	4741	23296	3829	27519	3091	29678	2508	31935	1610	39455	1130	29413

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis

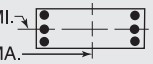


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.29	MA	17098	4741	26543	3875	31536	3129	34019	2552	36600	1648	45695	1124	34477
7L-5S		MI	15301	4741	23979	3830	28428	3083	30785	2512	33378	1605	41371	1206	29907
20-#11	2.29	MA	16543	4741	25758	3875	30502	3128	32727	2550	34870	1653	43507	1071	33584
8L-4S		MI	15802	4741	24746	3820	29349	3085	31908	2506	34878	1599	43278	1249	30528
20-#11	2.29	MA	15991	4741	24891	3886	29437	3138	31456	2558	33156	1659	41352	1012	32533
9L-3S		MI	16355	4741	25503	3820	30372	3077	33148	2510	36522	1605	45079	1340	30659
20-#11	2.29	MA	15442	4741	24109	3887	28410	3137	30179	2556	31394	1654	39123	932	31456
10L-2S		MI	17113	4741	26516	3821	31657	3079	34705	2503	38593	1599	47826	1431	30730
20-#14	3.31	MA	19696	5242	32211	4179	38725	3342	42701	2687	48235	1614	61073	1083	50000
5L-7S		MI	15144	5242	25386	4128	30007	3307	32637	2651	35728	1556	44933	783	39204
20-#14	3.31	MA	18905	5242	31036	4179	37159	3355	40795	2683	45710	1621	57699	974	48717
6E		MI	15793	5242	26338	4129	31266	3311	34174	2643	37806	1563	47337	886	40393
20-#14	3.31	MA	18129	5242	29892	4180	35646	3353	38947	2694	43151	1614	54701	872	47144
7L-5S		MI	16457	5242	27315	4131	32567	3300	35758	2649	39854	1556	50051	995	41496
20-#14	3.31	MA	17363	5242	28766	4180	34163	3351	37095	2690	40681	1621	51586	797	45254
8L-4S		MI	17149	5242	28413	4117	33885	3304	37366	2641	41984	1548	52757	1056	42593
20-#14	3.31	MA	16602	5242	27524	4195	32635	3364	35273	2701	38235	1628	48526	712	43376
9L-3S		MI	17911	5242	29497	4119	35348	3293	39139	2647	44319	1556	55304	1188	43383
22-#11	2.52	MA	18807	4854	29386	3944	35239	3172	38521	2579	42702	1642	53583	1256	39435
5L-8S		MI	14364	4854	22991	3899	27064	3138	29086	2544	31132	1603	38722	990	30970
22-#11	2.52	MA	18239	4854	28567	3945	34146	3182	37192	2576	40934	1648	51208	1181	38788
6L-7S		MI	14825	4854	23645	3899	27925	3140	30162	2548	32544	1597	40501	1040	31629
22-#11	2.52	MA	17683	4854	27769	3946	33091	3181	35902	2585	39141	1643	49097	1110	37963
7L-6S		MI	15291	4854	24310	3900	28804	3143	31235	2541	34007	1603	42201	1112	32324
22-#11	2.52	MA	17133	4854	26984	3946	32057	3180	34611	2583	37411	1648	46908	1057	37092
8L-5S		MI	15767	4854	24992	3900	29713	3135	32342	2545	35449	1597	44118	1187	32802
22-#11	2.52	MA	16587	4854	26117	3957	30991	3190	33340	2591	35697	1653	44753	998	35983
9L-4S		MI	16263	4854	25759	3891	30634	3137	33465	2539	36949	1592	46024	1231	33488
22-#11	2.52	MA	16044	4854	25335	3958	29964	3189	32063	2589	33936	1649	42525	918	34915
10L-3S		MI	16810	4854	26516	3891	31657	3129	34705	2543	38593	1597	47826	1322	33634
22-#14	3.64	MA	19703	5406	32790	4281	39383	3429	43489	2730	49335	1613	62532	952	53679
6L-7S		MI	15799	5406	26833	4230	31842	3381	34860	2698	38669	1544	48822	754	43308
22-#14	3.64	MA	18938	5406	31646	4282	37870	3428	41641	2741	46776	1605	59534	850	52150
7L-6S		MI	16441	5406	27785	4232	33101	3385	36397	2690	40747	1552	51226	857	44458
22-#14	3.64	MA	18181	5406	30520	4282	36387	3426	39789	2738	44306	1613	56418	774	50220
8L-5S		MI	17097	5406	28762	4233	34402	3375	37981	2696	42795	1544	53940	966	45634
22-#14	3.64	MA	17430	5406	29277	4297	34859	3439	37967	2749	41860	1620	53359	690	48314
9L-4S		MI	17781	5406	29860	4220	35720	3379	39589	2688	44926	1537	56647	1027	46685
24-#11	2.75	MA	18811	4968	29793	4016	35701	3234	39075	2609	43475	1642	54610	1167	42324
6L-8S		MI	14838	4968	24004	3969	28349	3190	30643	2577	33204	1595	41469	971	33858
24-#11	2.75	MA	18260	4968	28995	4017	34646	3233	37786	2618	41682	1637	52498	1096	41455
7E		MI	15294	4968	24658	3970	29210	3192	31718	2581	34615	1590	43248	1022	34499
24-#11	2.75	MA	17716	4968	28210	4017	33612	3232	36494	2615	39952	1643	50309	1043	40605
8L-6S		MI	15756	4968	25323	3971	30089	3194	32792	2574	36078	1595	44948	1093	35238
24-#11	2.75	MA	17176	4968	27343	4028	32546	3242	35223	2624	38238	1648	48154	984	39468
9L-5S		MI	16227	4968	26005	3971	30998	3186	33898	2578	37521	1590	46864	1169	35701
24-#11	2.75	MA	16638	4968	26561	4029	31519	3241	33946	2621	36477	1643	45926	904	38379
10L-4S		MI	16719	4968	26772	3962	31919	3189	35022	2572	39021	1585	48771	1212	36447
24-#14	3.97	MA	19735	5570	33400	4384	40094	3503	44335	2789	50400	1597	64367	828	57163
7E		MI	16447	5570	28280	4332	33677	3456	37083	2746	41610	1533	52711	725	47414
24-#14	3.97	MA	18988	5570	32274	4384	38611	3501	42483	2785	47930	1605	61251	752	55194
8L-6S		MI	17081	5570	29232	4334	34936	3460	38620	2737	43688	1540	55115	828	48533
24-#14	3.97	MA	18246	5570	31031	4400	37083	3514	40661	2796	45484	1612	58191	668	53258
9L-5S		MI	17730	5570	30209	4335	36237	3449	40204	2744	45737	1533	57829	937	49779

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

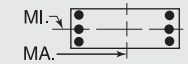
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.12	MA	19171	4369	27602	3649	32589	2969	34811	2465	36613	1733	44289	1621	20057
2E		MI	15329	4369	22525	3587	26221	2918	27774	2418	28801	1682	34511	1554	15892
6-#18	1.68	MA	20704	4659	30850	3831	36708	3102	39802	2549	43297	1717	53182	1579	29703
2L-3S		MI	14558	4659	22525	3764	26221	3041	27774	2514	28801	1670	34511	1261	23280
6-#18	1.68	MA	18214	4659	27602	3831	32589	3098	34811	2567	36613	1730	44289	1345	29437
3L-2S		MI	16486	4659	25046	3769	29418	3051	31626	2501	33868	1657	41172	1494	23415
8-#14	1.26	MA	19662	4441	28332	3719	33705	3022	36245	2502	38699	1748	47218	1638	22688
2L-4S		MI	13769	4441	20556	3659	23817	2982	24983	2465	25228	1701	30436	1310	17852
8-#14	1.26	MA	18213	4441	26477	3719	31351	3021	33394	2514	34852	1755	42070	1506	22638
3E		MI	14595	4441	21639	3661	25280	2972	26757	2471	27563	1708	32983	1442	17966
8-#14	1.26	MA	17161	4441	25097	3720	29486	3035	31133	2511	31801	1748	38680	1375	22411
4L-2S		MI	15721	4441	23086	3662	27115	2976	28980	2463	30504	1701	36872	1573	17969
8-#18	2.24	MA	22188	4950	34098	4013	40827	3235	44792	2633	49982	1701	62076	1537	39302
2L-4S		MI	14328	4950	23151	3941	26860	3191	28548	2583	29845	1632	36808	971	28693
8-#18	2.24	MA	19751	4950	30850	4013	36708	3231	39802	2652	43297	1714	53182	1303	38914
3E		MI	15718	4950	25046	3946	29418	3174	31626	2596	33868	1646	41172	1201	30637
8-#18	2.24	MA	17980	4950	28428	4012	33435	3253	35835	2643	37993	1701	47339	1069	36391
4L-2S		MI	17609	4950	27567	3951	32616	3184	35477	2583	38934	1632	47833	1435	30879
10-#11	1.09	MA	19228	4354	27292	3676	32482	2992	34805	2485	36785	1758	44788	1661	19834
2L-5S		MI	13496	4354	19732	3631	22944	2951	23958	2457	23915	1724	28657	1379	15633
10-#11	1.09	MA	18208	4354	25995	3677	30837	2992	32813	2494	34097	1764	41168	1570	19821
3L-4S		MI	14025	4354	20499	3621	23864	2954	25081	2450	25415	1719	30563	1422	15731
10-#11	1.09	MA	17468	4354	25033	3678	29535	3002	31235	2492	31968	1760	38782	1479	19746
4L-3S		MI	14607	4354	21256	3622	24887	2946	26321	2454	27059	1724	32364	1513	15758
10-#11	1.09	MA	16799	4354	24059	3689	28367	3001	29809	2501	30025	1766	36292	1433	19552
5L-2S		MI	15401	4354	22270	3622	26172	2948	27878	2448	29131	1719	35111	1604	15744
10-#14	1.58	MA	20546	4605	30188	3821	36058	3097	39097	2550	42546	1740	52366	1618	28190
2L-5S		MI	13725	4605	20905	3775	24334	3053	25599	2520	26040	1697	31619	1220	21115
10-#14	1.58	MA	19116	4605	28332	3822	33705	3096	36245	2562	38699	1748	47218	1486	28099
3L-4S		MI	14466	4605	22003	3761	25652	3057	27207	2512	28170	1689	34326	1282	22074
10-#14	1.58	MA	18080	4605	26953	3823	31839	3110	33985	2558	35648	1741	43827	1355	27822
4L-3S		MI	15281	4605	23086	3763	27115	3046	28980	2519	30504	1697	36872	1413	22234
10-#14	1.58	MA	17142	4605	25556	3838	30164	3108	31940	2570	32864	1749	40280	1289	26522
5L-2S		MI	16393	4605	24533	3764	28950	3050	31203	2510	33446	1689	40762	1544	22276
10-#18	2.80	MA	23632	5241	37346	4195	44947	3368	49783	2717	56667	1685	70969	1494	48876
2L-5S		MI	14246	5241	23751	4144	27751	3314	29608	2679	31242	1621	38824	803	33810
10-#18	2.80	MA	21243	5241	34098	4194	40827	3364	44792	2736	49982	1698	62076	1261	48384
3L-4S		MI	15485	5241	25672	4122	30057	3324	32400	2666	34912	1608	43469	911	35684
10-#18	2.80	MA	19511	5241	31676	4194	37554	3386	40826	2728	44678	1685	56232	1027	45499
4L-3S		MI	16848	5241	27567	4127	32616	3307	35477	2679	38934	1621	47833	1141	37978
10-#18	2.80	MA	17941	5241	29224	4220	34611	3382	37234	2746	39837	1698	50079	913	42795
5L-2S		MI	18704	5241	30088	4132	35813	3317	39328	2666	44001	1608	54494	1375	38314
12-#11	1.31	MA	19858	4467	28589	3747	34126	3044	36798	2518	39473	1753	48408	1648	23685
2L-6S		MI	13493	4467	20063	3701	23319	3011	24408	2486	24544	1722	29486	1285	17940
12-#11	1.31	MA	18848	4467	27292	3748	32482	3044	34805	2527	36785	1759	44788	1557	23652
3L-5S		MI	13995	4467	20745	3702	24229	3003	25515	2490	25987	1717	31403	1360	18539
12-#11	1.31	MA	18117	4467	26329	3749	31180	3054	33228	2525	34656	1755	42402	1466	23552
4E		MI	14518	4467	21512	3692	25149	3005	26638	2483	27487	1712	33310	1404	18713
12-#11	1.31	MA	17454	4467	25355	3760	30011	3053	31801	2534	32713	1761	39912	1420	23298
5L-3S		MI	15094	4467	22270	3693	26172	2997	27878	2487	29131	1717	35111	1495	18761
12-#11	1.31	MA	16820	4467	24491	3761	28858	3063	30397	2532	30846	1767	37385	1345	22440
6L-2S		MI	15882	4467	23283	3693	27457	3000	29434	2481	31202	1712	37857	1586	18765

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.89	MA	21413	4768	32044	3923	38412	3172	41948	2597	46393	1733	57513	1597	33679
2L-6S		MI	13718	4768	21374	3875	24867	3139	26238	2561	26932	1693	32794	1082	24445
12-#14	1.89	MA	20002	4768	30188	3924	36058	3171	39097	2609	42546	1740	52366	1466	33552
3L-5S		MI	14419	4768	22352	3877	26169	3128	27822	2568	28981	1685	35508	1191	25199
12-#14	1.89	MA	18981	4768	28808	3925	34193	3184	36836	2606	39495	1733	48975	1335	33232
4E		MI	15150	4768	23450	3863	27487	3132	29430	2559	31111	1678	38215	1253	26290
12-#14	1.89	MA	18056	4768	27412	3941	32518	3183	34791	2618	36711	1741	45428	1269	31799
5L-3S		MI	15955	4768	24533	3865	28950	3121	31203	2566	33446	1685	40762	1384	26490
12-#14	1.89	MA	17169	4768	26172	3941	30864	3197	32778	2614	34033	1749	41834	1160	30705
6L-2S		MI	17053	4768	25980	3866	30785	3125	33426	2558	36387	1678	44651	1515	26563
12-#18	3.36	MA	22698	5532	37346	4376	44947	3497	49783	2820	56667	1682	70969	1218	57850
3L-5S		MI	15398	5532	26272	4326	30948	3447	33459	2762	36309	1596	45485	743	40724
12-#18	3.36	MA	21002	5532	34924	4376	41673	3519	45816	2812	51362	1669	65126	985	54649
4E		MI	16614	5532	28193	4304	33255	3457	36251	2749	39978	1583	50130	851	42717
12-#18	3.36	MA	19465	5532	32472	4402	38730	3515	42224	2830	46521	1682	58972	871	52075
5L-3S		MI	17951	5532	30088	4309	35813	3440	39328	2762	44001	1596	54494	1081	45310
12-#18	3.36	MA	17991	5532	30291	4402	35824	3538	38688	2822	41866	1695	52765	677	47950
6L-2S		MI	19776	5532	32609	4314	39010	3450	43179	2749	49067	1583	61155	1315	45728
14-#11	1.53	MA	20479	4581	29885	3818	35771	3096	38790	2551	42161	1748	52028	1636	27528
2L-7S		MI	13503	4581	20411	3771	23725	3061	24891	2525	25152	1710	30533	1195	20428
14-#11	1.53	MA	19478	4581	28589	3819	34126	3095	36798	2560	39473	1754	48408	1544	27477
3L-6S		MI	13990	4581	21076	3772	24604	3063	25965	2519	26615	1715	32233	1266	20831
14-#11	1.53	MA	18755	4581	27626	3820	32824	3105	35220	2558	37344	1749	46022	1453	27354
4L-5S		MI	14487	4581	21758	3773	25514	3055	27071	2523	28058	1710	34150	1342	21401
14-#11	1.53	MA	18100	4581	26652	3831	31656	3105	33794	2567	35401	1755	43532	1407	26981
5L-4S		MI	15005	4581	22526	3763	26434	3057	28195	2516	29558	1705	36056	1385	21687
14-#11	1.53	MA	17472	4581	25787	3832	30503	3115	32390	2565	33534	1761	41005	1332	26158
6L-3S		MI	15575	4581	23283	3763	27457	3049	29434	2520	31202	1710	37857	1476	21755
14-#11	1.53	MA	16857	4581	24946	3833	29388	3115	31028	2574	31641	1757	38755	1261	25582
7L-2S		MI	16355	4581	24296	3764	28742	3052	30991	2514	33273	1705	40604	1568	21778
14-#14	2.21	MA	22265	4932	33900	4025	40766	3247	44799	2645	50240	1725	62661	1577	39159
2L-7S		MI	13730	4932	21869	3976	25444	3210	26924	2617	27796	1674	34280	950	27204
14-#14	2.21	MA	20871	4932	32044	4026	38412	3245	41948	2656	46393	1733	57513	1446	38999
3L-6S		MI	14408	4932	22821	3978	26702	3214	28461	2609	29874	1681	36684	1053	28556
14-#14	2.21	MA	19864	4932	30664	4027	36547	3259	39688	2653	43342	1726	54123	1314	38640
4L-5S		MI	15101	4932	23798	3979	28004	3203	30045	2615	31922	1674	39398	1162	29298
14-#14	2.21	MA	18952	4932	29268	4043	34871	3258	37642	2665	40558	1734	50576	1249	37091
5L-4S		MI	15822	4932	24896	3966	29322	3207	31653	2607	34052	1666	42104	1224	30501
14-#14	2.21	MA	18078	4932	28028	4044	33217	3272	35629	2662	37880	1741	46982	1140	36036
6L-3S		MI	16616	4932	25980	3967	30785	3196	33426	2613	36387	1674	44651	1355	30738
14-#14	2.21	MA	17222	4932	26820	4044	31620	3271	33677	2674	35166	1734	43786	1038	34235
7L-2S		MI	17703	4932	27427	3969	32620	3200	35649	2605	39328	1666	48540	1486	30840
14-#18	3.92	MA	22459	5823	38172	4558	45793	3652	50807	2896	58047	1653	74019	942	63835
4L-5S		MI	16526	5823	28793	4507	34145	3580	37310	2844	41376	1571	52146	683	47638
14-#18	3.92	MA	20953	5823	35719	4584	42850	3648	47215	2915	53206	1666	67866	829	61165
5L-4S		MI	17719	5823	30714	4486	36452	3590	40102	2831	45045	1558	56791	792	49785
14-#18	3.92	MA	19509	5823	33539	4584	39944	3671	43678	2906	48550	1679	61658	635	57135
6L-3S		MI	19032	5823	32609	4491	39010	3573	43179	2844	49067	1571	61155	1022	52636
14-#18	3.92	MA	18093	5823	31416	4583	37135	3666	40248	2925	43830	1666	56147	453	52840
7L-2S		MI	20828	5823	35130	4496	42207	3583	47031	2831	54134	1558	67816	1255	53129
16-#11	1.75	MA	21092	4694	31182	3889	37415	3148	40782	2584	44849	1743	55648	1623	31364
2L-8S		MI	13521	4694	20770	3842	24149	3110	25372	2554	25812	1708	31501	1126	22531
16-#11	1.75	MA	20100	4694	29885	3890	35771	3147	38790	2593	42161	1749	52028	1532	31297
3L-7S		MI	13998	4694	21425	3842	25010	3113	26448	2558	27224	1703	33280	1177	23267
16-#11	1.75	MA	19384	4694	28923	3891	34469	3157	37212	2591	40032	1744	49641	1441	31154
4L-6S		MI	14479	4694	22089	3843	25889	3115	27522	2551	28687	1708	34980	1248	23728
16-#11	1.75	MA	18736	4694	27949	3902	33300	3157	35786	2600	38089	1750	47152	1394	30675
5E		MI	14972	4694	22772	3843	26799	3107	28628	2555	30129	1703	36896	1323	24272

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

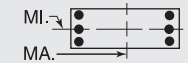
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.75	MA	18115	4694	27084	3903	32147	3167	34382	2598	36222	1756	44625	1319	29883
6L-4S		MI	15484	4694	23539	3834	27719	3109	29752	2549	31629	1697	38803	1367	24658
16-#11	1.75	MA	17507	4694	26242	3904	31033	3166	33021	2607	34329	1752	42375	1248	29267
7L-3S		MI	16049	4694	24296	3834	28742	3101	30991	2553	33273	1703	40604	1458	24744
16-#11	1.75	MA	16906	4694	25414	3905	29941	3166	31657	2605	32502	1758	40050	1195	28232
8L-2S		MI	16823	4694	25309	3835	30027	3103	32548	2546	35345	1697	43351	1549	24780
16-#14	2.52	MA	21726	5096	33900	4128	40766	3320	44799	2704	50240	1726	62661	1426	44441
3L-7S		MI	14418	5096	23316	4078	27279	3284	29147	2664	30737	1662	38169	921	31277
16-#14	2.52	MA	20732	5096	32520	4129	38900	3334	42539	2701	47189	1718	59271	1294	44049
4L-6S		MI	15088	5096	24268	4080	28537	3288	30684	2656	32815	1670	40573	1024	32581
16-#14	2.52	MA	19833	5096	31124	4145	37225	3333	40494	2712	44405	1726	55724	1228	42396
5E		MI	15771	5096	25245	4081	29839	3278	32268	2663	34864	1662	43287	1133	33410
16-#14	2.52	MA	18971	5096	29883	4146	35571	3347	38481	2709	41727	1734	52130	1120	41352
6L-4S		MI	16484	5096	26343	4068	31157	3282	33876	2654	36994	1655	45994	1195	34645
16-#14	2.52	MA	18127	5096	28676	4147	33973	3345	36529	2721	39013	1727	48934	1018	39513
7L-3S		MI	17268	5096	27427	4069	32620	3271	35649	2661	39328	1662	48540	1326	34979
16-#14	2.52	MA	17292	5096	27487	4148	32407	3344	34573	2718	36393	1735	45621	941	37771
8L-2S		MI	18343	5096	28873	4071	34455	3275	37872	2652	42270	1655	52430	1457	35108
16-#18	4.48	MA	22409	6113	38967	4766	46969	3781	52205	2999	59891	1650	76759	786	70242
5E		MI	17631	6113	31314	4689	37343	3713	41162	2927	46442	1547	58807	623	54584
16-#18	4.48	MA	20993	6113	36787	4765	44063	3804	48668	2991	55235	1663	70551	593	66343
6L-4S		MI	18804	6113	33235	4668	39649	3723	43953	2914	50112	1533	63452	732	56883
16-#18	4.48	MA	19605	6113	34664	4765	41255	3799	45238	3009	50514	1650	65040	410	61981
7L-3S		MI	20096	6113	35130	4673	42207	3706	47031	2927	54134	1547	67816	962	59958
18-#11	1.97	MA	20713	4808	31182	3961	37415	3199	40782	2626	44849	1743	55648	1519	35113
3L-8S		MI	14014	4808	21783	3912	25434	3162	26929	2587	27884	1701	34247	1108	25402
18-#11	1.97	MA	20004	4808	30219	3961	36114	3209	39205	2624	42720	1739	53261	1428	34951
4L-7S		MI	14486	4808	22438	3913	26295	3165	28005	2591	29295	1695	36026	1158	26114
18-#11	1.97	MA	19363	4808	29246	3973	34945	3209	37778	2632	40778	1745	50772	1382	34379
5L-6S		MI	14963	4808	23102	3914	27174	3167	29078	2584	30758	1701	37726	1229	26631
18-#11	1.97	MA	18749	4808	28381	3974	33792	3219	36374	2631	38910	1751	48245	1307	33614
6L-5S		MI	15450	4808	23785	3914	28084	3159	30185	2588	32201	1695	39643	1305	27153
18-#11	1.97	MA	18147	4808	27539	3975	32678	3218	35013	2639	37017	1747	45995	1236	32945
7L-4S		MI	15958	4808	24552	3905	29004	3161	31308	2582	33701	1690	41549	1348	27625
18-#11	1.97	MA	17553	4808	26710	3975	31586	3218	33649	2638	35190	1753	43670	1182	31937
8L-3S		MI	16518	4808	25309	3905	30027	3153	32548	2586	35345	1695	43351	1439	27728
18-#11	1.97	MA	16962	4808	25795	3987	30461	3228	32308	2646	33381	1759	41375	1124	30938
9L-2S		MI	17285	4808	26322	3906	31312	3155	34105	2579	37416	1690	46097	1531	27778
18-#14	2.84	MA	21587	5259	34376	4231	41254	3409	45390	2748	51036	1711	64418	1274	49434
4L-7S		MI	15095	5259	24763	4180	29114	3359	31370	2712	33679	1650	42058	892	35361
18-#14	2.84	MA	20700	5259	32979	4247	39578	3408	43345	2760	48252	1719	60871	1208	47711
5L-6S		MI	15756	5259	25715	4182	30372	3363	32907	2703	35757	1658	44462	995	36619
18-#14	2.84	MA	19849	5259	31739	4248	37925	3421	41332	2757	45574	1727	57277	1100	46588
6L-5S		MI	16431	5259	26692	4183	31674	3352	34491	2710	37805	1650	47176	1104	37531
18-#14	2.84	MA	19016	5259	30532	4249	36327	3420	39380	2768	42860	1719	54081	997	44800
7L-4S		MI	17135	5259	27790	4170	32992	3356	36099	2702	39935	1643	49883	1166	38709
18-#14	2.84	MA	18193	5259	29343	4250	34761	3419	37424	2765	40240	1727	50769	921	42956
8L-3S		MI	17911	5259	28873	4172	34455	3346	37872	2708	42270	1650	52430	1297	39216
18-#14	2.84	MA	17375	5259	28031	4266	33147	3433	35500	2777	37646	1735	47508	837	41102
9L-2S		MI	18974	5259	30320	4173	36290	3350	40095	2700	45211	1643	56319	1429	39371
18-#18	5.04	MA	22449	6404	40035	4947	48182	3936	53659	3075	61920	1648	79445	550	75569
6L-5S		MI	18719	6404	33835	4871	40540	3846	45013	3010	51509	1522	65468	563	61558
18-#18	5.04	MA	21086	6404	37912	4947	45374	3932	50229	3093	57199	1634	73933	368	71140
7L-4S		MI	19872	6404	35756	4849	42846	3856	47805	2996	55178	1509	70113	672	64004

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

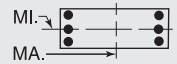


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.18	MA	20617	4921	31516	4032	37758	3261	41197	2657	45408	1734	56881	1415	38747
4L-8S		MI	14500	4921	22797	3983	26719	3214	28486	2620	29955	1693	36994	1089	28279
20-#11	2.18	MA	19982	4921	30542	4044	36589	3261	39771	2665	43466	1740	54392	1369	38090
5L-7S		MI	14967	4921	23451	3984	27580	3216	29562	2624	31366	1688	38773	1140	28969
20-#11	2.18	MA	19374	4921	29677	4045	35436	3271	38367	2664	41598	1746	51864	1294	37351
6E		MI	15440	4921	24116	3985	28459	3219	30635	2617	32829	1693	40473	1211	29538
20-#11	2.18	MA	18779	4921	28836	4045	34322	3270	37006	2672	39705	1742	49615	1223	36630
7L-5S		MI	15923	4921	24798	3985	29369	3211	31742	2621	34272	1688	42389	1287	30040
20-#11	2.18	MA	18191	4921	28007	4046	33230	3270	35642	2671	37878	1748	47290	1169	35647
8L-4S		MI	16426	4921	25565	3975	30289	3213	32865	2615	35772	1683	44296	1330	30589
20-#11	2.18	MA	17606	4921	27092	4058	32105	3280	34300	2679	36069	1754	44995	1111	34618
9L-3S		MI	16981	4921	26322	3976	31312	3205	34105	2619	37416	1688	46097	1421	30708
20-#11	2.18	MA	17025	4921	26267	4059	31021	3279	32952	2678	34209	1749	42623	1031	33502
10L-2S		MI	17742	4921	27336	3977	32597	3207	35662	2612	39487	1683	48844	1512	30771
20-#14	3.15	MA	21553	5423	34835	4349	41932	3482	46197	2807	52099	1711	66019	1188	53036
5L-7S		MI	15762	5423	26210	4283	30949	3434	33594	2759	36620	1639	45948	863	39454
20-#14	3.15	MA	20714	5423	33595	4350	40278	3496	44184	2804	49421	1719	62425	1080	51835
6E		MI	16415	5423	27162	4284	32207	3438	35130	2751	38698	1646	48352	966	40669
20-#14	3.15	MA	19892	5423	32387	4351	38680	3495	42232	2816	46707	1712	59229	977	50096
7L-5S		MI	17083	5423	28139	4286	33509	3427	36714	2757	40746	1639	51066	1075	41662
20-#14	3.15	MA	19079	5423	31199	4352	37115	3494	40276	2813	44087	1720	55917	901	48212
8L-4S		MI	17778	5423	29237	4272	34827	3431	38322	2749	42876	1631	53772	1137	42787
20-#14	3.15	MA	18272	5423	29886	4368	35501	3508	38352	2824	41493	1728	52655	816	46330
9L-3S		MI	18545	5423	30320	4274	36290	3420	40095	2755	45211	1639	56319	1268	43449
20-#18	5.60	MA	22541	6695	41160	5128	49493	4065	55219	3178	63884	1618	82826	325	80316
7L-5S		MI	19872	6695	36356	5053	43737	3979	48864	3092	56575	1497	72129	504	68558
22-#11	2.40	MA	20594	5035	31839	4114	38234	3312	41763	2698	46154	1735	58012	1356	41808
5L-8S		MI	14981	5035	23810	4054	28004	3266	30043	2653	32026	1686	39740	1071	31160
22-#11	2.40	MA	19992	5035	30974	4115	37081	3322	40359	2696	44286	1741	55484	1281	41091
6L-7S		MI	15443	5035	24464	4055	28865	3268	31118	2656	33438	1681	41519	1121	31830
22-#11	2.40	MA	19403	5035	30132	4116	35967	3322	38998	2705	42393	1736	53235	1210	40321
7L-6S		MI	15912	5035	25129	4055	29744	3271	32192	2650	34901	1686	43219	1192	32449
22-#11	2.40	MA	18820	5035	29304	4117	34875	3322	37634	2703	40566	1742	50910	1157	39362
8L-5S		MI	16390	5035	25811	4056	30654	3263	33298	2654	36343	1681	45136	1268	32933
22-#11	2.40	MA	18242	5035	28389	4129	33750	3332	36293	2712	38758	1749	48615	1098	38304
9L-4S		MI	16889	5035	26578	4046	31574	3265	34422	2647	37843	1676	47042	1311	33552
22-#11	2.40	MA	17666	5035	27563	4129	32666	3331	34945	2710	36897	1744	46243	1018	37209
10L-3S		MI	17439	5035	27336	4047	32597	3257	35662	2651	39487	1681	48844	1403	33685
22-#11	2.40	MA	17064	5035	26744	4130	31554	3341	33611	2719	35096	1750	43958	962	35864
11L-2S		MI	18194	5035	28349	4048	33882	3259	37218	2645	41558	1676	51590	1494	33761
22-#14	3.47	MA	21566	5586	35451	4453	42632	3571	47035	2851	53269	1712	67573	1059	57093
6L-7S		MI	16420	5586	27657	4385	32784	3509	35817	2807	39561	1627	49837	834	43555
22-#14	3.47	MA	20755	5586	34243	4453	41034	3570	45083	2863	50554	1704	64377	957	55400
7L-6S		MI	17066	5586	28609	4386	34042	3513	37354	2798	41639	1635	52241	937	44730
22-#14	3.47	MA	19953	5586	33055	4454	39468	3569	43127	2860	47934	1712	61065	881	53476
8L-5S		MI	17725	5586	29586	4388	35344	3502	38937	2805	43688	1627	54955	1046	45799
22-#14	3.47	MA	19156	5586	31742	4470	37855	3582	41203	2872	45340	1720	57803	796	51566
9L-4S		MI	18413	5586	30684	4375	36662	3506	40545	2796	45818	1620	57662	1108	46877
24-#11	2.62	MA	20602	5148	32271	4186	38725	3374	42352	2729	46974	1736	59104	1268	44835
6L-8S		MI	15456	5148	24823	4125	29289	3318	31600	2685	34098	1679	42487	1052	34046
24-#11	2.62	MA	20019	5148	31429	4187	37611	3374	40990	2738	45081	1731	56855	1197	44018
7E		MI	15914	5148	25477	4126	30150	3320	32675	2689	35509	1674	44266	1103	34698
24-#11	2.62	MA	19442	5148	30601	4188	36520	3374	39627	2736	43254	1737	54530	1144	43081
8L-6S		MI	16378	5148	26142	4126	31029	3322	33749	2683	36972	1679	45966	1174	35363
24-#11	2.62	MA	18870	5148	29685	4199	35395	3383	38285	2745	41446	1743	52235	1085	41994
9L-5S		MI	16853	5148	26824	4127	31939	3314	34855	2687	38415	1674	47882	1250	35832
24-#11	2.62	MA	18300	5148	28860	4200	34310	3383	36937	2743	39586	1739	49863	1005	40897
10L-4S		MI	17347	5148	27592	4117	32859	3317	35979	2680	39915	1669	49789	1293	36513

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.62	MA	17700	5148	28041	4201	33198	3393	35604	2752	37784	1745	47578	949	39556
11L-3S		MI	17892	5148	28349	4118	33882	3309	37218	2684	41558	1674	51590	1384	36660
24-#14	3.78	MA	21606	5750	36099	4556	43388	3645	47934	2910	54401	1697	69525	937	60711
7E		MI	17070	5750	29104	4487	34619	3584	38040	2854	42503	1616	53726	805	47663
24-#14	3.78	MA	20814	5750	34910	4556	41822	3644	45979	2907	51781	1705	66212	861	58747
8L-6S		MI	17708	5750	30056	4489	35877	3588	39577	2846	44581	1623	56130	908	48802
24-#14	3.78	MA	20027	5750	33598	4572	40208	3657	44054	2919	49187	1713	62951	776	56809
9L-5S		MI	18361	5750	31033	4490	37179	3577	41161	2852	46629	1616	58844	1017	49943

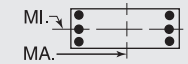
RECTANGULAR TIED COLUMNS 34" x 44"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.07	MA	20932	4549	29915	3818	35391	3108	37796	2583	39728	1827	48062	1716	21137
2E		MI	15947	4549	23357	3741	27165	3044	28730	2525	29690	1764	35520	1634	15929
6-#18	1.60	MA	22567	4840	33345	4000	39741	3241	43066	2667	46818	1813	57514	1677	31323
2L-3S		MI	15174	4840	23357	3917	27165	3167	28730	2621	29690	1753	35520	1341	23350
6-#18	1.60	MA	19928	4840	29915	4001	35391	3238	37796	2687	39728	1826	48062	1443	31057
3L-2S		MI	17108	4840	25878	3922	30362	3177	32581	2608	34756	1739	42181	1574	23458
8-#14	1.20	MA	21450	4622	30679	3888	36560	3161	39299	2621	41853	1838	51138	1732	23903
2L-4S		MI	14383	4622	21379	3814	24758	3110	25940	2573	26121	1784	31451	1391	17915
8-#14	1.20	MA	19917	4622	28721	3889	34077	3161	36291	2633	37795	1847	45675	1601	23853
3E		MI	15212	4622	22463	3815	26222	3099	27713	2579	28455	1791	33998	1522	18008
8-#14	1.20	MA	18806	4622	27267	3890	32111	3175	33908	2630	34579	1841	42073	1469	23626
4L-2S		MI	16340	4622	23910	3817	28057	3103	29936	2571	31397	1784	37887	1654	18003
8-#18	2.14	MA	24149	5131	36774	4182	44091	3374	48336	2751	53908	1798	66967	1638	41462
2L-4S		MI	14943	5131	23984	4094	27804	3317	29504	2691	30734	1715	37817	1051	28977
8-#18	2.14	MA	21566	5131	33345	4183	39741	3371	43066	2771	46818	1812	57514	1404	41074
3E		MI	16339	5131	25878	4099	30362	3300	32581	2704	34756	1728	42181	1281	30717
8-#18	2.14	MA	19692	5131	30791	4183	36289	3395	38883	2764	41192	1798	51296	1170	38681
4L-2S		MI	18236	5131	28399	4104	33560	3310	36433	2691	39823	1715	48842	1514	30930
10-#11	1.04	MA	20986	4534	29578	3845	35266	3131	37775	2604	39827	1849	48544	1754	20887
2L-5S		MI	14110	4534	20551	3786	23884	3079	24915	2566	24809	1808	29675	1460	15692
10-#11	1.04	MA	19907	4534	28211	3846	33531	3131	35674	2613	36992	1855	44705	1663	20874
3L-4S		MI	14640	4534	21318	3777	24805	3082	26038	2559	26309	1803	31581	1503	15774
10-#11	1.04	MA	19126	4534	27196	3848	32160	3141	34012	2611	34749	1852	42171	1572	20799
4L-3S		MI	15223	4534	22076	3777	25828	3074	27278	2563	27953	1808	33382	1594	15790
10-#11	1.04	MA	18419	4534	26171	3859	30929	3141	32510	2620	32704	1858	39536	1525	20605
5L-2S		MI	16019	4534	23089	3778	27113	3076	28835	2557	30025	1803	36129	1685	15773
10-#14	1.50	MA	22392	4785	32637	3990	39044	3236	42308	2668	45912	1831	56601	1714	29709
2L-5S		MI	14339	4785	21728	3929	25276	3181	26555	2629	26932	1780	32634	1301	21286
10-#14	1.50	MA	20878	4785	30679	3991	36560	3235	39299	2680	41853	1840	51138	1582	29618
3L-4S		MI	15082	4785	22826	3916	26593	3185	28163	2620	29062	1772	35341	1362	22143
10-#14	1.50	MA	19783	4785	29225	3993	34594	3250	36917	2678	38638	1833	47536	1451	29341
4L-3S		MI	15900	4785	23910	3918	28057	3174	29936	2627	31397	1780	37887	1493	22282
10-#14	1.50	MA	18792	4785	27754	4009	32830	3249	34763	2690	35705	1842	43778	1384	28088
5L-2S		MI	17015	4785	25356	3919	29892	3178	32159	2618	34338	1772	41777	1625	22313
10-#18	2.67	MA	25690	5421	40204	4364	48440	3507	53605	2836	60998	1784	76420	1598	51576
2L-5S		MI	14858	5421	24583	4297	28695	3440	30564	2786	32131	1703	39833	882	34061
10-#18	2.67	MA	23156	5421	36774	4364	44091	3504	48336	2855	53908	1797	66967	1365	51084
3L-4S		MI	16103	5421	26505	4276	31002	3450	33355	2773	35801	1690	44478	991	35960
10-#18	2.67	MA	21323	5421	34221	4365	40639	3528	44153	2848	48282	1784	60749	1131	48312
4L-3S		MI	17472	5421	28399	4281	33560	3433	36433	2786	39823	1703	48842	1221	38065
10-#18	2.67	MA	19662	5421	31636	4392	37537	3525	40367	2868	43147	1797	54222	1016	45354
5L-2S		MI	19336	5421	30920	4286	36757	3443	40284	2773	44890	1690	55503	1455	38370

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis

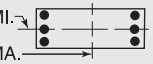


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.25	MA	21657	4648	30946	3916	37000	3183	39876	2636	42662	1844	52382	1743	24949
2L-6S		MI	14106	4648	20882	3857	24260	3139	25365	2594	25438	1806	30504	1366	18063
12-#11	1.25	MA	20587	4648	29578	3917	35266	3183	37775	2646	39827	1850	48544	1652	24916
3L-5S		MI	14610	4648	21564	3857	25169	3131	26471	2598	26881	1801	32421	1441	18652
12-#11	1.25	MA	19815	4648	28564	3918	33894	3193	36113	2644	37584	1846	46010	1560	24816
4E		MI	15135	4648	22332	3848	26090	3134	27595	2592	28381	1795	34328	1485	18759
12-#11	1.25	MA	19116	4648	27539	3930	32664	3193	34611	2653	35539	1853	43375	1514	24595
5L-3S		MI	15712	4648	23089	3848	27113	3125	28835	2596	30025	1801	36129	1576	18798
12-#11	1.25	MA	18446	4648	26628	3931	31449	3204	33133	2652	33572	1860	40694	1439	23717
6L-2S		MI	16501	4648	24102	3849	28398	3128	30391	2589	32096	1795	38875	1667	18797
12-#14	1.80	MA	23315	4949	34595	4092	41527	3311	45316	2715	49971	1823	62064	1695	35502
2L-6S		MI	14331	4949	22198	4030	25809	3266	27194	2669	27825	1776	33809	1162	24610
12-#14	1.80	MA	21821	4949	32637	4093	39044	3310	42308	2728	45912	1832	56601	1564	35375
3L-5S		MI	15035	4949	23175	4032	27111	3255	28778	2676	29873	1768	36523	1272	25368
12-#14	1.80	MA	20741	4949	31183	4095	37078	3325	39925	2725	42697	1826	52999	1432	35054
4E		MI	15769	4949	24273	4018	28428	3259	30386	2668	32003	1761	39230	1333	26364
12-#14	1.80	MA	19764	4949	29712	4111	35313	3324	37771	2738	39764	1834	49241	1366	33661
5L-3S		MI	16576	4949	25356	4020	29892	3249	32159	2674	34338	1768	41777	1464	26542
12-#14	1.80	MA	18827	4949	28406	4112	33571	3338	35651	2735	36943	1843	45427	1257	32474
6L-2S		MI	17678	4949	26803	4021	31727	3253	34383	2666	37279	1761	45666	1596	26604
12-#18	3.21	MA	24706	5712	40204	4546	48440	3637	53605	2939	60998	1783	76420	1326	61090
3L-5S		MI	16015	5712	27104	4479	31892	3573	34415	2869	37198	1678	46494	823	41171
12-#18	3.21	MA	22910	5712	37650	4547	44989	3661	49422	2933	55372	1770	70202	1092	57986
4E		MI	17236	5712	29026	4458	34199	3583	37207	2856	40867	1665	51139	931	42987
12-#18	3.21	MA	21284	5712	35066	4574	41887	3658	45636	2952	50237	1783	63675	977	55164
5L-3S		MI	18580	5712	30920	4463	36757	3566	40284	2869	44890	1678	55503	1161	45403
12-#18	3.21	MA	19724	5712	32768	4574	38824	3681	41909	2945	45299	1796	57076	784	50981
6L-2S		MI	20413	5712	33441	4468	39954	3576	44135	2856	49956	1665	62164	1395	45789
14-#11	1.46	MA	22317	4761	32313	3987	38735	3235	41978	2669	45497	1838	56221	1731	29002
2L-7S		MI	14116	4761	21231	3927	24666	3189	25848	2634	26046	1793	31551	1276	20566
14-#11	1.46	MA	21258	4761	30946	3988	37000	3235	39876	2678	42662	1845	52382	1640	28951
3L-6S		MI	14604	4761	21895	3927	25545	3191	26922	2627	27509	1798	33251	1347	20953
14-#11	1.46	MA	20494	4761	29932	3989	35629	3245	38214	2677	40419	1841	49849	1549	28828
4L-5S		MI	15103	4761	22578	3928	26454	3183	28028	2631	28952	1793	35168	1423	21534
14-#11	1.46	MA	19802	4761	28906	4001	34398	3245	36712	2686	38373	1848	47214	1502	28545
5L-4S		MI	15622	4761	23345	3918	27375	3185	29152	2625	30452	1788	37074	1466	21738
14-#11	1.46	MA	19140	4761	27996	4002	33184	3255	35234	2685	36407	1854	44533	1427	27641
6L-3S		MI	16195	4761	24102	3919	28398	3177	30391	2629	32096	1793	38875	1557	21795
14-#11	1.46	MA	18491	4761	27110	4003	32011	3255	33801	2694	34414	1851	42146	1356	27022
7L-2S		MI	16977	4761	25115	3920	29683	3180	31948	2622	34167	1788	41622	1648	21812
14-#14	2.11	MA	24223	5112	36553	4194	44010	3386	48325	2763	54030	1816	67527	1677	41286
2L-7S		MI	14342	5112	22693	4131	26385	3337	27881	2725	28688	1757	35295	1030	27457
14-#14	2.11	MA	22746	5112	34595	4196	41527	3385	45316	2775	49971	1825	62064	1545	41125
3L-6S		MI	15023	5112	23645	4132	27644	3341	29418	2717	30766	1764	37699	1133	28739
14-#14	2.11	MA	21681	5112	33141	4197	39561	3399	42934	2773	46756	1818	58462	1414	40767
4L-5S		MI	15719	5112	24622	4134	28946	3330	31002	2723	32815	1757	40413	1243	29465
14-#14	2.11	MA	20718	5112	31670	4213	37796	3399	40780	2785	43823	1827	54705	1347	39249
5L-4S		MI	16443	5112	25720	4121	30263	3334	32609	2715	34945	1749	43119	1304	30580
14-#14	2.11	MA	19794	5112	30364	4214	36054	3413	38659	2782	41002	1836	50890	1239	38104
6L-3S		MI	17240	5112	26803	4122	31727	3323	34383	2722	37279	1757	45666	1435	30793
14-#14	2.11	MA	18889	5112	29093	4216	34372	3412	36604	2795	38143	1829	47496	1137	36312
7L-2S		MI	18331	5112	28250	4124	33562	3327	36606	2713	40221	1749	49555	1567	30884
14-#18	3.74	MA	24462	6003	41080	4728	49338	3794	54692	3017	62462	1755	79655	1053	67695
4L-5S		MI	17146	6003	29625	4661	35090	3706	38266	2952	42264	1654	53155	763	48076
14-#18	3.74	MA	22868	6003	38495	4756	46236	3791	50906	3037	57327	1769	73128	938	64996
5L-4S		MI	18345	6003	31547	4639	37396	3716	41058	2938	45934	1640	57800	871	50050
14-#18	3.74	MA	21340	6003	36198	4756	43174	3814	47178	3030	52389	1782	66529	745	60697
6L-3S		MI	19666	6003	33441	4644	39954	3699	44135	2952	49956	1654	62164	1101	52734
14-#18	3.74	MA	19842	6003	33961	4757	40215	3811	43564	3049	47383	1769	60665	562	56321
7L-2S		MI	21471	6003	35962	4649	43151	3709	47986	2938	55023	1640	68825	1335	53194

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis



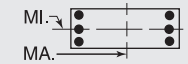
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.67	MA	22969	4875	33681	4058	40469	3287	44079	2702	48332	1833	60060	1719	33049
2L-8S		MI	14134	4875	21589	3997	25089	3238	26329	2663	26706	1791	32519	1207	22720
16-#11	1.67	MA	21919	4875	32313	4059	38735	3287	41978	2711	45497	1840	56221	1628	32982
3L-7S		MI	14612	4875	22244	3998	25951	3241	27405	2667	28118	1786	34298	1257	23470
16-#11	1.67	MA	21162	4875	31299	4060	37363	3297	40316	2710	43254	1836	53688	1537	32838
4L-6S		MI	15095	4875	22908	3998	26830	3243	28478	2660	29581	1791	35998	1329	23850
16-#11	1.67	MA	20478	4875	30274	4072	36133	3297	38813	2719	41208	1843	51052	1490	32444
5E		MI	15589	4875	23591	3999	27739	3235	29585	2664	31023	1786	37914	1404	24404
16-#11	1.67	MA	19823	4875	29363	4073	34918	3307	37335	2718	39242	1849	48372	1415	31573
6L-4S		MI	16104	4875	24358	3989	28660	3237	30708	2658	32523	1781	39821	1448	24711
16-#11	1.67	MA	19181	4875	28477	4074	33745	3307	35902	2727	37249	1846	45984	1345	30969
7L-3S		MI	16671	4875	25115	3990	29683	3229	31948	2662	34167	1786	41622	1539	24787
16-#11	1.67	MA	18546	4875	27605	4075	32596	3307	34466	2726	35326	1852	43523	1290	29894
8L-2S		MI	17447	4875	26128	3991	30968	3231	33505	2655	36239	1781	44369	1630	24817
16-#14	2.41	MA	23656	5276	36553	4298	44010	3460	48325	2822	54030	1817	67527	1527	46871
3L-7S		MI	15032	5276	24140	4233	28220	3412	30104	2773	31630	1745	39184	1001	31527
16-#14	2.41	MA	22605	5276	35099	4299	42044	3474	45942	2820	50815	1811	63925	1395	46479
4L-6S		MI	15705	5276	25092	4235	29479	3416	31641	2764	33708	1753	41588	1104	32859
16-#14	2.41	MA	21655	5276	33628	4315	40279	3474	43788	2832	47882	1820	60168	1329	44851
5E		MI	16391	5276	26069	4236	30781	3405	33225	2771	35756	1745	44302	1214	33574
16-#14	2.41	MA	20744	5276	32322	4317	38538	3488	41668	2830	45061	1828	56353	1220	43742
6L-4S		MI	17107	5276	27167	4223	32098	3409	34833	2762	37886	1738	47009	1275	34793
16-#14	2.41	MA	19851	5276	31051	4318	36855	3487	39612	2842	42202	1822	52959	1118	41888
7L-3S		MI	17895	5276	28250	4224	33562	3398	36606	2769	40221	1745	49555	1407	35038
16-#14	2.41	MA	18969	5276	29800	4319	35206	3487	37552	2840	39443	1830	49449	1041	40165
8L-2S		MI	18973	5276	29697	4226	35397	3402	38829	2761	43162	1738	53445	1538	35155
16-#18	4.28	MA	24419	6294	41925	4937	50586	3924	56176	3121	64417	1754	82581	899	74731
5E		MI	18255	6294	32146	4843	38287	3839	42118	3034	47331	1629	59816	703	55014
16-#18	4.28	MA	22919	6294	39628	4938	47524	3947	52448	3114	59479	1768	75982	705	70434
6L-4S		MI	19435	6294	34068	4821	40593	3849	44909	3021	51001	1616	64461	811	57142
16-#18	4.28	MA	21450	6294	37391	4939	44565	3944	48833	3134	54473	1754	70118	523	65994
7L-3S		MI	20734	6294	35962	4826	43151	3832	47986	3034	55023	1629	68825	1042	60061
18-#11	1.88	MA	22572	4988	33681	4130	40469	3339	44079	2744	48332	1835	60060	1617	37009
3L-8S		MI	14628	4988	22603	4068	26374	3290	27886	2696	28778	1784	35265	1188	25589
18-#11	1.88	MA	21822	4988	32667	4131	39098	3349	42417	2743	46089	1831	57526	1525	36847
4L-7S		MI	15101	4988	23257	4069	27236	3293	28962	2699	30189	1779	37044	1239	26315
18-#11	1.88	MA	21145	4988	31641	4143	37867	3349	40915	2752	44043	1838	54891	1479	36352
5L-6S		MI	15580	4988	23922	4069	28115	3295	30035	2693	31652	1784	38744	1310	26752
18-#11	1.88	MA	20496	4988	30731	4144	36653	3359	39436	2751	42077	1844	52210	1404	35511
6L-5S		MI	16069	4988	24604	4070	29024	3287	31142	2697	33095	1779	40661	1386	27283
18-#11	1.88	MA	19861	4988	29845	4145	35480	3359	38003	2760	40084	1840	49823	1333	34907
7L-4S		MI	16579	4988	25371	4060	29945	3289	32265	2691	34595	1774	42567	1429	27681
18-#11	1.88	MA	19233	4988	28973	4146	34331	3359	36568	2758	38161	1847	47362	1279	33806
8L-3S		MI	17141	4988	26128	4061	30968	3281	33505	2694	36239	1779	44369	1520	27773
18-#11	1.88	MA	18610	4988	28010	4158	33147	3369	35155	2767	36256	1853	44927	1220	32838
9L-2S		MI	17911	4988	27142	4061	32253	3283	35062	2688	38310	1774	47115	1611	27817
18-#14	2.71	MA	23515	5439	37057	4401	44528	3549	48951	2867	54874	1803	69388	1377	52191
4L-7S		MI	15711	5439	25587	4335	30055	3487	32327	2820	34571	1734	43073	972	35608
18-#14	2.71	MA	22577	5439	35586	4418	42763	3548	46797	2880	51940	1812	65631	1310	50463
5L-6S		MI	16375	5439	26539	4337	31314	3491	33864	2812	36649	1741	45477	1075	36893
18-#14	2.71	MA	21678	5439	34280	4419	41021	3563	44676	2877	49120	1821	61816	1202	49388
6L-5S		MI	17054	5439	27516	4338	32616	3480	35448	2818	38697	1734	48191	1185	37694
18-#14	2.71	MA	20797	5439	33009	4420	39338	3562	42621	2890	46261	1814	58422	1100	47473
7L-4S		MI	17761	5439	28614	4325	33933	3484	37056	2810	40827	1726	50898	1246	38902

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis

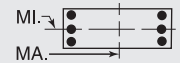


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.71	MA	19927	5439	31758	4422	37690	3561	40561	2887	43502	1823	54912	1023	45708
8L-3S		MI	18540	5439	29697	4327	35397	3473	38829	2816	43162	1734	53445	1378	39278
18-#14	2.71	MA	19062	5439	30376	4438	35991	3576	38535	2900	40771	1832	51450	938	43713
9L-2S		MI	19608	5439	31144	4328	37232	3477	41052	2808	46103	1726	57334	1509	39420
18-#18	4.81	MA	24468	6584	43058	5120	51873	4080	57718	3198	66569	1753	85435	666	80190
6L-5S		MI	19346	6584	34667	5024	41484	3972	45969	3117	52398	1604	66477	643	61980
18-#18	4.81	MA	23026	6584	40821	5120	48914	4077	54103	3218	61563	1740	79571	484	75685
7L-4S		MI	20507	6584	36589	5003	43790	3982	48760	3104	56067	1591	71122	752	64259
20-#11	2.09	MA	22474	5101	34034	4202	40832	3401	44518	2776	48924	1826	61365	1514	40853
4L-8S		MI	15115	5101	23616	4139	27659	3342	29443	2728	30849	1777	38012	1170	28464
20-#11	2.09	MA	21804	5101	33009	4214	39601	3401	43016	2785	46878	1832	58730	1467	40268
5L-7S		MI	15584	5101	24270	4140	28521	3344	30519	2732	32260	1772	39791	1220	29167
20-#11	2.09	MA	21161	5101	32099	4215	38387	3411	41538	2783	44912	1839	56049	1392	39454
6E		MI	16059	5101	24935	4140	29400	3347	31592	2726	33723	1777	41491	1292	29659
20-#11	2.09	MA	20533	5101	31213	4216	37214	3411	40105	2793	42919	1835	53662	1321	38798
7L-5S		MI	16544	5101	25617	4141	30309	3339	32698	2730	35166	1772	43407	1367	30169
20-#11	2.09	MA	19911	5101	30340	4217	36065	3411	38669	2791	40996	1842	51200	1267	37722
8L-4S		MI	17049	5101	26384	4131	31230	3341	33822	2723	36666	1767	45314	1411	30648
20-#11	2.09	MA	19294	5101	29377	4229	34881	3421	37257	2800	39091	1848	48766	1209	36724
9L-3S		MI	17606	5101	27142	4132	32253	3333	35062	2727	38310	1772	47115	1502	30755
20-#11	2.09	MA	18680	5101	28508	4230	33740	3421	35838	2799	37133	1845	46249	1129	35511
10L-2S		MI	18370	5101	28155	4132	33538	3335	36618	2721	40381	1767	49862	1593	30812
20-#14	3.01	MA	23485	5603	37545	4520	45246	3623	49805	2927	55999	1805	71094	1292	56086
5L-7S		MI	16380	5603	27034	4438	31890	3561	34550	2867	37512	1722	46963	943	39698
20-#14	3.01	MA	22597	5603	36238	4521	43504	3637	47685	2925	53179	1813	67279	1183	54980
6E		MI	17037	5603	27986	4439	33149	3566	36087	2859	39590	1730	49367	1046	40940
20-#14	3.01	MA	21729	5603	34967	4522	41822	3637	45629	2937	50320	1807	63885	1081	53067
7L-5S		MI	17708	5603	28963	4441	34451	3555	37671	2866	41639	1722	52081	1156	41823
20-#14	3.01	MA	20870	5603	33716	4524	40173	3636	43569	2935	47561	1816	60376	1004	51199
8L-4S		MI	18407	5603	30061	4427	35768	3559	39279	2857	43769	1715	54787	1217	42978
20-#14	3.01	MA	20016	5603	32334	4540	38474	3651	41543	2947	44829	1824	56913	919	49306
9L-3S		MI	19177	5603	31144	4429	37232	3548	41052	2864	46103	1722	57334	1349	43514
20-#18	5.35	MA	24574	6875	44251	5302	53264	4210	59373	3302	68653	1726	89024	445	85393
7L-5S		MI	20509	6875	37188	5206	44681	4105	49820	3200	57464	1579	73138	583	68973
22-#11	2.29	MA	22454	5215	34377	4284	41336	3453	45117	2818	49713	1827	62569	1455	44191
5L-8S		MI	15597	5215	24629	4210	28944	3394	31000	2761	32920	1770	40758	1151	31345
22-#11	2.29	MA	21818	5215	33466	4286	40122	3463	43639	2816	47747	1834	59888	1380	43401
6L-7S		MI	16062	5215	25283	4210	29806	3396	32075	2765	34332	1765	42537	1202	32026
22-#11	2.29	MA	21196	5215	32580	4287	38949	3463	42206	2825	45754	1830	57501	1310	42694
7L-6S		MI	16532	5215	25948	4211	30685	3399	33149	2759	35795	1770	44237	1273	32570
22-#11	2.29	MA	20581	5215	31708	4288	37800	3463	40770	2824	43831	1837	55039	1256	41644
8L-5S		MI	17013	5215	26630	4212	31594	3391	34255	2763	37237	1765	46154	1349	33062
22-#11	2.29	MA	19970	5215	30745	4300	36615	3473	39358	2833	41926	1843	52605	1197	40616
9L-4S		MI	17514	5215	27398	4202	32515	3393	35379	2756	38737	1759	48060	1392	33613
22-#11	2.29	MA	19361	5215	29876	4301	35474	3473	37939	2832	39968	1839	50088	1117	39426
10L-3S		MI	18066	5215	28155	4203	33538	3385	36618	2760	40381	1765	49862	1483	33735
22-#11	2.29	MA	18717	5215	29014	4302	34304	3483	36535	2841	38072	1846	47668	1060	38081
11L-2S		MI	18824	5215	29168	4203	34823	3387	38175	2754	42452	1759	52608	1574	33803
22-#14	3.31	MA	23504	5767	38196	4623	45987	3712	50693	2972	57238	1806	72743	1165	60534
6L-7S		MI	17040	5767	28481	4540	33725	3636	36773	2915	40454	1711	50852	915	43796
22-#14	3.31	MA	22646	5767	36925	4625	44305	3712	48637	2984	54379	1799	69348	1063	58669
7L-6S		MI	17690	5767	29433	4541	34984	3640	38310	2906	42532	1718	53256	1017	44997
22-#14	3.31	MA	21798	5767	35674	4626	42656	3711	46578	2982	51620	1808	65839	986	56761
8L-5S		MI	18353	5767	30410	4543	36286	3629	39894	2913	44580	1711	55970	1127	45960
22-#14	3.31	MA	20955	5767	34292	4642	40957	3725	44552	2994	48888	1817	62376	901	54858
9L-4S		MI	19044	5767	31508	4529	37603	3633	41502	2905	46710	1703	58677	1188	47065
24-#11	2.50	MA	22467	5328	34834	4357	41856	3515	45740	2849	50582	1829	63727	1369	47353
6L-8S		MI	16074	5328	25642	4281	30229	3446	32556	2794	34992	1762	43505	1133	34229

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.50	MA	21851	5328	33948	4358	40683	3515	44307	2858	48589	1825	61340	1298	46597
7E		MI	16534	5328	26297	4281	31091	3448	33632	2798	36403	1757	45284	1183	34892
24-#11	2.50	MA	21242	5328	33076	4359	39534	3515	42872	2857	46666	1831	58878	1244	45570
8L-6S		MI	17001	5328	26961	4282	31970	3451	34706	2792	37866	1762	46984	1255	35484
24-#11	2.50	MA	20637	5328	32112	4371	38350	3525	41459	2866	44761	1838	56443	1185	44512
9L-5S		MI	17477	5328	27644	4283	32879	3442	35812	2796	39309	1757	48901	1330	35959
24-#11	2.50	MA	20034	5328	31244	4372	37209	3525	40040	2865	42803	1834	53926	1105	43344
10L-4S		MI	17974	5328	28411	4273	33800	3445	36936	2789	40809	1752	50807	1374	36576
24-#11	2.50	MA	19392	5328	30381	4373	36038	3535	38636	2874	40907	1841	51507	1048	41980
11L-3S		MI	18521	5328	29168	4273	34823	3437	38175	2793	42452	1757	52608	1465	36711
24-#14	3.61	MA	23552	5930	38883	4727	46788	3786	51646	3032	58438	1792	74811	1044	64278
7E		MI	17692	5930	29928	4642	35560	3711	38996	2962	43395	1699	54741	886	47902
24-#14	3.61	MA	22714	5930	37632	4728	45139	3786	49586	3029	55679	1801	71302	967	62331
8L-6S		MI	18335	5930	30880	4644	36819	3715	40533	2954	45473	1706	57145	989	49065
24-#14	3.61	MA	21881	5930	36250	4744	43440	3800	47560	3042	52947	1809	67839	882	60400
9L-5S		MI	18991	5930	31857	4645	38121	3704	42117	2960	47521	1699	59859	1098	50102

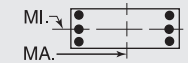
RECTANGULAR TIED COLUMNS 34" x 46"

4-#18	1.02	MA	22767	4729	32313	3988	38300	3247	40894	2701	42933	1920	51961	1809	22217
2E		MI	16564	4729	24190	3894	28109	3171	29686	2633	30579	1847	36529	1714	15965
6-#18	1.53	MA	24503	5020	35924	4169	42881	3380	46443	2785	50419	1906	61974	1773	32943
2L-3S		MI	15791	5020	24190	4071	28109	3294	29686	2728	30579	1835	36529	1420	23417
6-#18	1.53	MA	21716	5020	32313	4171	38300	3378	40894	2806	42933	1920	51961	1540	32677
3L-2S		MI	17730	5020	26711	4076	31307	3304	33537	2715	35645	1822	43190	1654	23501
8-#14	1.15	MA	23312	4802	33110	4057	39522	3300	42466	2739	45116	1929	55185	1826	25118
2L-4S		MI	14997	4802	22203	3969	25700	3237	26897	2681	27013	1867	32466	1471	17974
8-#14	1.15	MA	21693	4802	31050	4058	36909	3300	39300	2752	40845	1939	49406	1695	25068
3E		MI	15828	4802	23286	3970	27163	3226	28670	2688	29348	1875	35013	1603	18049
8-#14	1.15	MA	20523	4802	29522	4060	34843	3315	36796	2750	37465	1933	45592	1563	24841
4L-2S		MI	16959	4802	24733	3972	28998	3230	30893	2679	32289	1867	38902	1734	18035
8-#18	2.05	MA	26185	5311	39536	4351	47461	3513	51992	2869	57906	1893	71987	1737	43622
2L-4S		MI	15558	5311	24816	4248	28748	3443	30460	2798	31623	1797	38826	1130	29255
8-#18	2.05	MA	23454	5311	35924	4352	42881	3511	46443	2890	50419	1907	61974	1504	43234
3E		MI	16959	5311	26711	4253	31307	3427	33537	2811	35645	1810	43190	1360	30792
8-#18	2.05	MA	21477	5311	33239	4354	39250	3536	42043	2885	44481	1894	55380	1270	40995
4L-2S		MI	18862	5311	29232	4258	34504	3437	37388	2798	40712	1797	49851	1594	30981
10-#14	1.44	MA	24311	4966	35170	4159	42135	3375	45631	2786	49387	1922	60963	1809	31227
2L-5S		MI	14953	4966	22552	4084	26217	3308	27512	2737	27824	1863	33649	1381	21453
10-#14	1.44	MA	22713	4966	33110	4161	39522	3375	42466	2799	45116	1931	55185	1678	31137
3L-4S		MI	15698	4966	23650	4071	27535	3312	29120	2729	29954	1856	36356	1442	22208
10-#14	1.44	MA	21559	4966	31582	4162	37456	3390	39962	2797	41736	1926	51371	1546	30860
4L-3S		MI	16518	4966	24733	4073	28998	3301	30893	2735	32289	1863	38902	1574	22327
10-#14	1.44	MA	20514	4966	30037	4179	35602	3390	37698	2810	38654	1935	47403	1479	29666
5L-2S		MI	17636	4966	26180	4074	30833	3305	33116	2727	35230	1856	42792	1705	22349
10-#18	2.56	MA	27822	5602	43147	4533	52041	3646	57540	2954	65392	1880	82000	1701	54276
2L-5S		MI	15471	5602	25416	4451	29639	3566	31520	2894	33020	1786	40842	962	34304
10-#18	2.56	MA	25143	5602	39536	4534	47461	3644	51992	2974	57906	1894	71987	1468	53784
3L-4S		MI	16722	5602	27337	4429	31946	3576	34311	2880	36690	1772	45487	1071	36231
10-#18	2.56	MA	23208	5602	36850	4536	43830	3669	47592	2969	51968	1881	65393	1234	51150
4L-3S		MI	18096	5602	29232	4434	34504	3560	37388	2894	40712	1786	49851	1301	38148
10-#18	2.56	MA	21455	5602	34133	4564	40569	3667	43612	2990	46549	1895	58493	1117	47928
5L-2S		MI	19967	5602	31753	4439	37701	3570	41240	2880	45779	1772	56512	1534	38425

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

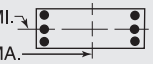


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.20	MA	23528	4828	33387	4085	39981	3322	43068	2755	45960	1934	56483	1836	26213
2L-6S		MI	14720	4828	21701	4012	25200	3267	26322	2703	26332	1889	31523	1446	18182
12-#11	1.20	MA	22400	4828	31949	4087	38156	3322	40857	2764	42978	1942	52426	1745	26180
3L-5S		MI	15225	4828	22384	4013	26109	3259	27428	2707	27775	1884	33439	1522	18712
12-#11	1.20	MA	21586	4828	30883	4088	36715	3333	39111	2763	40621	1938	49745	1654	26079
4E		MI	15751	4828	23151	4003	27030	3262	28552	2701	29275	1879	35346	1565	18804
12-#11	1.20	MA	20850	4828	29806	4100	35423	3333	37533	2773	38472	1945	46964	1607	25858
5L-3S		MI	16330	4828	23908	4004	28053	3253	29791	2705	30919	1884	37147	1656	18834
12-#11	1.20	MA	20145	4828	28850	4101	34147	3344	35980	2772	36407	1952	44130	1532	25000
6L-2S		MI	17121	4828	24921	4004	29338	3256	31348	2698	32990	1879	39893	1748	18827
12-#14	1.73	MA	25291	5129	37231	4261	44748	3450	48797	2833	53658	1914	66742	1792	37324
2L-6S		MI	14944	5129	23022	4185	26751	3394	28151	2778	28717	1859	34824	1243	24768
12-#14	1.73	MA	23713	5129	35170	4263	42135	3450	45631	2846	49387	1924	60963	1661	37197
3L-5S		MI	15650	5129	23999	4187	28052	3383	29735	2784	30766	1852	37538	1352	25532
12-#14	1.73	MA	22574	5129	33642	4265	40069	3465	43127	2845	46007	1918	57150	1529	36877
4E		MI	16386	5129	25097	4173	29370	3387	31343	2776	32896	1844	40245	1413	26434
12-#14	1.73	MA	21545	5129	32097	4281	38215	3465	40864	2858	42925	1928	53182	1462	35535
5L-3S		MI	17196	5129	26180	4175	30833	3376	33116	2782	35230	1852	42792	1545	26592
12-#14	1.73	MA	20558	5129	30725	4283	36385	3479	38636	2856	39962	1937	49147	1354	34250
6L-2S		MI	18302	5129	27627	4176	32668	3380	35339	2774	38172	1844	46681	1676	26645
12-#18	3.07	MA	26789	5892	43147	4716	52041	3777	57540	3059	65392	1880	82000	1431	64330
3L-5S		MI	16631	5892	27937	4633	32836	3699	35371	2976	38087	1761	47503	902	41438
12-#18	3.07	MA	24893	5892	40462	4717	48411	3802	53141	3053	59454	1868	75406	1198	61348
4E		MI	17858	5892	29858	4611	35143	3709	38163	2963	41756	1748	52148	1011	43252
12-#18	3.07	MA	23178	5892	37744	4745	45150	3800	49161	3074	54035	1881	68506	1081	58269
5L-3S		MI	19209	5892	31753	4616	37701	3693	41240	2976	45779	1761	56512	1241	45492
12-#18	3.07	MA	21531	5892	35330	4747	41931	3824	45243	3068	48824	1895	61515	888	54044
6L-2S		MI	21050	5892	34274	4621	40898	3703	45091	2963	50845	1748	63173	1474	45849
14-#11	1.40	MA	24229	4942	34826	4156	41805	3374	45278	2787	48942	1929	60541	1826	30476
2L-7S		MI	14729	4942	22050	4082	25606	3317	26805	2743	26940	1877	32569	1357	20687
14-#11	1.40	MA	23111	4942	33387	4157	39981	3374	43068	2797	45960	1936	56483	1735	30425
3L-6S		MI	15219	4942	22714	4083	26485	3319	27878	2736	28403	1882	34269	1428	21071
14-#11	1.40	MA	22305	4942	32322	4159	38540	3385	41321	2796	43603	1933	53803	1643	30302
4L-5S		MI	15719	4942	23397	4084	27394	3311	28985	2740	29846	1877	36186	1504	21664
14-#11	1.40	MA	21577	4942	31245	4171	37247	3385	39743	2805	41454	1940	51022	1596	30058
5L-4S		MI	16240	4942	24164	4074	28315	3313	30108	2734	31346	1872	38092	1547	21786
14-#11	1.40	MA	20880	4942	30289	4172	35972	3396	38191	2805	39389	1947	48188	1521	29131
6L-3S		MI	16814	4942	24921	4075	29338	3305	31348	2737	32990	1877	39893	1638	21834
14-#11	1.40	MA	20196	4942	29359	4174	34740	3396	36686	2814	37295	1944	45663	1451	28467
7L-2S		MI	17598	4942	25934	4075	30623	3308	32905	2731	35061	1872	42640	1729	21845
14-#14	2.01	MA	26254	5293	39291	4363	47361	3525	51962	2881	57929	1907	72521	1775	43412
2L-7S		MI	14955	5293	23517	4286	27327	3465	28837	2833	29581	1840	36310	1111	27705
14-#14	2.01	MA	24694	5293	37231	4365	44748	3525	48797	2894	53658	1916	66742	1644	43251
3L-6S		MI	15638	5293	24469	4287	28586	3469	30374	2825	31658	1847	38714	1214	28897
14-#14	2.01	MA	23571	5293	35703	4367	42682	3539	46293	2892	50278	1911	62928	1512	42893
4L-5S		MI	16336	5293	25446	4289	29887	3458	31958	2832	33707	1840	41428	1323	29627
14-#14	2.01	MA	22556	5293	34157	4383	40828	3539	44029	2905	47196	1920	58960	1445	41419
5L-4S		MI	17063	5293	26544	4275	31205	3462	33566	2823	35837	1833	44134	1384	30654
14-#14	2.01	MA	21583	5293	32786	4385	38998	3554	41802	2903	44233	1929	54925	1337	40180
6L-3S		MI	17863	5293	27627	4277	32668	3451	35339	2830	38172	1840	46681	1516	30847
14-#14	2.01	MA	20629	5293	31451	4387	37231	3554	39642	2916	41229	1924	51332	1234	38408
7L-2S		MI	18957	5293	29074	4279	34503	3455	37562	2821	41113	1833	50570	1647	30927
14-#18	3.58	MA	26540	6183	44073	4899	52991	3935	58690	3137	66941	1854	85419	1162	71582
4L-5S		MI	17765	6183	30458	4814	36034	3832	39222	3059	43153	1736	54164	842	48507
14-#18	3.58	MA	24858	6183	41356	4927	49730	3933	54710	3158	61522	1868	78519	1045	68633
5L-4S		MI	18972	6183	32379	4793	38340	3842	42014	3046	46823	1723	58809	951	50309
14-#18	3.58	MA	23245	6183	38942	4928	46511	3957	50791	3152	56310	1882	71528	852	64290
6L-3S		MI	20299	6183	34274	4798	40898	3826	45091	3059	50845	1736	63173	1181	52829
14-#18	3.58	MA	21664	6183	36591	4930	43401	3955	46992	3173	51027	1869	65312	670	59848
7L-2S		MI	22112	6183	36795	4803	44096	3836	48942	3046	55912	1723	69834	1415	53257

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis



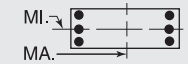
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.60	MA	24920	5055	36264	4227	43629	3426	47488	2820	51924	1924	64599	1815	34734
2L-8S		MI	14746	5055	22409	4153	26030	3367	27286	2771	27600	1875	33537	1288	22904
16-#11	1.60	MA	23812	5055	34826	4228	41805	3426	45278	2830	48942	1931	60541	1724	34667
3L-7S		MI	15226	5055	23063	4153	26891	3369	28362	2775	29012	1870	35316	1338	23595
16-#11	1.60	MA	23014	5055	33760	4230	40364	3437	43531	2829	46585	1928	57861	1633	34523
4L-6S		MI	15711	5055	23728	4154	27770	3371	29435	2769	30475	1875	37016	1409	23968
16-#11	1.60	MA	22294	5055	32683	4242	39071	3437	41953	2838	44436	1935	55079	1586	34222
5E		MI	16207	5055	24410	4155	28679	3363	30542	2773	31917	1870	38932	1485	24533
16-#11	1.60	MA	21603	5055	31727	4243	37796	3448	40401	2837	42371	1942	52246	1511	33269
6L-4S		MI	16723	5055	25177	4145	29600	3365	31665	2766	33417	1865	40839	1528	24763
16-#11	1.60	MA	20927	5055	30797	4245	36565	3448	38896	2847	40277	1939	49721	1440	32622
7L-3S		MI	17291	5055	25934	4146	30623	3357	32905	2770	35061	1870	42640	1620	24828
16-#11	1.60	MA	20259	5055	29881	4246	35358	3448	37388	2846	38258	1946	47122	1385	31568
8L-2S		MI	18070	5055	26948	4146	31908	3359	34462	2764	37133	1865	45387	1711	24853
16-#14	2.30	MA	25660	5456	39291	4467	47361	3599	51962	2941	57929	1909	72521	1627	49301
3L-7S		MI	15646	5456	24964	4388	29162	3539	31060	2881	32522	1828	40199	1082	31771
16-#14	2.30	MA	24552	5456	37763	4469	45295	3614	49458	2939	54549	1903	68707	1495	48909
4L-6S		MI	16321	5456	25916	4390	30421	3543	32597	2873	34600	1836	42603	1185	33034
16-#14	2.30	MA	23550	5456	36218	4486	43441	3614	47195	2952	51467	1913	64739	1428	47317
5E		MI	17011	5456	26893	4391	31722	3532	34181	2879	36648	1828	45317	1294	33735
16-#14	2.30	MA	22589	5456	34846	4487	41611	3629	44967	2950	48504	1922	60704	1320	46118
6L-4S		MI	17729	5456	27991	4378	33040	3537	35789	2871	38778	1821	48024	1356	34871
16-#14	2.30	MA	21649	5456	33511	4489	39844	3629	42808	2963	45500	1916	57111	1217	44281
7L-3S		MI	18520	5456	29074	4379	34503	3526	37562	2877	41113	1828	50570	1487	35095
16-#14	2.30	MA	20719	5456	32197	4491	38112	3629	40645	2961	42602	1926	53404	1140	42587
8L-2S		MI	19603	5456	30521	4381	36338	3530	39785	2869	44054	1821	54460	1618	35201
16-#18	4.09	MA	26503	6474	44967	5109	54310	4066	60258	3242	69008	1855	88532	1009	79014
5E		MI	18878	6474	32979	4996	39231	3965	43073	3142	48220	1711	60825	783	55437
16-#18	4.09	MA	24921	6474	42553	5110	51091	4090	56340	3237	63797	1869	81541	816	74558
6L-4S		MI	20065	6474	34900	4975	41537	3975	45865	3128	51890	1698	65470	891	57397
16-#18	4.09	MA	23370	6474	40203	5112	47981	4088	52541	3258	58513	1856	75325	634	70054
7L-3S		MI	21372	6474	36795	4980	44096	3959	48942	3142	55912	1711	69834	1121	60160
16-#18	4.09	MA	21836	6474	37889	5113	44934	4086	48735	3252	53415	1869	68881	499	65455
8L-2S		MI	23159	6474	39316	4985	47293	3969	52793	3128	60979	1698	76495	1355	60654
18-#11	1.80	MA	24504	5168	36264	4299	43629	3478	47488	2863	51924	1926	64599	1713	38904
3L-8S		MI	15241	5168	23422	4224	27315	3418	28843	2804	29672	1868	36283	1269	25772
18-#11	1.80	MA	23714	5168	35199	4301	42188	3489	45742	2862	49567	1923	61918	1622	38742
4L-7S		MI	15716	5168	24076	4224	28176	3421	29919	2808	31083	1862	38062	1320	26507
18-#11	1.80	MA	23001	5168	34122	4313	40896	3489	44164	2871	47418	1930	59137	1575	38334
5L-6S		MI	16197	5168	24741	4225	29055	3423	30992	2802	32546	1868	39762	1391	26870
18-#11	1.80	MA	22317	5168	33166	4314	39620	3500	42611	2870	45353	1937	56303	1500	37414
6L-5S		MI	16688	5168	25423	4225	29964	3415	32099	2806	33989	1862	41679	1467	27410
18-#11	1.80	MA	21648	5168	32236	4316	38389	3500	41106	2880	43259	1934	53778	1429	36781
7L-4S		MI	17200	5168	26190	4216	30885	3417	33222	2799	35489	1857	43585	1510	27735
18-#11	1.80	MA	20987	5168	31320	4317	37182	3500	39599	2879	41239	1941	51180	1375	35686
8L-3S		MI	17764	5168	26948	4216	31908	3409	34462	2803	37133	1862	45387	1601	27817
18-#11	1.80	MA	20330	5168	30308	4329	35939	3511	38115	2888	39240	1948	48605	1316	34756
9L-2S		MI	18536	5168	27961	4217	33193	3411	36018	2797	39204	1857	48133	1692	27855
18-#14	2.59	MA	25517	5620	39823	4571	47908	3689	52624	2987	58820	1896	74486	1478	54925
4L-7S		MI	16327	5620	26411	4490	30997	3614	33283	2928	35463	1817	44088	1053	35849
18-#14	2.59	MA	24528	5620	38278	4588	46053	3689	50360	3000	55737	1905	70518	1411	53227
5L-6S		MI	16994	5620	27363	4492	32256	3618	34820	2920	37541	1824	46492	1156	37161
18-#14	2.59	MA	23580	5620	36906	4590	44224	3704	48133	2998	52774	1915	66483	1303	52063
6L-5S		MI	17676	5620	28340	4493	33557	3607	36404	2926	39590	1817	49206	1265	37853

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

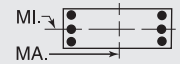


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.59	MA	22652	5620	35571	4591	42456	3704	45973	3011	49771	1909	62889	1200	50165
7L-4S		MI	18386	5620	29438	4480	34875	3611	38012	2918	41720	1809	51913	1327	39085
18-#14	2.59	MA	21734	5620	34257	4593	40725	3704	43810	3009	46873	1918	59183	1123	48428
8L-3S		MI	19169	5620	30521	4481	36338	3600	39785	2925	44054	1817	54460	1458	39338
18-#14	2.59	MA	20823	5620	32805	4610	38940	3718	41682	3022	44003	1928	55518	1038	46266
9L-2S		MI	20241	5620	31968	4483	38173	3604	42008	2916	46996	1809	58349	1589	39467
18-#18	4.60	MA	26564	6765	46164	5292	55671	4223	61889	3321	71283	1855	91554	780	84845
6L-5S		MI	19973	6765	35500	5178	42428	4098	46925	3224	53287	1687	67486	723	62396
18-#18	4.60	MA	25042	6765	43814	5293	52561	4221	58090	3342	66000	1842	85338	598	80278
7L-4S		MI	21141	6765	37421	5156	44735	4108	49716	3211	56956	1673	72131	831	64509
18-#18	4.60	MA	23535	6765	41501	5295	49514	4219	54284	3336	60901	1856	78894	463	75638
8L-3S		MI	22428	6765	39316	5161	47293	4092	52793	3224	60979	1687	76495	1061	67487
20-#11	1.99	MA	24405	5282	36637	4372	44013	3541	47952	2895	52548	1918	65976	1611	42959
4L-8S		MI	15730	5282	24435	4294	28600	3470	30400	2837	31743	1860	39030	1251	28645
20-#11	1.99	MA	23699	5282	35560	4383	42720	3541	46374	2904	50400	1925	63195	1564	42455
5L-7S		MI	16201	5282	25089	4295	29461	3473	31475	2841	33154	1855	40809	1301	29361
20-#11	1.99	MA	23022	5282	34604	4385	41445	3551	44821	2903	48335	1932	60361	1489	41564
6E		MI	16678	5282	25754	4296	30340	3475	32549	2835	34617	1860	42509	1372	29777
20-#11	1.99	MA	22360	5282	33674	4386	40213	3552	43316	2913	46241	1928	57836	1419	40944
7L-5S		MI	17164	5282	26436	4296	31249	3467	33655	2839	36060	1855	44425	1448	30295
20-#11	1.99	MA	21705	5282	32758	4388	39007	3552	41809	2912	44221	1936	55238	1364	39810
8L-4S		MI	17671	5282	27204	4287	32170	3469	34779	2832	37560	1850	46332	1491	30705
20-#11	1.99	MA	21055	5282	31747	4400	37763	3563	40326	2921	42222	1943	52663	1306	38849
9L-3S		MI	18230	5282	27961	4287	33193	3461	36018	2836	39204	1855	48133	1583	30801
20-#11	1.99	MA	20408	5282	30835	4401	36565	3563	38836	2920	40165	1939	50002	1226	37536
10L-2S		MI	18997	5282	28974	4288	34478	3463	37575	2830	41275	1850	50880	1674	30851
20-#14	2.88	MA	25491	5783	40338	4690	48666	3764	53526	3047	60008	1898	76297	1394	59147
5L-7S		MI	16998	5783	27858	4592	32832	3689	35507	2976	38405	1805	47978	1024	39936
20-#14	2.88	MA	24555	5783	38966	4692	46837	3779	51298	3045	57045	1907	72261	1286	58015
6E		MI	17658	5783	28809	4594	34091	3693	37043	2967	40483	1813	50382	1127	41204
20-#14	2.88	MA	23639	5783	37631	4694	45069	3778	49139	3058	54042	1902	68668	1183	56057
7L-5S		MI	18332	5783	29787	4596	35392	3682	38627	2974	42531	1805	53096	1236	41981
20-#14	2.88	MA	22733	5783	36317	4695	43338	3778	46976	3056	51144	1911	64962	1106	54278
8L-4S		MI	19034	5783	30885	4582	36710	3686	40235	2965	44661	1798	55802	1298	43164
20-#14	2.88	MA	21833	5783	34866	4712	41553	3793	44847	3069	48274	1920	61297	1021	52159
9L-3S		MI	19809	5783	31968	4584	38173	3675	42008	2972	46996	1805	58349	1429	43576
20-#14	2.88	MA	20935	5783	33557	4714	39834	3793	42709	3067	45323	1915	57508	906	49797
10L-2S		MI	20870	5783	33415	4585	40008	3679	44232	2964	49937	1798	62238	1560	43729
20-#18	5.12	MA	26683	7056	47426	5475	57142	4354	63639	3426	73486	1829	95351	562	90518
7L-5S		MI	21052	7056	38021	5360	45625	4231	50776	3307	58353	1662	74147	663	69380
20-#18	5.12	MA	25203	7056	45112	5477	54094	4352	59833	3420	68388	1843	88907	426	85835
8L-4S		MI	22203	7056	39942	5338	47932	4241	53567	3294	62023	1649	78792	772	71642
22-#11	2.19	MA	24388	5395	36999	4454	44544	3593	48584	2937	53382	1919	67253	1554	46583
5L-8S		MI	16213	5395	25448	4365	29885	3522	31957	2870	33814	1853	41776	1232	31524
22-#11	2.19	MA	23718	5395	36043	4456	43269	3603	47031	2936	51316	1927	64419	1479	45718
6L-7S		MI	16680	5395	26103	4366	30746	3524	33032	2874	35226	1848	43555	1283	32218
22-#11	2.19	MA	23062	5395	35112	4457	42038	3604	45527	2945	49223	1923	61894	1408	45083
7L-6S		MI	17153	5395	26767	4367	31625	3527	34106	2867	36689	1853	45255	1354	32688
22-#11	2.19	MA	22414	5395	34197	4459	40831	3604	44019	2945	47203	1930	59295	1353	43938
8L-5S		MI	17635	5395	27450	4367	32534	3519	35212	2871	38131	1848	47172	1430	33187
22-#11	2.19	MA	21771	5395	33185	4471	39587	3615	42536	2954	45204	1937	56721	1295	42947
9L-4S		MI	18138	5395	28217	4358	33455	3521	36336	2865	39631	1843	49078	1473	33672
22-#11	2.19	MA	21129	5395	32273	4472	38389	3615	41046	2953	43147	1934	54060	1215	41658
10L-3S		MI	18692	5395	28974	4358	34478	3513	37575	2869	41275	1848	50880	1564	33783
22-#11	2.19	MA	20442	5395	31368	4474	37160	3625	39572	2963	41156	1941	51506	1158	40319
11L-2S		MI	19453	5395	29987	4359	35763	3515	39132	2862	43346	1843	53626	1655	33844
22-#14	3.16	MA	25517	5947	41027	4794	49450	3853	54464	3093	61316	1900	78040	1269	63972
6L-7S		MI	17660	5947	29304	4695	34667	3764	37730	3023	41346	1794	51867	995	44031

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.16	MA	24612	5947	39692	4796	47682	3853	52305	3106	58313	1894	74447	1166	61957
7L-6S		MI	18313	5947	30256	4696	35926	3768	39267	3015	43424	1801	54271	1098	45258
22-#14	3.16	MA	23718	5947	38377	4797	45951	3853	50141	3104	55415	1903	70740	1089	60076
8L-5S		MI	18980	5947	31234	4698	37227	3757	40851	3021	45472	1794	56985	1207	46116
22-#14	3.16	MA	22829	5947	36926	4814	44166	3868	48013	3117	52545	1913	67076	1004	58058
9L-4S		MI	19675	5947	32331	4684	38545	3761	42458	3013	47602	1786	59692	1269	47250
22-#14	3.16	MA	21935	5947	35617	4816	42447	3868	45875	3115	49594	1907	63287	889	55670
10L-3S		MI	20441	5947	33415	4686	40008	3750	44232	3019	49937	1794	62238	1400	47811
22-#18	5.63	MA	26842	7346	48723	5658	58674	4485	65381	3505	75874	1830	98920	390	96046
8L-5S		MI	22198	7346	40542	5541	48823	4364	54627	3389	63420	1637	80808	603	76389
24-#11	2.39	MA	24406	5509	37481	4527	45093	3655	49242	2969	54298	1921	68477	1468	49877
6L-8S		MI	16691	5509	26461	4436	31170	3574	33513	2903	35886	1846	44523	1214	34407
24-#11	2.39	MA	23757	5509	36551	4528	43862	3655	47737	2978	52205	1918	65951	1397	49192
7E		MI	17154	5509	27116	4437	32031	3576	34589	2907	37297	1841	46302	1264	35081
24-#11	2.39	MA	23115	5509	35635	4530	42655	3656	46229	2977	50185	1925	63353	1343	48071
8L-6S		MI	17623	5509	27781	4438	32910	3579	35662	2900	38760	1846	48002	1336	35602
24-#11	2.39	MA	22478	5509	34624	4541	41412	3666	44746	2987	48185	1932	60779	1284	47050
9L-5S		MI	18101	5509	28463	4438	33819	3570	36769	2904	40203	1841	49919	1411	36084
24-#11	2.39	MA	21838	5509	33712	4543	40214	3667	43256	2986	46129	1929	58117	1204	45784
10L-4S		MI	18600	5509	29230	4428	34740	3573	37892	2898	41703	1836	51825	1455	36637
24-#11	2.39	MA	21157	5509	32807	4544	38984	3677	41782	2995	44138	1936	55564	1147	44426
11L-3S		MI	19150	5509	29987	4429	35763	3565	39132	2902	43346	1841	53626	1546	36761
24-#11	2.39	MA	20469	5509	31906	4546	37790	3678	40301	2995	42156	1943	53009	1089	43080
12L-2S		MI	19905	5509	31000	4430	37048	3567	40689	2895	45418	1836	56373	1637	36834
24-#14	3.45	MA	25572	6111	41752	4898	50295	3928	55470	3153	62583	1887	80226	1149	67864
7E		MI	18315	6111	30751	4797	36502	3839	39953	3070	44287	1782	55756	966	48135
24-#14	3.45	MA	24688	6111	40438	4900	48564	3928	53307	3151	59685	1896	76519	1072	65944
8L-6S		MI	18961	6111	31703	4798	37761	3843	41490	3062	46365	1790	58160	1069	49323
24-#14	3.45	MA	23810	6111	38986	4916	46779	3943	51179	3164	56816	1905	72854	987	63963
9L-5S		MI	19620	6111	32680	4800	39062	3832	43074	3069	48414	1782	60874	1178	50258
24-#14	3.45	MA	22920	6111	37677	4918	45059	3943	49040	3162	53865	1900	69066	872	61549
10L-4S		MI	20308	6111	33778	4787	40380	3836	44682	3060	50544	1775	63581	1240	51346

RECTANGULAR TIED COLUMNS 34" x 48"

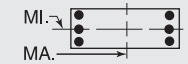
6-#18	1.47	MA	26513	5200	38588	4338	46127	3520	49932	2903	54070	1997	66561	1869	34563
2L-3S		MI	16407	5200	25022	4224	29054	3420	30642	2836	31468	1918	37538	1500	23480
6-#18	1.47	MA	23576	5200	34795	4340	41316	3518	44104	2925	46207	2012	55988	1636	34297
3L-2S		MI	18351	5200	27543	4229	32251	3430	34493	2822	36534	1904	44199	1734	23543
8-#14	1.10	MA	25246	4982	35626	4226	42591	3439	45745	2857	48487	2020	59358	1919	26333
2L-4S		MI	15612	4982	23027	4124	26642	3365	27853	2789	27905	1950	33481	1552	18029
8-#14	1.10	MA	23543	4982	33463	4228	39848	3440	42422	2870	44004	2030	53264	1788	26283
3E		MI	16444	4982	24110	4125	28105	3354	29626	2796	30240	1958	36028	1683	18088
8-#14	1.10	MA	22312	4982	31861	4230	37682	3455	39796	2869	40460	2025	49239	1656	26056
4L-2S		MI	17577	4982	25557	4127	29940	3358	31849	2788	33181	1950	39917	1815	18067
8-#18	1.96	MA	28295	5491	42381	4520	50937	3653	55760	2988	61933	1984	77135	1836	45782
2L-4S		MI	16173	5491	25649	4401	29693	3570	31416	2905	32512	1880	39835	1210	29528
8-#18	1.96	MA	25416	5491	38588	4522	46127	3651	49932	3009	54070	1999	66561	1602	45394
3E		MI	17578	5491	27543	4406	32251	3553	34493	2918	36534	1893	44199	1440	30865
8-#18	1.96	MA	23335	5491	35771	4524	42318	3677	45316	3005	47840	1988	59591	1369	43333
4L-2S		MI	19488	5491	30064	4411	35448	3563	38344	2905	41601	1880	50860	1674	31030
10-#14	1.38	MA	26303	5146	37788	4328	45333	3514	49067	2904	52970	2013	65453	1904	32746
2L-5S		MI	15567	5146	23376	4239	27159	3435	28468	2845	28717	1946	34664	1461	21615

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

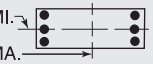


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.38	MA	24621	5146	35626	4330	42591	3515	45745	2918	48487	2023	59358	1772	32655
3L-4S		MI	16314	5146	24474	4226	28477	3440	30076	2837	30847	1939	37371	1523	22269
10-#14	1.38	MA	23407	5146	34024	4332	40424	3530	43119	2916	44943	2018	55333	1641	32379
4L-3S		MI	17136	5146	25557	4227	29940	3429	31849	2843	33181	1946	39917	1654	22372
10-#14	1.38	MA	22310	5146	32404	4349	38481	3530	40746	2930	41712	2028	51155	1573	31255
5L-2S		MI	18257	5146	27004	4229	31775	3433	34072	2835	36123	1939	43807	1786	22384
10-#18	2.45	MA	30029	5782	46175	4702	55748	3786	61588	3072	69797	1971	87709	1803	56976
2L-5S		MI	16084	5782	26248	4604	30583	3693	32475	3001	33909	1868	41851	1042	34540
10-#18	2.45	MA	27204	5782	42381	4704	50937	3784	55760	3094	61933	1986	77135	1569	56484
3L-4S		MI	17340	5782	28170	4583	32890	3703	35267	2988	37579	1855	46496	1150	36497
10-#18	2.45	MA	25167	5782	39564	4706	47128	3810	51144	3089	55703	1974	70165	1335	54013
4L-3S		MI	18720	5782	30064	4588	35448	3686	38344	3001	41601	1868	50860	1380	38228
10-#18	2.45	MA	23323	5782	36714	4735	43708	3808	46969	3111	50020	1989	62890	1217	50517
5L-2S		MI	20597	5782	32585	4593	38645	3696	42195	2988	46668	1855	57521	1614	38480
12-#11	1.15	MA	25472	5008	35914	4254	43067	3461	46371	2873	49366	2025	60711	1929	27476
2L-6S		MI	15333	5008	22520	4168	26140	3395	27279	2812	27226	1973	32541	1527	18298
12-#11	1.15	MA	24285	5008	34404	4256	41153	3462	44052	2883	46237	2033	56435	1838	27443
3L-5S		MI	15839	5008	23203	4168	27050	3387	28385	2816	28669	1968	34457	1603	18769
12-#11	1.15	MA	23430	5008	33287	4258	39643	3473	42221	2882	43766	2030	53607	1747	27343
4E		MI	16367	5008	23970	4159	27970	3390	29509	2809	30169	1962	36364	1646	18846
12-#11	1.15	MA	22657	5008	32159	4270	38288	3473	40568	2892	41514	2037	50680	1700	27122
5L-3S		MI	16947	5008	24727	4159	28993	3381	30748	2813	31813	1968	38165	1737	18869
12-#11	1.15	MA	21917	5008	31157	4271	36952	3484	38941	2891	39350	2045	47693	1625	26290
6L-2S		MI	17740	5008	25740	4160	30278	3384	32305	2807	33884	1962	40911	1828	18857
12-#14	1.65	MA	27340	5309	39951	4430	48076	3589	52390	2952	57453	2005	71547	1888	39147
2L-6S		MI	15557	5309	23846	4340	27692	3521	29107	2886	29609	1942	35839	1323	24922
12-#14	1.65	MA	25678	5309	37788	4432	45333	3589	49067	2965	52970	2015	65453	1757	39020
3L-5S		MI	16266	5309	24823	4342	28994	3510	30691	2893	31658	1935	38553	1433	25692
12-#14	1.65	MA	24481	5309	36186	4434	43167	3605	46441	2964	49425	2010	61428	1625	38699
4E		MI	17004	5309	25921	4328	30312	3514	32299	2884	33788	1927	41260	1494	26500
12-#14	1.65	MA	23399	5309	34567	4451	41223	3605	44069	2977	46195	2020	57249	1557	37420
5L-3S		MI	17816	5309	27004	4330	31775	3503	34072	2891	36123	1935	43807	1625	26640
12-#14	1.65	MA	22361	5309	33129	4454	39305	3620	41734	2976	43089	2030	52993	1449	36034
6L-2S		MI	18925	5309	28451	4331	33610	3508	36296	2882	39064	1927	47696	1757	26684
12-#18	2.94	MA	28947	6073	46175	4886	55748	3917	61588	3178	69797	1973	87709	1536	67570
3L-5S		MI	17247	6073	28769	4786	33781	3826	36327	3084	38976	1843	48512	982	41671
12-#18	2.94	MA	26951	6073	43357	4888	51939	3943	56972	3173	63566	1961	80739	1302	64735
4E		MI	18480	6073	30691	4765	36087	3836	39118	3070	42645	1830	53157	1091	43511
12-#18	2.94	MA	25144	6073	40507	4917	48519	3941	52798	3195	57883	1976	73464	1184	61390
5L-3S		MI	19836	6073	32585	4770	38645	3819	42195	3084	46668	1843	57521	1321	45578
12-#18	2.94	MA	23412	6073	37976	4919	45144	3967	48689	3191	52418	1991	66081	991	57138
6L-2S		MI	21684	6073	35106	4775	41842	3829	46047	3070	51734	1830	64182	1554	45907
14-#11	1.34	MA	26213	5122	37423	4325	44982	3513	48690	2906	52495	2020	64988	1920	31950
2L-7S		MI	15342	5122	22869	4238	26547	3445	27762	2851	27834	1960	33587	1437	20803
14-#11	1.34	MA	25036	5122	35914	4327	43067	3514	46371	2915	49366	2028	60711	1829	31900
3L-6S		MI	15833	5122	23534	4239	27425	3447	28835	2845	29297	1966	35287	1509	21186
14-#11	1.34	MA	24190	5122	34797	4329	41557	3525	44540	2915	46895	2025	57884	1737	31777
4L-5S		MI	16335	5122	24216	4239	28335	3439	29942	2849	30740	1960	37204	1584	21733
14-#11	1.34	MA	23425	5122	33668	4341	40202	3525	42887	2925	44643	2032	54957	1690	31533
5L-4S		MI	16857	5122	24983	4230	29255	3441	31065	2842	32240	1955	39110	1628	21832
14-#11	1.34	MA	22692	5122	32666	4342	38866	3536	41260	2924	42479	2040	51970	1615	30627
6L-3S		MI	17432	5122	25740	4230	30278	3433	32305	2846	33884	1960	40911	1719	21872
14-#11	1.34	MA	21975	5122	31692	4344	37576	3537	39683	2934	40285	2037	49307	1544	29916
7L-2S		MI	18219	5122	26754	4231	31563	3436	33862	2840	35955	1955	43658	1810	21877
14-#14	1.93	MA	28360	5473	42113	4533	50818	3664	55713	2999	61935	1998	77642	1872	45538
2L-7S		MI	15567	5473	24341	4441	28269	3592	29794	2942	30473	1923	37325	1191	27946
14-#14	1.93	MA	26716	5473	39951	4535	48076	3664	52390	3012	57453	2008	71547	1741	45378
3L-6S		MI	16253	5473	25293	4442	29527	3596	31331	2933	32551	1931	39729	1294	29050

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

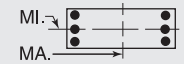
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	1.93	MA	25535	5473	38349	4537	45909	3679	49764	3011	53908	2003	67522	1610	45019
4L-5S		MI	16953	5473	26270	4444	30829	3585	32915	2940	34599	1923	42443	1404	29785
14-#14	1.93	MA	24468	5473	36729	4554	43966	3680	47391	3025	50677	2013	63343	1542	43601
5L-4S		MI	17683	5473	27368	4430	32147	3589	34522	2932	36729	1916	45149	1465	30725
14-#14	1.93	MA	23444	5473	35292	4556	42048	3695	45057	3023	47572	2023	59087	1433	42263
6L-3S		MI	18486	5473	28451	4432	33610	3578	36296	2938	39064	1923	47696	1596	30899
14-#14	1.93	MA	22442	5473	33893	4558	40196	3695	42794	3037	44424	2018	55295	1331	40521
7L-2S		MI	19583	5473	29898	4433	35445	3582	38519	2930	42005	1916	51585	1728	30969
14-#18	3.43	MA	28694	6364	47151	5070	56750	4076	62800	3258	71429	1948	91312	1268	75495
4L-5S		MI	18385	6364	31290	4968	36978	3959	40178	3166	44042	1819	55173	922	48824
14-#18	3.43	MA	26923	6364	44301	5098	53330	4074	58626	3279	65746	1963	84038	1150	72285
5L-4S		MI	19597	6364	33212	4946	39284	3969	42970	3153	47712	1805	59818	1031	50564
14-#18	3.43	MA	25224	6364	41770	5100	49955	4100	54517	3275	60281	1978	76655	958	67915
6L-3S		MI	20931	6364	35106	4951	41842	3952	46047	3166	51734	1819	64182	1261	52920
14-#18	3.43	MA	23560	6364	39306	5103	46694	4098	50534	3297	54741	1967	70086	776	63421
7L-2S		MI	22752	6364	37627	4956	45040	3962	49898	3153	56801	1805	70843	1494	53319
16-#11	1.53	MA	26944	5235	38932	4396	46896	3565	51009	2938	55624	2015	69265	1910	36419
2L-8S		MI	15359	5235	23228	4308	26970	3495	28243	2880	28494	1958	34555	1368	23084
16-#11	1.53	MA	25777	5235	37423	4398	44982	3566	48690	2948	52495	2022	64988	1819	36351
3L-7S		MI	15840	5235	23882	4309	27832	3497	29319	2884	29906	1953	36334	1419	23711
16-#11	1.53	MA	24939	5235	36306	4399	43471	3576	46860	2948	50024	2020	62161	1728	36208
4L-6S		MI	16327	5235	24547	4310	28710	3499	30392	2878	31369	1958	38034	1490	24082
16-#11	1.53	MA	24182	5235	35177	4411	42117	3577	45206	2958	47772	2027	59233	1680	35943
5E		MI	16824	5235	25229	4310	29620	3491	31499	2882	32811	1953	39950	1566	24658
16-#11	1.53	MA	23457	5235	34176	4413	40781	3588	43579	2957	45608	2035	56246	1605	34972
6L-4S		MI	17341	5235	25996	4301	30540	3493	32622	2875	34311	1948	41857	1609	24812
16-#11	1.53	MA	22747	5235	33201	4415	39490	3589	42002	2967	43414	2032	53583	1535	34279
7L-3S		MI	17912	5235	26754	4301	31563	3485	33862	2879	35955	1953	43658	1700	24869
16-#11	1.53	MA	22045	5235	32242	4417	38226	3589	40423	2966	41298	2039	50848	1480	33253
8L-2S		MI	18692	5235	27767	4302	32848	3487	35419	2873	38027	1948	46405	1791	24889
16-#14	2.21	MA	27738	5637	42113	4637	50818	3739	55713	3060	61935	2000	77642	1725	51731
3L-7S		MI	16260	5637	25788	4543	30104	3667	32017	2989	33414	1912	41214	1162	32010
16-#14	2.21	MA	26572	5637	40511	4639	48652	3754	53087	3058	58391	1995	73617	1594	51339
4L-6S		MI	16938	5637	26739	4544	31362	3671	33554	2981	35492	1919	43618	1265	33186
16-#14	2.21	MA	25518	5637	38892	4656	46708	3755	50714	3072	55160	2005	69438	1526	49796
5E		MI	17630	5637	27717	4546	32664	3660	35138	2987	37541	1912	46332	1375	33891
16-#14	2.21	MA	24509	5637	37454	4658	44791	3770	48379	3071	52055	2016	65182	1418	48500
6L-4S		MI	18351	5637	28814	4533	33982	3664	36746	2979	39671	1904	49039	1436	34946
16-#14	2.21	MA	23520	5637	36055	4660	42939	3770	46116	3084	48906	2011	61390	1316	46693
7L-3S		MI	19145	5637	29898	4534	35445	3653	38519	2985	42005	1912	51585	1567	35150
16-#14	2.21	MA	22542	5637	34678	4662	41124	3771	43849	3083	45869	2021	57486	1237	45030
8L-2S		MI	20232	5637	31345	4536	37280	3657	40742	2977	44947	1904	55475	1699	35245
16-#18	3.92	MA	28664	6654	48094	5280	58140	4207	64454	3364	73609	1950	94611	1117	83198
5E		MI	19501	6654	33811	5150	40175	4092	44029	3249	49109	1794	61834	862	55852
16-#18	3.92	MA	26997	6654	45563	5282	54765	4233	60345	3359	68144	1965	87229	924	78714
6L-4S		MI	20694	6654	35733	5128	42482	4102	46821	3236	52778	1781	66479	971	57646
16-#18	3.92	MA	25364	6654	43099	5284	51505	4231	56362	3381	62604	1953	80660	742	74161
7L-3S		MI	22008	6654	37627	5133	45040	4085	49898	3249	56801	1794	70843	1201	60255
16-#18	3.92	MA	23748	6654	40674	5287	48310	4230	52371	3376	57258	1968	73866	606	69476
8L-2S		MI	23804	6654	40148	5138	48237	4095	53749	3236	61868	1781	77504	1435	60719
18-#11	1.72	MA	26509	5349	38932	4469	46896	3617	51009	2981	55624	2017	69265	1809	40799
3L-8S		MI	15855	5349	24241	4379	28255	3546	29800	2913	30566	1951	37301	1350	25949
18-#11	1.72	MA	25679	5349	37815	4470	45385	3628	49179	2981	53153	2014	66438	1718	40637
4L-7S		MI	16332	5349	24895	4380	29117	3549	30875	2917	31977	1946	39080	1400	26623

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

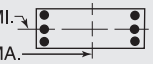


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.72	MA	24929	5349	36687	4482	44031	3629	47525	2990	50901	2022	63510	1670	40327
5L-6S		MI	16814	5349	25560	4380	29995	3551	31949	2911	33440	1951	40780	1472	26984
18-#11	1.72	MA	24211	5349	35685	4484	42695	3640	45898	2990	48737	2029	60523	1595	39323
6L-5S		MI	17307	5349	26242	4381	30905	3543	33055	2914	34883	1946	42697	1547	27534
18-#11	1.72	MA	23508	5349	34711	4486	41404	3640	44321	3000	46543	2027	57860	1525	38647
7L-4S		MI	17820	5349	27010	4371	31825	3545	34179	2908	36383	1941	44603	1591	27787
18-#11	1.72	MA	22813	5349	33752	4488	40140	3641	42742	2999	44427	2034	55125	1470	37578
8L-3S		MI	18385	5349	27767	4372	32848	3537	35419	2912	38027	1946	46405	1682	27860
18-#11	1.72	MA	22123	5349	32692	4500	38838	3652	41188	3009	42332	2042	52411	1411	36603
9L-2S		MI	19160	5349	28780	4373	34133	3539	36975	2906	40098	1941	49151	1773	27892
18-#14	2.48	MA	27592	5800	42674	4741	51394	3829	56409	3106	62874	1988	79711	1578	57658
4L-7S		MI	16942	5800	27234	4645	31939	3742	34240	3037	36356	1900	45103	1133	36084
18-#14	2.48	MA	26552	5800	41054	4758	49451	3829	54037	3119	59643	1998	75532	1510	56003
5L-6S		MI	17613	5800	28186	4647	33197	3746	35777	3028	38434	1908	47507	1236	37329
18-#14	2.48	MA	25556	5800	39617	4760	47533	3845	51702	3118	56537	2008	71276	1402	54746
6L-5S		MI	18297	5800	29163	4648	34499	3735	37361	3035	40482	1900	50221	1346	38008
18-#14	2.48	MA	24580	5800	38218	4762	45681	3845	49439	3132	53389	2003	67484	1300	52874
7L-4S		MI	19011	5800	30261	4635	35817	3739	38969	3026	42612	1893	52928	1407	39163
18-#14	2.48	MA	23615	5800	36841	4764	43867	3845	47172	3130	50352	2013	63581	1222	51176
8L-3S		MI	19796	5800	31345	4636	37280	3728	40742	3033	44947	1900	55475	1538	39396
18-#14	2.48	MA	22656	5800	35320	4781	41997	3861	44942	3144	47345	2023	59714	1137	48842
9L-2S		MI	20872	5800	32792	4638	39115	3732	42965	3024	47888	1893	59364	1670	39515
18-#18	4.41	MA	28735	6945	49356	5464	59576	4366	66173	3443	76007	1952	97802	891	89532
6L-5S		MI	20600	6945	36332	5331	43372	4225	47880	3331	54176	1769	68495	803	62804
18-#18	4.41	MA	27132	6945	46892	5466	56315	4364	62190	3465	70467	1940	91233	709	84917
7L-4S		MI	21774	6945	38254	5310	45679	4235	50672	3318	57845	1756	73140	911	64754
18-#18	4.41	MA	25546	6945	44467	5468	53120	4363	58199	3461	65121	1955	84439	572	80195
8L-3S		MI	23069	6945	40148	5315	48237	4218	53749	3331	61868	1769	77504	1141	67587
20-#11	1.91	MA	26409	5462	39325	4541	47300	3680	51498	3013	56281	2009	70714	1708	45065
4L-8S		MI	16345	5462	25254	4450	29540	3598	31357	2946	32637	1944	40048	1332	28821
20-#11	1.91	MA	25667	5462	38196	4553	45945	3681	49844	3023	54030	2017	67787	1660	44653
5L-7S		MI	16817	5462	25909	4451	30401	3601	32432	2950	34048	1939	41827	1382	29539
20-#11	1.91	MA	24956	5462	37194	4555	44609	3692	48217	3023	51865	2024	64800	1586	43680
6E		MI	17296	5462	26573	4451	31280	3603	33506	2943	35511	1944	43527	1453	29891
20-#11	1.91	MA	24260	5462	36220	4557	43319	3692	46641	3032	49672	2022	62137	1515	43018
7L-5S		MI	17784	5462	27256	4452	32190	3595	34612	2947	36954	1939	45443	1529	30419
20-#11	1.91	MA	23572	5462	35261	4558	42055	3693	45061	3032	47556	2029	59402	1460	41908
8L-4S		MI	18293	5462	28023	4442	33110	3597	35736	2941	38454	1934	47350	1572	30759
20-#11	1.91	MA	22889	5462	34201	4570	40752	3704	43507	3042	45461	2037	56687	1402	40953
9L-3S		MI	18854	5462	28780	4443	34133	3589	36975	2945	40098	1939	49151	1663	30846
20-#11	1.91	MA	22204	5462	33246	4572	39497	3704	41946	3041	43306	2034	53882	1322	39577
10L-2S		MI	19623	5462	29793	4444	35418	3591	38532	2938	42169	1934	51898	1755	30890
20-#14	2.76	MA	27571	5964	43217	4860	52193	3904	57359	3167	64126	1991	81627	1495	62220
5L-7S		MI	17616	5964	28681	4747	33774	3816	36463	3084	39297	1889	48993	1104	40168
20-#14	2.76	MA	26587	5964	41779	4862	50276	3919	55025	3165	61020	2001	77371	1387	60997
6E		MI	18279	5964	29633	4749	35032	3820	38000	3076	41375	1896	51397	1207	41464
20-#14	2.76	MA	25623	5964	40380	4864	48424	3920	52762	3179	57872	1996	73579	1284	59065
7L-5S		MI	18956	5964	30610	4750	36334	3810	39584	3082	43423	1889	54111	1317	42134
20-#14	2.76	MA	24671	5964	39003	4867	46609	3920	50494	3178	54835	2006	69675	1206	57325
8L-4S		MI	19661	5964	31708	4737	37652	3814	41192	3074	45553	1881	56817	1378	43347
20-#14	2.76	MA	23724	5964	37482	4884	44739	3935	48264	3191	51828	2016	65809	1122	55035
9L-3S		MI	20439	5964	32792	4739	39115	3803	42965	3080	47888	1889	59364	1509	43637
20-#14	2.76	MA	22768	5964	36111	4886	42937	3936	46023	3190	48735	2011	61812	1006	52656
10L-2S		MI	21505	5964	34238	4740	40950	3807	45188	3072	50829	1881	63253	1641	43778
20-#18	4.90	MA	28868	7236	50686	5648	61126	4497	68018	3549	78330	1927	101807	676	95690
7L-5S		MI	21682	7236	38853	5513	46570	4358	51732	3414	59242	1744	75156	743	69782
20-#18	4.90	MA	27309	7236	48260	5650	57931	4496	64027	3545	72984	1942	95013	539	90927
8L-4S		MI	22840	7236	40775	5492	48876	4368	54523	3401	62912	1731	79801	851	71884

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

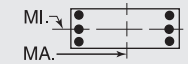
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.10	MA	26396	5576	39705	4624	47859	3733	52163	3056	57158	2012	72064	1651	48986
5L-8S		MI	16829	5576	26267	4521	30825	3650	32913	2979	34708	1937	42794	1313	31698
22-#11	2.10	MA	25691	5576	38704	4626	46523	3744	50536	3056	54994	2019	69077	1576	48042
6L-7S		MI	17298	5576	26922	4522	31686	3652	33989	2983	36120	1932	44574	1364	32405
22-#11	2.10	MA	25002	5576	37729	4628	45233	3744	48960	3065	52801	2016	66414	1505	47393
7L-6S		MI	17772	5576	27587	4522	32565	3655	35062	2976	37583	1937	46273	1435	32801
22-#11	2.10	MA	24321	5576	36770	4629	43969	3745	47380	3065	50685	2024	63679	1450	46244
8L-5S		MI	18257	5576	28269	4523	33475	3647	36169	2980	39025	1932	48190	1510	33309
22-#11	2.10	MA	23645	5576	35711	4641	42666	3756	45826	3075	48589	2031	60964	1392	45298
9L-4S		MI	18762	5576	29036	4513	34395	3649	37292	2974	40525	1926	50096	1554	33729
22-#11	2.10	MA	22962	5576	34755	4643	41411	3756	44265	3074	46435	2029	58159	1312	43906
10L-3S		MI	19318	5576	29793	4514	35418	3641	38532	2978	42169	1932	51898	1645	33829
22-#11	2.10	MA	22225	5576	33807	4645	40123	3767	42721	3084	44349	2036	55470	1254	42581
11L-2S		MI	20081	5576	30806	4514	36703	3643	40089	2971	44240	1926	54644	1736	33885
22-#14	3.03	MA	27604	6127	43942	4965	53018	3994	58347	3213	65503	1993	83465	1371	67255
6L-7S		MI	18280	6127	30128	4850	35609	3891	38686	3131	42238	1877	52882	1075	44261
22-#14	3.03	MA	26652	6127	42543	4967	51166	3995	56084	3226	62355	1988	79673	1269	65263
7L-6S		MI	18936	6127	31080	4851	36867	3895	40223	3123	44316	1884	55286	1178	45514
22-#14	3.03	MA	25711	6127	41166	4969	49352	3995	53817	3225	59318	1998	75770	1190	63481
8L-5S		MI	19606	6127	32057	4853	38169	3884	41807	3129	46365	1877	58000	1288	46268
22-#14	3.03	MA	24776	6127	39645	4986	47482	4010	51587	3238	56310	2008	71903	1106	61233
9L-4S		MI	20304	6127	33155	4839	39487	3888	43415	3121	48495	1870	60707	1349	47430
22-#14	3.03	MA	23824	6127	38273	4988	45680	4011	49346	3237	53218	2004	67906	991	58829
10L-3S		MI	21074	6127	34238	4841	40950	3877	45188	3128	50829	1877	63253	1481	47874
22-#18	5.39	MA	29042	7527	52053	5832	62742	4629	69855	3629	80847	1929	105587	506	101674
8L-5S		MI	22838	7527	41374	5695	49767	4491	55583	3497	64309	1720	81817	683	76784
24-#11	2.29	MA	26419	5689	40213	4697	48437	3795	52855	3088	58123	2014	73354	1566	52408
6L-8S		MI	17309	5689	27281	4592	32110	3702	34470	3012	36780	1930	45541	1295	34580
24-#11	2.29	MA	25736	5689	39239	4698	47147	3796	51279	3098	55930	2011	70691	1495	51771
7E		MI	17774	5689	27935	4592	32971	3704	35546	3016	38191	1924	47320	1345	35266
24-#11	2.29	MA	25061	5689	38280	4700	45883	3797	49699	3098	53813	2019	67956	1440	50584
8L-6S		MI	18244	5689	28600	4593	33850	3707	36619	3009	39654	1930	49020	1416	35716
24-#11	2.29	MA	24391	5689	37220	4712	44580	3808	48145	3107	51718	2026	65241	1382	49608
9L-5S		MI	18724	5689	29282	4594	34760	3698	37726	3013	41097	1924	50937	1492	36206
24-#11	2.29	MA	23711	5689	36265	4714	43325	3808	46584	3107	49564	2023	62435	1302	48240
10L-4S		MI	19225	5689	30049	4584	35680	3701	38849	3007	42597	1919	52843	1535	36696
24-#11	2.29	MA	22995	5689	35316	4716	42037	3819	45040	3117	47477	2031	59747	1244	46895
11L-3S		MI	19777	5689	30806	4585	36703	3693	40089	3010	44240	1924	54644	1626	36809
24-#11	2.29	MA	22271	5689	34373	4717	40786	3820	43488	3116	45341	2028	57054	1187	45510
12L-2S		MI	20536	5689	31820	4585	37988	3695	41646	3004	46312	1919	57391	1718	36876
24-#14	3.31	MA	27667	6291	44705	5069	53909	4069	59407	3274	66838	1981	85768	1253	71469
7E		MI	18936	6291	31575	4952	37444	3966	40909	3179	45180	1865	56771	1046	48362
24-#14	3.31	MA	26737	6291	43328	5071	52094	4070	57140	3272	63800	1991	81864	1175	69646
8L-6S		MI	19586	6291	32527	4953	38702	3970	42446	3170	47258	1873	59175	1149	49576
24-#14	3.31	MA	25813	6291	41807	5088	50224	4085	54909	3286	60793	2001	77998	1090	67438
9L-5S		MI	20249	6291	33504	4955	40004	3959	44030	3177	49306	1865	61889	1259	50409
24-#14	3.31	MA	24865	6291	40436	5090	48423	4085	52669	3284	57701	1996	74001	975	65008
10L-4S		MI	20940	6291	34602	4942	41322	3963	45638	3168	51436	1858	64596	1320	51524

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

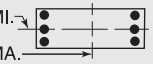
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.04	MA	14696	3928	21168	3274	24867	2666	26450	2216	27552	1563	33161	1462	14462
2L-3S		MI	13479	3928	19619	3273	22902	2663	24070	2225	24383	1570	28957	1330	14472
6-#18	1.85	MA	16258	4309	24800	3487	29305	2819	31756	2309	34393	1514	42090	1364	24893
2L-3S		MI	14202	4309	22097	3484	25878	2811	27603	2322	28922	1527	34872	1130	24666
8-#14	1.39	MA	15431	4091	22717	3376	26832	2740	28831	2263	30721	1553	37364	1435	19080
2L-4S		MI	13353	4091	20011	3375	23303	2749	24555	2267	25037	1553	30403	1172	18851
8-#18	2.47	MA	17459	4600	27502	3669	32733	2952	35908	2393	39863	1491	49308	1309	32878
2L-4S		MI	13975	4600	22773	3662	26568	2963	28439	2394	30050	1491	37369	842	30013
10-#11	1.20	MA	15086	4004	21854	3334	25821	2711	27643	2247	29223	1569	35430	1463	16707
2L-5S		MI	13060	4004	19142	3344	22371	2716	23454	2258	23610	1574	28466	1237	16383
10-#11	1.20	MA	14239	4004	20770	3334	24447	2709	25978	2254	26993	1574	32466	1372	16702
3L-4S		MI	13621	4004	19961	3334	23354	2718	24654	2251	25224	1569	30518	1281	16641
10-#14	1.74	MA	16150	4255	24266	3479	28796	2815	31211	2311	33890	1542	41567	1409	23675
2L-5S		MI	13317	4255	20387	3491	23861	2821	25218	2324	25911	1550	31690	1083	22101
10-#14	1.74	MA	14966	4255	22717	3478	26832	2812	28831	2320	30721	1550	37364	1278	23599
3L-4S		MI	14102	4255	21560	3477	25268	2824	26936	2314	28206	1542	34607	1146	23357
10-#18	3.09	MA	18629	4891	30205	3851	36161	3085	40061	2477	45334	1469	56526	1254	40837
2L-5S		MI	13908	4891	23422	3867	27530	3087	29584	2492	31559	1483	39553	680	35191
10-#18	3.09	MA	16657	4891	27502	3847	32733	3077	35908	2491	39863	1483	49308	1021	40391
3L-4S		MI	15217	4891	25476	3844	29996	3096	32592	2478	35521	1469	44586	787	37546

RECTANGULAR TIED COLUMNS 36" x 38"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.17	MA	16639	4210	24256	3485	28479	2834	30374	2350	31826	1636	38396	1520	17937
2E		MI	15711	4210	23024	3469	26934	2821	28675	2339	29921	1624	36007	1503	16896
6-#18	1.75	MA	17979	4500	27141	3666	32138	2967	34805	2434	37701	1617	46171	1470	26513
2L-3S		MI	14894	4500	23024	3647	26934	2946	28675	2437	29921	1615	36007	1215	24749
6-#18	1.75	MA	15776	4500	24256	3664	28479	2960	30374	2449	31826	1630	38396	1237	26286
3L-2S		MI	16957	4500	25727	3651	30362	2954	32828	2423	35392	1601	43225	1449	24941
8-#14	1.32	MA	17079	4282	24909	3555	29486	2888	31670	2388	33730	1653	41036	1537	20295
2L-4S		MI	14042	4282	20929	3540	24357	2885	25628	2382	26039	1641	31545	1258	18929
8-#14	1.32	MA	15795	4282	23258	3555	27392	2885	29133	2399	30333	1661	36518	1406	20258
3E		MI	14923	4282	22086	3540	25921	2873	27523	2388	28554	1649	34302	1389	19091
8-#14	1.32	MA	14858	4282	22027	3555	25727	2898	27116	2394	27637	1653	33550	1275	20066
4L-2S		MI	16126	4282	23635	3541	27886	2876	29903	2378	31723	1641	38506	1521	19115
8-#18	2.34	MA	19276	4791	30025	3848	35796	3100	39237	2518	43576	1597	53947	1420	35038
2L-4S		MI	14665	4791	23701	3825	27625	3097	29512	2508	31049	1579	38504	927	30343
8-#18	2.34	MA	17120	4791	27141	3846	32138	3093	34805	2533	37701	1610	46171	1187	34693
3E		MI	16145	4791	25727	3829	30362	3079	32828	2521	35392	1593	43225	1160	32626
8-#18	2.34	MA	15546	4791	24983	3843	29222	3113	31272	2522	33038	1597	41077	953	32253
4L-2S		MI	18165	4791	28430	3833	33790	3087	36980	2507	40862	1579	50443	1394	32933
10-#11	1.14	MA	16704	4195	23985	3513	28404	2858	30399	2372	32112	1669	38938	1564	17760
2L-5S		MI	13748	4195	20055	3510	23424	2852	24527	2373	24614	1663	29611	1323	16543
10-#11	1.14	MA	15798	4195	22830	3514	26940	2857	28624	2379	29725	1674	35755	1473	17755
3L-4S		MI	14311	4195	20874	3500	24406	2854	25727	2366	26228	1658	31663	1367	16692
10-#11	1.14	MA	15139	4195	21970	3514	25777	2866	27216	2377	27830	1669	33662	1382	17694
4L-3S		MI	14930	4195	21683	3500	25499	2846	27051	2370	27997	1663	33610	1458	16739
10-#11	1.14	MA	14542	4195	21099	3525	24732	2865	25940	2384	26101	1674	31464	1337	17520
5L-2S		MI	15780	4195	22767	3500	26874	2847	28716	2362	30227	1658	36575	1549	16737
10-#14	1.64	MA	17854	4446	26561	3658	31581	2963	34207	2436	37126	1644	45554	1513	25194
2L-5S		MI	14005	4446	21305	3656	24915	2956	26291	2439	26913	1638	32832	1169	22301
10-#14	1.64	MA	16587	4446	24909	3657	29486	2960	31670	2446	33730	1652	41036	1382	25118
3L-4S		MI	14793	4446	22478	3642	26322	2959	28008	2430	29208	1631	35748	1232	23441
10-#14	1.64	MA	15664	4446	23678	3657	27822	2973	29653	2441	31034	1644	38068	1251	24876
4L-3S		MI	15661	4446	23635	3643	27886	2948	29903	2435	31723	1638	38506	1363	23653

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

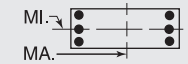
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.64	MA	14827	4446	22431	3672	26325	2970	27827	2452	28574	1652	34941	1187	23645
5L-2S		MI	16849	4446	25184	3643	29850	2951	32284	2426	34892	1631	42709	1495	23716
10-#18	2.92	MA	20540	5082	32910	4030	39454	3233	43669	2602	49450	1577	61722	1370	43537
2L-5S		MI	14595	5082	24349	4030	28587	3222	30656	2606	32558	1570	40689	765	35720
10-#18	2.92	MA	18426	5082	30025	4028	35796	3226	39237	2618	43576	1590	53947	1137	43091
3L-4S		MI	15911	5082	26403	4007	31053	3230	33664	2592	36520	1557	45722	872	37867
10-#18	2.92	MA	16885	5082	27867	4025	32880	3246	35704	2607	38913	1577	48853	903	40306
4L-3S		MI	17360	5082	28430	4011	33790	3212	36980	2605	40862	1570	50443	1106	40492
10-#18	2.92	MA	15487	5082	25680	4049	30255	3239	32501	2622	34658	1590	43446	793	38009
5L-2S		MI	19342	5082	31132	4014	37218	3220	41133	2591	46333	1557	57661	1339	40897
12-#11	1.37	MA	17257	4308	25140	3584	29869	2910	32173	2405	34499	1663	42121	1549	21194
2L-6S		MI	13751	4308	20411	3581	23828	2913	25012	2403	25291	1662	30506	1231	18946
12-#11	1.37	MA	16360	4308	23985	3585	28404	2909	30399	2412	32112	1668	38938	1458	21168
3L-5S		MI	14285	4308	21139	3581	24799	2904	26193	2406	26843	1656	32576	1306	19598
12-#11	1.37	MA	15709	4308	23125	3585	27242	2918	28990	2410	30218	1663	36844	1366	21083
4E		MI	14841	4308	21958	3571	25781	2906	27392	2399	28458	1651	34628	1350	19875
12-#11	1.37	MA	15118	4308	22254	3595	26197	2917	27715	2417	28489	1668	34647	1321	20781
5L-3S		MI	15454	4308	22767	3571	26874	2897	28716	2402	30227	1656	36575	1442	19946
12-#11	1.37	MA	14551	4308	21481	3596	25166	2926	26460	2415	26826	1673	32425	1246	20065
6L-2S		MI	16296	4308	23851	3571	28249	2899	30382	2395	32456	1651	39539	1533	19965
12-#14	1.97	MA	18614	4609	28212	3760	33675	3037	36745	2483	40523	1635	50071	1489	30079
2L-6S		MI	14007	4609	21811	3757	25489	3043	26980	2481	27875	1636	34102	1034	25850
12-#14	1.97	MA	17363	4609	26561	3760	31581	3035	34207	2493	37126	1643	45554	1358	29968
3L-5S		MI	14752	4609	22854	3758	26879	3031	28671	2486	30082	1628	37035	1143	26685
12-#14	1.97	MA	16454	4609	25329	3759	29916	3047	32191	2489	34431	1635	42586	1226	29683
4E		MI	15529	4609	24027	3744	28286	3034	30389	2477	32377	1621	39952	1205	27950
12-#14	1.97	MA	15629	4609	24082	3774	28419	3045	30364	2499	31971	1643	39459	1163	28327
5L-3S		MI	16384	4609	25184	3745	29850	3023	32284	2482	34892	1628	42709	1337	28203
12-#14	1.97	MA	14837	4609	22973	3774	26942	3057	28565	2494	29605	1650	36306	1054	27408
6L-2S		MI	17558	4609	26733	3746	31815	3026	34664	2473	38061	1621	46912	1468	28300
12-#18	3.51	MA	21775	5373	35794	4212	43112	3366	48101	2687	55325	1557	69498	1320	52019
2L-6S		MI	14600	5373	25223	4208	29579	3373	31844	2677	34219	1561	42871	515	39949
12-#18	3.51	MA	19699	5373	32910	4209	39454	3359	43669	2702	49450	1570	61722	1086	51484
3L-5S		MI	15837	5373	27052	4212	32015	3355	34808	2690	38028	1548	47907	710	43139
12-#18	3.51	MA	18190	5373	30751	4207	36538	3379	40136	2691	44788	1557	56628	853	48402
4E		MI	17126	5373	29106	4189	34481	3363	37817	2676	41990	1535	52940	818	45434
12-#18	3.51	MA	16821	5373	28564	4231	33913	3372	36933	2706	40533	1570	51222	743	45962
5L-3S		MI	18546	5373	31132	4192	37218	3345	41133	2689	46333	1548	57661	1051	48351
12-#18	3.51	MA	15508	5373	26618	4229	31321	3392	33778	2695	36442	1584	45796	549	42475
6L-2S		MI	20493	5373	33835	4196	40645	3353	45286	2676	51803	1535	64879	1285	48844
14-#11	1.60	MA	17802	4422	26295	3655	31334	2962	33948	2438	36887	1657	45304	1533	24617
2L-7S		MI	13768	4422	20786	3651	24265	2963	25532	2443	25946	1650	31634	1143	21523
14-#11	1.60	MA	16914	4422	25140	3655	29869	2961	32173	2445	34499	1663	42121	1442	24575
3L-6S		MI	14285	4422	21495	3651	25203	2965	26678	2436	27520	1655	33471	1214	22044
14-#11	1.60	MA	16269	4422	24280	3656	28707	2970	30765	2443	32605	1657	40027	1351	24468
4L-5S		MI	14814	4422	22223	3652	26173	2956	27859	2439	29073	1650	35540	1289	22666
14-#11	1.60	MA	15685	4422	23409	3666	27662	2969	29490	2450	30876	1663	37830	1306	24054
5L-4S		MI	15364	4422	23042	3641	27156	2958	29058	2432	30687	1645	37592	1334	23053
14-#11	1.60	MA	15124	4422	22636	3667	26631	2978	28234	2447	29213	1668	35608	1231	23370
6L-3S		MI	15971	4422	23851	3642	28249	2949	30382	2435	32456	1650	39539	1425	23145
14-#11	1.60	MA	14575	4422	21883	3667	25634	2977	27017	2455	27528	1663	33634	1160	22805
7L-2S		MI	16804	4422	24935	3642	29624	2951	32048	2428	34685	1645	42504	1516	23180
14-#14	2.30	MA	19362	4773	29864	3862	35769	3112	39282	2530	43920	1626	54589	1465	34955
2L-7S		MI	14030	4773	22345	3859	26111	3114	27719	2538	28806	1618	35703	904	28718

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis

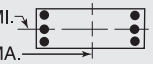


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.30	MA	18126	4773	28212	3862	33675	3110	36745	2541	40523	1634	50071	1334	34811
3L-6S		MI	14750	4773	23360	3859	27454	3118	29360	2528	31044	1625	38305	1007	30176
14-#14	2.30	MA	17229	4773	26981	3862	32010	3122	34728	2536	37828	1626	47103	1202	34489
4L-5S		MI	15485	4773	24403	3860	28844	3106	31051	2534	33251	1618	41239	1116	31084
14-#14	2.30	MA	16416	4773	25733	3876	30514	3120	32901	2546	35368	1634	43977	1139	33024
5L-4S		MI	16251	4773	25576	3846	30251	3109	32769	2524	35546	1610	44155	1179	32457
14-#14	2.30	MA	15635	4773	24625	3876	29036	3132	31103	2542	33002	1641	40823	1030	32055
6L-3S		MI	17095	4773	26733	3847	31815	3097	34664	2530	38061	1618	46912	1310	32747
14-#14	2.30	MA	14871	4773	23545	3876	27608	3130	29358	2552	30603	1634	38024	927	30463
7L-2S		MI	18254	4773	28283	3848	33780	3101	37044	2521	41230	1610	51116	1442	32875
14-#18	4.09	MA	20946	5663	35794	4391	43112	3492	48101	2786	55325	1551	69498	1036	59874
3L-6S		MI	15838	5663	27925	4390	33007	3506	35997	2761	39689	1539	50089	460	47530
14-#18	4.09	MA	19466	5663	33636	4389	40197	3512	44568	2775	50662	1537	64404	803	56532
4L-5S		MI	17051	5663	29754	4394	35443	3488	38961	2774	43499	1526	55124	655	50592
14-#18	4.09	MA	18124	5663	31449	4413	37572	3505	41365	2790	46408	1551	58997	693	53948
5L-4S		MI	18315	5663	31809	4371	37908	3496	41970	2761	47461	1513	60158	763	53035
14-#18	4.09	MA	16837	5663	29503	4410	34979	3525	38210	2779	42316	1564	53571	499	50593
6L-3S		MI	19709	5663	33835	4374	40645	3478	45286	2774	51803	1526	64879	996	56206
16-#11	1.82	MA	18340	4535	27450	3726	32799	3014	35723	2470	39274	1652	48487	1518	28035
2L-8S		MI	13795	4535	21172	3722	24721	3013	26050	2472	26656	1649	32683	1075	23774
16-#11	1.82	MA	17460	4535	26295	3726	31334	3013	33948	2478	36887	1657	45304	1427	27976
3L-7S		MI	14300	4535	21870	3722	25640	3015	27198	2476	28175	1644	34599	1126	24571
16-#11	1.82	MA	16821	4535	25435	3727	30171	3022	32539	2475	34992	1652	43210	1336	27850
4L-6S		MI	14812	4535	22579	3722	26578	3017	28343	2469	29749	1649	36435	1197	25148
16-#11	1.82	MA	16243	4535	24564	3737	29127	3021	31264	2483	33263	1657	41012	1291	27338
5E		MI	15335	4535	23307	3722	27548	3008	29524	2472	31302	1644	38505	1273	25744
16-#11	1.82	MA	15689	4535	23791	3737	28095	3030	30009	2480	31601	1662	38791	1216	26681
6L-4S		MI	15879	4535	24126	3712	28531	3010	30724	2465	32916	1639	40557	1317	26227
16-#11	1.82	MA	15145	4535	23037	3738	27099	3028	28792	2488	29915	1657	36816	1144	26061
7L-3S		MI	16480	4535	24935	3712	29624	3001	32048	2468	34685	1644	42504	1408	26339
16-#11	1.82	MA	14609	4535	22296	3738	26122	3027	27572	2485	28288	1662	34764	1092	25190
8L-2S		MI	17306	4535	26019	3713	30999	3003	33714	2461	36915	1639	45469	1499	26389
16-#14	2.63	MA	20097	4936	31515	3964	37863	3187	41819	2578	47317	1617	59107	1441	39823
2L-8S		MI	14069	4936	22893	3960	26759	3186	28456	2579	29815	1615	37184	805	31573
16-#14	2.63	MA	18876	4936	29864	3964	35769	3185	39282	2588	43920	1624	54589	1310	39650
3L-7S		MI	14771	4936	23894	3961	28075	3189	30100	2585	31975	1608	39907	878	33095
16-#14	2.63	MA	17990	4936	28632	3964	34105	3197	37265	2583	41225	1617	51621	1178	39209
4L-6S		MI	15481	4936	24910	3962	29419	3192	31740	2576	34213	1615	42508	981	34503
16-#14	2.63	MA	17188	4936	27385	3979	32608	3195	35438	2594	38765	1624	48495	1115	37733
5E		MI	16206	4936	25953	3963	30809	3181	33432	2581	36420	1608	45442	1090	35495
16-#14	2.63	MA	16419	4936	26276	3978	31130	3207	33640	2589	36399	1632	45341	1006	36681
6L-4S		MI	16961	4936	27125	3948	32216	3184	35149	2572	38715	1600	48359	1153	36835
16-#14	2.63	MA	15665	4936	25196	3978	29702	3205	31895	2599	34000	1624	42542	903	35142
7L-3S		MI	17795	4936	28283	3949	33780	3172	37044	2577	41230	1608	51116	1284	37285
16-#14	2.63	MA	14921	4936	24133	3978	28302	3202	30147	2595	31685	1632	39623	829	33513
8L-2S		MI	18941	4936	29832	3950	35744	3175	39424	2568	44399	1600	55319	1415	37443
16-#18	4.68	MA	20717	5954	36520	4570	43855	3645	49000	2859	56537	1517	72180	753	64691
4L-6S		MI	17049	5954	30628	4572	36434	3639	40150	2846	45160	1517	57306	406	55135
16-#18	4.68	MA	19401	5954	34333	4595	41230	3638	45797	2875	52283	1531	66773	643	61964
5E		MI	18240	5954	32457	4575	38870	3621	43114	2859	48969	1504	62342	601	58076
16-#18	4.68	MA	18138	5954	32387	4592	38637	3658	42642	2864	48191	1544	61347	449	58733
6L-4S		MI	19481	5954	34512	4552	41336	3629	46122	2845	52931	1491	67375	708	60664
18-#11	2.05	MA	18871	4649	28605	3797	34263	3066	37497	2503	41661	1646	51669	1503	31448
2L-9S		MI	13828	4649	21486	3803	25149	3074	26587	2512	27381	1648	33772	999	25973
18-#11	2.05	MA	17998	4649	27450	3797	32799	3065	35723	2511	39274	1651	48487	1412	31374
3L-8S		MI	14324	4649	22256	3793	26096	3065	27716	2505	28885	1643	35648	1058	26854
18-#11	2.05	MA	17366	4649	26590	3797	31636	3074	34314	2508	37380	1646	46393	1321	31229
4L-7S		MI	14825	4649	22954	3793	27015	3067	28864	2509	30404	1637	37563	1109	27628

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

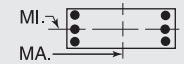
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.05	MA	16794	4649	25719	3808	30592	3072	33039	2516	35651	1651	44195	1276	30630
5L-6S		MI	15331	4649	23663	3793	27953	3069	30009	2501	31979	1643	39400	1180	28258
18-#11	2.05	MA	16245	4649	24946	3808	29560	3082	31784	2513	33988	1657	41973	1200	29998
6L-5S		MI	15849	4649	24391	3793	28923	3060	31190	2505	33531	1637	41469	1256	28830
18-#11	2.05	MA	15708	4649	24192	3809	28564	3080	30566	2521	32302	1651	39999	1129	29325
7L-4S		MI	16388	4649	25210	3783	29906	3062	32389	2498	35146	1632	43521	1300	29399
18-#11	2.05	MA	15177	4649	23451	3809	27587	3079	29346	2518	30675	1657	37947	1077	28480
8L-3S		MI	16982	4649	26019	3783	30999	3053	33714	2501	36915	1637	45469	1391	29529
18-#11	2.05	MA	14650	4649	22632	3819	26581	3088	28146	2526	29065	1662	35932	1018	27533
9L-2S		MI	17801	4649	27103	3784	32374	3055	35379	2494	39144	1632	48433	1482	29594
18-#14	2.96	MA	19615	5100	31515	4066	37863	3259	41819	2635	47317	1615	59107	1286	44485
3L-8S		MI	14806	5100	24442	4062	28723	3261	30836	2627	32984	1605	41388	779	35867
18-#14	2.96	MA	18740	5100	30283	4066	36199	3272	39802	2631	44621	1608	56139	1154	43866
4L-7S		MI	15498	5100	25443	4063	30040	3264	32480	2632	35144	1597	44110	852	37482
18-#14	2.96	MA	17949	5100	29036	4081	34702	3269	37976	2641	42161	1615	53012	1090	42452
5L-6S		MI	16199	5100	26459	4064	31383	3267	34121	2623	37382	1605	46712	954	38844
18-#14	2.96	MA	17190	5100	27927	4081	33225	3282	36177	2636	39796	1623	49859	982	41321
6L-5S		MI	16915	5100	27502	4065	32773	3256	35812	2628	39589	1597	49645	1064	39915
18-#14	2.96	MA	16446	5100	26848	4080	31796	3279	34433	2647	37397	1615	47059	879	39829
7L-4S		MI	17661	5100	28674	4051	34180	3259	37529	2619	41884	1590	52562	1126	41196
18-#14	2.96	MA	15711	5100	25784	4080	30396	3277	32685	2642	35082	1623	44141	805	38104
8L-3S		MI	18484	5100	29832	4051	35744	3247	39424	2625	44399	1597	55319	1258	41820
18-#18	5.26	MA	20655	6245	37218	4776	44888	3771	50229	2959	58158	1511	74548	593	70008
5L-6S		MI	18350	6245	33331	4753	39862	3772	44302	2930	50630	1495	64524	351	62744
18-#18	5.26	MA	19414	6245	35272	4774	42295	3791	47074	2948	54066	1524	69123	398	66892
6L-5S		MI	19510	6245	35160	4757	42298	3754	47267	2943	54440	1482	69560	546	65587
20-#11	2.28	MA	18530	4762	28605	3868	34263	3116	37497	2544	41661	1646	51669	1396	34769
3L-9S		MI	14355	4762	22570	3874	26524	3126	28252	2545	29610	1641	36736	982	29028
20-#11	2.28	MA	17905	4762	27745	3868	33101	3126	36088	2541	39767	1641	49576	1305	34607
4L-8S		MI	14847	4762	23340	3864	27471	3117	29382	2538	31114	1636	38612	1041	29941
20-#11	2.28	MA	17338	4762	26874	3879	32056	3124	34813	2549	38038	1646	47378	1260	33930
5L-7S		MI	15343	4762	24039	3864	28390	3119	30529	2541	32633	1631	40528	1092	30692
20-#11	2.28	MA	16795	4762	26101	3879	31025	3133	33558	2546	36375	1651	45156	1185	33320
6E		MI	15844	4762	24748	3864	29328	3120	31675	2534	34208	1636	42365	1164	31372
20-#11	2.28	MA	16263	4762	25347	3879	30028	3132	32341	2554	34690	1646	43182	1114	32597
7L-5S		MI	16356	4762	25476	3864	30298	3112	32856	2538	35760	1631	44434	1239	31924
20-#11	2.28	MA	15737	4762	24606	3880	29052	3131	31121	2551	33063	1651	41130	1062	31774
8L-4S		MI	16890	4762	26294	3854	31281	3113	34055	2531	37375	1626	46486	1283	32569
20-#11	2.28	MA	15216	4762	23787	3890	28045	3140	29921	2559	31452	1656	39115	1003	30797
9L-3S		MI	17479	4762	27103	3854	32374	3105	35379	2534	39144	1631	48433	1374	32715
20-#11	2.28	MA	14696	4762	23048	3890	27075	3139	28715	2556	29795	1651	37160	937	29799
10L-2S		MI	18291	4762	28187	3854	33748	3107	37045	2527	41373	1626	51398	1466	32794
20-#14	3.29	MA	19480	5264	31935	4168	38293	3347	42340	2678	48018	1599	60657	1130	48538
4L-8S		MI	15531	5264	25992	4164	30688	3336	33216	2674	36153	1595	45591	752	40220
20-#14	3.29	MA	18698	5264	30688	4183	36797	3344	40513	2688	45558	1606	57530	1066	47181
5L-7S		MI	16215	5264	26992	4165	32005	3339	34860	2680	38313	1587	48313	825	41877
20-#14	3.29	MA	17949	5264	29579	4183	35319	3357	38714	2684	43192	1614	54377	957	45972
6E		MI	16907	5264	28008	4166	33348	3342	36501	2670	40551	1595	50915	928	43196
20-#14	3.29	MA	17215	5264	28499	4183	33891	3354	36970	2694	40794	1606	51577	855	44526
7L-5S		MI	17614	5264	29051	4167	34738	3330	38192	2676	42758	1587	53849	1037	44345
20-#14	3.29	MA	16489	5264	27436	4182	32491	3352	35222	2689	38479	1614	48658	781	42759
8L-4S		MI	18351	5264	30223	4153	36145	3334	39909	2666	45053	1580	56765	1100	45572
20-#18	5.85	MA	20794	6536	38156	4956	45954	3924	51506	3032	59941	1504	76898	348	74983
6E		MI	19518	6536	36034	4935	43290	3905	48455	3014	56101	1473	71742	296	70202

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

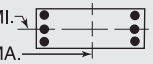
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.51	MA	18436	4875	28900	3939	34566	3177	37863	2574	42154	1635	52758	1290	37984
4L-9S		MI	14876	4875	23654	3945	27899	3177	29918	2578	31839	1635	39701	965	32088
22-#11	2.51	MA	17875	4875	28029	3950	33521	3176	36588	2582	40425	1640	50561	1245	37236
5L-8S		MI	15363	4875	24425	3935	28846	3169	31047	2571	33344	1630	41577	1024	33031
22-#11	2.51	MA	17337	4875	27256	3950	32490	3185	35333	2579	38763	1645	48339	1170	36645
6L-7S		MI	15854	4875	25123	3935	29765	3171	32195	2574	34863	1625	43492	1076	33762
22-#11	2.51	MA	16811	4875	26502	3950	31493	3184	34115	2587	37077	1640	46365	1099	35874
7L-6S		MI	16350	4875	25832	3935	30703	3172	33340	2567	36437	1630	45329	1147	34490
22-#11	2.51	MA	16291	4875	25761	3950	30517	3183	32896	2584	35450	1645	44313	1047	35073
8L-5S		MI	16857	4875	26560	3935	31673	3164	34521	2570	37990	1625	47398	1222	35024
22-#11	2.51	MA	15774	4875	24942	3961	29510	3192	31695	2592	33839	1651	42298	988	34066
9L-4S		MI	17386	4875	27378	3925	32656	3165	35721	2563	39604	1619	49450	1267	35737
22-#11	2.51	MA	15260	4875	24203	3961	28540	3191	30490	2589	32183	1645	40343	922	33047
10L-3S		MI	17970	4875	28187	3925	33748	3157	37045	2567	41373	1625	51398	1358	35899
22-#14	3.62	MA	19437	5427	32339	4285	38891	3419	43050	2736	48955	1597	62048	1042	51917
5L-8S		MI	16246	5427	27541	4267	32653	3410	35596	2722	39322	1584	49795	726	44581
22-#14	3.62	MA	18697	5427	31230	4285	37413	3432	41252	2731	46589	1605	58895	933	50634
6L-7S		MI	16922	5427	28541	4268	33969	3414	37240	2727	41482	1577	52517	799	46281
22-#14	3.62	MA	17972	5427	30150	4285	35985	3429	39507	2741	44190	1597	56095	831	49230
7L-6S		MI	17605	5427	29557	4268	35313	3417	38881	2718	43720	1584	55119	902	47559
22-#14	3.62	MA	17256	5427	29087	4285	34585	3427	37759	2737	41876	1605	53176	757	47422
8L-5S		MI	18304	5427	30600	4269	36703	3405	40572	2723	45927	1577	58052	1011	48782
24-#11	2.74	MA	18407	4989	29184	4021	34986	3228	38363	2614	42813	1635	53744	1230	40548
5L-9S		MI	15391	4989	24738	4016	29274	3229	31584	2611	34069	1629	42665	949	35154
24-#11	2.74	MA	17874	4989	28411	4021	33955	3237	37107	2612	41150	1640	51522	1154	39974
6L-8S		MI	15873	4989	25509	4005	30221	3221	32713	2604	35573	1623	44541	1008	36127
24-#11	2.74	MA	17353	4989	27657	4021	32958	3236	35890	2619	39464	1635	49548	1083	39158
7E		MI	16359	4989	26207	4006	31140	3222	33861	2607	37092	1618	46457	1059	36838
24-#11	2.74	MA	16837	4989	26916	4021	31981	3235	34670	2617	37837	1640	47496	1031	38377
8L-6S		MI	16851	4989	26916	4006	32078	3224	35006	2600	38666	1623	48294	1130	37611
24-#11	2.74	MA	16326	4989	26097	4032	30975	3244	33470	2624	36227	1645	45480	972	37316
9L-5S		MI	17353	4989	27644	4006	33048	3215	36187	2603	40219	1618	50363	1206	38129
24-#11	2.74	MA	15817	4989	25358	4032	30005	3243	32264	2622	34570	1640	43525	906	36301
10L-4S		MI	17877	4989	28463	3996	34031	3217	37386	2596	41833	1613	52415	1250	38904
24-#14	3.95	MA	19436	5591	32881	4387	39507	3506	43789	2779	49986	1596	63413	909	55306
6L-8S		MI	16952	5591	29090	4369	34617	3485	37976	2769	42491	1574	53998	700	48951
24-#14	3.95	MA	18720	5591	31802	4387	38079	3504	42044	2789	47587	1588	60613	807	53941
7E		MI	17620	5591	30090	4370	35934	3488	39620	2774	44651	1567	56720	773	50691
24-#14	3.95	MA	18013	5591	30738	4387	36679	3501	40296	2784	45272	1596	57694	733	52093
8L-6S		MI	18295	5591	31106	4371	37277	3492	41261	2765	46889	1574	59322	875	51931

RECTANGULAR TIED COLUMNS 36" x 40"

4-#18	1.11	MA	18338	4400	26505	3664	31194	2981	33263	2475	34845	1737	42054	1622	19017
2E		MI	16404	4400	23952	3633	27991	2955	29747	2453	30920	1711	37143	1588	16934
6-#18	1.67	MA	19778	4691	29571	3845	35083	3114	37974	2559	41125	1719	50389	1575	28133
2L-3S		MI	15586	4691	23952	3811	27991	3080	29747	2551	30920	1702	37143	1300	24827
6-#18	1.67	MA	17427	4691	26505	3844	31194	3109	33263	2576	34845	1732	42054	1342	27906
3L-2S		MI	17656	4691	26654	3814	31419	3088	33900	2537	36391	1689	44361	1533	24989
8-#14	1.25	MA	18805	4473	27191	3734	32254	3035	34629	2513	36854	1754	44842	1639	21510
2L-4S		MI	14731	4473	21846	3704	25411	3020	26701	2497	27042	1730	32687	1344	19001
8-#14	1.25	MA	17436	4473	25438	3735	30030	3033	31934	2524	33229	1761	40010	1507	21473
3E		MI	15614	4473	23004	3705	26975	3009	28596	2503	29557	1737	35444	1475	19137
8-#14	1.25	MA	16440	4473	24132	3735	28265	3046	29796	2521	30353	1754	36831	1376	21281
4L-2S		MI	16821	4473	24553	3706	28940	3012	30976	2494	32726	1730	39647	1607	19150
8-#18	2.22	MA	21173	4982	32638	4027	38971	3247	42686	2643	47404	1701	58723	1529	37198
2L-4S		MI	15355	4982	24628	3989	28682	3231	30584	2622	32048	1667	39639	1012	30665

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

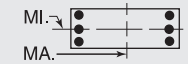
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	2.22	MA	18871	4982	29571	4026	35083	3242	37974	2660	41125	1714	50389	1296	36853
3E		MI	16841	4982	26654	3992	31419	3213	33900	2635	36391	1680	44361	1245	32714
8-#18	2.22	MA	17194	4982	27281	4025	31988	3263	34225	2651	36141	1701	44920	1062	34519
4L-2S		MI	18870	4982	29357	3996	34847	3221	38053	2621	41861	1667	51578	1479	32987
10-#11	1.08	MA	18399	4386	26206	3692	31100	3006	33273	2497	35095	1767	42581	1664	18813
2L-5S		MI	14436	4386	20968	3675	24476	2989	25600	2489	25618	1752	30756	1409	16621
10-#11	1.08	MA	17435	4386	24980	3693	29545	3005	31390	2505	32554	1772	39180	1572	18808
3L-4S		MI	15000	4386	21787	3665	25459	2990	26800	2482	27233	1746	32808	1453	16740
10-#11	1.08	MA	16735	4386	24069	3694	28313	3014	29897	2503	30538	1767	36940	1481	18747
4L-3S		MI	15622	4386	22595	3665	26552	2982	28124	2485	29002	1752	34755	1544	16776
10-#11	1.08	MA	16100	4386	23146	3705	27207	3014	28546	2511	28699	1773	34596	1436	18582
5L-2S		MI	16473	4386	23680	3666	27927	2983	29790	2478	31231	1746	37720	1635	16768
10-#14	1.56	MA	19636	4637	28945	3837	34477	3110	37323	2561	40479	1746	49675	1617	26713
2L-5S		MI	14693	4637	22223	3821	25969	3092	27364	2554	27916	1727	33973	1255	22495
10-#14	1.56	MA	18286	4637	27191	3837	32254	3108	34629	2572	36854	1753	44842	1485	26637
3L-4S		MI	15484	4637	23396	3807	27376	3095	29081	2545	30211	1719	36890	1317	23520
10-#14	1.56	MA	17304	4637	25885	3837	30489	3121	32490	2568	33978	1746	41663	1354	26395
4L-3S		MI	16355	4637	24553	3807	28940	3083	30976	2550	32726	1727	39647	1449	23704
10-#14	1.56	MA	16415	4637	24564	3853	28902	3119	30554	2579	31353	1753	38327	1289	25202
5L-2S		MI	17547	4637	26102	3808	30904	3087	33356	2541	35895	1719	43851	1580	23756
10-#18	2.78	MA	22531	5273	35704	4209	42860	3380	47397	2727	53684	1683	67057	1483	46237
2L-5S		MI	15283	5273	25276	4194	29644	3356	31728	2720	33557	1658	41824	849	36098
10-#18	2.78	MA	20273	5273	32638	4208	38971	3375	42686	2744	47404	1697	58723	1250	45791
3L-4S		MI	16606	5273	27331	4171	32110	3364	34736	2706	37519	1645	46857	957	38180
10-#18	2.78	MA	18632	5273	30347	4206	35877	3396	38936	2735	42421	1683	53254	1016	43094
4L-3S		MI	18062	5273	29357	4174	34847	3346	38053	2719	41861	1658	51578	1191	40587
10-#18	2.78	MA	17144	5273	28028	4232	33093	3390	35538	2752	37873	1697	47474	904	40595
5L-2S		MI	20053	5273	32060	4178	38274	3354	42205	2706	47332	1645	58796	1424	40956
12-#11	1.30	MA	18992	4499	27432	3763	32655	3057	35157	2530	37636	1762	45982	1650	22457
2L-6S		MI	14439	4499	21324	3746	24881	3049	26085	2519	26295	1750	31651	1317	19085
12-#11	1.30	MA	18037	4499	26206	3764	31100	3057	33273	2538	35095	1767	42581	1558	22432
3L-5S		MI	14974	4499	22052	3746	25851	3040	27266	2522	27848	1745	33720	1392	19751
12-#11	1.30	MA	17345	4499	25294	3765	29868	3066	31780	2536	33080	1762	40341	1467	22347
4E		MI	15533	4499	22871	3736	26834	3042	28465	2515	29462	1740	35772	1436	19927
12-#11	1.30	MA	16717	4499	24372	3775	28761	3065	30429	2544	31241	1768	37997	1422	22132
5L-3S		MI	16148	4499	23680	3736	27927	3034	29790	2518	31231	1745	37720	1527	19986
12-#11	1.30	MA	16115	4499	23553	3776	27669	3075	29100	2542	29472	1773	35623	1347	21337
6L-2S		MI	16991	4499	24764	3736	29302	3035	31455	2511	33460	1740	40684	1619	19997
12-#14	1.88	MA	20452	4800	30698	3939	36701	3185	40017	2608	44104	1738	54508	1595	31902
2L-6S		MI	14694	4800	22729	3922	26544	3178	28053	2596	28878	1724	35243	1119	26038
12-#14	1.88	MA	19118	4800	28945	3939	34477	3183	37323	2619	40479	1745	49675	1463	31790
3L-5S		MI	15443	4800	23772	3923	27933	3167	29744	2602	31085	1717	38177	1228	26876
12-#14	1.88	MA	18151	4800	27639	3939	32713	3196	35184	2615	37603	1738	46496	1332	31506
4E		MI	16223	4800	24945	3909	29341	3170	31461	2592	33380	1709	41094	1291	28034
12-#14	1.88	MA	17274	4800	26317	3955	31126	3194	33248	2626	34978	1745	43159	1267	30179
5L-3S		MI	17082	4800	26102	3910	30904	3158	33356	2598	35895	1717	43851	1422	28259
12-#14	1.88	MA	16433	4800	25143	3955	29561	3207	31343	2622	32453	1752	39786	1158	29171
6L-2S		MI	18259	4800	27651	3910	32869	3161	35737	2588	39064	1709	48054	1554	28343
12-#18	3.33	MA	23858	5564	38770	4391	46749	3513	52108	2812	59964	1666	75391	1437	55259
2L-6S		MI	15284	5564	26150	4372	30636	3508	32916	2791	35218	1649	44006	600	40380
12-#18	3.33	MA	21641	5564	35704	4389	42860	3508	47397	2829	53684	1679	67057	1204	54724
3L-5S		MI	16529	5564	27979	4375	33072	3489	35881	2804	39027	1636	49042	795	43647
12-#18	3.33	MA	20033	5564	33414	4388	39766	3529	43647	2819	48700	1666	61588	970	51711
4E		MI	17826	5564	30033	4352	35537	3497	38889	2791	42989	1623	54075	902	45739

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	3.33	MA	18576	5564	31094	4413	36982	3523	40250	2836	44153	1679	55808	858	49337
5L-3S		MI	19254	5564	32060	4356	38274	3479	42205	2804	47332	1636	58796	1136	48453
12-#18	3.33	MA	17177	5564	29031	4412	34232	3544	36904	2827	39779	1692	49992	664	45477
6L-2S		MI	21210	5564	34763	4360	41702	3487	46358	2790	52802	1623	66014	1370	48907
14-#11	1.52	MA	19577	4613	28657	3834	34209	3109	37040	2563	40177	1756	49384	1636	26091
2L-7S		MI	14456	4613	21699	3817	25318	3099	26605	2559	26950	1739	32779	1229	21747
14-#11	1.52	MA	18631	4613	27432	3835	32655	3109	35157	2571	37636	1762	45982	1545	26049
3L-6S		MI	14975	4613	22408	3817	26256	3101	27751	2551	28524	1744	34616	1300	22182
14-#11	1.52	MA	17945	4613	26520	3835	31423	3118	33664	2569	35621	1757	43742	1453	25942
4L-5S		MI	15505	4613	23136	3817	27226	3092	28932	2555	30077	1739	36685	1375	22816
14-#11	1.52	MA	17324	4613	25598	3846	30316	3117	32313	2577	33782	1762	41399	1408	25609
5L-4S		MI	16057	4613	23955	3807	28209	3094	30131	2548	31691	1734	38737	1420	23109
14-#11	1.52	MA	16729	4613	24779	3847	29224	3127	30983	2575	32013	1768	39024	1333	24848
6L-3S		MI	16666	4613	24764	3807	29302	3085	31455	2551	33460	1739	40684	1511	23188
14-#11	1.52	MA	16146	4613	23981	3848	28168	3126	29694	2583	30220	1763	36912	1262	24320
7L-2S		MI	17502	4613	25848	3807	30676	3087	33121	2544	35689	1734	43649	1602	23216
14-#14	2.19	MA	21254	4964	32452	4041	38925	3259	42712	2655	47729	1729	59340	1573	37081
2L-7S		MI	14717	4964	23262	4023	27165	3250	28792	2653	29808	1706	36845	990	29006
14-#14	2.19	MA	19936	4964	30698	4041	36701	3258	40017	2667	44104	1737	54508	1441	36937
3L-6S		MI	15440	4964	24278	4024	28508	3253	30433	2643	32047	1714	39447	1093	30467
14-#14	2.19	MA	18982	4964	29393	4042	34937	3271	37879	2663	41228	1729	51329	1310	36615
4L-5S		MI	16178	4964	25321	4025	29898	3242	32124	2649	34254	1706	42380	1202	31272
14-#14	2.19	MA	18117	4964	28071	4057	33350	3269	35943	2674	38603	1737	47992	1245	35171
5L-4S		MI	16948	4964	26494	4011	31305	3245	33841	2640	36549	1699	45297	1265	32545
14-#14	2.19	MA	17288	4964	26896	4057	31785	3282	34037	2670	36078	1744	44618	1136	34200
6L-3S		MI	17796	4964	27651	4012	32869	3233	35737	2645	39064	1706	48054	1396	32807
14-#14	2.19	MA	16475	4964	25753	4058	30272	3281	32189	2681	33518	1737	41621	1034	32526
7L-2S		MI	18960	4964	29200	4013	34834	3236	38117	2636	42233	1699	52257	1527	32921
14-#18	3.89	MA	22980	5854	38770	4571	46749	3641	52108	2913	59964	1661	75391	1158	63654
3L-6S		MI	16526	5854	28853	4553	34063	3641	37069	2876	40688	1627	51224	545	47953
14-#18	3.89	MA	21403	5854	36480	4570	43654	3662	48358	2903	54980	1648	69922	924	60364
4L-5S		MI	17747	5854	30682	4557	36499	3622	40033	2889	44498	1614	56260	740	51090
14-#18	3.89	MA	19974	5854	34160	4595	40870	3656	44961	2920	50432	1661	64143	812	57863
5L-4S		MI	19019	5854	32736	4534	38965	3630	43042	2875	48460	1601	61293	848	53334
14-#18	3.89	MA	18603	5854	32097	4594	38121	3677	41615	2911	46059	1674	58326	618	54123
6L-3S		MI	20422	5854	34763	4538	41702	3612	46358	2888	52802	1614	66014	1081	56313
16-#11	1.73	MA	20154	4726	29883	3905	35764	3161	38924	2595	42718	1751	52785	1622	29720
2L-8S		MI	14481	4726	22085	3888	25774	3149	27123	2588	27660	1738	33828	1161	23989
16-#11	1.73	MA	19216	4726	28657	3906	34209	3160	37040	2604	40177	1757	49384	1531	29661
3L-7S		MI	14989	4726	22783	3888	26693	3151	28271	2591	29179	1733	35743	1212	24801
16-#11	1.73	MA	18537	4726	27746	3906	32977	3170	35547	2601	38162	1752	47143	1439	29535
4L-6S		MI	15503	4726	23492	3888	27631	3153	29417	2584	30753	1738	37580	1283	25286
16-#11	1.73	MA	17923	4726	26824	3917	31871	3169	34196	2610	36323	1757	44800	1394	29096
5E		MI	16027	4726	24220	3888	28601	3144	30597	2588	32306	1733	39650	1359	25892
16-#11	1.73	MA	17333	4726	26005	3918	30778	3179	32867	2608	34554	1763	42425	1319	28365
6L-4S		MI	16574	4726	25039	3878	29584	3146	31797	2580	33920	1727	41701	1403	26286
16-#11	1.73	MA	16757	4726	25207	3918	29723	3178	31577	2616	32761	1758	40313	1248	27805
7L-3S		MI	17177	4726	25848	3878	30676	3137	33121	2584	35689	1733	43649	1494	26385
16-#11	1.73	MA	16186	4726	24422	3919	28689	3177	30286	2614	31031	1763	38125	1195	26843
8L-2S		MI	18006	4726	26932	3878	32051	3139	34787	2577	37919	1727	46613	1585	26428
16-#14	2.50	MA	22044	5127	34205	4143	41149	3334	45406	2703	51353	1721	64173	1550	42253
2L-8S		MI	14754	5127	23811	4125	27813	3322	29528	2695	30818	1704	38326	891	31962
16-#14	2.50	MA	20741	5127	32452	4144	38925	3333	42712	2714	47729	1729	59340	1419	42080
3L-7S		MI	15459	5127	24812	4126	29130	3325	31172	2700	32977	1696	41048	964	33378
16-#14	2.50	MA	19799	5127	31146	4144	37161	3346	40573	2710	44852	1721	56161	1288	41724
4L-6S		MI	16173	5127	25827	4127	30473	3328	32813	2691	35216	1704	43650	1066	34819
16-#14	2.50	MA	18946	5127	29824	4159	35574	3344	38637	2721	42227	1729	52825	1223	40176
5E		MI	16902	5127	26870	4127	31863	3316	34504	2696	37423	1696	46584	1176	35680

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

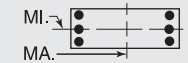
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	2.50	MA	18128	5127	28650	4160	34009	3357	36731	2717	39703	1736	49451	1114	39211
6L-4S		MI	17661	5127	28043	4113	33270	3320	36222	2687	39718	1689	49500	1238	37054
16-#14	2.50	MA	17326	5127	27506	4160	32496	3355	34883	2728	37143	1729	46453	1012	37501
7L-3S		MI	18499	5127	29200	4114	34834	3308	38117	2692	42233	1696	52257	1370	37348
16-#14	2.50	MA	16534	5127	26380	4160	31013	3354	33031	2724	34673	1736	43338	936	35882
8L-2S		MI	19650	5127	30749	4115	36798	3311	40497	2683	45401	1689	56461	1501	37491
16-#18	4.44	MA	22746	6145	39546	4752	47543	3795	53069	2988	61260	1630	78256	878	69046
4L-6S		MI	17741	6145	31555	4735	37491	3773	41222	2960	46159	1605	58442	491	55549
16-#18	4.44	MA	21343	6145	37226	4777	44759	3789	49672	3005	56712	1643	72477	766	66403
5E		MI	18941	6145	33384	4739	39927	3755	44186	2973	49968	1592	63478	685	58564
16-#18	4.44	MA	19998	6145	35163	4776	42010	3810	46326	2995	52339	1656	66660	572	62791
6L-4S		MI	20191	6145	35439	4716	42393	3763	47194	2959	53930	1578	68511	793	60957
18-#11	1.95	MA	20723	4840	31109	3976	37319	3213	40807	2628	45259	1746	56186	1608	33343
2L-9S		MI	14514	4840	22399	3969	26202	3210	27660	2628	28385	1737	34917	1085	26267
18-#11	1.95	MA	19793	4840	29883	3977	35764	3212	38924	2637	42718	1752	52785	1517	33270
3L-8S		MI	15013	4840	23169	3958	27149	3201	28789	2621	29889	1731	36792	1144	27067
18-#11	1.95	MA	19121	4840	28972	3977	34532	3222	37431	2634	40703	1747	50545	1426	33125
4L-7S		MI	15515	4840	23867	3959	28068	3203	29937	2624	31408	1726	38708	1195	27855
18-#11	1.95	MA	18513	4840	28050	3988	33425	3221	36080	2643	38864	1752	48201	1380	32593
5L-6S		MI	16024	4840	24576	3959	29006	3205	31082	2617	32983	1731	40545	1266	28395
18-#11	1.95	MA	17930	4840	27230	3989	32333	3231	34750	2640	37095	1757	45827	1305	31888
6L-5S		MI	16543	4840	25304	3959	29976	3196	32263	2620	34535	1726	42614	1342	28977
18-#11	1.95	MA	17359	4840	26433	3989	31278	3230	33461	2649	35302	1753	43715	1234	31274
7L-4S		MI	17085	4840	26123	3949	30959	3198	33462	2613	36150	1721	44666	1386	29461
18-#11	1.95	MA	16795	4840	25648	3990	30244	3229	32169	2646	33572	1758	41526	1181	30338
8L-3S		MI	17682	4840	26932	3949	32051	3189	34787	2617	37919	1726	46613	1477	29577
18-#11	1.95	MA	16235	4840	24781	4001	29178	3239	30898	2655	31859	1763	39371	1122	29416
9L-2S		MI	18504	4840	28016	3949	33426	3191	36452	2610	40148	1721	49578	1568	29634
18-#14	2.81	MA	21534	5291	34205	4246	41149	3407	45406	2761	51353	1721	64173	1397	47219
3L-8S		MI	15493	5291	25360	4227	29777	3396	31909	2742	33987	1693	42530	864	36298
18-#14	2.81	MA	20603	5291	32900	4246	39384	3420	43267	2757	48477	1713	60994	1266	46781
4L-7S		MI	16189	5291	26361	4228	31094	3400	33553	2748	36146	1686	45252	937	37761
18-#14	2.81	MA	19761	5291	31578	4261	37798	3419	41332	2769	45852	1721	57657	1201	45192
5L-6S		MI	16894	5291	27377	4229	32438	3403	35193	2738	38385	1693	47853	1040	39155
18-#14	2.81	MA	18954	5291	30403	4262	36233	3432	39426	2765	43328	1728	54284	1092	44145
6L-5S		MI	17614	5291	28419	4230	33827	3391	36885	2744	40592	1686	50787	1149	40099
18-#14	2.81	MA	18163	5291	29260	4262	34720	3430	37577	2776	40768	1721	51286	990	42486
7L-4S		MI	18364	5291	29592	4216	35235	3394	38602	2734	42887	1678	53704	1212	41415
18-#14	2.81	MA	17382	5291	28134	4262	33237	3428	35725	2772	38298	1728	48170	914	40822
8L-3S		MI	19192	5291	30749	4216	36798	3383	40497	2740	45401	1686	56461	1343	41886
18-#14	2.81	MA	16605	5291	26891	4278	31709	3442	33903	2783	35852	1736	45111	830	39040
9L-2S		MI	20330	5291	32299	4217	38763	3386	42877	2730	48570	1678	60664	1475	42055
18-#18	5.00	MA	22688	6436	40293	4959	48648	3922	54383	3089	62992	1625	80811	720	74970
5L-6S		MI	18935	6436	34258	4917	40919	3906	45374	3044	51629	1583	65660	436	63166
18-#18	5.00	MA	21367	6436	38229	4957	45898	3943	51037	3079	58618	1639	74994	526	71479
6L-5S		MI	20114	6436	36087	4920	43355	3888	48339	3057	55439	1570	70696	631	66066
20-#11	2.17	MA	20364	4953	31109	4047	37319	3264	40807	2669	45259	1746	56186	1503	36875
3L-9S		MI	15043	4953	23483	4039	27577	3262	29325	2661	30614	1730	37881	1068	29318
20-#11	2.17	MA	19698	4953	30198	4048	36087	3274	39314	2667	43244	1741	53946	1412	36713
4L-8S		MI	15537	4953	24253	4029	28524	3253	30455	2654	32119	1725	39757	1127	30152
20-#11	2.17	MA	19096	4953	29276	4059	34980	3273	37963	2675	41405	1747	51602	1366	36097
5L-7S		MI	16035	4953	24952	4029	29443	3255	31602	2657	33638	1720	41672	1178	30916
20-#11	2.17	MA	18519	4953	28456	4060	33888	3282	36634	2673	39637	1752	49228	1291	35417
6E		MI	16538	4953	25660	4030	30380	3257	32748	2650	35212	1725	43509	1250	31508

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

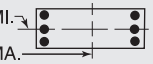


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.17	MA	17953	4953	27659	4060	32832	3282	35344	2681	37844	1747	47116	1220	34750
7L-5S		MI	17053	4953	26388	4030	31351	3248	33929	2653	36765	1720	45579	1325	32070
20-#11	2.17	MA	17395	4953	26874	4061	31798	3281	34053	2679	36113	1753	44928	1167	33839
8L-4S		MI	17589	4953	27207	4020	32333	3250	35128	2646	38379	1715	47631	1369	32634
20-#11	2.17	MA	16841	4953	26007	4072	30732	3290	32782	2687	34400	1758	42773	1108	32886
9L-3S		MI	18181	4953	28016	4020	33426	3241	36452	2649	40148	1720	49578	1460	32765
20-#11	2.17	MA	16288	4953	25225	4072	29705	3290	31505	2685	32638	1753	40544	1028	31848
10L-2S		MI	18996	4953	29100	4020	34801	3243	38118	2642	42377	1715	52542	1552	32836
20-#14	3.13	MA	21396	5455	34653	4348	41608	3495	45962	2805	52102	1705	65827	1244	51746
4L-8S		MI	16221	5455	26909	4329	31742	3471	34289	2789	37156	1683	46733	838	40644
20-#14	3.13	MA	20565	5455	33332	4364	40022	3494	44026	2816	49477	1713	62490	1179	50217
5L-7S		MI	16909	5455	27910	4330	33059	3474	35933	2795	39315	1676	49455	911	42154
20-#14	3.13	MA	19767	5455	32157	4364	38456	3507	42120	2812	46952	1720	59116	1070	49091
6E		MI	17605	5455	28926	4331	34402	3478	37574	2786	41554	1683	52057	1014	43502
20-#14	3.13	MA	18987	5455	31013	4364	36943	3505	40272	2823	44393	1713	56119	968	47479
7L-5S		MI	18316	5455	29969	4332	35792	3466	39265	2791	43761	1676	54990	1123	44527
20-#14	3.13	MA	18215	5455	29887	4365	35461	3503	38420	2819	41923	1720	53003	892	45719
8L-4S		MI	19057	5455	31141	4318	37199	3469	40982	2782	46055	1668	57907	1185	45787
20-#14	3.13	MA	17449	5455	28645	4380	33933	3516	36598	2830	39477	1728	49943	807	43963
9L-3S		MI	19875	5455	32299	4319	38763	3457	42877	2787	48570	1676	60664	1317	46420
20-#18	5.56	MA	22713	6727	41296	5139	49787	4076	55748	3163	64898	1621	83328	480	80185
6E		MI	20224	6727	36961	5099	44347	4039	49527	3128	57100	1561	72878	381	70801
22-#11	2.38	MA	20268	5066	31424	4119	37641	3326	41197	2700	45785	1736	57347	1398	40300
4L-9S		MI	15565	5066	24567	4110	28951	3314	30991	2694	32844	1724	40846	1051	32375
22-#11	2.38	MA	19672	5066	30501	4130	36535	3325	39847	2708	43946	1742	55004	1352	39608
5L-8S		MI	16055	5066	25338	4100	29898	3305	32120	2687	34348	1719	42721	1110	33240
22-#11	2.38	MA	19100	5066	29682	4130	35442	3334	38517	2706	42178	1747	52629	1277	38949
6L-7S		MI	16548	5066	26036	4100	30818	3307	33268	2690	35867	1714	44637	1162	33984
22-#11	2.38	MA	18541	5066	28885	4131	34387	3334	37228	2714	40385	1742	50517	1206	38233
7L-6S		MI	17047	5066	26745	4101	31755	3308	34414	2683	37441	1719	46474	1233	34626
22-#11	2.38	MA	17988	5066	28100	4132	33353	3333	35936	2712	38655	1748	48329	1153	37345
8L-5S		MI	17557	5066	27473	4101	32726	3300	35594	2686	38994	1714	48543	1308	35168
22-#11	2.38	MA	17439	5066	27233	4143	32287	3342	34665	2720	36941	1753	46174	1094	36361
9L-4S		MI	18088	5066	28291	4091	33708	3302	36794	2679	40608	1708	50595	1352	35804
22-#11	2.38	MA	16892	5066	26451	4143	31260	3342	33388	2718	35179	1748	43945	1014	35344
10L-3S		MI	18675	5066	29100	4091	34801	3293	38118	2682	42377	1714	52542	1444	35951
22-#14	3.44	MA	21357	5618	35085	4466	42246	3568	46720	2863	53102	1705	67323	1157	55250
5L-8S		MI	16938	5618	28459	4432	33707	3546	36669	2837	40325	1673	50936	812	44957
22-#14	3.44	MA	20570	5618	33911	4466	40680	3581	44814	2859	50577	1712	63949	1048	54048
6L-7S		MI	17618	5618	29459	4432	35024	3549	38313	2842	42484	1665	53659	885	46554
22-#14	3.44	MA	19799	5618	32767	4467	39167	3580	42966	2870	48018	1705	60951	946	52481
7L-6S		MI	18306	5618	30475	4433	36367	3552	39954	2833	44722	1673	56260	987	47861
22-#14	3.44	MA	19037	5618	31641	4467	37685	3578	41114	2867	45548	1712	57836	870	50679
8L-5S		MI	19009	5618	31518	4434	37757	3541	41645	2838	46929	1665	59194	1096	48962
22-#14	3.44	MA	18280	5618	30398	4482	36157	3591	39292	2878	43102	1720	54776	785	48893
9L-4S		MI	19742	5618	32690	4420	39164	3544	43362	2829	49224	1658	62110	1159	50172
24-#11	2.60	MA	20241	5180	31727	4201	38089	3377	41730	2741	46487	1737	58405	1338	43124
5L-9S		MI	16082	5180	25651	4181	30326	3366	32657	2727	35073	1718	43810	1034	35438
24-#11	2.60	MA	19675	5180	30908	4201	36997	3386	40401	2739	44719	1742	56030	1263	42485
6L-8S		MI	16567	5180	26422	4171	31273	3357	33786	2720	36577	1712	45686	1094	36334
24-#11	2.60	MA	19121	5180	30110	4202	35942	3385	39111	2747	42926	1737	53919	1192	41721
7E		MI	17055	5180	27120	4171	32192	3359	34934	2723	38096	1707	47602	1145	37057
24-#11	2.60	MA	18573	5180	29325	4203	34908	3385	37820	2745	41196	1742	51730	1139	40855
8L-6S		MI	17550	5180	27829	4171	33130	3360	36079	2716	39671	1712	49438	1216	37747
24-#11	2.60	MA	18030	5180	28459	4214	33842	3394	36549	2753	39482	1748	49575	1080	39841
9L-5S		MI	18055	5180	28557	4172	34100	3352	37260	2719	41223	1707	51508	1292	38272
24-#11	2.60	MA	17488	5180	27676	4214	32815	3393	35272	2751	37721	1743	47347	1000	38823
10L-4S		MI	18582	5180	29375	4161	35083	3353	38459	2712	42838	1702	53560	1336	38974

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#14	3.75	MA	21362	5782	35664	4568	42904	3656	47509	2907	54202	1704	68782	1026	59014
6L-8S		MI	17647	5782	30008	4534	35671	3621	39049	2884	43494	1663	55140	785	49321
24-#14	3.75	MA	20600	5782	34521	4569	41391	3655	45660	2918	51642	1697	65784	924	57489
7E		MI	18319	5782	31008	4535	36988	3624	40693	2890	45653	1655	57862	858	50961
24-#14	3.75	MA	19847	5782	33395	4569	39909	3653	43808	2914	49172	1704	62668	848	55647
8L-6S		MI	18999	5782	32024	4535	38332	3627	42334	2880	47891	1663	60464	961	52229
24-#14	3.75	MA	19100	5782	32152	4584	38381	3666	41986	2925	46726	1712	59608	763	53832
9L-5S		MI	19694	5782	33067	4536	39721	3616	44025	2886	50098	1655	63397	1070	53404

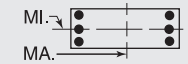
RECTANGULAR TIED COLUMNS 36" x 42"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.06	MA	20114	4591	28843	3843	34021	3128	36272	2600	37980	1837	45848	1722	20097
2E		MI	17097	4591	24879	3796	29048	3090	30819	2567	31919	1799	38278	1673	16972
6-#18	1.59	MA	21655	4882	32091	4024	38141	3261	41262	2684	44665	1821	54741	1679	29753
2L-3S		MI	16278	4882	24879	3974	29048	3215	30819	2665	31919	1790	38278	1385	24900
6-#18	1.59	MA	19156	4882	28843	4024	34021	3257	36272	2702	37980	1834	45848	1446	29526
3L-2S		MI	18354	4882	27582	3978	32476	3223	34972	2651	37389	1777	45496	1618	25035
8-#14	1.19	MA	20608	4664	29562	3913	35134	3182	37706	2638	40071	1852	48784	1739	22725
2L-4S		MI	15420	4664	22764	3869	26465	3156	27774	2613	28044	1818	33828	1429	19067
8-#14	1.19	MA	19154	4664	27706	3914	32780	3181	34855	2650	36223	1860	43636	1607	22688
3E		MI	16305	4664	23922	3870	28029	3144	29669	2618	30559	1826	36586	1561	19181
8-#14	1.19	MA	18099	4664	26327	3915	30915	3195	32594	2647	33172	1853	40246	1476	22496
4L-2S		MI	17516	4664	25471	3871	29994	3147	32049	2609	33728	1818	40789	1692	19184
8-#18	2.12	MA	23148	5173	35339	4206	42260	3394	46253	2768	51349	1805	63635	1637	39358
2L-4S		MI	16045	5173	25555	4152	29739	3366	31656	2736	33047	1755	40775	1097	30979
8-#18	2.12	MA	20700	5173	32091	4206	38141	3390	41262	2787	44665	1818	54741	1403	39013
3E		MI	17537	5173	27582	4156	32476	3348	34972	2749	37389	1768	45496	1330	32797
8-#18	2.12	MA	18920	5173	29669	4206	34867	3412	37296	2778	39360	1805	48898	1170	36813
4L-2S		MI	19573	5173	30284	4159	35904	3356	39125	2736	42860	1755	52714	1564	33039
10-#11	1.03	MA	20172	4577	28516	3871	33909	3153	36267	2622	38158	1863	46358	1763	19866
2L-5S		MI	15124	4577	21881	3841	25529	3125	26673	2605	26623	1841	31901	1495	16686
10-#11	1.03	MA	19149	4577	27219	3872	32264	3152	34274	2631	35470	1869	42738	1671	19861
3L-4S		MI	15690	4577	22700	3831	26512	3127	27873	2598	28237	1835	33953	1539	16784
10-#11	1.03	MA	18407	4577	26257	3873	30962	3162	32697	2629	33341	1865	40352	1580	19800
4L-3S		MI	16313	4577	23508	3831	27604	3118	29197	2601	30006	1841	35900	1630	16811
10-#11	1.03	MA	17736	4577	25283	3885	29794	3162	31270	2638	31399	1871	37862	1534	19635
5L-2S		MI	17166	4577	24593	3831	28979	3120	30863	2594	32235	1835	38865	1721	16797
10-#14	1.49	MA	21496	4828	31418	4016	37487	3257	40558	2686	43918	1845	53932	1719	28231
2L-5S		MI	15382	4828	23141	3986	27023	3228	28437	2669	28918	1815	35115	1340	22684
10-#14	1.49	MA	20062	4828	29562	4016	35134	3256	37706	2698	40071	1853	48784	1587	28155
3L-4S		MI	16175	4828	24313	3971	28430	3231	30154	2660	31213	1808	38032	1403	23593
10-#14	1.49	MA	19022	4828	28182	4017	33268	3270	35446	2694	37020	1845	45394	1456	27913
4L-3S		MI	17049	4828	25471	3972	29994	3219	32049	2666	33728	1815	40789	1534	23753
10-#14	1.49	MA	18079	4828	26786	4033	31593	3269	33401	2706	34235	1853	41847	1390	26771
5L-2S		MI	18244	4828	27020	3973	31959	3222	34429	2656	36897	1808	44992	1666	23794
10-#18	2.65	MA	24601	5464	38587	4388	46379	3527	51243	2852	58034	1789	72528	1595	48937
2L-5S		MI	15970	5464	26204	4357	30701	3491	32800	2834	34556	1746	42959	934	36373
10-#18	2.65	MA	22200	5464	35339	4388	42260	3523	46253	2871	51349	1802	63635	1361	48491
3L-4S		MI	17300	5464	28258	4334	33167	3499	35808	2821	38517	1733	47992	1042	38486
10-#18	2.65	MA	20458	5464	32917	4387	38987	3545	42286	2863	46045	1789	57791	1127	45909
4L-3S		MI	18763	5464	30284	4338	35904	3481	39125	2833	42860	1746	52714	1275	40678
10-#18	2.65	MA	18878	5464	30465	4414	36044	3541	38695	2881	41204	1802	51638	1014	43157
5L-2S		MI	20762	5464	32987	4341	39331	3489	43277	2820	48331	1733	59932	1509	41014

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

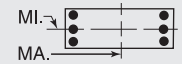


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.24	MA	20805	4690	29813	3942	35553	3205	38259	2655	40846	1858	49978	1750	23721
2L-6S		MI	15127	4690	22237	3912	25934	3185	27158	2634	27299	1839	32796	1403	19220
12-#11	1.24	MA	19791	4690	28516	3943	33909	3204	36267	2664	38158	1864	46358	1659	23695
3L-5S		MI	15664	4690	22965	3912	26904	3177	28339	2638	28852	1834	34865	1478	19852
12-#11	1.24	MA	19058	4690	27553	3944	32607	3214	34689	2662	36029	1860	43972	1568	23611
4E		MI	16224	4690	23784	3902	27886	3178	29538	2630	30466	1829	36917	1522	19976
12-#11	1.24	MA	18393	4690	26579	3955	31438	3214	33263	2670	34087	1866	41482	1521	23419
5L-3S		MI	16840	4690	24593	3902	28979	3170	30863	2634	32235	1834	38865	1613	20024
12-#11	1.24	MA	17756	4690	25715	3956	30285	3224	31859	2669	32219	1872	38955	1446	22616
6L-2S		MI	17686	4690	25677	3902	30354	3171	32528	2627	34464	1829	41829	1705	20029
12-#14	1.79	MA	22369	4991	33274	4118	39841	3332	43409	2733	47765	1837	59080	1699	33724
2L-6S		MI	15382	4991	23647	4087	27598	3314	29125	2711	29880	1813	36385	1205	26218
12-#14	1.79	MA	20951	4991	31418	4119	37487	3331	40558	2745	43918	1845	53932	1567	33613
3L-5S		MI	16133	4991	24690	4088	28987	3302	30817	2717	32087	1805	39319	1314	27061
12-#14	1.79	MA	19926	4991	30038	4119	35622	3345	38297	2742	40867	1838	50542	1436	33328
4E		MI	16916	4991	25862	4074	30395	3306	32534	2707	34382	1798	42235	1377	28112
12-#14	1.79	MA	18996	4991	28642	4135	33946	3343	36252	2754	38082	1846	46994	1370	32043
5L-3S		MI	17778	4991	27020	4075	31959	3294	34429	2713	36897	1805	44992	1508	28313
12-#14	1.79	MA	18105	4991	27402	4136	32293	3357	34239	2750	35405	1853	43401	1261	30942
6L-2S		MI	18960	4991	28569	4075	33923	3297	36809	2704	40066	1798	49196	1639	28385
12-#18	3.17	MA	26022	5755	41835	4570	50498	3660	56234	2937	64719	1773	81421	1552	58499
2L-6S		MI	15969	5755	27077	4535	31692	3642	33988	2906	36216	1737	45141	685	40801
12-#18	3.17	MA	23663	5755	38587	4569	46379	3656	51243	2955	58034	1786	72528	1319	57964
3L-5S		MI	17220	5755	28906	4539	34128	3624	36953	2919	40026	1724	50177	880	44042
12-#18	3.17	MA	21955	5755	36165	4569	43106	3678	47277	2947	52730	1773	66685	1085	55048
4E		MI	18524	5755	30961	4516	36594	3632	39961	2905	43988	1711	55210	987	46038
12-#18	3.17	MA	20408	5755	33713	4595	40163	3674	43685	2965	47889	1786	60531	971	52430
5L-3S		MI	19960	5755	32987	4519	39331	3614	43277	2918	48331	1724	59932	1221	48550
12-#18	3.17	MA	18924	5755	31533	4595	37257	3697	40148	2957	43233	1799	54324	778	48514
6L-2S		MI	21926	5755	35690	4523	42759	3622	47430	2904	53801	1711	67150	1454	48968
14-#11	1.44	MA	21429	4804	31109	4013	37198	3257	40251	2688	43534	1853	53598	1737	27566
2L-7S		MI	15143	4804	22612	3982	26371	3235	27678	2674	27954	1828	33924	1315	21884
14-#11	1.44	MA	20425	4804	29813	4014	35553	3256	38259	2696	40846	1859	49978	1646	27523
3L-6S		MI	15664	4804	23321	3983	27308	3237	28824	2667	29528	1833	35761	1386	22316
14-#11	1.44	MA	19698	4804	28850	4015	34251	3266	36681	2695	38717	1854	47591	1555	27417
4L-5S		MI	16196	4804	24049	3983	28279	3229	30005	2670	31081	1828	37830	1461	22962
14-#11	1.44	MA	19041	4804	27876	4026	33083	3266	35255	2703	36775	1860	45102	1509	27174
5L-4S		MI	16750	4804	24868	3973	29261	3230	31204	2663	32695	1823	39882	1506	23162
14-#11	1.44	MA	18411	4804	27011	4027	31930	3276	33851	2702	34907	1866	42575	1433	26333
6L-3S		MI	17361	4804	25677	3973	30354	3222	32528	2667	34464	1828	41829	1597	23229
14-#11	1.44	MA	17793	4804	26170	4028	30815	3275	32490	2710	33014	1862	40325	1363	25762
7L-2S		MI	18199	4804	26761	3973	31729	3223	34194	2660	36694	1823	44794	1688	23252
14-#14	2.08	MA	23226	5155	35130	4220	42194	3407	46261	2781	51612	1830	64227	1678	39207
2L-7S		MI	15403	5155	24180	4188	28219	3386	29865	2768	30811	1795	37987	1076	29286
14-#14	2.08	MA	21825	5155	33274	4221	39841	3406	43409	2792	47765	1838	59080	1547	39064
3L-6S		MI	16130	5155	25196	4189	29562	3389	31506	2759	33049	1802	40588	1178	30646
14-#14	2.08	MA	20813	5155	31894	4222	37976	3419	41149	2789	44714	1830	55689	1415	38741
4L-5S		MI	16871	5155	26239	4190	30952	3377	33197	2764	35256	1795	43522	1288	31454
14-#14	2.08	MA	19897	5155	30498	4237	36300	3418	39104	2801	41929	1838	52142	1350	37331
5L-4S		MI	17644	5155	27412	4176	32359	3380	34914	2755	37551	1787	46439	1350	32628
14-#14	2.08	MA	19018	5155	29257	4238	34646	3432	37090	2798	39252	1846	48548	1241	36270
6L-3S		MI	18495	5155	28569	4177	33923	3369	36809	2760	40066	1795	49196	1482	32864
14-#14	2.08	MA	18157	5155	28050	4239	33048	3431	35138	2810	36537	1839	45352	1139	34608
7L-2S		MI	19664	5155	30118	4178	35888	3372	39190	2751	43235	1787	53399	1613	32966
14-#18	3.70	MA	25095	6045	41835	4751	50498	3789	56234	3039	64719	1770	81421	1276	67434
3L-6S		MI	17214	6045	29780	4717	35120	3775	38141	2990	41687	1715	52359	630	48366
14-#18	3.70	MA	23419	6045	39413	4751	47225	3811	52267	3031	59414	1757	75578	1043	64224
4L-5S		MI	18442	6045	31609	4720	37556	3757	41105	3003	45497	1702	57395	825	51578
14-#18	3.70	MA	21903	6045	36961	4777	44282	3807	48675	3050	54573	1770	69425	929	61724
5L-4S		MI	19723	6045	33663	4698	40022	3765	44114	2989	49459	1688	62428	933	53626

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

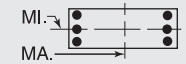
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.70	MA	20447	6045	34781	4777	41376	3830	45139	3042	49918	1783	63217	735	57689
6L-3S		MI	21133	6045	35690	4701	42759	3747	47430	3002	53801	1702	67150	1166	56416
14-#18	3.70	MA	19022	6045	32658	4777	38568	3825	41708	3060	45197	1770	57706	553	53591
7L-2S		MI	23068	6045	38393	4705	46187	3755	51583	2988	59272	1688	74368	1400	56909
16-#11	1.65	MA	22045	4917	32406	4084	38842	3308	42244	2721	46222	1847	57218	1724	31405
2L-8S		MI	15168	4917	22998	4053	26826	3286	28196	2704	28664	1827	34973	1247	24198
16-#11	1.65	MA	21049	4917	31109	4085	37198	3308	40251	2729	43534	1853	53598	1633	31346
3L-7S		MI	15678	4917	23696	4053	27746	3287	29344	2707	30183	1822	36888	1298	24999
16-#11	1.65	MA	20330	4917	30147	4086	35896	3318	38674	2728	41405	1849	51211	1542	31220
4L-6S		MI	16193	4917	24405	4053	28683	3289	30490	2700	31758	1827	38725	1369	25418
16-#11	1.65	MA	19679	4917	29173	4097	34727	3318	37247	2736	39463	1855	48722	1496	30865
5E		MI	16720	4917	25133	4054	29654	3280	31670	2703	33310	1822	40794	1445	26037
16-#11	1.65	MA	19056	4917	28308	4098	33574	3328	35843	2734	37595	1861	46195	1421	30056
6L-4S		MI	17269	4917	25952	4043	30636	3282	32870	2696	34925	1816	42846	1489	26343
16-#11	1.65	MA	18445	4917	27466	4099	32460	3327	34482	2743	35702	1857	43945	1350	29500
7L-3S		MI	17874	4917	26761	4044	31729	3274	34194	2699	36694	1822	44794	1580	26429
16-#11	1.65	MA	17841	4917	26638	4100	31368	3327	33118	2741	33875	1863	41620	1296	28508
8L-2S		MI	18706	4917	27845	4044	33104	3275	35860	2692	38923	1816	47758	1671	26465
16-#14	2.38	MA	24070	5318	36986	4322	44548	3482	49112	2828	55459	1822	69375	1658	44683
2L-8S		MI	15439	5318	24729	4290	28867	3457	30601	2810	31820	1792	39468	976	32341
16-#14	2.38	MA	22685	5318	35130	4323	42194	3480	46261	2840	51612	1830	64227	1527	44510
3L-7S		MI	16148	5318	25729	4291	30184	3460	32245	2815	33980	1785	42190	1049	33654
16-#14	2.38	MA	21686	5318	33750	4324	40329	3494	44000	2837	48561	1823	60837	1395	44154
4L-6S		MI	16865	5318	26745	4291	31527	3464	33886	2806	36218	1792	44792	1152	35082
16-#14	2.38	MA	20781	5318	32354	4340	38654	3493	41955	2848	45776	1831	57290	1330	42632
5E		MI	17597	5318	27788	4292	32917	3452	35577	2811	38425	1785	47725	1261	35860
16-#14	2.38	MA	19914	5318	31113	4341	37000	3507	39942	2845	43099	1839	53696	1221	41607
6L-4S		MI	18360	5318	28961	4278	34324	3455	37294	2802	40720	1777	50642	1324	37141
16-#14	2.38	MA	19065	5318	29906	4341	35402	3506	37990	2857	40384	1831	50500	1119	39880
7L-3S		MI	19202	5318	30118	4279	35888	3443	39190	2808	43235	1785	53399	1455	37409
16-#14	2.38	MA	18226	5318	28717	4342	33836	3504	36034	2854	37765	1839	47188	1043	38281
8L-2S		MI	20358	5318	31667	4280	37852	3447	41570	2798	46404	1777	57602	1587	37538
16-#18	4.23	MA	24855	6336	42661	4933	51344	3944	57258	3115	66099	1741	84471	1000	73430
4L-6S		MI	18433	6336	32483	4899	38548	3908	42294	3074	47158	1693	59577	576	55955
16-#18	4.23	MA	23366	6336	40209	4959	48401	3940	53666	3134	61258	1754	78318	887	70893
5E		MI	19641	6336	34312	4902	40984	3890	45258	3087	50967	1679	64613	770	59043
16-#18	4.23	MA	21938	6336	38029	4959	45495	3963	50129	3126	56602	1767	72110	693	66886
6L-4S		MI	20899	6336	36366	4879	43450	3898	48267	3073	54929	1666	69646	878	61243
16-#18	4.23	MA	20539	6336	35906	4958	42687	3958	46699	3144	51882	1754	66599	511	62720
7L-3S		MI	22286	6336	38393	4883	46187	3880	51583	3086	59272	1679	74368	1111	64278
18-#11	1.86	MA	22654	5030	33703	4155	40487	3360	44236	2753	48910	1842	60838	1712	35239
2L-9S		MI	15200	5030	23312	4134	27254	3346	28733	2744	29389	1826	36061	1171	26552
18-#11	1.86	MA	21666	5030	32406	4156	38842	3360	42244	2762	46222	1848	57218	1620	35165
3L-8S		MI	15701	5030	24082	4124	28201	3337	29862	2737	30894	1820	37937	1230	27274
18-#11	1.86	MA	20954	5030	31443	4157	37541	3370	40666	2760	44093	1844	54831	1529	35020
4L-7S		MI	16205	5030	24780	4124	29120	3339	31010	2740	32413	1815	39853	1281	28076
18-#11	1.86	MA	20309	5030	30470	4168	36372	3369	39240	2769	42151	1850	52342	1483	34566
5L-6S		MI	16716	5030	25489	4124	30058	3341	32155	2733	33987	1820	41690	1352	28527
18-#11	1.86	MA	19692	5030	29605	4169	35219	3379	37836	2767	40283	1856	49814	1408	33786
6L-5S		MI	17238	5030	26217	4124	31028	3332	33336	2736	35540	1815	43759	1428	29120
18-#11	1.86	MA	19087	5030	28763	4170	34105	3379	36475	2776	38390	1852	47565	1337	33239
7L-4S		MI	17782	5030	27036	4114	32011	3334	34535	2729	37154	1810	45811	1472	29520
18-#11	1.86	MA	18490	5030	27934	4171	33013	3379	35111	2774	36563	1858	45240	1284	32210
8L-3S		MI	18381	5030	27845	4114	33104	3325	35860	2732	38923	1815	47758	1563	29623

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

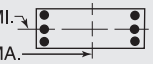


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.86	MA	17897	5030	27019	4182	31888	3389	33769	2783	34755	1864	42945	1225	31320
9L-2S		MI	19206	5030	28929	4115	34479	3327	37525	2725	41152	1810	50723	1654	29673
18-#14	2.68	MA	23532	5482	36986	4425	44548	3555	49112	2887	55459	1823	69375	1507	49952
3L-8S		MI	16180	5482	26278	4392	30831	3532	32981	2857	34989	1782	43671	950	36672
18-#14	2.68	MA	22545	5482	35606	4426	42683	3569	46852	2884	52408	1816	65985	1375	49565
4L-7S		MI	16880	5482	27278	4393	32148	3535	34625	2863	37149	1774	46393	1023	38034
18-#14	2.68	MA	21652	5482	34209	4442	41007	3568	44806	2896	49623	1823	62438	1309	47944
5L-6S		MI	17589	5482	28294	4394	33492	3538	36266	2853	39387	1782	48995	1126	39458
18-#14	2.68	MA	20796	5482	32969	4443	39353	3582	42793	2893	46946	1831	58844	1201	46950
6L-5S		MI	18312	5482	29337	4394	34881	3527	37957	2859	41594	1774	51929	1235	40277
18-#14	2.68	MA	19958	5482	31762	4444	37756	3580	40841	2904	44231	1824	55648	1098	45162
7L-4S		MI	19066	5482	30510	4380	36289	3530	39675	2850	43889	1767	54845	1297	41628
18-#14	2.68	MA	19130	5482	30573	4444	36190	3579	38886	2901	41612	1832	52335	1022	43519
8L-3S		MI	19898	5482	31667	4381	37852	3518	41570	2855	46404	1774	57602	1429	41950
18-#14	2.68	MA	18307	5482	29260	4460	34576	3593	36961	2913	39018	1840	49074	938	41652
9L-2S		MI	21042	5482	33216	4382	39817	3521	43950	2846	49573	1767	61806	1560	42105
18-#18	4.76	MA	24802	6627	43457	5141	52520	4073	58656	3218	67943	1738	87211	844	79984
5L-6S		MI	19631	6627	35185	5080	41976	4041	46446	3158	52628	1671	66795	521	63564
18-#18	4.76	MA	23400	6627	41277	5140	49614	4096	55120	3210	63287	1751	81004	651	76102
6L-5S		MI	20818	6627	37015	5084	44412	4023	49411	3171	56438	1657	71831	716	66537
18-#18	4.76	MA	22026	6627	39154	5140	46806	4091	51689	3228	58566	1738	75492	468	71868
7L-4S		MI	22056	6627	39069	5061	46877	4031	52419	3158	60400	1644	76864	823	68886
20-#11	2.06	MA	22275	5144	33703	4227	40487	3412	44236	2795	48910	1843	60838	1608	38981
3L-9S		MI	15730	5144	24396	4205	28629	3398	30398	2777	31619	1819	39026	1154	29601
20-#11	2.06	MA	21569	5144	32740	4228	39185	3422	42659	2793	46781	1839	58451	1517	38819
4L-8S		MI	16227	5144	25166	4195	29576	3389	31528	2770	33123	1814	40902	1213	30356
20-#11	2.06	MA	20931	5144	31766	4239	38016	3421	41232	2802	44839	1845	55962	1470	38275
5L-7S		MI	16727	5144	25864	4195	30495	3391	32676	2773	34642	1809	42817	1264	31135
20-#11	2.06	MA	20320	5144	30902	4240	36863	3431	39828	2800	42971	1851	53434	1395	37521
6E		MI	17233	5144	26573	4195	31433	3393	33821	2766	36216	1814	44654	1336	31640
20-#11	2.06	MA	19722	5144	30060	4241	35749	3431	38467	2809	41078	1847	51185	1324	36920
7L-5S		MI	17749	5144	27301	4195	32403	3384	35002	2769	37769	1809	46723	1411	32211
20-#11	2.06	MA	19130	5144	29231	4242	34657	3431	37103	2807	39251	1853	48860	1271	35917
8L-4S		MI	18288	5144	28120	4185	33386	3386	36201	2762	39383	1804	48775	1455	32695
20-#11	2.06	MA	18543	5144	28316	4253	33532	3440	35762	2816	37443	1859	46565	1212	34996
9L-3S		MI	18883	5144	28929	4185	34479	3377	37525	2765	41152	1809	50723	1546	32814
20-#11	2.06	MA	17958	5144	27491	4254	32448	3440	34414	2814	35583	1854	44193	1132	33861
10L-2S		MI	19701	5144	30013	4186	35854	3379	39191	2758	43382	1804	53687	1637	32877
20-#14	2.98	MA	23392	5645	37461	4528	45036	3644	49703	2931	56255	1808	71133	1355	54975
4L-8S		MI	16910	5645	27827	4494	32796	3607	35362	2905	38158	1772	47875	924	41013
20-#14	2.98	MA	22510	5645	36065	4544	43361	3643	47658	2943	53470	1816	67585	1289	53266
5L-7S		MI	17602	5645	28828	4495	34113	3610	37006	2910	40318	1764	50597	997	42422
20-#14	2.98	MA	21665	5645	34825	4545	41707	3656	45645	2940	50793	1824	63992	1181	52237
6E		MI	18302	5645	29843	4496	35456	3613	38646	2901	42556	1772	53199	1099	43802
20-#14	2.98	MA	20837	5645	33617	4546	40109	3655	43693	2952	48078	1817	60795	1078	50453
7L-5S		MI	19017	5645	30886	4497	36846	3602	40338	2906	44763	1764	56132	1208	44703
20-#14	2.98	MA	20019	5645	32429	4547	38543	3654	41737	2949	45459	1824	57483	1002	48766
8L-4S		MI	19762	5645	32059	4483	38253	3605	42055	2897	47058	1757	59049	1271	45997
20-#14	2.98	MA	19207	5645	31116	4562	36930	3668	39813	2960	42865	1832	54222	917	46940
9L-3S		MI	20585	5645	33216	4483	39817	3593	43950	2902	49573	1764	61806	1403	46487
20-#18	5.29	MA	24837	6918	44525	5322	53734	4228	60110	3294	69972	1735	89897	608	85337
6E		MI	20929	6918	37888	5262	45403	4174	50599	3243	58099	1648	74013	466	71193
20-#18	5.29	MA	23487	6918	42402	5322	50925	4224	56680	3313	65251	1722	84385	426	81033
7L-5S		MI	22084	6918	39717	5266	47839	4156	53563	3255	61908	1635	79049	661	74056
22-#11	2.27	MA	22178	5257	34037	4299	40830	3474	44651	2826	49469	1834	62071	1504	42617
4L-9S		MI	16254	5257	25480	4276	30004	3450	32064	2809	33848	1813	41991	1137	32655
22-#11	2.27	MA	21546	5257	33063	4310	39661	3473	43224	2835	47527	1840	59582	1458	41990
5L-8S		MI	16746	5257	26250	4266	30951	3441	33194	2802	35352	1808	43866	1196	33443

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

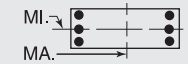
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.27	MA	20941	5257	32198	4311	38508	3483	41821	2833	45659	1846	57054	1383	41260
6L-7S		MI	17242	5257	26949	4266	31870	3443	34341	2806	36871	1802	45782	1248	34200
22-#11	2.27	MA	20348	5257	31356	4312	37394	3483	40459	2842	43766	1841	54805	1312	40608
7L-6S		MI	17743	5257	27658	4266	32808	3445	35487	2799	38446	1808	47619	1319	34758
22-#11	2.27	MA	19762	5257	30528	4313	36302	3482	39096	2840	41940	1847	52480	1258	39629
8L-5S		MI	18255	5257	28386	4266	33778	3436	36668	2802	39998	1802	49688	1394	35309
22-#11	2.27	MA	19181	5257	29613	4324	35177	3492	37754	2849	40131	1853	50185	1200	38677
9L-4S		MI	18789	5257	29204	4256	34761	3438	37867	2795	41612	1797	51740	1438	35868
22-#11	2.27	MA	18602	5257	28787	4325	34093	3492	36406	2847	38271	1849	47813	1119	37565
10L-3S		MI	19378	5257	30013	4256	35854	3429	39191	2798	43382	1802	53687	1530	36002
22-#11	2.27	MA	17999	5257	27968	4326	32981	3502	35072	2856	36469	1855	45528	1063	36313
11L-2S		MI	20190	5257	31097	4256	37229	3431	40857	2791	45611	1797	56652	1621	36078
22-#14	3.27	MA	23357	5809	37921	4646	45714	3717	50509	2991	57317	1808	72733	1269	58597
5L-8S		MI	17630	5809	29376	4596	34761	3682	37742	2952	41327	1761	52078	897	45363
22-#14	3.27	MA	22522	5809	36681	4647	44061	3731	48496	2987	54640	1816	69139	1161	57489
6L-7S		MI	18314	5809	30377	4597	36078	3685	39386	2957	43487	1754	54800	970	46819
22-#14	3.27	MA	21704	5809	35473	4648	42463	3730	46544	2999	51925	1809	65943	1058	55752
7L-6S		MI	19006	5809	31393	4598	37421	3688	41026	2948	45725	1761	57402	1073	48156
22-#14	3.27	MA	20896	5809	34284	4649	40897	3729	44588	2996	49306	1817	62631	982	53968
8L-5S		MI	19713	5809	32436	4599	38811	3676	42718	2954	47932	1754	60335	1182	49137
22-#14	3.27	MA	20094	5809	32972	4665	39284	3743	42664	3008	46712	1825	59370	897	52191
9L-4S		MI	20450	5809	33608	4585	40218	3680	44435	2944	50227	1746	63252	1245	50379
22-#18	5.82	MA	24924	7208	45650	5504	55045	4357	61670	3397	71936	1706	93279	383	90214
7L-6S		MI	22086	7208	40591	5444	48831	4307	54752	3327	63569	1626	81231	412	78838
24-#11	2.48	MA	22154	5371	34360	4381	41306	3525	45217	2868	50215	1835	63202	1445	45712
5L-9S		MI	16773	5371	26564	4347	31379	3502	33730	2842	36077	1806	44955	1120	35714
24-#11	2.48	MA	21554	5371	33495	4382	40152	3535	43813	2866	48347	1841	60674	1370	45003
6L-8S		MI	17260	5371	27335	4337	32326	3493	34859	2835	37581	1801	46831	1179	36535
24-#11	2.48	MA	20967	5371	32653	4383	39038	3535	42452	2875	46454	1836	58425	1299	44301
7E		MI	17751	5371	28033	4337	33245	3495	36007	2839	39100	1796	48746	1231	37271
24-#11	2.48	MA	20387	5371	31825	4384	37947	3534	41088	2873	44628	1842	56100	1245	43346
8L-6S		MI	18248	5371	28742	4337	34183	3497	37152	2831	40675	1801	50583	1302	37879
24-#11	2.48	MA	19811	5371	30910	4395	36822	3544	39746	2881	42819	1848	53805	1187	42363
9L-5S		MI	18755	5371	29470	4337	35153	3488	38333	2835	42227	1796	52653	1377	38412
24-#11	2.48	MA	19237	5371	30084	4396	35737	3544	38398	2880	40959	1844	51433	1107	41272
10L-4S		MI	19285	5371	30288	4327	36136	3490	39532	2828	43842	1791	54705	1422	39040
24-#11	2.48	MA	18637	5371	29265	4397	34625	3554	37065	2888	39158	1850	49148	1050	40000
11L-3S		MI	19869	5371	31097	4327	37229	3481	40857	2831	45611	1796	56652	1513	39187
24-#14	3.57	MA	23367	5973	38537	4749	46414	3806	51348	3035	58487	1809	74287	1140	62751
6L-8S		MI	18341	5973	30926	4699	36725	3757	40122	2999	44496	1751	56281	871	49722
24-#14	3.57	MA	22560	5973	37329	4750	44816	3805	49396	3047	55772	1802	71091	1038	61058
7E		MI	19017	5973	31926	4699	38042	3760	41766	3005	46656	1744	59004	944	51224
24-#14	3.57	MA	21761	5973	36140	4751	43251	3804	47440	3043	53153	1809	67779	962	59234
8L-6S		MI	19702	5973	32942	4700	39386	3763	43407	2995	48894	1751	61605	1047	52521
24-#14	3.57	MA	20968	5973	34828	4767	41637	3817	45516	3055	50559	1817	64517	877	57427
9L-5S		MI	20401	5973	33985	4701	40775	3751	45098	3001	51101	1744	64539	1156	53577

RECTANGULAR TIED COLUMNS 36" x 44"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.01	MA	21968	4782	31271	4022	36962	3276	39400	2725	41230	1936	49777	1821	21177
2E		MI	17789	4782	25806	3959	30105	3224	31891	2681	32918	1887	39413	1758	17009
6-#18	1.52	MA	23610	5073	34701	4203	41311	3409	44669	2809	48320	1922	59229	1782	31373
2L-3S		MI	16969	5073	25806	4138	30105	3349	31891	2779	32918	1878	39413	1470	24970
6-#18	1.52	MA	20962	5073	31271	4204	36962	3405	39400	2829	41230	1935	49777	1549	31146
3L-2S		MI	19050	5073	28509	4141	33533	3357	36044	2766	38388	1865	46631	1703	25078
8-#14	1.14	MA	22488	4855	32023	4092	38127	3330	40903	2764	43360	1948	52860	1838	23940
2L-4S		MI	16109	4855	23682	4034	27519	3292	28846	2728	29047	1907	34970	1515	19130

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis



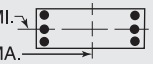
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.14	MA	20950	4855	30065	4094	35643	3329	37895	2776	39301	1957	47397	1707	23903
3E		MI	16996	4855	24840	4035	29083	3280	30741	2733	31562	1914	37727	1646	19223
8-#14	1.14	MA	19835	4855	28611	4095	33678	3343	35512	2773	36086	1951	43795	1576	23711
4L-2S		MI	18209	4855	26389	4036	31048	3283	33122	2724	34731	1907	41931	1778	19218
8-#18	2.02	MA	25202	5364	38131	4385	45661	3542	49939	2893	55410	1907	68682	1743	41518
2L-4S		MI	16734	5364	26483	4316	30796	3500	32728	2851	34046	1843	41910	1181	31287
8-#18	2.02	MA	22607	5364	34701	4386	41311	3538	44669	2913	48320	1921	59229	1509	41173
3E		MI	18233	5364	28509	4319	33533	3482	36044	2863	38388	1856	46631	1415	32877
8-#18	2.02	MA	20724	5364	32147	4386	37859	3562	40486	2906	42695	1907	53011	1276	39131
4L-2S		MI	20276	5364	31212	4323	36960	3490	40197	2850	43859	1843	53849	1649	33090
10-#14	1.42	MA	23434	5019	33981	4195	40610	3404	43912	2811	47419	1941	58323	1820	29750
2L-5S		MI	16070	5019	24059	4150	28077	3363	29509	2785	29921	1904	36257	1426	22867
10-#14	1.42	MA	21915	5019	32023	4196	38127	3404	40903	2823	43360	1949	52860	1689	29674
3L-4S		MI	16866	5019	25231	4136	29484	3366	31227	2775	32216	1896	39174	1488	23662
10-#14	1.42	MA	20816	5019	30569	4197	36161	3418	38521	2821	40145	1943	49259	1557	29432
4L-3S		MI	17742	5019	26389	4137	31048	3355	33122	2781	34731	1904	41931	1620	23800
10-#14	1.42	MA	19820	5019	29098	4213	34396	3417	36366	2833	37212	1952	45501	1491	28352
5L-2S		MI	18941	5019	27938	4138	33013	3358	35502	2771	37900	1896	46134	1751	23832
10-#18	2.53	MA	26752	5655	41560	4567	50011	3675	55209	2978	62500	1893	78135	1704	51637
2L-5S		MI	16658	5655	27131	4520	31758	3625	33872	2948	35555	1834	44095	1019	36640
10-#18	2.53	MA	24205	5655	38131	4568	45661	3671	49939	2997	55410	1906	68682	1470	51191
3L-4S		MI	17993	5655	29185	4498	34223	3633	36880	2935	39516	1820	49128	1127	38786
10-#18	2.53	MA	22361	5655	35577	4568	42209	3695	45756	2990	49785	1893	62464	1237	48750
4L-3S		MI	19463	5655	31212	4501	36960	3615	40197	2948	43859	1834	53849	1360	40765
10-#18	2.53	MA	20690	5655	32992	4595	39107	3692	41970	3010	44650	1906	55937	1121	45736
5L-2S		MI	21470	5655	33914	4505	40388	3623	44349	2934	49329	1820	61067	1594	41070
12-#11	1.18	MA	22695	4881	32283	4121	38564	3352	41480	2780	44171	1954	54109	1849	24984
2L-6S		MI	15814	4881	23150	4077	26986	3322	28231	2750	28303	1928	33941	1489	19350
12-#11	1.18	MA	21623	4881	30916	4123	36830	3352	39379	2789	41336	1960	50270	1758	24959
3L-5S		MI	16353	4881	23878	4077	27956	3313	29412	2753	29856	1923	36010	1564	19916
12-#11	1.18	MA	20848	4881	29902	4124	35459	3362	37717	2788	39093	1957	47737	1667	24874
4E		MI	16914	4881	24697	4067	28939	3315	30611	2746	31470	1918	38062	1608	20023
12-#11	1.18	MA	20146	4881	28876	4135	34228	3362	36215	2797	37047	1963	45101	1620	24682
5L-3S		MI	17533	4881	25505	4067	30032	3306	31936	2749	33239	1923	40009	1699	20061
12-#11	1.18	MA	19474	4881	27966	4137	33014	3373	34737	2796	35081	1970	42421	1545	23902
6L-2S		MI	18380	4881	26590	4068	31407	3308	33601	2742	35469	1918	42974	1791	20060
12-#14	1.70	MA	24363	5182	35939	4297	43093	3479	46920	2858	51478	1933	63787	1801	35547
2L-6S		MI	16069	5182	24565	4252	28652	3450	30198	2826	30883	1901	37527	1290	26391
12-#14	1.70	MA	22862	5182	33981	4298	40610	3479	43912	2871	47419	1942	58323	1670	35435
3L-5S		MI	16823	5182	25608	4253	30041	3438	31890	2832	33090	1894	40460	1399	27241
12-#14	1.70	MA	21778	5182	32527	4299	38644	3493	41529	2868	44204	1936	54722	1539	35151
4E		MI	17609	5182	26780	4239	31449	3441	33607	2823	35385	1886	43377	1462	28186
12-#14	1.70	MA	20796	5182	31056	4316	36879	3492	39375	2881	41271	1944	50964	1472	33919
5L-3S		MI	18474	5182	27938	4239	33013	3429	35502	2828	37900	1894	46134	1594	28364
12-#14	1.70	MA	19855	5182	29750	4317	35137	3507	37255	2878	38450	1953	47150	1364	32721
6L-2S		MI	19659	5182	29487	4240	34977	3433	37882	2819	41069	1886	50337	1725	28427
12-#18	3.03	MA	28267	5945	44990	4749	54360	3808	60478	3062	69590	1879	87588	1665	61739
2L-6S		MI	16653	5945	28005	4699	32749	3776	35060	3020	37215	1825	46277	770	41214
12-#18	3.03	MA	25764	5945	41560	4749	50011	3804	55209	3081	62500	1892	78135	1431	61204
3L-5S		MI	17912	5945	29834	4702	35185	3758	38025	3033	41025	1812	51313	964	44304
12-#18	3.03	MA	23956	5945	39007	4750	46559	3828	51026	3075	56875	1879	71917	1198	58413
4E		MI	19222	5945	31888	4679	37651	3766	41033	3019	44987	1798	56346	1072	46330
12-#18	3.03	MA	22320	5945	36422	4777	43457	3825	47240	3094	51740	1892	65390	1082	55539
5L-3S		MI	20665	5945	33914	4683	40388	3748	44349	3032	49329	1812	61067	1306	48643

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

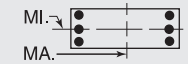
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	3.03	MA	20749	5945	34125	4778	40394	3848	43512	3087	46802	1905	58791	889	51585
6L-2S		MI	22640	5945	36617	4686	43816	3756	48502	3018	54800	1798	68285	1539	49029
14-#11	1.38	MA	23359	4995	33651	4192	40299	3404	43582	2813	47006	1949	57948	1838	29040
2L-7S		MI	15830	4995	23525	4148	27423	3372	28752	2790	28958	1917	35069	1401	22016
14-#11	1.38	MA	22296	4995	32283	4193	38564	3404	41480	2822	44171	1955	54109	1746	28998
3L-6S		MI	16353	4995	24234	4148	28361	3373	29897	2783	30533	1922	36905	1472	22445
14-#11	1.38	MA	21529	4995	31269	4195	37193	3414	39818	2821	41928	1952	51575	1655	28891
4L-5S		MI	16886	4995	24962	4148	29331	3365	31078	2786	32085	1917	38975	1547	23083
14-#11	1.38	MA	20835	4995	30244	4206	35962	3414	38316	2830	39882	1958	48940	1609	28676
5L-4S		MI	17442	4995	25781	4138	30314	3366	32277	2779	33700	1912	41027	1592	23212
14-#11	1.38	MA	20169	4995	29333	4207	34748	3424	36838	2828	37916	1965	46259	1534	27824
6L-3S		MI	18055	4995	26590	4138	31407	3358	33601	2782	35469	1917	42974	1683	23270
14-#11	1.38	MA	19518	4995	28447	4209	33575	3424	35405	2837	35923	1961	43872	1463	27209
7L-2S		MI	18895	4995	27674	4138	32782	3360	35267	2775	37698	1912	45939	1774	23286
14-#14	1.99	MA	25276	5346	37897	4399	45576	3554	49929	2906	55537	1926	69250	1783	41333
2L-7S		MI	16090	5346	25098	4353	29273	3521	30938	2883	31813	1883	39128	1161	29558
14-#14	1.99	MA	23792	5346	35939	4400	43093	3553	46920	2918	51478	1935	63787	1651	41190
3L-6S		MI	16819	5346	26114	4354	30616	3525	32578	2874	34052	1891	41730	1264	30818
14-#14	1.99	MA	22722	5346	34485	4402	41127	3568	44538	2916	48263	1928	60185	1520	40868
4L-5S		MI	17564	5346	27157	4355	32006	3513	34270	2879	36259	1883	44664	1373	31632
14-#14	1.99	MA	21754	5346	33014	4418	39362	3567	42383	2928	45330	1937	56427	1453	39503
5L-4S		MI	18339	5346	28329	4341	33413	3516	35987	2870	38554	1876	47580	1436	32706
14-#14	1.99	MA	20825	5346	31708	4419	37621	3581	40263	2925	42509	1946	52613	1345	38348
6L-3S		MI	19194	5346	29487	4342	34977	3504	37882	2875	41069	1883	50337	1567	32920
14-#14	1.99	MA	19916	5346	30437	4420	35938	3581	38207	2938	39650	1939	49218	1243	36708
7L-2S		MI	20367	5346	31036	4342	36942	3507	40262	2866	44238	1876	54541	1699	33010
14-#18	3.54	MA	27290	6236	44990	4931	54360	3937	60478	3166	69590	1878	87588	1392	71214
3L-6S		MI	17902	6236	30707	4880	36177	3909	39213	3104	42686	1803	53495	715	48771
14-#18	3.54	MA	25516	6236	42436	4932	50909	3961	56295	3159	63965	1864	81370	1159	68112
4L-5S		MI	19138	6236	32536	4884	38613	3891	42177	3117	46496	1789	58530	910	51991
14-#18	3.54	MA	23911	6236	39851	4959	47806	3958	52509	3179	58830	1878	74843	1043	65364
5L-4S		MI	20425	6236	34591	4861	41079	3899	45186	3103	50457	1776	63564	1018	53912
14-#18	3.54	MA	22371	6236	37554	4959	44744	3981	48782	3172	53892	1891	68244	850	61289
6L-3S		MI	21844	6236	36617	4865	43816	3881	48502	3116	54800	1789	68285	1251	56514
14-#18	3.54	MA	20862	6236	35318	4960	41785	3978	45167	3191	48886	1878	62380	668	57129
7L-2S		MI	23788	6236	39320	4868	47244	3889	52655	3103	60271	1776	75503	1485	56974
16-#11	1.58	MA	24015	5108	35019	4263	42033	3456	45683	2846	49841	1944	61786	1826	33089
2L-8S		MI	15855	5108	23911	4219	27879	3422	29270	2820	29669	1916	36118	1333	24400
16-#11	1.58	MA	22961	5108	33651	4264	40299	3456	43582	2855	47006	1950	57948	1735	33031
3L-7S		MI	16366	5108	24609	4219	28798	3424	30417	2823	31188	1910	38033	1384	25131
16-#11	1.58	MA	22201	5108	32637	4266	38928	3466	41920	2853	44763	1946	55414	1644	32904
4L-6S		MI	16884	5108	25318	4219	29736	3425	31563	2816	32762	1916	39870	1455	25547
16-#11	1.58	MA	21513	5108	31611	4277	37697	3466	40417	2863	42717	1953	52779	1597	32645
5E		MI	17412	5108	26046	4219	30706	3417	32744	2819	34315	1910	41939	1531	26177
16-#11	1.58	MA	20855	5108	30701	4278	36483	3476	38939	2861	40751	1960	50098	1522	31754
6L-4S		MI	17963	5108	26865	4209	31689	3418	33943	2812	35929	1905	43991	1575	26396
16-#11	1.58	MA	20210	5108	29815	4280	35310	3476	37506	2870	38758	1956	47711	1451	31155
7L-3S		MI	18570	5108	27674	4209	32782	3410	35267	2815	37698	1910	45939	1666	26471
16-#11	1.58	MA	19573	5108	28943	4281	34161	3476	36071	2869	36835	1962	45249	1397	30186
8L-2S		MI	19404	5108	28758	4209	34157	3411	36933	2808	39927	1905	48903	1757	26502
16-#14	2.27	MA	26175	5509	39855	4501	48060	3629	52937	2953	59596	1918	74713	1764	47113
2L-8S		MI	16124	5509	25647	4455	29921	3593	31674	2925	32823	1881	40610	1062	32713
16-#14	2.27	MA	24708	5509	37897	4503	45576	3628	49929	2965	55537	1927	69250	1633	46940
3L-7S		MI	16836	5509	26647	4455	31238	3596	33318	2931	34982	1873	43332	1135	33923

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis

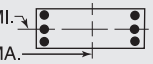


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	2.27	MA	23651	5509	36443	4504	43611	3643	47546	2963	52322	1921	65648	1502	46584
4L-6S		MI	17556	5509	27663	4456	32581	3599	34959	2921	37221	1881	45933	1238	35254
16-#14	2.27	MA	22695	5509	34972	4520	41846	3642	45392	2975	49388	1929	61890	1435	45100
5E		MI	18292	5509	28706	4457	33971	3588	36650	2927	39428	1873	48867	1347	36036
16-#14	2.27	MA	21779	5509	33666	4521	40104	3656	43272	2973	46568	1938	58076	1327	43984
6L-4S		MI	19059	5509	29879	4443	35378	3591	38367	2917	41723	1866	51784	1409	37223
16-#14	2.27	MA	20881	5509	32395	4523	38421	3656	41216	2985	43709	1932	54681	1224	42278
7L-3S		MI	19904	5509	31036	4444	36942	3579	40262	2923	44238	1873	54541	1541	37468
16-#14	2.27	MA	19994	5509	31143	4524	36773	3655	39156	2983	40950	1940	51172	1147	40710
8L-2S		MI	21064	5509	32585	4445	38907	3582	42642	2913	47406	1866	58744	1672	37585
16-#18	4.04	MA	27044	6527	45866	5113	55258	4094	61565	3243	71055	1850	90823	1119	77842
4L-6S		MI	19126	6527	33410	5062	39605	4042	43366	3188	48156	1781	60712	660	56352
16-#18	4.04	MA	25469	6527	43281	5141	52156	4091	57779	3263	65920	1863	84296	1004	75207
5E		MI	20340	6527	35239	5066	42041	4024	46330	3201	51966	1767	65748	855	59514
16-#18	4.04	MA	23957	6527	40984	5141	49094	4114	54051	3256	60982	1877	77697	811	71015
6L-4S		MI	21606	6527	37294	5043	44506	4032	49339	3188	55928	1754	70781	963	61524
16-#18	4.04	MA	22477	6527	38747	5142	46135	4111	50437	3276	55976	1863	71833	629	66789
7L-3S		MI	23002	6527	39320	5046	47244	4014	52655	3200	60271	1767	75503	1196	64381
18-#11	1.77	MA	24662	5221	36386	4334	43768	3508	47784	2879	52676	1938	65625	1814	37134
2L-9S		MI	15886	5221	24225	4300	28307	3482	29806	2859	30394	1914	37206	1257	26831
18-#11	1.77	MA	23617	5221	35019	4335	42033	3508	45683	2888	49841	1945	61786	1723	37060
3L-8S		MI	16389	5221	24995	4290	29254	3474	30935	2852	31898	1909	39082	1316	27474
18-#11	1.77	MA	22864	5221	34005	4336	40662	3518	44021	2886	47598	1941	59253	1632	36916
4L-7S		MI	16895	5221	25693	4290	30173	3475	32083	2856	33417	1904	40998	1367	28249
18-#11	1.77	MA	22183	5221	32979	4348	39431	3518	42519	2895	45552	1948	56617	1585	36550
5L-6S		MI	17408	5221	26402	4290	31111	3477	33228	2849	34991	1909	42835	1438	28655
18-#11	1.77	MA	21531	5221	32069	4349	38217	3528	41041	2894	43586	1954	53937	1510	35690
6L-5S		MI	17932	5221	27130	4290	32081	3468	34409	2852	36544	1904	44904	1514	29259
18-#11	1.77	MA	20893	5221	31183	4350	37044	3528	39607	2903	41593	1951	51550	1439	35105
7L-4S		MI	18477	5221	27949	4280	33064	3470	35608	2845	38158	1899	46956	1558	29577
18-#11	1.77	MA	20262	5221	30310	4352	35895	3528	38172	2902	39670	1957	49088	1385	34094
8L-3S		MI	19079	5221	28758	4280	34157	3462	36933	2848	39927	1904	48903	1649	29668
18-#11	1.77	MA	19636	5221	29347	4363	34711	3538	36759	2911	37765	1964	46654	1327	33244
9L-2S		MI	19907	5221	29842	4280	35531	3463	38598	2841	42156	1899	51868	1740	29712
18-#14	2.56	MA	25610	5673	39855	4605	48060	3703	52937	3013	59596	1920	74713	1614	52686
3L-8S		MI	16868	5673	27196	4557	31885	3668	34054	2972	35992	1870	44813	1036	37039
18-#14	2.56	MA	24565	5673	38401	4606	46094	3717	50555	3010	56381	1913	71111	1483	52299
4L-7S		MI	17571	5673	28196	4558	33202	3671	35698	2978	38151	1863	47535	1108	38299
18-#14	2.56	MA	23621	5673	36930	4622	44329	3717	48400	3023	53447	1922	67353	1416	50709
5L-6S		MI	18283	5673	29212	4558	34546	3674	37339	2969	40390	1870	50137	1211	39696
18-#14	2.56	MA	22717	5673	35624	4624	42587	3731	46280	3020	50627	1931	63539	1308	49627
6L-5S		MI	19010	5673	30255	4559	35935	3662	39030	2974	42597	1863	53070	1320	40451
18-#14	2.56	MA	21831	5673	34353	4625	40905	3730	44224	3033	47768	1924	60144	1206	47858
7L-4S		MI	19767	5673	31428	4545	37343	3666	40747	2965	44891	1855	55987	1383	41737
18-#14	2.56	MA	20955	5673	33102	4626	39256	3730	42165	3030	45009	1933	56635	1129	46246
8L-3S		MI	20603	5673	32585	4546	38907	3654	42642	2970	47406	1863	58744	1514	42011
18-#14	2.56	MA	20086	5673	31720	4642	37557	3744	40139	3043	42277	1942	53172	1044	44212
9L-2S		MI	21752	5673	34134	4547	40871	3657	45023	2961	50575	1855	62948	1646	42153
18-#18	4.55	MA	26998	6818	46711	5322	56506	4224	63049	3347	73010	1849	93749	965	85049
5L-6S		MI	20327	6818	36113	5244	43032	4175	47519	3273	53627	1758	67930	606	63955
18-#18	4.55	MA	25513	6818	44414	5323	53443	4247	59321	3340	68072	1862	87150	772	80761
6L-5S		MI	21522	6818	37942	5247	45468	4157	50483	3285	57437	1745	72966	801	66999
18-#18	4.55	MA	24059	6818	42177	5324	50484	4244	55706	3360	63066	1849	81286	590	76468
7L-4S		MI	22768	6818	39996	5224	47934	4165	53491	3272	61399	1732	77999	908	69162
20-#11	1.97	MA	24265	5335	36386	4406	43768	3559	47784	2920	52676	1940	65625	1712	41087
3L-9S		MI	16418	5335	25309	4371	29682	3534	31472	2892	32623	1908	40171	1240	29876
20-#11	1.97	MA	23519	5335	35372	4407	42396	3570	46122	2919	50433	1936	63092	1620	40925
4L-8S		MI	16916	5335	26079	4360	30629	3526	32601	2885	34127	1903	42047	1299	30554

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

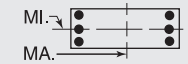
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.97	MA	22845	5335	34347	4419	41166	3570	44620	2928	48387	1943	60456	1574	40463
5L-7S		MI	17418	5335	26777	4361	31548	3527	33749	2888	35646	1898	43962	1350	31348
20-#11	1.97	MA	22199	5335	33436	4420	39952	3580	43142	2927	46421	1949	57776	1499	39632
6E		MI	17926	5335	27486	4361	32486	3529	34894	2881	37220	1903	45799	1421	31768
20-#11	1.97	MA	21567	5335	32550	4421	38779	3580	41709	2936	44428	1945	55388	1428	39059
7L-5S		MI	18445	5335	28214	4361	33456	3520	36075	2885	38773	1898	47868	1497	32349
20-#11	1.97	MA	20943	5335	31678	4423	37630	3580	40273	2935	42505	1952	52927	1374	38007
8L-4S		MI	18986	5335	29033	4351	34439	3522	37274	2878	40387	1893	49920	1541	32754
20-#11	1.97	MA	20322	5335	30715	4434	36445	3590	38861	2944	40600	1959	50492	1315	37126
9L-3S		MI	19583	5335	29842	4351	35531	3513	38598	2881	42156	1898	51868	1632	32861
20-#11	1.97	MA	19705	5335	29846	4435	35304	3590	37442	2943	38642	1955	47975	1235	35891
10L-2S		MI	20404	5335	30926	4351	36906	3515	40264	2874	44386	1893	54832	1723	32918
20-#14	2.84	MA	25467	5836	40359	4708	48577	3792	53563	3058	60440	1906	76574	1464	58014
4L-8S		MI	17600	5836	28745	4659	33850	3743	36434	3020	39161	1860	49016	1009	41375
20-#14	2.84	MA	24534	5836	38888	4725	46812	3792	51409	3070	57506	1915	72817	1398	56328
5L-7S		MI	18295	5836	29745	4660	35167	3746	38078	3025	41320	1853	51739	1082	42684
20-#14	2.84	MA	23641	5836	37582	4726	45070	3806	49289	3068	54686	1923	69002	1290	55277
6E		MI	18999	5836	30761	4661	36510	3749	39719	3016	43559	1860	54340	1185	44095
20-#14	2.84	MA	22766	5836	36311	4727	43388	3805	47233	3080	51827	1917	65608	1187	53446
7L-5S		MI	19717	5836	31804	4662	37900	3737	41410	3021	45765	1853	57274	1294	44875
20-#14	2.84	MA	21902	5836	35060	4728	41739	3805	45173	3078	49068	1925	62098	1110	51791
8L-4S		MI	20467	5836	32977	4647	39307	3740	43128	3012	48060	1845	60190	1357	46203
20-#14	2.84	MA	21043	5836	33678	4745	40040	3819	43147	3090	46336	1934	58635	1026	49799
9L-3S		MI	21293	5836	34134	4648	40871	3729	45023	3018	50575	1853	62948	1488	46551
20-#18	5.05	MA	27043	7109	47843	5505	57793	4380	64591	3424	75162	1848	96603	733	90525
6E		MI	21510	7109	38816	5426	46460	4308	51671	3357	59098	1736	75148	551	71576
20-#18	5.05	MA	25613	7109	45607	5505	54834	4377	60976	3444	70156	1835	90739	551	86164
7L-5S		MI	22798	7109	40645	5429	48896	4290	54636	3370	62907	1723	80184	746	74510
22-#11	2.17	MA	24166	5448	36740	4478	44131	3622	48224	2952	53268	1931	66930	1609	44933
4L-9S		MI	16943	5448	26393	4441	31057	3586	33137	2925	34852	1902	43135	1223	32927
22-#11	2.17	MA	23499	5448	35714	4490	42900	3622	46721	2961	51222	1937	64295	1562	44384
5L-8S		MI	17437	5448	27163	4431	32004	3577	34267	2918	36356	1897	45011	1282	33639
22-#11	2.17	MA	22859	5448	34804	4491	41686	3632	45243	2960	49256	1944	61614	1487	43578
6L-7S		MI	17935	5448	27862	4431	32923	3579	35414	2921	37875	1891	46927	1334	34410
22-#11	2.17	MA	22233	5448	33918	4492	40513	3632	43810	2969	47263	1940	59227	1416	43000
7L-6S		MI	18438	5448	28570	4432	33861	3581	36560	2914	39450	1897	48764	1405	34885
22-#11	2.17	MA	21615	5448	33046	4493	39364	3632	42374	2968	45340	1947	56766	1362	41926
8L-5S		MI	18953	5448	29298	4432	34831	3572	37741	2918	41002	1891	50833	1480	35445
22-#11	2.17	MA	21000	5448	32082	4505	38180	3642	40962	2977	43435	1953	54331	1304	41013
9L-4S		MI	19489	5448	30117	4422	35814	3574	38940	2910	42617	1886	52885	1524	35930
22-#11	2.17	MA	20389	5448	31214	4506	37039	3642	39543	2975	41477	1950	51814	1224	39802
10L-3S		MI	20081	5448	30926	4422	36906	3565	40264	2914	44386	1891	54832	1616	36051
22-#11	2.17	MA	19743	5448	30351	4507	35868	3652	38139	2984	39581	1956	49395	1167	38559
11L-2S		MI	20896	5448	32010	4422	38281	3567	41930	2907	46615	1886	57797	1707	36120
22-#14	3.13	MA	25435	6000	40846	4827	49295	3866	54417	3118	61565	1907	78280	1379	61956
5L-8S		MI	18322	6000	30294	4761	35815	3817	38814	3067	42330	1850	53220	983	45721
22-#14	3.13	MA	24553	6000	39540	4828	47554	3881	52297	3115	58745	1916	74465	1271	60933
6L-7S		MI	19010	6000	31295	4762	37132	3821	40459	3073	44489	1842	55942	1056	47078
22-#14	3.13	MA	23688	6000	38269	4829	45871	3880	50241	3127	55886	1909	71071	1169	59043
7L-6S		MI	19706	6000	32310	4763	38475	3824	42099	3063	46727	1850	58544	1159	48445
22-#14	3.13	MA	22834	6000	37018	4831	44222	3879	48182	3125	53127	1918	67561	1092	57344
8L-5S		MI	20416	6000	33353	4764	39865	3812	43791	3069	48934	1842	61477	1268	49307
22-#14	3.13	MA	21986	6000	35636	4847	42523	3894	46156	3137	50395	1927	64098	1007	55393
9L-4S		MI	21158	6000	34526	4750	41272	3815	45508	3059	51229	1835	64394	1330	50582

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

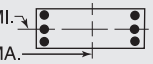
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#18	5.56	MA	27143	7399	49036	5687	59184	4510	66246	3528	77246	1821	100192	511	95876
7L-6S		MI	22796	7399	41518	5607	49888	4441	55824	3441	64568	1714	82366	496	79215
24-#11	2.36	MA	24145	5562	37082	4561	44635	3673	48823	2994	54057	1932	68134	1550	48311
5L-9S		MI	17463	5562	27477	4512	32432	3638	34803	2958	37081	1895	46100	1206	35984
24-#11	2.36	MA	23512	5562	36171	4562	43420	3684	47344	2993	52091	1939	65453	1475	47529
6L-8S		MI	17953	5562	28248	4502	33379	3629	35932	2951	38586	1890	47976	1265	36730
24-#11	2.36	MA	22891	5562	35285	4563	42248	3684	45911	3002	50098	1935	63066	1405	46898
7E		MI	18446	5562	28946	4502	34298	3631	37080	2954	40105	1885	49891	1317	37479
24-#11	2.36	MA	22279	5562	34413	4564	41098	3684	44476	3000	48174	1942	60604	1351	45849
8L-6S		MI	18945	5562	29655	4503	35235	3633	38225	2947	41679	1890	51728	1388	38006
24-#11	2.36	MA	21670	5562	33450	4576	39914	3694	43063	3010	46270	1948	58170	1292	44906
9L-5S		MI	19455	5562	30383	4503	36206	3624	39406	2950	43232	1885	53797	1463	38547
24-#11	2.36	MA	21064	5562	32581	4577	38773	3694	41644	3008	44312	1944	55653	1212	43717
10L-4S		MI	19987	5562	31201	4493	37188	3626	40606	2943	44846	1880	55849	1508	39103
24-#11	2.36	MA	20420	5562	31719	4578	37602	3704	40241	3017	42416	1951	53234	1155	42453
11L-3S		MI	20574	5562	32010	4493	38281	3617	41930	2947	46615	1885	57797	1599	39238
24-#14	3.41	MA	25452	6164	41498	4930	50037	3955	55306	3162	62804	1908	79928	1253	66515
6L-8S		MI	19035	6164	31843	4863	37779	3892	41195	3115	45499	1840	57423	956	50075
24-#14	3.41	MA	24598	6164	40227	4932	48354	3955	53250	3175	59945	1902	76534	1150	64647
7E		MI	19716	6164	32844	4864	39096	3895	42839	3120	47658	1832	60145	1029	51479
24-#14	3.41	MA	23754	6164	38976	4933	46706	3954	51190	3172	57186	1911	73024	1073	62905
8L-6S		MI	20404	6164	33860	4865	40440	3899	44479	3111	49896	1840	62747	1132	52806
24-#14	3.41	MA	22915	6164	37594	4949	45007	3969	49164	3185	54454	1919	69562	989	60993
9L-5S		MI	21107	6164	34902	4866	41829	3887	46171	3116	52103	1832	65680	1241	53746

RECTANGULAR TIED COLUMNS 36" x 46"

6-#18	1.45	MA	25643	5264	37400	4382	44595	3556	48195	2934	52064	2021	63853	1884	32993
2L-3S		MI	17660	5264	26733	4301	31162	3484	32963	2893	33917	1966	40549	1554	25037
6-#18	1.45	MA	22845	5264	33789	4384	40014	3554	42646	2955	44577	2035	53840	1650	32766
3L-2S		MI	19747	5264	29436	4305	34589	3492	37116	2880	39387	1953	47767	1788	25121
8-#14	1.09	MA	24445	5046	34573	4271	41232	3477	44219	2889	46765	2044	57071	1937	25155
2L-4S		MI	16797	5046	24600	4199	28573	3427	29919	2843	30049	1995	36112	1600	19189
8-#14	1.09	MA	22822	5046	32513	4273	38619	3477	41053	2902	42494	2054	51292	1806	25118
3E		MI	17687	5046	25757	4200	30137	3415	31814	2849	32564	2003	38869	1732	19264
8-#14	1.09	MA	21648	5046	30985	4275	36553	3492	38549	2900	39114	2048	47479	1675	24926
4L-2S		MI	18902	5046	27306	4201	32102	3419	34194	2839	35733	1995	43072	1863	19250
8-#18	1.93	MA	27334	5555	41012	4564	49175	3689	53744	3018	59550	2008	73866	1848	43678
2L-4S		MI	17424	5555	27410	4479	31852	3635	33800	2965	35045	1930	43045	1266	31588
8-#18	1.93	MA	24591	5555	37400	4566	44595	3687	48195	3039	52064	2021	63853	1614	43333
3E		MI	18927	5555	29436	4483	34589	3617	37116	2978	39387	1944	47767	1500	32952
8-#18	1.93	MA	22605	5555	34715	4567	40964	3711	43796	3034	46126	2009	57259	1381	41475
4L-2S		MI	20977	5555	32139	4486	38017	3625	41269	2964	44858	1930	54985	1733	33141
10-#14	1.36	MA	25449	5210	36633	4374	43845	3552	47384	2936	51036	2037	62850	1920	31269
2L-5S		MI	16758	5210	24976	4315	29131	3499	30582	2900	30923	1992	37399	1511	23045
10-#14	1.36	MA	23846	5210	34573	4375	41232	3552	44219	2949	46765	2046	57071	1789	31193
3L-4S		MI	17556	5210	26149	4301	30538	3502	32299	2890	33218	1985	40315	1574	23727
10-#14	1.36	MA	22687	5210	33045	4377	39166	3566	41715	2947	43385	2041	53258	1658	30951
4L-3S		MI	18435	5210	27306	4302	32102	3490	34194	2896	35733	1992	43072	1706	23846
10-#14	1.36	MA	21639	5210	31500	4394	37312	3566	39451	2960	40303	2050	49290	1590	29945
5L-2S		MI	19637	5210	28856	4303	34067	3493	36575	2887	38902	1985	47276	1837	23868
10-#18	2.42	MA	28981	5846	44623	4746	53755	3822	59293	3103	67037	1994	83879	1812	54337
2L-5S		MI	17346	5846	28058	4684	32814	3760	34944	3063	36553	1921	45230	1104	36898
10-#18	2.42	MA	26289	5846	41012	4747	49175	3820	53744	3123	59550	2008	73866	1578	53891
3L-4S		MI	18687	5846	30113	4661	35280	3768	37953	3049	40515	1908	50263	1212	39079
10-#18	2.42	MA	24343	5846	38326	4749	45545	3844	49345	3118	53612	1995	67272	1345	51617
4L-3S		MI	20162	5846	32139	4665	38017	3750	41269	3062	44858	1921	54985	1445	40848

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

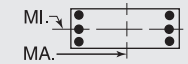
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	2.42	MA	22580	5846	35609	4777	42283	3842	45364	3139	48194	2009	60371	1228	48330
5L-2S		MI	22177	5846	34842	4668	41445	3758	45422	3048	50328	1908	62202	1679	41125
12-#11	1.13	MA	24663	5072	34844	4300	41688	3499	44821	2905	47611	2050	58374	1948	26248
2L-6S		MI	16502	5072	24063	4243	28039	3458	29304	2866	29308	2017	35086	1575	19477
12-#11	1.13	MA	23531	5072	33405	4302	39864	3500	42611	2914	44629	2057	54316	1857	26223
3L-5S		MI	17042	5072	24791	4243	29009	3449	30485	2869	30860	2012	37155	1650	19976
12-#11	1.13	MA	22715	5072	32340	4303	38423	3510	40864	2914	42272	2054	51636	1766	26138
4E		MI	17605	5072	25610	4233	29992	3451	31685	2862	32475	2007	39207	1694	20067
12-#11	1.13	MA	21976	5072	31263	4315	37131	3510	39286	2923	40123	2061	48854	1719	25946
5L-3S		MI	18225	5072	26418	4233	31084	3442	33009	2865	34244	2012	41154	1785	20097
12-#11	1.13	MA	21269	5072	30307	4317	35855	3521	37734	2922	38058	2068	46021	1644	25195
6L-2S		MI	19074	5072	27503	4233	32459	3444	34674	2858	36473	2007	44119	1877	20091
12-#14	1.63	MA	26435	5373	38694	4476	46458	3626	50550	2983	55307	2030	68628	1903	37369
2L-6S		MI	16757	5373	25483	4417	29706	3585	31271	2942	31885	1990	38668	1376	26559
12-#14	1.63	MA	24850	5373	36633	4478	43845	3626	47384	2996	51036	2039	62850	1772	37258
3L-5S		MI	17513	5373	26526	4417	31095	3574	32962	2947	34092	1982	41602	1485	27416
12-#14	1.63	MA	23707	5373	35105	4479	41779	3641	44880	2994	47656	2033	59036	1641	36973
4E		MI	18302	5373	27698	4403	32503	3577	34680	2938	36387	1975	44519	1548	28256
12-#14	1.63	MA	22673	5373	33560	4496	39925	3641	42617	3007	44574	2043	55068	1573	35808
5L-3S		MI	19170	5373	28856	4404	34067	3565	36575	2943	38902	1982	47276	1679	28414
12-#14	1.63	MA	21681	5373	32188	4498	38095	3656	40389	3006	41611	2052	51033	1465	34508
6L-2S		MI	20358	5373	30405	4405	36031	3568	38955	2934	42071	1975	51479	1811	28467
12-#18	2.90	MA	30591	6136	48234	4928	58335	3955	64842	3187	74523	1981	93892	1776	64979
2L-6S		MI	17339	6136	28932	4862	33806	3911	36132	3134	38214	1913	47412	855	41617
12-#18	2.90	MA	27944	6136	44623	4929	53755	3953	59293	3208	67037	1995	83879	1542	64444
3L-5S		MI	18603	6136	30761	4866	36242	3893	39097	3147	42024	1899	52448	1049	44559
12-#18	2.90	MA	26036	6136	41938	4931	50125	3977	54894	3202	61099	1982	77285	1308	61803
4E		MI	19920	6136	32815	4843	38708	3901	42105	3133	45986	1886	57481	1157	46617
12-#18	2.90	MA	24309	6136	39220	4958	46864	3975	50913	3223	55680	1996	70384	1192	58664
5L-3S		MI	21369	6136	34842	4846	41445	3883	45422	3146	50328	1899	62202	1390	48732
12-#18	2.90	MA	22652	6136	36806	4960	43645	3999	46995	3217	50469	2010	63394	999	54688
6L-2S		MI	23352	6136	37544	4850	44873	3891	49574	3133	55799	1886	69420	1624	49089
14-#11	1.32	MA	25367	5186	36282	4371	43513	3551	47031	2938	50593	2045	62432	1937	30514
2L-7S		MI	16518	5186	24438	4314	28476	3508	29825	2906	29963	2006	36213	1487	22142
14-#11	1.32	MA	24245	5186	34844	4373	41688	3551	44821	2947	47611	2052	58374	1846	30472
3L-6S		MI	17042	5186	25147	4314	29414	3510	30970	2899	31537	2011	38050	1558	22570
14-#11	1.32	MA	23436	5186	33778	4374	40248	3562	43075	2946	45254	2049	55693	1755	30365
4L-5S		MI	17577	5186	25875	4314	30384	3501	32151	2902	33090	2006	40120	1633	23147
14-#11	1.32	MA	22706	5186	32701	4386	38955	3562	41497	2956	43105	2056	52912	1708	30150
5L-4S		MI	18134	5186	26694	4304	31367	3503	33350	2895	34704	2001	42171	1677	23260
14-#11	1.32	MA	22005	5186	31745	4388	37680	3573	39944	2955	41040	2063	50078	1633	29323
6L-3S		MI	18748	5186	27503	4304	32459	3494	34674	2898	36473	2006	44119	1769	23309
14-#11	1.32	MA	21319	5186	30815	4389	36448	3573	38439	2964	38946	2060	47553	1562	28660
7L-2S		MI	19591	5186	28587	4304	33834	3496	36340	2891	38702	2001	47083	1860	23319
14-#14	1.90	MA	27404	5537	40754	4578	49071	3701	53716	3031	59578	2022	74407	1886	43460
2L-7S		MI	16777	5537	26016	4518	30327	3657	32011	2998	32816	1972	40270	1247	29824
14-#14	1.90	MA	25837	5537	38694	4580	46458	3701	50550	3044	55307	2031	68628	1755	43316
3L-6S		MI	17508	5537	27032	4519	31670	3660	33651	2989	35054	1979	42872	1350	30985
14-#14	1.90	MA	24708	5537	37166	4581	44392	3716	48046	3042	51927	2026	64815	1624	42994
4L-5S		MI	18256	5537	28075	4520	33060	3648	35343	2995	37261	1972	45805	1459	31805
14-#14	1.90	MA	23688	5537	35620	4598	42538	3716	45782	3055	48845	2035	60847	1556	41687
5L-4S		MI	19035	5537	29247	4506	34467	3652	37060	2985	39556	1965	48722	1521	32781
14-#14	1.90	MA	22710	5537	34249	4600	40708	3731	43555	3053	45882	2045	56812	1448	40434
6L-3S		MI	19892	5537	30405	4506	36031	3640	38955	2991	42071	1972	51479	1653	32973

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

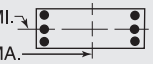


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	1.90	MA	21752	5537	32913	4601	38941	3731	41395	3066	42878	2039	53219	1346	38828
7L-2S		MI	21069	5537	31954	4507	37996	3643	41335	2981	45240	1965	55682	1784	33053
14-#18	3.38	MA	29565	6427	48234	5111	58335	4086	64842	3292	74523	1982	93892	1506	74994
3L-6S		MI	18591	6427	31635	5044	37234	4044	40285	3218	43685	1890	54630	800	49167
14-#18	3.38	MA	27692	6427	45549	5112	54705	4110	60443	3286	68585	1969	87298	1272	72026
4L-5S		MI	19833	6427	33464	5047	39670	4026	43249	3231	47495	1877	59666	995	52242
14-#18	3.38	MA	25998	6427	42832	5140	51444	4108	56462	3307	63166	1983	80397	1156	69019
5L-4S		MI	21127	6427	35518	5024	42136	4034	46258	3218	51456	1864	64699	1102	54192
14-#18	3.38	MA	24373	6427	40417	5142	48225	4132	52544	3301	57955	1996	73407	963	64922
6L-3S		MI	22553	6427	37544	5028	44873	4016	49574	3230	55799	1877	69420	1336	56609
14-#18	3.38	MA	22780	6427	38067	5143	45115	4130	48745	3322	52672	1983	67190	781	60714
7L-2S		MI	24506	6427	40247	5032	48300	4024	53727	3217	61269	1864	76638	1569	57037
16-#11	1.51	MA	26062	5299	37721	4442	45337	3603	49241	2971	53575	2040	66489	1927	34774
2L-8S		MI	16542	5299	24824	4384	28932	3558	30343	2935	30673	2005	37262	1419	24597
16-#11	1.51	MA	24949	5299	36282	4444	43513	3603	47031	2980	50593	2047	62432	1836	34716
3L-7S		MI	17055	5299	25522	4384	29851	3560	31490	2938	32192	1999	39178	1470	25257
16-#11	1.51	MA	24148	5299	35217	4445	42072	3614	45285	2979	48236	2044	59751	1745	34589
4L-6S		MI	17574	5299	26231	4385	30788	3561	32636	2931	33766	2005	41015	1541	25672
16-#11	1.51	MA	23425	5299	34139	4457	40779	3614	43707	2989	46087	2051	56970	1697	34354
5E		MI	18104	5299	26959	4385	31759	3553	33817	2935	35319	1999	43084	1617	26315
16-#11	1.51	MA	22731	5299	33184	4458	39504	3625	42154	2988	44022	2058	54136	1622	33459
6L-4S		MI	18657	5299	27778	4375	32741	3555	35016	2928	36933	1994	45136	1661	26447
16-#11	1.51	MA	22053	5299	32253	4460	38272	3625	40649	2997	41928	2054	51611	1552	32814
7L-3S		MI	19266	5299	28587	4375	33834	3546	36340	2931	38702	1999	47083	1752	26513
16-#11	1.51	MA	21382	5299	31338	4461	37066	3625	39142	2996	39909	2061	49013	1497	31876
8L-2S		MI	20102	5299	29671	4375	35209	3548	38006	2924	40931	1994	50048	1843	26538
16-#14	2.17	MA	28359	5700	42814	4680	51684	3776	56881	3078	63848	2015	80186	1869	49543
2L-8S		MI	16810	5700	26565	4619	30975	3729	32747	3040	33825	1969	41751	1148	33076
16-#14	2.17	MA	26808	5700	40754	4682	49071	3776	53716	3091	59578	2024	74407	1738	49370
3L-7S		MI	17525	5700	27565	4620	32292	3732	34391	3046	35985	1962	44474	1220	34185
16-#14	2.17	MA	25694	5700	39226	4684	47005	3791	51211	3089	56198	2018	70594	1607	49014
4L-6S		MI	18248	5700	28581	4621	33635	3735	36031	3036	38223	1969	47075	1323	35419
16-#14	2.17	MA	24686	5700	37681	4700	45151	3791	48948	3102	53116	2028	66626	1539	47581
5E		MI	18987	5700	29624	4622	35025	3723	37723	3042	40430	1962	50009	1432	36206
16-#14	2.17	MA	23721	5700	36309	4702	43321	3805	46720	3100	50153	2037	62590	1431	46370
6L-4S		MI	19756	5700	30796	4608	36432	3726	39440	3033	42725	1954	52925	1495	37301
16-#14	2.17	MA	22775	5700	34974	4704	41554	3805	44561	3113	47149	2032	58997	1329	44695
7L-3S		MI	20605	5700	31954	4609	37996	3715	41335	3038	45240	1962	55682	1626	37525
16-#14	2.17	MA	21840	5700	33659	4705	39822	3805	42398	3111	44251	2041	55291	1251	43131
8L-2S		MI	21769	5700	33503	4610	39961	3718	43715	3029	48409	1954	59886	1758	37631
16-#18	3.86	MA	29314	6718	49160	5294	59285	4243	65992	3371	76072	1956	97311	1236	82281
4L-6S		MI	19818	6718	34337	5226	40661	4177	44438	3303	49155	1868	61848	745	56741
16-#18	3.86	MA	27651	6718	46443	5322	56024	4241	62011	3391	70653	1969	90410	1119	79394
5E		MI	21040	6718	36166	5229	43098	4159	47402	3315	52965	1855	66884	940	59944
16-#18	3.86	MA	26056	6718	44029	5323	52805	4265	58093	3386	65441	1983	83420	927	75178
6L-4S		MI	22313	6718	38221	5206	45563	4167	50411	3302	56927	1842	71917	1048	61799
16-#18	3.86	MA	24493	6718	41679	5325	49695	4263	54294	3406	60158	1970	77203	745	70907
7L-3S		MI	23716	6718	40247	5210	48300	4149	53727	3315	61269	1855	76638	1281	64480
16-#18	3.86	MA	22947	6718	39365	5326	46648	4261	50487	3401	55060	1984	70760	609	66508
8L-2S		MI	25642	6718	42950	5213	51728	4157	57880	3301	66740	1842	83856	1515	64974
18-#11	1.70	MA	26749	5412	39159	4513	47161	3655	51452	3004	56557	2035	70547	1916	39029
2L-9S		MI	16572	5412	25138	4465	29359	3619	30879	2975	31398	2003	38351	1343	27054
18-#11	1.70	MA	25645	5412	37721	4515	45337	3655	49241	3013	53575	2042	66489	1825	38956
3L-8S		MI	17077	5412	25908	4455	30307	3610	32008	2968	32902	1998	40227	1402	27669
18-#11	1.70	MA	24851	5412	36655	4516	43896	3666	47495	3012	51218	2038	63809	1734	38811
4L-7S		MI	17585	5412	26606	4455	31226	3612	33156	2971	34421	1993	42143	1453	28376
18-#11	1.70	MA	24135	5412	35578	4528	42604	3666	45917	3022	49069	2045	61028	1687	38544
5L-6S		MI	18100	5412	27315	4455	32163	3613	34301	2964	35995	1998	43979	1524	28779

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

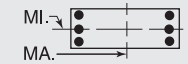
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.70	MA	23448	5412	34622	4529	41328	3677	44364	3021	47004	2053	58194	1612	37601
6L-5S		MI	18625	5412	28043	4456	33134	3605	35482	2968	37548	1993	46049	1600	29395
18-#11	1.70	MA	22776	5412	33692	4531	40097	3677	42860	3030	44910	2049	55669	1541	36972
7L-4S		MI	19173	5412	28862	4445	34116	3606	36682	2960	39162	1988	48101	1644	29631
18-#11	1.70	MA	22112	5412	32776	4532	38890	3677	41352	3029	42891	2056	53070	1486	35990
8L-3S		MI	19777	5412	29671	4446	35209	3598	38006	2964	40931	1993	50048	1735	29712
18-#11	1.70	MA	21452	5412	31765	4544	37647	3688	39869	3039	40891	2063	50496	1428	35075
9L-2S		MI	20607	5412	30755	4446	36584	3600	39671	2957	43161	1988	53013	1826	29750
18-#14	2.45	MA	27766	5864	42814	4784	51684	3851	56881	3139	63848	2017	80186	1721	55420
3L-8S		MI	17555	5864	28114	4722	32940	3803	35127	3088	36994	1959	45955	1121	37398
18-#14	2.45	MA	26664	5864	41286	4786	49618	3866	54377	3137	60468	2011	76372	1590	55033
4L-7S		MI	18262	5864	29114	4722	34256	3807	36771	3093	39154	1951	48677	1194	38558
18-#14	2.45	MA	25669	5864	39741	4803	47763	3865	52113	3150	57386	2020	72404	1522	53487
5L-6S		MI	18977	5864	30130	4723	35600	3810	38412	3084	41392	1959	51279	1297	39861
18-#14	2.45	MA	24715	5864	38369	4804	45934	3880	49886	3148	54423	2030	68369	1414	52312
6L-5S		MI	19707	5864	31173	4724	36989	3798	40103	3089	43599	1951	54212	1406	40620
18-#14	2.45	MA	23782	5864	37034	4806	44166	3880	47727	3161	51420	2024	64776	1312	50572
7L-4S		MI	20468	5864	32346	4710	38397	3801	41820	3080	45894	1944	57129	1469	41819
18-#14	2.45	MA	22859	5864	35720	4808	42435	3880	45563	3159	48522	2034	61070	1234	49002
8L-3S		MI	21307	5864	33503	4711	39961	3789	43715	3085	48409	1951	59886	1600	42071
18-#14	2.45	MA	21942	5864	34268	4824	40650	3895	43435	3172	45652	2043	57405	1150	46796
9L-2S		MI	22460	5864	35052	4712	41925	3793	46095	3076	51578	1944	64089	1731	42201
18-#18	4.35	MA	29274	7009	50054	5504	60604	4374	67560	3476	78139	1956	100423	1083	89785
5L-6S		MI	21023	7009	37040	5407	44089	4310	48591	3387	54626	1846	69066	691	64337
18-#18	4.35	MA	27707	7009	47640	5505	57385	4398	63642	3470	72928	1970	93433	890	85454
6L-5S		MI	22226	7009	38869	5411	46525	4292	51555	3400	58436	1833	74102	885	67453
18-#18	4.35	MA	26172	7009	45290	5507	54276	4396	59843	3491	67644	1957	87217	708	81118
7L-4S		MI	23479	7009	40924	5388	48991	4300	54563	3386	62397	1820	79135	993	69431
18-#18	4.35	MA	24653	7009	42976	5508	51228	4394	56036	3485	62546	1971	80773	573	76678
8L-3S		MI	24862	7009	42950	5392	51728	4282	57880	3399	66740	1833	83856	1227	72347
20-#11	1.88	MA	26332	5526	39159	4585	47161	3707	51452	3046	56557	2036	70547	1814	43193
3L-9S		MI	17105	5526	26222	4536	30734	3670	32545	3008	33627	1997	41316	1326	30145
20-#11	1.88	MA	25546	5526	38094	4587	45721	3718	49705	3045	54200	2033	67867	1723	43031
4L-8S		MI	17606	5526	26992	4526	31681	3662	33674	3001	35131	1992	43191	1385	30747
20-#11	1.88	MA	24836	5526	37016	4599	44428	3718	48127	3054	52051	2040	65085	1676	42662
5L-7S		MI	18110	5526	27690	4526	32601	3663	34822	3004	36650	1987	45107	1436	31498
20-#11	1.88	MA	24156	5526	36061	4600	43153	3729	46575	3054	49986	2047	62252	1601	41750
6E		MI	18619	5526	28399	4526	33538	3665	35967	2997	38225	1992	46944	1507	31891
20-#11	1.88	MA	23490	5526	35130	4602	41921	3729	45070	3063	47892	2044	59726	1530	41135
7L-5S		MI	19140	5526	29127	4526	34509	3657	37148	3000	39777	1987	49013	1583	32483
20-#11	1.88	MA	22832	5526	34215	4603	40715	3729	43562	3062	45872	2051	57128	1476	40110
8L-4S		MI	19683	5526	29946	4516	35491	3658	38347	2993	41392	1981	51065	1627	32811
20-#11	1.88	MA	22179	5526	33203	4615	39471	3740	42079	3072	43873	2058	54554	1417	39214
9L-3S		MI	20282	5526	30755	4516	36584	3650	39671	2997	43161	1987	53013	1718	32907
20-#11	1.88	MA	21528	5526	32291	4616	38273	3740	40589	3071	41816	2055	51892	1337	37938
10L-2S		MI	21106	5526	31839	4517	37959	3651	41337	2989	45390	1981	55977	1809	32957
20-#14	2.72	MA	27621	6027	43346	4888	52231	3940	57543	3184	64739	2004	82151	1572	61052
4L-8S		MI	18289	6027	29663	4824	34904	3878	37507	3135	40163	1949	50158	1095	41729
20-#14	2.72	MA	26637	6027	41801	4905	50376	3940	55279	3197	61657	2013	78183	1505	59403
5L-7S		MI	18988	6027	30663	4825	36221	3881	39151	3141	42323	1941	52880	1168	42940
20-#14	2.72	MA	25695	6027	40429	4906	48547	3955	53052	3195	58694	2022	74148	1397	58262
6E		MI	19695	6027	31679	4826	37564	3885	40792	3131	44561	1949	55482	1270	44308
20-#14	2.72	MA	24773	6027	39094	4908	46779	3955	50892	3208	55691	2017	70555	1295	56459
7L-5S		MI	20417	6027	32722	4826	38954	3873	42483	3137	46768	1941	58415	1380	45042

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

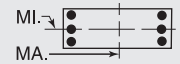


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.72	MA	23862	6027	37780	4910	45048	3955	48729	3206	52793	2026	66848	1217	54845
8L-4S		MI	21170	6027	33895	4812	40361	3876	44200	3127	49063	1934	61332	1442	46335
20-#14	2.72	MA	22956	6027	36329	4926	43263	3970	46601	3219	49923	2036	63184	1133	52683
9L-3S		MI	22000	6027	35052	4813	41925	3864	46095	3133	51578	1941	64089	1574	46614
20-#14	2.72	MA	22054	6027	35019	4928	41544	3970	44462	3217	46972	2030	59395	1017	50459
10L-2S		MI	23143	6027	36601	4814	43890	3867	48476	3123	54747	1934	68293	1705	46766
20-#18	4.83	MA	29329	7300	51252	5687	61966	4531	69191	3554	80414	1956	103446	854	95748
6E		MI	22210	7300	39743	5589	47517	4443	52743	3471	60096	1824	76284	636	71953
20-#18	4.83	MA	27820	7300	48902	5688	58856	4529	65392	3575	75131	1944	97230	672	91346
7L-5S		MI	23394	7300	41572	5593	49953	4425	55708	3484	63906	1811	81320	831	74956
20-#18	4.83	MA	26327	7300	46588	5690	55808	4527	61585	3569	70032	1957	90786	537	86862
8L-4S		MI	24629	7300	43626	5570	52419	4433	58716	3470	67868	1797	86353	938	77087
22-#11	2.07	MA	26233	5639	39532	4658	47545	3770	51915	3078	57181	2028	71924	1713	47250
4L-9S		MI	17632	5639	27306	4607	32109	3722	34210	3041	35856	1991	44280	1309	33193
22-#11	2.07	MA	25529	5639	38455	4670	46252	3770	50337	3087	55033	2035	69143	1665	46787
5L-8S		MI	18128	5639	28076	4597	33056	3714	35340	3034	37361	1985	46156	1368	33830
22-#11	2.07	MA	24855	5639	37499	4671	44977	3780	48785	3086	52968	2042	66309	1590	45903
6L-7S		MI	18628	5639	28774	4597	33975	3715	36487	3037	38880	1980	48072	1420	34616
22-#11	2.07	MA	24196	5639	36569	4673	43745	3781	47280	3096	50874	2039	63784	1520	45300
7L-6S		MI	19133	5639	29483	4597	34913	3717	37633	3030	40454	1985	49909	1491	35008
22-#11	2.07	MA	23544	5639	35653	4674	42539	3781	45772	3095	48854	2046	61186	1465	44235
8L-5S		MI	19650	5639	30211	4597	35883	3708	38814	3033	42007	1980	51978	1566	35579
22-#11	2.07	MA	22897	5639	34642	4686	41295	3792	44289	3104	46855	2053	58611	1407	43357
9L-4S		MI	20188	5639	31030	4587	36866	3710	40013	3026	43621	1975	54030	1610	35989
22-#11	2.07	MA	22253	5639	33730	4687	40097	3792	42799	3104	44798	2050	55950	1327	42056
10L-3S		MI	20783	5639	31839	4587	37959	3702	41337	3029	45390	1980	55977	1702	36099
22-#11	2.07	MA	21550	5639	32824	4689	38868	3803	41325	3113	42807	2057	53396	1269	40828
11L-2S		MI	21601	5639	32923	4588	39334	3703	43003	3022	47619	1975	58942	1793	36161
22-#14	2.99	MA	27593	6191	43861	5007	52989	4015	58445	3244	65928	2005	83962	1488	65328
5L-8S		MI	19014	6191	31212	4926	36869	3953	39887	3182	43332	1938	54361	1068	46071
22-#14	2.99	MA	26662	6191	42490	5009	51160	4030	56217	3242	62965	2015	79927	1380	64217
6L-7S		MI	19705	6191	32212	4927	38186	3956	41531	3188	45492	1931	57084	1141	47331
22-#14	2.99	MA	25751	6191	41154	5010	49392	4030	54058	3255	59962	2009	76333	1278	62353
7L-6S		MI	20405	6191	33228	4928	39529	3959	43172	3179	47730	1938	59685	1244	48728
22-#14	2.99	MA	24850	6191	39840	5012	47661	4030	51894	3254	57064	2019	72627	1200	60696
8L-5S		MI	21119	6191	34271	4929	40919	3948	44863	3184	49937	1931	62619	1353	49473
22-#14	2.99	MA	23955	6191	38389	5029	45876	4044	49766	3267	54194	2028	68962	1116	58575
9L-4S		MI	21864	6191	35444	4915	42326	3951	46581	3175	52232	1924	65535	1416	50781
22-#14	2.99	MA	23059	6191	37080	5030	44157	4044	47628	3265	51243	2023	65174	1000	56324
10L-3S		MI	22686	6191	36601	4915	43890	3939	48476	3180	54747	1931	68293	1547	51152
22-#18	5.31	MA	29442	7590	52513	5870	63436	4662	70941	3659	82617	1930	107243	636	101589
7L-6S		MI	23505	7590	42446	5771	50945	4576	56896	3555	65567	1802	83502	581	79586
22-#18	5.31	MA	27973	7590	50199	5871	60388	4660	67134	3654	77519	1944	100799	501	97061
8L-5S		MI	24655	7590	44275	5774	53381	4558	59860	3568	69377	1789	88537	776	82484
24-#11	2.26	MA	26215	5753	39893	4740	48077	3822	52548	3120	58015	2030	73201	1655	50920
5L-9S		MI	18154	5753	28390	4678	33484	3774	35876	3074	38086	1984	47245	1292	36247
24-#11	2.26	MA	25547	5753	38937	4742	46801	3832	50995	3119	55949	2037	70367	1580	50061
6L-8S		MI	18645	5753	29161	4668	34431	3765	37005	3067	39590	1979	49121	1351	36919
24-#11	2.26	MA	24894	5753	38007	4743	45570	3833	49490	3129	53856	2034	67842	1509	49469
7E		MI	19141	5753	29859	4668	35350	3767	38153	3070	41109	1974	51036	1403	37683
24-#11	2.26	MA	24248	5753	37092	4745	44363	3833	47982	3128	51836	2041	65244	1454	48365
8L-6S		MI	19642	5753	30568	4668	36288	3769	39298	3063	42683	1979	52873	1474	38129
24-#11	2.26	MA	23607	5753	36080	4757	43120	3844	46499	3137	49837	2048	62669	1396	47469
9L-5S		MI	20154	5753	31296	4668	37258	3760	40479	3066	44236	1974	54942	1549	38680
24-#11	2.26	MA	22966	5753	35168	4758	41922	3844	45009	3136	47780	2045	60008	1316	46178
10L-4S		MI	20688	5753	32114	4658	38241	3762	41679	3059	45850	1969	56994	1594	39164
24-#11	2.26	MA	22282	5753	34263	4760	40692	3854	43535	3146	45789	2052	57454	1259	44930
11L-3S		MI	21278	5753	32923	4658	39334	3753	43003	3062	47619	1974	58942	1685	39288

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.26	MA	21589	5753	33362	4761	39497	3855	42054	3145	43807	2059	54900	1201	43620
12L-2S		MI	22090	5753	34007	4658	40709	3755	44668	3055	49849	1969	61906	1776	39361
24-#14	3.26	MA	27616	6355	44550	5111	53772	4105	59383	3290	67236	2007	85705	1363	70178
6L-8S		MI	19730	6355	32761	5028	38834	4028	42267	3230	46501	1928	58565	1042	50421
24-#14	3.26	MA	26716	6355	43215	5113	52005	4105	57223	3303	64232	2002	82112	1261	68256
7E		MI	20413	6355	33762	5029	40150	4031	43912	3235	48661	1921	61287	1115	51729
24-#14	3.26	MA	25825	6355	41901	5114	50274	4104	55060	3301	61334	2011	78406	1183	66555
8L-6S		MI	21106	6355	34777	5030	41494	4034	45552	3226	50899	1928	63889	1218	53085
24-#14	3.26	MA	24941	6355	40449	5131	48489	4119	52932	3314	58465	2021	74741	1099	64474
9L-5S		MI	21813	6355	35820	5031	42883	4022	47244	3231	53106	1921	66822	1327	53911
24-#14	3.26	MA	24049	6355	39140	5133	46770	4119	50793	3312	55514	2015	70952	983	62196
10L-4S		MI	22550	6355	36993	5017	44291	4026	48961	3222	55401	1913	69739	1390	55169
24-#18	5.80	MA	29594	7881	53811	6053	64969	4793	72683	3738	85005	1931	110812	465	107274
8L-6S		MI	24653	7881	45148	5952	54372	4709	61049	3640	71038	1780	90719	527	87234

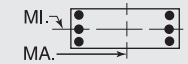
RECTANGULAR TIED COLUMNS 36" x 48"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.39	MA	27753	5455	40189	4561	47991	3703	51840	3059	55863	2117	68611	1985	34613
2L-3S		MI	18351	5455	27661	4465	32218	3618	34035	3008	34916	2054	41684	1639	25100
6-#18	1.39	MA	24805	5455	36396	4564	43180	3702	46012	3081	48000	2132	58037	1752	34386
3L-2S		MI	20442	5455	30364	4468	35646	3626	38188	2994	40386	2040	48902	1873	25163
8-#14	1.04	MA	26480	5237	37213	4450	44451	3624	47654	3014	50285	2141	61416	2036	26370
2L-4S		MI	17486	5237	25518	4364	29627	3563	30992	2958	31052	2084	37254	1686	19244
8-#14	1.04	MA	24771	5237	35050	4452	41708	3624	44331	3027	45802	2151	55322	1904	26333
3E		MI	18378	5237	26675	4365	31191	3551	32887	2964	33567	2091	40011	1817	19303
8-#14	1.04	MA	23537	5237	33448	4455	39542	3640	41705	3026	42257	2146	51296	1773	26141
4L-2S		MI	19595	5237	28224	4365	33156	3554	35267	2954	36736	2084	44214	1949	19282
8-#18	1.85	MA	29545	5746	43982	4743	52802	3836	57669	3143	63726	2104	79184	1952	45838
2L-4S		MI	18113	5746	28337	4643	32909	3769	34872	3079	36044	2018	44181	1351	31883
8-#18	1.85	MA	26654	5746	40189	4745	47991	3835	51840	3165	55863	2119	68611	1718	45493
3E		MI	19622	5746	30364	4646	35646	3751	38188	3092	40386	2031	48902	1585	33025
8-#18	1.85	MA	24563	5746	37371	4748	44182	3860	47224	3161	49633	2107	61641	1485	43843
4L-2S		MI	21677	5746	33066	4650	39074	3759	42341	3078	45857	2018	56120	1818	33190
10-#14	1.30	MA	27542	5400	39375	4553	47193	3699	50976	3061	54767	2133	67511	2020	32788
2L-5S		MI	17446	5400	25894	4480	30185	3634	31655	3015	31926	2081	38540	1597	23219
10-#14	1.30	MA	25853	5400	37213	4555	44451	3699	47654	3075	50285	2143	61416	1889	32712
3L-4S		MI	18247	5400	27067	4466	31592	3638	33372	3006	34221	2074	41457	1660	23788
10-#14	1.30	MA	24636	5400	35611	4557	42284	3715	45028	3073	46740	2138	57391	1757	32470
4L-3S		MI	19127	5400	28224	4467	33156	3626	35267	3011	36736	2081	44214	1791	23890
10-#14	1.30	MA	23534	5400	33991	4574	40341	3715	42655	3087	43509	2148	53212	1689	31550
5L-2S		MI	20332	5400	29773	4468	35121	3629	37647	3002	39905	2074	48417	1923	23903
10-#18	2.31	MA	31290	6037	47775	4925	57612	3969	63497	3228	71590	2091	89758	1918	57037
2L-5S		MI	18033	6037	28985	4847	33871	3894	36016	3177	37552	2009	46365	1189	37150
10-#18	2.31	MA	28451	6037	43982	4927	52802	3968	57669	3250	63726	2106	79184	1685	56591
3L-4S		MI	19380	6037	31040	4824	36337	3902	39025	3163	41514	1996	51398	1297	39366
10-#18	2.31	MA	26402	6037	41165	4929	48993	3993	53053	3245	57496	2094	72214	1451	54509
4L-3S		MI	20861	6037	33066	4828	39074	3884	42341	3176	45857	2009	56120	1530	40928
10-#18	2.31	MA	24548	6037	38315	4958	45573	3992	48878	3267	51812	2109	64940	1333	50940
5L-2S		MI	22883	6037	35769	4832	42502	3892	46494	3162	51327	1996	63338	1764	41180
12-#11	1.08	MA	26707	5263	37493	4479	44925	3647	48280	3030	51166	2146	62773	2046	27512
2L-6S		MI	17190	5263	24976	4408	29091	3594	30377	2981	30312	2106	36231	1661	19599
12-#11	1.08	MA	25516	5263	35984	4481	43011	3647	45961	3040	48037	2154	58496	1955	27486
3L-5S		MI	17731	5263	25704	4409	30062	3585	31558	2985	31864	2101	38300	1736	20033

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

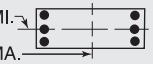


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.08	MA	24658	5263	34867	4483	41501	3658	44131	3039	45566	2151	55669	1864	27401
4E		MI	18295	5263	26523	4398	31044	3587	32758	2978	33479	2096	40352	1780	20110
12-#11	1.08	MA	23883	5263	33738	4495	40146	3659	42477	3049	43314	2158	52742	1817	27210
5L-3S		MI	18916	5263	27331	4399	32137	3578	34082	2981	35248	2101	42299	1871	20132
12-#11	1.08	MA	23140	5263	32737	4497	38810	3670	40850	3049	41150	2166	49755	1742	26494
6L-2S		MI	19768	5263	28415	4399	33512	3580	35747	2974	37477	2096	45264	1962	20121
12-#14	1.56	MA	28584	5564	41538	4655	49936	3774	54299	3108	59250	2126	73605	2005	39192
2L-6S		MI	17444	5564	26400	4581	30760	3721	32344	3057	32888	2078	39810	1462	26721
12-#14	1.56	MA	26916	5564	39375	4657	47193	3774	50976	3122	54767	2136	67511	1873	39080
3L-5S		MI	18203	5564	27443	4582	32150	3709	34035	3062	35095	2071	42744	1571	27588
12-#14	1.56	MA	25714	5564	37773	4659	45027	3789	48351	3121	51223	2131	63485	1742	38796
4E		MI	18994	5564	28616	4568	33557	3712	35752	3053	37390	2063	45660	1633	28323
12-#14	1.56	MA	24627	5564	36153	4676	43083	3790	45978	3134	47992	2141	59307	1674	37708
5L-3S		MI	19864	5564	29773	4569	35121	3701	37647	3058	39905	2071	48417	1765	28463
12-#14	1.56	MA	23585	5564	34716	4678	41166	3805	43643	3133	44886	2151	55051	1566	36303
6L-2S		MI	21056	5564	31323	4570	37085	3704	40028	3049	43074	2063	52621	1896	28507
12-#18	2.78	MA	32995	6327	51568	5107	62423	4102	69325	3312	79453	2077	100332	1885	68219
2L-6S		MI	18024	6327	29859	5025	34863	4045	37205	3248	39213	2000	48547	939	42013
12-#18	2.78	MA	30204	6327	47775	5109	57612	4101	63497	3334	71590	2092	89758	1651	67684
3L-5S		MI	19294	6327	31688	5029	37299	4027	40169	3261	43023	1987	53583	1134	44807
12-#18	2.78	MA	28195	6327	44958	5111	53803	4126	58881	3329	65359	2081	82788	1418	65219
4E		MI	20617	6327	33743	5006	39765	4035	43177	3248	46985	1974	58616	1242	46897
12-#18	2.78	MA	26377	6327	42108	5140	50383	4125	54706	3351	59676	2096	75513	1300	61804
5L-3S		MI	22073	6327	35769	5010	42502	4017	46494	3260	51327	1987	63338	1475	48818
12-#18	2.78	MA	24633	6327	39577	5142	47008	4150	50598	3346	54211	2111	68131	1107	57823
6L-2S		MI	24063	6327	38472	5013	45929	4025	50646	3247	56798	1974	70556	1709	49147
14-#11	1.26	MA	27451	5376	39003	4550	46839	3698	50600	3063	54295	2141	67050	2037	31988
2L-7S		MI	17205	5376	25351	4479	29528	3644	30898	3021	30967	2095	37358	1573	22263
14-#11	1.26	MA	26271	5376	37493	4552	44925	3699	48280	3073	51166	2149	62773	1946	31946
3L-6S		MI	17730	5376	26060	4479	30466	3646	32043	3014	32541	2100	39195	1644	22692
14-#11	1.26	MA	25421	5376	36377	4554	43415	3710	46450	3072	48695	2146	59946	1854	31839
4L-5S		MI	18267	5376	26788	4479	31437	3637	33224	3017	34094	2095	41264	1719	23207
14-#11	1.26	MA	24653	5376	35248	4566	42060	3710	44796	3082	46443	2153	57018	1807	31624
5L-4S		MI	18826	5376	27607	4469	32419	3639	34423	3010	35708	2089	43316	1763	23306
14-#11	1.26	MA	23918	5376	34246	4568	40724	3721	43169	3081	44279	2161	54031	1732	30828
6L-3S		MI	19442	5376	28415	4469	33512	3630	35747	3014	37477	2095	45264	1855	23346
14-#11	1.26	MA	23197	5376	33272	4569	39434	3722	41592	3091	42085	2158	51368	1661	30116
7L-2S		MI	20286	5376	29500	4470	34887	3632	37413	3007	39706	2089	48228	1946	23351
14-#14	1.82	MA	29610	5728	43700	4757	52679	3849	57622	3156	63733	2118	79699	1989	45586
2L-7S		MI	17463	5728	26934	4683	31381	3793	33083	3114	33818	2061	41412	1332	30084
14-#14	1.82	MA	27960	5728	41538	4759	49936	3849	54299	3169	59250	2128	73605	1858	45442
3L-6S		MI	18198	5728	27950	4684	32724	3796	34724	3104	36057	2068	44013	1435	31146
14-#14	1.82	MA	26773	5728	39936	4761	47769	3864	51673	3168	55706	2123	69580	1726	45120
4L-5S		MI	18948	5728	28993	4685	34114	3784	36415	3110	38264	2061	46947	1544	31973
14-#14	1.82	MA	25700	5728	38316	4778	45826	3864	49300	3182	52475	2134	65401	1658	43884
5L-4S		MI	19729	5728	30165	4670	35521	3787	38133	3100	40559	2053	49864	1607	32852
14-#14	1.82	MA	24672	5728	36878	4780	43908	3880	46966	3180	49369	2144	61145	1550	42529
6L-3S		MI	20590	5728	31323	4671	37085	3775	40028	3106	43074	2061	52621	1738	33025
14-#14	1.82	MA	23664	5728	35479	4782	42056	3880	44703	3194	46221	2139	57353	1448	40965
7L-2S		MI	21770	5728	32872	4672	39050	3779	42408	3097	46242	2053	56824	1870	33095
14-#18	3.24	MA	31920	6618	51568	5291	62423	4234	69325	3418	79453	2079	100332	1618	78774
3L-6S		MI	19280	6618	32562	5207	38290	4178	41357	3333	44684	1978	55765	885	49555
14-#18	3.24	MA	29947	6618	48751	5293	58614	4259	64709	3413	73222	2068	93362	1384	75967
4L-5S		MI	20528	6618	34391	5211	40727	4160	44322	3345	48493	1965	60801	1080	52487
14-#18	3.24	MA	28164	6618	45901	5321	55194	4258	60534	3435	67539	2083	86087	1266	72691
5L-4S		MI	21828	6618	36445	5188	43192	4168	47330	3332	52455	1952	65834	1187	54467
14-#18	3.24	MA	26453	6618	43370	5324	51819	4283	56426	3431	62074	2098	78705	1074	68588
6L-3S		MI	23261	6618	38472	5191	45929	4150	50646	3345	56798	1965	70556	1421	56700
14-#18	3.24	MA	24777	6618	40906	5326	48558	4282	52442	3453	56534	2086	72135	892	64347
7L-2S		MI	25223	6618	41174	5195	49357	4158	54799	3331	62268	1952	77774	1654	57099

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

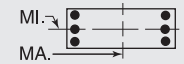


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.44	MA	28186	5490	40512	4621	48754	3750	52919	3096	57424	2136	71327	2027	36459
2L-8S		MI	17229	5490	25737	4550	29984	3694	31416	3051	31677	2093	38407	1504	24788
16-#11	1.44	MA	27015	5490	39003	4623	46839	3751	50600	3106	54295	2143	67050	1936	36400
3L-7S		MI	17743	5490	26435	4550	30903	3696	32563	3054	33196	2088	40323	1556	25378
16-#11	1.44	MA	26173	5490	37886	4625	45329	3762	48769	3105	51823	2141	64223	1845	36274
4L-6S		MI	18264	5490	27144	4550	31841	3698	33709	3047	34770	2093	42160	1627	25793
16-#11	1.44	MA	25413	5490	36757	4637	43974	3762	47115	3115	49572	2148	61295	1797	36038
5E		MI	18796	5490	27872	4550	32811	3689	34890	3050	36323	2088	44229	1702	26379
16-#11	1.44	MA	24685	5490	35756	4638	42638	3773	45488	3114	47407	2156	58308	1722	35170
6L-4S		MI	19350	5490	28691	4540	33794	3691	36089	3043	37937	2083	46281	1747	26497
16-#11	1.44	MA	23972	5490	34781	4640	41348	3774	43912	3124	45214	2153	55645	1651	34478
7L-3S		MI	19961	5490	29500	4540	34887	3682	37413	3047	39706	2088	48228	1838	26553
16-#11	1.44	MA	23267	5490	33822	4642	40084	3774	42332	3124	43098	2160	52910	1596	33577
8L-2S		MI	20799	5490	30584	4540	36262	3684	39079	3039	41936	2083	51193	1929	26573
16-#14	2.08	MA	30620	5891	45863	4859	55421	3923	60944	3203	68216	2111	85794	1973	51973
2L-8S		MI	17496	5891	27482	4784	32029	3864	33819	3155	34828	2058	42893	1233	33374
16-#14	2.08	MA	28987	5891	43700	4861	52679	3924	57622	3217	63733	2121	79699	1842	51800
3L-7S		MI	18213	5891	28483	4785	33346	3867	35463	3161	36987	2050	45615	1306	34441
16-#14	2.08	MA	27814	5891	42098	4863	50512	3939	54996	3215	60188	2116	75674	1710	51444
4L-6S		MI	18939	5891	29499	4786	34689	3871	37104	3152	39226	2058	48217	1409	35579
16-#14	2.08	MA	26755	5891	40478	4880	48568	3939	52623	3229	56957	2126	71496	1642	50074
5E		MI	19681	5891	30542	4787	36079	3859	38796	3157	41433	2050	51150	1518	36373
16-#14	2.08	MA	25740	5891	39041	4882	46651	3955	50288	3228	53852	2136	67240	1534	48763
6L-4S		MI	20453	5891	31714	4773	37486	3862	40513	3148	43728	2043	54067	1581	37376
16-#14	2.08	MA	24746	5891	37642	4885	44799	3955	48025	3241	50704	2131	63448	1432	47130
7L-3S		MI	21305	5891	32872	4774	39050	3850	42408	3153	46242	2050	56824	1712	37580
16-#14	2.08	MA	23763	5891	36265	4887	42984	3955	45758	3240	47667	2141	59544	1354	45445
8L-2S		MI	22473	5891	34421	4774	41015	3853	44788	3144	49411	2043	61028	1843	37675
16-#18	3.70	MA	31664	6909	52544	5474	63425	4392	70537	3498	81086	2054	103935	1351	86747
4L-6S		MI	20510	6909	35265	5389	41718	4311	45510	3417	50154	1956	62983	830	57123
16-#18	3.70	MA	29913	6909	49694	5503	60005	4391	66363	3520	75402	2070	96661	1233	83597
5E		MI	21738	6909	37094	5393	44154	4293	48474	3430	53964	1943	68019	1025	60185
16-#18	3.70	MA	28234	6909	47163	5505	56630	4416	62254	3515	69937	2085	89278	1040	79374
6L-4S		MI	23018	6909	39148	5370	46620	4301	51483	3416	57926	1930	73052	1133	62068
16-#18	3.70	MA	26588	6909	44700	5508	53369	4415	58270	3537	64397	2073	82709	858	75073
7L-3S		MI	24429	6909	41174	5373	49357	4283	54799	3429	62268	1943	77774	1366	64575
16-#18	3.70	MA	24960	6909	42274	5510	50174	4414	54279	3532	59051	2088	75915	722	70605
8L-2S		MI	26364	6909	43877	5377	52785	4291	58952	3415	67739	1930	84991	1600	65039
18-#11	1.63	MA	28913	5603	42021	4692	50668	3802	55238	3129	60552	2131	75604	2017	40925
2L-9S		MI	17259	5603	26051	4631	30412	3755	31952	3091	32402	2092	39496	1429	27239
18-#11	1.63	MA	27751	5603	40512	4694	48754	3803	52919	3138	57424	2138	71327	1926	40851
3L-8S		MI	17765	5603	26821	4621	31359	3746	33081	3084	33906	2087	41372	1488	27858
18-#11	1.63	MA	26916	5603	39395	4695	47243	3814	51088	3138	54952	2135	68499	1835	40706
4L-7S		MI	18275	5603	27519	4621	32278	3748	34229	3087	35425	2082	43287	1539	28497
18-#11	1.63	MA	26163	5603	38266	4708	45889	3814	49434	3148	52700	2143	65572	1787	40452
5L-6S		MI	18791	5603	28228	4621	33216	3750	35374	3080	37000	2087	45124	1610	28899
18-#11	1.63	MA	25442	5603	37265	4709	44553	3825	47807	3147	50536	2150	62585	1712	39519
6L-5S		MI	19318	5603	28956	4621	34186	3741	36555	3083	38552	2082	47193	1686	29528
18-#11	1.63	MA	24736	5603	36290	4711	43262	3826	46231	3157	48343	2148	59922	1642	38844
7L-4S		MI	19868	5603	29775	4611	35169	3743	37755	3076	40167	2077	49245	1730	29683
18-#11	1.63	MA	24038	5603	35331	4713	41998	3826	44651	3156	46226	2155	57187	1587	37898
8L-3S		MI	20474	5603	30584	4611	36262	3734	39079	3079	41936	2082	51193	1821	29755
18-#11	1.63	MA	23345	5603	34272	4725	40695	3837	43097	3166	44131	2163	54472	1528	36914
9L-2S		MI	21306	5603	31668	4611	37637	3736	40744	3072	44165	2077	54157	1912	29787
18-#14	2.34	MA	30000	6055	45863	4964	55421	3998	60944	3264	68216	2113	85794	1826	58154
3L-8S		MI	18243	6055	29032	4887	33994	3939	36200	3203	37997	2047	47096	1207	37749
18-#14	2.34	MA	28841	6055	44261	4966	53255	4014	58318	3263	64671	2109	81769	1695	57767
4L-7S		MI	18952	6055	30032	4887	35310	3942	37844	3208	40156	2040	49819	1280	38810
18-#14	2.34	MA	27794	6055	42641	4983	51311	4014	55946	3276	61440	2119	77590	1627	56276
5L-6S		MI	19670	6055	31048	4888	36654	3945	39484	3199	42395	2047	52420	1382	40020

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

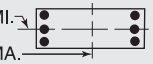
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.34	MA	26792	6055	41203	4985	49393	4029	53611	3275	58335	2129	73334	1519	55005
6L-5S		MI	20403	6055	32091	4889	38044	3934	41176	3204	44601	2040	55354	1492	40785
18-#14	2.34	MA	25810	6055	39804	4987	47541	4030	51348	3288	55187	2124	69542	1417	53306
7L-4S		MI	21167	6055	33263	4875	39451	3937	42893	3195	46896	2033	58270	1554	41897
18-#14	2.34	MA	24840	6055	38428	4989	45727	4030	49081	3287	52150	2134	65638	1338	51660
8L-3S		MI	22010	6055	34421	4876	41015	3925	44788	3201	49411	2040	61028	1686	42129
18-#14	2.34	MA	23875	6055	36907	5006	43857	4045	46851	3301	49142	2144	61772	1254	49404
9L-2S		MI	23167	6055	35970	4877	42979	3928	47168	3191	52580	2033	65231	1817	42248
18-#18	4.17	MA	31630	7200	53487	5685	64815	4524	72191	3604	83265	2056	107235	1199	94520
5L-6S		MI	21719	7200	37967	5571	45146	4444	49663	3501	55625	1934	70201	775	64712
18-#18	4.17	MA	29980	7200	50957	5687	61440	4549	68082	3599	77800	2071	99852	1007	90181
6L-5S		MI	22929	7200	39796	5574	47582	4426	52627	3514	59435	1921	75237	970	67900
18-#18	4.17	MA	28364	7200	48493	5689	58180	4548	64099	3621	72260	2060	93283	825	85816
7L-4S		MI	24189	7200	41851	5551	50048	4434	55636	3500	63396	1907	80270	1078	69696
18-#18	4.17	MA	26764	7200	46068	5691	54985	4547	60107	3616	66914	2075	86489	688	81310
8L-3S		MI	25579	7200	43877	5555	52785	4416	58952	3513	67739	1921	84991	1311	72447
20-#11	1.81	MA	28478	5717	42021	4765	50668	3855	55238	3171	60552	2133	75604	1916	45299
3L-9S		MI	17793	5717	27135	4702	31787	3807	33618	3124	34631	2086	42461	1412	30331
20-#11	1.81	MA	27651	5717	40905	4766	49157	3866	53407	3171	58081	2130	72776	1825	45137
4L-8S		MI	18295	5717	27905	4692	32734	3798	34747	3117	36136	2081	44336	1471	30935
20-#11	1.81	MA	26904	5717	39776	4778	47803	3866	51753	3181	55829	2138	69849	1777	44866
5L-7S		MI	18801	5717	28603	4692	33653	3800	35895	3120	37655	2076	46252	1522	31620
20-#11	1.81	MA	26190	5717	38774	4780	46467	3877	50127	3180	53665	2145	66862	1703	43874
6E		MI	19312	5717	29312	4692	34591	3801	37040	3113	39229	2081	48089	1593	32011
20-#11	1.81	MA	25490	5717	37800	4782	45176	3878	48550	3190	51471	2142	64199	1632	43215
7L-5S		MI	19835	5717	30040	4692	35561	3793	38221	3116	40782	2076	50158	1669	32615
20-#11	1.81	MA	24799	5717	36841	4784	43912	3878	46970	3189	49355	2150	61464	1577	42225
8L-4S		MI	20380	5717	30859	4682	36544	3794	39420	3109	42396	2070	52210	1713	32865
20-#11	1.81	MA	24113	5717	35781	4796	42610	3889	45416	3199	47260	2158	58749	1519	41261
9L-3S		MI	20981	5717	31668	4682	37637	3786	40744	3112	44165	2076	54157	1804	32952
20-#11	1.81	MA	23415	5717	34826	4797	41355	3890	43855	3199	45105	2155	55944	1439	40001
10L-2S		MI	21807	5717	32752	4682	39011	3788	42410	3105	46394	2070	57122	1895	32996
20-#14	2.60	MA	29853	6218	46423	5068	55997	4089	61641	3310	69154	2101	87863	1679	64089
4L-8S		MI	18979	6218	30581	4989	35958	4014	38580	3250	41166	2037	51300	1180	42077
20-#14	2.60	MA	28819	6218	44803	5085	54053	4089	59268	3324	65923	2111	83685	1611	62489
5L-7S		MI	19681	6218	31581	4990	37275	4017	40224	3256	43325	2030	54022	1253	43189
20-#14	2.60	MA	27828	6218	43366	5087	52136	4104	56934	3322	62817	2121	79429	1503	61255
6E		MI	20391	6218	32597	4990	38618	4020	41865	3246	45563	2037	56624	1356	44467
20-#14	2.60	MA	26858	6218	41967	5089	50284	4105	54671	3336	59669	2116	75636	1401	59490
7L-5S		MI	21116	6218	33640	4991	40008	4008	43556	3252	47770	2030	59557	1465	45206
20-#14	2.60	MA	25900	6218	40590	5091	48469	4105	52404	3334	56632	2126	71733	1323	57881
8L-4S		MI	21872	6218	34812	4977	41415	4012	45273	3242	50065	2022	62474	1528	46416
20-#14	2.60	MA	24947	6218	39069	5108	46599	4120	50173	3348	53625	2137	67866	1238	55589
9L-3S		MI	22706	6218	35970	4978	42979	4000	47168	3248	52580	2030	65231	1659	46674
20-#14	2.60	MA	23989	6218	37698	5110	44798	4120	47933	3347	50533	2132	63870	1123	53360
10L-2S		MI	23853	6218	37519	4979	44944	4003	49548	3239	55749	2022	69434	1791	46815
20-#18	4.63	MA	31696	7490	54750	5869	66251	4682	73910	3683	85663	2058	110426	973	101005
6E		MI	22910	7490	40670	5752	48574	4577	53815	3585	61095	1912	77419	721	72322
20-#18	4.63	MA	30107	7490	52286	5871	62990	4681	69927	3705	80123	2047	103856	792	96576
7L-5S		MI	24101	7490	42499	5756	51010	4559	56780	3598	64905	1899	82455	916	75396
20-#18	4.63	MA	28534	7490	49861	5873	59795	4680	65936	3701	74777	2062	97062	655	92029
8L-4S		MI	25344	7490	44554	5733	53476	4567	59788	3584	68867	1885	87488	1023	77347
22-#11	1.99	MA	28377	5830	42414	4837	51072	3917	55726	3204	61210	2125	77053	1815	49567
4L-9S		MI	18321	5830	28219	4773	33162	3858	35283	3157	36861	2080	45425	1395	33428

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

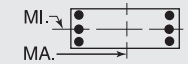


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.99	MA	27637	5830	41285	4849	49717	3918	54072	3213	58958	2133	74125	1768	49201
5L-8S		MI	18819	5830	28989	4762	34109	3850	36413	3149	38365	2074	47301	1454	34016
22-#11	1.99	MA	26929	5830	40284	4851	48381	3929	52446	3213	56794	2140	71139	1693	48235
6L-7S		MI	19321	5830	29687	4763	35028	3852	37560	3153	39884	2069	49216	1505	34745
22-#11	1.99	MA	26236	5830	39309	4853	47091	3929	50869	3223	54600	2137	68476	1622	47589
7L-6S		MI	19828	5830	30396	4763	35966	3853	38706	3146	41458	2074	51053	1577	35128
22-#11	1.99	MA	25551	5830	38350	4855	45827	3930	49289	3222	52484	2145	65741	1567	46557
8L-5S		MI	20346	5830	31124	4763	36936	3845	39887	3149	43011	2069	53123	1652	35709
22-#11	1.99	MA	24871	5830	37291	4867	44524	3941	47736	3232	50389	2152	63026	1509	45612
9L-4S		MI	20887	5830	31943	4753	37919	3846	41086	3142	44625	2064	55175	1696	36045
22-#11	1.99	MA	24187	5830	36335	4868	43269	3942	46174	3231	48234	2150	60220	1429	44327
10L-3S		MI	21483	5830	32752	4753	39011	3838	42410	3145	46394	2069	57122	1787	36146
22-#11	1.99	MA	23446	5830	35387	4870	41981	3953	44630	3241	46148	2157	57532	1371	43120
11L-2S		MI	22304	5830	33836	4753	40386	3839	44076	3138	48623	2064	60086	1879	36202
22-#14	2.86	MA	29829	6382	46966	5187	56796	4164	62591	3371	70406	2104	89779	1596	68712
5L-8S		MI	19706	6382	32130	5091	37923	4089	40960	3298	44335	2027	55503	1154	46414
22-#14	2.86	MA	28850	6382	45528	5189	54878	4179	60256	3370	67300	2114	85523	1487	67510
6L-7S		MI	20400	6382	33130	5092	39240	4092	42604	3303	46494	2020	58225	1227	47577
22-#14	2.86	MA	27892	6382	44129	5191	53026	4179	57993	3383	64152	2109	81731	1385	65683
7L-6S		MI	21103	6382	34146	5093	40583	4095	44245	3294	48732	2027	60827	1330	48919
22-#14	2.86	MA	26944	6382	42753	5193	51212	4180	55726	3382	61115	2119	77827	1307	64078
8L-5S		MI	21821	6382	35189	5093	41973	4083	45936	3299	50939	2020	63760	1439	49635
22-#14	2.86	MA	26003	6382	41232	5210	49342	4195	53496	3395	58108	2129	73961	1223	61782
9L-4S		MI	22569	6382	36362	5079	43380	4086	47653	3290	53234	2012	66677	1502	50933
22-#14	2.86	MA	25049	6382	39860	5212	47540	4195	51255	3394	55015	2124	69964	1107	59525
10L-3S		MI	23395	6382	37519	5080	44944	4075	49548	3295	55749	2020	69434	1633	51215
22-#18	5.09	MA	31822	7781	56079	6053	67801	4814	75755	3790	87986	2033	114430	758	107351
7L-6S		MI	24084	7781	43373	5934	52001	4710	57968	3670	66566	1890	84637	666	79949
22-#18	5.09	MA	30275	7781	53654	6055	64606	4813	71764	3785	82640	2049	107636	622	102763
8L-5S		MI	25373	7781	45202	5938	54438	4692	60932	3682	70376	1876	89673	861	82916
24-#11	2.17	MA	28362	5944	42795	4920	51631	3970	56392	3246	62087	2127	78402	1758	53539
5L-9S		MI	18844	5944	29303	4843	34537	3910	36949	3189	39090	2073	48390	1378	36505
24-#11	2.17	MA	27660	5944	41793	4922	50295	3981	54765	3246	59923	2135	75415	1683	52600
6L-8S		MI	19338	5944	30073	4833	35484	3902	38078	3182	40594	2068	50265	1437	37103
24-#11	2.17	MA	26973	5944	40819	4924	49005	3981	53188	3256	57729	2132	72752	1612	51966
7E		MI	19835	5944	30772	4833	36403	3903	39226	3186	42113	2063	52181	1489	37873
24-#11	2.17	MA	26295	5944	39859	4925	47741	3982	51608	3255	55613	2140	70017	1557	50894
8L-6S		MI	20338	5944	31480	4834	37341	3905	40371	3178	43687	2068	54018	1560	38248
24-#11	2.17	MA	25621	5944	38800	4937	46438	3993	50055	3265	53518	2147	67303	1499	49967
9L-5S		MI	20853	5944	32208	4834	38311	3897	41552	3182	45240	2063	56087	1635	38809
24-#11	2.17	MA	24939	5944	37845	4939	45183	3993	48494	3264	51363	2144	64497	1419	48656
10L-4S		MI	21389	5944	33027	4824	39294	3898	42752	3175	46854	2058	58139	1680	39223
24-#11	2.17	MA	24207	5944	36896	4941	43895	4004	46949	3274	49277	2152	61809	1361	47429
11L-3S		MI	21981	5944	33836	4824	40386	3890	44076	3178	48623	2063	60086	1771	39337
24-#11	2.17	MA	23491	5944	35953	4943	42644	4005	45397	3274	47140	2149	59116	1304	46018
12L-2S		MI	22796	5944	34920	4824	41761	3891	45742	3171	50853	2058	63051	1862	39403
24-#14	3.13	MA	29859	6545	47691	5291	57621	4254	63579	3417	71783	2106	91617	1472	73771
6L-8S		MI	20423	6545	33679	5193	39888	4163	43340	3345	47504	2017	59706	1128	50760
24-#14	3.13	MA	28912	6545	46292	5293	55769	4254	61316	3431	68635	2101	87825	1370	71883
7E		MI	21111	6545	34679	5194	41204	4167	44984	3350	49663	2009	62429	1201	51973
24-#14	3.13	MA	27975	6545	44915	5296	53954	4254	59049	3429	65598	2112	83922	1291	70235
8L-6S		MI	21806	6545	35695	5195	42548	4170	46625	3341	51901	2017	65030	1303	53359
24-#14	3.13	MA	27045	6545	43394	5313	52084	4270	56819	3443	62591	2122	80055	1207	67980
9L-5S		MI	22517	6545	36738	5196	43938	4158	48316	3347	54108	2009	67964	1412	54072
24-#14	3.13	MA	26095	6545	42023	5315	50283	4270	54578	3441	59498	2117	76059	1092	65697
10L-4S		MI	23258	6545	37911	5182	45345	4161	50034	3337	56403	2002	70881	1475	55361
24-#18	5.56	MA	31988	8072	57447	6237	69417	4946	77592	3869	90503	2035	118210	588	113510
8L-6S		MI	25366	8072	46076	6116	55429	4843	62121	3754	72036	1867	91855	612	87592

RECTANGULAR TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.66	MA	18757	4702	28168	3840	33313	3109	36000	2555	38816	1710	47440	1560	26561
2L-3S		MI	16547	4702	25283	3837	29655	3103	31568	2570	32941	1723	39665	1327	26369
8-#14	1.25	MA	17853	4484	25926	3730	30659	3032	32866	2510	34849	1747	42311	1628	20330
2L-4S		MI	15626	4484	23043	3730	26900	3042	28312	2516	28756	1747	34826	1365	20144
8-#18	2.22	MA	20062	4993	31052	4022	36972	3242	40432	2639	44691	1690	55216	1510	35093
2L-4S		MI	16315	4993	26010	4017	30398	3255	32467	2644	34153	1690	42346	1043	32609
10-#11	1.08	MA	17477	4397	24997	3689	29575	3003	31595	2494	33233	1763	40217	1655	17790
2L-5S		MI	15308	4397	22111	3700	25904	3009	27136	2507	27222	1768	32743	1428	17605
10-#11	1.08	MA	16569	4397	23842	3689	28111	3001	29820	2502	30845	1768	37035	1564	17792
3L-4S		MI	15908	4397	22982	3689	26948	3011	28411	2499	28951	1763	34941	1473	17745
10-#14	1.56	MA	18632	4647	27578	3832	32753	3106	35403	2558	38245	1738	46829	1604	25235
2L-5S		MI	15594	4647	23448	3847	27498	3114	29022	2574	29693	1746	36217	1277	23859
10-#14	1.56	MA	17361	4647	25926	3832	30659	3104	32866	2568	34849	1746	42311	1473	25171
3L-4S		MI	16435	4647	24695	3832	28994	3116	30849	2563	32153	1738	39344	1341	24960
10-#18	2.77	MA	21333	5283	33937	4203	40630	3375	44864	2723	50566	1670	62992	1460	43597
2L-5S		MI	16253	5283	26707	4223	31431	3382	33696	2743	35773	1683	44715	883	38361
10-#18	2.77	MA	19208	5283	31052	4201	36972	3369	40432	2739	44691	1683	55216	1227	43192
3L-4S		MI	17659	5283	28894	4199	34056	3388	36899	2728	40028	1670	50122	993	40652

RECTANGULAR TIED COLUMNS 38" x 40"

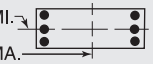
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.05	MA	19193	4613	27637	3847	32495	3132	34588	2603	36083	1835	43465	1717	19056
2E		MI	18183	4613	26310	3831	30831	3119	32763	2592	34057	1823	40934	1700	18014
6-#18	1.58	MA	20640	4903	30703	4029	36384	3265	39299	2687	42363	1817	51799	1671	28181
2L-3S		MI	17318	4903	26310	4011	30831	3245	32763	2692	34057	1816	40934	1417	26447
6-#18	1.58	MA	18282	4903	27637	4027	32495	3259	34588	2704	36083	1831	43465	1437	27989
3L-2S		MI	19535	4903	29195	4013	34489	3252	37195	2676	39931	1803	48710	1650	26609
8-#14	1.18	MA	19662	4685	28312	3919	33551	3187	35954	2642	38096	1853	46260	1735	21545
2L-4S		MI	16394	4685	24060	3905	28073	3185	29507	2638	29875	1841	36102	1456	20216
8-#14	1.18	MA	18290	4685	26558	3919	31327	3185	33259	2653	34471	1860	41427	1603	21521
3E		MI	17336	4685	25292	3905	29737	3173	31524	2643	32571	1849	39069	1588	20352
8-#14	1.18	MA	17291	4685	25253	3920	29562	3198	31121	2650	31595	1853	38248	1472	21359
4L-2S		MI	18627	4685	26943	3905	31832	3175	34061	2633	35968	1841	43587	1719	20365
8-#18	2.11	MA	22042	5194	33769	4210	40272	3398	44010	2771	48643	1800	60133	1625	37253
2L-4S		MI	17083	5194	27037	4190	31573	3398	33662	2765	35269	1783	43615	1133	32956
8-#18	2.11	MA	19731	5194	30703	4209	36384	3392	39299	2788	42363	1813	51799	1391	36946
3E		MI	18672	5194	29195	4193	34489	3378	37195	2776	39931	1796	48710	1367	34874
8-#18	2.11	MA	18046	5194	28413	4208	33289	3414	35549	2779	37379	1800	46330	1157	34902
4L-2S		MI	20846	5194	32079	4195	38147	3385	41627	2760	45806	1783	56485	1600	35147
10-#11	1.03	MA	19255	4598	27321	3878	32396	3158	34598	2626	36339	1866	44002	1760	18843
2L-5S		MI	16075	4598	23123	3876	27075	3154	28332	2630	28343	1862	34022	1519	17674
10-#11	1.03	MA	18289	4598	26095	3879	30841	3157	32715	2635	33797	1872	40601	1669	18845
3L-4S		MI	16676	4598	23993	3865	28119	3155	29607	2622	30072	1857	36220	1564	17793
10-#11	1.03	MA	17586	4598	25184	3879	29609	3167	31222	2633	31782	1867	38360	1578	18798
4L-3S		MI	17339	4598	24853	3865	29282	3146	31016	2625	31966	1862	38314	1655	17829
10-#11	1.03	MA	16950	4598	24262	3890	28503	3166	29871	2641	29943	1872	36017	1532	18658
5L-2S		MI	18249	4598	26008	3864	30747	3147	32791	2617	34354	1857	41496	1746	17821
10-#14	1.48	MA	20498	4849	30066	4021	35775	3262	38648	2690	41721	1845	51092	1712	26753
2L-5S		MI	16361	4849	24465	4021	28671	3258	30218	2696	30812	1839	37493	1368	24065
10-#14	1.48	MA	19143	4849	28312	4022	33551	3260	35954	2701	38096	1852	46260	1581	26690
3L-4S		MI	17205	4849	25712	4007	30167	3260	32044	2686	33272	1832	40619	1432	25038

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

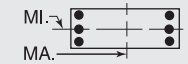
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.48	MA	18158	4849	27006	4022	31786	3273	33815	2697	35220	1845	43081	1450	26479
4L-3S		MI	18134	4849	26943	4007	31832	3248	34061	2690	35968	1839	43587	1563	25223
10-#14	1.48	MA	17265	4849	25685	4037	30200	3271	31879	2708	32595	1852	39744	1385	25429
5L-2S		MI	19409	4849	28595	4007	33926	3250	36599	2680	39364	1832	48105	1695	25274
10-#18	2.63	MA	23409	5485	36836	4392	44161	3531	48721	2855	54922	1782	68467	1579	46297
2L-5S		MI	17019	5485	27734	4396	32607	3524	34891	2864	36889	1776	45984	973	38663
10-#18	2.63	MA	21140	5485	33769	4391	40272	3525	44010	2872	48643	1795	60133	1345	45892
3L-4S		MI	18433	5485	29921	4372	35232	3531	38094	2849	41143	1763	51391	1083	40990
10-#18	2.63	MA	19490	5485	31479	4390	37178	3547	40260	2863	43659	1782	54665	1111	43466
4L-3S		MI	19990	5485	32079	4374	38147	3511	41627	2860	45806	1776	56485	1317	43287
10-#18	2.63	MA	17993	5485	29159	4415	34394	3541	36863	2880	39111	1795	48885	1000	40926
5L-2S		MI	22124	5485	34964	4377	41806	3518	46059	2845	51681	1763	64261	1550	43656
12-#11	1.23	MA	19851	4711	28547	3949	33951	3210	36482	2659	38880	1861	47403	1746	22492
2L-6S		MI	16083	4711	23504	3947	27508	3215	28852	2660	29068	1862	34983	1428	20366
12-#11	1.23	MA	18893	4711	27321	3949	32396	3209	34598	2668	36339	1867	44002	1655	22473
3L-5S		MI	16654	4711	24278	3946	28539	3206	30107	2663	30730	1857	37205	1504	21046
12-#11	1.23	MA	18198	4711	26410	3950	31164	3219	33105	2665	34323	1862	41762	1564	22402
4E		MI	17249	4711	25148	3936	29584	3207	31382	2655	32459	1851	39403	1549	21191
12-#11	1.23	MA	17568	4711	25488	3961	30057	3218	31755	2674	32484	1867	39418	1518	22236
5L-3S		MI	17905	4711	26008	3936	30747	3198	32791	2658	34354	1857	41496	1640	21249
12-#11	1.23	MA	16964	4711	24668	3962	28965	3228	30425	2671	30716	1873	37044	1443	21499
6L-2S		MI	18807	4711	27163	3935	32211	3199	34565	2650	36741	1851	44679	1731	21261
12-#14	1.78	MA	21318	5012	31819	4124	37999	3337	41343	2737	45346	1837	55925	1690	31945
2L-6S		MI	16370	5012	25007	4123	29287	3345	30957	2739	31843	1838	38857	1235	27811
12-#14	1.78	MA	19979	5012	30066	4124	35775	3335	38648	2748	41721	1844	51092	1559	31848
3L-5S		MI	17168	5012	26116	4124	30765	3333	32755	2743	34209	1830	42011	1344	28740
12-#14	1.78	MA	19008	5012	28760	4124	34010	3348	36509	2744	38845	1837	47913	1428	31595
4E		MI	18000	5012	27363	4109	32262	3335	34582	2733	36669	1823	45137	1408	29856
12-#14	1.78	MA	18127	5012	27438	4139	32424	3346	34574	2755	36220	1844	44577	1363	30401
5L-3S		MI	18917	5012	28595	4109	33926	3323	36599	2738	39364	1830	48105	1539	30082
12-#14	1.78	MA	17282	5012	26264	4140	30858	3359	32668	2752	33695	1852	41203	1254	29387
6L-2S		MI	20178	5012	30246	4109	36020	3325	39136	2727	42761	1823	52623	1671	30166
12-#18	3.16	MA	24744	5776	39902	4574	48050	3664	53432	2940	61202	1764	76801	1533	55324
2L-6S		MI	17033	5776	28672	4576	33672	3677	36168	2937	38672	1770	48334	729	43417
12-#18	3.16	MA	22515	5776	36836	4573	44161	3658	48721	2957	54922	1777	68467	1299	54831
3L-5S		MI	18363	5776	30618	4578	36265	3657	39323	2949	42764	1757	53760	923	46865
12-#18	3.16	MA	20897	5776	34545	4571	41067	3680	44972	2947	49939	1764	62999	1065	52074
4E		MI	19749	5776	32806	4554	38890	3664	42526	2933	47018	1743	59167	1033	49069
12-#18	3.16	MA	19430	5776	32226	4597	38283	3674	41574	2964	45391	1777	57219	954	49662
5L-3S		MI	21276	5776	34964	4556	41806	3644	46059	2944	51681	1757	64261	1266	51693
12-#18	3.16	MA	18023	5776	30162	4595	35533	3695	38228	2955	41018	1791	51402	760	45991
6L-2S		MI	23374	5776	37848	4558	45464	3651	50491	2929	57556	1743	72036	1500	52147
14-#11	1.44	MA	20438	4825	29773	4020	35505	3262	38365	2692	41421	1856	50804	1732	26128
2L-7S		MI	16107	4825	23906	4018	27976	3265	29409	2700	29769	1851	36192	1342	23191
14-#11	1.44	MA	19489	4825	28547	4020	33951	3261	36482	2700	38880	1861	47403	1641	26094
3L-6S		MI	16660	4825	24659	4018	28973	3267	30626	2693	31455	1856	38166	1413	23668
14-#11	1.44	MA	18801	4825	27636	4021	32719	3271	34989	2698	36865	1857	45163	1550	26001
4L-5S		MI	17225	4825	25433	4017	30004	3257	31881	2695	33118	1851	40388	1488	24380
14-#11	1.44	MA	18177	4825	26713	4032	31612	3270	33638	2706	35026	1862	42819	1504	25785
5L-4S		MI	17813	4825	26303	4007	31049	3259	33156	2688	34847	1846	42586	1533	24583
14-#11	1.44	MA	17580	4825	25894	4032	30520	3279	32308	2704	33257	1867	40445	1429	25007
6L-3S		MI	18463	4825	27163	4006	32211	3250	34565	2690	36741	1851	44679	1624	24662
14-#11	1.44	MA	16994	4825	25097	4033	29464	3279	31019	2712	31464	1863	38333	1358	24484
7L-2S		MI	19357	4825	28318	4006	33676	3251	36340	2683	39128	1846	47862	1716	24690

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.07	MA	22125	5176	33573	4226	40223	3411	44037	2785	48970	1829	60758	1668	37128
2L-7S		MI	16401	5176	25579	4225	29953	3417	31749	2796	32841	1821	40575	1109	31090
14-#14	2.07	MA	20801	5176	31819	4226	37999	3410	41343	2796	45346	1836	55925	1537	37000
3L-6S		MI	17173	5176	26658	4226	31381	3420	33494	2786	35240	1829	43375	1211	32538
14-#14	2.07	MA	19842	5176	30513	4226	36234	3423	39204	2792	42470	1829	52746	1406	36709
4L-5S		MI	17960	5176	27767	4226	32859	3407	35292	2791	37606	1821	46528	1320	33430
14-#14	2.07	MA	18973	5176	29192	4242	34648	3421	37268	2803	39845	1836	49409	1341	35390
5L-4S		MI	18781	5176	29014	4211	34356	3410	37119	2780	40066	1814	49655	1384	34671
14-#14	2.07	MA	18140	5176	28017	4242	33082	3434	35362	2799	37320	1844	46036	1232	34414
6L-3S		MI	19687	5176	30246	4211	36020	3397	39136	2785	42761	1821	52623	1515	34933
14-#14	2.07	MA	17323	5176	26874	4242	31569	3432	33514	2810	34760	1836	43038	1130	32865
7L-2S		MI	20933	5176	31897	4212	38115	3400	41673	2775	46158	1814	57141	1647	35047
14-#18	3.68	MA	23861	6067	39902	4754	48050	3791	53432	3041	61202	1759	76801	1253	63766
3L-6S		MI	18371	6067	31557	4757	37330	3810	40600	3022	44547	1750	56110	679	51516
14-#18	3.68	MA	22273	6067	37612	4753	44955	3813	49683	3031	56218	1746	71333	1019	60718
4L-5S		MI	19676	6067	33503	4760	39923	3790	43755	3033	48638	1737	61535	873	55043
14-#18	3.68	MA	20834	6067	35292	4778	42171	3807	46285	3048	51670	1759	65553	907	58420
5L-4S		MI	21036	6067	35690	4735	42548	3797	46958	3017	52893	1723	66942	983	57184
14-#18	3.68	MA	19454	6067	33229	4777	39422	3828	42939	3039	47297	1773	59736	714	54626
6L-3S		MI	22536	6067	37848	4738	45464	3777	50491	3028	57556	1737	72036	1216	60093
16-#11	1.64	MA	21018	4938	30999	4091	37060	3314	40249	2725	43962	1851	54206	1718	29759
2L-8S		MI	16139	4938	24319	4089	28465	3316	29964	2731	30530	1851	37323	1275	25657
16-#11	1.64	MA	20077	4938	29773	4091	35505	3313	38365	2733	41421	1856	50804	1627	29709
3L-7S		MI	16680	4938	25061	4089	29441	3317	31183	2733	32157	1845	39375	1327	26513
16-#11	1.64	MA	19395	4938	28861	4092	34273	3323	36872	2731	39406	1851	48564	1536	29597
4L-6S		MI	17228	4938	25814	4088	30438	3318	32401	2726	33842	1851	41349	1398	26977
16-#11	1.64	MA	18778	4938	27939	4103	33167	3322	35522	2739	37567	1857	46221	1490	29270
5E		MI	17787	4938	26588	4088	31469	3309	33656	2728	35505	1845	43571	1473	27659
16-#11	1.64	MA	18186	4938	27120	4103	32074	3331	34192	2737	35798	1862	43846	1415	28523
6L-4S		MI	18370	4938	27458	4078	32514	3311	34931	2721	37234	1840	45768	1518	27971
16-#11	1.64	MA	17607	4938	26322	4104	31019	3331	32903	2745	34005	1857	41734	1344	28014
7L-3S		MI	19014	4938	28318	4077	33676	3301	36340	2723	39128	1845	47862	1609	28069
16-#11	1.64	MA	17035	4938	25537	4104	29985	3330	31611	2743	32275	1863	39546	1291	27095
8L-2S		MI	19900	4938	29473	4077	35141	3303	38114	2716	41516	1840	51045	1700	28113
16-#14	2.37	MA	22919	5340	35326	4328	42447	3486	46731	2832	52595	1821	65590	1646	42303
2L-8S		MI	16448	5340	26167	4327	30648	3490	32539	2839	33923	1820	42174	1010	34363
16-#14	2.37	MA	21610	5340	33573	4328	40223	3484	44037	2843	48970	1828	60758	1515	42145
3L-7S		MI	17200	5340	27230	4328	32047	3492	34287	2844	36238	1812	45093	1085	35758
16-#14	2.37	MA	20663	5340	32267	4329	38458	3498	41898	2839	46094	1821	57579	1384	41822
4L-6S		MI	17962	5340	28310	4328	33476	3495	36031	2833	38637	1820	47893	1187	37274
16-#14	2.37	MA	19805	5340	30945	4344	36872	3496	39962	2850	43469	1828	54242	1319	40392
5E		MI	18739	5340	29419	4328	34953	3482	37830	2838	41003	1812	51046	1296	38134
16-#14	2.37	MA	18983	5340	29771	4344	35306	3509	38056	2846	40945	1836	50868	1210	39450
6L-4S		MI	19550	5340	30666	4313	36450	3485	39656	2828	43463	1805	54173	1360	39484
16-#14	2.37	MA	18177	5340	28627	4345	33793	3507	36208	2857	38385	1828	47871	1108	37835
7L-3S		MI	20445	5340	31897	4314	38115	3472	41673	2832	46158	1812	57141	1491	39778
16-#14	2.37	MA	17381	5340	27501	4345	32310	3506	34356	2854	35915	1836	44755	1032	36345
8L-2S		MI	21677	5340	33549	4314	40209	3475	44210	2822	49555	1805	61659	1623	39921
16-#18	4.21	MA	23623	6357	40678	4935	48844	3946	54394	3116	62498	1728	79667	973	69393
4L-6S		MI	19682	6357	34441	4939	40989	3943	45032	3106	50422	1730	63885	629	59639
16-#18	4.21	MA	22209	6357	38358	4960	46060	3940	50996	3133	57950	1742	73887	861	66992
5E		MI	20963	6357	36387	4941	43581	3923	48187	3117	54513	1717	69311	823	63039
16-#18	4.21	MA	20854	6357	36295	4959	43311	3961	47650	3123	53577	1755	68071	668	63285
6L-4S		MI	22299	6357	38575	4917	46206	3930	51390	3102	58768	1704	74718	933	65329
18-#11	1.85	MA	21590	5052	32224	4161	38615	3366	42132	2758	46503	1846	57607	1704	33384
2L-9S		MI	16179	5052	24656	4170	28923	3377	30538	2771	31306	1850	38490	1200	28173
18-#11	1.85	MA	20657	5052	30999	4162	37060	3365	40249	2766	43962	1851	54206	1613	33319
3L-8S		MI	16711	5052	25474	4160	29929	3368	31738	2763	32917	1845	40505	1259	28941

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

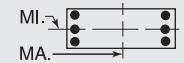
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.85	MA	19982	5052	30087	4163	35828	3374	38756	2764	41947	1846	51965	1522	33190
4L-7S		MI	17247	5052	26216	4160	30906	3369	32958	2766	34544	1840	42557	1311	29820
18-#11	1.85	MA	19371	5052	29165	4174	34721	3374	37405	2772	40108	1852	49622	1476	32764
5L-6S		MI	17789	5052	26969	4159	31903	3370	34175	2758	36230	1845	44532	1383	30292
18-#11	1.85	MA	18785	5052	28346	4174	33629	3383	36075	2770	38339	1857	47247	1401	32046
6L-5S		MI	18343	5052	27743	4159	32934	3361	35431	2761	37892	1840	46753	1458	30948
18-#11	1.85	MA	18212	5052	27548	4175	32574	3382	34786	2778	36546	1852	45136	1330	31542
7L-4S		MI	18920	5052	28613	4148	33979	3362	36706	2754	39621	1835	48951	1503	31357
18-#11	1.85	MA	17645	5052	26763	4175	31539	3382	33494	2776	34816	1858	42947	1277	30587
8L-3S		MI	19558	5052	29473	4148	35141	3353	38114	2756	41516	1840	51045	1594	31472
18-#11	1.85	MA	17082	5052	25896	4186	30474	3391	32223	2784	33103	1863	40792	1218	29764
9L-2S		MI	20437	5052	30628	4148	36606	3355	39889	2749	43903	1835	54228	1685	31529
18-#14	2.66	MA	22407	5503	35326	4431	42447	3559	46731	2890	52595	1820	65590	1493	47287
3L-8S		MI	17243	5503	27818	4430	32742	3565	35076	2886	37320	1811	46692	986	38995
18-#14	2.66	MA	21471	5503	34021	4431	40682	3572	44592	2887	49719	1813	62411	1362	46933
4L-7S		MI	17987	5503	28881	4430	34142	3567	36824	2891	39635	1803	49611	1060	40437
18-#14	2.66	MA	20624	5503	32699	4446	39096	3571	42657	2898	47094	1820	59075	1297	45405
5L-6S		MI	18739	5503	29961	4430	35570	3570	38568	2881	42034	1811	52411	1163	42001
18-#14	2.66	MA	19812	5503	31524	4447	37530	3584	40751	2894	44570	1827	55701	1188	44492
6L-5S		MI	19507	5503	31070	4430	37048	3557	40367	2885	44399	1803	55564	1272	42848
18-#14	2.66	MA	19017	5503	30381	4447	36017	3582	38902	2905	42010	1820	52703	1086	42815
7L-4S		MI	20307	5503	32317	4416	38544	3559	42194	2875	46859	1796	58691	1336	44295
18-#14	2.66	MA	18231	5503	29255	4447	34534	3580	37051	2901	39540	1827	49588	1010	41279
8L-3S		MI	21191	5503	33549	4416	40209	3547	44210	2880	49555	1803	61659	1467	44620
18-#14	2.66	MA	17450	5503	28012	4462	33006	3594	35228	2912	37094	1835	46528	925	39544
9L-2S		MI	22411	5503	35200	4416	42303	3549	46748	2869	52952	1796	66176	1599	44789
18-#18	4.74	MA	23560	6648	41424	5142	49949	4073	55708	3217	64230	1724	82221	815	75548
5L-6S		MI	20968	6648	37326	5121	44647	4076	49464	3190	56297	1710	71661	578	67782
18-#18	4.74	MA	22228	6648	39361	5141	47199	4094	52362	3207	59856	1737	76405	622	71964
6L-5S		MI	22228	6648	39272	5123	47240	4056	52619	3201	60388	1697	77087	773	71063
20-#11	2.05	MA	22156	5165	33450	4232	40169	3417	44016	2791	49044	1841	61008	1690	37006
2L-10S		MI	16223	5165	25072	4241	29418	3428	31107	2801	32037	1839	39718	1119	30456
20-#11	2.05	MA	21230	5165	32224	4233	38615	3417	42132	2799	46503	1846	57607	1599	36927
3L-9S		MI	16748	5165	25811	4241	30388	3429	32313	2804	33694	1845	41673	1185	31429
20-#11	2.05	MA	20561	5165	31313	4234	37383	3426	40639	2797	44488	1841	55367	1508	36781
4L-8S		MI	17275	5165	26629	4231	31394	3420	33513	2796	35305	1839	43688	1244	32230
20-#11	2.05	MA	19956	5165	30391	4244	36276	3425	39289	2805	42649	1846	53023	1462	36266
5L-7S		MI	17806	5165	27371	4230	32371	3421	34732	2799	36931	1834	45740	1296	33085
20-#11	2.05	MA	19376	5165	29572	4245	35184	3435	37959	2803	40880	1852	50649	1387	35573
6E		MI	18343	5165	28124	4230	33367	3422	35950	2791	38617	1839	47714	1367	33612
20-#11	2.05	MA	18808	5165	28774	4246	34128	3434	36670	2811	39087	1847	48537	1316	35015
7L-5S		MI	18891	5165	28898	4230	34399	3413	37205	2794	40280	1834	49936	1443	34244
20-#11	2.05	MA	18247	5165	27989	4246	33094	3433	35378	2809	37357	1852	46348	1263	34085
8L-4S		MI	19463	5165	29768	4219	35443	3414	38480	2786	42009	1829	52134	1488	34740
20-#11	2.05	MA	17690	5165	27122	4257	32028	3443	34107	2817	35644	1858	44194	1205	33229
9L-3S		MI	20095	5165	30628	4219	36606	3405	39889	2789	43903	1834	54228	1579	34871
20-#11	2.05	MA	17135	5165	26340	4258	31001	3442	32830	2815	33882	1853	41965	1124	32174
10L-2S		MI	20967	5165	31783	4219	38070	3406	41663	2781	46290	1829	57410	1670	34942
20-#14	2.96	MA	22269	5667	35774	4533	42906	3647	47287	2934	53344	1804	67244	1340	52000
4L-8S		MI	18027	5667	29470	4532	34836	3639	37613	2934	40717	1801	51210	962	43636
20-#14	2.96	MA	21432	5667	34453	4548	41320	3646	45351	2945	50719	1812	63907	1275	50427
5L-7S		MI	18761	5667	30533	4532	36236	3642	39361	2938	43032	1794	54129	1036	45126
20-#14	2.96	MA	20629	5667	33278	4549	39754	3659	43445	2941	48194	1819	60534	1166	49456
6E		MI	19504	5667	31613	4532	37664	3644	41106	2928	45431	1801	56928	1139	46642

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis

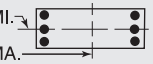


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.96	MA	19844	5667	32134	4549	38241	3657	41597	2952	45635	1812	57536	1064	47804
7L-5S		MI	20263	5667	32721	4533	39142	3632	42904	2933	47796	1794	60082	1248	47572
20-#14	2.96	MA	19068	5667	31008	4549	36758	3655	39745	2948	43165	1819	54420	988	46223
8L-4S		MI	21054	5667	33968	4518	40639	3634	44731	2922	50256	1787	63208	1312	49006
20-#14	2.96	MA	18296	5667	29765	4565	35230	3668	37923	2959	40719	1827	51361	903	44527
9L-3S		MI	21928	5667	35200	4518	42303	3622	46748	2927	52952	1794	66176	1443	49458
20-#18	5.26	MA	23580	6939	42427	5322	51088	4227	57073	3292	66136	1719	84739	575	80661
6E		MI	22233	6939	40210	5302	48305	4209	53896	3274	62172	1690	79436	528	75944
22-#11	2.26	MA	21798	5279	33450	4304	40169	3469	44016	2832	49044	1841	61008	1585	40532
3L-10S		MI	16791	5279	26227	4312	30882	3480	32881	2834	34424	1834	42901	1104	33739
22-#11	2.26	MA	21134	5279	32539	4304	38937	3478	42523	2830	47029	1836	58768	1494	40371
4L-9S		MI	17310	5279	26966	4312	31852	3481	34087	2837	36081	1839	44856	1170	34691
22-#11	2.26	MA	20535	5279	31617	4315	37831	3477	41172	2838	45190	1841	56425	1448	39775
5L-8S		MI	17832	5279	27784	4302	32859	3472	35287	2829	37692	1834	46871	1229	35525
22-#11	2.26	MA	19960	5279	30798	4316	36738	3487	39842	2836	43421	1847	54050	1373	39104
6L-7S		MI	18358	5279	28526	4301	33836	3473	36507	2832	39319	1829	48923	1281	36357
22-#11	2.26	MA	19398	5279	30000	4317	35683	3486	38553	2844	41629	1842	51938	1302	38494
7L-6S		MI	18890	5279	29279	4301	34832	3474	37724	2824	41004	1834	50897	1352	36936
22-#11	2.26	MA	18842	5279	29215	4317	34649	3485	37261	2842	39898	1847	49750	1249	37588
8L-5S		MI	19433	5279	30053	4301	35863	3465	38980	2827	42667	1829	53119	1427	37547
22-#11	2.26	MA	18290	5279	28348	4328	33583	3495	35990	2850	38185	1853	47595	1191	36700
9L-4S		MI	20000	5279	30923	4290	36908	3466	40255	2819	44396	1824	55317	1472	38121
22-#11	2.26	MA	17740	5279	27566	4329	32556	3494	34714	2848	36423	1848	45366	1110	35668
10L-3S		MI	20627	5279	31783	4290	38070	3457	41663	2822	46290	1829	57410	1563	38268
22-#14	3.26	MA	22228	5830	36206	4651	43544	3720	48045	2992	54344	1804	68740	1253	55458
5L-8S		MI	18799	5830	31121	4634	36931	3714	40150	2981	44114	1792	55728	938	48287
22-#14	3.26	MA	21436	5830	35032	4651	41978	3733	46139	2989	51819	1811	65366	1144	54408
6L-7S		MI	19525	5830	32184	4634	38330	3717	41898	2986	46428	1785	58647	1012	49822
22-#14	3.26	MA	20659	5830	33888	4651	40465	3732	44291	3000	49259	1804	62369	1041	52801
7L-6S		MI	20259	5830	33264	4635	39759	3719	43643	2975	48827	1792	61446	1115	51295
22-#14	3.26	MA	19892	5830	32762	4652	38982	3730	42439	2996	46789	1811	59253	966	51175
8L-5S		MI	21009	5830	34373	4635	41236	3707	45442	2980	51193	1785	64600	1224	52304
22-#14	3.26	MA	19131	5830	31519	4667	37454	3743	40617	3007	44344	1819	56193	881	49460
9L-4S		MI	21792	5830	35620	4620	42733	3709	47268	2970	53653	1777	67726	1288	53683
24-#11	2.46	MA	21701	5392	33765	4375	40492	3530	44406	2862	49570	1831	62169	1480	43959
4L-10S		MI	17351	5392	27382	4383	32347	3531	34656	2867	36812	1828	46084	1089	37027
24-#11	2.46	MA	21107	5392	32843	4386	39385	3529	43055	2871	47731	1836	59826	1434	43290
5L-9S		MI	17866	5392	28120	4383	33317	3533	35862	2870	38468	1833	48039	1155	37959
24-#11	2.46	MA	20538	5392	32023	4387	38293	3539	41726	2869	45963	1842	57451	1359	42640
6L-8S		MI	18383	5392	28939	4372	34324	3523	37062	2862	40079	1828	50054	1214	38825
24-#11	2.46	MA	19980	5392	31226	4387	37238	3538	40437	2877	44170	1837	55339	1288	41979
7E		MI	18904	5392	29681	4372	35300	3525	38282	2865	41706	1823	52106	1266	39635
24-#11	2.46	MA	19430	5392	30441	4388	36203	3537	39145	2875	42440	1842	53151	1235	41096
8L-6S		MI	19431	5392	30434	4372	36297	3526	39499	2857	43392	1828	54080	1337	40264
24-#11	2.46	MA	18883	5392	29574	4399	35138	3547	37874	2883	40726	1848	50996	1177	40177
9L-5S		MI	19970	5392	31208	4372	37328	3517	40754	2860	45054	1823	56302	1412	40856
24-#11	2.46	MA	18339	5392	28792	4400	34111	3546	36597	2881	38964	1843	48768	1096	39165
10L-4S		MI	20532	5392	32078	4361	38373	3518	42029	2852	46783	1818	58500	1457	41501
24-#14	3.55	MA	22232	5994	36785	4753	44202	3808	48834	3036	55444	1803	70199	1122	59369
6L-8S		MI	19562	5994	32772	4736	39025	3789	42688	3028	47511	1783	60246	914	52946
24-#14	3.55	MA	21464	5994	35641	4754	42689	3807	46985	3047	52884	1796	67201	1019	57806
7E		MI	20279	5994	33835	4737	40425	3792	44436	3033	49825	1776	63165	988	54526
24-#14	3.55	MA	20706	5994	34516	4754	41206	3805	45134	3043	50414	1803	64086	944	56089
8L-6S		MI	21005	5994	34915	4737	41853	3794	46180	3023	52224	1783	65964	1091	55957
24-#14	3.55	MA	19953	5994	33273	4769	39678	3818	43311	3054	47968	1811	61026	859	54392
9L-5S		MI	21747	5994	36024	4737	43331	3781	47979	3027	54590	1776	69117	1200	57043

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

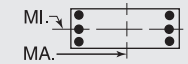
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.00	MA	21057	4814	30085	4036	35454	3287	37732	2735	39347	1940	47407	1822	20136
2E		MI	18955	4814	27337	4005	32007	3262	33958	2713	35172	1916	42203	1791	18052
6-#18	1.50	MA	22605	5105	33333	4218	39573	3420	42723	2819	46032	1924	56300	1780	29801
2L-3S		MI	18088	5105	27337	4184	32007	3388	33958	2813	35172	1909	42203	1507	26520
6-#18	1.50	MA	20098	5105	30085	4217	35454	3416	37732	2837	39347	1938	47407	1546	29609
3L-2S		MI	20312	5105	30222	4187	35665	3395	38390	2797	41047	1896	49979	1740	26655
8-#14	1.13	MA	21553	4887	30792	4108	36562	3342	39168	2774	41442	1957	50350	1840	22760
2L-4S		MI	17161	4887	25077	4079	29246	3329	30703	2760	30994	1935	37377	1547	20282
8-#14	1.13	MA	20095	4887	28936	4109	34209	3341	36316	2786	37595	1965	45203	1709	22736
3E		MI	18106	4887	26309	4080	30910	3317	32720	2765	33690	1942	40345	1678	20396
8-#14	1.13	MA	19037	4887	27557	4110	32344	3355	34056	2783	34544	1957	41812	1577	22574
4L-2S		MI	19400	4887	27960	4080	33004	3319	35257	2755	37087	1935	44863	1810	20399
8-#18	2.01	MA	24106	5396	36581	4399	43692	3553	47713	2903	52717	1908	65194	1737	39413
2L-4S		MI	17852	5396	28064	4364	32749	3541	34857	2886	36384	1876	44885	1223	33295
8-#18	2.01	MA	21648	5396	33333	4399	39573	3549	42723	2922	46032	1922	56300	1504	39106
3E		MI	19447	5396	30222	4366	35665	3521	38390	2897	41047	1889	49979	1457	34957
8-#18	2.01	MA	19860	5396	30911	4399	36300	3571	38757	2914	40728	1908	50457	1270	37223
4L-2S		MI	21629	5396	33106	4368	39323	3528	42822	2882	46922	1876	57754	1690	35199
10-#14	1.41	MA	22445	5050	32648	4210	38916	3417	42019	2822	45289	1949	55498	1820	28272
2L-5S		MI	17128	5050	25481	4196	29843	3402	31414	2818	31931	1933	38768	1459	24266
10-#14	1.41	MA	21006	5050	30792	4211	36562	3416	39168	2834	41442	1957	50350	1688	28209
3L-4S		MI	17974	5050	26729	4182	31340	3404	33240	2808	34391	1926	41895	1523	25112
10-#14	1.41	MA	19962	5050	29412	4212	34697	3430	36907	2830	38391	1950	46960	1557	27997
4L-3S		MI	18907	5050	27960	4182	33004	3392	35257	2812	37087	1933	44863	1654	25272
10-#14	1.41	MA	19016	5050	28016	4228	33022	3429	34862	2842	35606	1958	43413	1491	27012
5L-2S		MI	20186	5050	29612	4182	35099	3394	37794	2802	40484	1926	49381	1786	25313
10-#18	2.51	MA	25568	5687	39829	4581	47811	3686	52704	2988	59401	1892	74087	1695	48997
2L-5S		MI	17786	5687	28761	4570	33782	3667	36086	2986	38004	1870	47253	1063	38954
10-#18	2.51	MA	23155	5687	36581	4581	43692	3682	47713	3006	52717	1906	65194	1461	48592
3L-4S		MI	19206	5687	30948	4545	36407	3674	39289	2970	42259	1856	52660	1173	41320
10-#18	2.51	MA	21403	5687	34159	4581	40419	3704	43747	2998	47412	1892	59350	1228	46308
4L-3S		MI	20770	5687	33106	4548	39323	3654	42822	2981	46922	1870	57754	1407	43378
10-#18	2.51	MA	19815	5687	31707	4607	37476	3700	40155	3016	42571	1906	53197	1114	43507
5L-2S		MI	22914	5687	35991	4550	42981	3661	47254	2966	52796	1856	65530	1640	43714
12-#11	1.17	MA	21751	4913	31037	4138	36980	3365	39720	2791	42219	1963	51548	1851	23755
2L-6S		MI	16850	4913	24516	4122	28679	3359	30047	2783	30189	1956	36262	1519	20508
12-#11	1.17	MA	20734	4913	29740	4139	35336	3365	37728	2800	39531	1969	47928	1760	23737
3L-5S		MI	17422	4913	25289	4122	29711	3350	31303	2785	31851	1951	38484	1595	21115
12-#11	1.17	MA	19998	4913	28777	4140	34034	3375	36150	2798	37402	1964	45541	1669	23666
4E		MI	18019	4913	26160	4111	30755	3351	32578	2778	33580	1946	40682	1640	21240
12-#11	1.17	MA	19332	4913	27803	4151	32865	3375	34724	2807	35460	1970	43052	1623	23499
5L-3S		MI	18676	4913	27020	4111	31918	3342	33986	2780	35474	1951	42776	1731	21288
12-#11	1.17	MA	18692	4913	26939	4152	31712	3385	33320	2805	33592	1977	40525	1548	22786
6L-2S		MI	19581	4913	28175	4111	33383	3343	35761	2773	37862	1946	45958	1822	21293
12-#14	1.69	MA	23322	5214	34504	4312	41270	3492	44870	2869	49136	1942	60646	1800	33768
2L-6S		MI	17136	5214	26024	4298	30460	3489	32152	2861	32962	1932	40133	1326	28001
12-#14	1.69	MA	21900	5214	32648	4313	38916	3491	42019	2881	45289	1950	55498	1668	33671
3L-5S		MI	17937	5214	27133	4298	31938	3476	33951	2865	35328	1924	43286	1435	28937
12-#14	1.69	MA	20870	5214	31268	4314	37051	3505	39758	2878	42238	1942	52108	1537	33418
4E		MI	18772	5214	28380	4284	33434	3479	35777	2855	37788	1917	46413	1499	29935
12-#14	1.69	MA	19937	5214	29872	4330	35375	3504	37713	2890	39453	1950	48561	1471	32279
5L-3S		MI	19693	5214	29612	4284	35099	3466	37794	2860	40484	1924	49381	1630	30135

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

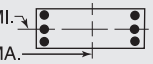


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.69	MA	19041	5214	28632	4331	33721	3517	35700	2886	36776	1958	44967	1363	31168
6L-2S		MI	20957	5214	31263	4284	37193	3469	40332	2849	43880	1917	53899	1762	30208
12-#18	3.01	MA	26998	5977	43077	4763	51931	3819	57694	3072	66086	1877	82980	1653	58564
2L-6S		MI	17797	5977	29699	4749	34848	3820	37363	3059	39788	1863	49603	819	43872
12-#18	3.01	MA	24625	5977	39829	4763	47811	3815	52704	3090	59401	1890	74087	1419	58071
3L-5S		MI	19134	5977	31646	4751	37441	3800	40518	3070	43879	1850	55029	1013	47151
12-#18	3.01	MA	22908	5977	37407	4762	44538	3837	48737	3082	54097	1877	68244	1185	55437
4E		MI	20527	5977	33833	4727	40066	3807	43721	3054	48134	1836	60436	1123	49391
12-#18	3.01	MA	21351	5977	34955	4789	41595	3833	45146	3100	49256	1890	62090	1072	52773
5L-3S		MI	22062	5977	35991	4729	42981	3787	47254	3065	52796	1850	65530	1357	51790
12-#18	3.01	MA	19858	5977	32774	4788	38689	3856	41609	3092	44600	1903	55883	878	49065
6L-2S		MI	24171	5977	38875	4732	46640	3794	51686	3050	58671	1836	73305	1590	52208
14-#11	1.37	MA	22378	5026	32334	4209	38625	3417	41713	2824	44907	1958	55168	1838	27603
2L-7S		MI	16873	5026	24918	4193	29148	3410	30605	2823	30890	1945	37471	1433	23334
14-#11	1.37	MA	21370	5026	31037	4210	36980	3417	39720	2833	42219	1964	51548	1747	27568
3L-6S		MI	17428	5026	25671	4193	30144	3411	31822	2815	32576	1950	39445	1504	23809
14-#11	1.37	MA	20641	5026	30074	4210	35678	3427	38143	2831	40090	1959	49161	1656	27476
4L-5S		MI	17994	5026	26444	4193	31175	3402	33077	2818	34239	1945	41667	1580	24489
14-#11	1.37	MA	19981	5026	29100	4222	34510	3427	36716	2840	38148	1965	46672	1610	27286
5L-4S		MI	18585	5026	27315	4182	32220	3403	34352	2810	35968	1940	43865	1625	24636
14-#11	1.37	MA	19349	5026	28235	4223	33356	3436	35312	2838	36280	1971	44144	1535	26500
6L-3S		MI	19237	5026	28175	4182	33383	3394	35761	2813	37862	1945	45958	1716	24704
14-#11	1.37	MA	18729	5026	27394	4224	32242	3436	33951	2847	34387	1967	41895	1464	25932
7L-2S		MI	20133	5026	29330	4182	34847	3395	37536	2805	40249	1940	49141	1807	24726
14-#14	1.97	MA	24185	5378	36360	4415	43623	3567	47722	2917	52983	1934	65794	1779	39254
2L-7S		MI	17166	5378	26596	4400	31126	3561	32945	2918	33960	1915	41851	1199	31390
14-#14	1.97	MA	22778	5378	34504	4416	41270	3566	44870	2928	49136	1942	60646	1648	39126
3L-6S		MI	17941	5378	27675	4400	32554	3564	34689	2908	36359	1923	44651	1302	32726
14-#14	1.97	MA	21761	5378	33124	4416	39404	3580	42610	2925	46085	1935	57256	1517	38835
4L-5S		MI	18732	5378	28784	4401	34032	3551	36488	2913	38725	1915	47804	1411	33624
14-#14	1.97	MA	20840	5378	31728	4432	37729	3578	40565	2937	43301	1943	53708	1451	37563
5L-4S		MI	19557	5378	30031	4386	35529	3554	38315	2902	41185	1908	50931	1475	34754
14-#14	1.97	MA	19957	5378	30487	4433	36075	3592	38552	2934	40623	1951	50115	1342	36494
6L-3S		MI	20466	5378	31263	4386	37193	3541	40332	2907	43880	1915	53899	1606	34990
14-#14	1.97	MA	19092	5378	29280	4434	34477	3591	36600	2946	37908	1943	46919	1240	34969
7L-2S		MI	21717	5378	32914	4386	39287	3544	42869	2897	47277	1908	58417	1738	35092
14-#18	3.51	MA	26065	6268	43077	4944	51931	3948	57694	3174	66086	1874	82980	1377	67546
3L-6S		MI	19139	6268	32584	4931	38506	3953	41795	3143	45662	1843	57379	769	51963
14-#18	3.51	MA	24379	6268	40655	4944	48657	3970	53728	3166	60782	1861	77137	1143	64604
4L-5S		MI	20452	6268	34530	4933	41099	3933	44950	3154	49754	1830	62805	963	55370
14-#18	3.51	MA	22851	6268	38203	4970	45714	3966	50136	3185	55941	1874	70984	1029	62060
5L-4S		MI	21820	6268	36717	4909	43724	3940	48153	3139	54008	1817	68211	1073	57498
14-#18	3.51	MA	21386	6268	36022	4970	42808	3989	46599	3177	51285	1887	64776	836	58229
6L-3S		MI	23329	6268	38875	4911	46640	3920	51686	3150	58671	1830	73305	1306	60196
14-#18	3.51	MA	19951	6268	33899	4970	40000	3984	43169	3195	46564	1874	59265	653	54326
7L-2S		MI	25404	6268	41760	4914	50298	3927	56118	3134	64546	1817	81081	1540	60689
16-#11	1.56	MA	22997	5140	33630	4280	40269	3469	43705	2857	47595	1952	58788	1826	31444
2L-8S		MI	16905	5140	25331	4264	29636	3460	31159	2853	31651	1945	38602	1366	25879
16-#11	1.56	MA	21998	5140	32334	4280	38625	3469	41713	2866	44907	1958	55168	1735	31393
3L-7S		MI	17448	5140	26073	4264	30612	3462	32379	2856	33277	1940	40654	1418	26656
16-#11	1.56	MA	21276	5140	31371	4281	37323	3479	40135	2864	42778	1954	52781	1644	31282
4L-6S		MI	17997	5140	26826	4264	31609	3463	33597	2848	34963	1945	42628	1489	27117
16-#11	1.56	MA	20622	5140	30397	4293	36154	3478	38709	2873	40836	1960	50292	1597	31049
5E		MI	18559	5140	27599	4264	32640	3454	34852	2851	36626	1940	44850	1564	27813
16-#11	1.56	MA	19996	5140	29532	4294	35001	3488	37305	2871	38968	1966	47764	1522	30222
6L-4S		MI	19144	5140	28470	4253	33685	3455	36127	2843	38355	1935	47047	1609	28027
16-#11	1.56	MA	19383	5140	28690	4294	33887	3488	35944	2880	37075	1962	45515	1451	29670
7L-3S		MI	19790	5140	29330	4253	34847	3446	37536	2846	40249	1940	49141	1700	28114

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

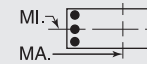


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.56	MA	18777	5140	27862	4295	32795	3488	34580	2878	35249	1968	43190	1398	28775
8L-2S		MI	20679	5140	30485	4253	36312	3447	39310	2838	42636	1935	52324	1791	28150
16-#14	2.26	MA	25034	5541	38215	4517	45977	3642	50573	2964	56830	1927	70941	1759	44733
2L-8S		MI	17212	5541	27184	4502	31820	3634	33734	2961	35042	1914	43450	1101	34773
16-#14	2.26	MA	23642	5541	36360	4518	43623	3641	47722	2976	52983	1935	65794	1628	44575
3L-7S		MI	17968	5541	28247	4503	33220	3636	35482	2966	37357	1906	46369	1175	36054
16-#14	2.26	MA	22638	5541	34980	4519	41758	3654	45461	2973	49932	1928	62403	1496	44252
4L-6S		MI	18733	5541	29327	4503	34648	3639	37227	2955	39756	1914	49169	1278	37461
16-#14	2.26	MA	21729	5541	33584	4534	40082	3653	43416	2984	47148	1935	58856	1431	42860
5E		MI	19514	5541	30435	4503	36126	3626	39025	2960	42122	1906	52322	1387	38325
16-#14	2.26	MA	20857	5541	32343	4535	38429	3667	41403	2981	44470	1943	55262	1322	41828
6L-4S		MI	20328	5541	31683	4488	37623	3628	40852	2950	44582	1899	55449	1451	39571
16-#14	2.26	MA	20003	5541	31136	4536	36831	3666	39451	2993	41755	1936	52066	1220	40236
7L-3S		MI	21227	5541	32914	4488	39287	3616	42869	2954	47277	1906	58417	1582	39839
16-#14	2.26	MA	19159	5541	29947	4537	35265	3665	37495	2990	39136	1944	48754	1144	38778
8L-2S		MI	22465	5541	34566	4489	41382	3618	45406	2944	50674	1899	62934	1713	39968
16-#18	4.01	MA	25821	6559	43903	5126	52777	4103	58718	3251	67466	1845	86030	1101	73802
4L-6S		MI	20454	6559	35468	5112	42164	4086	46227	3227	51537	1823	65154	719	60077
16-#18	4.01	MA	24321	6559	41450	5152	49834	4099	55126	3269	62625	1858	79877	987	71367
5E		MI	21744	6559	37415	5115	44757	4066	49382	3238	55629	1810	70580	913	63561
16-#18	4.01	MA	22883	6559	39270	5152	46928	4122	51590	3261	57970	1871	73669	793	67416
6L-4S		MI	23089	6559	39602	5091	47382	4073	52585	3223	59883	1797	75987	1023	65637
16-#18	4.01	MA	21474	6559	37147	5152	44119	4117	48159	3279	53249	1858	68158	611	63443
7L-3S		MI	24572	6559	41760	5093	50298	4053	56118	3234	64546	1810	81081	1256	68598
18-#11	1.76	MA	23609	5253	34927	4350	41914	3521	45698	2890	50284	1947	62408	1813	35280
2L-9S		MI	16944	5253	25667	4346	30094	3521	31734	2894	32427	1944	39769	1292	28480
18-#11	1.76	MA	22617	5253	33630	4351	40269	3521	43705	2899	47595	1953	58788	1722	35215
3L-8S		MI	17478	5253	26486	4335	31100	3512	32934	2886	34038	1939	41785	1350	29160
18-#11	1.76	MA	21902	5253	32667	4352	38968	3531	42128	2897	45466	1949	56401	1631	35085
4L-7S		MI	18016	5253	27227	4335	32077	3513	34154	2889	35665	1934	43836	1403	29982
18-#11	1.76	MA	21255	5253	31694	4364	37799	3530	40701	2906	43524	1955	53912	1585	34747
5L-6S		MI	18560	5253	27981	4335	33074	3515	35371	2881	37351	1939	45811	1474	30431
18-#11	1.76	MA	20635	5253	30829	4364	36646	3540	39297	2904	41656	1961	51384	1509	33951
6L-5S		MI	19116	5253	28754	4335	34105	3506	36626	2884	39013	1934	48033	1549	31100
18-#11	1.76	MA	20027	5253	29987	4365	35532	3540	37936	2913	39763	1957	49135	1439	33412
7L-4S		MI	19696	5253	29625	4324	35150	3507	37901	2876	40742	1929	50230	1594	31416
18-#11	1.76	MA	19427	5253	29158	4366	34440	3539	36572	2911	37937	1963	46810	1385	32473
8L-3S		MI	20336	5253	30485	4324	36312	3498	39310	2879	42636	1934	52324	1685	31519
18-#11	1.76	MA	18831	5253	28243	4378	33315	3549	35231	2919	36128	1969	44515	1327	31683
9L-2S		MI	21218	5253	31640	4323	37777	3499	41085	2871	45024	1929	55507	1776	31569
18-#14	2.54	MA	24494	5705	38215	4620	45977	3715	50573	3023	56830	1927	70941	1608	50021
3L-8S		MI	18010	5705	28835	4605	33915	3708	36271	3008	38439	1904	47968	1077	39399
18-#14	2.54	MA	23501	5705	36836	4621	44112	3729	48313	3020	53779	1920	67551	1476	49667
4L-7S		MI	18757	5705	29898	4605	35314	3711	38019	3013	40754	1897	50887	1151	40729
18-#14	2.54	MA	22603	5705	35439	4637	42436	3728	46268	3032	50995	1928	64004	1410	48170
5L-6S		MI	19512	5705	30978	4605	36743	3713	39764	3003	43153	1904	53686	1254	42202
18-#14	2.54	MA	21743	5705	34199	4637	40782	3742	44254	3029	48317	1936	60410	1302	47170
6L-5S		MI	20284	5705	32087	4605	38220	3701	41563	3007	45518	1897	56840	1363	43038
18-#14	2.54	MA	20900	5705	32992	4638	39184	3741	42302	3040	45602	1929	57214	1200	45513
7L-4S		MI	21089	5705	33334	4590	39717	3703	43389	2997	47978	1890	59966	1427	44385
18-#14	2.54	MA	20066	5705	31803	4639	37619	3739	40347	3037	42983	1936	53902	1123	44009
8L-3S		MI	21977	5705	34566	4591	41382	3691	45406	3002	50674	1897	62934	1558	44683
18-#14	2.54	MA	19239	5705	30490	4655	36005	3753	38422	3049	40389	1944	50640	1039	42108
9L-2S		MI	23203	5705	36217	4591	43476	3693	47943	2992	54071	1890	67452	1689	44838
18-#18	4.51	MA	25765	6850	44698	5334	53953	4232	60117	3353	69310	1842	88770	945	80610
5L-6S		MI	21744	6850	38353	5294	45822	4219	50659	3311	57412	1803	72930	669	68212
18-#18	4.51	MA	24351	6850	42518	5334	51047	4255	56580	3345	64654	1855	82563	751	76623
6L-5S		MI	23013	6850	40299	5296	48415	4199	53814	3322	61504	1790	78356	863	71575
18-#18	4.51	MA	22966	6850	40395	5333	48239	4250	53150	3363	59933	1842	77051	569	72580
7L-4S		MI	24336	6850	42486	5272	51040	4206	57017	3307	65758	1777	83763	973	73802

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis



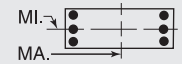
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.95	MA	24213	5367	36224	4421	43558	3573	47690	2923	52972	1942	66028	1800	39112
2L-10S		MI	16988	5367	26083	4417	30589	3572	32303	2924	33158	1934	40997	1210	30744
20-#11	1.95	MA	23230	5367	34927	4422	41914	3573	45698	2931	50284	1948	62408	1709	39033
3L-9S		MI	17514	5367	26822	4417	31559	3573	33508	2927	34814	1939	42952	1276	31733
20-#11	1.95	MA	22521	5367	33964	4423	40612	3582	44120	2930	48154	1944	60021	1618	38887
4L-8S		MI	18043	5367	27641	4406	32565	3564	34709	2919	36425	1934	44967	1335	32448
20-#11	1.95	MA	21880	5367	32990	4434	39443	3582	42693	2938	46212	1950	57532	1572	38454
5L-7S		MI	18576	5367	28382	4406	33542	3565	35928	2922	38052	1929	47019	1387	33311
20-#11	1.95	MA	21265	5367	32126	4435	38290	3592	41289	2937	44345	1956	55004	1497	37684
6E		MI	19116	5367	29136	4406	34538	3567	37146	2914	39738	1934	48994	1458	33750
20-#11	1.95	MA	20664	5367	31284	4436	37176	3592	39928	2945	42451	1952	52755	1426	37157
7L-5S		MI	19667	5367	29909	4405	35570	3557	38401	2917	41401	1929	51215	1534	34395
20-#11	1.95	MA	20070	5367	30455	4437	36084	3591	38565	2944	40625	1958	50430	1372	36177
8L-4S		MI	20241	5367	30780	4395	36614	3559	39676	2909	43130	1923	53413	1579	34801
20-#11	1.95	MA	19479	5367	29540	4448	34959	3601	37223	2952	38816	1964	48135	1314	35363
9L-3S		MI	20876	5367	31640	4395	37777	3550	41085	2912	45024	1929	55507	1670	34920
20-#11	1.95	MA	18892	5367	28715	4449	33875	3601	35875	2951	36956	1959	45763	1234	34208
10L-2S		MI	21751	5367	32795	4394	39242	3551	42859	2904	47411	1923	58690	1761	34983
20-#14	2.82	MA	24353	5868	38691	4723	46465	3804	51164	3067	57626	1913	72699	1456	55082
4L-8S		MI	18796	5868	30486	4707	36009	3783	38809	3056	41836	1895	52486	1053	44036
20-#14	2.82	MA	23466	5868	37295	4739	44790	3803	49119	3079	54842	1920	69152	1390	53489
5L-7S		MI	19534	5868	31550	4707	37409	3786	40557	3060	44151	1888	55405	1127	45414
20-#14	2.82	MA	22615	5868	36055	4740	43136	3817	47106	3076	52164	1928	65558	1282	52519
6E		MI	20281	5868	32629	4707	38837	3788	42301	3050	46550	1895	58204	1230	46950
20-#14	2.82	MA	21783	5868	34847	4741	41538	3815	45154	3088	49449	1921	62362	1179	50799
7L-5S		MI	21044	5868	33738	4707	40315	3776	44100	3055	48915	1888	61358	1339	47759
20-#14	2.82	MA	20959	5868	33659	4741	39972	3814	43198	3085	46830	1929	59049	1103	49250
8L-4S		MI	21839	5868	34985	4693	41811	3778	45926	3045	51375	1880	64484	1402	49199
20-#14	2.82	MA	20142	5868	32346	4757	38359	3828	41274	3096	44236	1937	55788	1019	47390
9L-3S		MI	22718	5868	36217	4693	43476	3766	47943	3049	54071	1888	67452	1534	49524
20-#18	5.01	MA	25794	7140	45766	5515	55166	4388	61571	3429	71339	1839	91456	709	85848
6E		MI	23014	7140	41237	5476	49481	4352	55091	3396	63287	1784	80706	618	76367
20-#18	5.01	MA	24433	7140	43643	5515	52358	4383	58140	3448	66618	1826	85944	526	81734
7L-5S		MI	24263	7140	43183	5478	52073	4332	58246	3407	67378	1770	86131	813	79615
22-#11	2.15	MA	23836	5480	36224	4493	43558	3624	47690	2964	52972	1943	66028	1696	42848
3L-10S		MI	17556	5480	27238	4488	32054	3624	34077	2957	35545	1928	44180	1195	34025
22-#11	2.15	MA	23133	5480	35261	4494	42257	3634	46112	2963	50842	1939	63641	1605	42687
4L-9S		MI	18078	5480	27977	4488	33024	3625	35283	2959	37202	1933	46135	1261	34992
22-#11	2.15	MA	22497	5480	34287	4505	41088	3634	44686	2971	48900	1945	61152	1559	42168
5L-8S		MI	18602	5480	28796	4477	34030	3616	36483	2952	38813	1928	48150	1320	35740
22-#11	2.15	MA	21889	5480	33422	4506	39935	3644	43282	2970	47033	1951	58624	1484	41423
6L-7S		MI	19131	5480	29537	4477	35007	3617	37703	2954	40439	1923	50202	1372	36588
22-#11	2.15	MA	21293	5480	32580	4507	38821	3644	41921	2978	45139	1946	56375	1413	40887
7L-6S		MI	19665	5480	30291	4477	36003	3618	38920	2947	42125	1928	52176	1443	37074
22-#11	2.15	MA	20704	5480	31752	4508	37729	3643	40557	2977	43313	1952	54050	1360	39887
8L-5S		MI	20211	5480	31064	4476	37035	3609	40176	2950	43788	1923	54398	1518	37696
22-#11	2.15	MA	20119	5480	30837	4519	36604	3653	39215	2985	41504	1958	51755	1301	39039
9L-4S		MI	20781	5480	31935	4466	38079	3611	41451	2942	45517	1918	56596	1563	38185
22-#11	2.15	MA	19537	5480	30011	4520	35520	3653	37867	2983	39644	1954	49382	1221	37908
10L-3S		MI	21410	5480	32795	4465	39242	3601	42859	2945	47411	1923	58690	1655	38318
22-#11	2.15	MA	18934	5480	29192	4521	34408	3663	36534	2992	37843	1960	47098	1165	36749
11L-2S		MI	22279	5480	33950	4465	40706	3603	44634	2937	49798	1918	61872	1746	38394
22-#14	3.10	MA	24316	6032	39151	4841	47143	3878	51970	3127	58689	1913	74299	1370	58817
5L-8S		MI	19571	6032	32138	4809	38103	3858	41346	3103	45233	1886	57004	1029	48682

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.10	MA	23476	6032	37911	4842	45489	3891	49957	3123	56011	1921	70706	1262	57873
6L-7S		MI	20301	6032	33201	4809	39503	3861	43094	3108	47547	1879	59923	1103	50107
22-#14	3.10	MA	22653	6032	36703	4843	43892	3890	48005	3135	53296	1914	67510	1159	56093
7L-6S		MI	21039	6032	34281	4809	40931	3863	44838	3098	49946	1886	62722	1206	51614
22-#14	3.10	MA	21840	6032	35514	4844	42326	3889	46050	3132	50677	1921	64197	1083	54499
8L-5S		MI	21794	6032	35390	4810	42409	3850	46637	3102	52312	1879	65875	1315	52489
22-#14	3.10	MA	21032	6032	34202	4859	40712	3903	44125	3144	48083	1929	60936	998	52679
9L-4S		MI	22581	6032	36637	4795	43906	3853	48464	3092	54772	1871	69002	1378	53906
22-#18	5.51	MA	25876	7431	46891	5697	56477	4516	63131	3532	73303	1810	94838	484	90905
7L-6S		MI	24266	7431	44122	5658	53139	4485	59523	3480	69162	1764	88481	568	84538
24-#11	2.35	MA	23738	5593	36558	4565	43901	3686	48105	2995	53530	1933	67261	1593	46486
4L-10S		MI	18118	5593	28393	4559	33518	3676	35852	2990	37933	1923	47363	1180	37310
24-#11	2.35	MA	23108	5593	35584	4576	42733	3686	46678	3004	51588	1939	64772	1546	45887
5L-9S		MI	18636	5593	29132	4558	34488	3677	37058	2992	39589	1928	49318	1246	38256
24-#11	2.35	MA	22505	5593	34719	4577	41579	3696	45274	3002	49721	1945	62244	1471	45165
6L-8S		MI	19155	5593	29951	4548	35495	3668	38258	2985	41200	1923	51333	1305	39038
24-#11	2.35	MA	21915	5593	33877	4578	40465	3695	43913	3011	47828	1941	59995	1400	44577
7E		MI	19679	5593	30692	4548	36471	3669	39478	2987	42827	1917	53385	1357	39864
24-#11	2.35	MA	21331	5593	33049	4579	39374	3695	42549	3009	46001	1947	57670	1347	43601
8L-6S		MI	20209	5593	31446	4547	37468	3670	40695	2980	44513	1923	55359	1428	40402
24-#11	2.35	MA	20752	5593	32134	4590	38249	3705	41208	3018	44192	1953	55375	1288	42722
9L-5S		MI	20750	5593	32219	4547	38499	3661	41950	2982	46175	1917	57581	1503	41004
24-#11	2.35	MA	20175	5593	31308	4591	37164	3705	39860	3016	42332	1949	53002	1208	41612
10L-4S		MI	21315	5593	33090	4537	39544	3662	43225	2975	47904	1912	59779	1548	41567
24-#11	2.35	MA	19573	5593	30489	4592	36052	3715	38526	3025	40531	1955	50718	1152	40432
11L-3S		MI	21939	5593	33950	4536	40706	3653	44634	2977	49798	1917	61872	1639	41714
24-#14	3.38	MA	24326	6195	39766	4944	47843	3966	52809	3171	59858	1913	75853	1241	63132
6L-8S		MI	20336	6195	33789	4911	40198	3933	43883	3151	48630	1877	61522	1005	53336
24-#14	3.38	MA	23512	6195	38559	4945	46245	3965	50857	3183	57143	1906	72657	1139	61395
7E		MI	21058	6195	34852	4911	41597	3935	45631	3155	50944	1870	64440	1079	54807
24-#14	3.38	MA	22708	6195	37370	4946	44679	3964	48901	3179	54524	1914	69345	1063	59757
8L-6S		MI	21788	6195	35932	4912	43026	3938	47376	3145	53343	1877	67240	1182	56272
24-#14	3.38	MA	21910	6195	36058	4962	43066	3978	46977	3191	51930	1922	66084	978	57975
9L-5S		MI	22535	6195	37041	4912	44503	3925	49174	3150	55709	1870	70393	1291	57227

RECTANGULAR TIED COLUMNS 38" x 44"

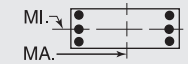
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.44	MA	24652	5306	36057	4407	42881	3576	46273	2951	49823	2031	60945	1888	31421
2L-3S		MI	18858	5306	28365	4358	33182	3531	35153	2934	36287	2002	43472	1597	26590
6-#18	1.44	MA	21995	5306	32628	4407	38532	3573	41003	2971	42733	2044	51492	1654	31229
3L-2S		MI	21088	5306	31249	4360	36841	3537	39585	2918	42162	1989	51248	1830	26698
8-#14	1.08	MA	23524	5088	33367	4297	39693	3498	42507	2907	44867	2058	54583	1945	23975
2L-4S		MI	17928	5088	26094	4254	30418	3473	31898	2882	32113	2029	38653	1638	20345
8-#14	1.08	MA	21982	5088	31409	4298	37210	3497	39498	2919	40808	2067	49120	1813	23951
3E		MI	18875	5088	27326	4254	32083	3461	33915	2887	34809	2036	41621	1769	20438
8-#14	1.08	MA	20864	5088	29955	4300	35244	3512	37116	2916	37593	2061	45518	1682	23789
4L-2S		MI	20173	5088	28977	4255	34177	3463	36453	2877	38206	2029	46139	1900	20433
8-#18	1.91	MA	26252	5597	39487	4588	47231	3709	51542	3035	56913	2017	70397	1849	41573
2L-4S		MI	18621	5597	29091	4537	33925	3683	36052	3007	37499	1969	46154	1313	33627
8-#18	1.91	MA	23646	5597	36057	4589	42881	3706	46273	3055	49823	2030	60945	1615	41266
3E		MI	20222	5597	31249	4539	36841	3664	39585	3018	42162	1983	51248	1547	35037
8-#18	1.91	MA	21755	5597	33504	4590	39430	3729	42090	3048	44197	2017	54726	1381	39570
4L-2S		MI	22411	5597	34134	4542	40499	3670	44017	3003	48037	1969	59023	1780	35250

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.35	MA	24475	5252	35325	4399	42176	3573	45515	2954	48926	2051	60046	1926	29791
2L-5S		MI	17895	5252	26498	4371	31016	3545	32609	2940	33050	2027	40044	1550	24462
10-#14	1.35	MA	22951	5252	33367	4401	39693	3572	42507	2966	44867	2059	54583	1795	29728
3L-4S		MI	18744	5252	27745	4356	32513	3548	34436	2930	35510	2020	43171	1614	25180
10-#14	1.35	MA	21848	5252	31913	4402	37727	3586	40125	2964	41652	2053	50981	1663	29516
4L-3S		MI	19679	5252	28977	4357	34177	3535	36453	2934	38206	2027	46139	1745	25319
10-#14	1.35	MA	20849	5252	30442	4418	35962	3586	37970	2976	38719	2062	47224	1597	28607
5L-2S		MI	20961	5252	30628	4357	36271	3538	38990	2924	41603	2020	50657	1876	25351
10-#18	2.39	MA	27811	5888	42917	4770	51581	3842	56812	3120	64003	2002	79850	1810	51697
2L-5S		MI	18553	5888	29788	4743	34958	3810	37281	3107	39119	1963	48523	1153	39237
10-#18	2.39	MA	25252	5888	39487	4771	47231	3839	51542	3139	56913	2015	70397	1576	51292
3L-4S		MI	19979	5888	31975	4719	37583	3816	40484	3091	43374	1949	53929	1263	41643
10-#18	2.39	MA	23399	5888	36933	4771	43779	3862	47359	3132	51287	2002	64179	1342	49177
4L-3S		MI	21550	5888	34134	4721	40499	3797	44017	3102	48037	1963	59023	1497	43465
10-#18	2.39	MA	21719	5888	34348	4799	40677	3859	43573	3152	46153	2015	57652	1227	46105
5L-2S		MI	23702	5888	37018	4723	44157	3803	48449	3087	53912	1949	66799	1730	43770
12-#11	1.12	MA	23733	5115	33621	4327	40129	3521	43084	2923	45680	2064	55835	1956	25019
2L-6S		MI	17616	5115	25527	4298	29850	3504	31243	2905	31309	2050	37541	1611	20646
12-#11	1.12	MA	22657	5115	32254	4328	38394	3521	40983	2933	42845	2071	51997	1865	25000
3L-5S		MI	18190	5115	26301	4297	30882	3494	32499	2908	32972	2045	39763	1686	21179
12-#11	1.12	MA	21880	5115	31239	4329	37023	3531	39321	2931	40602	2067	49463	1774	24929
4E		MI	18788	5115	27172	4287	31926	3496	33774	2900	34701	2040	41961	1731	21286
12-#11	1.12	MA	21176	5115	30214	4341	35792	3531	37819	2940	38556	2074	46828	1727	24763
5L-3S		MI	19448	5115	28032	4287	33089	3486	35182	2903	36595	2045	44055	1822	21325
12-#11	1.12	MA	20502	5115	29304	4342	34578	3541	36341	2939	36590	2080	44147	1652	24080
6L-2S		MI	20354	5115	29187	4286	34554	3488	36957	2895	38983	2040	47237	1913	21324
12-#14	1.61	MA	25408	5416	37283	4501	44659	3648	48524	3001	52985	2043	65509	1908	35590
2L-6S		MI	17902	5416	27041	4473	31632	3633	33348	2983	34081	2026	41409	1417	28183
12-#14	1.61	MA	23902	5416	35325	4503	42176	3647	45515	3014	48926	2052	60046	1776	35493
3L-5S		MI	18706	5416	28150	4473	33110	3620	35146	2987	36447	2018	44562	1526	29129
12-#14	1.61	MA	22813	5416	33871	4504	40210	3661	43133	3011	45711	2046	56444	1645	35240
4E		MI	19544	5416	29397	4459	34607	3623	36973	2977	38907	2011	47689	1590	30009
12-#14	1.61	MA	21828	5416	32400	4520	38445	3661	40979	3024	42778	2054	52687	1578	34170
5L-3S		MI	20468	5416	30628	4459	36271	3610	38990	2982	41603	2018	50657	1721	30187
12-#14	1.61	MA	20882	5416	31094	4522	36704	3675	38858	3021	39957	2063	48872	1470	32957
6L-2S		MI	21736	5416	32280	4459	38366	3613	41527	2972	44999	2011	55175	1852	30249
12-#18	2.87	MA	29336	6179	46346	4952	55930	3975	62082	3204	71093	1988	89303	1770	61804
2L-6S		MI	18561	6179	30726	4922	36024	3962	38558	3180	40903	1956	50872	909	44318
12-#18	2.87	MA	26820	6179	42917	4953	51581	3972	56812	3223	64003	2001	79850	1537	61311
3L-5S		MI	19905	6179	32673	4925	38616	3943	41713	3191	44994	1943	56298	1103	47429
12-#18	2.87	MA	25001	6179	40363	4953	48129	3995	52629	3217	58377	1988	73632	1303	58829
4E		MI	21305	6179	34860	4901	41241	3949	44916	3175	49249	1930	61705	1213	49706
12-#18	2.87	MA	23355	6179	37778	4980	45027	3992	48843	3236	53243	2001	67105	1188	55900
5L-3S		MI	22848	6179	37018	4903	44157	3930	48449	3187	53912	1943	66799	1447	51883
12-#18	2.87	MA	21775	6179	35481	4981	41965	4015	45115	3229	48305	2014	60506	995	52174
6L-2S		MI	24965	6179	39903	4905	47815	3936	52881	3171	59787	1930	74575	1680	52269
14-#11	1.31	MA	24400	5228	34989	4398	41863	3573	45186	2956	48515	2059	59674	1944	29077
2L-7S		MI	17639	5228	25929	4369	30319	3554	31801	2946	32011	2040	38750	1524	23471
14-#11	1.31	MA	23333	5228	33621	4399	40129	3573	43084	2965	45680	2066	55835	1853	29042
3L-6S		MI	18195	5228	26682	4369	31315	3555	33018	2938	33697	2045	40724	1595	23945
14-#11	1.31	MA	22563	5228	32607	4400	38757	3583	41422	2964	43437	2062	53302	1762	28950
4L-5S		MI	18764	5228	27456	4368	32347	3546	34273	2941	35360	2040	42946	1671	24557
14-#11	1.31	MA	21867	5228	31581	4412	37527	3583	39920	2973	41391	2068	50666	1715	28760
5L-4S		MI	19356	5228	28327	4358	33391	3547	35548	2933	37088	2034	45144	1716	24686
14-#11	1.31	MA	21199	5228	30671	4413	36312	3593	38442	2972	39425	2075	47986	1640	28000
6L-3S		MI	20010	5228	29187	4357	34554	3538	36957	2936	38983	2040	47237	1807	24744
14-#11	1.31	MA	20545	5228	29785	4414	35140	3593	37009	2981	37432	2071	45599	1569	27386
7L-2S		MI	20909	5228	30342	4357	36018	3540	38731	2928	41370	2034	50420	1898	24761

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

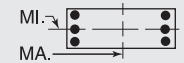
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	1.88	MA	26327	5579	39241	4604	47143	3722	51532	3049	57044	2036	70972	1889	41380
2L-7S		MI	17932	5579	27612	4575	32299	3705	34141	3040	35079	2009	43127	1290	31682
14-#14	1.88	MA	24837	5579	37283	4605	44659	3722	48524	3061	52985	2044	65509	1758	41252
3L-6S		MI	18709	5579	28692	4575	33727	3708	35885	3030	37478	2017	45927	1393	32907
14-#14	1.88	MA	23762	5579	35829	4606	42694	3736	46142	3059	49770	2038	61907	1626	40962
4L-5S		MI	19504	5579	29801	4576	35205	3695	37684	3035	39844	2009	49080	1502	33813
14-#14	1.88	MA	22789	5579	34358	4622	40929	3735	43987	3071	46836	2047	58150	1560	39749
5L-4S		MI	20331	5579	31048	4561	36701	3697	39510	3025	42304	2002	52207	1565	34832
14-#14	1.88	MA	21856	5579	33052	4624	39187	3750	41867	3068	44016	2055	54335	1451	38582
6L-3S		MI	21244	5579	32280	4561	38366	3685	41527	3029	44999	2009	55175	1697	35046
14-#14	1.88	MA	20942	5579	31781	4625	37504	3749	39811	3081	41157	2049	50941	1349	37093
7L-2S		MI	22499	5579	33931	4561	40460	3687	44064	3019	48396	2002	59692	1828	35136
14-#18	3.35	MA	28354	6470	46346	5134	55930	4105	62082	3308	71093	1987	89303	1498	71326
3L-6S		MI	19907	6470	33611	5104	39682	4095	42990	3264	46778	1936	58648	859	52400
14-#18	3.35	MA	26568	6470	43793	5135	52479	4128	57899	3301	65468	1974	83085	1264	68518
4L-5S		MI	21227	6470	35557	5106	42275	4076	46145	3275	50869	1923	64074	1053	55644
14-#18	3.35	MA	24952	6470	41208	5162	49377	4125	54113	3321	60333	1987	76558	1149	65718
5L-4S		MI	22603	6470	37744	5082	44899	4082	49348	3260	55124	1910	69480	1163	57807
14-#18	3.35	MA	23402	6470	38911	5163	46314	4148	50385	3314	55395	2000	69959	956	61867
6L-3S		MI	24120	6470	39903	5085	47815	4063	52881	3271	59787	1923	74575	1396	60294
14-#18	3.35	MA	21883	6470	36674	5163	43355	4145	46770	3333	50388	1987	64096	773	57919
7L-2S		MI	26205	6470	42787	5087	51473	4069	57313	3255	65662	1910	82350	1630	60754
16-#11	1.49	MA	25059	5341	36356	4468	43598	3625	47287	2989	51350	2054	63513	1933	33129
2L-8S		MI	17670	5341	26343	4440	30807	3605	32355	2976	32772	2039	39881	1457	26094
16-#11	1.49	MA	24001	5341	34989	4470	41863	3625	45186	2998	48515	2060	59674	1841	33078
3L-7S		MI	18215	5341	27084	4440	31783	3606	33575	2979	34398	2034	41933	1509	26793
16-#11	1.49	MA	23238	5341	33975	4471	40492	3635	43524	2997	46272	2057	57141	1750	32967
4L-6S		MI	18767	5341	27837	4439	32780	3607	34792	2971	36084	2039	43907	1580	27252
16-#11	1.49	MA	22548	5341	32949	4482	39261	3635	42022	3006	44226	2063	54505	1704	32757
5E		MI	19330	5341	28611	4439	33811	3598	36048	2974	37747	2034	46129	1655	27932
16-#11	1.49	MA	21887	5341	32039	4484	38047	3645	40543	3005	42260	2070	51825	1629	31928
6L-4S		MI	19917	5341	29482	4429	34856	3599	37323	2966	39476	2029	48327	1700	28081
16-#11	1.49	MA	21240	5341	31153	4485	36874	3645	39110	3014	40267	2066	49437	1558	31331
7L-3S		MI	20565	5341	30342	4428	36018	3590	38731	2969	41370	2034	50420	1791	28156
16-#11	1.49	MA	20600	5341	30281	4486	35725	3645	37675	3013	38344	2073	46976	1504	30468
8L-2S		MI	21457	5341	31497	4428	37483	3591	40506	2961	43757	2029	53603	1883	28187
16-#14	2.15	MA	27231	5743	41199	4706	49626	3797	54541	3096	61103	2028	76435	1871	47163
2L-8S		MI	17976	5743	28201	4677	32993	3777	34930	3083	36161	2007	44726	1192	35174
16-#14	2.15	MA	25757	5743	39241	4707	47143	3797	51532	3108	57044	2037	70972	1739	47005
3L-7S		MI	18735	5743	29264	4677	34393	3780	36678	3088	38476	2000	47645	1266	36342
16-#14	2.15	MA	24695	5743	37787	4708	45177	3811	49150	3106	53829	2031	67370	1608	46682
4L-6S		MI	19504	5743	30344	4678	35821	3782	38422	3078	40875	2007	50444	1369	37641
16-#14	2.15	MA	23734	5743	36316	4725	43412	3810	46996	3118	50895	2039	63613	1541	45342
5E		MI	20288	5743	31452	4678	37299	3770	40221	3082	43241	2000	53598	1478	38512
16-#14	2.15	MA	22813	5743	35010	4726	41670	3825	44875	3116	48075	2048	59799	1433	44216
6L-4S		MI	21106	5743	32700	4663	38796	3772	42048	3072	45701	1992	56724	1541	39653
16-#14	2.15	MA	21911	5743	33739	4727	39988	3824	42820	3128	45216	2042	56404	1331	42656
7L-3S		MI	22008	5743	33931	4663	40460	3760	44064	3077	48396	2000	59692	1673	39898
16-#14	2.15	MA	21020	5743	32487	4729	38339	3823	40760	3126	42457	2050	52895	1254	41192
8L-2S		MI	23251	5743	35582	4663	42554	3762	46602	3066	51793	1992	64210	1804	40015
16-#18	3.83	MA	28105	6760	47222	5317	56828	4261	63168	3385	72558	1959	92538	1225	78239
4L-6S		MI	21226	6760	36495	5286	43340	4228	47422	3348	52653	1916	66423	809	60506
16-#18	3.83	MA	26517	6760	44637	5344	53726	4258	59382	3405	67423	1973	86011	1110	75555
5E		MI	22524	6760	38442	5288	45933	4209	50577	3359	56744	1903	71849	1003	63878

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

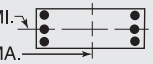


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	3.83	MA	24995	6760	42340	5344	50664	4281	55655	3398	62485	1986	79412	916	71582
6L-4S		MI	23877	6760	40629	5264	48558	4215	53780	3344	60999	1890	77256	1113	65939
16-#18	3.83	MA	23504	6760	40104	5345	47705	4278	52040	3418	57479	1973	73548	734	67568
7L-3S		MI	25369	6760	42787	5266	51473	4196	57313	3355	65662	1903	82350	1346	68701
18-#11	1.68	MA	25710	5455	37724	4539	45332	3676	49388	3022	54185	2049	67352	1921	37175
2L-9S		MI	17709	5455	26679	4521	31265	3666	32930	3016	33548	2039	41048	1383	28698
18-#11	1.68	MA	24660	5455	36356	4541	43598	3676	47287	3031	51350	2055	63513	1830	37110
3L-8S		MI	18245	5455	27498	4511	32272	3657	34130	3009	35159	2034	43064	1442	29374
18-#11	1.68	MA	23904	5455	35342	4542	42226	3687	45625	3030	49107	2051	60979	1739	36981
4L-7S		MI	18784	5455	28239	4511	33248	3658	35350	3011	36786	2028	45116	1494	30119
18-#11	1.68	MA	23221	5455	34317	4553	40996	3687	44123	3039	47061	2058	58344	1692	36742
5L-6S		MI	19331	5455	28992	4510	34245	3659	36567	3004	38471	2034	47090	1565	30566
18-#11	1.68	MA	22566	5455	33406	4555	39781	3697	42645	3038	45095	2065	55663	1617	35863
6L-5S		MI	19889	5455	29766	4510	35276	3650	37822	3006	40134	2028	49312	1640	31248
18-#11	1.68	MA	21925	5455	32520	4556	38609	3697	41212	3047	43102	2061	53276	1546	35280
7L-4S		MI	20471	5455	30637	4499	36321	3651	39097	2999	41863	2023	51509	1685	31472
18-#11	1.68	MA	21291	5455	31648	4557	37459	3697	39776	3045	41178	2067	50815	1492	34372
8L-3S		MI	21113	5455	31497	4499	37483	3642	40506	3001	43757	2028	53603	1776	31564
18-#11	1.68	MA	20662	5455	30685	4569	36275	3707	38363	3054	39274	2074	48380	1434	33517
9L-2S		MI	21998	5455	32652	4499	38948	3643	42281	2994	46145	2023	56786	1867	31608
18-#14	2.42	MA	26664	5906	41199	4809	49626	3871	54541	3156	61103	2030	76435	1721	52755
3L-8S		MI	18776	5906	29852	4779	35087	3852	37467	3131	39558	1998	49244	1168	39795
18-#14	2.42	MA	25614	5906	39745	4811	47660	3886	52159	3153	57888	2023	72834	1589	52401
4L-7S		MI	19526	5906	30915	4780	36487	3855	39215	3135	41873	1991	52163	1242	41013
18-#14	2.42	MA	24665	5906	38274	4827	45895	3885	50004	3166	54954	2032	69076	1523	50947
5L-6S		MI	20286	5906	31995	4780	37915	3857	40960	3125	44272	1998	54962	1345	42381
18-#14	2.42	MA	23755	5906	36968	4828	44153	3899	47884	3163	52134	2040	65262	1414	49857
6L-5S		MI	21061	5906	33104	4780	39393	3845	42758	3130	46637	1991	58116	1453	43222
18-#14	2.42	MA	22865	5906	35697	4830	42471	3899	45828	3176	49275	2034	61867	1312	48230
7L-4S		MI	21870	5906	34351	4765	40890	3847	44585	3119	49097	1983	61242	1517	44471
18-#14	2.42	MA	21984	5906	34445	4831	40822	3898	43769	3173	46516	2043	58358	1235	46771
8L-3S		MI	22762	5906	35582	4765	42554	3835	46602	3124	51793	1991	64210	1649	44745
18-#14	2.42	MA	21109	5906	33063	4847	39123	3912	41742	3186	43784	2051	54895	1151	44697
9L-2S		MI	23993	5906	37234	4766	44649	3837	49139	3114	55190	1983	68728	1780	44887
18-#18	4.31	MA	28054	7051	48067	5525	58076	4391	64652	3489	74513	1958	95464	1071	85409
5L-6S		MI	22521	7051	39380	5468	46998	4361	51854	3433	58528	1897	74199	759	68634
18-#18	4.31	MA	26558	7051	45770	5526	55014	4414	60924	3482	69575	1972	88865	877	81318
6L-5S		MI	23798	7051	41326	5470	49591	4342	55009	3444	62619	1883	79625	953	72079
18-#18	4.31	MA	25092	7051	43533	5527	52055	4411	57310	3502	64569	1958	83001	695	77235
7L-4S		MI	25130	7051	43513	5446	52216	4348	58212	3428	66874	1870	85032	1063	74098
20-#11	1.87	MA	26353	5568	39092	4610	47067	3728	51490	3055	57020	2044	71190	1909	41218
2L-10S		MI	17752	5568	27095	4592	31760	3716	33499	3047	34279	2028	42276	1301	31047
20-#11	1.87	MA	25312	5568	37724	4611	45332	3728	49388	3064	54185	2050	67352	1818	41139
3L-9S		MI	18281	5568	27834	4592	32730	3718	34704	3049	35935	2033	44231	1367	32000
20-#11	1.87	MA	24562	5568	36710	4613	43961	3739	47726	3063	51942	2046	64818	1727	40993
4L-8S		MI	18812	5568	28652	4582	33736	3709	35905	3042	37546	2028	46246	1426	32659
20-#11	1.87	MA	23885	5568	35684	4624	42730	3739	46224	3072	49896	2053	62183	1680	40653
5L-7S		MI	19347	5568	29394	4581	34713	3710	37124	3044	39173	2023	48298	1478	33448
20-#11	1.87	MA	23236	5568	34774	4625	41516	3749	44746	3070	47930	2059	59502	1605	39803
6E		MI	19888	5568	30147	4581	35710	3711	38342	3037	40859	2028	50273	1549	33885
20-#11	1.87	MA	22601	5568	33888	4627	40343	3749	43313	3080	45937	2056	57115	1534	39234
7L-5S		MI	20442	5568	30921	4581	36741	3702	39597	3039	42522	2023	52495	1625	34541
20-#11	1.87	MA	21974	5568	33016	4628	39194	3749	41877	3078	44013	2062	54653	1480	38283
8L-4S		MI	21018	5568	31792	4570	37786	3703	40872	3032	44250	2018	54692	1670	34860
20-#11	1.87	MA	21350	5568	32053	4639	38010	3759	40465	3087	42109	2069	52219	1422	37446
9L-3S		MI	21655	5568	32652	4570	38948	3694	42281	3034	46145	2023	56786	1761	34967
20-#11	1.87	MA	20730	5568	31184	4641	36868	3759	39046	3086	40151	2065	49702	1342	36259
10L-2S		MI	22534	5568	33806	4570	40413	3695	44055	3027	48532	2018	59969	1852	35024

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

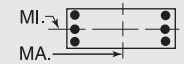
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.69	MA	26521	6070	41703	4913	50143	3960	55167	3201	61946	2016	78297	1571	58119
4L-8S		MI	19564	6070	31503	4882	37182	3927	40004	3178	42955	1989	53762	1144	44427
20-#14	2.69	MA	25582	6070	40232	4929	48378	3960	53013	3213	59013	2024	74539	1504	56563
5L-7S		MI	20306	6070	32567	4882	38582	3930	41752	3183	45270	1982	56680	1218	45694
20-#14	2.69	MA	24684	6070	38926	4930	46637	3974	50892	3211	56193	2033	70725	1396	55505
6E		MI	21057	6070	33646	4882	40010	3932	43497	3172	47669	1989	59480	1321	47128
20-#14	2.69	MA	23804	6070	37655	4932	44954	3974	48837	3223	53334	2027	67330	1294	53814
7L-5S		MI	21824	6070	34755	4882	41488	3919	45295	3177	50034	1982	62633	1429	47942
20-#14	2.69	MA	22934	6070	36403	4933	43305	3973	46777	3221	50575	2035	63821	1217	52309
8L-4S		MI	22624	6070	36002	4867	42984	3922	47122	3167	52494	1974	65760	1493	49288
20-#14	2.69	MA	22070	6070	35022	4949	41606	3987	44751	3233	47843	2044	60358	1132	50278
9L-3S		MI	23507	6070	37234	4868	44649	3909	49139	3171	55190	1982	68728	1625	49589
20-#18	4.78	MA	28094	7342	49200	5708	59363	4547	66194	3566	76665	1957	98318	838	91072
6E		MI	23795	7342	42264	5649	50656	4494	56286	3517	64402	1877	81975	708	76781
20-#18	4.78	MA	26653	7342	46963	5708	56404	4544	62579	3586	71659	1944	92454	656	86919
7L-5S		MI	25053	7342	44211	5652	53249	4475	59441	3528	68494	1863	87401	903	80110
22-#11	2.05	MA	25956	5682	39092	4682	47067	3780	51490	3097	57020	2045	71190	1806	45165
3L-10S		MI	18322	5682	28250	4663	33225	3768	35273	3079	36666	2022	45459	1286	34324
22-#11	2.05	MA	25213	5682	38077	4684	45695	3791	49828	3095	54777	2041	68657	1715	45004
4L-9S		MI	18846	5682	28989	4663	34195	3770	36479	3082	38323	2028	47414	1352	35285
22-#11	2.05	MA	24542	5682	37052	4695	44465	3790	48325	3105	52731	2048	66021	1669	44571
5L-8S		MI	19373	5682	29807	4653	35201	3760	37679	3074	39934	2022	49429	1411	35949
22-#11	2.05	MA	23899	5682	36142	4696	43250	3801	46847	3103	50765	2054	63341	1594	43748
6L-7S		MI	19903	5682	30549	4652	36178	3762	38899	3077	41560	2017	51481	1463	36781
22-#11	2.05	MA	23270	5682	35255	4698	42077	3801	45414	3112	48772	2051	60954	1523	43191
7L-6S		MI	20440	5682	31302	4652	37174	3763	40116	3069	43246	2022	53455	1534	37208
22-#11	2.05	MA	22648	5682	34383	4699	40928	3801	43978	3111	46848	2057	58492	1469	42198
8L-5S		MI	20988	5682	32076	4652	38206	3754	41371	3072	44909	2017	55677	1610	37841
22-#11	2.05	MA	22031	5682	33420	4710	39744	3811	42566	3120	44944	2064	56057	1410	41379
9L-4S		MI	21560	5682	32946	4641	39250	3755	42647	3064	46638	2012	57875	1655	38246
22-#11	2.05	MA	21416	5682	32551	4712	38603	3811	41147	3119	42986	2060	53541	1330	40166
10L-3S		MI	22192	5682	33806	4641	40413	3746	44055	3067	48532	2017	59969	1746	38368
22-#11	2.05	MA	20757	5682	31689	4713	37432	3821	39743	3128	41090	2067	51121	1273	39023
11L-2S		MI	23064	5682	34961	4641	41878	3747	45830	3060	50919	2012	63151	1837	38436
22-#14	2.96	MA	26488	6233	42190	5031	50862	4035	56021	3261	63072	2017	80002	1486	62188
5L-8S		MI	20342	6233	33155	4984	39276	4002	42542	3225	46352	1980	58279	1120	49068
22-#14	2.96	MA	25599	6233	40884	5033	49120	4049	53901	3258	60252	2026	76188	1377	61158
6L-7S		MI	21076	6233	34218	4984	40676	4004	44290	3230	48666	1973	61198	1194	50384
22-#14	2.96	MA	24730	6233	39613	5034	47437	4048	51845	3270	57393	2019	72793	1275	59406
7L-6S		MI	21818	6233	35298	4984	42104	4007	46034	3220	51065	1980	63998	1296	51880
22-#14	2.96	MA	23870	6233	38362	5035	45789	4048	49786	3268	54634	2028	69284	1198	57856
8L-5S		MI	22577	6233	36406	4984	43582	3994	47833	3224	53431	1973	67151	1405	52670
22-#14	2.96	MA	23016	6233	36980	5051	44090	4062	47759	3280	51902	2037	65821	1113	55866
9L-4S		MI	23368	6233	37654	4970	45079	3997	49659	3214	55891	1965	70278	1469	54103
22-#18	5.26	MA	28188	7633	50393	5890	60754	4677	67849	3670	78749	1930	101907	617	96620
7L-6S		MI	25052	7633	45149	5831	54315	4627	60718	3601	70277	1857	89750	658	84946
24-#11	2.24	MA	25857	5795	39445	4754	47430	3842	51929	3128	57612	2036	72496	1704	49013
4L-10S		MI	18885	5795	29405	4734	34690	3820	37048	3112	39053	2017	48642	1271	37584
24-#11	2.24	MA	25192	5795	38419	4766	46199	3842	50427	3137	55566	2043	69860	1657	48496
5L-9S		MI	19405	5795	30144	4734	35660	3821	38254	3115	40710	2022	50597	1337	38546
24-#11	2.24	MA	24554	5795	37509	4767	44985	3853	48948	3136	53600	2049	67180	1582	47698
6L-8S		MI	19927	5795	30962	4723	36666	3812	39454	3107	42321	2017	52612	1396	39245
24-#11	2.24	MA	23931	5795	36623	4768	43812	3853	47515	3145	51607	2045	64792	1511	47151
7E		MI	20453	5795	31704	4723	37643	3813	40673	3110	43948	2012	54664	1448	40087

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

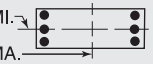
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.24	MA	23315	5795	35751	4770	42663	3853	46080	3144	49683	2052	62331	1457	46119
8L-6S		MI	20985	5795	32457	4723	38639	3815	41891	3102	45633	2017	56638	1519	40535
24-#11	2.24	MA	22703	5795	34788	4781	41479	3863	44667	3153	47779	2059	59896	1399	45288
9L-5S		MI	21529	5795	33231	4723	39670	3806	43146	3105	47296	2012	58860	1594	41148
24-#11	2.24	MA	22094	5795	33919	4782	40337	3863	43248	3152	45821	2055	57379	1319	44077
10L-4S		MI	22096	5795	34101	4712	40715	3807	44421	3097	49025	2006	61058	1639	41631
24-#11	2.24	MA	21449	5795	33057	4784	39167	3873	41845	3161	43925	2061	54960	1262	42913
11L-3S		MI	22723	5795	34961	4712	41878	3798	45830	3100	50919	2012	63151	1730	41765
24-#14	3.23	MA	26504	6397	42842	5135	51603	4124	56909	3305	64311	2018	81651	1359	66817
6L-8S		MI	21110	6397	34806	5086	41370	4077	45079	3273	49749	1971	62797	1096	53717
24-#14	3.23	MA	25644	6397	41571	5136	49921	4123	54854	3318	61452	2012	78256	1257	65005
7E		MI	21836	6397	35869	5086	42770	4079	46827	3277	52063	1964	65716	1170	55081
24-#14	3.23	MA	24794	6397	40320	5137	48272	4123	52794	3315	58693	2020	74747	1180	63410
8L-6S		MI	22571	6397	36949	5086	44198	4082	48571	3267	54462	1971	68516	1272	56580
24-#14	3.23	MA	23949	6397	38938	5154	46573	4137	50768	3328	55961	2029	71284	1095	61460
9L-5S		MI	23321	6397	38058	5087	45676	4069	50370	3272	56828	1964	71669	1381	57406

RECTANGULAR TIED COLUMNS 38" x 46"

6-#18	1.37	MA	26780	5508	38876	4596	46309	3731	49948	3083	53709	2135	65731	1995	33041
2L-3S		MI	19628	5508	29392	4531	34358	3673	36348	3055	37403	2096	44741	1687	26657
6-#18	1.37	MA	23974	5508	35265	4597	41729	3729	44399	3104	46222	2149	55718	1761	32849
3L-2S		MI	21863	5508	32276	4533	38016	3680	40780	3040	43277	2082	52517	1921	26741
8-#14	1.03	MA	25578	5290	36036	4486	42942	3653	45972	3039	48414	2160	58957	2049	25190
2L-4S		MI	18696	5290	27111	4429	31591	3617	33094	3005	33233	2123	39929	1728	20404
8-#14	1.03	MA	23950	5290	33976	4488	40329	3653	42806	3052	44143	2169	53179	1917	25166
3E		MI	19645	5290	28343	4429	33255	3604	35111	3009	35928	2130	42897	1860	20479
8-#14	1.03	MA	22772	5290	32448	4489	38263	3668	40302	3050	40763	2164	49365	1786	25004
4L-2S		MI	20945	5290	29994	4429	35350	3607	37648	2999	39325	2123	47415	1991	20465
8-#18	1.83	MA	28481	5799	42487	4777	50889	3864	55497	3167	61195	2122	75744	1959	43733
2L-4S		MI	19389	5799	30118	4710	35101	3826	37247	3128	38615	2062	47423	1403	33952
8-#18	1.83	MA	25727	5799	38876	4779	46309	3862	49948	3188	53709	2136	65731	1725	43426
3E		MI	20996	5799	32276	4713	38016	3806	40780	3139	43277	2076	52517	1637	35112
8-#18	1.83	MA	23732	5799	36191	4780	42678	3886	45549	3183	47771	2123	59137	1491	41943
4L-2S		MI	23192	5799	35161	4715	41675	3813	45212	3124	49152	2062	60293	1870	35301
10-#14	1.29	MA	26586	5454	38096	4588	45555	3728	49138	3086	52685	2152	64736	2032	31310
2L-5S		MI	18662	5454	27515	4546	32189	3689	33805	3062	34169	2121	41320	1641	24652
10-#14	1.29	MA	24978	5454	36036	4590	42942	3728	45972	3099	48414	2162	58957	1900	31246
3L-4S		MI	19513	5454	28762	4531	33685	3692	35631	3052	36629	2114	44447	1704	25245
10-#14	1.29	MA	23815	5454	34508	4592	40876	3743	43468	3097	45034	2156	55144	1769	31035
4L-3S		MI	20450	5454	29994	4531	35350	3679	37648	3057	39325	2121	47415	1836	25365
10-#14	1.29	MA	22763	5454	32963	4608	39022	3743	41204	3110	41952	2165	51176	1702	30215
5L-2S		MI	21736	5454	31645	4532	37444	3682	40185	3046	42722	2114	51933	1967	25387
10-#18	2.29	MA	30138	6090	46099	4959	55469	3997	61046	3252	68681	2109	85757	1923	54397
2L-5S		MI	19319	6090	30815	4916	36134	3952	38476	3228	40235	2056	49792	1243	39512
10-#18	2.29	MA	27433	6090	42487	4961	50889	3995	55497	3272	61195	2123	75744	1689	53992
3L-4S		MI	20752	6090	33002	4892	38759	3959	41679	3212	44489	2043	55198	1353	41960
10-#18	2.29	MA	25477	6090	39802	4962	47259	4019	51097	3267	55257	2110	69150	1455	52072
4L-3S		MI	22329	6090	35161	4895	41675	3939	45212	3224	49152	2056	60293	1587	43548
10-#18	2.29	MA	23705	6090	37084	4990	43998	4017	47117	3288	49838	2124	62250	1339	48719
5L-2S		MI	24489	6090	38045	4897	45333	3946	49644	3208	55027	2043	68068	1820	43825
12-#11	1.07	MA	25796	5316	36300	4516	43396	3676	46574	3055	49262	2166	60264	2060	26283
2L-6S		MI	18383	5316	26539	4473	31022	3648	32439	3028	32430	2145	38821	1702	20780
12-#11	1.07	MA	24661	5316	34861	4517	41572	3677	44364	3065	46280	2173	56207	1969	26264
3L-5S		MI	18958	5316	27313	4473	32053	3639	33694	3031	34093	2139	41042	1777	21240
12-#11	1.07	MA	23842	5316	33796	4519	40131	3687	42618	3064	43923	2169	53526	1878	26193
4E		MI	19557	5316	28183	4462	33098	3640	34969	3023	35822	2134	43240	1822	21331

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

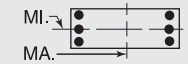
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.07	MA	23102	5316	32719	4530	38838	3688	41040	3073	41774	2177	50745	1830	26026
5L-3S		MI	20218	5316	29043	4462	34260	3631	36378	3026	37716	2139	45334	1913	21361
12-#11	1.07	MA	22392	5316	31763	4532	37563	3698	39487	3073	39709	2184	47911	1755	25382
6L-2S		MI	21127	5316	30198	4462	35725	3632	38153	3018	40103	2134	48517	2004	21355
12-#14	1.54	MA	27577	5617	40157	4690	48168	3803	52303	3133	56956	2145	70515	2015	37413
2L-6S		MI	18669	5617	28058	4648	32805	3777	34543	3105	35200	2119	42685	1508	28359
12-#14	1.54	MA	25986	5617	38096	4692	45555	3803	49138	3146	52685	2154	64736	1883	37316
3L-5S		MI	19475	5617	29167	4648	34283	3764	36342	3110	37566	2112	45838	1616	29316
12-#14	1.54	MA	24839	5617	36568	4694	43489	3818	46634	3144	49305	2149	60923	1752	37063
4E		MI	20316	5617	30414	4633	35780	3766	38169	3099	40026	2105	48965	1680	30079
12-#14	1.54	MA	23800	5617	35023	4710	41635	3818	44370	3157	46223	2158	56955	1685	36072
5L-3S		MI	21242	5617	31645	4634	37444	3754	40185	3104	42722	2112	51933	1812	30237
12-#14	1.54	MA	22805	5617	33651	4712	39805	3832	42142	3155	43260	2167	52920	1576	34755
6L-2S		MI	22514	5617	33297	4634	39538	3756	42723	3094	46118	2105	56450	1943	30290
12-#18	2.75	MA	31758	6380	49710	5141	60049	4130	66595	3336	76168	2096	95770	1886	65044
2L-6S		MI	19325	6380	31754	5096	37199	4105	39753	3301	42018	2049	52141	999	44754
12-#18	2.75	MA	29097	6380	46099	5142	55469	4128	61046	3357	68681	2109	85757	1653	64551
3L-5S		MI	20675	6380	33700	5098	39792	4085	42908	3312	46110	2036	57567	1193	47700
12-#18	2.75	MA	27178	6380	43413	5144	51839	4152	56646	3351	62744	2097	79163	1419	62247
4E		MI	22082	6380	35887	5074	42417	4092	46111	3297	50364	2023	62974	1303	50015
12-#18	2.75	MA	25441	6380	40696	5172	48578	4150	52666	3372	57325	2110	72263	1302	59044
5L-3S		MI	23632	6380	38045	5076	45333	4072	49644	3308	55027	2036	68068	1537	51972
12-#18	2.75	MA	23774	6380	38282	5173	45359	4175	48748	3366	52113	2124	65272	1109	55316
6L-2S		MI	25758	6380	40930	5079	48991	4079	54076	3292	60902	2023	75844	1770	52329
14-#11	1.25	MA	26503	5430	37738	4587	45221	3728	48784	3088	52244	2160	64322	2049	30551
2L-7S		MI	18405	5430	26941	4544	31490	3699	32996	3068	33132	2134	40029	1615	23603
14-#11	1.25	MA	25378	5430	36300	4588	43396	3729	46574	3098	49262	2168	60264	1958	30516
3L-6S		MI	18963	5430	27694	4544	32486	3700	34214	3061	34818	2139	42003	1686	24078
14-#11	1.25	MA	24567	5430	35234	4590	41955	3739	44828	3097	46905	2164	57584	1867	30424
4L-5S		MI	19533	5430	28468	4544	33518	3691	35469	3063	36480	2134	44225	1762	24621
14-#11	1.25	MA	23833	5430	34157	4601	40663	3739	43250	3106	44756	2171	54802	1820	30234
5L-4S		MI	20127	5430	29338	4533	34562	3692	36744	3056	38209	2129	46423	1807	24734
14-#11	1.25	MA	23130	5430	33201	4603	39388	3750	41697	3105	42691	2178	51969	1745	29507
6L-3S		MI	20782	5430	30198	4533	35725	3683	38153	3058	40103	2134	48517	1898	24783
14-#11	1.25	MA	22442	5430	32271	4604	38156	3750	40192	3115	40597	2175	49444	1674	28844
7L-2S		MI	21683	5430	31353	4533	37190	3684	39927	3051	42491	2129	51699	1989	24793
14-#14	1.80	MA	28551	5781	42217	4793	50781	3878	55469	3181	61227	2137	76294	1998	43507
2L-7S		MI	18697	5781	28629	4750	33471	3849	35336	3163	36198	2103	44403	1381	31967
14-#14	1.80	MA	26978	5781	40157	4794	48168	3878	52303	3194	56956	2147	70515	1866	43378
3L-6S		MI	19478	5781	29709	4750	34899	3851	37081	3152	38597	2110	47202	1483	33082
14-#14	1.80	MA	25844	5781	38629	4796	46102	3893	49799	3192	53576	2141	66701	1735	43088
4L-5S		MI	20275	5781	30818	4750	36377	3839	38879	3157	40963	2103	50356	1592	33998
14-#14	1.80	MA	24819	5781	37083	4813	44248	3892	47535	3205	50494	2151	62733	1668	41947
5L-4S		MI	21105	5781	32065	4736	37874	3841	40706	3147	43423	2095	53482	1656	34907
14-#14	1.80	MA	23837	5781	35711	4814	42418	3907	45308	3203	47531	2160	58698	1559	40678
6L-3S		MI	22021	5781	33297	4736	39538	3829	42723	3151	46118	2103	56450	1788	35099
14-#14	1.80	MA	22874	5781	34376	4816	40651	3907	43149	3216	44527	2154	55105	1457	39235
7L-2S		MI	23280	5781	34948	4736	41633	3831	45260	3141	49515	2095	60968	1919	35179
14-#18	3.20	MA	30727	6671	49710	5324	60049	4261	66595	3441	76168	2096	95770	1617	75106
3L-6S		MI	20675	6671	34638	5277	40857	4238	44185	3385	47893	2029	59917	949	52827
14-#18	3.20	MA	28842	6671	47025	5325	56419	4285	62195	3435	70230	2083	89176	1383	72459
4L-5S		MI	22002	6671	36584	5280	43450	4218	47340	3396	51985	2016	65343	1143	55910
14-#18	3.20	MA	27136	6671	44307	5353	53158	4283	58215	3456	64811	2097	82276	1266	69393
5L-4S		MI	23385	6671	38771	5256	46075	4225	50543	3381	56239	2003	70750	1253	58109

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

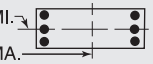


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.20	MA	25501	6671	41893	5355	49939	4308	54297	3450	59600	2111	75285	1073	65539
6L-3S		MI	24909	6671	40930	5258	48991	4205	54076	3392	60902	2016	75844	1487	60389
14-#18	3.20	MA	23898	6671	39543	5356	46829	4306	50498	3471	54316	2098	69069	891	61726
7L-2S		MI	27004	6671	43814	5260	52649	4212	58508	3377	66777	2003	83619	1720	60817
16-#11	1.43	MA	27202	5543	39177	4657	47045	3780	50995	3121	55226	2155	68380	2039	34813
2L-8S		MI	18436	5543	27354	4615	31978	3749	33551	3099	33892	2133	41160	1548	26304
16-#11	1.43	MA	26085	5543	37738	4659	45221	3780	48784	3131	52244	2162	64322	1947	34763
3L-7S		MI	18982	5543	28096	4615	32955	3750	34771	3101	35519	2128	43212	1600	26925
16-#11	1.43	MA	25282	5543	36673	4660	43780	3791	47038	3130	49887	2159	61642	1856	34651
4L-6S		MI	19536	5543	28849	4615	33951	3752	35988	3094	37205	2133	45186	1671	27384
16-#11	1.43	MA	24555	5543	35596	4672	42487	3791	45460	3139	47738	2166	58860	1809	34441
5E		MI	20100	5543	29623	4615	34982	3742	37244	3096	38868	2128	47408	1747	28000
16-#11	1.43	MA	23859	5543	34640	4674	41212	3802	43908	3138	45673	2173	56027	1734	33641
6L-4S		MI	20689	5543	30493	4604	36027	3744	38519	3089	40597	2123	49606	1791	28132
16-#11	1.43	MA	23178	5543	33710	4675	39980	3802	42403	3148	43579	2170	53501	1663	32997
7L-3S		MI	21339	5543	31353	4604	37190	3735	39927	3091	42491	2128	51699	1883	28198
16-#11	1.43	MA	22504	5543	32794	4677	38774	3803	40895	3147	41560	2177	50903	1609	32173
8L-2S		MI	22233	5543	32508	4604	38654	3736	41702	3084	44878	2123	54882	1974	28223
16-#14	2.06	MA	29512	5944	44277	4895	53394	3953	58634	3228	65497	2130	82072	1981	49593
2L-8S		MI	18740	5944	29218	4852	34166	3921	36125	3205	37281	2101	46002	1283	35451
16-#14	2.06	MA	27955	5944	42217	4897	50781	3953	55469	3241	61227	2139	76294	1849	49435
3L-7S		MI	19503	5944	30281	4852	35566	3924	37873	3210	39595	2094	48921	1357	36623
16-#14	2.06	MA	26834	5944	40689	4898	48715	3967	52965	3239	57847	2134	72480	1718	49112
4L-6S		MI	20274	5944	31360	4852	36994	3926	39618	3200	41994	2101	51720	1459	37814
16-#14	2.06	MA	25822	5944	39144	4915	46861	3967	50701	3252	54765	2143	68512	1651	47836
5E		MI	21062	5944	32469	4853	38472	3914	41417	3204	44360	2094	54874	1568	38694
16-#14	2.06	MA	24851	5944	37772	4917	45031	3982	48474	3250	51802	2152	64477	1542	46611
6L-4S		MI	21883	5944	33716	4838	39968	3916	43243	3194	46820	2086	58000	1632	39731
16-#14	2.06	MA	23901	5944	36437	4918	43264	3982	46314	3263	48798	2147	60884	1440	45096
7L-3S		MI	22789	5944	34948	4838	41633	3904	45260	3199	49515	2094	60968	1764	39955
16-#14	2.06	MA	22961	5944	35122	4920	41532	3982	44151	3261	45900	2156	57177	1362	43511
8L-2S		MI	24036	5944	36599	4838	43727	3906	47797	3189	52912	2086	65486	1895	40061
16-#18	3.66	MA	30473	6962	50636	5507	60999	4418	67744	3519	77716	2070	99189	1347	82705
4L-6S		MI	21998	6962	37522	5459	44516	4371	48617	3469	53768	2010	67693	899	60926
16-#18	3.66	MA	28797	6962	47919	5535	57738	4416	63764	3540	72297	2084	92289	1230	79761
5E		MI	23303	6962	39469	5462	47108	4351	51772	3481	57859	1996	73118	1093	64140
16-#18	3.66	MA	27191	6962	45505	5537	54519	4441	59846	3535	67086	2098	85298	1037	75783
6L-4S		MI	24664	6962	41656	5437	49733	4358	54975	3465	62114	1983	78525	1203	66235
16-#18	3.66	MA	25617	6962	43155	5538	51410	4439	56047	3555	61803	2085	79082	855	71742
7L-3S		MI	26164	6962	43814	5440	52649	4338	58508	3476	66777	1996	83619	1436	68800
16-#18	3.66	MA	24060	6962	40841	5539	48362	4436	52240	3550	56704	2098	72638	720	67540
8L-2S		MI	28230	6962	46699	5442	56307	4345	62940	3461	72652	1983	91395	1670	69294
18-#11	1.61	MA	27892	5656	40615	4728	48869	3832	53205	3154	58208	2150	72437	2028	39071
2L-9S		MI	18474	5656	27691	4697	32436	3810	34126	3139	34669	2133	42328	1474	28900
18-#11	1.61	MA	26784	5656	39177	4730	47045	3832	50995	3163	55226	2157	68380	1937	39006
3L-8S		MI	19011	5656	28509	4686	33443	3801	35326	3131	36280	2128	44343	1533	29581
18-#11	1.61	MA	25988	5656	38111	4731	45604	3843	49248	3163	52869	2154	65699	1846	38876
4L-7S		MI	19553	5656	29251	4686	34419	3802	36546	3134	37907	2123	46395	1585	30250
18-#11	1.61	MA	25268	5656	37034	4743	44312	3843	47670	3172	50720	2161	62918	1798	38648
5L-6S		MI	20101	5656	30004	4686	35416	3803	37763	3126	39592	2128	48369	1656	30696
18-#11	1.61	MA	24578	5656	36078	4745	43036	3854	46118	3171	48655	2168	60084	1724	37782
6L-5S		MI	20661	5656	30778	4686	36447	3794	39018	3129	41255	2123	50591	1731	31376
18-#11	1.61	MA	23903	5656	35148	4746	41805	3854	44613	3181	46561	2165	57559	1653	37154
7L-4S		MI	21245	5656	31648	4675	37492	3796	40293	3121	42984	2117	52788	1776	31526
18-#11	1.61	MA	23236	5656	34232	4748	40598	3854	43105	3180	44542	2172	54961	1598	36284
8L-3S		MI	21889	5656	32508	4675	38654	3786	41702	3124	44878	2123	54882	1867	31608
18-#11	1.61	MA	22574	5656	33221	4759	39355	3865	41622	3189	42542	2179	52386	1540	35360
9L-2S		MI	22777	5656	33663	4675	40119	3788	43476	3116	47265	2117	58065	1958	31645

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

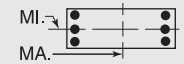
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.32	MA	28917	6108	44277	4999	53394	4027	58634	3288	65497	2132	82072	1832	55489
3L-8S		MI	19542	6108	30869	4954	36260	3996	38663	3253	40677	2092	50520	1259	40153
18-#14	2.32	MA	27809	6108	42749	5000	51328	4042	56130	3287	62117	2126	78259	1701	55134
4L-7S		MI	20296	6108	31932	4954	37660	3999	40411	3257	42992	2085	53438	1333	41290
18-#14	2.32	MA	26809	6108	41204	5017	49473	4042	53867	3300	59035	2136	74291	1634	53738
5L-6S		MI	21059	6108	33012	4955	39088	4001	42155	3247	45391	2092	56238	1435	42554
18-#14	2.32	MA	25850	6108	39832	5019	47644	4057	51639	3298	56072	2145	70256	1525	52552
6L-5S		MI	21838	6108	34121	4955	40566	3988	43954	3252	47757	2085	59391	1544	43401
18-#14	2.32	MA	24911	6108	38497	5021	45876	4057	49480	3311	53069	2139	66662	1423	50968
7L-4S		MI	22650	6108	35368	4940	42063	3991	45780	3242	50216	2077	62518	1608	44553
18-#14	2.32	MA	23983	6108	37183	5022	44145	4057	47316	3309	50171	2149	62956	1345	49421
8L-3S		MI	23546	6108	36599	4940	43727	3978	47797	3246	52912	2085	65486	1739	44805
18-#14	2.32	MA	23061	6108	35731	5039	42360	4071	45188	3322	47301	2158	59291	1261	47311
9L-2S		MI	24781	6108	38251	4940	45821	3981	50335	3236	56309	2077	70004	1871	44935
18-#18	4.12	MA	30428	7253	51530	5717	62318	4549	69313	3625	79784	2071	102302	1194	90146
5L-6S		MI	23297	7253	40407	5641	48174	4504	53049	3554	59643	1990	75468	849	69047
18-#18	4.12	MA	28849	7253	49116	5718	59100	4574	65395	3619	74572	2084	95311	1001	86048
6L-5S		MI	24582	7253	42353	5643	50767	4484	56204	3565	63734	1976	80894	1043	72386
18-#18	4.12	MA	27302	7253	46766	5720	55990	4572	61596	3640	69289	2071	89095	819	81940
7L-4S		MI	25922	7253	44540	5619	53392	4491	59407	3549	67989	1963	86301	1153	74389
18-#18	4.12	MA	25772	7253	44452	5721	52942	4569	57789	3634	64191	2085	82651	684	77698
8L-3S		MI	27400	7253	46699	5621	56307	4471	62940	3560	72652	1976	91395	1386	77207
20-#11	1.78	MA	28575	5770	42054	4799	50694	3884	55415	3187	61190	2145	76495	2017	43324
2L-10S		MI	18516	5770	28107	4768	32931	3861	34694	3169	35400	2122	43555	1392	31318
20-#11	1.78	MA	27476	5770	40615	4801	48869	3884	53205	3196	58208	2152	72437	1926	43245
3L-9S		MI	19047	5770	28846	4768	33901	3862	35900	3172	37056	2127	45510	1459	32201
20-#11	1.78	MA	26686	5770	39550	4802	47428	3895	51458	3195	55851	2149	69757	1835	43099
4L-8S		MI	19580	5770	29664	4757	34907	3853	37100	3164	38667	2122	47526	1517	32864
20-#11	1.78	MA	25972	5770	38473	4814	46136	3895	49880	3205	53702	2156	66976	1788	42853
5L-7S		MI	20117	5770	30406	4757	35884	3854	38320	3167	40294	2117	49578	1570	33580
20-#11	1.78	MA	25289	5770	37517	4815	44861	3906	48328	3204	51637	2163	64142	1713	41929
6E		MI	20661	5770	31159	4757	36881	3855	39537	3159	41980	2122	51552	1641	34014
20-#11	1.78	MA	24620	5770	36587	4817	43629	3906	46823	3213	49543	2160	61617	1642	41316
7L-5S		MI	21216	5770	31933	4756	37912	3846	40793	3162	43642	2117	53774	1716	34684
20-#11	1.78	MA	23959	5770	35671	4818	42422	3906	45315	3213	47524	2167	59019	1588	40401
8L-4S		MI	21795	5770	32803	4746	38957	3847	42068	3154	45371	2112	55971	1761	34917
20-#11	1.78	MA	23303	5770	34660	4830	41179	3917	43832	3222	45524	2174	56444	1529	39496
9L-3S		MI	22434	5770	33663	4746	40119	3838	43476	3157	47265	2117	58065	1852	35013
20-#11	1.78	MA	22649	5770	33747	4832	39981	3917	42342	3221	43467	2171	53783	1449	38327
10L-2S		MI	23315	5770	34818	4745	41584	3840	45251	3149	49653	2112	61248	1943	35063
20-#14	2.57	MA	28771	6271	44809	5103	53941	4117	59296	3334	66388	2119	84037	1684	61157
4L-8S		MI	20333	6271	32520	5056	38354	4071	41200	3300	44074	2083	55037	1235	44810
20-#14	2.57	MA	27782	6271	43264	5119	52086	4117	57032	3347	63306	2128	80069	1617	59651
5L-7S		MI	21078	6271	33583	5057	39754	4073	42948	3305	46389	2076	57956	1309	45968
20-#14	2.57	MA	26835	6271	41892	5121	50257	4132	54805	3345	60343	2138	76034	1508	58499
6E		MI	21833	6271	34663	5057	41182	4076	44692	3295	48788	2083	60756	1411	47300
20-#14	2.57	MA	25907	6271	40557	5123	48489	4132	52645	3358	57340	2132	72441	1406	56849
7L-5S		MI	22603	6271	35772	5057	42660	4063	46491	3299	51153	2076	63909	1520	48120
20-#14	2.57	MA	24990	6271	39243	5124	46758	4131	50482	3356	54442	2141	68735	1328	55338
8L-4S		MI	23407	6271	37019	5042	44157	4066	48318	3289	53613	2068	67036	1584	49373
20-#14	2.57	MA	24079	6271	37791	5141	44973	4146	48354	3369	51572	2151	65070	1244	53191
9L-3S		MI	24294	6271	38251	5042	45821	4053	50335	3294	56309	2076	70004	1715	49651
20-#14	2.57	MA	23172	6271	36482	5143	43254	4146	46215	3367	48621	2145	61281	1129	51103
10L-2S		MI	25517	6271	39902	5043	47916	4056	52872	3283	59705	2068	74522	1847	49804

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

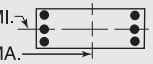


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#18	4.58	MA	30479	7544	52728	5900	63680	4707	70944	3703	82059	2071	105324	965	96332
6E		MI	24576	7544	43291	5823	51832	4637	57481	3638	65518	1970	83244	798	77187
20-#18	4.58	MA	28957	7544	50377	5901	60570	4705	67144	3724	76776	2058	99108	783	92156
7L-5S		MI	25842	7544	45238	5825	54425	4617	60636	3649	69609	1957	88670	993	80597
20-#18	4.58	MA	27452	7544	48064	5903	57522	4702	63338	3718	71677	2072	92664	648	87870
8L-4S		MI	27162	7544	47425	5801	57050	4624	63839	3634	73864	1943	94076	1103	82566
22-#11	1.96	MA	28159	5883	42054	4872	50694	3936	55415	3229	61190	2147	76495	1915	47482
3L-10S		MI	19088	5883	29262	4839	34396	3913	36469	3202	37787	2117	46738	1377	34593
22-#11	1.96	MA	27376	5883	40988	4873	49253	3947	53669	3228	58833	2144	73815	1824	47320
4L-9S		MI	19614	5883	30001	4839	35366	3914	37675	3205	39443	2122	48693	1443	35505
22-#11	1.96	MA	26669	5883	39911	4885	47960	3947	52091	3238	56684	2151	71033	1777	46985
5L-8S		MI	20142	5883	30819	4828	36372	3905	38875	3197	41054	2117	50708	1502	36153
22-#11	1.96	MA	25991	5883	38955	4886	46685	3958	50538	3237	54619	2158	68200	1702	46081
6L-7S		MI	20675	5883	31561	4828	37349	3906	40095	3200	42681	2111	52760	1554	36913
22-#11	1.96	MA	25329	5883	38025	4888	45453	3958	49033	3246	52525	2155	65675	1631	45481
7L-6S		MI	21214	5883	32314	4828	38345	3907	41312	3192	44367	2117	54735	1625	37337
22-#11	1.96	MA	24674	5883	37109	4889	44247	3958	47526	3245	50505	2162	63076	1577	44523
8L-5S		MI	21764	5883	33088	4827	39377	3898	42567	3195	46030	2111	56956	1701	37983
22-#11	1.96	MA	24023	5883	36098	4901	43003	3969	46043	3255	48506	2169	60502	1518	43637
9L-4S		MI	22339	5883	33958	4817	40421	3899	43842	3187	47759	2106	59154	1746	38305
22-#11	1.96	MA	23376	5883	35186	4903	41805	3969	44552	3254	46449	2165	57841	1439	42441
10L-3S		MI	22973	5883	34818	4817	41584	3890	45251	3190	49653	2111	61248	1837	38416
22-#11	1.96	MA	22672	5883	34281	4904	40576	3980	43078	3263	44458	2172	55287	1381	41322
11L-2S		MI	23848	5883	35973	4816	43049	3891	47026	3182	52040	2106	64431	1928	38478
22-#14	2.83	MA	28743	6435	45324	5222	54699	4192	60198	3394	67577	2121	85848	1600	65573
5L-8S		MI	21113	6435	34172	5159	40449	4146	43737	3348	47471	2074	59555	1210	49446
22-#14	2.83	MA	27806	6435	43953	5223	52870	4206	57970	3392	64614	2130	81813	1491	64453
6L-7S		MI	21851	6435	35235	5159	41849	4148	45485	3352	49785	2067	62474	1285	50654
22-#14	2.83	MA	26889	6435	42617	5225	51102	4206	55811	3405	61611	2125	78220	1389	62738
7L-6S		MI	22597	6435	36315	5159	43277	4151	47230	3342	52184	2074	65274	1387	52051
22-#14	2.83	MA	25982	6435	41303	5227	49371	4206	53648	3403	58713	2134	74513	1311	61243
8L-5S		MI	23359	6435	37423	5159	44755	4138	49028	3347	54550	2067	68427	1496	52846
22-#14	2.83	MA	25082	6435	39852	5243	47586	4221	51519	3416	55843	2143	70849	1227	59078
9L-4S		MI	24154	6435	38670	5145	46251	4141	50855	3336	57010	2059	71554	1560	54191
22-#14	2.83	MA	24184	6435	38543	5245	45867	4221	49381	3415	52892	2138	67060	1112	56962
10L-3S		MI	25032	6435	39902	5145	47916	4128	52872	3341	59705	2067	74522	1691	54494
22-#18	5.03	MA	30586	7834	53989	6083	65150	4838	72693	3808	84262	2045	109121	747	102388
7L-6S		MI	25837	7834	46176	6004	55490	4770	61913	3722	71393	1950	91019	748	85346
22-#18	5.03	MA	29105	7834	51675	6085	62103	4835	68887	3803	79164	2059	102677	612	98057
8L-5S		MI	27084	7834	48122	6007	58083	4750	65068	3733	75484	1937	96445	943	88644
24-#11	2.14	MA	28059	5997	42427	4944	51077	3998	55879	3261	61815	2138	77872	1814	51540
4L-10S		MI	19653	5997	30417	4910	35861	3965	38244	3235	40174	2111	49921	1362	37872
24-#11	2.14	MA	27357	5997	41350	4956	49785	3999	54301	3271	59666	2146	75091	1766	51115
5L-9S		MI	20175	5997	31155	4909	36831	3966	39449	3238	41831	2116	51876	1428	38814
24-#11	2.14	MA	26686	5997	40394	4957	48509	4009	52748	3270	57601	2153	72257	1692	50237
6L-8S		MI	20699	5997	31974	4899	37837	3957	40650	3230	43442	2111	53891	1487	39446
24-#11	2.14	MA	26029	5997	39463	4959	47278	4010	51243	3279	55507	2149	69732	1621	49649
7E		MI	21227	5997	32716	4899	38814	3958	41869	3233	45069	2106	55943	1539	40248
24-#11	2.14	MA	25380	5997	38548	4960	46071	4010	49736	3278	53487	2156	67134	1566	48650
8L-6S		MI	21761	5997	33469	4898	39810	3959	43087	3225	46754	2111	57917	1610	40664
24-#11	2.14	MA	24736	5997	37536	4972	44828	4021	48253	3288	51488	2163	64559	1508	47781
9L-5S		MI	22307	5997	34243	4898	40842	3950	44342	3228	48417	2106	60139	1685	41288
24-#11	2.14	MA	24094	5997	36624	4974	43629	4021	46763	3287	49431	2160	61898	1428	46559
10L-4S		MI	22877	5997	35113	4888	41886	3951	45617	3220	50146	2101	62337	1730	41692
24-#11	2.14	MA	23394	5997	35719	4975	42400	4032	45289	3296	47440	2167	59345	1370	45419
11L-3S		MI	23506	5997	35973	4887	43049	3942	47026	3223	52040	2106	64431	1821	41815
24-#11	2.14	MA	22710	5997	34818	4976	41205	4032	43807	3295	45458	2174	56790	1313	44085
12L-2S		MI	24376	5997	37128	4887	44513	3943	48800	3215	54427	2101	67613	1913	41889

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#14	3.09	MA	28765	6598	46013	5325	55483	4281	61136	3440	68885	2123	87592	1474	70411
6L-8S		MI	21884	6598	35823	5261	42543	4221	46274	3395	50868	2065	64073	1186	54091
24-#14	3.09	MA	27858	6598	44678	5327	53715	4281	58976	3453	65881	2117	83998	1372	68636
7E		MI	22613	6598	36886	5261	43943	4223	48022	3400	53182	2057	66992	1261	55348
24-#14	3.09	MA	26962	6598	43363	5329	51984	4281	56813	3451	62983	2126	80292	1294	67095
8L-6S		MI	23352	6598	37966	5261	45371	4225	49767	3389	55581	2065	69792	1363	56808
24-#14	3.09	MA	26072	6598	41912	5346	50199	4296	54685	3464	60114	2136	76627	1210	64971
9L-5S		MI	24106	6598	39075	5261	46849	4213	51566	3394	57947	2057	72945	1472	57580
24-#14	3.09	MA	25177	6598	40603	5347	48480	4296	52547	3462	57163	2130	72839	1094	62827
10L-4S		MI	24894	6598	40322	5247	48346	4215	53392	3384	60407	2050	76072	1536	59008
24-#18	5.49	MA	30732	8125	55287	6266	66683	4968	74436	3887	86650	2045	112690	576	108258
8L-6S		MI	27081	8125	49060	6186	59149	4903	66345	3806	77267	1930	98795	698	93520

RECTANGULAR TIED COLUMNS 38" x 48"

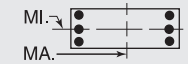
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.32	MA	28991	5710	41789	4785	49855	3887	53749	3215	57656	2237	70660	2101	34661
2L-3S		MI	20397	5710	30419	4704	35534	3816	37543	3176	38518	2189	46010	1777	26720
6-#18	1.32	MA	26034	5710	37996	4787	45045	3885	47921	3237	49793	2252	60086	1867	34469
3L-2S		MI	22638	5710	33303	4707	39192	3823	41975	3161	44393	2175	53786	2011	26783
8-#18	1.75	MA	30792	6000	45582	4966	54666	4020	59577	3299	65519	2224	81234	2068	45893
2L-4S		MI	20158	6000	31145	4884	36276	3969	38442	3249	39730	2156	48692	1493	34270
8-#18	1.75	MA	27890	6000	41789	4968	49855	4018	53749	3321	57656	2239	70660	1834	45586
3E		MI	21769	6000	33303	4886	39192	3949	41975	3260	44393	2169	53786	1727	35185
8-#18	1.75	MA	25790	6000	38972	4971	46046	4044	49133	3317	51426	2227	63690	1600	44341
4L-2S		MI	23972	6000	36188	4889	42850	3956	46407	3245	50268	2156	61562	1960	35350
10-#14	1.23	MA	28779	5655	40962	4777	49053	3884	52885	3218	56565	2254	69568	2137	32828
2L-5S		MI	19429	5655	28532	4721	33361	3833	35000	3184	35288	2215	42596	1731	24838
10-#14	1.23	MA	27085	5655	38800	4779	46311	3884	49563	3232	52082	2264	63474	2005	32765
3L-4S		MI	20282	5655	29779	4706	34858	3835	36827	3174	37748	2208	45723	1795	25307
10-#14	1.23	MA	25864	5655	37198	4781	44144	3899	46937	3230	48538	2259	59449	1874	32554
4L-3S		MI	21222	5655	31011	4706	36523	3823	38844	3179	40444	2215	48690	1927	25409
10-#14	1.23	MA	24758	5655	35578	4798	42201	3900	44564	3244	45307	2269	55270	1806	31835
5L-2S		MI	22510	5655	32662	4706	38617	3825	41381	3169	43841	2208	53208	2058	25422
10-#18	2.19	MA	32548	6291	49376	5148	59477	4153	65405	3384	73383	2210	91808	2034	57097
2L-5S		MI	20086	6291	31842	5090	37310	4095	39671	3349	41350	2149	51061	1333	39780
10-#18	2.19	MA	29695	6291	45582	5150	54666	4151	59577	3406	65519	2225	81234	1801	56692
3L-4S		MI	21524	6291	34029	5066	39934	4102	42874	3334	45605	2136	56468	1443	42269
10-#18	2.19	MA	27637	6291	42765	5152	50857	4177	54961	3401	59289	2214	74264	1567	54993
4L-3S		MI	23107	6291	36188	5068	42850	4082	46407	3345	50268	2149	61562	1677	43628
10-#18	2.19	MA	25773	6291	39915	5181	47437	4175	50787	3423	53605	2229	66989	1449	51348
5L-2S		MI	25274	6291	39072	5070	46508	4089	50839	3329	56143	2136	69337	1910	43880
12-#11	1.03	MA	27940	5518	39073	4705	46783	3832	50190	3188	52966	2267	64835	2163	27546
2L-6S		MI	19149	5518	27551	4649	32193	3792	33635	3150	33551	2239	40100	1793	20909
12-#11	1.03	MA	26746	5518	37564	4706	44869	3832	47871	3197	49837	2275	60558	2072	27528
3L-5S		MI	19725	5518	28324	4648	33224	3783	34890	3153	35214	2234	42322	1868	21296
12-#11	1.03	MA	25886	5518	36447	4708	43358	3843	46040	3197	47365	2272	57731	1981	27457
4E		MI	20326	5518	29195	4638	34269	3784	36165	3146	36943	2228	44519	1913	21374
12-#11	1.03	MA	25108	5518	35318	4720	42004	3844	44386	3207	45113	2279	54803	1933	27290
5L-3S		MI	20989	5518	30055	4638	35431	3775	37574	3148	38837	2234	46613	2004	21396
12-#11	1.03	MA	24363	5518	34317	4722	40668	3855	42759	3206	42949	2287	51816	1859	26690
6L-2S		MI	21899	5518	31210	4637	36896	3776	39349	3141	41224	2228	49796	2095	21385
12-#14	1.48	MA	29827	5819	43125	4879	51796	3958	56208	3265	61048	2246	75663	2121	39235
2L-6S		MI	19435	5819	29075	4823	33978	3920	35739	3227	36319	2213	43960	1598	28530

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

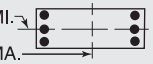


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.48	MA	28152	5819	40962	4881	49053	3959	52885	3279	56565	2256	69568	1990	39138
3L-5S		MI	20244	5819	30183	4823	35456	3908	37538	3232	38685	2206	47114	1707	29499
12-#14	1.48	MA	26945	5819	39360	4884	46887	3974	50260	3278	53020	2251	65543	1858	38885
4E		MI	21087	5819	31431	4808	36952	3910	39364	3222	41145	2198	50240	1771	30145
12-#14	1.48	MA	25854	5819	37740	4900	44943	3974	47887	3291	49789	2262	61364	1790	37987
5L-3S		MI	22016	5819	32662	4808	38617	3898	41381	3226	43841	2206	53208	1902	30285
12-#14	1.48	MA	24808	5819	36303	4903	43026	3990	45552	3290	46684	2272	57108	1682	36561
6L-2S		MI	23291	5819	34314	4809	40711	3900	43918	3216	47237	2198	57726	2034	30329
12-#18	2.63	MA	34264	6582	53169	5330	64287	4286	71234	3468	81246	2197	102381	2001	68284
2L-6S		MI	20090	6582	32781	5269	38375	4248	40948	3422	43134	2142	53411	1089	45181
12-#18	2.63	MA	31458	6582	49376	5332	59477	4284	65405	3490	73383	2212	91808	1767	67791
3L-5S		MI	21446	6582	34727	5271	40968	4228	44103	3433	47225	2129	58836	1283	47963
12-#18	2.63	MA	29437	6582	46558	5334	55668	4310	60789	3485	67152	2201	84837	1534	65691
4E		MI	22858	6582	36914	5247	43593	4235	47306	3418	51480	2116	64243	1393	50317
12-#18	2.63	MA	27609	6582	43708	5363	52248	4308	56615	3507	61469	2216	77563	1415	62204
5L-3S		MI	24415	6582	39072	5250	46508	4215	50839	3429	56143	2129	69337	1627	52058
12-#18	2.63	MA	25855	6582	41177	5365	48873	4334	52506	3502	56004	2231	70180	1223	58492
6L-2S		MI	26549	6582	41957	5252	50167	4222	55271	3414	62017	2116	77113	1860	52387
14-#11	1.20	MA	28688	5631	40583	4776	48697	3884	52509	3220	56094	2262	69112	2154	32025
2L-7S		MI	19171	5631	27953	4720	32661	3843	34192	3191	34253	2228	41308	1707	23729
14-#11	1.20	MA	27504	5631	39073	4777	46783	3884	50190	3230	52966	2270	64835	2063	31990
3L-6S		MI	19730	5631	28706	4720	33658	3844	35410	3183	35938	2233	43283	1778	24206
14-#11	1.20	MA	26651	5631	37956	4779	45273	3895	48359	3230	50494	2267	62008	1971	31898
4L-5S		MI	20302	5631	29479	4719	34689	3835	36665	3186	37601	2228	45504	1853	24682
14-#11	1.20	MA	25881	5631	36828	4791	43918	3896	46705	3239	48242	2274	59080	1924	31709
5L-4S		MI	20897	5631	30350	4709	35734	3836	37940	3178	39330	2223	47702	1898	24780
14-#11	1.20	MA	25143	5631	35826	4793	42582	3907	45078	3239	46078	2282	56093	1849	31021
6L-3S		MI	21554	5631	31210	4708	36896	3827	39349	3181	41224	2228	49796	1989	24821
14-#11	1.20	MA	24420	5631	34852	4794	41292	3907	43502	3249	43885	2279	53430	1778	30307
7L-2S		MI	22457	5631	32365	4708	38361	3828	41123	3173	43612	2223	52979	2080	24826
14-#14	1.73	MA	30858	5982	45287	4982	54539	4033	59531	3313	65530	2239	81757	2106	45633
2L-7S		MI	19463	5982	29646	4925	34644	3993	36532	3285	37317	2197	45679	1472	32245
14-#14	1.73	MA	29201	5982	43125	4984	51796	4034	56208	3326	61048	2249	75663	1974	45505
3L-6S		MI	20246	5982	30726	4925	36072	3995	38276	3275	39716	2204	48478	1574	33251
14-#14	1.73	MA	28009	5982	41523	4986	49629	4049	53582	3325	57503	2244	71637	1843	45214
4L-5S		MI	21046	5982	31835	4925	37550	3983	40075	3279	42082	2197	51632	1683	34177
14-#14	1.73	MA	26931	5982	39903	5003	47686	4049	51209	3338	54272	2254	67459	1775	44158
5L-4S		MI	21879	5982	33082	4910	39047	3985	41901	3269	44542	2189	54758	1747	34978
14-#14	1.73	MA	25898	5982	38465	5005	45768	4064	48875	3337	51167	2264	63203	1667	42783
6L-3S		MI	22798	5982	34314	4911	40711	3973	43918	3274	47237	2197	57726	1878	35151
14-#14	1.73	MA	24887	5982	37066	5007	43916	4065	46612	3351	48019	2259	59411	1565	41396
7L-2S		MI	24061	5982	35965	4911	42805	3975	46456	3263	50634	2189	62244	2010	35222
14-#18	3.07	MA	33184	6873	53169	5514	64287	4417	71234	3574	81246	2199	102381	1734	78886
3L-6S		MI	21443	6873	35665	5451	42033	4381	45380	3506	49008	2122	61186	1039	53247
14-#18	3.07	MA	31198	6873	50352	5516	60478	4443	66618	3569	75015	2188	95411	1500	76428
4L-5S		MI	22776	6873	37611	5453	44626	4361	48535	3517	53100	2109	66612	1233	56169
14-#18	3.07	MA	29403	6873	47502	5545	57058	4441	62443	3591	69332	2203	88137	1382	73083
5L-4S		MI	24166	6873	39798	5429	47251	4368	51738	3502	57354	2096	72019	1343	58405
14-#18	3.07	MA	27682	6873	44971	5547	53683	4467	58334	3587	63867	2218	80754	1189	69244
6L-3S		MI	25697	6873	41957	5431	50167	4348	55271	3513	62017	2109	77113	1577	60480
14-#18	3.07	MA	25995	6873	42507	5549	50423	4466	54351	3609	58326	2206	74185	1008	65424
7L-2S		MI	27801	6873	44841	5434	53825	4355	59703	3498	67892	2096	84888	1810	60879
16-#11	1.37	MA	29427	5744	42092	4846	50611	3936	54828	3253	59223	2257	73389	2144	36498
2L-8S		MI	19202	5744	28366	4791	33149	3894	34747	3221	35013	2228	42439	1639	26508
16-#11	1.37	MA	28252	5744	40583	4848	48697	3936	52509	3263	56094	2264	69112	2053	36448
3L-7S		MI	19750	5744	29108	4791	34126	3895	35967	3224	36640	2222	44491	1691	27051
16-#11	1.37	MA	27407	5744	39466	4850	47187	3947	50678	3262	53623	2262	66284	1962	36336
4L-6S		MI	20304	5744	29861	4790	35122	3896	37184	3216	38326	2228	46465	1762	27511

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

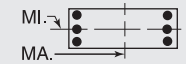
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.37	MA	26643	5744	38337	4862	45832	3948	49024	3272	51371	2269	63357	1914	36126
5E		MI	20871	5744	30634	4790	36154	3887	38439	3219	39989	2222	48687	1838	28064
16-#11	1.37	MA	25912	5744	37335	4864	44496	3959	47398	3272	49207	2277	60370	1839	35361
6L-4S		MI	21461	5744	31505	4780	37198	3888	39715	3211	41717	2217	50885	1883	28181
16-#11	1.37	MA	25197	5744	36361	4865	43206	3959	45821	3282	47013	2274	57707	1768	34667
7L-3S		MI	22113	5744	32365	4779	38361	3879	41123	3214	43612	2222	52979	1974	28238
16-#11	1.37	MA	24489	5744	35402	4867	41942	3960	44241	3281	44897	2281	54972	1713	33891
8L-2S		MI	23009	5744	33520	4779	39825	3880	42898	3206	45999	2217	56161	2065	28258
16-#14	1.97	MA	31875	6146	47450	5084	57281	4108	62853	3360	70013	2231	87852	2090	52023
2L-8S		MI	19505	6146	30234	5027	35338	4065	37321	3328	38400	2195	47278	1373	35711
16-#14	1.97	MA	30234	6146	45287	5086	54539	4108	59531	3374	65530	2241	81757	1958	51865
3L-7S		MI	20270	6146	31298	5027	36738	4068	39069	3332	40714	2188	50196	1448	36897
16-#14	1.97	MA	29056	6146	43685	5088	52372	4124	56905	3372	61986	2237	77732	1827	51542
4L-6S		MI	21044	6146	32377	5027	38167	4070	40814	3322	43113	2195	52996	1550	37982
16-#14	1.97	MA	27991	6146	42065	5105	50428	4124	54532	3386	58755	2247	73553	1759	50343
5E		MI	21835	6146	33486	5027	39644	4057	42612	3327	45479	2188	56149	1659	38871
16-#14	1.97	MA	26971	6146	40628	5107	48511	4139	52197	3384	55649	2257	69297	1651	49015
6L-4S		MI	22659	6146	34733	5013	41141	4060	44439	3316	47939	2180	59276	1723	39806
16-#14	1.97	MA	25972	6146	39229	5109	46659	4140	49934	3398	52501	2252	65505	1549	47555
7L-3S		MI	23568	6146	35965	5013	42805	4047	46456	3321	50634	2188	62244	1854	40010
16-#14	1.97	MA	24984	6146	37852	5111	44844	4140	47667	3397	49464	2262	61602	1470	45844
8L-2S		MI	24819	6146	37616	5013	44900	4050	48993	3311	54031	2180	66762	1986	40105
16-#18	3.51	MA	32925	7164	54145	5698	65289	4576	72446	3654	82879	2174	105985	1467	87197
4L-6S		MI	22770	7164	38550	5633	45691	4514	49812	3591	54883	2103	68962	989	61338
16-#18	3.51	MA	31161	7164	51295	5726	61869	4574	68271	3676	77195	2189	98710	1349	83982
5E		MI	24082	7164	40496	5635	48284	4494	52967	3602	58975	2089	74388	1183	64396
16-#18	3.51	MA	29470	7164	48764	5728	58494	4600	64163	3671	71730	2204	91328	1156	80018
6L-4S		MI	25450	7164	42683	5611	50909	4501	56170	3586	63229	2076	79794	1293	66525
16-#18	3.51	MA	27813	7164	46300	5731	55233	4598	60179	3693	66190	2193	84758	974	76130
7L-3S		MI	26958	7164	44841	5613	53825	4481	59703	3597	67892	2089	84888	1526	68895
16-#18	3.51	MA	26174	7164	43875	5733	52039	4597	56188	3688	60844	2208	77964	838	71463
8L-2S		MI	29033	7164	47726	5615	57483	4488	64135	3582	73767	2076	92664	1760	69359
18-#11	1.54	MA	30157	5858	43601	4917	52526	3987	57147	3286	62352	2252	77665	2134	40966
2L-9S		MI	19239	5858	28702	4872	33607	3955	35322	3262	35790	2227	43607	1565	29096
18-#11	1.54	MA	28991	5858	42092	4919	50611	3988	54828	3296	59223	2259	73389	2043	40901
3L-8S		MI	19778	5858	29521	4862	34614	3945	36522	3254	37401	2222	45622	1624	29783
18-#11	1.54	MA	28153	5858	40975	4921	49101	3999	52997	3295	56752	2256	70561	1952	40772
4L-7S		MI	20322	5858	30262	4862	35591	3947	37741	3257	39027	2217	47674	1676	30377
18-#11	1.54	MA	27397	5858	39846	4933	47746	4000	51343	3305	54500	2264	67634	1904	40543
5L-6S		MI	20872	5858	31016	4861	36587	3948	38959	3249	40713	2222	49648	1747	30823
18-#11	1.54	MA	26672	5858	38845	4935	46410	4010	49717	3305	52336	2271	64647	1829	39708
6L-5S		MI	21433	5858	31789	4861	37618	3939	40214	3252	42376	2217	51870	1822	31443
18-#11	1.54	MA	25963	5858	37870	4936	45120	4011	48140	3314	50142	2269	61984	1759	39033
7L-4S		MI	22019	5858	32660	4850	38663	3940	41489	3244	44105	2212	54068	1867	31578
18-#11	1.54	MA	25263	5858	36911	4938	43856	4012	46560	3314	48026	2276	59249	1704	38208
8L-3S		MI	22665	5858	33520	4850	39825	3931	42898	3247	45999	2217	56161	1958	31650
18-#11	1.54	MA	24567	5858	35852	4950	42553	4023	45007	3324	45931	2284	56534	1645	37213
9L-2S		MI	23555	5858	34675	4850	41290	3932	44672	3239	48386	2212	59344	2050	31683
18-#14	2.22	MA	31253	6309	47450	5188	57281	4183	62853	3421	70013	2234	87852	1943	58222
3L-8S		MI	20309	6309	31886	5129	37433	4140	39858	3375	41796	2186	51795	1349	40410
18-#14	2.22	MA	30087	6309	45847	5190	55115	4198	60227	3420	66469	2229	83826	1811	57868
4L-7S		MI	21066	6309	32949	5129	38833	4142	41606	3380	44111	2179	54714	1423	41561
18-#14	2.22	MA	29035	6309	44228	5207	53171	4199	57855	3433	63238	2239	79648	1743	56541
5L-6S		MI	21831	6309	34029	5129	40261	4145	43351	3369	46510	2186	57514	1526	42721

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

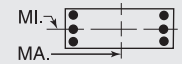


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.22	MA	28027	6309	42790	5209	51253	4214	55520	3432	60132	2249	75392	1635	55254
6L-5S		MI	22614	6309	35138	5130	41739	4132	45149	3374	48876	2179	60667	1635	43577
18-#14	2.22	MA	27040	6309	41391	5211	49401	4214	53257	3445	56984	2244	71600	1533	53724
7L-4S		MI	23429	6309	36385	5115	43235	4135	46976	3364	51335	2171	63794	1699	44631
18-#14	2.22	MA	26064	6309	40014	5213	47587	4215	50990	3444	53947	2254	67696	1455	52054
8L-3S		MI	24329	6309	37616	5115	44900	4122	48993	3368	54031	2179	66762	1830	44863
18-#14	2.22	MA	25095	6309	38493	5230	45717	4230	48760	3457	50940	2265	63830	1370	49949
9L-2S		MI	25568	6309	39268	5115	46994	4125	51530	3358	57428	2171	71280	1962	44982
18-#18	3.95	MA	32886	7454	55088	5908	66680	4707	74099	3760	85058	2176	109284	1315	94899
5L-6S		MI	24073	7454	41434	5814	49350	4647	54244	3675	60758	2083	76737	939	69452
18-#18	3.95	MA	31224	7454	52557	5910	63305	4733	69991	3755	79593	2191	101901	1123	90813
6L-5S		MI	25366	7454	43380	5817	51942	4627	57399	3686	64850	2070	82163	1133	72639
18-#18	3.95	MA	29595	7454	50093	5912	60044	4731	66007	3777	74053	2180	95332	941	86696
7L-4S		MI	26713	7454	45567	5793	54567	4634	60602	3671	69104	2056	87570	1243	74674
18-#18	3.95	MA	27984	7454	47668	5915	56849	4730	62016	3772	68707	2195	88538	804	82288
8L-3S		MI	28199	7454	47726	5795	57483	4614	64135	3682	73767	2070	92664	1476	77307
20-#11	1.71	MA	30879	5971	45111	4988	54440	4039	59466	3319	65481	2246	81942	2124	45430
2L-10S		MI	19281	5971	29118	4943	34102	4005	35890	3292	36520	2216	44835	1484	31583
20-#11	1.71	MA	29721	5971	43601	4990	52526	4040	57147	3329	62352	2254	77665	2033	45351
3L-9S		MI	19813	5971	29857	4943	35072	4006	37096	3295	38177	2222	46789	1550	32395
20-#11	1.71	MA	28891	5971	42484	4992	51015	4051	55316	3328	59881	2251	74838	1942	45205
4L-8S		MI	20348	5971	30676	4933	36079	3997	38296	3287	39788	2216	48805	1609	33064
20-#11	1.71	MA	28141	5971	41356	5004	49661	4051	53663	3338	57629	2259	71911	1894	44959
5L-7S		MI	20887	5971	31417	4932	37055	3999	39516	3290	41415	2211	50857	1661	33707
20-#11	1.71	MA	27423	5971	40354	5005	48325	4062	52036	3337	55465	2266	68924	1820	44062
6E		MI	21433	5971	32171	4932	38052	4000	40733	3282	43100	2216	52831	1732	34141
20-#11	1.71	MA	26720	5971	39380	5007	47034	4063	50459	3347	53271	2263	66261	1749	43402
7L-5S		MI	21990	5971	32944	4932	39083	3991	41989	3285	44763	2211	55053	1807	34820
20-#11	1.71	MA	26026	5971	38421	5009	45770	4064	48879	3347	51155	2271	63526	1694	42531
8L-4S		MI	22571	5971	33815	4921	40128	3992	43264	3277	46492	2206	57250	1852	34971
20-#11	1.71	MA	25337	5971	37361	5021	44467	4074	47326	3357	49060	2278	60811	1636	41557
9L-3S		MI	23212	5971	34675	4921	41290	3983	44672	3280	48386	2211	59344	1943	35058
20-#11	1.71	MA	24637	5971	36406	5023	43212	4075	45765	3356	46905	2276	58005	1556	40444
10L-2S		MI	24096	5971	35830	4921	42755	3984	46447	3272	50774	2206	62527	2034	35102
20-#14	2.47	MA	31105	6473	48010	5292	57857	4273	63550	3467	70951	2222	89921	1796	64194
4L-8S		MI	21102	6473	33537	5231	39527	4215	42396	3422	45193	2177	56313	1325	45116
20-#14	2.47	MA	30064	6473	46390	5309	55913	4274	61177	3481	67720	2232	85742	1728	62750
5L-7S		MI	21850	6473	34600	5231	40927	4217	44144	3427	47508	2170	59232	1399	46235
20-#14	2.47	MA	29068	6473	44953	5311	53996	4289	58843	3479	64615	2242	81486	1620	61501
6E		MI	22608	6473	35680	5232	42355	4220	45888	3417	49907	2177	62032	1502	47466
20-#14	2.47	MA	28092	6473	43554	5314	52144	4289	56580	3493	61467	2237	77694	1518	59903
7L-5S		MI	23382	6473	36789	5232	43833	4207	47687	3421	52272	2170	65185	1611	48293
20-#14	2.47	MA	27128	6473	42177	5316	50329	4290	54313	3491	58430	2247	73791	1439	58271
8L-4S		MI	24189	6473	38036	5217	45330	4210	49513	3411	54732	2162	68312	1675	49454
20-#14	2.47	MA	26170	6473	40656	5333	48459	4305	52082	3505	55423	2257	69924	1355	56128
9L-3S		MI	25079	6473	39268	5217	46994	4197	51530	3416	57428	2170	71280	1806	49712
20-#14	2.47	MA	25210	6473	39284	5335	46658	4305	49842	3503	52330	2252	65927	1239	54045
10L-2S		MI	26308	6473	40919	5218	49088	4199	54067	3405	60825	2162	75797	1938	49853
20-#18	4.39	MA	32948	7745	56350	6092	68115	4866	75819	3839	87456	2178	112475	1089	101627
6E		MI	25357	7745	44319	5996	53008	4780	58676	3759	66633	2063	84513	889	77586
20-#18	4.39	MA	31346	7745	53887	6094	64855	4864	71835	3861	81916	2167	105906	907	97443
7L-5S		MI	26630	7745	46265	5998	55601	4760	61831	3770	70724	2050	89939	1083	80896
20-#18	4.39	MA	29761	7745	51461	6096	61660	4863	67844	3857	76570	2182	99112	771	93110
8L-4S		MI	27957	7745	48452	5974	58226	4767	65034	3755	74979	2036	95346	1193	82846
22-#11	1.88	MA	30444	6085	45111	5061	54440	4092	59466	3362	65481	2249	81942	2023	49798
3L-10S		MI	19854	6085	30273	5014	35567	4057	37665	3325	38908	2211	48017	1468	34855
22-#11	1.88	MA	29620	6085	43994	5062	52929	4103	57635	3361	63010	2246	79115	1932	49637
4L-9S		MI	20382	6085	31012	5014	36537	4058	38871	3327	40564	2216	49972	1534	35698

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

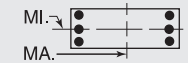


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.88	MA	28877	6085	42865	5075	51575	4103	55982	3371	60758	2254	76187	1885	49376
5L-8S		MI	20912	6085	31831	5004	37543	4049	40071	3320	42175	2211	51988	1593	36350
22-#11	1.88	MA	28165	6085	41864	5076	50239	4114	54355	3370	58594	2261	73200	1810	48420
6L-7S		MI	21447	6085	32572	5003	38520	4050	41291	3322	43802	2206	54039	1645	37040
22-#11	1.88	MA	27469	6085	40889	5078	48948	4115	52778	3380	56400	2258	70537	1739	47775
7L-6S		MI	21988	6085	33326	5003	39517	4052	42508	3315	45488	2211	56014	1716	37463
22-#11	1.88	MA	26781	6085	39930	5080	47684	4115	51199	3380	54284	2266	67802	1684	46859
8L-5S		MI	22540	6085	34099	5003	40548	4042	43763	3317	47151	2206	58236	1792	38122
22-#11	1.88	MA	26098	6085	38870	5092	46382	4126	49645	3389	52189	2273	65088	1626	45905
9L-4S		MI	23116	6085	34970	4992	41593	4044	45038	3310	48879	2201	60433	1837	38362
22-#11	1.88	MA	25413	6085	37915	5094	45127	4127	48084	3389	50034	2270	62282	1546	44763
10L-3S		MI	23753	6085	35830	4992	42755	4035	46447	3312	50774	2206	62527	1928	38462
22-#11	1.88	MA	24668	6085	36967	5095	43839	4138	46539	3399	47948	2278	59594	1488	43603
11L-2S		MI	24631	6085	36985	4992	44220	4036	48222	3305	53161	2201	65710	2019	38518
22-#14	2.71	MA	31080	6636	48553	5412	58656	4348	64500	3528	72203	2224	91837	1712	68970
5L-8S		MI	21884	6636	35189	5333	41621	4290	44933	3470	48590	2168	60831	1301	49817
22-#14	2.71	MA	30095	6636	47115	5414	56738	4364	62165	3527	69098	2234	87581	1604	67755
6L-7S		MI	22625	6636	36252	5334	43021	4292	46681	3474	50904	2160	63750	1375	50918
22-#14	2.71	MA	29130	6636	45716	5416	54886	4364	59902	3540	65950	2229	83789	1502	66090
7L-6S		MI	23375	6636	37331	5334	44449	4294	48425	3464	53303	2168	66549	1478	52217
22-#14	2.71	MA	28177	6636	44339	5418	53072	4364	57635	3539	62912	2240	79885	1423	64494
8L-5S		MI	24141	6636	38440	5334	45927	4282	50224	3469	55669	2160	69703	1587	53018
22-#14	2.71	MA	27230	6636	42818	5435	51202	4380	55405	3552	59905	2250	76019	1339	62314
9L-4S		MI	24939	6636	39687	5319	47424	4284	52051	3458	58129	2153	72830	1651	54275
22-#14	2.71	MA	26274	6636	41447	5437	49400	4380	53164	3551	56813	2245	72022	1224	60204
10L-3S		MI	25821	6636	40919	5320	49088	4272	54067	3463	60825	2160	75797	1782	54557
22-#18	4.82	MA	33068	8036	57680	6276	69666	4997	77664	3945	89779	2153	116479	874	108207
7L-6S		MI	26621	8036	47203	6178	56666	4913	63108	3843	72508	2043	92289	838	85738
22-#18	4.82	MA	31508	8036	55254	6278	66471	4996	73672	3941	84433	2168	109685	737	103831
8L-5S		MI	27877	8036	49149	6180	59259	4893	66263	3854	76599	2030	97714	1033	89115
24-#11	2.05	MA	30342	6198	45503	5133	54844	4155	59954	3394	66138	2241	83392	1923	54068
4L-10S		MI	20420	6198	31428	5085	37032	4109	39439	3358	41295	2205	51200	1453	38131
24-#11	2.05	MA	29605	6198	44374	5145	53489	4155	58301	3404	63887	2248	80464	1875	53745
5L-9S		MI	20944	6198	32167	5085	38002	4110	40645	3360	42952	2210	53155	1519	39005
24-#11	2.05	MA	28900	6198	43373	5147	52153	4166	56674	3403	61722	2256	77477	1800	52784
6L-8S		MI	21470	6198	32986	5074	39008	4101	41845	3353	44563	2205	55170	1578	39643
24-#11	2.05	MA	28209	6198	42398	5149	50863	4167	55097	3413	59529	2253	74814	1729	52152
7E		MI	22000	6198	33727	5074	39985	4102	43065	3355	46189	2200	57222	1630	40375
24-#11	2.05	MA	27527	6198	41439	5151	49599	4167	53518	3412	57413	2261	72079	1674	51193
8L-6S		MI	22537	6198	34481	5074	40981	4103	44283	3348	47875	2205	59197	1701	40789
24-#11	2.05	MA	26850	6198	40380	5163	48296	4178	51964	3422	55317	2268	69364	1616	50257
9L-5S		MI	23085	6198	35254	5074	42013	4094	45538	3350	49538	2200	61418	1777	41426
24-#11	2.05	MA	26167	6198	39424	5164	47041	4179	50403	3422	53163	2265	66559	1536	49058
10L-4S		MI	23657	6198	36125	5063	43057	4096	46813	3343	51267	2195	63616	1822	41750
24-#11	2.05	MA	25431	6198	38476	5166	45753	4190	48859	3431	51077	2273	63871	1478	47946
11L-3S		MI	24289	6198	36985	5063	44220	4086	48222	3345	53161	2200	65710	1913	41864
24-#11	2.05	MA	24712	6198	37533	5168	44501	4190	47307	3431	48940	2270	61178	1421	46509
12L-2S		MI	25161	6198	38140	5063	45685	4088	49996	3338	55548	2195	68893	2004	41931
24-#14	2.96	MA	31109	6800	49278	5516	59481	4438	65488	3574	73580	2227	93675	1588	74014
6L-8S		MI	22657	6800	36840	5436	43716	4364	47470	3517	51987	2159	65349	1277	54457
24-#14	2.96	MA	30155	6800	47879	5518	57629	4439	63225	3587	70432	2222	89883	1486	72285
7E		MI	23390	6800	37903	5436	45116	4367	49218	3522	54301	2151	68268	1351	55610
24-#14	2.96	MA	29213	6800	46502	5520	55814	4439	60958	3586	67395	2232	85980	1408	70723
8L-6S		MI	24133	6800	38983	5436	46544	4369	50963	3511	56700	2159	71067	1454	56973
24-#14	2.96	MA	28276	6800	44981	5537	53944	4454	58728	3600	64388	2242	82113	1324	68506
9L-5S		MI	24891	6800	40092	5436	48022	4357	52761	3516	59066	2151	74221	1563	57751
24-#14	2.96	MA	27324	6800	43609	5539	52143	4455	56487	3598	61296	2237	78116	1208	66369
10L-4S		MI	25682	6800	41339	5422	49518	4359	54588	3506	61526	2144	77347	1627	59094
24-#18	5.26	MA	33229	8327	59048	6460	71281	5129	79501	4025	92296	2155	120259	704	114566
8L-6S		MI	27870	8327	50088	6360	60324	5046	67540	3928	78383	2023	100064	788	93907

RECTANGULAR TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.50	MA	21501	5116	31835	4212	37685	3416	40623	2815	43601	1916	53209	1766	28229
2L-3S		MI	19135	5116	28769	4211	33796	3410	35912	2832	37321	1929	44875	1532	28067
8-#14	1.13	MA	20519	4897	29433	4104	34849	3339	37279	2772	39338	1952	47677	1830	21580
2L-4S		MI	18141	4897	26374	4105	30860	3350	32446	2779	32837	1952	39665	1568	21431
8-#18	2.00	MA	22911	5406	34901	4394	41573	3549	45335	2899	49881	1898	61543	1720	37307
2L-4S		MI	18898	5406	29545	4391	34590	3564	36874	2907	38617	1898	47741	1253	35276
10-#14	1.41	MA	21358	5061	31187	4206	37073	3414	39973	2819	42963	1944	52510	1808	26793
2L-5S		MI	18115	5061	26806	4222	31498	3423	33204	2837	33837	1951	41161	1481	25649
10-#14	1.41	MA	19999	5061	29433	4206	34849	3412	37279	2830	39338	1951	47677	1677	26741
3L-4S		MI	19011	5061	28127	4207	33084	3425	35140	2826	36462	1944	44498	1546	26557
10-#18	2.50	MA	24284	5697	37967	4576	45462	3682	50046	2984	56160	1880	69877	1674	46356
2L-5S		MI	18843	5697	30291	4598	35695	3692	38187	3008	40349	1894	50295	1095	41245
10-#18	2.50	MA	22005	5697	34901	4574	41573	3676	45335	3001	49881	1894	61543	1440	45987
3L-4S		MI	20347	5697	32611	4573	38479	3697	41585	2991	44897	1880	56075	1207	43830

RECTANGULAR TIED COLUMNS 40" x 42"

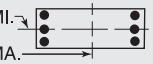
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.43	MA	23554	5328	34574	4411	41005	3579	44184	2954	47399	2028	57859	1880	29849
2L-3S		MI	19989	5328	29901	4394	35097	3561	37237	2960	38560	2028	46285	1627	28140
6-#18	1.43	MA	21039	5328	31327	4411	36886	3575	39193	2973	40715	2041	48966	1646	29687
3L-2S		MI	22361	5328	32967	4395	38985	3567	41948	2943	44839	2014	54620	1861	28275
8-#14	1.07	MA	22497	5110	32022	4303	37991	3503	40629	2911	42813	2061	51917	1941	22795
2L-4S		MI	18992	5110	27495	4289	32158	3502	33771	2908	34079	2051	41083	1664	21497
8-#14	1.07	MA	21036	5110	30166	4304	35638	3501	37777	2922	38966	2069	46769	1810	22782
3E		MI	19996	5110	28800	4289	33922	3489	35910	2912	36955	2059	44262	1795	21611
8-#14	1.07	MA	19975	5110	28787	4304	33772	3515	35517	2919	35915	2062	43379	1678	22646
4L-2S		MI	21375	5110	30554	4289	36146	3491	38604	2901	40580	2051	49094	1926	21614
8-#18	1.90	MA	25062	5618	37822	4593	45125	3712	49174	3038	54084	2012	66753	1838	39467
2L-4S		MI	19750	5618	30677	4575	35891	3715	38198	3035	39856	1997	49151	1348	35641
8-#18	1.90	MA	22594	5618	34574	4592	41005	3708	44184	3057	47399	2025	57859	1604	39194
3E		MI	21449	5618	32967	4576	38985	3694	41948	3044	44839	2010	54620	1581	37117
8-#18	1.90	MA	20799	5618	32153	4592	37732	3730	40217	3049	42095	2012	52016	1370	37624
4L-2S		MI	23777	5618	36033	4577	42874	3700	46659	3027	51119	1997	62954	1815	37359
10-#14	1.34	MA	23393	5273	33878	4405	40345	3577	43480	2958	46660	2054	57064	1921	28312
2L-5S		MI	18964	5273	27927	4407	32795	3575	34529	2966	35079	2051	42579	1577	25863
10-#14	1.34	MA	21950	5273	32022	4406	37991	3576	40629	2970	42813	2062	51917	1789	28260
3L-4S		MI	19863	5273	29248	4391	34382	3577	36465	2955	37704	2043	45915	1641	26630
10-#14	1.34	MA	20903	5273	30642	4407	36126	3590	38368	2967	39762	2054	48526	1658	28076
4L-3S		MI	20855	5273	30554	4391	36146	3564	38604	2959	40580	2051	49094	1773	26791
10-#14	1.34	MA	19953	5273	29246	4422	34450	3589	36323	2978	36978	2062	44979	1592	27246
5L-2S		MI	22218	5273	32308	4391	38370	3566	41298	2948	44205	2043	53927	1904	26832
10-#18	2.38	MA	26532	5909	41070	4774	49244	3845	54164	3123	60769	1996	75646	1795	49056
2L-5S		MI	19692	5909	31423	4782	36996	3843	39512	3136	41588	1992	51705	1190	41554
10-#18	2.38	MA	24108	5909	37822	4774	45125	3841	49174	3141	54084	2010	66753	1562	48687
3L-4S		MI	21204	5909	33743	4756	39780	3848	42909	3119	46135	1979	57485	1302	44185
10-#18	2.38	MA	22348	5909	35401	4774	41851	3863	45208	3133	48779	1996	60909	1328	46698
4L-3S		MI	22870	5909	36033	4758	42874	3827	46659	3129	51119	1992	62954	1535	46078
10-#18	2.38	MA	20752	5909	32948	4800	38908	3859	41616	3151	43938	2010	54756	1214	43844
5L-2S		MI	25158	5909	39099	4759	46763	3833	51370	3112	57398	1979	71288	1769	46414
12-#11	1.11	MA	22696	5136	32261	4333	38407	3526	41182	2928	43593	2068	53118	1953	23788
2L-6S		MI	18663	5136	26899	4332	31557	3533	33076	2931	33204	2072	39885	1635	21804

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis



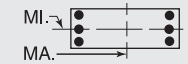
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.11	MA	21677	5136	30964	4334	36763	3526	39189	2937	40905	2074	49498	1862	23777
3L-5S		MI	19270	5136	27718	4332	32649	3523	34405	2933	34972	2066	42260	1711	22379
12-#11	1.11	MA	20938	5136	30001	4335	35461	3536	37612	2935	38775	2069	47111	1770	23718
4E		MI	19904	5136	28640	4321	33756	3524	35756	2925	36811	2061	44603	1756	22503
12-#11	1.11	MA	20270	5136	29027	4346	34292	3535	36185	2944	36833	2075	44622	1724	23573
5L-3S		MI	20603	5136	29552	4320	34988	3514	37249	2927	38826	2066	46843	1847	22551
12-#11	1.11	MA	19629	5136	28163	4347	33139	3545	34781	2942	34966	2081	42094	1649	22950
6L-2S		MI	21565	5136	30778	4320	36543	3515	39133	2919	41367	2060	50245	1938	22556
12-#14	1.61	MA	24274	5437	35734	4507	42699	3652	46332	3005	50507	2046	62212	1901	33811
2L-6S		MI	18980	5437	28506	4509	33454	3663	35318	3010	36179	2050	44038	1446	29792
12-#14	1.61	MA	22847	5437	33878	4508	40345	3651	43480	3017	46660	2054	57064	1769	33727
3L-5S		MI	19832	5437	29680	4509	35019	3650	37224	3014	38704	2043	47411	1555	30827
12-#14	1.61	MA	21813	5437	32498	4509	38480	3665	41220	3014	43609	2047	53674	1638	33501
4E		MI	20719	5437	31002	4494	36606	3652	39160	3003	41329	2035	50748	1619	31757
12-#14	1.61	MA	20876	5437	31102	4525	36804	3664	39174	3026	40825	2055	50127	1572	32508
5L-3S		MI	21698	5437	32308	4493	38370	3639	41298	3006	44205	2043	53927	1751	31958
12-#14	1.61	MA	19978	5437	29862	4525	35150	3677	37161	3023	38147	2063	46533	1464	31384
6L-2S		MI	23046	5437	34061	4493	40594	3641	43993	2995	47830	2035	58760	1882	32030
12-#18	2.86	MA	27970	6200	44318	4956	53363	3978	59155	3207	67453	1980	84539	1753	58627
2L-6S		MI	19716	6200	32426	4962	38135	3997	40877	3211	43494	1987	54223	950	46982
12-#18	2.86	MA	25586	6200	41070	4956	49244	3974	54164	3225	60769	1994	75646	1519	58173
3L-5S		MI	21139	6200	34489	4963	40884	3976	44223	3220	47867	1974	60040	1144	50279
12-#18	2.86	MA	23859	6200	38648	4956	45971	3996	50198	3217	55464	1980	69803	1286	55817
4E		MI	22622	6200	36809	4938	43668	3981	47621	3203	52415	1961	65819	1256	52775
12-#18	2.86	MA	22294	6200	36196	4982	43028	3992	46606	3236	50623	1994	63649	1172	53104
5L-3S		MI	24258	6200	39099	4939	46763	3960	51370	3213	57398	1974	71288	1489	55030
12-#18	2.86	MA	20792	6200	34016	4982	40122	4015	43069	3227	45968	2007	57442	978	49603
6L-2S		MI	26509	6200	42165	4941	50652	3965	56081	3196	63678	1961	79622	1723	55448
14-#11	1.30	MA	23326	5249	33558	4404	40052	3578	43174	2961	46281	2062	56738	1940	27639
2L-7S		MI	18692	5249	27327	4404	32056	3584	33670	2972	33952	2062	41175	1550	24789
14-#11	1.30	MA	22315	5249	32261	4405	38407	3578	41182	2969	43593	2069	53118	1849	27611
3L-6S		MI	19281	5249	28125	4403	33111	3585	34959	2963	35745	2067	43286	1621	25310
14-#11	1.30	MA	21584	5249	31298	4406	37105	3588	39604	2968	41463	2064	50731	1758	27531
4L-5S		MI	19883	5249	28944	4403	34204	3575	36289	2966	37513	2061	45661	1697	25963
14-#11	1.30	MA	20922	5249	30324	4417	35937	3587	38178	2976	39521	2070	48242	1711	27364
5L-4S		MI	20510	5249	29866	4392	35310	3576	37639	2957	39352	2056	48005	1742	26110
14-#11	1.30	MA	20287	5249	29459	4418	34783	3597	36774	2975	37654	2076	45714	1636	26662
6L-3S		MI	21203	5249	30778	4391	36543	3566	39133	2960	41367	2061	50245	1833	26178
14-#11	1.30	MA	19665	5249	28618	4419	33669	3597	35413	2983	35760	2072	43465	1565	26095
7L-2S		MI	22158	5249	32004	4391	38097	3567	41016	2951	43909	2055	53646	1925	26200
14-#14	1.88	MA	25141	5600	37590	4609	45052	3727	49183	3053	54354	2039	67360	1881	39300
2L-7S		MI	19020	5600	29115	4612	34165	3736	36164	3068	37244	2035	45873	1321	33515
14-#14	1.88	MA	23729	5600	35734	4610	42699	3726	46332	3064	50507	2047	62212	1749	39185
3L-6S		MI	19843	5600	30259	4612	35678	3738	38012	3057	39804	2042	48870	1424	34816
14-#14	1.88	MA	22708	5600	34354	4611	40833	3740	44071	3061	47456	2040	58822	1618	38923
4L-5S		MI	20684	5600	31434	4611	37243	3725	39918	3061	42328	2035	52244	1533	35809
14-#14	1.88	MA	21783	5600	32958	4627	39158	3739	42026	3073	44672	2047	55275	1552	37788
5L-4S		MI	21560	5600	32755	4596	38829	3727	41854	3050	44953	2027	55581	1597	36880
14-#14	1.88	MA	20896	5600	31717	4628	37504	3752	40013	3070	41994	2055	51681	1443	36708
6L-3S		MI	22527	5600	34061	4596	40594	3714	43993	3054	47830	2035	58760	1729	37117
14-#14	1.88	MA	20028	5600	30510	4629	35906	3751	38061	3082	39280	2048	48485	1341	35320
7L-2S		MI	23861	5600	35815	4595	42818	3715	46687	3043	51454	2027	63592	1860	37218
14-#18	3.33	MA	27034	6491	44318	5138	53363	4107	59155	3309	67453	1978	84539	1477	67653
3L-6S		MI	21156	6491	35492	5144	42024	4130	45588	3295	49773	1970	62557	904	55598

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

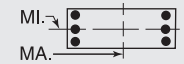


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.33	MA	25337	6491	41896	5137	50090	4129	55188	3301	62149	1964	78696	1243	64975
4L-5S		MI	22554	6491	37556	5145	44773	4109	48934	3305	54147	1956	68374	1098	59027
14-#18	3.33	MA	23800	6491	39444	5164	47147	4125	51597	3320	57308	1978	72543	1130	62386
5L-4S		MI	24010	6491	39875	5120	47557	4114	52332	3288	58694	1943	74153	1210	61403
14-#18	3.33	MA	22326	6491	37264	5163	44241	4148	48060	3312	52652	1991	66335	936	58756
6L-3S		MI	25618	6491	42165	5121	50652	4093	56081	3297	63678	1956	79622	1443	63976
14-#18	3.33	MA	20881	6491	35141	5163	41433	4143	44630	3330	47931	1978	60824	754	55193
7L-2S		MI	27834	6491	45232	5122	54540	4098	60793	3280	69958	1943	87956	1677	64469
16-#11	1.49	MA	23948	5363	34854	4475	41696	3630	45167	2994	48969	2057	60358	1927	31482
2L-8S		MI	18731	5363	27768	4475	32577	3635	34262	3002	34763	2062	42388	1484	27574
16-#11	1.49	MA	22945	5363	33558	4476	40052	3630	43174	3002	46281	2063	56738	1836	31439
3L-7S		MI	19308	5363	28553	4475	33611	3636	35553	3004	36493	2057	44576	1537	28318
16-#11	1.49	MA	22220	5363	32595	4477	38750	3640	41597	3001	44151	2059	54351	1745	31341
4L-6S		MI	19892	5363	29351	4474	34666	3636	36843	2996	38286	2061	46688	1608	28823
16-#11	1.49	MA	21565	5363	31621	4488	37581	3639	40170	3009	42209	2065	51862	1699	31154
5E		MI	20488	5363	30170	4474	35758	3627	38172	2998	40054	2056	49062	1683	29545
16-#11	1.49	MA	20936	5363	30756	4489	36428	3649	38766	3008	40342	2071	49334	1624	30382
6L-4S		MI	21109	5363	31092	4463	36865	3628	39523	2990	41893	2051	51406	1728	29712
16-#11	1.49	MA	20320	5363	29914	4490	35314	3649	37405	3016	38449	2067	47085	1553	29832
7L-3S		MI	21795	5363	32004	4462	38097	3618	41016	2992	43909	2056	53646	1819	29798
16-#11	1.49	MA	19712	5363	29086	4491	34222	3648	36041	3015	36622	2073	44760	1499	29033
8L-2S		MI	22743	5363	33229	4461	39652	3619	42900	2984	46450	2050	57047	1911	29835
16-#14	2.14	MA	25995	5764	39445	4712	47406	3802	52034	3100	58201	2031	72508	1860	44781
2L-8S		MI	19075	5764	29743	4714	34906	3810	37006	3112	38399	2034	47590	1224	37214
16-#14	2.14	MA	24598	5764	37590	4712	45052	3801	49183	3112	54354	2039	67360	1729	44638
3L-7S		MI	19878	5764	30869	4714	36388	3811	38858	3116	40869	2026	50705	1299	38475
16-#14	2.14	MA	23589	5764	36210	4713	43187	3814	46922	3109	51303	2032	63970	1597	44344
4L-6S		MI	20692	5764	32013	4714	37902	3813	40706	3105	43429	2034	53703	1402	39849
16-#14	2.14	MA	22675	5764	34814	4729	41511	3813	44877	3120	48519	2040	60422	1532	43082
5E		MI	21522	5764	33187	4713	39467	3800	42612	3108	45953	2026	57077	1511	40805
16-#14	2.14	MA	21799	5764	33573	4730	39857	3827	42864	3117	45841	2048	56829	1423	42041
6L-4S		MI	22388	5764	34509	4698	41053	3802	44548	3097	48578	2019	60413	1575	42001
16-#14	2.14	MA	20941	5764	32366	4731	38260	3826	40912	3129	43127	2041	53633	1321	40582
7L-3S		MI	23344	5764	35815	4698	42818	3788	46687	3101	51454	2026	63592	1707	42269
16-#14	2.14	MA	20094	5764	31177	4732	36694	3825	38956	3126	40507	2048	50320	1245	39218
8L-2S		MI	24664	5764	37568	4697	45042	3790	49381	3090	55079	2019	68425	1838	42398
16-#18	3.81	MA	26786	6782	45144	5319	54209	4262	60179	3386	68833	1948	87589	1201	74164
4L-6S		MI	22567	6782	38559	5326	45912	4263	50299	3379	56053	1952	70891	858	64239
16-#18	3.81	MA	25276	6782	42692	5345	51266	4258	56587	3404	63992	1962	81436	1087	71687
5E		MI	23940	6782	40622	5327	48662	4242	53645	3389	60426	1939	76708	1052	67793
16-#18	3.81	MA	23828	6782	40512	5345	48360	4281	53050	3396	59337	1975	75228	894	67933
6L-4S		MI	25372	6782	42942	5302	51446	4247	57043	3372	64974	1925	82487	1164	70063
16-#18	3.81	MA	22409	6782	38389	5345	45552	4276	49620	3414	54616	1962	69717	711	64152
7L-3S		MI	26953	6782	45232	5303	54540	4226	60793	3381	69958	1939	87956	1397	72918
18-#11	1.67	MA	24563	5476	36151	4546	43341	3682	47159	3026	51657	2052	63978	1914	35320
2L-9S		MI	18777	5476	28127	4557	33066	3696	34874	3043	35590	2062	43634	1411	30326
18-#11	1.67	MA	23568	5476	34854	4547	41696	3681	45167	3035	48969	2058	60358	1823	35263
3L-8S		MI	19345	5476	28994	4546	34131	3687	36145	3035	37304	2057	45789	1470	31061
18-#11	1.67	MA	22849	5476	33892	4548	40395	3691	43589	3033	46839	2054	57971	1732	35147
4L-7S		MI	19916	5476	29779	4546	35165	3688	37437	3037	39034	2051	47977	1523	31852
18-#11	1.67	MA	22199	5476	32918	4559	39226	3691	42162	3042	44897	2060	55482	1686	34924
5L-6S		MI	20494	5476	30577	4545	36221	3688	38726	3029	40827	2056	50089	1594	32343
18-#11	1.67	MA	21577	5476	32053	4560	38073	3701	40758	3040	43030	2066	52954	1611	34109
6L-5S		MI	21085	5476	31396	4544	37313	3679	40056	3031	42595	2051	52464	1669	33092
18-#11	1.67	MA	20967	5476	31211	4561	36959	3701	39397	3049	41137	2062	50705	1540	33573
7L-4S		MI	21701	5476	32318	4534	38420	3680	41406	3023	44434	2045	54807	1714	33311
18-#11	1.67	MA	20364	5476	30382	4562	35867	3700	38034	3047	39310	2068	48380	1487	32728
8L-3S		MI	22381	5476	33229	4533	39652	3670	42900	3025	46450	2050	57047	1806	33414

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.67	MA	19766	5476	29467	4573	34742	3710	36692	3056	37501	2074	46085	1428	31933
9L-2S		MI	23321	5476	34455	4532	41207	3671	44783	3017	48991	2045	60449	1897	33464
18-#14	2.41	MA	26838	5927	41301	4814	49759	3877	54886	3147	62048	2024	77655	1840	50256
2L-9S		MI	19141	5927	30254	4832	35602	3897	37879	3170	39578	2033	49363	1117	40362
18-#14	2.41	MA	25454	5927	39445	4815	47406	3876	52034	3159	58201	2032	72508	1709	50087
3L-8S		MI	19930	5927	31497	4817	37130	3884	39701	3159	42024	2026	52422	1202	42161
18-#14	2.41	MA	24456	5927	38066	4816	45540	3889	49774	3156	55150	2025	69117	1577	49762
4L-7S		MI	20724	5927	32623	4816	38612	3886	41553	3163	44494	2018	55538	1277	43446
18-#14	2.41	MA	23554	5927	36669	4831	43865	3888	47729	3168	52366	2032	65570	1512	48388
5L-6S		MI	21527	5927	33766	4816	40125	3888	43401	3152	47053	2026	58536	1380	44889
18-#14	2.41	MA	22688	5927	35429	4832	42211	3902	45716	3165	49688	2040	61976	1403	47381
6L-5S		MI	22348	5927	34941	4816	41691	3875	45307	3156	49578	2018	61909	1489	45812
18-#14	2.41	MA	21841	5927	34222	4833	40613	3901	43764	3176	46974	2033	58780	1301	45854
7L-4S		MI	23204	5927	36263	4800	43277	3876	47243	3145	52203	2011	65246	1553	47119
18-#14	2.41	MA	21003	5927	33033	4834	39047	3900	41808	3173	44354	2041	55468	1225	44488
8L-3S		MI	24149	5927	37568	4800	45042	3863	49381	3149	55079	2018	68425	1685	47417
18-#14	2.41	MA	20171	5927	31720	4850	37434	3913	39884	3185	41760	2049	52207	1140	42550
9L-2S		MI	25456	5927	39322	4800	47266	3865	52076	3138	58704	2011	73258	1816	47572
18-#18	4.29	MA	26726	7072	45940	5527	55385	4391	61578	3488	70677	1946	90329	1045	81005
5L-6S		MI	23952	7072	41625	5507	49801	4396	55011	3464	62333	1934	79225	812	72901
18-#18	4.29	MA	25302	7072	43760	5527	52479	4414	58041	3480	66022	1959	84122	851	77131
6L-5S		MI	25302	7072	43688	5509	52551	4375	58357	3473	66706	1921	85042	1006	76576
18-#18	4.29	MA	23907	7072	41637	5527	49671	4409	54610	3499	61301	1946	78610	669	73278
7L-4S		MI	26711	7072	46008	5483	55335	4380	61754	3456	71254	1908	90822	1118	78750
20-#11	1.86	MA	25171	5589	37448	4617	44985	3734	49151	3059	54345	2047	67598	1902	39154
2L-10S		MI	18829	5589	28571	4629	33593	3747	35481	3074	36370	2052	44807	1317	32823
20-#11	1.86	MA	24183	5589	36151	4618	43341	3733	47159	3068	51657	2053	63978	1811	39083
3L-9S		MI	19388	5589	29353	4628	34620	3748	36758	3076	38132	2057	47035	1397	33836
20-#11	1.86	MA	23471	5589	35188	4619	42039	3743	45581	3066	49527	2049	61591	1720	38952
4L-8S		MI	19951	5589	30220	4617	35686	3739	38029	3068	39845	2052	49190	1456	34554
20-#11	1.86	MA	22827	5589	34214	4630	40870	3743	44155	3075	47585	2055	59102	1673	38628
5L-7S		MI	20517	5589	31005	4617	36720	3739	39320	3070	41575	2046	51378	1509	35389
20-#11	1.86	MA	22210	5589	33350	4631	39717	3753	42751	3073	45718	2061	56574	1598	37842
6E		MI	21089	5589	31802	4616	37775	3740	40609	3062	43368	2051	53490	1580	35869
20-#11	1.86	MA	21606	5589	32508	4632	38603	3752	41390	3082	43825	2056	54325	1527	37318
7L-5S		MI	21675	5589	32622	4615	38868	3731	41939	3064	45137	2046	55865	1655	36590
20-#11	1.86	MA	21009	5589	31679	4633	37511	3752	40026	3080	41998	2062	52000	1474	36430
8L-4S		MI	22285	5589	33544	4604	39974	3731	43290	3056	46976	2040	58208	1700	36907
20-#11	1.86	MA	20416	5589	30764	4644	36386	3762	38684	3089	40189	2069	49705	1415	35652
9L-3S		MI	22960	5589	34455	4604	41207	3722	44783	3058	48991	2045	60449	1792	37026
20-#11	1.86	MA	19826	5589	29939	4645	35302	3762	37336	3087	38329	2064	47332	1335	34544
10L-2S		MI	23893	5589	35681	4603	42761	3723	46667	3050	51532	2040	63850	1883	37089
20-#14	2.68	MA	26299	6091	41301	4917	49759	3950	54886	3207	62048	2024	77655	1689	55533
3L-9S		MI	19992	6091	32007	4934	37826	3972	40573	3218	43203	2025	54195	1095	45336
20-#14	2.68	MA	25312	6091	39921	4918	47894	3964	52625	3203	58997	2017	74265	1557	55180
4L-8S		MI	20772	6091	33250	4919	39354	3959	42395	3207	45649	2018	57255	1180	47093
20-#14	2.68	MA	24420	6091	38525	4934	46218	3963	50580	3215	56213	2025	70718	1491	53705
5L-7S		MI	21557	6091	34376	4919	40836	3961	44247	3210	48119	2010	60371	1255	48427
20-#14	2.68	MA	23564	6091	37285	4934	44565	3977	48567	3212	53535	2033	67124	1383	52728
6E		MI	22351	6091	35520	4918	42349	3963	46095	3199	50678	2018	63368	1358	49935
20-#14	2.68	MA	22727	6091	36077	4935	42967	3976	46615	3224	50821	2026	63928	1280	51135
7L-5S		MI	23162	6091	36694	4918	43915	3949	48001	3203	53203	2010	66742	1467	50830
20-#14	2.68	MA	21899	6091	34889	4936	41401	3974	44659	3221	48201	2033	60616	1204	49723
8L-4S		MI	24009	6091	38016	4903	45501	3951	49937	3192	55828	2003	70079	1531	52236
20-#14	2.68	MA	21077	6091	33576	4952	39788	3988	42735	3232	45607	2041	57354	1120	47827
9L-3S		MI	24944	6091	39322	4902	47266	3938	52076	3196	58704	2010	73258	1663	52562
20-#18	4.76	MA	26751	7363	47008	5709	56598	4547	63031	3564	72706	1943	93015	809	86348
6E		MI	25314	7363	44691	5689	53690	4529	59722	3548	68612	1916	87559	766	81582
20-#18	4.76	MA	25379	7363	44885	5708	53790	4542	59601	3583	67985	1930	87503	627	82422
7L-5S		MI	26644	7363	46754	5690	56439	4508	63068	3557	72986	1903	93376	960	85233

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.04	MA	24792	5703	37448	4688	44985	3785	49151	3101	54345	2048	67598	1798	42901
3L-10S		MI	19438	5703	29797	4700	35148	3799	37364	3107	38911	2047	48208	1303	36285
22-#11	2.04	MA	24086	5703	36485	4689	43684	3795	47574	3099	52216	2044	65211	1707	42754
4L-9S		MI	19992	5703	30579	4699	36175	3800	38641	3109	40673	2052	50436	1383	37350
22-#11	2.04	MA	23447	5703	35511	4701	42515	3795	46147	3108	50273	2050	62722	1661	42340
5L-8S		MI	20549	5703	31446	4688	37241	3790	39912	3101	42386	2046	52591	1442	38052
22-#11	2.04	MA	22836	5703	34646	4702	41362	3805	44743	3106	48406	2056	60194	1585	41579
6L-7S		MI	21110	5703	32231	4687	38275	3791	41204	3103	44116	2041	54780	1495	38929
22-#11	2.04	MA	22237	5703	33805	4703	40248	3804	43382	3115	46513	2051	57945	1515	41066
7L-6S		MI	21678	5703	33028	4687	39330	3792	42493	3095	45909	2046	56892	1566	39399
22-#11	2.04	MA	21645	5703	32976	4703	39156	3804	42018	3113	44686	2057	55620	1461	40136
8L-5S		MI	22258	5703	33847	4686	40422	3782	43823	3097	47678	2041	59266	1641	40096
22-#11	2.04	MA	21058	5703	32061	4715	38031	3814	40677	3122	42877	2063	53325	1402	39375
9L-4S		MI	22864	5703	34770	4675	41529	3783	45173	3089	49517	2035	61610	1687	40502
22-#11	2.04	MA	20473	5703	31235	4716	36947	3813	39329	3120	41017	2059	50952	1322	38241
10L-3S		MI	23533	5703	35681	4675	42761	3774	46667	3091	51532	2040	63850	1778	40635
22-#11	2.04	MA	19869	5703	30416	4717	35835	3823	37995	3129	39216	2065	48668	1266	37173
11L-2S		MI	24459	5703	36907	4674	44316	3774	48550	3083	54073	2035	67251	1869	40711
22-#14	2.95	MA	26157	6255	41777	5020	50248	4039	55477	3251	62844	2010	79413	1537	60597
4L-9S		MI	20832	6255	33761	5036	40050	4047	43267	3265	46827	2017	59028	1073	50317
22-#14	2.95	MA	25275	6255	40381	5036	48572	4038	53432	3263	60060	2018	75866	1471	59030
5L-8S		MI	21603	6255	35004	5021	41578	4034	45089	3254	49273	2010	62088	1158	52035
22-#14	2.95	MA	24429	6255	39141	5037	46918	4052	51418	3259	57382	2025	72272	1363	58081
6L-7S		MI	22379	6255	36130	5021	43060	4036	46941	3258	51743	2002	65203	1233	53417
22-#14	2.95	MA	23601	6255	37933	5037	45321	4050	49466	3271	54668	2018	69076	1260	56425
7L-6S		MI	23164	6255	37273	5020	44573	4037	48790	3247	54303	2010	68201	1336	54987
22-#14	2.95	MA	22783	6255	36744	5038	43755	4049	47511	3268	52048	2026	65763	1184	54966
8L-5S		MI	23967	6255	38448	5020	46139	4024	50695	3251	56828	2002	71574	1445	55857
22-#14	2.95	MA	21970	6255	35432	5054	42141	4063	45586	3280	49454	2034	62502	1099	53111
9L-4S		MI	24804	6255	39770	5005	47725	4026	52631	3240	59453	1995	74911	1509	57353
22-#18	5.24	MA	26828	7654	48133	5890	57909	4675	64591	3667	74670	1914	96397	584	91583
7L-6S		MI	26656	7654	47757	5871	57579	4662	64433	3632	74892	1898	95894	720	90280
24-#11	2.23	MA	24694	5816	37782	4760	45328	3847	49566	3132	54904	2038	68831	1694	46555
4L-10S		MI	20039	5816	31022	4770	36703	3851	39248	3140	41452	2042	51609	1289	39776
24-#11	2.23	MA	24061	5816	36808	4772	44160	3847	48140	3141	52961	2044	66342	1648	46058
5L-9S		MI	20589	5816	31805	4770	37730	3852	40525	3142	43214	2047	53838	1369	40822
24-#11	2.23	MA	23455	5816	35943	4772	43006	3857	46736	3139	51094	2050	63814	1573	45321
6L-8S		MI	21141	5816	32671	4759	38795	3842	41795	3134	44927	2041	55993	1428	41556
24-#11	2.23	MA	22861	5816	35101	4773	41892	3856	45374	3148	49201	2046	61565	1502	44818
7E		MI	21698	5816	33457	4758	39829	3843	43087	3136	46657	2036	58181	1481	42472
24-#11	2.23	MA	22275	5816	34273	4774	40801	3856	44011	3146	47374	2052	59240	1448	43848
8L-6S		MI	22261	5816	34254	4758	40885	3844	44376	3128	48450	2041	60293	1552	42933
24-#11	2.23	MA	21693	5816	33358	4786	39676	3866	42669	3155	45565	2058	56945	1390	43071
9L-5S		MI	22836	5816	35073	4757	41977	3834	45706	3130	50219	2035	62667	1627	43608
24-#11	2.23	MA	21113	5816	32532	4787	38591	3865	41321	3153	43705	2054	54572	1310	41942
10L-4S		MI	23436	5816	35996	4746	43084	3835	47057	3122	52058	2030	65011	1673	44094
24-#11	2.23	MA	20510	5816	31713	4787	37479	3875	39988	3162	41904	2060	52287	1253	40852
11L-3S		MI	24100	5816	36907	4746	44316	3826	48550	3124	54073	2035	67251	1764	44241
24-#14	3.21	MA	26119	6418	42237	5138	50926	4113	56283	3310	63907	2010	81013	1451	64363
5L-9S		MI	21660	6418	35515	5139	42274	4122	45962	3312	50452	2009	63860	1051	55305
24-#14	3.21	MA	25283	6418	40996	5139	49272	4126	54270	3307	61229	2018	77420	1342	63439
6L-8S		MI	22423	6418	36757	5123	43802	4109	47784	3301	52898	2002	66920	1136	56985
24-#14	3.21	MA	24464	6418	39789	5140	47674	4125	52318	3319	58515	2011	74224	1240	61723
7E		MI	23191	6418	37883	5123	45284	4111	49636	3305	55368	1994	70036	1211	58414
24-#14	3.21	MA	23655	6418	38600	5141	46108	4124	50362	3315	55895	2018	70911	1164	60218
8L-6S		MI	23967	6418	39027	5123	46797	4112	51484	3294	57928	2002	73034	1314	60044
24-#14	3.21	MA	22852	6418	37288	5156	44495	4138	48438	3327	53301	2026	67650	1079	58402
9L-5S		MI	24761	6418	40202	5122	48363	4099	53390	3298	60452	1994	76407	1423	60891

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

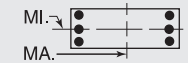
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.36	MA	25692	5540	37413	4610	44451	3743	47876	3093	51326	2140	62660	1993	31469
2L-3S		MI	20842	5540	31032	4578	36398	3712	38561	3088	39798	2126	47696	1723	28210
6-#18	1.36	MA	23028	5540	33984	4611	40102	3740	42606	3113	44236	2153	53207	1760	31307
3L-2S		MI	23221	5540	34099	4579	40286	3717	43272	3071	46077	2113	56030	1956	28318
8-#14	1.02	MA	24560	5322	34711	4502	41259	3666	44111	3050	46374	2168	56306	2051	24010
2L-4S		MI	19842	5322	28616	4474	33455	3654	35096	3037	35321	2150	42500	1759	21560
8-#14	1.02	MA	23014	5322	32753	4503	38776	3666	41102	3062	42315	2177	50843	1920	23997
3E		MI	20849	5322	29921	4474	35220	3641	37235	3041	38197	2158	45679	1891	21653
8-#14	1.02	MA	21893	5322	31299	4504	36810	3680	38720	3059	39100	2170	47241	1788	23861
4L-2S		MI	22231	5322	31675	4473	37444	3643	39929	3030	41822	2150	50512	2022	21648
8-#18	1.82	MA	27301	5831	40843	4792	48801	3876	53146	3177	58416	2126	72112	1954	41627
2L-4S		MI	20602	5831	31808	4758	37192	3866	39523	3163	41094	2095	50561	1443	35998
8-#18	1.82	MA	24685	5831	37413	4792	44451	3873	47876	3197	51326	2139	62660	1721	41354
3E		MI	22306	5831	34099	4759	40286	3845	43272	3173	46077	2108	56030	1677	37197
8-#18	1.82	MA	22786	5831	34860	4793	41000	3896	43693	3190	45700	2126	56441	1487	39998
4L-2S		MI	24643	5831	37165	4761	44175	3850	47983	3156	52357	2095	64364	1910	37410
10-#14	1.28	MA	25515	5485	36669	4604	43742	3741	47119	3097	50433	2161	61769	2032	29831
2L-5S		MI	19814	5485	29047	4591	34093	3727	35854	3095	36321	2150	43996	1673	26071
10-#14	1.28	MA	23986	5485	34711	4605	41259	3740	44111	3109	46374	2169	56306	1901	29779
3L-4S		MI	20716	5485	30369	4576	35679	3729	37790	3084	38946	2142	47333	1737	26699
10-#14	1.28	MA	22880	5485	33257	4606	39293	3755	41728	3107	43159	2163	52704	1770	29595
4L-3S		MI	21710	5485	31675	4576	37444	3716	39929	3088	41822	2150	50512	1869	26838
10-#14	1.28	MA	21878	5485	31786	4623	37528	3754	39574	3119	40226	2172	48946	1703	28855
5L-2S		MI	23077	5485	33428	4576	39668	3718	42623	3077	45447	2142	55344	2000	26869
10-#18	2.27	MA	28868	6121	44273	4973	53151	4009	58415	3262	65506	2111	81565	1915	51756
2L-5S		MI	20542	6121	32555	4965	38297	3994	40836	3264	42826	2090	53116	1285	41854
10-#18	2.27	MA	26298	6121	40843	4974	48801	4006	53146	3281	58416	2125	72112	1681	51387
3L-4S		MI	22060	6121	34875	4940	41081	3999	44234	3247	47373	2077	58896	1397	44532
10-#18	2.27	MA	24436	6121	38289	4975	45349	4029	48963	3274	52790	2111	65894	1448	49593
4L-3S		MI	23733	6121	37165	4941	44175	3978	47983	3257	52357	2090	64364	1631	46165
10-#18	2.27	MA	22748	6121	35704	5002	42247	4026	45177	3294	47656	2125	59367	1332	46461
5L-2S		MI	26030	6121	40231	4942	48064	3983	52695	3240	58636	2077	72698	1864	46470
12-#11	1.06	MA	24769	5348	34959	4532	41693	3690	44688	3067	47189	2174	57562	2062	25052
2L-6S		MI	19512	5348	28014	4518	32853	3685	34401	3060	34447	2171	41306	1732	21950
12-#11	1.06	MA	23691	5348	33591	4533	39959	3690	42587	3076	44354	2181	53723	1971	25040
3L-5S		MI	20121	5348	28834	4517	33945	3676	35731	3062	36216	2166	43681	1807	22443
12-#11	1.06	MA	22911	5348	32577	4534	38587	3700	40925	3075	42111	2177	51189	1880	24981
4E		MI	20756	5348	29756	4506	35052	3676	37081	3054	38055	2161	46024	1853	22550
12-#11	1.06	MA	22206	5348	31552	4546	37357	3700	39423	3084	40065	2184	48554	1833	24837
5L-3S		MI	21457	5348	30667	4506	36284	3667	38574	3056	40070	2165	48264	1944	22589
12-#11	1.06	MA	21529	5348	30641	4547	36142	3710	37945	3083	38099	2190	45874	1758	24252
6L-2S		MI	22422	5348	31893	4505	37838	3668	40458	3048	42611	2160	51666	2035	22587
12-#14	1.53	MA	26453	5649	38627	4706	46226	3816	50128	3144	54492	2153	67232	2014	35633
2L-6S		MI	19829	5649	29626	4694	34751	3815	36643	3139	37421	2149	45455	1542	29984
12-#14	1.53	MA	24941	5649	36669	4707	43742	3815	47119	3157	50433	2162	61769	1883	35549
3L-5S		MI	20684	5649	30801	4694	36317	3802	38549	3143	39946	2142	48829	1651	31032
12-#14	1.53	MA	23849	5649	35215	4709	41777	3830	44737	3154	47218	2156	58167	1751	35324
4E		MI	21574	5649	32123	4678	37903	3804	40485	3132	42571	2134	52165	1715	31831
12-#14	1.53	MA	22859	5649	33744	4725	40012	3829	42583	3167	44284	2164	54409	1685	34412
5L-3S		MI	22556	5649	33428	4678	39668	3791	42623	3136	45447	2142	55344	1847	32009
12-#14	1.53	MA	21910	5649	32438	4726	38270	3843	40462	3164	41464	2173	50595	1576	33184
6L-2S		MI	23908	5649	35182	4678	41892	3793	45318	3124	49072	2134	60177	1978	32072

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

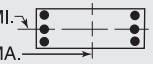


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	2.73	MA	30402	6412	47703	5155	57501	4142	63685	3346	72596	2097	91018	1876	61867
2L-6S		MI	20563	6412	33558	5146	39436	4148	42201	3339	44732	2086	55633	1045	47461
12-#18	2.73	MA	27873	6412	44273	5156	53151	4139	58415	3365	65506	2110	81565	1642	61413
3L-5S		MI	21994	6412	35621	5147	42185	4127	45548	3349	49105	2073	61450	1239	50573
12-#18	2.73	MA	26045	6412	41719	5156	49699	4162	54232	3359	59880	2097	75347	1409	59234
4E		MI	23484	6412	37941	5121	44969	4132	48945	3332	53653	2059	67230	1351	53113
12-#18	2.73	MA	24389	6412	39134	5184	46597	4159	50446	3378	54746	2110	68820	1293	56249
5L-3S		MI	25127	6412	40231	5123	48064	4111	52695	3341	58636	2073	72698	1585	55123
12-#18	2.73	MA	22801	6412	36837	5184	43535	4183	46719	3372	49808	2124	62221	1100	52749
6L-2S		MI	27388	6412	43297	5124	51953	4116	57406	3324	64916	2059	81032	1818	55509
14-#11	1.24	MA	25439	5461	36326	4603	43427	3742	46790	3100	50024	2169	61401	2051	29113
2L-7S		MI	19541	5461	28443	4589	33352	3736	34995	3101	35196	2161	42595	1647	24932
14-#11	1.24	MA	24370	5461	34959	4604	41693	3742	44688	3109	47189	2176	57562	1960	29085
3L-6S		MI	20132	5461	29240	4589	34407	3737	36284	3093	36988	2166	44707	1718	25454
14-#11	1.24	MA	23597	5461	33945	4605	40322	3752	43027	3108	44946	2172	55028	1869	29005
4L-5S		MI	20735	5461	30059	4588	35500	3728	37614	3095	38757	2161	47082	1793	26031
14-#11	1.24	MA	22898	5461	32919	4617	39091	3752	41524	3117	42900	2179	52393	1822	28839
5L-4S		MI	21364	5461	30982	4577	36606	3728	38965	3087	40596	2155	49425	1839	26160
14-#11	1.24	MA	22228	5461	32009	4618	37877	3762	40046	3115	40934	2185	49712	1747	28170
6L-3S		MI	22059	5461	31893	4577	37838	3719	40458	3089	42611	2160	51666	1930	26218
14-#11	1.24	MA	21573	5461	31123	4619	36704	3762	38613	3124	38941	2182	47325	1676	27554
7L-2S		MI	23016	5461	33119	4576	39393	3720	42341	3081	45152	2155	55067	2021	26235
14-#14	1.79	MA	27376	5812	40585	4808	48709	3891	53136	3192	58551	2146	72695	1995	41426
2L-7S		MI	19868	5812	30236	4797	35462	3888	37489	3197	38486	2134	47290	1417	33828
14-#14	1.79	MA	25880	5812	38627	4810	46226	3890	50128	3204	54492	2154	67232	1864	41312
3L-6S		MI	20695	5812	31380	4796	36975	3890	39337	3186	41046	2141	50288	1520	35006
14-#14	1.79	MA	24801	5812	37173	4811	44260	3904	47745	3202	51277	2148	63630	1733	41050
4L-5S		MI	21538	5812	32555	4796	38541	3877	41243	3190	43570	2134	53661	1629	36010
14-#14	1.79	MA	23824	5812	35702	4827	42495	3904	45591	3214	48343	2157	59873	1666	39987
5L-4S		MI	22418	5812	33876	4781	40127	3879	43179	3179	46195	2126	56998	1693	36959
14-#14	1.79	MA	22887	5812	34396	4828	40753	3918	43471	3211	45523	2165	56058	1558	38806
6L-3S		MI	23389	5812	35182	4780	41892	3866	45318	3183	49072	2134	60177	1825	37172
14-#14	1.79	MA	21969	5812	33125	4830	39071	3918	41415	3224	42664	2159	52664	1455	37466
7L-2S		MI	24727	5812	36936	4780	44116	3867	48012	3172	52696	2126	65010	1956	37262
14-#18	3.18	MA	29416	6703	47703	5337	57501	4272	63685	3450	72596	2096	91018	1603	71433
3L-6S		MI	22008	6703	36624	5327	43325	4281	46913	3423	51011	2068	63968	999	56068
14-#18	3.18	MA	27619	6703	45149	5338	54049	4295	59502	3443	66970	2083	84800	1370	68914
4L-5S		MI	23413	6703	38687	5328	46074	4260	50259	3433	55385	2055	69784	1193	59316
14-#18	3.18	MA	25993	6703	42564	5365	50947	4292	55716	3463	61836	2096	78273	1254	66061
5L-4S		MI	24877	6703	41007	5303	48858	4265	53656	3416	59933	2042	75564	1305	61734
14-#18	3.18	MA	24434	6703	40267	5366	47884	4316	51988	3456	56898	2109	71674	1061	62431
6L-3S		MI	26493	6703	43297	5304	51953	4244	57406	3425	64916	2055	81032	1539	64074
14-#18	3.18	MA	22906	6703	38030	5366	44925	4312	48374	3475	51891	2096	65811	879	58847
7L-2S		MI	28721	6703	46363	5306	55841	4249	62117	3408	71196	2042	89366	1772	64534
16-#11	1.42	MA	26101	5575	37694	4674	45162	3794	48891	3133	52859	2164	65239	2039	33167
2L-8S		MI	19580	5575	28883	4661	33873	3787	35587	3132	36007	2162	43808	1580	27803
16-#11	1.42	MA	25040	5575	36326	4675	43427	3794	46790	3142	50024	2171	61401	1948	33124
3L-7S		MI	20158	5575	29669	4660	34907	3788	36879	3134	37737	2156	45997	1633	28461
16-#11	1.42	MA	24274	5575	35312	4676	42056	3804	45128	3140	47781	2167	58867	1857	33026
4L-6S		MI	20744	5575	30466	4660	35962	3789	38168	3126	39530	2161	48109	1704	28966
16-#11	1.42	MA	23582	5575	34287	4688	40826	3804	43626	3149	45735	2174	56232	1810	32838
5E		MI	21342	5575	31285	4659	37054	3779	39497	3128	41298	2156	50483	1779	29617
16-#11	1.42	MA	22918	5575	33376	4689	39611	3814	42147	3148	43769	2180	53551	1735	32096
6L-4S		MI	21965	5575	32208	4648	38161	3780	40848	3120	43137	2150	52827	1825	29766
16-#11	1.42	MA	22269	5575	32490	4690	38438	3814	40714	3157	41776	2176	51164	1664	31499
7L-3S		MI	22654	5575	33119	4648	39393	3771	42341	3122	45152	2155	55067	1916	29841
16-#11	1.42	MA	21627	5575	31618	4691	37289	3814	39279	3156	39852	2183	48702	1610	30741
8L-2S		MI	23604	5575	34345	4647	40948	3771	44225	3114	47694	2150	58468	2007	29872

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

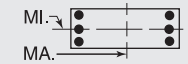
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	2.05	MA	28285	5976	42543	4911	51192	3966	56145	3239	62610	2138	78158	1977	47211
2L-8S		MI	19922	5976	30864	4899	36203	3962	38331	3241	39641	2133	49007	1320	37507
16-#14	2.05	MA	26805	5976	40585	4912	48709	3965	53136	3251	58551	2147	72695	1845	47068
3L-7S		MI	20729	5976	31990	4899	37686	3963	40183	3245	42111	2126	52123	1395	38783
16-#14	2.05	MA	25738	5976	39131	4913	46743	3979	50754	3249	55336	2141	69093	1714	46774
4L-6S		MI	21546	5976	33134	4899	39199	3965	42032	3234	44671	2133	55120	1498	40037
16-#14	2.05	MA	24773	5976	37660	4929	44978	3979	48600	3261	52402	2149	65336	1647	45577
5E		MI	22380	5976	34308	4898	40765	3952	43937	3238	47195	2126	58494	1607	41003
16-#14	2.05	MA	23847	5976	36354	4931	43236	3993	46479	3259	49582	2158	61521	1539	44438
6L-4S		MI	23249	5976	35630	4883	42351	3954	45873	3226	49820	2118	61831	1671	42083
16-#14	2.05	MA	22941	5976	35083	4932	41554	3992	44424	3271	46723	2152	58127	1437	43024
7L-3S		MI	24209	5976	36936	4883	44116	3940	48012	3230	52696	2126	65010	1803	42328
16-#14	2.05	MA	22045	5976	33831	4933	39905	3992	42364	3269	43964	2160	54617	1360	41540
8L-2S		MI	25534	5976	38689	4882	46340	3942	50706	3219	56321	2118	69842	1934	42445
16-#18	3.64	MA	29163	6994	48579	5520	58398	4428	64772	3527	74060	2068	94253	1331	78627
4L-6S		MI	23423	6994	39690	5509	47213	4414	51624	3507	57291	2050	72302	953	64700
16-#18	3.64	MA	27565	6994	45994	5547	55296	4425	60986	3547	68926	2082	87726	1215	75893
5E		MI	24805	6994	41754	5510	49963	4393	54970	3517	61664	2037	78118	1147	68079
16-#18	3.64	MA	26033	6994	43696	5548	52234	4449	57258	3540	63988	2095	81127	1022	72136
6L-4S		MI	26245	6994	44073	5485	52747	4398	58367	3500	66212	2024	83898	1259	70387
16-#18	3.64	MA	24531	6994	41460	5548	49275	4445	53643	3560	58981	2082	75263	840	68330
7L-3S		MI	27835	6994	46363	5486	55841	4377	62117	3510	71196	2037	89366	1493	73021
18-#11	1.60	MA	26755	5688	39062	4745	46896	3845	50992	3165	55694	2159	69078	2028	37216
2L-9S		MI	19625	5688	29242	4743	34362	3849	36199	3173	36834	2162	45055	1507	30546
18-#11	1.60	MA	25702	5688	37694	4746	45162	3845	48891	3175	52859	2166	65239	1936	37158
3L-8S		MI	20195	5688	30109	4732	35427	3839	37470	3165	38548	2156	47210	1566	31287
18-#11	1.60	MA	24943	5688	36680	4747	43791	3856	47229	3173	50616	2162	62706	1845	37043
4L-7S		MI	20768	5688	30894	4731	36461	3840	38762	3167	40278	2151	49398	1619	31994
18-#11	1.60	MA	24257	5688	35654	4759	42560	3856	45727	3182	48570	2168	60070	1799	36837
5L-6S		MI	21348	5688	31692	4731	37517	3841	40051	3159	42071	2156	51510	1690	32485
18-#11	1.60	MA	23599	5688	34744	4760	41346	3866	44249	3181	46604	2175	57390	1724	36029
6L-5S		MI	21941	5688	32511	4730	38609	3831	41381	3161	43839	2150	53884	1765	33201
18-#11	1.60	MA	22956	5688	33858	4761	40173	3866	42816	3190	44611	2171	55003	1653	35448
7L-4S		MI	22559	5688	33433	4719	39716	3832	42732	3153	45678	2145	56228	1811	33367
18-#11	1.60	MA	22320	5688	32986	4762	39024	3866	41380	3189	42687	2178	52541	1599	34642
8L-3S		MI	23242	5688	34345	4718	40948	3823	44225	3155	47694	2150	58468	1902	33459
18-#11	1.60	MA	21688	5688	32023	4774	37839	3876	39967	3198	40783	2184	50106	1540	33778
9L-2S		MI	24185	5688	35571	4718	42502	3823	46108	3147	50235	2145	61869	1993	33503
18-#14	2.30	MA	29182	6140	44501	5013	53675	4040	59153	3286	66669	2131	83621	1958	52990
2L-9S		MI	19987	6140	31375	5017	36899	4049	39204	3299	40820	2133	50780	1213	40756
18-#14	2.30	MA	27717	6140	42543	5014	51192	4040	56145	3299	62610	2139	78158	1827	52821
3L-8S		MI	20779	6140	32618	5001	38427	4036	41026	3288	43266	2125	53840	1298	42509
18-#14	2.30	MA	26661	6140	41089	5015	49226	4054	53762	3296	59394	2133	74556	1696	52496
4L-7S		MI	21577	6140	33744	5001	39910	4038	42878	3292	45736	2118	56955	1373	43750
18-#14	2.30	MA	25707	6140	39618	5032	47462	4053	51608	3309	56461	2142	70799	1629	51179
5L-6S		MI	22384	6140	34887	5001	41423	4040	44726	3281	48295	2125	59953	1476	45076
18-#14	2.30	MA	24793	6140	38312	5033	45720	4068	49488	3306	53641	2150	66984	1521	50077
6L-5S		MI	23209	6140	36062	5000	42989	4027	46632	3285	50820	2118	63327	1585	46008
18-#14	2.30	MA	23898	6140	37041	5034	44037	4067	47432	3319	50782	2144	63590	1418	48593
7L-4S		MI	24068	6140	37383	4985	44575	4028	48568	3274	53445	2110	66663	1649	47205
18-#14	2.30	MA	23013	6140	35789	5035	42388	4067	45372	3316	48023	2153	60080	1341	47147
8L-3S		MI	25018	6140	38689	4985	46340	4015	50706	3278	56321	2118	69842	1781	47479
18-#14	2.30	MA	22133	6140	34407	5052	40689	4081	43346	3329	45291	2161	56618	1257	45168
9L-2S		MI	26330	6140	40443	4984	48564	4017	53401	3267	59946	2110	74675	1912	47621

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

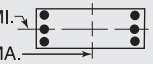


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	4.09	MA	29109	7285	49423	5729	59646	4558	66255	3631	76016	2067	97179	1176	85741
5L-6S		MI	24813	7285	42757	5691	51102	4547	56335	3592	63571	2033	80636	907	73354
18-#18	4.09	MA	27602	7285	47126	5729	56584	4582	62528	3624	71078	2081	90580	983	81862
6L-5S		MI	26172	7285	44820	5692	53851	4526	59681	3601	67944	2019	86452	1101	76858
18-#18	4.09	MA	26126	7285	44889	5730	53625	4578	58913	3644	66071	2067	84716	801	77986
7L-4S		MI	27590	7285	47140	5667	56635	4531	63079	3584	72492	2006	92232	1213	79068
20-#11	1.77	MA	27402	5802	40429	4816	48631	3897	53094	3198	58529	2154	72917	2016	41260
2L-10S		MI	19676	5802	29686	4814	34889	3900	36806	3204	37614	2152	46227	1413	33120
20-#11	1.77	MA	26357	5802	39062	4817	46896	3897	50992	3207	55694	2160	69078	1925	41189
3L-9S		MI	20238	5802	30468	4814	35916	3901	38083	3206	39375	2157	48456	1493	34054
20-#11	1.77	MA	25604	5802	38047	4818	45525	3908	49330	3206	53451	2157	66544	1834	41058
4L-8S		MI	20802	5802	31335	4803	36982	3891	39354	3198	41089	2151	50611	1552	34778
20-#11	1.77	MA	24924	5802	37022	4830	44294	3908	47828	3215	51405	2163	63909	1787	40835
5L-7S		MI	21370	5802	32120	4802	38016	3892	40646	3200	42819	2146	52799	1605	35531
20-#11	1.77	MA	24272	5802	36112	4831	43080	3918	46350	3214	49439	2170	61229	1712	39968
6E		MI	21945	5802	32918	4801	39071	3893	41935	3192	44612	2151	54911	1676	36009
20-#11	1.77	MA	23635	5802	35226	4832	41907	3918	44917	3223	47446	2166	58841	1641	39401
7L-5S		MI	22533	5802	33737	4801	40164	3883	43264	3194	46380	2145	57286	1751	36746
20-#11	1.77	MA	23004	5802	34353	4833	40758	3918	43481	3222	45522	2173	56380	1587	38549
8L-4S		MI	23146	5802	34659	4790	41270	3884	44615	3186	48219	2140	59629	1797	36966
20-#11	1.77	MA	22379	5802	33390	4845	39574	3928	42069	3231	43618	2179	53945	1529	37705
9L-3S		MI	23823	5802	35571	4789	42502	3874	46108	3188	50235	2145	61869	1888	37073
20-#11	1.77	MA	21755	5802	32521	4846	38433	3928	40650	3230	41660	2175	51428	1448	36644
10L-2S		MI	24759	5802	36796	4789	44057	3875	47992	3180	52776	2139	65271	1979	37130
20-#14	2.56	MA	28617	6303	44501	5116	53675	4115	59153	3346	66669	2132	83621	1808	58570
3L-9S		MI	20841	6303	33128	5119	39123	4124	41898	3347	44445	2125	55613	1191	45725
20-#14	2.56	MA	27572	6303	43047	5118	51710	4129	56771	3344	63453	2126	80019	1677	58218
4L-8S		MI	21624	6303	34371	5104	40651	4111	43720	3336	46891	2117	58672	1276	47514
20-#14	2.56	MA	26629	6303	41576	5134	49945	4128	54617	3356	60520	2134	76262	1610	56791
5L-7S		MI	22413	6303	35497	5103	42134	4113	45572	3339	49361	2110	61788	1351	48727
20-#14	2.56	MA	25725	6303	40270	5135	48203	4143	52496	3354	57700	2143	72447	1502	55723
6E		MI	23211	6303	36641	5103	43647	4115	47420	3328	51920	2117	64786	1454	50121
20-#14	2.56	MA	24840	6303	38999	5136	46520	4142	50441	3366	54841	2137	69053	1400	54171
7L-5S		MI	24026	6303	37815	5103	45213	4101	49326	3332	54445	2110	68159	1562	51023
20-#14	2.56	MA	23966	6303	37747	5138	44872	4141	48381	3364	52082	2145	65544	1323	52761
8L-4S		MI	24877	6303	39137	5087	46799	4103	51262	3321	57070	2102	71496	1627	52325
20-#14	2.56	MA	23097	6303	36365	5154	43173	4156	46355	3376	49350	2154	62081	1238	50744
9L-3S		MI	25817	6303	40443	5087	48564	4090	53401	3325	59946	2110	74675	1759	52626
20-#18	4.55	MA	29145	7575	50556	5911	60933	4715	67798	3708	78168	2066	100033	944	91607
6E		MI	26180	7575	45823	5872	54991	4680	61046	3676	69850	2015	88970	861	82028
20-#18	4.55	MA	27692	7575	48319	5912	57974	4711	64183	3728	73161	2053	94169	762	87660
7L-5S		MI	27519	7575	47886	5874	57740	4659	64392	3685	74224	2001	94786	1055	85651
22-#11	1.95	MA	27005	5915	40429	4888	48631	3949	53094	3240	58529	2155	72917	1913	45217
3L-10S		MI	20286	5915	30912	4885	36444	3952	38689	3236	40155	2147	49629	1399	36603
22-#11	1.95	MA	26258	5915	39415	4889	47260	3959	51432	3239	56286	2151	70383	1822	45071
4L-9S		MI	20843	5915	31694	4884	37471	3953	39966	3239	41917	2151	51857	1479	37567
22-#11	1.95	MA	25584	5915	38390	4900	46029	3959	49929	3248	54240	2158	67748	1775	44753
5L-8S		MI	21403	5915	32561	4873	38537	3943	41237	3230	43630	2146	54012	1538	38274
22-#11	1.95	MA	24938	5915	37479	4902	44815	3970	48451	3247	52274	2165	65067	1700	43912
6L-7S		MI	21966	5915	33346	4873	39571	3944	42529	3233	45360	2141	56201	1591	39072
22-#11	1.95	MA	24306	5915	36593	4903	43642	3970	47018	3256	50281	2161	62680	1629	43357
7L-6S		MI	22536	5915	34144	4872	40626	3945	43818	3224	47153	2146	58312	1662	39539
22-#11	1.95	MA	23681	5915	35721	4904	42493	3970	45582	3255	48357	2167	60219	1575	42462
8L-5S		MI	23119	5915	34963	4872	41718	3935	45148	3227	48922	2140	60687	1737	40250
22-#11	1.95	MA	23061	5915	34758	4916	41308	3980	44170	3264	46453	2174	57784	1517	41636
9L-4S		MI	23727	5915	35885	4861	42825	3936	46499	3218	50761	2135	63030	1783	40563
22-#11	1.95	MA	22443	5915	33889	4917	40167	3980	42751	3262	44495	2170	55267	1437	40519
10L-3S		MI	24398	5915	36796	4860	44057	3926	47992	3221	52776	2140	65271	1874	40684

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.95	MA	21783	5915	33027	4918	38996	3990	41347	3271	42599	2177	52848	1380	39475
11L-2S		MI	25328	5915	38022	4860	45612	3927	49875	3212	55317	2134	68672	1965	40753
22-#14	2.81	MA	28472	6467	45005	5220	54193	4204	59779	3391	67512	2118	85482	1658	63939
4L-9S		MI	21683	6467	34882	5221	41347	4199	44592	3394	48069	2116	60445	1169	50702
22-#14	2.81	MA	27539	6467	43534	5236	52428	4203	57625	3404	64579	2127	81725	1592	62414
5L-8S		MI	22458	6467	36125	5206	42875	4186	46414	3383	50515	2109	63505	1254	52451
22-#14	2.81	MA	26645	6467	42228	5237	50686	4217	55505	3401	61759	2135	77911	1484	61375
6L-7S		MI	23238	6467	37251	5206	44358	4188	48266	3387	52985	2102	66621	1329	53712
22-#14	2.81	MA	25770	6467	40957	5239	49004	4217	53449	3413	58900	2129	74516	1381	59759
7L-6S		MI	24027	6467	38394	5205	45871	4189	50115	3376	55545	2109	69618	1432	55173
22-#14	2.81	MA	24905	6467	39705	5240	47355	4216	51389	3411	56141	2138	71007	1304	58355
8L-5S		MI	24834	6467	39569	5205	47437	4176	52020	3380	58070	2102	72992	1540	56048
22-#14	2.81	MA	24046	6467	38323	5256	45656	4230	49363	3423	53409	2146	67544	1220	56326
9L-4S		MI	25675	6467	40891	5190	49023	4178	53956	3369	60695	2094	76329	1605	57444
22-#18	5.00	MA	29234	7866	51749	6093	62324	4844	69452	3812	80251	2039	103622	722	97350
7L-6S		MI	27527	7866	48889	6054	58879	4813	65757	3760	76130	1997	97304	815	90719
24-#11	2.13	MA	26905	6028	40783	4960	48994	4011	53533	3272	59121	2146	74222	1810	49083
4L-10S		MI	20890	6028	32138	4956	37998	4004	40573	3269	42696	2141	53030	1385	40091
24-#11	2.13	MA	26237	6028	39757	4971	47763	4011	52031	3281	57075	2153	71587	1764	48676
5L-9S		MI	21442	6028	32920	4955	39026	4004	41850	3272	44458	2146	55259	1466	41084
24-#11	2.13	MA	25596	6028	38847	4973	46549	4022	50552	3280	55109	2159	68906	1689	47861
6L-8S		MI	21997	6028	33787	4944	40091	3995	43121	3263	46171	2141	57413	1524	41775
24-#11	2.13	MA	24969	6028	37961	4974	45376	4022	49119	3289	53116	2156	66519	1618	47316
7E		MI	22555	6028	34572	4944	41125	3996	44413	3265	47901	2135	59602	1577	42615
24-#11	2.13	MA	24350	6028	37089	4975	44227	4022	47684	3287	51192	2162	64057	1564	46380
8L-6S		MI	23121	6028	35369	4943	42181	3996	45702	3257	49694	2140	61714	1648	43072
24-#11	2.13	MA	23735	6028	36125	4987	43043	4032	46271	3297	49288	2169	61623	1505	45570
9L-5S		MI	23699	6028	36189	4943	43273	3987	47031	3259	51463	2135	64088	1723	43760
24-#11	2.13	MA	23123	6028	35257	4988	41902	4032	44852	3295	47330	2165	59106	1425	44426
10L-4S		MI	24301	6028	37111	4932	44380	3988	48382	3251	53302	2130	66432	1769	44158
24-#11	2.13	MA	22477	6028	34394	4989	40731	4042	43449	3304	45434	2172	56687	1368	43361
11L-3S		MI	24968	6028	38022	4931	45612	3978	49875	3253	55317	2134	68672	1860	44293
24-#14	3.07	MA	28438	6630	45492	5338	54911	4278	60634	3451	68638	2119	87188	1573	68044
5L-9S		MI	22514	6630	36635	5323	43571	4274	47287	3441	51694	2108	65278	1147	55685
24-#14	3.07	MA	27554	6630	44186	5340	53170	4292	58513	3448	65818	2128	83374	1465	67033
6L-8S		MI	23281	6630	37878	5308	45099	4261	49109	3430	54140	2101	68338	1232	57396
24-#14	3.07	MA	26688	6630	42915	5341	51487	4292	56458	3461	62959	2122	79979	1363	65354
7E		MI	24053	6630	39004	5308	46582	4262	50961	3434	56610	2093	71453	1307	58706
24-#14	3.07	MA	25833	6630	41663	5342	49838	4291	54398	3458	60200	2130	76470	1286	63904
8L-6S		MI	24834	6630	40148	5307	48095	4264	52809	3423	59170	2101	74451	1410	60229
24-#14	3.07	MA	24983	6630	40282	5358	48139	4305	52372	3471	57468	2139	73007	1201	61915
9L-5S		MI	25632	6630	41323	5307	49661	4251	54715	3427	61694	2093	77824	1518	61080

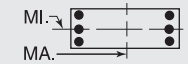
RECTANGULAR TIED COLUMNS 40" x 46"

6-#18	1.30	MA	27917	5752	40352	4809	48023	3907	51701	3232	55353	2250	67610	2105	33089
2L-3S		MI	21694	5752	32164	4761	37699	3863	39886	3216	41036	2224	49106	1818	28277
6-#18	1.30	MA	25102	5752	36740	4810	43443	3904	46152	3253	47867	2264	57597	1872	32927
3L-2S		MI	24079	5752	35230	4762	41587	3868	44597	3199	47315	2211	57440	2051	28361
8-#18	1.74	MA	29626	6043	43963	4991	52603	4040	57250	3316	62840	2237	77623	2069	43787
2L-4S		MI	21454	6043	32940	4941	38493	4017	40847	3291	42332	2193	51972	1538	36347
8-#18	1.74	MA	26862	6043	40352	4992	48023	4037	51701	3337	55353	2250	67610	1836	43514
3E		MI	23164	6043	35230	4943	41587	3996	44597	3301	47315	2207	57440	1772	37272

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

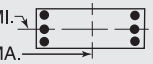


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	1.74	MA	24859	6043	37666	4993	44393	4062	47301	3331	49415	2238	61016	1602	42399
4L-2S		MI	25507	6043	38297	4944	45476	4001	49308	3284	53595	2193	65774	2005	37461
10-#14	1.22	MA	27722	5698	39559	4803	47265	3905	50891	3236	54334	2267	66623	2143	31349
2L-5S		MI	20664	5698	30168	4776	35391	3879	37180	3224	37563	2249	45413	1769	26274
10-#14	1.22	MA	26109	5698	37499	4804	44652	3905	47725	3249	50063	2277	60844	2012	31298
3L-4S		MI	21568	5698	31490	4761	36977	3881	39115	3213	40188	2242	48750	1833	26764
10-#14	1.22	MA	24943	5698	35971	4806	42586	3919	45221	3247	46683	2271	57030	1880	31113
4L-3S		MI	22565	5698	32796	4761	38742	3868	41254	3217	43064	2249	51929	1965	26884
10-#14	1.22	MA	23887	5698	34426	4823	40732	3919	42958	3260	43601	2281	53062	1813	30477
5L-2S		MI	23935	5698	34549	4760	40966	3870	43948	3206	46689	2242	56762	2096	26905
10-#18	2.17	MA	31292	6334	47575	5172	57183	4173	62799	3401	70326	2223	87636	2033	54456
2L-5S		MI	21392	6334	33687	5148	39598	4145	42161	3392	44064	2189	54526	1380	42145
10-#18	2.17	MA	28575	6334	43963	5174	52603	4170	57250	3421	62840	2237	77623	1800	54087
3L-4S		MI	22916	6334	36007	5123	42382	4150	45558	3375	48611	2176	60306	1492	44872
10-#18	2.17	MA	26610	6334	41278	5175	48973	4195	52850	3416	56902	2224	71029	1566	52516
4L-3S		MI	24596	6334	38297	5124	45476	4129	49308	3385	53595	2189	65774	1726	46248
10-#18	2.17	MA	24830	6334	38560	5203	45712	4193	48870	3437	51483	2238	64128	1449	49094
5L-2S		MI	26901	6334	41363	5126	49365	4134	54019	3368	59875	2176	74108	1959	46525
12-#11	1.02	MA	26928	5560	37756	4731	45104	3853	48328	3206	50913	2281	62155	2172	26315
2L-6S		MI	20361	5560	29130	4703	34149	3838	35726	3190	35691	2271	42727	1828	22091
12-#11	1.02	MA	25791	5560	36318	4732	43280	3854	46117	3215	47931	2288	58097	2081	26304
3L-5S		MI	20972	5560	29949	4703	35241	3828	37056	3192	37460	2266	45101	1903	22503
12-#11	1.02	MA	24970	5560	35252	4734	41839	3864	44371	3214	45574	2285	55417	1989	26245
4E		MI	21608	5560	30871	4692	36348	3829	38407	3184	39299	2260	47445	1949	22595
12-#11	1.02	MA	24227	5560	34175	4746	40546	3865	42793	3224	43425	2292	52635	1942	26101
5L-3S		MI	22310	5560	31783	4691	37580	3819	39900	3186	41314	2265	49685	2040	22625
12-#11	1.02	MA	23515	5560	33219	4747	39271	3875	41240	3223	41360	2299	49801	1867	25562
6L-2S		MI	23277	5560	33008	4691	39134	3820	41783	3178	43855	2260	53086	2131	22618
12-#14	1.47	MA	28717	5861	41619	4905	49878	3980	54056	3283	58605	2260	72401	2126	37456
2L-6S		MI	20679	5861	30747	4879	36049	3967	37968	3268	38663	2249	46872	1638	30169
12-#14	1.47	MA	27121	5861	39559	4907	47265	3979	50891	3296	54334	2269	66623	1995	37372
3L-5S		MI	21536	5861	31922	4878	37615	3954	39874	3272	41188	2241	50246	1746	31231
12-#14	1.47	MA	25970	5861	38031	4908	45199	3994	48387	3294	50954	2264	62809	1863	37146
4E		MI	22429	5861	33244	4863	39201	3956	41810	3261	43813	2234	53583	1811	31901
12-#14	1.47	MA	24928	5861	36486	4925	43345	3994	46123	3307	47872	2273	58841	1796	36329
5L-3S		MI	23414	5861	34549	4863	40966	3943	43948	3265	46689	2241	56762	1943	32059
12-#14	1.47	MA	23928	5861	35114	4927	41515	4009	43896	3305	44909	2283	54806	1688	34992
6L-2S		MI	24770	5861	36303	4863	43190	3945	46643	3254	50313	2234	61594	2074	32112
12-#18	2.61	MA	32922	6624	51186	5354	61763	4306	68347	3485	77812	2210	97649	1997	65107
2L-6S		MI	21411	6624	34690	5329	40737	4299	43526	3467	45970	2184	57044	1140	47930
12-#18	2.61	MA	30248	6624	47575	5355	57183	4303	62799	3506	70326	2224	87636	1763	64653
3L-5S		MI	22848	6624	36753	5330	43486	4278	46872	3477	50343	2171	62860	1334	50860
12-#18	2.61	MA	28318	6624	44889	5357	53553	4328	58399	3500	64388	2211	81042	1530	62679
4E		MI	24345	6624	39073	5305	46270	4283	50269	3460	54891	2158	68640	1446	53445
12-#18	2.61	MA	26572	6624	42172	5385	50292	4326	54419	3521	58969	2225	74141	1413	59412
5L-3S		MI	25995	6624	41363	5306	49365	4262	54019	3469	59875	2171	74108	1680	55212
12-#18	2.61	MA	24896	6624	39758	5386	47073	4350	50501	3515	53758	2239	67151	1220	55930
6L-2S		MI	28266	6624	44429	5307	53253	4267	58730	3452	66154	2158	82443	1913	55569
14-#11	1.19	MA	27639	5674	39195	4802	46929	3905	50538	3239	53895	2276	66212	2161	30587
2L-7S		MI	20390	5674	29558	4775	34648	3889	36320	3231	36439	2261	44016	1743	25069
14-#11	1.19	MA	26510	5674	37756	4803	45104	3906	48328	3248	50913	2283	62155	2070	30559
3L-6S		MI	20982	5674	30356	4774	35703	3890	37610	3223	38232	2266	46128	1814	25593
14-#11	1.19	MA	25696	5674	36691	4805	43663	3916	46581	3247	48556	2280	59474	1979	30480
4L-5S		MI	21587	5674	31175	4774	36796	3880	38939	3225	40001	2260	48503	1889	26095
14-#11	1.19	MA	24961	5674	35614	4817	42371	3917	45003	3257	46407	2287	56693	1932	30313
5L-4S		MI	22218	5674	32097	4763	37902	3881	40290	3217	41840	2255	50846	1935	26208
14-#11	1.19	MA	24255	5674	34658	4818	41096	3927	43451	3256	44342	2294	53859	1857	29686
6L-3S		MI	22914	5674	33008	4762	39134	3871	41783	3219	43855	2260	53086	2026	26257

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

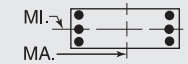
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.19	MA	23565	5674	33727	4820	39864	3928	41946	3265	42249	2291	51334	1786	29019
7L-2S		MI	23874	5674	34234	4761	40689	3872	43667	3211	46396	2254	56488	2117	26268
14-#14	1.71	MA	29697	6025	43680	5007	52491	4054	57222	3331	62876	2253	78180	2109	43552
2L-7S		MI	20717	6025	31357	4981	36760	4040	38814	3326	39728	2233	48707	1513	34132
14-#14	1.71	MA	28118	6025	41619	5009	49878	4054	54056	3344	58605	2262	72401	1978	43438
3L-6S		MI	21546	6025	32501	4981	38273	4042	40662	3315	42288	2240	51705	1616	35189
14-#14	1.71	MA	26979	6025	40091	5011	47812	4069	51552	3342	55225	2256	68588	1846	43176
4L-5S		MI	22393	6025	33676	4981	39839	4029	42568	3319	44812	2233	55079	1724	36206
14-#14	1.71	MA	25950	6025	38546	5027	45958	4069	49289	3355	52143	2266	64620	1779	42199
5L-4S		MI	23275	6025	34997	4965	41425	4031	44504	3308	47437	2226	58415	1789	37033
14-#14	1.71	MA	24963	6025	37174	5029	44128	4084	47061	3353	49180	2275	60585	1671	40913
6L-3S		MI	24249	6025	36303	4965	43190	4018	46643	3312	50313	2233	61594	1921	37226
14-#14	1.71	MA	23997	6025	35839	5031	42361	4084	44902	3366	46176	2270	56991	1569	39631
7L-2S		MI	25592	6025	38057	4965	45414	4019	49337	3301	53938	2226	66427	2052	37306
14-#18	3.04	MA	31886	6915	51186	5537	61763	4436	68347	3590	77812	2211	97649	1727	75213
3L-6S		MI	22859	6915	37756	5511	44626	4432	48237	3551	52250	2167	65378	1094	56529
14-#18	3.04	MA	29990	6915	48501	5539	58133	4461	63948	3584	71875	2198	91055	1494	72882
4L-5S		MI	24272	6915	39819	5512	47375	4411	51583	3561	56623	2153	71194	1288	59598
14-#18	3.04	MA	28274	6915	45783	5567	54872	4459	59968	3605	66456	2212	84154	1377	69754
5L-4S		MI	25744	6915	42139	5487	50159	4416	54981	3544	61171	2140	76974	1400	62058
14-#18	3.04	MA	26629	6915	43369	5568	51653	4483	56050	3599	61244	2225	77164	1184	66140
6L-3S		MI	27368	6915	44429	5488	53253	4395	58730	3553	66154	2153	82443	1634	64169
14-#18	3.04	MA	25016	6915	41019	5569	48543	4481	52250	3620	55961	2212	70947	1002	62552
7L-2S		MI	29605	6915	47495	5489	57142	4400	63442	3536	72434	2140	90777	1867	64597
16-#11	1.36	MA	28341	5787	40633	4873	48753	3957	52748	3272	56877	2271	70270	2150	34852
2L-8S		MI	20428	5787	29999	4846	35168	3940	36912	3261	37250	2261	45229	1676	28026
16-#11	1.36	MA	27221	5787	39195	4874	46929	3957	50538	3281	53895	2278	66212	2059	34809
3L-7S		MI	21008	5787	30784	4846	36203	3941	38204	3264	38981	2256	47418	1729	28598
16-#11	1.36	MA	26414	5787	38129	4876	45488	3968	48791	3280	51538	2275	63532	1968	34710
4L-6S		MI	21596	5787	31581	4845	37258	3942	39493	3255	40773	2261	49529	1800	29104
16-#11	1.36	MA	25685	5787	37052	4888	44195	3968	47213	3290	49389	2282	60751	1921	34523
5E		MI	22195	5787	32401	4845	38350	3932	40823	3258	42542	2255	51904	1875	29684
16-#11	1.36	MA	24986	5787	36096	4889	42920	3979	45661	3289	47324	2289	57917	1846	33817
6L-4S		MI	22821	5787	33323	4834	39457	3933	42174	3249	44381	2250	54247	1921	29817
16-#11	1.36	MA	24302	5787	35166	4890	41688	3979	44156	3298	45230	2286	55392	1775	33171
7L-3S		MI	23511	5787	34234	4833	40689	3923	43667	3252	46396	2255	56488	2012	29883
16-#11	1.36	MA	23627	5787	34250	4892	40482	3980	42648	3297	43211	2293	52794	1721	32461
8L-2S		MI	24464	5787	35460	4832	42244	3924	45550	3243	48937	2249	59889	2103	29908
16-#14	1.96	MA	30662	6188	45740	5109	55104	4129	60387	3378	67146	2245	83959	2092	49641
2L-8S		MI	20769	6188	31985	5084	37501	4113	39656	3370	40883	2232	50424	1416	37791
16-#14	1.96	MA	29099	6188	43680	5111	52491	4129	57222	3391	62876	2254	78180	1961	49498
3L-7S		MI	21580	6188	33111	5084	38984	4115	41508	3374	43353	2225	53540	1491	39084
16-#14	1.96	MA	27973	6188	42152	5113	50425	4144	54718	3389	59496	2249	74367	1829	49204
4L-6S		MI	22399	6188	34255	5083	40497	4117	43357	3363	45913	2232	56538	1594	40219
16-#14	1.96	MA	26956	6188	40606	5129	48571	4144	52454	3402	56414	2258	70399	1762	48084
5E		MI	23237	6188	35429	5083	42063	4104	45263	3367	48437	2225	59911	1702	41196
16-#14	1.96	MA	25981	6188	39235	5131	46741	4159	50227	3400	53451	2268	66363	1654	46843
6L-4S		MI	24109	6188	36751	5068	43649	4106	47198	3356	51062	2217	63248	1767	42161
16-#14	1.96	MA	25027	6188	37899	5133	44974	4158	48067	3413	50447	2262	62770	1552	45486
7L-3S		MI	25073	6188	38057	5067	45414	4092	49337	3359	53938	2225	66427	1899	42385
16-#14	1.96	MA	24083	6188	36585	5135	43242	4158	45904	3411	47549	2272	59064	1474	43878
8L-2S		MI	26402	6188	39810	5067	47638	4094	52031	3348	57563	2217	71260	2030	42491
16-#18	3.48	MA	31629	7206	52112	5720	62713	4594	69497	3668	79361	2185	101068	1458	83118
4L-6S		MI	24279	7206	40822	5692	48514	4565	52948	3636	58529	2149	73712	1048	65153

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

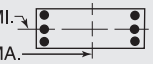


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	3.48	MA	29942	7206	49395	5748	59452	4592	65517	3689	73942	2198	94167	1341	80116
5E		MI	25668	7206	42885	5694	51264	4543	56294	3645	62903	2136	79528	1242	68356
16-#18	3.48	MA	28325	7206	46981	5750	56233	4616	61598	3684	68731	2212	87177	1148	76374
6L-4S		MI	27117	7206	45205	5668	54048	4549	59692	3628	67450	2122	85308	1354	70705
16-#18	3.48	MA	26741	7206	44630	5751	53124	4614	57799	3704	63448	2199	80961	966	72713
7L-3S		MI	28716	7206	47495	5670	57142	4528	63442	3638	72434	2136	90777	1588	73120
16-#18	3.48	MA	25174	7206	42317	5753	50076	4612	53993	3699	58349	2213	74517	831	68317
8L-2S		MI	30922	7206	50562	5671	61031	4533	68153	3621	78713	2122	99111	1821	73614
18-#11	1.53	MA	29034	5900	42072	4944	50577	4009	54958	3304	59859	2266	74328	2140	39111
2L-9S		MI	20473	5900	30358	4928	35657	4001	37525	3303	38078	2261	46475	1604	30759
18-#11	1.53	MA	27923	5900	40633	4945	48753	4009	52748	3314	56877	2273	70270	2049	39054
3L-8S		MI	21044	5900	31225	4917	36723	3992	38796	3294	39791	2256	48630	1662	31508
18-#11	1.53	MA	27123	5900	39568	4947	47312	4020	51002	3313	54520	2270	67590	1957	38938
4L-7S		MI	21620	5900	32010	4917	37757	3993	40087	3297	41522	2251	50819	1715	32131
18-#11	1.53	MA	26400	5900	38490	4958	46019	4020	49424	3322	52371	2277	64808	1910	38733
5L-6S		MI	22202	5900	32807	4916	38813	3993	41377	3288	43315	2255	52931	1786	32622
18-#11	1.53	MA	25708	5900	37535	4960	44744	4031	47871	3322	50306	2284	61975	1835	37957
6L-5S		MI	22796	5900	33627	4915	39905	3984	42706	3290	45083	2250	55305	1861	33271
18-#11	1.53	MA	25030	5900	36604	4961	43513	4031	46366	3331	48212	2280	59450	1765	37327
7L-4S		MI	23416	5900	34549	4904	41012	3985	44057	3282	46922	2245	57649	1907	33421
18-#11	1.53	MA	24361	5900	35689	4963	42306	4032	44859	3330	46193	2288	56851	1710	36568
8L-3S		MI	24101	5900	35460	4904	42244	3975	45550	3284	48937	2250	59889	1998	33503
18-#11	1.53	MA	23696	5900	34677	4975	41063	4042	43375	3340	44193	2295	54277	1652	35634
9L-2S		MI	25047	5900	36686	4903	43798	3976	47434	3276	51478	2244	63290	2089	33541
18-#14	2.20	MA	31615	6352	47800	5212	57717	4204	63553	3425	71417	2238	89737	2075	55724
2L-9S		MI	20833	6352	32496	5201	38197	4201	40529	3428	42062	2232	52197	1309	41140
18-#14	2.20	MA	30066	6352	45740	5213	55104	4204	60387	3438	67146	2247	83959	1944	55555
3L-8S		MI	21629	6352	33739	5186	39725	4188	42351	3417	44508	2224	55257	1394	42790
18-#14	2.20	MA	28953	6352	44212	5215	53038	4219	57883	3437	63766	2241	80145	1812	55230
4L-7S		MI	22430	6352	34864	5186	41208	4190	44203	3421	46978	2217	58373	1469	44046
18-#14	2.20	MA	27948	6352	42667	5232	51184	4219	55620	3450	60684	2251	76177	1745	53982
5L-6S		MI	23241	6352	36008	5186	42721	4192	46051	3410	49537	2224	61370	1572	45257
18-#14	2.20	MA	26984	6352	41295	5233	49354	4233	53392	3448	57721	2260	72142	1637	52781
6L-5S		MI	24069	6352	37183	5185	44287	4179	47957	3414	52062	2217	64744	1680	46198
18-#14	2.20	MA	26041	6352	39960	5235	47587	4233	51233	3461	54718	2255	68549	1535	51352
7L-4S		MI	24932	6352	38504	5170	45873	4180	49893	3403	54687	2209	68081	1745	47287
18-#14	2.20	MA	25108	6352	38646	5237	45855	4233	49070	3459	51820	2264	64842	1457	49783
8L-3S		MI	25885	6352	39810	5170	47638	4167	52031	3407	57563	2217	71260	1877	47539
18-#14	2.20	MA	24181	6352	37194	5253	44070	4248	46941	3472	48950	2273	61178	1372	47811
9L-2S		MI	27203	6352	41564	5169	49862	4169	54726	3396	61188	2209	76092	2008	47669
18-#18	3.91	MA	31581	7497	53006	5930	64032	4725	71066	3774	81429	2185	104181	1305	90495
5L-6S		MI	25673	7497	43888	5874	52403	4698	57660	3720	64809	2131	82046	1002	73799
18-#18	3.91	MA	29990	7497	50592	5931	60814	4749	67147	3768	76217	2199	97190	1112	86629
6L-5S		MI	27041	7497	45952	5875	55152	4676	61006	3729	69182	2118	87862	1196	77132
18-#18	3.91	MA	28432	7497	48242	5933	57704	4747	63348	3789	70934	2186	90974	930	82893
7L-4S		MI	28467	7497	48271	5850	57936	4682	64403	3712	73730	2104	93642	1308	79380
18-#18	3.91	MA	26892	7497	45928	5934	54656	4745	59542	3783	65835	2200	84530	795	78597
8L-3S		MI	30043	7497	50562	5851	61031	4661	68153	3722	78713	2118	99111	1542	82067
20-#11	1.70	MA	29721	6014	43510	5014	52402	4061	57168	3337	62841	2261	78386	2129	43366
2L-10S		MI	20524	6014	30801	5000	36185	4053	38131	3333	38858	2251	47648	1509	33409
20-#11	1.70	MA	28617	6014	42072	5016	50577	4061	54958	3347	59859	2268	74328	2038	43295
3L-9S		MI	21087	6014	31584	4999	37212	4053	39408	3335	40619	2256	49877	1590	34265
20-#11	1.70	MA	27824	6014	41006	5017	49136	4072	53212	3346	57502	2264	71647	1947	43164
4L-8S		MI	21653	6014	32450	4988	38278	4044	40679	3327	42333	2251	52032	1648	34996
20-#11	1.70	MA	27107	6014	39929	5029	47844	4072	51634	3355	55353	2271	68866	1900	42941
5L-7S		MI	22224	6014	33236	4987	39312	4045	41971	3329	44063	2245	54220	1701	35668
20-#11	1.70	MA	26421	6014	38973	5031	46569	4083	50081	3354	53288	2279	66032	1825	42102
6E		MI	22801	6014	34033	4987	40367	4045	43260	3321	45856	2250	56332	1772	36146

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

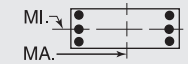
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.70	MA	25749	6014	38043	5032	45337	4083	48576	3364	51194	2275	63507	1754	41488
7L-5S		MI	23390	6014	34852	4986	41460	4036	44590	3323	47624	2245	58707	1847	36856
20-#11	1.70	MA	25086	6014	37127	5034	44130	4083	47069	3363	49175	2282	60909	1699	40682
8L-4S		MI	24006	6014	35775	4975	42566	4037	45941	3315	49463	2239	61050	1893	37023
20-#11	1.70	MA	24427	6014	36116	5046	42887	4094	45586	3372	47175	2289	58334	1641	39768
9L-3S		MI	24685	6014	36686	4975	43798	4027	47434	3317	51478	2244	63290	1984	37119
20-#11	1.70	MA	23759	6014	35204	5047	41689	4094	44096	3372	45118	2286	55673	1561	38733
10L-2S		MI	25624	6014	37912	4974	45353	4028	49317	3309	54020	2239	66691	2075	37169
20-#14	2.45	MA	31021	6515	47800	5316	57717	4279	63553	3486	71417	2240	89737	1927	61608
3L-9S		MI	21689	6515	34249	5304	40421	4276	43223	3476	45687	2224	57030	1287	46105
20-#14	2.45	MA	29920	6515	46272	5317	55651	4293	61049	3484	68037	2234	85924	1795	61255
4L-8S		MI	22476	6515	35492	5288	41949	4263	45045	3465	48133	2216	60090	1372	47797
20-#14	2.45	MA	28925	6515	44727	5334	53796	4293	58785	3497	64955	2243	81956	1728	59891
5L-7S		MI	23269	6515	36618	5288	43432	4265	46897	3469	50602	2209	63205	1447	49019
20-#14	2.45	MA	27973	6515	43355	5336	51967	4308	56558	3495	61992	2253	77921	1620	58727
6E		MI	24070	6515	37762	5288	44945	4267	48745	3458	53162	2216	66203	1550	50301
20-#14	2.45	MA	27040	6515	42020	5337	50199	4308	54398	3508	58989	2247	74328	1518	57228
7L-5S		MI	24889	6515	38936	5287	46511	4253	50651	3461	55687	2209	69577	1658	51212
20-#14	2.45	MA	26118	6515	40706	5339	48468	4308	52235	3506	56091	2257	70621	1440	55696
8L-4S		MI	25744	6515	40258	5272	48097	4255	52587	3450	58312	2201	72913	1723	52410
20-#14	2.45	MA	25202	6515	39254	5356	46683	4323	50107	3519	53221	2266	66956	1355	53685
9L-3S		MI	26688	6515	41564	5272	49862	4242	54726	3454	61188	2209	76092	1855	52689
20-#14	2.45	MA	24290	6515	37945	5357	44964	4323	47969	3517	50270	2260	63168	1240	51732
10L-2S		MI	27993	6515	43317	5271	52086	4244	57420	3443	64813	2201	80925	1986	52841
20-#18	4.35	MA	31627	7788	54204	6113	65394	4882	72696	3852	83704	2185	107203	1076	96903
6E		MI	27045	7788	46955	6056	56292	4831	62371	3804	71088	2113	90380	956	82465
20-#18	4.35	MA	30094	7788	51853	6115	62284	4880	68897	3873	78420	2173	100987	894	92950
7L-5S		MI	28393	7788	49018	6057	59041	4809	65717	3814	75462	2100	96197	1150	85922
20-#18	4.35	MA	28578	7788	49540	6116	59236	4878	65091	3867	73322	2186	94543	758	88859
8L-4S		MI	29798	7788	51338	6032	61825	4815	69114	3797	80009	2087	101976	1262	88079
22-#11	1.87	MA	29304	6127	43510	5087	52402	4113	57168	3380	62841	2263	78386	2027	47534
3L-10S		MI	21135	6127	32027	5070	37740	4104	40015	3366	41399	2246	51050	1496	36890
22-#11	1.87	MA	28517	6127	42445	5088	50961	4124	55422	3379	60484	2259	75705	1936	47387
4L-9S		MI	21694	6127	32809	5070	38767	4105	41292	3368	43160	2251	53278	1576	37777
22-#11	1.87	MA	27807	6127	41367	5100	49668	4124	53844	3388	58335	2266	72924	1889	47149
5L-8S		MI	22256	6127	33676	5059	39832	4096	42563	3360	44874	2246	55433	1635	38490
22-#11	1.87	MA	27126	6127	40412	5102	48393	4135	52291	3387	56270	2273	70090	1814	46252
6L-7S		MI	22821	6127	34461	5058	40867	4096	43854	3362	46604	2240	57621	1687	39208
22-#11	1.87	MA	26461	6127	39481	5103	47161	4135	50787	3397	54176	2270	67565	1743	45653
7L-6S		MI	23394	6127	35259	5058	41922	4097	45144	3354	48397	2245	59733	1758	39675
22-#11	1.87	MA	25803	6127	38566	5105	45955	4135	49279	3396	52157	2277	64967	1689	44801
8L-5S		MI	23978	6127	36078	5057	43014	4088	46473	3356	50165	2240	62108	1834	40400
22-#11	1.87	MA	25149	6127	37554	5116	44711	4146	47796	3405	50157	2284	62392	1630	43906
9L-4S		MI	24589	6127	37000	5046	44121	4088	47824	3348	52004	2234	64451	1879	40622
22-#11	1.87	MA	24499	6127	36642	5118	43513	4146	46306	3404	48100	2281	59731	1550	42842
10L-3S		MI	25263	6127	37912	5046	45353	4079	49317	3350	54020	2239	66691	1970	40732
22-#11	1.87	MA	23794	6127	35737	5119	42284	4157	44832	3414	46109	2288	57177	1493	41751
11L-2S		MI	26196	6127	39138	5045	46908	4080	51201	3342	56561	2234	70093	2061	40794
22-#14	2.69	MA	30874	6679	48332	5420	58264	4368	64214	3531	72308	2227	91703	1778	67280
4L-9S		MI	22534	6679	36003	5406	42645	4351	45917	3523	49311	2216	61862	1265	51077
22-#14	2.69	MA	29890	6679	46787	5436	56409	4368	61951	3544	69226	2236	87735	1711	65810
5L-8S		MI	23312	6679	37246	5391	44173	4338	47740	3512	51757	2208	64922	1350	52810
22-#14	2.69	MA	28948	6679	45415	5438	54580	4383	59723	3542	66263	2245	83699	1603	64678
6L-7S		MI	24096	6679	38372	5390	45656	4340	49591	3516	54227	2201	68038	1425	54001

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

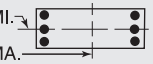
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	2.69	MA	28026	6679	44080	5440	52812	4383	57564	3555	63260	2240	80106	1501	63112
7L-6S		MI	24890	6679	39515	5390	47169	4341	51440	3505	56787	2208	71036	1528	55352
22-#14	2.69	MA	27114	6679	42766	5441	51081	4383	55401	3553	60362	2249	76400	1423	61616
8L-5S		MI	25700	6679	40690	5390	48735	4328	53346	3509	59311	2201	74409	1636	56234
22-#14	2.69	MA	26209	6679	41315	5458	49296	4398	53272	3566	57492	2259	72735	1338	59566
9L-4S		MI	26546	6679	42012	5374	50321	4330	55281	3498	61936	2193	77746	1701	57532
22-#14	2.69	MA	25307	6679	40005	5460	47577	4397	51134	3565	54541	2253	68947	1223	57584
10L-3S		MI	27480	6679	43317	5374	52086	4317	57420	3502	64813	2201	80925	1833	57835
22-#18	4.78	MA	31730	8078	55465	6296	66864	5013	74446	3957	85907	2159	111000	858	103171
7L-6S		MI	28398	8078	50021	6238	60180	4964	67082	3888	77368	2095	98714	910	91149
22-#18	4.78	MA	30236	8078	53151	6298	63817	5011	70640	3951	80808	2173	104556	722	99035
8L-5S		MI	29726	8078	52084	6239	62930	4942	70428	3898	81741	2082	104531	1104	94725
24-#11	2.03	MA	29203	6241	43883	5159	52785	4176	57632	3412	63466	2254	79763	1925	51610
4L-10S		MI	21740	6241	33253	5141	39294	4156	41898	3399	43940	2241	54451	1482	40374
24-#11	2.03	MA	28499	6241	42806	5171	51492	4176	56054	3421	61317	2261	76981	1878	51305
5L-9S		MI	22295	6241	34035	5141	40321	4157	43175	3401	45702	2246	56679	1562	41292
24-#11	2.03	MA	27824	6241	41850	5173	50217	4187	54502	3420	59252	2268	74148	1803	50407
6L-8S		MI	22852	6241	34902	5130	41387	4147	44446	3393	47415	2240	58834	1621	41989
24-#11	2.03	MA	27164	6241	40920	5174	48986	4187	52997	3430	57158	2265	71623	1733	49820
7E		MI	23412	6241	35687	5129	42421	4148	45738	3395	49145	2235	61023	1673	42751
24-#11	2.03	MA	26512	6241	40004	5175	47779	4187	51489	3429	55138	2272	69024	1678	48925
8L-6S		MI	23980	6241	36485	5129	43477	4149	47027	3387	50938	2240	63134	1744	43208
24-#11	2.03	MA	25864	6241	38993	5187	46536	4198	50006	3438	53139	2279	66450	1620	48048
9L-5S		MI	24560	6241	37304	5128	44569	4139	48357	3389	52707	2235	65509	1820	43910
24-#11	2.03	MA	25219	6241	38081	5189	45337	4198	48516	3437	51082	2276	63789	1540	46956
10L-4S		MI	25166	6241	38226	5117	45676	4140	49708	3381	54546	2229	67853	1865	44219
24-#11	2.03	MA	24518	6241	37175	5190	44108	4209	47042	3447	49091	2283	61235	1482	45883
11L-3S		MI	25835	6241	39138	5116	46908	4131	51201	3383	56561	2234	70093	1956	44342
24-#11	2.03	MA	23831	6241	36275	5192	42913	4209	45561	3446	47109	2290	58681	1424	44537
12L-2S		MI	26762	6241	40363	5116	48462	4131	53084	3375	59102	2229	73494	2047	44416
24-#14	2.93	MA	30844	6842	48847	5538	59022	4443	65116	3592	73497	2228	93513	1694	71738
5L-9S		MI	23367	6842	37756	5508	44869	4426	48612	3571	52936	2208	66695	1243	56057
24-#14	2.93	MA	29912	6842	47476	5540	57193	4458	62889	3590	70534	2238	89478	1586	70636
6L-8S		MI	24138	6842	38999	5493	46397	4413	50434	3560	55382	2200	69755	1328	57798
24-#14	2.93	MA	28999	6842	46141	5542	55425	4458	60730	3603	67530	2232	85885	1484	69005
7E		MI	24914	6842	40125	5493	47880	4414	52286	3563	57852	2193	72871	1403	58992
24-#14	2.93	MA	28098	6842	44826	5543	53694	4458	58566	3601	64632	2242	82178	1406	67541
8L-6S		MI	25699	6842	41269	5492	49393	4416	54134	3552	60412	2200	75868	1506	60407
24-#14	2.93	MA	27202	6842	43375	5560	51909	4472	56438	3614	61763	2251	78514	1321	65454
9L-5S		MI	26502	6842	42443	5492	50958	4403	56040	3556	62936	2193	79242	1614	61265
24-#14	2.93	MA	26306	6842	42066	5562	50190	4472	54300	3612	58812	2246	74725	1206	63443
10L-4S		MI	27339	6842	43765	5477	52545	4405	57976	3545	65561	2185	82579	1679	62653
24-#18	5.22	MA	31871	8369	56763	6480	68397	5144	76189	4036	88295	2160	114569	686	109225
8L-6S		MI	29732	8369	53087	6419	64069	5097	71793	3973	83648	2078	107048	864	99850

RECTANGULAR TIED COLUMNS 40" x 48"

6-#18	1.25	MA	30228	5964	43390	5008	51720	4070	55658	3371	59449	2357	72710	2217	34709
2L-3S		MI	22547	5964	33296	4944	39000	4014	41210	3345	42274	2323	50517	1913	28340
6-#18	1.25	MA	27263	5964	39597	5010	46909	4069	49830	3393	51586	2372	62136	1983	34547
3L-2S		MI	24937	5964	36362	4945	42888	4019	45921	3328	48554	2310	58851	2147	28403
8-#18	1.67	MA	32038	6255	47183	5189	56530	4203	61486	3455	67312	2343	83283	2183	45947
2L-4S		MI	22305	6255	34072	5125	39794	4168	42172	3419	43570	2292	53382	1633	36689
8-#18	1.67	MA	29125	6255	43390	5192	51720	4202	55658	3477	59449	2359	72710	1950	45674
3E		MI	24020	6255	36362	5126	42888	4147	45921	3429	48554	2305	58851	1867	37345
8-#18	1.67	MA	27017	6255	40573	5194	47911	4227	51042	3473	53219	2347	65740	1716	44750
4L-2S		MI	26370	6255	39428	5127	46777	4152	50632	3412	54833	2292	67185	2101	37510

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

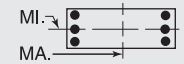
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.17	MA	30015	5910	42549	5002	50913	4068	54795	3375	58362	2374	71626	2253	32868
2L-5S		MI	21514	5910	31289	4961	36688	4031	38505	3354	38805	2348	46831	1864	26472
10-#14	1.17	MA	28317	5910	40386	5004	48171	4069	51472	3388	53879	2384	65531	2122	32816
3L-4S		MI	22420	5910	32611	4946	38275	4033	40440	3343	41430	2341	50167	1929	26826
10-#14	1.17	MA	27091	5910	38784	5006	46004	4084	48846	3387	50335	2380	61506	1991	32632
4L-3S		MI	23419	5910	33917	4945	40039	4020	42579	3346	44306	2348	53346	2061	26928
10-#14	1.17	MA	25982	5910	37165	5023	44061	4084	46473	3401	47104	2390	57328	1923	32111
5L-2S		MI	24792	5910	35670	4945	42263	4022	45274	3335	47931	2341	58179	2192	26941
10-#18	2.08	MA	33803	6546	50976	5371	61341	4336	67314	3540	75176	2330	93857	2150	57156
2L-5S		MI	22242	6546	34819	5332	40898	4295	43485	3521	45302	2287	55936	1476	42429
10-#18	2.08	MA	30939	6546	47183	5373	56530	4335	61486	3561	67312	2345	83283	1916	56787
3L-4S		MI	23772	6546	37138	5306	43682	4301	46883	3504	49850	2274	61716	1587	45205
10-#18	2.08	MA	28870	6546	44366	5376	52722	4360	56870	3557	61082	2334	76313	1683	55465
4L-3S		MI	25457	6546	39428	5308	46777	4280	50632	3513	54833	2287	67185	1821	46328
10-#18	2.08	MA	26998	6546	41516	5404	49302	4359	52695	3579	55398	2349	69039	1565	51743
5L-2S		MI	27770	6546	42495	5309	50666	4285	55344	3496	61113	2274	75519	2055	46580
12-#14	1.41	MA	31068	6073	44711	5104	53656	4143	58117	3422	62845	2367	77720	2238	39278
2L-6S		MI	21528	6073	31868	5064	37347	4119	39293	3397	39905	2348	48290	1734	30348
12-#14	1.41	MA	29388	6073	42549	5106	50913	4144	54795	3436	58362	2377	71626	2106	39194
3L-5S		MI	22387	6073	33043	5063	38912	4106	41199	3401	42429	2340	51663	1842	31425
12-#14	1.41	MA	28177	6073	40947	5108	48747	4159	52169	3434	54818	2372	67601	1975	38969
4E		MI	23283	6073	34365	5048	40498	4108	43135	3390	45055	2333	55000	1907	31968
12-#14	1.41	MA	27081	6073	39327	5125	46803	4159	49796	3448	51587	2382	63422	1907	38258
5L-3S		MI	24271	6073	35670	5048	42263	4095	45274	3394	47931	2340	58179	2039	32108
12-#14	1.41	MA	26032	6073	37890	5127	44886	4174	47461	3447	48481	2392	59166	1799	36809
6L-2S		MI	25630	6073	37424	5047	44487	4097	47968	3383	51555	2333	63012	2170	32152
12-#18	2.50	MA	35529	6837	54769	5553	66152	4469	73142	3624	83039	2317	104431	2117	68347
2L-6S		MI	22259	6837	35822	5512	42038	4449	44850	3595	47208	2283	58454	1236	48390
12-#18	2.50	MA	32710	6837	50976	5555	61341	4468	67314	3646	75176	2332	93857	1883	67893
3L-5S		MI	23702	6837	37885	5513	44787	4428	48197	3605	51581	2270	64271	1430	51138
12-#18	2.50	MA	30679	6837	48159	5557	57532	4493	62698	3641	68945	2321	86887	1649	66151
4E		MI	25205	6837	40205	5488	47571	4434	51594	3588	56129	2256	70050	1541	53770
12-#18	2.50	MA	28841	6837	45309	5586	54112	4492	58524	3663	63262	2336	79612	1531	62591
5L-3S		MI	26862	6837	42495	5489	50666	4413	55344	3597	61113	2270	75519	1775	55298
12-#18	2.50	MA	27077	6837	42778	5588	50737	4517	54415	3658	57797	2351	72230	1339	59144
6L-2S		MI	29141	6837	45561	5491	54554	4418	60055	3580	67392	2256	83853	2009	55627
14-#11	1.14	MA	29924	5886	42162	5001	50555	4069	54418	3378	57894	2383	71174	2271	32061
2L-7S		MI	21239	5886	30673	4960	35944	4041	37646	3360	37683	2360	45437	1839	25202
14-#11	1.14	MA	28736	5886	40653	5002	48641	4070	52099	3388	54765	2390	66897	2179	32033
3L-6S		MI	21833	5886	31471	4960	36999	4042	38935	3352	39476	2365	47549	1910	25729
14-#11	1.14	MA	27881	5886	39536	5004	47130	4080	50268	3387	52294	2388	64069	2088	31954
4L-5S		MI	22439	5886	32290	4959	38092	4033	40265	3354	41245	2360	49923	1986	26156
14-#11	1.14	MA	27108	5886	38407	5016	45776	4081	48614	3397	50042	2395	61142	2041	31787
5L-4S		MI	23072	5886	33212	4948	39198	4033	41615	3346	43084	2355	52267	2031	26255
14-#11	1.14	MA	26368	5886	37406	5018	44440	4092	46988	3396	47878	2403	58155	1966	31208
6L-3S		MI	23770	5886	34124	4948	40430	4024	43109	3348	45099	2359	54507	2122	26295
14-#11	1.14	MA	25643	5886	36431	5020	43149	4093	45411	3406	45684	2400	55492	1895	30488
7L-2S		MI	24731	5886	35350	4947	41985	4025	44992	3340	47640	2354	57908	2213	26300
14-#14	1.64	MA	32104	6237	46874	5206	56399	4218	61440	3470	67328	2359	83815	2222	45679
2L-7S		MI	21565	6237	32478	5166	38057	4192	40139	3456	40970	2332	50125	1609	34430
14-#14	1.64	MA	30441	6237	44711	5208	53656	4218	58117	3483	62845	2369	77720	2091	45564
3L-6S		MI	22397	6237	33622	5166	39570	4194	41987	3444	43530	2340	53122	1712	35367
14-#14	1.64	MA	29244	6237	43109	5210	51489	4234	55491	3482	59301	2365	73695	1959	45302
4L-5S		MI	23247	6237	34796	5165	41136	4181	43893	3448	46054	2332	56496	1820	36397

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

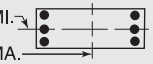


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	1.64	MA	28162	6237	41490	5227	49546	4234	53119	3495	56070	2375	69517	1891	44423
5L-4S		MI	24132	6237	36118	5150	42722	4183	45829	3437	48679	2325	59833	1885	37104
14-#14	1.64	MA	27125	6237	40052	5229	47628	4249	50784	3494	52964	2385	65261	1783	43028
6L-3S		MI	25109	6237	37424	5150	44487	4170	47968	3441	51555	2332	63012	2017	37278
14-#14	1.64	MA	26110	6237	38653	5231	45776	4250	48521	3507	49816	2380	61468	1681	41815
7L-2S		MI	26456	6237	39177	5149	46711	4171	50662	3430	55180	2325	67844	2148	37348
14-#18	2.92	MA	34445	7127	54769	5737	66152	4601	73142	3730	83039	2319	104431	1850	78993
3L-6S		MI	23711	7127	38888	5694	45926	4582	49562	3679	53488	2265	66788	1190	56980
14-#18	2.92	MA	32448	7127	51952	5739	62343	4626	68526	3725	76808	2307	97461	1616	76877
4L-5S		MI	25130	7127	40951	5695	48676	4561	52908	3689	57861	2252	72605	1383	59872
14-#18	2.92	MA	30642	7127	49102	5768	58923	4625	64352	3747	71125	2322	90186	1498	73463
5L-4S		MI	26609	7127	43271	5670	51460	4567	56305	3672	62409	2239	78384	1495	62376
14-#18	2.92	MA	28911	7127	46571	5770	55548	4650	60243	3743	65660	2338	82803	1305	69884
6L-3S		MI	28240	7127	45561	5671	54554	4546	60055	3682	67392	2252	83853	1729	64260
14-#18	2.92	MA	27214	7127	44107	5772	52287	4649	56260	3764	60119	2326	76234	1123	66307
7L-2S		MI	30487	7127	48627	5672	58443	4551	64766	3665	73672	2239	92187	1963	64659
16-#11	1.30	MA	30666	5999	43672	5072	52469	4121	56737	3411	61023	2378	75450	2261	36537
2L-8S		MI	21277	5999	31114	5032	36464	4093	38237	3391	38494	2361	46650	1773	28243
16-#11	1.30	MA	29487	5999	42162	5073	50555	4121	54418	3420	57894	2385	71174	2170	36493
3L-7S		MI	21859	5999	31899	5031	37499	4093	39529	3393	40224	2355	48838	1825	28730
16-#11	1.30	MA	28639	5999	41046	5075	49045	4132	52587	3420	55423	2382	68346	2079	36395
4L-6S		MI	22447	5999	32697	5031	38554	4094	40818	3385	42017	2360	50950	1896	29239
16-#11	1.30	MA	27873	5999	39917	5087	47690	4133	50934	3430	53171	2390	65419	2031	36208
5E		MI	23049	5999	33516	5030	39646	4085	42148	3387	43786	2355	53325	1972	29748
16-#11	1.30	MA	27140	5999	38915	5089	46354	4144	49307	3429	51007	2398	62432	1956	35546
6L-4S		MI	23676	5999	34438	5019	40753	4085	43499	3379	45625	2349	55668	2017	29866
16-#11	1.30	MA	26421	5999	37941	5091	45064	4144	47730	3439	48813	2395	59769	1885	34848
7L-3S		MI	24368	5999	35350	5018	41985	4076	44992	3381	47640	2354	57908	2108	29923
16-#11	1.30	MA	25712	5999	36982	5092	43799	4145	46150	3438	46697	2402	57034	1830	34194
8L-2S		MI	25323	5999	36575	5018	43540	4077	46876	3373	50181	2349	61310	2199	29943
16-#14	1.88	MA	33126	6400	49036	5308	59141	4293	64762	3517	71810	2352	89909	2206	52071
2L-8S		MI	21617	6400	33106	5269	38799	4265	40982	3499	42125	2332	51842	1512	38067
16-#14	1.88	MA	31479	6400	46874	5310	56399	4293	61440	3531	67328	2362	83815	2075	51928
3L-7S		MI	22430	6400	34232	5268	40281	4267	42833	3503	44595	2324	54957	1587	39377
16-#14	1.88	MA	30295	6400	45272	5312	54232	4308	58814	3529	63783	2357	79790	1944	51634
4L-6S		MI	23253	6400	35375	5268	41794	4269	44682	3492	47155	2332	57955	1690	40395
16-#14	1.88	MA	29226	6400	43652	5329	52288	4309	56441	3543	60552	2367	75611	1876	50604
5E		MI	24093	6400	36550	5268	43360	4256	46588	3496	49679	2324	61329	1798	41384
16-#14	1.88	MA	28201	6400	42215	5332	50371	4324	54107	3541	57447	2377	71355	1768	49256
6L-4S		MI	24969	6400	37872	5252	44946	4258	48523	3485	52304	2317	64665	1863	42236
16-#14	1.88	MA	27198	6400	40816	5334	48519	4324	51844	3555	54299	2372	67563	1665	47968
7L-3S		MI	25936	6400	39177	5252	46711	4244	50662	3489	55180	2324	67844	1995	42440
16-#14	1.88	MA	26206	6400	39439	5336	46704	4325	49576	3553	51262	2383	63659	1587	46230
8L-2S		MI	27270	6400	40931	5252	48935	4246	53357	3477	58805	2317	72677	2126	42535
16-#18	3.33	MA	34183	7418	55745	5921	67154	4759	74354	3810	84672	2294	108034	1583	87637
4L-6S		MI	25135	7418	41954	5876	49815	4715	54273	3764	59767	2247	75122	1144	65596
16-#18	3.33	MA	32408	7418	52895	5949	63734	4758	70180	3831	78988	2309	100760	1465	84355
5E		MI	26532	7418	44017	5877	52565	4694	57619	3773	64141	2234	80939	1337	68627
16-#18	3.33	MA	30705	7418	50364	5952	60358	4783	66071	3827	73523	2324	93377	1272	80647
6L-4S		MI	27987	7418	46337	5852	55349	4700	61016	3756	68688	2221	86719	1449	71016
16-#18	3.33	MA	29038	7418	47901	5954	57098	4782	62088	3849	67983	2313	86808	1090	77000
7L-3S		MI	29594	7418	48627	5853	58443	4679	64766	3766	73672	2234	92187	1683	73215
16-#18	3.33	MA	27388	7418	45475	5956	53903	4781	58097	3844	62637	2328	80014	953	72241
8L-2S		MI	31811	7418	51693	5854	62332	4684	69477	3749	79952	2221	100521	1917	73679
18-#11	1.46	MA	31399	6112	45181	5142	54383	4173	59056	3443	64152	2373	79727	2251	41006
2L-9S		MI	21322	6112	31473	5114	36953	4154	38850	3432	39322	2361	47896	1700	30965
18-#11	1.46	MA	30229	6112	43672	5144	52469	4173	56737	3453	61023	2380	75450	2160	40949
3L-8S		MI	21894	6112	32340	5103	38019	4144	40121	3424	41035	2356	50051	1759	31722

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

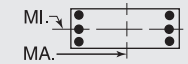
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.46	MA	29388	6112	42555	5146	50959	4184	54906	3453	58551	2377	72623	2069	40834
4L-7S		MI	22471	6112	33125	5102	39053	4145	41413	3426	42766	2350	52240	1811	32263
18-#11	1.46	MA	28629	6112	41426	5158	49604	4185	53253	3463	56300	2385	69696	2021	40628
5L-6S		MI	23055	6112	33923	5101	40109	4146	42702	3418	44558	2355	54351	1882	32756
18-#11	1.46	MA	27902	6112	40425	5160	48268	4196	51626	3462	54135	2392	66709	1946	39891
6L-5S		MI	23651	6112	34742	5101	41201	4136	44032	3420	46327	2350	56726	1958	33338
18-#11	1.46	MA	27190	6112	39450	5161	46978	4196	50049	3472	51942	2390	64046	1876	39212
7L-4S		MI	24273	6112	35664	5090	42308	4137	45382	3412	48166	2344	59070	2003	33473
18-#11	1.46	MA	26487	6112	38491	5163	45714	4197	48470	3471	49826	2397	61311	1821	38507
8L-3S		MI	24960	6112	36575	5089	43540	4128	46876	3414	50181	2349	61310	2094	33546
18-#11	1.46	MA	25788	6112	37432	5175	44411	4208	46916	3481	47730	2405	58596	1762	37500
9L-2S		MI	25909	6112	37801	5089	45094	4128	48759	3406	52722	2344	64711	2186	33578
18-#14	2.11	MA	34134	6564	51199	5411	61884	4368	68085	3564	76293	2344	96004	2191	58457
2L-9S		MI	21680	6564	33617	5386	39495	4353	41854	3558	43304	2331	53615	1405	41559
18-#14	2.11	MA	32503	6564	49036	5413	59141	4368	64762	3578	71810	2355	89909	2059	58288
3L-8S		MI	22479	6564	34859	5371	41023	4340	43676	3546	45750	2324	56674	1490	43063
18-#14	2.11	MA	31332	6564	47434	5415	56975	4383	62137	3577	68266	2350	85884	1928	57964
4L-7S		MI	23283	6564	35985	5371	42505	4342	45528	3550	48220	2316	59790	1565	44335
18-#14	2.11	MA	30274	6564	45815	5432	55031	4384	59764	3590	65035	2360	81705	1860	56798
5L-6S		MI	24097	6564	37129	5370	44018	4344	47376	3539	50779	2324	62788	1668	45432
18-#14	2.11	MA	29261	6564	44377	5434	53113	4399	57429	3589	61930	2370	77449	1752	55494
6L-5S		MI	24928	6564	38304	5370	45584	4331	49282	3543	53304	2316	66161	1776	46384
18-#14	2.11	MA	28270	6564	42978	5436	51261	4399	55166	3602	58781	2365	73657	1650	54131
7L-4S		MI	25795	6564	39625	5355	47170	4332	51218	3532	55929	2309	69498	1841	47365
18-#14	2.11	MA	27289	6564	41601	5438	49447	4399	52899	3601	55744	2375	69754	1571	52435
8L-3S		MI	26752	6564	40931	5354	48935	4319	53357	3536	58805	2316	72677	1973	47597
18-#14	2.11	MA	26315	6564	40080	5455	47577	4415	50669	3614	52737	2385	65887	1487	50478
9L-2S		MI	28073	6564	42685	5354	51159	4321	56051	3525	62430	2309	77510	2104	47716
18-#18	3.75	MA	34141	7709	56688	6131	68544	4891	76008	3916	86851	2296	111333	1431	95266
5L-6S		MI	26534	7709	45020	6057	53704	4848	58984	3848	66047	2229	83456	1097	74235
18-#18	3.75	MA	32467	7709	54158	6133	65169	4916	71899	3911	81386	2311	103951	1238	91432
6L-5S		MI	27909	7709	47083	6059	56453	4827	62330	3857	70420	2216	89273	1291	77399
18-#18	3.75	MA	30827	7709	51694	6135	61909	4915	67916	3933	75846	2300	97381	1057	87711
7L-4S		MI	29343	7709	49403	6033	59237	4833	65728	3840	74968	2203	95053	1403	79686
18-#18	3.75	MA	29204	7709	49269	6138	58714	4914	63925	3928	70500	2315	90587	920	83055
8L-3S		MI	30927	7709	51693	6035	62332	4812	69477	3850	79952	2216	100521	1637	82167
20-#11	1.63	MA	32125	6226	46690	5213	56298	4225	61375	3476	67280	2367	84004	2241	45472
2L-10S		MI	21371	6226	31917	5185	37481	4205	39457	3463	40101	2351	49069	1606	33692
20-#11	1.63	MA	30963	6226	45181	5215	54383	4225	59056	3486	64152	2375	79727	2150	45401
3L-9S		MI	21937	6226	32699	5184	38508	4206	40734	3465	41863	2356	51298	1686	34470
20-#11	1.63	MA	30129	6226	44064	5217	52873	4236	57225	3486	61680	2372	76900	2059	45270
4L-8S		MI	22505	6226	33566	5174	39574	4196	42004	3457	43576	2350	53452	1745	35208
20-#11	1.63	MA	29376	6226	42935	5229	51518	4237	55572	3495	59428	2380	73972	2011	45047
5L-7S		MI	23077	6226	34351	5173	40608	4197	43296	3459	45307	2345	55641	1798	35800
20-#11	1.63	MA	28655	6226	41934	5231	50182	4248	53945	3495	57264	2387	70985	1937	44242
6E		MI	23656	6226	35148	5172	41663	4198	44585	3451	47100	2350	57753	1869	36279
20-#11	1.63	MA	27950	6226	40960	5232	48892	4248	52368	3505	55071	2384	68322	1866	43581
7L-5S		MI	24247	6226	35968	5172	42756	4188	45915	3453	48868	2344	60127	1944	36926
20-#11	1.63	MA	27253	6226	40000	5234	47628	4249	50789	3504	52955	2392	65587	1811	42827
8L-4S		MI	24865	6226	36890	5161	43862	4189	47266	3445	50707	2339	62471	1989	37077
20-#11	1.63	MA	26561	6226	38941	5246	46325	4260	49235	3514	50859	2399	62873	1753	41841
9L-3S		MI	25546	6226	37801	5160	45094	4180	48759	3447	52722	2344	64711	2080	37164
20-#11	1.63	MA	25858	6226	37986	5248	45070	4260	47674	3513	48705	2397	60067	1673	40840
10L-2S		MI	26488	6226	39027	5160	46649	4180	50642	3439	55263	2339	68112	2172	37208

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

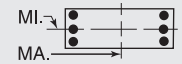


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.34	MA	33513	6727	51199	5515	61884	4443	68085	3625	76293	2347	96004	2044	64645
3L-9S		MI	22538	6727	35370	5488	41719	4428	44548	3605	46928	2323	58447	1383	46518
20-#14	2.34	MA	32354	6728	49597	5517	59717	4458	65459	3624	72749	2342	91978	1912	64293
4L-8S		MI	23328	6727	36613	5473	43247	4415	46370	3594	49374	2315	61507	1468	48066
20-#14	2.34	MA	31308	6727	47977	5534	57773	4458	63086	3637	69518	2352	87800	1844	63004
5L-7S		MI	24124	6727	37739	5473	44729	4417	48222	3598	51844	2308	64623	1543	49305
20-#14	2.34	MA	30307	6728	46540	5536	55856	4474	60752	3636	66412	2362	83544	1736	61739
6E		MI	24929	6728	38883	5472	46242	4419	50070	3587	54404	2315	67620	1646	50476
20-#14	2.34	MA	29326	6728	45141	5538	54004	4474	58489	3650	63264	2358	79752	1634	60304
7L-5S		MI	25752	6727	40057	5472	47808	4405	51976	3590	56929	2308	70994	1754	51396
20-#14	2.34	MA	28357	6728	43764	5540	52189	4474	56222	3648	60227	2368	75848	1556	58647
8L-4S		MI	26610	6728	41379	5457	49394	4407	53912	3579	59554	2301	74331	1819	52491
20-#14	2.34	MA	27394	6728	42243	5557	50319	4490	53991	3662	57220	2378	71982	1471	56652
9L-3S		MI	27557	6727	42685	5457	51159	4394	56051	3583	62430	2308	77510	1951	52749
20-#14	2.34	MA	26432	6728	40871	5559	48518	4490	51751	3660	54127	2373	67985	1356	54714
10L-2S		MI	28868	6727	44438	5456	53383	4396	58745	3572	66055	2301	82342	2082	52890
20-#18	4.17	MA	34199	8000	57951	6315	69980	5049	77728	3995	89249	2298	114524	1205	102235
6E		MI	27911	8000	48086	6239	57593	4981	63695	3932	72327	2212	91790	1051	82894
20-#18	4.17	MA	32584	8000	55487	6317	66719	5048	73744	4017	83709	2286	107955	1023	98441
7L-5S		MI	29266	8000	50150	6240	60342	4960	67041	3942	76700	2198	97607	1245	86186
20-#18	4.17	MA	30988	8000	53062	6319	63524	5047	69753	4013	78363	2301	101161	887	93883
8L-4S		MI	30680	8000	52469	6215	63126	4966	70439	3925	81248	2185	103387	1357	88380
22-#11	1.79	MA	31690	6339	46690	5286	56298	4277	61375	3519	67280	2370	84004	2140	49851
3L-10S		MI	21984	6339	33143	5256	39036	4257	41340	3496	42643	2346	52470	1592	37169
22-#11	1.79	MA	30862	6339	45574	5288	54787	4288	59545	3518	64809	2367	81177	2049	49704
4L-9S		MI	22545	6339	33925	5255	40063	4258	42617	3498	44404	2351	54699	1672	37980
22-#11	1.79	MA	30116	6339	44445	5300	53433	4289	57891	3528	62557	2374	78249	2002	49466
5L-8S		MI	23108	6339	34792	5244	41128	4248	43888	3490	46118	2345	56854	1731	38700
22-#11	1.79	MA	29401	6339	43443	5302	52097	4299	56264	3528	60393	2382	75262	1927	48599
6L-7S		MI	23676	6339	35577	5244	42163	4249	45180	3492	47848	2340	59042	1784	39340
22-#11	1.79	MA	28701	6339	42469	5303	50806	4300	54687	3537	58200	2379	72599	1856	47953
7L-6S		MI	24251	6339	36374	5243	43218	4250	46469	3484	49641	2345	61154	1855	39807
22-#11	1.79	MA	28010	6339	41510	5305	49542	4301	53108	3537	56083	2387	69864	1801	47152
8L-5S		MI	24837	6339	37194	5243	44310	4240	47799	3486	51409	2339	63529	1930	40512
22-#11	1.79	MA	27324	6339	40450	5317	48239	4312	51554	3547	53988	2394	67150	1743	46186
9L-4S		MI	25450	6339	38116	5232	45417	4241	49149	3478	53248	2334	65872	1975	40679
22-#11	1.79	MA	26628	6339	39495	5319	46984	4312	49993	3546	51833	2391	64344	1663	45156
10L-3S		MI	26126	6339	39027	5231	46649	4231	50642	3480	55263	2339	68112	2067	40779
22-#11	1.79	MA	25890	6339	38547	5320	45696	4323	48449	3556	49747	2399	61656	1605	43983
11L-2S		MI	27062	6339	40253	5230	48204	4232	52526	3472	57805	2333	71514	2158	40835
22-#14	2.58	MA	33364	6891	51759	5619	62460	4533	68782	3671	77232	2335	98073	1897	70621
4L-9S		MI	23385	6891	37124	5591	43943	4503	47242	3652	50553	2315	63280	1361	51444
22-#14	2.58	MA	32329	6891	50140	5636	60516	4533	66409	3685	74001	2345	93894	1829	69220
5L-8S		MI	24167	6891	38367	5575	45470	4490	49065	3641	52999	2307	66340	1446	53077
22-#14	2.58	MA	31338	6891	48702	5638	58598	4548	64074	3683	70895	2355	89638	1721	67990
6L-7S		MI	24954	6891	39493	5575	46953	4492	50916	3645	55469	2300	69455	1521	54283
22-#14	2.58	MA	30368	6891	47303	5640	56746	4549	61811	3697	67747	2350	85846	1619	66486
7L-6S		MI	25751	6891	40636	5575	48466	4493	52765	3634	58029	2307	72453	1624	55525
22-#14	2.58	MA	29410	6891	45926	5642	54932	4549	59544	3696	64710	2360	81943	1540	64865
8L-5S		MI	26566	6891	41811	5574	50032	4480	54671	3638	60553	2300	75826	1732	56416
22-#14	2.58	MA	28457	6891	44405	5659	53062	4564	57314	3709	61703	2370	78076	1456	62832
9L-4S		MI	27415	6891	43132	5559	51618	4482	56607	3627	63178	2293	79163	1797	57616
22-#14	2.58	MA	27500	6891	43034	5661	51260	4565	55073	3708	58610	2365	74080	1340	60866
10L-3S		MI	28354	6891	44438	5559	53383	4469	58745	3631	66055	2300	82342	1929	57898
22-#18	4.58	MA	34314	8290	59280	6499	71530	5181	79572	4101	91572	2273	118529	990	109045
7L-6S		MI	29267	8290	51153	6421	61481	5114	68406	4016	78606	2194	100125	1005	91572
22-#18	4.58	MA	32742	8290	56855	6501	68335	5180	75581	4097	86226	2288	111735	853	104724
8L-5S		MI	30604	8290	53216	6422	64231	5093	71752	4026	82979	2181	105941	1199	94986

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	1.95	MA	31588	6453	47083	5359	56701	4340	61864	3551	67938	2362	85453	2040	54137
4L-10S		MI	22591	6453	34369	5327	40590	4309	43224	3529	45184	2341	55872	1578	40651
24-#11	1.95	MA	30847	6453	45954	5371	55347	4340	60210	3561	65686	2369	82526	1992	53884
5L-9S		MI	23147	6453	35151	5326	41617	4310	44501	3531	46945	2345	58100	1658	41493
24-#11	1.95	MA	30138	6453	44953	5372	54011	4351	58583	3561	63522	2377	79539	1917	52961
6L-8S		MI	23706	6453	36018	5315	42683	4300	45771	3522	48659	2340	60255	1717	42197
24-#11	1.95	MA	29445	6453	43978	5374	52720	4352	57006	3570	61328	2374	76876	1846	52329
7E		MI	24269	6453	36803	5315	43717	4301	47063	3525	50389	2335	62443	1770	42883
24-#11	1.95	MA	28759	6453	43019	5376	51456	4353	55427	3570	59212	2382	74141	1791	51483
8L-6S		MI	24839	6453	37600	5314	44773	4302	48352	3516	52182	2340	64555	1841	43339
24-#11	1.95	MA	28079	6453	41960	5388	50154	4363	53873	3580	57117	2389	71426	1733	50536
9L-5S		MI	25422	6453	38419	5313	45865	4292	49682	3519	53950	2334	66930	1916	44055
24-#11	1.95	MA	27395	6453	41004	5390	48899	4364	52312	3579	54962	2386	68621	1653	49476
10L-4S		MI	26029	6453	39342	5303	46972	4293	51033	3510	55789	2329	69273	1961	44278
24-#11	1.95	MA	26655	6453	40056	5391	47611	4375	50768	3589	52876	2394	65932	1595	48322
11L-3S		MI	26701	6453	40253	5302	48204	4283	52526	3513	57805	2334	71514	2053	44391
24-#11	1.95	MA	25933	6453	39113	5393	46359	4376	49216	3588	50740	2391	63239	1537	46986
12L-2S		MI	27631	6453	41479	5301	49758	4284	54409	3504	60346	2328	74915	2144	44458
24-#14	2.81	MA	33338	7055	52302	5738	63259	4608	69732	3732	78483	2337	99989	1813	75444
5L-9S		MI	24221	7055	38877	5693	46166	4578	49937	3700	54178	2307	68112	1339	56419
24-#14	2.81	MA	32357	7055	50865	5740	61341	4623	67397	3731	75378	2347	95733	1705	74247
6L-8S		MI	24995	7055	40120	5678	47694	4565	51759	3689	56624	2299	71172	1424	58095
24-#14	2.81	MA	31398	7055	49466	5743	59489	4624	65134	3744	72230	2343	91941	1603	72676
7E		MI	25775	7055	41246	5677	49177	4566	53611	3692	59094	2292	74288	1499	59270
24-#14	2.81	MA	30449	7055	48089	5745	57674	4624	62867	3743	69193	2353	88037	1524	71090
8L-6S		MI	26564	7055	42390	5677	50690	4568	55459	3681	61654	2299	77286	1602	60580
24-#14	2.81	MA	29507	7055	46568	5762	55804	4639	60637	3757	66185	2363	84171	1440	69018
9L-5S		MI	27370	7055	43564	5677	52256	4555	57365	3685	64178	2292	80659	1710	61445
24-#14	2.81	MA	28553	7055	45196	5764	54003	4639	58396	3755	63093	2358	80174	1325	67024
10L-4S		MI	28211	7055	44886	5661	53842	4557	59301	3674	66803	2284	83996	1775	62739
24-#18	5.00	MA	34470	8581	60648	6683	73146	5313	81409	4181	94089	2275	122309	820	115577
8L-6S		MI	30607	8581	54219	6603	65370	5247	73118	4101	84886	2176	108459	959	100266

RECTANGULAR TIED COLUMNS 42" x 42"

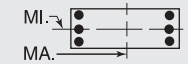
6-#18	1.36	MA	24501	5550	35816	4604	42438	3738	45644	3089	48767	2132	59418	1980	29895
2L-3S		MI	21979	5550	32568	4604	38319	3734	40654	3108	42082	2145	50525	1747	29760
8-#14	1.02	MA	23440	5332	33252	4497	39420	3663	42090	3047	44184	2166	53483	2042	22829
2L-4S		MI	20912	5332	30016	4499	35201	3675	36978	3055	37286	2166	44945	1779	22712
8-#18	1.81	MA	26017	5841	39064	4786	46557	3871	50635	3173	55451	2116	68312	1938	39519
2L-4S		MI	21739	5841	33394	4785	39165	3889	41678	3184	43462	2116	53575	1471	38015
10-#14	1.28	MA	24341	5496	35108	4600	41774	3738	44941	3094	48031	2158	58631	2022	28351
2L-5S		MI	20890	5496	30476	4617	35879	3749	37784	3114	38349	2167	46546	1693	27473
10-#14	1.28	MA	22893	5496	33252	4600	39420	3736	42090	3106	44184	2166	53483	1891	28309
3L-4S		MI	21843	5496	31872	4601	37555	3750	39829	3103	41133	2159	50093	1759	28149
10-#18	2.27	MA	27495	6132	42312	4968	50676	4004	55625	3258	62136	2100	77205	1896	49114
2L-5S		MI	21690	6132	34190	4993	40341	4018	43076	3286	45306	2113	56315	1315	44172
10-#18	2.27	MA	25061	6132	39064	4967	46557	4000	50635	3276	55451	2113	68312	1662	48778
3L-4S		MI	23293	6132	36642	4967	43284	4022	46668	3268	50147	2100	62468	1428	47078

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

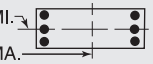


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.30	MA	26732	5773	38770	4813	46022	3910	49479	3235	52829	2249	64375	2099	31515
2L-3S		MI	22920	5773	33810	4797	39751	3893	42114	3243	43449	2249	52084	1847	29830
6-#18	1.30	MA	24060	5773	35340	4814	41672	3907	44210	3255	45739	2262	54922	1865	31380
3L-2S		MI	25448	5773	37058	4798	43870	3897	47105	3224	50134	2236	60977	2081	29938
8-#18	1.73	MA	28347	6064	42199	4995	50371	4043	54749	3319	59919	2235	73828	2060	41679
2L-4S		MI	22678	6064	34636	4979	40597	4048	43138	3319	44829	2220	55134	1571	38397
8-#18	1.73	MA	25723	6064	38770	4995	46022	4040	49479	3339	52829	2248	64375	1826	41437
3E		MI	24486	6064	37058	4979	43870	4026	47105	3327	50134	2233	60977	1805	39357
8-#18	1.73	MA	23817	6064	36216	4996	42570	4063	45296	3332	47203	2235	58156	1592	40416
4L-2S		MI	26970	6064	40305	4979	47989	4030	52095	3308	56818	2220	69871	2038	39570
10-#14	1.22	MA	26553	5719	38013	4808	45309	3909	48723	3240	51940	2271	63491	2139	29869
2L-5S		MI	21827	5719	31706	4812	37308	3909	39245	3250	39720	2271	48112	1794	27694
10-#14	1.22	MA	25021	5719	36055	4810	42825	3909	45715	3252	47881	2279	58028	2007	29828
3L-4S		MI	22782	5719	33102	4796	38984	3910	41290	3239	42504	2264	51659	1860	28218
10-#14	1.22	MA	23911	5719	34601	4811	40860	3923	43332	3250	44666	2273	54426	1876	29668
4L-3S		MI	23835	5719	34482	4795	40849	3897	43551	3242	45555	2271	55049	1992	28357
10-#14	1.22	MA	22906	5719	33130	4827	39095	3923	41178	3262	41732	2281	50669	1809	29096
5L-2S		MI	25287	5719	36338	4794	43203	3898	46402	3230	49403	2263	60197	2123	28388
10-#18	2.16	MA	29923	6355	45629	5177	54721	4176	60019	3404	67009	2221	83280	2021	51814
2L-5S		MI	22627	6355	35431	5187	41773	4177	44537	3421	46673	2217	57874	1415	44489
10-#18	2.16	MA	27343	6355	42199	5177	50371	4173	54749	3423	59919	2234	73828	1787	51478
3L-4S		MI	24237	6355	37884	5161	44716	4181	48129	3403	51514	2204	64027	1529	47450
10-#18	2.16	MA	25472	6355	39646	5178	46920	4196	50566	3416	54293	2221	67609	1553	50000
4L-3S		MI	26012	6355	40305	5161	47989	4159	52095	3411	56818	2217	69871	1762	48865
10-#18	2.16	MA	23777	6355	37061	5205	43817	4193	46780	3436	49159	2234	61082	1438	46806
5L-2S		MI	28455	6355	43553	5161	52109	4163	57086	3393	63503	2204	78764	1996	49170
12-#11	1.01	MA	25805	5581	36296	4737	43257	3859	46293	3210	48698	2285	59288	2169	25083
2L-6S		MI	21501	5581	30611	4738	35993	3867	37704	3215	37712	2291	45234	1852	23261
12-#11	1.01	MA	24724	5581	34929	4739	41523	3859	44191	3219	45863	2291	55449	2078	25079
3L-5S		MI	22146	5581	31476	4737	37146	3857	39108	3217	39579	2285	47762	1927	23707
12-#11	1.01	MA	23943	5581	33915	4740	40152	3869	42529	3218	43620	2288	52916	1987	25031
4E		MI	22818	5581	32449	4726	38315	3857	40535	3208	41522	2279	50251	1973	23814
12-#11	1.01	MA	23235	5581	32889	4751	38921	3869	41027	3227	41574	2294	50281	1940	24906
5L-3S		MI	23560	5581	33412	4725	39617	3847	42112	3210	43651	2284	52638	2064	23852
12-#11	1.01	MA	22557	5581	31979	4753	37707	3879	39549	3226	39608	2301	47600	1865	24419
6L-2S		MI	24584	5581	34709	4724	41261	3848	44104	3201	46339	2278	56258	2156	23851
12-#14	1.46	MA	27496	5882	39971	4911	47792	3984	51732	3287	55999	2263	68954	2120	35675
2L-6S		MI	21851	5882	32321	4915	38008	3998	40084	3295	40890	2272	49666	1666	31794
12-#14	1.46	MA	25980	5882	38013	4912	45309	3984	48723	3300	51940	2272	63491	1989	35603
3L-5S		MI	22755	5882	33562	4914	39662	3984	42097	3298	43567	2264	53260	1774	32948
12-#14	1.46	MA	24883	5882	36559	4913	43343	3998	46341	3297	48725	2265	59890	1857	35402
4E		MI	23698	5882	34958	4898	41337	3985	44142	3286	46352	2256	56807	1840	33654
12-#14	1.46	MA	23890	5882	35088	4930	41578	3997	44186	3310	45791	2274	56132	1791	34648
5L-3S		MI	24739	5882	36338	4897	43203	3971	46402	3289	49403	2263	60197	1971	33832
12-#14	1.46	MA	22938	5882	33782	4931	39836	4012	42066	3307	42971	2283	52318	1682	33403
6L-2S		MI	26175	5882	38194	4897	45556	3973	49254	3277	53250	2255	65345	2103	33894
12-#18	2.60	MA	31465	6646	49059	5358	59071	4309	65288	3488	74099	2206	92733	1981	61928
2L-6S		MI	22661	6646	36499	5368	42986	4333	45991	3498	48702	2214	60560	1179	50642
12-#18	2.60	MA	28925	6646	45629	5359	54721	4306	60019	3508	67009	2219	83280	1748	61510
3L-5S		MI	24178	6646	38679	5369	45892	4310	49527	3506	53358	2201	66767	1373	53736
12-#18	2.60	MA	27088	6646	43075	5360	51269	4329	55836	3501	61383	2206	77062	1514	59631
4E		MI	25759	6646	41132	5342	48835	4314	53119	3487	58199	2188	72921	1486	56551
12-#18	2.60	MA	25424	6646	40490	5387	48167	4326	52050	3520	56249	2219	70535	1399	56588
5L-3S		MI	27503	6646	43553	5343	52109	4292	57086	3495	63503	2201	78764	1720	58363
12-#18	2.60	MA	23827	6646	38193	5387	45105	4350	48322	3514	51311	2233	63936	1206	53311
6L-2S		MI	29909	6646	46801	5343	56228	4296	62076	3477	70188	2188	87657	1954	58749

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

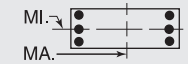


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.18	MA	26478	5695	37664	4808	44992	3911	48394	3243	51533	2280	63127	2157	29149
2L-7S		MI	21537	5695	31066	4810	36523	3918	38335	3256	38507	2282	46605	1768	26399
14-#11	1.18	MA	25405	5695	36296	4809	43257	3911	46293	3252	48698	2286	59288	2066	29126
3L-6S		MI	22162	5695	31907	4809	37637	3919	39696	3248	40400	2286	48854	1839	26970
14-#11	1.18	MA	24631	5695	35282	4811	41886	3921	44631	3251	46455	2282	56755	1975	29058
4L-5S		MI	22801	5695	32772	4808	38791	3909	41100	3249	42267	2280	51382	1914	27505
14-#11	1.18	MA	23930	5695	34257	4822	40655	3921	43128	3260	44409	2289	54119	1928	28911
5L-4S		MI	23467	5695	33746	4797	39959	3909	42527	3241	44210	2274	53871	1961	27634
14-#11	1.18	MA	23258	5695	33346	4823	39441	3931	41650	3259	42443	2296	51439	1853	28335
6L-3S		MI	24202	5695	34709	4796	41261	3899	44104	3243	46339	2278	56258	2052	27692
14-#11	1.18	MA	22600	5695	32460	4825	38268	3931	40217	3268	40450	2292	49052	1783	27716
7L-2S		MI	25219	5695	36006	4795	42906	3900	46097	3234	49027	2272	59878	2143	27709
14-#14	1.70	MA	28423	6046	41929	5013	50275	4059	54740	3335	60058	2256	74418	2102	41471
2L-7S		MI	21899	6046	32970	5018	38764	4071	40983	3354	42022	2257	51617	1543	35995
14-#14	1.70	MA	26923	6046	39971	5014	47792	4058	51732	3347	55999	2264	68954	1970	41369
3L-6S		MI	22774	6046	34177	5017	40362	4073	42935	3342	44737	2264	54813	1646	37114
14-#14	1.70	MA	25839	6046	38517	5016	45826	4073	49349	3345	52784	2258	65353	1839	41133
4L-5S		MI	23668	6046	35418	5016	42015	4059	44948	3345	47414	2256	58407	1754	38220
14-#14	1.70	MA	24858	6046	37046	5032	44061	4072	47195	3357	49850	2267	61595	1772	40219
5L-4S		MI	24600	6046	36814	5000	43691	4060	46993	3333	50199	2249	61954	1820	39085
14-#14	1.70	MA	23917	6046	35740	5033	42320	4086	45075	3354	47030	2275	57781	1664	39022
6L-3S		MI	25629	6046	38194	5000	45556	4046	49254	3337	53250	2256	65345	1951	39298
14-#14	1.70	MA	22996	6046	34469	5034	40637	4086	43019	3367	44171	2269	54386	1562	37829
7L-2S		MI	27050	6046	40050	4999	47910	4047	52105	3325	57097	2248	70492	2083	39389
14-#18	3.03	MA	32978	6936	52488	5540	63420	4442	70558	3572	81189	2192	102186	1942	72029
2L-7S		MI	22744	6936	37624	5550	44297	4461	47551	3600	50666	2185	63942	954	56585
14-#18	3.03	MA	30476	6936	49059	5541	59071	4439	65288	3592	74099	2205	92733	1709	71536
3L-6S		MI	24205	6936	39747	5550	47106	4466	50981	3582	55387	2198	69453	1137	59776
14-#18	3.03	MA	28669	6936	46505	5541	55619	4462	61105	3585	68473	2192	86515	1475	69302
4L-5S		MI	25695	6936	41927	5550	50011	4443	54518	3590	60042	2185	75661	1330	63007
14-#18	3.03	MA	27034	6936	43920	5568	52517	4459	57319	3605	63339	2205	79988	1360	66394
5L-4S		MI	27249	6936	44380	5524	52955	4447	58110	3571	64883	2172	81814	1444	65692
14-#18	3.03	MA	25465	6936	41623	5569	49454	4483	53592	3598	58401	2218	73389	1167	62982
6L-3S		MI	28965	6936	46801	5524	56228	4425	62076	3580	70188	2185	87657	1678	67854
14-#18	3.03	MA	23929	6936	39386	5570	46495	4480	49977	3617	53394	2205	67526	984	59603
7L-2S		MI	31335	6936	50049	5525	60347	4429	67066	3561	76872	2172	96550	1911	68313
16-#11	1.35	MA	27143	5808	39032	4879	46726	3962	50495	3276	54368	2274	66966	2146	33204
2L-8S		MI	21583	5808	31534	4882	37076	3970	38964	3288	39368	2283	47900	1702	29526
16-#11	1.35	MA	26078	5808	37664	4880	44992	3962	48394	3285	51533	2281	63127	2055	33168
3L-7S		MI	22195	5808	32362	4881	38168	3970	40328	3289	41195	2277	50225	1756	30134
16-#11	1.35	MA	25310	5808	36650	4882	43620	3973	46732	3284	49290	2277	60593	1964	33082
4L-6S		MI	22815	5808	33204	4880	39282	3971	41689	3281	43088	2281	52474	1827	30687
16-#11	1.35	MA	24615	5808	35624	4893	42390	3973	45230	3293	47244	2284	57958	1917	32915
5E		MI	23448	5808	34069	4879	40435	3961	43093	3282	44956	2275	55002	1902	31302
16-#11	1.35	MA	23949	5808	34714	4894	41176	3983	43751	3292	45278	2290	55278	1842	32259
6L-4S		MI	24108	5808	35043	4868	41604	3961	44519	3274	46898	2269	57491	1948	31451
16-#11	1.35	MA	23298	5808	33828	4896	40003	3983	42318	3301	43285	2287	52890	1771	31659
7L-3S		MI	24837	5808	36006	4867	42906	3951	46097	3275	49027	2273	59878	2039	31526
16-#11	1.35	MA	22654	5808	32956	4897	38854	3983	40883	3300	41361	2293	50429	1717	31005
8L-2S		MI	25846	5808	37302	4866	44550	3951	48089	3267	51715	2267	63498	2130	31556
16-#14	1.95	MA	29337	6209	43887	5115	52759	4134	57749	3382	64117	2248	79881	2083	47258
2L-8S		MI	21963	6209	33637	5121	39552	4145	41879	3398	43250	2257	53453	1447	39847
16-#14	1.95	MA	27852	6209	41929	5116	50275	4133	54740	3394	60058	2257	74418	1952	47129
3L-7S		MI	22818	6209	34826	5120	41117	4146	43834	3401	45869	2250	56765	1523	41246
16-#14	1.95	MA	26780	6209	40475	5118	48310	4148	52358	3392	56842	2250	70816	1820	46861
4L-6S		MI	23683	6209	36033	5119	42715	4147	45786	3389	48584	2257	59961	1625	42443
16-#14	1.95	MA	25810	6209	39004	5134	46545	4147	50203	3404	53909	2259	67058	1754	45805
5E		MI	24566	6209	37273	5118	44369	4134	47800	3393	51261	2249	63555	1734	43508
16-#14	1.95	MA	24881	6209	37698	5135	44803	4161	48083	3402	51089	2268	63244	1645	44651
6L-4S		MI	25487	6209	38670	5103	46045	4135	49845	3381	54046	2241	67102	1800	44513

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis



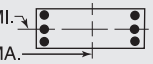
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	1.95	MA	23971	6209	36427	5137	43120	4161	46027	3414	48230	2261	59849	1543	43382
7L-3S		MI	26505	6209	40050	5102	47910	4121	52105	3384	57097	2248	70492	1931	44758
16-#14	1.95	MA	23071	6209	35175	5138	41472	4160	43968	3412	45471	2270	56340	1466	41877
8L-2S		MI	27913	6209	41905	5101	50263	4122	54957	3372	60944	2241	75640	2063	44875
16-#18	3.46	MA	31998	7227	52488	5722	63420	4572	70558	3676	81189	2191	102186	1670	81558
3L-7S		MI	24281	7227	40872	5731	48416	4594	52541	3684	57351	2169	72835	912	65664
16-#18	3.46	MA	30220	7227	49935	5723	59969	4595	66375	3669	75563	2178	95968	1436	79006
4L-6S		MI	25717	7227	42995	5732	51225	4599	55972	3666	62071	2183	78346	1094	68935
16-#18	3.46	MA	28612	7227	47350	5750	56866	4592	62589	3689	70429	2191	89441	1321	76220
5E		MI	27183	7227	45175	5732	54131	4576	59508	3674	66727	2169	84554	1288	72299
16-#18	3.46	MA	27070	7227	45053	5751	53804	4616	58862	3682	65491	2204	82842	1128	72677
6L-4S		MI	28711	7227	47627	5706	57074	4580	63100	3656	71568	2156	90707	1402	74867
16-#18	3.46	MA	25560	7227	42816	5751	50845	4613	55247	3702	60484	2191	76979	945	69221
7L-3S		MI	30400	7227	50049	5706	60347	4558	67066	3664	76872	2169	96550	1635	77341
18-#11	1.52	MA	27800	5922	40399	4950	48461	4014	52596	3309	57203	2269	70805	2134	37255
2L-9S		MI	21636	5922	31915	4964	37596	4032	39615	3329	40247	2284	49225	1631	32404
18-#11	1.52	MA	26743	5922	39032	4951	46726	4014	50495	3318	54368	2276	66966	2043	37205
3L-8S		MI	22239	5922	32830	4952	38721	4022	40956	3320	42056	2278	51520	1689	33215
18-#11	1.52	MA	25981	5922	38018	4952	45355	4025	48833	3317	52125	2272	64432	1952	37102
4L-7S		MI	22846	5922	33659	4952	39812	4022	42320	3322	43883	2271	53845	1743	33875
18-#11	1.52	MA	25293	5922	36992	4964	44124	4025	47331	3326	50079	2279	61797	1905	36917
5L-6S		MI	23460	5922	34501	4951	40927	4022	43681	3313	45776	2276	56094	1814	34412
18-#11	1.52	MA	24633	5922	36082	4965	42910	4035	45853	3325	48113	2285	59116	1830	36190
6L-5S		MI	24087	5922	35366	4950	42080	4012	45085	3315	47644	2270	58622	1889	35096
18-#11	1.52	MA	23987	5922	35196	4966	41737	4035	44420	3334	46120	2281	56729	1759	35608
7L-4S		MI	24742	5922	36340	4938	43249	4013	46512	3307	49586	2264	61111	1935	35263
18-#11	1.52	MA	23348	5922	34323	4968	40588	4035	42984	3332	44196	2288	54267	1705	34903
8L-3S		MI	25465	5922	37302	4938	44550	4003	48089	3308	51715	2268	63498	2026	35355
18-#11	1.52	MA	22715	5922	33360	4979	39404	4045	41572	3341	42292	2295	51833	1647	34030
9L-2S		MI	26466	5922	38599	4937	46195	4003	50082	3300	54403	2262	67118	2117	35398
18-#14	2.19	MA	30239	6373	45845	5217	55242	4209	60757	3429	68176	2241	85344	2065	53040
2L-9S		MI	22038	6373	34180	5239	40292	4234	42806	3457	44503	2258	55339	1342	43401
18-#14	2.19	MA	28768	6373	43887	5219	52759	4208	57749	3442	64117	2249	79881	1933	52885
3L-8S		MI	22877	6373	35493	5223	41905	4220	44730	3445	47097	2250	58600	1427	45148
18-#14	2.19	MA	27707	6373	42433	5220	50793	4222	55366	3439	60901	2243	76279	1802	52587
4L-7S		MI	23723	6373	36681	5222	43471	4221	46686	3449	49716	2242	61913	1503	46509
18-#14	2.19	MA	26749	6373	40962	5236	49028	4222	53212	3452	57968	2252	72521	1735	51404
5L-6S		MI	24578	6373	37889	5222	45069	4222	48638	3437	52431	2249	65109	1605	47780
18-#14	2.19	MA	25830	6373	39656	5237	47286	4236	51092	3449	55148	2260	68707	1627	50289
6L-5S		MI	25451	6373	39129	5221	46723	4208	50651	3440	55108	2242	68703	1714	48808
18-#14	2.19	MA	24930	6373	38385	5239	45603	4235	49036	3462	52289	2254	65312	1525	48946
7L-4S		MI	26362	6373	40525	5205	48398	4210	52696	3428	57893	2234	72250	1779	49939
18-#14	2.19	MA	24041	6373	37133	5240	43955	4235	46976	3459	49530	2263	61803	1448	47480
8L-3S		MI	27370	6373	41905	5204	50263	4196	54957	3431	60944	2241	75640	1911	50213
18-#14	2.19	MA	23158	6373	35751	5256	42256	4249	44950	3472	46798	2271	58340	1363	45627
9L-2S		MI	28764	6373	43761	5203	52617	4197	57808	3420	64791	2233	80788	2042	50355
18-#18	3.90	MA	31745	7518	53364	5905	64318	4728	71645	3753	82653	2163	105421	1397	88739
4L-7S		MI	25789	7518	44120	5913	52536	4727	57532	3769	64035	2153	81728	870	74763
18-#18	3.90	MA	30162	7518	50780	5932	61216	4725	67859	3773	77519	2177	98894	1282	86063
5L-6S		MI	27202	7518	46243	5913	55344	4732	60962	3750	68756	2167	87240	1052	78115
18-#18	3.90	MA	28645	7518	48482	5933	58154	4749	64131	3766	72581	2190	92295	1088	82394
6L-5S		MI	28645	7518	48423	5914	58250	4709	64499	3758	73412	2153	93447	1246	81608
18-#18	3.90	MA	27159	7518	46246	5933	55195	4746	60516	3786	67574	2177	86431	906	78860
7L-4S		MI	30149	7518	50875	5887	61193	4713	68091	3740	78253	2140	99600	1359	84070

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis



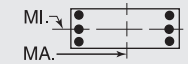
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.69	MA	28450	6035	41767	5021	50195	4066	54698	3342	60038	2264	74643	2122	41301
2L-10S		MI	21695	6035	32387	5036	38156	4083	40259	3360	41075	2274	50472	1538	35213
20-#11	1.69	MA	27401	6035	40399	5022	48461	4066	52596	3351	57203	2271	70805	2031	41238
3L-9S		MI	22289	6035	33212	5035	39240	4083	41607	3362	42935	2278	52845	1618	36119
20-#11	1.69	MA	26645	6035	39385	5023	47089	4077	50934	3350	54960	2267	68271	1940	41119
4L-8S		MI	22887	6035	34127	5023	40365	4074	42949	3353	44744	2272	55140	1677	36911
20-#11	1.69	MA	25962	6035	38360	5035	45859	4076	49432	3359	52914	2273	65636	1894	40917
5L-7S		MI	23488	6035	34956	5022	41457	4074	44312	3355	46571	2266	57465	1730	37620
20-#11	1.69	MA	25308	6035	37449	5036	44644	4087	47954	3357	50948	2280	62955	1819	40128
6E		MI	24097	6035	35798	5022	42571	4074	45674	3346	48464	2271	59714	1801	38142
20-#11	1.69	MA	24668	6035	36563	5037	43472	4087	46521	3366	48955	2276	60568	1748	39560
7L-5S		MI	24719	6035	36662	5021	43724	4064	47078	3348	50332	2265	62242	1876	38889
20-#11	1.69	MA	24035	6035	35691	5039	42322	4087	45085	3365	47031	2283	58106	1694	38808
8L-4S		MI	25368	6035	37636	5009	44893	4065	48504	3339	52274	2259	64731	1922	39072
20-#11	1.69	MA	23407	6035	34728	5050	41138	4097	43673	3374	45127	2289	55672	1635	37954
9L-3S		MI	26086	6035	38599	5008	46195	4055	50082	3341	54403	2263	67118	2014	39179
20-#11	1.69	MA	22781	6035	33859	5051	39997	4097	42254	3373	43169	2286	53155	1555	36988
10L-2S		MI	27080	6035	39896	5007	47839	4055	52074	3332	57091	2257	70738	2105	39236
20-#14	2.44	MA	29672	6537	45845	5321	55242	4283	60757	3489	68176	2242	85344	1915	58637
3L-9S		MI	22949	6537	36036	5341	42645	4309	45657	3505	48350	2250	60487	1322	48668
20-#14	2.44	MA	28623	6537	44391	5322	53276	4297	58375	3487	64960	2236	81742	1783	58311
4L-8S		MI	23779	6537	37348	5325	44259	4295	47582	3493	50944	2243	63748	1407	50456
20-#14	2.44	MA	27674	6537	42920	5338	51511	4297	56220	3499	62027	2244	77985	1717	57013
5L-7S		MI	24615	6537	38537	5325	45825	4296	49537	3496	53563	2235	67061	1483	51782
20-#14	2.44	MA	26766	6537	41614	5340	49769	4311	54100	3497	59207	2253	74170	1608	55933
6E		MI	25461	6537	39745	5324	47422	4297	51489	3484	56278	2242	70257	1585	53124
20-#14	2.44	MA	25876	6537	40343	5341	48087	4310	52044	3509	56348	2247	70776	1506	54519
7L-5S		MI	26325	6537	40985	5323	49076	4283	53502	3487	58955	2234	73851	1694	54119
20-#14	2.44	MA	24997	6537	39091	5342	46438	4310	49985	3507	53589	2255	67266	1429	53090
8L-4S		MI	27226	6537	42381	5307	50752	4284	55548	3476	61740	2226	77398	1759	55363
20-#14	2.44	MA	24124	6537	37709	5359	44739	4324	47959	3519	50857	2264	63803	1345	51197
9L-3S		MI	28223	6537	43761	5306	52617	4271	57808	3479	64791	2233	80788	1891	55664
20-#18	4.33	MA	31688	7809	54209	6114	65566	4858	73128	3857	84609	2162	108347	1243	95922
5L-7S		MI	27271	7809	47368	6095	56655	4860	62522	3853	70720	2137	90621	827	83882
20-#18	4.33	MA	30194	7809	51912	6114	62504	4882	69401	3850	79671	2176	101748	1049	92130
6E		MI	28662	7809	49491	6095	59463	4865	65952	3835	75441	2151	96133	1010	87315
20-#18	4.33	MA	28731	7809	49675	6115	59544	4879	65786	3870	74664	2162	95884	867	88386
7L-5S		MI	30083	7809	51671	6095	62369	4842	69489	3843	80096	2137	102340	1203	90932
22-#11	1.86	MA	29093	6148	43134	5092	51930	4118	56799	3375	62873	2259	78482	2111	45344
2L-11S		MI	21727	6148	32864	5107	38689	4145	40918	3402	41962	2275	51807	1469	37951
22-#11	1.86	MA	28052	6148	41767	5093	50195	4118	54698	3384	60038	2265	74643	2020	45268
3L-10S		MI	22345	6148	33683	5106	39801	4135	42251	3393	43764	2269	54092	1525	38902
22-#11	1.86	MA	27302	6148	40753	5094	48824	4128	53036	3382	57795	2262	72110	1929	45135
4L-9S		MI	22935	6148	34509	5105	40885	4135	43599	3395	45624	2273	56465	1605	39839
22-#11	1.86	MA	26625	6148	39727	5106	47593	4128	51533	3392	55749	2268	69474	1882	44917
5L-8S		MI	23527	6148	35424	5094	42010	4125	44941	3386	47432	2267	58760	1664	40613
22-#11	1.86	MA	25976	6148	38817	5107	46379	4139	50055	3390	53783	2275	66794	1807	44071
6L-7S		MI	24124	6148	36253	5093	43102	4126	46305	3388	49259	2261	61085	1717	41368
22-#11	1.86	MA	25341	6148	37931	5108	45206	4139	48622	3399	51790	2271	64407	1736	43516
7L-6S		MI	24727	6148	37094	5092	44216	4126	47666	3379	51152	2265	63334	1788	41878
22-#11	1.86	MA	24714	6148	37059	5109	44057	4139	47187	3398	49866	2278	61945	1682	42718
8L-5S		MI	25344	6148	37959	5091	45369	4116	49070	3381	53020	2259	65862	1863	42671
22-#11	1.86	MA	24091	6148	36095	5121	42873	4149	45774	3407	47962	2284	59510	1624	41883
9L-4S		MI	25988	6148	38933	5080	46538	4117	50496	3372	54962	2253	68351	1910	42880

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

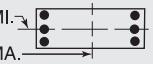
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.86	MA	23471	6148	35227	5122	41732	4149	44355	3406	46004	2280	56994	1543	40887
10L-3S		MI	26700	6148	39896	5079	47839	4107	52074	3374	57091	2258	70738	2001	43001
22-#11	1.86	MA	22809	6148	34364	5123	40561	4159	42951	3415	44108	2287	54574	1487	39866
11L-2S		MI	27688	6148	41192	5078	49484	4107	54066	3365	59779	2252	74358	2092	43070
22-#14	2.68	MA	29527	6700	46349	5424	55759	4372	61383	3534	69019	2228	87205	1765	64035
4L-9S		MI	23847	6700	37892	5443	44999	4383	48509	3552	52197	2243	65635	1302	53943
22-#14	2.68	MA	28588	6700	44878	5441	53994	4371	59229	3547	66086	2237	83448	1698	62633
5L-8S		MI	24669	6700	39204	5428	46612	4370	50433	3540	54791	2235	68896	1386	55770
22-#14	2.68	MA	27690	6700	43572	5442	52253	4386	57109	3544	63266	2245	79633	1590	61584
6L-7S		MI	25496	6700	40393	5427	48178	4371	52389	3543	57410	2227	72208	1462	57064
22-#14	2.68	MA	26810	6700	42301	5443	50570	4385	55053	3556	60407	2239	76239	1488	60102
7L-6S		MI	26332	6700	41601	5426	49776	4372	54341	3532	60125	2234	75404	1565	58475
22-#14	2.68	MA	25940	6700	41049	5445	48921	4384	52993	3554	57648	2248	72729	1411	58707
8L-5S		MI	27187	6700	42841	5425	51430	4358	56354	3535	62802	2227	78998	1673	59440
22-#14	2.68	MA	25077	6700	39667	5461	47222	4399	50967	3566	54916	2256	69266	1326	56774
9L-4S		MI	28079	6700	44237	5409	53105	4359	58399	3523	65587	2219	82545	1739	60785
22-#18	4.76	MA	31720	8100	55342	6296	66853	5015	74671	3935	86761	2161	111201	1010	101884
6L-7S		MI	28731	8100	50616	6277	60774	4993	67513	3937	77405	2121	99515	785	92902
22-#18	4.76	MA	30279	8100	53105	6297	63894	5012	71056	3954	81754	2148	105337	828	98066
7L-6S		MI	30102	8100	52739	6277	63582	4998	70943	3919	82125	2135	105026	967	96533
24-#11	2.03	MA	28696	6262	43134	5164	51930	4170	56799	3417	62873	2260	78482	2008	49296
3L-11S		MI	22384	6262	34161	5178	40333	4197	42910	3435	44650	2270	55427	1456	41661
24-#11	2.03	MA	27952	6262	42120	5165	50558	4180	55137	3415	60630	2257	75948	1917	49149
4L-10S		MI	22989	6262	34980	5177	41445	4187	44244	3426	46452	2264	57712	1513	42595
24-#11	2.03	MA	27280	6262	41095	5177	49328	4180	53635	3424	58584	2263	73313	1870	48851
5L-9S		MI	23574	6262	35806	5176	42530	4187	45592	3428	48312	2268	60085	1593	43563
24-#11	2.03	MA	26637	6262	40184	5178	48113	4191	52157	3423	56618	2270	70633	1795	48018
6L-8S		MI	24161	6262	36721	5165	43654	4177	46934	3419	50120	2262	62380	1651	44320
24-#11	2.03	MA	26007	6262	39298	5179	46941	4191	50723	3432	54625	2266	68245	1724	47475
7E		MI	24753	6262	37549	5164	44746	4178	48297	3421	51947	2256	64705	1705	45118
24-#11	2.03	MA	25385	6262	38426	5180	45791	4190	49288	3431	52701	2273	65784	1670	46633
8L-6S		MI	25351	6262	38391	5163	45860	4178	49658	3412	53840	2260	66954	1776	45618
24-#11	2.03	MA	24768	6262	37463	5192	44607	4201	47875	3440	50797	2279	63349	1612	45816
9L-5S		MI	25963	6262	39256	5162	47014	4168	51062	3414	55708	2254	69482	1851	46385
24-#11	2.03	MA	24153	6262	36594	5193	43466	4201	46456	3439	48839	2275	60832	1532	44790
10L-4S		MI	26602	6262	40230	5151	48182	4168	52489	3405	57650	2248	71971	1897	46685
24-#11	2.03	MA	23495	6262	35732	5194	42295	4211	45053	3448	46943	2282	58413	1475	43787
11L-3S		MI	27309	6262	41192	5150	49484	4159	54066	3407	59779	2253	74358	1988	46820
24-#14	2.92	MA	29492	6864	46836	5543	56478	4446	62237	3594	70145	2229	88911	1680	68261
5L-9S		MI	24735	6864	39748	5546	47353	4458	51360	3599	56044	2235	70782	1281	59224
24-#14	2.92	MA	28602	6864	45530	5544	54736	4461	60117	3591	67325	2238	85096	1571	67240
6L-8S		MI	25547	6864	41060	5530	48966	4444	53284	3588	58638	2228	74044	1366	61091
24-#14	2.92	MA	27732	6864	44259	5545	53053	4460	58061	3604	64466	2232	81702	1469	65693
7E		MI	26366	6864	42249	5529	50532	4446	55240	3591	61257	2220	77356	1442	62354
24-#14	2.92	MA	26871	6864	43007	5547	51405	4459	56002	3601	61707	2240	78192	1392	64330
8L-6S		MI	27194	6864	43456	5528	52130	4447	57192	3579	63972	2227	80552	1545	63830
24-#14	2.92	MA	26017	6864	41625	5563	49706	4474	53976	3614	58975	2249	74729	1307	62358
9L-5S		MI	28040	6864	44697	5527	53783	4433	59205	3582	66649	2219	84146	1653	64769
24-#18	5.19	MA	31805	8390	56535	6478	68244	5145	76325	4039	88844	2134	114790	789	107763
7E		MI	30170	8390	53864	6458	64893	5126	72503	4021	84089	2105	108408	742	102060

RECTANGULAR TIED COLUMNS 42" x 46"

6-#18	1.24	MA	29052	5996	41828	5022	49737	4082	53453	3381	56998	2364	69488	2216	33135
2L-3S		MI	23860	5996	35051	4991	41183	4052	43575	3378	44816	2353	53643	1948	29897
6-#18	1.24	MA	26230	5996	38216	5023	45157	4080	47905	3402	49512	2378	59475	1983	33000
3L-2S		MI	26394	5996	38299	4991	45302	4056	48565	3359	51501	2340	62536	2181	29981
8-#18	1.66	MA	30769	6287	45439	5204	54317	4215	59002	3465	64484	2351	79501	2180	43839
2L-4S		MI	23617	6287	35877	5172	42029	4208	44599	3454	46197	2324	56693	1672	38745

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis



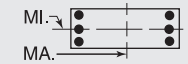
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	1.66	MA	27996	6287	41828	5205	49737	4213	53453	3486	56998	2365	69488	1946	43597
3E		MI	25431	6287	38299	5172	45302	4185	48565	3462	51501	2337	62536	1905	39432
8-#18	1.66	MA	25986	6287	39142	5207	46107	4237	49054	3480	51060	2352	62894	1713	42761
4L-2S		MI	27922	6287	41547	5173	49422	4189	53556	3444	58186	2324	71429	2139	39621
10-#14	1.16	MA	28856	5941	41022	5017	48975	4081	52644	3386	55983	2383	68509	2255	31388
2L-5S		MI	22764	5941	32936	5006	38737	4069	40706	3386	41091	2376	49678	1896	27909
10-#14	1.16	MA	27239	5941	38962	5019	46362	4081	49478	3399	51712	2392	62730	2123	31347
3L-4S		MI	23722	5941	34332	4991	40413	4071	42752	3375	43876	2368	53225	1961	28283
10-#14	1.16	MA	26070	5941	37434	5021	44296	4096	46974	3397	48332	2387	58917	1992	31187
4L-3S		MI	24777	5941	35712	4990	42278	4057	45012	3378	46927	2375	56616	2093	28402
10-#14	1.16	MA	25011	5941	35888	5037	42442	4096	44711	3410	45250	2396	54949	1924	30732
5L-2S		MI	26232	5941	37568	4989	44631	4058	47864	3366	50774	2367	61763	2224	28424
10-#18	2.07	MA	32444	6578	49051	5385	58897	4348	64551	3550	71971	2338	89514	2144	54514
2L-5S		MI	23564	6578	36673	5380	43205	4336	45998	3556	48040	2321	59433	1516	44797
10-#18	2.07	MA	29716	6578	45439	5387	54317	4346	59002	3570	64484	2352	79501	1910	54178
3L-4S		MI	25180	6578	39125	5354	46149	4340	49589	3538	52881	2308	65586	1629	47814
10-#18	2.07	MA	27743	6578	42754	5388	50687	4370	54603	3565	58547	2339	72907	1677	52950
4L-3S		MI	26962	6578	41547	5354	49422	4318	53556	3546	58186	2321	71429	1863	48948
10-#18	2.07	MA	25955	6578	40036	5416	47426	4368	50623	3586	53128	2353	66007	1560	49458
5L-2S		MI	29414	6578	44795	5354	53541	4322	58546	3528	64870	2308	80323	2096	49225
12-#14	1.40	MA	29856	6105	43082	5120	51588	4156	55809	3433	60254	2375	74288	2238	37498
2L-6S		MI	22787	6105	33551	5110	39437	4158	41545	3431	42261	2376	51232	1767	31988
12-#14	1.40	MA	28256	6105	41022	5121	48975	4156	52644	3446	55983	2385	68509	2106	37425
3L-5S		MI	23694	6105	34792	5109	41091	4144	43558	3434	44938	2368	54826	1875	33159
12-#14	1.40	MA	27100	6105	39494	5123	46909	4171	50140	3444	52603	2379	64696	1975	37225
4E		MI	24640	6105	36188	5093	42766	4145	45603	3422	47723	2361	58373	1941	33724
12-#14	1.40	MA	26054	6105	37949	5140	45055	4171	47876	3457	49521	2388	60728	1907	36578
5L-3S		MI	25684	6105	37568	5092	44631	4132	47864	3425	50774	2368	61763	2073	33882
12-#14	1.40	MA	25052	6105	36577	5141	43225	4185	45649	3455	46558	2398	56692	1799	35221
6L-2S		MI	27124	6105	39424	5091	46985	4133	50715	3413	54621	2360	66911	2204	33935
12-#18	2.48	MA	34082	6868	52662	5567	63478	4481	70100	3634	79457	2325	99528	2108	65168
2L-6S		MI	23596	6868	37740	5562	44419	4492	47451	3633	50069	2318	62119	1280	51145
12-#18	2.48	MA	31397	6868	49051	5569	58897	4479	64551	3655	71971	2338	89514	1874	64750
3L-5S		MI	25120	6868	39921	5562	47325	4469	50988	3641	54725	2305	68326	1473	54039
12-#18	2.48	MA	29458	6868	46365	5570	55267	4503	60152	3649	66033	2326	82920	1641	63102
4E		MI	26708	6868	42373	5536	50268	4473	54580	3622	59566	2292	74479	1587	56907
12-#18	2.48	MA	27702	6868	43648	5598	52006	4501	56171	3670	60614	2339	76020	1524	59769
5L-3S		MI	28460	6868	44795	5536	53541	4451	58546	3630	64870	2305	80323	1820	58452
12-#18	2.48	MA	26018	6868	41234	5599	48787	4525	52253	3664	55403	2353	69029	1331	56529
6L-2S		MI	30875	6868	48043	5536	57660	4455	63537	3612	71555	2292	89216	2054	58809
14-#11	1.13	MA	28773	5918	40651	5017	48636	4082	52291	3389	55546	2392	68103	2273	30623
2L-7S		MI	22473	5918	32290	5005	37950	4079	39797	3393	39880	2387	48175	1870	26542
14-#11	1.13	MA	27641	5918	39212	5019	46812	4083	50081	3399	52564	2399	64045	2182	30600
3L-6S		MI	23100	5918	33131	5004	39064	4079	41158	3384	41773	2391	50424	1941	27117
14-#11	1.13	MA	26825	5918	38147	5020	45371	4093	48334	3398	50207	2396	61365	2091	30533
4L-5S		MI	23740	5918	33996	5003	40218	4070	42562	3386	43641	2385	52952	2016	27570
14-#11	1.13	MA	26088	5918	37070	5032	44079	4094	46757	3407	48058	2403	58583	2043	30386
5L-4S		MI	24408	5918	34970	4992	41386	4070	43988	3377	45583	2379	55441	2062	27683
14-#11	1.13	MA	25380	5918	36114	5033	42803	4104	45204	3406	45993	2410	55750	1968	29858
6L-3S		MI	25145	5918	35933	4991	42688	4060	45566	3379	47712	2383	57828	2153	27731
14-#11	1.13	MA	24688	5918	35184	5035	41572	4105	43699	3416	43900	2406	53225	1898	29187
7L-2S		MI	26164	5918	37230	4990	44333	4060	47558	3370	50400	2377	61448	2244	27742

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

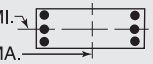


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	1.63	MA	30840	6269	45143	5222	54201	4231	58975	3481	64525	2368	80066	2221	43597
2L-7S		MI	22834	6269	34200	5213	40193	4232	42444	3490	43393	2362	53184	1644	36320
14-#14	1.63	MA	29256	6269	43082	5223	51588	4231	55809	3494	60254	2377	74288	2089	43495
3L-6S		MI	23713	6269	35407	5212	41790	4233	44396	3478	46108	2369	56380	1747	37306
14-#14	1.63	MA	28113	6269	41554	5225	49522	4246	53305	3492	56874	2372	70474	1958	43259
4L-5S		MI	24609	6269	36648	5211	43444	4219	46409	3481	48785	2361	59974	1855	38428
14-#14	1.63	MA	27080	6269	40009	5242	47668	4245	51042	3505	53792	2381	66506	1890	42444
5L-4S		MI	25545	6269	38044	5195	45120	4220	48454	3469	51570	2353	63521	1921	39159
14-#14	1.63	MA	26089	6269	38637	5244	45838	4260	48814	3503	50829	2390	62471	1782	41138
6L-3S		MI	26577	6269	39424	5194	46985	4206	50715	3473	54621	2360	66911	2052	39352
14-#14	1.63	MA	25119	6269	37302	5245	44071	4260	46655	3516	47825	2385	58878	1680	40016
7L-2S		MI	28003	6269	41279	5193	49339	4208	53566	3461	58468	2353	72059	2184	39432
14-#18	2.90	MA	35690	7159	56274	5749	68058	4614	75649	3718	86944	2311	109541	2072	75809
2L-7S		MI	23676	7159	38865	5743	45730	4620	49011	3735	52033	2289	65501	1055	57262
14-#18	2.90	MA	33043	7159	52662	5750	63478	4612	70100	3739	79457	2325	99528	1838	75316
3L-6S		MI	25144	7159	40988	5743	48538	4625	52442	3717	56754	2302	71012	1237	60270
14-#18	2.90	MA	31136	7159	49977	5752	59847	4636	65701	3733	73519	2312	92933	1604	73295
4L-5S		MI	26642	7159	43169	5744	51444	4602	55978	3725	61410	2289	77220	1431	63305
14-#18	2.90	MA	29411	7159	47259	5780	56586	4634	61720	3754	68100	2326	86033	1488	70104
5L-4S		MI	28204	7159	45621	5717	54387	4606	59570	3707	66251	2276	83373	1544	66040
14-#18	2.90	MA	27757	7159	44845	5781	53367	4658	57802	3748	62889	2340	79042	1295	66728
6L-3S		MI	29928	7159	48043	5718	57660	4584	63537	3715	71555	2289	89216	1778	67949
14-#18	2.90	MA	26136	7159	42495	5783	50258	4656	54003	3769	57606	2327	72826	1113	63362
7L-2S		MI	32308	7159	51291	5718	61779	4588	68527	3696	78240	2276	98109	2012	68377
16-#11	1.29	MA	29478	6031	42089	5088	50461	4134	54501	3422	58528	2387	72161	2262	34889
2L-8S		MI	22519	6031	32758	5077	38503	4131	40425	3424	40741	2388	49470	1804	29762
16-#11	1.29	MA	28355	6031	40651	5089	48636	4135	52291	3432	55546	2394	68103	2171	34853
3L-7S		MI	23133	6031	33586	5076	39595	4131	41789	3426	42568	2382	51795	1857	30277
16-#11	1.29	MA	27545	6031	39585	5091	47196	4145	50545	3431	53189	2390	65422	2080	34767
4L-6S		MI	23754	6031	34428	5075	40709	4131	43150	3417	44461	2386	54044	1928	30833
16-#11	1.29	MA	26814	6031	38508	5103	45903	4146	48967	3440	51040	2397	62641	2033	34600
5E		MI	24389	6031	35293	5074	41862	4121	44554	3419	46329	2380	56572	2003	31369
16-#11	1.29	MA	26113	6031	37552	5104	44628	4156	47414	3439	48975	2405	59807	1958	33988
6L-4S		MI	25051	6031	36267	5063	43031	4122	45981	3410	48271	2374	59061	2049	31502
16-#11	1.29	MA	25427	6031	36622	5106	43396	4156	45909	3449	46882	2401	57282	1887	33337
7L-3S		MI	25782	6031	37230	5062	44333	4112	47558	3412	50400	2378	61448	2140	31567
16-#11	1.29	MA	24749	6031	35706	5107	42190	4157	44402	3448	44862	2408	54684	1832	32741
8L-2S		MI	26794	6031	38526	5061	45977	4112	49551	3403	53088	2372	65068	2232	31592
16-#14	1.86	MA	31811	6432	47203	5324	56814	4306	62141	3528	68795	2360	85845	2204	49688
2L-8S		MI	22897	6432	34867	5316	40980	4305	43340	3534	44621	2362	55019	1548	40147
16-#14	1.86	MA	30242	6432	45143	5326	54201	4306	58975	3541	64525	2370	80066	2072	49559
3L-7S		MI	23755	6432	36056	5315	42546	4306	45296	3537	47240	2354	58331	1624	41566
16-#14	1.86	MA	29112	6432	43615	5327	52135	4320	56471	3539	61145	2364	76253	1941	49291
4L-6S		MI	24624	6432	37263	5314	44144	4308	47248	3525	49955	2361	61527	1726	42633
16-#14	1.86	MA	28090	6432	42069	5344	50281	4320	54207	3552	58062	2374	72285	1873	48325
5E		MI	25511	6432	38503	5313	45798	4294	49261	3529	52633	2354	65121	1835	43712
16-#14	1.86	MA	27111	6432	40698	5346	48451	4335	51980	3550	55100	2383	68250	1765	47066
6L-4S		MI	26435	6432	39900	5297	47473	4295	51306	3517	55417	2346	68668	1901	44591
16-#14	1.86	MA	26152	6432	39362	5347	46684	4335	49820	3563	52096	2377	64657	1663	45866
7L-3S		MI	27457	6432	41279	5297	49339	4281	53566	3520	58468	2353	72059	2032	44815
16-#14	1.86	MA	25204	6432	38048	5349	44952	4335	47657	3561	49198	2387	60950	1585	44233
8L-2S		MI	28870	6432	43135	5296	51692	4282	56418	3508	62315	2345	77206	2164	44921
16-#18	3.31	MA	34660	7450	56274	5932	68058	4745	75649	3823	86944	2312	109541	1802	85878
3L-7S		MI	25217	7450	42113	5925	49849	4753	54002	3820	58718	2273	74394	1012	66331
16-#18	3.31	MA	32783	7450	53588	5934	64427	4769	71250	3817	81006	2299	102947	1568	83522
4L-6S		MI	26661	7450	44236	5925	52657	4758	57432	3801	63439	2286	79905	1195	69420
16-#18	3.31	MA	31086	7450	50871	5961	61166	4767	67269	3838	75587	2313	96046	1452	80460
5E		MI	28135	7450	46417	5925	55563	4735	60969	3809	68094	2273	86113	1388	72592
16-#18	3.31	MA	29460	7450	48457	5963	57948	4791	63351	3833	70375	2326	89055	1259	76952
6L-4S		MI	29672	7450	48869	5899	58506	4739	64561	3791	72935	2260	92266	1502	75207

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis



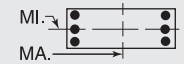
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	3.31	MA	27866	7450	46106	5964	54838	4789	59552	3853	65092	2314	82839	1077	73511
7L-3S		MI	31370	7450	51291	5899	61779	4717	68527	3799	78240	2273	98109	1736	77440
16-#18	3.31	MA	26289	7450	43793	5966	51790	4787	55746	3848	59994	2327	76395	941	69032
8L-2S		MI	33718	7450	54539	5900	65899	4721	73518	3781	84924	2260	107002	1969	77934
18-#11	1.45	MA	30175	6144	43528	5159	52285	4186	56711	3455	61510	2381	76218	2251	39150
2L-9S		MI	22571	6144	33139	5159	39023	4192	41076	3466	41621	2388	50795	1732	32628
18-#11	1.45	MA	29060	6144	42089	5160	50461	4186	54501	3464	58528	2388	72161	2160	39100
3L-8S		MI	23176	6144	34054	5148	40148	4182	42418	3457	43429	2382	53090	1791	33449
18-#11	1.45	MA	28257	6144	41024	5162	49020	4197	52755	3463	56171	2385	69480	2069	38997
4L-7S		MI	23785	6144	34883	5147	41239	4183	43781	3459	45256	2376	55415	1844	34017
18-#11	1.45	MA	27532	6144	39947	5174	47727	4197	51177	3473	54022	2392	66699	2022	38812
5L-6S		MI	24401	6144	35725	5146	42354	4183	45143	3450	47149	2381	57664	1915	34556
18-#11	1.45	MA	26837	6144	38991	5175	46452	4208	49624	3472	51957	2399	63865	1947	38125
6L-5S		MI	25030	6144	36590	5145	43507	4173	46547	3452	49017	2375	60192	1990	35167
18-#11	1.45	MA	26157	6144	38061	5177	45221	4208	48119	3481	49864	2396	61340	1876	37493
7L-4S		MI	25687	6144	37564	5134	44676	4174	47973	3443	50959	2369	62681	2037	35317
18-#11	1.45	MA	25485	6144	37145	5178	44014	4209	46612	3481	47844	2403	58742	1822	36844
8L-3S		MI	26412	6144	38526	5133	45977	4164	49551	3445	53088	2373	65068	2128	35398
18-#11	1.45	MA	24818	6144	36134	5190	42770	4219	45129	3490	45844	2410	56167	1763	35898
9L-2S		MI	27416	6144	39823	5132	47622	4164	51543	3436	55776	2367	68688	2219	35436
18-#14	2.10	MA	32768	6596	49263	5426	59427	4380	65306	3575	73066	2353	91624	2187	55773
2L-9S		MI	22971	6596	35410	5434	41721	4394	44267	3593	45874	2362	56905	1443	43859
18-#14	2.10	MA	31214	6596	47203	5428	56814	4380	62141	3588	68795	2362	85845	2055	55618
3L-8S		MI	23814	6596	36723	5418	43334	4380	46191	3581	48468	2355	60167	1528	45444
18-#14	2.10	MA	30096	6596	45675	5430	54748	4395	59636	3586	65415	2357	82032	1924	55320
4L-7S		MI	24663	6596	37911	5417	44900	4381	48147	3585	51087	2347	63479	1604	46825
18-#14	2.10	MA	29085	6596	44130	5446	52894	4395	57373	3599	62333	2366	78064	1856	54219
5L-6S		MI	25522	6596	39119	5416	46498	4382	50099	3573	53802	2354	66675	1706	47969
18-#14	2.10	MA	28117	6596	42758	5448	51064	4410	55145	3598	59370	2375	74029	1748	53002
6L-5S		MI	26399	6596	40359	5415	48151	4369	52112	3576	56480	2346	70269	1815	49010
18-#14	2.10	MA	27169	6596	41423	5450	49297	4410	52986	3611	56367	2370	70435	1646	51726
7L-4S		MI	27314	6596	41755	5400	49827	4370	54157	3564	59264	2338	73816	1881	50020
18-#14	2.10	MA	26232	6596	40108	5451	47565	4410	50823	3609	53469	2379	66729	1568	50134
8L-3S		MI	28325	6596	43135	5399	51692	4356	56418	3567	62315	2345	77206	2012	50273
18-#14	2.10	MA	25302	6596	38657	5468	45780	4424	48694	3622	50599	2389	63064	1484	48298
9L-2S		MI	29725	6596	44991	5398	54046	4357	59269	3556	66162	2338	82354	2143	50402
18-#18	3.73	MA	34402	7741	57199	6115	69008	4902	76799	3902	88492	2286	112960	1532	93779
4L-7S		MI	26730	7741	45361	6106	53968	4886	58992	3904	65402	2257	83287	970	75421
18-#18	3.73	MA	32732	7741	54482	6143	65747	4900	72818	3922	83073	2299	106059	1415	90834
5L-6S		MI	28151	7741	47484	6107	56776	4891	62423	3885	70123	2270	88799	1152	78592
18-#18	3.73	MA	31131	7741	52068	6145	62528	4924	68900	3917	77862	2313	99068	1223	87197
6L-5S		MI	29602	7741	49665	6107	59682	4868	65959	3893	74779	2257	95006	1346	81897
18-#18	3.73	MA	29563	7741	49718	6146	59418	4922	65101	3938	72579	2300	92852	1040	83680
7L-4S		MI	31116	7741	52117	6081	62625	4872	69551	3875	79620	2244	101159	1460	84404
18-#18	3.73	MA	28012	7741	47404	6148	56370	4920	61294	3932	67480	2314	86408	905	79302
8L-3S		MI	32789	7741	54539	6081	65899	4850	73518	3883	84924	2257	107002	1693	86927
20-#11	1.61	MA	30864	6258	44966	5230	54110	4238	58922	3488	64492	2376	80276	2241	43407
2L-10S		MI	22629	6258	33611	5231	39583	4244	41720	3497	42449	2379	52042	1639	35520
20-#11	1.61	MA	29757	6258	43528	5231	52285	4238	56711	3497	61510	2383	76218	2150	43344
3L-9S		MI	23226	6258	34436	5230	40667	4244	43068	3498	44309	2383	54415	1720	36342
20-#11	1.61	MA	28961	6258	42462	5233	50844	4249	54965	3496	59153	2380	73538	2059	43225
4L-8S		MI	23825	6258	35351	5219	41792	4234	44410	3490	46118	2377	56710	1778	37142
20-#11	1.61	MA	28242	6258	41385	5245	49552	4249	53387	3506	57004	2387	70756	2011	43023
5L-7S		MI	24429	6258	36180	5218	42884	4235	45774	3492	47944	2371	59035	1832	37761

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

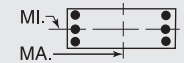


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.61	MA	27553	6258	40429	5246	48276	4260	51835	3505	54939	2394	67923	1936	42269
6E		MI	25040	6258	37022	5217	43998	4235	47135	3483	49837	2376	61284	1903	38285
20-#11	1.61	MA	26878	6258	39499	5248	47045	4260	50330	3514	52845	2391	65398	1866	41654
7L-5S		MI	25664	6258	37886	5216	45151	4225	48539	3485	51705	2370	63812	1978	38962
20-#11	1.61	MA	26212	6258	38583	5249	45838	4261	48822	3513	50826	2398	62799	1811	40955
8L-4S		MI	26315	6258	38860	5205	46320	4225	49965	3476	53647	2363	66301	2024	39129
20-#11	1.61	MA	25551	6258	37572	5261	44595	4271	47339	3523	48826	2405	60225	1753	40029
9L-3S		MI	27036	6258	39823	5204	47622	4216	51543	3478	55776	2368	68688	2115	39225
20-#11	1.61	MA	24880	6258	36660	5262	43397	4271	45849	3522	46770	2402	57564	1673	39098
10L-2S		MI	28033	6258	41120	5203	49266	4216	53535	3469	58464	2362	72308	2206	39275
20-#14	2.33	MA	32174	6759	49263	5530	59427	4455	65306	3636	73066	2355	91624	2038	61674
3L-9S		MI	23885	6759	37266	5536	44074	4469	47118	3641	49721	2355	62053	1423	49119
20-#14	2.33	MA	31067	6759	47735	5532	57361	4470	62802	3634	69686	2349	87810	1907	61349
4L-8S		MI	24719	6759	38578	5520	45688	4455	49043	3629	52315	2347	65315	1508	50749
20-#14	2.33	MA	30067	6759	46190	5548	55506	4470	60538	3647	66604	2359	83842	1839	60125
5L-7S		MI	25558	6759	39767	5519	47253	4456	50998	3632	54934	2339	68627	1584	52093
20-#14	2.33	MA	29110	6759	44818	5550	53677	4485	58311	3645	63641	2368	79807	1731	58946
6E		MI	26408	6759	40975	5518	48851	4457	52950	3620	57649	2346	71823	1686	53312
20-#14	2.33	MA	28172	6759	43483	5552	51909	4485	56152	3658	60638	2362	76214	1629	57597
7L-5S		MI	27276	6759	42215	5518	50505	4443	54964	3623	60327	2339	75417	1795	54319
20-#14	2.33	MA	27246	6759	42169	5554	50178	4484	53988	3656	57740	2372	72508	1551	56043
8L-4S		MI	28181	6759	43611	5502	52181	4445	57009	3612	63111	2331	78964	1860	55448
20-#14	2.33	MA	26326	6759	40717	5570	48393	4499	51860	3669	54870	2381	68843	1467	54166
9L-3S		MI	29182	6759	44991	5501	54046	4431	59269	3615	66162	2338	82354	1992	55726
20-#14	2.33	MA	25409	6759	39408	5572	46674	4499	49722	3667	51919	2376	65054	1351	52346
10L-2S		MI	30570	6759	46847	5500	56400	4432	62121	3603	70009	2330	87502	2123	55879
20-#18	4.14	MA	34351	8032	58093	6325	70327	5033	78367	4007	90560	2286	116072	1379	101223
5L-7S		MI	28217	8032	48609	6288	58087	5019	63983	3988	72087	2241	92180	928	84530
20-#18	4.14	MA	32775	8032	55679	6326	67108	5057	74449	4001	85348	2300	109082	1186	97461
6E		MI	29617	8032	50732	6288	60896	5024	67413	3970	76808	2254	97692	1110	87784
20-#18	4.14	MA	31231	8032	53329	6328	63998	5055	70650	4022	80065	2287	102865	1004	93867
7L-5S		MI	31047	8032	52913	6289	63801	5001	70950	3978	81464	2241	103899	1304	91217
20-#18	4.14	MA	29704	8032	51015	6329	60951	5053	66843	4016	74967	2301	96421	869	89586
8L-4S		MI	32539	8032	55365	6263	66745	5005	74542	3959	86305	2228	110052	1417	93626
22-#11	1.78	MA	31547	6371	46405	5301	55934	4290	61132	3521	67474	2371	84334	2230	47661
2L-11S		MI	22663	6371	34088	5303	40116	4306	42379	3538	43336	2380	53377	1570	38246
22-#11	1.78	MA	30447	6371	44966	5302	54110	4290	58922	3530	64492	2378	80276	2139	47585
3L-10S		MI	23281	6371	34907	5302	41228	4296	43713	3530	45137	2374	55662	1627	39206
22-#11	1.78	MA	29657	6371	43901	5304	52669	4301	57175	3529	62135	2375	77596	2048	47451
4L-9S		MI	23873	6371	35733	5301	42312	4296	45061	3531	46997	2378	58035	1707	40059
22-#11	1.78	MA	28944	6371	42824	5315	51376	4301	55597	3539	59986	2382	74814	2001	47234
5L-8S		MI	24468	6371	36648	5290	43437	4286	46402	3523	48806	2372	60330	1765	40842
22-#11	1.78	MA	28261	6371	41868	5317	50101	4312	54045	3538	57921	2389	71980	1926	46418
6L-7S		MI	25066	6371	37477	5289	44529	4287	47766	3524	50632	2366	62655	1819	41509
22-#11	1.78	MA	27592	6371	40938	5318	48869	4312	52540	3547	55827	2386	69455	1855	45817
7L-6S		MI	25672	6371	38318	5288	45643	4287	49127	3516	52525	2370	64904	1890	42020
22-#11	1.78	MA	26931	6371	40022	5320	47663	4312	51032	3546	53808	2393	66857	1800	45071
8L-5S		MI	26292	6371	39183	5287	46796	4277	50531	3517	54393	2364	67432	1965	42757
22-#11	1.78	MA	26275	6371	39011	5332	46419	4323	49549	3556	51808	2400	64283	1742	44165
9L-4S		MI	26938	6371	40157	5276	47965	4277	51958	3509	56335	2358	69921	2011	42938
22-#11	1.78	MA	25622	6371	38099	5333	45221	4323	48059	3555	49751	2397	61621	1662	43203
10L-3S		MI	27653	6371	41120	5275	49266	4267	53535	3510	58464	2363	72308	2102	43049
22-#11	1.78	MA	24916	6371	37193	5335	43992	4334	46585	3564	47760	2404	59068	1605	42101
11L-2S		MI	28643	6371	42417	5274	50911	4268	55528	3502	61152	2357	75928	2193	43111
22-#14	2.56	MA	32026	6923	49795	5634	59974	4545	65968	3681	73957	2342	93589	1890	67376
4L-9S		MI	24786	6923	39122	5638	46428	4543	49970	3688	53568	2347	67201	1403	54343
22-#14	2.56	MA	31037	6923	48250	5651	58119	4545	63704	3694	70875	2351	89621	1822	66041
5L-8S		MI	25611	6923	40434	5622	48041	4530	51894	3676	56162	2340	70462	1487	56061
22-#14	2.56	MA	30089	6923	46878	5652	56290	4559	61477	3692	67912	2361	85586	1714	64896
6L-7S		MI	26442	6923	41623	5622	49607	4531	53850	3679	58781	2332	73775	1564	57371

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

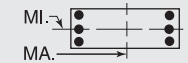
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	2.56	MA	29162	6923	45543	5654	54522	4559	59317	3705	64909	2355	81993	1612	63477
7L-6S		MI	27283	6923	42830	5621	51205	4532	55802	3668	61496	2339	76971	1666	58662
22-#14	2.56	MA	28246	6923	44229	5656	52791	4559	57154	3703	62011	2364	78286	1534	61958
8L-5S		MI	28142	6923	44071	5620	52859	4518	57815	3671	64174	2331	80565	1774	59637
22-#14	2.56	MA	27335	6923	42777	5672	51006	4574	55026	3716	59141	2374	74622	1450	60042
9L-4S		MI	29038	6923	45467	5604	54534	4519	59860	3659	66958	2323	84112	1840	60873
22-#14	2.56	MA	26428	6923	41468	5674	49287	4574	52887	3714	56190	2368	70833	1334	58192
10L-3S		MI	30030	6923	46847	5603	56400	4506	62121	3662	70009	2331	87502	1972	61176
22-#18	4.55	MA	34394	8322	59291	6508	71688	5190	79998	4085	92835	2287	119095	1150	107744
6L-7S		MI	29682	8322	51857	6470	62206	5152	68973	4072	78772	2225	101074	885	93657
22-#18	4.55	MA	32873	8322	56941	6510	68578	5188	76199	4106	87551	2274	112878	968	103940
7L-6S		MI	31062	8322	53980	6470	65015	5157	72403	4054	83493	2238	106585	1068	96995
22-#18	4.55	MA	31369	8322	54627	6511	65531	5186	72392	4100	82453	2288	106434	833	99885
8L-5S		MI	32471	8322	56161	6470	67921	5134	75940	4062	88148	2225	112792	1261	100550
24-#11	1.94	MA	31131	6485	46405	5373	55934	4342	61132	3563	67474	2373	84334	2128	51823
3L-11S		MI	23311	6485	35385	5374	41760	4358	44372	3571	46024	2375	56997	1558	41955
24-#11	1.94	MA	30347	6485	45339	5374	54493	4353	59385	3562	65117	2370	81653	2037	51676
4L-10S		MI	23926	6485	36204	5373	42872	4348	45705	3562	47825	2369	59282	1614	42897
24-#11	1.94	MA	29639	6485	44262	5386	53200	4353	57808	3571	62968	2377	78872	1990	51444
5L-9S		MI	24514	6485	37030	5372	43957	4348	47053	3564	49685	2373	61655	1694	43781
24-#11	1.94	MA	28961	6485	43306	5388	51925	4364	56255	3571	60903	2384	76038	1915	50572
6L-8S		MI	25103	6485	37945	5360	45081	4338	48395	3556	51494	2367	63949	1753	44546
24-#11	1.94	MA	28298	6485	42376	5389	50694	4364	54750	3580	58809	2381	73513	1844	49985
7E		MI	25697	6485	38773	5360	46173	4338	49759	3557	53320	2361	66274	1806	45260
24-#11	1.94	MA	27643	6485	41460	5391	49487	4364	53242	3579	56790	2388	70915	1790	49192
8L-6S		MI	26299	6485	39615	5359	47287	4339	51120	3549	55214	2365	68524	1877	45759
24-#11	1.94	MA	26992	6485	40449	5403	48243	4375	51759	3589	54790	2395	68340	1731	48305
9L-5S		MI	26913	6485	40480	5358	48441	4329	52524	3550	57081	2359	71051	1952	46543
24-#11	1.94	MA	26345	6485	39537	5404	47045	4375	50269	3588	52733	2391	65679	1651	47313
10L-4S		MI	27554	6485	41454	5346	49609	4329	53950	3542	59023	2353	73541	1998	46746
24-#11	1.94	MA	25642	6485	38632	5406	45816	4386	48795	3597	50742	2399	63125	1594	46229
11L-3S		MI	28264	6485	42417	5346	50911	4319	55528	3543	61152	2357	75928	2090	46870
24-#11	1.94	MA	24952	6485	37731	5407	44621	4386	47314	3596	48760	2406	60571	1536	44975
12L-2S		MI	29248	6485	43713	5345	52555	4320	57520	3535	63841	2351	79548	2181	46943
24-#14	2.80	MA	31995	7086	50310	5753	60732	4619	66870	3742	75146	2344	95400	1805	71966
5L-9S		MI	25676	7086	40978	5740	48781	4618	52821	3735	57415	2340	72349	1383	59620
24-#14	2.80	MA	31057	7086	48939	5755	58903	4634	64642	3740	72183	2353	91365	1697	70852
6L-8S		MI	26493	7086	42290	5725	50395	4605	54746	3724	60009	2332	75610	1467	61379
24-#14	2.80	MA	30140	7086	47603	5756	57135	4634	62483	3753	69179	2348	87771	1595	69365
7E		MI	27315	7086	43479	5724	51961	4606	56701	3727	62628	2324	78922	1543	62658
24-#14	2.80	MA	29233	7086	46289	5758	55404	4634	60319	3751	66281	2357	84065	1517	67880
8L-6S		MI	28147	7086	44686	5723	53558	4607	58653	3715	65343	2332	82118	1646	64016
24-#14	2.80	MA	28332	7086	44838	5775	53619	4649	58191	3764	63412	2366	80400	1433	65925
9L-5S		MI	28998	7086	45927	5722	55212	4593	60666	3718	68021	2324	85712	1754	64964
24-#14	2.80	MA	27434	7086	43529	5776	51900	4649	56053	3762	60461	2361	76612	1317	64045
10L-4S		MI	29885	7086	47323	5706	56888	4594	62712	3706	70805	2316	89259	1820	66298
24-#18	4.97	MA	34491	8613	60552	6691	73159	5321	81748	4190	95038	2261	122891	932	114166
7E		MI	31126	8613	55105	6652	66326	5285	73964	4156	85456	2209	109967	843	102694
24-#18	4.97	MA	33009	8613	58238	6693	70111	5319	77941	4185	89939	2274	116447	797	110174
8L-6S		MI	32487	8613	57228	6652	69134	5290	77394	4138	90177	2222	115478	1025	106223

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

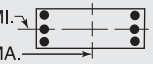


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.19	MA	31464	6219	44990	5231	53584	4254	57566	3527	61242	2477	74759	2333	34755
2L-3S		MI	24799	6219	36293	5184	42616	4211	45035	3513	46184	2457	55202	2048	29960
6-#18	1.19	MA	28491	6219	41197	5233	48773	4253	51738	3549	53379	2492	64185	2099	34620
3L-2S		MI	27339	6219	39541	5184	46735	4215	50026	3494	52868	2443	64095	2282	30023
8-#18	1.59	MA	33282	6510	48783	5413	58395	4387	63395	3611	69105	2463	85333	2299	45999
2L-4S		MI	24555	6510	37119	5365	43462	4367	46060	3589	47564	2427	58252	1772	38881
8-#18	1.59	MA	30359	6510	44990	5415	53584	4386	57566	3633	61242	2478	74759	2066	45757
3E		MI	26375	6510	39541	5366	46735	4344	50026	3597	52868	2441	64095	2006	39505
8-#18	1.59	MA	28244	6510	42173	5417	49775	4411	52950	3628	55012	2467	67789	1832	44921
4L-2S		MI	28873	6510	42789	5366	50854	4348	55016	3579	59553	2427	72988	2239	39670
10-#14	1.12	MA	31249	6164	44136	5226	52773	4253	56704	3532	60160	2495	73684	2370	32907
2L-5S		MI	23701	6164	34166	5201	40166	4230	42168	3522	42463	2480	51244	1997	28072
10-#14	1.12	MA	29547	6164	41973	5228	50031	4253	53381	3545	55677	2505	67589	2239	32866
3L-4S		MI	24661	6164	35562	5185	41841	4231	44213	3511	45247	2473	54791	2062	28344
10-#14	1.12	MA	28318	6164	40371	5230	47864	4269	50755	3544	52132	2500	63564	2107	32705
4L-3S		MI	25719	6164	36942	5185	43707	4217	46473	3514	48298	2480	58182	2194	28447
10-#14	1.12	MA	27206	6164	38751	5247	45921	4269	48382	3557	48901	2510	59385	2039	32320
5L-2S		MI	27177	6164	38798	5184	46060	4218	49325	3502	52145	2472	63330	2325	28459
10-#18	1.98	MA	35056	6800	52577	5594	63205	4520	69223	3695	76969	2450	95906	2266	57214
2L-5S		MI	24501	6800	37914	5573	44638	4495	47458	3692	49408	2425	60992	1616	45097
10-#18	1.98	MA	32180	6800	48783	5596	58395	4519	63395	3717	69105	2465	85333	2032	56878
3L-4S		MI	26123	6800	40367	5547	47581	4500	51050	3673	54249	2411	67145	1729	48171
10-#18	1.98	MA	30103	6800	45966	5599	54586	4544	58779	3713	62875	2454	78363	1799	55926
4L-3S		MI	27912	6800	42789	5547	50854	4477	55016	3681	59553	2425	72988	1963	49028
10-#18	1.98	MA	28223	6800	43116	5627	51166	4543	54604	3735	57191	2469	71088	1681	52127
5L-2S		MI	30372	6800	46037	5548	54973	4481	60007	3663	66238	2411	81882	2197	49280
12-#14	1.34	MA	32307	6328	46298	5328	55516	4328	60026	3579	64642	2487	79778	2354	39320
2L-6S		MI	23723	6328	34781	5304	40866	4318	43006	3567	43632	2481	52798	1868	32177
12-#14	1.34	MA	30622	6328	44136	5330	52773	4328	56704	3593	60160	2497	73684	2223	39248
3L-5S		MI	24633	6328	36022	5303	42519	4304	45019	3570	46310	2473	56392	1976	33365
12-#14	1.34	MA	29407	6328	42534	5333	50607	4343	54078	3591	56615	2493	69658	2091	39047
4E		MI	25582	6328	37418	5288	44195	4306	47064	3558	49094	2465	59939	2042	33790
12-#14	1.34	MA	28308	6328	40914	5350	48663	4344	51705	3605	53384	2503	65480	2023	38521
5L-3S		MI	26629	6328	38798	5287	46060	4292	49325	3561	52145	2472	63330	2174	33930
12-#14	1.34	MA	27255	6328	39476	5352	46746	4359	49370	3603	50279	2513	61224	1915	37048
6L-2S		MI	28072	6328	40654	5286	48414	4293	52176	3549	55992	2465	68477	2305	33974
12-#18	2.38	MA	36792	7091	56370	5776	68016	4653	75051	3780	84832	2437	106480	2233	68408
2L-6S		MI	24531	7091	38982	5755	45851	4651	48912	3768	51437	2422	63678	1380	51638
12-#18	2.38	MA	33960	7091	52577	5778	63205	4652	69223	3802	76969	2452	95906	1999	67990
3L-5S		MI	26061	7091	41162	5755	48757	4628	52449	3776	56092	2409	69885	1573	54333
12-#18	2.38	MA	31919	7091	49759	5780	59397	4677	64607	3797	70738	2440	88936	1765	66601
4E		MI	27656	7091	43615	5729	51700	4633	56040	3757	60933	2396	76038	1687	57255
12-#18	2.38	MA	30072	7091	46909	5809	55977	4676	60432	3819	65055	2456	81662	1647	62966
5L-3S		MI	29415	7091	46037	5729	54973	4610	60007	3766	66238	2409	81882	1921	58538
12-#18	2.38	MA	28300	7091	44378	5811	52601	4701	56324	3814	59590	2471	74279	1454	59781
6L-2S		MI	31839	7091	49284	5729	59092	4614	64997	3747	72922	2396	90775	2154	58867
14-#11	1.08	MA	31158	6140	43742	5226	52413	4254	56327	3535	59694	2504	73235	2388	32097
2L-7S		MI	23409	6140	33514	5201	39377	4240	41258	3530	41253	2492	49745	1971	26680
14-#11	1.08	MA	29967	6140	42233	5228	50499	4255	54008	3545	56565	2511	68959	2296	32075
3L-6S		MI	24037	6140	34355	5200	40491	4240	42619	3521	43146	2496	51994	2042	27260
14-#11	1.08	MA	29110	6140	41116	5229	48988	4266	52177	3544	54093	2509	66131	2205	32007
4L-5S		MI	24679	6140	35220	5199	41645	4230	44023	3523	45014	2490	54522	2117	27630
14-#11	1.08	MA	28335	6140	39987	5241	47634	4266	50524	3554	51841	2516	63204	2158	31860
5L-4S		MI	25348	6140	36194	5187	42813	4231	45450	3514	46956	2484	57011	2164	27729
14-#11	1.08	MA	27593	6140	38986	5243	46297	4277	48897	3554	49677	2524	60217	2083	31389
6L-3S		MI	26088	6140	37157	5187	44115	4221	47027	3516	49085	2488	59398	2255	27769

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

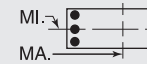


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.08	MA	26866	6140	38011	5245	45007	4278	47320	3563	47484	2521	57554	2012	30663
7L-2S		MI	27108	6140	38454	5186	45760	4221	49020	3507	51773	2482	63018	2346	27774
14-#14	1.56	MA	33349	6491	48461	5431	58259	4403	63349	3627	69125	2480	85873	2339	45723
2L-7S		MI	23770	6491	35430	5407	41621	4392	43905	3626	44765	2466	54750	1745	36637
14-#14	1.56	MA	31680	6491	46298	5433	55516	4403	60026	3640	64642	2490	79778	2207	45622
3L-6S		MI	24651	6491	36637	5406	43219	4393	45857	3614	47479	2473	57946	1848	37492
14-#14	1.56	MA	30478	6491	44696	5435	53349	4418	57400	3639	61098	2485	75753	2076	45385
4L-5S		MI	25551	6491	37878	5406	44873	4379	47870	3617	50157	2466	61540	1956	38631
14-#14	1.56	MA	29392	6491	43076	5452	51406	4419	55028	3652	57867	2495	71574	2008	44682
5L-4S		MI	26489	6491	39274	5390	46549	4380	49916	3605	52941	2458	65087	2022	39230
14-#14	1.56	MA	28351	6491	41639	5454	49488	4434	52693	3651	54761	2505	67318	1900	43263
6L-3S		MI	27525	6491	40654	5389	48414	4367	52176	3609	55992	2465	68477	2153	39404
14-#14	1.56	MA	27332	6491	40240	5456	47636	4434	50430	3664	51613	2500	63526	1798	42223
7L-2S		MI	28954	6491	42509	5388	50768	4368	55028	3597	59839	2457	73625	2285	39474
14-#18	2.78	MA	38495	7382	60163	5958	72827	4786	80879	3864	92695	2424	117054	2199	79589
2L-7S		MI	24609	7382	40107	5936	47162	4779	50472	3870	53400	2393	67060	1155	57836
14-#18	2.78	MA	35704	7382	56370	5960	68016	4785	75051	3886	84832	2439	106480	1966	79096
3L-6S		MI	26083	7382	42230	5937	49970	4784	53902	3852	58121	2406	72571	1338	60754
14-#18	2.78	MA	33696	7382	53553	5962	64207	4810	70435	3881	78601	2427	99510	1732	77317
4L-5S		MI	27589	7382	44410	5937	52876	4761	57439	3860	62777	2393	78779	1531	63595
14-#18	2.78	MA	31880	7382	50703	5991	60787	4809	66260	3903	72918	2442	92235	1614	73831
5L-4S		MI	29157	7382	46863	5911	55819	4765	61031	3842	67618	2380	84932	1645	66380
14-#18	2.78	MA	30139	7382	48172	5993	57412	4834	62152	3898	67453	2457	84853	1421	70510
6L-3S		MI	30889	7382	49284	5911	59092	4743	64997	3850	72922	2393	90775	1878	68040
14-#18	2.78	MA	28433	7382	45708	5995	54152	4833	58168	3920	61912	2446	78284	1239	66919
7L-2S		MI	33279	7382	52532	5911	63212	4747	69988	3831	79607	2380	99668	2112	68439
16-#11	1.24	MA	31903	6254	45252	5297	54327	4306	58646	3568	62822	2499	77512	2378	36574
2L-8S		MI	23454	6254	33982	5272	39930	4291	41887	3561	42115	2493	51040	1905	29974
16-#11	1.24	MA	30721	6254	43742	5299	52413	4307	56327	3578	59694	2506	73235	2287	36538
3L-7S		MI	24070	6254	34810	5271	41022	4292	43250	3562	43941	2487	53365	1959	30414
16-#11	1.24	MA	29871	6254	42625	5300	50902	4318	54496	3577	57222	2503	70408	2196	36451
4L-6S		MI	24693	6254	35652	5271	42136	4292	44612	3554	45834	2491	55614	2029	30974
16-#11	1.24	MA	29102	6254	41497	5312	49548	4318	52843	3587	54970	2511	67481	2148	36284
5E		MI	25329	6254	36517	5270	43289	4282	46016	3555	47702	2485	58142	2105	31433
16-#11	1.24	MA	28366	6254	40495	5314	48212	4329	51216	3587	52806	2518	64494	2073	35724
6L-4S		MI	25993	6254	37491	5258	44458	4283	47442	3547	49644	2479	60631	2151	31551
16-#11	1.24	MA	27646	6254	39521	5316	46921	4330	49639	3596	50613	2516	61831	2002	35021
7L-3S		MI	26727	6254	38454	5257	45760	4273	49020	3548	51773	2483	63018	2242	31608
16-#11	1.24	MA	26934	6254	38562	5318	45657	4330	48060	3596	48496	2523	59096	1947	34461
8L-2S		MI	27740	6254	39750	5256	47404	4273	51012	3540	54462	2477	66638	2333	31628
16-#14	1.79	MA	34375	6655	50623	5533	61001	4477	66671	3674	73608	2472	91967	2323	52118
2L-8S		MI	23832	6655	36097	5510	42409	4465	44801	3670	45992	2467	56585	1649	40439
16-#14	1.79	MA	32723	6655	48461	5535	58259	4478	63349	3687	69125	2483	85873	2192	51989
3L-7S		MI	24693	6655	37285	5510	43975	4467	46757	3673	48612	2459	59898	1725	41879
16-#14	1.79	MA	31534	6655	46859	5537	56092	4493	60723	3686	65581	2478	81847	2060	51721
4L-6S		MI	25565	6655	38493	5509	45573	4468	48709	3662	51326	2466	63094	1828	42818
16-#14	1.79	MA	30460	6655	45239	5554	54148	4493	58350	3700	62350	2488	77669	1992	50858
5E		MI	26455	6655	39733	5508	47227	4454	50722	3665	54004	2458	66688	1936	43912
16-#14	1.79	MA	29431	6655	43801	5556	52231	4509	56016	3698	59244	2498	73413	1884	49489
6L-4S		MI	27383	6655	41130	5492	48902	4455	52767	3653	56788	2450	70235	2002	44666
16-#14	1.79	MA	28423	6655	42402	5558	50379	4509	53753	3712	56096	2493	69621	1782	48370
7L-3S		MI	28408	6655	42509	5491	50768	4441	55028	3656	59839	2457	73625	2133	44870
16-#14	1.79	MA	27427	6655	41025	5560	48564	4509	51485	3710	53059	2503	65717	1704	46603
8L-2S		MI	29825	6655	44365	5490	53121	4443	57879	3644	63686	2450	78773	2265	44965
16-#18	3.17	MA	37416	7673	60163	6142	72827	4918	80879	3970	92695	2425	117054	1932	90198
3L-7S		MI	26154	7673	43355	6118	51281	4912	55462	3955	60085	2377	75953	1113	66986
16-#18	3.17	MA	35439	7673	57346	6144	69018	4943	76263	3965	86465	2414	110084	1698	88067
4L-6S		MI	27605	7673	45478	6118	54090	4917	58893	3936	64806	2390	81464	1295	69895
16-#18	3.17	MA	33653	7673	54496	6173	65598	4942	72089	3987	80781	2429	102809	1580	84717
5E		MI	29087	7673	47658	6119	56995	4894	62430	3944	69462	2377	87672	1489	72877

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis



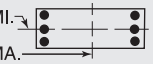
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	3.17	MA	31941	7673	51965	6175	62223	4967	67980	3983	75316	2444	95426	1388	81262
6L-4S		MI	30631	7673	50111	6092	59939	4898	66021	3926	74302	2364	93825	1602	75541
16-#18	3.17	MA	30263	7673	49501	6177	58962	4966	63996	4005	69776	2433	88857	1206	77772
7L-3S		MI	32337	7673	52532	6093	63212	4876	69988	3934	79607	2377	99668	1836	77535
16-#18	3.17	MA	28604	7673	47076	6179	55767	4964	60005	4000	64430	2448	82063	1069	73002
8L-2S		MI	34696	7673	55780	6093	67331	4880	74978	3916	86292	2364	108561	2070	77999
18-#11	1.39	MA	32640	6367	46761	5368	56241	4358	60965	3601	65951	2494	81789	2368	41046
2L-9S		MI	23507	6367	34363	5355	40450	4353	42537	3602	42994	2493	52365	1834	32845
18-#11	1.39	MA	31466	6367	45252	5369	54327	4359	58646	3611	62822	2501	77512	2277	40996
3L-8S		MI	24113	6367	35279	5343	41575	4343	43879	3594	44803	2487	54660	1892	33676
18-#11	1.39	MA	30623	6367	44135	5371	52817	4370	56816	3610	60351	2498	74685	2186	40893
4L-7S		MI	24723	6367	36107	5342	42666	4344	45243	3595	46629	2481	56985	1946	34154
18-#11	1.39	MA	29861	6367	43006	5383	51462	4370	55162	3620	58099	2506	71757	2138	40707
5L-6S		MI	25341	6367	36949	5341	43781	4344	46604	3587	48523	2486	59234	2017	34696
18-#11	1.39	MA	29131	6367	42005	5385	50126	4381	53535	3619	55935	2513	68770	2063	40067
6L-5S		MI	25972	6367	37814	5340	44934	4334	48008	3588	50390	2480	61762	2092	35234
18-#11	1.39	MA	28417	6367	41030	5387	48836	4382	51958	3629	53741	2511	66107	1993	39384
7L-4S		MI	26631	6367	38788	5329	46103	4334	49434	3580	52332	2474	64251	2138	35369
18-#11	1.39	MA	27711	6367	40071	5388	47571	4382	50379	3629	51625	2518	63372	1938	38798
8L-3S		MI	27359	6367	39750	5328	47404	4324	51012	3581	54462	2478	66638	2229	35441
18-#11	1.39	MA	27010	6367	39011	5401	46269	4393	48825	3638	49530	2526	60658	1879	37776
9L-2S		MI	28366	6367	41047	5327	49049	4325	53004	3573	57150	2472	70258	2320	35473
18-#14	2.01	MA	35389	6819	52786	5635	63744	4552	69994	3721	78091	2465	98061	2307	58507
2L-9S		MI	23905	6819	36640	5628	43149	4554	45728	3729	47245	2467	58472	1544	44258
18-#14	2.01	MA	33751	6819	50623	5637	61001	4553	66671	3735	73608	2475	91967	2176	58352
3L-8S		MI	24751	6819	37953	5613	44763	4540	47652	3718	49839	2459	61733	1629	45733
18-#14	2.01	MA	32575	6819	49021	5639	58835	4568	64046	3733	70063	2470	87942	2045	58054
4L-7S		MI	25603	6819	39141	5612	46329	4541	49608	3721	52459	2451	65045	1705	47133
18-#14	2.01	MA	31513	6819	47401	5656	56891	4568	61673	3747	66833	2480	83763	1977	57049
5L-6S		MI	26465	6819	40349	5611	47926	4543	51560	3709	55173	2458	68241	1807	48153
18-#14	2.01	MA	30495	6819	45964	5658	54973	4584	59338	3746	63727	2490	79507	1868	55724
6L-5S		MI	27346	6819	41589	5610	49580	4529	53573	3712	57851	2451	71835	1916	49207
18-#14	2.01	MA	29499	6819	44565	5660	53121	4584	57075	3759	60579	2486	75715	1766	54527
7L-4S		MI	28264	6819	42985	5594	51256	4530	55618	3700	60635	2443	75382	1982	50098
18-#14	2.01	MA	28514	6819	43188	5662	51307	4584	54808	3758	57542	2496	71812	1688	52803
8L-3S		MI	29279	6819	44365	5593	53121	4516	57879	3703	63686	2450	78773	2113	50331
18-#14	2.01	MA	27536	6819	41667	5679	49437	4599	52578	3771	54535	2506	67945	1604	51052
9L-2S		MI	30684	6819	46221	5593	55475	4517	60730	3692	67533	2442	83921	2245	50450
18-#18	3.57	MA	37153	7963	61139	6326	73829	5076	82091	4050	94328	2401	120657	1665	98848
4L-7S		MI	27671	7963	46603	6300	55400	5045	60453	4039	66770	2361	84846	1070	76067
18-#18	3.57	MA	35394	7963	58289	6354	70409	5075	77917	4072	88644	2416	113383	1547	95621
5L-6S		MI	29100	7963	48726	6300	58209	5050	63883	4020	71491	2374	90358	1253	79060
18-#18	3.57	MA	33709	7963	55758	6356	67033	5100	73808	4067	83179	2431	106000	1354	92036
6L-5S		MI	30559	7963	50906	6300	61115	5027	67420	4029	76146	2361	96565	1446	82178
18-#18	3.57	MA	32058	7963	53294	6359	63773	5099	69825	4089	77639	2419	99431	1172	88552
7L-4S		MI	32081	7963	53358	6274	64058	5031	71012	4010	80987	2348	102718	1560	84731
18-#18	3.57	MA	30426	7963	50869	6361	60578	5097	65833	4084	72293	2435	92637	1036	83805
8L-3S		MI	33763	7963	55780	6274	67331	5009	74978	4018	86292	2361	108561	1794	87027
20-#11	1.55	MA	33370	6480	48270	5439	58155	4410	63285	3634	69080	2488	86066	2358	45513
2L-10S		MI	23564	6480	34835	5426	41010	4405	43182	3633	43822	2484	53612	1741	35820
20-#11	1.55	MA	32204	6480	46761	5440	56241	4410	60965	3644	65951	2496	81789	2267	45450
3L-9S		MI	24162	6480	35660	5425	42094	4405	44530	3635	45682	2488	55985	1821	36557
20-#11	1.55	MA	31367	6480	45644	5442	54731	4421	59135	3643	63480	2493	78962	2176	45331
4L-8S		MI	24764	6480	36575	5414	43219	4395	45871	3626	47491	2482	58280	1880	37367

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

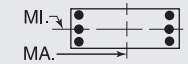
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.55	MA	30611	6480	44515	5454	53376	4422	57481	3653	61228	2501	76034	2128	45129
5L-7S		MI	25369	6480	37404	5413	44311	4395	47235	3628	49317	2476	60605	1933	37898
20-#11	1.55	MA	29887	6480	43514	5456	52040	4433	55854	3652	59064	2508	73047	2053	44417
6E		MI	25982	6480	38246	5412	45425	4396	48596	3619	51211	2480	62854	2004	38425
20-#11	1.55	MA	29179	6480	42539	5458	50750	4434	54277	3662	56870	2505	70384	1983	43752
7L-5S		MI	26609	6480	39110	5411	46578	4386	50000	3621	53078	2474	65381	2079	39032
20-#11	1.55	MA	28479	6480	41580	5459	49486	4434	52698	3661	54754	2513	67649	1928	43114
8L-4S		MI	27262	6480	40084	5400	47747	4386	51427	3612	55020	2468	67871	2125	39183
20-#11	1.55	MA	27784	6480	40521	5471	48183	4445	51144	3671	52659	2520	64935	1869	42115
9L-3S		MI	27984	6480	41047	5399	49049	4376	53004	3614	57150	2473	70258	2216	39270
20-#11	1.55	MA	27079	6480	39565	5473	46928	4446	49583	3671	50504	2518	62129	1790	41225
10L-2S		MI	28984	6480	42344	5398	50693	4377	54997	3606	59838	2467	73878	2308	39314
20-#14	2.23	MA	34767	6982	52786	5739	63744	4627	69994	3782	78091	2468	98061	2160	64712
3L-9S		MI	24821	6982	38496	5731	45503	4629	48580	3777	51092	2459	63619	1524	49513
20-#14	2.23	MA	33602	6982	51184	5741	61577	4643	67368	3781	74546	2463	94036	2029	64386
4L-8S		MI	25658	6982	39808	5715	47116	4615	50504	3765	53686	2452	66881	1609	51034
20-#14	2.23	MA	32551	6982	49564	5758	59633	4643	64995	3794	71315	2473	89858	1961	63251
5L-7S		MI	26501	6982	40997	5714	48682	4616	52460	3768	56306	2444	70193	1685	52398
20-#14	2.23	MA	31544	6982	48126	5761	57716	4658	62661	3793	68210	2483	85602	1853	61967
6E		MI	27354	6982	42205	5713	50280	4617	54412	3756	59020	2451	73389	1787	53495
20-#14	2.23	MA	30559	6982	46727	5763	55864	4659	60398	3807	65062	2478	81810	1751	60695
7L-5S		MI	28226	6982	43445	5712	51934	4604	56425	3759	61698	2443	76983	1896	54513
20-#14	2.23	MA	29585	6982	45350	5765	54049	4659	58131	3805	62025	2488	77906	1672	59011
8L-4S		MI	29135	6982	44841	5697	53609	4605	58470	3748	64482	2435	80530	1961	55529
20-#14	2.23	MA	28617	6982	43830	5782	52179	4674	55900	3819	59017	2498	74039	1588	57162
9L-3S		MI	30140	6982	46221	5696	55475	4591	60730	3751	67533	2443	83921	2093	55787
20-#14	2.23	MA	27653	6982	42458	5784	50378	4675	53660	3817	55925	2493	70043	1473	55311
10L-2S		MI	31533	6982	48077	5695	57828	4592	63582	3739	71380	2435	89068	2224	55928
20-#18	3.97	MA	37108	8254	62082	6536	75219	5208	83745	4156	96507	2402	123956	1514	106542
5L-7S		MI	29163	8254	49851	6482	59520	5178	65443	4123	73454	2345	93739	1028	85167
20-#18	3.97	MA	35448	8254	59551	6538	71844	5233	79636	4151	91042	2418	116574	1321	102829
6E		MI	30571	8254	51974	6482	62328	5183	68874	4105	78175	2358	99251	1210	88245
20-#18	3.97	MA	33823	8254	57088	6540	68584	5232	75653	4173	85502	2406	110005	1139	99270
7L-5S		MI	32010	8254	54154	6482	65234	5160	72410	4113	82831	2345	105458	1404	91495
20-#18	3.97	MA	32215	8254	54662	6543	65389	5230	71662	4168	80156	2421	103211	1002	94622
8L-4S		MI	33510	8254	56606	6456	68177	5164	76002	4094	87672	2332	111611	1518	93947
22-#11	1.70	MA	34092	6594	49780	5509	60070	4462	65604	3667	72209	2483	90343	2348	49977
2L-11S		MI	23598	6594	35312	5498	41543	4466	43841	3675	44709	2485	54947	1672	38533
22-#11	1.70	MA	32934	6594	48270	5511	58155	4462	63285	3676	69080	2491	86066	2257	49901
3L-10S		MI	24217	6594	36131	5497	42655	4456	45174	3666	46510	2479	57232	1728	39503
22-#11	1.70	MA	32103	6594	47153	5513	56645	4473	61454	3676	66609	2488	83238	2166	49768
4L-9S		MI	24811	6594	36957	5496	43739	4457	46522	3668	48370	2483	59605	1808	40273
22-#11	1.70	MA	31353	6594	46025	5525	55290	4474	59800	3686	64357	2495	80311	2119	49551
5L-8S		MI	25408	6594	37872	5485	44864	4447	47864	3659	50179	2477	61899	1867	41064
22-#11	1.70	MA	30635	6594	45023	5527	53954	4485	58173	3685	62193	2503	77324	2044	48773
6L-7S		MI	26009	6594	38701	5484	45956	4447	49228	3661	52006	2471	64224	1920	41646
22-#11	1.70	MA	29933	6594	44049	5528	52664	4485	56597	3695	59999	2500	74661	1973	48124
7L-6S		MI	26617	6594	39542	5483	47070	4448	50589	3652	53899	2475	66474	1991	42159
22-#11	1.70	MA	29239	6594	43090	5530	51400	4486	55017	3694	57883	2508	71926	1918	47437
8L-5S		MI	27238	6594	40407	5482	48223	4438	51993	3654	55766	2469	69001	2066	42829
22-#11	1.70	MA	28550	6594	42030	5542	50097	4497	53463	3704	55788	2515	69211	1860	46458
9L-4S		MI	27887	6594	41381	5471	49392	4438	53419	3645	57708	2463	71491	2113	42995
22-#11	1.70	MA	27853	6594	41075	5544	48842	4497	51902	3704	53633	2512	66406	1780	45537
10L-3S		MI	28604	6594	42344	5470	50693	4428	54997	3647	59838	2468	73878	2204	43096

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

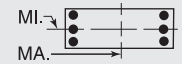


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.70	MA	27112	6594	40126	5546	47554	4508	50358	3713	51547	2520	63717	1722	44350
11L-2S		MI	29597	6594	43641	5469	52338	4429	56989	3638	62526	2462	77498	2295	43151
22-#14	2.46	MA	34617	7146	53346	5844	64320	4718	70691	3828	79029	2455	100131	2013	70718
4L-9S		MI	25724	7146	40352	5833	47857	4704	51431	3824	54939	2452	68767	1504	54777
22-#14	2.46	MA	33576	7146	51726	5861	62376	4718	68318	3842	75798	2465	95952	1945	69463
5L-8S		MI	26553	7146	41664	5817	49470	4690	53355	3812	57533	2444	72029	1589	56343
22-#14	2.46	MA	32580	7146	50289	5863	60458	4733	65983	3840	72692	2475	91696	1837	68216
6L-7S		MI	27388	7146	42853	5816	51036	4691	55311	3815	60153	2436	75341	1665	57672
22-#14	2.46	MA	31605	7146	48890	5865	58606	4733	63720	3854	69544	2471	87904	1735	66872
7L-6S		MI	28232	7146	44060	5815	52634	4692	57263	3804	62867	2444	78537	1767	58843
22-#14	2.46	MA	30641	7146	47513	5867	56792	4734	61453	3853	66507	2481	84000	1657	65225
8L-5S		MI	29095	7146	45301	5815	54287	4678	59276	3807	65545	2436	82131	1876	59830
22-#14	2.46	MA	29684	7146	45992	5884	54922	4749	59223	3866	63500	2491	80134	1572	63336
9L-4S		MI	29996	7146	46697	5799	55963	4680	61321	3795	68329	2428	85678	1941	60957
22-#14	2.46	MA	28725	7146	44620	5886	53120	4749	56982	3865	60408	2486	76137	1457	61513
10L-3S		MI	30991	7146	48077	5798	57828	4666	63582	3798	71380	2435	89068	2073	61239
22-#18	4.37	MA	37161	8545	63344	6720	76655	5366	85464	4235	98905	2404	127148	1288	113641
6L-7S		MI	30632	8545	53099	6663	63639	5311	70434	4207	80139	2329	102633	986	94286
22-#18	4.37	MA	35559	8545	60881	6722	73394	5365	81481	4257	93365	2393	120578	1106	110005
7L-6S		MI	32021	8545	55222	6664	66447	5316	73864	4189	84860	2342	108144	1168	97448
22-#18	4.37	MA	33976	8545	58455	6724	70199	5363	77490	4253	88019	2408	113784	969	105453
8L-5S		MI	33440	8545	57402	6664	69353	5293	77401	4197	89516	2329	114351	1362	100825
24-#11	1.86	MA	33656	6707	49780	5582	60070	4514	65604	3709	72209	2486	90343	2248	54350
3L-11S		MI	24248	6707	36609	5569	43187	4518	45833	3708	47397	2480	58567	1659	42239
24-#11	1.86	MA	32832	6707	48663	5584	58559	4525	63773	3709	69738	2483	87515	2156	54203
4L-10S		MI	24864	6707	37428	5568	44299	4508	47167	3699	49198	2474	60852	1715	43191
24-#11	1.86	MA	32088	6707	47534	5596	57205	4526	62119	3718	67486	2490	84588	2109	53971
5L-9S		MI	25453	6707	38254	5567	45384	4509	48515	3701	51058	2478	63225	1796	43993
24-#11	1.86	MA	31376	6707	46533	5598	55869	4537	60492	3718	65322	2498	81601	2034	53133
6L-8S		MI	26045	6707	39169	5556	46508	4499	49856	3692	52867	2472	65519	1854	44767
24-#11	1.86	MA	30679	6707	45558	5599	54578	4537	58916	3728	63128	2495	78938	1963	52499
7E		MI	26642	6707	39997	5555	47600	4499	51220	3694	54694	2466	67844	1908	45397
24-#11	1.86	MA	29991	6707	44599	5601	53314	4538	57336	3727	61012	2503	76203	1908	51764
8L-6S		MI	27245	6707	40839	5554	48714	4500	52581	3685	56587	2470	70094	1979	45897
24-#11	1.86	MA	29307	6707	43539	5613	52011	4549	55782	3737	58917	2510	73488	1850	50805
9L-5S		MI	27862	6707	41704	5553	49868	4490	53985	3687	58454	2464	72621	2054	46625
24-#11	1.86	MA	28622	6707	42584	5615	50756	4549	54221	3736	56762	2507	70683	1770	49854
10L-4S		MI	28505	6707	42678	5542	51036	4490	55412	3678	60396	2458	75111	2100	46805
24-#11	1.86	MA	27879	6707	41636	5617	49468	4560	52677	3746	54676	2515	67994	1712	48686
11L-3S		MI	29217	6707	43641	5541	52338	4480	56989	3680	62526	2462	77498	2191	46918
24-#11	1.86	MA	27154	6707	40693	5618	48217	4561	51125	3746	52539	2512	65301	1654	47450
12L-2S		MI	30205	6707	44937	5540	53982	4480	58982	3671	65214	2456	81117	2282	46985
24-#14	2.68	MA	34590	7309	53889	5963	65119	4793	71641	3889	80281	2458	102046	1930	75685
5L-9S		MI	26617	7309	42208	5935	50210	4778	54282	3871	58786	2444	73915	1484	60007
24-#14	2.68	MA	33604	7309	52451	5965	63201	4808	69306	3888	77175	2468	97790	1822	74472
6L-8S		MI	27438	7309	43520	5919	51824	4765	56207	3860	61380	2437	77176	1568	61659
24-#14	2.68	MA	32639	7309	51052	5967	61349	4808	67043	3901	74027	2463	93998	1719	73057
7E		MI	28264	7309	44709	5918	53389	4766	58162	3863	64000	2429	80489	1644	62955
24-#14	2.68	MA	31685	7309	49675	5969	59534	4809	64776	3900	70990	2473	90095	1641	71446
8L-6S		MI	29100	7309	45916	5918	54987	4767	60114	3851	66714	2436	83685	1747	64197
24-#14	2.68	MA	30738	7309	48155	5986	57664	4824	62546	3913	67983	2483	86228	1557	69517
9L-5S		MI	29955	7309	47157	5917	56641	4753	62128	3854	69392	2428	87279	1855	65155
24-#14	2.68	MA	29782	7309	46783	5988	55863	4824	60305	3912	64890	2478	82232	1441	67665
10L-4S		MI	30846	7309	48553	5901	58317	4754	64173	3842	72176	2420	90826	1921	66384
24-#18	4.76	MA	37271	8836	64674	6904	78205	5498	87309	4342	101228	2380	131152	1072	120756
7E		MI	32082	8836	56347	6845	67758	5444	75424	4292	86824	2313	111526	943	103422
24-#18	4.76	MA	35710	8836	62249	6906	75010	5496	83318	4337	95882	2395	124358	936	116296
8L-6S		MI	33452	8836	58470	6845	70566	5449	78854	4273	91545	2326	117037	1126	106669

RECTANGULAR TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.24	MA	27770	6007	40126	5016	47592	4077	51083	3377	54332	2358	66090	2204	31558
2L-3S		MI	25092	6007	36696	5017	43242	4074	45813	3397	47242	2372	56637	1971	31450
8-#18	1.65	MA	29393	6297	43556	5198	51941	4210	56352	3461	61422	2344	75543	2165	41730
2L-4S		MI	24848	6297	37572	5199	44140	4231	46900	3474	48706	2344	59871	1698	40758
10-#14	1.16	MA	27591	5952	39357	5013	46875	4078	50327	3383	53447	2380	65214	2245	29907
2L-5S		MI	23934	5952	34474	5032	40661	4091	42782	3405	43239	2391	52392	1916	29330
10-#14	1.16	MA	26055	5952	37399	5014	44392	4077	47318	3395	49388	2389	59751	2114	29875
3L-4S		MI	24942	5952	35945	5016	42426	4092	44936	3393	46173	2383	56149	1982	29737
10-#18	2.07	MA	30976	6588	46985	5380	56291	4343	61622	3546	68512	2330	84995	2126	51870
2L-5S		MI	24806	6588	38417	5408	45388	4361	48383	3578	50661	2343	62797	1544	47141
10-#18	2.07	MA	28386	6588	43556	5380	51941	4340	56352	3565	61422	2343	75543	1892	51565
3L-4S		MI	26508	6588	41002	5381	48490	4364	52169	3558	55796	2330	69324	1659	50398

RECTANGULAR TIED COLUMNS 44" x 46"

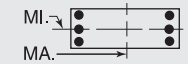
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.19	MA	30187	6240	43304	5235	51451	4257	55206	3530	58643	2479	71367	2327	33178
2L-3S		MI	26123	6240	38052	5220	44812	4241	47416	3539	48744	2481	58352	2076	31517
6-#18	1.19	MA	27358	6240	39692	5237	46871	4255	49657	3551	51156	2493	61354	2093	33070
3L-2S		MI	28808	6240	41482	5220	49162	4245	52686	3519	55834	2467	67805	2310	31601
8-#18	1.58	MA	31911	6531	46915	5417	56031	4390	60755	3614	66129	2466	81380	2291	43890
2L-4S		MI	25878	6531	38928	5403	45710	4398	48503	3616	50209	2453	61586	1803	40905
8-#18	1.58	MA	29129	6531	43304	5418	51451	4388	55206	3635	58643	2479	71367	2057	43677
3E		MI	27797	6531	41482	5402	49162	4374	52686	3623	55834	2466	67805	2037	41592
8-#18	1.58	MA	27112	6531	40618	5420	47821	4413	50807	3629	52705	2467	64773	1823	42918
4L-2S		MI	30437	6531	44912	5401	53512	4378	57956	3603	62924	2453	77258	2271	41781
10-#14	1.11	MA	29990	6185	42485	5232	50685	4258	54397	3536	57632	2498	70396	2366	31426
2L-5S		MI	24963	6185	35818	5237	42227	4259	44386	3548	44746	2501	54114	2022	29496
10-#14	1.11	MA	28369	6185	40425	5234	48072	4258	51231	3549	53361	2507	64617	2235	31394
3L-4S		MI	25973	6185	37289	5220	43992	4260	46540	3536	47679	2493	57872	2088	29802
10-#14	1.11	MA	27197	6185	38897	5235	46006	4272	48727	3547	49981	2502	60803	2103	31255
4L-3S		MI	27089	6185	38743	5219	45958	4246	48922	3538	50895	2499	61474	2220	29921
10-#14	1.11	MA	26135	6185	37351	5252	44152	4272	46464	3560	46899	2511	56835	2036	30912
5L-2S		MI	28628	6185	40701	5218	48441	4246	51931	3526	54954	2490	66937	2351	29943
10-#18	1.98	MA	33594	6822	50526	5599	60612	4523	66304	3698	73615	2452	91393	2255	54570
2L-5S		MI	25835	6822	39773	5611	46958	4528	49987	3720	52164	2452	64512	1649	47467
10-#18	1.98	MA	30856	6822	46915	5600	56031	4521	60755	3719	66129	2466	81380	2021	54265
3L-4S		MI	27544	6822	42358	5584	50060	4531	53773	3700	57299	2439	71039	1764	50787
10-#18	1.98	MA	28875	6822	44230	5601	52401	4546	56356	3714	60191	2453	74786	1787	53373
4L-3S		MI	29429	6822	44912	5584	53512	4507	57956	3707	62924	2452	77258	1998	51648
10-#18	1.98	MA	27080	6822	41512	5629	49140	4543	52375	3734	54772	2467	67885	1671	49811
5L-2S		MI	32028	6822	48341	5583	57861	4511	63225	3688	70014	2439	86711	2232	51925
12-#14	1.33	MA	30994	6349	44545	5334	53298	4333	57563	3583	61903	2490	76174	2349	37539
2L-6S		MI	24994	6349	36470	5340	42969	4348	45274	3593	45985	2502	55763	1895	33817
12-#14	1.33	MA	29389	6349	42485	5336	50685	4332	54397	3596	57632	2500	70396	2218	37477
3L-5S		MI	25952	6349	37776	5339	44711	4334	47394	3596	48805	2494	59577	2003	35102
12-#14	1.33	MA	28230	6349	40957	5338	48619	4347	51893	3594	54252	2494	66582	2086	37299
4E		MI	26950	6349	39247	5323	46476	4335	49548	3583	51738	2485	63335	2070	35546
12-#14	1.33	MA	27181	6349	39412	5354	46765	4347	49629	3607	51170	2504	62614	2019	36821
5L-3S		MI	28054	6349	40701	5321	48441	4320	51931	3586	54954	2491	66937	2201	35704
12-#14	1.33	MA	26175	6349	38040	5356	44935	4362	47402	3605	48207	2513	58579	1911	35441
6L-2S		MI	29578	6349	42659	5320	50925	4321	54939	3573	59013	2483	72400	2333	35757

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

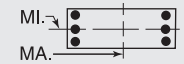


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	2.37	MA	35241	7112	54138	5780	65192	4656	71853	3783	81102	2439	101406	2219	65229
2L-6S		MI	25880	7112	40906	5794	48245	4684	51529	3798	54316	2451	67366	1417	54398
12-#18	2.37	MA	32544	7112	50526	5782	60612	4654	66304	3804	73615	2453	91393	1985	64843
3L-5S		MI	27491	7112	43203	5793	51307	4661	55256	3804	59254	2438	73965	1610	57236
12-#18	2.37	MA	30596	7112	47841	5783	56981	4679	61905	3798	67678	2440	84799	1751	63516
4E		MI	29171	7112	45788	5766	54409	4664	59042	3785	64389	2425	80492	1725	60399
12-#18	2.37	MA	28833	7112	45124	5811	53720	4676	57924	3819	62259	2454	77898	1634	60115
5L-3S		MI	31025	7112	48341	5765	57861	4640	63225	3792	70014	2438	86711	1959	61692
12-#18	2.37	MA	27141	7112	42709	5813	50501	4701	54006	3813	57047	2467	70908	1442	57115
6L-2S		MI	33585	7112	51771	5765	62211	4644	68495	3772	77104	2425	96163	2193	62049
14-#11	1.08	MA	29906	6161	42107	5232	50344	4260	54044	3540	57197	2507	69993	2385	30657
2L-7S		MI	24655	6161	35136	5235	41397	4269	43425	3555	43468	2512	52504	1996	28019
14-#11	1.08	MA	28772	6161	40669	5234	48520	4260	51834	3549	54216	2514	65936	2293	30641
3L-6S		MI	25316	6161	36022	5234	42570	4269	44858	3546	45461	2516	54892	2067	28648
14-#11	1.08	MA	27954	6161	39603	5235	47079	4270	50088	3548	51858	2511	63255	2202	30583
4L-5S		MI	25991	6161	36932	5233	43784	4259	46336	3547	47427	2510	57572	2142	29044
14-#11	1.08	MA	27214	6161	38526	5247	45787	4271	48510	3558	49710	2518	60474	2155	30454
5L-4S		MI	26696	6161	37958	5221	45015	4259	47839	3538	49473	2503	60208	2188	29157
14-#11	1.08	MA	26505	6161	37570	5249	44511	4281	46957	3557	47644	2525	57640	2080	30025
6L-3S		MI	27475	6161	38972	5220	46386	4248	49501	3539	51716	2507	62741	2280	29205
14-#11	1.08	MA	25811	6161	36640	5250	43280	4282	45452	3566	45551	2522	55115	2009	29348
7L-2S		MI	28552	6161	40339	5219	48120	4248	51602	3530	54551	2500	66580	2371	29216
14-#14	1.56	MA	31983	6513	46605	5436	55911	4407	60728	3631	66174	2483	81953	2332	43641
2L-7S		MI	25050	6513	37157	5444	43770	4423	46227	3653	47185	2489	57832	1774	38529
14-#14	1.56	MA	30393	6513	44545	5438	53298	4407	57563	3644	61903	2492	76174	2201	43551
3L-6S		MI	25978	6513	38428	5442	45452	4423	48282	3640	50044	2495	61226	1876	39432
14-#14	1.56	MA	29247	6513	43017	5440	51232	4422	55059	3642	58523	2487	72361	2069	43337
4L-5S		MI	26925	6513	39734	5441	47194	4409	50403	3643	52864	2486	65041	1985	40665
14-#14	1.56	MA	28210	6513	41472	5456	49378	4422	52795	3655	55441	2496	68393	2002	42682
5L-4S		MI	27912	6513	41205	5425	48959	4409	52557	3631	55797	2478	68798	2051	41286
14-#14	1.56	MA	27216	6513	40100	5458	47548	4437	50567	3653	52478	2506	64358	1894	41356
6L-3S		MI	29004	6513	42659	5424	50925	4395	54939	3633	59013	2484	72400	2183	41478
14-#14	1.56	MA	26242	6513	38765	5460	45781	4437	48408	3666	49474	2500	60764	1792	40392
7L-2S		MI	30514	6513	44617	5422	53408	4396	57948	3621	63072	2475	77863	2314	41558
14-#18	2.77	MA	36857	7403	57749	5962	69772	4789	77402	3867	88588	2426	111419	2182	75874
2L-7S		MI	25976	7403	42099	5976	49636	4814	53184	3901	56400	2423	70956	1195	60904
14-#18	2.77	MA	34198	7403	54138	5964	65192	4787	71853	3888	81102	2440	101406	1949	75414
3L-6S		MI	27528	7403	44335	5976	52595	4817	56799	3882	61406	2437	76819	1378	64050
14-#18	2.77	MA	32282	7403	51452	5965	61561	4812	67453	3882	75164	2427	94812	1715	73699
4L-5S		MI	29113	7403	46633	5975	55657	4794	60526	3889	66344	2423	83418	1571	67030
14-#18	2.77	MA	30548	7403	48735	5993	58300	4809	63473	3903	69745	2440	87911	1598	70444
5L-4S		MI	30764	7403	49217	5948	58759	4797	64312	3869	71479	2410	89945	1686	70052
14-#18	2.77	MA	28885	7403	46321	5994	55082	4834	59555	3897	64534	2454	80921	1405	67304
6L-3S		MI	32589	7403	51771	5947	62211	4773	68495	3876	77104	2423	96163	1920	71729
14-#18	2.77	MA	27255	7403	43971	5996	51972	4832	55756	3918	59251	2441	74704	1223	63934
7L-2S		MI	35114	7403	55201	5947	66561	4777	73765	3856	84194	2410	105616	2153	72157
16-#11	1.23	MA	30614	6275	43546	5303	52169	4311	56255	3573	60179	2502	74051	2374	34926
2L-8S		MI	24707	6275	35631	5307	41982	4321	44091	3586	44379	2514	53882	1930	31482
16-#11	1.23	MA	29488	6275	42107	5305	50344	4312	54044	3582	57197	2509	69993	2283	34895
3L-7S		MI	25355	6275	36503	5306	43131	4321	45526	3588	46303	2507	56343	1984	31962
16-#11	1.23	MA	28676	6275	41042	5306	48903	4322	52298	3581	54840	2506	67313	2192	34820
4L-6S		MI	26011	6275	37389	5305	44304	4321	46959	3579	48296	2511	58730	2055	32569
16-#11	1.23	MA	27943	6275	39965	5318	47611	4323	50720	3591	52691	2513	64531	2144	34671
5E		MI	26681	6275	38300	5304	45518	4311	48438	3580	50262	2504	61411	2130	33054
16-#11	1.23	MA	27240	6275	39009	5320	46336	4333	49167	3590	50626	2520	61698	2070	34153
6L-4S		MI	27379	6275	39325	5292	46749	4311	49940	3571	52308	2498	64046	2177	33187
16-#11	1.23	MA	26552	6275	38078	5321	45104	4334	47663	3599	48533	2517	59173	1999	33498
7L-3S		MI	28152	6275	40339	5291	48120	4300	51602	3572	54551	2502	66580	2268	33252

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

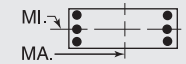


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.23	MA	25872	6275	37163	5323	43897	4334	46155	3598	46513	2524	56574	1944	32979
8L-2S		MI	29222	6275	41707	5290	49855	4300	53703	3563	57386	2495	70419	2359	33277
16-#14	1.78	MA	32958	6676	48666	5539	58524	4482	63894	3678	70444	2476	87732	2315	49735
2L-8S		MI	25124	6676	37863	5547	44604	4497	47176	3698	48485	2490	59785	1679	42521
16-#14	1.78	MA	31383	6676	46605	5540	55911	4482	60728	3691	66174	2485	81953	2184	49618
3L-7S		MI	26030	6676	39115	5546	46253	4497	49235	3700	51244	2481	63295	1756	44071
16-#14	1.78	MA	30249	6676	45077	5542	53845	4497	58224	3689	62794	2479	78139	2052	49373
4L-6S		MI	26947	6676	40386	5545	47935	4498	51291	3688	54103	2488	66689	1858	45057
16-#14	1.78	MA	29223	6676	43532	5559	51991	4497	55960	3702	59711	2489	74171	1985	48560
5E		MI	27883	6676	41692	5543	49677	4484	53411	3690	56923	2479	70504	1966	46243
16-#14	1.78	MA	28240	6676	42160	5560	50161	4512	53733	3700	56749	2498	70136	1877	47282
6L-4S		MI	28860	6676	43163	5527	51442	4484	55565	3678	59856	2470	74261	2033	47021
16-#14	1.78	MA	27278	6676	40825	5562	48394	4511	51574	3713	53745	2493	66543	1775	46236
7L-3S		MI	29940	6676	44617	5526	53408	4470	57948	3680	63072	2477	77863	2164	47245
16-#14	1.78	MA	26326	6676	39511	5564	46662	4511	49410	3711	50847	2502	62837	1697	44577
8L-2S		MI	31436	6676	46575	5524	55891	4471	60956	3668	67131	2468	83326	2296	47351
16-#18	3.16	MA	35823	7694	57749	6145	69772	4920	77402	3972	88588	2426	111419	1913	85981
3L-7S		MI	27617	7694	45528	6158	53985	4947	58453	3986	63490	2409	80409	1156	70669
16-#18	3.16	MA	33936	7694	55064	6147	66142	4945	73002	3966	82650	2414	104825	1679	83918
4L-6S		MI	29144	7694	47765	6157	56944	4950	62068	3966	68496	2422	86272	1339	73726
16-#18	3.16	MA	32229	7694	52346	6175	62880	4942	69022	3987	77232	2427	97924	1562	80794
5E		MI	30703	7694	50062	6157	60007	4927	65796	3973	73434	2409	92871	1532	76846
16-#18	3.16	MA	30593	7694	49932	6176	59662	4967	65104	3982	72020	2441	90934	1369	77517
6L-4S		MI	32329	7694	52647	6130	63109	4930	69582	3953	78569	2396	99398	1647	79741
16-#18	3.16	MA	28991	7694	47582	6178	56552	4965	61305	4002	66737	2428	84718	1187	74246
7L-3S		MI	34126	7694	55201	6129	66561	4906	73765	3960	84194	2409	105616	1881	81760
16-#18	3.16	MA	27405	7694	45268	6179	53504	4963	57498	3997	61638	2442	78274	1052	69731
8L-2S		MI	36617	7694	58631	6128	70910	4910	79034	3940	91284	2396	115069	2114	82254
18-#11	1.39	MA	31314	6388	44984	5374	53993	4363	58465	3605	63161	2497	78109	2363	39189
2L-9S		MI	24768	6388	36036	5390	42532	4383	44780	3628	45310	2515	55286	1860	34509
18-#11	1.39	MA	30196	6388	43546	5376	52169	4364	56255	3615	60179	2504	74051	2272	39145
3L-8S		MI	25405	6388	36999	5378	43717	4373	46192	3619	47214	2509	57720	1919	35404
18-#11	1.39	MA	29390	6388	42480	5377	50728	4374	54508	3614	57822	2501	71371	2181	39054
4L-7S		MI	26048	6388	37871	5377	44866	4373	47628	3621	49138	2502	60182	1973	35909
18-#11	1.39	MA	28663	6388	41403	5389	49435	4375	52930	3623	55673	2508	68589	2134	38887
5L-6S		MI	26698	6388	38757	5376	46039	4373	49061	3612	51131	2506	62569	2043	36498
18-#11	1.39	MA	27966	6388	40447	5390	48160	4385	51378	3622	53608	2515	65755	2059	38289
6L-5S		MI	27362	6388	39667	5375	47253	4362	50539	3613	53097	2499	65250	2118	37062
18-#11	1.39	MA	27283	6388	39517	5392	46928	4385	49873	3632	51515	2512	63230	1988	37653
7L-4S		MI	28055	6388	40693	5363	48484	4363	52041	3604	55143	2493	67885	2165	37212
18-#11	1.39	MA	26609	6388	38601	5393	45722	4386	48365	3631	49495	2519	60632	1934	37113
8L-3S		MI	28822	6388	41707	5362	49855	4352	53703	3605	57386	2496	70419	2256	37294
18-#11	1.39	MA	25940	6388	37590	5405	44478	4396	46882	3640	47495	2526	58058	1875	36153
9L-2S		MI	29885	6388	43075	5361	51589	4352	55804	3596	60221	2490	74257	2347	37332
18-#14	2.00	MA	33920	6840	50726	5641	61137	4557	67059	3725	74715	2468	93510	2298	55822
2L-9S		MI	25208	6840	38439	5666	45388	4586	48158	3758	49812	2491	61785	1576	46560
18-#14	2.00	MA	32360	6840	48666	5643	58524	4557	63894	3738	70444	2477	87732	2167	55680
3L-8S		MI	26099	6840	39821	5649	47087	4572	50184	3745	52544	2482	65248	1660	48116
18-#14	2.00	MA	31237	6840	47138	5644	56458	4572	61390	3736	67064	2472	83918	2035	55406
4L-7S		MI	26995	6840	41073	5648	48736	4572	52244	3748	55303	2474	68758	1737	49625
18-#14	2.00	MA	30222	6840	45592	5661	54604	4572	59126	3749	63982	2481	79950	1968	54451
5L-6S		MI	27902	6840	42344	5647	50419	4573	54299	3735	58162	2480	72152	1839	50691
18-#14	2.00	MA	29250	6840	44221	5663	52774	4586	56899	3747	61019	2491	75915	1860	53216
6L-5S		MI	28829	6840	43650	5645	52160	4558	56420	3738	60982	2471	75967	1948	51836
18-#14	2.00	MA	28298	6840	42886	5664	51007	4586	54739	3760	58016	2485	72322	1757	52091
7L-4S		MI	29796	6840	45121	5629	53925	4559	58574	3725	63915	2463	79724	2014	52754
18-#14	2.00	MA	27357	6840	41571	5666	49275	4586	52576	3759	55118	2495	68615	1680	50474
8L-3S		MI	30865	6840	46575	5628	55891	4545	60956	3728	67131	2469	83326	2146	53006
18-#14	2.00	MA	26423	6840	40120	5683	47490	4601	50448	3772	52248	2504	64951	1595	48826
9L-2S		MI	32347	6840	48533	5627	58374	4545	63965	3715	71190	2461	88789	2277	53136

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

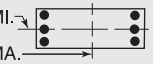
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	3.56	MA	35562	7985	58675	6328	70722	5078	78551	4051	90137	2400	114838	1643	94167
4L-7S		MI	29227	7985	48958	6340	58335	5080	63723	4070	70580	2395	89862	1117	80287
18-#18	3.56	MA	33882	7985	55958	6356	67461	5075	74571	4071	84718	2414	107938	1526	91163
5L-6S		MI	30730	7985	51195	6339	61294	5083	67338	4050	75586	2408	95725	1299	83425
18-#18	3.56	MA	32271	7985	53544	6358	64242	5100	70653	4066	79507	2428	100947	1333	87753
6L-5S		MI	32266	7985	53492	6338	64356	5060	71065	4057	80524	2395	102324	1493	86681
18-#18	3.56	MA	30693	7985	51194	6359	61132	5098	66854	4087	74223	2415	94731	1151	84452
7L-4S		MI	33867	7985	56077	6311	67459	5063	74851	4037	85659	2382	108851	1608	89460
18-#18	3.56	MA	29133	7985	48880	6361	58085	5096	63047	4081	69125	2429	88287	1016	79991
8L-3S		MI	35638	7985	58631	6311	70910	5039	79034	4044	91284	2395	115069	1842	91787
20-#11	1.54	MA	32007	6502	46423	5445	55817	4415	60675	3638	66143	2492	82166	2353	43448
2L-10S		MI	24822	6502	36534	5462	43126	4435	45462	3660	46187	2506	56608	1768	37650
20-#11	1.54	MA	30896	6502	44984	5447	53993	4415	58465	3648	63161	2499	78109	2261	43391
3L-9S		MI	25463	6502	37403	5461	44267	4435	46881	3661	48145	2510	59125	1848	38429
20-#11	1.54	MA	30097	6502	43919	5448	52552	4426	56718	3647	60804	2496	75428	2170	43284
4L-8S		MI	26096	6502	38366	5449	45451	4425	48293	3652	50049	2503	61559	1907	39303
20-#11	1.54	MA	29375	6502	42842	5460	51260	4426	55140	3656	58655	2503	72647	2123	43101
5L-7S		MI	26733	6502	39239	5448	46600	4425	49729	3653	51973	2497	64021	1961	39861
20-#11	1.54	MA	28683	6502	41886	5461	49984	4437	53588	3655	56590	2510	69813	2048	42431
6E		MI	27378	6502	40125	5447	47773	4425	51162	3644	53966	2501	66408	2032	40433
20-#11	1.54	MA	28007	6502	40955	5463	48753	4437	52083	3665	54497	2507	67288	1977	41812
7L-5S		MI	28036	6502	41035	5446	48987	4414	52640	3646	55932	2494	69089	2107	41068
20-#11	1.54	MA	27338	6502	40040	5464	47546	4438	50575	3664	52477	2514	64690	1923	41220
8L-4S		MI	28724	6502	42060	5434	50218	4414	54143	3637	57978	2487	71724	2153	41235
20-#11	1.54	MA	26674	6502	39028	5476	46303	4448	49092	3673	50477	2521	62115	1865	40282
9L-3S		MI	29485	6502	43075	5433	51589	4404	55804	3638	60221	2491	74257	2245	41331
20-#11	1.54	MA	26001	6502	38116	5478	45105	4449	47602	3672	48421	2517	59454	1785	39453
10L-2S		MI	30541	6502	44442	5432	53324	4404	57906	3629	63056	2485	78096	2336	41381
20-#14	2.22	MA	33324	7003	50726	5745	61137	4632	67059	3786	74715	2470	93510	2150	61739
3L-9S		MI	26179	7003	40397	5768	47872	4661	51166	3805	53871	2484	67249	1557	52117
20-#14	2.22	MA	32212	7003	49198	5746	59071	4647	64555	3784	71335	2464	89697	2018	61438
4L-8S		MI	27060	7003	41779	5752	49571	4646	53193	3793	56603	2475	70712	1642	53718
20-#14	2.22	MA	31208	7003	47653	5763	57217	4646	62292	3797	68253	2474	85729	1951	60353
5L-7S		MI	27947	7003	43031	5750	51219	4647	55252	3795	59362	2466	74221	1719	55190
20-#14	2.22	MA	30246	7003	46281	5765	55387	4661	60064	3795	65290	2483	81694	1843	59158
6E		MI	28845	7003	44302	5749	52902	4648	57308	3783	62221	2473	77615	1821	56333
20-#14	2.22	MA	29304	7003	44946	5766	53620	4661	57905	3808	62287	2478	78100	1740	57957
7L-5S		MI	29762	7003	45608	5748	54644	4633	59428	3785	65041	2464	81430	1929	57440
20-#14	2.22	MA	28373	7003	43632	5768	51888	4661	55741	3806	59389	2487	74394	1663	56378
8L-4S		MI	30719	7003	47079	5731	56409	4634	61582	3773	67974	2455	85187	1996	58485
20-#14	2.22	MA	27449	7003	42180	5785	50103	4676	53613	3819	56519	2496	70729	1578	54687
9L-3S		MI	31777	7003	48533	5730	58374	4620	63965	3775	71190	2462	88789	2127	58764
20-#14	2.22	MA	26528	7003	40871	5786	48384	4676	51475	3817	53568	2491	66941	1463	52896
10L-2S		MI	33247	7003	50491	5729	60858	4620	66973	3763	75249	2453	94252	2259	58916
20-#18	3.95	MA	35508	8275	59569	6538	72041	5208	80120	4156	92204	2401	117951	1490	101548
5L-7S		MI	30810	8275	52388	6521	62685	5213	68993	4154	77670	2381	99314	1078	89925
20-#18	3.95	MA	33921	8275	57155	6540	68822	5233	76202	4150	86993	2414	110960	1297	98008
6E		MI	32291	8275	54625	6521	65644	5216	72608	4135	82676	2394	105178	1260	93144
20-#18	3.95	MA	32367	8275	54805	6541	65712	5231	72403	4171	81710	2402	104744	1115	94629
7L-5S		MI	33804	8275	56922	6520	68706	5193	76335	4141	87614	2381	111777	1454	96531
20-#18	3.95	MA	30831	8275	52491	6542	62665	5229	68596	4165	76611	2415	98300	980	90266
8L-4S		MI	35382	8275	59507	6493	71808	5196	80121	4122	92749	2367	118304	1569	99205
22-#11	1.70	MA	32693	6615	47861	5516	57642	4467	62885	3671	69125	2487	86224	2342	47703
2L-11S		MI	24862	6615	37040	5534	43689	4497	46159	3702	47126	2508	58027	1700	40499

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

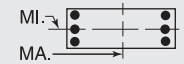


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.70	MA	31589	6615	46423	5517	55817	4467	60675	3681	66143	2494	82166	2251	47634
3L-10S		MI	25526	6615	37902	5533	44860	4487	47563	3693	49022	2501	60446	1757	41542
22-#11	1.70	MA	30796	6615	45357	5519	54377	4478	58929	3680	63786	2490	79486	2160	47513
4L-9S		MI	26151	6615	38771	5532	46001	4487	48982	3694	50980	2505	62963	1837	42353
22-#11	1.70	MA	30080	6615	44280	5531	53084	4478	57351	3689	61637	2498	76705	2112	47314
5L-8S		MI	26778	6615	39734	5520	47186	4476	50395	3685	52884	2498	65398	1895	43208
22-#11	1.70	MA	29394	6615	43324	5532	51809	4489	55798	3688	59572	2505	73871	2038	46579
6L-7S		MI	27410	6615	40606	5519	48335	4477	51830	3686	54808	2492	67860	1949	43816
22-#11	1.70	MA	28723	6615	42394	5534	50577	4489	54293	3698	57478	2501	71346	1967	45976
7L-6S		MI	28050	6615	41492	5518	49508	4477	53263	3677	56801	2495	70247	2020	44374
22-#11	1.70	MA	28060	6615	41478	5535	49371	4489	52786	3697	55459	2508	68748	1912	45333
8L-5S		MI	28704	6615	42403	5516	50722	4466	54742	3679	58767	2489	72927	2095	45073
22-#11	1.70	MA	27401	6615	40467	5547	48127	4500	51302	3706	53459	2516	66173	1854	44416
9L-4S		MI	29386	6615	43428	5505	51952	4466	56244	3669	60813	2482	75563	2142	45255
22-#11	1.70	MA	26736	6615	39555	5548	46929	4500	49812	3705	51403	2512	63512	1774	43554
10L-3S		MI	30141	6615	44442	5504	53324	4456	57906	3671	63056	2486	78096	2233	45366
22-#11	1.70	MA	26038	6615	38649	5550	45700	4511	48338	3715	49411	2519	60958	1716	42439
11L-2S		MI	31190	6615	45810	5502	55058	4456	60007	3662	65891	2479	81935	2324	45427
22-#14	2.45	MA	33176	7167	51258	5849	61684	4721	67721	3831	75606	2457	95476	2001	67468
4L-9S		MI	27138	7167	42355	5870	50355	4735	54175	3852	57930	2476	72712	1538	57683
22-#14	2.45	MA	32182	7167	49713	5865	59829	4721	65457	3844	72524	2466	91508	1934	66267
5L-8S		MI	28009	7167	43737	5854	52054	4721	56201	3840	60662	2467	76175	1623	59328
22-#14	2.45	MA	31229	7167	48341	5867	58000	4736	63230	3842	69561	2476	87472	1826	65106
6L-7S		MI	28887	7167	44989	5853	53703	4722	58261	3842	63421	2459	79684	1700	60764
22-#14	2.45	MA	30298	7167	47006	5869	56232	4736	61070	3855	66558	2470	83879	1723	63832
7L-6S		MI	29776	7167	46260	5851	55385	4722	60316	3830	66280	2465	83079	1802	61981
22-#14	2.45	MA	29376	7167	45692	5870	54501	4736	58907	3853	63660	2480	80173	1646	62290
8L-5S		MI	30684	7167	47566	5850	57127	4708	62437	3833	69100	2457	86893	1911	63055
22-#14	2.45	MA	28462	7167	44240	5887	52716	4751	56779	3866	60790	2489	76508	1561	60506
9L-4S		MI	31631	7167	49037	5834	58892	4709	64591	3820	72033	2448	90650	1977	64214
22-#14	2.45	MA	27551	7167	42931	5889	50997	4751	54640	3864	57839	2483	72719	1446	58787
10L-3S		MI	32680	7167	50491	5832	60858	4694	66973	3823	75249	2454	94252	2109	64517
22-#18	4.35	MA	35547	8566	60767	6721	73402	5366	81751	4234	94479	2401	120973	1261	108282
6L-7S		MI	32369	8566	55818	6703	67034	5346	74262	4238	84760	2366	108767	1039	99580
22-#18	4.35	MA	34015	8566	58417	6723	70292	5364	77951	4255	89196	2388	114757	1079	104823
7L-6S		MI	33829	8566	58054	6703	69993	5349	77877	4219	89766	2380	114631	1221	102882
22-#18	4.35	MA	32501	8566	56103	6724	67245	5362	74145	4249	84098	2402	108313	944	100555
8L-5S		MI	35321	8566	60351	6702	73056	5326	81605	4226	94704	2366	121230	1415	106395
24-#11	1.85	MA	32276	6729	47861	5588	57642	4519	62885	3713	69125	2489	86224	2240	51874
3L-11S		MI	25552	6729	38407	5605	45424	4549	48261	3735	49961	2502	61866	1688	44415
24-#11	1.85	MA	31488	6729	46796	5590	56201	4530	61139	3712	66768	2485	83544	2149	51739
4L-10S		MI	26212	6729	39270	5604	46595	4539	49664	3726	51857	2496	64285	1745	45439
24-#11	1.85	MA	30778	6729	45718	5602	54908	4530	59561	3722	64619	2492	80762	2102	51526
5L-9S		MI	26831	6729	40138	5603	47736	4539	51083	3727	53815	2500	66802	1825	46282
24-#11	1.85	MA	30097	6729	44763	5603	53633	4541	58008	3721	62554	2499	77929	2027	50732
6L-8S		MI	27454	6729	41102	5591	48920	4528	52496	3718	55719	2493	69237	1884	47118
24-#11	1.85	MA	29431	6729	43832	5605	52401	4541	56503	3730	60460	2496	75404	1956	50142
7E		MI	28081	6729	41974	5590	50069	4528	53932	3719	57643	2486	71698	1938	47775
24-#11	1.85	MA	28773	6729	42917	5606	51195	4541	54996	3730	58441	2503	72805	1902	49451
8L-6S		MI	28716	6729	42860	5589	51242	4528	55365	3710	59636	2490	74085	2008	48319
24-#11	1.85	MA	28120	6729	41905	5618	49951	4552	53513	3739	56441	2510	70231	1843	48554
9L-5S		MI	29365	6729	43770	5587	52456	4518	56843	3711	61602	2484	76766	2083	49077
24-#11	1.85	MA	27470	6729	40993	5619	48753	4552	52023	3738	54384	2507	67570	1763	47661
10L-4S		MI	30042	6729	44796	5576	53687	4518	58345	3702	63648	2477	79401	2130	49273
24-#11	1.85	MA	26766	6729	40088	5621	47524	4563	50549	3748	52393	2514	65016	1706	46565
11L-3S		MI	30792	6729	45810	5575	55058	4508	60007	3704	65891	2481	81935	2221	49397
24-#11	1.85	MA	26074	6729	39187	5622	46329	4563	49067	3747	50411	2521	62462	1648	45402
12L-2S		MI	31834	6729	47177	5573	56793	4508	62108	3695	68726	2474	85774	2312	49470
24-#14	2.67	MA	33144	7330	51773	5968	62442	4796	68623	3892	76795	2459	97286	1917	72189
5L-9S		MI	28084	7330	44313	5972	52838	4810	57183	3900	61989	2469	78175	1520	63212

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#14	2.67	MA	32201	7330	50401	5969	60613	4811	66395	3890	73832	2468	93251	1809	71061
6L-8S		MI	28947	7330	45695	5956	54537	4796	59209	3887	64721	2460	81638	1605	64945
24-#14	2.67	MA	31279	7330	49066	5971	58845	4811	64236	3903	70828	2463	89658	1706	69716
7E		MI	29816	7330	46947	5955	56186	4797	61269	3890	67479	2451	85147	1682	66347
24-#14	2.67	MA	30367	7330	47752	5973	57114	4811	62073	3901	67930	2472	85951	1629	68209
8L-6S		MI	30696	7330	48218	5953	57868	4797	63325	3877	70339	2458	88542	1784	67635
24-#14	2.67	MA	29462	7330	46301	5989	55329	4825	59944	3914	65061	2482	82287	1544	66384
9L-5S		MI	31595	7330	49524	5952	59610	4783	65445	3880	73159	2449	92356	1892	68678
24-#14	2.67	MA	28560	7330	44992	5991	53610	4825	57806	3912	62110	2476	78498	1429	64634
10L-4S		MI	32533	7330	50995	5936	61375	4784	67599	3867	76092	2440	96114	1959	69943
24-#18	4.74	MA	35640	8857	62028	6904	74873	5497	83500	4339	96682	2375	124770	1043	115034
7E		MI	33906	8857	59247	6885	71384	5479	79532	4323	91850	2352	118220	1000	109253
24-#18	4.74	MA	34147	8857	59714	6906	71825	5495	79694	4334	91584	2389	118326	908	110856
8L-6S		MI	35346	8857	61484	6884	74343	5482	83147	4303	96856	2365	124084	1182	112637

RECTANGULAR TIED COLUMNS 44" x 48"

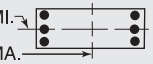
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.14	MA	32698	6473	46591	5454	55448	4437	59475	3683	63035	2596	76808	2449	34798
2L-3S		MI	27154	6473	39409	5423	46382	4409	49020	3681	50247	2590	60067	2182	31580
6-#18	1.14	MA	29718	6473	42798	5456	50638	4436	53647	3705	55172	2611	66235	2215	34690
3L-2S		MI	29845	6473	42838	5423	50732	4412	54289	3661	57337	2577	69520	2415	31643
8-#18	1.52	MA	34524	6764	50384	5636	60259	4570	65303	3767	70898	2583	87382	2415	46050
2L-4S		MI	26908	6764	40285	5606	47280	4565	50106	3758	51711	2562	63301	1909	41041
8-#18	1.52	MA	31593	6764	46591	5638	55448	4569	59475	3789	63035	2598	76808	2182	45837
3E		MI	28833	6764	42838	5605	50732	4542	54289	3765	57337	2576	69520	2143	41665
8-#18	1.52	MA	29471	6764	43774	5640	51640	4594	54859	3784	56805	2587	69838	1948	45078
4L-2S		MI	31480	6764	46268	5605	55082	4545	59559	3745	64427	2562	78973	2376	41830
10-#14	1.07	MA	32483	6419	45723	5451	54633	4438	58613	3689	61957	2615	75741	2487	32944
2L-5S		MI	25991	6419	37162	5441	43794	4428	45989	3691	46253	2611	55837	2128	29591
10-#14	1.07	MA	30777	6419	43560	5453	51891	4438	55290	3702	57474	2626	69647	2355	32913
3L-4S		MI	27004	6419	38633	5425	45559	4428	48144	3679	49186	2603	59594	2195	29863
10-#14	1.07	MA	29545	6419	41958	5455	49724	4453	52664	3701	53930	2621	65622	2224	32774
4L-3S		MI	28122	6419	40087	5424	47524	4414	50526	3681	52402	2609	63196	2326	29965
10-#14	1.07	MA	28430	6419	40338	5472	47781	4454	50291	3714	50699	2631	61443	2156	32431
5L-2S		MI	29665	6419	42045	5422	50008	4415	53535	3669	56461	2600	68659	2457	29978
10-#18	1.89	MA	36306	7055	54177	5817	65070	4703	71131	3851	78762	2570	97956	2382	57270
2L-5S		MI	26864	7055	41129	5815	48528	4695	51590	3862	53667	2561	66227	1755	47784
10-#18	1.89	MA	33421	7055	50384	5820	60259	4702	65303	3873	70898	2585	87382	2148	56965
3L-4S		MI	28579	7055	43714	5788	51630	4698	55376	3842	58801	2548	72754	1870	51004
10-#18	1.89	MA	31336	7055	47567	5822	56450	4727	60687	3869	64668	2574	80412	1915	56106
4L-3S		MI	30470	7055	46268	5787	55082	4675	59559	3849	64427	2561	78973	2104	51728
10-#18	1.89	MA	29448	7055	44717	5850	53030	4726	56513	3891	58984	2589	73138	1796	52498
5L-2S		MI	33077	7055	49698	5786	59431	4678	64829	3830	71517	2548	88426	2337	51980
12-#14	1.28	MA	33545	6582	47885	5553	57376	4513	61935	3736	66440	2608	81836	2471	39362
2L-6S		MI	26022	6582	37814	5545	44535	4517	46878	3736	47492	2612	57486	2001	34014
12-#14	1.28	MA	31855	6582	45723	5555	54633	4513	58613	3750	61957	2618	75741	2339	39299
3L-5S		MI	26982	6582	39120	5543	46277	4502	48998	3739	50312	2604	61300	2110	35301
12-#14	1.28	MA	30637	6582	44120	5557	52467	4528	55987	3748	58413	2613	71716	2208	39121
4E		MI	27984	6582	40591	5527	48042	4503	51152	3726	53245	2595	65058	2176	35613
12-#14	1.28	MA	29535	6582	42501	5574	50523	4529	53614	3762	55182	2623	67537	2140	38738
5L-3S		MI	29090	6582	42045	5526	50008	4489	53535	3729	56461	2601	68659	2308	35753
12-#14	1.28	MA	28478	6582	41063	5576	48606	4544	51279	3760	52076	2633	63281	2032	37278
6L-2S		MI	30618	6582	44003	5525	52491	4489	56543	3716	60520	2593	74122	2439	35797

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis



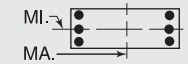
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	2.27	MA	38051	7346	57970	5999	69880	4836	76960	3936	86625	2557	108529	2348	68469
2L-6S		MI	26907	7346	42262	5997	49815	4851	53132	3940	55819	2560	69082	1522	54926
12-#18	2.27	MA	35208	7346	54177	6001	65070	4835	71131	3958	78762	2572	97956	2115	68083
3L-5S		MI	28525	7346	44559	5996	52877	4828	56860	3946	60757	2547	75680	1716	57547
12-#18	2.27	MA	33158	7346	51360	6003	61261	4860	66515	3953	72531	2560	90986	1881	67041
4E		MI	30211	7346	47144	5969	55980	4831	60646	3927	65891	2534	82207	1831	60771
12-#18	2.27	MA	31302	7346	48510	6032	57841	4859	62341	3975	66848	2575	83711	1763	63330
5L-3S		MI	32072	7346	49698	5969	59431	4808	64829	3934	71517	2547	88426	2064	61778
12-#18	2.27	MA	29523	7346	45979	6034	54466	4884	58232	3970	61383	2590	76329	1570	60405
6L-2S		MI	34642	7346	53127	5968	63781	4811	70098	3914	78607	2534	97878	2298	62107
14-#11	1.03	MA	32392	6395	45322	5451	54271	4440	58236	3693	61493	2625	75297	2504	32132
2L-7S		MI	25682	6395	36473	5441	42961	4438	45029	3698	44977	2623	54231	2102	28163
14-#11	1.03	MA	31198	6395	43813	5453	52356	4440	55917	3702	58364	2632	71020	2413	32115
3L-6S		MI	26345	6395	37359	5440	44134	4438	46462	3689	46970	2626	56618	2173	28799
14-#11	1.03	MA	30338	6395	42696	5455	50846	4451	54087	3702	55893	2630	68193	2322	32057
4L-5S		MI	27022	6395	38270	5438	45348	4428	47940	3691	48936	2620	59299	2248	29104
14-#11	1.03	MA	29562	6395	41567	5467	49491	4452	52433	3712	53641	2637	65266	2275	31928
5L-4S		MI	27728	6395	39295	5427	46579	4428	49443	3682	50982	2613	61934	2295	29203
14-#11	1.03	MA	28817	6395	40566	5468	48155	4463	50806	3711	51477	2645	62279	2200	31564
6L-3S		MI	28508	6395	40309	5426	47950	4417	51105	3683	53225	2617	64468	2386	29243
14-#11	1.03	MA	28089	6395	39591	5470	46865	4463	49229	3721	49283	2642	59616	2129	30830
7L-2S		MI	29588	6395	41677	5424	49685	4417	53206	3674	56060	2610	68306	2477	29248
14-#14	1.49	MA	34591	6746	50048	5655	60119	4587	65258	3783	70923	2601	87930	2455	45767
2L-7S		MI	26078	6746	38501	5648	45336	4591	47830	3796	48692	2599	59554	1880	38764
14-#14	1.49	MA	32917	6746	47885	5657	57376	4588	61935	3797	66440	2611	81836	2324	45677
3L-6S		MI	27008	6746	39772	5647	47018	4592	49886	3783	51551	2605	62949	1983	39627
14-#14	1.49	MA	31712	6746	46283	5659	55210	4603	59309	3796	62895	2606	77810	2192	45464
4L-5S		MI	27958	6746	41078	5646	48760	4577	52006	3786	54371	2596	66763	2091	40879
14-#14	1.49	MA	30622	6746	44663	5676	53266	4603	56937	3809	59664	2616	73632	2124	44933
5L-4S		MI	28948	6746	42549	5629	50525	4578	54161	3774	57304	2588	70521	2158	41357
14-#14	1.49	MA	29578	6746	43226	5678	51348	4619	54602	3808	56559	2626	69376	2016	43491
6L-3S		MI	30043	6746	44003	5628	52491	4564	56543	3776	60520	2594	74122	2289	41530
14-#14	1.49	MA	28555	6746	41827	5680	49496	4619	52339	3821	53411	2621	65584	1914	42490
7L-2S		MI	31557	6746	45961	5627	54974	4564	59552	3764	64579	2585	79586	2420	41600
14-#18	2.65	MA	39764	7637	61763	6181	74691	4969	82788	4020	94488	2543	119103	2315	79654
2L-7S		MI	27001	7637	43455	6179	51206	4981	54787	4043	57902	2533	72671	1301	61374
14-#18	2.65	MA	36960	7637	57970	6183	69880	4968	76960	4042	86625	2558	108529	2081	79194
3L-6S		MI	28560	7637	45692	6179	54165	4984	58402	4024	62909	2546	78534	1483	64567
14-#18	2.65	MA	34942	7637	55153	6185	66072	4993	72344	4037	80394	2547	101559	1848	77747
4L-5S		MI	30151	7637	47989	6178	57227	4961	62129	4031	67847	2533	85133	1676	67336
14-#18	2.65	MA	33117	7637	52303	6214	62652	4992	68169	4059	74711	2562	94285	1730	74188
5L-4S		MI	31811	7637	50574	6151	60329	4964	65915	4011	72981	2519	91660	1792	70416
14-#18	2.65	MA	31367	7637	49772	6216	59276	5017	64060	4054	69246	2577	86902	1537	71122
6L-3S		MI	33643	7637	53127	6150	63781	4941	70098	4018	78607	2533	97878	2025	71820
14-#18	2.65	MA	29653	7637	47308	6218	56016	5016	60077	4076	63705	2566	80333	1355	67472
7L-2S		MI	36178	7637	56557	6150	68131	4944	75368	3998	85697	2519	107331	2259	72219
16-#11	1.18	MA	33140	6508	46831	5522	56185	4491	60556	3725	64622	2620	79574	2495	36611
2L-8S		MI	25734	6508	36969	5513	43547	4490	45695	3730	45888	2624	55608	2037	31633
16-#11	1.18	MA	31954	6508	45322	5524	54271	4492	58236	3735	61493	2627	75297	2404	36580
3L-7S		MI	26384	6508	37841	5512	44696	4490	47130	3731	47812	2617	58070	2091	32105
16-#11	1.18	MA	31102	6508	44205	5526	52760	4503	56406	3735	59022	2624	72470	2312	36505
4L-6S		MI	27041	6508	38727	5510	45869	4490	48563	3722	49805	2621	60457	2162	32718
16-#11	1.18	MA	30331	6508	43076	5538	51406	4504	54752	3744	56770	2632	69542	2265	36356
5E		MI	27713	6508	39637	5509	47083	4480	50042	3723	51771	2615	63137	2237	33118

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.18	MA	29593	6508	42075	5539	50069	4514	53125	3744	54606	2639	66555	2190	35897
6L-4S		MI	28413	6508	40663	5498	48313	4480	51544	3714	53817	2608	65773	2283	33236
16-#11	1.18	MA	28870	6508	41100	5541	48779	4515	51548	3754	52412	2637	63892	2119	35187
7L-3S		MI	29188	6508	41677	5496	49685	4469	53206	3716	56060	2612	68306	2375	33293
16-#11	1.18	MA	28156	6508	40141	5543	47515	4516	49969	3753	50296	2644	61157	2064	34636
8L-2S		MI	30260	6508	43045	5495	51419	4469	55307	3707	58895	2605	72145	2466	33313
16-#14	1.70	MA	35623	6910	52210	5757	62861	4662	68581	3831	75405	2593	94025	2440	52165
2L-8S		MI	26150	6910	39207	5752	46170	4665	48779	3841	49992	2600	61508	1785	42829
16-#14	1.70	MA	33964	6910	50048	5759	60119	4663	65258	3844	70923	2603	87930	2308	52048
3L-7S		MI	27059	6910	40459	5750	47819	4666	50839	3843	52751	2591	65017	1862	44403
16-#14	1.70	MA	32771	6910	48445	5762	57952	4678	62632	3843	67378	2598	83905	2177	51803
4L-6S		MI	27979	6910	41730	5749	49502	4666	52895	3831	55610	2597	68412	1964	45251
16-#14	1.70	MA	31693	6910	46826	5779	56008	4678	60259	3856	64147	2608	79726	2109	51106
5E		MI	28919	6910	43036	5748	51243	4652	55015	3833	58430	2589	72226	2072	46455
16-#14	1.70	MA	30660	6910	45388	5781	54091	4693	57925	3855	61042	2618	75470	2001	49714
6L-4S		MI	29900	6910	44507	5732	53008	4653	57169	3821	61363	2580	75984	2139	47096
16-#14	1.70	MA	29649	6910	43989	5783	52239	4694	55662	3869	57894	2614	71678	1899	48737
7L-3S		MI	30983	6910	45961	5730	54974	4638	59552	3823	64579	2586	79586	2270	47300
16-#14	1.70	MA	28649	6910	42612	5785	50424	4694	53395	3867	54856	2624	67775	1820	46965
8L-2S		MI	32484	6910	47919	5729	57457	4639	62560	3811	68638	2578	85049	2402	47395
16-#18	3.03	MA	38681	7927	61763	6365	74691	5101	82788	4126	94488	2545	119103	2048	90301
3L-7S		MI	28645	7927	46885	6361	55555	5114	60057	4128	64992	2518	82124	1262	71140
16-#18	3.03	MA	36693	7927	58946	6367	70882	5126	78172	4121	88258	2534	112133	1814	88488
4L-6S		MI	30180	7927	49121	6361	58514	5117	63672	4108	69999	2532	87987	1444	74235
16-#18	3.03	MA	34897	7927	56096	6396	67462	5125	73997	4143	82574	2549	104859	1696	85068
5E		MI	31747	7927	51418	6360	61577	5094	67399	4115	74937	2518	94586	1637	77147
16-#18	3.03	MA	33175	7927	53565	6398	64087	5150	69889	4139	77109	2564	97476	1504	81864
6L-4S		MI	33381	7927	54003	6333	64679	5097	71185	4095	80071	2505	101113	1753	80097
16-#18	3.03	MA	31489	7927	51102	6400	60827	5149	65905	4161	71569	2553	90907	1322	78316
7L-3S		MI	35187	7927	56557	6332	68131	5074	75368	4102	85697	2518	107331	1986	81855
16-#18	3.03	MA	29820	7927	48676	6402	57632	5148	61914	4156	66223	2568	84113	1185	73746
8L-2S		MI	37689	7927	59987	6332	72480	5077	80638	4082	92787	2505	116784	2220	82319
18-#11	1.33	MA	33880	6622	48341	5593	58099	4543	62875	3758	67751	2615	83851	2485	41085
2L-9S		MI	25794	6622	37373	5595	44097	4552	46384	3772	46819	2625	57012	1967	34737
18-#11	1.33	MA	32703	6622	46831	5595	56185	4544	60556	3768	64622	2622	79574	2394	41041
3L-8S		MI	26434	6622	38336	5584	45281	4542	47796	3763	48723	2619	59447	2025	35588
18-#11	1.33	MA	31856	6622	45715	5596	54674	4555	58725	3768	62151	2619	76747	2303	40949
4L-7S		MI	27078	6622	39209	5582	46430	4542	49232	3764	50647	2612	61908	2079	36051
18-#11	1.33	MA	31092	6622	44586	5608	53320	4555	57071	3777	59899	2627	73819	2255	40782
5L-6S		MI	27730	6622	40095	5581	47603	4542	50665	3755	52640	2616	64296	2150	36645
18-#11	1.33	MA	30360	6622	43584	5610	51984	4566	55444	3777	57735	2634	70832	2180	40238
6L-5S		MI	28396	6622	41005	5580	48817	4531	52143	3756	54606	2609	66976	2225	37129
18-#11	1.33	MA	29643	6622	42610	5612	50693	4567	53868	3787	55541	2631	68169	2109	39550
7L-4S		MI	29091	6622	42030	5568	50048	4531	53645	3747	56652	2603	69612	2272	37264
18-#11	1.33	MA	28935	6622	41651	5614	49429	4568	52288	3786	53425	2639	65434	2054	39008
8L-3S		MI	29860	6622	43045	5567	51419	4521	55307	3749	58895	2607	72145	2363	37337
18-#11	1.33	MA	28232	6622	40591	5626	48126	4578	50734	3796	51330	2647	62720	1996	38044
9L-2S		MI	30926	6622	44412	5566	53154	4521	57409	3739	61730	2600	75984	2454	37369
18-#14	1.92	MA	36641	7073	54373	5860	65604	4737	71903	3878	79888	2586	100119	2424	58556
2L-9S		MI	26234	7073	39783	5870	46955	4754	49762	3901	51319	2601	63508	1682	46985
18-#14	1.92	MA	34998	7073	52210	5862	62861	4737	68581	3892	75405	2596	94025	2293	58414
3L-8S		MI	27127	7073	41165	5854	48654	4740	51788	3888	54051	2592	66971	1766	48420
18-#14	1.92	MA	33816	7073	50608	5864	60695	4753	65955	3890	71861	2591	89999	2161	58140
4L-7S		MI	28027	7073	42417	5853	50302	4741	53847	3891	56810	2584	70480	1843	49953
18-#14	1.92	MA	32750	7073	48988	5881	58751	4753	63582	3904	68630	2601	85821	2093	57292
5L-6S		MI	28938	7073	43688	5851	51985	4741	55903	3878	59669	2590	73875	1946	50883
18-#14	1.92	MA	31728	7073	47551	5883	56833	4768	61247	3902	65524	2611	81565	1985	55947
6L-5S		MI	29868	7073	44994	5850	53727	4727	58023	3881	62489	2581	77689	2054	52044
18-#14	1.92	MA	30727	7073	46152	5885	54981	4769	58984	3916	62376	2606	77773	1883	54913
7L-4S		MI	30838	7073	46465	5834	55492	4727	60178	3868	65422	2573	81447	2121	52832

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

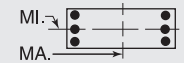
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	1.92	MA	29738	7073	44775	5887	53167	4769	56717	3915	59339	2616	73869	1804	53161
8L-3S		MI	31911	7073	47919	5833	57457	4713	62560	3871	68638	2579	85049	2252	53064
18-#14	1.92	MA	28756	7073	43254	5904	51297	4784	54487	3928	56332	2626	70003	1720	51553
9L-2S		MI	33399	7073	49877	5831	59941	4714	65569	3858	72697	2570	90512	2383	53183
18-#18	3.41	MA	38415	8218	62739	6549	75693	5259	84000	4206	96121	2520	122707	1781	99260
4L-7S		MI	30260	8218	50314	6543	59905	5247	65326	4212	72082	2504	91577	1223	80922
18-#18	3.41	MA	36646	8218	59890	6577	72273	5258	79825	4228	90437	2536	115432	1663	95967
5L-6S		MI	31772	8218	52551	6542	62864	5250	68941	4192	77089	2517	97440	1405	83925
18-#18	3.41	MA	34950	8218	57359	6580	68898	5283	75717	4223	84972	2551	108050	1470	92628
6L-5S		MI	33316	8218	54848	6542	65927	5227	72669	4199	82027	2504	104039	1598	86977
18-#18	3.41	MA	33290	8218	54895	6582	65637	5282	71733	4245	79432	2539	101480	1288	89175
7L-4S		MI	34926	8218	57433	6515	69029	5230	76455	4179	87162	2491	110566	1714	89809
18-#18	3.41	MA	31648	8218	52470	6584	62442	5281	67742	4240	74086	2554	94686	1152	84538
8L-3S		MI	36706	8218	59987	6514	72480	5207	80638	4186	92787	2504	116784	1947	91887
20-#11	1.48	MA	34612	6735	49850	5664	60013	4595	65194	3791	70880	2609	88128	2475	45554
2L-10S		MI	25848	6735	37872	5667	44690	4604	47066	3803	47696	2616	58334	1875	37948
20-#11	1.48	MA	33443	6735	48341	5666	58099	4596	62875	3801	67751	2617	83851	2384	45497
3L-9S		MI	26491	6735	38741	5666	45831	4604	48485	3805	49654	2620	60851	1955	38655
20-#11	1.48	MA	32603	6735	47224	5667	56589	4607	61044	3800	65280	2614	81023	2293	45390
4L-8S		MI	27126	6735	39704	5655	47015	4594	49897	3796	51558	2614	63286	2014	39541
20-#11	1.48	MA	31844	6735	46095	5679	55234	4607	59390	3810	63028	2622	78096	2245	45207
5L-7S		MI	27765	6735	40576	5653	48165	4594	51333	3797	53481	2607	65747	2068	40003
20-#11	1.48	MA	31118	6735	45094	5681	53898	4618	57763	3810	60864	2629	75109	2170	44587
6E		MI	28412	6735	41462	5652	49337	4594	52766	3788	55475	2611	68134	2138	40579
20-#11	1.48	MA	30407	6735	44119	5683	52608	4619	56187	3819	58670	2626	72446	2100	43917
7L-5S		MI	29073	6735	42373	5651	50552	4583	54244	3789	57441	2604	70815	2213	41138
20-#11	1.48	MA	29705	6735	43160	5685	51343	4619	54607	3819	56554	2634	69711	2045	43383
8L-4S		MI	29762	6735	43398	5639	51782	4583	55747	3780	59487	2598	73450	2260	41289
20-#11	1.48	MA	29008	6735	42101	5697	50041	4630	53053	3829	54459	2641	66996	1986	42380
9L-3S		MI	30526	6735	44412	5638	53154	4573	57409	3781	61730	2601	75984	2351	41376
20-#11	1.48	MA	28300	6735	41145	5698	48786	4631	51492	3828	52304	2639	64191	1907	41567
10L-2S		MI	31584	6735	45780	5637	54888	4573	59510	3772	64565	2595	79823	2442	41420
20-#14	2.13	MA	36018	7237	54373	5964	65604	4812	71903	3939	79888	2588	100119	2277	64776
3L-9S		MI	27207	7237	41741	5972	49438	4829	52770	3948	55378	2593	68971	1663	52537
20-#14	2.13	MA	34848	7237	52770	5966	63437	4827	69277	3938	76344	2583	96094	2145	64475
4L-8S		MI	28092	7237	43123	5956	51137	4815	54796	3936	58110	2585	72434	1748	54020
20-#14	2.13	MA	33792	7237	51151	5983	61494	4828	66905	3951	73113	2593	91915	2077	63491
5L-7S		MI	28982	7237	44375	5955	52786	4815	56856	3938	60869	2576	75944	1825	55513
20-#14	2.13	MA	32781	7237	49713	5985	59576	4843	64570	3950	70007	2604	87659	1969	62188
6E		MI	29883	7237	45646	5954	54468	4816	58912	3926	63728	2583	79338	1927	56523
20-#14	2.13	MA	31791	7237	48314	5987	57724	4843	62307	3963	66859	2599	83867	1867	61076
7L-5S		MI	30804	7237	46952	5952	56210	4802	61032	3928	66548	2574	83153	2035	57646
20-#14	2.13	MA	30813	7237	46937	5989	55909	4844	60040	3962	63822	2609	79964	1789	59364
8L-4S		MI	31765	7237	48423	5936	57975	4802	63186	3916	69481	2565	86910	2102	58566
20-#14	2.13	MA	29841	7237	45416	6006	54039	4859	57810	3976	60815	2619	76097	1705	57712
9L-3S		MI	32828	7237	49877	5935	59941	4788	65569	3918	72697	2572	90512	2233	58824
20-#14	2.13	MA	28873	7237	44045	6008	52238	4859	55569	3974	57722	2614	72100	1589	55782
10L-2S		MI	34303	7237	51835	5934	62424	4789	68577	3906	76756	2563	95975	2365	58965
20-#18	3.79	MA	38367	8509	63683	6759	77084	5391	85654	4312	98300	2522	126006	1629	106883
5L-7S		MI	31848	8509	53744	6725	64255	5380	70596	4296	79173	2490	101029	1184	90610
20-#18	3.79	MA	36696	8509	61152	6761	73708	5416	81545	4307	92835	2537	118623	1437	103411
6E		MI	33338	8509	55981	6724	67214	5383	74211	4277	84179	2503	106893	1366	93637
20-#18	3.79	MA	35061	8509	58688	6763	70448	5415	77561	4329	87295	2526	112054	1255	100050
7L-5S		MI	34860	8509	58278	6723	70276	5360	77938	4283	89117	2490	113492	1559	96824

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

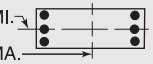


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#18	3.79	MA	33443	8509	56263	6766	67253	5414	73570	4324	81949	2541	105260	1118	95345
8L-4S		MI	36448	8509	60863	6696	73378	5363	81725	4264	94252	2476	120019	1674	99548
22-#11	1.63	MA	35338	6848	51360	5735	61927	4647	67513	3824	74009	2604	92404	2465	50019
2L-11S		MI	25889	6848	38377	5739	45254	4666	47763	3845	48634	2618	59754	1806	40802
22-#11	1.63	MA	34176	6848	49850	5736	60013	4648	65194	3834	70880	2612	88128	2374	49951
3L-10S		MI	26545	6848	39240	5738	46425	4656	49167	3836	50531	2611	62173	1863	41857
22-#11	1.63	MA	33342	6848	48733	5738	58503	4659	63363	3833	68408	2609	85300	2283	49829
4L-9S		MI	27180	6848	40108	5737	47566	4656	50586	3838	52489	2615	64690	1943	42578
22-#11	1.63	MA	32589	6848	47605	5750	57148	4659	61709	3843	66156	2616	82373	2235	49631
5L-8S		MI	27810	6848	41072	5725	48750	4645	51999	3829	54393	2608	67124	2002	43443
22-#11	1.63	MA	31869	6848	46603	5752	55812	4670	60082	3842	63992	2624	79386	2161	48941
6L-7S		MI	28444	6848	41944	5724	49899	4645	53434	3830	56316	2602	69586	2056	43958
22-#11	1.63	MA	31164	6848	45629	5754	54522	4671	58506	3852	61799	2621	76723	2090	48288
7L-6S		MI	29086	6848	42830	5723	51072	4645	54867	3821	58310	2606	71973	2127	44519
22-#11	1.63	MA	30467	6848	44669	5755	53258	4671	56926	3852	59683	2629	73988	2035	47713
8L-5S		MI	29742	6848	43740	5722	52286	4635	56346	3822	60276	2599	74654	2202	45146
22-#11	1.63	MA	29776	6848	43610	5767	51955	4682	55372	3862	57587	2636	71273	1977	46720
9L-4S		MI	30427	6848	44766	5710	53517	4635	57848	3813	62322	2593	77289	2248	45312
22-#11	1.63	MA	29076	6848	42655	5769	50700	4683	53811	3861	55433	2633	68468	1897	45908
10L-3S		MI	31185	6848	45780	5709	54888	4625	59510	3814	64565	2596	79823	2340	45412
22-#11	1.63	MA	28334	6848	41706	5771	49412	4694	52267	3871	53347	2641	65779	1839	44706
11L-2S		MI	32236	6848	47147	5708	56623	4625	61611	3805	67400	2590	83661	2431	45468
22-#14	2.34	MA	35868	7400	54933	6068	66180	4902	72600	3985	80826	2576	102188	2130	70809
4L-9S		MI	28168	7400	43699	6075	51921	4904	55779	3995	59437	2586	74434	1645	58098
22-#14	2.34	MA	34822	7400	53313	6085	64236	4903	70227	3999	77595	2586	98010	2062	69700
5L-8S		MI	29044	7400	45081	6058	53620	4890	57805	3983	62169	2577	77897	1729	59626
22-#14	2.34	MA	33821	7400	51876	6087	62318	4918	67893	3997	74490	2596	93754	1954	68435
6L-7S		MI	29925	7400	46333	6057	55269	4890	59864	3985	64927	2569	81407	1806	61084
22-#14	2.34	MA	32841	7400	50477	6089	60466	4918	65630	4011	71342	2591	89962	1852	67248
7L-6S		MI	30818	7400	47604	6056	56951	4891	61920	3973	67787	2575	84801	1909	62170
22-#14	2.34	MA	31873	7400	49100	6091	58652	4919	63362	4009	68305	2601	86058	1773	65575
8L-5S		MI	31729	7400	48910	6055	58693	4876	64040	3976	70607	2566	88616	2017	63258
22-#14	2.34	MA	30911	7400	47579	6108	56782	4934	61132	4023	65298	2611	82192	1689	63878
9L-4S		MI	32681	7400	50381	6038	60458	4877	66195	3963	73540	2558	92373	2083	64298
22-#14	2.34	MA	29950	7400	46207	6110	54980	4934	58891	4022	62205	2607	78195	1574	61984
10L-3S		MI	33734	7400	51835	6037	62424	4863	68577	3966	76756	2564	95975	2215	64580
22-#18	4.17	MA	38416	8800	64945	6943	78519	5549	87373	4391	100698	2524	129197	1403	114214
6L-7S		MI	33413	8800	57174	6906	68604	5513	75866	4380	86263	2475	110482	1145	100256
22-#18	4.17	MA	36804	8800	62481	6945	75259	5548	83390	4413	95158	2513	122628	1222	110809
7L-6S		MI	34882	8800	59410	6906	71564	5516	79481	4361	91269	2489	116346	1327	103367
22-#18	4.17	MA	35210	8800	60056	6947	72064	5547	79398	4409	89812	2528	115834	1085	106166
8L-5S		MI	36383	8800	61708	6905	74626	5493	83208	4368	96207	2475	122945	1520	106684
24-#11	1.77	MA	34902	6962	51360	5807	61927	4699	67513	3867	74009	2607	92404	2365	54401
3L-11S		MI	26580	6962	39745	5810	46988	4718	49865	3878	51469	2613	63592	1795	44715
24-#11	1.77	MA	34074	6962	50243	5809	60417	4710	65682	3866	71537	2604	89577	2273	54267
4L-10S		MI	27241	6962	40607	5809	48159	4708	51268	3869	53366	2606	66012	1852	45751
24-#11	1.77	MA	33327	6962	49114	5821	59062	4711	64028	3876	69285	2611	86650	2226	54054
5L-9S		MI	27863	6962	41476	5808	49300	4708	52688	3870	55324	2610	68529	1932	46505
24-#11	1.77	MA	32612	6962	48112	5823	57726	4722	62402	3875	67121	2619	83663	2151	53300
6L-8S		MI	28488	6962	42439	5796	50484	4697	54100	3861	57228	2603	70963	1990	47351
24-#11	1.77	MA	31912	6962	47138	5825	56436	4723	60825	3885	64928	2616	81000	2080	52662
7E		MI	29117	6962	43311	5795	51633	4697	55536	3863	59151	2597	73425	2044	47916
24-#11	1.77	MA	31221	6962	46179	5826	55172	4723	59245	3885	62811	2623	78265	2025	52037
8L-6S		MI	29754	6962	44197	5794	52806	4697	56969	3854	61145	2601	75812	2115	48463
24-#11	1.77	MA	30535	6962	45119	5838	53869	4734	57691	3894	60716	2631	75550	1967	51065
9L-5S		MI	30405	6962	45108	5793	54021	4687	58447	3855	63111	2594	78493	2190	49152
24-#11	1.77	MA	29841	6962	44164	5840	52614	4735	56130	3894	58562	2628	72744	1887	50221
10L-4S		MI	31085	6962	46133	5781	55251	4687	59949	3846	65157	2587	81128	2237	49332

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	1.77	MA	29103	6962	43216	5842	51326	4746	54586	3904	56475	2636	70056	1829	49039
11L-3S		MI	31837	6962	47147	5780	56623	4677	61611	3847	67400	2591	83661	2328	49445
24-#11	1.77	MA	28375	6962	42272	5844	50075	4746	53034	3903	54339	2633	67363	1771	47901
12L-2S		MI	32883	6962	48515	5779	58357	4677	63712	3838	70235	2585	87500	2419	49512
24-#14	2.56	MA	35840	7564	55476	6187	66979	4977	73550	4046	82078	2579	104104	2046	75919
5L-9S		MI	29117	7564	45657	6177	54404	4979	58787	4043	63496	2579	79897	1626	63666
24-#14	2.56	MA	34849	7564	54038	6190	65061	4993	71215	4045	78973	2589	99848	1938	74689
6L-8S		MI	29984	7564	47039	6161	56103	4964	60813	4030	66228	2570	83360	1711	65240
24-#14	2.56	MA	33879	7564	52639	6192	63209	4993	68952	4058	75825	2584	96056	1836	73429
7E		MI	30857	7564	48291	6159	57752	4965	62873	4033	68986	2561	86870	1788	66663
24-#14	2.56	MA	32920	7564	51262	6194	61394	4993	66685	4057	72787	2594	92153	1758	71792
8L-6S		MI	31741	7564	49562	6158	59435	4966	64929	4020	71845	2568	90264	1890	67823
24-#14	2.56	MA	31968	7564	49741	6211	59525	5009	64455	4070	69780	2604	88286	1673	70052
9L-5S		MI	32644	7564	50868	6157	61177	4951	67049	4023	74666	2559	94079	1998	68879
24-#14	2.56	MA	31011	7564	48370	6213	57723	5009	62214	4069	66688	2599	84289	1558	68191
10L-4S		MI	33587	7564	52339	6141	62941	4952	69203	4010	77599	2550	97836	2065	70029
24-#18	4.55	MA	38523	9090	66274	7127	80069	5681	89218	4497	103021	2499	133201	1188	121549
7E		MI	34955	9090	60603	7088	72954	5646	81136	4465	93353	2461	119935	1106	109920
24-#18	4.55	MA	36951	9090	63849	7129	76874	5680	85227	4493	97675	2515	126407	1052	117000
8L-6S		MI	36405	9090	62840	7088	75913	5649	84750	4445	98359	2474	125799	1288	113115

RECTANGULAR TIED COLUMNS 46" x 46"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.13	MA	31320	6484	44779	5448	53165	4433	56959	3679	60287	2593	73245	2438	33221
2L-3S		MI	28485	6484	41168	5450	48585	4431	51410	3700	52801	2607	63232	2204	33137
8-#18	1.51	MA	33051	6775	48391	5630	57745	4566	62508	3763	67774	2580	83258	2401	43941
2L-4S		MI	28238	6775	42094	5633	49535	4588	52559	3778	54350	2581	66651	1934	43065
10-#14	1.06	MA	31123	6429	43948	5447	52395	4434	56150	3686	59281	2613	72282	2478	31462
2L-5S		MI	27259	6429	38814	5467	45862	4449	48217	3710	48548	2626	58722	2147	31014
10-#14	1.06	MA	29498	6429	41888	5448	49782	4434	52985	3699	55010	2623	66503	2346	31440
3L-4S		MI	28323	6429	40360	5450	47716	4449	50481	3697	51630	2617	62690	2215	31320
10-#18	1.89	MA	34741	7066	52002	5812	62326	4699	68057	3847	75260	2567	93271	2365	54625
2L-5S		MI	28204	7066	42988	5843	50854	4719	54128	3883	56417	2581	69764	1781	50155
10-#18	1.89	MA	31995	7066	48391	5813	57745	4697	62508	3868	67774	2581	83258	2132	54348
3L-4S		MI	30006	7066	45705	5815	54115	4721	58108	3863	61836	2568	76664	1898	53560

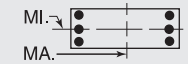
RECTANGULAR TIED COLUMNS 46" x 48"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.09	MA	33932	6728	48191	5677	57313	4621	61384	3839	64828	2716	78858	2564	34841
2L-3S		MI	29612	6728	42644	5663	50299	4606	53163	3849	54446	2722	65111	2315	33200
6-#18	1.09	MA	30945	6728	44398	5679	52502	4620	55556	3861	56965	2731	68284	2331	34757
3L-2S		MI	32453	6728	46255	5662	54879	4608	58712	3828	61932	2708	75124	2548	33263
8-#18	1.45	MA	35764	7019	51984	5859	62124	4754	67212	3923	72691	2703	89432	2531	46101
2L-4S		MI	29364	7019	43570	5846	51249	4763	54312	3927	55994	2696	68530	2045	43201
8-#18	1.45	MA	32825	7019	48191	5861	57313	4753	61384	3945	64828	2718	78858	2297	45912
3E		MI	31394	7019	46255	5845	54879	4739	58712	3933	61932	2708	75124	2278	43825
8-#18	1.45	MA	30697	7019	45374	5863	53504	4778	56768	3940	58598	2707	71888	2064	45225
4L-2S		MI	34190	7019	49867	5843	59460	4741	64260	3912	69418	2695	85137	2512	43990
10-#14	1.02	MA	33716	6673	47309	5675	56494	4623	60522	3846	63754	2736	77799	2603	32980
2L-5S		MI	28383	6673	40277	5681	47572	4625	49970	3860	50197	2742	60608	2259	31110
10-#14	1.02	MA	32006	6673	45147	5677	53751	4623	57199	3859	59272	2746	71705	2472	32959
3L-4S		MI	29449	6673	41822	5664	49426	4626	52234	3847	53279	2732	64576	2326	31382

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

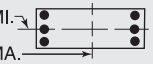


f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.02	MA	30771	6673	43545	5679	51584	4638	54573	3858	55727	2741	67679	2340	32839
4L-3S		MI	30627	6673	43350	5663	51492	4611	54738	3849	56659	2738	68390	2458	31484
10-#14	1.02	MA	29654	6673	41925	5696	49641	4638	52200	3871	52496	2751	63501	2272	32533
5L-2S		MI	32255	6673	45411	5661	54105	4611	57903	3836	60930	2728	74168	2589	31497
10-#18	1.81	MA	37555	7310	55778	6041	66934	4887	73040	4007	80555	2690	100005	2498	57325
2L-5S		MI	29329	7310	44464	6056	52568	4894	55881	4032	58062	2696	71642	1892	50490
10-#18	1.81	MA	34660	7310	51984	6043	62124	4886	67212	4029	72691	2705	89432	2264	57048
3L-4S		MI	31137	7310	47181	6028	55829	4896	59861	4012	63481	2682	78543	2009	53704
10-#18	1.81	MA	32567	7310	49167	6045	58315	4911	62596	4025	66461	2693	82462	2030	56260
4L-3S		MI	33132	7310	49867	6026	59460	4872	64260	4017	69418	2695	85137	2242	54428
10-#18	1.81	MA	30673	7310	46317	6074	54895	4910	58421	4046	60777	2708	75187	1912	52860
5L-2S		MI	35888	7310	53478	6025	64040	4874	69809	3996	76905	2681	95150	2476	54680
12-#14	1.22	MA	34782	6837	49472	5777	59236	4697	63844	3893	68237	2729	83893	2587	39402
2L-6S		MI	28422	6837	40966	5785	48355	4715	50908	3905	51505	2744	62352	2134	35862
12-#14	1.22	MA	33088	6837	47309	5780	56494	4698	60522	3906	63754	2739	77799	2456	39349
3L-5S		MI	29433	6837	42337	5783	50185	4700	53136	3907	54468	2734	66387	2242	37123
12-#14	1.22	MA	31866	6837	45707	5782	54327	4713	57896	3905	60210	2734	73774	2325	39191
4E		MI	30488	6837	43883	5767	52039	4700	55399	3894	57550	2725	70355	2309	37435
12-#14	1.22	MA	30761	6837	44088	5799	52383	4713	55523	3919	56979	2744	69595	2257	38845
5L-3S		MI	31653	6837	45411	5765	54105	4686	57903	3896	60930	2730	74168	2440	37575
12-#14	1.22	MA	29702	6837	42650	5801	50466	4729	53188	3917	53873	2754	65339	2149	37501
6L-2S		MI	33266	6837	47471	5763	56718	4686	61069	3883	65201	2721	79947	2572	37619
12-#18	2.17	MA	39308	7600	59571	6222	71745	5020	78868	4092	88418	2676	110579	2464	68529
2L-6S		MI	29386	7600	45661	6239	53930	5052	57511	4111	60337	2696	74665	1663	58251
12-#18	2.17	MA	36455	7600	55778	6224	66934	5019	73040	4113	80555	2692	100005	2231	68172
3L-5S		MI	31092	7600	48075	6238	57148	5027	61430	4117	65548	2683	81655	1856	60779
12-#18	2.17	MA	34396	7600	52960	6227	63125	5044	68424	4109	74324	2680	93035	1997	67297
4E		MI	32870	7600	50793	6210	60409	5029	65410	4096	70967	2669	88556	1973	64208
12-#18	2.17	MA	32533	7600	50110	6255	59705	5043	64250	4131	68641	2695	85761	1879	63685
5L-3S		MI	34834	7600	53478	6208	64040	5005	69809	4102	76905	2682	95150	2206	65018
12-#18	2.17	MA	30745	7600	47580	6257	56330	5068	60141	4126	63176	2710	78378	1686	61015
6L-2S		MI	37550	7600	57090	6207	68620	5007	75358	4081	84391	2668	105163	2440	65347
14-#14	1.43	MA	35832	7001	51634	5880	61979	4772	67167	3940	72720	2721	89988	2572	45811
2L-7S		MI	28488	7001	41691	5889	49201	4790	51914	3966	52772	2731	64537	2014	40845
14-#14	1.43	MA	34154	7001	49472	5882	59236	4772	63844	3954	68237	2731	83893	2440	45731
3L-6S		MI	29467	7001	43026	5887	50968	4790	54074	3953	55776	2736	68131	2117	41771
14-#14	1.43	MA	32944	7001	47870	5884	57070	4788	61218	3952	64693	2726	79868	2309	45538
4L-5S		MI	30467	7001	44398	5886	52798	4775	56301	3955	58739	2727	72166	2225	43136
14-#14	1.43	MA	31851	7001	46250	5901	55126	4788	58846	3966	61462	2736	75690	2241	45157
5L-4S		MI	31511	7001	45943	5869	54652	4775	58565	3942	61821	2717	76134	2292	43483
14-#14	1.43	MA	30803	7001	44813	5903	53208	4803	56511	3965	58356	2746	71434	2133	43711
6L-3S		MI	32665	7001	47471	5867	56718	4760	61069	3943	65201	2723	79947	2423	43656
14-#14	1.43	MA	29778	7001	43414	5905	51356	4804	54248	3978	55208	2742	67642	2031	42716
7L-2S		MI	34263	7001	49531	5866	59331	4760	64234	3930	69472	2713	85726	2555	43727
14-#18	2.54	MA	41030	7891	63364	6404	76556	5153	84696	4176	96281	2663	121153	2431	79717
2L-7S		MI	29496	7891	46922	6422	55400	5182	59261	4216	62540	2670	78462	1445	64942
14-#18	2.54	MA	38214	7891	59571	6406	71745	5152	78868	4198	88418	2678	110579	2197	79289
3L-6S		MI	31140	7891	49273	6421	58510	5185	63060	4195	67823	2683	84678	1627	68419
14-#18	2.54	MA	36187	7891	56754	6408	67936	5177	74252	4193	82187	2667	103609	1964	78167
4L-5S		MI	32818	7891	51687	6419	61729	5160	66978	4201	73035	2669	91668	1820	71096
14-#18	2.54	MA	34354	7891	53904	6437	64516	5176	70078	4215	76504	2682	96334	1845	74536
5L-4S		MI	34569	7891	54404	6391	64990	5162	70959	4180	78453	2656	98569	1936	74483
14-#18	2.54	MA	32596	7891	51373	6439	61141	5201	65969	4210	71039	2697	88952	1653	71721
6L-3S		MI	36503	7891	57090	6390	68620	5138	75358	4186	84391	2669	105163	2170	75600
14-#18	2.54	MA	30873	7891	48909	6441	57880	5200	61986	4232	65498	2686	82382	1471	68011
7L-2S		MI	39183	7891	60701	6388	73200	5140	80907	4165	91878	2655	115176	2404	75999
16-#11	1.13	MA	34375	6763	48411	5747	58043	4677	62465	3883	66422	2741	81636	2612	36647
2L-8S		MI	28117	6763	40075	5753	47313	4688	49662	3899	49815	2755	60355	2168	33296

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis



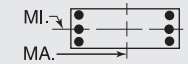
f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.13	MA	33187	6763	46902	5749	56128	4677	60146	3893	63293	2748	77359	2521	36622
3L-7S		MI	28800	6763	40991	5752	48520	4688	51169	3900	51835	2748	62954	2222	33801
16-#11	1.13	MA	32332	6763	45785	5751	54618	4688	58315	3892	60821	2745	74532	2429	36556
4L-6S		MI	29492	6763	41921	5750	49752	4688	52674	3891	53928	2751	65479	2293	34469
16-#11	1.13	MA	31559	6763	44656	5763	53263	4689	56661	3902	58570	2753	71604	2382	36424
5E		MI	30199	6763	42877	5749	51027	4677	54227	3891	55994	2744	68312	2368	34803
16-#11	1.13	MA	30819	6763	43655	5765	51927	4700	55034	3901	56405	2760	68617	2307	36065
6L-4S		MI	30936	6763	43954	5737	52319	4677	55805	3882	58142	2737	71094	2415	34921
16-#11	1.13	MA	30095	6763	42680	5766	50637	4700	53458	3911	54212	2758	65954	2236	35347
7L-3S		MI	31752	6763	45020	5735	53760	4666	57551	3883	60500	2740	73774	2506	34977
16-#11	1.13	MA	29379	6763	41721	5768	49373	4701	51878	3911	52096	2765	63219	2181	34803
8L-2S		MI	32883	6763	46458	5734	55585	4666	59761	3873	63482	2733	77832	2597	34997
16-#14	1.63	MA	36869	7164	53797	5982	64721	4847	70490	3988	77203	2714	96082	2556	52211
2L-8S		MI	28570	7164	42437	5993	50082	4864	52917	4011	54145	2732	66610	1920	45236
16-#14	1.63	MA	35205	7164	51634	5984	61979	4847	67167	4001	72720	2724	89988	2425	52105
3L-7S		MI	29528	7164	43751	5991	51814	4865	55080	4013	57043	2723	70316	1997	46790
16-#14	1.63	MA	34008	7164	50032	5986	59812	4863	64541	4000	69176	2719	85963	2293	51881
4L-6S		MI	30497	7164	45086	5989	53581	4865	57239	4000	60046	2729	73909	2100	47692
16-#14	1.63	MA	32926	7164	48413	6003	57868	4863	62168	4013	65945	2729	81784	2225	51347
5E		MI	31487	7164	46458	5988	55411	4850	59467	4002	63009	2719	77944	2208	49012
16-#14	1.63	MA	31889	7164	46975	6005	55951	4878	59834	4012	62839	2739	77528	2117	49932
6L-4S		MI	32520	7164	48003	5971	57265	4850	61730	3989	66092	2710	81912	2275	49526
16-#14	1.63	MA	30874	7164	45576	6007	54099	4878	57571	4026	59691	2734	73736	2015	48962
7L-3S		MI	33662	7164	49531	5969	59331	4835	64234	3991	69472	2715	85726	2406	49730
16-#14	1.63	MA	29871	7164	44199	6009	52284	4879	55304	4024	56654	2744	69832	1937	47317
8L-2S		MI	35246	7164	51592	5968	61944	4835	67400	3978	73742	2706	91505	2538	49825
16-#18	2.90	MA	42722	8182	67157	6586	81366	5286	90525	4260	104144	2650	131726	2397	90894
2L-8S		MI	29640	8182	48220	6605	56933	5313	61004	4295	64928	2671	82031	1273	71087
16-#18	2.90	MA	39943	8182	63364	6588	76556	5285	84696	4282	96281	2665	121153	2164	90400
3L-7S		MI	31241	8182	50534	6604	59980	5315	64810	4300	70026	2657	88475	1409	75237
16-#18	2.90	MA	37945	8182	60547	6590	72747	5310	80080	4277	90051	2654	114183	1930	88900
4L-6S		MI	32860	8182	52884	6602	63090	5318	68609	4279	75310	2670	94691	1591	78614
16-#18	2.90	MA	36140	8182	57697	6619	69327	5309	75906	4299	84367	2669	106908	1812	85410
5E		MI	34512	8182	55298	6601	66309	5293	72527	4285	80521	2656	101682	1784	81436
16-#18	2.90	MA	34410	8182	55166	6621	65952	5334	71797	4295	78902	2684	99525	1619	82453
6L-4S		MI	36236	8182	58016	6573	69570	5295	76508	4264	85940	2642	108582	1900	84685
16-#18	2.90	MA	32714	8182	52702	6623	62691	5333	67814	4316	73362	2672	92956	1438	78846
7L-3S		MI	38142	8182	60701	6572	73200	5271	80907	4270	91878	2655	115176	2134	86175
16-#18	2.90	MA	31038	8182	50277	6625	59496	5332	63823	4312	68016	2687	86162	1301	74474
8L-2S		MI	40788	8182	64313	6570	77780	5273	86456	4249	99364	2642	125189	2368	86639
18-#11	1.27	MA	35118	6876	49921	5818	59957	4729	64784	3916	69550	2735	85913	2602	41122
2L-9S		MI	28184	6876	40502	5836	47894	4751	50389	3941	50797	2757	61838	2099	36640
18-#11	1.27	MA	33938	6876	48411	5820	58043	4729	62465	3925	66422	2743	81636	2511	41085
3L-8S		MI	28857	6876	41514	5824	49138	4740	51872	3932	52797	2750	64413	2157	37459
18-#11	1.27	MA	33089	6876	47294	5822	56532	4740	60634	3925	63950	2740	78808	2420	41003
4L-7S		MI	29535	6876	42429	5822	50344	4740	53379	3933	54817	2743	67011	2212	37954
18-#11	1.27	MA	32322	6876	46166	5834	55178	4741	58980	3935	61698	2748	75881	2372	40853
5L-6S		MI	30222	6876	43360	5821	51576	4739	54884	3923	56910	2746	69536	2282	38602
18-#11	1.27	MA	31588	6876	45164	5835	53841	4752	57353	3934	59534	2755	72894	2297	40405
6L-5S		MI	30923	6876	44316	5820	52851	4729	56437	3924	58976	2739	72370	2357	39024
18-#11	1.27	MA	30869	6876	44190	5837	52551	4752	55777	3944	57341	2752	70231	2226	39709
7L-4S		MI	31655	6876	45393	5808	54144	4728	58015	3915	61124	2732	75151	2405	39160
18-#11	1.27	MA	30159	6876	43231	5839	51287	4753	54197	3943	55224	2760	67496	2171	39175
8L-3S		MI	32465	6876	46458	5806	55585	4718	59761	3916	63482	2735	77832	2496	39232

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.27	MA	29446	6876	42171	5851	49984	4764	52643	3953	53129	2767	64781	2113	38303
9L-2S		MI	33589	6876	47897	5805	57409	4718	61971	3906	66463	2728	81890	2587	39264
18-#14	1.83	MA	37892	7328	55959	6084	67464	4922	73812	4035	81686	2706	102177	2541	58604
2L-9S		MI	28665	7328	43046	6112	50911	4954	53954	4071	55546	2734	68724	1818	49739
18-#14	1.83	MA	36242	7328	53797	6086	64721	4922	70490	4049	77203	2716	96082	2409	58474
3L-8S		MI	29606	7328	44497	6095	52695	4939	56082	4058	58416	2725	72388	1903	51125
18-#14	1.83	MA	35057	7328	52195	6088	62555	4937	67864	4047	73658	2711	92057	2278	58222
4L-7S		MI	30554	7328	45811	6093	54427	4939	58246	4060	61314	2716	76095	1980	52741
18-#14	1.83	MA	33986	7328	50575	6105	60611	4938	65491	4061	70427	2721	87878	2210	57530
5L-6S		MI	31513	7328	47146	6092	56194	4939	60405	4047	64317	2721	79688	2082	53623
18-#14	1.83	MA	32960	7328	49138	6107	58693	4953	63156	4059	67322	2732	83622	2102	56163
6L-5S		MI	32493	7328	48518	6090	58024	4925	62632	4049	67280	2712	83723	2191	54896
18-#14	1.83	MA	31956	7328	47739	6109	56841	4953	60893	4073	64174	2727	79830	2000	55214
7L-4S		MI	33515	7328	50064	6073	59878	4925	64896	4036	70362	2702	87691	2258	55566
18-#14	1.83	MA	30963	7328	46362	6111	55027	4954	58626	4072	61137	2737	75927	1921	53508
8L-3S		MI	34647	7328	51592	6072	61944	4910	67400	4038	73742	2708	91505	2389	55798
18-#14	1.83	MA	29977	7328	44841	6128	53157	4969	56396	4085	58129	2747	72060	1837	52042
9L-2S		MI	36218	7328	53652	6070	64557	4910	70566	4025	78013	2699	97283	2521	55917
18-#18	3.26	MA	41644	8473	67157	6770	81366	5418	90525	4366	104144	2652	131726	2130	101507
3L-8S		MI	31377	8473	51832	6787	61513	5446	66553	4379	72414	2658	92044	1237	81328
18-#18	3.26	MA	39675	8473	64340	6772	77557	5443	85909	4362	97914	2640	124756	1897	99664
4L-7S		MI	32954	8473	54145	6786	64560	5448	70359	4385	77513	2644	98488	1373	85550
18-#18	3.26	MA	37896	8473	61490	6801	74137	5442	81734	4383	92230	2655	117482	1779	96304
5L-6S		MI	34549	8473	56496	6784	67670	5451	74158	4364	82796	2657	104704	1555	88831
18-#18	3.26	MA	36191	8473	58959	6803	70762	5467	77625	4379	86765	2671	110099	1586	93207
6L-5S		MI	36178	8473	58910	6783	70889	5426	78076	4369	88007	2643	111695	1748	91795
18-#18	3.26	MA	34521	8473	56495	6805	67502	5466	73642	4401	81225	2659	103530	1404	89697
7L-4S		MI	37876	8473	61627	6755	74150	5428	82057	4349	93426	2629	118595	1864	94919
18-#18	3.26	MA	32870	8473	54070	6807	64307	5465	69651	4396	75879	2674	96736	1268	85257
8L-3S		MI	39756	8473	64313	6753	77780	5404	86456	4354	99364	2642	125189	2098	96747
20-#11	1.41	MA	35853	6990	51430	5889	61871	4780	67103	3948	72679	2730	90189	2592	45593
2L-10S		MI	28244	6990	41029	5908	48520	4803	51109	3973	51723	2749	63235	2008	40004
20-#11	1.41	MA	34681	6990	49921	5891	59957	4781	64784	3958	69550	2738	85913	2501	45543
3L-9S		MI	28922	6990	41941	5907	49718	4802	52599	3974	53779	2752	65896	2088	40765
20-#11	1.41	MA	33838	6990	48804	5893	58446	4792	62953	3958	67079	2735	83085	2410	45447
4L-8S		MI	29590	6990	42952	5895	50962	4792	54082	3965	55779	2745	68471	2146	41626
20-#11	1.41	MA	33077	6990	47675	5905	57092	4793	61299	3968	64827	2743	80158	2362	45280
5L-7S		MI	30263	6990	43868	5893	52169	4792	55590	3966	57799	2738	71069	2201	42113
20-#11	1.41	MA	32349	6990	46674	5906	55756	4804	59673	3967	62663	2750	77171	2287	44751
6E		MI	30944	6990	44798	5892	53400	4791	57095	3956	59892	2741	73594	2272	42741
20-#11	1.41	MA	31636	6990	45699	5908	54465	4804	58096	3977	60469	2747	74508	2217	44075
7L-5S		MI	31640	6990	45754	5890	54675	4781	58647	3957	61957	2734	76428	2347	43244
20-#11	1.41	MA	30931	6990	44740	5910	53201	4805	56516	3976	58353	2755	71773	2162	43550
8L-4S		MI	32366	6990	46831	5879	55968	4780	60225	3948	64106	2727	79209	2394	43395
20-#11	1.41	MA	30232	6990	43680	5922	51898	4816	54962	3986	56258	2762	69058	2103	42636
9L-3S		MI	33170	6990	47897	5877	57409	4770	61971	3949	66463	2730	81890	2485	43482
20-#11	1.41	MA	29521	6990	42725	5924	50643	4816	53401	3986	54103	2759	66253	2023	41823
10L-2S		MI	34287	6990	49335	5876	59233	4769	64182	3939	69445	2723	85947	2576	43526
20-#14	2.04	MA	38903	7491	58122	6186	70206	4997	77135	4082	86168	2699	108271	2525	64991
2L-10S		MI	28768	7491	43797	6216	51804	5029	54981	4117	56866	2721	70714	1686	53753
20-#14	2.04	MA	37267	7491	55959	6188	67464	4997	73812	4096	81686	2709	102177	2393	64839
3L-9S		MI	29696	7491	45106	6214	53523	5029	57119	4119	59817	2727	74502	1801	55589
20-#14	2.04	MA	36093	7491	54357	6191	65297	5012	71186	4095	78141	2704	98152	2262	64560
4L-8S		MI	30628	7491	46557	6197	55308	5014	59248	4106	62687	2718	78167	1886	57022
20-#14	2.04	MA	35032	7491	52738	6208	63354	5012	68814	4108	74910	2714	93973	2194	63725
5L-7S		MI	31566	7491	47872	6196	57040	5014	61411	4108	65585	2708	81873	1963	58651
20-#14	2.04	MA	34017	7491	51300	6210	61436	5028	66479	4107	71805	2724	89717	2086	62402
6E		MI	32516	7491	49207	6194	58807	5014	63570	4095	68588	2714	85467	2065	59561
20-#14	2.04	MA	33023	7491	49901	6212	59584	5028	64216	4120	68656	2719	85925	1984	61448
7L-5S		MI	33486	7491	50579	6192	60637	4999	65798	4097	71551	2704	89502	2174	60793

RECTANGULAR TIED COLUMNS 46" x 48"

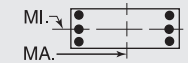
Short columns – no sidesway
Bending on major or minor axis

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.04	MA	32040	7491	48524	6214	57769	5028	61949	4119	65619	2729	82021	1905	59707
8L-4S		MI	34499	7491	52124	6176	62491	5000	68061	4084	74633	2695	93470	2241	61604
20-#14	2.04	MA	31064	7491	47003	6231	55899	5044	59719	4132	62612	2739	78155	1821	58195
9L-3S		MI	35619	7491	53652	6174	64557	4985	70566	4086	78013	2701	97283	2372	61862
20-#14	2.04	MA	30093	7491	45632	6233	54098	5044	57478	4131	59520	2735	74158	1706	56240
10L-2S		MI	37177	7491	55712	6172	67170	4985	73731	4073	82284	2691	103062	2504	62003
20-#18	3.62	MA	41378	8763	68133	6954	82368	5576	91737	4446	105777	2627	135330	1863	110456
4L-8S		MI	33085	8763	55443	6969	66093	5579	72101	4463	79901	2644	102057	1201	91585
20-#18	3.62	MA	39624	8763	65283	6982	78948	5575	87562	4468	100093	2642	128055	1745	107214
5L-7S		MI	34639	8763	57757	6967	69140	5581	75908	4469	84999	2631	108501	1336	95878
20-#18	3.62	MA	37944	8763	62752	6984	75573	5600	83454	4463	94628	2657	120673	1553	103982
6E		MI	36211	8763	60107	6966	72250	5584	79707	4448	90282	2643	114717	1518	99069
20-#18	3.62	MA	36298	8763	60289	6987	72312	5599	79470	4485	89088	2646	114103	1371	100564
7L-5S		MI	37817	8763	62521	6965	75469	5559	83625	4454	95494	2630	121708	1711	102171
20-#18	3.62	MA	34671	8763	57863	6989	69117	5598	75479	4480	83742	2661	107309	1234	96054
8L-4S		MI	39492	8763	65239	6937	78730	5561	87606	4433	100913	2616	128608	1828	105181
22-#11	1.55	MA	36582	7103	52939	5960	63785	4832	69422	3981	75808	2725	94466	2582	50061
2L-11S		MI	28282	7103	41562	5981	49115	4865	51845	4016	52713	2751	64739	1940	43111
22-#11	1.55	MA	35417	7103	51430	5962	61871	4833	67103	3991	72679	2733	90189	2491	49999
3L-10S		MI	28982	7103	42467	5979	50345	4855	53319	4006	54705	2743	67293	1997	44147
22-#11	1.55	MA	34580	7103	50313	5963	60361	4844	65272	3991	70208	2730	87362	2400	49888
4L-9S		MI	29652	7103	43379	5978	51543	4854	54809	4007	56761	2747	69954	2077	44894
22-#11	1.55	MA	33825	7103	49184	5975	59006	4844	63619	4000	67956	2737	84435	2352	49707
5L-8S		MI	30315	7103	44391	5966	52786	4844	56292	3998	58761	2740	72528	2136	45795
22-#11	1.55	MA	33102	7103	48183	5977	57670	4855	61992	4000	65792	2745	81448	2278	49104
6L-7S		MI	30983	7103	45306	5964	53993	4843	57800	3999	60781	2733	75127	2190	46275
22-#11	1.55	MA	32394	7103	47208	5979	56380	4856	60415	4010	63598	2742	78785	2207	48446
7L-6S		MI	31659	7103	46237	5963	55225	4843	59305	3989	62874	2736	77652	2261	46887
22-#11	1.55	MA	31695	7103	46249	5981	55115	4857	58835	4009	61482	2750	76050	2152	47928
8L-5S		MI	32349	7103	47193	5961	56500	4832	60857	3990	64939	2729	80485	2336	47462
22-#11	1.55	MA	31001	7103	45190	5993	53813	4867	57282	4019	59387	2757	73335	2094	46974
9L-4S		MI	33070	7103	48270	5949	57792	4832	62435	3981	67088	2722	83267	2383	47628
22-#11	1.55	MA	30298	7103	44234	5994	52558	4868	55721	4018	57232	2754	70529	2014	46175
10L-3S		MI	33869	7103	49335	5948	59233	4822	64182	3981	69445	2725	85947	2474	47729
22-#11	1.55	MA	29556	7103	43286	5996	51270	4879	54176	4028	55146	2762	67841	1956	45051
11L-2S		MI	34979	7103	50774	5946	61058	4821	66392	3972	72427	2718	90005	2565	47785
22-#14	2.24	MA	38280	7655	58122	6291	70206	5072	77135	4143	86168	2701	108271	2378	71200
3L-10S		MI	29796	7655	45857	6318	54417	5104	58147	4164	61137	2714	76492	1669	59647
22-#14	2.24	MA	37117	7655	56520	6293	68040	5087	74509	4142	82624	2696	104246	2246	70897
4L-9S		MI	30715	7655	47166	6316	56136	5104	60285	4166	64088	2719	80281	1784	61447
22-#14	2.24	MA	36066	7655	54900	6310	66096	5087	72136	4156	79393	2707	100067	2178	69932
5L-8S		MI	31637	7655	48618	6300	57921	5089	62413	4153	66958	2710	83946	1869	62927
22-#14	2.24	MA	35061	7655	53463	6312	64178	5103	69802	4154	76287	2717	95811	2070	68647
6L-7S		MI	32566	7655	49932	6298	59652	5089	64577	4155	69855	2701	87652	1946	64518
22-#14	2.24	MA	34076	7655	52064	6314	62326	5103	67539	4168	73139	2712	92019	1968	67615
7L-6S		MI	33507	7655	51267	6296	61420	5089	66736	4142	72859	2706	91245	2048	65507
22-#14	2.24	MA	33104	7655	50687	6316	60512	5103	65271	4166	70102	2722	88116	1890	65914
8L-5S		MI	34467	7655	52639	6294	63249	5074	68963	4144	75822	2697	95280	2157	66701
22-#14	2.24	MA	32138	7655	49166	6333	58642	5118	63041	4180	67095	2732	84249	1806	64357
9L-4S		MI	35470	7655	54184	6278	65104	5074	71227	4131	78904	2688	99248	2224	67640
22-#14	2.24	MA	31176	7655	47794	6335	56840	5119	60800	4178	64002	2727	80253	1690	62437
10L-3S		MI	36581	7655	55712	6276	67170	5060	73731	4133	82284	2693	103062	2355	67922
22-#18	3.99	MA	41328	9054	69076	7164	83759	5708	93390	4552	107956	2629	138629	1712	118140
5L-8S		MI	34766	9054	59055	7151	70673	5712	77650	4547	87387	2631	112070	1165	101856
22-#18	3.99	MA	39671	9054	66545	7166	80384	5733	89282	4547	102491	2644	131246	1519	114775
6L-7S		MI	36299	9054	61368	7149	73721	5714	81457	4553	92485	2617	118514	1300	106220
22-#18	3.99	MA	38048	9054	64082	7168	77123	5732	85298	4569	96951	2633	124677	1337	111444
7L-6S		MI	37850	9054	63718	7148	76830	5717	85256	4532	97769	2630	124730	1482	109327
22-#18	3.99	MA	36444	9054	61656	7171	73928	5730	81307	4565	91605	2648	117883	1201	106865
8L-5S		MI	39433	9054	66133	7146	80049	5692	89174	4538	102980	2616	131721	1675	112562

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	1.70	MA	37304	7216	54449	6031	65699	4884	71741	4014	78937	2720	98743	2573	54525
2L-12S		MI	28317	7216	42100	6053	49745	4917	52574	4048	53713	2752	66242	1872	46224
24-#11	1.70	MA	36146	7216	52939	6033	63785	4885	69422	4024	75808	2727	94466	2481	54451
3L-11S		MI	29014	7216	43000	6051	50940	4917	54055	4048	55695	2745	68797	1929	47207
24-#11	1.70	MA	35315	7216	51823	6034	62275	4896	67591	4023	73337	2725	91639	2390	54328
4L-10S		MI	29712	7216	43906	6050	52169	4907	55529	4039	57687	2738	71350	1987	48294
24-#11	1.70	MA	34565	7216	50694	6046	60920	4896	65938	4033	71085	2732	88711	2343	54132
5L-9S		MI	30375	7216	44818	6048	53367	4906	57019	4040	59743	2742	74012	2067	49028
24-#11	1.70	MA	33847	7216	49692	6048	59584	4907	64311	4033	68921	2740	85724	2268	53462
6L-8S		MI	31033	7216	45829	6037	54611	4896	58502	4030	61743	2734	76586	2125	49950
24-#11	1.70	MA	33145	7216	48718	6050	58294	4908	62734	4043	66727	2737	83061	2197	52820
7E		MI	31696	7216	46745	6035	55817	4895	60010	4031	63763	2727	79184	2180	50441
24-#11	1.70	MA	32452	7216	47759	6052	57030	4908	61154	4042	64611	2744	80326	2142	52304
8L-6S		MI	32367	7216	47675	6034	57049	4895	61515	4022	65856	2731	81709	2250	51038
24-#11	1.70	MA	31763	7216	46699	6064	55727	4919	59601	4052	62516	2752	77612	2084	51317
9L-5S		MI	33052	7216	48631	6032	58324	4884	63067	4023	67921	2724	84543	2325	51679
24-#11	1.70	MA	31067	7216	45744	6065	54472	4920	58040	4051	60361	2749	74806	2004	50532
10L-4S		MI	33768	7216	49708	6020	59617	4884	64645	4013	70070	2717	87325	2373	51859
24-#11	1.70	MA	30327	7216	44796	6067	53184	4931	56495	4061	58275	2757	72118	1946	49381
11L-3S		MI	34561	7216	50774	6019	61058	4873	66392	4014	72427	2720	90005	2464	51973
24-#11	1.70	MA	29597	7216	43852	6069	51932	4931	54944	4060	56138	2754	69425	1888	48341
12L-2S		MI	35665	7216	52212	6017	62882	4873	68602	4005	75409	2713	94063	2555	52039
24-#14	2.45	MA	38129	7818	58682	6395	70782	5162	77832	4189	87107	2689	110340	2231	77233
4L-10S		MI	30810	7818	47917	6420	57030	5178	61312	4212	65408	2706	82271	1652	65546
24-#14	2.45	MA	37089	7818	57063	6412	68839	5162	75459	4203	83876	2699	106162	2163	76148
5L-9S		MI	31721	7818	49226	6418	58749	5178	63451	4214	68359	2712	86060	1767	67313
24-#14	2.45	MA	36093	7818	55625	6414	66921	5177	73124	4202	80770	2709	101906	2055	74899
6L-8S		MI	32634	7818	50678	6402	60534	5164	65579	4201	71228	2703	89724	1851	68838
24-#14	2.45	MA	35118	7818	54226	6416	65069	5178	70861	4215	77622	2704	98114	1953	73791
7E		MI	33555	7818	51992	6400	62265	5164	67742	4203	74126	2693	93431	1929	70393
24-#14	2.45	MA	34155	7818	52849	6418	63255	5178	68594	4214	74585	2714	94210	1874	72127
8L-6S		MI	34486	7818	53327	6398	64033	5164	69902	4190	77130	2699	97024	2031	71459
24-#14	2.45	MA	33198	7818	51328	6435	61385	5193	66364	4227	71578	2724	90344	1790	70525
9L-5S		MI	35438	7818	54699	6397	65862	5149	72129	4191	80093	2689	101059	2140	72618
24-#14	2.45	MA	32239	7818	49957	6437	59583	5194	64123	4226	68485	2720	86347	1674	68640
10L-4S		MI	36432	7818	56244	6380	67717	5149	74393	4178	83175	2680	105027	2207	73674
24-#18	4.35	MA	41374	9345	70339	7348	85194	5866	95110	4632	110354	2631	141820	1486	125586
6L-8S		MI	36423	9345	62666	7332	75253	5845	83199	4632	94873	2618	122083	1129	112140
24-#18	4.35	MA	39773	9345	67875	7350	81934	5865	91126	4653	104814	2619	135251	1304	122328
7E		MI	37936	9345	64980	7331	78301	5847	87006	4637	99972	2604	128527	1264	116478
24-#18	4.35	MA	38191	9345	65450	7352	78739	5863	87135	4649	99468	2634	128457	1167	117690
8L-6S		MI	39466	9345	67330	7329	81411	5850	90805	4616	105255	2617	134743	1446	119601

RECTANGULAR TIED COLUMNS 48" x 48"

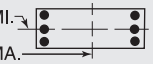
6-#18	1.04	MA	35165	6983	49792	5900	59177	4804	63292	3995	66621	2836	80907	2680	34883
2L-3S		MI	32172	6983	45999	5902	54367	4803	57464	4017	58758	2851	70334	2447	34820
8-#18	1.39	MA	37004	7273	53585	6082	63988	4937	69121	4079	74484	2823	91481	2647	46150
2L-4S		MI	31923	7273	46975	6086	55368	4962	58676	4096	60391	2826	73937	2180	45361
10-#18	1.74	MA	38802	7564	57378	6264	68799	5070	74949	4163	82348	2810	102055	2614	57380
2L-5S		MI	31897	7564	47918	6297	56759	5093	60330	4202	62570	2828	77236	2028	53213
10-#18	1.74	MA	35898	7564	53585	6266	63988	5069	69121	4185	74484	2825	91481	2380	57128
3L-4S		MI	33799	7564	50768	6268	60179	5095	64505	4180	68254	2813	84511	2146	56404

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.63	MA	5747	2369	9386	1676	10036	1354	10231	1108	10338	742	12093	660	6366
2L-3S		MI	5326	2369	8743	1670	9230	1361	9271	1115	9069	749	10452	571	6404
6-#14	2.34	MA	6088	2515	10214	1758	11015	1407	11388	1133	11865	710	14030	599	8918
2L-3S		MI	5498	2515	9301	1748	9881	1417	10037	1143	10079	720	11732	471	8922
6-#18	4.17	MA	6894	2888	12155	1963	13351	1540	14154	1193	15518	624	18604	428	15084
2L-3S		MI	5903	2888	10606	1945	11434	1557	11870	1211	12498	642	14758	200	14009
8-#11	2.17	MA	6026	2479	10029	1745	10842	1403	11192	1135	11607	726	13733	626	8349
2L-4S		MI	5305	2479	8860	1747	9381	1403	9456	1135	9366	740	11017	456	8105
8-#14	3.13	MA	6476	2675	11127	1858	12149	1476	12740	1171	13651	686	16328	547	11714
2L-4S		MI	5467	2675	9465	1858	10093	1476	10297	1171	10496	706	12521	303	10687
8-#18	5.56	MA	7540	3172	13704	2138	15267	1658	16439	1256	18538	574	22450	321	19836
2L-4S		MI	5849	3172	10880	2138	11790	1658	12308	1256	13204	610	16067	-103	15751
10-#11	2.71	MA	6302	2590	10672	1814	11648	1451	12152	1162	12876	711	15374	592	10320
2L-5S		MI	5315	2590	9037	1810	9601	1458	9719	1169	9672	717	11521	380	9499
10-#11	2.71	MA	5889	2590	10029	1808	10842	1458	11192	1169	11607	717	13733	503	10313
3L-4S		MI	5587	2590	9503	1816	10187	1451	10416	1162	10634	724	12658	422	9914
10-#14	3.91	MA	6860	2835	12040	1957	13283	1545	14091	1209	15437	662	18626	494	14490
2L-5S		MI	5481	2835	9714	1949	10402	1555	10667	1219	11018	692	13225	190	12371
10-#14	3.91	MA	6283	2835	11127	1948	12149	1555	12740	1219	13651	672	16328	366	14399
3L-4S		MI	5862	2835	10378	1958	11227	1545	11648	1209	12282	682	14819	250	13269
10-#18	6.94	MA	7251	3455	13704	2295	15267	1794	16439	1336	18538	542	22450	-13	22387
3L-4S		MI	6561	3455	12429	2312	13707	1777	14592	1318	16224	560	19913	-209	19109

RECTANGULAR TIED COLUMNS 24" x 26"

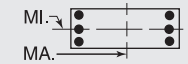
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.00	MA	6384	2428	10144	1745	10758	1421	10809	1180	10554	835	12182	773	4784
2E		MI	5872	2428	9365	1729	9865	1406	9884	1166	9614	823	11049	758	4389
4-#14	1.44	MA	6645	2526	10766	1796	11496	1455	11678	1196	11699	814	13646	734	6704
2E		MI	6103	2526	9924	1780	10515	1438	10648	1180	10622	800	12326	715	6131
4-#18	2.56	MA	7264	2774	12280	1932	13269	1542	13770	1236	14458	759	17138	628	11364
2E		MI	6650	2774	11231	1908	12067	1520	12478	1214	13037	738	15347	597	10335
6-#11	1.50	MA	6701	2538	10856	1814	11662	1471	11887	1208	11978	821	14036	742	6998
2L-3S		MI	5734	2538	9365	1792	9865	1462	9884	1200	9614	814	11049	635	6441
6-#11	1.50	MA	6234	2538	10144	1809	10758	1478	10809	1215	10554	828	12182	654	7036
3L-2S		MI	6155	2538	10008	1798	10671	1455	10844	1193	10883	807	12690	724	6398
6-#14	2.16	MA	7087	2685	11779	1896	12772	1526	13198	1236	13708	793	16251	687	9829
2L-3S		MI	5906	2685	9924	1870	10515	1517	10648	1228	10622	786	12326	534	8981
6-#14	2.16	MA	6431	2685	10766	1888	11496	1536	11678	1246	11699	803	13646	559	9834
3L-2S		MI	6498	2685	10837	1879	11649	1507	12000	1218	12407	776	14624	662	8958
6-#18	3.85	MA	8002	3058	14030	2109	15438	1664	16353	1302	17873	715	21525	532	16704
2L-3S		MI	6311	3058	11231	2065	12067	1656	12478	1295	13037	706	15347	263	14342
6-#18	3.85	MA	6896	3058	12280	2092	13269	1682	13770	1320	14458	732	17138	305	15881
3L-2S		MI	7306	3058	12781	2083	13984	1638	14763	1277	16056	688	19193	490	15148
8-#11	2.00	MA	7014	2649	11568	1883	12567	1521	12964	1237	13402	807	15890	712	9191
2L-4S		MI	5712	2649	9481	1869	10015	1503	10068	1221	9910	806	11615	519	8260
8-#11	2.00	MA	6551	2649	10856	1878	11662	1528	11887	1244	11978	814	14036	623	9209
3E		MI	6017	2649	10008	1861	10671	1510	10844	1228	10883	799	12690	601	8411
8-#11	2.00	MA	6215	2649	10275	1887	10927	1521	11017	1237	10886	821	12825	539	9038
4L-2S		MI	6435	2649	10651	1867	11477	1503	11804	1221	12151	792	14331	690	8385
8-#14	2.88	MA	7523	2845	12792	1995	14049	1597	14719	1276	15717	771	18856	640	12929
2L-4S		MI	5873	2845	10088	1980	10727	1576	10908	1256	11039	771	13115	366	10874

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

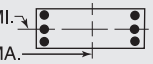


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.88	MA	6874	2845	11779	1987	12772	1607	13198	1286	13708	781	16251	512	12882
3E		MI	6302	2845	10837	1970	11649	1586	12000	1266	12407	761	14624	482	11734
8-#14	2.88	MA	6403	2845	10951	1999	11735	1597	11971	1276	12168	791	14546	393	11929
4L-2S		MI	6887	2845	11750	1979	12784	1576	13351	1256	14193	751	16923	610	11760
8-#18	5.13	MA	8728	3341	15781	2286	17606	1786	18937	1369	21288	671	25913	437	21996
2L-4S		MI	6254	3341	11506	2258	12424	1757	12916	1339	13743	674	16656	-41	16532
8-#18	5.13	MA	7641	3341	14030	2269	15438	1804	16353	1387	17873	688	21525	209	20591
3E		MI	6973	3341	12781	2240	13984	1775	14763	1357	16056	656	19193	156	18545
8-#18	5.13	MA	6848	3341	12592	2287	13673	1786	14266	1369	15256	706	18642	5	18612
4L-2S		MI	7954	3341	14330	2258	15901	1757	17047	1339	19076	639	23039	384	19908
10-#11	2.50	MA	7324	2760	12280	1952	13472	1571	14042	1266	14826	794	17744	681	11373
2L-5S		MI	5721	2760	9659	1932	10236	1559	10332	1255	10216	783	12118	444	9633
10-#11	2.50	MA	6865	2760	11568	1947	12567	1578	12964	1273	13402	800	15890	593	11366
3L-4S		MI	5995	2760	10124	1938	10821	1552	11029	1248	11179	790	13256	485	10066
10-#11	2.50	MA	6533	2760	10987	1956	11832	1571	12095	1266	12310	807	14679	509	11044
4L-3S		MI	6298	2760	10651	1931	11477	1559	11804	1255	12151	783	14331	567	10365
10-#11	2.50	MA	6232	2760	10475	1951	11175	1578	11312	1273	11231	800	13393	468	10532
5L-2S		MI	6712	2760	11293	1936	12283	1552	12764	1248	13420	776	15972	656	10360
10-#14	3.61	MA	7954	3004	13805	2095	15325	1668	16239	1316	17726	750	21460	593	16009
2L-5S		MI	5886	3004	10337	2070	11037	1655	11278	1304	11560	757	13820	253	12661
10-#14	3.61	MA	7313	3004	12792	2087	14049	1678	14719	1326	15717	760	18856	465	15918
3L-4S		MI	6269	3004	11001	2080	11861	1645	12260	1294	12825	747	15414	313	13452
10-#14	3.61	MA	6847	3004	11964	2099	13011	1668	13491	1316	14177	770	17151	346	14797
4L-3S		MI	6693	3004	11750	2069	12784	1655	13351	1304	14193	737	16923	429	14474
10-#14	3.61	MA	6426	3004	11232	2091	12084	1678	12387	1326	12653	760	15345	286	13923
5L-2S		MI	7272	3004	12663	2079	13918	1645	14702	1294	15979	727	19221	557	14544
10-#18	6.41	MA	8374	3625	15781	2446	17606	1926	18937	1453	21288	644	25913	114	25372
3L-4S		MI	6968	3625	13055	2432	14340	1875	15201	1402	16762	625	20502	-147	19937
10-#18	6.41	MA	7595	3625	14342	2464	15842	1908	16850	1436	18671	662	23030	-90	22609
4L-3S		MI	7666	3625	14330	2414	15901	1893	17047	1420	19076	607	23039	50	22820
12-#11	3.00	MA	7632	2870	12992	2021	14377	1621	15120	1294	16249	780	19598	651	13546
2L-6S		MI	5744	2870	9835	2009	10458	1601	10626	1289	10603	774	12702	349	10904
12-#11	3.00	MA	7176	2870	12280	2016	13472	1627	14042	1301	14826	787	17744	562	13515
3L-5S		MI	6004	2870	10302	2002	11042	1608	11292	1282	11485	768	13759	410	11493
12-#11	3.00	MA	6847	2870	11699	2025	12737	1621	13172	1294	13734	794	16533	478	13066
4E		MI	6276	2870	10767	2008	11627	1601	11989	1275	12448	774	14897	451	11889
12-#11	3.00	MA	6549	2870	11187	2020	12079	1627	12390	1301	12654	787	15247	437	12595
5L-3S		MI	6576	2870	11293	2000	12283	1608	12764	1282	13420	768	15972	533	12308
12-#11	3.00	MA	6264	2870	10701	2015	11425	1621	11643	1308	11665	794	14050	377	11941
6L-2S		MI	6987	2870	11936	2006	13089	1601	13725	1275	14689	761	17612	621	12325
12-#14	4.33	MA	7746	3164	13805	2187	15325	1749	16239	1366	17726	738	21460	418	18946
3L-5S		MI	6282	3164	11250	2170	12171	1724	12630	1342	13346	733	16118	201	15167
12-#14	4.33	MA	7286	3164	12976	2199	14287	1739	15012	1356	16185	748	19755	298	17686
4E		MI	6661	3164	11914	2179	12995	1714	13611	1332	14610	723	17712	261	16051
12-#14	4.33	MA	6870	3164	12245	2191	13360	1749	13908	1366	14662	738	17949	239	16720
5L-3S		MI	7080	3164	12663	2169	13918	1724	14702	1342	15979	713	19221	376	17205
12-#18	7.69	MA	8332	3909	16093	2641	18010	2030	19434	1502	22085	618	27418	-186	26419
4E		MI	7626	3909	14604	2607	16257	1994	17485	1464	19782	575	24348	-254	23213
14-#11	3.50	MA	7485	2981	12992	2085	14377	1677	15120	1330	16249	773	19598	532	15658
3L-6S		MI	6027	2981	10478	2079	11264	1649	11586	1316	11872	759	14343	315	12715
14-#11	3.50	MA	7158	2981	12411	2094	13641	1670	14250	1323	15158	780	18387	448	15102
4L-5S		MI	6285	2981	10944	2071	11848	1656	12252	1309	12754	752	15400	376	13359
14-#11	3.50	MA	6863	2981	11899	2089	12984	1677	13468	1330	14078	773	17101	407	14665
5L-4S		MI	6554	2981	11410	2077	12433	1649	12949	1302	13716	759	16537	417	13723
14-#11	3.50	MA	6580	2981	11413	2084	12329	1670	12721	1337	13089	780	15904	347	13955
6L-3S		MI	6852	2981	11936	2069	13089	1656	13725	1309	14689	752	17612	499	14244
14-#14	5.05	MA	7720	3324	13989	2298	15564	1809	16532	1396	18194	727	22360	251	20592
4L-5S		MI	6674	3324	12163	2270	13305	1793	13981	1380	15132	708	18416	148	17693

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	5.05	MA	7309	3324	13257	2290	14636	1819	15428	1406	16671	717	20554	192	19537
5L-4S		MI	7049	3324	12827	2279	14129	1783	14962	1370	16396	699	20010	208	18664
16-#11	4.00	MA	7466	3092	13123	2163	14546	1720	15328	1352	16582	766	20240	417	17147
4L-6S		MI	6307	3092	11121	2148	12070	1698	12547	1343	13141	743	15983	281	14535
16-#11	4.00	MA	7174	3092	12611	2158	13889	1727	14546	1358	15502	759	18955	376	16741
5E		MI	6563	3092	11587	2140	12654	1705	13212	1337	14023	736	17040	342	15213
16-#11	4.00	MA	6894	3092	12125	2153	13234	1720	13798	1365	14512	766	17758	316	15979
6L-4S		MI	6830	3092	12052	2146	13239	1698	13910	1330	14985	743	18178	383	15568
16-#14	5.77	MA	7743	3483	14270	2390	15913	1890	16949	1446	18679	695	23159	145	22371
5E		MI	7062	3483	13076	2369	14439	1862	15333	1418	16918	684	20714	95	20236
18-#11	4.50	MA	7482	3202	13323	2228	14794	1777	15623	1387	16926	745	20809	346	18766
5L-6S		MI	6586	3202	11763	2217	12876	1747	13507	1371	14410	728	17624	247	16363
18-#11	4.50	MA	7205	3202	12837	2223	14139	1770	14876	1394	15936	752	19612	286	18010
6L-5S		MI	6839	3202	12230	2209	13460	1754	14173	1364	15291	721	18681	307	17004
20-#11	5.00	MA	7514	3313	13549	2292	15044	1820	15954	1423	17360	738	21466	255	20049
6E		MI	6862	3313	12406	2286	13682	1796	14467	1398	15678	712	19265	213	18199

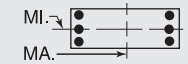
RECTANGULAR TIED COLUMNS 24" x 28"

4-#14	1.34	MA	7663	2695	12328	1934	13217	1572	13424	1296	13416	893	15672	815	7311
2E		MI	6512	2695	10547	1901	11150	1538	11259	1265	11164	865	12921	778	6164
4-#18	2.38	MA	8357	2944	14002	2070	15212	1661	15777	1339	16518	842	19631	718	12444
2E		MI	7059	2944	11857	2028	12701	1618	13087	1298	13575	802	15936	659	10384
6-#11	1.39	MA	7724	2708	12423	1952	13371	1585	13648	1308	13715	900	16090	823	7629
2L-3S		MI	6141	2708	9986	1915	10500	1562	10496	1286	10158	880	11647	699	6476
6-#11	1.39	MA	7210	2708	11642	1947	12376	1593	12453	1315	12136	907	14022	734	7667
3L-2S		MI	6564	2708	10629	1921	11306	1555	11456	1279	11427	873	13288	787	6429
6-#14	2.01	MA	8155	2855	13440	2034	14635	1644	15114	1338	15649	874	18584	773	10740
2L-3S		MI	6314	2855	10547	1991	11150	1617	11259	1313	11164	851	12921	598	9035
6-#14	2.01	MA	7432	2855	12328	2027	13217	1654	13424	1347	13416	884	15672	645	10745
3L-2S		MI	6907	2855	11460	2001	12284	1607	12611	1303	12950	841	15219	725	8998
6-#18	3.57	MA	9180	3227	15930	2247	17633	1786	18661	1409	20328	803	24563	631	18324
2L-3S		MI	6719	3227	11857	2185	12701	1755	13087	1378	13575	771	15936	325	14665
6-#18	3.57	MA	7959	3227	14002	2232	15212	1804	15777	1427	16518	820	19631	404	17809
3L-2S		MI	7718	3227	13406	2203	14617	1737	15371	1361	16595	753	19782	552	15210
8-#11	1.86	MA	8072	2819	13204	2021	14367	1635	14844	1338	15294	887	18158	795	10034
2L-4S		MI	6119	2819	10103	1992	10650	1604	10681	1306	10454	871	12212	583	8410
8-#11	1.86	MA	7562	2819	12423	2017	13371	1643	13648	1345	13715	894	16090	707	10051
3E		MI	6425	2819	10629	1984	11306	1611	11456	1313	11427	864	13288	664	8452
8-#11	1.86	MA	7194	2819	11788	2026	12564	1637	12684	1338	12504	901	14742	621	9990
4L-2S		MI	6844	2819	11272	1990	12112	1604	12417	1306	12696	858	14928	753	8420
8-#14	2.68	MA	8640	3015	14553	2133	16053	1716	16805	1379	17881	855	21496	730	14144
2L-4S		MI	6280	3015	10711	2101	11361	1676	11519	1341	11581	837	13710	429	11054
8-#14	2.68	MA	7925	3015	13440	2127	14635	1726	15114	1389	15649	865	18584	602	14097
3E		MI	6710	3015	11460	2091	12284	1686	12611	1351	12950	827	15219	545	11797
8-#14	2.68	MA	7409	3015	12534	2140	13483	1716	13751	1379	13937	874	16683	480	13192
4L-2S		MI	7298	3015	12373	2101	13418	1676	13962	1341	14736	817	17517	673	11805
8-#18	4.76	MA	9989	3511	17858	2424	20054	1912	21545	1480	24139	763	29495	545	24156
2L-4S		MI	6659	3511	12132	2377	13057	1856	13525	1423	14281	739	17245	22	17124
8-#18	4.76	MA	8788	3511	15930	2409	17633	1929	18661	1497	20328	781	24563	318	23018
3E		MI	7382	3511	13406	2360	14617	1873	15371	1441	16595	721	19782	218	18859

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

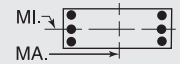


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	4.76	MA	7918	3511	14352	2430	15664	1912	16332	1480	17407	799	21333	107	20619
4L-2S		MI	8367	3511	14955	2377	16534	1856	17655	1423	19614	703	23628	446	19978
10-#11	2.32	MA	8416	2929	13985	2090	15363	1686	16039	1368	16874	875	20225	768	12426
2L-5S		MI	6128	2929	10280	2055	10870	1660	10944	1340	10760	849	12716	507	9760
10-#11	2.32	MA	7911	2929	13204	2086	14367	1693	14844	1375	15294	882	18158	679	12419
3L-4S		MI	6403	2929	10746	2061	11456	1653	11641	1333	11723	856	13853	549	10213
10-#11	2.32	MA	7547	2929	12569	2095	13560	1687	13879	1368	14084	889	16810	593	12193
4L-3S		MI	6707	2929	11272	2053	12112	1660	12417	1340	12696	849	14928	630	10415
10-#11	2.32	MA	7218	2929	12009	2091	12839	1695	13011	1375	12887	882	15376	553	11576
5L-2S		MI	7122	2929	11915	2059	12918	1653	13377	1333	13965	842	16569	719	10398
10-#14	3.35	MA	9120	3174	15665	2233	17471	1788	18495	1421	20114	835	24409	687	17527
2L-5S		MI	6292	3174	10960	2192	11671	1755	11890	1389	12102	822	14415	316	12943
10-#14	3.35	MA	8412	3174	14553	2226	16053	1798	16805	1431	17881	845	21496	559	17437
3L-4S		MI	6677	3174	11624	2201	12495	1745	12871	1379	13367	812	16008	377	13629
10-#14	3.35	MA	7902	3174	13646	2239	14901	1789	15441	1421	16169	855	19595	437	16348
4L-3S		MI	7103	3174	12373	2191	13418	1755	13962	1389	14736	802	17517	492	14544
10-#14	3.35	MA	7441	3174	12846	2233	13870	1799	14214	1431	14477	845	17576	379	15515
5L-2S		MI	7684	3174	13286	2200	14552	1745	15314	1379	16521	792	19815	620	14595
10-#18	5.95	MA	9604	3795	17858	2587	20054	2054	21545	1568	24139	741	29495	231	28300
3L-4S		MI	7324	3795	13681	2552	14974	1974	15809	1486	17301	689	21091	-85	20760
10-#18	5.95	MA	8749	3795	16280	2607	18085	2037	19217	1550	21218	759	26265	21	26121
4L-3S		MI	8038	3795	14955	2534	16534	1992	17655	1503	19614	671	23628	112	23126
12-#11	2.79	MA	8757	3040	14766	2159	16359	1736	17235	1398	18453	863	22293	740	14809
2L-6S		MI	6150	3040	10457	2132	11093	1701	11239	1374	11147	840	13299	413	11104
12-#11	2.79	MA	8256	3040	13985	2155	15363	1743	16039	1404	16874	870	20225	652	14778
3L-5S		MI	6411	3040	10923	2124	11676	1708	11904	1368	12029	833	14356	473	11620
12-#11	2.79	MA	7895	3040	13350	2165	14556	1737	15075	1398	15663	877	18878	566	14413
4E		MI	6684	3040	11388	2130	12262	1701	12602	1361	12992	840	15494	515	12034
12-#11	2.79	MA	7569	3040	12790	2160	13834	1745	14207	1404	14466	870	17444	525	13842
5L-3S		MI	6985	3040	11915	2122	12918	1708	13377	1368	13965	833	16569	596	12361
12-#11	2.79	MA	7258	3040	12260	2156	13116	1739	13378	1411	13368	877	16107	466	13210
6L-2S		MI	7398	3040	12558	2128	13724	1701	14337	1361	15233	826	18210	685	12367
12-#14	4.02	MA	8894	3334	15665	2326	17471	1871	18495	1473	20114	826	24409	517	20768
3L-5S		MI	6688	3334	11873	2291	12805	1824	13241	1427	13888	798	16713	264	15444
12-#14	4.02	MA	8389	3334	14759	2339	16319	1861	17131	1463	18402	836	22508	395	19526
4E		MI	7070	3334	12537	2301	13630	1814	14222	1417	15153	788	18306	324	16225
12-#14	4.02	MA	7934	3334	13959	2332	15289	1871	15904	1473	16709	826	20488	336	18600
5L-3S		MI	7491	3334	13286	2291	14552	1824	15314	1427	16521	778	19815	439	17281
12-#14	4.02	MA	7500	3334	13202	2326	14263	1861	14732	1483	15158	836	18607	250	17415
6L-2S		MI	8067	3334	14199	2300	15686	1814	16665	1417	18307	768	22113	567	17366
12-#18	7.14	MA	9568	4078	18207	2784	20506	2162	22101	1620	25029	720	31197	-65	30770
4E		MI	8035	4078	15230	2727	16890	2093	18093	1548	20320	639	24937	-191	24082
14-#11	3.25	MA	8598	3151	14766	2224	16359	1793	17235	1434	18453	858	22293	624	17132
3L-6S		MI	6433	3151	11099	2201	11899	1750	12199	1402	12416	825	14940	379	12913
14-#11	3.25	MA	8240	3151	14131	2234	15552	1787	16270	1427	17242	864	20946	538	16648
4L-5S		MI	6692	3151	11566	2193	12483	1757	12865	1395	13298	818	15997	439	13486
14-#11	3.25	MA	7918	3151	13571	2230	14830	1795	15403	1434	16045	858	19512	498	16115
5L-4S		MI	6963	3151	12031	2199	13068	1750	13562	1388	14261	825	17135	480	13866
14-#11	3.25	MA	7609	3151	13041	2225	14112	1789	14573	1441	14948	864	18175	438	15425
6L-3S		MI	7262	3151	12558	2191	13724	1757	14337	1395	15233	818	18210	562	14302
14-#11	3.25	MA	7309	3151	12475	2235	13422	1796	13712	1434	13874	871	16913	371	14767
7L-2S		MI	7672	3151	13200	2197	14530	1750	15297	1388	16502	811	19851	651	14329
14-#14	4.69	MA	8871	3493	15871	2439	17737	1933	18821	1505	20634	817	25420	352	22721
4L-5S		MI	7081	3493	12786	2391	13940	1893	14592	1465	15674	774	19011	211	17965
14-#14	4.69	MA	8421	3493	15071	2432	16707	1943	17594	1515	18942	807	23401	293	21704
5L-4S		MI	7459	3493	13450	2401	14764	1883	15573	1455	16939	764	20604	271	18837
14-#14	4.69	MA	7992	3493	14314	2425	15681	1933	16422	1525	17390	817	21520	207	20585
6L-3S		MI	7876	3493	14199	2390	15686	1893	16665	1465	18307	754	22113	387	20011

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	3.71	MA	8583	3261	14912	2303	16547	1837	17466	1457	18821	852	23013	511	18893
4L-6S		MI	6714	3261	11742	2270	12705	1799	13159	1429	13685	809	16581	345	14730
16-#11	3.71	MA	8263	3261	14352	2299	15826	1845	16598	1464	17624	845	21580	470	18395
5E		MI	6971	3261	12209	2262	13289	1806	13825	1422	14567	802	17638	405	15358
16-#11	3.71	MA	7957	3261	13822	2295	15108	1839	15769	1471	16527	852	20243	411	17650
6L-4S		MI	7240	3261	12674	2268	13874	1799	14522	1415	15530	809	18776	446	15709
16-#11	3.71	MA	7659	3261	13256	2304	14418	1846	14907	1464	15453	859	18981	344	16953
7L-3S		MI	7537	3261	13200	2260	14530	1806	15297	1422	16502	802	19851	528	16238
16-#14	5.36	MA	8904	3653	16184	2532	18125	2016	19284	1557	21175	788	26313	251	24826
5E		MI	7470	3653	13699	2491	15074	1962	15944	1503	17460	749	21309	158	20504
16-#14	5.36	MA	8479	3653	15427	2525	17100	2006	18112	1567	19623	798	24432	164	23696
6L-4S		MI	7845	3653	14363	2500	15898	1952	16925	1493	18724	740	22902	219	21461
18-#11	4.18	MA	8605	3372	15133	2368	16822	1895	17794	1494	19203	833	23647	443	20680
5L-6S		MI	6993	3372	12385	2339	13511	1848	14120	1456	14954	793	18222	311	16557
18-#11	4.18	MA	8302	3372	14604	2364	16104	1889	16965	1501	18106	840	22310	383	19882
6L-5S		MI	7248	3372	12851	2331	14095	1854	14785	1449	15836	787	19279	371	17231
18-#11	4.18	MA	8006	3372	14037	2373	15413	1897	16103	1494	17032	847	21049	316	19148
7L-4S		MI	7515	3372	13317	2337	14680	1848	15482	1442	16798	793	20416	412	17561
18-#14	6.03	MA	8961	3812	16539	2625	18518	2078	19802	1608	21855	778	27344	122	26781
6L-5S		MI	7857	3812	14612	2591	16208	2031	17295	1541	19246	725	23607	106	23057
20-#11	4.64	MA	8644	3483	15385	2433	17100	1939	18160	1531	19685	828	24378	356	22123
6E		MI	7270	3483	13028	2408	14317	1896	15080	1483	16223	778	19863	277	18390
20-#11	4.64	MA	8351	3483	14818	2442	16409	1947	17298	1524	18611	834	23116	289	21352
7L-5S		MI	7523	3483	13494	2401	14901	1903	15746	1477	17105	771	20920	337	19029
22-#11	5.11	MA	8693	3593	15599	2512	17405	1997	18494	1553	20190	822	25184	261	23562
7L-6S		MI	7545	3593	13670	2478	15123	1945	16040	1511	17492	762	21503	243	20229

RECTANGULAR TIED COLUMNS 24" x 30"

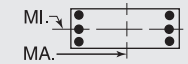
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.25	MA	8750	2865	13986	2072	15013	1685	15277	1395	15231	971	17807	895	7919
2E		MI	6920	2865	11170	2023	11784	1638	11871	1350	11706	931	13516	841	6196
4-#18	2.22	MA	9521	3113	15821	2207	17261	1780	17891	1441	18675	924	22237	805	13524
2E		MI	7469	3113	12483	2148	13334	1717	13695	1382	14113	867	16525	721	10432
6-#11	1.30	MA	8815	2878	14086	2090	15177	1699	15516	1408	15550	978	18254	902	8261
2L-3S		MI	6549	2878	10608	2037	11134	1663	11109	1371	10702	946	12244	762	6509
6-#11	1.30	MA	8254	2878	13236	2086	14093	1707	14202	1414	13815	985	15972	814	8299
3L-2S		MI	6972	2878	11251	2043	11940	1656	12069	1364	11971	939	13885	851	6459
6-#14	1.88	MA	9292	3025	15198	2172	16558	1757	17137	1438	17687	954	21028	856	11651
2L-3S		MI	6721	3025	11170	2113	11784	1717	11871	1398	11706	916	13516	661	9083
6-#14	1.88	MA	8502	3025	13986	2166	15013	1769	15277	1448	15231	964	17807	728	11656
3L-2S		MI	7316	3025	12083	2122	12918	1707	13222	1388	13492	906	15814	789	9036
6-#18	3.33	MA	10429	3397	17926	2385	19935	1908	21076	1515	22884	888	27716	727	19944
2L-3S		MI	7126	3397	12483	2305	13334	1853	13695	1462	14113	835	16525	387	14980
6-#18	3.33	MA	9091	3397	15821	2372	17261	1925	17891	1532	18675	906	22237	499	19660
3L-2S		MI	8129	3397	14032	2323	15251	1836	15979	1445	17133	817	20371	615	15265
8-#11	1.73	MA	9198	2989	14936	2159	16261	1749	16829	1438	17285	967	20536	877	10876
2L-4S		MI	6526	2989	10724	2114	11285	1705	11294	1392	10999	937	12810	646	8494
8-#11	1.73	MA	8642	2989	14086	2155	15177	1757	15516	1445	15550	974	18254	789	10893
3E		MI	6833	2989	11251	2106	11940	1712	12069	1399	11971	930	13885	728	8491

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

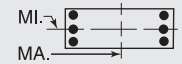


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.73	MA	8242	2989	13396	2166	14301	1752	14456	1438	14220	980	16770	701	10838
4L-2S		MI	7253	2989	11893	2112	12746	1705	13029	1392	13240	923	15526	817	8455
8-#14	2.50	MA	9827	3184	16410	2271	18104	1830	18997	1482	20144	937	24249	817	15359
2L-4S		MI	6687	3184	11333	2223	11996	1776	12131	1426	12123	902	14305	492	11228
8-#14	2.50	MA	9045	3184	15198	2266	16558	1841	17137	1492	17687	947	21028	689	15312
3E		MI	7119	3184	12083	2213	12918	1786	13222	1436	13492	892	15814	608	11856
8-#14	2.50	MA	8483	3184	14213	2280	15306	1832	15637	1482	15803	956	18930	564	14477
4L-2S		MI	7708	3184	12996	2222	14052	1776	14573	1426	15278	882	18112	736	11848
8-#18	4.44	MA	11322	3681	20032	2562	22610	2035	24262	1588	27092	853	33194	648	26316
2L-4S		MI	7064	3681	12757	2497	13690	1954	14133	1507	14819	803	17834	84	17357
8-#18	4.44	MA	10006	3681	17926	2549	19935	2053	21076	1606	22884	871	27716	420	25501
3E		MI	7791	3681	14032	2480	15251	1972	15979	1525	17133	785	20371	281	19165
8-#18	4.44	MA	9058	3681	16209	2572	17762	2035	18505	1588	19657	888	24136	205	22654
4L-2S		MI	8780	3681	15581	2497	17168	1954	18264	1507	20153	768	24217	508	20046
10-#11	2.17	MA	9577	3099	15787	2228	17345	1799	18143	1469	19020	956	22818	852	13479
2L-5S		MI	6535	3099	10902	2177	11505	1760	11557	1426	11305	915	13313	571	9882
10-#11	2.17	MA	9025	3099	14936	2224	16261	1807	16829	1476	17285	963	20536	764	13472
3L-4S		MI	6811	3099	11367	2183	12091	1753	12254	1419	12267	922	14451	612	10355
10-#11	2.17	MA	8629	3099	14247	2235	15385	1802	15770	1469	15954	969	19052	676	13360
4L-3S		MI	7115	3099	11893	2175	12746	1760	13029	1426	13240	915	15526	694	10458
10-#11	2.17	MA	8273	3099	13640	2231	14602	1811	14816	1476	14640	963	17469	636	12631
5L-2S		MI	7532	3099	12536	2181	13552	1753	13989	1419	14509	908	17167	783	10436
10-#14	3.13	MA	10355	3344	17623	2371	19649	1902	20857	1525	22601	919	27470	779	19046
2L-5S		MI	6698	3344	11583	2313	12306	1855	12501	1474	12645	888	15009	380	13216
10-#14	3.13	MA	9581	3344	16410	2365	18104	1913	18997	1535	20144	929	24249	651	18955
3L-4S		MI	7085	3344	12246	2323	13130	1845	13482	1464	13909	878	16603	440	13800
10-#14	3.13	MA	9026	3344	15425	2379	16852	1905	17497	1525	18260	939	22151	526	17921
4L-3S		MI	7512	3344	12996	2312	14052	1855	14573	1474	15278	868	18112	555	14610
10-#14	3.13	MA	8526	3344	14557	2374	15733	1916	16147	1535	16398	929	19918	468	17084
5L-2S		MI	8095	3344	13909	2322	15187	1845	15925	1464	17064	858	20410	683	14643
10-#18	5.56	MA	10906	3964	20032	2727	22610	2181	24262	1679	27092	835	33194	342	31286
3L-4S		MI	7731	3964	14306	2672	15607	2073	16417	1570	17839	753	21680	-23	21590
10-#18	5.56	MA	9973	3964	18314	2749	20436	2163	21691	1661	23865	853	29615	126	28674
4L-3S		MI	8448	3964	15581	2654	17168	2090	18264	1587	20153	736	24217	174	23424
10-#18	5.56	MA	9134	3964	16798	2736	18493	2181	19379	1679	20674	835	25816	22	25702
5L-2S		MI	9425	3964	17130	2672	19084	2073	20548	1570	23172	718	28063	402	24794
12-#11	2.60	MA	9953	3210	16637	2297	18429	1849	19456	1500	20754	945	25101	827	16073
2L-6S		MI	6557	3210	11078	2254	11728	1802	11851	1460	11692	906	13897	476	11299
12-#11	2.60	MA	9405	3210	15787	2294	17345	1858	18143	1507	19020	952	22818	739	16042
3L-5S		MI	6819	3210	11545	2246	12311	1809	12517	1453	12574	899	14954	537	11741
12-#11	2.60	MA	9013	3210	15097	2304	16469	1852	17083	1500	17689	958	21334	651	15779
4E		MI	7092	3210	12010	2252	12897	1802	13214	1446	13536	906	16092	578	12174
12-#11	2.60	MA	8659	3210	14490	2300	15686	1861	16130	1507	16375	952	19752	611	15099
5L-3S		MI	7395	3210	12536	2244	13552	1809	13989	1453	14509	899	17167	660	12412
12-#11	2.60	MA	8322	3210	13916	2297	14908	1855	15219	1514	15169	958	18274	552	14502
6L-2S		MI	7809	3210	13179	2250	14358	1802	14950	1446	15778	892	18808	749	12408
12-#14	3.75	MA	10112	3503	17623	2465	19649	1986	20857	1578	22601	912	27470	612	22591
3L-5S		MI	7095	3503	12496	2413	13440	1924	13852	1512	14431	863	17307	327	15712
12-#14	3.75	MA	9562	3503	16638	2479	18397	1977	19357	1569	20717	922	25372	487	21388
4E		MI	7478	3503	13159	2423	14264	1914	14833	1502	15695	853	18901	387	16393
12-#14	3.75	MA	9068	3503	15770	2473	17279	1988	18007	1578	18855	912	23139	429	20519
5L-3S		MI	7901	3503	13909	2412	15187	1924	15925	1512	17064	843	20410	503	17353
12-#14	3.75	MA	8596	3503	14948	2468	16165	1980	16717	1588	17148	922	21055	343	19125
6L-2S		MI	8480	3503	14822	2422	16321	1914	17276	1502	18850	833	22708	631	17420
12-#18	6.67	MA	10877	4248	20419	2926	23111	2291	24876	1735	28074	817	35093	48	34728
4E		MI	8445	4248	15855	2847	17524	2191	18702	1632	20859	704	25526	-129	24944
12-#18	6.67	MA	10050	4248	18903	2914	21168	2309	22564	1752	24883	800	31294	-57	31007
5L-3S		MI	9137	4248	17130	2829	19084	2209	20548	1650	23172	686	28063	68	27740

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

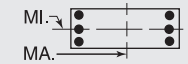
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	3.03	MA	9782	3320	16637	2363	18429	1908	19456	1538	20754	941	25101	714	18606
3L-6S		MI	6840	3320	11721	2323	12534	1851	12811	1487	12961	890	15538	442	13104
14-#11	3.03	MA	9392	3320	15947	2373	17553	1902	18397	1531	19424	947	23616	626	18213
4L-5S		MI	7100	3320	12187	2315	13117	1858	13477	1480	13842	883	16595	503	13608
14-#11	3.03	MA	9042	3320	15340	2370	16771	1911	17443	1538	18110	941	22034	586	17576
5L-4S		MI	7372	3320	12653	2321	13703	1851	14174	1473	14805	890	17732	544	14005
14-#11	3.03	MA	8707	3320	14766	2366	15992	1906	16532	1544	16904	947	20556	527	16918
6L-3S		MI	7672	3320	13179	2314	14358	1858	14950	1480	15778	883	18808	626	14357
14-#11	3.03	MA	8381	3320	14152	2376	15244	1914	15586	1538	15724	954	19167	458	16240
7L-2S		MI	8083	3320	13822	2319	15164	1851	15910	1473	17046	877	20448	714	14372
14-#14	4.38	MA	10093	3663	17850	2579	19943	2049	21217	1612	23174	905	28593	448	24873
4L-5S		MI	7488	3663	13409	2513	14574	1993	15204	1550	16216	839	19606	274	18229
14-#14	4.38	MA	9604	3663	16982	2573	18824	2061	19867	1622	21312	895	26360	390	23911
5L-4S		MI	7868	3663	14072	2522	15398	1983	16185	1540	17481	829	21199	334	19003
14-#14	4.38	MA	9137	3663	16161	2567	17711	2052	18577	1632	19604	905	24277	304	22588
6L-3S		MI	8287	3663	14822	2512	16321	1993	17276	1550	18850	819	22708	450	20088
14-#18	7.78	MA	10955	4532	21008	3091	23842	2436	25750	1826	29091	764	36773	-135	35922
5L-4S		MI	9096	4532	17404	3021	19441	2310	20986	1695	23878	654	29372	-236	28193
16-#11	3.47	MA	9769	3431	16797	2442	18637	1953	19710	1561	21159	936	25899	601	20658
4L-6S		MI	7121	3431	12364	2393	13340	1900	13772	1514	14229	875	17178	408	14920
16-#11	3.47	MA	9421	3431	16190	2439	17855	1961	18757	1568	19845	930	24316	561	20061
5E		MI	7380	3431	12830	2385	13923	1906	14438	1508	15111	868	18235	469	15480
16-#11	3.47	MA	9090	3431	15616	2435	17076	1956	17846	1575	18639	936	22838	502	19344
6L-4S		MI	7650	3431	13295	2391	14509	1900	15135	1501	16074	875	19373	510	15847
16-#11	3.47	MA	8766	3431	15002	2446	16328	1964	16900	1568	17459	943	21450	433	18672
7L-3S		MI	7948	3431	13822	2383	15164	1906	15910	1508	17046	868	20448	592	16296
16-#14	5.00	MA	10135	3823	18194	2673	20370	2133	21727	1665	23769	878	29581	352	27322
5E		MI	7878	3823	14322	2613	15708	2062	16555	1588	18002	815	21904	221	20764
16-#14	5.00	MA	9673	3823	17373	2667	19256	2124	20437	1675	22061	888	27498	266	26063
6L-4S		MI	8255	3823	14985	2622	16532	2052	17536	1578	19267	805	23497	282	21626
18-#11	3.90	MA	9798	3542	17041	2508	18939	2011	20071	1599	21579	919	26598	536	22550
5L-6S		MI	7401	3542	13006	2462	14146	1948	14732	1542	15498	859	18819	374	16744
18-#11	3.90	MA	9469	3542	16467	2504	18160	2006	19160	1606	20373	925	25121	477	21779
6L-5S		MI	7657	3542	13473	2454	14729	1955	15398	1535	16380	852	19876	435	17356
18-#11	3.90	MA	9148	3542	15852	2515	17412	2014	18213	1599	19193	932	23732	408	21069
7L-4S		MI	7925	3542	13938	2460	15315	1948	16095	1528	17343	859	21014	476	17697
18-#14	5.63	MA	10204	3982	18585	2767	20802	2197	22297	1718	24518	870	30719	227	29549
6L-5S		MI	8266	3982	15235	2712	16842	2131	17906	1626	19788	790	24202	169	23314
20-#11	4.33	MA	9845	3652	17317	2574	19244	2056	20473	1637	22108	914	27403	452	24221
6E		MI	7678	3652	13649	2531	14952	1997	15692	1569	16767	844	20460	340	18575
20-#11	4.33	MA	9527	3652	16703	2584	18496	2064	19527	1630	20928	921	26014	383	23474
7L-5S		MI	7933	3652	14116	2523	15535	2004	16358	1562	17649	837	21517	400	19236
22-#11	4.77	MA	9903	3763	17553	2653	19580	2115	20840	1661	22663	910	28296	358	25886
7L-6S		MI	7954	3763	14292	2600	15758	2046	16653	1596	18036	828	22101	306	20413

RECTANGULAR TIED COLUMNS 24" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.17	MA	9906	3035	15741	2210	16915	1798	17235	1494	17142	1048	20053	973	8527
2E		MI	7328	3035	11793	2144	12418	1738	12482	1435	12249	996	14110	904	6226
4-#18	2.08	MA	10753	3283	17737	2345	19381	1895	20111	1543	20931	1005	24955	890	14604
2E		MI	7878	3283	13108	2268	13967	1816	14303	1466	14651	931	17114	783	10479
6-#11	1.22	MA	9976	3048	15846	2227	17089	1812	17468	1505	17482	1055	20528	980	8893
2L-3S		MI	6957	3048	11229	2159	11769	1764	11721	1457	11247	1012	12842	826	6540
6-#11	1.22	MA	9367	3048	14926	2225	15917	1821	16043	1512	15591	1062	18031	892	8931
3L-2S		MI	7380	3048	11872	2165	12575	1757	12681	1450	12515	1005	14483	914	6488

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

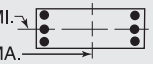
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.76	MA	10499	3194	17053	2309	18587	1871	19266	1539	19824	1033	23583	938	12563
2L-3S		MI	7129	3194	11793	2234	12418	1817	12482	1483	12249	982	14110	724	9128
6-#14	1.76	MA	9640	3194	15741	2305	16915	1883	17235	1549	17142	1043	20053	810	12567
3L-2S		MI	7725	3194	12706	2244	13553	1807	13833	1473	14034	972	16408	852	9073
6-#18	3.13	MA	11748	3567	20019	2523	22291	2023	23599	1619	25538	973	30981	818	21564
2L-3S		MI	7534	3567	13108	2425	13967	1952	14303	1546	14651	899	17114	449	15230
6-#18	3.13	MA	10293	3567	17737	2512	19381	2043	20111	1637	20931	990	24955	591	21280
3L-2S		MI	8540	3567	14657	2443	15884	1934	16588	1528	17671	882	20960	677	15320
8-#11	1.63	MA	10394	3158	16765	2297	18261	1862	18893	1536	19372	1045	23025	958	11718
2L-4S		MI	6934	3158	11346	2236	11920	1805	11906	1477	11543	1003	13407	710	8545
8-#11	1.63	MA	9790	3158	15846	2294	17089	1872	17468	1543	17482	1052	20528	869	11736
3E		MI	7241	3158	11872	2228	12575	1812	12681	1484	12515	996	14483	792	8528
8-#11	1.63	MA	9358	3158	15102	2305	16143	1867	16321	1537	16032	1059	18904	780	11680
4L-2S		MI	7662	3158	12515	2234	13381	1805	13642	1477	13784	989	16123	880	8488
8-#14	2.34	MA	11083	3354	18365	2409	20260	1943	21296	1583	22505	1017	27114	902	16574
2L-4S		MI	7094	3354	11956	2345	12630	1876	12742	1511	12666	967	14899	556	11397
8-#14	2.34	MA	10234	3354	17053	2404	18587	1955	19266	1593	19824	1027	23583	774	16527
3E		MI	7527	3354	12706	2334	13553	1886	13833	1521	14034	957	16408	671	11911
8-#14	2.34	MA	9626	3354	15989	2419	17235	1948	17629	1583	17767	1037	21288	647	15782
4L-2S		MI	8117	3354	13619	2344	14687	1876	15185	1511	15820	947	18706	799	11890
8-#18	4.17	MA	12726	3850	22302	2700	25201	2152	27086	1695	30144	941	37008	747	28476
2L-4S		MI	7470	3850	13383	2617	14324	2053	14741	1591	15357	867	18423	146	17583
8-#18	4.17	MA	11294	3850	20019	2689	22291	2171	23599	1713	25538	958	30981	519	28037
3E		MI	8200	3850	14657	2600	15884	2071	16588	1609	17671	850	20960	343	19464
8-#18	4.17	MA	10267	3850	18162	2713	19931	2155	20785	1695	22005	976	27052	299	24716
4L-2S		MI	9193	3850	16207	2617	17801	2053	18872	1591	20691	832	24806	570	20112
10-#11	2.03	MA	10808	3269	17685	2366	19433	1913	20318	1567	21263	1035	25522	935	14532
2L-5S		MI	6942	3269	11523	2300	12140	1861	12169	1511	11849	980	13911	634	10000
10-#11	2.03	MA	10209	3269	16765	2363	18261	1922	18893	1575	19372	1042	23025	846	14525
3L-4S		MI	7218	3269	11989	2305	12726	1854	12866	1504	12812	987	15048	676	10489
10-#11	2.03	MA	9781	3269	16021	2374	17315	1917	17746	1568	17922	1049	21401	757	14440
4L-3S		MI	7524	3269	12515	2298	13381	1861	13642	1511	13784	980	16123	757	10500
10-#11	2.03	MA	9396	3269	15367	2371	16472	1926	16713	1576	16491	1042	19672	717	13696
5L-2S		MI	7942	3269	13158	2304	14187	1854	14602	1504	15053	973	17764	846	10472
10-#14	2.93	MA	11660	3514	19677	2509	21933	2015	23327	1628	25186	1002	30644	867	20565
2L-5S		MI	7104	3514	12206	2435	12940	1955	13112	1559	13187	953	15604	443	13426
10-#14	2.93	MA	10820	3514	18365	2504	20260	2028	21296	1638	22505	1012	27114	739	20474
3L-4S		MI	7492	3514	12869	2444	13764	1945	14093	1549	14451	943	17197	503	13966
10-#14	2.93	MA	10219	3514	17301	2519	18908	2020	19659	1628	20448	1022	24818	612	19515
4L-3S		MI	7921	3514	13619	2434	14687	1955	15185	1559	15820	933	18706	618	14672
10-#14	2.93	MA	9679	3514	16365	2514	17702	2033	18185	1638	18417	1012	22370	555	18542
5L-2S		MI	8506	3514	14532	2443	15821	1945	16536	1549	17606	923	21005	746	14689
10-#18	5.21	MA	12279	4134	22302	2866	25201	2300	27086	1789	30144	926	37008	447	34328
3L-4S		MI	8137	4134	14932	2792	16240	2171	17026	1653	18377	818	22269	40	22035
10-#18	5.21	MA	11269	4134	20445	2891	22841	2283	24273	1771	26612	944	33079	227	31255
4L-3S		MI	8858	4134	16207	2774	17801	2189	18872	1671	20691	800	24806	236	23716
10-#18	5.21	MA	10361	4134	18808	2880	20731	2303	21741	1789	23121	926	28900	124	28203
5L-2S		MI	9839	4134	17756	2792	19718	2171	21157	1653	23711	782	28652	464	24867
12-#11	2.44	MA	11218	3380	18604	2435	20605	1963	21743	1598	23154	1025	28019	912	17337
2L-6S		MI	6963	3380	11699	2377	12363	1903	12464	1545	12236	972	14494	540	11487
12-#11	2.44	MA	10623	3380	17685	2432	19433	1972	20318	1606	21263	1032	25522	823	17305
3L-5S		MI	7226	3380	12166	2369	12946	1910	13130	1539	13118	965	15551	600	11858

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

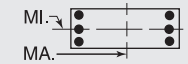
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.44	MA	10199	3380	16941	2443	18487	1967	19171	1599	19813	1039	23898	735	17162
4E		MI	7501	3380	12631	2375	13532	1903	13827	1532	14081	972	16689	642	12309
12-#11	2.44	MA	9818	3380	16286	2440	17644	1976	18138	1607	18381	1032	22169	695	16367
5L-3S		MI	7804	3380	13158	2367	14187	1910	14602	1539	15053	965	17764	723	12462
12-#11	2.44	MA	9453	3380	15668	2437	16805	1972	17152	1614	17067	1039	20551	636	15816
6L-2S		MI	8219	3380	13801	2373	14993	1903	15562	1532	16322	958	19405	812	12447
12-#14	3.52	MA	11399	3673	19677	2604	21933	2100	23327	1683	25186	996	30644	704	24413
3L-5S		MI	7502	3673	13119	2535	14074	2024	14463	1597	14973	929	17902	390	15974
12-#14	3.52	MA	10805	3673	18613	2619	20581	2093	21689	1673	23130	1006	28349	577	23271
4E		MI	7886	3673	13782	2544	14898	2014	15444	1587	16237	919	19496	450	16557
12-#14	3.52	MA	10271	3673	17677	2614	19374	2105	20216	1683	21099	996	25901	519	22364
5L-3S		MI	8311	3673	14532	2534	15821	2024	16536	1597	17606	909	21005	566	17421
12-#14	3.52	MA	9761	3673	16792	2609	18174	2097	18807	1693	19235	1006	23614	434	20862
6L-2S		MI	8892	3673	15445	2543	16955	2014	17887	1587	19392	899	23303	694	17473
12-#18	6.25	MA	12256	4418	22727	3068	25751	2412	27760	1847	31218	912	39106	155	37830
4E		MI	8854	4418	16481	2967	18157	2290	19310	1716	21397	768	26115	-67	25800
12-#18	6.25	MA	11362	4418	21090	3057	23641	2431	25229	1864	27727	894	34927	52	34622
5L-3S		MI	9552	4418	17756	2949	19718	2308	21157	1734	23711	750	28652	130	28025
14-#11	2.84	MA	11034	3490	18604	2501	20605	2022	21743	1637	23154	1022	28019	801	20080
3L-6S		MI	7247	3490	12342	2446	13169	1951	13424	1573	13505	956	16135	506	13290
14-#11	2.84	MA	10614	3490	17860	2512	19660	2017	20596	1630	21704	1029	26396	712	19796
4L-5S		MI	7508	3490	12809	2438	13752	1958	14090	1566	14387	949	17192	566	13724
14-#11	2.84	MA	10235	3490	17206	2509	18816	2026	19563	1638	20272	1022	24666	672	19048
5L-4S		MI	7781	3490	13274	2444	14338	1951	14787	1559	15349	956	18330	608	14139
14-#11	2.84	MA	9874	3490	16587	2506	17977	2022	18577	1645	18958	1029	23048	613	18434
6L-3S		MI	8082	3490	13801	2436	14993	1958	15562	1566	16322	949	19405	689	14409
14-#11	2.84	MA	9522	3490	15926	2517	17171	2031	17553	1639	17672	1036	21360	525	17650
7L-2S		MI	8494	3490	14443	2442	15799	1951	16523	1559	17591	942	21046	778	14414
14-#14	4.10	MA	11385	3833	19925	2719	22253	2165	23720	1717	25811	991	31879	541	27046
4L-5S		MI	7896	3833	14032	2634	15208	2093	15815	1635	16759	904	20200	337	18487
14-#14	4.10	MA	10856	3833	18989	2714	21047	2177	22246	1727	23780	981	29431	484	26158
5L-4S		MI	8277	3833	14695	2644	16032	2083	16796	1625	18023	894	21794	397	19165
14-#14	4.10	MA	10352	3833	18104	2709	19847	2170	20838	1737	21916	991	27145	398	24618
6L-3S		MI	8698	3833	15445	2633	16955	2093	17887	1635	19392	884	23303	513	20161
14-#14	4.10	MA	9860	3833	17157	2724	18693	2182	19375	1727	20092	1001	24998	300	23109
7L-2S		MI	9274	3833	16358	2643	18089	2083	19239	1625	21178	874	25601	641	20242
14-#18	7.29	MA	12351	4702	23372	3234	26551	2560	28716	1940	32334	862	40953	-20	40815
5L-4S		MI	9507	4702	18030	3141	20074	2409	21595	1778	24416	719	29961	-173	29091
16-#11	3.25	MA	11024	3601	18779	2581	20832	2067	22021	1662	23594	1019	28893	689	22442
4L-6S		MI	7529	3601	12985	2515	13975	2000	14384	1600	14774	940	17776	472	15103
16-#11	3.25	MA	10649	3601	18125	2578	19989	2077	20988	1669	22163	1013	27163	649	21736
5E		MI	7788	3601	13452	2507	14558	2007	15050	1593	15655	934	18833	532	15596
16-#11	3.25	MA	10292	3601	17507	2575	19150	2072	20002	1676	20848	1019	25545	590	21062
6L-4S		MI	8059	3601	13917	2513	15144	2000	15747	1586	16618	940	19971	573	15980
16-#11	3.25	MA	9942	3601	16845	2586	18343	2081	18978	1670	19562	1026	23857	502	20311
7L-3S		MI	8358	3601	14443	2505	15799	2007	16523	1593	17591	934	21046	655	16352
16-#11	3.25	MA	9598	3601	16238	2584	17530	2077	18010	1677	18292	1033	22243	455	19347
8L-2S		MI	8768	3601	15086	2511	16605	2000	17483	1586	18860	927	22687	744	16376
16-#14	4.69	MA	11436	3992	20301	2814	22720	2250	24276	1772	26461	965	32962	449	29858
5E		MI	8287	3992	14945	2734	16342	2162	17166	1673	18545	880	22498	285	21017
16-#14	4.69	MA	10937	3992	19416	2809	21519	2242	22868	1782	24598	975	30675	363	28386
6L-4S		MI	8665	3992	15608	2744	17167	2152	18147	1663	19809	870	24092	345	21786
16-#14	4.69	MA	10450	3992	18469	2824	20365	2255	21406	1772	22774	985	28528	264	26824
7L-3S		MI	9083	3992	16358	2733	18089	2162	19239	1673	21178	860	25601	460	22894

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

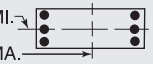
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	3.66	MA	11060	3711	19045	2648	21161	2127	22413	1700	24053	1003	29661	626	24431
5L-6S		MI	7808	3711	13628	2584	14781	2049	15345	1627	16043	925	19417	438	16925
18-#11	3.66	MA	10705	3711	18426	2645	20322	2122	21427	1708	22739	1010	28042	567	23699
6L-5S		MI	8066	3711	14094	2576	15364	2056	16010	1620	16924	918	20474	498	17473
18-#11	3.66	MA	10359	3711	17765	2656	19515	2131	20403	1701	21453	1016	26354	479	22979
7L-4S		MI	8335	3711	14560	2582	15950	2049	16707	1613	17887	925	21611	539	17829
18-#11	3.66	MA	10017	3711	17157	2653	18702	2127	19435	1709	20183	1023	24740	432	21980
8L-3S		MI	8632	3711	15086	2574	16605	2056	17483	1620	18860	918	22687	621	18290
18-#14	5.27	MA	11516	4152	20728	2908	23192	2314	24898	1827	27279	960	34206	328	32165
6L-5S		MI	8675	4152	15858	2834	17477	2231	18518	1710	20330	856	24796	232	23564
18-#14	5.27	MA	11035	4152	19781	2924	22038	2327	23436	1817	25455	970	32059	229	30552
7L-4S		MI	9050	4152	16521	2843	18301	2221	19499	1701	21595	846	26390	292	24418
20-#11	4.06	MA	11116	3822	19346	2714	21494	2172	22852	1739	24630	1000	30539	544	26344
6E		MI	8087	3822	14271	2653	15587	2098	16305	1654	17311	909	21058	404	18755
20-#11	4.06	MA	10772	3822	18684	2725	20688	2181	21828	1732	23343	1007	28852	456	25630
7L-5S		MI	8343	3822	14737	2645	16170	2104	16971	1648	18193	902	22115	464	19353
20-#11	4.06	MA	10433	3822	18076	2722	19874	2177	20860	1740	22073	1013	27237	409	24619
8L-4S		MI	8610	3822	15202	2651	16756	2098	17668	1641	19156	909	23252	505	19685
20-#14	5.86	MA	11614	4312	21093	3023	23711	2399	25466	1861	28136	954	35589	194	34291
7L-5S		MI	9060	4312	16771	2934	18611	2300	19869	1748	22116	831	27094	179	26124
22-#11	4.47	MA	11182	3933	19603	2794	21860	2232	23252	1763	25234	997	31349	434	28245
7L-6S		MI	8363	3933	14913	2722	16393	2146	17265	1682	18580	894	22698	370	20591
22-#11	4.47	MA	10846	3933	18996	2791	21046	2227	22285	1771	23964	1004	29734	386	27265
8L-5S		MI	8617	3933	15380	2714	16976	2153	17931	1675	19462	887	23755	430	21236
24-#11	4.88	MA	11256	4043	19915	2860	22218	2277	23710	1802	25855	994	32231	364	29915
8L-6S		MI	8638	4043	15556	2791	17199	2195	18225	1709	19849	878	24339	336	22433

RECTANGULAR TIED COLUMNS 24" x 34"

4-#14	1.10	MA	11130	3205	17592	2348	18922	1912	19274	1591	19151	1126	22407	1051	9134
2E		MI	7736	3205	12416	2266	13053	1838	13093	1520	12791	1061	14705	968	6257
4-#18	1.96	MA	12055	3453	19749	2483	21588	2008	22438	1644	23285	1085	27783	973	15684
2E		MI	8287	3453	13734	2388	14601	1914	14912	1550	15190	996	17702	846	10524
6-#11	1.15	MA	11204	3217	17702	2365	19106	1926	19513	1601	19511	1132	22911	1058	9525
2L-3S		MI	7364	3217	11851	2282	12404	1864	12334	1542	11791	1077	13439	889	6570
6-#11	1.15	MA	10548	3217	16713	2363	17846	1935	17981	1609	17464	1139	20199	969	9563
3L-2S		MI	7788	3217	12494	2288	13210	1857	13294	1535	13060	1070	15080	978	6516
6-#14	1.65	MA	11774	3364	19004	2447	20722	1984	21462	1636	22057	1111	26248	1018	13474
2L-3S		MI	7537	3364	12416	2356	13053	1917	13093	1568	12791	1047	14705	787	9171
6-#14	1.65	MA	10847	3364	17592	2443	18922	1998	19274	1647	19151	1121	22407	890	13479
3L-2S		MI	8134	3364	13329	2366	14187	1907	14444	1558	14577	1037	17003	915	9110
6-#18	2.94	MA	13137	3737	22209	2661	24724	2137	26228	1722	28290	1056	34360	908	23184
2L-3S		MI	7942	3737	13734	2545	14601	2051	14912	1630	15190	964	17702	512	15318
6-#18	2.94	MA	11564	3737	19749	2651	21588	2158	22438	1740	23285	1073	27783	680	22900
3L-2S		MI	8950	3737	15283	2563	16518	2033	17196	1612	18209	946	21549	739	15374
8-#11	1.53	MA	11658	3328	18691	2434	20366	1976	21046	1632	21557	1123	25624	1037	12561
2L-4S		MI	7341	3328	11967	2359	12555	1906	12519	1563	12087	1069	14005	773	8591
8-#11	1.53	MA	11007	3328	17702	2432	19106	1986	19513	1641	19511	1130	22911	948	12578
3E		MI	7649	3328	12494	2351	13210	1913	13294	1570	13060	1062	15080	855	8563
8-#11	1.53	MA	10542	3328	16904	2444	18091	1982	18282	1635	17941	1137	21144	860	12523
4L-2S		MI	8071	3328	13136	2357	14016	1906	14254	1563	14329	1055	16721	944	8520
8-#14	2.21	MA	12408	3524	20415	2547	22522	2057	23650	1681	24963	1097	30089	986	17789
2L-4S		MI	7502	3524	12579	2466	13264	1976	13353	1596	13208	1032	15494	619	11560
8-#14	2.21	MA	11492	3524	19004	2543	20722	2070	21462	1692	22057	1107	26248	858	17742
3E		MI	7935	3524	13329	2456	14187	1986	14444	1606	14577	1023	17003	734	11964

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

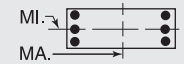


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.21	MA	10838	3524	17862	2559	19270	2063	19700	1683	19828	1117	23750	730	17106
4L-2S		MI	8527	3524	14242	2465	15321	1976	15796	1596	16363	1013	19301	862	11931
8-#18	3.92	MA	14200	4020	24669	2838	27859	2266	30018	1800	33296	1027	40936	842	30636
2L-4S		MI	7876	4020	14008	2737	14957	2152	15350	1675	15896	932	19012	208	17802
8-#18	3.92	MA	12652	4020	22209	2829	24724	2287	26228	1818	28290	1044	34360	614	30228
3E		MI	8609	4020	15283	2720	16518	2169	17196	1692	18209	914	21549	405	19756
8-#18	3.92	MA	11545	4020	20212	2854	22186	2272	23171	1800	24452	1062	30080	390	26805
4L-2S		MI	9605	4020	16832	2737	18434	2152	19481	1675	21229	896	25395	633	20177
10-#11	1.91	MA	12107	3439	19679	2504	21627	2026	22578	1664	23604	1114	28336	1016	15585
2L-5S		MI	7348	3439	12145	2422	12775	1962	12782	1597	12393	1046	14508	698	10113
10-#11	1.91	MA	11461	3439	18691	2501	20366	2036	21046	1672	21557	1121	25624	927	15578
3L-4S		MI	7626	3439	12610	2428	13361	1955	13479	1590	13356	1053	15646	739	10542
10-#11	1.91	MA	11001	3439	17892	2513	19351	2032	19814	1666	19987	1128	23856	839	15493
4L-3S		MI	7932	3439	13136	2420	14016	1962	14254	1597	14329	1046	16721	821	10540
10-#11	1.91	MA	10587	3439	17191	2510	18447	2042	18707	1674	18438	1121	21984	798	14771
5L-2S		MI	8351	3439	13779	2426	14822	1955	15215	1590	15597	1039	18362	910	10508
10-#14	2.76	MA	13035	3683	21827	2647	24322	2129	25838	1726	27869	1083	33929	953	22084
2L-5S		MI	7510	3683	12829	2556	13574	2055	13723	1644	13729	1018	16199	506	13570
10-#14	2.76	MA	12128	3683	20415	2643	22522	2142	23650	1736	24963	1093	30089	825	21993
3L-4S		MI	7900	3683	13492	2566	14399	2045	14704	1634	14994	1008	17792	566	14127
10-#14	2.76	MA	11482	3683	19273	2659	21070	2136	21888	1727	22734	1103	27591	697	21128
4L-3S		MI	8330	3683	14242	2556	15321	2055	15796	1644	16363	998	19301	681	14731
10-#14	2.76	MA	10901	3683	18269	2655	19776	2149	20304	1738	20534	1093	24933	640	20012
5L-2S		MI	8917	3683	15155	2565	16455	2045	17147	1634	18148	988	21599	809	14734
10-#18	4.90	MA	13723	4304	24669	3006	27859	2415	30018	1896	33296	1015	40936	548	37422
3L-4S		MI	8544	4304	15558	2912	16874	2270	17634	1737	18915	882	22858	102	22250
10-#18	4.90	MA	12634	4304	22672	3032	25322	2401	26961	1879	29457	1033	36656	324	33864
4L-3S		MI	9268	4304	16832	2894	18434	2288	19481	1755	21229	864	25395	299	24000
10-#18	4.90	MA	11657	4304	20914	3022	23056	2422	24210	1896	25665	1015	32096	222	30752
5L-2S		MI	10252	4304	18381	2912	20351	2270	21765	1737	24249	847	29241	526	24938
12-#11	2.29	MA	12551	3549	20668	2573	22887	2076	24110	1695	25651	1105	31048	995	18600
2L-6S		MI	7369	3549	12321	2499	12998	2003	13076	1631	12780	1037	15092	604	11669
12-#11	2.29	MA	11910	3549	19679	2570	21627	2086	22578	1703	23604	1112	28336	907	18569
3L-5S		MI	7633	3549	12787	2491	13581	2010	13742	1624	13662	1030	16149	664	11971
12-#11	2.29	MA	11454	3549	18881	2582	20612	2082	21346	1697	22034	1119	26569	818	18458
4E		MI	7909	3549	13253	2497	14167	2003	14439	1617	14625	1037	17287	705	12441
12-#11	2.29	MA	11045	3549	18179	2580	19708	2092	20239	1705	20485	1112	24697	777	17646
5L-3S		MI	8213	3549	13779	2489	14822	2010	15215	1624	15597	1030	18362	787	12505
12-#11	2.29	MA	10654	3549	17517	2577	18808	2088	19143	1700	19062	1119	22937	718	17151
6L-2S		MI	8629	3549	14422	2495	15628	2003	16175	1617	16866	1024	20003	876	12486
12-#14	3.31	MA	12756	3843	21827	2743	24322	2215	25838	1781	27869	1079	33929	793	26236
3L-5S		MI	7908	3843	13742	2656	14709	2124	15075	1682	15515	994	18497	453	16210
12-#14	3.31	MA	12117	3843	20685	2758	22870	2208	24076	1772	25640	1089	31431	665	25175
4E		MI	8295	3843	14405	2666	15533	2114	16056	1672	16780	984	20090	513	16716
12-#14	3.31	MA	11543	3843	19681	2754	21576	2221	22492	1783	23440	1079	28773	607	24129
5L-3S		MI	8721	3843	15155	2655	16455	2124	17147	1682	18148	974	21599	629	17485
12-#14	3.31	MA	10995	3843	18732	2750	20288	2215	20978	1794	21420	1089	26283	522	22625
6L-2S		MI	9303	3843	16068	2665	17589	2114	18499	1672	19934	964	23897	757	17525
12-#18	5.88	MA	13707	4588	25132	3209	28458	2529	30751	1957	34462	1004	43233	258	40959
4E		MI	9206	4588	17107	3086	18791	2389	19919	1800	21935	833	26704	-5	26682
12-#18	5.88	MA	12745	4588	23374	3200	26192	2550	28000	1974	30670	986	38673	156	37690
5L-3S		MI	9922	4588	18381	3069	20351	2406	21765	1817	24249	815	29241	192	28303
14-#11	2.68	MA	12356	3660	20668	2640	22887	2136	24110	1734	25651	1103	31048	886	21554
3L-6S		MI	7654	3660	12964	2568	13804	2052	14037	1658	14049	1022	16733	569	13470
14-#11	2.68	MA	11904	3660	19869	2651	21872	2132	22878	1728	24081	1110	29281	797	21396
4L-5S		MI	7916	3660	13430	2560	14387	2059	14702	1651	14931	1015	17790	630	13837
14-#11	2.68	MA	11498	3660	19168	2649	20968	2142	21771	1736	22531	1103	27409	756	20530
5L-4S		MI	8189	3660	13896	2566	14973	2052	15399	1644	15894	1022	18927	671	14269

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

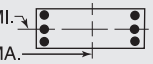


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.68	MA	11110	3660	18505	2646	20068	2138	20675	1731	21109	1110	25649	697	19971
6L-3S		MI	8491	3660	14422	2558	15628	2059	16175	1651	16866	1015	20003	753	14459
14-#11	2.68	MA	10732	3660	17796	2658	19204	2148	19616	1739	19716	1117	23815	609	19076
7L-2S		MI	8905	3660	15065	2564	16434	2052	17135	1644	18135	1008	21643	842	14455
14-#14	3.86	MA	12746	4002	22097	2858	24670	2280	26264	1817	28547	1075	35272	633	29241
4L-5S		MI	8303	4002	14655	2756	15843	2193	16426	1720	17301	970	20795	400	18738
14-#14	3.86	MA	12178	4002	21093	2854	23375	2294	24680	1828	26346	1065	32614	575	28258
5L-4S		MI	8686	4002	15318	2765	16667	2183	17407	1710	18565	960	22388	461	19322
14-#14	3.86	MA	11637	4002	20144	2850	22088	2287	23166	1839	24326	1075	30124	489	26674
6L-3S		MI	9109	4002	16068	2755	17589	2193	18499	1720	19934	950	23897	576	20230
14-#14	3.86	MA	11108	4002	19128	2866	20850	2301	21594	1830	22349	1085	27528	362	25152
7L-2S		MI	9687	4002	16981	2765	18724	2183	19850	1710	21720	940	26195	704	20297
14-#18	6.86	MA	13818	4871	25833	3377	29328	2679	31790	2053	35676	957	45249	90	44662
5L-4S		MI	9919	4871	18656	3261	20707	2507	22203	1862	24955	783	30550	-111	29981
16-#11	3.06	MA	12349	3771	20858	2720	23132	2182	24411	1759	26127	1101	31994	776	24243
4L-6S		MI	7936	3771	13607	2637	14610	2101	14997	1685	15318	1006	18373	535	15281
16-#11	3.06	MA	11947	3771	20157	2718	22228	2192	23304	1768	24578	1094	30121	735	23423
5E		MI	8196	3771	14073	2629	15193	2108	15663	1679	16200	999	19431	596	15709
16-#11	3.06	MA	11562	3771	19494	2715	21329	2188	22207	1762	23155	1101	28362	676	22802
6L-4S		MI	8468	3771	14538	2635	15779	2101	16360	1672	17162	1006	20568	637	16109
16-#11	3.06	MA	11187	3771	18785	2727	20465	2198	21148	1770	21763	1108	26528	588	21941
7L-3S		MI	8768	3771	15065	2627	16434	2108	17135	1679	18135	999	21643	719	16405
16-#11	3.06	MA	10818	3771	18134	2725	19593	2194	20111	1778	20303	1101	24779	540	20982
8L-2S		MI	9179	3771	15708	2633	17240	2101	18095	1672	19404	992	23284	807	16420
16-#14	4.41	MA	12807	4162	22504	2954	25175	2366	26868	1873	29252	1051	36454	542	32396
5E		MI	8695	4162	15568	2856	16977	2262	17777	1757	19087	945	23093	348	21265
16-#14	4.41	MA	12271	4162	21555	2950	23888	2359	25354	1884	27232	1061	33965	457	30735
6L-4S		MI	9075	4162	16231	2865	17801	2252	18758	1748	20351	935	24686	408	21942
16-#14	4.41	MA	11748	4162	20540	2966	22650	2373	23782	1875	25255	1071	31369	330	29162
7L-3S		MI	9494	4162	16981	2855	18724	2262	19850	1757	21720	925	26195	523	22968
18-#11	3.44	MA	12392	3881	21145	2787	23489	2242	24836	1799	26625	1085	32834	714	26322
5L-6S		MI	8216	3881	14249	2706	15416	2150	15957	1713	16587	991	20014	501	17101
18-#11	3.44	MA	12011	3881	20482	2785	22589	2238	23739	1793	25202	1092	31074	655	25641
6L-5S		MI	8475	3881	14716	2699	15999	2156	16623	1706	17469	984	21071	562	17586
18-#11	3.44	MA	11639	3881	19773	2796	21725	2248	22680	1801	23809	1099	29240	567	24814
7L-4S		MI	8745	3881	15181	2704	16585	2150	17320	1699	18431	991	22209	603	17957
18-#11	3.44	MA	11272	3881	19122	2794	20853	2244	21643	1809	22350	1092	27492	519	23819
8L-3S		MI	9043	3881	15708	2697	17240	2156	18095	1706	19404	984	23284	685	18347
18-#14	4.96	MA	12899	4322	22967	3050	25687	2432	27542	1929	30138	1047	37805	425	34809
6L-5S		MI	9084	4322	16481	2955	18111	2331	19129	1795	20873	921	25391	295	23808
18-#14	4.96	MA	12382	4322	21952	3065	24450	2445	25970	1920	28161	1057	35210	298	33183
7L-4S		MI	9461	4322	17144	2965	18935	2321	20110	1785	22137	911	26984	355	24573
20-#11	3.82	MA	12456	3992	21471	2854	23850	2288	25271	1824	27249	1083	33786	634	28488
6E		MI	8495	3992	14892	2776	16222	2198	16917	1740	17856	975	21655	467	18929
20-#11	3.82	MA	12087	3992	20762	2865	22985	2298	24212	1832	25856	1090	31953	546	27692
7L-5S		MI	8752	3992	15359	2768	16805	2205	17583	1733	18737	968	22712	528	19467
20-#11	3.82	MA	11723	3992	20111	2863	22113	2294	23176	1841	24397	1083	30204	498	26662
8L-4S		MI	9020	3992	15824	2774	17391	2198	18280	1726	19700	975	23850	569	19812
20-#14	5.51	MA	13009	4481	23364	3165	26250	2517	28158	1965	31067	1043	39050	265	37216
7L-5S		MI	9470	4481	17394	3055	19245	2400	20480	1833	22658	897	27689	242	26365
22-#11	4.21	MA	12531	4103	21751	2934	24246	2348	25745	1864	27903	1081	34665	526	30575
7L-6S		MI	8772	4102	15535	2845	17028	2247	17878	1767	19125	959	23296	433	20764
22-#11	4.21	MA	12170	4103	21100	2932	23374	2344	24708	1872	26443	1074	32916	478	29511
8L-5S		MI	9027	4103	16001	2837	17611	2254	18543	1760	20006	952	24353	493	21350
24-#11	4.59	MA	12615	4213	22088	3001	24634	2394	26240	1903	28490	1066	35629	457	32366
8L-6S		MI	9048	4213	16178	2914	17834	2296	18838	1795	20393	944	24937	399	22604

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



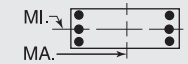
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.04	MA	12423	3374	19540	2485	21035	2025	21411	1687	21257	1202	24872	1127	9742
2E		MI	8144	3374	13039	2387	13687	1938	13704	1605	13333	1126	15300	1031	6286
4-#18	1.85	MA	13426	3623	21858	2621	23900	2122	24859	1743	25736	1164	30723	1055	16764
2E		MI	8696	3623	14360	2508	15234	2013	15520	1633	15728	1060	18291	908	10568
6-#11	1.08	MA	12501	3387	19655	2503	21228	2039	21664	1698	21636	1209	25404	1135	10157
2L-3S		MI	7772	3387	12472	2404	13039	1965	12946	1628	12335	1143	14037	953	6599
6-#11	1.08	MA	11797	3387	18597	2501	19880	2049	20025	1706	19433	1216	22476	1046	10195
3L-2S		MI	8196	3387	13115	2410	13845	1958	13907	1621	13604	1136	15678	1041	6544
6-#14	1.56	MA	13117	3534	21051	2585	22962	2098	23754	1732	24388	1189	29023	1098	14385
2L-3S		MI	7944	3534	13039	2478	13687	2017	13704	1653	13333	1112	15300	850	9211
6-#14	1.56	MA	12122	3534	19540	2582	21035	2112	21411	1744	21257	1199	24872	970	14390
3L-2S		MI	8542	3534	13952	2487	14821	2007	15056	1643	15119	1102	17598	978	9145
6-#18	2.78	MA	14596	3906	24495	2799	27262	2250	28946	1823	31141	1138	37849	995	24804
2L-3S		MI	8349	3906	14360	2665	15234	2149	15520	1714	15728	1028	18291	574	15400
6-#18	2.78	MA	12904	3906	21858	2791	23900	2273	24859	1841	25736	1155	30723	767	24520
3L-2S		MI	9360	3906	15909	2683	17151	2132	17805	1696	18748	1010	22137	801	15426
8-#11	1.44	MA	12990	3498	20712	2572	22577	2089	23303	1729	23839	1201	28332	1115	13403
2L-4S		MI	7748	3498	12589	2481	13189	2007	13131	1648	12631	1134	14603	837	8633
8-#11	1.44	MA	12292	3498	19655	2570	21228	2100	21664	1738	21636	1208	25404	1027	13421
3E		MI	8057	3498	13115	2473	13845	2014	13907	1655	13604	1127	15678	919	8597
8-#11	1.44	MA	11795	3498	18802	2582	20145	2096	20349	1733	19946	1214	23493	938	13365
4L-2S		MI	8479	3498	13758	2479	14651	2007	14867	1648	14873	1120	17318	1007	8551
8-#14	2.08	MA	13802	3693	22562	2685	24889	2170	26096	1777	27519	1177	33174	1068	19004
2L-4S		MI	7909	3693	13202	2588	13899	2076	13964	1681	13750	1098	16089	682	11719
8-#14	2.08	MA	12818	3693	21051	2682	22962	2184	23754	1789	24388	1187	29023	940	18957
3E		MI	8344	3693	13952	2577	14821	2086	15056	1691	15119	1088	17598	797	12012
8-#14	2.08	MA	12118	3693	19831	2698	21411	2179	21871	1781	21986	1197	26318	812	18450
4L-2S		MI	8936	3693	14865	2587	15956	2076	16407	1681	16905	1078	19896	925	11971
8-#18	3.70	MA	15745	4190	27132	2976	30624	2379	33033	1903	36546	1111	44976	934	32796
2L-4S		MI	8282	4190	14634	2857	15590	2250	15958	1758	16434	996	19600	271	18016
8-#18	3.70	MA	14080	4190	24495	2968	27262	2402	28946	1921	31141	1129	37849	706	32388
3E		MI	9018	4190	15909	2839	17151	2268	17805	1776	18748	979	22137	467	20041
8-#18	3.70	MA	12893	4190	22359	2995	24546	2389	25652	1904	26996	1146	33219	479	28919
4L-2S		MI	10016	4190	17458	2857	19068	2250	20089	1758	21767	961	25983	695	20239
10-#11	1.81	MA	13475	3608	21770	2642	23926	2139	24943	1760	26042	1193	31260	1096	16638
2L-5S		MI	7755	3608	12766	2544	13410	2062	13394	1682	12938	1112	15106	761	10222
10-#11	1.81	MA	12781	3608	20712	2640	22577	2150	23303	1769	23839	1199	28332	1007	16631
3L-4S		MI	8034	3608	13231	2550	13995	2055	14091	1675	13900	1119	16243	803	10592
10-#11	1.81	MA	12289	3608	19860	2652	21493	2146	21988	1764	22149	1206	26421	919	16546
4L-3S		MI	8340	3608	13758	2542	14651	2062	14867	1682	14873	1112	17318	884	10578
10-#11	1.81	MA	11847	3608	19111	2650	20528	2157	20806	1773	20482	1199	24405	877	15855
5L-2S		MI	8760	3608	14401	2548	15457	2055	15827	1675	16142	1105	18959	973	10543
10-#14	2.60	MA	14479	3853	24074	2785	26816	2242	28439	1822	30651	1164	37325	1038	23602
2L-5S		MI	7917	3853	13452	2678	14209	2155	14334	1729	14272	1083	16793	569	13708
10-#14	2.60	MA	13505	3853	22562	2781	24889	2257	26096	1834	27519	1174	33174	910	23512
3L-4S		MI	8308	3853	14115	2687	15033	2145	15315	1719	15536	1073	18387	629	14283
10-#14	2.60	MA	12813	3853	21342	2798	23338	2251	24214	1826	25117	1184	30469	782	22761
4L-3S		MI	8739	3853	14865	2677	15956	2155	16407	1729	16905	1064	19896	745	14787
10-#14	2.60	MA	12191	3853	20270	2795	21956	2265	22522	1838	22747	1174	27605	723	21494
5L-2S		MI	9327	3853	15778	2687	17090	2145	17758	1719	18691	1054	22194	873	14778
10-#18	4.63	MA	15237	4474	27132	3145	30624	2530	33033	2001	36546	1102	44976	646	40250
3L-4S		MI	8951	4474	16183	3032	17507	2369	18243	1821	19454	947	23446	164	22461

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	4.63	MA	14070	4474	24996	3172	27908	2518	29739	1984	32400	1120	40346	418	36498
4L-3S		MI	9678	4474	17458	3014	19068	2386	20089	1839	21767	929	25983	361	24279
10-#18	4.63	MA	13022	4474	23117	3164	25486	2540	26774	2002	28307	1102	35404	317	33345
5L-2S		MI	10666	4474	19007	3032	20984	2369	22374	1821	24787	911	29829	589	25007
12-#11	2.17	MA	13954	3719	22828	2711	25274	2190	26582	1791	28245	1184	34188	1077	19864
2L-6S		MI	7776	3719	12942	2621	13632	2104	13689	1716	13325	1103	15689	667	11847
12-#11	2.17	MA	13266	3719	21770	2709	23926	2200	24943	1800	26042	1191	31260	988	19833
3L-5S		MI	8040	3719	13409	2613	14216	2111	14355	1710	14206	1096	16746	727	12080
12-#11	2.17	MA	12778	3719	20918	2721	22842	2196	23627	1795	24352	1198	29349	900	19722
4E		MI	8317	3719	13874	2619	14801	2104	15052	1703	15169	1103	17884	769	12538
12-#11	2.17	MA	12340	3719	20169	2719	21876	2207	22445	1804	22685	1191	27333	858	18934
5L-3S		MI	8622	3719	14401	2611	15457	2111	15827	1710	16142	1096	18959	850	12547
12-#11	2.17	MA	11922	3719	19462	2717	20917	2203	21275	1799	21154	1198	25432	799	18394
6L-2S		MI	9038	3719	15044	2617	16263	2104	16787	1703	17411	1089	20600	939	12523
12-#14	3.13	MA	14183	4013	24074	2881	26816	2329	28439	1879	30651	1161	37325	880	28058
3L-5S		MI	8315	4013	14365	2778	15343	2224	15686	1766	16057	1059	19091	516	16348
12-#14	3.13	MA	13499	4013	22854	2898	25265	2323	26556	1871	28249	1171	34620	752	27098
4E		MI	8703	4013	15028	2787	16167	2214	16667	1757	17322	1049	20685	576	16870
12-#14	3.13	MA	12884	4013	21782	2894	23883	2337	24864	1883	25878	1161	31756	693	25907
5L-3S		MI	9131	4013	15778	2777	17090	2224	17758	1766	18691	1039	22194	692	17547
12-#14	3.13	MA	12298	4013	20769	2891	22508	2332	23188	1875	23701	1171	29062	608	24412
6L-2S		MI	9714	4013	16691	2786	18224	2214	19110	1757	20477	1029	24492	820	17571
12-#18	5.56	MA	15228	4757	27633	3350	31270	2646	33826	2064	37805	1093	47473	357	44115
4E		MI	9613	4757	17732	3206	19424	2487	20527	1883	22473	897	27292	58	26939
12-#18	5.56	MA	14197	4757	25754	3342	28848	2669	30861	2082	33712	1076	42531	256	40805
5L-3S		MI	10333	4757	19007	3189	20984	2505	22374	1901	24787	879	29829	255	28576
12-#18	5.56	MA	13214	4757	23977	3334	26439	2656	28028	2100	29955	1093	37914	104	37418
6L-2S		MI	11310	4757	20556	3206	22901	2487	24658	1883	27807	862	33676	482	29753
14-#11	2.53	MA	13747	3830	22828	2778	25274	2250	26582	1831	28245	1183	34188	969	23029
3L-6S		MI	8060	3830	13585	2690	14438	2153	14649	1744	14594	1087	17330	633	13645
14-#11	2.53	MA	13263	3830	21975	2790	24190	2247	25266	1826	26555	1190	32277	880	22895
4L-5S		MI	8323	3830	14052	2683	15022	2160	15315	1737	15475	1081	18387	693	13946
14-#11	2.53	MA	12829	3830	21227	2788	23225	2257	24085	1835	24888	1183	30261	839	22022
5L-4S		MI	8598	3830	14517	2689	15607	2153	16012	1730	16438	1087	19525	735	14396
14-#11	2.53	MA	12414	3830	20520	2786	22265	2254	22914	1830	23356	1190	28360	780	21508
6L-3S		MI	8901	3830	15044	2681	16263	2160	16787	1737	17411	1081	20600	816	14509
14-#11	2.53	MA	12010	3830	19763	2798	21343	2264	21785	1839	21858	1197	26380	692	20517
7L-2S		MI	9315	3830	15686	2687	17069	2153	17748	1730	18679	1074	22241	905	14495
14-#14	3.65	MA	14177	4172	24365	2997	27192	2395	28899	1916	31380	1158	38772	722	31456
4L-5S		MI	8711	4172	15278	2877	16477	2293	17037	1804	17843	1035	21389	463	18983
14-#14	3.65	MA	13570	4172	23293	2994	25810	2410	27207	1927	29010	1148	35907	663	30331
5L-4S		MI	9095	4172	15941	2887	17301	2283	18018	1794	19108	1025	22983	524	19475
14-#14	3.65	MA	12990	4172	22280	2991	24435	2404	25530	1919	26833	1158	33214	578	28755
6L-3S		MI	9520	4172	16691	2877	18224	2293	19110	1804	20477	1015	24492	639	20297
14-#14	3.65	MA	12424	4172	21196	3007	23114	2418	23912	1931	24702	1168	30407	451	27232
7L-2S		MI	10099	4172	17604	2886	19358	2283	20461	1794	22262	1005	26790	767	20350
14-#18	6.48	MA	15356	5041	28391	3519	32210	2797	34948	2161	39117	1049	49658	195	48298
5L-4S		MI	10330	5041	19281	3381	21341	2606	22811	1946	25493	847	31139	-49	30876
14-#18	6.48	MA	14388	5041	26614	3511	29801	2785	32115	2180	35359	1067	45040	43	44825
6L-3S		MI	11023	5041	20556	3363	22901	2624	24658	1964	27807	830	33676	148	32920
16-#11	2.89	MA	13743	3940	23033	2859	25539	2297	26906	1857	28758	1182	35205	861	26060
4L-6S		MI	8343	3940	14228	2760	15244	2201	15609	1771	15862	1072	18971	599	15454
16-#11	2.89	MA	13313	3940	22285	2857	24573	2307	25724	1866	27091	1175	33189	819	25119
5E		MI	8604	3940	14695	2752	15828	2208	16275	1764	16744	1065	20028	659	15818
16-#11	2.89	MA	12902	3940	21578	2855	23614	2304	24554	1861	25559	1182	31288	761	24563
6L-4S		MI	8877	3940	15160	2758	16413	2201	16972	1757	17707	1072	21166	701	16234
16-#11	2.89	MA	12501	3940	20821	2867	22692	2314	23424	1870	24061	1189	29308	673	23587
7L-3S		MI	9178	3940	15686	2750	17069	2208	17748	1764	18679	1065	22241	782	16457

RECTANGULAR TIED COLUMNS 24" x 36"

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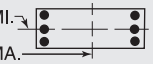


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

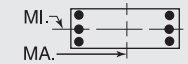
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.89	MA	12106	3940	20127	2865	21761	2311	22318	1879	22490	1182	27425	624	22641
8L-2S		MI	9590	3940	16329	2756	17875	2201	18708	1757	19948	1058	23882	871	16462
16-#14	4.17	MA	14248	4332	24804	3094	27736	2482	29549	1972	32141	1136	40058	633	34766
5E		MI	9103	4332	16191	2977	17611	2362	18389	1842	19629	1011	23688	411	21506
16-#14	4.17	MA	13674	4332	23792	3091	26362	2476	27873	1964	29964	1146	37365	548	33111
6L-4S		MI	9484	4332	16854	2987	18435	2352	19370	1832	20894	1001	25281	471	22094
16-#14	4.17	MA	13115	4332	22708	3107	25041	2491	26255	1976	27834	1156	34558	421	31536
7L-3S		MI	9906	4332	17604	2976	19358	2362	20461	1842	22262	991	26790	587	23039
16-#14	4.17	MA	12563	4332	21713	3104	23708	2485	24670	1988	25601	1146	31883	352	29891
8L-2S		MI	10481	4332	18517	2986	20492	2352	21813	1832	24048	981	29088	715	23117
16-#18	7.41	MA	15547	5325	29251	3688	33163	2913	36202	2259	40764	1040	52167	-18	52035
6L-4S		MI	10978	5325	20830	3556	23257	2724	25096	2008	28513	798	34985	-155	34127
18-#11	3.25	MA	13793	4051	23342	2926	25922	2357	27363	1897	29294	1167	36117	800	28223
5L-6S		MI	8624	4051	14871	2829	16050	2250	16570	1798	17131	1056	20612	565	17273
18-#11	3.25	MA	13385	4051	22635	2924	24962	2354	26193	1892	27762	1174	34216	741	27605
6L-5S		MI	8883	4051	15337	2821	16634	2257	17235	1791	18013	1049	21669	625	17695
18-#11	3.25	MA	12988	4051	21879	2936	24040	2364	25063	1901	26263	1181	32236	654	26664
7L-4S		MI	9155	4051	15803	2827	17219	2250	17933	1784	18976	1056	22807	666	18082
18-#11	3.25	MA	12596	4051	21185	2934	23110	2361	23957	1910	24693	1174	30353	605	25682
8L-3S		MI	9454	4051	16329	2819	17875	2257	18708	1791	19948	1049	23882	748	18401
18-#11	3.25	MA	12207	4051	20450	2946	22201	2371	22813	1905	23209	1181	28511	548	24700
9L-2S		MI	9864	4051	16972	2825	18681	2250	19668	1784	21217	1042	25522	837	18423
18-#14	4.69	MA	14352	4491	25303	3190	28289	2549	30215	2009	33095	1133	41516	519	37479
6L-5S		MI	9492	4491	17104	3077	18745	2431	19740	1880	21415	986	25986	358	24046
18-#14	4.69	MA	13798	4491	24219	3207	26968	2563	28597	2021	30965	1143	38709	392	35852
7L-4S		MI	9871	4491	17767	3086	19570	2421	20721	1870	22679	976	27579	418	24724
18-#14	4.69	MA	13252	4491	23224	3204	25635	2557	27013	2033	28732	1133	36034	322	34045
8L-3S		MI	10289	4491	18517	3076	20492	2431	21813	1880	24048	966	29088	534	25776
20-#11	3.61	MA	13865	4162	23693	2994	26311	2404	27832	1923	29965	1166	37144	722	30655
6E		MI	8903	4162	15514	2898	16856	2299	17530	1826	18400	1041	22253	531	19099
20-#11	3.61	MA	13470	4162	22937	3005	25389	2414	26703	1932	28466	1173	35164	634	29747
7L-5S		MI	9161	4162	15980	2890	17440	2306	18196	1819	19282	1034	23310	591	19576
20-#11	3.61	MA	13082	4162	22242	3004	24458	2411	25596	1941	26896	1166	33281	586	28729
8L-4S		MI	9431	4162	16445	2896	18026	2299	18893	1812	20244	1041	24447	632	19936
20-#11	3.61	MA	12696	4162	21508	3015	23549	2421	24452	1936	25412	1173	31439	529	27722
9L-3S		MI	9728	4162	16972	2888	18681	2306	19668	1819	21217	1034	25522	714	20341
20-#14	5.21	MA	14475	4651	25731	3307	28895	2635	30940	2066	34096	1130	42860	362	40179
7L-5S		MI	9880	4651	18017	3177	19880	2500	21091	1918	23201	962	28284	305	26600
20-#14	5.21	MA	13935	4651	24736	3303	27562	2630	29355	2078	31863	1120	40185	292	38341
8L-4S		MI	10256	4651	18680	3186	20704	2491	22072	1908	24465	952	29877	366	27362
22-#11	3.97	MA	13950	4272	23994	3075	26737	2464	28342	1963	30669	1165	38092	615	32836
7L-6S		MI	9181	4272	16156	2967	17662	2348	18490	1853	19669	1025	23893	497	20932
22-#11	3.97	MA	13564	4272	23300	3073	25807	2461	27236	1972	29099	1158	36209	566	31783
8L-5S		MI	9437	4272	16623	2959	18246	2354	19156	1846	20551	1018	24950	557	21460
22-#11	3.97	MA	13182	4272	22565	3085	24898	2471	26091	1967	27615	1165	34367	510	30751
9L-4S		MI	9705	4272	17088	2965	18832	2348	19853	1839	21513	1025	26088	598	21797
22-#14	5.73	MA	14611	4811	26247	3403	29489	2702	31698	2123	34995	1107	44336	263	42647
8L-5S		MI	10264	4811	18930	3276	21014	2570	22443	1956	24987	938	30582	253	29166
24-#11	4.33	MA	14043	4383	24358	3142	27155	2511	28875	2003	31302	1150	39137	547	34842
8L-6S		MI	9457	4383	16799	3036	18468	2396	19451	1880	20938	1009	25534	463	22772
24-#11	4.33	MA	13663	4383	23623	3154	26246	2522	27731	1998	29818	1157	37295	491	33719
9L-5S		MI	9712	4383	17266	3028	19052	2403	20116	1873	21819	1003	26591	523	23346

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

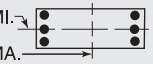


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.75	MA	14865	3792	24063	2759	26317	2235	27341	1840	28285	1243	33772	1136	17844
2E		MI	9104	3792	14985	2628	15868	2112	16129	1717	16266	1124	18880	970	10611
6-#11	1.03	MA	13867	3557	21704	2641	23457	2153	23920	1794	23859	1285	28005	1211	10788
2L-3S		MI	8179	3557	13094	2526	13674	2066	13559	1713	12880	1209	14634	1016	6626
6-#11	1.03	MA	13114	3557	20577	2640	22020	2163	22173	1803	21500	1292	24861	1122	10826
3L-2S		MI	8604	3557	13737	2532	14480	2059	14519	1706	14148	1202	16275	1105	6571
6-#14	1.48	MA	14530	3704	23195	2723	25308	2211	26151	1829	26816	1267	31907	1176	15296
2L-3S		MI	8352	3704	13662	2599	14322	2117	14315	1738	13875	1177	15894	913	9250
6-#14	1.48	MA	13466	3704	21584	2720	23254	2226	23654	1841	23459	1277	27445	1048	15301
3L-2S		MI	8951	3704	14575	2609	15456	2107	15667	1728	15661	1167	18192	1041	9179
6-#18	2.63	MA	16124	4076	26877	2936	29905	2364	31703	1920	34089	1218	41450	1080	26424
2L-3S		MI	8757	4076	14985	2785	15868	2248	16129	1797	16266	1093	18880	636	15477
6-#18	2.63	MA	14312	4076	24063	2930	26317	2388	27341	1940	28285	1236	33772	852	26140
3L-2S		MI	9770	4076	16534	2802	17784	2230	18413	1780	19286	1075	22726	864	15478
8-#11	1.37	MA	14392	3667	22831	2710	24893	2203	25666	1825	26218	1278	31149	1193	14246
2L-4S		MI	8156	3667	13210	2603	13824	2107	13744	1734	13176	1200	15200	900	8672
8-#11	1.37	MA	13645	3667	21704	2709	23457	2214	23920	1835	23859	1285	28005	1104	14263
3E		MI	8465	3667	13737	2596	14480	2114	14519	1741	14148	1193	16275	982	8630
8-#11	1.37	MA	13116	3667	20797	2721	22304	2211	22520	1830	22049	1291	25950	1016	14207
4L-2S		MI	8888	3667	14379	2601	15286	2107	15479	1734	15417	1186	17916	1071	8582
8-#14	1.97	MA	15266	3863	24806	2823	27362	2283	28648	1873	30172	1255	36370	1149	20219
2L-4S		MI	8316	3863	13825	2709	14533	2176	14575	1766	14293	1163	16683	745	11874
8-#14	1.97	MA	14213	3863	23195	2820	25308	2298	26151	1886	26816	1265	31907	1021	20172
3E		MI	8752	3863	14575	2699	15456	2186	15667	1776	15661	1153	18192	860	12057
8-#14	1.97	MA	13466	3863	21896	2837	23657	2293	24147	1879	24241	1275	28995	893	19811
4L-2S		MI	9346	3863	15488	2708	16590	2176	17018	1766	17447	1143	20490	988	12010
8-#18	3.51	MA	17361	4360	29692	3114	33493	2492	36065	2000	39894	1194	49129	1024	34956
2L-4S		MI	8688	4360	15260	2977	16224	2349	16567	1842	16972	1061	20189	333	18224
8-#18	3.51	MA	15577	4360	26877	3107	29905	2517	31703	2019	34089	1212	41450	796	34548
3E		MI	9426	4360	16534	2959	17784	2367	18413	1860	19286	1043	22726	530	20193
8-#18	3.51	MA	14310	4360	24602	3136	27013	2505	28193	2004	29637	1230	36453	569	31057
4L-2S		MI	10428	4360	18083	2977	19701	2349	20698	1842	22306	1025	26572	757	20297
10-#11	1.71	MA	14911	3778	23958	2779	26330	2253	27413	1856	28577	1270	34293	1175	17691
2L-5S		MI	8162	3778	13388	2667	14045	2163	14007	1768	13482	1177	15703	825	10328
10-#11	1.71	MA	14170	3778	22831	2778	24893	2264	25666	1866	26218	1277	31149	1087	17684
3L-4S		MI	8441	3778	13853	2673	14630	2156	14704	1761	14445	1184	16841	866	10638
10-#11	1.71	MA	13646	3778	21924	2790	23740	2261	24267	1861	24408	1284	29094	998	17599
4L-3S		MI	8749	3778	14379	2665	15286	2163	15479	1768	15417	1177	17916	948	10615
10-#11	1.71	MA	13175	3778	21128	2789	22714	2272	23010	1871	22623	1277	26935	955	16950
5L-2S		MI	9169	3778	15022	2671	16092	2156	16440	1761	16686	1171	19557	1037	10577
10-#14	2.47	MA	15992	4023	26417	2923	29416	2356	31145	1918	33529	1244	40832	1121	25121
2L-5S		MI	8323	4023	14075	2799	14843	2255	14946	1813	14814	1149	17388	632	13842
10-#14	2.47	MA	14950	4023	24806	2920	27362	2371	28648	1931	30172	1254	36370	993	25030
3L-4S		MI	8715	4023	14738	2809	15667	2245	15927	1804	16078	1139	18981	692	14435
10-#14	2.47	MA	14212	4023	23508	2937	25711	2366	26645	1924	27597	1264	33457	865	24413
4L-3S		MI	9148	4023	15488	2799	16590	2255	17018	1813	17447	1129	20490	808	14841
10-#14	2.47	MA	13550	4023	22368	2934	24241	2381	24845	1937	25057	1254	30386	805	22987
5L-2S		MI	9737	4023	16401	2808	17724	2245	18370	1804	19233	1119	22788	936	14821
10-#18	4.39	MA	16821	4643	29692	3284	33493	2645	36065	2099	39894	1188	49129	740	42950
3L-4S		MI	9358	4643	16809	3152	18140	2467	18851	1905	19992	1011	24035	226	22665
10-#18	4.39	MA	15575	4643	27417	3313	30601	2634	32555	2084	35442	1205	44132	512	39158
4L-3S		MI	10088	4643	18083	3134	19701	2485	20698	1922	22306	993	26572	423	24551
10-#18	4.39	MA	14457	4643	25417	3306	28023	2658	29399	2103	31047	1188	38822	409	35983
5L-2S		MI	11078	4643	19632	3152	21618	2467	22982	1905	25325	976	30418	651	25075
12-#11	2.05	MA	15426	3889	25085	2849	27767	2303	29159	1887	30937	1263	37437	1158	21127
2L-6S		MI	8182	3889	13564	2744	14267	2205	14301	1802	13869	1169	16287	731	11952

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

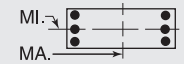
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.05	MA	14691	3889	23958	2847	26330	2314	27413	1897	28577	1270	34293	1069	21096
3L-5S		MI	8448	3889	14030	2736	14851	2212	14967	1795	14751	1162	17344	791	12185
12-#11	2.05	MA	14171	3889	23051	2859	25177	2311	26013	1892	26767	1277	32238	980	20986
4E		MI	8725	3889	14496	2742	15436	2205	15664	1788	15713	1169	18482	832	12589
12-#11	2.05	MA	13704	3889	22255	2858	24151	2322	24757	1902	24982	1270	30079	938	20232
5L-3S		MI	9030	3889	15022	2734	16092	2212	16440	1795	16686	1162	19557	914	12588
12-#11	2.05	MA	13259	3889	21504	2856	23131	2319	23513	1897	23342	1277	28036	879	19629
6L-2S		MI	9448	3889	15665	2740	16898	2205	17400	1788	17955	1155	21198	1003	12560
12-#14	2.96	MA	15679	4182	26417	3020	29416	2443	31145	1976	33529	1242	40832	966	29881
3L-5S		MI	8722	4182	14988	2899	15977	2324	16297	1851	16600	1124	19686	579	16482
12-#14	2.96	MA	14949	4182	25119	3037	27765	2438	29142	1969	30954	1252	37919	838	29041
4E		MI	9111	4182	15651	2909	16802	2314	17278	1841	17864	1114	21279	639	17021
12-#14	2.96	MA	14294	4182	23979	3034	26295	2453	27342	1982	28414	1242	34848	777	27696
5L-3S		MI	9540	4182	16401	2898	17724	2324	18370	1851	19233	1105	22788	755	17606
12-#14	2.96	MA	13670	4182	22902	3031	24833	2448	25559	1974	26080	1252	31951	692	26223
6L-2S		MI	10125	4182	17314	2908	18858	2314	19721	1841	21019	1095	25087	883	17618
12-#18	5.26	MA	16820	4927	30231	3490	34189	2763	36917	2163	41246	1181	51810	456	47296
4E		MI	10021	4927	18358	3326	20057	2586	21135	1967	23011	961	27881	120	27141
12-#18	5.26	MA	15720	4927	28231	3483	31611	2787	33761	2183	36851	1163	46501	353	43966
5L-3S		MI	10743	4927	19632	3309	21618	2604	22982	1985	25325	944	30418	317	28843
12-#18	5.26	MA	14671	4927	26341	3477	29046	2776	30634	2168	32816	1181	41522	201	40495
6L-2S		MI	11724	4927	21182	3326	23535	2586	25266	1967	28345	926	34264	544	29826
14-#11	2.39	MA	15206	3999	25085	2916	27767	2364	29159	1928	30937	1263	37437	1051	24503
3L-6S		MI	8467	3999	14207	2813	15073	2253	15262	1829	15138	1153	17928	697	13816
14-#11	2.39	MA	14691	3999	24178	2929	26614	2361	27760	1924	29127	1270	35382	963	24369
4L-5S		MI	8731	3999	14673	2805	15657	2260	15927	1822	16020	1146	18985	757	14051
14-#11	2.39	MA	14228	3999	23382	2927	25588	2372	26503	1933	27341	1263	33223	920	23524
5L-4S		MI	9006	3999	15139	2811	16242	2253	16625	1815	16982	1153	20122	798	14519
14-#11	2.39	MA	13787	3999	22631	2926	24568	2369	25259	1929	25701	1270	31180	861	22949
6L-3S		MI	9310	3999	15665	2803	16898	2260	17400	1822	17955	1146	21198	880	14552
14-#11	2.39	MA	13357	3999	21827	2938	23588	2380	24059	1938	24096	1276	29053	774	21973
7L-2S		MI	9725	3999	16308	2809	17704	2253	18360	1815	19224	1139	22838	969	14535
14-#14	3.45	MA	15677	4342	26730	3137	29819	2510	31639	2014	34311	1241	42382	810	33690
4L-5S		MI	9118	4342	15901	2999	17111	2393	17648	1889	18386	1100	21984	527	19131
14-#14	3.45	MA	15030	4342	25590	3134	28349	2525	29839	2026	31770	1231	39311	750	32417
5L-4S		MI	9504	4342	16564	3008	17936	2383	18629	1879	19650	1090	23578	587	19624
14-#14	3.45	MA	14412	4342	24513	3131	26887	2520	28056	2019	29437	1241	36413	665	30860
6L-3S		MI	9930	4342	17314	2998	18858	2393	19721	1889	21019	1080	25087	702	20361
14-#14	3.45	MA	13809	4342	23361	3148	25483	2535	26336	2032	27153	1251	33395	538	29347
7L-2S		MI	10511	4342	18227	3008	19992	2383	21072	1879	22805	1070	27385	830	20403
14-#18	6.14	MA	16965	5211	31045	3661	35199	2915	38122	2263	42656	1139	54179	296	51982
5L-4S		MI	10679	5211	19907	3501	21974	2705	23420	2030	26031	912	31727	13	31643
14-#18	6.14	MA	15932	5211	29155	3654	32634	2904	34995	2248	38621	1157	49200	145	48428
6L-3S		MI	11440	5211	21182	3483	23535	2722	25266	2047	28345	894	34264	210	33182
16-#11	2.74	MA	15206	4110	25305	2998	28050	2411	29506	1955	31486	1262	38526	945	27751
4L-6S		MI	8750	4110	14850	2882	15879	2302	16222	1856	16407	1138	19569	662	15623
16-#11	2.74	MA	14747	4110	24509	2996	27024	2422	28250	1964	29701	1255	36367	902	26826
5E		MI	9012	4110	15316	2874	16463	2309	16888	1850	17288	1131	20626	723	15923
16-#11	2.74	MA	14310	4110	23758	2995	26004	2419	27006	1960	28061	1262	34324	844	26275
6L-4S		MI	9286	4110	15781	2880	17048	2302	17585	1843	18251	1138	21763	764	16356
16-#11	2.74	MA	13883	4110	22954	3007	25025	2430	25805	1969	26455	1269	32197	756	25248
7L-3S		MI	9588	4110	16308	2872	17704	2309	18360	1850	19224	1131	22838	846	16506
16-#11	2.74	MA	13462	4110	22216	3006	24036	2427	24630	1978	24774	1262	30180	706	24323
8L-2S		MI	10001	4110	16951	2878	18510	2302	19320	1843	20493	1124	24479	935	16503

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.95	MA	15758	4502	27201	3234	30403	2598	32336	2071	35127	1219	43773	722	37148
5E		MI	9511	4502	16814	3099	18246	2462	19000	1927	20171	1076	24282	474	21742
16-#14	3.95	MA	15147	4502	26124	3231	28942	2593	30553	2064	32793	1229	40875	637	35511
6L-4S		MI	9894	4502	17477	3108	19070	2452	19981	1917	21436	1066	25876	534	22242
16-#14	3.95	MA	14550	4502	24972	3248	27538	2608	28833	2077	30510	1239	37857	511	33946
7L-3S		MI	10317	4502	18227	3098	19992	2462	21072	1927	22805	1056	27385	650	23107
16-#14	3.95	MA	13963	4502	23915	3245	26120	2603	27148	2090	28117	1229	34988	440	32146
8L-2S		MI	10894	4502	19140	3107	21127	2452	22424	1917	24590	1046	29683	778	23173
16-#18	7.02	MA	17177	5495	31969	3831	36222	3033	39357	2327	44426	1132	56879	89	56387
6L-4S		MI	11391	5495	21456	3676	23891	2823	25704	2092	29051	862	35573	-93	35041
18-#11	3.08	MA	15262	4221	25636	3065	28461	2472	29996	1995	32060	1248	39511	885	30134
5L-6S		MI	9032	4221	15492	2951	16685	2351	17182	1884	17675	1122	21209	628	17440
18-#11	3.08	MA	14829	4221	24885	3064	27441	2469	28752	1991	30420	1255	37468	826	29590
6L-5S		MI	9292	4221	15959	2943	17269	2358	17848	1877	18557	1115	22266	689	17801
18-#11	3.08	MA	14405	4221	24081	3076	26461	2480	27552	2000	28814	1262	35341	738	28530
7L-4S		MI	9564	4221	16424	2949	17854	2351	18545	1870	19520	1122	23404	730	18203
18-#11	3.08	MA	13988	4221	23343	3075	25473	2477	26376	2010	27133	1255	33324	688	27569
8L-3S		MI	9864	4221	16951	2941	18510	2358	19320	1877	20493	1115	24479	812	18453
18-#11	3.08	MA	13574	4221	22563	3087	24506	2488	25160	2005	25544	1262	31345	632	26528
9L-2S		MI	10275	4221	17593	2947	19316	2351	20281	1870	21761	1108	26120	900	18467
18-#14	4.44	MA	15874	4661	27736	3331	30996	2665	33051	2109	36150	1217	45337	610	40173
6L-5S		MI	9901	4661	17727	3198	19380	2531	20351	1965	21957	1052	26580	421	24279
18-#14	4.44	MA	15284	4661	26584	3348	29592	2680	31330	2122	33866	1227	42319	483	38557
7L-4S		MI	10282	4661	18390	3208	20204	2521	21332	1955	23222	1042	28174	481	24870
18-#14	4.44	MA	14702	4661	25526	3345	28175	2675	29645	2135	31473	1217	39451	412	36809
8L-3S		MI	10701	4661	19140	3198	21127	2531	22424	1965	24590	1032	29683	597	25848
20-#11	3.42	MA	15343	4331	26012	3133	28878	2519	30499	2022	32779	1248	40612	808	32843
6E		MI	9311	4331	16135	3020	17491	2400	18142	1911	18944	1106	22850	594	19265
20-#11	3.42	MA	14923	4331	25208	3145	27898	2530	29298	2031	31174	1254	38485	721	31818
7L-5S		MI	9570	4331	16602	3012	18075	2406	18808	1904	19826	1099	23907	655	19682
20-#11	3.42	MA	14509	4331	24470	3144	26909	2527	28123	2041	29492	1248	36468	671	30821
8L-4S		MI	9841	4331	17067	3018	18660	2400	19505	1897	20789	1106	25045	696	20057
20-#11	3.42	MA	14099	4331	23690	3156	25943	2538	26907	2036	27903	1254	34489	614	29807
9L-3S		MI	10139	4331	17593	3010	19316	2406	20281	1904	21761	1099	26120	778	20396
20-#11	3.42	MA	13651	4331	22956	3155	24967	2535	25738	2046	26326	1261	32571	551	28460
10L-2S		MI	10548	4331	18236	3016	20122	2400	21241	1897	23030	1093	27761	866	20422
20-#14	4.93	MA	16010	4821	28195	3448	31646	2752	33827	2167	37223	1216	46781	456	43179
7L-5S		MI	10289	4821	18640	3298	20514	2600	21703	2003	23743	1027	28878	369	26830
20-#14	4.93	MA	15435	4821	27137	3445	30229	2748	32142	2180	34830	1206	43913	385	41322
8L-4S		MI	10667	4821	19303	3308	21338	2591	22684	1993	25008	1017	30472	429	27508
22-#11	3.76	MA	15437	4442	26335	3215	29335	2580	31045	2062	33533	1247	41629	703	35112
7L-6S		MI	9589	4442	16778	3089	18297	2448	19103	1938	20213	1091	24491	560	21096
22-#11	3.76	MA	15026	4442	25597	3213	28346	2577	29869	2072	31851	1240	39612	653	34080
8L-5S		MI	9847	4442	17244	3082	18881	2455	19769	1931	21095	1084	25548	621	21566
22-#11	3.76	MA	14617	4442	24817	3225	27380	2588	28653	2067	30262	1247	37633	597	33061
9L-4S		MI	10116	4442	17710	3087	19466	2448	20466	1924	22058	1091	26686	662	21917
22-#11	3.76	MA	14172	4442	24082	3224	26403	2585	27485	2077	28685	1254	35715	533	31723
10L-3S		MI	10413	4442	18236	3080	20122	2455	21241	1931	23030	1084	27761	744	22335
22-#14	5.43	MA	16161	4980	28749	3545	32283	2820	34640	2224	38187	1194	48375	357	45923
8L-5S		MI	10675	4980	19553	3398	21648	2670	23054	2041	25529	1003	31176	316	29394
24-#11	4.11	MA	15540	4553	26724	3282	29783	2628	31616	2103	34211	1233	42756	636	37344
8L-6S		MI	9866	4553	17421	3159	19103	2497	20063	1966	21482	1075	26132	526	22934
24-#11	4.11	MA	15131	4553	25944	3294	28816	2638	30400	2099	32622	1240	40777	579	36230
9L-5S		MI	10122	4553	17887	3151	19687	2504	20729	1959	22364	1068	27189	586	23453
24-#11	4.11	MA	14689	4553	25209	3293	27840	2635	29231	2108	31045	1247	38859	515	34989
10L-4S		MI	10390	4553	18353	3157	20272	2497	21426	1952	23326	1075	28326	628	23783

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

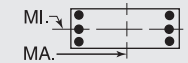
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.67	MA	16374	3962	26365	2897	28840	2349	29928	1936	30930	1321	36931	1216	18924
2E		MI	9513	3962	15611	2748	16501	2210	16737	1801	16804	1189	19469	1032	10653
6-#14	1.41	MA	16010	3873	25435	2861	27759	2325	28653	1925	29341	1344	34901	1254	16208
2L-3S		MI	8760	3873	14285	2721	14956	2217	14927	1823	14418	1243	16489	976	9287
6-#14	1.41	MA	14878	3873	23724	2859	25578	2340	26002	1938	25758	1354	30127	1126	16212
3L-2S		MI	9359	3873	15198	2730	16090	2207	16278	1813	16204	1233	18787	1104	9213
6-#18	2.50	MA	17722	4246	29356	3074	32654	2477	34565	2016	37135	1299	45162	1164	28044
2L-3S		MI	9165	4246	15611	2905	16501	2347	16737	1881	16804	1157	19469	698	15550
6-#18	2.50	MA	15790	4246	26365	3069	28840	2503	29928	2037	30930	1316	36931	936	27760
3L-2S		MI	10180	4246	17160	2922	18418	2329	19022	1864	19824	1139	23315	926	15528
8-#11	1.30	MA	15861	3837	25046	2848	27315	2316	28134	1922	28676	1353	34076	1270	15088
2L-4S		MI	8563	3837	13832	2726	14459	2208	14356	1819	13720	1266	15798	964	8709
8-#11	1.30	MA	15066	3837	23850	2847	25790	2327	26280	1931	26165	1361	30716	1181	15105
3E		MI	8873	3837	14358	2718	15114	2215	15132	1826	14693	1259	16873	1046	8662
8-#11	1.30	MA	14505	3837	22889	2860	24568	2325	24797	1928	24239	1368	28517	1092	15050
4L-2S		MI	9296	3837	15001	2724	15920	2208	16092	1819	15962	1252	18513	1134	8612
8-#14	1.88	MA	16797	4033	27146	2961	29940	2397	31305	1970	32923	1334	39675	1228	21434
2L-4S		MI	8723	4033	14448	2831	15168	2276	15187	1851	14835	1228	17278	808	12025
8-#14	1.88	MA	15676	4033	25435	2959	27759	2413	28653	1983	29341	1344	34901	1100	21387
3E		MI	9160	4033	15198	2820	16090	2286	16278	1860	16204	1218	18787	923	12101
8-#14	1.88	MA	14883	4033	24059	2976	26008	2408	26529	1977	26592	1353	31781	972	21127
4L-2S		MI	9755	4033	16111	2830	17224	2276	17629	1851	17989	1208	21085	1051	12048
8-#18	3.33	MA	19046	4529	32348	3252	36468	2606	39201	2096	43340	1276	53393	1111	37116
2L-4S		MI	9094	4529	15885	3097	16857	2448	17175	1926	17510	1125	20778	395	18427
8-#18	3.33	MA	17144	4529	29356	3246	32654	2631	34565	2117	37135	1294	45162	884	36708
3E		MI	9835	4529	17160	3079	18418	2465	19022	1944	19824	1107	23315	592	20278
8-#18	3.33	MA	15796	4529	26942	3276	29585	2622	30840	2103	32376	1312	39797	656	33219
4L-2S		MI	10838	4529	18709	3097	20334	2448	21306	1926	22844	1090	27161	820	20354
10-#11	1.63	MA	16416	3948	26242	2917	28840	2366	29988	1953	31188	1347	37436	1254	18744
2L-5S		MI	8570	3948	14009	2789	14679	2264	14619	1853	14026	1243	16301	888	10431
10-#11	1.63	MA	15628	3948	25046	2916	27315	2378	28134	1963	28676	1354	34076	1165	18737
3L-4S		MI	8849	3948	14474	2795	15265	2257	15316	1846	14989	1250	17438	930	10680
10-#11	1.63	MA	15071	3948	24085	2929	26093	2375	26651	1959	26750	1361	31877	1076	18652
4L-3S		MI	9157	3948	15001	2787	15920	2264	16092	1853	15962	1243	18513	1012	10651
10-#11	1.63	MA	14572	3948	23242	2928	25006	2386	25320	1969	24852	1354	29575	1033	18053
5L-2S		MI	9578	3948	15644	2793	16726	2257	17052	1846	17230	1236	20154	1100	10610
10-#14	2.34	MA	17575	4193	28857	3061	32122	2469	33957	2015	36505	1323	44448	1203	26640
2L-5S		MI	8730	4193	14698	2921	15478	2355	15557	1898	15356	1214	17983	695	13971
10-#14	2.34	MA	16465	4192	27146	3058	29940	2485	31305	2028	32923	1333	39675	1075	26549
3L-4S		MI	9123	4193	15361	2931	16302	2345	16538	1888	16621	1204	19576	755	14584
10-#14	2.34	MA	15680	4192	25770	3076	28190	2481	29181	2022	30175	1343	36555	947	26084
4L-3S		MI	9556	4193	16111	2920	17224	2355	17629	1898	17989	1194	21085	871	14893
10-#14	2.34	MA	14977	4192	24562	3074	26632	2496	27273	2035	27464	1333	33277	886	24491
5L-2S		MI	10147	4192	17024	2930	18358	2345	18981	1888	19775	1184	23383	999	14863
10-#18	4.17	MA	18475	4813	32348	3423	36468	2760	39201	2197	43340	1272	53393	832	45650
3L-4S		MI	9765	4813	17434	3272	18774	2566	19459	1989	20530	1075	24624	289	22865
10-#18	4.17	MA	17149	4813	29934	3453	33399	2750	35477	2183	38581	1290	48028	604	41842
4L-3S		MI	10498	4813	18709	3254	20334	2584	21306	2006	22844	1058	27161	486	24818
10-#18	4.17	MA	15960	4813	27813	3447	30664	2776	32129	2205	33884	1272	42351	499	38664
5L-2S		MI	11491	4813	20258	3272	22251	2566	23590	1989	25864	1040	31007	713	25141
12-#11	1.95	MA	16967	4058	27438	2986	30365	2416	31841	1984	33699	1340	40796	1237	22391
2L-6S		MI	8589	4058	14185	2866	14902	2305	14914	1887	14413	1234	16884	794	12050

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

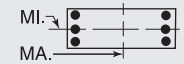


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.95	MA	16184	4058	26242	2985	28840	2428	29988	1994	31188	1347	37436	1149	22360
3L-5S		MI	8855	4058	14652	2858	15485	2312	15580	1881	15295	1228	17941	854	12287
12-#11	1.95	MA	15632	4058	25281	2998	27618	2425	28505	1990	29262	1354	35237	1060	22249
4E		MI	9133	4058	15117	2864	16071	2305	16277	1874	16258	1234	19079	896	12639
12-#11	1.95	MA	15137	4058	24438	2997	26531	2437	27174	2000	27363	1347	32935	1017	21539
5L-3S		MI	9439	4058	15644	2856	16726	2312	17052	1881	17230	1228	20154	977	12627
12-#11	1.95	MA	14665	4058	23643	2996	25451	2434	25856	1996	25618	1354	30750	958	20870
6L-2S		MI	9857	4058	16287	2862	17532	2305	18012	1874	18499	1221	21795	1066	12596
12-#14	2.81	MA	17244	4352	28857	3158	32122	2557	33957	2073	36505	1322	44448	1049	31703
3L-5S		MI	9129	4352	15611	3021	16612	2424	16908	1936	17142	1190	20281	642	16611
12-#14	2.81	MA	16468	4352	27480	3176	30371	2553	31832	2067	33757	1332	41328	921	31003
4E		MI	9519	4352	16274	3030	17436	2414	17889	1926	18407	1180	21874	703	17167
12-#14	2.81	MA	15773	4352	26272	3174	28813	2569	29925	2080	31046	1322	38051	860	29496
5L-3S		MI	9950	4352	17024	3020	18358	2424	18981	1936	19775	1170	23383	818	17663
12-#14	2.81	MA	15110	4352	25132	3172	27265	2564	28036	2074	28556	1332	34949	775	28058
6L-2S		MI	10536	4352	17937	3029	19493	2414	20332	1926	21561	1160	25681	946	17663
12-#18	5.00	MA	18481	5097	32925	3630	37213	2879	40113	2263	44786	1267	56258	552	50503
4E		MI	10429	5097	18984	3446	20691	2685	21744	2051	23550	1026	28470	182	27339
12-#18	5.00	MA	17312	5097	30804	3625	34478	2904	36766	2284	40089	1250	50582	446	47171
5L-3S		MI	11154	5097	20258	3429	22251	2702	23590	2069	25864	1008	31007	379	29104
12-#18	5.00	MA	16196	5097	28801	3619	31759	2894	33449	2270	35775	1267	45240	295	43630
6L-2S		MI	12138	5097	21807	3446	24168	2685	25875	2051	28883	990	34853	607	29898
14-#11	2.27	MA	16735	4169	27438	3055	30365	2478	31841	2025	33699	1340	40796	1132	25977
3L-6S		MI	8874	4169	14828	2935	15708	2354	15874	1915	15682	1219	18525	760	13934
14-#11	2.27	MA	16187	4169	26477	3067	29143	2475	30358	2021	31773	1347	38597	1044	25844
4L-5S		MI	9139	4169	15295	2927	16291	2361	16540	1908	16564	1212	19582	820	14153
14-#11	2.27	MA	15696	4169	25634	3066	28056	2487	29027	2031	29874	1340	36295	1000	25036
5L-4S		MI	9415	4169	15760	2933	16877	2354	17237	1901	17527	1219	20720	862	14586
14-#11	2.27	MA	15228	4169	24839	3065	26976	2484	27710	2027	28130	1348	34110	942	24397
6L-3S		MI	9719	4169	16287	2925	17532	2361	18012	1908	18499	1212	21795	943	14594
14-#11	2.27	MA	14772	4169	23988	3078	25938	2495	26438	2037	26422	1355	31836	854	23444
7L-2S		MI	10135	4169	16929	2931	18339	2354	18973	1901	19768	1205	23436	1032	14573
14-#14	3.28	MA	17247	4512	29191	3276	32552	2625	34484	2112	37339	1322	46102	896	35944
4L-5S		MI	9526	4512	16524	3120	17746	2493	18260	1974	18928	1165	22579	590	19261
14-#14	3.28	MA	16559	4512	27983	3273	30995	2641	32576	2125	34629	1312	42824	835	34513
5L-4S		MI	9913	4512	17187	3130	18570	2483	19241	1964	20192	1155	24172	650	19769
14-#14	3.28	MA	15903	4512	26843	3271	29446	2637	30688	2119	32138	1322	39722	750	32990
6L-3S		MI	10340	4512	17937	3120	19493	2493	20332	1974	21561	1146	25681	765	20422
14-#14	3.28	MA	15263	4512	25623	3289	27958	2652	28865	2132	29701	1332	36492	623	31496
7L-2S		MI	10922	4512	18850	3129	20627	2483	21684	1964	23347	1136	27979	893	20454
14-#18	5.83	MA	18643	5381	33796	3802	38293	3033	41402	2364	46294	1227	58813	394	55710
5L-4S		MI	11088	5381	20533	3621	22607	2803	24028	2114	26569	976	32316	76	31839
14-#18	5.83	MA	17545	5381	31793	3796	35573	3023	38086	2350	41980	1245	53471	243	52090
6L-3S		MI	11805	5381	21807	3603	24168	2821	25875	2131	28883	958	34853	273	33439
16-#11	2.60	MA	16738	4280	27673	3136	30668	2526	32212	2052	34284	1340	41957	1027	29436
4L-6S		MI	9158	4280	15471	3004	16514	2403	16834	1942	16951	1203	20166	726	15788
16-#11	2.60	MA	16251	4280	26830	3135	29581	2537	30881	2062	32386	1334	39655	984	28542
5E		MI	9420	4280	15938	2996	17097	2410	17500	1935	17833	1196	21223	786	16026
16-#11	2.60	MA	15787	4280	26035	3134	28500	2534	29563	2058	30641	1341	37470	925	27929
6L-4S		MI	9695	4280	16403	3002	17683	2403	18197	1928	18795	1203	22361	828	16476
16-#11	2.60	MA	15334	4280	25184	3147	27463	2546	28292	2068	28934	1348	35196	838	26924
7L-3S		MI	9997	4280	16929	2995	18339	2410	18973	1935	19768	1196	23436	909	16556
16-#11	2.60	MA	14888	4280	24403	3146	26416	2543	27047	2078	27145	1341	33045	787	26029
8L-2S		MI	10412	4280	17572	3000	19145	2403	19933	1928	21037	1190	25077	998	16544
16-#14	3.75	MA	17337	4671	29694	3373	33176	2713	35228	2170	38211	1301	47598	809	39541
5E		MI	9919	4671	17437	3220	18880	2562	19611	2012	20714	1141	24877	537	21918
16-#14	3.75	MA	16688	4671	28554	3371	31627	2709	33339	2164	35720	1311	44496	725	37935
6L-4S		MI	10304	4671	18100	3230	19704	2552	20592	2002	21978	1131	26470	597	22386

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

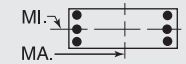
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.75	MA	16055	4671	27334	3389	30140	2725	31517	2177	33283	1321	41266	598	36391
7L-3S		MI	10727	4671	18850	3219	20627	2562	21684	2012	23347	1121	27979	713	23173
16-#14	3.75	MA	15431	4671	26214	3387	28639	2720	29732	2191	30730	1311	38204	526	34394
8L-2S		MI	11306	4671	19763	3229	21761	2552	23035	2002	25133	1111	30277	841	23227
16-#18	6.67	MA	18877	5664	34784	3974	39387	3152	42723	2430	48185	1223	61702	191	60576
6L-4S		MI	11804	5664	22082	3795	24524	2922	26313	2176	29589	927	36162	-31	35982
18-#11	2.92	MA	16801	4390	28026	3204	31106	2587	32735	2093	34897	1327	43015	968	32055
5L-6S		MI	9439	4390	16114	3073	17320	2452	17795	1969	18220	1188	21807	692	17603
18-#11	2.92	MA	16341	4390	27231	3203	30025	2584	31417	2089	33152	1334	40830	909	31466
6L-5S		MI	9701	4390	16580	3066	17903	2458	18461	1962	19102	1181	22864	752	17903
18-#11	2.92	MA	15892	4390	26380	3216	28988	2596	30146	2099	31445	1341	38556	821	30411
7L-4S		MI	9973	4390	17046	3072	18489	2452	19158	1955	20064	1188	24002	794	18322
18-#11	2.92	MA	15449	4390	25599	3215	27941	2593	28901	2109	29657	1334	36405	771	29479
8L-3S		MI	10274	4390	17572	3064	19145	2458	19933	1962	21037	1181	25077	875	18504
18-#11	2.92	MA	15004	4390	24772	3227	26918	2605	27613	2105	27967	1341	34288	715	28325
9L-2S		MI	10686	4390	18215	3070	19951	2452	20893	1955	22306	1174	26717	964	18509
18-#14	4.22	MA	17466	4831	30265	3471	33808	2781	35991	2209	39302	1301	49269	699	42893
6L-5S		MI	10310	4831	18350	3320	20014	2631	20962	2050	22500	1117	27175	484	24507
18-#14	4.22	MA	16839	4831	29044	3489	32321	2797	34168	2222	36865	1311	46039	572	41298
7L-4S		MI	10692	4831	19013	3329	20838	2621	21943	2040	23764	1107	28768	545	25014
18-#14	4.22	MA	16221	4831	27925	3486	30820	2793	32383	2236	34312	1301	42977	501	39354
8L-3S		MI	11113	4831	19763	3319	21761	2631	23035	2050	25133	1097	30277	660	25917
18-#14	4.22	MA	15601	4831	26740	3504	29353	2808	30537	2229	31899	1311	39972	419	37094
9L-2S		MI	11688	4831	20676	3329	22895	2621	24386	2040	26919	1087	32575	788	25993
20-#11	3.25	MA	16890	4501	28427	3272	31550	2635	33271	2120	35664	1327	44190	893	35007
6E		MI	9719	4501	16757	3143	18126	2500	18755	1997	19489	1172	23448	658	19426
20-#11	3.25	MA	16445	4501	27576	3285	30513	2646	31999	2130	33956	1334	41916	805	33905
7L-5S		MI	9979	4501	17223	3135	18709	2507	19421	1990	20370	1165	24505	718	19785
20-#11	3.25	MA	16006	4501	26795	3284	29466	2643	30754	2140	32168	1327	39765	755	32936
8L-4S		MI	10250	4501	17688	3141	19295	2500	20118	1983	21333	1172	25642	759	20175
20-#11	3.25	MA	15562	4501	25968	3297	28443	2655	29466	2136	30478	1335	37648	698	31811
9L-3S		MI	10550	4501	18215	3133	19951	2507	20893	1990	22306	1165	26717	841	20450
20-#11	3.25	MA	15086	4501	25191	3295	27409	2652	28229	2146	28801	1342	35596	635	30453
10L-2S		MI	10960	4501	18858	3139	20757	2500	21854	1983	23575	1158	28358	930	20470
20-#14	4.69	MA	17615	4990	30755	3588	34502	2869	36820	2267	40447	1300	50813	547	46215
7L-5S		MI	10698	4990	19263	3420	21148	2700	22314	2088	24285	1093	29473	432	27056
20-#14	4.69	MA	17004	4990	29635	3586	33001	2865	35035	2281	37894	1290	47751	475	44322
8L-4S		MI	11078	4990	19926	3429	21972	2691	23295	2078	25550	1083	31066	492	27651
20-#14	4.69	MA	16385	4990	28451	3604	31534	2881	33189	2274	35481	1300	44746	394	42031
9L-3S		MI	11496	4990	20676	3419	22895	2700	24386	2088	26919	1073	32575	607	28656
22-#11	3.57	MA	16994	4612	28772	3354	32038	2696	33853	2161	36468	1327	45276	789	37404
7L-6S		MI	9998	4612	17399	3212	18932	2549	19715	2024	20757	1157	25088	624	21257
22-#11	3.57	MA	16558	4612	27991	3353	30991	2694	32608	2171	34679	1320	43125	738	36400
8L-5S		MI	10256	4612	17866	3204	19515	2556	20381	2017	21639	1150	26145	684	21670
22-#11	3.57	MA	16115	4612	27164	3366	29968	2705	31320	2167	32989	1328	41008	682	35301
9L-4S		MI	10526	4612	18331	3210	20101	2549	21078	2010	22602	1157	27283	725	22035
22-#11	3.57	MA	15643	4612	26387	3365	28934	2702	30083	2177	31312	1335	38956	618	33921
10L-3S		MI	10824	4612	18858	3202	20757	2556	21854	2017	23575	1150	28358	807	22391
22-#14	5.16	MA	17779	5150	31346	3686	35183	2937	37687	2326	41476	1280	52524	450	49233
8L-5S		MI	11085	5150	20176	3519	22282	2770	23665	2126	26071	1068	31771	379	29617
22-#14	5.16	MA	17162	5150	30161	3704	33716	2953	35840	2319	39064	1290	49519	368	46977
9L-4S		MI	11461	5150	20839	3529	23107	2760	24646	2116	27336	1058	33365	439	30296

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

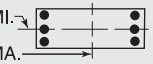
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	3.90	MA	17106	4722	29187	3422	32516	2744	34462	2202	37190	1314	46485	722	39869
8L-6S		MI	10275	4722	18042	3281	19738	2598	20676	2051	22026	1141	26729	590	23093
24-#11	3.90	MA	16664	4722	28360	3435	31492	2755	33174	2199	35501	1321	44368	666	38796
9L-5S		MI	10532	4722	18509	3273	20321	2604	21341	2044	22908	1134	27786	650	23557
24-#11	3.90	MA	16195	4722	27583	3434	30459	2752	31937	2208	33823	1328	42316	602	37394
10L-4S		MI	10801	4722	18974	3279	20907	2598	22038	2037	23871	1141	28924	691	23900
24-#14	5.63	MA	17932	5310	31872	3803	35897	3025	38492	2364	42646	1279	54293	343	51929
9L-5S		MI	11469	5310	21089	3619	23417	2839	25016	2164	27857	1044	34069	326	32189

RECTANGULAR TIED COLUMNS 24" x 42"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.59	MA	17950	4132	28763	3035	31469	2462	32620	2033	33673	1399	40200	1295	20004
2E		MI	9921	4132	16236	2868	17134	2309	17346	1885	17343	1253	20058	1095	10694
6-#14	1.34	MA	17560	4043	27772	2999	30316	2438	31261	2021	31945	1420	38004	1331	17119
2L-3S		MI	9167	4043	14908	2842	15590	2317	15538	1907	14960	1308	17083	1039	9323
6-#14	1.34	MA	16358	4043	25962	2997	28007	2454	28455	2035	28143	1430	32919	1203	17124
3L-2S		MI	9767	4043	15821	2852	16725	2307	16889	1898	16746	1298	19382	1167	9245
6-#18	2.38	MA	19389	4415	31932	3212	35509	2591	37532	2112	40279	1378	48984	1246	29664
2L-3S		MI	9572	4415	16236	3025	17134	2445	17346	1965	17343	1221	20058	761	15620
6-#18	2.38	MA	17336	4415	28763	3208	31469	2618	32620	2135	33673	1396	40200	1019	29380
3L-2S		MI	10589	4415	17786	3042	19051	2428	19630	1947	20362	1204	23904	988	15577
8-#11	1.24	MA	17399	4007	27357	2986	29843	2430	30707	2018	31203	1428	37111	1346	15930
2L-4S		MI	8970	4007	14453	2848	15094	2309	14969	1905	14264	1331	16395	1027	8744
8-#11	1.24	MA	16556	4007	26092	2985	28230	2428	28746	2028	28547	1435	33535	1258	15948
3E		MI	9281	4007	14980	2840	15749	2316	15744	1912	15237	1324	17470	1109	8692
8-#11	1.24	MA	15962	4007	25077	2998	26939	2439	27179	2025	26512	1443	31192	1169	15892
4L-2S		MI	9704	4007	15622	2846	16555	2309	16704	1905	16506	1318	19111	1198	8641
8-#14	1.79	MA	18398	4203	29583	3099	32624	2510	34067	2066	35746	1410	43089	1307	22649
2L-4S		MI	9130	4203	15071	2952	15802	2376	15798	1935	15377	1294	17872	871	12155
8-#14	1.79	MA	17208	4203	27772	3097	30316	2527	31261	2080	31945	1420	38004	1179	22602
3E		MI	9568	4203	15821	2942	16725	2386	16889	1945	16746	1284	19382	987	12143
8-#14	1.79	MA	16368	4203	26317	3115	28466	2523	29015	2075	29029	1431	34676	1051	22342
4L-2S		MI	10164	4203	16734	2951	17859	2376	18241	1935	18532	1274	21680	1115	12086
8-#18	3.17	MA	20801	4699	35101	3390	39549	2719	42443	2192	46884	1358	57768	1198	39276
2L-4S		MI	9501	4699	16511	3217	17490	2546	17783	2010	18049	1189	21367	457	18625
8-#18	3.17	MA	18779	4699	31932	3385	35509	2746	37532	2215	40279	1376	48984	970	38868
3E		MI	10243	4699	17786	3199	19051	2564	19630	2028	20362	1172	23904	654	20358
8-#18	3.17	MA	17350	4699	29379	3416	32262	2737	33592	2203	35211	1393	43250	743	35404
4L-2S		MI	11249	4699	19335	3217	20968	2546	21914	2010	23382	1154	27750	882	20409
10-#11	1.55	MA	17990	4118	28622	3055	31456	2480	32668	2049	33860	1421	40688	1331	19797
2L-5S		MI	8977	4118	14631	2911	15314	2364	15232	1939	14571	1309	16898	952	10530
10-#11	1.55	MA	17154	4118	27357	3054	29843	2478	30707	2059	31203	1428	37111	1242	19790
3L-4S		MI	9256	4118	15096	2917	15900	2357	15929	1932	15533	1316	18036	993	10720
10-#11	1.55	MA	16564	4118	26342	3067	28552	2489	29140	2056	29169	1436	34768	1154	19705
4L-3S		MI	9565	4118	15622	2909	16555	2364	16704	1939	16506	1309	19111	1075	10685
10-#11	1.55	MA	16036	4118	25452	3067	27404	2487	27735	2066	27163	1430	32322	1110	19166
5L-2S		MI	9986	4118	16265	2915	17361	2357	17665	1932	17775	1302	20752	1164	10642
10-#14	2.23	MA	19226	4362	31394	3198	34933	2583	36874	2111	39548	1400	48174	1284	28159
2L-5S		MI	9137	4362	15321	3043	16112	2455	16168	1983	15899	1279	18577	758	14097
10-#14	2.23	MA	18048	4362	29583	3197	32624	2599	34067	2125	35746	1410	43089	1156	28068
3L-4S		MI	9531	4362	15984	3052	16936	2445	17149	1973	17163	1269	20171	818	14729
10-#14	2.23	MA	17217	4362	28128	3215	30774	2595	31822	2120	32831	1421	39761	1028	27759
4L-3S		MI	9965	4362	16734	3042	17859	2455	18241	1983	18532	1259	21680	934	14940
10-#14	2.23	MA	16473	4362	26852	3213	29129	2612	29807	2134	29956	1411	36277	965	26006
5L-2S		MI	10556	4362	17647	3051	18993	2445	19592	1973	20318	1249	23978	1062	14904
10-#18	3.97	MA	20198	4983	35101	3562	39549	2875	42443	2295	46884	1355	57768	922	48350
3L-4S		MI	10172	4983	18060	3392	19407	2665	20068	2072	21068	1140	25213	351	23060

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

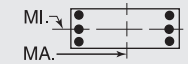
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.97	MA	18793	4983	32547	3593	36302	2866	38503	2282	41817	1373	52034	694	44550
4L-3S		MI	10907	4983	19335	3374	20968	2682	21914	2090	23382	1122	27750	548	25069
10-#18	3.97	MA	17533	4983	30306	3588	33412	2893	34964	2305	36818	1355	45990	587	41386
5L-2S		MI	11903	4983	20884	3392	22884	2665	24199	2072	26402	1104	31596	775	25205
12-#11	1.86	MA	18576	4228	29888	3124	33069	2530	34629	2080	36516	1414	44264	1316	23655
2L-6S		MI	8996	4228	14807	2988	15537	2406	15526	1973	14958	1300	17482	858	12144
12-#11	1.86	MA	17745	4228	28622	3124	31456	2528	32668	2091	33860	1421	40688	1227	23623
3L-5S		MI	9262	4228	15273	2981	16120	2413	16192	1966	15839	1293	18539	918	12387
12-#11	1.86	MA	17161	4228	27607	3137	30165	2539	31101	2087	31825	1429	38344	1139	23513
4E		MI	9541	4228	15739	2986	16706	2406	16889	1959	16802	1300	19677	959	12685
12-#11	1.86	MA	16637	4228	26717	3136	29017	2537	29696	2097	29820	1423	35899	1095	22856
5L-3S		MI	9847	4228	16265	2979	17361	2413	17665	1966	17775	1293	20752	1041	12665
12-#11	1.86	MA	16138	4228	25878	3135	27876	2549	28304	2094	27978	1431	33572	1036	22117
6L-2S		MI	10266	4228	16908	2985	18167	2406	18625	1959	19044	1286	22393	1130	12631
12-#14	2.68	MA	18877	4522	31394	3297	34933	2671	36874	2170	39548	1400	48174	1132	33526
3L-5S		MI	9537	4522	16234	3142	17246	2524	17519	2021	17684	1255	20875	705	16737
12-#14	2.68	MA	18056	4522	29939	3315	33083	2668	34628	2165	36633	1411	44847	1004	32983
4E		MI	9928	4522	16897	3152	18070	2514	18500	2011	18949	1245	22469	766	17311
12-#14	2.68	MA	17320	4522	28663	3313	31437	2684	32613	2179	33758	1401	41362	942	31307
5L-3S		MI	10359	4522	17647	3141	18993	2524	19592	2021	20318	1235	23978	881	17718
12-#14	2.68	MA	16618	4522	27459	3311	29801	2680	30618	2173	31117	1411	38056	857	29915
6L-2S		MI	10946	4522	18560	3151	20127	2514	20943	2011	22103	1225	26276	1009	17707
12-#18	4.76	MA	20212	5267	35716	3770	40342	2995	43415	2362	48423	1352	60818	646	53735
4E		MI	10837	5267	19609	3566	21324	2783	22352	2135	24088	1090	29059	244	27532
12-#18	4.76	MA	18973	5267	33475	3765	37452	3021	39876	2385	43424	1335	54774	538	50418
5L-3S		MI	11565	5267	20884	3548	22884	2801	24199	2153	26402	1073	31596	441	29361
12-#18	4.76	MA	17791	5267	31358	3761	34578	3013	36370	2372	38831	1352	49070	387	46795
6L-2S		MI	12551	5267	22433	3566	24801	2783	26483	2135	29422	1055	35442	669	29967
14-#11	2.17	MA	18332	4339	29888	3193	33069	2578	34629	2122	36516	1415	44264	1212	27451
3L-6S		MI	9281	4339	15450	3058	16343	2455	16487	2000	16226	1285	19123	824	14029
14-#11	2.17	MA	17752	4339	28872	3206	31778	2590	33062	2118	34482	1422	41921	1124	27318
4L-5S		MI	9546	4339	15916	3050	16926	2462	17152	1993	17108	1278	20180	884	14253
14-#11	2.17	MA	17233	4339	27983	3205	30630	2588	31656	2129	32476	1416	39475	1080	26556
5L-4S		MI	9823	4339	16382	3056	17512	2455	17850	1986	18071	1285	21317	925	14637
14-#11	2.17	MA	16738	4339	27143	3204	29489	2599	30265	2125	30634	1424	37148	1021	25850
6L-3S		MI	10128	4339	16908	3048	18167	2462	18625	1993	19044	1278	22393	1007	14635
14-#11	2.17	MA	16255	4339	26244	3217	28394	2597	28923	2136	28831	1432	34727	934	24929
7L-2S		MI	10545	4339	17551	3054	18973	2455	19585	1986	20312	1271	24033	1096	14610
14-#14	3.13	MA	18885	4681	31749	3415	35391	2740	37434	2209	40435	1401	49932	980	38216
4L-5S		MI	9933	4681	17147	3242	18380	2593	18871	2059	19470	1231	23173	653	19387
14-#14	3.13	MA	18157	4681	30474	3413	33746	2756	35419	2224	37560	1391	46447	918	36621
5L-4S		MI	10322	4681	17810	3252	19204	2583	19852	2049	20735	1221	24767	713	19911
14-#14	3.13	MA	17463	4681	29269	3411	32110	2753	33424	2218	34919	1401	43141	834	35142
6L-3S		MI	10750	4681	18560	3241	20127	2593	20943	2059	22103	1211	26276	829	20481
14-#14	3.13	MA	16786	4681	27981	3429	30539	2769	31499	2232	32333	1412	39699	707	33504
7L-2S		MI	11333	4681	19473	3251	21261	2583	22295	2049	23889	1201	28574	957	20500
14-#18	5.56	MA	20392	5550	36644	3943	41492	3150	44787	2465	50029	1314	63558	490	59482
5L-4S		MI	11497	5550	21158	3741	23241	2902	24637	2197	27108	1041	32905	138	32030
14-#18	5.56	MA	19229	5550	34527	3938	38618	3141	41282	2452	45437	1332	57853	339	55810
6L-3S		MI	12217	5550	22433	3723	24801	2920	26483	2215	29422	1023	35442	335	33691
14-#18	5.56	MA	18093	5550	32261	3969	35857	3168	37899	2475	40943	1350	51912	114	51137
7L-2S		MI	13194	5550	23982	3741	26718	2902	28768	2197	32441	1005	39288	562	34712

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

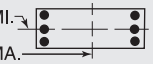


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.48	MA	18338	4449	30138	3275	33391	2640	35023	2149	37138	1415	45497	1108	31121
4L-6S		MI	9565	4449	16093	3127	17149	2503	17447	2027	17495	1269	20764	789	15917
16-#11	2.48	MA	17823	4449	29248	3274	32243	2638	33617	2160	35133	1409	43051	1065	30267
5E		MI	9828	4449	16559	3119	17732	2510	18113	2021	18377	1262	21821	850	16125
16-#11	2.48	MA	17332	4449	28408	3273	31102	2649	32226	2156	33291	1417	40725	1006	29590
6L-4S		MI	10104	4449	17024	3125	18318	2503	18810	2014	19340	1269	22958	891	16582
16-#11	2.48	MA	16853	4449	27510	3286	30007	2647	30884	2167	31488	1425	38303	919	28615
7L-3S		MI	10407	4449	17551	3117	18973	2510	19585	2021	20312	1262	24033	973	16599
16-#11	2.48	MA	16381	4449	26686	3285	28902	2659	29570	2177	29600	1419	36018	868	27720
8L-2S		MI	10822	4449	18194	3123	19779	2503	20546	2014	21581	1255	25674	1062	16583
16-#14	3.57	MA	18986	4841	32284	3513	36054	2828	38226	2269	41362	1381	51533	895	41946
5E		MI	10327	4841	18060	3342	19514	2662	20222	2097	21256	1206	25471	600	22044
16-#14	3.57	MA	18299	4841	31080	3511	34418	2825	36230	2263	38720	1391	48226	810	40383
6L-4S		MI	10713	4841	18723	3351	20339	2652	21203	2087	22521	1196	27065	660	22527
16-#14	3.57	MA	17629	4841	29791	3529	32848	2841	34306	2277	36135	1402	44784	684	38800
7L-3S		MI	11138	4841	19473	3341	21261	2662	22295	2097	23889	1187	28574	776	23236
16-#14	3.57	MA	16968	4841	28609	3528	31262	2837	32421	2292	33428	1392	41528	611	36668
8L-2S		MI	11718	4841	20386	3350	22395	2652	23646	2087	25675	1177	30872	904	23280
16-#18	6.35	MA	20647	5834	37696	4115	42658	3270	46193	2532	52043	1312	66637	290	64824
6L-4S		MI	12216	5834	22707	3915	25157	3020	26921	2260	30127	991	36751	32	36549
16-#18	6.35	MA	19528	5834	35430	4146	39897	3297	42810	2555	47548	1329	60696	65	60287
7L-3S		MI	12910	5834	23982	3898	26718	3038	28768	2278	32441	973	39288	228	38061
18-#11	2.79	MA	18409	4560	30513	3343	33856	2688	35578	2191	37789	1403	46628	1049	33985
5L-6S		MI	9847	4560	16735	3196	17955	2552	18407	2055	18764	1253	22404	755	17762
18-#11	2.79	MA	17922	4560	29673	3342	32715	2699	34187	2187	35947	1410	44301	991	33334
6L-5S		MI	10109	4560	17202	3188	18538	2559	19073	2048	19646	1247	23461	816	18003
18-#11	2.79	MA	17447	4560	28775	3355	31620	2697	32845	2198	34144	1418	41880	903	32307
7L-4S		MI	10383	4560	17667	3194	19124	2552	19770	2041	20609	1253	24599	857	18437
18-#11	2.79	MA	16978	4560	27951	3355	30515	2709	31530	2208	32256	1412	39594	852	31412
8L-3S		MI	10684	4560	18194	3186	19779	2559	20546	2048	21581	1247	25674	939	18553
18-#11	2.79	MA	16500	4560	27078	3368	29435	2707	30171	2205	30472	1420	37340	796	30141
9L-2S		MI	11097	4560	18836	3192	20585	2552	21506	2041	22850	1240	27315	1028	18551
18-#14	4.02	MA	19126	5001	32891	3611	36727	2897	39037	2308	42522	1382	53311	786	45636
6L-5S		MI	10719	5001	18973	3442	20649	2731	21574	2135	23042	1182	27770	547	24708
18-#14	4.02	MA	18463	5001	31602	3629	35156	2913	37112	2322	39937	1392	49870	660	44073
7L-4S		MI	11102	5001	19636	3451	21473	2721	22555	2125	24306	1172	29363	608	25154
18-#14	4.02	MA	17809	5001	30420	3627	33571	2910	35227	2336	37230	1382	46614	587	41925
8L-3S		MI	11524	5001	20386	3441	22395	2731	23646	2135	25675	1162	30872	723	25984
18-#14	4.02	MA	17141	5001	29168	3646	32022	2926	33277	2331	34671	1392	43410	506	39628
9L-2S		MI	12101	5001	21299	3450	23529	2721	24997	2125	27461	1152	33170	851	26049
18-#18	7.14	MA	20945	6118	38599	4323	43937	3425	47722	2635	54154	1309	69479	17	69401
7L-4S		MI	12861	6118	24256	4090	27074	3139	29206	2322	33147	941	40597	-75	40120
20-#11	3.10	MA	18507	4671	30939	3412	34328	2750	36148	2219	38604	1403	47877	976	37082
6E		MI	10127	4671	17378	3265	18761	2601	19368	2082	20033	1238	24045	721	19584
20-#11	3.10	MA	18035	4671	30040	3425	33233	2748	34805	2229	36801	1411	45456	888	36006
7L-5S		MI	10388	4671	17845	3257	19344	2608	20033	2075	20915	1231	25102	782	19885
20-#11	3.10	MA	17571	4671	29216	3424	32128	2759	33491	2239	34913	1405	43170	837	35075
8L-4S		MI	10660	4671	18310	3263	19930	2601	20730	2068	21877	1238	26240	823	20290
20-#11	3.10	MA	17093	4671	28344	3437	31048	2757	32132	2236	33129	1413	40916	781	33833
9L-3S		MI	10960	4671	18836	3255	20585	2608	21506	2075	22850	1231	27315	905	20501
20-#11	3.10	MA	16575	4671	27523	3436	29957	2769	30826	2246	31358	1421	38730	718	32471
10L-2S		MI	11371	4671	19479	3261	21391	2601	22466	2068	24119	1224	28956	993	20514
20-#14	4.46	MA	19289	5160	33413	3729	37465	2986	39918	2367	43739	1382	54955	636	49287
7L-5S		MI	11108	5160	19886	3541	21783	2800	22925	2173	24828	1158	30068	495	27276
20-#14	4.46	MA	18642	5160	32230	3727	35879	2982	38033	2381	41031	1372	51699	564	47191
8L-4S		MI	11488	5160	20549	3551	22607	2791	23906	2163	26092	1148	31661	555	27791
20-#14	4.46	MA	17975	5160	30979	3745	34330	2998	36083	2376	38473	1383	48496	482	44863
9L-3S		MI	11908	5160	21299	3540	23529	2800	24997	2173	27461	1138	33170	670	28726

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.40	MA	18619	4781	31305	3494	34846	2798	36766	2260	39457	1404	49032	873	39710
7L-6S		MI	10406	4781	18021	3334	19567	2650	20328	2109	21302	1222	25686	687	21413
22-#11	3.40	MA	18158	4781	30481	3493	33741	2809	35452	2270	37569	1398	46747	822	38743
8L-5S		MI	10666	4781	18487	3326	20150	2656	20994	2102	22184	1215	26743	748	21770
22-#11	3.40	MA	17682	4781	29609	3506	32661	2807	34092	2267	35785	1406	44493	766	37529
9L-4S		MI	10936	4781	18953	3332	20736	2650	21691	2095	23146	1222	27881	789	22150
22-#11	3.40	MA	17182	4781	28789	3505	31570	2819	32786	2277	34014	1414	42307	702	36146
10L-3S		MI	11235	4781	19479	3324	21391	2656	22466	2102	24119	1215	28956	871	22445
22-#11	3.40	MA	16671	4781	27980	3504	30496	2817	31442	2274	32152	1408	40075	649	34796
11L-2S		MI	11644	4781	20122	3330	22197	2650	23426	2095	25388	1208	30597	959	22469
22-#14	4.91	MA	19467	5320	34041	3827	38188	3054	40840	2426	44833	1362	56784	540	52465
8L-5S		MI	11495	5320	20799	3641	22917	2870	24276	2211	26614	1134	32366	442	29835
22-#14	4.91	MA	18802	5320	32790	3845	36639	3071	38890	2421	42275	1373	53581	459	50106
9L-4S		MI	11873	5320	21462	3651	23741	2860	25257	2201	27878	1124	33959	502	30435
24-#11	3.71	MA	18742	4892	31746	3562	35354	2859	37413	2302	40226	1391	50323	807	42417
8L-6S		MI	10684	4892	18664	3403	20373	2698	21288	2137	22571	1207	27327	653	23249
24-#11	3.71	MA	18266	4892	30874	3575	34274	2857	36053	2298	38442	1399	48069	751	41231
9L-5S		MI	10942	4892	19130	3395	20956	2705	21954	2130	23452	1200	28384	713	23658
24-#11	3.71	MA	17769	4892	30054	3574	33183	2869	34747	2309	36671	1407	45883	687	39825
10L-4S		MI	11211	4892	19596	3401	21542	2698	22651	2123	24415	1207	29521	755	24015
24-#11	3.71	MA	17264	4892	29245	3573	32109	2867	33403	2305	34809	1401	43651	633	38458
11L-3S		MI	11509	4892	20122	3394	22197	2705	23426	2130	25388	1200	30597	837	24386
24-#14	5.36	MA	19622	5479	34600	3945	38947	3143	41696	2465	46077	1363	58666	435	55357
9L-5S		MI	11880	5479	21712	3741	24051	2939	25628	2249	28399	1109	34664	389	32405

RECTANGULAR TIED COLUMNS 24" x 44"

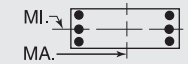
4-#18	1.52	MA	19596	4301	31258	3173	34203	2576	35418	2129	36513	1476	43578	1373	21084
2E		MI	10330	4301	16862	2988	17768	2408	17954	1969	17881	1318	20647	1157	10734
6-#14	1.28	MA	19177	4213	30206	3137	32978	2551	33974	2118	34614	1494	41216	1407	18030
2L-3S		MI	9575	4213	15531	2964	16225	2417	16149	1992	15502	1373	17678	1102	9357
6-#14	1.28	MA	17906	4213	28296	3136	30543	2548	31013	2133	30603	1505	35819	1280	18035
3L-2S		MI	10176	4213	16444	2973	17359	2407	17500	1982	17288	1363	19976	1230	9278
6-#18	2.27	MA	21124	4585	34604	3350	38469	2704	40604	2209	43520	1457	52916	1328	31284
2L-3S		MI	9980	4585	16862	3145	17768	2544	17954	2049	17881	1286	20647	823	15686
6-#18	2.27	MA	18950	4585	31258	3346	34203	2732	35418	2233	36513	1475	43578	1100	31000
3L-2S		MI	10998	4585	18411	3162	19684	2526	20238	2031	20901	1268	24493	1051	15625
8-#11	1.18	MA	19005	4177	29765	3124	32476	2543	33386	2114	33827	1502	40256	1422	16773
2L-4S		MI	9378	4177	15075	2970	15729	2409	15581	1990	14809	1397	16993	1091	8777
8-#11	1.18	MA	18114	4177	28431	3123	30775	2541	31318	2125	31025	1510	36463	1334	16790
3E		MI	9688	4177	15601	2963	16384	2416	16357	1997	15781	1390	18068	1173	8722
8-#11	1.18	MA	17487	4177	27361	3137	29414	2553	29667	2122	28882	1518	33976	1245	16735
4L-2S		MI	10112	4177	16244	2969	17190	2409	17317	1990	17050	1383	19708	1261	8670
8-#14	1.70	MA	20067	4372	32116	3237	35414	2624	36935	2163	38625	1484	46613	1386	23864
2L-4S		MI	9537	4372	15694	3074	16436	2476	16409	2020	15919	1359	18467	934	12210
8-#14	1.70	MA	18808	4372	30206	3235	32978	2621	33974	2177	34614	1495	41216	1258	23817
3E		MI	9976	4372	16444	3064	17359	2486	17500	2030	17288	1349	19976	1050	12183
8-#14	1.70	MA	17922	4372	28673	3254	31028	2637	31607	2172	31541	1506	37680	1130	23557
4L-2S		MI	10572	4372	17357	3073	18493	2476	18852	2020	19074	1339	22274	1178	12122
8-#18	3.03	MA	22625	4869	37951	3527	42735	2833	45790	2289	50526	1439	62253	1282	41436
2L-4S		MI	9907	4869	17137	3337	18124	2645	18392	2094	18587	1254	21956	520	18819
8-#18	3.03	MA	20484	4869	34604	3524	38469	2861	40604	2313	43520	1456	52916	1055	41028
3E		MI	10652	4869	18411	3319	19684	2663	20238	2111	20901	1236	24493	717	20435

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

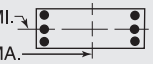


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.03	MA	18973	4869	31911	3555	35045	2853	36449	2301	38144	1474	46813	827	37612
4L-2S		MI	11660	4869	19960	3337	21601	2645	22523	2094	23920	1218	28339	944	20463
10-#11	1.48	MA	19632	4287	31100	3193	34177	2593	35454	2145	36628	1495	44049	1408	20850
2L-5S		MI	9384	4287	15252	3034	15949	2465	15844	2024	15115	1375	17496	1016	10628
10-#11	1.48	MA	18748	4287	29765	3193	32476	2591	33386	2156	33827	1503	40256	1320	20843
3L-4S		MI	9664	4287	15717	3040	16535	2458	16542	2017	16078	1381	18633	1057	10759
10-#11	1.48	MA	18126	4287	28696	3206	31116	2604	31735	2153	31683	1511	37768	1231	20758
4L-3S		MI	9973	4287	16244	3032	17190	2465	17317	2024	17050	1375	19708	1139	10719
10-#11	1.48	MA	17569	4287	27759	3205	29907	2602	30255	2164	29571	1506	35179	1186	20287
5L-2S		MI	10395	4287	16887	3038	17996	2458	18277	2017	18319	1368	21349	1227	10674
10-#14	2.13	MA	20946	4532	34027	3336	37850	2696	39896	2207	42637	1474	52010	1364	29677
2L-5S		MI	9543	4532	15944	3164	16746	2555	16779	2068	16441	1345	19172	821	14219
10-#14	2.13	MA	19699	4532	32116	3335	35414	2693	36935	2222	38625	1485	46613	1236	29587
3L-4S		MI	9938	4532	16607	3174	17571	2545	17760	2058	17705	1335	20765	881	14871
10-#14	2.13	MA	18822	4532	30583	3354	33464	2710	34568	2217	35553	1496	43077	1108	29277
4L-3S		MI	10373	4532	17357	3163	18493	2555	18852	2068	19074	1325	22274	997	14986
10-#14	2.13	MA	18037	4532	29239	3353	31731	2707	32446	2232	32524	1488	39386	1044	27532
5L-2S		MI	10966	4532	18270	3173	19627	2545	20203	2058	20860	1315	24572	1125	14944
10-#18	3.79	MA	21992	5153	37951	3701	42735	2989	45790	2393	50526	1438	62253	1010	51050
3L-4S		MI	10580	5153	18686	3511	20041	2763	20676	2156	21607	1204	25802	413	23251
10-#18	3.79	MA	20505	5153	35258	3733	39311	2982	41635	2381	45151	1455	56150	782	47281
4L-3S		MI	11316	5153	19960	3494	21601	2781	22523	2174	23920	1187	28339	610	25154
10-#18	3.79	MA	19175	5153	32895	3729	36265	3009	37905	2405	39849	1438	49739	673	44149
5L-2S		MI	12315	5153	21509	3511	23518	2763	24807	2156	26940	1169	32185	838	25268
12-#11	1.77	MA	20253	4398	32434	3262	35878	2643	37522	2177	39430	1488	47841	1394	24918
2L-6S		MI	9403	4398	15428	3111	16172	2507	16139	2058	15502	1366	18079	921	12234
12-#11	1.77	MA	19375	4398	31100	3262	34177	2642	35454	2187	36628	1496	44049	1305	24887
3L-5S		MI	9670	4398	15895	3103	16755	2514	16805	2052	16384	1359	19136	981	12484
12-#11	1.77	MA	18758	4398	30030	3275	32817	2654	33803	2184	34485	1504	41561	1217	24776
4E		MI	9948	4398	16360	3109	17341	2507	17502	2045	17346	1366	20274	1023	12727
12-#11	1.77	MA	18206	4398	29093	3275	31608	2652	32323	2195	32373	1499	38972	1172	24181
5L-3S		MI	10256	4398	16887	3101	17996	2514	18277	2052	18319	1359	21349	1105	12702
12-#11	1.77	MA	17680	4398	28210	3274	30407	2664	30858	2192	30433	1507	36503	1114	23369
6L-2S		MI	10675	4398	17529	3107	18802	2507	19238	2045	19588	1352	22990	1193	12665
12-#14	2.56	MA	20580	4692	34027	3435	37850	2765	39896	2267	42637	1475	52010	1214	35348
3L-5S		MI	9944	4692	16857	3264	17881	2624	18131	2106	18227	1320	21470	769	16859
12-#14	2.56	MA	19712	4692	32494	3454	35900	2782	37529	2262	39564	1486	48474	1086	34980
4E		MI	10336	4692	17520	3273	18705	2614	19112	2096	19491	1310	23063	829	17451
12-#14	2.56	MA	18936	4692	31150	3452	34166	2779	35406	2277	36535	1478	44783	1022	33129
5L-3S		MI	10768	4692	18270	3263	19627	2624	20203	2106	20860	1300	24572	944	17771
12-#14	2.56	MA	18195	4692	29882	3451	32444	2796	33305	2272	33753	1489	41272	938	31794
6L-2S		MI	11356	4692	19183	3273	20761	2614	21555	2096	22646	1290	26870	1072	17751
12-#18	4.55	MA	22013	5436	38604	3910	43578	3110	46822	2461	52157	1436	65487	737	56990
4E		MI	11245	5436	20235	3686	21957	2882	22961	2219	24626	1155	29648	307	27720
12-#18	4.55	MA	20704	5436	36242	3906	40531	3138	43091	2485	46856	1419	59076	628	53707
5L-3S		MI	11975	5436	21509	3668	23518	2900	24807	2236	26940	1137	32185	504	29613
12-#18	4.55	MA	19455	5436	34011	3902	37502	3131	39397	2474	41985	1436	53009	477	49724
6L-2S		MI	12964	5436	23058	3686	25435	2882	27092	2219	29960	1119	36031	731	30036
14-#11	2.07	MA	19997	4509	32434	3331	35878	2692	37522	2218	39430	1489	47841	1291	28925
3L-6S		MI	9689	4509	16071	3180	16978	2555	17099	2086	16771	1350	19720	887	14120
14-#11	2.07	MA	19385	4509	31364	3344	34518	2704	35871	2215	37287	1497	45354	1203	28792
4L-5S		MI	9954	4509	16538	3172	17561	2562	17765	2079	17653	1343	20777	947	14349
14-#11	2.07	MA	18838	4509	30428	3344	33309	2702	34391	2226	35175	1492	42764	1158	28086
5L-4S		MI	10231	4509	17003	3178	18147	2555	18462	2072	18615	1350	21915	989	14686
14-#11	2.07	MA	18316	4509	29544	3343	32108	2714	32926	2223	33235	1500	40296	1100	27310
6L-3S		MI	10537	4509	17529	3170	18802	2562	19238	2079	19588	1343	22990	1070	14675
14-#11	2.07	MA	17807	4509	28598	3357	30956	2712	31513	2234	31337	1509	37727	1013	26428
7L-2S		MI	10954	4509	18172	3176	19608	2555	20198	2072	20857	1337	24631	1159	14647

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

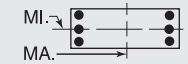
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.98	MA	20592	4851	34404	3553	38335	2854	40490	2307	43575	1477	53872	1064	40505
4L-5S		MI	10341	4851	17770	3364	19015	2693	19482	2144	20013	1296	23768	716	19509
14-#14	2.98	MA	19824	4851	33060	3552	36602	2851	38367	2322	40547	1468	50180	1001	38739
5L-4S		MI	10730	4851	18433	3373	19839	2683	20463	2134	21277	1286	25361	776	20050
14-#14	2.98	MA	19091	4851	31792	3551	34879	2868	36266	2317	37765	1479	46669	916	37317
6L-3S		MI	11159	4851	19183	3363	20761	2693	21555	2144	22646	1276	26870	892	20539
14-#14	2.98	MA	18377	4851	30435	3570	33225	2865	34239	2332	35042	1490	43015	790	35520
7L-2S		MI	11744	4851	20096	3372	21896	2683	22906	2134	24432	1266	29169	1020	20546
14-#18	5.30	MA	22211	5720	39588	4083	44798	3267	48277	2565	53863	1400	68414	583	63297
5L-4S		MI	11906	5720	21784	3861	23874	3001	25245	2281	27646	1105	33494	200	32217
14-#18	5.30	MA	20981	5720	37357	4080	41769	3259	44583	2554	48991	1418	62346	432	59462
6L-3S		MI	12628	5720	23058	3843	25435	3018	27092	2299	29960	1087	36031	397	33939
14-#18	5.30	MA	19781	5720	34971	4111	38859	3287	41018	2578	44224	1435	56028	207	54681
7L-2S		MI	13609	5720	24608	3861	27351	3001	29376	2281	32980	1070	39877	625	34785
16-#11	2.36	MA	20007	4619	32699	3413	36219	2754	37939	2247	40088	1491	49146	1189	32805
4L-6S		MI	9972	4619	16714	3249	17784	2604	18060	2113	18040	1335	21361	853	16010
16-#11	2.36	MA	19464	4619	31762	3413	35011	2752	36459	2257	37976	1485	46557	1144	32002
5E		MI	10236	4619	17181	3241	18367	2611	18725	2106	18921	1328	22418	913	16222
16-#11	2.36	MA	18946	4619	30878	3412	33810	2764	34994	2254	36037	1493	44088	1086	31256
6L-4S		MI	10512	4619	17646	3247	18953	2604	19422	2099	19884	1335	23556	955	16634
16-#11	2.36	MA	18441	4619	29932	3426	32657	2762	33581	2265	34139	1502	41520	998	30319
7L-3S		MI	10816	4619	18172	3239	19608	2611	20198	2106	20857	1328	24631	1036	16642
16-#11	2.36	MA	17943	4619	29065	3425	31493	2775	32197	2276	32151	1496	39100	947	29341
8L-2S		MI	11232	4619	18815	3245	20414	2604	21158	2099	22125	1321	26272	1125	16622
16-#14	3.41	MA	20703	5011	34971	3652	39038	2924	41328	2367	44558	1458	55577	979	44361
5E		MI	10735	5011	18683	3463	20149	2762	20833	2182	21798	1272	26066	663	22167
16-#14	3.41	MA	19978	5011	33703	3651	37315	2940	39227	2362	41776	1469	52066	894	42853
6L-4S		MI	11122	5011	19346	3473	20973	2752	21814	2172	23063	1262	27660	723	22664
16-#14	3.41	MA	19271	5011	32346	3669	35661	2937	37200	2377	39053	1480	48412	768	41114
7L-3S		MI	11548	5011	20096	3462	21896	2762	22906	2182	24432	1252	29169	839	23297
16-#14	3.41	MA	18573	5011	31101	3668	33992	2954	35215	2392	36202	1471	44963	694	38968
8L-2S		MI	12130	5011	21009	3472	23030	2752	24257	2172	26217	1242	31467	967	23332
16-#18	6.06	MA	22487	6004	40704	4257	46035	3388	49769	2634	55998	1399	71683	387	69129
6L-4S		MI	12561	6004	23333	4035	25791	3119	27530	2344	30666	1055	37340	94	36735
16-#18	6.06	MA	21304	6004	38317	4288	43126	3416	46205	2658	51231	1417	65365	162	64150
7L-3S		MI	13327	6004	24608	4018	27351	3137	29376	2361	32980	1038	39877	291	38305
18-#11	2.66	MA	20085	4730	33096	3482	36712	2802	38527	2288	40778	1478	50350	1130	35925
5L-6S		MI	10255	4730	17357	3318	18590	2653	19020	2140	19308	1319	23002	819	17902
18-#11	2.66	MA	19571	4730	32213	3482	35511	2814	37062	2285	38838	1487	47881	1072	35207
6L-5S		MI	10517	4730	17823	3310	19173	2660	19686	2133	20190	1312	24059	879	18100
18-#11	2.66	MA	19070	4730	31267	3495	34358	2813	35649	2296	36940	1495	45313	984	34217
7L-4S		MI	10792	4730	18289	3316	19759	2653	20383	2126	21153	1319	25197	921	18551
18-#11	2.66	MA	18576	4730	30399	3494	33195	2825	34265	2307	34952	1489	42893	933	33267
8L-3S		MI	11094	4730	18815	3308	20414	2660	21158	2133	22125	1312	26272	1002	18603
18-#11	2.66	MA	18064	4730	29548	3494	32058	2823	32834	2304	33074	1498	40501	877	31974
9L-2S		MI	11508	4730	19458	3314	21220	2653	22118	2126	23394	1305	27912	1091	18591
18-#14	3.84	MA	20856	5170	35613	3750	39751	3013	42188	2407	45787	1459	57463	872	48402
6L-5S		MI	11127	5170	19596	3563	21283	2831	22185	2220	23584	1247	28364	611	24831
18-#14	3.84	MA	20156	5170	34256	3769	38097	3010	40161	2422	43065	1470	53809	746	46717
7L-4S		MI	11512	5170	20259	3573	22107	2821	23166	2210	24849	1237	29958	671	25291
18-#14	3.84	MA	19465	5170	33011	3768	36428	3026	38176	2437	40213	1461	50360	672	44523
8L-3S		MI	11935	5170	21009	3562	23030	2831	24257	2220	26217	1228	31467	786	26048
18-#14	3.84	MA	18749	5170	31694	3787	34797	3023	36122	2432	37519	1472	46958	591	42196
9L-2S		MI	12513	5170	21922	3572	24164	2821	25609	2210	28003	1218	33765	914	26104

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	6.82	MA	22809	6287	41663	4466	47392	3544	51391	2737	58237	1398	74703	117	73850
7L-4S		MI	13275	6287	24882	4210	27708	3238	29814	2406	33685	1006	41186	-13	41107
20-#11	2.95	MA	20191	4840	33547	3551	37212	2865	39130	2317	41640	1480	51674	1058	39163
6E		MI	10536	4840	18000	3387	19396	2702	19980	2168	20577	1304	24643	785	19738
20-#11	2.95	MA	19694	4840	32601	3564	36059	2863	37717	2327	39742	1488	49105	970	38121
7L-5S		MI	10797	4840	18466	3379	19979	2708	20646	2161	21459	1297	25700	845	19983
20-#11	2.95	MA	19204	4840	31734	3563	34896	2875	36333	2338	37754	1482	46686	919	37197
8L-4S		MI	11070	4840	18931	3385	20565	2702	21343	2154	22422	1304	26837	887	20403
20-#11	2.95	MA	18693	4840	30882	3563	33759	2873	34902	2335	35876	1491	44294	863	35872
9L-3S		MI	11371	4840	19458	3378	21220	2708	22118	2161	23394	1297	27912	968	20552
20-#11	2.95	MA	18144	4840	29952	3576	32611	2885	33527	2346	34012	1499	41974	799	34513
10L-2S		MI	11782	4840	20101	3383	22026	2702	23079	2154	24663	1290	29553	1057	20556
20-#14	4.26	MA	21033	5330	36166	3869	40532	3082	43122	2467	47076	1460	59207	724	52327
7L-5S		MI	11517	5330	20509	3663	22417	2900	23536	2258	25370	1223	30662	558	27493
20-#14	4.26	MA	20349	5330	34922	3868	38863	3099	41137	2482	44224	1451	55757	650	50087
8L-4S		MI	11899	5330	21172	3672	23241	2891	24517	2248	26634	1213	32256	618	27927
20-#14	4.26	MA	19634	5330	33604	3886	37232	3096	39083	2477	41530	1462	52355	569	47730
9L-3S		MI	12320	5330	21922	3662	24164	2900	25609	2258	28003	1203	33765	734	28794
22-#11	3.25	MA	20314	4951	33935	3633	37760	2913	39785	2359	42544	1481	52898	956	42031
7L-6S		MI	10815	4951	18642	3456	20202	2750	20940	2195	21846	1288	26283	751	21566
22-#11	3.25	MA	19827	4951	33068	3633	36597	2925	38401	2369	40556	1476	50478	905	41109
8L-5S		MI	11075	4951	19109	3449	20785	2757	21606	2188	22728	1281	27340	811	21868
22-#11	3.25	MA	19317	4951	32216	3632	35460	2923	36970	2366	38678	1484	48086	849	39775
9L-4S		MI	11346	4951	19574	3455	21371	2750	22303	2181	23691	1288	28478	852	22262
22-#11	3.25	MA	18775	4951	31287	3645	34312	2935	35595	2377	36814	1492	45767	785	38395
10L-3S		MI	11646	4951	20101	3447	22026	2757	23079	2188	24663	1281	29553	934	22498
22-#11	3.25	MA	18249	4951	30435	3645	33182	2933	34181	2374	34853	1487	43404	731	37044
11L-2S		MI	12056	4951	20743	3453	22832	2750	24039	2181	25932	1274	31194	1023	22517
22-#14	4.69	MA	21225	5489	36832	3967	41299	3171	44098	2526	48236	1441	61154	629	55658
8L-5S		MI	11905	5489	21422	3763	23551	2970	24887	2296	27156	1199	32960	505	30049
22-#14	4.69	MA	20512	5489	35515	3986	39668	3168	42044	2521	45541	1452	57752	547	53272
9L-4S		MI	12284	5489	22085	3772	24375	2960	25869	2286	28420	1189	34554	565	30571
24-#11	3.55	MA	20446	5062	34402	3702	38298	2975	40469	2400	43357	1469	54271	891	44989
8L-6S		MI	11093	5062	19285	3526	21008	2799	21901	2222	23115	1272	27924	717	23401
24-#11	3.55	MA	19937	5062	33551	3701	37161	2973	39038	2397	41479	1477	51879	835	43683
9L-5S		MI	11352	5062	19752	3518	21591	2806	22566	2215	23997	1265	28981	777	23757
24-#11	3.55	MA	19401	5062	32621	3715	36013	2985	37663	2408	39615	1485	49559	771	42280
10L-4S		MI	11622	5062	20217	3524	22177	2799	23264	2208	24959	1272	30119	818	24127
24-#11	3.55	MA	18878	5062	31770	3714	34883	2984	36249	2405	37655	1480	47196	717	40913
11L-3S		MI	11920	5062	20743	3516	22832	2806	24039	2215	25932	1265	31194	900	24441
24-#14	5.11	MA	21381	5649	37425	4086	42104	3240	45005	2566	49552	1443	63149	525	58820
9L-5S		MI	12290	5649	22335	3862	24685	3039	26239	2334	28942	1175	35258	452	32617

RECTANGULAR TIED COLUMNS 24" x 46"

4-#18	1.45	MA	21310	4471	33849	3311	37043	2689	38321	2225	39431	1552	47066	1450	22164
2E		MI	10738	4471	17488	3108	18401	2506	18562	2053	18419	1382	21236	1219	10773
6-#14	1.22	MA	20863	4383	32736	3275	35746	2665	36792	2214	37380	1568	44537	1484	18941
2L-3S		MI	9982	4383	16154	3085	16859	2517	16760	2077	16045	1438	18273	1166	9390
6-#14	1.22	MA	19522	4383	30726	3274	33183	2662	33676	2229	33159	1580	38828	1356	18946
3L-2S		MI	10584	4383	17067	3095	17993	2507	18112	2067	17831	1429	20571	1293	9309
6-#18	2.17	MA	22929	4755	37373	3488	41535	2818	43782	2305	46830	1534	56957	1408	32904
2L-3S		MI	10388	4755	17488	3264	18401	2643	18562	2133	18419	1350	21236	885	15749
6-#18	2.17	MA	20633	4755	33849	3485	37043	2846	38321	2330	39431	1553	47066	1181	32620
3L-2S		MI	11408	4755	19037	3282	20318	2625	20847	2115	21439	1332	25082	1113	15672

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

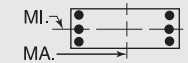
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#11	1.13	MA	20679	4346	32270	3262	35214	2657	36169	2211	36547	1576	43509	1498	17615
2L-4S		MI	9785	4346	15696	3093	16364	2510	16194	2076	15353	1463	17590	1155	8809
8-#11	1.13	MA	19740	4346	30866	3262	33425	2655	33994	2222	33600	1584	39500	1409	17633
3E		MI	10096	4346	16223	3085	17019	2517	16969	2083	16326	1456	18665	1236	8751
8-#11	1.13	MA	19080	4346	29743	3275	31996	2667	32259	2219	31347	1593	36868	1320	17577
4L-2S		MI	10520	4346	16865	3091	17825	2510	17929	2076	17594	1449	20306	1325	8698
8-#14	1.63	MA	21804	4542	34746	3374	38309	2737	39907	2259	41600	1558	50246	1463	25079
2L-4S		MI	9945	4542	16317	3195	17071	2576	17020	2105	16462	1424	19062	997	12262
8-#14	1.63	MA	20477	4542	32736	3374	35746	2735	36792	2274	37380	1570	44537	1335	25032
3E		MI	10384	4542	17067	3185	17993	2586	18112	2115	17831	1414	20571	1113	12223
8-#14	1.63	MA	19543	4542	31125	3393	33697	2752	34304	2270	34150	1582	40793	1207	24772
4L-2S		MI	10981	4542	17980	3195	19127	2576	19463	2105	19616	1404	22869	1241	12158
8-#18	2.90	MA	24519	5039	40896	3665	46027	2946	49243	2385	54228	1517	66849	1366	43596
2L-4S		MI	10314	5039	17762	3457	18757	2743	19000	2178	19125	1318	22545	582	19009
8-#18	2.90	MA	22258	5039	37373	3662	41535	2975	43782	2410	46830	1535	56957	1138	43188
3E		MI	11060	5039	19037	3439	20318	2761	20847	2195	21439	1301	25082	779	20508
8-#18	2.90	MA	20665	5039	34541	3695	37934	2969	39411	2400	41155	1553	50485	911	39842
4L-2S		MI	12070	5039	20586	3457	22234	2743	23131	2178	24459	1283	28928	1006	20516
10-#11	1.41	MA	21342	4457	33673	3331	37004	2707	38344	2242	39494	1569	47519	1485	21903
2L-5S		MI	9791	4457	15874	3156	16584	2566	16457	2110	15659	1440	18093	1079	10751
10-#11	1.41	MA	20410	4457	32270	3331	35214	2705	36169	2253	36547	1578	43509	1396	21896
3L-4S		MI	10072	4457	16339	3162	17170	2559	17154	2103	16622	1447	19231	1120	10795
10-#11	1.41	MA	19755	4457	31146	3344	33785	2718	34434	2250	34294	1586	40877	1307	21811
4L-3S		MI	10381	4457	16865	3154	17825	2566	17929	2110	17594	1440	20306	1202	10751
10-#11	1.41	MA	19170	4457	30162	3344	32516	2716	32880	2261	32076	1581	38144	1262	21417
5L-2S		MI	10803	4457	17508	3160	18631	2559	18890	2103	18863	1433	21947	1291	10705
10-#14	2.04	MA	22734	4702	36756	3474	40872	2810	43023	2304	45821	1548	55956	1443	31196
2L-5S		MI	9950	4702	16567	3286	17381	2655	17390	2153	16983	1410	19766	884	14338
10-#14	2.04	MA	21419	4702	34746	3473	38309	2807	39907	2319	41600	1560	50246	1315	31105
3L-4S		MI	10346	4702	17230	3295	18205	2645	18371	2143	18248	1400	21360	945	15010
10-#14	2.04	MA	20496	4702	33135	3493	36260	2824	37420	2315	38371	1572	46502	1187	30796
4L-3S		MI	10782	4702	17980	3285	19127	2655	19463	2153	19616	1390	22869	1060	15030
10-#14	2.04	MA	19669	4702	31723	3492	34439	2822	35190	2330	35189	1564	42604	1123	29068
5L-2S		MI	11375	4702	18893	3294	20262	2645	20814	2143	21402	1380	25167	1188	14984
10-#18	3.62	MA	23854	5322	40896	3840	46027	3104	49243	2490	54228	1517	66849	1096	53750
3L-4S		MI	10987	5322	19311	3631	20674	2862	21285	2240	22145	1269	26391	475	23438
10-#18	3.62	MA	22287	5322	38065	3872	42426	3097	44872	2480	48554	1535	60376	869	50034
4L-3S		MI	11726	5322	20586	3614	22234	2880	23131	2258	24459	1251	28928	672	25237
10-#18	3.62	MA	20885	5322	35581	3869	39224	3126	40951	2505	42959	1518	53597	758	46951
5L-2S		MI	12726	5322	22135	3631	24151	2862	25416	2240	27478	1233	32774	900	25330
12-#11	1.70	MA	22000	4568	35077	3400	38793	2757	40520	2273	42441	1562	51528	1472	26182
2L-6S		MI	9810	4568	16050	3233	16806	2607	16752	2144	16046	1432	18677	985	12322
12-#11	1.70	MA	21074	4568	33673	3400	37004	2755	38344	2284	39494	1571	47519	1383	26151
3L-5S		MI	10077	4568	16516	3225	17390	2614	17417	2137	16928	1425	19734	1045	12578
12-#11	1.70	MA	20424	4568	32550	3414	35574	2768	36610	2281	37241	1579	44886	1294	26040
4E		MI	10356	4568	16982	3231	17976	2607	18114	2130	17891	1432	20872	1086	12768
12-#11	1.70	MA	19843	4568	31566	3413	34305	2766	35055	2293	35023	1574	42154	1249	25515
5L-3S		MI	10664	4568	17508	3223	18631	2614	18890	2137	18863	1425	21947	1168	12738
12-#11	1.70	MA	19290	4568	30638	3413	33044	2779	33516	2290	32985	1583	39543	1191	24628
6L-2S		MI	11084	4568	18151	3229	19437	2607	19850	2130	20132	1418	23588	1257	12699
12-#14	2.45	MA	22351	4861	36756	3573	40872	2879	43023	2364	45821	1550	55956	1294	37171
3L-5S		MI	10351	4861	17480	3385	18515	2724	18742	2191	18769	1386	22065	832	16977
12-#14	2.45	MA	21437	4861	35145	3592	38822	2897	40535	2360	42592	1562	52211	1166	36819
4E		MI	10744	4861	18143	3395	19339	2714	19723	2181	20033	1376	23658	892	17588

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

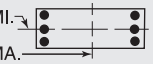


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#14	2.45	MA	20620	4861	33733	3592	37002	2894	38305	2375	39409	1554	48313	1102	34961
5L-3S		MI	11177	4861	18893	3385	20262	2724	20814	2191	21402	1366	25167	1007	17822
12-#14	2.45	MA	19840	4861	32402	3591	35192	2911	36098	2371	36486	1566	44597	1018	33694
6L-2S		MI	11766	4861	19806	3394	21396	2714	22166	2181	23188	1356	27465	1135	17793
12-#18	4.35	MA	23884	5606	41588	4049	46919	3226	50334	2560	55953	1518	70268	826	60268
4E		MI	11653	5606	20860	3806	22591	2981	23569	2303	25164	1219	30237	369	27905
12-#18	4.35	MA	22504	5606	39105	4046	43716	3254	46412	2585	50358	1501	63489	716	57036
5L-3S		MI	12385	5606	22135	3788	24151	2998	25416	2320	27478	1201	32774	566	29861
12-#18	4.35	MA	21188	5606	36761	4043	40532	3248	42529	2575	45217	1519	57057	566	52682
6L-2S		MI	13377	5606	23684	3806	26068	2981	27700	2303	30498	1184	36620	793	30103
14-#11	1.98	MA	21731	4678	35077	3469	38793	2806	40520	2315	42441	1564	51528	1370	30400
3L-6S		MI	10096	4678	16693	3302	17612	2656	17712	2171	17315	1416	20318	951	14209
14-#11	1.98	MA	21087	4678	33953	3483	37364	2818	38785	2313	40188	1573	48896	1281	30266
4L-5S		MI	10362	4678	17159	3294	18196	2663	18378	2164	18197	1409	21375	1011	14444
14-#11	1.98	MA	20511	4678	32969	3482	36095	2816	37230	2324	37970	1568	46163	1236	29625
5L-4S		MI	10639	4678	17625	3300	18782	2656	19075	2157	19160	1416	22512	1052	14732
14-#11	1.98	MA	19962	4678	32041	3482	34833	2829	35692	2321	35932	1576	43552	1178	28775
6L-3S		MI	10945	4678	18151	3292	19437	2663	19850	2164	20132	1409	23588	1134	14714
14-#11	1.98	MA	19426	4678	31048	3496	33623	2827	34208	2332	33939	1585	40836	1091	27941
7L-2S		MI	11364	4678	18794	3298	20243	2656	20810	2157	21401	1402	25228	1223	14683
14-#14	2.85	MA	22368	5021	37155	3692	41385	2969	43651	2405	46812	1552	57921	1146	42813
4L-5S		MI	10749	5021	18393	3485	19649	2793	20093	2229	20555	1361	24363	779	19628
14-#14	2.85	MA	21559	5021	35743	3691	39564	2966	41421	2420	43630	1544	54022	1082	40869
5L-4S		MI	11139	5021	19056	3495	20473	2783	21074	2219	21819	1351	25956	839	20186
14-#14	2.85	MA	20788	5021	34412	3690	37755	2984	39213	2416	40707	1556	50306	998	39513
6L-3S		MI	11569	5021	19806	3484	21396	2793	22166	2229	23188	1341	27465	955	20594
14-#14	2.85	MA	20036	5021	32986	3710	36017	2981	37084	2431	37847	1568	46440	872	37553
7L-2S		MI	12155	5021	20719	3494	22530	2783	23517	2219	24974	1331	29763	1083	20592
14-#18	5.07	MA	24099	5890	42629	4224	48208	3383	51873	2665	57757	1483	73380	674	67152
5L-4S		MI	12314	5890	22410	3981	24507	3099	25854	2365	28184	1169	34083	263	32400
14-#18	5.07	MA	22803	5890	40285	4221	45025	3376	47990	2655	52615	1501	66949	524	62949
6L-3S		MI	13040	5890	23684	3963	26068	3117	27700	2383	30498	1152	36620	459	34182
14-#18	5.07	MA	21538	5890	37777	4253	41968	3405	44243	2680	47584	1519	60254	299	58065
7L-2S		MI	14023	5890	25233	3981	27985	3099	29984	2365	33518	1134	40466	687	34857
16-#11	2.26	MA	21744	4789	35357	3552	39153	2868	40960	2344	43135	1566	52905	1268	34490
4L-6S		MI	10380	4789	17335	3371	18418	2705	18672	2199	18584	1400	21959	917	16100
16-#11	2.26	MA	21173	4789	34373	3552	37884	2867	39405	2355	40916	1561	50172	1223	33745
5E		MI	10644	4789	17802	3364	19002	2712	19338	2192	19466	1394	23016	977	16317
16-#11	2.26	MA	20628	4789	33445	3551	36623	2879	37867	2352	38879	1569	47561	1165	32928
6L-4S		MI	10921	4789	18267	3369	19588	2705	20035	2185	20428	1400	24153	1018	16684
16-#11	2.26	MA	20097	4789	32452	3565	35412	2878	36383	2363	36886	1578	44846	1078	32037
7L-3S		MI	11225	4789	18794	3362	20243	2712	20810	2192	21401	1394	25228	1100	16683
16-#11	2.26	MA	19573	4789	31541	3565	34190	2890	34930	2375	34798	1573	42291	1026	30973
8L-2S		MI	11642	4789	19437	3368	21049	2705	21771	2185	22670	1387	26869	1189	16660
16-#14	3.26	MA	22489	5180	37754	3791	42127	3039	44536	2465	47851	1534	59731	1061	46788
5E		MI	11144	5180	19306	3585	20783	2862	21445	2267	22341	1337	26661	726	22286
16-#14	3.26	MA	21726	5180	36422	3790	40317	3056	42329	2461	44928	1546	56015	977	45346
6L-4S		MI	11531	5180	19969	3594	21607	2852	22426	2257	23605	1327	28254	787	22799
16-#14	3.26	MA	20982	5180	34997	3809	38580	3053	40199	2476	42068	1558	52149	851	43445
7L-3S		MI	11959	5180	20719	3584	22530	2862	23517	2267	24974	1317	29763	902	23356
16-#14	3.26	MA	20247	5180	33689	3809	36827	3071	38115	2492	39072	1550	48506	777	41293
8L-2S		MI	12541	5180	21632	3594	23664	2852	24869	2257	26760	1307	32061	1030	23383
16-#18	5.80	MA	24397	6173	43808	4398	49517	3505	53451	2735	60014	1483	76840	481	73237
6L-4S		MI	12971	6173	23959	4155	26424	3218	28138	2428	31204	1120	37929	156	36917
16-#18	5.80	MA	23150	6173	41300	4430	46460	3534	49705	2760	54983	1501	70146	256	68268
7L-3S		MI	13690	6173	25233	4138	27985	3235	29984	2445	33518	1102	40466	353	38545
16-#18	5.80	MA	21921	6173	38999	4427	43375	3527	46036	2785	49713	1484	63812	127	62914
8L-2S		MI	14665	6173	26782	4155	29901	3218	32269	2428	36537	1084	44312	580	39596

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



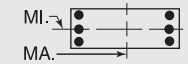
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.54	MA	21830	4900	35776	3621	39673	2917	41581	2386	43863	1554	54181	1210	37874
5L-6S		MI	10662	4900	17978	3441	19224	2754	19632	2226	19853	1385	23599	882	17993
18-#11	2.54	MA	21289	4900	34848	3621	38412	2929	40042	2383	41826	1563	51571	1152	37087
6L-5S		MI	10926	4900	18445	3433	19808	2760	20298	2219	20735	1378	24656	943	18195
18-#11	2.54	MA	20762	4900	33855	3634	37201	2928	38558	2395	39833	1571	48855	1065	36140
7L-4S		MI	11201	4900	18910	3439	20394	2754	20995	2212	21697	1385	25794	984	18630
18-#11	2.54	MA	20242	4900	32944	3634	35980	2940	37106	2406	37745	1566	46300	1012	35105
8L-3S		MI	11504	4900	19437	3431	21049	2760	21771	2219	22670	1378	26869	1066	18646
18-#11	2.54	MA	19696	4900	32050	3634	34786	2939	35603	2403	35773	1575	43771	956	33825
9L-2S		MI	11918	4900	20079	3437	21855	2754	22731	2212	23939	1371	28510	1155	18631
18-#14	3.67	MA	22655	5340	38432	3890	42880	3128	45444	2506	49149	1536	61725	957	51191
6L-5S		MI	11536	5340	20219	3685	21917	2931	22796	2305	24126	1313	28959	674	24951
18-#14	3.67	MA	21918	5340	37007	3909	41143	3126	43315	2521	46289	1548	57859	831	49346
7L-4S		MI	11921	5340	20882	3694	22741	2921	23777	2295	25391	1303	30552	734	25425
18-#14	3.67	MA	21191	5340	35700	3908	39390	3143	41230	2536	43293	1540	54215	756	47147
8L-3S		MI	12346	5340	21632	3684	23664	2931	24869	2305	26760	1293	32061	849	26111
18-#14	3.67	MA	20426	5340	34416	3907	37677	3140	39073	2532	40463	1552	50615	675	44799
9L-2S		MI	12925	5340	22545	3693	24798	2921	26220	2295	28546	1283	34359	977	26157
18-#18	6.52	MA	24742	6457	44824	4608	50952	3662	55166	2840	62381	1484	80037	214	78286
7L-4S		MI	13689	6457	25508	4330	28341	3336	30422	2490	34224	1070	41775	50	41450
18-#18	6.52	MA	23530	6457	42523	4605	47867	3656	51497	2865	57111	1467	73703	85	73088
8L-3S		MI	14380	6457	26782	4312	29901	3354	32269	2508	36537	1052	44312	246	42940
20-#11	2.83	MA	21945	5010	36252	3690	40201	2979	42217	2415	44773	1556	55580	1139	41250
6E		MI	10944	5010	18621	3510	20030	2802	20593	2253	21122	1369	25240	848	19888
20-#11	2.83	MA	21422	5010	35259	3703	38991	2978	40733	2426	42780	1564	52864	1052	40250
7L-5S		MI	11206	5010	19088	3502	20614	2809	21258	2246	22003	1362	26297	909	20078
20-#11	2.83	MA	20906	5010	34348	3703	37769	2990	39281	2437	40692	1559	50310	999	39242
8L-4S		MI	11479	5010	19553	3508	21200	2802	21956	2239	22966	1369	27435	950	20513
20-#11	2.83	MA	20361	5010	33454	3703	36576	2989	37778	2434	38720	1568	47780	943	37930
9L-3S		MI	11781	5010	20079	3500	21855	2809	22731	2246	23939	1362	28510	1032	20600
20-#11	2.83	MA	19782	5010	32478	3716	35370	3001	36334	2445	36762	1577	45326	880	36580
10L-2S		MI	12193	5010	20722	3506	22661	2802	23691	2239	25207	1355	30151	1121	20598
20-#14	4.08	MA	22845	5500	39017	4009	43706	3198	46430	2566	50509	1538	63568	810	55254
7L-5S		MI	11926	5500	21132	3784	23051	3000	24147	2343	25912	1288	31257	621	27621
20-#14	4.08	MA	22125	5500	37710	4008	41953	3215	44346	2581	47514	1530	59924	736	53008
8L-4S		MI	12309	5500	21795	3794	23876	2991	25128	2333	27177	1278	32850	681	28061
20-#14	4.08	MA	21362	5500	36427	4007	40240	3213	42189	2577	44684	1542	56324	655	50632
9L-3S		MI	12731	5500	22545	3784	24798	3000	26220	2343	28546	1269	34359	797	28860
20-#14	4.08	MA	20580	5500	35026	4026	38509	3230	40117	2592	41875	1554	52832	563	48275
10L-2S		MI	13307	5500	23458	3793	25932	2991	27571	2333	30331	1259	36657	925	28925
20-#18	7.25	MA	25120	6741	46046	4782	52360	3784	56958	2945	64510	1449	83595	43	83277
8L-4S		MI	14331	6741	27057	4504	30258	3455	32707	2553	37243	1021	45621	-57	45240
22-#11	3.11	MA	22077	5121	36662	3772	40780	3028	42909	2457	45727	1558	56873	1039	44366
7L-6S		MI	11223	5121	19264	3579	20837	2851	21553	2280	22390	1354	26881	814	21716
22-#11	3.11	MA	21565	5121	35751	3772	39559	3040	41456	2468	43639	1553	54319	986	43384
8L-5S		MI	11484	5121	19730	3571	21420	2858	22219	2273	23272	1347	27938	875	21964
22-#11	3.11	MA	21021	5121	34857	3772	38365	3039	39953	2465	41667	1561	51789	930	42039
9L-4S		MI	11756	5121	20196	3577	22006	2851	22916	2267	24235	1354	29076	916	22372
22-#11	3.11	MA	20449	5121	33881	3785	37159	3051	38510	2477	39709	1570	49335	867	40668
10L-3S		MI	12056	5121	20722	3569	22661	2858	23691	2273	25207	1347	30151	998	22549
22-#11	3.11	MA	19895	5121	32988	3785	35973	3050	37024	2474	37650	1565	46841	812	39264
11L-2S		MI	12467	5121	21365	3575	23467	2851	24651	2267	26476	1340	31792	1086	22561
22-#14	4.48	MA	23051	5659	39720	4108	44516	3288	47461	2626	51734	1520	65634	715	58878
8L-5S		MI	12314	5659	22045	3884	24186	3070	25499	2381	27698	1264	33555	568	30260

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

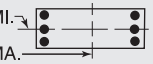
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	4.48	MA	22290	5659	38437	4107	42803	3285	45304	2622	48904	1532	62033	634	56472
9L-4S		MI	12695	5659	22708	3894	25010	3060	26480	2371	28963	1254	35148	628	30704
22-#14	4.48	MA	21514	5659	37036	4126	41072	3302	43233	2637	46095	1544	58542	543	54093
10L-3S		MI	13115	5659	23458	3883	25932	3070	27571	2381	30331	1244	36657	744	31604
24-#11	3.39	MA	22219	5232	37155	3841	41348	3090	43631	2499	46586	1546	58328	973	47530
8L-6S		MI	11502	5232	19907	3648	21643	2900	22513	2308	23659	1338	28522	780	23550
24-#11	3.39	MA	21676	5232	36261	3841	40154	3089	42128	2497	44613	1554	55799	917	46154
9L-5S		MI	11761	5232	20373	3640	22226	2906	23179	2301	24541	1331	29579	841	23853
24-#11	3.39	MA	21110	5232	35285	3855	38948	3101	40685	2508	42656	1563	53345	854	44761
10L-4S		MI	12032	5232	20838	3646	22812	2900	23876	2294	25504	1338	30716	882	24236
24-#11	3.39	MA	20560	5232	34391	3854	37762	3100	39199	2505	40597	1558	50850	799	43380
11L-3S		MI	12331	5232	21365	3638	23467	2906	24651	2301	26476	1331	31792	964	24494
24-#11	3.39	MA	20019	5232	33430	3868	36564	3112	37759	2516	38643	1567	48107	724	41738
12L-2S		MI	12740	5232	22008	3644	24273	2900	25612	2294	27745	1324	33432	1052	24516
24-#14	4.89	MA	23210	5819	40447	4207	45365	3357	48420	2667	53125	1522	67743	614	62319
9L-5S		MI	12701	5819	22958	3984	25320	3139	26850	2419	29484	1240	35853	516	32825
24-#14	4.89	MA	22440	5819	39046	4226	43635	3375	46348	2682	50316	1534	64251	523	59917
10L-4S		MI	13079	5819	23621	3993	26144	3129	27831	2409	30748	1230	37447	576	33355

RECTANGULAR TIED COLUMNS 24" x 48"

4-#18	1.39	MA	23092	4641	36537	3449	39988	2803	41328	2322	42407	1626	50662	1527	23244
2E		MI	11146	4641	18113	3227	19034	2605	19171	2136	18957	1447	21824	1282	10812
6-#14	1.17	MA	22617	4552	35363	3413	38620	2778	39715	2310	40242	1642	47967	1559	19853
2L-3S		MI	10390	4552	16777	3207	17494	2617	17371	2162	16587	1504	18867	1229	9422
6-#14	1.17	MA	21207	4552	33253	3412	35930	2776	36445	2326	35812	1655	41945	1431	19857
3L-2S		MI	10992	4552	17690	3216	18628	2607	18723	2152	18373	1494	21165	1357	9340
6-#18	2.08	MA	24802	4925	40238	3626	44706	2931	47064	2402	50178	1609	61108	1488	34524
2L-3S		MI	10795	4925	18113	3384	19034	2741	19171	2216	18957	1415	21824	948	15807
6-#18	2.08	MA	22385	4925	36537	3624	39988	2961	41328	2428	42407	1628	50662	1260	34240
3L-2S		MI	11817	4925	19662	3402	20951	2724	21455	2199	21977	1397	25670	1175	15718
8-#11	1.08	MA	22421	4516	34871	3400	38059	2770	39058	2307	39363	1650	46871	1573	18458
2L-4S		MI	10192	4516	16318	3215	16998	2611	16806	2161	15897	1529	18188	1218	8839
8-#11	1.08	MA	21434	4516	33398	3400	36181	2769	36776	2319	36271	1659	42645	1484	18475
3E		MI	10504	4516	16844	3207	17654	2618	17582	2168	16870	1522	19263	1300	8779
8-#11	1.08	MA	20741	4516	32220	3414	34683	2782	34957	2316	33910	1668	39869	1396	18419
4L-2S		MI	10928	4516	17487	3213	18460	2611	18542	2161	18139	1515	20904	1389	8725
8-#14	1.56	MA	23610	4712	37473	3512	41310	2851	42985	2355	44672	1632	53988	1540	26294
2L-4S		MI	10352	4712	16940	3317	17705	2676	17631	2190	17004	1489	19656	1060	12309
8-#14	1.56	MA	22214	4712	35363	3512	38620	2849	39715	2371	40242	1645	47967	1412	26247
3E		MI	10792	4712	17690	3307	18628	2686	18723	2200	18373	1479	21165	1176	12261
8-#14	1.56	MA	21233	4712	33673	3531	36471	2866	37107	2367	36855	1657	44014	1284	25987
4L-2S		MI	11390	4712	18603	3316	19762	2676	20074	2190	20159	1470	23464	1304	12193
8-#18	2.78	MA	26482	5208	43939	3803	49425	3060	52800	2481	57948	1591	71554	1448	45756
2L-4S		MI	10721	5208	18388	3577	19391	2842	19609	2261	19663	1383	23133	644	19195
8-#18	2.78	MA	24100	5208	40238	3801	44706	3089	47064	2508	50178	1610	61108	1221	45348
3E		MI	11468	5208	19662	3559	20951	2860	21455	2279	21977	1365	25670	841	20579
8-#18	2.78	MA	22425	5208	37267	3834	40928	3084	42479	2499	44224	1630	54266	993	42092
4L-2S		MI	12480	5208	21212	3577	22868	2842	23740	2261	24997	1347	29516	1069	20569
10-#11	1.35	MA	23121	4627	36344	3469	39936	2820	41340	2338	42455	1643	51097	1561	22956
2L-5S		MI	10198	4627	16495	3278	17219	2666	17070	2195	16204	1506	18691	1143	10843
10-#11	1.35	MA	22140	4627	34871	3469	38059	2819	39058	2350	39363	1652	46871	1472	22949
3L-4S		MI	10479	4627	16960	3284	17804	2659	17767	2188	17166	1513	19828	1184	10831
10-#11	1.35	MA	21453	4627	33693	3483	36560	2832	37239	2347	37002	1661	44095	1383	22864
4L-3S		MI	10789	4627	17487	3277	18460	2666	18542	2195	18139	1506	20904	1266	10783
10-#11	1.35	MA	20839	4627	32662	3483	35230	2831	35610	2359	34676	1657	41218	1338	22556
5L-2S		MI	11212	4627	18130	3282	19266	2659	19502	2188	19408	1499	22544	1354	10735

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



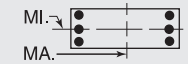
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.95	MA	24592	4871	39583	3612	44000	2923	46255	2400	49102	1622	60010	1521	32715
2L-5S		MI	10357	4871	17190	3407	18015	2755	18002	2238	17525	1475	20361	948	14454
10-#14	1.95	MA	23208	4871	37473	3612	41310	2921	42985	2416	44672	1635	53988	1393	32624
3L-4S		MI	10753	4871	17853	3417	18839	2745	18983	2228	18790	1465	21954	1008	15086
10-#14	1.95	MA	22238	4871	35783	3631	39161	2939	40377	2412	41285	1647	50036	1265	32315
4L-3S		MI	11190	4871	18603	3406	19762	2755	20074	2238	20159	1455	23464	1123	15073
10-#14	1.95	MA	21370	4871	34303	3631	37252	2936	38039	2428	37949	1640	45930	1201	30614
5L-2S		MI	11784	4871	19516	3416	20896	2745	21426	2228	21945	1445	25762	1251	15022
10-#18	3.47	MA	25786	5492	43939	3978	49425	3218	52800	2587	57948	1593	71554	1181	56450
3L-4S		MI	11394	5492	19937	3751	21307	2961	21893	2324	22683	1333	26979	538	23622
10-#18	3.47	MA	24138	5492	40968	4011	45647	3212	48215	2578	51995	1612	64712	954	52810
4L-3S		MI	12135	5492	21212	3734	22868	2978	23740	2341	24997	1315	29516	735	25316
10-#18	3.47	MA	22664	5492	38364	4009	42288	3242	44102	2605	46127	1596	57565	842	49776
5L-2S		MI	13137	5492	22761	3751	24785	2961	26024	2324	28017	1298	33363	962	25386
12-#11	1.63	MA	23814	4737	37816	3538	41814	2870	43623	2369	45547	1636	55323	1549	27445
2L-6S		MI	10217	4737	16671	3355	17441	2708	17364	2229	16591	1497	19274	1048	12408
12-#11	1.63	MA	22840	4737	36344	3538	39936	2869	41340	2381	42455	1645	51097	1460	27414
3L-5S		MI	10484	4737	17138	3348	18025	2715	18030	2223	17472	1490	20331	1109	12670
12-#11	1.63	MA	22158	4737	35166	3552	38438	2882	39522	2378	40094	1654	48321	1371	27304
4E		MI	10764	4737	17603	3354	18610	2708	18727	2216	18435	1497	21469	1150	12808
12-#11	1.63	MA	21549	4737	34135	3552	37108	2881	37893	2390	37769	1650	45444	1326	26858
5L-3S		MI	11072	4737	18130	3346	19266	2715	19502	2223	19408	1490	22544	1232	12773
12-#11	1.63	MA	20968	4737	33163	3552	35786	2893	36280	2388	35634	1659	42691	1268	25893
6L-2S		MI	11493	4737	18772	3352	20072	2708	20463	2216	20676	1484	24185	1320	12732
12-#14	2.34	MA	24191	5031	39583	3711	44000	2993	46255	2461	49102	1625	60010	1374	38993
3L-5S		MI	10758	5031	18103	3507	19149	2824	19353	2276	19311	1451	22659	895	17093
12-#14	2.34	MA	23231	5031	37893	3731	41851	3011	43647	2457	45716	1637	56058	1246	38641
4E		MI	11152	5031	18766	3516	19973	2814	20334	2266	20576	1441	24253	955	17722
12-#14	2.34	MA	22372	5031	36413	3731	39942	3009	41309	2473	42380	1630	51952	1182	36804
5L-3S		MI	11586	5031	19516	3506	20896	2824	21426	2276	21945	1431	25762	1071	17869
12-#14	2.34	MA	21554	5031	35018	3730	38046	3027	38995	2469	39316	1643	48031	1098	35593
6L-2S		MI	12176	5031	20429	3516	22030	2814	22777	2266	23730	1421	28060	1199	17835
12-#18	4.17	MA	25824	5776	44669	4189	50365	3341	53951	2658	59766	1595	75158	914	63568
4E		MI	12061	5776	21486	3926	23224	3079	24178	2386	25703	1283	30826	431	28087
12-#18	4.17	MA	24373	5776	42065	4187	47007	3371	49838	2685	53898	1579	68011	802	60405
5L-3S		MI	12795	5776	22761	3908	24785	3097	26024	2404	28017	1266	33363	628	30031
12-#18	4.17	MA	22989	5776	39608	4184	43668	3365	45766	2676	48506	1598	61216	653	55668
6L-2S		MI	13789	5776	24310	3926	26701	3079	28308	2386	31036	1248	37209	856	30169
14-#11	1.90	MA	23534	4848	37816	3607	41814	2919	43623	2412	45547	1638	55323	1448	31874
3L-6S		MI	10503	4848	17314	3425	18247	2757	18324	2257	17859	1482	20915	1014	14295
14-#11	1.90	MA	22857	4848	36638	3621	40315	2932	41804	2410	43186	1648	52547	1359	31740
4L-5S		MI	10769	4848	17781	3417	18831	2764	18990	2250	18741	1475	21972	1074	14536
14-#11	1.90	MA	22252	4848	35607	3621	38985	2931	40175	2421	40861	1643	49670	1314	31173
5L-4S		MI	11047	4848	18246	3423	19416	2757	19687	2243	19704	1482	23110	1116	14775
14-#11	1.90	MA	21676	4848	34635	3621	37664	2943	38563	2419	38726	1652	46917	1256	30246
6L-3S		MI	11354	4848	18772	3415	20072	2764	20463	2250	20676	1475	24185	1198	14752
14-#11	1.90	MA	21114	4848	33595	3635	36395	2942	37008	2430	36638	1661	44054	1168	29466
7L-2S		MI	11773	4848	19415	3421	20878	2757	21423	2243	21945	1468	25826	1286	14718
14-#14	2.73	MA	24213	5191	40003	3831	44541	3083	46917	2502	50146	1628	62079	1227	44967
4L-5S		MI	11156	5191	19016	3607	20283	2893	20704	2314	21097	1427	24957	842	19744
14-#14	2.73	MA	23363	5191	38523	3830	42632	3081	44579	2518	46810	1620	57973	1162	43008
5L-4S		MI	11547	5191	19679	3616	21108	2883	21685	2304	22362	1417	26551	902	20319
14-#14	2.73	MA	22554	5191	37128	3830	40736	3099	42265	2514	43746	1633	54052	1078	41731
6L-3S		MI	11978	5191	20429	3606	22030	2893	22777	2314	23730	1407	28060	1018	20648

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

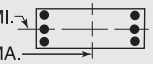


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.73	MA	21764	5191	35634	3849	38915	3097	40034	2530	40749	1645	49974	952	39602
7L-2S		MI	12565	5191	21342	3615	23164	2883	24128	2304	25516	1397	30358	1146	20636
14-#18	4.86	MA	26057	6059	45766	4364	51725	3499	55574	2764	61668	1561	78457	763	71048
5L-4S		MI	12723	6059	23035	4101	25141	3198	26462	2449	28722	1234	34672	325	32580
14-#18	4.86	MA	24694	6059	43309	4362	48387	3494	51502	2755	56277	1581	71662	613	66466
6L-3S		MI	13451	6059	24310	4083	26701	3216	28308	2466	31036	1216	37209	522	34422
14-#18	4.86	MA	23364	6059	40679	4395	45182	3523	47574	2782	51001	1600	64590	388	61490
7L-2S		MI	14436	6059	25859	4101	28618	3198	30593	2449	34056	1198	41055	749	34927
16-#11	2.17	MA	23550	4959	38111	3690	42193	2982	44087	2441	46278	1641	56773	1347	36175
4L-6S		MI	10787	4959	17957	3494	19053	2805	19285	2284	19128	1466	22556	980	16187
16-#11	2.17	MA	22950	4959	37080	3690	40863	2981	42457	2452	43953	1636	53896	1302	35497
5E		MI	11052	4959	18423	3486	19637	2812	19950	2277	20010	1459	23613	1040	16409
16-#11	2.17	MA	22379	4959	36108	3690	39541	2994	40845	2450	41818	1645	51143	1244	34606
6L-4S		MI	11329	4959	18889	3492	20222	2805	20647	2270	20973	1466	24751	1082	16733
16-#11	2.17	MA	21821	4959	35067	3704	38273	2992	39291	2462	39730	1655	48280	1156	33768
7L-3S		MI	11634	4959	19415	3484	20878	2812	21423	2277	21945	1459	25826	1163	16723
16-#11	2.17	MA	21271	4959	34114	3704	36993	3005	37769	2473	37542	1650	45591	1104	32614
8L-2S		MI	12051	4959	20058	3490	21684	2805	22383	2270	23214	1452	27467	1252	16697
16-#14	3.13	MA	24344	5350	40633	3930	45322	3153	47849	2563	51240	1610	63995	1143	49225
5E		MI	11552	5350	19929	3706	21418	2962	22056	2352	22883	1402	27255	789	22402
16-#14	3.13	MA	23543	5350	39238	3930	43425	3171	45535	2559	48176	1623	60074	1059	47861
6L-4S		MI	11940	5350	20592	3716	22242	2952	23037	2342	24147	1392	28849	850	22931
16-#14	3.13	MA	22761	5350	37744	3949	41605	3169	43304	2575	45179	1635	55996	933	45792
7L-3S		MI	12369	5350	21342	3706	23164	2962	24128	2352	25516	1382	30358	965	23414
16-#14	3.13	MA	21990	5350	36375	3949	39768	3187	41120	2591	42039	1628	52158	858	43644
8L-2S		MI	12952	5350	22255	3715	24298	2952	25480	2342	27302	1372	32656	1093	23428
16-#18	5.56	MA	26376	6343	47010	4539	53105	3622	57238	2835	64048	1563	82108	574	77284
6L-4S		MI	13380	6343	24584	4275	27058	3316	28746	2511	31742	1184	38518	218	37095
16-#18	5.56	MA	25066	6343	44380	4572	49900	3652	53310	2861	58772	1582	75036	349	72225
7L-3S		MI	14102	6343	25859	4257	28618	3334	30593	2529	34056	1166	41055	415	38780
16-#18	5.56	MA	23772	6343	41968	4570	46665	3646	49464	2888	53246	1567	68358	218	66734
8L-2S		MI	15079	6343	27408	4275	30535	3316	32877	2511	37076	1149	44901	643	39671
18-#11	2.44	MA	23643	5069	38553	3759	42740	3031	44740	2483	47045	1629	58122	1290	39831
5L-6S		MI	11070	5069	18600	3563	19859	2854	20245	2311	20397	1451	24197	946	18081
18-#11	2.44	MA	23076	5069	37581	3759	41419	3044	43128	2481	44910	1638	55369	1231	38972
6L-5S		MI	11334	5069	19066	3555	20443	2861	20911	2304	21279	1444	25254	1006	18287
18-#11	2.44	MA	22522	5069	36540	3773	40151	3043	41573	2493	42822	1648	52506	1144	38078
7L-4S		MI	11609	5069	19532	3561	21028	2854	21608	2297	22241	1451	26392	1048	18682
18-#11	2.44	MA	21977	5069	35586	3773	38871	3055	40051	2504	40634	1643	49817	1091	36954
8L-3S		MI	11913	5069	20058	3553	21684	2861	22383	2304	23214	1444	27467	1129	18689
18-#11	2.44	MA	21384	5069	34650	3773	37620	3054	38476	2502	38568	1652	47150	1035	35693
9L-2S		MI	12328	5069	20701	3559	22490	2854	23343	2297	24483	1437	29108	1218	18671
18-#14	3.52	MA	24522	5510	41348	4029	46115	3243	48805	2604	52607	1613	66096	1040	54002
6L-5S		MI	11945	5510	20842	3806	22552	3031	23407	2390	24669	1378	29553	737	25068
18-#14	3.52	MA	23748	5510	39854	4049	44295	3241	46574	2620	49609	1625	62017	914	51991
7L-4S		MI	12331	5510	21505	3816	23376	3021	24388	2380	25933	1368	31147	797	25556
18-#14	3.52	MA	22985	5510	38485	4048	42458	3259	44390	2636	46469	1618	58180	839	49796
8L-3S		MI	12757	5510	22255	3805	24298	3031	25480	2390	27302	1358	32656	913	26172
18-#14	3.52	MA	22171	5510	37140	4048	40663	3257	42129	2632	43504	1631	54381	758	47435
9L-2S		MI	13337	5510	23168	3815	25433	3021	26831	2380	29088	1348	34954	1040	26210
18-#18	6.25	MA	26746	6627	48081	4749	54618	3780	59046	2941	66543	1565	85482	309	82977
7L-4S		MI	14103	6627	26133	4450	28974	3435	31031	2574	34762	1135	42364	112	41628
18-#18	6.25	MA	25470	6627	45669	4747	51384	3775	55199	2968	61017	1549	78804	179	77442
8L-3S		MI	14798	6627	27408	4432	30535	3453	32877	2591	37076	1117	44901	309	43173
20-#11	2.71	MA	23767	5180	39053	3829	43296	3094	45410	2512	48002	1632	59595	1219	43342
6E		MI	11352	5180	19243	3632	20665	2903	21205	2339	21666	1435	25838	912	19977
20-#11	2.71	MA	23218	5180	38013	3842	42028	3093	43855	2524	45914	1641	56732	1132	42394
7L-5S		MI	11614	5180	19709	3624	21249	2910	21871	2332	22548	1428	26895	972	20171

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



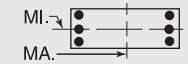
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.71	MA	22676	5180	37059	3842	40748	3105	42333	2535	43726	1636	54043	1079	41298
8L-4S		MI	11888	5180	20174	3630	21834	2903	22568	2325	23510	1435	28032	1014	20621
20-#11	2.71	MA	22098	5180	36122	3842	39498	3104	40759	2533	41660	1646	51376	1023	40004
9L-3S		MI	12191	5180	20701	3622	22490	2910	23343	2332	24483	1428	29108	1095	20650
20-#11	2.71	MA	21489	5180	35100	3856	38235	3117	39247	2545	39609	1655	48787	960	38670
10L-2S		MI	12604	5180	21344	3628	23296	2903	24304	2325	25752	1421	30748	1184	20639
20-#14	3.91	MA	24726	5669	41964	4149	46985	3314	49844	2665	54039	1615	68039	895	58198
7L-5S		MI	12335	5669	21755	3906	23686	3100	24758	2428	26455	1354	31852	684	27738
20-#14	3.91	MA	23970	5669	40594	4148	45148	3331	47660	2681	50900	1608	64201	820	55955
8L-4S		MI	12719	5669	22418	3915	24510	3091	25740	2418	27719	1344	33445	744	28192
20-#14	3.91	MA	23159	5669	39250	4148	43353	3329	45399	2677	47934	1621	60402	739	53567
9L-3S		MI	13143	5669	23168	3905	25433	3100	26831	2428	29088	1334	34954	860	28924
20-#14	3.91	MA	22336	5669	37782	4167	41540	3347	43229	2693	44990	1633	56717	648	51151
10L-2S		MI	13720	5669	24081	3915	26567	3091	28182	2418	30874	1324	37252	988	28980
20-#18	6.94	MA	27149	6911	49370	4924	56102	3903	60935	3047	68788	1531	89250	139	88164
8L-4S		MI	14746	6911	27682	4624	30891	3554	33315	2636	37782	1085	46210	5	46174
22-#11	2.98	MA	23908	5291	39485	3911	43906	3143	46138	2555	49006	1634	60958	1120	46715
7L-6S		MI	11632	5291	19885	3701	21471	2952	22165	2366	22935	1419	27478	878	21863
22-#11	2.98	MA	23371	5291	38531	3911	42626	3156	44616	2566	46818	1629	58269	1067	45647
8L-5S		MI	11893	5291	20352	3693	22055	2958	22831	2359	23816	1412	28536	938	22057
22-#11	2.98	MA	22794	5291	37595	3911	41375	3154	43041	2564	44752	1639	55601	1011	44321
9L-4S		MI	12166	5291	20817	3699	22640	2952	23528	2352	24779	1419	29673	980	22480
22-#11	2.98	MA	22191	5291	36573	3925	40112	3167	41529	2576	42701	1648	53013	948	42965
10L-3S		MI	12467	5291	21344	3691	23296	2958	24304	2359	25752	1412	30748	1061	22599
22-#11	2.98	MA	21609	5291	35636	3925	38869	3166	39973	2573	40544	1643	50387	892	41444
11L-2S		MI	12879	5291	21986	3697	24102	2952	25264	2352	27021	1406	32389	1150	22603
22-#14	4.30	MA	24947	5829	42704	4248	47838	3404	50930	2726	55330	1598	70223	801	62123
8L-5S		MI	12724	5829	22668	4006	24820	3170	26110	2466	28240	1329	34150	631	30412
22-#14	4.30	MA	24137	5829	41360	4247	46043	3402	48669	2722	52364	1611	66424	720	59706
9L-4S		MI	13106	5829	23331	4015	25644	3160	27091	2456	29505	1319	35743	692	30835
22-#14	4.30	MA	23322	5829	39892	4267	44230	3419	46499	2738	49421	1623	62739	629	57304
10L-3S		MI	13527	5829	24081	4005	26567	3170	28182	2466	30874	1310	37252	807	31671
24-#11	3.25	MA	24061	5401	40004	3981	44503	3206	46898	2598	49910	1622	62495	1055	50000
8L-6S		MI	11911	5401	20528	3770	22277	3000	23126	2393	24204	1404	29119	844	23695
24-#11	3.25	MA	23484	5401	39068	3981	43253	3205	45324	2595	47844	1632	59827	999	48642
9L-5S		MI	12171	5401	20995	3763	22861	3007	23792	2386	25085	1397	30176	904	23947
24-#11	3.25	MA	22888	5401	38045	3994	41990	3217	43811	2607	45793	1641	57239	936	47265
10L-4S		MI	12442	5401	21460	3768	23446	3000	24489	2379	26048	1404	31314	945	24344
24-#11	3.25	MA	22310	5401	37109	3994	40747	3216	42255	2605	43636	1636	54613	880	45768
11L-3S		MI	12742	5401	21986	3761	24102	3007	25264	2386	27021	1397	32389	1027	24546
24-#11	3.25	MA	21742	5401	36102	4008	39492	3229	40746	2616	41589	1646	51721	806	44116
12L-2S		MI	13152	5401	22629	3767	24908	3000	26224	2379	28289	1390	34030	1116	24564
24-#14	4.69	MA	25107	5989	43470	4347	48733	3474	51939	2767	56794	1601	72446	701	65852
9L-5S		MI	13111	5989	23581	4105	25954	3239	27461	2504	30026	1305	36448	579	33030
24-#14	4.69	MA	24298	5989	42002	4367	46920	3492	49769	2783	53851	1613	68760	610	63428
10L-4S		MI	13491	5989	24244	4115	26778	3229	28442	2494	31291	1295	38041	639	33485

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

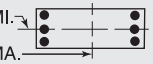
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.38	MA	7180	2722	11583	1948	12408	1581	12608	1302	12620	893	14742	812	7030
2L-3S		MI	6712	2722	10871	1943	11503	1588	11530	1309	11196	900	12888	723	7073
6-#14	2.00	MA	7567	2869	12508	2029	13518	1635	13918	1329	14348	864	16954	756	9870
2L-3S		MI	6909	2869	11495	2021	12241	1645	12397	1339	12339	874	14349	628	9892
6-#18	3.55	MA	8485	3241	14762	2240	16182	1772	17070	1394	18509	785	22222	601	16768
2L-3S		MI	7375	3241	13011	2223	14013	1790	14486	1412	15094	803	17835	373	16260
8-#11	1.85	MA	7495	2833	12295	2017	13313	1631	13686	1331	14044	879	16596	781	9228
2L-4S		MI	6693	2833	11002	2021	11673	1631	11738	1331	11529	893	13531	609	9211
8-#14	2.66	MA	8005	3029	13520	2128	14794	1706	15438	1369	16357	843	19559	709	12975
2L-4S		MI	6881	3029	11679	2132	12480	1706	12690	1369	12808	863	15249	462	12136
8-#18	4.73	MA	9214	3525	16512	2418	18350	1894	19654	1461	21923	741	26610	505	22068
2L-4S		MI	7324	3525	13323	2418	14418	1894	14983	1461	15892	776	19339	73	18888
10-#11	2.31	MA	7806	2944	13007	2086	14218	1681	14763	1359	15468	865	18450	751	11413
2L-5S		MI	6709	2944	11201	2085	11920	1688	12033	1366	11873	872	14099	537	10678
10-#11	2.31	MA	7345	2944	12295	2081	13313	1688	13686	1366	14044	872	16596	662	11418
3L-4S		MI	7011	2944	11714	2090	12578	1681	12816	1359	12952	879	15385	578	11213
10-#14	3.33	MA	8438	3188	14533	2228	16070	1777	16959	1409	18366	821	22163	662	16062
2L-5S		MI	6903	3188	11960	2224	12829	1787	13107	1419	13293	831	16048	355	14251
10-#14	3.33	MA	7794	3188	13520	2220	14794	1787	15438	1419	16357	831	19559	534	15993
3L-4S		MI	7326	3188	12692	2232	13756	1777	14211	1409	14817	841	17854	415	15001
10-#18	5.92	MA	8857	3809	16512	2578	18350	2034	19654	1545	21923	715	26610	182	25730
3L-4S		MI	8072	3809	15074	2596	16586	2016	17567	1528	19306	732	23727	-22	23617

RECTANGULAR TIED COLUMNS 26" x 28"

4-#14	1.24	MA	8219	2893	13170	2078	14081	1690	14261	1397	14162	971	16492	890	7346
2E		MI	7603	2893	12223	2062	12987	1674	13117	1382	12979	957	15052	873	6771
4-#18	2.20	MA	8915	3142	14848	2212	16076	1779	16611	1439	17259	919	20445	792	12495
2E		MI	8225	3142	13743	2195	14758	1758	15203	1419	15730	900	18532	764	11464
6-#11	1.29	MA	8280	2906	13263	2097	14237	1705	14487	1410	14464	978	16914	898	7661
2L-3S		MI	7190	2906	11598	2076	12249	1698	12251	1402	11839	972	13594	793	7108
6-#11	1.29	MA	7765	2906	12482	2093	13241	1712	13291	1417	12884	985	14846	810	7705
3L-2S		MI	7660	2906	12310	2081	13154	1691	13329	1395	13262	965	15448	881	7061
6-#14	1.85	MA	8712	3053	14282	2178	15500	1763	15952	1439	16394	951	19405	848	10781
2L-3S		MI	7388	3053	12223	2154	12987	1755	13117	1432	12979	946	15052	697	9946
6-#14	1.85	MA	7987	3053	13170	2171	14081	1773	14261	1448	14162	961	16492	720	10803
3L-2S		MI	8048	3053	13236	2162	14263	1745	14638	1422	14988	936	17657	825	9909
6-#18	3.30	MA	9741	3425	16776	2390	18497	1904	19495	1509	21070	879	25377	706	18388
2L-3S		MI	7854	3425	13743	2354	14758	1898	15203	1504	15730	873	18532	441	16628
6-#18	3.30	MA	8514	3425	14848	2375	16076	1922	16611	1527	17259	897	20445	478	18163
3L-2S		MI	8968	3425	15493	2372	16926	1880	17787	1486	19145	856	22919	669	16830
8-#11	1.71	MA	8629	3017	14044	2166	15233	1755	15682	1440	16043	966	18982	871	10070
2L-4S		MI	7171	3017	11729	2154	12419	1741	12459	1424	12171	965	14237	678	9281
8-#11	1.71	MA	8118	3017	13263	2162	14237	1763	14487	1446	14464	972	16914	782	10096
3E		MI	7509	3017	12310	2146	13154	1748	13329	1431	13262	958	15448	762	9294
8-#11	1.71	MA	7749	3017	12628	2172	13429	1756	13522	1440	13253	979	15566	696	10063
4L-2S		MI	7975	3017	13022	2151	14059	1741	14407	1424	14686	951	17302	851	9263
8-#14	2.47	MA	9199	3213	15395	2278	16918	1835	17642	1480	18627	932	22317	805	14190
2L-4S		MI	7359	3213	12408	2265	13225	1816	13410	1462	13448	934	15952	531	12337
8-#14	2.47	MA	8482	3213	14282	2271	15500	1845	15952	1490	16394	942	19405	677	14164
3E		MI	7834	3213	13236	2253	14263	1826	14638	1472	14988	924	17657	650	13012
8-#14	2.47	MA	7963	3213	13376	2284	14347	1835	14588	1480	14683	952	17504	555	13422
4L-2S		MI	8487	3213	14249	2262	15539	1816	16158	1462	16997	914	20262	778	13020
8-#18	4.40	MA	10553	3709	18703	2567	20918	2029	22379	1579	24881	840	30309	619	24228
2L-4S		MI	7800	3709	14055	2550	15162	2002	15700	1553	16528	847	20036	142	19156
8-#18	4.40	MA	9346	3709	16776	2552	18497	2047	19495	1597	21070	858	25377	392	23433
3E		MI	8602	3709	15493	2532	16926	2020	17787	1570	19145	829	22919	346	21316

RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis



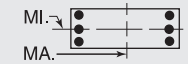
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	4.40	MA	8471	3709	15198	2573	16528	2029	17166	1579	18148	875	22147	182	20924
4L-2S		MI	9700	3709	17244	2549	19095	2002	20371	1553	22559	812	27307	573	22138
10-#11	2.14	MA	8974	3127	14825	2235	16229	1805	16878	1469	17622	953	21049	843	12466
2L-5S		MI	7187	3127	11928	2219	12666	1798	12755	1460	12515	944	14806	607	10816
10-#11	2.14	MA	8467	3127	14044	2231	15233	1813	15682	1476	16043	960	18982	755	12471
3L-4S		MI	7490	3127	12441	2224	13323	1791	13537	1453	13595	951	16091	648	11376
10-#11	2.14	MA	8102	3127	13409	2241	14425	1807	14718	1469	14832	967	17634	669	12380
4L-3S		MI	7825	3127	13022	2215	14059	1798	14407	1460	14686	944	17302	732	11468
10-#11	2.14	MA	7772	3127	12849	2237	13704	1814	13850	1476	13635	960	16200	628	11734
5L-2S		MI	8287	3127	13734	2220	14963	1791	15484	1453	16110	937	19156	820	11451
10-#14	3.09	MA	9680	3372	16507	2378	18336	1907	19332	1522	20860	913	25229	762	17581
2L-5S		MI	7379	3372	12689	2357	13574	1897	13827	1512	13933	903	16751	425	14569
10-#14	3.09	MA	8970	3372	15395	2371	16918	1917	17642	1532	18627	923	22317	634	17512
3L-4S		MI	7804	3372	13420	2365	14502	1887	14931	1502	15457	913	18557	484	15197
10-#14	3.09	MA	8457	3372	14488	2384	15766	1907	16278	1522	16915	933	20416	512	16573
4L-3S		MI	8275	3372	14249	2353	15539	1897	16158	1512	16997	903	20262	603	16063
10-#14	3.09	MA	7995	3372	13688	2377	14735	1917	15051	1532	15223	923	18396	454	15840
5L-2S		MI	8921	3372	15261	2361	16816	1887	17679	1502	19006	893	22866	731	16114
10-#18	5.49	MA	10165	3993	18703	2730	20918	2172	22379	1667	24881	818	30309	305	28703
3L-4S		MI	8550	3993	15805	2727	17331	2124	18284	1619	19942	803	24424	46	24129
10-#18	5.49	MA	9303	3993	17125	2750	18949	2154	20051	1650	21959	836	27079	95	26419
4L-3S		MI	9340	3993	17244	2709	19095	2142	20371	1637	22559	785	27307	250	26078
12-#11	2.57	MA	9317	3238	15606	2304	17224	1855	18073	1499	19201	941	23117	816	14852
2L-6S		MI	7218	3238	12155	2283	12916	1841	13085	1495	12949	937	15463	516	12397
12-#11	2.57	MA	8814	3238	14825	2300	16229	1863	16878	1506	17622	948	21049	727	14835
3L-5S		MI	7505	3238	12640	2288	13571	1848	13832	1488	13939	930	16660	576	12877
12-#11	2.57	MA	8451	3238	14190	2310	15421	1857	15913	1499	16411	955	19702	641	14597
4E		MI	7805	3238	13153	2293	14228	1841	14615	1481	15018	937	17945	617	13393
12-#11	2.57	MA	8124	3238	13630	2306	14700	1864	15045	1506	15214	948	18268	601	13998
5L-3S		MI	8138	3238	13734	2284	14963	1848	15484	1488	16110	930	19156	701	13625
12-#11	2.57	MA	7812	3238	13100	2302	13982	1858	14216	1513	14117	955	16931	541	13467
6L-2S		MI	8596	3238	14446	2289	15868	1841	16562	1481	17534	924	21010	790	13631
12-#14	3.71	MA	9453	3532	16507	2471	18336	1990	19332	1574	20860	904	25229	592	20850
3L-5S		MI	7825	3532	13701	2457	14851	1967	15347	1552	15942	881	19356	377	17354
12-#14	3.71	MA	8946	3532	15601	2484	17184	1980	17968	1564	19148	914	23328	470	19746
4E		MI	8245	3532	14433	2465	15778	1957	16451	1542	17466	891	21162	437	18079
12-#14	3.71	MA	8488	3532	14801	2477	16154	1990	16741	1574	17455	904	21309	411	18960
5L-3S		MI	8711	3532	15261	2453	16816	1967	17679	1552	19006	881	22866	556	19103
12-#14	3.71	MA	8051	3532	14044	2470	15128	1980	15569	1584	15904	914	19428	325	17722
6L-2S		MI	9352	3532	16274	2461	18092	1957	19199	1542	21015	871	25471	684	19188
12-#18	6.59	MA	10125	4276	19053	2927	21370	2280	22935	1720	25770	796	32011	9	31948
4E		MI	9290	4276	17556	2904	19499	2247	20868	1686	23357	759	28811	-49	28524
14-#11	3.00	MA	9157	3349	15606	2369	17224	1913	18073	1536	19201	936	23117	700	17193
3L-6S		MI	7535	3349	12867	2352	13821	1891	14163	1524	14373	924	17317	486	14404
14-#11	3.00	MA	8798	3349	14971	2379	16417	1907	17109	1529	17990	942	21770	614	16828
4L-5S		MI	7820	3349	13352	2357	14475	1898	14910	1517	15363	917	18513	546	14946
14-#11	3.00	MA	8473	3349	14411	2375	15696	1914	16241	1536	16793	936	20336	573	16270
5L-4S		MI	8118	3349	13865	2362	15133	1891	15692	1510	16442	924	19799	587	15424
14-#11	3.00	MA	8163	3349	13881	2371	14978	1908	15412	1543	15696	942	18999	514	15678
6L-3S		MI	8448	3349	14446	2353	15868	1898	16562	1517	17534	917	21010	671	15776
14-#11	3.00	MA	7861	3349	13315	2380	14287	1916	14550	1536	14622	949	17737	447	15077
7L-2S		MI	8904	3349	15158	2358	16773	1891	17640	1510	18958	910	22864	759	15803

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

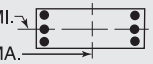
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	4.33	MA	9430	3691	16713	2583	18602	2052	19658	1606	21380	894	26241	427	22938
4L-5S		MI	8266	3691	14714	2557	16127	2038	16868	1592	17951	860	21960	330	20160
14-#14	4.33	MA	8977	3691	15913	2577	17572	2062	18431	1616	19688	885	24221	368	22058
5L-4S		MI	8682	3691	15446	2565	17054	2028	17972	1582	19475	869	23766	389	20979
14-#14	4.33	MA	8544	3691	15156	2570	16546	2052	17259	1626	18136	894	22340	282	20887
6L-3S		MI	9143	3691	16274	2553	18092	2038	19199	1592	21015	860	25471	509	22137
16-#11	3.43	MA	9141	3459	15752	2448	17413	1957	18304	1559	19569	930	23837	586	19071
4L-6S		MI	7850	3459	13579	2421	14726	1941	15241	1552	15797	910	19171	455	16422
16-#11	3.43	MA	8819	3459	15192	2444	16691	1965	17437	1566	18372	923	22404	546	18550
5E		MI	8133	3459	14064	2426	15380	1947	15988	1546	16786	903	20367	515	17021
16-#11	3.43	MA	8512	3459	14662	2440	15973	1958	16607	1573	17275	930	21067	486	17899
6L-4S		MI	8429	3459	14577	2431	16038	1941	16770	1539	17866	910	21653	556	17466
16-#11	3.43	MA	8212	3459	14096	2449	15283	1966	15746	1566	16201	937	19805	419	17294
7L-3S		MI	8756	3459	15158	2422	16773	1947	17640	1546	18958	903	22864	640	17923
16-#14	4.95	MA	9461	3851	17026	2676	18990	2134	20121	1658	21920	865	27133	326	25174
5E		MI	8703	3851	15727	2656	17403	2109	18388	1632	19960	838	24565	283	22984
16-#14	4.95	MA	9032	3851	16269	2670	17964	2125	18949	1668	20369	875	25253	239	24065
6L-4S		MI	9115	3851	16459	2664	18331	2099	19492	1622	21483	848	26371	342	23893
18-#11	3.86	MA	9163	3570	15973	2513	17687	2015	18632	1595	19952	911	24471	518	20834
5L-6S		MI	8163	3570	14291	2490	15630	1990	16318	1581	17221	896	21025	425	18448
18-#11	3.86	MA	8858	3570	15444	2509	16969	2009	17803	1602	18854	918	23134	459	20129
6L-5S		MI	8443	3570	14776	2495	16285	1997	17066	1574	18210	889	22221	485	19101
18-#11	3.86	MA	8560	3570	14877	2519	16279	2016	16941	1595	17780	925	21873	392	19484
7L-4S		MI	8737	3570	15289	2500	16942	1990	17848	1567	19290	896	23507	525	19517
18-#14	5.56	MA	9516	4011	17381	2769	19383	2197	20639	1709	22601	856	28165	197	27237
6L-5S		MI	9136	4010	16740	2756	18680	2180	19909	1672	21969	817	27169	236	25824
20-#11	4.29	MA	9201	3681	16225	2578	17965	2059	18999	1632	20433	906	25202	431	22366
6E		MI	8473	3681	15003	2559	16535	2040	17396	1610	18644	882	22878	394	20481
20-#11	4.29	MA	8906	3681	15658	2588	17275	2066	18137	1625	19359	912	23940	364	21684
7L-5S		MI	8752	3681	15488	2564	17190	2047	18143	1603	19634	875	24075	454	21185
22-#11	4.71	MA	9249	3791	16439	2657	18270	2116	19332	1655	20938	900	26008	337	23890
7L-6S		MI	8782	3791	15715	2629	17440	2090	18474	1638	20068	868	24732	364	22522

RECTANGULAR TIED COLUMNS 26" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.15	MA	9388	3077	14949	2228	16006	1813	16240	1504	16090	1055	18754	976	7953
2E		MI	8082	3077	12952	2195	13732	1783	13837	1475	13619	1029	15756	942	6803
4-#18	2.05	MA	10161	3326	16789	2362	18254	1907	18851	1549	19530	1007	23177	885	13575
2E		MI	8706	3326	14475	2326	15502	1866	15920	1511	16366	970	19228	833	11512
6-#11	1.20	MA	9454	3090	15047	2246	16171	1828	16480	1517	16412	1062	19205	984	8293
2L-3S		MI	7669	3090	12324	2210	12995	1808	12972	1496	12481	1044	14301	862	7141
6-#11	1.20	MA	8891	3090	14197	2243	15087	1836	15167	1524	14677	1069	16922	895	8336
3L-2S		MI	8139	3090	13036	2215	13899	1801	14050	1489	13905	1037	16155	951	7091
6-#14	1.73	MA	9932	3237	16162	2328	17552	1886	18100	1547	18547	1038	21975	937	11692
2L-3S		MI	7866	3237	12952	2287	13732	1864	13837	1525	13619	1017	15756	767	9994
6-#14	1.73	MA	9139	3237	14949	2322	16006	1897	16240	1557	16090	1048	18754	809	11714
3L-2S		MI	8528	3237	13964	2295	15008	1854	15357	1515	15628	1007	18360	894	9947
6-#18	3.08	MA	11072	3609	18894	2539	20928	2035	22036	1623	23738	971	28656	807	20008
2L-3S		MI	8332	3609	14475	2486	15502	2006	15920	1595	16366	944	19228	509	16756
6-#18	3.08	MA	9729	3609	16789	2526	18254	2052	18851	1640	19530	989	23177	579	19783
3L-2S		MI	9450	3609	16225	2503	17671	1988	18504	1578	19780	926	23616	737	16885
8-#11	1.60	MA	9838	3201	15898	2316	17255	1878	17794	1548	18147	1051	21487	959	10912
2L-4S		MI	7649	3201	12456	2288	13164	1851	13180	1518	12813	1037	14943	748	9336
8-#11	1.60	MA	9280	3201	15047	2312	16171	1886	16480	1555	16412	1058	19205	870	10938
3E		MI	7988	3201	13036	2279	13899	1858	14050	1524	13905	1030	16155	832	9333

RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

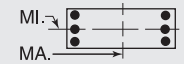
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.60	MA	8879	3201	14358	2322	15295	1881	15421	1548	15082	1065	17720	782	10905
4L-2S		MI	8455	3201	13748	2284	14804	1851	15128	1518	15328	1023	18008	920	9297
8-#14	2.31	MA	10468	3396	17374	2427	19097	1958	19960	1591	21004	1020	25196	898	15405
2L-4S		MI	7837	3396	13136	2398	13971	1925	14130	1555	14088	1006	16655	600	12530
8-#14	2.31	MA	9684	3396	16162	2422	17552	1969	18100	1601	18547	1030	21975	770	15379
3E		MI	8313	3396	13964	2387	15008	1935	15357	1565	15628	996	18360	719	13071
8-#14	2.31	MA	9120	3396	15177	2436	16300	1961	16600	1591	16663	1040	19877	645	14729
4L-2S		MI	8968	3396	14977	2395	16285	1925	16878	1555	17637	986	20965	847	13063
8-#18	4.10	MA	11969	3893	20999	2717	23602	2162	25222	1696	27947	936	34134	728	26388
2L-4S		MI	8277	3893	14787	2681	15907	2110	16417	1645	17163	918	20733	210	19414
8-#18	4.10	MA	10647	3893	18894	2704	20928	2180	22036	1714	23738	954	28656	501	25965
3E		MI	9082	3893	16225	2663	17671	2128	18504	1662	19780	900	23616	414	21664
8-#18	4.10	MA	9693	3893	17176	2726	18755	2162	19465	1696	20512	971	25076	285	22989
4L-2S		MI	10185	3893	17975	2681	19839	2110	21088	1645	23195	882	28004	641	22206
10-#11	2.00	MA	10218	3311	16748	2385	18339	1928	19107	1579	19882	1040	23769	934	13519
2L-5S		MI	7664	3311	12655	2352	13412	1908	13476	1553	13157	1016	15512	676	10949
10-#11	2.00	MA	9664	3311	15898	2381	17255	1937	17794	1586	18147	1047	21487	845	13524
3L-4S		MI	7968	3311	13167	2357	14069	1901	14258	1546	14237	1023	16797	717	11485
10-#11	2.00	MA	9267	3311	15208	2392	16379	1931	16734	1579	16817	1054	20003	757	13461
4L-3S		MI	8305	3311	13748	2349	14804	1908	15128	1553	15328	1016	18008	801	11511
10-#11	2.00	MA	8909	3311	14601	2388	15596	1940	15781	1586	15502	1047	18420	717	12801
5L-2S		MI	8768	3311	14460	2354	15709	1901	16206	1546	16752	1009	19862	890	11489
10-#14	2.88	MA	10998	3556	18586	2527	20643	2030	21820	1634	23461	1003	28417	860	19100
2L-5S		MI	7856	3556	13417	2490	14320	2006	14547	1605	14573	974	17454	494	14738
10-#14	2.88	MA	10222	3556	17374	2521	19097	2042	19960	1644	21004	1013	25196	732	19030
3L-4S		MI	8283	3556	14149	2498	15247	1996	15650	1595	16097	984	19260	553	15386
10-#14	2.88	MA	9664	3556	16389	2535	17845	2033	18460	1634	19120	1023	23098	607	18167
4L-3S		MI	8755	3556	14977	2486	16285	2006	16878	1605	17637	974	20965	672	16129
10-#14	2.88	MA	9161	3556	15521	2530	16727	2044	17110	1644	17258	1013	20865	549	17301
5L-2S		MI	9404	3556	15990	2494	17561	1996	18398	1595	19646	964	23569	800	16161
10-#18	5.13	MA	11550	4177	20999	2881	23602	2308	25222	1787	27947	918	34134	422	31737
3L-4S		MI	9028	4177	16537	2858	18075	2233	19001	1711	20578	874	25121	114	24383
10-#18	5.13	MA	10611	4177	19281	2904	21429	2290	22651	1769	24720	936	30555	207	29001
4L-3S		MI	9822	4177	17975	2840	19839	2250	21088	1729	23195	856	28004	318	26417
10-#18	5.13	MA	9766	4177	17766	2891	19486	2308	20339	1787	21529	918	26756	102	26216
5L-2S		MI	10910	4177	19726	2858	22007	2233	23672	1711	26610	838	32391	546	27494
12-#11	2.40	MA	10595	3422	17598	2454	19423	1978	20421	1609	21616	1029	26051	909	16116
2L-6S		MI	7695	3422	12881	2417	13662	1951	13806	1589	13592	1009	16169	586	12613
12-#11	2.40	MA	10045	3422	16748	2450	18339	1987	19107	1616	19882	1036	23769	820	16098
3L-5S		MI	7983	3422	13367	2422	14316	1958	14553	1582	14581	1002	17366	646	13009
12-#11	2.40	MA	9651	3422	16058	2461	17463	1981	18048	1609	18551	1043	22285	732	15980
4E		MI	8285	3422	13879	2427	14974	1951	15336	1575	15661	1009	18651	687	13548
12-#11	2.40	MA	9296	3422	15451	2457	16680	1990	17094	1616	17237	1036	20702	692	15268
5L-3S		MI	8618	3422	14460	2418	15709	1958	16206	1582	16752	1002	19862	771	13675
12-#11	2.40	MA	8957	3422	14877	2454	15902	1984	16183	1623	16031	1043	19225	633	14785
6L-2S		MI	9078	3422	15172	2423	16614	1951	17283	1575	18176	995	21716	859	13671
12-#14	3.46	MA	10754	3716	18586	2621	20643	2114	21820	1687	23461	996	28417	693	22672
3L-5S		MI	8302	3716	14430	2590	15596	2077	16067	1645	16582	953	20059	446	17658
12-#14	3.46	MA	10202	3716	17601	2635	19391	2105	20320	1678	21577	1006	26320	568	21629
4E		MI	8725	3716	15162	2598	16523	2067	17171	1635	18106	962	21865	506	18266
12-#14	3.46	MA	9704	3716	16733	2629	18272	2117	18970	1687	19715	996	24086	510	20825
5L-3S		MI	9192	3716	15990	2586	17561	2077	18398	1645	19646	953	23569	625	19175
12-#14	3.46	MA	9230	3716	15912	2624	17159	2108	17680	1697	18007	1006	22003	424	19464
6L-2S		MI	9836	3716	17003	2594	18837	2067	19919	1635	21655	943	26174	753	19243

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	6.15	MA	11517	4460	21387	3081	24103	2418	25836	1843	28928	900	36033	128	35048
4E		MI	9769	4460	18287	3036	20243	2355	21584	1778	23992	829	29508	19	29385
12-#18	6.15	MA	10684	4460	19871	3068	22160	2436	23524	1860	25738	883	32235	24	32104
5L-3S		MI	10553	4460	19726	3018	22007	2372	23672	1796	26610	812	32391	223	31229
14-#11	2.80	MA	10423	3533	17598	2519	19423	2037	20421	1647	21616	1025	26051	795	18667
3L-6S		MI	8013	3533	13593	2486	14566	2001	14884	1617	15015	995	18023	555	14617
14-#11	2.80	MA	10032	3533	16908	2530	18547	2031	19361	1640	20286	1032	24567	707	18410
4L-5S		MI	8299	3533	14079	2491	15221	2008	15631	1610	16005	989	19220	615	15078
14-#11	2.80	MA	9680	3533	16301	2526	17764	2040	18408	1647	18972	1025	22984	667	17743
5L-4S		MI	8598	3533	14591	2496	15878	2001	16414	1604	17084	995	20505	656	15577
14-#11	2.80	MA	9344	3533	15727	2523	16986	2035	17497	1654	17766	1032	21507	608	17197
6L-3S		MI	8929	3533	15172	2487	16614	2008	17283	1610	18176	989	21716	740	15831
14-#11	2.80	MA	9015	3533	15113	2533	16237	2043	16551	1647	16586	1039	20118	540	16491
7L-2S		MI	9386	3533	15884	2492	17518	2001	18361	1604	19600	982	23570	829	15847
14-#14	4.04	MA	10734	3875	18813	2735	20936	2178	22180	1721	24033	989	29541	529	25110
4L-5S		MI	8744	3875	15443	2690	16872	2148	17588	1685	18591	931	22663	399	20459
14-#14	4.04	MA	10242	3875	17945	2729	19818	2189	20830	1731	22172	979	27307	471	24305
5L-4S		MI	9163	3875	16174	2698	17800	2138	18691	1675	20115	941	24469	458	21163
14-#14	4.04	MA	9772	3875	17124	2723	18704	2180	19540	1741	20464	989	25224	385	22920
6L-3S		MI	9626	3875	17003	2686	18837	2148	19919	1685	21655	931	26174	578	22214
14-#18	7.18	MA	11590	4744	21976	3245	24834	2563	26710	1934	29946	847	37713	-55	37375
5L-4S		MI	10504	4744	20038	3213	22412	2477	24168	1845	27407	785	33896	-77	33410
16-#11	3.20	MA	10410	3643	17759	2599	19631	2082	20675	1671	22021	1021	26849	682	20853
4L-6S		MI	8328	3643	14305	2555	15471	2051	15962	1646	16439	982	19877	525	16632
16-#11	3.20	MA	10060	3643	17152	2596	18848	2090	19722	1678	20707	1014	25267	642	20226
5E		MI	8612	3643	14791	2560	16126	2058	16709	1639	17429	975	21074	585	17153
16-#11	3.20	MA	9727	3643	16578	2592	18070	2085	18811	1685	19501	1021	23789	583	19619
6L-4S		MI	8910	3643	15303	2565	16783	2051	17491	1632	18508	982	22359	625	17617
16-#11	3.20	MA	9401	3643	15964	2602	17321	2093	17864	1678	18321	1028	22400	515	18945
7L-3S		MI	9238	3643	15884	2556	17518	2058	18361	1639	19600	975	23570	710	17981
16-#14	4.62	MA	10774	4035	19157	2829	21363	2261	22690	1774	24628	961	30528	433	27709
5E		MI	9182	4035	16455	2789	18148	2219	19108	1725	20600	909	25268	352	23278
16-#14	4.62	MA	10309	4035	18336	2823	20250	2253	21400	1784	22921	971	28445	347	26390
6L-4S		MI	9597	4035	17187	2797	19076	2209	20212	1715	22124	919	27074	411	24075
18-#11	3.60	MA	10438	3754	18002	2665	19932	2140	21035	1709	22441	1003	27549	617	22715
5L-6S		MI	8641	3754	15017	2624	16376	2101	17039	1675	17863	968	21731	494	18656
18-#11	3.60	MA	10107	3754	17428	2661	19154	2135	20124	1716	21236	1010	26071	558	22050
6L-5S		MI	8924	3754	15503	2629	17031	2107	17787	1668	18852	961	22927	554	19232
18-#11	3.60	MA	9784	3754	16814	2672	18405	2143	19178	1709	20056	1017	24683	490	21406
7L-4S		MI	9219	3754	16015	2634	17688	2101	18569	1661	19932	968	24213	595	19666
18-#14	5.19	MA	10841	4194	19549	2923	21795	2325	23260	1828	25378	954	31666	308	29872
6L-5S		MI	9617	4194	17468	2889	19425	2289	20629	1765	22609	888	27872	305	26113
20-#11	4.00	MA	10485	3865	18278	2730	20238	2185	21438	1746	22970	999	28354	533	24489
6E		MI	8953	3865	15729	2693	17281	2150	18117	1703	19287	954	23585	464	20687
20-#11	4.00	MA	10164	3865	17664	2741	19489	2193	20491	1740	21790	1006	26965	465	23842
7L-5S		MI	9233	3865	16215	2698	17935	2157	18865	1696	20276	947	24781	524	21316
22-#11	4.40	MA	10541	3975	18514	2810	20573	2244	21805	1770	23525	995	29247	440	26250
7L-6S		MI	9262	3975	16441	2762	18186	2200	19195	1732	20710	940	25439	433	22725

RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis

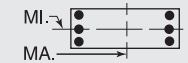
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.08	MA	10632	3261	16834	2377	18045	1936	18333	1611	18124	1138	21135	1060	8561
2E		MI	8561	3261	13680	2328	14477	1893	14557	1568	14259	1100	16459	1011	6834
4-#18	1.92	MA	11482	3509	18835	2511	20511	2031	21206	1659	21908	1094	26030	976	14655
2E		MI	9186	3509	15206	2457	16247	1974	16637	1603	17001	1041	19925	901	11559
6-#11	1.13	MA	10702	3274	16936	2396	18220	1951	18568	1623	18466	1146	21614	1068	8925
2L-3S		MI	8147	3274	13051	2344	13740	1918	13693	1589	13123	1116	15007	932	7172
6-#11	1.13	MA	10092	3274	16017	2393	17048	1960	17143	1630	16575	1152	19117	979	8968
3L-2S		MI	8618	3274	13763	2349	14645	1912	14771	1582	14547	1109	16861	1020	7120
6-#14	1.62	MA	11226	3421	18146	2477	19718	2009	20364	1656	20805	1123	24666	1025	12603
2L-3S		MI	8345	3421	13680	2420	14477	1974	14557	1618	14259	1089	16459	836	10039
6-#14	1.62	MA	10365	3421	16834	2472	18045	2021	18333	1666	18124	1133	21135	897	12626
3L-2S		MI	9008	3421	14693	2428	15754	1964	16077	1608	16268	1079	19063	964	9985
6-#18	2.88	MA	12480	3793	21117	2689	23421	2160	24694	1735	26514	1062	32057	904	21628
2L-3S		MI	8811	3793	15206	2617	16247	2114	16637	1687	17001	1015	19925	578	16850
6-#18	2.88	MA	11019	3793	18835	2678	20511	2179	21206	1753	21908	1080	26030	677	21403
3L-2S		MI	9933	3793	16957	2635	18415	2096	19221	1670	20416	997	24313	805	16940
8-#11	1.50	MA	11121	3385	17856	2465	19392	2001	19993	1654	20357	1136	24111	1045	11755
2L-4S		MI	8127	3385	13182	2422	13910	1961	13901	1611	13455	1109	15650	817	9387
8-#11	1.50	MA	10516	3385	16936	2462	18220	2010	18568	1661	18466	1143	21614	956	11781
3E		MI	8467	3385	13763	2413	14645	1968	14771	1618	14547	1102	16861	901	9370
8-#11	1.50	MA	10083	3385	16192	2473	17274	2005	17420	1655	17016	1149	19991	868	11748
4L-2S		MI	8934	3385	14475	2418	15550	1961	15849	1611	15971	1095	18715	990	9330
8-#14	2.16	MA	11813	3580	19458	2577	21391	2081	22394	1700	23486	1107	28196	989	16620
2L-4S		MI	8314	3580	13864	2531	14716	2035	14850	1648	14728	1077	17359	669	12717
8-#14	2.16	MA	10961	3580	18146	2572	19718	2093	20364	1710	20805	1117	24666	861	16594
3E		MI	8793	3580	14693	2520	15754	2045	16077	1658	16268	1067	19063	788	13126
8-#14	2.16	MA	10350	3580	17082	2587	18366	2086	18726	1700	18749	1127	22370	734	16057
4L-2S		MI	9449	3580	15705	2528	17030	2035	17598	1648	18277	1057	21668	916	13105
8-#18	3.85	MA	13462	4077	23399	2866	26331	2289	28181	1811	31121	1030	38083	833	28548
2L-4S		MI	8754	4077	15518	2813	16651	2219	17134	1736	17799	988	21430	278	19665
8-#18	3.85	MA	12023	4077	21117	2855	23421	2308	24694	1829	26514	1047	32057	605	28204
3E		MI	9562	4077	16957	2795	18415	2236	19221	1754	20416	971	24313	482	22003
8-#18	3.85	MA	10990	4077	19260	2879	21061	2291	21880	1811	22982	1065	28128	385	25083
4L-2S		MI	10669	4077	18707	2812	20583	2219	21805	1736	23831	953	28701	710	22272
10-#11	1.87	MA	11536	3495	18775	2534	20564	2051	21418	1685	22247	1126	26608	1022	14572
2L-5S		MI	8142	3495	13382	2486	14157	2018	14197	1647	13800	1088	16218	746	11077
10-#11	1.87	MA	10936	3495	17856	2531	19392	2060	19993	1692	20357	1133	24111	934	14577
3L-4S		MI	8447	3495	13894	2491	14815	2011	14979	1640	14879	1095	17504	787	11542
10-#11	1.87	MA	10506	3495	17112	2542	18446	2056	18845	1686	18907	1140	22488	845	14514
4L-3S		MI	8784	3495	14475	2482	15550	2018	15849	1647	15971	1088	18715	871	11553
10-#11	1.87	MA	10120	3495	16458	2539	17603	2065	17813	1693	17475	1133	20758	805	13879
5L-2S		MI	9248	3495	15187	2487	16455	2011	16927	1640	17394	1081	20569	959	11525
10-#14	2.70	MA	12392	3740	20770	2676	23063	2153	24424	1745	26168	1092	31727	954	20619
2L-5S		MI	8333	3740	14146	2623	15065	2115	15266	1698	15213	1045	18157	563	14900
10-#14	2.70	MA	11549	3740	19458	2672	21391	2166	22394	1755	23486	1102	28196	826	20549
3L-4S		MI	8762	3740	14877	2631	15992	2106	16370	1688	16737	1055	19963	622	15570
10-#14	2.70	MA	10945	3740	18394	2687	20039	2158	20757	1745	21430	1112	25901	699	19783
4L-3S		MI	9235	3740	15705	2619	17030	2115	17598	1698	18277	1045	21668	741	16191
10-#14	2.70	MA	10402	3740	17458	2682	18832	2170	19283	1755	19399	1102	23453	642	18775
5L-2S		MI	9886	3740	16718	2627	18306	2106	19118	1688	20286	1036	24272	869	16208
10-#18	4.81	MA	13012	4361	23399	3032	26331	2436	28181	1904	31121	1015	38083	533	34829
3L-4S		MI	9506	4361	17269	2990	18819	2341	19717	1803	21214	944	25818	182	24628

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis

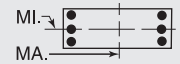


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	4.81	MA	11995	4361	21542	3057	23971	2420	25367	1887	27588	1033	34154	313	31612
4L-3S		MI	10304	4361	18707	2972	20583	2358	21805	1821	23831	926	28701	387	26747
10-#18	4.81	MA	11080	4361	19905	3046	21862	2439	22836	1904	24097	1015	29975	210	28772
5L-2S		MI	11396	4361	20457	2989	22752	2341	24388	1803	27245	909	33088	614	27567
12-#11	2.25	MA	11948	3606	19695	2603	21736	2101	22843	1716	24138	1116	29106	1000	17380
2L-6S		MI	8172	3606	13608	2550	14407	2061	14527	1682	14234	1081	16875	655	12823
12-#11	2.25	MA	11352	3606	18775	2600	20564	2110	21418	1723	22247	1123	26608	911	17362
3L-5S		MI	8461	3606	14094	2555	15062	2068	15275	1675	15223	1074	18072	715	13136
12-#11	2.25	MA	10926	3606	18031	2611	19619	2106	20270	1717	20797	1130	24985	822	17275
4E		MI	8764	3606	14606	2560	15719	2061	16057	1668	16303	1081	19357	756	13688
12-#11	2.25	MA	10542	3606	17377	2608	18775	2115	19238	1724	19365	1123	23256	782	16548
5L-3S		MI	9098	3606	15187	2552	16455	2068	16927	1675	17394	1074	20569	840	13725
12-#11	2.25	MA	10177	3606	16759	2606	17936	2110	18251	1732	18051	1130	21637	723	16120
6L-2S		MI	9559	3606	15899	2557	17359	2061	18004	1668	18818	1067	22422	929	13711
12-#14	3.25	MA	12130	3899	20770	2771	23063	2238	24424	1800	26168	1086	31727	791	24495
3L-5S		MI	8780	3899	15158	2723	16341	2186	16787	1738	17222	1024	20762	515	17833
12-#14	3.25	MA	11533	3899	19706	2786	21711	2230	22787	1790	24111	1096	29432	664	23534
4E		MI	9205	3899	15890	2731	17269	2176	17891	1728	18746	1034	22568	575	18447
12-#14	3.25	MA	10996	3899	18770	2782	20505	2243	21314	1800	22080	1086	26983	606	22593
5L-3S		MI	9674	3899	16718	2719	18306	2186	19118	1738	20286	1024	24272	694	19243
12-#14	3.25	MA	10483	3899	17885	2777	19305	2235	19905	1810	20217	1096	24697	521	21233
6L-2S		MI	10319	3899	17731	2727	19582	2176	20639	1728	22295	1014	26877	822	19296
12-#18	5.77	MA	12985	4644	23825	3234	26881	2548	28855	1963	32195	1001	40181	242	38179
4E		MI	10249	4644	19019	3167	20988	2463	22301	1870	24628	900	30205	87	29626
12-#18	5.77	MA	12084	4644	22188	3223	24771	2568	26323	1980	28704	983	36002	138	35178
5L-3S		MI	11037	4644	20457	3149	22752	2481	24388	1888	27245	882	33088	291	31552
14-#11	2.63	MA	11764	3716	19695	2669	21736	2160	22843	1754	24138	1113	29106	888	20141
3L-6S		MI	8490	3716	14320	2620	15312	2111	15605	1711	15658	1067	18729	625	14824
14-#11	2.63	MA	11341	3716	18951	2680	20791	2156	21695	1748	22688	1120	27482	799	20011
4L-5S		MI	8778	3716	14805	2625	15967	2118	16352	1704	16647	1060	19926	685	15204
14-#11	2.63	MA	10961	3716	18296	2678	19947	2165	20663	1755	21256	1113	25753	759	19227
5L-4S		MI	9078	3716	15318	2630	16624	2111	17135	1697	17727	1067	21211	726	15725
14-#11	2.63	MA	10598	3716	17678	2675	19108	2160	19676	1763	19942	1120	24134	700	18739
6L-3S		MI	9410	3716	15899	2621	17359	2118	18004	1704	18818	1060	22422	810	15883
14-#11	2.63	MA	10244	3716	17016	2686	18302	2170	18652	1757	18656	1127	22447	612	17922
7L-2S		MI	9869	3716	16611	2626	18264	2111	19082	1697	20242	1054	24276	898	15889
14-#14	3.79	MA	12114	4059	21018	2886	23384	2303	24817	1834	26793	1081	32962	628	27305
4L-5S		MI	9223	4059	16171	2823	17617	2257	18307	1778	19231	1002	23366	468	20749
14-#14	3.79	MA	11583	4059	20082	2881	22178	2315	23344	1844	24762	1071	30514	571	26423
5L-4S		MI	9643	4059	16903	2831	18545	2247	19411	1768	20755	1012	25172	528	21342
14-#14	3.79	MA	11075	4059	19197	2877	20977	2308	21936	1854	22898	1081	28228	485	24982
6L-3S		MI	10109	4059	17731	2819	19582	2257	20639	1778	22295	1002	26877	647	22287
14-#14	3.79	MA	10580	4059	18250	2892	19823	2320	20473	1844	21074	1091	26080	387	23602
7L-2S		MI	10749	4059	18744	2827	20859	2247	22159	1768	24304	993	29482	775	22368
14-#18	6.73	MA	13075	4928	24470	3400	27681	2696	29811	2056	33310	951	42029	66	41619
5L-4S		MI	10985	4928	20769	3344	23156	2585	24885	1937	28043	856	34593	-9	34536
16-#11	3.00	MA	11754	3827	19870	2750	21963	2206	23120	1779	24578	1110	29979	777	22654
4L-6S		MI	8806	3827	15032	2689	16217	2161	16683	1739	17081	1054	20583	594	16836
16-#11	3.00	MA	11377	3827	19216	2747	21120	2215	22088	1787	23147	1103	28250	737	21914
5E		MI	9092	3827	15517	2694	16872	2168	17430	1733	18071	1047	21780	654	17279
16-#11	3.00	MA	11017	3827	18597	2744	20281	2210	21101	1794	21832	1110	26631	677	21362
6L-4S		MI	9390	3827	16030	2699	17529	2161	18212	1726	19150	1054	23065	695	17764
16-#11	3.00	MA	10665	3827	17936	2755	19474	2220	20077	1788	20546	1117	24944	589	20580
7L-3S		MI	9720	3827	16611	2690	18264	2168	19082	1733	20242	1047	24276	779	18037
16-#11	3.00	MA	10319	3827	17328	2752	18661	2215	19110	1795	19276	1124	23329	542	19716
8L-2S		MI	10176	3827	17323	2695	19169	2161	20160	1726	21666	1040	26130	868	18061
16-#14	4.33	MA	12164	4219	21394	2981	23850	2387	25374	1889	27443	1055	34044	536	30263
5E		MI	9662	4219	17184	2922	18894	2328	19828	1818	21240	981	25971	421	23564

RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

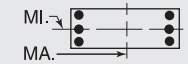
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	4.33	MA	11662	4219	20509	2976	22650	2380	23966	1899	25579	1065	31758	450	28744
6L-4S		MI	10079	4219	17915	2930	19821	2318	20932	1808	22764	991	27777	480	24251
16-#14	4.33	MA	11172	4219	19562	2991	21496	2392	22503	1889	23755	1075	29611	351	27311
7L-3S		MI	10540	4219	18744	2919	20859	2328	22159	1818	24304	981	29482	599	25324
18-#11	3.37	MA	11789	3938	20135	2816	22292	2265	23513	1818	25037	1093	30747	714	24607
5L-6S		MI	9120	3938	15744	2758	17122	2211	17761	1768	18505	1040	22437	564	18857
18-#11	3.37	MA	11432	3938	19517	2813	21453	2261	22526	1825	23723	1100	29128	655	23995
6L-5S		MI	9404	3938	16229	2763	17776	2218	18508	1761	19495	1033	23634	624	19359
18-#11	3.37	MA	11083	3938	18855	2824	20646	2270	21502	1819	22437	1107	27441	566	23245
7L-4S		MI	9700	3938	16742	2768	18434	2211	19290	1754	20574	1040	24919	664	19812
18-#11	3.37	MA	10740	3938	18248	2821	19833	2265	20534	1826	21167	1114	25826	519	22344
8L-3S		MI	10028	3938	17323	2759	19169	2218	20160	1761	21666	1033	26130	749	20186
18-#14	4.87	MA	12243	4378	21821	3076	24323	2452	25996	1944	28260	1050	35289	415	32518
6L-5S		MI	10097	4378	18197	3022	20170	2399	21348	1858	23249	959	28576	374	26395
18-#14	4.87	MA	11758	4378	20874	3091	23169	2465	24534	1934	26437	1060	33141	316	31032
7L-4S		MI	10511	4378	18928	3030	21097	2389	22452	1848	24773	969	30382	433	27172
20-#11	3.75	MA	11843	4048	20436	2882	22625	2311	23951	1856	25614	1090	31626	632	26636
6E		MI	9432	4048	16456	2827	18026	2261	18838	1797	19929	1026	24291	533	20887
20-#11	3.75	MA	11498	4048	19775	2893	21819	2320	22927	1850	24328	1097	29938	544	25915
7L-5S		MI	9714	4048	16941	2832	18681	2267	19586	1790	20918	1019	25488	593	21443
20-#11	3.75	MA	11157	4048	19167	2890	21005	2315	21959	1857	23058	1104	28323	497	24979
8L-4S		MI	10008	4048	17454	2837	19338	2261	20368	1783	21998	1026	26773	634	21867
20-#14	5.41	MA	12338	4538	22186	3191	24841	2537	26564	1978	29118	1044	36672	280	34764
7L-5S		MI	10530	4538	19209	3122	21446	2470	22869	1898	25258	938	31180	327	29240
22-#11	4.13	MA	11909	4159	20694	2962	22991	2370	24352	1881	26218	1087	32435	521	28591
7L-6S		MI	9742	4159	17168	2896	18931	2310	19916	1825	21353	1012	26145	503	22923
22-#11	4.13	MA	11571	4159	20086	2959	22177	2365	23384	1888	24948	1094	30821	474	27620
8L-5S		MI	10022	4159	17653	2901	19586	2317	20663	1818	22342	1005	27341	563	23530
24-#11	4.50	MA	11982	4270	21006	3028	23349	2416	24809	1920	26839	1084	33318	451	30267
8L-6S		MI	10050	4270	17880	2965	19836	2360	20994	1854	22776	998	27999	472	24965

RECTANGULAR TIED COLUMNS 26" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.02	MA	11950	3445	18823	2527	20199	2059	20515	1716	20263	1222	23635	1144	9168
2E		MI	9040	3445	14408	2461	15223	2002	15276	1661	14899	1172	17162	1080	6864
4-#18	1.81	MA	12877	3693	20985	2661	22864	2154	23676	1768	24391	1180	29003	1066	15735
2E		MI	9666	3693	15938	2589	16991	2082	17354	1695	17637	1112	20622	969	11604
6-#11	1.06	MA	12024	3458	18930	2545	20383	2074	20757	1727	20625	1229	24142	1151	9557
2L-3S		MI	8626	3458	13778	2478	14486	2029	14415	1683	13765	1188	15713	1001	7202
6-#11	1.06	MA	11366	3458	17941	2543	19123	2083	19224	1735	18578	1236	21430	1062	9600
3L-2S		MI	9097	3458	14490	2483	15391	2022	15492	1676	15189	1181	17567	1090	7148
6-#14	1.53	MA	12595	3605	20234	2626	21999	2131	22703	1761	23169	1208	27475	1111	13515
2L-3S		MI	8823	3605	14408	2553	15223	2083	15276	1711	14899	1160	17162	905	10082
6-#14	1.53	MA	11666	3605	18823	2622	20199	2145	20515	1772	20263	1218	23635	983	13537
3L-2S		MI	9487	3605	15421	2561	16499	2073	16797	1701	16908	1150	19766	1033	10021
6-#18	2.71	MA	13963	3977	23445	2838	26000	2283	27466	1846	29396	1151	35579	1000	23248
2L-3S		MI	9290	3977	15938	2749	16991	2222	17354	1779	17637	1085	20622	646	16938
6-#18	2.71	MA	12384	3977	20985	2829	22864	2304	23676	1864	24391	1169	29003	772	23023
3L-2S		MI	10414	3977	17688	2766	19159	2204	19938	1761	21052	1068	25010	873	16994
8-#11	1.41	MA	12479	3568	19919	2614	21643	2124	22289	1758	22672	1220	26855	1130	12597
2L-4S		MI	8606	3568	13909	2556	14656	2071	14622	1705	14098	1181	16356	887	9433
8-#11	1.41	MA	11826	3568	18930	2612	20383	2134	20757	1766	20625	1227	24142	1042	12623
3E		MI	8946	3568	14490	2547	15391	2078	15492	1712	15189	1174	17567	971	9406
8-#11	1.41	MA	11360	3568	18132	2623	19368	2130	19525	1761	19055	1234	22375	953	12590
4L-2S		MI	9414	3568	15202	2552	16296	2071	16570	1705	16613	1167	19421	1059	9362

RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

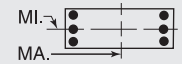
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.04	MA	13232	3764	21646	2726	23799	2204	24891	1806	26075	1194	31316	1079	17835
2L-4S		MI	8792	3764	14593	2664	15461	2144	15569	1741	15368	1148	18062	738	12899
8-#14	2.04	MA	12312	3764	20234	2722	21999	2217	22703	1817	23169	1204	27475	951	17809
3E		MI	9272	3764	15421	2653	16499	2154	16797	1751	16908	1138	19766	857	13179
8-#14	2.04	MA	11656	3764	19092	2738	20547	2211	20942	1808	20940	1213	24977	823	17406
4L-2S		MI	9930	3764	16434	2661	17775	2144	18317	1741	18917	1129	22371	985	13146
8-#18	3.62	MA	15031	4261	25904	3015	29136	2411	31256	1924	34402	1122	42155	934	30708
2L-4S		MI	9230	4261	16250	2944	17395	2327	17850	1828	18435	1059	22127	346	19908
8-#18	3.62	MA	13475	4261	23445	3006	26000	2432	27466	1942	29396	1139	35579	706	30364
3E		MI	10042	4261	17688	2926	19159	2344	19938	1846	21052	1041	25010	550	22170
8-#18	3.62	MA	12362	4261	21448	3032	23462	2418	24410	1924	25558	1157	31300	482	27203
4L-2S		MI	11152	4261	19439	2943	21328	2327	22521	1828	24466	1023	29397	778	22337
10-#11	1.76	MA	12929	3679	20907	2683	22904	2174	23821	1789	24718	1211	29567	1110	15625
2L-5S		MI	8620	3679	14108	2620	14903	2128	14918	1740	14442	1160	16924	815	11201
10-#11	1.76	MA	12281	3679	19919	2681	21643	2184	22289	1797	22672	1218	26855	1021	15630
3L-4S		MI	8925	3679	14621	2625	15560	2121	15700	1733	15521	1167	18210	856	11595
10-#11	1.76	MA	11820	3679	19120	2693	20628	2180	21057	1792	21102	1225	25088	932	15567
4L-3S		MI	9263	3679	15202	2616	16296	2128	16570	1740	16613	1160	19421	940	11593
10-#11	1.76	MA	11405	3679	18419	2690	19724	2189	19950	1800	19552	1218	23215	891	14968
5L-2S		MI	9728	3679	15914	2621	17200	2121	17648	1733	18037	1153	21275	1029	11561
10-#14	2.55	MA	13861	3924	23058	2826	25598	2276	27079	1851	28981	1180	35157	1046	22137
2L-5S		MI	8811	3924	14874	2756	15810	2225	15986	1791	15853	1117	18860	632	15056
10-#14	2.55	MA	12950	3924	21646	2822	23799	2289	24891	1862	26075	1189	31316	918	22068
3L-4S		MI	9240	3924	15606	2764	16738	2215	17090	1781	17377	1127	20666	691	15749
10-#14	2.55	MA	12301	3924	20504	2838	22347	2283	23130	1852	23846	1199	28818	790	21421
4L-3S		MI	9715	3924	16434	2752	17775	2225	18317	1791	18917	1117	22371	810	16250
10-#14	2.55	MA	11717	3924	19500	2834	21053	2296	21545	1863	21645	1189	26160	732	20261
5L-2S		MI	10368	3924	17447	2760	19051	2215	19838	1781	20926	1107	24976	938	16253
10-#18	4.52	MA	14550	4544	25904	3183	29136	2561	31256	2020	34402	1110	42155	640	37697
3L-4S		MI	9984	4544	18000	3121	19564	2449	20434	1895	21849	1015	26514	251	24867
10-#18	4.52	MA	13454	4544	23908	3209	26598	2547	28199	2003	30563	1128	37876	416	34252
4L-3S		MI	10785	4544	19439	3103	21328	2466	22521	1913	24466	997	29397	455	27070
10-#18	4.52	MA	12470	4544	22150	3200	24332	2568	25449	2020	26771	1110	33316	314	31377
5L-2S		MI	11882	4544	21189	3121	23496	2449	25105	1895	27881	979	33785	682	27638
12-#11	2.12	MA	13376	3790	21896	2753	24164	2224	25353	1820	26765	1202	32280	1089	18643
2L-6S		MI	8649	3790	14335	2684	15153	2171	15248	1776	14876	1153	17581	725	12980
12-#11	2.12	MA	12732	3790	20907	2750	22904	2234	23821	1828	24718	1209	29567	1000	18626
3L-5S		MI	8939	3790	14820	2689	15808	2178	15996	1769	15866	1146	18778	785	13259
12-#11	2.12	MA	12274	3790	20109	2762	21889	2230	22589	1823	23148	1216	27800	911	18539
4E		MI	9243	3790	15333	2694	16465	2171	16778	1762	16945	1153	20064	826	13746
12-#11	2.12	MA	11863	3790	19407	2759	20985	2240	21482	1831	21599	1209	25928	870	17840
5L-3S		MI	9578	3790	15914	2685	17200	2178	17648	1769	18037	1146	21275	910	13769
12-#11	2.12	MA	11470	3790	18745	2757	20085	2236	20386	1825	20176	1216	24168	811	17352
6L-2S		MI	10040	3790	16626	2690	18105	2171	18726	1762	19460	1139	23129	998	13749
12-#14	3.05	MA	13581	4083	23058	2922	25598	2362	27079	1906	28981	1175	35157	886	26317
3L-5S		MI	9258	4083	15887	2856	17086	2296	17507	1831	17862	1095	21465	585	17988
12-#14	3.05	MA	12939	4083	21916	2937	24147	2355	25318	1897	26752	1185	32659	758	25461
4E		MI	9684	4083	16618	2864	18014	2286	18610	1821	19386	1105	23271	644	18622
12-#14	3.05	MA	12362	4083	20912	2933	22852	2369	23733	1908	24551	1175	30000	700	24375
5L-3S		MI	10155	4083	17447	2852	19051	2296	19838	1831	20926	1095	24976	763	19308
12-#14	3.05	MA	11810	4083	19963	2929	21565	2362	22220	1919	22531	1185	27511	615	23028
6L-2S		MI	10802	4083	18459	2860	20328	2286	21358	1821	22935	1085	27580	891	19347
12-#18	5.43	MA	14530	4828	26368	3387	29734	2675	31989	2081	35568	1099	44452	350	41338
4E		MI	10728	4828	19751	3299	21732	2571	23018	1962	25264	971	30902	155	29861

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

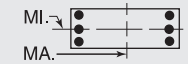
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	5.43	MA	13561	4828	24609	3377	27468	2696	29239	2098	31776	1081	39892	248	38303
5L-3S		MI	11520	4828	21189	3281	23496	2589	25105	1979	27881	953	33785	359	31868
14-#11	2.47	MA	13179	3900	21896	2819	24164	2284	25353	1860	26765	1200	32280	979	21615
3L-6S		MI	8968	3900	15047	2753	16058	2221	16326	1804	16300	1139	19435	694	15025
14-#11	2.47	MA	12725	3900	21097	2831	23149	2280	24122	1854	25195	1207	30512	890	21507
4L-5S		MI	9256	3900	15532	2758	16712	2228	17073	1797	17289	1132	20632	754	15326
14-#11	2.47	MA	12317	3900	20396	2828	22245	2290	23014	1862	23646	1200	28640	849	20722
5L-4S		MI	9558	3900	16045	2763	17370	2221	17856	1791	18369	1139	21918	795	15869
14-#11	2.47	MA	11928	3900	19733	2826	21346	2286	21918	1856	22223	1207	26880	790	20259
6L-3S		MI	9891	3900	16626	2755	18105	2228	18726	1797	19460	1132	23129	879	15933
14-#11	2.47	MA	11548	3900	19024	2838	20481	2296	20859	1865	20830	1214	25046	702	19370
7L-2S		MI	10350	3900	17338	2760	19010	2221	19803	1791	20884	1125	24983	968	15930
14-#14	3.56	MA	13570	4243	23327	3037	25947	2428	27506	1942	29658	1171	36499	726	29522
4L-5S		MI	9701	4243	16899	2956	18363	2367	19027	1871	19871	1074	24069	537	20930
14-#14	3.56	MA	12999	4243	22323	3033	24652	2441	25921	1953	27458	1161	33841	668	28500
5L-4S		MI	10124	4243	17631	2964	19290	2357	20131	1861	21395	1084	25875	597	21515
14-#14	3.56	MA	12453	4243	21374	3029	23365	2434	24408	1964	25437	1171	31351	582	27070
6L-3S		MI	10591	4243	18459	2952	20328	2367	21358	1871	22935	1074	27580	716	22356
14-#14	3.56	MA	11921	4243	20359	3045	22127	2448	22836	1955	23460	1181	28755	455	25693
7L-2S		MI	11233	4243	19472	2960	21604	2357	22879	1861	24944	1064	30185	844	22423
14-#18	6.33	MA	14637	5112	27069	3554	30604	2825	33029	2177	36782	1052	46468	182	45262
5L-4S		MI	11466	5112	21501	3476	23900	2693	25602	2028	28679	927	35290	60	34883
16-#11	2.82	MA	13172	4011	22086	2900	24409	2330	25654	1885	27242	1198	33225	869	24472
4L-6S		MI	9285	4011	15759	2823	16963	2271	17404	1833	17724	1125	21289	664	17034
16-#11	2.82	MA	12767	4011	21385	2898	23505	2340	24547	1893	25692	1191	31353	829	23613
5E		MI	9571	4011	16244	2828	17617	2278	18151	1826	18713	1119	22486	724	17400
16-#11	2.82	MA	12381	4011	20722	2895	22606	2336	23450	1888	24269	1198	29593	770	23129
6L-4S		MI	9870	4011	16757	2833	18275	2271	18934	1819	19793	1125	23771	764	17906
16-#11	2.82	MA	12004	4011	20013	2907	21742	2346	22391	1896	22877	1205	27759	682	22231
7L-3S		MI	10202	4011	17338	2824	19010	2278	19803	1826	20884	1119	24983	849	18090
16-#11	2.82	MA	11632	4011	19362	2904	20870	2342	21354	1904	21418	1198	26010	634	21384
8L-2S		MI	10658	4011	18050	2829	19915	2271	20881	1819	22308	1112	26836	937	18104
16-#14	4.07	MA	13629	4403	23735	3133	26452	2513	28109	1998	30364	1147	37682	635	32635
5E		MI	10141	4403	17912	3055	19639	2437	20548	1911	21880	1052	26674	490	23842
16-#14	4.07	MA	13090	4403	22786	3129	25165	2507	26595	2009	28344	1157	35192	550	31126
6L-4S		MI	10560	4403	18644	3063	20566	2428	21651	1901	23404	1062	28480	549	24423
16-#14	4.07	MA	12563	4403	21771	3145	23927	2520	25023	2000	26367	1167	32596	423	29695
7L-3S		MI	11023	4403	19472	3052	21604	2437	22879	1911	24944	1052	30185	669	25398
18-#11	3.18	MA	13214	4122	22373	2967	24766	2390	26079	1924	27739	1182	34065	808	26510
5L-6S		MI	9599	4122	16471	2892	17867	2321	18482	1862	19147	1112	23143	633	19053
18-#11	3.18	MA	12831	4122	21710	2964	23866	2386	24982	1919	26316	1189	32305	749	25963
6L-5S		MI	9884	4122	16956	2897	18522	2328	19229	1855	20137	1105	24340	693	19480
18-#11	3.18	MA	12457	4122	21001	2976	23002	2396	23923	1927	24924	1196	30471	661	25100
7L-4S		MI	10181	4122	17469	2902	19179	2321	20011	1848	21216	1112	25625	734	19953
18-#11	3.18	MA	12088	4122	20350	2974	22130	2392	22887	1935	23464	1189	28723	613	24215
8L-3S		MI	10510	4122	18050	2893	19915	2328	20881	1855	22308	1105	26836	818	20242
18-#14	4.58	MA	13720	4562	24198	3229	26964	2579	28783	2054	31250	1143	39032	518	35193
6L-5S		MI	10578	4562	18925	3155	20915	2508	22068	1951	23889	1031	29279	443	26669
18-#14	4.58	MA	13199	4562	23183	3244	25727	2592	27211	2045	29273	1153	36437	391	33709
7L-4S		MI	10993	4562	19657	3163	21843	2498	23172	1941	25413	1041	31085	502	27342
20-#11	3.53	MA	13277	4232	22699	3034	25127	2436	26514	1950	28363	1180	35018	728	28806
6E		MI	9911	4232	17183	2961	18772	2371	19559	1890	20571	1098	24997	603	21080

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

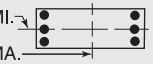
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.53	MA	12906	4232	21990	3045	24262	2446	25456	1958	26970	1187	33184	640	27975
7L-5S		MI	10194	4232	17668	2966	19427	2378	20307	1883	21561	1091	26194	663	21564
20-#11	3.53	MA	12540	4232	21339	3043	23390	2442	24419	1966	25511	1180	31435	592	27054
8L-4S		MI	10490	4232	18181	2971	20084	2371	21089	1876	22640	1098	27479	703	22007
20-#14	5.09	MA	13828	4722	24594	3344	27527	2665	29399	2090	32179	1139	40277	358	37735
7L-5S		MI	11011	4722	19938	3255	22192	2579	23589	1991	25898	1009	31883	396	29511
22-#11	3.88	MA	13352	4343	22979	3114	25523	2496	26988	1989	29017	1178	35896	619	30856
7L-6S		MI	10222	4343	17895	3030	19677	2420	20637	1919	21995	1084	26851	572	23115
22-#11	3.88	MA	12989	4343	22328	3112	24651	2492	25951	1997	27558	1171	34148	571	29899
8L-5S		MI	10503	4343	18380	3035	20332	2427	21385	1912	22984	1077	28048	632	23652
24-#11	4.24	MA	13434	4454	23316	3181	25911	2542	27483	2028	29604	1162	36860	550	32749
8L-6S		MI	10531	4454	18607	3099	20582	2470	21715	1948	23419	1070	28705	542	25155

RECTANGULAR TIED COLUMNS 26" x 36"

4-#18	1.71	MA	14347	3877	23240	2810	25331	2277	26250	1875	26980	1266	32095	1153	16815
2E		MI	10146	3877	16669	2720	17735	2190	18071	1787	18273	1182	21319	1037	11648
6-#11	1.00	MA	13420	3642	21028	2695	22660	2197	23059	1831	22889	1311	26789	1234	10189
2L-3S		MI	9104	3642	14505	2612	15232	2139	15136	1776	14408	1259	16419	1071	7231
6-#11	1.00	MA	12714	3642	19970	2693	21312	2207	21420	1840	20686	1318	23860	1145	10232
3L-2S		MI	9576	3642	15217	2617	16136	2132	16213	1770	15831	1253	18273	1159	7176
6-#14	1.44	MA	14038	3788	22427	2776	24394	2254	25148	1865	25637	1292	30404	1196	14426
2L-3S		MI	9302	3788	15137	2686	15968	2193	15996	1804	15539	1231	17865	974	10122
6-#14	1.44	MA	13040	3788	20916	2772	22467	2269	22805	1877	22506	1302	26252	1068	14448
3L-2S		MI	9967	3788	16150	2694	17244	2183	17517	1794	17548	1221	20469	1102	10056
6-#18	2.56	MA	15522	4161	25877	2987	28693	2406	30337	1955	32385	1239	39222	1093	24868
2L-3S		MI	9769	4161	16669	2880	17735	2330	18071	1871	18273	1156	21319	714	17020
6-#18	2.56	MA	13823	4161	23240	2979	25331	2428	26250	1973	26980	1257	32095	865	24643
3L-2S		MI	10896	4161	18420	2898	19904	2313	20654	1853	21688	1138	25707	942	17046
8-#11	1.33	MA	13911	3752	22086	2764	24009	2247	24699	1862	25092	1303	29717	1215	13440
2L-4S		MI	9084	3752	14636	2690	15401	2182	15344	1798	14740	1252	17062	956	9475
8-#11	1.33	MA	13210	3752	21028	2762	22660	2257	23059	1871	22889	1310	26789	1126	13465
3E		MI	9424	3752	15217	2681	16136	2188	16213	1805	15831	1246	18273	1040	9440
8-#11	1.33	MA	12712	3752	20176	2774	21576	2254	21744	1866	21199	1317	24878	1037	13433
4L-2S		MI	9893	3752	15928	2686	17041	2182	17291	1798	17255	1239	20127	1129	9394
8-#14	1.92	MA	14725	3948	23939	2875	26321	2327	27490	1910	28769	1279	34555	1167	19050
2L-4S		MI	9270	3948	15321	2798	16207	2254	16289	1834	16008	1220	18765	807	13076
8-#14	1.92	MA	13738	3948	22427	2872	24394	2341	25148	1922	25637	1289	30404	1039	19024
3E		MI	9751	3948	16150	2786	17244	2263	17517	1844	17548	1210	20469	927	13227
8-#14	1.92	MA	13035	3948	21207	2889	22842	2335	23265	1914	23236	1299	27699	911	18774
4L-2S		MI	10410	3948	17162	2794	18520	2254	19037	1834	19557	1200	23074	1055	13186
8-#18	3.42	MA	16677	4445	28514	3165	32055	2534	34424	2035	37790	1212	46349	1032	32868
2L-4S		MI	9708	4445	16981	3075	18140	2435	18567	1920	19071	1129	22824	414	20145
8-#18	3.42	MA	15003	4445	25877	3157	28693	2557	30337	2053	32385	1230	39222	804	32524
3E		MI	10522	4445	18420	3057	19904	2452	20654	1938	21688	1112	25707	619	22264
8-#18	3.42	MA	13810	4445	23741	3184	25978	2544	27042	2036	28239	1248	34591	577	29350
4L-2S		MI	11636	4445	20170	3075	22072	2435	23238	1920	25102	1094	30094	846	22399
10-#11	1.67	MA	14396	3863	23144	2833	25357	2297	26338	1894	27294	1295	32645	1196	16678
2L-5S		MI	9098	3863	14835	2754	15649	2238	15639	1834	15084	1232	17630	885	11320
10-#11	1.67	MA	13701	3863	22086	2831	24009	2307	24699	1902	25092	1302	29717	1107	16683
3L-4S		MI	9404	3863	15348	2759	16306	2231	16421	1827	16164	1239	18916	926	11645
10-#11	1.67	MA	13207	3863	21233	2843	22925	2304	23383	1897	23402	1309	27806	1018	16620
4L-3S		MI	9742	3863	15928	2750	17041	2238	17291	1834	17255	1232	20127	1010	11631
10-#11	1.67	MA	12764	3863	20485	2841	21960	2314	22202	1906	21734	1302	25790	976	16067
5L-2S		MI	10208	3863	16640	2755	17946	2231	18369	1827	18679	1225	21981	1098	11596

RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

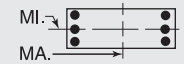
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.40	MA	15405	4108	25450	2975	28248	2399	29833	1955	31900	1266	38706	1137	23656
2L-5S		MI	9288	4108	15602	2889	16555	2334	16706	1884	16493	1188	19563	701	15206
10-#14	2.40	MA	14427	4108	23939	2972	26321	2413	27490	1967	28769	1276	34555	1009	23587
3L-4S		MI	9719	4108	16334	2897	17483	2324	17810	1874	18017	1198	21369	760	15922
10-#14	2.40	MA	13731	4108	22719	2988	24769	2408	25608	1959	26367	1286	31850	881	23078
4L-3S		MI	10195	4108	17162	2885	18520	2334	19037	1884	19557	1188	23074	879	16306
10-#14	2.40	MA	13107	4108	21646	2985	23387	2422	23915	1971	23996	1276	28985	822	21760
5L-2S		MI	10849	4108	18175	2893	19797	2324	20558	1874	21566	1178	25679	1007	16297
10-#18	4.27	MA	16164	4728	28514	3334	32055	2686	34424	2133	37790	1204	46349	744	40397
3L-4S		MI	10462	4728	18732	3253	20308	2557	21151	1987	22485	1085	27211	319	25099
10-#18	4.27	MA	14989	4728	26378	3361	29340	2673	31129	2116	33644	1221	41718	516	36918
4L-3S		MI	11267	4728	20170	3235	22072	2575	23238	2004	25102	1068	30094	523	27386
10-#18	4.27	MA	13935	4728	24499	3353	26918	2696	28165	2134	29551	1204	36776	415	34030
5L-2S		MI	12367	4728	21921	3252	24240	2557	25822	1987	28517	1050	34482	751	27707
12-#11	2.00	MA	14878	3974	24201	2902	26706	2347	27977	1925	29497	1287	35573	1176	19907
2L-6S		MI	9126	3974	15062	2818	15899	2281	15969	1869	15518	1225	18288	794	13093
12-#11	2.00	MA	14187	3974	23144	2900	25357	2357	26338	1934	27294	1294	32645	1088	19889
3L-5S		MI	9417	3974	15547	2823	16553	2288	16717	1862	16508	1218	19484	854	13377
12-#11	2.00	MA	13698	3974	22291	2912	24273	2354	25023	1929	25604	1301	30734	999	19802
4E		MI	9722	3974	16060	2828	17211	2281	17499	1855	17587	1225	20770	895	13801
12-#11	2.00	MA	13258	3974	21543	2910	23308	2364	23841	1937	23937	1294	28718	957	19142
5L-3S		MI	10058	3974	16640	2819	17946	2288	18369	1862	18679	1218	21981	979	13811
12-#11	2.00	MA	12838	3974	20836	2908	22349	2361	22671	1932	22406	1301	26817	898	18590
6L-2S		MI	10521	3974	17352	2824	18851	2281	19447	1855	20103	1211	23835	1068	13787
12-#14	2.88	MA	15108	4267	25450	3072	28248	2486	29833	2012	31900	1263	38706	979	28140
3L-5S		MI	9736	4267	16615	2989	17832	2405	18226	1924	18502	1167	22168	654	18137
12-#14	2.88	MA	14420	4267	24230	3088	26696	2480	27950	2004	29498	1273	36001	851	27408
4E		MI	10163	4267	17347	2997	18759	2395	19330	1914	20026	1177	23974	713	18793
12-#14	2.88	MA	13802	4267	23158	3085	25314	2494	26258	2016	27128	1263	33137	792	26168
5L-3S		MI	10636	4267	18175	2985	19797	2405	20558	1924	21566	1167	25679	832	19370
12-#14	2.88	MA	13213	4267	22145	3082	23940	2488	24582	2008	24951	1273	30443	707	24849
6L-2S		MI	11285	4267	19188	2993	21073	2395	22078	1914	23575	1157	28283	960	19394
12-#18	5.13	MA	16152	5012	29015	3539	32702	2802	35216	2196	39049	1195	48845	455	44525
4E		MI	11208	5012	20482	3430	22476	2679	23735	2053	25900	1041	31599	223	30090
12-#18	5.13	MA	15113	5012	27136	3531	30280	2824	32252	2214	34956	1177	43903	354	41476
5L-3S		MI	12003	5012	21921	3412	24240	2697	25822	2071	28517	1024	34482	428	32176
12-#18	5.13	MA	14123	5012	25359	3523	27870	2812	29419	2232	31199	1195	39286	202	38298
6L-2S		MI	13092	5012	23671	3429	26409	2679	28406	2053	31931	1006	38870	655	32993
14-#11	2.33	MA	14670	4084	24201	2969	26706	2407	27977	1965	29497	1286	35573	1068	23090
3L-6S		MI	9446	4084	15774	2887	16803	2331	17047	1898	16942	1211	20142	764	15179
14-#11	2.33	MA	14184	4084	23349	2981	25622	2404	26662	1960	27807	1293	33662	980	22981
4L-5S		MI	9735	4084	16259	2892	17458	2338	17795	1891	17932	1204	21338	824	15444
14-#11	2.33	MA	13747	4084	22600	2979	24657	2414	25480	1968	26140	1286	31646	938	22227
5L-4S		MI	10037	4084	16771	2897	18116	2331	18577	1884	19011	1211	22624	865	15951
14-#11	2.33	MA	13331	4084	21893	2977	23697	2411	24310	1964	24609	1293	29745	879	21703
6L-3S		MI	10371	4084	17352	2888	18851	2338	19447	1891	20103	1204	23835	949	15983
14-#11	2.33	MA	12925	4084	21137	2989	22775	2421	23180	1972	23110	1300	27765	791	20833
7L-2S		MI	10832	4084	18064	2893	19756	2331	20524	1884	21526	1197	25689	1037	15970
14-#14	3.37	MA	15100	4427	25741	3188	28623	2552	30293	2049	32629	1261	40152	821	31760
4L-5S		MI	10180	4427	17628	3089	19108	2476	19747	1964	20511	1145	24773	606	21079
14-#14	3.37	MA	14489	4427	24669	3185	27241	2566	28601	2061	30259	1251	37288	762	30589
5L-4S		MI	10604	4427	18360	3097	20035	2466	20851	1954	22035	1155	26579	666	21684
14-#14	3.37	MA	13906	4427	23657	3181	25867	2561	26924	2053	28082	1261	34594	677	29185
6L-3S		MI	11072	4427	19188	3085	21073	2476	22078	1964	23575	1145	28283	785	22423

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis

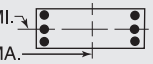


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.37	MA	13337	4427	22573	3198	24546	2575	25306	2064	25952	1271	31787	550	27822
7L-2S		MI	11717	4427	20201	3093	22349	2466	23599	1954	25584	1135	30888	913	22477
14-#18	5.98	MA	16276	5296	29773	3708	33642	2953	36339	2293	40360	1150	51030	293	48956
5L-4S		MI	11946	5296	22233	3607	24645	2801	26319	2120	29314	997	35987	128	35109
14-#18	5.98	MA	15300	5296	27996	3700	31232	2940	33506	2312	36603	1168	46413	141	45691
6L-3S		MI	12733	5296	23671	3589	26409	2819	28406	2138	31931	979	38870	332	37017
16-#11	2.67	MA	14666	4195	24406	3050	26971	2454	28301	1991	30010	1285	36590	961	26157
4L-6S		MI	9763	4195	16485	2956	17708	2381	18125	1927	18366	1197	21995	733	17227
16-#11	2.67	MA	14233	4195	23658	3048	26005	2465	27120	2000	28343	1278	34574	919	25322
5E		MI	10050	4195	16971	2961	18363	2388	18872	1920	19355	1190	23192	793	17518
16-#11	2.67	MA	13820	4195	22951	3047	25046	2461	25949	1995	26812	1285	32673	860	24821
6L-4S		MI	10350	4195	17483	2966	19020	2381	19655	1913	20435	1197	24478	834	18044
16-#11	2.67	MA	13417	4195	22195	3058	24124	2471	24820	2003	25313	1292	30693	772	23899
7L-3S		MI	10683	4195	18064	2958	19756	2388	20524	1920	21526	1190	25689	918	18142
16-#11	2.67	MA	13020	4195	21500	3057	23193	2468	23713	2012	23742	1285	28810	723	23076
8L-2S		MI	11141	4195	18776	2963	20660	2381	21602	1913	22950	1183	27543	1007	18147
16-#14	3.85	MA	15170	4586	26181	3284	29168	2639	30943	2105	33390	1238	41439	732	35021
5E		MI	10621	4586	18641	3188	20384	2547	21267	2004	22520	1124	27377	559	24030
16-#14	3.85	MA	14592	4586	25168	3281	27794	2633	29267	2097	31214	1248	38745	647	33534
6L-4S		MI	11041	4586	19372	3196	21312	2537	22371	1994	24044	1134	29183	618	24590
16-#14	3.85	MA	14029	4586	24084	3298	26473	2647	27649	2109	29083	1258	35939	520	32118
7L-3S		MI	11506	4586	20201	3185	22349	2547	23599	2004	25584	1124	30888	738	25469
16-#14	3.85	MA	13474	4586	23089	3294	25140	2642	26064	2121	26850	1248	33264	451	30446
8L-2S		MI	12146	4586	21213	3193	23626	2537	25119	1994	27593	1114	33492	866	25547
16-#18	6.84	MA	16462	5579	30633	3877	34594	3069	37593	2391	42008	1141	53540	80	53112
6L-4S		MI	12679	5579	23983	3785	26813	2923	28902	2187	32729	953	40374	32	40149
18-#11	3.00	MA	14715	4306	24716	3118	27354	2515	28759	2031	30546	1270	37502	900	28424
5L-6S		MI	10078	4306	17197	3026	18613	2431	19203	1955	19790	1183	23849	703	19243
18-#11	3.00	MA	14305	4306	24009	3116	26394	2511	27589	2026	29015	1277	35601	841	27944
6L-5S		MI	10363	4306	17683	3031	19268	2438	19950	1948	20779	1177	25046	763	19598
18-#11	3.00	MA	13905	4306	23252	3128	25472	2522	26459	2035	27516	1284	33621	753	26972
7L-4S		MI	10662	4306	18195	3036	19925	2431	20732	1941	21859	1183	26332	803	20090
18-#11	3.00	MA	13511	4306	22558	3126	24542	2518	25353	2043	25945	1277	31738	704	26112
8L-3S		MI	10992	4306	18776	3027	20660	2438	21602	1948	22950	1177	27543	888	20296
18-#11	3.00	MA	13120	4306	21823	3138	23632	2528	24208	2038	24462	1284	29896	647	25145
9L-2S		MI	11447	4306	19488	3032	21565	2431	22680	1941	24374	1170	29397	976	20319
18-#14	4.33	MA	15272	4746	26679	3381	29721	2705	31609	2142	34345	1235	42897	617	37895
6L-5S		MI	11058	4746	19653	3288	21661	2618	22788	2044	24529	1102	29982	512	26938
18-#14	4.33	MA	14715	4746	25596	3397	28400	2720	29991	2154	32214	1245	40090	491	36426
7L-4S		MI	11475	4746	20385	3296	22588	2608	23892	2034	26053	1112	31788	571	27508
18-#14	4.33	MA	14165	4746	24601	3394	27067	2714	28406	2166	29982	1235	37415	421	34805
8L-3S		MI	11937	4746	21213	3284	23626	2618	25119	2044	27593	1102	33492	690	28510
20-#11	3.33	MA	14786	4416	25067	3185	27743	2561	29228	2057	31217	1269	38529	822	31000
6E		MI	10391	4416	17909	3095	19518	2481	20281	1984	21213	1170	25703	672	21269
20-#11	3.33	MA	14389	4416	24310	3197	26821	2572	28098	2066	29719	1276	36549	734	30052
7L-5S		MI	10675	4416	18395	3100	20172	2488	21028	1977	22203	1163	26900	732	21682
20-#11	3.33	MA	13998	4416	23616	3195	25890	2568	26992	2075	28148	1269	34666	685	29155
8L-4S		MI	10971	4416	18907	3105	20830	2481	21810	1970	23282	1170	28185	773	22144
20-#11	3.33	MA	13610	4416	22881	3207	24981	2579	25848	2070	26665	1276	32824	628	28215
9L-3S		MI	11300	4416	19488	3096	21565	2488	22680	1977	24374	1163	29397	857	22447
20-#14	4.81	MA	15394	4906	27107	3497	30327	2792	32334	2199	35346	1232	44241	461	40746
7L-5S		MI	11492	4906	20666	3388	22937	2689	24308	2084	26538	1081	32586	465	29776
20-#14	4.81	MA	14849	4906	26112	3494	28994	2786	30749	2211	33113	1222	41566	391	39173
8L-4S		MI	11907	4906	21398	3396	23864	2679	25412	2074	28062	1091	34392	524	30436
22-#11	3.67	MA	14870	4527	25368	3266	28169	2622	29738	2097	31922	1268	39477	715	33137
7L-6S		MI	10702	4527	18621	3164	20423	2531	21358	2012	22637	1156	27557	642	23301

RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.67	MA	14482	4527	24674	3264	27239	2618	28631	2106	30351	1261	37594	666	32204
8L-5S		MI	10984	4527	19107	3169	21077	2538	22106	2006	23627	1149	28754	702	23770
22-#11	3.67	MA	14097	4527	23939	3276	26330	2629	27487	2101	28867	1268	35752	609	31285
9L-4S		MI	11279	4527	19619	3174	21735	2531	22888	1999	24706	1156	30039	742	24204
22-#14	5.29	MA	15528	5065	27624	3594	30921	2859	33091	2256	36244	1210	45717	361	43467
8L-5S		MI	11924	5065	21679	3488	24213	2759	25829	2124	28547	1059	35191	417	32627
24-#11	4.00	MA	14962	4637	25731	3333	28587	2669	30271	2137	32554	1253	40522	647	35258
8L-6S		MI	11012	4637	19333	3233	21327	2580	22436	2041	24061	1142	29411	611	25340
24-#11	4.00	MA	14580	4637	24997	3345	27678	2679	29126	2132	31070	1259	38680	590	34314
9L-5S		MI	11292	4637	19819	3238	21982	2587	23183	2034	25050	1135	30608	671	25861

RECTANGULAR TIED COLUMNS 26" x 38"

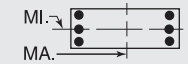
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.62	MA	15892	4061	25599	2959	27912	2400	28893	1980	29674	1350	35306	1240	17895
2E		MI	10625	4061	17401	2852	18480	2299	18788	1878	18909	1253	22016	1105	11691
6-#14	1.37	MA	15555	3972	24725	2925	26903	2377	27706	1970	28211	1375	33451	1281	15337
2L-3S		MI	9780	3972	15865	2819	16713	2302	16716	1897	16179	1303	18568	1043	10161
6-#14	1.37	MA	14489	3972	23114	2922	24849	2392	25209	1982	24855	1385	28988	1153	15359
3L-2S		MI	10446	3972	16878	2827	17989	2292	18236	1887	18188	1293	21173	1171	10090
6-#18	2.43	MA	17156	4345	28414	3137	31500	2529	33254	2060	35479	1326	42985	1184	26488
2L-3S		MI	10247	4345	17401	3012	18480	2438	18788	1963	18909	1226	22016	782	17097
6-#18	2.43	MA	15337	4345	25599	3130	27912	2553	28893	2080	29674	1344	35306	956	26263
3L-2S		MI	11377	4345	19151	3029	20648	2421	21371	1945	22323	1209	26404	1010	17098
8-#11	1.26	MA	15416	3936	24358	2913	26489	2370	27223	1967	27616	1387	32697	1298	14282
2L-4S		MI	9562	3936	15362	2824	16147	2292	16065	1892	15382	1324	17768	1026	9514
8-#11	1.26	MA	14668	3936	23231	2912	25052	2380	25476	1976	25257	1394	29553	1210	14308
3E		MI	9903	3936	15943	2815	16882	2299	16935	1899	16474	1317	18979	1110	9472
8-#11	1.26	MA	14138	3936	22324	2924	23899	2377	24077	1972	23447	1400	27498	1121	14275
4L-2S		MI	10373	3936	16655	2820	17787	2292	18012	1892	17897	1311	20833	1198	9424
8-#14	1.82	MA	16293	4132	26336	3025	28957	2450	30203	2015	31568	1364	37913	1253	20265
2L-4S		MI	9748	4132	16050	2931	16952	2363	17009	1927	16648	1291	19468	876	13248
8-#14	1.82	MA	15238	4132	24725	3022	26903	2465	27706	2027	28211	1374	33451	1125	20239
3E		MI	10230	4132	16878	2919	17989	2373	18236	1937	18188	1281	21173	996	13272
8-#14	1.82	MA	14488	4132	23426	3039	25252	2460	25702	2020	25636	1384	30538	997	20032
4L-2S		MI	10890	4132	17891	2927	19266	2363	19757	1927	20197	1271	23777	1124	13225
8-#18	3.24	MA	18398	4628	31228	3314	35088	2657	37616	2140	41284	1302	50663	1128	35028
2L-4S		MI	10185	4628	17713	3207	18884	2543	19284	2012	19706	1200	23521	483	20376
8-#18	3.24	MA	16606	4628	28414	3307	31500	2681	33254	2159	35479	1319	42985	900	34684
3E		MI	11002	4628	19151	3189	20648	2561	21371	2030	22323	1182	26404	687	22353
8-#18	3.24	MA	15332	4628	26138	3336	28608	2670	29745	2144	31026	1337	37988	673	31523
4L-2S		MI	12118	4628	20902	3206	22816	2543	23955	2012	25738	1165	30791	914	22457
10-#11	1.58	MA	15938	4047	25485	2982	27926	2420	28969	1998	29976	1379	35841	1281	17731
2L-5S		MI	9575	4047	15562	2888	16394	2348	16360	1927	15726	1304	18337	954	11436
10-#11	1.58	MA	15195	4047	24358	2981	26489	2431	27223	2007	27616	1386	32697	1192	17736
3L-4S		MI	9882	4047	16074	2893	17052	2342	17142	1920	16806	1311	19622	995	11691
10-#11	1.58	MA	14669	4047	23451	2993	25336	2428	25823	2003	25806	1393	30642	1103	17673
4L-3S		MI	10222	4047	16655	2884	17787	2348	18012	1927	17897	1304	20833	1079	11668
10-#11	1.58	MA	14197	4047	22655	2992	24310	2438	24567	2012	24021	1386	28483	1061	17176
5L-2S		MI	10688	4047	17367	2889	18692	2342	19090	1920	19321	1297	22687	1168	11630
10-#14	2.28	MA	17023	4292	27947	3125	31011	2522	32700	2059	34925	1352	42375	1226	25175
2L-5S		MI	9765	4292	16331	3022	17301	2444	17425	1977	17133	1260	20266	770	15352

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis

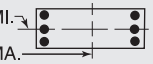


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.28	MA	15977	4292	26336	3122	28957	2537	30203	2072	31568	1362	37913	1098	25105
3L-4S		MI	10197	4292	17062	3030	18228	2434	18529	1967	18657	1270	22072	829	16091
10-#14	2.28	MA	15236	4292	25038	3139	27306	2532	28200	2065	28993	1372	35001	970	24755
4L-3S		MI	10675	4292	17891	3018	19266	2444	19757	1977	20197	1260	23777	948	16360
10-#14	2.28	MA	14571	4292	23898	3136	25836	2547	26400	2078	26453	1362	31930	910	23270
5L-2S		MI	11331	4292	18903	3026	20542	2434	21277	1967	22206	1250	26382	1076	16339
10-#18	4.05	MA	17854	4912	31228	3485	35088	2810	37616	2239	41284	1295	50663	844	43097
3L-4S		MI	10940	4912	19463	3384	21052	2665	21868	2079	23121	1156	27908	387	25326
10-#18	4.05	MA	16600	4912	28953	3513	32196	2799	34107	2224	36831	1313	45666	616	39611
4L-3S		MI	11748	4912	20902	3366	22816	2683	23955	2096	25738	1138	30791	591	27586
10-#18	4.05	MA	15475	4912	26953	3506	29618	2823	30950	2244	32436	1295	40357	513	36729
5L-2S		MI	12852	4912	22652	3384	24985	2665	26539	2079	29153	1120	35179	819	27775
12-#11	1.89	MA	16455	4157	26612	3051	29362	2470	30716	2029	32335	1372	38985	1263	21170
2L-6S		MI	9604	4157	15788	2952	16644	2391	16691	1963	16160	1297	18994	864	13201
12-#11	1.89	MA	15717	4157	25485	3050	27926	2481	28969	2039	29976	1379	35841	1174	21153
3L-5S		MI	9896	4157	16274	2957	17299	2398	17438	1956	17150	1290	20191	924	13492
12-#11	1.89	MA	15195	4157	24578	3062	26773	2478	27570	2034	28166	1386	33786	1085	21066
4E		MI	10201	4157	16786	2962	17956	2391	18220	1949	18230	1297	21476	965	13853
12-#11	1.89	MA	14727	4157	23782	3061	25747	2489	26314	2044	26381	1379	31627	1043	20454
5L-3S		MI	10538	4157	17367	2953	18692	2398	19090	1956	19321	1290	22687	1049	13851
12-#11	1.89	MA	14280	4157	23031	3059	24726	2486	25070	2039	24740	1386	29584	984	19835
6L-2S		MI	11002	4157	18079	2958	19596	2391	20168	1949	20745	1283	24541	1137	13823
12-#14	2.73	MA	16709	4451	27947	3222	31011	2609	32700	2117	34925	1351	42375	1070	29962
3L-5S		MI	10214	4451	17344	3122	18577	2515	18946	2017	19142	1238	22871	723	18282
12-#14	2.73	MA	15975	4451	26649	3239	29360	2604	30697	2110	32350	1361	39463	942	29376
4E		MI	10643	4451	18075	3130	19504	2505	20050	2007	20666	1248	24677	782	18959
12-#14	2.73	MA	15317	4451	25509	3236	27891	2619	28897	2123	29809	1351	36392	882	27974
5L-3S		MI	11116	4451	18903	3118	20542	2515	21277	2017	22206	1238	26382	901	19429
12-#14	2.73	MA	14689	4451	24432	3233	26429	2614	27114	2116	27476	1361	33494	797	26696
6L-2S		MI	11767	4451	19916	3126	21818	2505	22798	2007	24215	1228	28986	1029	19440
12-#18	4.86	MA	17849	5196	31767	3691	35784	2927	38468	2303	42636	1289	53345	560	47739
4E		MI	11687	5196	21214	3561	23221	2787	24452	2145	26536	1112	32296	292	30313
12-#18	4.86	MA	16741	5196	29767	3684	33206	2952	35312	2323	38241	1271	48035	457	44697
5L-3S		MI	12486	5196	22652	3543	24985	2805	26539	2163	29153	1094	35179	496	32479
12-#18	4.86	MA	15684	5196	27877	3677	30641	2941	32185	2308	34206	1289	43056	305	41457
6L-2S		MI	13579	5196	24403	3561	27153	2787	29123	2145	32567	1076	39566	723	33066
14-#11	2.21	MA	16234	4268	26612	3119	29362	2531	30716	2070	32335	1372	38985	1157	24564
3L-6S		MI	9923	4268	16500	3021	17549	2441	17768	1991	17584	1283	20848	833	15288
14-#11	2.21	MA	15716	4268	25705	3131	28209	2528	29316	2065	30525	1378	36930	1068	24455
4L-5S		MI	10213	4268	16986	3026	18204	2448	18516	1985	18574	1276	22044	893	15558
14-#11	2.21	MA	15252	4268	24909	3130	27183	2539	28060	2075	28740	1372	34771	1025	23743
5L-4S		MI	10517	4268	17498	3031	18861	2441	19298	1978	19653	1283	23330	934	16007
14-#11	2.21	MA	14809	4268	24158	3128	26163	2536	26816	2070	27100	1378	32728	967	23155
6L-3S		MI	10852	4268	18079	3022	19596	2448	20168	1985	20745	1276	24541	1018	16026
14-#11	2.21	MA	14376	4268	23354	3141	25183	2547	25616	2080	25494	1385	30601	879	22313
7L-2S		MI	11313	4268	18791	3027	20501	2441	21246	1978	22169	1269	26395	1107	16009
14-#14	3.19	MA	16706	4611	28260	3339	31415	2677	33194	2155	35706	1349	43925	915	34018
4L-5S		MI	10659	4611	18356	3222	19853	2586	20466	2057	21151	1217	25476	675	21224
14-#14	3.19	MA	16055	4611	27120	3336	29945	2692	31394	2168	33166	1339	40854	855	32691
5L-4S		MI	11084	4611	19088	3230	20781	2576	21570	2047	22675	1227	27282	735	21848
14-#14	3.19	MA	15433	4611	26043	3333	28483	2687	29611	2160	30832	1349	37956	770	31325
6L-3S		MI	11554	4611	19916	3218	21818	2586	22798	2057	24215	1217	28986	854	22487
14-#14	3.19	MA	14827	4611	24891	3350	27079	2702	27891	2173	28549	1359	34938	643	29941
7L-2S		MI	12200	4611	20929	3226	23095	2576	24318	2047	26224	1207	31591	982	22529
14-#18	5.67	MA	17990	5480	32581	3861	36794	3080	39674	2403	44046	1247	55714	400	52699
5L-4S		MI	12427	5480	22964	3739	25389	2909	27035	2212	29950	1068	36684	196	35329
14-#18	5.67	MA	16949	5480	30691	3854	34229	3069	36547	2388	40010	1264	50735	249	49375
6L-3S		MI	13218	5480	24403	3721	27153	2927	29123	2230	32567	1050	39566	400	37314

RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis



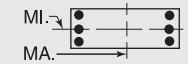
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.53	MA	16234	4379	26832	3201	29646	2578	31063	2096	32884	1371	40074	1050	27841
4L-6S		MI	10241	4379	17212	3090	18454	2491	18846	2020	19008	1269	22702	803	17379
16-#11	2.53	MA	15773	4379	26036	3199	28620	2589	29807	2106	31099	1364	37915	1008	27041
5E		MI	10529	4379	17698	3095	19109	2498	19593	2013	19998	1262	23898	863	17632
16-#11	2.53	MA	15333	4379	25285	3198	27600	2586	28563	2101	29459	1371	35872	949	26479
6L-4S		MI	10830	4379	18210	3100	19766	2491	20376	2006	21077	1269	25184	903	18155
16-#11	2.53	MA	14904	4379	24481	3210	26620	2597	27362	2111	27854	1378	33745	861	25583
7L-3S		MI	11164	4379	18791	3091	20501	2498	21246	2013	22169	1262	26395	988	18191
16-#11	2.53	MA	14481	4379	23743	3208	25631	2594	26186	2120	26172	1371	31728	811	24794
8L-2S		MI	11623	4379	19503	3096	21406	2491	22323	2006	23592	1255	28249	1076	18188
16-#14	3.64	MA	16785	4770	28731	3436	31999	2764	33891	2213	36523	1328	45316	827	37419
5E		MI	11100	4770	19369	3321	21130	2656	21987	2097	23160	1195	28080	628	24174
16-#14	3.64	MA	16170	4770	27655	3433	30537	2759	32108	2205	34189	1337	42419	742	35968
6L-4S		MI	11522	4770	20101	3330	22057	2646	23091	2087	24684	1205	29886	688	24752
16-#14	3.64	MA	15570	4770	26503	3450	29133	2774	30388	2218	31905	1347	39400	615	34579
7L-3S		MI	11989	4770	20929	3318	23095	2656	24318	2097	26224	1195	31591	807	25537
16-#14	3.64	MA	14978	4770	25445	3447	27716	2769	28703	2231	29512	1337	36532	545	32708
8L-2S		MI	12630	4770	21942	3326	24371	2646	25839	2087	28233	1185	34196	935	25603
16-#18	6.48	MA	18197	5763	33506	4032	37817	3198	40909	2467	45815	1240	58413	193	57321
6L-4S		MI	13161	5763	24715	3916	27557	3032	29619	2279	33365	1024	41071	101	40367
18-#11	2.84	MA	16290	4489	27163	3268	30057	2639	31553	2137	33458	1357	41059	990	30348
5L-6S		MI	10556	4489	17924	3160	19359	2541	19924	2049	20432	1255	24555	772	19429
18-#11	2.84	MA	15853	4489	26412	3267	29037	2636	30309	2132	31818	1364	39016	931	29808
6L-5S		MI	10843	4489	18409	3164	20013	2548	20671	2042	21421	1248	25752	832	19712
18-#11	2.84	MA	15428	4489	25608	3279	28057	2647	29109	2142	30213	1371	36889	844	28861
7L-4S		MI	11142	4489	18922	3169	20671	2541	21454	2035	22501	1255	27038	873	20224
18-#11	2.84	MA	15008	4489	24870	3278	27068	2644	27933	2151	28531	1364	34872	794	28034
8L-3S		MI	11474	4489	19503	3161	21406	2548	22323	2042	23592	1248	28249	957	20349
18-#11	2.84	MA	14592	4489	24090	3290	26102	2655	26717	2147	26942	1371	32893	737	26953
9L-2S		MI	11930	4489	20215	3166	22311	2541	23401	2035	25016	1242	30103	1046	20362
18-#14	4.10	MA	16900	4930	29266	3533	32591	2831	34606	2250	37546	1326	46881	715	40624
6L-5S		MI	11538	4930	20382	3421	22406	2727	23507	2137	25169	1174	30685	581	27131
18-#14	4.10	MA	16306	4930	28114	3550	31187	2846	32885	2263	35262	1336	43863	588	39182
7L-4S		MI	11957	4930	21113	3429	23333	2717	24611	2127	26693	1184	32491	640	27669
18-#14	4.10	MA	15720	4930	27056	3547	29770	2841	31200	2276	32869	1326	40994	517	37363
8L-3S		MI	12420	4930	21942	3417	24371	2727	25839	2137	28233	1174	34196	759	28581
20-#11	3.16	MA	16370	4600	27539	3336	30473	2686	32056	2164	34177	1357	42160	914	33141
6E		MI	10870	4600	18636	3229	20263	2591	21002	2077	21856	1242	26409	742	21452
20-#11	3.16	MA	15947	4600	26735	3348	29494	2697	30855	2173	32572	1363	40033	826	32145
7L-5S		MI	11155	4600	19121	3234	20918	2598	21749	2070	22845	1235	27606	802	21796
20-#11	3.16	MA	15531	4600	25997	3347	28505	2694	29679	2182	30891	1357	38016	776	31281
8L-4S		MI	11453	4600	19634	3239	21575	2591	22531	2064	23925	1242	28892	842	22276
20-#11	3.16	MA	15118	4600	25217	3359	27539	2705	28463	2178	29302	1363	36037	720	30228
9L-3S		MI	11782	4600	20215	3230	22311	2598	23401	2070	25016	1235	30103	927	22502
20-#11	3.16	MA	14669	4600	24483	3357	26562	2702	27295	2187	27725	1370	34119	656	28996
10L-2S		MI	12236	4600	20927	3235	23215	2591	24479	2064	26440	1228	31957	1015	22528
20-#14	4.55	MA	17035	5089	29725	3650	33241	2919	35382	2308	38618	1324	48325	560	43796
7L-5S		MI	11973	5089	21394	3521	23682	2798	25028	2177	27178	1152	33289	534	30035
20-#14	4.55	MA	16454	5089	28667	3647	31824	2914	33697	2321	36225	1314	45456	490	42028
8L-4S		MI	12389	5089	22126	3529	24610	2788	26132	2167	28702	1162	35095	593	30596
22-#11	3.47	MA	16463	4711	27862	3417	30930	2747	32602	2204	34931	1356	43177	808	35435
7L-6S		MI	11182	4711	19348	3298	21168	2641	22079	2106	23279	1228	28263	711	23483

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

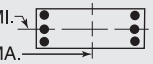
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.47	MA	16049	4711	27124	3416	29942	2744	31426	2214	33250	1349	41160	758	34534
8L-5S		MI	11465	4711	19833	3303	21823	2648	22827	2099	24269	1221	29460	771	23884
22-#11	3.47	MA	15639	4711	26344	3428	28975	2755	30210	2209	31661	1356	39181	702	33509
9L-4S		MI	11761	4711	20346	3308	22480	2641	23609	2092	25348	1228	30745	812	24336
22-#11	3.47	MA	15192	4711	25609	3427	27999	2752	29041	2219	30084	1363	37262	638	32253
10L-3S		MI	12089	4711	20927	3299	23215	2648	24479	2099	26440	1221	31957	896	24652
22-#14	5.01	MA	17182	5249	30279	3747	33878	2986	36194	2366	39582	1303	49918	462	46700
8L-5S		MI	12406	5249	22407	3621	24959	2869	26548	2217	29187	1131	35894	487	32883
24-#11	3.79	MA	16565	4821	28251	3485	31378	2794	33172	2245	35609	1342	44304	741	37793
8L-6S		MI	11492	4821	20060	3367	22073	2691	23157	2135	24703	1214	30117	681	25521
24-#11	3.79	MA	16155	4821	27470	3497	30412	2805	31956	2240	34020	1349	42325	684	36793
9L-5S		MI	11774	4821	20545	3372	22728	2697	23905	2128	25693	1207	31314	741	25975
24-#11	3.79	MA	15710	4821	26736	3496	29436	2802	30788	2250	32443	1356	40406	621	35515
10L-4S		MI	12068	4821	21058	3377	23385	2691	24687	2121	26772	1214	32599	781	26402

RECTANGULAR TIED COLUMNS 26" x 40"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.54	MA	17510	4245	28063	3109	30608	2523	31649	2084	32474	1435	38637	1326	18975
2E		MI	11105	4245	18132	2983	19224	2407	19504	1970	19545	1323	22713	1174	11733
6-#14	1.30	MA	17146	4156	27127	3075	29527	2500	30378	2074	30890	1459	36616	1365	16248
2L-3S		MI	10259	4156	16594	2952	17458	2412	17435	1989	16820	1374	19271	1112	10198
6-#14	1.30	MA	16011	4156	25416	3072	27346	2516	27727	2088	27308	1469	31842	1237	16271
3L-2S		MI	10925	4156	17606	2960	18735	2402	18956	1980	18828	1364	21876	1240	10124
6-#18	2.31	MA	18864	4529	31055	3286	34422	2652	36286	2164	38679	1412	46868	1274	28108
2L-3S		MI	10726	4529	18132	3143	19224	2547	19504	2055	19545	1297	22713	851	17170
6-#18	2.31	MA	16925	4529	28063	3281	30608	2677	31649	2186	32474	1430	38637	1046	27883
3L-2S		MI	11857	4529	19883	3160	21392	2529	22088	2037	22959	1279	27100	1078	17148
8-#11	1.20	MA	16996	4120	26734	3062	29083	2492	29861	2071	30229	1469	35795	1381	15124
2L-4S		MI	10040	4120	16089	2958	16893	2402	16786	1985	16024	1396	18474	1095	9551
8-#11	1.20	MA	16200	4120	25538	3061	27558	2504	28007	2081	27717	1476	32435	1292	15150
3E		MI	10382	4120	16670	2949	17628	2409	17656	1992	17116	1389	19686	1179	9504
8-#11	1.20	MA	15637	4120	24577	3074	26336	2501	26524	2077	25792	1483	30236	1204	15117
4L-2S		MI	10852	4120	17382	2954	18533	2402	18733	1985	18540	1382	21539	1268	9454
8-#14	1.73	MA	17936	4316	28838	3174	31708	2573	33030	2119	34472	1448	41390	1339	21480
2L-4S		MI	10226	4316	16778	3064	17697	2472	17728	2020	17288	1363	20171	946	13311
8-#14	1.73	MA	16812	4316	27127	3172	29527	2588	30378	2133	30890	1458	36616	1211	21454
3E		MI	10709	4316	17606	3052	18735	2482	18956	2030	18828	1353	21876	1065	13316
8-#14	1.73	MA	16016	4316	25750	3190	27776	2584	28254	2126	28142	1468	33496	1083	21247
4L-2S		MI	11370	4316	18619	3060	20011	2472	20476	2020	20837	1343	24480	1193	13263
8-#18	3.08	MA	20194	4812	34047	3464	38236	2780	40923	2244	44884	1390	55099	1221	37188
2L-4S		MI	10662	4812	18444	3338	19628	2651	20001	2104	20342	1271	24217	551	20601
8-#18	3.08	MA	18283	4812	31055	3458	34422	2806	36286	2265	38679	1408	46868	994	36844
3E		MI	11482	4812	19883	3320	21392	2669	22088	2121	22959	1253	27100	755	22438
8-#18	3.08	MA	16928	4812	28641	3488	31352	2796	32561	2251	33919	1426	41503	766	33720
4L-2S		MI	12601	4812	21633	3338	23561	2651	24672	2104	26374	1235	31488	983	22514
10-#11	1.50	MA	17554	4231	27930	3132	30608	2543	31714	2102	32740	1462	39155	1365	18784
2L-5S		MI	10053	4231	16288	3022	17140	2459	17081	2021	16368	1376	19043	1024	11548
10-#11	1.50	MA	16763	4231	26734	3131	29083	2554	29861	2112	30229	1469	35795	1276	18789
3L-4S		MI	10361	4231	16801	3027	17797	2452	17864	2014	17448	1382	20328	1065	11733
10-#11	1.50	MA	16204	4231	25773	3143	27861	2551	28377	2108	28303	1476	33596	1187	18726
4L-3S		MI	10701	4231	17382	3018	18533	2459	18733	2021	18540	1376	21539	1149	11704
10-#11	1.50	MA	15703	4231	24931	3142	26774	2563	27047	2118	26404	1469	31294	1144	18294
5L-2S		MI	11168	4231	18094	3023	19437	2452	19811	2014	19963	1369	23393	1237	11663
10-#14	2.16	MA	18716	4475	30549	3274	33890	2645	35682	2164	38054	1438	46163	1314	26694
2L-5S		MI	10243	4475	17059	3155	18046	2553	18145	2070	17773	1331	20970	839	15493
10-#14	2.16	MA	17602	4475	28838	3272	31708	2660	33030	2177	34472	1448	41390	1186	26624
3L-4S		MI	10676	4475	17791	3163	18973	2543	19249	2060	19297	1341	22776	898	16256

RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

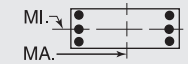
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.16	MA	16815	4475	27461	3290	29958	2656	30905	2171	31724	1458	38270	1058	26368
4L-3S		MI	11155	4475	18619	3151	20011	2553	20476	2070	20837	1331	24480	1017	16412
10-#14	2.16	MA	16109	4475	26253	3287	28400	2672	28998	2185	29014	1448	34992	996	24792
5L-2S		MI	11811	4475	19632	3160	21287	2543	21997	2060	22846	1321	27085	1145	16381
10-#18	3.85	MA	19620	5096	34047	3635	38236	2934	40923	2345	44884	1386	55099	942	45797
3L-4S		MI	11418	5096	20195	3516	21797	2773	22585	2170	23757	1226	28605	455	25547
10-#18	3.85	MA	18285	5096	31632	3665	35166	2924	37198	2331	40124	1403	49733	714	42329
4L-3S		MI	12229	5096	21633	3498	23561	2791	24672	2188	26374	1209	31488	660	27679
10-#18	3.85	MA	17089	5096	29511	3659	32432	2950	33850	2353	35427	1386	44057	609	39472
5L-2S		MI	13336	5096	23384	3515	25729	2773	27256	2170	29788	1191	35876	887	27841
12-#11	1.80	MA	18106	4341	29126	3201	32133	2593	33568	2134	35251	1455	42515	1349	22434
2L-6S		MI	10081	4341	16515	3086	17390	2502	17412	2056	16803	1369	19700	933	13305
12-#11	1.80	MA	17321	4341	27930	3200	30608	2604	31714	2143	32740	1462	39155	1260	22416
3L-5S		MI	10374	4341	17000	3091	18045	2508	18159	2049	17792	1362	20897	993	13603
12-#11	1.80	MA	16766	4341	26969	3212	29386	2602	30231	2140	30814	1469	36956	1171	22330
4E		MI	10679	4341	17513	3096	18702	2502	18941	2043	18872	1369	22182	1034	13902
12-#11	1.80	MA	16270	4341	26127	3211	28299	2613	28900	2149	28916	1462	34654	1128	21775
5L-3S		MI	11017	4341	18094	3087	19437	2508	19811	2049	19963	1362	23393	1118	13890
12-#11	1.80	MA	15796	4341	25331	3210	27219	2610	27583	2146	27171	1470	32469	1069	21087
6L-2S		MI	11482	4341	18806	3092	20342	2502	20889	2043	21387	1355	25247	1207	13859
12-#14	2.60	MA	18384	4635	30549	3372	33890	2733	35682	2222	38054	1437	46163	1160	31785
3L-5S		MI	10692	4635	18072	3255	19322	2624	19666	2110	19782	1310	23574	792	18422
12-#14	2.60	MA	17605	4635	29172	3389	32139	2729	33557	2216	35306	1447	43043	1032	31362
4E		MI	11122	4635	18804	3263	20250	2614	20769	2100	21306	1320	25380	851	19122
12-#14	2.60	MA	16906	4635	27964	3387	30581	2744	31650	2229	32596	1437	39766	971	29791
5L-3S		MI	11597	4635	19632	3251	21287	2624	21997	2110	22846	1310	27085	970	19486
12-#14	2.60	MA	16240	4635	26824	3385	29032	2740	29761	2223	30105	1447	36664	886	28566
6L-2S		MI	12249	4635	20645	3259	22564	2614	23517	2100	24855	1300	29689	1098	19485
12-#18	4.62	MA	19622	5380	34624	3842	38980	3053	41834	2411	46329	1381	57964	662	50979
4E		MI	12167	5380	21945	3693	23965	2895	25169	2237	27171	1182	32993	360	30531
12-#18	4.62	MA	18444	5380	32503	3836	36246	3079	38487	2432	41632	1363	52288	556	47964
5L-3S		MI	12968	5380	23384	3675	25729	2913	27256	2255	29788	1165	35876	564	32775
12-#18	4.62	MA	17321	5380	30499	3831	33527	3069	35171	2418	37318	1381	46946	405	44565
6L-2S		MI	14064	5380	25134	3692	27898	2895	29840	2237	33203	1147	40263	792	33138
14-#11	2.10	MA	17874	4452	29126	3269	32133	2654	33568	2175	35251	1455	42515	1244	26038
3L-6S		MI	10401	4452	17227	3155	18295	2551	18489	2085	18226	1355	21554	903	15393
14-#11	2.10	MA	17323	4452	28165	3281	30911	2652	32085	2171	33326	1462	40316	1155	25929
4L-5S		MI	10692	4452	17712	3160	18949	2558	19237	2078	19216	1348	22751	963	15669
14-#11	2.10	MA	16831	4452	27323	3280	29824	2663	30754	2181	31427	1456	38014	1112	25268
5L-4S		MI	10996	4452	18225	3165	19607	2551	20019	2071	20296	1355	24036	1004	16060
14-#11	2.10	MA	16361	4452	26527	3279	28744	2660	29436	2177	29682	1463	35829	1053	24612
6L-3S		MI	11332	4452	18806	3156	20342	2558	20889	2078	21387	1348	25247	1088	16069
14-#11	2.10	MA	15902	4452	25676	3292	27706	2672	28165	2187	27975	1470	33555	965	23807
7L-2S		MI	11794	4452	19518	3161	21247	2551	21967	2071	22811	1341	27101	1176	16047
14-#14	3.03	MA	18386	4795	30883	3489	34320	2801	36209	2261	38888	1436	47817	1007	36296
4L-5S		MI	11137	4795	19085	3355	20599	2695	21186	2150	21791	1288	26179	745	21364
14-#14	3.03	MA	17695	4795	29675	3487	32763	2817	34301	2274	36178	1427	44539	945	34804
5L-4S		MI	11564	4795	19816	3363	21526	2685	22290	2140	23315	1298	27985	804	22008
14-#14	3.03	MA	17035	4795	28535	3485	31214	2812	32413	2268	33688	1436	41437	861	33490
6L-3S		MI	12035	4795	20645	3351	22564	2695	23517	2150	24855	1288	29689	923	22548
14-#14	3.03	MA	16392	4795	27314	3503	29726	2828	30590	2282	31250	1446	38207	734	31952
7L-2S		MI	12683	4795	21657	3359	23840	2685	25038	2140	26864	1278	32294	1051	22580
14-#18	5.38	MA	19781	5663	35495	4014	40060	3207	43123	2512	47837	1341	60519	504	56488
5L-4S		MI	12908	5663	23696	3870	26133	3017	27752	2304	30586	1138	37380	264	35544

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis

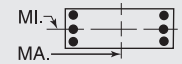


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	5.38	MA	18673	5663	33491	4008	37341	3197	39807	2498	43523	1359	55177	353	53122
6L-3S		MI	13701	5663	25134	3852	27898	3035	29840	2322	33203	1121	40263	469	37604
16-#11	2.40	MA	17876	4563	29361	3351	32436	2702	33939	2202	35837	1455	43676	1138	29526
4L-6S		MI	10719	4563	17939	3224	19200	2601	19567	2114	19650	1341	23408	872	17485
16-#11	2.40	MA	17387	4563	28519	3350	31349	2713	32608	2212	33938	1449	41374	1095	28771
5E		MI	11008	4563	18424	3229	19854	2608	20315	2107	20640	1334	24604	932	17743
16-#11	2.40	MA	16921	4563	27723	3348	30268	2711	31290	2208	32194	1456	39189	1037	28143
6L-4S		MI	11310	4563	18937	3234	20512	2601	21097	2100	21719	1341	25890	973	18212
16-#11	2.40	MA	16466	4563	26872	3361	29231	2722	30019	2218	30486	1463	36915	949	27282
7L-3S		MI	11644	4563	19518	3225	21247	2608	21967	2107	22811	1334	27101	1057	18241
16-#11	2.40	MA	16017	4563	26091	3360	28184	2719	28774	2228	28698	1456	34764	899	26446
8L-2S		MI	12104	4563	20230	3230	22152	2601	23044	2100	24235	1327	28955	1146	18228
16-#14	3.46	MA	18476	4954	31386	3587	34944	2889	36953	2319	39760	1416	49313	920	39829
5E		MI	11579	4954	20097	3455	21875	2766	22707	2190	23800	1267	28783	697	24314
16-#14	3.46	MA	17823	4954	30246	3585	33395	2885	35064	2313	37270	1426	46211	835	38427
6L-4S		MI	12003	4954	20829	3463	22802	2756	23810	2180	25324	1277	30589	757	24911
16-#14	3.46	MA	17185	4954	29025	3602	31908	2900	33242	2326	34832	1436	42981	709	36944
7L-3S		MI	12471	4954	21657	3451	23840	2766	25038	2190	26864	1267	32294	876	25603
16-#14	3.46	MA	16557	4954	27906	3600	30407	2896	31457	2340	32279	1426	39919	637	34998
8L-2S		MI	13114	4954	22670	3459	25116	2756	26558	2180	28873	1257	34899	1004	25657
16-#18	6.15	MA	20009	5947	36483	4185	41155	3326	44444	2578	49728	1337	63408	301	61593
6L-4S		MI	13643	5947	25446	4047	28302	3140	30336	2371	34001	1094	41768	169	40580
18-#11	2.70	MA	17939	4673	29715	3419	32874	2763	34461	2243	36450	1442	44734	1079	32282
5L-6S		MI	11035	4673	18651	3293	20104	2651	20645	2142	21074	1327	25262	842	19580
18-#11	2.70	MA	17476	4673	28919	3418	31793	2761	33144	2239	34705	1449	42549	1020	31679
6L-5S		MI	11323	4673	19136	3298	20759	2658	21392	2135	22064	1320	26458	902	19823
18-#11	2.70	MA	17025	4673	28068	3430	30756	2772	31872	2249	32997	1456	40275	933	30765
7L-4S		MI	11623	4673	19649	3303	21416	2651	22175	2128	23143	1327	27744	942	20354
18-#11	2.70	MA	16579	4673	27287	3429	29709	2770	30627	2259	31209	1449	38124	882	29954
8L-3S		MI	11955	4673	20230	3294	22152	2658	23044	2135	24235	1320	28955	1027	20400
18-#11	2.70	MA	16134	4673	26461	3442	28686	2781	29339	2255	29519	1457	36008	826	28781
9L-2S		MI	12413	4673	20942	3299	23056	2651	24122	2128	25658	1313	30809	1115	20404
18-#14	3.89	MA	18603	5114	31957	3684	35576	2957	37716	2358	40852	1415	50984	810	43377
6L-5S		MI	12018	5114	21110	3554	23151	2837	24227	2230	25809	1245	31388	650	27271
18-#14	3.89	MA	17972	5114	30736	3702	34089	2973	35893	2371	38414	1425	47754	683	41945
7L-4S		MI	12439	5114	21842	3562	24079	2827	25331	2220	27333	1255	33194	709	27826
18-#14	3.89	MA	17349	5114	29616	3700	32588	2968	34108	2385	35861	1415	44692	612	39950
8L-3S		MI	12903	5114	22670	3550	25116	2837	26558	2230	28873	1245	34899	829	28651
18-#14	3.89	MA	16728	5114	28431	3718	31121	2984	32262	2379	33449	1425	41687	530	37847
9L-2S		MI	13543	5114	23683	3558	26392	2827	28079	2220	30882	1235	37503	957	28727
20-#11	3.00	MA	18028	4784	30115	3487	33318	2811	34997	2270	37216	1442	45909	1004	35219
6E		MI	11349	4784	19363	3363	21009	2701	21723	2171	22498	1313	27116	811	21631
20-#11	3.00	MA	17580	4784	29264	3499	32281	2822	33726	2280	35509	1449	43635	916	34254
7L-5S		MI	11635	4784	19848	3367	21664	2708	22470	2164	23487	1307	28312	871	21907
20-#11	3.00	MA	17138	4784	28483	3498	31234	2820	32481	2290	33720	1442	41484	866	33431
8L-4S		MI	11934	4784	20361	3372	22321	2701	23252	2157	24567	1313	29598	912	22406
20-#11	3.00	MA	16693	4784	27657	3511	30211	2831	31193	2286	32030	1450	39368	810	32262
9L-3S		MI	12264	4784	20942	3364	23056	2708	24122	2164	25658	1307	30809	996	22556
20-#11	3.00	MA	16202	4784	26880	3510	29177	2828	29956	2296	30353	1457	37316	746	31030
10L-2S		MI	12719	4784	21654	3369	23961	2701	25200	2157	27082	1300	32663	1085	22576
20-#14	4.33	MA	18751	5273	32447	3802	36270	3045	38545	2416	41997	1415	52528	658	46883
7L-5S		MI	12454	5273	22123	3654	24428	2908	25748	2270	27818	1224	33993	603	30234
20-#14	4.33	MA	18134	5273	31327	3800	34769	3041	36760	2430	39443	1405	49466	586	44911
8L-4S		MI	12872	5273	22855	3662	25355	2898	26851	2260	29342	1234	35799	662	30753
20-#14	4.33	MA	17514	5273	30142	3817	33302	3056	34914	2423	37031	1415	46461	505	42776
9L-3S		MI	13334	5273	23683	3650	26392	2908	28079	2270	30882	1224	37503	781	31693

RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

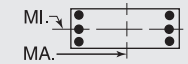
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.30	MA	18130	4895	30460	3569	33806	2872	35580	2311	38020	1442	46995	900	37749
7L-6S		MI	11662	4895	20075	3432	21914	2751	22801	2200	23922	1300	28969	781	23661
22-#11	3.30	MA	17692	4895	29679	3567	32759	2870	34335	2321	36232	1436	44844	850	36889
8L-5S		MI	11946	4895	20560	3437	22569	2758	23548	2193	24911	1293	30166	841	23995
22-#11	3.30	MA	17248	4895	28853	3580	31736	2881	33047	2317	34542	1443	42728	793	35748
9L-4S		MI	12243	4895	21073	3442	23226	2751	24330	2186	25991	1300	31452	881	24465
22-#11	3.30	MA	16773	4895	28076	3579	30702	2879	31810	2327	32865	1450	40676	730	34492
10L-3S		MI	12571	4895	21654	3433	23961	2758	25200	2193	27082	1293	32663	966	24708
22-#14	4.76	MA	18912	5433	33038	3899	36950	3113	39412	2475	43026	1394	54239	561	49881
8L-5S		MI	12888	5433	23136	3754	25704	2978	27268	2310	29827	1202	36597	556	33133
22-#14	4.76	MA	18294	5433	31853	3917	35483	3129	37565	2468	40613	1404	51234	479	47714
9L-4S		MI	13303	5433	23867	3762	26631	2968	28372	2300	31351	1212	38403	615	33688
24-#11	3.60	MA	18242	5005	30875	3637	34283	2920	36188	2352	38743	1429	48204	833	40353
8L-6S		MI	11972	5005	20787	3501	22819	2801	23878	2228	25345	1286	30823	750	25697
24-#11	3.60	MA	17799	5005	30049	3649	33260	2931	34900	2348	37053	1436	46088	777	39238
9L-5S		MI	12255	5005	21272	3506	23473	2808	24626	2221	26335	1279	32020	810	26087
24-#11	3.60	MA	17327	5005	29272	3648	32227	2929	33663	2358	35376	1443	44036	713	37960
10L-4S		MI	12551	5005	21785	3511	24131	2801	25408	2214	27414	1286	33306	851	26530
24-#14	5.19	MA	19067	5592	33564	4017	37665	3201	40217	2513	44195	1394	56008	454	52658
9L-5S		MI	13319	5592	24148	3853	26980	3049	28789	2350	31836	1181	39202	508	35990

RECTANGULAR TIED COLUMNS 26" x 42"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.47	MA	19204	4429	30632	3258	33418	2646	34520	2189	35378	1519	42086	1411	20055
2E		MI	11584	4429	18864	3114	19968	2515	20221	2062	20180	1394	23410	1242	11774
6-#14	1.24	MA	18812	4340	29634	3224	32265	2623	33164	2178	33656	1541	39900	1448	17160
2L-3S		MI	10737	4340	17322	3085	18204	2521	18155	2082	17460	1446	19974	1181	10234
6-#14	1.24	MA	17607	4340	27823	3222	29957	2639	30358	2193	29854	1551	34814	1320	17182
3L-2S		MI	11405	4340	18335	3093	19480	2511	19676	2073	19469	1436	22579	1309	10157
6-#18	2.20	MA	20648	4712	33801	3436	37458	2775	39432	2268	41984	1498	50870	1362	29728
2L-3S		MI	11204	4712	18864	3274	19968	2655	20221	2146	20180	1368	23410	919	17240
6-#18	2.20	MA	18587	4712	30632	3431	33418	2801	34520	2291	35378	1516	42086	1135	29503
3L-2S		MI	12338	4712	20614	3292	22137	2637	22805	2129	23595	1350	27797	1146	17197
8-#11	1.14	MA	18650	4304	29215	3212	31792	2615	32613	2176	32918	1549	39012	1464	15967
2L-4S		MI	10518	4304	16816	3091	17638	2512	17507	2079	16666	1468	19181	1165	9586
8-#11	1.14	MA	17806	4304	27950	3211	30179	2613	30652	2186	30262	1557	35436	1375	15993
3E		MI	10860	4304	17397	3083	18374	2519	18377	2086	17758	1461	20392	1249	9535
8-#11	1.14	MA	17210	4304	26935	3224	28888	2625	29085	2183	28227	1564	33092	1286	15960
4L-2S		MI	11331	4304	18109	3088	19278	2512	19455	2079	19182	1454	22246	1337	9484
8-#14	1.65	MA	19653	4500	31445	3324	34574	2695	35971	2223	37458	1531	44985	1424	22695
2L-4S		MI	10704	4500	17507	3197	18442	2582	18448	2113	17928	1434	20874	1015	13370
8-#14	1.65	MA	18460	4500	29634	3322	32265	2712	33164	2238	33656	1541	39900	1296	22669
3E		MI	11188	4500	18335	3185	19480	2592	19676	2123	19469	1424	22579	1134	13358
8-#14	1.65	MA	17617	4500	28179	3340	30415	2708	30919	2232	30741	1551	36572	1168	22462
4L-2S		MI	11850	4500	19348	3193	20756	2582	21196	2113	21477	1414	25183	1262	13301
8-#18	2.93	MA	22066	4996	36970	3613	41498	2903	44343	2348	48590	1478	59654	1314	39348
2L-4S		MI	11139	4996	19176	3470	20373	2759	20718	2196	20978	1341	24914	619	20821
8-#18	2.93	MA	20035	4996	33801	3608	37458	2930	39432	2371	41984	1496	50870	1086	39004
3E		MI	11961	4996	20614	3452	22137	2777	22805	2213	23595	1323	27797	823	22518
8-#18	2.93	MA	18599	4996	31247	3639	34211	2921	35492	2359	36916	1513	45136	859	35941
4L-2S		MI	13083	4996	22365	3469	24305	2759	25389	2196	27009	1306	32185	1051	22569
10-#11	1.43	MA	19243	4415	30481	3281	33405	2666	34573	2207	35575	1542	42588	1448	19837
2L-5S		MI	10531	4415	17015	3156	17886	2569	17802	2114	17011	1447	19749	1093	11657
10-#11	1.43	MA	18405	4415	29215	3280	31792	2663	32613	2217	32918	1550	39012	1360	19842
3L-4S		MI	10839	4415	17528	3161	18543	2562	18585	2107	18090	1454	21034	1134	11773
10-#11	1.43	MA	17814	4415	28200	3293	30501	2675	31046	2214	30883	1557	36669	1271	19779
4L-3S		MI	11179	4415	18109	3152	19278	2569	19455	2114	19182	1447	22246	1218	11738

RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

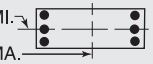
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.43	MA	17284	4415	27310	3292	29353	2673	29640	2224	28878	1551	34223	1227	19422
5L-2S		MI	11647	4415	18821	3157	20183	2562	20532	2107	20606	1441	24099	1307	11695
10-#14	2.06	MA	20484	4659	33256	3423	36882	2768	38777	2268	41260	1521	50070	1400	28212
2L-5S		MI	10720	4659	17788	3288	18791	2663	18865	2163	18414	1403	21673	908	15629
10-#14	2.06	MA	19302	4659	31445	3422	34574	2784	35971	2283	37458	1531	44985	1272	28143
3L-4S		MI	11155	4659	18519	3296	19719	2653	19969	2153	19937	1413	23479	967	16416
10-#14	2.06	MA	18468	4659	29990	3440	32723	2780	33725	2277	34542	1541	41657	1145	27887
4L-3S		MI	11634	4659	19348	3285	20756	2663	21196	2163	21477	1403	25183	1087	16459
10-#14	2.06	MA	17721	4659	28714	3438	31078	2797	31710	2291	31668	1532	38173	1082	26326
5L-2S		MI	12292	4659	20360	3293	22033	2653	22717	2153	23486	1393	27788	1215	16423
10-#18	3.66	MA	21460	5280	36970	3786	41498	3058	44343	2451	48590	1475	59654	1038	48497
3L-4S		MI	11897	5280	20926	3647	22541	2881	23302	2262	24392	1297	29302	524	25763
10-#18	3.66	MA	20046	5280	34416	3816	38251	3050	40403	2438	43522	1493	53920	810	45072
4L-3S		MI	12710	5280	22365	3629	24305	2899	25389	2280	27009	1279	32185	728	27769
10-#18	3.66	MA	18778	5280	32174	3812	35361	3077	36864	2461	38523	1475	47876	703	42259
5L-2S		MI	13820	5280	24115	3646	26474	2881	27973	2262	30424	1262	36573	955	27905
12-#11	1.71	MA	19831	4525	31746	3350	35018	2716	36534	2238	38231	1535	46164	1433	23698
2L-6S		MI	10559	4525	17242	3220	18136	2612	18133	2150	17445	1441	20406	1003	13406
12-#11	1.71	MA	18998	4525	30481	3349	33405	2714	34573	2248	35575	1543	42588	1345	23680
3L-5S		MI	10852	4525	17727	3225	18790	2619	18880	2143	18434	1434	21603	1063	13712
12-#11	1.71	MA	18412	4525	29465	3362	32114	2725	33006	2245	33540	1550	40245	1256	23593
4E		MI	11158	4525	18240	3230	19448	2612	19662	2136	19514	1441	22888	1104	13949
12-#11	1.71	MA	17886	4525	28575	3362	30966	2723	31601	2255	31535	1544	37799	1212	23107
5L-3S		MI	11497	4525	18821	3221	20183	2619	20532	2143	20606	1434	24099	1188	13929
12-#11	1.71	MA	17385	4525	27736	3361	29825	2735	30210	2252	29692	1552	35473	1154	22345
6L-2S		MI	11962	4525	19532	3226	21088	2612	21610	2136	22029	1427	25953	1276	13894
12-#14	2.47	MA	20135	4819	33256	3521	36882	2856	38777	2327	41260	1521	50070	1249	33607
3L-5S		MI	11170	4819	18800	3388	20068	2734	20385	2203	20422	1381	24277	861	18559
12-#14	2.47	MA	19309	4819	31800	3540	35032	2853	36532	2322	38344	1532	46742	1121	33309
4E		MI	11601	4819	19532	3396	20995	2724	21489	2193	21946	1391	26083	920	19280
12-#14	2.47	MA	18570	4819	30525	3538	33386	2869	34516	2336	35470	1522	43258	1059	31620
5L-3S		MI	12077	4819	20360	3384	22033	2734	22717	2203	23486	1381	27788	1039	19541
12-#14	2.47	MA	17864	4819	29320	3536	31751	2865	32521	2330	32828	1532	39951	974	30460
6L-2S		MI	12730	4819	21373	3392	23309	2724	24237	2193	25495	1371	30393	1167	19530
12-#18	4.40	MA	21471	5564	37585	3994	42292	3178	45315	2518	50128	1472	62704	762	54244
4E		MI	12646	5564	22677	3824	24709	3003	25885	2329	27807	1253	33690	428	30744
12-#18	4.40	MA	20222	5564	35343	3989	39401	3205	41775	2541	45129	1455	56660	654	51275
5L-3S		MI	13450	5564	24115	3806	26474	3021	27973	2347	30424	1235	36573	632	33002
12-#18	4.40	MA	19032	5564	33226	3984	36527	3197	38270	2529	40536	1472	50956	503	47514
6L-2S		MI	14550	5564	25866	3824	28642	3003	30556	2329	33839	1218	40960	860	33207
14-#11	2.00	MA	19587	4636	31746	3419	35018	2764	36534	2279	38231	1536	46164	1329	27512
3L-6S		MI	10879	4636	17954	3289	19041	2662	19211	2179	18869	1427	22260	972	15494
14-#11	2.00	MA	19005	4636	30730	3432	33727	2775	34967	2276	36196	1544	43821	1241	27404
4L-5S		MI	11171	4636	18439	3294	19695	2668	19958	2172	19858	1420	23457	1032	15777
14-#11	2.00	MA	18483	4636	29841	3431	32579	2773	33562	2286	34191	1538	41375	1197	26803
5L-4S		MI	11475	4636	18952	3299	20353	2662	20740	2165	20938	1427	24742	1073	16111
14-#11	2.00	MA	17986	4636	29001	3430	31438	2785	32170	2283	32349	1545	39049	1139	26076
6L-3S		MI	11812	4636	19532	3290	21088	2668	21610	2172	22029	1420	25953	1157	16110
14-#11	2.00	MA	17501	4636	28103	3443	30343	2783	30828	2293	30546	1553	36628	1051	25316
7L-2S		MI	12275	4636	20244	3295	21993	2662	22688	2165	23453	1413	27807	1246	16084
14-#14	2.88	MA	20141	4978	33611	3639	37340	2925	39338	2367	42146	1522	51828	1097	38593
4L-5S		MI	11616	4978	19813	3488	21344	2804	21906	2243	22431	1360	26882	814	21500
14-#14	2.88	MA	19409	4978	32335	3638	35695	2941	37323	2381	39272	1512	48343	1035	36929
5L-4S		MI	12044	4978	20545	3496	22271	2794	23010	2233	23955	1370	28688	873	22165

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis



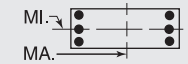
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.88	MA	18711	4978	31131	3636	34059	2938	35328	2375	36630	1522	45037	951	35678
6L-3S		MI	12516	4978	21373	3484	23309	2804	24237	2243	25495	1360	30393	992	22608
14-#14	2.88	MA	18030	4978	29842	3654	32488	2954	33403	2390	34045	1533	41595	824	33981
7L-2S		MI	13166	4978	22386	3492	24585	2794	25758	2233	27504	1350	32997	1120	22626
14-#18	5.13	MA	21647	5847	38512	4166	43441	3334	46687	2621	51734	1434	65444	606	60323
5L-4S		MI	13388	5847	24427	4002	26878	3126	28469	2396	31222	1209	38077	333	35754
14-#18	5.13	MA	20473	5847	36395	4161	40567	3325	43182	2608	47142	1452	59739	455	56708
6L-3S		MI	14185	5847	25866	3984	28642	3143	30556	2413	33839	1191	40960	537	37889
14-#18	5.13	MA	19329	5847	34130	4192	37806	3352	39799	2631	42648	1470	53798	230	52285
7L-2S		MI	15274	5847	27616	4001	30810	3126	33140	2396	37253	1173	45348	764	38492
16-#11	2.29	MA	19593	4746	31996	3501	35340	2826	36928	2307	38853	1537	47397	1226	31211
4L-6S		MI	11197	4746	18666	3358	19945	2711	20288	2207	20292	1413	24114	942	17587
16-#11	2.29	MA	19075	4746	31106	3500	34192	2823	35523	2318	36848	1531	44952	1182	30510
5E		MI	11487	4746	19151	3363	20600	2718	21036	2200	21282	1406	25311	1002	17851
16-#11	2.29	MA	18582	4746	30266	3499	33051	2835	34131	2314	35005	1538	42625	1123	29814
6L-4S		MI	11790	4746	19664	3368	21257	2711	21818	2193	22362	1413	26596	1042	18266
16-#11	2.29	MA	18101	4746	29368	3512	31956	2833	32789	2324	33203	1546	40204	1036	28996
7L-3S		MI	12125	4746	20244	3359	21993	2718	22688	2200	23453	1406	27807	1127	18284
16-#11	2.29	MA	17626	4746	28544	3511	30851	2845	31475	2335	31314	1540	37918	985	28075
8L-2S		MI	12586	4746	20956	3364	22897	2711	23766	2193	24877	1399	29661	1215	18268
16-#14	3.30	MA	20241	5138	34146	3738	38003	3014	40129	2426	43074	1502	53428	1011	42250
5E		MI	12059	5138	20826	3588	22620	2875	23426	2283	24440	1338	29486	766	24450
16-#14	3.30	MA	19550	5138	32942	3736	36367	3010	38134	2420	40432	1512	50122	927	40911
6L-4S		MI	12483	5138	21557	3596	23548	2865	24530	2273	25964	1348	31292	826	25066
16-#14	3.30	MA	18875	5138	31653	3754	34797	3026	36209	2434	37847	1523	46680	800	39270
7L-3S		MI	12953	5138	22386	3584	24585	2875	25758	2283	27504	1338	32997	945	25666
16-#14	3.30	MA	18210	5138	30471	3753	33212	3023	34324	2449	35139	1513	43424	728	37316
8L-2S		MI	13598	5138	23398	3592	25861	2865	27278	2273	29513	1328	35602	1073	25710
16-#18	5.86	MA	21896	6131	39564	4339	44607	3454	48093	2688	53748	1432	68523	406	65924
6L-4S		MI	14125	6131	26178	4179	29046	3248	31053	2462	34636	1165	42465	237	40788
16-#18	5.86	MA	20768	6131	37299	4369	41846	3480	44710	2711	49253	1449	62582	181	61412
7L-3S		MI	14914	6131	27616	4161	30810	3265	33140	2480	37253	1147	45348	441	42755
18-#11	2.57	MA	19663	4857	32371	3569	35805	2874	37483	2349	39504	1524	48528	1167	34226
5L-6S		MI	11514	4857	19378	3427	20850	2761	21366	2236	21716	1399	25968	911	19683
18-#11	2.57	MA	19174	4857	31531	3568	34665	2885	36092	2345	37662	1532	46201	1108	33557
6L-5S		MI	11802	4857	19863	3432	21505	2768	22113	2229	22706	1392	27165	971	19930
18-#11	2.57	MA	18696	4857	30633	3581	33569	2883	34750	2356	35859	1539	43780	1021	32684
7L-4S		MI	12103	4857	20376	3437	22162	2761	22896	2222	23785	1399	28450	1012	20416
18-#11	2.57	MA	18225	4857	29809	3580	32464	2895	33436	2366	33971	1533	41495	970	31790
8L-3S		MI	12436	4857	20956	3428	22897	2768	23766	2229	24877	1392	29661	1096	20449
18-#11	2.57	MA	17746	4857	28937	3593	31384	2893	32076	2363	32187	1541	39241	913	30628
9L-2S		MI	12895	4857	21668	3433	23802	2761	24843	2222	26301	1385	31515	1185	20446
18-#14	3.71	MA	20380	5298	34752	3836	38676	3082	40940	2465	44234	1502	55207	903	46156
6L-5S		MI	12498	5298	21839	3687	23897	2946	24947	2323	26449	1317	32091	719	27407
18-#14	3.71	MA	19712	5298	33464	3854	37105	3098	39015	2479	41649	1513	51765	777	44568
7L-4S		MI	12920	5298	22570	3695	24824	2936	26051	2313	27973	1327	33897	778	27980
18-#14	3.71	MA	19054	5298	32281	3852	35520	3095	37131	2494	38941	1503	48509	704	42565
8L-3S		MI	13386	5298	23398	3683	25861	2946	27278	2323	29513	1317	35602	898	28717
18-#14	3.71	MA	18384	5298	31030	3871	33971	3111	35181	2488	36382	1513	45306	623	40439
9L-2S		MI	14027	5298	24411	3692	27138	2936	28799	2313	31522	1307	38206	1026	28782
18-#18	6.59	MA	22189	6415	40468	4547	45886	3609	49622	2791	55859	1429	71365	133	70559
7L-4S		MI	14856	6415	27928	4356	31215	3370	33637	2529	38051	1121	46853	142	45840

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

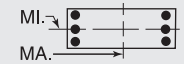
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.86	MA	19760	4968	32797	3637	36278	2935	38053	2376	40318	1525	49778	1093	37304
6E		MI	11828	4968	20090	3496	21755	2811	22444	2264	23140	1385	27822	881	21781
20-#11	2.86	MA	19286	4968	31898	3650	35182	2933	36711	2387	38516	1532	47356	1006	36378
7L-5S		MI	12115	4968	20575	3501	22409	2818	23191	2258	24130	1378	29018	941	22015
20-#11	2.86	MA	18819	4968	31074	3650	34077	2945	35397	2397	36627	1526	45071	955	35510
8L-4S		MI	12414	4968	21087	3506	23067	2811	23974	2251	25209	1385	30304	981	22532
20-#11	2.86	MA	18341	4968	30202	3663	32997	2943	34037	2394	34843	1534	42817	898	34314
9L-3S		MI	12746	4968	21668	3497	23802	2818	24843	2258	26301	1378	31515	1066	22607
20-#11	2.86	MA	17819	4968	29382	3662	31906	2955	32731	2404	33073	1542	40631	835	33090
10L-2S		MI	13202	4968	22380	3502	24707	2811	25921	2251	27724	1372	33369	1154	22620
20-#14	4.12	MA	20541	5457	35274	3954	39414	3171	41822	2524	45451	1503	56850	753	49875
7L-5S		MI	12935	5457	22851	3787	25173	3017	26467	2363	28458	1295	34696	672	30370
20-#14	4.12	MA	19889	5457	34092	3952	37829	3167	39937	2539	42743	1493	53595	681	47823
8L-4S		MI	13354	5457	23583	3795	26100	3007	27571	2353	29982	1305	36502	731	30905
20-#14	4.12	MA	19221	5457	32841	3970	36280	3183	37987	2533	40184	1503	50391	599	45666
9L-3S		MI	13817	5457	24411	3783	27138	3017	28799	2363	31522	1295	38206	850	31763
22-#11	3.14	MA	19872	5078	33163	3720	36795	2983	38672	2418	41172	1525	50933	990	40078
7L-6S		MI	12141	5078	20801	3566	22660	2861	23522	2293	24564	1372	29676	850	23834
22-#11	3.14	MA	19408	5078	32339	3719	35690	2995	37357	2428	39284	1519	48647	939	39235
8L-5S		MI	12426	5078	21287	3570	23314	2868	24269	2286	25553	1365	30872	910	24103
22-#11	3.14	MA	18931	5078	31467	3732	34610	2993	35998	2425	37500	1527	46393	883	38006
9L-4S		MI	12724	5078	21799	3575	23972	2861	25051	2279	26633	1372	32158	951	24591
22-#11	3.14	MA	18415	5078	30647	3731	33519	3005	34692	2435	35729	1535	44207	820	36759
10L-3S		MI	13054	5078	22380	3567	24707	2868	25921	2286	27724	1365	33369	1035	24762
22-#11	3.14	MA	17914	5078	29838	3730	32445	3003	33348	2432	33867	1529	41976	766	35536
11L-2S		MI	13508	5078	23092	3572	25612	2861	26999	2279	29148	1358	35223	1124	24786
22-#14	4.53	MA	20717	5617	35903	4052	40137	3239	42743	2583	46545	1483	58680	657	53090
8L-5S		MI	13369	5617	23864	3887	26449	3088	27988	2403	30467	1274	37300	625	33337
22-#14	4.53	MA	20051	5617	34652	4070	38588	3256	40793	2578	43986	1493	55477	576	50901
9L-4S		MI	13786	5617	24596	3895	27377	3078	29092	2393	31991	1284	39106	684	33840
24-#11	3.43	MA	19994	5189	33604	3788	37303	3045	39318	2459	41940	1513	52223	924	42937
8L-6S		MI	12453	5189	21513	3635	23564	2911	24599	2322	25988	1358	31530	820	25869
24-#11	3.43	MA	19518	5189	32732	3801	36223	3043	37959	2456	40156	1520	49969	868	41702
9L-5S		MI	12736	5189	21999	3640	24219	2918	25347	2315	26977	1351	32726	880	26195
24-#11	3.43	MA	19018	5189	31912	3800	35132	3055	36653	2466	38386	1528	47783	805	40432
10L-4S		MI	13033	5189	22511	3645	24876	2911	26129	2308	28057	1358	34012	920	26655
24-#11	3.43	MA	18509	5189	31103	3799	34058	3053	35309	2463	36524	1522	45552	751	39192
11L-3S		MI	13360	5189	23092	3636	25612	2918	26999	2315	29148	1351	35223	1005	26913
24-#14	4.95	MA	20874	5776	36462	4170	40897	3328	43599	2623	47788	1483	60562	552	56143
9L-5S		MI	13801	5776	24877	3987	27725	3159	29508	2443	32476	1252	39905	577	36233

RECTANGULAR TIED COLUMNS 26" x 44"

4-#18	1.40	MA	20971	4613	33305	3408	36342	2769	37505	2293	38388	1602	45653	1495	21135
2E		MI	12063	4613	19596	3246	20713	2623	20938	2154	20816	1465	24107	1310	11814
6-#14	1.18	MA	20551	4524	32246	3373	35118	2746	36065	2283	36496	1621	43301	1530	18071
2L-3S		MI	11215	4524	18050	3218	18949	2630	18875	2175	18100	1517	20677	1250	10268
6-#14	1.18	MA	19277	4524	30335	3372	32682	2743	33104	2298	32484	1632	37904	1402	18093
3L-2S		MI	11884	4524	19063	3226	20225	2620	20395	2165	20109	1507	23282	1378	10189
6-#18	2.10	MA	22506	4896	36651	3585	40608	2897	42691	2373	45395	1583	54991	1450	31348
2L-3S		MI	11683	4896	19596	3406	20713	2763	20938	2238	20816	1438	24107	987	17306
6-#18	2.10	MA	20323	4896	33305	3581	36342	2925	37505	2397	38388	1601	45653	1222	31123
3L-2S		MI	12818	4896	21346	3423	22881	2745	23522	2221	24231	1420	28494	1215	17245
8-#11	1.09	MA	20378	4488	31801	3361	34615	2738	35478	2280	35712	1629	42346	1546	16809
2L-4S		MI	10996	4488	17542	3225	18384	2622	18228	2172	17309	1540	19887	1234	9620
8-#11	1.09	MA	19485	4488	30467	3361	32914	2737	33410	2291	32910	1637	38554	1457	16835
3E		MI	11339	4488	18123	3216	19119	2629	19098	2179	18400	1533	21098	1318	9564

RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

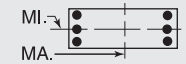
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.09	MA	18857	4488	29397	3374	31554	2749	31760	2288	30767	1646	36066	1368	16802
4L-2S		MI	11810	4488	18835	3221	20024	2622	20176	2172	19824	1526	22952	1407	9512
8-#14	1.57	MA	21444	4684	34156	3473	37553	2818	39026	2328	40507	1611	48699	1508	23910
2L-4S		MI	11182	4684	18235	3330	19188	2691	19168	2206	18569	1506	21577	1084	13425
8-#14	1.57	MA	20182	4684	32246	3472	35118	2815	36065	2343	36496	1622	43301	1380	23884
3E		MI	11666	4684	19063	3318	20225	2701	20395	2215	20109	1496	23282	1203	13398
8-#14	1.57	MA	19292	4684	30712	3491	33168	2832	33698	2338	33423	1633	39765	1252	23677
4L-2S		MI	12330	4684	20076	3326	21502	2691	21916	2206	22117	1486	25886	1331	13337
8-#18	2.80	MA	24013	5180	39998	3762	44875	3026	47878	2453	52401	1565	64328	1404	41508
2L-4S		MI	11617	5180	19908	3601	21117	2867	21435	2287	21614	1412	25611	687	21036
8-#18	2.80	MA	21862	5180	36651	3759	40608	3054	42691	2477	45395	1582	54991	1177	41164
3E		MI	12441	5180	21346	3583	22881	2885	23522	2305	24231	1394	28494	892	22595
8-#18	2.80	MA	20344	5180	33959	3790	37184	3046	38536	2466	40019	1600	48888	949	38186
4L-2S		MI	13565	5180	23096	3601	25050	2867	26106	2287	27645	1376	32882	1119	22623
10-#11	1.36	MA	21007	4598	33135	3430	36316	2788	37546	2311	38513	1622	46139	1531	20890
2L-5S		MI	11009	4598	17742	3289	18631	2679	18523	2208	17653	1519	20455	1163	11763
10-#11	1.36	MA	20121	4598	31801	3430	34615	2787	35478	2322	35712	1630	42346	1443	20895
3L-4S		MI	11318	4598	18254	3294	19289	2672	19306	2201	18732	1526	21741	1204	11812
10-#11	1.36	MA	19497	4598	30731	3443	33255	2799	33828	2319	33568	1639	39859	1354	20832
4L-3S		MI	11658	4598	18835	3286	20024	2679	20176	2208	19824	1519	22952	1288	11772
10-#11	1.36	MA	18938	4598	29795	3443	32046	2797	32347	2330	31456	1633	37269	1310	20559
5L-2S		MI	12127	4598	19547	3291	20929	2672	21253	2201	21248	1512	24806	1376	11727
10-#14	1.97	MA	22326	4843	36066	3573	39989	2891	41986	2373	44518	1601	54096	1486	29731
2L-5S		MI	11198	4843	18516	3421	19537	2772	19585	2256	19054	1474	22376	977	15763
10-#14	1.97	MA	21075	4843	34156	3572	37553	2888	39026	2388	40507	1612	48699	1358	29662
3L-4S		MI	11633	4843	19248	3429	20464	2762	20688	2246	20577	1484	24182	1036	16489
10-#14	1.97	MA	20195	4843	32623	3590	35603	2904	36659	2383	37434	1623	45163	1230	29405
4L-3S		MI	12114	4843	20076	3418	21502	2772	21916	2256	22117	1474	25886	1156	16504
10-#14	1.97	MA	19406	4843	31279	3589	33870	2901	34536	2397	34406	1615	41471	1167	27870
5L-2S		MI	12773	4843	21089	3426	22778	2762	23436	2246	24126	1464	28491	1284	16463
10-#18	3.50	MA	23376	5464	39998	3936	44875	3182	47878	2557	52401	1564	64328	1132	51197
3L-4S		MI	12375	5464	21658	3778	23285	2989	24018	2354	25028	1368	29999	592	25974
10-#18	3.50	MA	21881	5464	37305	3967	41451	3175	43722	2545	47026	1581	58225	904	47839
4L-3S		MI	13190	5464	23096	3760	25050	3007	26106	2372	27645	1350	32882	796	27854
10-#18	3.50	MA	20542	5464	34942	3964	38404	3203	39992	2569	41724	1564	51814	795	45088
5L-2S		MI	14303	5464	24847	3778	27218	2989	28689	2354	31060	1332	37269	1024	27968
12-#11	1.64	MA	21631	4709	34470	3500	38017	2839	39614	2342	41315	1615	49932	1517	24961
2L-6S		MI	11036	4709	17968	3354	18881	2722	18854	2243	18087	1512	21112	1072	13504
12-#11	1.64	MA	20750	4709	33135	3499	36316	2837	37546	2353	38513	1624	46139	1429	24944
3L-5S		MI	11330	4709	18454	3359	19536	2729	19601	2237	19077	1506	22309	1132	13817
12-#11	1.64	MA	20131	4709	32066	3512	34956	2849	35896	2350	36370	1632	43651	1340	24857
4E		MI	11637	4709	18966	3364	20193	2722	20384	2230	20156	1512	23595	1173	13991
12-#11	1.64	MA	19577	4709	31129	3512	33748	2847	34415	2361	34258	1626	41062	1296	24447
5L-3S		MI	11976	4709	19547	3355	20929	2729	21253	2237	21248	1506	24806	1257	13965
12-#11	1.64	MA	19049	4709	30245	3511	32547	2859	32951	2358	32318	1635	38593	1237	23609
6L-2S		MI	12442	4709	20259	3360	21833	2722	22331	2230	22672	1499	26660	1346	13928
12-#14	2.36	MA	21959	5003	36066	3671	39989	2960	41986	2432	44518	1602	54096	1336	35430
3L-5S		MI	11648	5003	19529	3521	20813	2843	21105	2296	21063	1453	24980	930	18691
12-#14	2.36	MA	21088	5003	34533	3690	38039	2977	39620	2427	41446	1613	50560	1208	35131
4E		MI	12080	5003	20260	3529	21740	2833	22209	2286	22586	1463	26786	989	19435
12-#14	2.36	MA	20307	5003	33189	3689	36306	2974	37497	2442	38417	1605	46868	1145	33460
5L-3S		MI	12557	5003	21089	3517	22778	2843	23436	2296	24126	1453	28491	1108	19594
12-#14	2.36	MA	19563	5003	31921	3688	34583	2990	35396	2437	35635	1616	43357	1061	32377
6L-2S		MI	13212	5003	22101	3525	24054	2833	24957	2286	26135	1443	31096	1236	19573

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

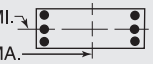


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	4.20	MA	23395	5747	40651	4145	45717	3303	48909	2625	54032	1563	67563	859	57534
4E		MI	13125	5747	23408	3956	25454	3112	26602	2421	28443	1323	34386	496	30952
12-#18	4.20	MA	22076	5747	38289	4141	42670	3331	45178	2649	48731	1545	61151	750	54629
5L-3S		MI	13932	5747	24847	3938	27218	3129	28689	2439	31060	1306	37269	701	33095
12-#18	4.20	MA	20818	5747	36058	4137	39641	3324	41484	2638	43860	1563	55084	599	50493
6L-2S		MI	15035	5747	26597	3955	29386	3112	31273	2421	34474	1288	41657	928	33276
14-#11	1.91	MA	21375	4820	34470	3568	38017	2887	39614	2384	41315	1617	49932	1415	28986
3L-6S		MI	11357	4820	18680	3423	19786	2772	19932	2272	19511	1499	22966	1042	15592
14-#11	1.91	MA	20760	4820	33400	3582	36657	2899	37964	2381	39172	1625	47444	1326	28878
4L-5S		MI	11649	4820	19166	3428	20441	2779	20679	2265	20500	1492	24163	1102	15882
14-#11	1.91	MA	20210	4820	32463	3581	35449	2897	36484	2392	37060	1619	44855	1282	28348
5L-4S		MI	11954	4820	19678	3433	21098	2772	21461	2258	21580	1499	25448	1143	16160
14-#11	1.91	MA	19686	4820	31580	3581	34248	2909	35019	2389	35120	1628	42386	1223	27547
6L-3S		MI	12291	4820	20259	3424	21833	2779	22331	2265	22672	1492	26660	1227	16150
14-#11	1.91	MA	19175	4820	30634	3594	33095	2908	33605	2400	33222	1636	39818	1136	26840
7L-2S		MI	12755	4820	20971	3429	22738	2772	23409	2258	24095	1485	28513	1315	16121
14-#14	2.75	MA	21971	5162	36444	3790	40475	3049	42581	2472	45457	1603	55957	1186	40856
4L-5S		MI	12094	5162	20542	3621	22089	2914	22626	2336	23071	1431	27585	883	21632
14-#14	2.75	MA	21198	5162	35100	3789	38741	3046	40458	2487	42428	1595	52265	1123	39066
5L-4S		MI	12523	5162	21273	3629	23017	2904	23729	2326	24595	1441	29391	942	22318
14-#14	2.75	MA	20462	5162	33832	3787	37019	3063	38357	2482	39646	1606	48754	1039	37890
6L-3S		MI	12997	5162	22101	3617	24054	2914	24957	2336	26135	1431	31096	1061	22665
14-#14	2.75	MA	19743	5162	32475	3806	35365	3060	36330	2497	36924	1617	45100	913	36027
7L-2S		MI	13648	5162	23114	3625	25330	2904	26477	2326	28144	1421	33700	1189	22672
14-#18	4.90	MA	23588	6031	41635	4318	46937	3460	50364	2729	55738	1526	70489	705	64202
5L-4S		MI	13869	6031	25159	4133	27622	3234	29186	2488	31857	1279	38774	401	35960
14-#18	4.90	MA	22349	6031	39405	4314	43908	3452	46670	2718	50866	1544	64421	554	60216
6L-3S		MI	14668	6031	26597	4115	29386	3251	31273	2505	34474	1262	41657	605	38169
14-#18	4.90	MA	21139	6031	37018	4346	40999	3480	43106	2742	46099	1562	58103	329	55700
7L-2S		MI	15761	6031	28348	4132	31555	3234	33857	2488	37889	1244	46045	833	38565
16-#11	2.18	MA	21384	4930	34734	3651	38358	2949	40032	2412	41973	1618	51237	1312	32896
4L-6S		MI	11676	4930	19392	3492	20691	2822	21009	2301	20935	1485	24820	1011	17686
16-#11	2.18	MA	20838	4930	33798	3650	37150	2947	38552	2423	39861	1613	48648	1268	32259
5E		MI	11966	4930	19878	3497	21346	2828	21757	2294	21924	1478	26017	1071	17955
16-#11	2.18	MA	20318	4930	32914	3650	35949	2959	37087	2420	37922	1621	46179	1209	31491
6L-4S		MI	12270	4930	20390	3502	22003	2822	22539	2287	23004	1485	27302	1112	18319
16-#11	2.18	MA	19811	4930	31968	3663	34796	2958	35674	2431	36024	1629	43610	1122	30725
7L-3S		MI	12605	4930	20971	3493	22738	2828	23409	2294	24095	1478	28513	1196	18327
16-#11	2.18	MA	19310	4930	31101	3662	33633	2970	34290	2442	34036	1624	41191	1070	29716
8L-2S		MI	13067	4930	21683	3498	23643	2822	24487	2287	25519	1471	30367	1285	18307
16-#14	3.15	MA	22080	5322	37010	3888	41177	3118	43419	2532	46440	1585	57663	1101	44683
5E		MI	12538	5322	21554	3721	23366	2985	24146	2376	25080	1410	30190	835	24582
16-#14	3.15	MA	21351	5322	35742	3887	39454	3135	41318	2527	43658	1596	54151	1017	43418
6L-4S		MI	12964	5322	22286	3729	24293	2975	25250	2366	26604	1420	31996	895	25217
16-#14	3.15	MA	20639	5322	34385	3906	37800	3132	39291	2542	40935	1607	50498	891	41613
7L-3S		MI	13434	5322	23114	3717	25330	2985	26477	2376	28144	1410	33700	1014	25727
16-#14	3.15	MA	19938	5322	33140	3905	36131	3149	37306	2557	38083	1598	47048	817	39662
8L-2S		MI	14081	5322	24127	3725	26607	2975	27998	2366	30153	1400	36305	1142	25762
16-#18	5.59	MA	23859	6315	42751	4492	48174	3581	51857	2798	57873	1525	73759	509	69961
6L-4S		MI	14606	6315	26909	4310	29791	3356	31770	2554	35272	1235	43162	305	40992
16-#18	5.59	MA	22667	6315	40364	4523	45265	3609	48292	2822	53105	1543	67441	284	65356
7L-3S		MI	15398	6315	28348	4292	31555	3374	33857	2572	37889	1218	46045	510	43030
18-#11	2.45	MA	21461	5041	35132	3719	38851	2998	40620	2454	42663	1606	52440	1253	36179
5L-6S		MI	11992	5041	20104	3561	21596	2871	22087	2329	22358	1471	26674	981	19782
18-#11	2.45	MA	20945	5041	34248	3719	37650	3010	39155	2451	40723	1614	49972	1195	35441
6L-5S		MI	12281	5041	20590	3566	22250	2878	22835	2322	23348	1464	27871	1041	20035
18-#11	2.45	MA	20441	5041	33302	3732	36497	3008	37742	2462	38825	1622	47403	1108	34617
7L-4S		MI	12583	5041	21102	3571	22908	2871	23617	2316	24428	1471	29156	1081	20472

RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

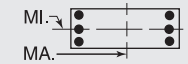


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.45	MA	19945	5041	32435	3732	35334	3020	36358	2473	36837	1617	44983	1056	33638
8L-3S		MI	12917	5041	21683	3562	23643	2878	24487	2322	25519	1464	30367	1166	20498
18-#11	2.45	MA	19432	5041	31583	3731	34197	3018	34927	2470	34959	1625	42591	1000	32493
9L-2S		MI	13376	5041	22395	3567	24548	2871	25564	2316	26943	1457	32221	1254	20487
18-#14	3.54	MA	22232	5481	37653	3987	41890	3207	44279	2572	47669	1586	59549	995	48959
6L-5S		MI	12978	5481	22567	3820	24642	3056	25667	2416	27089	1388	32794	788	27539
18-#14	3.54	MA	21527	5481	36296	4006	40236	3204	42252	2587	44946	1597	55895	869	47209
7L-4S		MI	13401	5481	23299	3828	25569	3046	26770	2406	28613	1398	34600	848	28131
18-#14	3.54	MA	20832	5481	35051	4004	38567	3221	40267	2602	42095	1588	52445	795	45208
8L-3S		MI	13869	5481	24127	3817	26607	3056	27998	2416	30153	1388	36305	967	28782
18-#14	3.54	MA	20115	5481	33734	4023	36936	3218	38213	2597	39400	1599	49043	714	43067
9L-2S		MI	14512	5481	25140	3825	27883	3046	29518	2406	32162	1378	38909	1095	28837
18-#18	6.29	MA	24176	6599	43710	4701	49531	3737	53478	2902	60112	1524	76778	239	75032
7L-4S		MI	15339	6599	28660	4488	31959	3478	34354	2621	38687	1191	47549	210	46043
20-#11	2.73	MA	21567	5152	35583	3788	39351	3060	41223	2482	43525	1607	53764	1181	39395
6E		MI	12308	5152	20816	3630	22500	2921	23165	2358	23782	1457	28528	950	21881
20-#11	2.73	MA	21067	5152	34637	3801	38198	3058	39810	2493	41627	1615	51196	1094	38517
7L-5S		MI	12595	5152	21302	3635	23155	2928	23912	2351	24772	1450	29725	1010	22119
20-#11	2.73	MA	20574	5152	33769	3801	37035	3070	38426	2504	39639	1610	48776	1042	37564
8L-4S		MI	12895	5152	21814	3640	23813	2921	24695	2344	25851	1457	31010	1051	22621
20-#11	2.73	MA	20063	5152	32918	3800	35898	3068	36995	2501	37761	1618	46384	986	36385
9L-3S		MI	13227	5152	22395	3631	24548	2928	25564	2351	26943	1450	32221	1135	22658
20-#11	2.73	MA	19511	5152	31988	3814	34750	3080	35620	2512	35897	1626	44064	923	35175
10L-2S		MI	13685	5152	23107	3636	25453	2921	26642	2344	28367	1443	34075	1224	22662
20-#14	3.93	MA	22407	5641	38206	4105	42672	3277	45212	2632	48958	1587	61292	847	52814
7L-5S		MI	13416	5641	23580	3920	25918	3126	27187	2456	29098	1367	35399	741	30502
20-#14	3.93	MA	21719	5641	36961	4104	41003	3293	43228	2647	46106	1578	57842	773	50763
8L-4S		MI	13836	5641	24311	3928	26845	3116	28291	2446	30622	1377	37205	800	31055
20-#14	3.93	MA	21002	5641	35644	4123	39372	3290	41174	2642	43412	1589	54441	692	48592
9L-3S		MI	14301	5641	25140	3916	27883	3126	29518	2456	32162	1367	38909	919	31831
22-#11	3.00	MA	21689	5262	35971	3870	39900	3108	41878	2524	44429	1608	54989	1080	42422
7L-6S		MI	12621	5262	21528	3699	23405	2971	24243	2387	25206	1443	30382	920	23982
22-#11	3.00	MA	21199	5262	35104	3870	38736	3120	40494	2535	42441	1603	52569	1028	41495
8L-5S		MI	12907	5262	22013	3704	24060	2978	24990	2380	26196	1437	31579	980	24208
22-#11	3.00	MA	20689	5262	34252	3869	37599	3118	39063	2532	40563	1611	50177	972	40283
9L-4S		MI	13206	5262	22526	3709	24717	2971	25772	2373	27275	1443	32864	1020	24714
22-#11	3.00	MA	20143	5262	33322	3883	36451	3130	37688	2543	38699	1620	47857	908	39050
10L-3S		MI	13536	5262	23107	3700	25453	2978	26642	2380	28367	1437	34075	1105	24814
22-#11	3.00	MA	19614	5262	32471	3882	35321	3129	36273	2540	36738	1614	45494	854	37713
11L-2S		MI	13991	5262	23819	3705	26357	2971	27720	2373	29790	1430	35929	1193	24834
22-#14	4.33	MA	22597	5801	38872	4204	43438	3366	46189	2692	50117	1568	63239	751	56327
8L-5S		MI	13851	5801	24592	4020	27194	3197	28708	2496	31107	1345	38003	694	33470
22-#14	4.33	MA	21883	5801	37554	4223	41807	3363	44135	2687	47423	1579	59838	670	54125
9L-4S		MI	14269	5801	25324	4028	28122	3187	29811	2486	32631	1355	39809	753	33988
24-#11	3.27	MA	21820	5373	36438	3939	40437	3170	42562	2566	45242	1596	56361	1014	45430
8L-6S		MI	12933	5373	22240	3769	24310	3021	25321	2415	26630	1430	32236	889	26037
24-#11	3.27	MA	21310	5373	35586	3939	39301	3169	41131	2563	43364	1604	53970	958	44186
9L-5S		MI	13217	5373	22725	3774	24965	3028	26068	2408	27619	1423	33432	949	26300
24-#11	3.27	MA	20770	5373	34657	3952	38152	3181	39756	2574	41500	1613	51650	894	42930
10L-4S		MI	13514	5373	23238	3778	25622	3021	26850	2401	28699	1430	34718	990	26778
24-#11	3.27	MA	20245	5373	33805	3951	37022	3179	38341	2571	39540	1607	49287	840	41616
11L-3S		MI	13843	5373	23819	3770	26357	3028	27720	2408	29790	1423	35929	1074	26968
24-#14	4.72	MA	22756	5960	39465	4322	44243	3435	47096	2732	51434	1570	65235	648	59665
9L-5S		MI	14283	5960	25605	4120	28471	3268	30228	2536	33116	1324	40608	647	36442

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

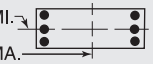
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.34	MA	22812	4796	36083	3557	39381	2892	40604	2397	41484	1684	49339	1578	22215
2E		MI	12542	4796	20327	3377	21457	2731	21655	2246	21452	1535	24803	1378	11853
6-#14	1.13	MA	22364	4708	34962	3523	38084	2869	39079	2387	39440	1701	46821	1612	18982
2L-3S		MI	11694	4708	18779	3351	19694	2740	19595	2268	18740	1589	21380	1319	10302
6-#14	1.13	MA	21021	4708	32951	3522	35522	2866	35963	2403	35219	1713	41112	1484	19004
3L-2S		MI	12363	4708	19792	3359	20971	2730	21115	2258	20749	1579	23985	1447	10220
6-#18	2.01	MA	24438	5080	39606	3734	43873	3020	46065	2477	48883	1667	59231	1536	32968
2L-3S		MI	12161	5080	20327	3537	21457	2871	21655	2330	21452	1509	24803	1055	17369
6-#18	2.01	MA	22134	5080	36083	3731	39381	3049	40604	2503	41484	1685	49339	1309	32743
3L-2S		MI	13299	5080	22078	3555	23625	2853	24239	2312	24866	1491	29191	1283	17292
8-#11	1.04	MA	22180	4672	34491	3511	37552	2861	38458	2384	38610	1709	45799	1627	17652
2L-4S		MI	11474	4672	18269	3359	19130	2732	18949	2266	17951	1612	20593	1304	9651
8-#11	1.04	MA	21239	4672	33088	3510	35763	2860	36283	2396	35663	1718	41789	1538	17677
3E		MI	11817	4672	18850	3350	19865	2739	19819	2273	19042	1605	21804	1388	9593
8-#11	1.04	MA	20577	4672	31964	3524	34334	2872	34548	2393	33411	1727	39157	1450	17645
4L-2S		MI	12289	4672	19562	3355	20770	2732	20897	2266	20466	1598	23658	1476	9540
8-#14	1.51	MA	23309	4867	36972	3622	40647	2941	42194	2432	43660	1691	52530	1592	25125
2L-4S		MI	11660	4867	18963	3463	19933	2801	19888	2299	19209	1577	22280	1153	13477
8-#14	1.51	MA	21978	4867	34962	3622	38084	2939	39079	2448	39440	1703	46821	1464	25099
3E		MI	12145	4867	19792	3451	20971	2811	21115	2308	20749	1567	23985	1272	13438
8-#14	1.51	MA	21041	4867	33350	3641	36035	2956	36591	2443	36210	1715	43077	1336	24892
4L-2S		MI	12810	4867	20804	3459	22247	2801	22636	2299	22758	1557	26590	1400	13373
8-#18	2.68	MA	26035	5364	43130	3912	48365	3149	51526	2557	56281	1649	69122	1494	43668
2L-4S		MI	12094	5364	20639	3732	21861	2975	22151	2379	22249	1482	26308	756	21246
8-#18	2.68	MA	23764	5364	39606	3909	43873	3178	46065	2582	48883	1667	59231	1266	43324
3E		MI	12920	5364	22078	3715	23625	2993	24239	2397	24866	1465	29191	960	22668
8-#18	2.68	MA	22163	5364	36775	3941	40272	3171	41695	2572	43208	1685	52758	1039	40453
4L-2S		MI	14046	5364	23828	3732	25794	2975	26822	2379	28281	1447	33579	1187	22676
10-#11	1.30	MA	22845	4782	35895	3580	39342	2911	40633	2416	41557	1702	49808	1614	21943
2L-5S		MI	11487	4782	18468	3423	19377	2789	19245	2301	18295	1591	21161	1232	11871
10-#11	1.30	MA	21910	4782	34491	3580	37552	2910	38458	2427	38610	1711	45799	1525	21948
3L-4S		MI	11796	4782	18981	3428	20034	2782	20027	2295	19375	1598	22447	1273	11848
10-#11	1.30	MA	21254	4782	33367	3593	36123	2922	36724	2424	36358	1720	43167	1437	21885
4L-3S		MI	12137	4782	19562	3419	20770	2789	20897	2301	20466	1591	23658	1357	11804
10-#11	1.30	MA	20666	4782	32384	3593	34854	2921	35169	2435	34139	1715	40434	1392	21702
5L-2S		MI	12606	4782	20274	3424	21674	2782	21975	2295	21890	1584	25512	1446	11758
10-#14	1.88	MA	24243	5027	38982	3722	43210	3014	45310	2477	47881	1681	58240	1571	31250
2L-5S		MI	11675	5027	19244	3554	20282	2882	20304	2349	19694	1546	23079	1046	15892
10-#14	1.88	MA	22923	5027	36972	3721	40647	3011	42194	2493	43660	1693	52530	1443	31180
3L-4S		MI	12111	5027	19976	3562	21209	2872	21408	2339	21218	1556	24885	1106	16548
10-#14	1.88	MA	21996	5027	35360	3741	38598	3028	39707	2488	40431	1705	48786	1315	30924
4L-3S		MI	12593	5027	20804	3551	22247	2882	22636	2349	22758	1546	26590	1225	16549
10-#14	1.88	MA	21166	5027	33949	3740	36777	3026	37477	2504	37248	1697	44888	1252	29425
5L-2S		MI	13253	5027	21817	3559	23523	2872	24156	2339	24766	1536	29194	1353	16502
10-#18	3.34	MA	25367	5648	43130	4086	48365	3306	51526	2662	56281	1650	69122	1224	53897
3L-4S		MI	12853	5648	22390	3910	24030	3098	24735	2446	25664	1438	30696	660	26181
10-#18	3.34	MA	23791	5648	40298	4118	44764	3300	47156	2652	50607	1668	62650	997	50630
4L-3S		MI	13671	5648	23828	3892	25794	3115	26822	2464	28281	1420	33579	864	27937
10-#18	3.34	MA	22380	5648	37815	4115	41562	3329	43234	2677	45012	1650	55871	886	47760
5L-2S		MI	14786	5648	25578	3909	27962	3098	29406	2446	31696	1403	37966	1092	28030
12-#11	1.57	MA	23505	4893	37298	3649	41131	2961	42809	2447	44504	1695	53817	1601	26225
2L-6S		MI	11514	4893	18695	3487	19627	2832	19575	2337	18729	1584	21819	1142	13598

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

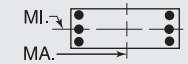
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.57	MA	22576	4893	35895	3649	39342	2960	40633	2458	41557	1704	49808	1512	26207
3L-5S		MI	11808	4893	19180	3492	20282	2839	20322	2330	19719	1577	23015	1202	13920
12-#11	1.57	MA	21924	4893	34771	3662	37913	2972	38899	2455	39304	1713	47176	1423	26120
4E		MI	12116	4893	19693	3497	20939	2832	21105	2323	20798	1584	24301	1243	14032
12-#11	1.57	MA	21342	4893	33787	3662	36643	2971	37344	2466	37086	1708	44443	1379	25797
5L-3S		MI	12455	4893	20274	3489	21674	2839	21975	2330	21890	1577	25512	1327	14001
12-#11	1.57	MA	20786	4893	32859	3662	35382	2983	35806	2464	35049	1717	41832	1320	24879
6L-2S		MI	12922	4893	20986	3494	22579	2832	23052	2323	23314	1571	27366	1415	13962
12-#14	2.26	MA	23858	5187	38982	3821	43210	3083	45310	2537	47881	1683	58240	1423	37252
3L-5S		MI	12126	5187	20257	3654	21558	2952	21825	2389	21703	1524	25683	999	18820
12-#14	2.26	MA	22940	5187	37370	3840	41161	3101	42822	2533	44651	1695	54496	1295	36954
4E		MI	12559	5187	20989	3662	22486	2943	22929	2379	23226	1534	27489	1058	19587
12-#14	2.26	MA	22119	5187	35959	3839	39340	3098	40592	2549	41469	1687	50597	1231	35311
5L-3S		MI	13037	5187	21817	3650	23523	2952	24156	2389	24766	1524	29194	1177	19645
12-#14	2.26	MA	21336	5187	34627	3839	37530	3115	38385	2544	38546	1699	46881	1147	34175
6L-2S		MI	13693	5187	22830	3658	24799	2943	25677	2379	26775	1514	31799	1305	19616
12-#18	4.01	MA	25393	5931	43822	4296	49257	3428	52617	2732	58005	1650	72541	954	60848
4E		MI	13605	5931	24140	4087	26198	3220	27319	2513	29079	1394	35083	565	31156
12-#18	4.01	MA	24003	5931	41339	4293	46054	3457	48695	2757	52411	1633	65762	844	58026
5L-3S		MI	14414	5931	25578	4069	27962	3237	29406	2530	31696	1376	37966	769	33185
12-#18	4.01	MA	22678	5931	38995	4290	42871	3451	44812	2747	47270	1651	59331	694	53502
6L-2S		MI	15519	5931	27329	4087	30131	3220	31990	2513	35110	1359	42354	996	33343
14-#11	1.83	MA	23236	5004	37298	3718	41131	3010	42809	2489	44504	1697	53817	1499	30461
3L-6S		MI	11835	5004	19407	3557	20532	2882	20653	2366	20153	1571	23672	1111	15687
14-#11	1.83	MA	22589	5004	36174	3731	39702	3023	41074	2486	42251	1706	51185	1410	30352
4L-5S		MI	12128	5004	19892	3562	21187	2889	21400	2359	21143	1564	24869	1171	15985
14-#11	1.83	MA	22011	5004	35191	3731	38433	3021	39519	2498	40033	1701	48452	1366	29902
5L-4S		MI	12433	5004	20405	3567	21844	2882	22182	2352	22222	1571	26155	1212	16206
14-#11	1.83	MA	21460	5004	34263	3731	37171	3034	37981	2495	37995	1710	45841	1307	29023
6L-3S		MI	12771	5004	20986	3558	22579	2889	23052	2359	23314	1564	27366	1296	16188
14-#11	1.83	MA	20922	5004	33269	3745	35961	3032	36497	2506	36002	1719	43126	1220	28378
7L-2S		MI	13236	5004	21698	3563	23484	2882	24130	2352	24738	1557	29220	1385	16157
14-#14	2.63	MA	23875	5346	39381	3940	43723	3173	45938	2578	48872	1685	60205	1275	42982
4L-5S		MI	12573	5346	21270	3754	22834	3023	23345	2429	23712	1503	28288	952	21760
14-#14	2.63	MA	23061	5346	37969	3939	41902	3170	43708	2593	45690	1677	56306	1211	41213
5L-4S		MI	13003	5346	22002	3762	23762	3013	24449	2419	25235	1513	30094	1011	22468
14-#14	2.63	MA	22286	5346	36637	3938	40093	3188	41500	2589	42767	1689	52590	1127	40121
6L-3S		MI	13478	5346	22830	3750	24799	3023	25677	2429	26775	1503	31799	1130	22721
14-#14	2.63	MA	21530	5346	35212	3958	38356	3185	39371	2604	39907	1701	48724	1000	38090
7L-2S		MI	14130	5346	23843	3758	26076	3013	27197	2419	28784	1493	34403	1258	22718
14-#18	4.68	MA	25605	6215	44862	4470	50547	3586	54156	2837	59809	1615	75654	802	68125
5L-4S		MI	14349	6215	25890	4264	28367	3342	29903	2579	32493	1350	39471	469	36162
14-#18	4.68	MA	24299	6215	42518	4467	47363	3579	50273	2827	54668	1633	69222	651	63755
6L-3S		MI	15151	6215	27329	4246	30131	3360	31990	2597	35110	1332	42354	673	38419
14-#18	4.68	MA	23024	6215	40010	4499	44306	3608	46527	2852	49637	1651	62528	427	59157
7L-2S		MI	16247	6215	29079	4264	32299	3342	34574	2579	38525	1315	46742	901	38637
16-#11	2.09	MA	23249	5114	37578	3801	41491	3073	43249	2518	45198	1699	55194	1397	34581
4L-6S		MI	12154	5114	20119	3626	21437	2932	21731	2394	21577	1557	25526	1081	17781
16-#11	2.09	MA	22675	5114	36594	3800	40222	3071	41695	2529	42980	1694	52461	1352	34018
5E		MI	12445	5114	20604	3631	22091	2939	22478	2387	22566	1550	26723	1141	18058
16-#11	2.09	MA	22128	5114	35666	3800	38961	3084	40156	2526	40942	1703	49851	1294	33174
6L-4S		MI	12749	5114	21117	3636	22749	2932	23260	2380	23646	1557	28009	1181	18369
16-#11	2.09	MA	21594	5114	34673	3814	37750	3082	38672	2537	38949	1712	47135	1207	32468
7L-3S		MI	13085	5114	21698	3627	23484	2939	24130	2387	24738	1550	29220	1266	18368

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis

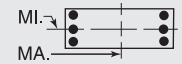


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.09	MA	21068	5114	33762	3813	36529	3095	37219	2548	36861	1707	44581	1155	31368
8L-2S		MI	13548	5114	22410	3632	24389	2932	25208	2380	26161	1543	31074	1354	18345
16-#14	3.01	MA	23995	5506	39979	4039	44465	3243	46823	2638	49911	1667	62016	1190	47127
5E		MI	13017	5506	22283	3854	24111	3094	24866	2469	25720	1481	30893	905	24710
16-#14	3.01	MA	23227	5506	38647	4038	42656	3260	44616	2634	46988	1679	58300	1106	45949
6L-4S		MI	13444	5506	23014	3862	25038	3084	25970	2459	27244	1491	32699	964	25366
16-#14	3.01	MA	22478	5506	37222	4057	40918	3257	42486	2649	44128	1691	54433	980	43974
7L-3S		MI	13916	5506	23843	3850	26076	3094	27197	2469	28784	1481	34403	1083	25786
16-#14	3.01	MA	21739	5506	35915	4056	39165	3275	40402	2665	41132	1683	50790	906	42034
8L-2S		MI	14564	5506	24855	3858	27352	3084	28718	2459	30793	1471	37008	1211	25813
16-#18	5.35	MA	25898	6499	46042	4644	51855	3708	55734	2907	62067	1616	79114	609	74028
6L-4S		MI	15088	6499	27641	4442	30535	3464	32487	2646	35908	1306	43859	374	41192
16-#18	5.35	MA	24641	6499	43534	4677	48798	3737	51988	2932	57035	1634	72419	384	69344
7L-3S		MI	15883	6499	29079	4424	32299	3482	34574	2664	38525	1288	46742	578	43301
16-#18	5.35	MA	23401	6499	41232	4674	45713	3730	48319	2957	51765	1617	66085	255	64247
8L-2S		MI	16969	6499	30830	4441	34467	3464	37158	2646	41939	1271	51129	805	43916
18-#11	2.35	MA	23334	5225	37998	3870	42011	3121	43870	2560	45927	1687	56471	1339	38142
5L-6S		MI	12471	5225	20831	3695	22341	2981	22808	2423	23001	1543	27380	1050	19879
18-#11	2.35	MA	22791	5225	37070	3869	40750	3134	42331	2557	43889	1696	53860	1281	37331
6L-5S		MI	12761	5225	21316	3700	22996	2988	23556	2416	23990	1536	28577	1110	20137
18-#11	2.35	MA	22261	5225	36076	3883	39540	3132	40847	2568	41896	1705	51144	1194	36566
7L-4S		MI	13063	5225	21829	3705	23653	2981	24338	2409	25070	1543	29862	1151	20525
18-#11	2.35	MA	21738	5225	35166	3883	38318	3145	39395	2580	39808	1700	48590	1142	35496
8L-3S		MI	13397	5225	22410	3696	24389	2988	25208	2416	26161	1536	31074	1235	20542
18-#11	2.35	MA	21180	5225	34272	3882	37124	3143	37892	2577	37836	1709	46060	1086	34376
9L-2S		MI	13858	5225	23122	3701	25293	2981	26286	2409	27585	1529	32927	1324	20527
18-#14	3.39	MA	24159	5665	40657	4138	45218	3332	47731	2679	51208	1669	64009	1086	51785
6L-5S		MI	13458	5665	23295	3953	25387	3165	26386	2509	27729	1460	33497	857	27668
18-#14	3.39	MA	23417	5665	39232	4157	43481	3330	45602	2694	48348	1681	60143	959	49868
7L-4S		MI	13882	5665	24027	3961	26314	3155	27490	2499	29253	1469	35303	917	28278
18-#14	3.39	MA	22685	5665	37925	4156	41728	3347	43517	2710	45353	1673	56499	885	47878
8L-3S		MI	14351	5665	24855	3950	27352	3165	28718	2509	30793	1460	37008	1036	28845
18-#14	3.39	MA	21919	5665	36642	4155	40015	3344	41360	2705	42523	1685	52899	804	45731
9L-2S		MI	14995	5665	25868	3958	28628	3155	30238	2499	32802	1450	39613	1164	28891
18-#18	6.02	MA	26238	6782	47057	4854	53291	3865	57449	3012	64434	1616	82311	342	79550
7L-4S		MI	15822	6782	29391	4619	32703	3586	35070	2713	39322	1262	48246	278	46241
18-#18	6.02	MA	25014	6782	44756	4851	50205	3859	53780	3037	59164	1599	75977	213	74405
8L-3S		MI	16610	6782	30830	4601	34467	3604	37158	2731	41939	1244	51129	482	48194
20-#11	2.61	MA	23449	5336	38473	3938	42539	3184	44506	2588	46836	1689	57869	1268	41492
6E		MI	12787	5336	21543	3764	23246	3031	23886	2452	24424	1529	29234	1020	21978
20-#11	2.61	MA	22923	5336	37480	3952	41329	3183	43022	2600	44843	1698	55154	1181	40670
7L-5S		MI	13075	5336	22028	3769	23901	3038	24633	2445	25414	1522	30431	1080	22222
20-#11	2.61	MA	22404	5336	36569	3952	40107	3195	41570	2611	42755	1693	52599	1129	39629
8L-4S		MI	13376	5336	22541	3774	24558	3031	25416	2438	26494	1529	31716	1120	22677
20-#11	2.61	MA	21859	5336	35675	3952	38914	3193	40067	2608	40783	1702	50070	1073	38475
9L-3S		MI	13708	5336	23122	3765	25293	3038	26286	2445	27585	1522	32927	1205	22706
20-#11	2.61	MA	21276	5336	34699	3965	37708	3206	38623	2619	38825	1711	47616	1009	37286
10L-2S		MI	14167	5336	23834	3770	26198	3031	27363	2438	29009	1515	34781	1293	22704
20-#14	3.76	MA	24347	5825	41242	4257	46044	3402	48717	2739	52569	1671	65852	939	55770
7L-5S		MI	13896	5825	24308	4053	26663	3236	27907	2549	29738	1438	36102	810	30631
20-#14	3.76	MA	23622	5825	39935	4256	44291	3419	46633	2755	49573	1663	62208	865	53731
8L-4S		MI	14318	5825	25040	4061	27591	3226	29011	2539	31262	1448	37908	869	31201
20-#14	3.76	MA	22858	5825	38652	4255	42578	3417	44476	2750	46743	1675	58608	784	51555
9L-3S		MI	14784	5825	25868	4049	28628	3236	30238	2549	32802	1438	39613	989	31897
20-#14	3.76	MA	22071	5825	37251	4274	40847	3434	42404	2766	43934	1687	55116	692	49244
10L-2S		MI	15425	5825	26881	4057	29905	3226	31759	2539	34811	1428	42217	1117	31962
20-#18	6.69	MA	26610	7066	48280	5028	54698	3987	59241	3117	66563	1581	85868	171	84579
8L-4S		MI	16551	7066	31142	4796	34872	3708	37654	2780	42737	1218	52634	183	51306

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.87	MA	23580	5446	38883	4021	43118	3233	45198	2631	47790	1691	59163	1168	44781
7L-6S		MI	13100	5446	22255	3833	24151	3081	24964	2480	25848	1515	31088	989	24080
22-#11	2.87	MA	23065	5446	37973	4021	41897	3245	43745	2642	45702	1686	56608	1116	43767
8L-5S		MI	13387	5446	22740	3838	24806	3088	25711	2473	26838	1508	32285	1049	24311
22-#11	2.87	MA	22520	5446	37079	4021	40703	3244	42242	2639	43730	1695	54079	1060	42579
9L-4S		MI	13687	5446	23253	3843	25463	3081	26494	2466	27917	1515	33570	1090	24825
22-#11	2.87	MA	21944	5446	36103	4034	39497	3256	40799	2650	41772	1704	51625	996	41368
10L-3S		MI	14018	5446	23834	3834	26198	3088	27363	2473	29009	1508	34781	1174	24866
22-#11	2.87	MA	21388	5446	35209	4034	38311	3255	39313	2648	39714	1699	49130	941	39912
11L-2S		MI	14474	5446	24546	3839	27103	3081	28441	2466	30433	1502	36635	1263	24877
22-#14	4.14	MA	24552	5985	41945	4356	46854	3492	49748	2800	53794	1653	67918	844	59592
8L-5S		MI	14332	5985	25321	4153	27940	3307	29427	2589	31747	1416	38706	763	33600
22-#14	4.14	MA	23789	5985	40662	4355	45141	3489	47591	2795	50964	1665	64317	763	57386
9L-4S		MI	14751	5985	26053	4161	28867	3297	30531	2579	33271	1426	40512	822	34134
22-#14	4.14	MA	23008	5985	39261	4374	43410	3506	45520	2811	48155	1677	60826	672	55116
10L-3S		MI	15214	5985	26881	4149	29905	3307	31759	2589	34811	1416	42217	941	34945
24-#11	3.13	MA	23721	5557	39376	4090	43686	3295	45920	2673	48649	1679	60618	1102	47909
8L-6S		MI	13413	5557	22967	3902	25056	3131	26042	2509	27272	1502	32942	959	26184
24-#11	3.13	MA	23178	5557	38482	4090	42492	3294	44417	2670	46677	1688	58088	1046	46688
9L-5S		MI	13698	5557	23452	3907	25710	3138	26789	2502	28262	1495	34139	1019	26403
24-#11	3.13	MA	22607	5557	37506	4103	41287	3306	42974	2682	44719	1697	55634	983	45454
10L-4S		MI	13996	5557	23965	3912	26368	3131	27571	2495	29341	1502	35424	1059	26898
24-#11	3.13	MA	22054	5557	36612	4103	40100	3305	41488	2679	42660	1692	53140	928	44022
11L-3S		MI	14326	5557	24546	3904	27103	3138	28441	2502	30433	1495	36635	1144	27021
24-#11	3.13	MA	21511	5557	35651	4117	38902	3317	40048	2690	40706	1701	50396	854	42517
12L-2S		MI	14780	5557	25258	3908	28008	3131	29519	2495	31856	1488	38489	1232	27043
24-#14	4.52	MA	24712	6144	42672	4455	47704	3561	50707	2840	55185	1655	70027	743	63224
9L-5S		MI	14765	6144	26334	4253	29216	3378	30948	2629	33756	1395	41311	716	36572
24-#14	4.52	MA	23937	6144	41271	4474	45973	3579	48635	2856	52376	1667	66535	651	60994
10L-4S		MI	15182	6144	27065	4261	30143	3368	32052	2619	35280	1405	43117	775	37074

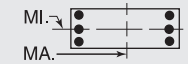
RECTANGULAR TIED COLUMNS 26" x 48"

4-#18	1.28	MA	24728	4980	38965	3706	42534	3015	43816	2502	44645	1765	53143	1661	23295
2E		MI	13021	4980	21059	3509	22201	2839	22372	2338	22088	1606	25500	1447	11892
6-#14	1.08	MA	24251	4892	37782	3672	41166	2992	42207	2492	42488	1782	50459	1694	19893
2L-3S		MI	12172	4892	19507	3484	20440	2849	20314	2361	19380	1660	22083	1388	10334
6-#14	1.08	MA	22838	4892	35672	3672	38476	2990	38937	2508	38058	1794	44437	1566	19916
3L-2S		MI	12842	4892	20520	3492	21716	2839	21835	2351	21389	1650	24688	1516	10251
6-#18	1.92	MA	26445	5264	42666	3884	47252	3143	49552	2582	52416	1747	63589	1622	34588
2L-3S		MI	12640	5264	21059	3669	22201	2979	22372	2422	22088	1579	25500	1124	17427
6-#18	1.92	MA	24019	5264	38965	3882	42534	3173	43816	2608	44645	1767	53143	1394	34363
3L-2S		MI	13779	5264	22809	3686	24370	2961	24955	2404	25502	1562	29888	1351	17338
8-#11	1.00	MA	24055	4856	37286	3660	40604	2984	41552	2489	41613	1789	49369	1708	18494
2L-4S		MI	11952	4856	18996	3493	19875	2842	19670	2359	18593	1684	21299	1373	9682
8-#11	1.00	MA	23066	4856	35813	3660	38727	2983	39270	2500	38520	1799	45143	1619	18520
3E		MI	12296	4856	19577	3484	20611	2849	20540	2366	19685	1677	22510	1457	9621
8-#11	1.00	MA	22371	4856	34635	3674	37228	2996	37451	2498	36159	1808	42366	1531	18487
4L-2S		MI	12768	4856	20289	3489	21515	2842	21618	2359	21108	1670	24364	1546	9568
8-#14	1.44	MA	25248	5051	39892	3772	43856	3064	45477	2537	46918	1772	56480	1675	26340
2L-4S		MI	12138	5051	19692	3596	20678	2910	20607	2391	19849	1649	22983	1222	13524
8-#14	1.44	MA	23847	5051	37782	3771	41166	3062	42207	2553	42488	1784	50459	1547	26314
3E		MI	12624	5051	20520	3584	21716	2920	21835	2401	21389	1639	24688	1341	13476

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

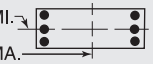


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.44	MA	22864	5051	36092	3791	39017	3080	39599	2549	39101	1797	46506	1419	26107
4L-2S		MI	13289	5051	21533	3592	22992	2910	23355	2391	23398	1629	27293	1469	13408
8-#18	2.56	MA	28132	5548	46367	4061	51971	3272	55288	2662	60187	1729	74035	1582	45828
2L-4S		MI	12572	5548	21371	3864	22606	3083	22868	2471	22885	1553	27005	824	21453
8-#18	2.56	MA	25740	5548	42666	4059	47252	3302	49552	2688	52416	1749	63589	1355	45484
3E		MI	13400	5548	22809	3846	24370	3101	24955	2489	25502	1535	29888	1028	22739
8-#18	2.56	MA	24057	5548	39695	4092	43474	3296	44967	2679	46463	1768	56747	1127	42743
4L-2S		MI	14527	5548	24560	3863	26538	3083	27539	2471	28917	1517	34276	1256	22729
10-#11	1.25	MA	24757	4966	38759	3729	42482	3034	43834	2520	44705	1783	53595	1696	22996
2L-5S		MI	11965	4966	19195	3557	20123	2899	19966	2395	18937	1663	21868	1302	11914
10-#11	1.25	MA	23774	4966	37286	3729	40604	3033	41552	2532	41613	1792	49369	1607	23001
3L-4S		MI	12274	4966	19708	3562	20780	2892	20748	2388	20017	1670	23153	1343	11884
10-#11	1.25	MA	23085	4966	36108	3743	39106	3046	39733	2529	39251	1801	46592	1519	22938
4L-3S		MI	12616	4966	20289	3553	21515	2899	21618	2395	21108	1663	24364	1427	11836
10-#11	1.25	MA	22468	4966	35077	3743	37776	3045	38104	2541	36926	1797	43716	1473	22755
5L-2S		MI	13085	4966	21001	3558	22420	2892	22696	2388	22532	1656	26218	1515	11788
10-#14	1.80	MA	26234	5211	42002	3872	46546	3136	48747	2581	51348	1762	62502	1656	32769
2L-5S		MI	12153	5211	19973	3687	21027	2991	21024	2441	20334	1617	23782	1115	16018
10-#14	1.80	MA	24845	5211	39892	3871	43856	3134	45477	2597	46918	1774	56480	1528	32699
3L-4S		MI	12590	5211	20705	3695	21955	2981	22128	2432	21858	1627	25588	1175	16605
10-#14	1.80	MA	23871	5211	38202	3891	41707	3152	42869	2594	43531	1787	52528	1400	32443
4L-3S		MI	13072	5211	21533	3684	22992	2991	23355	2441	23398	1617	27293	1294	16592
10-#14	1.80	MA	23000	5211	36723	3890	39798	3150	40531	2610	40195	1779	48422	1335	30991
5L-2S		MI	13733	5211	22545	3692	24268	2981	24876	2432	25407	1607	29897	1422	16541
10-#18	3.21	MA	27433	5831	46367	4236	51971	3430	55288	2768	60187	1731	74035	1315	56597
3L-4S		MI	13332	5831	23121	4041	24774	3206	25452	2538	26300	1509	31393	728	26384
10-#18	3.21	MA	25775	5831	43396	4269	48193	3424	50703	2759	54234	1751	67193	1088	53443
4L-3S		MI	14151	5831	24560	4023	26538	3223	27539	2555	28917	1491	34276	933	28016
10-#18	3.21	MA	24292	5831	40792	4267	44834	3454	46590	2785	48365	1735	60046	976	50321
5L-2S		MI	15268	5831	26310	4041	28707	3206	30123	2538	32331	1473	38663	1160	28086
12-#11	1.50	MA	25453	5077	40231	3798	44359	3084	46117	2551	47797	1776	57821	1684	27488
2L-6S		MI	11992	5077	19422	3621	20373	2942	20296	2430	19372	1656	22525	1211	13690
12-#11	1.50	MA	24476	5077	38759	3798	42482	3083	43834	2563	44705	1785	53595	1595	27471
3L-5S		MI	12286	5077	19907	3626	21027	2949	21043	2424	20361	1649	23721	1271	14020
12-#11	1.50	MA	23791	5077	37581	3812	40983	3096	42016	2560	42343	1794	50818	1506	27384
4E		MI	12594	5077	20420	3631	21685	2942	21826	2417	21441	1656	25007	1312	14071
12-#11	1.50	MA	23180	5077	36550	3812	39653	3095	40387	2572	40018	1790	47941	1461	27156
5L-3S		MI	12934	5077	21001	3622	22420	2949	22696	2424	22532	1649	26218	1396	14036
12-#11	1.50	MA	22597	5077	35578	3812	38332	3107	38775	2570	37883	1799	45188	1403	26155
6L-2S		MI	13402	5077	21713	3627	23325	2942	23773	2417	23956	1642	28072	1485	13995
12-#14	2.16	MA	25832	5370	42002	3971	46546	3207	48747	2642	51348	1764	62502	1509	39075
3L-5S		MI	12604	5370	20986	3787	22303	3062	22545	2482	22343	1596	26387	1068	18946
12-#14	2.16	MA	24867	5370	40312	3990	44397	3224	46139	2638	47962	1777	58549	1381	38776
4E		MI	13038	5370	21717	3795	23231	3052	23648	2472	23867	1605	28193	1127	19667
12-#14	2.16	MA	24005	5370	38833	3990	42488	3222	43801	2655	44625	1769	54444	1316	37173
5L-3S		MI	13517	5370	22545	3783	24268	3062	24876	2482	25407	1596	29897	1247	19691
12-#14	2.16	MA	23182	5370	37437	3990	40591	3240	41487	2651	41562	1782	50523	1232	35944
6L-2S		MI	14174	5370	23558	3791	25545	3052	26396	2472	27415	1586	32502	1375	19658
12-#18	3.85	MA	27467	6115	47097	4447	52911	3553	56439	2838	62004	1733	77639	1048	64186
4E		MI	14084	6115	24872	4219	26943	3328	28036	2605	29714	1465	35780	633	31356
12-#18	3.85	MA	26006	6115	44493	4444	49552	3583	52326	2865	56136	1717	70492	936	61217
5L-3S		MI	14895	6115	26310	4201	28707	3345	30123	2622	32331	1447	38663	837	33271
12-#18	3.85	MA	24613	6115	42036	4442	46214	3577	48254	2856	50745	1737	63697	786	56541
6L-2S		MI	16003	6115	28060	4218	30875	3328	32707	2605	35746	1429	43051	1065	33409
14-#11	1.75	MA	25172	5187	40231	3868	44359	3133	46117	2594	47797	1778	57821	1583	31935
3L-6S		MI	12313	5187	20134	3690	21278	2992	21374	2459	20795	1642	24379	1181	15780
14-#11	1.75	MA	24493	5187	39053	3881	42861	3146	44298	2592	45436	1787	55044	1494	31826
4L-5S		MI	12606	5187	20619	3695	21932	2999	22121	2452	21785	1635	25575	1241	16085

RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

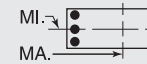


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.75	MA	23885	5187	38022	3881	41531	3145	42669	2603	43110	1783	52167	1449	31465
5L-4S		MI	12912	5187	21132	3700	22590	2992	22904	2445	22864	1642	26861	1282	16249
14-#11	1.75	MA	23307	5187	37050	3881	40209	3158	41057	2601	40976	1792	49414	1391	30506
6L-3S		MI	13250	5187	21713	3692	23325	2999	23773	2452	23956	1635	28072	1366	16226
14-#11	1.75	MA	22743	5187	36010	3895	38941	3156	39502	2612	38887	1801	46551	1303	29878
7L-2S		MI	13716	5187	22425	3697	24230	2992	24851	2445	25380	1629	29926	1454	16192
14-#14	2.52	MA	25853	5530	42422	4090	47087	3297	49409	2683	52392	1767	64571	1362	45108
4L-5S		MI	13052	5530	21998	3887	23580	3133	24065	2522	24352	1574	28991	1021	21886
14-#14	2.52	MA	24999	5530	40943	4090	45178	3295	47071	2699	49056	1760	60465	1297	43371
5L-4S		MI	13483	5530	22730	3895	24507	3123	25169	2512	25875	1584	30797	1080	22614
14-#14	2.52	MA	24185	5530	39547	4089	43281	3312	44757	2696	45992	1772	56544	1213	42189
6L-3S		MI	13958	5530	23558	3883	25545	3133	26396	2522	27415	1574	32502	1199	22774
14-#14	2.52	MA	23390	5530	38054	4109	41461	3310	42526	2712	42995	1785	52466	1087	40169
7L-2S		MI	14611	5530	24571	3891	26821	3123	27917	2512	29424	1564	35106	1327	22763
14-#18	4.49	MA	27696	6399	48194	4622	54271	3711	58062	2945	63907	1699	80938	897	72089
5L-4S		MI	14830	6399	26622	4396	29111	3450	30620	2671	33129	1421	40168	537	36360
14-#18	4.49	MA	26323	6399	45737	4619	50933	3706	53990	2935	58516	1719	74143	747	67323
6L-3S		MI	15634	6399	28060	4378	30875	3468	32707	2689	35746	1403	43051	742	38512
14-#18	4.49	MA	24983	6399	43107	4653	47727	3735	50062	2962	53240	1738	67071	522	62658
7L-2S		MI	16732	6399	29811	4395	33043	3450	35291	2671	39161	1385	47439	969	38707
16-#11	2.00	MA	25188	5298	40526	3950	44739	3196	46581	2623	48528	1780	59270	1482	36265
4L-6S		MI	12632	5298	20846	3760	22182	3042	22452	2488	22219	1629	26233	1150	17874
16-#11	2.00	MA	24586	5298	39495	3950	43408	3195	44951	2634	46202	1776	56393	1437	35785
5E		MI	12924	5298	21331	3765	22837	3049	23199	2481	23209	1622	27429	1210	18157
16-#11	2.00	MA	24011	5298	38523	3950	42087	3208	43339	2632	44068	1785	53640	1379	34863
6L-4S		MI	13228	5298	21844	3770	23494	3042	23981	2474	24288	1629	28715	1251	18417
16-#11	2.00	MA	23451	5298	37482	3964	40819	3207	41785	2643	41979	1794	50777	1291	34225
7L-3S		MI	13565	5298	22425	3761	24230	3049	24851	2481	25380	1622	29926	1335	18408
16-#11	2.00	MA	22899	5298	36529	3964	39539	3219	40263	2655	39791	1790	48088	1239	33031
8L-2S		MI	14028	5298	23137	3766	25134	3042	25929	2474	26804	1615	31780	1424	18382
16-#14	2.88	MA	25983	5690	43053	4189	47868	3367	50341	2744	53486	1750	66487	1278	49582
5E		MI	13496	5690	23011	3987	24856	3204	25586	2562	26361	1553	31596	974	24836
16-#14	2.88	MA	25177	5690	41657	4189	45971	3385	48028	2740	50422	1762	62566	1194	48442
6L-4S		MI	13924	5690	23743	3995	25783	3194	26689	2552	27884	1562	33402	1033	25511
16-#14	2.88	MA	24390	5690	40163	4209	44151	3382	45796	2756	47425	1775	58487	1068	46351
7L-3S		MI	14397	5690	24571	3983	26821	3204	27917	2562	29424	1553	35106	1152	25844
16-#14	2.88	MA	23615	5690	38794	4208	42314	3400	43612	2772	44285	1767	54650	993	44431
8L-2S		MI	15046	5690	25584	3991	28097	3194	29437	2552	31433	1543	37711	1280	25858
16-#18	5.13	MA	28011	6683	49438	4797	55651	3834	59726	3015	66287	1701	84589	707	78126
6L-4S		MI	15569	6683	28372	4573	31279	3572	33203	2738	36544	1376	44556	442	41388
16-#18	5.13	MA	26690	6683	46808	4830	52446	3864	55798	3042	61011	1721	77517	483	73376
7L-3S		MI	16367	6683	29811	4555	33043	3590	35291	2756	39161	1359	47439	646	43566
16-#18	5.13	MA	25386	6683	44396	4828	49211	3858	51952	3068	55485	1705	70838	352	68163
8L-2S		MI	17456	6683	31561	4573	35212	3572	37874	2738	42575	1341	51826	874	43991
18-#11	2.25	MA	25280	5409	40968	4020	45286	3245	47234	2665	49295	1769	60619	1425	40114
5L-6S		MI	12950	5409	21558	3829	23087	3092	23529	2516	23643	1615	28086	1120	19972
18-#11	2.25	MA	24710	5409	39996	4020	43965	3258	45622	2663	47160	1778	57866	1367	39227
6L-5S		MI	13240	5409	22043	3834	23742	3099	24277	2510	24632	1608	29283	1180	20237
18-#11	2.25	MA	24154	5409	38955	4033	42696	3257	44067	2675	45071	1787	55003	1279	38528
7L-4S		MI	13543	5409	22556	3839	24399	3092	25059	2503	25712	1615	30569	1220	20577
18-#11	2.25	MA	23606	5409	38001	4033	41416	3269	42545	2686	42884	1783	52314	1227	37365
8L-3S		MI	13878	5409	23137	3830	25134	3099	25929	2510	26804	1608	31780	1305	20584
18-#11	2.25	MA	23012	5409	37065	4033	40166	3268	40970	2684	40817	1792	49647	1171	36277
9L-2S		MI	14339	5409	23848	3835	26039	3092	27007	2503	28227	1601	33634	1393	20566
18-#14	3.25	MA	26160	5849	43767	4289	48661	3457	51298	2785	54852	1752	68587	1175	54634
6L-5S		MI	13938	5849	24024	4086	26132	3274	27106	2602	28369	1531	34200	926	27793
18-#14	3.25	MA	25381	5849	42273	4308	46841	3455	49066	2801	51855	1765	64509	1049	52543
7L-4S		MI	14363	5849	24755	4094	27060	3265	28210	2592	29893	1541	36006	986	28422

RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

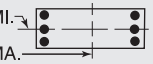


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	3.25	MA	24612	5849	40904	4308	45004	3473	46882	2817	48715	1757	60671	974	50574
8L-3S		MI	14833	5849	25584	4083	28097	3274	29437	2602	31433	1531	37711	1105	28906
18-#14	3.25	MA	23798	5849	39560	4307	43209	3470	44621	2813	45750	1770	56872	893	48430
9L-2S		MI	15479	5849	26596	4091	29374	3265	30958	2592	33442	1521	40316	1233	28944
18-#18	5.77	MA	28375	6966	50509	5007	57164	3992	61534	3121	68782	1703	87963	443	84113
7L-4S		MI	16304	6966	30123	4750	33448	3694	35787	2805	39958	1332	48943	346	46436
18-#18	5.77	MA	27089	6966	48097	5005	53930	3987	57687	3148	63256	1687	81284	313	78854
8L-3S		MI	17095	6966	31561	4733	35212	3712	37874	2822	42575	1315	51826	550	48456
20-#11	2.50	MA	25404	5519	41468	4089	45842	3308	47904	2694	50252	1771	62092	1354	43595
6E		MI	13266	5519	22270	3898	23992	3141	24607	2545	25067	1601	29940	1089	22073
20-#11	2.50	MA	24852	5519	40428	4103	44574	3307	46349	2706	48164	1781	59229	1267	42838
7L-5S		MI	13554	5519	22755	3903	24646	3148	25355	2538	26056	1594	31137	1149	22322
20-#11	2.50	MA	24308	5519	39474	4103	43294	3320	44828	2717	45976	1776	56540	1214	41705
8L-4S		MI	13856	5519	23268	3908	25304	3141	26137	2531	27136	1601	32423	1190	22731
20-#11	2.50	MA	23717	5519	38538	4103	42044	3318	43253	2715	43909	1785	53873	1158	40582
9L-3S		MI	14189	5519	23848	3899	26039	3148	27007	2538	28227	1594	33634	1274	22756
20-#11	2.50	MA	23116	5519	37515	4116	40780	3331	41741	2726	41859	1795	51285	1095	39345
10L-2S		MI	14649	5519	24560	3904	26944	3141	28084	2531	29651	1587	35488	1363	22745
20-#14	3.61	MA	26362	6009	44383	4408	49531	3527	52336	2846	56285	1755	70531	1030	58743
7L-5S		MI	14377	6009	25037	4186	27409	3345	28627	2642	30378	1509	36805	879	30757
20-#14	3.61	MA	25601	6009	43014	4408	47694	3545	50152	2862	53146	1747	66693	955	56724
8L-4S		MI	14799	6009	25768	4194	28336	3335	29730	2632	31902	1519	38611	938	31345
20-#14	3.61	MA	24788	6009	41669	4407	45899	3543	47891	2858	50180	1760	62894	874	54552
9L-3S		MI	15267	6009	26596	4182	29374	3345	30958	2642	33442	1509	40316	1058	31962
20-#14	3.61	MA	23961	6009	40202	4427	44085	3560	45721	2874	47236	1773	59209	783	52047
10L-2S		MI	15909	6009	27609	4190	30650	3335	32478	2632	35451	1500	42920	1186	32017
20-#18	6.41	MA	28772	7250	51798	5182	58648	4115	63423	3228	71027	1670	91730	273	89561
8L-4S		MI	17034	7250	31873	4928	35616	3816	38371	2871	43373	1288	53331	251	51499
22-#11	2.75	MA	25545	5630	41900	4172	46451	3357	48632	2737	51256	1774	63455	1255	47155
7L-6S		MI	13580	5630	22982	3967	24897	3191	25685	2574	26490	1587	31794	1059	24176
22-#11	2.75	MA	25004	5630	40947	4172	45171	3370	47110	2748	49068	1769	60766	1202	46050
8L-5S		MI	13867	5630	23467	3972	25551	3198	26432	2567	27480	1580	32991	1119	24411
22-#11	2.75	MA	24426	5630	40010	4172	43921	3369	45535	2746	47002	1778	58099	1146	44893
9L-4S		MI	14167	5630	23980	3977	26209	3191	27215	2560	28560	1587	34276	1159	24882
22-#11	2.75	MA	23820	5630	38988	4186	42658	3381	44023	2758	44951	1788	55511	1083	43680
10L-3S		MI	14499	5630	24560	3968	26944	3198	28084	2567	29651	1580	35488	1244	24915
22-#11	2.75	MA	23235	5630	38052	4186	41415	3380	42467	2755	42794	1783	52884	1028	42132
11L-2S		MI	14957	5630	25272	3973	27849	3191	29162	2560	31075	1573	37341	1332	24920
22-#14	3.97	MA	26581	6168	45124	4507	50384	3617	53422	2907	57576	1738	72715	936	62883
8L-5S		MI	14813	6168	26049	4286	28685	3416	30147	2682	32387	1488	39410	832	33726
22-#14	3.97	MA	25770	6168	43779	4507	48589	3615	51161	2903	54610	1750	68916	855	60682
9L-4S		MI	15233	6168	26781	4294	29612	3406	31251	2672	33911	1498	41216	891	34277
22-#14	3.97	MA	24949	6168	42311	4526	46775	3633	48991	2919	51666	1763	65231	764	58218
10L-3S		MI	15698	6168	27609	4282	30650	3416	32478	2682	35451	1488	42920	1010	35012
24-#11	3.00	MA	25696	5741	42419	4241	47049	3420	49392	2779	52160	1762	64992	1190	50399
8L-6S		MI	13893	5741	23694	4036	25801	3241	26763	2602	27914	1573	33648	1028	26280
24-#11	3.00	MA	25119	5741	41483	4241	45799	3419	47818	2777	50094	1771	62325	1134	49208
9L-5S		MI	14179	5741	24179	4041	26456	3248	27510	2595	28904	1566	34845	1088	26503
24-#11	3.00	MA	24519	5741	40460	4255	44535	3431	46305	2789	48043	1781	59737	1071	47980
10L-4S		MI	14477	5741	24691	4046	27113	3241	28292	2589	29983	1573	36130	1129	27015
24-#11	3.00	MA	23938	5741	39524	4255	43292	3430	44749	2786	45886	1776	57110	1015	46450
11L-3S		MI	14808	5741	25272	4037	27849	3248	29162	2595	31075	1566	37341	1213	27073
24-#11	3.00	MA	23367	5741	38517	4269	42038	3443	43240	2798	43838	1785	54219	941	44945
12L-2S		MI	15263	5741	25984	4042	28753	3241	30240	2589	32499	1560	39195	1302	27092
24-#14	4.33	MA	26744	6328	45889	4607	51279	3687	54431	2948	59040	1740	74937	836	66818
9L-5S		MI	15247	6328	27062	4386	29961	3487	31668	2722	34396	1466	42014	785	36698
24-#14	4.33	MA	25929	6328	44421	4626	49465	3705	52261	2964	56097	1753	71252	744	64396
10L-4S		MI	15665	6328	27794	4394	30889	3477	32771	2712	35920	1476	43820	844	37216

RECTANGULAR TIED COLUMNS 28" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.19	MA	8836	3104	14103	2242	15102	1824	15325	1511	15212	1056	17738	974	7692
2L-3S		MI	8319	3104	13322	2238	14106	1832	14130	1518	13633	1063	15670	885	7740
6-#14	1.72	MA	9269	3251	15124	2323	16365	1882	16789	1540	17140	1029	20225	923	10820
2L-3S		MI	8542	3251	14012	2316	14946	1892	15098	1549	14908	1039	17313	795	10857
6-#18	3.06	MA	10301	3623	17621	2533	19361	2022	20329	1609	21811	956	26191	780	18450
2L-3S		MI	9070	3623	15694	2518	16940	2039	17445	1627	18000	974	21259	552	18274
8-#11	1.59	MA	9186	3215	14884	2311	16098	1875	16521	1541	16791	1044	19806	946	10105
2L-4S		MI	8303	3215	13468	2317	14295	1876	14361	1541	14001	1057	16390	772	10124
8-#14	2.30	MA	9758	3411	16237	2422	17783	1954	18479	1581	19373	1010	23137	880	14235
2L-4S		MI	8517	3411	14217	2429	15212	1954	15425	1581	15429	1030	18324	630	13643
8-#18	4.08	MA	11116	3907	19549	2710	21782	2147	23213	1679	25622	917	31123	694	24298
2L-4S		MI	9024	3907	16043	2716	17393	2147	18000	1679	18890	952	22960	256	21219
10-#11	1.99	MA	9532	3325	15665	2381	17094	1925	17716	1571	18370	1031	21873	919	12504
2L-5S		MI	8326	3325	13689	2382	14569	1934	14688	1578	14383	1038	17024	704	11884
10-#11	1.99	MA	9024	3325	14884	2376	16098	1932	16521	1578	16791	1038	19806	830	12521
3L-4S		MI	8657	3325	14249	2386	15291	1926	15556	1571	15580	1045	18458	744	12476
10-#14	2.87	MA	10241	3570	17349	2522	19201	2026	20169	1623	21606	991	26050	837	17633
2L-5S		MI	8548	3570	14530	2522	15600	2036	15888	1633	15969	1001	19217	529	16031
10-#14	2.87	MA	9528	3570	16237	2515	17783	2036	18479	1633	19373	1001	23137	709	17582
3L-4S		MI	9013	3570	15330	2528	16631	2026	17115	1623	17661	1011	21236	587	16789
10-#18	5.10	MA	10725	4191	19549	2872	21782	2290	23213	1767	25622	895	31123	380	29095
3L-4S		MI	9858	4191	17971	2893	19813	2272	20885	1750	22701	913	27892	169	26707

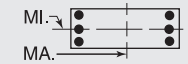
RECTANGULAR TIED COLUMNS 28" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.07	MA	10026	3289	15913	2384	17000	1942	17203	1613	16950	1139	19701	1057	7986
2E		MI	9330	3289	14854	2367	15811	1928	15935	1599	15654	1126	18133	1040	7411
4-#18	1.90	MA	10801	3538	17757	2516	19247	2034	19811	1657	20385	1090	24117	965	13624
2E		MI	10030	3538	16539	2498	17804	2014	18279	1639	18742	1072	22073	940	12592
6-#11	1.11	MA	10092	3302	16009	2403	17165	1957	17445	1627	17274	1146	20155	1065	8324
2L-3S		MI	8874	3302	14162	2383	14972	1952	14968	1620	14381	1141	16494	961	7773
6-#11	1.11	MA	9528	3302	15158	2400	16081	1965	16131	1634	15540	1153	17873	976	8371
3L-2S		MI	9391	3302	14943	2388	15967	1944	16164	1613	15960	1134	18562	1049	7723
6-#14	1.61	MA	10571	3449	17125	2484	18545	2014	19063	1656	19407	1121	22922	1018	11732
2L-3S		MI	9097	3449	14854	2460	15811	2011	15935	1650	15654	1117	18133	870	10906
6-#14	1.61	MA	9776	3449	15913	2478	17000	2025	17203	1666	16950	1131	19701	890	11768
3L-2S		MI	9826	3449	15966	2467	17230	2001	17626	1641	17886	1107	21046	998	10859
6-#18	2.86	MA	11715	3821	19862	2694	21921	2162	22996	1731	24593	1054	29596	887	20070
2L-3S		MI	9625	3821	16539	2661	17804	2157	18279	1727	18742	1051	22073	627	18376
6-#18	2.86	MA	10367	3821	17757	2681	19247	2179	19811	1748	20385	1072	24117	659	19894
3L-2S		MI	10860	3821	18467	2676	20225	2139	21163	1709	22552	1033	27005	854	18505
8-#11	1.49	MA	10477	3413	16859	2472	18249	2007	18758	1658	19009	1135	22438	1040	10948
2L-4S		MI	8858	3413	14308	2462	15160	1996	15199	1643	14749	1135	17214	847	10179
8-#11	1.49	MA	9917	3413	16009	2469	17165	2015	17445	1664	17274	1142	20155	951	10979
3E		MI	9229	3413	14943	2453	15967	2002	16164	1650	15960	1129	18562	933	10176
8-#11	1.49	MA	9515	3413	15319	2479	16288	2010	16385	1658	15944	1149	18671	864	10966
4L-2S		MI	9742	3413	15724	2457	16963	1994	17359	1643	17539	1122	20629	1022	10139
8-#14	2.14	MA	11109	3609	18337	2583	20091	2086	20923	1700	21864	1104	26143	979	15450
2L-4S		MI	9072	3609	15059	2573	16077	2073	16262	1682	16174	1107	19145	705	13857
8-#14	2.14	MA	10323	3609	17125	2578	18545	2098	19063	1710	19407	1114	22922	851	15442
3E		MI	9594	3609	15966	2560	17230	2083	17626	1692	17886	1097	21046	827	14286

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis

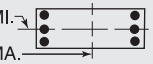


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.14	MA	9756	3609	16140	2592	17293	2089	17563	1700	17523	1124	20824	726	14972
4L-2S		MI	10316	3609	17079	2567	18648	2073	19316	1682	20119	1087	23958	955	14278
8-#18	3.81	MA	12615	4105	21967	2871	24595	2289	26182	1804	28802	1019	35074	808	26458
2L-4S		MI	9577	4105	16889	2858	18257	2264	18834	1779	19631	1029	23774	330	21504
8-#18	3.81	MA	11287	4105	19862	2858	21921	2307	22996	1822	24593	1036	29596	581	26169
3E		MI	10461	4105	18467	2838	20225	2282	21163	1797	22552	1011	27005	540	24124
8-#18	3.81	MA	10328	4105	18144	2881	19748	2289	20425	1804	21367	1054	26016	365	23313
4L-2S		MI	11678	4105	20395	2853	22646	2264	24047	1779	26363	993	31937	768	24366
10-#11	1.86	MA	10858	3523	17709	2541	19333	2057	20072	1688	20744	1124	24720	1015	13557
2L-5S		MI	8880	3523	14529	2527	15435	2053	15527	1679	15131	1116	17848	779	12029
10-#11	1.86	MA	10303	3523	16859	2538	18249	2066	18758	1695	19009	1131	22438	926	13574
3L-4S		MI	9212	3523	15089	2531	16156	2046	16395	1672	16328	1123	19282	820	12538
10-#11	1.86	MA	9904	3523	16169	2548	17372	2060	17699	1688	17679	1138	20953	839	13529
4L-3S		MI	9580	3523	15724	2522	16963	2052	17359	1679	17539	1116	20629	906	12564
10-#11	1.86	MA	9545	3523	15562	2545	16590	2069	16746	1695	16365	1131	19371	799	12964
5L-2S		MI	10090	3523	16505	2526	17959	2044	18555	1672	19118	1109	22697	994	12542
10-#14	2.68	MA	11641	3768	19550	2683	21636	2159	22783	1743	24320	1087	29365	941	19152
2L-5S		MI	9101	3768	15372	2666	16465	2155	16725	1734	16715	1078	20038	604	16214
10-#14	2.68	MA	10862	3768	18337	2677	20091	2170	20923	1753	21864	1097	26143	813	19100
3L-4S		MI	9568	3768	16172	2673	17496	2145	17952	1724	18407	1088	22057	662	16998
10-#14	2.68	MA	10302	3768	17352	2691	18839	2161	19423	1743	19980	1107	24046	688	18405
4L-3S		MI	10085	3768	17079	2660	18648	2155	19316	1734	20119	1078	23958	785	17647
10-#14	2.68	MA	9796	3768	16484	2686	17720	2173	18073	1753	18118	1097	21812	630	17507
5L-2S		MI	10800	3768	18191	2667	20066	2145	21006	1724	22351	1068	26870	913	17680
10-#18	4.76	MA	12193	4389	21967	3035	24595	2435	26182	1895	28802	1001	35074	502	32176
3L-4S		MI	10413	4389	18816	3036	20678	2390	21719	1850	23442	989	28706	244	26986
10-#18	4.76	MA	11248	4389	20249	3058	22422	2417	23611	1877	25575	1019	31495	287	29317
4L-3S		MI	11284	4389	20395	3015	22646	2407	24047	1867	26363	972	31937	454	29477
10-#18	4.76	MA	10398	4389	18733	3045	20479	2435	21299	1895	22384	1001	27696	182	26715
5L-2S		MI	12486	4389	22322	3030	25067	2390	26932	1850	30174	954	36869	681	30194
12-#11	2.23	MA	11236	3634	18559	2611	20417	2107	21385	1719	22479	1113	27002	990	16158
2L-6S		MI	8918	3634	14780	2592	15712	2097	15893	1716	15613	1111	18579	692	13954
12-#11	2.23	MA	10685	3634	17709	2607	19333	2116	20072	1726	20744	1120	24720	901	16152
3L-5S		MI	9233	3634	15310	2596	16430	2103	16722	1709	16711	1104	19916	752	14290
12-#11	2.23	MA	10289	3634	17019	2617	18456	2110	19012	1719	19413	1127	23235	814	16085
4E		MI	9563	3634	15870	2601	17152	2096	17590	1702	17907	1111	21350	792	14889
12-#11	2.23	MA	9933	3634	16412	2614	17674	2119	18059	1726	18099	1120	21653	774	15429
5L-3S		MI	9928	3634	16505	2591	17959	2102	18555	1709	19118	1104	22697	878	14939
12-#11	2.23	MA	9592	3634	15838	2611	16895	2113	17148	1733	16893	1127	20175	714	15052
6L-2S		MI	10434	3634	17286	2595	18955	2094	19750	1702	20697	1097	24765	967	14935
12-#14	3.21	MA	12168	3928	20762	2783	23182	2231	24644	1787	26777	1070	32586	902	22833
2L-6S		MI	9155	3928	15727	2759	16858	2218	17243	1786	17395	1069	21069	475	18306
12-#14	3.21	MA	11396	3928	19550	2777	21636	2242	22783	1797	24320	1080	29365	774	22748
3L-5S		MI	9597	3928	16485	2766	17884	2228	18415	1776	18947	1059	22950	561	19440
12-#14	3.21	MA	10841	3928	18564	2791	20384	2234	21283	1787	22436	1090	27267	649	21862
4E		MI	10059	3928	17284	2773	18914	2218	19642	1766	20640	1069	24969	620	20164
12-#14	3.21	MA	10341	3928	17696	2785	19266	2245	19933	1797	20575	1080	25033	591	21029
5L-3S		MI	10571	3928	18191	2760	20066	2228	21006	1776	22351	1059	26870	742	20998
12-#14	3.21	MA	9864	3928	16875	2780	18152	2236	18643	1806	18867	1090	22950	505	19790
6L-2S		MI	11280	3928	19304	2766	21485	2218	22696	1766	24584	1049	29783	870	21065
12-#18	5.71	MA	12156	4673	22354	3235	25096	2545	26796	1951	29783	983	36973	208	35358
4E		MI	11238	4673	20744	3213	23099	2515	24603	1920	27253	950	33638	157	32504
12-#18	5.71	MA	11318	4673	20838	3222	23153	2563	24484	1968	26593	965	33175	104	32593
5L-3S		MI	12099	4673	22322	3193	25067	2532	26932	1937	30174	932	36869	368	34788
14-#11	2.60	MA	11612	3745	19410	2680	21501	2157	22699	1750	24213	1102	29284	965	18752
2L-7S		MI	8966	3745	14995	2671	16018	2155	16227	1739	16118	1105	19385	598	15511
14-#11	2.60	MA	11064	3745	18559	2676	20417	2166	21385	1757	22479	1109	27002	876	18725
3L-6S		MI	9271	3745	15561	2661	16708	2147	17089	1746	17192	1099	20647	665	16158

RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis



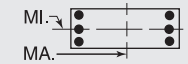
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.60	MA	10671	3745	17870	2687	19540	2160	20326	1750	21148	1116	25518	789	18601
4L-5S		MI	9584	3745	16091	2666	17426	2154	17918	1739	18290	1092	21984	724	16561
14-#11	2.60	MA	10318	3745	17263	2683	18758	2169	19373	1757	19834	1109	23935	749	17903
5L-4S		MI	9911	3745	16651	2670	18148	2146	18786	1732	19486	1099	23417	764	17171
14-#11	2.60	MA	9980	3745	16689	2680	17980	2164	18462	1764	18628	1116	22458	689	17465
6L-3S		MI	10274	3745	17286	2660	18955	2152	19750	1739	20697	1092	24765	851	17305
14-#11	2.60	MA	9650	3745	16075	2690	17231	2172	17515	1757	17448	1123	21069	621	16732
7L-2S		MI	10777	3745	18067	2664	19951	2145	20946	1732	22276	1085	26833	939	17321
14-#14	3.75	MA	11924	4087	20762	2877	23182	2315	24644	1840	26777	1062	32586	735	26389
3L-6S		MI	9650	4087	16840	2859	18276	2290	18933	1828	19628	1050	23981	432	21461
14-#14	3.75	MA	11375	4087	19777	2891	21930	2306	23143	1830	24893	1072	30488	610	25339
4L-5S		MI	10088	4087	17597	2866	19302	2300	20105	1818	21180	1040	25862	518	22678
14-#14	3.75	MA	10880	4087	18909	2885	20811	2317	21793	1840	23031	1062	28254	552	24562
5L-4S		MI	10545	4087	18397	2872	20332	2290	21332	1808	22872	1050	27882	577	23349
14-#14	3.75	MA	10407	4087	18088	2879	19698	2309	20503	1850	21324	1072	26171	467	23241
6L-3S		MI	11053	4087	19304	2859	21485	2300	22696	1818	24584	1040	29783	699	24340
14-#18	6.67	MA	12227	4956	22943	3400	25827	2690	27670	2042	30801	930	38653	25	38507
5L-4S		MI	12055	4956	22672	3390	25519	2640	27487	1990	31064	910	38570	71	38050
16-#11	2.97	MA	11440	3855	19410	2745	21501	2216	22699	1788	24213	1098	29284	852	21292
3L-7S		MI	9319	3855	15776	2740	17014	2205	17423	1769	17697	1093	21453	570	17756
16-#11	2.97	MA	11050	3855	18720	2756	20624	2211	21640	1781	22883	1105	27800	764	21041
4L-6S		MI	9622	3855	16342	2731	17704	2198	18284	1776	18771	1086	22714	637	18372
16-#11	2.97	MA	10699	3855	18113	2752	19842	2219	20686	1788	21569	1098	26217	724	20385
5E		MI	9932	3855	16872	2735	18422	2204	19113	1769	19869	1079	24051	697	18838
16-#11	2.97	MA	10364	3855	17539	2749	19064	2214	19775	1794	20363	1105	24740	664	19883
6L-4S		MI	10257	3855	17432	2739	19143	2196	19981	1762	21065	1086	25485	737	19409
16-#11	2.97	MA	10037	3855	16925	2759	18315	2222	18829	1788	19183	1112	23351	596	19183
7L-3S		MI	10617	3855	18067	2729	19951	2202	20946	1769	22276	1079	26833	823	19666
16-#14	4.29	MA	11904	4247	20989	2991	23475	2378	25003	1873	27350	1055	33709	572	28832
4L-6S		MI	10141	4247	17952	2959	19694	2362	20623	1870	21861	1031	26894	390	24631
16-#14	4.29	MA	11414	4247	20121	2985	22357	2390	23653	1883	25488	1045	31475	514	28085
5E		MI	10574	4247	18709	2965	20720	2372	21795	1860	23412	1021	28775	476	25841
16-#14	4.29	MA	10946	4247	19300	2979	21243	2381	22363	1893	23781	1055	29392	428	26706
6L-4S		MI	11028	4247	19509	2972	21751	2362	23022	1850	25105	1031	30794	534	26550
18-#11	3.34	MA	11426	3966	19570	2825	21708	2261	22953	1811	24618	1094	30082	739	23492
4L-7S		MI	9668	3966	16557	2809	18009	2255	18618	1799	19276	1081	23520	543	20009
18-#11	3.34	MA	11078	3966	18963	2821	20926	2269	22000	1818	23304	1087	28500	699	22872
5L-6S		MI	9969	3966	17123	2800	18700	2248	19480	1805	20350	1074	24782	609	20596
18-#11	3.34	MA	10745	3966	18389	2818	20148	2264	21089	1825	22098	1094	27022	640	22311
6L-5S		MI	10277	3966	17653	2804	19418	2254	20309	1799	21448	1067	26119	669	21122
18-#11	3.34	MA	10421	3966	17775	2828	19399	2272	20142	1818	20918	1101	25633	571	21641
7L-4S		MI	10600	3966	18213	2808	20139	2246	21177	1792	22645	1074	27553	709	21658
18-#14	4.82	MA	11943	4407	21333	3085	23902	2462	25513	1927	27945	1028	34696	475	31499
5L-6S		MI	10627	4407	19065	3058	21113	2435	22313	1911	24093	1011	29806	347	27812
18-#14	4.82	MA	11480	4407	20512	3079	22789	2453	24223	1937	26237	1038	32613	389	30183
6L-5S		MI	11056	4407	19822	3065	22139	2445	23485	1902	25645	1001	31687	433	28962
20-#11	3.71	MA	11454	4077	19813	2891	22010	2319	23313	1849	25038	1076	30782	674	25365
5L-7S		MI	10015	4077	17338	2878	19005	2305	19814	1828	20855	1069	25588	515	22268
20-#11	3.71	MA	11124	4077	19239	2887	21232	2314	22402	1856	23832	1083	29304	615	24746
6E		MI	10314	4077	17905	2869	19696	2298	20675	1835	21929	1062	26850	582	22828
20-#11	3.71	MA	10801	4077	18625	2897	20483	2322	21456	1849	22652	1090	27915	546	24105
7L-5S		MI	10620	4077	18434	2873	20414	2304	21505	1828	23027	1055	28187	642	23410

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

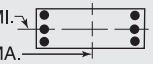
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	5.36	MA	12009	4566	21724	3179	24334	2526	26083	1980	28694	1021	35834	350	33671
6E		MI	11109	4566	20177	3158	22531	2507	24004	1953	26326	992	32718	304	31004
22-#11	4.09	MA	11500	4187	20090	2956	22316	2364	23716	1887	25567	1072	31586	590	27189
6L-7S		MI	10360	4187	18119	2948	20001	2356	21009	1858	22434	1056	27656	488	24517
22-#11	4.09	MA	11180	4187	19476	2967	21567	2373	22770	1880	24387	1079	30198	521	26574
7L-6S		MI	10657	4187	18686	2938	20692	2348	21871	1865	23508	1049	28918	554	25067
24-#11	4.46	MA	11555	4298	20326	3036	22651	2423	24083	1911	26122	1068	32480	496	29013
7E		MI	10703	4298	18900	3017	20997	2406	22205	1888	24014	1044	29724	460	26723

RECTANGULAR TIED COLUMNS 28" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.00	MA	11358	3487	17927	2545	19176	2074	19431	1728	19106	1228	22218	1147	8594
2E		MI	9886	3487	15696	2512	16676	2047	16772	1700	16400	1203	18954	1115	7441
4-#18	1.79	MA	12209	3736	19932	2677	21642	2168	22301	1775	22884	1183	27105	1062	14704
2E		MI	10586	3736	17385	2641	18668	2132	19113	1738	19483	1149	22887	1015	12639
6-#11	1.04	MA	11428	3500	18027	2564	19351	2089	19667	1740	19450	1236	22701	1155	8956
2L-3S		MI	9429	3500	15002	2529	15837	2071	15806	1721	15129	1219	17318	1036	7804
6-#11	1.04	MA	10816	3500	17108	2561	18179	2098	18242	1748	17560	1243	20203	1067	9003
3L-2S		MI	9947	3500	15783	2533	16833	2064	17002	1714	16708	1212	19386	1125	7752
6-#14	1.51	MA	11953	3647	19239	2644	20849	2146	21462	1773	21787	1213	25748	1112	12643
2L-3S		MI	9652	3647	15696	2605	16676	2129	16772	1751	16400	1194	18954	945	10951
6-#14	1.51	MA	11091	3647	17927	2640	19176	2159	19431	1783	19106	1223	22218	984	12680
3L-2S		MI	10382	3647	16808	2612	18095	2119	18463	1742	18632	1184	21866	1073	10896
6-#18	2.68	MA	13211	4019	22215	2854	24551	2296	25788	1851	27491	1151	33132	991	21690
2L-3S		MI	10181	4019	17385	2804	18668	2274	19113	1826	19483	1127	22887	701	18470
6-#18	2.68	MA	11745	4019	19932	2844	21642	2316	22301	1868	22884	1169	27105	763	21514
3L-2S		MI	11419	4019	19312	2819	21089	2257	21997	1809	23294	1110	27819	928	18560
8-#11	1.39	MA	11848	3611	18946	2633	20523	2139	21092	1771	21341	1226	25198	1133	11790
2L-4S		MI	9413	3611	15148	2608	16025	2115	16038	1744	15497	1214	18038	923	10229
8-#11	1.39	MA	11241	3611	18027	2630	19351	2148	19667	1779	19450	1233	22701	1044	11822
3E		MI	9784	3611	15783	2598	16833	2121	17002	1751	16708	1207	19386	1009	10213
8-#11	1.39	MA	10807	3611	17283	2641	18405	2144	18520	1772	18000	1240	21077	955	11809
4L-2S		MI	10298	3611	16564	2602	17829	2114	18198	1744	18287	1200	21453	1097	10172
8-#14	2.01	MA	12542	3807	20551	2744	22521	2219	23492	1818	24468	1197	29279	1076	16665
2L-4S		MI	9626	3807	15901	2718	16942	2192	17099	1783	16920	1185	19965	780	14064
8-#14	2.01	MA	11687	3807	19239	2739	20849	2231	21462	1827	21787	1207	25748	948	16657
3E		MI	10150	3807	16808	2705	18095	2202	18463	1793	18632	1175	21866	902	14341
8-#14	2.01	MA	11075	3807	18175	2754	19497	2224	19824	1818	19730	1217	23453	821	16323
4L-2S		MI	10873	3807	17921	2711	19513	2192	20153	1783	20865	1165	24779	1030	14320
8-#18	3.57	MA	14197	4303	24497	3032	27461	2425	29276	1927	32097	1119	39158	919	28618
2L-4S		MI	10130	4303	17734	3001	19121	2382	19668	1879	20372	1105	24588	404	21781
8-#18	3.57	MA	12752	4303	22215	3021	24551	2444	25788	1944	27491	1136	33132	691	28329
3E		MI	11018	4303	19312	2981	21089	2400	21997	1897	23294	1088	27819	614	24230
8-#18	3.57	MA	11714	4303	20358	3045	22191	2428	22975	1927	23958	1154	29203	471	25436
4L-2S		MI	12240	4303	21240	2996	23510	2382	24881	1879	27105	1070	32751	842	24432
10-#11	1.74	MA	12265	3721	19866	2702	21695	2189	22517	1802	23231	1216	27695	1110	14610
2L-5S		MI	9434	3721	15369	2673	16300	2173	16365	1781	15880	1194	18672	855	12168
10-#11	1.74	MA	11662	3721	18946	2700	20523	2199	21092	1810	21341	1223	25198	1021	14627
3L-4S		MI	9767	3721	15929	2677	17021	2165	17233	1774	17076	1201	20106	895	12595
10-#11	1.74	MA	11231	3721	18202	2710	19577	2194	19945	1803	19891	1230	23574	932	14582
4L-3S		MI	10136	3721	16564	2667	17829	2172	18198	1781	18287	1194	21453	981	12606
10-#11	1.74	MA	10844	3721	17548	2708	18734	2203	18912	1811	18459	1223	21845	892	14055
5L-2S		MI	10647	3721	17345	2671	18825	2164	19393	1774	19866	1187	23521	1070	12578
10-#14	2.51	MA	13123	3966	21863	2844	24194	2291	25522	1862	27149	1182	32809	1041	20670
2L-5S		MI	9655	3966	16214	2811	17330	2274	17562	1835	17460	1156	20858	679	16389

RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

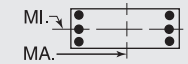
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.51	MA	12277	3966	20551	2839	22521	2303	23492	1872	24468	1192	29279	913	20619
3L-4S		MI	10123	3966	17014	2818	18361	2264	18789	1825	19153	1166	22878	737	17201
10-#14	2.51	MA	11671	3966	19487	2854	21170	2296	21855	1862	22412	1202	26984	786	20043
4L-3S		MI	10642	3966	17921	2804	19513	2274	20153	1835	20865	1156	24779	860	17710
10-#14	2.51	MA	11125	3966	18551	2849	19963	2308	20381	1872	20381	1192	24535	729	18996
5L-2S		MI	11359	3966	19033	2811	20931	2264	21843	1825	23097	1146	27691	988	17726
10-#18	4.46	MA	13744	4587	24497	3198	27461	2573	29276	2020	32097	1104	39158	620	35132
3L-4S		MI	10968	4587	19662	3179	21542	2507	22553	1949	24183	1066	29520	318	27257
10-#18	4.46	MA	12721	4587	22640	3223	25101	2556	26462	2003	28565	1122	35229	400	31957
4L-3S		MI	11844	4587	21240	3158	23510	2525	24881	1967	27105	1048	32751	528	29849
10-#18	4.46	MA	11800	4587	21003	3212	22992	2575	23931	2020	25074	1104	31050	296	29324
5L-2S		MI	13050	4587	23168	3173	25931	2507	27766	1949	30915	1031	37683	756	30267
12-#11	2.09	MA	12677	3832	20785	2772	22867	2240	23942	1834	25122	1206	30192	1087	17421
2L-6S		MI	9472	3832	15620	2738	16578	2217	16732	1818	16361	1189	19403	768	14097
12-#11	2.09	MA	12079	3832	19866	2769	21695	2249	22517	1841	23231	1213	27695	998	17416
3L-5S		MI	9788	3832	16150	2742	17296	2223	17561	1811	17459	1182	20740	827	14428
12-#11	2.09	MA	11652	3832	19122	2780	20750	2244	21370	1835	21781	1220	26071	910	17349
4E		MI	10119	3832	16710	2746	18017	2215	18429	1804	18655	1189	22174	867	14952
12-#11	2.09	MA	11267	3832	18468	2777	19906	2253	20337	1842	20350	1213	24342	870	16722
5L-3S		MI	10485	3832	17345	2736	18825	2222	19393	1811	19866	1182	23521	954	14989
12-#11	2.09	MA	10900	3832	17849	2774	19067	2249	19351	1849	19035	1220	22723	810	16286
6L-2S		MI	10993	3832	18126	2740	19820	2214	20589	1804	21445	1175	25589	1042	14974
12-#14	3.01	MA	13699	4126	23175	2944	25867	2363	27553	1907	29831	1166	36340	1006	24656
2L-6S		MI	9708	4126	16569	2904	17723	2337	18080	1887	18141	1147	21890	550	18584
12-#14	3.01	MA	12860	4126	21863	2939	24194	2376	25522	1917	27149	1176	32809	878	24571
3L-5S		MI	10151	4126	17326	2910	18749	2347	19252	1877	19693	1137	23770	636	19614
12-#14	3.01	MA	12260	4126	20799	2954	22842	2368	23885	1907	25093	1186	30514	751	23788
4E		MI	10615	4126	18126	2917	19779	2337	20479	1867	21386	1147	25790	695	20363
12-#14	3.01	MA	11720	4126	19863	2949	21636	2381	22411	1917	23062	1176	28066	693	22812
5L-3S		MI	11129	4126	19033	2904	20931	2346	21843	1877	23097	1137	27691	817	21066
12-#14	3.01	MA	11205	4126	18978	2944	20435	2373	21003	1927	21198	1186	25780	608	21590
6L-2S		MI	11841	4126	20146	2911	22350	2336	23533	1867	25330	1127	30603	945	21118
12-#18	5.36	MA	13714	4871	24922	3400	28011	2685	29950	2079	33171	1090	41256	328	38516
4E		MI	11795	4871	21590	3356	23963	2632	25437	2020	27994	1027	34452	231	32770
12-#18	5.36	MA	12807	4871	23285	3389	25902	2704	27418	2096	29680	1072	37077	224	35719
5L-3S		MI	12660	4871	23168	3336	25931	2650	27766	2037	30915	1009	37683	442	35152
14-#11	2.44	MA	13087	3943	21705	2841	24040	2290	25367	1865	27013	1196	32689	1064	20226
2L-7S		MI	9519	3943	15835	2816	16883	2275	17066	1841	16866	1184	20209	673	15715
14-#11	2.44	MA	12493	3943	20785	2838	22867	2299	23942	1872	25122	1203	30192	975	20199
3L-6S		MI	9826	3943	16401	2807	17574	2267	17927	1847	17940	1177	21471	740	16387
14-#11	2.44	MA	12069	3943	20041	2849	21922	2294	22794	1866	23672	1210	28568	887	20111
4L-5S		MI	10139	3943	16931	2811	18292	2273	18756	1841	19038	1170	22807	800	16697
14-#11	2.44	MA	11687	3943	19387	2846	21078	2303	21762	1873	22240	1203	26839	847	19399
5L-4S		MI	10468	3943	17491	2815	19013	2266	19624	1834	20235	1177	24241	840	17302
14-#11	2.44	MA	11323	3943	18769	2843	20239	2299	20776	1881	20926	1210	25221	788	18986
6L-3S		MI	10831	3943	18126	2805	19820	2272	20589	1841	21445	1170	25589	926	17357
14-#11	2.44	MA	10967	3943	18107	2854	19433	2308	19752	1874	19640	1217	23533	699	18183
7L-2S		MI	11336	3943	18907	2810	20816	2264	21784	1834	23025	1163	27657	1015	17363
14-#14	3.52	MA	13438	4285	23175	3039	25867	2448	27553	1961	29831	1161	36340	842	28516
3L-6S		MI	10204	4285	17682	3003	19141	2409	19770	1929	20374	1127	24802	507	21735
14-#14	3.52	MA	12843	4285	22111	3054	24515	2441	25915	1952	27774	1171	34045	715	27554
4L-5S		MI	10643	4285	18439	3010	20167	2419	20942	1919	21926	1117	26683	594	22851
14-#14	3.52	MA	12309	4285	21175	3049	23309	2453	24442	1961	25743	1161	31596	658	26640
5L-4S		MI	11103	4285	19239	3017	21197	2409	22169	1909	23618	1127	28702	652	23545

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis

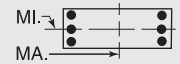


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.52	MA	11799	4285	20290	3044	22108	2445	23034	1971	23880	1171	29310	572	25333
6L-3S		MI	11612	4285	20146	3004	22350	2419	23533	1919	25330	1117	30603	774	24413
14-#14	3.52	MA	11301	4285	19343	3059	20954	2458	21571	1961	22056	1181	27163	473	24080
7L-2S		MI	12318	4285	21258	3011	23768	2409	25223	1909	27562	1107	33516	902	24494
14-#18	6.25	MA	13801	5154	25568	3566	28811	2833	30906	2172	34287	1040	43104	153	42149
5L-4S		MI	12614	5154	23517	3533	26384	2757	28321	2090	31805	987	39384	145	38311
16-#11	2.79	MA	12903	4053	21705	2907	24040	2349	25367	1903	27013	1193	32689	953	22977
3L-7S		MI	9872	4053	16616	2886	17879	2325	18261	1870	18445	1171	22276	646	17959
16-#11	2.79	MA	12482	4053	20961	2918	23094	2344	24219	1897	25563	1200	31065	864	22859
4L-6S		MI	10176	4053	17182	2876	18569	2317	19123	1877	19519	1164	23538	712	18598
16-#11	2.79	MA	12103	4053	20306	2915	22251	2354	23187	1904	24131	1193	29336	824	22084
5E		MI	10488	4053	17712	2880	19287	2323	19952	1870	20617	1157	24875	772	18974
16-#11	2.79	MA	11742	4053	19688	2912	21412	2349	22201	1912	22817	1200	27718	765	21652
6L-4S		MI	10814	4053	18272	2884	20009	2316	20820	1863	21814	1164	26309	812	19570
16-#11	2.79	MA	11389	4053	19026	2923	20605	2358	21176	1905	21530	1207	26030	677	20838
7L-3S		MI	11175	4053	18907	2875	20816	2322	21784	1870	23025	1157	27657	898	19722
16-#11	2.79	MA	11041	4053	18419	2920	19792	2354	20209	1913	20260	1214	24416	630	20071
8L-2S		MI	11677	4053	19688	2879	21812	2314	22980	1863	24604	1151	29724	987	19746
16-#14	4.02	MA	13421	4445	23423	3153	26188	2513	27946	1996	30456	1155	37575	680	31338
4L-6S		MI	10695	4445	18794	3103	20559	2481	21460	1971	22606	1108	27714	465	24901
16-#14	4.02	MA	12892	4445	22487	3149	24981	2525	26472	2006	28425	1145	35127	623	30477
5E		MI	11130	4445	19551	3110	21585	2491	22632	1961	24158	1098	29595	551	26096
16-#14	4.02	MA	12387	4445	21602	3144	23781	2518	25064	2016	26561	1155	32841	537	29090
6L-4S		MI	11586	4445	20351	3117	22616	2481	23859	1951	25851	1108	31615	609	26743
16-#14	4.02	MA	11894	4445	20655	3159	22627	2530	23601	2006	24737	1165	30693	438	27782
7L-3S		MI	12092	4445	21258	3104	23768	2491	25223	1961	27562	1098	33516	732	27754
18-#11	3.13	MA	12893	4164	21880	2987	24266	2395	25644	1928	27453	1190	33563	841	25510
4L-7S		MI	10222	4164	17397	2955	18875	2375	19457	1900	20024	1159	24344	618	20210
18-#11	3.13	MA	12517	4164	21226	2984	23423	2404	24612	1935	26021	1183	31833	801	24776
5L-6S		MI	10525	4164	17963	2945	19565	2367	20318	1907	21098	1152	25606	685	20819
18-#11	3.13	MA	12158	4164	20607	2981	22584	2399	23626	1943	24707	1190	30215	742	24280
6L-5S		MI	10834	4164	18493	2949	20283	2373	21147	1900	22196	1145	26943	745	21257
18-#11	3.13	MA	11808	4164	19946	2992	21778	2408	22601	1936	23421	1197	28527	654	23499
7L-4S		MI	11158	4164	19053	2953	21005	2366	22015	1893	23393	1152	28377	785	21817
18-#11	3.13	MA	11462	4164	19338	2989	20964	2404	21634	1944	22151	1204	26913	607	22695
8L-3S		MI	11517	4164	19688	2944	21812	2372	22980	1900	24604	1145	29724	871	22081
18-#14	4.52	MA	13470	4605	23799	3248	26654	2598	28502	2051	31106	1130	38658	587	34323
5L-6S		MI	11182	4605	19907	3203	21978	2554	23150	2012	24839	1089	30627	422	28078
18-#14	4.52	MA	12969	4605	22914	3244	25453	2590	27094	2061	29242	1140	36371	502	32859
6L-5S		MI	11614	4605	20664	3210	23004	2563	24322	2003	26391	1079	32508	508	29277
18-#14	4.52	MA	12481	4605	21967	3259	24300	2602	25632	2051	27418	1150	34224	403	31497
7L-4S		MI	12066	4605	21464	3216	24034	2553	25549	1993	28083	1089	34527	567	29954
20-#11	3.48	MA	12927	4275	22145	3053	24595	2454	26037	1967	27912	1174	34330	778	27473
5L-7S		MI	10570	4275	18178	3024	19871	2425	20652	1930	21604	1147	26412	591	22467
20-#11	3.48	MA	12571	4275	21527	3050	23756	2449	25051	1974	26598	1180	32712	719	26918
6E		MI	10871	4275	18745	3014	20561	2417	21514	1937	22678	1140	27674	657	23048
20-#11	3.48	MA	12223	4275	20865	3061	22950	2458	24026	1968	25312	1187	31024	631	26167
7L-5S		MI	11178	4275	19274	3018	21279	2424	22343	1930	23775	1133	29011	717	23545
20-#11	3.48	MA	11880	4275	20258	3058	22136	2454	23059	1975	24042	1194	29410	584	25326
8L-4S		MI	11500	4275	19834	3023	22001	2416	23211	1923	24972	1140	30445	757	24073
20-#14	5.02	MA	13547	4764	24226	3343	27126	2662	29125	2105	31923	1124	39902	466	36639
6E		MI	11666	4764	21019	3303	23396	2626	24841	2054	27072	1070	33539	379	31267
20-#14	5.02	MA	13063	4764	23279	3358	25972	2675	27662	2095	30100	1134	37754	367	35223
7L-5S		MI	12094	4764	21776	3309	24422	2636	26013	2044	28623	1060	35420	466	32408
22-#11	3.83	MA	12981	4385	22446	3120	24928	2499	26476	2005	28488	1171	35209	696	29562
6L-7S		MI	10916	4385	18959	3093	20866	2475	21848	1960	23183	1134	28480	563	24729

RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

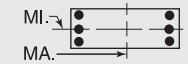
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.83	MA	12636	4385	21785	3131	24122	2509	25451	1999	27202	1177	33521	608	28840
7L-6S		MI	11214	4385	19526	3083	21557	2468	22709	1967	24257	1127	29742	630	25285
22-#11	3.83	MA	12295	4385	21177	3128	23308	2504	24484	2006	25932	1184	31907	561	27963
8L-5S		MI	11520	4385	20055	3088	22275	2474	23539	1960	25354	1121	31078	690	25837
22-#14	5.52	MA	13641	4924	24591	3458	27645	2747	29692	2140	32781	1118	41285	332	38960
7L-6S		MI	12146	4924	22132	3402	24814	2698	26531	2096	29304	1051	36451	337	34465
24-#11	4.18	MA	13045	4496	22704	3200	25294	2559	26876	2030	29093	1168	36019	586	31519
7E		MI	11260	4496	19740	3162	21862	2525	23043	1990	24762	1122	30547	536	26996
24-#11	4.18	MA	12708	4496	22096	3197	24480	2554	25909	2037	27823	1174	34404	539	30607
8L-6S		MI	11556	4496	20307	3153	22553	2518	23905	1996	25836	1115	31809	602	27528

RECTANGULAR TIED COLUMNS 28" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.68	MA	13698	3934	22221	2838	24140	2300	24915	1892	25497	1275	30222	1158	15784
2E		MI	11143	3934	18230	2784	19532	2249	19947	1838	20224	1226	23701	1089	12684
6-#14	1.42	MA	13416	3845	21465	2805	23276	2279	23945	1886	24280	1304	28702	1204	13554
2L-3S		MI	10207	3845	16538	2749	17541	2248	17609	1852	17145	1272	19775	1020	10993
6-#14	1.42	MA	12484	3845	20053	2801	21476	2292	21757	1897	21374	1314	24862	1076	13591
3L-2S		MI	10939	3845	17650	2756	18960	2238	19300	1843	19378	1262	22687	1148	10932
6-#18	2.52	MA	14789	4217	24681	3015	27276	2429	28704	1970	30503	1246	36798	1092	23310
2L-3S		MI	10736	4217	18230	2947	19532	2392	19947	1926	20224	1204	23701	775	18558
6-#18	2.52	MA	13203	4217	22221	3006	24140	2450	24915	1988	25497	1264	30222	864	23134
3L-2S		MI	11978	4217	20158	2961	21953	2374	22831	1909	24035	1186	28633	1002	18614
8-#11	1.31	MA	13299	3809	21147	2794	22920	2272	23532	1884	23786	1316	28086	1224	12632
2L-4S		MI	9967	3809	15987	2753	16891	2235	16876	1846	16245	1292	18862	998	10276
8-#11	1.31	MA	12645	3809	20158	2792	21660	2281	22000	1892	21739	1323	25373	1135	12664
3E		MI	10339	3809	16623	2743	17698	2241	17840	1853	17456	1285	20209	1084	10248
8-#11	1.31	MA	12178	3809	19360	2803	20645	2277	20768	1886	20169	1330	23606	1046	12651
4L-2S		MI	10854	3809	17404	2747	18694	2233	19036	1846	19035	1278	22277	1173	10205
8-#14	1.89	MA	14054	4005	22877	2905	25075	2351	26133	1931	27186	1290	32543	1172	17880
2L-4S		MI	10181	4005	16743	2862	17807	2311	17936	1884	17666	1263	20786	855	14264
8-#14	1.89	MA	13132	4005	21465	2901	23276	2364	23945	1942	24280	1300	28702	1044	17872
3E		MI	10706	4005	17650	2849	18960	2321	19300	1894	19378	1253	22687	977	14394
8-#14	1.89	MA	12474	4005	20323	2917	21824	2358	22183	1933	22051	1310	26204	916	17695
4L-2S		MI	11431	4005	18762	2856	20378	2311	20990	1884	21611	1243	25599	1105	14361
8-#18	3.36	MA	15861	4501	27140	3193	30412	2557	32494	2048	35508	1217	43374	1026	30778
2L-4S		MI	10684	4501	18580	3144	19985	2499	20502	1979	21114	1182	25402	478	22049
8-#18	3.36	MA	14298	4501	24681	3183	27276	2578	28704	2066	30503	1235	36798	798	30489
3E		MI	11575	4501	20158	3124	21953	2517	22831	1997	24035	1165	28633	689	24330
8-#18	3.36	MA	13180	4501	22684	3209	24738	2564	25648	2048	26664	1252	32519	574	27588
4L-2S		MI	12801	4501	22086	3139	24374	2499	25715	1979	27846	1147	33565	916	24497
10-#11	1.64	MA	13751	3920	22135	2863	24181	2322	25064	1915	25832	1307	30798	1203	15663
2L-5S		MI	9988	3920	16209	2818	17165	2292	17204	1883	16628	1272	19496	930	12302
10-#11	1.64	MA	13101	3920	21147	2861	22920	2332	23532	1923	23786	1314	28086	1114	15680
3L-4S		MI	10322	3920	16769	2822	17887	2285	18072	1876	17824	1279	20930	970	12648
10-#11	1.64	MA	12638	3920	20348	2872	21906	2328	22300	1917	22216	1321	26319	1025	15635
4L-3S		MI	10692	3920	17404	2812	18694	2291	19036	1883	19035	1272	22277	1057	12646
10-#11	1.64	MA	12222	3920	19647	2870	21001	2337	21193	1926	20666	1314	24446	984	15157
5L-2S		MI	11204	3920	18185	2817	19690	2283	20232	1876	20614	1265	24345	1145	12614
10-#14	2.36	MA	14686	4164	24288	3005	26875	2423	28321	1976	30093	1276	36384	1139	22189
2L-5S		MI	10209	4164	17056	2955	18195	2393	18399	1936	18206	1233	21679	754	16558
10-#14	2.36	MA	13772	4164	22877	3001	25075	2437	26133	1987	27186	1286	32543	1011	22138
3L-4S		MI	10679	4164	17856	2962	19226	2383	19626	1926	19899	1243	23698	812	17397
10-#14	2.36	MA	13120	4164	21735	3017	23624	2430	24371	1978	24957	1296	30045	883	21703
4L-3S		MI	11199	4164	18762	2949	20378	2393	20990	1936	21611	1233	25599	935	17769
10-#14	2.36	MA	12534	4164	20731	3013	22330	2444	22787	1988	22757	1286	27387	825	20498
5L-2S		MI	11918	4164	19875	2956	21796	2383	22680	1926	23843	1223	28512	1063	17771

RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

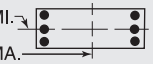
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	4.20	MA	15376	4785	27140	3361	30412	2707	32494	2144	35508	1206	43374	732	37832
3L-4S		MI	11523	4785	20508	3322	22406	2625	23387	2049	24925	1143	30334	392	27520
10-#18	4.20	MA	14274	4785	25144	3387	27874	2693	29438	2126	31669	1223	39095	508	34626
4L-3S		MI	12402	4785	22086	3301	24374	2642	25715	2067	27846	1125	33565	602	30084
10-#18	4.20	MA	13284	4785	23385	3377	25609	2714	26687	2144	27877	1206	34535	406	31985
5L-2S		MI	13614	4785	24013	3316	26795	2625	28600	2049	31657	1107	38497	830	30338
12-#11	1.97	MA	14199	4030	23124	2932	25441	2372	26596	1946	27879	1298	33511	1182	18685
2L-6S		MI	10026	4030	16460	2883	17443	2336	17570	1919	17109	1267	20227	843	14223
12-#11	1.97	MA	13554	4030	22135	2930	24181	2382	25064	1954	25832	1305	30798	1093	18679
3L-5S		MI	10343	4030	16990	2887	18161	2343	18399	1912	18207	1260	21564	903	14561
12-#11	1.97	MA	13094	4030	21337	2942	23166	2378	23832	1949	24262	1312	29031	1005	18612
4E		MI	10674	4030	17550	2891	18882	2335	19267	1905	19404	1267	22997	943	15010
12-#11	1.97	MA	12681	4030	20635	2939	22262	2388	22725	1957	22713	1305	27159	964	18026
5L-3S		MI	11042	4030	18185	2882	19690	2341	20232	1912	20614	1260	24345	1029	15032
12-#11	1.97	MA	12287	4030	19973	2937	21362	2384	21629	1951	21290	1312	25399	905	17527
6L-2S		MI	11550	4030	18966	2886	20686	2334	21427	1905	22194	1253	26413	1118	15013
12-#14	2.84	MA	15311	4324	25700	3105	28675	2496	30508	2021	32999	1262	40224	1107	26478
2L-6S		MI	10261	4324	17411	3048	18588	2456	18917	1988	18887	1224	22710	625	18854
12-#14	2.84	MA	14405	4324	24288	3101	26875	2509	28321	2032	30093	1272	36384	979	26393
3L-5S		MI	10706	4324	18168	3055	19614	2465	20089	1978	20439	1214	24591	711	19782
12-#14	2.84	MA	13760	4324	23146	3116	25424	2503	26559	2022	27864	1282	33886	851	25737
4E		MI	11172	4324	18968	3062	20644	2455	21316	1968	22131	1224	26611	770	20556
12-#14	2.84	MA	13180	4324	22142	3112	24129	2516	24975	2033	25663	1272	31228	793	24608
5L-3S		MI	11687	4324	19875	3049	21796	2465	22680	1978	23843	1214	28512	892	21130
12-#14	2.84	MA	12626	4324	21193	3108	22842	2509	23461	2044	23643	1282	28738	708	23417
6L-2S		MI	12401	4324	20987	3055	23215	2455	24370	1968	26076	1204	31424	1020	21170
12-#18	5.04	MA	15354	5069	27603	3564	31010	2821	33228	2205	36675	1194	45671	443	41704
4E		MI	12352	5069	22435	3499	24827	2750	26271	2120	28735	1103	35266	306	33028
12-#18	5.04	MA	14377	5069	25845	3554	28745	2842	30477	2222	32883	1176	41111	340	38898
5L-3S		MI	13221	5069	24013	3478	26795	2768	28600	2137	31657	1086	38497	516	35507
14-#11	2.29	MA	14643	4141	24112	3002	26701	2422	28128	1977	29926	1290	36223	1161	21700
2L-7S		MI	10072	4141	16675	2962	17748	2394	17904	1942	17614	1262	21033	749	15913
14-#11	2.29	MA	14002	4141	23124	2999	25441	2432	26596	1985	27879	1296	33511	1072	21673
3L-6S		MI	10380	4141	17241	2952	18439	2387	18766	1949	18688	1255	22294	815	16513
14-#11	2.29	MA	13546	4141	22325	3011	24426	2428	25365	1980	26309	1303	31744	984	21585
4L-5S		MI	10695	4141	17771	2956	19157	2393	19595	1942	19786	1248	23631	875	16829
14-#11	2.29	MA	13137	4141	21624	3008	23522	2438	24258	1988	24760	1296	29871	943	20906
5L-4S		MI	11024	4141	18331	2960	19878	2385	20463	1935	20983	1255	25065	915	17365
14-#11	2.29	MA	12745	4141	20961	3006	22623	2434	23161	1982	23337	1303	28111	884	20433
6L-3S		MI	11389	4141	18966	2951	20686	2391	21427	1942	22194	1248	26413	1001	17407
14-#11	2.29	MA	12364	4141	20252	3017	21759	2444	22102	1990	21945	1310	26278	796	19651
7L-2S		MI	11894	4141	19747	2955	21682	2384	22623	1935	23773	1241	28480	1090	17404
14-#14	3.31	MA	15032	4483	25700	3200	28675	2581	30508	2076	32999	1258	40224	947	30642
3L-6S		MI	10757	4483	18524	3148	20006	2528	20607	2030	21120	1205	25622	582	22001
14-#14	3.31	MA	14393	4483	24558	3216	27223	2575	28747	2067	30770	1267	37726	819	29793
4L-5S		MI	11198	4483	19281	3155	21032	2538	21779	2020	22671	1195	27503	669	23017
14-#14	3.31	MA	13819	4483	23554	3212	25929	2588	27163	2078	28569	1258	35068	761	28731
5L-4S		MI	11660	4483	20081	3162	22062	2528	23006	2010	24364	1205	29523	727	23736
14-#14	3.31	MA	13270	4483	22605	3208	24642	2582	25649	2089	26549	1267	32578	675	27452
6L-3S		MI	12172	4483	20987	3148	23215	2538	24370	2020	26076	1195	31424	849	24483
14-#14	3.31	MA	12735	4483	21590	3224	23404	2595	24077	2080	24572	1277	29983	548	26217
7L-2S		MI	12880	4483	22100	3155	24633	2528	26060	2010	28308	1185	34336	977	24549
14-#18	5.88	MA	15457	5352	28305	3732	31881	2971	34267	2301	37888	1147	47687	274	45846
5L-4S		MI	13172	5352	24363	3676	27248	2875	29155	2190	32546	1064	40198	219	38565

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

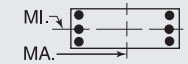
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.62	MA	14447	4251	24112	3068	26701	2482	28128	2016	29926	1287	36223	1052	24662
3L-7S		MI	10426	4251	17456	3031	18744	2444	19100	1972	19193	1249	23100	721	18155
16-#11	2.62	MA	13995	4251	23314	3080	25687	2478	26897	2011	28356	1294	34456	963	24555
4L-6S		MI	10731	4251	18022	3021	19435	2437	19961	1979	20267	1242	24362	788	18807
16-#11	2.62	MA	13588	4251	22613	3077	24782	2488	25790	2019	26806	1287	32584	922	23794
5E		MI	11044	4251	18552	3025	20153	2443	20790	1972	21365	1235	25699	848	19106
16-#11	2.62	MA	13200	4251	21950	3075	23883	2484	24693	2013	25384	1294	30824	863	23344
6L-4S		MI	11371	4251	19112	3030	20874	2435	21658	1965	22562	1242	27133	888	19716
16-#11	2.62	MA	12821	4251	21241	3087	23019	2494	23634	2021	23991	1301	28990	775	22510
7L-3S		MI	11733	4251	19747	3020	21682	2442	22623	1972	23773	1235	28480	974	19775
16-#11	2.62	MA	12448	4251	20590	3084	22147	2490	22597	2030	22532	1294	27242	727	21771
8L-2S		MI	12236	4251	20528	3024	22677	2434	23818	1965	25352	1229	30548	1063	19789
16-#14	3.78	MA	15020	4643	25970	3316	29023	2647	30935	2112	33676	1253	41567	786	33866
4L-6S		MI	11249	4643	19636	3248	21424	2600	22297	2072	23352	1186	28535	540	25163
16-#14	3.78	MA	14451	4643	24966	3312	27729	2661	29351	2123	31475	1243	38909	728	32864
5E		MI	11687	4643	20393	3254	22450	2610	23469	2062	24904	1176	30416	626	26262
16-#14	3.78	MA	13908	4643	24017	3308	26441	2654	27837	2134	29455	1253	36419	643	31502
6L-4S		MI	12145	4643	21193	3261	23481	2600	24696	2052	26597	1186	32435	684	26931
16-#14	3.78	MA	13379	4643	23002	3324	25204	2667	26265	2125	27478	1263	33823	516	30212
7L-3S		MI	12652	4643	22100	3248	24633	2610	26060	2062	28308	1176	34336	807	27828
18-#11	2.95	MA	14440	4362	24303	3149	26947	2528	28429	2042	30403	1285	37168	942	27522
4L-7S		MI	10777	4362	18237	3100	19740	2494	20295	2002	20773	1237	25168	694	20404
18-#11	2.95	MA	14036	4362	23601	3147	26043	2538	27322	2050	28853	1279	35296	901	26690
5L-6S		MI	11080	4362	18803	3090	20431	2487	21157	2009	21847	1230	26430	760	21035
18-#11	2.95	MA	13651	4362	22939	3144	25143	2534	26225	2044	27430	1285	33536	842	26260
6L-5S		MI	11391	4362	19333	3095	21149	2493	21986	2002	22944	1223	27767	820	21388
18-#11	2.95	MA	13275	4362	22230	3156	24279	2544	25167	2053	26038	1292	31702	754	25375
7L-4S		MI	11716	4362	19893	3099	21870	2485	22854	1995	24141	1230	29201	860	21972
18-#11	2.95	MA	12904	4362	21579	3153	23407	2540	24130	2061	24578	1285	29954	706	24598
8L-3S		MI	12076	4362	20528	3089	22677	2492	23818	2002	25352	1223	30548	946	22137
18-#14	4.25	MA	15078	4803	26377	3412	29529	2733	31539	2168	34381	1229	42749	696	37006
5L-6S		MI	11737	4803	20749	3347	22843	2672	23987	2113	25585	1167	31447	497	28337
18-#14	4.25	MA	14540	4803	25428	3408	28241	2726	30025	2179	32361	1239	40260	611	35564
6L-5S		MI	12172	4803	21506	3354	23869	2682	25159	2104	27137	1157	33328	583	29513
18-#14	4.25	MA	14016	4803	24413	3423	27004	2740	28453	2170	30384	1249	37664	483	34219
7L-4S		MI	12626	4803	22306	3361	24899	2672	26386	2094	28829	1167	35348	642	30140
20-#11	3.28	MA	14481	4473	24590	3216	27303	2588	28854	2081	30900	1270	38009	880	29592
5L-7S		MI	11125	4473	19018	3169	20736	2545	21491	2032	22352	1225	27236	666	22659
20-#11	3.28	MA	14099	4473	23927	3213	26404	2584	27757	2076	29477	1277	36249	821	29113
6E		MI	11427	4473	19585	3160	21426	2537	22352	2038	23426	1218	28498	733	23262
20-#11	3.28	MA	13725	4473	23218	3225	25540	2594	26699	2084	28085	1283	34415	733	28247
7L-5S		MI	11735	4473	20114	3164	22144	2543	23182	2032	24523	1211	29835	793	23676
20-#11	3.28	MA	13357	4473	22567	3223	24667	2590	25662	2092	26625	1277	32666	685	27432
8L-4S		MI	12058	4473	20674	3168	22866	2536	24049	2025	25720	1218	31268	833	24226
20-#14	4.73	MA	15167	4962	26840	3507	30041	2799	32213	2224	35267	1225	44100	578	39637
6E		MI	12222	4962	21861	3447	24261	2745	25678	2155	27817	1147	34360	454	31523
20-#14	4.73	MA	14647	4962	25825	3523	28804	2812	30641	2215	33290	1235	41505	451	38238
7L-5S		MI	12653	4962	22618	3454	25287	2755	26850	2145	29369	1137	36240	541	32711
22-#11	3.61	MA	14543	4583	24916	3283	27664	2634	29289	2107	31524	1268	38961	800	31960
6L-7S		MI	11472	4583	19799	3238	21732	2595	22686	2061	23931	1212	29304	639	24920
22-#11	3.61	MA	14173	4583	24207	3294	26800	2644	28231	2115	30131	1274	37127	712	31125
7L-6S		MI	11771	4583	20366	3229	22422	2587	23548	2068	25005	1206	30565	705	25496

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

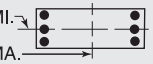
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.61	MA	13807	4583	23556	3292	25928	2640	27194	2123	28672	1268	35379	664	30273
8L-5S		MI	12078	4583	20895	3233	23140	2593	24377	2061	26102	1199	31902	765	25968
22-#14	5.20	MA	15274	5122	27237	3623	30604	2884	32829	2260	36197	1221	45345	419	42268
7L-6S		MI	12704	5122	22974	3547	25679	2817	27368	2197	30050	1128	37272	412	34718
24-#11	3.93	MA	14617	4694	25195	3363	28060	2694	29763	2146	32178	1266	39840	692	34007
7E		MI	11816	4694	20580	3307	22728	2645	23882	2091	25510	1200	31371	611	27185
24-#11	3.93	MA	14254	4694	24544	3361	27188	2690	28726	2154	30718	1259	38091	643	33119
8L-6S		MI	12114	4694	21147	3298	23418	2637	24744	2098	26584	1193	32633	678	27737

RECTANGULAR TIED COLUMNS 28" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.59	MA	15268	4132	24622	2999	26762	2433	27640	2007	28224	1367	33467	1251	16864
2E		MI	11699	4132	19076	2927	20397	2367	20781	1938	20965	1303	24515	1163	12728
6-#14	1.34	MA	14958	4043	23804	2966	25826	2411	26541	1998	26887	1394	31784	1295	14465
2L-3S		MI	10762	4043	17379	2894	18406	2367	18446	1953	17891	1349	20595	1095	11034
6-#14	1.34	MA	13958	4043	22292	2963	23899	2425	24199	2010	23756	1404	27633	1167	14502
3L-2S		MI	11495	4043	18492	2901	19825	2357	20137	1943	20124	1340	23507	1223	10967
6-#18	2.38	MA	16447	4415	27259	3176	30124	2561	31727	2087	33629	1340	40594	1191	24930
2L-3S		MI	11291	4415	19076	3089	20397	2510	20781	2026	20965	1281	24515	849	18640
6-#18	2.38	MA	14742	4415	24622	3168	26762	2584	27640	2105	28224	1358	33467	963	24754
3L-2S		MI	12536	4415	21004	3104	22818	2492	23665	2008	24776	1263	29447	1077	18666
8-#11	1.24	MA	14830	4007	23459	2955	25441	2404	26094	1996	26344	1406	31102	1314	13475
2L-4S		MI	10522	4007	16827	2898	17756	2354	17714	1947	16994	1370	19686	1073	10318
8-#11	1.24	MA	14128	4007	22402	2953	24092	2414	24455	2005	24141	1413	28173	1225	13506
3E		MI	10894	4007	17463	2889	18563	2361	18679	1954	18204	1363	21033	1160	10282
8-#11	1.24	MA	13629	4007	21549	2965	23008	2411	23140	2000	22451	1420	26263	1137	13493
4L-2S		MI	11410	4007	18244	2893	19559	2353	19874	1947	19784	1356	23101	1248	10236
8-#14	1.79	MA	15647	4203	25315	3066	27753	2483	28884	2043	30018	1381	35936	1266	19095
2L-4S		MI	10735	4203	17585	3007	18672	2430	18773	1985	18412	1340	21606	930	14396
8-#14	1.79	MA	14657	4203	23804	3063	25826	2498	26541	2055	26887	1391	31784	1138	19087
3E		MI	11261	4203	18492	2994	19825	2440	20137	1995	20124	1330	23507	1052	14442
8-#14	1.79	MA	13952	4203	22583	3079	24274	2492	24659	2047	24485	1401	29079	1010	18923
4L-2S		MI	11988	4203	19604	3001	21243	2430	21827	1985	22357	1320	26420	1180	14401
8-#18	3.17	MA	17606	4699	29896	3354	33486	2690	35814	2167	39033	1314	47721	1130	32938
2L-4S		MI	11238	4699	19425	3287	20849	2617	21336	2079	21855	1259	26216	553	22311
8-#18	3.17	MA	15925	4699	27259	3346	30124	2712	31727	2185	33629	1332	40594	902	32649
3E		MI	12132	4699	21004	3267	22818	2635	23665	2096	24776	1241	29447	763	24424
8-#18	3.17	MA	14726	4699	25123	3373	27409	2700	28433	2168	29483	1349	35964	675	29767
4L-2S		MI	13361	4699	22931	3282	25238	2617	26549	2079	28587	1224	34379	990	24559
10-#11	1.55	MA	15318	4118	24517	3024	26789	2454	27734	2027	28547	1398	34030	1295	16716
2L-5S		MI	10543	4118	17049	2963	18031	2412	18042	1984	17376	1350	20320	1006	12432
10-#11	1.55	MA	14620	4118	23459	3022	25441	2465	26094	2036	26344	1405	31102	1206	16733
3L-4S		MI	10877	4118	17609	2967	18752	2404	18910	1977	18573	1357	21754	1046	12698
10-#11	1.55	MA	14125	4118	22607	3034	24357	2461	24779	2031	24654	1412	29191	1117	16688
4L-3S		MI	11248	4118	18244	2958	19559	2411	19874	1984	19784	1350	23101	1132	12684
10-#11	1.55	MA	13680	4118	21858	3032	23392	2471	23597	2040	22987	1405	27175	1076	16269
5L-2S		MI	11760	4118	19025	2962	20555	2403	21070	1977	21363	1344	25169	1221	12649
10-#14	2.23	MA	16329	4362	26827	3166	29679	2556	31226	2088	33150	1369	40087	1236	23708
2L-5S		MI	10762	4362	17898	3100	19060	2512	19236	2037	18952	1311	22499	829	16721
10-#14	2.23	MA	15348	4362	25315	3162	27753	2570	28884	2100	30018	1379	35936	1108	23657
3L-4S		MI	11234	4362	18698	3107	20091	2502	20463	2027	20645	1321	24519	887	17589
10-#14	2.23	MA	14650	4362	24095	3179	26201	2564	27001	2092	27616	1388	33231	980	23384
4L-3S		MI	11755	4362	19604	3093	21243	2512	21827	2037	22357	1311	26420	1010	17825
10-#14	2.23	MA	14023	4362	23023	3176	24819	2578	25309	2104	25246	1379	30366	921	22013
5L-2S		MI	12476	4362	20717	3100	22661	2502	23517	2027	24589	1301	29332	1138	17815
10-#18	3.97	MA	17091	4983	29896	3523	33486	2841	35814	2265	39033	1305	47721	842	40532
3L-4S		MI	12078	4983	21353	3465	23270	2742	24221	2149	25666	1220	31148	466	27776

RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

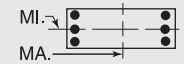
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.97	MA	15909	4983	27760	3550	30771	2828	32520	2248	34888	1323	43091	614	37324
4L-3S		MI	12961	4983	22931	3444	25238	2760	26549	2167	28587	1202	34379	676	30187
10-#18	3.97	MA	14848	4983	25881	3542	28349	2851	29555	2266	30795	1305	38149	513	34695
5L-2S		MI	14176	4983	24859	3459	27659	2742	29434	2149	32398	1184	39311	904	30407
12-#11	1.86	MA	15801	4228	25575	3093	28138	2504	29373	2058	30750	1390	36958	1276	19949
2L-6S		MI	10580	4228	17300	3028	18308	2456	18409	2021	17857	1345	21051	918	14343
12-#11	1.86	MA	15108	4228	24517	3091	26789	2515	27734	2067	28547	1397	34030	1187	19943
3L-5S		MI	10898	4228	17830	3032	19026	2462	19238	2014	18955	1338	22388	978	14689
12-#11	1.86	MA	14617	4228	23665	3103	25705	2511	26418	2062	26857	1404	32119	1098	19876
4E		MI	11230	4228	18390	3037	19748	2455	20106	2007	20152	1345	23821	1018	15065
12-#11	1.86	MA	14175	4228	22916	3101	24740	2522	25236	2071	25190	1397	30103	1056	19341
5L-3S		MI	11598	4228	19025	3027	20555	2461	21070	2014	21363	1338	25169	1104	15074
12-#11	1.86	MA	13754	4228	22209	3100	23781	2518	24066	2066	23658	1404	28202	998	18775
6L-2S		MI	12108	4228	19806	3031	21551	2453	22266	2007	22942	1331	27237	1193	15050
12-#14	2.68	MA	17004	4522	28338	3265	31606	2628	33569	2133	36281	1356	44238	1206	28301
2L-6S		MI	10814	4522	18253	3193	19453	2574	19754	2089	19633	1302	23531	700	19116
12-#14	2.68	MA	16031	4522	26827	3262	29679	2642	31226	2145	33150	1366	40087	1078	28216
3L-5S		MI	11260	4522	19010	3200	20479	2584	20926	2079	21185	1292	25412	786	19943
12-#14	2.68	MA	15340	4522	25606	3279	28128	2637	29344	2137	30748	1376	37382	950	27707
4E		MI	11728	4522	19810	3206	21509	2574	22153	2069	22877	1302	27431	845	20744
12-#14	2.68	MA	14720	4522	24534	3275	26746	2651	27652	2149	28377	1366	34517	891	26418
5L-3S		MI	12245	4522	20717	3193	22661	2584	23517	2079	24589	1292	29332	967	21192
12-#14	2.68	MA	14127	4522	23521	3272	25371	2645	25976	2141	26200	1376	31824	806	25271
6L-2S		MI	12960	4522	21829	3200	24080	2574	25207	2069	26822	1282	32244	1095	21216
12-#18	4.76	MA	17075	5267	30397	3728	34133	2957	36607	2328	40293	1296	50218	554	44921
4E		MI	12909	5267	23281	3642	25691	2867	27105	2219	29477	1180	36080	380	33279
12-#18	4.76	MA	16030	5267	28518	3720	31711	2980	33642	2346	36200	1278	45276	452	42128
5L-3S		MI	13781	5267	24859	3621	27659	2885	29434	2237	32398	1162	39311	590	35854
12-#18	4.76	MA	15032	5267	26741	3712	29301	2967	30809	2364	32442	1296	40658	300	39154
6L-2S		MI	14983	5267	26787	3636	30080	2867	32318	2219	36209	1145	44243	818	36233
14-#11	2.17	MA	16280	4339	26633	3162	29486	2554	31012	2090	32953	1382	39886	1257	23174
2L-7S		MI	10626	4339	17515	3107	18614	2514	18743	2044	18363	1340	21856	824	16105
14-#11	2.17	MA	15592	4339	25575	3161	28138	2565	29373	2098	30750	1389	36958	1168	23147
3L-6S		MI	10934	4339	18081	3097	19304	2506	19604	2051	19437	1333	23118	891	16634
14-#11	2.17	MA	15104	4339	24722	3172	27054	2561	28057	2093	29060	1396	35047	1079	23059
4L-5S		MI	11250	4339	18611	3102	20022	2512	20433	2044	20534	1326	24455	951	16957
14-#11	2.17	MA	14666	4339	23974	3171	26089	2572	26876	2102	27393	1389	33031	1037	22424
5L-4S		MI	11580	4339	19171	3106	20744	2505	21301	2037	21731	1333	25889	991	17425
14-#11	2.17	MA	14248	4339	23267	3169	25129	2568	25705	2097	25861	1396	31130	978	21887
6L-3S		MI	11946	4339	19806	3096	21551	2511	22266	2044	22942	1326	27237	1077	17457
14-#11	2.17	MA	13840	4339	22510	3181	24207	2579	24576	2106	24362	1403	29149	891	21137
7L-2S		MI	12453	4339	20587	3100	22547	2503	23461	2037	24521	1319	29304	1166	17444
14-#14	3.13	MA	16708	4681	28338	3362	31606	2715	33569	2190	36281	1353	44238	1048	32768
3L-6S		MI	11311	4681	19366	3292	20871	2647	21444	2131	21866	1283	26443	657	22260
14-#14	3.13	MA	16023	4681	27118	3378	30055	2709	31686	2182	33879	1363	41533	920	32053
4L-5S		MI	11754	4681	20123	3299	21897	2657	22616	2121	23417	1273	28324	744	23178
14-#14	3.13	MA	15409	4681	26046	3375	28673	2723	29994	2194	31509	1353	38669	861	30836
5L-4S		MI	12217	4681	20923	3306	22927	2647	23843	2111	25110	1283	30343	802	23921
14-#14	3.13	MA	14823	4681	25033	3372	27298	2717	28318	2186	29332	1363	35975	776	29599
6L-3S		MI	12730	4681	21829	3293	24080	2657	25207	2121	26822	1273	32244	924	24549
14-#14	3.13	MA	14250	4681	23949	3388	25978	2732	26700	2198	27201	1373	33168	649	28323
7L-2S		MI	13441	4681	22942	3300	25498	2647	26897	2111	29054	1263	35157	1052	24603
14-#18	5.56	MA	17196	5550	31155	3897	35073	3108	37729	2425	41604	1252	52402	391	49595
5L-4S		MI	13731	5550	25209	3819	28112	2993	29989	2290	33288	1141	41012	294	38813

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	5.56	MA	16212	5550	29378	3889	32663	3096	34896	2444	37847	1269	47785	239	46535
6L-3S		MI	14594	5550	26787	3799	30080	3010	32318	2307	36209	1123	44243	504	41193
16-#11	2.48	MA	16072	4449	26633	3230	29486	2615	31012	2129	32953	1381	39886	1149	26347
3L-7S		MI	10980	4449	18296	3176	19610	2564	19938	2073	19942	1327	23924	797	18344
16-#11	2.48	MA	15588	4449	25780	3242	28402	2612	29697	2125	31263	1388	37975	1060	26239
4L-6S		MI	11286	4449	18862	3167	20300	2556	20800	2080	21016	1320	25186	863	18929
16-#11	2.48	MA	15153	4449	25031	3240	27437	2622	28515	2133	29595	1381	35959	1018	25516
5E		MI	11600	4449	19392	3171	21018	2562	21629	2073	22113	1314	26523	923	19233
16-#11	2.48	MA	14738	4449	24325	3238	26478	2618	27345	2128	28064	1388	34058	959	25005
6L-4S		MI	11928	4449	19952	3175	21739	2555	22497	2067	23310	1320	27957	963	19779
16-#11	2.48	MA	14333	4449	23568	3250	25556	2629	26215	2137	26565	1394	32078	871	24199
7L-3S		MI	12291	4449	20587	3165	22547	2561	23461	2073	24521	1314	29304	1049	19826
16-#11	2.48	MA	13934	4449	22874	3248	24625	2625	25109	2146	24995	1388	30195	823	23497
8L-2S		MI	12795	4449	21368	3169	23543	2553	24657	2067	26100	1307	31372	1138	19831
16-#14	3.57	MA	16700	4841	28629	3478	31982	2781	34029	2227	37010	1350	45684	890	36417
4L-6S		MI	11804	4841	20478	3392	22289	2719	23134	2173	24098	1263	29355	615	25418
16-#14	3.57	MA	16091	4841	27557	3475	30600	2795	32337	2239	34640	1340	42820	831	35265
5E		MI	12243	4841	21235	3399	23315	2729	24306	2163	25650	1253	31236	701	26422
16-#14	3.57	MA	15511	4841	26544	3472	29225	2790	30661	2231	32463	1350	40126	746	33942
6L-4S		MI	12703	4841	22035	3406	24346	2719	25533	2153	27342	1263	33256	760	27114
16-#14	3.57	MA	14944	4841	25461	3488	27905	2804	29043	2242	30333	1360	37319	619	32682
7L-3S		MI	13212	4841	22942	3393	25498	2729	26897	2163	29054	1253	35157	882	27899
16-#14	3.57	MA	14386	4841	24466	3485	26572	2798	27458	2254	28100	1350	34644	550	30947
8L-2S		MI	13917	4841	24054	3400	26916	2719	28587	2153	31287	1243	38069	1010	27977
16-#18	6.35	MA	17377	5834	32015	4066	36025	3224	38983	2523	43252	1243	54912	178	53943
6L-4S		MI	14545	5834	27136	3996	30533	3118	32873	2360	37099	1101	45944	207	44371
18-#11	2.79	MA	16067	4560	26838	3311	29751	2662	31336	2156	33465	1380	40903	1041	29417
4L-7S		MI	11331	4560	19077	3245	20605	2614	21134	2103	21521	1315	25992	769	20592
18-#11	2.79	MA	15636	4560	26089	3309	28786	2672	30154	2164	31798	1373	38887	999	28616
5L-6S		MI	11635	4560	19643	3236	21296	2606	21995	2110	22595	1308	27254	836	21227
18-#11	2.79	MA	15224	4560	25382	3307	27826	2669	28984	2159	30267	1380	36986	940	28126
6L-5S		MI	11947	4560	20173	3240	22014	2613	22824	2103	23692	1301	28591	896	21515
18-#11	2.79	MA	14822	4560	24626	3319	26904	2679	27854	2168	28768	1386	35006	852	27268
7L-4S		MI	12273	4560	20733	3244	22735	2605	23692	2096	24889	1308	30025	936	22122
18-#11	2.79	MA	14426	4560	23932	3317	25974	2676	26748	2177	27198	1380	33123	803	26527
8L-3S		MI	12635	4560	21368	3234	23543	2611	24657	2103	26100	1301	31372	1022	22192
18-#11	2.79	MA	14034	4560	23197	3329	25064	2686	25604	2172	25714	1386	31281	747	25526
9L-2S		MI	13136	4560	22149	3239	24539	2604	25852	2096	27679	1294	33440	1111	22214
18-#14	4.02	MA	16768	5001	29069	3575	32527	2868	34679	2283	37771	1328	46971	801	39703
5L-6S		MI	12293	5001	21591	3492	23708	2791	24825	2214	26331	1244	32268	572	28589
18-#14	4.02	MA	16193	5001	28056	3571	31152	2862	33003	2275	35594	1338	44277	716	38297
6L-5S		MI	12729	5001	22348	3499	24734	2801	25996	2205	27883	1234	34149	658	29673
18-#14	4.02	MA	15631	5001	26972	3588	29832	2876	31385	2287	33464	1347	41471	589	36983
7L-4S		MI	13185	5001	23148	3506	25764	2791	27223	2195	29575	1244	36168	717	30321
18-#14	4.02	MA	15078	5001	25977	3585	28499	2871	29800	2299	31231	1338	38796	520	35300
8L-3S		MI	13691	5001	24054	3492	26916	2801	28587	2205	31287	1234	38069	839	31243
20-#11	3.10	MA	16116	4671	27147	3378	30134	2722	31794	2196	34001	1365	41815	980	31722
5L-7S		MI	11680	4671	19858	3315	21601	2664	22329	2133	23100	1303	28060	742	22845
20-#11	3.10	MA	15707	4671	26440	3376	29175	2719	30623	2191	32470	1371	39914	921	31252
6E		MI	11983	4671	20424	3305	22292	2657	23191	2140	24174	1296	29322	808	23470
20-#11	3.10	MA	15308	4671	25684	3388	28253	2729	29494	2199	30971	1378	37934	833	30344
7L-5S		MI	12293	4671	20954	3309	23010	2663	24020	2133	25271	1289	30659	868	23802
20-#11	3.10	MA	14915	4671	24989	3386	27322	2726	28387	2208	29400	1371	36051	784	29565
8L-4S		MI	12617	4671	21514	3313	23731	2655	24888	2126	26468	1296	32092	908	24375
20-#11	3.10	MA	14525	4671	24255	3398	26413	2736	27243	2203	27917	1378	34209	728	28591
9L-3S		MI	12976	4671	22149	3304	24539	2661	25852	2133	27679	1289	33440	994	24553
20-#14	4.46	MA	16869	5160	29567	3671	33079	2934	35346	2320	38726	1325	48429	687	42664
6E		MI	12779	5160	22703	3592	25126	2864	26515	2256	28563	1225	35180	529	31772

RECTANGULAR TIED COLUMNS 28" x 36"

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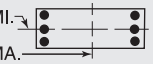


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	4.46	MA	16312	5160	28484	3688	31759	2949	33728	2332	36595	1335	45622	560	41296
7L-5S		MI	13211	5160	23460	3599	26152	2874	27687	2246	30115	1215	37061	616	32931
20-#14	4.46	MA	15764	5160	27489	3684	30426	2943	32143	2344	34362	1325	42947	490	39662
8L-4S		MI	13664	5160	24260	3605	27182	2864	28913	2236	31808	1225	39080	674	33539
22-#11	3.40	MA	16186	4781	27498	3445	30523	2769	32263	2222	34673	1363	42842	902	34381
6L-7S		MI	12027	4781	20639	3384	22597	2714	23525	2163	24679	1290	30127	714	25105
22-#11	3.40	MA	15790	4781	26741	3457	29601	2779	31133	2231	33174	1370	40862	814	33426
7L-6S		MI	12328	4781	21206	3374	23288	2707	24386	2170	25753	1284	31389	781	25702
22-#11	3.40	MA	15400	4781	26047	3455	28671	2776	30027	2239	31603	1363	38979	765	32609
8L-5S		MI	12636	4781	21735	3378	24006	2713	25216	2163	26851	1277	32726	840	26094
22-#11	3.40	MA	15013	4781	25312	3467	27761	2786	28882	2234	30120	1370	37137	708	31662
9L-4S		MI	12958	4781	22295	3382	24727	2705	26083	2156	28047	1284	34160	881	26636
22-#14	4.91	MA	16988	5320	29995	3787	33686	3021	36070	2377	39727	1322	49773	530	45619
7L-6S		MI	13261	5320	23816	3691	26544	2936	28205	2298	30796	1206	38092	487	34964
22-#14	4.91	MA	16445	5320	29000	3784	32353	3015	34485	2389	37494	1312	47098	460	44033
8L-5S		MI	13690	5320	24573	3698	27570	2946	29377	2288	32348	1196	39973	573	36144
24-#11	3.71	MA	16269	4892	27799	3526	30950	2829	32772	2262	35377	1362	43790	795	36513
7E		MI	12372	4892	21420	3453	23593	2764	24720	2193	26258	1278	32195	687	27369
24-#11	3.71	MA	15881	4892	27105	3524	30019	2826	31666	2270	33806	1355	41907	746	35660
8L-6S		MI	12671	4892	21987	3443	24283	2757	25582	2200	27332	1271	33457	753	27941
24-#11	3.71	MA	15497	4892	26370	3536	29110	2836	30522	2265	32323	1362	40065	689	34737
9L-5S		MI	12978	4892	22516	3447	25002	2763	26411	2193	28430	1264	34794	813	28389
24-#14	5.36	MA	17120	5479	30512	3884	34280	3088	36828	2434	40625	1299	51249	431	48411
8L-6S		MI	13740	5479	24928	3791	27963	3008	29895	2340	33029	1187	41005	444	38165

RECTANGULAR TIED COLUMNS 28" x 38"

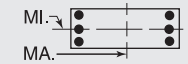
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.50	MA	16917	4330	27135	3160	29507	2565	30444	2120	31064	1458	36841	1344	17944
2E		MI	12255	4330	19921	3070	21261	2484	21615	2038	21707	1379	25329	1237	12771
6-#14	1.27	MA	16580	4241	26255	3127	28499	2543	29261	2111	29607	1484	34994	1386	15377
2L-3S		MI	11317	4241	18221	3039	19271	2486	19284	2054	18637	1427	21416	1170	11072
6-#14	1.27	MA	15511	4241	24644	3124	26444	2558	26764	2124	26250	1494	30532	1258	15413
3L-2S		MI	12051	4241	19334	3045	20690	2476	20974	2044	20870	1417	24328	1298	11002
6-#18	2.26	MA	18186	4613	29950	3337	33095	2694	34806	2200	36869	1434	44520	1288	26550
2L-3S		MI	11847	4613	19921	3232	21261	2627	21615	2126	21707	1358	25329	923	18717
6-#18	2.26	MA	16361	4613	27135	3330	29507	2718	30444	2220	31064	1451	36841	1060	26374
3L-2S		MI	13094	4613	21849	3247	23682	2609	24499	2108	25518	1340	30261	1151	18718
8-#11	1.17	MA	16441	4205	25885	3116	28084	2536	28779	2109	29015	1496	34245	1404	14317
2L-4S		MI	11076	4205	17667	3044	18621	2474	18553	2049	17742	1448	20510	1149	10357
8-#11	1.17	MA	15691	4205	24758	3114	26648	2547	27033	2118	26656	1502	31101	1315	14349
3E		MI	11450	4205	18303	3034	19429	2480	19517	2056	18953	1441	21857	1235	10315
8-#11	1.17	MA	15159	4205	23851	3127	25495	2544	25634	2114	24846	1509	29046	1226	14336
4L-2S		MI	11966	4205	19084	3038	20425	2472	20713	2049	20532	1434	23925	1324	10267
8-#14	1.69	MA	17321	4401	27866	3227	30553	2616	31758	2156	32963	1472	39456	1358	20310
2L-4S		MI	11289	4401	18427	3151	19537	2549	19610	2086	19158	1418	22427	1005	14463
8-#14	1.69	MA	16262	4401	26255	3224	28499	2631	29261	2168	29607	1482	34994	1230	20302
3E		MI	11817	4401	19334	3138	20690	2558	20974	2096	20870	1408	24328	1127	14487
8-#14	1.69	MA	15510	4401	24957	3241	26848	2626	27257	2161	27032	1492	32082	1102	20138
4L-2S		MI	12545	4401	20446	3145	22108	2548	22664	2086	23102	1398	27240	1255	14440
8-#18	3.01	MA	19433	4897	32764	3514	36683	2822	39168	2280	42673	1409	52198	1232	35098
2L-4S		MI	11791	4897	20271	3430	21713	2735	22171	2179	22596	1336	27030	627	22565

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

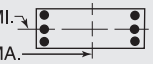


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.01	MA	17633	4897	29950	3508	33095	2846	34806	2299	36869	1427	44520	1004	34809
3E		MI	12688	4897	21849	3410	23682	2752	24499	2196	25518	1318	30261	837	24513
8-#18	3.01	MA	16353	4897	27675	3536	30203	2835	31296	2284	32416	1445	39523	777	31972
4L-2S		MI	13921	4897	23777	3425	26103	2735	27383	2179	29329	1300	35193	1065	24617
10-#11	1.47	MA	16964	4316	27012	3185	29521	2587	30526	2140	31374	1488	37389	1386	17769
2L-5S		MI	11097	4316	17889	3109	18896	2532	18881	2086	18124	1428	21144	1081	12557
10-#11	1.47	MA	16219	4316	25885	3184	28084	2597	28779	2149	29015	1495	34245	1297	17786
3L-4S		MI	11432	4316	18449	3113	19617	2524	19748	2079	19321	1435	22577	1121	12744
10-#11	1.47	MA	15691	4316	24978	3196	26931	2594	27380	2145	27205	1502	32190	1208	17741
4L-3S		MI	11803	4316	19084	3103	20425	2530	20713	2086	20532	1428	23925	1207	12721
10-#11	1.47	MA	15218	4316	24182	3194	25905	2605	26124	2154	25420	1495	30031	1166	17392
5L-2S		MI	12317	4316	19865	3107	21421	2523	21908	2079	22111	1422	25993	1296	12683
10-#14	2.11	MA	18053	4560	29478	3327	32607	2688	34255	2201	36320	1461	43919	1331	25227
2L-5S		MI	11316	4560	18740	3244	19925	2631	20073	2138	19698	1389	23320	904	16878
10-#14	2.11	MA	17004	4560	27866	3324	30553	2703	31758	2213	32963	1471	39456	1203	25175
3L-4S		MI	11789	4560	19540	3251	20956	2621	21300	2128	21391	1399	25339	962	17775
10-#14	2.11	MA	16260	4560	26568	3341	28902	2698	29754	2206	30388	1481	36544	1075	24964
4L-3S		MI	12312	4560	20446	3238	22108	2631	22664	2138	23102	1389	27240	1085	17879
10-#14	2.11	MA	15592	4560	25428	3338	27432	2713	27955	2219	27848	1471	33473	1014	23540
5L-2S		MI	13034	4560	21559	3245	23526	2621	24354	2128	25335	1379	30153	1213	17858
10-#18	3.76	MA	18886	5181	32764	3685	36683	2975	39168	2379	42673	1403	52198	948	43232
3L-4S		MI	12633	5181	22199	3607	24134	2860	25055	2249	26407	1296	31962	540	28025
10-#18	3.76	MA	17625	5181	30489	3714	33791	2964	35658	2364	38221	1421	47201	720	40048
4L-3S		MI	13519	5181	23777	3587	26103	2877	27383	2267	29329	1279	35193	751	30286
10-#18	3.76	MA	16493	5181	28489	3707	31213	2988	32502	2384	33826	1403	41891	617	37453
5L-2S		MI	14738	5181	25705	3602	28524	2860	30268	2249	33139	1261	40125	978	30475
12-#11	1.76	MA	17483	4426	28138	3254	30958	2637	32272	2171	33733	1481	40532	1368	21212
2L-6S		MI	11134	4426	18140	3174	19174	2576	19247	2122	18606	1423	21874	994	14459
12-#11	1.76	MA	16743	4426	27012	3253	29521	2648	30526	2180	31374	1488	37389	1280	21206
3L-5S		MI	11452	4426	18670	3178	19892	2582	20076	2115	19703	1416	23211	1054	14813
12-#11	1.76	MA	16219	4426	26105	3265	28368	2645	29127	2176	29564	1495	35334	1191	21139
4E		MI	11785	4426	19230	3182	20613	2574	20944	2109	20900	1423	24645	1094	15117
12-#11	1.76	MA	15749	4426	25309	3264	27342	2655	27870	2185	27779	1488	33175	1148	20666
5L-3S		MI	12154	4426	19865	3172	21421	2580	21908	2115	22111	1416	25993	1180	15115
12-#11	1.76	MA	15301	4426	24558	3262	26322	2653	26626	2181	26139	1495	31132	1090	20030
6L-2S		MI	12665	4426	20646	3176	22416	2573	23104	2109	23690	1409	28060	1269	15087
12-#14	2.54	MA	18778	4720	31089	3426	34661	2760	36752	2246	39677	1449	48381	1303	30123
2L-6S		MI	11367	4720	19095	3337	20318	2693	20591	2190	20379	1379	24351	775	19372
12-#14	2.54	MA	17737	4720	29478	3424	32607	2775	34255	2258	36320	1459	43919	1175	30038
3L-5S		MI	11815	4720	19852	3344	21344	2703	21763	2180	21931	1369	26232	861	20100
12-#14	2.54	MA	17001	4720	28179	3441	30956	2770	32252	2251	33745	1469	41006	1047	29698
4E		MI	12284	4720	20652	3351	22374	2693	22990	2170	23623	1379	28252	920	20927
12-#14	2.54	MA	16340	4720	27039	3438	29486	2785	30452	2264	31205	1459	37935	987	28240
5L-3S		MI	12802	4720	21559	3338	23526	2703	24354	2180	25335	1369	30153	1042	21251
12-#14	2.54	MA	15709	4720	25962	3435	28024	2781	28669	2257	28871	1469	35038	902	27151
6L-2S		MI	13519	4720	22671	3345	24945	2693	26044	2170	27568	1360	33065	1170	21263
12-#18	4.51	MA	18878	5465	33303	3891	37379	3092	40020	2444	44026	1396	54879	664	48166
4E		MI	13465	5465	24126	3785	26555	2985	27939	2319	30218	1257	36894	454	33524
12-#18	4.51	MA	17763	5465	31303	3884	34801	3117	36864	2463	39631	1379	49570	561	45406
5L-3S		MI	14341	5465	25705	3764	28524	3003	30268	2337	33139	1239	40125	664	36044
12-#18	4.51	MA	16699	5465	29413	3877	32236	3105	33736	2448	35595	1396	44591	409	42248
6L-2S		MI	15548	5465	27632	3779	30944	2985	33152	2319	36950	1221	45057	892	36306
14-#11	2.05	MA	17997	4537	29265	3323	32395	2687	34019	2202	36093	1474	43676	1351	24649
2L-7S		MI	11179	4537	18355	3252	19479	2633	19581	2145	19111	1418	22680	900	16291
14-#11	2.05	MA	17262	4537	28138	3322	30958	2698	32272	2211	33733	1480	40532	1262	24621
3L-6S		MI	11488	4537	18921	3243	20170	2626	20443	2152	20185	1411	23942	966	16750
14-#11	2.05	MA	16742	4537	27232	3334	29805	2695	30873	2207	31923	1487	38478	1173	24534
4L-5S		MI	11805	4537	19451	3247	20888	2632	21272	2145	21282	1404	25279	1026	17080

RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

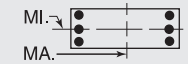
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.05	MA	16275	4537	26436	3333	28779	2706	29617	2216	30138	1480	36319	1131	23952
5L-4S		MI	12136	4537	20011	3251	21609	2624	22140	2138	22479	1411	26713	1066	17481
14-#11	2.05	MA	15831	4537	25685	3331	27759	2703	28373	2212	28498	1487	34276	1072	23348
6L-3S		MI	12503	4537	20646	3241	22416	2631	23104	2145	23690	1404	28060	1152	17501
14-#11	2.05	MA	15396	4537	24881	3343	26779	2713	27172	2221	26893	1494	32149	984	22638
7L-2S		MI	13011	4537	21427	3246	23412	2623	24300	2138	25269	1397	30128	1241	17483
14-#14	2.96	MA	18464	4879	31089	3523	34661	2848	36752	2303	39677	1448	48381	1148	34894
3L-6S		MI	11865	4879	20208	3437	21736	2766	22281	2232	22612	1360	27264	732	22512
14-#14	2.96	MA	17734	4879	29790	3541	33010	2843	34749	2296	37102	1458	45468	1020	34334
4L-5S		MI	12309	4879	20965	3444	22762	2776	23453	2222	24163	1350	29145	819	23333
14-#14	2.96	MA	17079	4879	28650	3538	31540	2858	32949	2309	34561	1448	42397	959	32953
5L-4S		MI	12774	4879	21765	3451	23792	2766	24680	2212	25856	1360	31164	877	24101
14-#14	2.96	MA	16455	4879	27573	3535	30078	2853	31166	2302	32228	1458	39500	875	31773
6L-3S		MI	13289	4879	22671	3438	24945	2775	26044	2222	27568	1350	33065	999	24613
14-#14	2.96	MA	15845	4879	26421	3552	28674	2868	29446	2314	29944	1467	36481	748	30343
7L-2S		MI	14001	4879	23784	3444	26363	2765	27734	2212	29800	1340	35977	1127	24655
14-#18	5.26	MA	19016	5748	34118	4061	38389	3245	41225	2543	45435	1354	57248	504	53395
5L-4S		MI	14289	5748	26054	3962	28976	3110	30823	2390	34029	1217	41826	368	39055
14-#18	5.26	MA	17967	5748	32228	4055	35824	3234	38098	2528	41400	1372	52269	353	50298
6L-3S		MI	15156	5748	27632	3942	30944	3128	33152	2407	36950	1200	45057	578	41525
16-#11	2.35	MA	17777	4647	29265	3391	32395	2748	34019	2242	36093	1473	43676	1244	28031
3L-7S		MI	11534	4647	19136	3322	20475	2683	20777	2175	20690	1405	24748	872	18528
16-#11	2.35	MA	17261	4647	28359	3403	31241	2745	32620	2238	34283	1480	41622	1155	27924
4L-6S		MI	11841	4647	19702	3312	21165	2676	21638	2182	21764	1398	26010	939	19046
16-#11	2.35	MA	16798	4647	27563	3402	30215	2756	31363	2247	32498	1473	39463	1113	27248
5E		MI	12155	4647	20232	3316	21883	2682	22467	2175	22861	1392	27347	999	19356
16-#11	2.35	MA	16356	4647	26812	3400	29195	2753	30119	2243	30857	1480	37420	1054	26672
6L-4S		MI	12484	4647	20792	3320	22605	2674	23335	2168	24058	1398	28781	1039	19839
16-#11	2.35	MA	15925	4647	26008	3413	28216	2764	28919	2252	29252	1487	35293	966	25904
7L-3S		MI	12849	4647	21427	3311	23412	2681	24300	2175	25269	1392	30128	1125	19876
16-#11	2.35	MA	15500	4647	25270	3411	27227	2761	27743	2262	27570	1480	33276	917	25128
8L-2S		MI	13354	4647	22208	3315	24408	2673	25495	2168	26848	1385	32196	1214	19873
16-#14	3.38	MA	18461	5039	31401	3640	35064	2915	37246	2341	40458	1446	49931	992	38989
4L-6S		MI	12358	5039	21320	3537	23154	2838	23971	2274	24844	1341	30176	690	25666
16-#14	3.38	MA	17812	5039	30261	3638	33594	2930	35446	2354	37918	1436	46860	932	37678
5E		MI	12799	5039	22077	3544	24180	2848	25143	2264	26396	1331	32057	776	26577
16-#14	3.38	MA	17194	5039	29185	3635	32133	2925	33663	2347	35584	1446	43962	847	36409
6L-4S		MI	13261	5039	22877	3550	25211	2838	26370	2254	28088	1341	34076	835	27293
16-#14	3.38	MA	16590	5039	28033	3652	30728	2940	31943	2359	33301	1456	40944	720	35032
7L-3S		MI	13772	5039	23784	3537	26363	2848	27734	2264	29800	1331	35977	957	27967
16-#14	3.38	MA	15995	5039	26975	3649	29311	2935	30258	2372	30908	1446	38075	650	33250
8L-2S		MI	14479	5039	24896	3544	27781	2838	29424	2254	32033	1321	38890	1085	28033
16-#18	6.02	MA	19219	6032	35042	4232	39412	3363	42460	2607	47205	1348	59948	297	58230
6L-4S		MI	15105	6032	27982	4139	31397	3235	33707	2460	37840	1178	46758	281	44609
18-#11	2.64	MA	17776	4758	29485	3472	32678	2795	34366	2269	36642	1473	44765	1138	31313
4L-7S		MI	11885	4758	19917	3391	21471	2734	21972	2205	22269	1393	26816	845	20774
18-#11	2.64	MA	17316	4758	28690	3471	31652	2806	33110	2279	34857	1466	42607	1095	30552
5L-6S		MI	12191	4758	20483	3381	22161	2726	22834	2212	23343	1386	28078	911	21345
18-#11	2.64	MA	16878	4758	27939	3470	30632	2803	31866	2274	33217	1473	40564	1037	30000
6L-5S		MI	12504	4758	21013	3385	22879	2732	23663	2205	24441	1379	29415	971	21637
18-#11	2.64	MA	16450	4758	27135	3482	29652	2814	30665	2284	31611	1480	38436	949	29178
7L-4S		MI	12831	4758	21573	3389	23601	2725	24531	2198	25637	1386	30848	1011	22193
18-#11	2.64	MA	16028	4758	26397	3480	28664	2811	29490	2293	29930	1473	36420	899	28428
8L-3S		MI	13193	4758	22208	3380	24408	2731	25495	2205	26848	1379	32196	1097	22244

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

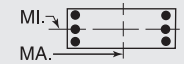


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.64	MA	15610	4758	25617	3493	27697	2822	28273	2289	28341	1480	34441	843	27362
9L-2S		MI	13696	4758	22989	3384	25404	2723	26691	2198	28427	1372	34264	1186	22257
18-#14	3.81	MA	18538	5199	31873	3737	35648	3002	37943	2399	41275	1424	51322	904	42412
5L-6S		MI	12848	5199	22433	3637	24573	2910	25662	2315	27077	1322	33088	647	28835
18-#14	3.81	MA	17926	5199	30796	3735	34187	2997	36161	2391	38941	1434	48424	820	41058
6L-5S		MI	13286	5199	23190	3643	25599	2920	26833	2306	28628	1312	34969	733	29828
18-#14	3.81	MA	17328	5199	29644	3752	32783	3012	34440	2404	36657	1444	45406	693	39731
7L-4S		MI	13744	5199	23989	3650	26629	2910	28060	2296	30321	1322	36989	792	30498
18-#14	3.81	MA	16738	5199	28586	3749	31366	3008	32755	2417	34264	1434	42537	622	37898
8L-3S		MI	14251	5199	24896	3637	27781	2920	29424	2306	32033	1312	38890	914	31315
20-#11	2.93	MA	17831	4869	29817	3540	33089	2856	34856	2310	37216	1459	45751	1078	33863
5L-7S		MI	12235	4869	20698	3460	22467	2784	23168	2235	23848	1381	28884	817	23026
20-#11	2.93	MA	17396	4869	29066	3539	32069	2853	33612	2305	35576	1465	43708	1019	33332
6E		MI	12539	4869	21264	3450	23157	2776	24029	2242	24922	1374	30145	884	23647
20-#11	2.93	MA	16971	4869	28262	3551	31089	2864	32412	2315	33971	1472	41580	931	32458
7L-5S		MI	12850	4869	21794	3454	23875	2782	24858	2235	26020	1367	31482	943	23925
20-#11	2.93	MA	16552	4869	27524	3549	30100	2861	31236	2324	32289	1465	39564	881	31724
8L-4S		MI	13175	4869	22354	3459	24596	2775	25726	2228	27216	1374	32916	984	24520
20-#11	2.93	MA	16137	4869	26744	3562	29134	2872	30020	2320	30700	1472	37584	825	30633
9L-3S		MI	13535	4869	22989	3449	25404	2781	26691	2235	28427	1367	34264	1070	24608
20-#11	2.93	MA	15688	4869	26009	3560	28158	2869	28852	2329	29123	1479	35666	761	29513
10L-2S		MI	14035	4869	23770	3453	26400	2773	27886	2228	30006	1360	36332	1159	24634
20-#14	4.23	MA	18651	5358	32407	3834	36241	3070	38658	2436	42298	1423	52886	792	45719
6E		MI	13335	5358	23545	3736	25991	2983	27352	2357	29309	1303	36001	604	32014
20-#14	4.23	MA	18059	5358	31255	3852	34837	3085	36937	2449	40014	1433	49868	665	44393
7L-5S		MI	13769	5358	24302	3743	27017	2993	28524	2347	30861	1293	37882	691	33085
20-#14	4.23	MA	17474	5358	30198	3849	33420	3080	35252	2462	37621	1423	47000	595	42556
8L-4S		MI	14224	5358	25102	3750	28047	2983	29750	2337	32554	1303	39901	749	33714
22-#11	3.23	MA	17910	4979	30192	3608	33505	2903	35359	2336	37935	1458	46852	1001	36668
6L-7S		MI	12583	4979	21479	3529	23462	2834	24363	2264	25427	1369	30951	790	25284
22-#11	3.23	MA	17488	4979	29389	3620	32526	2914	34158	2346	36330	1465	44724	913	35745
7L-6S		MI	12885	4979	22046	3519	24153	2826	25225	2271	26501	1362	32213	856	25903
22-#11	3.23	MA	17072	4979	28651	3619	31537	2911	32983	2355	34648	1458	42708	864	34973
8L-5S		MI	13194	4979	22575	3524	24871	2832	26054	2264	27599	1355	33550	916	26216
22-#11	3.23	MA	16660	4979	27871	3631	30571	2922	31766	2351	33059	1465	40728	807	33909
9L-4S		MI	13517	4979	23135	3528	25592	2825	26922	2258	28795	1362	34984	956	26780
22-#11	3.23	MA	16212	4979	27136	3629	29595	2919	30598	2360	31482	1472	38810	744	32765
10L-3S		MI	13876	4979	23770	3518	26400	2831	27886	2264	30006	1355	36332	1042	26969
22-#14	4.65	MA	18784	5518	32866	3951	36891	3157	39434	2494	43371	1421	54330	638	49010
7L-6S		MI	13818	5518	24657	3836	27409	3055	29042	2399	31542	1283	38913	562	35204
22-#14	4.65	MA	18205	5518	31809	3949	35474	3152	37749	2507	40978	1411	51462	567	47222
8L-5S		MI	14250	5518	25415	3843	28435	3065	30214	2389	33094	1273	40794	648	36348
24-#11	3.52	MA	18002	5090	30515	3689	33962	2964	35905	2377	38689	1458	47868	896	39037
7E		MI	12929	5090	22260	3598	24458	2884	25559	2294	27006	1356	33019	762	27547
24-#11	3.52	MA	17589	5090	29778	3688	32974	2961	34729	2386	37007	1451	45851	846	38227
8L-6S		MI	13229	5090	22827	3589	25149	2876	26420	2301	28080	1349	34281	829	28140
24-#11	3.52	MA	17179	5090	28997	3700	32008	2972	33513	2382	35419	1458	43872	790	37189
9L-5S		MI	13536	5090	23356	3593	25867	2883	27250	2294	29178	1342	35618	888	28512
24-#11	3.52	MA	16732	5090	28263	3699	31031	2969	32345	2391	33842	1465	41954	726	36022
10L-4S		MI	13858	5090	23916	3597	26588	2875	28117	2287	30375	1349	37052	929	29046
24-#14	5.08	MA	18929	5677	33420	4048	37528	3224	40247	2552	44334	1400	55924	540	51896
8L-6S		MI	14299	5677	25770	3936	28828	3127	30732	2441	33774	1264	41825	519	38403

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

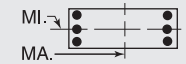
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.43	MA	18647	4528	29762	3321	32375	2697	33371	2232	34017	1548	40343	1436	19024
2E		MI	12811	4528	20767	3213	22125	2602	22449	2138	22448	1456	26143	1311	12813
6-#14	1.21	MA	18282	4439	28819	3288	31295	2676	32103	2223	32440	1573	38331	1475	16288
2L-3S		MI	11872	4439	19063	3183	20136	2605	20121	2155	19383	1505	22236	1245	11110
6-#14	1.21	MA	17144	4439	27108	3286	29114	2691	29451	2237	28858	1583	33557	1347	16325
3L-2S		MI	12606	4439	20176	3190	21555	2595	21811	2145	21616	1495	25149	1373	11035
6-#18	2.14	MA	20005	4811	32753	3498	36189	2826	38007	2312	40222	1526	48574	1384	28170
2L-3S		MI	12402	4811	20767	3375	22125	2745	22449	2226	22448	1434	26143	998	18790
6-#18	2.14	MA	18059	4811	29762	3492	32375	2851	33371	2334	34017	1544	40343	1156	27994
3L-2S		MI	13651	4811	22695	3390	24546	2727	25333	2208	26259	1417	31075	1225	18768
8-#11	1.11	MA	18131	4403	28423	3277	30851	2669	31587	2221	31781	1584	37515	1492	15160
2L-4S		MI	11631	4403	18507	3189	19487	2593	19391	2151	18490	1526	21334	1224	10394
8-#11	1.11	MA	17333	4403	27227	3276	29326	2680	29734	2231	29270	1591	34155	1404	15191
3E		MI	12005	4403	19143	3179	20294	2600	20356	2157	19701	1519	22681	1310	10346
8-#11	1.11	MA	16769	4403	26266	3288	28104	2678	28250	2227	27344	1598	31956	1315	15178
4L-2S		MI	12522	4403	19924	3184	21290	2592	21551	2151	21280	1512	24749	1399	10297
8-#14	1.61	MA	19074	4599	30530	3388	33476	2748	34755	2268	36022	1563	43105	1450	21525
2L-4S		MI	11844	4599	19269	3296	20402	2667	20447	2187	19904	1495	23248	1080	14526
8-#14	1.61	MA	17946	4599	28819	3386	31295	2764	32103	2282	32440	1573	38331	1322	21517
3E		MI	12372	4599	20176	3283	21555	2677	21811	2197	21616	1485	25149	1202	14531
8-#14	1.61	MA	17148	4599	27442	3403	29544	2760	29979	2275	29691	1583	35211	1194	21353
4L-2S		MI	13101	4599	21288	3290	22973	2667	23501	2187	23848	1476	28061	1330	14478
8-#18	2.86	MA	21341	5095	35745	3675	40004	2954	42644	2392	46427	1504	56804	1332	37258
2L-4S		MI	12345	5095	21117	3573	22577	2852	23005	2279	23338	1412	27844	701	22814
8-#18	2.86	MA	19422	5095	32753	3670	36189	2980	38007	2413	40222	1522	48574	1104	36969
3E		MI	13245	5095	22695	3553	24546	2870	25333	2296	26259	1395	31075	911	24598
8-#18	2.86	MA	18060	5095	30339	3699	33120	2970	34282	2399	35462	1539	43208	876	34203
4L-2S		MI	14480	5095	24622	3568	26967	2852	28218	2279	30070	1377	36007	1139	24674
10-#11	1.39	MA	18690	4514	29619	3346	32376	2719	33441	2252	34293	1577	40875	1476	18822
2L-5S		MI	11651	4514	18729	3254	19761	2651	19719	2187	18872	1507	21968	1157	12679
10-#11	1.39	MA	17897	4514	28423	3345	30851	2730	31587	2262	31781	1584	37515	1387	18839
3L-4S		MI	11987	4514	19288	3258	20483	2644	20587	2180	20069	1513	23401	1197	12786
10-#11	1.39	MA	17337	4514	27462	3357	29629	2728	30104	2258	29856	1591	35316	1299	18794
4L-3S		MI	12359	4514	19924	3249	21290	2650	21551	2187	21280	1507	24749	1283	12757
10-#11	1.39	MA	16835	4514	26619	3356	28542	2739	28773	2268	27957	1584	33014	1255	18524
5L-2S		MI	12873	4514	20705	3253	22286	2642	22747	2180	22859	1500	26817	1372	12716
10-#14	2.01	MA	19857	4758	32241	3487	35657	2820	37406	2313	39604	1552	47878	1425	26745
2L-5S		MI	11870	4758	19582	3389	20790	2750	20910	2239	20444	1466	24140	979	17031
10-#14	2.01	MA	18739	4758	30530	3485	33476	2836	34755	2327	36022	1562	43105	1297	26694
3L-4S		MI	12344	4758	20381	3396	21821	2740	22137	2229	22137	1476	26160	1038	17880
10-#14	2.01	MA	17949	4758	29153	3503	31726	2832	32630	2320	33274	1572	39985	1169	26482
4L-3S		MI	12868	4758	21288	3383	22973	2750	23501	2239	23848	1466	28061	1160	17931
10-#14	2.01	MA	17240	4758	27945	3501	30168	2848	30723	2334	30563	1562	36707	1107	25079
5L-2S		MI	13592	4758	22401	3389	24391	2740	25191	2229	26081	1456	30973	1288	17900
10-#18	3.57	MA	20763	5379	35745	3847	40004	3109	42644	2493	46427	1499	56804	1052	45932
3L-4S		MI	13188	5379	23044	3750	24998	2977	25889	2349	27149	1373	32776	615	28268
10-#18	3.57	MA	19421	5379	33331	3877	36934	3099	38919	2479	41667	1517	51439	824	42799
4L-3S		MI	14077	5379	24622	3730	26967	2995	28218	2367	30070	1355	36007	825	30379
10-#18	3.57	MA	18218	5379	31210	3871	34200	3124	35571	2501	36970	1499	45763	719	40257
5L-2S		MI	15300	5379	26550	3745	29388	2977	31102	2349	33881	1338	40939	1052	30541
12-#11	1.67	MA	19244	4624	30815	3415	33901	2769	35295	2283	36804	1570	44235	1460	22476
2L-6S		MI	11688	4624	18980	3319	20039	2695	20086	2224	19354	1501	22698	1069	14571

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis

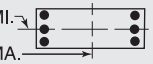


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.67	MA	18457	4624	29619	3414	32376	2780	33441	2293	34293	1577	40875	1371	22470
3L-5S		MI	12007	4624	19510	3323	20757	2701	20915	2217	20451	1494	24035	1129	14934
12-#11	1.67	MA	17901	4624	28658	3427	31154	2778	31958	2289	32367	1584	38676	1282	22403
4E		MI	12341	4624	20070	3327	21478	2694	21782	2210	21648	1501	25469	1169	15166
12-#11	1.67	MA	17402	4624	27815	3426	30067	2789	30627	2299	30468	1577	36374	1239	22001
5L-3S		MI	12710	4624	20705	3318	22286	2700	22747	2217	22859	1494	26817	1255	15154
12-#11	1.67	MA	16927	4624	27020	3424	28987	2787	29309	2295	28724	1585	34189	1181	21292
6L-2S		MI	13222	4624	21486	3322	23282	2692	23943	2210	24438	1487	28884	1344	15123
12-#14	2.41	MA	20632	4918	33952	3587	37839	2893	40058	2358	43186	1542	52652	1399	31946
2L-6S		MI	11920	4918	19937	3482	21183	2812	21428	2291	21125	1457	25172	850	19622
12-#14	2.41	MA	19524	4918	32241	3585	35657	2908	37406	2371	39604	1552	47878	1271	31861
3L-5S		MI	12369	4918	20694	3489	22209	2822	22600	2281	22677	1447	27053	936	20251
12-#14	2.41	MA	18741	4918	30864	3603	33907	2904	35282	2365	36856	1562	44758	1143	31608
4E		MI	12839	4918	21494	3495	23239	2812	23827	2271	24369	1457	29072	995	21106
12-#14	2.41	MA	18039	4918	29656	3601	32349	2920	33375	2379	34145	1552	41481	1082	30074
5L-3S		MI	13360	4918	22401	3482	24391	2822	25191	2281	26081	1447	30973	1117	21308
12-#14	2.41	MA	17370	4918	28516	3599	30800	2916	31486	2372	31655	1562	38379	997	29056
6L-2S		MI	14078	4918	23513	3489	25810	2812	26881	2271	28314	1437	33886	1245	21308
12-#18	4.29	MA	20763	5663	36322	4054	40748	3227	43556	2559	47872	1495	59670	772	51438
4E		MI	14022	5663	24972	3928	27419	3103	28773	2419	30959	1334	37708	528	33764
12-#18	4.29	MA	19577	5663	34201	4048	38014	3253	40208	2580	43175	1477	53993	666	48733
5L-3S		MI	14901	5663	26550	3907	29388	3120	31102	2437	33881	1316	40939	739	36145
12-#18	4.29	MA	18446	5663	32198	4043	35294	3243	36892	2567	38862	1495	48652	515	45212
6L-2S		MI	16111	5663	28478	3922	31809	3103	33986	2419	37692	1298	45871	966	36378
14-#11	1.95	MA	19794	4735	32011	3484	35426	2819	37148	2314	39315	1563	47595	1444	26123
2L-7S		MI	11733	4735	19195	3398	20344	2753	20419	2247	19859	1496	23504	975	16472
14-#11	1.95	MA	19012	4735	30815	3483	33901	2830	35295	2324	36804	1570	44235	1355	26096
3L-6S		MI	12043	4735	19761	3388	21035	2745	21281	2254	20933	1489	24766	1042	16862
14-#11	1.95	MA	18459	4735	29854	3496	32679	2828	33811	2320	34878	1577	42036	1266	26008
4L-5S		MI	12360	4735	20291	3392	21753	2751	22110	2247	22030	1482	26103	1102	17200
14-#11	1.95	MA	17965	4735	29011	3495	31592	2839	32481	2330	32980	1571	39734	1223	25491
5L-4S		MI	12692	4735	20851	3396	22474	2744	22978	2240	23227	1489	27537	1142	17534
14-#11	1.95	MA	17493	4735	28216	3494	30512	2837	31163	2326	31235	1578	37549	1164	24816
6L-3S		MI	13059	4735	21486	3387	23282	2750	23943	2247	24438	1482	28884	1228	17543
14-#11	1.95	MA	17032	4735	27364	3506	29474	2848	29891	2336	29527	1585	35275	1077	24155
7L-2S		MI	13568	4735	22267	3391	24278	2742	25138	2240	26017	1475	30952	1317	17521
14-#14	2.81	MA	20301	5077	33952	3685	37839	2981	40058	2416	43186	1541	52652	1246	37021
3L-6S		MI	12418	5077	21049	3582	22601	2885	23118	2333	23357	1438	28084	807	22757
14-#14	2.81	MA	19525	5077	32575	3703	36088	2976	37934	2410	40438	1551	49532	1118	36636
4L-5S		MI	12864	5077	21807	3588	23627	2894	24290	2323	24909	1428	29965	894	23484
14-#14	2.81	MA	18830	5077	31367	3700	34530	2992	36026	2424	37728	1541	46254	1056	35082
5L-4S		MI	13331	5077	22606	3595	24657	2884	25517	2313	26602	1438	31985	952	24277
14-#14	2.81	MA	18167	5077	30227	3698	32982	2988	34137	2417	35237	1551	43152	972	33972
6L-3S		MI	13847	5077	23513	3582	25810	2894	26881	2323	28314	1428	33886	1074	24675
14-#14	2.81	MA	17520	5077	29006	3716	31494	3004	32315	2431	32800	1561	39922	845	32381
7L-2S		MI	14561	5077	24626	3589	27228	2884	28571	2313	30546	1418	36798	1202	24706
14-#18	5.00	MA	20918	5946	37193	4226	41828	3381	44845	2660	49380	1455	62224	614	57244
5L-4S		MI	14847	5946	26900	4105	29840	3228	31657	2489	34770	1294	42640	442	39290
14-#18	5.00	MA	19802	5946	35189	4220	39108	3372	41528	2646	45067	1473	56883	463	53866
6L-3S		MI	15717	5946	28478	4085	31809	3245	33986	2507	37692	1276	45871	652	41851
16-#11	2.23	MA	19562	4846	32011	3552	35426	2881	37148	2355	39315	1563	47595	1338	29716
3L-7S		MI	12087	4846	19976	3467	21340	2803	21615	2277	21438	1483	25572	948	18707
16-#11	2.23	MA	19014	4846	31050	3565	34204	2878	35665	2352	37390	1570	45396	1250	29609
4L-6S		MI	12396	4846	20542	3457	22031	2795	22477	2283	22512	1477	26834	1014	19158
16-#11	2.23	MA	18523	4846	30207	3564	33117	2889	34334	2361	35491	1564	43094	1206	28991
5E		MI	12711	4846	21072	3461	22749	2802	23306	2277	23610	1470	28171	1074	19475
16-#11	2.23	MA	18054	4846	29412	3563	32036	2887	33016	2358	33746	1571	40909	1148	28346
6L-4S		MI	13041	4846	21632	3466	23470	2794	24174	2270	24806	1477	29605	1114	19896

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

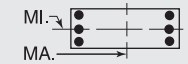
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.23	MA	17597	4846	28561	3575	30999	2898	31745	2367	32039	1578	38635	1060	27625
7L-3S		MI	13406	4846	22267	3456	24278	2800	25138	2277	26017	1470	30952	1200	19925
16-#11	2.23	MA	17146	4846	27780	3574	29952	2896	30500	2377	30250	1571	36484	1010	26765
8L-2S		MI	13913	4846	23048	3460	25273	2793	26334	2270	27596	1463	33020	1289	19913
16-#14	3.21	MA	20302	5237	34286	3802	38269	3049	40585	2455	44020	1541	54305	1092	41582
4L-6S		MI	12913	5237	22162	3681	24019	2957	24808	2375	25590	1419	30997	765	25909
16-#14	3.21	MA	19613	5237	33078	3800	36712	3064	38678	2468	41310	1531	51028	1031	40103
5E		MI	13356	5237	22919	3688	25045	2967	25980	2365	27142	1409	32877	851	26727
16-#14	3.21	MA	18957	5237	31938	3798	35163	3060	36789	2462	38819	1541	47926	946	38902
6L-4S		MI	13818	5237	23719	3695	26076	2957	27207	2355	28834	1419	34897	910	27467
16-#14	3.21	MA	18316	5237	30717	3816	33676	3076	34966	2476	36382	1551	44696	820	37367
7L-3S		MI	14331	5237	24626	3682	27228	2967	28571	2365	30546	1409	36798	1032	28033
16-#14	3.21	MA	17684	5237	29597	3814	32174	3072	33182	2489	33829	1541	41634	748	35581
8L-2S		MI	15040	5237	25738	3689	28646	2957	30261	2355	32779	1399	39710	1160	28087
16-#18	5.71	MA	21142	6230	38181	4397	42923	3500	46165	2726	51272	1451	65114	411	62543
6L-4S		MI	15665	6230	28827	4282	32261	3353	34542	2560	38581	1255	47572	356	44842
18-#11	2.51	MA	19564	4956	32246	3634	35729	2928	37519	2383	39901	1563	48756	1233	33208
4L-7S		MI	12440	4956	20757	3536	22336	2853	22811	2306	23017	1471	27640	920	20951
18-#11	2.51	MA	19076	4956	31403	3633	34642	2940	36188	2393	38002	1557	46454	1190	32499
5L-6S		MI	12746	4956	21323	3526	23027	2846	23672	2313	24091	1464	28902	987	21458
18-#11	2.51	MA	18611	4956	30608	3632	33561	2937	34870	2389	36258	1564	44269	1132	31880
6L-5S		MI	13060	4956	21853	3531	23745	2852	24501	2306	25189	1457	30239	1046	21757
18-#11	2.51	MA	18158	4956	29757	3645	32524	2948	33599	2399	34550	1571	41995	1044	31103
7L-4S		MI	13388	4956	22413	3535	24466	2844	25369	2300	26385	1464	31672	1087	22254
18-#11	2.51	MA	17710	4956	28976	3643	31477	2946	32354	2409	32762	1564	39844	994	30270
8L-3S		MI	13751	4956	23048	3525	25273	2850	26334	2306	27596	1457	33020	1173	22295
18-#11	2.51	MA	17264	4956	28149	3656	30454	2957	31066	2405	31072	1572	37727	937	29219
9L-2S		MI	14255	4956	23829	3529	26269	2843	27529	2300	29175	1450	35088	1262	22300
18-#14	3.62	MA	20390	5397	34789	3900	38893	3137	41330	2513	44892	1520	55801	1005	45134
5L-6S		MI	13404	5397	23274	3781	25438	3029	26499	2416	27823	1399	33909	722	29074
18-#14	3.62	MA	19739	5397	33649	3898	37344	3133	39441	2507	42401	1530	52699	921	43845
6L-5S		MI	13843	5397	24032	3788	26464	3039	27671	2407	29374	1389	35790	808	29978
18-#14	3.62	MA	19104	5397	32428	3916	35857	3148	37618	2521	39964	1540	49469	794	42362
7L-4S		MI	14303	5397	24831	3795	27494	3029	28897	2397	31067	1399	37809	867	30670
18-#14	3.62	MA	18478	5397	31308	3913	34356	3144	35833	2534	37411	1530	46407	722	40526
8L-3S		MI	14812	5397	25738	3782	28646	3039	30261	2407	32779	1389	39710	989	31384
18-#14	3.62	MA	17856	5397	30123	3931	32889	3160	33987	2528	34998	1540	43402	641	38576
9L-2S		MI	15516	5397	26851	3788	30065	3029	31951	2397	35011	1380	42623	1117	31460
20-#11	2.79	MA	19626	5067	32599	3702	36167	2990	38042	2424	40514	1550	49814	1174	36014
5L-7S		MI	12790	5067	21538	3605	23332	2903	24006	2336	24596	1459	29708	893	23202
20-#11	2.79	MA	19164	5067	31804	3701	35086	2987	36724	2420	38769	1557	47629	1115	35420
6E		MI	13095	5067	22104	3596	24022	2896	24868	2343	25670	1452	30969	959	23760
20-#11	2.79	MA	18714	5067	30953	3714	34049	2998	35452	2430	37061	1564	45355	1028	34588
7L-5S		MI	13407	5067	22634	3600	24740	2902	25697	2336	26768	1445	32306	1019	24044
20-#11	2.79	MA	18270	5067	30172	3713	33002	2996	34208	2440	35273	1558	43204	977	33780
8L-4S		MI	13733	5067	23194	3604	25462	2894	26565	2329	27965	1452	33740	1059	24607
20-#11	2.79	MA	17825	5067	29345	3725	31979	3007	32920	2436	33583	1565	41087	921	32695
9L-3S		MI	14094	5067	23829	3594	26269	2901	27529	2336	29175	1445	35088	1145	24662
20-#11	2.79	MA	17331	5067	28568	3724	30945	3005	31682	2446	31906	1572	39035	857	31653
10L-2S		MI	14596	5067	24610	3598	27265	2893	28725	2329	30755	1438	37155	1234	24682
20-#14	4.02	MA	20515	5556	35360	3998	39526	3205	42092	2552	45984	1520	57473	895	48800
6E		MI	13891	5556	24387	3881	26856	3102	28189	2458	30055	1380	36821	679	32251
20-#14	4.02	MA	19886	5556	34139	4015	38038	3221	40270	2565	43546	1529	54243	769	47366
7L-5S		MI	14327	5556	25144	3888	27882	3111	29361	2448	31607	1370	38702	766	33235

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

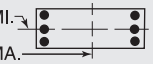
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	4.02	MA	19265	5556	33019	4013	36537	3216	38485	2579	40993	1520	51181	697	45480
8L-4S		MI	14784	5556	25944	3894	28912	3101	30587	2438	33299	1380	40722	824	33885
20-#14	4.02	MA	18644	5556	31834	4031	35070	3232	36638	2573	38580	1529	48176	615	43498
9L-3S		MI	15289	5556	26851	3881	30065	3111	31951	2448	35011	1370	42623	947	34731
22-#11	3.06	MA	19714	5177	33000	3770	36611	3037	38578	2451	41280	1550	50989	1099	38963
6L-7S		MI	13138	5177	22319	3674	24328	2953	25202	2366	26175	1447	31775	865	25458
22-#11	3.06	MA	19266	5177	32149	3783	35574	3049	37306	2461	39573	1557	48715	1011	38080
7L-6S		MI	13441	5177	22886	3665	25018	2946	26063	2373	27249	1440	33037	932	26065
22-#11	3.06	MA	18825	5177	31368	3782	34527	3046	36061	2471	37784	1551	46564	961	37295
8L-5S		MI	13751	5177	23415	3669	25736	2952	26892	2366	28347	1433	34374	991	26335
22-#11	3.06	MA	18381	5177	30541	3794	33504	3057	34773	2467	36094	1558	44447	905	36176
9L-4S		MI	14076	5177	23975	3673	26458	2944	27760	2359	29544	1440	35808	1032	26920
22-#11	3.06	MA	17903	5177	29764	3793	32470	3055	33536	2477	34417	1565	42395	841	35043
10L-3S		MI	14435	5177	24610	3663	27265	2951	28725	2366	30755	1433	37155	1118	27024
22-#14	4.42	MA	20661	5716	35850	4115	40220	3293	42921	2610	47128	1519	59017	743	52378
7L-6S		MI	14376	5716	25499	3981	28274	3174	29879	2500	32288	1361	39734	637	35439
22-#14	4.42	MA	20046	5716	34730	4113	38718	3289	41137	2624	44575	1509	55955	672	50443
8L-5S		MI	14809	5716	26256	3987	29300	3184	31051	2490	33839	1351	41615	723	36498
22-#14	4.42	MA	19426	5716	33545	4131	37251	3304	39290	2618	42163	1519	52949	590	48428
9L-4S		MI	15262	5716	27056	3994	30331	3174	32278	2480	35532	1361	43634	782	37110
24-#11	3.34	MA	19815	5288	33345	3852	37098	3099	39160	2492	42084	1550	52075	995	41577
7E		MI	13485	5288	23100	3744	25324	3004	26397	2396	27754	1434	33843	838	27720
24-#11	3.34	MA	19377	5288	32564	3851	36051	3096	37915	2502	40296	1544	49924	945	40814
8L-6S		MI	13786	5288	23667	3734	26014	2996	27259	2403	28828	1427	35105	904	28334
24-#11	3.34	MA	18934	5288	31737	3864	35028	3108	36627	2498	38606	1551	47807	888	39662
9L-5S		MI	14095	5288	24196	3738	26732	3002	28088	2396	29926	1420	36442	964	28630
24-#11	3.34	MA	18459	5288	30960	3862	33995	3105	35390	2508	36928	1558	45755	825	38506
10L-4S		MI	14417	5288	24756	3742	27454	2995	28956	2389	31123	1427	37876	1004	29186
24-#14	4.82	MA	20820	5875	36441	4213	40900	3361	43788	2669	48157	1498	60728	646	55413
8L-6S		MI	14857	5875	26612	4080	29693	3246	31569	2542	34520	1342	42646	594	38635
24-#14	4.82	MA	20202	5875	35256	4230	39433	3377	41942	2662	45745	1508	57723	565	53365
9L-5S		MI	15287	5875	27369	4087	30719	3256	32741	2532	36072	1332	44527	681	39765

RECTANGULAR TIED COLUMNS 28" x 42"

4-#18	1.36	MA	20456	4726	32501	3482	35367	2830	36420	2345	37083	1639	43972	1527	20104
2E		MI	13367	4726	21613	3356	22989	2719	23283	2238	23189	1533	26957	1386	12854
6-#14	1.15	MA	20063	4637	31496	3449	34214	2808	35068	2336	35368	1662	41795	1565	17199
2L-3S		MI	12427	4637	19905	3328	21001	2724	20958	2256	20129	1582	23057	1320	11145
6-#14	1.15	MA	18856	4637	29685	3447	31906	2824	32262	2350	31566	1672	36710	1437	17236
3L-2S		MI	13162	4637	21018	3334	22420	2714	22648	2246	22362	1572	25969	1448	11068
6-#18	2.04	MA	21905	5009	35670	3659	39407	2958	41331	2425	43689	1618	52756	1478	29790
2L-3S		MI	12957	5009	21613	3518	22989	2862	23283	2326	23189	1511	26957	1072	18860
6-#18	2.04	MA	19838	5009	32501	3654	35367	2985	36420	2447	37083	1636	43972	1251	29614
3L-2S		MI	14209	5009	23540	3533	25410	2845	26167	2308	27000	1493	31889	1299	18817
8-#11	1.06	MA	19901	4601	31073	3438	33741	2801	34518	2333	34633	1670	40912	1581	16002
2L-4S		MI	12185	4601	19347	3334	20352	2713	20230	2252	19238	1604	22158	1300	10429
8-#11	1.06	MA	19055	4601	29808	3437	32128	2799	32557	2344	31976	1678	37336	1492	16034
3E		MI	12560	4601	19983	3325	21159	2719	21194	2259	20449	1597	23505	1386	10377
8-#11	1.06	MA	18458	4601	28793	3450	30837	2811	30990	2340	29942	1686	34993	1403	16021
4L-2S		MI	13077	4601	20764	3329	22155	2712	22390	2252	22028	1590	25573	1475	10326
8-#14	1.53	MA	20907	4797	33307	3549	36523	2880	37874	2381	39170	1652	46881	1541	22740
2L-4S		MI	12398	4797	20111	3440	21267	2786	21284	2288	20650	1573	24068	1155	14585
8-#14	1.53	MA	19710	4797	31496	3547	34214	2897	35068	2395	35368	1662	41795	1413	22732
3E		MI	12928	4797	21018	3427	22420	2796	22648	2298	22362	1563	25969	1277	14573
8-#14	1.53	MA	18865	4797	30041	3565	32364	2893	32822	2389	32452	1672	38468	1285	22568
4L-2S		MI	13658	4797	22130	3434	23838	2786	24338	2288	24594	1553	28882	1405	14516

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

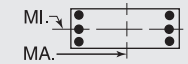
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	2.72	MA	23330	5293	38839	3836	43447	3087	46243	2504	50295	1598	61540	1430	39418
2L-4S		MI	12899	5293	21962	3716	23442	2970	23839	2378	24079	1489	28658	775	23056
8-#18	2.72	MA	21291	5293	35670	3832	39407	3114	41331	2527	43689	1615	52756	1202	39129
3E		MI	13801	5293	23540	3695	25410	2987	26167	2396	27000	1472	31889	985	24678
8-#18	2.72	MA	19847	5293	33116	3862	36160	3105	37391	2515	38622	1633	47022	975	36459
4L-2S		MI	15039	5293	25468	3710	27831	2970	29052	2378	30811	1454	36821	1213	24729
10-#11	1.33	MA	20496	4712	32339	3507	35354	2851	36479	2365	37289	1663	44489	1566	19875
2L-5S		MI	12205	4712	19569	3399	20627	2771	20558	2289	19620	1585	22791	1232	12798
10-#11	1.33	MA	19656	4712	31073	3506	33741	2849	34518	2375	34633	1671	40912	1477	19892
3L-4S		MI	12542	4712	20128	3403	21348	2763	21425	2282	20817	1591	24225	1272	12826
10-#11	1.33	MA	19063	4712	30058	3519	32450	2861	32951	2372	32598	1679	38569	1388	19847
4L-3S		MI	12914	4712	20764	3394	22155	2769	22390	2289	22028	1585	25573	1358	12791
10-#11	1.33	MA	18532	4712	29168	3518	31302	2859	31545	2382	30593	1673	36123	1344	19667
5L-2S		MI	13429	4712	21545	3398	23151	2762	23585	2282	23607	1578	27641	1447	12748
10-#14	1.91	MA	21741	4956	35117	3648	38831	2953	40681	2425	42971	1642	51966	1517	28264
2L-5S		MI	12424	4956	20424	3533	21655	2869	21747	2340	21190	1544	24961	1054	17180
10-#14	1.91	MA	20555	4956	33307	3647	36523	2969	37874	2440	39170	1652	46881	1389	28213
3L-4S		MI	12899	4956	21223	3540	22686	2859	22974	2330	22882	1554	26980	1113	17946
10-#14	1.91	MA	19718	4956	31851	3665	34672	2965	35629	2434	36254	1662	43553	1261	28001
4L-3S		MI	13424	4956	22130	3527	23838	2869	24338	2340	24594	1544	28882	1235	17978
10-#14	1.91	MA	18968	4956	30576	3663	33027	2982	33614	2448	33379	1653	40068	1199	26630
5L-2S		MI	14149	4956	23243	3534	25256	2859	26028	2330	26827	1534	31794	1363	17941
10-#18	3.40	MA	22721	5577	38839	4009	43447	3242	46243	2607	50295	1595	61540	1154	48632
3L-4S		MI	13743	5577	23890	3893	25863	3095	26723	2449	27890	1450	33590	689	28506
10-#18	3.40	MA	21298	5577	36285	4040	40200	3234	42303	2595	45227	1613	55806	926	45576
4L-3S		MI	14635	5577	25468	3873	27831	3113	29052	2466	30811	1432	36821	899	30469
10-#18	3.40	MA	20024	5577	34043	4035	37310	3260	38764	2617	40228	1595	49762	819	43106
5L-2S		MI	15861	5577	27396	3888	30252	3095	31936	2449	34622	1414	41753	1127	30605
12-#11	1.59	MA	21086	4822	33604	3576	36967	2901	38440	2396	39946	1656	48065	1551	23739
2L-6S		MI	12242	4822	19820	3464	20904	2815	20924	2325	20102	1579	23522	1145	14679
12-#11	1.59	MA	20251	4822	32339	3575	35354	2899	36479	2406	37289	1664	44489	1462	23734
3L-5S		MI	12561	4822	20350	3468	21622	2821	21753	2319	21200	1572	24859	1205	15052
12-#11	1.59	MA	19662	4822	31323	3588	34063	2911	34912	2403	35255	1672	42145	1373	23667
4E		MI	12896	4822	20910	3473	22344	2813	22621	2312	22396	1579	26293	1245	15212
12-#11	1.59	MA	19135	4822	30433	3587	32915	2909	33506	2413	33249	1666	39700	1329	23347
5L-3S		MI	13266	4822	21545	3463	23151	2820	23585	2319	23607	1572	27641	1331	15192
12-#11	1.59	MA	18632	4822	29594	3587	31775	2921	32115	2410	31407	1673	37373	1271	22561
6L-2S		MI	13778	4822	22326	3467	24147	2812	24781	2312	25186	1565	29708	1420	15158
12-#14	2.30	MA	22567	5116	36928	3748	41140	3025	43487	2470	46773	1632	57051	1494	33768
2L-6S		MI	12473	5116	20779	3626	22048	2931	22265	2392	21871	1535	25992	925	19865
12-#14	2.30	MA	21391	5116	35117	3746	38831	3041	40681	2485	42971	1642	51966	1366	33683
3L-5S		MI	12924	5116	21536	3633	23074	2941	23437	2382	23423	1525	27873	1011	20398
12-#14	2.30	MA	20562	5116	33662	3765	36981	3038	38435	2479	40056	1652	48638	1238	33430
4E		MI	13395	5116	22336	3640	24104	2931	24664	2372	25115	1535	29893	1070	21280
12-#14	2.30	MA	19819	5116	32386	3763	35335	3054	36420	2493	37181	1643	45153	1175	31920
5L-3S		MI	13917	5116	23243	3627	25256	2941	26028	2382	26827	1525	31794	1192	21363
12-#14	2.30	MA	19111	5116	31182	3761	33700	3050	34425	2488	34540	1653	41847	1091	30948
6L-2S		MI	14637	5116	24355	3634	26675	2931	27718	2372	29059	1515	34706	1320	21352
12-#18	4.08	MA	22728	5861	39454	4217	44241	3362	47214	2674	51833	1592	64590	878	54736
4E		MI	14578	5861	25818	4071	28283	3220	29607	2519	31701	1410	38522	602	33997
12-#18	4.08	MA	21472	5861	37212	4212	41350	3389	43675	2697	46834	1575	58546	770	52106
5L-3S		MI	15460	5861	27396	4050	30252	3238	31936	2537	34622	1393	41753	813	36242
12-#18	4.08	MA	20274	5861	35095	4208	38476	3380	40170	2685	42242	1592	52842	619	48208
6L-2S		MI	16674	5861	29323	4065	32673	3220	34820	2519	38433	1375	46685	1040	36447

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis

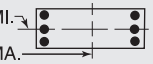


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.86	MA	21672	4933	34869	3645	38580	2952	40400	2427	42602	1649	51641	1535	27597
2L-7S		MI	12286	4933	20034	3543	21210	2872	21258	2348	20607	1574	24328	1051	16648
14-#11	1.86	MA	20841	4933	33604	3644	36967	2949	38440	2437	39946	1657	48065	1447	27570
3L-6S		MI	12597	4933	20601	3533	21900	2865	22120	2355	21681	1567	25590	1117	16970
14-#11	1.86	MA	20257	4933	32588	3657	35676	2961	36873	2434	37911	1665	45722	1358	27482
4L-5S		MI	12915	4933	21131	3538	22618	2871	22949	2348	22779	1560	26927	1177	17317
14-#11	1.86	MA	19734	4933	31699	3657	34528	2959	35467	2444	35906	1659	43276	1314	27040
5L-4S		MI	13248	4933	21691	3542	23340	2863	23816	2341	23975	1567	28361	1217	17585
14-#11	1.86	MA	19235	4933	30859	3656	33388	2971	34076	2441	34064	1667	40949	1256	26290
6L-3S		MI	13616	4933	22326	3532	24147	2870	24781	2348	25186	1560	29708	1303	17584
14-#11	1.86	MA	18748	4933	29961	3669	32293	2969	32733	2451	32261	1674	38528	1168	25687
7L-2S		MI	14126	4933	23107	3536	25143	2862	25977	2341	26765	1553	31776	1392	17559
14-#14	2.68	MA	22218	5275	36928	3846	41140	3114	43487	2530	46773	1632	57051	1342	39147
3L-6S		MI	12972	5275	21891	3726	23466	3003	23955	2434	24103	1515	28905	882	22998
14-#14	2.68	MA	21397	5275	35473	3864	39289	3110	41241	2524	43858	1642	53723	1214	38857
4L-5S		MI	13420	5275	22648	3733	24492	3013	25127	2424	25655	1505	30786	969	23631
14-#14	2.68	MA	20661	5275	34197	3863	37644	3126	39226	2538	40983	1633	50239	1152	37224
5L-4S		MI	13887	5275	23448	3740	25522	3003	26354	2414	27348	1515	32805	1027	24449
14-#14	2.68	MA	19960	5275	32993	3861	36008	3123	37231	2533	38342	1643	46932	1067	36195
6L-3S		MI	14405	5275	24355	3727	26675	3013	27718	2424	29059	1505	34706	1150	24734
14-#14	2.68	MA	19275	5275	31704	3879	34437	3139	35306	2547	35757	1653	43490	941	34437
7L-2S		MI	15120	5275	25468	3733	28093	3003	29408	2414	31292	1496	37619	1278	24752
14-#18	4.76	MA	22901	6144	40381	4390	45390	3517	48587	2777	53440	1554	67330	722	61139
5L-4S		MI	15405	6144	27745	4248	30704	3345	32491	2589	35512	1371	43454	516	39521
14-#18	4.76	MA	21719	6144	38264	4385	42516	3509	45081	2764	48847	1572	61625	571	57389
6L-3S		MI	16278	6144	29323	4227	32673	3363	34820	2607	38433	1353	46685	726	42003
14-#18	4.76	MA	20566	6144	35999	4416	39755	3536	41699	2787	44353	1590	55684	346	53205
7L-2S		MI	17481	6144	31251	4242	35094	3345	37704	2589	42244	1335	51616	954	42272
16-#11	2.12	MA	21427	5044	34869	3713	38580	3000	40400	2468	42602	1650	51641	1432	31401
3L-7S		MI	12641	5044	20816	3612	22206	2923	22453	2378	22186	1562	26396	1023	18881
16-#11	2.12	MA	20847	5044	33854	3726	37289	3011	38833	2465	40568	1658	49298	1343	31294
4L-6S		MI	12950	5044	21382	3603	22896	2915	23315	2385	23260	1555	27658	1090	19266
16-#11	2.12	MA	20327	5044	32964	3726	36141	3009	37428	2475	38562	1652	46852	1299	30743
5E		MI	13267	5044	21912	3607	23614	2921	24144	2378	24358	1548	28995	1149	19591
16-#11	2.12	MA	19832	5044	32124	3725	35001	3021	36037	2472	36720	1660	44526	1241	30026
6L-4S		MI	13597	5044	22472	3611	24335	2914	25012	2371	25554	1555	30429	1190	19951
16-#11	2.12	MA	19349	5044	31226	3738	33906	3019	34694	2482	34917	1667	42104	1153	29362
7L-3S		MI	13963	5044	23107	3601	25143	2920	25977	2378	26765	1548	31776	1276	19969
16-#11	2.12	MA	18872	5044	30402	3737	32800	3030	33380	2493	33029	1661	39819	1102	28413
8L-2S		MI	14471	5044	23888	3605	26139	2912	27172	2371	28344	1541	33844	1365	19953
16-#14	3.06	MA	22224	5435	37283	3964	41598	3182	44048	2569	47660	1632	58809	1190	44195
4L-6S		MI	13468	5435	23004	3826	24884	3076	25645	2476	26336	1496	31817	840	26146
16-#14	3.06	MA	21495	5435	36008	3963	39952	3199	42033	2583	44785	1623	55324	1128	42541
5E		MI	13912	5435	23761	3833	25910	3086	26817	2466	27888	1486	33698	926	26873
16-#14	3.06	MA	20800	5435	34803	3961	38317	3195	40038	2577	42144	1633	52017	1044	41420
6L-4S		MI	14376	5435	24561	3839	26941	3076	28044	2456	29580	1496	35718	985	27636
16-#14	3.06	MA	20122	5435	33515	3979	36746	3211	38113	2592	39558	1643	48576	917	39720
7L-3S		MI	14890	5435	25468	3826	28093	3086	29408	2466	31292	1486	37619	1107	28096
16-#14	3.06	MA	19454	5435	32332	3978	35161	3208	36228	2606	36851	1634	45320	845	37942
8L-2S		MI	15601	5435	26580	3833	29511	3076	31098	2456	33525	1476	40531	1235	28140
16-#18	5.44	MA	23146	6428	41433	4562	46556	3637	49993	2844	55453	1552	70409	522	66594
6L-4S		MI	16224	6428	29673	4425	33125	3471	35376	2660	39323	1331	48386	430	45070
16-#18	5.44	MA	22009	6428	39168	4593	43795	3664	46610	2867	50959	1569	64468	297	62318
7L-3S		MI	17089	6428	31251	4405	35094	3488	37704	2677	42244	1314	51616	640	47535
18-#11	2.39	MA	21433	5154	35119	3796	38902	3061	40794	2496	43224	1651	52874	1328	35103
4L-7S		MI	12994	5154	21597	3681	23201	2973	23649	2408	23765	1549	28464	996	21124
18-#11	2.39	MA	20917	5154	34229	3795	37754	3059	39389	2506	41219	1645	50429	1284	34456
5L-6S		MI	13301	5154	22163	3672	23892	2965	24511	2415	24839	1542	29726	1062	21567

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis



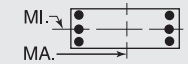
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.39	MA	20425	5154	33389	3794	36614	3071	37997	2503	39377	1653	48102	1226	33768
6L-5S		MI	13616	5154	22693	3676	24610	2971	25340	2408	25937	1535	31062	1122	21872
18-#11	2.39	MA	19945	5154	32491	3807	35519	3069	36655	2513	37574	1661	45681	1138	33045
7L-4S		MI	13945	5154	23253	3680	25331	2964	26208	2401	27134	1542	32496	1162	22312
18-#11	2.39	MA	19472	5154	31667	3806	34413	3081	35341	2524	35686	1654	43395	1087	32125
8L-3S		MI	14309	5154	23888	3670	26139	2970	27172	2408	28344	1535	33844	1248	22344
18-#11	2.39	MA	18992	5154	30795	3819	33333	3078	33981	2520	33902	1662	41141	1031	31095
9L-2S		MI	14814	5154	24669	3675	27135	2962	28368	2401	29924	1529	35912	1337	22341
18-#14	3.44	MA	22322	5595	37818	4062	42261	3271	44839	2628	48587	1613	60409	1105	47868
5L-6S		MI	13959	5595	24116	3926	26303	3148	27336	2517	28569	1477	34729	797	29308
18-#14	3.44	MA	21633	5595	36614	4061	40625	3267	42844	2622	45945	1623	57103	1020	46658
6L-5S		MI	14400	5595	24873	3932	27329	3158	28508	2508	30120	1467	36610	883	30124
18-#14	3.44	MA	20961	5595	35325	4079	39054	3284	40919	2637	43360	1633	53661	894	45013
7L-4S		MI	14861	5595	25673	3939	28359	3148	29734	2498	31813	1477	38630	942	30838
18-#14	3.44	MA	20299	5595	34143	4077	37469	3280	39034	2651	40653	1624	50405	821	43183
8L-3S		MI	15372	5595	26580	3926	29511	3158	31098	2508	33525	1467	40531	1064	31451
18-#14	3.44	MA	19628	5595	32892	4095	35920	3296	37084	2645	38094	1634	47202	740	41224
9L-2S		MI	16078	5595	27693	3933	30930	3148	32788	2498	35757	1457	43443	1192	31516
18-#18	6.12	MA	23435	6712	42337	4770	47835	3793	51521	2947	57564	1549	73251	249	71452
7L-4S		MI	17038	6712	31601	4603	35546	3596	38260	2730	43133	1292	53318	343	50639
20-#11	2.65	MA	21502	5265	35494	3864	39367	3109	41350	2538	43875	1638	54005	1269	38176
5L-7S		MI	13345	5265	22378	3751	24197	3023	24845	2438	25344	1537	30531	968	23373
20-#11	2.65	MA	21014	5265	34655	3863	38227	3121	39958	2534	42033	1646	51678	1210	37514
6E		MI	13651	5265	22944	3741	24888	3015	25706	2445	26418	1530	31793	1035	23870
20-#11	2.65	MA	20537	5265	33756	3876	37132	3119	38616	2545	40230	1654	49257	1123	36735
7L-5S		MI	13963	5265	23474	3745	25606	3021	26535	2438	27516	1523	33130	1094	24159
20-#11	2.65	MA	20067	5265	32932	3875	36026	3131	37302	2555	38342	1648	46971	1072	35841
8L-4S		MI	14290	5265	24034	3749	26327	3014	27403	2431	28713	1530	34564	1135	24668
20-#11	2.65	MA	19589	5265	32060	3888	34946	3129	35942	2551	36558	1655	44717	1016	34777
9L-3S		MI	14653	5265	24669	3740	27135	3020	28368	2438	29924	1523	35912	1221	24713
20-#11	2.65	MA	19064	5265	31240	3888	33855	3140	34636	2562	34787	1663	42531	952	33758
10L-2S		MI	15155	5265	25450	3744	28130	3012	29563	2431	31503	1516	37979	1310	24726
20-#14	3.83	MA	22459	5754	38425	4160	42934	3340	45650	2667	49747	1613	62188	996	51907
6E		MI	14447	5754	25229	4025	27721	3220	29026	2559	30801	1458	37642	755	32483
20-#14	3.83	MA	21793	5754	37136	4179	41363	3356	43725	2681	47162	1623	58746	870	50314
7L-5S		MI	14885	5754	25986	4032	28747	3230	30198	2549	32353	1448	39523	841	33381
20-#14	3.83	MA	21137	5754	35954	4177	39778	3352	41840	2696	44455	1614	55490	797	48434
8L-4S		MI	15343	5754	26786	4039	29777	3220	31424	2539	34045	1458	41542	899	34052
20-#14	3.83	MA	20468	5754	34703	4195	38229	3369	39890	2690	41896	1624	52287	716	46443
9L-3S		MI	15851	5754	27693	4026	30930	3230	32788	2549	35757	1448	43443	1022	34801
22-#11	2.92	MA	21598	5375	35920	3932	39840	3171	41919	2565	44690	1639	55254	1195	41264
6L-7S		MI	13694	5375	23159	3820	25193	3073	26040	2468	26924	1525	32599	941	25628
22-#11	2.92	MA	21125	5375	35021	3945	38745	3169	40577	2576	42887	1647	52833	1108	40431
7L-6S		MI	13998	5375	23725	3810	25884	3065	26902	2474	27998	1518	33861	1007	26176
22-#11	2.92	MA	20658	5375	34197	3945	37639	3181	39263	2586	40999	1641	50548	1057	39562
8L-5S		MI	14309	5375	24255	3814	26602	3072	27731	2468	29095	1511	35198	1067	26451
22-#11	2.92	MA	20181	5375	33325	3958	36560	3179	37903	2583	39215	1648	48294	1000	38464
9L-4S		MI	14634	5375	24815	3818	27323	3064	28599	2461	30292	1518	36632	1107	27021
22-#11	2.92	MA	19662	5375	32505	3957	35468	3190	36597	2593	37444	1656	46108	937	37419
10L-3S		MI	14995	5375	25450	3809	28130	3070	29563	2468	31503	1511	37979	1193	27079
22-#11	2.92	MA	19158	5375	31696	3956	34395	3188	35253	2590	35582	1650	43876	883	36086
11L-2S		MI	15495	5375	26231	3813	29126	3063	30759	2461	33082	1504	40047	1282	27102
22-#14	4.21	MA	22618	5914	38947	4278	43671	3428	46531	2726	50964	1614	63831	846	55622
7L-6S		MI	14933	5914	26341	4125	29139	3293	30716	2601	33034	1439	40554	712	35668

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

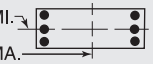
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	4.21	MA	21967	5914	37764	4277	42086	3425	44647	2741	48256	1604	60576	774	53693
8L-5S		MI	15368	5914	27098	4132	30165	3303	31888	2591	34585	1429	42435	798	36644
22-#14	4.21	MA	21300	5914	36513	4295	40537	3441	42697	2735	45698	1614	57372	692	51670
9L-4S		MI	15823	5914	27898	4139	31196	3293	33115	2581	36278	1439	44455	857	37276
24-#11	3.18	MA	21709	5486	36286	4014	40358	3219	42538	2607	45544	1640	56409	1093	44133
7E		MI	14041	5486	23940	3889	26189	3123	27236	2497	28503	1512	34667	913	27889
24-#11	3.18	MA	21246	5486	35462	4014	39252	3231	41224	2617	43655	1634	54124	1042	43288
8L-6S		MI	14343	5486	24507	3879	26879	3116	28097	2504	29577	1505	35929	980	28484
24-#11	3.18	MA	20769	5486	34590	4027	38173	3229	39864	2614	41871	1642	51870	985	42156
9L-5S		MI	14653	5486	25036	3883	27598	3122	28926	2497	30674	1499	37266	1039	28746
24-#11	3.18	MA	20266	5486	33770	4026	37081	3241	38558	2624	40101	1649	49684	922	41018
10L-4S		MI	14976	5486	25596	3888	28319	3114	29794	2490	31871	1505	38700	1080	29322
24-#11	3.18	MA	19755	5486	32961	4025	36008	3238	37214	2621	38238	1643	47453	868	39777
11L-3S		MI	15335	5486	26231	3878	29126	3120	30759	2497	33082	1499	40047	1166	29440
24-#14	4.59	MA	22792	6073	39575	4376	44395	3497	47453	2786	52058	1594	65661	750	58960
8L-6S		MI	15415	6073	27454	4225	30558	3365	32406	2643	35266	1419	43467	669	38862
24-#14	4.59	MA	22125	6073	38324	4395	42846	3513	45503	2780	49500	1604	62458	669	56904
9L-5S		MI	15847	6073	28211	4232	31584	3375	33578	2633	36818	1409	45347	756	39911

RECTANGULAR TIED COLUMNS 28" x 44"

4-#18	1.30	MA	22345	4924	35352	3643	38481	2962	39592	2457	40263	1728	47729	1617	21184
2E		MI	13923	4924	22458	3499	23853	2837	24117	2338	23931	1610	27770	1460	12894
6-#14	1.10	MA	21924	4835	34285	3610	37257	2941	38156	2448	38377	1748	45387	1653	18110
2L-3S		MI	12981	4835	20747	3472	21866	2843	21795	2357	20875	1660	23877	1395	11180
6-#14	1.10	MA	20648	4835	32375	3609	34821	2937	35195	2463	34366	1759	39990	1525	18147
3L-2S		MI	13717	4835	21860	3479	23285	2833	23485	2347	23108	1650	26790	1523	11100
6-#18	1.95	MA	23885	5207	38698	3820	42747	3091	44778	2537	47270	1710	57066	1572	31410
2L-3S		MI	13512	5207	22458	3661	23853	2980	24117	2426	23931	1588	27770	1146	18926
6-#18	1.95	MA	21696	5207	35352	3816	38481	3118	39592	2561	40263	1727	47729	1344	31234
3L-2S		MI	14766	5207	24386	3676	26274	2962	27001	2408	27742	1570	32702	1373	18865
8-#11	1.01	MA	21751	4799	33837	3599	36754	2934	37571	2446	37597	1756	44437	1669	16844
2L-4S		MI	12740	4799	20187	3480	21217	2833	21068	2354	19986	1682	22981	1375	10462
8-#11	1.01	MA	20856	4799	32502	3598	35053	2932	35503	2457	34795	1765	40644	1580	16876
3E		MI	13115	4799	20823	3470	22025	2839	22033	2361	21197	1675	24329	1461	10407
8-#11	1.01	MA	20226	4799	31433	3611	33693	2944	33852	2454	32651	1773	38156	1491	16863
4L-2S		MI	13633	4799	21604	3474	23021	2831	23228	2354	22776	1668	26397	1550	10355
8-#14	1.46	MA	22820	4995	36196	3710	39692	3013	41116	2493	42389	1738	50784	1631	23955
2L-4S		MI	12953	4995	20953	3585	22132	2905	22121	2389	21396	1651	24889	1230	14640
8-#14	1.46	MA	21554	4995	34285	3708	37257	3010	38156	2508	38377	1749	45387	1503	23947
3E		MI	13483	4995	21860	3572	23285	2915	23485	2399	23108	1641	26790	1352	14613
8-#14	1.46	MA	20662	4995	32752	3727	35307	3027	35789	2503	35305	1760	41851	1375	23783
4L-2S		MI	14214	4995	22972	3579	24703	2905	25175	2389	25340	1631	29702	1480	14552
8-#18	2.60	MA	25399	5491	42045	3997	47014	3219	49965	2617	54276	1691	66404	1526	41578
2L-4S		MI	13453	5491	22808	3859	24306	3087	24673	2478	24820	1566	29472	849	23293
8-#18	2.60	MA	23240	5491	38698	3993	42747	3247	44778	2641	47270	1709	57066	1299	41289
3E		MI	14357	5491	24386	3838	26274	3105	27001	2496	27742	1548	32702	1060	24755
8-#18	2.60	MA	21715	5491	36006	4025	39324	3239	40623	2630	41894	1726	50963	1071	38739
4L-2S		MI	15598	5491	26314	3853	28695	3087	29886	2478	31553	1531	37634	1287	24783
10-#11	1.27	MA	22382	4910	35171	3668	38455	2984	39639	2477	40398	1750	48229	1655	20928
2L-5S		MI	12760	4910	20409	3545	21492	2890	21396	2390	20369	1663	23615	1308	12876
10-#11	1.27	MA	21493	4910	33837	3667	36754	2982	37571	2488	37597	1758	44437	1566	20945
3L-4S		MI	13097	4910	20968	3549	22213	2883	22264	2383	21565	1670	25049	1348	12865
10-#11	1.27	MA	20868	4910	32767	3680	35394	2994	35920	2485	35453	1766	41949	1477	20900
4L-3S		MI	13469	4910	21604	3539	23021	2889	23228	2390	22776	1663	26397	1434	12825
10-#11	1.27	MA	20308	4910	31830	3680	34186	2992	34440	2496	33341	1761	39360	1433	20753
5L-2S		MI	13985	4910	22385	3543	24016	2881	24424	2383	24355	1656	28464	1523	12780

RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

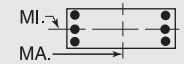
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#14	1.83	MA	23705	5154	38106	3809	42128	3085	44077	2538	46400	1728	56181	1609	29783
2L-5S		MI	12978	5154	21265	3678	22520	2988	22584	2441	21936	1622	25782	1129	17324
10-#14	1.83	MA	22451	5154	36196	3808	39692	3082	41116	2553	42389	1739	50784	1481	29732
3L-4S		MI	13454	5154	22065	3685	23551	2978	23811	2431	23628	1631	27801	1188	18008
10-#14	1.83	MA	21567	5154	34662	3827	37743	3099	38750	2548	39316	1750	47248	1353	29520
4L-3S		MI	13980	5154	22972	3672	24703	2988	25175	2441	25340	1622	29702	1310	18023
10-#14	1.83	MA	20776	5154	33318	3826	36009	3096	36627	2563	36288	1742	43556	1290	28193
5L-2S		MI	14706	5154	24085	3678	26121	2978	26865	2431	27573	1612	32614	1438	17982
10-#18	3.25	MA	24759	5775	42045	4171	47014	3376	49965	2721	54276	1690	66404	1254	51332
3L-4S		MI	14298	5775	24735	4036	26727	3213	27557	2549	28631	1527	34404	763	28738
10-#18	3.25	MA	23256	5775	39352	4202	43590	3368	45810	2709	48901	1707	60301	1026	48378
4L-3S		MI	15193	5775	26314	4016	28695	3230	29886	2566	31553	1509	37634	973	30554
10-#18	3.25	MA	21909	5775	36989	4198	40543	3396	42079	2734	43599	1690	53889	917	45681
5L-2S		MI	16421	5775	28241	4031	31116	3213	32770	2549	35363	1491	42566	1201	30668
12-#11	1.52	MA	23008	5020	36505	3737	40157	3034	41707	2508	43200	1743	52022	1641	25003
2L-6S		MI	12796	5020	20660	3610	21770	2934	21763	2427	20850	1657	24346	1220	14783
12-#11	1.52	MA	22124	5020	35171	3736	38455	3032	39639	2519	40398	1751	48229	1552	24997
3L-5S		MI	13116	5020	21190	3614	22488	2940	22592	2420	21948	1650	25683	1280	15166
12-#11	1.52	MA	21503	5020	34101	3750	37095	3044	37988	2516	38255	1759	45742	1463	24930
4E		MI	13451	5020	21750	3618	23209	2933	23459	2413	23144	1657	27117	1320	15255
12-#11	1.52	MA	20948	5020	33165	3749	35887	3042	36508	2527	36143	1754	43153	1419	24702
5L-3S		MI	13822	5020	22385	3608	24016	2939	24424	2420	24355	1650	28464	1406	15229
12-#11	1.52	MA	20418	5020	32281	3749	34686	3054	35043	2524	34203	1762	40684	1361	23836
6L-2S		MI	14335	5020	23166	3613	25012	2931	25619	2413	25934	1643	30532	1495	15192
12-#14	2.19	MA	24582	5314	40016	3909	44564	3157	47038	2583	50411	1718	61578	1587	35591
2L-6S		MI	13027	5314	21621	3771	22913	3050	23102	2493	22617	1612	26813	1000	20099
12-#14	2.19	MA	23338	5314	38106	3908	42128	3154	44077	2598	46400	1729	56181	1459	35506
3L-5S		MI	13479	5314	22378	3778	23939	3060	24274	2483	24168	1602	28694	1086	20542
12-#14	2.19	MA	22462	5314	36573	3927	40178	3171	41711	2593	43327	1740	52645	1331	35253
4E		MI	13951	5314	23178	3784	24969	3050	25501	2473	25861	1612	30713	1145	21363
12-#14	2.19	MA	21678	5314	35229	3925	38445	3168	39588	2608	40299	1732	48954	1268	33777
5L-3S		MI	14473	5314	24085	3771	26121	3060	26865	2483	27573	1602	32614	1267	21416
12-#14	2.19	MA	20931	5314	33961	3924	36722	3185	37487	2603	37517	1743	45442	1184	32716
6L-2S		MI	15195	5314	25197	3778	27540	3050	28555	2473	29805	1592	35527	1395	21396
12-#18	3.90	MA	24775	6059	42698	4380	47856	3497	50996	2789	55907	1689	69638	981	58060
4E		MI	15134	6059	26663	4213	29148	3338	30441	2619	32442	1487	39336	677	34226
12-#18	3.90	MA	23447	6059	40336	4376	44810	3524	47265	2813	50606	1671	63227	872	55507
5L-3S		MI	16019	6059	28241	4193	31116	3355	32770	2637	35363	1469	42566	887	36335
12-#18	3.90	MA	22182	6059	38105	4372	41781	3517	43571	2802	45735	1689	57159	721	51235
6L-2S		MI	17236	6059	30169	4208	33537	3338	35654	2619	39174	1452	47498	1114	36516
14-#11	1.77	MA	23629	5131	37840	3806	41858	3084	43775	2539	46002	1736	55815	1627	29071
2L-7S		MI	12840	5131	20874	3688	22075	2992	22096	2450	21355	1652	25152	1126	16819
14-#11	1.77	MA	22751	5131	36505	3806	40157	3082	41707	2550	43200	1744	52022	1538	29044
3L-6S		MI	13151	5131	21441	3679	22765	2984	22958	2457	22429	1645	26414	1193	17075
14-#11	1.77	MA	22134	5131	35436	3819	38796	3094	40056	2547	41057	1752	49535	1449	28956
4L-5S		MI	13470	5131	21971	3683	23484	2991	23787	2450	23527	1638	27751	1252	17431
14-#11	1.77	MA	21582	5131	34499	3818	37588	3092	38576	2558	38945	1747	46945	1405	28599
5L-4S		MI	13803	5131	22531	3687	24205	2983	24655	2443	24724	1645	29185	1293	17634
14-#11	1.77	MA	21056	5131	33615	3818	36387	3105	37111	2555	37005	1755	44477	1346	27771
6L-3S		MI	14172	5131	23166	3678	25012	2989	25619	2450	25934	1638	30532	1379	17624
14-#11	1.77	MA	20543	5131	32669	3831	35234	3103	35698	2566	35107	1763	41908	1259	27230
7L-2S		MI	14683	5131	23947	3682	26008	2982	26815	2443	27514	1631	32600	1468	17595
14-#14	2.56	MA	24216	5473	40016	4008	44564	3227	47038	2643	50411	1719	61578	1437	41273
3L-6S		MI	13527	5473	22733	3871	24331	3122	24792	2535	24849	1593	29725	957	23232

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

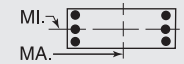


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#14	2.56	MA	23348	5473	38483	4026	42614	3244	44672	2638	47339	1730	58042	1309	40983
4L-5S		MI	13975	5473	23490	3877	25357	3132	25964	2525	26401	1583	31606	1044	23773
14-#14	2.56	MA	22572	5473	37139	4025	40881	3240	42549	2653	44310	1722	54351	1246	39377
5L-4S		MI	14444	5473	24290	3884	26387	3122	27191	2515	28094	1593	33626	1102	24617
14-#14	2.56	MA	21832	5473	35871	4024	39158	3257	40448	2648	41528	1733	50840	1162	38359
6L-3S		MI	14963	5473	25197	3871	27540	3132	28555	2525	29805	1583	35527	1225	24791
14-#14	2.56	MA	21110	5473	34514	4043	37504	3254	38421	2662	38805	1744	47186	1035	36512
7L-2S		MI	15679	5473	26309	3878	28958	3122	30245	2515	32038	1573	38439	1353	24799
14-#18	4.55	MA	24965	6342	43682	4553	49076	3653	52452	2893	57613	1652	72564	826	65081
5L-4S		MI	15962	6342	28591	4391	31569	3463	33325	2689	36253	1448	44268	590	39746
14-#18	4.55	MA	23717	6342	41452	4549	46047	3646	48757	2882	52741	1670	66497	676	60945
6L-3S		MI	16839	6342	30169	4370	33537	3481	35654	2707	39174	1430	47498	801	42103
14-#18	4.55	MA	22498	6342	39065	4581	43138	3673	45193	2906	47974	1688	60179	451	56688
7L-2S		MI	18045	6342	32097	4385	35958	3463	38538	2689	42985	1412	52430	1028	42345
16-#11	2.03	MA	23373	5242	37840	3875	41858	3132	43775	2581	46002	1737	55815	1524	33086
3L-7S		MI	13196	5242	21656	3758	23071	3042	23292	2480	22934	1640	27220	1099	19051
16-#11	2.03	MA	22760	5242	36770	3888	40498	3144	42124	2578	43858	1745	53327	1435	32979
4L-6S		MI	13505	5242	22222	3748	23761	3035	24154	2487	24008	1633	28482	1165	19371
16-#11	2.03	MA	22212	5242	35833	3887	39289	3143	40644	2589	41746	1740	50738	1391	32506
5E		MI	13822	5242	22752	3752	24479	3041	24983	2480	25106	1626	29819	1225	19704
16-#11	2.03	MA	21690	5242	34950	3887	38088	3155	39179	2586	39807	1748	48269	1332	31713
6L-4S		MI	14153	5242	23312	3756	25201	3033	25850	2473	26303	1633	31252	1265	20003
16-#11	2.03	MA	21180	5242	34004	3900	36935	3153	37766	2597	37909	1757	45701	1245	31114
7L-3S		MI	14520	5242	23947	3747	26008	3039	26815	2480	27514	1626	32600	1351	20011
16-#11	2.03	MA	20678	5242	33136	3900	35772	3165	36383	2608	35921	1751	43281	1193	30073
8L-2S		MI	15029	5242	24728	3751	27004	3032	28011	2473	29093	1619	34668	1440	19992
16-#14	2.92	MA	24226	5633	40394	4126	45050	3316	47633	2682	51350	1721	63440	1287	46712
4L-6S		MI	14022	5633	23846	3970	25749	3195	26482	2577	27082	1574	32638	915	26378
16-#14	2.92	MA	23457	5633	39050	4125	43316	3313	45510	2697	48321	1712	59748	1224	44990
5E		MI	14468	5633	24603	3977	26775	3205	27654	2567	28634	1564	34519	1001	27015
16-#14	2.92	MA	22724	5633	37782	4124	41594	3330	43409	2692	45539	1723	56237	1140	43963
6L-4S		MI	14933	5633	25403	3984	27806	3195	28881	2557	30326	1574	36538	1060	27803
16-#14	2.92	MA	22008	5633	36425	4142	39940	3326	41382	2707	42817	1734	52583	1014	42092
7L-3S		MI	15449	5633	26309	3971	28958	3204	30245	2567	32038	1564	38439	1182	28157
16-#14	2.92	MA	21303	5633	35180	4141	38271	3343	39397	2722	39965	1725	49133	940	40331
8L-2S		MI	16161	5633	27422	3978	30376	3194	31935	2557	34270	1554	41351	1310	28192
16-#18	5.19	MA	25232	6626	44798	4727	50313	3774	53944	2962	59748	1651	75834	631	70677
6L-4S		MI	16783	6626	30519	4568	33989	3588	36210	2759	40064	1408	49200	504	45293
16-#18	5.19	MA	24030	6626	42411	4758	47404	3802	50379	2986	54980	1669	69516	406	66331
7L-3S		MI	17652	6626	32097	4548	35958	3606	38538	2777	42985	1390	52430	714	47843
18-#11	2.28	MA	23381	5352	38104	3957	42199	3195	44192	2609	46660	1739	57120	1421	36999
4L-7S		MI	13549	5352	22437	3827	24067	3092	24487	2510	24513	1627	29288	1071	21292
18-#11	2.28	MA	22837	5352	37168	3957	40990	3193	42712	2620	44548	1733	54531	1377	36423
5L-6S		MI	13857	5352	23003	3817	24757	3085	25349	2516	25587	1620	30549	1138	21672
18-#11	2.28	MA	22318	5352	36284	3956	39789	3205	41247	2617	42608	1741	52062	1318	35661
6L-5S		MI	14172	5352	23533	3821	25475	3091	26178	2510	26685	1613	31886	1197	21985
18-#11	2.28	MA	21812	5352	35338	3969	38636	3203	39834	2628	40710	1750	49494	1231	35002
7L-4S		MI	14502	5352	24093	3825	26197	3083	27046	2503	27882	1620	33320	1238	22367
18-#11	2.28	MA	21313	5352	34471	3969	37473	3215	38451	2639	38722	1744	47074	1179	33991
8L-3S		MI	14867	5352	24728	3816	27004	3090	28011	2510	29093	1613	34668	1324	22394
18-#11	2.28	MA	20790	5352	33619	3968	36336	3213	37020	2636	36844	1752	44682	1123	32991
9L-2S		MI	15373	5352	25509	3820	28000	3082	29206	2503	30672	1607	36735	1413	22382
18-#14	3.29	MA	24334	5793	40960	4225	45752	3385	48471	2742	52333	1702	65145	1202	50614
5L-6S		MI	14515	5793	24958	4070	27168	3267	28173	2618	29314	1555	35550	872	29537
18-#14	3.29	MA	23608	5793	39692	4223	44029	3402	46370	2737	49551	1713	61634	1118	49495
6L-5S		MI	14957	5793	25715	4077	28194	3277	29345	2608	30866	1545	37431	959	30266
18-#14	3.29	MA	22899	5793	38335	4242	42375	3399	44343	2752	46828	1724	57980	992	47681
7L-4S		MI	15419	5793	26515	4084	29224	3267	30571	2599	32559	1555	39450	1017	31003

RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

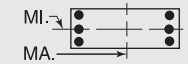


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	3.29	MA	22199	5793	37090	4241	40706	3416	42358	2767	43976	1715	54530	918	45869
8L-3S		MI	15931	5793	27422	4071	30376	3277	31935	2608	34270	1545	41351	1139	31516
18-#14	3.29	MA	21481	5793	35773	4260	39075	3412	40304	2762	41282	1726	51129	837	43910
9L-2S		MI	16640	5793	28534	4077	31795	3267	33625	2599	36503	1535	44264	1267	31571
18-#18	5.84	MA	25544	6910	45757	4935	51670	3930	55565	3066	61987	1650	78853	361	75993
7L-4S		MI	17598	6910	32446	4745	36410	3713	39094	2830	43875	1369	54132	418	50860
20-#11	2.53	MA	23458	5463	38502	4026	42692	3243	44780	2651	47350	1726	58323	1363	40348
5L-7S		MI	13900	5463	23218	3896	25063	3142	25683	2539	26093	1615	31355	1044	23540
20-#11	2.53	MA	22943	5463	37618	4025	41491	3255	43315	2648	45410	1734	55855	1304	39614
6E		MI	14206	5463	23784	3886	25753	3135	26545	2546	27167	1608	32617	1110	23976
20-#11	2.53	MA	22440	5463	36672	4039	40338	3253	41902	2659	43512	1743	53286	1217	38896
7L-5S		MI	14520	5463	24314	3890	26471	3141	27374	2539	28264	1601	33954	1170	24272
20-#11	2.53	MA	21945	5463	35805	4038	39174	3265	40519	2670	41524	1737	50866	1165	37913
8L-4S		MI	14848	5463	24874	3895	27192	3133	28242	2532	29461	1608	35388	1210	24727
20-#11	2.53	MA	21432	5463	34953	4038	38038	3263	39088	2667	39646	1746	48475	1109	36878
9L-3S		MI	15211	5463	25509	3885	28000	3140	29206	2539	30672	1601	36735	1296	24764
20-#11	2.53	MA	20878	5463	34024	4051	36889	3276	37713	2678	37782	1754	46155	1046	35797
10L-2S		MI	15715	5463	26290	3889	28996	3132	30402	2532	32251	1594	38803	1385	24768
20-#14	3.65	MA	24484	5952	41603	4323	46465	3474	49330	2782	53562	1703	67031	1096	55040
6E		MI	15004	5952	26071	4170	28586	3339	29863	2660	31547	1535	38462	830	32709
20-#14	3.65	MA	23781	5952	40246	4342	44811	3471	47303	2797	50839	1714	63377	970	53279
7L-5S		MI	15443	5952	26828	4177	29612	3349	31035	2650	33099	1525	40343	916	33523
20-#14	3.65	MA	23088	5952	39001	4341	43142	3488	45319	2812	47988	1705	59928	896	51417
8L-4S		MI	15902	5952	27628	4183	30642	3339	32261	2640	34791	1535	42363	974	34215
20-#14	3.65	MA	22371	5952	37684	4359	41511	3485	43265	2807	45293	1716	56526	815	49427
9L-3S		MI	16411	5952	28534	4170	31795	3349	33625	2650	36503	1525	44264	1097	34869
22-#11	2.79	MA	23563	5573	38953	4094	43192	3305	45383	2679	48212	1728	59647	1290	43571
6L-7S		MI	14249	5573	23999	3965	26058	3193	26879	2569	27672	1603	33423	1016	25794
22-#11	2.79	MA	23064	5573	38007	4108	42039	3303	43970	2690	46314	1736	57079	1203	42798
7L-6S		MI	14554	5573	24565	3955	26749	3185	27740	2576	28746	1596	34685	1083	26283
22-#11	2.79	MA	22571	5573	37139	4107	40875	3315	42587	2701	44326	1730	54659	1151	41841
8L-5S		MI	14866	5573	25095	3960	27467	3191	28569	2569	29843	1589	36022	1142	26563
22-#11	2.79	MA	22060	5573	36288	4107	39739	3314	41156	2698	42448	1739	52267	1095	40771
9L-4S		MI	15192	5573	25655	3964	28188	3184	29437	2562	31040	1596	37456	1183	27082
22-#11	2.79	MA	21511	5573	35358	4120	38590	3326	39781	2709	40584	1747	49947	1032	39713
10L-3S		MI	15554	5573	26290	3954	28996	3190	30402	2569	32251	1589	38803	1269	27131
22-#11	2.79	MA	20980	5573	34507	4119	37460	3324	38366	2706	38623	1742	47584	977	38300
11L-2S		MI	16055	5573	27071	3958	29992	3182	31597	2562	33830	1582	40871	1357	27151
22-#14	4.02	MA	24656	6112	42156	4442	47247	3543	50264	2842	54851	1704	68774	948	58886
7L-6S		MI	15490	6112	27183	4270	30004	3412	31553	2702	33780	1516	41375	787	35892
22-#14	4.02	MA	23970	6112	40911	4440	45577	3560	48280	2857	51999	1695	65325	874	56973
8L-5S		MI	15926	6112	27940	4276	31030	3422	32725	2692	35331	1506	43256	873	36785
22-#14	4.02	MA	23254	6112	39594	4459	43946	3557	46226	2852	49304	1706	61923	793	54951
9L-4S		MI	16383	6112	28740	4283	32061	3412	33952	2682	37024	1516	45275	932	37438
24-#11	3.04	MA	23683	5684	39341	4177	43740	3353	46038	2721	49116	1729	60872	1189	46705
7E		MI	14597	5684	24780	4034	27054	3243	28074	2599	29251	1590	35491	988	28054
24-#11	3.04	MA	23194	5684	38474	4176	42577	3366	44655	2732	47127	1723	58452	1137	45773
8L-6S		MI	14900	5684	25347	4025	27745	3235	28936	2606	30325	1583	36753	1055	28591
24-#11	3.04	MA	22684	5684	37622	4176	41440	3364	43224	2729	45249	1732	56060	1081	44669
9L-5S		MI	15210	5684	25876	4029	28463	3241	29765	2599	31422	1577	38090	1115	28859
24-#11	3.04	MA	22140	5684	36692	4189	40291	3376	41849	2740	43385	1740	53740	1018	43628
10L-4S		MI	15535	5684	26436	4033	29184	3234	30633	2592	32619	1583	39523	1155	29435
24-#11	3.04	MA	21612	5684	35841	4189	39161	3374	40434	2737	41425	1735	51377	963	42197
11L-3S		MI	15895	5684	27071	4023	29992	3240	31597	2599	33830	1577	40871	1241	29495
24-#14	4.38	MA	24844	6271	42822	4540	48013	3633	51240	2902	56010	1685	70722	852	62536
8L-6S		MI	15973	6271	28296	4369	31423	3484	33243	2744	36012	1497	44287	744	39084
24-#14	4.38	MA	24130	6271	41504	4559	46382	3629	49187	2897	53316	1697	67320	771	60483
9L-5S		MI	16407	6271	29053	4376	32449	3494	34415	2734	37564	1487	46168	831	40053

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.24	MA	24314	5122	38316	3803	41719	3094	42887	2570	43537	1817	51613	1706	22264
2E		MI	14479	5122	23304	3642	24717	2955	24951	2438	24672	1686	28584	1534	12933
6-#14	1.05	MA	23865	5033	37187	3771	40423	3073	41366	2561	41499	1834	49105	1741	19022
2L-3S		MI	13536	5033	21589	3617	22731	2962	22632	2458	21621	1738	24698	1470	11213
6-#14	1.05	MA	22519	5033	35177	3770	37860	3070	38251	2576	37279	1846	43396	1613	19058
3L-2S		MI	14273	5033	22701	3623	24150	2952	24322	2448	23853	1728	27610	1598	11131
6-#18	1.86	MA	25945	5406	41840	3981	46211	3223	48348	2649	50935	1799	61504	1664	33030
2L-3S		MI	14067	5406	23304	3804	24717	3097	24951	2526	24672	1665	28584	1220	18989
6-#18	1.86	MA	23634	5406	38316	3978	41719	3252	42887	2675	43537	1817	51613	1436	32854
3L-2S		MI	15323	5406	25231	3819	27138	3080	27835	2508	28483	1647	33516	1448	18912
8-#14	1.40	MA	24812	5193	39197	3870	42985	3145	44481	2605	45720	1825	54814	1721	25170
2L-4S		MI	13507	5193	21795	3730	22997	3024	22958	2490	22142	1728	25709	1305	14692
8-#14	1.40	MA	23478	5193	37187	3870	40423	3143	41366	2621	41499	1836	49105	1593	25162
3E		MI	14038	5193	22701	3716	24150	3034	24322	2500	23853	1718	27610	1428	14653
8-#14	1.40	MA	22538	5193	35576	3889	38373	3160	38879	2616	38270	1848	45361	1465	24998
4L-2S		MI	14770	5193	23814	3723	25568	3024	26012	2490	26086	1708	30523	1556	14588
8-#18	2.48	MA	27549	5689	45364	4158	50704	3352	53809	2729	58334	1781	71396	1622	43738
2L-4S		MI	14007	5689	23653	4002	25170	3205	25507	2578	25562	1643	30286	924	23525
8-#18	2.48	MA	25269	5689	41840	4155	46211	3380	48348	2755	50935	1800	61504	1394	43449
3E		MI	14913	5689	25231	3981	27138	3223	27835	2596	28483	1625	33516	1134	24828
8-#18	2.48	MA	23662	5689	39008	4187	42610	3374	43978	2744	45261	1818	55032	1167	41043
4L-2S		MI	16156	5689	27159	3996	29559	3205	30720	2578	32294	1607	38448	1361	24836
10-#11	1.21	MA	24347	5108	38116	3829	41680	3116	42922	2589	43620	1836	52097	1743	21981
2L-5S		MI	13314	5108	21249	3690	22357	3010	22235	2492	21117	1741	24439	1383	12924
10-#11	1.21	MA	23410	5108	36713	3828	39891	3115	40747	2601	40673	1845	48088	1654	21998
3L-4S		MI	13651	5108	21808	3694	23079	3002	23102	2485	22313	1748	25873	1423	12901
10-#11	1.21	MA	22752	5108	35589	3842	38461	3127	39013	2598	38421	1854	45456	1566	21953
4L-3S		MI	14025	5108	22444	3685	23886	3009	24067	2492	23524	1741	27221	1509	12857
10-#11	1.21	MA	22163	5108	34605	3842	37192	3126	37458	2609	36202	1849	42723	1521	21806
5L-2S		MI	14541	5108	23225	3689	24882	3001	25262	2485	25103	1734	29288	1598	12811
10-#14	1.75	MA	25750	5352	41207	3970	45548	3218	47597	2650	49941	1815	60524	1700	31302
2L-5S		MI	13532	5352	22107	3822	23385	3107	23421	2542	22682	1699	26602	1204	17464
10-#14	1.75	MA	24426	5352	39197	3969	42985	3215	44481	2666	45720	1826	54814	1572	31250
3L-4S		MI	14009	5352	22907	3829	24416	3097	24648	2532	24374	1709	28622	1263	18067
10-#14	1.75	MA	23496	5352	37586	3988	40936	3232	41994	2661	42490	1838	51070	1444	31039
4L-3S		MI	14536	5352	23814	3816	25568	3106	26012	2542	26086	1699	30523	1385	18068
10-#14	1.75	MA	22663	5352	36174	3988	39115	3230	39764	2677	39308	1830	47172	1380	29766
5L-2S		MI	15263	5352	24926	3823	26986	3096	27702	2532	28319	1689	33435	1513	18021
10-#18	3.11	MA	26878	5973	45364	4332	50704	3509	53809	2834	58334	1782	71396	1352	54032
3L-4S		MI	14854	5973	25581	4179	27591	3330	28391	2648	29373	1603	35218	837	28966
10-#18	3.11	MA	25293	5973	42532	4365	47103	3502	49439	2824	52660	1800	64923	1125	51204
4L-3S		MI	15750	5973	27159	4159	29559	3348	30720	2666	32294	1586	38448	1047	30637
10-#18	3.11	MA	23875	5973	40048	4362	43900	3531	45517	2849	47065	1783	58144	1014	48253
5L-2S		MI	16981	5973	29087	4174	31980	3330	33604	2648	36105	1568	43380	1275	30730
12-#11	1.45	MA	25009	5218	39520	3898	43469	3166	45098	2621	46567	1829	56106	1730	26267
2L-6S		MI	13350	5218	21500	3755	22635	3054	22601	2529	21598	1735	25170	1296	14884
12-#11	1.45	MA	24078	5218	38116	3898	41680	3165	42922	2632	43620	1838	52097	1641	26261
3L-5S		MI	13671	5218	22030	3759	23353	3060	23430	2522	22696	1728	26507	1355	15278
12-#11	1.45	MA	23424	5218	36992	3911	40251	3177	41188	2629	41368	1847	49465	1553	26194
4E		MI	14006	5218	22589	3763	24074	3052	24298	2515	23893	1735	27941	1396	15295
12-#11	1.45	MA	22840	5218	36008	3911	38981	3176	39633	2640	39149	1842	46732	1508	26022
5L-3S		MI	14378	5218	23225	3754	24882	3059	25262	2522	25103	1728	29288	1482	15265

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

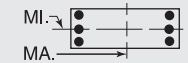
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.45	MA	22282	5218	35080	3911	37720	3188	38095	2638	37112	1850	44121	1450	25117
6L-2S		MI	14891	5218	24006	3758	25878	3051	26458	2515	26683	1722	31356	1571	15226
12-#14	2.10	MA	26678	5512	43218	4070	48111	3290	50712	2695	54162	1805	66233	1680	37413
2L-6S		MI	13581	5512	22463	3915	23778	3169	23939	2594	23363	1690	27634	1075	20233
12-#14	2.10	MA	25364	5512	41207	4069	45548	3287	47597	2711	49941	1816	60524	1552	37328
3L-5S		MI	14033	5512	23220	3922	24804	3179	25111	2584	24914	1680	29515	1161	20681
12-#14	2.10	MA	24442	5512	39596	4088	43499	3305	45109	2706	46711	1828	56780	1424	37075
4E		MI	14506	5512	24020	3929	25834	3169	26338	2574	26607	1690	31534	1220	21428
12-#14	2.10	MA	23618	5512	38184	4087	41678	3302	42879	2722	43529	1820	52881	1360	35646
5L-3S		MI	15030	5512	24926	3916	26986	3179	27702	2584	28319	1680	33435	1342	21467
12-#14	2.10	MA	22831	5512	36852	4087	39868	3319	40672	2717	40606	1832	49165	1276	34491
6L-2S		MI	15752	5512	26039	3923	28405	3169	29392	2574	30551	1670	36347	1470	21438
12-#18	3.73	MA	26902	6257	46055	4542	51595	3631	54900	2904	60058	1782	74815	1082	61409
4E		MI	15691	6257	27509	4356	30012	3455	31275	2719	33183	1564	40150	751	34450
12-#18	3.73	MA	25503	6257	43572	4539	48392	3660	50978	2929	54464	1765	68036	972	58609
5L-3S		MI	16578	6257	29087	4336	31980	3473	33604	2736	36105	1546	43380	961	36425
12-#18	3.73	MA	24170	6257	41228	4536	45209	3653	47095	2919	49323	1783	61605	822	54294
6L-2S		MI	17798	6257	31015	4351	34401	3455	36488	2719	39916	1528	48312	1189	36583
14-#11	1.70	MA	25666	5329	40923	3967	45259	3216	47273	2652	49514	1822	60116	1717	30545
2L-7S		MI	13394	5329	21714	3834	22940	3112	22935	2552	22103	1730	25976	1202	16965
14-#11	1.70	MA	24740	5329	39520	3967	43469	3215	45098	2663	46567	1831	56106	1628	30518
3L-6S		MI	13706	5329	22281	3824	23631	3104	23797	2558	23177	1723	27238	1268	17176
14-#11	1.70	MA	24091	5329	38396	3980	42040	3227	43363	2660	44315	1840	53474	1540	30430
4L-5S		MI	14025	5329	22811	3828	24349	3110	24626	2552	24275	1716	28575	1328	17541
14-#11	1.70	MA	23510	5329	37412	3980	40771	3226	41808	2671	42096	1835	50742	1495	30167
5L-4S		MI	14359	5329	23371	3832	25070	3103	25493	2545	25472	1723	30009	1368	17680
14-#11	1.70	MA	22957	5329	36484	3980	39509	3238	40270	2669	40059	1844	48131	1437	29258
6L-3S		MI	14728	5329	24006	3823	25878	3109	26458	2552	26683	1716	31356	1454	17663
14-#11	1.70	MA	22417	5329	35491	3993	38299	3237	38786	2680	38066	1852	45415	1349	28675
7L-2S		MI	15240	5329	24787	3827	26874	3101	27653	2545	28262	1709	33424	1543	17631
14-#14	2.45	MA	26294	5671	43218	4169	48111	3360	50712	2756	54162	1807	66233	1531	43399
3L-6S		MI	14081	5671	23575	4015	25196	3241	25629	2636	25595	1671	30546	1033	23462
14-#14	2.45	MA	25380	5671	41606	4188	46062	3377	48225	2751	50932	1818	62489	1403	43110
4L-5S		MI	14530	5671	24332	4022	26222	3251	26801	2626	27147	1661	32427	1119	23912
14-#14	2.45	MA	24563	5671	40194	4187	44241	3374	45995	2767	47750	1810	58590	1339	41542
5L-4S		MI	15000	5671	25132	4029	27252	3241	28028	2616	28839	1671	34446	1177	24779
14-#14	2.45	MA	23784	5671	38863	4186	42431	3392	43787	2762	44827	1822	54874	1255	40433
6L-3S		MI	15520	5671	26039	4016	28405	3251	29392	2626	30551	1661	36347	1300	24847
14-#14	2.45	MA	23024	5671	37437	4205	40694	3389	41658	2778	41967	1834	51008	1129	38604
7L-2S		MI	16238	5671	27151	4022	29823	3241	31082	2616	32784	1651	39260	1428	24844
14-#18	4.35	MA	27110	6540	47096	4716	52885	3788	56439	3009	61862	1747	77927	929	68986
5L-4S		MI	16520	6540	29436	4534	32433	3580	34159	2789	36994	1524	45082	665	39967
14-#18	4.35	MA	25795	6540	44752	4713	49701	3782	52556	2999	56721	1766	71496	779	64532
6L-3S		MI	17399	6540	31015	4513	34401	3598	36488	2807	39916	1507	48312	875	42199
14-#18	4.35	MA	24511	6540	42244	4746	46644	3811	48810	3024	51690	1784	64801	554	60217
7L-2S		MI	18609	6540	32942	4528	36822	3580	39372	2789	43726	1489	53244	1102	42417
16-#11	1.94	MA	25398	5440	40923	4036	45259	3265	47273	2694	49514	1824	60116	1615	34771
3L-7S		MI	13750	5440	22496	3903	23936	3162	24130	2581	23683	1718	28044	1174	19217
16-#11	1.94	MA	24753	5440	39799	4049	43829	3277	45538	2691	47262	1833	57484	1527	34663
4L-6S		MI	14060	5440	23062	3893	24627	3154	24992	2588	24757	1711	29306	1241	19473
16-#11	1.94	MA	24176	5440	38815	4049	42560	3276	43984	2703	45043	1828	54751	1482	34279
5E		MI	14378	5440	23592	3897	25345	3160	25821	2581	25854	1704	30642	1300	19815
16-#11	1.94	MA	23627	5440	37887	4049	41299	3288	42445	2700	43006	1837	52140	1423	33407
6L-4S		MI	14710	5440	24152	3902	26066	3153	26689	2574	27051	1711	32076	1341	20054

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis

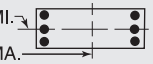


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.94	MA	23091	5440	36894	4062	40088	3287	40961	2711	41012	1845	49424	1336	32841
7L-3S		MI	15077	5440	24787	3892	26874	3159	27653	2581	28262	1704	33424	1427	20053
16-#11	1.94	MA	22562	5440	35984	4062	38867	3299	39508	2722	38924	1840	46870	1284	31745
8L-2S		MI	15586	5440	25568	3896	27869	3151	28849	2574	29841	1697	35492	1516	20030
16-#14	2.80	MA	26309	5831	43616	4288	48624	3449	51340	2796	55153	1808	68198	1383	49142
4L-6S		MI	14577	5831	24688	4115	26614	3314	27319	2678	27828	1651	33458	990	26604
16-#14	2.80	MA	25499	5831	42205	4287	46803	3447	49110	2812	51970	1800	64300	1319	47451
5E		MI	15023	5831	25445	4122	27640	3323	28491	2668	29379	1642	35339	1076	27154
16-#14	2.80	MA	24727	5831	40873	4286	44994	3464	46903	2807	49047	1812	60584	1235	46384
6L-4S		MI	15490	5831	26245	4128	28671	3313	29718	2658	31072	1651	37359	1135	27965
16-#14	2.80	MA	23974	5831	39447	4305	43257	3461	44773	2823	46188	1824	56717	1109	44481
7L-3S		MI	16007	5831	27151	4115	29823	3323	31082	2668	32784	1642	39260	1257	28216
16-#14	2.80	MA	23232	5831	38140	4304	41503	3479	42689	2838	43192	1816	53074	1034	42748
8L-2S		MI	16721	5831	28264	4122	31241	3313	32772	2658	35016	1632	42172	1385	28243
16-#18	4.97	MA	27399	6824	48275	4891	54193	3910	58017	3079	64120	1748	81388	737	74792
6L-4S		MI	17342	6824	31364	4711	34854	3706	37044	2859	40805	1485	50014	578	45511
16-#18	4.97	MA	26132	6824	45767	4923	51136	3939	54271	3104	59088	1766	74693	512	70389
7L-3S		MI	18214	6824	32942	4691	36822	3723	39372	2877	43726	1467	53244	788	47963
16-#18	4.97	MA	24883	6824	43466	4920	48051	3933	50602	3129	53818	1749	68359	383	65544
8L-2S		MI	19413	6824	34870	4706	39243	3706	42257	2859	47537	1450	58176	1016	48236
18-#11	2.18	MA	25410	5550	41203	4119	45619	3328	47713	2723	50209	1826	61493	1513	38894
4L-7S		MI	14103	5550	23277	3972	24932	3212	25326	2611	25262	1705	30111	1147	21456
18-#11	2.18	MA	24837	5550	40219	4118	44349	3326	46159	2734	47990	1821	58760	1469	38400
5L-6S		MI	14412	5550	23843	3962	25623	3204	26188	2618	26336	1698	31373	1213	21775
18-#11	2.18	MA	24292	5550	39291	4118	43088	3338	44620	2731	45953	1830	56149	1410	37561
6L-5S		MI	14728	5550	24373	3967	26341	3210	27017	2611	27433	1692	32710	1273	22095
18-#11	2.18	MA	23759	5550	38298	4132	41878	3337	43136	2742	43959	1839	53434	1323	36974
7L-4S		MI	15058	5550	24933	3971	27062	3203	27884	2604	28630	1698	34144	1313	22421
18-#11	2.18	MA	23235	5550	37387	4131	40656	3349	41684	2753	41871	1834	50879	1271	35868
8L-3S		MI	15424	5550	25568	3961	27869	3209	28849	2611	29841	1692	35492	1399	22437
18-#11	2.18	MA	22675	5550	36493	4131	39462	3348	40181	2751	39899	1842	48350	1215	34905
9L-2S		MI	15931	5550	26349	3965	28865	3201	30045	2604	31420	1685	37559	1488	22422
18-#14	3.14	MA	26427	5991	44215	4387	49366	3519	52226	2856	56191	1790	70009	1299	53371
5L-6S		MI	15070	5991	25800	4215	28033	3386	29010	2719	30060	1632	36371	947	29761
18-#14	3.14	MA	25662	5991	42883	4386	47557	3536	50018	2852	53268	1802	66293	1214	52341
6L-5S		MI	15513	5991	26557	4221	29059	3396	30182	2709	31612	1622	38252	1034	30404
18-#14	3.14	MA	24916	5991	41458	4405	45819	3534	47889	2868	50408	1814	62427	1088	50368
7L-4S		MI	15977	5991	27357	4228	30089	3386	31408	2700	33305	1632	40271	1092	31164
18-#14	3.14	MA	24180	5991	40151	4404	44066	3551	45804	2883	47413	1806	58783	1014	48583
8L-3S		MI	16491	5991	28264	4215	31241	3396	32772	2709	35016	1622	42172	1214	31579
18-#14	3.14	MA	23413	5991	38867	4403	42353	3548	43647	2879	44582	1818	55183	933	46571
9L-2S		MI	17201	5991	29376	4222	32660	3386	34462	2700	37249	1612	45084	1342	31625
18-#18	5.59	MA	27734	7108	49291	5100	55629	4068	59732	3184	66487	1748	84584	470	80581
7L-4S		MI	18159	7108	33292	4888	37275	3831	39928	2930	44616	1445	54946	492	51077
18-#18	5.59	MA	26501	7108	46990	5097	52543	4061	56064	3209	61217	1731	78250	341	75687
8L-3S		MI	19022	7108	34870	4868	39243	3849	42257	2947	47537	1428	58176	702	53538
20-#11	2.42	MA	25493	5661	41622	4187	46139	3376	48334	2765	50937	1814	62769	1456	42529
5L-7S		MI	14455	5661	24058	4041	25928	3262	26521	2641	26841	1693	32179	1119	23702
20-#11	2.42	MA	24952	5661	40694	4187	44878	3389	46795	2762	48900	1823	60159	1397	41721
6E		MI	14762	5661	24624	4032	26618	3254	27383	2648	27915	1686	33441	1186	24079
20-#11	2.42	MA	24423	5661	39701	4201	43667	3387	45312	2773	46906	1832	57443	1310	41073
7L-5S		MI	15076	5661	25154	4036	27336	3261	28212	2641	29012	1679	34778	1245	24382
20-#11	2.42	MA	23902	5661	38791	4201	42445	3400	43859	2785	44818	1827	54888	1258	39998
8L-4S		MI	15405	5661	25714	4040	28058	3253	29080	2634	30209	1686	36212	1286	24783
20-#11	2.42	MA	23346	5661	37897	4200	41252	3398	42356	2782	42846	1835	52359	1202	38999
9L-3S		MI	15769	5661	26349	4030	28865	3259	30045	2641	31420	1679	37559	1372	24812
20-#11	2.42	MA	22771	5661	36920	4214	40046	3410	40912	2793	40889	1844	49905	1138	37822
10L-2S		MI	16274	5661	27130	4034	29861	3252	31240	2634	32999	1672	39627	1460	24810

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

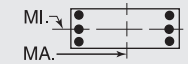
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	3.49	MA	26589	6150	44893	4486	50119	3609	53134	2897	57489	1792	72002	1194	58197
6E		MI	15560	6150	26913	4314	29451	3458	30700	2761	32293	1613	39283	905	32931
20-#14	3.49	MA	25849	6150	43468	4505	48382	3606	51004	2912	54629	1804	68136	1068	56264
7L-5S		MI	16000	6150	27670	4321	30477	3468	31872	2751	33845	1603	41164	991	33661
20-#14	3.49	MA	25120	6150	42161	4504	46629	3623	48920	2928	51633	1796	64492	993	54428
8L-4S		MI	16461	6150	28470	4328	31507	3458	33098	2741	35537	1613	43183	1049	34375
20-#14	3.49	MA	24354	6150	40877	4503	44916	3621	46763	2924	48803	1808	60892	912	52448
9L-3S		MI	16971	6150	29376	4315	32660	3468	34462	2751	37249	1603	45084	1172	34935
20-#14	3.49	MA	23563	6150	39476	4522	43185	3638	44691	2939	45994	1820	57400	821	50056
10L-2S		MI	17677	6150	30489	4322	34078	3458	36152	2741	39482	1593	47997	1300	35000
20-#18	6.21	MA	28101	7391	50513	5275	57036	4190	61525	3289	68615	1713	88142	299	85847
8L-4S		MI	18969	7391	35220	5066	39695	3956	42812	3000	48427	1406	59878	406	56659
22-#11	2.66	MA	25607	5771	42098	4256	46667	3439	48971	2793	51846	1816	64168	1384	45885
6L-7S		MI	14805	5771	24839	4110	26924	3312	27717	2671	28420	1681	34247	1091	25956
22-#11	2.66	MA	25082	5771	41105	4270	45456	3437	47487	2805	49853	1825	61452	1297	45180
7L-6S		MI	15110	5771	25405	4101	27614	3305	28579	2678	29494	1674	35509	1158	26386
22-#11	2.66	MA	24564	5771	40194	4270	44235	3450	46034	2816	47765	1820	58898	1245	44132
8L-5S		MI	15423	5771	25935	4105	28332	3311	29408	2671	30591	1667	36846	1218	26673
22-#11	2.66	MA	24019	5771	39300	4269	43041	3448	44531	2813	45793	1829	56368	1189	43097
9L-4S		MI	15750	5771	26495	4109	29054	3303	30276	2664	31788	1674	38280	1258	27142
22-#11	2.66	MA	23440	5771	38324	4283	41835	3461	43088	2824	43836	1837	53914	1125	41944
10L-3S		MI	16112	5771	27130	4099	29861	3309	31240	2671	32999	1667	39627	1344	27182
22-#11	2.66	MA	22881	5771	37430	4283	40649	3459	41602	2822	41777	1832	51420	1070	40536
11L-2S		MI	16615	5771	27911	4104	30857	3302	32436	2664	34578	1660	41695	1433	27194
22-#14	3.84	MA	26775	6310	45478	4604	50945	3678	54120	2957	58850	1794	73845	1047	62167
7L-6S		MI	16046	6310	28025	4414	30869	3531	32390	2803	34525	1594	42195	862	36111
22-#14	3.84	MA	26052	6310	44171	4604	49192	3696	52035	2973	55854	1786	70202	973	60281
8L-5S		MI	16484	6310	28782	4421	31895	3540	33562	2793	36077	1584	44076	948	36924
22-#14	3.84	MA	25288	6310	42888	4603	47479	3693	49878	2968	53024	1798	66602	892	58270
9L-4S		MI	16942	6310	29582	4428	32926	3530	34789	2783	37770	1594	46096	1007	37596
22-#14	3.84	MA	24502	6310	41487	4622	45748	3710	47807	2984	50215	1810	63110	801	55920
10L-3S		MI	17450	6310	30489	4415	34078	3540	36152	2793	39482	1584	47997	1129	38286
24-#11	2.91	MA	25737	5882	42508	4339	47246	3487	49662	2836	52800	1818	65461	1284	49292
7E		MI	15153	5882	25620	4180	27920	3362	28913	2700	29999	1668	36315	1064	28214
24-#11	2.91	MA	25223	5882	41598	4339	46024	3500	48209	2847	50712	1813	62907	1232	48270
8L-6S		MI	15457	5882	26187	4170	28610	3355	29774	2707	31073	1662	37577	1131	28696
24-#11	2.91	MA	24678	5882	40704	4339	44831	3498	46706	2844	48740	1822	60377	1176	47201
9L-5S		MI	15768	5882	26716	4174	29328	3361	30603	2700	32171	1655	38914	1190	28969
24-#11	2.91	MA	24105	5882	39727	4352	43625	3511	45263	2855	46783	1830	57923	1112	46071
10L-4S		MI	16094	5882	27276	4178	30050	3353	31471	2694	33367	1662	40347	1231	29497
24-#11	2.91	MA	23549	5882	38834	4352	42438	3509	43777	2853	44724	1825	55429	1057	44640
11L-3S		MI	16454	5882	27911	4169	30857	3360	32436	2700	34578	1655	41695	1317	29548
24-#11	2.91	MA	23003	5882	37873	4365	41240	3522	42337	2864	42769	1834	52685	983	43268
12L-2S		MI	16955	5882	28692	4173	31853	3352	33631	2694	36157	1648	43763	1405	29571
24-#14	4.19	MA	26977	6469	46181	4703	51755	3768	55151	3018	60075	1776	75911	952	66142
8L-6S		MI	16530	6469	29138	4514	32288	3603	34080	2845	36758	1575	45108	819	39302
24-#14	4.19	MA	26214	6469	44898	4703	50042	3765	52994	3013	57245	1788	72311	871	64100
9L-5S		MI	16966	6469	29895	4521	33314	3613	35252	2835	38310	1565	46989	906	40191
24-#14	4.19	MA	25434	6469	43497	4722	48311	3783	50922	3029	54436	1800	68819	780	61791
10L-4S		MI	17421	6469	30695	4527	34344	3603	36479	2825	40002	1575	49008	964	40827

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

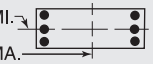


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.19	MA	26363	5320	41393	3964	45080	3227	46304	2682	46884	1903	55624	1795	23344
2E		MI	15034	5320	24149	3785	25582	3072	25785	2537	25413	1763	29398	1608	12972
6-#14	1.00	MA	25885	5231	40202	3932	43711	3205	44699	2673	44734	1921	52950	1829	19933
2L-3S		MI	14091	5231	22431	3761	23596	3081	23469	2559	22367	1815	25519	1545	11245
6-#14	1.00	MA	24469	5231	38092	3931	41022	3203	41429	2689	40304	1933	46929	1701	19970
3L-2S		MI	14828	5231	23543	3768	25015	3071	25159	2549	24599	1805	28431	1673	11162
6-#18	1.79	MA	28085	5604	45094	4142	49798	3355	52040	2762	54655	1885	66070	1756	34650
2L-3S		MI	14622	5604	24149	3947	25582	3215	25785	2625	25413	1741	29398	1294	19047
6-#18	1.79	MA	25652	5604	41393	4139	45080	3385	46304	2788	46884	1905	55624	1528	34474
3L-2S		MI	15880	5604	26077	3962	28002	3197	28669	2608	29224	1724	34330	1522	18958
8-#14	1.34	MA	26885	5391	42311	4031	46401	3278	47969	2718	49164	1911	58972	1810	26385
2L-4S		MI	14062	5391	22637	3874	23862	3143	23795	2591	22888	1806	26530	1380	14739
8-#14	1.34	MA	25481	5391	40202	4031	43711	3275	44699	2734	44734	1923	52950	1682	26377
3E		MI	14593	5391	23543	3861	25015	3153	25159	2601	24599	1796	28431	1503	14691
8-#14	1.34	MA	24494	5391	38512	4050	41562	3293	42091	2730	41347	1936	48998	1554	26213
4L-2S		MI	15326	5391	24656	3868	26433	3143	26849	2591	26832	1786	31343	1631	14623
8-#18	2.38	MA	29780	5887	48795	4319	54517	3484	57776	2842	62426	1868	76516	1716	45898
2L-4S		MI	14562	5887	24499	4145	26034	3322	26341	2678	26303	1719	31100	998	23752
8-#18	2.38	MA	27378	5887	45094	4317	49798	3514	52040	2868	54655	1887	66070	1489	45609
3E		MI	15469	5887	26077	4124	28002	3340	28669	2696	29224	1702	34330	1208	24899
8-#18	2.38	MA	25688	5887	42123	4350	46020	3508	47455	2859	48701	1907	59228	1261	43370
4L-2S		MI	16715	5887	28005	4139	30423	3322	31554	2678	33035	1684	39262	1436	24889
10-#11	1.16	MA	26392	5306	41174	3989	45027	3248	46328	2702	46954	1922	56092	1831	23034
2L-5S		MI	13868	5306	22088	3835	23223	3130	23073	2593	21865	1819	25263	1458	12967
10-#11	1.16	MA	25407	5306	39701	3989	43150	3247	44046	2713	43862	1932	51866	1742	23051
3L-4S		MI	14206	5306	22648	3840	23944	3122	23941	2587	23062	1826	26697	1499	12937
10-#11	1.16	MA	24716	5306	38523	4003	41652	3260	42227	2711	41501	1941	49089	1654	23006
4L-3S		MI	14580	5306	23284	3830	24751	3128	24905	2593	24273	1819	28044	1585	12889
10-#11	1.16	MA	24098	5306	37492	4003	40322	3259	40598	2723	39176	1936	46213	1608	22859
5L-2S		MI	15097	5306	24065	3834	25747	3121	26101	2587	25852	1812	30112	1674	12841
10-#14	1.67	MA	27874	5550	44421	4131	49091	3350	51239	2763	53594	1901	64994	1791	32820
2L-5S		MI	14086	5550	22949	3967	24250	3225	24258	2643	23428	1777	27423	1279	17602
10-#14	1.67	MA	26481	5550	42311	4131	46401	3348	47969	2779	49164	1914	58972	1663	32769
3L-4S		MI	14564	5550	23749	3974	25281	3215	25485	2633	25120	1787	29442	1338	18123
10-#14	1.67	MA	25504	5550	40622	4150	44252	3366	45361	2775	45777	1926	55020	1535	32557
4L-3S		MI	15092	5550	24656	3961	26433	3225	26849	2643	26832	1777	31343	1460	18111
10-#14	1.67	MA	24629	5550	39142	4150	42344	3363	43023	2791	42441	1919	50914	1470	31351
5L-2S		MI	15820	5550	25768	3967	27851	3215	28539	2633	29065	1767	34256	1588	18060
10-#18	2.98	MA	29077	6171	48795	4494	54517	3642	57776	2948	62426	1870	76516	1449	56732
3L-4S		MI	15409	6171	26427	4322	28455	3448	29225	2748	30114	1680	36032	911	29189
10-#18	2.98	MA	27411	6171	45824	4527	50738	3637	53191	2939	56472	1889	69674	1222	54054
4L-3S		MI	16307	6171	28005	4302	30423	3465	31554	2766	33035	1662	39262	1122	30716
10-#18	2.98	MA	25920	6171	43220	4525	47380	3666	49078	2965	50604	1873	62527	1110	50840
5L-2S		MI	17541	6171	29932	4316	32844	3448	34438	2748	36846	1645	44194	1349	30786
12-#11	1.39	MA	27090	5416	42646	4059	46905	3299	48611	2733	50046	1915	60318	1819	27530
2L-6S		MI	13904	5416	22340	3900	23500	3173	23439	2630	22346	1813	25994	1371	14982
12-#11	1.39	MA	26111	5416	41174	4059	45027	3297	46328	2745	46954	1925	56092	1730	27524
3L-5S		MI	14225	5416	22870	3905	24218	3180	24269	2623	23444	1806	27331	1431	15344
12-#11	1.39	MA	25424	5416	39996	4072	43529	3310	44510	2742	44593	1934	53315	1642	27457
4E		MI	14561	5416	23429	3909	24940	3172	25136	2616	24641	1813	28765	1471	15335
12-#11	1.39	MA	24811	5416	38965	4072	42199	3309	42881	2754	42268	1929	50439	1596	27286
5L-3S		MI	14933	5416	24065	3899	25747	3178	26101	2623	25852	1806	30112	1557	15300
12-#11	1.39	MA	24226	5416	37993	4072	40878	3322	41269	2752	40133	1939	47686	1538	26405
6L-2S		MI	15448	5416	24846	3903	26743	3171	27296	2616	27431	1800	32180	1646	15259
12-#14	2.01	MA	28853	5710	46531	4231	51781	3422	54509	2808	58024	1891	71015	1771	39236
2L-6S		MI	14134	5710	23305	4060	24643	3288	24776	2695	24108	1768	28454	1150	20362

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

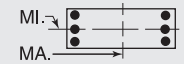
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	2.01	MA	27471	5710	44421	4230	49091	3420	51239	2824	53594	1904	64994	1644	39151
3L-5S		MI	14588	5710	24062	4067	25669	3298	25948	2685	25660	1758	30335	1237	20817
12-#14	2.01	MA	26503	5710	42732	4250	46942	3438	48631	2820	50208	1916	61041	1516	38898
4E		MI	15062	5710	24862	4074	26699	3288	27175	2675	27353	1768	32355	1295	21490
12-#14	2.01	MA	25637	5710	41252	4249	45034	3436	46293	2836	46871	1909	56935	1451	37526
5L-3S		MI	15586	5710	25768	4060	27851	3298	28539	2685	29065	1758	34256	1417	21514
12-#14	2.01	MA	24811	5710	39857	4249	43137	3453	43980	2832	43808	1921	53014	1367	36274
6L-2S		MI	16310	5710	26881	4067	29270	3288	30229	2675	31297	1748	37168	1545	21480
12-#18	3.57	MA	29109	6455	49525	4704	55457	3765	58927	3019	64243	1871	80119	1182	64782
4E		MI	16247	6455	28354	4499	30876	3573	32109	2819	33925	1641	40964	825	34669
12-#18	3.57	MA	27639	6455	46921	4702	52098	3795	54814	3045	58375	1856	72973	1070	61727
5L-3S		MI	17137	6455	29932	4479	32844	3591	34438	2836	36846	1623	44194	1035	36511
12-#18	3.57	MA	26238	6455	44464	4700	48760	3789	50742	3036	52984	1875	66178	920	57383
6L-2S		MI	18360	6455	31860	4494	35265	3573	37322	2819	40657	1605	49126	1263	36649
14-#11	1.63	MA	27783	5527	44119	4128	48783	3349	50893	2764	53138	1909	64544	1807	32020
2L-7S		MI	13948	5527	22554	3979	23806	3231	23773	2653	22852	1808	26800	1277	17063
14-#11	1.63	MA	26809	5527	42646	4128	46905	3348	48611	2776	50046	1918	60318	1718	31992
3L-6S		MI	14260	5527	23121	3970	24496	3224	24635	2660	23926	1801	28062	1344	17274
14-#11	1.63	MA	26127	5527	41468	4142	45407	3360	46792	2773	47685	1927	57541	1629	31905
4L-5S		MI	14580	5527	23651	3974	25214	3230	25464	2653	25023	1794	29399	1403	17650
14-#11	1.63	MA	25518	5527	40437	4142	44077	3359	45163	2785	45360	1923	54665	1584	31711
5L-4S		MI	14914	5527	24211	3978	25936	3222	26332	2646	26220	1801	30832	1444	17723
14-#11	1.63	MA	24938	5527	39465	4142	42755	3372	43551	2783	43225	1932	51912	1526	30752
6L-3S		MI	15284	5527	24846	3968	26743	3228	27296	2653	27431	1794	32180	1530	17700
14-#11	1.63	MA	24371	5527	38425	4155	41487	3371	41996	2794	41137	1941	49049	1439	30123
7L-2S		MI	15797	5527	25627	3972	27739	3221	28492	2646	29010	1787	34248	1618	17667
14-#14	2.34	MA	28452	5869	46531	4330	51781	3492	54509	2869	58024	1894	71015	1624	45526
3L-6S		MI	14635	5869	24417	4160	26061	3360	26466	2737	26341	1748	31367	1108	23623
14-#14	2.34	MA	27492	5870	44842	4350	49632	3510	51901	2865	54638	1906	67063	1496	45236
4L-5S		MI	15085	5870	25174	4166	27087	3370	27638	2727	27893	1738	33247	1194	24047
14-#14	2.34	MA	26634	5869	43362	4349	47724	3508	49563	2881	51302	1899	62957	1432	43718
5L-4S		MI	15556	5870	25974	4173	28117	3360	28865	2717	29585	1748	35267	1252	24846
14-#14	2.34	MA	25816	5869	41967	4349	45827	3526	47250	2877	48238	1911	59036	1348	42515
6L-3S		MI	16077	5870	26881	4160	29270	3370	30229	2727	31297	1738	37168	1375	24901
14-#14	2.34	MA	25018	5869	40473	4368	44007	3524	45018	2893	45241	1924	54958	1222	40714
7L-2S		MI	16797	5869	27993	4167	30688	3360	31919	2717	33530	1728	40080	1503	24889
14-#18	4.17	MA	29335	6738	50622	4879	56817	3923	60550	3125	66146	1838	83419	1031	72634
5L-4S		MI	17077	6738	30282	4677	33297	3698	34993	2889	37736	1601	45896	739	40184
14-#18	4.17	MA	27953	6738	48165	4877	53479	3918	56478	3116	60755	1857	76624	881	68150
6L-3S		MI	17959	6738	31860	4656	35265	3716	37322	2907	40657	1583	49126	949	42292
14-#18	4.17	MA	26604	6738	45535	4910	50273	3947	52550	3142	55479	1877	69552	656	63790
7L-2S		MI	19172	6738	33788	4671	37686	3698	40206	2889	44468	1566	54058	1177	42487
16-#11	1.86	MA	27503	5638	44119	4197	48783	3398	50893	2807	53138	1911	64544	1706	36455
3L-7S		MI	14304	5638	23336	4048	24802	3281	24969	2683	24431	1796	28868	1250	19371
16-#11	1.86	MA	26825	5638	42941	4211	47284	3410	49075	2805	50777	1920	61767	1617	36348
4L-6S		MI	14615	5638	23902	4039	25492	3274	25831	2690	25505	1789	30129	1316	19572
16-#11	1.86	MA	26220	5638	41910	4211	45954	3409	47445	2816	48452	1916	58891	1572	36060
5E		MI	14933	5638	24432	4043	26210	3280	26660	2683	26602	1782	31466	1376	19922
16-#11	1.86	MA	25644	5638	40938	4211	44633	3422	45833	2814	46317	1925	56138	1514	35107
6L-4S		MI	15266	5638	24992	4047	26931	3272	27527	2676	27799	1789	32900	1416	20102
16-#11	1.86	MA	25081	5638	39897	4225	43364	3421	44279	2825	44229	1934	53275	1426	34497
7L-3S		MI	15634	5638	25627	4037	27739	3279	28492	2683	29010	1782	34248	1502	20093
16-#11	1.86	MA	24527	5638	38944	4225	42085	3433	42757	2837	42041	1930	50586	1374	33427
8L-2S		MI	16144	5638	26408	4042	28735	3271	29687	2676	30589	1775	36315	1591	20067

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

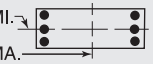


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	2.68	MA	28472	6029	46951	4449	52322	3582	55171	2910	59068	1896	73084	1477	51572
4L-6S		MI	15132	6029	25530	4259	27479	3432	28156	2779	28574	1729	34279	1065	26827
16-#14	2.68	MA	27621	6029	45472	4449	50414	3580	52833	2926	55732	1889	68979	1413	49923
5E		MI	15579	6029	26287	4266	28505	3442	29328	2769	30125	1719	36160	1151	27288
16-#14	2.68	MA	26811	6029	44077	4448	48517	3598	50520	2922	52668	1901	65058	1329	48765
6L-4S		MI	16047	6029	27087	4273	29536	3432	30555	2759	31818	1729	38179	1210	28125
16-#14	2.68	MA	26020	6029	42583	4468	46697	3596	48288	2938	49671	1914	60979	1203	46888
7L-3S		MI	16565	6029	27993	4260	30688	3442	31919	2769	33530	1719	40080	1332	28274
16-#14	2.68	MA	25240	6029	41213	4468	44860	3614	46104	2954	46531	1907	57142	1128	45191
8L-2S		MI	17280	6029	29106	4267	32106	3432	33609	2759	35762	1709	42993	1460	28288
16-#18	4.76	MA	29646	7022	51866	5055	58197	4046	62214	3195	68526	1840	87069	841	78939
6L-4S		MI	17901	7022	32210	4854	35718	3823	37878	2959	41546	1562	50828	652	45726
16-#18	4.76	MA	28315	7022	49236	5088	54992	4076	58286	3222	63250	1859	79998	617	74493
7L-3S		MI	18775	7022	33788	4834	37686	3841	40206	2977	44468	1544	54058	863	48061
16-#18	4.76	MA	27002	7022	46824	5085	51757	4070	54440	3248	57724	1843	73319	486	69552
8L-2S		MI	19978	7022	35716	4848	40107	3823	43091	2959	48279	1526	58990	1090	48311
18-#11	2.09	MA	27518	5748	44414	4280	49162	3460	51357	2836	53869	1913	65993	1605	40790
4L-7S		MI	14658	5748	24117	4117	25797	3331	26164	2713	26010	1783	30935	1222	21616
18-#11	2.09	MA	26917	5748	43383	4280	47832	3459	49728	2847	51544	1909	63117	1560	40386
5L-6S		MI	14967	5748	24683	4108	26488	3324	27026	2720	27084	1776	32197	1289	21874
18-#11	2.09	MA	26344	5748	42411	4280	46510	3472	48116	2845	49409	1918	60364	1502	39468
6L-5S		MI	15284	5748	25213	4112	27206	3330	27855	2713	28181	1770	33534	1348	22203
18-#11	2.09	MA	25786	5748	41370	4294	45242	3471	46561	2856	47321	1927	57501	1414	38875
7L-4S		MI	15615	5748	25773	4116	27927	3322	28723	2706	29378	1776	34968	1389	22472
18-#11	2.09	MA	25235	5748	40416	4294	43962	3484	45039	2868	45133	1923	54812	1362	37757
8L-3S		MI	15981	5748	26408	4107	28735	3329	29687	2713	30589	1770	36315	1475	22480
18-#11	2.09	MA	24640	5748	39480	4294	42712	3482	43464	2866	43067	1932	52144	1306	36838
9L-2S		MI	16489	5748	27189	4111	29731	3321	30883	2706	32168	1763	38383	1563	22461
18-#14	3.01	MA	28600	6189	47582	4549	53104	3653	56103	2971	60162	1879	75000	1394	56140
5L-6S		MI	15625	6189	26642	4359	28898	3505	29847	2820	30806	1710	37191	1022	29981
18-#14	3.01	MA	27797	6189	46186	4548	51207	3670	53790	2967	57098	1892	71079	1310	55022
6L-5S		MI	16070	6189	27399	4366	29924	3515	31019	2810	32358	1700	39072	1109	30539
18-#14	3.01	MA	27013	6189	44693	4568	49387	3668	51558	2983	54101	1904	67001	1184	53072
7L-4S		MI	16535	6189	28199	4373	30954	3505	32245	2801	34050	1710	41092	1167	31322
18-#14	3.01	MA	26241	6189	43323	4567	47550	3686	49374	2999	50961	1897	63163	1109	51324
8L-3S		MI	17050	6189	29106	4360	32106	3515	33609	2810	35762	1700	42993	1289	31640
18-#14	3.01	MA	25425	6189	41979	4567	45755	3684	47113	2995	47995	1909	59364	1028	49221
9L-2S		MI	17761	6189	30218	4366	33525	3505	35299	2801	37995	1690	45905	1417	31677
18-#18	5.36	MA	30006	7306	52937	5265	59710	4205	64022	3302	71021	1842	90444	577	85215
7L-4S		MI	18719	7306	34138	5031	38139	3948	40762	3030	45357	1522	55760	566	51289
18-#18	5.36	MA	28709	7306	50525	5263	56476	4199	60176	3328	65495	1826	83765	447	80228
8L-3S		MI	19585	7306	35716	5011	40107	3966	43091	3047	48279	1505	58990	776	53822
20-#11	2.32	MA	27609	5859	44855	4349	49709	3509	52010	2878	54636	1902	67343	1548	44720
5L-7S		MI	15010	5859	24898	4187	26793	3382	27360	2742	27589	1771	33003	1194	23862
20-#11	2.32	MA	27040	5859	43883	4349	48388	3522	50398	2876	52501	1911	64590	1490	43834
6E		MI	15318	5859	25464	4177	27484	3374	28222	2749	28663	1764	34265	1261	24179
20-#11	2.32	MA	26486	5859	42843	4363	47119	3521	48843	2888	50413	1920	61727	1402	43256
7L-5S		MI	15633	5859	25994	4181	28202	3380	29051	2742	29760	1757	35602	1321	24489
20-#11	2.32	MA	25939	5859	41889	4363	45840	3534	47322	2899	48225	1916	59038	1350	42093
8L-4S		MI	15962	5859	26554	4185	28923	3373	29919	2736	30957	1764	37036	1361	24837
20-#11	2.32	MA	25347	5859	40953	4363	44589	3533	45747	2897	46159	1925	56370	1294	41138
9L-3S		MI	16327	5859	27189	4176	29731	3379	30883	2742	32168	1757	38383	1447	24862
20-#11	2.32	MA	24743	5859	39930	4377	43326	3545	44235	2908	44108	1934	53782	1230	39862
10L-2S		MI	16832	5859	27970	4180	30726	3371	32079	2736	33747	1750	40451	1536	24851
20-#14	3.35	MA	28775	6348	48296	4648	53897	3743	57060	3012	61529	1882	77101	1291	61284
6E		MI	16116	6348	27755	4459	30316	3577	31537	2862	33039	1691	40104	980	33148
20-#14	3.35	MA	27998	6348	46803	4667	52077	3741	54828	3028	58531	1894	73022	1164	59265
7L-5S		MI	16558	6348	28512	4466	31342	3587	32709	2852	34591	1681	41985	1066	33796

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

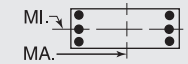
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	3.35	MA	27232	6348	45433	4667	50240	3758	52644	3044	55392	1887	69185	1089	57466
8L-4S		MI	17020	6348	29312	4472	32372	3577	33935	2842	36283	1691	44004	1125	34531
20-#14	3.35	MA	26418	6348	44089	4667	48445	3756	50383	3040	52426	1899	65386	1009	55408
9L-3S		MI	17531	6348	30218	4459	33525	3587	35299	2852	37995	1681	45905	1247	34999
20-#14	3.35	MA	25558	6348	42621	4686	46631	3774	48213	3056	49482	1912	61701	917	52911
10L-2S		MI	18239	6348	31331	4466	34943	3577	36989	2842	40227	1671	48817	1375	35055
20-#18	5.95	MA	30398	7590	54226	5440	61194	4328	65911	3408	73265	1808	94211	407	90920
8L-4S		MI	19531	7590	36065	5209	40560	4074	43646	3100	49168	1483	60692	480	56870
22-#11	2.55	MA	27732	5970	45356	4418	50265	3572	52681	2907	55594	1904	68815	1477	48205
6L-7S		MI	15360	5970	25679	4256	27789	3432	28556	2772	29168	1759	35071	1167	26114
22-#11	2.55	MA	27181	5970	44315	4432	48997	3571	51126	2919	53505	1913	65953	1390	47577
7L-6S		MI	15666	5970	26245	4246	28480	3424	29417	2779	30242	1752	36333	1234	26487
22-#11	2.55	MA	26637	5970	43362	4432	47717	3584	49604	2930	51317	1909	63263	1337	46434
8L-5S		MI	15980	5970	26775	4250	29198	3430	30246	2772	31340	1745	37670	1293	26781
22-#11	2.55	MA	26049	5970	42425	4432	46467	3583	48029	2928	49251	1918	60596	1281	45442
9L-4S		MI	16308	5970	27335	4254	29919	3423	31114	2765	32536	1752	39103	1334	27199
22-#11	2.55	MA	25449	5970	41403	4446	45204	3595	46517	2939	47200	1927	58008	1218	44192
10L-3S		MI	16671	5970	27970	4245	30726	3429	32079	2772	33747	1745	40451	1420	27232
22-#11	2.55	MA	24861	5970	40467	4446	43961	3594	44961	2937	45043	1923	55382	1163	42794
11L-2S		MI	17174	5970	28751	4249	31722	3421	33274	2765	35326	1738	42519	1508	27237
22-#14	3.68	MA	28974	6508	48913	4767	54767	3813	58098	3072	62962	1884	79044	1145	65467
7L-6S		MI	16603	6508	28867	4559	31734	3649	33227	2904	35271	1671	43016	937	36327
22-#14	3.68	MA	28215	6508	47543	4767	52930	3831	55914	3088	59822	1877	75206	1070	63617
8L-5S		MI	17042	6508	29624	4565	32760	3659	34399	2894	36823	1662	44897	1023	37058
22-#14	3.68	MA	27403	6508	46199	4766	51135	3828	53653	3085	56856	1889	71408	990	61532
9L-4S		MI	17502	6508	30424	4572	33791	3649	35626	2884	38516	1671	46916	1082	37752
22-#14	3.68	MA	26577	6508	44731	4786	49321	3846	51483	3101	53912	1902	67722	898	59074
10L-3S		MI	18011	6508	31331	4559	34943	3659	36989	2894	40227	1662	48817	1204	38353
24-#11	2.79	MA	27871	6080	45788	4501	50875	3621	53408	2950	56597	1907	70179	1378	51894
7E		MI	15709	6080	26460	4325	28785	3482	29751	2802	30747	1746	37139	1139	28371
24-#11	2.79	MA	27331	6080	44834	4501	49595	3634	51886	2961	54410	1902	67489	1325	50779
8L-6S		MI	16013	6080	27026	4315	29475	3474	30613	2809	31821	1740	38400	1206	28797
24-#11	2.79	MA	26753	6080	43898	4501	48344	3633	50312	2959	52343	1911	64822	1269	49752
9L-5S		MI	16325	6080	27556	4319	30193	3480	31442	2802	32919	1733	39737	1266	29076
24-#11	2.79	MA	26149	6080	42875	4515	47081	3645	48799	2971	50293	1921	62234	1206	48525
10L-4S		MI	16652	6080	28116	4324	30915	3473	32310	2795	34115	1740	41171	1306	29556
24-#11	2.79	MA	25566	6080	41939	4515	45838	3644	47243	2968	48135	1916	59608	1151	47105
11L-3S		MI	17013	6080	28751	4314	31722	3479	33274	2802	35326	1733	42519	1392	29600
24-#11	2.79	MA	24992	6080	40933	4529	44583	3657	45735	2980	46088	1925	56716	1076	45743
12L-2S		MI	17515	6080	29532	4318	32718	3471	34470	2795	36905	1726	44586	1481	29619
24-#14	4.02	MA	29190	6667	49653	4867	55619	3903	59184	3133	64252	1867	81228	1051	69775
8L-6S		MI	17088	6667	29980	4658	33153	3722	34917	2946	37504	1652	45928	894	39515
24-#14	4.02	MA	28380	6667	48309	4866	53825	3901	56924	3129	61286	1879	77429	970	67734
9L-5S		MI	17525	6667	30737	4665	34179	3732	36089	2936	39056	1642	47809	981	40326
24-#14	4.02	MA	27560	6667	46841	4886	52011	3919	54753	3146	58343	1892	73744	879	65243
10L-4S		MI	17981	6667	31536	4672	35209	3722	37316	2926	40748	1652	49829	1039	40981

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

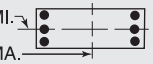
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.04	MA	10730	3514	16970	2560	18159	2086	18409	1736	18137	1230	21106	1147	8354
2L-3S		MI	10165	3514	16120	2557	17075	2094	17096	1743	16402	1237	18824	1058	8404
6-#14	1.50	MA	11210	3661	18089	2640	19539	2142	20026	1766	20267	1205	23870	1099	11770
2L-3S		MI	10414	3661	16876	2634	17993	2154	18166	1775	17810	1215	20648	971	11817
6-#18	2.67	MA	12357	4034	20829	2848	22914	2289	23956	1838	25448	1137	30536	967	20125
2L-3S		MI	11005	4034	18724	2835	20239	2306	20771	1856	21240	1155	25057	739	19996
8-#11	1.39	MA	11116	3625	17820	2629	19243	2136	19723	1767	19871	1219	23388	1122	10982
2L-4S		MI	10152	3625	16280	2636	17282	2139	17350	1767	16806	1233	19622	945	11021
8-#14	2.00	MA	11750	3821	19301	2739	21084	2215	21886	1809	22723	1188	27091	1060	15493
2L-4S		MI	10393	3821	17103	2748	18287	2217	18526	1809	18383	1208	21772	807	15207
8-#18	3.56	MA	13261	4317	22934	3025	25588	2416	27142	1912	29656	1102	36014	888	26526
2L-4S		MI	10964	4317	19112	3035	20740	2416	21385	1912	22222	1137	26956	445	23626
10-#11	1.73	MA	11498	3736	18670	2698	20327	2186	21036	1798	21606	1208	25670	1097	13595
2L-5S		MI	10181	3736	16523	2702	17584	2198	17710	1805	17227	1215	20321	880	13120
10-#11	1.73	MA	10941	3736	17820	2695	19243	2195	19723	1805	19871	1215	23388	1008	13617
3L-4S		MI	10541	3736	17131	2705	18366	2189	18663	1798	18541	1222	21904	920	13591
10-#14	2.50	MA	12284	3980	20513	2839	22630	2287	23747	1852	25180	1171	30312	1022	19199
2L-5S		MI	10432	3980	17448	2842	18714	2301	19036	1862	18978	1181	22759	711	17704
10-#14	2.50	MA	11502	3980	19301	2833	21084	2298	21886	1862	22723	1181	27091	894	19166
3L-4S		MI	10939	3980	18316	2847	19832	2290	20386	1852	20839	1191	24993	769	18634
10-#18	4.44	MA	14152	4601	25039	3203	28262	2544	30327	1985	33865	1066	41493	810	32894
2L-5S		MI	11031	4601	19701	3200	21472	2562	22259	2003	23239	1084	28636	262	27201
10-#18	4.44	MA	12836	4601	22934	3190	25588	2562	27142	2003	29656	1084	36014	582	32557
3L-4S		MI	11886	4601	21217	3212	23415	2544	24571	1985	26430	1102	32435	367	29623

RECTANGULAR TIED COLUMNS 30" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.67	MA	12937	3962	21030	2843	22772	2304	23395	1891	23861	1272	28180	1149	14752
2E		MI	12079	3962	19692	2825	21232	2288	21731	1873	22095	1256	25997	1126	13719
6-#14	1.41	MA	12680	3873	20332	2812	21980	2284	22560	1890	22768	1303	26831	1199	12681
2L-3S		MI	11051	3873	17840	2790	18987	2282	19129	1884	18670	1299	21596	1052	11862
6-#14	1.41	MA	11816	3873	19020	2807	20307	2297	20529	1900	20087	1313	23300	1071	12728
3L-2S		MI	11849	3873	19052	2796	20532	2271	20989	1875	21126	1289	24817	1180	11807
6-#18	2.50	MA	13942	4246	23313	3020	25682	2433	26883	1967	28467	1240	34207	1077	21745
2L-3S		MI	11643	4246	19692	2990	21232	2433	21731	1964	22095	1238	25997	820	20090
6-#18	2.50	MA	12471	4246	21030	3009	22772	2452	23395	1984	23861	1258	28180	849	21616
3L-2S		MI	12999	4246	21797	3002	23906	2416	24916	1946	26303	1220	31476	1047	20180
8-#11	1.30	MA	12575	3837	20037	2802	21654	2278	22192	1889	22325	1316	26284	1220	11824
2L-4S		MI	10789	3837	17242	2793	18276	2268	18314	1877	17668	1317	20572	1026	11072
8-#11	1.30	MA	11967	3837	19118	2799	20482	2287	20767	1896	20434	1323	23787	1131	11860
3E		MI	11192	3837	17931	2783	19153	2273	19374	1884	18999	1311	22057	1114	11055
8-#11	1.30	MA	11531	3837	18374	2810	19536	2282	19619	1890	18984	1330	22163	1042	11864
4L-2S		MI	11754	3837	18781	2786	20237	2265	20687	1877	20733	1304	24339	1203	11015
8-#14	1.88	MA	13270	4033	21644	2912	23652	2357	24590	1935	25450	1287	30361	1163	16708
2L-4S		MI	11029	4033	18067	2904	19280	2346	19489	1918	19242	1292	22719	888	15434
8-#14	1.88	MA	12414	4033	20332	2907	21980	2369	22560	1945	22768	1297	26831	1035	16716
3E		MI	11599	4033	19052	2890	20532	2354	20989	1928	21126	1282	24817	1013	15556
8-#14	1.88	MA	11799	4033	19268	2922	20628	2361	20922	1935	20712	1307	24536	908	16579
4L-2S		MI	12390	4033	20264	2895	22078	2343	22850	1918	23583	1272	28038	1141	15535
8-#18	3.33	MA	14931	4529	25595	3198	28591	2562	30370	2043	33074	1208	40233	1005	28686
2L-4S		MI	11600	4529	20079	3189	21733	2543	22345	2020	23077	1220	27896	526	23930
8-#18	3.33	MA	13480	4529	23313	3187	25682	2581	26883	2060	28467	1226	34207	777	28444
3E		MI	12567	4529	21797	3167	23906	2561	24916	2037	26303	1202	31476	741	26390
8-#18	3.33	MA	12437	4529	21455	3211	23321	2564	24069	2043	24935	1243	30278	557	25778
4L-2S		MI	13905	4529	23902	3180	26581	2543	28102	2020	30511	1185	36954	969	26592

RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

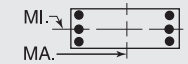
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.63	MA	12992	3948	20956	2871	22826	2328	23616	1920	24216	1307	28781	1197	14648
2L-5S		MI	10817	3948	17485	2859	18578	2327	18675	1914	18089	1299	21272	962	13271
10-#11	1.63	MA	12388	3948	20037	2868	21654	2337	22192	1927	22325	1313	26284	1108	14670
3L-4S		MI	11179	3948	18092	2862	19360	2318	19628	1907	19403	1306	22855	1002	13648
10-#11	1.63	MA	11956	3948	19293	2879	20708	2332	21044	1921	20875	1320	24660	1020	14644
4L-3S		MI	11580	3948	18781	2852	20237	2324	20687	1914	20733	1299	24339	1089	13659
10-#11	1.63	MA	11568	3948	18639	2876	19865	2342	20012	1928	19443	1313	22931	980	14223
5L-2S		MI	12137	3948	19632	2855	21321	2315	22001	1907	22468	1293	26621	1178	13631
10-#14	2.34	MA	13854	4193	22956	3011	25325	2429	26620	1979	28131	1272	33892	1128	20718
2L-5S		MI	11068	4193	18411	2998	19707	2429	19999	1971	19837	1264	23706	792	17893
10-#14	2.34	MA	13005	4192	21644	3007	23652	2441	24590	1989	25450	1282	30361	1000	20685
3L-4S		MI	11577	4193	19279	3004	20826	2418	21349	1961	21699	1274	25940	850	18856
10-#14	2.34	MA	12396	4192	20580	3022	22300	2434	22953	1979	23393	1292	28066	873	20293
4L-3S		MI	12141	4193	20264	2989	22078	2427	22850	1971	23583	1264	28038	975	19228
10-#14	2.34	MA	11849	4192	19644	3017	21094	2446	21479	1989	21362	1282	25618	816	19208
5L-2S		MI	12925	4193	21477	2995	23623	2415	24710	1961	26040	1254	31259	1103	19245
10-#18	4.17	MA	15907	4813	27877	3375	31501	2690	33858	2119	37680	1176	46260	933	35594
2L-5S		MI	11664	4813	20668	3354	22464	2689	23219	2111	24094	1167	29576	343	27675
10-#18	4.17	MA	14475	4813	25595	3364	28591	2709	30370	2136	33074	1193	40233	706	35257
3L-4S		MI	12524	4813	22184	3367	24407	2671	25531	2093	27285	1184	33375	447	29919
10-#18	4.17	MA	13447	4813	23738	3388	26231	2693	27557	2119	29541	1211	36304	486	32291
4L-3S		MI	13478	4813	23902	3344	26581	2689	28102	2111	30511	1167	36954	663	32674
10-#18	4.17	MA	12521	4813	22101	3377	24122	2712	25025	2136	26050	1193	32125	382	29862
5L-2S		MI	14800	4813	26007	3357	29255	2671	31287	2093	34720	1149	42433	890	32967
12-#11	1.95	MA	13407	4058	21876	2940	23998	2378	25041	1951	26106	1297	31278	1174	17462
2L-6S		MI	10864	4058	17761	2924	18883	2371	19077	1952	18618	1295	22077	877	15340
12-#11	1.95	MA	12807	4058	20956	2937	22826	2387	23616	1959	24216	1304	28781	1086	17466
3L-5S		MI	11207	4058	18335	2928	19662	2377	19988	1945	19824	1288	23554	937	15732
12-#11	1.95	MA	12378	4058	20212	2948	21881	2383	22469	1952	22765	1310	27158	997	17416
4E		MI	11565	4058	18942	2931	20444	2368	20942	1938	21138	1295	25137	977	16215
12-#11	1.95	MA	11992	4058	19558	2945	21037	2392	21437	1960	21334	1304	25428	957	16888
5L-3S		MI	11964	4058	19632	2921	21321	2374	22001	1945	22468	1288	26621	1064	16252
12-#11	1.95	MA	11623	4058	18940	2942	20198	2387	20450	1967	20020	1310	23810	898	16443
6L-2S		MI	12518	4058	20482	2924	22405	2365	23314	1938	24203	1282	28903	1153	16238
12-#14	2.81	MA	14431	4352	24268	3111	26998	2501	28651	2024	30812	1256	37423	1093	24710
2L-6S		MI	11133	4352	18802	3092	20139	2493	20569	2025	20587	1257	24844	667	20411
12-#14	2.81	MA	13590	4352	22956	3106	25325	2514	26620	2034	28131	1266	33892	965	24643
3L-5S		MI	11615	4352	19623	3098	21253	2502	21859	2015	22294	1247	26927	753	21411
12-#14	2.81	MA	12987	4352	21892	3121	23973	2506	24983	2024	26075	1276	31597	838	24034
4E		MI	12119	4352	20491	3103	22371	2490	23209	2005	24156	1257	29161	811	22305
12-#14	2.81	MA	12445	4352	20956	3117	22767	2518	23509	2034	24044	1266	29149	780	23021
5L-3S		MI	12678	4352	21477	3089	23623	2499	24710	2015	26040	1247	31259	936	22888
12-#14	2.81	MA	11927	4352	20071	3112	21566	2511	22101	2044	22180	1276	26862	695	21935
6L-2S		MI	13455	4352	22689	3095	25169	2488	26570	2005	28497	1237	34480	1064	22941
12-#18	5.00	MA	15457	5097	27877	3541	31501	2838	33858	2212	37680	1161	46260	634	42062
3L-5S		MI	12587	5097	22773	3531	25139	2817	26404	2184	28302	1131	35055	264	33534
12-#18	5.00	MA	14443	5097	26020	3566	29141	2821	31044	2195	34148	1179	42331	414	38842
4E		MI	13436	5097	24289	3544	27082	2799	28716	2166	31493	1149	38853	369	35948
12-#18	5.00	MA	13530	5097	24383	3555	27032	2841	28513	2212	30657	1161	38152	310	36246
5L-3S		MI	14378	5097	26007	3522	29255	2817	31287	2184	34720	1131	42433	584	38821
14-#11	2.27	MA	13818	4169	22795	3009	25171	2428	26466	1982	27997	1287	33775	1152	20269
2L-7S		MI	10920	4169	17997	3004	19219	2430	19444	1976	19173	1291	22970	784	17186
14-#11	2.27	MA	13221	4169	21876	3006	23998	2437	25041	1990	26106	1294	31278	1063	20254
3L-6S		MI	11253	4169	18611	2993	19967	2422	20391	1983	20353	1284	24359	852	17835

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.27	MA	12796	4169	21132	3017	23053	2433	23894	1983	24656	1301	29655	974	20183
4L-5S		MI	11593	4169	19185	2997	20746	2427	21302	1976	21558	1277	25836	912	18203
14-#11	2.27	MA	12413	4169	20478	3014	22209	2442	22862	1991	23224	1294	27925	934	19563
5L-4S		MI	11949	4169	19792	3000	21528	2419	22255	1969	22872	1284	27419	952	18777
14-#11	2.27	MA	12047	4169	19859	3011	21370	2437	21875	1998	21910	1301	26307	875	19143
6L-3S		MI	12344	4169	20482	2990	22405	2424	23314	1976	24203	1277	28903	1039	18832
14-#11	2.27	MA	11690	4169	19198	3022	20564	2446	20851	1992	20624	1307	24619	787	18434
7L-2S		MI	12895	4169	21332	2993	23489	2415	24628	1969	25938	1271	31185	1128	18837
14-#14	3.28	MA	14169	4512	24268	3206	26998	2586	28651	2079	30812	1251	37423	929	28593
3L-6S		MI	11679	4512	20014	3192	21685	2565	22429	2068	23043	1240	28065	629	23853
14-#14	3.28	MA	13572	4512	23204	3221	25646	2578	27013	2069	28756	1261	35127	802	27796
4L-5S		MI	12156	4512	20836	3197	22798	2574	23719	2058	24751	1230	30148	714	24941
14-#14	3.28	MA	13035	4512	22268	3216	24439	2591	25540	2079	26725	1251	32679	745	26847
5L-4S		MI	12655	4512	21704	3203	23917	2563	25069	2048	26613	1240	32382	772	25775
14-#14	3.28	MA	12522	4512	21383	3212	23239	2583	24131	2088	24861	1261	30393	659	25672
6L-3S		MI	13210	4512	22689	3189	25169	2571	26570	2058	28497	1230	34480	897	26539
14-#14	3.28	MA	12022	4512	20436	3227	22085	2596	22669	2079	23037	1271	28245	560	24544
7L-2S		MI	13981	4512	23901	3195	26714	2560	28430	2048	30953	1220	37701	1025	26620
14-#18	5.83	MA	15427	5381	28302	3743	32051	2950	34532	2271	38754	1147	48358	342	45425
4L-5S		MI	13500	5381	24878	3709	27813	2944	29590	2257	32511	1096	40533	186	39429
14-#18	5.83	MA	14526	5381	26665	3732	29942	2969	32000	2288	35263	1129	44179	239	42666
5L-4S		MI	14338	5381	26394	3721	29756	2927	31902	2240	35701	1113	44332	290	42006
16-#11	2.60	MA	13633	4280	22795	3075	25171	2488	26466	2021	27997	1284	33775	1040	23035
3L-7S		MI	11308	4280	18847	3073	20303	2480	20758	2007	20907	1280	25252	759	19632
16-#11	2.60	MA	13210	4280	22051	3086	24225	2483	25319	2014	26547	1291	32152	951	22947
4L-6S		MI	11638	4280	19461	3063	21051	2472	21704	2014	22087	1273	26641	827	20334
16-#11	2.60	MA	12830	4280	21397	3083	23382	2492	24287	2022	25115	1284	30423	911	22247
5E		MI	11976	4280	20035	3066	21830	2477	22615	2007	23293	1266	28119	887	20683
16-#11	2.60	MA	12467	4280	20779	3080	22543	2487	23300	2029	23801	1291	28804	852	21848
6L-4S		MI	12330	4280	20643	3069	22612	2469	23569	2000	24607	1273	29701	927	21333
16-#11	2.60	MA	12112	4280	20117	3091	21736	2497	22276	2023	22515	1298	27116	764	21085
7L-3S		MI	12723	4280	21332	3059	23489	2474	24628	2007	25938	1266	31185	1014	21406
16-#11	2.60	MA	11763	4280	19509	3089	20923	2492	21308	2030	21245	1304	25502	717	20415
8L-2S		MI	13270	4280	22182	3063	24573	2466	25942	2000	27672	1260	33468	1103	21431
16-#14	3.75	MA	14152	4671	24516	3321	27318	2651	29044	2113	31437	1245	38658	767	31575
4L-6S		MI	12219	4671	21227	3291	23230	2638	24289	2111	25500	1223	31286	590	27309
16-#14	3.75	MA	13620	4671	23580	3316	26112	2663	27570	2123	29406	1235	36210	710	30683
5E		MI	12692	4671	22048	3297	24344	2646	25579	2101	27208	1213	33369	676	28481
16-#14	3.75	MA	13112	4671	22695	3311	24912	2656	26162	2133	27542	1245	33923	624	29424
6L-4S		MI	13187	4671	22916	3303	25462	2635	26929	2091	29069	1223	35603	734	29262
16-#14	3.75	MA	12616	4671	21748	3326	23758	2668	24699	2123	25719	1255	31776	525	28239
7L-3S		MI	13737	4671	23901	3289	26714	2644	28430	2101	30953	1213	37701	858	30184
16-#18	6.67	MA	15512	5664	28948	3909	32851	3098	35488	2364	39870	1097	50205	167	49117
5E		MI	14404	5664	26984	3886	30487	3072	32775	2331	36719	1060	46012	107	45356
18-#11	2.92	MA	13622	4390	22971	3155	25397	2533	26744	2046	28437	1281	34649	929	25705
4L-7S		MI	11694	4390	19698	3142	21387	2530	22072	2038	22642	1269	27534	734	22085
18-#11	2.92	MA	13244	4390	22316	3153	24554	2542	25711	2053	27006	1274	32920	889	24937
5L-6S		MI	12021	4390	20312	3132	22135	2522	23018	2044	23822	1262	28923	802	22808
18-#11	2.92	MA	12884	4390	21698	3150	23715	2538	24725	2060	25691	1281	31301	829	24556
6L-5S		MI	12357	4390	20886	3135	22914	2527	23929	2038	25028	1255	30401	862	23169
18-#11	2.92	MA	12532	4390	21037	3161	22909	2547	23701	2054	24405	1288	29614	741	23744
7L-4S		MI	12708	4390	21493	3139	23696	2519	24882	2031	26342	1262	31983	902	23845
18-#11	2.92	MA	12185	4390	20429	3158	22095	2542	22733	2061	23135	1295	27999	694	23035
8L-3S		MI	13098	4390	22182	3128	24573	2524	25942	2038	27672	1255	33468	989	23976
18-#14	4.22	MA	14199	4831	24892	3416	27785	2735	29600	2168	32088	1220	39740	674	34527
5L-6S		MI	12756	4831	22439	3391	24776	2710	26149	2155	27957	1205	34507	551	30777
18-#14	4.22	MA	13696	4831	24007	3411	26584	2728	28192	2178	30224	1230	37454	589	33189
6L-5S		MI	13225	4831	23260	3397	25889	2719	27439	2145	29664	1196	36590	637	32028

RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
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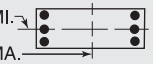


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	4.22	MA	13204	4831	23060	3426	25430	2740	26730	2168	28400	1240	35306	490	31948
7L-4S		MI	13715	4831	24128	3402	27008	2707	28789	2135	31526	1205	38824	695	32762
20-#11	3.25	MA	13656	4501	23236	3222	25726	2592	27136	2084	28896	1264	35417	866	27634
5L-7S		MI	12076	4501	20548	3211	22471	2580	23385	2068	24377	1258	29817	709	24545
20-#11	3.25	MA	13298	4501	22617	3219	24887	2588	26150	2092	27582	1271	33798	807	27190
6E		MI	12402	4501	21162	3201	23219	2572	24331	2075	25557	1251	31205	777	25238
20-#11	3.25	MA	12948	4501	21956	3230	24081	2597	25126	2085	26296	1278	32111	719	26410
7L-5S		MI	12735	4501	21736	3204	23998	2577	25242	2068	26763	1244	32683	837	25661
20-#11	3.25	MA	12604	4501	21348	3227	23267	2592	24158	2093	25026	1285	30496	671	25662
8L-4S		MI	13084	4501	22343	3208	24780	2569	26196	2061	28077	1251	34266	877	26301
20-#14	4.69	MA	14275	4990	25319	3511	28257	2800	30223	2222	32905	1214	40984	553	36965
6E		MI	13288	4990	23651	3491	26321	2782	28009	2198	30414	1188	37728	512	34257
20-#14	4.69	MA	13788	4990	24372	3526	27103	2813	28760	2213	31081	1224	38837	454	35669
7L-5S		MI	13753	4990	24472	3496	27435	2791	29299	2188	32121	1178	39811	598	35582
22-#11	3.57	MA	13709	4612	23537	3288	26059	2638	27575	2123	29473	1261	36295	784	29832
6L-7S		MI	12456	4612	21398	3280	23555	2631	24699	2099	26112	1247	32099	684	27011
22-#11	3.57	MA	13362	4612	22875	3299	25253	2647	26551	2116	28187	1268	34608	696	29081
7L-6S		MI	12779	4612	22012	3270	24303	2622	25645	2106	27292	1240	33488	752	27675
22-#11	3.57	MA	13020	4612	22268	3296	24439	2642	25583	2124	26916	1275	32993	649	28296
8L-5S		MI	13111	4612	22586	3273	25082	2628	26556	2099	28497	1233	34965	812	28157
22-#14	5.16	MA	14367	5150	25684	3626	28776	2885	30790	2257	33763	1208	42368	419	39400
7L-6S		MI	13816	5150	24863	3591	27867	2855	29869	2241	32870	1171	40949	474	37747
24-#11	3.90	MA	13773	4722	23795	3368	26425	2697	27976	2147	30077	1258	37105	673	31757
7E		MI	12834	4722	22248	3349	24639	2681	26012	2130	27846	1236	34381	659	29481
24-#11	3.90	MA	13433	4722	23187	3365	25611	2693	27008	2155	28807	1265	35490	626	30935
8L-6S		MI	13155	4722	22862	3339	25387	2672	26959	2137	29026	1229	35770	727	30119

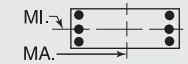
RECTANGULAR TIED COLUMNS 30" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.57	MA	14519	4174	23457	3015	25417	2446	26153	2016	26603	1371	31441	1250	15832
2E		MI	12718	4174	20659	2980	22225	2415	22691	1981	22950	1339	26937	1206	13764
6-#14	1.32	MA	14236	4085	22696	2984	24552	2426	25186	2011	25392	1400	29930	1297	13592
2L-3S		MI	11688	4085	18803	2946	19980	2410	20092	1994	19529	1383	22543	1133	11904
6-#14	1.32	MA	13303	4085	21284	2980	22753	2439	22998	2022	22486	1410	26089	1169	13639
3L-2S		MI	12487	4085	20016	2952	21526	2399	21953	1984	21986	1373	25764	1261	11843
6-#18	2.35	MA	15613	4458	25916	3193	28552	2575	29943	2094	31609	1341	38017	1184	23365
2L-3S		MI	12280	4458	20659	3144	22225	2560	22691	2072	22950	1321	26937	900	20178
6-#18	2.35	MA	14023	4458	23457	3183	25417	2596	26153	2112	26603	1359	31441	956	23236
3L-2S		MI	13640	4458	22765	3157	24899	2543	25876	2054	27158	1303	32416	1127	20234
8-#11	1.22	MA	14119	4049	22375	2974	24197	2420	24775	2009	24900	1413	29317	1317	12667
2L-4S		MI	11425	4049	18203	2950	19270	2397	19279	1986	18530	1402	21523	1108	11118
8-#11	1.22	MA	13464	4049	21386	2972	22937	2429	23243	2018	22853	1420	26605	1228	12703
3E		MI	11830	4049	18892	2939	20146	2402	20338	1993	19861	1395	23007	1196	11091
8-#11	1.22	MA	12996	4049	20588	2983	21922	2425	22011	2012	21283	1427	24837	1140	12706
4L-2S		MI	12392	4049	19743	2943	21230	2394	21652	1986	21596	1388	25289	1284	11047
8-#14	1.76	MA	14877	4245	24107	3084	26352	2498	27374	2056	28298	1386	33770	1265	17923
2L-4S		MI	11666	4245	19030	3060	20274	2474	20452	2027	20102	1375	23666	970	15539
8-#14	1.76	MA	13952	4245	22696	3080	24552	2512	25186	2067	25392	1396	29930	1137	17931
3E		MI	12237	4245	20016	3046	21526	2483	21953	2037	21986	1365	25764	1094	15609
8-#14	1.76	MA	13291	4245	21554	3096	23101	2505	23425	2058	23163	1406	27432	1009	17804
4L-2S		MI	13030	4245	21228	3051	23071	2471	23813	2027	24443	1356	28985	1222	15576

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis

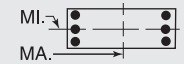


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.14	MA	16689	4742	28376	3370	31688	2703	33733	2172	36614	1312	44594	1118	30846
2L-4S		MI	12235	4742	21047	3344	22726	2670	23305	2128	23932	1303	28836	606	24224
8-#18	3.14	MA	15121	4742	25916	3361	28552	2724	29943	2190	31609	1330	38017	890	30604
3E		MI	13206	4742	22765	3321	24899	2688	25876	2145	27158	1285	32416	821	26490
8-#18	3.14	MA	13997	4742	23920	3387	26015	2710	26886	2172	27770	1348	33738	666	27960
4L-2S		MI	14549	4742	24870	3334	27573	2670	29062	2128	31366	1268	37894	1049	26657
10-#11	1.53	MA	14572	4160	23363	3043	25458	2470	26307	2041	26947	1404	32029	1296	15701
2L-5S		MI	11454	4160	18446	3015	19571	2456	19639	2024	18951	1384	22223	1043	13416
10-#11	1.53	MA	13921	4160	22375	3041	24197	2480	24775	2049	24900	1411	29317	1208	15723
3L-4S		MI	11816	4160	19053	3019	20354	2447	20593	2017	20265	1391	23805	1083	13701
10-#11	1.53	MA	13457	4160	21576	3052	23183	2476	23543	2043	23330	1418	27550	1119	15697
4L-3S		MI	12218	4160	19743	3009	21230	2453	21652	2024	21596	1384	25289	1171	13699
10-#11	1.53	MA	13039	4160	20875	3050	22278	2485	22436	2051	21781	1411	25678	1078	15338
5L-2S		MI	12777	4160	20593	3012	22314	2444	22966	2017	23330	1377	27572	1259	13667
10-#14	2.21	MA	15510	4405	25519	3184	28152	2571	29562	2101	31204	1372	37611	1232	22236
2L-5S		MI	11704	4405	19375	3154	20701	2558	20962	2080	20697	1348	24653	873	18075
10-#14	2.21	MA	14594	4405	24107	3180	26352	2584	27374	2112	28298	1382	33770	1104	22204
3L-4S		MI	12214	4405	20243	3160	21819	2546	22312	2070	22559	1358	26887	931	19072
10-#14	2.21	MA	13940	4405	22965	3196	24901	2577	25613	2103	26069	1392	31272	976	21975
4L-3S		MI	12780	4405	21228	3145	23071	2555	23813	2080	24443	1348	28985	1056	19287
10-#14	2.21	MA	13351	4405	21961	3192	23606	2591	24028	2114	23868	1382	28614	918	20725
5L-2S		MI	13566	4405	22440	3151	24617	2544	25673	2070	26900	1338	32206	1184	19290
10-#18	3.92	MA	17750	5025	30836	3547	34824	2832	37522	2250	41619	1283	51170	1052	38294
2L-5S		MI	12297	5025	21636	3508	23457	2816	24179	2219	24949	1250	30516	423	28138
10-#18	3.92	MA	16202	5025	28376	3538	31688	2853	33733	2268	36614	1301	44594	824	37957
3L-4S		MI	13161	5025	23152	3521	25400	2798	26491	2201	28140	1267	34315	527	30207
10-#18	3.92	MA	15094	5025	26379	3564	29151	2839	30676	2250	32776	1318	40314	601	34989
4L-3S		MI	14120	5025	24870	3499	27573	2816	29062	2219	31366	1250	37894	743	32784
10-#18	3.92	MA	14098	5025	24621	3555	26885	2860	27925	2268	28983	1301	35754	498	32576
5L-2S		MI	15446	5025	26975	3511	30247	2798	32247	2201	35575	1232	43373	970	33038
12-#11	1.84	MA	15022	4271	24352	3112	26718	2520	27839	2072	28993	1395	34742	1275	18726
2L-6S		MI	11500	4271	18722	3081	19877	2501	20042	2062	19480	1380	23027	959	15474
12-#11	1.84	MA	14375	4271	23363	3110	25458	2530	26307	2080	26947	1402	32029	1187	18730
3L-5S		MI	11844	4271	19296	3085	20655	2506	20953	2055	20686	1373	24505	1018	15875
12-#11	1.84	MA	13914	4271	22565	3121	24443	2526	25076	2074	25377	1409	30262	1098	18680
4E		MI	12203	4271	19903	3088	21438	2497	21906	2048	22000	1380	26087	1058	16274
12-#11	1.84	MA	13500	4271	21863	3119	23539	2536	23969	2082	23827	1402	28390	1057	18204
5L-3S		MI	12602	4271	20593	3078	22314	2503	22966	2055	23330	1373	27572	1146	16296
12-#11	1.84	MA	13104	4271	21201	3117	22639	2532	22872	2077	22405	1409	26630	998	17693
6L-2S		MI	13158	4271	21443	3081	23398	2494	24279	2048	25065	1366	29854	1235	16276
12-#14	2.65	MA	16137	4564	26931	3284	29952	2643	31750	2146	34110	1358	41451	1200	26533
2L-6S		MI	11768	4564	19766	3248	21133	2621	21532	2134	21446	1341	25791	748	20708
12-#14	2.65	MA	15229	4564	25519	3280	28152	2656	29562	2157	31204	1368	37611	1072	26465
3L-5S		MI	12251	4564	20587	3254	22246	2630	22822	2124	23154	1331	27874	834	21591
12-#14	2.65	MA	14581	4564	24377	3295	26700	2650	27801	2148	28975	1378	35113	944	26004
4E		MI	12757	4564	21455	3259	23365	2619	24172	2114	25016	1341	30108	892	22517
12-#14	2.65	MA	13998	4564	23373	3291	25406	2663	26216	2158	26775	1368	32455	886	24832
5L-3S		MI	13318	4564	22440	3245	24617	2627	25673	2124	26900	1331	32206	1017	22953
12-#14	2.65	MA	13442	4564	22424	3287	24119	2657	24703	2169	24754	1378	29965	801	23793
6L-2S		MI	14098	4564	23652	3251	26162	2616	27533	2114	29356	1321	35427	1145	22992
12-#18	4.71	MA	17269	5309	30836	3715	34824	2981	37522	2346	41619	1272	51170	759	45302
3L-5S		MI	13223	5309	23741	3686	26131	2944	27364	2292	29157	1214	35995	344	33987
12-#18	4.71	MA	16177	5309	28839	3741	32287	2967	34466	2329	37781	1289	46890	535	42058
4E		MI	14076	5309	25257	3699	28074	2926	29676	2274	32348	1232	39793	449	36230
12-#18	4.71	MA	15195	5309	27081	3732	30021	2988	31715	2346	33989	1272	42330	432	39477
5L-3S		MI	15022	5309	26975	3676	30247	2944	32247	2292	35575	1214	43373	664	39066
14-#11	2.14	MA	15468	4381	25340	3181	27979	2570	29371	2103	31040	1386	37454	1255	21743
2L-7S		MI	11556	4381	18958	3161	20212	2559	20409	2086	20035	1376	23921	866	17402

RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

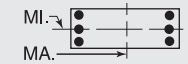
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.14	MA	14825	4381	24352	3179	26718	2580	27839	2111	28993	1393	34742	1166	21728
3L-6S		MI	11889	4381	19572	3150	20961	2551	21355	2092	21215	1369	25309	934	17969
14-#11	2.14	MA	14367	4381	23553	3190	25703	2576	26608	2105	27423	1400	32975	1077	21658
4L-5S		MI	12230	4381	20146	3154	21739	2556	22266	2086	22421	1362	26787	993	18345
14-#11	2.14	MA	13956	4381	22852	3188	24799	2586	25501	2113	25874	1393	31102	1036	21082
5L-4S		MI	12588	4381	20754	3157	22522	2548	23220	2079	23735	1369	28370	1033	18840
14-#11	2.14	MA	13563	4381	22189	3186	23900	2582	24404	2108	24451	1400	29343	977	20598
6L-3S		MI	12984	4381	21443	3147	23398	2553	24279	2086	25065	1362	29854	1121	18882
14-#11	2.14	MA	13180	4381	21480	3197	23036	2591	23345	2116	23059	1407	27509	889	19923
7L-2S		MI	13537	4381	22293	3150	24482	2544	25593	2079	26800	1355	32136	1210	18878
14-#14	3.09	MA	15858	4724	26931	3379	29952	2729	31750	2201	34110	1354	41451	1039	30719
3L-6S		MI	12315	4724	20978	3348	22678	2694	23392	2177	23903	1324	29012	710	24145
14-#14	3.09	MA	15216	4724	25789	3395	28500	2722	29989	2192	31881	1364	38953	911	30055
4L-5S		MI	12794	4724	21799	3353	23792	2702	24682	2167	25611	1314	31095	795	25120
14-#14	3.09	MA	14638	4724	24785	3391	27206	2735	28404	2203	29681	1354	36295	854	28953
5L-4S		MI	13295	4724	22667	3359	24910	2691	26032	2157	27472	1324	33329	853	25983
14-#14	3.09	MA	14088	4724	23836	3387	25918	2729	26891	2214	27660	1364	33806	768	27822
6L-3S		MI	13852	4724	23652	3345	26162	2700	27533	2167	29356	1314	35427	978	26609
14-#14	3.09	MA	13550	4724	22821	3403	24681	2742	25319	2205	25683	1374	31210	641	26658
7L-2S		MI	14626	4724	24864	3351	27708	2688	29393	2157	31813	1304	38648	1106	26675
14-#18	5.49	MA	17246	5593	31299	3919	35423	3096	38256	2407	42786	1260	53467	469	49160
4L-5S		MI	14137	5593	25846	3863	28805	3071	30550	2365	33365	1179	41473	266	39874
14-#18	5.49	MA	16277	5593	29541	3909	33157	3117	35505	2425	38994	1242	48906	366	46414
5L-4S		MI	14980	5593	27362	3876	30748	3054	32862	2348	36556	1196	45272	370	42284
16-#11	2.45	MA	15271	4492	25340	3248	27979	2630	29371	2142	31040	1384	37454	1145	24720
3L-7S		MI	11944	4492	19809	3230	21296	2609	21723	2116	21769	1364	26203	841	19845
16-#11	2.45	MA	14817	4492	24542	3260	26964	2626	28140	2136	29470	1391	35687	1056	24631
4L-6S		MI	12275	4492	20423	3219	22045	2601	22669	2123	22949	1358	27592	909	20469
16-#11	2.45	MA	14408	4492	23841	3257	26059	2636	27033	2145	27921	1384	33815	1015	23969
5E		MI	12615	4492	20997	3223	22823	2606	23580	2116	24155	1351	29069	968	20824
16-#11	2.45	MA	14019	4492	23178	3255	25160	2632	25936	2139	26498	1391	32055	956	23509
6L-4S		MI	12969	4492	21604	3226	23606	2598	24533	2109	25469	1358	30652	1008	21401
16-#11	2.45	MA	13638	4492	22469	3266	24296	2642	24877	2147	25105	1398	30221	868	22777
7L-3S		MI	13363	4492	22293	3216	24482	2603	25593	2116	26800	1351	32136	1096	21460
16-#11	2.45	MA	13263	4492	21818	3264	23424	2638	23841	2155	23646	1391	28473	820	22145
8L-2S		MI	13913	4492	23144	3219	25566	2595	26906	2109	28535	1344	34418	1185	21474
16-#14	3.53	MA	15845	4883	27201	3495	30300	2794	32176	2237	34787	1350	42794	879	34124
4L-6S		MI	12856	4883	22190	3447	24224	2766	25252	2220	26360	1306	32233	671	27597
16-#14	3.53	MA	15273	4883	26196	3491	29006	2808	30592	2248	32587	1340	40136	821	33084
5E		MI	13331	4883	23011	3453	25337	2775	26542	2210	28067	1297	34316	757	28658
16-#14	3.53	MA	14727	4883	25247	3487	27718	2801	29078	2259	30567	1350	37646	736	31866
6L-4S		MI	13829	4883	23879	3459	26456	2763	27892	2200	29929	1306	36550	815	29467
16-#14	3.53	MA	14195	4883	24232	3503	26481	2815	27506	2250	28590	1360	35050	609	30714
7L-3S		MI	14381	4883	24864	3445	27708	2772	29393	2210	31813	1297	38648	939	30258
16-#18	6.27	MA	17347	5876	32000	4087	36293	3245	39295	2503	43999	1213	55483	300	53383
5E		MI	15043	5876	27951	4040	31480	3199	33735	2439	37574	1143	46952	187	45793
18-#11	2.75	MA	15263	4603	25531	3329	28224	2676	29672	2168	31517	1382	38400	1035	27602
4L-7S		MI	12330	4603	20659	3299	22380	2659	23036	2147	23504	1353	28485	816	22296
18-#11	2.75	MA	14858	4603	24829	3326	27320	2686	28565	2176	29967	1375	36527	994	26863
5L-6S		MI	12659	4603	21273	3289	23129	2651	23982	2154	24684	1347	29874	884	22972
18-#11	2.75	MA	14471	4603	24167	3324	26420	2682	27468	2170	28545	1382	34767	935	26424
6L-5S		MI	12996	4603	21847	3292	23907	2656	24893	2147	25890	1340	31351	943	23310
18-#11	2.75	MA	14093	4603	23458	3336	25556	2692	26410	2178	27152	1389	32934	847	25639
7L-4S		MI	13349	4603	22454	3295	24690	2648	25847	2140	27204	1347	32934	983	23958

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

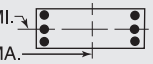
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.75	MA	13721	4603	22807	3333	24684	2688	25373	2186	25693	1382	31185	799	24968
8L-3S		MI	13740	4603	23144	3285	25566	2653	26906	2147	28535	1340	34418	1071	24033
18-#14	3.97	MA	15902	5043	27608	3591	30806	2880	32780	2293	35493	1326	43977	789	37224
5L-6S		MI	13394	5043	23402	3547	25769	2838	27112	2264	28817	1289	35454	632	31062
18-#14	3.97	MA	15361	5043	26659	3587	29518	2874	31266	2304	33473	1336	41487	703	35923
6L-5S		MI	13865	5043	24224	3553	26883	2847	28402	2254	30524	1279	37537	718	32205
18-#14	3.97	MA	14833	5043	25644	3602	28281	2887	29694	2295	31496	1345	38891	576	34715
7L-4S		MI	14358	5043	25092	3559	28001	2836	29752	2244	32386	1289	39771	776	32965
20-#11	3.06	MA	15304	4713	25818	3396	28580	2736	30097	2207	32014	1366	39240	974	29764
5L-7S		MI	12713	4713	21509	3368	23464	2710	24350	2178	25239	1342	30767	791	24754
20-#11	3.06	MA	14920	4713	25155	3393	27681	2732	29000	2201	30591	1373	37480	915	29343
6E		MI	13040	4713	22123	3358	24213	2701	25296	2185	26419	1336	32156	859	25472
20-#11	3.06	MA	14544	4713	24446	3405	26817	2742	27942	2209	29199	1380	35646	827	28508
7L-5S		MI	13375	4713	22697	3361	24991	2706	26207	2178	27625	1329	33634	918	25801
20-#11	3.06	MA	14175	4713	23795	3402	25945	2738	26905	2217	27739	1373	33898	779	27798
8L-4S		MI	13725	4713	23304	3365	25774	2698	27160	2171	28939	1336	35216	958	26468
20-#14	4.41	MA	15989	5203	28071	3686	31318	2946	33454	2349	36379	1321	45327	671	39991
6E		MI	13927	5203	24615	3647	27315	2911	28972	2307	31273	1272	38675	593	34538
20-#14	4.41	MA	15466	5203	27056	3702	30081	2959	31882	2340	34402	1331	42732	544	38727
7L-5S		MI	14394	5203	25436	3653	28428	2919	30262	2297	32981	1262	40759	679	35758
22-#11	3.36	MA	15365	4824	26144	3462	28941	2782	30533	2232	32638	1364	40192	894	32253
6L-7S		MI	13094	4824	22359	3437	24549	2760	25663	2209	26974	1331	33049	766	27218
22-#11	3.36	MA	14993	4824	25435	3474	28077	2792	29474	2240	31246	1371	38358	806	31383
7L-6S		MI	13419	4824	22973	3427	25297	2751	26610	2216	28154	1325	34438	834	27907
22-#11	3.36	MA	14626	4824	24784	3471	27205	2788	28437	2249	29786	1364	36610	758	30635
8L-5S		MI	13752	4824	23548	3430	26075	2757	27521	2209	29360	1318	35916	893	28297
22-#14	4.85	MA	16094	5362	28467	3802	31880	3032	34070	2385	37308	1317	46572	512	42751
7L-6S		MI	14456	5362	25827	3747	28860	2983	30833	2350	33730	1255	41896	555	38024
24-#11	3.67	MA	15438	4934	26423	3543	29337	2842	31006	2272	33292	1362	41071	785	34264
7E		MI	13473	4934	23210	3506	25633	2810	26977	2239	28708	1320	35332	741	29687
24-#11	3.67	MA	15074	4934	25772	3541	28465	2838	29969	2280	31833	1355	39322	737	33477
8L-6S		MI	13796	4934	23824	3496	26381	2801	27923	2246	29888	1314	36720	809	30349

RECTANGULAR TIED COLUMNS 30" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.48	MA	16188	4386	26004	3188	28193	2588	29031	2139	29468	1468	34840	1350	16912
2E		MI	13357	4386	21627	3134	23218	2542	23651	2089	23805	1422	27877	1286	13808
6-#14	1.25	MA	15877	4298	25180	3157	27257	2568	27935	2132	28136	1496	33165	1394	14504
2L-3S		MI	12325	4298	19767	3102	20974	2539	21055	2103	20389	1466	23490	1214	11945
6-#14	1.25	MA	14876	4298	23669	3153	25330	2582	25593	2143	25005	1506	29014	1266	14551
3L-2S		MI	13125	4298	20979	3108	22519	2527	22916	2093	22846	1457	26711	1342	11878
6-#18	2.22	MA	17371	4670	28641	3365	31555	2717	33118	2219	34872	1442	41967	1289	24985
2L-3S		MI	12918	4670	21627	3298	23218	2687	23651	2180	23805	1404	27877	980	20260
6-#18	2.22	MA	15661	4670	26004	3357	28193	2739	29031	2237	29468	1460	34840	1061	24856
3L-2S		MI	14281	4670	23732	3311	25892	2670	26836	2162	28013	1386	33356	1208	20286
8-#11	1.16	MA	15749	4261	24833	3146	26873	2561	27490	2130	27596	1509	32486	1413	13509
2L-4S		MI	12062	4261	19164	3107	20263	2526	20244	2096	19393	1486	22474	1189	11160
8-#11	1.16	MA	15046	4261	23775	3144	25524	2572	25850	2139	25393	1516	29558	1325	13545
3E		MI	12467	4261	19854	3096	21140	2532	21303	2103	20723	1479	23958	1277	11125
8-#11	1.16	MA	14546	4261	22923	3156	24440	2568	24535	2134	23703	1523	27648	1236	13548
4L-2S		MI	13030	4261	20704	3100	22224	2523	22617	2096	22458	1472	26240	1366	11079
8-#14	1.67	MA	16569	4457	26692	3256	29184	2640	30278	2176	31268	1484	37316	1364	19138
2L-4S		MI	12302	4457	19994	3216	21267	2602	21415	2136	20962	1459	24613	1051	15611
8-#14	1.67	MA	15576	4457	25180	3253	27257	2654	27935	2188	28136	1494	33165	1236	19146
3E		MI	12875	4457	20979	3202	22519	2611	22916	2146	22846	1449	26711	1175	15657

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

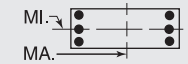
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.67	MA	14869	4457	23960	3270	25706	2649	26053	2180	25735	1504	30460	1109	19019
4L-2S		MI	13669	4457	22191	3207	24065	2600	24776	2136	25303	1439	29932	1303	15616
8-#18	2.96	MA	18534	4954	31278	3542	34917	2845	37205	2299	40277	1415	49094	1228	33006
2L-4S		MI	12871	4954	22014	3498	23719	2798	24265	2235	24787	1386	29776	686	24511
8-#18	2.96	MA	16847	4954	28641	3534	31555	2868	33118	2317	34872	1433	41967	1000	32764
3E		MI	13846	4954	23732	3476	25892	2815	26836	2253	28013	1368	33356	901	26584
8-#18	2.96	MA	15643	4954	26505	3562	28840	2855	29823	2300	30727	1451	37336	773	30169
4L-2S		MI	15192	4954	25837	3489	28566	2798	30022	2235	32221	1350	38834	1129	26719
10-#11	1.44	MA	16238	4372	25891	3215	28221	2612	29129	2161	29799	1501	35415	1394	16754
2L-5S		MI	12090	4372	19407	3172	20565	2585	20604	2134	19813	1468	23173	1125	13556
10-#11	1.44	MA	15539	4372	24833	3214	26873	2622	27490	2170	27596	1508	32486	1305	16776
3L-4S		MI	12453	4372	20014	3176	21347	2576	21557	2127	21127	1475	24756	1164	13751
10-#11	1.44	MA	15043	4372	23980	3225	25789	2619	26174	2165	25906	1515	30576	1217	16750
4L-3S		MI	12856	4372	20704	3165	22224	2582	22617	2134	22458	1468	26240	1252	13737
10-#11	1.44	MA	14597	4372	23232	3224	24824	2629	24993	2174	24239	1508	28560	1175	16463
5L-2S		MI	13415	4372	21554	3169	23308	2573	23930	2127	24192	1461	28522	1341	13702
10-#14	2.08	MA	17253	4617	28203	3356	31111	2712	32620	2221	34399	1471	41468	1335	23755
2L-5S		MI	12340	4617	20338	3310	21694	2686	21925	2189	21557	1432	25600	954	18251
10-#14	2.08	MA	16269	4617	26692	3353	29184	2727	30278	2233	31268	1481	37316	1207	23722
3L-4S		MI	12852	4617	21206	3316	22813	2675	23275	2179	23419	1442	27834	1012	19253
10-#14	2.08	MA	15568	4617	25471	3369	27633	2721	28395	2225	28866	1491	34611	1079	23548
4L-3S		MI	13419	4617	22191	3301	24065	2683	24776	2189	25303	1432	29932	1137	19344
10-#14	2.08	MA	14939	4617	24399	3366	26251	2735	26703	2237	26495	1481	31747	1019	22256
5L-2S		MI	14207	4617	23403	3307	25610	2672	26636	2179	27759	1422	33153	1265	19334
10-#18	3.70	MA	19682	5237	33915	3720	38279	2974	41292	2379	45682	1389	56220	1167	40994
2L-5S		MI	12931	5237	22604	3663	24450	2943	25139	2326	25804	1333	31456	503	28590
10-#18	3.70	MA	18016	5237	31278	3712	34917	2996	37205	2397	40277	1406	49094	940	40657
3L-4S		MI	13799	5237	24120	3676	26393	2925	27451	2309	28995	1350	35255	607	30487
10-#18	3.70	MA	16829	5237	29142	3739	32202	2984	33910	2380	36132	1424	44463	712	37716
4L-3S		MI	14761	5237	25837	3653	28566	2943	30022	2326	32221	1333	38834	823	32887
10-#18	3.70	MA	15762	5237	27263	3731	29780	3006	30946	2398	32039	1406	39521	611	35341
5L-2S		MI	16092	5237	27942	3666	31240	2925	33207	2309	36429	1315	44313	1050	33107
12-#11	1.73	MA	16723	4483	26948	3285	29570	2662	30768	2192	32002	1493	38343	1375	19989
2L-6S		MI	12136	4483	19683	3238	20871	2630	21006	2171	20342	1464	23978	1040	15603
12-#11	1.73	MA	16028	4483	25891	3283	28221	2672	29129	2201	29799	1500	35415	1286	19993
3L-5S		MI	12480	4483	20258	3241	21649	2635	21917	2164	21548	1457	25455	1100	16014
12-#11	1.73	MA	15535	4483	25038	3295	27137	2669	27814	2196	28109	1506	33504	1198	19943
4E		MI	12841	4483	20865	3245	22432	2626	22871	2157	22862	1464	27038	1139	16328
12-#11	1.73	MA	15093	4483	24289	3293	26172	2679	26632	2205	26442	1500	31488	1156	19532
5L-3S		MI	13241	4483	21554	3235	23308	2632	23930	2164	24192	1457	28522	1227	16338
12-#11	1.73	MA	14670	4483	23583	3291	25212	2676	25462	2200	24910	1506	29587	1097	18951
6L-2S		MI	13798	4483	22404	3238	24392	2623	25244	2157	25927	1450	30804	1316	16314
12-#14	2.50	MA	17930	4776	29714	3456	33038	2785	34963	2266	37530	1458	45619	1305	28355
2L-6S		MI	12403	4776	20729	3404	22126	2750	22495	2243	22306	1425	26738	829	20997
12-#14	2.50	MA	16954	4776	28203	3453	31111	2799	32620	2278	34399	1468	41468	1177	28288
3L-5S		MI	12888	4776	21550	3410	23240	2758	23785	2233	24014	1415	28821	915	21765
12-#14	2.50	MA	16260	4776	26983	3469	29560	2793	30738	2270	31997	1478	38763	1049	27996
4E		MI	13396	4776	22418	3415	24358	2747	25135	2223	25875	1425	31055	973	22723
12-#14	2.50	MA	15637	4776	25911	3466	28178	2808	29046	2282	29627	1468	35898	990	26657
5L-3S		MI	13958	4776	23403	3401	25610	2756	26636	2233	27759	1415	33153	1098	23015
12-#14	2.50	MA	15043	4776	24898	3463	26803	2802	27369	2274	27450	1478	33205	905	25679
6L-2S		MI	14740	4776	24616	3407	27156	2744	28496	2223	30216	1405	36374	1226	23039
12-#18	4.44	MA	19170	5521	33915	3889	38279	3125	41292	2477	45682	1380	56220	879	48542
3L-5S		MI	13858	5521	24709	3840	27124	3071	28324	2400	30012	1297	36935	424	34431

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis

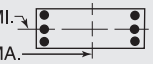


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	4.44	MA	17998	5521	31779	3916	35564	3112	37997	2460	41537	1397	51590	652	45304
4E		MI	14715	5521	26225	3853	29067	3053	30636	2382	33203	1315	40733	529	36505
12-#18	4.44	MA	16946	5521	29900	3908	33142	3135	35033	2478	37443	1380	46648	550	42761
5L-3S		MI	15666	5521	27942	3830	31240	3071	33207	2400	36429	1297	44313	744	39177
12-#18	4.44	MA	15943	5521	28123	3900	30733	3122	32200	2496	33686	1397	42031	398	39857
6L-2S		MI	16982	5521	30047	3843	33914	3053	36393	2382	40638	1279	49791	972	39473
14-#11	2.02	MA	17204	4593	28006	3354	30918	2712	32408	2223	34205	1485	41271	1356	23218
2L-7S		MI	12191	4593	19920	3317	21206	2688	21374	2195	20897	1460	24871	947	17611
14-#11	2.02	MA	16514	4593	26948	3352	29570	2722	30768	2232	32002	1492	38343	1267	23202
3L-6S		MI	12525	4593	20534	3307	21955	2680	22320	2202	22077	1453	26260	1015	18098
14-#11	2.02	MA	16024	4593	26096	3364	28486	2719	29453	2227	30312	1498	36432	1178	23132
4L-5S		MI	12868	4593	21108	3311	22733	2685	23231	2195	23283	1446	27738	1075	18483
14-#11	2.02	MA	15584	4593	25347	3362	27521	2729	28271	2236	28645	1492	34416	1137	22612
5L-4S		MI	13226	4593	21715	3314	23516	2677	24184	2188	24597	1453	29320	1114	18899
14-#11	2.02	MA	15165	4593	24640	3360	26561	2726	27101	2231	27113	1498	32515	1078	22062
6L-3S		MI	13624	4593	22404	3304	24392	2682	25244	2195	25927	1446	30804	1202	18931
14-#11	2.02	MA	14756	4593	23884	3372	25639	2736	25971	2240	25615	1505	30534	990	21428
7L-2S		MI	14177	4593	23255	3307	25476	2674	26557	2188	27662	1439	33087	1291	18918
14-#14	2.92	MA	17633	4936	29714	3552	33038	2871	34963	2323	37530	1455	45619	1147	32845
3L-6S		MI	12951	4936	21941	3504	23672	2822	24355	2286	24763	1407	29959	791	24429
14-#14	2.92	MA	16945	4936	28494	3569	31487	2866	33080	2315	35128	1465	42914	1019	32336
4L-5S		MI	13431	4936	22763	3509	24785	2831	25645	2276	26470	1398	32042	876	25293
14-#14	2.92	MA	16328	4936	27422	3566	30105	2880	31388	2327	32758	1455	40049	960	31072
5L-4S		MI	13935	4936	23631	3515	25903	2819	26995	2266	28332	1407	34276	934	26186
14-#14	2.92	MA	15739	4936	26409	3562	28730	2874	29712	2319	30581	1465	37356	875	30000
6L-3S		MI	14493	4936	24616	3501	27156	2828	28496	2276	30216	1398	36374	1059	26676
14-#14	2.92	MA	15164	4936	25326	3579	27409	2888	28094	2331	28451	1475	34549	748	28683
7L-2S		MI	15269	4936	25828	3507	28701	2817	30356	2266	32673	1388	39595	1187	26729
14-#18	5.19	MA	19153	5805	34416	4094	38926	3241	42084	2539	46942	1371	58717	591	52926
4L-5S		MI	14774	5805	26814	4017	29798	3198	31510	2473	34220	1262	42413	346	40309
14-#18	5.19	MA	18115	5805	32537	4086	36504	3264	39120	2557	42848	1353	53775	489	50217
5L-4S		MI	15622	5805	28330	4030	31741	3181	33822	2455	37411	1279	46212	450	42555
14-#18	5.19	MA	17125	5805	30760	4078	34095	3251	36287	2575	39091	1371	49158	337	47358
6L-3S		MI	16562	5805	30047	4008	33914	3198	36393	2473	40638	1262	49791	666	45442
16-#11	2.31	MA	16995	4704	28006	3421	30918	2772	32408	2263	34205	1483	41271	1248	26405
3L-7S		MI	12580	4704	20770	3387	22290	2738	22687	2226	22632	1449	27153	922	20052
16-#11	2.31	MA	16509	4704	27153	3433	29834	2769	31092	2258	32515	1490	39360	1159	26316
4L-6S		MI	12912	4704	21384	3376	23039	2730	23633	2233	23812	1442	28542	990	20598
16-#11	2.31	MA	16072	4704	26405	3431	28869	2779	29911	2267	30848	1483	37344	1117	25702
5E		MI	13253	4704	21958	3380	23817	2735	24544	2226	25017	1435	30020	1050	20961
16-#11	2.31	MA	15656	4704	25698	3429	27909	2776	28740	2262	29316	1490	35443	1059	25178
6L-4S		MI	13609	4704	22565	3383	24600	2727	25498	2219	26332	1442	31602	1089	21464
16-#11	2.31	MA	15250	4704	24942	3441	26988	2786	27611	2271	27817	1497	33462	971	24486
7L-3S		MI	14004	4704	23255	3373	25476	2732	26557	2226	27662	1435	33087	1177	21511
16-#11	2.31	MA	14849	4704	24247	3439	26057	2783	26504	2280	26247	1490	31580	922	23774
8L-2S		MI	14554	4704	24105	3376	26560	2724	27871	2219	29397	1428	35369	1266	21516
16-#14	3.33	MA	17624	5096	30006	3669	33414	2938	35423	2360	38260	1453	47065	989	36695
4L-6S		MI	13493	5096	23154	3603	25217	2894	26215	2329	27220	1390	33180	752	27877
16-#14	3.33	MA	17013	5096	28934	3665	32032	2952	33731	2372	35889	1443	44201	930	35498
5E		MI	13970	5096	23975	3609	26331	2903	27505	2319	28927	1380	35263	838	28830
16-#14	3.33	MA	16429	5096	27921	3662	30657	2947	32054	2364	33713	1453	41507	845	34337
6L-4S		MI	14469	5096	24843	3615	27449	2892	28855	2309	30789	1390	37497	896	29667
16-#14	3.33	MA	15859	5096	26837	3679	29336	2961	30436	2376	31582	1463	38700	718	33072
7L-3S		MI	15023	5096	25828	3601	28701	2900	30356	2319	32673	1380	39595	1020	30329
16-#14	3.33	MA	15298	5096	25842	3675	28003	2955	28852	2387	29349	1453	36025	649	31432
8L-2S		MI	15794	5096	27040	3606	30247	2889	32216	2309	35130	1370	42816	1148	30407
16-#18	5.93	MA	19271	6089	35174	4263	39866	3392	43207	2637	48253	1327	60902	429	57705
5E		MI	15682	6089	28919	4195	32472	3326	34695	2546	38429	1226	47892	267	46221

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

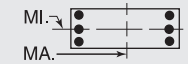
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	5.93	MA	18294	6089	33397	4255	37457	3380	40374	2655	44496	1344	56284	277	54754
6L-4S		MI	16520	6089	30435	4208	34415	3309	37007	2529	41619	1244	51690	372	48630
18-#11	2.60	MA	16990	4815	28211	3502	31183	2819	32732	2289	34718	1482	42288	1140	29498
4L-7S		MI	12967	4815	21620	3456	23374	2788	24001	2257	24366	1438	29436	897	22501
18-#11	2.60	MA	16557	4815	27463	3500	30218	2829	31550	2298	33051	1475	40272	1098	28800
5L-6S		MI	13297	4815	22234	3445	24123	2780	24947	2264	25546	1431	30824	965	23101
18-#11	2.60	MA	16143	4815	26756	3498	29258	2826	30380	2293	31519	1482	38371	1039	28300
6L-5S		MI	13635	4815	22808	3449	24901	2785	25858	2257	26752	1424	32302	1025	23445
18-#11	2.60	MA	15740	4815	25999	3510	28336	2836	29250	2302	30020	1489	36391	952	27552
7L-4S		MI	13989	4815	23415	3452	25684	2777	26811	2250	28066	1431	33885	1064	24025
18-#11	2.60	MA	15342	4815	25305	3508	27406	2833	28144	2311	28450	1482	34508	903	26865
8L-3S		MI	14381	4815	24105	3442	26560	2782	27871	2257	29397	1424	35369	1152	24087
18-#11	2.60	MA	14947	4815	24570	3520	26496	2843	26999	2306	26966	1489	32666	846	25892
9L-2S		MI	14929	4815	24955	3445	27644	2774	29184	2250	31131	1417	37651	1241	24109
18-#14	3.75	MA	17691	5255	30445	3765	33959	3024	36073	2417	39021	1430	48352	900	39934
5L-6S		MI	14032	5255	24366	3703	26763	2967	28075	2373	29676	1373	36401	713	31338
18-#14	3.75	MA	17113	5255	29432	3762	32584	3019	34397	2409	36844	1440	45658	815	38687
6L-5S		MI	14505	5255	25187	3709	27876	2975	29365	2363	31384	1363	38485	799	32376
18-#14	3.75	MA	16548	5255	28349	3778	31263	3033	32779	2420	34713	1450	42851	688	37470
7L-4S		MI	15000	5255	26055	3715	28994	2964	30716	2353	33246	1373	40718	857	33163
18-#14	3.75	MA	15992	5255	27354	3775	29930	3027	31194	2432	32481	1440	40176	619	35779
8L-3S		MI	15550	5255	27040	3700	30247	2973	32216	2363	35130	1363	42816	982	33977
18-#18	6.67	MA	19450	6372	36034	4432	40819	3508	44461	2735	49901	1318	63411	216	62177
6L-5S		MI	16581	6372	31024	4372	35146	3454	37881	2620	42637	1191	53370	189	52161
20-#11	2.89	MA	17038	4925	28520	3569	31566	2880	33189	2329	35254	1467	43200	1079	31905
5L-7S		MI	13351	4925	22470	3525	24458	2839	25314	2288	26101	1427	31718	872	24956
20-#11	2.89	MA	16627	4925	27813	3567	30607	2876	32019	2324	33722	1474	41299	1020	31425
6E		MI	13679	4925	23084	3515	25207	2830	26261	2294	27281	1420	33107	940	25609
20-#11	2.89	MA	16226	4925	27057	3579	29685	2886	30889	2333	32223	1481	39319	932	30625
7L-5S		MI	14015	4925	23659	3518	25985	2835	27172	2288	28487	1413	34584	1000	25936
20-#11	2.89	MA	15831	4925	26363	3577	28754	2883	29783	2342	30653	1474	37436	884	29961
8L-4S		MI	14366	4925	24266	3521	26768	2827	28125	2281	29801	1420	36167	1039	26583
20-#11	2.89	MA	15440	4925	25628	3589	27845	2893	28639	2337	29169	1481	35594	827	28953
9L-3S		MI	14757	4925	24955	3511	27644	2832	29184	2288	31131	1413	37651	1127	26659
20-#14	4.17	MA	17791	5415	30944	3862	34511	3091	36740	2453	39975	1427	49809	785	43048
6E		MI	14566	5415	25578	3803	28308	3039	29936	2416	32133	1356	39622	674	34811
20-#14	4.17	MA	17231	5415	29860	3878	33190	3105	35121	2465	37845	1437	47003	659	41829
7L-5S		MI	15036	5415	26399	3809	29422	3048	31225	2406	33841	1346	41706	760	35929
20-#14	4.17	MA	16680	5415	28865	3875	31857	3100	33537	2477	35612	1427	44328	589	40135
8L-4S		MI	15527	5415	27267	3814	30540	3036	32576	2396	35702	1356	43939	818	36671
22-#11	3.18	MA	17108	5036	28871	3637	31955	2926	33658	2355	35925	1466	44227	1001	34554
6L-7S		MI	13732	5036	23321	3594	25542	2889	26628	2318	27836	1416	34000	847	27418
22-#11	3.18	MA	16710	5036	28115	3649	31033	2937	32529	2364	34426	1473	42247	913	33704
7L-6S		MI	14058	5036	23935	3584	26291	2880	27574	2325	29016	1409	35389	915	28118
22-#11	3.18	MA	16317	5036	27420	3647	30103	2933	31422	2373	32856	1466	40364	864	33002
8L-5S		MI	14392	5036	24509	3587	27069	2886	28485	2318	30222	1402	36866	975	28432
22-#11	3.18	MA	15928	5036	26686	3659	29193	2944	30278	2368	31372	1473	38522	808	32020
9L-4S		MI	14742	5036	25116	3591	27852	2877	29439	2311	31536	1409	38449	1015	29091
22-#14	4.58	MA	17909	5574	31371	3978	35117	3178	37464	2510	40976	1424	51154	629	46146
7L-6S		MI	15097	5574	26790	3903	29854	3111	31796	2459	34590	1339	42843	636	38294
22-#14	4.58	MA	17362	5574	30376	3975	33784	3172	35879	2522	38743	1414	48479	559	44500
8L-5S		MI	15563	5574	27611	3908	30967	3120	33086	2449	36297	1329	44927	722	39487

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

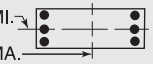
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	3.47	MA	17190	5147	29172	3718	32382	2987	34168	2395	36629	1465	45175	894	36789
7E		MI	14112	5147	24171	3663	26626	2939	27941	2349	29571	1405	36282	822	29886
24-#11	3.47	MA	16800	5147	28478	3716	31451	2983	33062	2404	35059	1458	43292	845	36048
8L-6S		MI	14436	5147	24785	3653	27375	2930	28888	2356	30751	1398	37671	890	30573
24-#11	3.47	MA	16414	5147	27744	3728	30542	2994	31917	2399	33575	1465	41450	789	35092
9L-5S		MI	14768	5147	25359	3656	28153	2936	29799	2349	31956	1391	39149	950	30931
24-#14	5.00	MA	18039	5734	31888	4074	35711	3244	38222	2567	41874	1402	52630	529	48873
8L-6S		MI	15624	5734	28003	4002	31399	3184	33656	2503	37047	1321	46064	597	41787

RECTANGULAR TIED COLUMNS 30" x 38"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.40	MA	17942	4598	28672	3360	31102	2730	31996	2260	32453	1566	38376	1448	17992
2E		MI	13995	4598	22595	3288	24210	2669	24611	2197	24660	1504	28817	1366	13851
6-#14	1.18	MA	17604	4510	27785	3329	30094	2710	30816	2252	31002	1592	36537	1491	15415
2L-3S		MI	12962	4510	20730	3258	21967	2667	22019	2212	21249	1550	24437	1295	11984
6-#14	1.18	MA	16533	4510	26174	3326	28040	2725	28319	2265	27646	1602	32075	1363	15462
3L-2S		MI	13764	4510	21943	3264	23513	2656	23879	2202	23706	1540	27658	1423	11913
6-#18	2.11	MA	19215	4882	31486	3538	34690	2858	36357	2340	38258	1541	46054	1392	26605
2L-3S		MI	13555	4882	22595	3453	24210	2814	24611	2288	24660	1487	28817	1060	20337
6-#18	2.11	MA	17384	4882	28672	3531	31102	2883	31996	2360	32453	1559	38376	1164	26476
3L-2S		MI	14921	4882	24700	3466	26885	2797	27796	2270	28868	1469	34296	1288	20338
8-#11	1.09	MA	17465	4474	27412	3319	29680	2703	30336	2250	30413	1604	35792	1509	14351
2L-4S		MI	12698	4474	20125	3263	21257	2655	21208	2205	20255	1570	23424	1271	11199
8-#11	1.09	MA	16714	4474	26285	3317	28243	2714	28590	2260	28054	1611	32648	1420	14388
3E		MI	13104	4474	20815	3253	22134	2661	22268	2212	21585	1563	24908	1359	11157
8-#11	1.09	MA	16181	4474	25378	3330	27090	2711	27190	2255	26244	1618	30594	1331	14391
4L-2S		MI	13668	4474	21665	3257	23218	2652	23581	2205	23320	1556	27191	1447	11109
8-#14	1.58	MA	18347	4669	29396	3429	32148	2782	33313	2297	34359	1581	41000	1463	20353
2L-4S		MI	12939	4669	20957	3372	22261	2731	22378	2245	21822	1543	25560	1132	15678
8-#14	1.58	MA	17286	4669	27785	3426	30094	2797	30816	2310	31002	1591	36537	1335	20361
3E		MI	13513	4669	21943	3358	23513	2739	23879	2255	23706	1533	27658	1256	15702
8-#14	1.58	MA	16532	4669	26487	3443	28443	2792	28812	2302	28427	1601	33625	1207	20234
4L-2S		MI	14308	4669	23155	3363	25058	2728	25739	2245	26162	1523	30879	1384	15655
8-#18	2.81	MA	20467	5166	34300	3715	38278	2987	40719	2420	44063	1517	53733	1336	35166
2L-4S		MI	13508	5166	22982	3653	24711	2925	25225	2343	25641	1469	30716	766	24790
8-#18	2.81	MA	18660	5166	31486	3708	34690	3011	36357	2439	38258	1535	46054	1108	34924
3E		MI	14485	5166	24700	3630	26885	2942	27796	2361	28868	1451	34296	982	26673
8-#18	2.81	MA	17375	5166	29211	3737	31798	3000	32848	2424	33806	1552	41057	881	32406
4L-2S		MI	15835	5166	26805	3643	29559	2925	30982	2343	33076	1433	39774	1209	26777
10-#11	1.37	MA	17989	4584	28539	3388	31117	2753	32083	2281	32773	1597	38936	1491	17807
2L-5S		MI	12726	4584	20369	3329	21559	2714	21568	2243	20675	1552	24124	1206	13693
10-#11	1.37	MA	17243	4584	27412	3386	29680	2764	30336	2291	30413	1604	35792	1402	17829
3L-4S		MI	13090	4584	20976	3333	22341	2705	22522	2236	21989	1559	25706	1246	13797
10-#11	1.37	MA	16714	4584	26505	3399	28527	2761	28937	2286	28603	1611	33738	1314	17803
4L-3S		MI	13493	4584	21665	3322	23218	2711	23581	2243	23320	1552	27191	1334	13774
10-#11	1.37	MA	16239	4584	25709	3397	27501	2772	27680	2296	26818	1604	31579	1271	17599
5L-2S		MI	14054	4584	22515	3326	24302	2702	24895	2236	25055	1545	29473	1422	13736
10-#14	1.97	MA	19082	4829	31008	3529	34202	2854	35810	2342	37716	1569	45462	1436	25274
2L-5S		MI	12976	4829	21302	3466	22688	2814	22888	2298	22417	1516	26547	1035	18421
10-#14	1.97	MA	18029	4829	29396	3526	32148	2869	33313	2355	34359	1579	41000	1308	25241
3L-4S		MI	13489	4829	22170	3472	23806	2803	24238	2288	24278	1526	28781	1093	19328
10-#14	1.97	MA	17283	4829	28098	3543	30497	2864	31309	2347	31784	1589	38087	1180	25067
4L-3S		MI	14058	4829	23155	3457	25058	2812	25739	2298	26162	1516	30879	1218	19398
10-#14	1.97	MA	16613	4829	26958	3540	29027	2879	29510	2360	29244	1579	35016	1119	23799
5L-2S		MI	14847	4829	24367	3463	26604	2800	27599	2288	28619	1506	34100	1346	19377
10-#18	3.51	MA	21701	5450	37115	3892	41866	3116	45081	2499	49868	1493	61411	1280	43694
2L-5S		MI	13566	5450	23571	3817	25443	3070	26099	2434	26659	1416	32396	583	29032

RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis



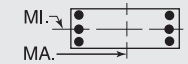
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.51	MA	19917	5450	34300	3885	38278	3140	40719	2519	44063	1510	53733	1052	43357
3L-4S		MI	14437	5450	25087	3830	27386	3052	28411	2417	29850	1433	36195	688	30761
10-#18	3.51	MA	18650	5450	32025	3914	35386	3129	37210	2504	39610	1528	48736	824	40471
4L-3S		MI	15402	5450	26805	3807	29559	3070	30982	2434	33076	1416	39774	903	32986
10-#18	3.51	MA	17512	5450	30025	3907	32808	3153	34053	2524	35215	1510	43426	721	38156
5L-2S		MI	16737	5450	28910	3820	32233	3052	34167	2417	37284	1398	45253	1131	33175
12-#11	1.64	MA	18510	4695	29665	3457	32553	2804	33829	2313	35132	1590	42080	1474	21253
2L-6S		MI	12772	4695	20645	3395	21864	2759	21971	2281	21204	1548	24928	1122	15726
12-#11	1.64	MA	17768	4695	28539	3456	31117	2814	32083	2322	32773	1597	38936	1385	21257
3L-5S		MI	13117	4695	21219	3398	22643	2764	22882	2274	22410	1541	26406	1181	16148
12-#11	1.64	MA	17242	4695	27632	3468	29964	2811	30683	2318	30963	1604	36881	1296	21207
4E		MI	13479	4695	21826	3402	23425	2755	23835	2267	23724	1548	27989	1221	16380
12-#11	1.64	MA	16771	4695	26836	3466	28938	2822	29427	2327	29178	1597	34723	1254	20870
5L-3S		MI	13879	4695	22515	3391	24302	2761	24895	2274	25055	1541	29473	1309	16378
12-#11	1.64	MA	16321	4695	26085	3465	27918	2819	28183	2323	27537	1604	32680	1195	20216
6L-2S		MI	14437	4695	23366	3395	25386	2752	26208	2267	26789	1534	31755	1397	16351
12-#14	2.37	MA	19809	4989	32619	3628	36257	2927	38307	2387	41072	1558	49924	1408	30178
2L-6S		MI	13038	4989	21693	3560	23120	2878	23458	2352	23166	1509	27685	910	21279
12-#14	2.37	MA	18765	4989	31008	3626	34202	2942	35810	2399	37716	1568	45462	1280	30110
3L-5S		MI	13525	4989	22514	3566	24233	2887	24748	2342	24873	1499	29768	996	21934
12-#14	2.37	MA	18026	4989	29709	3643	32551	2937	33807	2392	35141	1578	42550	1152	29896
4E		MI	14034	4989	23382	3571	25351	2875	26098	2332	26735	1509	32002	1054	22923
12-#14	2.37	MA	17362	4989	28569	3640	31081	2952	32007	2405	32600	1568	39479	1092	28494
5L-3S		MI	14598	4989	24367	3557	26604	2884	27599	2342	28619	1499	34100	1179	23074
12-#14	2.37	MA	16729	4989	27492	3637	29620	2947	30224	2398	30267	1578	36581	1007	27591
6L-2S		MI	15382	4989	25579	3563	28149	2873	29459	2332	31076	1489	37321	1307	23085
12-#18	4.21	MA	21157	5733	37115	4063	41866	3268	45081	2599	49868	1486	61411	996	51782
3L-5S		MI	14494	5733	25676	3995	28117	3198	29284	2508	30867	1380	37875	505	34865
12-#18	4.21	MA	19907	5733	34840	4091	38974	3257	41571	2584	45415	1504	56414	768	48579
4E		MI	15354	5733	27192	4007	30060	3180	31596	2490	34058	1398	41673	609	36773
12-#18	4.21	MA	18785	5733	32839	4085	36396	3281	38415	2603	41020	1486	51104	665	46096
5L-3S		MI	16309	5733	28910	3985	32233	3198	34167	2508	37284	1380	45253	825	39284
12-#18	4.21	MA	17715	5733	30949	4078	33831	3270	35288	2588	36985	1504	46125	513	42830
6L-2S		MI	17630	5733	31015	3998	34907	3180	37353	2490	41493	1362	50731	1052	39546
14-#11	1.92	MA	19026	4806	30792	3526	33990	2854	35576	2344	37491	1582	45224	1456	24692
2L-7S		MI	12827	4806	20881	3474	22200	2817	22338	2305	21759	1544	25822	1028	17813
14-#11	1.92	MA	18288	4806	29665	3525	32553	2865	33829	2353	35132	1589	42080	1367	24676
3L-6S		MI	13162	4806	21495	3464	22948	2809	23284	2312	22939	1537	27211	1097	18221
14-#11	1.92	MA	17767	4806	28759	3537	31400	2862	32430	2349	33322	1596	40025	1278	24606
4L-5S		MI	13505	4806	22069	3467	23727	2814	24195	2305	24145	1530	28688	1156	18616
14-#11	1.92	MA	17299	4806	27963	3535	30374	2872	31173	2358	31537	1589	37867	1236	24153
5L-4S		MI	13864	4806	22676	3471	24509	2806	25149	2298	25459	1537	30271	1196	18955
14-#11	1.92	MA	16852	4806	27212	3534	29354	2869	29929	2354	29897	1596	35824	1177	23532
6L-3S		MI	14263	4806	23366	3461	25386	2811	26208	2305	26789	1530	31755	1284	18975
14-#11	1.92	MA	16417	4806	26408	3546	28375	2880	28729	2363	28291	1603	33696	1089	22951
7L-2S		MI	14818	4806	24216	3464	26470	2803	27522	2298	28524	1523	34037	1372	18957
14-#14	2.76	MA	19495	5148	32619	3725	36257	3014	38307	2444	41072	1556	49924	1253	34971
3L-6S		MI	13587	5148	22905	3660	24665	2950	25318	2395	25623	1491	30906	872	24706
14-#14	2.76	MA	18761	5148	31320	3743	34605	3009	36304	2437	38497	1566	47012	1125	34639
4L-5S		MI	14069	5148	23726	3665	25779	2959	26608	2385	27330	1481	32990	957	25460
14-#14	2.76	MA	18104	5148	30180	3740	33136	3024	34504	2450	35957	1556	43941	1064	33204
5L-4S		MI	14574	5148	24594	3671	26897	2948	27958	2375	29192	1491	35223	1015	26383
14-#14	2.76	MA	17476	5148	29104	3737	31674	3019	32721	2443	33623	1566	41043	980	32206
6L-3S		MI	15134	5148	25579	3657	28149	2956	29459	2385	31076	1481	37321	1140	26739

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis

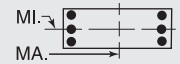


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.76	MA	16864	5148	27952	3754	30270	3034	31001	2456	31340	1576	38025	853	30728
7L-2S		MI	15912	5148	26791	3663	29695	2945	31319	2375	33533	1471	40542	1268	26782
14-#18	4.91	MA	21149	6017	37654	4269	42562	3386	45933	2663	51220	1480	64093	712	56721
4L-5S		MI	15412	6017	27781	4172	30791	3326	32470	2581	35075	1345	43353	426	40735
14-#18	4.91	MA	20041	6017	35654	4262	39984	3410	42777	2683	46825	1462	58783	608	54072
5L-4S		MI	16263	6017	29297	4185	32734	3308	34782	2563	38266	1362	47152	531	42818
14-#18	4.91	MA	18985	6017	33764	4255	37419	3399	39650	2668	42790	1480	53804	457	50948
6L-3S		MI	17207	6017	31015	4162	34907	3326	37353	2581	41493	1345	50731	746	45571
16-#11	2.19	MA	18805	4916	30792	3594	33990	2915	35576	2384	37491	1582	45224	1350	28090
3L-7S		MI	13216	4916	21731	3543	23284	2867	23652	2336	23494	1533	28104	1003	20252
16-#11	2.19	MA	18287	4916	29885	3606	32837	2912	34176	2380	35681	1589	43169	1261	28001
4L-6S		MI	13549	4916	22345	3533	24032	2859	24598	2342	24674	1526	29493	1072	20721
16-#11	2.19	MA	17822	4916	29090	3605	31811	2923	32920	2389	33896	1582	41011	1218	27447
5E		MI	13891	4916	22919	3537	24811	2864	25509	2336	25880	1519	30970	1131	21093
16-#11	2.19	MA	17379	4916	28339	3603	30791	2920	31676	2385	32256	1589	38968	1160	26854
6L-4S		MI	14248	4916	23526	3540	25593	2856	26462	2329	27194	1526	32553	1171	21524
16-#11	2.19	MA	16946	4916	27535	3615	29811	2930	30475	2394	30650	1596	36840	1072	26213
7L-3S		MI	14644	4916	24216	3530	26470	2861	27522	2336	28524	1519	34037	1259	21561
16-#11	2.19	MA	16520	4916	26797	3614	28823	2928	29300	2404	28969	1589	34824	1022	25415
8L-2S		MI	15196	4916	25066	3533	27554	2853	28835	2329	30259	1512	36319	1347	21558
16-#14	3.16	MA	19490	5308	32931	3842	36660	3081	38801	2482	41854	1554	51474	1097	39289
4L-6S		MI	14130	5308	24117	3759	26211	3023	27178	2438	28079	1474	34127	833	28150
16-#14	3.16	MA	18839	5308	31791	3840	35190	3096	37001	2495	39314	1544	48403	1037	37926
5E		MI	14609	5308	24938	3765	27324	3031	28468	2428	29787	1464	36211	919	28996
16-#14	3.16	MA	18217	5308	30715	3837	33728	3091	35218	2488	36980	1554	45505	952	36835
6L-4S		MI	15110	5308	25806	3771	28442	3020	29819	2418	31649	1474	38444	977	29862
16-#14	3.16	MA	17610	5308	29563	3854	32324	3106	33498	2500	34696	1564	42487	825	35413
7L-3S		MI	15666	5308	26791	3757	29695	3029	31319	2428	33533	1464	40542	1102	30397
16-#14	3.16	MA	17012	5308	28505	3851	30907	3101	31813	2513	32303	1554	39619	755	33774
8L-2S		MI	16439	5308	28004	3762	31240	3017	33179	2418	35989	1454	43763	1229	30463
16-#18	5.61	MA	21283	6301	38468	4439	43572	3539	47139	2763	52630	1438	66461	552	62080
5E		MI	16321	6301	29886	4349	33465	3453	35655	2654	39284	1309	48832	348	46640
16-#18	5.61	MA	20241	6301	36578	4432	41007	3527	44012	2747	48594	1455	61482	401	59088
6L-4S		MI	17163	6301	31402	4362	35408	3436	37967	2637	42474	1327	52630	452	48890
18-#11	2.46	MA	18804	5027	31012	3675	34274	2962	35923	2411	38040	1582	46313	1243	31393
4L-7S		MI	13603	5027	22581	3613	24368	2917	24965	2366	25229	1522	30386	978	22699
18-#11	2.46	MA	18342	5027	30217	3674	33248	2973	34666	2420	36255	1575	44154	1201	30748
5L-6S		MI	13934	5027	23195	3602	25116	2909	25912	2373	26408	1515	31775	1047	23225
18-#11	2.46	MA	17902	5027	29466	3672	32228	2970	33422	2416	34615	1582	42112	1142	30182
6L-5S		MI	14274	5027	23770	3606	25895	2914	26823	2366	27614	1508	33253	1106	23577
18-#11	2.46	MA	17472	5027	28662	3685	31248	2981	32222	2425	33010	1589	39984	1054	29483
7L-4S		MI	14629	5027	24377	3609	26677	2906	27776	2359	28928	1515	34835	1146	24089
18-#11	2.46	MA	17049	5027	27924	3683	30259	2978	31046	2435	31328	1582	37968	1004	28712
8L-3S		MI	15022	5027	25066	3599	27554	2911	28835	2366	30259	1508	36319	1234	24140
18-#11	2.46	MA	16629	5027	27144	3695	29293	2989	29830	2430	29739	1589	35988	948	27756
9L-2S		MI	15571	5027	25917	3602	28638	2903	30149	2359	31994	1501	38602	1322	24153
18-#14	3.55	MA	19567	5467	33403	3939	37244	3169	39498	2540	42670	1533	52865	1009	42657
5L-6S		MI	14670	5467	25329	3859	27756	3095	29039	2482	30536	1457	37348	794	31608
18-#14	3.55	MA	18951	5467	32326	3937	35782	3164	37716	2533	40337	1543	49968	924	41478
6L-5S		MI	15145	5467	26150	3865	28870	3104	30328	2472	32244	1447	39432	880	32542
18-#14	3.55	MA	18350	5467	31174	3954	34378	3179	35995	2545	38053	1553	46949	798	40107
7L-4S		MI	15642	5467	27018	3871	29988	3092	31679	2462	34105	1457	41665	938	33355
18-#14	3.55	MA	17757	5467	30116	3951	32961	3174	34310	2558	35660	1543	44081	727	38415
8L-3S		MI	16194	5467	28004	3856	31240	3101	33179	2472	35989	1447	43763	1063	34049
18-#18	6.32	MA	21483	6584	39392	4610	44595	3656	48373	2827	54399	1431	69161	345	67063
6L-5S		MI	17222	6584	31991	4526	36139	3581	38841	2728	43492	1274	54310	269	52573
20-#11	2.74	MA	18858	5138	31344	3743	34684	3023	36413	2451	38614	1567	47298	1183	34057
5L-7S		MI	13988	5138	23432	3682	25452	2968	26279	2397	26963	1511	32668	953	25153

RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.74	MA	18421	5138	30592	3741	33664	3020	35169	2447	36974	1574	45255	1124	33514
6E		MI	14317	5138	24046	3671	26200	2959	27225	2404	28143	1504	34057	1022	25733
20-#11	2.74	MA	17994	5138	29789	3754	32685	3031	33968	2456	35369	1581	43128	1036	32759
7L-5S		MI	14654	5138	24620	3675	26979	2964	28136	2397	29349	1497	35535	1081	26067
20-#11	2.74	MA	17574	5138	29051	3752	31696	3028	32793	2466	33687	1574	41111	987	32013
8L-4S		MI	15007	5138	25227	3678	27761	2956	29090	2390	30663	1504	37117	1121	26649
20-#11	2.74	MA	17157	5138	28271	3765	30730	3039	31577	2461	32098	1581	39132	930	31022
9L-3S		MI	15399	5138	25917	3668	28638	2961	30149	2397	31994	1497	38602	1209	26714
20-#11	2.74	MA	16696	5138	27536	3763	29753	3036	30408	2471	30521	1588	37214	867	30074
10L-2S		MI	15945	5138	26767	3671	29722	2953	31462	2390	33728	1490	40884	1297	26740
20-#14	3.95	MA	19679	5627	33937	4036	37836	3236	40213	2577	43693	1531	54430	897	46133
6E		MI	15205	5627	26542	3959	29302	3167	30899	2525	32993	1440	40569	755	35077
20-#14	3.95	MA	19083	5627	32785	4054	36432	3251	38492	2590	41409	1541	51412	770	44809
7L-5S		MI	15677	5627	27363	3965	30415	3176	32189	2515	34700	1430	42653	841	36094
20-#14	3.95	MA	18495	5627	31728	4051	35015	3246	36807	2603	39016	1531	48543	700	43067
8L-4S		MI	16170	5627	28231	3970	31533	3165	33539	2505	36562	1440	44886	899	36861
22-#11	3.01	MA	18937	5248	31719	3811	35101	3070	36915	2478	39334	1567	48399	1107	36849
6L-7S		MI	14370	5248	24282	3751	26536	3018	27592	2428	28698	1500	34951	928	27613
22-#11	3.01	MA	18513	5248	30916	3823	34121	3081	35715	2488	37728	1574	46272	1019	36043
7L-6S		MI	14697	5248	24896	3741	27284	3009	28539	2435	29878	1493	36339	997	28243
22-#11	3.01	MA	18095	5248	30178	3821	33133	3078	34539	2497	36047	1567	44255	969	35320
8L-5S		MI	15033	5248	25470	3744	28063	3015	29450	2428	31084	1486	37817	1056	28562
22-#11	3.01	MA	17681	5248	29397	3834	32166	3089	33323	2493	34458	1574	42276	913	34294
9L-4S		MI	15384	5248	26077	3747	28845	3006	30403	2421	32398	1493	39400	1096	29207
22-#11	3.01	MA	17232	5248	28663	3832	31190	3086	32155	2502	32881	1581	40358	849	33320
10L-3S		MI	15773	5248	26767	3737	29722	3012	31462	2428	33728	1486	40884	1184	29285
22-#14	4.34	MA	19810	5787	34396	4153	38486	3323	40989	2635	44766	1530	55874	743	49520
7L-6S		MI	15737	5787	27754	4059	30847	3240	32759	2568	35450	1422	43790	717	38558
22-#14	4.34	MA	19227	5787	33339	4151	37069	3318	39304	2648	42373	1520	53005	672	47727
8L-5S		MI	16205	5787	28575	4064	31961	3248	34049	2558	37157	1412	45874	803	39652
24-#11	3.28	MA	19028	5359	32042	3892	35558	3131	37461	2519	40087	1567	49416	1001	39332
7E		MI	14750	5359	25132	3820	27620	3068	28906	2459	30433	1489	37233	904	30079
24-#11	3.28	MA	18613	5359	31305	3891	34569	3128	36286	2528	38406	1560	47399	951	38630
8L-6S		MI	15076	5359	25746	3810	28368	3059	29852	2466	31613	1482	38622	972	30756
24-#11	3.28	MA	18202	5359	30524	3903	33603	3139	35070	2524	36817	1567	45420	895	37571
9L-5S		MI	15409	5359	26320	3813	29147	3065	30763	2459	32819	1475	40099	1031	31062
24-#11	3.28	MA	17753	5359	29790	3901	32627	3136	33901	2533	35240	1573	43502	831	36512
10L-4S		MI	15758	5359	26927	3817	29929	3056	31717	2452	34133	1482	41682	1071	31714
24-#14	4.74	MA	19954	5946	34950	4250	39123	3391	41802	2693	45730	1508	57467	645	52396
8L-6S		MI	16266	5946	28966	4158	32393	3312	34619	2612	37906	1405	47011	678	42047

RECTANGULAR TIED COLUMNS 30" x 40"

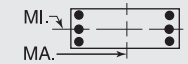
4-#18	1.33	MA	19782	4811	31460	3533	34143	2872	35092	2380	35560	1662	42048	1546	19072
2E		MI	14633	4811	23562	3443	25203	2796	25571	2305	25515	1587	29757	1446	13893
6-#14	1.13	MA	19416	4722	30511	3501	33063	2851	33828	2372	33989	1688	40046	1586	16326
2L-3S		MI	13599	4722	21694	3414	22961	2795	22982	2321	22109	1634	25384	1376	12021
6-#14	1.13	MA	18276	4722	28800	3499	30881	2867	31176	2386	30407	1698	35273	1458	16373
3L-2S		MI	14401	4722	22906	3420	24506	2784	24842	2311	24565	1624	28605	1504	11946
6-#18	2.00	MA	21145	5094	34452	3710	37957	3000	39729	2460	41765	1640	50279	1494	28225
2L-3S		MI	14193	5094	23562	3607	25203	2941	25571	2396	25515	1570	29757	1140	20410
6-#18	2.00	MA	19193	5094	31460	3704	34143	3026	35092	2482	35560	1658	42048	1266	28096
3L-2S		MI	15561	5094	25667	3620	27877	2924	28756	2378	29723	1552	35236	1368	20388

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis

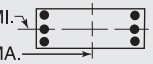


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.04	MA	19266	4686	30111	3491	32619	2845	33314	2371	33334	1699	39235	1604	15194
2L-4S		MI	13335	4686	21087	3420	22251	2784	22173	2315	21117	1654	24375	1352	11236
8-#11	1.04	MA	18466	4686	28915	3490	31094	2856	31460	2381	30823	1706	35875	1515	15230
3E		MI	13741	4686	21776	3410	23128	2790	23232	2322	22447	1647	25859	1440	11189
8-#11	1.04	MA	17901	4686	27954	3503	29872	2854	29977	2377	28897	1713	33676	1426	15233
4L-2S		MI	14306	4686	22627	3413	24212	2781	24546	2315	24182	1641	28141	1529	11139
8-#14	1.50	MA	20211	4882	32222	3601	35244	2924	36480	2417	37571	1678	44820	1561	21568
2L-4S		MI	13576	4882	21921	3528	23254	2859	23341	2354	22681	1627	26507	1213	15741
8-#14	1.50	MA	19081	4882	30511	3599	33063	2939	33828	2431	33989	1687	40046	1433	21576
3E		MI	14150	4882	22906	3514	24506	2868	24842	2364	24565	1617	28605	1337	15746
8-#14	1.50	MA	18280	4882	29134	3617	31312	2935	31703	2425	31241	1697	36926	1305	21449
4L-2S		MI	14947	4882	24118	3519	26052	2856	26702	2354	27022	1607	31826	1465	15693
8-#18	2.67	MA	22486	5378	37444	3887	41771	3129	44365	2540	47970	1618	58510	1442	37326
2L-4S		MI	14144	5378	23950	3807	25704	3052	26185	2451	26496	1552	31656	846	25062
8-#18	2.67	MA	20560	5378	34452	3882	37957	3154	39729	2561	41765	1635	50279	1214	37084
3E		MI	15124	5378	25667	3785	27877	3069	28756	2469	29723	1534	35236	1062	26758
8-#18	2.67	MA	19193	5378	32037	3911	34887	3145	36004	2547	37006	1653	44914	986	34670
4L-2S		MI	16477	5378	27772	3797	30552	3052	31942	2451	33931	1516	40714	1289	26834
10-#11	1.30	MA	19826	4796	31307	3560	34144	2895	35168	2402	35845	1692	42595	1587	18860
2L-5S		MI	13363	4796	21330	3486	22553	2843	22533	2353	21538	1636	25074	1287	13824
10-#11	1.30	MA	19032	4796	30111	3559	32619	2907	33314	2412	33334	1699	39235	1499	18882
3L-4S		MI	13727	4796	21937	3489	23335	2834	23486	2346	22852	1643	26657	1327	13839
10-#11	1.30	MA	18470	4796	29150	3572	31397	2904	31831	2408	31408	1706	37036	1410	18856
4L-3S		MI	14131	4796	22627	3479	24212	2840	24546	2353	24182	1636	28141	1415	13810
10-#11	1.30	MA	17967	4796	28307	3571	30310	2915	30500	2418	29510	1699	34733	1367	18740
5L-2S		MI	14692	4796	23477	3483	25296	2831	25859	2346	25917	1630	30423	1504	13769
10-#14	1.88	MA	20997	5041	33933	3701	37425	2996	39131	2462	41153	1667	49593	1535	26793
2L-5S		MI	13612	5041	22265	3622	23681	2943	23851	2407	23276	1600	27495	1116	18586
10-#14	1.88	MA	19876	5041	32222	3699	35244	3012	36480	2476	37571	1677	44820	1407	26760
3L-4S		MI	14126	5041	23133	3628	24799	2931	25201	2397	25138	1610	29728	1174	19398
10-#14	1.88	MA	19083	5041	30845	3717	33493	3007	34355	2469	34823	1687	41700	1279	26586
4L-3S		MI	14696	5041	24118	3613	26052	2940	26702	2407	27022	1600	31826	1299	19449
10-#14	1.88	MA	18371	5041	29637	3714	31936	3023	32448	2483	32113	1677	38422	1218	25355
5L-2S		MI	15487	5041	25330	3619	27597	2929	28562	2397	29479	1590	35047	1427	19419
10-#18	3.33	MA	23807	5662	40435	4065	45585	3257	49002	2620	54175	1596	66741	1389	46394
2L-5S		MI	14200	5662	24539	3972	26435	3197	27059	2542	27514	1498	33336	663	29465
10-#18	3.33	MA	21905	5662	37444	4059	41771	3283	44365	2641	47970	1613	58510	1162	46057
3L-4S		MI	15074	5662	26055	3984	28378	3179	29371	2525	30705	1516	37135	768	31027
10-#18	3.33	MA	20557	5662	35029	4089	38702	3273	40640	2627	43211	1631	53145	934	43254
4L-3S		MI	16043	5662	27772	3962	30552	3197	31942	2542	33931	1498	40714	983	33079
10-#18	3.33	MA	19348	5662	32908	4083	35967	3299	37293	2649	38514	1613	47468	829	40982
5L-2S		MI	17381	5662	29877	3975	33226	3179	35127	2525	38139	1481	46193	1211	33241
12-#11	1.56	MA	20382	4907	32503	3629	35669	2945	37021	2433	38357	1685	45955	1571	22516
2L-6S		MI	13408	4907	21606	3552	22858	2888	22935	2390	22066	1632	25879	1203	15845
12-#11	1.56	MA	19592	4907	31307	3628	34144	2957	35168	2443	35845	1692	42595	1482	22521
3L-5S		MI	13754	4907	22180	3555	23637	2893	23846	2384	23272	1625	27357	1262	16279
12-#11	1.56	MA	19035	4907	30346	3641	32922	2954	33684	2439	33919	1699	40396	1394	22471
4E		MI	14116	4907	22787	3559	24419	2885	24800	2377	24586	1632	28939	1302	16429
12-#11	1.56	MA	18535	4907	29503	3640	31835	2965	32353	2449	32021	1693	38093	1350	22219
5L-3S		MI	14518	4907	23477	3548	25296	2890	25859	2384	25917	1625	30423	1390	16418
12-#11	1.56	MA	18058	4907	28708	3639	30755	2963	31036	2445	30276	1700	35909	1292	21487
6L-2S		MI	15076	4907	24327	3552	26380	2881	27173	2377	27651	1619	32706	1479	16386
12-#14	2.25	MA	21775	5201	35644	3801	39607	3068	41783	2507	44736	1656	54367	1510	32000
2L-6S		MI	13674	5201	22656	3716	24113	3006	24421	2461	24026	1592	28632	991	21553
12-#14	2.25	MA	20663	5201	33933	3799	37425	3084	39131	2521	41153	1666	49593	1382	31933
3L-5S		MI	14162	5201	23477	3722	25227	3015	25711	2451	25733	1582	30716	1077	22097
12-#14	2.25	MA	19877	5201	32556	3816	35675	3080	37007	2514	38405	1676	46473	1254	31718
4E		MI	14672	5201	24345	3727	26345	3004	27061	2441	27595	1592	32949	1135	23045

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis



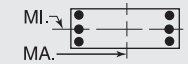
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	2.25	MA	19172	5201	31348	3814	34117	3095	35099	2528	35695	1666	43196	1193	30344
5L-3S		MI	15238	5201	25330	3713	27597	3012	28562	2451	29479	1582	35047	1260	23131
12-#14	2.25	MA	18500	5201	30208	3812	32568	3091	33211	2522	33204	1676	40094	1108	29449
6L-2S		MI	16023	5201	26543	3719	29143	3001	30422	2441	31936	1572	38268	1388	23130
12-#18	4.00	MA	23233	5945	40435	4236	45585	3411	49002	2721	54175	1591	66741	1110	55022
3L-5S		MI	15130	5945	26644	4149	29109	3325	30244	2616	31722	1463	38815	585	35289
12-#18	4.00	MA	21903	5945	38021	4266	42516	3402	45277	2707	49416	1609	61376	882	51882
4E		MI	15994	5945	28160	4162	31052	3307	32556	2598	34913	1481	42613	689	37035
12-#18	4.00	MA	20710	5945	35900	4260	39781	3427	41929	2729	44719	1591	55699	776	49481
5L-3S		MI	16951	5945	29877	4139	33226	3325	35127	2616	38139	1463	46193	905	39385
12-#18	4.00	MA	19572	5945	33896	4255	37062	3417	38613	2715	40405	1609	50358	625	45838
6L-2S		MI	18277	5945	31983	4152	35900	3307	38313	2598	42347	1445	51671	1132	39618
14-#11	1.82	MA	20934	5018	33699	3699	37194	2996	38875	2464	40868	1678	49315	1555	26166
2L-7S		MI	13462	5018	21842	3631	23194	2946	23303	2414	22621	1628	26772	1110	18010
14-#11	1.82	MA	20149	5018	32503	3697	35669	3007	37021	2474	38357	1685	45955	1466	26150
3L-6S		MI	13798	5018	22456	3621	23942	2938	24249	2421	23801	1621	28161	1178	18340
14-#11	1.82	MA	19595	5018	31542	3710	34447	3004	35538	2470	36431	1692	43756	1377	26080
4L-5S		MI	14142	5018	23030	3624	24721	2943	25160	2414	25007	1614	29639	1237	18745
14-#11	1.82	MA	19098	5018	30700	3709	33360	3016	34207	2480	34532	1686	41453	1334	25705
5L-4S		MI	14502	5018	23637	3628	25503	2935	26113	2407	26321	1621	31221	1277	19009
14-#11	1.82	MA	18625	5018	29904	3708	32280	3013	32889	2476	32787	1693	39269	1276	25009
6L-3S		MI	14902	5018	24327	3617	26380	2940	27173	2414	27651	1614	32706	1365	19017
14-#11	1.82	MA	18163	5018	29053	3720	31242	3024	31618	2486	31080	1700	36995	1188	24490
7L-2S		MI	15458	5018	25177	3621	27464	2932	28486	2407	29386	1608	34988	1454	18995
14-#14	2.63	MA	21442	5360	35644	3898	39607	3156	41783	2566	44736	1656	54367	1356	37098
3L-6S		MI	14223	5360	23868	3816	25659	3079	26281	2504	26482	1575	31853	953	24977
14-#14	2.63	MA	20663	5360	34267	3916	37856	3152	39658	2559	41987	1666	51247	1229	36847
4L-5S		MI	14707	5360	24689	3821	26772	3087	27571	2494	28190	1565	33937	1039	25622
14-#14	2.63	MA	19965	5360	33059	3914	36298	3168	37751	2573	39277	1656	47969	1167	35349
5L-4S		MI	15213	5360	25557	3827	27890	3076	28922	2484	30052	1575	36170	1096	26576
14-#14	2.63	MA	19299	5360	31919	3912	34750	3164	35862	2566	36787	1666	44867	1083	34438
6L-3S		MI	15775	5360	26543	3813	29143	3085	30422	2494	31936	1565	38268	1221	26801
14-#14	2.63	MA	18649	5360	30698	3930	33262	3179	34040	2580	34349	1676	41637	956	32793
7L-2S		MI	16555	5360	27755	3819	30688	3073	32282	2484	34392	1555	41489	1349	26833
14-#18	4.67	MA	23231	6229	41012	4443	46330	3530	49914	2787	55621	1587	69607	830	60545
4L-5S		MI	16049	6229	28749	4326	31784	3453	33430	2689	35930	1427	44293	506	41153
14-#18	4.67	MA	22054	6229	38892	4438	43596	3556	46566	2808	50924	1569	63930	724	57978
5L-4S		MI	16904	6229	30265	4339	33727	3435	35742	2671	39121	1445	48092	611	43076
14-#18	4.67	MA	20932	6229	36888	4432	40876	3546	43250	2794	46610	1587	58589	573	54481
6L-3S		MI	17852	6229	31983	4316	35900	3453	38313	2689	42347	1427	51671	826	45679
16-#11	2.08	MA	20701	5128	33699	3767	37194	3057	38875	2505	40868	1678	49315	1450	29775
3L-7S		MI	13852	5128	22692	3700	24278	2996	24616	2445	24356	1617	29055	1085	20447
16-#11	2.08	MA	20151	5128	32738	3779	35972	3054	37392	2501	38942	1685	47116	1361	29686
4L-6S		MI	14186	5128	23307	3690	25026	2988	25563	2452	25536	1610	30443	1153	20840
16-#11	2.08	MA	19658	5128	31896	3778	34885	3066	36061	2511	37043	1679	44813	1318	29202
5E		MI	14529	5128	23881	3693	25805	2993	26474	2445	26742	1603	31921	1212	21221
16-#11	2.08	MA	19188	5128	31100	3777	33804	3063	34743	2507	35299	1686	42629	1259	28538
6L-4S		MI	14886	5128	24488	3697	26587	2985	27427	2438	28056	1610	33504	1252	21581
16-#11	2.08	MA	18729	5128	30249	3790	32767	3075	33472	2517	33591	1693	40355	1172	27956
7L-3S		MI	15283	5128	25177	3687	27464	2990	28486	2445	29386	1603	34988	1340	21610
16-#11	2.08	MA	18276	5128	29468	3789	31720	3072	32227	2527	31803	1686	38203	1121	27070
8L-2S		MI	15836	5128	26028	3690	28548	2982	29800	2438	31121	1596	37270	1429	21598
16-#14	3.00	MA	21443	5520	35978	4016	40037	3224	42310	2604	45569	1655	56020	1203	41904
4L-6S		MI	14767	5520	25081	3915	27204	3151	28142	2547	28939	1558	35074	914	28417

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis

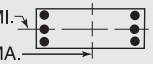


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.00	MA	20751	5520	34770	4014	38480	3240	40403	2618	42859	1645	52743	1142	40366
5E		MI	15247	5520	25902	3921	28318	3160	29431	2537	30647	1548	37158	1000	29158
16-#14	3.00	MA	20091	5520	33630	4012	36931	3236	38514	2611	40369	1655	49641	1057	39361
6L-4S		MI	15750	5520	26770	3927	29436	3148	30782	2527	32508	1558	39391	1058	30052
16-#14	3.00	MA	19447	5520	32409	4029	35443	3251	36691	2625	37931	1665	46411	930	37773
7L-3S		MI	16308	5520	27755	3913	30688	3157	32282	2537	34392	1548	41489	1183	30463
16-#14	3.00	MA	18812	5520	31289	4027	33942	3247	34906	2638	35378	1655	43349	859	36145
8L-2S		MI	17083	5520	28967	3918	32234	3146	34142	2527	36849	1538	44710	1310	30517
16-#18	5.33	MA	23383	6513	41883	4615	47410	3684	51202	2888	57129	1547	72161	672	66507
5E		MI	16960	6513	30854	4504	34458	3580	36615	2762	40138	1392	49772	428	47050
16-#18	5.33	MA	22275	6513	39880	4609	44690	3675	47886	2874	52815	1564	66819	521	63147
6L-4S		MI	17806	6513	32370	4516	36401	3563	38927	2745	43329	1410	53570	532	49144
18-#11	2.34	MA	20703	5239	33934	3848	37496	3105	39245	2532	41453	1679	50476	1345	33289
4L-7S		MI	14240	5239	23543	3769	25362	3046	25930	2476	26091	1606	31337	1060	22892
18-#11	2.34	MA	20213	5239	33092	3847	36410	3116	37915	2542	39555	1672	48173	1301	32707
5L-6S		MI	14572	5239	24157	3759	26110	3038	26876	2483	27271	1599	32726	1128	23345
18-#11	2.34	MA	19746	5239	32296	3846	35329	3113	36597	2538	37810	1679	45989	1243	32071
6L-5S		MI	14912	5239	24731	3763	26889	3043	27787	2476	28476	1592	34203	1188	23705
18-#11	2.34	MA	19290	5239	31445	3859	34292	3125	35325	2548	36103	1686	43715	1155	31430
7L-4S		MI	15268	5239	25338	3766	27671	3035	28741	2469	29791	1599	35786	1227	24149
18-#11	2.34	MA	18841	5239	30664	3858	33245	3122	34081	2558	34314	1680	41563	1105	30572
8L-3S		MI	15663	5239	26028	3756	28548	3040	29800	2476	31121	1592	37270	1315	24190
18-#11	2.34	MA	18395	5239	29838	3870	32222	3133	32793	2554	32624	1687	39447	1048	29641
9L-2S		MI	16213	5239	26878	3759	29632	3032	31113	2469	32856	1585	39552	1404	24195
18-#14	3.38	MA	21529	5679	36481	4113	40661	3312	43054	2663	46441	1635	57516	1116	45394
5L-6S		MI	15307	5679	26293	4015	28750	3223	30002	2591	31396	1541	38295	875	31871
18-#14	3.38	MA	20875	5679	35341	4111	39112	3308	41166	2656	43951	1645	54414	1032	44297
6L-5S		MI	15784	5679	27114	4021	29863	3232	31292	2581	33103	1531	40379	961	32702
18-#14	3.38	MA	20237	5679	34120	4129	37625	3324	39343	2670	41514	1655	51184	905	42763
7L-4S		MI	16283	5679	27982	4027	30981	3221	32642	2571	34965	1541	42612	1019	33543
18-#14	3.38	MA	19608	5679	33000	4127	36124	3320	37558	2683	38960	1645	48122	833	41083
8L-3S		MI	16837	5679	28967	4012	32234	3229	34142	2581	36849	1531	44710	1144	34118
18-#14	3.38	MA	18984	5679	31815	4145	34657	3335	35712	2677	36548	1655	45117	752	39284
9L-2S		MI	17607	5679	30179	4018	33779	3218	36002	2571	39306	1521	47931	1272	34194
18-#18	6.00	MA	23604	6797	42871	4787	48504	3803	52523	2954	59020	1542	75050	469	71834
6L-5S		MI	17863	6797	32959	4681	37132	3708	39801	2836	44347	1356	55250	349	52977
20-#11	2.60	MA	20765	5350	34288	3916	37935	3166	39768	2573	42066	1665	51533	1285	36221
5L-7S		MI	14625	5350	24393	3839	26446	3097	27243	2507	27825	1595	33619	1035	25344
20-#11	2.60	MA	20301	5350	33492	3915	36854	3164	38450	2570	40321	1672	49349	1227	35610
6E		MI	14955	5350	25007	3828	27194	3088	28190	2514	29005	1588	35008	1103	25853
20-#11	2.60	MA	19848	5350	32641	3928	35817	3175	37179	2579	38614	1679	47075	1139	34911
7L-5S		MI	15294	5350	25581	3832	27973	3094	29101	2507	30211	1581	36485	1163	26195
20-#11	2.60	MA	19402	5350	31860	3927	34770	3172	35934	2589	36826	1673	44923	1088	34079
8L-4S		MI	15647	5350	26188	3835	28755	3085	30054	2500	31525	1588	38068	1202	26713
20-#11	2.60	MA	18956	5350	31034	3939	33747	3184	34646	2586	35136	1680	42807	1032	33112
9L-3S		MI	16040	5350	26878	3825	29632	3090	31113	2507	32856	1581	39552	1290	26768
20-#11	2.60	MA	18460	5350	30257	3938	32713	3181	33409	2595	33458	1687	40755	969	32188
10L-2S		MI	16588	5350	27728	3828	30716	3082	32427	2500	34590	1574	41834	1379	26788
20-#14	3.75	MA	21653	5839	37051	4211	41294	3380	43817	2701	47533	1634	59188	1006	49246
6E		MI	15844	5839	27505	4115	30295	3296	31862	2634	33853	1523	41516	836	35337
20-#14	3.75	MA	21021	5839	35831	4229	39806	3396	41995	2715	45096	1644	55958	880	47762
7L-5S		MI	16317	5839	28326	4121	31409	3304	33152	2624	35560	1513	43600	922	36254
20-#14	3.75	MA	20397	5839	34711	4227	38305	3392	40210	2728	42542	1634	52896	808	46030
8L-4S		MI	16813	5839	29194	4126	32527	3293	34502	2614	37422	1523	45833	980	37047
20-#14	3.75	MA	19775	5839	33526	4244	36838	3408	38363	2722	40130	1644	49891	726	44198
9L-3S		MI	17363	5839	30179	4112	33779	3302	36002	2624	39306	1513	47931	1105	37768
22-#11	2.86	MA	20852	5460	34688	3984	38379	3214	40304	2601	42833	1665	52709	1210	39152
6L-7S		MI	15008	5460	25243	3908	27530	3147	28557	2537	29560	1584	35901	1010	27803

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

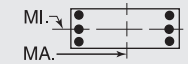
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.86	MA	20402	5460	33837	3997	37342	3225	39033	2611	41125	1672	50435	1123	38398
7L-6S		MI	15337	5460	25857	3897	28278	3138	29503	2544	30740	1577	37290	1078	28364
22-#11	2.86	MA	19959	5460	33056	3996	36295	3222	37788	2621	39337	1666	48283	1072	37591
8L-5S		MI	15673	5460	26431	3901	29057	3144	30414	2537	31946	1570	38768	1138	28690
22-#11	2.86	MA	19514	5460	32230	4009	35272	3234	36500	2617	37647	1673	46167	1016	36589
9L-4S		MI	16025	5460	27038	3904	29839	3135	31368	2531	33260	1577	40350	1177	29274
22-#11	2.86	MA	19023	5460	31453	4008	34238	3231	35263	2627	35970	1680	44115	952	35640
10L-3S		MI	16416	5460	27728	3894	30716	3141	32427	2537	34590	1570	41834	1265	29341
22-#14	4.13	MA	21798	5999	37542	4328	41987	3468	44646	2760	48678	1634	60732	854	52770
7L-6S		MI	16377	5999	28717	4215	31841	3368	33722	2677	36309	1506	44737	798	38815
22-#14	4.13	MA	21179	5999	36422	4326	40486	3464	42861	2773	46125	1624	57670	782	50986
8L-5S		MI	16847	5999	29538	4220	32954	3377	35012	2667	38017	1496	46821	884	39812
22-#14	4.13	MA	20559	5999	35237	4344	39019	3480	41015	2767	43712	1634	54664	701	49120
9L-4S		MI	17339	5999	30406	4226	34072	3365	36362	2658	39879	1506	49054	942	40562
24-#11	3.12	MA	20953	5571	35033	4066	38866	3275	40886	2642	43637	1665	53795	1106	41892
7E		MI	15389	5571	26093	3977	28614	3197	29870	2568	31295	1573	38183	985	30267
24-#11	3.12	MA	20512	5571	34252	4065	37819	3273	39642	2652	41848	1659	51643	1056	41108
8L-6S		MI	15716	5571	26708	3967	29362	3188	30817	2575	32475	1566	39572	1053	30877
24-#11	3.12	MA	20068	5571	33426	4078	36796	3284	38354	2648	40158	1666	49527	999	40071
9L-5S		MI	16050	5571	27282	3970	30141	3194	31728	2568	33681	1559	41050	1113	31189
24-#11	3.12	MA	19591	5571	32649	4077	35763	3281	37116	2658	38481	1673	47475	936	39095
10L-4S		MI	16400	5571	27889	3973	30923	3185	32681	2561	34995	1566	42632	1152	31832
24-#14	4.50	MA	21956	6158	38133	4426	42668	3537	45513	2818	49707	1613	62443	757	55951
8L-6S		MI	16907	6158	29929	4314	33386	3440	35582	2721	38766	1489	47959	759	42302
24-#14	4.50	MA	21336	6158	36948	4444	41201	3552	43667	2812	47294	1623	59438	675	54051
9L-5S		MI	17374	6158	30751	4320	34500	3449	36872	2711	40474	1479	50042	845	43375

RECTANGULAR TIED COLUMNS 30" x 42"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.27	MA	21708	5023	34369	3705	37316	3013	38320	2501	38789	1758	45858	1643	20152
2E		MI	15271	5023	24530	3597	26196	2923	26531	2412	26369	1670	30697	1527	13934
6-#14	1.07	MA	21314	4934	33358	3674	36163	2993	36972	2493	37079	1782	43691	1681	17237
2L-3S		MI	14236	4934	22657	3570	23954	2924	23945	2430	22968	1718	26331	1457	12056
6-#14	1.07	MA	20105	4934	31547	3672	33855	3010	34165	2507	33277	1793	38606	1553	17284
3L-2S		MI	15039	4934	23869	3576	25500	2913	25805	2420	25425	1708	29552	1585	11979
6-#18	1.90	MA	23162	5306	37538	3882	41356	3142	43231	2581	45394	1738	54642	1594	29845
2L-3S		MI	14830	5306	24530	3762	26196	3069	26531	2504	26369	1652	30697	1221	20480
6-#18	1.90	MA	21088	5306	34369	3878	37316	3169	38320	2603	38789	1756	45858	1367	29716
3L-2S		MI	16201	5306	26635	3774	28870	3051	29716	2486	30578	1635	36176	1448	20437
8-#14	1.43	MA	22160	5094	35168	3774	38472	3066	39778	2538	40881	1773	48776	1658	22783
2L-4S		MI	14212	5094	22884	3684	24247	2988	24304	2463	23541	1711	27454	1294	15800
8-#14	1.43	MA	20961	5094	33358	3772	36163	3082	36972	2552	37079	1783	43691	1530	22791
3E		MI	14788	5094	23869	3670	25500	2996	25805	2473	25425	1701	29552	1418	15788
8-#14	1.43	MA	20113	5094	31902	3790	34313	3078	34726	2546	34164	1793	40363	1402	22664
4L-2S		MI	15586	5094	25082	3675	27045	2985	27665	2463	27882	1691	32773	1546	15731
8-#18	2.54	MA	24591	5590	40707	4060	45396	3271	48143	2660	52000	1718	63426	1546	39486
2L-4S		MI	14780	5590	24917	3961	26697	3179	27145	2559	27351	1635	32596	927	25328
8-#18	2.54	MA	22545	5590	37538	4055	41356	3297	43231	2683	45394	1735	54642	1318	39244
3E		MI	15762	5590	26635	3939	28870	3196	29716	2577	30578	1617	36176	1142	26838
8-#18	2.54	MA	21096	5590	34985	4086	38109	3289	39291	2671	40327	1753	48908	1091	36959
4L-2S		MI	17118	5590	28740	3952	31544	3179	32902	2559	34786	1599	41654	1370	26889
10-#11	1.24	MA	21748	5009	34197	3733	37303	3037	38384	2522	39004	1784	46389	1683	19913
2L-5S		MI	13999	5009	22291	3643	23546	2972	23498	2462	22400	1721	26025	1369	13878
10-#11	1.24	MA	20906	5009	32931	3732	35690	3035	36423	2533	36348	1792	42813	1594	19935
3L-4S		MI	14364	5009	22898	3646	24329	2963	24451	2455	23714	1728	27608	1409	13879
10-#11	1.24	MA	20312	5009	31916	3745	34399	3047	34856	2529	34313	1800	40470	1505	19909
4L-3S		MI	14768	5009	23588	3636	25205	2969	25510	2462	25044	1721	29092	1496	13844

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

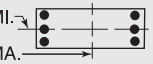
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.24	MA	19779	5009	31026	3744	33252	3045	33451	2540	32308	1794	38024	1462	19793
5L-2S		MI	15331	5009	24438	3639	26289	2960	26824	2455	26779	1714	31374	1585	13801
10-#14	1.79	MA	22997	5253	36979	3873	40780	3138	42584	2583	44683	1763	53862	1634	28311
2L-5S		MI	14248	5253	23228	3778	24675	3071	24814	2516	24136	1683	28442	1197	18747
10-#14	1.79	MA	21808	5253	35168	3872	38472	3154	39778	2597	40881	1773	48776	1506	28279
3L-4S		MI	14763	5253	24096	3784	25793	3060	26164	2506	25998	1693	30675	1255	19464
10-#14	1.79	MA	20968	5253	33713	3890	36622	3151	37532	2591	37966	1783	45448	1378	28105
4L-3S		MI	15335	5253	25082	3769	27045	3068	27665	2516	27882	1683	32773	1380	19496
10-#14	1.79	MA	20215	5253	32437	3888	34976	3167	35517	2606	35091	1774	41964	1316	26923
5L-2S		MI	16127	5253	26294	3775	28591	3057	29525	2506	30339	1673	35994	1508	19460
10-#18	3.17	MA	26001	5874	43876	4237	49436	3399	53054	2740	58606	1697	72210	1497	49094
2L-5S		MI	14835	5874	25506	4126	27428	3324	28018	2650	28369	1581	34276	743	29890
10-#18	3.17	MA	23980	5874	40707	4232	45396	3426	48143	2763	52000	1715	63426	1270	48757
3L-4S		MI	15712	5874	27022	4139	29371	3306	30331	2632	31559	1599	38075	848	31287
10-#18	3.17	MA	22551	5874	38154	4263	42149	3417	44203	2751	46932	1733	57692	1042	46063
4L-3S		MI	16683	5874	28740	4116	31544	3324	32902	2650	34786	1581	41654	1063	33169
10-#18	3.17	MA	21270	5874	35912	4258	39259	3444	40664	2773	41933	1715	51648	935	43547
5L-2S		MI	18025	5874	30845	4129	34218	3306	36087	2632	38994	1564	47133	1291	33305
12-#11	1.49	MA	22340	5119	35462	3802	38916	3087	40345	2553	41661	1777	49965	1668	23780
2L-6S		MI	14044	5119	22567	3708	23852	3017	23900	2500	22929	1717	26830	1284	15960
12-#11	1.49	MA	21503	5119	34197	3801	37303	3085	38384	2564	39004	1785	46389	1579	23784
3L-5S		MI	14391	5119	23141	3712	24630	3022	24811	2493	24134	1710	28307	1344	16406
12-#11	1.49	MA	20912	5119	33181	3814	36012	3097	36817	2560	36969	1793	44046	1490	23734
4E		MI	14753	5119	23748	3715	25413	3014	25764	2486	25448	1717	29890	1384	16476
12-#11	1.49	MA	20384	5119	32292	3813	34865	3095	35412	2571	34964	1787	41600	1447	23578
5L-3S		MI	15156	5119	24438	3705	26289	3019	26824	2493	26779	1710	31374	1472	16456
12-#11	1.49	MA	19880	5119	31452	3812	33724	3106	34020	2567	33122	1795	39274	1388	22766
6L-2S		MI	15715	5119	25288	3709	27373	3010	28137	2486	28514	1703	33656	1560	16421
12-#14	2.14	MA	23826	5413	38790	3973	43089	3210	45390	2628	48485	1753	58947	1610	33823
2L-6S		MI	14309	5413	23620	3872	25107	3135	25384	2570	24885	1676	29579	1072	21737
12-#14	2.14	MA	22646	5413	36979	3971	40780	3226	42584	2642	44683	1763	53862	1482	33755
3L-5S		MI	14798	5413	24441	3878	26220	3143	26674	2560	26593	1666	31663	1158	22256
12-#14	2.14	MA	21814	5413	35524	3990	38930	3223	40339	2636	41767	1773	50534	1355	33541
4E		MI	15310	5413	25309	3883	27338	3132	28025	2550	28455	1676	33896	1216	23117
12-#14	2.14	MA	21068	5413	34248	3988	37285	3239	38324	2650	38893	1764	47049	1292	32207
5L-3S		MI	15877	5413	26294	3869	28591	3141	29525	2560	30339	1666	35994	1341	23186
12-#14	2.14	MA	20357	5413	33044	3986	35649	3235	36328	2645	36251	1774	43743	1208	31221
6L-2S		MI	16664	5413	27506	3875	30136	3129	31385	2550	32795	1656	39215	1469	23175
12-#18	3.81	MA	25395	6158	43876	4410	49436	3554	53054	2843	58606	1695	72210	1221	58262
3L-5S		MI	15766	6158	27611	4303	30102	3452	31204	2724	32577	1546	39755	665	35706
12-#18	3.81	MA	23985	6158	41323	4440	46190	3546	49114	2830	53538	1712	66476	994	55212
4E		MI	16633	6158	29127	4316	32045	3434	33516	2706	35768	1564	43553	769	37290
12-#18	3.81	MA	22722	6158	39081	4436	43299	3573	45575	2853	48539	1695	60432	886	52837
5L-3S		MI	17594	6158	30845	4294	34218	3452	36087	2724	38994	1546	47133	985	39482
12-#18	3.81	MA	21516	6158	36964	4431	40425	3564	42070	2841	43947	1712	54728	735	48879
6L-2S		MI	18923	6158	32950	4306	36893	3434	39273	2706	43202	1528	52611	1212	39687
14-#11	1.73	MA	22928	5230	36727	3871	40529	3137	42306	2585	44317	1771	53542	1653	27640
2L-7S		MI	14098	5230	22803	3788	24188	3075	24267	2524	23483	1712	27723	1191	18202
14-#11	1.73	MA	22095	5230	35462	3870	38916	3135	40345	2595	41661	1778	49965	1564	27625
3L-6S		MI	14435	5230	23418	3778	24936	3067	25214	2531	24663	1706	29112	1260	18455
14-#11	1.73	MA	21508	5230	34447	3883	37625	3147	38778	2592	39626	1786	47622	1475	27554
4L-5S		MI	14780	5230	23992	3781	25715	3072	26125	2524	25869	1699	30589	1319	18871
14-#11	1.73	MA	20984	5230	33557	3882	36478	3145	37372	2602	37621	1780	45177	1431	27267
5L-4S		MI	15140	5230	24599	3785	26497	3064	27078	2517	27183	1706	32172	1359	19059

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

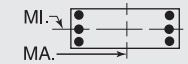
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.73	MA	20483	5230	32717	3882	35337	3156	35981	2599	35778	1788	42850	1373	26494
6L-3S		MI	15541	5230	25288	3774	27373	3069	28137	2524	28514	1699	33656	1447	19058
14-#11	1.73	MA	19994	5230	31819	3895	34242	3154	34639	2609	33976	1796	40429	1285	25997
7L-2S		MI	16097	5230	26139	3778	28457	3061	29451	2517	30248	1692	35938	1535	19033
14-#14	2.50	MA	23476	5572	38790	4071	43089	3299	45390	2687	48485	1753	58947	1459	39224
3L-6S		MI	14859	5572	24832	3972	26652	3207	27245	2613	27342	1659	32800	1034	25240
14-#14	2.50	MA	22651	5572	37335	4089	41239	3295	43145	2681	45569	1763	55619	1331	38974
4L-5S		MI	15344	5572	25653	3977	27766	3216	28534	2603	29050	1649	34884	1120	25779
14-#14	2.50	MA	21913	5572	36059	4088	39593	3311	41130	2695	42695	1754	52134	1269	37507
5L-4S		MI	15852	5572	26521	3983	28884	3204	29885	2593	30911	1659	37117	1177	26761
14-#14	2.50	MA	21208	5572	34854	4086	37957	3308	39135	2690	40053	1764	48828	1184	36564
6L-3S		MI	16415	5572	27506	3969	30136	3213	31385	2603	32795	1649	39215	1302	26860
14-#14	2.50	MA	20520	5572	33566	4104	36387	3324	37210	2704	37468	1774	45386	1058	34876
7L-2S		MI	17197	5572	28718	3975	31682	3202	33245	2593	35252	1639	42436	1430	26879
14-#18	4.44	MA	25401	6441	44492	4618	50230	3674	54026	2910	60144	1692	75260	945	64397
4L-5S		MI	16686	6441	29717	4481	32776	3580	34390	2797	36785	1510	45233	586	41562
14-#18	4.44	MA	24154	6441	42250	4613	47339	3701	50486	2933	55145	1674	69216	838	61933
5L-4S		MI	17545	6441	31232	4493	34719	3562	36702	2779	39976	1528	49032	691	43327
14-#18	4.44	MA	22965	6441	40133	4608	44465	3693	46981	2921	50552	1692	63511	687	58049
6L-3S		MI	18496	6441	32950	4471	36893	3580	39273	2797	43202	1510	52611	906	45783
14-#18	4.44	MA	21805	6441	37868	4639	41704	3719	43598	2943	46058	1710	57570	462	54099
7L-2S		MI	19813	6441	35055	4484	39567	3562	42458	2779	47411	1493	58090	1134	46052
16-#11	1.98	MA	22683	5341	36727	3939	40529	3185	42306	2626	44317	1771	53542	1549	31459
3L-7S		MI	14489	5341	23654	3857	25272	3125	25581	2555	25218	1701	30005	1166	20636
16-#11	1.98	MA	22100	5341	35712	3952	39238	3197	40739	2623	42282	1779	51198	1460	31371
4L-6S		MI	14823	5341	24268	3847	26020	3117	26527	2562	26398	1695	31394	1235	20956
16-#11	1.98	MA	21579	5341	34822	3951	38091	3195	39333	2633	40277	1773	48753	1416	30967
5E		MI	15166	5341	24842	3850	26799	3122	27438	2555	27604	1688	32872	1294	21346
16-#11	1.98	MA	21082	5341	33982	3951	36950	3207	37942	2630	38435	1781	46426	1358	30228
6L-4S		MI	15525	5341	25449	3854	27581	3114	28392	2548	28918	1695	34454	1334	21636
16-#11	1.98	MA	20597	5341	33084	3964	35855	3205	36600	2640	36632	1789	44005	1270	29715
7L-3S		MI	15923	5341	26139	3843	28457	3119	29451	2555	30248	1688	35938	1422	21654
16-#11	1.98	MA	20118	5341	32260	3963	34750	3216	35285	2650	34744	1783	41719	1219	28736
8L-2S		MI	16477	5341	26989	3847	29541	3111	30764	2548	31983	1681	38221	1510	21638
16-#14	2.86	MA	23481	5732	39145	4189	43547	3367	45951	2726	49371	1753	60704	1307	44404
4L-6S		MI	15404	5732	26044	4071	28198	3279	29105	2656	29799	1642	36021	995	28677
16-#14	2.86	MA	22749	5732	37869	4188	41902	3384	43936	2740	46497	1744	57220	1245	42819
5E		MI	15886	5732	26865	4077	29311	3288	30395	2646	31506	1632	38105	1081	29314
16-#14	2.86	MA	22051	5732	36665	4186	40266	3380	41941	2735	43855	1754	53913	1161	41912
6L-4S		MI	16390	5732	27733	4083	30429	3277	31745	2636	33368	1642	40338	1139	30237
16-#14	2.86	MA	21369	5732	35376	4204	38695	3396	40016	2749	41270	1764	50471	1034	40153
7L-3S		MI	16949	5732	28718	4069	31682	3285	33245	2646	35252	1632	42436	1264	30526
16-#14	2.86	MA	20697	5732	34194	4202	37110	3393	38131	2763	38562	1755	47216	961	38547
8L-2S		MI	17726	5732	29931	4074	33227	3274	35105	2636	37709	1622	45657	1392	30570
16-#18	5.08	MA	25570	6725	45419	4790	51380	3830	55398	3013	61750	1654	78000	789	70984
5E		MI	17599	6725	31822	4658	35451	3707	37575	2870	40993	1475	50712	508	47453
16-#18	5.08	MA	24397	6725	43302	4786	48505	3821	51893	3000	57158	1672	72295	638	67242
6L-4S		MI	18448	6725	33337	4671	37394	3690	39887	2852	44184	1493	54510	612	49392
16-#18	5.08	MA	23251	6725	41037	4816	45744	3848	48510	3023	52664	1689	66354	413	63199
7L-3S		MI	19390	6725	35055	4648	39567	3707	42458	2870	47411	1475	58090	828	52075
18-#11	2.23	MA	22688	5451	36977	4021	40851	3247	42700	2654	44939	1772	54775	1445	35184
4L-7S		MI	14877	5451	24504	3926	26356	3175	26894	2586	26953	1690	32287	1141	23079
18-#11	2.23	MA	22170	5451	36087	4021	39704	3245	41294	2664	42934	1766	52329	1401	34677
5L-6S		MI	15210	5451	25118	3916	27104	3167	27841	2592	28133	1684	33676	1210	23460

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis

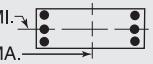


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.23	MA	21676	5451	35248	4020	38563	3257	39903	2661	41091	1774	50002	1343	33968
6L-5S		MI	15551	5451	25692	3919	27883	3172	28752	2586	29339	1677	35154	1269	23829
18-#11	2.23	MA	21194	5451	34349	4033	37468	3255	38560	2671	39289	1782	47581	1255	33393
7L-4S		MI	15907	5451	26299	3923	28665	3164	29705	2579	30653	1684	36736	1309	24207
18-#11	2.23	MA	20719	5451	33525	4032	36363	3266	37246	2682	37400	1776	45296	1204	32444
8L-3S		MI	16303	5451	26989	3913	29541	3169	30764	2586	31983	1677	38221	1397	24240
18-#11	2.23	MA	20239	5451	32653	4045	35283	3264	35887	2678	35616	1784	43042	1148	31546
9L-2S		MI	16855	5451	27839	3916	30626	3161	32078	2579	33718	1670	40503	1485	24237
18-#14	3.21	MA	23578	5892	39680	4287	44210	3456	46742	2785	50299	1734	62305	1221	48143
5L-6S		MI	15945	5892	27256	4171	29743	3352	30965	2700	32256	1624	39242	956	32128
18-#14	3.21	MA	22886	5892	38476	4286	42574	3452	44747	2780	47657	1744	58998	1137	47143
6L-5S		MI	16424	5892	28077	4177	30857	3360	32255	2690	33963	1614	41326	1042	32858
18-#14	3.21	MA	22211	5892	37187	4304	41004	3469	42822	2794	45072	1754	55557	1010	45440
7L-4S		MI	16924	5892	28945	4183	31975	3349	33605	2680	35825	1624	43559	1100	33726
18-#14	3.21	MA	21545	5892	36005	4302	39419	3465	40938	2808	42364	1745	52301	938	43781
8L-3S		MI	17480	5892	29931	4168	33227	3358	35105	2690	37709	1614	45657	1225	34185
18-#14	3.21	MA	20873	5892	34754	4320	37870	3481	38988	2802	39806	1755	49097	856	42107
9L-2S		MI	18252	5892	31143	4174	34773	3346	36965	2680	40166	1605	48878	1353	34250
18-#18	5.71	MA	25812	7009	46471	4963	52545	3950	56804	3080	63764	1651	81079	590	76455
6L-5S		MI	18503	7009	33927	4835	38125	3835	40761	2944	45202	1439	56190	429	53373
18-#18	5.71	MA	24681	7009	44206	4994	49785	3976	53421	3103	59269	1669	75137	365	72320
7L-4S		MI	19345	7009	35443	4848	40068	3817	43073	2926	48392	1457	59989	534	55479
20-#11	2.48	MA	22757	5562	37352	4090	41317	3295	43255	2695	45590	1759	55905	1386	38395
5L-7S		MI	15262	5562	25354	3995	27440	3226	28208	2616	28688	1679	34570	1116	25530
20-#11	2.48	MA	22266	5562	36513	4089	40176	3307	41864	2692	43748	1767	53579	1328	37713
6E		MI	15594	5562	25968	3985	28188	3217	29154	2623	29868	1672	35958	1185	25969
20-#11	2.48	MA	21788	5562	35614	4102	39081	3305	40521	2702	41945	1775	51157	1240	37078
7L-5S		MI	15933	5562	26542	3989	28967	3223	30065	2616	31073	1666	37436	1244	26319
20-#11	2.48	MA	21316	5562	34790	4101	37976	3316	39207	2713	40057	1769	48872	1189	36157
8L-4S		MI	16288	5562	27149	3992	29749	3214	31019	2609	32387	1672	39019	1284	26774
20-#11	2.48	MA	20837	5562	33918	4114	36896	3314	37848	2709	38273	1777	46618	1133	35222
9L-3S		MI	16681	5562	27839	3982	30626	3219	32078	2616	33718	1666	40503	1372	26819
20-#11	2.48	MA	20310	5562	33098	4113	35805	3326	36542	2720	36502	1784	44432	1069	34206
10L-2S		MI	17230	5562	28689	3985	31710	3211	33392	2609	35453	1659	42785	1460	26832
20-#14	3.57	MA	23714	6051	40286	4385	44883	3525	47554	2824	51459	1734	64084	1113	52386
6E		MI	16483	6051	28468	4271	31289	3424	32825	2743	34712	1607	42464	917	35591
20-#14	3.57	MA	23045	6051	38998	4404	43312	3541	45629	2839	48874	1744	60642	987	50735
7L-5S		MI	16958	6051	29290	4277	32402	3433	34115	2733	36420	1597	44547	1003	36410
20-#14	3.57	MA	22384	6051	37815	4402	41727	3537	43744	2853	46166	1735	57386	914	49024
8L-4S		MI	17455	6051	30158	4282	33520	3421	35465	2723	38282	1607	46780	1061	37229
20-#14	3.57	MA	21715	6051	36564	4420	40178	3554	41794	2847	43608	1745	54183	833	47197
9L-3S		MI	18007	6051	31143	4268	34773	3430	36965	2733	40166	1597	48878	1186	37838
20-#18	6.35	MA	26095	7292	47375	5171	53825	4105	58333	3183	65875	1648	83921	316	81460
7L-5S		MI	19401	7292	36032	5013	40799	3963	43946	3017	49410	1404	61669	351	59321
22-#11	2.72	MA	22853	5672	37778	4158	41789	3357	43824	2723	46404	1760	57155	1313	41462
6L-7S		MI	15646	5672	26204	4065	28524	3276	29522	2647	30422	1668	36852	1091	27987
22-#11	2.72	MA	22377	5672	36879	4171	40694	3355	42482	2733	44602	1768	54734	1225	40770
7L-6S		MI	15975	5672	26819	4054	29272	3267	30468	2654	31602	1661	38241	1160	28480
22-#11	2.72	MA	21908	5672	36055	4170	39589	3367	41168	2744	42713	1762	52448	1174	39875
8L-5S		MI	16313	5672	27393	4058	30051	3273	31379	2647	32808	1655	39718	1219	28813
22-#11	2.72	MA	21430	5672	35183	4183	38509	3365	39808	2740	40929	1770	50194	1118	38905
9L-4S		MI	16666	5672	28000	4061	30833	3264	32332	2640	34122	1661	41301	1259	29338
22-#11	2.72	MA	20908	5672	34363	4183	37418	3376	38502	2751	39159	1777	48008	1054	37911
10L-3S		MI	17057	5672	28689	4051	31710	3270	33392	2647	35453	1655	42785	1347	29395
22-#11	2.72	MA	20403	5672	33554	4182	36344	3374	37158	2747	37297	1771	45777	1000	36616
11L-2S		MI	17604	5672	29540	4054	32794	3261	34705	2640	37187	1648	45067	1435	29419
22-#14	3.93	MA	23872	6211	40808	4503	45621	3613	48435	2884	52676	1734	65727	963	56039
7L-6S		MI	17017	6211	29681	4371	32834	3496	34685	2786	37169	1590	45685	879	39066

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.93	MA	23217	6211	39626	4502	44035	3610	46550	2898	49968	1725	62471	891	54277
8L-5S		MI	17489	6211	30502	4376	33948	3505	35975	2777	38877	1580	47768	965	39968
22-#14	3.93	MA	22549	6211	38375	4520	42486	3626	44600	2892	47409	1735	59268	809	52416
9L-4S		MI	17983	6211	31370	4382	35066	3494	37325	2767	40738	1590	50001	1023	40742
24-#11	2.97	MA	22963	5783	38145	4240	42307	3405	44443	2765	47258	1761	58310	1210	44469
7E		MI	16027	5783	27055	4134	29608	3326	30835	2678	32157	1657	39134	1066	30450
24-#11	2.97	MA	22497	5783	37320	4239	41202	3417	43129	2775	45370	1755	56025	1159	43598
8L-6S		MI	16355	5783	27669	4123	30356	3317	31781	2685	33337	1650	40523	1135	30994
24-#11	2.97	MA	22020	5783	36448	4252	40122	3415	41769	2772	43586	1763	53770	1103	42592
9L-5S		MI	16691	5783	28243	4127	31135	3323	32692	2678	34543	1644	42000	1194	31312
24-#11	2.97	MA	21503	5783	35628	4252	39031	3426	40463	2782	41815	1771	51585	1039	41620
10L-4S		MI	17042	5783	28850	4130	31917	3314	33646	2671	35857	1650	43583	1234	31898
24-#11	2.97	MA	21000	5783	34819	4251	37957	3424	39119	2778	39953	1765	49353	985	40302
11L-3S		MI	17432	5783	29540	4120	32794	3320	34705	2678	37187	1644	45067	1322	31967
24-#14	4.29	MA	24044	6370	41437	4601	46344	3682	49356	2943	53770	1715	67557	867	59537
8L-6S		MI	17547	6370	30893	4470	34380	3569	36545	2830	39626	1573	48906	840	42550
24-#14	4.29	MA	23377	6370	40186	4620	44795	3698	47406	2937	51211	1725	64353	786	57644
9L-5S		MI	18016	6370	31714	4476	35493	3577	37835	2820	41333	1563	50989	926	43530

RECTANGULAR TIED COLUMNS 30" x 44"

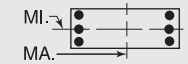
4-#18	1.21	MA	23719	5235	37399	3877	40620	3155	41679	2621	42138	1854	49804	1739	21232
2E		MI	15909	5235	25498	3752	27189	3050	27491	2520	27224	1753	31637	1607	13974
6-#14	1.02	MA	23297	5146	36325	3846	39396	3135	40247	2613	40259	1875	47472	1776	18149
2L-3S		MI	14873	5146	23621	3726	24948	3052	24908	2539	23828	1802	27278	1538	12091
6-#14	1.02	MA	22018	5146	34414	3845	36960	3132	37286	2628	36248	1886	42075	1648	18196
3L-2S		MI	15677	5146	24833	3732	26493	3041	26768	2529	26285	1792	30499	1666	12011
6-#18	1.82	MA	25264	5519	40746	4055	44887	3284	46865	2701	49144	1836	59141	1693	31465
2L-3S		MI	15467	5519	25498	3916	27189	3196	27491	2611	27224	1735	31637	1301	20546
6-#18	1.82	MA	23068	5519	37399	4051	40620	3312	41679	2725	42138	1853	49804	1466	31336
3L-2S		MI	16840	5519	27603	3929	29863	3178	30676	2594	31433	1718	37116	1528	20485
8-#14	1.36	MA	24195	5306	38235	3946	41832	3207	43207	2658	44270	1865	52869	1754	23998
2L-4S		MI	14849	5306	23848	3840	25241	3116	25267	2572	24401	1794	28401	1375	15855
8-#14	1.36	MA	22927	5306	36325	3945	39396	3204	40247	2673	40259	1876	47472	1626	24006
3E		MI	15425	5306	24833	3826	26493	3124	26768	2582	26285	1784	30499	1499	15828
8-#14	1.36	MA	22032	5306	34791	3963	37446	3221	37880	2668	37186	1887	43936	1498	23879
4L-2S		MI	16224	5306	26045	3831	28039	3113	28628	2572	28742	1774	33720	1627	15767
8-#18	2.42	MA	26783	5802	44092	4232	49153	3412	52052	2781	56151	1817	68479	1648	41646
2L-4S		MI	15416	5802	25885	4116	27690	3306	28105	2667	28206	1718	33536	1007	25588
8-#18	2.42	MA	24616	5802	40746	4228	44887	3440	46865	2805	49144	1835	59141	1421	41404
3E		MI	16401	5802	27603	4093	29863	3323	30676	2685	31433	1700	37116	1222	26915
8-#18	2.42	MA	23085	5802	38053	4260	41463	3433	42710	2794	43769	1852	53038	1193	39274
4L-2S		MI	17760	5802	29708	4106	32537	3306	33862	2667	35641	1682	42594	1450	26943
10-#11	1.18	MA	23756	5221	37207	3905	40595	3179	41732	2643	42283	1877	50320	1778	20966
2L-5S		MI	14635	5221	23252	3800	24540	3101	24462	2572	23262	1805	26976	1450	13929
10-#11	1.18	MA	22865	5221	35872	3904	38893	3177	39664	2654	39482	1885	46527	1689	20988
3L-4S		MI	15001	5221	23859	3803	25323	3092	25415	2565	24576	1812	28558	1490	13918
10-#11	1.18	MA	22238	5221	34803	3918	37533	3189	38013	2651	37338	1894	44040	1600	20962
4L-3S		MI	15406	5221	24549	3793	26199	3098	26475	2572	25906	1805	30042	1578	13878
10-#11	1.18	MA	21677	5221	33866	3917	36325	3187	36533	2661	35226	1888	41450	1556	20846
5L-2S		MI	15969	5221	25399	3796	27283	3089	27788	2565	27641	1798	32325	1667	13833

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

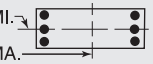


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.70	MA	25084	5465	40146	4046	44267	3280	46168	2703	48282	1855	58266	1732	29830
2L-5S		MI	14884	5465	24192	3934	25668	3199	25777	2625	24996	1767	29389	1278	18903
10-#14	1.70	MA	23825	5465	38235	4045	41832	3277	43207	2718	44270	1866	52869	1604	29797
3L-4S		MI	15401	5465	25060	3940	26786	3188	27128	2615	26858	1777	31622	1336	19527
10-#14	1.70	MA	22939	5465	36702	4063	39882	3293	40841	2713	41198	1877	49333	1476	29623
4L-3S		MI	15973	5465	26045	3926	28039	3197	28628	2625	28742	1767	33720	1461	19542
10-#14	1.70	MA	22145	5465	35358	4062	38149	3290	38718	2728	38169	1869	45642	1413	28503
5L-2S		MI	16766	5465	27257	3931	29584	3186	30488	2615	31198	1757	36941	1589	19500
10-#18	3.03	MA	28282	6086	47438	4409	53419	3541	57238	2861	63158	1798	77816	1603	51794
2L-5S		MI	15470	6086	26474	4280	28421	3451	28978	2758	29224	1664	35216	824	30171
10-#18	3.03	MA	26141	6086	44092	4406	49153	3569	52052	2885	56151	1816	68479	1376	51457
3L-4S		MI	16349	6086	27990	4293	30364	3433	31291	2740	32414	1682	39015	928	31542
10-#18	3.03	MA	24630	6086	41399	4437	45729	3561	47897	2874	50776	1834	62376	1148	48899
4L-3S		MI	17323	6086	29708	4271	32537	3451	33862	2758	35641	1664	42594	1144	33254
10-#18	3.03	MA	23277	6086	39037	4433	42683	3589	44166	2898	45474	1816	55965	1039	46128
5L-2S		MI	18668	6086	31813	4283	35211	3433	37047	2740	39849	1647	48073	1371	33368
12-#11	1.42	MA	24384	5331	38541	3974	42296	3229	43800	2674	45085	1870	54112	1764	25044
2L-6S		MI	14680	5331	23529	3865	24846	3146	24865	2610	23791	1801	27780	1366	16072
12-#11	1.42	MA	23498	5331	37207	3974	40595	3227	41732	2685	42283	1878	50320	1675	25048
3L-5S		MI	15027	5331	24103	3869	25624	3151	25776	2603	24997	1794	29258	1425	16505
12-#11	1.42	MA	22875	5331	36137	3987	39234	3239	40081	2682	40140	1887	47832	1586	24998
4E		MI	15391	5331	24710	3872	26407	3143	26729	2596	26311	1801	30840	1465	16518
12-#11	1.42	MA	22318	5331	35200	3986	38026	3238	38601	2693	38028	1881	45243	1542	24857
5L-3S		MI	15794	5331	25399	3862	27283	3148	27788	2603	27641	1794	32325	1553	16493
12-#11	1.42	MA	21787	5331	34317	3986	36825	3250	37136	2690	36088	1889	42774	1484	24051
6L-2S		MI	16354	5331	26250	3865	28367	3139	29102	2596	29376	1787	34607	1642	16456
12-#14	2.05	MA	25964	5625	42056	4145	46703	3352	49129	2748	52293	1845	63664	1710	35645
2L-6S		MI	14945	5625	24583	4028	26100	3263	26348	2679	25745	1760	30526	1153	21884
12-#14	2.05	MA	24715	5625	40146	4144	44267	3349	46168	2763	48282	1856	58266	1582	35578
3L-5S		MI	15435	5625	25404	4034	27214	3272	27637	2669	27453	1750	32610	1239	22410
12-#14	2.05	MA	23836	5625	38612	4163	42318	3366	43802	2758	45209	1867	54731	1454	35363
4E		MI	15948	5625	26272	4039	28332	3261	28988	2659	29314	1760	34843	1297	23185
12-#14	2.05	MA	23050	5625	37268	4162	40584	3363	41679	2773	42180	1859	51039	1391	34081
5L-3S		MI	16516	5625	27257	4025	29584	3269	30488	2669	31198	1750	36941	1422	23239
12-#14	2.05	MA	22300	5625	36000	4161	38862	3379	39578	2768	39398	1870	47528	1307	33001
6L-2S		MI	17305	5625	28470	4031	31130	3258	32348	2659	33655	1740	40162	1550	23218
12-#18	3.64	MA	27644	6370	47438	4583	53419	3697	57238	2965	63158	1797	77816	1330	61502
3L-5S		MI	16402	6370	28579	4458	31095	3579	32164	2831	33432	1629	40695	745	36114
12-#18	3.64	MA	26154	6370	44745	4614	49995	3690	53083	2953	57782	1815	71713	1103	58568
4E		MI	17272	6370	30095	4471	33038	3561	34476	2814	36623	1647	44493	850	37540
12-#18	3.64	MA	24819	6370	42383	4611	46949	3718	49352	2978	52481	1797	65302	994	55947
5L-3S		MI	18236	6370	31813	4448	35211	3579	37047	2831	39849	1629	48073	1065	39575
12-#18	3.64	MA	23546	6370	40152	4607	43920	3710	45658	2966	47610	1815	59234	843	51953
6L-2S		MI	19568	6370	33918	4461	37885	3561	40233	2814	44057	1611	53551	1293	39756
14-#11	1.65	MA	25007	5442	39875	4043	43997	3279	45868	2705	47887	1863	57905	1750	29114
2L-7S		MI	14734	5442	23765	3945	25181	3204	25232	2634	24345	1797	28674	1273	18317
14-#11	1.65	MA	24126	5442	38541	4043	42296	3277	43800	2716	45085	1871	54112	1661	29099
3L-6S		MI	15071	5442	24379	3934	25930	3196	26178	2640	25525	1790	30062	1341	18566
14-#11	1.65	MA	23507	5442	37471	4056	40936	3289	42149	2713	42942	1880	51625	1572	29029
4L-5S		MI	15417	5442	24953	3938	26708	3201	27089	2634	26731	1783	31540	1400	18994
14-#11	1.65	MA	22954	5442	36535	4056	39727	3288	40669	2724	40830	1874	49036	1528	28840
5L-4S		MI	15778	5442	25560	3941	27491	3193	28043	2627	28045	1790	33123	1440	19108
14-#11	1.65	MA	22426	5442	35651	4055	38526	3300	39204	2721	38890	1883	46567	1470	27985
6L-3S		MI	16179	5442	26250	3931	28367	3198	29102	2634	29376	1783	34607	1528	19098
14-#11	1.65	MA	21911	5442	34705	4068	37373	3298	37791	2731	36992	1891	43999	1382	27444
7L-2S		MI	16737	5442	27100	3934	29451	3190	30415	2627	31111	1776	36889	1617	19070
14-#14	2.39	MA	25596	5785	42056	4244	46703	3421	49129	2808	52293	1846	63664	1560	41350
3L-6S		MI	15495	5785	25795	4128	27646	3336	28208	2722	28202	1743	33747	1115	25439

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis



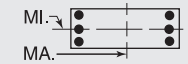
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.39	MA	24725	5785	40523	4263	44753	3438	46763	2803	49220	1857	60128	1432	41100
4L-5S		MI	15982	5785	26616	4133	28759	3344	29498	2712	29909	1733	35831	1201	25933
14-#14	2.39	MA	23945	5785	39179	4262	43020	3435	44640	2818	46192	1849	56436	1369	39676
5L-4S		MI	16491	5785	27484	4139	29877	3333	30848	2702	31771	1743	38064	1258	26835
14-#14	2.39	MA	23202	5785	37911	4260	41297	3452	42539	2813	43410	1860	52925	1285	38642
6L-3S		MI	17055	5785	28470	4125	31130	3341	32348	2712	33655	1733	40162	1383	26917
14-#14	2.39	MA	22477	5785	36554	4279	39643	3449	40512	2828	40687	1871	49271	1158	36979
7L-2S		MI	17839	5785	29682	4131	32675	3330	34208	2702	36112	1723	43383	1511	26925
14-#18	4.24	MA	27658	6654	48092	4792	54262	3818	58269	3033	64789	1796	81051	1058	68276
4L-5S		MI	17324	6654	30684	4635	33769	3707	35350	2905	37640	1593	46173	667	41964
14-#18	4.24	MA	26341	6654	45729	4788	51215	3846	54539	3057	59488	1778	74639	948	65786
5L-4S		MI	18185	6654	32200	4648	35712	3689	37662	2887	40831	1611	49972	771	43574
14-#18	4.24	MA	25085	6654	43499	4784	48186	3839	50845	3046	54616	1796	68572	798	61650
6L-3S		MI	19140	6654	33918	4625	37885	3707	40233	2905	44057	1593	53551	987	45883
14-#18	4.24	MA	23859	6654	41112	4816	45277	3867	47280	3070	49849	1814	62254	573	57650
7L-2S		MI	20460	6654	36023	4638	40559	3689	43418	2887	48266	1576	59030	1214	46125
16-#11	1.89	MA	24750	5553	39875	4112	43997	3328	45868	2747	47887	1865	57905	1647	33144
3L-7S		MI	15125	5553	24615	4014	26265	3254	26545	2664	26080	1786	30956	1248	20821
16-#11	1.89	MA	24135	5553	38806	4125	42637	3340	44217	2744	45743	1873	55418	1558	33055
4L-6S		MI	15460	5553	25229	4004	27014	3246	27492	2671	27260	1779	32345	1316	21067
16-#11	1.89	MA	23585	5553	37869	4125	41428	3338	42737	2755	43631	1867	52828	1514	32743
5E		MI	15804	5553	25803	4007	27792	3251	28403	2664	28466	1772	33822	1375	21468
16-#11	1.89	MA	23061	5553	36985	4124	40227	3350	41272	2752	41692	1876	50360	1456	31925
6L-4S		MI	16163	5553	26410	4011	28575	3243	29356	2657	29780	1779	35405	1415	21688
16-#11	1.89	MA	22550	5553	36039	4138	39075	3348	39859	2763	39794	1884	47791	1368	31402
7L-3S		MI	16562	5553	27100	4000	29451	3248	30415	2664	31111	1772	36889	1503	21696
16-#11	1.89	MA	22045	5553	35172	4137	37911	3360	38476	2773	37806	1879	45371	1316	30415
8L-2S		MI	17117	5553	27950	4004	30535	3240	31729	2657	32845	1765	39171	1592	21676
16-#14	2.73	MA	25606	5944	42433	4362	47189	3510	49724	2848	53232	1848	65525	1410	46834
4L-6S		MI	16041	5944	27008	4227	29191	3408	30068	2765	30659	1725	36968	1076	28931
16-#14	2.73	MA	24833	5944	41089	4361	45456	3507	47601	2863	50203	1839	61833	1347	45285
5E		MI	16524	5944	27829	4233	30305	3416	31358	2755	32366	1715	39052	1162	29467
16-#14	2.73	MA	24096	5944	39821	4360	43733	3524	45500	2858	47421	1850	58322	1263	44291
6L-4S		MI	17030	5944	28697	4239	31423	3405	32708	2746	34228	1725	41285	1220	30419
16-#14	2.73	MA	23377	5944	38464	4379	42079	3521	43473	2873	44698	1861	54668	1136	42552
7L-3S		MI	17590	5944	29682	4225	32675	3414	34208	2755	36112	1715	43383	1345	30587
16-#14	2.73	MA	22668	5944	37220	4378	40410	3538	41488	2887	41847	1852	51219	1063	40978
8L-2S		MI	18369	5944	30894	4230	34221	3402	36068	2746	38569	1706	46604	1473	30622
16-#18	4.85	MA	27845	6937	49075	4965	55481	3975	59725	3137	66494	1760	83977	903	75509
5E		MI	18238	6937	32789	4812	36443	3834	38535	2978	41848	1558	51652	588	47848
16-#18	4.85	MA	26605	6937	46845	4961	52452	3967	56031	3126	61623	1777	77909	753	71370
6L-4S		MI	19091	6937	34305	4825	38386	3817	40847	2960	45039	1575	55450	693	49635
16-#18	4.85	MA	25395	6937	44458	4993	49543	3995	52466	3150	56855	1795	71591	528	67278
7L-3S		MI	20036	6937	36023	4803	40559	3834	43418	2978	48266	1558	59030	908	52181
18-#11	2.13	MA	24758	5663	40140	4194	44338	3390	46285	2775	48545	1866	59210	1544	37079
4L-7S		MI	15513	5663	25465	4083	27349	3305	27859	2695	27815	1775	33238	1223	23262
18-#11	2.13	MA	24212	5663	39203	4194	43130	3388	44805	2786	46433	1860	56621	1500	36657
5L-6S		MI	15847	5663	26079	4073	28098	3296	28805	2702	28995	1768	34627	1291	23572
18-#11	2.13	MA	23691	5663	38320	4193	41929	3400	43340	2783	44493	1869	54152	1442	35871
6L-5S		MI	16189	5663	26653	4076	28876	3301	29716	2695	30201	1761	36104	1350	23951
18-#11	2.13	MA	23183	5663	37374	4207	40776	3398	41927	2794	42595	1877	51584	1354	35363
7L-4S		MI	16546	5663	27260	4080	29659	3293	30670	2688	31515	1768	37687	1390	24263
18-#11	2.13	MA	22682	5663	36506	4206	39612	3410	40544	2805	40607	1872	49164	1302	34328
8L-3S		MI	16943	5663	27950	4069	30535	3298	31729	2695	32845	1761	39171	1478	24289

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

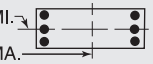


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.13	MA	22158	5663	35655	4206	38476	3409	39112	2802	38729	1880	46772	1246	33471
9L-2S		MI	17496	5663	28800	4073	31619	3290	33043	2688	34580	1754	41453	1567	24278
18-#14	3.07	MA	25713	6104	43000	4461	47891	3580	50562	2908	54214	1829	67231	1325	50905
5L-6S		MI	16583	6104	28220	4327	30737	3480	31928	2809	33115	1708	40190	1037	32379
18-#14	3.07	MA	24983	6104	41732	4460	46169	3596	48461	2903	51432	1840	63719	1241	49947
6L-5S		MI	17063	6104	29041	4333	31850	3489	33218	2799	34823	1698	42273	1123	33010
18-#14	3.07	MA	24270	6104	40375	4479	44515	3593	46433	2917	48710	1851	60065	1114	48135
7L-4S		MI	17565	6104	29909	4339	32968	3477	34568	2789	36685	1708	44506	1181	33906
18-#14	3.07	MA	23567	6104	39130	4477	42845	3610	44449	2932	45858	1842	56616	1041	46509
8L-3S		MI	18122	6104	30894	4324	34221	3486	36068	2799	38569	1698	46604	1306	34250
18-#14	3.07	MA	22847	6104	37813	4496	41214	3607	42395	2927	43164	1853	53214	960	44675
9L-2S		MI	18896	6104	32106	4330	35766	3475	37928	2789	41025	1688	49825	1434	34305
18-#18	5.45	MA	28108	7221	50191	5139	56719	4096	61217	3206	68629	1759	87247	708	81111
6L-5S		MI	19144	7221	34894	4990	39117	3962	41721	3051	46056	1522	57130	510	53762
18-#18	5.45	MA	26913	7221	47805	5170	53810	4124	57652	3230	63862	1776	80929	483	76927
7L-4S		MI	19989	7221	36410	5002	41060	3944	44033	3034	49247	1540	60929	614	55719
20-#11	2.36	MA	24835	5774	40538	4263	44831	3438	46873	2817	49235	1854	60414	1486	40579
5L-7S		MI	15900	5774	26315	4152	28433	3355	29173	2726	29550	1764	35520	1198	25711
20-#11	2.36	MA	24317	5774	39654	4263	43630	3450	45408	2814	47295	1862	57945	1428	39823
6E		MI	16232	5774	26930	4142	29182	3346	30119	2733	30730	1757	36909	1266	26081
20-#11	2.36	MA	23813	5774	38708	4276	42477	3448	43995	2825	45397	1870	55377	1340	39262
7L-5S		MI	16572	5774	27504	4145	29960	3352	31030	2726	31936	1750	38387	1325	26440
20-#11	2.36	MA	23315	5774	37841	4275	41314	3460	42612	2836	43409	1865	52957	1288	38247
8L-4S		MI	16927	5774	28111	4149	30743	3343	31983	2719	33250	1757	39969	1365	26833
20-#11	2.36	MA	22802	5774	36989	4275	40177	3459	41180	2833	41531	1873	50565	1232	37353
9L-3S		MI	17322	5774	28800	4138	31619	3348	33043	2726	34580	1750	41453	1453	26870
20-#11	2.36	MA	22245	5774	36059	4288	39028	3471	39806	2843	39667	1881	48245	1169	36240
10L-2S		MI	17872	5774	29651	4142	32703	3340	34356	2719	36315	1743	43736	1542	26874
20-#14	3.41	MA	25862	6263	43642	4560	48604	3669	51421	2947	55444	1830	69117	1219	55552
6E		MI	17121	6263	29432	4427	32282	3552	33788	2852	35572	1691	43411	998	35840
20-#14	3.41	MA	25155	6263	42285	4578	46950	3666	49394	2962	52721	1841	65463	1092	53728
7L-5S		MI	17598	6263	30253	4433	33396	3561	35078	2842	37280	1681	45494	1084	36561
20-#14	3.41	MA	24458	6263	41040	4577	45281	3682	47410	2977	49869	1832	62013	1019	52049
8L-4S		MI	18097	6263	31121	4438	34514	3550	36428	2832	39141	1691	47728	1142	37406
20-#14	3.41	MA	23740	6263	39723	4596	43650	3679	45356	2972	47175	1843	58611	938	50258
9L-3S		MI	18650	6263	32106	4424	35766	3558	37928	2842	41025	1681	49825	1267	37906
20-#18	6.06	MA	28415	7505	51151	5348	58076	4252	62839	3310	70869	1758	90266	437	86595
7L-5S		MI	20043	7505	36999	5167	41792	4090	44906	3125	50265	1487	62609	431	59704
22-#11	2.60	MA	24939	5885	40988	4332	45331	3500	47476	2845	50097	1855	61738	1414	43778
6L-7S		MI	16284	5885	27166	4221	29517	3405	30486	2757	31284	1753	37803	1173	28167
22-#11	2.60	MA	24438	5885	40042	4345	44178	3499	46063	2856	48199	1863	59169	1326	43159
7L-6S		MI	16614	5885	27780	4211	30266	3396	31432	2764	32464	1746	39191	1241	28593
22-#11	2.60	MA	23943	5885	39175	4344	43015	3511	44680	2867	46211	1858	56749	1274	42172
8L-5S		MI	16952	5885	28354	4214	31044	3402	32343	2757	33670	1739	40669	1300	28934
22-#11	2.60	MA	23431	5885	38323	4344	41878	3509	43248	2864	44333	1866	54358	1218	41241
9L-4S		MI	17306	5885	28961	4218	31827	3393	33297	2750	34984	1746	42251	1340	29399
22-#11	2.60	MA	22880	5885	37394	4357	40729	3521	41874	2875	42468	1874	52038	1155	40152
10L-3S		MI	17699	5885	29651	4208	32703	3399	34356	2757	36315	1739	43736	1428	29448
22-#11	2.60	MA	22346	5885	36542	4357	39599	3519	40459	2872	40508	1869	49675	1100	38864
11L-2S		MI	18247	5885	30501	4211	33787	3390	35670	2750	38050	1732	46018	1517	29467
22-#14	3.75	MA	26033	6423	44196	4678	49386	3738	52355	3007	56732	1831	70860	1070	59328
7L-6S		MI	17656	6423	30644	4527	33828	3625	35648	2895	38029	1674	46632	960	39312
22-#14	3.75	MA	25342	6423	42951	4677	47717	3755	50370	3022	53881	1822	67410	997	57597
8L-5S		MI	18130	6423	31465	4532	34941	3633	36938	2886	39736	1664	48715	1046	40119
22-#14	3.75	MA	24625	6423	41634	4695	46086	3752	48317	3017	51186	1833	64008	916	55753
9L-4S		MI	18626	6423	32333	4538	36059	3622	38288	2876	41598	1674	50949	1104	40918
24-#11	2.84	MA	25059	5995	41377	4414	45879	3549	48131	2887	51001	1856	62962	1312	47062
7E		MI	16666	5995	28016	4291	30601	3455	31800	2787	33019	1742	40085	1148	30629

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.84	MA	24568	5995	40509	4414	44716	3561	46748	2898	49012	1851	60542	1260	46101
8L-6S		MI	16994	5995	28630	4280	31350	3447	32746	2794	34199	1735	41474	1216	31108
24-#11	2.84	MA	24057	5995	39658	4413	43579	3559	45316	2895	47134	1859	58150	1204	45134
9L-5S		MI	17331	5995	29204	4284	32128	3452	33657	2787	35405	1728	42951	1275	31433
24-#11	2.84	MA	23510	5995	38728	4426	42431	3571	43942	2906	45270	1868	55831	1141	44068
10L-4S		MI	17683	5995	29811	4287	32911	3443	34610	2781	36719	1735	44534	1315	31962
24-#11	2.84	MA	22979	5995	37877	4426	41301	3569	42527	2903	43310	1862	53468	1086	42757
11L-3S		MI	18074	5995	30501	4277	33787	3449	35670	2787	38050	1728	46018	1403	32022
24-#14	4.09	MA	26219	6583	44861	4777	50152	3827	53331	3067	57892	1812	72807	975	63154
8L-6S		MI	18188	6583	31856	4626	35373	3697	37508	2939	40486	1657	49853	921	42794
24-#14	4.09	MA	25504	6583	43544	4795	48521	3824	51278	3062	55197	1824	69406	894	61277
9L-5S		MI	18659	6583	32678	4632	36486	3706	38798	2929	42193	1647	51936	1007	43681

RECTANGULAR TIED COLUMNS 30" x 46"

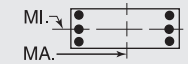
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.16	MA	25815	5447	40550	4050	44057	3297	45170	2742	45590	1949	53886	1834	22312
2E		MI	16547	5447	26465	3906	28181	3177	28451	2628	28079	1836	32577	1687	14013
6-#18	1.74	MA	27451	5731	44073	4227	48549	3426	50631	2822	52988	1931	63778	1792	33085
2L-3S		MI	16105	5731	26465	4070	28181	3323	28451	2719	28079	1818	32577	1381	20609
6-#18	1.74	MA	25134	5731	40550	4224	44057	3454	45170	2847	45590	1950	53886	1564	32956
3L-2S		MI	17480	5731	28570	4083	30856	3305	31636	2702	32287	1801	38056	1608	20532
8-#14	1.30	MA	26315	5518	41423	4118	45324	3349	46769	2779	47780	1958	57098	1849	25213
2L-4S		MI	15485	5518	24811	3996	26234	3244	26231	2681	25261	1878	29348	1456	15907
8-#14	1.30	MA	24977	5518	39413	4118	42761	3347	43653	2794	43559	1970	51389	1721	25221
3E		MI	16063	5518	25796	3982	27487	3253	27731	2691	27145	1868	31446	1580	15868
8-#14	1.30	MA	24036	5518	37801	4137	40711	3364	41166	2790	40329	1981	47645	1593	25094
4L-2S		MI	16862	5518	27009	3988	29032	3242	29591	2681	29601	1858	34667	1708	15803
8-#18	2.32	MA	29061	6015	47597	4404	53042	3554	56092	2901	60387	1914	73669	1750	43806
2L-4S		MI	16053	6015	26853	4270	28682	3433	29065	2775	29061	1800	34476	1087	25843
8-#18	2.32	MA	26773	6015	44073	4401	48549	3583	50631	2927	52988	1932	63778	1522	43564
3E		MI	17039	6015	28570	4248	30856	3450	31636	2793	32287	1783	38056	1302	26988
8-#18	2.32	MA	25160	6015	41242	4434	44948	3576	46261	2917	47314	1950	57305	1295	41613
4L-2S		MI	18401	6015	30675	4261	33530	3433	34822	2775	36496	1765	43534	1530	26996
10-#11	1.13	MA	25849	5433	40337	4077	44018	3321	45212	2763	45683	1970	54387	1872	22019
2L-5S		MI	15272	5433	24214	3956	25534	3230	25427	2682	24124	1889	27926	1532	13977
10-#11	1.13	MA	24910	5433	38934	4077	42229	3319	43036	2774	42736	1978	50377	1784	22041
3L-4S		MI	15638	5433	24821	3960	26316	3221	26380	2675	25438	1896	29509	1572	13954
10-#11	1.13	MA	24250	5433	37810	4091	40799	3332	41302	2772	40484	1987	47745	1695	22015
4L-3S		MI	16043	5433	25510	3950	27193	3227	27439	2682	26768	1889	30993	1659	13910
10-#11	1.13	MA	23660	5433	36826	4090	39530	3330	39747	2783	38265	1982	45012	1650	21899
5L-2S		MI	16607	5433	26361	3953	28277	3218	28753	2675	28503	1882	33275	1748	13864
10-#14	1.63	MA	27255	5678	43433	4218	47886	3422	49884	2824	52001	1948	62808	1829	31349
2L-5S		MI	15520	5678	25155	4090	26662	3328	26740	2734	25856	1851	30336	1359	19055
10-#14	1.63	MA	25928	5678	41423	4217	45324	3419	46769	2839	47780	1960	57098	1701	31316
3L-4S		MI	16038	5678	26023	4096	27780	3317	28091	2724	27717	1861	32569	1417	19586
10-#14	1.63	MA	24995	5678	39811	4236	43274	3436	44281	2835	44550	1971	53354	1573	31142
4L-3S		MI	16611	5678	27009	4082	29032	3325	29591	2734	29601	1851	34667	1542	19586
10-#14	1.63	MA	24159	5678	38399	4236	41453	3434	42051	2850	41368	1963	49456	1509	30094
5L-2S		MI	17406	5678	28221	4087	30578	3314	31451	2724	32058	1841	37888	1670	19540
10-#18	2.90	MA	30649	6298	51121	4582	57534	3683	61553	2981	67785	1896	83561	1707	54494
2L-5S		MI	16105	6298	27442	4435	29414	3578	29938	2866	30078	1747	36156	904	30391
10-#18	2.90	MA	28388	6298	47597	4579	53042	3712	56092	3006	60387	1914	73669	1480	54157
3L-4S		MI	16987	6298	28958	4448	31357	3560	32251	2848	33269	1765	39955	1008	31791

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

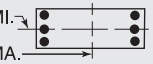


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	2.90	MA	26796	6298	44765	4611	49441	3705	51722	2996	54713	1932	67197	1252	51759
4L-3S		MI	17963	6298	30675	4425	33530	3578	34822	2866	36496	1747	43534	1224	33337
10-#18	2.90	MA	25370	6298	42282	4608	46238	3734	47800	3022	49118	1915	60418	1142	48724
5L-2S		MI	19311	6298	32780	4438	36204	3560	38007	2848	40704	1730	49013	1451	33430
12-#11	1.36	MA	26513	5544	41741	4147	45807	3371	47387	2794	48630	1963	58396	1859	26307
2L-6S		MI	15316	5544	24490	4022	25839	3275	25829	2719	24653	1885	28731	1447	16180
12-#11	1.36	MA	25579	5544	40337	4146	44018	3369	45212	2806	45683	1971	54387	1771	26311
3L-5S		MI	15664	5544	25064	4026	26618	3280	26740	2712	25859	1878	30208	1507	16558
12-#11	1.36	MA	24924	5544	39214	4160	42589	3382	43477	2803	43431	1980	51755	1682	26261
4E		MI	16028	5544	25671	4029	27400	3272	27694	2705	27173	1885	31791	1547	16559
12-#11	1.36	MA	24337	5544	38230	4160	41319	3380	41922	2814	41212	1975	49022	1637	26121
5L-3S		MI	16432	5544	26361	4019	28277	3277	28753	2712	28503	1878	33275	1634	16529
12-#11	1.36	MA	23779	5544	37302	4159	40058	3393	40384	2812	39175	1984	46411	1579	25343
6L-2S		MI	16993	5544	27211	4022	29361	3269	30066	2705	30238	1871	35557	1723	16489
12-#14	1.96	MA	28187	5837	45443	4318	50449	3494	52999	2868	56221	1938	68517	1808	37468
2L-6S		MI	15581	5837	25547	4184	27094	3392	27311	2788	26605	1844	31473	1234	22027
12-#14	1.96	MA	26869	5837	43433	4317	47886	3491	49884	2884	52001	1950	62808	1680	37400
3L-5S		MI	16072	5837	26368	4190	28207	3400	28601	2778	28312	1834	33557	1320	22560
12-#14	1.96	MA	25944	5837	41821	4336	45837	3509	47397	2880	48771	1962	59064	1553	37186
4E		MI	16586	5837	27236	4195	29325	3389	29951	2768	30174	1844	35790	1378	23250
12-#14	1.96	MA	25116	5837	40410	4335	44016	3506	45166	2895	45589	1953	55165	1489	35968
5L-3S		MI	17155	5837	28221	4181	30578	3397	31451	2778	32058	1834	37888	1503	23290
12-#14	1.96	MA	24327	5837	39078	4335	42206	3523	42959	2891	42666	1965	51449	1405	34790
6L-2S		MI	17945	5837	29433	4187	32123	3386	33311	2768	34515	1824	41109	1631	23261
12-#18	3.48	MA	29980	6582	51121	4756	57534	3840	61553	3086	67785	1896	83561	1438	64742
3L-5S		MI	17038	6582	29547	4612	32088	3706	33124	2939	34287	1712	41635	825	36496
12-#18	3.48	MA	28409	6582	48289	4788	53933	3834	57183	3076	62111	1915	77088	1210	61951
4E		MI	17911	6582	31063	4625	34031	3688	35436	2922	37478	1729	45433	930	37785
12-#18	3.48	MA	27003	6582	45806	4785	50731	3862	53261	3101	56517	1897	70309	1100	59072
5L-3S		MI	18877	6582	32780	4602	36204	3706	38007	2939	40704	1712	49013	1145	39665
12-#18	3.48	MA	25662	6582	43462	4782	47547	3856	49378	3091	51375	1916	63878	949	55060
6L-2S		MI	20213	6582	34885	4615	38878	3688	41193	2922	44912	1694	54491	1373	39823
14-#11	1.58	MA	27172	5654	43144	4216	47597	3421	49562	2826	51577	1956	62405	1846	30589
2L-7S		MI	15370	5654	24726	4102	26175	3333	26196	2743	25208	1881	29624	1354	18424
14-#11	1.58	MA	26243	5654	41741	4215	45807	3420	47387	2837	48630	1965	58396	1757	30573
3L-6S		MI	15708	5654	25340	4091	26924	3325	27143	2750	26388	1874	31013	1422	18674
14-#11	1.58	MA	25592	5654	40617	4229	44378	3432	45652	2834	46378	1973	55764	1669	30503
4L-5S		MI	16054	5654	25914	4095	27702	3330	28054	2743	27593	1867	32491	1482	19114
14-#11	1.58	MA	25010	5654	39633	4229	43109	3430	44097	2845	44159	1968	53031	1624	30340
5L-4S		MI	16416	5654	26521	4098	28484	3322	29007	2736	28908	1874	34073	1522	19155
14-#11	1.58	MA	24455	5654	38705	4229	41848	3443	42559	2843	42122	1977	50420	1566	29482
6L-3S		MI	16818	5654	27211	4088	29361	3327	30066	2743	30238	1867	35557	1609	19137
14-#11	1.58	MA	23913	5654	37712	4242	40637	3441	41075	2854	40129	1986	47704	1478	28896
7L-2S		MI	17376	5654	28061	4091	30445	3319	31380	2736	31973	1860	37840	1698	19106
14-#14	2.28	MA	27802	5997	45443	4417	50449	3564	52999	2929	56221	1940	68517	1660	43476
3L-6S		MI	16131	5997	26759	4284	28639	3464	29171	2831	29062	1826	34695	1196	25582
14-#14	2.28	MA	26884	5997	43831	4436	48400	3581	50512	2924	52992	1952	64773	1532	43226
4L-5S		MI	16619	5997	27580	4289	29753	3472	30461	2821	30769	1817	36778	1282	26082
14-#14	2.28	MA	26064	5997	42420	4435	46579	3578	48282	2940	49809	1944	60874	1468	41858
5L-4S		MI	17129	5997	28448	4295	30871	3461	31811	2811	32631	1826	39011	1339	26905
14-#14	2.28	MA	25282	5997	41088	4434	44769	3596	46074	2936	46887	1955	57158	1384	40729
6L-3S		MI	17695	5997	29433	4281	32123	3470	33311	2821	34515	1817	41109	1464	26973
14-#14	2.28	MA	24519	5997	39663	4453	43032	3593	43945	2951	44027	1967	53292	1258	39099
7L-2S		MI	18480	5997	30645	4287	33669	3459	35171	2811	36972	1807	44330	1592	26970
14-#18	4.06	MA	30002	6866	51812	4966	58425	3962	62644	3156	69510	1897	86980	1168	72180
4L-5S		MI	17961	6866	31652	4789	34762	3834	36310	3013	38495	1676	47113	747	42358
14-#18	4.06	MA	28614	6866	49329	4963	55223	3991	58722	3181	63915	1880	80201	1057	69442
5L-4S		MI	18826	6866	33168	4802	36705	3816	38622	2995	41686	1694	50912	851	43815

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis



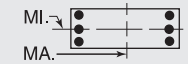
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	4.06	MA	27291	6866	46985	4960	52039	3984	54839	3171	58774	1898	73770	907	65284
6L-3S		MI	19783	6866	34885	4780	38878	3834	41193	3013	44912	1676	54491	1067	45979
14-#18	4.06	MA	26000	6866	44477	4992	48982	4013	51093	3196	53743	1916	67075	682	61247
7L-2S		MI	21107	6866	36990	4793	41552	3816	44378	2995	49120	1659	59970	1294	46197
16-#11	1.81	MA	26903	5765	43144	4285	47597	3470	49562	2868	51577	1958	62405	1744	34829
3L-7S		MI	15761	5765	25576	4171	27259	3383	27510	2774	26942	1870	31907	1329	20936
16-#11	1.81	MA	26255	5765	42021	4298	46167	3482	47827	2865	49325	1966	59773	1656	34740
4L-6S		MI	16097	5765	26190	4160	28008	3375	28456	2781	28122	1863	33295	1397	21175
16-#11	1.81	MA	25677	5765	41037	4298	44898	3481	46273	2876	47106	1961	57040	1611	34530
5E		MI	16442	5765	26764	4164	28786	3380	29367	2774	29328	1856	34773	1457	21587
16-#11	1.81	MA	25126	5765	40109	4298	43637	3493	44734	2874	45069	1970	54429	1553	33628
6L-4S		MI	16802	5765	27371	4167	29568	3372	30321	2767	30642	1863	36355	1497	21739
16-#11	1.81	MA	24588	5765	39116	4311	42426	3492	43250	2885	43076	1979	51714	1465	33061
7L-3S		MI	17201	5765	28061	4157	30445	3377	31380	2774	31973	1856	37840	1584	21738
16-#11	1.81	MA	24057	5765	38205	4311	41205	3504	41797	2896	40988	1974	49159	1413	32105
8L-2S		MI	17757	5765	28911	4160	31529	3369	32694	2767	33707	1849	40122	1673	21714
16-#14	2.61	MA	27816	6156	45842	4536	50962	3653	53628	2969	57212	1942	70482	1512	49264
4L-6S		MI	16678	6156	27971	4383	30185	3536	31031	2874	31518	1809	37916	1157	29143
16-#14	2.61	MA	27003	6156	44430	4535	49142	3651	51397	2985	54030	1934	66584	1448	47762
5E		MI	17162	6156	28792	4389	31298	3545	32321	2864	33226	1799	39999	1243	29615
16-#14	2.61	MA	26228	6156	43098	4534	47332	3668	49190	2980	51107	1945	62868	1364	46677
6L-4S		MI	17669	6156	29660	4395	32416	3534	33671	2855	35088	1809	42233	1301	30552
16-#14	2.61	MA	25471	6156	41673	4553	45595	3665	47061	2996	48247	1957	59002	1237	44969
7L-3S		MI	18231	6156	30645	4381	33669	3542	35171	2864	36972	1799	44330	1426	30646
16-#14	2.61	MA	24725	6156	40366	4552	43842	3683	44976	3011	45252	1949	55358	1163	43438
8L-2S		MI	19012	6156	31857	4386	35214	3531	37031	2855	39428	1789	47551	1554	30673
16-#18	4.64	MA	30206	7149	52853	5140	59715	4120	64184	3261	71314	1862	90092	1015	79830
5E		MI	18877	7149	33757	4967	37436	3961	39495	3086	42703	1641	52592	668	48236
16-#18	4.64	MA	28900	7149	50509	5137	56532	4113	60301	3251	66173	1880	83661	865	75532
6L-4S		MI	19733	7149	35273	4980	39379	3944	41807	3068	45894	1658	56390	773	49873
16-#18	4.64	MA	27625	7149	48001	5169	53474	4142	56554	3276	61141	1898	76966	640	71405
7L-3S		MI	20681	7149	36990	4957	41552	3961	44378	3086	49120	1641	59970	988	52283
16-#18	4.64	MA	26367	7149	45699	5166	50389	4135	52886	3302	55871	1881	70633	511	66808
8L-2S		MI	21995	7149	39095	4970	44226	3944	47564	3068	53329	1623	65448	1216	52556
18-#11	2.03	MA	26914	5876	43424	4367	47957	3532	50002	2896	52272	1960	63782	1643	38975
4L-7S		MI	16150	5876	26427	4240	28343	3434	28824	2805	28677	1859	34189	1304	23441
18-#11	2.03	MA	26340	5876	42440	4367	46687	3531	48448	2908	50053	1955	61049	1598	38647
5L-6S		MI	16484	5876	27041	4230	29092	3425	29770	2812	29857	1852	35578	1372	23681
18-#11	2.03	MA	25792	5876	41512	4367	45426	3543	46909	2905	48016	1963	58439	1540	37781
6L-5S		MI	16827	5876	27615	4233	29870	3430	30681	2805	31063	1845	37055	1432	24069
18-#11	2.03	MA	25258	5876	40519	4380	44216	3542	45425	2916	46023	1972	55723	1452	37230
7L-4S		MI	17185	5876	28222	4236	30652	3422	31634	2798	32377	1852	38638	1472	24316
18-#11	2.03	MA	24731	5876	39608	4380	42994	3554	43973	2927	43935	1967	53168	1400	36225
8L-3S		MI	17583	5876	28911	4226	31529	3427	32694	2805	33707	1845	40122	1559	24333
18-#11	2.03	MA	24170	5876	38714	4380	41801	3553	42470	2925	41962	1976	50639	1344	35401
9L-2S		MI	18136	5876	29762	4230	32613	3419	34007	2798	35442	1838	42404	1648	24318
18-#14	2.93	MA	27934	6316	46440	4635	51704	3723	54513	3030	58251	1924	72293	1427	53678
5L-6S		MI	17221	6316	29183	4483	31730	3609	32891	2918	33975	1792	41137	1118	32625
18-#14	2.93	MA	27165	6316	45108	4634	49895	3740	52305	3025	55328	1936	68577	1343	52632
6L-5S		MI	17702	6316	30004	4489	32844	3617	34181	2908	35683	1782	43220	1204	33158
18-#14	2.93	MA	26415	6316	43683	4653	48157	3738	50176	3041	52468	1947	64711	1217	50849
7L-4S		MI	18205	6316	30872	4495	33962	3606	35531	2898	37544	1792	45454	1262	34081
18-#14	2.93	MA	25675	6316	42376	4652	46404	3755	48091	3056	49472	1939	61067	1143	49265
8L-3S		MI	18764	6316	31857	4481	35214	3614	37031	2908	39428	1782	47551	1387	34312

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

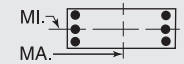


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.93	MA	24907	6316	41093	4651	44691	3752	45935	3052	46642	1951	57467	1062	47266
9L-2S		MI	19540	6316	33070	4486	36760	3603	38891	2898	41885	1772	50773	1515	34358
18-#18	5.22	MA	30491	7433	54033	5314	61024	4242	65762	3331	73571	1862	93553	823	85800
6L-5S		MI	19784	7433	35862	5144	40110	4089	42681	3159	46911	1605	58070	590	54145
18-#18	5.22	MA	29231	7433	51524	5347	57967	4270	62015	3356	68540	1881	86858	598	81583
7L-4S		MI	20633	7433	37378	5157	42053	4071	44993	3142	50102	1623	61869	694	55955
18-#18	5.22	MA	27989	7433	49223	5344	54882	4264	58347	3381	63270	1863	80524	469	76937
8L-3S		MI	21573	7433	39095	5134	44226	4089	47564	3159	53329	1605	65448	910	58578
20-#11	2.26	MA	26998	5986	43844	4436	48477	3581	50623	2939	53000	1948	65059	1585	42774
5L-7S		MI	16537	5986	27277	4309	29427	3484	30137	2835	30412	1848	36471	1279	25888
20-#11	2.26	MA	26454	5986	42916	4436	47216	3593	49084	2936	50963	1956	62448	1527	41939
6E		MI	16870	5986	27891	4299	30176	3475	31083	2842	31592	1841	37860	1347	26190
20-#11	2.26	MA	25923	5986	41923	4450	46005	3592	47601	2947	48970	1965	59732	1439	41403
7L-5S		MI	17210	5986	28465	4302	30954	3481	31994	2835	32798	1834	39337	1407	26557
20-#11	2.26	MA	25400	5986	41012	4449	44783	3604	46148	2958	46882	1960	57178	1387	40350
8L-4S		MI	17567	5986	29072	4306	31736	3472	32948	2829	34112	1841	40920	1447	26889
20-#11	2.26	MA	24843	5986	40118	4449	43590	3603	44645	2956	44909	1969	54648	1331	39503
9L-3S		MI	17962	5986	29762	4295	32613	3478	34007	2835	35442	1834	42404	1534	26918
20-#11	2.26	MA	24265	5986	39142	4463	42384	3615	43201	2967	42952	1978	52194	1268	38291
10L-2S		MI	18514	5986	30612	4299	33697	3469	35321	2829	37177	1827	44686	1623	26916
20-#14	3.26	MA	28095	6476	47119	4734	52458	3813	55421	3070	59549	1926	74286	1323	58593
6E		MI	17760	6476	30395	4583	33276	3681	34751	2961	36432	1775	44358	1079	36083
20-#14	3.26	MA	27351	6476	45693	4753	50720	3810	53292	3086	56689	1937	70420	1196	56739
7L-5S		MI	18238	6476	31217	4589	34389	3689	36041	2951	38139	1765	46441	1165	36709
20-#14	3.26	MA	26618	6476	44386	4752	48967	3827	51207	3101	53693	1929	66777	1122	55102
8L-4S		MI	18738	6476	32085	4594	35507	3678	37391	2941	40001	1775	48675	1223	37580
20-#14	3.26	MA	25851	6476	43103	4751	47254	3825	49050	3097	50863	1941	63176	1041	53147
9L-3S		MI	19293	6476	33070	4580	36760	3687	38891	2951	41885	1765	50773	1348	37972
20-#14	3.26	MA	25030	6476	41702	4770	45524	3842	46978	3112	48054	1953	59685	950	50841
10L-2S		MI	20065	6476	34282	4586	38305	3675	40751	2941	44342	1755	53994	1476	38037
20-#18	5.80	MA	30821	7717	55048	5524	62459	4399	67476	3436	75938	1863	96749	556	91779
7L-5S		MI	20685	7717	37967	5321	42784	4217	45866	3233	51120	1570	63549	511	60081
20-#18	5.80	MA	29594	7717	52747	5521	59374	4392	63808	3461	70668	1846	90415	427	87083
8L-4S		MI	21526	7717	39483	5334	44727	4199	48178	3215	54310	1587	67347	616	62055
22-#11	2.49	MA	27111	6097	44319	4505	49005	3643	51260	2967	53910	1950	66457	1513	46102
6L-7S		MI	16921	6097	28127	4378	30511	3534	31451	2866	32147	1837	38753	1254	28342
22-#11	2.49	MA	26584	6097	43326	4519	47794	3642	49776	2978	51917	1958	63742	1426	45563
7L-6S		MI	17253	6097	28741	4368	31260	3525	32397	2873	33327	1830	40142	1322	28703
22-#11	2.49	MA	26064	6097	42415	4518	46573	3654	48323	2990	49829	1953	61187	1374	44481
8L-5S		MI	17592	6097	29315	4371	32038	3531	33308	2866	34532	1823	41620	1382	29051
22-#11	2.49	MA	25518	6097	41521	4518	45379	3653	46820	2987	47856	1962	58657	1318	43597
9L-4S		MI	17946	6097	29922	4375	32820	3522	34261	2859	35847	1830	43202	1422	29458
22-#11	2.49	MA	24936	6097	40545	4532	44173	3665	45377	2998	45899	1971	56203	1255	42409
10L-3S		MI	18340	6097	30612	4364	33697	3528	35321	2866	37177	1823	44686	1509	29499
22-#11	2.49	MA	24375	6097	39652	4532	42987	3664	43891	2995	43840	1966	53709	1200	41136
11L-2S		MI	18889	6097	31462	4368	34781	3519	36634	2859	38912	1816	46969	1598	29511
22-#14	3.59	MA	28280	6635	47703	4852	53283	3882	56407	3131	60910	1928	76129	1176	62637
7L-6S		MI	18296	6635	31608	4683	34821	3753	36611	3005	38889	1758	47579	1041	39552
22-#14	3.59	MA	27552	6635	46396	4852	51530	3900	54322	3146	57914	1919	72486	1102	60947
8L-5S		MI	18771	6635	32429	4688	35934	3762	37901	2995	40596	1748	49662	1127	40266
22-#14	3.59	MA	26787	6635	45113	4851	49817	3897	52165	3142	55084	1931	68886	1021	59035
9L-4S		MI	19268	6635	33297	4694	37053	3750	39251	2985	42458	1758	51896	1185	41090
22-#14	3.59	MA	25997	6635	43712	4870	48086	3914	50094	3157	52275	1943	65394	929	56698
10L-3S		MI	19820	6635	34282	4680	38305	3759	40751	2995	44342	1748	53994	1309	41627
22-#18	6.38	MA	31182	8001	56270	5698	63866	4521	69269	3541	78067	1828	100307	384	97245
8L-5S		MI	21580	8001	40072	5499	45459	4345	49052	3306	55328	1534	69027	433	66041
24-#11	2.71	MA	27241	6207	44730	4588	49584	3692	51951	3009	54863	1951	67751	1413	49671
7E		MI	17304	6207	28977	4447	31595	3584	32764	2897	33881	1826	41035	1229	30803

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.71	MA	26724	6207	43819	4588	48362	3704	50498	3021	52775	1946	65196	1361	48616
8L-6S		MI	17634	6207	29591	4437	32344	3576	33711	2904	35061	1819	42424	1297	31217
24-#11	2.71	MA	26179	6207	42925	4587	47169	3703	48995	3018	50803	1955	62667	1305	47695
9L-5S		MI	17971	6207	30165	4440	33122	3581	34622	2897	36267	1812	43902	1357	31550
24-#11	2.71	MA	25602	6207	41949	4601	45963	3715	47552	3029	48846	1964	60213	1242	46532
10L-4S		MI	18324	6207	30773	4444	33905	3572	35575	2890	37581	1819	45484	1397	32024
24-#11	2.71	MA	25044	6207	41055	4601	44776	3714	46066	3027	46787	1959	57718	1186	45236
11L-3S		MI	18716	6207	31462	4434	34781	3578	36634	2897	38912	1812	46969	1485	32076
24-#11	2.71	MA	24495	6207	40094	4614	43578	3726	44626	3038	44832	1968	54975	1112	43994
12L-2S		MI	19263	6207	32312	4437	35865	3569	37948	2890	40646	1805	49251	1573	32098
24-#14	3.91	MA	28480	6795	48407	4951	54093	3972	57438	3191	62135	1910	78195	1081	66801
8L-6S		MI	18829	6795	32820	4782	36367	3825	38471	3048	41345	1740	50800	1002	43032
24-#14	3.91	MA	27716	6795	47123	4951	52380	3969	55281	3187	59304	1921	74595	1000	64870
9L-5S		MI	19301	6795	33641	4788	37480	3834	39761	3038	43053	1730	52883	1088	43829
24-#14	3.91	MA	26932	6795	45722	4970	50649	3987	53209	3202	56496	1933	71103	909	62561
10L-4S		MI	19795	6795	34509	4794	38598	3823	41111	3028	44915	1740	55117	1146	44611

RECTANGULAR TIED COLUMNS 30" x 48"

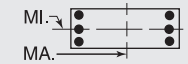
4-#18	1.11	MA	27997	5659	43821	4222	47626	3439	48792	2862	49123	2042	58105	1929	23392
2E		MI	17185	5659	27433	4060	29174	3304	29411	2736	28934	1919	33517	1767	14052
6-#18	1.67	MA	29725	5943	47522	4399	52344	3567	54528	2942	56894	2024	68551	1890	34705
2L-3S		MI	16742	5943	27433	4225	29174	3450	29411	2827	28934	1901	33517	1461	20667
6-#18	1.67	MA	27285	5943	43821	4397	47626	3597	48792	2968	49123	2043	58105	1662	34576
3L-2S		MI	18119	5943	29538	4238	31848	3432	32596	2810	33142	1884	38996	1689	20578
8-#14	1.25	MA	28521	5730	44731	4291	48947	3491	50461	2899	51410	2050	61464	1944	26428
2L-4S		MI	16122	5730	25775	4152	27228	3373	27194	2790	26120	1962	30295	1537	15954
8-#14	1.25	MA	27113	5730	42621	4290	46257	3489	47191	2915	46980	2063	55442	1816	26436
3E		MI	16700	5730	26760	4138	28480	3381	28694	2800	28004	1952	32393	1661	15906
8-#14	1.25	MA	26125	5730	40931	4310	44108	3507	44583	2911	43593	2075	51490	1688	26309
4L-2S		MI	17501	5730	27972	4144	30026	3370	30554	2790	30461	1942	35614	1789	15838
8-#18	2.22	MA	31426	6227	51223	4577	57062	3696	60264	3022	64665	2006	78997	1850	45966
2L-4S		MI	16689	6227	27820	4425	29675	3560	30025	2883	29916	1883	35416	1167	26092
8-#18	2.22	MA	29016	6227	47522	4575	52344	3726	54528	3048	56894	2026	68551	1623	45724
3E		MI	17678	6227	29538	4402	31848	3577	32596	2901	33142	1866	38996	1383	27059
8-#18	2.22	MA	27319	6227	44551	4608	48566	3720	49943	3039	50940	2045	61708	1395	43976
4L-2S		MI	19041	6227	31643	4415	34522	3560	35782	2883	37351	1848	44474	1610	27049
10-#11	1.08	MA	28027	5645	43589	4250	47573	3462	48822	2884	49204	2062	58589	1966	23072
2L-5S		MI	15908	5645	25175	4113	26528	3359	26391	2791	24986	1973	28877	1613	14020
10-#11	1.08	MA	27039	5645	42116	4250	45696	3461	46540	2895	46112	2071	54363	1878	23094
3L-4S		MI	16275	5645	25782	4117	27310	3350	27345	2784	26300	1980	30459	1653	13990
10-#11	1.08	MA	26347	5645	40938	4264	44197	3474	44722	2893	43750	2081	51587	1789	23068
4L-3S		MI	16681	5645	26472	4106	28187	3356	28404	2791	27631	1973	31944	1741	13942
10-#11	1.08	MA	25728	5645	39907	4264	42867	3473	43092	2905	41425	2076	48710	1744	22952
5L-2S		MI	17245	5645	27322	4110	29271	3347	29718	2784	29365	1966	34226	1830	13894
10-#14	1.56	MA	29513	5890	46841	4390	51637	3563	53731	2944	55840	2040	67485	1925	32868
2L-5S		MI	16157	5890	26119	4246	27655	3456	27704	2843	26715	1935	31283	1440	19203
10-#14	1.56	MA	28116	5890	44731	4390	48947	3561	50461	2960	51410	2053	61464	1797	32835
3L-4S		MI	16675	5890	26987	4252	28773	3445	29054	2833	28577	1945	33516	1498	19642
10-#14	1.56	MA	27136	5890	43041	4410	46798	3579	47853	2956	48023	2065	57511	1669	32661
4L-3S		MI	17249	5890	27972	4238	30026	3454	30554	2843	30461	1935	35614	1623	19629
10-#14	1.56	MA	26259	5890	41562	4409	44890	3577	45515	2972	44687	2058	53406	1605	31696
5L-2S		MI	18045	5890	29184	4243	31571	3442	32414	2833	32918	1925	38835	1751	19579

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

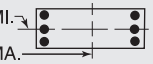


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	2.78	MA	33102	6510	54924	4754	61781	3825	66000	3102	72435	1989	89443	1811	57194
2L-5S		MI	16740	6510	28409	4589	30406	3705	30898	2974	30933	1830	37096	984	30606
10-#18	2.78	MA	30721	6510	51223	4752	57062	3854	60264	3128	64665	2008	78997	1583	56857
3L-4S		MI	17624	6510	29925	4602	32349	3687	33211	2956	34124	1848	40895	1089	32035
10-#18	2.78	MA	29047	6510	48252	4785	53284	3849	55679	3119	58711	2028	72154	1356	54644
4L-3S		MI	18603	6510	31643	4579	34522	3705	35782	2974	37351	1830	44474	1304	33416
10-#18	2.78	MA	27549	6510	45648	4783	49926	3878	51566	3145	52843	2012	65008	1244	51336
5L-2S		MI	19954	6510	33748	4592	37197	3687	38967	2956	41559	1813	49953	1532	33486
12-#11	1.30	MA	28727	5756	45061	4319	49451	3513	51105	2915	52296	2055	62815	1954	27571
2L-6S		MI	15952	5756	25451	4179	26833	3404	26794	2829	25515	1969	29682	1529	16285
12-#11	1.30	MA	27745	5756	43589	4319	47573	3512	48822	2926	49204	2064	58589	1865	27575
3L-5S		MI	16301	5756	26025	4182	27612	3409	27705	2822	26721	1962	31159	1588	16608
12-#11	1.30	MA	27057	5756	42411	4333	46075	3524	47004	2924	46843	2074	55813	1777	27525
4E		MI	16665	5756	26632	4186	28394	3401	28658	2815	28035	1969	32742	1628	16598
12-#11	1.30	MA	26442	5756	41380	4333	44745	3523	45375	2936	44517	2069	52936	1731	27384
5L-3S		MI	17069	5756	27322	4176	29271	3406	29718	2822	29365	1962	34226	1716	16564
12-#11	1.30	MA	25856	5756	40408	4333	43423	3536	43763	2933	42382	2078	50183	1673	26642
6L-2S		MI	17631	5756	28172	4179	30355	3398	31031	2815	31100	1955	36508	1805	16522
12-#14	1.88	MA	30495	6049	48951	4490	54327	3636	57001	2989	60270	2030	73507	1906	39290
2L-6S		MI	16217	6049	26510	4340	28087	3520	28274	2897	27465	1927	32421	1315	22165
12-#14	1.88	MA	29109	6049	46841	4490	51637	3634	53731	3005	55840	2043	67485	1778	39223
3L-5S		MI	16709	6049	27331	4346	29201	3529	29564	2887	29172	1918	34504	1401	22707
12-#14	1.88	MA	28137	6049	45151	4509	49488	3651	51123	3001	52454	2055	63533	1650	39008
4E		MI	17223	6049	28199	4351	30319	3517	30914	2877	31034	1927	36737	1459	23312
12-#14	1.88	MA	27268	6049	43672	4509	47580	3649	48785	3017	49117	2048	59427	1586	37865
5L-3S		MI	17794	6049	29184	4337	31571	3526	32414	2887	32918	1918	38835	1584	23336
12-#14	1.88	MA	26440	6049	42276	4508	45683	3667	46472	3013	46054	2061	55506	1502	36585
6L-2S		MI	18585	6049	30397	4343	33117	3515	34274	2877	35375	1908	42056	1712	23303
12-#18	3.33	MA	32403	6794	54924	4929	61781	3983	66000	3208	72435	1990	89443	1544	67982
3L-5S		MI	17674	6794	30514	4767	33080	3833	34084	3047	35142	1795	42575	905	36709
12-#18	3.33	MA	30750	6794	51953	4962	58003	3977	61415	3199	66482	2010	82600	1316	65358
4E		MI	18549	6794	32030	4779	35023	3815	36396	3030	38332	1812	46373	1010	38025
12-#18	3.33	MA	29273	6794	49349	4960	54644	4007	57302	3225	60614	1994	75453	1204	62213
5L-3S		MI	19519	6794	33748	4757	37197	3833	38967	3047	41559	1795	49953	1225	39751
12-#18	3.33	MA	27864	6794	46892	4958	51306	4001	53230	3216	55223	2014	68658	1054	58197
6L-2S		MI	20858	6794	35853	4770	39871	3815	42153	3030	45767	1777	55431	1453	39889
14-#11	1.52	MA	29422	5866	46534	4388	51328	3563	53387	2946	55388	2048	67041	1942	32063
2L-7S		MI	16006	5866	25687	4258	27169	3462	27161	2853	26070	1965	30575	1436	18527
14-#11	1.52	MA	28445	5866	45061	4388	49451	3562	51105	2958	52296	2058	62815	1853	32047
3L-6S		MI	16344	5866	26301	4248	27917	3454	28107	2860	27250	1958	31964	1504	18779
14-#11	1.52	MA	27761	5866	43883	4402	47952	3574	49286	2955	49935	2067	60039	1765	31977
4L-5S		MI	16691	5866	26875	4252	28696	3459	29018	2853	28456	1951	33441	1563	19185
14-#11	1.52	MA	27150	5866	42852	4402	46622	3573	47657	2967	47609	2062	57162	1719	31814
5L-4S		MI	17054	5866	27482	4255	29478	3451	29972	2846	29770	1958	35024	1603	19197
14-#11	1.52	MA	26568	5866	41880	4402	45301	3586	46045	2965	45475	2072	54409	1661	30986
6L-3S		MI	17456	5866	28172	4245	30355	3456	31031	2853	31100	1951	36508	1691	19175
14-#11	1.52	MA	26000	5866	40840	4416	44033	3585	44490	2976	43386	2081	51546	1574	30353
7L-2S		MI	18015	5866	29022	4248	31439	3448	32345	2846	32835	1944	38790	1780	19141
14-#14	2.19	MA	30093	6209	48951	4590	54327	3706	57001	3050	60270	2033	73507	1759	45603
3L-6S		MI	16768	6209	27722	4440	29633	3592	30134	2940	29921	1910	35642	1277	25720
14-#14	2.19	MA	29129	6209	47261	4609	52178	3724	54393	3046	56884	2046	69555	1631	45352
4L-5S		MI	17257	6209	28543	4445	30746	3601	31424	2930	31629	1900	37725	1363	26227
14-#14	2.19	MA	28268	6209	45781	4609	50270	3721	52055	3062	53548	2038	65449	1567	44051
5L-4S		MI	17768	6209	29411	4451	31864	3590	32774	2920	33491	1910	39959	1420	26972
14-#14	2.19	MA	27447	6209	44386	4608	48373	3739	49742	3058	50484	2051	61528	1483	42824
6L-3S		MI	18335	6209	30397	4437	33117	3598	34274	2930	35375	1900	42056	1545	27027
14-#14	2.19	MA	26646	6209	42892	4628	46553	3737	47510	3074	47487	2063	57449	1356	41237
7L-2S		MI	19121	6209	31609	4443	34662	3587	36134	2920	37831	1890	45278	1673	27015

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

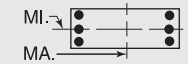
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.89	MA	32433	7078	55654	5140	62721	4106	67151	3279	74253	1992	93046	1276	76111
4L-5S		MI	18599	7078	32619	4944	35755	3961	37269	3121	39350	1759	48053	827	42745
14-#18	3.89	MA	30974	7078	53050	5137	59363	4136	63038	3305	68385	1976	85899	1164	73113
5L-4S		MI	19466	7078	34135	4957	37698	3943	39582	3103	42541	1777	51852	931	44051
14-#18	3.89	MA	29583	7078	50593	5135	56024	4130	58966	3296	62993	1996	79104	1015	68950
6L-3S		MI	20426	7078	35853	4934	39871	3961	42153	3121	45767	1759	55431	1147	46072
14-#18	3.89	MA	28226	7078	47963	5168	52819	4160	55038	3322	57718	2015	72033	790	64891
7L-2S		MI	21754	7078	37958	4947	42545	3943	45338	3103	49975	1741	60910	1374	46267
16-#11	1.73	MA	29141	5977	46534	4457	51328	3612	53387	2989	55388	2051	67041	1841	36514
3L-7S		MI	16397	5977	26538	4328	28253	3512	28475	2884	27805	1954	32857	1411	21040
16-#11	1.73	MA	28461	5977	45356	4471	49830	3624	51569	2986	53027	2060	64265	1752	36425
4L-6S		MI	16734	5977	27152	4317	29001	3504	29421	2890	28985	1947	34246	1479	21280
16-#11	1.73	MA	27854	5977	44325	4471	48500	3623	49940	2998	50702	2055	61388	1707	36243
5E		MI	17079	5977	27726	4321	29780	3509	30332	2884	30190	1940	35724	1538	21703
16-#11	1.73	MA	27276	5977	43353	4471	47178	3636	48327	2996	48567	2065	58635	1649	35339
6L-4S		MI	17440	5977	28333	4324	30562	3501	31285	2877	31504	1947	37306	1578	21787
16-#11	1.73	MA	26711	5977	42312	4485	45910	3635	46773	3007	46478	2074	55772	1562	34726
7L-3S		MI	17840	5977	29022	4314	31439	3506	32345	2884	32835	1940	38790	1666	21778
16-#11	1.73	MA	26155	5977	41359	4485	44630	3648	45251	3019	44291	2069	53083	1509	33807
8L-2S		MI	18397	5977	29873	4317	32523	3498	33658	2877	34570	1933	41073	1755	21752
16-#14	2.50	MA	30113	6369	49371	4709	54868	3796	57663	3091	61314	2036	75576	1612	51694
4L-6S		MI	17315	6369	28934	4539	31178	3665	31994	2983	32378	1893	38863	1238	29282
16-#14	2.50	MA	29258	6369	47891	4708	52960	3794	55325	3107	57978	2028	71471	1548	50251
5E		MI	17801	6369	29756	4545	32291	3673	33284	2974	34086	1883	40946	1324	29760
16-#14	2.50	MA	28444	6369	46496	4708	51063	3812	53012	3103	54914	2041	67550	1464	49070
6L-4S		MI	18309	6369	30624	4551	33410	3662	34634	2964	35947	1893	43180	1382	30624
16-#14	2.50	MA	27650	6369	45002	4727	49242	3809	50780	3119	51917	2053	63471	1337	47404
7L-3S		MI	18872	6369	31609	4537	34662	3670	36134	2974	37831	1883	45278	1507	30704
16-#14	2.50	MA	26867	6369	43633	4727	47405	3827	48596	3135	48777	2046	59633	1262	45867
8L-2S		MI	19654	6369	32821	4543	36208	3659	37994	2964	40288	1873	48499	1635	30718
16-#18	4.44	MA	32655	7362	56751	5315	64081	4264	68774	3385	76156	1959	96345	1125	84031
5E		MI	19515	7362	34724	5121	38429	4088	40455	3194	43558	1724	53532	748	48617
16-#18	4.44	MA	31281	7362	54294	5312	60743	4258	64702	3376	70764	1978	89550	975	79726
6L-4S		MI	20374	7362	36240	5134	40372	4071	42767	3176	46749	1741	57330	853	50106
16-#18	4.44	MA	29941	7362	51664	5345	57538	4288	60774	3402	65489	1998	82479	750	75579
7L-3S		MI	21326	7362	37958	5111	42545	4088	45338	3194	49975	1724	60910	1068	52381
16-#18	4.44	MA	28619	7362	49252	5343	54303	4282	56928	3428	59962	1982	75800	620	70906
8L-2S		MI	22643	7362	40063	5124	45219	4071	48524	3176	54184	1706	66388	1296	52631
18-#11	1.95	MA	29156	6088	46829	4540	51707	3675	53851	3018	56119	2053	68491	1740	40870
4L-7S		MI	16787	6088	27388	4397	29337	3563	29788	2914	29539	1943	35139	1386	23557
18-#11	1.95	MA	28553	6088	45798	4540	50377	3673	52222	3029	53794	2048	65614	1695	40647
5L-6S		MI	17122	6088	28002	4386	30085	3554	30734	2921	30719	1936	36528	1454	23786
18-#11	1.95	MA	27978	6088	44826	4540	49056	3686	50610	3027	51659	2058	62861	1637	39697
6L-5S		MI	17465	6088	28576	4390	30864	3559	31645	2914	31925	1929	38006	1513	24184
18-#11	1.95	MA	27418	6088	43785	4554	47788	3685	49055	3038	49570	2067	59998	1549	39103
7L-4S		MI	17824	6088	29183	4393	31646	3551	32599	2907	33239	1936	39588	1553	24368
18-#11	1.95	MA	26865	6088	42831	4554	46508	3698	47533	3050	47383	2062	57309	1497	38133
8L-3S		MI	18222	6088	29873	4383	32523	3556	33658	2914	34570	1929	41073	1641	24375
18-#11	1.95	MA	26268	6088	41895	4554	45258	3697	45958	3048	45316	2072	54641	1441	37242
9L-2S		MI	18777	6088	30723	4386	33607	3548	34972	2907	36304	1922	43355	1730	24357
18-#14	2.81	MA	30240	6528	50001	4808	55650	3866	58595	3152	62408	2018	77492	1528	56464
5L-6S		MI	17858	6528	30147	4639	32724	3737	33854	3027	34835	1876	42084	1199	32849
18-#14	2.81	MA	29433	6528	48606	4808	53753	3884	56282	3148	59344	2031	73571	1444	55325
6L-5S		MI	18341	6528	30968	4645	33837	3745	35144	3017	36542	1866	44167	1285	33303

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

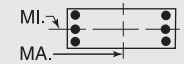


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.81	MA	28646	6528	47112	4827	51932	3882	54050	3164	56347	2043	69493	1318	53582
7L-4S		MI	18846	6528	31836	4651	34955	3734	36494	3007	38404	1876	46401	1343	34253
18-#14	2.81	MA	27869	6528	45743	4827	50095	3899	51866	3180	53207	2036	65655	1243	52050
8L-3S		MI	19405	6528	32821	4637	36208	3743	37994	3017	40288	1866	48499	1468	34373
18-#14	2.81	MA	27052	6528	44398	4826	48301	3897	49605	3176	50241	2049	61856	1162	49880
9L-2S		MI	20183	6528	34033	4642	37753	3732	39854	3007	42745	1856	51720	1596	34411
18-#18	5.00	MA	32961	7645	57995	5490	65461	4387	70438	3455	78535	1961	99996	936	90523
6L-5S		MI	20425	7645	36829	5298	41103	4216	43641	3267	47766	1688	59010	670	54520
18-#18	5.00	MA	31637	7645	55365	5523	62256	4417	66510	3482	73259	1980	92925	711	86286
7L-4S		MI	21276	7645	38345	5311	43046	4198	45953	3250	50957	1706	62809	774	56185
18-#18	5.00	MA	30331	7645	52953	5521	59022	4411	62664	3508	67733	1964	86246	580	81567
8L-3S		MI	22220	7645	40063	5289	45219	4216	48524	3267	54184	1688	66388	990	58682
20-#11	2.17	MA	29247	6198	47270	4609	52255	3724	54504	3060	56886	2042	69840	1683	44978
5L-7S		MI	17174	6198	28238	4466	30421	3613	31102	2945	31274	1932	37422	1361	26061
20-#11	2.17	MA	28676	6198	46298	4609	50933	3736	52892	3058	54751	2051	67087	1625	44062
6E		MI	17507	6198	28852	4456	31169	3604	32048	2952	32454	1925	38810	1429	26296
20-#11	2.17	MA	28119	6198	45258	4623	49665	3735	51337	3069	52663	2060	64224	1537	43483
7L-5S		MI	17849	6198	29426	4459	31948	3610	32959	2945	33660	1918	40288	1488	26672
20-#11	2.17	MA	27570	6198	44304	4623	48385	3748	49816	3081	50475	2056	61535	1485	42464
8L-4S		MI	18206	6198	30033	4462	32730	3601	33912	2938	34974	1925	41870	1528	26943
20-#11	2.17	MA	26977	6198	43368	4623	47135	3747	48241	3079	48408	2065	58867	1429	41595
9L-3S		MI	18603	6198	30723	4452	33607	3607	34972	2945	36304	1918	43355	1616	26968
20-#11	2.17	MA	26371	6198	42345	4637	45872	3759	46729	3090	46358	2074	56279	1366	40357
10L-2S		MI	19155	6198	31573	4456	34691	3598	36285	2938	38039	1911	45637	1705	26957
20-#14	3.13	MA	30414	6688	50716	4907	56443	3956	59552	3193	63775	2021	79593	1425	61585
6E		MI	18398	6688	31359	4739	34269	3809	35714	3070	37292	1859	45305	1160	36321
20-#14	3.13	MA	29633	6688	49222	4927	54622	3954	57320	3209	60777	2033	75514	1299	59768
7L-5S		MI	18878	6688	32180	4745	35382	3818	37004	3060	38999	1849	47388	1246	36853
20-#14	3.13	MA	28863	6688	47853	4926	52785	3972	55136	3225	57637	2026	71677	1224	58184
8L-4S		MI	19380	6688	33048	4750	36501	3807	38354	3050	40861	1859	49622	1304	37750
20-#14	3.13	MA	28048	6688	46508	4926	50991	3970	52876	3221	54672	2039	67878	1143	56059
9L-3S		MI	19936	6688	34033	4736	37753	3815	39854	3060	42745	1849	51720	1429	38037
20-#14	3.13	MA	27184	6688	45040	4946	49177	3987	50705	3237	51728	2051	64193	1052	53747
10L-2S		MI	20710	6688	35245	4742	39299	3804	41715	3050	45202	1839	54941	1557	38092
20-#18	5.56	MA	33315	7929	59066	5700	66975	4545	72246	3562	81030	1962	103371	671	97012
7L-5S		MI	21327	7929	38935	5476	43777	4344	46826	3341	51974	1653	64489	591	60451
20-#18	5.56	MA	32024	7929	56654	5698	63740	4540	68399	3588	75504	1947	96692	541	92245
8L-4S		MI	22171	7929	40450	5489	45720	4326	49138	3323	55165	1670	68287	696	62284
22-#11	2.38	MA	29369	6309	47771	4678	52811	3786	55175	3089	57843	2044	71313	1613	48431
6L-7S		MI	17559	6309	29088	4535	31505	3663	32415	2976	33009	1921	39704	1336	28514
22-#11	2.38	MA	28816	6309	46730	4692	51543	3785	53620	3101	55755	2053	68450	1525	47867
7L-6S		MI	17891	6309	29702	4525	32253	3654	33362	2983	34189	1914	41093	1404	28809
22-#11	2.38	MA	28270	6309	45777	4692	50263	3798	52098	3112	53567	2049	65761	1473	46801
8L-5S		MI	18231	6309	30276	4528	33032	3660	34273	2976	35395	1907	42570	1463	29166
22-#11	2.38	MA	27681	6309	44840	4692	49013	3797	50523	3110	51501	2058	63093	1417	45952
9L-4S		MI	18587	6309	30884	4532	33814	3651	35226	2969	36709	1914	44153	1503	29515
22-#11	2.38	MA	27078	6309	43818	4706	47749	3809	49011	3121	49450	2067	60505	1353	44682
10L-3S		MI	18981	6309	31573	4521	34691	3657	36285	2976	38039	1907	45637	1591	29549
22-#11	2.38	MA	26488	6309	42882	4706	46506	3808	47455	3119	47293	2063	57879	1298	43431
11L-2S		MI	19531	6309	32423	4525	35775	3648	37599	2969	39774	1900	47919	1680	29553
22-#14	3.44	MA	30613	6847	51332	5027	57312	4026	60590	3254	65207	2024	81536	1280	65963
7L-6S		MI	18935	6847	32571	4839	35815	3882	37574	3114	39748	1841	48526	1122	39788
22-#14	3.44	MA	29849	6847	49963	5026	55475	4044	58406	3270	62068	2016	77698	1205	64326
8L-5S		MI	19412	6847	33392	4844	36928	3890	38864	3104	41456	1831	50609	1208	40410
22-#14	3.44	MA	29035	6847	48618	5026	53681	4042	56146	3266	59102	2029	73899	1124	62246
9L-4S		MI	19910	6847	34260	4850	38046	3879	40214	3094	43318	1841	52843	1266	41259
22-#14	3.44	MA	28182	6847	47150	5045	51867	4060	53975	3282	56158	2041	70214	1033	59902
10L-3S		MI	20464	6847	35245	4836	39299	3887	41715	3104	45202	1831	54941	1390	41694

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#18	6.11	MA	33700	8213	60355	5875	68458	4668	74135	3668	83275	1929	107138	501	102938
8L-5S		MI	22224	8213	41040	5653	46451	4472	50012	3414	56183	1617	69967	513	66406
24-#11	2.60	MA	29508	6420	48203	4761	53420	3835	55902	3132	58847	2046	72676	1513	52253
7E		MI	17942	6420	29939	4604	32589	3713	33729	3007	34744	1910	41986	1311	30973
24-#11	2.60	MA	28966	6420	47249	4761	52140	3848	54380	3143	56659	2042	69987	1460	51143
8L-6S		MI	18273	6420	30553	4594	33337	3705	34675	3014	35923	1903	43375	1379	31324
24-#11	2.60	MA	28380	6420	46313	4761	50890	3847	52806	3141	54593	2051	67319	1404	50277
9L-5S		MI	18611	6420	31127	4597	34116	3710	35586	3007	37129	1896	44852	1438	31665
24-#11	2.60	MA	27780	6420	45290	4775	49627	3860	51293	3152	52542	2060	64731	1341	49012
10L-4S		MI	18965	6420	31734	4601	34898	3701	36540	3000	38443	1903	46435	1478	32083
24-#11	2.60	MA	27194	6420	44354	4775	48384	3858	49737	3150	50385	2056	62105	1286	47737
11L-3S		MI	19358	6420	32423	4590	35775	3707	37599	3007	39774	1896	47919	1566	32127
24-#11	2.60	MA	26618	6420	43348	4789	47129	3871	48229	3162	48337	2065	59213	1211	46430
12L-2S		MI	19906	6420	33274	4594	36859	3698	38912	3000	41509	1889	50201	1655	32146
24-#14	3.75	MA	30827	7007	52072	5126	58165	4116	61676	3315	66498	2006	83720	1186	70477
8L-6S		MI	19469	7007	33783	4938	37360	3954	39434	3157	42205	1824	51747	1083	43265
24-#14	3.75	MA	30015	7007	50728	5126	56370	4114	59416	3311	63532	2019	79921	1105	68439
9L-5S		MI	19943	7007	34604	4944	38473	3962	40724	3147	43913	1814	53830	1169	43973
24-#14	3.75	MA	29190	7007	49260	5145	54557	4132	57245	3327	60589	2031	76236	1014	66063
10L-4S		MI	20438	7007	35472	4950	39592	3951	42074	3137	45774	1824	56064	1227	44778

RECTANGULAR TIED COLUMNS 32" x 32"

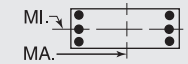
6-#14	1.32	MA	13407	4100	21425	2979	23110	2422	23657	2007	23750	1393	27914	1286	12718
2L-3S		MI	12541	4100	20113	2975	21438	2434	21627	2017	21069	1403	24383	1158	12773
6-#18	2.34	MA	14672	4472	24410	3186	26812	2569	27978	2083	29444	1329	35282	1163	21800
2L-3S		MI	13197	4472	22128	3175	23902	2589	24490	2100	24837	1347	29255	935	21710
8-#11	1.22	MA	13301	4063	21128	2970	22785	2416	23291	2007	23309	1407	27370	1307	11857
2L-4S		MI	12256	4063	19464	2978	20667	2421	20719	2008	19968	1421	23250	1130	11914
8-#14	1.76	MA	13998	4259	22737	3079	24783	2494	25688	2052	26431	1377	31444	1250	16750
2L-4S		MI	12524	4259	20361	3089	21758	2499	22020	2052	21694	1397	25618	995	16675
8-#18	3.13	MA	15664	4756	26693	3364	29722	2698	31465	2159	34050	1297	41309	1091	28752
2L-4S		MI	13161	4756	22553	3377	24451	2701	25164	2159	25912	1332	31353	644	26110
10-#11	1.52	MA	13720	4174	22047	3039	23957	2466	24716	2038	25200	1397	29868	1285	14684
2L-5S		MI	12292	4174	19729	3044	20996	2480	21111	2046	20427	1404	24018	1067	14386
10-#11	1.52	MA	13115	4174	21128	3036	22785	2476	23291	2045	23309	1404	27370	1196	14712
3L-4S		MI	12681	4174	20384	3047	21839	2471	22143	2039	21859	1411	25747	1107	14701
10-#14	2.20	MA	14583	4419	24049	3179	26456	2567	27718	2096	29113	1362	34975	1215	20764
2L-5S		MI	12572	4419	20737	3184	22225	2584	22577	2106	22344	1372	26701	903	19411
10-#14	2.20	MA	13732	4419	22737	3174	24783	2579	25688	2106	26431	1372	31444	1087	20747
3L-4S		MI	13122	4419	21673	3189	23431	2572	24050	2096	24375	1382	29149	960	20536
10-#18	3.91	MA	16643	5039	28975	3541	32631	2827	34953	2235	38657	1265	47335	1019	35667
2L-5S		MI	13242	5039	23198	3543	25252	2848	26120	2252	27027	1283	33201	468	30386
10-#18	3.91	MA	15206	5039	26693	3530	29722	2846	31465	2252	34050	1283	41309	792	35374
3L-4S		MI	14173	5039	24835	3554	27361	2829	28651	2235	30518	1300	37380	572	32614

RECTANGULAR TIED COLUMNS 32" x 34"

4-#18	1.47	MA	15340	4415	24692	3193	26693	2592	27391	2140	27710	1466	32660	1342	15879
2E		MI	14391	4415	23226	3175	25032	2577	25585	2123	25814	1450	30330	1321	14844
6-#14	1.24	MA	15056	4326	23926	3163	25829	2573	26428	2136	26503	1496	31157	1390	13630
2L-3S		MI	13265	4326	21206	3142	22569	2572	22725	2134	22050	1493	25466	1245	12816
6-#14	1.24	MA	14121	4326	22515	3159	24030	2587	24240	2147	23597	1506	27316	1262	13684
3L-2S		MI	14133	4326	22518	3147	24241	2560	24755	2124	24732	1483	28996	1373	12755
6-#18	2.21	MA	16437	4698	27152	3370	29829	2721	31181	2218	32715	1437	39237	1276	23420
2L-3S		MI	13922	4698	23226	3341	25032	2725	25585	2216	25814	1436	30330	1021	21798

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

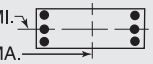
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	2.21	MA	14842	4698	24692	3361	26693	2742	27391	2236	27710	1454	32660	1048	23330
3L-2S		MI	15401	4698	25508	3352	27942	2706	29072	2199	30420	1418	36357	1249	21854
8-#11	1.15	MA	14939	4290	23603	3154	25475	2568	26018	2135	26014	1509	30548	1410	12700
2L-4S		MI	12980	4290	20555	3146	21798	2559	21818	2125	20953	1511	24336	1217	11961
8-#11	1.15	MA	14282	4290	22614	3151	24214	2577	24486	2143	23968	1516	27836	1322	12740
3E		MI	13417	4290	21299	3135	22744	2564	22965	2132	22403	1504	25960	1306	11933
8-#11	1.15	MA	13814	4290	21816	3163	23199	2573	23254	2138	22398	1523	26069	1233	12757
4L-2S		MI	14027	4290	22218	3138	23916	2555	24390	2124	24293	1497	28457	1395	11890
8-#14	1.65	MA	15698	4486	25338	3263	27629	2646	28616	2181	29410	1482	34997	1358	17965
2L-4S		MI	13248	4486	21454	3257	22889	2637	23118	2169	22675	1487	26701	1082	16754
8-#14	1.65	MA	14772	4486	23926	3259	25829	2659	26428	2192	26503	1492	31157	1230	17986
3E		MI	13865	4486	22518	3242	24241	2645	24755	2179	24732	1477	28996	1209	16824
8-#14	1.65	MA	14109	4486	22784	3275	24378	2652	24666	2183	24274	1502	28659	1102	17890
4L-2S		MI	14726	4486	23830	3247	25914	2632	26786	2169	27413	1467	32527	1337	16791
8-#18	2.94	MA	17516	4982	29612	3547	32965	2849	34971	2296	37720	1408	45813	1210	30912
2L-4S		MI	13885	4982	23651	3543	25581	2837	26259	2275	26888	1421	32428	730	26431
8-#18	2.94	MA	15942	4982	27152	3538	29829	2870	31181	2314	32715	1425	39237	982	30710
3E		MI	14936	4982	25508	3519	27942	2854	29072	2292	30420	1404	36357	950	28650
8-#18	2.94	MA	14814	4982	25156	3564	27291	2856	28124	2296	28876	1443	34957	759	28320
4L-2S		MI	16396	4982	27790	3530	30852	2834	32560	2275	35027	1386	42384	1177	28817
10-#11	1.43	MA	15393	4400	24591	3223	26735	2618	27550	2166	28061	1501	33261	1390	15737
2L-5S		MI	13016	4400	20820	3213	22127	2619	22211	2164	21412	1494	25104	1154	14542
10-#11	1.43	MA	14741	4400	23603	3221	25475	2628	26018	2174	26014	1507	30548	1301	15765
3L-4S		MI	13406	4400	21474	3215	22970	2609	23243	2156	22843	1501	26833	1194	14754
10-#11	1.43	MA	14275	4400	22804	3232	24460	2624	24787	2169	24444	1514	28781	1212	15754
4L-3S		MI	13840	4400	22218	3204	23916	2614	24390	2163	24293	1494	28457	1283	14752
10-#11	1.43	MA	13857	4400	22103	3230	23555	2633	23679	2177	22895	1507	26909	1171	15512
5L-2S		MI	14447	4400	23138	3207	25088	2605	25815	2155	26184	1487	30954	1372	14720
10-#14	2.07	MA	16334	4645	26750	3363	29429	2718	30804	2226	32316	1468	38838	1325	22283
2L-5S		MI	13296	4645	21830	3352	23356	2722	23675	2223	23326	1462	27783	990	19607
10-#14	2.07	MA	15415	4645	25338	3359	27629	2731	28616	2237	29410	1478	34997	1197	22266
3L-4S		MI	13847	4645	22766	3357	24562	2709	25148	2213	25357	1472	30232	1047	20692
10-#14	2.07	MA	14759	4645	24196	3375	26177	2725	26854	2228	27180	1488	32499	1069	22124
4L-3S		MI	14459	4645	23830	3342	25914	2717	26786	2223	27413	1462	32527	1174	20806
10-#14	2.07	MA	14168	4645	23192	3371	24883	2738	25270	2239	24980	1478	29841	1011	20943
5L-2S		MI	15313	4645	25142	3346	27586	2704	28816	2213	30094	1452	36057	1302	20809
10-#18	3.68	MA	18581	5266	32072	3725	36101	2978	38761	2374	42726	1378	52389	1144	38367
2L-5S		MI	13964	5266	24296	3709	26382	2985	27215	2368	28003	1372	34276	555	30897
10-#18	3.68	MA	17027	5266	29612	3715	32965	2999	34971	2392	37720	1396	45813	917	38074
3L-4S		MI	14898	5266	25933	3720	28491	2966	29746	2350	31494	1389	38455	658	32928
10-#18	3.68	MA	15914	5266	27615	3741	30427	2984	31914	2374	33882	1414	41533	693	35340
4L-3S		MI	15936	5266	27790	3696	30852	2982	32560	2368	35027	1372	42384	878	35484
10-#18	3.68	MA	14913	5266	25857	3732	28161	3006	29163	2392	30090	1396	36973	590	33152
5L-2S		MI	17379	5266	30073	3707	33762	2963	36047	2350	39633	1354	48410	1105	35738
12-#11	1.72	MA	15844	4511	25580	3292	27995	2668	29082	2197	30108	1492	35973	1369	18765
2L-6S		MI	13070	4511	21121	3279	22460	2664	22649	2202	21988	1491	25983	1073	16734
12-#11	1.72	MA	15195	4511	24591	3290	26735	2678	27550	2205	28061	1498	33261	1280	18780
3L-5S		MI	13441	4511	21739	3282	23299	2669	23636	2195	23302	1484	27601	1132	17202
12-#11	1.72	MA	14733	4511	23793	3301	25720	2674	26319	2200	26491	1505	31493	1191	18742
4E		MI	13829	4511	22394	3285	24143	2660	24668	2187	24734	1491	29330	1172	17537
12-#11	1.72	MA	14318	4511	23092	3299	24816	2683	25212	2208	24942	1498	29621	1150	18376
5L-3S		MI	14260	4511	23138	3274	25088	2664	25815	2194	26184	1484	30954	1260	17560

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis



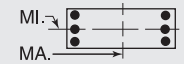
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#11	1.72	MA	13921	4511	22429	3296	23916	2679	24115	2202	23519	1505	27861	1091	17851
6L-2S		MI	14863	4511	24057	3277	26261	2655	27240	2186	28075	1477	33451	1349	17540
12-#14	2.48	MA	16963	4805	28161	3463	31229	2790	32991	2271	35222	1454	42679	1293	26586
2L-6S		MI	13373	4805	22257	3447	23828	2787	24297	2278	24143	1456	29027	869	22595
12-#14	2.48	MA	16052	4805	26750	3459	29429	2804	30804	2282	32316	1464	38838	1165	26533
3L-5S		MI	13894	4805	23142	3452	25028	2794	25705	2268	26007	1446	31314	954	23416
12-#14	2.48	MA	15401	4805	25608	3474	27977	2797	29042	2273	30087	1474	36340	1037	26262
4E		MI	14441	4805	24078	3456	26235	2782	27179	2258	28038	1456	33762	1012	24503
12-#14	2.48	MA	14816	4805	24604	3470	26683	2810	27458	2284	27886	1464	33682	979	25047
5L-3S		MI	15047	4805	25142	3441	27586	2789	28816	2268	30094	1446	36057	1139	24775
12-#14	2.48	MA	14258	4805	23655	3466	25395	2804	25944	2294	25866	1474	31192	894	24158
6L-2S		MI	15894	4805	26454	3446	29259	2777	30846	2258	32776	1436	39588	1267	24815
12-#18	4.41	MA	18098	5549	32072	3893	36101	3127	38761	2470	42726	1367	52389	851	45427
3L-5S		MI	14977	5549	26578	3887	29292	3114	30702	2444	32610	1340	40302	483	37261
12-#18	4.41	MA	16999	5549	30075	3919	33563	3113	35704	2453	38887	1385	48110	627	42402
4E		MI	15899	5549	28215	3898	31401	3094	33234	2426	36101	1357	44481	586	39466
12-#18	4.41	MA	16012	5549	28317	3909	31297	3134	32953	2470	35095	1367	43550	524	40042
5L-3S		MI	16924	5549	30073	3873	33762	3111	36047	2444	39633	1340	48410	806	42306
14-#11	2.01	MA	16291	4622	26568	3361	29256	2718	30614	2228	32154	1483	38685	1348	21785
2L-7S		MI	13136	4622	21379	3359	22826	2723	23050	2227	22592	1488	26792	962	18910
14-#11	2.01	MA	15646	4622	25580	3359	27995	2728	29082	2237	30108	1490	35973	1259	21780
3L-6S		MI	13495	4622	22041	3348	23633	2714	24074	2233	23879	1481	28480	1050	19434
14-#11	2.01	MA	15187	4622	24781	3370	26980	2724	27851	2231	28538	1496	34206	1170	21725
4L-5S		MI	13864	4622	22659	3351	24471	2719	25060	2226	25193	1474	30098	1109	19874
14-#11	2.01	MA	14775	4622	24080	3368	26076	2734	26744	2239	26988	1490	32334	1129	21252
5L-4S		MI	14249	4622	23313	3354	25315	2710	26093	2219	26624	1481	31827	1149	20314
14-#11	2.01	MA	14381	4622	23417	3366	25177	2730	25647	2233	25565	1496	30574	1071	20756
6L-3S		MI	14677	4622	24057	3343	26261	2714	27240	2225	28075	1474	33451	1238	20356
14-#11	2.01	MA	13996	4622	22708	3377	24313	2739	24588	2242	24173	1503	28740	983	20184
7L-2S		MI	15276	4622	24977	3346	27433	2705	28665	2218	29965	1468	35948	1326	20352
14-#14	2.90	MA	17587	4964	29573	3562	33029	2863	35179	2316	38128	1440	46519	1260	30873
2L-7S		MI	13465	4964	22622	3562	24347	2871	24865	2313	25001	1450	30411	734	25242
14-#14	2.90	MA	16682	4964	28161	3558	31229	2876	32991	2327	35222	1450	42679	1132	30792
3L-6S		MI	13970	4964	23569	3547	25500	2859	26327	2323	26824	1441	32558	833	26321
14-#14	2.90	MA	16038	4964	27020	3574	29777	2869	31230	2318	32993	1460	40181	1004	30308
4L-5S		MI	14487	4964	24454	3551	26701	2866	27735	2313	28688	1431	34844	919	27238
14-#14	2.90	MA	15458	4964	26015	3570	28483	2883	29646	2328	30792	1450	37523	946	29165
5L-4S		MI	15028	4964	25390	3556	27907	2854	29209	2303	30719	1441	37293	976	28257
14-#14	2.90	MA	14905	4964	25066	3566	27195	2876	28132	2339	28772	1460	35033	861	28181
6L-3S		MI	15630	4964	26454	3541	29259	2861	30846	2313	32776	1431	39588	1103	28735
14-#14	2.90	MA	14365	4964	24051	3582	25958	2890	26560	2330	26795	1470	32437	734	26981
7L-2S		MI	16470	4964	27766	3546	30932	2849	32877	2303	35457	1421	43118	1231	28802
14-#18	5.15	MA	18072	5833	32535	4096	36699	3242	39494	2531	43892	1355	54686	561	49497
4L-5S		MI	15977	5833	28861	4064	32202	3242	34190	2520	37216	1307	46329	411	43662
14-#18	5.15	MA	17097	5833	30776	4087	34433	3263	36743	2549	40100	1338	50126	458	46968
5L-4S		MI	16888	5833	30498	4075	34311	3223	36721	2502	40707	1325	50508	514	46038
16-#11	2.29	MA	16735	4732	27557	3430	30516	2768	32147	2260	34201	1474	41398	1327	24800
2L-8S		MI	13208	4732	21691	3425	23185	2769	23507	2266	23213	1485	27675	892	20974
16-#11	2.29	MA	16094	4732	26568	3428	29256	2778	30614	2268	32154	1481	38685	1238	24776
3L-7S		MI	13560	4732	22298	3428	23998	2774	24475	2258	24483	1478	29289	939	21555
16-#11	2.29	MA	15638	4732	25770	3439	28241	2774	29383	2262	30584	1488	36918	1150	24703
4L-6S		MI	13917	4732	22960	3417	24805	2764	25499	2265	25769	1471	30977	1027	22138
16-#11	2.29	MA	15228	4732	25069	3437	27336	2784	28276	2270	29035	1481	35046	1109	24137
5E		MI	14283	4732	23578	3420	25644	2769	26485	2257	27083	1465	32595	1086	22555

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis

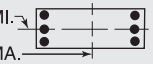


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#11	2.29	MA	14837	4732	24406	3435	26437	2780	27179	2265	27612	1488	33286	1050	23666
6L-4S		MI	14666	4732	24233	3423	26487	2760	27518	2250	28515	1471	34325	1126	23085
16-#11	2.29	MA	14455	4732	23697	3446	25573	2790	26121	2273	26220	1494	31452	962	23035
7L-3S		MI	15091	4732	24977	3412	27433	2765	28665	2256	29965	1465	35948	1215	23145
16-#11	2.29	MA	14079	4732	23046	3444	24701	2786	25084	2281	24760	1488	29704	914	22388
8L-2S		MI	15687	4732	25896	3415	28605	2755	30090	2249	31856	1458	38445	1304	23159
16-#14	3.31	MA	17308	5124	29573	3658	33029	2948	35179	2371	38128	1436	46519	1100	35044
3L-7S		MI	14061	5124	23934	3661	26019	2944	26895	2357	27682	1435	33941	699	29033
16-#14	3.31	MA	16669	5124	28431	3674	31577	2942	33418	2362	35899	1446	44021	972	34373
4L-6S		MI	14561	5124	24881	3646	27173	2931	28358	2367	29506	1425	36089	798	30064
16-#14	3.31	MA	16094	5124	27427	3670	30283	2955	31834	2373	33698	1436	41363	914	33294
5E		MI	15074	5124	25766	3651	28374	2939	29766	2357	31370	1415	38375	884	31071
16-#14	3.31	MA	15546	5124	26478	3666	28995	2949	30320	2384	31678	1446	38873	829	32219
6L-4S		MI	15611	5124	26702	3656	29580	2926	31239	2347	33401	1425	40823	941	32029
16-#14	3.31	MA	15011	5124	25463	3682	27758	2962	28748	2375	29701	1456	36278	702	31070
7L-3S		MI	16208	5124	27766	3641	30932	2934	32877	2357	35457	1415	43118	1068	32688
16-#18	5.88	MA	18170	6117	33236	4264	37569	3391	40533	2627	45106	1309	56702	392	53927
5E		MI	16967	6117	31143	4241	35112	3371	37677	2596	41823	1275	52356	339	50095
18-#11	2.58	MA	16539	4843	27557	3497	30516	2828	32147	2299	34201	1472	41398	1217	27767
3L-8S		MI	13631	4843	22610	3494	24357	2819	24932	2297	25104	1475	30172	869	23650
18-#11	2.58	MA	16086	4843	26759	3509	29501	2824	30915	2293	32631	1479	39631	1129	27678
4L-7S		MI	13981	4843	23218	3497	25171	2824	25900	2289	26374	1468	31786	916	24209
18-#11	2.58	MA	15679	4843	26057	3506	28597	2834	29808	2301	31082	1472	37758	1088	27030
5L-6S		MI	14336	4843	23879	3486	25977	2815	26924	2296	27660	1462	33474	1004	24848
18-#11	2.58	MA	15290	4843	25395	3504	27697	2830	28711	2296	29659	1479	35999	1029	26581
6L-5S		MI	14699	4843	24498	3489	26816	2819	27910	2288	28974	1455	35092	1063	25244
18-#11	2.58	MA	14911	4843	24686	3515	26833	2840	27653	2304	28266	1485	34165	941	25894
7L-4S		MI	15080	4843	25152	3492	27659	2810	28943	2281	30406	1462	36822	1103	25853
18-#11	2.58	MA	14537	4843	24035	3513	25961	2836	26616	2312	26807	1479	32416	893	25271
8L-3S		MI	15503	4843	25896	3481	28605	2815	30090	2287	31856	1455	38445	1192	25928
18-#14	3.72	MA	17294	5283	29843	3774	33377	3014	35606	2407	38805	1432	47862	940	38454
4L-7S		MI	14652	5283	25246	3761	27692	3016	28925	2402	30363	1419	37472	664	32816
18-#14	3.72	MA	16725	5283	28839	3770	32083	3027	34022	2418	36605	1422	45204	882	37433
5L-6S		MI	15148	5283	26193	3746	28846	3004	30388	2412	32187	1409	39619	763	33819
18-#14	3.72	MA	16181	5283	27890	3766	30795	3021	32508	2429	34584	1432	42714	796	36271
6L-5S		MI	15657	5283	27078	3751	30046	3011	31796	2402	34051	1400	41905	848	34912
18-#14	3.72	MA	15651	5283	26875	3781	29558	3034	30936	2420	32607	1442	40118	669	35169
7L-4S		MI	16189	5283	28014	3756	31253	2999	33270	2392	36082	1409	44354	906	35816
20-#11	2.87	MA	16531	4954	27747	3578	30761	2874	32447	2324	34678	1470	42343	1108	30650
4L-8S		MI	14052	4954	23530	3563	25529	2869	26357	2328	26994	1465	32669	846	26303
20-#11	2.87	MA	16126	4954	27046	3575	29857	2884	31340	2332	33128	1463	40471	1067	29929
5L-7S		MI	14399	4954	24137	3566	26343	2874	27325	2320	28264	1459	34283	893	26870
20-#11	2.87	MA	15740	4954	26383	3573	28958	2880	30243	2327	31705	1470	38711	1008	29500
6E		MI	14752	4954	24799	3555	27149	2865	28349	2327	29550	1452	35971	981	27560
20-#11	2.87	MA	15364	4954	25674	3585	28094	2890	29185	2335	30313	1477	36877	920	28761
7L-5S		MI	15113	4954	25417	3558	27988	2869	29335	2319	30865	1445	37590	1041	27938
20-#11	2.87	MA	14992	4954	25023	3582	27222	2886	28148	2343	28854	1470	35129	872	28152
8L-4S		MI	15491	4954	26071	3561	28831	2860	30368	2312	32296	1452	39319	1081	28618
20-#14	4.14	MA	17350	5443	30251	3869	33882	3100	36209	2463	39511	1408	49044	849	41578
5L-7S		MI	15238	5443	26558	3861	29365	3088	30956	2447	33044	1404	41002	628	36525
20-#14	4.14	MA	16811	5443	29302	3865	32595	3093	34696	2474	37491	1418	46555	764	40335
6E		MI	15731	5443	27505	3846	30518	3076	32418	2457	34868	1394	43150	727	37587
20-#14	4.14	MA	16285	5443	28286	3881	31357	3107	33124	2465	35514	1428	43959	637	39203
7L-5S		MI	16235	5443	28390	3851	31719	3083	33827	2447	36732	1384	45436	813	38761
22-#11	3.15	MA	16571	5064	28034	3645	31118	2934	32872	2364	35175	1454	43183	1046	32834
5L-8S		MI	14469	5064	24449	3633	26701	2919	27782	2359	28885	1456	35166	824	28930
22-#11	3.15	MA	16187	5064	27372	3642	30218	2930	31776	2358	33752	1461	41423	987	32422
6L-7S		MI	14815	5064	25057	3636	27515	2924	28750	2352	30155	1449	36781	871	29536

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.15	MA	15813	5064	26663	3654	29354	2940	30717	2366	32360	1468	39590	899	31633
7L-6S		MI	15165	5064	25718	3625	28321	2915	29774	2358	31441	1442	38468	959	30276
22-#11	3.15	MA	15444	5064	26012	3651	28482	2936	29680	2374	30900	1461	37841	851	30985
8L-5S		MI	15524	5064	26337	3627	29160	2919	30760	2351	32755	1435	40087	1018	30638
22-#14	4.55	MA	17437	5603	30713	3965	34395	3166	36884	2519	40397	1404	50395	732	44409
6L-7S		MI	15820	5603	27870	3961	31037	3161	32986	2491	35726	1388	44533	593	40246
22-#14	4.55	MA	16915	5603	29698	3981	33157	3179	35312	2510	38420	1414	47800	605	43221
7L-6S		MI	16309	5603	28817	3946	32191	3148	34449	2501	37550	1378	46680	692	41365
24-#11	3.44	MA	16632	5175	28360	3711	31479	2980	33308	2389	35799	1452	44136	966	35347
6L-8S		MI	14885	5175	25368	3702	27873	2970	29207	2390	30775	1446	37663	801	31563
24-#11	3.44	MA	16260	5175	27651	3723	30614	2990	32249	2397	34406	1459	42302	878	34511
7E		MI	15228	5175	25976	3705	28687	2974	30175	2383	32045	1439	39278	848	32208
24-#11	3.44	MA	15893	5175	27000	3720	29742	2986	31212	2405	32947	1452	40554	830	33824
8L-6S		MI	15576	5175	26638	3694	29493	2965	31199	2389	33332	1432	40965	936	32989
24-#14	4.96	MA	17540	5762	31110	4081	34957	3251	37500	2555	41326	1399	51640	572	47249
7E		MI	16398	5762	29182	4060	32710	3233	35016	2536	38407	1373	48063	558	43978

RECTANGULAR TIED COLUMNS 32" x 36"

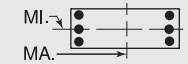
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.39	MA	17108	4641	27386	3377	29625	2743	30421	2271	30712	1570	36212	1448	16959
2E		MI	15117	4641	24323	3341	26162	2714	26680	2239	26790	1539	31405	1407	14888
6-#14	1.17	MA	16797	4552	26556	3347	28689	2725	29329	2265	29386	1599	34546	1493	14541
2L-3S		MI	13990	4552	22299	3310	23699	2710	23823	2251	23032	1583	26548	1332	12856
6-#14	1.17	MA	15793	4552	25045	3344	26762	2739	26987	2276	26255	1609	30395	1365	14596
3L-2S		MI	14859	4552	23611	3315	25372	2698	25853	2241	25713	1573	30079	1460	12790
6-#18	2.08	MA	18294	4925	30023	3554	32987	2872	34508	2351	36116	1543	43339	1387	25040
2L-3S		MI	14648	4925	24323	3507	26162	2861	26680	2332	26790	1525	31405	1108	21880
6-#18	2.08	MA	16579	4925	27386	3546	29625	2895	30421	2369	30712	1561	36212	1159	24950
3L-2S		MI	16130	4925	26606	3518	29072	2842	30167	2315	31397	1507	37432	1335	21906
8-#11	1.08	MA	16668	4516	26206	3338	28305	2719	28885	2264	28848	1612	33871	1513	13542
2L-4S		MI	13704	4516	21646	3315	22929	2698	22917	2243	21937	1601	25422	1305	12002
8-#11	1.08	MA	15964	4516	25149	3336	26956	2729	27246	2272	26646	1618	30943	1424	13582
3E		MI	14142	4516	22389	3304	23875	2702	24065	2249	23387	1594	27046	1393	11967
8-#11	1.08	MA	15463	4516	24296	3348	25872	2726	25931	2267	24956	1625	29033	1335	13599
4L-2S		MI	14753	4516	23309	3307	25047	2693	25490	2242	25277	1588	29543	1482	11921
8-#14	1.56	MA	17490	4712	28068	3447	30616	2797	31672	2310	32517	1586	38697	1463	19180
2L-4S		MI	13972	4712	22547	3425	24020	2775	24216	2286	23657	1577	27784	1169	16826
8-#14	1.56	MA	16495	4712	26556	3444	28689	2811	29329	2321	29386	1596	34546	1335	19201
3E		MI	14591	4712	23611	3409	25372	2782	25853	2296	25713	1567	30079	1296	16872
8-#14	1.56	MA	15786	4712	25336	3460	27138	2805	27447	2313	26984	1606	31841	1207	19105
4L-2S		MI	15453	4712	24923	3414	27045	2770	27884	2286	28395	1557	33609	1424	16831
8-#18	2.78	MA	19462	5208	32660	3731	36349	3001	38595	2431	41521	1517	50466	1326	33072
2L-4S		MI	14609	5208	24748	3709	26712	2974	27353	2390	27865	1511	33503	816	26744
8-#18	2.78	MA	17769	5208	30023	3723	32987	3023	34508	2449	36116	1534	43339	1099	32870
3E		MI	15664	5208	26606	3684	29072	2990	30167	2408	31397	1493	37432	1036	28744
8-#18	2.78	MA	16560	5208	27887	3751	30272	3011	31214	2432	31971	1552	38709	871	30559
4L-2S		MI	17128	5208	28888	3695	31982	2971	33654	2390	36003	1475	43459	1263	28879
10-#11	1.35	MA	17158	4627	27264	3407	29653	2769	30525	2295	31051	1604	36799	1494	16790
2L-5S		MI	13740	4627	21911	3381	23258	2757	23310	2281	22396	1585	26190	1242	14694
10-#11	1.35	MA	16458	4627	26206	3405	28305	2779	28885	2303	28848	1610	33871	1405	16818
3L-4S		MI	14131	4627	22565	3384	24101	2748	24342	2274	23827	1591	27920	1282	14804

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.35	MA	15960	4627	25354	3417	27221	2776	27570	2298	27158	1617	31961	1316	16807
4L-3S		MI	14566	4627	23309	3373	25047	2753	25490	2280	25277	1585	29543	1371	14790
10-#11	1.35	MA	15513	4627	24605	3415	26256	2786	26388	2307	25491	1610	29945	1274	16650
5L-2S		MI	15173	4627	24228	3376	26219	2743	26915	2273	27168	1578	32040	1459	14755
10-#14	1.95	MA	18176	4871	29579	3547	32543	2869	34014	2354	35649	1573	42848	1434	23801
2L-5S		MI	14020	4871	22923	3519	24486	2860	24773	2340	24307	1552	28866	1077	19796
10-#14	1.95	MA	17189	4871	28068	3543	30616	2883	31672	2366	32517	1583	38697	1306	23785
3L-4S		MI	14573	4871	23859	3524	25693	2847	26246	2330	26338	1562	31314	1134	20772
10-#14	1.95	MA	16487	4871	26848	3560	29065	2878	29789	2358	30115	1593	35992	1178	23643
4L-3S		MI	15186	4871	24923	3509	27045	2855	27884	2340	28395	1552	33609	1261	20862
10-#14	1.95	MA	15855	4871	25776	3557	27683	2892	28097	2370	27745	1583	33128	1118	22489
5L-2S		MI	16041	4871	26235	3514	28717	2842	29914	2330	31076	1542	37140	1389	20853
10-#18	3.47	MA	20613	5492	35297	3909	39711	3129	42682	2511	46926	1490	57593	1265	41067
2L-5S		MI	14686	5492	25394	3875	27512	3121	28310	2484	28980	1461	35351	641	31397
10-#18	3.47	MA	18941	5492	32660	3901	36349	3152	38595	2529	41521	1508	50466	1038	40774
3L-4S		MI	15624	5492	27031	3886	29621	3102	30841	2466	32471	1478	39530	744	33234
10-#18	3.47	MA	17748	5492	30524	3928	33634	3139	35301	2512	37376	1525	45836	810	38096
4L-3S		MI	16666	5492	28888	3862	31982	3119	33654	2484	36003	1461	43459	964	35587
10-#18	3.47	MA	16676	5492	28645	3920	31212	3162	32336	2530	33282	1508	40893	709	35971
5L-2S		MI	18113	5492	31170	3873	34892	3100	37142	2466	40610	1443	49485	1192	35807
12-#11	1.63	MA	17644	4737	28322	3476	31002	2819	32164	2326	33254	1595	39727	1474	20029
2L-6S		MI	13794	4737	22212	3447	23591	2803	23749	2320	22972	1582	27069	1160	16871
12-#11	1.63	MA	16948	4737	27264	3474	29653	2829	30525	2335	31051	1602	36799	1386	20043
3L-5S		MI	14166	4737	22830	3450	24430	2807	24735	2313	24286	1575	28687	1219	17352
12-#11	1.63	MA	16454	4737	26411	3486	28569	2826	29209	2330	29361	1609	34889	1297	20006
4E		MI	14555	4737	23484	3453	25274	2798	25767	2305	25718	1582	30417	1259	17592
12-#11	1.63	MA	16010	4737	25663	3484	27604	2836	28027	2338	27694	1602	32873	1255	19716
5L-3S		MI	14987	4737	24228	3442	26219	2803	26915	2311	27168	1575	32040	1348	17602
12-#11	1.63	MA	15586	4737	24956	3482	26644	2833	26857	2333	26163	1609	30972	1196	19118
6L-2S		MI	15591	4737	25148	3445	27392	2794	28340	2304	29059	1568	34537	1437	17578
12-#14	2.34	MA	18856	5031	31091	3646	34470	2941	36357	2399	38780	1560	47000	1404	28408
2L-6S		MI	14096	5031	23350	3614	24959	2924	25395	2395	25125	1546	30110	956	22911
12-#14	2.34	MA	17876	5031	29579	3643	32543	2956	34014	2411	35649	1570	42848	1276	28356
3L-5S		MI	14619	5031	24235	3619	26159	2932	26803	2385	26989	1536	32396	1041	23603
12-#14	2.34	MA	17180	5031	28359	3660	30992	2950	32132	2403	33247	1580	40143	1148	28174
4E		MI	15167	5031	25171	3624	27365	2919	28277	2375	29020	1546	34845	1099	24710
12-#14	2.34	MA	16555	5031	27287	3656	29610	2964	30440	2415	30876	1570	37279	1089	26887
5L-3S		MI	15775	5031	26235	3609	28717	2927	29914	2385	31076	1536	37140	1226	24837
12-#14	2.34	MA	15958	5031	26274	3653	28235	2959	28763	2407	28699	1580	34585	1004	26074
6L-2S		MI	16624	5031	27547	3614	30390	2915	31944	2375	33757	1526	40670	1354	24861
12-#18	4.17	MA	20098	5776	35297	4078	39711	3280	42682	2609	46926	1481	57593	977	48667
3L-5S		MI	15700	5776	27676	4052	30422	3250	31797	2560	33586	1429	41377	569	37751
12-#18	4.17	MA	18921	5776	33161	4105	36996	3268	39388	2592	42781	1499	52962	750	45676
4E		MI	16627	5776	29313	4063	32531	3231	34328	2542	37077	1446	45557	672	39766
12-#18	4.17	MA	17863	5776	31282	4097	34574	3290	36423	2610	38687	1481	48020	648	43379
5L-3S		MI	17656	5776	31170	4039	34892	3247	37142	2560	40610	1429	49485	892	42417
12-#18	4.17	MA	16854	5776	29505	4089	32164	3278	33590	2628	34930	1499	43403	496	40380
6L-2S		MI	19088	5776	33453	4050	37801	3228	40629	2542	45216	1411	55512	1120	42713
14-#11	1.90	MA	18127	4848	29379	3545	32350	2869	33803	2357	35457	1587	42656	1455	23260
2L-7S		MI	13859	4848	22470	3527	23957	2862	24149	2345	23577	1579	27878	1049	19136
14-#11	1.90	MA	17435	4848	28322	3543	31002	2880	32164	2366	33254	1594	39727	1367	23254
3L-6S		MI	14220	4848	23131	3516	24764	2853	25174	2351	24863	1572	29566	1137	19570
14-#11	1.90	MA	16944	4848	27469	3555	29918	2876	30848	2361	31564	1601	37817	1278	23199
4L-5S		MI	14589	4848	23750	3519	25603	2857	26160	2344	26177	1565	31185	1196	20022
14-#11	1.90	MA	16503	4848	26721	3553	28953	2887	29667	2370	29897	1594	35801	1236	22794
5L-4S		MI	14975	4848	24404	3522	26446	2848	27192	2336	27609	1572	32914	1236	20373
14-#11	1.90	MA	16082	4848	26014	3551	27993	2883	28496	2365	28366	1601	33900	1177	22228
6L-3S		MI	15405	4848	25148	3511	27392	2853	28340	2343	29059	1565	34537	1325	20405

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

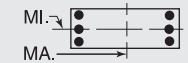
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.90	MA	15671	4848	25257	3563	27071	2893	27367	2373	26867	1608	31919	1089	21710
7L-2S		MI	16005	4848	26067	3514	28564	2844	29765	2335	30949	1558	37035	1414	20392
14-#14	2.73	MA	19529	5191	32602	3746	36397	3014	38699	2444	41911	1548	51151	1374	32999
2L-7S		MI	14187	5191	23715	3729	25477	3009	25963	2430	25982	1540	31493	821	25522
14-#14	2.73	MA	18557	5191	31091	3743	34470	3028	36357	2456	38780	1558	47000	1246	32918
3L-6S		MI	14694	5191	24662	3714	26631	2997	27425	2440	27806	1531	33641	920	26632
14-#14	2.73	MA	17867	5191	29871	3759	32919	3022	34474	2448	36378	1568	44295	1118	32611
4L-5S		MI	15213	5191	25547	3719	27832	3004	28833	2430	29670	1521	35927	1006	27423
14-#14	2.73	MA	17247	5191	28799	3756	31537	3037	32782	2460	34008	1558	41430	1059	31299
5L-4S		MI	15756	5191	26483	3724	29038	2992	30307	2420	31701	1531	38375	1063	28477
14-#14	2.73	MA	16656	5191	27786	3753	30162	3031	31106	2452	31831	1568	38737	974	30389
6L-3S		MI	16360	5191	27547	3709	30390	2999	31944	2430	33757	1521	40670	1190	28802
14-#14	2.73	MA	16078	5191	26702	3769	28841	3045	29488	2464	29700	1578	35930	847	29030
7L-2S		MI	17203	5191	28859	3713	32063	2987	33975	2420	36439	1511	44201	1318	28855
14-#18	4.86	MA	20079	6059	35798	4283	40358	3396	43475	2671	48185	1472	60089	689	53290
4L-5S		MI	16703	6059	29958	4230	33332	3379	35284	2636	38193	1396	47404	497	44143
14-#18	4.86	MA	19035	6059	33919	4275	37936	3419	40510	2689	44092	1455	55147	587	50823
5L-4S		MI	17619	6059	31596	4241	35441	3359	37816	2618	41684	1414	51583	601	46332
14-#18	4.86	MA	18039	6059	32142	4267	35526	3406	37677	2707	40335	1472	50530	435	47963
6L-3S		MI	18636	6059	33453	4216	37801	3376	40629	2636	45216	1396	55512	820	49238
16-#11	2.17	MA	18606	4959	30437	3614	33699	2919	35443	2388	37660	1579	45584	1436	26485
2L-8S		MI	13931	4959	22781	3594	24316	2907	24607	2383	24197	1576	28761	979	21183
16-#11	2.17	MA	17918	4959	29379	3612	32350	2930	33803	2397	35457	1586	42656	1347	26461
3L-7S		MI	14284	4959	23389	3596	25129	2912	25574	2376	25467	1569	30376	1026	21779
16-#11	2.17	MA	17430	4959	28527	3624	31266	2926	32488	2392	33767	1593	40745	1259	26388
4L-6S		MI	14642	4959	24051	3585	25936	2903	26599	2382	26753	1562	32063	1114	22275
16-#11	2.17	MA	16992	4959	27778	3622	30301	2937	31306	2401	32100	1586	38729	1217	25881
5E		MI	15009	4959	24669	3588	26775	2908	27585	2375	28068	1555	33682	1174	22702
16-#11	2.17	MA	16574	4959	27071	3620	29341	2933	30136	2396	30569	1593	36828	1158	25344
6L-4S		MI	15393	4959	25323	3591	27618	2898	28617	2367	29499	1562	35411	1214	23149
16-#11	2.17	MA	16166	4959	26315	3632	28419	2944	29006	2405	29070	1600	34847	1070	24764
7L-3S		MI	15820	4959	26067	3580	28564	2903	29765	2374	30949	1555	37035	1302	23196
16-#11	2.17	MA	15764	4959	25621	3630	27489	2940	27900	2413	27499	1593	32965	1021	24032
8L-2S		MI	16417	4959	26987	3583	29736	2894	31190	2366	32840	1548	39532	1391	23201
16-#14	3.13	MA	19232	5350	32602	3843	36397	3100	38699	2501	41911	1545	51151	1216	37474
3L-7S		MI	14784	5350	25027	3829	27150	3081	27993	2474	28664	1525	35024	786	29309
16-#14	3.13	MA	18548	5350	31382	3859	34846	3095	36817	2493	39509	1555	48446	1088	36965
4L-6S		MI	15286	5350	25974	3814	28304	3069	29456	2484	30487	1515	37171	885	30370
16-#14	3.13	MA	17933	5350	30310	3856	33464	3109	35125	2505	37139	1545	45581	1029	35723
5E		MI	15801	5350	26859	3819	29504	3077	30864	2474	32351	1505	39458	971	31254
16-#14	3.13	MA	17347	5350	29297	3853	32089	3103	33448	2497	34962	1555	42888	944	34720
6L-4S		MI	16340	5350	27795	3823	30711	3064	32337	2464	34382	1515	41906	1028	32246
16-#14	3.13	MA	16775	5350	28213	3869	30768	3117	31830	2509	32832	1565	40081	817	33414
7L-3S		MI	16939	5350	28859	3808	32063	3072	33975	2474	36439	1505	44201	1155	32759
16-#14	3.13	MA	16211	5350	27219	3866	29435	3112	30245	2521	30599	1555	37406	748	31903
8L-2S		MI	17776	5350	30171	3813	33735	3059	36005	2464	39120	1495	47731	1283	32837
16-#18	5.56	MA	20194	6343	36556	4452	41298	3548	44597	2769	49497	1428	62274	527	58300
5E		MI	17695	6343	32241	4407	36242	3507	38772	2712	42799	1364	53431	425	50568
16-#18	5.56	MA	19210	6343	34779	4444	38888	3535	41764	2787	45740	1446	57657	375	55547
6L-4S		MI	18601	6343	33878	4418	38351	3488	41303	2694	46290	1382	57610	529	52925
18-#11	2.44	MA	18397	5069	30437	3682	33699	2980	35443	2428	37660	1578	45584	1328	29663
3L-8S		MI	14354	5069	23701	3663	25488	2958	26032	2414	26088	1566	31258	956	23858
18-#11	2.44	MA	17913	5069	29585	3693	32615	2976	34127	2423	35970	1585	43673	1239	29573
4L-7S		MI	14705	5069	24308	3666	26302	2962	26999	2407	27358	1559	32873	1003	24430

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

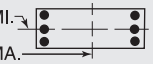


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.44	MA	17477	5069	28836	3692	31650	2987	32945	2432	34303	1578	41657	1198	28978
5L-6S		MI	15061	5069	24970	3655	27108	2953	28024	2413	28644	1552	34560	1092	24984
18-#11	2.44	MA	17062	5069	28129	3690	30690	2983	31775	2427	32771	1585	39756	1139	28465
6L-5S		MI	15426	5069	25588	3657	27947	2958	29010	2406	29958	1545	36179	1151	25389
18-#11	2.44	MA	16657	5069	27373	3702	29768	2994	30645	2436	31273	1592	37775	1051	27827
7L-4S		MI	15808	5069	26243	3660	28790	2949	30042	2398	31390	1552	37908	1191	25920
18-#11	2.44	MA	16258	5069	26678	3700	28838	2990	29539	2444	29702	1585	35893	1002	27121
8L-3S		MI	16232	5069	26987	3649	29736	2953	31190	2405	32840	1545	39532	1280	25983
18-#11	2.44	MA	15862	5069	25944	3712	27928	3001	28395	2439	28219	1592	34051	945	26246
9L-2S		MI	16826	5069	27906	3652	30908	2944	32615	2397	34731	1538	42029	1368	26005
18-#14	3.52	MA	19223	5510	32893	3959	36773	3167	39159	2538	42640	1542	52597	1058	41336
4L-7S		MI	15376	5510	26339	3929	28823	3154	30023	2519	31345	1509	38554	751	33107
18-#14	3.52	MA	18614	5510	31821	3956	35390	3181	37467	2550	40270	1532	49733	999	40156
5L-6S		MI	15874	5510	27286	3914	29977	3141	31486	2529	33169	1499	40702	850	34122
18-#14	3.52	MA	18032	5510	30809	3952	34016	3176	35791	2542	38093	1542	47039	914	39064
6L-5S		MI	16385	5510	28171	3918	31177	3149	32894	2519	35032	1490	42988	935	35095
18-#14	3.52	MA	17465	5510	29725	3969	32695	3190	34173	2554	35963	1552	44232	787	37808
7L-4S		MI	16920	5510	29107	3923	32383	3136	34368	2509	37063	1499	45436	992	36031
18-#14	3.52	MA	16906	5510	28730	3966	31362	3184	32588	2565	33730	1542	41557	718	36243
8L-3S		MI	17514	5510	30171	3908	33735	3144	36005	2519	39120	1490	47731	1120	36711
18-#18	6.25	MA	20369	6627	37416	4621	42250	3664	45851	2867	51145	1419	64784	314	62959
6L-5S		MI	18679	6627	34523	4584	39152	3636	42259	2788	47406	1332	59458	354	57022
20-#11	2.71	MA	18392	5180	30642	3763	33963	3027	35766	2454	38173	1577	46601	1220	32756
4L-8S		MI	14776	5180	24620	3732	26660	3008	27457	2445	27978	1556	33755	934	26538
20-#11	2.71	MA	17960	5180	29894	3761	32998	3037	34585	2463	36506	1570	44585	1178	32081
5L-7S		MI	15124	5180	25228	3735	27474	3012	28424	2438	29248	1549	35370	981	27089
20-#11	2.71	MA	17547	5180	29187	3759	32038	3034	33414	2458	34974	1577	42684	1120	31590
6E		MI	15478	5180	25889	3724	28280	3003	29449	2444	30535	1542	37057	1069	27697
20-#11	2.71	MA	17145	5180	28430	3771	31117	3044	32285	2467	33476	1584	40704	1032	30897
7L-5S		MI	15841	5180	26508	3727	29119	3008	30435	2437	31849	1535	38676	1128	28083
20-#11	2.71	MA	16748	5180	27736	3769	30186	3040	31178	2476	31905	1577	38821	983	30214
8L-4S		MI	16220	5180	27162	3730	29962	2999	31467	2430	33280	1542	40405	1168	28689
20-#11	2.71	MA	16355	5180	27002	3781	29277	3051	30034	2471	30421	1584	36979	926	29303
9L-3S		MI	16642	5180	27906	3719	30908	3003	32615	2436	34731	1535	42029	1257	28765
20-#14	3.91	MA	19289	5669	33333	4055	37317	3254	39810	2595	43401	1519	53884	969	44598
5L-7S		MI	15963	5669	27651	4028	30495	3226	32054	2564	34026	1494	42085	715	36913
20-#14	3.91	MA	18712	5669	32320	4052	35943	3248	38133	2587	41225	1529	51190	884	43420
6E		MI	16458	5669	28598	4013	31649	3214	33516	2574	35850	1484	44232	814	37885
20-#14	3.91	MA	18150	5669	31236	4069	34622	3262	36515	2598	39094	1539	48383	757	42211
7L-5S		MI	16965	5669	29483	4018	32850	3221	34924	2564	37714	1474	46519	900	38943
20-#14	3.91	MA	17595	5669	30241	4065	33289	3256	34930	2610	36861	1529	45708	688	40594
8L-4S		MI	17496	5669	30419	4023	34056	3209	36398	2554	39745	1484	48967	957	39829
22-#11	2.98	MA	18439	5291	30952	3830	34347	3087	36224	2494	38709	1562	47513	1159	35190
5L-8S		MI	15194	5291	25540	3801	27832	3058	28882	2477	29869	1546	36252	911	29223
22-#11	2.98	MA	18029	5291	30245	3828	33387	3084	35054	2489	37177	1569	45612	1101	34718
6L-7S		MI	15541	5291	26147	3804	28646	3062	29849	2469	31139	1539	37867	958	29753
22-#11	2.98	MA	17630	5291	29488	3840	32465	3094	33924	2498	35678	1576	43632	1013	33973
7L-6S		MI	15892	5291	26809	3793	29452	3053	30873	2476	32425	1532	39555	1046	30413
22-#11	2.98	MA	17235	5291	28794	3838	31535	3091	32818	2507	34108	1569	41749	964	33313
8L-5S		MI	16253	5291	27427	3796	30291	3058	31860	2468	33739	1525	41173	1105	30782
22-#11	2.98	MA	16844	5291	28059	3850	30625	3101	31673	2502	32624	1576	39907	907	32367
9L-4S		MI	16630	5291	28081	3799	31135	3049	32892	2461	35171	1532	42902	1145	31454
22-#14	4.30	MA	19387	5829	33831	4152	37870	3320	40476	2631	44356	1517	55341	855	47787
6L-7S		MI	16547	5829	28963	4128	32168	3298	34084	2608	36707	1478	45615	680	40654
22-#14	4.30	MA	18829	5829	32748	4168	36549	3334	38858	2643	42226	1527	52535	728	46621
7L-6S		MI	17038	5829	29910	4113	33322	3286	35547	2618	38531	1468	47763	779	41660
22-#14	4.30	MA	18279	5829	31753	4165	35216	3329	37273	2655	39993	1517	49859	658	44953
8L-5S		MI	17541	5829	30795	4118	34522	3293	36955	2608	40395	1458	50049	864	42797

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	3.25	MA	18509	5401	31302	3897	34735	3134	36693	2520	39380	1561	48540	1081	37850
6L-8S		MI	15610	5401	26459	3870	29004	3108	30307	2508	31760	1536	38750	888	31864
24-#11	3.25	MA	18111	5401	30546	3909	33814	3144	35563	2529	37881	1568	46560	993	37055
7E		MI	15955	5401	27067	3873	29818	3113	31274	2500	33030	1529	40364	935	32424
24-#11	3.25	MA	17719	5401	29852	3907	32883	3141	34457	2538	36311	1561	44677	945	36415
8L-6S		MI	16304	5401	27728	3862	30624	3103	32298	2507	34316	1522	42052	1023	33132
24-#11	3.25	MA	17331	5401	29117	3919	31974	3151	33313	2533	34827	1568	42835	888	35435
9L-5S		MI	16663	5401	28347	3865	31463	3108	33285	2499	35630	1515	43670	1082	33486
24-#14	4.69	MA	19504	5989	34259	4268	38476	3407	41200	2688	45357	1514	56686	698	50980
7E		MI	17126	5989	30275	4228	33841	3371	36114	2653	39389	1463	49146	645	44381
24-#14	4.69	MA	18958	5989	33264	4265	37143	3401	39615	2700	43124	1504	54011	628	49321
8L-6S		MI	17614	5989	31222	4213	34994	3358	37577	2663	41213	1453	51293	744	45444

RECTANGULAR TIED COLUMNS 32" x 38"

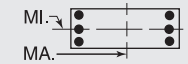
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.32	MA	18967	4867	30208	3561	32697	2895	33547	2400	33843	1673	39910	1552	18039
2E		MI	15843	4867	25421	3507	27292	2850	27774	2355	27767	1629	32481	1493	14931
6-#14	1.11	MA	18628	4779	29315	3531	31689	2876	32371	2393	32398	1701	38081	1596	15452
2L-3S		MI	14715	4779	23392	3477	24830	2848	24921	2368	24014	1673	27631	1419	12895
6-#14	1.11	MA	17556	4779	27704	3528	29635	2891	29874	2406	29041	1711	33619	1468	15507
3L-2S		MI	15585	4779	24704	3482	26503	2835	26951	2358	26695	1663	31161	1547	12824
6-#18	1.97	MA	20243	5151	33022	3738	36285	3023	37909	2480	39648	1649	47589	1496	26660
2L-3S		MI	15373	5151	25421	3673	27292	2998	27774	2448	27767	1614	32481	1194	21957
6-#18	1.97	MA	18408	5151	30208	3731	32697	3047	33547	2500	33843	1667	39910	1268	26570
3L-2S		MI	16858	5151	27703	3684	30202	2979	31262	2430	32373	1596	38507	1421	21958
8-#11	1.03	MA	18489	4742	28939	3522	31276	2870	31893	2392	31812	1713	37340	1614	14385
2L-4S		MI	14429	4742	22736	3483	24060	2836	24017	2360	22921	1692	26509	1392	12042
8-#11	1.03	MA	17736	4742	27812	3520	29839	2881	30146	2401	29452	1720	34196	1525	14425
3E		MI	14867	4742	23480	3472	25006	2841	25164	2367	24371	1685	28132	1481	12000
8-#11	1.03	MA	17202	4742	26905	3532	28686	2878	28747	2397	27642	1727	32141	1437	14441
4L-2S		MI	15479	4742	24400	3475	26178	2832	26589	2359	26262	1678	30630	1570	11952
8-#14	1.48	MA	19373	4938	30927	3631	33744	2948	34868	2438	35754	1689	42543	1568	20395
2L-4S		MI	14697	4938	23640	3592	25151	2913	25314	2403	24639	1667	28866	1256	16893
8-#14	1.48	MA	18309	4938	29315	3628	31689	2963	32371	2451	32398	1699	38081	1440	20416
3E		MI	15317	4938	24704	3577	26503	2920	26951	2413	26695	1657	31161	1383	16917
8-#14	1.48	MA	17554	4938	28017	3645	30038	2958	30367	2444	29823	1709	35168	1312	20320
4L-2S		MI	16180	4938	26016	3582	28175	2908	28981	2403	29376	1647	34692	1511	16870
8-#18	2.63	MA	21499	5435	35837	3915	39873	3152	42271	2560	45452	1625	55267	1440	35232
2L-4S		MI	15333	5435	25846	3875	27842	3110	28448	2506	28841	1600	34578	902	27049
8-#18	2.63	MA	19687	5435	33022	3908	36285	3176	37909	2579	39648	1642	47589	1212	35030
3E		MI	16391	5435	27703	3850	30202	3127	31262	2524	32373	1582	38507	1122	28833
8-#18	2.63	MA	18397	5435	30747	3937	33393	3165	34399	2564	35195	1660	42592	985	32827
4L-2S		MI	17859	5435	29986	3861	33112	3107	34749	2506	36980	1564	44534	1349	28937
10-#11	1.28	MA	19014	4853	30066	3591	32712	2920	33639	2423	34171	1706	40484	1597	17843
2L-5S		MI	14464	4853	23001	3549	24389	2896	24409	2399	23380	1675	27277	1329	14819
10-#11	1.28	MA	18266	4853	28939	3589	31276	2931	31893	2433	31812	1713	37340	1508	17871
3L-4S		MI	14856	4853	23656	3552	25232	2886	25442	2392	24812	1682	29006	1369	14850
10-#11	1.28	MA	17736	4853	28032	3601	30122	2928	30493	2428	30002	1720	35285	1419	17860
4L-3S		MI	15292	4853	24400	3541	26178	2891	26589	2398	26262	1675	30630	1458	14827
10-#11	1.28	MA	17260	4853	27236	3600	29097	2939	29237	2438	28217	1713	33127	1377	17771
5L-2S		MI	15900	4853	25319	3544	27350	2882	28014	2391	28152	1668	33127	1547	14789
10-#14	1.85	MA	20110	5098	32538	3731	35798	3020	37365	2483	39111	1678	47005	1541	25320
2L-5S		MI	14744	5098	24016	3687	25617	2997	25871	2457	25289	1642	29949	1164	19980

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

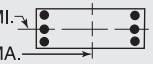


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.85	MA	19055	5098	30927	3728	33744	3035	34868	2496	35754	1688	42543	1413	25303
3L-4S		MI	15298	5098	24952	3692	26823	2985	27344	2447	27320	1652	32397	1221	20847
10-#14	1.85	MA	18306	5098	29628	3745	32093	3031	32864	2489	33179	1698	39631	1285	25161
4L-3S		MI	15913	5098	26016	3677	28175	2992	28981	2457	29376	1642	34692	1348	20916
10-#14	1.85	MA	17634	5098	28488	3742	30623	3045	31065	2501	30639	1688	36560	1224	24048
5L-2S		MI	16770	5098	27328	3682	29848	2980	31012	2447	32058	1632	38223	1476	20896
10-#18	3.29	MA	22738	5718	38651	4093	43461	3280	46632	2639	51257	1600	62946	1384	43767
2L-5S		MI	15408	5718	26491	4041	28642	3258	29404	2600	29956	1550	36426	727	31885
10-#18	3.29	MA	20948	5718	35837	4086	39873	3305	42271	2659	45452	1618	55267	1156	43474
3L-4S		MI	16350	5718	28128	4052	30752	3239	31936	2582	33448	1568	40605	830	33532
10-#18	3.29	MA	19675	5718	33561	4114	36981	3293	38761	2644	41000	1636	50270	929	40881
4L-3S		MI	17395	5718	29986	4028	33112	3255	34749	2600	36980	1550	44534	1050	35686
10-#18	3.29	MA	18531	5718	31561	4108	34403	3318	35605	2664	36605	1618	44961	825	38796
5L-2S		MI	18847	5718	32268	4039	36022	3236	38237	2582	41586	1532	50561	1278	35875
12-#11	1.54	MA	19536	4964	31192	3660	34149	2970	35386	2454	36530	1699	43628	1579	21292
2L-6S		MI	14518	4964	23302	3615	24722	2941	24848	2438	23956	1672	28155	1247	17002
12-#11	1.54	MA	18792	4964	30066	3658	32712	2981	33639	2464	34171	1706	40484	1490	21307
3L-5S		MI	14890	4964	23921	3618	25561	2946	25834	2430	25270	1665	29774	1307	17497
12-#11	1.54	MA	18266	4964	29159	3671	31559	2978	32240	2459	32361	1713	38429	1401	21270
4E		MI	15280	4964	24575	3621	26405	2937	26867	2423	26702	1672	31503	1347	17644
12-#11	1.54	MA	17793	4964	28363	3669	30533	2989	30984	2469	30576	1706	36270	1359	21066
5L-3S		MI	15713	4964	25319	3610	27350	2941	28014	2429	28152	1665	33127	1435	17642
12-#11	1.54	MA	17342	4964	27612	3668	29513	2986	29740	2464	28936	1713	34228	1300	20392
6L-2S		MI	16318	4964	26238	3613	28523	2932	29439	2422	30043	1658	35624	1524	17614
12-#14	2.22	MA	20840	5257	34149	3830	37852	3093	39862	2528	42468	1666	51468	1513	30231
2L-6S		MI	14819	5257	24443	3782	26089	3062	26493	2512	26106	1636	31193	1043	23195
12-#14	2.22	MA	19793	5257	32538	3828	35798	3108	37365	2541	39111	1676	47005	1385	30178
3L-5S		MI	15344	5257	25328	3787	27290	3070	27901	2502	27970	1626	33479	1128	23784
12-#14	2.22	MA	19051	5257	31239	3845	34147	3103	35362	2533	36536	1686	44093	1257	29997
4E		MI	15893	5257	26264	3792	28496	3057	29375	2492	30001	1636	35927	1185	24791
12-#14	2.22	MA	18384	5257	30099	3842	32677	3118	33562	2546	33996	1676	41022	1197	28739
5L-3S		MI	16503	5257	27328	3776	29848	3065	31012	2502	32058	1626	38223	1313	24896
12-#14	2.22	MA	17749	5257	29023	3839	31215	3113	31779	2539	31662	1686	38124	1112	27920
6L-2S		MI	17354	5257	28640	3781	31521	3052	33042	2492	34739	1616	41753	1441	24908
12-#18	3.95	MA	22192	6002	38651	4263	43461	3433	46632	2739	51257	1594	62946	1100	51907
3L-5S		MI	16424	6002	28774	4218	31552	3386	32892	2676	34563	1518	42453	655	38230
12-#18	3.95	MA	20935	6002	36376	4292	40569	3422	43123	2724	46805	1611	57949	872	48980
4E		MI	17355	6002	30411	4229	33661	3367	35423	2658	38054	1535	46632	758	40058
12-#18	3.95	MA	19807	6002	34376	4285	37991	3446	39967	2743	42410	1594	52639	769	46768
5L-3S		MI	18388	6002	32268	4205	36022	3384	38237	2676	41586	1518	50561	978	42524
12-#18	3.95	MA	18731	6002	32486	4278	35426	3435	36839	2728	38375	1611	47660	617	43394
6L-2S		MI	19825	6002	34550	4216	38932	3365	41724	2658	46193	1500	56587	1206	42786
14-#11	1.80	MA	20054	5074	32319	3729	35586	3021	37132	2485	38889	1691	46772	1561	24734
2L-7S		MI	14582	5074	23560	3696	25088	3000	25249	2462	24561	1669	28965	1136	19356
14-#11	1.80	MA	19314	5074	31192	3727	34149	3031	35386	2495	36530	1698	43628	1472	24728
3L-6S		MI	14944	5074	24222	3685	25895	2991	26273	2469	25847	1662	30652	1225	19701
14-#11	1.80	MA	18791	5074	30286	3740	32996	3028	33986	2490	34720	1705	41573	1384	24673
4L-5S		MI	15314	5074	24840	3688	26734	2996	27259	2461	27161	1655	32271	1284	20165
14-#11	1.80	MA	18322	5074	29490	3738	31970	3039	32730	2500	32935	1698	39414	1341	24347
5L-4S		MI	15701	5074	25494	3690	27577	2987	28292	2454	28593	1662	34000	1324	20429
14-#11	1.80	MA	17874	5074	28739	3737	30950	3036	31486	2495	31295	1705	37371	1283	23707
6L-3S		MI	16132	5074	26238	3679	28523	2991	29439	2460	30043	1655	35624	1412	20449
14-#11	1.80	MA	17437	5074	27935	3749	29970	3047	30286	2505	29690	1712	35244	1195	23253
7L-2S		MI	16734	5074	27158	3682	29695	2982	30864	2453	31933	1648	38121	1501	20431
14-#14	2.59	MA	21563	5417	35760	3930	39906	3165	42359	2573	45824	1655	55930	1486	35125
2L-7S		MI	14909	5417	24808	3897	26608	3147	27060	2547	26964	1630	32576	908	25793
14-#14	2.59	MA	20524	5417	34149	3927	37852	3180	39862	2585	42468	1665	51468	1358	35044
3L-6S		MI	15418	5417	25755	3882	27762	3135	28523	2557	28788	1620	34723	1007	26935

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis



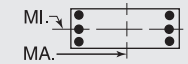
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.59	MA	19788	5417	32850	3945	36201	3175	37859	2578	39893	1674	48555	1230	34828
4L-5S		MI	15938	5417	26640	3886	28962	3142	29931	2547	30652	1611	37010	1093	27602
14-#14	2.59	MA	19128	5417	31710	3942	34731	3190	36059	2591	37352	1665	45484	1169	33446
5L-4S		MI	16483	5417	27576	3891	30169	3130	31405	2537	32683	1620	39458	1150	28692
14-#14	2.59	MA	18498	5417	30634	3939	33269	3185	34276	2584	35019	1674	42587	1084	32625
6L-3S		MI	17089	5417	28640	3876	31521	3137	33042	2547	34739	1611	41753	1277	28866
14-#14	2.59	MA	17883	5417	29482	3956	31865	3200	32556	2597	32735	1684	39568	958	31100
7L-2S		MI	17934	5417	29952	3881	33193	3125	35073	2537	37420	1601	45284	1405	28908
14-#18	4.61	MA	22180	6286	39190	4469	44157	3551	47485	2803	52609	1587	65627	816	57114
4L-5S		MI	17429	6286	31056	4396	34462	3515	36379	2752	39169	1486	48479	583	44613
14-#18	4.61	MA	21067	6286	37190	4462	41579	3575	44328	2823	48214	1570	60318	712	54732
5L-4S		MI	18349	6286	32693	4407	36571	3496	38911	2734	42660	1503	52658	687	46619
14-#18	4.61	MA	20004	6286	35300	4455	39014	3564	41201	2808	44179	1587	55338	561	51502
6L-3S		MI	19371	6286	34550	4382	38932	3512	41724	2752	46193	1486	56587	907	49351
16-#11	2.05	MA	20568	5185	33446	3798	37022	3071	38879	2517	41249	1684	49916	1544	28170
2L-8S		MI	14653	5185	23872	3762	25447	3046	25706	2501	25181	1666	29847	1067	21385
16-#11	2.05	MA	19833	5185	32319	3797	35586	3082	37132	2526	38889	1691	46772	1455	28146
3L-7S		MI	15008	5185	24480	3765	26260	3051	26674	2493	26451	1659	31462	1114	21997
16-#11	2.05	MA	19313	5185	31412	3809	34433	3079	35733	2522	37079	1698	44717	1366	28073
4L-6S		MI	15367	5185	25141	3754	27067	3041	27698	2500	27737	1652	33150	1202	22406
16-#11	2.05	MA	18847	5185	30617	3807	33407	3089	34477	2531	35294	1691	42558	1324	27638
5E		MI	15735	5185	25760	3757	27906	3046	28684	2492	29052	1645	34768	1261	22844
16-#11	2.05	MA	18402	5185	29866	3806	32386	3086	33233	2527	33654	1698	40515	1265	27029
6L-4S		MI	16120	5185	26414	3760	28749	3037	29717	2485	30483	1652	36497	1301	23209
16-#11	2.05	MA	17968	5185	29062	3818	31407	3097	32032	2536	32049	1705	38388	1177	26511
7L-3S		MI	16548	5185	27158	3749	29695	3041	30864	2491	31933	1645	38121	1390	23245
16-#11	2.05	MA	17540	5185	28324	3817	30418	3094	30856	2545	30367	1698	36371	1127	25690
8L-2S		MI	17146	5185	28077	3751	30867	3032	32289	2484	33824	1638	40618	1478	23242
16-#14	2.96	MA	21249	5576	35760	4027	39906	3252	42359	2630	45824	1653	55930	1330	39904
3L-7S		MI	15507	5576	26120	3996	28281	3219	29091	2591	29645	1615	36106	873	29577
16-#14	2.96	MA	20519	5576	34462	4044	38255	3247	40356	2623	43249	1663	53017	1202	39580
4L-6S		MI	16011	5576	27067	3981	29435	3207	30553	2601	31469	1605	38254	972	30669
16-#14	2.96	MA	19865	5576	33322	4042	36785	3262	38556	2636	40709	1653	49946	1142	38164
5E		MI	16528	5576	27952	3986	30635	3214	31962	2591	33333	1595	40540	1057	31432
16-#14	2.96	MA	19240	5576	32245	4039	35323	3258	36773	2629	38375	1663	47049	1057	37249
6L-4S		MI	17069	5576	28888	3991	31841	3202	33435	2581	35364	1605	42988	1115	32458
16-#14	2.96	MA	18631	5576	31093	4056	33919	3272	35053	2642	36092	1673	44030	930	35779
7L-3S		MI	17670	5576	29952	3976	33193	3209	35073	2591	37420	1595	45284	1242	32827
16-#14	2.96	MA	18030	5576	30035	4053	32502	3268	33368	2654	33699	1663	41162	859	34282
8L-2S		MI	18509	5576	31264	3981	34866	3197	37103	2581	40101	1585	48814	1370	32893
16-#18	5.26	MA	22312	6569	40004	4640	45167	3703	48690	2903	54019	1545	67996	656	62728
5E		MI	18423	6569	33338	4573	37372	3644	39867	2828	43776	1453	54506	511	51031
16-#18	5.26	MA	21263	6569	38114	4633	42602	3692	45563	2887	49984	1563	63017	505	59633
6L-4S		MI	19333	6569	34976	4584	39481	3625	42398	2810	47267	1471	58685	615	53208
18-#11	2.31	MA	20348	5296	33446	3866	37022	3132	38879	2557	41249	1684	49916	1437	31558
3L-8S		MI	15078	5296	24791	3831	26619	3096	27131	2532	27072	1656	32345	1044	24058
18-#11	2.31	MA	19831	5296	32539	3878	35869	3129	37479	2553	39439	1691	47861	1348	31469
4L-7S		MI	15430	5296	25399	3834	27433	3101	28099	2525	28342	1649	33959	1091	24645
18-#11	2.31	MA	19368	5296	31744	3877	34843	3140	36223	2562	37654	1684	45702	1306	30937
5L-6S		MI	15787	5296	26061	3823	28239	3092	29123	2531	29628	1642	35647	1179	25115
18-#11	2.31	MA	18926	5296	30993	3875	33823	3137	34979	2558	36013	1691	43659	1247	30355
6L-5S		MI	16153	5296	26679	3826	29078	3096	30109	2524	30942	1635	37265	1238	25530
18-#11	2.31	MA	18495	5296	30189	3887	32844	3147	33779	2567	34408	1697	41532	1159	29777
7L-4S		MI	16536	5296	27333	3829	29921	3087	31142	2516	32374	1642	38994	1278	25984

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

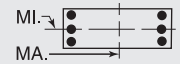


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.31	MA	18069	5296	29451	3886	31855	3145	32603	2576	32727	1691	39515	1110	28984
8L-3S		MI	16961	5296	28077	3818	30867	3092	32289	2522	33824	1635	40618	1367	26035
18-#11	2.31	MA	17648	5296	28671	3898	30889	3155	31387	2572	31138	1697	37536	1053	28136
9L-2S		MI	17557	5296	28997	3821	32039	3082	33714	2515	35715	1629	43115	1456	26048
18-#14	3.33	MA	21244	5736	36073	4144	40309	3320	42853	2668	46606	1651	57480	1175	44242
4L-7S		MI	16100	5736	27432	4096	29953	3292	31121	2636	32326	1599	39637	838	33372
18-#14	3.33	MA	20595	5736	34933	4141	38839	3335	41053	2681	44066	1641	54409	1114	42894
5L-6S		MI	16601	5736	28379	4081	31107	3279	32584	2646	34150	1589	41784	937	34416
18-#14	3.33	MA	19976	5736	33856	4139	37378	3330	39270	2674	41732	1651	51511	1029	41886
6L-5S		MI	17113	5736	29264	4086	32308	3287	33992	2636	36014	1579	44071	1022	35272
18-#14	3.33	MA	19372	5736	32704	4156	35973	3345	37550	2686	39448	1661	48493	903	40469
7L-4S		MI	17650	5736	30200	4091	33514	3274	35466	2626	38045	1589	46519	1079	36240
18-#14	3.33	MA	18776	5736	31647	4153	34556	3340	35865	2699	37055	1651	45624	832	38917
8L-3S		MI	18247	5736	31264	4076	34866	3282	37103	2636	40101	1579	48814	1207	36783
18-#18	5.92	MA	22508	6853	40929	4810	46190	3821	49925	2967	55789	1539	70695	449	67784
6L-5S		MI	19408	6853	35621	4750	40282	3772	43354	2904	48382	1421	60533	440	57477
20-#11	2.57	MA	20346	5406	33666	3947	37306	3179	39226	2584	41798	1683	51005	1331	34862
4L-8S		MI	15500	5406	25711	3900	27791	3146	28556	2563	28963	1646	34842	1021	26737
20-#11	2.57	MA	19885	5406	32871	3946	36280	3190	37970	2593	40013	1676	48846	1288	34245
5L-7S		MI	15850	5406	26318	3903	28605	3151	29524	2556	30233	1639	36456	1068	27301
20-#11	2.57	MA	19446	5406	32119	3944	35260	3187	36726	2589	38373	1683	46803	1230	33687
6E		MI	16205	5406	26980	3892	29411	3142	30548	2562	31519	1632	38144	1156	27828
20-#11	2.57	MA	19018	5406	31316	3957	34280	3198	35525	2598	36767	1690	44676	1142	33050
7L-5S		MI	16568	5406	27598	3895	30250	3146	31534	2555	32833	1626	39762	1215	28224
20-#11	2.57	MA	18595	5406	30578	3955	33291	3195	34349	2608	35086	1683	42659	1092	32283
8L-4S		MI	16949	5406	28253	3898	31093	3137	32567	2547	34265	1632	41492	1255	28755
20-#11	2.57	MA	18177	5406	29798	3967	32325	3206	33133	2603	33497	1690	40680	1036	31398
9L-3S		MI	17372	5406	28997	3887	32039	3142	33714	2554	35715	1626	43115	1344	28820
20-#11	2.57	MA	17715	5406	29063	3966	31349	3203	31965	2613	31920	1697	38762	972	30542
10L-2S		MI	17965	5406	29916	3890	33211	3133	35139	2546	37605	1619	45612	1433	28846
20-#14	3.70	MA	21320	5896	36544	4241	40893	3407	43550	2726	47422	1630	58871	1087	47632
5L-7S		MI	16689	5896	28744	4196	31626	3364	33152	2681	35008	1584	43168	802	37175
20-#14	3.70	MA	20706	5896	35467	4238	39432	3402	41768	2719	45089	1640	55973	1002	46535
6E		MI	17185	5896	29691	4181	32780	3351	34614	2691	36832	1574	45315	901	38176
20-#14	3.70	MA	20107	5896	34315	4256	38028	3417	40047	2731	42805	1650	52955	875	45167
7L-5S		MI	17694	5896	30576	4186	33980	3359	36022	2681	38695	1564	47601	987	39119
20-#14	3.70	MA	19516	5896	33258	4253	36611	3412	38362	2744	40412	1640	50086	804	43563
8L-4S		MI	18227	5896	31512	4190	35187	3347	37496	2671	40726	1574	50049	1044	40036
22-#11	2.82	MA	20400	5517	33997	4015	37717	3240	39716	2624	42372	1669	51990	1271	37558
5L-8S		MI	15919	5517	26630	3969	28963	3196	29981	2594	30853	1636	37339	998	29421
22-#11	2.82	MA	19963	5517	33246	4013	36697	3237	38472	2620	40732	1676	49947	1212	37022
6L-7S		MI	16267	5517	27238	3972	29777	3201	30949	2587	32123	1629	38953	1045	29964
22-#11	2.82	MA	19538	5517	32442	4026	35717	3248	37272	2629	39127	1683	47820	1124	36330
7L-6S		MI	16620	5517	27899	3961	30583	3192	31973	2593	33409	1623	40641	1133	30545
22-#11	2.82	MA	19118	5517	31705	4024	34728	3245	36096	2639	37445	1676	45803	1074	35587
8L-5S		MI	16981	5517	28518	3964	31422	3196	32959	2586	34724	1616	42259	1193	30922
22-#11	2.82	MA	18702	5517	30924	4037	33762	3256	34880	2634	35856	1683	43824	1018	34666
9L-4S		MI	17360	5517	29172	3967	32266	3187	33992	2578	36155	1623	43989	1233	31524
22-#11	2.82	MA	18243	5517	30190	4035	32786	3253	33711	2644	34279	1690	41906	954	33797
10L-3S		MI	17781	5517	29916	3956	33211	3192	35139	2585	37605	1616	45612	1321	31602
22-#14	4.07	MA	21430	6055	37078	4338	41486	3474	44265	2764	48445	1628	60435	974	51195
6L-7S		MI	17273	6055	30056	4296	33299	3436	35182	2725	37689	1568	46698	767	40987
22-#14	4.07	MA	20836	6055	35926	4355	40082	3489	42544	2776	46162	1638	57417	848	49873
7L-6S		MI	17766	6055	31003	4281	34453	3424	36644	2735	39513	1558	48845	866	41947
22-#14	4.07	MA	20250	6055	34869	4353	38665	3485	40859	2789	43769	1628	54549	777	48217
8L-5S		MI	18272	6055	31888	4285	35653	3431	38053	2725	41377	1548	51132	951	42973
24-#11	3.08	MA	20477	5628	34373	4083	38133	3287	40219	2651	43091	1669	53091	1194	40360
6L-8S		MI	16336	5628	27550	4038	30135	3246	31406	2625	32744	1626	39836	976	32108

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	3.08	MA	20054	5628	33569	4095	37154	3298	39018	2660	41486	1676	50964	1106	39616
7E		MI	16682	5628	28157	4041	30949	3251	32374	2618	34014	1620	41450	1023	32633
24-#11	3.08	MA	19637	5628	32832	4093	36165	3295	37842	2670	39804	1669	48947	1057	38895
8L-6S		MI	17033	5628	28819	4030	31755	3242	33398	2624	35300	1613	43138	1111	33264
24-#11	3.08	MA	19224	5628	32051	4106	35199	3306	36626	2665	38215	1676	46968	1000	37939
9L-5S		MI	17392	5628	29437	4033	32594	3247	34384	2617	36614	1606	44757	1170	33626
24-#11	3.08	MA	18775	5628	31317	4104	34222	3303	35458	2675	36638	1682	45050	937	37043
10L-4S		MI	17769	5628	30091	4036	33438	3237	35416	2610	38046	1613	46486	1210	34290
24-#14	4.44	MA	21560	6215	37538	4455	42136	3562	45041	2821	49518	1627	61879	820	54587
7E		MI	17854	6215	31368	4395	34971	3509	37212	2770	40370	1553	50229	732	44775
24-#14	4.44	MA	20978	6215	36480	4452	40719	3557	43357	2834	47125	1617	59011	749	52880
8L-6S		MI	18343	6215	32315	4380	36125	3496	38675	2780	42194	1543	52376	831	45728

RECTANGULAR TIED COLUMNS 32" x 40"

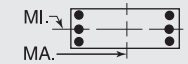
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.25	MA	20918	5094	33159	3744	35911	3046	36813	2528	37104	1776	43754	1656	19119
2E		MI	16569	5094	26519	3673	28422	2987	28869	2470	28743	1718	33556	1579	14973
6-#14	1.05	MA	20551	5005	32203	3715	34831	3027	35553	2522	35539	1803	41761	1697	16363
2L-3S		MI	15440	5005	24485	3645	25961	2986	26019	2485	24995	1763	28714	1506	12932
6-#14	1.05	MA	19409	5005	30492	3713	32649	3043	32901	2535	31957	1813	36988	1569	16418
3L-2S		MI	16311	5005	25797	3650	27634	2973	28049	2475	27677	1753	32244	1634	12858
6-#18	1.88	MA	22284	5377	36150	3922	39725	3174	41450	2608	43309	1754	51985	1604	28280
2L-3S		MI	16098	5377	26519	3839	28422	3134	28869	2564	28743	1703	33556	1280	22030
6-#18	1.88	MA	20327	5377	33159	3916	35911	3200	36813	2630	37104	1771	43754	1376	28190
3L-2S		MI	17586	5377	28801	3850	31332	3115	32356	2546	33350	1685	39582	1507	22008
8-#14	1.41	MA	21347	5164	33914	3815	37012	3099	38204	2567	39121	1792	46535	1672	21610
2L-4S		MI	15421	5164	24734	3760	26282	3050	26412	2520	25620	1757	29949	1343	16956
8-#14	1.41	MA	20215	5164	32203	3813	34831	3115	35553	2580	35539	1802	41761	1544	21631
3E		MI	16042	5164	25797	3744	27634	3058	28049	2530	27677	1747	32244	1470	16961
8-#14	1.41	MA	19412	5164	30826	3830	33080	3111	33428	2574	32790	1812	38641	1416	21535
4L-2S		MI	16907	5164	27109	3749	29306	3046	30079	2520	30358	1737	35775	1598	16908
8-#18	2.50	MA	23629	5661	39142	4099	43539	3303	46086	2688	49514	1732	60216	1552	37392
2L-4S		MI	16057	5661	26944	4041	28972	3247	29543	2622	29818	1689	35653	988	27346
8-#18	2.50	MA	21697	5661	36150	4093	39725	3329	41450	2709	43309	1749	51985	1324	37190
3E		MI	17118	5661	28801	4016	31332	3263	32356	2640	33350	1671	39582	1208	28918
8-#18	2.50	MA	20325	5661	33736	4123	36655	3319	37725	2696	38549	1767	46620	1096	35122
4L-2S		MI	18589	5661	31083	4027	34242	3244	35844	2622	37956	1653	45609	1436	28994
10-#11	1.22	MA	20962	5079	32996	3775	35912	3072	36894	2552	37398	1807	44314	1699	18896
2L-5S		MI	15188	5079	24092	3718	25520	3034	25509	2517	24364	1765	28363	1417	14877
10-#11	1.22	MA	20166	5079	31800	3773	34387	3083	35041	2562	34886	1814	40954	1610	18924
3L-4S		MI	15581	5079	24746	3720	26364	3025	26541	2509	25796	1772	30092	1457	14892
10-#11	1.22	MA	19603	5079	30839	3786	33165	3080	33557	2558	32961	1821	38755	1521	18913
4L-3S		MI	16017	5079	25490	3709	27309	3030	27689	2516	27246	1765	31716	1545	14863
10-#11	1.22	MA	19098	5079	29996	3785	32078	3092	32226	2568	31062	1815	36453	1478	18824
5L-2S		MI	16626	5079	26410	3712	28481	3020	29114	2508	29136	1759	34213	1634	14822
10-#14	1.76	MA	22135	5324	35625	3914	39193	3172	40856	2611	42703	1782	51308	1646	26839
2L-5S		MI	15468	5324	25109	3854	26748	3135	26968	2574	26271	1732	31031	1250	20157
10-#14	1.76	MA	21012	5324	33914	3912	37012	3187	38204	2625	39121	1792	46535	1518	26822
3L-4S		MI	16023	5324	26046	3859	27954	3123	28442	2565	28302	1741	33479	1308	20917
10-#14	1.76	MA	20216	5324	32537	3930	35261	3183	36080	2619	36373	1802	43415	1390	26680
4L-3S		MI	16639	5324	27109	3844	29306	3130	30079	2574	30358	1732	35775	1435	20968
10-#14	1.76	MA	19503	5324	31329	3928	33704	3199	34173	2632	33662	1792	40137	1329	25620
5L-2S		MI	17498	5324	28421	3849	30979	3118	32110	2565	33039	1722	39305	1563	20938

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

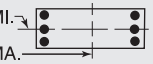


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.13	MA	24956	5945	42134	4276	47353	3432	50723	2768	55719	1709	68447	1499	46467
2L-5S		MI	16131	5945	27589	4207	29773	3394	30499	2716	30933	1639	37501	813	32281
10-#18	3.13	MA	23047	5945	39142	4271	43539	3457	46086	2789	49514	1727	60216	1272	46174
3L-4S		MI	17076	5945	29226	4218	31882	3375	33030	2698	34424	1657	41680	916	33822
10-#18	3.13	MA	21693	5945	36728	4300	40469	3447	42362	2775	44754	1745	54851	1044	43695
4L-3S		MI	18124	5945	31083	4194	34242	3392	35844	2716	37956	1639	45609	1136	35779
10-#18	3.13	MA	20478	5945	34607	4295	37735	3473	39014	2797	40057	1727	49174	939	41366
5L-2S		MI	19580	5945	33366	4205	37152	3372	39331	2698	42563	1621	51636	1364	35941
12-#11	1.46	MA	21519	5190	34192	3844	37437	3122	38748	2583	39909	1800	47674	1682	22556
2L-6S		MI	15242	5190	24393	3784	25853	3080	25948	2555	24940	1762	29242	1335	17129
12-#11	1.46	MA	20728	5190	32996	3843	35912	3133	36894	2593	37398	1807	44314	1594	22570
3L-5S		MI	15615	5190	25011	3787	26692	3084	26934	2548	26255	1756	30860	1394	17638
12-#11	1.46	MA	20168	5190	32035	3855	34690	3130	35411	2589	35472	1814	42115	1505	22533
4E		MI	16006	5190	25666	3790	27536	3075	27966	2540	27686	1762	32589	1434	17693
12-#11	1.46	MA	19667	5190	31192	3854	33603	3142	34080	2599	33573	1808	39813	1462	22419
5L-3S		MI	16439	5190	26410	3779	28481	3080	29114	2547	29136	1756	34213	1523	17681
12-#11	1.46	MA	19189	5190	30397	3853	32523	3139	32762	2595	31829	1815	37628	1403	21674
6L-2S		MI	17045	5190	27329	3782	29654	3071	30539	2539	31027	1749	36710	1611	17650
12-#14	2.11	MA	22916	5484	37336	4014	41375	3244	43508	2656	46285	1771	56082	1621	32053
2L-6S		MI	15542	5484	25536	3949	27220	3200	27591	2629	27088	1726	32275	1130	23363
12-#14	2.11	MA	21801	5484	35625	4012	39193	3260	40856	2670	42703	1781	51308	1493	32001
3L-5S		MI	16068	5484	26421	3954	28421	3208	28999	2619	28952	1716	34562	1215	23959
12-#14	2.11	MA	21012	5484	34248	4030	37443	3255	38732	2663	39955	1791	48188	1365	31819
4E		MI	16619	5484	27357	3959	29627	3195	30472	2609	30983	1726	37010	1272	24867
12-#14	2.11	MA	20305	5484	33040	4028	35885	3271	36824	2677	37244	1781	44911	1303	30605
5L-3S		MI	17231	5484	28421	3944	30979	3203	32110	2619	33039	1716	39305	1400	24953
12-#14	2.11	MA	19631	5484	31900	4026	34336	3267	34935	2671	34754	1791	41809	1219	29696
6L-2S		MI	18084	5484	29733	3949	32651	3190	34140	2609	35721	1706	42836	1528	24953
12-#18	3.75	MA	24379	6228	42134	4448	47353	3586	50723	2869	55719	1705	68447	1220	55147
3L-5S		MI	17148	6228	29871	4384	32682	3523	33986	2792	35539	1607	43528	741	38699
12-#18	3.75	MA	23042	6228	39719	4478	44283	3576	46998	2855	50959	1723	63082	992	52312
4E		MI	18082	6228	31509	4395	34792	3504	36518	2774	39030	1624	47707	845	40343
12-#18	3.75	MA	21843	6228	37598	4472	41549	3601	43650	2877	46262	1705	57405	886	50121
5L-3S		MI	19119	6228	33366	4371	37152	3520	39331	2792	42563	1607	51636	1065	42625
12-#18	3.75	MA	20700	6228	35595	4466	38830	3592	40334	2863	41948	1723	52064	735	46445
6L-2S		MI	20561	6228	35648	4382	40062	3501	42819	2774	47169	1589	57662	1292	42858
14-#11	1.71	MA	22073	5301	35388	3913	38962	3172	40602	2614	42420	1793	51034	1666	26208
2L-7S		MI	15306	5301	24651	3864	26219	3139	26348	2580	25545	1759	30051	1224	19539
14-#11	1.71	MA	21285	5301	34192	3912	37437	3183	38748	2624	39909	1800	47674	1577	26203
3L-6S		MI	15668	5301	25312	3853	27026	3130	27373	2586	26831	1753	31739	1312	19827
14-#11	1.71	MA	20730	5301	33231	3924	36215	3181	37265	2620	37983	1807	45475	1489	26148
4L-5S		MI	16039	5301	25931	3856	27865	3134	28359	2579	28145	1746	33357	1371	20305
14-#11	1.71	MA	20232	5301	32388	3923	35128	3192	35934	2630	36085	1801	43173	1445	25911
5L-4S		MI	16427	5301	26585	3859	28708	3125	29391	2571	29577	1753	35087	1411	20483
14-#11	1.71	MA	19757	5301	31593	3922	34048	3189	34616	2626	34340	1808	40988	1387	25194
6L-3S		MI	16859	5301	27329	3848	29654	3130	30539	2578	31027	1746	36710	1500	20491
14-#11	1.71	MA	19294	5301	30741	3935	33010	3201	33345	2636	32633	1815	38714	1299	24740
7L-2S		MI	17462	5301	28248	3851	30826	3121	31964	2570	32918	1739	39207	1589	20470
14-#14	2.46	MA	23690	5643	39047	4114	43556	3316	46160	2701	49867	1761	60855	1595	37252
2L-7S		MI	15632	5643	25902	4064	27739	3285	28158	2664	27945	1720	33659	995	26056
14-#14	2.46	MA	22583	5643	37336	4112	41375	3332	43508	2715	46285	1770	56082	1467	37171
3L-6S		MI	16142	5643	26848	4049	28893	3272	29621	2674	29769	1710	35806	1094	27214
14-#14	2.46	MA	21801	5643	35959	4130	39624	3328	41383	2708	43537	1780	52962	1339	36954
4L-5S		MI	16664	5643	27733	4054	30093	3280	31029	2664	31633	1700	38092	1180	27776
14-#14	2.46	MA	21100	5643	34751	4127	38066	3343	39476	2722	40827	1770	49684	1278	35606
5L-4S		MI	17211	5643	28669	4059	31300	3267	32503	2654	33664	1710	40540	1237	28810
14-#14	2.46	MA	20431	5643	33611	4125	36518	3339	37587	2716	38336	1780	46582	1193	34738
6L-3S		MI	17818	5643	29733	4044	32651	3275	34140	2664	35721	1700	42836	1364	28927

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis



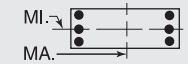
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.46	MA	19779	5643	32390	4143	35030	3355	35764	2729	35899	1790	43352	1067	33190
7L-2S		MI	18665	5643	31045	4049	34324	3263	36170	2654	38402	1691	46366	1492	28959
14-#18	4.38	MA	24375	6512	42711	4655	48098	3705	51635	2935	57164	1700	71312	940	60967
4L-5S		MI	18154	6512	32154	4562	35592	3652	37474	2868	40146	1575	49554	669	45074
14-#18	4.38	MA	23191	6512	40590	4649	45363	3730	48287	2956	52467	1683	65636	834	58694
5L-4S		MI	19078	6512	33791	4573	37701	3632	40005	2850	43637	1592	53733	773	46899
14-#18	4.38	MA	22062	6512	38586	4644	42644	3720	44971	2942	48153	1700	60294	683	55077
6L-3S		MI	20104	6512	35648	4548	40062	3649	42819	2868	47169	1575	57662	993	49459
16-#11	1.95	MA	22622	5411	36584	3982	40487	3222	42455	2645	44932	1786	54394	1650	29855
2L-8S		MI	15376	5411	24963	3930	26578	3184	26806	2618	26165	1756	30934	1154	21580
16-#11	1.95	MA	21839	5411	35388	3981	38962	3233	40602	2655	42420	1793	51034	1561	29830
3L-7S		MI	15732	5411	25570	3933	27391	3189	27773	2611	27436	1750	32548	1201	22208
16-#11	1.95	MA	21287	5411	34427	3994	37740	3231	39118	2651	40495	1801	48835	1472	29757
4L-6S		MI	16092	5411	26232	3922	28198	3180	28798	2617	28722	1743	34236	1289	22532
16-#11	1.95	MA	20793	5411	33584	3992	36653	3242	37787	2661	38596	1794	46533	1429	29405
5E		MI	16460	5411	26850	3925	29037	3185	29784	2610	30036	1736	35854	1348	22982
16-#11	1.95	MA	20321	5411	32789	3991	35572	3240	36470	2657	36851	1801	44348	1371	28721
6L-4S		MI	16847	5411	27504	3928	29880	3175	30816	2603	31468	1743	37584	1388	23266
16-#11	1.95	MA	19860	5411	31937	4004	34535	3251	35198	2667	35144	1808	42074	1283	28274
7L-3S		MI	17275	5411	28248	3917	30826	3180	31964	2609	32918	1736	39207	1477	23295
16-#11	1.95	MA	19406	5411	31157	4003	33488	3248	33953	2677	33356	1802	39923	1232	27362
8L-2S		MI	17875	5411	29168	3920	31998	3171	33389	2602	34808	1729	41704	1566	23283
16-#14	2.81	MA	23358	5803	39047	4212	43556	3404	46160	2760	49867	1760	60855	1442	42334
3L-7S		MI	16230	5803	27213	4164	29412	3357	30189	2708	30627	1705	37189	960	29837
16-#14	2.81	MA	22582	5803	37670	4229	41805	3400	44035	2753	47119	1770	57736	1314	42087
4L-6S		MI	16736	5803	28160	4149	30565	3345	31651	2718	32451	1695	39336	1059	30960
16-#14	2.81	MA	21888	5803	36462	4227	40248	3416	42128	2767	44409	1760	54458	1253	40619
5E		MI	17255	5803	29045	4154	31766	3352	33060	2708	34314	1685	41623	1144	31605
16-#14	2.81	MA	21225	5803	35321	4225	38699	3411	40239	2760	41918	1770	51356	1168	39788
6L-4S		MI	17797	5803	29981	4159	32972	3340	34533	2699	36345	1695	44071	1202	32665
16-#14	2.81	MA	20578	5803	34101	4243	37211	3427	38416	2774	39481	1780	48126	1041	38165
7L-3S		MI	18400	5803	31045	4143	34324	3347	36170	2708	38402	1685	46366	1329	32893
16-#14	2.81	MA	19940	5803	32981	4241	35710	3423	36631	2788	36928	1770	45064	970	36692
8L-2S		MI	19242	5803	32357	4148	35997	3335	38201	2699	41083	1675	49897	1457	32947
16-#18	5.00	MA	24524	6796	43582	4827	49177	3859	52924	3036	58672	1660	73867	782	67210
5E		MI	19151	6796	34436	4739	38502	3780	40961	2944	44752	1543	55581	598	51484
16-#18	5.00	MA	23408	6796	41578	4821	46458	3849	49608	3022	54359	1678	68525	631	63733
6L-4S		MI	20065	6796	36073	4750	40611	3761	43493	2926	48243	1560	59760	701	53484
18-#11	2.19	MA	22390	5522	36584	4050	40487	3283	42455	2686	44932	1786	54394	1545	33453
3L-8S		MI	15801	5522	25882	3999	27750	3235	28231	2650	28056	1747	33431	1131	24252
18-#11	2.19	MA	21841	5522	35623	4063	39264	3281	40972	2682	43006	1794	52195	1456	33364
4L-7S		MI	16154	5522	26490	4002	28564	3239	29198	2642	29326	1740	35045	1178	24854
18-#11	2.19	MA	21349	5522	34780	4062	38178	3292	39641	2692	41107	1787	49893	1413	32908
5L-6S		MI	16513	5522	27151	3991	29370	3230	30222	2649	30612	1733	36733	1266	25241
18-#11	2.19	MA	20881	5522	33985	4060	37097	3290	38323	2688	39363	1794	47708	1354	32254
6L-5S		MI	16879	5522	27770	3994	30209	3235	31209	2641	31927	1726	38352	1326	25668
18-#11	2.19	MA	20423	5522	33133	4073	36060	3301	37052	2698	37655	1801	45434	1266	31744
7L-4S		MI	17263	5522	28424	3997	31052	3225	32241	2634	33358	1733	40081	1366	26045
18-#11	2.19	MA	19972	5522	32353	4072	35013	3298	35807	2708	35867	1795	43283	1216	30861
8L-3S		MI	17690	5522	29168	3986	31998	3230	33389	2640	34808	1726	41704	1454	26086
18-#11	2.19	MA	19525	5522	31526	4085	33990	3310	34519	2704	34177	1802	41167	1160	30048
9L-2S		MI	18287	5522	30087	3989	33170	3221	34814	2633	36699	1719	44202	1543	26091
18-#14	3.16	MA	23358	5962	39381	4329	43987	3472	46687	2798	50701	1759	62509	1288	47169
4L-7S		MI	16824	5962	28525	4264	31084	3429	32219	2753	33308	1689	40720	925	33629

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

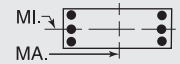


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	3.16	MA	22669	5962	38173	4327	42429	3488	44779	2812	47991	1749	59231	1227	45644
5L-6S		MI	17327	5962	29472	4249	32238	3417	33682	2763	35132	1679	42867	1024	34704
18-#14	3.16	MA	22011	5962	37032	4325	40880	3484	42890	2805	45500	1759	56129	1142	44736
6L-5S		MI	17841	5962	30357	4253	33439	3424	35090	2753	36996	1669	45153	1109	35443
18-#14	3.16	MA	21370	5962	35812	4342	39393	3499	41068	2819	43063	1769	52899	1016	43150
7L-4S		MI	18380	5962	31293	4258	34645	3412	36563	2743	39027	1679	47601	1166	36444
18-#14	3.16	MA	20738	5962	34692	4340	37892	3495	39283	2832	40510	1759	49837	944	41623
8L-3S		MI	18978	5962	32357	4243	35997	3420	38201	2753	41083	1669	49897	1294	36852
18-#14	3.16	MA	20111	5962	33507	4358	36425	3511	37436	2826	38097	1769	46832	863	40061
9L-2S		MI	19815	5962	33669	4248	37669	3407	40231	2743	43764	1659	53427	1422	36928
18-#18	5.63	MA	24741	7079	44570	4998	50272	3977	54244	3102	60564	1656	76756	579	72411
6L-5S		MI	20138	7079	36719	4916	41412	3909	44449	3020	49359	1510	61608	526	57924
20-#11	2.44	MA	22391	5633	36819	4132	40789	3331	42826	2713	45517	1787	55555	1440	36968
4L-8S		MI	16224	5633	26801	4068	28922	3285	29656	2681	29947	1737	35928	1108	26930
20-#11	2.44	MA	21902	5633	35976	4131	39703	3342	41495	2723	43619	1780	53253	1396	36420
5L-7S		MI	16575	5633	27409	4071	29736	3289	30623	2673	31217	1730	37543	1156	27508
20-#11	2.44	MA	21437	5633	35181	4130	38622	3340	40177	2719	41874	1787	51068	1338	35791
6E		MI	16931	5633	28071	4060	30542	3280	31647	2680	32503	1723	39230	1244	27955
20-#11	2.44	MA	20982	5633	34330	4142	37585	3351	38906	2729	40167	1794	48794	1250	35222
7L-5S		MI	17296	5633	28689	4063	31381	3285	32634	2672	33817	1716	40849	1303	28360
20-#11	2.44	MA	20534	5633	33549	4141	36538	3349	37661	2739	38378	1788	46643	1200	34365
8L-4S		MI	17677	5633	29343	4066	32224	3276	33666	2665	35249	1723	42578	1343	28819
20-#11	2.44	MA	20088	5633	32722	4154	35515	3360	36373	2735	36688	1795	44527	1143	33515
9L-3S		MI	18102	5633	30087	4055	33170	3280	34814	2671	36699	1716	44202	1432	28874
20-#11	2.44	MA	19590	5633	31945	4153	34481	3357	35136	2745	35011	1802	42475	1080	32566
10L-2S		MI	18696	5633	31007	4058	34342	3271	36239	2664	38589	1709	46699	1520	28894
20-#14	3.52	MA	23443	6122	39884	4427	44610	3560	47431	2857	51573	1739	64005	1202	50678
5L-7S		MI	17414	6122	29837	4363	32757	3502	34249	2798	35989	1674	44250	889	37430
20-#14	3.52	MA	22791	6122	38743	4424	43061	3556	45542	2850	49083	1749	60903	1117	49678
6E		MI	17913	6122	30784	4348	33911	3489	35712	2808	37813	1664	46397	988	38460
20-#14	3.52	MA	22155	6122	37523	4442	41574	3572	43719	2864	46645	1759	57673	990	48144
7L-5S		MI	18423	6122	31669	4353	35111	3497	37120	2798	39677	1654	48684	1074	39290
20-#14	3.52	MA	21528	6122	36403	4440	40073	3568	41935	2877	44092	1749	54611	919	46564
8L-4S		MI	18958	6122	32605	4358	36318	3484	38594	2788	41708	1664	51132	1131	40237
20-#14	3.52	MA	20906	6122	35218	4458	38606	3583	40088	2871	41679	1759	51606	837	44993
9L-3S		MI	19553	6122	33669	4343	37669	3492	40231	2798	43764	1654	53427	1258	40806
22-#11	2.68	MA	22452	5743	37172	4200	41227	3392	43348	2754	46130	1773	56613	1380	39937
5L-8S		MI	16644	5743	27721	4138	30094	3335	31081	2712	31837	1727	38425	1086	29612
22-#11	2.68	MA	21989	5743	36377	4199	40147	3390	42031	2750	44385	1780	54428	1322	39333
6L-7S		MI	16993	5743	28328	4141	30908	3339	32048	2704	33107	1720	40040	1133	30169
22-#11	2.68	MA	21538	5743	35526	4211	39110	3401	40759	2760	42678	1787	52154	1234	38706
7L-6S		MI	17347	5743	28990	4130	31714	3330	33072	2711	34393	1713	41727	1221	30671
22-#11	2.68	MA	21092	5743	34745	4210	38063	3399	39514	2770	40889	1781	50003	1183	37875
8L-5S		MI	17709	5743	29608	4132	32553	3335	34059	2703	35708	1706	43346	1280	31058
22-#11	2.68	MA	20647	5743	33918	4223	37040	3410	38227	2766	39200	1788	47887	1127	36988
9L-4S		MI	18089	5743	30263	4135	33397	3326	35091	2696	37139	1713	45075	1320	31590
22-#11	2.68	MA	20153	5743	33141	4222	36006	3408	36989	2776	37522	1795	45835	1064	36062
10L-3S		MI	18511	5743	31007	4124	34342	3330	36239	2702	38589	1706	46699	1409	31658
22-#14	3.87	MA	23566	6282	40454	4524	45243	3628	48194	2895	52665	1738	65677	1092	54632
6L-7S		MI	17999	6282	31149	4463	34429	3574	36280	2843	38671	1658	47781	854	41239
22-#14	3.87	MA	22935	6282	39234	4542	43755	3644	46371	2909	50227	1748	62447	965	53147
7L-6S		MI	18495	6282	32096	4448	35583	3562	37742	2852	40495	1648	49928	953	42228
22-#14	3.87	MA	22313	6282	38114	4540	42254	3640	44586	2922	47674	1738	59385	893	51514
8L-5S		MI	19002	6282	32981	4453	36784	3569	39151	2843	42358	1638	52214	1038	43143
22-#14	3.87	MA	21691	6282	36929	4558	40787	3655	42740	2916	45262	1748	56379	812	49794
9L-4S		MI	19533	6282	33917	4458	37990	3557	40624	2833	44389	1648	54663	1096	44042
24-#11	2.92	MA	22538	5854	37573	4268	41672	3440	43884	2782	46897	1773	57788	1305	42878
6L-8S		MI	17061	5854	28640	4207	31266	3385	32505	2743	33728	1717	40922	1063	32299

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
24-#11	2.92	MA	22089	5854	36722	4281	40634	3451	42613	2792	45189	1781	55514	1218	42196
7E		MI	17408	5854	29248	4210	32080	3390	33473	2736	34998	1710	42537	1110	32836
24-#11	2.92	MA	21647	5854	35941	4279	39587	3449	41368	2801	43401	1774	53363	1167	41389
8L-6S		MI	17760	5854	29909	4199	32887	3380	34497	2742	36284	1703	44224	1198	33391
24-#11	2.92	MA	21203	5854	35114	4292	38564	3460	40080	2798	41711	1781	51247	1111	40466
9L-5S		MI	18121	5854	30528	4202	33725	3385	35484	2735	37598	1696	45843	1257	33761
24-#11	2.92	MA	20713	5854	34337	4291	37531	3458	38843	2807	40034	1788	49195	1047	39561
10L-4S		MI	18499	5854	31182	4204	34569	3376	36516	2727	39030	1703	47572	1297	34359
24-#14	4.22	MA	23709	6441	40945	4642	45937	3716	49023	2954	53809	1738	67220	939	58157
7E		MI	18581	6441	32461	4563	36102	3646	38310	2887	41352	1643	51311	819	45056
24-#14	4.22	MA	23091	6441	39825	4640	44436	3712	47238	2967	51256	1728	64158	868	56472
8L-6S		MI	19073	6441	33408	4548	37256	3634	39773	2897	43176	1633	53459	918	46006
24-#14	4.22	MA	22471	6441	38640	4657	42969	3728	45391	2961	48844	1738	61153	786	54718
9L-5S		MI	19577	6441	34293	4553	38456	3641	41181	2887	45040	1623	55745	1003	47002

RECTANGULAR TIED COLUMNS 32" x 42"

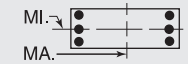
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#18	1.19	MA	22959	5320	36238	3928	39265	3197	40220	2657	40494	1878	47744	1759	20199
2E		MI	17295	5320	27616	3838	29552	3123	29964	2586	29720	1807	34631	1665	15014
6-#14	1.00	MA	22565	5231	35219	3899	38113	3178	38875	2650	38791	1903	45587	1798	17275
2L-3S		MI	16164	5231	25578	3812	27092	3123	27117	2602	25977	1853	29796	1593	12968
6-#14	1.00	MA	21353	5231	33409	3897	35804	3195	36069	2664	34989	1914	40501	1670	17329
3L-2S		MI	17036	5231	26890	3817	28764	3111	29147	2592	28658	1843	33327	1721	12890
6-#18	1.79	MA	24417	5604	39407	4106	43305	3326	45131	2737	47099	1858	56528	1710	29900
2L-3S		MI	16823	5604	27616	4005	29552	3271	29964	2680	29720	1792	34631	1366	22100
6-#18	1.79	MA	22338	5604	36238	4101	39265	3353	40220	2760	40494	1876	47744	1483	29810
3L-2S		MI	18314	5604	29899	4016	32462	3252	33451	2662	34326	1775	40657	1594	22057
8-#14	1.34	MA	23413	5391	37030	3999	40421	3251	41681	2695	42593	1893	50672	1775	22825
2L-4S		MI	16145	5391	25827	3927	27412	3188	27510	2637	26602	1847	31031	1430	17015
8-#14	1.34	MA	22211	5391	35219	3997	38113	3267	38875	2709	38791	1904	45587	1647	22846
3E		MI	16768	5391	26890	3912	28764	3196	29147	2647	28658	1837	33327	1557	17003
8-#14	1.34	MA	21362	5391	33764	4015	36262	3263	36630	2704	35875	1914	42259	1519	22750
4L-2S		MI	17634	5391	28202	3917	30437	3183	31177	2637	31340	1827	36857	1685	16946
8-#18	2.38	MA	25852	5887	42576	4283	47345	3454	50043	2817	53705	1838	65312	1662	39552
2L-4S		MI	16781	5887	28041	4206	30102	3383	30638	2738	30794	1778	36729	1074	27637
8-#18	2.38	MA	23799	5887	39407	4278	43305	3481	45131	2839	47099	1855	56528	1434	39350
3E		MI	17844	5887	29899	4182	32462	3399	33451	2756	34326	1760	40657	1294	28998
8-#18	2.38	MA	22344	5887	36854	4309	40058	3472	41191	2827	42032	1873	50794	1207	37444
4L-2S		MI	19319	5887	32181	4193	35372	3380	36939	2738	38933	1742	46684	1522	29049
10-#11	1.16	MA	23000	5306	36055	3958	39253	3223	40289	2680	40719	1906	48290	1800	19949
2L-5S		MI	15912	5306	25183	3886	26651	3173	26608	2634	25348	1856	29449	1504	14931
10-#11	1.16	MA	22156	5306	34789	3958	37640	3221	38329	2691	38062	1913	44713	1711	19977
3L-4S		MI	16306	5306	25837	3889	27495	3163	27641	2627	26780	1863	31179	1544	14932
10-#11	1.16	MA	21560	5306	33774	3971	36348	3232	36761	2687	36028	1921	42370	1623	19966
4L-3S		MI	16742	5306	26581	3878	28440	3168	28788	2633	28230	1856	32802	1633	14897
10-#11	1.16	MA	21027	5306	32884	3970	35201	3230	35356	2697	34022	1915	39924	1579	19877
5L-2S		MI	17352	5306	27500	3881	29612	3159	30213	2626	30121	1849	35299	1722	14854
10-#14	1.67	MA	24252	5550	38841	4098	42730	3323	44488	2740	46395	1883	55757	1751	28358
2L-5S		MI	16192	5550	26202	4022	27879	3273	28066	2692	27252	1822	32114	1337	20330
10-#14	1.67	MA	23060	5550	37030	4097	40421	3339	41681	2754	42593	1894	50672	1623	28341
3L-4S		MI	16748	5550	27139	4027	29085	3261	29540	2682	29283	1831	34562	1395	20983
10-#14	1.67	MA	22218	5550	35575	4115	38571	3336	39436	2749	39677	1904	47344	1495	28199
4L-3S		MI	17365	5550	28202	4012	30437	3268	31177	2692	31340	1822	36857	1522	21015

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#14	1.67	MA	21463	5550	34299	4113	36925	3352	37421	2763	36803	1894	43860	1433	27204
5L-2S		MI	18225	5550	29514	4017	32110	3256	33208	2682	34021	1812	40388	1650	20979
10-#18	2.98	MA	27267	6171	45745	4460	51385	3583	54954	2896	60311	1817	74096	1613	49167
2L-5S		MI	16854	6171	28687	4373	30903	3531	31594	2832	31909	1728	38576	899	32531
10-#18	2.98	MA	25238	6171	42576	4456	47345	3610	50043	2919	53705	1835	65312	1386	48874
3L-4S		MI	17801	6171	30324	4384	33012	3512	34125	2814	35401	1746	42755	1002	34106
10-#18	2.98	MA	23803	6171	40023	4486	44098	3601	46103	2907	48638	1853	59578	1158	46536
4L-3S		MI	18853	6171	32181	4359	35372	3528	36939	2832	38933	1728	46684	1222	35869
10-#18	2.98	MA	22516	6171	37781	4482	41208	3628	42563	2930	43639	1835	53534	1051	43953
5L-2S		MI	20312	6171	34463	4370	38282	3509	40426	2814	43539	1710	52711	1450	36005
12-#11	1.39	MA	23593	5416	37320	4028	40866	3273	42250	2711	43375	1899	51866	1785	23820
2L-6S		MI	15966	5416	25484	3952	26984	3218	27047	2673	25925	1853	30328	1422	17251
12-#11	1.39	MA	22754	5416	36055	4027	39253	3271	40289	2722	40719	1906	48290	1696	23834
3L-5S		MI	16340	5416	26102	3955	27823	3223	28033	2665	27239	1846	31947	1481	17713
12-#11	1.39	MA	22162	5416	35039	4040	37961	3283	38722	2718	38684	1914	45946	1608	23797
4E		MI	16731	5416	26756	3958	28667	3214	29066	2658	28670	1853	33676	1521	17739
12-#11	1.39	MA	21632	5416	34150	4039	36814	3280	37317	2729	36679	1908	43501	1564	23683
5L-3S		MI	17165	5416	27500	3947	29612	3218	30213	2664	30121	1846	35299	1610	17719
12-#11	1.39	MA	21127	5416	33310	4038	35673	3292	35925	2725	34837	1916	41174	1505	22962
6L-2S		MI	17772	5416	28420	3950	30785	3209	31638	2657	32011	1839	37797	1699	17685
12-#14	2.01	MA	25084	5710	40651	4198	45038	3395	47294	2785	50197	1873	60842	1727	33876
2L-6S		MI	16265	5710	26629	4117	28351	3338	28689	2746	28070	1816	33358	1217	23525
12-#14	2.01	MA	23900	5710	38841	4196	42730	3412	44488	2799	46395	1884	55757	1599	33823
3L-5S		MI	16793	5710	27514	4122	29551	3345	30097	2736	29934	1806	35644	1302	24130
12-#14	2.01	MA	23065	5710	37386	4215	40879	3408	42242	2793	43479	1894	52429	1471	33642
4E		MI	17345	5710	28451	4127	30758	3333	31570	2726	31964	1816	38093	1359	24939
12-#14	2.01	MA	22317	5710	36110	4213	39234	3424	40227	2808	40604	1884	48945	1409	32483
5L-3S		MI	17958	5710	29514	4111	32110	3340	33208	2736	34021	1806	40388	1487	25008
12-#14	2.01	MA	21604	5710	34905	4211	37598	3421	38232	2802	37963	1895	45638	1325	31480
6L-2S		MI	18813	5710	30826	4116	33782	3328	35238	2726	36702	1796	43918	1615	24997
12-#18	3.57	MA	26658	6455	45745	4633	51385	3738	54954	2999	60311	1815	74096	1337	58387
3L-5S		MI	17872	6455	30969	4550	33812	3659	35081	2908	36516	1696	44603	827	39159
12-#18	3.57	MA	25241	6455	43192	4664	48139	3730	51014	2986	55243	1832	68362	1110	55673
4E		MI	18810	6455	32606	4561	35922	3640	37612	2890	40007	1714	48782	931	40621
12-#18	3.57	MA	23971	6455	40950	4659	45248	3756	47475	3009	50244	1815	62318	1002	53236
5L-3S		MI	19850	6455	34463	4537	38282	3657	40426	2908	43539	1696	52711	1151	42722
12-#18	3.57	MA	22760	6455	38833	4654	42374	3748	43970	2997	45652	1832	56614	851	49530
6L-2S		MI	21296	6455	36746	4548	41192	3638	43914	2890	48146	1678	58737	1378	42927
14-#11	1.63	MA	24182	5527	38585	4097	42479	3323	44211	2742	46032	1892	55442	1770	27682
2L-7S		MI	16029	5527	25741	4032	27350	3277	27448	2698	26529	1850	31138	1311	19660
14-#11	1.63	MA	23348	5527	37320	4096	40866	3321	42250	2753	43375	1900	51866	1681	27677
3L-6S		MI	16392	5527	26403	4021	28157	3268	28472	2704	27815	1843	32825	1399	19949
14-#11	1.63	MA	22760	5527	36305	4109	39574	3333	40683	2749	41341	1907	49523	1592	27622
4L-5S		MI	16764	5527	27021	4024	28996	3273	29458	2697	29129	1836	34444	1459	20440
14-#11	1.63	MA	22233	5527	35415	4108	38427	3331	39278	2760	39335	1901	47077	1549	27486
5L-4S		MI	17153	5527	27676	4027	29839	3264	30491	2689	30561	1843	36173	1499	20534
14-#11	1.63	MA	21731	5527	34575	4107	37286	3342	37886	2756	37493	1909	44750	1490	26688
6L-3S		MI	17585	5527	28420	4016	30785	3268	31638	2695	32011	1836	37797	1587	20532
14-#11	1.63	MA	21241	5527	33677	4120	36191	3340	36544	2767	35690	1917	42329	1403	26190
7L-2S		MI	18189	5527	29339	4019	31957	3259	33063	2688	33902	1829	40294	1676	20507
14-#14	2.34	MA	25908	5870	42462	4298	47347	3468	50100	2830	53998	1864	65928	1704	39378
2L-7S		MI	16355	5869	26995	4232	28870	3423	29256	2781	28927	1810	34741	1082	26312
14-#14	2.34	MA	24733	5870	40651	4296	45038	3484	47294	2844	50197	1874	60842	1576	39297
3L-6S		MI	16866	5870	27941	4217	30024	3410	30719	2791	30751	1800	36889	1181	27375
14-#14	2.34	MA	23905	5869	39196	4314	43188	3480	45048	2838	47281	1884	57515	1448	39081
4L-5S		MI	17389	5870	28826	4221	31224	3418	32127	2781	32615	1790	39175	1267	27945
14-#14	2.34	MA	23164	5869	37920	4313	41542	3496	43033	2853	44406	1874	54030	1385	37779
5L-4S		MI	17937	5870	29762	4226	32430	3405	33601	2771	34646	1800	41623	1324	28887

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

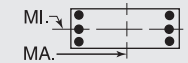
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.34	MA	22456	5869	36716	4311	39907	3493	41038	2847	41765	1885	50724	1301	36821
6L-3S		MI	18546	5869	30826	4211	33782	3413	35238	2781	36702	1790	43918	1451	28986
14-#14	2.34	MA	21766	5869	35427	4329	38336	3509	39113	2861	39180	1895	47282	1175	35299
7L-2S		MI	19395	5869	32138	4216	35455	3400	37268	2771	39383	1781	47449	1579	29005
14-#18	4.17	MA	26662	6738	46360	4841	52179	3858	55925	3066	61849	1812	77146	1061	64848
4L-5S		MI	18880	6738	33251	4727	36722	3788	38569	2984	41122	1664	50630	756	45526
14-#18	4.17	MA	25408	6738	44119	4836	49288	3885	52386	3089	56850	1794	71102	954	62540
5L-4S		MI	19808	6738	34889	4738	38832	3769	41100	2966	44613	1681	54809	859	47172
14-#18	4.17	MA	24212	6738	42002	4832	46414	3876	48881	3077	52258	1812	65397	803	58688
6L-3S		MI	20837	6738	36746	4714	41192	3785	43914	2984	48146	1664	58737	1079	49563
14-#18	4.17	MA	23045	6738	39736	4862	43653	3903	45498	3099	47763	1830	59456	578	54970
7L-2S		MI	22270	6738	39028	4725	44102	3766	47401	2966	52752	1646	64764	1306	49832
16-#11	1.86	MA	24768	5638	39850	4166	44092	3373	46172	2774	48688	1885	59018	1755	31539
2L-8S		MI	16100	5638	26053	4098	27709	3323	27905	2736	27150	1847	32020	1241	21770
16-#11	1.86	MA	23937	5638	38585	4165	42479	3371	44211	2784	46032	1893	55442	1666	31515
3L-7S		MI	16456	5638	26661	4101	28523	3328	28873	2729	28420	1840	33635	1288	22377
16-#11	1.86	MA	23353	5638	37570	4178	41187	3383	42644	2780	43997	1900	53099	1577	31442
4L-6S		MI	16816	5638	27322	4090	29329	3318	29897	2735	29706	1833	35322	1377	22654
16-#11	1.86	MA	22830	5638	36680	4177	40040	3381	41239	2791	41992	1894	50653	1534	31183
5E		MI	17186	5638	27941	4093	30168	3323	30883	2728	31020	1826	36941	1436	23116
16-#11	1.86	MA	22331	5638	35840	4176	38899	3392	39847	2787	40150	1902	48327	1475	30420
6L-4S		MI	17573	5638	28595	4096	31011	3314	31916	2720	32452	1833	38670	1476	23321
16-#11	1.86	MA	21844	5638	34942	4189	37804	3390	38505	2798	38347	1910	45905	1388	29939
7L-3S		MI	18003	5638	29339	4085	31957	3318	33063	2727	33902	1826	40294	1564	23339
16-#11	1.86	MA	21364	5638	34118	4189	36699	3402	37191	2808	36459	1904	43620	1336	29046
8L-2S		MI	18604	5638	30258	4088	33129	3309	34488	2719	35792	1819	42791	1653	23322
16-#14	2.68	MA	25559	6029	42462	4396	47347	3556	50100	2889	53998	1864	65928	1552	44764
3L-7S		MI	16954	6029	28307	4331	30542	3495	31287	2826	31608	1795	38272	1047	30090
16-#14	2.68	MA	24738	6029	41007	4414	45496	3553	47855	2883	51083	1874	62600	1424	44517
4L-6S		MI	17461	6029	29253	4316	31696	3482	32749	2836	33432	1785	40419	1146	31232
16-#14	2.68	MA	24002	6029	39731	4413	43851	3569	45840	2897	48208	1864	59115	1362	43088
5E		MI	17981	6029	30138	4321	32897	3490	34157	2826	35296	1775	42705	1231	31773
16-#14	2.68	MA	23301	6029	38527	4411	42215	3565	43845	2892	45567	1875	55809	1277	42169
6L-4S		MI	18525	6029	31074	4326	34103	3478	35631	2816	37327	1785	45154	1289	32829
16-#14	2.68	MA	22617	6029	37238	4429	40644	3581	41920	2906	42982	1885	52367	1151	40570
7L-3S		MI	19130	6029	32138	4311	35455	3485	37268	2826	39383	1775	47449	1416	32956
16-#14	2.68	MA	21942	6029	36056	4427	39059	3578	40035	2920	40274	1875	49111	1078	39134
8L-2S		MI	19974	6029	33450	4316	37128	3473	39299	2816	42065	1765	50979	1544	33000
16-#18	4.76	MA	26828	7022	47288	5014	53329	4014	57298	3169	63456	1774	79886	905	71743
5E		MI	19878	7022	35534	4905	39632	3917	42056	3060	45729	1632	56656	684	51928
16-#18	4.76	MA	25647	7022	45171	5009	50454	4005	53793	3156	58863	1792	74181	754	67870
6L-4S		MI	20796	7022	37171	4916	41741	3897	44587	3042	49220	1649	60835	787	53753
16-#18	4.76	MA	24494	7022	42905	5040	47693	4032	50410	3179	54369	1809	68240	529	64058
7L-3S		MI	21816	7022	39028	4891	44102	3914	47401	3060	52752	1632	64764	1007	56395
18-#11	2.09	MA	24523	5748	39850	4234	44092	3421	46172	2815	48688	1886	59018	1651	35349
3L-8S		MI	16525	5748	26973	4168	28881	3373	29330	2767	29040	1837	34517	1219	24440
18-#11	2.09	MA	23942	5748	38835	4247	42800	3433	44605	2812	46654	1894	56675	1562	35259
4L-7S		MI	16879	5748	27580	4171	29695	3378	30298	2760	30310	1830	36132	1266	25058
18-#11	2.09	MA	23422	5748	37945	4246	41653	3431	43199	2822	44648	1888	54230	1518	34890
5L-6S		MI	17238	5748	28242	4160	30501	3369	31322	2766	31596	1823	37819	1354	25364
18-#11	2.09	MA	22927	5748	37106	4246	40512	3443	41808	2819	42806	1895	51903	1460	34159
6L-5S		MI	17606	5748	28860	4162	31340	3373	32308	2759	32911	1816	39438	1413	25801
18-#11	2.09	MA	22443	5748	36207	4259	39417	3440	40466	2829	41003	1903	49482	1372	33693
7L-4S		MI	17990	5748	29514	4165	32183	3364	33341	2751	34342	1823	41167	1453	26103

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

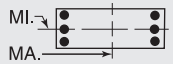


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.09	MA	21966	5748	35383	4258	38312	3452	39152	2839	39115	1897	47196	1321	32750
8L-3S		MI	18418	5748	30258	4154	33129	3369	34488	2758	35792	1816	42791	1542	26135
18-#11	2.09	MA	21476	5748	34511	4271	37232	3450	37792	2836	37331	1905	44942	1265	31981
9L-2S		MI	19016	5748	31178	4157	34301	3359	35913	2750	37683	1809	45288	1630	26132
18-#14	3.01	MA	25563	6189	42818	4514	47805	3625	50661	2928	54885	1864	67685	1400	49950
4L-7S		MI	17549	6189	29619	4431	32215	3567	33317	2870	34290	1779	41802	1012	33879
18-#14	3.01	MA	24834	6189	41542	4512	46159	3641	48646	2942	52010	1855	64201	1338	48408
5L-6S		MI	18052	6189	30565	4416	33369	3555	34780	2880	36114	1769	43950	1111	34984
18-#14	3.01	MA	24138	6189	40337	4511	44524	3637	46651	2937	49369	1865	60894	1254	47524
6L-5S		MI	18569	6189	31450	4421	34569	3562	36188	2870	37977	1759	46236	1196	35610
18-#14	3.01	MA	23460	6189	39049	4529	42953	3654	44726	2951	46784	1875	57452	1127	45851
7L-4S		MI	19109	6189	32386	4426	35776	3550	37661	2860	40008	1769	48684	1253	36644
18-#14	3.01	MA	22791	6189	37866	4527	41368	3650	42841	2965	44076	1865	54196	1055	44361
8L-3S		MI	19709	6189	33450	4411	37128	3557	39299	2870	42065	1759	50979	1381	36919
18-#14	3.01	MA	22118	6189	36615	4545	39819	3666	40891	2960	41517	1876	50993	973	42638
9L-2S		MI	20548	6189	34762	4416	38800	3545	41329	2860	44746	1749	54510	1509	36984
18-#18	5.36	MA	27066	7306	48340	5186	54494	4133	58704	3236	65469	1771	82965	706	77074
6L-5S		MI	20868	7306	37816	5082	42542	4045	45543	3136	50335	1600	62683	612	58361
18-#18	5.36	MA	25927	7306	46074	5217	51734	4160	55321	3259	60975	1789	77023	481	73167
7L-4S		MI	21777	7306	39453	5093	44651	4026	48075	3118	53826	1617	66862	715	60358
20-#11	2.32	MA	24527	5859	40100	4316	44414	3483	46566	2843	49310	1887	60252	1547	39074
4L-8S		MI	16948	5859	27892	4237	30053	3423	30755	2798	30931	1827	37014	1196	27116
20-#11	2.32	MA	24011	5859	39210	4316	43266	3481	45160	2853	47305	1881	57806	1503	38605
5L-7S		MI	17300	5859	28500	4240	30867	3428	31723	2791	32201	1820	38629	1243	27710
20-#11	2.32	MA	23518	5859	38371	4315	42125	3493	43769	2850	45463	1888	55479	1445	37903
6E		MI	17657	5859	29161	4229	31673	3419	32747	2797	33487	1813	40317	1331	28077
20-#11	2.32	MA	23038	5859	37472	4328	41030	3491	42427	2860	43660	1896	53058	1357	37410
7L-5S		MI	18023	5859	29780	4232	32512	3423	33733	2790	34801	1806	41935	1390	28493
20-#11	2.32	MA	22564	5859	36648	4327	39925	3502	41113	2870	41772	1890	50772	1306	36460
8L-4S		MI	18405	5859	30434	4235	33355	3414	34765	2782	36233	1813	43664	1430	28880
20-#11	2.32	MA	22084	5859	35776	4340	38845	3500	39753	2867	39988	1898	48518	1250	35653
9L-3S		MI	18831	5859	31178	4224	34301	3419	35913	2789	37683	1806	45288	1519	28925
20-#11	2.32	MA	21555	5859	34956	4339	37754	3512	38447	2877	38217	1906	46332	1187	34608
10L-2S		MI	19426	5859	32097	4226	35473	3410	37338	2781	39574	1799	47785	1608	28938
20-#14	3.35	MA	25659	6348	43352	4612	48468	3713	51452	2987	55812	1845	69286	1315	53738
5L-7S		MI	18139	6348	30930	4531	33888	3640	35347	2915	36971	1764	45333	976	37678
20-#14	3.35	MA	24969	6348	42148	4610	46832	3710	49457	2982	53171	1855	65979	1230	52850
6E		MI	18640	6348	31877	4516	35041	3627	36810	2925	38795	1754	47480	1075	38737
20-#14	3.35	MA	24296	6348	40859	4629	45261	3726	47532	2996	50585	1865	62538	1104	51142
7L-5S		MI	19152	6348	32762	4521	36242	3635	38218	2915	40659	1744	49766	1161	39456
20-#14	3.35	MA	23632	6348	39677	4627	43676	3722	45647	3010	47878	1856	59282	1031	49597
8L-4S		MI	19689	6348	33698	4526	37448	3622	39692	2905	42690	1754	52215	1218	40435
20-#14	3.35	MA	22962	6348	38426	4645	42127	3739	43697	3005	45319	1866	56078	950	47918
9L-3S		MI	20285	6348	34762	4510	38800	3630	41329	2915	44746	1744	54510	1345	40876
20-#18	5.95	MA	27346	7590	49243	5394	55774	4289	60232	3339	67580	1768	85807	432	82295
7L-5S		MI	21849	7590	40099	5259	45452	4174	49031	3212	54942	1567	68710	540	64821
22-#11	2.55	MA	24596	5970	40476	4385	44879	3531	47121	2884	49961	1874	61382	1488	42328
5L-8S		MI	17368	5970	28811	4306	31225	3473	32180	2829	32821	1817	39512	1173	29797
22-#11	2.55	MA	24106	5970	39636	4384	43738	3543	45730	2881	48119	1881	59055	1430	41651
6L-7S		MI	17719	5970	29419	4309	32039	3478	33147	2822	34092	1810	41126	1220	30369
22-#11	2.55	MA	23629	5970	38737	4397	42643	3541	44388	2891	46317	1889	56634	1342	41098
7L-6S		MI	18074	5970	30081	4298	32845	3469	34172	2828	35378	1803	42814	1308	30794
22-#11	2.55	MA	23158	5970	37913	4396	41538	3552	43073	2902	44428	1883	54349	1291	40176
8L-5S		MI	18437	5970	30699	4301	33684	3473	35158	2821	36692	1796	44432	1367	31190
22-#11	2.55	MA	22679	5970	37041	4409	40458	3550	41714	2898	42644	1891	52095	1235	39331
9L-4S		MI	18818	5970	31353	4304	34528	3464	36190	2814	38124	1803	46161	1407	31654
22-#11	2.55	MA	22155	5970	36221	4408	39367	3562	40408	2909	40874	1899	49909	1171	38309
10L-3S		MI	19241	5970	32097	4293	35473	3469	37338	2820	39574	1796	47785	1496	31712

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.55	MA	21648	5970	35412	4407	38293	3560	39064	2905	39011	1893	47677	1117	37128
11L-2S		MI	19834	5970	33017	4296	36646	3460	38763	2813	41464	1790	50282	1585	31736
22-#14	3.68	MA	25794	6508	43959	4710	49141	3782	52263	3027	56972	1845	71065	1206	58097
6L-7S		MI	18726	6508	32242	4631	35560	3712	37378	2960	39652	1748	48863	941	41485
22-#14	3.68	MA	25126	6508	42670	4728	47570	3798	50338	3041	54387	1855	67623	1080	56441
7L-6S		MI	19223	6508	33189	4616	36714	3699	38840	2970	41476	1738	51011	1040	42502
22-#14	3.68	MA	24467	6508	41488	4727	45985	3795	48454	3055	51680	1846	64367	1007	54843
8L-5S		MI	19732	6508	34074	4620	37915	3707	40248	2960	43340	1728	53297	1125	43308
22-#14	3.68	MA	23798	6508	40237	4745	44436	3811	46504	3049	49121	1856	61164	926	53204
9L-4S		MI	20265	6508	35010	4625	39121	3695	41722	2950	45371	1738	55745	1183	44238
24-#11	2.79	MA	24691	6080	40901	4453	45351	3593	47691	2912	50776	1875	62632	1415	45403
6L-8S		MI	17787	6080	29731	4375	32397	3523	33605	2861	34712	1807	42009	1150	32483
24-#11	2.79	MA	24216	6080	40003	4466	44256	3591	46348	2922	48973	1882	60211	1327	44793
7E		MI	18135	6080	30339	4378	33211	3528	34572	2853	35982	1800	43623	1197	33034
24-#11	2.79	MA	23748	6080	39178	4465	43151	3603	45034	2933	47085	1876	57925	1276	43896
8L-6S		MI	18488	6080	31000	4367	34018	3519	35597	2860	37268	1793	45311	1285	33514
24-#11	2.79	MA	23270	6080	38306	4478	42071	3600	43675	2929	45301	1884	55671	1220	43014
9L-5S		MI	18850	6080	31618	4370	34857	3524	36583	2852	38583	1787	46929	1345	33893
24-#11	2.79	MA	22751	6080	37486	4477	40980	3612	42369	2940	43530	1892	53485	1156	42015
10L-4S		MI	19229	6080	32273	4373	35700	3514	37615	2845	40014	1793	48659	1385	34426
24-#11	2.79	MA	22246	6080	36677	4477	39906	3610	41025	2936	41668	1886	51254	1102	40810
11L-3S		MI	19650	6080	33017	4362	36646	3519	38763	2851	41464	1787	50282	1473	34495
24-#14	4.02	MA	25950	6667	44481	4828	49878	3871	53145	3086	58189	1845	72708	1056	61748
7E		MI	19309	6667	33554	4730	37233	3784	39408	3004	42334	1733	52394	906	45300
24-#14	4.02	MA	25296	6667	43298	4826	48293	3867	51260	3100	55481	1836	69452	984	60097
8L-6S		MI	19802	6667	34501	4715	38387	3772	40871	3014	44157	1723	54541	1004	46277
24-#14	4.02	MA	24628	6667	42047	4845	46744	3883	49310	3094	52923	1846	66249	902	58476
9L-5S		MI	20308	6667	35386	4720	39587	3779	42279	3004	46021	1713	56827	1090	47167

RECTANGULAR TIED COLUMNS 32" x 44"

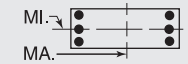
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.14	MA	25092	5546	39446	4112	42760	3348	43766	2785	44013	1981	51879	1861	21279
2E		MI	18021	5546	28714	4004	30683	3260	31058	2702	30696	1896	35706	1751	15054
6-#18	1.70	MA	26641	5830	42793	4290	47026	3477	48953	2865	51019	1962	61217	1815	31520
2L-3S		MI	17548	5830	28714	4171	30683	3407	31058	2796	30696	1881	35706	1452	22166
6-#18	1.70	MA	24440	5830	39446	4286	42760	3505	43766	2889	44013	1979	51879	1588	31430
3L-2S		MI	19041	5830	30996	4182	33592	3388	34546	2778	35303	1864	41733	1680	22105
8-#14	1.28	MA	25569	5617	40275	4182	43971	3402	45298	2823	46152	1992	54955	1877	24040
2L-4S		MI	16870	5617	26920	4095	28543	3326	28608	2754	27584	1937	32114	1517	17070
8-#14	1.28	MA	24299	5617	38364	4181	41535	3399	42337	2838	42141	2003	49557	1749	24061
3E		MI	17493	5617	27983	4080	29895	3334	30245	2764	29640	1927	34409	1644	17043
8-#14	1.28	MA	23402	5617	36831	4200	39586	3416	39971	2833	39068	2014	46022	1621	23965
4L-2S		MI	18360	5617	29295	4084	31568	3321	32275	2754	32321	1917	37940	1772	16982
8-#18	2.27	MA	28166	6114	46139	4467	51292	3606	54139	2945	58026	1943	70554	1770	41712
2L-4S		MI	17505	6114	29139	4372	31232	3520	31732	2854	31771	1867	37804	1160	27920
8-#18	2.27	MA	25992	6114	42793	4463	47026	3633	48953	2969	51019	1961	61217	1543	41510
3E		MI	18571	6114	30996	4348	33592	3536	34546	2872	35303	1849	41733	1380	29075
8-#18	2.27	MA	24455	6114	40100	4495	43602	3626	44797	2958	45644	1978	55114	1315	39791
4L-2S		MI	20049	6114	33279	4359	36502	3517	38033	2854	39909	1832	47759	1608	29103
10-#11	1.11	MA	25129	5532	39242	4142	42734	3374	43825	2809	44168	2004	52410	1901	21002
2L-5S		MI	16636	5532	26273	4054	27782	3311	27708	2752	26332	1946	30536	1591	14982

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.11	MA	24237	5532	37908	4142	41033	3372	41757	2819	41367	2013	48617	1812	21030
3L-4S		MI	17030	5532	26927	4057	28626	3302	28740	2744	27764	1953	32265	1631	14971
10-#11	1.11	MA	23609	5532	36838	4155	39673	3384	40106	2816	39223	2021	46130	1724	21019
4L-3S		MI	17468	5532	27671	4046	29571	3307	29888	2751	29214	1946	33889	1720	14931
10-#11	1.11	MA	23046	5532	35902	4155	38464	3383	38626	2827	37111	2016	43541	1679	20930
5L-2S		MI	18078	5532	28591	4049	30743	3297	31313	2743	31105	1939	36386	1809	14886
10-#14	1.60	MA	26461	5777	42185	4282	46407	3474	48259	2868	50163	1982	60352	1855	29876
2L-5S		MI	16916	5777	27296	4189	29009	3411	29164	2809	28234	1911	33196	1424	20498
10-#14	1.60	MA	25199	5777	40275	4281	43971	3471	45298	2883	46152	1993	54955	1727	29860
3L-4S		MI	17473	5777	28232	4194	30216	3398	30638	2799	30265	1921	35645	1482	21045
10-#14	1.60	MA	24310	5777	38741	4300	42021	3488	42932	2878	43079	2004	51419	1599	29718
4L-3S		MI	18091	5777	29295	4179	31568	3406	32275	2809	32321	1911	37940	1609	21061
10-#14	1.60	MA	23514	5777	37398	4299	40288	3485	40809	2893	40051	1996	47727	1536	28801
5L-2S		MI	18953	5777	30607	4184	33240	3394	34306	2799	35002	1902	41470	1737	21019
10-#18	2.84	MA	29670	6397	49485	4644	55558	3734	59325	3025	65033	1924	79891	1725	51867
2L-5S		MI	17576	6397	29784	4539	32033	3667	32688	2948	32886	1817	39651	985	32775
10-#18	2.84	MA	27521	6397	46139	4640	51292	3762	54139	3049	58026	1942	70554	1497	51574
3L-4S		MI	18527	6397	31422	4550	34142	3648	35220	2930	36377	1835	43830	1089	34383
10-#18	2.84	MA	26004	6397	43446	4672	47868	3754	49984	3038	52651	1960	64451	1270	49403
4L-3S		MI	19581	6397	33279	4525	36502	3665	38033	2948	39909	1817	47759	1309	35954
10-#18	2.84	MA	24645	6397	41084	4668	44822	3782	46253	3062	47349	1942	58040	1161	46557
5L-2S		MI	21044	6397	35561	4536	39412	3645	41521	2930	44516	1799	53786	1536	36068
12-#11	1.33	MA	25759	5643	40577	4211	44435	3424	45893	2840	46970	1997	56203	1887	25083
2L-6S		MI	16690	5643	26574	4120	28115	3357	28146	2790	26909	1943	31414	1510	17370
12-#11	1.33	MA	24871	5643	39242	4211	42734	3422	43825	2851	44168	2006	52410	1798	25098
3L-5S		MI	17064	5643	27193	4123	28954	3361	29133	2783	28223	1936	33033	1569	17769
12-#11	1.33	MA	24247	5643	38173	4224	41374	3435	42174	2848	42025	2014	49923	1710	25060
4E		MI	17456	5643	27847	4126	29798	3352	30165	2776	29655	1943	34762	1609	17782
12-#11	1.33	MA	23688	5643	37236	4224	40165	3433	40694	2858	39913	2009	47333	1665	24946
5L-3S		MI	17891	5643	28591	4115	30743	3357	31313	2782	31105	1936	36386	1697	17756
12-#11	1.33	MA	23156	5643	36352	4223	38964	3445	39229	2855	37973	2017	44865	1607	24258
6L-2S		MI	18499	5643	29510	4118	31916	3347	32738	2775	32995	1929	38883	1786	17719
12-#14	1.92	MA	27343	5936	44096	4382	48842	3547	51220	2913	54175	1972	65749	1833	35698
2L-6S		MI	16989	5936	27722	4284	29482	3476	29786	2863	29051	1906	34441	1304	23681
12-#14	1.92	MA	26091	5936	42185	4381	46407	3543	48259	2928	50163	1983	60352	1705	35646
3L-5S		MI	17518	5936	28608	4289	30682	3483	31195	2853	30915	1896	36727	1389	24296
12-#14	1.92	MA	25210	5936	40652	4399	44457	3560	45893	2923	47091	1994	56816	1577	35464
4E		MI	18071	5936	29544	4294	31888	3471	32668	2843	32946	1906	39175	1446	25008
12-#14	1.92	MA	24421	5936	39308	4398	42724	3557	43770	2938	44062	1986	53124	1514	34374
5L-3S		MI	18685	5936	30607	4279	33240	3478	34306	2853	35002	1896	41470	1574	25061
12-#14	1.92	MA	23668	5936	38040	4397	41001	3574	41669	2933	41280	1997	49613	1429	33273
6L-2S		MI	19541	5936	31919	4284	34913	3466	36336	2843	37684	1886	45001	1702	25041
12-#18	3.41	MA	29030	6681	49485	4818	55558	3891	59325	3129	65033	1923	79891	1452	61627
3L-5S		MI	18597	6681	32067	4716	34943	3796	36176	3024	37492	1785	45678	913	39404
12-#18	3.41	MA	27532	6681	46793	4849	52134	3883	55170	3118	59657	1941	73789	1225	59061
4E		MI	19537	6681	33704	4727	37052	3777	38707	3006	40984	1803	49857	1017	40893
12-#18	3.41	MA	26191	6681	44430	4845	49088	3911	51440	3142	54356	1923	67377	1116	56368
5L-3S		MI	20580	6681	35561	4703	39412	3793	41521	3024	44516	1785	53786	1237	42815
12-#18	3.41	MA	24912	6681	42200	4842	46059	3903	47745	3130	49485	1941	61310	965	52649
6L-2S		MI	22030	6681	37843	4714	42322	3774	45008	3006	49122	1767	59813	1464	42996
14-#11	1.55	MA	26384	5753	41911	4281	46136	3474	47961	2871	49772	1991	59996	1873	29156
2L-7S		MI	16753	5753	26832	4201	28481	3416	28547	2815	27513	1940	32224	1399	19777
14-#11	1.55	MA	25501	5753	40577	4280	44435	3473	45893	2882	46970	1999	56203	1784	29151
3L-6S		MI	17117	5753	27494	4190	29288	3407	29571	2822	28799	1933	33912	1487	20068
14-#11	1.55	MA	24881	5753	39507	4293	43075	3485	44242	2879	44827	2007	53715	1696	29096
4L-5S		MI	17489	5753	28112	4192	30127	3411	30558	2814	30114	1926	35530	1546	20548
14-#11	1.55	MA	24325	5753	38570	4293	41866	3483	42762	2889	42715	2002	51126	1651	28960
5L-4S		MI	17879	5753	28766	4195	30970	3402	31590	2807	31545	1933	37259	1586	20582

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

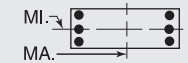
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.55	MA	23796	5753	37687	4292	40665	3495	41297	2886	40775	2010	48657	1593	28188
6L-3S		MI	18312	5753	29510	4184	31916	3407	32738	2813	32995	1926	38883	1675	20572
14-#11	1.55	MA	23280	5753	36741	4306	39513	3493	39884	2897	38877	2018	46089	1505	27645
7L-2S		MI	18917	5753	30430	4187	33088	3398	34163	2806	34886	1920	41380	1763	20544
14-#14	2.24	MA	28219	6096	46006	4482	51278	3619	54181	2958	58186	1962	71146	1811	41504
2L-7S		MI	17077	6096	28088	4399	30000	3560	30354	2898	29909	1900	35824	1169	26562
14-#14	2.24	MA	26975	6096	44096	4480	48842	3616	51220	2973	54175	1973	65749	1683	41423
3L-6S		MI	17590	6096	29034	4384	31154	3548	31817	2908	31733	1890	37971	1268	27531
14-#14	2.24	MA	26101	6096	42562	4499	46892	3633	48854	2968	51102	1984	62213	1555	41207
4L-5S		MI	18115	6096	29919	4389	32355	3555	33225	2898	33596	1880	40257	1354	28109
14-#14	2.24	MA	25318	6096	41218	4498	45159	3630	46731	2983	48073	1976	58522	1492	39964
5L-4S		MI	18664	6096	30856	4394	33561	3543	34699	2888	35627	1890	42706	1411	28961
14-#14	2.24	MA	24572	6096	39950	4497	43437	3646	44630	2978	45291	1987	55010	1407	38911
6L-3S		MI	19274	6096	31919	4379	34913	3551	36336	2898	37684	1880	45001	1538	29044
14-#14	2.24	MA	23844	6096	38593	4515	41783	3643	42603	2993	42569	1998	51357	1281	37428
7L-2S		MI	20125	6096	33231	4384	36586	3538	38366	2888	40365	1870	48531	1666	29051
14-#18	3.98	MA	29042	6965	50139	5027	56401	4012	60356	3197	66664	1922	83126	1180	68758
4L-5S		MI	19606	6965	34349	4893	37852	3924	39663	3100	42099	1753	51705	842	45970
14-#18	3.98	MA	27717	6965	47776	5023	53354	4039	56626	3221	61363	1905	76715	1070	66201
5L-4S		MI	20537	6965	35986	4904	39962	3905	42195	3082	45590	1771	55884	945	47440
14-#18	3.98	MA	26454	6965	45546	5019	50325	4032	52932	3210	56491	1922	70647	920	62334
6L-3S		MI	21570	6965	37843	4880	42322	3922	45008	3100	49122	1753	59813	1165	49663
14-#18	3.98	MA	25221	6965	43159	5051	47416	4060	49367	3234	51724	1940	64329	695	58586
7L-2S		MI	23006	6965	40126	4891	45232	3903	48496	3082	53729	1735	65839	1393	49905
16-#11	1.77	MA	27005	5864	43245	4350	47838	3524	50029	2902	52574	1984	63788	1859	33224
2L-8S		MI	16823	5864	27144	4267	28840	3461	29005	2854	28134	1937	33107	1329	21954
16-#11	1.77	MA	26126	5864	41911	4349	46136	3523	47961	2913	49772	1992	59996	1770	33200
3L-7S		MI	17180	5864	27751	4270	29654	3466	29972	2846	29404	1930	34721	1376	22495
16-#11	1.77	MA	25510	5864	40841	4363	44776	3535	46310	2910	47628	2000	57508	1682	33127
4L-6S		MI	17541	5864	28413	4259	30460	3457	30996	2853	30690	1923	36409	1464	22772
16-#11	1.77	MA	24958	5864	39905	4362	43568	3533	44830	2921	45516	1995	54919	1637	32972
5E		MI	17912	5864	29031	4262	31299	3461	31983	2845	32004	1917	38027	1523	23247
16-#11	1.77	MA	24432	5864	39021	4362	42367	3545	43365	2918	43577	2003	52450	1579	32127
6L-4S		MI	18299	5864	29686	4265	32142	3452	33015	2838	33436	1923	39756	1563	23373
16-#11	1.77	MA	23919	5864	38075	4375	41214	3543	41952	2928	41679	2011	49882	1491	31602
7L-3S		MI	18730	5864	30430	4254	33088	3457	34163	2844	34886	1917	41380	1652	23381
16-#11	1.77	MA	23413	5864	37208	4374	40050	3555	40568	2939	39691	2006	47462	1440	30742
8L-2S		MI	19332	5864	31349	4256	34260	3448	35587	2837	36777	1910	43877	1741	23361
16-#14	2.56	MA	27852	6255	46006	4580	51278	3688	54181	3018	58186	1963	71146	1661	47194
3L-7S		MI	17677	6255	29400	4499	31673	3633	32385	2943	32590	1885	39354	1134	30337
16-#14	2.56	MA	26984	6255	44473	4599	49328	3705	51814	3013	55113	1975	67610	1533	46947
4L-6S		MI	18186	6255	30346	4484	32827	3620	33847	2953	34414	1875	41502	1233	31389
16-#14	2.56	MA	26208	6255	43129	4598	47595	3702	49692	3028	52085	1966	63919	1470	45568
5E		MI	18708	6255	31231	4489	34027	3628	35255	2943	36278	1865	43788	1318	31936
16-#14	2.56	MA	25469	6255	41861	4597	45872	3719	47591	3023	49303	1977	60408	1385	44558
6L-4S		MI	19253	6255	32168	4494	35234	3615	36729	2933	38309	1875	46236	1376	32908
16-#14	2.56	MA	24747	6255	40504	4615	44218	3716	45563	3038	46580	1988	56754	1259	42995
7L-3S		MI	19859	6255	33231	4478	36586	3623	38366	2943	40365	1865	48531	1503	33017
16-#14	2.56	MA	24035	6255	39259	4614	42549	3732	43579	3053	43728	1979	53304	1186	41606
8L-2S		MI	20705	6255	34543	4483	38258	3610	40397	2933	43046	1855	52062	1631	33052
16-#18	4.55	MA	29225	7248	51123	5200	57621	4168	61812	3301	68369	1886	86052	1025	76053
5E		MI	20606	7248	36632	5071	40762	4053	43151	3176	46705	1721	57731	770	52364
16-#18	4.55	MA	27978	7248	48892	5196	54592	4161	58118	3290	63498	1904	79985	875	72043
6L-4S		MI	21527	7248	38269	5082	42872	4034	45682	3158	50196	1738	61910	873	54017

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

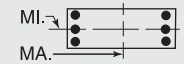


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	4.55	MA	26760	7248	46505	5228	51683	4188	54553	3314	58730	1921	73667	650	68201
7L-3S		MI	22551	7248	40126	5057	45232	4050	48496	3176	53729	1721	65839	1093	56501
18-#11	1.99	MA	26748	5975	43245	4418	47838	3573	50029	2944	52574	1985	63788	1756	37244
3L-8S		MI	17249	5975	28063	4336	30012	3512	30430	2885	30024	1927	35604	1306	24623
18-#11	1.99	MA	26135	5975	42176	4432	46477	3585	48378	2941	50430	1993	61301	1667	37155
4L-7S		MI	17603	5975	28671	4339	30826	3516	31397	2877	31294	1920	37218	1353	25215
18-#11	1.99	MA	25586	5975	41239	4431	45269	3583	46898	2952	48318	1988	58712	1623	36883
5L-6S		MI	17963	5975	29332	4328	31632	3507	32421	2884	32581	1914	38906	1441	25482
18-#11	1.99	MA	25064	5975	40355	4431	44068	3595	45433	2949	46378	1996	56243	1565	36072
6L-5S		MI	18332	5975	29951	4331	32471	3512	33408	2876	33895	1907	40524	1500	25931
18-#11	1.99	MA	24554	5975	39409	4444	42915	3593	44020	2960	44480	2005	53674	1477	35563
7L-4S		MI	18717	5975	30605	4334	33314	3502	34440	2869	35326	1914	42254	1540	26158
18-#11	1.99	MA	24051	5975	38542	4443	41752	3606	42637	2970	42492	1999	51254	1426	34652
8L-3S		MI	19146	5975	31349	4323	34260	3507	35587	2875	36777	1907	43877	1629	26184
18-#11	1.99	MA	23526	5975	37690	4443	40615	3604	41205	2967	40614	2007	48863	1370	33881
9L-2S		MI	19745	5975	32268	4326	35432	3498	37012	2868	38667	1900	46374	1718	26173
18-#14	2.88	MA	27861	6415	46383	4699	51764	3777	54775	3058	59125	1965	73007	1511	52684
4L-7S		MI	18273	6415	30712	4599	33346	3705	34415	2987	35271	1869	42885	1099	34123
18-#14	2.88	MA	27091	6415	45039	4697	50031	3774	52653	3073	56096	1956	69316	1448	51185
5L-6S		MI	18778	6415	31658	4584	34500	3693	35877	2997	37095	1859	45032	1197	35252
18-#14	2.88	MA	26357	6415	43771	4696	48308	3791	50551	3068	53314	1967	65805	1363	50212
6L-5S		MI	19296	6415	32543	4588	35700	3700	37286	2987	38959	1849	47319	1283	35772
18-#14	2.88	MA	25641	6415	42414	4715	46654	3788	48524	3083	50591	1978	62151	1237	48573
7L-4S		MI	19838	6415	33479	4593	36906	3688	38759	2977	40990	1859	49767	1340	36838
18-#14	2.88	MA	24935	6415	41170	4714	44985	3805	46540	3098	47740	1969	58701	1164	47128
8L-3S		MI	20440	6415	34543	4578	38258	3695	40397	2987	43046	1849	52062	1468	36983
18-#14	2.88	MA	24214	6415	39852	4732	43354	3802	44486	3093	45045	1980	55299	1082	45240
9L-2S		MI	21281	6415	35855	4583	39931	3683	42427	2977	45728	1839	55592	1595	37039
18-#18	5.11	MA	29485	7532	52238	5374	58858	4289	63304	3370	70504	1885	89322	830	81773
6L-5S		MI	21597	7532	38914	5248	43672	4182	46638	3252	51312	1689	63758	698	58790
18-#18	5.11	MA	28282	7532	49852	5405	55949	4317	59739	3394	65737	1903	83004	604	77838
7L-4S		MI	22510	7532	40551	5259	45781	4163	49170	3234	54803	1706	67937	801	60618
20-#11	2.22	MA	26756	6085	43510	4501	48178	3635	50446	2972	53232	1987	65093	1653	41180
4L-8S		MI	17672	6085	28983	4405	31184	3562	31854	2916	31915	1917	38101	1283	27297
20-#11	2.22	MA	26211	6085	42573	4500	46970	3633	48966	2983	51120	1981	62504	1609	40802
5L-7S		MI	18025	6085	29590	4408	31998	3566	32822	2909	33185	1911	39715	1330	27906
20-#11	2.22	MA	25691	6085	41690	4500	45769	3645	47501	2980	49180	1989	60035	1551	40022
6E		MI	18383	6085	30252	4397	32804	3557	33846	2915	34471	1904	41403	1418	28196
20-#11	2.22	MA	25185	6085	40744	4513	44616	3644	46088	2991	47282	1998	57467	1463	39527
7L-5S		MI	18749	6085	30870	4400	33643	3562	34833	2908	35785	1897	43021	1478	28622
20-#11	2.22	MA	24685	6085	39876	4513	43453	3656	44705	3001	45294	1992	55047	1412	38568
8L-4S		MI	19133	6085	31525	4403	34486	3553	35865	2900	37217	1904	44751	1518	28939
20-#11	2.22	MA	24163	6085	39025	4512	42316	3654	43273	2998	43416	2000	52655	1356	37812
9L-3S		MI	19560	6085	32268	4392	35432	3557	37012	2907	38667	1897	46374	1606	28976
20-#11	2.22	MA	23612	6085	38095	4525	41168	3666	41898	3009	41552	2009	50336	1292	36667
10L-2S		MI	20156	6085	33188	4395	36604	3548	38437	2899	40558	1890	48871	1695	28980
20-#14	3.20	MA	27966	6575	46950	4797	52466	3846	55614	3118	60107	1946	74713	1426	56811
5L-7S		MI	18864	6575	32024	4698	35018	3777	36445	3032	37953	1854	46415	1063	37920
20-#14	3.20	MA	27239	6575	45682	4796	50743	3863	53512	3113	57325	1957	71202	1342	55873
6E		MI	19366	6575	32970	4683	36172	3765	37908	3042	39777	1844	48563	1162	39008
20-#14	3.20	MA	26528	6575	44325	4815	49089	3860	51485	3128	54603	1968	67548	1215	54160
7L-5S		MI	19881	6575	33855	4688	37373	3772	39316	3032	41640	1834	50849	1248	39617
20-#14	3.20	MA	25828	6575	43080	4814	47420	3877	49501	3142	51751	1959	64098	1142	52661
8L-4S		MI	20419	6575	34791	4693	38579	3760	40790	3022	43671	1844	53297	1305	40627
20-#14	3.20	MA	25109	6575	41763	4832	45789	3874	47447	3138	49057	1970	60697	1060	50817
9L-3S		MI	21017	6575	35855	4678	39931	3768	42427	3032	45728	1834	55592	1432	40944
20-#18	5.68	MA	29788	7816	53198	5583	60215	4445	64926	3474	72744	1884	92341	559	87493
7L-5S		MI	22581	7816	41196	5425	46582	4310	50126	3328	55918	1656	69785	626	65244

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.44	MA	26831	6196	43908	4569	48671	3683	51034	3014	53922	1974	66297	1595	44729
5L-8S		MI	18093	6196	29902	4474	32356	3612	33279	2947	33806	1908	40598	1261	29977
22-#11	2.44	MA	26315	6196	43024	4569	47470	3696	49569	3011	51982	1982	63828	1537	43976
6L-7S		MI	18444	6196	30510	4477	33170	3616	34247	2940	35076	1901	42212	1308	30563
22-#11	2.44	MA	25811	6196	42078	4582	46317	3694	48156	3022	50084	1991	61260	1449	43494
7L-6S		MI	18800	6196	31171	4466	33976	3607	35271	2946	36362	1894	43900	1396	30913
22-#11	2.44	MA	25315	6196	41211	4582	45154	3706	46773	3033	48096	1985	58840	1398	42489
8L-5S		MI	19165	6196	31790	4469	34815	3612	36258	2939	37676	1887	45519	1455	31319
22-#11	2.44	MA	24802	6196	40359	4581	44017	3704	45341	3030	46217	1994	56448	1341	41695
9L-4S		MI	19547	6196	32444	4472	35659	3603	37290	2931	39108	1894	47248	1495	31716
22-#11	2.44	MA	24248	6196	39429	4595	42869	3716	43967	3040	44353	2002	54128	1278	40574
10L-3S		MI	19971	6196	33188	4461	36604	3607	38437	2938	40558	1887	48871	1584	31764
22-#11	2.44	MA	23713	6196	38578	4594	41739	3714	42552	3037	42393	1996	51765	1224	39410
11L-2S		MI	20565	6196	34107	4464	37777	3598	39862	2930	42448	1880	51369	1672	31784
22-#14	3.52	MA	28113	6734	47592	4896	53179	3936	56473	3158	61337	1947	76599	1320	61538
6L-7S		MI	19452	6734	33336	4798	36691	3850	38476	3077	40634	1838	49946	1028	41725
22-#14	3.52	MA	27409	6734	46235	4914	51525	3933	54446	3172	58614	1958	72945	1193	59755
7L-6S		MI	19951	6734	34282	4783	37845	3837	39938	3087	42458	1828	52093	1127	42770
22-#14	3.52	MA	26714	6734	44990	4913	49856	3949	52461	3187	55762	1949	69495	1120	58203
8L-5S		MI	20462	6734	35167	4788	39045	3845	41346	3077	44322	1818	54380	1212	43470
22-#14	3.52	MA	25996	6734	43673	4932	48225	3946	50408	3182	53068	1960	66094	1039	56401
9L-4S		MI	20997	6734	36103	4793	40252	3832	42820	3067	46353	1828	56828	1270	44428
24-#11	2.66	MA	26935	6306	44358	4638	49171	3746	51637	3042	54784	1976	67621	1523	47935
6L-8S		MI	18512	6306	30821	4543	33529	3662	34704	2978	35696	1898	43095	1238	32662
24-#11	2.66	MA	26434	6306	43412	4651	48019	3744	50224	3053	52886	1984	65053	1435	47407
7E		MI	18861	6306	31429	4546	34342	3667	35672	2971	36966	1891	44710	1285	33227
24-#11	2.66	MA	25941	6306	42545	4651	46855	3756	48841	3064	50897	1978	62633	1384	46415
8L-6S		MI	19216	6306	32091	4535	35149	3657	36696	2977	38252	1884	46397	1373	33633
24-#11	2.66	MA	25429	6306	41693	4650	45718	3754	47409	3061	49019	1987	60241	1327	45583
9L-5S		MI	19578	6306	32709	4538	35988	3662	37682	2970	39567	1877	48016	1432	34021
24-#11	2.66	MA	24880	6306	40764	4664	44570	3766	46035	3072	47155	1995	57921	1264	44486
10L-4S		MI	19958	6306	33363	4541	36831	3653	38715	2962	40998	1884	49745	1472	34490
24-#11	2.66	MA	24347	6306	39912	4663	43440	3764	44620	3069	45195	1989	55558	1210	43298
11L-3S		MI	20381	6306	34107	4530	37777	3658	39862	2969	42448	1877	51369	1561	34549
24-#14	3.84	MA	28283	6894	48146	5014	53961	4005	57407	3217	62625	1948	78342	1171	65359
7E		MI	20036	6894	34647	4898	38364	3922	40506	3121	43315	1823	53476	993	45537
24-#14	3.84	MA	27594	6894	46901	5013	52292	4022	55422	3232	59774	1939	74893	1098	63753
8L-6S		MI	20532	6894	35594	4883	39518	3910	41969	3131	45139	1813	55624	1091	46542
24-#14	3.84	MA	26877	6894	45583	5032	50661	4019	53369	3227	57079	1951	71491	1017	61992
9L-5S		MI	21039	6894	36479	4888	40718	3917	43377	3121	47003	1803	57910	1177	47328

RECTANGULAR TIED COLUMNS 32" x 46"

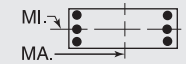
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.09	MA	27316	5772	42783	4296	46395	3500	47453	2914	47643	2081	56160	1962	22359
2E		MI	18747	5772	29812	4170	31813	3396	32153	2818	31673	1985	36781	1838	15093
6-#18	1.63	MA	28957	6056	46307	4473	50888	3628	52914	2994	55041	2064	66051	1920	33140
2L-3S		MI	18274	6056	29812	4337	31813	3544	32153	2912	31673	1970	36781	1538	22229
6-#18	1.63	MA	26634	6056	42783	4470	46395	3657	47453	3019	47643	2082	56160	1692	33050
3L-2S		MI	19769	6056	32094	4348	34723	3525	35641	2894	36279	1953	42808	1766	22152
8-#14	1.22	MA	27817	5843	43648	4366	47662	3553	49056	2952	49840	2091	59383	1978	25255
2L-4S		MI	17594	5843	28013	4262	29674	3464	29705	2871	28565	2027	33197	1604	17122
8-#14	1.22	MA	26477	5843	41638	4366	45099	3551	45940	2967	45619	2103	53673	1850	25276
3E		MI	18218	5843	29076	4247	31026	3471	31343	2881	30622	2017	35492	1731	17083

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.22	MA	25533	5843	40026	4385	43049	3568	43453	2963	42389	2115	49929	1722	25180
4L-2S		MI	19086	5843	30388	4252	32698	3459	33373	2871	33303	2007	39023	1859	17018
8-#18	2.17	MA	30572	6340	49831	4651	55380	3757	58375	3074	62440	2046	75943	1878	43872
2L-4S		MI	18230	6340	30237	4538	32362	3656	32827	2970	32747	1956	38879	1247	28198
8-#18	2.17	MA	28277	6340	46307	4648	50888	3786	52914	3099	55041	2064	66051	1650	43670
3E		MI	19297	6340	32094	4514	34723	3672	35641	2988	36279	1938	42808	1467	29148
8-#18	2.17	MA	26657	6340	43475	4680	47287	3779	48544	3089	49367	2082	59579	1423	42165
4L-2S		MI	20778	6340	34376	4525	37632	3653	39128	2970	40886	1921	48834	1694	29156
10-#11	1.06	MA	27350	5758	42559	4326	46356	3525	47501	2937	47747	2103	56676	2001	22055
2L-5S		MI	17360	5758	27364	4223	28913	3450	28807	2870	27317	2037	31622	1679	15030
10-#11	1.06	MA	26409	5758	41155	4326	44567	3524	45325	2948	44800	2112	52667	1913	22083
3L-4S		MI	17755	5758	28018	4225	29757	3440	29840	2862	28748	2043	33351	1719	15007
10-#11	1.06	MA	25748	5758	40031	4339	43137	3536	43591	2946	42547	2121	50035	1824	22072
4L-3S		MI	18193	5758	28762	4214	30702	3445	30987	2868	30198	2037	34975	1808	14963
10-#11	1.06	MA	25157	5758	39048	4339	41868	3535	42036	2957	40329	2116	47302	1779	21983
5L-2S		MI	18804	5758	29681	4217	31875	3436	32412	2861	32089	2030	37472	1896	14917
10-#14	1.53	MA	28760	6003	45658	4466	50225	3626	52171	2997	54060	2081	65092	1958	31395
2L-5S		MI	17639	6003	28389	4357	30140	3549	30262	2926	29215	2001	34279	1511	20662
10-#14	1.53	MA	27430	6003	43648	4465	47662	3623	49056	3012	49840	2093	59383	1830	31378
3L-4S		MI	18198	6003	29325	4362	31347	3536	31736	2916	31246	2011	36727	1569	21105
10-#14	1.53	MA	26494	6003	42037	4484	45612	3640	46568	3008	46610	2105	55638	1702	31236
4L-3S		MI	18817	6003	30388	4347	32698	3544	33373	2926	33303	2001	39023	1696	21105
10-#14	1.53	MA	25656	6003	40625	4484	43791	3638	44338	3023	43428	2097	51740	1638	30409
5L-2S		MI	19680	6003	31700	4352	34371	3531	35403	2916	35984	1991	42553	1824	21059
10-#18	2.72	MA	32165	6624	53354	4828	59872	3885	63837	3153	69838	2028	85834	1835	54567
2L-5S		MI	18299	6624	30882	4705	33163	3804	33783	3064	33862	1906	40726	1071	33011
10-#18	2.72	MA	29896	6624	49831	4825	55380	3914	58375	3179	62440	2046	75943	1608	54274
3L-4S		MI	19252	6624	32519	4716	35272	3785	36314	3046	37354	1924	44905	1175	34655
10-#18	2.72	MA	28298	6624	46999	4857	51779	3908	54005	3169	56765	2065	69470	1380	52297
4L-3S		MI	20309	6624	34376	4691	37632	3801	39128	3064	40886	1906	48834	1395	36037
10-#18	2.72	MA	26866	6624	44515	4854	48576	3937	50083	3194	51171	2047	62691	1270	49176
5L-2S		MI	21775	6624	36659	4702	40542	3782	42615	3046	45492	1889	54861	1622	36130
12-#11	1.27	MA	28015	5869	43962	4395	48145	3575	49676	2968	50694	2096	60685	1988	26347
2L-6S		MI	17413	5869	27665	4289	29246	3495	29246	2908	27893	2034	32501	1597	17485
12-#11	1.27	MA	27080	5869	42559	4395	46356	3574	47501	2979	47747	2105	56676	1900	26361
3L-5S		MI	17789	5869	28283	4292	30085	3500	30232	2901	29207	2027	34119	1656	17821
12-#11	1.27	MA	26423	5869	41435	4409	44927	3586	45766	2977	45494	2114	54044	1811	26324
4E		MI	18181	5869	28937	4295	30929	3491	31265	2893	30639	2034	35849	1696	17823
12-#11	1.27	MA	25835	5869	40451	4408	43658	3585	44211	2988	43276	2109	51311	1766	26210
5L-3S		MI	18617	5869	29681	4284	31875	3495	32412	2900	32089	2027	37472	1785	17792
12-#11	1.27	MA	25275	5869	39523	4408	42396	3597	42673	2985	41238	2118	48700	1708	25560
6L-2S		MI	19225	5869	30601	4286	33047	3486	33837	2892	33980	2020	39969	1874	17753
12-#14	1.83	MA	29694	6163	47668	4566	52787	3698	55287	3042	58281	2071	70801	1937	37521
2L-6S		MI	17712	6163	28816	4452	30612	3613	30884	2980	30033	1996	35523	1390	23832
12-#14	1.83	MA	28373	6163	45658	4565	50225	3695	52171	3057	54060	2083	65092	1809	37468
3L-5S		MI	18242	6163	29701	4457	31813	3621	32293	2970	31897	1986	37810	1476	24457
12-#14	1.83	MA	27445	6163	44047	4584	48175	3713	49684	3053	50831	2095	61348	1681	37287
4E		MI	18797	6163	30637	4462	33019	3609	33766	2960	33928	1996	40258	1533	25073
12-#14	1.83	MA	26615	6163	42635	4583	46354	3710	47454	3068	47648	2087	57449	1617	36277
5L-3S		MI	19412	6163	31700	4447	34371	3616	35403	2970	35984	1986	42553	1661	25112
12-#14	1.83	MA	25823	6163	41303	4583	44544	3727	45246	3064	44726	2099	53733	1533	35073
6L-2S		MI	20269	6163	33012	4451	36044	3604	37434	2960	38665	1976	46084	1788	25083
12-#18	3.26	MA	31494	6907	53354	5002	59872	4043	63837	3258	69838	2029	85834	1566	64867
3L-5S		MI	19321	6907	33164	4882	36073	3932	37271	3140	38469	1874	46753	1000	39638
12-#18	3.26	MA	29915	6907	50522	5035	56271	4036	59466	3248	64164	2047	79362	1338	62476
4E		MI	20264	6907	34802	4893	38182	3913	39802	3122	41960	1892	50932	1103	41159
12-#18	3.26	MA	28503	6907	48039	5032	53069	4065	55545	3274	58569	2030	72583	1227	59516
5L-3S		MI	21310	6907	36659	4869	40542	3930	42615	3140	45492	1874	54861	1323	42905

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

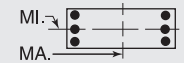
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	3.26	MA	27155	6907	45695	5029	49885	4059	51662	3263	53428	2048	66152	1077	55802
6L-2S		MI	22763	6907	38941	4880	43452	3910	46103	3122	50099	1856	60888	1550	43063
14-#11	1.48	MA	28676	5980	45366	4464	49935	3626	51851	2999	53640	2089	64694	1975	30631
2L-7S		MI	17477	5980	27923	4369	29612	3554	29647	2933	28497	2031	33310	1486	19889
14-#11	1.48	MA	27745	5980	43962	4464	48145	3624	49676	3011	50694	2098	60685	1887	30625
3L-6S		MI	17841	5980	28584	4358	30419	3545	30671	2939	29784	2024	34998	1574	20183
14-#11	1.48	MA	27092	5980	42838	4478	46716	3637	47941	3008	48441	2107	58053	1798	30570
4L-5S		MI	18214	5980	29203	4361	31258	3550	31657	2932	31098	2017	36616	1633	20605
14-#11	1.48	MA	26508	5980	41855	4478	45447	3635	46386	3019	46222	2102	55320	1753	30434
5L-4S		MI	18605	5980	29857	4364	32101	3541	32690	2924	32529	2024	38346	1673	20629
14-#11	1.48	MA	25952	5980	40927	4477	44186	3647	44848	3016	44185	2111	52709	1695	29696
6L-3S		MI	19038	5980	30601	4353	33047	3545	33837	2931	33980	2017	39969	1762	20611
14-#11	1.48	MA	25409	5980	39933	4491	42975	3646	43364	3028	42192	2120	49994	1607	29105
7L-2S		MI	19644	5980	31520	4356	34219	3536	35262	2923	35870	2010	42466	1851	20580
14-#14	2.14	MA	30621	6322	49679	4666	55350	3770	58402	3087	62502	2061	76510	1917	43630
2L-7S		MI	17800	6322	29181	4567	31131	3698	31452	3015	30890	1990	36906	1256	26806
14-#14	2.14	MA	29309	6322	47668	4665	52787	3768	55287	3102	58281	2073	70801	1789	43549
3L-6S		MI	18314	6322	30127	4552	32285	3686	32915	3025	32714	1980	39054	1355	27682
14-#14	2.14	MA	28388	6322	46057	4684	50738	3785	52799	3098	55051	2085	67057	1661	43333
4L-5S		MI	18840	6322	31013	4557	33486	3693	34323	3015	34578	1970	41340	1441	28270
14-#14	2.14	MA	27564	6322	44645	4683	48917	3782	50569	3113	51869	2077	63158	1597	42162
5L-4S		MI	19391	6322	31949	4561	34692	3681	35796	3005	36609	1980	43788	1498	29031
14-#14	2.14	MA	26779	6322	43314	4682	47107	3800	48362	3109	48946	2089	59442	1513	41010
6L-3S		MI	20002	6322	33012	4546	36044	3688	37434	3015	38665	1970	46084	1625	29099
14-#14	2.14	MA	26013	6322	41888	4701	45370	3797	46232	3124	46086	2100	55576	1387	39576
7L-2S		MI	20854	6322	34324	4551	37716	3676	39464	3005	41347	1960	49614	1753	29097
14-#18	3.80	MA	31514	7191	54046	5212	60764	4165	64927	3328	71563	2029	89253	1296	72694
4L-5S		MI	20332	7191	35447	5059	38983	4061	40758	3216	43075	1842	52780	928	46286
14-#18	3.80	MA	30118	7191	51563	5209	57561	4194	61006	3353	65968	2012	82474	1185	69878
5L-4S		MI	21265	7191	37084	5070	41092	4042	43289	3198	46567	1860	56959	1031	47702
14-#18	3.80	MA	28788	7191	49219	5206	54377	4187	57123	3343	60827	2030	76043	1035	66014
6L-3S		MI	22302	7191	38941	5046	43452	4058	46103	3216	50099	1842	60888	1251	49759
14-#18	3.80	MA	27489	7191	46711	5238	51320	4216	53376	3369	55795	2048	69348	810	62250
7L-2S		MI	23742	7191	41224	5057	46362	4039	49590	3198	54705	1824	66914	1479	49977
16-#11	1.70	MA	29333	6090	46769	4534	51724	3676	54026	3031	56587	2082	68704	1962	34909
2L-8S		MI	17546	6090	28234	4435	29971	3600	30104	2971	29118	2028	34193	1416	22133
16-#11	1.70	MA	28407	6090	45366	4533	49935	3674	51851	3042	53640	2091	64694	1874	34885
3L-7S		MI	17904	6090	28842	4438	30785	3604	31072	2964	30388	2021	35807	1463	22608
16-#11	1.70	MA	27758	6090	44242	4547	48505	3687	50116	3039	51388	2100	62062	1785	34812
4L-6S		MI	18266	6090	29504	4427	31591	3595	32096	2970	31674	2014	37495	1551	22887
16-#11	1.70	MA	27177	6090	43258	4547	47236	3685	48562	3050	49169	2095	59330	1740	34657
5E		MI	18637	6090	30122	4430	32430	3600	33082	2963	32988	2007	39114	1611	23375
16-#11	1.70	MA	26624	6090	42330	4546	45975	3698	47023	3048	47132	2104	56719	1682	33840
6L-4S		MI	19026	6090	30776	4433	33273	3591	34114	2955	34420	2014	40843	1651	23423
16-#11	1.70	MA	26085	6090	41337	4560	44764	3696	45539	3059	45139	2113	54003	1594	33269
7L-3S		MI	19457	6090	31520	4422	34219	3595	35262	2962	35870	2007	42466	1739	23422
16-#11	1.70	MA	25553	6090	40426	4560	43543	3709	44087	3070	43051	2108	51449	1542	32451
8L-2S		MI	20060	6090	32440	4425	35391	3586	36687	2954	37761	2000	44964	1828	23399
16-#14	2.45	MA	30236	6482	49679	4765	55350	3840	58402	3147	62502	2063	76510	1768	49624
3L-7S		MI	18401	6482	30493	4666	32804	3770	33482	3060	33572	1975	40437	1221	30578
16-#14	2.45	MA	29323	6482	48067	4784	53301	3857	55915	3143	59272	2075	72766	1640	49377
4L-6S		MI	18911	6482	31439	4651	33958	3758	34945	3070	35396	1965	42584	1320	31540
16-#14	2.45	MA	28506	6482	46655	4783	51480	3855	53684	3158	56090	2067	68868	1576	48062
5E		MI	19434	6482	32325	4656	35158	3766	36353	3060	37259	1955	44871	1405	32095

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

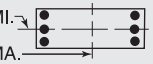


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	2.45	MA	27727	6482	45324	4782	49670	3872	51477	3154	53167	2079	65152	1492	46956
6L-4S		MI	19981	6482	33261	4661	36365	3753	37827	3050	39290	1965	47319	1463	32982
16-#14	2.45	MA	26968	6482	43898	4801	47933	3869	49348	3169	50307	2091	61286	1366	45439
7L-3S		MI	20588	6482	34324	4646	37716	3761	39464	3060	41347	1955	49614	1590	33076
16-#14	2.45	MA	26219	6482	42591	4800	46180	3887	47263	3185	47311	2082	57642	1292	43988
8L-2S		MI	21436	6482	35636	4651	39389	3748	41494	3050	44028	1945	53145	1718	33103
16-#18	4.35	MA	31715	7475	55086	5386	62053	4322	66467	3433	73366	1994	92366	1143	80260
5E		MI	21333	7475	37729	5237	41892	4190	44245	3292	47682	1810	58806	856	52793
16-#18	4.35	MA	30401	7475	52742	5383	58870	4316	62584	3423	68225	2012	85935	993	76249
6L-4S		MI	22258	7475	39366	5248	44002	4170	46777	3274	51173	1828	62985	959	54275
16-#18	4.35	MA	29118	7475	50234	5416	55813	4345	58837	3448	63194	2031	79240	768	72394
7L-3S		MI	23285	7475	41224	5223	46362	4187	49590	3292	54705	1810	66914	1179	56603
16-#18	4.35	MA	27853	7475	47933	5413	52727	4338	55169	3474	57924	2013	72906	639	68041
8L-2S		MI	24714	7475	43506	5234	49272	4168	53078	3274	59312	1792	72941	1407	56876
18-#11	1.91	MA	29064	6201	46769	4603	51724	3724	54026	3073	56587	2084	68704	1861	39140
3L-8S		MI	17972	6201	29154	4504	31143	3650	31529	3002	31009	2018	36690	1393	24800
18-#11	1.91	MA	28418	6201	45645	4616	50295	3737	52291	3070	54335	2093	66072	1772	39050
4L-7S		MI	18328	6201	29762	4507	31957	3655	32496	2995	32279	2011	38305	1441	25329
18-#11	1.91	MA	27842	6201	44662	4616	49026	3735	50737	3081	52116	2088	63339	1727	38877
5L-6S		MI	18689	6201	30423	4496	32763	3645	33521	3001	33565	2004	39992	1529	25597
18-#11	1.91	MA	27292	6201	43734	4616	47764	3748	49198	3079	50079	2097	60728	1669	37991
6L-5S		MI	19058	6201	31041	4499	33602	3650	34507	2994	34879	1997	41611	1588	26058
18-#11	1.91	MA	26756	6201	42740	4629	46554	3746	47714	3090	48086	2106	58012	1581	37438
7L-4S		MI	19444	6201	31696	4502	34445	3641	35539	2987	36311	2004	43340	1628	26212
18-#11	1.91	MA	26227	6201	41830	4629	45332	3759	46262	3101	45998	2101	55458	1529	36566
8L-3S		MI	19874	6201	32440	4491	35391	3646	36687	2993	37761	1997	44964	1717	26228
18-#11	1.91	MA	25666	6201	40936	4629	44139	3757	44759	3098	44026	2110	52928	1473	35728
9L-2S		MI	20474	6201	33359	4494	36563	3636	38112	2986	39651	1990	47461	1805	26213
18-#14	2.75	MA	30250	6641	50077	4883	55863	3930	59030	3188	63493	2065	78476	1620	55418
4L-7S		MI	18997	6641	31805	4766	34477	3843	35513	3104	36253	1959	43968	1186	34362
18-#14	2.75	MA	29439	6641	48666	4883	54043	3927	56800	3203	60311	2057	74577	1556	53974
5L-6S		MI	19504	6641	32751	4751	35630	3830	36975	3114	38077	1949	46115	1284	35403
18-#14	2.75	MA	28667	6641	47334	4882	52233	3944	54592	3199	57388	2069	70861	1472	52909
6L-5S		MI	20023	6641	33636	4756	36831	3838	38384	3104	39941	1939	48401	1370	35931
18-#14	2.75	MA	27914	6641	45909	4901	50496	3942	52463	3214	54528	2081	66995	1346	51313
7L-4S		MI	20567	6641	34573	4761	38037	3826	39857	3094	41972	1949	50849	1427	36928
18-#14	2.75	MA	27171	6641	44601	4900	48743	3959	50379	3230	51532	2073	63351	1271	49904
8L-3S		MI	21170	6641	35636	4746	39389	3833	41494	3104	44028	1939	53145	1554	37046
18-#14	2.75	MA	26402	6641	43318	4899	47030	3956	48222	3225	48702	2084	59751	1190	47866
9L-2S		MI	22013	6641	36948	4751	41062	3821	43525	3094	46709	1929	56675	1682	37092
18-#18	4.89	MA	31997	7758	56266	5561	63362	4444	68045	3503	75624	1995	95826	951	86506
6L-5S		MI	22326	7758	40012	5414	44802	4318	47733	3367	52288	1778	64833	784	59212
18-#18	4.89	MA	30729	7758	53758	5593	60305	4473	64298	3528	70592	2013	89131	726	82559
7L-4S		MI	23243	7758	41649	5425	46912	4299	50264	3350	55779	1795	69012	888	60874
18-#18	4.89	MA	29479	7758	51457	5590	57220	4467	60630	3553	65323	1996	82798	597	78157
8L-3S		MI	24260	7758	43506	5400	49272	4315	53078	3367	59312	1778	72941	1108	63438
20-#11	2.12	MA	29075	6311	47049	4685	52084	3787	54467	3101	57282	2086	70081	1759	43286
4L-8S		MI	18396	6311	30073	4573	32315	3700	32954	3034	32899	2008	39187	1371	27474
20-#11	2.12	MA	28502	6311	46065	4685	50815	3786	52912	3112	55063	2081	67348	1714	43009
5L-7S		MI	18750	6311	30681	4576	33129	3705	33921	3026	34169	2001	40802	1418	28053
20-#11	2.12	MA	27956	6311	45137	4685	49554	3798	51373	3110	53026	2090	64737	1656	42147
6E		MI	19109	6311	31342	4565	33935	3696	34946	3033	35455	1994	42489	1506	28311
20-#11	2.12	MA	27423	6311	44144	4698	48343	3796	49890	3121	51033	2099	62022	1568	41610
7L-5S		MI	19476	6311	31961	4568	34774	3700	35932	3025	36770	1987	44108	1565	28748
20-#11	2.12	MA	26897	6311	43233	4698	47122	3809	48437	3132	48945	2094	59467	1516	40688
8L-4S		MI	19861	6311	32615	4571	35618	3691	36964	3018	38201	1994	45837	1605	28995
20-#11	2.12	MA	26339	6311	42339	4698	45928	3807	46934	3130	46973	2103	56938	1460	39871
9L-3S		MI	20288	6311	33359	4560	36563	3696	38112	3024	39651	1987	47461	1694	29024

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

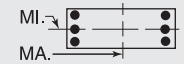
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.12	MA	25760	6311	41363	4711	44722	3820	45490	3141	45015	2111	54484	1397	38742
10L-2S		MI	20886	6311	34279	4563	37735	3687	39537	3017	41542	1980	49958	1782	29022
20-#14	3.06	MA	30366	6801	50676	4982	56605	3999	59915	3248	64531	2047	80286	1536	59897
5L-7S		MI	19589	6801	33117	4866	36149	3915	37543	3149	38934	1944	47498	1150	38155
20-#14	3.06	MA	29600	6801	49344	4982	54796	4017	57708	3244	61609	2059	76570	1451	58868
6E		MI	20093	6801	34063	4851	37303	3903	39006	3159	40758	1934	49645	1249	39272
20-#14	3.06	MA	28852	6801	47919	5001	53058	4014	55579	3259	58749	2071	72704	1325	57197
7L-5S		MI	20609	6801	34948	4856	38503	3910	40414	3149	42622	1924	51932	1335	39775
20-#14	3.06	MA	28115	6801	46612	5000	51305	4031	53494	3274	55753	2063	69061	1251	55755
8L-4S		MI	21149	6801	35884	4861	39710	3898	41888	3139	44653	1934	54380	1392	40816
20-#14	3.06	MA	27348	6801	45328	4999	49592	4029	51337	3270	52923	2074	65460	1170	53741
9L-3S		MI	21749	6801	36948	4845	41062	3905	43525	3149	46709	1924	56675	1519	41010
20-#14	3.06	MA	26523	6801	43927	5018	47862	4046	49266	3286	50114	2086	61969	1078	51603
10L-2S		MI	22587	6801	38260	4850	42734	3893	45555	3139	49391	1914	60206	1647	41075
20-#18	5.43	MA	32323	8042	57281	5770	64797	4602	69759	3608	77991	1995	99023	684	92742
7L-5S		MI	23312	8042	42294	5591	47712	4447	51220	3443	56895	1746	70860	712	65660
20-#18	5.43	MA	31087	8042	54980	5767	61712	4595	66091	3633	72721	1978	92689	555	88290
8L-4S		MI	24220	8042	43931	5602	49821	4428	53752	3426	60386	1763	75039	816	67493
22-#11	2.33	MA	29158	6422	47469	4754	52604	3836	55087	3144	58010	2074	71357	1701	47140
5L-8S		MI	18818	6422	30993	4643	33487	3750	34379	3065	34790	1998	41684	1348	30153
22-#11	2.33	MA	28615	6422	46541	4754	51343	3848	53549	3141	55973	2083	68746	1643	46309
6L-7S		MI	19170	6422	31600	4645	34301	3755	35346	3057	36060	1991	43299	1395	30753
22-#11	2.33	MA	28085	6422	45547	4767	50132	3847	52065	3152	53980	2092	66031	1555	45785
7L-6S		MI	19527	6422	32262	4635	35107	3746	36371	3064	37346	1984	44986	1483	31028
22-#11	2.33	MA	27563	6422	44637	4767	48911	3859	50612	3163	51892	2087	63476	1503	44815
8L-5S		MI	19892	6422	32880	4637	35946	3750	37357	3056	38660	1977	46605	1542	31445
22-#11	2.33	MA	27008	6422	43743	4767	47717	3858	49109	3161	49919	2096	60947	1447	44018
9L-4S		MI	20275	6422	33535	4640	36790	3741	38389	3049	40092	1984	48334	1582	31775
22-#11	2.33	MA	26432	6422	42767	4781	46511	3870	47666	3172	47962	2105	58493	1384	42856
10L-3S		MI	20701	6422	34279	4629	37735	3746	39537	3055	41542	1977	49958	1671	31815
22-#11	2.33	MA	25869	6422	41873	4780	45325	3869	46180	3169	45903	2100	55998	1329	41716
11L-2S		MI	21296	6422	35198	4632	38908	3737	40962	3048	43433	1970	52455	1760	31827
22-#14	3.36	MA	30525	6960	51354	5081	57358	4089	60823	3288	65829	2049	82280	1431	64833
6L-7S		MI	20178	6960	34429	4966	37822	3987	39573	3194	41616	1928	51029	1115	41958
22-#14	3.36	MA	29784	6960	49929	5100	55621	4086	58694	3304	62969	2061	78414	1305	63089
7L-6S		MI	20678	6960	35375	4951	38976	3975	41036	3204	43439	1918	53176	1214	43033
22-#14	3.36	MA	29052	6960	48622	5100	53868	4104	56609	3319	59974	2053	74770	1230	61594
8L-5S		MI	21191	6960	36260	4955	40176	3983	42444	3194	45303	1908	55462	1299	43627
22-#14	3.36	MA	28286	6960	47339	5099	52155	4101	54453	3315	57143	2065	71170	1149	59623
9L-4S		MI	21728	6960	37196	4960	41382	3970	43918	3184	47334	1918	57910	1357	44615
22-#14	3.36	MA	27471	6960	45938	5118	50425	4118	52381	3330	54335	2076	67678	1058	57452
10L-3S		MI	22324	6960	38260	4945	42734	3978	45555	3194	49391	1908	60206	1484	44969
22-#18	5.98	MA	32680	8326	58504	5945	66204	4724	71552	3713	80120	1960	102580	512	98439
8L-5S		MI	24290	8326	44576	5769	50622	4575	54708	3519	61501	1713	76886	641	72132
24-#11	2.54	MA	29270	6533	47944	4823	53132	3898	55724	3172	58920	2076	72756	1630	50474
6L-8S		MI	19237	6533	31912	4712	34660	3800	35804	3096	36680	1988	44181	1325	32836
24-#11	2.54	MA	28744	6533	46951	4837	51922	3897	54240	3183	56927	2085	70040	1542	49963
7E		MI	19588	6533	32520	4715	35473	3805	36771	3088	37950	1981	45796	1372	33415
24-#11	2.54	MA	28225	6533	46040	4836	50700	3909	52787	3194	54839	2080	67486	1490	48948
8L-6S		MI	19943	6533	33181	4704	36280	3796	37796	3095	39237	1974	47484	1460	33749
24-#11	2.54	MA	27679	6533	45146	4836	49507	3908	51284	3192	52866	2089	64956	1434	48168
9L-5S		MI	20307	6533	33800	4707	37119	3801	38782	3087	40551	1967	49102	1519	34146
24-#11	2.54	MA	27100	6533	44170	4850	48301	3920	49841	3203	50909	2098	62502	1371	46975
10L-4S		MI	20688	6533	34454	4709	37962	3791	39814	3080	41982	1974	50831	1559	34551

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.54	MA	26539	6533	43276	4849	47114	3919	48355	3200	48850	2093	60008	1316	45811
11L-3S		MI	21111	6533	35198	4699	38908	3796	40962	3086	43433	1967	52455	1648	34603
24-#11	2.54	MA	25989	6533	42315	4863	45916	3931	46915	3212	46896	2101	57264	1241	44572
12L-2S		MI	21704	6533	36117	4701	40080	3787	42387	3079	45323	1960	54952	1737	34625
24-#14	3.67	MA	30708	7120	51939	5200	58184	4159	61810	3349	67190	2051	84123	1284	68990
7E		MI	20763	7120	35741	5065	39494	4060	41604	3238	44297	1913	54559	1080	45769
24-#14	3.67	MA	29983	7120	50632	5199	56431	4176	59725	3364	64194	2043	80479	1210	67440
8L-6S		MI	21260	7120	36687	5050	40648	4047	43066	3248	46121	1903	56706	1178	46802
24-#14	3.67	MA	29218	7120	49349	5199	54718	4173	57568	3360	61364	2055	76879	1129	65511
9L-5S		MI	21770	7120	37572	5055	41849	4055	44475	3238	47985	1893	58993	1264	47484
24-#14	3.67	MA	28429	7120	47948	5218	52987	4191	55497	3375	58555	2066	73387	1038	63308
10L-4S		MI	22303	7120	38508	5060	43055	4042	45948	3228	50016	1903	61441	1321	48425

RECTANGULAR TIED COLUMNS 32" x 48"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.04	MA	29631	5999	46249	4480	50172	3651	51281	3042	51362	2180	60586	2063	23439
2E		MI	19472	5999	30909	4336	32943	3533	33248	2934	32649	2074	37856	1924	15132
6-#18	1.56	MA	31363	6282	49950	4657	54890	3780	57016	3122	59132	2162	71032	2023	34760
2L-3S		MI	18999	6282	30909	4502	32943	3680	33248	3028	32649	2060	37856	1624	22287
6-#18	1.56	MA	28918	6282	46249	4655	50172	3809	51281	3149	51362	2182	60586	1796	34670
3L-2S		MI	20496	6282	33192	4513	35853	3661	36735	3010	37256	2042	43883	1852	22198
8-#14	1.17	MA	30156	6070	47150	4550	51493	3704	52953	3080	53656	2190	63956	2079	26470
2L-4S		MI	18318	6070	29106	4430	30805	3602	30803	2988	29547	2117	34279	1691	17169
8-#14	1.17	MA	28746	6070	45040	4550	48803	3702	49683	3096	49226	2202	57934	1951	26491
3E		MI	18943	6070	30169	4415	32157	3609	32441	2998	31603	2107	36575	1818	17121
8-#14	1.17	MA	27755	6070	43351	4569	46654	3720	47075	3093	45839	2215	53982	1823	26395
4L-2S		MI	19812	6070	31481	4419	33829	3597	34471	2988	34284	2097	40105	1946	17053
8-#18	2.08	MA	33070	6566	53651	4835	59608	3908	62752	3202	66903	2145	81478	1984	46032
2L-4S		MI	18954	6566	31335	4704	33492	3793	33922	3086	33724	2045	39954	1333	28470
8-#18	2.08	MA	30653	6566	49950	4832	54890	3938	57016	3228	59132	2164	71032	1756	45830
3E		MI	20024	6566	33192	4680	35853	3809	36735	3104	37256	2027	43883	1553	29219
8-#18	2.08	MA	28951	6566	46979	4865	51112	3932	52431	3219	53179	2184	64189	1529	44562
4L-2S		MI	21506	6566	35474	4691	38763	3790	40223	3086	41862	2010	49909	1780	29209
10-#11	1.02	MA	29661	5985	46004	4510	50119	3677	51316	3066	51453	2202	61087	2101	23108
2L-5S		MI	18084	5985	28454	4391	30044	3588	29907	2987	28301	2127	32709	1766	15073
10-#11	1.02	MA	28672	5985	44531	4510	48241	3675	49034	3077	48361	2211	56861	2013	23136
3L-4S		MI	18479	5985	29109	4394	30888	3579	30939	2980	29732	2134	34438	1806	15043
10-#11	1.02	MA	27978	5985	43353	4524	46743	3688	47216	3075	46000	2220	54084	1924	23125
4L-3S		MI	18918	5985	29853	4383	31833	3583	32087	2986	31182	2127	36061	1895	14995
10-#11	1.02	MA	27357	5985	42322	4524	45413	3687	45586	3086	43675	2216	51207	1879	23036
5L-2S		MI	19530	5985	30772	4386	33006	3574	33512	2979	33073	2120	38559	1984	14947
10-#14	1.46	MA	31151	6229	49260	4650	54183	3777	56223	3125	58086	2180	69977	2060	32914
2L-5S		MI	18363	6229	29482	4525	31271	3686	31360	3043	30197	2091	35362	1598	20822
10-#14	1.46	MA	29751	6229	47150	4650	51493	3775	52953	3141	53656	2192	63956	1932	32897
3L-4S		MI	18923	6229	30418	4529	32477	3674	32834	3033	32228	2101	37810	1656	21161
10-#14	1.46	MA	28768	6229	45461	4669	49344	3792	50345	3137	50269	2205	60003	1804	32755
4L-3S		MI	19543	6229	31481	4514	33829	3682	34471	3043	34284	2091	40105	1783	21148
10-#14	1.46	MA	27889	6229	43981	4669	47435	3790	48007	3154	46933	2197	55897	1739	32029
5L-2S		MI	20407	6229	32793	4519	35502	3669	36501	3033	36966	2081	43636	1911	21097
10-#18	2.60	MA	34753	6850	57352	5012	64327	4037	68488	3282	74674	2127	91924	1944	57267
2L-5S		MI	19023	6850	31980	4870	34293	3940	34878	3180	34839	1995	41802	1157	33241
10-#18	2.60	MA	32363	6850	53651	5010	59608	4066	62752	3308	66903	2147	81478	1717	56974
3L-4S		MI	19978	6850	33617	4881	36402	3921	37409	3162	38330	2013	45981	1261	34921
10-#18	2.60	MA	30682	6850	50680	5043	55830	4061	58167	3299	60950	2166	74635	1489	55216
4L-3S		MI	21037	6850	35474	4857	38763	3937	40223	3180	41862	1995	49909	1481	36116
10-#18	2.60	MA	29178	6850	48076	5041	52472	4090	54054	3325	55082	2150	67488	1377	51811
5L-2S		MI	22506	6850	37756	4868	41672	3918	43710	3162	46469	1978	55936	1708	36186

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

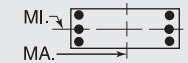
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.22	MA	30362	6095	47476	4579	51996	3727	53599	3097	54545	2195	65313	2089	27610
2L-6S		MI	18137	6095	28755	4457	30378	3634	30345	3026	28877	2124	33587	1684	17597
12-#11	1.22	MA	29379	6095	46004	4579	50119	3726	51316	3108	51453	2204	61087	2001	27625
3L-5S		MI	18513	6095	29374	4460	31216	3638	31332	3018	30191	2117	35206	1744	17871
12-#11	1.22	MA	28689	6095	44826	4593	48621	3738	49498	3106	49092	2213	58310	1912	27588
4E		MI	18906	6095	30028	4463	32060	3629	32364	3011	31623	2124	36935	1784	17862
12-#11	1.22	MA	28073	6095	43795	4593	47291	3737	47869	3118	46767	2209	55433	1867	27474
5L-3S		MI	19342	6095	30772	4452	33006	3634	33512	3017	33073	2117	38559	1872	17827
12-#11	1.22	MA	27485	6095	42823	4593	45969	3750	46257	3115	44632	2218	52680	1808	26869
6L-2S		MI	19951	6095	31691	4455	34178	3624	34936	3010	34964	2110	41056	1961	17786
12-#14	1.76	MA	32137	6389	51370	4750	56873	3849	59493	3170	62516	2170	75999	2041	39343
2L-6S		MI	18436	6389	29909	4619	31743	3751	31982	3097	31015	2086	36606	1477	23978
12-#14	1.76	MA	30747	6389	49260	4749	54183	3847	56223	3186	58086	2182	69977	1913	39291
3L-5S		MI	18967	6389	30794	4624	32944	3759	33390	3087	32878	2076	38892	1563	24615
12-#14	1.76	MA	29772	6389	47570	4769	52034	3865	53615	3182	54699	2195	66025	1785	39109
4E		MI	19522	6389	31730	4629	34150	3746	34864	3077	34909	2086	41340	1620	25135
12-#14	1.76	MA	28900	6389	46091	4768	50125	3863	51277	3198	51363	2187	61919	1720	38192
5L-3S		MI	20139	6389	32793	4614	35502	3754	36501	3087	36966	2076	43636	1747	25159
12-#14	1.76	MA	28069	6389	44696	4768	48229	3880	48964	3195	48300	2200	57998	1636	36882
6L-2S		MI	20997	6389	34105	4619	37175	3741	38532	3077	39647	2066	47166	1875	25125
12-#18	3.13	MA	34050	7134	57352	5187	64327	4195	68488	3388	74674	2129	91924	1677	68107
3L-5S		MI	20045	7134	34262	5048	37203	4069	38365	3256	39445	1963	47828	1086	39865
12-#18	3.13	MA	32391	7134	54381	5220	60549	4189	63903	3379	68721	2148	85081	1450	65917
4E		MI	20991	7134	35899	5059	39312	4050	40897	3238	42937	1981	52007	1189	41421
12-#18	3.13	MA	30906	7134	51777	5218	57190	4219	59790	3405	62853	2133	77934	1338	62680
5L-3S		MI	22040	7134	37756	5034	41672	4066	43710	3256	46469	1963	55936	1409	42991
12-#18	3.13	MA	29490	7134	49320	5216	53852	4213	55718	3396	57461	2152	71139	1188	58987
6L-2S		MI	23496	7134	40039	5045	44582	4047	47198	3238	51075	1945	61963	1637	43129
14-#11	1.42	MA	31060	6206	48949	4648	53874	3777	55881	3128	57638	2188	69539	2077	32105
2L-7S		MI	18200	6206	29013	4537	30743	3693	30746	3050	29482	2121	34397	1573	19998
14-#11	1.42	MA	30081	6206	47476	4648	51996	3776	53599	3139	54545	2197	65313	1988	32099
3L-6S		MI	18565	6206	29675	4526	31550	3684	31770	3057	30768	2114	36084	1662	20294
14-#11	1.42	MA	29395	6206	46298	4662	50498	3788	51780	3137	52184	2207	62536	1900	32044
4L-5S		MI	18939	6206	30293	4529	32389	3688	32757	3049	32082	2107	37703	1721	20660
14-#11	1.42	MA	28782	6206	45267	4662	49168	3787	50151	3149	49859	2202	59659	1854	31909
5L-4S		MI	19330	6206	30948	4532	33232	3679	33789	3042	33514	2114	39432	1761	20672
14-#11	1.42	MA	28199	6206	44295	4662	47847	3800	48539	3146	47724	2211	56906	1796	31210
6L-3S		MI	19764	6206	31691	4521	34178	3684	34936	3048	34964	2107	41056	1849	20649
14-#11	1.42	MA	27629	6206	43255	4676	46578	3799	46984	3158	45636	2221	54043	1709	30570
7L-2S		MI	20371	6206	32611	4524	35350	3675	36361	3041	36854	2100	43553	1938	20615
14-#14	2.05	MA	33114	6548	53480	4849	59563	3921	62763	3215	66946	2160	82021	2022	45757
2L-7S		MI	18523	6548	30274	4734	32262	3836	32550	3132	31872	2080	37989	1343	27044
14-#14	2.05	MA	31734	6548	51370	4849	56873	3919	59493	3231	62516	2172	75999	1894	45676
3L-6S		MI	19038	6548	31221	4719	33416	3824	34013	3142	33696	2070	40136	1442	27828
14-#14	2.05	MA	30766	6548	49680	4868	54724	3937	56885	3227	59130	2185	72046	1766	45459
4L-5S		MI	19565	6548	32106	4724	34616	3831	35421	3132	35560	2060	42423	1528	28426
14-#14	2.05	MA	29902	6548	48201	4868	52815	3935	54547	3243	55793	2178	67941	1701	44372
5L-4S		MI	20117	6548	33042	4729	35823	3819	36894	3122	37591	2070	44871	1585	29098
14-#14	2.05	MA	29078	6548	46805	4868	50919	3953	52234	3239	52730	2190	64020	1617	43117
6L-3S		MI	20730	6548	34105	4714	37175	3826	38532	3132	39647	2060	47166	1712	29153
14-#14	2.05	MA	28273	6548	45312	4887	49098	3950	50002	3255	49733	2203	59941	1491	41742
7L-2S		MI	21584	6548	35417	4719	38847	3814	40562	3122	42328	2050	50697	1840	29141
14-#18	3.65	MA	34078	7417	58082	5397	65267	4318	69639	3459	76492	2131	95527	1410	76657
4L-5S		MI	21057	7417	36545	5225	40113	4197	41853	3332	44052	1931	53855	1014	46512

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

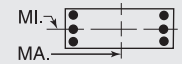


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.65	MA	32611	7417	55478	5395	61909	4348	65526	3485	70623	2115	88380	1298	73571
5L-4S		MI	21994	7417	38182	5236	42222	4178	44384	3314	47543	1949	58034	1117	47959
14-#18	3.65	MA	31213	7417	53021	5393	58570	4342	61454	3476	65232	2134	81585	1149	69726
6L-3S		MI	23033	7417	40039	5212	44582	4195	47198	3332	51075	1931	61963	1337	49852
14-#18	3.65	MA	29849	7417	50391	5426	55365	4372	57526	3502	59956	2154	74514	924	65962
7L-2S		MI	24477	7417	42321	5223	47492	4176	50685	3314	55682	1913	67989	1565	50047
16-#11	1.63	MA	31752	6316	50422	4717	55751	3827	58164	3159	60730	2181	73764	2065	36594
2L-8S		MI	18270	6316	29325	4603	31102	3738	31203	3089	30102	2118	35279	1504	22308
16-#11	1.63	MA	30778	6316	48949	4717	53874	3826	55881	3171	57638	2190	69539	1976	36570
3L-7S		MI	18628	6316	29933	4606	31916	3743	32171	3082	31372	2111	36894	1551	22717
16-#11	1.63	MA	30097	6316	47771	4731	52376	3839	54063	3168	55276	2200	66762	1888	36497
4L-6S		MI	18991	6316	30594	4595	32722	3734	33195	3088	32658	2104	38581	1639	22998
16-#11	1.63	MA	29488	6316	46740	4731	51046	3837	52434	3180	52951	2195	63885	1842	36342
5E		MI	19363	6316	31213	4598	33561	3738	34182	3081	33973	2097	40200	1698	23441
16-#11	1.63	MA	28907	6316	45768	4731	49724	3850	50821	3178	50816	2204	61132	1784	35560
6L-4S		MI	19752	6316	31867	4601	34404	3729	35214	3073	35404	2104	41929	1738	23472
16-#11	1.63	MA	28341	6316	44727	4745	48456	3849	49267	3189	48728	2214	58269	1697	34942
7L-3S		MI	20184	6316	32611	4590	35350	3734	36361	3080	36854	2097	43553	1827	23463
16-#11	1.63	MA	27783	6316	43774	4745	47176	3862	47745	3201	46540	2209	55580	1644	34171
8L-2S		MI	20788	6316	33530	4593	36522	3725	37786	3072	38745	2090	46050	1915	23437
16-#14	2.34	MA	32712	6708	53480	4949	59563	3992	62763	3276	66946	2162	82021	1875	52054
3L-7S		MI	19125	6708	31586	4834	33935	3908	34580	3177	34553	2065	41520	1308	30813
16-#14	2.34	MA	31752	6708	51790	4968	57414	4009	60155	3272	63560	2175	78068	1747	51807
4L-6S		MI	19636	6708	32533	4819	35089	3896	36043	3187	36377	2055	43667	1407	31686
16-#14	2.34	MA	30895	6708	50311	4968	55505	4007	57817	3288	60224	2168	73962	1682	50567
5E		MI	20160	6708	33418	4824	36289	3903	37451	3177	38241	2045	45953	1492	32250
16-#14	2.34	MA	30077	6708	48915	4967	53609	4025	55504	3284	57160	2180	70041	1598	49361
6L-4S		MI	20708	6708	34354	4829	37495	3891	38925	3167	40272	2055	48401	1550	33054
16-#14	2.34	MA	29280	6708	47422	4987	51788	4023	53272	3300	54163	2193	65963	1472	47902
7L-3S		MI	21317	6708	35417	4814	38847	3899	40562	3177	42328	2045	50697	1677	33134
16-#14	2.34	MA	28493	6708	46052	4986	49951	4041	51088	3316	51023	2185	62125	1397	46329
8L-2S		MI	22166	6708	36729	4818	40520	3886	42592	3167	45010	2035	54227	1805	33148
16-#18	4.17	MA	34298	7701	59179	5572	66627	4476	71262	3565	78394	2097	98826	1259	84483
5E		MI	22060	7701	38827	5402	43023	4326	45340	3407	48658	1899	59882	942	53175
16-#18	4.17	MA	32916	7701	56722	5570	63289	4471	67190	3556	73003	2117	92031	1109	80490
6L-4S		MI	22988	7701	40464	5413	45132	4307	47871	3390	52149	1917	64061	1046	54528
16-#18	4.17	MA	31568	7701	54092	5603	60084	4500	63262	3582	67727	2136	84960	884	76636
7L-3S		MI	24018	7701	42321	5389	47492	4323	50685	3407	55682	1899	67989	1266	56701
16-#18	4.17	MA	30238	7701	51680	5601	56849	4495	59416	3608	62201	2120	78281	754	72212
8L-2S		MI	25451	7701	44604	5400	50402	4304	54173	3390	60288	1881	74016	1493	56951
18-#11	1.83	MA	31471	6427	50422	4787	55751	3876	58164	3202	60730	2184	73764	1964	41035
3L-8S		MI	18696	6427	30245	4673	32274	3788	32628	3120	31993	2108	37776	1481	24973
18-#11	1.83	MA	30793	6427	49244	4800	54253	3889	56345	3199	58368	2193	70988	1875	40946
4L-7S		MI	19052	6427	30852	4676	33088	3793	33596	3113	33263	2101	39391	1528	25439
18-#11	1.83	MA	30188	6427	48213	4800	52923	3888	54716	3211	56043	2188	68111	1830	40773
5L-6S		MI	19414	6427	31514	4665	33894	3784	34620	3119	34549	2094	41079	1616	25708
18-#11	1.83	MA	29611	6427	47241	4800	51602	3900	53104	3209	53908	2198	65358	1772	39917
6L-5S		MI	19784	6427	32132	4667	34733	3789	35607	3112	35863	2087	42697	1675	26181
18-#11	1.83	MA	29049	6427	46200	4814	50333	3899	51549	3220	51820	2207	62495	1685	39318
7L-4S		MI	20171	6427	32786	4670	35576	3779	36639	3104	37295	2094	44426	1715	26263
18-#11	1.83	MA	28494	6427	45246	4814	49054	3912	50027	3232	49632	2202	59806	1632	38493
8L-3S		MI	20601	6427	33530	4659	36522	3784	37786	3111	38745	2087	46050	1804	26271
18-#11	1.83	MA	27897	6427	44310	4814	47803	3911	48452	3229	47566	2211	57139	1576	37585
9L-2S		MI	21203	6427	34450	4662	37694	3775	39211	3103	40636	2081	48547	1893	26252
18-#14	2.64	MA	32731	6868	53900	5068	60104	4082	63425	3317	67990	2165	84090	1728	58151
4L-7S		MI	19722	6868	32898	4934	35607	3981	36611	3221	37235	2049	45050	1273	34594
18-#14	2.64	MA	31880	6868	52421	5068	58195	4080	61087	3333	64654	2158	79984	1663	56775
5L-6S		MI	20230	6868	33844	4919	36761	3968	38073	3231	39058	2039	47197	1371	35550

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

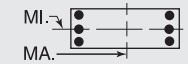


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.64	MA	31069	6868	51025	5067	56299	4097	58774	3329	61590	2170	76063	1579	55613
6L-5S		MI	20750	6868	34730	4924	37962	3976	39481	3221	40922	2029	49484	1457	36085
18-#14	2.64	MA	30278	6868	49532	5087	54478	4095	56542	3345	58593	2183	71984	1453	54073
7L-4S		MI	21295	6868	35666	4928	39168	3963	40955	3211	42953	2039	51932	1514	37004
18-#14	2.64	MA	29498	6868	48162	5086	52641	4113	54358	3361	55453	2175	68147	1378	52543
8L-3S		MI	21900	6868	36729	4913	40520	3971	42592	3221	45010	2029	54227	1641	37107
18-#14	2.64	MA	28680	6868	46818	5086	50846	4111	52098	3357	52487	2188	64348	1297	50516
9L-2S		MI	22745	6868	38041	4918	42193	3958	44623	3211	47691	2019	57758	1769	37145
18-#18	4.69	MA	34601	7985	60422	5748	68007	4599	72926	3636	80774	2099	102477	1070	91274
6L-5S		MI	23055	7985	41109	5580	45932	4455	48828	3483	53265	1867	65908	870	59627
18-#18	4.69	MA	33268	7985	57793	5781	64802	4629	68998	3662	75498	2119	95405	845	87329
7L-4S		MI	23975	7985	42746	5591	48042	4435	51359	3466	56756	1884	70087	974	61124
18-#18	4.69	MA	31954	7985	55381	5778	61568	4623	65152	3688	69972	2103	88727	714	82874
8L-3S		MI	24996	7985	44604	5566	50402	4452	54173	3483	60288	1867	74016	1194	63542
20-#11	2.03	MA	31486	6538	50716	4870	56131	3939	58628	3231	61461	2186	75214	1863	45392
4L-8S		MI	19120	6538	31164	4742	33446	3839	34053	3151	33883	2098	40274	1458	27646
20-#11	2.03	MA	30884	6538	49685	4870	54801	3938	56998	3242	59135	2181	72337	1818	45203
5L-7S		MI	19475	6538	31772	4745	34260	3843	35021	3144	35153	2091	41888	1505	28164
20-#11	2.03	MA	30311	6538	48713	4870	53479	3950	55386	3240	57001	2191	69584	1760	44280
6E		MI	19835	6538	32433	4734	35066	3834	36045	3150	36440	2084	43576	1593	28422
20-#11	2.03	MA	29752	6538	47673	4883	52211	3949	53831	3251	54912	2200	66721	1672	43698
7L-5S		MI	20203	6538	33052	4737	35905	3839	37031	3143	37754	2078	45194	1652	28871
20-#11	2.03	MA	29201	6538	46719	4883	50931	3962	52310	3263	52724	2195	64032	1620	42821
8L-4S		MI	20588	6538	33706	4739	36749	3830	38064	3135	39185	2084	46923	1692	29049
20-#11	2.03	MA	28607	6538	45783	4883	49681	3961	50735	3261	50658	2205	61365	1564	41935
9L-3S		MI	21016	6538	34450	4729	37694	3834	39211	3142	40636	2078	48547	1781	29074
20-#11	2.03	MA	27999	6538	44760	4897	48417	3973	49223	3272	48607	2214	58777	1501	40834
10L-2S		MI	21615	6538	35369	4731	38866	3825	40636	3134	42526	2071	51044	1870	29063
20-#14	2.93	MA	32857	7027	54531	5167	60885	4152	64357	3378	69084	2148	86006	1644	62994
5L-7S		MI	20315	7027	34210	5033	37280	4053	38641	3266	39916	2034	48581	1237	38386
20-#14	2.93	MA	32052	7027	53135	5167	58989	4170	62044	3374	66021	2160	82085	1560	61871
6E		MI	20820	7027	35156	5018	38434	4041	40104	3276	41740	2024	50728	1336	39419
20-#14	2.93	MA	31268	7027	51642	5186	57168	4167	59812	3390	63023	2173	78006	1434	60253
7L-5S		MI	21337	7027	36041	5023	39634	4048	41512	3266	43604	2014	53014	1422	39929
20-#14	2.93	MA	30494	7027	50272	5186	55331	4185	57628	3406	59883	2165	74168	1359	58764
8L-4S		MI	21878	7027	36978	5028	40841	4036	42985	3256	45635	2024	55463	1479	40948
20-#14	2.93	MA	29678	7027	48928	5186	53536	4183	55368	3402	56918	2178	70370	1278	56688
9L-3S		MI	22480	7027	38041	5013	42193	4043	44623	3266	47691	2014	57758	1606	41074
20-#14	2.93	MA	28809	7027	47460	5205	51723	4201	53197	3418	53974	2191	66684	1187	54557
10L-2S		MI	23320	7027	39353	5018	43865	4031	46653	3256	50372	2004	61288	1734	41130
20-#18	5.21	MA	34951	8268	61494	5958	69520	4757	74734	3742	83269	2101	105851	805	98042
7L-5S		MI	24042	8268	43392	5757	48842	4583	52315	3559	57871	1835	71935	799	66068
20-#18	5.21	MA	33651	8268	59082	5956	66286	4752	70888	3768	77743	2085	99173	675	93538
8L-4S		MI	24954	8268	45029	5768	50952	4564	54846	3542	61362	1852	76114	902	67740
22-#11	2.23	MA	31576	6648	51158	4939	56678	3988	59281	3273	62227	2174	76563	1806	49562
5L-8S		MI	19543	6648	32083	4811	34618	3889	35478	3182	35774	2088	42771	1435	30323
22-#11	2.23	MA	31006	6648	50186	4939	55357	4001	57669	3271	60093	2184	73810	1748	48648
6L-7S		MI	19895	6648	32691	4814	35432	3893	36446	3175	37044	2081	44385	1482	30891
22-#11	2.23	MA	30450	6648	49145	4953	54088	3999	56114	3282	58004	2193	70947	1660	48081
7L-6S		MI	20253	6648	33353	4803	36238	3884	37470	3181	38330	2075	46073	1570	31140
22-#11	2.23	MA	29902	6648	48192	4953	52809	4012	54592	3294	55817	2188	68258	1608	47154
8L-5S		MI	20620	6648	33971	4806	37077	3889	38456	3174	39644	2068	47691	1630	31567
22-#11	2.23	MA	29312	6648	47255	4953	51558	4011	53017	3292	53750	2198	65591	1552	46289
9L-4S		MI	21003	6648	34625	4809	37921	3880	39489	3167	41076	2075	49421	1670	31832
22-#11	2.23	MA	28707	6648	46233	4966	50295	4024	51505	3303	51699	2207	63003	1489	45154
10L-3S		MI	21429	6648	35369	4798	38866	3884	40636	3173	42526	2068	51044	1758	31865
22-#11	2.23	MA	28115	6648	45297	4966	49052	4022	49949	3301	49542	2202	60376	1433	44115
11L-2S		MI	22026	6648	36289	4801	40039	3875	42061	3165	44417	2061	53541	1847	31870

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

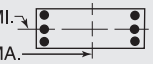
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.22	MA	33029	7187	55245	5267	61679	4242	65314	3419	70451	2150	88106	1541	68136
6L-7S		MI	20904	7187	35522	5133	38953	4125	40671	3311	42597	2018	52111	1202	42187
22-#14	3.22	MA	32250	7187	53751	5286	59858	4240	63082	3435	67453	2163	84028	1415	66442
7L-6S		MI	21406	7187	36468	5118	40106	4113	42134	3321	44421	2008	54258	1301	43290
22-#14	3.22	MA	31482	7187	52382	5286	58021	4258	60898	3451	64314	2156	80190	1340	64991
8L-5S		MI	21920	7187	37353	5123	41307	4120	43542	3311	46285	1998	56545	1386	43780
22-#14	3.22	MA	30668	7187	51038	5285	56226	4255	58638	3447	61348	2168	76391	1259	62868
9L-4S		MI	22458	7187	38290	5128	42513	4108	45016	3301	48316	2008	58993	1444	44798
22-#14	3.22	MA	29809	7187	49570	5305	54413	4273	56467	3463	58404	2181	72706	1168	60704
10L-3S		MI	23056	7187	39353	5113	43865	4115	46653	3311	50372	1998	61288	1571	45036
22-#18	5.73	MA	35333	8552	62782	6133	71004	4880	76623	3848	85514	2067	109619	635	104217
8L-5S		MI	25023	8552	45674	5934	51752	4712	55802	3635	62478	1803	77962	727	72535
24-#11	2.44	MA	31697	6759	51659	5008	57234	4051	59951	3302	63185	2177	78036	1736	53020
6L-8S		MI	19962	6759	33003	4880	35791	3939	36903	3213	37665	2078	45268	1413	33006
24-#11	2.44	MA	31145	6759	50618	5022	55966	4050	58396	3314	61096	2186	75173	1648	52467
7E		MI	20314	6759	33610	4883	36604	3944	37871	3206	38935	2072	46882	1460	33600
24-#11	2.44	MA	30600	6759	49664	5022	54686	4062	56874	3325	58909	2182	72484	1595	51492
8L-6S		MI	20670	6759	34272	4872	37411	3934	38895	3212	40221	2065	48570	1548	33861
24-#11	2.44	MA	30013	6759	48728	5022	53436	4061	55300	3323	56842	2191	69817	1540	50647
9L-5S		MI	21035	6759	34890	4875	38250	3939	39881	3205	41535	2058	50188	1607	34269
24-#11	2.44	MA	29411	6759	47705	5036	52173	4074	53787	3334	54792	2200	67228	1476	49479
10L-4S		MI	21416	6759	35545	4878	39093	3930	40914	3198	42967	2065	51918	1647	34611
24-#11	2.44	MA	28822	6759	46769	5036	50930	4073	52231	3332	52634	2196	64602	1421	48347
11L-3S		MI	21841	6759	36289	4867	40039	3934	42061	3204	44417	2058	53541	1736	34655
24-#11	2.44	MA	28244	6759	45763	5049	49675	4085	50723	3344	50587	2205	61710	1346	47005
12L-2S		MI	22435	6759	37208	4870	41211	3925	43486	3197	46307	2051	56038	1824	34673
24-#14	3.52	MA	33226	7346	55861	5386	62548	4312	66352	3480	71884	2153	90049	1396	72640
7E		MI	21490	7346	36834	5233	40625	4198	42702	3355	45279	2003	55642	1167	45996
24-#14	3.52	MA	32463	7346	54492	5385	60711	4330	64168	3496	68744	2146	86212	1321	71158
8L-6S		MI	21989	7346	37780	5218	41779	4185	44164	3365	47102	1993	57789	1265	47057
24-#14	3.52	MA	31650	7346	53148	5385	58916	4328	61908	3492	65778	2158	82413	1240	69055
9L-5S		MI	22500	7346	38665	5223	42980	4193	45572	3355	48966	1983	60075	1351	47637
24-#14	3.52	MA	30802	7346	51680	5404	57103	4345	59737	3508	62834	2171	78728	1149	66858
10L-4S		MI	23035	7346	39601	5228	44186	4180	47046	3345	50997	1993	62524	1408	48607

RECTANGULAR TIED COLUMNS 34" x 34"

6-#14	1.17	MA	15876	4566	25157	3342	27106	2721	27669	2261	27615	1592	32384	1483	13666
2L-3S		MI	14940	4566	23745	3338	25306	2734	25481	2272	24709	1602	28543	1355	13727
6-#18	2.08	MA	17260	4939	28388	3548	31105	2867	32419	2342	33821	1532	40456	1368	23474
2L-3S		MI	15661	4939	25928	3538	27969	2888	28629	2360	28816	1550	33880	1141	23418
8-#11	1.08	MA	15759	4530	24831	3334	26752	2716	27261	2261	27128	1606	31779	1504	12732
2L-4S		MI	14631	4530	23044	3343	24476	2721	24497	2263	23512	1620	27300	1326	12803
8-#14	1.56	MA	16520	4726	26569	3442	28906	2793	29857	2306	30521	1578	36225	1451	18006
2L-4S		MI	14927	4726	24015	3454	25655	2800	25908	2308	25386	1598	29886	1195	17969
8-#18	2.77	MA	18343	5222	30848	3725	34241	2995	36209	2420	38826	1503	47032	1302	30977
2L-4S		MI	15632	5222	26391	3741	28567	3002	29362	2420	29983	1538	36176	851	28669
10-#11	1.35	MA	16214	4641	25819	3403	28012	2766	28793	2292	29175	1597	34492	1483	15773
2L-5S		MI	14674	4641	23331	3409	24833	2781	24923	2303	24009	1604	28140	1265	15681
10-#11	1.35	MA	15560	4641	24831	3400	26752	2775	27261	2300	27128	1604	31779	1394	15805
3L-4S		MI	15094	4641	24032	3412	25737	2771	26030	2294	25558	1611	30012	1306	15807
10-#14	1.95	MA	17157	4886	27980	3542	30706	2865	32045	2351	33427	1564	40065	1418	22328
2L-5S		MI	14986	4886	24423	3550	26160	2885	26511	2364	26091	1574	31068	1104	21154
10-#14	1.95	MA	16236	4886	26569	3538	28906	2879	29857	2362	30521	1574	36225	1290	22325
3L-4S		MI	15578	4886	25427	3554	27454	2872	28096	2353	28292	1584	33727	1162	22211
10-#18	3.46	MA	19411	5506	33307	3902	37377	3124	39999	2498	43832	1474	53608	1236	38438
2L-5S		MI	15729	5506	27093	3909	29438	3151	30401	2516	31196	1491	38193	682	33714
10-#18	3.46	MA	17851	5506	30848	3893	34241	3145	36209	2516	38826	1491	47032	1009	38184
3L-4S		MI	16734	5506	28851	3919	31703	3130	33152	2498	34988	1509	42753	785	35681

RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

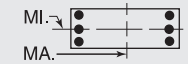
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.31	MA	18027	4895	28768	3566	31056	2899	31812	2403	31955	1671	37585	1546	17004
2E		MI	16980	4895	27164	3548	29245	2884	29867	2388	29922	1656	35099	1526	15968
6-#14	1.10	MA	17715	4807	27933	3538	30121	2881	30723	2398	30635	1701	35927	1592	14577
2L-3S		MI	15758	4807	24976	3517	26583	2881	26723	2397	25820	1698	29771	1448	13767
6-#14	1.10	MA	16710	4807	26421	3534	28194	2895	28380	2410	27504	1711	31776	1464	14638
3L-2S		MI	16695	4807	26388	3521	28383	2868	28911	2386	28726	1688	33611	1576	13701
6-#18	1.96	MA	19217	5179	31405	3743	34418	3027	35898	2483	37360	1645	44711	1485	25094
2L-3S		MI	16480	5179	27164	3716	29245	3034	29867	2484	29922	1645	35099	1233	23500
6-#18	1.96	MA	17498	5179	28768	3735	31056	3050	31812	2501	31955	1662	37585	1257	25038
3L-2S		MI	18082	5179	29624	3725	32381	3013	33657	2466	34927	1627	41675	1460	23526
8-#11	1.02	MA	17587	4771	27580	3529	29737	2876	30281	2397	30101	1714	35256	1612	13574
2L-4S		MI	15449	4771	24272	3522	25753	2869	25741	2389	24626	1716	28531	1420	12845
8-#11	1.02	MA	16881	4771	26522	3527	28388	2887	28641	2406	27898	1721	32328	1523	13618
3E		MI	15919	4771	25070	3511	26768	2873	26972	2395	26196	1709	30298	1508	12809
8-#11	1.02	MA	16379	4771	25669	3539	27304	2883	27326	2401	26208	1728	30417	1435	13645
4L-2S		MI	16578	4771	26059	3513	28029	2863	28504	2386	28243	1703	33010	1597	12763
8-#14	1.47	MA	18410	4966	29444	3637	32048	2954	33065	2443	33767	1688	40078	1562	19221
2L-4S		MI	15745	4966	25246	3633	26931	2947	27149	2433	26497	1694	31113	1287	18041
8-#14	1.47	MA	17413	4966	27933	3634	30121	2968	30723	2455	30635	1698	35927	1434	19254
3E		MI	16410	4966	26388	3617	28383	2953	28911	2442	28726	1684	33611	1415	18087
8-#14	1.47	MA	16703	4966	26713	3651	28569	2962	28840	2446	28234	1708	33222	1306	19184
4L-2S		MI	17340	4966	27799	3621	30183	2940	31099	2431	31633	1674	37452	1543	18046
8-#18	2.61	MA	20388	5463	34042	3920	37780	3156	39985	2563	42765	1618	51838	1424	33137
2L-4S		MI	16450	5463	27627	3919	29844	3148	30600	2544	31089	1633	37396	943	29010
8-#18	2.61	MA	18690	5463	31405	3912	34418	3179	35898	2581	37360	1636	44711	1197	32970
3E		MI	17585	5463	29624	3893	32381	3162	33657	2562	34927	1616	41675	1167	30904
8-#18	2.61	MA	17477	5463	29269	3940	31703	3166	32604	2564	33215	1653	40081	969	30938
4L-2S		MI	19168	5463	32083	3902	35517	3141	37447	2544	39933	1598	48251	1394	31039
10-#11	1.27	MA	18078	4881	28637	3598	31085	2926	31920	2428	32304	1706	38184	1593	16826
2L-5S		MI	15492	4881	24559	3589	26110	2929	26166	2428	25123	1701	29371	1358	15809
10-#11	1.27	MA	17376	4881	27580	3596	29737	2937	30281	2437	30101	1713	35256	1504	16858
3L-4S		MI	15912	4881	25260	3592	27014	2919	27273	2420	26673	1707	31243	1399	15857
10-#11	1.27	MA	16878	4881	26727	3608	28653	2933	28965	2432	28411	1720	33346	1415	16860
4L-3S		MI	16379	4881	26059	3580	28029	2923	28504	2426	28243	1701	33010	1488	15843
10-#11	1.27	MA	16430	4881	25979	3606	27687	2944	27784	2441	26744	1713	31330	1374	16793
5L-2S		MI	17034	4881	27047	3583	29289	2914	30036	2417	30289	1694	35723	1576	15808
10-#14	1.84	MA	19098	5126	30956	3737	33975	3026	35408	2488	36898	1676	44229	1532	23846
2L-5S		MI	15803	5126	25653	3729	27437	3033	27753	2489	27203	1670	32296	1197	21357
10-#14	1.84	MA	18109	5126	29444	3734	32048	3040	33065	2499	33767	1685	40078	1405	23844
3L-4S		MI	16396	5126	26658	3733	28731	3019	29337	2478	29404	1680	34954	1255	22291
10-#14	1.84	MA	17405	5126	28224	3750	30496	3034	31183	2491	31365	1695	37373	1277	23729
4L-3S		MI	17056	5126	27799	3717	30183	3026	31099	2487	31633	1670	37452	1383	22381
10-#14	1.84	MA	16772	5126	27152	3747	29114	3049	29491	2503	28995	1685	34508	1217	22714
5L-2S		MI	17979	5126	29211	3721	31983	3012	33286	2476	34539	1660	41292	1511	22372
10-#18	3.27	MA	21543	5747	36679	4098	41142	3284	44072	2643	48170	1592	58965	1363	41138
2L-5S		MI	16544	5747	28329	4087	30714	3297	31640	2640	32302	1587	39412	774	34262
10-#18	3.27	MA	19865	5747	34042	4090	37780	3307	39985	2661	42765	1609	51838	1136	40884
3L-4S		MI	17554	5747	30087	4096	32980	3276	34390	2622	36094	1604	43972	877	36013
10-#18	3.27	MA	18668	5747	31906	4117	35065	3295	36691	2644	38620	1627	47208	909	38465
4L-3S		MI	18675	5747	32083	4070	35517	3291	37447	2640	39933	1587	48251	1101	38287
10-#18	3.27	MA	17591	5747	30027	4109	32643	3317	33726	2662	34526	1609	42266	807	36570
5L-2S		MI	20240	5747	34543	4080	38653	3270	41237	2622	44938	1569	54828	1328	38507

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.53	MA	18565	4992	29695	3667	32434	2977	33559	2459	34507	1698	41112	1574	20067
2L-6S		MI	15555	4992	24885	3656	26471	2975	26601	2454	25747	1699	30324	1278	18147
12-#11	1.53	MA	17868	4992	28637	3665	31085	2987	31920	2468	32304	1705	38184	1485	20087
3L-5S		MI	15954	4992	25548	3658	27370	2979	27698	2459	27170	1692	32083	1337	18703
12-#11	1.53	MA	17372	4992	27785	3677	30001	2983	30605	2463	30614	1712	36274	1396	20064
4E		MI	16371	4992	26249	3661	28274	2970	28805	2451	28719	1699	33956	1378	18856
12-#11	1.53	MA	16927	4992	27036	3675	29036	2994	29423	2472	28947	1705	34258	1354	19893
5L-3S		MI	16836	4992	27047	3649	29289	2974	30036	2457	30289	1692	35723	1467	18865
12-#11	1.53	MA	16502	4992	26329	3673	28076	2990	28253	2467	27415	1712	32357	1296	19278
6L-2S		MI	17487	4992	28036	3652	30549	2964	31568	2449	32336	1685	38435	1556	18841
12-#14	2.21	MA	19780	5286	32467	3837	35902	3098	37751	2532	40029	1663	48380	1503	28460
2L-6S		MI	15891	5286	26116	3824	27949	3098	28427	2545	28089	1666	33647	1079	24790
12-#14	2.21	MA	18798	5286	30956	3834	33975	3112	35408	2544	36898	1673	44229	1375	28420
3L-5S		MI	16453	5286	27065	3828	29237	3105	29941	2534	30109	1656	36136	1165	25455
12-#14	2.21	MA	18100	5286	29736	3850	32423	3107	33526	2536	34496	1683	41524	1247	28268
4E		MI	17041	5286	28069	3832	30531	3092	31525	2523	32310	1666	38794	1223	26532
12-#14	2.21	MA	17472	5286	28663	3847	31041	3121	31833	2548	32126	1673	38660	1188	27108
5L-3S		MI	17696	5286	29211	3817	31983	3098	33286	2532	34539	1656	41292	1351	26660
12-#14	2.21	MA	16873	5286	27651	3844	29667	3115	30157	2540	29949	1683	35966	1102	26366
6L-2S		MI	18612	5286	30623	3821	33783	3085	35474	2521	37445	1646	45133	1479	26684
12-#18	3.92	MA	21026	6030	36679	4267	41142	3436	44072	2741	48170	1583	58965	1075	48786
3L-5S		MI	17647	6030	30788	4264	33850	3426	35430	2718	37307	1557	45988	709	41131
12-#18	3.92	MA	19843	6030	34543	4294	38427	3423	40778	2724	44024	1600	54335	848	46037
4E		MI	18644	6030	32547	4273	36116	3405	38180	2701	41099	1575	50548	811	43061
12-#18	3.92	MA	18780	6030	32664	4286	36005	3446	37813	2742	39931	1583	49393	746	43981
5L-3S		MI	19752	6030	34543	4247	38653	3419	41237	2718	44938	1557	54828	1035	45657
12-#18	3.92	MA	17766	6030	30887	4278	33595	3433	34981	2760	36174	1600	44776	594	40888
6L-2S		MI	21300	6030	37003	4257	41789	3398	45027	2701	49943	1540	61404	1262	45953
14-#11	1.78	MA	19049	5103	30753	3736	33782	3027	35199	2491	36709	1690	44040	1555	23301
2L-7S		MI	15630	5103	25164	3737	26867	3035	27075	2493	26401	1696	31202	1169	20682
14-#11	1.78	MA	18355	5103	29695	3735	32434	3037	33559	2499	34507	1697	41112	1466	23304
3L-6S		MI	16016	5103	25873	3725	27731	3025	28133	2485	27794	1690	33036	1257	21051
14-#11	1.78	MA	17863	5103	28843	3746	31350	3034	32244	2494	32817	1704	39202	1377	23262
4L-5S		MI	16412	5103	26536	3728	28630	3029	29230	2490	29217	1683	34796	1316	21574
14-#11	1.78	MA	17421	5103	28094	3745	30385	3044	31062	2503	31149	1697	37186	1335	22969
5L-4S		MI	16827	5103	27238	3730	29534	3020	30337	2482	30766	1690	36668	1357	21847
14-#11	1.78	MA	16999	5103	27387	3743	29425	3040	29892	2498	29618	1704	35285	1276	22387
6L-3S		MI	17289	5103	28036	3719	30549	3024	31568	2488	32336	1683	38435	1446	21880
14-#11	1.78	MA	16587	5103	26631	3755	28503	3051	28762	2507	28119	1711	33304	1189	21982
7L-2S		MI	17936	5103	29024	3721	31810	3014	33101	2480	34383	1676	41148	1535	21866
14-#14	2.57	MA	20456	5445	33979	3937	37829	3171	40093	2577	43161	1650	52532	1473	33054
2L-7S		MI	15996	5445	26513	3940	28512	3184	29043	2580	29018	1662	34891	920	27594
14-#14	2.57	MA	19481	5445	32467	3933	35902	3185	37751	2589	40029	1660	48380	1345	32988
3L-6S		MI	16540	5445	27528	3924	29749	3171	30615	2589	30995	1652	37487	1047	28867
14-#14	2.57	MA	18788	5445	31247	3950	34350	3179	35868	2581	37627	1670	45675	1217	32801
4L-5S		MI	17097	5445	28477	3928	31037	3177	32129	2579	33015	1642	39977	1132	29568
14-#14	2.57	MA	18166	5445	30175	3947	32968	3193	34176	2593	35257	1660	42811	1158	31517
5L-4S		MI	17681	5445	29481	3932	32331	3164	33713	2568	35216	1652	42635	1190	30767
14-#14	2.57	MA	17572	5445	29162	3943	31594	3188	32500	2585	33080	1670	40117	1073	30766
6L-3S		MI	18330	5445	30623	3916	33783	3170	35474	2577	37445	1642	45133	1318	30928
14-#14	2.57	MA	16993	5445	28078	3960	30273	3202	30882	2597	30950	1680	37311	946	29365
7L-2S		MI	19240	5445	32035	3920	35582	3157	37662	2566	40351	1632	48974	1446	30982
14-#18	4.58	MA	21005	6314	37180	4472	41789	3552	44865	2803	49429	1574	61462	787	53644
4L-5S		MI	18736	6314	33248	4441	36986	3555	39219	2796	42313	1528	52564	643	48038
14-#18	4.58	MA	19955	6314	35301	4464	39367	3574	41900	2821	45336	1556	56520	685	51415
5L-4S		MI	19722	6314	35006	4451	39251	3534	41970	2779	46105	1546	57124	745	50144
14-#18	4.58	MA	18953	6314	33524	4456	36957	3562	39068	2839	41579	1574	51902	533	48461
6L-3S		MI	20817	6314	37003	4425	41789	3548	45027	2796	49943	1528	61404	969	53018

RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

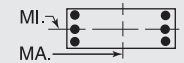
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.04	MA	19530	5213	31811	3806	35131	3077	36838	2522	38912	1682	46969	1535	26528
2L-8S		MI	15711	5213	25502	3803	27255	3081	27570	2532	26989	1681	32166	1100	22844
16-#11	2.04	MA	18840	5213	30753	3804	33782	3087	35199	2531	36709	1689	44040	1447	26514
3L-7S		MI	16090	5213	26153	3806	28127	3085	28607	2524	28448	1688	33915	1148	23527
16-#11	2.04	MA	18350	5213	29900	3816	32698	3084	33883	2526	35019	1696	42130	1358	26455
4L-6S		MI	16474	5213	26862	3794	28991	3076	29665	2516	29841	1681	35748	1236	23960
16-#11	2.04	MA	17911	5213	29152	3814	31733	3094	32702	2534	33352	1689	40114	1316	26055
5E		MI	16868	5213	27525	3797	29891	3080	30762	2522	31263	1674	37508	1295	24456
16-#11	2.04	MA	17492	5213	28445	3812	30773	3091	31531	2529	31821	1696	38213	1257	25502
6L-4S		MI	17280	5213	28226	3799	30795	3070	31869	2513	32813	1681	39381	1336	24834
16-#11	2.04	MA	17082	5213	27688	3824	29851	3101	30402	2538	30322	1703	36232	1169	25033
7L-3S		MI	17739	5213	29024	3788	31810	3074	33101	2519	34383	1674	41148	1425	24881
16-#11	2.04	MA	16679	5213	26994	3822	28921	3098	29295	2547	28752	1696	34350	1121	24281
8L-2S		MI	18383	5213	30013	3790	33070	3064	34633	2511	36429	1667	43860	1514	24886
16-#14	2.94	MA	20158	5605	33979	4033	37829	3257	40093	2634	43161	1647	52532	1315	37548
3L-7S		MI	16644	5605	27924	4040	30312	3256	31231	2625	31924	1648	38732	888	31675
16-#14	2.94	MA	19471	5605	32758	4050	36277	3251	38211	2626	40759	1657	49827	1187	37227
4L-6S		MI	17183	5605	28940	4024	31549	3243	32803	2634	33901	1638	41328	1015	32896
16-#14	2.94	MA	18854	5605	31686	4046	34895	3266	36518	2638	38388	1647	46962	1128	35939
5E		MI	17736	5605	29889	4028	32836	3250	34317	2623	35922	1628	43818	1100	33694
16-#14	2.94	MA	18265	5605	30674	4043	33521	3260	34842	2630	36212	1657	44269	1043	35091
6L-4S		MI	18315	5605	30893	4032	34131	3236	35901	2613	38122	1638	46476	1158	34852
16-#14	2.94	MA	17691	5605	29590	4060	32200	3274	33224	2642	34081	1667	41462	916	33745
7L-3S		MI	18959	5605	32035	4016	35582	3243	37662	2622	40351	1628	48974	1286	35189
16-#14	2.94	MA	17124	5605	28595	4056	30867	3268	31639	2654	31848	1657	38787	847	32359
8L-2S		MI	19863	5605	33446	4020	37382	3229	39850	2611	43257	1618	52814	1414	35267
16-#18	5.23	MA	21117	6598	37938	4641	42729	3703	45987	2901	50741	1530	63647	625	58881
5E		MI	19814	6598	35708	4619	40122	3683	43009	2875	47318	1499	59140	577	54978
16-#18	5.23	MA	20127	6598	36161	4633	40319	3690	43155	2919	46984	1547	59029	473	56059
6L-4S		MI	20789	6598	37466	4628	42387	3662	45760	2857	51110	1517	63701	679	57256
18-#11	2.29	MA	19321	5324	31811	3873	35131	3137	36838	2562	38912	1681	46969	1428	29719
3L-8S		MI	16171	5324	26491	3873	28515	3132	29102	2563	29035	1672	34879	1080	25723
18-#11	2.29	MA	18834	5324	30958	3885	34047	3134	35523	2557	37222	1688	45058	1339	29644
4L-7S		MI	16547	5324	27142	3875	29387	3136	30139	2555	30495	1679	36627	1128	26380
18-#11	2.29	MA	18398	5324	30210	3883	33082	3144	34341	2566	35555	1681	43042	1297	29149
5L-6S		MI	16929	5324	27851	3864	30252	3126	31198	2547	31887	1672	38461	1216	26875
18-#11	2.29	MA	17981	5324	29503	3881	32122	3141	33171	2561	34024	1688	41141	1238	28622
6L-5S		MI	17320	5324	28513	3866	31151	3130	32294	2553	33310	1665	40221	1275	27346
18-#11	2.29	MA	17574	5324	28746	3893	31200	3151	32041	2569	32525	1695	39160	1150	28092
7L-4S		MI	17730	5324	29215	3868	32055	3120	33401	2545	34859	1672	42093	1315	27816
18-#11	2.29	MA	17173	5324	28052	3891	30269	3148	30935	2578	30954	1688	37278	1101	27367
8L-3S		MI	18186	5324	30013	3857	33070	3124	34633	2550	36429	1665	43860	1404	27878
18-#11	2.29	MA	16776	5324	27317	3903	29360	3158	29790	2573	29471	1695	35436	1045	26588
9L-2S		MI	18827	5324	31001	3859	34330	3114	36165	2542	38476	1658	46573	1493	27900
18-#14	3.31	MA	20148	5764	34270	4149	38204	3324	40553	2671	43890	1644	53978	1157	41594
4L-7S		MI	17286	5764	29336	4140	32111	3329	33419	2670	34830	1634	42573	855	35767
18-#14	3.31	MA	19536	5764	33198	4146	36822	3338	38861	2683	41520	1635	51113	1098	40371
5L-6S		MI	17821	5764	30351	4124	33349	3315	34991	2679	36807	1624	45168	982	36938
18-#14	3.31	MA	18952	5764	32185	4143	35448	3332	37185	2675	39343	1644	48420	1013	39430
6L-5S		MI	18370	5764	31300	4128	34636	3322	36504	2668	38828	1614	47658	1068	37829
18-#14	3.31	MA	18382	5764	31101	4159	34127	3346	35567	2687	37213	1654	45613	886	38135
7L-4S		MI	18944	5764	32304	4132	35931	3309	38089	2658	41028	1624	50316	1126	38926
18-#14	3.31	MA	17820	5764	30106	4156	32794	3341	33982	2699	34980	1644	42938	817	36694
8L-3S		MI	19584	5764	33446	4116	37382	3315	39850	2667	43257	1614	52814	1253	39445

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

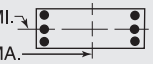


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	5.88	MA	21289	6881	38798	4810	43681	3819	47242	2999	52388	1521	66156	412	63678
6L-5S		MI	20883	6881	38168	4796	43258	3812	46799	2953	52323	1470	65717	511	61948
20-#11	2.55	MA	19315	5435	32016	3954	35395	3184	37162	2588	39425	1680	47986	1320	32830
4L-8S		MI	16627	5435	27479	3942	29776	3182	30634	2594	31082	1663	37591	1059	28608
20-#11	2.55	MA	18881	5435	31267	3952	34430	3194	35980	2597	37758	1673	45970	1278	32251
5L-7S		MI	17001	5435	28130	3944	30648	3186	31671	2586	32541	1670	39339	1107	29241
20-#11	2.55	MA	18467	5435	30560	3950	33470	3191	34810	2592	36227	1680	44069	1219	31747
6E		MI	17381	5435	28839	3933	31512	3176	32730	2578	33934	1663	41173	1195	29794
20-#11	2.55	MA	18063	5435	29804	3962	32548	3201	33680	2600	34728	1687	42088	1131	31159
7L-5S		MI	17770	5435	29502	3935	32411	3180	33826	2584	35357	1656	42933	1254	30243
20-#11	2.55	MA	17665	5435	29110	3960	31618	3198	32574	2609	33157	1680	40206	1082	30458
8L-4S		MI	18177	5435	30203	3937	33316	3170	34933	2576	36906	1663	44805	1295	30795
20-#11	2.55	MA	17270	5435	28375	3972	30709	3208	31430	2604	31674	1687	38364	1026	29642
9L-3S		MI	18631	5435	31001	3926	34330	3174	36165	2581	38476	1656	46573	1383	30871
20-#14	3.68	MA	20213	5924	34709	4246	38749	3410	41203	2728	44651	1622	55265	1068	44811
5L-7S		MI	17923	5924	30748	4239	33911	3401	35607	2715	37737	1620	46413	823	39868
20-#14	3.68	MA	19634	5924	33696	4243	37375	3405	39527	2720	42474	1632	52571	983	43782
6E		MI	18455	5924	31763	4223	35148	3388	37179	2724	39714	1610	49009	950	40993
20-#14	3.68	MA	19068	5924	32613	4259	36054	3419	37909	2732	40344	1642	49764	856	42533
7L-5S		MI	18999	5924	32712	4227	36436	3394	38692	2713	41734	1600	51499	1035	41972
20-#14	3.68	MA	18511	5924	31618	4256	34721	3413	36324	2743	38111	1632	47089	787	41039
8L-4S		MI	19569	5924	33716	4231	37730	3381	40277	2702	43934	1610	54157	1093	43014
22-#11	2.80	MA	19362	5545	32325	4021	35779	3244	37620	2628	39961	1665	48898	1259	35359
5L-8S		MI	17081	5545	28468	4011	31036	3232	32166	2626	33129	1654	40303	1038	31498
22-#11	2.80	MA	18951	5545	31618	4019	34819	3241	36449	2623	38430	1672	46997	1200	34876
6L-7S		MI	17453	5545	29119	4013	31908	3236	33203	2617	34588	1661	42052	1086	32109
22-#11	2.80	MA	18549	5545	30862	4031	33897	3251	35320	2632	36931	1679	45016	1112	34232
7L-6S		MI	17830	5545	29828	4002	32772	3226	34262	2609	35981	1654	43886	1174	32716
22-#11	2.80	MA	18153	5545	30167	4029	32967	3248	34213	2640	35360	1672	43134	1063	33555
8L-5S		MI	18217	5545	30490	4004	33672	3230	35358	2615	37403	1647	45646	1233	33146
22-#11	2.80	MA	17760	5545	29433	4041	32057	3258	33069	2635	33877	1679	41292	1006	32702
9L-4S		MI	18622	5545	31192	4007	34576	3220	36466	2607	38953	1654	47518	1274	33771
22-#14	4.04	MA	20310	6084	35208	4342	39302	3477	41870	2765	45605	1619	56722	953	48144
6L-7S		MI	18556	6084	32159	4339	35711	3473	37795	2760	40643	1606	50254	790	43977
22-#14	4.04	MA	19749	6084	34124	4359	37981	3491	40252	2776	43475	1629	53915	827	46941
7L-6S		MI	19083	6084	33175	4323	36948	3460	39367	2769	42620	1596	52850	918	45059
22-#14	4.04	MA	19196	6084	33129	4356	36648	3485	38667	2788	41242	1619	51240	757	45394
8L-5S		MI	19624	6084	34124	4327	38236	3467	40880	2758	44640	1586	55339	1003	46123
24-#11	3.06	MA	19431	5656	32676	4088	36167	3291	38088	2654	40632	1664	49925	1181	38007
6L-8S		MI	17532	5656	29456	4080	32296	3282	33698	2657	35175	1645	43016	1017	34392
24-#11	3.06	MA	19032	5656	31919	4100	35245	3302	36959	2663	39134	1670	47945	1093	37312
7E		MI	17902	5656	30107	4082	33169	3286	34735	2649	36635	1652	44764	1065	34982
24-#11	3.06	MA	18638	5656	31225	4098	34315	3298	35853	2672	37563	1664	46062	1044	36655
8L-6S		MI	18277	5656	30816	4071	34033	3276	35794	2640	38027	1645	46598	1153	35641
24-#11	3.06	MA	18248	5656	30490	4110	33406	3308	34708	2667	36080	1670	44220	987	35767
9L-5S		MI	18661	5656	31479	4073	34932	3280	36891	2646	39450	1638	48358	1212	36054
24-#14	4.41	MA	20426	6243	35636	4459	39908	3563	42594	2821	46606	1616	58067	797	51355
7E		MI	19185	6243	33571	4439	37511	3546	39983	2805	43549	1592	54094	758	48093
24-#14	4.41	MA	19877	6243	34641	4455	38575	3558	41009	2833	44373	1606	55391	727	49757
8L-6S		MI	19708	6243	34586	4423	38748	3532	41555	2814	45526	1582	56690	885	49135

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

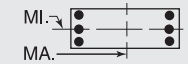
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.24	MA	19992	5136	31744	3761	34292	3060	35098	2540	35233	1781	41445	1656	18084
2E		MI	17800	5136	28400	3725	30522	3030	31105	2512	31028	1752	36318	1618	16011
6-#14	1.04	MA	19652	5047	30845	3733	33285	3042	33926	2534	33793	1809	39624	1700	15488
2L-3S		MI	16576	5047	26207	3696	27860	3028	27964	2522	26932	1794	30998	1541	13806
6-#14	1.04	MA	18578	5047	29234	3730	31231	3057	31429	2547	30437	1819	35162	1572	15549
3L-2S		MI	17515	5047	27618	3700	29660	3015	30152	2511	29838	1784	34838	1669	13735
6-#18	1.86	MA	21271	5420	34558	3938	37880	3188	39460	2620	41037	1757	49123	1600	26714
2L-3S		MI	17299	5420	28400	3893	30522	3180	31105	2608	31028	1740	36318	1325	23577
6-#18	1.86	MA	19431	5420	31744	3932	34292	3212	35098	2640	35233	1774	41445	1373	26658
3L-2S		MI	18905	5420	30860	3902	33658	3158	34895	2590	36033	1723	42894	1552	23578
8-#14	1.39	MA	20398	5207	32457	3833	35339	3114	36423	2579	37150	1798	44086	1673	20436
2L-4S		MI	16563	5207	26477	3812	28208	3094	28391	2558	27609	1790	32340	1380	18108
8-#14	1.39	MA	19333	5207	30845	3830	33285	3129	33926	2592	33793	1808	39624	1545	20469
3E		MI	17229	5207	27618	3796	29660	3101	30152	2567	29838	1780	34838	1508	18132
8-#14	1.39	MA	18575	5207	29547	3847	31634	3124	31922	2585	31218	1818	36712	1417	20399
4L-2S		MI	18161	5207	29030	3800	31460	3087	32340	2556	32744	1770	38679	1636	18085
8-#18	2.48	MA	22531	5703	37373	4116	41468	3317	43822	2700	46842	1732	56802	1544	35297
2L-4S		MI	17267	5703	28863	4096	31120	3294	31839	2668	32195	1729	38615	1035	29341
8-#18	2.48	MA	20713	5703	34558	4109	37880	3341	39460	2719	41037	1750	49123	1316	35130
3E		MI	18406	5703	30860	4070	33658	3308	34895	2686	36033	1711	42894	1259	30993
8-#18	2.48	MA	19418	5703	32283	4137	34988	3330	35951	2704	36585	1768	44126	1089	33235
4L-2S		MI	19993	5703	33319	4080	36794	3287	38685	2668	41039	1693	49471	1486	31097
10-#11	1.21	MA	20039	5122	31592	3793	34308	3087	35196	2565	35569	1815	42032	1702	17879
2L-5S		MI	16309	5122	25787	3769	27387	3077	27409	2554	26238	1797	30602	1451	15872
10-#11	1.21	MA	19290	5122	30466	3792	32871	3098	33449	2574	33210	1822	38888	1613	17911
3L-4S		MI	16730	5122	26488	3771	28291	3067	28516	2546	27787	1804	32474	1492	15903
10-#11	1.21	MA	18758	5122	29559	3804	31718	3095	32050	2570	31400	1829	36833	1524	17913
4L-3S		MI	17198	5122	27287	3760	29306	3071	29747	2551	29357	1797	34242	1581	15880
10-#11	1.21	MA	18282	5122	28763	3803	30692	3106	30794	2579	29615	1822	34674	1482	17846
5L-2S		MI	17854	5122	28275	3762	30566	3062	31279	2543	31404	1790	36954	1670	15842
10-#14	1.74	MA	21137	5366	34068	3933	37393	3187	38920	2624	40507	1786	48549	1645	25365
2L-5S		MI	16620	5366	26884	3908	28714	3180	28994	2614	28315	1766	33523	1290	21553
10-#14	1.74	MA	20080	5366	32457	3930	35339	3202	36423	2637	37150	1796	44086	1517	25362
3L-4S		MI	17215	5366	27888	3912	30008	3167	30579	2603	30515	1776	36181	1348	22366
10-#14	1.74	MA	19329	5366	31158	3947	33688	3197	34419	2630	34575	1806	41174	1389	25248
4L-3S		MI	17876	5366	29030	3896	31460	3173	32340	2612	32744	1766	38679	1476	22435
10-#14	1.74	MA	18655	5366	30018	3944	32218	3212	32620	2642	32035	1796	38103	1329	24288
5L-2S		MI	18801	5366	30442	3900	33260	3160	34528	2601	35650	1756	42520	1604	22414
10-#18	3.10	MA	23774	5987	40187	4293	45057	3445	48184	2779	52647	1708	64480	1488	43838
2L-5S		MI	17360	5987	29565	4264	31990	3443	32878	2764	33408	1682	40631	867	34596
10-#18	3.10	MA	21977	5987	37373	4286	41468	3469	43822	2799	46842	1726	56802	1260	43584
3L-4S		MI	18373	5987	31323	4274	34256	3422	35629	2746	37200	1700	45191	969	36336
10-#18	3.10	MA	20699	5987	35098	4315	38576	3458	40312	2784	42390	1743	51805	1033	41279
4L-3S		MI	19498	5987	33319	4248	36794	3437	38685	2764	41039	1682	49471	1193	38386
10-#18	3.10	MA	19551	5987	33098	4308	35998	3482	37156	2804	37995	1726	46495	929	39144
5L-2S		MI	21068	5987	35779	4257	39930	3416	42475	2746	46044	1664	56047	1420	38575
12-#11	1.45	MA	20562	5232	32719	3863	35744	3137	36942	2596	37929	1808	45176	1684	21331
2L-6S		MI	16372	5232	26113	3836	27748	3123	27844	2579	26861	1795	31555	1371	18287
12-#11	1.45	MA	19817	5232	31592	3861	34308	3148	35196	2605	35569	1815	42032	1595	21350
3L-5S		MI	16772	5232	26776	3838	28647	3127	28941	2585	28284	1788	33315	1430	18853
12-#11	1.45	MA	19289	5232	30686	3873	33155	3145	33797	2601	33759	1821	39977	1507	21328
4E		MI	17190	5232	27477	3841	29551	3117	30048	2577	29834	1795	35187	1471	18907

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

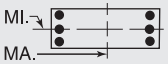


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.45	MA	18815	5232	29890	3872	32129	3156	32540	2610	31974	1815	37818	1464	21237
5L-3S		MI	17655	5232	28275	3829	30566	3121	31279	2582	31404	1788	36954	1560	18906
12-#11	1.45	MA	18363	5232	29139	3870	31109	3153	31296	2606	30334	1821	35775	1405	20561
6L-2S		MI	18308	5232	29264	3832	31826	3112	32812	2574	33450	1781	39666	1649	18878
12-#14	2.09	MA	21869	5526	35679	4032	39447	3259	41417	2669	43863	1775	53011	1618	30282
2L-6S		MI	16708	5526	27347	4003	29226	3246	29669	2670	29201	1762	34874	1172	24975
12-#14	2.09	MA	20820	5526	34068	4030	37393	3274	38920	2682	40507	1785	48549	1490	30243
3L-5S		MI	17271	5526	28296	4007	30514	3252	31182	2659	31221	1752	37363	1258	25649
12-#14	2.09	MA	20075	5526	32769	4047	35742	3269	36916	2675	37932	1795	45636	1362	30090
4E		MI	17861	5526	29300	4011	31808	3239	32767	2648	33421	1762	40022	1316	26613
12-#14	2.09	MA	19407	5526	31629	4044	34272	3284	35117	2687	35391	1785	42565	1302	28975
5L-3S		MI	18517	5526	30442	3996	33260	3245	34528	2657	35650	1752	42520	1444	26719
12-#14	2.09	MA	18769	5526	30553	4041	32811	3279	33334	2680	33058	1795	39668	1217	28144
6L-2S		MI	19436	5526	31854	4000	35059	3232	36716	2646	38557	1742	46360	1572	26730
12-#18	3.72	MA	23225	6271	40187	4463	45057	3598	48184	2879	52647	1701	64480	1204	52026
3L-5S		MI	18465	6271	32024	4441	35126	3572	36668	2842	38413	1653	47207	801	41657
12-#18	3.72	MA	21963	6271	37912	4492	42164	3587	44674	2864	48194	1719	59483	976	49369
4E		MI	19465	6271	33782	4451	37392	3551	39419	2824	42206	1670	51767	903	43377
12-#18	3.72	MA	20829	6271	35912	4485	39586	3611	41518	2883	43799	1701	54174	873	47365
5L-3S		MI	20578	6271	35779	4425	39930	3565	42475	2842	46044	1653	56047	1127	45764
12-#18	3.72	MA	19748	6271	34022	4479	37021	3600	38391	2868	39764	1719	49195	721	43943
6L-2S		MI	22132	6271	38239	4434	43066	3544	46265	2824	51049	1635	62623	1354	46026
14-#11	1.69	MA	21081	5343	33846	3932	37181	3187	38689	2627	40288	1800	48320	1667	24775
2L-7S		MI	16446	5343	26392	3917	28144	3183	28318	2619	27516	1793	32433	1263	20860
14-#11	1.69	MA	20340	5343	32719	3930	35744	3198	36942	2637	37929	1807	45176	1578	24778
3L-6S		MI	16834	5343	27101	3905	29008	3173	29376	2610	28908	1786	34267	1351	21189
14-#11	1.69	MA	19815	5343	31813	3943	34591	3195	35543	2632	36119	1814	43121	1489	24736
4L-5S		MI	17231	5343	27764	3907	29907	3177	30473	2616	30331	1779	36027	1410	21728
14-#11	1.69	MA	19345	5343	31017	3941	33565	3206	34287	2642	34334	1807	40962	1446	24534
5L-4S		MI	17647	5343	28466	3910	30812	3168	31580	2608	31880	1786	37899	1451	21904
14-#11	1.69	MA	18896	5343	30266	3940	32545	3203	33043	2637	32693	1814	38919	1388	23875
6L-3S		MI	18109	5343	29264	3898	31826	3172	32812	2614	33450	1779	39666	1539	21923
14-#11	1.69	MA	18457	5343	29462	3952	31566	3214	31842	2646	31088	1821	36792	1300	23463
7L-2S		MI	18758	5343	30252	3901	33087	3162	34344	2605	35497	1772	42379	1628	21906
14-#14	2.44	MA	22595	5686	37290	4132	41502	3331	43914	2714	47220	1763	57473	1590	35180
2L-7S		MI	16812	5686	27743	4119	29789	3331	30284	2706	30130	1758	36119	1013	27887
14-#14	2.44	MA	21553	5686	35679	4129	39447	3346	41417	2727	43863	1773	53011	1462	35114
3L-6S		MI	17357	5686	28759	4103	31026	3318	31856	2715	32107	1748	38714	1140	29122
14-#14	2.44	MA	20814	5686	34381	4147	37796	3341	39414	2719	41288	1783	50099	1334	34927
4L-5S		MI	17917	5686	29708	4107	32313	3325	33370	2704	34127	1738	41204	1225	29760
14-#14	2.44	MA	20152	5686	33240	4144	36326	3356	37614	2732	38748	1773	47028	1274	33678
5L-4S		MI	18502	5686	30712	4111	33608	3311	34955	2693	36327	1748	43862	1283	30854
14-#14	2.44	MA	19519	5686	32164	4141	34865	3351	35831	2725	36414	1783	44130	1189	32887
6L-3S		MI	19153	5686	31854	4095	35059	3318	36716	2702	38557	1738	46360	1411	30992
14-#14	2.44	MA	18902	5686	31012	4158	33461	3366	34111	2738	34131	1793	41112	1063	31459
7L-2S		MI	20065	5686	33265	4099	36859	3304	38904	2691	41463	1728	50201	1539	31034
14-#18	4.33	MA	23211	6554	40726	4669	45752	3715	49036	2943	53999	1695	67162	920	57495
4L-5S		MI	19556	6554	34484	4619	38262	3700	40458	2920	43419	1624	53783	735	48555
14-#18	4.33	MA	22092	6554	38726	4663	43174	3740	45880	2963	49604	1677	61852	816	55376
5L-4S		MI	20546	6554	36242	4628	40528	3679	43208	2903	47211	1641	58344	837	50455
14-#18	4.33	MA	21024	6554	36836	4656	40609	3728	42753	2948	45569	1695	56873	665	52040
6L-3S		MI	21646	6554	38239	4602	43066	3694	46265	2920	51049	1624	62623	1061	53131
16-#11	1.93	MA	21597	5454	34973	4001	38618	3238	40435	2658	42647	1793	51464	1649	28213
2L-8S		MI	16527	5454	26730	3983	28532	3229	28813	2658	28103	1777	33397	1194	23061
16-#11	1.93	MA	20860	5454	33846	3999	37181	3248	38689	2668	40288	1800	48320	1560	28199
3L-7S		MI	16907	5454	27381	3986	29404	3233	29850	2650	29562	1784	35146	1242	23761
16-#11	1.93	MA	20338	5454	32939	4012	36028	3245	37290	2663	38478	1807	46265	1471	28140
4L-6S		MI	17293	5454	28090	3974	30268	3224	30908	2642	30955	1777	36980	1330	24099

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

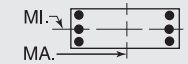
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.93	MA	19871	5454	32144	4010	35002	3256	36033	2673	36693	1800	44106	1429	27822
5E		MI	17687	5454	28753	3977	31168	3228	32005	2647	32378	1770	38739	1389	24608
16-#11	1.93	MA	19424	5454	31393	4009	33982	3253	34789	2668	35053	1807	42063	1370	27195
6L-4S		MI	18101	5454	29454	3979	32072	3218	33112	2639	33927	1777	40612	1430	24894
16-#11	1.93	MA	18989	5454	30589	4021	33002	3264	33589	2678	33447	1814	39936	1282	26798
7L-3S		MI	18561	5454	30252	3967	33087	3222	34344	2645	35497	1770	42379	1518	24930
16-#11	1.93	MA	18559	5454	29851	4020	32014	3261	32413	2687	31766	1807	37919	1233	25955
8L-2S		MI	19206	5454	31241	3970	34347	3212	35876	2637	37544	1763	45091	1607	24927
16-#14	2.79	MA	22280	5845	37290	4229	41502	3419	43914	2772	47220	1761	57473	1435	39978
3L-7S		MI	17460	5845	29155	4219	31588	3404	32472	2750	33036	1744	39959	981	31964
16-#14	2.79	MA	21547	5845	35992	4246	39851	3414	41911	2764	44645	1771	54561	1307	39761
4L-6S		MI	18002	5845	30170	4203	32826	3390	34044	2759	35013	1734	42555	1108	33221
16-#14	2.79	MA	20890	5845	34852	4244	38381	3429	40111	2777	42105	1761	51490	1247	38394
5E		MI	18557	5845	31119	4207	34113	3397	35558	2749	37033	1724	45045	1193	33884
16-#14	2.79	MA	20263	5845	33775	4241	36919	3424	38328	2770	39771	1771	48592	1162	37638
6L-4S		MI	19138	5845	32123	4211	35408	3384	37142	2738	39234	1734	47703	1251	35081
16-#14	2.79	MA	19651	5845	32623	4258	35515	3439	36608	2783	37487	1781	45574	1035	36133
7L-3S		MI	19784	5845	33265	4195	36859	3390	38904	2747	41463	1724	50201	1379	35257
16-#14	2.79	MA	19048	5845	31566	4255	34098	3434	34923	2795	35094	1771	42705	964	34775
8L-2S		MI	20690	5845	34677	4199	38659	3377	41092	2736	44369	1714	54041	1507	35323
16-#18	4.95	MA	23341	6838	41541	4840	46762	3868	50242	3043	55409	1653	69531	760	63361
5E		MI	20637	6838	36944	4796	41398	3829	44248	2999	48424	1594	60360	669	55487
16-#18	4.95	MA	22285	6838	39650	4833	44197	3857	47114	3028	51374	1671	64552	609	60162
6L-4S		MI	21616	6838	38702	4805	43664	3808	46998	2981	52216	1612	64920	771	57561
18-#11	2.17	MA	21376	5564	34973	4069	38618	3299	40435	2699	42647	1793	51464	1542	31614
3L-8S		MI	16988	5564	27719	4052	29792	3279	30345	2689	30150	1768	36110	1173	25938
18-#11	2.17	MA	20858	5564	34066	4081	37465	3296	39036	2694	40837	1799	49409	1454	31539
4L-7S		MI	17365	5564	28370	4055	30665	3283	31382	2681	31609	1775	37858	1221	26612
18-#11	2.17	MA	20393	5564	33271	4079	36439	3306	37780	2704	39052	1793	47250	1411	31120
5L-6S		MI	17748	5564	29079	4043	31529	3274	32441	2673	33001	1768	39692	1309	27013
18-#11	2.17	MA	19949	5564	32519	4078	35419	3303	36536	2699	37412	1799	45207	1353	30522
6L-5S		MI	18141	5564	29741	4046	32428	3278	33537	2678	34424	1761	41452	1368	27497
18-#11	2.17	MA	19517	5564	31716	4090	34439	3314	35335	2709	35807	1806	43080	1265	30061
7L-4S		MI	18552	5564	30443	4048	33332	3268	34644	2670	35974	1768	43324	1409	27879
18-#11	2.17	MA	19090	5564	30978	4089	33450	3311	34160	2718	34125	1799	41063	1215	29246
8L-3S		MI	19009	5564	31241	4037	34347	3272	35876	2676	37544	1761	45091	1498	27930
18-#11	2.17	MA	18667	5564	30198	4101	32484	3322	32943	2714	32536	1806	39084	1159	28504
9L-2S		MI	19651	5564	32230	4039	35607	3262	37408	2668	39590	1755	47804	1586	27944
18-#14	3.13	MA	22275	6005	37603	4346	41905	3486	44408	2809	48001	1760	59023	1279	44520
4L-7S		MI	18104	6005	30567	4319	33388	3476	34660	2795	35942	1730	43800	948	36053
18-#14	3.13	MA	21623	6005	36463	4343	40435	3501	42608	2822	45461	1750	55952	1219	43121
5L-6S		MI	18641	6005	31582	4303	34626	3463	36232	2804	37919	1720	46396	1075	37259
18-#14	3.13	MA	21001	6005	35386	4341	38973	3496	40825	2815	43128	1760	53054	1134	42281
6L-5S		MI	19192	6005	32531	4307	35913	3469	37746	2793	39939	1710	48885	1161	38018
18-#14	3.13	MA	20394	6005	34234	4358	37569	3511	39105	2828	40844	1770	50036	1008	40818
7L-4S		MI	19768	6005	33535	4311	37207	3456	39330	2783	42140	1720	51543	1218	39152
18-#14	3.13	MA	19795	6005	33177	4355	36152	3506	37420	2840	38451	1760	47168	937	39404
8L-3S		MI	20410	6005	34677	4295	38659	3462	41092	2792	44369	1710	54041	1346	39516
18-#18	5.57	MA	23534	7122	42465	5010	47785	3986	51476	3107	57178	1646	72230	553	68305
6L-5S		MI	21707	7122	39403	4973	44534	3958	48037	3077	53429	1565	66936	603	62448
20-#11	2.41	MA	21374	5675	35193	4150	38901	3346	40783	2726	43196	1792	52553	1436	34936
4L-8S		MI	17445	5675	28707	4122	31053	3330	31877	2720	32196	1759	38822	1152	28821
20-#11	2.41	MA	20912	5675	34398	4149	37875	3357	39526	2735	41411	1785	50394	1393	34426
5L-7S		MI	17820	5675	29358	4124	31925	3334	32914	2712	33656	1766	40571	1200	29471

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

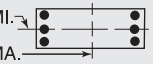


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.41	MA	20471	5675	33646	4147	36855	3354	38282	2730	39771	1792	48351	1335	33852
6E		MI	18201	5675	30067	4113	32789	3324	33973	2704	35048	1759	42404	1288	29932
20-#11	2.41	MA	20041	5675	32843	4159	35876	3364	37082	2740	38166	1799	46224	1247	33332
7L-5S		MI	18591	5675	30730	4115	33688	3328	35069	2709	36471	1752	44164	1347	30393
20-#11	2.41	MA	19617	5675	32105	4158	34887	3362	35906	2749	36484	1792	44207	1197	32542
8L-4S		MI	19000	5675	31431	4117	34593	3318	36176	2701	38020	1759	46037	1388	30861
20-#11	2.41	MA	19197	5675	31324	4170	33921	3372	34690	2745	34895	1799	42228	1141	31762
9L-3S		MI	19455	5675	32230	4106	35607	3322	37408	2707	39590	1752	47804	1477	30926
20-#11	2.41	MA	18734	5675	30590	4169	32945	3369	33522	2754	33318	1806	40310	1077	30884
10L-2S		MI	20094	5675	33218	4108	36868	3312	38940	2699	41637	1746	50516	1565	30952
20-#14	3.48	MA	22350	6164	38074	4443	42489	3573	45105	2867	48818	1738	60414	1192	47857
5L-7S		MI	18742	6164	31978	4418	35188	3548	36848	2840	38848	1716	47640	916	40150
20-#14	3.48	MA	21733	6164	36997	4440	41027	3568	43323	2860	46484	1748	57517	1107	46925
6E		MI	19276	6164	32994	4402	36425	3535	38420	2849	40825	1706	50236	1043	41309
20-#14	3.48	MA	21130	6164	35845	4458	39623	3583	41602	2873	44200	1758	54498	980	45513
7L-5S		MI	19822	6164	33943	4406	37713	3542	39934	2838	42845	1696	52726	1128	42160
20-#14	3.48	MA	20537	6164	34788	4455	38206	3578	39917	2885	41807	1748	51630	909	44044
8L-4S		MI	20395	6164	34947	4410	39007	3528	41518	2828	45046	1706	55384	1186	43237
22-#11	2.66	MA	21428	5786	35524	4218	39312	3407	41273	2766	43771	1778	53538	1376	37738
5L-8S		MI	17899	5786	29696	4191	32313	3380	33409	2751	34243	1750	41535	1131	31709
22-#11	2.66	MA	20990	5786	34773	4216	38292	3404	40029	2762	42130	1785	51495	1317	37187
6L-7S		MI	18273	5786	30347	4193	33185	3384	34446	2743	35702	1757	43283	1179	32336
22-#11	2.66	MA	20562	5786	33969	4229	37312	3415	38828	2771	40525	1792	49368	1229	36609
7L-6S		MI	18651	5786	31056	4182	34049	3374	35505	2735	37095	1750	45117	1267	32854
22-#11	2.66	MA	20141	5786	33232	4227	36324	3412	37653	2780	38843	1785	47351	1180	35844
8L-5S		MI	19039	5786	31718	4184	34949	3378	36602	2741	38518	1744	46877	1326	33295
22-#11	2.66	MA	19723	5786	32451	4239	35357	3423	36436	2776	37255	1792	45372	1123	35026
9L-4S		MI	19445	5786	32420	4186	35853	3368	37709	2732	40067	1750	48749	1367	33840
22-#11	2.66	MA	19263	5786	31717	4238	34381	3420	35268	2785	35678	1799	43454	1060	34171
10L-3S		MI	19898	5786	33218	4175	36868	3372	38940	2738	41637	1744	50516	1456	33918
22-#14	3.83	MA	22459	6324	38609	4540	43081	3641	45820	2905	49841	1737	61979	1079	51580
6L-7S		MI	19376	6324	33390	4518	36988	3621	39036	2885	41754	1702	51481	883	44256
22-#14	3.83	MA	21861	6324	37457	4557	41677	3656	44099	2917	47557	1747	58961	952	50215
7L-6S		MI	19906	6324	34405	4502	38225	3607	40608	2894	43731	1692	54077	1010	45372
22-#14	3.83	MA	21272	6324	36399	4555	40260	3651	42414	2930	45164	1737	56092	882	48693
8L-5S		MI	20449	6324	35354	4506	39513	3614	42122	2883	45752	1682	56567	1096	46309
24-#11	2.90	MA	21505	5896	35900	4285	39729	3454	41775	2793	44490	1778	54639	1300	40525
6L-8S		MI	18351	5896	30684	4260	33574	3430	34941	2782	36290	1742	44247	1110	34602
24-#11	2.90	MA	21080	5896	35096	4298	38749	3465	40575	2802	42884	1784	52512	1212	39892
7E		MI	18722	5896	31335	4262	34446	3434	35978	2774	37749	1748	45995	1158	35208
24-#11	2.90	MA	20661	5896	34359	4296	37760	3462	39399	2812	41203	1778	50495	1162	39150
8L-6S		MI	19099	5896	32044	4251	35310	3424	37037	2766	39141	1742	47829	1246	35780
24-#11	2.90	MA	20246	5896	33578	4308	36794	3473	38183	2807	39614	1784	48516	1106	38296
9L-5S		MI	19485	5896	32707	4253	36209	3428	38134	2772	40564	1735	49589	1305	36203
24-#11	2.90	MA	19797	5896	32844	4307	35818	3470	37015	2817	38037	1791	46597	1042	37461
10L-4S		MI	19889	5896	33408	4256	37113	3418	39241	2764	42114	1742	51461	1346	36817
24-#14	4.18	MA	22587	6484	39068	4657	43731	3728	46596	2962	50914	1735	63423	925	54925
7E		MI	20006	6484	34802	4618	38788	3693	41224	2930	44661	1688	55322	851	48370
24-#14	4.18	MA	22003	6484	38010	4654	42314	3723	44911	2975	48521	1725	60554	854	53351
8L-6S		MI	20532	6484	35817	4602	40025	3680	42796	2939	46638	1678	57917	978	49444

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

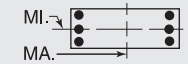
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.18	MA	22053	5376	34857	3956	37678	3220	38534	2676	38647	1890	45460	1766	19164
2E		MI	18620	5376	29636	3902	31798	3176	32344	2636	32134	1847	37537	1710	16053
6-#18	1.76	MA	23423	5660	37849	4134	41492	3349	43171	2756	44852	1868	53691	1714	28334
2L-3S		MI	18118	5660	29636	4070	31798	3325	32344	2731	32134	1835	37537	1417	23650
6-#18	1.76	MA	21461	5660	34857	4128	37678	3374	38534	2778	38647	1885	45460	1486	28278
3L-2S		MI	19726	5660	32095	4080	34934	3304	36134	2714	37140	1818	44114	1644	23628
8-#14	1.32	MA	22483	5447	35606	4028	38780	3275	39929	2716	40670	1907	48250	1783	21651
2L-4S		MI	17380	5447	27707	3991	29485	3241	29632	2683	28721	1886	33568	1473	18171
8-#14	1.32	MA	21348	5447	33895	4026	36599	3291	37278	2729	37088	1917	43476	1655	21684
3E		MI	18048	5447	28849	3975	30937	3248	31394	2692	30950	1876	36066	1601	18176
8-#14	1.32	MA	20544	5447	32518	4044	34848	3286	35153	2723	34340	1927	40356	1527	21614
4L-2S		MI	18981	5447	30261	3979	32737	3235	33582	2681	33856	1867	39906	1729	18123
8-#18	2.35	MA	24772	5944	40840	4311	45307	3477	47808	2836	51057	1845	61922	1662	37457
2L-4S		MI	18085	5944	30099	4274	32396	3440	33077	2792	33301	1824	39834	1127	29664
8-#18	2.35	MA	22834	5944	37849	4305	41492	3503	43171	2858	44852	1863	53691	1434	37290
3E		MI	19227	5944	32095	4248	34934	3454	36134	2810	37140	1806	44114	1351	31078
8-#18	2.35	MA	21457	5944	35434	4335	38423	3493	39446	2844	40092	1881	48326	1206	35561
4L-2S		MI	20818	5944	34555	4257	38070	3433	39924	2792	42145	1789	50690	1578	31154
10-#11	1.15	MA	22097	5362	34684	3989	37680	3248	38621	2701	38950	1922	46034	1810	18932
2L-5S		MI	17127	5362	27015	3949	28664	3225	28652	2679	27352	1894	31833	1545	15930
10-#11	1.15	MA	21299	5362	33488	3988	36155	3259	36767	2711	36439	1929	42674	1721	18964
3L-4S		MI	17548	5362	27716	3951	29568	3215	29759	2671	28901	1901	33706	1586	15945
10-#11	1.15	MA	20735	5362	32527	4000	34933	3257	35284	2707	34513	1936	40475	1632	18966
4L-3S		MI	18017	5362	28515	3940	30583	3219	30990	2677	30471	1894	35473	1674	15916
10-#11	1.15	MA	20230	5362	31684	3999	33846	3268	33953	2717	32615	1930	38173	1589	18899
5L-2S		MI	18674	5362	29503	3942	31843	3209	32522	2669	32518	1887	38185	1763	15875
10-#14	1.65	MA	23273	5607	37317	4128	40961	3347	42581	2761	44252	1896	53023	1757	26884
2L-5S		MI	17437	5607	28115	4087	29991	3327	30236	2739	29426	1862	34750	1383	21744
10-#14	1.65	MA	22147	5607	35606	4126	38780	3363	39929	2774	40670	1906	48250	1629	26881
3L-4S		MI	18034	5607	29119	4091	31285	3314	31820	2728	31627	1872	37408	1441	22436
10-#14	1.65	MA	21350	5607	34229	4144	37029	3359	37805	2768	37922	1916	45130	1501	26767
4L-3S		MI	18696	5607	30261	4075	32737	3320	33582	2737	33856	1862	39906	1569	22487
10-#14	1.65	MA	20634	5607	33021	4141	35472	3374	35897	2781	35212	1906	41852	1440	25875
5L-2S		MI	19623	5607	31673	4079	34536	3307	35769	2726	36762	1852	43747	1697	22456
10-#18	2.94	MA	26103	6228	43832	4488	49121	3606	52444	2916	57262	1823	70153	1609	46538
2L-5S		MI	18176	6228	30800	4442	33267	3589	34116	2888	34514	1777	41850	959	34872
10-#18	2.94	MA	24187	6228	40840	4483	45307	3631	47808	2937	51057	1841	61922	1382	46284
3L-4S		MI	19193	6228	32559	4451	35532	3568	36867	2870	38306	1795	46410	1061	36652
10-#18	2.94	MA	22828	6228	38426	4512	42237	3622	44083	2923	46297	1859	56557	1154	44123
4L-3S		MI	20321	6228	34555	4425	38070	3583	39924	2888	42145	1777	50690	1285	38479
10-#18	2.94	MA	21608	6228	36305	4507	39503	3647	40735	2945	41600	1841	50880	1049	41735
5L-2S		MI	21895	6228	37015	4434	41206	3562	43713	2870	47150	1759	57266	1513	38641
12-#11	1.38	MA	22656	5473	35880	4058	39205	3298	40474	2733	41462	1915	49394	1794	22594
2L-6S		MI	17190	5473	27341	4016	29025	3271	29087	2705	27976	1892	32786	1465	18421
12-#11	1.38	MA	21862	5473	34684	4057	37680	3309	38621	2742	38950	1922	46034	1705	22614
3L-5S		MI	17590	5473	28004	4018	29924	3275	30184	2711	29398	1885	34546	1524	18917
12-#11	1.38	MA	21302	5473	33723	4070	36458	3307	37138	2739	37025	1929	43835	1616	22592
4E		MI	18009	5473	28705	4020	30828	3265	31291	2702	30948	1892	36418	1565	18957
12-#11	1.38	MA	20800	5473	32880	4068	35371	3318	35807	2748	35126	1923	41533	1573	22500
5L-3S		MI	18475	5473	29503	4009	31843	3269	32522	2708	32518	1885	38185	1654	18945
12-#11	1.38	MA	20320	5473	32085	4067	34291	3316	34489	2745	33381	1930	39348	1514	21852
6L-2S		MI	19128	5473	30492	4011	33104	3260	34055	2700	34564	1878	40898	1742	18914

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis

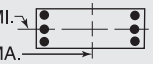


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.99	MA	24056	5766	39028	4228	43143	3420	45233	2805	47835	1886	57797	1732	32105
2L-6S		MI	17524	5766	28578	4182	30503	3393	30910	2795	30312	1858	36101	1265	25153
12-#14	1.99	MA	22938	5766	37317	4226	40961	3435	42581	2819	44252	1896	53023	1604	32065
3L-5S		MI	18089	5766	29527	4186	31791	3400	32424	2784	32332	1848	38591	1351	25837
12-#14	1.99	MA	22147	5766	35940	4243	39211	3431	40457	2813	41504	1906	49903	1476	31913
4E		MI	18681	5766	30531	4190	33085	3386	34008	2773	34533	1858	41249	1409	26690
12-#14	1.99	MA	21438	5766	34732	4241	37653	3447	38549	2826	38794	1896	46626	1414	30856
5L-3S		MI	19338	5766	31673	4175	34536	3393	35769	2782	36762	1848	43747	1537	26776
12-#14	1.99	MA	20762	5766	33591	4239	36104	3442	36660	2820	36304	1906	43524	1330	29932
6L-2S		MI	20259	5766	33084	4179	36336	3379	37957	2771	39668	1838	47587	1665	26775
12-#18	3.53	MA	25523	6511	43832	4660	49121	3760	52444	3017	57262	1819	70153	1330	55266
3L-5S		MI	19282	6511	33260	4619	36403	3718	37906	2966	39520	1748	48426	893	42030
12-#18	3.53	MA	24181	6511	41418	4690	46051	3750	48719	3003	52502	1836	64787	1102	52730
4E		MI	20287	6511	35018	4628	38668	3697	40657	2948	43312	1766	52987	995	43686
12-#18	3.53	MA	22976	6511	39297	4684	43317	3776	45372	3025	47806	1819	59111	997	50484
5L-3S		MI	21403	6511	37015	4602	41206	3711	43713	2966	47150	1748	57266	1219	45865
12-#18	3.53	MA	21827	6511	37293	4678	40597	3766	42056	3011	43492	1836	53769	845	47035
6L-2S		MI	22962	6511	39475	4612	44342	3690	47503	2948	52156	1730	63842	1447	46098
14-#11	1.61	MA	23210	5583	37076	4127	40730	3348	42328	2764	43973	1908	52754	1777	26249
2L-7S		MI	17263	5583	27620	4096	29421	3331	29561	2744	28630	1890	33664	1356	20993
14-#11	1.61	MA	22422	5583	35880	4126	39205	3359	40474	2774	41462	1915	49394	1689	26253
3L-6S		MI	17652	5583	28329	4085	30285	3321	30619	2736	30022	1883	35498	1444	21323
14-#11	1.61	MA	21865	5583	34919	4139	37983	3357	38991	2770	39536	1922	47195	1600	26211
4L-5S		MI	18050	5583	28992	4087	31184	3325	31716	2742	31445	1876	37258	1503	21877
14-#11	1.61	MA	21365	5583	34076	4138	36896	3368	37660	2780	37637	1916	44893	1557	26098
5L-4S		MI	18466	5583	29694	4090	32089	3316	32823	2734	32994	1883	39130	1544	21957
14-#11	1.61	MA	20889	5583	33281	4136	35816	3366	36343	2776	35893	1923	42708	1498	25371
6L-3S		MI	18930	5583	30492	4078	33104	3320	34055	2739	34564	1876	40898	1633	21965
14-#11	1.61	MA	20424	5583	32430	4149	34778	3377	35071	2786	34185	1930	40434	1410	24915
7L-2S		MI	19580	5583	31480	4081	34364	3310	35587	2731	36611	1869	43610	1721	21944
14-#14	2.32	MA	24833	5926	40739	4327	45324	3492	47884	2850	51417	1875	62570	1706	37307
2L-7S		MI	17628	5926	28974	4298	31065	3479	31526	2831	31241	1854	37346	1106	28171
14-#14	2.32	MA	23722	5926	39028	4325	43143	3508	45233	2864	47835	1885	57797	1578	37240
3L-6S		MI	18175	5926	29989	4282	32303	3465	33098	2840	33218	1844	39942	1233	29299
14-#14	2.32	MA	22938	5926	37651	4343	41392	3503	43108	2858	45086	1895	54677	1450	37054
4L-5S		MI	18736	5926	30938	4286	33590	3472	34612	2829	35238	1834	42431	1318	29946
14-#14	2.32	MA	22235	5926	36443	4341	39834	3519	41201	2871	42376	1885	51399	1389	35853
5L-4S		MI	19323	5926	31942	4290	34885	3458	36196	2818	37439	1844	45089	1376	30936
14-#14	2.32	MA	21564	5926	35302	4339	38285	3515	39312	2865	39886	1895	48297	1304	34972
6L-3S		MI	19976	5926	33084	4274	36336	3465	37957	2827	39668	1834	47587	1504	31053
14-#14	2.32	MA	20909	5926	34082	4356	36798	3530	37489	2878	37448	1905	45067	1178	33573
7L-2S		MI	20890	5926	34496	4278	38136	3452	40145	2816	42574	1824	51428	1632	31085
14-#18	4.12	MA	25517	6795	44409	4867	49865	3879	53356	3083	58707	1814	73018	1050	61376
4L-5S		MI	20376	6795	35720	4796	39538	3846	41696	3044	44525	1719	55003	827	49061
14-#18	4.12	MA	24327	6795	42288	4861	47131	3904	50008	3104	54011	1796	67342	944	59254
5L-4S		MI	21370	6795	37478	4806	41804	3825	44447	3027	48317	1736	59563	929	50758
14-#18	4.12	MA	23193	6795	40285	4856	44411	3895	46692	3091	49697	1814	62000	793	55657
6L-3S		MI	22474	6795	39475	4780	44342	3840	47503	3044	52156	1719	63842	1153	53239
16-#11	1.84	MA	23762	5694	38272	4196	42255	3398	44182	2795	46484	1901	56114	1761	29898
2L-8S		MI	17344	5694	27958	4163	29809	3377	30056	2784	29217	1874	34628	1287	23270
16-#11	1.84	MA	22977	5694	37076	4195	40730	3410	42328	2805	43973	1908	52754	1672	29884
3L-7S		MI	17725	5694	28609	4165	30681	3381	31093	2775	30677	1881	36377	1335	23916
16-#11	1.84	MA	22423	5694	36115	4208	39508	3407	40845	2801	42047	1916	50555	1584	29825
4L-6S		MI	18111	5694	29318	4154	31545	3371	32152	2767	32069	1874	38211	1423	24232
16-#11	1.84	MA	21927	5694	35272	4207	38421	3418	39514	2811	40149	1909	48253	1540	29602
5E		MI	18507	5694	29981	4156	32445	3375	33248	2773	33492	1867	39971	1482	24756
16-#11	1.84	MA	21454	5694	34477	4206	37340	3416	38196	2807	38404	1916	46068	1482	28896
6L-4S		MI	18921	5694	30682	4159	33349	3366	34355	2765	35041	1874	41843	1523	24951

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

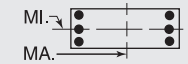
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.84	MA	20992	5694	33626	4218	36303	3427	36925	2817	36696	1923	43794	1394	28457
7L-3S		MI	19382	5694	31480	4147	34364	3370	35587	2770	36611	1867	43610	1612	24980
16-#11	1.84	MA	20537	5694	32845	4217	35256	3425	35680	2827	34908	1917	41643	1344	27643
8L-2S		MI	20029	5694	32469	4150	35624	3360	37119	2762	38658	1860	46322	1701	24968
16-#14	2.65	MA	24500	6086	40739	4425	45324	3580	47884	2909	51417	1875	62570	1553	42408
3L-7S		MI	18277	6086	30386	4398	32865	3551	33714	2875	34147	1840	41186	1074	32245
16-#14	2.65	MA	23722	6086	39362	4443	43573	3576	45760	2902	48669	1885	59451	1425	42191
4L-6S		MI	18820	6086	31401	4382	34103	3538	35286	2885	36124	1830	43782	1201	33453
16-#14	2.65	MA	23024	6086	38154	4441	42016	3591	43852	2916	45958	1875	56173	1363	40864
5E		MI	19377	6086	32350	4386	35390	3544	36800	2874	38145	1820	46272	1286	34068
16-#14	2.65	MA	22359	6086	37013	4438	40467	3587	41964	2910	43468	1885	53071	1279	40021
6L-4S		MI	19960	6086	33354	4390	36684	3531	38384	2863	40345	1830	48930	1344	35177
16-#14	2.65	MA	21709	6086	35793	4456	38979	3603	40141	2923	41030	1894	49841	1152	38543
7L-3S		MI	20608	6086	34496	4374	38136	3537	40145	2872	42574	1820	51428	1472	35323
16-#14	2.65	MA	21069	6086	34673	4454	37478	3599	38356	2937	38477	1885	46779	1080	37223
8L-2S		MI	21517	6086	35908	4378	39936	3524	42333	2861	45480	1810	55269	1600	35377
16-#18	4.71	MA	25664	7079	45280	5039	50945	4033	54645	3184	60216	1774	75573	892	67896
5E		MI	21459	7079	38179	4973	42674	3975	45486	3123	49530	1690	61579	761	55984
16-#18	4.71	MA	24542	7079	43277	5033	48225	4023	51329	3170	55902	1792	70231	741	64303
6L-4S		MI	22442	7079	39938	4983	44940	3954	48237	3105	53322	1707	66139	863	57860
18-#11	2.06	MA	23529	5805	38272	4264	42255	3460	44182	2836	46484	1902	56114	1656	33510
3L-8S		MI	17805	5805	28947	4232	31070	3427	31588	2815	31264	1865	37341	1266	26146
18-#11	2.06	MA	22978	5805	37311	4277	41032	3457	42699	2832	44559	1909	53915	1567	33435
4L-7S		MI	18183	5805	29598	4235	31942	3431	32625	2807	32723	1872	39089	1314	26838
18-#11	2.06	MA	22485	5805	36469	4276	39946	3468	41368	2842	42660	1902	51613	1524	33103
5L-6S		MI	18567	5805	30307	4223	32806	3422	33684	2798	34116	1865	40923	1402	27147
18-#11	2.06	MA	22015	5805	35673	4275	38865	3466	40050	2838	40915	1909	49428	1465	32428
6L-5S		MI	18961	5805	30969	4226	33705	3426	34780	2804	35538	1858	42683	1461	27644
18-#11	2.06	MA	21556	5805	34822	4287	37828	3477	38779	2848	39208	1916	47154	1378	32003
7L-4S		MI	19373	5805	31671	4228	34609	3416	35887	2796	37088	1865	44555	1502	27940
18-#11	2.06	MA	21103	5805	34041	4286	36781	3475	37534	2858	37419	1910	45003	1327	31139
8L-3S		MI	19831	5805	32469	4216	35624	3420	37119	2801	38658	1858	46322	1591	27981
18-#11	2.06	MA	20655	5805	33215	4299	35758	3486	36246	2854	35729	1917	42886	1271	30442
9L-2S		MI	20475	5805	33458	4219	36885	3410	38651	2793	40704	1851	49035	1680	27986
18-#14	2.98	MA	24499	6245	41073	4543	45755	3648	48412	2947	52251	1874	64224	1399	47325
4L-7S		MI	18922	6245	31797	4498	34665	3623	35902	2920	37054	1826	45027	1041	36330
18-#14	2.98	MA	23807	6245	39865	4540	44197	3664	46504	2961	49540	1864	60946	1338	45886
5L-6S		MI	19461	6245	32813	4482	35902	3610	37474	2929	39031	1816	47623	1168	37571
18-#14	2.98	MA	23147	6245	38724	4538	42648	3659	44615	2955	47050	1874	57844	1253	45076
6L-5S		MI	20013	6245	33762	4486	37190	3616	38987	2919	41051	1806	50113	1253	38201
18-#14	2.98	MA	22503	6245	37504	4556	41161	3675	42793	2968	44613	1884	54615	1127	43523
7L-4S		MI	20592	6245	34766	4490	38484	3603	40572	2908	43251	1816	52771	1311	39373
18-#14	2.98	MA	21868	6245	36384	4554	39660	3671	41008	2982	42059	1874	51552	1055	42148
8L-3S		MI	21236	6245	35908	4474	39936	3610	42333	2917	45480	1806	55269	1439	39586
18-#14	2.98	MA	21238	6245	35199	4572	38193	3686	39161	2975	39647	1884	48547	973	40542
9L-2S		MI	22139	6245	37319	4478	41736	3596	44521	2906	48387	1796	59109	1567	39662
18-#18	5.29	MA	25878	7362	46268	5210	52040	4152	55965	3250	62107	1770	78462	689	72971
6L-5S		MI	22532	7362	40639	5151	45810	4104	49276	3201	54536	1660	68155	695	62938
20-#11	2.29	MA	23530	5915	38507	4346	42557	3507	44552	2863	47070	1902	57275	1551	37042
4L-8S		MI	18262	5915	29935	4301	32330	3478	33120	2846	33310	1856	40053	1245	29027
20-#11	2.29	MA	23040	5915	37665	4345	41471	3519	43221	2873	45171	1895	54973	1508	36612
5L-7S		MI	18639	5915	30586	4304	33202	3482	34157	2838	34770	1863	41802	1293	29694
20-#11	2.29	MA	22572	5915	36869	4344	40390	3516	41904	2869	43427	1902	52788	1449	35965
6E		MI	19021	5915	31295	4292	34066	3472	35216	2829	36162	1856	43636	1381	30065

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis

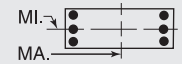


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.29	MA	22116	5915	36018	4357	39353	3527	40632	2879	41719	1909	50514	1361	35522
7L-5S		MI	19412	5915	31958	4295	34965	3476	36313	2835	37585	1849	45395	1440	30539
20-#11	2.29	MA	21666	5915	35237	4355	38306	3525	39387	2889	39931	1903	48363	1311	34640
8L-4S		MI	19822	5915	32659	4297	35870	3466	37420	2827	39134	1856	47268	1481	30925
20-#11	2.29	MA	21220	5915	34411	4368	37283	3536	38099	2885	38241	1910	46246	1255	33905
9L-3S		MI	20278	5915	33458	4286	36885	3470	38651	2833	40704	1849	49035	1570	30980
20-#11	2.29	MA	20719	5915	33634	4367	36249	3534	36862	2895	36564	1917	44194	1191	32931
10L-2S		MI	20919	5915	34446	4288	38145	3460	40183	2824	42751	1842	51747	1659	31000
20-#14	3.31	MA	24584	6405	41576	4640	46378	3736	49156	3006	53122	1854	65720	1312	50918
5L-7S		MI	19561	6405	33209	4597	36465	3696	38090	2965	39960	1812	48868	1009	40425
20-#14	3.31	MA	23929	6405	40435	4638	44829	3732	47267	2999	50632	1863	62618	1228	50098
6E		MI	20097	6405	34224	4581	37702	3682	39662	2974	41937	1802	51463	1136	41618
20-#14	3.31	MA	23290	6405	39215	4656	43342	3747	45444	3013	48195	1873	59388	1101	48513
7L-5S		MI	20645	6405	35173	4585	38990	3689	41175	2963	43957	1792	53953	1221	42342
20-#14	3.31	MA	22660	6405	38095	4654	41841	3743	43659	3027	45641	1863	56326	1030	47082
8L-4S		MI	21220	6405	36177	4589	40284	3675	42760	2953	46158	1802	56611	1279	43456
20-#14	3.31	MA	22035	6405	36910	4671	40374	3759	41813	3020	43229	1873	53321	948	45519
9L-3S		MI	21859	6405	37319	4574	41736	3682	44521	2962	48387	1792	59109	1407	43843
22-#11	2.52	MA	23591	6026	38861	4414	42995	3569	45075	2904	47683	1888	58333	1491	40128
5L-8S		MI	18718	6026	30924	4371	33590	3528	34652	2877	35357	1847	42766	1225	31914
22-#11	2.52	MA	23126	6026	38065	4413	41915	3566	43757	2900	45938	1895	56148	1433	39506
6L-7S		MI	19092	6026	31575	4373	34462	3532	35689	2869	36817	1854	44514	1273	32557
22-#11	2.52	MA	22673	6026	37214	4426	40878	3578	42486	2910	44230	1903	53874	1345	39003
7L-6S		MI	19472	6026	32284	4362	35326	3522	36748	2861	38209	1847	46348	1361	32988
22-#11	2.52	MA	22226	6026	36433	4425	39831	3575	41241	2920	42442	1896	51723	1295	38148
8L-5S		MI	19861	6026	32946	4364	36226	3526	37845	2866	39632	1840	48108	1420	33440
22-#11	2.52	MA	21780	6026	35607	4437	38807	3586	39953	2916	40752	1903	49606	1238	37374
9L-4S		MI	20269	6026	33648	4366	37130	3516	38952	2858	41181	1847	49980	1461	33907
22-#11	2.52	MA	21284	6026	34830	4436	37774	3584	38716	2926	39075	1910	47554	1175	36423
10L-3S		MI	20722	6026	34446	4355	38145	3520	40183	2864	42751	1840	51747	1549	33974
22-#14	3.64	MA	24706	6564	42146	4738	47011	3804	49919	3044	54214	1853	67392	1202	55047
6L-7S		MI	20197	6564	34621	4697	38265	3768	40278	3010	42866	1798	52708	976	44528
22-#14	3.64	MA	24071	6564	40926	4755	45523	3820	48096	3058	51777	1863	64162	1076	53512
7L-6S		MI	20728	6564	35636	4681	39502	3755	41850	3019	44843	1788	55304	1103	45677
22-#14	3.64	MA	23446	6564	39806	4753	44022	3815	46311	3071	49224	1853	61100	1004	52026
8L-5S		MI	21273	6564	36585	4685	40790	3761	43363	3008	46863	1778	57794	1189	46490
22-#14	3.64	MA	22824	6564	38621	4771	42555	3831	44465	3065	46811	1863	58095	923	50503
9L-4S		MI	21844	6564	37589	4689	42084	3748	44948	2998	49064	1788	60452	1247	47551
24-#11	2.75	MA	23677	6137	39261	4482	43440	3616	45611	2931	48449	1889	59508	1416	43051
6L-8S		MI	19170	6137	31912	4440	34851	3578	36185	2908	37404	1838	45478	1204	34805
24-#11	2.75	MA	23226	6137	38410	4495	42402	3628	44340	2941	46742	1896	57234	1329	42490
7E		MI	19543	6137	32563	4442	35723	3582	37221	2900	38863	1845	47227	1252	35427
24-#11	2.75	MA	22782	6137	37629	4494	41355	3625	43095	2951	44953	1889	55083	1278	41659
8L-6S		MI	19920	6137	33272	4431	36587	3572	38280	2892	40256	1838	49060	1340	35913
24-#11	2.75	MA	22337	6137	36803	4506	40332	3636	41807	2947	43263	1896	52966	1222	40848
9L-5S		MI	20308	6137	33935	4433	37486	3576	39377	2897	41678	1831	50820	1399	36347
24-#11	2.75	MA	21845	6137	36026	4505	39299	3634	40570	2957	41586	1903	50914	1158	39919
10L-4S		MI	20713	6137	34636	4435	38390	3566	40484	2889	43228	1838	52693	1440	36886
24-#14	3.97	MA	24847	6724	42637	4855	47705	3892	50748	3103	55359	1852	68935	1050	58518
7E		MI	20828	6724	36033	4797	40065	3840	42466	3055	45772	1784	56549	944	48639
24-#14	3.97	MA	24227	6724	41517	4853	46203	3888	48963	3116	52806	1842	65873	979	56979
8L-6S		MI	21356	6724	37048	4781	41302	3827	44038	3064	47749	1774	59145	1071	49746
24-#14	3.97	MA	23606	6724	40332	4871	44736	3903	47116	3110	50393	1852	62868	897	55473
9L-5S		MI	21897	6724	37997	4785	42589	3833	45551	3053	49769	1764	61634	1156	50645

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

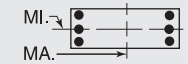
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.12	MA	24210	5617	38107	4152	41214	3381	42119	2813	42199	1998	49630	1875	20244
2E		MI	19439	5617	30872	4080	33074	3322	33582	2760	33240	1942	38757	1802	16094
6-#18	1.68	MA	25672	5901	41276	4329	45254	3510	47031	2893	48805	1978	58414	1826	29954
2L-3S		MI	18937	5901	30872	4248	33074	3471	33582	2855	33240	1931	38757	1509	23720
6-#18	1.68	MA	23588	5901	38107	4324	41214	3536	42119	2916	42199	1996	49630	1599	29898
3L-2S		MI	20548	5901	33331	4257	36210	3450	37372	2838	38246	1913	45333	1736	23677
8-#14	1.26	MA	24665	5688	38892	4224	42370	3436	43585	2852	44304	2014	52568	1891	22866
2L-4S		MI	18198	5688	28938	4170	30762	3389	30874	2808	29832	1983	34795	1566	18230
8-#14	1.26	MA	23461	5688	37081	4222	40062	3452	40779	2866	40502	2024	47482	1763	22899
3E		MI	18867	5688	30080	4154	32214	3395	32635	2817	32061	1973	37293	1694	18218
8-#14	1.26	MA	22610	5688	35626	4240	38212	3448	38533	2861	37587	2035	44155	1635	22829
4L-2S		MI	19801	5688	31492	4158	34013	3382	34823	2806	34967	1963	41133	1822	18161
8-#18	2.24	MA	27111	6184	44445	4506	49294	3638	51942	2973	55410	1958	67198	1778	39617
2L-4S		MI	18903	6184	31335	4451	33673	3586	34315	2916	34407	1919	41053	1219	29979
8-#18	2.24	MA	25052	6184	41276	4502	45254	3665	47031	2995	48805	1975	58414	1550	39450
3E		MI	20047	6184	33331	4425	36210	3600	37372	2934	38246	1902	45333	1443	31158
8-#18	2.24	MA	23593	6184	38722	4532	42007	3656	43091	2983	43737	1993	52680	1323	37914
4L-2S		MI	21641	6184	35791	4434	39346	3579	41162	2916	43251	1884	51909	1671	31209
10-#11	1.09	MA	24251	5603	37913	4184	41202	3409	42195	2838	42434	2027	50190	1917	19985
2L-5S		MI	17944	5603	28243	4129	29941	3373	29895	2805	28466	1990	33064	1638	15984
10-#11	1.09	MA	23406	5603	36648	4183	39589	3406	40234	2848	39777	2035	46614	1829	20017
3L-4S		MI	18367	5603	28944	4131	30845	3363	31002	2797	30015	1997	34937	1679	15985
10-#11	1.09	MA	22809	5603	35632	4196	38298	3418	38667	2845	37742	2042	44271	1740	20019
4L-3S		MI	18836	5603	29743	4120	31860	3367	32233	2803	31585	1990	36704	1768	15950
10-#11	1.09	MA	22275	5603	34742	4196	37150	3416	37261	2855	35737	2036	41825	1696	19952
5L-2S		MI	19493	5603	30731	4122	33120	3357	33766	2794	33632	1983	39416	1856	15907
10-#14	1.58	MA	25507	5847	40702	4323	44679	3508	46391	2897	48106	2004	57653	1868	28403
2L-5S		MI	18255	5847	29346	4266	31268	3474	31477	2864	30538	1959	35977	1476	21930
10-#14	1.58	MA	24312	5847	38892	4322	42370	3524	43585	2911	44304	2014	52568	1740	28400
3L-4S		MI	18852	5847	30350	4270	32562	3461	33062	2853	32738	1968	38635	1534	22502
10-#14	1.58	MA	23467	5847	37437	4340	40520	3521	41339	2906	41389	2025	49240	1612	28286
4L-3S		MI	19516	5847	31492	4254	34013	3468	34823	2862	34967	1959	41133	1662	22534
10-#14	1.58	MA	22711	5847	36161	4338	38875	3537	39324	2920	38514	2015	45755	1549	27475
5L-2S		MI	20444	5847	32903	4258	35813	3454	37011	2851	37873	1949	44974	1790	22498
10-#18	2.80	MA	28531	6468	47614	4684	53334	3767	56854	3052	62016	1937	75982	1729	49238
2L-5S		MI	18993	6468	32036	4619	34543	3735	35354	3012	35621	1872	43070	1051	35140
10-#18	2.80	MA	26495	6468	44445	4679	49294	3793	51942	3075	55410	1955	67198	1502	48984
3L-4S		MI	20012	6468	33794	4628	36809	3714	38105	2994	39413	1890	47630	1153	36960
10-#18	2.80	MA	25054	6468	41891	4710	46047	3785	48002	3063	50343	1973	61464	1274	46994
4L-3S		MI	21144	6468	35791	4602	39346	3729	41162	3012	43251	1872	51909	1377	38569
10-#18	2.80	MA	23762	6468	39650	4705	43157	3812	44463	3086	45344	1955	55420	1166	44344
5L-2S		MI	22722	6468	38251	4612	42482	3708	44952	2994	48256	1855	58485	1605	38705
12-#11	1.31	MA	24846	5713	39178	4253	42815	3459	44156	2869	45090	2020	53766	1902	23858
2L-6S		MI	18007	5713	28569	4196	30302	3419	30330	2831	29090	1988	34017	1558	18551
12-#11	1.31	MA	24005	5713	37913	4253	41202	3457	42195	2879	42434	2028	50190	1814	23878
3L-5S		MI	18408	5713	29232	4198	31201	3423	31427	2836	30513	1981	35777	1617	18976
12-#11	1.31	MA	23412	5713	36897	4266	39911	3468	40628	2876	40399	2036	47847	1725	23855
4E		MI	18828	5713	29933	4200	32105	3413	32534	2828	32062	1988	37649	1658	19003
12-#11	1.31	MA	22881	5713	36008	4265	38763	3466	39222	2886	38394	2029	45401	1681	23764
5L-3S		MI	19294	5713	30731	4189	33120	3417	33766	2834	33632	1981	39416	1747	18983
12-#11	1.31	MA	22374	5713	35168	4264	37622	3478	37831	2883	36551	2037	43075	1623	23150
6L-2S		MI	19949	5713	31720	4191	34381	3408	35298	2826	35679	1974	42129	1836	18949

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.89	MA	26341	6007	42513	4423	46987	3580	49197	2942	51908	1994	62738	1844	33927
2L-6S		MI	18341	6007	29808	4361	31780	3540	32152	2920	31424	1954	37328	1358	25324
12-#14	1.89	MA	25154	6007	40702	4421	44679	3597	46391	2956	48106	2005	57653	1716	33888
3L-5S		MI	18907	6007	30757	4365	33067	3547	33665	2909	33444	1945	39818	1444	26020
12-#14	1.89	MA	24317	6007	39247	4440	42829	3593	44146	2951	45191	2015	54325	1588	33735
4E		MI	19500	6007	31761	4369	34362	3533	35250	2898	35644	1954	42476	1502	26762
12-#14	1.89	MA	23566	6007	37971	4438	41183	3609	42131	2965	42316	2005	50840	1526	32750
5L-3S		MI	20159	6007	32903	4354	35813	3540	37011	2907	37873	1945	44974	1630	26831
12-#14	1.89	MA	22851	6007	36767	4436	39547	3606	40135	2959	39675	2015	47534	1441	31727
6L-2S		MI	21082	6007	34315	4358	37613	3527	39199	2896	40780	1935	48815	1758	26820
12-#18	3.36	MA	27920	6752	47614	4856	53334	3922	56854	3155	62016	1935	75982	1453	58506
3L-5S		MI	20100	6752	34496	4796	37679	3864	39144	3090	40626	1843	49646	985	42295
12-#18	3.36	MA	26496	6752	45060	4887	50088	3913	52914	3143	56948	1952	70248	1226	56121
4E		MI	21108	6752	36254	4806	39944	3843	41895	3072	44418	1861	54206	1087	43988
12-#18	3.36	MA	25221	6752	42819	4882	47197	3940	49375	3165	51949	1935	64204	1118	53620
5L-3S		MI	22228	6752	38251	4780	42482	3857	44952	3090	48256	1843	58485	1311	45962
12-#18	3.36	MA	24004	6752	40702	4878	44323	3932	45869	3153	47357	1952	58500	967	50163
6L-2S		MI	23791	6752	40710	4789	45618	3836	48742	3072	53262	1826	65061	1539	46167
14-#11	1.53	MA	25437	5824	40443	4322	44428	3509	46116	2900	47747	2013	57343	1887	27723
2L-7S		MI	18080	5824	28849	4276	30698	3479	30804	2870	29744	1986	34896	1449	21121
14-#11	1.53	MA	24600	5824	39178	4322	42815	3507	44156	2911	45090	2021	53766	1798	27727
3L-6S		MI	18470	5824	29558	4265	31562	3469	31863	2862	31137	1979	36730	1537	21453
14-#11	1.53	MA	24011	5824	38163	4335	41524	3518	42589	2907	43055	2029	51423	1710	27685
4L-5S		MI	18868	5824	30220	4267	32461	3473	32959	2867	32559	1972	38489	1596	21962
14-#11	1.53	MA	23483	5824	37273	4334	40376	3516	41183	2918	41050	2023	48978	1666	27572
5L-4S		MI	19286	5824	30922	4269	33366	3463	34066	2859	34109	1979	40362	1637	22008
14-#11	1.53	MA	22979	5824	36433	4333	39235	3528	39792	2914	39208	2030	46651	1607	26874
6L-3S		MI	19750	5824	31720	4258	34381	3467	35298	2865	35679	1972	42129	1726	22006
14-#11	1.53	MA	22488	5824	35535	4346	38140	3526	38449	2924	37405	2038	44230	1520	26373
7L-2S		MI	20401	5824	32708	4260	35641	3458	36830	2857	37725	1966	44841	1815	21981
14-#14	2.21	MA	27168	6167	44324	4523	49296	3653	52004	2987	55710	1984	67823	1820	39433
2L-7S		MI	18444	6167	30205	4477	32342	3626	32767	2956	32353	1950	38573	1199	28447
14-#14	2.21	MA	25989	6167	42513	4521	46987	3669	49197	3001	51908	1995	62738	1692	39366
3L-6S		MI	18993	6167	31220	4461	33580	3613	34339	2965	34330	1940	41169	1326	29470
14-#14	2.21	MA	25158	6167	41058	4539	45137	3665	46952	2996	48992	2005	59410	1565	39180
4L-5S		MI	19555	6167	32169	4465	34867	3619	35853	2954	36350	1930	43658	1411	30127
14-#14	2.21	MA	24414	6167	39782	4538	43492	3682	44937	3010	46118	1995	55926	1502	38041
5L-4S		MI	20143	6167	33173	4469	36161	3606	37437	2943	38551	1940	46317	1469	31014
14-#14	2.21	MA	23705	6167	38578	4536	41856	3678	42942	3004	43476	2006	52619	1418	37066
6L-3S		MI	20798	6167	34315	4453	37613	3612	39199	2952	40780	1930	48815	1597	31113
14-#14	2.21	MA	23012	6167	37289	4554	40285	3694	41017	3018	40891	2016	49177	1291	35708
7L-2S		MI	21714	6167	35727	4457	39413	3599	41387	2941	43686	1921	52655	1725	31131
14-#18	3.92	MA	27921	7035	48229	5064	54128	4042	57825	3222	63554	1932	79032	1177	65287
4L-5S		MI	21196	7035	36956	4974	40815	3992	42934	3168	45631	1814	56222	919	49471
14-#18	3.92	MA	26661	7035	45987	5060	51237	4069	54286	3245	58555	1914	72988	1069	62918
5L-4S		MI	22193	7035	38714	4983	43080	3971	45685	3151	49423	1832	60782	1021	51055
14-#18	3.92	MA	25459	7035	43870	5055	48363	4060	50781	3233	53963	1932	67283	919	59310
6L-3S		MI	23302	7035	40710	4957	45618	3986	48742	3168	53262	1814	65061	1245	53343
14-#18	3.92	MA	24286	7035	41605	5086	45602	4087	47398	3256	49468	1950	61342	693	55819
7L-2S		MI	24850	7035	43170	4966	48754	3965	52531	3151	58267	1796	71638	1473	53612
16-#11	1.75	MA	26024	5935	41708	4392	46041	3559	48077	2931	50403	2006	60919	1872	31583
2L-8S		MI	18160	5935	29186	4343	31086	3525	31299	2909	30331	1970	35860	1380	23473
16-#11	1.75	MA	25191	5935	40443	4391	44428	3557	46116	2942	47747	2014	57343	1783	31569
3L-7S		MI	18542	5935	29837	4345	31958	3529	32336	2901	31791	1977	37608	1429	24044
16-#11	1.75	MA	24605	5935	39428	4404	43137	3569	44549	2938	45712	2022	54999	1695	31509
4L-6S		MI	18929	5935	30546	4334	32822	3519	33395	2893	33183	1970	39442	1517	24361
16-#11	1.75	MA	24080	5935	38538	4403	41989	3566	43144	2949	43707	2016	52554	1651	31378
5E		MI	19326	5935	31209	4336	33722	3523	34491	2899	34606	1963	41202	1575	24900

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

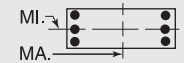
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.75	MA	23580	5935	37698	4402	40848	3578	41753	2945	41864	2023	50227	1592	30605
6L-4S		MI	19741	5935	31910	4339	34626	3514	35598	2890	36155	1970	43074	1616	25006
16-#11	1.75	MA	23092	5935	36800	4415	39753	3576	40410	2956	40062	2031	47806	1505	30122
7L-3S		MI	20203	5935	32708	4327	35641	3518	36830	2896	37725	1963	44841	1705	25023
16-#11	1.75	MA	22611	5935	35976	4414	38648	3588	39096	2966	38173	2025	45520	1454	29344
8L-2S		MI	20851	5935	33697	4329	36901	3508	38362	2888	39772	1957	47554	1794	25007
16-#14	2.52	MA	26818	6326	44324	4621	49296	3741	52004	3046	55710	1985	67823	1669	44838
3L-7S		MI	19094	6326	31616	4577	34142	3698	34955	3001	35259	1936	42414	1166	32518
16-#14	2.52	MA	25993	6326	42869	4639	47446	3738	49758	3040	52794	1995	64496	1541	44621
4L-6S		MI	19639	6326	32632	4561	35379	3685	36527	3010	37236	1926	45009	1294	33624
16-#14	2.52	MA	25255	6326	41593	4637	45800	3754	47743	3055	49920	1985	61011	1479	43346
5E		MI	20197	6326	33581	4565	36667	3691	38041	2999	39256	1916	47499	1379	34247
16-#14	2.52	MA	24551	6326	40388	4636	44164	3750	45748	3049	47278	1996	57705	1394	42412
6L-4S		MI	20782	6326	34585	4569	37961	3678	39625	2988	41457	1926	50157	1437	35259
16-#14	2.52	MA	23864	6326	39100	4654	42594	3767	43823	3063	44693	2006	54263	1268	40973
7L-3S		MI	21431	6326	35727	4553	39413	3685	41387	2997	43686	1916	52655	1565	35386
16-#14	2.52	MA	23187	6326	37917	4652	41008	3763	41938	3078	41985	1996	51007	1195	39703
8L-2S		MI	22342	6326	37138	4557	41213	3671	43575	2986	46592	1906	56496	1693	35430
16-#18	4.48	MA	28085	7319	49156	5237	55278	4197	59198	3325	65161	1894	81772	1021	72235
5E		MI	22280	7319	39415	5151	43951	4121	46724	3247	50637	1785	62798	853	56472
16-#18	4.48	MA	26897	7319	47039	5232	52403	4189	55692	3313	60568	1911	76067	870	68481
6L-4S		MI	23268	7319	41173	5160	46216	4100	49475	3229	54429	1803	67358	955	58152
16-#18	4.48	MA	25738	7319	44774	5263	49642	4215	52309	3335	56074	1929	70126	645	64895
7L-3S		MI	24365	7319	43170	5134	48754	4114	52531	3247	58267	1785	71638	1179	60715
18-#11	1.97	MA	25778	6045	41708	4460	46041	3607	48077	2973	50403	2007	60919	1768	35405
3L-8S		MI	18622	6045	30175	4412	32347	3575	32831	2940	32378	1961	38572	1360	26347
18-#11	1.97	MA	25196	6045	40693	4473	44750	3619	46510	2969	48369	2015	58576	1679	35330
4L-7S		MI	19001	6045	30826	4414	33219	3579	33868	2932	33837	1968	40320	1408	26970
18-#11	1.97	MA	24674	6045	39803	4472	43602	3617	45105	2980	46363	2009	56130	1636	35096
5L-6S		MI	19386	6045	31535	4403	34083	3570	34927	2924	35230	1961	42154	1496	27276
18-#11	1.97	MA	24177	6045	38964	4471	42461	3628	43713	2976	44521	2017	53803	1577	34342
6L-5S		MI	19781	6045	32197	4405	34982	3574	36023	2930	36653	1955	43914	1555	27786
18-#11	1.97	MA	23692	6045	38065	4484	41366	3626	42371	2987	42718	2024	51382	1490	33875
7L-4S		MI	20194	6045	32899	4408	35886	3564	37131	2922	38202	1961	45786	1596	27998
18-#11	1.97	MA	23214	6045	37241	4484	40261	3638	41057	2997	40830	2018	49097	1439	33045
8L-3S		MI	20653	6045	33697	4396	36901	3568	38362	2927	39772	1955	47554	1684	28030
18-#11	1.97	MA	22723	6045	36369	4497	39181	3636	39697	2994	39046	2026	46843	1382	32327
9L-2S		MI	21299	6045	34686	4399	38162	3558	39894	2919	41819	1948	50266	1773	28028
18-#14	2.84	MA	26821	6486	44679	4739	49754	3810	52564	3085	56596	1985	69581	1517	50059
4L-7S		MI	19740	6486	33028	4677	35942	3771	37143	3045	38165	1922	46254	1134	36600
18-#14	2.84	MA	26089	6486	43403	4737	48109	3826	50549	3100	53722	1975	66096	1455	48664
5L-6S		MI	20281	6486	34043	4661	37179	3757	38715	3055	40142	1912	48850	1261	37784
18-#14	2.84	MA	25390	6486	42199	4736	46473	3823	48554	3094	51080	1986	62790	1371	47766
6L-5S		MI	20835	6486	34992	4665	38467	3764	40229	3044	42162	1902	51340	1346	38378
18-#14	2.84	MA	24709	6486	40910	4754	44902	3839	46629	3108	48495	1996	59348	1244	46249
7L-4S		MI	21415	6486	35996	4669	39761	3750	41813	3033	44363	1912	53998	1404	39500
18-#14	2.84	MA	24037	6486	39728	4752	43317	3835	44745	3122	45787	1986	56092	1171	44923
8L-3S		MI	22061	6486	37138	4653	41213	3757	43575	3042	46592	1902	56496	1532	39652
18-#14	2.84	MA	23364	6486	38477	4770	41768	3851	42795	3117	43229	1997	52889	1090	43152
9L-2S		MI	22966	6486	38550	4657	43013	3744	45763	3031	49498	1892	60336	1660	39717
18-#18	5.04	MA	28321	7603	50208	5410	56443	4317	60604	3392	67174	1891	84851	822	77675
6L-5S		MI	23356	7603	41875	5328	47087	4249	50514	3325	55642	1756	69374	787	63419
18-#18	5.04	MA	27175	7603	47943	5440	53683	4344	57221	3415	62680	1909	78909	596	73992
7L-4S		MI	24333	7603	43633	5338	49352	4228	53265	3307	59434	1773	73935	890	65275

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

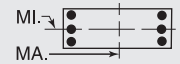


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.18	MA	25783	6156	41958	4542	46363	3669	48471	3001	51025	2008	62152	1664	39148
4L-8S		MI	19080	6156	31163	4481	33607	3626	34363	2971	34425	1953	41284	1339	29227
20-#11	2.18	MA	25264	6156	41068	4541	45215	3667	47066	3011	49020	2002	59706	1621	38809
5L-7S		MI	19458	6156	31814	4484	34479	3630	35400	2963	35884	1959	43033	1387	29899
20-#11	2.18	MA	24770	6156	40229	4541	44074	3678	45674	3007	47177	2010	57380	1562	38085
6E		MI	19841	6156	32523	4472	35343	3620	36459	2955	37277	1953	44867	1475	30194
20-#11	2.18	MA	24288	6156	39330	4554	42979	3676	44332	3018	45375	2017	54958	1475	37632
7L-5S		MI	20233	6156	33186	4475	36243	3624	37556	2961	38699	1946	46627	1534	30681
20-#11	2.18	MA	23812	6156	38506	4553	41874	3688	43018	3028	43486	2011	52673	1423	36752
8L-4S		MI	20644	6156	33887	4477	37147	3614	38663	2953	40249	1953	48499	1575	30986
20-#11	2.18	MA	23332	6156	37634	4566	40794	3686	41658	3025	41702	2019	50419	1367	36053
9L-3S		MI	21101	6156	34686	4465	38162	3618	39894	2958	41819	1946	50266	1663	31031
20-#11	2.18	MA	22801	6156	36814	4565	39703	3698	40352	3035	39932	2027	48233	1304	34996
10L-2S		MI	21743	6156	35674	4468	39422	3608	41426	2950	43865	1939	52978	1752	31044
20-#14	3.15	MA	26916	6645	45214	4837	50417	3899	53356	3144	57524	1965	71181	1431	53991
5L-7S		MI	20380	6645	34440	4776	37742	3843	39331	3090	41071	1908	50095	1102	40692
20-#14	3.15	MA	26223	6645	44010	4835	48781	3895	51361	3139	54882	1976	67875	1347	53126
6E		MI	20918	6645	35455	4760	38979	3830	40903	3099	43048	1898	52691	1229	41920
20-#14	3.15	MA	25547	6645	42721	4854	47211	3911	49436	3153	52297	1986	64433	1220	51535
7L-5S		MI	21468	6645	36404	4764	40267	3836	42417	3089	45069	1888	55180	1314	42519
20-#14	3.15	MA	24880	6645	41539	4852	45625	3908	47551	3167	49589	1976	61177	1148	50153
8L-4S		MI	22044	6645	37408	4768	41561	3823	44001	3078	47269	1898	57838	1372	43669
20-#14	3.15	MA	24209	6645	40288	4870	44076	3924	45601	3162	47031	1987	57974	1066	48425
9L-3S		MI	22686	6645	38550	4753	43013	3829	45763	3087	49498	1888	60336	1500	43913
20-#18	5.60	MA	28597	7887	51112	5618	57723	4473	62132	3495	69285	1888	87693	548	83110
7L-5S		MI	24422	7887	44335	5505	50223	4378	54304	3403	60647	1727	75951	721	70392
22-#11	2.40	MA	25851	6267	42334	4611	46828	3717	49026	3042	51676	1995	63283	1605	42529
5L-8S		MI	19536	6267	32152	4550	34867	3676	35896	3003	36471	1944	43997	1318	32112
22-#11	2.40	MA	25360	6267	41494	4610	45687	3729	47635	3039	49834	2003	60956	1547	41833
6L-7S		MI	19912	6267	32803	4553	35739	3680	36932	2994	37931	1950	45745	1366	32772
22-#11	2.40	MA	24880	6267	40595	4623	44592	3726	46293	3049	48031	2011	58535	1459	41391
7L-6S		MI	20292	6267	33512	4541	36604	3670	37991	2986	39323	1944	47579	1454	33117
22-#11	2.40	MA	24408	6267	39771	4622	43487	3738	44979	3059	46143	2004	56249	1408	40465
8L-5S		MI	20683	6267	34174	4544	37503	3674	39088	2992	40746	1937	49339	1513	33581
22-#11	2.40	MA	23928	6267	38899	4635	42407	3736	43619	3056	44359	2012	53995	1352	39743
9L-4S		MI	21091	6267	34876	4546	38407	3664	40195	2984	42295	1944	51211	1554	33971
22-#11	2.40	MA	23402	6267	38079	4634	41316	3748	42313	3066	42588	2020	51809	1289	38693
10L-3S		MI	21546	6267	35674	4535	39422	3668	41426	2989	43865	1937	52978	1643	34028
22-#11	2.40	MA	22893	6267	37270	4633	40242	3746	40969	3063	40726	2014	49578	1235	37682
11L-2S		MI	22186	6267	36663	4537	40682	3658	42958	2981	45912	1930	55691	1731	34052
22-#14	3.47	MA	27050	6805	45821	4935	51090	3967	54167	3184	58684	1966	72960	1323	58492
6L-7S		MI	21017	6805	35852	4876	39542	3915	41519	3135	43977	1894	53935	1069	44793
22-#14	3.47	MA	26379	6805	44532	4953	49519	3983	52242	3198	56099	1976	69518	1197	56830
7L-6S		MI	21550	6805	36867	4860	40779	3902	43091	3144	45954	1884	56531	1196	45975
22-#14	3.47	MA	25717	6805	43349	4952	47934	3980	50357	3212	53391	1966	66263	1124	55393
8L-5S		MI	22097	6805	37816	4864	42067	3908	44605	3133	47975	1874	59021	1282	46666
22-#14	3.47	MA	25047	6805	42098	4970	46385	3996	48407	3207	50833	1977	63059	1043	53707
9L-4S		MI	22670	6805	38820	4868	43361	3895	46189	3123	50175	1884	61679	1340	47762
24-#11	2.62	MA	25946	6377	42759	4679	47300	3779	49596	3070	52491	1996	64532	1532	45584
6L-8S		MI	19989	6377	33140	4620	36128	3726	37428	3034	38518	1935	46709	1297	35002
24-#11	2.62	MA	25469	6377	41861	4692	46205	3777	48254	3080	50688	2004	62111	1444	45107
7E		MI	20363	6377	33791	4622	37000	3730	38465	3026	39977	1942	48458	1345	35640
24-#11	2.62	MA	24999	6377	41037	4691	45100	3788	46940	3090	48800	1998	59826	1393	44182
8L-6S		MI	20742	6377	34500	4610	37864	3720	39523	3017	41370	1935	50292	1433	36043
24-#11	2.62	MA	24521	6377	40164	4704	44020	3786	45580	3087	47015	2005	57571	1337	43422
9L-5S		MI	21130	6377	35163	4613	38763	3724	40620	3023	42793	1928	52051	1492	36487
24-#11	2.62	MA	23999	6377	39344	4703	42929	3798	44274	3097	45245	2013	55386	1274	42396
10L-4S		MI	21537	6377	35864	4615	39667	3714	41727	3015	44342	1935	53924	1533	36953

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis



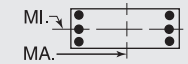
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.62	MA	23493	6377	38535	4702	41855	3796	42930	3094	43383	2007	53154	1220	41301
11L-3S		MI	21990	6377	36663	4604	40682	3718	42958	3021	45912	1928	55691	1622	37022
24-#14	3.78	MA	27205	6964	46342	5053	51827	4056	55048	3243	59901	1966	74604	1173	62132
7E		MI	21649	6964	37263	4976	41341	3988	43707	3180	46884	1880	57776	1037	48901
24-#14	3.78	MA	26548	6964	45160	5051	50242	4052	53163	3257	57193	1956	71348	1101	60641
8L-6S		MI	22179	6964	38278	4960	42579	3974	45279	3189	48861	1870	60372	1164	50041
24-#14	3.78	MA	25880	6964	43909	5070	48693	4068	51213	3252	54634	1967	68145	1019	58995
9L-5S		MI	22723	6964	39227	4964	43866	3981	46793	3178	50881	1860	62862	1249	50820
RECTANGULAR TIED COLUMNS 34" x 44"															
4-#18	1.07	MA	26465	5857	41493	4347	44899	3542	45853	2950	45888	2107	53954	1983	21324
2E		MI	20259	5857	32107	4257	34351	3468	34820	2884	34347	2037	39976	1894	16134
6-#18	1.60	MA	28018	6141	44840	4524	49165	3670	51040	3029	52894	2088	63292	1937	31574
2L-3S		MI	19755	6141	32107	4425	34351	3617	34820	2979	34347	2026	39976	1601	23786
6-#18	1.60	MA	25812	6141	41493	4521	44899	3698	45853	3053	45888	2106	53954	1710	31518
3L-2S		MI	21369	6141	34567	4434	37487	3596	38610	2962	39352	2008	46552	1829	23725
8-#14	1.20	MA	26943	5928	42314	4419	46110	3596	47389	2989	48034	2119	57040	1999	24081
2L-4S		MI	19016	5928	30169	4349	32039	3536	32115	2933	30944	2079	36022	1659	18285
8-#14	1.20	MA	25670	5928	40404	4418	43675	3593	44428	3004	44022	2130	51643	1871	24114
3E		MI	19686	5928	31311	4333	33491	3543	33877	2942	33173	2069	38520	1787	18258
8-#14	1.20	MA	24772	5928	38871	4436	41725	3610	42062	2999	40950	2141	48107	1743	24044
4L-2S		MI	20621	5928	32722	4337	35290	3529	36065	2932	36079	2059	42361	1915	18197
8-#18	2.14	MA	29547	6425	48186	4702	53431	3799	56226	3109	59901	2069	72629	1892	41777
2L-4S		MI	19720	6425	32570	4628	34949	3732	35553	3040	35513	2015	42273	1311	30288
8-#18	2.14	MA	27367	6425	44840	4698	49165	3827	51040	3133	52894	2087	63292	1665	41610
3E		MI	20867	6425	34567	4602	37487	3746	38610	3058	39352	1997	46552	1535	31235
8-#18	2.14	MA	25826	6425	42147	4729	45741	3819	46885	3122	47519	2105	57189	1437	40294
4L-2S		MI	22465	6425	37027	4612	40623	3725	42400	3040	44357	1979	53128	1763	31263
10-#11	1.04	MA	26502	5843	41278	4380	44873	3569	45918	2974	46053	2132	54501	2024	21038
2L-5S		MI	18762	5843	29471	4309	31218	3521	31138	2931	29580	2087	34296	1731	16035
10-#11	1.04	MA	25609	5843	39944	4379	43172	3568	43850	2985	43252	2140	50708	1936	21070
3L-4S		MI	19185	5843	30172	4311	32122	3511	32245	2923	31130	2094	36168	1772	16024
10-#11	1.04	MA	24979	5843	38874	4392	41812	3580	42199	2982	41108	2148	48220	1847	21072
4L-3S		MI	19655	5843	30971	4299	33137	3515	33477	2928	32699	2087	37935	1861	15984
10-#11	1.04	MA	24416	5843	37937	4392	40603	3578	40719	2993	38996	2143	45631	1802	21005
5L-2S		MI	20313	5843	31959	4302	34397	3505	35009	2920	34746	2080	40647	1950	15939
10-#14	1.50	MA	27837	6088	44225	4519	48546	3669	50350	3034	52045	2109	62437	1977	29921
2L-5S		MI	19072	6088	30576	4445	32544	3622	32719	2989	31649	2055	37204	1569	22110
10-#14	1.50	MA	26573	6088	42314	4517	46110	3666	47389	3049	48034	2120	57040	1849	29919
3L-4S		MI	19671	6088	31580	4449	33839	3608	34303	2978	33850	2065	39863	1627	22564
10-#14	1.50	MA	25682	6088	40781	4536	44160	3683	45023	3044	44961	2131	53504	1721	29804
4L-3S		MI	20336	6088	32722	4433	35290	3615	36065	2987	36079	2055	42361	1755	22579
10-#14	1.50	MA	24883	6088	39437	4535	42427	3679	42900	3058	41933	2123	49813	1658	29088
5L-2S		MI	21265	6088	34134	4437	37090	3602	38252	2976	38985	2045	46201	1883	22538
10-#18	2.67	MA	31056	6708	51532	4879	57698	3927	61412	3189	66908	2050	81967	1847	51938
2L-5S		MI	19809	6708	33272	4796	35819	3881	36592	3136	36727	1968	44289	1143	35400
10-#18	2.67	MA	28900	6708	48186	4875	53431	3955	56226	3213	59901	2068	72629	1619	51684
3L-4S		MI	20831	6708	35030	4806	38085	3860	39343	3118	40519	1985	48849	1245	37261
10-#18	2.67	MA	27378	6708	45493	4907	50007	3948	52071	3202	54526	2086	66526	1392	49893
4L-3S		MI	21966	6708	37027	4780	40623	3874	42400	3136	44357	1968	53128	1469	38654
10-#18	2.67	MA	26014	6708	43131	4903	46961	3976	48340	3226	49224	2068	60115	1283	46969
5L-2S		MI	23548	6708	39486	4789	43759	3853	46190	3118	49363	1950	59704	1697	38768

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis

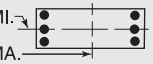


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.25	MA	27133	5954	42612	4449	46574	3619	47986	3006	48855	2125	58293	2010	25122
2L-6S		MI	18824	5954	29797	4375	31579	3567	31573	2956	30204	2085	35248	1652	18678
12-#11	1.25	MA	26244	5954	41278	4448	44873	3618	45918	3016	46053	2133	54501	1922	25141
3L-5S		MI	19226	5954	30460	4378	32478	3571	32670	2962	31627	2078	37008	1711	19032
12-#11	1.25	MA	25618	5954	40208	4461	43513	3630	44267	3013	43910	2142	52013	1833	25119
4E		MI	19646	5954	31161	4380	33382	3561	33777	2954	33176	2085	38880	1752	19045
12-#11	1.25	MA	25058	5954	39272	4461	42305	3628	42787	3024	41798	2136	49424	1788	25028
5L-3S		MI	20114	5954	31959	4369	34397	3565	35009	2959	34746	2078	40647	1840	19020
12-#11	1.25	MA	24525	5954	38388	4460	41104	3640	41322	3021	39858	2144	46955	1730	24455
6L-2S		MI	20769	5954	32948	4371	35658	3555	36541	2951	36793	2071	43360	1929	18983
12-#14	1.80	MA	28722	6247	46135	4618	50982	3741	53311	3079	56056	2099	67834	1955	35750
2L-6S		MI	19158	6247	31039	4540	33057	3688	33393	3045	32535	2051	38555	1451	25489
12-#14	1.80	MA	27467	6247	44225	4617	48546	3738	50350	3093	52045	2110	62437	1828	35710
3L-5S		MI	19726	6247	31988	4544	34344	3694	34907	3034	34555	2041	41045	1537	26198
12-#14	1.80	MA	26583	6247	42691	4636	46596	3755	47984	3088	48972	2121	58901	1700	35558
4E		MI	20320	6247	32992	4548	35639	3681	36491	3023	36756	2051	43703	1594	26830
12-#14	1.80	MA	25791	6247	41348	4635	44863	3752	45861	3103	45944	2113	55210	1636	34656
5L-3S		MI	20980	6247	34134	4533	37090	3687	38252	3032	38985	2041	46201	1722	26884
12-#14	1.80	MA	25037	6247	40080	4634	43140	3769	43760	3098	43162	2124	51699	1552	33532
6L-2S		MI	21904	6247	35546	4537	38890	3674	40440	3021	41891	2031	50042	1850	26863
12-#18	3.21	MA	30414	6992	51532	5053	57698	4084	61412	3293	66908	2049	81967	1574	61746
3L-5S		MI	20918	6992	35732	4974	38955	4010	40382	3214	41732	1938	50865	1077	42552
12-#18	3.21	MA	28910	6992	48840	5084	54274	4076	57257	3282	61532	2067	75864	1347	59540
4E		MI	21929	6992	37490	4983	41221	3989	43133	3196	45524	1956	55425	1179	44283
12-#18	3.21	MA	27563	6992	46477	5080	51227	4104	53527	3306	56231	2049	69453	1238	56773
5L-3S		MI	23053	6992	39486	4957	43759	4003	46190	3214	49363	1938	59704	1403	46055
12-#18	3.21	MA	26278	6992	44247	5077	48198	4097	49833	3294	51360	2067	63385	1087	53326
6L-2S		MI	24620	6992	41946	4966	46894	3982	49980	3196	54368	1921	66281	1631	46236
14-#11	1.46	MA	27760	6064	43947	4518	48276	3670	50054	3037	51657	2118	62086	1996	29197
2L-7S		MI	18897	6064	30077	4456	31975	3627	32047	2996	30858	2083	36127	1543	21243
14-#11	1.46	MA	26875	6064	42612	4517	46574	3668	47986	3047	48855	2126	58293	1907	29201
3L-6S		MI	19287	6064	30786	4445	32839	3617	33106	2987	32251	2076	37961	1631	21578
14-#11	1.46	MA	26253	6064	41543	4531	45214	3680	46335	3044	46712	2135	55806	1819	29159
4L-5S		MI	19687	6064	31448	4447	33739	3621	34202	2993	33674	2069	39720	1690	22022
14-#11	1.46	MA	25697	6064	40606	4530	44006	3678	44855	3055	44600	2129	53217	1774	29046
5L-4S		MI	20105	6064	32150	4449	34643	3611	35309	2985	35223	2076	41593	1731	22057
14-#11	1.46	MA	25166	6064	39722	4530	42805	3690	43390	3052	42660	2137	50748	1716	28384
6L-3S		MI	20570	6064	32948	4438	35658	3615	36541	2991	36793	2069	43360	1819	22046
14-#11	1.46	MA	24648	6064	38776	4543	41652	3688	41977	3063	40762	2146	48179	1629	27835
7L-2S		MI	21222	6064	33936	4440	36918	3606	38073	2982	38840	2062	46072	1908	22018
14-#14	2.11	MA	29600	6407	48046	4718	53417	3813	56272	3123	60068	2089	73231	1934	41559
2L-7S		MI	19260	6407	31435	4656	33619	3773	34009	3081	33464	2046	39800	1292	28717
14-#14	2.11	MA	28353	6407	46135	4717	50982	3810	53311	3138	56056	2100	67834	1806	41493
3L-6S		MI	19810	6407	32451	4640	34857	3760	35581	3090	35441	2037	42396	1419	29635
14-#14	2.11	MA	27476	6407	44602	4736	49032	3827	50945	3133	52984	2111	64298	1678	41306
4L-5S		MI	20374	6407	33400	4644	36144	3766	37095	3079	37462	2027	44886	1504	30303
14-#14	2.11	MA	26691	6407	43258	4734	47299	3824	48822	3148	49955	2103	60607	1614	40242
5L-4S		MI	20964	6407	34404	4648	37438	3753	38679	3068	39662	2037	47544	1562	31087
14-#14	2.11	MA	25942	6407	41990	4733	45576	3841	46721	3143	47173	2114	57096	1530	39168
6L-3S		MI	21620	6407	35546	4632	38890	3760	40440	3077	41891	2027	50042	1690	31170
14-#14	2.11	MA	25212	6407	40633	4752	43922	3838	44694	3158	44450	2125	53442	1404	37863
7L-2S		MI	22538	6407	36957	4636	40690	3746	42628	3066	44797	2017	53882	1818	31177
14-#18	3.74	MA	30424	7276	52186	5261	58540	4205	62443	3361	68539	2048	85201	1301	69226
4L-5S		MI	22015	7276	38191	5151	42091	4138	44172	3292	46737	1909	57441	1011	49726
14-#18	3.74	MA	29092	7276	49823	5258	55493	4233	58713	3386	63238	2031	78790	1192	66600
5L-4S		MI	23016	7276	39950	5160	44357	4117	46923	3275	50529	1927	62001	1113	51345
14-#18	3.74	MA	27823	7276	47593	5254	52464	4225	55019	3374	58366	2048	72722	1042	62999
6L-3S		MI	24128	7276	41946	5134	46894	4132	49980	3292	54368	1909	66281	1337	53443
14-#18	3.74	MA	26584	7276	45206	5285	49555	4253	51454	3398	53599	2066	66404	817	59498
7L-2S		MI	25682	7276	44406	5144	50030	4111	53770	3275	59373	1892	72857	1565	53685

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis



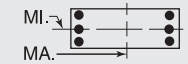
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.67	MA	28382	6175	45281	4587	49977	3720	52122	3068	54459	2111	65879	1982	33268
2L-8S		MI	18977	6175	30414	4523	32363	3673	32542	3035	31445	2067	37091	1474	23671
16-#11	1.67	MA	27502	6175	43947	4587	48276	3718	50054	3079	51657	2119	62086	1893	33253
3L-7S		MI	19360	6175	31065	4525	33235	3677	33579	3027	32905	2074	38839	1522	24167
16-#11	1.67	MA	26884	6175	42877	4600	46915	3730	48403	3076	49513	2128	59598	1805	33194
4L-6S		MI	19748	6175	31774	4514	34100	3667	34638	3019	34297	2067	40673	1610	24487
16-#11	1.67	MA	26331	6175	41940	4599	45707	3728	46923	3086	47401	2122	57009	1760	33063
5E		MI	20145	6175	32437	4516	34999	3671	35734	3024	35720	2060	42433	1669	25007
16-#11	1.67	MA	25803	6175	41057	4599	44506	3740	45458	3083	45462	2131	54541	1702	32320
6L-4S		MI	20561	6175	33138	4518	35903	3662	36841	3016	37270	2067	44305	1710	25058
16-#11	1.67	MA	25289	6175	40111	4612	43353	3739	44045	3094	43564	2139	51972	1615	31792
7L-3S		MI	21024	6175	33936	4507	36918	3666	38073	3022	38840	2060	46072	1799	25066
16-#11	1.67	MA	24781	6175	39243	4612	42190	3751	42661	3105	41575	2133	49552	1563	31057
8L-2S		MI	21673	6175	34925	4509	38178	3656	39605	3014	40886	2053	48785	1887	25046
16-#14	2.41	MA	29233	6567	48046	4817	53417	3883	56272	3183	60068	2090	73231	1784	47268
3L-7S		MI	19911	6567	32847	4756	35419	3846	36197	3126	36370	2032	43641	1259	32784
16-#14	2.41	MA	28362	6567	46512	4835	51467	3899	53905	3178	56995	2102	69696	1656	47051
4L-6S		MI	20457	6567	33862	4740	36656	3832	37769	3135	38348	2022	46237	1386	33788
16-#14	2.41	MA	27583	6567	45168	4834	49734	3896	51783	3193	53966	2093	66004	1592	45842
5E		MI	21017	6567	34811	4744	37944	3839	39283	3124	40368	2013	48726	1472	34422
16-#14	2.41	MA	26840	6567	43900	4833	48011	3913	49682	3188	51184	2104	62493	1508	44813
6L-4S		MI	21603	6567	35815	4748	39238	3825	40867	3113	42568	2022	51384	1530	35338
16-#14	2.41	MA	26116	6567	42543	4852	46357	3910	47654	3203	48462	2115	58839	1382	43424
7L-3S		MI	22255	6567	36957	4732	40690	3832	42628	3122	44797	2013	53882	1658	35447
16-#14	2.41	MA	25401	6567	41299	4851	44688	3927	45670	3218	45610	2106	55389	1308	42063
8L-2S		MI	23168	6567	38369	4736	42490	3818	44816	3111	47704	2003	57723	1786	35482
16-#18	4.28	MA	30605	7560	53170	5435	59760	4361	63899	3465	70244	2012	88127	1147	76446
5E		MI	23102	7560	40651	5328	45227	4267	47962	3370	51743	1880	64017	945	56918
16-#18	4.28	MA	29351	7560	50939	5431	56731	4354	60205	3454	65373	2030	82060	997	72696
6L-4S		MI	24093	7560	42409	5338	47493	4246	50713	3353	55535	1898	68578	1048	58437
16-#18	4.28	MA	28126	7560	48552	5463	53822	4382	56640	3478	60605	2047	75742	772	69101
7L-3S		MI	25195	7560	44406	5312	50030	4260	53770	3370	59373	1880	72857	1271	60821
18-#11	1.88	MA	28125	6286	45281	4656	49977	3768	52122	3110	54459	2113	65879	1879	37301
3L-8S		MI	19439	6286	31403	4592	33624	3723	34074	3066	33492	2058	39803	1453	26543
18-#11	1.88	MA	27510	6286	44211	4669	48617	3780	50471	3107	52315	2121	63391	1791	37226
4L-7S		MI	19819	6286	32054	4594	34496	3727	35111	3058	34952	2065	41552	1501	27094
18-#11	1.88	MA	26960	6286	43275	4668	47408	3778	48991	3118	50203	2115	60802	1746	37077
5L-6S		MI	20205	6286	32763	4583	35360	3718	36170	3050	36344	2058	43386	1589	27401
18-#11	1.88	MA	26436	6286	42391	4668	46207	3790	47526	3115	48263	2124	58333	1688	36264
6L-5S		MI	20600	6286	33425	4585	36259	3722	37267	3055	37767	2051	45145	1648	27925
18-#11	1.88	MA	25925	6286	41445	4681	45054	3789	46113	3125	46365	2132	55765	1600	35752
7L-4S		MI	21014	6286	34127	4588	37163	3712	38374	3047	39316	2058	47018	1689	28054
18-#11	1.88	MA	25420	6286	40578	4681	43891	3801	44729	3136	44377	2126	53345	1549	34964
8L-3S		MI	21475	6286	34925	4576	38178	3716	39605	3053	40886	2051	48785	1778	28080
18-#11	1.88	MA	24894	6286	39726	4680	42754	3799	43298	3133	42499	2135	50953	1493	34179
9L-2S		MI	22121	6286	35914	4578	39439	3706	41137	3045	42933	2044	51497	1866	28068
18-#14	2.71	MA	29241	6726	48423	4935	53903	3972	56866	3223	61006	2092	75093	1634	52793
4L-7S		MI	20557	6726	34259	4856	37219	3918	38385	3171	39277	2018	47481	1227	36863
18-#14	2.71	MA	28468	6726	47079	4934	52170	3969	54744	3238	57978	2083	71401	1571	51455
5L-6S		MI	21100	6726	35274	4840	38456	3904	39957	3180	41254	2008	50077	1354	37949
18-#14	2.71	MA	27731	6726	45811	4933	50447	3985	52642	3233	55196	2094	67890	1486	50465
6L-5S		MI	21656	6726	36223	4844	39744	3911	41470	3169	43274	1999	52567	1439	38552
18-#14	2.71	MA	27012	6726	44454	4951	48793	3982	50615	3248	52473	2105	64236	1360	48996
7L-4S		MI	22238	6726	37227	4848	41038	3898	43055	3158	45474	2008	55225	1497	39583

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis

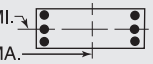


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.71	MA	26303	6726	43209	4950	47124	3999	48631	3263	49621	2096	60787	1286	47675
8L-3S		MI	22885	6726	38369	4832	42490	3904	44816	3167	47704	1999	57723	1625	39717
18-#14	2.71	MA	25582	6726	41892	4969	45493	3996	46577	3258	46927	2107	57385	1205	45787
9L-2S		MI	23793	6726	39781	4836	44289	3891	47004	3156	50610	1989	61564	1753	39772
18-#18	4.81	MA	30862	7843	54286	5608	60997	4482	65391	3534	72379	2011	91397	952	82416
6L-5S		MI	24179	7843	43111	5506	48363	4395	51752	3449	56748	1851	70594	879	63890
18-#18	4.81	MA	29652	7843	51899	5640	58088	4510	61827	3558	67612	2029	85079	726	78726
7L-4S		MI	25161	7843	44869	5515	50629	4374	54503	3431	60540	1869	75154	982	65556
20-#11	2.09	MA	28133	6396	45546	4738	50318	3830	52539	3138	55117	2114	67184	1777	41254
4L-8S		MI	19898	6396	32391	4661	34884	3773	35606	3097	35539	2049	42516	1432	29421
20-#11	2.09	MA	27586	6396	44609	4738	49109	3829	51059	3149	53005	2108	64595	1732	41018
5L-7S		MI	20276	6396	33042	4663	35756	3777	36643	3089	36998	2056	44264	1480	30024
20-#11	2.09	MA	27065	6396	43725	4737	47908	3841	49594	3146	51065	2117	62126	1674	40213
6E		MI	20660	6396	33751	4652	36620	3768	37702	3081	38391	2049	46098	1568	30319
20-#11	2.09	MA	26557	6396	42779	4750	46755	3839	48181	3156	49167	2125	59558	1586	39716
7L-5S		MI	21053	6396	34414	4654	37520	3772	38799	3086	39814	2042	47858	1627	30819
20-#11	2.09	MA	26055	6396	41912	4750	45592	3851	46797	3167	47179	2120	57138	1535	38877
8L-4S		MI	21465	6396	35115	4657	38424	3762	39906	3078	41363	2049	49730	1668	31045
20-#11	2.09	MA	25532	6396	41060	4749	44455	3849	45366	3164	45301	2128	54746	1479	38112
9L-3S		MI	21923	6396	35914	4645	39439	3766	41137	3084	42933	2042	51497	1757	31082
20-#11	2.09	MA	24980	6396	40131	4763	43307	3861	43991	3175	43437	2136	52426	1415	37078
10L-2S		MI	22567	6396	36902	4648	40699	3756	42669	3076	44980	2035	54210	1846	31086
20-#14	3.01	MA	29346	6886	48989	5034	54605	4041	57705	3283	61989	2073	76798	1549	57078
5L-7S		MI	21199	6886	35671	4955	39019	3990	40573	3215	42183	2004	51322	1195	40952
20-#14	3.01	MA	28615	6886	47721	5032	52883	4058	55603	3278	59207	2084	73287	1464	56124
6E		MI	21738	6886	36686	4939	40256	3977	42145	3225	44160	1994	53918	1322	42114
20-#14	3.01	MA	27902	6886	46364	5051	51229	4055	53576	3293	56484	2095	69633	1338	54578
7L-5S		MI	22290	6886	37635	4943	41544	3983	43658	3214	46180	1984	56407	1407	42691
20-#14	3.01	MA	27198	6886	45120	5050	49560	4072	51591	3308	53633	2086	66184	1264	53256
8L-4S		MI	22869	6886	38639	4947	42838	3970	45243	3203	48381	1994	59066	1465	43824
20-#14	3.01	MA	26478	6886	43802	5069	47929	4068	49538	3303	50938	2097	62782	1183	51358
9L-3S		MI	23512	6886	39781	4932	44289	3976	47004	3212	50610	1984	61564	1593	43981
20-#18	5.35	MA	31162	8127	55245	5817	62354	4639	67013	3638	74619	2010	94417	681	88370
7L-5S		MI	25248	8127	45570	5683	51499	4524	55542	3527	61753	1822	77170	813	70857
22-#11	2.29	MA	28208	6507	45943	4807	50810	3879	53127	3180	55807	2102	68387	1718	44942
5L-8S		MI	20354	6507	33380	4730	36144	3824	37139	3128	37586	2040	45228	1411	32305
22-#11	2.29	MA	27690	6507	45060	4806	49609	3891	51662	3177	53867	2110	65919	1660	44166
6L-7S		MI	20731	6507	34031	4733	37016	3828	38176	3120	39045	2047	46976	1459	32956
22-#11	2.29	MA	27185	6507	44114	4820	48457	3889	50249	3188	51969	2118	63350	1572	43684
7L-6S		MI	21113	6507	34740	4721	37881	3818	39234	3112	40437	2040	48810	1547	33242
22-#11	2.29	MA	26686	6507	43246	4819	47293	3901	48865	3198	49981	2113	60930	1521	42795
8L-5S		MI	21504	6507	35402	4723	38780	3822	40331	3118	41860	2033	50570	1606	33719
22-#11	2.29	MA	26166	6507	42395	4819	46156	3899	47434	3195	48102	2121	58539	1465	42050
9L-4S		MI	21914	6507	36104	4726	39684	3812	41438	3109	43410	2040	52442	1647	34032
22-#11	2.29	MA	25617	6507	41465	4832	45008	3911	46059	3206	46238	2129	56219	1401	40982
10L-3S		MI	22370	6507	36902	4714	40699	3816	42669	3115	44980	2033	54210	1736	34081
22-#11	2.29	MA	25080	6507	40614	4831	43878	3910	44644	3203	44278	2124	53856	1347	40000
11L-2S		MI	23011	6507	37891	4717	41959	3806	44201	3107	47026	2026	56922	1825	34100
22-#14	3.31	MA	29492	7045	49632	5132	55318	4130	58564	3323	63218	2074	78684	1442	61789
6L-7S		MI	21837	7045	37082	5055	40818	4062	42761	3260	45089	1990	55163	1162	45051
22-#14	3.31	MA	28784	7045	48275	5151	53664	4127	56537	3338	60496	2085	75031	1316	60168
7L-6S		MI	22372	7045	38097	5039	42056	4049	44333	3269	47066	1980	57758	1289	46266
22-#14	3.31	MA	28086	7045	47030	5150	51995	4144	54552	3353	57644	2076	71581	1242	58791
8L-5S		MI	22921	7045	39046	5043	43343	4056	45846	3259	49086	1970	60248	1375	46837
22-#14	3.31	MA	27368	7045	45713	5168	50364	4141	52499	3348	54949	2087	68179	1161	56936
9L-4S		MI	23496	7045	40051	5047	44638	4042	47431	3248	51287	1980	62906	1433	47968
24-#11	2.50	MA	28312	6618	46394	4875	51311	3941	53730	3208	56669	2103	69711	1646	48124
6L-8S		MI	20808	6618	34368	4799	37405	3874	38671	3159	39632	2031	47940	1390	35193

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.50	MA	27809	6618	45448	4889	50158	3939	52317	3219	54771	2111	67143	1558	47653
7E		MI	21183	6618	35019	4802	38277	3878	39708	3151	41092	2038	49689	1438	35848
24-#11	2.50	MA	27314	6618	44581	4888	48994	3951	50933	3230	52782	2106	64723	1507	46718
8L-6S		MI	21563	6618	35728	4790	39141	3868	40766	3143	42484	2031	51523	1526	36168
24-#11	2.50	MA	26801	6618	43729	4888	47858	3949	49502	3227	50904	2114	62331	1451	45991
9L-5S		MI	21952	6618	36391	4793	40040	3872	41863	3149	43907	2024	53283	1585	36624
24-#11	2.50	MA	26250	6618	42799	4901	46709	3961	48127	3237	49040	2122	60011	1387	44890
10L-4S		MI	22360	6618	37092	4795	40945	3862	42970	3141	45456	2031	55155	1626	37017
24-#11	2.50	MA	25715	6618	41948	4900	45579	3960	46713	3234	47080	2117	57648	1333	43882
11L-3S		MI	22814	6618	37891	4784	41959	3866	44201	3146	47026	2024	56922	1715	37077
24-#14	3.61	MA	29661	7205	50185	5251	56100	4199	59498	3383	64507	2075	80428	1294	65767
7E		MI	22470	7205	38494	5155	42618	4135	44949	3305	47995	1976	59003	1130	49157
24-#14	3.61	MA	28968	7205	48940	5249	54431	4216	57513	3398	61655	2066	76978	1220	64335
8L-6S		MI	23003	7205	39509	5139	43856	4121	46521	3314	49972	1966	61599	1257	50329
24-#14	3.61	MA	28251	7205	47623	5268	52800	4213	55460	3393	58961	2077	73576	1139	62521
9L-5S		MI	23548	7205	40458	5143	45143	4128	48034	3303	51992	1956	64089	1342	50991

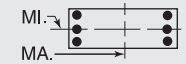
RECTANGULAR TIED COLUMNS 34" x 46"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.02	MA	28816	6098	45017	4542	48733	3702	49736	3086	49695	2214	58433	2090	22404
2E		MI	21078	6098	33343	4435	35627	3614	36058	3007	35453	2133	41195	1987	16173
6-#18	1.53	MA	30461	6381	48540	4720	53226	3831	55198	3166	57094	2196	68325	2048	33194
2L-3S		MI	20574	6381	33343	4602	35627	3763	36058	3103	35453	2121	41195	1693	23849
6-#18	1.53	MA	28133	6381	45017	4717	48733	3860	49736	3191	49695	2214	58433	1820	33138
3L-2S		MI	22190	6381	35803	4612	38763	3742	39848	3086	40458	2104	47771	1921	23772
8-#14	1.15	MA	29318	6169	45874	4614	50000	3757	51343	3125	51899	2224	61667	2107	25296
2L-4S		MI	19834	6169	31399	4528	33316	3683	33357	3058	32055	2175	37249	1752	18337
8-#14	1.15	MA	27976	6169	43863	4614	47437	3755	48227	3141	47679	2236	55957	1979	25329
3E		MI	20504	6169	32541	4512	34767	3690	35118	3068	34284	2165	39747	1880	18298
8-#14	1.15	MA	27030	6169	42252	4633	45388	3772	45740	3136	44449	2248	52213	1851	25259
4L-2S		MI	21441	6169	33953	4516	36567	3676	37306	3057	37190	2155	43588	2008	18233
8-#18	2.05	MA	32081	6665	52064	4897	57718	3960	60659	3246	64493	2178	78216	2006	43937
2L-4S		MI	20538	6665	33806	4806	36225	3877	36791	3164	36620	2110	43492	1403	30589
8-#18	2.05	MA	29779	6665	48540	4894	53226	3988	55198	3271	57094	2196	68325	1778	43770
3E		MI	21688	6665	35803	4780	38763	3892	39848	3182	40458	2092	47771	1627	31308
8-#18	2.05	MA	28155	6665	45709	4926	49625	3982	50827	3261	51420	2215	61852	1550	42700
4L-2S		MI	23287	6665	38263	4789	41899	3871	43638	3164	45464	2074	54348	1855	31316
10-#14	1.44	MA	30264	6328	47884	4714	52563	3830	54458	3170	56120	2214	67376	2086	31440
2L-5S		MI	19889	6328	31807	4624	33821	3769	33960	3114	32761	2151	38432	1662	22286
10-#14	1.44	MA	28931	6328	45874	4713	50000	3827	51343	3186	51899	2226	61667	1958	31437
3L-4S		MI	20489	6328	32811	4628	35116	3756	35545	3103	34961	2161	41090	1720	22623
10-#14	1.44	MA	27993	6328	44262	4732	47950	3844	48855	3181	48670	2238	57923	1830	31323
4L-3S		MI	21155	6328	33953	4612	36567	3762	37306	3112	37190	2151	43588	1848	22624
10-#14	1.44	MA	27153	6328	42850	4732	46129	3842	46625	3197	45487	2230	54024	1767	30713
5L-2S		MI	22086	6328	35365	4616	38367	3749	39494	3102	40097	2141	47428	1976	22577
10-#18	2.56	MA	33680	6949	55588	5074	62210	4088	66120	3325	71891	2161	88108	1963	54638
2L-5S		MI	20626	6949	34508	4974	37096	4027	37831	3260	37833	2063	45508	1235	35653
10-#18	2.56	MA	31403	6949	52064	5071	57718	4117	60659	3351	64493	2179	78216	1736	54384
3L-4S		MI	21650	6949	36266	4983	39361	4006	40581	3242	41625	2081	50068	1337	37556
10-#18	2.56	MA	29799	6949	49232	5104	54117	4110	56288	3341	58818	2197	71744	1508	52819
4L-3S		MI	22788	6949	38263	4957	41899	4020	43638	3260	45464	2063	54348	1561	38737
10-#18	2.56	MA	28362	6949	46749	5101	50915	4139	52367	3366	53224	2180	64965	1398	49611
5L-2S		MI	24373	6949	40722	4967	45035	3999	47428	3242	50469	2045	60924	1789	38830

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

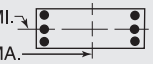


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.20	MA	29517	6194	46184	4644	50483	3780	51965	3142	52757	2230	62975	2118	26385
2L-6S		MI	19641	6194	31025	4555	32856	3715	32817	3082	31318	2181	36479	1745	18800
12-#11	1.20	MA	28580	6194	44780	4644	48694	3779	49790	3153	49810	2239	58965	2029	26405
3L-5S		MI	20044	6194	31688	4558	33755	3719	33913	3088	32741	2174	38239	1804	19085
12-#11	1.20	MA	27921	6194	43656	4657	47265	3791	48055	3151	47557	2247	56333	1940	26382
4E		MI	20465	6194	32389	4560	34659	3709	35020	3079	34290	2181	40111	1845	19086
12-#11	1.20	MA	27333	6194	42672	4657	45996	3790	46500	3162	45339	2242	53600	1895	26291
5L-3S		MI	20933	6194	33187	4548	35674	3713	36252	3085	35860	2174	41879	1934	19056
12-#11	1.20	MA	26771	6194	41744	4657	44734	3802	44962	3159	43302	2251	50989	1837	25768
6L-2S		MI	21589	6194	34176	4551	36935	3703	37784	3077	37907	2168	44591	2022	19017
12-#14	1.73	MA	31201	6488	49894	4814	55125	3902	57574	3215	60341	2204	73085	2066	37572
2L-6S		MI	19975	6488	32270	4719	34334	3835	34635	3170	33647	2147	39782	1544	25649
12-#14	1.73	MA	29877	6488	47884	4813	52563	3899	54458	3231	56120	2216	67376	1938	37533
3L-5S		MI	20544	6488	33219	4723	35621	3841	36148	3159	35667	2137	42272	1630	26372
12-#14	1.73	MA	28946	6488	46272	4832	50513	3917	51971	3226	52891	2228	63632	1810	37380
4E		MI	21139	6488	34223	4727	36915	3828	37733	3148	37868	2147	44930	1687	26895
12-#14	1.73	MA	28113	6488	44861	4831	48692	3914	49741	3242	49708	2220	59733	1746	36575
5L-3S		MI	21800	6488	35365	4712	38367	3834	39494	3157	40097	2137	47428	1815	26935
12-#14	1.73	MA	27319	6488	43529	4831	46883	3931	47533	3237	46785	2232	56017	1662	35344
6L-2S		MI	22726	6488	36776	4716	40167	3821	41682	3146	43003	2127	51269	1943	26906
12-#18	3.07	MA	33006	7233	55588	5249	62210	4245	66120	3431	71891	2161	88108	1694	64986
3L-5S		MI	21736	7233	36968	5151	40231	4156	41620	3338	42838	2034	52084	1169	42802
12-#18	3.07	MA	31421	7233	52756	5281	58609	4239	61750	3420	66217	2179	81635	1466	62986
4E		MI	22750	7233	38726	5160	42497	4135	44371	3320	46630	2051	56644	1271	44572
12-#18	3.07	MA	30002	7233	50273	5278	55407	4268	57828	3446	60622	2162	74856	1355	59942
5L-3S		MI	23877	7233	40722	5134	45035	4149	47428	3338	50469	2034	60924	1495	46145
12-#18	3.07	MA	28649	7233	47929	5275	52223	4261	53945	3436	55481	2180	68425	1205	56523
6L-2S		MI	25447	7233	43182	5144	48171	4128	51218	3320	55474	2016	67500	1723	46303
14-#11	1.40	MA	30180	6305	47587	4713	52273	3830	54140	3173	55704	2223	66984	2105	30672
2L-7S		MI	19714	6305	31305	4636	33252	3775	33290	3121	31973	2179	37358	1636	21361
14-#11	1.40	MA	29247	6305	46184	4713	50483	3829	51965	3184	52757	2232	62975	2016	30675
3L-6S		MI	20105	6305	32014	4624	34116	3765	34349	3113	33365	2172	39192	1724	21700
14-#11	1.40	MA	28592	6305	45060	4727	49054	3841	50230	3182	50504	2241	60342	1927	30633
4L-5S		MI	20505	6305	32676	4627	35016	3769	35445	3119	34788	2166	40952	1783	22080
14-#11	1.40	MA	28007	6305	44076	4726	47785	3840	48675	3193	48286	2236	57610	1882	30521
5L-4S		MI	20924	6305	33378	4629	35920	3759	36552	3111	36337	2172	42824	1824	22103
14-#11	1.40	MA	27449	6305	43148	4726	46524	3852	47137	3190	46248	2244	54999	1824	29901
6L-3S		MI	21390	6305	34176	4618	36935	3763	37784	3116	37907	2166	44591	1913	22085
14-#11	1.40	MA	26905	6305	42155	4740	45313	3851	45653	3202	44255	2253	52283	1737	29303
7L-2S		MI	22043	6305	35164	4620	38195	3754	39316	3108	39954	2159	47303	2002	22054
14-#14	2.01	MA	32130	6647	51904	4914	57688	3974	60689	3260	64562	2194	78795	2046	43685
2L-7S		MI	20076	6647	32666	4835	34896	3920	35250	3206	34576	2143	41027	1385	28980
14-#14	2.01	MA	30815	6647	49894	4913	55125	3972	57574	3275	60341	2206	73085	1918	43619
3L-6S		MI	20628	6647	33681	4819	36133	3907	36822	3215	36553	2133	43623	1512	29794
14-#14	2.01	MA	29891	6647	48282	4932	53076	3989	55086	3271	57111	2218	69341	1790	43432
4L-5S		MI	21193	6647	34630	4823	37421	3914	38336	3204	38573	2123	46113	1597	30475
14-#14	2.01	MA	29065	6647	46871	4931	51255	3986	52856	3287	53929	2210	65443	1726	42456
5L-4S		MI	21784	6647	35634	4827	38715	3900	39920	3193	40774	2133	48771	1655	31158
14-#14	2.01	MA	28277	6647	45539	4930	49445	4004	50649	3282	51006	2222	61727	1642	41278
6L-3S		MI	22441	6647	36776	4811	40167	3907	41682	3202	43003	2123	51269	1783	31226
14-#14	2.01	MA	27508	6647	44114	4949	47708	4001	48519	3298	48146	2234	57860	1515	40037
7L-2S		MI	23361	6647	38188	4815	41967	3893	43870	3191	45909	2113	55110	1911	31223
14-#18	3.58	MA	33024	7516	56279	5458	63102	4368	67211	3500	73615	2162	91527	1424	73194
4L-5S		MI	22835	7516	39427	5328	43367	4284	45410	3416	47844	2005	58660	1103	49974
14-#18	3.58	MA	31622	7516	53796	5455	59899	4396	63289	3526	68021	2144	84748	1313	70298
5L-4S		MI	23839	7516	41185	5338	45633	4263	48161	3399	51636	2022	63221	1206	51628
14-#18	3.58	MA	30285	7516	51452	5452	56716	4390	59406	3515	62880	2162	78317	1163	66722
6L-3S		MI	24955	7516	43182	5312	48171	4278	51218	3416	55474	2005	67500	1429	53539
14-#18	3.58	MA	28980	7516	48944	5485	53658	4419	55659	3541	57848	2181	71622	938	63228
7L-2S		MI	26512	7516	45642	5321	51307	4257	55008	3399	60480	1987	74076	1657	53757

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

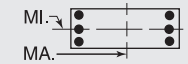
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.60	MA	30838	6415	48991	4782	54062	3880	56315	3204	58651	2216	70993	2091	34952
2L-8S		MI	19794	6415	31642	4703	33640	3821	33785	3161	32560	2164	38322	1567	23863
16-#11	1.60	MA	29910	6415	47587	4782	52273	3879	54140	3216	55704	2225	66984	2003	34938
3L-7S		MI	20177	6415	32293	4705	34512	3825	34822	3152	34019	2170	40070	1615	24285
16-#11	1.60	MA	29259	6415	46463	4796	50844	3891	52405	3213	53451	2234	64352	1914	34879
4L-6S		MI	20566	6415	33002	4694	35377	3815	35881	3144	35412	2164	41904	1703	24608
16-#11	1.60	MA	28677	6415	45479	4795	49574	3890	50851	3224	51233	2229	61619	1869	34747
5E		MI	20964	6415	33665	4696	36276	3819	36978	3150	36834	2157	43664	1762	25068
16-#11	1.60	MA	28123	6415	44551	4795	48313	3902	49312	3221	49195	2237	59008	1811	34043
6L-4S		MI	21381	6415	34366	4698	37180	3810	38085	3142	38384	2164	45536	1803	25108
16-#11	1.60	MA	27582	6415	43558	4809	47102	3901	47828	3233	47202	2246	56292	1724	33467
7L-3S		MI	21844	6415	35164	4687	38195	3814	39316	3147	39954	2157	47303	1892	25107
16-#11	1.60	MA	27048	6415	42648	4809	45881	3913	46376	3244	45114	2241	53738	1671	32784
8L-2S		MI	22495	6415	36153	4689	39455	3804	40848	3139	42000	2150	50016	1981	25084
16-#14	2.30	MA	31745	6807	51904	5012	57688	4044	60689	3320	64562	2196	78795	1897	49698
3L-7S		MI	20728	6807	34078	4935	36696	3993	37438	3251	37482	2129	44868	1352	33044
16-#14	2.30	MA	30828	6807	50293	5032	55639	4061	58202	3316	61332	2208	75050	1769	49481
4L-6S		MI	21276	6807	35093	4919	37933	3979	39010	3260	39459	2119	47464	1479	33948
16-#14	2.30	MA	30008	6807	48881	5031	53818	4059	55972	3331	58150	2200	71152	1705	48351
5E		MI	21837	6807	36042	4923	39221	3986	40524	3249	41479	2109	49953	1565	34592
16-#14	2.30	MA	29227	6807	47549	5030	52008	4076	53764	3327	55227	2212	67436	1621	47221
6L-4S		MI	22424	6807	37046	4927	40515	3973	42108	3238	43680	2119	52612	1623	35412
16-#14	2.30	MA	28464	6807	46124	5049	50271	4073	51635	3342	52367	2224	63570	1495	45894
7L-3S		MI	23077	6807	38188	4911	41967	3979	43870	3247	45909	2109	55110	1751	35506
16-#14	2.30	MA	27713	6807	44817	5048	48518	4091	49550	3358	49371	2216	59926	1421	44411
8L-2S		MI	23992	6807	39600	4915	43767	3966	46058	3236	48815	2099	58950	1879	35533
16-#18	4.09	MA	33223	7800	57320	5633	64392	4525	68750	3605	75419	2127	94639	1271	80674
5E		MI	23924	7800	41887	5506	46503	4413	49200	3494	52849	1975	65237	1037	57163
16-#18	4.09	MA	31902	7800	54976	5630	61208	4518	64867	3595	70278	2145	88208	1121	76947
6L-4S		MI	24918	7800	43645	5515	48769	4392	51951	3477	56641	1993	69797	1140	58717
16-#18	4.09	MA	30612	7800	52468	5662	58151	4547	61120	3621	65247	2163	81513	896	73359
7L-3S		MI	26024	7800	45642	5489	51307	4406	55008	3494	60480	1975	74076	1364	60923
16-#18	4.09	MA	29340	7800	50166	5659	55066	4541	57452	3646	59977	2146	75180	767	69178
8L-2S		MI	27568	7800	48101	5498	54443	4385	58798	3477	65485	1958	80652	1591	61196
18-#11	1.80	MA	30569	6526	48991	4851	54062	3929	56315	3247	58651	2218	70993	1990	39196
3L-8S		MI	20256	6526	32631	4772	34901	3871	35317	3192	34606	2155	41034	1546	26733
18-#11	1.80	MA	29922	6526	47867	4865	52633	3942	54580	3244	56398	2227	68361	1901	39121
4L-7S		MI	20637	6526	33282	4774	35773	3875	36354	3183	36066	2161	42783	1594	27213
18-#11	1.80	MA	29343	6526	46883	4865	51364	3940	53026	3255	54180	2222	65628	1856	38972
5L-6S		MI	21024	6526	33991	4763	36637	3865	37413	3175	37458	2155	44617	1682	27522
18-#11	1.80	MA	28792	6526	45955	4864	50102	3952	51487	3253	52142	2231	63017	1798	38192
6L-5S		MI	21420	6526	34653	4765	37536	3869	38510	3181	38881	2148	46376	1741	28052
18-#11	1.80	MA	28254	6526	44962	4878	48892	3951	50003	3264	50149	2239	60302	1710	37635
7L-4S		MI	21835	6526	35355	4767	38441	3860	39617	3173	40430	2155	48249	1782	28107
18-#11	1.80	MA	27724	6526	44051	4878	47670	3963	48551	3275	48061	2234	57747	1658	36896
8L-3S		MI	22296	6526	36153	4756	39455	3864	40848	3178	42000	2148	50016	1871	28123
18-#11	1.80	MA	27162	6526	43157	4877	46477	3962	47048	3272	46089	2243	55218	1602	36041
9L-2S		MI	22944	6526	37142	4758	40716	3854	42380	3170	44047	2141	52728	1960	28108
18-#14	2.59	MA	31758	6967	52303	5131	58202	4134	61317	3361	65553	2198	80760	1749	55527
4L-7S		MI	21375	6967	35490	5035	38496	4065	39626	3296	40388	2115	48709	1320	37120
18-#14	2.59	MA	30944	6967	50891	5131	56381	4131	59087	3376	62370	2190	76861	1685	54259
5L-6S		MI	21919	6967	36505	5019	39733	4052	41198	3305	42365	2105	51304	1447	38108
18-#14	2.59	MA	30169	6967	49559	5130	54571	4148	56880	3372	59448	2202	73145	1601	53172
6L-5S		MI	22477	6967	37454	5023	41021	4058	42712	3294	44385	2095	53794	1532	38720

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

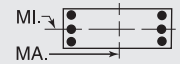


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.59	MA	29413	6967	48134	5149	52834	4146	54750	3387	56588	2214	69279	1474	51762
7L-4S		MI	23060	6967	38458	5027	42315	4045	44296	3283	46586	2105	56452	1590	39662
18-#14	2.59	MA	28667	6967	46827	5148	51081	4163	52666	3403	53592	2206	65635	1400	50321
8L-3S		MI	23709	6967	39600	5011	43767	4051	46058	3292	48815	2095	58950	1718	39780
18-#14	2.59	MA	27897	6967	45544	5147	49368	4160	50509	3398	50762	2218	62035	1319	48447
9L-2S		MI	24619	6967	41011	5015	45566	4038	48246	3281	51721	2085	62791	1846	39826
18-#18	4.60	MA	33502	8084	58500	5807	65700	4647	70328	3675	77677	2127	98100	1079	87193
6L-5S		MI	25003	8084	44347	5683	49639	4541	52990	3573	57854	1946	71813	971	64353
18-#18	4.60	MA	32227	8084	55991	5839	62643	4676	66582	3700	72645	2145	91405	854	83511
7L-4S		MI	25988	8084	46105	5692	51905	4520	55741	3555	61646	1964	76373	1074	65832
18-#18	4.60	MA	30969	8084	53690	5836	59558	4669	62913	3726	67375	2128	85071	725	79348
8L-3S		MI	27084	8084	48101	5666	54443	4535	58798	3573	65485	1946	80652	1298	68298
20-#11	1.99	MA	30580	6637	49270	4934	54422	3992	56756	3275	59345	2220	72370	1888	43360
4L-8S		MI	20715	6637	33619	4841	36161	3921	36850	3223	36653	2146	43747	1526	29610
20-#11	1.99	MA	30005	6637	48286	4934	53153	3990	55201	3286	57127	2215	69637	1843	43195
5L-7S		MI	21095	6637	34270	4843	37033	3925	37886	3215	38113	2153	45495	1574	30144
20-#11	1.99	MA	29457	6637	47358	4934	51892	4003	53662	3284	55089	2224	67027	1785	42347
6E		MI	21480	6637	34979	4832	37897	3916	38945	3206	39505	2146	47329	1662	30441
20-#11	1.99	MA	28922	6637	46365	4947	50681	4001	52179	3295	53096	2232	64311	1697	41806
7L-5S		MI	21874	6637	35642	4834	38797	3920	40042	3212	40928	2139	49089	1721	30953
20-#11	1.99	MA	28395	6637	45455	4947	49460	4014	50726	3306	51008	2227	61756	1645	41014
8L-4S		MI	22286	6637	36343	4837	39701	3910	41149	3204	42477	2146	50961	1761	31101
20-#11	1.99	MA	27836	6637	44561	4947	48266	4012	49223	3303	49036	2236	59227	1589	40181
9L-3S		MI	22746	6637	37142	4825	40716	3914	42380	3210	44047	2139	52728	1850	31130
20-#11	1.99	MA	27255	6637	43584	4960	47060	4024	47779	3315	47078	2245	56773	1526	39177
10L-2S		MI	23391	6637	38130	4827	41976	3904	43912	3201	46094	2132	55441	1939	31128
20-#14	2.88	MA	31874	7126	52901	5230	58944	4203	62202	3421	66591	2180	82570	1664	60178
5L-7S		MI	22018	7126	36901	5134	40295	4137	41814	3341	43294	2100	52549	1288	41206
20-#14	2.88	MA	31104	7126	51570	5229	57134	4221	59995	3417	63668	2192	78854	1580	59130
6E		MI	22559	7126	37916	5118	41533	4124	43386	3350	45271	2091	55145	1415	42274
20-#14	2.88	MA	30353	7126	50144	5249	55397	4218	57866	3432	60808	2204	74988	1454	57640
7L-5S		MI	23112	7126	38865	5122	42820	4131	44900	3339	47292	2081	57635	1500	42859
20-#14	2.88	MA	29613	7126	48837	5248	53644	4235	55781	3448	57813	2196	71345	1380	56239
8L-4S		MI	23692	7126	39870	5126	44115	4117	46484	3328	49492	2091	60293	1558	43906
20-#14	2.88	MA	28845	7126	47554	5247	51931	4233	53624	3443	54982	2208	67744	1299	54315
9L-3S		MI	24337	7126	41011	5111	45566	4124	48246	3337	51721	2081	62791	1686	44047
20-#14	2.88	MA	28016	7126	46153	5266	50200	4250	51553	3459	52174	2219	64253	1207	52342
10L-2S		MI	25242	7126	42423	5115	47366	4110	50434	3326	54627	2071	66631	1814	44112
20-#18	5.12	MA	33825	8367	59515	6017	67135	4804	72043	3780	80044	2128	101296	811	93682
7L-5S		MI	26074	8367	46806	5860	52775	4670	56780	3651	62860	1917	78389	905	71313
20-#18	5.12	MA	32581	8367	57214	6014	64050	4798	68374	3805	74774	2110	94963	682	89469
8L-4S		MI	27050	8367	48564	5870	55041	4649	59531	3633	66652	1935	82949	1008	72970
22-#11	2.19	MA	30663	6747	49690	5003	54942	4040	57376	3317	60073	2208	73647	1830	47366
5L-8S		MI	21172	6747	34608	4910	37421	3972	38382	3254	38700	2137	46459	1505	32492
22-#11	2.19	MA	30118	6747	48762	5003	53681	4053	55838	3315	58036	2217	71036	1772	46507
6L-7S		MI	21550	6747	35259	4912	38294	3976	39419	3246	40159	2144	48208	1553	33077
22-#11	2.19	MA	29586	6747	47769	5016	52471	4051	54354	3326	56043	2226	68320	1684	45981
7L-6S		MI	21933	6747	35968	4901	39158	3966	40477	3238	41552	2137	50042	1641	33363
22-#11	2.19	MA	29062	6747	46858	5016	51249	4064	52901	3337	53955	2221	65766	1632	45138
8L-5S		MI	22325	6747	36630	4903	40057	3970	41574	3243	42974	2130	51801	1700	33853
22-#11	2.19	MA	28506	6747	45964	5016	50055	4062	51398	3335	51983	2229	63236	1576	44326
9L-4S		MI	22736	6747	37332	4906	40961	3960	42681	3235	44524	2137	53674	1741	34091
22-#11	2.19	MA	27928	6747	44988	5029	48850	4075	49955	3346	50025	2238	60782	1513	43287
10L-3S		MI	23193	6747	38130	4894	41976	3964	43912	3241	46094	2130	55441	1829	34132
22-#11	2.19	MA	27363	6747	44094	5029	47663	4073	48469	3343	47967	2233	58288	1458	42316
11L-2S		MI	23835	6747	39119	4897	43236	3954	45445	3233	48140	2123	58153	1918	34144
22-#14	3.16	MA	32032	7286	53580	5329	59697	4293	63110	3462	67889	2182	84564	1560	65094
6L-7S		MI	22657	7286	38313	5234	42095	4210	44002	3385	46201	2086	56390	1255	45302

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.16	MA	31287	7286	52154	5348	57959	4290	60981	3477	65029	2194	80698	1433	63527
7L-6S		MI	23194	7286	39328	5218	43333	4196	45574	3394	48178	2076	58986	1382	46444
22-#14	3.16	MA	30552	7286	50847	5348	56206	4308	58897	3493	62033	2186	77054	1359	62163
8L-5S		MI	23744	7286	40277	5222	44620	4203	47088	3384	50198	2067	61475	1468	47004
22-#14	3.16	MA	29785	7286	49564	5347	54493	4305	56740	3488	59203	2198	73454	1278	60191
9L-4S		MI	24321	7286	41281	5226	45914	4190	48672	3373	52398	2076	64133	1525	48148
22-#14	3.16	MA	28966	7286	48163	5366	52763	4322	54668	3504	56394	2210	69962	1187	58184
10L-3S		MI	24962	7286	42423	5210	47366	4196	50434	3382	54627	2067	66631	1653	48310
22-#18	5.63	MA	34178	8651	60737	6191	68543	4926	73835	3885	82172	2093	104854	640	99605
8L-5S		MI	27137	8651	49266	6038	55911	4798	60570	3729	67865	1888	84965	839	78299
24-#11	2.39	MA	30775	6858	50165	5072	55470	4103	58013	3346	60983	2210	75045	1759	50672
6L-8S		MI	21627	6858	35596	4979	38682	4022	39914	3285	40746	2128	49172	1484	35380
24-#11	2.39	MA	30246	6858	49172	5085	54260	4101	56529	3357	58990	2219	72329	1671	50159
7E		MI	22003	6858	36247	4982	39554	4026	40951	3277	42206	2135	50920	1532	36011
24-#11	2.39	MA	29725	6858	48262	5085	53038	4114	55076	3368	56902	2214	69775	1619	49267
8L-6S		MI	22384	6858	36956	4970	40418	4016	42009	3269	43598	2128	52754	1620	36290
24-#11	2.39	MA	29173	6858	47368	5085	51845	4112	53573	3366	54930	2222	67245	1563	48474
9L-5S		MI	22774	6858	37619	4972	41317	4020	43106	3274	45021	2121	54514	1679	36757
24-#11	2.39	MA	28597	6858	46391	5098	50639	4125	52130	3377	52972	2231	64791	1500	47402
10L-4S		MI	23183	6858	38320	4975	42222	4010	44213	3266	46570	2128	56386	1720	37078
24-#11	2.39	MA	28035	6858	45498	5098	49452	4123	50644	3374	50913	2226	62297	1445	46431
11L-3S		MI	23638	6858	39119	4963	43236	4014	45445	3272	48140	2121	58153	1809	37130
24-#11	2.39	MA	27482	6858	44537	5112	48254	4136	49204	3385	48959	2235	59553	1370	45096
12L-2S		MI	24278	6858	40107	4966	44497	4004	46977	3264	50187	2114	60866	1897	37152
24-#14	3.45	MA	32214	7445	54165	5448	60522	4363	64097	3522	69250	2184	86407	1413	69423
7E		MI	23291	7445	39725	5334	43895	4282	46190	3430	49107	2072	60230	1223	49406
24-#14	3.45	MA	31485	7445	52857	5447	58769	4380	62012	3538	66254	2176	82763	1339	68061
8L-6S		MI	23825	7445	40740	5318	45132	4269	47762	3439	51084	2062	62826	1350	50611
24-#14	3.45	MA	30719	7445	51574	5446	57056	4377	59855	3533	63424	2188	79163	1258	66074
9L-5S		MI	24372	7445	41689	5322	46420	4275	49276	3429	53104	2053	65316	1435	51157
24-#14	3.45	MA	29927	7445	50173	5466	55326	4395	57784	3549	60615	2200	75671	1166	64033
10L-4S		MI	24945	7445	42693	5326	47714	4262	50860	3418	55305	2062	67974	1493	52270

RECTANGULAR TIED COLUMNS 34" x 48"

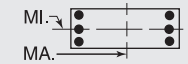
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.47	MA	33001	6622	52378	4915	57436	3992	59504	3302	61371	2301	73512	2157	34814
2L-3S		MI	21392	6622	34579	4780	36903	3909	37296	3227	36559	2217	42414	1785	23907
6-#18	1.47	MA	30550	6622	48677	4913	52717	4021	53769	3329	53600	2320	63067	1930	34758
3L-2S		MI	23010	6622	37039	4789	40039	3888	41086	3210	41564	2199	48991	2013	23818
8-#14	1.10	MA	31790	6409	49570	4810	54039	3918	55445	3262	55902	2329	66447	2214	26511
2L-4S		MI	20651	6409	32630	4707	34593	3831	34598	3184	33167	2271	38476	1845	18384
8-#14	1.10	MA	30378	6409	47460	4809	51349	3916	52175	3278	51472	2341	60426	2086	26544
3E		MI	21323	6409	33772	4691	36044	3837	36360	3193	35396	2261	40974	1973	18336
8-#14	1.10	MA	29385	6409	45770	4829	49200	3934	49567	3274	48085	2354	56473	1958	26474
4L-2S		MI	22260	6409	35184	4695	37844	3824	38548	3182	38302	2251	44815	2101	18268
8-#18	1.96	MA	34712	6906	56079	5092	62154	4120	65240	3382	69142	2283	83958	2118	46097
2L-4S		MI	21356	6906	35042	4983	37502	4023	38030	3288	37726	2205	44711	1495	30885
8-#18	1.96	MA	32289	6906	52378	5090	57436	4150	59504	3409	61371	2303	73512	1890	45930
3E		MI	22507	6906	37039	4957	40039	4038	41086	3306	41564	2187	48991	1719	31379
8-#18	1.96	MA	30582	6906	49407	5123	53658	4144	54919	3399	55418	2322	66670	1663	45132
4L-2S		MI	24110	6906	39498	4967	43175	4017	44876	3288	46570	2170	55567	1947	31369
10-#14	1.38	MA	32788	6569	51680	4909	56729	3990	58715	3307	60332	2319	72469	2195	32959
2L-5S		MI	20707	6569	33038	4803	35098	3916	35202	3239	33872	2247	39659	1755	22458

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.38	MA	31385	6569	49570	4909	54039	3988	55445	3323	55902	2332	66447	2067	32956
3L-4S		MI	21307	6569	34042	4807	36392	3903	36786	3228	36073	2257	42317	1813	22680
10-#14	1.38	MA	30400	6569	47880	4928	51890	4006	52837	3319	52515	2344	62495	1939	32842
4L-3S		MI	21974	6569	35184	4791	37844	3909	38548	3238	38302	2247	44815	1941	22667
10-#14	1.38	MA	29519	6569	46400	4928	49981	4004	50499	3335	49179	2337	58389	1874	32351
5L-2S		MI	22906	6569	36595	4795	39644	3896	40735	3227	41208	2237	48656	2069	22616
10-#18	2.45	MA	36401	7189	59780	5270	66873	4249	70976	3462	76913	2266	94404	2078	57338
2L-5S		MI	21442	7189	35744	5151	38372	4173	39069	3384	38939	2158	46727	1327	35899
10-#18	2.45	MA	34003	7189	56079	5267	62154	4279	65240	3488	69142	2285	83958	1851	57084
3L-4S		MI	22469	7189	37502	5160	40637	4152	41820	3366	42731	2176	51287	1430	37845
10-#18	2.45	MA	32317	7189	53108	5301	58376	4273	60655	3479	63189	2305	77116	1623	55771
4L-3S		MI	23610	7189	39498	5135	43175	4166	44876	3384	46570	2158	55567	1653	38816
10-#18	2.45	MA	30807	7189	50504	5298	55018	4303	56542	3506	57320	2289	69969	1511	52268
5L-2S		MI	25198	7189	41958	5144	46311	4145	48666	3366	51575	2141	62143	1881	38886
12-#11	1.15	MA	31998	6435	49891	4839	54542	3941	56093	3279	56795	2335	67810	2224	27649
2L-6S		MI	20459	6435	32253	4735	34133	3863	34060	3208	32432	2278	37711	1838	18919
12-#11	1.15	MA	31012	6435	48419	4839	52665	3940	53811	3290	53703	2344	63584	2136	27668
3L-5S		MI	20862	6435	32916	4737	35032	3867	35156	3213	33855	2271	39470	1897	19135
12-#11	1.15	MA	30321	6435	47241	4853	51166	3952	51992	3288	51342	2353	60807	2047	27646
4E		MI	21283	6435	33617	4740	35937	3857	36263	3205	35405	2278	41343	1938	19126
12-#11	1.15	MA	29703	6435	46210	4853	49836	3951	50363	3299	49016	2349	57931	2002	27555
5L-3S		MI	21752	6435	34415	4728	36951	3861	37495	3211	36975	2271	43110	2027	19091
12-#11	1.15	MA	29114	6435	45238	4853	48515	3964	48751	3297	46882	2358	55178	1944	27087
6L-2S		MI	22409	6435	35404	4731	38212	3851	39027	3203	39021	2264	45822	2116	19050
12-#14	1.65	MA	33776	6728	53790	5009	59419	4063	61985	3352	64762	2309	78491	2176	39395
2L-6S		MI	20792	6728	33500	4898	35610	3982	35876	3295	34758	2243	41010	1637	25804
12-#14	1.65	MA	32383	6728	51680	5009	56729	4060	58715	3368	60332	2322	72469	2048	39355
3L-5S		MI	21362	6728	34449	4902	36898	3989	37390	3284	36779	2233	43499	1722	26541
12-#14	1.65	MA	31406	6728	49990	5028	54580	4078	56107	3364	56945	2334	68517	1920	39203
4E		MI	21958	6728	35453	4906	38192	3975	38974	3273	38979	2243	46158	1780	26957
12-#14	1.65	MA	30531	6728	48510	5028	52671	4076	53769	3380	53609	2327	64411	1855	38507
5L-3S		MI	22621	6728	36595	4891	39644	3982	40735	3282	41208	2233	48656	1908	26981
12-#14	1.65	MA	29698	6728	47115	5027	50775	4094	51456	3376	50546	2339	60490	1771	37165
6L-2S		MI	23547	6728	38007	4895	41444	3968	42923	3272	44114	2223	52496	2036	26948
12-#18	2.94	MA	35697	7473	59780	5445	66873	4407	70976	3568	76913	2267	94404	1811	68226
3L-5S		MI	22554	7473	38203	5328	41508	4302	42859	3462	43944	2129	53303	1261	43045
12-#18	2.94	MA	34030	7473	56809	5478	63095	4401	66391	3559	70959	2287	87562	1584	66459
4E		MI	23571	7473	39962	5338	43773	4281	45609	3444	47736	2147	57864	1364	44855
12-#18	2.94	MA	32539	7473	54205	5476	59736	4431	62278	3585	65091	2271	80415	1472	63128
5L-3S		MI	24700	7473	41958	5312	46311	4295	48666	3462	51575	2129	62143	1587	46231
12-#18	2.94	MA	31117	7473	51748	5473	56398	4426	58206	3576	59700	2291	73620	1322	59754
6L-2S		MI	26275	7473	44418	5321	49447	4274	52456	3444	56580	2111	68719	1815	46369
14-#11	1.34	MA	32696	6545	51364	4909	56420	3991	58375	3310	59887	2328	72036	2212	32146
2L-7S		MI	20531	6545	32533	4816	34529	3923	34533	3247	33087	2276	38589	1729	21475
14-#11	1.34	MA	31716	6545	49891	4909	54542	3990	56093	3321	56795	2337	67810	2124	32149
3L-6S		MI	20923	6545	33242	4804	35393	3913	35592	3239	34479	2269	40423	1817	21819
14-#11	1.34	MA	31028	6545	48713	4922	53044	4003	54274	3319	54434	2346	65033	2035	32107
4L-5S		MI	21323	6545	33904	4807	36293	3917	36688	3244	35902	2262	42183	1876	22134
14-#11	1.34	MA	30414	6545	47683	4922	51714	4001	52645	3331	52108	2342	62157	1990	31995
5L-4S		MI	21743	6545	34606	4809	37197	3907	37796	3236	37451	2269	44055	1917	22146
14-#11	1.34	MA	29829	6545	46710	4922	50392	4014	51033	3328	49974	2351	59404	1931	31426
6L-3S		MI	22209	6545	35404	4797	38212	3911	39027	3242	39021	2262	45822	2006	22123
14-#11	1.34	MA	29258	6545	45670	4936	49124	4013	49478	3340	47885	2360	56541	1844	30775
7L-2S		MI	22863	6545	36392	4800	39472	3902	40559	3234	41068	2255	48535	2095	22089
14-#14	1.93	MA	34757	6888	55899	5109	62109	4135	65255	3396	69192	2299	84512	2157	45812
2L-7S		MI	20893	6888	33897	5014	36173	4068	36492	3331	35687	2239	42255	1478	29237
14-#14	1.93	MA	33373	6888	53790	5108	59419	4133	61985	3412	64762	2312	78491	2029	45745
3L-6S		MI	21446	6888	34912	4998	37410	4054	38064	3340	37664	2229	44850	1605	29949

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

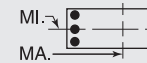
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	1.93	MA	32402	6888	52100	5128	57270	4150	59377	3409	61376	2324	74538	1901	45559
4L-5S		MI	22011	6888	35861	5002	38698	4061	39578	3329	39685	2219	47340	1690	30642
14-#14	1.93	MA	31535	6888	50620	5128	55361	4148	57039	3425	58039	2317	70433	1836	44682
5L-4S		MI	22604	6888	36865	5006	39992	4048	41162	3318	41885	2229	49998	1748	31225
14-#14	1.93	MA	30708	6888	49225	5127	53465	4166	54726	3421	54976	2329	66512	1752	43397
6L-3S		MI	23262	6888	38007	4990	41444	4054	42923	3327	44114	2219	52496	1876	31279
14-#14	1.93	MA	29902	6888	47731	5147	51644	4164	52494	3437	51979	2342	62433	1626	42230
7L-2S		MI	24184	6888	39419	4994	43244	4041	45111	3316	47020	2209	56337	2004	31268
14-#18	3.43	MA	35722	7757	60510	5655	67813	4530	72127	3639	78730	2269	98008	1544	77188
4L-5S		MI	23655	7757	40663	5506	44644	4430	46649	3540	48950	2100	59880	1195	50215
14-#18	3.43	MA	34249	7757	57906	5653	64455	4560	68014	3665	72862	2253	90861	1432	74013
5L-4S		MI	24662	7757	42421	5515	46909	4409	49399	3522	52742	2118	64440	1298	51907
14-#18	3.43	MA	32844	7757	55449	5651	61116	4554	63942	3656	67471	2273	84066	1282	70480
6L-3S		MI	25781	7757	44418	5489	49447	4423	52456	3540	56580	2100	68719	1522	53632
14-#18	3.43	MA	31473	7757	52819	5684	57911	4584	60014	3682	62195	2292	76994	1058	67007
7L-2S		MI	27342	7757	46877	5499	52583	4402	56246	3522	61586	2082	75295	1749	53827
16-#11	1.53	MA	33391	6656	52837	4978	58297	4041	60658	3341	62979	2321	76262	2200	36637
2L-8S		MI	20611	6656	32870	4882	34917	3969	35028	3286	33674	2260	39553	1661	24050
16-#11	1.53	MA	32415	6656	51364	4978	56420	4040	58375	3352	59887	2330	72036	2111	36623
3L-7S		MI	20995	6656	33521	4885	35790	3973	36065	3278	35133	2267	41301	1709	24400
16-#11	1.53	MA	31731	6656	50186	4992	54921	4053	56557	3350	57526	2339	69259	2023	36564
4L-6S		MI	21384	6656	34230	4873	36654	3963	37124	3270	36526	2260	43135	1797	24726
16-#11	1.53	MA	31121	6656	49155	4992	53591	4052	54928	3362	55201	2335	66383	1977	36432
5E		MI	21783	6656	34893	4876	37553	3967	38221	3275	37949	2253	44895	1856	25126
16-#11	1.53	MA	30539	6656	48183	4992	52270	4064	53315	3359	53066	2344	63630	1919	35773
6L-4S		MI	22200	6656	35594	4878	38457	3957	39328	3267	39498	2260	46767	1897	25157
16-#11	1.53	MA	29971	6656	47143	5005	51002	4063	51761	3371	50977	2353	60767	1832	35146
7L-3S		MI	22665	6656	36392	4867	39472	3961	40559	3273	41068	2253	48535	1985	25147
16-#11	1.53	MA	29412	6656	46189	5005	49722	4076	50239	3382	48790	2349	58078	1779	34522
8L-2S		MI	23316	6656	37381	4869	40732	3952	42091	3265	43115	2246	51247	2074	25121
16-#14	2.21	MA	34354	7047	55899	5208	62109	4205	65255	3457	69192	2302	84512	2009	52128
3L-7S		MI	21545	7047	35309	5114	37973	4140	38680	3376	38594	2225	46095	1445	33297
16-#14	2.21	MA	33391	7047	54210	5228	59960	4223	62647	3453	65806	2314	80560	1882	51911
4L-6S		MI	22094	7047	36324	5098	39210	4127	40252	3385	40571	2215	48691	1572	34102
16-#14	2.21	MA	32530	7047	52730	5227	58051	4221	60309	3470	62470	2307	76454	1817	50872
5E		MI	22657	7047	37273	5102	40498	4133	41765	3374	42591	2205	51181	1658	34758
16-#14	2.21	MA	31710	7047	51335	5227	56155	4238	57996	3466	59406	2319	72533	1733	49638
6L-4S		MI	23245	7047	38277	5106	41792	4120	43350	3363	44791	2215	53839	1716	35484
16-#14	2.21	MA	30910	7047	49841	5246	54334	4236	55764	3482	56409	2332	68455	1607	48383
7L-3S		MI	23900	7047	39419	5090	43244	4126	45111	3372	47020	2205	56337	1844	35564
16-#14	2.21	MA	30121	7047	48472	5246	52497	4254	53580	3498	53269	2325	64617	1532	46773
8L-2S		MI	24816	7047	40830	5094	45043	4113	47299	3361	49927	2195	60177	1972	35578
16-#18	3.92	MA	35940	8040	61607	5830	69173	4688	73750	3745	80633	2236	101307	1393	84918
5E		MI	24745	8040	43123	5683	47780	4559	50439	3618	53955	2071	66456	1129	57403
16-#18	3.92	MA	34551	8040	59149	5828	65835	4683	69678	3736	75242	2255	94512	1243	81231
6L-4S		MI	25743	8040	44881	5692	50045	4538	53189	3601	57747	2088	71016	1232	58991
16-#18	3.92	MA	33196	8040	56520	5861	62630	4712	65750	3762	69966	2275	87440	1018	77666
7L-3S		MI	26852	8040	46877	5666	52583	4552	56246	3618	61586	2071	75295	1456	61021
16-#18	3.92	MA	31859	8040	54108	5859	59395	4707	61904	3789	64440	2259	80762	888	73303
8L-2S		MI	28400	8040	49337	5676	55719	4531	60036	3601	66591	2053	81872	1683	61271
18-#11	1.72	MA	33110	6767	52837	5047	58297	4090	60658	3384	62979	2323	76262	2099	41091
3L-8S		MI	21073	6767	33859	4952	36178	4019	36561	3317	35721	2251	42265	1640	26918
18-#11	1.72	MA	32430	6767	51659	5061	56799	4103	58839	3381	60618	2333	73485	2011	41016
4L-7S		MI	21455	6767	34510	4954	37050	4023	37597	3309	37180	2258	44014	1688	27328

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

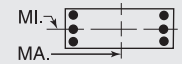


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.72	MA	31823	6767	50628	5061	55469	4102	57210	3393	58293	2328	70609	1965	40868
5L-6S		MI	21843	6767	35219	4942	37914	4013	38656	3301	38573	2251	45848	1776	27640
18-#11	1.72	MA	31244	6767	49656	5061	54147	4114	55598	3391	56158	2337	67855	1907	40128
6L-5S		MI	22239	6767	35881	4945	38813	4017	39753	3307	39995	2244	47608	1835	28114
18-#11	1.72	MA	30680	6767	48615	5075	52879	4113	54043	3402	54070	2347	64993	1820	39522
7L-4S		MI	22655	6767	36583	4947	39718	4008	40860	3298	41545	2251	49480	1876	28159
18-#11	1.72	MA	30124	6767	47661	5075	51599	4126	52521	3414	51882	2342	62303	1767	38840
8L-3S		MI	23117	6767	37381	4936	40732	4012	42091	3304	43115	2244	51247	1964	28166
18-#11	1.72	MA	29526	6767	46725	5075	50349	4125	50946	3411	49815	2351	59636	1711	37913
9L-2S		MI	23766	6767	38370	4938	41993	4002	43623	3296	45161	2237	53959	2053	28148
18-#14	2.48	MA	34372	7207	56320	5327	62650	4295	65917	3498	70236	2304	86582	1862	58260
4L-7S		MI	22193	7207	36720	5214	39773	4212	40868	3421	41500	2211	49936	1413	37371
18-#14	2.48	MA	33518	7207	54840	5327	60741	4293	63579	3514	66900	2297	82476	1798	57076
5L-6S		MI	22739	7207	37735	5198	41010	4199	42440	3430	43477	2201	52531	1540	38262
18-#14	2.48	MA	32704	7207	53445	5327	58845	4311	61266	3511	63836	2310	78555	1714	55888
6L-5S		MI	23297	7207	38684	5202	42297	4206	43953	3419	45497	2191	55021	1625	38885
18-#14	2.48	MA	31910	7207	51951	5346	57024	4309	59034	3527	60839	2322	74476	1588	54548
7L-4S		MI	23883	7207	39689	5206	43592	4192	45538	3408	47698	2201	57679	1683	39737
18-#14	2.48	MA	31127	7207	50582	5346	55187	4326	56850	3543	57699	2315	70639	1513	52982
8L-3S		MI	24533	7207	40830	5190	45043	4199	47299	3417	49927	2191	60177	1811	39841
18-#14	2.48	MA	30291	7207	49237	5345	53392	4324	54590	3539	54733	2327	66840	1432	51131
9L-2S		MI	25445	7207	42242	5194	46843	4185	49487	3406	52833	2181	64018	1939	39879
18-#18	4.41	MA	36240	8324	62850	6005	70553	4811	75414	3816	83013	2237	104958	1203	92004
6L-5S		MI	25826	8324	45582	5860	50916	4687	54228	3697	58960	2042	73032	1063	64606
18-#18	4.41	MA	34900	8324	60221	6038	67348	4841	71486	3842	77737	2257	97886	979	88347
7L-4S		MI	26815	8324	47341	5870	53181	4666	56979	3679	62752	2059	77592	1166	66102
18-#18	4.41	MA	33578	8324	57809	6036	64113	4835	67640	3868	72211	2241	91208	848	83922
8L-3S		MI	27914	8324	49337	5844	55719	4681	60036	3697	66591	2042	81872	1390	68402
20-#11	1.91	MA	33124	6877	53131	5130	58676	4153	61122	3412	63710	2326	77711	1998	45466
4L-8S		MI	21533	6877	34847	5021	37438	4069	38093	3348	37767	2242	44978	1619	29794
20-#11	1.91	MA	32520	6877	52100	5130	57346	4152	59492	3424	61385	2321	74835	1953	45301
5L-7S		MI	21913	6877	35498	5023	38310	4073	39130	3340	39227	2249	46726	1667	30259
20-#11	1.91	MA	31945	6877	51128	5130	56025	4164	57880	3422	59250	2330	72081	1895	44489
6E		MI	22299	6877	36207	5012	39174	4064	40188	3332	40619	2242	48560	1755	30559
20-#11	1.91	MA	31384	6877	50088	5144	54757	4163	56326	3433	57162	2340	69218	1808	43901
7L-5S		MI	22694	6877	36870	5014	40074	4068	41285	3338	42042	2235	50320	1814	31085
20-#11	1.91	MA	30831	6877	49134	5144	53477	4176	54804	3445	54974	2335	66529	1755	43164
8L-4S		MI	23107	6877	37571	5016	40978	4058	42392	3330	43591	2242	52192	1855	31155
20-#11	1.91	MA	30237	6877	48198	5144	52226	4175	53229	3442	52908	2344	63862	1699	42260
9L-3S		MI	23568	6877	38370	5005	41993	4062	43623	3335	45161	2235	53959	1944	31180
20-#11	1.91	MA	29627	6877	47175	5157	50963	4188	51717	3454	50857	2354	61274	1636	41294
10L-2S		MI	24214	6877	39358	5007	43253	4052	45156	3327	47208	2228	56672	2032	31169
20-#14	2.76	MA	34498	7367	56950	5427	63431	4365	66849	3559	71330	2287	88497	1779	63291
5L-7S		MI	22837	7367	38132	5313	41572	4285	43056	3466	44406	2197	53776	1381	41455
20-#14	2.76	MA	33690	7367	55555	5426	61535	4383	64536	3555	68266	2300	84576	1695	62145
6E		MI	23379	7367	39147	5297	42810	4271	44628	3475	46383	2187	56372	1508	42428
20-#14	2.76	MA	32902	7367	54061	5446	59714	4381	62304	3571	65269	2312	80498	1569	60722
7L-5S		MI	23934	7367	40096	5301	44097	4278	46141	3464	48403	2177	58862	1593	43022
20-#14	2.76	MA	32125	7367	52692	5445	57877	4399	60120	3587	62129	2305	76660	1494	59198
8L-4S		MI	24516	7367	41100	5305	45392	4264	47726	3453	50604	2187	61520	1651	43986
20-#14	2.76	MA	31308	7367	51347	5445	56082	4397	57860	3584	59164	2317	72861	1413	57297
9L-3S		MI	25162	7367	42242	5290	46843	4271	49487	3462	52833	2177	64018	1779	44112
20-#14	2.76	MA	30436	7367	49879	5464	54269	4414	55689	3600	56220	2330	69176	1321	55343
10L-2S		MI	26069	7367	43654	5294	48643	4258	51675	3451	55739	2167	67859	1907	44167
20-#18	4.90	MA	36587	8608	63922	6216	72066	4970	77222	3922	85508	2239	108332	939	99046
7L-5S		MI	26899	8608	48042	6038	54051	4816	58018	3775	63966	2012	79608	997	71761
20-#18	4.90	MA	35280	8608	61510	6214	68832	4964	73376	3948	79982	2223	101654	809	94731
8L-4S		MI	27879	8608	49800	6047	56317	4795	60769	3757	67758	2030	84169	1100	73237

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

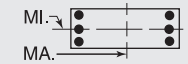
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.10	MA	33214	6988	53573	5199	59224	4202	61775	3455	64477	2314	79060	1941	49733
5L-8S		MI	21991	6988	35836	5090	38698	4119	39625	3380	39814	2233	47690	1598	32675
22-#11	2.10	MA	32642	6988	52601	5199	57902	4215	60163	3453	62342	2323	76307	1883	48855
6L-7S		MI	22369	6988	36487	5092	39571	4123	40662	3371	41273	2240	49439	1646	33193
22-#11	2.10	MA	32085	6988	51560	5213	56634	4214	58608	3464	60254	2333	73444	1795	48284
7L-6S		MI	22753	6988	37196	5081	40435	4114	41720	3363	42666	2233	51273	1734	33482
22-#11	2.10	MA	31535	6988	50607	5213	55354	4226	57086	3476	58066	2328	70755	1743	47493
8L-5S		MI	23146	6988	37859	5083	41334	4118	42817	3369	44089	2226	53032	1793	33984
22-#11	2.10	MA	30943	6988	49670	5213	54104	4225	55511	3474	56000	2337	68088	1687	46612
9L-4S		MI	23558	6988	38560	5085	42238	4108	43924	3361	45638	2233	54905	1834	34148
22-#11	2.10	MA	30336	6988	48648	5227	52841	4238	53999	3485	53949	2347	65500	1624	45610
10L-3S		MI	24016	6988	39358	5074	43253	4112	45156	3366	47208	2226	56672	1923	34182
22-#11	2.10	MA	29743	6988	47712	5227	51598	4237	52443	3483	51792	2342	62874	1568	44559
11L-2S		MI	24659	6988	40347	5076	44514	4102	46688	3358	49255	2220	59384	2011	34186
22-#14	3.03	MA	34669	7526	57664	5526	64225	4455	67806	3600	72697	2290	90598	1676	68407
6L-7S		MI	23477	7526	39544	5413	43372	4357	45244	3511	47312	2183	57617	1348	45548
22-#14	3.03	MA	33887	7526	56171	5546	62404	4453	65574	3616	69699	2302	86520	1550	66906
7L-6S		MI	24015	7526	40559	5397	44610	4344	46816	3520	49289	2173	60213	1475	46599
22-#14	3.03	MA	33116	7526	54801	5545	60567	4471	63390	3632	66560	2295	82682	1474	65421
8L-5S		MI	24567	7526	41508	5401	45897	4350	48329	3509	51309	2163	62702	1560	47168
22-#14	3.03	MA	32300	7526	53457	5545	58772	4469	61130	3628	63594	2307	78883	1394	63471
9L-4S		MI	25145	7526	42512	5405	47191	4337	49914	3498	53510	2173	65361	1618	48230
22-#14	3.03	MA	31438	7526	51989	5564	56959	4487	58959	3645	60650	2320	75198	1302	61483
10L-3S		MI	25788	7526	43654	5389	48643	4343	51675	3507	55739	2163	67859	1746	48377
22-#18	5.39	MA	36965	8892	65210	6391	73550	5092	79111	4028	87753	2206	112100	769	105468
8L-5S		MI	27964	8892	50502	6215	57187	4944	61808	3853	68971	1983	86185	932	78741
24-#11	2.29	MA	33335	7099	54074	5268	59780	4265	62445	3484	65434	2317	80533	1871	53226
6L-8S		MI	22446	7099	36824	5159	39959	4170	41157	3411	41861	2224	50403	1577	35561
24-#11	2.29	MA	32781	7099	53033	5282	58512	4264	60890	3495	63346	2326	77670	1783	52669
7E		MI	22823	7099	37475	5161	40831	4174	42194	3403	43320	2231	52151	1625	36129
24-#11	2.29	MA	32234	7099	52079	5282	57232	4276	59368	3507	61158	2321	74981	1731	51829
8L-6S		MI	23205	7099	38184	5150	41695	4164	43252	3394	44713	2224	53985	1713	36408
24-#11	2.29	MA	31645	7099	51143	5282	55982	4275	57794	3505	59092	2331	72314	1675	50967
9L-5S		MI	23596	7099	38847	5152	42594	4168	44349	3400	46135	2217	55745	1772	36888
24-#11	2.29	MA	31041	7099	50120	5296	54718	4288	56282	3516	57041	2340	69726	1612	49930
10L-4S		MI	24006	7099	39548	5155	43499	4158	45456	3392	47685	2224	57617	1813	37138
24-#11	2.29	MA	30451	7099	49184	5296	53475	4287	54725	3514	54884	2335	67100	1556	48899
11L-3S		MI	24462	7099	40347	5143	44514	4162	46688	3398	49255	2217	59384	1902	37182
24-#11	2.29	MA	29871	7099	48178	5310	52220	4299	53217	3525	52836	2345	64208	1482	47559
12L-2S		MI	25103	7099	41335	5146	45774	4152	48220	3389	51301	2211	62097	1991	37200
24-#14	3.31	MA	34865	7686	58281	5645	65094	4526	68845	3661	74130	2292	92541	1530	73098
7E		MI	24112	7686	40955	5513	45172	4429	47432	3555	50218	2169	61458	1316	49650
24-#14	3.31	MA	34099	7686	56911	5645	63257	4543	66660	3677	70990	2285	88704	1455	71650
8L-6S		MI	24648	7686	41971	5497	46409	4416	49004	3564	52195	2159	64053	1443	50773
24-#14	3.31	MA	33285	7686	55567	5644	61462	4541	64400	3673	68024	2297	84905	1375	69651
9L-5S		MI	25197	7686	42920	5501	47697	4423	50517	3554	54216	2149	66543	1528	51320
24-#14	3.31	MA	32432	7686	54099	5664	59649	4559	62229	3689	65080	2310	81219	1283	67630
10L-4S		MI	25771	7686	43924	5505	48991	4409	52102	3543	56416	2159	69201	1586	52466

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.04	MA	18634	5061	29309	3728	31553	3038	32117	2531	31885	1803	37308	1691	14612
2L-3S		MI	17628	5061	27798	3725	29626	3052	29774	2543	28754	1813	33156	1563	14679
6-#18	1.85	MA	20139	5434	32787	3932	35849	3183	37289	2615	38604	1746	46084	1583	25146
2L-3S		MI	18416	5434	30150	3924	32487	3205	33202	2633	33199	1764	38957	1355	25120
8-#14	1.39	MA	19331	5221	30821	3828	33480	3110	34459	2576	35016	1791	41459	1661	19261
2L-4S		MI	17620	5221	28089	3841	30001	3119	30234	2580	29483	1810	34603	1405	19256
8-#18	2.47	MA	21313	5718	35424	4109	39211	3311	41376	2695	44009	1720	53211	1522	33199
2L-4S		MI	18393	5718	30651	4128	33134	3321	33995	2696	34459	1755	41453	1067	31306
10-#11	1.20	MA	18997	5136	30011	3789	32517	3084	33316	2562	33556	1809	39569	1692	16861
2L-5S		MI	17346	5136	27352	3798	29119	3101	29179	2575	27996	1816	32715	1473	16862
10-#11	1.20	MA	18295	5136	28953	3788	31168	3094	31676	2571	31353	1816	36641	1603	16896
3L-4S		MI	17795	5136	28101	3799	30085	3091	30361	2566	29663	1823	34730	1515	16910
10-#14	1.74	MA	20020	5381	32332	3928	35407	3183	36802	2621	38148	1778	45610	1631	23890
2L-5S		MI	17688	5381	28528	3938	30546	3205	30885	2636	30244	1788	35889	1316	22931
10-#14	1.74	MA	19029	5381	30821	3924	33480	3197	34459	2633	35016	1788	41459	1503	23900
3L-4S		MI	18323	5381	29600	3941	31928	3191	32577	2624	32614	1798	38754	1375	23810
10-#18	3.09	MA	22472	6001	38061	4286	42573	3440	45463	2775	49414	1693	60338	1461	41207
2L-5S		MI	18506	6001	31409	4298	34074	3473	35117	2794	35770	1711	43638	905	36885
10-#18	3.09	MA	20789	6001	35424	4278	39211	3463	41376	2793	44009	1711	53211	1234	40987
3L-4S		MI	19587	6001	33288	4306	36496	3450	38082	2776	39864	1728	48580	1007	38824

RECTANGULAR TIED COLUMNS 36" x 38"

4-#18	1.17	MA	21016	5405	33280	3961	35887	3224	36650	2680	36622	1888	42979	1760	18128
2E		MI	19866	5405	31532	3943	33919	3210	34592	2667	34443	1874	40329	1742	17091
6-#18	1.75	MA	22298	5688	36095	4139	39475	3353	41012	2760	42427	1864	50658	1704	26766
2L-3S		MI	19334	5688	31532	4113	33919	3361	34592	2765	34443	1865	40329	1454	25197
6-#18	1.75	MA	20454	5688	33280	4132	35887	3377	36650	2780	36622	1882	42979	1477	26740
3L-2S		MI	21060	5688	34169	4121	37281	3338	38679	2747	39848	1848	47456	1681	25198
8-#14	1.32	MA	21423	5476	33987	4035	36935	3280	37978	2720	38545	1906	45630	1778	20476
2L-4S		MI	18537	5476	29465	4032	31433	3276	31628	2713	30733	1913	35983	1504	19323
8-#14	1.32	MA	20356	5476	32376	4032	34880	3295	35481	2733	35189	1916	41168	1650	20517
3E		MI	19250	5476	30686	4015	32984	3281	33511	2721	33135	1903	38688	1632	19347
8-#14	1.32	MA	19597	5476	31077	4049	33229	3291	33477	2726	32614	1926	38255	1522	20471
4L-2S		MI	20250	5476	32197	4018	34911	3267	35853	2709	36266	1893	42840	1760	19300
8-#18	2.34	MA	23561	5972	38909	4316	43064	3481	45374	2840	48232	1840	58336	1648	35359
2L-4S		MI	19310	5972	32033	4317	34565	3477	35385	2828	35703	1856	42826	1165	31664
8-#18	2.34	MA	21739	5972	36095	4309	39475	3506	41012	2859	42427	1858	50658	1420	35224
3E		MI	20531	5972	34169	4290	37281	3489	38679	2845	39848	1839	47456	1393	33153
8-#18	2.34	MA	20440	5972	33819	4338	36583	3495	37502	2844	37974	1875	45661	1193	33632
4L-2S		MI	22237	5972	36806	4298	40643	3467	42766	2827	45253	1821	54583	1620	33257
10-#11	1.14	MA	21063	5390	33119	3996	35903	3254	36753	2707	36968	1924	43580	1807	17914
2L-5S		MI	18263	5390	28726	3989	30551	3258	30575	2708	29248	1919	34100	1572	16925
10-#11	1.14	MA	20313	5390	31993	3995	34467	3265	35006	2716	34609	1931	40436	1718	17949
3L-4S		MI	18712	5390	29474	3991	31516	3248	31756	2700	30915	1926	36115	1614	16956
10-#11	1.14	MA	19780	5390	31086	4007	33314	3262	33607	2712	32799	1938	38381	1630	17963
4L-3S		MI	19213	5390	30327	3979	32600	3252	33072	2705	32605	1919	38026	1703	16933
10-#11	1.14	MA	19303	5390	30290	4006	32288	3273	32350	2721	31014	1931	36222	1587	17915
5L-2S		MI	19917	5390	31384	3981	33949	3241	34711	2696	34808	1912	40954	1792	16895
10-#14	1.64	MA	22164	5635	35598	4135	38989	3353	40475	2765	41902	1895	50092	1750	25409
2L-5S		MI	18604	5635	29905	4128	31978	3362	32279	2769	31494	1890	37270	1415	23142
10-#14	1.64	MA	21104	5635	33987	4132	36935	3368	37978	2778	38545	1905	45630	1622	25419
3L-4S		MI	19241	5635	30977	4131	33360	3348	33971	2758	33864	1900	40135	1474	23885
10-#14	1.64	MA	20352	5635	32688	4149	35284	3363	35974	2771	35970	1915	42717	1494	25328
4L-3S		MI	19948	5635	32197	4115	34911	3354	35853	2766	36266	1890	42840	1602	23954

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

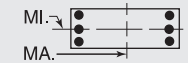
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.64	MA	19676	5635	31548	4146	33814	3378	34175	2784	33430	1905	39646	1434	24520
5L-2S		MI	20942	5635	33709	4118	36838	3339	38196	2754	39397	1880	46991	1730	23933
10-#18	2.92	MA	24808	6256	41723	4493	46652	3610	49735	2919	54036	1816	66015	1592	43907
2L-5S		MI	19421	6256	32791	4487	35506	3628	36507	2926	37014	1812	45011	1003	37190
10-#18	2.92	MA	23006	6256	38909	4487	43064	3634	45374	2939	48232	1833	58336	1364	43687
3L-4S		MI	20506	6256	34670	4495	37927	3605	39472	2908	41107	1830	49953	1105	39174
10-#18	2.92	MA	21723	6256	36634	4515	40171	3623	41864	2924	43779	1851	53339	1137	41666
4L-3S		MI	21711	6256	36806	4467	40643	3618	42766	2925	45253	1812	54583	1332	41086
10-#18	2.92	MA	20571	6256	34634	4508	37593	3647	38708	2944	39384	1833	48030	1033	39479
5L-2S		MI	23400	6256	39443	4475	44005	3595	46853	2907	50658	1794	61710	1560	41275
12-#11	1.37	MA	21587	5501	34246	4065	37340	3304	38499	2738	39327	1917	46724	1789	21368
2L-6S		MI	18335	5501	29076	4056	30940	3305	31044	2735	29920	1917	35127	1494	19579
12-#11	1.37	MA	20841	5501	33119	4064	35903	3315	36753	2747	36968	1923	43580	1701	21392
3L-5S		MI	18761	5501	29783	4058	31900	3309	32214	2739	31451	1911	37028	1553	20116
12-#11	1.37	MA	20312	5501	32213	4076	34750	3312	35353	2743	35158	1930	41525	1612	21383
4E		MI	19208	5501	30532	4060	32865	3298	33396	2731	33118	1917	39043	1595	20171
12-#11	1.37	MA	19837	5501	31417	4075	33724	3323	34097	2752	33373	1923	39366	1569	21311
5L-3S		MI	19706	5501	31384	4048	33949	3302	34711	2736	34808	1911	40954	1684	20169
12-#11	1.37	MA	19384	5501	30666	4073	32704	3320	32853	2748	31733	1930	37323	1511	20724
6L-2S		MI	20406	5501	32442	4050	35297	3291	36350	2727	37011	1904	43882	1772	20141
12-#14	1.97	MA	22898	5795	37209	4234	41043	3425	42972	2810	45259	1883	54554	1723	30329
2L-6S		MI	18705	5795	30403	4225	32530	3429	32945	2806	32448	1887	38728	1300	26765
12-#14	1.97	MA	21846	5795	35598	4232	38989	3440	40475	2823	41902	1893	50092	1595	30305
3L-5S		MI	19307	5795	31416	4228	33905	3434	34621	2814	34625	1877	41421	1385	27530
12-#14	1.97	MA	21099	5795	34299	4249	37338	3435	38471	2816	39327	1903	47180	1467	30177
4E		MI	19938	5795	32488	4231	35287	3420	36313	2803	36995	1887	44286	1445	28436
12-#14	1.97	MA	20429	5795	33159	4246	35868	3450	36672	2828	36787	1893	44109	1406	29204
5L-3S		MI	20640	5795	33709	4215	36838	3426	38196	2811	39397	1877	46991	1573	28541
12-#14	1.97	MA	19789	5795	32083	4243	34406	3445	34889	2821	34453	1903	41211	1322	28359
6L-2S		MI	21627	5795	35220	4218	38765	3412	40538	2799	42528	1867	51142	1701	28553
12-#18	3.51	MA	26041	6540	44538	4671	50240	3739	54097	2999	59841	1791	73693	1535	52433
2L-6S		MI	19592	6540	33651	4656	36458	3744	37761	3024	38662	1803	47520	790	41863
12-#18	3.51	MA	24257	6540	41723	4664	46652	3763	49735	3019	54036	1809	66015	1308	52137
3L-5S		MI	20615	6540	35428	4664	38868	3757	40594	3006	42419	1786	52138	942	44876
12-#18	3.51	MA	22990	6540	39448	4692	43759	3752	46226	3004	49584	1827	61018	1080	49747
4E		MI	21686	6540	37307	4672	41289	3734	43559	2987	46512	1803	57080	1044	46731
12-#18	3.51	MA	21852	6540	37448	4686	41181	3776	43069	3023	45189	1809	55708	977	47695
5L-3S		MI	22878	6540	39443	4645	44005	3747	46853	3005	50658	1786	61710	1271	49004
12-#18	3.51	MA	20765	6540	35558	4679	38616	3765	39942	3008	41154	1827	50729	825	44476
6L-2S		MI	24550	6540	42080	4653	47367	3724	50940	2987	56062	1768	68837	1499	49266
14-#11	1.60	MA	22108	5612	35373	4135	38777	3354	40246	2769	41686	1909	49867	1772	24815
2L-7S		MI	18418	5612	29378	4137	31367	3366	31553	2774	30624	1916	36074	1387	22315
14-#11	1.60	MA	21365	5612	34246	4133	37340	3365	38499	2778	39327	1916	46724	1683	24828
3L-6S		MI	18832	5612	30134	4125	32289	3355	32683	2766	32123	1909	38055	1475	22686
14-#11	1.60	MA	20839	5612	33339	4145	36187	3362	37100	2774	37517	1923	44669	1594	24796
4L-5S		MI	19257	5612	30841	4127	33248	3359	33853	2771	33654	1902	39956	1534	23303
14-#11	1.60	MA	20367	5612	32544	4144	35161	3373	35843	2783	35732	1916	42510	1552	24703
5L-4S		MI	19701	5612	31590	4129	34213	3348	35035	2762	35321	1909	41971	1576	23378
14-#11	1.60	MA	19917	5612	31793	4142	34141	3370	34599	2779	34092	1923	40467	1493	24036
6L-3S		MI	20196	5612	32442	4117	35297	3352	36350	2767	37011	1902	43882	1665	23397
14-#11	1.60	MA	19478	5612	30989	4155	33161	3381	33399	2788	32487	1930	38340	1405	23623
7L-2S		MI	20892	5612	33500	4119	36646	3341	37990	2758	39214	1896	46810	1753	23380
14-#14	2.30	MA	23626	5954	38820	4334	43097	3497	45469	2855	48615	1872	59017	1695	35234
2L-7S		MI	18822	5954	30831	4341	33136	3515	33669	2863	33449	1884	40072	1144	30004

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis

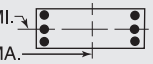


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.30	MA	22581	5954	37209	4331	41043	3512	42972	2868	45259	1881	54554	1567	35181
3L-6S		MI	19406	5954	31915	4324	34457	3501	35287	2851	35579	1875	42879	1271	31209
14-#14	2.30	MA	21840	5954	35911	4349	39392	3507	40969	2861	42684	1891	51642	1439	35020
4L-5S		MI	20003	5954	32928	4328	35832	3507	36964	2859	37756	1865	45572	1356	31933
14-#14	2.30	MA	21175	5954	34771	4346	37922	3522	39169	2873	40143	1881	48571	1379	33903
5L-4S		MI	20629	5954	34000	4331	37214	3493	38656	2847	40126	1875	48437	1415	32981
14-#14	2.30	MA	20541	5954	33694	4343	36460	3518	37386	2866	37810	1891	45673	1294	33100
6L-3S		MI	21326	5954	35220	4314	38765	3498	40538	2855	42528	1865	51142	1543	33118
14-#14	2.30	MA	19922	5954	32542	4360	35056	3533	35666	2879	35526	1901	42655	1167	31806
7L-2S		MI	22306	5954	36731	4318	40692	3484	42881	2844	45660	1855	55293	1671	33160
14-#18	4.09	MA	25495	6823	44538	4841	50240	3891	54097	3099	59841	1785	73693	1252	60578
3L-6S		MI	20783	6823	36288	4833	39820	3873	41848	3103	44067	1777	54647	730	49420
14-#18	4.09	MA	24242	6823	42262	4870	47347	3880	50588	3083	55389	1802	68696	1024	57866
4L-5S		MI	21794	6823	38065	4841	42230	3885	44681	3085	47824	1759	59264	882	52558
14-#18	4.09	MA	23117	6823	40262	4863	44769	3904	47431	3103	50994	1785	63387	921	55934
5L-4S		MI	22854	6823	39944	4849	44651	3862	47646	3067	51917	1777	64207	983	54325
14-#18	4.09	MA	22044	6823	38372	4856	42204	3893	44304	3088	46958	1802	58408	769	52564
6L-3S		MI	24033	6823	42080	4822	47367	3875	50940	3085	56062	1759	68837	1210	56911
16-#11	1.82	MA	22625	5722	36500	4204	40213	3404	41992	2800	44046	1902	53011	1754	28255
2L-8S		MI	18509	5722	29741	4204	31785	3412	32086	2814	31256	1901	37120	1319	24751
16-#11	1.82	MA	21886	5722	35373	4202	38777	3415	40246	2809	41686	1909	49867	1665	28250
3L-7S		MI	18915	5722	30435	4206	32715	3416	33193	2806	32827	1908	39002	1368	25444
16-#11	1.82	MA	21363	5722	34466	4215	37624	3412	38846	2805	39876	1916	47813	1577	28203
4L-6S		MI	19327	5722	31192	4194	33637	3405	34322	2797	34325	1901	40983	1456	25800
16-#11	1.82	MA	20894	5722	33671	4213	36598	3423	37590	2814	38091	1909	45654	1534	28001
5E		MI	19748	5722	31899	4196	34597	3409	35493	2802	35857	1894	42884	1515	26385
16-#11	1.82	MA	20447	5722	32920	4212	35578	3420	36346	2810	36451	1916	43611	1475	27356
6L-4S		MI	20190	5722	32647	4198	35562	3399	36674	2793	37524	1901	44900	1557	26578
16-#11	1.82	MA	20010	5722	32116	4224	34598	3431	35145	2819	34846	1923	41484	1388	26958
7L-3S		MI	20682	5722	33500	4186	36646	3402	37990	2798	39214	1894	46810	1645	26615
16-#11	1.82	MA	19579	5722	31378	4222	33609	3428	33970	2829	33164	1916	39467	1338	26210
8L-2S		MI	21375	5722	34558	4188	37994	3392	39629	2789	41417	1888	49738	1734	26612
16-#14	2.63	MA	24349	6114	40432	4434	45151	3570	47966	2900	51972	1860	63479	1668	40127
2L-8S		MI	18952	6114	31348	4437	33730	3582	34427	2920	34347	1862	41548	1044	33236
16-#14	2.63	MA	23310	6114	38820	4431	43097	3585	45469	2913	48615	1870	59017	1540	40049
3L-7S		MI	19522	6114	32343	4441	35063	3588	36012	2908	36580	1872	44223	1114	34375
16-#14	2.63	MA	22575	6114	37522	4448	41446	3580	43466	2906	46040	1880	56104	1412	39859
4L-6S		MI	20101	6114	33426	4424	36384	3573	37630	2896	38711	1862	47030	1241	35660
16-#14	2.63	MA	21916	6114	36382	4446	39976	3595	41666	2918	43500	1870	53033	1351	38617
5E		MI	20694	6114	34439	4427	37759	3579	39306	2904	40887	1852	49724	1326	36351
16-#14	2.63	MA	21286	6114	35305	4443	38514	3590	39883	2911	41166	1880	50136	1267	37850
6L-4S		MI	21315	6114	35511	4431	39141	3565	40998	2892	43258	1862	52588	1385	37520
16-#14	2.63	MA	20672	6114	34153	4460	37110	3605	38163	2924	38883	1890	47117	1140	36476
7L-3S		MI	22007	6114	36731	4414	40692	3571	42881	2900	45660	1852	55293	1513	37687
16-#14	2.63	MA	20066	6114	33096	4457	35693	3600	36478	2937	36490	1880	44249	1069	35255
8L-2S		MI	22981	6114	38243	4417	42619	3556	45223	2888	48791	1842	59444	1641	37753
16-#18	4.68	MA	25481	7107	45077	5047	50935	4009	54949	3163	61193	1778	76375	968	66017
4L-6S		MI	21961	7107	38925	5011	43182	4001	45935	3183	49471	1750	61774	669	57002
16-#18	4.68	MA	24369	7107	43077	5040	48357	4033	51793	3183	56798	1760	71065	864	63979
5E		MI	22961	7107	40702	5019	45592	4014	48768	3165	53228	1732	66391	821	60005
16-#18	4.68	MA	23308	7107	41187	5034	45792	4022	48666	3168	52763	1778	66086	713	60677
6L-4S		MI	24009	7107	42581	5027	48013	3991	51733	3147	57322	1750	71333	922	61950
18-#11	2.05	MA	23139	5833	37627	4273	41650	3455	43739	2831	46405	1895	56155	1736	31691
2L-9S		MI	18606	5833	30064	4285	32224	3473	32581	2841	31976	1900	38206	1243	27242
18-#11	2.05	MA	22404	5833	36500	4271	40213	3465	41992	2841	44046	1901	53011	1648	31669
3L-8S		MI	19005	5833	30799	4274	33133	3462	33726	2846	33459	1893	40048	1300	27833
18-#11	2.05	MA	21884	5833	35593	4284	39060	3462	40593	2836	42236	1908	50957	1559	31607
4L-7S		MI	19409	5833	31493	4275	34064	3466	34832	2837	35030	1900	41930	1349	28575

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

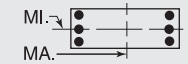
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.05	MA	21418	5833	34798	4282	38034	3473	39336	2845	40451	1901	48798	1516	31297
5L-6S		MI	19818	5833	32250	4264	34986	3456	35962	2828	36528	1893	43911	1437	28920
18-#11	2.05	MA	20973	5833	34046	4281	37014	3470	38092	2841	38810	1908	46755	1458	30681
6L-5S		MI	20237	5833	32956	4265	35945	3459	37132	2833	38060	1886	45812	1496	29477
18-#11	2.05	MA	20539	5833	33243	4293	36035	3481	36892	2850	37205	1915	44628	1370	30297
7L-4S		MI	20676	5833	33705	4267	36910	3449	38314	2824	39727	1893	47828	1537	29775
18-#11	2.05	MA	20111	5833	32505	4292	35046	3478	35716	2860	35523	1908	42611	1320	29498
8L-3S		MI	21166	5833	34558	4255	37994	3452	39629	2829	41417	1886	49738	1626	29826
18-#11	2.05	MA	19687	5833	31725	4304	34080	3489	34500	2855	33935	1915	40632	1264	28861
9L-2S		MI	21855	5833	35615	4257	39343	3442	41268	2820	43620	1879	52666	1715	29839
18-#14	2.96	MA	24034	6274	40432	4531	45151	3657	47966	2958	51972	1858	63479	1512	44912
3L-8S		MI	19650	6274	32859	4537	35657	3654	36769	2965	37479	1849	45699	1015	37561
18-#14	2.96	MA	23304	6274	39133	4548	43500	3652	45963	2950	49397	1868	60566	1384	44694
4L-7S		MI	20216	6274	33854	4540	36990	3660	38354	2953	39712	1859	48374	1084	38757
18-#14	2.96	MA	22650	6274	37993	4545	42030	3667	44163	2963	46857	1858	57495	1324	43342
5L-6S		MI	20791	6274	34938	4524	38311	3646	39972	2941	41842	1849	51181	1211	40118
18-#14	2.96	MA	22025	6274	36916	4543	40568	3662	42380	2956	44523	1868	54598	1239	42606
6L-5S		MI	21379	6274	35951	4527	39686	3651	41649	2949	44019	1839	53875	1296	40779
18-#14	2.96	MA	21416	6274	35764	4560	39164	3677	40660	2969	42239	1878	51579	1112	41157
7L-4S		MI	21996	6274	37023	4530	41068	3637	43341	2937	46389	1849	56739	1355	42056
18-#14	2.96	MA	20815	6274	34707	4557	37747	3672	38975	2982	39846	1868	48711	1042	39878
8L-3S		MI	22683	6274	38243	4514	42619	3643	45223	2945	48791	1839	59444	1483	42250
18-#18	5.26	MA	25609	7391	45891	5218	51945	4162	56155	3263	62603	1736	78744	808	71984
5L-6S		MI	23128	7391	41562	5188	46544	4130	50022	3263	54876	1724	68901	608	64607
18-#18	5.26	MA	24559	7391	44001	5211	49381	4150	53028	3247	58568	1754	73765	657	68813
6L-5S		MI	24118	7391	43339	5196	48954	4142	52855	3245	58633	1706	73518	760	67483
20-#11	2.28	MA	22918	5944	37627	4341	41650	3516	43739	2872	46405	1894	56155	1630	35083
3L-9S		MI	19101	5944	31122	4355	33572	3523	34221	2872	34178	1892	41134	1224	30289
20-#11	2.28	MA	22401	5944	36720	4353	40497	3513	42339	2867	44595	1901	54100	1541	35007
4L-8S		MI	19498	5944	31857	4343	34482	3513	35365	2877	35662	1885	42976	1281	30920
20-#11	2.28	MA	21938	5944	35924	4351	39471	3523	41083	2877	42810	1894	51942	1499	34601
5L-7S		MI	19899	5944	32551	4345	35412	3516	36471	2868	37232	1892	44858	1330	31660
20-#11	2.28	MA	21496	5944	35173	4350	38451	3520	39839	2872	41170	1901	49899	1440	34011
6E		MI	20306	5944	33307	4333	36334	3506	37601	2859	38731	1885	46839	1418	32044
20-#11	2.28	MA	21064	5944	34370	4362	37471	3531	38638	2882	39564	1908	47772	1352	33604
7L-5S		MI	20723	5944	34014	4335	37294	3509	38771	2864	40263	1878	48740	1476	32576
20-#11	2.28	MA	20639	5944	33632	4361	36483	3528	37463	2891	37883	1901	45755	1303	32793
8L-4S		MI	21160	5944	34763	4336	38259	3499	39953	2855	41930	1885	50756	1518	32967
20-#11	2.28	MA	20217	5944	32851	4373	35516	3539	36247	2887	36294	1908	43776	1246	32115
9L-3S		MI	21646	5944	35615	4325	39343	3502	41268	2860	43620	1878	52666	1607	33032
20-#11	2.28	MA	19754	5944	32117	4372	34540	3536	35078	2896	34717	1915	41857	1182	31215
10L-2S		MI	22333	5944	36673	4326	40691	3492	42908	2851	45823	1871	55595	1696	33058
20-#14	3.29	MA	24028	6433	40744	4648	45554	3724	48460	2995	52754	1857	65029	1357	49459
4L-8S		MI	20343	6433	34371	4637	37584	3727	39112	3010	40610	1836	49851	985	41896
20-#14	3.29	MA	23379	6433	39604	4645	44084	3739	46660	3008	50213	1847	61958	1296	48076
5L-7S		MI	20905	6433	35366	4640	38917	3732	40697	2998	42843	1846	52526	1054	43149
20-#14	3.29	MA	22759	6433	38528	4642	42623	3735	44878	3001	47880	1857	59060	1212	47305
6E		MI	21476	6433	36449	4624	40238	3718	42315	2986	44973	1836	55333	1181	44476
20-#14	3.29	MA	22154	6433	37375	4660	41218	3749	43157	3014	45596	1867	56042	1085	45847
7L-5S		MI	22060	6433	37462	4627	41613	3724	43991	2994	47150	1826	58026	1266	45216
20-#14	3.29	MA	21558	6433	36318	4657	39801	3745	41472	3026	43203	1857	53173	1014	44512
8L-4S		MI	22672	6433	38534	4630	42995	3709	45683	2982	49520	1836	60891	1325	46465
20-#18	5.85	MA	25799	7674	46815	5388	52969	4279	57390	3327	64373	1730	81443	600	76967
6E		MI	24285	7674	44199	5365	49906	4258	54109	3343	60281	1697	76028	547	72231

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

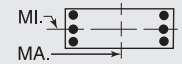
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.51	MA	22916	6054	37847	4422	41934	3563	44086	2898	46954	1894	57244	1524	38404
4L-9S		MI	19593	6054	32180	4424	34921	3573	35860	2903	36381	1884	44062	1205	33343
22-#11	2.51	MA	22455	6054	37051	4421	40908	3574	42829	2908	45169	1887	55086	1481	37912
5L-8S		MI	19988	6054	32914	4412	35830	3563	37004	2908	37865	1877	45904	1262	34013
22-#11	2.51	MA	22015	6054	36300	4419	39888	3571	41585	2903	43529	1894	53043	1422	37346
6L-7S		MI	20387	6054	33609	4414	36761	3566	38111	2899	39435	1884	47786	1311	34728
22-#11	2.51	MA	21586	6054	35496	4431	38908	3581	40385	2913	41923	1901	50915	1335	36878
7L-6S		MI	20792	6054	34365	4402	37683	3556	39240	2890	40934	1877	49767	1399	35172
22-#11	2.51	MA	21163	6054	34759	4430	37919	3579	39209	2922	40242	1894	48899	1285	36092
8L-5S		MI	21206	6054	35072	4404	38642	3559	40411	2895	42466	1870	51668	1457	35681
22-#11	2.51	MA	20744	6054	33978	4442	36953	3589	37993	2918	38653	1901	46920	1228	35376
9L-4S		MI	21640	6054	35820	4406	39608	3549	41592	2886	44133	1877	53684	1499	36157
22-#11	2.51	MA	20283	6054	33244	4441	35977	3586	36825	2927	37076	1908	45001	1165	34498
10L-3S		MI	22124	6054	36673	4394	40691	3552	42908	2891	45823	1870	55595	1588	36235
22-#14	3.62	MA	24102	6593	41215	4745	46138	3812	49157	3053	53570	1835	66420	1269	52818
5L-8S		MI	21031	6593	35882	4737	39511	3799	41454	3055	43741	1824	54002	955	46240
22-#14	3.62	MA	23487	6593	40139	4742	44677	3807	47375	3046	51236	1845	63522	1184	51955
6L-7S		MI	21590	6593	36877	4740	40844	3805	43039	3043	45974	1834	56677	1024	47550
22-#14	3.62	MA	22887	6593	38987	4759	43273	3822	45654	3059	48953	1855	60504	1057	50546
7L-6S		MI	22156	6593	37961	4723	42165	3790	44657	3031	48104	1824	59484	1151	48830
22-#14	3.62	MA	22295	6593	37929	4757	41856	3817	43969	3071	46560	1845	57635	987	49156
8L-5S		MI	22736	6593	38973	4727	43540	3796	46334	3039	50281	1814	62177	1236	49661
24-#11	2.74	MA	22969	6165	38178	4490	42344	3624	44576	2939	47528	1880	58230	1463	41228
5L-9S		MI	20082	6165	33237	4493	36269	3623	37499	2934	38584	1876	46990	1186	36402
24-#11	2.74	MA	22532	6165	37427	4488	41324	3621	43332	2934	45888	1886	56187	1405	40684
6L-8S		MI	20475	6165	33972	4481	37179	3613	38644	2939	40068	1869	48832	1243	37110
24-#11	2.74	MA	22105	6165	36623	4500	40345	3632	42131	2944	44283	1893	54059	1317	40159
7E		MI	20872	6165	34666	4483	38109	3616	39750	2930	41638	1876	50714	1291	37803
24-#11	2.74	MA	21685	6165	35886	4499	39356	3629	40956	2953	42601	1886	52043	1267	39396
8L-6S		MI	21274	6165	35423	4471	39031	3606	40879	2921	43137	1869	52695	1379	38304
24-#11	2.74	MA	21268	6165	35105	4511	38390	3639	39740	2949	41012	1893	50063	1211	38642
9L-5S		MI	21686	6165	36130	4473	39991	3609	42050	2926	44669	1862	54596	1438	38793
24-#11	2.74	MA	20810	6165	34371	4510	37413	3637	38571	2958	39435	1900	48145	1147	37786
10L-4S		MI	22118	6165	36878	4475	40956	3599	43232	2917	46336	1869	56612	1480	39344
24-#14	3.95	MA	24211	6752	41750	4842	46731	3879	49872	3091	54593	1834	67984	1157	56617
6L-8S		MI	21715	6752	37393	4836	41438	3871	43797	3099	46872	1811	58153	925	50594
24-#14	3.95	MA	23615	6752	40598	4859	45327	3894	48151	3103	52309	1843	64966	1030	55253
7E		MI	22269	6752	38388	4840	42771	3877	45382	3088	49105	1821	60828	995	51958
24-#14	3.95	MA	23027	6752	39540	4856	43910	3889	46466	3116	49916	1834	62098	959	53809
8L-6S		MI	22831	6752	39472	4823	44092	3863	47000	3076	51236	1811	63635	1121	53194

RECTANGULAR TIED COLUMNS 36" x 40"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.11	MA	23187	5659	36556	4168	39446	3395	40256	2825	40190	2004	47166	1876	19208
2E		MI	20784	5659	32914	4132	35350	3365	35983	2799	35687	1976	41702	1840	17133
6-#18	1.67	MA	24560	5943	39547	4346	43260	3523	44892	2904	46396	1981	55397	1824	28386
2L-3S		MI	20252	5943	32914	4302	35350	3516	35983	2897	35687	1967	41702	1552	25270
6-#18	1.67	MA	22595	5943	36556	4340	39446	3549	40256	2926	40190	1999	47166	1596	28360
3L-2S		MI	21981	5943	35551	4310	38712	3494	40070	2879	41092	1949	48829	1779	25248
8-#14	1.25	MA	23619	5730	37298	4242	40548	3451	41654	2865	42220	2021	49965	1893	21691
2L-4S		MI	19453	5730	30842	4222	32865	3432	33022	2846	31982	2015	37364	1603	19386
8-#14	1.25	MA	22482	5730	35587	4240	38367	3466	39003	2878	38638	2031	45191	1765	21732
3E		MI	20168	5730	32062	4206	34416	3438	34904	2854	34384	2005	40069	1731	19391
8-#14	1.25	MA	21676	5730	34210	4257	36616	3462	36878	2872	35890	2041	42071	1637	21686
4L-2S		MI	21170	5730	33573	4209	36343	3424	37247	2842	37515	1995	44220	1859	19338
8-#18	2.22	MA	25913	6227	42539	4523	47074	3652	49529	2984	52601	1959	63627	1772	37519
2L-4S		MI	20227	6227	33415	4506	35997	3632	36775	2960	36947	1958	44198	1264	32014

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

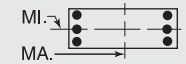
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	2.22	MA	23970	6227	39547	4517	43260	3677	44892	3006	46396	1977	55397	1544	37384
3E		MI	21451	6227	35551	4479	38712	3645	40070	2977	41092	1940	48829	1491	33238
8-#18	2.22	MA	22589	6227	37133	4547	40190	3667	41167	2992	41636	1995	50031	1316	35988
4L-2S		MI	23161	6227	38188	4487	42074	3622	44157	2959	46497	1922	55956	1718	33314
10-#11	1.08	MA	23231	5645	36373	4203	39448	3424	40347	2851	40503	2037	47753	1921	18967
2L-5S		MI	19179	5645	30099	4180	31983	3416	31970	2842	30501	2021	35485	1672	16983
10-#11	1.08	MA	22433	5645	35177	4202	37923	3435	38494	2861	37992	2044	44393	1832	19002
3L-4S		MI	19630	5645	30848	4182	32948	3405	33152	2833	32168	2028	37500	1713	16998
10-#11	1.08	MA	21868	5645	34216	4215	36701	3433	37011	2857	36066	2051	42195	1744	19016
4L-3S		MI	20131	5645	31700	4170	34032	3409	34467	2838	33858	2021	39411	1802	16969
10-#11	1.08	MA	21361	5645	33373	4214	35614	3444	35680	2867	34167	2045	39892	1701	18968
5L-2S		MI	20835	5645	32758	4172	35381	3399	36107	2829	36061	2014	42339	1891	16928
10-#14	1.56	MA	24411	5890	39009	4341	42729	3523	44306	2910	45802	2011	54738	1868	26928
2L-5S		MI	19521	5890	31281	4319	33410	3519	33672	2903	32743	1992	38651	1514	23346
10-#14	1.56	MA	23282	5890	37298	4339	40548	3539	41654	2923	42220	2021	49965	1740	26937
3L-4S		MI	20158	5890	32353	4322	34792	3505	35365	2891	35113	2002	41515	1573	23955
10-#14	1.56	MA	22483	5890	35921	4357	38797	3534	39530	2917	39472	2031	46845	1612	26847
4L-3S		MI	20867	5890	33573	4305	36343	3510	37247	2899	37515	1992	44220	1701	24006
10-#14	1.56	MA	21766	5890	34713	4355	37239	3550	37622	2931	36761	2021	43567	1551	26122
5L-2S		MI	21862	5890	35085	4309	38270	3496	39590	2887	40647	1982	48372	1829	23975
10-#18	2.78	MA	27249	6510	45531	4700	50888	3780	54166	3064	58806	1937	71858	1719	46607
2L-5S		MI	20337	6510	34173	4676	36937	3783	37898	3058	38258	1914	46383	1101	37484
10-#18	2.78	MA	25327	6510	42539	4694	47074	3806	49529	3085	52601	1955	63627	1492	46387
3L-4S		MI	21424	6510	36052	4684	39359	3761	40862	3040	42351	1931	51325	1203	39515
10-#18	2.78	MA	23963	6510	40125	4724	44005	3796	45804	3071	47841	1972	58262	1264	44539
4L-3S		MI	22634	6510	38188	4656	42074	3773	44157	3057	46497	1914	55956	1430	41179
10-#18	2.78	MA	22739	6510	38004	4718	41270	3822	42456	3093	43144	1955	52586	1159	42090
5L-2S		MI	24327	6510	40825	4664	45436	3751	48244	3039	51901	1896	63082	1658	41341
12-#11	1.30	MA	23791	5756	37569	4272	40973	3474	42201	2882	43014	2030	51113	1905	22632
2L-6S		MI	19251	5756	30450	4247	32372	3463	32439	2868	31172	2020	36512	1594	19722
12-#11	1.30	MA	22997	5756	36373	4271	39448	3486	40347	2892	40503	2037	47753	1816	22656
3L-5S		MI	19678	5756	31157	4249	33332	3466	33609	2873	32703	2013	38413	1652	20180
12-#11	1.30	MA	22435	5756	35412	4284	38226	3483	38864	2888	38577	2044	45555	1727	22646
4E		MI	20126	5756	31905	4251	34297	3456	34791	2864	34371	2020	40428	1694	20220
12-#11	1.30	MA	21932	5756	34569	4283	37139	3494	37533	2898	36679	2038	43252	1684	22575
5L-3S		MI	20625	5756	32758	4239	35381	3459	36107	2869	36061	2013	42339	1783	20208
12-#11	1.30	MA	21452	5756	33774	4282	36059	3492	36216	2894	34934	2045	41068	1626	22023
6L-2S		MI	21326	5756	33816	4241	36729	3449	37746	2861	38263	2006	45267	1872	20177
12-#14	1.88	MA	25196	6049	40720	4441	44910	3595	46958	2955	49384	2000	59512	1842	32151
2L-6S		MI	19620	6049	31780	4415	33962	3585	34339	2939	33697	1990	40108	1399	26952
12-#14	1.88	MA	24075	6049	39009	4439	42729	3611	44306	2968	45802	2010	54738	1714	32127
3L-5S		MI	20224	6049	32793	4418	35337	3591	36015	2947	35874	1980	42802	1484	27731
12-#14	1.88	MA	23282	6049	37632	4457	40979	3607	42181	2962	43054	2020	51618	1587	32000
4E		MI	20857	6049	33865	4422	36719	3577	37707	2936	38245	1990	45667	1543	28512
12-#14	1.88	MA	22571	6049	36424	4455	39421	3622	40274	2975	40343	2010	48341	1525	31099
5L-3S		MI	21561	6049	35085	4405	38270	3583	39590	2944	40647	1980	48372	1671	28598
12-#14	1.88	MA	21892	6049	35283	4452	37872	3618	38385	2969	37853	2020	45239	1441	30157
6L-2S		MI	22549	6049	36596	4408	40197	3568	41932	2932	43778	1970	52523	1799	28598
12-#18	3.33	MA	28569	6794	48522	4877	54702	3909	58802	3144	65011	1915	80089	1667	55673
2L-6S		MI	20505	6794	35033	4845	37889	3899	39152	3156	39906	1905	48893	888	42333
12-#18	3.33	MA	26667	6794	45531	4872	50888	3934	54166	3165	58806	1932	71858	1440	55377
3L-5S		MI	21532	6794	36810	4853	40299	3912	41985	3138	43663	1887	53510	1040	45167
12-#18	3.33	MA	25319	6794	43116	4901	47819	3925	50441	3151	54046	1950	66493	1212	53137
4E		MI	22607	6794	38689	4861	42721	3889	44949	3119	47756	1905	58452	1142	47065

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

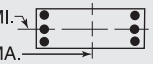


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	3.33	MA	24109	6794	40995	4896	45084	3950	47093	3173	49349	1932	60817	1107	50834
5L-3S		MI	23804	6794	40825	4834	45436	3902	48244	3137	51901	1887	63082	1369	49105
12-#18	3.33	MA	22955	6794	38992	4890	42365	3940	43777	3159	45035	1950	55475	955	47609
6L-2S		MI	25480	6794	43462	4842	48798	3879	52331	3119	57306	1869	70209	1597	49338
14-#11	1.52	MA	24348	5866	38765	4341	42498	3524	44055	2913	45526	2023	54473	1889	26289
2L-7S		MI	19334	5866	30751	4328	32799	3523	32949	2908	31876	2019	37459	1487	22454
14-#11	1.52	MA	23557	5866	37569	4340	40973	3536	42201	2923	43014	2030	51113	1800	26302
3L-6S		MI	19749	5866	31508	4317	33721	3513	34078	2899	33375	2012	39440	1574	22828
14-#11	1.52	MA	22999	5866	36608	4353	39751	3533	40718	2919	41089	2038	48915	1711	26270
4L-5S		MI	20174	5866	32214	4318	34680	3516	35249	2904	34906	2005	41341	1633	23371
14-#11	1.52	MA	22499	5866	35765	4352	38664	3544	39387	2929	39190	2031	46612	1668	26177
5L-4S		MI	20619	5866	32963	4320	35645	3506	36430	2896	36574	2012	43356	1675	23431
14-#11	1.52	MA	22021	5866	34970	4351	37584	3542	38069	2925	37445	2038	44428	1609	25540
6L-3S		MI	21115	5866	33816	4308	36729	3509	37746	2900	38263	2005	45267	1764	23440
14-#11	1.52	MA	21555	5866	34118	4363	36546	3553	36798	2935	35738	2045	42153	1522	25082
7L-2S		MI	21813	5866	34873	4310	38078	3499	39385	2892	40466	1998	48195	1853	23418
14-#14	2.19	MA	25975	6209	42430	4541	47092	3668	49609	3000	52966	1990	64286	1817	37360
2L-7S		MI	19738	6209	32208	4531	34568	3672	35063	2996	34698	1987	41453	1243	30310
14-#14	2.19	MA	24861	6209	40720	4539	44910	3683	46958	3013	49384	2000	59512	1689	37307
3L-6S		MI	20323	6209	33291	4515	35889	3658	36681	2984	36829	1977	44260	1369	31395
14-#14	2.19	MA	24074	6209	39343	4557	43160	3679	44833	3007	46636	2010	56392	1561	37146
4L-5S		MI	20922	6209	34304	4518	37264	3663	38357	2992	39006	1967	46953	1454	32132
14-#14	2.19	MA	23369	6209	38135	4554	41602	3695	42926	3020	43926	2000	53114	1500	36092
5L-4S		MI	21550	6209	35376	4521	38646	3649	40050	2981	41376	1977	49818	1514	33062
14-#14	2.19	MA	22696	6209	36994	4552	40053	3690	41037	3014	41435	2010	50012	1415	35196
6L-3S		MI	22248	6209	36596	4505	40197	3655	41932	2989	43778	1967	52523	1642	33180
14-#14	2.19	MA	22039	6209	35774	4570	38566	3706	39214	3028	38998	2020	46782	1288	33945
7L-2S		MI	23231	6209	38108	4508	42124	3641	44275	2977	46909	1957	56674	1770	33211
14-#18	3.89	MA	27992	7078	48522	5049	54702	4063	58802	3245	65011	1910	80089	1388	64358
3L-6S		MI	21698	7078	37670	5022	41251	4028	43239	3235	45310	1878	56020	828	49882
14-#18	3.89	MA	26659	7078	46108	5079	51633	4053	55077	3231	60251	1928	74724	1160	61775
4L-5S		MI	22714	7078	39447	5030	43661	4041	46072	3217	49068	1860	60637	980	52871
14-#18	3.89	MA	25464	7078	43987	5073	48899	4079	51730	3253	55554	1910	69047	1054	59599
5L-4S		MI	23777	7078	41326	5038	46083	4018	49036	3199	53161	1878	65579	1081	54652
14-#18	3.89	MA	24323	7078	41983	5067	46179	4069	48413	3239	51240	1928	63706	903	56221
6L-3S		MI	24961	7078	43462	5011	48798	4031	52331	3217	57306	1860	70209	1309	57019
16-#11	1.73	MA	24900	5977	39961	4411	44023	3575	45908	2945	48037	2016	57833	1872	29940
2L-8S		MI	19425	5977	31115	4396	33217	3570	33482	2948	32508	2004	38505	1419	24975
16-#11	1.73	MA	24114	5977	38765	4409	42498	3586	44055	2954	45526	2024	54473	1784	29935
3L-7S		MI	19832	5977	31809	4398	34147	3573	34588	2939	34079	2011	40387	1467	25583
16-#11	1.73	MA	23559	5977	37804	4422	41276	3583	42572	2951	43600	2031	52275	1695	29888
4L-6S		MI	20244	5977	32565	4386	35069	3563	35718	2930	35578	2004	42368	1555	25941
16-#11	1.73	MA	23061	5977	36961	4421	40189	3595	41241	2960	41701	2024	49972	1652	29777
5E		MI	20667	5977	33272	4388	36029	3566	36888	2935	37109	1997	44269	1614	26543
16-#11	1.73	MA	22587	5977	36166	4420	39108	3592	39923	2957	39957	2031	47788	1593	29065
6L-4S		MI	21110	5977	34021	4390	36994	3556	38070	2927	38776	2004	46284	1656	26636
16-#11	1.73	MA	22124	5977	35314	4433	38071	3603	38652	2966	38249	2038	45513	1505	28624
7L-3S		MI	21603	5977	34873	4378	38078	3559	39385	2932	40466	1997	48195	1745	26664
16-#11	1.73	MA	21667	5977	34534	4431	37024	3601	37407	2976	36461	2032	43362	1455	27914
8L-2S		MI	22297	5977	35931	4379	39426	3549	41024	2923	42669	1990	51123	1833	26652
16-#14	2.50	MA	26747	6369	44141	4641	49273	3740	52261	3044	56548	1979	69059	1792	42557
2L-8S		MI	19866	6369	32724	4628	35162	3739	35821	3053	35597	1964	42929	1143	33658
16-#14	2.50	MA	25641	6369	42430	4639	47092	3756	49609	3058	52966	1989	64286	1664	42479
3L-7S		MI	20438	6369	33719	4631	36495	3744	37406	3041	37830	1974	45604	1213	34677
16-#14	2.50	MA	24860	6369	41054	4656	45341	3751	47485	3052	50218	1999	61166	1536	42289
4L-6S		MI	21019	6369	34803	4615	37816	3730	39024	3029	39960	1964	48411	1340	35846
16-#14	2.50	MA	24160	6369	39846	4654	43783	3767	45577	3065	47508	1989	57888	1474	41100
5E		MI	21614	6369	35815	4618	39191	3736	40700	3037	42137	1954	51104	1425	36547

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

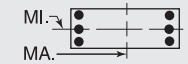
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#14	2.50	MA	23492	6369	38705	4652	42235	3763	43688	3059	45017	1999	54786	1390	40243
6L-4S		MI	22237	6369	36888	4621	40573	3722	42392	3025	44507	1964	53969	1484	37607
16-#14	2.50	MA	22840	6369	37485	4670	40747	3778	41866	3072	42580	2009	51556	1263	38909
7L-3S		MI	22931	6369	38108	4605	42124	3727	44275	3033	46909	1954	56674	1612	37753
16-#14	2.50	MA	22198	6369	36365	4668	39246	3774	40081	3086	40027	1999	48494	1191	37739
8L-2S		MI	23907	6369	39619	4608	44051	3713	46617	3022	50040	1944	60825	1740	37807
16-#18	4.44	MA	27985	7362	49099	5256	55447	4182	59714	3311	66456	1906	82955	1108	70445
4L-6S		MI	22879	7362	40307	5199	44613	4156	47326	3315	50715	1852	63146	767	57457
16-#18	4.44	MA	26803	7362	46979	5250	52713	4207	56366	3332	61759	1888	77278	1002	68383
5E		MI	23883	7362	42084	5207	47023	4169	50159	3297	54472	1834	67764	919	60549
16-#18	4.44	MA	25676	7362	44975	5245	49993	4197	53050	3318	57445	1906	71937	851	64858
6L-4S		MI	24936	7362	43963	5215	49445	4146	53123	3279	58566	1852	72706	1020	62272
18-#11	1.95	MA	25450	6088	41157	4480	45547	3625	47762	2976	50548	2009	61193	1856	33587
2L-9S		MI	19521	6088	31438	4477	33656	3630	33977	2974	33228	2003	39591	1343	27501
18-#11	1.95	MA	24667	6088	39961	4479	44023	3636	45908	2986	48037	2017	57833	1767	33564
3L-8S		MI	19922	6088	32172	4465	34565	3620	35121	2979	34711	1996	41433	1399	28054
18-#11	1.95	MA	24115	6088	39000	4491	42800	3633	44425	2982	46111	2024	55635	1678	33502
4L-7S		MI	20326	6088	32867	4467	35496	3623	36227	2970	36282	2003	43315	1448	28716
18-#11	1.95	MA	23620	6088	38157	4490	41714	3645	43094	2992	44213	2017	53332	1635	33291
5L-6S		MI	20736	6088	33623	4455	36418	3613	37357	2962	37781	1996	45296	1536	29060
18-#11	1.95	MA	23149	6088	37362	4489	40633	3642	41777	2988	42468	2024	51148	1577	32596
6L-5S		MI	21157	6088	34330	4457	37377	3616	38527	2967	39312	1989	47197	1595	29633
18-#11	1.95	MA	22689	6088	36510	4502	39596	3654	40505	2998	40760	2031	48873	1489	32170
7L-4S		MI	21597	6088	35078	4459	38342	3606	39709	2958	40979	1996	49213	1637	29835
18-#11	1.95	MA	22235	6088	35730	4501	38549	3651	39260	3008	38972	2025	46722	1439	31407
8L-3S		MI	22087	6088	35931	4447	39426	3609	41024	2963	42669	1989	51123	1726	29877
18-#11	1.95	MA	21775	6088	34903	4513	37526	3662	37972	3004	37282	2032	44606	1382	30743
9L-2S		MI	22779	6088	36989	4449	40775	3599	42664	2954	44872	1982	54051	1814	29881
18-#14	2.81	MA	26415	6528	44141	4738	49273	3828	52261	3103	56548	1979	69059	1638	47646
3L-8S		MI	20565	6528	34235	4728	37089	3811	38163	3098	38728	1951	47080	1113	37978
18-#14	2.81	MA	25640	6528	42765	4756	47522	3824	50136	3097	53800	1989	65939	1510	47428
4L-7S		MI	21134	6528	35230	4731	38422	3817	39748	3086	40961	1961	49755	1183	39055
18-#14	2.81	MA	24945	6528	41557	4754	45965	3839	48229	3110	51090	1979	62661	1449	46119
5L-6S		MI	21710	6528	36314	4714	39743	3802	41366	3074	43091	1951	52562	1310	40304
18-#14	2.81	MA	24282	6528	40416	4752	44416	3835	46340	3104	48599	1989	59559	1364	45298
6L-5S		MI	22301	6528	37327	4718	41118	3808	43042	3082	45268	1941	55256	1395	40974
18-#14	2.81	MA	23636	6528	39196	4769	42929	3851	44518	3117	46162	1999	56330	1238	43885
7L-4S		MI	22919	6528	38399	4721	42500	3794	44735	3070	47639	1951	58120	1454	42148
18-#14	2.81	MA	22998	6528	38076	4767	41427	3846	42733	3131	43609	1989	53267	1166	42658
8L-3S		MI	23608	6528	39619	4704	44051	3800	46617	3078	50040	1941	60825	1582	42319
18-#14	2.81	MA	22366	6528	36891	4785	39960	3862	40886	3125	41196	1999	50262	1084	41009
9L-2S		MI	24579	6528	41131	4708	45978	3785	48960	3066	53172	1931	64976	1710	42395
18-#18	5.00	MA	28130	7645	49970	5428	56527	4336	61003	3412	67964	1866	85509	950	77090
5L-6S		MI	24048	7645	42944	5377	47975	4285	51413	3395	56120	1825	70273	706	65055
18-#18	5.00	MA	27015	7645	47967	5422	53807	4326	57687	3398	63650	1883	80168	799	73517
6L-5S		MI	25042	7645	44721	5385	50385	4298	54246	3377	59877	1807	74891	858	68018
20-#11	2.17	MA	25217	6198	41157	4548	45547	3686	47762	3017	50548	2010	61193	1751	37189
3L-9S		MI	20017	6198	32495	4546	35004	3680	35616	3005	35431	1995	42519	1324	30600
20-#11	2.17	MA	24668	6198	40196	4560	44325	3684	46279	3013	48622	2017	58995	1662	37113
4L-8S		MI	20415	6198	33230	4534	35914	3670	36760	3010	36914	1988	44361	1380	31140
20-#11	2.17	MA	24176	6198	39353	4559	43238	3695	44948	3023	46724	2010	56692	1619	36798
5L-7S		MI	20817	6198	33924	4536	36844	3673	37867	3002	38485	1995	46243	1429	31851
20-#11	2.17	MA	23707	6198	38558	4558	42158	3692	43630	3019	44979	2017	54508	1560	36132
6E		MI	21225	6198	34681	4524	37766	3663	38996	2993	39984	1988	48224	1517	32185

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

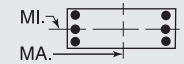


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
20-#11	2.17	MA	23250	6198	37706	4571	41121	3704	42359	3029	43272	2025	52233	1473	35719
7L-5S		MI	21643	6198	35388	4526	38726	3667	40167	2998	41515	1981	50125	1576	32731
20-#11	2.17	MA	22798	6198	36926	4570	40074	3701	41114	3039	41483	2018	50082	1422	34906
8L-4S		MI	22081	6198	36136	4528	39691	3656	41348	2989	43182	1988	52141	1618	33031
20-#11	2.17	MA	22351	6198	36099	4582	39051	3712	39826	3035	39793	2025	47966	1366	34261
9L-3S		MI	22569	6198	36989	4516	40775	3660	42664	2994	44872	1981	54051	1706	33086
20-#11	2.17	MA	21849	6198	35322	4581	38017	3710	38589	3045	38116	2032	45914	1302	33283
10L-2S		MI	23257	6198	38046	4518	42123	3649	44303	2985	47075	1974	56979	1795	33106
20-#14	3.13	MA	26414	6688	44476	4856	49704	3896	52788	3141	57382	1978	70713	1485	52564
4L-8S		MI	21260	6688	35747	4827	39016	3883	40506	3143	41859	1939	51231	1084	42308
20-#14	3.13	MA	25724	6688	43268	4854	48146	3912	50881	3155	54672	1968	67435	1423	51149
5L-7S		MI	21824	6688	36742	4831	40349	3889	42091	3131	44092	1949	53906	1153	43444
20-#14	3.13	MA	25066	6688	42127	4851	46597	3907	48992	3149	52182	1978	64333	1339	50358
6E		MI	22396	6688	37826	4814	41670	3875	43709	3119	46223	1939	56713	1280	44767
20-#14	3.13	MA	24425	6688	40907	4869	45110	3923	47169	3162	49744	1988	61103	1212	48871
7L-5S		MI	22983	6688	38838	4817	43045	3880	45385	3127	48399	1929	59407	1365	45409
20-#14	3.13	MA	23792	6688	39787	4867	43609	3919	45384	3176	47191	1978	58041	1140	47586
8L-4S		MI	23597	6688	39910	4821	44427	3866	47077	3115	50770	1939	62271	1424	46685
20-#14	3.13	MA	23164	6688	38602	4885	42142	3934	43538	3169	44779	1988	55036	1059	45980
9L-3S		MI	24282	6688	41131	4804	45978	3872	48960	3123	53172	1929	64976	1552	46881
20-#18	5.56	MA	28341	7929	50958	5599	57621	4455	62323	3478	69855	1861	88399	747	82196
6E		MI	25207	7929	45581	5554	51337	4414	55500	3475	61525	1798	77400	645	72672
22-#11	2.38	MA	25218	6309	41392	4630	45850	3734	48133	3044	51134	2010	62355	1646	40720
4L-9S		MI	20509	6309	33553	4615	36353	3731	37255	3036	37634	1987	45447	1304	33650
22-#11	2.38	MA	24729	6309	40549	4628	44763	3745	46802	3054	49235	2003	60052	1603	40312
5L-8S		MI	20906	6309	34288	4603	37262	3720	38400	3041	39117	1980	47289	1361	34231
22-#11	2.38	MA	24262	6309	39754	4627	43683	3743	45484	3050	47490	2010	57868	1544	39673
6L-7S		MI	21306	6309	34982	4605	38193	3724	39506	3033	40688	1987	49171	1410	34966
22-#11	2.38	MA	23807	6309	38903	4640	42646	3754	44213	3060	45783	2018	55593	1456	39271
7L-6S		MI	21712	6309	35738	4593	39115	3713	40636	3024	42186	1980	51152	1498	35313
22-#11	2.38	MA	23359	6309	38122	4639	41599	3751	42968	3070	43995	2011	53442	1406	38411
8L-5S		MI	22127	6309	36445	4595	40074	3717	41806	3029	43718	1973	53053	1557	35836
22-#11	2.38	MA	22913	6309	37295	4652	40575	3763	41680	3066	42305	2018	51326	1350	37748
9L-4S		MI	22563	6309	37194	4597	41039	3706	42988	3020	45385	1980	55069	1598	36224
22-#11	2.38	MA	22415	6309	36518	4650	39542	3760	40443	3076	40627	2025	49274	1286	36772
10L-3S		MI	23048	6309	38046	4585	42123	3710	44303	3025	47075	1973	56979	1687	36291
22-#14	3.44	MA	26498	6847	44978	4953	50327	3984	53532	3200	58254	1958	72209	1398	56187
5L-8S		MI	21949	6847	37258	4927	40943	3956	42848	3188	44991	1926	55383	1054	46648
22-#14	3.44	MA	25845	6847	43838	4951	48779	3980	51644	3194	55764	1968	69107	1313	55424
6L-7S		MI	22509	6847	38253	4930	42276	3961	44433	3176	47224	1936	58058	1123	47842
22-#14	3.44	MA	25208	6847	42618	4969	47291	3995	49821	3207	53326	1977	65877	1187	53865
7L-6S		MI	23078	6847	39337	4914	43597	3947	46051	3164	49354	1926	60865	1250	49160
22-#14	3.44	MA	24580	6847	41498	4967	45790	3991	48036	3221	50773	1968	62815	1115	52525
8L-5S		MI	23660	6847	40350	4917	44971	3953	47728	3172	51531	1916	63558	1335	49853
22-#14	3.44	MA	23957	6847	40313	4985	44323	4007	46189	3214	48361	1977	59810	1033	50959
9L-4S		MI	24270	6847	41422	4920	46354	3939	49420	3160	53901	1926	66423	1394	51086
24-#11	2.60	MA	25278	6420	41745	4698	46288	3795	48655	3085	51746	1996	63412	1586	43833
5L-9S		MI	20999	6420	34611	4684	37701	3781	38895	3068	39837	1979	48375	1285	36706
24-#11	2.60	MA	24814	6420	40950	4696	45208	3793	47338	3081	50002	2004	61228	1528	43217
6L-8S		MI	21394	6420	35345	4672	38611	3770	40039	3073	41320	1972	50217	1342	37327
24-#11	2.60	MA	24362	6420	40099	4709	44170	3804	46066	3091	48294	2011	58953	1440	42776
7E		MI	21792	6420	36040	4674	39541	3774	41145	3064	42891	1979	52099	1391	38038
24-#11	2.60	MA	23916	6420	39318	4708	43123	3801	44821	3101	46506	2004	56802	1390	41920
8L-6S		MI	22195	6420	36796	4662	40463	3763	42275	3055	44389	1972	54080	1479	38444
24-#11	2.60	MA	23471	6420	38491	4721	42100	3813	43533	3097	44816	2011	54686	1333	41219
9L-5S		MI	22609	6420	37503	4664	41423	3767	43445	3060	45921	1965	55981	1537	38946
24-#11	2.60	MA	22977	6420	37714	4720	41067	3810	42296	3107	43139	2018	52634	1270	40265
10L-4S		MI	23042	6420	38252	4666	42388	3756	44627	3051	47588	1972	57997	1579	39414

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis



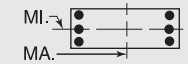
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#14	3.75	MA	26618	7007	45549	5051	50960	4052	54295	3238	59346	1957	73880	1288	60404
6L-8S		MI	22634	7007	38770	5027	42870	4028	45191	3233	48122	1913	59534	1024	50997
24-#14	3.75	MA	25986	7007	44329	5069	49473	4068	52473	3252	56908	1967	70650	1161	58868
7E		MI	23190	7007	39765	5030	44203	4034	46776	3221	50355	1923	62209	1094	52247
24-#14	3.75	MA	25362	7007	43209	5067	47971	4063	50688	3266	54355	1957	67588	1089	57472
8L-6S		MI	23755	7007	40848	5014	45524	4019	48394	3209	52485	1913	65016	1220	53521
24-#14	3.75	MA	24740	7007	42024	5084	46504	4079	48841	3259	51943	1967	64583	1008	55946
9L-5S		MI	24333	7007	41861	5017	46898	4025	50070	3217	54662	1903	67709	1305	54303
RECTANGULAR TIED COLUMNS 36" x 42"															
4-#18	1.06	MA	25461	5914	39976	4375	43163	3565	44019	2969	43904	2118	51516	1991	20288
2E		MI	21703	5914	34296	4321	36781	3520	37373	2931	36931	2077	43074	1938	17174
6-#18	1.59	MA	26926	6198	43145	4552	47203	3693	48931	3049	50510	2098	60300	1942	30006
2L-3S		MI	21170	6198	34296	4490	36781	3672	37373	3029	36931	2068	43074	1650	25340
6-#18	1.59	MA	24838	6198	39976	4548	43163	3720	44019	3072	43904	2116	51516	1714	29980
3L-2S		MI	22902	6198	36933	4498	40143	3649	41460	3011	42336	2050	50201	1877	25297
8-#14	1.19	MA	25917	5985	40753	4449	44320	3621	45488	3009	46016	2135	54463	2008	22906
2L-4S		MI	20370	5985	32218	4413	34296	3589	34416	2979	33232	2117	38745	1702	19445
8-#14	1.19	MA	24711	5985	38943	4447	42011	3637	42682	3024	42214	2145	49378	1880	22947
3E		MI	21086	5985	33438	4396	35848	3595	36298	2987	35634	2107	41450	1830	19433
8-#14	1.19	MA	23858	5985	37488	4465	40161	3633	40437	3018	39298	2156	46050	1752	22901
4L-2S		MI	22089	5985	34950	4399	37775	3580	38641	2975	38765	2097	45601	1958	19376
8-#18	2.12	MA	28369	6481	46314	4730	51243	3822	53842	3129	57115	2078	69084	1894	39679
2L-4S		MI	21144	6481	34797	4695	37428	3788	38166	3092	38190	2059	45571	1362	32355
8-#18	2.12	MA	26305	6481	43145	4725	47203	3849	48931	3152	50510	2095	60300	1666	39544
3E		MI	22370	6481	36933	4668	40143	3800	41460	3109	42336	2042	50201	1589	33318
8-#18	2.12	MA	24841	6481	40591	4756	43956	3840	44991	3139	45442	2113	54566	1438	38371
4L-2S		MI	24084	6481	39570	4676	43505	3777	45547	3091	47740	2024	57328	1816	33369
10-#11	1.03	MA	25502	5900	39771	4410	43151	3594	44100	2996	44148	2148	52091	2035	20020
2L-5S		MI	20096	5900	31472	4371	33415	3573	33366	2976	31753	2124	36870	1771	17037
10-#11	1.03	MA	24655	5900	38506	4409	41538	3592	42139	3006	41492	2156	48514	1946	20055
3L-4S		MI	20547	5900	32221	4373	34380	3563	34547	2967	33420	2131	38885	1813	17038
10-#11	1.03	MA	24058	5900	37490	4422	40247	3604	40572	3003	39457	2164	46171	1857	20069
4L-3S		MI	21049	5900	33074	4361	35464	3566	35863	2972	35110	2124	40796	1902	17003
10-#11	1.03	MA	23522	5900	36600	4421	39099	3602	39167	3013	37452	2158	43725	1813	20021
5L-2S		MI	21754	5900	34131	4363	36813	3556	37502	2963	37313	2117	43724	1990	16960
10-#14	1.49	MA	26760	6144	42564	4548	46628	3693	48295	3054	49818	2125	59549	1985	28447
2L-5S		MI	20437	6144	32658	4509	34841	3676	35066	3036	33993	2095	40032	1613	23545
10-#14	1.49	MA	25563	6144	40753	4547	44320	3709	45488	3069	46016	2135	54463	1857	28456
3L-4S		MI	21076	6144	33730	4512	36223	3661	36758	3024	36363	2105	42896	1672	24021
10-#14	1.49	MA	24717	6144	39298	4565	42469	3706	43243	3063	43100	2146	51136	1729	28366
4L-3S		MI	21786	6144	34950	4496	37775	3667	38641	3032	38765	2095	45601	1800	24053
10-#14	1.49	MA	23958	6144	38022	4563	40824	3722	41228	3077	40226	2136	47651	1666	27738
5L-2S		MI	22783	6144	36461	4499	39702	3653	40983	3020	41896	2085	49752	1928	24016
10-#18	2.65	MA	29793	6765	49483	4907	55283	3950	58754	3209	63721	2057	77868	1845	49307
2L-5S		MI	21252	6765	35555	4864	38368	3939	39288	3190	39502	2015	47755	1199	37769
10-#18	2.65	MA	27751	6765	46314	4902	51243	3977	53842	3231	57115	2075	69084	1617	49087
3L-4S		MI	22343	6765	37434	4872	40790	3916	42253	3172	43595	2033	52698	1301	39849
10-#18	2.65	MA	26306	6765	43760	4933	47996	3969	49902	3219	52048	2093	63350	1390	47440
4L-3S		MI	23556	6765	39570	4845	43505	3929	45547	3189	47740	2015	57328	1528	41269
10-#18	2.65	MA	25009	6765	41518	4928	45106	3995	46363	3242	47049	2075	57306	1282	44720
5L-2S		MI	25253	6765	42207	4853	46867	3906	49634	3171	53145	1997	64455	1756	41405

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

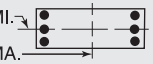


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.24	MA	26098	6010	41036	4479	44764	3644	46061	3027	46805	2141	55667	2020	23896
2L-6S		MI	20167	6010	31823	4439	33804	3620	33835	3002	32424	2123	37897	1693	19860
12-#11	1.24	MA	25256	6010	39771	4478	43151	3642	44100	3037	44148	2149	52091	1931	23920
3L-5S		MI	20595	6010	32530	4441	34764	3623	35005	3007	33956	2116	39798	1752	20240
12-#11	1.24	MA	24661	6010	38755	4491	41860	3654	42533	3034	42114	2157	49747	1842	23910
4E		MI	21044	6010	33279	4443	35729	3613	36187	2998	35623	2123	41813	1794	20267
12-#11	1.24	MA	24129	6010	37866	4491	40712	3652	41127	3044	40108	2151	47302	1798	23838
5L-3S		MI	21543	6010	34131	4431	36813	3616	37502	3003	37313	2116	43724	1882	20247
12-#11	1.24	MA	23622	6010	37026	4490	39572	3664	39736	3041	38266	2158	44975	1740	23331
6L-2S		MI	22245	6010	35189	4433	38161	3606	39141	2994	39516	2109	46652	1971	20212
12-#14	1.79	MA	27597	6304	44375	4648	48937	3765	51101	3099	53620	2115	64634	1961	33974
2L-6S		MI	20536	6304	33156	4606	35394	3742	35733	3073	34947	2092	41489	1498	27133
12-#14	1.79	MA	26407	6304	42564	4646	46628	3782	48295	3113	49818	2125	59549	1833	33950
3L-5S		MI	21142	6304	34169	4609	36768	3748	37409	3081	37124	2082	44183	1583	27926
12-#14	1.79	MA	25568	6304	41109	4665	44778	3778	46049	3108	46902	2136	56221	1705	33822
4E		MI	21776	6304	35241	4612	38150	3734	39101	3069	39494	2092	47047	1642	28584
12-#14	1.79	MA	24815	6304	39833	4663	43132	3794	44034	3122	44028	2126	52736	1643	33007
5L-3S		MI	22481	6304	36461	4596	39702	3739	40983	3077	41896	2082	49752	1770	28653
12-#14	1.79	MA	24098	6304	38629	4661	41497	3791	42039	3116	41386	2136	49430	1558	31964
6L-2S		MI	23471	6304	37973	4599	41629	3725	43326	3065	45027	2072	53904	1898	28642
12-#18	3.17	MA	31201	7049	52652	5084	59324	4079	63665	3288	70327	2037	86651	1797	58913
2L-6S		MI	21419	7049	36415	5034	39320	4055	40542	3288	41150	2006	50265	987	42792
12-#18	3.17	MA	29180	7049	49483	5080	55283	4106	58754	3311	63721	2055	77868	1569	58617
3L-5S		MI	22449	7049	38192	5042	41730	4067	43375	3270	44907	1988	54882	1138	45448
12-#18	3.17	MA	27751	7049	46929	5110	52037	4097	54814	3299	58654	2072	72134	1341	56557
4E		MI	23528	7049	40071	5050	44152	4045	46340	3251	49000	2006	59824	1240	47391
12-#18	3.17	MA	26470	7049	44687	5106	49146	4124	51274	3321	53655	2055	66090	1234	53990
5L-3S		MI	24728	7049	42207	5022	46867	4057	49634	3269	53145	1988	64455	1467	49202
12-#18	3.17	MA	25248	7049	42570	5101	46272	4115	47769	3309	49062	2072	60386	1083	50778
6L-2S		MI	26409	7049	44844	5030	50229	4035	53721	3251	58550	1971	71582	1695	49407
14-#11	1.44	MA	26690	6121	42301	4548	46377	3695	48022	3058	49461	2134	59243	2004	27763
2L-7S		MI	20250	6121	32125	4520	34231	3680	34344	3042	33128	2122	38844	1586	22588
14-#11	1.44	MA	25852	6121	41036	4547	44764	3692	46061	3068	46805	2142	55667	1916	27776
3L-6S		MI	20666	6121	32881	4508	35152	3670	35474	3033	34627	2115	40825	1674	22965
14-#11	1.44	MA	25261	6121	40021	4560	43473	3704	44494	3065	44770	2150	53324	1827	27744
4L-5S		MI	21092	6121	33588	4510	36112	3673	36644	3038	36159	2108	42726	1733	23436
14-#11	1.44	MA	24732	6121	39131	4560	42325	3702	43088	3075	42765	2144	50878	1783	27652
5L-4S		MI	21538	6121	34336	4512	37077	3663	37826	3029	37826	2115	44741	1774	23482
14-#11	1.44	MA	24227	6121	38291	4559	41185	3714	41697	3072	40923	2152	48551	1725	27052
6L-3S		MI	22035	6121	35189	4500	38161	3667	39141	3034	39516	2108	46652	1863	23481
14-#11	1.44	MA	23735	6121	37393	4572	40089	3712	40355	3082	39120	2159	46130	1637	26547
7L-2S		MI	22733	6121	36247	4502	39510	3656	40781	3025	41719	2101	49580	1952	23455
14-#14	2.08	MA	28426	6464	46185	4748	51245	3838	53907	3144	57422	2105	69719	1937	39487
2L-7S		MI	20653	6464	33584	4722	36000	3829	36457	3129	35948	2089	42834	1341	30607
14-#14	2.08	MA	27245	6464	44375	4746	48937	3854	51101	3158	53620	2115	64634	1809	39433
3L-6S		MI	21239	6464	34668	4705	37321	3815	38075	3117	38078	2079	45640	1468	31575
14-#14	2.08	MA	26411	6464	42920	4764	47086	3850	48855	3153	50704	2126	61306	1681	39272
4L-5S		MI	21840	6464	35680	4709	38695	3820	39751	3126	40255	2069	48334	1553	32325
14-#14	2.08	MA	25665	6464	41644	4763	45441	3867	46840	3167	47830	2116	57821	1619	38295
5L-4S		MI	22469	6464	36753	4712	40077	3806	41443	3114	42625	2079	51198	1613	33140
14-#14	2.08	MA	24953	6464	40440	4761	43805	3863	44845	3161	45188	2126	54515	1535	37300
6L-3S		MI	23170	6464	37973	4695	41629	3812	43326	3122	45027	2069	53904	1741	33239
14-#14	2.08	MA	24258	6464	39151	4779	42234	3879	42920	3176	42603	2137	51073	1408	36104
7L-2S		MI	24154	6464	39484	4699	43556	3797	45668	3110	48159	2059	58055	1869	33257
14-#18	3.70	MA	30593	7332	52652	5257	59324	4234	63665	3391	70327	2034	86651	1520	68138
3L-6S		MI	22614	7332	39052	5211	42682	4183	44629	3367	46554	1980	57392	926	50333
14-#18	3.70	MA	29180	7332	50098	5288	56077	4226	59725	3378	65259	2052	80918	1293	65714
4L-5S		MI	23633	7332	40829	5219	45092	4196	47462	3349	50311	1962	62009	1078	53150
14-#18	3.70	MA	27914	7332	47856	5283	53186	4252	56186	3401	60260	2034	74874	1185	63283
5L-4S		MI	24701	7332	42708	5227	47514	4173	50427	3331	54405	1980	66951	1179	54973

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

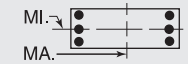
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.70	MA	26706	7332	45739	5278	50312	4244	52681	3389	55668	2052	69169	1035	59915
6L-3S		MI	25889	7332	44844	5200	50229	4186	53721	3349	58550	1962	71582	1407	57123
14-#18	3.70	MA	25528	7332	43474	5309	47551	4271	49298	3412	51173	2069	63228	809	56649
7L-2S		MI	27554	7332	47481	5208	53591	4163	57808	3330	63955	1944	78709	1634	57392
16-#11	1.65	MA	27279	6232	43566	4617	47990	3745	49983	3089	52118	2127	62819	1989	31625
2L-8S		MI	20341	6232	32488	4587	34649	3727	34877	3082	33761	2107	39890	1518	25192
16-#11	1.65	MA	26444	6232	42301	4617	46377	3743	48022	3099	49461	2135	59243	1901	31620
3L-7S		MI	20748	6232	33182	4589	35579	3731	35984	3073	35331	2114	41772	1567	25717
16-#11	1.65	MA	25857	6232	41286	4630	45086	3754	46455	3096	47427	2143	56900	1812	31573
4L-6S		MI	21162	6232	33939	4577	36501	3720	37113	3064	36830	2107	43753	1655	26078
16-#11	1.65	MA	25331	6232	40396	4629	43938	3752	45049	3106	45421	2137	54454	1768	31462
5E		MI	21585	6232	34646	4579	37461	3724	38284	3069	38362	2100	45654	1713	26627
16-#11	1.65	MA	24829	6232	39556	4628	42798	3764	43658	3103	43579	2145	52128	1710	30782
6L-4S		MI	22029	6232	35394	4581	38426	3713	39465	3060	40029	2107	47669	1755	26690
16-#11	1.65	MA	24340	6232	38658	4641	41702	3762	42316	3113	41776	2152	49706	1622	30296
7L-3S		MI	22523	6232	36247	4569	39510	3717	40781	3065	41719	2100	49580	1844	26708
16-#11	1.65	MA	23857	6232	37834	4640	40597	3773	41001	3124	39888	2146	47421	1571	29631
8L-2S		MI	23219	6232	37304	4571	40858	3706	42420	3056	43922	2093	52508	1933	26692
16-#14	2.38	MA	29250	6623	47996	4848	53553	3910	56713	3189	61223	2095	74804	1914	44987
2L-8S		MI	20780	6623	34100	4818	36594	3895	37215	3186	36846	2066	44310	1242	33991
16-#14	2.38	MA	28075	6623	46185	4846	51245	3926	53907	3203	57422	2105	69719	1786	44909
3L-7S		MI	21355	6623	35095	4822	37927	3901	38799	3174	39079	2076	46985	1312	34970
16-#14	2.38	MA	27248	6623	44730	4864	49395	3923	51662	3198	54506	2116	66391	1658	44719
4L-6S		MI	21937	6623	36179	4805	39248	3887	40418	3162	41210	2066	49792	1439	36026
16-#14	2.38	MA	26507	6623	43454	4862	47749	3939	49647	3212	51631	2106	62907	1595	43597
5E		MI	22533	6623	37192	4808	40622	3893	42094	3170	43386	2056	52485	1524	36738
16-#14	2.38	MA	25801	6623	42250	4861	46113	3935	47652	3206	48990	2116	59600	1511	42645
6L-4S		MI	23158	6623	38264	4812	42004	3878	43786	3159	45757	2066	55350	1583	37689
16-#14	2.38	MA	25112	6623	40961	4879	44543	3952	45727	3221	46405	2127	56158	1385	41364
7L-3S		MI	23854	6623	39484	4795	43556	3884	45668	3167	48159	2056	58055	1711	37816
16-#14	2.38	MA	24432	6623	39779	4877	42958	3948	43842	3235	43697	2117	52903	1312	40096
8L-2S		MI	24832	6623	40996	4798	45483	3870	48011	3155	51290	2047	62206	1839	37860
16-#18	4.23	MA	30594	7616	53267	5465	60117	4354	64636	3458	71865	2031	89701	1244	74904
4L-6S		MI	23796	7616	41689	5388	46044	4312	48716	3447	51959	1953	64519	865	57901
16-#18	4.23	MA	29342	7616	51025	5460	57227	4381	61097	3481	66866	2014	83658	1137	72595
5E		MI	24805	7616	43466	5396	48454	4325	51549	3429	55716	1935	69136	1017	60870
16-#18	4.23	MA	28148	7616	48908	5456	54352	4372	57592	3469	62274	2031	77953	986	69076
6L-4S		MI	25862	7616	45345	5404	50876	4302	54514	3411	59810	1953	74078	1119	62587
16-#18	4.23	MA	26983	7616	46643	5486	51591	4399	54209	3491	57779	2049	72012	761	65713
7L-3S		MI	27038	7616	47481	5377	53591	4314	57808	3428	63955	1935	78709	1346	65035
18-#11	1.86	MA	27864	6342	44832	4687	49603	3795	51943	3120	54774	2121	66396	1974	35482
2L-9S		MI	20436	6342	32811	4668	35088	3788	35372	3108	34480	2106	40976	1442	27708
18-#11	1.86	MA	27033	6342	43566	4686	47990	3793	49983	3131	52118	2128	62819	1885	35460
3L-8S		MI	20838	6342	33546	4656	35997	3777	36517	3113	35964	2099	42818	1499	28270
18-#11	1.86	MA	26449	6342	42551	4699	46699	3804	48416	3127	50083	2136	60476	1797	35397
4L-7S		MI	21243	6342	34240	4658	36928	3781	37623	3104	37534	2106	44700	1548	28850
18-#11	1.86	MA	25926	6342	41661	4698	45551	3802	47010	3138	48078	2130	58031	1753	35269
5L-6S		MI	21654	6342	34996	4646	37849	3770	38753	3095	39033	2099	46681	1636	29197
18-#11	1.86	MA	25427	6342	40822	4697	44411	3814	45619	3134	46236	2138	55704	1694	34518
6L-5S		MI	22076	6342	35703	4648	38809	3774	39923	3100	40564	2092	48582	1694	29785
18-#11	1.86	MA	24941	6342	39923	4710	43315	3812	44276	3144	44433	2146	53283	1607	34049
7L-4S		MI	22517	6342	36452	4650	39774	3763	41105	3091	42232	2099	50597	1736	29893
18-#11	1.86	MA	24461	6342	39099	4709	42210	3824	42962	3155	42545	2140	50997	1556	33329
8L-3S		MI	23009	6342	37304	4638	40858	3767	42420	3096	43922	2092	52508	1825	29926

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

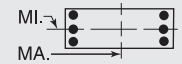


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.86	MA	23970	6342	38227	4722	41130	3821	41603	3151	40761	2147	48743	1500	32599
9L-2S		MI	23701	6342	38362	4640	42207	3757	44059	3088	46124	2085	55436	1914	29923
18-#14	2.68	MA	28900	6783	47996	4946	53553	3999	56713	3248	61223	2096	74804	1762	50380
3L-8S		MI	21481	6783	35612	4918	38521	3968	39557	3231	39978	2054	48461	1212	38385
18-#14	2.68	MA	28078	6783	46541	4964	51703	3995	54468	3243	58308	2106	71477	1634	50161
4L-7S		MI	22051	6783	36607	4921	39854	3973	41142	3219	42211	2064	51136	1282	39346
18-#14	2.68	MA	27343	6783	45265	4962	50058	4011	52453	3257	55433	2096	67992	1572	48911
5L-6S		MI	22629	6783	37691	4905	41175	3959	42760	3207	44341	2054	53943	1409	40483
18-#14	2.68	MA	26642	6783	44061	4961	48422	4008	50458	3251	52792	2106	64685	1487	47998
6L-5S		MI	23221	6783	38703	4908	42549	3965	44436	3215	46518	2044	56636	1494	41163
18-#14	2.68	MA	25958	6783	42772	4979	46851	4024	48533	3265	50207	2117	61244	1361	46635
7L-4S		MI	23842	6783	39775	4911	43931	3951	46128	3203	48888	2054	59501	1553	42234
18-#14	2.68	MA	25283	6783	41590	4977	45266	4020	46648	3280	47499	2107	57988	1288	45406
8L-3S		MI	24533	6783	40996	4895	45483	3956	48011	3211	51290	2044	62206	1681	42386
18-#14	2.68	MA	24610	6783	40339	4995	43717	4037	44698	3274	44940	2117	54785	1207	43650
9L-2S		MI	25506	6783	42507	4898	47410	3942	50353	3200	54421	2034	66357	1809	42451
18-#18	4.76	MA	30756	7900	54194	5638	61267	4510	66009	3561	73472	1993	92442	1088	81924
5L-6S		MI	24968	7900	44326	5566	49406	4440	52803	3527	57364	1926	71646	804	65492
18-#18	4.76	MA	29574	7900	52077	5633	58392	4501	62504	3548	68879	2011	86737	938	78261
6L-5S		MI	25966	7900	46103	5574	51816	4453	55636	3509	61121	1909	76263	956	68543
18-#18	4.76	MA	28422	7900	49812	5664	55632	4528	59121	3571	64385	2029	80796	712	74799
7L-4S		MI	27013	7900	47982	5582	54238	4430	58601	3491	65214	1926	81205	1058	70228
20-#11	2.06	MA	27619	6453	44832	4755	49603	3843	51943	3162	54774	2121	66396	1870	39295
3L-9S		MI	20932	6453	33869	4737	36436	3838	37012	3139	36683	2098	43904	1423	30810
20-#11	2.06	MA	27037	6453	43816	4768	48312	3855	50376	3158	52740	2129	64053	1782	39219
4L-8S		MI	21332	6453	34603	4725	37346	3827	38156	3144	38167	2091	45746	1480	31353
20-#11	2.06	MA	26517	6453	42926	4767	47164	3852	48971	3169	50734	2123	61607	1738	39006
5L-7S		MI	21735	6453	35298	4727	38276	3831	39262	3135	39737	2098	47628	1528	31986
20-#11	2.06	MA	26022	6453	42087	4766	46024	3864	47580	3165	48892	2131	59280	1679	38260
6E		MI	22144	6453	36054	4715	39198	3820	40392	3126	41236	2091	49609	1616	32321
20-#11	2.06	MA	25538	6453	41188	4779	44928	3862	46237	3176	47090	2139	56859	1592	37805
7L-5S		MI	22563	6453	36761	4717	40158	3824	41562	3131	42767	2084	51510	1675	32882
20-#11	2.06	MA	25061	6453	40364	4779	43823	3874	44923	3186	45201	2133	54574	1541	37033
8L-4S		MI	23002	6453	37510	4719	41123	3814	42744	3123	44434	2091	53526	1717	33092
20-#11	2.06	MA	24573	6453	39492	4792	42743	3872	43563	3183	43417	2140	52319	1484	36323
9L-3S		MI	23491	6453	38362	4707	42207	3817	44059	3128	46124	2084	55436	1806	33137
20-#11	2.06	MA	24048	6453	38672	4791	41652	3883	42258	3193	41647	2148	50134	1421	35370
10L-2S		MI	24181	6453	39420	4709	43555	3807	45699	3119	48327	2077	58364	1894	33150
20-#14	2.98	MA	28903	6942	48352	5064	54012	4067	57274	3287	62110	2096	76562	1610	55602
4L-8S		MI	22176	6942	37123	5018	40448	4040	41900	3276	43109	2041	52612	1183	42710
20-#14	2.98	MA	28173	6942	47076	5062	52366	4084	55259	3302	59235	2086	73077	1548	54236
5L-7S		MI	22742	6942	38118	5021	41781	4046	43485	3264	45342	2051	55287	1252	43731
20-#14	2.98	MA	27477	6942	45872	5060	50730	4080	53264	3296	56594	2097	69771	1464	53357
6E		MI	23316	6942	39202	5005	43102	4031	45103	3252	47472	2041	58094	1379	44946
20-#14	2.98	MA	26798	6942	44583	5079	49160	4096	51339	3310	54009	2107	66329	1337	51916
7L-5S		MI	23905	6942	40215	5008	44476	4037	46779	3260	49649	2031	60788	1464	45597
20-#14	2.98	MA	26129	6942	43401	5077	47575	4093	49454	3325	51301	2097	63073	1265	50694
8L-4S		MI	24521	6942	41287	5011	45858	4023	48471	3248	52019	2041	63652	1523	46775
20-#14	2.98	MA	25456	6942	42149	5095	46026	4109	47504	3319	48742	2107	59870	1183	48918
9L-3S		MI	25208	6942	42507	4995	47410	4029	50353	3256	54421	2031	66357	1651	46951
20-#18	5.29	MA	30988	8184	55246	5810	62433	4630	67415	3628	75485	1991	95521	889	87465
6E		MI	26129	8184	46963	5743	52768	4569	56890	3607	62769	1900	78773	743	73104
20-#18	5.29	MA	29848	8184	52981	5841	59672	4656	64032	3651	70990	2008	89579	664	83906
7L-5S		MI	27118	8184	48740	5751	55178	4582	59723	3589	66526	1882	83390	895	76032
22-#11	2.27	MA	27623	6564	45081	4837	49925	3905	52337	3189	55396	2122	67629	1766	43037
4L-9S		MI	21426	6564	34927	4806	37785	3888	38651	3170	38886	2089	46832	1404	33916
22-#11	2.27	MA	27105	6564	44192	4836	48777	3903	50932	3200	53391	2116	65183	1723	42725
5L-8S		MI	21823	6564	35661	4794	38694	3878	39795	3175	40369	2083	48674	1460	34443

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

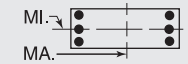
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.27	MA	26612	6564	43352	4835	47637	3914	49540	3196	51549	2124	62856	1664	42007
6L-7S		MI	22225	6564	36355	4796	39625	3881	40902	3166	41940	2089	50556	1509	35124
22-#11	2.27	MA	26131	6564	42453	4848	46541	3912	48198	3207	49746	2132	60435	1577	41565
7L-6S		MI	22631	6564	37112	4784	40547	3871	42031	3158	43439	2083	52537	1597	35449
22-#11	2.27	MA	25657	6564	41629	4848	45436	3924	46884	3217	47858	2126	58150	1526	40743
8L-5S		MI	23048	6564	37819	4786	41506	3874	43202	3163	44970	2076	54438	1656	35986
22-#11	2.27	MA	25177	6564	40757	4861	44356	3922	45524	3214	46074	2133	55896	1469	40052
9L-4S		MI	23485	6564	38567	4788	42471	3864	44383	3154	46637	2083	56454	1698	36287
22-#11	2.27	MA	24649	6564	39937	4860	43265	3933	44218	3224	44303	2141	53710	1406	39064
10L-3S		MI	23972	6564	39420	4776	43555	3867	45699	3159	48327	2076	58364	1787	36345
22-#11	2.27	MA	24138	6564	39128	4859	42192	3931	42874	3221	42441	2135	51478	1352	38161
11L-2S		MI	24659	6564	40478	4778	44904	3857	47338	3150	50530	2069	61292	1875	36369
22-#14	3.27	MA	28997	7102	48886	5162	54675	4156	58065	3347	63037	2076	78162	1525	59570
5L-8S		MI	22867	7102	38635	5118	42375	4112	44242	3321	46240	2028	56763	1153	47046
22-#14	3.27	MA	28306	7102	47682	5160	53039	4152	56070	3341	60396	2087	74856	1440	58722
6L-7S		MI	23429	7102	39630	5121	43708	4118	45827	3309	48473	2038	59438	1222	48126
22-#14	3.27	MA	27632	7102	46393	5178	51468	4169	54145	3355	57810	2097	71414	1314	57206
7L-6S		MI	23999	7102	40713	5104	45029	4104	47445	3297	50603	2028	62245	1349	49414
22-#14	3.27	MA	26967	7102	45211	5177	49883	4165	52261	3369	55103	2087	68158	1241	55928
8L-5S		MI	24584	7102	41726	5108	46403	4109	49121	3305	52780	2018	64939	1434	50040
22-#14	3.27	MA	26296	7102	43960	5195	48334	4181	50311	3364	52544	2097	64955	1160	54194
9L-4S		MI	25196	7102	42798	5111	47785	4095	50814	3293	55151	2028	67803	1493	51313
22-#18	5.82	MA	31261	8467	56150	6018	63712	4785	68944	3731	77596	1988	98363	615	93032
7L-6S		MI	27281	8467	49600	5920	56130	4698	60977	3687	68174	1873	85900	683	80734
24-#11	2.48	MA	27690	6674	45457	4905	50390	3953	52893	3231	56048	2109	68759	1708	46450
5L-9S		MI	21917	6674	35984	4876	39133	3938	40290	3201	41089	2081	49760	1385	37003
24-#11	2.48	MA	27200	6674	44617	4905	49250	3964	51501	3228	54205	2117	66433	1649	45758
6L-8S		MI	22312	6674	36719	4864	40043	3928	41435	3206	42572	2075	51602	1441	37537
24-#11	2.48	MA	26721	6674	43719	4918	48155	3962	50159	3238	52403	2125	64012	1561	45327
7E		MI	22711	6674	37413	4866	40973	3931	42541	3197	44143	2081	53484	1490	38265
24-#11	2.48	MA	26250	6674	42895	4917	47049	3974	48845	3248	50514	2119	61726	1510	44459
8L-6S		MI	23116	6674	38170	4854	41895	3921	43670	3189	45642	2075	55465	1578	38580
24-#11	2.48	MA	25771	6674	42022	4930	45969	3972	47485	3245	48730	2127	59472	1454	43785
9L-5S		MI	23531	6674	38877	4856	42855	3924	44841	3194	47173	2068	57366	1637	39095
24-#11	2.48	MA	25247	6674	41202	4929	44878	3984	46179	3255	46960	2134	57286	1391	42764
10L-4S		MI	23965	6674	39625	4857	43820	3914	46023	3185	48840	2075	59382	1679	39480
24-#11	2.48	MA	24739	6674	40393	4928	43805	3981	44835	3252	45097	2128	55055	1337	41833
11L-3S		MI	24450	6674	40478	4846	44904	3917	47338	3190	50530	2068	61292	1767	39549
24-#14	3.57	MA	29130	7261	49493	5260	55347	4225	58877	3386	64197	2077	79941	1416	64091
6L-8S		MI	23553	7261	40146	5217	44302	4185	46585	3366	49371	2015	60915	1123	51392
24-#14	3.57	MA	28460	7261	48204	5278	53777	4241	56952	3400	61612	2087	76499	1290	62505
7E		MI	24111	7261	41141	5221	45635	4190	48170	3354	51604	2025	63590	1192	52529
24-#14	3.57	MA	27800	7261	47022	5276	52192	4237	55067	3414	58905	2077	73244	1217	61170
8L-6S		MI	24678	7261	42225	5204	46956	4176	49788	3342	53735	2015	66397	1319	53840
24-#14	3.57	MA	27131	7261	45771	5295	50643	4253	53117	3409	56346	2088	70040	1136	59477
9L-5S		MI	25259	7261	43238	5207	48330	4182	51464	3350	55912	2006	69090	1404	54489

RECTANGULAR TIED COLUMNS 36" x 44"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.01	MA	27837	6168	43541	4582	47038	3735	47941	3114	47763	2233	56030	2105	21368
2E		MI	22621	6168	35678	4510	38212	3676	38764	3063	38175	2178	44447	2036	17214
6-#18	1.52	MA	29394	6452	46887	4759	51304	3863	53127	3193	54769	2214	65367	2059	31626
2L-3S		MI	22087	6452	35678	4679	38212	3827	38764	3161	38175	2170	44447	1748	25406
6-#18	1.52	MA	27184	6452	43541	4755	47038	3891	47941	3218	47763	2232	56030	1832	31600
3L-2S		MI	23822	6452	38315	4687	41574	3804	42851	3143	43580	2152	51573	1975	25345
8-#14	1.14	MA	28317	6239	44354	4655	48250	3791	49480	3154	49915	2246	59125	2122	24121
2L-4S		MI	21287	6239	33595	4603	35728	3746	35810	3112	34481	2220	40126	1801	19500

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.14	MA	27042	6239	42443	4654	45814	3788	46519	3169	45904	2257	53728	1994	24162
3E		MI	22004	6239	34815	4587	37280	3751	37692	3120	36883	2210	42831	1929	19473
8-#14	1.14	MA	26142	6239	40910	4673	43864	3805	44153	3164	42831	2268	50192	1866	24116
4L-2S		MI	23008	6239	36326	4590	39207	3737	40035	3108	40014	2200	46982	2057	19412
8-#18	2.02	MA	30927	6736	50233	4937	55571	3992	58313	3273	61776	2195	74705	2014	41839
2L-4S		MI	22061	6736	36179	4884	38859	3943	39556	3224	39434	2161	46943	1460	32689
8-#18	2.02	MA	28742	6736	46887	4933	51304	4020	53127	3297	54769	2213	65367	1787	41704
3E		MI	23290	6736	38315	4857	41574	3956	42851	3241	43580	2143	51573	1687	33395
8-#18	2.02	MA	27196	6736	44194	4964	47880	4012	48972	3286	49394	2231	59264	1559	40783
4L-2S		MI	25007	6736	40952	4865	44936	3933	46938	3223	48984	2125	58700	1915	33423
10-#14	1.42	MA	29212	6399	46264	4755	50685	3863	52441	3199	53927	2236	64523	2100	29965
2L-5S		MI	21354	6399	34034	4700	36273	3832	36460	3169	35242	2197	41412	1712	23738
10-#14	1.42	MA	27946	6399	44354	4754	48250	3860	49480	3214	49915	2247	59125	1972	29975
3L-4S		MI	21994	6399	35106	4703	37655	3818	38152	3157	37612	2207	44277	1771	24083
10-#14	1.42	MA	27053	6399	42821	4773	46300	3877	47114	3209	46843	2258	55590	1844	29885
4L-3S		MI	22705	6399	36326	4686	39207	3824	40035	3165	40014	2197	46982	1899	24098
10-#14	1.42	MA	26253	6399	41477	4771	44567	3874	44991	3224	43814	2250	51898	1781	29367
5L-2S		MI	23703	6399	37838	4690	41134	3810	42377	3153	43146	2187	51133	2027	24057
10-#18	2.53	MA	32441	7020	53579	5114	59837	4121	63499	3353	68783	2177	84042	1969	52007
2L-5S		MI	22168	7020	36937	5053	39799	4094	40679	3322	40746	2116	49128	1297	38046
10-#18	2.53	MA	30279	7020	50233	5110	55571	4148	58313	3377	61776	2194	74705	1741	51787
3L-4S		MI	23262	7020	38816	5061	42221	4072	43643	3304	44839	2134	54070	1399	40174
10-#18	2.53	MA	28751	7020	47540	5142	52147	4141	54158	3366	56401	2212	68602	1514	50370
4L-3S		MI	24478	7020	40952	5034	44936	4084	46938	3321	48984	2116	58700	1626	41354
10-#18	2.53	MA	27382	7020	45178	5138	49100	4169	50427	3390	51099	2194	62190	1405	47366
5L-2S		MI	26179	7020	43589	5042	48298	4061	51025	3303	54389	2099	65827	1854	41468
12-#11	1.18	MA	28507	6265	44648	4686	48714	3815	50078	3171	50740	2252	60384	2133	25159
2L-6S		MI	21084	6265	33197	4630	35236	3777	35230	3136	33677	2226	39282	1792	19994
12-#11	1.18	MA	27616	6265	43314	4685	47012	3813	48010	3182	47938	2261	56591	2045	25183
3L-5S		MI	21512	6265	33904	4632	36196	3781	36400	3141	35208	2219	41183	1851	20296
12-#11	1.18	MA	26990	6265	42244	4699	45652	3825	46360	3179	45795	2269	54103	1956	25174
4E		MI	21962	6265	34652	4634	37161	3770	37582	3132	36875	2226	43198	1893	20309
12-#11	1.18	MA	26429	6265	41307	4698	44444	3823	44879	3190	43683	2263	51514	1912	25102
5L-3S		MI	22462	6265	35505	4622	38245	3774	38898	3137	38565	2219	45109	1982	20283
12-#11	1.18	MA	25894	6265	40424	4698	43243	3835	43414	3187	41743	2272	49046	1853	24646
6L-2S		MI	23165	6265	36562	4624	39593	3763	40537	3128	40768	2212	48037	2070	20246
12-#14	1.70	MA	30100	6559	48175	4855	53121	3936	55402	3244	57938	2226	69920	2078	35796
2L-6S		MI	21452	6559	34533	4796	36825	3899	37126	3206	36196	2194	42870	1597	27307
12-#14	1.70	MA	28842	6559	46264	4854	50685	3933	52441	3259	53927	2237	64523	1950	35772
3L-5S		MI	22059	6559	35545	4799	38200	3905	38803	3214	38373	2184	45564	1682	28117
12-#14	1.70	MA	27956	6559	44731	4872	48735	3949	50075	3254	50854	2248	60987	1822	35645
4E		MI	22694	6559	36617	4803	39582	3890	40495	3202	40744	2194	48428	1741	28653
12-#14	1.70	MA	27162	6559	43387	4871	47002	3946	47952	3269	47825	2240	57295	1759	34929
5L-3S		MI	23401	6559	37838	4786	41134	3896	42377	3210	43146	2184	51133	1869	28706
12-#14	1.70	MA	26405	6559	42119	4870	45279	3963	45851	3264	45043	2251	53784	1675	33779
6L-2S		MI	24393	6559	39349	4789	43061	3882	44720	3198	46277	2174	55284	1997	28686
12-#18	3.03	MA	33938	7303	56926	5291	64103	4249	68686	3433	75789	2158	93379	1924	62153
2L-6S		MI	22333	7303	37797	5223	40752	4210	41933	3420	42393	2108	51638	1085	43241
12-#18	3.03	MA	31797	7303	53579	5287	59837	4277	63499	3457	68783	2176	84042	1696	61857
3L-5S		MI	23366	7303	39574	5231	43161	4223	44766	3402	46150	2090	56255	1237	45722
12-#18	3.03	MA	30287	7303	50887	5319	56413	4269	59344	3446	63407	2193	77939	1469	60005
4E		MI	24449	7303	41453	5239	45583	4200	47730	3383	50244	2108	61197	1338	47710
12-#18	3.03	MA	28934	7303	48524	5315	53366	4297	55614	3470	58106	2176	71528	1359	57163
5L-3S		MI	25652	7303	43589	5211	48298	4213	51025	3401	54389	2090	65827	1565	49295

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

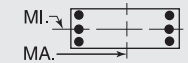
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	3.03	MA	27644	7303	46294	5311	50337	4290	51920	3459	53235	2193	65460	1209	53984
6L-2S		MI	27338	7303	46226	5219	51660	4190	55112	3383	59794	2072	72954	1793	49476
14-#11	1.38	MA	29135	6376	45982	4755	50415	3865	52146	3203	53542	2245	64176	2119	29237
2L-7S		MI	21166	6376	33498	4711	35662	3838	35740	3176	34381	2225	40229	1685	22716
14-#11	1.38	MA	28249	6376	44648	4755	48714	3863	50078	3213	50740	2254	60384	2031	29251
3L-6S		MI	21583	6376	34254	4699	36584	3827	36869	3167	35879	2218	42210	1773	23098
14-#11	1.38	MA	27626	6376	43578	4768	47353	3875	48428	3210	48597	2262	57896	1942	29218
4L-5S		MI	22009	6376	34961	4701	37544	3831	38040	3172	37411	2211	44111	1832	23496
14-#11	1.38	MA	27068	6376	42642	4767	46145	3873	46947	3221	46485	2257	55307	1898	29126
5L-4S		MI	22456	6376	35710	4703	38509	3821	39221	3163	39078	2218	46126	1874	23531
14-#11	1.38	MA	26536	6376	41758	4767	44944	3885	45483	3218	44545	2265	52838	1839	28572
6L-3S		MI	22954	6376	36562	4691	39593	3824	40537	3168	40768	2211	48037	1963	23521
14-#11	1.38	MA	26017	6376	40812	4780	43791	3884	44069	3229	42647	2273	50270	1752	28016
7L-2S		MI	23654	6376	37620	4693	40942	3814	42176	3159	42971	2204	50965	2051	23492
14-#14	1.99	MA	30981	6718	50085	4955	55557	4008	58363	3289	61949	2216	75317	2056	41613
2L-7S		MI	21568	6718	34960	4912	37432	3985	37851	3262	37197	2191	44214	1440	30897
14-#14	1.99	MA	29731	6718	48175	4953	53121	4005	55402	3304	57938	2227	69920	1928	41559
3L-6S		MI	22156	6718	36044	4896	38752	3971	39469	3251	39328	2181	47021	1567	31749
14-#14	1.99	MA	28851	6718	46641	4972	51171	4022	53035	3299	54865	2238	66384	1800	41399
4L-5S		MI	22758	6718	37057	4899	40127	3977	41145	3259	41505	2172	49715	1652	32513
14-#14	1.99	MA	28063	6718	45298	4971	49438	4019	50913	3313	51837	2230	62692	1737	40511
5L-4S		MI	23389	6718	38129	4902	41509	3963	42837	3247	43875	2181	52579	1711	33214
14-#14	1.99	MA	27313	6718	44030	4970	47715	4035	48812	3308	49055	2241	59181	1653	39413
6L-3S		MI	24091	6718	39349	4886	43061	3968	44720	3255	46277	2172	55284	1839	33296
14-#14	1.99	MA	26580	6718	42673	4988	46061	4032	46784	3323	46332	2252	55527	1527	38284
7L-2S		MI	25077	6718	40861	4889	44988	3954	47062	3243	49408	2162	59435	1967	33304
14-#18	3.54	MA	33298	7587	56926	5465	64103	4406	68686	3537	75789	2157	93379	1651	71918
3L-6S		MI	23529	7587	40434	5400	44114	4339	46020	3499	47798	2081	58764	1024	50775
14-#18	3.54	MA	31805	7587	54233	5496	60679	4398	64531	3526	70414	2175	87276	1423	69682
4L-5S		MI	24552	7587	42211	5408	46523	4351	48853	3481	51555	2063	63382	1176	53420
14-#18	3.54	MA	30468	7587	51871	5492	57633	4426	60800	3550	65112	2157	80865	1314	66984
5L-4S		MI	25624	7587	44090	5416	48945	4329	51817	3463	55649	2081	68324	1277	55286
14-#18	3.54	MA	29192	7587	49640	5489	54604	4418	57106	3538	60241	2175	74798	1164	63645
6L-3S		MI	26815	7587	46226	5389	51660	4341	55112	3481	59794	2063	72954	1505	57223
14-#18	3.54	MA	27948	7587	47253	5520	51695	4446	53541	3563	55474	2192	68480	939	60389
7L-2S		MI	28486	7587	48863	5397	55022	4319	59199	3462	65199	2046	80081	1732	57465
16-#11	1.58	MA	29760	6486	47317	4824	52116	3915	54215	3234	56344	2239	67969	2105	33310
2L-8S		MI	21256	6486	33861	4778	36081	3885	36273	3215	35013	2210	41275	1617	25404
16-#11	1.58	MA	28877	6486	45982	4824	50415	3913	52146	3244	53542	2247	64176	2017	33305
3L-7S		MI	21665	6486	34556	4780	37011	3888	37379	3207	36584	2216	43157	1666	25846
16-#11	1.58	MA	28257	6486	44913	4837	49055	3925	50496	3241	51398	2255	61689	1928	33258
4L-6S		MI	22079	6486	35312	4768	37933	3878	38509	3198	38082	2210	45138	1754	26210
16-#11	1.58	MA	27703	6486	43976	4837	47846	3923	49016	3252	49286	2250	59100	1884	33146
5E		MI	22503	6486	36019	4770	38893	3881	39679	3203	39614	2203	47039	1813	26691
16-#11	1.58	MA	27174	6486	43092	4836	46645	3935	47551	3249	47347	2258	56631	1825	32507
6L-4S		MI	22948	6486	36768	4772	39858	3871	40861	3194	41281	2210	49054	1855	26743
16-#11	1.58	MA	26658	6486	42146	4849	45492	3934	46137	3260	45449	2266	54063	1738	31972
7L-3S		MI	23443	6486	37620	4760	40942	3874	42176	3199	42971	2203	50965	1943	26751
16-#11	1.58	MA	26149	6486	41279	4849	44329	3946	44754	3271	43460	2261	51643	1686	31362
8L-2S		MI	24140	6486	38678	4762	42290	3864	43815	3190	45174	2196	53893	2032	26731
16-#14	2.27	MA	31855	6878	51995	5054	57992	4080	61324	3334	65961	2206	80714	2034	47417
2L-8S		MI	21695	6878	35477	5009	38026	4052	38608	3319	38096	2169	45691	1341	34259
16-#14	2.27	MA	30612	6878	50085	5053	55557	4077	58363	3348	61949	2217	75317	1906	47339
3L-7S		MI	22271	6878	36472	5012	39359	4058	40193	3307	40329	2179	48366	1411	35257

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis

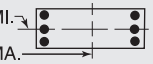


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	2.27	MA	29739	6878	48552	5072	53607	4094	55996	3343	58877	2229	71781	1778	47149
4L-6S		MI	22855	6878	37555	4996	40679	4044	41811	3296	42459	2169	51172	1537	36199
16-#14	2.27	MA	28957	6878	47208	5071	51873	4091	53874	3358	55848	2220	68089	1715	46107
5E		MI	23453	6878	38568	4999	42054	4049	43488	3304	44636	2159	53866	1622	36924
16-#14	2.27	MA	28212	6878	45940	5069	50151	4108	51772	3353	53066	2231	64578	1631	45056
6L-4S		MI	24079	6878	39640	5002	43436	4035	45180	3292	47006	2169	56730	1682	37768
16-#14	2.27	MA	27485	6878	44583	5088	48497	4105	49745	3368	50343	2242	60924	1505	43839
7L-3S		MI	24776	6878	40861	4986	44988	4041	47062	3300	49408	2159	59435	1810	37877
16-#14	2.27	MA	26768	6878	43338	5087	46828	4121	47761	3383	47492	2233	57475	1431	42449
8L-2S		MI	25757	6878	42372	4989	46914	4026	49405	3288	52539	2149	63587	1938	37912
16-#18	4.04	MA	33307	7871	57579	5674	64945	4527	69717	3605	77420	2156	96614	1378	79393
4L-6S		MI	24714	7871	43071	5577	47476	4467	50107	3579	53203	2054	65891	963	58336
16-#18	4.04	MA	31984	7871	55217	5670	61899	4554	65986	3629	72119	2138	90203	1269	76825
5E		MI	25726	7871	44848	5585	49885	4480	52940	3561	56960	2037	70509	1115	61138
16-#18	4.04	MA	30723	7871	52986	5666	58870	4547	62292	3618	67248	2156	84135	1119	73332
6L-4S		MI	26787	7871	46727	5593	52307	4457	55904	3543	61053	2054	75451	1217	62895
16-#18	4.04	MA	29493	7871	50600	5698	55961	4575	58727	3642	62480	2173	77817	894	69980
7L-3S		MI	27968	7871	48863	5566	55022	4470	59199	3560	65199	2037	80081	1444	65141
18-#11	1.77	MA	30380	6597	48651	4893	53817	3965	56283	3265	59145	2232	71762	2091	37377
2L-9S		MI	21351	6597	34185	4859	36520	3945	36768	3242	35732	2208	42361	1541	27908
18-#11	1.77	MA	29502	6597	47317	4893	52116	3963	54215	3276	56344	2240	67969	2003	37355
3L-8S		MI	21754	6597	34919	4847	37429	3935	37912	3247	37216	2201	44203	1598	28479
18-#11	1.77	MA	28885	6597	46247	4906	50756	3975	52564	3273	54200	2248	65482	1914	37293
4L-7S		MI	22160	6597	35614	4849	38359	3938	39018	3238	38786	2208	46085	1647	28979
18-#11	1.77	MA	28334	6597	45310	4906	49547	3974	51084	3283	52088	2243	62892	1870	37164
5L-6S		MI	22572	6597	36370	4837	39281	3928	40148	3229	40285	2201	48066	1735	29329
18-#11	1.77	MA	27808	6597	44427	4905	48346	3986	49619	3280	50148	2251	60424	1811	36448
6L-5S		MI	22995	6597	37077	4839	40241	3931	41318	3234	41817	2195	49967	1794	29882
18-#11	1.77	MA	27295	6597	43481	4919	47193	3984	48206	3291	48250	2259	57855	1724	35933
7L-4S		MI	23437	6597	37825	4841	41206	3921	42500	3225	43484	2201	51982	1835	29949
18-#11	1.77	MA	26789	6597	42613	4918	46030	3996	46822	3302	46262	2254	55435	1672	35265
8L-3S		MI	23929	6597	38678	4829	42290	3924	43815	3230	45174	2195	53893	1924	29975
18-#11	1.77	MA	26263	6597	41762	4917	44893	3994	45391	3299	44384	2262	53044	1616	34465
9L-2S		MI	24623	6597	39736	4831	43639	3914	45455	3221	47377	2188	56821	2013	29964
18-#14	2.56	MA	31488	7037	51995	5153	57992	4150	61324	3393	65961	2207	80714	1884	53113
3L-8S		MI	22396	7037	36988	5109	39953	4124	40951	3364	41227	2156	49842	1311	38668
18-#14	2.56	MA	30620	7037	50462	5172	56042	4166	58957	3388	62888	2219	77178	1756	52895
4L-7S		MI	22968	7037	37983	5112	41286	4130	42536	3352	43460	2166	52517	1381	39628
18-#14	2.56	MA	29844	7037	49118	5170	54309	4163	56835	3403	59859	2210	73487	1693	51716
5L-6S		MI	23548	7037	39067	5095	42606	4116	44154	3340	45590	2156	55324	1508	40656
18-#14	2.56	MA	29105	7037	47850	5169	52586	4180	54733	3398	57077	2221	69975	1609	50707
6L-5S		MI	24142	7037	40080	5099	43981	4122	45830	3348	47767	2146	58017	1593	41347
18-#14	2.56	MA	28383	7037	46493	5188	50932	4177	52706	3413	54355	2232	66322	1483	49406
7L-4S		MI	24764	7037	41152	5102	45363	4107	47522	3337	50138	2156	60882	1652	42317
18-#14	2.56	MA	27672	7037	45249	5187	49263	4194	50721	3428	51503	2223	62872	1409	48057
8L-3S		MI	25457	7037	42372	5085	46914	4113	49405	3345	52539	2146	63587	1780	42451
18-#14	2.56	MA	26950	7037	43931	5205	47632	4191	48668	3423	48809	2234	59470	1328	46317
9L-2S		MI	26432	7037	43883	5089	48841	4099	51747	3333	55671	2136	67738	1908	42506
18-#18	4.55	MA	33486	8154	58563	5847	66165	4683	71173	3709	79126	2119	99540	1224	86683
5L-6S		MI	25887	8154	45708	5755	50838	4596	54194	3659	58608	2028	73018	902	65920
18-#18	4.55	MA	32239	8154	56333	5843	63136	4675	67478	3698	74254	2137	93473	1073	83042
6L-5S		MI	26890	8154	47485	5763	53247	4608	57027	3641	62365	2010	77635	1054	68871
18-#18	4.55	MA	31022	8154	53946	5875	60227	4703	63914	3722	69487	2155	87155	848	79593
7L-4S		MI	27941	8154	49364	5771	55669	4586	59991	3623	66458	2028	82577	1156	70532
20-#11	1.97	MA	30123	6708	48651	4962	53817	4013	56283	3307	59145	2233	71762	1989	41401
3L-9S		MI	21848	6708	35242	4929	37868	3995	38407	3273	37935	2200	45289	1522	31009
20-#11	1.97	MA	29510	6708	47581	4975	52457	4025	54632	3304	57002	2241	69274	1900	41325
4L-8S		MI	22249	6708	35977	4917	38778	3985	39551	3278	39419	2193	47131	1579	31561

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

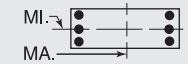
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.97	MA	28961	6708	46645	4975	51249	4024	53152	3314	54890	2236	66685	1855	41181
5L-7S		MI	22653	6708	36671	4919	39708	3988	40658	3269	40989	2200	49013	1628	32116
20-#11	1.97	MA	28438	6708	45761	4974	50048	4036	51687	3311	52950	2244	64216	1797	40396
6E		MI	23063	6708	37428	4907	40630	3978	41787	3260	42488	2193	50994	1716	32452
20-#11	1.97	MA	27928	6708	44815	4988	48895	4034	50274	3322	51052	2252	61648	1710	39896
7L-5S		MI	23483	6708	38135	4909	41590	3981	42958	3265	44020	2186	52895	1774	33029
20-#11	1.97	MA	27425	6708	43948	4987	47731	4046	48890	3333	49064	2247	59228	1658	39174
8L-4S		MI	23923	6708	38883	4910	42555	3971	44139	3256	45687	2193	54910	1816	33151
20-#11	1.97	MA	26902	6708	43096	4987	46595	4044	47459	3330	47186	2255	56836	1602	38396
9L-3S		MI	24413	6708	39736	4899	43639	3974	45455	3261	47377	2186	56821	1905	33188
20-#11	1.97	MA	26348	6708	42166	5000	45446	4056	46084	3341	45322	2264	54516	1539	37475
10L-2S		MI	25104	6708	40793	4900	44987	3964	47094	3252	49580	2180	59749	1994	33192
20-#14	2.84	MA	31495	7197	52373	5271	58478	4239	61918	3433	66899	2209	82575	1734	58639
4L-8S		MI	23093	7197	38500	5208	41880	4197	43293	3409	44358	2143	53993	1282	43084
20-#14	2.84	MA	30725	7197	51029	5270	56745	4236	59795	3448	63871	2200	78884	1671	57337
5L-7S		MI	23660	7197	39495	5212	43213	4202	44878	3397	46591	2153	56668	1351	44011
20-#14	2.84	MA	29991	7197	49761	5269	55022	4252	57694	3443	61089	2211	75373	1587	56365
6E		MI	24237	7197	40578	5195	44533	4188	46496	3385	48722	2143	59475	1478	45119
20-#14	2.84	MA	29275	7197	48404	5288	53368	4249	55667	3458	58366	2222	71719	1461	54982
7L-5S		MI	24827	7197	41591	5198	45908	4194	48173	3393	50898	2133	62168	1563	45781
20-#14	2.84	MA	28568	7197	47159	5286	51699	4266	53682	3473	55514	2213	68269	1387	53673
8L-4S		MI	25445	7197	42663	5202	47290	4180	49865	3381	53269	2143	65033	1622	46861
20-#14	2.84	MA	27848	7197	45842	5305	50068	4263	51629	3468	52820	2224	64867	1306	51882
9L-3S		MI	26134	7197	43883	5185	48841	4185	51747	3389	55671	2133	67738	1750	47019
20-#18	5.05	MA	33740	8438	59679	6021	67402	4804	72665	3778	81261	2118	102810	1028	92772
6E		MI	27051	8438	48345	5932	54200	4724	58281	3739	64013	2001	80145	842	73526
20-#18	5.05	MA	32535	8438	57292	6052	64493	4832	69100	3802	76494	2136	96492	803	89226
7L-5S		MI	28045	8438	50122	5940	56609	4737	61114	3721	67770	1984	84762	993	76540
22-#11	2.17	MA	30130	6818	48916	5045	54158	4076	56700	3335	59804	2234	73067	1886	45354
4L-9S		MI	22342	6818	36300	4998	39217	4045	40046	3304	40138	2192	48217	1503	34114
22-#11	2.17	MA	29585	6818	47979	5044	52950	4074	55220	3346	57692	2229	70478	1841	45149
5L-8S		MI	22741	6818	37035	4986	40126	4035	41191	3309	41622	2185	50059	1560	34648
22-#11	2.17	MA	29065	6818	47095	5044	51749	4086	53755	3343	55752	2237	68009	1783	44349
6L-7S		MI	23143	6818	37729	4988	41057	4038	42297	3300	43192	2192	51941	1609	35255
22-#11	2.17	MA	28558	6818	46149	5057	50596	4084	52342	3353	53854	2246	65441	1696	43864
7L-6S		MI	23551	6818	38485	4976	41978	4028	43427	3291	44691	2185	53922	1697	35580
22-#11	2.17	MA	28058	6818	45282	5056	49432	4096	50958	3364	51866	2240	63021	1644	43090
8L-5S		MI	23969	6818	39192	4978	42938	4031	44597	3296	46223	2178	55823	1755	36132
22-#11	2.17	MA	27537	6818	44430	5056	48296	4094	49527	3361	49987	2248	60629	1588	42332
9L-4S		MI	24407	6818	39941	4980	43903	4021	45779	3287	47890	2185	57838	1797	36349
22-#11	2.17	MA	26986	6818	43501	5069	47147	4106	48152	3372	48123	2257	58309	1525	41375
10L-3S		MI	24895	6818	40793	4968	44987	4025	47094	3292	49580	2178	59749	1886	36397
22-#11	2.17	MA	26447	6818	42649	5069	46017	4105	46737	3369	46163	2251	55946	1470	40464
11L-2S		MI	25583	6818	41851	4970	46336	4014	48733	3284	51783	2172	62677	1975	36417
22-#14	3.13	MA	31600	7356	52939	5370	59180	4308	62756	3493	67882	2190	84281	1649	62967
5L-8S		MI	23784	7356	40011	5308	43807	4269	45636	3454	47490	2131	58144	1252	47436
22-#14	3.13	MA	30871	7356	51671	5369	57458	4325	60655	3488	65100	2201	80770	1565	62028
6L-7S		MI	24348	7356	41006	5311	45140	4275	47221	3442	49723	2140	60819	1321	48403
22-#14	3.13	MA	30159	7356	50314	5387	55804	4322	58628	3503	62377	2212	77116	1439	60568
7L-6S		MI	24921	7356	42090	5295	46460	4261	48839	3430	51853	2131	63626	1448	49587
22-#14	3.13	MA	29458	7356	49070	5386	54135	4338	56643	3518	59526	2203	73666	1365	59295
8L-5S		MI	25507	7356	43103	5298	47835	4266	50515	3438	54030	2121	66320	1533	50222
22-#14	3.13	MA	28739	7356	47752	5405	52504	4335	54590	3513	56831	2214	70265	1284	57455
9L-4S		MI	26122	7356	44175	5301	49217	4252	52207	3426	56400	2131	69184	1592	51403

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

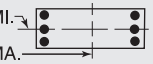
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#18	5.56	MA	34036	8722	60638	6230	68760	4960	74286	3882	83500	2117	105829	758	98877
7L-6S		MI	28206	8722	50982	6109	57562	4853	62368	3819	69417	1975	87272	781	81151
24-#11	2.36	MA	30205	6929	49313	5113	54651	4124	57288	3377	60493	2222	74270	1827	49078
5L-9S		MI	22834	6929	37358	5067	40565	4095	41686	3335	42341	2184	51145	1484	37222
24-#11	2.36	MA	29688	6929	48430	5113	53450	4136	55823	3374	58553	2230	71802	1769	48306
6L-8S		MI	23230	6929	38092	5055	41475	4085	42830	3340	43825	2177	52987	1541	37741
24-#11	2.36	MA	29184	6929	47484	5126	52297	4134	54410	3385	56656	2239	69233	1682	47833
7E		MI	23631	6929	38787	5057	42405	4089	43936	3331	45395	2184	54869	1589	38396
24-#11	2.36	MA	28686	6929	46616	5125	51134	4146	53026	3395	54667	2233	66813	1630	47010
8L-6S		MI	24037	6929	39543	5045	43327	4078	45066	3322	46894	2177	56850	1677	38712
24-#11	2.36	MA	28174	6929	45765	5125	49997	4145	51595	3392	52789	2242	64422	1574	46271
9L-5S		MI	24452	6929	40250	5047	44287	4082	46236	3327	48425	2170	58751	1736	39241
24-#11	2.36	MA	27620	6929	44835	5138	48848	4157	50220	3403	50925	2250	62102	1510	45280
10L-4S		MI	24888	6929	40999	5049	45252	4071	47418	3319	50093	2177	60767	1778	39544
24-#11	2.36	MA	27084	6929	43984	5138	47718	4155	48805	3400	48965	2244	59739	1456	44387
11L-3S		MI	25374	6929	41851	5037	46336	4075	48733	3324	51783	2170	62677	1867	39604
24-#14	3.41	MA	31744	7516	53582	5468	59893	4397	63616	3533	69111	2191	86167	1543	67697
6L-8S		MI	24471	7516	41523	5408	45734	4341	47979	3499	50621	2118	62295	1222	51777
24-#14	3.41	MA	31038	7516	52225	5487	58239	4394	61589	3548	66389	2202	82513	1417	66163
7E		MI	25032	7516	42518	5411	47067	4347	49563	3487	52854	2128	64970	1291	52803
24-#14	3.41	MA	30342	7516	50980	5486	56570	4411	59604	3563	63537	2193	79063	1343	64901
8L-6S		MI	25601	7516	43601	5395	48387	4333	51181	3475	54984	2118	67777	1418	54059
24-#14	3.41	MA	29624	7516	49663	5505	54939	4408	57551	3558	60842	2204	75662	1262	63035
9L-5S		MI	26184	7516	44614	5398	49762	4339	52858	3483	57161	2108	70471	1503	54670

RECTANGULAR TIED COLUMNS 36" x 46"

6-#18	1.45	MA	31964	6707	50774	4966	55564	4034	57481	3338	59147	2328	70598	2176	33246
2L-3S		MI	23005	6707	37060	4868	39644	3982	40154	3293	39419	2271	45819	1846	25469
6-#18	1.45	MA	29632	6707	47250	4963	51072	4062	52020	3363	51748	2346	60707	1948	33220
3L-2S		MI	24742	6707	39697	4876	43006	3960	44241	3275	44823	2253	52946	2073	25392
8-#14	1.09	MA	30819	6494	48099	4862	52338	3961	53630	3299	53959	2357	63951	2236	25336
2L-4S		MI	22204	6494	34971	4794	37160	3902	37204	3245	35731	2322	41506	1900	19552
8-#14	1.09	MA	29475	6494	46089	4861	49775	3959	50514	3314	49738	2369	58241	2108	25377
3E		MI	22921	6494	36191	4777	38711	3908	39086	3253	38133	2312	44211	2028	19513
8-#14	1.09	MA	28527	6494	44477	4881	47726	3976	48027	3310	46509	2381	54497	1980	25331
4L-2S		MI	23927	6494	37703	4780	40638	3894	41429	3241	41264	2302	48363	2156	19448
8-#18	1.93	MA	33589	6990	54298	5143	60056	4162	62942	3418	66545	2311	80490	2133	43999
2L-4S		MI	22978	6990	37561	5073	40291	4098	40947	3356	40678	2262	48315	1558	33016
8-#18	1.93	MA	31282	6990	50774	5140	55564	4191	57481	3443	59147	2329	70598	1906	43864
3E		MI	24209	6990	39697	5046	43006	4111	44241	3373	44823	2244	52946	1785	33468
8-#18	1.93	MA	29653	6990	47942	5173	51963	4184	53111	3433	53473	2347	64126	1678	43221
4L-2S		MI	25930	6990	42334	5054	46368	4088	48328	3355	50228	2227	60073	2013	33476
10-#14	1.36	MA	31767	6654	50109	4962	54901	4034	56745	3343	58180	2347	69660	2215	31484
2L-5S		MI	22270	6654	35410	4890	37705	3989	37854	3302	36492	2299	42793	1811	23927
10-#14	1.36	MA	30431	6654	48099	4961	52338	4031	53630	3359	53959	2359	63951	2087	31494
3L-4S		MI	22911	6654	36482	4893	39087	3975	39546	3290	38862	2309	45658	1870	24142
10-#14	1.36	MA	29491	6654	46488	4980	50289	4048	51143	3354	50730	2371	60207	1959	31403
4L-3S		MI	23624	6654	37703	4877	40638	3980	41429	3298	41264	2299	48363	1998	24143
10-#14	1.36	MA	28649	6654	45076	4980	48468	4046	48912	3370	47547	2363	56308	1895	31008
5L-2S		MI	24623	6654	39214	4880	42565	3966	43771	3286	44395	2289	52514	2126	24096
10-#18	2.42	MA	35193	7274	57821	5321	64549	4291	68403	3498	73944	2293	90381	2091	54707
2L-5S		MI	23083	7274	38319	5242	41231	4250	42069	3454	41990	2218	50500	1395	38316
10-#18	2.42	MA	32909	7274	54298	5318	60056	4320	62942	3523	66545	2311	80490	1864	54487
3L-4S		MI	24180	7274	40198	5250	43653	4227	45034	3436	46083	2236	55442	1497	40493
10-#18	2.42	MA	31300	7274	51466	5350	56455	4313	58572	3513	60871	2329	74017	1636	53327
4L-3S		MI	25399	7274	42334	5223	46368	4240	48328	3453	50228	2218	60073	1724	41437

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

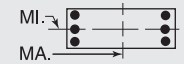
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#18	2.42	MA	29858	7274	48982	5347	53253	4342	54650	3538	55277	2312	67238	1526	50029
5L-2S		MI	27103	7274	44971	5231	49730	4217	52415	3435	55633	2200	67200	1952	41530
12-#11	1.13	MA	31018	6520	48405	4893	52822	3985	54254	3316	54820	2363	65264	2247	26423
2L-6S		MI	22000	6520	34570	4821	36668	3935	36626	3269	34929	2328	40667	1892	20124
12-#11	1.13	MA	30080	6520	47001	4893	51032	3983	52079	3327	51873	2372	61255	2158	26447
3L-5S		MI	22429	6520	35277	4823	37627	3938	37796	3274	36460	2322	42568	1950	20349
12-#11	1.13	MA	29420	6520	45878	4906	49603	3996	50344	3324	49621	2381	58623	2069	26437
4E		MI	22879	6520	36026	4825	38593	3928	38978	3265	38128	2328	44583	1992	20350
12-#11	1.13	MA	28830	6520	44894	4906	48334	3994	48789	3336	47402	2376	55890	2024	26366
5L-3S		MI	23380	6520	36878	4813	39677	3931	40293	3270	39817	2322	46494	2081	20319
12-#11	1.13	MA	28268	6520	43966	4906	47072	4007	47251	3333	45365	2385	53279	1966	25968
6L-2S		MI	24084	6520	37936	4815	41025	3921	41932	3262	42020	2315	49422	2170	20280
12-#14	1.63	MA	32706	6813	52119	5062	57464	4106	59861	3388	62401	2337	75369	2195	37619
2L-6S		MI	22368	6813	35909	4987	38257	4056	38520	3339	37446	2296	44251	1696	27476
12-#14	1.63	MA	31379	6813	50109	5061	54901	4103	56745	3404	58180	2349	69660	2067	37595
3L-5S		MI	22976	6813	36922	4990	39632	4061	40196	3347	39623	2287	46944	1781	28302
12-#14	1.63	MA	30446	6813	48498	5080	52851	4121	54258	3399	54950	2361	65916	1939	37467
4E		MI	23612	6813	37994	4993	41014	4047	41889	3335	41993	2296	49809	1840	28718
12-#14	1.63	MA	29611	6813	47086	5079	51030	4118	52028	3415	51768	2353	62017	1875	36864
5L-3S		MI	24320	6813	39214	4977	42565	4053	43771	3343	44395	2287	52514	1968	28757
12-#14	1.63	MA	28815	6813	45754	5078	49221	4135	49820	3410	48845	2365	58301	1791	35604
6L-2S		MI	25314	6813	40726	4980	44492	4039	46114	3331	47526	2277	56665	2096	28728
12-#18	2.90	MA	36778	7558	61345	5498	69041	4419	73864	3577	81343	2275	100273	2049	65393
2L-6S		MI	23247	7558	39179	5411	42183	4366	43323	3552	43637	2209	53010	1183	43681
12-#18	2.90	MA	34517	7558	57821	5495	64549	4448	68403	3603	73944	2293	90381	1821	65097
3L-5S		MI	24284	7558	40956	5419	44593	4378	46156	3534	47394	2191	57627	1335	45988
12-#18	2.90	MA	32926	7558	54989	5527	60948	4442	64033	3593	68270	2311	83909	1594	63482
4E		MI	25369	7558	42835	5427	47015	4355	49121	3515	51488	2209	62569	1436	48022
12-#18	2.90	MA	31501	7558	52506	5524	57745	4470	60111	3618	62675	2294	77130	1483	60354
5L-3S		MI	26576	7558	44971	5400	49730	4368	52415	3533	55633	2191	67200	1664	49385
12-#18	2.90	MA	30143	7558	50162	5521	54561	4464	56228	3608	57534	2312	70699	1333	57224
6L-2S		MI	28265	7558	47608	5408	53092	4345	56502	3515	61038	2174	74327	1891	49543
14-#11	1.32	MA	31683	6630	49808	4962	54611	4035	56429	3347	57767	2357	69273	2234	30712
2L-7S		MI	22083	6630	34872	4902	37094	3995	37135	3309	35633	2327	41614	1785	22840
14-#11	1.32	MA	30748	6630	48405	4962	52822	4034	54254	3358	54820	2365	65264	2145	30725
3L-6S		MI	22500	6630	35628	4890	38016	3985	38265	3300	37132	2320	43595	1873	23227
14-#11	1.32	MA	30092	6630	47281	4975	51392	4046	52519	3356	52568	2374	62632	2056	30693
4L-5S		MI	22927	6630	36335	4892	38976	3988	39435	3305	38663	2313	45496	1931	23554
14-#11	1.32	MA	29506	6630	46297	4975	50123	4044	50964	3367	50349	2369	59899	2011	30600
5L-4S		MI	23374	6630	37083	4894	39941	3978	40617	3297	40330	2320	47511	1973	23577
14-#11	1.32	MA	28946	6630	45369	4975	48862	4057	49426	3364	48312	2378	57288	1953	30099
6L-3S		MI	23873	6630	37936	4882	41025	3981	41932	3302	42020	2313	49422	2062	23559
14-#11	1.32	MA	28401	6630	44376	4988	47651	4055	47942	3375	46319	2387	54572	1866	29491
7L-2S		MI	24573	6630	38994	4884	42374	3971	43572	3293	44223	2307	52350	2151	23528
14-#14	1.90	MA	33638	6973	54130	5161	60026	4178	62976	3433	66621	2327	81079	2174	43739
2L-7S		MI	22484	6973	36337	5103	38863	4142	39245	3396	38447	2294	45595	1539	31180
14-#14	1.90	MA	32320	6973	52119	5161	57464	4176	59861	3449	62401	2339	75369	2046	43686
3L-6S		MI	23073	6973	37420	5086	40184	4128	40863	3384	40577	2284	48402	1666	31917
14-#14	1.90	MA	31393	6973	50508	5180	55414	4193	57373	3444	59171	2351	71625	1918	43525
4L-5S		MI	23676	6973	38433	5090	41559	4134	42539	3392	42754	2274	51096	1751	32696
14-#14	1.90	MA	30565	6973	49096	5179	53593	4190	55143	3460	55989	2343	67727	1854	42740
5L-4S		MI	24309	6973	39505	5093	42941	4119	44231	3380	45124	2284	53960	1810	33284
14-#14	1.90	MA	29775	6973	47765	5178	51784	4208	52936	3455	53066	2355	64011	1770	41535
6L-3S		MI	25012	6973	40726	5076	44492	4125	46114	3388	47526	2274	56665	1938	33352

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#14	1.90	MA	29004	6973	46339	5197	50046	4205	50807	3471	50206	2367	60145	1644	40484
7L-2S		MI	26000	6973	42237	5080	46419	4111	48456	3376	50658	2264	60816	2066	33349
14-#18	3.38	MA	36108	7842	61345	5672	69041	4577	73864	3683	81343	2276	100273	1779	75698
3L-6S		MI	24445	7842	41816	5589	45545	4494	47410	3631	49042	2182	60137	1122	51207
14-#18	3.38	MA	34533	7842	58513	5705	65440	4570	69494	3672	75668	2294	93800	1552	73679
4L-5S		MI	25471	7842	43593	5597	47955	4507	50243	3613	52799	2165	64754	1274	53684
14-#18	3.38	MA	33125	7842	56030	5702	62237	4599	65572	3698	70074	2277	87021	1441	70703
5L-4S		MI	26546	7842	45472	5605	50377	4484	53208	3595	56893	2182	69696	1375	55592
14-#18	3.38	MA	31782	7842	53686	5699	59054	4592	61689	3688	64933	2295	80590	1291	67412
6L-3S		MI	27742	7842	47608	5577	53092	4497	56502	3613	61038	2165	74327	1603	57319
14-#18	3.38	MA	30471	7842	51178	5731	55997	4621	57943	3713	59901	2313	73896	1066	64182
7L-2S		MI	29417	7842	50245	5585	56454	4474	60589	3594	66443	2147	81453	1830	57537
16-#11	1.51	MA	32343	6741	51212	5031	56400	4085	58604	3378	60714	2350	73282	2221	34995
2L-8S		MI	22172	6741	35235	4970	37512	4042	37668	3349	36265	2312	42660	1717	25609
16-#11	1.51	MA	31413	6741	49808	5031	54611	4084	56429	3389	57767	2358	69273	2132	34990
3L-7S		MI	22581	6741	35929	4972	38443	4045	38775	3340	37836	2319	44542	1765	25970
16-#11	1.51	MA	30760	6741	48685	5044	53182	4096	54694	3387	55515	2367	66641	2043	34942
4L-6S		MI	22996	6741	36686	4960	39365	4035	39904	3332	39335	2312	46523	1853	26339
16-#11	1.51	MA	30177	6741	47701	5044	51912	4095	53140	3398	53296	2362	63908	1998	34831
5E		MI	23422	6741	37393	4962	40325	4038	41075	3337	40866	2305	48424	1912	26753
16-#11	1.51	MA	29621	6741	46773	5044	50651	4107	51601	3395	51259	2371	61297	1940	34239
6L-4S		MI	23867	6741	38141	4963	41290	4028	42256	3328	42533	2312	50439	1954	26793
16-#11	1.51	MA	29079	6741	45780	5058	49441	4106	50117	3406	49265	2380	58582	1853	33654
7L-3S		MI	24363	6741	38994	4952	42374	4032	43572	3333	44223	2305	52350	2043	26792
16-#11	1.51	MA	28544	6741	44869	5057	48219	4118	48665	3418	47177	2375	56027	1801	33105
8L-2S		MI	25061	6741	40051	4953	43722	4021	45211	3324	46426	2298	55278	2131	26769
16-#14	2.17	MA	34563	7132	56140	5261	62589	4250	66092	3478	70842	2317	86788	2154	49847
2L-8S		MI	22610	7132	36853	5199	39457	4209	40002	3452	39345	2271	47071	1440	34519
16-#14	2.17	MA	33253	7132	54130	5260	60026	4248	62976	3494	66621	2329	81079	2026	49769
3L-7S		MI	23187	7132	37848	5203	40790	4215	41587	3440	41578	2281	49746	1509	35536
16-#14	2.17	MA	32333	7132	52518	5280	57977	4265	60489	3489	63392	2341	77335	1898	49579
4L-6S		MI	23772	7132	38932	5186	42111	4200	43205	3429	43709	2271	52553	1636	36367
16-#14	2.17	MA	31510	7132	51106	5279	56156	4263	58259	3505	60210	2333	73436	1834	48631
5E		MI	24372	7132	39945	5189	43486	4206	44882	3437	45885	2261	55247	1721	37106
16-#14	2.17	MA	30726	7132	49775	5278	54346	4280	56051	3500	57287	2345	69720	1750	47476
6L-4S		MI	25000	7132	41017	5193	44868	4192	46574	3425	48256	2271	58111	1781	37842
16-#14	2.17	MA	29961	7132	48349	5297	52609	4277	53922	3516	54427	2357	65854	1624	46335
7L-3S		MI	25699	7132	42237	5176	46419	4197	48456	3433	50658	2261	60816	1909	37936
16-#14	2.17	MA	29207	7132	47042	5296	50856	4295	51837	3531	51431	2349	62210	1549	44817
8L-2S		MI	26681	7132	43748	5179	48346	4183	50799	3421	53789	2251	64967	2037	37963
16-#18	3.86	MA	36124	8125	62037	5882	69932	4699	74955	3752	83067	2276	103692	1509	83912
4L-6S		MI	25631	8125	44453	5766	48907	4623	51497	3711	54447	2156	67264	1061	58761
16-#18	3.86	MA	34731	8125	59553	5879	66730	4728	71033	3778	77472	2259	96913	1399	81073
5E		MI	26648	8125	46230	5774	51317	4635	54330	3693	58204	2138	71881	1213	61399
16-#18	3.86	MA	33403	8125	57209	5876	63546	4721	67150	3767	72331	2277	90482	1249	77625
6L-4S		MI	27712	8125	48109	5782	53739	4613	57295	3675	62297	2156	76823	1315	63197
16-#18	3.86	MA	32107	8125	54701	5908	60489	4750	63404	3793	67300	2295	83787	1024	74300
7L-3S		MI	28897	8125	50245	5755	56454	4625	60589	3692	66443	2138	81453	1542	65243
16-#18	3.86	MA	30829	8125	52400	5905	57404	4743	59735	3818	62030	2278	77453	895	70178
8L-2S		MI	30558	8125	52882	5763	59816	4603	64676	3674	71847	2120	88580	1770	65516
18-#11	1.70	MA	32999	6851	52615	5100	58190	4135	60779	3409	63661	2343	77292	2208	39273
2L-9S		MI	22267	6851	35558	5051	37952	4102	38163	3375	36985	2311	43746	1641	28101
18-#11	1.70	MA	32073	6851	51212	5100	56400	4134	58604	3420	60714	2352	73282	2119	39250
3L-8S		MI	22670	6851	36293	5039	38861	4092	39308	3380	38468	2304	45588	1697	28682
18-#11	1.70	MA	31424	6851	50088	5114	54971	4146	56870	3418	58462	2360	70650	2030	39188
4L-7S		MI	23077	6851	36987	5041	39791	4095	40414	3371	40039	2311	47470	1746	29104
18-#11	1.70	MA	30844	6851	49104	5113	53702	4145	55315	3429	56243	2355	67917	1985	39060
5L-6S		MI	23490	6851	37743	5029	40713	4085	41544	3363	41538	2304	49451	1834	29457

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

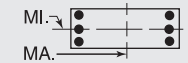
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.70	MA	30291	6851	48176	5113	52440	4157	53776	3426	54206	2364	65307	1927	38386
6L-5S		MI	23913	6851	38450	5031	41673	4089	42714	3368	43069	2297	51352	1893	29947
18-#11	1.70	MA	29752	6851	47183	5127	51230	4156	52292	3438	52212	2373	62591	1840	37822
7L-4S		MI	24357	6851	39199	5033	42638	4078	43896	3359	44736	2304	53367	1935	30002
18-#11	1.70	MA	29220	6851	46272	5126	50008	4168	50840	3449	50124	2368	60037	1787	37213
8L-3S		MI	24850	6851	40051	5021	43722	4082	45211	3364	46426	2297	55278	2024	30019
18-#11	1.70	MA	28658	6851	45378	5126	48815	4167	49337	3446	48152	2377	57507	1731	36342
9L-2S		MI	25545	6851	41109	5023	45071	4071	46850	3355	48629	2290	58206	2112	30004
18-#14	2.45	MA	34179	7292	56140	5360	62589	4320	66092	3538	70842	2319	86788	2005	55847
3L-8S		MI	23312	7292	38365	5299	41384	4281	42345	3497	42477	2258	51222	1410	38926
18-#14	2.45	MA	33265	7292	54528	5379	60540	4338	63604	3534	67613	2331	83044	1877	55629
4L-7S		MI	23885	7292	39360	5302	42717	4287	43930	3485	44710	2268	53898	1480	39904
18-#14	2.45	MA	32449	7292	53117	5378	58719	4335	61374	3550	64430	2323	79145	1813	54535
5L-6S		MI	24467	7292	40443	5286	44038	4273	45548	3474	46840	2258	56704	1607	40823
18-#14	2.45	MA	31670	7292	51785	5378	56909	4352	59167	3545	61507	2335	75429	1729	53425
6L-5S		MI	25062	7292	41456	5289	45413	4278	47224	3482	49017	2248	59398	1692	41527
18-#14	2.45	MA	30911	7292	50359	5397	55172	4350	57037	3561	58647	2347	71563	1603	52197
7L-4S		MI	25686	7292	42528	5292	46795	4264	48916	3470	51387	2258	62262	1751	42395
18-#14	2.45	MA	30162	7292	49052	5396	53419	4367	54953	3576	55652	2339	67920	1529	50723
8L-3S		MI	26381	7292	43748	5276	48346	4270	50799	3478	53789	2248	64967	1879	42514
18-#14	2.45	MA	29392	7292	47769	5395	51706	4364	52796	3572	52822	2351	64319	1448	49010
9L-2S		MI	27358	7292	45260	5279	50273	4256	53141	3466	56920	2238	69119	2007	42560
18-#18	4.35	MA	36321	8409	63077	6056	71222	4856	76494	3857	84871	2241	106804	1357	91460
5L-6S		MI	26807	8409	47090	5943	52269	4751	55584	3791	59852	2129	74391	1000	66340
18-#18	4.35	MA	35007	8409	60733	6053	68038	4850	72611	3847	79730	2259	100373	1206	87861
6L-5S		MI	27814	8409	48867	5951	54679	4764	58417	3773	63609	2112	79008	1152	69130
18-#18	4.35	MA	33725	8409	58225	6086	64981	4878	68865	3872	74698	2278	93679	982	84440
7L-4S		MI	28869	8409	50746	5959	57101	4741	61382	3755	67702	2129	83950	1254	70829
18-#18	4.35	MA	32461	8409	55924	6083	61896	4872	65196	3898	69428	2260	87345	853	80268
8L-3S		MI	30043	8409	52882	5932	59816	4754	64676	3772	71847	2112	88580	1481	73158
20-#11	1.88	MA	32730	6962	52615	5169	58190	4184	60779	3452	63661	2345	77292	2106	43507
3L-9S		MI	22764	6962	36616	5120	39300	4153	39803	3406	39188	2303	46674	1622	31201
20-#11	1.88	MA	32084	6962	51492	5183	56760	4196	59045	3449	61408	2353	74660	2017	43431
4L-8S		MI	23166	6962	37350	5108	40209	4142	40947	3411	40671	2296	48516	1678	31762
20-#11	1.88	MA	31507	6962	50508	5183	55491	4195	57490	3460	59190	2348	71927	1972	43287
5L-7S		MI	23571	6962	38045	5110	41140	4146	42053	3403	42242	2303	50398	1727	32241
20-#11	1.88	MA	30958	6962	49580	5182	54230	4207	55952	3458	57153	2357	69316	1914	42539
6E		MI	23982	6962	38801	5098	42062	4135	43183	3394	43740	2296	52379	1815	32580
20-#11	1.88	MA	30421	6962	48586	5196	53019	4206	54468	3469	55159	2366	66600	1827	41993
7L-5S		MI	24403	6962	39508	5100	43022	4139	44353	3399	45272	2289	54280	1874	33138
20-#11	1.88	MA	29893	6962	47676	5196	51798	4218	53015	3480	53071	2361	64046	1774	41328
8L-4S		MI	24844	6962	40257	5102	43987	4128	45535	3390	46939	2296	56295	1916	33207
20-#11	1.88	MA	29333	6962	46782	5195	50604	4217	51512	3477	51099	2370	61516	1718	40479
9L-3S		MI	25335	6962	41109	5090	45071	4132	46850	3395	48629	2289	58206	2004	33236
20-#11	1.88	MA	28750	6962	45806	5209	49398	4229	50068	3488	49142	2379	59062	1655	39598
10L-2S		MI	26027	6962	42167	5092	46419	4121	48490	3386	50832	2282	61134	2093	33234
20-#14	2.72	MA	34191	7451	56538	5479	63103	4410	66720	3579	71833	2321	88753	1857	61677
4L-8S		MI	24009	7451	39876	5399	43311	4353	44687	3542	45608	2246	55374	1380	43340
20-#14	2.72	MA	33380	7451	55127	5478	61282	4407	64490	3594	68651	2313	84855	1793	60451
5L-7S		MI	24579	7451	40871	5402	44644	4359	46272	3530	47841	2255	58049	1450	44284
20-#14	2.72	MA	32608	7451	53795	5477	59472	4425	62282	3590	65728	2325	81139	1709	59381
6E		MI	25156	7451	41955	5386	45965	4345	47890	3518	49971	2246	60856	1577	45286
20-#14	2.72	MA	31854	7451	52370	5497	57735	4422	60153	3606	62868	2337	77272	1583	58069
7L-5S		MI	25748	7451	42968	5389	47340	4351	49567	3526	52148	2236	63549	1662	45959

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

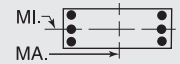


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.72	MA	31111	7451	51063	5496	55982	4439	58068	3621	59872	2329	73629	1508	56637
8L-4S		MI	26368	7451	44040	5392	48722	4336	51259	3515	54518	2246	66414	1721	46944
20-#14	2.72	MA	30341	7451	49779	5495	54269	4437	55911	3617	57042	2341	70029	1427	54872
9L-3S		MI	27059	7451	45260	5376	50273	4342	53141	3523	56920	2236	69119	1849	47085
20-#14	2.72	MA	29510	7451	48378	5514	52538	4454	53840	3632	54233	2353	66537	1336	53061
10L-2S		MI	28031	7451	46771	5379	52200	4328	55484	3511	60052	2226	73270	1977	47150
20-#18	4.83	MA	36596	8693	64257	6231	72531	4978	78072	3927	87128	2242	110265	1164	98117
6E		MI	27973	8693	49727	6121	55631	4880	59671	3871	65256	2103	81517	940	73940
20-#18	4.83	MA	35327	8693	61748	6263	69474	5007	74326	3952	82097	2260	103570	939	94600
7L-5S		MI	28970	8693	51504	6129	58041	4892	62504	3853	69014	2085	86135	1092	76875
20-#18	4.83	MA	34076	8693	59447	6260	66388	5000	70657	3978	76827	2243	97236	810	90536
8L-4S		MI	30016	8693	53383	6137	60463	4870	65469	3835	73107	2103	91077	1193	78485
22-#11	2.07	MA	32741	7073	52895	5252	58550	4246	61220	3480	64355	2347	78669	2004	47670
4L-9S		MI	23259	7073	37674	5189	40649	4203	41442	3438	41391	2295	49602	1602	34305
22-#11	2.07	MA	32167	7073	51911	5252	57280	4245	59665	3491	62137	2342	75936	1959	47512
5L-8S		MI	23658	7073	38408	5177	41558	4192	42586	3443	42874	2288	51444	1659	34848
22-#11	2.07	MA	31620	7073	50983	5251	56019	4257	58127	3489	60099	2350	73325	1901	46698
6L-7S		MI	24062	7073	39102	5179	42488	4196	43693	3434	44445	2295	53326	1708	35380
22-#11	2.07	MA	31087	7073	49990	5265	54809	4256	56643	3500	58106	2359	70610	1814	46168
7L-6S		MI	24470	7073	39859	5167	43410	4185	44822	3425	45943	2288	55307	1796	35708
22-#11	2.07	MA	30561	7073	49079	5265	53587	4268	55190	3511	56018	2354	68055	1761	45449
8L-5S		MI	24889	7073	40566	5169	44370	4189	45993	3430	47475	2281	57208	1855	36275
22-#11	2.07	MA	30004	7073	48185	5265	52393	4267	53687	3508	54046	2363	65526	1705	44621
9L-4S		MI	25328	7073	41314	5171	45335	4179	47174	3421	49142	2288	59223	1896	36408
22-#11	2.07	MA	29425	7073	47209	5278	51188	4279	52244	3520	52089	2372	63072	1642	43704
10L-3S		MI	25817	7073	42167	5159	46419	4182	48490	3426	50832	2281	61134	1985	36449
22-#11	2.07	MA	28858	7073	46316	5278	50001	4278	50758	3517	50030	2367	60577	1587	42713
11L-2S		MI	26507	7073	43225	5161	47768	4172	50129	3417	53035	2274	64062	2074	36460
22-#14	2.99	MA	34306	7611	57137	5578	63844	4480	67605	3639	72872	2303	90564	1773	66377
5L-8S		MI	24702	7611	41388	5499	45238	4426	47030	3587	48739	2233	59525	1351	47761
22-#14	2.99	MA	33538	7611	55805	5577	62035	4497	65398	3635	69949	2315	86848	1688	65344
6L-7S		MI	25268	7611	42383	5502	46571	4431	48615	3575	50972	2243	62200	1420	48673
22-#14	2.99	MA	32790	7611	54380	5596	60298	4494	63268	3650	67089	2327	82982	1562	63952
7L-6S		MI	25842	7611	43466	5485	47892	4417	50233	3563	53102	2233	65007	1547	49754
22-#14	2.99	MA	32052	7611	53073	5596	58544	4512	61184	3666	64093	2319	79338	1488	62557
8L-5S		MI	26430	7611	44479	5489	49267	4423	51909	3571	55279	2223	67700	1632	50399
22-#14	2.99	MA	31284	7611	51790	5595	56832	4509	59027	3662	61263	2331	75738	1407	60742
9L-4S		MI	27046	7611	45551	5492	50649	4409	53601	3559	57650	2233	70565	1691	51489
22-#14	2.99	MA	30461	7611	50389	5614	55101	4526	56955	3677	58454	2343	72246	1316	58896
10L-3S		MI	27733	7611	46771	5475	52200	4414	55484	3568	60052	2223	73270	1819	51651
22-#18	5.31	MA	36915	8976	65272	6440	73966	5136	79787	4032	89495	2242	113461	897	104778
7L-6S		MI	29130	8976	52364	6298	58993	5008	63758	3951	70661	2076	88644	879	81559
22-#18	5.31	MA	35677	8976	62971	6437	70881	5129	76118	4057	84225	2225	107128	768	100747
8L-5S		MI	30119	8976	54141	6306	61403	5021	66591	3933	74418	2058	93262	1031	84538
24-#11	2.26	MA	32823	7183	53315	5321	59070	4295	61841	3522	65084	2335	79945	1946	51717
5L-9S		MI	23751	7183	38731	5258	41997	4253	43081	3469	43593	2287	52530	1583	37413
24-#11	2.26	MA	32279	7183	52387	5321	57809	4308	60302	3520	63046	2343	77334	1888	50862
6L-8S		MI	24149	7183	39466	5246	42907	4242	44226	3474	45077	2280	54372	1640	37940
24-#11	2.26	MA	31749	7183	51393	5334	56598	4306	58818	3531	61053	2352	74619	1800	50345
7E		MI	24550	7183	40160	5248	43837	4246	45332	3465	46647	2287	56254	1689	38522
24-#11	2.26	MA	31226	7183	50483	5334	55376	4318	57365	3542	58965	2347	72064	1748	49575
8L-6S		MI	24957	7183	40917	5236	44759	4236	46461	3456	48146	2280	58235	1777	38840
24-#11	2.26	MA	30672	7183	49589	5334	54183	4317	55862	3540	56993	2356	69535	1692	48767
9L-5S		MI	25374	7183	41623	5238	45719	4239	47632	3461	49678	2273	60136	1835	39383
24-#11	2.26	MA	30095	7183	48613	5347	52977	4329	54419	3551	55036	2365	67081	1629	47815
10L-4S		MI	25811	7183	42372	5240	46684	4229	48814	3452	51345	2280	62151	1877	39606
24-#11	2.26	MA	29531	7183	47719	5347	51790	4328	52933	3548	52977	2360	64586	1574	46843
11L-3S		MI	26298	7183	43225	5228	47768	4232	50129	3457	53035	2273	64062	1966	39657

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.26	MA	28976	7183	46758	5361	50592	4340	51493	3559	51022	2369	61843	1499	45603
12L-2S		MI	26984	7183	44282	5230	49116	4222	51768	3448	55238	2266	66990	2055	39679
24-#14	3.26	MA	34463	7771	57815	5677	64598	4569	68513	3680	74170	2305	92557	1668	71311
6L-8S		MI	25390	7771	42899	5598	47165	4498	49372	3632	51871	2220	63676	1321	52154
24-#14	3.26	MA	33720	7771	56390	5696	62860	4567	66384	3695	71310	2317	88691	1542	69842
7E		MI	25953	7771	43894	5602	48498	4504	50957	3620	54103	2230	66351	1390	53071
24-#14	3.26	MA	32987	7771	55083	5695	61107	4584	64299	3711	68314	2309	85047	1467	68484
8L-6S		MI	26523	7771	44978	5585	49819	4490	52575	3608	56234	2220	69158	1517	54227
24-#14	3.26	MA	32220	7771	53800	5694	59394	4581	62142	3706	65484	2321	81447	1386	66619
9L-5S		MI	27108	7771	45990	5588	51194	4495	54252	3616	58411	2210	71852	1602	54847
24-#14	3.26	MA	31406	7771	52399	5714	57664	4599	60071	3722	62675	2333	77955	1295	64739
10L-4S		MI	27721	7771	47063	5592	52576	4481	55944	3604	60781	2220	74716	1661	56031
24-#18	5.80	MA	37264	9260	66494	6615	75373	5258	81580	4137	91624	2207	117019	726	110887
8L-6S		MI	30278	9260	55001	6475	62355	5137	67845	4030	76066	2050	95771	818	89195

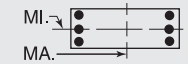
RECTANGULAR TIED COLUMNS 36" x 48"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.39	MA	34638	6961	54806	5173	59982	4204	61992	3483	63610	2439	75993	2291	34866
2L-3S		MI	23923	6961	38442	5057	41075	4138	41545	3425	40663	2372	47191	1944	25527
6-#18	1.39	MA	32182	6961	51105	5171	55263	4234	56257	3509	55839	2459	65547	2064	34840
3L-2S		MI	25662	6961	41079	5065	44437	4115	45632	3407	46067	2355	54318	2171	25438
8-#14	1.04	MA	33424	6749	51989	5069	56585	4131	57937	3443	58148	2468	68939	2349	26551
2L-4S		MI	23121	6749	36347	4984	38592	4059	38597	3378	36980	2424	42887	1999	19599
8-#14	1.04	MA	32010	6749	49879	5069	53895	4129	54667	3459	53718	2481	62918	2221	26592
3E		MI	23839	6749	37568	4968	40143	4065	40480	3386	39382	2414	45592	2127	19551
8-#14	1.04	MA	31015	6749	48190	5088	51746	4147	52059	3455	50331	2493	58965	2093	26546
4L-2S		MI	24846	6749	39079	4971	42070	4051	42822	3374	42513	2404	49743	2255	19483
8-#18	1.85	MA	36354	7245	58507	5350	64700	4332	67728	3562	71381	2422	86439	2252	46159
2L-4S		MI	23894	7245	38943	5262	41722	4254	42337	3488	41922	2364	49688	1656	33280
8-#18	1.85	MA	33924	7245	54806	5348	59982	4362	61992	3589	63610	2441	75993	2024	46024
3E		MI	25128	7245	41079	5234	44437	4266	45632	3505	46067	2346	54318	1883	33539
8-#18	1.85	MA	32212	7245	51835	5381	56204	4356	57407	3580	57656	2461	69151	1797	45410
4L-2S		MI	26851	7245	43716	5242	47799	4244	49719	3487	51472	2328	61445	2111	33529
10-#14	1.30	MA	34424	6908	54099	5169	59275	4204	61207	3488	62578	2458	74961	2329	33003
2L-5S		MI	23187	6908	36787	5081	39137	4146	39248	3435	37741	2402	44174	1910	24111
10-#14	1.30	MA	33019	6908	51989	5168	56585	4202	57937	3504	58148	2471	68939	2201	33012
3L-4S		MI	23828	6908	37859	5084	40519	4132	40940	3423	40111	2412	47038	1969	24198
10-#14	1.30	MA	32032	6908	50299	5188	54436	4219	55329	3500	54761	2483	64987	2073	32922
4L-3S		MI	24542	6908	39079	5067	42070	4137	42822	3431	42513	2402	49743	2097	24186
10-#14	1.30	MA	31148	6908	48820	5187	52527	4217	52991	3516	51425	2476	60881	2009	32652
5L-2S		MI	25543	6908	40590	5071	43997	4123	45165	3419	45645	2392	53895	2225	24135
10-#18	2.31	MA	38048	7529	62208	5528	69419	4461	73464	3642	79152	2404	96885	2212	57407
2L-5S		MI	23999	7529	39701	5431	42662	4405	43460	3586	43233	2319	51873	1493	38578
10-#18	2.31	MA	35643	7529	58507	5525	64700	4491	67728	3668	71381	2423	86439	1985	57187
3L-4S		MI	25098	7529	41580	5439	45084	4382	46424	3568	47327	2337	56815	1595	40806
10-#18	2.31	MA	33951	7529	55536	5558	60922	4485	63143	3659	65427	2443	79597	1757	56311
4L-3S		MI	26320	7529	43716	5412	47799	4395	49719	3585	51472	2319	61445	1822	41516
10-#18	2.31	MA	32437	7529	52932	5556	57564	4515	59030	3686	59559	2427	72450	1645	52709
5L-2S		MI	28028	7529	46353	5420	51161	4372	53806	3567	56877	2302	68572	2050	41586
12-#11	1.08	MA	33632	6774	52306	5100	57088	4155	58587	3460	59045	2475	70307	2360	27686
2L-6S		MI	22916	6774	35944	5013	38100	4092	38021	3403	36181	2431	42051	1991	20251
12-#11	1.08	MA	32645	6774	50834	5100	55210	4154	56305	3472	55952	2484	66081	2271	27710
3L-5S		MI	23346	6774	36651	5015	39059	4096	39191	3408	37713	2424	43953	2050	20399

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.08	MA	31953	6774	49656	5113	53712	4167	54486	3470	53591	2493	63305	2182	27701
4E		MI	23797	6774	37399	5016	40024	4085	40373	3399	39380	2431	45968	2092	20389
12-#11	1.08	MA	31334	6774	48625	5114	52382	4165	52857	3481	51266	2488	60428	2137	27629
5L-3S		MI	24298	6774	38252	5005	41108	4089	41689	3404	41070	2424	47879	2180	20354
12-#11	1.08	MA	30744	6774	47653	5114	51060	4178	51245	3479	49131	2498	57675	2079	27297
6L-2S		MI	25003	6774	39309	5006	42457	4078	43328	3395	43273	2417	50807	2269	20313
12-#14	1.56	MA	35415	7068	56209	5269	61965	4276	64477	3533	67008	2448	80983	2310	39441
2L-6S		MI	23284	7068	37285	5177	39689	4212	39914	3472	38696	2399	45632	1795	27640
12-#14	1.56	MA	34019	7068	54099	5268	59275	4274	61207	3549	62578	2461	74961	2182	39417
3L-5S		MI	23893	7068	38298	5180	41064	4218	41590	3480	40872	2389	48325	1880	28483
12-#14	1.56	MA	33039	7068	52409	5288	57126	4292	58599	3545	59191	2473	71009	2054	39290
4E		MI	24531	7068	39370	5184	42446	4204	43282	3468	43243	2399	51190	1939	28780
12-#14	1.56	MA	32162	7068	50930	5287	55217	4289	56261	3561	55855	2466	66903	1990	38812
5L-3S		MI	25240	7068	40590	5167	43997	4210	45165	3476	45645	2389	53895	2067	28804
12-#14	1.56	MA	31327	7068	49534	5287	53320	4307	53948	3557	52792	2479	62982	1906	37436
6L-2S		MI	26235	7068	42102	5170	45924	4195	47507	3464	48776	2379	58046	2195	28770
12-#18	2.78	MA	39723	7812	65909	5705	74137	4590	79200	3722	86923	2386	107331	2173	68633
2L-6S		MI	24162	7812	40561	5600	43614	4521	44714	3684	44881	2310	54382	1281	44111
12-#18	2.78	MA	37341	7812	62208	5703	69419	4619	73464	3748	79152	2406	96885	1945	68337
3L-5S		MI	25201	7812	42338	5608	46024	4534	47547	3665	48638	2293	59000	1433	46247
12-#18	2.78	MA	35668	7812	59237	5736	65641	4614	68879	3739	73198	2425	90043	1718	66987
4E		MI	26289	7812	44217	5616	48446	4511	50511	3647	52732	2310	63942	1534	48328
12-#18	2.78	MA	34171	7812	56633	5733	62282	4643	64766	3766	67330	2409	82896	1606	63561
5L-3S		MI	27499	7812	46353	5589	51161	4524	53806	3665	56877	2293	68572	1762	49471
12-#18	2.78	MA	32744	7812	54176	5731	58944	4638	60694	3757	61939	2429	76101	1456	60499
6L-2S		MI	29192	7812	48990	5597	54523	4501	57893	3647	62282	2275	75699	1989	49609
14-#11	1.26	MA	34332	6885	53779	5169	58965	4205	60869	3492	62137	2468	74533	2347	32186
2L-7S		MI	22999	6885	36245	5094	38526	4153	38531	3443	36885	2430	42999	1884	22959
14-#11	1.26	MA	33350	6885	52306	5169	57088	4204	58587	3503	59045	2477	70307	2259	32199
3L-6S		MI	23416	6885	37001	5082	39448	4142	39660	3434	38384	2423	44980	1972	23353
14-#11	1.26	MA	32661	6885	51128	5183	55590	4217	56768	3501	56683	2486	67531	2170	32167
4L-5S		MI	23844	6885	37708	5084	40408	4146	40831	3439	39916	2416	46881	2031	23608
14-#11	1.26	MA	32046	6885	50098	5183	54259	4216	55139	3512	54358	2482	64654	2125	32074
5L-4S		MI	24293	6885	38457	5086	41373	4135	42012	3430	41583	2423	48896	2072	23620
14-#11	1.26	MA	31459	6885	49125	5183	52938	4228	53527	3510	52223	2491	61901	2067	31633
6L-3S		MI	24791	6885	39309	5074	42457	4139	43328	3435	43273	2416	50807	2161	23597
14-#11	1.26	MA	30887	6885	48085	5196	51670	4227	51972	3522	50135	2500	59038	1979	30971
7L-2S		MI	25493	6885	40367	5076	43805	4128	44967	3426	45476	2409	53735	2250	23563
14-#14	1.82	MA	36399	7227	58319	5368	64655	4348	67748	3578	71438	2438	87004	2291	45865
2L-7S		MI	23399	7227	37713	5293	40295	4299	40638	3529	39696	2396	46976	1638	31456
14-#14	1.82	MA	35011	7227	56209	5368	61965	4346	64477	3594	67008	2451	80983	2163	45812
3L-6S		MI	23990	7227	38797	5277	41616	4285	42257	3517	41827	2386	49783	1765	32080
14-#14	1.82	MA	34038	7227	54519	5387	59816	4364	61869	3590	63622	2464	77030	2035	45651
4L-5S		MI	24594	7227	39810	5280	42991	4290	43933	3525	44004	2376	52476	1850	32875
14-#14	1.82	MA	33168	7227	53040	5387	57907	4362	59531	3606	60285	2456	72924	1971	44981
5L-4S		MI	25228	7227	40882	5283	44373	4276	45625	3513	46374	2386	55341	1909	33351
14-#14	1.82	MA	32339	7227	51644	5387	56010	4380	57218	3602	57222	2469	69003	1887	43665
6L-3S		MI	25932	7227	42102	5267	45924	4282	47507	3521	48776	2376	58046	2037	33406
14-#14	1.82	MA	31530	7227	50151	5406	54190	4377	54986	3618	54225	2481	64925	1761	42703
7L-2S		MI	26922	7227	43613	5270	47851	4268	49850	3509	51907	2366	62197	2165	33394
14-#18	3.24	MA	39021	8096	65909	5880	74137	4748	79200	3828	86923	2388	107331	1906	79478
3L-6S		MI	25361	8096	43198	5778	46976	4649	48801	3763	50286	2284	61509	1220	51631
14-#18	3.24	MA	37366	8096	62938	5913	70359	4742	74615	3819	80969	2408	100489	1678	77704
4L-5S		MI	26390	8096	44975	5786	49386	4662	51634	3745	54043	2266	66126	1372	53940
14-#18	3.24	MA	35885	8096	60334	5911	67000	4772	70502	3845	75101	2392	93342	1566	74438
5L-4S		MI	27468	8096	46854	5794	51808	4639	54598	3727	58136	2284	71069	1474	55893
14-#18	3.24	MA	34474	8096	57876	5909	63662	4766	66430	3836	69710	2411	86547	1416	71214
6L-3S		MI	28667	8096	48990	5766	54523	4652	57893	3745	62282	2266	75699	1701	57412
14-#18	3.24	MA	33097	8096	55247	5942	60457	4796	62502	3863	64434	2431	79475	1192	67865
7L-2S		MI	30346	8096	51627	5774	57885	4629	61980	3726	67686	2248	82826	1928	57607

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

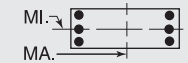
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.44	MA	35029	6995	55252	5238	60843	4255	63152	3523	65229	2461	78759	2335	36679
2L-8S		MI	23088	6995	36608	5161	38944	4199	39064	3483	37518	2415	44045	1816	25810
16-#11	1.44	MA	34051	6995	53779	5238	58965	4254	60869	3534	62137	2470	74533	2247	36674
3L-7S		MI	23498	6995	37303	5163	39875	4203	40170	3474	39088	2422	45927	1865	26089
16-#11	1.44	MA	33366	6995	52601	5252	57467	4267	59051	3532	59775	2479	71757	2158	36627
4L-6S		MI	23914	6995	38059	5151	40797	4192	41300	3465	40587	2415	47908	1953	26464
16-#11	1.44	MA	32753	6995	51570	5252	56137	4266	57422	3544	57450	2475	68880	2112	36516
5E		MI	24340	6995	38766	5153	41756	4196	42470	3470	42118	2408	49809	2011	26811
16-#11	1.44	MA	32170	6995	50598	5252	54815	4278	55809	3541	55315	2484	66127	2054	35978
6L-4S		MI	24786	6995	39515	5155	42722	4185	43652	3461	43786	2415	51824	2053	26841
16-#11	1.44	MA	31601	6995	49558	5266	53547	4277	54255	3553	53227	2493	63264	1967	35341
7L-3S		MI	25282	6995	40367	5143	43805	4189	44967	3466	45476	2408	53735	2142	26832
16-#11	1.44	MA	31040	6995	48604	5266	52267	4290	52733	3564	51039	2489	60575	1914	34861
8L-2S		MI	25981	6995	41425	5145	45154	4179	46606	3458	47678	2401	56663	2231	26806
16-#14	2.08	MA	37375	7387	60429	5468	67345	4421	71018	3623	75869	2428	93026	2272	52277
2L-8S		MI	23525	7387	38230	5390	40889	4366	41396	3585	40595	2373	48452	1539	34772
16-#14	2.08	MA	35996	7387	58319	5468	64655	4419	67748	3639	71438	2441	87004	2144	52199
3L-7S		MI	24103	7387	39225	5393	42222	4371	42981	3574	42828	2383	51127	1608	35809
16-#14	2.08	MA	35029	7387	56629	5487	62506	4436	65139	3635	68052	2454	83052	2016	52009
4L-6S		MI	24690	7387	40308	5377	43543	4357	44599	3562	44958	2373	53934	1735	36529
16-#14	2.08	MA	34166	7387	55150	5487	60597	4434	62801	3651	64716	2446	78946	1952	51167
5E		MI	25291	7387	41321	5380	44918	4363	46275	3570	47135	2363	56628	1820	37283
16-#14	2.08	MA	33343	7387	53754	5486	58700	4452	60488	3647	61652	2459	75025	1868	49904
6L-4S		MI	25920	7387	42393	5383	46300	4348	47967	3558	49505	2373	59492	1880	37914
16-#14	2.08	MA	32540	7387	52261	5506	56880	4450	58256	3663	58655	2471	70947	1742	48850
7L-3S		MI	26620	7387	43613	5367	47851	4354	49850	3566	51907	2363	62197	2007	37994
16-#14	2.08	MA	31748	7387	50891	5505	55043	4467	56072	3679	55515	2464	67109	1666	47200
8L-2S		MI	27605	7387	45125	5370	49778	4340	52192	3554	55038	2353	66348	2135	38008
16-#18	3.70	MA	39045	8380	66639	6090	75077	4871	80351	3899	88740	2390	110935	1639	88458
4L-6S		MI	26549	8380	45835	5955	50338	4778	52888	3843	55691	2257	68636	1159	59178
16-#18	3.70	MA	37581	8380	64035	6088	71719	4900	76238	3925	82872	2374	103788	1527	85337
5E		MI	27569	8380	47612	5963	52748	4791	55721	3825	59448	2240	73253	1311	61653
16-#18	3.70	MA	36185	8380	61577	6086	68381	4895	72166	3916	77481	2394	96993	1377	81953
6L-4S		MI	28637	8380	49491	5971	55170	4768	58685	3807	63541	2257	78195	1413	63492
16-#18	3.70	MA	34824	8380	58948	6119	65175	4924	68238	3942	72205	2413	89921	1152	78672
7L-3S		MI	29825	8380	51627	5944	57885	4781	61980	3824	67686	2240	82826	1640	65341
16-#18	3.70	MA	33480	8380	56536	6117	61941	4919	64392	3969	66679	2397	83243	1022	74189
8L-2S		MI	31491	8380	54264	5952	61247	4758	66067	3806	73091	2222	89953	1868	65591
18-#11	1.63	MA	35721	7106	56724	5307	62720	4305	65434	3554	68321	2454	82985	2323	41168
2L-9S		MI	23182	7106	36932	5242	39383	4260	39559	3509	38237	2414	45131	1740	28289
18-#11	1.63	MA	34747	7106	55252	5307	60843	4304	63152	3565	65229	2463	78759	2234	41146
3L-8S		MI	23587	7106	37666	5230	40293	4249	40703	3514	39721	2407	46973	1797	28881
18-#11	1.63	MA	34066	7106	54074	5321	59345	4317	61333	3563	62868	2472	75982	2146	41084
4L-7S		MI	23995	7106	38360	5232	41223	4253	41809	3505	41291	2414	48855	1846	29224
18-#11	1.63	MA	33457	7106	53043	5321	58015	4316	59704	3575	60542	2468	73106	2100	40955
5L-6S		MI	24408	7106	39117	5220	42145	4243	42939	3496	42790	2407	50836	1934	29581
18-#11	1.63	MA	32877	7106	52071	5321	56693	4328	58092	3572	58408	2477	70353	2042	40331
6L-5S		MI	24832	7106	39824	5222	43105	4246	44109	3501	44321	2400	52737	1992	30009
18-#11	1.63	MA	32311	7106	51030	5335	55425	4327	56537	3584	56319	2486	67490	1955	39716
7L-4S		MI	25276	7106	40572	5224	44070	4236	45291	3493	45989	2407	54752	2034	30054
18-#11	1.63	MA	31753	7106	50076	5335	54145	4340	55015	3595	54131	2482	64801	1902	39175
8L-3S		MI	25770	7106	41425	5212	45154	4239	46606	3498	47678	2400	56663	2123	30061
18-#11	1.63	MA	31155	7106	49140	5335	52895	4339	53441	3593	52065	2491	62133	1846	38228
9L-2S		MI	26466	7106	42483	5214	46503	4229	48246	3489	49881	2393	59591	2212	30043

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

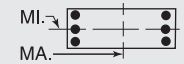


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.34	MA	36973	7547	60429	5567	67345	4491	71018	3684	75869	2431	93026	2125	58581
3L-8S		MI	24228	7547	39741	5490	42816	4438	43739	3630	43726	2361	52603	1509	39176
18-#14	2.34	MA	36013	7547	58739	5587	65196	4509	68409	3680	72482	2444	89073	1997	58363
4L-7S		MI	24802	7546	40736	5493	44149	4444	45324	3619	45959	2371	55278	1579	40174
18-#14	2.34	MA	35156	7546	57260	5586	63287	4506	66072	3696	69146	2436	84968	1933	57367
5L-6S		MI	25385	7546	41820	5476	45470	4429	46942	3607	48089	2361	58085	1705	40986
18-#14	2.34	MA	34339	7547	55864	5586	61390	4524	63758	3692	66082	2449	81047	1849	56151
6L-5S		MI	25982	7547	42832	5480	46845	4435	48618	3615	50266	2351	60779	1790	41703
18-#14	2.34	MA	33542	7547	54370	5606	59570	4522	61526	3708	63085	2461	76968	1722	55008
7L-4S		MI	26608	7547	43905	5483	48227	4421	50310	3603	52637	2361	63643	1850	42471
18-#14	2.34	MA	32756	7547	53001	5605	57733	4540	59342	3724	59945	2454	73130	1647	53404
8L-3S		MI	27304	7547	45125	5466	49778	4426	52192	3611	55038	2351	66348	1978	42575
18-#14	2.34	MA	31918	7546	51657	5605	55938	4538	57082	3720	56979	2467	69332	1567	51728
9L-2S		MI	28283	7546	46636	5470	51705	4412	54535	3599	58170	2341	70499	2106	42612
18-#18	4.17	MA	39260	8664	67735	6265	76437	5029	81974	4005	90643	2356	114234	1487	96254
5L-6S		MI	27726	8664	48472	6132	53700	4907	56975	3923	61096	2231	75763	1098	66751
18-#18	4.17	MA	37879	8664	65278	6263	73099	5023	77902	3996	85251	2376	107439	1337	92715
6L-5S		MI	28737	8664	50249	6140	56110	4919	59807	3905	64853	2213	80380	1250	69383
18-#18	4.17	MA	36532	8664	62649	6296	69894	5053	73974	4022	79976	2395	100367	1113	89340
7L-4S		MI	29795	8664	52128	6148	58532	4897	62772	3887	68946	2231	85322	1352	71120
18-#18	4.17	MA	35203	8664	60237	6294	66659	5047	70128	4049	74450	2380	93689	982	84964
8L-3S		MI	30973	8664	54264	6121	61247	4909	66067	3904	73091	2213	89953	1579	73262
20-#11	1.81	MA	35440	7217	56724	5376	62720	4354	65434	3597	68321	2456	82985	2222	45613
3L-9S		MI	23680	7217	37989	5311	40732	4310	41198	3540	40440	2406	48059	1721	31388
20-#11	1.81	MA	34762	7217	55546	5390	61222	4367	63616	3594	65960	2465	80208	2133	45537
4L-8S		MI	24082	7217	38724	5299	41641	4300	42342	3545	41923	2399	49901	1778	31959
20-#11	1.81	MA	34156	7217	54516	5390	59892	4366	61986	3606	63634	2461	77332	2088	45393
5L-7S		MI	24488	7217	39418	5301	42572	4303	43449	3536	43494	2406	51783	1826	32361
20-#11	1.81	MA	33579	7217	53543	5390	58571	4379	60374	3604	61500	2470	74579	2030	44690
6E		MI	24900	7217	40175	5289	43494	4293	44578	3527	44993	2399	53764	1914	32705
20-#11	1.81	MA	33017	7217	52503	5404	57302	4377	58820	3615	59411	2479	71716	1943	44094
7L-5S		MI	25322	7217	40881	5291	44453	4296	45749	3532	46524	2392	55665	1973	33203
20-#11	1.81	MA	32462	7217	51549	5404	56022	4390	57298	3627	57223	2475	69027	1890	43495
8L-4S		MI	25764	7217	41630	5293	45419	4286	46930	3524	48191	2399	57680	2015	33261
20-#11	1.81	MA	31866	7217	50613	5404	54772	4389	55723	3624	55157	2484	66359	1834	42572
9L-3S		MI	26256	7217	42483	5281	46503	4289	48246	3529	49881	2392	59591	2104	33286
20-#11	1.81	MA	31255	7217	49590	5418	53509	4402	54211	3636	53106	2493	63771	1771	41738
10L-2S		MI	26949	7217	43540	5283	47851	4279	49885	3520	52084	2385	62519	2192	33275
20-#14	2.60	MA	36990	7706	60849	5687	67886	4581	71679	3725	76912	2434	95095	1978	64714
4L-8S		MI	24926	7706	41252	5589	44743	4510	46081	3675	46857	2348	56754	1479	43589
20-#14	2.60	MA	36138	7706	59369	5686	65977	4579	69342	3741	73576	2426	90989	1913	63578
5L-7S		MI	25497	7706	42247	5593	46076	4516	47666	3663	49090	2358	59430	1549	44551
20-#14	2.60	MA	35327	7706	57974	5686	64080	4597	67028	3737	70512	2439	87068	1830	62406
6E		MI	26076	7706	43331	5576	47397	4502	49284	3652	51221	2348	62236	1676	45449
20-#14	2.60	MA	34536	7706	56480	5705	62260	4594	64797	3753	67515	2451	82990	1703	61177
7L-5S		MI	26669	7706	44344	5579	48772	4507	50960	3660	53398	2338	64930	1761	46133
20-#14	2.60	MA	33756	7706	55111	5705	60423	4612	62612	3769	64375	2444	79152	1628	59616
8L-4S		MI	27291	7706	45416	5583	50154	4493	52653	3648	55768	2348	67794	1820	47023
20-#14	2.60	MA	32938	7706	53767	5704	58628	4610	60352	3765	61409	2457	75353	1547	57887
9L-3S		MI	27983	7706	46636	5566	51705	4499	54535	3656	58170	2338	70499	1948	47149
20-#14	2.60	MA	32062	7706	52299	5724	56815	4628	58181	3781	58466	2469	71668	1456	56173
10L-2S		MI	28958	7706	48148	5569	53632	4485	56878	3644	61301	2328	74651	2076	47205
20-#18	4.63	MA	39556	8947	68979	6441	77817	5152	83638	4076	93022	2358	117885	1298	103498
6E		MI	28894	8947	51109	6310	57062	5035	61062	4003	66500	2204	82890	1038	74345
20-#18	4.63	MA	38223	8947	66350	6474	74612	5182	79710	4102	87747	2378	110813	1073	100027
7L-5S		MI	29896	8947	52886	6318	59472	5048	63894	3985	70257	2186	87507	1190	77126
20-#18	4.63	MA	36908	8947	63937	6471	71378	5176	75864	4128	82220	2362	104135	943	95755
8L-4S		MI	30945	8947	54765	6326	61894	5025	66859	3967	74351	2204	92449	1291	78773

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

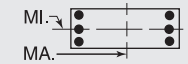


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.99	MA	35454	7327	57019	5459	63100	4417	65898	3625	69052	2459	84434	2121	49987
4L-9S		MI	24175	7327	39047	5380	42081	4360	42837	3571	42643	2398	50987	1702	34491
22-#11	1.99	MA	34852	7327	55988	5459	61770	4416	64269	3637	66727	2454	81558	2076	49828
5L-8S		MI	24576	7327	39782	5368	42990	4350	43982	3576	44126	2391	52829	1758	35044
22-#11	1.99	MA	34278	7327	55016	5459	60448	4429	62657	3635	64592	2463	78805	2018	49055
6L-7S		MI	24980	7327	40476	5370	43920	4353	45088	3567	45697	2398	54711	1807	35502
22-#11	1.99	MA	33718	7327	53976	5473	59180	4428	61102	3646	62503	2473	75942	1931	48477
7L-6S		MI	25390	7327	41232	5358	44842	4343	46218	3559	47196	2391	56692	1895	35832
22-#11	1.99	MA	33167	7327	53022	5473	57900	4440	59580	3658	60316	2468	73253	1878	47822
8L-5S		MI	25810	7327	41939	5360	45802	4346	47388	3564	48727	2384	58593	1954	36394
22-#11	1.99	MA	32574	7327	52085	5473	56650	4439	58005	3655	58249	2477	70585	1822	46921
9L-4S		MI	26249	7327	42688	5362	46767	4336	48570	3555	50394	2391	60608	1996	36465
22-#11	1.99	MA	31966	7327	51063	5487	55386	4452	56493	3667	56199	2486	67997	1759	46050
10L-3S		MI	26739	7327	43540	5350	47851	4339	49885	3560	52084	2384	62519	2085	36498
22-#11	1.99	MA	31371	7327	50127	5487	54143	4451	54937	3665	54041	2482	65371	1703	44977
11L-2S		MI	27430	7327	44598	5352	49200	4329	51524	3551	54287	2377	65447	2173	36503
22-#14	2.86	MA	37115	7866	61479	5786	68667	4651	72612	3786	78006	2416	97011	1894	69800
5L-8S		MI	25619	7866	42764	5689	46670	4583	48424	3720	49989	2335	60906	1450	48008
22-#14	2.86	MA	36309	7866	60084	5786	66770	4669	70298	3782	74943	2429	93090	1810	68667
6L-7S		MI	26187	7866	43759	5692	48003	4588	50009	3708	52222	2345	63581	1519	48937
22-#14	2.86	MA	35523	7866	58590	5805	64950	4667	68067	3798	71945	2442	89011	1684	67355
7L-6S		MI	26763	7866	44843	5676	49324	4574	51627	3696	54352	2335	66388	1646	49917
22-#14	2.86	MA	34749	7866	57221	5805	63113	4684	65882	3814	68806	2434	85174	1609	65835
8L-5S		MI	27353	7866	45855	5679	50699	4580	53303	3704	56529	2325	69081	1731	50573
22-#14	2.86	MA	33932	7866	55876	5804	61318	4682	63622	3810	65840	2447	81375	1528	64055
9L-4S		MI	27971	7866	46927	5682	52081	4565	54995	3693	58899	2335	71946	1790	51572
22-#14	2.86	MA	33066	7866	54409	5824	59505	4700	61451	3826	62896	2459	77690	1437	62241
10L-3S		MI	28659	7866	48148	5666	53632	4571	56878	3701	61301	2325	74651	1918	51718
22-#18	5.09	MA	39899	9231	70050	6651	79331	5310	85446	4182	95517	2360	121259	1034	110733
7L-6S		MI	30053	9231	53746	6487	60424	5164	65149	4083	71905	2178	90017	977	81959
22-#18	5.09	MA	38598	9231	67638	6649	76096	5305	81600	4208	89991	2344	114581	903	106412
8L-5S		MI	31046	9231	55523	6495	62834	5176	67981	4065	75662	2160	94634	1129	84880
24-#11	2.17	MA	35543	7438	57461	5528	63647	4466	66551	3668	69819	2447	85784	2064	54263
5L-9S		MI	24668	7438	40105	5449	43429	4410	44477	3602	44846	2390	53915	1683	37598
24-#11	2.17	MA	34973	7438	56489	5528	62326	4479	64939	3666	67684	2456	83031	2006	53425
6L-8S		MI	25067	7438	40839	5438	44338	4400	45621	3607	46329	2383	55757	1739	38134
24-#11	2.17	MA	34416	7438	55448	5542	61057	4478	63384	3677	65596	2466	80168	1918	52862
7E		MI	25469	7438	41534	5439	45269	4403	46727	3599	47900	2390	57639	1788	38644
24-#11	2.17	MA	33867	7438	54494	5542	59778	4490	61862	3689	63408	2461	77479	1866	52153
8L-6S		MI	25877	7438	42290	5428	46191	4393	47857	3590	49399	2383	59620	1876	38964
24-#11	2.17	MA	33278	7438	53558	5542	58527	4489	60288	3687	61341	2470	74811	1810	51274
9L-5S		MI	26295	7438	42997	5429	47150	4396	49027	3595	50930	2376	61521	1935	39521
24-#11	2.17	MA	32672	7438	52535	5556	57264	4502	58776	3698	59291	2480	72223	1747	50367
10L-4S		MI	26733	7438	43745	5431	48116	4386	50209	3586	52597	2383	63536	1977	39665
24-#11	2.17	MA	32080	7438	51599	5556	56021	4501	57219	3696	57134	2475	69597	1691	49314
11L-3S		MI	27221	7438	44598	5419	49200	4389	51524	3591	54287	2376	65447	2065	39709
24-#11	2.17	MA	31498	7438	50593	5570	54766	4513	55711	3707	55086	2484	66705	1617	48095
12L-2S		MI	27909	7438	45656	5421	50548	4379	53164	3582	56490	2369	68375	2154	39728
24-#14	3.13	MA	37284	8025	62194	5885	69460	4741	73568	3827	79373	2419	99111	1791	74934
6L-8S		MI	26309	8025	44275	5789	48597	4655	50766	3765	53120	2322	65057	1420	52434
24-#14	3.13	MA	36504	8025	60700	5905	67640	4739	71337	3843	76375	2432	95033	1665	73542
7E		MI	26873	8025	45270	5792	49930	4661	52351	3753	55353	2332	67732	1489	53333
24-#14	3.13	MA	35735	8025	59331	5904	65803	4757	69152	3859	73236	2424	91195	1590	72060
8L-6S		MI	27445	8025	46354	5776	51251	4646	53969	3741	57483	2322	70539	1616	54389
24-#14	3.13	MA	34920	8025	57986	5904	64008	4755	66892	3855	70270	2437	87396	1509	70229
9L-5S		MI	28032	8025	47367	5779	52625	4652	55645	3749	59660	2312	73232	1701	55019
24-#14	3.13	MA	34062	8025	56518	5923	62195	4772	64721	3871	67326	2449	83711	1418	68381
10L-4S		MI	28646	8025	48439	5782	54008	4638	57338	3738	62030	2322	76097	1760	56117
24-#18	5.56	MA	40273	9515	71339	6826	80815	5433	87335	4288	97762	2327	125027	864	117237
8L-6S		MI	31204	9515	56383	6664	63786	5292	69236	4162	77310	2151	97144	916	89591

RECTANGULAR TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.66	MA	23324	5957	37631	4339	41071	3518	42563	2900	43816	1972	52192	1808	26818
2L-3S		MI	21477	5957	34817	4332	37482	3542	38201	2920	38012	1989	44514	1581	26817
8-#14	1.25	MA	22448	5744	35517	4237	38530	3447	39533	2861	39941	2015	47173	1883	20515
2L-4S		MI	20618	5744	32607	4251	34825	3457	35032	2867	34009	2035	39799	1627	20538
8-#18	2.22	MA	24591	6241	40445	4516	44659	3646	46925	2980	49621	1947	59871	1752	35417
2L-4S		MI	21462	6241	35356	4538	38178	3659	39054	2984	39364	1983	47195	1297	34019
10-#11	1.08	MA	22087	5659	34646	4199	37499	3421	38309	2848	38366	2033	45127	1912	17948
2L-5S		MI	20324	5659	31817	4208	33883	3440	33907	2863	32412	2040	37770	1692	17978
10-#11	1.08	MA	21336	5659	33519	4198	36062	3432	36563	2858	36007	2040	41984	1824	17986
3L-4S		MI	20803	5659	32613	4210	34909	3429	35163	2853	34197	2047	39929	1735	18009
10-#14	1.56	MA	23190	5904	37128	4337	40584	3519	42030	2906	43298	2003	51635	1855	25452
2L-5S		MI	20697	5904	33078	4348	35409	3544	35730	2925	34826	2013	41190	1539	24745
10-#14	1.56	MA	22128	5904	35517	4334	38530	3534	39533	2919	39941	2013	47173	1727	25473
3L-4S		MI	21374	5904	34218	4351	36879	3529	37529	2912	37366	2023	44261	1599	25403
10-#18	2.77	MA	25842	6525	43260	4694	48247	3775	51287	3059	55426	1923	67549	1696	43975
2L-5S		MI	21591	6525	36170	4709	39188	3812	40259	3084	40774	1941	49564	1137	39802
10-#18	2.77	MA	24034	6525	40445	4687	44659	3799	46925	3079	49621	1941	59871	1468	43786
3L-4S		MI	22747	6525	38170	4715	41766	3788	43415	3064	45169	1959	54874	1241	42044

RECTANGULAR TIED COLUMNS 38" x 40"

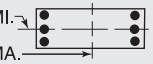
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.05	MA	24321	5942	38254	4380	41214	3569	41977	2973	41734	2117	48872	1986	19251
2E		MI	23063	5942	36353	4362	39078	3554	39753	2960	39401	2104	46049	1968	18213
6-#18	1.58	MA	25697	6226	41246	4557	45028	3697	46614	3052	47939	2095	57102	1934	28438
2L-3S		MI	22500	6226	36353	4533	39078	3707	39753	3060	39401	2097	46049	1685	26890
6-#18	1.58	MA	23728	6226	38254	4552	41214	3723	41977	3074	41734	2113	48872	1706	28437
3L-2S		MI	24350	6226	39167	4539	42666	3683	44115	3040	45206	2079	53727	1912	26868
8-#14	1.18	MA	24754	6013	38990	4455	42316	3626	43379	3014	43769	2136	51680	2004	21730
2L-4S		MI	21640	6013	34137	4453	36420	3623	36587	3008	35405	2143	41342	1732	20601
8-#14	1.18	MA	23615	6013	37279	4453	40134	3642	40727	3028	40187	2146	46906	1876	21777
3E		MI	22401	6013	35436	4436	38071	3628	38591	3015	37980	2133	44254	1860	20606
8-#14	1.18	MA	22808	6013	35902	4471	38384	3638	38603	3021	37439	2156	43786	1748	21753
4L-2S		MI	23472	6013	37047	4439	40125	3613	41088	3003	41336	2123	48717	1988	20553
8-#18	2.11	MA	27054	6510	44237	4735	48842	3826	51250	3132	54144	2073	65333	1882	37577
2L-4S		MI	22483	6510	36892	4739	39773	3824	40605	3124	40754	2090	48730	1401	34396
8-#18	2.11	MA	25106	6510	41246	4729	45028	3852	46614	3154	47939	2091	57102	1654	37473
3E		MI	23789	6510	39167	4710	42666	3835	44115	3139	45206	2073	53727	1628	35398
8-#18	2.11	MA	23722	6510	38831	4759	41958	3842	42889	3140	43179	2108	51737	1426	36403
4L-2S		MI	25620	6510	41981	4717	46254	3811	48476	3120	51011	2055	61406	1856	35474
10-#11	1.03	MA	24366	5928	38061	4417	41216	3600	42074	3001	42056	2152	49473	2033	19001
2L-5S		MI	21345	5928	33344	4411	35479	3606	35464	3004	33810	2149	39318	1798	18036
10-#11	1.03	MA	23566	5928	36865	4416	39691	3612	40220	3011	39544	2159	46113	1944	19039
3L-4S		MI	21824	5928	34140	4413	36505	3596	36720	2995	35595	2155	41476	1840	18051
10-#11	1.03	MA	23000	5928	35904	4429	38469	3609	38737	3007	37618	2166	43914	1855	19062
4L-3S		MI	22358	5928	35046	4400	37658	3598	38119	2999	37405	2149	43531	1929	18022
10-#11	1.03	MA	22493	5928	35061	4428	37382	3620	37406	3017	35720	2160	41612	1812	19031
5L-2S		MI	23111	5928	36173	4402	39094	3588	39866	2990	39765	2142	46675	2018	17981
10-#14	1.48	MA	25548	6173	40700	4555	44497	3699	46031	3059	47351	2126	56453	1979	26971
2L-5S		MI	21718	6173	34608	4550	37004	3710	37284	3066	36221	2122	42733	1644	24963
10-#14	1.48	MA	24417	6173	38990	4553	42316	3714	43379	3072	43769	2136	51680	1851	26991
3L-4S		MI	22397	6173	35748	4553	38474	3695	39084	3053	38761	2132	45804	1704	25473

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

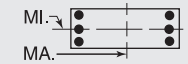
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.48	MA	23616	6173	37613	4571	40565	3710	41255	3066	41021	2145	48560	1723	26922
4L-3S		MI	23152	6173	37047	4536	40125	3700	41088	3060	41336	2122	48717	1832	25524
10-#14	1.48	MA	22897	6173	36405	4568	39007	3726	39347	3080	38311	2136	45282	1661	26362
5L-2S		MI	24216	6173	38658	4539	42180	3685	43585	3048	44693	2112	53179	1960	25494
10-#18	2.63	MA	28393	6793	47229	4912	52656	3955	55887	3212	60349	2051	73564	1829	46675
2L-5S		MI	22611	6793	37706	4909	40783	3977	41811	3224	42163	2048	51099	1241	40115
10-#18	2.63	MA	26466	6793	44237	4906	48842	3980	51250	3233	54144	2068	65333	1602	46486
3L-4S		MI	23771	6793	39706	4916	43361	3953	44967	3204	46558	2066	56409	1345	42412
10-#18	2.63	MA	25098	6793	41823	4936	45772	3970	47525	3220	49384	2086	59968	1374	44944
4L-3S		MI	25062	6793	41981	4887	46254	3964	48476	3219	51011	2048	61406	1572	43879
10-#18	2.63	MA	23869	6793	39702	4930	43038	3996	44178	3241	44687	2068	54292	1269	42433
5L-2S		MI	26874	6793	44796	4894	49842	3940	52838	3199	56816	2031	69084	1800	44041
12-#11	1.23	MA	24927	6039	39257	4487	42741	3651	43928	3032	44567	2145	52833	2016	22669
2L-6S		MI	21426	6039	33720	4479	35895	3654	35966	3031	34529	2148	40419	1721	21031
12-#11	1.23	MA	24131	6039	38061	4485	41216	3662	42074	3042	42056	2152	49473	1927	22696
3L-5S		MI	21881	6039	34471	4480	36915	3657	37210	3036	36170	2141	42462	1780	21444
12-#11	1.23	MA	23569	6039	37100	4498	39994	3659	40591	3038	40130	2160	47274	1839	22698
4E		MI	22357	6039	35266	4482	37941	3646	38467	3026	37955	2148	44620	1823	21484
12-#11	1.23	MA	23064	6039	36257	4497	38907	3671	39260	3048	38231	2153	44972	1795	22644
5L-3S		MI	22888	6039	36173	4470	39094	3649	39866	3031	39765	2141	46675	1911	21472
12-#11	1.23	MA	22583	6039	35462	4496	37827	3668	37942	3044	36486	2160	42787	1737	22189
6L-2S		MI	23637	6039	37300	4471	40531	3638	41612	3021	42124	2134	49819	2000	21441
12-#14	1.78	MA	26335	6332	42411	4655	46678	3771	48682	3104	50934	2115	61227	1953	32198
2L-6S		MI	21831	6332	35143	4647	37597	3778	37999	3104	37244	2120	44298	1531	28762
12-#14	1.78	MA	25212	6332	40700	4653	44497	3787	46031	3117	47351	2125	56453	1825	32186
3L-5S		MI	22473	6332	36220	4650	39059	3783	39782	3111	39578	2110	47195	1616	29639
12-#14	1.78	MA	24417	6332	39324	4670	42746	3782	43906	3111	44603	2135	53333	1697	32081
4E		MI	23147	6332	37360	4653	40529	3768	41581	3098	42118	2120	50266	1677	30335
12-#14	1.78	MA	23704	6332	38116	4668	41189	3798	41999	3125	41893	2125	50056	1636	31334
5L-3S		MI	23897	6332	38658	4636	42180	3772	43585	3105	44693	2110	53179	1805	30421
12-#14	1.78	MA	23023	6332	36975	4666	39640	3794	40110	3118	39403	2135	46954	1551	30373
6L-2S		MI	24954	6332	40269	4638	44234	3757	46082	3092	48050	2100	57641	1933	30420
12-#18	3.16	MA	29718	7077	50221	5089	56470	4083	60523	3292	66554	2028	81795	1777	55746
2L-6S		MI	22802	7077	38630	5080	41806	4094	43045	3288	43933	2042	53798	1033	45503
12-#18	3.16	MA	27809	7077	47229	5084	52656	4109	55887	3313	60349	2046	73564	1550	55484
3L-5S		MI	23896	7077	40520	5086	44371	4106	46172	3303	47968	2024	58777	1185	48323
12-#18	3.16	MA	26456	7077	44815	5113	49586	4099	52162	3299	55589	2064	68199	1322	53533
4E		MI	25043	7077	42521	5093	46949	4081	49329	3284	52363	2042	64087	1288	50476
12-#18	3.16	MA	25242	7077	42694	5108	46852	4124	48814	3321	50892	2046	62522	1217	51171
5L-3S		MI	26320	7077	44796	5065	49842	4093	52838	3299	56816	2024	69084	1516	52345
12-#18	3.16	MA	24084	7077	40690	5102	44132	4115	45498	3307	46579	2064	57181	1065	48168
6L-2S		MI	28115	7077	47610	5071	53430	4068	57200	3279	62620	2007	76762	1744	52578
14-#11	1.44	MA	25484	6149	40453	4556	44266	3701	45781	3063	47078	2138	56193	2000	26328
2L-7S		MI	21519	6149	34043	4560	36352	3715	36512	3072	35283	2148	41435	1616	23921
14-#11	1.44	MA	24693	6149	39257	4555	42741	3712	43928	3073	44567	2146	52833	1911	26346
3L-6S		MI	21960	6149	34847	4548	37332	3704	37713	3062	36889	2141	43563	1704	24341
14-#11	1.44	MA	24133	6149	38296	4567	41519	3709	42445	3069	42641	2153	50634	1822	26326
4L-5S		MI	22413	6149	35598	4550	38352	3707	38957	3067	38529	2134	45606	1762	24846
14-#11	1.44	MA	23632	6149	37453	4566	40432	3721	41114	3079	40742	2146	48332	1779	26251
5L-4S		MI	22886	6149	36393	4551	39378	3696	40213	3057	40314	2141	47764	1805	24905
14-#11	1.44	MA	23153	6149	36658	4565	39352	3718	39796	3075	38998	2153	46147	1721	25704
6L-3S		MI	23414	6149	37300	4539	40531	3699	41612	3062	42124	2134	49819	1894	24914
14-#11	1.44	MA	22686	6149	35807	4578	38314	3730	38525	3085	37290	2160	43873	1633	25241
7L-2S		MI	24160	6149	38427	4540	41968	3688	43359	3052	44483	2127	52963	1982	24892

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis

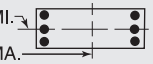


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.07	MA	27116	6492	44122	4754	48860	3843	51334	3149	54516	2104	66001	1928	37413
2L-7S		MI	21961	6492	35602	4764	38247	3865	38776	3161	38317	2118	45742	1377	32471
14-#14	2.07	MA	26000	6492	42411	4752	46678	3859	48682	3162	50934	2114	61227	1800	37371
3L-6S		MI	22584	6492	36754	4747	39651	3850	40496	3149	40601	2108	48760	1504	33501
14-#14	2.07	MA	25210	6492	41035	4770	44928	3855	46558	3156	48185	2124	58107	1672	37233
4L-5S		MI	23222	6492	37831	4750	41113	3855	42279	3156	42934	2098	51658	1589	34333
14-#14	2.07	MA	24503	6492	39827	4768	43370	3870	44650	3169	45475	2114	54829	1611	36324
5L-4S		MI	23891	6492	38971	4753	42583	3840	44078	3143	45475	2108	54729	1649	35189
14-#14	2.07	MA	23828	6492	38686	4766	41821	3866	42762	3163	42985	2124	51727	1526	35410
6L-3S		MI	24636	6492	40269	4735	44234	3845	46082	3150	48050	2098	57641	1777	35306
14-#14	2.07	MA	23169	6492	37466	4783	40334	3882	40939	3177	40547	2134	48497	1399	34305
7L-2S		MI	25686	6492	41881	4738	46288	3830	48579	3137	51406	2088	62103	1905	35338
14-#18	3.68	MA	29138	7361	50221	5261	56470	4237	60523	3393	66554	2024	81795	1498	64471
3L-6S		MI	24084	7361	41445	5257	45395	4223	47407	3368	49738	2018	61477	977	53574
14-#18	3.68	MA	27800	7361	47806	5291	53401	4227	56799	3379	61794	2042	76430	1270	62163
4L-5S		MI	25167	7361	43335	5264	47959	4234	50534	3383	53773	2000	66456	1129	56553
14-#18	3.68	MA	26599	7361	45685	5285	50666	4253	53451	3401	57097	2024	70753	1164	59933
5L-4S		MI	26301	7361	45335	5270	50537	4210	53690	3363	58168	2018	71765	1232	58581
14-#18	3.68	MA	25454	7361	43682	5279	47947	4243	50135	3387	52784	2042	65412	1013	56770
6L-3S		MI	27564	7361	47610	5242	53430	4221	57200	3379	62620	2000	76762	1460	60799
16-#11	1.64	MA	26039	6260	41649	4625	45791	3751	47635	3094	49589	2131	59553	1984	29982
2L-8S		MI	21620	6260	34432	4628	36800	3762	37083	3112	35961	2134	42563	1549	26695
16-#11	1.64	MA	25250	6260	40453	4624	44266	3762	45781	3104	47078	2139	56193	1895	29985
3L-7S		MI	22053	6260	35170	4629	37789	3765	38259	3103	37643	2140	44579	1598	27256
16-#11	1.64	MA	24694	6260	39492	4636	43044	3760	44298	3100	45152	2146	53994	1806	29948
4L-6S		MI	22491	6260	35973	4617	38769	3754	39459	3093	39248	2134	46707	1686	27659
16-#11	1.64	MA	24195	6260	38649	4635	41957	3771	42967	3110	43254	2139	51692	1763	29855
5E		MI	22941	6260	36725	4619	39789	3757	40703	3098	40888	2127	48749	1745	28243
16-#11	1.64	MA	23720	6260	37854	4634	40876	3768	41650	3106	41509	2146	49507	1704	29227
6L-4S		MI	23412	6260	37520	4620	40815	3746	41960	3088	42673	2134	50908	1787	28320
16-#11	1.64	MA	23255	6260	37003	4647	39839	3780	40378	3116	39802	2153	47233	1617	28783
7L-3S		MI	23938	6260	38427	4608	41968	3749	43359	3093	44483	2127	52963	1876	28349
16-#11	1.64	MA	22798	6260	36222	4646	38792	3777	39133	3126	38013	2147	45082	1566	28176
8L-2S		MI	24680	6260	39554	4609	43404	3738	45105	3083	46842	2120	56107	1965	28337
16-#14	2.37	MA	27891	6651	45833	4854	51041	3916	53986	3194	58098	2094	70774	1902	42613
2L-8S		MI	22104	6651	36156	4861	38884	3932	39588	3219	39281	2097	47335	1279	36055
16-#14	2.37	MA	26782	6651	44122	4852	48860	3931	51334	3207	54516	2104	66001	1774	42547
3L-7S		MI	22714	6651	37213	4864	40301	3937	41273	3206	41674	2107	50204	1350	37132
16-#14	2.37	MA	25998	6651	42746	4870	47109	3927	49210	3201	51768	2114	62881	1646	42380
4L-6S		MI	23332	6651	38365	4847	41705	3922	42993	3193	43957	2097	53222	1476	38249
16-#14	2.37	MA	25296	6651	41538	4868	45551	3943	47302	3214	49057	2104	59603	1585	41329
5E		MI	23965	6651	39442	4850	43167	3927	44776	3201	46291	2087	56120	1561	39042
16-#14	2.37	MA	24626	6651	40397	4865	44003	3938	45413	3208	46567	2114	56501	1500	40456
6L-4S		MI	24629	6651	40582	4852	44637	3912	46576	3188	48831	2097	59191	1622	40037
16-#14	2.37	MA	23972	6651	39177	4883	42515	3954	43591	3222	44129	2124	53271	1374	39265
7L-3S		MI	25369	6651	41881	4835	46288	3917	48579	3195	51406	2087	62103	1750	40183
16-#14	2.37	MA	23327	6651	38057	4881	41014	3950	41806	3235	41576	2114	50209	1302	38092
8L-2S		MI	26413	6651	43492	4838	48342	3902	51076	3182	54763	2077	66565	1878	40237
16-#18	4.21	MA	29130	7644	50798	5468	57215	4356	61435	3459	67999	2019	84661	1218	70826
4L-6S		MI	25353	7644	44259	5434	48983	4352	51769	3448	55542	1993	69155	921	61671
16-#18	4.21	MA	27942	7644	48677	5462	54480	4382	58087	3480	63302	2002	78984	1112	68713
5E		MI	26424	7644	46149	5441	51547	4363	54896	3463	59578	1976	74134	1072	64803
16-#18	4.21	MA	26810	7644	46673	5457	51761	4372	54771	3466	58989	2019	73643	961	65398
6L-4S		MI	27547	7644	48149	5448	54126	4339	58052	3443	63973	1993	79444	1176	66718
18-#11	1.85	MA	26590	6371	42845	4694	47315	3801	49489	3125	52101	2125	62913	1967	33630
2L-9S		MI	21726	6371	34778	4709	37271	3823	37613	3139	36731	2133	43727	1474	29360
18-#11	1.85	MA	25805	6371	41649	4693	45791	3812	47635	3135	49589	2132	59553	1878	33617
3L-8S		MI	22153	6371	35559	4697	38237	3812	38830	3143	38320	2126	45706	1531	29979

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis



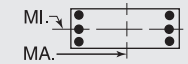
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.85	MA	25251	6371	40688	4706	44568	3810	46152	3131	47664	2139	57354	1790	33566
4L-7S		MI	22583	6371	36297	4699	39226	3815	40005	3134	40002	2133	47723	1581	30596
18-#11	1.85	MA	24756	6371	39845	4704	43482	3821	44821	3141	45765	2132	55052	1747	33456
5L-6S		MI	23019	6371	37100	4686	40205	3804	41206	3125	41607	2126	49850	1668	30983
18-#11	1.85	MA	24283	6371	39050	4703	42401	3819	43503	3137	44020	2139	52867	1688	32757
6L-5S		MI	23466	6371	37851	4688	41225	3807	42450	3129	43247	2119	51893	1727	31635
18-#11	1.85	MA	23821	6371	38199	4716	41364	3830	42232	3147	42313	2147	50593	1600	32329
7L-4S		MI	23935	6371	38647	4689	42251	3796	43706	3120	45032	2126	54052	1770	31731
18-#11	1.85	MA	23366	6371	37418	4715	40317	3827	40987	3157	40525	2140	48442	1550	31666
8L-3S		MI	24458	6371	39554	4677	43404	3799	45105	3124	46842	2119	56107	1858	31772
18-#11	1.85	MA	22905	6371	36592	4728	39294	3839	39699	3153	38835	2147	46325	1494	30992
9L-2S		MI	25196	6371	40681	4678	44841	3788	46852	3115	49202	2112	59251	1947	31777
18-#14	2.66	MA	27558	6811	45833	4952	51041	4004	53986	3252	58098	2093	70774	1749	47718
3L-8S		MI	22855	6811	37767	4961	40938	4005	42085	3264	42637	2085	51798	1252	40765
18-#14	2.66	MA	26780	6811	44456	4969	49290	3999	51861	3246	55350	2103	67654	1621	47524
4L-7S		MI	23460	6811	38824	4964	42355	4010	43770	3251	45030	2095	54666	1322	41805
18-#14	2.66	MA	26082	6811	43248	4967	47733	4015	49954	3259	52639	2093	64376	1560	46346
5L-6S		MI	24074	6811	39977	4947	43759	3995	45490	3238	47314	2085	57685	1449	43004
18-#14	2.66	MA	25417	6811	42108	4965	46184	4011	48065	3253	50149	2103	61275	1475	45510
6L-5S		MI	24703	6811	41053	4949	45221	3999	47273	3245	49648	2075	60582	1534	43762
18-#14	2.66	MA	24768	6811	40888	4983	44696	4026	46242	3266	47712	2113	58045	1348	44236
7L-4S		MI	25362	6811	42193	4952	46691	3984	49073	3233	52188	2085	63653	1594	44881
18-#14	2.66	MA	24128	6811	39768	4981	43195	4022	44457	3280	45158	2103	54982	1277	43102
8L-3S		MI	26096	6811	43492	4935	48342	3989	51076	3240	54763	2075	66565	1722	45053
18-#14	2.66	MA	23494	6811	38583	4999	41728	4038	42611	3274	42746	2113	51977	1195	41461
9L-2S		MI	27134	6811	45103	4938	50396	3974	53573	3227	58120	2065	71028	1850	45129
18-#18	4.74	MA	29272	7928	51669	5640	58294	4510	62724	3560	69507	1980	87215	1060	77509
5L-6S		MI	26610	7928	47073	5612	52571	4480	56131	3527	61347	1969	76834	865	69791
18-#18	4.74	MA	28151	7928	49665	5634	55575	4500	59408	3546	65194	1997	81873	909	74049
6L-5S		MI	27670	7928	48963	5618	55135	4491	59258	3543	65382	1951	81813	1016	73068
20-#11	2.05	MA	27137	6481	44041	4763	48840	3851	51342	3157	54612	2118	66273	1951	37270
2L-10S		MI	21794	6481	35171	4777	37731	3870	38192	3179	37514	2133	44953	1393	31845
20-#11	2.05	MA	26356	6481	42845	4762	47315	3862	49489	3166	52101	2125	62913	1862	37244
3L-9S		MI	22258	6481	35905	4779	38707	3873	39360	3170	39091	2126	46871	1457	32669
20-#11	2.05	MA	25806	6481	41884	4775	46093	3860	48006	3163	50175	2132	60714	1773	37179
4L-8S		MI	22682	6481	36686	4766	39674	3862	40576	3174	40679	2119	48850	1513	33268
20-#11	2.05	MA	25312	6481	41042	4774	45006	3871	46675	3172	48276	2125	58412	1730	36978
5L-7S		MI	23110	6481	37423	4768	40662	3865	41752	3165	42361	2126	50867	1563	33938
20-#11	2.05	MA	24842	6481	40246	4772	43926	3869	45357	3169	46532	2132	56227	1672	36293
6E		MI	23544	6481	38227	4755	41642	3854	42952	3156	43966	2119	52994	1651	34312
20-#11	2.05	MA	24383	6481	39395	4785	42889	3880	44086	3178	44824	2140	53953	1584	35878
7L-5S		MI	23989	6481	38978	4757	42662	3857	44196	3160	45607	2112	55037	1709	34936
20-#11	2.05	MA	23931	6481	38614	4784	41842	3877	42841	3188	43036	2133	51802	1534	35163
8L-4S		MI	24455	6481	39774	4758	43688	3846	45453	3151	47392	2119	57196	1752	35137
20-#11	2.05	MA	23482	6481	37788	4797	40819	3889	41553	3185	41346	2140	49685	1477	34508
9L-3S		MI	24975	6481	40681	4746	44841	3849	46852	3155	49202	2112	59251	1841	35192
20-#11	2.05	MA	22980	6481	37011	4796	39785	3886	40316	3194	39669	2147	47633	1414	33624
10L-2S		MI	25710	6481	41808	4748	46278	3838	48598	3146	51561	2105	62395	1929	35212
20-#14	2.96	MA	27556	6971	46167	5069	51472	4072	54513	3291	58932	2093	72428	1596	52665
4L-8S		MI	23600	6971	39378	5061	42992	4077	44582	3309	45994	2074	56260	1224	45414
20-#14	2.96	MA	26863	6971	44959	5067	49914	4087	52606	3304	56222	2083	69150	1534	51373
5L-7S		MI	24201	6971	40436	5064	44409	4082	46267	3296	48387	2084	59128	1295	46488
20-#14	2.96	MA	26203	6971	43819	5065	48365	4083	50717	3298	53731	2093	66048	1450	50570
6E		MI	24811	6971	41588	5046	45813	4067	47987	3283	50671	2074	62147	1421	47765

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis

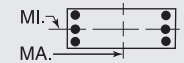


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.96	MA	25559	6971	42599	5083	46878	4099	48894	3311	51294	2103	62818	1323	49218
7L-5S		MI	25435	6971	42664	5049	47275	4072	49770	3290	53004	2064	65044	1506	48492
20-#14	2.96	MA	24924	6971	41479	5081	45377	4094	47109	3325	48740	2093	59756	1251	48078
8L-4S		MI	26089	6971	43804	5052	48745	4057	51570	3278	55544	2074	68115	1567	49722
20-#14	2.96	MA	24294	6971	40294	5098	43910	4110	45263	3319	46328	2103	56751	1170	46428
9L-3S		MI	26819	6971	45103	5035	50396	4062	53573	3285	58120	2064	71028	1695	49918
20-#18	5.26	MA	29481	8212	52657	5811	59389	4629	64045	3626	71399	1975	90104	857	82721
6E		MI	27855	8212	49888	5789	56159	4609	60492	3607	67152	1945	84512	808	77931
22-#11	2.26	MA	26905	6592	44041	4831	48840	3913	51342	3198	54612	2118	66273	1846	40868
3L-10S		MI	22324	6592	36298	4846	39168	3920	39938	3211	39873	2125	48097	1375	35122
22-#11	2.26	MA	26357	6592	43080	4844	47618	3910	49859	3194	52686	2125	64074	1757	40790
4L-9S		MI	22786	6592	37032	4848	40144	3923	41106	3201	41450	2118	50015	1439	35982
22-#11	2.26	MA	25866	6592	42238	4843	46531	3921	48528	3204	50788	2118	61772	1714	40491
5L-8S		MI	23208	6592	37813	4835	41110	3912	42323	3206	43039	2112	51994	1496	36564
22-#11	2.26	MA	25398	6592	41442	4842	45451	3919	47211	3200	49043	2126	59587	1655	39833
6L-7S		MI	23634	6592	38550	4837	42099	3915	43498	3196	44720	2118	54011	1545	37283
22-#11	2.26	MA	24942	6592	40591	4854	44414	3930	45939	3210	47336	2133	57313	1568	39430
7L-6S		MI	24066	6592	39354	4825	43079	3904	44699	3187	46326	2112	56138	1633	37646
22-#11	2.26	MA	24492	6592	39810	4853	43367	3928	44694	3220	45547	2126	55162	1517	38665
8L-5S		MI	24508	6592	40105	4826	44099	3907	45943	3191	47966	2105	58181	1692	38244
22-#11	2.26	MA	24046	6592	38984	4866	42343	3939	43406	3216	43857	2133	53045	1461	38029
9L-4S		MI	24972	6592	40901	4828	45125	3896	47199	3182	49751	2112	60340	1734	38540
22-#11	2.26	MA	23546	6592	38207	4865	41310	3936	42169	3226	42180	2140	50993	1397	37110
10L-3S		MI	25489	6592	41808	4815	46278	3899	48598	3186	51561	2105	62395	1823	38607
22-#14	3.26	MA	27639	7130	46670	5167	52095	4160	55257	3349	59804	2072	73924	1509	56409
5L-8S		MI	24340	7130	40989	5161	45046	4149	47079	3354	49350	2062	60722	1196	50048
22-#14	3.26	MA	26984	7130	45530	5165	50547	4155	53368	3343	57313	2082	70822	1424	55635
6L-7S		MI	24937	7130	42047	5163	46464	4154	48764	3341	51744	2072	63591	1267	51180
22-#14	3.26	MA	26344	7130	44310	5182	49059	4171	51546	3356	54876	2092	67592	1297	54208
7L-6S		MI	25542	7130	43199	5146	47868	4139	50485	3328	54027	2062	66609	1394	52531
22-#14	3.26	MA	25713	7130	43190	5180	47558	4167	49761	3370	52323	2082	64530	1226	53011
8L-5S		MI	26162	7130	44276	5149	49329	4144	52267	3335	56361	2052	69507	1479	53231
22-#14	3.26	MA	25088	7130	42005	5198	46091	4182	47914	3363	49910	2092	61525	1144	51403
9L-4S		MI	26813	7130	45416	5152	50799	4129	54067	3323	58901	2062	72578	1539	54560
24-#11	2.46	MA	26905	6702	44276	4913	49143	3960	51713	3225	55198	2118	67434	1741	44399
4L-10S		MI	22852	6702	37425	4915	40605	3970	41685	3242	42232	2118	51241	1358	38405
24-#11	2.46	MA	26417	6702	43434	4912	48056	3971	50382	3235	53299	2112	65132	1698	44010
5L-9S		MI	23312	6702	38159	4917	41581	3973	42853	3232	43809	2111	53159	1421	39299
24-#11	2.46	MA	25952	6702	42638	4911	46976	3969	49064	3231	51554	2119	62947	1639	43377
6L-8S		MI	23732	6702	38940	4905	42547	3962	44069	3237	45398	2104	55138	1478	39865
24-#11	2.46	MA	25498	6702	41787	4923	45938	3980	47793	3241	49847	2126	60673	1551	42985
7E		MI	24155	6702	39677	4906	43536	3965	45245	3227	47080	2111	57155	1528	40631
24-#11	2.46	MA	25050	6702	41006	4922	44891	3978	46548	3251	48059	2119	58522	1501	42173
8L-6S		MI	24585	6702	40481	4894	44515	3954	46445	3218	48685	2104	59282	1615	40984
24-#11	2.46	MA	24604	6702	40180	4935	43868	3989	45260	3247	46369	2126	56405	1445	41553
9L-5S		MI	25025	6702	41232	4895	45536	3957	47689	3222	50325	2097	61325	1674	41558
24-#11	2.46	MA	24109	6702	39403	4934	42835	3987	44023	3257	44691	2133	54353	1381	40600
10L-4S		MI	25486	6702	42028	4897	46561	3947	48946	3213	52110	2104	63484	1717	41941
24-#14	3.55	MA	27759	7290	47241	5264	52728	4228	56020	3388	60895	2072	75595	1399	60705
6L-8S		MI	25075	7290	42601	5260	47101	4222	49576	3399	52707	2050	65184	1169	54691
24-#14	3.55	MA	27124	7290	46020	5282	51240	4243	54197	3401	58458	2082	72365	1272	59207
7E		MI	25668	7290	43658	5263	48518	4226	51261	3386	55100	2060	68053	1240	55881
24-#14	3.55	MA	26497	7290	44901	5280	49739	4239	52413	3415	55905	2072	69303	1200	57953
8L-6S		MI	26269	7290	44810	5246	49922	4212	52982	3373	57384	2050	71071	1366	57302
24-#14	3.55	MA	25875	7290	43716	5298	48272	4255	50566	3408	53492	2082	66298	1119	56385
9L-5S		MI	26885	7290	45887	5249	51384	4216	54764	3380	59717	2041	73969	1451	57978

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

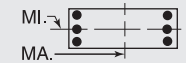
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.00	MA	26711	6211	41844	4598	45112	3748	45919	3125	45609	2238	53402	2106	20331
2E		MI	24086	6211	37889	4562	40673	3719	41304	3100	40791	2211	47583	2072	18254
6-#18	1.50	MA	28179	6495	45013	4776	49152	3877	50830	3205	52215	2218	62186	2058	30058
2L-3S		MI	23522	6495	37889	4733	40673	3872	41304	3200	40791	2205	47583	1789	26960
6-#18	1.50	MA	26088	6495	41844	4771	45112	3904	45919	3228	45609	2236	53402	1830	30057
3L-2S		MI	25376	6495	40703	4740	44261	3847	45666	3180	46596	2187	55262	2016	26917
8-#14	1.13	MA	27168	6282	42615	4674	46269	3806	47392	3167	47727	2256	56359	2125	22945
2L-4S		MI	22662	6282	35667	4655	38016	3789	38142	3149	36800	2252	42885	1836	20660
8-#14	1.13	MA	25960	6282	40804	4672	43960	3822	44586	3181	43926	2266	51274	1997	22992
3E		MI	23424	6282	36966	4638	39667	3794	40146	3157	39375	2242	45798	1964	20648
8-#14	1.13	MA	25106	6282	39349	4690	42110	3819	42340	3175	41010	2276	47946	1869	22968
4L-2S		MI	24496	6282	38577	4641	41721	3779	42643	3144	42732	2232	50260	2092	20591
8-#18	2.01	MA	29626	6778	48182	4953	53192	4006	55742	3285	58821	2198	70970	2009	39737
2L-4S		MI	23505	6778	38428	4939	41368	3989	42157	3264	42143	2198	50265	1505	34764
8-#18	2.01	MA	27557	6778	45013	4948	49152	4032	50830	3308	52215	2215	62186	1782	39633
3E		MI	24814	6778	40703	4910	44261	4000	45666	3280	46596	2180	55262	1732	35478
8-#18	2.01	MA	26090	6778	42460	4979	45905	4024	46890	3295	47147	2233	56452	1554	38817
4L-2S		MI	26648	6778	43518	4917	47849	3976	50028	3260	52400	2163	62940	1960	35529
10-#14	1.41	MA	28013	6441	44426	4773	48577	3878	50198	3212	51529	2246	61444	2101	28489
2L-5S		MI	22739	6441	36139	4752	38600	3876	38839	3207	37617	2230	44277	1749	25175
10-#14	1.41	MA	26814	6441	42615	4772	46269	3895	47392	3226	47727	2256	56359	1973	28510
3L-4S		MI	23419	6441	37279	4755	40070	3861	40639	3194	40157	2240	47348	1809	25539
10-#14	1.41	MA	25966	6441	41160	4790	44418	3891	45146	3220	44812	2266	53031	1845	28441
4L-3S		MI	24176	6441	38577	4738	41721	3866	42643	3201	42732	2230	50260	1937	25571
10-#14	1.41	MA	25206	6441	39884	4788	42773	3907	43131	3234	41937	2257	49547	1783	27992
5L-2S		MI	25242	6441	40188	4741	43775	3851	45140	3189	46089	2220	54722	2065	25535
10-#18	2.51	MA	31054	7062	51351	5130	57232	4134	60653	3365	65426	2177	79754	1961	49375
2L-5S		MI	23631	7062	39242	5109	42378	4142	43362	3364	43553	2156	52633	1345	40419
10-#18	2.51	MA	29007	7062	48182	5126	53192	4161	55742	3387	58821	2195	70970	1733	49186
3L-4S		MI	24795	7062	41242	5116	44956	4118	46518	3344	47948	2174	57943	1449	42771
10-#18	2.51	MA	27557	7062	45629	5156	49945	4152	51802	3375	53753	2213	65236	1506	47874
4L-3S		MI	26089	7062	43518	5088	47849	4129	50028	3359	52400	2156	62940	1676	43969
10-#18	2.51	MA	26256	7062	43387	5152	47055	4179	48263	3398	48754	2195	59192	1398	45083
5L-2S		MI	27906	7062	46332	5094	51437	4105	54390	3339	58205	2138	70619	1904	44105
12-#11	1.17	MA	27350	6307	42894	4705	46713	3830	47966	3185	48520	2263	57567	2137	23932
2L-6S		MI	22447	6307	35247	4682	37491	3820	37523	3173	35928	2257	41966	1827	21177
12-#11	1.17	MA	26506	6307	41629	4704	45100	3828	46005	3195	45863	2270	53991	2048	23960
3L-5S		MI	22902	6307	35998	4683	38511	3823	38767	3177	37568	2250	44009	1885	21504
12-#11	1.17	MA	25911	6307	40614	4717	43809	3840	44438	3192	43828	2278	51648	1959	23962
4E		MI	23380	6307	36793	4685	39537	3813	40023	3168	39353	2257	46168	1928	21530
12-#11	1.17	MA	25378	6307	39724	4716	42661	3838	43033	3202	41823	2272	49202	1915	23907
5L-3S		MI	23911	6307	37700	4672	40690	3815	41423	3172	41163	2250	48223	2017	21510
12-#11	1.17	MA	24869	6307	38884	4716	41521	3849	41641	3199	39981	2280	46876	1857	23505
6L-2S		MI	24661	6307	38827	4674	42127	3805	43169	3163	43522	2243	51367	2105	21476
12-#14	1.69	MA	28852	6601	46236	4873	50886	3951	53004	3256	55331	2236	66530	2078	34020
2L-6S		MI	22851	6601	36673	4849	39192	3944	39554	3245	38640	2228	45841	1636	28952
12-#14	1.69	MA	27660	6601	44426	4871	48577	3967	50198	3271	51529	2246	61444	1950	34009
3L-5S		MI	23495	6601	37750	4852	40654	3949	41337	3252	40973	2218	48739	1721	29848
12-#14	1.69	MA	26818	6601	42971	4890	46727	3963	47953	3265	48614	2256	58116	1822	33903
4E		MI	24170	6601	38890	4855	42124	3934	43136	3239	43514	2228	51810	1781	30407
12-#14	1.69	MA	26064	6601	41695	4888	45081	3979	45938	3279	45739	2247	54632	1759	33257
5L-3S		MI	24922	6601	40188	4838	43775	3939	45140	3246	46089	2218	54722	1909	30476

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.69	MA	25345	6601	40491	4886	43446	3976	43942	3274	43098	2257	51325	1675	32190
6L-2S		MI	25981	6601	41800	4840	45829	3924	47637	3234	49445	2209	59184	2037	30465
12-#18	3.01	MA	32467	7346	54520	5308	61273	4263	65565	3444	72032	2157	88537	1912	58986
2L-6S		MI	23820	7346	40167	5280	43402	4259	44597	3428	45322	2149	55333	1137	45999
12-#18	3.01	MA	30439	7346	51351	5303	57232	4289	60653	3467	65426	2174	79754	1685	58724
3L-5S		MI	24919	7346	42057	5287	45966	4270	47724	3443	49358	2132	60312	1289	48622
12-#18	3.01	MA	29005	7346	48798	5334	53986	4281	56713	3455	60359	2192	74020	1457	56981
4E		MI	26069	7346	44057	5294	48544	4246	50880	3424	53753	2149	65622	1393	50828
12-#18	3.01	MA	27720	7346	46556	5329	51095	4308	53174	3478	55360	2174	67976	1350	54347
5L-3S		MI	27350	7346	46332	5265	51437	4257	54390	3439	58205	2132	70619	1620	52442
12-#18	3.01	MA	26493	7346	44439	5324	48221	4299	49669	3465	50767	2192	62272	1199	51378
6L-2S		MI	29150	7346	49146	5272	55025	4233	58752	3419	64010	2114	78297	1848	52647
14-#11	1.37	MA	27943	6418	44159	4774	48326	3880	49927	3216	51176	2256	61144	2122	27802
2L-7S		MI	22540	6418	35570	4763	37948	3881	38069	3213	36682	2257	42983	1721	24061
14-#11	1.37	MA	27103	6418	42894	4773	46713	3878	47966	3226	48520	2263	57567	2033	27820
3L-6S		MI	22982	6418	36374	4751	38928	3871	39269	3204	38287	2250	45110	1809	24486
14-#11	1.37	MA	26511	6418	41879	4786	45422	3890	46399	3223	46485	2271	55224	1944	27800
4L-5S		MI	23435	6418	37125	4752	39948	3874	40513	3208	39927	2243	47153	1868	24910
14-#11	1.37	MA	25981	6418	40989	4785	44274	3888	44994	3233	44480	2265	52779	1900	27725
5L-4S		MI	23910	6418	37920	4754	40974	3863	41770	3199	41712	2250	49312	1910	24956
14-#11	1.37	MA	25476	6418	40149	4785	43134	3899	43602	3230	42637	2273	50452	1842	27225
6L-3S		MI	24439	6418	38827	4742	42127	3866	43169	3203	43522	2243	51367	1999	24955
14-#11	1.37	MA	24982	6418	39251	4798	42039	3897	42260	3240	40835	2281	48031	1754	26713
7L-2S		MI	25185	6418	39954	4743	43563	3855	44916	3194	45882	2236	54511	2088	24930
14-#14	1.97	MA	29684	6761	48047	4973	53194	4023	55811	3301	59133	2226	71615	2054	39539
2L-7S		MI	22982	6761	37132	4966	39842	4031	40331	3302	39713	2227	47285	1482	32790
14-#14	1.97	MA	28499	6761	46236	4971	50886	4039	53004	3316	55331	2236	66530	1926	39497
3L-6S		MI	23606	6761	38284	4949	41246	4016	42051	3290	41996	2217	50303	1609	33690
14-#14	1.97	MA	27664	6761	44781	4989	49035	4036	50759	3310	52416	2247	63202	1798	39359
4L-5S		MI	24245	6761	39361	4952	42708	4021	43834	3297	44330	2207	53201	1694	34539
14-#14	1.97	MA	26915	6761	43505	4988	47390	4052	48744	3324	49541	2237	59717	1736	38541
5L-4S		MI	24916	6761	40501	4955	44178	4006	45633	3284	46870	2217	56272	1754	35266
14-#14	1.97	MA	26201	6761	42301	4986	45754	4048	46749	3319	46900	2247	56411	1651	37525
6L-3S		MI	25662	6761	41800	4937	45829	4011	47637	3291	49445	2207	59184	1882	35365
14-#14	1.97	MA	25504	6761	41012	5004	44184	4064	44824	3333	44314	2257	52969	1525	36489
7L-2S		MI	26715	6761	43411	4940	47883	3996	50134	3278	52802	2197	63647	2010	35384
14-#18	3.51	MA	31857	7629	54520	5480	61273	4418	65565	3547	72032	2154	88537	1636	68251
3L-6S		MI	25105	7629	42981	5457	46990	4388	48958	3508	51127	2125	63011	1081	54061
14-#18	3.51	MA	30438	7629	51967	5511	58026	4409	61625	3535	66964	2172	82804	1409	66130
4L-5S		MI	26191	7629	44871	5464	49554	4399	52086	3523	55162	2108	67990	1233	56849
14-#18	3.51	MA	29166	7629	49725	5506	55135	4436	58086	3557	61965	2154	76760	1301	63635
5L-4S		MI	27330	7629	46871	5471	52133	4375	55242	3503	59557	2125	73300	1336	58926
14-#18	3.51	MA	27954	7629	47608	5502	52261	4428	54580	3545	57373	2172	71055	1151	60504
6L-3S		MI	28598	7629	49146	5442	55025	4386	58752	3519	64010	2108	78297	1564	60903
14-#18	3.51	MA	26770	7629	45343	5532	49500	4454	51198	3568	52879	2189	65114	925	57459
7L-2S		MI	30381	7629	51961	5449	58613	4362	63113	3499	69815	2090	85975	1791	61172
16-#11	1.56	MA	28533	6529	45424	4843	49939	3930	51888	3247	53833	2249	64720	2107	31666
2L-8S		MI	22640	6529	35959	4831	38396	3929	38640	3254	37359	2242	44110	1654	26927
16-#11	1.56	MA	27697	6529	44159	4842	48326	3928	49927	3257	51176	2256	61144	2018	31669
3L-7S		MI	23074	6529	36697	4832	39385	3932	39815	3245	39041	2249	46127	1704	27396
16-#11	1.56	MA	27108	6529	43144	4855	47035	3940	48360	3254	49142	2264	58801	1929	31633
4L-6S		MI	23514	6529	37500	4820	40364	3921	41016	3235	40646	2242	48254	1791	27803
16-#11	1.56	MA	26581	6529	42254	4855	45887	3938	46955	3264	47136	2258	56355	1885	31540
5E		MI	23964	6529	38252	4821	41384	3924	42260	3240	42287	2236	50297	1850	28311
16-#11	1.56	MA	26078	6529	41415	4854	44747	3950	45563	3261	45294	2266	54028	1827	30953
6L-4S		MI	24436	6529	39047	4823	42410	3913	43516	3230	44072	2242	52456	1893	28375
16-#11	1.56	MA	25588	6529	40516	4867	43652	3948	44221	3271	43491	2274	51607	1739	30461
7L-3S		MI	24963	6529	39954	4811	43563	3916	44916	3235	45882	2236	54511	1981	28393

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

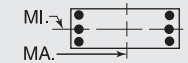
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.56	MA	25104	6529	39692	4866	42546	3959	42907	3282	41603	2268	49321	1688	29909
8L-2S		MI	25706	6529	41081	4812	45000	3905	46662	3225	48241	2229	57655	2070	28377
16-#14	2.26	MA	30509	6920	49858	5072	55503	4095	58617	3346	62935	2216	76700	2030	45043
2L-8S		MI	23124	6920	37686	5063	40479	4098	41143	3360	40676	2205	48879	1384	36349
16-#14	2.26	MA	29332	6920	48047	5071	53194	4111	55811	3360	59133	2226	71615	1902	44977
3L-7S		MI	23735	6920	38743	5066	41897	4103	42828	3347	43069	2215	51747	1455	37447
16-#14	2.26	MA	28502	6920	46592	5089	51344	4108	53565	3355	56218	2237	68287	1775	44810
4L-6S		MI	24355	6920	39895	5049	43301	4088	44548	3335	45353	2205	54766	1581	38438
16-#14	2.26	MA	27759	6920	45316	5087	49698	4124	51550	3369	53343	2227	64802	1712	43839
5E		MI	24990	6920	40972	5052	44762	4093	46331	3342	47687	2195	57663	1666	39245
16-#14	2.26	MA	27051	6920	44112	5086	48063	4120	49555	3363	50701	2237	61496	1628	42869
6L-4S		MI	25655	6920	42112	5054	46232	4078	48131	3329	50227	2205	60734	1726	40119
16-#14	2.26	MA	26359	6920	42823	5104	46492	4137	47630	3378	48116	2247	58054	1501	41743
7L-3S		MI	26397	6920	43411	5037	47883	4083	50134	3336	52802	2195	63647	1854	40246
16-#14	2.26	MA	25677	6920	41641	5102	44907	4133	45745	3392	45409	2238	54798	1429	40448
8L-2S		MI	27443	6920	45022	5040	49937	4068	52631	3323	56158	2185	68109	1982	40290
16-#18	4.01	MA	31856	7913	55136	5688	62066	4538	66536	3614	73570	2151	91587	1360	75312
4L-6S		MI	26376	7913	45795	5635	50578	4516	53320	3588	56932	2101	70690	1025	62150
16-#18	4.01	MA	30598	7913	52894	5684	59176	4565	62997	3637	68571	2134	85544	1253	72943
5E		MI	27451	7913	47685	5641	53142	4528	56447	3603	60967	2083	75669	1176	65095
16-#18	4.01	MA	29398	7913	50777	5679	56301	4556	59492	3625	63979	2151	79839	1102	69656
6L-4S		MI	28578	7913	49685	5648	55721	4503	59604	3583	65362	2101	80978	1280	67057
16-#18	4.01	MA	28228	7913	48512	5710	53540	4583	56109	3647	59484	2169	73898	877	66513
7L-3S		MI	29834	7913	51961	5620	58613	4515	63113	3599	69815	2083	85975	1508	69355
18-#11	1.76	MA	29120	6639	46690	4912	51552	3981	53849	3278	56489	2242	68296	2091	35525
2L-9S		MI	22746	6639	36305	4912	38866	3990	39170	3281	38130	2242	45275	1580	29579
18-#11	1.76	MA	28287	6639	45424	4912	49939	3979	51888	3288	53833	2250	64720	2003	35512
3L-8S		MI	23174	6639	37086	4900	39833	3979	40386	3285	39719	2235	47254	1636	30208
18-#11	1.76	MA	27702	6639	44409	4925	48648	3990	50321	3285	51798	2257	62377	1914	35461
4L-7S		MI	23605	6639	37823	4901	40821	3982	41562	3276	41400	2242	49271	1686	30736
18-#11	1.76	MA	27177	6639	43519	4924	47501	3988	48915	3295	49793	2251	59931	1870	35351
5L-6S		MI	24042	6639	38627	4889	41801	3971	42762	3266	43006	2235	51398	1774	31126
18-#11	1.76	MA	26677	6639	42680	4923	46360	4000	47524	3292	47950	2259	57604	1812	34688
6L-5S		MI	24490	6639	39378	4891	42821	3974	44006	3271	44646	2228	53441	1832	31709
18-#11	1.76	MA	26189	6639	41781	4936	45265	3998	46182	3302	46148	2267	55183	1724	34214
7L-4S		MI	24960	6639	40174	4892	43847	3963	45263	3261	46431	2235	55600	1875	31789
18-#11	1.76	MA	25708	6639	40957	4935	44159	4009	44868	3313	44259	2261	52898	1673	33604
8L-3S		MI	25484	6639	41081	4880	45000	3966	46662	3266	48241	2228	57655	1964	31821
18-#11	1.76	MA	25217	6639	40085	4948	43080	4007	43508	3309	42475	2269	50644	1617	32860
9L-2S		MI	26224	6639	42208	4881	46437	3955	48409	3256	50600	2221	60799	2052	31818
18-#14	2.54	MA	30159	7080	49858	5171	55503	4184	58617	3405	62935	2216	76700	1879	50451
3L-8S		MI	23875	7080	39297	5163	42534	4171	43640	3405	44033	2194	53341	1356	41056
18-#14	2.54	MA	29335	7080	48403	5189	53652	4180	56371	3400	60019	2227	73372	1751	50258
4L-7S		MI	24482	7080	40355	5166	43951	4176	45325	3392	46426	2204	56210	1427	42116
18-#14	2.54	MA	28597	7080	47127	5187	52007	4196	54356	3414	57145	2217	69888	1689	49151
5L-6S		MI	25098	7080	41507	5149	45355	4161	47045	3379	48710	2194	59228	1554	43192
18-#14	2.54	MA	27894	7080	45923	5186	50371	4193	52361	3408	54503	2227	66581	1604	48220
6L-5S		MI	25729	7080	42583	5151	46816	4166	48828	3387	51043	2184	62125	1639	43963
18-#14	2.54	MA	27207	7080	44634	5204	48800	4209	50436	3423	51918	2238	63139	1478	47009
7L-4S		MI	26390	7080	43723	5154	48286	4151	50628	3374	53583	2194	65197	1699	44968
18-#14	2.54	MA	26530	7080	43452	5202	47215	4205	48552	3437	49211	2228	59884	1405	45755
8L-3S		MI	27126	7080	45022	5137	49937	4156	52631	3381	56158	2184	68109	1827	45120
18-#14	2.54	MA	25856	7080	42200	5220	45666	4222	46602	3431	46652	2238	56680	1324	44133
9L-2S		MI	28167	7080	46633	5140	51992	4141	55128	3368	59515	2174	72571	1955	45185

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

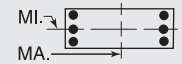


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	4.51	MA	32015	8197	56063	5861	63216	4693	67909	3717	75177	2113	94328	1204	82268
5L-6S		MI	27635	8197	48610	5812	54166	4645	57682	3667	62737	2077	78368	969	70263
18-#18	4.51	MA	30828	8197	53946	5856	60341	4685	64403	3704	70584	2131	88623	1054	78831
6L-5S		MI	28700	8197	50500	5819	56730	4656	60809	3683	66772	2059	83347	1120	73358
18-#18	4.51	MA	29670	8197	51681	5887	57581	4711	61020	3727	66090	2149	82682	828	75588
7L-4S		MI	29816	8197	52500	5825	59309	4632	63966	3663	71167	2077	88657	1224	75217
20-#11	1.95	MA	29703	6750	47955	4982	53165	4031	55810	3309	59146	2235	71873	2076	39376
2L-10S		MI	22814	6750	36698	4980	39327	4037	39748	3321	38912	2242	46501	1498	32146
20-#11	1.95	MA	28874	6750	46690	4981	51552	4029	53849	3319	56489	2243	68296	1988	39350
3L-9S		MI	23278	6750	37432	4981	40303	4040	40917	3312	40489	2235	48419	1562	32886
20-#11	1.95	MA	28291	6750	45674	4994	50261	4040	52282	3316	54455	2250	65953	1899	39285
4L-8S		MI	23704	6750	38213	4969	41269	4029	42133	3316	42078	2228	50398	1619	33496
20-#11	1.95	MA	27770	6750	44784	4993	49114	4038	50876	3326	52449	2244	63507	1855	39160
5L-7S		MI	24133	6750	38950	4971	42258	4032	43308	3307	43760	2235	52415	1668	34079
20-#11	1.95	MA	27273	6750	43945	4992	47973	4050	49485	3323	50607	2252	61181	1797	38429
6E		MI	24568	6750	39754	4958	43238	4021	44509	3297	45365	2228	54542	1756	34455
20-#11	1.95	MA	26787	6750	43046	5005	46878	4048	48143	3333	48804	2260	58760	1709	37971
7L-5S		MI	25014	6750	40505	4960	44258	4024	45753	3302	47005	2221	56585	1815	35097
20-#11	1.95	MA	26309	6750	42222	5004	45772	4059	46828	3344	46916	2254	56474	1658	37306
8L-4S		MI	25481	6750	41301	4961	45284	4013	47009	3292	48790	2228	58744	1857	35198
20-#11	1.95	MA	25820	6750	41350	5017	44693	4057	45469	3340	45132	2262	54220	1602	36583
9L-3S		MI	26002	6750	42208	4949	46437	4016	48409	3297	50600	2221	60799	1946	35243
20-#11	1.95	MA	25294	6750	40530	5017	43601	4069	44163	3351	43361	2269	52034	1538	35733
10L-2S		MI	26739	6750	43335	4950	47873	4005	50155	3287	52959	2214	63943	2035	35256
20-#14	2.82	MA	30162	7239	50213	5289	55961	4252	59178	3445	63821	2217	78457	1727	55702
4L-8S		MI	24622	7239	40908	5263	44588	4243	46137	3450	47389	2182	57803	1329	45771
20-#14	2.82	MA	29429	7239	48937	5287	54315	4269	57163	3459	60947	2207	74973	1665	54473
5L-7S		MI	25225	7239	41966	5266	46005	4248	47822	3437	49782	2192	60672	1400	46795
20-#14	2.82	MA	28730	7239	47733	5285	52680	4265	55168	3453	58305	2217	71666	1581	53578
6E		MI	25836	7239	43118	5248	47409	4233	49542	3424	52066	2182	63690	1526	47953
20-#14	2.82	MA	28049	7239	46445	5304	51109	4281	53243	3468	55720	2228	68225	1454	52286
7L-5S		MI	26462	7239	44194	5251	48871	4238	51325	3432	54400	2172	66588	1611	48692
20-#14	2.82	MA	27377	7239	45262	5302	49524	4278	51358	3482	53012	2218	64969	1381	51070
8L-4S		MI	27119	7239	45335	5254	50341	4223	53125	3419	56940	2182	69659	1671	49813
20-#14	2.82	MA	26704	7239	44011	5320	47975	4294	49408	3476	50454	2228	61765	1300	49396
9L-3S		MI	27851	7239	46633	5237	51992	4228	55128	3426	59515	2172	72571	1799	49988
20-#18	5.01	MA	32245	8481	57115	6034	64382	4813	69315	3784	77190	2111	97407	1005	88027
6E		MI	28883	8481	51424	5989	57754	4774	62044	3747	68541	2052	86047	913	78397
20-#18	5.01	MA	31099	8481	54850	6064	61621	4840	65932	3807	72696	2128	91465	780	84685
7L-5S		MI	29938	8481	53314	5996	60319	4785	65171	3763	72577	2035	91026	1064	81634
22-#11	2.15	MA	29458	6861	47955	5050	53165	4079	55810	3351	59146	2236	71873	1972	43185
3L-10S		MI	23345	6861	37825	5049	40763	4087	41495	3352	41271	2234	49645	1481	35421
22-#11	2.15	MA	28878	6861	46939	5063	51874	4090	54243	3347	57111	2244	69529	1884	43107
4L-9S		MI	23808	6861	38559	5051	41740	4090	42663	3343	42848	2227	51563	1544	36198
22-#11	2.15	MA	28359	6861	46050	5062	50727	4088	52837	3358	55106	2238	67084	1840	42914
5L-8S		MI	24231	6861	39340	5038	42706	4079	43879	3347	44437	2220	53542	1601	36789
22-#11	2.15	MA	27865	6861	45210	5061	49586	4100	51446	3354	53264	2245	64757	1781	42175
6L-7S		MI	24658	6861	40077	5040	43695	4082	45055	3338	46119	2227	55559	1651	37424
22-#11	2.15	MA	27382	6861	44312	5074	48491	4098	50103	3365	51461	2253	62336	1694	41730
7L-6S		MI	25091	6861	40881	5027	44674	4071	46255	3329	47724	2220	57686	1738	37789
22-#11	2.15	MA	26906	6861	43487	5073	47386	4110	48789	3375	49573	2247	60050	1643	41013
8L-5S		MI	25534	6861	41632	5029	45694	4074	47499	3333	49364	2214	59729	1797	38404
22-#11	2.15	MA	26426	6861	42615	5086	46306	4108	47430	3371	47788	2255	57796	1587	40310
9L-4S		MI	25999	6861	42428	5030	46720	4063	48756	3324	51149	2220	61888	1840	38604
22-#11	2.15	MA	25896	6861	41795	5086	45214	4119	46124	3382	46018	2262	55610	1523	39424
10L-3S		MI	26518	6861	43335	5018	47873	4066	50155	3328	52959	2214	63943	1928	38662
22-#11	2.15	MA	25384	6861	40986	5085	44141	4117	44780	3378	44156	2256	53379	1469	38574
11L-2S		MI	27252	6861	44461	5020	49310	4055	51902	3319	55319	2207	67086	2017	38685

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.10	MA	30255	7399	50748	5387	56624	4341	59969	3504	64749	2197	80058	1641	59805
5L-8S		MI	25363	7399	42520	5363	46642	4315	48634	3495	50746	2171	62266	1301	50478
22-#14	3.10	MA	29561	7399	49544	5385	54988	4337	57974	3498	62107	2207	76752	1557	58942
6L-7S		MI	25962	7399	43577	5365	48059	4320	50319	3482	53139	2180	65134	1372	51484
22-#14	3.10	MA	28885	7399	48255	5403	53417	4354	56049	3512	59522	2218	73310	1430	57572
7L-6S		MI	26569	7399	44729	5348	49463	4305	52040	3469	55423	2171	68152	1499	52719
22-#14	3.10	MA	28217	7399	47073	5402	51832	4350	54164	3527	56814	2208	70054	1358	56391
8L-5S		MI	27191	7399	45806	5351	50925	4310	53822	3476	57756	2161	71050	1584	53430
22-#14	3.10	MA	27546	7399	45822	5420	50283	4366	52214	3521	54256	2218	66851	1276	54667
9L-4S		MI	27844	7399	46946	5353	52395	4295	55622	3464	60297	2171	74121	1644	54654
22-#18	5.51	MA	32515	8764	58019	6242	65661	4969	70843	3887	79301	2108	100249	731	93800
7L-6S		MI	30122	8764	54238	6167	61342	4902	66406	3827	74346	2028	93725	856	86549
24-#11	2.35	MA	29462	6971	48205	5132	53487	4141	56203	3378	59768	2237	73106	1869	46926
4L-10S		MI	23874	6971	38952	5118	42200	4137	43241	3383	43631	2227	52789	1463	38701
24-#11	2.35	MA	28945	6971	47315	5131	52340	4139	54798	3389	57762	2231	70660	1825	46638
5L-9S		MI	24334	6971	39686	5120	43176	4140	44410	3374	45208	2220	54707	1527	39514
24-#11	2.35	MA	28453	6971	46475	5130	51199	4150	53407	3385	55920	2238	68333	1766	45925
6L-8S		MI	24755	6971	40466	5107	44143	4129	45626	3378	46796	2213	56686	1583	40088
24-#11	2.35	MA	27974	6971	45577	5143	50104	4148	52064	3396	54117	2246	65912	1679	45492
7E		MI	25180	6971	41204	5109	45131	4132	46801	3369	48478	2220	58703	1633	40772
24-#11	2.35	MA	27500	6971	44753	5143	48999	4160	50750	3406	52229	2240	63627	1628	44726
8L-6S		MI	25611	6971	42008	5097	46111	4121	48002	3360	50083	2213	60830	1721	41126
24-#11	2.35	MA	27021	6971	43880	5156	47919	4158	49390	3403	50445	2248	61372	1571	44041
9L-5S		MI	26052	6971	42759	5098	47131	4124	49246	3364	51724	2206	62873	1779	41717
24-#11	2.35	MA	26495	6971	43060	5155	46828	4169	48085	3413	48674	2256	59187	1508	43120
10L-4S		MI	26515	6971	43555	5100	48157	4113	50502	3355	53509	2213	65032	1822	42007
24-#11	2.35	MA	25986	6971	42251	5154	45754	4167	46741	3410	46812	2250	56955	1454	42288
11L-3S		MI	27031	6971	44461	5087	49310	4116	51902	3359	55319	2206	67086	1911	42076
24-#14	3.38	MA	30387	7559	51355	5485	57297	4410	60780	3543	65909	2197	81837	1533	64311
6L-8S		MI	26099	7559	44131	5462	48696	4388	51131	3540	54103	2159	66728	1274	55116
24-#14	3.38	MA	29715	7559	50066	5503	55726	4426	58855	3557	63324	2208	78395	1407	62866
7E		MI	26694	7559	45188	5465	50113	4393	52816	3527	56496	2169	69596	1344	56182
24-#14	3.38	MA	29052	7559	48884	5501	54141	4422	56970	3572	60616	2198	75139	1334	61686
8L-6S		MI	27298	7559	46340	5448	51517	4378	54537	3514	58779	2159	72615	1471	57489
24-#14	3.38	MA	28382	7559	47632	5520	52592	4439	55020	3566	58058	2208	71936	1253	59945
9L-5S		MI	27916	7559	47417	5451	52979	4383	56319	3521	61113	2149	75512	1556	58175

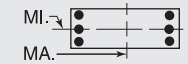
RECTANGULAR TIED COLUMNS 38" x 44"

6-#18	1.44	MA	30769	6763	48934	4994	53443	4057	55214	3358	56644	2340	67442	2181	31678
2L-3S		MI	24545	6763	39425	4933	42268	4037	42856	3340	42181	2312	49118	1893	27026
6-#18	1.44	MA	28555	6763	45588	4990	49177	4084	50028	3382	49638	2358	58105	1954	31677
3L-2S		MI	26401	6763	42239	4940	45856	4012	47218	3320	47985	2295	56796	2120	26965
8-#14	1.08	MA	29690	6551	46393	4892	50389	3986	51571	3319	51797	2373	61211	2245	24160
2L-4S		MI	23683	6551	37198	4857	39611	3955	39697	3291	38196	2360	44429	1941	20715
8-#14	1.08	MA	28413	6551	44483	4891	47953	3982	48610	3334	47786	2384	55814	2117	24207
3E		MI	24447	6551	38496	4840	41262	3960	41701	3298	40771	2350	47341	2069	20688
8-#14	1.08	MA	27511	6551	42950	4909	46003	3999	46244	3329	44713	2395	52278	1989	24183
4L-2S		MI	25520	6551	40107	4843	43316	3945	44198	3285	44127	2340	51803	2197	20627
8-#18	1.91	MA	32307	7047	52280	5171	57710	4185	60400	3437	63651	2321	76780	2136	41897
2L-4S		MI	24527	7047	39964	5139	42963	4154	43708	3404	43533	2306	51799	1609	35124
8-#18	1.91	MA	30116	7047	48934	5168	53443	4213	55214	3461	56644	2339	67442	1909	41793
3E		MI	25838	7047	42239	5111	45856	4165	47218	3420	47985	2288	56796	1837	35555

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

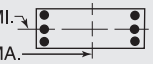


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	1.91	MA	28566	7047	46241	5199	50019	4206	51059	3450	51269	2357	61339	1681	41256
4L-2S		MI	27676	7047	45054	5117	49444	4141	51579	3400	53790	2270	64475	2064	35583
10-#14	1.35	MA	30587	6710	48304	4992	52825	4058	54532	3364	55808	2363	66608	2223	30008
2L-5S		MI	23760	6710	37669	4954	40195	4043	40394	3348	39012	2339	45820	1853	25382
10-#14	1.35	MA	29319	6710	46393	4990	50389	4055	51571	3379	51797	2374	61211	2095	30029
3L-4S		MI	24442	6710	38809	4957	41665	4028	42194	3335	41552	2348	48891	1914	25602
10-#14	1.35	MA	28424	6710	44860	5009	48439	4072	49205	3374	48724	2385	57675	1967	29960
4L-3S		MI	25200	6710	40107	4940	43316	4032	44198	3343	44127	2339	51803	2042	25617
10-#14	1.35	MA	27622	6710	43516	5008	46706	4068	47082	3389	45696	2377	53983	1904	29636
5L-2S		MI	26267	6710	41718	4943	45370	4018	46695	3330	47484	2329	56266	2170	25575
10-#18	2.39	MA	33825	7331	55627	5349	61976	4314	65586	3517	70658	2303	86117	2091	52075
2L-5S		MI	24652	7331	40779	5310	43973	4307	44914	3504	44943	2264	54168	1449	40713
10-#18	2.39	MA	31657	7331	52280	5345	57710	4342	60400	3541	63651	2320	76780	1863	51886
3L-4S		MI	25818	7331	42779	5317	46551	4282	48070	3484	49338	2281	59478	1553	43122
10-#18	2.39	MA	30124	7331	49588	5376	54286	4334	56245	3530	58276	2338	70677	1636	50834
4L-3S		MI	27116	7331	45054	5288	49444	4294	51579	3499	53790	2264	64475	1780	44054
10-#18	2.39	MA	28751	7331	47225	5373	51239	4362	52515	3554	52974	2320	64266	1527	47750
5L-2S		MI	28937	7331	47868	5295	53032	4269	55941	3480	59595	2246	72153	2008	44168
12-#11	1.12	MA	29881	6576	46684	4923	50853	4010	52171	3337	52625	2380	62474	2257	25196
2L-6S		MI	23468	6576	36774	4884	39086	3987	39080	3315	37326	2366	43514	1932	21319
12-#11	1.12	MA	28989	6576	45349	4923	49152	4008	50103	3348	49823	2388	58681	2168	25224
3L-5S		MI	23924	6576	37525	4886	40107	3990	40324	3319	38966	2359	45557	1991	21560
12-#11	1.12	MA	28361	6576	44280	4936	47791	4020	48452	3345	47680	2396	56194	2079	25225
4E		MI	24402	6576	38320	4887	41132	3979	41580	3310	40752	2366	47716	2033	21573
12-#11	1.12	MA	27799	6576	43343	4936	46583	4018	46972	3356	45568	2391	53605	2035	25171
5L-3S		MI	24935	6576	39227	4875	42286	3982	42979	3314	42562	2359	49771	2122	21547
12-#11	1.12	MA	27263	6576	42459	4935	45382	4030	45507	3353	43628	2399	51136	1977	24829
6L-2S		MI	25685	6576	40354	4877	43722	3971	44726	3305	44921	2352	52915	2211	21510
12-#14	1.61	MA	31477	6870	50214	5091	55260	4130	57493	3409	59820	2353	72005	2201	35843
2L-6S		MI	23872	6870	38203	5051	40788	4110	41109	3386	40035	2337	47385	1741	29136
12-#14	1.61	MA	30217	6870	48304	5090	52825	4127	54532	3424	55808	2364	66608	2073	35831
3L-5S		MI	24517	6870	39280	5054	42249	4115	42892	3393	42369	2327	50282	1826	30051
12-#14	1.61	MA	29328	6870	46770	5109	50875	4144	52166	3419	52736	2375	63072	1945	35726
4E		MI	25194	6870	40420	5057	43719	4100	44691	3380	44909	2337	53353	1886	30475
12-#14	1.61	MA	28533	6870	45427	5108	49141	4141	50043	3434	49707	2367	59380	1882	35194
5L-3S		MI	25947	6870	41718	5040	45370	4105	46695	3387	47484	2327	56266	2014	30529
12-#14	1.61	MA	27774	6870	44159	5106	47419	4158	47942	3429	46925	2378	55869	1798	34017
6L-2S		MI	27008	6870	43330	5042	47425	4090	49192	3375	50841	2317	60728	2142	30508
12-#18	2.87	MA	35326	7614	58973	5526	66242	4442	70773	3597	77664	2284	95455	2046	62226
2L-6S		MI	24839	7614	41703	5480	44997	4424	46148	3568	46712	2257	56867	1241	46483
12-#18	2.87	MA	33179	7614	55627	5522	61976	4470	65586	3621	70658	2302	86117	1818	61964
3L-5S		MI	25941	7614	43593	5487	47561	4435	49275	3583	50747	2239	61847	1393	48912
12-#18	2.87	MA	31663	7614	52934	5554	58552	4463	61431	3610	65282	2319	80014	1591	60459
4E		MI	27095	7614	45593	5494	50140	4411	52432	3564	55142	2257	67156	1497	51171
12-#18	2.87	MA	30306	7614	50571	5550	55506	4491	57701	3634	59981	2302	73603	1481	57540
5L-3S		MI	28379	7614	47868	5465	53032	4422	55941	3579	59595	2239	72153	1724	52535
12-#18	2.87	MA	29011	7614	48341	5546	52477	4483	54007	3623	55110	2319	67536	1331	54625
6L-2S		MI	30184	7614	50682	5472	56620	4398	60303	3559	65399	2222	79832	1952	52716
14-#11	1.31	MA	30510	6687	48018	4992	52554	4060	54239	3368	55427	2373	66267	2243	29277
2L-7S		MI	23561	6687	37097	4966	39543	4048	39626	3355	38080	2366	44531	1827	24195
14-#11	1.31	MA	29622	6687	46684	4992	50853	4058	52171	3379	52625	2381	62474	2154	29294
3L-6S		MI	24004	6687	37900	4954	40523	4037	40826	3346	39685	2359	46658	1914	24627
14-#11	1.31	MA	28998	6687	45614	5005	49493	4070	50520	3376	50482	2389	59987	2065	29275
4L-5S		MI	24457	6687	38652	4955	41543	4040	42070	3350	41326	2352	48701	1973	24971
14-#11	1.31	MA	28439	6687	44677	5005	48284	4069	49040	3387	48370	2384	57397	2021	29200
5L-4S		MI	24933	6687	39447	4957	42569	4030	43326	3341	43111	2359	50860	2016	25005
14-#11	1.31	MA	27906	6687	43794	5004	47083	4081	47575	3384	46430	2392	54929	1962	28753
6L-3S		MI	25463	6687	40354	4944	43722	4032	44726	3345	44921	2352	52915	2104	24995

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

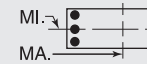


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.31	MA	27386	6687	42848	5017	45930	4079	46162	3395	44532	2401	52360	1875	28189
7L-2S		MI	26210	6687	41481	4946	45159	4022	46472	3336	47280	2345	56059	2193	24966
14-#14	1.88	MA	32360	7029	52125	5191	57696	4203	60454	3454	63831	2343	77402	2179	41665
2L-7S		MI	24002	7029	38662	5168	41438	4197	41886	3444	41108	2335	48829	1587	33101
14-#14	1.88	MA	31107	7029	50214	5190	55260	4199	57493	3469	59820	2354	72005	2051	41623
3L-6S		MI	24627	7029	39814	5151	42842	4182	43606	3431	43392	2325	51847	1714	33873
14-#14	1.88	MA	30225	7029	48681	5209	53310	4216	55126	3464	56747	2365	68469	1923	41486
4L-5S		MI	25268	7029	40891	5154	44304	4187	45389	3438	45725	2315	54744	1798	34739
14-#14	1.88	MA	29436	7029	47337	5207	51577	4213	53004	3479	53718	2357	64778	1860	40771
5L-4S		MI	25940	7029	42031	5157	45774	4172	47188	3425	48266	2325	57815	1859	35340
14-#14	1.88	MA	28683	7029	46069	5206	49854	4230	50903	3474	50936	2368	61267	1776	39649
6L-3S		MI	26688	7029	43330	5139	47425	4177	49192	3432	50841	2315	60728	1987	35422
14-#14	1.88	MA	27948	7029	44712	5225	48200	4227	48875	3489	48214	2379	57613	1649	38693
7L-2S		MI	27743	7029	44941	5142	49479	4162	51689	3420	54197	2305	65190	2115	35430
14-#18	3.35	MA	34685	7898	58973	5700	66242	4599	70773	3701	77664	2283	95455	1773	72031
3L-6S		MI	26126	7898	44517	5658	48585	4553	50510	3648	52517	2233	64546	1185	54537
14-#18	3.35	MA	33185	7898	56280	5731	62818	4591	66618	3690	72289	2301	89352	1545	70126
4L-5S		MI	27216	7898	46407	5664	51149	4564	53637	3663	56552	2215	69525	1337	57136
14-#18	3.35	MA	31842	7898	53918	5727	59772	4619	62887	3714	66987	2283	82941	1436	67356
5L-4S		MI	28358	7898	48407	5671	53728	4540	56793	3643	60947	2233	74835	1440	59263
14-#18	3.35	MA	30562	7898	51687	5724	56743	4612	59193	3703	62116	2301	76873	1286	64275
6L-3S		MI	29630	7898	50682	5643	56620	4551	60303	3659	65399	2215	79832	1668	61003
14-#18	3.35	MA	29312	7898	49300	5755	53834	4639	55628	3727	57349	2318	70555	1061	61260
7L-2S		MI	31419	7898	53497	5649	60208	4527	64665	3639	71204	2197	87510	1895	61245
16-#11	1.49	MA	31136	6797	49352	5062	54255	4110	56307	3399	58229	2366	70060	2229	33351
2L-8S		MI	23661	6797	37486	5034	39991	4095	40197	3396	38758	2351	45658	1759	27152
16-#11	1.49	MA	30252	6797	48018	5061	52554	4108	54239	3410	55427	2374	66267	2140	33354
3L-7S		MI	24095	6797	38224	5035	40980	4098	41372	3386	40439	2358	47675	1809	27531
16-#11	1.49	MA	29631	6797	46948	5074	51194	4120	52588	3407	53283	2383	63779	2051	33318
4L-6S		MI	24536	6797	39027	5023	41960	4088	42573	3377	42045	2351	49802	1897	27943
16-#11	1.49	MA	29075	6797	46012	5074	49985	4119	51108	3418	51171	2377	61190	2007	33224
5E		MI	24987	6797	39778	5024	42980	4091	43817	3381	43685	2344	51845	1955	28376
16-#11	1.49	MA	28545	6797	45128	5073	48784	4131	49643	3415	49232	2385	58721	1948	32686
6L-4S		MI	25460	6797	40574	5026	44006	4080	45073	3372	45470	2351	54004	1998	28427
16-#11	1.49	MA	28028	6797	44182	5087	47632	4129	48230	3426	47334	2394	56153	1861	32145
7L-3S		MI	25988	6797	41481	5013	45159	4083	46472	3376	47280	2344	56059	2087	28435
16-#11	1.49	MA	27518	6797	43315	5086	46468	4141	46847	3437	45345	2388	53733	1809	31656
8L-2S		MI	26732	6797	42608	5015	46596	4072	48219	3367	49639	2338	59202	2175	28416
16-#14	2.15	MA	33237	7189	54035	5291	60131	4275	63415	3499	67842	2333	82799	2157	47473
2L-8S		MI	24143	7189	39216	5265	42075	4265	42698	3501	42072	2314	50422	1489	36634
16-#14	2.15	MA	31991	7189	52125	5290	57696	4272	60454	3514	63831	2344	77402	2029	47407
3L-7S		MI	24756	7189	40274	5268	43492	4270	44383	3488	44465	2324	53291	1559	37754
16-#14	2.15	MA	31115	7189	50591	5308	55746	4289	58087	3509	60758	2356	73866	1901	47240
4L-6S		MI	25377	7189	41426	5251	44896	4255	46103	3476	46748	2314	56309	1686	38620
16-#14	2.15	MA	30331	7189	49248	5307	54013	4285	55965	3524	57730	2347	70175	1838	46364
5E		MI	26014	7189	42502	5254	46358	4260	47886	3483	49082	2304	59207	1771	39443
16-#14	2.15	MA	29584	7189	47980	5306	52290	4302	53863	3519	54948	2358	66664	1754	45290
6L-4S		MI	26681	7189	43642	5256	47828	4245	49686	3470	51622	2314	62278	1831	40198
16-#14	2.15	MA	28855	7189	46623	5325	50636	4299	51836	3534	52225	2369	63010	1627	44242
7L-3S		MI	27425	7189	44941	5239	49479	4249	51689	3477	54197	2304	65190	1959	40307
16-#14	2.15	MA	28135	7189	45378	5323	48967	4316	49852	3548	49373	2360	59560	1554	42821
8L-2S		MI	28473	7189	46552	5242	51533	4234	54186	3465	57554	2294	69652	2087	40342
16-#18	3.83	MA	34691	8182	59626	5908	67085	4720	71804	3770	79295	2282	98689	1500	79829
4L-6S		MI	27399	8182	47331	5835	52173	4681	54872	3728	58322	2209	72224	1129	62619
16-#18	3.83	MA	33363	8182	57264	5905	64038	4748	68073	3794	73994	2264	92278	1391	77192
5E		MI	28478	8182	49222	5842	54737	4692	57999	3743	62357	2191	77203	1280	65380
16-#18	3.83	MA	32096	8182	55033	5901	61009	4740	64379	3782	69123	2282	86210	1241	73952
6L-4S		MI	29609	8182	51222	5849	57316	4668	61155	3723	66752	2209	82513	1384	67389
16-#18	3.83	MA	30860	8182	52647	5932	58100	4768	60815	3806	64355	2300	79892	1016	70839
7L-3S		MI	30869	8182	53497	5820	60208	4679	64665	3739	71204	2191	87510	1612	69461

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

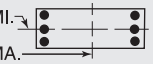
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.68	MA	31758	6908	50687	5131	55956	4160	58375	3431	61030	2359	73852	2215	37421
2L-9S		MI	23758	6908	37832	5115	40462	4156	40727	3422	39528	2351	46823	1685	29790
18-#11	1.68	MA	30878	6908	49352	5130	54255	4159	56307	3441	58229	2367	70060	2126	37407
3L-8S		MI	24195	6908	38613	5103	41428	4146	41943	3427	41117	2344	48802	1742	30431
18-#11	1.68	MA	30260	6908	48283	5144	52895	4171	54656	3438	56085	2376	67572	2037	37356
4L-7S		MI	24627	6908	39350	5104	42417	4149	43119	3417	42799	2351	50819	1791	30870
18-#11	1.68	MA	29707	6908	47346	5143	51687	4169	53176	3449	53973	2370	64983	1993	37246
5L-6S		MI	25065	6908	40154	5092	43396	4138	44319	3408	44404	2344	52946	1879	31266
18-#11	1.68	MA	29180	6908	46462	5143	50486	4181	51711	3446	52033	2379	62514	1934	36627
6L-5S		MI	25514	6908	40905	5093	44417	4141	45563	3412	46044	2337	54989	1938	31778
18-#11	1.68	MA	28666	6908	45516	5156	49333	4179	50298	3457	50135	2387	59946	1847	36105
7L-4S		MI	25985	6908	41701	5095	45443	4130	46819	3403	47829	2344	57148	1980	31844
18-#11	1.68	MA	28159	6908	44649	5155	48169	4191	48915	3468	48147	2381	57526	1795	35556
8L-3S		MI	26510	6908	42608	5083	46596	4133	48219	3407	49639	2337	59202	2069	31871
18-#11	1.68	MA	27631	6908	43797	5155	47033	4189	47483	3465	46269	2390	55134	1739	34740
9L-2S		MI	27251	6908	43735	5084	48032	4122	49965	3398	51998	2330	62346	2158	31859
18-#14	2.42	MA	32869	7348	54035	5389	60131	4344	63415	3559	67842	2334	82799	2007	53185
3L-8S		MI	24896	7348	40827	5365	44129	4337	45195	3546	45428	2302	54884	1461	41339
18-#14	2.42	MA	31999	7348	52502	5408	58182	4361	61048	3554	64770	2346	79264	1879	52991
4L-7S		MI	25504	7348	41885	5368	45546	4342	46880	3533	47821	2312	57753	1532	42419
18-#14	2.42	MA	31220	7348	51158	5407	56448	4358	58926	3569	61741	2337	75572	1816	51970
5L-6S		MI	26122	7348	43037	5351	46950	4327	48600	3521	50105	2302	60771	1659	43374
18-#14	2.42	MA	30478	7348	49890	5406	54726	4375	56824	3564	58959	2348	72061	1732	50940
6L-5S		MI	26754	7348	44113	5353	48412	4332	50383	3528	52439	2292	63669	1743	44159
18-#14	2.42	MA	29754	7348	48533	5424	53072	4371	54797	3578	56236	2359	68407	1605	49803
7L-4S		MI	27417	7348	45253	5356	49882	4317	52183	3515	54979	2302	66740	1804	45050
18-#14	2.42	MA	29040	7348	47288	5423	51403	4388	52812	3593	53385	2350	64957	1532	48425
8L-3S		MI	28156	7348	46552	5339	51533	4322	54186	3522	57554	2292	69652	1932	45185
18-#14	2.42	MA	28317	7348	45971	5442	49772	4385	50759	3588	50690	2361	61556	1451	46832
9L-2S		MI	29199	7348	48163	5342	53587	4307	56683	3509	60910	2282	74114	2060	45240
18-#18	4.31	MA	34869	8466	60610	6082	68304	4876	73260	3873	81001	2246	101615	1346	87046
5L-6S		MI	28660	8466	50146	6012	55761	4810	59234	3807	64126	2184	79903	1073	70725
18-#18	4.31	MA	33615	8466	58380	6078	65275	4869	69566	3862	76129	2263	95548	1195	83653
6L-5S		MI	29729	8466	52036	6019	58326	4821	62361	3823	68161	2167	84882	1224	73640
18-#18	4.31	MA	32392	8466	55993	6110	62366	4897	66001	3886	71362	2281	89230	970	80441
7L-4S		MI	30850	8466	54036	6026	60904	4797	65517	3803	72556	2184	90192	1328	75544
20-#11	1.87	MA	32377	7019	52021	5200	57658	4210	60443	3462	63832	2352	77645	2201	41482
2L-10S		MI	23834	7019	38225	5183	40922	4204	41305	3463	40310	2351	48049	1604	32439
20-#11	1.87	MA	31501	7019	50687	5199	55956	4209	58375	3472	61030	2360	73852	2112	41456
3L-9S		MI	24299	7019	38959	5184	41899	4207	42473	3453	41887	2344	49967	1667	33096
20-#11	1.87	MA	30886	7019	49617	5213	54596	4221	56724	3470	58887	2369	71365	2023	41391
4L-8S		MI	24725	7019	39740	5172	42865	4196	43690	3458	43476	2337	51946	1724	33716
20-#11	1.87	MA	30335	7019	48680	5212	53388	4219	55244	3480	56775	2363	68775	1979	41266
5L-7S		MI	25155	7019	40477	5173	43853	4199	44865	3448	45158	2344	53963	1774	34214
20-#11	1.87	MA	29811	7019	47797	5212	52187	4231	53779	3477	54835	2372	66307	1920	40573
6E		MI	25591	7019	41281	5161	44833	4188	46066	3439	46763	2337	56090	1861	34594
20-#11	1.87	MA	29300	7019	46851	5225	51034	4229	52366	3488	52937	2380	63738	1833	40068
7L-5S		MI	26038	7019	42032	5163	45853	4191	47310	3443	48403	2330	58133	1920	35176
20-#11	1.87	MA	28796	7019	45983	5224	49871	4241	50983	3499	50949	2374	61318	1781	39462
8L-4S		MI	26507	7019	42828	5164	46879	4180	48566	3434	50188	2337	60292	1963	35257
20-#11	1.87	MA	28271	7019	45132	5224	48734	4240	49552	3496	49071	2383	58927	1725	38669
9L-3S		MI	27029	7019	43735	5152	48032	4183	49965	3439	51998	2330	62346	2051	35294
20-#11	1.87	MA	27716	7019	44202	5237	47585	4252	48177	3507	47207	2391	56607	1662	37860
10L-2S		MI	27767	7019	44862	5153	49469	4172	51712	3429	54358	2323	65490	2140	35298

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

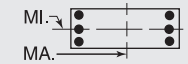
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.69	MA	32876	7508	54412	5508	60617	4433	64009	3599	68781	2336	84661	1857	58740
4L-8S		MI	25643	7508	42438	5465	46183	4409	47692	3591	48785	2291	59347	1434	46051
20-#14	2.69	MA	32103	7508	53068	5507	58884	4430	61886	3613	65752	2327	80969	1794	57587
5L-7S		MI	26248	7508	43496	5468	47600	4414	49377	3578	51178	2301	62215	1504	47095
20-#14	2.69	MA	31366	7508	51800	5505	57161	4447	59785	3608	62970	2338	77458	1710	56596
6E		MI	26861	7508	44648	5450	49004	4399	51097	3566	53462	2291	65234	1631	48134
20-#14	2.69	MA	30647	7508	50443	5524	55507	4444	57758	3623	60248	2349	73804	1583	55375
7L-5S		MI	27489	7508	45725	5453	50466	4404	52880	3573	55795	2281	68131	1716	48887
20-#14	2.69	MA	29938	7508	49199	5523	53838	4461	55773	3638	57396	2340	70354	1510	54037
8L-4S		MI	28148	7508	46865	5456	51936	4389	54680	3560	58335	2291	71202	1776	49899
20-#14	2.69	MA	29217	7508	47881	5542	52207	4458	53720	3633	54702	2351	66953	1429	52391
9L-3S		MI	28882	7508	48163	5439	53587	4394	56683	3567	60910	2281	74114	1904	50056
20-#18	4.78	MA	35120	8749	61726	6255	69542	4997	74752	3942	83136	2244	104885	1150	93374
6E		MI	29911	8749	52960	6190	59349	4938	63595	3887	69931	2160	87581	1017	78852
20-#18	4.78	MA	33909	8749	59339	6287	66633	5025	71187	3966	78369	2262	98567	925	90063
7L-5S		MI	30970	8749	54850	6196	61914	4950	66723	3903	73966	2142	92560	1168	81914
22-#11	2.05	MA	32120	7129	52021	5269	57658	4259	60443	3504	63832	2354	77645	2098	45501
3L-10S		MI	24366	7129	39352	5252	42359	4254	43051	3494	42670	2343	51192	1586	35712
22-#11	2.05	MA	31508	7129	50951	5282	56297	4271	58792	3501	61689	2362	75157	2009	45423
4L-9S		MI	24829	7129	40086	5253	43335	4257	44220	3485	44247	2336	53111	1650	36407
22-#11	2.05	MA	30961	7129	50015	5281	55089	4269	57312	3511	59577	2356	72568	1965	45284
5L-8S		MI	25253	7129	40867	5241	44301	4246	45436	3489	45836	2329	55090	1706	37008
22-#11	2.05	MA	30439	7129	49131	5281	53888	4281	55847	3508	57637	2365	70099	1906	44525
6L-7S		MI	25681	7129	41604	5243	45290	4249	46612	3480	47517	2336	57107	1756	37560
22-#11	2.05	MA	29930	7129	48185	5294	52735	4279	54434	3519	55739	2373	67531	1819	44035
7L-6S		MI	26115	7129	42408	5230	46270	4238	47812	3470	49122	2329	59234	1844	37927
22-#11	2.05	MA	29429	7129	47318	5294	51572	4291	53051	3530	53751	2368	65111	1767	43375
8L-5S		MI	26560	7129	43159	5232	47290	4241	49056	3475	50763	2323	61277	1902	38559
22-#11	2.05	MA	28907	7129	46466	5293	50435	4290	51620	3527	51872	2376	62719	1711	42602
9L-4S		MI	27026	7129	43955	5233	48316	4230	50312	3465	52548	2329	63436	1945	38665
22-#11	2.05	MA	28355	7129	45536	5306	49286	4302	50245	3538	50008	2384	60399	1648	41757
10L-3S		MI	27546	7129	44862	5221	49469	4233	51712	3470	54358	2323	65490	2034	38714
22-#11	2.05	MA	27814	7129	44685	5306	48156	4300	48830	3535	48048	2379	58036	1593	40828
11L-2S		MI	28281	7129	45988	5222	50906	4222	53458	3460	56717	2316	68634	2122	38734
22-#14	2.96	MA	32980	7668	54979	5606	61320	4502	64847	3658	69764	2317	86366	1772	63215
5L-8S		MI	26386	7668	44050	5565	48237	4482	50189	3636	52141	2279	63809	1406	50771
22-#14	2.96	MA	32248	7668	53711	5605	59597	4519	62746	3653	66982	2328	82855	1688	62258
6L-7S		MI	26986	7668	45107	5567	49654	4487	51874	3623	54535	2289	66677	1477	51781
22-#14	2.96	MA	31534	7668	52354	5624	57943	4516	60719	3668	64259	2339	79201	1562	60957
7L-6S		MI	27596	7668	46259	5550	51059	4472	53595	3610	56818	2279	69696	1604	52900
22-#14	2.96	MA	30830	7668	51109	5623	56274	4533	58734	3683	61407	2330	75752	1488	59656
8L-5S		MI	28220	7668	47336	5553	52520	4476	55377	3618	59152	2269	72593	1688	53623
22-#14	2.96	MA	30110	7668	49792	5641	54643	4530	56681	3678	58713	2341	72350	1407	57959
9L-4S		MI	28875	7668	48476	5555	53990	4461	57177	3605	61692	2279	75664	1749	54744
22-#18	5.26	MA	35413	9033	62686	6464	70899	5154	76373	4046	85375	2243	107905	880	99704
7L-6S		MI	31152	9033	55774	6367	62937	5067	67957	3967	75736	2136	95260	960	86999
24-#11	2.24	MA	32127	7240	52286	5351	57999	4321	60861	3532	64490	2355	78950	1995	49453
4L-10S		MI	24895	7240	40479	5321	43796	4304	44798	3525	45029	2336	54336	1568	38989
24-#11	2.24	MA	31583	7240	51349	5350	56790	4319	59380	3543	62378	2350	76361	1951	49276
5L-9S		MI	25356	7240	41213	5323	44772	4307	45966	3516	46606	2329	56255	1632	39721
24-#11	2.24	MA	31064	7240	50465	5350	55589	4331	57915	3540	60438	2358	73892	1892	48481
6L-8S		MI	25778	7240	41993	5310	45738	4296	47182	3520	48195	2322	58234	1689	40305
24-#11	2.24	MA	30558	7240	49519	5363	54436	4330	56502	3550	58541	2366	71324	1805	48005
7E		MI	26204	7240	42731	5312	46727	4299	48358	3511	49876	2329	60250	1738	40908

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

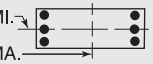
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.24	MA	30059	7240	48652	5363	53273	4342	55119	3561	56552	2361	68904	1753	47293
8L-6S		MI	26636	7240	43535	5299	47707	4288	49559	3501	51482	2322	62378	1826	41264
24-#11	2.24	MA	29540	7240	47800	5362	52136	4340	53688	3558	54674	2369	66512	1697	46540
9L-5S		MI	27079	7240	44286	5301	48727	4291	50803	3506	53122	2315	64421	1885	41871
24-#11	2.24	MA	28990	7240	46871	5376	50988	4352	52313	3569	52810	2377	64192	1634	45658
10L-4S		MI	27543	7240	45082	5302	49753	4280	52059	3496	54907	2322	66579	1927	42071
24-#11	2.24	MA	28452	7240	46019	5375	49857	4350	50898	3566	50850	2372	61829	1579	44748
11L-3S		MI	28060	7240	45988	5290	50906	4283	53458	3501	56717	2315	68634	2016	42131
24-#14	3.23	MA	33124	7827	55621	5705	62033	4592	65707	3698	70993	2318	88252	1666	67926
6L-8S		MI	27123	7827	45661	5664	50291	4554	52686	3681	55498	2267	68271	1379	55497
24-#14	3.23	MA	32415	7827	54264	5724	60379	4588	63680	3713	68270	2329	84598	1540	66547
7E		MI	27720	7827	46718	5667	51709	4559	54371	3668	57891	2277	71140	1449	56475
24-#14	3.23	MA	31716	7827	53020	5722	58709	4605	61695	3728	65419	2320	81149	1466	65282
8L-6S		MI	28326	7827	47870	5650	53113	4544	56092	3655	60175	2267	74158	1576	57671
24-#14	3.23	MA	30997	7827	51702	5741	57078	4602	59642	3723	62724	2331	77747	1385	63534
9L-5S		MI	28946	7827	48947	5653	54574	4549	57874	3662	62508	2257	77056	1661	58366

RECTANGULAR TIED COLUMNS 38" x 46"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.37	MA	33467	7032	53007	5212	57902	4236	59764	3510	61200	2461	72872	2304	33298
2L-3S		MI	25567	7032	40961	5134	43863	4201	44407	3480	43570	2420	50652	1997	27089
6-#18	1.37	MA	31130	7032	49484	5209	53410	4265	54303	3535	53801	2479	62980	2076	33297
3L-2S		MI	27426	7032	43776	5141	47451	4177	48769	3460	49375	2402	58331	2224	27012
8-#14	1.03	MA	32320	6819	50325	5110	54676	4165	55917	3472	56019	2490	66235	2364	25375
2L-4S		MI	24705	6819	38728	5059	41207	4121	41252	3432	39591	2469	45972	2046	20767
8-#14	1.03	MA	30973	6819	48314	5109	52113	4163	52802	3487	51798	2502	60526	2236	25422
3E		MI	25469	6819	40026	5042	42858	4126	43256	3439	42166	2459	48885	2174	20728
8-#14	1.03	MA	30024	6819	46703	5129	50064	4180	50314	3483	48569	2514	56781	2108	25398
4L-2S		MI	26544	6819	41637	5045	44912	4111	45753	3426	45523	2449	53347	2302	20663
8-#18	1.83	MA	35096	7316	56531	5390	62394	4365	65225	3590	68598	2443	82763	2261	44057
2L-4S		MI	25548	7316	41500	5340	44558	4319	45259	3544	44922	2413	53334	1713	35325
8-#18	1.83	MA	32784	7316	53007	5387	57902	4394	59764	3615	61200	2461	72872	2034	43953
3E		MI	26862	7316	43776	5311	47451	4330	48769	3560	49375	2396	58331	1941	35629
8-#18	1.83	MA	31151	7316	50176	5419	54301	4387	55394	3605	55525	2479	66399	1806	43416
4L-2S		MI	28704	7316	46590	5318	51039	4306	53131	3540	55180	2378	66009	2168	35636
10-#14	1.29	MA	33269	6979	52335	5210	57239	4238	59032	3517	60240	2480	71944	2344	31527
2L-5S		MI	24782	6979	39199	5156	41791	4209	41949	3489	40408	2447	47363	1958	25552
10-#14	1.29	MA	31931	6979	50325	5209	54676	4235	55917	3532	56019	2492	66235	2216	31548
3L-4S		MI	25464	6979	40339	5159	43261	4194	43749	3477	42948	2457	50434	2019	25661
10-#14	1.29	MA	30989	6979	48713	5228	52627	4252	53430	3528	52789	2504	62491	2088	31478
4L-3S		MI	26223	6979	41637	5142	44912	4199	45753	3484	45523	2447	53347	2147	25661
10-#14	1.29	MA	30146	6979	47301	5227	50806	4250	51199	3543	49607	2496	58592	2024	31249
5L-2S		MI	27292	6979	43249	5145	46966	4184	48250	3471	48880	2437	57809	2275	25615
10-#18	2.29	MA	36705	7599	60055	5567	66887	4493	70686	3670	75997	2425	92655	2219	54775
2L-5S		MI	25672	7599	42315	5510	45568	4472	46465	3644	46332	2371	55703	1553	41000
10-#18	2.29	MA	34415	7599	56531	5564	62394	4522	65225	3695	68598	2443	82763	1992	54586
3L-4S		MI	26842	7599	44315	5517	48147	4447	49621	3624	50727	2389	61012	1657	43466
10-#18	2.29	MA	32801	7599	53699	5596	58793	4516	60855	3685	62924	2461	76291	1764	53821
4L-3S		MI	28142	7599	46590	5488	51039	4458	53131	3639	55180	2371	66009	1884	44137
10-#18	2.29	MA	31354	7599	51216	5593	55591	4545	56933	3710	57329	2444	69512	1653	50434
5L-2S		MI	29967	7599	49404	5495	54627	4434	57493	3620	60984	2354	73688	2112	44230
12-#11	1.07	MA	32519	6845	50626	5142	55160	4189	56543	3490	56883	2497	67553	2376	26459
2L-6S		MI	24489	6845	38301	5087	40682	4154	40636	3456	38725	2475	45062	2037	21457
12-#11	1.07	MA	31579	6845	49223	5141	53370	4188	54368	3501	53936	2506	63544	2287	26487
3L-5S		MI	24946	6845	39052	5089	41702	4157	41880	3461	40365	2468	47105	2096	21612
12-#11	1.07	MA	30918	6845	48099	5155	51941	4200	52633	3498	51684	2515	60912	2198	26489
4E		MI	25424	6845	39847	5090	42728	4146	43137	3451	42150	2475	49264	2139	21613

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

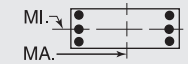
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.07	MA	30327	6845	47115	5155	50672	4199	51078	3510	49465	2510	58179	2154	26434
5L-3S		MI	25958	6845	40754	5078	43881	4149	44536	3456	43960	2468	51319	2227	21583
12-#11	1.07	MA	29764	6845	46187	5154	49411	4211	49540	3507	47428	2518	55568	2095	26161
6L-2S		MI	26709	6845	41881	5079	45318	4138	46282	3446	46319	2461	54462	2316	21544
12-#14	1.54	MA	34211	7138	54345	5310	59802	4310	62148	3562	64461	2470	77653	2323	37665
2L-6S		MI	24893	7138	39733	5253	42383	4276	42664	3527	41431	2445	48928	1846	29314
12-#14	1.54	MA	32881	7138	52335	5309	57239	4307	59032	3577	60240	2482	71944	2195	37654
3L-5S		MI	25539	7138	40810	5256	43845	4281	44446	3534	43764	2435	51826	1931	30249
12-#14	1.54	MA	31946	7138	50723	5328	55190	4325	56545	3573	57010	2494	68200	2068	37548
4E		MI	26217	7138	41950	5259	45315	4266	46246	3521	46304	2445	54897	1991	30540
12-#14	1.54	MA	31109	7138	49312	5327	53369	4322	54315	3588	53828	2486	64301	2004	37144
5L-3S		MI	26971	7138	43249	5242	46966	4271	48250	3529	48880	2435	57809	2119	30580
12-#14	1.54	MA	30311	7138	47980	5326	51559	4339	52107	3584	50905	2498	60585	1920	35853
6L-2S		MI	28034	7138	44860	5244	49020	4256	50747	3516	52236	2425	62271	2247	30551
12-#18	2.75	MA	38295	7883	63578	5744	71379	4622	76147	3750	83395	2407	102546	2177	65466
2L-6S		MI	25858	7883	43239	5681	46592	4589	47700	3708	48102	2365	58402	1345	46958
12-#18	2.75	MA	36027	7883	60055	5741	66887	4651	70686	3775	75997	2426	92655	1949	65204
3L-5S		MI	26963	7883	45129	5688	49156	4600	50827	3724	52137	2347	63381	1497	49195
12-#18	2.75	MA	34430	7883	57223	5774	63286	4644	66316	3765	70322	2444	86182	1722	63965
4E		MI	28120	7883	47129	5694	51735	4576	53983	3704	56532	2365	68691	1601	51508
12-#18	2.75	MA	33001	7883	54740	5771	60083	4673	62394	3790	64728	2427	79403	1611	60751
5L-3S		MI	29408	7883	49404	5666	54627	4587	57493	3719	60984	2347	73688	1828	52625
12-#18	2.75	MA	31637	7883	52396	5768	56900	4667	58511	3780	59587	2445	72972	1461	57908
6L-2S		MI	31217	7883	52219	5672	58215	4563	61854	3699	66789	2329	81366	2056	52783
14-#11	1.25	MA	33185	6955	52030	5211	56949	4240	58718	3521	59830	2490	71562	2363	30751
2L-7S		MI	24581	6955	38624	5169	41139	4215	41182	3497	39479	2474	46079	1932	24325
14-#11	1.25	MA	32249	6955	50626	5211	55160	4238	56543	3532	56883	2499	67553	2274	30768
3L-6S		MI	25025	6955	39427	5156	42119	4204	42383	3487	41084	2468	48206	2020	24763
14-#11	1.25	MA	31592	6955	49502	5224	53730	4251	54808	3529	54631	2508	64921	2185	30749
4L-5S		MI	25480	6955	40179	5158	43139	4207	43627	3492	42724	2461	50249	2078	25028
14-#11	1.25	MA	31004	6955	48519	5224	52461	4249	53253	3541	52412	2503	62188	2141	30674
5L-4S		MI	25956	6955	40974	5159	44165	4196	44883	3482	44509	2468	52408	2121	25051
14-#11	1.25	MA	30444	6955	47591	5224	51200	4261	51715	3538	50375	2512	59577	2082	30289
6L-3S		MI	26486	6955	41881	5147	45318	4199	46282	3487	46319	2461	54462	2210	25034
14-#11	1.25	MA	29897	6955	46597	5237	49989	4260	50231	3549	48382	2520	56862	1995	29671
7L-2S		MI	27235	6955	43008	5149	46754	4188	48029	3477	48678	2454	57606	2298	25002
14-#14	1.80	MA	35146	7298	56355	5409	62365	4382	65263	3606	68681	2460	83363	2303	43792
2L-7S		MI	25022	7298	40192	5370	43033	4363	43441	3585	42504	2444	50372	1692	33405
14-#14	1.80	MA	33824	7298	54345	5409	59802	4380	62148	3622	64461	2472	77653	2175	43749
3L-6S		MI	25649	7298	41345	5353	44437	4348	45161	3572	44787	2434	53390	1819	34050
14-#14	1.80	MA	32895	7298	52733	5428	57752	4397	59661	3618	61231	2484	73909	2047	43612
4L-5S		MI	26291	7298	42421	5356	45899	4353	46944	3579	47121	2424	56288	1903	34935
14-#14	1.80	MA	32064	7298	51322	5427	55931	4394	57430	3633	58049	2476	70011	1983	43015
5L-4S		MI	26964	7298	43561	5359	47369	4338	48743	3566	49661	2434	59359	1964	35410
14-#14	1.80	MA	31272	7298	49990	5426	54122	4412	55223	3629	55126	2488	66295	1899	41782
6L-3S		MI	27714	7298	44860	5341	49020	4343	50747	3574	52236	2424	62271	2092	35478
14-#14	1.80	MA	30499	7298	48565	5445	52384	4409	53094	3644	52266	2500	62429	1773	40917
7L-2S		MI	28770	7298	46471	5344	51074	4328	53244	3561	55593	2414	66733	2220	35475
14-#18	3.20	MA	37622	8167	63578	5919	71379	4779	76147	3855	83395	2408	102546	1907	75811
3L-6S		MI	27147	8167	46053	5858	50180	4718	52061	3788	53906	2340	66081	1289	55004
14-#18	3.20	MA	36042	8167	60746	5951	67778	4773	71777	3845	77721	2426	96074	1680	74152
4L-5S		MI	28240	8167	47943	5865	52744	4729	55189	3803	57942	2323	71060	1441	57415
14-#18	3.20	MA	34628	8167	58263	5948	64576	4802	67855	3870	72126	2409	89295	1569	71094
5L-4S		MI	29386	8167	49943	5872	55323	4704	58345	3783	62337	2340	76369	1544	59593

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

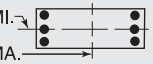


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.20	MA	33279	8167	55919	5945	61392	4795	63972	3860	66985	2427	82864	1419	68084
6L-3S		MI	30662	8167	52219	5843	58215	4716	61854	3799	66789	2323	81366	1772	61099
14-#18	3.20	MA	31963	8167	53411	5977	58335	4824	60226	3885	61954	2445	76169	1194	64935
7L-2S		MI	32455	8167	55033	5850	61803	4691	66216	3779	72594	2305	89045	1999	61317
16-#11	1.43	MA	33847	7066	53433	5280	58738	4290	60893	3552	62777	2483	75572	2350	35036
2L-8S		MI	24681	7066	39013	5236	41587	4262	41753	3537	40156	2460	47206	1864	27362
16-#11	1.43	MA	32915	7066	52030	5280	56949	4288	58718	3563	59830	2492	71562	2261	35039
3L-7S		MI	25117	7066	39750	5238	42576	4265	42929	3528	41838	2467	49223	1914	27660
16-#11	1.43	MA	32261	7066	50906	5293	55520	4301	56983	3561	57578	2501	68930	2172	35003
4L-6S		MI	25558	7066	40554	5226	43555	4254	44129	3519	43443	2460	51350	2002	28078
16-#11	1.43	MA	31676	7066	49922	5293	54250	4299	55429	3572	55359	2496	66198	2128	34909
5E		MI	26010	7066	41305	5227	44575	4257	45373	3523	45083	2453	53393	2061	28438
16-#11	1.43	MA	31119	7066	48994	5293	52989	4312	53890	3569	53322	2505	63587	2069	34427
6L-4S		MI	26484	7066	42101	5229	45601	4247	46630	3514	46868	2460	55552	2103	28478
16-#11	1.43	MA	30576	7066	48001	5306	51779	4310	52406	3580	51329	2513	60871	1982	33833
7L-3S		MI	27012	7066	43008	5216	46754	4249	48029	3518	48678	2453	57606	2192	28477
16-#11	1.43	MA	30040	7066	47090	5306	50557	4323	50954	3591	49241	2508	58317	1930	33395
8L-2S		MI	27758	7066	44135	5218	48191	4239	49775	3509	51038	2446	60750	2281	28454
16-#14	2.06	MA	36073	7458	58365	5509	64927	4454	68379	3651	72902	2451	89072	2283	49903
2L-8S		MI	25163	7458	40746	5467	43670	4431	44253	3642	43467	2422	51966	1594	36911
16-#14	2.06	MA	34759	7458	56355	5508	62365	4452	65263	3667	68681	2462	83363	2155	49837
3L-7S		MI	25777	7458	41804	5470	45087	4436	45938	3630	45860	2432	54834	1664	38053
16-#14	2.06	MA	33837	7458	54744	5527	60315	4469	62776	3662	65452	2474	79619	2027	49670
4L-6S		MI	26400	7458	42956	5453	46491	4421	47658	3617	48144	2422	57852	1791	38796
16-#14	2.06	MA	33012	7458	53332	5527	58494	4467	60546	3678	62269	2466	75720	1963	48902
5E		MI	27038	7458	44032	5456	47953	4426	49441	3624	50477	2412	60750	1876	39636
16-#14	2.06	MA	32225	7458	52000	5526	56685	4484	58338	3674	59346	2478	72004	1879	47720
6L-4S		MI	27707	7458	45172	5458	49423	4411	51241	3611	53018	2422	63821	1936	40272
16-#14	2.06	MA	31458	7458	50575	5545	54947	4481	56209	3689	56487	2490	68138	1752	46762
7L-3S		MI	28452	7458	46471	5441	51074	4416	53244	3618	55593	2412	66733	2064	40366
16-#14	2.06	MA	30701	7458	49268	5544	53194	4499	54124	3705	53491	2482	64494	1678	45209
8L-2S		MI	29502	7458	48082	5444	53128	4401	55741	3606	58949	2402	71196	2192	40393
16-#18	3.66	MA	37637	8451	64270	6128	72270	4901	77238	3924	85120	2408	105965	1637	84376
4L-6S		MI	28422	8451	48868	6035	53768	4846	56423	3868	59711	2316	73759	1233	63078
16-#18	3.66	MA	36237	8451	61787	6125	69068	4930	73316	3950	79525	2391	99186	1527	81459
5E		MI	29505	8451	50758	6042	56333	4857	59550	3883	63746	2298	78738	1385	65656
16-#18	3.66	MA	34903	8451	59443	6122	65884	4924	69433	3940	74384	2409	92755	1377	78286
6L-4S		MI	30640	8451	52758	6049	58911	4833	62707	3863	68141	2316	84048	1488	67713
16-#18	3.66	MA	33602	8451	56935	6155	62827	4953	65687	3965	69352	2427	86061	1152	75220
7L-3S		MI	31904	8451	55033	6020	61803	4844	66216	3879	72594	2298	89045	1716	69563
16-#18	3.66	MA	32318	8451	54633	6152	59742	4946	62018	3990	64083	2410	79727	1023	70990
8L-2S		MI	33683	8451	57847	6027	65391	4820	70578	3859	78398	2281	96723	1943	69836
18-#11	1.61	MA	34505	7177	54837	5349	60528	4340	63068	3583	65724	2476	79581	2337	39316
2L-9S		MI	24778	7177	39359	5318	42057	4323	42283	3564	40927	2460	48371	1790	29995
18-#11	1.61	MA	33577	7177	53433	5349	58738	4338	60893	3594	62777	2485	75572	2248	39303
3L-8S		MI	25216	7177	40140	5306	43024	4312	43500	3568	42515	2453	50350	1847	30648
18-#11	1.61	MA	32926	7177	52309	5362	57309	4351	59159	3592	60525	2494	72940	2159	39252
4L-7S		MI	25649	7177	40877	5307	44012	4315	44675	3559	44197	2460	52367	1897	31000
18-#11	1.61	MA	32345	7177	51325	5362	56040	4349	57604	3603	58306	2489	70207	2114	39142
5L-6S		MI	26088	7177	41681	5295	44992	4305	45876	3550	45802	2453	54494	1984	31401
18-#11	1.61	MA	31791	7177	50398	5362	54779	4362	56065	3600	56269	2498	67596	2056	38573
6L-5S		MI	26538	7177	42432	5296	46012	4307	47120	3554	47443	2446	56537	2043	31843
18-#11	1.61	MA	31250	7177	49404	5375	53568	4360	54581	3611	54276	2507	64880	1969	38000
7L-4S		MI	27009	7177	43228	5298	47038	4297	48376	3545	49228	2453	58695	2086	31898
18-#11	1.61	MA	30717	7177	48494	5375	52346	4373	53129	3623	52188	2502	62326	1917	37521
8L-3S		MI	27535	7177	44135	5285	48191	4300	49775	3549	51038	2446	60750	2174	31914
18-#11	1.61	MA	30153	7177	47600	5375	51153	4371	51626	3620	50215	2510	59796	1861	36630
9L-2S		MI	28278	7177	45262	5287	49628	4289	51522	3540	53397	2439	63894	2263	31899

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

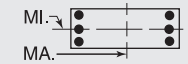


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.32	MA	35688	7617	58365	5608	64927	4524	68379	3712	72902	2452	89072	2134	55919
3L-8S		MI	25916	7617	42357	5567	45724	4503	46750	3687	46824	2411	56428	1566	41613
18-#14	2.32	MA	34772	7617	56754	5627	62878	4541	65891	3707	69672	2464	85328	2006	55725
4L-7S		MI	26526	7617	43415	5570	47142	4508	48435	3675	49217	2421	59296	1637	42715
18-#14	2.32	MA	33952	7617	55342	5626	61057	4539	63661	3723	66490	2456	81429	1942	54803
5L-6S		MI	27145	7617	44567	5553	48546	4493	50155	3662	51501	2411	62315	1764	43550
18-#14	2.32	MA	33171	7617	54010	5626	59247	4556	61454	3718	63567	2468	77713	1858	53668
6L-5S		MI	27779	7617	45644	5555	50007	4498	51938	3669	53834	2401	65212	1848	44351
18-#14	2.32	MA	32410	7617	52585	5645	57510	4554	59325	3734	60707	2480	73847	1732	52619
7L-4S		MI	28444	7617	46784	5558	51477	4483	53738	3656	56374	2411	68283	1909	45129
18-#14	2.32	MA	31658	7617	51278	5644	55757	4571	57240	3749	57711	2472	70204	1658	51111
8L-3S		MI	29185	7617	48082	5541	53128	4488	55741	3663	58949	2401	71196	2037	45247
18-#14	2.32	MA	30872	7617	49995	5643	54044	4568	55083	3745	54881	2484	66603	1577	49557
9L-2S		MI	30230	7617	49693	5543	55182	4473	58238	3651	62306	2391	75658	2165	45293
18-#18	4.12	MA	37832	8734	65310	6303	73560	5059	78777	4029	86924	2374	109078	1484	91841
5L-6S		MI	29685	8734	51682	6213	57356	4975	60785	3947	65516	2292	81437	1177	71177
18-#18	4.12	MA	36511	8734	62967	6300	70377	5052	74894	4019	81782	2392	102647	1334	88512
6L-5S		MI	30758	8734	53572	6219	59921	4986	63912	3963	69551	2274	86417	1328	73914
18-#18	4.12	MA	35223	8734	60458	6332	67319	5081	71148	4045	76751	2410	95952	1110	85349
7L-4S		MI	31883	8734	55572	6226	62499	4962	67068	3943	73946	2292	91726	1432	75863
18-#18	4.12	MA	33953	8734	58157	6329	64234	5075	67480	4070	71481	2393	89618	980	81225
8L-3S		MI	33136	8734	57847	6198	65391	4973	70578	3959	78398	2274	96723	1659	78018
20-#11	1.78	MA	35159	7287	56240	5418	62317	4390	65244	3614	68671	2469	83590	2324	43588
2L-10S		MI	24854	7287	39752	5386	42518	4370	42862	3605	41709	2459	49596	1709	32725
20-#11	1.78	MA	34235	7287	54837	5418	60528	4389	63068	3625	65724	2478	79581	2235	43562
3L-9S		MI	25320	7287	40486	5387	43494	4373	44030	3595	43286	2453	51515	1773	33300
20-#11	1.78	MA	33588	7287	53713	5432	59098	4401	61334	3623	63472	2487	76949	2146	43497
4L-8S		MI	25747	7287	41267	5375	44460	4363	45246	3600	44875	2446	53494	1829	33931
20-#11	1.78	MA	33009	7287	52729	5431	57829	4400	59779	3634	61253	2482	74216	2101	43372
5L-7S		MI	26178	7287	42004	5376	45449	4366	46422	3590	46556	2453	55510	1879	34344
20-#11	1.78	MA	32458	7287	51801	5431	56568	4412	58241	3631	59216	2491	71605	2043	42725
6E		MI	26615	7287	42808	5364	46429	4355	47622	3581	48162	2446	57638	1967	34729
20-#11	1.78	MA	31920	7287	50808	5445	55357	4410	56757	3643	57223	2500	68890	1956	42171
7L-5S		MI	27063	7287	43559	5365	47449	4358	48866	3585	49802	2439	59681	2025	35244
20-#11	1.78	MA	31390	7287	49897	5444	54136	4423	55304	3654	55135	2495	66335	1904	41633
8L-4S		MI	27532	7287	44355	5367	48475	4347	50123	3576	51587	2446	61839	2068	35313
20-#11	1.78	MA	30830	7287	49003	5444	52942	4421	53801	3651	53162	2503	63806	1848	40766
9L-3S		MI	28056	7287	45262	5355	49628	4350	51522	3580	53397	2439	63894	2157	35342
20-#11	1.78	MA	30246	7287	48027	5458	51736	4434	52357	3662	51205	2512	61352	1784	40006
10L-2S		MI	28795	7287	46389	5356	51065	4339	53268	3571	55756	2432	67038	2245	35340
20-#14	2.57	MA	35700	7777	58764	5727	65441	4614	69007	3752	73893	2454	91037	1986	61777
4L-8S		MI	26665	7777	43969	5667	47779	4575	49247	3732	50180	2399	60890	1539	46323
20-#14	2.57	MA	34886	7777	57352	5726	63620	4611	66777	3768	70711	2446	87139	1922	60715
5L-7S		MI	27271	7777	45026	5670	49196	4580	50932	3719	52573	2409	63759	1609	47387
20-#14	2.57	MA	34111	7777	56020	5725	61810	4629	64569	3763	67788	2458	83423	1838	59622
6E		MI	27886	7777	46178	5652	50600	4565	52652	3707	54857	2399	66777	1736	48310
20-#14	2.57	MA	33354	7777	54595	5745	60073	4626	62440	3779	64928	2470	79557	1711	58486
7L-5S		MI	28516	7777	47255	5655	52062	4570	54435	3714	57191	2389	69674	1821	49076
20-#14	2.57	MA	32608	7777	53288	5744	58320	4643	60355	3794	61932	2462	75913	1637	57021
8L-4S		MI	29177	7777	48395	5658	53531	4555	56235	3701	59731	2399	72746	1881	49981
20-#14	2.57	MA	31838	7777	52005	5743	56607	4641	58198	3790	59102	2474	72313	1556	55413
9L-3S		MI	29913	7777	49693	5641	55182	4560	58238	3708	62306	2389	75658	2009	50122
20-#14	2.57	MA	31004	7777	50604	5762	54876	4658	56127	3805	56293	2486	68821	1465	53798
10L-2S		MI	30952	7777	51304	5643	57237	4545	60735	3695	65663	2379	80120	2137	50187
20-#18	4.58	MA	38105	9018	66490	6477	74869	5181	80355	4099	89181	2374	112538	1292	98758
6E		MI	30938	9018	54496	6390	60944	5103	65147	4027	71321	2268	89116	1121	79298
20-#18	4.58	MA	36829	9018	63982	6509	71812	5210	76609	4124	84150	2392	105844	1067	95497
7L-5S		MI	32002	9018	56386	6397	63509	5114	68274	4043	75356	2250	94095	1272	82186
20-#18	4.58	MA	35572	9018	61681	6506	68727	5203	72941	4150	78880	2375	99510	938	91475
8L-4S		MI	33117	9018	58386	6404	66087	5090	71430	4023	79751	2268	99405	1376	84038

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

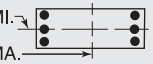
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.96	MA	34891	7398	56240	5487	62317	4439	65244	3657	68671	2471	83590	2222	47818
3L-10S		MI	25387	7398	40879	5455	43955	4421	44608	3636	44068	2452	52740	1691	35995
22-#11	1.96	MA	34246	7398	55116	5501	60888	4451	63509	3654	66419	2480	80958	2133	47740
4L-9S		MI	25850	7398	41613	5456	44931	4424	45776	3626	45645	2445	54658	1755	36609
22-#11	1.96	MA	33670	7398	54132	5500	59619	4450	61954	3665	64200	2475	78225	2088	47600
5L-8S		MI	26275	7398	42394	5444	45897	4413	46993	3631	47234	2438	56638	1811	37221
22-#11	1.96	MA	33122	7398	53205	5500	58357	4462	60416	3663	62163	2484	75615	2030	46882
6L-7S		MI	26704	7398	43131	5445	46886	4416	48168	3621	48916	2445	58654	1861	37690
22-#11	1.96	MA	32587	7398	52211	5514	57147	4461	58932	3674	60169	2493	72899	1943	46346
7L-6S		MI	27139	7398	43935	5433	47865	4405	49369	3612	50521	2438	60782	1949	38062
22-#11	1.96	MA	32060	7398	51301	5514	55925	4473	57479	3685	58082	2488	70344	1891	45750
8L-5S		MI	27585	7398	44686	5435	48885	4408	50613	3616	52161	2431	62825	2008	38642
22-#11	1.96	MA	31502	7398	50407	5513	54732	4472	55976	3682	56109	2497	67815	1835	44905
9L-4S		MI	28052	7398	45482	5436	49911	4397	51869	3607	53946	2438	64983	2050	38725
22-#11	1.96	MA	30921	7398	49431	5527	53526	4484	54533	3693	54152	2505	65361	1771	44108
10L-3S		MI	28573	7398	46389	5424	51065	4400	53268	3611	55756	2431	67038	2139	38765
22-#11	1.96	MA	30353	7398	48537	5527	52339	4483	53047	3691	52093	2500	62866	1716	43096
11L-2S		MI	29310	7398	47515	5425	52501	4389	55015	3602	58115	2425	70182	2228	38777
22-#14	2.83	MA	35814	7936	59362	5826	66183	4684	69892	3813	74932	2436	92848	1901	66638
5L-8S		MI	27408	7936	45580	5767	49833	4648	51744	3777	53537	2387	65352	1511	51040
22-#14	2.83	MA	35044	7936	58031	5825	64373	4701	67685	3808	72009	2448	89132	1817	65583
6L-7S		MI	28011	7936	46637	5769	51250	4653	53429	3764	55930	2397	68221	1582	52070
22-#14	2.83	MA	34292	7936	56605	5844	62636	4698	65555	3824	69149	2460	85266	1691	64363
7L-6S		MI	28622	7936	47789	5752	52654	4638	55149	3752	58214	2387	71239	1709	53076
22-#14	2.83	MA	33552	7936	55298	5843	60883	4716	63471	3839	66153	2452	81622	1617	62937
8L-5S		MI	29248	7936	48866	5755	54116	4643	56932	3759	60547	2378	74137	1793	53811
22-#14	2.83	MA	32783	7936	54015	5843	59170	4713	61314	3835	63323	2464	78022	1536	61277
9L-4S		MI	29905	7936	50006	5757	55586	4628	58732	3746	63088	2387	77208	1854	54830
22-#14	2.83	MA	31957	7936	52614	5862	57439	4730	59242	3850	60514	2476	74530	1444	59697
10L-3S		MI	30637	7936	51304	5740	57237	4633	60735	3753	65663	2378	80120	1982	54992
22-#18	5.03	MA	38421	9302	67506	6687	76304	5338	82070	4204	91548	2374	115735	1025	105665
7L-6S		MI	32182	9302	57311	6567	64532	5232	69509	4107	77125	2243	96794	1064	87439
22-#18	5.03	MA	37176	9302	65204	6684	73219	5332	78402	4230	86278	2357	109401	896	101604
8L-5S		MI	33236	9302	59201	6574	67097	5243	72636	4123	81161	2226	101773	1216	90470
24-#11	2.14	MA	34901	7509	56520	5570	62677	4501	65684	3685	69366	2473	84968	2120	51980
4L-10S		MI	25917	7509	42006	5524	45391	4471	46355	3667	46427	2445	55884	1674	39270
24-#11	2.14	MA	34328	7509	55536	5570	61408	4500	64130	3696	67147	2468	82235	2075	51827
5L-9S		MI	26378	7509	42740	5525	46367	4474	47523	3657	48004	2438	57802	1737	39923
24-#11	2.14	MA	33782	7509	54608	5569	60147	4512	62591	3694	65110	2477	79624	2017	51045
6L-8S		MI	26801	7509	43520	5513	47334	4463	48739	3662	49593	2431	59781	1794	40517
24-#11	2.14	MA	33250	7509	53615	5583	58936	4511	61107	3705	63116	2486	76908	1930	50523
7E		MI	27228	7509	44258	5515	48322	4466	49915	3652	51275	2438	61798	1844	41039
24-#11	2.14	MA	32725	7509	52704	5583	57714	4523	59654	3716	61028	2481	74354	1878	49874
8L-6S		MI	27661	7509	45062	5502	49302	4455	51115	3643	52880	2431	63925	1931	41399
24-#11	2.14	MA	32171	7509	51810	5582	56521	4522	58151	3713	59056	2490	71824	1822	49049
9L-5S		MI	28105	7509	45813	5504	50322	4458	52359	3647	54520	2424	65968	1990	42022
24-#11	2.14	MA	31592	7509	50834	5596	55315	4534	56708	3725	57099	2498	69370	1758	48215
10L-4S		MI	28570	7509	46609	5505	51348	4447	53616	3638	56305	2431	68127	2033	42133
24-#11	2.14	MA	31026	7509	49940	5596	54128	4533	55222	3722	55040	2493	66876	1703	47223
11L-3S		MI	29089	7509	47515	5493	52501	4450	55015	3642	58115	2424	70182	2121	42184
24-#11	2.14	MA	30470	7509	48979	5609	52930	4545	53782	3733	53085	2502	64132	1629	46094
12L-2S		MI	29823	7509	48642	5494	53938	4439	56761	3633	60475	2417	73326	2210	42207
24-#14	3.09	MA	35971	8096	60041	5925	66936	4773	70800	3853	76229	2438	94841	1797	71550
6L-8S		MI	28147	8096	47191	5866	51887	4720	54241	3822	56894	2376	69815	1484	55764

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#14	3.09	MA	35224	8096	58615	5944	65199	4771	68671	3869	73369	2450	90975	1671	70250
7E		MI	28746	8096	48248	5869	53304	4725	55926	3809	59287	2386	72683	1554	56762
24-#14	3.09	MA	34489	8096	57308	5943	63445	4788	66586	3884	70374	2442	87332	1596	68861
8L-6S		MI	29354	8096	49400	5852	54708	4710	57647	3796	61570	2376	75701	1681	57846
24-#14	3.09	MA	33721	8096	56025	5942	61733	4785	64429	3880	67544	2454	83731	1515	67149
9L-5S		MI	29976	8096	50477	5855	56170	4715	59429	3804	63904	2366	78599	1766	58554
24-#14	3.09	MA	32903	8096	54624	5962	60002	4803	62358	3895	64735	2466	80239	1424	65426
10L-4S		MI	30629	8096	51617	5857	57640	4700	61229	3791	66444	2376	81670	1826	59676
24-#18	5.49	MA	38767	9585	68728	6861	77711	5460	83863	4309	93677	2340	119293	854	111890
8L-6S		MI	33416	9585	60125	6745	68120	5360	73870	4187	82930	2219	104473	1008	95598

RECTANGULAR TIED COLUMNS 38" x 48"

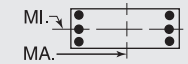
6-#18	1.32	MA	36274	7301	57234	5431	62528	4416	64481	3663	65849	2578	78474	2425	34918
2L-3S		MI	26590	7301	42498	5334	45458	4366	45959	3620	44960	2527	52187	2101	27147
6-#18	1.32	MA	33814	7301	53533	5429	57809	4446	58745	3689	58078	2597	68028	2198	34917
3L-2S		MI	28451	7301	45312	5341	49046	4342	50321	3600	50764	2510	59865	2328	27058
8-#18	1.75	MA	37994	7585	60935	5608	67246	4544	70216	3743	73620	2560	88920	2386	46217
2L-4S		MI	26570	7585	43037	5540	46154	4484	46811	3684	46312	2521	54868	1817	35440
8-#18	1.75	MA	35559	7585	57234	5606	62528	4574	64481	3769	65849	2580	78474	2158	46113
3E		MI	27886	7585	45312	5511	49046	4495	50321	3700	50764	2503	59865	2045	35699
8-#18	1.75	MA	33843	7585	54263	5639	58750	4569	59895	3760	59895	2599	71632	1931	45576
4L-2S		MI	29731	7585	48126	5518	52634	4471	54682	3680	56569	2485	67544	2272	35689
10-#14	1.23	MA	36060	7248	56518	5428	61821	4417	63699	3669	64824	2598	77453	2464	33046
2L-5S		MI	25803	7248	40729	5358	43386	4375	43504	3630	41803	2555	48907	2063	25631
10-#14	1.23	MA	34652	7248	54409	5428	59131	4415	60429	3685	60394	2610	71431	2336	33066
3L-4S		MI	26486	7248	41869	5361	44856	4360	45304	3618	44343	2565	51978	2124	25717
10-#14	1.23	MA	33663	7248	52719	5447	56982	4433	57821	3681	57007	2623	67479	2208	32997
4L-3S		MI	27246	7248	43167	5344	46507	4365	47308	3625	46918	2555	54890	2252	25704
10-#14	1.23	MA	32778	7248	51239	5447	55073	4431	55483	3697	53671	2615	63373	2144	32768
5L-2S		MI	28316	7248	44779	5347	48561	4350	49805	3612	50275	2546	59352	2380	25654
10-#18	2.19	MA	39693	7868	64636	5785	71965	4673	75952	3822	81390	2542	99366	2346	57475
2L-5S		MI	26693	7868	43851	5711	47163	4636	48016	3784	47722	2479	57237	1657	41279
10-#18	2.19	MA	37282	7868	60935	5783	67246	4703	70216	3849	73620	2562	88920	2119	57286
3L-4S		MI	27865	7868	45851	5717	49742	4612	51173	3764	52117	2497	62547	1761	43802
10-#18	2.19	MA	35585	7868	57964	5816	63468	4697	65631	3840	67666	2581	82078	1891	56652
4L-3S		MI	29168	7868	48126	5689	52634	4623	54682	3779	56569	2479	67544	1988	44216
10-#18	2.19	MA	34066	7868	55360	5814	60110	4727	61518	3866	61798	2566	74931	1779	53136
5L-2S		MI	30996	7868	50941	5696	56222	4599	59044	3760	62374	2461	75222	2216	44286
12-#11	1.03	MA	35266	7114	54722	5360	59633	4369	61081	3642	61294	2614	72804	2495	27723
2L-6S		MI	25510	7114	39827	5290	42278	4321	42193	3598	40123	2584	46610	2143	21591
12-#11	1.03	MA	34277	7114	53249	5360	57756	4368	58799	3654	58202	2624	68578	2406	27751
3L-5S		MI	25968	7114	40579	5292	43298	4324	43437	3602	41763	2577	48653	2201	21662
12-#11	1.03	MA	33584	7114	52071	5374	56258	4381	56980	3652	55841	2633	65802	2317	27753
4E		MI	26447	7114	41374	5293	44324	4313	44693	3593	43548	2584	50812	2244	21653
12-#11	1.03	MA	32964	7114	51040	5374	54928	4380	55351	3663	53515	2628	62925	2272	27698
5L-3S		MI	26981	7114	42281	5281	45477	4316	46093	3597	45358	2577	52866	2333	21618
12-#11	1.03	MA	32373	7114	50068	5374	53606	4392	53739	3661	51381	2638	60172	2214	27499
6L-2S		MI	27733	7114	43408	5282	46913	4305	47839	3588	47718	2570	56010	2421	21577
12-#14	1.48	MA	37053	7407	58628	5528	64511	4489	66970	3714	69254	2588	83474	2445	39488
2L-6S		MI	25913	7407	41263	5455	43979	4442	44219	3668	42826	2554	50471	1951	29487
12-#14	1.48	MA	35654	7407	56518	5528	61821	4487	63699	3730	64824	2600	77453	2317	39476
3L-5S		MI	26561	7407	42340	5458	45440	4447	46001	3675	45160	2544	53369	2036	30442

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.48	MA	34672	7407	54829	5547	59672	4505	61091	3726	61437	2613	73500	2189	39371
4E		MI	27240	7407	43480	5461	46910	4432	47801	3663	47700	2554	56440	2096	30602
12-#14	1.48	MA	33794	7407	53349	5547	57763	4503	58753	3742	58101	2605	69395	2125	39103
5L-3S		MI	27996	7407	44779	5444	48561	4437	49805	3670	50275	2544	59352	2224	30626
12-#14	1.48	MA	32956	7407	51954	5546	55866	4521	56440	3738	55038	2618	65474	2041	37697
6L-2S		MI	29059	7407	46390	5446	50615	4422	52302	3657	53632	2534	63815	2352	30593
12-#18	2.63	MA	41373	8152	68336	5963	76683	4802	81688	3902	89161	2525	109812	2307	68706
2L-6S		MI	26878	8152	44775	5881	48187	4754	49251	3848	49491	2472	59937	1449	47422
12-#18	2.63	MA	38985	8152	64636	5960	71965	4831	75952	3928	81390	2544	99366	2079	68444
3L-5S		MI	27985	8152	46665	5888	50751	4765	52378	3864	53527	2455	64916	1601	49470
12-#18	2.63	MA	37306	8152	61665	5994	68186	4826	71367	3919	75437	2564	92524	1852	67500
4E		MI	29146	8152	48665	5895	53330	4741	55534	3844	57921	2472	70225	1705	51837
12-#18	2.63	MA	35804	8152	59061	5991	64828	4855	67254	3946	69569	2548	85377	1739	63980
5L-3S		MI	30436	8152	50941	5866	56222	4752	59044	3859	62374	2455	75222	1932	52711
12-#18	2.63	MA	34371	8152	56603	5989	61490	4850	63182	3937	64178	2567	78582	1590	61226
6L-2S		MI	32249	8152	53755	5873	59810	4728	63406	3839	68179	2437	82901	2160	52849
14-#11	1.20	MA	35968	7224	56194	5429	61511	4419	63363	3673	64386	2607	77030	2483	32225
2L-7S		MI	25602	7224	40151	5372	42735	4382	42739	3639	40877	2583	47626	2037	24450
14-#11	1.20	MA	34984	7224	54722	5429	59633	4418	61081	3685	61294	2617	72804	2394	32243
3L-6S		MI	26047	7224	40954	5359	43714	4371	43939	3629	42482	2577	49754	2125	24896
14-#11	1.20	MA	34294	7224	53544	5443	58135	4431	59262	3683	58933	2626	70028	2305	32223
4L-5S		MI	26502	7224	41705	5361	44734	4374	45184	3634	44123	2570	51797	2184	25082
14-#11	1.20	MA	33677	7224	52513	5443	56805	4430	57633	3694	56608	2621	67151	2260	32148
5L-4S		MI	26979	7224	42501	5362	45760	4363	46440	3624	45908	2577	53955	2226	25094
14-#11	1.20	MA	33089	7224	51540	5443	55484	4442	56021	3692	54473	2631	64398	2202	31833
6L-3S		MI	27510	7224	43408	5350	46913	4366	47839	3629	47718	2570	56010	2315	25071
14-#11	1.20	MA	32516	7224	50500	5457	54215	4441	54466	3704	52384	2640	61535	2114	31159
7L-2S		MI	28259	7224	44535	5351	48350	4355	49586	3619	50077	2563	59154	2404	25038
14-#14	1.73	MA	38039	7567	60738	5628	67200	4562	70240	3759	73684	2578	89496	2426	45918
2L-7S		MI	26042	7567	41723	5572	44629	4530	44996	3726	43899	2552	51915	1797	33657
14-#14	1.73	MA	36649	7567	58628	5627	64511	4560	66970	3775	69254	2590	83474	2298	45876
3L-6S		MI	26671	7567	42875	5555	46033	4515	46716	3713	46183	2542	54934	1923	34222
14-#14	1.73	MA	35673	7567	56939	5647	62361	4577	64361	3771	65867	2603	79522	2170	45738
4L-5S		MI	27314	7567	43951	5558	47495	4520	48499	3720	48516	2532	57831	2008	35125
14-#14	1.73	MA	34801	7567	55459	5646	60453	4575	62024	3787	62531	2596	75416	2105	45272
5L-4S		MI	27989	7567	45091	5561	48964	4505	50298	3708	51057	2542	60902	2069	35477
14-#14	1.73	MA	33970	7567	54064	5646	58556	4593	59710	3783	59468	2608	71495	2021	43923
6L-3S		MI	28740	7567	46390	5543	50615	4509	52302	3715	53632	2532	63815	2197	35532
14-#14	1.73	MA	33158	7567	52570	5665	56736	4591	57478	3799	56471	2621	67417	1895	43050
7L-2S		MI	29798	7567	48001	5546	52670	4495	54799	3702	56988	2522	68277	2325	35520
14-#18	3.07	MA	40669	8436	68336	6138	76683	4960	81688	4008	89161	2527	109812	2040	79591
3L-6S		MI	28167	8436	47590	6058	51775	4882	53613	3928	55296	2448	67615	1393	55461
14-#18	3.07	MA	39008	8436	65366	6171	72905	4954	77103	3999	83208	2546	102970	1812	78207
4L-5S		MI	29264	8436	49480	6065	54340	4894	56740	3943	59331	2430	72594	1545	57687
14-#18	3.07	MA	37522	8436	62762	6169	69546	4984	72990	4026	77340	2530	95823	1700	74850
5L-4S		MI	30413	8436	51480	6072	56918	4869	59896	3924	63726	2448	77904	1648	59916
14-#18	3.07	MA	36105	8436	60304	6166	66208	4978	68918	4017	71948	2550	89028	1550	71928
6L-3S		MI	31693	8436	53755	6043	59810	4880	63406	3939	68179	2430	82901	1876	61192
14-#18	3.07	MA	34722	8436	57675	6200	63003	5008	64990	4043	66673	2569	81956	1325	68502
7L-2S		MI	33490	8436	56569	6050	63398	4856	67768	3919	73983	2413	90579	2103	61387
16-#11	1.37	MA	36666	7335	57667	5498	63389	4469	65646	3705	67478	2601	81256	2470	36721
2L-8S		MI	25702	7335	40540	5439	43183	4429	43310	3679	41555	2569	48754	1970	27490
16-#11	1.37	MA	35686	7335	56194	5498	61511	4468	63363	3716	64386	2610	77030	2382	36724
3L-7S		MI	26138	7335	41277	5441	44171	4432	44485	3670	43236	2576	50770	2020	27786
16-#11	1.37	MA	34999	7335	55016	5512	60013	4481	61545	3714	62025	2619	74254	2293	36687
4L-6S		MI	26580	7335	42081	5428	45151	4421	45686	3660	44842	2569	52898	2107	28211
16-#11	1.37	MA	34386	7335	53985	5512	58683	4480	59916	3725	59700	2614	71377	2248	36594
5E		MI	27033	7335	42832	5430	46171	4424	46930	3665	46482	2562	54941	2166	28496

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

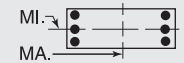
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.37	MA	33801	7335	53013	5512	57361	4492	58304	3723	57565	2624	68624	2190	36175
6L-4S		MI	27508	7335	43628	5431	47197	4413	48186	3655	48267	2569	57099	2208	28526
16-#11	1.37	MA	33231	7335	51973	5526	56093	4491	56749	3735	55477	2633	65761	2102	35527
7L-3S		MI	28037	7335	44535	5419	48350	4416	49586	3660	50077	2562	59154	2297	28517
16-#11	1.37	MA	32669	7335	51019	5526	54813	4504	55227	3746	53289	2628	63072	2050	35057
8L-2S		MI	28783	7335	45662	5421	49787	4405	51332	3650	52436	2555	62298	2386	28491
16-#14	1.97	MA	39018	7726	62848	5728	69890	4634	73510	3804	78115	2568	95518	2407	52333
2L-8S		MI	26182	7726	42276	5669	45266	4597	45808	3784	44863	2531	53509	1699	37180
16-#14	1.97	MA	37636	7726	60738	5727	67200	4632	70240	3820	73684	2580	89496	2279	52267
3L-7S		MI	26798	7726	43334	5672	46683	4602	47493	3771	47256	2541	56378	1769	38346
16-#14	1.97	MA	36666	7726	59049	5747	65051	4650	67631	3816	70298	2593	85544	2151	52100
4L-6S		MI	27422	7726	44486	5655	48087	4587	49213	3758	49539	2531	59396	1896	38967
16-#14	1.97	MA	35800	7726	57569	5746	63143	4648	65294	3832	66962	2586	81438	2086	51453
5E		MI	28062	7726	45562	5658	49549	4592	50996	3765	51873	2521	62293	1981	39825
16-#14	1.97	MA	34975	7726	56174	5746	61246	4665	62980	3828	63898	2598	77517	2002	50159
6L-4S		MI	28732	7726	46702	5660	51019	4577	52795	3752	54413	2531	65364	2041	40344
16-#14	1.97	MA	34170	7726	54680	5765	59426	4663	60748	3844	60901	2611	73438	1876	49302
7L-3S		MI	29479	7726	48001	5643	52670	4582	54799	3760	56988	2521	68277	2169	40424
16-#14	1.97	MA	33376	7726	53311	5765	57589	4681	58564	3860	57761	2603	69601	1801	47613
8L-2S		MI	30531	7726	49612	5646	54724	4567	57296	3747	60345	2511	72739	2297	40438
16-#18	3.51	MA	40692	8719	69066	6348	77623	5083	82839	4079	90979	2528	113416	1772	88952
4L-6S		MI	29445	8719	50404	6236	55363	5011	57975	4008	61101	2424	75294	1337	63528
16-#18	3.51	MA	39221	8719	66462	6346	74265	5113	78726	4105	85111	2513	106269	1660	85743
5E		MI	30531	8719	52294	6243	57928	5022	61102	4023	65136	2406	80273	1489	65925
16-#18	3.51	MA	37820	8719	64005	6344	70927	5107	74654	4096	79719	2532	99474	1511	82656
6L-4S		MI	31670	8719	54294	6249	60506	4998	64258	4003	69531	2424	85582	1592	68031
16-#18	3.51	MA	36452	8719	61376	6377	67721	5137	70726	4123	74444	2552	92402	1286	79340
7L-3S		MI	32938	8719	56569	6221	63398	5009	67768	4019	73983	2406	90579	1820	69661
16-#18	3.51	MA	35103	8719	58964	6375	64487	5131	66880	4149	68917	2536	85724	1155	75053
8L-2S		MI	34722	8719	59384	6227	66986	4985	72130	3999	79788	2388	98258	2047	69911
18-#11	1.54	MA	37360	7445	59139	5567	65266	4520	67928	3736	70570	2594	85482	2458	41211
2L-9S		MI	25798	7445	40886	5521	43653	4490	43840	3706	42325	2569	49918	1896	30194
18-#11	1.54	MA	36384	7445	57667	5567	63389	4518	65646	3747	67478	2603	81256	2370	41198
3L-8S		MI	26237	7445	41667	5508	44619	4479	45056	3710	43914	2562	51898	1952	30838
18-#11	1.54	MA	35701	7445	56489	5581	61890	4531	63827	3745	65117	2612	78480	2281	41147
4L-7S		MI	26670	7445	42404	5510	45608	4482	46232	3701	45596	2569	53914	2002	31126
18-#11	1.54	MA	35091	7445	55458	5581	60560	4530	62198	3757	62792	2608	75603	2235	41037
5L-6S		MI	27111	7445	43208	5498	46588	4471	47432	3691	47201	2562	56042	2090	31532
18-#11	1.54	MA	34509	7445	54486	5581	59239	4543	60586	3754	60657	2617	72850	2177	40526
6L-5S		MI	27561	7445	43959	5499	47608	4474	48677	3696	48841	2555	58084	2148	31904
18-#11	1.54	MA	33942	7445	53445	5595	57970	4541	59031	3766	58569	2626	69987	2090	39901
7L-4S		MI	28034	7445	44755	5501	48634	4464	49933	3686	50626	2562	60243	2191	31949
18-#11	1.54	MA	33383	7445	52491	5595	56691	4554	57509	3777	56381	2622	67298	2037	39442
8L-3S		MI	28560	7445	45662	5488	49787	4466	51332	3691	52436	2555	62298	2280	31957
18-#11	1.54	MA	32784	7445	51555	5595	55440	4553	55935	3775	54314	2631	64631	1981	38531
9L-2S		MI	29304	7445	46789	5490	51223	4456	53079	3681	54795	2548	65442	2368	31938
18-#14	2.22	MA	38616	7886	62848	5827	69890	4704	73510	3865	78115	2570	95518	2260	58653
3L-8S		MI	26937	7886	43888	5769	47320	4669	48305	3828	48219	2519	57971	1671	41879
18-#14	2.22	MA	37653	7886	61158	5846	67741	4722	70901	3861	74728	2583	91565	2132	58459
4L-7S		MI	27548	7886	44945	5772	48737	4674	49990	3816	50612	2529	60840	1742	43004
18-#14	2.22	MA	36792	7886	59679	5846	65833	4720	68564	3877	71392	2576	87459	2067	57649
5L-6S		MI	28169	7886	46097	5755	50141	4659	51710	3803	52896	2519	63858	1868	43720
18-#14	2.22	MA	35973	7886	58284	5845	63936	4738	66250	3873	68328	2588	83538	1983	56405
6L-5S		MI	28804	7886	47174	5757	51603	4664	53493	3810	55230	2509	66756	1953	44537

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

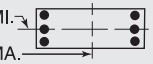


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.22	MA	35173	7886	56790	5865	62116	4735	64019	3889	65331	2601	79460	1857	55455
7L-4S		MI	29471	7886	48314	5760	53073	4649	55293	3797	57770	2519	69827	2014	45205
18-#14	2.22	MA	34385	7886	55420	5865	60279	4753	61834	3905	62191	2593	75622	1782	53813
8L-3S		MI	30213	7886	49612	5743	54724	4654	57296	3804	60345	2509	72739	2142	45308
18-#14	2.22	MA	33546	7886	54076	5864	58484	4751	59574	3901	59225	2606	71823	1701	52307
9L-2S		MI	31260	7886	51223	5745	56778	4639	59793	3792	63701	2499	77201	2270	45346
18-#18	3.95	MA	40905	9003	70163	6523	78983	5241	84462	4185	92881	2495	116715	1621	96654
5L-6S		MI	30710	9003	53218	6413	58951	5140	62336	4087	66905	2400	82972	1281	71621
18-#18	3.95	MA	39517	9003	67706	6521	75645	5235	80390	4176	87490	2514	109920	1471	93408
6L-5S		MI	31787	9003	55108	6420	61516	5151	65464	4103	70941	2382	87951	1432	74181
18-#18	3.95	MA	38164	9003	65077	6554	72440	5265	76462	4202	82214	2534	102848	1246	90196
7L-4S		MI	32916	9003	57108	6427	64094	5126	68620	4083	75336	2400	93261	1536	76176
18-#18	3.95	MA	36829	9003	62664	6552	69205	5260	72616	4229	76688	2518	96170	1116	85817
8L-3S		MI	34173	9003	59384	6398	66986	5138	72130	4099	79788	2382	98258	1764	78122
20-#11	1.71	MA	38050	7556	60612	5637	67144	4570	70211	3767	73663	2587	89708	2446	45694
2L-10S		MI	25874	7556	41279	5588	44113	4537	44418	3746	43107	2568	51144	1814	33004
20-#11	1.71	MA	37079	7556	59139	5637	65266	4569	67928	3778	70570	2596	85482	2357	45668
3L-9S		MI	26334	7556	42013	5590	45090	4540	45587	3737	44684	2561	53062	1878	33497
20-#11	1.71	MA	36399	7556	57961	5650	63768	4581	66110	3776	68209	2605	82706	2269	45603
4L-8S		MI	26769	7556	42794	5578	46056	4529	46803	3741	46273	2555	55041	1934	34141
20-#11	1.71	MA	35791	7556	56931	5650	62438	4580	64480	3788	65884	2601	79829	2223	45478
5L-7S		MI	27200	7556	43531	5579	47045	4532	47978	3732	47955	2561	57058	1984	34470
20-#11	1.71	MA	35213	7556	55958	5650	61116	4593	62868	3785	63749	2610	77076	2165	44884
6E		MI	27638	7556	44335	5567	48024	4522	49179	3723	49560	2555	59185	2072	34860
20-#11	1.71	MA	34649	7556	54918	5664	59848	4592	61314	3797	61661	2619	74213	2078	44279
7L-5S		MI	28087	7556	45086	5568	49044	4524	50423	3727	51200	2548	61228	2131	35309
20-#11	1.71	MA	34093	7556	53964	5664	58568	4604	59792	3808	59473	2615	71524	2025	43816
8L-4S		MI	28557	7556	45882	5570	50070	4514	51679	3718	52985	2555	63387	2173	35367
20-#11	1.71	MA	33496	7556	53028	5664	57318	4603	58217	3806	57407	2624	68857	1969	42873
9L-3S		MI	29082	7556	46789	5557	51223	4517	53079	3722	54795	2548	65442	2262	35392
20-#11	1.71	MA	32884	7556	52005	5678	56055	4616	56705	3818	55356	2633	66268	1906	42148
10L-2S		MI	29823	7556	47915	5559	52660	4506	54825	3713	57155	2541	68586	2351	35381
20-#14	2.47	MA	38632	8046	63268	5946	70431	4794	74171	3906	79158	2573	97587	2113	64815
4L-8S		MI	27686	8046	45499	5869	49374	4742	50802	3873	51576	2508	62433	1644	46587
20-#14	2.47	MA	37778	8046	61789	5946	68523	4792	71834	3922	75822	2566	93481	2048	63857
5L-7S		MI	28294	8046	46556	5872	50791	4747	52487	3861	53969	2517	65302	1714	47673
20-#14	2.47	MA	36964	8046	60393	5945	66626	4810	69520	3918	72758	2578	89560	1964	62658
6E		MI	28911	8046	47708	5854	52195	4732	54207	3848	56253	2508	68320	1841	48480
20-#14	2.47	MA	36170	8046	58900	5965	64806	4808	67289	3934	69761	2591	85482	1838	61618
7L-5S		MI	29542	8046	48785	5857	53657	4736	55990	3855	58586	2498	71218	1926	49261
20-#14	2.47	MA	35387	8046	57530	5964	62969	4826	65104	3950	66621	2583	81644	1763	60020
8L-4S		MI	30204	8046	49925	5860	55127	4722	57790	3842	61126	2508	74289	1986	50061
20-#14	2.47	MA	34554	8046	56186	5964	61174	4823	62844	3946	63655	2596	77845	1682	58461
9L-3S		MI	30943	8046	51223	5843	56778	4726	59793	3849	63701	2498	77201	2114	50187
20-#14	2.47	MA	33689	8046	54718	5983	59360	4841	60673	3962	60712	2609	74160	1591	56710
10L-2S		MI	31984	8046	52835	5845	58832	4711	62290	3837	67058	2488	81663	2242	50242
20-#18	4.39	MA	41199	9287	71407	6698	80363	5364	86126	4256	95261	2497	120366	1432	104181
6E		MI	31966	9287	56033	6590	62539	5268	66698	4167	72710	2375	90651	1225	79736
20-#18	4.39	MA	39859	9287	68777	6731	77158	5394	82198	4282	89985	2516	113294	1207	100986
7L-5S		MI	33033	9287	57923	6597	65104	5279	69825	4183	76745	2358	95630	1376	82451
20-#18	4.39	MA	38537	9287	66365	6729	73924	5388	78352	4309	84459	2500	106616	1076	96597
8L-4S		MI	34152	9287	59923	6604	67682	5255	72982	4163	81140	2375	100939	1480	84347
22-#11	1.88	MA	37769	7667	60612	5706	67144	4619	70211	3810	73663	2589	89708	2345	50135
3L-10S		MI	26408	7667	42406	5657	45550	4587	46165	3777	45467	2561	54288	1797	36271
22-#11	1.88	MA	37093	7667	59434	5720	65645	4631	68392	3807	71301	2598	86932	2256	50057
4L-9S		MI	26872	7667	43140	5659	46526	4590	47333	3768	47044	2554	56206	1860	36806
22-#11	1.88	MA	36488	7667	58403	5720	64315	4630	66763	3819	68976	2594	84055	2211	49917
5L-8S		MI	27298	7667	43920	5647	47493	4580	48549	3772	48632	2547	58185	1917	37429

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

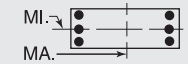


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.88	MA	35913	7667	57431	5720	62994	4643	65151	3817	66841	2603	81302	2153	49248
6L-7S		MI	27728	7667	44658	5648	48481	4583	49725	3763	50314	2554	60202	1967	37817
22-#11	1.88	MA	35352	7667	56391	5733	61725	4642	63596	3828	64753	2612	78439	2066	48661
7L-6S		MI	28163	7667	45462	5636	49461	4572	50925	3754	51919	2547	62329	2054	38192
22-#11	1.88	MA	34798	7667	55437	5733	60446	4654	62074	3840	62565	2608	75750	2013	48139
8L-5S		MI	28610	7667	46213	5637	50481	4575	52169	3758	53560	2540	64372	2113	38710
22-#11	1.88	MA	34205	7667	54500	5733	59195	4653	60499	3837	60499	2617	73083	1957	47219
9L-4S		MI	29078	7667	47009	5639	51507	4564	53426	3749	55345	2547	66531	2156	38782
22-#11	1.88	MA	33595	7667	53478	5747	57932	4666	58987	3849	58448	2626	70494	1894	46477
10L-3S		MI	29600	7667	47915	5627	52660	4567	54825	3753	57155	2540	68586	2244	38815
22-#11	1.88	MA	32999	7667	52542	5747	56689	4665	57431	3847	56291	2622	67868	1838	45380
11L-2S		MI	30339	7667	49042	5628	54097	4556	56572	3744	59514	2533	71730	2333	38820
22-#14	2.71	MA	38757	8205	63899	6045	71213	4865	75104	3967	80252	2556	99503	2029	70076
5L-8S		MI	28431	8205	47110	5969	51428	4814	53299	3918	54932	2496	66896	1616	51303
22-#14	2.71	MA	37948	8205	62503	6045	69316	4882	72790	3963	77189	2568	95582	1945	68917
6L-7S		MI	29035	8205	48167	5971	52845	4819	54984	3905	57326	2506	69764	1687	52353
22-#14	2.71	MA	37159	8205	61010	6064	67496	4880	70559	3979	74191	2581	91503	1819	67791
7L-6S		MI	29648	8205	49319	5954	54249	4804	56704	3893	59609	2496	72783	1813	53246
22-#14	2.71	MA	36382	8205	59640	6064	65659	4898	68374	3995	71051	2574	87666	1744	66235
8L-5S		MI	30276	8205	50396	5957	55711	4809	58487	3900	61943	2486	75680	1898	53995
22-#14	2.71	MA	35564	8205	58296	6064	63864	4896	66114	3991	68086	2586	83867	1663	64622
9L-4S		MI	30934	8205	51536	5959	57181	4794	60287	3887	64483	2496	78751	1959	54913
22-#14	2.71	MA	34695	8205	56828	6083	62050	4913	63943	4007	65142	2599	80181	1572	62907
10L-3S		MI	31668	8205	52835	5942	58832	4799	62290	3894	67058	2486	81663	2087	55059
22-#18	4.82	MA	41540	9570	72478	6909	81877	5522	87934	4362	97756	2499	123740	1167	111680
7L-6S		MI	33211	9570	58847	6768	66127	5397	71060	4247	78515	2351	98329	1168	87871
22-#18	4.82	MA	40231	9570	70066	6907	78642	5517	84088	4388	92230	2483	117062	1037	107392
8L-5S		MI	34270	9570	60737	6774	68692	5408	74187	4263	82550	2333	103308	1320	90734
24-#11	2.05	MA	37783	7777	60907	5789	67523	4681	70674	3838	74394	2591	91158	2244	54507
4L-10S		MI	26938	7777	43533	5727	46987	4638	47911	3809	47826	2554	57432	1779	39544
24-#11	2.05	MA	37182	7777	59876	5789	66193	4680	69045	3850	72068	2587	88281	2199	54354
5L-9S		MI	27400	7777	44267	5728	47963	4641	49080	3799	49403	2547	59350	1843	40118
24-#11	2.05	MA	36609	7777	58904	5789	64871	4693	67433	3848	69933	2596	85528	2141	53616
6L-8S		MI	27824	7777	45047	5716	48929	4630	50296	3804	50992	2540	61329	1899	40723
24-#11	2.05	MA	36051	7777	57863	5802	63603	4692	65878	3859	67845	2605	82665	2054	53046
7E		MI	28252	7777	45785	5717	49918	4633	51471	3794	52673	2547	63346	1949	41166
24-#11	2.05	MA	35500	7777	56909	5803	62323	4705	64357	3871	65657	2601	79976	2001	52468
8L-6S		MI	28686	7777	46589	5705	50898	4622	52672	3785	54279	2540	65473	2037	41529
24-#11	2.05	MA	34910	7777	55973	5803	61073	4703	62782	3868	63591	2610	77309	1945	51570
9L-5S		MI	29131	7777	47340	5707	51918	4625	53916	3789	55919	2533	67516	2095	42109
24-#11	2.05	MA	34302	7777	54950	5816	59810	4716	61270	3880	61540	2619	74720	1882	50790
10L-4S		MI	29597	7777	48136	5708	52944	4614	55172	3780	57704	2540	69675	2138	42192
24-#11	2.05	MA	33709	7777	54014	5816	58567	4715	59713	3878	59383	2615	72094	1826	49713
11L-3S		MI	30117	7777	49042	5696	54097	4617	56572	3784	59514	2533	71730	2227	42236
24-#11	2.05	MA	33125	7777	53008	5830	57312	4728	58205	3889	57335	2624	69202	1752	48615
12L-2S		MI	30852	7777	50169	5697	55533	4606	58318	3775	61873	2526	74874	2315	42255
24-#14	2.96	MA	38926	8365	64613	6145	72006	4955	76060	4008	81619	2558	101603	1926	75183
6L-8S		MI	29171	8365	48721	6068	53482	4886	55796	3963	58289	2484	71358	1588	56025
24-#14	2.96	MA	38142	8365	63120	6164	70186	4952	73829	4024	78621	2571	97525	1800	73973
7E		MI	29772	8365	49779	6071	54899	4891	57481	3950	60682	2494	74226	1659	57042
24-#14	2.96	MA	37370	8365	61750	6164	68349	4970	71644	4040	75482	2564	93687	1725	72456
8L-6S		MI	30381	8365	50931	6054	56304	4876	59202	3938	62966	2484	77245	1786	58016
24-#14	2.96	MA	36554	8365	60406	6163	66554	4968	69384	4036	72516	2576	89888	1644	70791
9L-5S		MI	31005	8365	52007	6057	57765	4881	60984	3945	65299	2474	80142	1871	58736
24-#14	2.96	MA	35693	8365	58938	6183	64740	4986	67213	4052	69572	2589	86203	1553	69111
10L-4S		MI	31660	8365	53147	6059	59235	4866	62784	3932	67840	2484	83213	1931	59762
24-#18	5.26	MA	41910	9854	73767	7084	83361	5645	89823	4468	100001	2465	127507	997	118201
8L-6S		MI	34448	9854	61661	6945	69715	5525	75422	4327	84320	2327	106007	1112	96024

RECTANGULAR TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.50	MA	26834	6509	42944	4769	46795	3872	48335	3200	49482	2209	58808	2044	28488
2L-3S		MI	24861	6509	39953	4764	42981	3897	43698	3222	43277	2227	50577	1816	28510
8-#14	1.13	MA	25889	6296	40681	4669	44084	3802	45104	3163	45319	2251	53395	2115	21768
2L-4S		MI	23940	6296	37594	4684	40152	3813	40328	3170	38989	2271	45501	1859	21816
8-#18	2.00	MA	28194	6792	45936	4947	50609	4000	52971	3280	55687	2187	67039	1992	37634
2L-4S		MI	24854	6792	40530	4971	43726	4016	44610	3288	44722	2222	53443	1536	36809
10-#14	1.41	MA	26684	6456	42392	4768	46265	3874	47756	3208	48901	2240	58168	2090	27013
2L-5S		MI	24029	6456	38097	4782	40775	3901	41072	3229	39860	2250	46997	1772	26594
10-#14	1.41	MA	25552	6456	40681	4766	44084	3890	45104	3222	45319	2250	53395	1962	27043
3L-4S		MI	24749	6456	39305	4784	42333	3886	42979	3215	42571	2260	50275	1834	26992
10-#18	2.50	MA	29537	7076	48927	5124	54424	4129	57608	3360	61892	2164	75270	1939	46741
2L-5S		MI	25000	7076	41400	5142	44806	4170	45899	3389	46231	2182	55997	1379	42766
10-#18	2.50	MA	27604	7076	45936	5118	50609	4154	52971	3382	55687	2182	67039	1712	46579
3L-4S		MI	26232	7076	43521	5148	47540	4145	49247	3368	50927	2200	61674	1484	45339

RECTANGULAR TIED COLUMNS 40" x 42"

6-#18	1.43	MA	29432	6792	46882	4999	51101	4061	52730	3361	53920	2338	64072	2174	30108
2L-3S		MI	25994	6792	41651	4975	44749	4072	45419	3370	44821	2340	52283	1926	28580
6-#18	1.43	MA	27337	6792	43713	4994	47061	4088	47819	3384	47314	2356	55288	1946	30130
3L-2S		MI	27970	6792	44643	4981	48563	4046	50056	3348	51026	2323	60514	2154	28537
8-#14	1.07	MA	28419	6579	44477	4898	48218	3991	49295	3324	49439	2377	58255	2242	22983
2L-4S		MI	25072	6579	39286	4898	41920	3989	42053	3320	40538	2385	47216	1970	21875
8-#14	1.07	MA	27209	6579	42666	4897	45909	4007	46489	3338	45637	2387	53169	2114	23036
3E		MI	25882	6579	40662	4880	43670	3993	44177	3326	43286	2375	50336	2098	21863
8-#14	1.07	MA	26354	6579	41211	4915	44059	4004	44244	3332	42722	2397	49842	1986	23031
4L-2S		MI	27023	6579	42373	4882	45852	3978	46829	3312	46868	2365	55110	2226	21806
8-#18	1.90	MA	30882	7075	50051	5176	55141	4189	57642	3441	60526	2317	72856	2125	39794
2L-4S		MI	25986	7075	42228	5182	45493	4190	46331	3436	46266	2336	55149	1647	37204
8-#18	1.90	MA	28809	7075	46882	5172	51101	4216	52730	3464	53920	2335	64072	1898	39718
3E		MI	27377	7075	44643	5153	48563	4200	50056	3450	51026	2318	60514	1874	37638
8-#18	1.90	MA	27338	7075	44329	5202	47854	4207	48790	3451	48853	2353	58338	1670	39250
4L-2S		MI	29333	7075	47634	5158	52377	4175	54693	3428	57231	2300	68745	2102	37689
10-#14	1.34	MA	29266	6738	46287	4998	50526	4063	52102	3369	53241	2367	63340	2218	28531
2L-5S		MI	25161	6738	39789	4995	42543	4077	42797	3378	41410	2365	48712	1883	26820
10-#14	1.34	MA	28064	6738	44477	4997	48218	4080	49295	3383	49439	2377	58255	2090	28562
3L-4S		MI	25882	6738	40997	4997	44101	4061	44704	3365	44120	2375	51990	1945	27058
10-#14	1.34	MA	27215	6738	43022	5015	46368	4076	47050	3377	46523	2387	54927	1962	28511
4L-3S		MI	26686	6738	42373	4980	45852	4066	46829	3371	46868	2365	55110	2072	27090
10-#14	1.34	MA	26453	6738	41746	5013	44722	4092	45035	3392	43649	2378	51442	1900	28239
5L-2S		MI	27820	6738	44084	4982	48033	4050	49480	3357	50451	2355	59883	2200	27054
10-#18	2.38	MA	32315	7359	53220	5354	59181	4318	62553	3521	67131	2297	81640	2077	49441
2L-5S		MI	26131	7359	43099	5354	46573	4344	47620	3537	47774	2296	57703	1489	43088
10-#18	2.38	MA	30262	7359	50051	5349	55141	4345	57642	3544	60526	2315	72856	1849	49279
3L-4S		MI	27366	7359	45220	5360	49308	4319	50968	3516	52471	2314	63380	1594	45725
10-#18	2.38	MA	28808	7359	47498	5380	51894	4336	53702	3531	55458	2332	67122	1622	48298
4L-3S		MI	28742	7359	47634	5330	52377	4329	54693	3530	57231	2296	68745	1822	46669
10-#18	2.38	MA	27503	7359	45256	5375	49004	4363	50163	3554	50459	2315	61078	1514	45434
5L-2S		MI	30679	7359	50626	5336	56191	4303	59329	3508	63436	2278	76976	2049	46805
12-#11	1.11	MA	28601	6604	44752	4931	48663	4016	49872	3342	50234	2384	59468	2254	23968
2L-6S		MI	24846	6604	38839	4924	41363	4021	41395	3344	39592	2390	46227	1960	22503

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

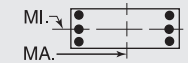
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.11	MA	27756	6604	43487	4930	47049	4014	47911	3353	47578	2392	55892	2165	23999
3L-5S		MI	25329	6604	39634	4926	42443	4023	42713	3347	41336	2383	48411	2018	22767
12-#11	1.11	MA	27160	6604	42472	4943	45758	4026	46344	3349	45543	2399	53548	2077	24011
4E		MI	25835	6604	40477	4927	43530	4012	44044	3338	43235	2390	50713	2061	22794
12-#11	1.11	MA	26626	6604	41582	4942	44611	4023	44938	3360	43538	2393	51103	2033	23971
5L-3S		MI	26399	6604	41438	4914	44752	4014	45527	3341	45161	2383	52912	2150	22774
12-#11	1.11	MA	26116	6604	40742	4941	43470	4035	43547	3356	41696	2401	48776	1974	23674
6L-2S		MI	27197	6604	42634	4915	46277	4003	47381	3332	47672	2375	56272	2239	22739
12-#14	1.61	MA	30106	6898	48098	5098	52835	4136	54908	3414	57043	2357	68425	2195	34065
2L-6S		MI	25285	6898	40359	5093	43176	4145	43560	3417	42502	2364	50384	1773	30781
12-#14	1.61	MA	28912	6898	46287	5096	50526	4152	52102	3428	53241	2367	63340	2067	34066
3L-5S		MI	25969	6898	41499	5095	44725	4149	45449	3423	44992	2354	53486	1858	31784
12-#14	1.61	MA	28069	6898	44832	5115	48676	4148	49856	3422	50325	2377	60012	1939	33980
4E		MI	26685	6898	42707	5097	46282	4134	47356	3409	47702	2364	56763	1919	32229
12-#14	1.61	MA	27313	6898	43556	5113	47031	4165	47841	3437	47451	2368	56528	1876	33500
5L-3S		MI	27483	6898	44084	5079	48033	4138	49480	3416	50451	2354	59883	2047	32298
12-#14	1.61	MA	26592	6898	42352	5111	45395	4161	45846	3431	44809	2378	53221	1792	32409
6L-2S		MI	28611	6898	45795	5082	50214	4122	52132	3402	54033	2344	64657	2175	32287
12-#18	2.86	MA	33731	7643	56389	5531	63222	4446	67465	3601	73737	2277	90423	2028	59058
2L-6S		MI	26342	7643	44087	5526	47668	4463	48941	3603	49665	2291	60593	1285	49246
12-#18	2.86	MA	31698	7643	53220	5526	59181	4473	62553	3623	67131	2294	81640	1801	58825
3L-5S		MI	27508	7643	46091	5531	50387	4473	52257	3617	53979	2274	65934	1437	51815
12-#18	2.86	MA	30259	7643	50667	5557	55935	4465	58613	3611	62064	2312	75906	1573	57395
4E		MI	28731	7643	48212	5537	53122	4447	55604	3595	58676	2291	71611	1542	54298
12-#18	2.86	MA	28969	7643	48425	5552	53044	4491	55074	3634	57065	2294	69862	1466	54693
5L-3S		MI	30092	7643	50626	5507	56191	4457	59329	3609	63436	2274	76976	1770	55682
12-#18	2.86	MA	27738	7643	46308	5548	50170	4483	51569	3621	52473	2312	64158	1315	51963
6L-2S		MI	32011	7643	53618	5513	60005	4432	63966	3588	69641	2256	85207	1997	55887
14-#11	1.30	MA	29196	6715	46017	5000	50276	4066	51832	3374	52891	2377	63044	2239	27841
2L-7S		MI	24948	6715	39184	5006	41850	4082	41978	3385	40395	2390	47312	1855	25539
14-#11	1.30	MA	28354	6715	44752	4999	48663	4064	49872	3384	50234	2385	59468	2150	27862
3L-6S		MI	25417	6715	40035	4994	42887	4071	43249	3375	42103	2383	49587	1943	26015
14-#11	1.30	MA	27761	6715	43737	5012	47371	4076	48304	3380	48200	2392	57125	2061	27854
4L-5S		MI	25897	6715	40830	4995	43968	4073	44567	3379	43848	2376	51771	2002	26384
14-#11	1.30	MA	27230	6715	42847	5011	46224	4074	46899	3391	46194	2386	54679	2018	27794
5L-4S		MI	26401	6715	41673	4996	45055	4062	45898	3369	45746	2383	54073	2045	26430
14-#11	1.30	MA	26724	6715	42007	5010	45083	4085	45508	3387	44352	2394	52352	1959	27392
6L-3S		MI	26962	6715	42634	4983	46277	4065	47381	3373	47672	2376	56272	2134	26429
14-#11	1.30	MA	26229	6715	41109	5023	43988	4083	44165	3398	42549	2402	49931	1872	26871
7L-2S		MI	27757	6715	43830	4984	47802	4053	49235	3363	50183	2369	59632	2222	26404
14-#14	1.88	MA	30940	7058	49909	5198	55143	4208	57714	3459	60845	2347	73510	2171	39590
2L-7S		MI	25430	7058	40850	5210	43870	4233	44389	3475	43646	2364	51927	1621	34997
14-#14	1.88	MA	29753	7058	48098	5196	52835	4224	54908	3473	57043	2357	68425	2043	39558
3L-6S		MI	26092	7058	42070	5193	45357	4217	46211	3462	46084	2354	55157	1748	35816
14-#14	1.88	MA	28916	7058	46643	5214	50985	4221	52662	3467	54127	2367	65097	1915	39441
4L-5S		MI	26770	7058	43210	5195	46906	4222	48100	3468	48574	2344	58259	1832	36768
14-#14	1.88	MA	28165	7058	45367	5213	49339	4237	50647	3481	51253	2358	61613	1853	38779
5L-4S		MI	27482	7058	44418	5197	48464	4206	50008	3454	51284	2354	61537	1894	37392
14-#14	1.88	MA	27449	7058	44163	5211	47703	4233	48652	3476	48611	2368	58306	1768	37742
6L-3S		MI	28275	7058	45795	5179	50214	4210	52132	3461	54033	2344	64657	2022	37491
14-#14	1.88	MA	26751	7058	42874	5229	46133	4249	46727	3490	46026	2378	54865	1642	36862
7L-2S		MI	29395	7058	47506	5181	52396	4195	54784	3447	57615	2334	69431	2150	37510
14-#18	3.33	MA	33119	7926	56389	5704	63222	4602	67465	3703	73737	2274	90423	1752	68359
3L-6S		MI	27717	7926	47079	5703	51482	4592	53577	3683	55870	2269	68823	1233	57830

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

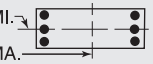


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.33	MA	31695	7926	53836	5734	59975	4593	63525	3691	68670	2292	84690	1525	66535
4L-5S		MI	28871	7926	49082	5709	54201	4602	56893	3697	60184	2252	74165	1384	60568
14-#18	3.33	MA	30419	7926	51594	5730	57084	4620	59985	3713	63671	2274	78646	1417	63976
5L-4S		MI	30080	7926	51203	5714	56936	4576	60241	3675	64881	2269	79841	1490	62912
14-#18	3.33	MA	29201	7926	49477	5725	54210	4611	56480	3701	59078	2292	72942	1267	61079
6L-3S		MI	31428	7926	53618	5685	60005	4586	63966	3689	69641	2252	85207	1718	64683
14-#18	3.33	MA	28013	7926	47211	5756	51449	4638	53097	3724	54584	2309	67000	1041	58253
7L-2S		MI	33330	7926	56609	5690	63820	4560	68603	3668	75846	2234	93437	1945	64952
16-#11	1.49	MA	29787	6826	47282	5069	51889	4116	53793	3405	55547	2370	66620	2224	31707
2L-8S		MI	25059	6826	39599	5074	42328	4130	42587	3426	41118	2377	48521	1789	28676
16-#11	1.49	MA	28949	6826	46017	5068	50276	4114	51832	3415	52891	2378	63044	2135	31719
3L-7S		MI	25519	6826	40380	5075	43375	4132	43831	3416	42907	2384	50672	1839	29081
16-#11	1.49	MA	28359	6826	45002	5081	48984	4126	50265	3412	50856	2385	60701	2046	31690
4L-6S		MI	25985	6826	41231	5063	44412	4121	45103	3406	44614	2376	52947	1927	29536
16-#11	1.49	MA	27831	6826	44112	5080	47837	4124	48860	3422	48851	2379	58255	2002	31613
5E		MI	26463	6826	42026	5064	45493	4124	46421	3410	46359	2369	55131	1985	29996
16-#11	1.49	MA	27327	6826	43273	5080	46696	4135	47468	3419	47009	2387	55929	1944	31118
6L-4S		MI	26963	6826	42869	5065	46580	4112	47751	3400	48258	2376	57433	2029	30060
16-#11	1.49	MA	26835	6826	42374	5093	45601	4133	46126	3429	45206	2395	53507	1856	30620
7L-3S		MI	27522	6826	43830	5052	47802	4115	49235	3404	50183	2369	59632	2117	30078
16-#11	1.49	MA	26351	6826	41550	5092	44496	4145	44812	3439	43318	2389	51222	1805	30179
8L-2S		MI	28313	6826	45026	5053	49327	4103	51088	3394	52695	2362	62992	2206	30062
16-#14	2.14	MA	31768	7217	51719	5297	57452	4280	60520	3503	64647	2337	78596	2147	45097
2L-8S		MI	25586	7217	41441	5308	44550	4301	45256	3533	44675	2343	53639	1524	38725
16-#14	2.14	MA	30588	7217	49909	5296	55143	4297	57714	3518	60845	2347	73510	2019	45043
3L-7S		MI	26235	7217	42560	5310	46051	4305	47040	3520	47229	2353	56701	1596	39947
16-#14	2.14	MA	29756	7217	48454	5314	53293	4293	55469	3512	57929	2357	70183	1891	44897
4L-6S		MI	26892	7217	43781	5292	47538	4290	48863	3506	49666	2343	59931	1722	40860
16-#14	2.14	MA	29011	7217	47178	5312	51648	4309	53454	3526	55055	2348	66698	1829	44075
5E		MI	27566	7217	44921	5295	49087	4294	50752	3513	52156	2333	63033	1807	41767
16-#14	2.14	MA	28300	7217	45974	5311	50012	4306	51459	3521	52413	2358	63392	1745	43084
6L-4S		MI	28272	7217	46129	5297	50645	4278	52659	3499	54867	2343	66311	1868	42549
16-#14	2.14	MA	27607	7217	44685	5329	48441	4322	49534	3535	49828	2368	59950	1618	42111
7L-3S		MI	29060	7217	47506	5279	52396	4282	54784	3506	57615	2333	69431	1996	42676
16-#14	2.14	MA	26923	7217	43503	5327	46856	4318	47649	3549	47120	2359	56694	1545	40789
8L-2S		MI	30174	7217	49217	5281	54577	4267	57436	3492	61197	2323	74204	2124	42720
16-#18	3.81	MA	33116	8210	57005	5912	64015	4722	68436	3770	75275	2271	93473	1476	75710
4L-6S		MI	29077	8210	50070	5880	55296	4720	58214	3763	62075	2247	77054	1181	66442
16-#18	3.81	MA	31853	8210	54763	5907	61125	4749	64897	3793	70276	2254	87430	1369	73280
5E		MI	30219	8210	52074	5886	58016	4730	61530	3776	66389	2229	82396	1332	69341
16-#18	3.81	MA	30649	8210	52646	5902	58250	4740	61392	3781	65684	2271	81725	1218	70222
6L-4S		MI	31417	8210	54195	5892	60750	4705	64878	3755	71086	2247	88072	1438	71562
16-#18	3.81	MA	29473	8210	50380	5933	55489	4767	58009	3804	61189	2289	75784	993	67295
7L-3S		MI	32752	8210	56609	5862	63820	4714	68603	3769	75846	2229	93437	1665	73675
18-#11	1.67	MA	30375	6936	48548	5138	53502	4166	55754	3436	58204	2363	70197	2209	35568
2L-9S		MI	25166	6936	39969	5156	42830	4191	43152	3453	41940	2377	49765	1716	31462
18-#11	1.67	MA	29541	6936	47282	5137	51889	4164	53793	3446	55547	2371	66620	2120	35563
3L-8S		MI	25629	6936	40795	5143	43853	4180	44440	3457	43630	2370	51881	1772	32161
18-#11	1.67	MA	28954	6936	46267	5150	50597	4176	52226	3443	53513	2379	64277	2031	35522
4L-7S		MI	26086	6936	41576	5145	44900	4182	45685	3447	45418	2377	54032	1823	32627
18-#11	1.67	MA	28428	6936	45377	5150	49450	4174	50821	3453	51507	2373	61832	1987	35428
5L-6S		MI	26550	6936	42427	5132	45937	4171	46956	3437	47126	2370	56307	1911	33065
18-#11	1.67	MA	27927	6936	44538	5149	48309	4186	49429	3450	49665	2380	59505	1929	34852
6L-5S		MI	27025	6936	43222	5133	47018	4174	48274	3441	48870	2362	58491	1969	33605
18-#11	1.67	MA	27438	6936	43639	5162	47214	4183	48087	3460	47863	2388	57084	1841	34372
7L-4S		MI	27523	6936	44065	5134	48104	4162	49605	3431	50769	2369	60793	2012	33684
18-#11	1.67	MA	26956	6936	42815	5161	46109	4195	46773	3470	45974	2382	54798	1790	33871
8L-3S		MI	28079	6936	45026	5122	49327	4165	51088	3435	52695	2362	62992	2101	33717

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

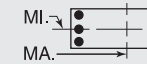


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.67	MA	26463	6936	41943	5174	45029	4193	45413	3467	44190	2390	52544	1734	33112
9L-2S		MI	28867	6936	46222	5123	50851	4154	52942	3425	55206	2355	66352	2190	33714
18-#14	2.41	MA	32591	7377	53530	5397	59760	4353	63327	3548	68448	2327	83681	2124	50597
2L-9S		MI	25751	7377	41967	5426	45264	4389	46061	3572	45845	2343	55407	1417	42331
18-#14	2.41	MA	31417	7377	51719	5396	57452	4369	60520	3563	64647	2337	78596	1996	50521
3L-8S		MI	26390	7377	43152	5408	46731	4373	47907	3578	48257	2333	58412	1498	43729
18-#14	2.41	MA	30591	7377	50264	5414	55602	4365	58275	3557	61731	2347	75268	1868	50349
4L-7S		MI	27034	7377	44271	5410	48232	4378	49692	3565	50811	2343	61475	1570	44910
18-#14	2.41	MA	29850	7377	48988	5412	53956	4381	56260	3571	58856	2338	71783	1805	49384
5L-6S		MI	27687	7377	45492	5392	49720	4362	51515	3551	53248	2333	64705	1697	45912
18-#14	2.41	MA	29145	7377	47784	5411	52320	4378	54265	3566	56215	2348	68477	1721	48434
6L-5S		MI	28356	7377	46632	5394	51269	4366	53404	3558	55738	2323	67806	1781	46779
18-#14	2.41	MA	28456	7377	46496	5429	50750	4394	52340	3580	53630	2358	65035	1595	47373
7L-4S		MI	29057	7377	47840	5396	52826	4351	55311	3544	58449	2333	71084	1843	47702
18-#14	2.41	MA	27777	7377	45313	5427	49165	4390	50455	3594	50922	2349	61779	1522	46092
8L-3S		MI	29840	7377	49217	5379	54577	4355	57436	3550	61197	2323	74204	1971	47854
18-#14	2.41	MA	27102	7377	44062	5445	47616	4407	48505	3588	48363	2359	58576	1441	44603
9L-2S		MI	30948	7377	50928	5381	56758	4339	60087	3537	64779	2313	78978	2099	47919
18-#18	4.29	MA	33274	8494	57932	6084	65165	4877	69808	3873	76882	2233	96214	1320	82601
5L-6S		MI	30424	8494	53062	6058	59110	4849	62850	3842	68280	2225	85285	1129	75077
18-#18	4.29	MA	32082	8494	55815	6080	62291	4868	66303	3861	72290	2251	90509	1170	79389
6L-5S		MI	31555	8494	55066	6063	61830	4859	66167	3856	72594	2207	90627	1280	78131
18-#18	4.29	MA	30918	8494	53549	6110	59530	4895	62920	3883	67795	2269	84568	944	76360
7L-4S		MI	32741	8494	57187	6069	64564	4833	69514	3835	77291	2225	96303	1386	80241
20-#11	1.86	MA	30960	7047	49813	5207	55115	4217	57715	3467	60861	2356	73773	2194	39424
2L-10S		MI	25241	7047	40387	5224	43321	4239	43769	3494	42774	2377	51073	1636	34276
20-#11	1.86	MA	30129	7047	48548	5207	53502	4214	55754	3477	58204	2364	70197	2105	39404
3L-9S		MI	25736	7047	41165	5225	44355	4241	45006	3484	44451	2370	53125	1700	34975
20-#11	1.86	MA	29545	7047	47532	5220	52210	4226	54187	3474	56169	2372	67854	2016	39349
4L-8S		MI	26195	7047	41991	5213	45378	4230	46294	3488	46141	2363	55241	1756	35653
20-#11	1.86	MA	29022	7047	46643	5219	51063	4224	52782	3484	54164	2366	65408	1972	39240
5L-7S		MI	26650	7047	42772	5214	46425	4233	47539	3478	47929	2370	57392	1807	36177
20-#11	1.86	MA	28523	7047	45803	5218	49922	4236	51390	3481	52322	2373	63081	1914	38592
6E		MI	27111	7047	43623	5201	47462	4221	48810	3468	49637	2363	59667	1894	36599
20-#11	1.86	MA	28037	7047	44904	5231	48827	4234	50048	3491	50519	2381	60660	1826	38129
7L-5S		MI	27584	7047	44418	5202	48542	4224	50128	3472	51382	2355	61851	1953	37210
20-#11	1.86	MA	27557	7047	44080	5230	47722	4245	48734	3502	48631	2375	58375	1775	37570
8L-4S		MI	28080	7047	45261	5203	49629	4213	51459	3462	53280	2362	64153	1996	37304
20-#11	1.86	MA	27068	7047	43208	5243	46642	4243	47374	3498	46847	2383	56120	1719	36833
9L-3S		MI	28633	7047	46222	5191	50851	4215	52942	3466	55206	2355	66352	2085	37349
20-#11	1.86	MA	26540	7047	42388	5242	45551	4255	46068	3509	45076	2391	53935	1655	36085
10L-2S		MI	29417	7047	47418	5192	52376	4204	54796	3456	57717	2348	69712	2173	37362
20-#14	2.68	MA	32241	7536	53530	5495	59760	4441	63327	3607	68448	2327	83681	1972	55993
3L-9S		MI	26553	7536	43677	5525	47446	4461	48712	3617	49427	2332	60181	1391	47288
20-#14	2.68	MA	31419	7536	52075	5514	57910	4438	61081	3602	65533	2337	80353	1844	55797
4L-8S		MI	27187	7536	44862	5508	48913	4446	50559	3623	51840	2322	63186	1473	48740
20-#14	2.68	MA	30684	7536	50799	5512	56265	4454	59066	3616	62658	2328	76869	1782	54704
5L-7S		MI	27827	7536	45982	5510	50414	4450	52344	3610	54393	2332	66248	1545	49883
20-#14	2.68	MA	29983	7536	49595	5510	54629	4450	57071	3610	60017	2338	73562	1697	53791
6E		MI	28476	7536	47203	5492	51901	4434	54166	3596	56830	2322	69478	1671	50970
20-#14	2.68	MA	29299	7536	48306	5528	53058	4466	55146	3625	57432	2348	70120	1571	52645
7L-5S		MI	29140	7536	48343	5494	53450	4439	56055	3603	59321	2312	72580	1756	51802
20-#14	2.68	MA	28625	7536	47124	5527	51473	4463	53261	3639	54724	2339	66864	1498	51403
8L-4S		MI	29837	7536	49551	5496	55008	4423	57963	3589	62031	2322	75858	1817	52850
20-#14	2.68	MA	27951	7536	45873	5545	49924	4479	51311	3633	52165	2349	63661	1417	49861
9L-3S		MI	30615	7536	50928	5478	56758	4427	60087	3595	64779	2312	78978	1945	53026
20-#18	4.76	MA	33502	8778	58984	6257	66331	4997	71215	3940	78895	2231	99293	1121	88577
6E		MI	31760	8778	56054	6235	62924	4977	67487	3922	74485	2203	93516	1077	83734
20-#18	4.76	MA	32350	8778	56718	6288	63570	5024	67832	3963	74401	2248	93351	896	85447
7L-5S		MI	32880	8778	58057	6241	65644	4987	70803	3936	78799	2185	98857	1228	86936

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.04	MA	30714	7158	49813	5276	55115	4265	57715	3508	60861	2357	73773	2090	43241
3L-10S		MI	25808	7158	41583	5293	44846	4289	45622	3525	45285	2371	54433	1620	37756
22-#11	2.04	MA	30133	7158	48797	5289	53823	4276	56148	3505	58826	2365	71430	2001	43173
4L-9S		MI	26309	7158	42361	5294	45879	4292	46860	3515	46962	2363	56485	1683	38492
22-#11	2.04	MA	29613	7158	47908	5288	52676	4274	54742	3515	56821	2359	68984	1957	43050
5L-8S		MI	26758	7158	43187	5282	46903	4280	48148	3519	48652	2356	58601	1740	39151
22-#11	2.04	MA	29117	7158	47068	5287	51535	4286	53351	3512	54978	2367	66657	1899	42337
6L-7S		MI	27210	7158	43968	5283	47949	4283	49392	3509	50441	2363	60752	1790	39730
22-#11	2.04	MA	28633	7158	46170	5300	50440	4284	52009	3522	53176	2374	64236	1811	41889
7L-6S		MI	27670	7158	44819	5270	48987	4271	50664	3499	52148	2356	63027	1878	40138
22-#11	2.04	MA	28156	7158	45345	5299	49335	4295	50695	3533	51287	2368	61951	1760	41274
8L-5S		MI	28140	7158	45614	5271	50067	4274	51982	3503	53893	2349	65211	1936	40813
22-#11	2.04	MA	27669	7158	44473	5312	48255	4293	49335	3529	49503	2376	59697	1704	40558
9L-4S		MI	28633	7158	46457	5272	51154	4263	53312	3493	55792	2355	67513	1980	40921
22-#11	2.04	MA	27143	7158	43653	5311	47164	4305	48029	3540	47733	2384	57511	1640	39772
10L-3S		MI	29184	7158	47418	5260	52376	4265	54796	3497	57717	2348	69712	2068	40978
22-#11	2.04	MA	26630	7158	42844	5311	46090	4303	46685	3536	45870	2378	55279	1586	38907
11L-2S		MI	29965	7158	48614	5261	53901	4254	56649	3487	60229	2341	73072	2157	41002
22-#14	2.95	MA	32243	7696	53886	5613	60219	4510	63888	3647	69335	2328	85438	1820	61243
4L-9S		MI	27350	7696	45388	5625	49627	4534	51364	3662	53009	2321	64955	1366	52254
22-#14	2.95	MA	31512	7696	52610	5612	58573	4526	61872	3661	66460	2318	81954	1758	60033
5L-8S		MI	27980	7696	46573	5607	51094	4518	53211	3668	55422	2311	67960	1447	53759
22-#14	2.95	MA	30816	7696	51406	5610	56937	4522	59877	3655	63819	2328	78647	1674	59154
6L-7S		MI	28615	7696	47693	5609	52595	4522	54995	3655	57975	2321	71022	1519	54867
22-#14	2.95	MA	30137	7696	50117	5628	55367	4539	57952	3670	61234	2338	75206	1547	57927
7L-6S		MI	29260	7696	48914	5592	54082	4507	56818	3641	60412	2311	74252	1646	56034
22-#14	2.95	MA	29467	7696	48935	5627	53781	4535	56068	3684	58526	2329	71950	1475	56722
8L-5S		MI	29920	7696	50054	5594	55631	4511	58707	3647	62903	2302	77354	1730	56835
22-#14	2.95	MA	28795	7696	47683	5645	52232	4551	54118	3678	55967	2339	68746	1393	55127
9L-4S		MI	30613	7696	51262	5596	57189	4495	60614	3634	65613	2311	80631	1792	57996
22-#18	5.24	MA	33769	9061	59887	6465	67610	5152	72743	4043	81006	2228	102135	847	94553
7L-6S		MI	33085	9061	59045	6412	66738	5106	72124	4002	80690	2180	101747	1025	92410
24-#11	2.23	MA	30718	7268	50063	5358	55436	4326	58109	3536	61482	2358	75006	1986	46995
4L-10S		MI	26373	7268	42780	5362	46371	4339	47476	3556	47796	2364	57793	1604	41241
24-#11	2.23	MA	30200	7268	49173	5357	54289	4324	56703	3546	59477	2352	72560	1942	46820
5L-9S		MI	26872	7268	43557	5364	47404	4342	48713	3546	49474	2357	59845	1667	42014
24-#11	2.23	MA	29707	7268	48333	5356	53148	4336	55312	3543	57635	2360	70234	1884	46087
6L-8S		MI	27318	7268	44383	5351	48427	4330	50001	3550	51164	2349	61961	1723	42655
24-#11	2.23	MA	29225	7268	47435	5369	52053	4334	53970	3553	55832	2367	67813	1796	45651
7E		MI	27768	7268	45164	5352	49474	4333	51246	3540	52952	2356	64112	1774	43285
24-#11	2.23	MA	28751	7268	46611	5368	50948	4346	52655	3564	53944	2361	65527	1745	44985
8L-6S		MI	28225	7268	46015	5339	50512	4322	52517	3530	54660	2349	66387	1862	43681
24-#11	2.23	MA	28271	7268	45738	5381	49868	4343	51296	3560	52160	2369	63273	1689	44288
9L-5S		MI	28693	7268	46811	5341	51592	4324	53835	3534	56404	2342	68571	1920	44351
24-#11	2.23	MA	27743	7268	44918	5381	48777	4355	49990	3571	50389	2377	61087	1625	43465
10L-4S		MI	29184	7268	47653	5342	52679	4313	55166	3524	58303	2348	70873	1963	44534
24-#11	2.23	MA	27232	7268	44109	5380	47703	4353	48646	3567	48527	2371	58856	1571	42618
11L-3S		MI	29732	7268	48614	5329	53901	4315	56649	3528	60229	2341	73072	2052	44603
24-#14	3.21	MA	32335	7856	54421	5711	60882	4598	64679	3706	70262	2308	87039	1735	65371
5L-9S		MI	28141	7856	47099	5725	51808	4606	54016	3707	56591	2311	69728	1340	57227
24-#14	3.21	MA	31644	7856	53216	5710	59246	4595	62684	3700	67621	2318	83733	1650	64522
6L-8S		MI	28767	7856	48284	5707	53275	4590	55862	3713	59004	2301	72733	1422	58784
24-#14	3.21	MA	30969	7856	51928	5728	57675	4611	60759	3715	65035	2329	80291	1524	63218
7E		MI	29398	7856	49404	5709	54776	4595	57647	3700	61557	2311	75795	1494	59859
24-#14	3.21	MA	30304	7856	50745	5726	56090	4607	58874	3729	62328	2319	77035	1451	62047
8L-6S		MI	30038	7856	50625	5691	56264	4579	59470	3686	63994	2301	79025	1620	61103
24-#14	3.21	MA	29632	7856	49494	5745	54541	4624	56924	3723	59769	2329	73832	1370	60401
9L-5S		MI	30695	7856	51765	5694	57812	4583	61359	3692	66485	2291	82127	1705	61875

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

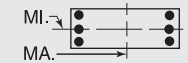
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.36	MA	32144	7074	50981	5229	55583	4250	57301	3522	58519	2466	69518	2303	31728
2L-3S		MI	27127	7074	43349	5187	46516	4246	47141	3518	46364	2454	53989	2036	28646
6-#18	1.36	MA	29926	7074	47635	5225	51316	4278	52115	3546	51513	2484	60180	2076	31750
3L-2S		MI	29106	7074	46341	5193	50331	4220	51777	3497	52569	2436	62220	2264	28585
8-#14	1.02	MA	31063	6862	48433	5128	52528	4180	53662	3484	53679	2500	63296	2368	24198
2L-4S		MI	26204	6862	40977	5111	43688	4165	43777	3469	42088	2500	48931	2081	21930
8-#14	1.02	MA	29784	6862	46523	5127	50093	4177	50701	3499	49667	2511	57899	2240	24251
3E		MI	27015	6862	42354	5093	45438	4169	45902	3475	44836	2490	52051	2209	21903
8-#14	1.02	MA	28881	6862	44989	5146	48143	4194	48335	3494	46595	2522	54363	2112	24246
4L-2S		MI	28157	6862	44065	5096	47620	4153	48554	3462	48418	2480	56825	2337	21842
8-#18	1.82	MA	33685	7358	54327	5406	59849	4378	62487	3601	65526	2448	78855	2258	41954
2L-4S		MI	27118	7358	43927	5394	47261	4365	48052	3584	47809	2450	56855	1757	37362
8-#18	1.82	MA	31490	7358	50981	5402	55583	4406	57301	3626	58519	2465	69518	2030	41878
3E		MI	28512	7358	46341	5365	50331	4374	51777	3598	52569	2432	62220	1984	37715
8-#18	1.82	MA	29936	7358	48288	5434	52159	4399	53146	3614	53144	2483	63415	1803	41410
4L-2S		MI	30471	7358	49333	5370	54145	4349	56414	3576	58774	2414	70451	2212	37743
10-#14	1.28	MA	31962	7021	50343	5228	54964	4252	56623	3529	57690	2490	68693	2346	30050
2L-5S		MI	26292	7021	41480	5209	44311	4253	44522	3527	42959	2479	50427	1994	26987
10-#14	1.28	MA	30691	7021	48433	5227	52528	4249	53662	3544	53679	2501	63296	2218	30081
3L-4S		MI	27015	7021	42688	5211	45869	4237	46429	3514	45670	2489	53705	2055	27120
10-#14	1.28	MA	29795	7021	46900	5246	50578	4266	51296	3539	50606	2512	59760	2090	30030
4L-3S		MI	27820	7021	44065	5193	47620	4241	48554	3520	48418	2479	56825	2183	27136
10-#14	1.28	MA	28991	7021	45556	5244	48845	4263	49173	3554	47577	2504	56069	2027	29836
5L-2S		MI	28956	7021	45776	5195	49801	4226	51205	3506	52000	2470	61598	2311	27094
10-#18	2.27	MA	35207	7642	57674	5584	64115	4507	67674	3681	72533	2429	88193	2213	52141
2L-5S		MI	27262	7642	44797	5566	48341	4519	49341	3685	49317	2410	59409	1599	43400
10-#18	2.27	MA	33034	7642	54327	5580	59849	4535	62487	3705	65526	2447	78855	1985	51979
3L-4S		MI	28501	7642	46918	5572	51075	4493	52689	3664	54014	2427	65085	1704	46103
10-#18	2.27	MA	31497	7642	51635	5611	56425	4527	58332	3694	60151	2464	72752	1758	51286
4L-3S		MI	29880	7642	49333	5542	54145	4503	56414	3678	58774	2410	70451	1932	46754
10-#18	2.27	MA	30120	7642	49272	5608	53378	4555	54602	3718	54849	2447	66341	1649	48122
5L-2S		MI	31821	7642	52324	5548	57959	4477	61051	3656	64979	2392	78681	2159	46868
12-#11	1.06	MA	31254	6887	48719	5161	52992	4205	54264	3503	54510	2507	64565	2380	25232
2L-6S		MI	25977	6887	40527	5139	43131	4197	43122	3493	41144	2505	47946	2071	22653
12-#11	1.06	MA	30360	6887	47385	5160	51291	4203	52196	3514	51708	2516	60772	2291	25263
3L-5S		MI	26461	6887	41323	5140	44211	4200	44440	3497	42889	2498	50131	2129	22823
12-#11	1.06	MA	29732	6887	46315	5173	49931	4215	50545	3511	49565	2524	58284	2202	25275
4E		MI	26967	6887	42166	5141	45298	4188	45771	3487	44788	2505	52433	2173	22836
12-#11	1.06	MA	29169	6887	45379	5173	48722	4214	49065	3522	47453	2518	55695	2158	25235
5L-3S		MI	27533	6887	43127	5128	46520	4191	47254	3491	46713	2498	54632	2261	22811
12-#11	1.06	MA	28632	6887	44495	5172	47521	4226	47600	3519	45513	2527	53226	2100	25007
6L-2S		MI	28332	6887	44323	5129	48045	4179	49108	3481	49225	2491	57992	2350	22774
12-#14	1.53	MA	32854	7181	52254	5328	57399	4325	59584	3574	61701	2480	74090	2324	35888
2L-6S		MI	26416	7181	42051	5306	44944	4321	45285	3566	44051	2479	52099	1884	30975
12-#14	1.53	MA	31591	7181	50343	5327	54964	4322	56623	3589	57690	2491	68693	2196	35888
3L-5S		MI	27101	7181	43191	5309	46493	4325	47173	3572	46542	2469	55201	1969	32001
12-#14	1.53	MA	30700	7181	48810	5345	53014	4338	54256	3584	54617	2502	65157	2068	35802
4E		MI	27819	7181	44399	5311	48050	4309	49081	3559	49252	2479	58478	2030	32298
12-#14	1.53	MA	29903	7181	47466	5344	51281	4335	52134	3599	51589	2494	61466	2005	35451
5L-3S		MI	28619	7181	45776	5293	49801	4313	51205	3565	52000	2469	61598	2158	32351
12-#14	1.53	MA	29143	7181	46198	5343	49558	4352	50033	3594	48807	2505	57955	1920	34247
6L-2S		MI	29748	7181	47487	5295	51982	4298	53857	3551	55582	2459	66372	2286	32331

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

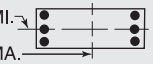


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	2.73	MA	36713	7926	61020	5761	68381	4636	72860	3761	79539	2410	97530	2168	62298
2L-6S		MI	27471	7926	45786	5738	49435	4637	50662	3751	51209	2405	62298	1395	49767
12-#18	2.73	MA	34560	7926	57674	5757	64115	4663	67674	3785	72533	2428	88193	1940	62065
3L-5S		MI	28641	7926	47789	5743	52155	4647	53978	3765	55522	2388	67640	1547	52123
12-#18	2.73	MA	33039	7926	54981	5789	60691	4656	63518	3774	67157	2445	82090	1713	60901
4E		MI	29867	7926	49910	5749	54889	4622	57326	3743	60219	2405	73316	1652	54667
12-#18	2.73	MA	31677	7926	52618	5785	57645	4684	59788	3798	61856	2428	75678	1603	57906
5L-3S		MI	31233	7926	52324	5719	57959	4632	61051	3757	64979	2387	78681	1880	55775
12-#18	2.73	MA	30378	7926	50388	5781	54616	4676	56094	3787	56985	2445	69611	1453	55250
6L-2S		MI	33157	7926	55316	5725	61773	4606	65687	3736	71184	2370	86912	2107	55956
14-#11	1.24	MA	31884	6998	50054	5230	54693	4255	56332	3534	57312	2500	68357	2366	29315
2L-7S		MI	26080	6998	40872	5221	43618	4258	43704	3534	41948	2506	49032	1967	25680
14-#11	1.24	MA	30995	6998	48719	5229	52992	4253	54264	3545	54510	2509	64565	2277	29336
3L-6S		MI	26549	6998	41723	5208	44655	4247	44976	3524	43656	2498	51306	2054	26164
14-#11	1.24	MA	30369	6998	47650	5242	51632	4265	52613	3542	52367	2517	62077	2188	29328
4L-5S		MI	27030	6998	42519	5209	45736	4250	46293	3528	45400	2491	53491	2113	26445
14-#11	1.24	MA	29809	6998	46713	5242	50423	4264	51133	3553	50255	2511	59488	2144	29268
5L-4S		MI	27534	6998	43362	5210	46823	4238	47624	3518	47299	2498	55793	2156	26479
14-#11	1.24	MA	29275	6998	45829	5241	49222	4276	49668	3550	48315	2520	57019	2086	28929
6L-3S		MI	28097	6998	44323	5197	48045	4241	49108	3522	49225	2491	57992	2245	26469
14-#11	1.24	MA	28754	6998	44883	5255	48070	4274	48255	3561	46417	2528	54451	1998	28355
7L-2S		MI	28892	6998	45519	5199	49570	4230	50961	3512	51736	2484	61352	2334	26441
14-#14	1.79	MA	33739	7340	54164	5428	59835	4397	62545	3619	65713	2470	79488	2302	41716
2L-7S		MI	26560	7340	42541	5424	45638	4409	46114	3624	45196	2478	53642	1732	35329
14-#14	1.79	MA	32483	7340	52254	5426	57399	4394	59584	3634	61701	2481	74090	2174	41685
3L-6S		MI	27224	7340	43762	5406	47125	4393	47936	3611	47633	2468	56872	1858	36008
14-#14	1.79	MA	31599	7340	50720	5445	55450	4411	57217	3629	58629	2492	70555	2046	41567
4L-5S		MI	27904	7340	44902	5408	48674	4397	49825	3617	50124	2458	59974	1943	36981
14-#14	1.79	MA	30807	7340	49377	5444	53716	4408	55095	3644	55600	2484	66863	1983	41024
5L-4S		MI	28617	7340	46110	5410	50232	4382	51732	3603	52834	2468	63252	2004	37466
14-#14	1.79	MA	30053	7340	48109	5443	51994	4424	52993	3639	52818	2495	63352	1899	39876
6L-3S		MI	29411	7340	47487	5393	51982	4386	53857	3610	55582	2458	66372	2132	37549
14-#14	1.79	MA	29316	7340	46752	5461	50340	4421	50966	3654	50095	2506	59698	1772	39090
7L-2S		MI	30534	7340	49198	5395	54164	4370	56509	3596	59164	2448	71146	2260	37556
14-#18	3.18	MA	36069	8209	61020	5934	68381	4792	72860	3865	79539	2409	97530	1895	72139
3L-6S		MI	28848	8209	48777	5915	53250	4766	55298	3831	57414	2383	70529	1343	58343
14-#18	3.18	MA	34565	8209	58327	5966	64958	4784	68705	3854	74164	2427	91427	1667	70559
4L-5S		MI	30006	8209	50781	5921	55969	4776	58615	3845	61727	2365	75871	1494	60872
14-#18	3.18	MA	33217	8209	55965	5962	61911	4812	64974	3878	68862	2409	85016	1558	67716
5L-4S		MI	31219	8209	52902	5926	58703	4750	61962	3823	66424	2383	81547	1600	63274
14-#18	3.18	MA	31932	8209	53734	5958	58882	4805	61280	3867	63991	2427	78948	1408	64890
6L-3S		MI	32572	8209	55316	5897	61773	4760	65687	3837	71184	2365	86912	1828	64783
14-#18	3.18	MA	30677	8209	51347	5990	55973	4833	57715	3891	59224	2444	72630	1183	61946
7L-2S		MI	34479	8209	58308	5902	65587	4735	70324	3816	77389	2348	95143	2055	65025
16-#11	1.42	MA	32512	7109	51388	5299	56395	4305	58400	3565	60114	2493	72150	2352	33392
2L-8S		MI	26190	7109	41287	5289	44096	4306	44313	3575	42671	2492	50241	1900	28890
16-#11	1.42	MA	31626	7109	50054	5298	54693	4304	56332	3576	57312	2502	68357	2263	33404
3L-7S		MI	26651	7109	42068	5290	45143	4309	45558	3565	44459	2499	52392	1950	29222
16-#11	1.42	MA	31003	7109	48984	5312	53333	4316	54681	3573	55168	2510	65870	2174	33375
4L-6S		MI	27118	7109	42919	5277	46180	4297	46829	3556	46167	2492	54666	2038	29684
16-#11	1.42	MA	30446	7109	48047	5311	52125	4314	53201	3584	53056	2505	63280	2130	33297
5E		MI	27596	7109	43715	5278	47261	4300	48147	3559	47911	2484	56851	2097	30061
16-#11	1.42	MA	29915	7109	47164	5311	50924	4326	51736	3581	51117	2513	60812	2072	32860
6L-4S		MI	28098	7109	44558	5279	48348	4289	49478	3550	49810	2491	59153	2140	30112
16-#11	1.42	MA	29397	7109	46218	5324	49771	4324	50323	3592	49219	2521	58243	1984	32310
7L-3S		MI	28658	7109	45519	5267	49570	4291	50961	3553	51736	2484	61352	2229	30120
16-#11	1.42	MA	28886	7109	45350	5323	48607	4336	48940	3602	47230	2516	55823	1933	31908
8L-2S		MI	29450	7109	46715	5268	51095	4280	52815	3544	54247	2477	64712	2317	30100

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

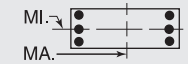
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	2.05	MA	34618	7500	56075	5527	62271	4469	65506	3664	69724	2460	84885	2280	47527
2L-8S		MI	26716	7500	43132	5522	46318	4477	46980	3683	46225	2458	55354	1635	39027
16-#14	2.05	MA	33369	7500	54164	5526	59835	4466	62545	3679	65713	2471	79488	2152	47473
3L-7S		MI	27366	7500	44252	5524	47819	4481	48765	3669	48778	2468	58416	1706	40275
16-#14	2.05	MA	32491	7500	52631	5545	57885	4483	60178	3674	62640	2482	75952	2024	47327
4L-6S		MI	28025	7500	45473	5506	49306	4465	50588	3656	51215	2458	61646	1833	41051
16-#14	2.05	MA	31705	7500	51287	5544	56152	4480	58056	3689	59611	2474	72260	1961	46613
5E		MI	28701	7500	46613	5508	50855	4470	52477	3662	53706	2448	64748	1918	41977
16-#14	2.05	MA	30955	7500	50019	5542	54429	4497	55954	3684	56829	2485	68749	1877	45515
6L-4S		MI	29409	7500	47821	5510	52413	4454	54384	3648	56416	2458	68026	1979	42628
16-#14	2.05	MA	30224	7500	48662	5561	52775	4494	53927	3699	54107	2496	65095	1750	44634
7L-3S		MI	30199	7500	49198	5492	54164	4458	56509	3655	59164	2448	71146	2107	42737
16-#14	2.05	MA	29503	7500	47417	5560	51106	4511	51942	3714	51255	2487	61645	1677	43180
8L-2S		MI	31315	7500	50909	5495	56345	4442	59160	3641	62746	2438	75919	2235	42772
16-#18	3.64	MA	36075	8493	61674	6143	69224	4913	73891	3934	81170	2408	100764	1622	80254
4L-6S		MI	30211	8493	51769	6092	57064	4895	59935	3911	63619	2361	78760	1291	66946
16-#18	3.64	MA	34741	8493	59311	6139	66177	4941	70160	3958	75869	2390	94353	1513	77547
5E		MI	31357	8493	53772	6098	59783	4904	63251	3925	67932	2343	84101	1442	69642
16-#18	3.64	MA	33469	8493	57081	6136	63148	4933	66466	3946	70998	2408	88286	1363	74557
6L-4S		MI	32559	8493	55893	6104	62518	4879	66599	3903	72629	2361	89778	1548	71917
16-#18	3.64	MA	32228	8493	54694	6167	60239	4961	62902	3971	66230	2426	81968	1137	71680
7L-3S		MI	33899	8493	58308	6074	65587	4889	70324	3917	77389	2343	95143	1775	73781
18-#11	1.60	MA	33135	7219	52722	5368	58096	4355	60468	3596	62915	2487	75943	2338	37463
2L-9S		MI	26296	7219	41657	5370	44598	4368	44879	3603	43492	2492	51484	1827	31685
18-#11	1.60	MA	32254	7219	51388	5368	56395	4354	58400	3607	60114	2495	72150	2249	37458
3L-8S		MI	26760	7219	42483	5358	45621	4356	46167	3607	45182	2485	53601	1884	32398
18-#11	1.60	MA	31634	7219	50318	5381	55034	4366	56749	3604	57970	2503	69662	2160	37417
4L-7S		MI	27218	7219	43264	5359	46668	4359	47412	3597	46971	2492	55752	1934	32768
18-#11	1.60	MA	31080	7219	49382	5380	53826	4364	55269	3615	55858	2498	67073	2116	37323
5L-6S		MI	27683	7219	44116	5346	47705	4347	48683	3587	48678	2485	58026	2022	33211
18-#11	1.60	MA	30551	7219	48498	5380	52625	4376	53804	3612	53918	2506	64604	2058	36799
6L-5S		MI	28159	7219	44911	5347	48786	4350	50001	3591	50423	2477	60211	2080	33673
18-#11	1.60	MA	30036	7219	47552	5393	51472	4374	52391	3623	52020	2514	62036	1970	36269
7L-4S		MI	28658	7219	45754	5348	49872	4339	51332	3581	52321	2484	62513	2124	33740
18-#11	1.60	MA	29528	7219	46685	5393	50309	4386	51008	3634	50032	2509	59616	1918	35838
8L-3S		MI	29215	7219	46715	5336	51095	4341	52815	3585	54247	2477	64712	2212	33766
18-#11	1.60	MA	29000	7219	45833	5392	49172	4385	49576	3631	48154	2517	57224	1862	35005
9L-2S		MI	30004	7219	47911	5337	52619	4330	54669	3575	56759	2470	68072	2301	33755
18-#14	2.30	MA	35491	7660	57985	5627	64706	4542	68466	3709	73735	2450	90282	2258	53330
2L-9S		MI	26881	7660	43658	5639	47032	4565	47786	3721	47394	2457	57122	1528	42749
18-#14	2.30	MA	34249	7660	56075	5626	62271	4539	65506	3724	69724	2461	84885	2130	53254
3L-8S		MI	27521	7660	44843	5621	48499	4549	49632	3728	49807	2447	60128	1609	44028
18-#14	2.30	MA	33377	7660	54541	5645	60321	4555	63139	3719	66651	2473	81349	2002	53083
4L-7S		MI	28166	7660	45963	5623	50000	4553	51417	3714	52360	2457	63190	1681	45234
18-#14	2.30	MA	32596	7660	53198	5643	58588	4552	61016	3734	63623	2464	77657	1939	52216
5L-6S		MI	28821	7660	47184	5606	51488	4538	53240	3700	54798	2447	66420	1808	46102
18-#14	2.30	MA	31851	7660	51930	5642	56865	4569	58915	3729	60841	2475	74146	1855	51163
6L-5S		MI	29492	7660	48324	5608	53036	4542	55128	3707	57288	2437	69521	1892	46987
18-#14	2.30	MA	31125	7660	50573	5661	55211	4566	56888	3744	58118	2486	70492	1728	50190
7L-4S		MI	30196	7660	49532	5610	54594	4526	57036	3693	59998	2447	72799	1954	47784
18-#14	2.30	MA	30409	7660	49328	5660	53542	4583	54903	3759	55266	2477	67043	1655	48781
8L-3S		MI	30980	7660	50909	5592	56345	4530	59160	3700	62746	2437	75919	2081	47918
18-#14	2.30	MA	29685	7660	48010	5678	51911	4580	52850	3754	52572	2488	63641	1574	47333
9L-2S		MI	32091	7660	52620	5594	58526	4515	61812	3686	66329	2427	80693	2209	47974

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

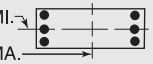


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	4.09	MA	36250	8777	62657	6317	70444	5069	75347	4038	82876	2372	103691	1468	87396
5L-6S		MI	31561	8777	54760	6270	60878	5023	64572	3990	69824	2339	86991	1239	75574
18-#18	4.09	MA	34991	8777	60427	6313	67415	5062	71653	4026	78004	2389	97623	1317	84248
6L-5S		MI	32696	8777	56764	6275	63597	5033	67888	4004	74137	2321	92332	1390	78429
18-#18	4.09	MA	33762	8777	58040	6345	64506	5090	68088	4050	73237	2407	91305	1092	81271
7L-4S		MI	33887	8777	58885	6281	66332	5007	71236	3983	78834	2339	98009	1496	80591
20-#11	1.77	MA	33756	7330	54057	5437	59797	4406	62536	3628	65717	2480	79735	2324	41530
2L-10S		MI	26371	7330	42076	5438	45089	4415	45495	3644	44326	2493	52792	1747	34589
20-#11	1.77	MA	32878	7330	52722	5437	58096	4404	60468	3638	62915	2488	75943	2235	41510
3L-9S		MI	26867	7330	42853	5440	46123	4418	46733	3634	46004	2485	54844	1811	35196
20-#11	1.77	MA	32261	7330	51653	5450	56735	4416	58817	3635	60772	2496	73455	2146	41455
4L-8S		MI	27327	7330	43679	5427	47146	4406	48020	3638	47694	2478	56961	1867	35888
20-#11	1.77	MA	31710	7330	50716	5449	55527	4414	57337	3646	58660	2491	70866	2102	41346
5L-7S		MI	27783	7330	44460	5428	48193	4409	49265	3628	49482	2485	59112	1918	36318
20-#11	1.77	MA	31184	7330	49832	5449	54326	4426	55872	3643	56720	2499	68397	2044	40744
6E		MI	28245	7330	45312	5415	49230	4398	50537	3618	51189	2478	61386	2005	36744
20-#11	1.77	MA	30671	7330	48886	5462	53173	4424	54459	3654	54822	2507	65829	1956	40233
7L-5S		MI	28719	7330	46107	5416	50310	4400	51854	3622	52934	2471	63571	2064	37282
20-#11	1.77	MA	30166	7330	48019	5462	52010	4436	53076	3665	52834	2502	63409	1904	39742
8L-4S		MI	29216	7330	46950	5418	51397	4389	53185	3612	54833	2477	65873	2107	37363
20-#11	1.77	MA	29640	7330	47167	5461	50873	4435	51644	3662	50956	2510	61017	1848	38932
9L-3S		MI	29770	7330	47911	5405	52619	4391	54669	3616	56759	2470	68072	2196	37400
20-#11	1.77	MA	29084	7330	46238	5474	49725	4447	50270	3672	49092	2518	58697	1785	38234
10L-2S		MI	30556	7330	49107	5406	54144	4380	56522	3606	59270	2463	71432	2285	37404
20-#14	2.56	MA	35124	7819	57985	5726	64706	4611	68466	3769	73735	2451	90282	2108	59031
3L-9S		MI	27684	7819	45369	5739	49213	4637	50437	3766	50977	2447	61896	1502	47702
20-#14	2.56	MA	34256	7819	56452	5744	62756	4628	66100	3764	70663	2463	86746	1980	58835
4L-8S		MI	28319	7819	46554	5721	50680	4621	52284	3772	53389	2437	64901	1584	49037
20-#14	2.56	MA	33481	7819	55108	5743	61023	4625	63977	3779	67634	2454	83055	1917	57831
5L-7S		MI	28961	7819	47674	5723	52182	4626	54069	3759	55942	2447	67963	1655	50204
20-#14	2.56	MA	32741	7819	53840	5742	59301	4641	61876	3774	64852	2465	79543	1833	56819
6E		MI	29612	7819	48895	5705	53669	4610	55891	3745	58380	2437	71193	1782	51160
20-#14	2.56	MA	32020	7819	52483	5761	57647	4638	59849	3789	62129	2476	75889	1706	55757
7L-5S		MI	30278	7819	50035	5708	55218	4614	57780	3752	60870	2427	74295	1867	52008
20-#14	2.56	MA	31308	7819	51238	5759	55977	4655	57864	3803	59278	2467	72440	1633	54389
8L-4S		MI	30977	7819	51243	5710	56775	4599	59688	3738	63580	2437	77573	1928	52936
20-#14	2.56	MA	30586	7819	49921	5778	54346	4652	55811	3798	56583	2478	69038	1552	52887
9L-3S		MI	31757	7819	52620	5692	58526	4603	61812	3745	66329	2427	80693	2056	53094
20-#18	4.55	MA	36499	9060	63773	6490	71681	5190	76839	4106	85011	2371	106960	1272	93961
6E		MI	32899	9060	57752	6447	64692	5152	69208	4070	76029	2316	95222	1187	84224
20-#18	4.55	MA	35283	9060	61386	6522	68772	5218	73274	4130	80244	2388	100642	1047	90882
7L-5S		MI	34024	9060	59756	6453	67412	5162	72524	4084	80342	2299	100563	1338	87231
22-#11	1.95	MA	33498	7440	54057	5506	59797	4454	62536	3669	65717	2481	79735	2221	45557
3L-10S		MI	26940	7440	43272	5508	46614	4465	47349	3675	46838	2486	56152	1731	38066
22-#11	1.95	MA	32885	7440	52987	5519	58437	4466	60885	3666	63574	2489	77248	2132	45490
4L-9S		MI	27435	7440	44049	5509	47647	4468	48586	3665	48515	2478	58204	1795	38713
22-#11	1.95	MA	32336	7440	52050	5519	57228	4464	59405	3677	61462	2484	74659	2088	45367
5L-8S		MI	27891	7440	44876	5496	48671	4457	49874	3669	50205	2471	60321	1851	39384
22-#11	1.95	MA	31813	7440	51167	5518	56027	4476	57940	3674	59522	2492	72190	2030	44695
6L-7S		MI	28344	7440	45656	5497	49717	4459	51119	3659	51993	2478	62472	1901	39871
22-#11	1.95	MA	31303	7440	50221	5531	54874	4475	56527	3685	57624	2500	69622	1942	44200
7L-6S		MI	28805	7440	46508	5485	50755	4448	52390	3649	53701	2471	64746	1989	40283
22-#11	1.95	MA	30800	7440	49353	5531	53711	4487	55144	3696	55636	2495	67202	1890	43651
8L-5S		MI	29276	7440	47303	5486	51835	4450	53708	3653	55445	2464	66931	2048	40888
22-#11	1.95	MA	30277	7440	48502	5530	52574	4485	53712	3693	53757	2503	64810	1834	42863
9L-4S		MI	29771	7440	48146	5487	52922	4439	55039	3643	57344	2470	69233	2091	40982
22-#11	1.95	MA	29724	7440	47572	5544	51426	4497	52338	3704	51893	2512	62490	1771	42127
10L-3S		MI	30323	7440	49107	5474	54144	4441	56522	3647	59270	2463	71432	2180	41031

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.95	MA	29182	7440	46721	5543	50296	4495	50923	3701	49933	2506	60127	1716	41179
11L-2S		MI	31105	7440	50303	5475	55669	4430	58376	3637	61781	2456	74792	2268	41050
22-#14	2.81	MA	35130	7979	58362	5844	65192	4700	69061	3809	74674	2453	92143	1958	64584
4L-9S		MI	28481	7979	47080	5838	51395	4709	53089	3811	54559	2436	66670	1477	52664
22-#14	2.81	MA	34360	7979	57018	5843	63459	4697	66938	3824	71645	2444	88452	1895	63456
5L-8S		MI	29113	7979	48265	5821	52862	4694	54935	3817	56971	2426	69675	1558	54053
22-#14	2.81	MA	33625	7979	55750	5842	61736	4714	64837	3819	68863	2455	84941	1811	62480
6L-7S		MI	29750	7979	49385	5823	54363	4698	56720	3804	59524	2436	72737	1630	55183
22-#14	2.81	MA	32908	7979	54393	5860	60082	4711	62810	3833	66141	2466	81287	1684	61335
7L-6S		MI	30397	7979	50606	5805	55850	4682	58543	3790	61962	2426	75967	1757	56224
22-#14	2.81	MA	32202	7979	53149	5859	58413	4727	60825	3848	63289	2457	77837	1611	60005
8L-5S		MI	31059	7979	51746	5807	57399	4686	60432	3797	64452	2416	79069	1841	57039
22-#14	2.81	MA	31481	7979	51831	5878	56782	4724	58772	3843	60594	2468	74435	1530	58449
9L-4S		MI	31754	7979	52954	5809	58957	4671	62339	3783	67163	2426	82346	1903	58085
22-#18	5.00	MA	36790	9344	64733	6699	73038	5347	78460	4210	87250	2370	109980	1002	100514
7L-6S		MI	34227	9344	60744	6624	68506	5280	73845	4150	82234	2294	103452	1135	92893
24-#11	2.13	MA	33505	7551	54321	5588	60138	4516	62953	3698	66375	2482	81041	2118	49522
4L-10S		MI	27505	7551	44468	5577	48139	4515	49203	3706	49349	2479	59512	1715	41548
24-#11	2.13	MA	32959	7551	53385	5588	58929	4514	61473	3708	64263	2477	78451	2074	49386
5L-9S		MI	28004	7551	45245	5578	49172	4518	50440	3696	51026	2472	61564	1778	42233
24-#11	2.13	MA	32439	7551	52501	5587	57728	4526	60008	3705	62323	2485	75983	2016	48651
6L-8S		MI	28452	7551	46072	5565	50195	4507	51728	3700	52716	2464	63681	1835	42885
24-#11	2.13	MA	31931	7551	51555	5601	56576	4525	58595	3716	60425	2494	73414	1928	48170
7E		MI	28903	7551	46852	5566	51242	4509	52973	3690	54505	2471	65832	1885	43426
24-#11	2.13	MA	31431	7551	50688	5600	55412	4537	57212	3727	58437	2488	70994	1876	47567
8L-6S		MI	29361	7551	47704	5554	52280	4498	54244	3680	56212	2464	68106	1973	43826
24-#11	2.13	MA	30911	7551	49836	5600	54275	4535	55780	3724	56559	2496	68602	1820	46799
9L-5S		MI	29830	7551	48499	5555	53360	4500	55562	3684	57957	2457	70291	2031	44491
24-#11	2.13	MA	30360	7551	48906	5613	53127	4547	54406	3735	54695	2505	66283	1757	46025
10L-4S		MI	30323	7551	49342	5556	54447	4489	56893	3674	59855	2463	72593	2075	44598
24-#11	2.13	MA	29820	7551	48055	5612	51997	4545	52991	3732	52735	2499	63920	1702	45097
11L-3S		MI	30872	7551	50303	5543	55669	4492	58376	3678	61781	2456	74792	2163	44658
24-#14	3.07	MA	35233	8138	58929	5943	65895	4769	69899	3868	75657	2434	93849	1873	69089
5L-9S		MI	29274	8138	48791	5938	53576	4782	55741	3856	58141	2426	71443	1451	57633
24-#14	3.07	MA	34503	8138	57661	5941	64172	4786	67798	3863	72875	2445	90338	1789	68147
6L-8S		MI	29902	8138	49976	5920	55043	4766	57587	3862	60553	2416	74448	1533	59076
24-#14	3.07	MA	33791	8138	56304	5960	62518	4783	65771	3878	70152	2456	86684	1662	66921
7E		MI	30535	8138	51096	5923	56544	4770	59372	3849	63107	2426	77510	1605	60172
24-#14	3.07	MA	33089	8138	55059	5959	60849	4800	63786	3893	67300	2447	83234	1589	65628
8L-6S		MI	31178	8138	52317	5905	58032	4755	61195	3835	65544	2416	80740	1731	61292
24-#14	3.07	MA	32370	8138	53742	5978	59218	4797	61732	3888	64606	2458	79832	1508	64019
9L-5S		MI	31836	8138	53457	5907	59580	4759	63084	3842	68034	2406	83842	1816	62078

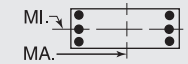
RECTANGULAR TIED COLUMNS 40" x 46"

6-#18	1.30	MA	34969	7357	55241	5459	60240	4439	62047	3682	63253	2593	75146	2431	33348
2L-3S		MI	28260	7357	45048	5399	48284	4420	48862	3666	47907	2568	55695	2146	28709
6-#18	1.30	MA	32629	7357	51717	5456	55748	4468	56586	3708	55854	2611	65254	2204	33370
3L-2S		MI	30241	7357	48040	5405	52098	4395	53499	3645	54112	2550	63926	2374	28632
8-#18	1.74	MA	36602	7641	58765	5636	64733	4568	67508	3762	70651	2575	85037	2389	44114
2L-4S		MI	28250	7641	45625	5606	49029	4539	49774	3732	49352	2563	58560	1867	37485
8-#18	1.74	MA	34285	7641	55241	5633	60240	4596	62047	3787	63253	2593	75146	2162	44038
3E		MI	29647	7641	48040	5576	52098	4549	53499	3746	54112	2546	63926	2094	37789

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

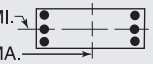


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	1.74	MA	32648	7641	52409	5665	56639	4590	57677	3777	57578	2611	68673	1934	43570
4L-2S		MI	31609	7641	51031	5582	55912	4523	58135	3724	60317	2528	72156	2322	37796
10-#14	1.22	MA	34771	7304	54560	5458	59577	4442	61320	3690	62300	2614	74228	2473	31569
2L-5S		MI	27424	7304	43172	5422	46079	4428	46247	3676	44509	2594	52142	2105	27071
10-#14	1.22	MA	33431	7304	52550	5457	57014	4439	58204	3705	58079	2625	68519	2345	31599
3L-4S		MI	28147	7304	44380	5424	47637	4413	48154	3663	47219	2604	55420	2166	27180
10-#14	1.22	MA	32488	7304	50938	5476	54965	4456	55717	3701	54849	2637	64775	2217	31548
4L-3S		MI	28954	7304	45757	5407	49387	4417	50278	3669	49967	2594	58540	2294	27180
10-#14	1.22	MA	31643	7304	49527	5475	53144	4454	53487	3717	51667	2629	60876	2153	31355
5L-2S		MI	30091	7304	47468	5409	51569	4401	52930	3656	53550	2584	63313	2422	27134
10-#18	2.17	MA	38215	7925	62288	5813	69225	4696	72969	3842	78050	2557	94928	2347	54841
2L-5S		MI	28393	7925	46496	5778	50108	4693	51063	3833	50861	2523	61115	1709	43705
10-#18	2.17	MA	35920	7925	58765	5810	64733	4725	67508	3867	70651	2576	85037	2119	54679
3L-4S		MI	29635	7925	48617	5783	52843	4667	54410	3812	55557	2541	66791	1814	46440
10-#18	2.17	MA	34301	7925	55933	5843	61131	4718	63138	3857	64977	2594	78565	1892	54115
4L-3S		MI	31017	7925	51031	5754	55912	4677	58135	3826	60317	2523	72156	2042	46837
10-#18	2.17	MA	32851	7925	53449	5840	57929	4747	59216	3882	59382	2577	71786	1781	50826
5L-2S		MI	32962	7925	54023	5759	59727	4652	62772	3804	66522	2506	80387	2269	46930
12-#11	1.02	MA	34020	7170	52847	5390	57498	4394	58832	3664	58947	2631	69843	2505	26495
2L-6S		MI	27109	7170	42216	5353	44899	4373	44849	3643	42697	2620	49666	2182	22799
12-#11	1.02	MA	33078	7170	51444	5390	55708	4393	56657	3675	56000	2639	65833	2416	26526
3L-5S		MI	27593	7170	43011	5354	45979	4376	46166	3647	44441	2613	51851	2241	22876
12-#11	1.02	MA	32417	7170	50320	5404	54279	4405	54922	3672	53747	2648	63201	2328	26538
4E		MI	28100	7170	43854	5355	47066	4365	47497	3637	46340	2620	54153	2284	22877
12-#11	1.02	MA	31825	7170	49336	5403	53010	4404	53367	3683	51529	2643	60468	2283	26498
5L-3S		MI	28666	7170	44815	5343	48288	4367	48980	3641	48266	2613	56352	2373	22847
12-#11	1.02	MA	31260	7170	48408	5403	51749	4416	51829	3681	49491	2652	57857	2225	26347
6L-2S		MI	29466	7170	46011	5344	49813	4356	50834	3631	50777	2606	59712	2461	22807
12-#14	1.47	MA	35715	7464	56570	5558	62140	4514	64435	3735	66520	2604	79937	2452	37710
2L-6S		MI	27548	7464	43743	5520	46712	4496	47009	3715	45601	2594	53814	1995	31163
12-#14	1.47	MA	34383	7464	54560	5557	59577	4511	61320	3750	62300	2615	74228	2324	37711
3L-5S		MI	28234	7464	44883	5522	48260	4501	48898	3721	48091	2584	56916	2079	32212
12-#14	1.47	MA	33446	7464	52949	5576	57528	4529	58832	3746	59070	2627	70484	2196	37625
4E		MI	28952	7464	46091	5524	49818	4485	50806	3708	50801	2594	60193	2141	32363
12-#14	1.47	MA	32607	7464	51537	5575	55707	4526	56602	3761	55888	2619	66586	2132	37393
5L-3S		MI	29754	7464	47468	5506	51569	4489	52930	3714	53550	2584	63313	2269	32402
12-#14	1.47	MA	31807	7464	50205	5574	53897	4543	54395	3757	52965	2631	62869	2048	36093
6L-2S		MI	30885	7464	49179	5509	53750	4473	55582	3701	57132	2574	68087	2397	32373
12-#18	2.61	MA	39810	8209	65812	5991	73717	4825	78430	3922	85448	2540	104820	2305	65538
2L-6S		MI	28601	8209	47484	5949	51203	4812	52383	3899	52752	2519	64004	1505	50277
12-#18	2.61	MA	37536	8209	62288	5988	69225	4853	72969	3947	78050	2558	94928	2077	65305
3L-5S		MI	29774	8209	49488	5955	53923	4822	55699	3913	57066	2501	69346	1657	52423
12-#18	2.61	MA	35934	8209	59456	6020	65624	4847	68599	3937	72375	2576	88456	1850	64437
4E		MI	31003	8209	51608	5961	56657	4796	59047	3892	61762	2519	75022	1762	55028
12-#18	2.61	MA	34500	8209	56973	6017	62421	4876	64677	3962	66781	2559	81677	1739	61137
5L-3S		MI	32372	8209	54023	5931	59727	4806	62772	3905	66522	2501	80387	1990	55865
12-#18	2.61	MA	33131	8209	54629	6014	59238	4869	60794	3952	61640	2577	75246	1589	58574
6L-2S		MI	34301	8209	57015	5937	63541	4780	67408	3884	72727	2484	88618	2217	56023
14-#11	1.19	MA	34687	7281	54251	5460	59287	4444	61007	3695	61893	2624	73852	2492	30789
2L-7S		MI	27211	7281	42561	5435	45386	4435	45431	3684	43501	2621	50752	2078	25816
14-#11	1.19	MA	33749	7281	52847	5459	57498	4443	58832	3706	58947	2633	69843	2403	30811
3L-6S		MI	27681	7281	43412	5422	46423	4423	46702	3674	45208	2614	53026	2166	26308
14-#11	1.19	MA	33091	7281	51724	5473	56068	4455	57097	3703	56694	2641	67211	2315	30802
4L-5S		MI	28163	7281	44207	5423	47504	4426	48020	3678	46953	2606	55211	2224	26502
14-#11	1.19	MA	32502	7281	50740	5473	54799	4454	55543	3714	54475	2636	64478	2270	30742
5L-4S		MI	28668	7281	45050	5424	48591	4415	49351	3668	48851	2613	57513	2267	26526
14-#11	1.19	MA	31941	7281	49812	5472	53538	4466	54004	3712	52438	2645	61867	2212	30474
6L-3S		MI	29231	7281	46011	5412	49813	4417	50834	3672	50777	2606	59712	2356	26508

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

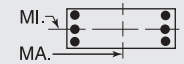
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.19	MA	31393	7281	48819	5486	52327	4465	52520	3723	50445	2654	59151	2124	29844
7L-2S		MI	30027	7281	47207	5413	51338	4406	52688	3662	53288	2599	63072	2445	26477
14-#14	1.71	MA	36652	7623	58581	5657	64703	4586	67551	3780	70741	2594	85647	2432	43843
2L-7S		MI	27691	7623	44233	5637	47406	4584	47838	3773	46745	2593	55357	1843	35569
14-#14	1.71	MA	35327	7623	56570	5657	62140	4584	64435	3795	66520	2606	79937	2304	43811
3L-6S		MI	28356	7623	45454	5620	48893	4569	49661	3760	49183	2583	58587	1969	36194
14-#14	1.71	MA	34396	7623	54959	5676	60090	4601	61948	3791	63291	2617	76193	2176	43694
4L-5S		MI	29037	7623	46594	5622	50442	4573	51550	3766	51673	2573	61689	2054	37189
14-#14	1.71	MA	33564	7623	53547	5675	58270	4598	59717	3806	60108	2609	72295	2112	43282
5L-4S		MI	29752	7623	47802	5624	51999	4557	53457	3753	54384	2583	64967	2115	37536
14-#14	1.71	MA	32769	7623	52215	5674	56460	4616	57510	3802	57185	2621	68579	2028	42019
6L-3S		MI	30548	7623	49179	5606	53750	4561	55582	3759	57132	2573	68087	2243	37604
14-#14	1.71	MA	31995	7623	50790	5693	54723	4613	55381	3817	54326	2633	64713	1902	41209
7L-2S		MI	31673	7623	50890	5608	55931	4546	58234	3745	60714	2563	72861	2371	37602
14-#18	3.04	MA	39135	8492	65812	6165	73717	4982	78430	4027	85448	2540	104820	2035	75919
3L-6S		MI	29980	8492	50476	6127	55017	4940	57020	3979	58957	2497	72235	1453	58844
14-#18	3.04	MA	37549	8492	62980	6197	70116	4976	74060	4017	79774	2558	98347	1808	74614
4L-5S		MI	31141	8492	52479	6132	57737	4950	60336	3993	63271	2479	77576	1604	61168
14-#18	3.04	MA	36130	8492	60497	6194	66914	5004	70138	4042	74179	2541	91569	1697	71473
5L-4S		MI	32358	8492	54600	6138	60471	4925	63684	3971	67968	2497	83253	1710	63628
14-#18	3.04	MA	34776	8492	58153	6191	63730	4998	66255	4032	69038	2559	85137	1547	68739
6L-3S		MI	33715	8492	57015	6108	63541	4934	67408	3985	72727	2479	88618	1938	64879
14-#18	3.04	MA	33455	8492	55645	6224	60673	5027	62509	4057	64007	2577	78443	1322	65519
7L-2S		MI	35627	8492	60006	6114	67355	4909	72045	3964	78932	2461	96849	2165	65097
16-#11	1.36	MA	35350	7391	55654	5529	61076	4494	63182	3726	64840	2617	77861	2479	35076
2L-8S		MI	27321	7391	42976	5503	45864	4482	46040	3725	44224	2607	51961	2011	29028
16-#11	1.36	MA	34417	7391	54251	5528	59287	4493	61007	3737	61893	2626	73852	2390	35088
3L-7S		MI	27782	7391	43757	5504	46911	4485	47285	3715	46012	2614	54112	2062	29357
16-#11	1.36	MA	33761	7391	53127	5542	57858	4505	59272	3734	59641	2634	71220	2302	35060
4L-6S		MI	28250	7391	44608	5491	47948	4474	48556	3705	47719	2607	56386	2149	29827
16-#11	1.36	MA	33175	7391	52143	5542	56589	4504	57718	3746	57422	2629	68487	2257	34982
5E		MI	28730	7391	45403	5492	49029	4476	49874	3709	49464	2599	58571	2208	30122
16-#11	1.36	MA	32617	7391	51215	5542	55327	4516	56179	3743	55385	2638	65876	2198	34609
6L-4S		MI	29232	7391	46246	5494	50116	4465	51205	3699	51363	2606	60873	2251	30163
16-#11	1.36	MA	32072	7391	50222	5555	54117	4515	54695	3754	53392	2647	63160	2111	34005
7L-3S		MI	29793	7391	47207	5481	51338	4467	52688	3703	53288	2599	63072	2340	30162
16-#11	1.36	MA	31535	7391	49312	5555	52895	4527	53243	3765	51304	2642	60606	2059	33572
8L-2S		MI	30586	7391	48403	5482	52863	4456	54542	3693	55800	2592	66432	2429	30138
16-#14	1.96	MA	37582	7783	60591	5757	67266	4658	70666	3825	74962	2584	91356	2411	49957
2L-8S		MI	27846	7783	44824	5735	48086	4652	48705	3832	47774	2572	57069	1746	39321
16-#14	1.96	MA	36265	7783	58581	5756	64703	4656	67551	3840	70741	2596	85647	2283	49903
3L-7S		MI	28498	7783	45944	5737	49587	4657	50490	3818	50328	2582	60131	1817	40595
16-#14	1.96	MA	35340	7783	56969	5775	62653	4673	65063	3836	67511	2607	81903	2155	49757
4L-6S		MI	29159	7783	47165	5719	51074	4641	52313	3805	52765	2572	63361	1944	41236
16-#14	1.96	MA	34513	7783	55557	5775	60832	4671	62833	3851	64329	2599	78004	2091	49165
5E		MI	29835	7783	48305	5722	52623	4645	54202	3811	55255	2562	66463	2028	42183
16-#14	1.96	MA	33724	7783	54226	5774	59023	4688	60625	3847	61406	2611	74288	2007	47956
6L-4S		MI	30545	7783	49513	5724	54181	4630	56109	3798	57966	2572	69741	2090	42702
16-#14	1.96	MA	32955	7783	52800	5793	57285	4685	58496	3862	58546	2623	70422	1881	47171
7L-3S		MI	31336	7783	50890	5706	55931	4634	58234	3804	60714	2562	72861	2218	42796
16-#14	1.96	MA	32196	7783	51493	5792	55532	4703	56412	3878	55551	2615	66778	1807	45589
8L-2S		MI	32455	7783	52601	5708	58113	4618	60885	3790	64296	2553	77634	2346	42823
16-#18	3.48	MA	39149	8776	66504	6375	74609	5104	79521	4097	87172	2541	108239	1765	84829
4L-6S		MI	31344	8776	53467	6304	58831	5069	61656	4059	65162	2475	80466	1401	67440

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

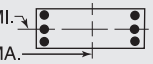


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	3.48	MA	37743	8776	64020	6372	71406	5133	75600	4122	81578	2524	101460	1655	81832
5E		MI	32495	8776	55471	6310	61551	5079	64972	4073	69476	2457	85807	1552	69934
16-#18	3.48	MA	36404	8776	61676	6369	68222	5126	71717	4112	76437	2542	95029	1505	78931
6L-4S		MI	33701	8776	57592	6315	64285	5053	68320	4051	74173	2475	91484	1658	72265
16-#18	3.48	MA	35097	8776	59168	6401	65165	5155	67970	4137	71405	2560	88334	1280	75820
7L-3S		MI	35045	8776	60006	6286	67355	5063	72045	4065	78932	2457	96849	1885	73883
16-#18	3.48	MA	33808	8776	56867	6398	62080	5149	64302	4162	66135	2543	82000	1151	71783
8L-2S		MI	36942	8776	62998	6291	71169	5037	76682	4044	85137	2439	105080	2113	74156
18-#11	1.53	MA	36010	7502	57058	5598	62866	4545	65358	3757	67787	2610	81870	2466	39358
2L-9S		MI	27426	7502	43346	5585	46366	4544	46605	3752	45045	2607	53204	1939	31902
18-#11	1.53	MA	35080	7502	55654	5598	61076	4543	63182	3768	64840	2619	77861	2377	39354
3L-8S		MI	27892	7502	44172	5572	47389	4533	47893	3756	46735	2600	55321	1995	32583
18-#11	1.53	MA	34428	7502	54531	5611	59647	4556	61448	3766	62588	2628	75229	2288	39312
4L-7S		MI	28351	7502	44953	5573	48436	4535	49138	3746	48523	2607	57472	2045	32903
18-#11	1.53	MA	33845	7502	53547	5611	58378	4554	59893	3777	60369	2623	72496	2244	39219
5L-6S		MI	28816	7502	45804	5561	49473	4524	50410	3736	50231	2600	59746	2133	33353
18-#11	1.53	MA	33290	7502	52619	5611	57117	4566	58354	3774	58332	2631	69885	2185	38753
6L-5S		MI	29293	7502	46599	5562	50554	4526	51727	3740	51975	2593	61931	2192	33738
18-#11	1.53	MA	32748	7502	51626	5624	55906	4565	56870	3785	56339	2640	67170	2098	38171
7L-4S		MI	29793	7502	47442	5563	51640	4515	53058	3730	53874	2599	64233	2235	33793
18-#11	1.53	MA	32213	7502	50715	5624	54684	4577	55418	3796	54251	2635	64615	2046	37748
8L-3S		MI	30352	7502	48403	5550	52863	4517	54542	3734	55800	2592	66432	2324	33810
18-#11	1.53	MA	31649	7502	49821	5624	53491	4576	53915	3794	52279	2644	62086	1990	36909
9L-2S		MI	31142	7502	49599	5551	54387	4506	56395	3724	58311	2585	69792	2412	33795
18-#14	2.20	MA	38506	7943	62601	5857	69828	4731	73781	3870	79183	2574	97065	2391	56064
2L-9S		MI	28010	7943	45350	5852	48800	4740	49510	3870	48944	2572	58837	1639	43158
18-#14	2.20	MA	37196	7943	60591	5856	67266	4728	70666	3885	74962	2586	91356	2263	55988
3L-8S		MI	28652	7943	46535	5835	50267	4725	51357	3877	51356	2562	61843	1720	44319
18-#14	2.20	MA	36277	7943	58979	5875	65216	4745	68179	3881	71732	2598	87612	2135	55816
4L-7S		MI	29299	7943	47655	5837	51768	4729	53142	3863	53910	2572	64905	1792	45550
18-#14	2.20	MA	35455	7943	57567	5874	63395	4743	65948	3896	68550	2589	83713	2071	55063
5L-6S		MI	29955	7943	48876	5819	53256	4713	54964	3850	56347	2562	68135	1918	46287
18-#14	2.20	MA	34672	7943	56236	5874	61585	4760	63741	3892	65627	2601	79997	1987	53902
6L-5S		MI	30628	7943	50016	5821	54804	4717	56853	3856	58837	2552	71237	2003	47190
18-#14	2.20	MA	33908	7943	54810	5893	59848	4758	61612	3907	62767	2613	76131	1861	53029
7L-4S		MI	31333	7943	51224	5823	56362	4702	58761	3842	61548	2562	74514	2064	47863
18-#14	2.20	MA	33155	7943	53503	5892	58095	4775	59527	3923	59771	2605	72488	1786	51486
8L-3S		MI	32120	7943	52601	5806	58113	4706	60885	3849	64296	2552	77634	2192	47981
18-#14	2.20	MA	32367	7943	52220	5891	56382	4772	57370	3918	56941	2617	68887	1705	50089
9L-2S		MI	33233	7943	54312	5808	60294	4690	63537	3835	67878	2542	82408	2320	48027
18-#18	3.91	MA	39342	9060	67544	6549	75898	5261	81061	4202	88976	2506	111351	1612	92210
5L-6S		MI	32697	9060	56459	6481	62645	5197	66293	4138	71367	2452	88697	1349	76060
18-#18	3.91	MA	38016	9060	65200	6546	72715	5255	77178	4192	83835	2524	104920	1462	89147
6L-5S		MI	33836	9060	58462	6487	65365	5207	69609	4152	75681	2435	94038	1500	78719
18-#18	3.91	MA	36722	9060	62692	6578	69658	5284	73431	4217	78804	2542	98226	1237	86138
7L-4S		MI	35031	9060	60583	6493	68099	5182	72957	4131	80378	2452	99715	1606	80933
18-#18	3.91	MA	35445	9060	60391	6575	66572	5277	69763	4242	73534	2525	91892	1108	82007
8L-3S		MI	36364	9060	62998	6463	71169	5192	76682	4145	85137	2435	105080	1833	82878
20-#11	1.70	MA	36666	7613	58461	5667	64655	4595	67533	3788	70734	2603	85880	2453	43636
2L-10S		MI	27502	7613	43764	5653	46857	4591	47222	3793	45879	2608	54512	1859	34878
20-#11	1.70	MA	35740	7613	57058	5667	62866	4593	65358	3799	67787	2612	81870	2364	43616
3L-9S		MI	27998	7613	44542	5654	47891	4594	48459	3784	47556	2600	56564	1922	35411
20-#11	1.70	MA	35091	7613	55934	5680	61436	4606	63623	3797	65535	2621	79238	2275	43561
4L-8S		MI	28459	7613	45368	5641	48914	4583	49747	3787	49246	2593	58681	1979	36117
20-#11	1.70	MA	34511	7613	54950	5680	60167	4604	62068	3808	63316	2616	76505	2231	43452
5L-7S		MI	28916	7613	46149	5642	49961	4585	50992	3777	51035	2600	60832	2029	36453
20-#11	1.70	MA	33958	7613	54022	5680	58906	4617	60530	3805	61279	2624	73895	2172	42904
6E		MI	29379	7613	47000	5630	50998	4574	52263	3768	52742	2593	63106	2117	36886

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

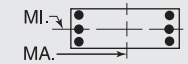
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.70	MA	33419	7613	53029	5693	57695	4615	59046	3816	59286	2633	71179	2085	42342
7L-5S		MI	29854	7613	47795	5631	52078	4576	53581	3771	54487	2586	65291	2175	37350
20-#11	1.70	MA	32888	7613	52119	5693	56474	4628	57593	3828	57198	2628	68624	2033	41927
8L-4S		MI	30352	7613	48638	5632	53165	4565	54912	3762	56385	2592	67593	2218	37419
20-#11	1.70	MA	32326	7613	51225	5693	55280	4626	56090	3825	55226	2637	66095	1977	41042
9L-3S		MI	30908	7613	49599	5619	54387	4568	56395	3765	58311	2585	69792	2307	37448
20-#11	1.70	MA	31741	7613	50248	5706	54074	4638	54647	3836	53268	2646	63641	1913	40365
10L-2S		MI	31695	7613	50795	5620	55912	4556	58249	3756	60822	2578	73152	2396	37446
20-#14	2.45	MA	38121	8102	62601	5956	69828	4801	73781	3930	79183	2576	97065	2242	62068
3L-9S		MI	28814	8102	47061	5952	50981	4813	52162	3915	52526	2561	63611	1613	48106
20-#14	2.45	MA	37208	8102	60989	5975	67779	4818	71294	3926	75953	2588	93321	2114	61872
4L-8S		MI	29451	8102	48246	5934	52448	4797	54009	3922	54939	2551	66616	1695	49325
20-#14	2.45	MA	36391	8102	59578	5974	65958	4815	69064	3941	72771	2580	89423	2051	60972
5L-7S		MI	30095	8102	49366	5937	53949	4801	55793	3908	57492	2561	69678	1766	50516
20-#14	2.45	MA	35613	8102	58246	5973	64148	4833	66856	3937	69848	2591	85707	1966	59855
6E		MI	30747	8102	50587	5919	55437	4786	57616	3895	59929	2551	72908	1893	51344
20-#14	2.45	MA	34854	8102	56821	5992	62411	4830	64727	3952	66988	2603	81841	1840	58892
7L-5S		MI	31416	8102	51727	5921	56986	4790	59505	3901	62420	2541	76010	1978	52209
20-#14	2.45	MA	34106	8102	55514	5992	60658	4847	62642	3968	63992	2595	78197	1766	57392
8L-4S		MI	32117	8102	52935	5923	58543	4774	61412	3887	65130	2551	79288	2039	53019
20-#14	2.45	MA	33335	8102	54230	5991	58945	4845	60486	3963	61162	2607	74597	1685	55939
9L-3S		MI	32899	8102	54312	5905	60294	4778	63537	3894	67878	2541	82408	2167	53160
20-#14	2.45	MA	32498	8102	52829	6010	57214	4862	58414	3979	58353	2619	71105	1593	54291
10L-2S		MI	34006	8102	56023	5908	62475	4763	66189	3880	71460	2531	87181	2295	53225
20-#18	4.35	MA	39613	9343	68724	6723	77207	5383	82639	4271	91234	2506	114812	1420	99385
6E		MI	34038	9343	59451	6659	66460	5326	70929	4218	77572	2430	96927	1297	84703
20-#18	4.35	MA	38331	9343	66215	6756	74150	5412	78892	4297	86202	2524	108117	1195	96375
7L-5S		MI	35167	9343	61454	6664	69179	5336	74246	4232	81886	2412	102269	1448	87518
20-#18	4.35	MA	37068	9343	63914	6753	71065	5406	75224	4322	80932	2507	101783	1066	92248
8L-4S		MI	36351	9343	63575	6670	71914	5310	77593	4211	86583	2430	107945	1554	89628
22-#11	1.87	MA	36397	7723	58461	5736	64655	4643	67533	3830	70734	2605	85880	2351	47874
3L-10S		MI	28071	7723	44960	5722	48382	4642	49076	3825	48390	2601	57872	1842	38368
22-#11	1.87	MA	35751	7723	57338	5749	63226	4656	65798	3828	68482	2614	83248	2262	47807
4L-9S		MI	28566	7723	45738	5723	49415	4644	50313	3815	50068	2594	59924	1906	38926
22-#11	1.87	MA	35173	7723	56354	5749	61957	4654	64243	3839	66263	2609	80515	2218	47684
5L-8S		MI	29024	7723	46564	5710	50438	4633	51601	3819	51757	2586	62041	1962	39610
22-#11	1.87	MA	34623	7723	55426	5749	60695	4667	62705	3836	64226	2618	77904	2159	47061
6L-7S		MI	29478	7723	47345	5711	51485	4635	52846	3809	53546	2593	64192	2013	40007
22-#11	1.87	MA	34087	7723	54433	5763	59485	4665	61221	3848	62233	2626	75188	2072	46516
7L-6S		MI	29939	7723	48196	5699	52523	4624	54117	3799	55253	2586	66466	2100	40424
22-#11	1.87	MA	33558	7723	53522	5762	58263	4678	59768	3859	60145	2621	72634	2020	46042
8L-5S		MI	30412	7723	48991	5700	53603	4627	55435	3803	56998	2579	68651	2159	40959
22-#11	1.87	MA	33000	7723	52628	5762	57070	4676	58265	3856	58172	2630	70104	1964	45179
9L-4S		MI	30908	7723	49834	5701	54690	4615	56766	3793	58897	2585	70953	2202	41041
22-#11	1.87	MA	32417	7723	51652	5776	55864	4689	56822	3867	56215	2639	67650	1900	44500
10L-3S		MI	31461	7723	50795	5688	55912	4618	58249	3797	60822	2578	73152	2291	41082
22-#11	1.87	MA	31848	7723	50758	5775	54677	4687	55336	3865	54156	2634	65156	1845	43467
11L-2S		MI	32245	7723	51991	5690	57437	4606	60103	3787	63334	2571	76512	2380	41094
22-#14	2.69	MA	38133	8262	62999	6075	70342	4890	74409	3970	80174	2578	99031	2094	67925
4L-9S		MI	29613	8262	48772	6052	53163	4885	54814	3960	56108	2551	68385	1588	53064
22-#14	2.69	MA	37321	8262	61588	6074	68521	4888	72179	3986	76991	2570	95132	2030	66893
5L-8S		MI	30246	8262	49957	6034	54630	4869	56660	3967	58521	2541	71390	1669	54339
22-#14	2.69	MA	36548	8262	60256	6073	66711	4905	69972	3982	74068	2581	91416	1946	65815
6L-7S		MI	30886	8262	51077	6036	56131	4874	58445	3953	61074	2551	74452	1741	55493

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

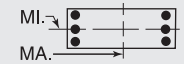
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	2.69	MA	35794	8262	58831	6092	64974	4902	67843	3997	71209	2593	87550	1820	64764
7L-6S		MI	31534	8262	52297	6019	57618	4858	60268	3939	63511	2541	77682	1867	56407
22-#14	2.69	MA	35051	8262	57524	6091	63221	4920	65758	4012	68213	2585	83906	1745	63305
8L-5S		MI	32198	8262	53438	6021	59167	4862	62157	3946	66002	2531	80784	1952	57239
22-#14	2.69	MA	34282	8262	56240	6091	61508	4917	63601	4008	65383	2597	80306	1664	61798
9L-4S		MI	32895	8262	54646	6023	60725	4846	64064	3932	68712	2541	84061	2013	58172
22-#14	2.69	MA	33452	8262	54839	6110	59777	4934	61530	4024	62574	2609	76814	1573	60185
10L-3S		MI	33673	8262	56023	6005	62475	4851	66189	3939	71460	2531	87181	2141	58334
22-#18	4.78	MA	39927	9627	69739	6933	78642	5541	84353	4376	93601	2507	118009	1153	106532
7L-6S		MI	35368	9627	62442	6836	70274	5455	75566	4298	83777	2408	105158	1245	93366
22-#18	4.78	MA	38675	9627	67438	6930	75557	5534	80685	4402	88331	2490	111675	1024	102504
8L-5S		MI	36488	9627	64446	6842	72993	5464	78882	4312	88091	2390	110500	1396	96331
24-#11	2.03	MA	36407	7834	58741	5819	65015	4706	67973	3859	71429	2607	87257	2249	52050
4L-10S		MI	28637	7834	46156	5791	49907	4692	50929	3856	50902	2594	61232	1826	41848
24-#11	2.03	MA	35832	7834	57757	5818	63746	4705	66419	3870	69210	2602	84524	2204	51913
5L-9S		MI	29137	7834	46934	5792	50940	4694	52166	3846	52579	2587	63284	1890	42445
24-#11	2.03	MA	35285	7834	56829	5818	62485	4717	64880	3868	67173	2611	81913	2146	51222
6L-8S		MI	29585	7834	47760	5780	51963	4683	53454	3850	54269	2580	65401	1946	43110
24-#11	2.03	MA	34751	7834	55836	5832	61274	4715	63396	3879	65180	2619	79198	2059	50694
7E		MI	30038	7834	48541	5781	53010	4685	54699	3840	56057	2586	67552	1996	43563
24-#11	2.03	MA	34225	7834	54926	5831	60053	4728	61943	3890	63092	2614	76643	2007	50163
8L-6S		MI	30497	7834	49392	5768	54048	4674	55971	3830	57765	2579	69826	2084	43967
24-#11	2.03	MA	33669	7834	54032	5831	58859	4726	60440	3887	61119	2623	74113	1951	49321
9L-5S		MI	30967	7834	50187	5769	55128	4677	57288	3834	59509	2572	72011	2143	44565
24-#11	2.03	MA	33089	7834	53055	5845	57653	4739	58997	3898	59162	2632	71659	1887	48603
10L-4S		MI	31461	7834	51030	5770	56215	4665	58619	3824	61408	2579	74313	2186	44660
24-#11	2.03	MA	32522	7834	52162	5845	56467	4737	57511	3896	57103	2627	69165	1832	47591
11L-3S		MI	32012	7834	51991	5758	57437	4668	60103	3828	63334	2571	76512	2275	44712
24-#11	2.03	MA	31965	7834	51201	5858	55269	4750	56071	3907	55149	2636	66421	1758	46626
12L-2S		MI	32793	7834	53187	5759	58962	4657	61956	3818	65845	2564	79872	2363	44734
24-#14	2.93	MA	38246	8421	63598	6174	71084	4960	75295	4031	81212	2560	100841	2010	72822
5L-9S		MI	30406	8421	50483	6152	55344	4957	57465	4005	59690	2540	73158	1562	58029
24-#14	2.93	MA	37478	8421	62266	6173	69274	4977	73087	4026	78289	2572	97125	1926	71780
6L-8S		MI	31036	8421	51668	6134	56811	4942	59312	4011	62103	2530	76163	1644	59359
24-#14	2.93	MA	36729	8421	60841	6192	67537	4975	70958	4042	75429	2583	93259	1799	70646
7E		MI	31672	8421	52788	6136	58312	4946	61097	3998	64656	2540	79225	1715	60478
24-#14	2.93	MA	35990	8421	59534	6191	65784	4992	68873	4057	72433	2575	89616	1725	69225
8L-6S		MI	32316	8421	54008	6118	59800	4930	62920	3984	67093	2530	82455	1842	61476
24-#14	2.93	MA	35222	8421	58251	6190	64071	4989	66716	4053	69603	2587	86015	1644	67665
9L-5S		MI	32977	8421	55149	6121	61348	4934	64808	3991	69584	2520	85557	1927	62276
24-#14	2.93	MA	34401	8421	56850	6209	62340	5007	64645	4068	66795	2599	82524	1553	66086
10L-4S		MI	33669	8421	56357	6123	62906	4919	66716	3977	72294	2530	88835	1988	63321
24-#18	5.22	MA	40270	9911	70961	7107	80049	5663	86146	4481	95730	2472	121566	982	112775
8L-6S		MI	36689	9911	65434	7013	74088	5583	80203	4378	89982	2386	113389	1193	102048

RECTANGULAR TIED COLUMNS 40" x 48"

6-#18	1.25	MA	37909	7640	59662	5689	65074	4628	66969	3843	68087	2716	80955	2559	34968
2L-3S		MI	29393	7640	46746	5611	50052	4594	50583	3814	49451	2682	57401	2256	28767
6-#18	1.25	MA	35445	7640	55961	5686	60355	4658	61233	3869	60317	2736	70509	2331	34990
3L-2S		MI	31377	7640	49738	5617	53866	4569	55220	3793	55656	2664	65631	2484	28678
8-#18	1.67	MA	39633	7924	63363	5866	69792	4757	72704	3923	75858	2699	91401	2519	46274
2L-4S		MI	29382	7924	47324	5818	50796	4713	51495	3880	50896	2677	60266	1977	37600
8-#18	1.67	MA	37194	7924	59662	5864	65074	4786	66969	3949	68087	2718	80955	2292	46198
3E		MI	30781	7924	49738	5788	53866	4723	55220	3894	55656	2659	65631	2204	37859
8-#18	1.67	MA	35474	7924	56691	5897	61296	4781	62383	3940	62134	2738	74113	2064	45730
4L-2S		MI	32747	7924	52730	5794	57680	4697	59856	3872	61861	2642	73862	2432	37849

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

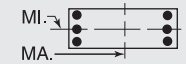
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.17	MA	37695	7587	58938	5688	64366	4631	66192	3851	67070	2737	79945	2599	33088
2L-5S		MI	28555	7587	44864	5636	47847	4604	47971	3826	46058	2709	53857	2216	27150
10-#14	1.17	MA	36285	7587	56828	5687	61676	4628	62922	3867	62640	2750	73923	2471	33118
3L-4S		MI	29280	7587	46072	5638	49405	4588	49879	3812	48769	2719	57135	2277	27236
10-#14	1.17	MA	35294	7587	55138	5707	59527	4646	60313	3863	59253	2762	69971	2343	33067
4L-3S		MI	30087	7587	47449	5620	51155	4592	52003	3818	51517	2709	60255	2405	27223
10-#14	1.17	MA	34408	7587	53659	5706	57619	4644	57975	3879	55917	2755	65865	2278	32874
5L-2S		MI	31226	7587	49160	5622	53337	4577	54655	3805	55099	2699	65028	2533	27172
10-#18	2.08	MA	41337	8208	67063	6043	74510	4885	78440	4003	83629	2681	101847	2480	57541
2L-5S		MI	29524	8208	48194	5990	51876	4867	52784	3981	52404	2637	62821	1819	44002
10-#18	2.08	MA	38920	8208	63363	6041	69792	4915	72704	4029	75858	2700	91401	2252	57379
3L-4S		MI	30768	8208	50315	5995	54610	4842	56132	3960	57101	2655	68497	1924	46565
10-#18	2.08	MA	37219	8208	60392	6074	66014	4909	68119	4020	69905	2720	84559	2025	56815
4L-3S		MI	32154	8208	52730	5966	57680	4852	59856	3974	61861	2637	73862	2152	46916
10-#18	2.08	MA	35695	8208	57788	6072	62655	4939	64006	4046	64037	2704	77412	1913	53549
5L-2S		MI	34102	8208	55721	5971	61494	4826	64493	3952	68066	2620	82093	2379	46986
12-#14	1.41	MA	38690	7747	61048	5787	67056	4703	69462	3895	71500	2727	85966	2580	39533
2L-6S		MI	28679	7747	45435	5733	48480	4672	48734	3864	47150	2708	55529	2106	31345
12-#14	1.41	MA	37289	7747	58938	5787	64366	4701	66192	3911	67070	2740	79945	2452	39533
3L-5S		MI	29366	7747	46575	5736	50028	4676	50623	3870	49641	2698	58631	2190	32302
12-#14	1.41	MA	36305	7747	57248	5807	62217	4719	63583	3908	63683	2752	75992	2324	39447
4E		MI	30086	7747	47783	5738	51586	4660	52531	3857	52351	2708	61909	2252	32425
12-#14	1.41	MA	35424	7747	55769	5806	60309	4716	61246	3924	60347	2745	71886	2259	39216
5L-3S		MI	30888	7747	49160	5720	53337	4665	54655	3863	55099	2698	65028	2380	32449
12-#14	1.41	MA	34585	7747	54373	5806	58412	4734	58932	3920	57284	2757	67965	2175	37949
6L-2S		MI	32021	7747	50871	5722	55518	4649	57307	3850	58681	2688	69802	2508	32415
12-#18	2.50	MA	43022	8491	70764	6221	79229	5014	84176	4082	91400	2663	112293	2440	68778
2L-6S		MI	29731	8491	49182	6161	52971	4986	54104	4047	54295	2633	65710	1615	50777
12-#18	2.50	MA	40627	8491	67063	6218	74510	5043	78440	4109	83629	2683	101847	2213	68545
3L-5S		MI	30907	8491	51186	6167	55690	4996	57420	4061	58609	2615	71051	1767	52715
12-#18	2.50	MA	38943	8491	64093	6251	70732	5038	73855	4100	77676	2702	95005	1985	67897
4E		MI	32139	8491	53307	6173	58425	4970	60768	4040	63306	2633	76728	1872	55382
12-#18	2.50	MA	37436	8491	61489	6249	67374	5068	69742	4126	71808	2686	87858	1873	64385
5L-3S		MI	33512	8491	55721	6143	61494	4980	64493	4054	68066	2615	82093	2100	55951
12-#18	2.50	MA	35999	8491	59031	6247	64036	5062	65670	4117	66416	2706	81063	1724	61935
6L-2S		MI	35444	8491	58713	6149	65308	4955	69130	4032	74271	2597	90324	2327	56089
14-#11	1.14	MA	37603	7564	58609	5689	64057	4633	65857	3855	66636	2747	79528	2618	32263
2L-7S		MI	28342	7564	44249	5649	47154	4611	47158	3834	45053	2736	52471	2189	25947
14-#11	1.14	MA	36617	7564	57137	5689	62179	4632	63575	3867	63544	2756	75302	2529	32285
3L-6S		MI	28813	7564	45100	5637	48191	4600	48429	3824	46761	2729	54745	2277	26449
14-#11	1.14	MA	35926	7564	55959	5703	60681	4645	61756	3865	61182	2766	72525	2440	32276
4L-5S		MI	29295	7564	45896	5638	49272	4602	49747	3828	48505	2721	56930	2336	26556
14-#11	1.14	MA	35308	7564	54928	5703	59351	4644	60127	3876	58857	2761	69649	2395	32217
5L-4S		MI	29801	7564	46738	5639	50359	4591	51078	3818	50404	2728	59232	2379	26568
14-#11	1.14	MA	34720	7564	53956	5703	58029	4656	58515	3874	56722	2770	66895	2337	32026
6L-3S		MI	30365	7564	47700	5626	51581	4594	52561	3822	52330	2721	61431	2467	26546
14-#11	1.14	MA	34145	7564	52915	5717	56761	4655	56960	3885	54634	2780	64033	2249	31338
7L-2S		MI	31162	7564	48896	5627	53106	4582	54414	3812	54841	2714	64791	2556	26512
14-#14	1.64	MA	39679	7906	63158	5887	69746	4775	72732	3940	75930	2717	91988	2561	45969
2L-7S		MI	28822	7906	45925	5851	49173	4760	49563	3923	48295	2708	57073	1954	35749
14-#14	1.64	MA	38285	7906	61048	5887	67056	4773	69462	3956	71500	2730	85966	2433	45937
3L-6S		MI	29488	7906	47146	5833	50661	4744	51386	3909	50732	2698	60302	2080	36375
14-#14	1.64	MA	37308	7906	59358	5906	64907	4791	66853	3953	68113	2742	82014	2305	45820
4L-5S		MI	30171	7906	48286	5835	52210	4748	53275	3915	53223	2688	63404	2165	37392

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

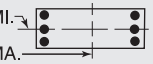


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	1.64	MA	36433	7906	57879	5906	62999	4789	64516	3969	64777	2735	77908	2240	45554
5L-4S		MI	30886	7906	49494	5837	53767	4733	55182	3902	55933	2698	66682	2226	37603
14-#14	1.64	MA	35600	7906	56483	5905	61102	4806	62202	3965	61714	2747	73987	2156	44172
6L-3S		MI	31684	7906	50871	5820	55518	4737	57307	3908	58681	2688	69802	2354	37658
14-#14	1.64	MA	34787	7906	54989	5925	59282	4804	59971	3981	58717	2760	69909	2030	43298
7L-2S		MI	32810	7906	52582	5822	57699	4721	59958	3895	62263	2678	74576	2482	37646
14-#18	2.92	MA	42316	8775	70764	6396	79229	5172	84176	4188	91400	2665	112293	2173	79699
3L-6S		MI	31111	8775	52174	6339	56785	5115	58741	4127	60500	2611	73941	1563	59336
14-#18	2.92	MA	40649	8775	67793	6429	75451	5166	79591	4179	85447	2685	105451	1946	78698
4L-5S		MI	32276	8775	54178	6344	59504	5124	62057	4141	64814	2593	79282	1714	61456
14-#18	2.92	MA	39157	8775	65190	6426	72092	5196	75478	4206	79578	2669	98304	1834	75249
5L-4S		MI	33497	8775	56299	6350	62239	5099	65405	4119	69511	2611	84959	1820	63975
14-#18	2.92	MA	37736	8775	62732	6424	68754	5190	71406	4197	74187	2688	91509	1684	72625
6L-3S		MI	34857	8775	58713	6320	65308	5109	69130	4133	74271	2593	90324	2048	64972
14-#18	2.92	MA	36348	8775	60103	6457	65549	5220	67478	4223	68911	2708	84437	1459	69120
7L-2S		MI	36774	8775	61705	6326	69122	5083	73766	4112	80476	2575	98555	2275	65167
16-#11	1.30	MA	38302	7674	60082	5759	65934	4684	68140	3886	69728	2740	83754	2606	36761
2L-8S		MI	28452	7674	44664	5717	47632	4659	47766	3875	45776	2722	53680	2123	29161
16-#11	1.30	MA	37321	7674	58609	5759	64057	4682	65857	3898	66636	2750	79528	2517	36773
3L-7S		MI	28914	7674	45445	5718	48679	4661	49011	3865	47565	2729	55831	2173	29488
16-#11	1.30	MA	36633	7674	57431	5772	62558	4695	64039	3896	64275	2759	76751	2428	36744
4L-6S		MI	29383	7674	46296	5706	49716	4650	50283	3855	49272	2722	58105	2261	29967
16-#11	1.30	MA	36018	7674	56400	5772	61228	4694	62410	3907	61949	2754	73875	2383	36667
5E		MI	29863	7674	47092	5707	50797	4652	51600	3859	51017	2715	60290	2319	30181
16-#11	1.30	MA	35432	7674	55428	5772	59907	4707	60798	3905	59814	2764	71121	2325	36367
6L-4S		MI	30366	7674	47935	5708	51884	4641	52931	3849	52915	2721	62592	2362	30211
16-#11	1.30	MA	34861	7674	54388	5786	58639	4705	59243	3917	57726	2773	68258	2237	35706
7L-3S		MI	30928	7674	48896	5695	53106	4644	54414	3853	54841	2714	64791	2451	30202
16-#11	1.30	MA	34291	7674	53434	5786	57359	4718	57721	3928	55538	2768	65569	2185	35239
8L-2S		MI	31722	7674	50092	5696	54630	4632	56268	3843	57352	2707	68151	2540	30176
16-#14	1.88	MA	40661	8066	65268	5987	72436	4848	76002	3985	80360	2707	98009	2542	52387
2L-8S		MI	28976	8066	46516	5948	49854	4828	50430	3981	49324	2687	58784	1856	39607
16-#14	1.88	MA	39275	8066	63158	5987	69746	4845	72732	4001	75930	2720	91988	2414	52333
3L-7S		MI	29629	8066	47636	5951	51355	4832	52215	3967	51877	2697	61846	1928	40813
16-#14	1.88	MA	38303	8066	61468	6006	67597	4863	70123	3997	72544	2732	88035	2286	52187
4L-6S		MI	30291	8066	48857	5933	52842	4817	54038	3954	54314	2687	65076	2055	41416
16-#14	1.88	MA	37435	8066	59988	6006	65689	4861	67786	4013	69207	2725	83930	2221	51731
5E		MI	30970	8066	49997	5935	54391	4821	55926	3960	56805	2677	68178	2139	42383
16-#14	1.88	MA	36607	8066	58593	6005	63792	4879	65472	4010	66144	2737	80009	2137	50406
6L-4S		MI	31681	8066	51205	5937	55949	4805	57834	3947	59515	2687	71456	2201	42774
16-#14	1.88	MA	35800	8066	57099	6025	61972	4877	63241	4026	63147	2750	75930	2011	49559
7L-3S		MI	32474	8066	52582	5919	57699	4809	59958	3953	62263	2677	74576	2329	42854
16-#14	1.88	MA	35003	8066	55730	6024	60135	4894	61056	4042	60007	2743	72092	1936	48013
8L-2S		MI	33595	8066	54293	5922	59881	4794	62610	3940	65845	2667	79349	2457	42868
16-#18	3.33	MA	42338	9059	71494	6606	80169	5295	85327	4259	93217	2667	115897	1906	89433
4L-6S		MI	32478	9059	55166	6516	60599	5243	63377	4207	66705	2588	82172	1511	67924
16-#18	3.33	MA	40861	9059	68890	6604	76811	5325	81214	4286	87349	2651	108750	1794	86136
5E		MI	33632	9059	57169	6522	63319	5253	66694	4221	71019	2571	87513	1662	70219
16-#18	3.33	MA	39454	9059	66433	6602	73472	5319	77142	4277	81958	2671	101955	1645	83343
6L-4S		MI	34842	9059	59290	6527	66053	5227	70041	4199	75716	2588	93190	1768	72606
16-#18	3.33	MA	38080	9059	63804	6635	70267	5349	73214	4303	76682	2690	94883	1420	79950
7L-3S		MI	36190	9059	61705	6498	69122	5237	73766	4213	80476	2571	98555	1995	73981
16-#18	3.33	MA	36726	9059	61391	6632	67033	5343	69368	4329	71156	2674	88205	1289	75896
8L-2S		MI	38092	9059	64696	6503	72937	5212	78403	4192	86681	2553	106786	2223	74231
18-#11	1.46	MA	38998	7785	61555	5828	67812	4734	70422	3918	72820	2733	87980	2593	41254
2L-9S		MI	28557	7785	45034	5799	48134	4720	48332	3902	46598	2722	54924	2050	32112
18-#11	1.46	MA	38020	7785	60082	5828	65934	4733	68140	3929	69728	2743	83754	2505	41249
3L-8S		MI	29023	7785	45860	5786	49157	4709	49620	3906	48287	2715	57040	2106	32717

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

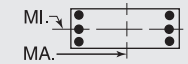
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.46	MA	37336	7785	58904	5841	64436	4745	66321	3927	67367	2752	80977	2416	41208
4L-7S		MI	29483	7785	46641	5787	50204	4711	50865	3896	50076	2722	59191	2157	33034
18-#11	1.46	MA	36724	7785	57873	5841	63106	4744	64692	3938	65041	2747	78100	2371	41114
5L-6S		MI	29949	7785	47492	5775	51241	4700	52136	3886	51783	2715	61465	2244	33492
18-#11	1.46	MA	36141	7785	56901	5842	61784	4757	63080	3936	62907	2757	75347	2313	40716
6L-5S		MI	30427	7785	48288	5776	52322	4703	53454	3890	53528	2708	63650	2303	33800
18-#11	1.46	MA	35573	7785	55860	5855	60516	4756	61525	3948	60818	2766	72484	2225	40079
7L-4S		MI	30928	7785	49131	5777	53408	4691	54785	3880	55427	2714	65952	2346	33845
18-#11	1.46	MA	35012	7785	54906	5855	59236	4768	60003	3959	58630	2761	69795	2172	39624
8L-3S		MI	31487	7785	50092	5764	54630	4694	56268	3884	57352	2707	68151	2435	33852
18-#11	1.46	MA	34412	7785	53970	5855	57986	4767	58429	3957	56564	2771	67128	2117	38823
9L-2S		MI	32279	7785	51288	5766	56155	4683	58122	3874	59864	2700	71511	2524	33834
18-#14	2.11	MA	41636	8225	67378	6087	75126	4920	79272	4030	84791	2697	104031	2523	58798
2L-9S		MI	29139	8225	47042	6066	50568	4916	51235	4020	50493	2686	60552	1749	43557
18-#14	2.11	MA	40257	8225	65268	6086	72436	4918	76002	4046	80360	2710	98009	2395	58722
3L-8S		MI	29783	8225	48227	6048	52035	4900	53082	4026	52906	2677	63558	1831	44602
18-#14	2.11	MA	39292	8225	63578	6106	70287	4935	73393	4042	76974	2722	94057	2267	58550
4L-7S		MI	30431	8225	49347	6050	53536	4905	54867	4012	55459	2686	66620	1903	45859
18-#14	2.11	MA	38429	8225	62098	6105	68379	4933	71056	4058	73638	2715	89951	2202	57923
5L-6S		MI	31090	8225	50567	6033	55024	4889	56689	3999	57897	2677	69850	2029	46466
18-#14	2.11	MA	37607	8225	60703	6105	66482	4951	68742	4054	70574	2728	86030	2118	56649
6L-5S		MI	31764	8225	51708	6035	56572	4893	58578	4005	60387	2667	72952	2114	47388
18-#14	2.11	MA	36805	8225	59209	6124	64662	4949	66511	4070	67577	2740	81952	1992	55826
7L-4S		MI	32471	8225	52916	6037	58130	4877	60486	3992	63097	2677	76229	2175	47939
18-#14	2.11	MA	36014	8225	57840	6124	62825	4967	64326	4086	64437	2733	78114	1917	54207
8L-3S		MI	33259	8225	54293	6019	59881	4882	62610	3998	65845	2667	79349	2303	48042
18-#14	2.11	MA	35175	8225	56495	6124	61030	4965	62066	4083	61471	2745	74315	1836	52871
9L-2S		MI	34374	8225	56004	6021	62062	4866	65262	3984	69428	2657	84123	2431	48080
18-#18	3.75	MA	42549	9343	72591	6781	81529	5453	86950	4365	95120	2633	119196	1755	97042
5L-6S		MI	33833	9343	58157	6693	64413	5372	68014	4287	72910	2566	90402	1459	76537
18-#18	3.75	MA	41155	9343	70134	6779	78191	5448	82878	4356	89729	2653	112401	1605	94084
6L-5S		MI	34976	9343	60161	6699	67133	5382	71330	4300	77224	2548	95744	1610	79001
18-#18	3.75	MA	39795	9343	67504	6812	74986	5477	78950	4383	84453	2672	105329	1380	90797
7L-4S		MI	36175	9343	62282	6705	69867	5356	74678	4279	81921	2566	101420	1716	81269
18-#18	3.75	MA	38455	9343	65092	6810	71751	5472	75104	4409	78927	2657	98650	1250	86649
8L-3S		MI	37512	9343	64696	6675	72937	5366	78403	4293	86681	2548	106786	1943	82982
20-#11	1.63	MA	39690	7896	63027	5897	69689	4784	72705	3949	75912	2726	92206	2581	45742
2L-10S		MI	28633	7896	45453	5867	48625	4768	48949	3943	47432	2723	56232	1970	35083
20-#11	1.63	MA	38716	7896	61555	5897	67812	4783	70422	3960	72820	2736	87980	2493	45722
3L-9S		MI	29129	7896	46230	5868	49659	4770	50186	3933	49109	2716	58284	2034	35620
20-#11	1.63	MA	38035	7896	60377	5911	66313	4795	68604	3958	70459	2745	85203	2404	45667
4L-8S		MI	29591	7896	47056	5856	50682	4759	51474	3937	50799	2708	60400	2090	36275
20-#11	1.63	MA	37426	7896	59346	5911	64983	4794	66974	3970	68133	2740	82326	2358	45558
5L-7S		MI	30049	7896	47837	5857	51729	4761	52719	3927	52587	2715	62551	2140	36585
20-#11	1.63	MA	36846	7896	58373	5911	63662	4807	65362	3967	65999	2750	79573	2300	45072
6E		MI	30513	7896	48689	5844	52766	4750	53990	3917	54295	2708	64825	2228	37024
20-#11	1.63	MA	36281	7896	57333	5924	62394	4806	63808	3979	63910	2759	76710	2213	44457
7L-5S		MI	30989	7896	49484	5845	53846	4753	55308	3921	56039	2701	67010	2287	37415
20-#11	1.63	MA	35723	7896	56379	5924	61114	4818	62286	3990	61723	2754	74021	2160	44011
8L-4S		MI	31488	7896	50327	5846	54933	4741	56639	3911	57938	2707	69312	2330	37473
20-#11	1.63	MA	35126	7896	55443	5924	59864	4817	60711	3988	59656	2764	71354	2104	43162
9L-3S		MI	32044	7896	51288	5834	56155	4744	58122	3915	59864	2700	71511	2418	37498
20-#11	1.63	MA	34512	7896	54420	5938	58600	4830	59199	4000	57605	2773	68766	2041	42431
10L-2S		MI	32833	7896	52484	5835	57680	4733	59975	3905	62375	2693	74871	2507	37487

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

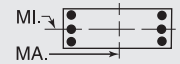


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.34	MA	41233	8385	67378	6186	75126	4990	79272	4091	84791	2700	104031	2375	65106
3L-9S		MI	29944	8385	48753	6166	52749	4988	53887	4064	54076	2676	65326	1724	48501
20-#14	2.34	MA	40274	8385	65688	6206	72977	5008	76663	4087	81404	2712	100079	2247	64910
4L-8S		MI	30583	8385	49938	6148	54216	4973	55733	4071	56488	2666	68331	1805	49605
20-#14	2.34	MA	39416	8385	64208	6205	71069	5006	74326	4103	78068	2705	95973	2183	64127
5L-7S		MI	31228	8385	51058	6150	55717	4977	57518	4057	59041	2676	71393	1877	50821
20-#14	2.34	MA	38600	8385	62813	6205	69172	5023	72012	4099	75004	2718	92052	2099	62900
6E		MI	31883	8385	52278	6132	57205	4961	59341	4044	61479	2666	74623	2004	51523
20-#14	2.34	MA	37803	8385	61319	6224	67352	5021	69781	4115	72007	2730	87973	1973	62047
7L-5S		MI	32553	8385	53419	6135	58754	4965	61230	4050	63969	2656	77725	2088	52406
20-#14	2.34	MA	37018	8385	59950	6224	65515	5039	67596	4131	68867	2723	84136	1898	60411
8L-4S		MI	33255	8385	54627	6137	60311	4950	63137	4037	66679	2666	81003	2150	53098
20-#14	2.34	MA	36184	8385	58605	6223	63720	5037	65336	4128	65901	2735	80337	1817	59018
9L-3S		MI	34039	8385	56004	6119	62062	4954	65262	4043	69428	2656	84123	2278	53224
20-#14	2.34	MA	35317	8385	57137	6243	61906	5055	63165	4144	62958	2748	76652	1726	57230
10L-2S		MI	35149	8385	57715	6121	64243	4938	67914	4029	73010	2646	88896	2406	53280
20-#18	4.17	MA	42841	9626	73835	6956	82909	5576	88614	4436	97500	2635	122847	1566	104847
6E		MI	35176	9626	61149	6871	68227	5500	72651	4366	79115	2544	98633	1407	85174
20-#18	4.17	MA	41495	9626	71205	6989	79704	5606	84686	4462	92224	2655	115775	1341	101659
7L-5S		MI	36310	9626	63153	6876	70947	5510	75967	4380	83429	2526	103975	1558	87798
20-#18	4.17	MA	40167	9626	68793	6987	76470	5600	80840	4489	86698	2639	109096	1210	97419
8L-4S		MI	37498	9626	65274	6882	73681	5485	79315	4359	88126	2544	109651	1664	89958
22-#11	1.79	MA	39409	8006	63027	5966	69689	4833	72705	3991	75912	2729	92206	2480	50190
3L-10S		MI	29202	8006	46649	5936	50150	4818	50802	3974	49943	2716	59592	1954	38610
22-#11	1.79	MA	38730	8006	61849	5980	68191	4845	70886	3989	73551	2738	89429	2392	50123
4L-9S		MI	29698	8006	47426	5937	51183	4820	52039	3964	51620	2709	61644	2017	39134
22-#11	1.79	MA	38125	8006	60818	5980	66861	4844	69257	4001	71226	2734	86552	2346	50000
5L-8S		MI	30156	8006	48252	5925	52206	4809	53327	3968	53310	2702	63760	2074	39831
22-#11	1.79	MA	37548	8006	59846	5980	65539	4857	67645	3998	69091	2743	83799	2288	49434
6L-7S		MI	30612	8006	49033	5926	53253	4812	54572	3958	55098	2708	65911	2124	40138
22-#11	1.79	MA	36985	8006	58806	5994	64271	4856	66090	4010	67002	2752	80936	2201	48838
7L-6S		MI	31074	8006	49885	5913	54291	4800	55844	3948	56806	2701	68185	2212	40562
22-#11	1.79	MA	36430	8006	57852	5994	62991	4869	64568	4021	64815	2748	78247	2148	48401
8L-5S		MI	31548	8006	50680	5914	55371	4803	57161	3952	58551	2694	70370	2270	41027
22-#11	1.79	MA	35836	8006	56915	5994	61741	4867	62993	4019	62748	2757	75580	2092	47506
9L-4S		MI	32044	8006	51523	5915	56458	4792	58492	3942	60449	2701	72672	2313	41098
22-#11	1.79	MA	35224	8006	55893	6007	60478	4880	61481	4031	60698	2766	72992	2029	46791
10L-3S		MI	32599	8006	52484	5903	57680	4794	59975	3946	62375	2693	74871	2402	41132
22-#11	1.79	MA	34627	8006	54957	6007	59235	4879	59925	4028	58540	2761	70366	1974	45770
11L-2S		MI	33384	8006	53680	5904	59205	4783	61829	3936	64886	2686	78231	2491	41136
22-#14	2.58	MA	41250	8545	67798	6305	75667	5080	79933	4132	85834	2702	106100	2228	71267
4L-9S		MI	30744	8545	50464	6265	54931	5061	56539	4109	57658	2665	70100	1698	53455
22-#14	2.58	MA	40398	8545	66318	6305	73759	5078	77596	4148	82498	2695	101995	2164	70343
5L-8S		MI	31379	8545	51649	6248	56398	5045	58385	4116	60070	2655	73105	1780	54617
22-#14	2.58	MA	39586	8545	64923	6304	71862	5096	75282	4144	79435	2708	98073	2080	69158
6L-7S		MI	32020	8545	52769	6250	57899	5049	60170	4102	62623	2665	76167	1852	55795
22-#14	2.58	MA	38795	8545	63429	6324	70042	5094	73051	4160	76437	2720	93995	1954	68215
7L-6S		MI	32671	8545	53989	6232	59386	5034	61993	4089	65061	2655	79397	1978	56585
22-#14	2.58	MA	38014	8545	62060	6323	68204	5111	70866	4176	73297	2713	90157	1879	66622
8L-5S		MI	33337	8545	55130	6234	60935	5038	63882	4095	67551	2646	82499	2063	57433
22-#14	2.58	MA	37196	8545	60715	6323	66410	5109	68606	4172	70332	2725	86358	1798	65174
9L-4S		MI	34036	8545	56338	6236	62493	5022	65789	4081	70262	2655	85776	2124	58254
22-#14	2.58	MA	36323	8545	59247	6343	64596	5127	66435	4188	67388	2738	82673	1707	63422
10L-3S		MI	34815	8545	57715	6219	64243	5026	67914	4088	73010	2646	88896	2252	58401
22-#18	4.58	MA	43179	9910	74906	7167	84423	5734	90422	4542	99995	2637	126221	1301	112536
7L-6S		MI	36509	9910	64141	7048	72041	5629	77287	4446	85320	2522	106864	1355	93831
22-#18	4.58	MA	41864	9910	72494	7164	81188	5729	86576	4569	94469	2621	119542	1171	108204
8L-5S		MI	37633	9910	66144	7054	74761	5639	80604	4460	89634	2504	112206	1506	96609

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	1.95	MA	39423	8117	63322	6049	70069	4896	73168	4020	76643	2731	93655	2379	54577
4L-10S		MI	29769	8117	47845	6005	51675	4868	52656	4005	52454	2709	62952	1937	42140
24-#11	1.95	MA	38820	8117	62291	6049	68738	4894	71539	4032	74318	2727	90778	2334	54441
5L-9S		MI	30264	8117	48622	6006	52708	4871	53893	3996	54131	2702	65004	2001	42651
24-#11	1.95	MA	38245	8117	61319	6049	67417	4907	69927	4030	72183	2736	88025	2276	53801
6L-8S		MI	30719	8117	49449	5994	53731	4859	55181	3999	55821	2695	67120	2057	43329
24-#11	1.95	MA	37685	8117	60278	6063	66149	4906	68372	4041	70095	2745	85162	2189	53223
7E		MI	31172	8117	50229	5995	54778	4862	56426	3990	57610	2701	69271	2108	43695
24-#11	1.95	MA	37133	8117	59324	6063	64869	4919	66851	4053	67907	2741	82473	2136	52773
8L-6S		MI	31632	8117	51081	5982	55816	4850	57697	3980	59317	2694	71545	2195	44104
24-#11	1.95	MA	36542	8117	58388	6063	63619	4918	65276	4050	65840	2750	79806	2080	51855
9L-5S		MI	32104	8117	51876	5983	56896	4853	59015	3983	61062	2687	73730	2254	44636
24-#11	1.95	MA	35933	8117	57365	6077	62355	4930	63764	4062	63790	2759	77218	2017	51155
10L-4S		MI	32598	8117	52719	5985	57983	4842	60346	3974	62961	2694	76032	2297	44719
24-#11	1.95	MA	35338	8117	56429	6077	61112	4929	62207	4060	61633	2755	74592	1961	50100
11L-3S		MI	33150	8117	53680	5972	59205	4844	61829	3977	64886	2686	78231	2386	44763
24-#11	1.95	MA	34753	8117	55423	6090	59857	4942	60699	4071	59585	2764	71700	1887	49176
12L-2S		MI	33933	8117	54876	5973	60730	4833	63683	3968	67398	2679	81591	2475	44782
24-#14	2.81	MA	41373	8704	68428	6405	76449	5150	80866	4193	86928	2685	108016	2145	76568
5L-9S		MI	31539	8704	52175	6365	57112	5133	59190	4154	61240	2655	74873	1673	58417
24-#14	2.81	MA	40567	8704	67033	6404	74552	5168	78552	4189	83865	2698	104095	2061	75423
6L-8S		MI	32170	8704	53360	6347	58579	5117	61037	4161	63652	2645	77878	1755	59635
24-#14	2.81	MA	39780	8704	65539	6424	72732	5166	76321	4205	80867	2710	100017	1935	74393
7E		MI	32808	8704	54480	6350	60080	5121	62822	4147	66206	2655	80940	1826	60777
24-#14	2.81	MA	39005	8704	64170	6423	70894	5184	74136	4221	77728	2703	96179	1860	72839
8L-6S		MI	33454	8704	55700	6332	61567	5106	64644	4134	68643	2645	84170	1953	61654
24-#14	2.81	MA	38188	8704	62825	6423	69100	5182	71876	4217	74762	2716	92380	1779	71338
9L-5S		MI	34117	8704	56841	6334	63116	5110	66533	4140	71133	2635	87272	2037	62470
24-#14	2.81	MA	37323	8704	61357	6442	67286	5199	69705	4233	71818	2728	88695	1687	69621
10L-4S		MI	34811	8704	58049	6336	64674	5094	68441	4126	73844	2645	90550	2099	63407
24-#18	5.00	MA	43547	10194	76195	7342	85906	5857	92311	4648	102240	2604	129988	1131	119004
8L-6S		MI	37833	10194	67132	7225	75856	5758	81924	4526	91525	2499	115095	1303	102506

RECTANGULAR TIED COLUMNS 42" x 42"

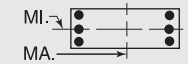
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.36	MA	30684	7089	48751	5222	53050	4245	54630	3517	55625	2458	65958	2290	30157
2L-3S		MI	28586	7089	45582	5218	49010	4271	49719	3540	49020	2475	57174	2062	30200
8-#14	1.02	MA	29669	6876	46338	5123	50167	4176	51199	3481	51151	2497	60150	2359	23021
2L-4S		MI	27602	6876	43073	5140	46008	4189	46147	3490	44433	2518	51737	2103	23090
8-#18	1.81	MA	32138	7372	51920	5400	57090	4373	59542	3597	62231	2437	74742	2241	39849
2L-4S		MI	28586	7372	46197	5426	49803	4391	50690	3607	50558	2473	60224	1786	39391
10-#14	1.28	MA	30518	7035	48149	5223	52476	4248	54005	3526	54952	2488	65236	2335	28573
2L-5S		MI	27701	7035	43607	5238	46671	4277	46938	3549	45360	2498	53338	2017	28415
10-#14	1.28	MA	29315	7035	46338	5222	50167	4265	51199	3540	51151	2498	60150	2207	28609
3L-4S		MI	28464	7035	44883	5240	48317	4261	48953	3535	48235	2508	56823	2079	28577
10-#18	2.27	MA	33574	7656	55089	5577	61130	4502	64453	3677	68837	2417	83526	2193	49505
2L-5S		MI	28750	7656	47125	5598	50953	4547	52062	3710	52164	2435	62964	1630	45776
10-#18	2.27	MA	31516	7656	51920	5572	57090	4528	59542	3700	62231	2435	74742	1965	49369
3L-4S		MI	30058	7656	49366	5603	53843	4520	55602	3687	57163	2452	69008	1738	48711

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

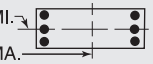


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.30	MA	33518	7386	53028	5464	57722	4443	59388	3686	60394	2592	71593	2425	31777
2L-3S		MI	29835	7386	47451	5441	50959	4455	51618	3696	50725	2595	59060	2178	30266
6-#18	1.30	MA	31297	7386	49682	5460	53456	4471	54202	3710	53388	2610	62256	2198	31820
3L-2S		MI	31936	7386	50620	5446	54999	4428	56530	3673	57330	2578	67844	2406	30205
8-#18	1.73	MA	35062	7669	56375	5641	61988	4572	64574	3766	67401	2574	80930	2380	42009
2L-4S		MI	29835	7669	48066	5649	51752	4575	52590	3763	52263	2593	62110	1902	39522
8-#18	1.73	MA	32863	7669	53028	5637	57722	4599	59388	3790	60394	2591	71593	2152	41958
3E		MI	31312	7669	50620	5618	54999	4584	56530	3776	57330	2575	67844	2130	39875
8-#18	1.73	MA	31306	7669	50335	5669	54298	4592	55233	3778	55019	2609	65490	1925	41551
4L-2S		MI	33392	7669	53789	5623	59039	4557	61441	3753	63936	2557	76628	2357	39903
10-#14	1.22	MA	33336	7332	52383	5465	57103	4447	58714	3695	59572	2617	70779	2469	30091
2L-5S		MI	28949	7332	45469	5463	48621	4462	48842	3706	47072	2619	55234	2134	28506
10-#14	1.22	MA	32063	7332	50473	5463	54667	4444	55753	3709	55560	2628	65381	2341	30128
3L-4S		MI	29713	7332	46745	5465	50266	4446	50857	3692	49947	2629	58718	2196	28639
10-#14	1.22	MA	31165	7332	48939	5482	52718	4461	53387	3705	52488	2639	61846	2213	30096
4L-3S		MI	30565	7332	48200	5447	52116	4450	53102	3697	52862	2619	62046	2324	28654
10-#14	1.22	MA	30361	7332	47595	5481	50984	4458	51264	3719	49459	2631	58154	2149	29934
5L-2S		MI	31770	7332	50011	5448	54425	4434	55909	3683	56664	2608	67131	2452	28613
10-#18	2.16	MA	36589	7953	59721	5818	66254	4700	69761	3845	74408	2555	90268	2335	52205
2L-5S		MI	29997	7953	48993	5822	52902	4730	53962	3866	53870	2555	64850	1746	46107
10-#18	2.16	MA	34410	7953	56375	5815	61988	4728	64574	3870	67401	2573	80930	2107	52069
3L-4S		MI	31309	7953	51235	5826	55792	4704	57501	3843	58868	2572	70894	1854	49008
10-#18	2.16	MA	32870	7953	53682	5846	58564	4721	60419	3858	62026	2590	74827	1880	51566
4L-3S		MI	32770	7953	53789	5796	59039	4712	61441	3856	63936	2555	76628	2081	49454
10-#18	2.16	MA	31489	7953	51319	5842	55518	4748	56689	3882	56724	2573	68416	1770	48482
5L-2S		MI	34832	7953	56958	5800	63079	4685	66353	3833	70542	2537	85412	2309	49568
12-#11	1.01	MA	32626	7198	50755	5398	55131	4400	56357	3669	56395	2635	66655	2503	25267
2L-6S		MI	28611	7198	44458	5393	47368	4407	47357	3672	45125	2644	52577	2209	23995
12-#11	1.01	MA	31732	7198	49421	5397	53430	4399	54289	3680	53593	2643	62862	2414	25301
3L-5S		MI	29122	7198	45298	5394	48509	4395	48749	3675	46967	2636	54904	2267	24087
12-#11	1.01	MA	31102	7198	48351	5411	52070	4411	52638	3677	51450	2651	60375	2326	25321
4E		MI	29658	7198	46188	5394	49657	4397	50154	3665	48973	2642	57350	2311	24100
12-#11	1.01	MA	30538	7198	47414	5410	50862	4409	51158	3687	49338	2646	57785	2281	25294
5L-3S		MI	30256	7198	47203	5381	50948	4385	51721	3668	51007	2634	59693	2400	24074
12-#11	1.01	MA	30001	7198	46531	5410	49661	4421	49693	3684	47398	2654	55317	2223	25179
6L-2S		MI	31103	7198	48468	5382	52561	4387	53682	3658	53664	2626	63269	2488	24037
12-#14	1.46	MA	34230	7492	54293	5564	59539	4519	61675	3739	63583	2607	76176	2447	35932
2L-6S		MI	29086	7492	46076	5561	49293	4531	49653	3745	48232	2620	57012	2025	32824
12-#14	1.46	MA	32964	7492	52383	5563	57103	4516	58714	3754	59572	2618	70779	2319	35943
3L-5S		MI	29810	7492	47280	5563	50929	4535	51648	3751	50874	2609	60319	2110	33949
12-#14	1.46	MA	32072	7492	50850	5582	55153	4533	56347	3749	56499	2629	67243	2191	35874
4E		MI	30569	7492	48556	5565	52575	4518	53663	3737	53748	2619	63804	2172	34120
12-#14	1.46	MA	31273	7492	49506	5581	53420	4530	54225	3764	53470	2621	63551	2128	35675
5L-3S		MI	31416	7492	50011	5546	54425	4522	55909	3742	56664	2609	67131	2300	34174
12-#14	1.46	MA	30512	7492	48238	5579	51697	4547	52124	3759	50688	2632	60040	2043	34468
6L-2S		MI	32614	7492	51821	5548	56733	4506	58715	3728	60466	2598	72217	2428	34153
12-#18	2.60	MA	38099	8237	63067	5996	70521	4829	74947	3925	81414	2536	99605	2289	62367
2L-6S		MI	30229	8237	50045	5994	54068	4850	55368	3933	55883	2552	67930	1547	53092
12-#18	2.60	MA	35940	8237	59721	5992	66254	4857	69761	3949	74408	2554	90268	2062	62162
3L-5S		MI	31468	8237	52162	5999	56942	4859	58874	3946	60475	2534	73634	1698	55354
12-#18	2.60	MA	34415	8237	57028	6023	62830	4849	65606	3938	69032	2572	84165	1834	61333
4E		MI	32766	8237	54404	6004	59833	4832	62413	3923	65474	2552	79678	1805	58195
12-#18	2.60	MA	33048	8237	54666	6020	59784	4877	61875	3962	63731	2554	77754	1725	58260
5L-3S		MI	34213	8237	56958	5973	63079	4841	66353	3936	70542	2534	85412	2033	59015
12-#18	2.60	MA	31745	8237	52435	6016	56755	4869	58181	3951	58860	2572	71686	1575	55860
6L-2S		MI	36257	8237	60127	5978	67120	4814	71264	3913	77147	2517	94195	2260	59196

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis



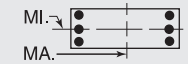
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.18	MA	33258	7309	52089	5467	56833	4450	58425	3700	59197	2628	70448	2489	29352
2L-7S		MI	28723	7309	44825	5475	47886	4455	47976	3713	45979	2644	53732	2106	27171
14-#11	1.18	MA	32368	7309	50755	5466	55131	4449	56357	3711	56395	2636	66655	2400	29377
3L-6S		MI	29220	7309	45723	5462	48981	4457	49318	3703	47782	2637	56153	2194	27710
14-#11	1.18	MA	31741	7309	49685	5480	53771	4461	54706	3708	54252	2644	64167	2312	29379
4L-5S		MI	29728	7309	46563	5463	50122	4445	50710	3706	49624	2629	58480	2252	27919
14-#11	1.18	MA	31180	7309	48749	5479	52563	4459	53226	3719	52140	2639	61578	2267	29333
5L-4S		MI	30261	7309	47453	5464	51270	4447	52115	3696	51629	2635	60926	2296	27953
14-#11	1.18	MA	30645	7309	47865	5479	51362	4471	51761	3716	50200	2647	59109	2209	29099
6L-3S		MI	30856	7309	48468	5451	52561	4436	53682	3699	53664	2627	63269	2385	27943
14-#11	1.18	MA	30123	7309	46919	5492	50209	4469	50348	3726	48302	2655	56541	2121	28514
7L-2S		MI	31699	7309	49733	5451	54174	4438	55643	3689	56320	2619	66845	2473	27915
14-#14	1.70	MA	35117	7652	56204	5664	61974	4592	64636	3784	67594	2597	81573	2425	41762
2L-7S		MI	29244	7652	46598	5679	50031	4620	50534	3804	49449	2620	58656	1875	37466
14-#14	1.70	MA	33859	7652	54293	5663	59539	4589	61675	3799	63583	2608	76176	2297	41744
3L-6S		MI	29946	7652	47886	5661	51602	4603	52459	3790	52034	2610	62098	2002	38153
14-#14	1.70	MA	32973	7652	52760	5682	57589	4605	59308	3794	60510	2619	72640	2169	41645
4L-5S		MI	30665	7652	49091	5663	53238	4607	54454	3796	54676	2599	65404	2086	39238
14-#14	1.70	MA	32179	7652	51416	5680	55856	4602	57186	3809	57482	2611	68948	2106	41270
5L-4S		MI	31419	7652	50366	5664	54883	4591	56469	3782	57550	2609	68889	2149	39592
14-#14	1.70	MA	31423	7652	50148	5679	54133	4619	55084	3804	54700	2622	65437	2021	40095
6L-3S		MI	32260	7652	51821	5646	56733	4594	58715	3787	60466	2599	72217	2277	39675
14-#14	1.70	MA	30684	7652	48791	5698	52479	4616	53057	3819	51977	2633	61783	1895	39347
7L-2S		MI	33451	7652	53632	5648	59042	4578	61521	3773	64268	2588	77302	2405	39682
14-#18	3.03	MA	39594	8521	66413	6173	74787	4957	80133	4005	88421	2518	108943	2244	72512
2L-7S		MI	30500	8521	50949	6202	55347	5006	56897	4036	57994	2549	70772	1273	59400
14-#18	3.03	MA	37453	8521	63067	6169	70521	4985	74947	4029	81414	2535	99605	2017	72243
3L-6S		MI	31697	8521	53214	6172	58108	4979	60280	4013	62488	2532	76714	1499	62190
14-#18	3.03	MA	35944	8521	60374	6201	67097	4978	70792	4018	76039	2553	93502	1789	70983
4L-5S		MI	32922	8521	55331	6176	60982	4987	63785	4026	67081	2514	82418	1649	64628
14-#18	3.03	MA	34591	8521	58012	6197	64050	5005	67061	4042	70737	2535	87091	1680	68065
5L-4S		MI	34207	8521	57573	6181	63873	4961	67324	4003	72080	2532	88462	1757	67319
14-#18	3.03	MA	33301	8521	55781	6193	61021	4998	63367	4031	65866	2553	81023	1530	65491
6L-3S		MI	35641	8521	60127	6150	67120	4969	71264	4015	77147	2514	94195	1984	68563
14-#18	3.03	MA	32042	8521	53395	6225	58112	5026	59803	4055	61099	2571	74705	1305	62483
7L-2S		MI	37667	8521	63296	6155	71160	4943	76176	3992	83753	2496	102979	2212	68805
16-#11	1.35	MA	33887	7420	53424	5536	58534	4501	60493	3731	61999	2621	74240	2475	33431
2L-8S		MI	28844	7420	45266	5543	48394	4516	48623	3755	46747	2631	55023	2040	30556
16-#11	1.35	MA	33000	7420	52089	5536	56833	4499	58425	3742	59197	2629	70448	2386	33447
3L-7S		MI	29331	7420	46090	5544	49499	4505	49937	3744	48636	2637	57308	2091	30918
16-#11	1.35	MA	32376	7420	51020	5549	55472	4511	56774	3739	57053	2637	67960	2298	33430
4L-6S		MI	29824	7420	46989	5531	50594	4507	51279	3734	50438	2630	59730	2179	31434
16-#11	1.35	MA	31818	7420	50083	5548	54264	4509	55294	3750	54941	2632	65371	2253	33366
5E		MI	30330	7420	47828	5532	51735	4495	52670	3738	52280	2622	62056	2237	31746
16-#11	1.35	MA	31286	7420	49199	5548	53063	4521	53829	3747	53002	2640	62902	2195	33028
6L-4S		MI	30861	7420	48718	5533	52883	4497	54076	3727	54286	2628	64502	2281	31797
16-#11	1.35	MA	30767	7420	48253	5561	51910	4519	52416	3757	51104	2649	60334	2107	32468
7L-3S		MI	31453	7420	49733	5520	54174	4486	55643	3731	56320	2620	66845	2369	31805
16-#11	1.35	MA	30255	7420	47386	5561	50747	4531	51032	3768	49115	2643	57914	2056	32070
8L-2S		MI	32293	7420	50999	5521	55787	4488	57604	3720	58977	2612	70421	2458	31785
16-#14	1.95	MA	35998	7811	58114	5764	64410	4664	67596	3829	71606	2587	86970	2403	47580
2L-8S		MI	29414	7811	47226	5777	50754	4688	51456	3864	50543	2600	60485	1779	41439
16-#14	1.95	MA	34747	7811	56204	5763	61974	4661	64636	3844	67594	2598	81573	2275	47536
3L-7S		MI	30102	7811	48408	5779	52340	4692	53341	3849	53251	2610	63741	1852	42820

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

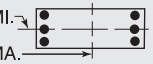


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	1.95	MA	33866	7811	54670	5781	60024	4678	62269	3839	64522	2609	78037	2147	47409
4L-6S		MI	30799	7811	49697	5761	53910	4676	55266	3835	55836	2600	67183	1978	43492
16-#14	1.95	MA	33078	7811	53327	5780	58291	4675	60147	3854	61493	2601	74346	2084	46856
5E		MI	31513	7811	50901	5762	55546	4679	57261	3841	58478	2589	70489	2063	44527
16-#14	1.95	MA	32327	7811	52059	5779	56569	4691	58045	3849	58711	2612	70834	1999	45733
6L-4S		MI	32262	7811	52177	5764	57192	4663	59276	3826	61352	2599	73974	2125	45058
16-#14	1.95	MA	31593	7811	50702	5798	54915	4688	56018	3864	55988	2623	67181	1873	45009
7L-3S		MI	33098	7811	53632	5746	59042	4667	61521	3832	64268	2589	77302	2253	45167
16-#14	1.95	MA	30870	7811	49457	5796	53245	4705	54033	3879	53137	2614	63731	1799	43529
8L-2S		MI	34283	7811	55443	5747	61350	4650	64327	3818	68070	2578	82387	2381	45202
16-#18	3.46	MA	38953	8804	66413	6347	74787	5114	80133	4109	88421	2516	108943	1972	82315
3L-7S		MI	31965	8804	54118	6380	59387	5134	61808	4116	64600	2529	79556	1225	68629
16-#18	3.46	MA	37457	8804	63721	6378	71363	5106	75978	4098	83045	2534	102840	1744	80669
4L-6S		MI	33149	8804	56383	6349	62148	5107	65191	4093	69094	2511	85497	1450	71316
16-#18	3.46	MA	36118	8804	61358	6374	68316	5134	72248	4122	77744	2516	96428	1635	77892
5E		MI	34363	8804	58500	6354	65023	5116	68696	4105	73687	2494	91202	1601	73924
16-#18	3.46	MA	34841	8804	59128	6371	65287	5127	68553	4111	72873	2534	90361	1484	75148
6L-4S		MI	35636	8804	60742	6358	67913	5089	72236	4083	78685	2511	97245	1708	76480
16-#18	3.46	MA	33595	8804	56741	6402	62378	5154	64989	4135	68105	2552	84043	1259	72247
7L-3S		MI	37055	8804	63296	6328	71160	5098	76176	4095	83753	2494	102979	1936	78101
18-#11	1.52	MA	34512	7530	54758	5605	60235	4551	62561	3762	64800	2614	78033	2461	37505
2L-9S		MI	28957	7530	45659	5626	48927	4565	49224	3783	47620	2632	56345	1969	33592
18-#11	1.52	MA	33628	7530	53424	5605	58534	4549	60493	3773	61999	2622	74240	2372	37507
3L-8S		MI	29451	7530	46531	5613	50007	4567	50584	3786	49404	2625	58599	2025	34317
18-#11	1.52	MA	33008	7530	52354	5618	57174	4561	58842	3770	59855	2631	71753	2283	37475
4L-7S		MI	29935	7530	47355	5613	51112	4555	51898	3776	51292	2631	60885	2076	34671
18-#11	1.52	MA	32452	7530	51417	5618	55965	4559	57362	3781	57743	2625	69164	2239	37395
5L-6S		MI	30426	7530	48254	5600	52207	4557	53240	3765	53095	2623	63306	2163	35165
18-#11	1.52	MA	31923	7530	50534	5617	54764	4571	55897	3778	55803	2633	66695	2181	36966
6L-5S		MI	30929	7530	49093	5601	53348	4545	54631	3769	54937	2615	65633	2222	35568
18-#11	1.52	MA	31406	7530	49588	5630	53611	4570	54484	3789	53905	2642	64127	2093	36428
7L-4S		MI	31457	7530	49983	5602	54496	4547	56037	3758	56942	2621	68078	2266	35635
18-#11	1.52	MA	30897	7530	48720	5630	52448	4582	53100	3799	51917	2636	61707	2042	36039
8L-3S		MI	32047	7530	50999	5589	55787	4536	57604	3762	58977	2613	70421	2354	35661
18-#11	1.52	MA	30368	7530	47869	5629	51311	4580	51669	3796	50039	2644	59315	1986	35262
9L-2S		MI	32883	7530	52264	5590	57400	4538	59565	3751	61634	2606	73998	2443	35650
18-#14	2.19	MA	36873	7971	60025	5864	66846	4736	70557	3874	75617	2577	92367	2381	53386
2L-9S		MI	29594	7971	47785	5895	51514	4777	52312	3903	51787	2601	62367	1674	45508
18-#14	2.19	MA	35629	7971	58114	5862	64410	4733	67596	3889	71606	2588	86970	2253	53321
3L-8S		MI	30271	7971	49037	5877	53063	4761	54262	3909	54345	2590	65571	1755	46735
18-#14	2.19	MA	34754	7971	56581	5881	62460	4750	65230	3884	68533	2600	83434	2125	53169
4L-7S		MI	30954	7971	50219	5879	54648	4764	56147	3894	57053	2600	68826	1828	48072
18-#14	2.19	MA	33971	7971	55237	5880	60727	4747	63107	3899	65504	2591	79743	2062	52456
5L-6S		MI	31646	7971	51508	5860	56219	4748	58072	3880	59638	2590	72268	1955	48840
18-#14	2.19	MA	33224	7971	53969	5879	59004	4764	61006	3894	62722	2602	76232	1977	51379
6L-5S		MI	32356	7971	52712	5862	57855	4752	60067	3886	62280	2579	75575	2039	49830
18-#14	2.19	MA	32496	7971	52612	5897	57350	4761	58979	3909	60000	2613	72578	1851	50567
7L-4S		MI	33100	7971	53988	5864	59500	4735	62082	3871	65154	2589	79059	2101	50518
18-#14	2.19	MA	31778	7971	51367	5896	55681	4777	56994	3924	57148	2604	69128	1777	49126
8L-3S		MI	33931	7971	55443	5846	61350	4739	64327	3877	68070	2579	82387	2229	50652
18-#14	2.19	MA	31040	7971	50050	5915	54050	4774	54941	3919	54454	2615	65726	1696	47820
9L-2S		MI	35110	7971	57254	5847	63659	4723	67134	3863	71872	2569	87472	2357	50707
18-#18	3.90	MA	38958	9088	67067	6555	75629	5235	81164	4178	90052	2515	112177	1699	90388
4L-7S		MI	33415	9088	57287	6557	63428	5263	66720	4196	71205	2509	88340	1176	77859
18-#18	3.90	MA	37631	9088	64704	6552	72583	5263	77434	4202	84751	2498	105766	1590	87737
5L-6S		MI	34588	9088	59552	6526	66189	5236	70103	4173	75700	2491	94281	1402	80466
18-#18	3.90	MA	36367	9088	62474	6548	69554	5255	73740	4190	79879	2515	99698	1439	84831
6L-5S		MI	35790	9088	61669	6531	69063	5245	73608	4185	80292	2473	99986	1552	83239
18-#18	3.90	MA	35133	9088	60087	6579	66645	5283	70175	4214	75112	2533	93380	1214	82029
7L-4S		MI	37051	9088	63911	6536	71953	5218	77147	4162	85291	2491	106029	1660	85672

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis



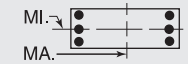
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.69	MA	35134	7641	56092	5674	61936	4601	64629	3793	67602	2607	81826	2447	41574
2L-10S		MI	29034	7641	46104	5694	49449	4626	49879	3824	48506	2633	57736	1890	36727
20-#11	1.69	MA	34254	7641	54758	5674	60235	4599	62561	3804	64800	2615	78033	2358	41561
3L-9S		MI	29563	7641	46924	5695	50540	4615	51185	3814	50276	2625	59921	1953	37308
20-#11	1.69	MA	33636	7641	53688	5687	58875	4611	60910	3801	62657	2624	75546	2269	41516
4L-8S		MI	30054	7641	47796	5682	51620	4617	52544	3817	52060	2618	62176	2010	38075
20-#11	1.69	MA	33083	7641	52752	5687	57666	4609	59430	3812	60545	2618	72956	2225	41422
5L-7S		MI	30536	7641	48620	5682	52725	4605	53859	3807	53949	2624	64461	2061	38428
20-#11	1.69	MA	32556	7641	51868	5686	56465	4621	57965	3809	58605	2626	70488	2167	40910
6E		MI	31024	7641	49519	5669	53821	4607	55201	3796	55751	2616	66882	2148	38904
20-#11	1.69	MA	32042	7641	50922	5700	55312	4620	56552	3820	56707	2635	67919	2079	40391
7L-5S		MI	31525	7641	50359	5670	54961	4596	56592	3800	57594	2608	69209	2207	39388
20-#11	1.69	MA	31536	7641	50055	5699	54149	4632	55169	3831	54719	2629	65499	2028	40011
8L-4S		MI	32050	7641	51248	5671	56109	4598	57998	3789	59599	2614	71655	2251	39469
20-#11	1.69	MA	31010	7641	49203	5698	53012	4630	53737	3828	52841	2638	63107	1972	39186
9L-3S		MI	32637	7641	52264	5658	57400	4586	59565	3793	61634	2606	73998	2339	39506
20-#11	1.69	MA	30452	7641	48273	5712	51864	4642	52362	3838	50977	2646	60788	1908	38557
10L-2S		MI	33471	7641	53529	5659	59013	4588	61526	3782	64290	2599	77574	2428	39510
20-#14	2.44	MA	36505	8130	60025	5962	66846	4805	70557	3934	75617	2578	92367	2231	59101
3L-9S		MI	30447	8130	49596	5995	53822	4849	55118	3948	55589	2591	67453	1651	50756
20-#14	2.44	MA	35636	8130	58491	5981	64896	4822	68191	3929	72544	2590	88831	2103	58925
4L-8S		MI	31121	8130	50847	5977	55371	4833	57068	3953	58147	2580	70656	1732	52040
20-#14	2.44	MA	34857	8130	57148	5980	63163	4819	66068	3944	69516	2581	85140	2040	58068
5L-7S		MI	31800	8130	52030	5978	56957	4837	58953	3939	60855	2590	73912	1805	53336
20-#14	2.44	MA	34116	8130	55880	5978	61440	4836	63967	3939	66734	2592	81629	1955	57033
6E		MI	32488	8130	53318	5960	58527	4820	60878	3925	63440	2580	77353	1931	54196
20-#14	2.44	MA	33392	8130	54522	5997	59786	4833	61940	3954	64011	2603	77975	1829	56129
7L-5S		MI	33193	8130	54523	5962	60163	4824	62873	3931	66081	2570	80660	2015	55146
20-#14	2.44	MA	32679	8130	53278	5996	58117	4850	59955	3969	61159	2594	74525	1756	54731
8L-4S		MI	33933	8130	55798	5963	61808	4808	64888	3916	68956	2579	84145	2078	55974
20-#14	2.44	MA	31956	8130	51960	6015	56486	4847	57902	3964	58465	2605	71124	1674	53369
9L-3S		MI	34759	8130	57254	5945	63659	4811	67134	3922	71872	2569	87472	2206	56131
20-#18	4.33	MA	39131	9372	68051	6729	76849	5391	82620	4281	91757	2479	115103	1544	97599
5L-7S		MI	34852	9372	60456	6734	67468	5391	71631	4275	77811	2488	97123	1128	86927
20-#18	4.33	MA	37879	9372	65820	6725	73820	5384	78926	4270	86886	2497	109036	1394	94535
6E		MI	36014	9372	62721	6704	70229	5365	75014	4253	82305	2470	103065	1353	89639
20-#18	4.33	MA	36656	9372	63433	6757	70911	5412	75361	4294	82119	2514	102718	1169	91685
7L-5S		MI	37206	9372	64838	6708	73103	5373	78519	4265	86898	2453	108769	1504	92569
22-#11	1.86	MA	35753	7752	57427	5744	63637	4651	66697	3824	70404	2600	85619	2433	45635
2L-11S		MI	29122	7752	46560	5762	49988	4674	50496	3852	49300	2620	59080	1821	39542
22-#11	1.86	MA	34876	7752	56092	5743	61936	4649	64629	3835	67602	2608	81826	2344	45611
3L-10S		MI	29638	7752	47369	5763	51062	4676	51840	3855	51162	2626	61312	1875	40441
22-#11	1.86	MA	34261	7752	55023	5756	60576	4661	62978	3832	65459	2617	79338	2255	45554
4L-9S		MI	30165	7752	48189	5764	52153	4665	53146	3845	52933	2619	63498	1938	41030
22-#11	1.86	MA	33711	7752	54086	5756	59367	4660	61498	3843	63346	2611	76749	2211	45446
5L-8S		MI	30654	7752	49062	5751	53233	4667	54505	3848	54717	2611	65752	1995	41775
22-#11	1.86	MA	33187	7752	53202	5755	58166	4672	60033	3840	61407	2620	74280	2153	44860
6L-7S		MI	31133	7752	49886	5752	54338	4655	55819	3838	56605	2617	68037	2046	42188
22-#11	1.86	MA	32675	7752	52256	5769	57014	4670	58620	3851	59509	2628	71712	2065	44358
7L-6S		MI	31620	7752	50784	5739	55434	4657	57162	3828	58408	2609	70459	2133	42647
22-#11	1.86	MA	32171	7752	51389	5768	55850	4682	57237	3862	57521	2622	69292	2014	43920
8L-5S		MI	32118	7752	51624	5739	56574	4646	58553	3831	60250	2601	72785	2192	43204
22-#11	1.86	MA	31648	7752	50537	5768	54713	4680	55805	3859	55642	2631	66900	1957	43116
9L-4S		MI	32641	7752	52514	5740	57722	4648	59959	3821	62255	2607	75231	2235	43299

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

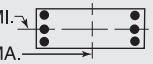
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.86	MA	31093	7752	49608	5781	53565	4692	54430	3869	53778	2639	64580	1894	42486
10L-3S		MI	33225	7752	53529	5727	59013	4636	61526	3824	64290	2600	77574	2324	43347
22-#11	1.86	MA	30550	7752	48756	5780	52435	4690	53016	3866	51818	2634	62217	1840	41519
11L-2S		MI	34056	7752	54794	5728	60626	4638	63486	3814	66947	2592	81150	2413	43367
22-#14	2.68	MA	36512	8290	60402	6080	67331	4895	71152	3974	76556	2580	94229	2081	64678
4L-9S		MI	31293	8290	51407	6095	56131	4922	57925	3993	59390	2581	72538	1627	56013
22-#14	2.68	MA	35738	8290	59058	6079	65598	4892	69029	3989	73527	2571	90537	2018	63690
5L-8S		MI	31966	8290	52658	6077	57680	4905	59875	3998	61949	2570	75741	1708	57353
22-#14	2.68	MA	35001	8290	57790	6078	63876	4908	66928	3984	70745	2582	87026	1933	62694
6L-7S		MI	32640	8290	53840	6078	59265	4909	61760	3984	64657	2580	78997	1781	58610
22-#14	2.68	MA	34282	8290	56433	6097	62222	4905	64901	3999	68022	2593	83372	1807	61702
7L-6S		MI	33324	8290	55129	6060	60836	4893	63684	3970	67242	2570	82439	1907	59557
22-#14	2.68	MA	33574	8290	55188	6096	60552	4922	62916	4014	65171	2584	79922	1734	60343
8L-5S		MI	34025	8290	56333	6062	62471	4896	65680	3975	69883	2560	85745	1992	60471
22-#14	2.68	MA	32852	8290	53871	6114	58921	4919	60863	4009	62476	2595	76521	1652	58927
9L-4S		MI	34760	8290	57609	6063	64117	4880	67695	3961	72758	2569	89230	2054	61427
22-#18	4.76	MA	39378	9655	69167	6903	78086	5512	84112	4350	93893	2478	118373	1349	104259
6L-7S		MI	36277	9655	63625	6912	71508	5520	76543	4355	84417	2468	105907	1079	96015
22-#18	4.76	MA	38167	9655	66780	6934	75177	5540	80548	4374	89125	2496	112055	1124	101307
7L-6S		MI	37429	9655	65890	6881	74269	5493	79926	4332	88911	2450	111849	1305	98831
24-#11	2.03	MA	35495	7862	57427	5812	63637	4699	66697	3866	70404	2602	85619	2330	49658
3L-11S		MI	29726	7862	47825	5831	51601	4725	52456	3883	51956	2613	62657	1806	43248
24-#11	2.03	MA	34883	7862	56357	5826	62277	4711	65046	3863	68260	2610	83131	2241	49589
4L-10S		MI	30239	7862	48634	5832	52675	4727	53801	3886	53819	2619	64888	1860	44128
24-#11	2.03	MA	34335	7862	55420	5825	61069	4710	63566	3874	66148	2604	80542	2197	49468
5L-9S		MI	30765	7862	49454	5833	53766	4715	55106	3876	55589	2612	67074	1923	44756
24-#11	2.03	MA	33814	7862	54537	5825	59868	4722	62101	3871	64208	2613	78073	2139	48815
6L-8S		MI	31251	7862	50327	5820	54846	4717	56466	3879	57373	2604	69328	1979	45481
24-#11	2.03	MA	33305	7862	53591	5838	58715	4720	60688	3882	62310	2621	75505	2051	48328
7E		MI	31728	7862	51151	5821	55951	4705	57780	3869	59262	2610	71614	2030	45950
24-#11	2.03	MA	32803	7862	52723	5837	57551	4732	59305	3893	60322	2615	73085	2000	47833
8L-6S		MI	32212	7862	52049	5808	57047	4707	59123	3859	61064	2602	74035	2118	46396
24-#11	2.03	MA	32282	7862	51872	5837	56415	4730	57873	3890	58444	2624	70693	1943	47049
9L-5S		MI	32708	7862	52889	5809	58187	4696	60514	3862	62907	2594	76361	2176	47019
24-#11	2.03	MA	31729	7862	50942	5850	55266	4742	56498	3901	56580	2632	68373	1880	46381
10L-4S		MI	33229	7862	53779	5809	59335	4698	61919	3852	64912	2600	78807	2220	47126
24-#11	2.03	MA	31189	7862	50091	5850	54136	4741	55084	3898	54620	2627	66010	1826	45434
11L-3S		MI	33810	7862	54794	5796	60626	4686	63486	3855	66947	2593	81150	2309	47185
24-#14	2.92	MA	36614	8450	60968	6179	68034	4964	71990	4034	77538	2561	95934	1996	69322
5L-9S		MI	32134	8450	53217	6195	58439	4994	60731	4038	63192	2571	77623	1603	61278
24-#14	2.92	MA	35882	8450	59700	6178	66311	4981	69889	4029	74756	2572	92423	1911	68360
6L-8S		MI	32806	8450	54469	6176	59988	4978	62681	4043	65751	2561	80826	1685	62673
24-#14	2.92	MA	35167	8450	58343	6197	64657	4978	67862	4044	72034	2583	88769	1785	67285
7E		MI	33476	8450	55651	6178	61574	4981	64566	4029	68459	2570	84082	1757	63894
24-#14	2.92	MA	34463	8450	57099	6195	62988	4994	65877	4059	69182	2574	85320	1712	65963
8L-6S		MI	34155	8450	56940	6160	63144	4965	66491	4015	71044	2560	87524	1884	64924
24-#14	2.92	MA	33743	8450	55781	6214	61357	4991	63823	4054	66487	2585	81918	1630	64492
9L-5S		MI	34852	8450	58144	6161	64780	4969	68486	4020	73685	2550	90830	1968	65806
24-#18	5.19	MA	39666	9939	70126	7111	79444	5669	85734	4454	96132	2477	121393	1079	110947
7E		MI	37692	9939	66794	7089	75548	5648	81454	4435	91022	2447	114691	1031	105122

RECTANGULAR TIED COLUMNS 42" x 46"

6-#18	1.24	MA	36471	7683	57474	5705	62578	4642	64330	3854	65305	2725	77419	2559	33397
2L-3S		MI	31084	7683	49320	5664	52908	4639	53518	3852	52430	2715	60946	2294	30329
6-#18	1.24	MA	34127	7683	53951	5702	58086	4670	58869	3880	57907	2743	67528	2332	33440
3L-2S		MI	33188	7683	52488	5669	56948	4612	58430	3829	59035	2698	69730	2522	30252
8-#18	1.66	MA	38107	7966	60998	5882	67071	4770	69791	3934	72704	2707	87311	2517	44169
2L-4S		MI	31083	7966	49935	5872	53701	4759	54490	3919	53968	2713	63996	2018	39645

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis



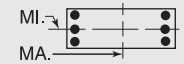
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	1.66	MA	35786	7966	57474	5879	62578	4799	64330	3959	65305	2726	77419	2290	44118
3E		MI	32562	7966	52488	5842	56948	4767	58430	3932	59035	2695	69730	2246	39949
8-#18	1.66	MA	34146	7966	54643	5912	58977	4792	59960	3949	59631	2744	70947	2062	43711
4L-2S		MI	34647	7966	55657	5846	60988	4741	63341	3909	65641	2677	78514	2473	39956
10-#14	1.16	MA	36273	7629	56786	5706	61915	4646	63607	3863	64359	2747	76512	2601	31610
2L-5S		MI	30196	7629	47331	5688	50570	4647	50745	3863	48784	2740	57129	2250	28590
10-#14	1.16	MA	34931	7629	54775	5705	59352	4643	60491	3879	60139	2759	70803	2473	31646
3L-4S		MI	30961	7629	48607	5690	52215	4631	52760	3849	51658	2750	60614	2313	28698
10-#14	1.16	MA	33986	7629	53164	5724	57303	4660	58004	3874	56909	2770	67059	2345	31614
4L-3S		MI	31815	7629	50062	5672	54066	4635	55006	3855	54574	2739	63942	2441	28699
10-#14	1.16	MA	33139	7629	51752	5723	55482	4658	55774	3890	53727	2762	63160	2282	31453
5L-2S		MI	33021	7629	51873	5673	56374	4619	57812	3840	58376	2729	69027	2569	28652
10-#18	2.07	MA	39724	8250	64522	6060	71563	4899	75253	4014	80102	2690	97202	2475	54905
2L-5S		MI	31244	8250	50862	6045	54851	4914	55862	4022	55575	2675	66736	1862	46430
10-#18	2.07	MA	37424	8250	60998	6057	67071	4928	69791	4039	72704	2708	87311	2247	54769
3L-4S		MI	32559	8250	53104	6050	57741	4887	59401	3999	60574	2692	72780	1970	49140
10-#18	2.07	MA	35801	8250	58166	6089	63470	4921	65421	4029	67030	2726	80838	2020	54266
4L-3S		MI	34024	8250	55657	6019	60988	4896	63341	4012	65641	2675	78514	2197	49537
10-#18	2.07	MA	34347	8250	55683	6086	60267	4950	61499	4054	61435	2709	74059	1909	51207
5L-2S		MI	36090	8250	58826	6024	65028	4869	68253	3989	72247	2657	87298	2425	49630
12-#14	1.40	MA	37219	7789	58796	5806	64478	4718	66722	3908	68580	2737	82222	2581	37755
2L-6S		MI	30333	7789	47937	5786	51243	4716	51557	3903	49944	2740	58908	2142	33021
12-#14	1.40	MA	35884	7789	56786	5805	61915	4715	63607	3924	64359	2749	76512	2453	37766
3L-5S		MI	31058	7789	49142	5788	52878	4720	53552	3908	52585	2730	62215	2227	34040
12-#14	1.40	MA	34945	7789	55174	5824	59866	4733	61119	3919	61130	2761	72768	2325	37697
4E		MI	31819	7789	50417	5790	54524	4704	55567	3894	55460	2740	65699	2289	34185
12-#14	1.40	MA	34105	7789	53762	5823	58045	4730	58889	3935	57947	2752	68870	2261	37497
5L-3S		MI	32667	7789	51873	5771	56374	4707	57812	3900	58376	2729	69027	2417	34225
12-#14	1.40	MA	33304	7789	52431	5822	56235	4747	56682	3930	55025	2764	65154	2177	36325
6L-2S		MI	33867	7789	53683	5773	58683	4691	60618	3885	62178	2719	74112	2545	34196
12-#18	2.48	MA	41324	8534	68045	6237	76055	5027	80714	4094	87501	2672	107093	2433	65607
2L-6S		MI	31475	8534	51914	6218	56017	5034	57268	4089	57588	2672	69816	1663	53639
12-#18	2.48	MA	39044	8534	64522	6234	71563	5056	75253	4119	80102	2690	97202	2205	65402
3L-5S		MI	32717	8534	54031	6222	58891	5043	60773	4102	62180	2654	75520	1814	55672
12-#18	2.48	MA	37437	8534	61690	6266	67962	5050	70882	4109	74428	2708	90730	1978	64817
4E		MI	34018	8534	56273	6227	61782	5016	64313	4079	67179	2672	81564	1921	58582
12-#18	2.48	MA	35998	8534	59207	6263	64759	5078	66961	4134	68834	2691	83951	1867	61510
5L-3S		MI	35469	8534	58826	6196	65028	5025	68253	4092	72247	2654	87298	2149	59105
12-#18	2.48	MA	34626	8534	56863	6260	61576	5072	63078	4124	63692	2709	77519	1717	59225
6L-2S		MI	37518	8534	61995	6201	69069	4998	73164	4069	78852	2637	96081	2376	59263
14-#11	1.13	MA	36188	7606	56472	5708	61625	4649	63296	3869	63957	2757	76141	2621	30826
2L-7S		MI	29971	7606	46683	5701	49835	4640	49881	3871	47694	2766	55633	2223	27313
14-#11	1.13	MA	35249	7606	55069	5708	59836	4648	61121	3880	61010	2766	72132	2532	30852
3L-6S		MI	30467	7606	47582	5688	50931	4643	51224	3861	49497	2758	58054	2311	27862
14-#11	1.13	MA	34590	7606	53945	5722	58407	4660	59386	3877	58757	2775	69500	2444	30853
4L-5S		MI	30977	7606	48421	5689	52071	4631	52615	3864	51339	2750	60381	2369	27976
14-#11	1.13	MA	34000	7606	52961	5721	57137	4658	57832	3888	56539	2770	66767	2399	30807
5L-4S		MI	31510	7606	49311	5689	53219	4633	54020	3854	53344	2756	62826	2413	28000
14-#11	1.13	MA	33438	7606	52033	5721	55876	4671	56293	3886	54501	2779	64156	2341	30652
6L-3S		MI	32106	7606	50326	5676	54510	4621	55587	3857	55379	2748	65169	2502	27982
14-#11	1.13	MA	32889	7606	51040	5735	54665	4669	54809	3897	52508	2788	61441	2253	30010
7L-2S		MI	32951	7606	51591	5677	56123	4623	57548	3847	58035	2741	68746	2591	27951

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	1.63	MA	38157	7949	60806	5905	67041	4790	69838	3953	72801	2727	87931	2561	43889
2L-7S		MI	30491	7949	48459	5904	51980	4805	52438	3962	51161	2741	60552	1992	37661
14-#14	1.63	MA	36830	7949	58796	5905	64478	4788	66722	3969	68580	2739	82222	2433	43870
3L-6S		MI	31194	7949	49748	5886	53551	4788	54363	3947	53746	2730	63993	2119	38349
14-#14	1.63	MA	35897	7949	57184	5924	62429	4805	64235	3964	65350	2751	78478	2305	43771
4L-5S		MI	31914	7949	50952	5888	55187	4792	56358	3953	56387	2720	67300	2203	39458
14-#14	1.63	MA	35063	7949	55773	5923	60608	4802	62005	3980	62168	2743	74579	2241	43538
5L-4S		MI	32670	7949	52228	5889	56832	4776	58373	3939	59262	2730	70784	2265	39663
14-#14	1.63	MA	34267	7949	54441	5922	58798	4820	59797	3975	59245	2754	70863	2157	42249
6L-3S		MI	33512	7949	53683	5871	58683	4779	60618	3944	62178	2720	74112	2393	39731
14-#14	1.63	MA	33490	7949	53016	5941	57061	4817	57668	3991	56385	2766	66997	2030	41438
7L-2S		MI	34706	7949	55494	5873	60991	4763	63425	3930	65979	2709	79197	2521	39728
14-#18	2.90	MA	42908	8818	71569	6414	80548	5156	86175	4174	94900	2654	116985	2390	76292
2L-7S		MI	31744	8818	52818	6426	57296	5189	58797	4192	59699	2669	72658	1389	59880
14-#18	2.90	MA	40647	8818	68045	6411	76055	5185	80714	4199	87501	2673	107093	2163	76023
3L-6S		MI	32944	8818	55083	6395	60057	5163	62180	4169	64194	2652	78600	1615	62728
14-#18	2.90	MA	39056	8818	65213	6444	72454	5178	76343	4189	81827	2691	100621	1935	75065
4L-5S		MI	34174	8818	57200	6400	62931	5171	65685	4182	68786	2634	84304	1765	64941
14-#18	2.90	MA	37632	8818	62730	6441	69252	5207	72422	4214	76232	2673	93842	1825	71841
5L-4S		MI	35463	8818	59442	6404	65822	5144	69224	4159	73785	2652	90348	1873	67698
14-#18	2.90	MA	36274	8818	60386	6438	66068	5200	68539	4204	71091	2692	87411	1675	69380
6L-3S		MI	36900	8818	61995	6374	69069	5153	73164	4171	78852	2634	96081	2100	68659
14-#18	2.90	MA	34948	8818	57878	6470	63011	5229	64792	4229	66060	2710	80716	1450	66088
7L-2S		MI	38932	8818	65164	6378	73109	5126	78075	4149	85458	2616	104865	2328	68877
16-#11	1.29	MA	36853	7717	57876	5777	63414	4699	65471	3900	66904	2750	80150	2608	35116
2L-8S		MI	30091	7717	47124	5769	50343	4702	50528	3913	48462	2753	56924	2157	30699
16-#11	1.29	MA	35918	7717	56472	5777	61625	4698	63296	3911	63957	2759	76141	2519	35132
3L-7S		MI	30579	7717	47948	5770	51449	4691	51842	3902	50350	2759	59209	2208	31060
16-#11	1.29	MA	35261	7717	55349	5791	60196	4710	61561	3908	61704	2768	73509	2431	35114
4L-6S		MI	31073	7717	48847	5757	52544	4693	53184	3892	52153	2751	61630	2296	31584
16-#11	1.29	MA	34674	7717	54365	5791	58927	4709	60007	3919	59486	2763	70776	2386	35051
5E		MI	31580	7717	49686	5758	53684	4681	54576	3895	53995	2743	63957	2354	31807
16-#11	1.29	MA	34115	7717	53437	5790	57665	4721	58468	3917	57448	2772	68165	2328	34786
6L-4S		MI	32111	7717	50576	5759	54832	4683	55981	3885	56001	2749	66403	2398	31847
16-#11	1.29	MA	33569	7717	52443	5804	56455	4720	56984	3928	55455	2781	65450	2240	34170
7L-3S		MI	32704	7717	51591	5746	56123	4671	57548	3888	58035	2742	68746	2487	31846
16-#11	1.29	MA	33031	7717	51533	5804	55233	4732	55532	3939	53367	2776	62895	2188	33740
8L-2S		MI	33545	7717	52857	5746	57736	4674	59509	3878	60692	2734	72322	2575	31823
16-#14	1.86	MA	39090	8108	62816	6005	69604	4862	72953	3998	77022	2717	93640	2540	50010
2L-8S		MI	30661	8108	49088	6002	52704	4873	53359	4021	52255	2721	62381	1896	41750
16-#14	1.86	MA	37770	8108	60806	6004	67041	4860	69838	4013	72801	2729	87931	2412	49966
3L-7S		MI	31350	8108	50270	6004	54289	4877	55244	4007	54963	2731	65637	1969	43024
16-#14	1.86	MA	36843	8108	59194	6023	64991	4877	67350	4009	69571	2741	84187	2284	49839
4L-6S		MI	32048	8108	51559	5986	55860	4861	57169	3992	57548	2721	69079	2095	43687
16-#14	1.86	MA	36014	8108	57783	6023	63171	4875	65120	4024	66389	2733	80288	2220	49421
5E		MI	32764	8108	52763	5987	57495	4864	59164	3998	60189	2710	72385	2179	44745
16-#14	1.86	MA	35223	8108	56451	6022	61361	4892	62913	4020	63466	2744	76572	2136	48184
6L-4S		MI	33515	8108	54039	5989	59141	4848	61179	3984	63064	2720	75870	2242	45132
16-#14	1.86	MA	34452	8108	55026	6041	59624	4889	60783	4036	60606	2756	72706	2010	47399
7L-3S		MI	34353	8108	55494	5971	60991	4852	63425	3989	65979	2710	79197	2370	45226
16-#14	1.86	MA	33691	8108	53719	6040	57871	4907	58699	4051	57610	2748	69062	1936	45956
8L-2S		MI	35540	8108	57305	5972	63299	4836	66231	3975	69781	2699	84283	2498	45253
16-#18	3.31	MA	42236	9101	71569	6589	80548	5313	86175	4279	94900	2655	116985	2121	86635
3L-7S		MI	33211	9101	55987	6603	61336	5318	63708	4272	66305	2649	81442	1341	69103
16-#18	3.31	MA	40659	9101	68737	6621	76947	5307	81804	4269	89225	2673	110513	1893	85271
4L-6S		MI	34399	9101	58252	6572	64097	5291	67091	4249	70799	2631	87383	1566	71845
16-#18	3.31	MA	39249	9101	66254	6618	73744	5336	77883	4294	83631	2656	103734	1783	82195
5E		MI	35617	9101	60369	6577	66972	5300	70596	4262	75392	2613	93088	1717	74233
16-#18	3.31	MA	37904	9101	63910	6615	70561	5329	74000	4284	78490	2674	97302	1632	79562
6L-4S		MI	36894	9101	62611	6582	69862	5273	74135	4239	80391	2631	99131	1824	76852

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	3.31	MA	36592	9101	61402	6647	67503	5358	70253	4309	73458	2692	90608	1408	76381
7L-3S		MI	38318	9101	65164	6551	73109	5282	78075	4251	85458	2613	104865	2052	78203
16-#18	3.31	MA	35298	9101	59101	6644	64418	5351	66585	4334	68188	2675	84274	1279	72558
8L-2S		MI	40335	9101	68333	6556	77149	5255	82987	4228	92064	2596	113649	2279	78476
18-#11	1.45	MA	37514	7827	59279	5847	65204	4749	67647	3931	69851	2744	84160	2595	39400
2L-9S		MI	30205	7827	47517	5851	50876	4750	51129	3940	49334	2754	58246	2086	33820
18-#11	1.45	MA	36582	7827	57876	5846	63414	4748	65471	3942	66904	2752	80150	2506	39403
3L-8S		MI	30698	7827	48389	5838	51956	4752	52489	3944	51119	2746	60500	2142	34461
18-#11	1.45	MA	35929	7827	56752	5860	61985	4760	63737	3939	64651	2761	77518	2418	39370
4L-7S		MI	31183	7827	49213	5839	53062	4741	53803	3933	53007	2752	62785	2193	34812
18-#11	1.45	MA	35345	7827	55768	5860	60716	4759	62182	3951	62433	2756	74786	2373	39291
5L-6S		MI	31675	7827	50112	5826	54157	4743	55145	3923	54810	2744	65206	2281	35315
18-#11	1.45	MA	34788	7827	54840	5859	59455	4771	60643	3948	60395	2765	72175	2315	38928
6L-5S		MI	32179	7827	50951	5827	55297	4731	56537	3926	56652	2736	67533	2339	35633
18-#11	1.45	MA	34245	7827	53847	5873	58244	4770	59160	3959	58402	2774	69459	2227	38336
7L-4S		MI	32708	7827	51841	5828	56445	4733	57942	3916	58657	2742	69979	2383	35689
18-#11	1.45	MA	33710	7827	52936	5873	57023	4782	57707	3970	56314	2769	66905	2175	37916
8L-3S		MI	33299	7827	52857	5815	57736	4722	59509	3919	60692	2735	72322	2472	35705
18-#11	1.45	MA	33145	7827	52042	5873	55829	4781	56204	3968	54342	2778	64375	2119	37178
9L-2S		MI	34137	7827	54122	5816	59349	4724	61470	3909	63348	2727	75898	2560	35690
18-#14	2.10	MA	40016	8268	64826	6105	72167	4935	76069	4043	81242	2707	99349	2520	56120
2L-9S		MI	30839	8268	49647	6120	53463	4962	54216	4060	53498	2721	64263	1791	45945
18-#14	2.10	MA	38703	8268	62816	6104	69604	4932	72953	4058	77022	2719	93640	2392	56055
3L-8S		MI	31518	8268	50898	6102	55012	4946	56166	4066	56057	2711	67466	1872	47043
18-#14	2.10	MA	37782	8268	61205	6123	67554	4949	70466	4054	73792	2731	89896	2264	55903
4L-7S		MI	32203	8268	52081	6104	56597	4949	58050	4051	58765	2721	70722	1945	48391
18-#14	2.10	MA	36958	8268	59793	6122	65733	4947	68235	4069	70610	2723	85998	2200	55315
5L-6S		MI	32897	8268	53369	6085	58168	4933	59975	4037	61350	2711	74164	2071	49034
18-#14	2.10	MA	36173	8268	58461	6122	63924	4964	66028	4065	67687	2735	82281	2116	54128
6L-5S		MI	33608	8268	54574	6087	59804	4937	61970	4043	63991	2700	77470	2156	50046
18-#14	2.10	MA	35406	8268	57036	6141	62186	4962	63899	4080	64827	2746	78415	1989	53365
7L-4S		MI	34354	8268	55849	6089	61449	4920	63985	4029	66866	2710	80955	2218	50597
18-#14	2.10	MA	34651	8268	55729	6140	60433	4979	61814	4096	61831	2738	74772	1915	51850
8L-3S		MI	35187	8268	57305	6070	63299	4924	66231	4034	69781	2700	84283	2346	50715
18-#14	2.10	MA	33862	8268	54446	6139	58720	4976	59657	4092	59001	2750	71172	1834	50607
9L-2S		MI	36368	8268	59115	6072	65608	4908	69037	4020	73583	2689	89368	2474	50761
18-#18	3.73	MA	42248	9385	72261	6798	81439	5435	87266	4348	96624	2655	120404	1851	95509
4L-7S		MI	34663	9385	59156	6780	65377	5446	68620	4352	72911	2628	90226	1292	78344
18-#18	3.73	MA	40851	9385	69777	6795	78237	5464	83344	4374	91029	2638	113625	1740	92569
5L-6S		MI	35841	9385	61421	6750	68138	5420	72003	4329	77405	2611	96167	1518	80988
18-#18	3.73	MA	39519	9385	67434	6792	75053	5458	79461	4364	85888	2656	107194	1590	89768
6L-5S		MI	37047	9385	63538	6754	71012	5428	75508	4341	81997	2593	101872	1668	83544
18-#18	3.73	MA	38220	9385	64925	6825	71996	5486	75714	4389	80857	2674	100499	1365	86691
7L-4S		MI	38313	9385	65780	6759	73902	5402	79047	4319	86996	2611	107915	1776	86039
18-#18	3.73	MA	36939	9385	62624	6822	68911	5480	72046	4414	75587	2657	94165	1236	82772
8L-3S		MI	39725	9385	68333	6728	77149	5410	82987	4331	92064	2593	113649	2003	87738
20-#11	1.61	MA	38171	7938	60683	5916	66993	4799	69822	3962	72797	2737	88169	2582	43680
2L-10S		MI	30280	7938	47962	5920	51398	4812	51784	3982	50220	2754	59636	2007	36949
20-#11	1.61	MA	37244	7938	59279	5916	65204	4798	67647	3973	69851	2745	84160	2493	43667
3L-9S		MI	30811	7938	48782	5920	52489	4800	53090	3971	51991	2747	61822	2071	37535
20-#11	1.61	MA	36593	7938	58156	5929	63775	4810	65912	3971	67598	2754	81528	2405	43622
4L-8S		MI	31302	7938	49654	5907	53569	4803	54450	3975	53775	2739	64076	2127	38226
20-#11	1.61	MA	36012	7938	57172	5929	62505	4809	64357	3982	65380	2749	78795	2360	43528
5L-7S		MI	31785	7938	50479	5908	54675	4791	55764	3965	55663	2745	66362	2178	38569

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.61	MA	35458	7938	56244	5929	61244	4821	62819	3979	63342	2758	76184	2302	43078
6E		MI	32274	7938	51377	5895	55770	4793	57106	3954	57466	2737	68783	2266	39052
20-#11	1.61	MA	34918	7938	55250	5942	60034	4820	61335	3990	61349	2767	73468	2214	42506
7L-5S		MI	32776	7938	52217	5896	56910	4781	58497	3958	59308	2729	71109	2324	39456
20-#11	1.61	MA	34385	7938	54340	5942	58812	4832	59882	4001	59261	2762	70914	2162	42096
8L-4S		MI	33303	7938	53106	5897	58058	4783	59903	3947	61314	2735	73555	2368	39525
20-#11	1.61	MA	33823	7938	53446	5942	57618	4831	58379	3999	57289	2771	68384	2106	41309
9L-3S		MI	33891	7938	54122	5884	59349	4772	61470	3951	63348	2728	75898	2456	39554
20-#11	1.61	MA	33237	7938	52470	5955	56412	4843	56936	4010	55331	2779	65930	2043	40626
10L-2S		MI	34726	7938	55387	5885	60962	4774	63431	3940	66005	2720	79475	2545	39552
20-#14	2.33	MA	39631	8427	64826	6204	72167	5005	76069	4103	81242	2709	99349	2371	62138
3L-9S		MI	31694	8427	51458	6220	55772	5034	57022	4105	57300	2712	69348	1767	51188
20-#14	2.33	MA	38715	8427	63215	6223	70117	5022	73581	4099	78013	2721	95605	2243	61963
4L-8S		MI	32370	8427	52709	6202	57321	5018	58972	4111	59859	2701	72551	1849	52346
20-#14	2.33	MA	37896	8427	61803	6222	68296	5019	71351	4114	74830	2713	91707	2179	61222
5L-7S		MI	33050	8427	53891	6203	58906	5022	60857	4096	62566	2711	75807	1921	53669
20-#14	2.33	MA	37116	8427	60471	6221	66486	5037	69143	4110	71908	2725	87991	2095	60079
6E		MI	33740	8427	55180	6185	60476	5005	62782	4082	65152	2701	79249	2048	54388
20-#14	2.33	MA	36354	8427	59046	6240	64749	5034	67014	4125	69048	2736	84125	1969	59286
7L-5S		MI	34447	8427	56384	6187	62112	5009	64777	4088	67793	2690	82556	2132	55359
20-#14	2.33	MA	35604	8427	57739	6240	62996	5051	64930	4141	66052	2728	80481	1895	57752
8L-4S		MI	35188	8427	57660	6188	63758	4993	66792	4073	70668	2700	86040	2195	56056
20-#14	2.33	MA	34820	8427	56456	6239	61283	5049	62773	4136	63222	2740	76881	1814	56452
9L-3S		MI	36017	8427	59115	6170	65608	4996	69037	4079	73583	2690	89368	2323	56197
20-#14	2.33	MA	33992	8427	55055	6258	59553	5066	60701	4152	60413	2752	73389	1722	54769
10L-2S		MI	37192	8427	60926	6172	67916	4980	71844	4065	77385	2679	94453	2450	56262
20-#18	4.14	MA	42439	9669	73301	6973	82729	5593	88805	4454	98428	2620	123517	1698	102959
5L-7S		MI	36103	9669	62325	6958	69417	5575	73531	4431	79516	2608	99009	1244	87601
20-#18	4.14	MA	41120	9669	70957	6970	79545	5586	84922	4443	93287	2639	117085	1548	99997
6E		MI	37270	9669	64590	6927	72178	5548	76914	4409	84011	2590	104951	1469	90153
20-#18	4.14	MA	39833	9669	68449	7002	76488	5615	81175	4469	88255	2657	110391	1323	97017
7L-5S		MI	38466	9669	66707	6932	75052	5557	80419	4421	88603	2573	110655	1620	92872
20-#18	4.14	MA	38564	9669	66148	6999	73403	5608	77507	4494	82985	2640	104057	1194	93003
8L-4S		MI	39720	9669	68949	6936	77943	5530	83958	4398	93602	2590	116699	1727	95252
22-#11	1.78	MA	38826	8049	62086	5985	68783	4850	71997	3993	75744	2730	92178	2569	47952
2L-11S		MI	30369	8049	48418	5988	51938	4860	52401	4010	51015	2741	60981	1938	39845
22-#11	1.78	MA	37902	8049	60683	5985	66993	4848	69822	4004	72797	2739	88169	2480	47928
3L-10S		MI	30885	8049	49227	5989	53011	4862	53745	4013	52877	2748	63212	1992	40684
22-#11	1.78	MA	37254	8049	59559	5998	65564	4860	68087	4002	70545	2747	85537	2392	47870
4L-9S		MI	31414	8049	50047	5990	54102	4851	55051	4003	54648	2740	65398	2056	41255
22-#11	1.78	MA	36676	8049	58575	5998	64295	4859	66532	4013	68326	2742	82804	2347	47763
5L-8S		MI	31903	8049	50920	5977	55182	4853	56411	4006	56432	2732	67652	2112	41993
22-#11	1.78	MA	36124	8049	57647	5998	63033	4871	64994	4010	66289	2751	80193	2289	47233
6L-7S		MI	32383	8049	51744	5977	56288	4841	57725	3996	58320	2738	69938	2163	42329
22-#11	1.78	MA	35587	8049	56654	6011	61823	4870	63510	4021	64296	2760	77478	2201	46681
7L-6S		MI	32871	8049	52642	5964	57383	4843	59067	3985	60123	2730	72359	2250	42796
22-#11	1.78	MA	35056	8049	55743	6011	60601	4882	62057	4033	62208	2755	74923	2149	46278
8L-5S		MI	33370	8049	53482	5965	58523	4831	60458	3989	61965	2723	74686	2309	43275
22-#11	1.78	MA	34497	8049	54849	6011	59408	4881	60554	4030	60236	2764	72394	2093	45444
9L-4S		MI	33894	8049	54372	5966	59671	4834	61864	3978	63970	2729	77131	2353	43358
22-#11	1.78	MA	33914	8049	53873	6024	58202	4893	59111	4041	58278	2773	69940	2030	44777
10L-3S		MI	34480	8049	55387	5953	60962	4822	63431	3982	66005	2721	79475	2441	43398
22-#11	1.78	MA	33343	8049	52980	6024	57015	4892	57625	4039	56220	2768	67445	1975	43825
11L-2S		MI	35312	8049	56652	5954	62575	4824	65392	3971	68661	2713	83051	2530	43410
22-#14	2.56	MA	39642	8587	65225	6323	72680	5094	76697	4144	82233	2711	101315	2223	68019
4L-9S		MI	32542	8587	53269	6320	58080	5107	59828	4150	61102	2702	74433	1744	56441
22-#14	2.56	MA	38828	8587	63813	6322	70859	5092	74466	4159	79051	2703	97416	2159	67140
5L-8S		MI	33216	8587	54520	6302	59629	5090	61778	4156	63661	2691	77637	1825	57656
22-#14	2.56	MA	38053	8587	62482	6321	69049	5109	72259	4155	76128	2715	93700	2075	66038
6L-7S		MI	33892	8587	55702	6303	61214	5094	63663	4141	66368	2701	80893	1898	58940

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

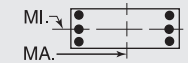
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	2.56	MA	37296	8587	61056	6340	67312	5106	70130	4170	73268	2726	89834	1948	65154
7L-6S		MI	34578	8587	56991	6285	62785	5078	65588	4127	68953	2691	84334	2024	59749
22-#14	2.56	MA	36550	8587	59749	6339	65559	5124	68045	4186	70273	2718	86190	1874	63662
8L-5S		MI	35281	8587	58195	6287	64421	5081	67583	4133	71595	2680	87641	2109	60682
22-#14	2.56	MA	35780	8587	58466	6339	63846	5121	65888	4181	67442	2730	82590	1793	62306
9L-4S		MI	36018	8587	59471	6288	66066	5065	69598	4118	74469	2690	91125	2171	61513
22-#14	2.56	MA	34948	8587	57065	6358	62115	5138	63817	4197	64634	2742	79098	1702	60659
10L-3S		MI	36841	8587	60926	6270	67916	5069	71844	4124	77385	2680	94453	2299	61675
22-#18	4.55	MA	42708	9952	74481	7147	84038	5715	90383	4523	100685	2621	126977	1506	110246
6L-7S		MI	37531	9952	65494	7135	73457	5704	78443	4511	86122	2588	107793	1195	96725
22-#18	4.55	MA	41432	9952	71973	7179	80980	5744	86637	4549	95654	2639	120282	1281	107358
7L-6S		MI	38688	9952	67759	7104	76218	5677	81825	4488	90616	2570	113735	1421	99339
22-#18	4.55	MA	40175	9952	69671	7176	77895	5737	82968	4574	90384	2622	113948	1152	103250
8L-5S		MI	39874	9952	69876	7109	79092	5685	85331	4501	95209	2552	119439	1571	102212
24-#11	1.94	MA	38557	8159	62086	6054	68783	4898	71997	4035	75744	2732	92178	2467	52185
3L-11S		MI	30973	8159	49683	6057	53551	4910	54362	4041	53671	2735	64557	1923	43549
24-#11	1.94	MA	37912	8159	60963	6067	67353	4911	70262	4033	73492	2740	89546	2379	52116
4L-10S		MI	31488	8159	50492	6058	54624	4912	55706	4044	55533	2741	66789	1977	44422
24-#11	1.94	MA	37336	8159	59979	6067	66084	4909	68708	4044	71273	2735	86813	2334	51995
5L-9S		MI	32014	8159	51313	6059	55715	4901	57012	4034	57304	2733	68974	2040	44980
24-#11	1.94	MA	36787	8159	59051	6067	64823	4922	67169	4041	69236	2744	84202	2275	51394
6L-8S		MI	32500	8159	52185	6046	56795	4903	58371	4037	59088	2725	71229	2097	45719
24-#11	1.94	MA	36252	8159	58057	6080	63612	4920	65685	4053	67243	2753	81487	2188	50858
7E		MI	32979	8159	53009	6047	57901	4891	59686	4027	60976	2731	73514	2148	46092
24-#11	1.94	MA	35725	8159	57147	6080	62391	4932	64233	4064	65155	2748	78932	2136	50444
8L-6S		MI	33464	8159	53907	6034	58996	4893	61028	4016	62779	2723	75935	2235	46543
24-#11	1.94	MA	35168	8159	56253	6080	61197	4931	62729	4061	63183	2757	76403	2080	49584
9L-5S		MI	33961	8159	54747	6034	60136	4882	62419	4020	64621	2716	78262	2294	47093
24-#11	1.94	MA	34587	8159	55277	6094	59991	4943	61286	4072	61225	2766	73949	2017	48932
10L-4S		MI	34483	8159	55637	6035	61284	4884	63825	4009	66627	2722	80708	2338	47187
24-#11	1.94	MA	34018	8159	54383	6093	58805	4942	59800	4070	59166	2761	71454	1962	47947
11L-3S		MI	35066	8159	56652	6022	62575	4872	65392	4013	68661	2714	83051	2426	47239
24-#11	1.94	MA	33460	8159	53422	6107	57607	4954	58360	4081	57212	2769	68711	1887	47088
12L-2S		MI	35895	8159	57917	6023	64188	4874	67353	4003	71318	2706	86627	2515	47261
24-#14	2.80	MA	39755	8747	65823	6422	73422	5164	77582	4204	83272	2693	103125	2138	73067
5L-9S		MI	33384	8747	55079	6420	60389	5179	62634	4195	64904	2692	79519	1720	61701
24-#14	2.80	MA	38984	8747	64492	6421	71612	5181	75374	4200	80349	2705	99409	2054	72002
6L-8S		MI	34057	8747	56330	6401	61938	5163	64584	4200	67462	2681	82722	1801	62973
24-#14	2.80	MA	38232	8747	63066	6440	69875	5179	73245	4215	77489	2717	95543	1928	71032
7E		MI	34729	8747	57513	6403	63523	5166	66469	4186	70170	2691	85978	1874	64220
24-#14	2.80	MA	37491	8747	61759	6439	68122	5196	71161	4231	74493	2709	91900	1854	69578
8L-6S		MI	35411	8747	58801	6385	65093	5150	68394	4172	72755	2681	89420	2001	65116
24-#14	2.80	MA	36722	8747	60476	6438	66409	5193	69004	4226	71663	2720	88299	1773	68167
9L-5S		MI	36109	8747	60006	6386	66729	5154	70389	4178	75397	2670	92726	2085	66015
24-#14	2.80	MA	35898	8747	59075	6457	64678	5211	66932	4242	68854	2732	84808	1681	66556
10L-4S		MI	36842	8747	61282	6388	68375	5137	72404	4163	78271	2680	96211	2147	66966
24-#18	4.97	MA	43019	10236	75496	7357	85473	5872	92098	4628	103052	2621	130174	1239	117547
7E		MI	38949	10236	68663	7312	77497	5832	83354	4591	92728	2567	116577	1147	105825
24-#18	4.97	MA	41773	10236	73195	7354	82388	5866	88429	4654	97782	2604	123840	1110	113513
8L-6S		MI	40096	10236	70928	7282	80258	5805	86737	4568	97222	2550	122519	1372	108543

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

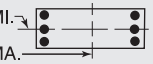


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.19	MA	39544	7980	62090	5946	67620	4840	69457	4023	70326	2855	83436	2693	35017
2L-3S		MI	32333	7980	51188	5888	54857	4823	55418	4008	54135	2835	62832	2410	30387
6-#18	1.19	MA	37077	7980	58389	5944	62901	4870	63721	4049	62555	2874	72990	2465	35060
3L-2S		MI	34439	7980	54357	5892	58897	4796	60329	3985	60741	2818	71616	2638	30298
8-#18	1.59	MA	41272	8263	65790	6124	72338	4969	75193	4103	78097	2837	93882	2653	46329
2L-4S		MI	32331	8263	51804	6096	55650	4943	56389	4075	55673	2833	65882	2134	39760
8-#18	1.59	MA	38828	8263	62090	6121	67620	4998	69457	4129	70326	2857	83436	2426	46278
3E		MI	33813	8263	54357	6065	58897	4951	60329	4088	60741	2815	71616	2362	40019
8-#18	1.59	MA	37105	8263	59119	6155	63841	4993	64871	4120	64373	2876	76594	2198	45871
4L-2S		MI	35901	8263	57526	6070	62937	4924	65241	4065	67346	2797	80400	2589	40009
10-#14	1.12	MA	39329	7927	61357	5947	66912	4844	68684	4032	69316	2876	82436	2734	33129
2L-5S		MI	31444	7927	49193	5913	52519	4833	52649	4020	50495	2861	59025	2367	28668
10-#14	1.12	MA	37918	7927	59247	5947	64222	4842	65414	4048	64886	2889	76415	2606	33165
3L-4S		MI	32210	7927	50468	5915	54164	4816	54664	4006	53370	2871	62510	2429	28755
10-#14	1.12	MA	36925	7927	57558	5966	62073	4860	62805	4044	61499	2901	72462	2478	33133
4L-3S		MI	33065	7927	51924	5896	56015	4820	56909	4012	56285	2860	65837	2557	28742
10-#14	1.12	MA	36037	7927	56078	5966	60165	4858	60468	4060	58163	2894	68357	2413	32971
5L-2S		MI	34273	7927	53734	5898	58323	4804	59716	3998	60087	2850	70923	2685	28691
10-#18	1.98	MA	42980	8547	69491	6301	77056	5097	80928	4183	85868	2819	104328	2614	57605
2L-5S		MI	32491	8547	52731	6268	56800	5098	57762	4178	57280	2795	68622	1978	46744
10-#18	1.98	MA	40558	8547	65790	6299	72338	5127	75193	4209	78097	2839	93882	2386	57469
3L-4S		MI	33809	8547	54973	6273	59690	5071	61301	4155	62279	2812	74666	2086	49265
10-#18	1.98	MA	38852	8547	62820	6332	68560	5121	70607	4200	72144	2858	87040	2159	56966
4L-3S		MI	35277	8547	57526	6242	62937	5080	65241	4168	67346	2795	80400	2313	49616
10-#18	1.98	MA	37325	8547	60216	6330	65201	5151	66494	4226	66275	2843	79893	2047	53950
5L-2S		MI	37346	8547	60695	6247	66978	5053	70152	4145	73952	2777	89184	2541	49686
12-#14	1.34	MA	40327	8086	63467	6047	69602	4916	71954	4077	73746	2866	88458	2715	39577
2L-6S		MI	31580	8086	49799	6011	53192	4901	53460	4060	51656	2861	60804	2259	33213
12-#14	1.34	MA	38923	8086	61357	6047	66912	4914	68684	4093	69316	2879	82436	2587	39588
3L-5S		MI	32307	8086	51003	6013	54828	4905	55455	4065	54297	2851	64110	2344	34125
12-#14	1.34	MA	37937	8086	59668	6066	64763	4932	66075	4089	65929	2891	78484	2459	39519
4E		MI	33068	8086	52279	6014	56473	4889	57470	4051	57172	2861	67595	2406	34247
12-#14	1.34	MA	37055	8086	58188	6066	62855	4930	63738	4105	62593	2884	74378	2394	39320
5L-3S		MI	33918	8086	53734	5996	58323	4892	59716	4057	60087	2850	70923	2534	34271
12-#14	1.34	MA	36215	8086	56793	6065	60958	4948	61424	4101	59530	2897	70457	2310	38192
6L-2S		MI	35119	8086	55545	5998	60632	4876	62522	4042	63889	2840	76008	2662	34238
12-#18	2.38	MA	44670	8831	73192	6478	81775	5226	86664	4263	93639	2802	114774	2574	68847
2L-6S		MI	32721	8831	53783	6441	57966	5218	59168	4245	59293	2792	71702	1779	54175
12-#18	2.38	MA	42268	8831	69491	6476	77056	5256	80928	4289	85868	2821	104328	2347	68642
3L-5S		MI	33966	8831	55900	6446	60840	5226	62673	4258	63885	2774	77406	1930	55981
12-#18	2.38	MA	40580	8831	66520	6509	73278	5250	76343	4280	79914	2841	97486	2119	68057
4E		MI	35271	8831	58142	6450	63731	5200	66212	4235	68884	2792	83450	2037	58761
12-#18	2.38	MA	39068	8831	63917	6507	69920	5280	72230	4306	74046	2825	90339	2007	64779
5L-3S		MI	36725	8831	60695	6420	66978	5208	70152	4248	73952	2774	89184	2265	59191
12-#18	2.38	MA	37627	8831	61459	6505	66582	5274	68158	4297	68655	2844	83544	1857	62627
6L-2S		MI	38778	8831	63864	6424	71018	5182	75064	4225	80558	2757	97968	2492	59329
14-#11	1.08	MA	39237	7903	61024	5950	66602	4847	68351	4037	68885	2887	82025	2753	32301
2L-7S		MI	31218	7903	48541	5927	51785	4826	51787	4029	49409	2887	57533	2341	27450
14-#11	1.08	MA	38250	7903	59552	5950	64725	4846	66069	4049	65793	2896	77799	2664	32326
3L-6S		MI	31715	7903	49440	5914	52880	4828	53129	4019	51211	2879	59954	2428	27968
14-#11	1.08	MA	37558	7903	58374	5963	63227	4859	64251	4046	63432	2905	75022	2575	32327
4L-5S		MI	32225	7903	50279	5914	54021	4817	54520	4022	53054	2871	62281	2487	28031
14-#11	1.08	MA	36939	7903	57343	5963	61897	4858	62621	4058	61107	2901	72146	2530	32281
5L-4S		MI	32760	7903	51169	5915	55168	4819	55926	4012	55059	2877	64727	2530	28043
14-#11	1.08	MA	36350	7903	56371	5963	60575	4871	61009	4056	58972	2910	69393	2472	32167
6L-3S		MI	33356	7903	52184	5902	56459	4807	57493	4015	57093	2870	67070	2619	28020

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

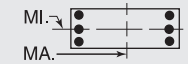
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.08	MA	35774	7903	55330	5977	59307	4869	59454	4067	56883	2919	66530	2385	31511
7L-2S		MI	34202	7903	53449	5903	58072	4809	59454	4005	59750	2862	70646	2708	27986
14-#14	1.56	MA	41318	8246	65577	6147	72292	4989	75224	4122	78176	2856	94480	2695	46015
2L-7S		MI	31737	8246	50321	6129	53930	4990	54341	4119	52872	2862	62447	2109	37849
14-#14	1.56	MA	39922	8246	63467	6146	69602	4987	71954	4138	73746	2869	88458	2567	45996
3L-6S		MI	32442	8246	51610	6111	55500	4974	56266	4105	55457	2851	65889	2235	38539
14-#14	1.56	MA	38942	8246	61777	6166	67453	5004	69345	4134	70359	2882	84506	2439	45897
4L-5S		MI	33164	8246	52814	6113	57136	4977	58261	4110	58099	2841	69196	2320	39575
14-#14	1.56	MA	38066	8246	60298	6165	65545	5002	67008	4150	67023	2874	80400	2375	45665
5L-4S		MI	33920	8246	54090	6114	58781	4961	60276	4096	60974	2851	72680	2382	39730
14-#14	1.56	MA	37230	8246	58903	6165	63648	5020	64694	4146	63960	2887	76479	2291	44412
6L-3S		MI	34765	8246	55545	6096	60632	4965	62522	4102	63889	2840	76008	2510	39784
14-#14	1.56	MA	36416	8246	57409	6184	61827	5018	62463	4162	60962	2899	72400	2165	43535
7L-2S		MI	35960	8246	57356	6098	62940	4948	65328	4087	67691	2830	81093	2638	39773
14-#18	2.78	MA	46343	9115	76893	6656	86493	5354	92400	4342	101410	2784	125220	2535	80072
2L-7S		MI	32989	9115	54687	6649	59245	5373	60697	4348	61404	2789	74544	1505	60348
14-#18	2.78	MA	43962	9115	73192	6653	81775	5384	86664	4369	93639	2804	114774	2307	79803
3L-6S		MI	34192	9115	56952	6618	62006	5346	64079	4325	65899	2772	80486	1731	63255
14-#18	2.78	MA	42289	9115	70221	6687	77997	5379	82079	4360	87685	2823	107931	2080	79145
4L-5S		MI	35425	9115	59069	6623	64880	5355	67585	4338	70491	2754	86190	1881	65246
14-#18	2.78	MA	40793	9115	67617	6684	74638	5408	77966	4386	81817	2807	100785	1968	75636
5L-4S		MI	36718	9115	61311	6628	67771	5328	71124	4315	75490	2772	92234	1989	68070
14-#18	2.78	MA	39366	9115	65160	6682	71300	5403	73894	4377	76426	2827	93990	1818	73306
6L-3S		MI	38159	9115	63864	6597	71018	5337	75064	4327	80558	2754	97968	2216	68752
14-#18	2.78	MA	37974	9115	62531	6715	68095	5432	69966	4403	71150	2846	86918	1593	69721
7L-2S		MI	40196	9115	67033	6602	75058	5310	79975	4305	87163	2736	106751	2444	68947
16-#11	1.24	MA	39938	8014	62497	6019	68480	4898	70634	4068	71977	2880	86251	2741	36801
2L-8S		MI	31338	8014	48982	5995	52293	4888	52433	4070	50177	2874	58824	2274	30837
16-#11	1.24	MA	38955	8014	61024	6019	66602	4897	68351	4080	68885	2889	82025	2652	36817
3L-7S		MI	31826	8014	49806	5996	53398	4876	53748	4060	52065	2880	61110	2325	31197
16-#11	1.24	MA	38266	8014	59846	6033	65104	4909	66533	4078	66524	2899	79248	2563	36799
4L-6S		MI	32321	8014	50705	5983	54493	4878	55090	4050	53868	2872	63531	2413	31731
16-#11	1.24	MA	37650	8014	58815	6033	63774	4908	64904	4089	64199	2894	76372	2518	36735
5E		MI	32829	8014	51544	5984	55634	4867	56481	4053	55710	2864	65857	2471	31865
16-#11	1.24	MA	37063	8014	57843	6033	62453	4921	63292	4087	62064	2903	73619	2460	36552
6L-4S		MI	33361	8014	52434	5984	56781	4869	57887	4043	57715	2871	68303	2515	31896
16-#11	1.24	MA	36491	8014	56803	6046	61184	4920	61737	4098	59976	2913	70756	2372	35878
7L-3S		MI	33955	8014	53449	5971	58072	4857	59454	4046	59750	2863	70646	2604	31887
16-#11	1.24	MA	35920	8014	55849	6046	59905	4932	60215	4110	57788	2908	68067	2320	35413
8L-2S		MI	34797	8014	54715	5972	59685	4859	61414	4036	62407	2855	74223	2693	31861
16-#14	1.79	MA	42302	8405	67687	6246	74982	5061	78494	4167	82606	2846	100501	2676	52440
2L-8S		MI	31907	8405	50949	6227	54653	5058	55263	4178	53967	2842	64277	2013	42053
16-#14	1.79	MA	40913	8405	65577	6246	72292	5059	75224	4183	78176	2859	94480	2548	52396
3L-7S		MI	32597	8405	52132	6229	56238	5062	57148	4164	56674	2852	67533	2085	43211
16-#14	1.79	MA	39939	8405	63887	6265	70143	5077	72615	4179	74790	2872	90527	2420	52269
4L-6S		MI	33297	8405	53420	6211	57809	5046	59073	4150	59259	2841	70974	2212	43876
16-#14	1.79	MA	39069	8405	62408	6265	68235	5074	70278	4195	71453	2864	86421	2356	52001
5E		MI	34015	8405	54625	6212	59444	5050	61068	4155	61901	2831	74281	2296	44957
16-#14	1.79	MA	38239	8405	61012	6265	66338	5092	67964	4191	68390	2877	82500	2272	50644
6L-4S		MI	34767	8405	55901	6214	61090	5033	63083	4141	64775	2841	77765	2359	45204
16-#14	1.79	MA	37430	8405	59519	6284	64517	5090	65733	4207	65393	2889	78422	2146	49795
7L-3S		MI	35606	8405	57356	6196	62940	5037	65328	4147	67691	2830	81093	2487	45284
16-#14	1.79	MA	36631	8405	58149	6284	62680	5108	63548	4223	62253	2882	74584	2071	48400
8L-2S		MI	36796	8405	59166	6197	65249	5021	68135	4132	71493	2820	86178	2615	45298

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

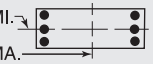


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	3.17	MA	45639	9398	76893	6831	86493	5513	92400	4448	101410	2786	125220	2268	90955
3L-7S		MI	34457	9398	57856	6826	63285	5502	65608	4428	68010	2769	83328	1457	69565
16-#18	3.17	MA	43982	9398	73922	6864	82715	5507	87815	4439	95456	2805	118377	2040	89903
4L-6S		MI	35649	9398	60121	6796	66046	5475	68991	4405	72504	2751	89269	1682	72364
16-#18	3.17	MA	42500	9398	71318	6862	79357	5537	83702	4466	89588	2790	111231	1928	86517
5E		MI	36871	9398	62238	6800	68921	5484	72496	4418	77097	2733	94974	1833	74535
16-#18	3.17	MA	41088	9398	68861	6859	76018	5531	79630	4457	84197	2809	104435	1778	84013
6L-4S		MI	38152	9398	64480	6805	71811	5457	76035	4395	82096	2751	101018	1940	77217
16-#18	3.17	MA	39709	9398	66231	6892	72813	5561	75702	4483	78921	2829	97364	1554	80542
7L-3S		MI	39580	9398	67033	6774	75058	5465	79975	4407	87163	2733	106751	2168	78301
16-#18	3.17	MA	38350	9398	63819	6890	69579	5555	71856	4509	73395	2813	90685	1423	76720
8L-2S		MI	41602	9398	70202	6779	79098	5439	84887	4384	93769	2716	115535	2395	78551
18-#11	1.39	MA	40635	8124	63970	6088	70357	4948	72916	4099	75070	2873	90477	2729	41295
2L-9S		MI	31452	8124	49375	6077	52826	4936	53035	4098	51049	2875	60146	2203	34042
18-#11	1.39	MA	39656	8124	62497	6088	68480	4947	70634	4111	71977	2882	86251	2640	41298
3L-8S		MI	31946	8124	50247	6064	53906	4938	54394	4102	52833	2867	62400	2259	34600
18-#11	1.39	MA	38970	8124	61319	6102	66982	4959	68815	4109	69616	2892	83474	2551	41266
4L-7S		MI	32432	8124	51071	6065	55011	4926	55708	4091	54722	2873	64686	2310	34949
18-#11	1.39	MA	38357	8124	60288	6102	65652	4958	67186	4120	67291	2887	80598	2506	41186
5L-6S		MI	32924	8124	51970	6052	56106	4929	57051	4081	56524	2865	67107	2398	35461
18-#11	1.39	MA	37773	8124	59316	6102	64330	4971	65574	4118	65156	2896	77845	2448	40899
6L-5S		MI	33430	8124	52810	6053	57247	4917	58442	4084	58367	2858	69434	2456	35695
18-#11	1.39	MA	37204	8124	58275	6116	63062	4970	64019	4130	63068	2906	74982	2360	40250
7L-4S		MI	33959	8124	53699	6054	58394	4919	59847	4074	60372	2864	71879	2500	35740
18-#11	1.39	MA	36642	8124	57321	6116	61782	4982	62497	4141	60880	2901	72293	2308	39798
8L-3S		MI	34551	8124	54715	6041	59685	4907	61414	4077	62407	2856	74223	2589	35748
18-#11	1.39	MA	36042	8124	56385	6116	60532	4981	60923	4139	58814	2910	69625	2252	39106
9L-2S		MI	35390	8124	55980	6041	61298	4909	63375	4067	65063	2848	77799	2678	35729
18-#14	2.01	MA	43280	8565	69797	6346	77672	5133	81764	4211	87037	2837	106523	2657	58854
2L-9S		MI	32071	8565	51509	6345	55412	5147	56119	4217	55210	2842	66159	1908	46348
18-#14	2.01	MA	41898	8565	67687	6346	74982	5131	78494	4227	82606	2849	100501	2529	58789
3L-8S		MI	32765	8565	52760	6327	56961	5131	58069	4223	57768	2832	69362	1989	47343
18-#14	2.01	MA	40930	8565	65997	6365	72833	5149	75885	4224	79220	2862	96549	2401	58637
4L-7S		MI	33451	8565	53942	6329	58546	5134	59954	4209	60476	2842	72618	2062	48579
18-#14	2.01	MA	40065	8565	64518	6365	70924	5147	73548	4240	75884	2854	92443	2337	58189
5L-6S		MI	34147	8565	55231	6310	60117	5118	61879	4194	63061	2831	76060	2188	49222
18-#14	2.01	MA	39240	8565	63122	6364	69028	5165	71234	4236	72820	2867	88522	2253	56885
6L-5S		MI	34860	8565	56435	6312	61753	5122	63874	4200	65703	2821	79366	2273	50256
18-#14	2.01	MA	38436	8565	61629	6384	67207	5162	69003	4252	69823	2879	84444	2127	56062
7L-4S		MI	35608	8565	57711	6314	63398	5106	65889	4186	68577	2831	82851	2335	50672
18-#14	2.01	MA	37643	8565	60259	6383	65370	5180	66818	4268	66683	2872	80606	2052	54590
8L-3S		MI	36442	8565	59166	6295	65249	5109	68135	4191	71493	2820	86178	2463	50776
18-#14	2.01	MA	36803	8565	58915	6383	63576	5178	64558	4264	63717	2885	76807	1971	53352
9L-2S		MI	37626	8565	60977	6297	67557	5093	70941	4177	75295	2810	91264	2591	50814
18-#18	3.57	MA	45660	9682	77623	7041	87434	5636	93551	4519	103227	2788	128823	2001	100662
4L-7S		MI	35912	9682	61024	7004	67326	5630	70519	4508	74616	2748	92112	1408	78800
18-#18	3.57	MA	44192	9682	75019	7039	84075	5665	89438	4546	97359	2772	121677	1889	97419
5L-6S		MI	37093	9682	63290	6973	70087	5604	73902	4485	79110	2731	98053	1634	81499
18-#18	3.57	MA	42793	9682	72562	7037	80737	5660	85366	4537	91968	2791	114881	1739	94744
6L-5S		MI	38304	9682	65407	6978	72961	5612	77408	4497	83703	2713	103758	1784	83843
18-#18	3.57	MA	41427	9682	69932	7070	77532	5689	81438	4563	86692	2811	107810	1514	91381
7L-4S		MI	39574	9682	67649	6982	75851	5585	80947	4475	88701	2731	109801	1892	86398
18-#18	3.57	MA	40081	9682	67520	7068	74297	5684	77592	4589	81166	2795	101131	1384	87463
8L-3S		MI	40990	9682	70202	6952	79098	5594	84887	4487	93769	2713	115535	2119	87842
20-#11	1.55	MA	41329	8235	65442	6157	72235	4998	75199	4131	78162	2866	94703	2716	45786
2L-10S		MI	31527	8235	49820	6145	53348	4998	53689	4140	51935	2876	61537	2124	37164
20-#11	1.55	MA	40353	8235	63970	6157	70357	4997	72916	4142	75070	2876	90477	2628	45773
3L-9S		MI	32058	8235	50640	6146	54439	4986	54995	4129	53706	2868	63722	2188	37755

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis



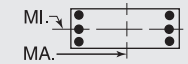
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.55	MA	39670	8235	62792	6171	68859	5009	71098	4140	72708	2885	87700	2539	45728
4L-8S		MI	32550	8235	51512	6133	55519	4988	56355	4133	55490	2860	65977	2244	38365
20-#11	1.55	MA	39060	8235	61761	6171	67529	5008	69469	4151	70383	2880	84824	2494	45634
5L-7S		MI	33034	8235	52337	6134	56624	4977	57669	4122	57378	2866	68262	2295	38706
20-#11	1.55	MA	38479	8235	60789	6171	66208	5021	67856	4149	68248	2889	82071	2435	45254
6E		MI	33524	8235	53235	6121	57719	4979	59011	4112	59181	2858	70683	2383	39197
20-#11	1.55	MA	37912	8235	59748	6185	64939	5020	66302	4161	66160	2899	79208	2348	44627
7L-5S		MI	34027	8235	54075	6122	58860	4967	60403	4115	61023	2851	73010	2441	39521
20-#11	1.55	MA	37354	8235	58794	6185	63660	5033	64780	4172	63972	2894	76519	2295	44185
8L-4S		MI	34555	8235	54964	6123	60007	4969	61808	4105	63028	2857	75456	2485	39579
20-#11	1.55	MA	36756	8235	57858	6185	62409	5031	63205	4170	61906	2903	73851	2240	43442
9L-3S		MI	35144	8235	55980	6110	61298	4957	63375	4108	65063	2849	77799	2574	39604
20-#11	1.55	MA	36141	8235	56835	6199	61146	5044	61693	4181	59855	2913	71263	2176	42704
10L-2S		MI	35980	8235	57245	6110	62911	4960	65336	4098	67720	2841	81375	2662	39593
20-#14	2.23	MA	42877	8724	69797	6446	77672	5204	81764	4272	87037	2839	106523	2510	65176
3L-9S		MI	32942	8724	53320	6445	57721	5219	58925	4262	59012	2832	71244	1884	51610
20-#14	2.23	MA	41914	8724	68107	6465	75523	5221	79155	4269	83650	2852	102570	2382	65000
4L-8S		MI	33618	8724	54571	6427	59270	5203	60875	4268	61570	2822	74447	1965	52643
20-#14	2.23	MA	41054	8724	66628	6465	73614	5219	76818	4285	80314	2844	98465	2318	64391
5L-7S		MI	34300	8724	55753	6428	60855	5207	62760	4254	64278	2832	77703	2038	53952
20-#14	2.23	MA	40235	8724	65232	6464	71718	5237	74504	4281	77250	2857	94544	2234	63135
6E		MI	34991	8724	57042	6410	62426	5191	64685	4239	66863	2821	81145	2165	54575
20-#14	2.23	MA	39436	8724	63739	6484	69897	5235	72273	4297	74253	2869	90465	2107	62333
7L-5S		MI	35700	8724	58246	6412	64061	5194	66680	4245	69505	2811	84451	2249	55566
20-#14	2.23	MA	38648	8724	62369	6483	68060	5252	70088	4313	71113	2862	86628	2032	60790
8L-4S		MI	36444	8724	59522	6413	65707	5178	68695	4231	72379	2821	87936	2311	56136
20-#14	2.23	MA	37813	8724	61025	6483	66265	5250	67828	4309	68147	2875	82829	1952	59562
9L-3S		MI	37274	8724	60977	6395	67557	5182	70941	4236	75295	2811	91264	2439	56262
20-#14	2.23	MA	36944	8724	59557	6502	64452	5268	65657	4325	65204	2887	79143	1860	57734
10L-2S		MI	38452	8724	62788	6397	69866	5165	73747	4222	79097	2800	96349	2567	56317
20-#18	3.97	MA	45869	9966	78720	7216	88794	5794	95174	4625	105130	2754	132122	1849	108337
5L-7S		MI	37354	9966	64193	7181	71366	5759	75431	4588	81221	2728	100895	1360	88052
20-#18	3.97	MA	44483	9966	76263	7214	85455	5788	91102	4616	99739	2774	125327	1699	105498
6E		MI	38525	9966	66459	7150	74127	5732	78814	4565	85716	2710	106837	1585	90657
20-#18	3.97	MA	43130	9966	73633	7247	82250	5818	87174	4643	94463	2793	118256	1475	102236
7L-5S		MI	39726	9966	68576	7155	77001	5741	82319	4577	90308	2693	112541	1736	93167
20-#18	3.97	MA	41797	9966	71221	7245	79016	5812	83328	4669	88937	2777	111577	1344	98223
8L-4S		MI	40984	9966	70818	7160	79892	5714	85858	4554	95307	2710	118585	1843	95606
22-#11	1.70	MA	42019	8346	66915	6226	74113	5048	77481	4162	81254	2859	98929	2704	50268
2L-11S		MI	31615	8346	50276	6214	53887	5046	54306	4167	52729	2863	62881	2055	40141
22-#11	1.70	MA	41047	8346	65442	6226	72235	5047	75199	4173	78162	2869	94703	2615	50245
3L-10S		MI	32133	8346	51085	6215	54961	5048	55650	4171	54592	2869	65113	2109	40897
22-#11	1.70	MA	40367	8346	64264	6240	70737	5060	73380	4171	75800	2878	91926	2527	50187
4L-9S		MI	32662	8346	51905	6215	56052	5036	56956	4160	56362	2861	67299	2173	41474
22-#11	1.70	MA	39760	8346	63233	6240	69407	5058	71751	4183	73475	2873	89050	2481	50079
5L-8S		MI	33151	8346	52778	6202	57132	5038	58316	4164	58146	2853	69553	2229	42133
22-#11	1.70	MA	39182	8346	62261	6240	68085	5071	70139	4180	71340	2883	86297	2423	49615
6L-7S		MI	33633	8346	53602	6203	58237	5027	59630	4153	60035	2859	71838	2280	42466
22-#11	1.70	MA	38618	8346	61221	6254	66817	5070	68584	4192	69252	2892	83434	2336	49009
7L-6S		MI	34121	8346	54500	6190	59332	5029	60972	4143	61837	2852	74260	2368	42940
22-#11	1.70	MA	38061	8346	60267	6254	65537	5083	67062	4203	67064	2887	80745	2283	48576
8L-5S		MI	34622	8346	55340	6191	60473	5017	62364	4146	63680	2844	76586	2426	43343
22-#11	1.70	MA	37467	8346	59330	6254	64287	5082	65487	4201	64998	2897	78077	2227	47784
9L-4S		MI	35147	8346	56230	6192	61620	5019	63769	4136	65685	2850	79032	2470	43415

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

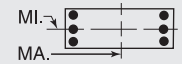


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.70	MA	36854	8346	58308	6268	63024	5094	63975	4213	62947	2906	75489	2164	47062
10L-3S		MI	35734	8346	57245	6179	62911	5008	65336	4140	67720	2842	81375	2559	43448
22-#11	1.70	MA	36255	8346	57372	6268	61781	5093	62419	4210	60790	2901	72863	2109	46147
11L-2S		MI	36567	8346	58510	6180	64524	5010	67297	4129	70376	2834	84951	2647	43453
22-#14	2.46	MA	42892	8884	70217	6565	78213	5294	82426	4313	88080	2842	108592	2363	71361
4L-9S		MI	33791	8884	55130	6545	60029	5292	61732	4307	62814	2822	76329	1861	56858
22-#14	2.46	MA	42038	8884	68738	6564	76304	5291	80088	4329	84744	2834	104486	2299	70604
5L-8S		MI	34465	8884	56381	6526	61578	5275	63682	4313	65372	2812	79532	1942	57950
22-#14	2.46	MA	41224	8884	67342	6564	74408	5309	77774	4326	81680	2847	100565	2215	69391
6L-7S		MI	35143	8884	57564	6528	63163	5279	65567	4298	68080	2822	82788	2015	59262
22-#14	2.46	MA	40430	8884	65849	6583	72587	5307	75543	4342	78683	2860	96487	2088	68610
7L-6S		MI	35831	8884	58852	6510	64734	5263	67491	4284	70665	2811	86230	2141	59936
22-#14	2.46	MA	39647	8884	64479	6583	70750	5325	73358	4358	75543	2852	92649	2013	66997
8L-5S		MI	36535	8884	60057	6512	66370	5266	69487	4290	73307	2801	89537	2225	60888
22-#14	2.46	MA	38817	8884	63135	6583	68955	5323	71098	4354	72578	2865	88850	1933	65712
9L-4S		MI	37275	8884	61333	6513	68015	5250	71502	4276	76181	2811	93021	2288	61595
22-#14	2.46	MA	37952	8884	61667	6602	67142	5340	68927	4370	69634	2877	85165	1841	63922
10L-3S		MI	38100	8884	62788	6495	69866	5254	73747	4281	79097	2801	96349	2416	61742
22-#18	4.37	MA	46159	10249	79964	7391	90174	5917	96838	4696	107509	2756	135773	1660	116272
6L-7S		MI	38785	10249	67362	7358	75406	5887	80342	4667	87827	2708	109679	1311	97319
22-#18	4.37	MA	44819	10249	77334	7424	86969	5947	92910	4722	102234	2775	128702	1435	113106
7L-6S		MI	39946	10249	69628	7328	78167	5861	83725	4645	92321	2690	115621	1537	99836
22-#18	4.37	MA	43497	10249	74922	7422	83734	5941	89064	4749	96708	2760	122023	1305	108998
8L-5S		MI	41136	10249	71745	7332	81041	5869	87230	4657	96914	2672	121325	1687	102505
24-#11	1.86	MA	41738	8456	66915	6295	74113	5097	77481	4204	81254	2862	98929	2603	54712
3L-11S		MI	32220	8456	51541	6283	55500	5096	56267	4198	55386	2856	66458	2040	43843
24-#11	1.86	MA	41061	8456	65737	6309	72614	5110	75662	4202	78893	2871	96152	2515	54643
4L-10S		MI	32736	8456	52350	6284	56574	5098	57611	4202	57248	2862	68689	2094	44635
24-#11	1.86	MA	40457	8456	64706	6309	71284	5109	74033	4214	76567	2866	93276	2469	54522
5L-9S		MI	33263	8456	53171	6285	57665	5086	58917	4192	59019	2854	70875	2158	45197
24-#11	1.86	MA	39881	8456	63734	6309	69963	5121	72421	4211	74433	2876	90523	2411	53981
6L-8S		MI	33750	8456	54043	6272	58745	5089	60277	4195	60803	2846	73129	2214	45903
24-#11	1.86	MA	39319	8456	62693	6323	68694	5120	70866	4223	72344	2885	87660	2324	53393
7E		MI	34229	8456	54867	6272	59850	5077	61591	4185	62691	2852	75415	2265	46229
24-#11	1.86	MA	38766	8456	61739	6323	67415	5133	69345	4234	70156	2880	84971	2271	52968
8L-6S		MI	34716	8456	55766	6259	60945	5079	62933	4174	64494	2845	77836	2353	46687
24-#11	1.86	MA	38173	8456	60803	6323	66164	5132	67770	4232	68090	2890	82303	2215	52130
9L-5S		MI	35214	8456	56605	6260	62086	5067	64325	4178	66336	2837	80162	2411	47163
24-#11	1.86	MA	37563	8456	59781	6337	64901	5144	66258	4244	66039	2899	79715	2152	51424
10L-4S		MI	35737	8456	57495	6261	63233	5069	65730	4167	68341	2843	82608	2455	47247
24-#11	1.86	MA	36967	8456	58844	6337	63658	5143	64701	4241	63882	2894	77089	2097	50475
11L-3S		MI	36321	8456	58510	6248	64524	5058	67297	4171	70376	2835	84951	2543	47291
24-#11	1.86	MA	36380	8456	57838	6351	62403	5156	63193	4253	61834	2904	74197	2022	49578
12L-2S		MI	37151	8456	59775	6249	66138	5060	69258	4160	73033	2827	88528	2632	47309
24-#14	2.68	MA	43015	9044	70847	6664	78994	5364	83358	4374	89174	2824	110508	2279	76826
5L-9S		MI	34634	9044	56941	6644	62338	5364	64538	4352	66615	2812	81414	1837	62115
24-#14	2.68	MA	42206	9044	69452	6664	77098	5381	81044	4370	86111	2837	106587	2195	75654
6L-8S		MI	35307	9044	58192	6626	63887	5348	66488	4358	69174	2802	84618	1918	63265
24-#14	2.68	MA	41417	9044	67958	6683	75277	5379	78813	4386	83113	2850	102508	2069	74801
7E		MI	35982	9044	59374	6628	65472	5351	68373	4343	71882	2812	87874	1991	64539
24-#14	2.68	MA	40639	9044	66589	6683	73440	5397	76628	4402	79974	2842	98671	1994	73211
8L-6S		MI	36665	9044	60663	6610	67043	5335	70298	4329	74467	2802	91315	2117	65302
24-#14	2.68	MA	39822	9044	65245	6682	71645	5395	74368	4399	77008	2855	94872	1913	71870
9L-5S		MI	37366	9044	61867	6611	68678	5339	72293	4335	77108	2791	94622	2202	66219
24-#14	2.68	MA	38954	9044	63777	6702	69832	5413	72197	4415	74064	2867	91187	1822	70117
10L-4S		MI	38101	9044	63143	6613	70324	5323	74308	4321	79983	2801	98106	2264	67052
24-#18	4.76	MA	46494	10533	81035	7602	91687	6075	98646	4802	110005	2758	139148	1396	123990
7E		MI	40205	10533	70531	7536	79446	6016	85254	4747	94433	2687	118463	1263	106514
24-#18	4.76	MA	45184	10533	78623	7600	88452	6069	94800	4829	104478	2742	132469	1265	119789
8L-6S		MI	41357	10533	72797	7505	82207	5989	88637	4724	98927	2670	124405	1488	109034

RECTANGULAR TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.24	MA	34892	7697	55075	5699	59861	4636	61475	3850	62269	2719	73668	2547	31825
2L-3S		MI	32668	7697	51729	5695	55595	4664	56289	3874	55263	2736	64331	2320	31886
8-#18	1.65	MA	36439	7981	58422	5876	64127	4765	66662	3930	69276	2700	83006	2502	42063
2L-4S		MI	32676	7981	52383	5904	56437	4785	57320	3943	56894	2735	67565	2047	41682
10-#14	1.16	MA	34709	7644	54422	5701	59242	4642	60805	3860	61453	2744	72864	2591	30132
2L-5S		MI	31730	7644	49635	5717	53124	4652	53355	3885	51341	2758	60239	2272	30024
10-#14	1.16	MA	33435	7644	52512	5700	56807	4638	57844	3875	57442	2755	67467	2463	30173
3L-4S		MI	32536	7644	50979	5719	54857	4655	55477	3870	54369	2766	63931	2335	30158
10-#18	2.07	MA	37969	8264	61768	6053	68394	4893	71848	4010	76283	2681	92343	2457	52268
2L-5S		MI	32858	8264	53366	6077	57657	4942	58776	4046	58599	2699	70491	1892	48833
10-#18	2.07	MA	35786	8264	58422	6049	64127	4921	66662	4034	69276	2699	83006	2229	52154
3L-4S		MI	34242	8264	55729	6081	60703	4914	62506	4022	63901	2716	76903	2002	51708

RECTANGULAR TIED COLUMNS 44" x 46"

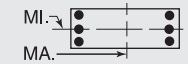
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.19	MA	37972	8008	59708	5951	64916	4844	66614	4027	67358	2857	79693	2687	33445
2L-3S		MI	34039	8008	53776	5930	57734	4857	58376	4038	57138	2862	66406	2441	31949
6-#18	1.19	MA	35626	8008	56184	5948	60424	4873	61152	4052	59960	2876	69801	2460	33506
3L-2S		MI	36265	8008	57122	5933	62000	4829	63562	4014	64144	2845	75744	2669	31872
8-#18	1.58	MA	39612	8292	63232	6129	69409	4973	72075	4106	74757	2840	89584	2645	44223
2L-4S		MI	34046	8292	54430	6139	58576	4978	59407	4107	58769	2861	69641	2169	41805
8-#18	1.58	MA	37286	8292	59708	6126	64916	5002	66614	4132	67358	2858	79693	2418	44195
3E		MI	35609	8292	57122	6107	62000	4986	63562	4118	64144	2844	75744	2396	42109
8-#18	1.58	MA	35643	8292	56876	6158	61315	4995	62243	4122	61684	2876	73220	2190	43842
4L-2S		MI	37816	8292	60469	6111	66266	4958	68749	4094	71151	2826	85081	2624	42116
10-#14	1.11	MA	37774	7955	59011	5954	64253	4850	65894	4037	66419	2880	78796	2730	31650
2L-5S		MI	33099	7955	51675	5954	55263	4847	55446	4050	53222	2885	62325	2395	30108
10-#14	1.11	MA	36430	7955	57001	5953	61691	4847	62778	4052	62198	2892	73087	2602	31692
3L-4S		MI	33906	7955	53018	5955	56996	4850	57568	4035	56251	2893	66016	2458	30217
10-#14	1.11	MA	35484	7955	55389	5972	59641	4864	60291	4048	58969	2904	69343	2474	31677
4L-3S		MI	34807	7955	54552	5936	58946	4833	59935	4040	59324	2882	69552	2586	30218
10-#14	1.11	MA	34636	7955	53978	5971	57820	4862	58061	4063	55786	2896	65444	2410	31543
5L-2S		MI	36083	7955	56462	5937	61382	4836	62896	4025	63335	2871	74949	2714	30171
10-#18	1.98	MA	41232	8575	66755	6306	73901	5101	77536	4186	82155	2822	99476	2603	54968
2L-5S		MI	34227	8575	55413	6312	59796	5135	60863	4211	60474	2825	72567	2014	49174
10-#18	1.98	MA	38928	8575	63232	6303	69409	5130	72075	4211	74757	2840	89584	2375	54854
3L-4S		MI	35614	8575	57776	6316	62843	5107	64594	4186	65775	2843	78978	2124	51840
10-#18	1.98	MA	37301	8575	60400	6335	65808	5124	67704	4201	69082	2858	83112	2148	54408
4L-3S		MI	37161	8575	60469	6284	66266	5114	68749	4198	71151	2825	85081	2351	52237
10-#18	1.98	MA	35843	8575	57916	6332	62605	5153	63783	4227	63488	2841	76333	2037	51577
5L-2S		MI	39349	8575	63815	6288	70533	5087	73935	4174	78158	2807	94418	2579	52330
12-#14	1.33	MA	38721	8114	61021	6054	66816	4922	69009	4081	70640	2870	84506	2710	37798
2L-6S		MI	33249	8114	52317	6052	55976	4936	56305	4090	54452	2886	64211	2289	34890
12-#14	1.33	MA	37385	8114	59011	6053	64253	4919	65894	4097	66419	2882	78796	2582	37819
3L-5S		MI	34014	8114	53585	6054	57699	4919	58407	4095	57234	2875	67722	2373	35862
12-#14	1.33	MA	36444	8114	57400	6072	62204	4937	63406	4092	63189	2894	75052	2454	37765
4E		MI	34816	8114	54929	6055	59432	4922	60529	4080	60262	2883	71414	2436	36008
12-#14	1.33	MA	35602	8114	55988	6071	60383	4934	61176	4108	60007	2886	71154	2390	37594
5L-3S		MI	35711	8114	56462	6036	61382	4905	62896	4085	63335	2872	74949	2564	36047
12-#14	1.33	MA	34800	8114	54656	6070	58573	4951	58969	4104	57084	2898	67438	2306	36550
6L-2S		MI	36980	8114	58372	6037	63817	4908	65857	4070	67346	2861	80347	2692	36018

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

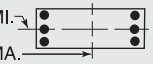


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	2.37	MA	42836	8859	70279	6483	78394	5230	82997	4266	89554	2804	109367	2561	65676
2L-6S		MI	34480	8859	56529	6486	61033	5256	62355	4279	62610	2824	75837	1819	57042
12-#18	2.37	MA	40551	8859	66755	6480	73901	5259	77536	4291	82155	2823	99476	2333	65495
3L-5S		MI	35791	8859	58760	6489	64062	5263	66049	4290	67481	2806	81904	1969	58940
12-#18	2.37	MA	38940	8859	63923	6513	70300	5252	73166	4281	76481	2841	93003	2106	64967
4E		MI	37165	8859	61122	6493	67109	5236	69780	4266	72782	2824	88315	2078	61868
12-#18	2.37	MA	37497	8859	61440	6510	67098	5281	69244	4306	70886	2823	86224	1995	61874
5L-3S		MI	38697	8859	63815	6462	70533	5243	73935	4278	78158	2806	94418	2306	62345
12-#18	2.37	MA	36121	8859	59096	6507	63914	5275	65361	4296	65745	2842	79793	1845	59861
6L-2S		MI	40867	8859	67161	6465	74799	5215	79121	4253	85164	2788	103756	2533	62503
14-#11	1.08	MA	37689	7931	58694	5957	63963	4854	65585	4042	66020	2891	78431	2750	30863
2L-7S		MI	32861	7931	50990	5967	54487	4860	54533	4058	52072	2910	60722	2368	28816
14-#11	1.08	MA	36749	7931	57290	5957	62174	4852	63410	4054	63073	2900	74421	2662	30892
3L-6S		MI	33384	7931	51936	5953	55640	4861	55946	4047	53970	2902	63290	2455	29372
14-#11	1.08	MA	36089	7931	56166	5970	60745	4865	61675	4051	60821	2909	71789	2573	30902
4L-5S		MI	33921	7931	52820	5954	56841	4849	57411	4050	55910	2894	65759	2514	29451
14-#11	1.08	MA	35498	7931	55182	5970	59475	4863	60121	4062	58602	2904	69056	2528	30867
5L-4S		MI	34484	7931	53757	5954	58050	4851	58892	4039	58022	2899	68348	2558	29474
14-#11	1.08	MA	34935	7931	54255	5970	58214	4875	58582	4060	56565	2912	66445	2470	30772
6L-3S		MI	35112	7931	54826	5941	59410	4839	60542	4042	60165	2891	70836	2647	29456
14-#11	1.08	MA	34385	7931	53261	5983	57004	4874	57098	4071	54572	2921	63730	2382	30170
7L-2S		MI	36005	7931	56161	5942	61111	4841	62610	4032	62967	2883	74629	2735	29425
14-#14	1.56	MA	39662	8274	63031	6153	69379	4994	72125	4126	74861	2860	90215	2689	43935
2L-7S		MI	33421	8274	52870	6171	56758	5005	57239	4150	55740	2887	65954	2141	39761
14-#14	1.56	MA	38333	8274	61021	6153	66816	4992	69009	4142	70640	2872	84506	2561	43927
3L-6S		MI	34162	8274	54227	6152	58411	5008	59266	4135	58463	2876	69608	2267	40513
14-#14	1.56	MA	37398	8274	59410	6172	64767	5009	66522	4137	67410	2884	80762	2433	43845
4L-5S		MI	34922	8274	55495	6153	60134	4991	61368	4140	61245	2865	73119	2351	41611
14-#14	1.56	MA	36562	8274	57998	6171	62946	5006	64292	4153	64228	2876	76863	2369	43641
5L-4S		MI	35719	8274	56839	6154	61867	4994	63490	4125	64274	2873	76811	2414	41789
14-#14	1.56	MA	35764	8274	56666	6170	61136	5024	62084	4148	61305	2888	73147	2285	42471
6L-3S		MI	36608	8274	58372	6136	63817	4978	65857	4130	67346	2862	80347	2542	41857
14-#14	1.56	MA	34986	8274	55241	6189	59399	5021	59955	4164	58445	2899	69281	2159	41657
7L-2S		MI	37871	8274	60283	6137	66253	4981	68817	4115	71358	2851	85744	2670	41854
14-#18	2.77	MA	44425	9143	73802	6661	82886	5359	88458	4346	96952	2787	119259	2518	76365
2L-7S		MI	34774	9143	57489	6694	62391	5412	63977	4383	64849	2823	78856	1549	63516
14-#18	2.77	MA	42158	9143	70279	6658	78394	5387	82997	4371	89554	2805	109367	2291	76123
3L-6S		MI	36041	9143	59876	6663	65300	5384	67541	4359	69616	2805	85174	1774	66653
14-#18	2.77	MA	40562	9143	67447	6690	74793	5381	78627	4361	83880	2823	102895	2063	75506
4L-5S		MI	37339	9143	62106	6667	68329	5392	71236	4370	74487	2787	91242	1924	68734
14-#18	2.77	MA	39134	9143	64964	6687	71590	5410	74705	4386	78285	2806	96116	1953	72199
5L-4S		MI	38699	9143	64469	6671	71375	5364	74966	4346	79789	2805	97653	2033	71801
14-#18	2.77	MA	37771	9143	62620	6684	68406	5403	70822	4376	73144	2824	89684	1803	70006
6L-3S		MI	40218	9143	67161	6639	74799	5372	79121	4357	85164	2787	103756	2261	72439
14-#18	2.77	MA	36441	9143	60112	6716	65349	5432	67075	4401	68112	2842	82990	1578	66642
7L-2S		MI	42370	9143	70508	6643	79065	5344	84307	4333	92171	2770	113093	2488	72657
16-#11	1.23	MA	38355	8042	60097	6026	65753	4904	67760	4074	68967	2884	82440	2737	35155
2L-8S		MI	32992	8042	51457	6035	55025	4922	55218	4100	52885	2898	62095	2302	32374
16-#11	1.23	MA	37418	8042	58694	6026	63963	4902	65585	4085	66020	2893	78431	2649	35175
3L-7S		MI	33505	8042	52325	6036	56189	4910	56601	4089	54874	2903	64515	2354	32769
16-#11	1.23	MA	36761	8042	57570	6040	62534	4915	63850	4082	63768	2902	75798	2560	35167
4L-6S		MI	34026	8042	53271	6022	57341	4912	58015	4078	56772	2895	67083	2441	33350
16-#11	1.23	MA	36173	8042	56586	6039	61265	4913	62296	4093	61549	2897	73066	2515	35115
5E		MI	34560	8042	54154	6023	58542	4900	59479	4081	58711	2887	69552	2500	33492
16-#11	1.23	MA	35613	8042	55658	6039	60003	4926	60757	4091	59512	2905	70455	2457	34958
6L-4S		MI	35120	8042	55091	6023	59751	4901	60960	4070	60823	2892	72141	2544	33532
16-#11	1.23	MA	35066	8042	54665	6053	58793	4924	59273	4102	57518	2914	67739	2369	34330
7L-3S		MI	35746	8042	56161	6010	61111	4889	62610	4073	62967	2884	74629	2633	33531

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

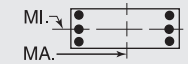


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.23	MA	34527	8042	53754	6052	57571	4937	57821	4113	55430	2909	65185	2317	33900
8L-2S		MI	36636	8042	57495	6011	62812	4891	64678	4063	65769	2876	78421	2721	33508
16-#14	1.78	MA	40597	8434	65042	6253	71942	5066	75240	4171	79081	2850	95924	2669	50062
2L-8S		MI	33606	8434	53536	6269	57524	5094	58215	4209	56900	2868	67902	2045	44197
16-#14	1.78	MA	39274	8434	63031	6252	69379	5064	72125	4187	74861	2862	90215	2541	50027
3L-7S		MI	34332	8434	54781	6271	59193	5077	60200	4194	59752	2877	71351	2119	45422
16-#14	1.78	MA	38345	8434	61420	6271	67330	5081	69637	4182	71631	2874	86471	2413	49918
4L-6S		MI	35069	8434	56138	6252	60847	5080	62227	4180	62474	2866	75005	2245	46147
16-#14	1.78	MA	37514	8434	60008	6271	65509	5079	67407	4198	68449	2866	82572	2349	49671
5E		MI	35824	8434	57406	6253	62570	5064	64328	4185	65256	2855	78516	2329	47322
16-#14	1.78	MA	36722	8434	58677	6270	63699	5096	65200	4193	65526	2878	78856	2265	48404
6L-4S		MI	36615	8434	58750	6254	64303	5067	66451	4170	68285	2863	82208	2392	47562
16-#14	1.78	MA	35949	8434	57251	6289	61962	5093	63070	4209	62666	2889	74990	2139	47617
7L-3S		MI	37500	8434	60283	6236	66253	5050	68817	4175	71358	2852	85744	2520	47656
16-#14	1.78	MA	35186	8434	55944	6288	60209	5111	60986	4224	59670	2881	71347	2064	46313
8L-2S		MI	38756	8434	62193	6237	68689	5053	71778	4160	75369	2841	91141	2648	47683
16-#18	3.16	MA	43751	9427	73802	6835	82886	5516	88458	4451	96952	2787	119259	2249	86741
3L-7S		MI	36331	9427	60835	6872	66657	5541	69163	4463	71855	2804	88193	1503	73266
16-#18	3.16	MA	42169	9427	70971	6867	79285	5509	84088	4441	91278	2805	112786	2021	85703
4L-6S		MI	37586	9427	63222	6840	69566	5513	72728	4439	76623	2786	94511	1728	76293
16-#18	3.16	MA	40754	9427	68487	6864	76082	5538	80166	4466	85684	2788	106007	1910	82548
5E		MI	38872	9427	65452	6844	72595	5520	76422	4450	81494	2769	100579	1879	78553
16-#18	3.16	MA	39405	9427	66143	6861	72899	5532	76283	4456	80542	2806	99576	1760	80178
6L-4S		MI	40220	9427	67815	6848	75641	5493	80152	4426	86795	2786	106990	1988	81473
16-#18	3.16	MA	38088	9427	63635	6894	69842	5560	72536	4481	75511	2824	92881	1535	76926
7L-3S		MI	41725	9427	70508	6816	79065	5500	84307	4437	92171	2769	113093	2215	82523
16-#18	3.16	MA	36789	9427	61334	6891	66756	5554	68868	4506	70241	2807	86547	1406	73315
8L-2S		MI	43861	9427	73854	6820	83332	5472	89494	4413	99177	2751	122431	2443	82796
18-#11	1.39	MA	39017	8153	61501	6095	67542	4954	69936	4105	71914	2877	86449	2724	39441
2L-9S		MI	33106	8153	51940	6104	55590	4970	55855	4128	53809	2899	63496	2232	35751
18-#11	1.39	MA	38084	8153	60097	6095	65753	4952	67760	4116	68967	2886	82440	2636	39452
3L-8S		MI	33635	8153	52792	6104	56726	4972	57286	4131	55687	2891	65887	2288	36344
18-#11	1.39	MA	37430	8153	58973	6109	64323	4965	66026	4113	66714	2895	79808	2547	39426
4L-7S		MI	34147	8153	53659	6105	57890	4960	58669	4120	57675	2897	68307	2340	36727
18-#11	1.39	MA	36845	8153	57989	6108	63054	4963	64471	4124	64496	2890	77075	2502	39359
5L-6S		MI	34665	8153	54605	6092	59043	4962	60083	4109	59573	2888	70876	2427	37285
18-#11	1.39	MA	36287	8153	57062	6108	61793	4976	62932	4122	62459	2899	74464	2444	39098
6L-5S		MI	35196	8153	55489	6092	60244	4950	61548	4112	61513	2880	73344	2486	37529
18-#11	1.39	MA	35743	8153	56068	6122	60582	4974	61449	4133	60465	2907	71748	2356	38495
7L-4S		MI	35754	8153	56425	6093	61452	4951	63028	4102	63625	2885	75934	2530	37584
18-#11	1.39	MA	35206	8153	55158	6122	59361	4987	59996	4144	58377	2902	69194	2304	38077
8L-3S		MI	36377	8153	57495	6079	62812	4939	64678	4105	65769	2877	78421	2619	37600
18-#11	1.39	MA	34641	8153	54264	6121	58167	4985	58493	4142	56405	2911	66664	2248	37439
9L-2S		MI	37263	8153	58829	6080	64513	4941	66747	4094	68570	2869	82214	2707	37585
18-#14	2.00	MA	41526	8593	67052	6353	74505	5139	78356	4216	83302	2840	101634	2648	56175
2L-9S		MI	33776	8593	54129	6388	58329	5163	59123	4249	58217	2869	69897	1942	48709
18-#14	2.00	MA	40210	8593	65042	6352	71942	5136	75240	4232	79081	2852	95924	2520	56120
3L-8S		MI	34515	8593	55447	6369	59960	5166	61176	4254	60911	2858	73299	2023	49786
18-#14	2.00	MA	39286	8593	63430	6371	69892	5153	72753	4227	75852	2864	92180	2392	55985
4L-7S		MI	35237	8593	56691	6370	61629	5150	63161	4239	63763	2867	76748	2097	51089
18-#14	2.00	MA	38460	8593	62018	6370	68071	5151	70523	4243	72669	2856	88282	2328	55562
5L-6S		MI	35969	8593	58048	6352	63283	5153	65188	4224	66486	2856	80402	2223	51791
18-#14	2.00	MA	37673	8593	60687	6370	66262	5168	68315	4238	69747	2868	84566	2244	54346
6L-5S		MI	36719	8593	59316	6353	65005	5136	67289	4229	69268	2845	83913	2307	52916
18-#14	2.00	MA	36904	8593	59261	6389	64525	5166	66186	4254	66887	2880	80699	2118	53584
7L-4S		MI	37506	8593	60660	6354	66739	5139	69412	4215	72296	2854	87605	2370	53330
18-#14	2.00	MA	36147	8593	57954	6388	62771	5183	64101	4269	63891	2872	77056	2044	52203
8L-3S		MI	38386	8593	62193	6335	68689	5122	71778	4220	75369	2842	91141	2498	53449
18-#14	2.00	MA	35357	8593	56671	6387	61059	5180	61944	4265	61061	2883	73456	1963	51045
9L-2S		MI	39635	8593	64104	6336	71124	5125	74739	4205	79380	2831	96538	2626	53495

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis



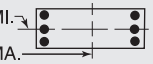
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	3.56	MA	43762	9710	74494	7045	83777	5638	89549	4521	98677	2788	122678	1979	95935
4L-7S		MI	37874	9710	64181	7049	70923	5669	74349	4543	78862	2785	97531	1458	83034
18-#18	3.56	MA	42359	9710	72011	7042	80575	5667	85627	4546	93082	2770	115899	1868	92917
5L-6S		MI	39117	9710	66568	7018	73832	5642	77914	4519	83629	2768	103849	1683	85958
18-#18	3.56	MA	41023	9710	69667	7039	77391	5660	81744	4536	87941	2789	109467	1718	90375
6L-5S		MI	40391	9710	68799	7021	76861	5649	81608	4530	88501	2750	109916	1834	88390
18-#18	3.56	MA	39718	9710	67159	7071	74334	5689	77998	4561	82910	2807	102773	1493	87229
7L-4S		MI	41727	9710	71161	7025	79908	5621	85339	4506	93802	2768	116328	1943	91178
18-#18	3.56	MA	38432	9710	64858	7068	71249	5683	74329	4586	77640	2789	96439	1364	83520
8L-3S		MI	43220	9710	73854	6994	83332	5629	89494	4517	99177	2750	122431	2170	92598
20-#11	1.54	MA	39676	8263	62904	6165	69331	5004	72111	4136	74861	2870	90458	2711	43722
2L-10S		MI	33189	8263	52345	6186	56142	5032	56548	4170	54747	2901	64968	2155	39030
20-#11	1.54	MA	38747	8263	61501	6164	67542	5003	69936	4147	71914	2879	86449	2623	43718
3L-9S		MI	33748	8263	53274	6173	57291	5020	57923	4159	56611	2892	67288	2218	39671
20-#11	1.54	MA	38095	8263	60377	6178	66113	5015	68201	4144	69661	2888	83817	2534	43681
4L-8S		MI	34275	8263	54126	6174	58428	5022	59354	4162	58489	2884	69680	2274	40317
20-#11	1.54	MA	37513	8263	59393	6178	64843	5014	66646	4156	67443	2883	81084	2489	43600
5L-7S		MI	34784	8263	54993	6174	59591	5010	60738	4151	60477	2890	72100	2326	40690
20-#11	1.54	MA	36958	8263	58465	6177	63582	5026	65108	4153	65405	2892	78473	2431	43247
6E		MI	35300	8263	55939	6161	60744	5012	62151	4141	62375	2881	74668	2413	41227
20-#11	1.54	MA	36416	8263	57472	6191	62372	5024	63624	4164	63412	2900	75758	2343	42665
7L-5S		MI	35829	8263	56823	6161	61945	5000	63616	4144	64315	2873	77137	2471	41562
20-#11	1.54	MA	35882	8263	56561	6191	61150	5037	62171	4175	61324	2895	73203	2291	42257
8L-4S		MI	36384	8263	57760	6162	63153	5002	65096	4133	66427	2879	79726	2516	41631
20-#11	1.54	MA	35320	8263	55667	6190	59956	5035	60668	4173	59352	2904	70674	2235	41567
9L-3S		MI	37005	8263	58829	6149	64513	4990	66747	4136	68570	2870	82214	2605	41660
20-#11	1.54	MA	34733	8263	54691	6204	58751	5048	59225	4184	57395	2913	68220	2172	40877
10L-2S		MI	37888	8263	60164	6149	66215	4991	68815	4125	71372	2862	86007	2693	41658
20-#14	2.22	MA	41140	8753	67052	6452	74505	5209	78356	4276	83302	2842	101634	2500	62206
3L-9S		MI	34695	8753	56040	6487	60764	5236	62084	4294	62228	2859	75294	1920	54300
20-#14	2.22	MA	40221	8753	65440	6471	72455	5226	75868	4272	80072	2854	97890	2372	62049
4L-8S		MI	35419	8753	57357	6469	62395	5239	64137	4299	64923	2848	78696	2001	55384
20-#14	2.22	MA	39400	8753	64029	6470	70634	5223	73638	4288	76890	2846	93991	2308	61466
5L-7S		MI	36136	8753	58602	6470	64064	5222	66122	4284	67774	2857	82146	2075	56761
20-#14	2.22	MA	38617	8753	62697	6469	68825	5240	71431	4283	73967	2858	90275	2224	60297
6E		MI	36864	8753	59959	6451	65718	5225	68149	4269	70497	2846	85800	2201	57443
20-#14	2.22	MA	37854	8753	61272	6488	67087	5238	69301	4299	71107	2870	86409	2098	59555
7L-5S		MI	37609	8753	61227	6452	67441	5208	70250	4274	73279	2835	89311	2285	58523
20-#14	2.22	MA	37101	8753	59964	6488	65334	5255	67217	4314	68112	2862	82765	2023	58101
8L-4S		MI	38392	8753	62570	6454	69174	5211	72373	4259	76308	2844	93002	2348	59094
20-#14	2.22	MA	36316	8753	58681	6487	63621	5253	65060	4310	65281	2873	79165	1942	56952
9L-3S		MI	39266	8753	64104	6435	71124	5195	74739	4264	79380	2832	96538	2476	59235
20-#14	2.22	MA	35487	8753	57280	6506	61891	5270	62988	4325	62473	2885	75673	1851	55234
10L-2S		MI	40510	8753	66014	6436	73560	5198	77700	4250	83391	2821	101935	2604	59300
20-#18	3.95	MA	43952	9994	75535	7219	85067	5795	91088	4626	100481	2753	125790	1826	103303
5L-7S		MI	39403	9994	67528	7226	75189	5798	79536	4623	85868	2767	106868	1413	92819
20-#18	3.95	MA	42627	9994	73191	7216	81883	5789	87205	4616	95340	2771	119359	1676	100596
6E		MI	40635	9994	69915	7195	78098	5770	83100	4598	90636	2749	113186	1638	95646
20-#18	3.95	MA	41334	9994	70682	7248	78826	5818	83459	4641	90308	2789	112664	1451	97549
7L-5S		MI	41898	9994	72145	7199	81127	5778	86794	4610	95507	2731	119254	1788	98245
20-#18	3.95	MA	40060	9994	68381	7245	75741	5811	79790	4666	85038	2772	106330	1322	93742
8L-4S		MI	43223	9994	74507	7202	84174	5750	90525	4586	100808	2749	125665	1897	100911
22-#11	1.70	MA	40333	8374	64308	6234	71121	5054	74286	4167	77808	2863	94468	2698	48000
2L-11S		MI	33286	8374	52828	6255	56713	5081	57201	4198	55588	2888	66398	2086	42170

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

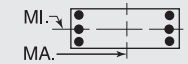


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.70	MA	39407	8374	62904	6233	69331	5053	72111	4178	74861	2872	90458	2609	47980
3L-10S		MI	33831	8374	53679	6255	57843	5083	58616	4201	57548	2894	68761	2141	42972
22-#11	1.70	MA	38758	8374	61780	6247	67902	5065	70376	4175	72608	2881	87826	2521	47932
4L-9S		MI	34388	8374	54609	6242	58992	5071	59991	4190	59412	2886	71081	2204	43597
22-#11	1.70	MA	38178	8374	60796	6247	66633	5064	68821	4187	70390	2876	85093	2476	47837
5L-8S		MI	34912	8374	55460	6243	60129	5072	61422	4193	61291	2877	73473	2260	44292
22-#11	1.70	MA	37625	8374	59869	6247	65372	5076	67283	4184	68352	2885	82483	2418	47401
6L-7S		MI	35419	8374	56328	6243	61292	5060	62806	4182	63279	2883	75893	2312	44657
22-#11	1.70	MA	37086	8374	58875	6260	64161	5075	65799	4195	66359	2894	79767	2330	46839
7L-6S		MI	35933	8374	57274	6230	62445	5062	64219	4172	65177	2874	78461	2399	45175
22-#11	1.70	MA	36555	8374	57965	6260	62939	5087	64346	4206	64271	2889	77212	2278	46440
8L-5S		MI	36459	8374	58157	6230	63646	5050	65684	4175	67116	2866	80930	2457	45592
22-#11	1.70	MA	35995	8374	57071	6260	61746	5086	62843	4204	62299	2897	74683	2222	45701
9L-4S		MI	37012	8374	59094	6231	64854	5052	67164	4164	69228	2872	83519	2502	45674
22-#11	1.70	MA	35410	8374	56095	6273	60540	5098	61400	4215	60342	2906	72229	2159	45027
10L-3S		MI	37630	8374	60164	6218	66215	5040	68815	4167	71372	2863	86007	2591	45715
22-#11	1.70	MA	34838	8374	55201	6273	59353	5097	59914	4212	58283	2901	69734	2104	44174
11L-2S		MI	38509	8374	61498	6218	67916	5041	70883	4156	74174	2855	89799	2679	45727
22-#14	2.45	MA	41150	8912	67450	6571	75018	5298	78984	4317	84293	2844	103599	2351	68109
4L-9S		MI	35594	8912	57950	6587	63200	5308	65044	4339	66239	2849	80691	1898	59848
22-#14	2.45	MA	40334	8912	66039	6570	73197	5296	76754	4332	81111	2836	99700	2288	67381
5L-8S		MI	36317	8912	59267	6569	64831	5311	67098	4344	68934	2838	84093	1979	60991
22-#14	2.45	MA	39556	8912	64707	6569	71387	5313	74546	4328	78188	2848	95984	2203	66254
6L-7S		MI	37030	8912	60512	6570	66500	5294	69083	4329	71786	2847	87543	2053	62411
22-#14	2.45	MA	38798	8912	63282	6588	69650	5310	72417	4344	75328	2860	92118	2077	65531
7L-6S		MI	37753	8912	61869	6551	68154	5297	71110	4314	74508	2836	91197	2179	63101
22-#14	2.45	MA	38049	8912	61975	6587	67897	5328	70332	4359	72332	2852	88474	2003	64008
8L-5S		MI	38494	8912	63137	6552	69877	5281	73211	4319	77290	2825	94708	2263	64141
22-#14	2.45	MA	37279	8912	60691	6587	66184	5325	68175	4355	69502	2863	84874	1922	62801
9L-4S		MI	39272	8912	64481	6553	71610	5284	75334	4304	80319	2834	98399	2326	64854
22-#14	2.45	MA	36444	8912	59290	6606	64453	5342	66104	4370	66693	2875	81382	1830	61120
10L-3S		MI	40142	8912	66014	6535	73560	5267	77700	4309	83391	2823	101935	2454	65016
22-#18	4.35	MA	44218	10278	76714	7393	86376	5917	92666	4695	102738	2753	129250	1634	110836
6L-7S		MI	40920	10278	70874	7404	79456	5927	84722	4702	92875	2748	116206	1368	102619
22-#18	4.35	MA	42937	10278	74206	7426	83319	5946	88920	4721	97707	2771	122556	1409	107883
7L-6S		MI	42141	10278	73261	7372	82365	5899	88287	4678	97643	2730	122524	1593	105355
22-#18	4.35	MA	41674	10278	71905	7423	80233	5940	85251	4746	92437	2754	116222	1280	103981
8L-5S		MI	43393	10278	75491	7376	85394	5906	91981	4690	102514	2713	128591	1743	108114
24-#11	1.85	MA	40063	8485	64308	6303	71121	5103	74286	4209	77808	2865	94468	2596	52240
3L-11S		MI	33926	8485	54162	6324	58414	5131	59269	4229	58390	2881	70191	2072	46080
24-#11	1.85	MA	39417	8485	63184	6316	69691	5115	72551	4207	75555	2874	91836	2508	52180
4L-10S		MI	34469	8485	55013	6325	59545	5133	60684	4232	60350	2887	72554	2126	46917
24-#11	1.85	MA	38839	8485	62200	6316	68422	5114	70997	4218	73337	2869	89103	2463	52073
5L-9S		MI	35024	8485	55943	6311	60693	5121	62059	4221	62214	2879	74874	2190	47527
24-#11	1.85	MA	38289	8485	61272	6316	67161	5126	69458	4215	71299	2878	86492	2405	51560
6L-8S		MI	35546	8485	56795	6312	61830	5122	63490	4224	64092	2870	77266	2246	48269
24-#11	1.85	MA	37753	8485	60279	6329	65950	5125	67974	4226	69306	2887	83776	2317	51016
7E		MI	36050	8485	57662	6312	62993	5110	64874	4214	66080	2876	79685	2298	48627
24-#11	1.85	MA	37224	8485	59368	6329	64729	5137	66522	4238	67218	2882	81222	2265	50625
8L-6S		MI	36562	8485	58608	6299	64146	5112	66287	4203	67978	2868	82254	2385	49129
24-#11	1.85	MA	36667	8485	58474	6329	63535	5136	65018	4235	65246	2890	78692	2209	49839
9L-5S		MI	37086	8485	59492	6300	65347	5100	67752	4206	69918	2859	84723	2443	49620
24-#11	1.85	MA	36084	8485	57498	6342	62329	5148	63575	4246	63289	2899	76238	2146	49180
10L-4S		MI	37636	8485	60428	6300	66556	5102	69232	4195	72030	2865	87312	2488	49714
24-#11	1.85	MA	35514	8485	56604	6342	61143	5147	62089	4243	61230	2894	73744	2091	48292
11L-3S		MI	38252	8485	61498	6287	67916	5090	70883	4198	74174	2856	89799	2577	49766
24-#11	1.85	MA	34954	8485	55643	6356	59945	5159	60649	4255	59275	2903	71000	2016	47451
12L-2S		MI	39128	8485	62832	6287	69617	5092	72951	4187	76975	2848	93592	2665	49788
24-#14	2.67	MA	41263	9072	68049	6670	75760	5368	79869	4377	85332	2826	105410	2267	73305
5L-9S		MI	36488	9072	59860	6687	65636	5380	68005	4384	70251	2839	86089	1876	65404

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#14	2.67	MA	40490	9072	66717	6669	73950	5385	77662	4373	82409	2838	101693	2183	72217
6L-8S		MI	37209	9072	61178	6668	67267	5383	70059	4389	72945	2828	89490	1957	66605
24-#14	2.67	MA	39735	9072	65292	6688	72213	5383	75532	4388	79549	2850	97827	2057	71408
7E		MI	37918	9072	62422	6669	68936	5367	72043	4374	75797	2837	92940	2031	67986
24-#14	2.67	MA	38992	9072	63985	6687	70460	5400	73448	4404	76553	2842	94184	1982	69921
8L-6S		MI	38637	9072	63780	6651	70590	5370	74071	4359	78520	2826	96594	2157	68766
24-#14	2.67	MA	38222	9072	62702	6686	68747	5397	71291	4400	73723	2854	90584	1901	68657
9L-5S		MI	39374	9072	65047	6652	72312	5353	76172	4364	81302	2815	100105	2241	69769
24-#14	2.67	MA	37395	9072	61301	6705	67016	5415	69219	4415	70914	2865	87092	1810	67012
10L-4S		MI	40147	9072	66391	6653	74046	5356	78294	4349	84330	2824	103797	2304	70611
24-#18	4.74	MA	44527	10561	77730	7603	87811	6075	94381	4801	105105	2754	132447	1367	118231
7E		MI	42425	10561	74220	7581	83722	6055	89908	4782	99882	2729	125543	1322	112432
24-#18	4.74	MA	43275	10561	75428	7600	84726	6068	90712	4826	99835	2736	126113	1237	114234
8L-6S		MI	43637	10561	76607	7550	86631	6027	93473	4758	104649	2712	131861	1548	115083

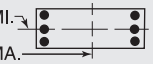
RECTANGULAR TIED COLUMNS 44" x 48"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.14	MA	41178	8319	64517	6204	70165	5052	71945	4203	72565	2993	85917	2827	35065
2L-3S		MI	35409	8319	55823	6165	59873	5051	60463	4202	59013	2988	68481	2563	32007
6-#18	1.14	MA	38708	8319	60817	6202	65447	5082	66209	4230	64794	3013	75471	2599	35126
3L-2S		MI	37638	8319	59170	6168	64139	5023	65650	4178	66019	2971	77819	2791	31918
8-#18	1.52	MA	42910	8603	68218	6382	74884	5181	77681	4283	80336	2976	96363	2787	46383
2L-4S		MI	35416	8603	56477	6373	60715	5172	61494	4271	60644	2987	71716	2291	41920
8-#18	1.52	MA	40462	8603	64517	6379	70165	5211	71945	4309	72565	2995	85917	2560	46355
3E		MI	36982	8603	59170	6342	64139	5179	65650	4282	66019	2970	77819	2518	42179
8-#18	1.52	MA	38735	8603	61547	6412	66387	5205	67359	4300	66611	3015	79074	2332	46002
4L-2S		MI	39191	8603	62516	6346	68406	5151	70836	4258	73026	2952	87156	2746	42169
10-#14	1.07	MA	40963	8266	63777	6207	69458	5058	71176	4213	71562	3016	84928	2868	33169
2L-5S		MI	34469	8266	53714	6190	57402	5041	57537	4215	55104	3012	64410	2518	30187
10-#14	1.07	MA	39550	8266	61667	6206	66768	5055	67906	4229	67132	3028	78907	2740	33211
3L-4S		MI	35277	8266	55058	6191	59135	5044	59659	4200	58133	3020	68102	2581	30273
10-#14	1.07	MA	38556	8266	59977	6226	64619	5073	65297	4225	63745	3041	74954	2612	33195
4L-3S		MI	36178	8266	56591	6173	61085	5027	62026	4205	61205	3009	71638	2709	30261
10-#14	1.07	MA	37667	8266	58498	6225	62710	5071	62960	4241	60409	3033	70848	2548	33062
5L-2S		MI	37456	8266	58502	6174	63521	5031	64987	4190	65217	2998	77035	2837	30210
10-#18	1.89	MA	44622	8887	71919	6559	79602	5309	83416	4363	88107	2958	106809	2748	57668
2L-5S		MI	35596	8887	57461	6547	61935	5328	62950	4375	62349	2951	74642	2136	49507
10-#18	1.89	MA	42195	8887	68218	6557	74884	5339	77681	4389	80336	2977	96363	2520	57554
3L-4S		MI	36986	8887	59823	6551	64982	5300	66681	4351	67650	2969	81053	2245	51965
10-#18	1.89	MA	40485	8887	65247	6590	71106	5333	73095	4380	74382	2997	89520	2293	57108
4L-3S		MI	38536	8887	62516	6519	68406	5308	70836	4362	73026	2951	87156	2473	52316
10-#18	1.89	MA	38954	8887	62644	6588	67747	5363	68982	4406	68514	2981	82374	2181	54340
5L-2S		MI	40728	8887	65862	6523	72672	5280	76022	4338	80032	2933	96494	2701	52386
12-#14	1.28	MA	41963	8426	65887	6306	72148	5130	74446	4258	75992	3006	90950	2849	39621
2L-6S		MI	34618	8426	54357	6289	58115	5130	58396	4255	56333	3013	66296	2412	35092
12-#14	1.28	MA	40557	8426	63777	6306	69458	5128	71176	4274	71562	3018	84928	2721	39641
3L-5S		MI	35384	8426	55625	6290	59838	5114	60498	4260	59115	3002	69807	2496	35947
12-#14	1.28	MA	39570	8426	62087	6325	67309	5145	68567	4270	68175	3031	80976	2593	39588
4E		MI	36187	8426	56968	6291	61571	5117	62620	4245	62144	3010	73499	2559	36070
12-#14	1.28	MA	38686	8426	60607	6325	65400	5143	66230	4286	64839	3023	76870	2529	39417
5L-3S		MI	37083	8426	58502	6272	63521	5100	64987	4250	65217	2999	77035	2687	36094
12-#14	1.28	MA	37844	8426	59212	6325	63504	5161	63916	4282	61776	3036	72949	2445	38428
6L-2S		MI	38354	8426	60412	6274	65957	5103	67948	4235	69228	2988	82432	2815	36060

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis



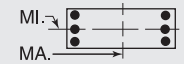
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	2.27	MA	46316	9170	75620	6736	84321	5438	89152	4443	95878	2940	117255	2708	68916
2L-6S		MI	35848	9170	58576	6720	63172	5449	64442	4443	64485	2950	77912	1941	57517
12-#18	2.27	MA	43909	9170	71919	6734	79602	5468	83416	4469	88107	2960	106809	2481	68735
3L-5S		MI	37162	9170	60807	6724	66201	5457	68136	4455	69356	2932	83979	2091	59267
12-#18	2.27	MA	42216	9170	68948	6767	75824	5462	78831	4460	82153	2979	99966	2253	68207
4E		MI	38539	9170	63169	6728	69248	5429	71867	4430	74657	2950	90391	2200	62001
12-#18	2.27	MA	40700	9170	66344	6765	72466	5492	74718	4486	76285	2963	92820	2141	65162
5L-3S		MI	40075	9170	65862	6696	72672	5436	76022	4442	80032	2932	96494	2428	62431
12-#18	2.27	MA	39255	9170	63887	6763	69127	5486	70646	4477	70894	2983	86024	1991	63128
6L-2S		MI	42249	9170	69208	6700	76938	5408	81208	4418	87039	2915	105831	2655	62569
14-#11	1.03	MA	40871	8243	63439	6210	69148	5062	70845	4219	71135	3027	84522	2888	32337
2L-7S		MI	34230	8243	53026	6204	56627	5055	56626	4224	53957	3038	62812	2491	28959
14-#11	1.03	MA	39883	8243	61967	6210	67271	5060	68563	4231	68043	3036	80296	2799	32366
3L-6S		MI	34754	8243	53972	6191	57779	5057	58039	4213	55855	3029	65381	2579	29442
14-#11	1.03	MA	39190	8243	60789	6224	65772	5073	66745	4228	65681	3045	77520	2711	32376
4L-5S		MI	35291	8243	54856	6191	58980	5045	59504	4216	57795	3021	67849	2637	29505
14-#11	1.03	MA	38570	8243	59758	6224	64442	5072	65115	4240	63356	3041	74643	2665	32342
5L-4S		MI	35855	8243	55792	6192	60189	5046	60984	4205	59907	3027	70439	2681	29517
14-#11	1.03	MA	37980	8243	58786	6224	63121	5085	63503	4238	61221	3050	71890	2607	32246
6L-3S		MI	36484	8243	56862	6178	61549	5034	62635	4208	62050	3018	72926	2770	29494
14-#11	1.03	MA	37404	8243	57745	6238	61853	5084	61949	4249	59133	3059	69027	2520	31678
7L-2S		MI	37378	8243	58196	6179	63250	5036	64703	4197	64852	3010	76719	2859	29460
14-#14	1.49	MA	42956	8585	67997	6406	74838	5202	77716	4303	80422	2996	96971	2830	46061
2L-7S		MI	34789	8585	54910	6407	58897	5200	59330	4315	57622	3014	68039	2263	39956
14-#14	1.49	MA	41557	8585	65887	6406	72148	5200	74446	4319	75992	3008	90950	2702	46054
3L-6S		MI	35532	8585	56267	6389	60551	5203	61357	4300	60345	3003	71693	2390	40713
14-#14	1.49	MA	40576	8585	64197	6425	69999	5218	71837	4315	72605	3021	86997	2574	45971
4L-5S		MI	36293	8585	57535	6390	62273	5186	63458	4305	63127	2992	75205	2474	41701
14-#14	1.49	MA	39698	8585	62717	6425	68090	5216	69500	4331	69269	3014	82892	2510	45767
5L-4S		MI	37091	8585	58879	6391	64007	5189	65581	4290	66155	3000	78896	2537	41856
14-#14	1.49	MA	38861	8585	61322	6424	66194	5233	67186	4327	66206	3026	78971	2426	44645
6L-3S		MI	37982	8585	60412	6372	65957	5172	67948	4295	69228	2989	82432	2665	41911
14-#14	1.49	MA	38044	8585	59828	6444	64373	5231	64955	4343	63208	3039	74892	2299	43762
7L-2S		MI	39247	8585	62322	6373	68392	5175	70908	4280	73239	2978	87829	2793	41899
14-#18	2.65	MA	47994	9454	79321	6914	89039	5567	94888	4523	103648	2922	127701	2669	80145
2L-7S		MI	36140	9454	59536	6929	64530	5605	66064	4547	66724	2949	80931	1670	64013
14-#18	2.65	MA	45606	9454	75620	6911	84321	5596	89152	4549	95878	2942	117255	2441	79903
3L-6S		MI	37411	9454	61923	6898	67439	5578	69629	4523	71491	2931	87249	1896	67216
14-#18	2.65	MA	43929	9454	72649	6944	80543	5591	84567	4540	89924	2961	110412	2214	79302
4L-5S		MI	38712	9454	64153	6902	70468	5585	73323	4534	76362	2914	93317	2046	69056
14-#18	2.65	MA	42428	9454	70045	6942	77184	5620	80454	4566	84056	2946	103265	2102	76013
5L-4S		MI	40077	9454	66516	6905	73514	5557	77053	4510	81664	2931	99728	2155	72031
14-#18	2.65	MA	40997	9454	67588	6940	73846	5615	76382	4557	78665	2965	96470	1952	73972
6L-3S		MI	41599	9454	69208	6874	76938	5565	81208	4521	87039	2914	105831	2383	72532
14-#18	2.65	MA	39600	9454	64958	6973	70641	5644	72454	4583	73389	2985	89399	1727	70306
7L-2S		MI	43756	9454	72555	6878	81204	5537	86395	4497	94046	2896	115169	2610	72727
16-#11	1.18	MA	41573	8353	64912	6279	71026	5112	73128	4250	74227	3020	88748	2876	36840
2L-8S		MI	34361	8353	53493	6273	57164	5117	57311	4266	54770	3025	64185	2425	32517
16-#11	1.18	MA	40589	8353	63439	6279	69148	5111	70845	4262	71135	3029	84522	2787	36859
3L-7S		MI	34875	8353	54360	6273	58328	5105	58694	4255	56759	3031	66605	2477	32912
16-#11	1.18	MA	39899	8353	62261	6293	67650	5123	69027	4259	68774	3038	81746	2698	36851
4L-6S		MI	35397	8353	55306	6260	59481	5107	60107	4244	58657	3023	69173	2564	33469
16-#11	1.18	MA	39282	8353	61230	6293	66320	5122	67398	4271	66448	3034	78869	2653	36800
5E		MI	35931	8353	56190	6260	60682	5095	61572	4247	60596	3014	71642	2623	33550

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

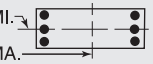


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.18	MA	38694	8353	60258	6293	64998	5135	65786	4269	64314	3043	76116	2595	36687
6L-4S		MI	36492	8353	57127	6261	61890	5096	63052	4236	62708	3020	74231	2667	33581
16-#11	1.18	MA	38121	8353	59218	6307	63730	5134	64231	4280	62225	3052	73253	2508	36044
7L-3S		MI	37119	8353	58196	6247	63250	5084	64703	4239	64852	3011	76719	2756	33571
16-#11	1.18	MA	37548	8353	58264	6307	62450	5146	62709	4292	60037	3048	70564	2455	35579
8L-2S		MI	38009	8353	59531	6248	64952	5086	66771	4228	67654	3003	80512	2845	33545
16-#14	1.70	MA	43942	8745	70106	6506	77528	5274	80986	4348	84852	2986	102993	2811	52492
2L-8S		MI	34974	8745	55576	6506	59663	5289	60306	4375	58782	2995	69987	2168	44517
16-#14	1.70	MA	42551	8745	67997	6505	74838	5272	77716	4364	80422	2998	96971	2683	52457
3L-7S		MI	35702	8745	56820	6507	61332	5272	62291	4360	61633	3004	73437	2241	45617
16-#14	1.70	MA	41575	8745	66307	6525	72689	5290	75107	4360	77036	3011	93019	2555	52348
4L-6S		MI	36440	8745	58177	6488	62986	5275	64318	4345	64356	2993	77091	2368	46345
16-#14	1.70	MA	40702	8745	64827	6525	70780	5288	72770	4376	73699	3004	88913	2491	52114
5E		MI	37196	8745	59445	6489	64709	5258	66419	4350	67138	2982	80602	2452	47451
16-#14	1.70	MA	39871	8745	63432	6524	68884	5306	70456	4372	70636	3016	84992	2407	50874
6L-4S		MI	37989	8745	60789	6491	66442	5261	68542	4335	70167	2990	84293	2515	47634
16-#14	1.70	MA	39060	8745	61938	6544	67063	5304	68225	4388	67639	3029	80914	2280	50021
7L-3S		MI	38875	8745	62322	6472	68392	5244	70908	4340	73239	2979	87829	2643	47714
16-#14	1.70	MA	38260	8745	60569	6543	65226	5321	66040	4404	64499	3021	77076	2205	48776
8L-2S		MI	40134	8745	64233	6473	70828	5248	73869	4325	77251	2968	93226	2771	47728
16-#18	3.03	MA	47288	9738	79321	7089	89039	5725	94888	4629	103648	2924	127701	2402	91061
3L-7S		MI	37700	9738	62882	7107	68796	5734	71250	4627	73730	2930	90269	1625	73756
16-#18	3.03	MA	45626	9738	76350	7122	85261	5719	90303	4620	97695	2944	120858	2174	90363
4L-6S		MI	38958	9738	65269	7075	71705	5706	74815	4603	78498	2913	96587	1850	76847
16-#18	3.03	MA	44139	9738	73746	7119	81903	5749	86190	4646	91827	2928	113711	2062	86888
5E		MI	40248	9738	67499	7079	74734	5714	78509	4614	83369	2895	102654	2001	78870
16-#18	3.03	MA	42721	9738	71289	7117	78564	5743	82118	4637	86436	2947	106916	1912	84669
6L-4S		MI	41600	9738	69862	7083	77781	5686	82239	4590	88670	2913	109066	2110	81863
16-#18	3.03	MA	41338	9738	68659	7150	75359	5773	78190	4663	81160	2967	99845	1688	81119
7L-3S		MI	43110	9738	72555	7051	81204	5693	86395	4601	94046	2895	115169	2337	82621
16-#18	3.03	MA	39974	9738	66247	7148	72125	5767	74344	4689	75634	2951	93166	1557	77526
8L-2S		MI	45251	9738	75901	7055	85471	5666	91581	4577	101052	2877	124506	2565	82871
18-#11	1.33	MA	42272	8464	66385	6348	72903	5162	75410	4281	77319	3013	92974	2864	41336
2L-9S		MI	34475	8464	53976	6341	57729	5165	57947	4294	55694	3027	65586	2355	35985
18-#11	1.33	MA	41291	8464	64912	6348	71026	5161	73128	4293	74227	3022	88748	2775	41348
3L-8S		MI	35005	8464	54827	6342	58866	5167	59379	4297	57572	3018	67978	2411	36487
18-#11	1.33	MA	40604	8464	63734	6362	69527	5173	71309	4291	71866	3031	85972	2686	41321
4L-7S		MI	35517	8464	55695	6342	60029	5155	60762	4286	59560	3024	70398	2463	36870
18-#11	1.33	MA	39990	8464	62703	6362	68197	5172	69680	4302	69540	3027	83095	2641	41255
5L-6S		MI	36036	8464	56641	6329	61182	5157	62175	4275	61458	3016	72966	2550	37439
18-#11	1.33	MA	39405	8464	61731	6362	66876	5185	68068	4300	67406	3036	80342	2583	41077
6L-5S		MI	36568	8464	57524	6329	62383	5145	63640	4278	63398	3007	75435	2609	37591
18-#11	1.33	MA	38834	8464	60690	6376	65608	5184	66513	4311	65317	3045	77479	2495	40415
7L-4S		MI	37127	8464	58461	6330	63591	5147	65120	4267	65510	3013	78024	2653	37636
18-#11	1.33	MA	38266	8464	59736	6376	64328	5196	64991	4323	63129	3041	74790	2443	39963
8L-3S		MI	37751	8464	59531	6317	64952	5135	66771	4270	67654	3005	80512	2742	37643
18-#11	1.33	MA	37671	8464	58800	6376	63077	5195	63417	4321	61063	3050	72123	2387	39380
9L-2S		MI	38638	8464	60865	6317	66653	5136	68839	4260	70455	2996	84304	2831	37625
18-#14	1.92	MA	44922	8904	72216	6606	80218	5347	84256	4393	89283	2976	109015	2792	58909
2L-9S		MI	35144	8904	56169	6624	60468	5358	61214	4415	60099	2996	71982	2065	49014
18-#14	1.92	MA	43538	8904	70106	6605	77528	5345	80986	4409	84852	2988	102993	2664	58853
3L-8S		MI	35884	8904	57486	6606	62099	5361	63267	4420	62793	2985	75384	2146	50103
18-#14	1.92	MA	42567	8904	68417	6625	75379	5362	78377	4405	81466	3001	99041	2536	58719
4L-7S		MI	36608	8904	58731	6607	63768	5344	65252	4405	65645	2994	78834	2219	51284
18-#14	1.92	MA	41700	8904	66937	6624	73470	5360	76040	4421	78130	2994	94935	2471	58449
5L-6S		MI	37341	8904	60088	6588	65422	5347	67279	4390	68367	2983	82488	2346	51988
18-#14	1.92	MA	40874	8904	65542	6624	71574	5378	73726	4417	75066	3006	91014	2387	57114
6L-5S		MI	38093	8904	61356	6589	67145	5330	69380	4395	71149	2972	85999	2430	53138
18-#14	1.92	MA	40068	8904	64048	6643	69753	5376	71495	4433	72069	3019	86935	2261	56287
7L-4S		MI	38882	8904	62700	6590	68878	5334	71503	4380	74178	2981	89690	2493	53406

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

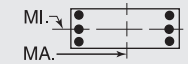
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	1.92	MA	39273	8904	62679	6643	67916	5394	69310	4449	68929	3011	83098	2186	54962
8L-3S		MI	39763	8904	64233	6572	70828	5317	73869	4385	77251	2969	93226	2621	53510
18-#14	1.92	MA	38431	8904	61334	6642	66121	5391	67050	4445	65963	3024	79299	2105	53709
9L-2S		MI	41015	8904	66143	6573	73264	5320	76830	4370	81262	2958	98623	2749	53547
18-#18	3.41	MA	47308	10021	80051	7299	89980	5848	96039	4699	105466	2926	131304	2135	101114
4L-7S		MI	39245	10021	66229	7284	73062	5863	76436	4707	80737	2911	99606	1580	83518
18-#18	3.41	MA	45834	10021	77447	7297	86621	5877	91926	4726	99598	2910	124157	2023	97785
5L-6S		MI	40492	10021	68615	7252	75971	5835	80001	4683	85504	2894	105924	1805	86504
18-#18	3.41	MA	44430	10021	74990	7295	83283	5872	87854	4717	94206	2930	117362	1873	95390
6L-5S		MI	41770	10021	70846	7256	79000	5842	83695	4694	90376	2876	111992	1955	88705
18-#18	3.41	MA	43059	10021	72360	7328	80078	5902	83926	4743	88931	2949	110291	1648	91950
7L-4S		MI	43111	10021	73208	7260	82047	5814	87426	4670	95677	2894	118403	2065	91561
18-#18	3.41	MA	41708	10021	69948	7325	76843	5896	80080	4769	83405	2933	103612	1518	88259
8L-3S		MI	44608	10021	75901	7228	85471	5822	91581	4681	101052	2876	124506	2292	92702
20-#11	1.48	MA	42967	8575	67857	6417	74781	5212	77693	4312	80411	3006	97200	2852	45828
2L-10S		MI	34558	8575	54380	6424	58282	5228	58641	4336	56632	3028	67059	2278	39255
20-#11	1.48	MA	41990	8575	66385	6417	72903	5211	75410	4324	77319	3015	92974	2763	45824
3L-9S		MI	35118	8575	55310	6410	59430	5216	60015	4325	58496	3020	69379	2341	39903
20-#11	1.48	MA	41306	8575	65207	6431	71405	5224	73592	4322	74958	3025	90198	2674	45787
4L-8S		MI	35645	8575	56162	6411	60567	5217	61447	4328	60374	3012	71771	2397	40460
20-#11	1.48	MA	40694	8575	64176	6431	70075	5222	71963	4333	72633	3020	87321	2629	45706
5L-7S		MI	36155	8575	57029	6411	61730	5205	62830	4317	62362	3017	74190	2449	40833
20-#11	1.48	MA	40112	8575	63204	6431	68753	5235	70350	4331	70498	3029	84568	2571	45430
6E		MI	36672	8575	57975	6398	62883	5207	64243	4306	64260	3009	76759	2536	41380
20-#11	1.48	MA	39544	8575	62163	6445	67485	5234	68796	4343	68409	3039	81705	2483	44792
7L-5S		MI	37202	8575	58859	6399	64084	5195	65708	4309	66200	3000	79228	2595	41627
20-#11	1.48	MA	38984	8575	61209	6445	66205	5247	67274	4354	66222	3034	79016	2431	44351
8L-4S		MI	37758	8575	59795	6399	65292	5197	67188	4299	68312	3006	81817	2639	41685
20-#11	1.48	MA	38386	8575	60273	6445	64955	5245	65699	4352	64155	3043	76348	2375	43714
9L-3S		MI	38380	8575	60865	6386	66653	5185	68839	4302	70455	2998	84304	2728	41710
20-#11	1.48	MA	37769	8575	59250	6459	63692	5258	64187	4363	62105	3052	73760	2311	42966
10L-2S		MI	39264	8575	62199	6386	68354	5186	70907	4291	73257	2989	88097	2817	41699
20-#14	2.13	MA	44519	9064	72216	6705	80218	5417	84256	4454	89283	2978	109015	2645	65244
3L-9S		MI	36053	9064	58079	6724	62904	5430	64174	4459	64110	2986	77380	2043	54639
20-#14	2.13	MA	43554	9064	70527	6724	78069	5435	81648	4450	85896	2991	105062	2517	65086
4L-8S		MI	36789	9064	59396	6705	64535	5433	66228	4464	66804	2975	80781	2124	55698
20-#14	2.13	MA	42692	9064	69047	6724	76160	5433	79310	4466	82560	2984	100957	2452	64647
5L-7S		MI	37508	9064	60641	6706	66204	5417	68213	4450	69656	2984	84231	2197	56955
20-#14	2.13	MA	41870	9064	67652	6724	74264	5450	76996	4462	79496	2996	97036	2368	63361
6E		MI	38237	9064	61998	6688	67858	5420	70240	4435	72379	2973	87885	2324	57639
20-#14	2.13	MA	41069	9064	66158	6743	72443	5448	74765	4478	76499	3009	92957	2242	62559
7L-5S		MI	38985	9064	63266	6689	69580	5403	72341	4440	75161	2962	91396	2408	58743
20-#14	2.13	MA	40279	9064	64789	6743	70606	5466	72580	4494	73359	3002	89119	2167	61158
8L-4S		MI	39769	9064	64610	6690	71314	5406	74464	4425	78189	2971	95088	2471	59173
20-#14	2.13	MA	39443	9064	63444	6742	68811	5464	70320	4490	70393	3014	85320	2086	59936
9L-3S		MI	40645	9064	66143	6671	73264	5389	76830	4430	81262	2959	98623	2599	59299
20-#14	2.13	MA	38572	9064	61976	6762	66998	5482	68149	4506	67450	3027	81635	1995	58225
10L-2S		MI	41892	9064	68054	6673	75699	5392	79791	4415	85273	2948	104021	2727	59355
20-#18	3.79	MA	47515	10305	81148	7474	91339	6006	97662	4806	107368	2893	134603	1983	108699
5L-7S		MI	40777	10305	69575	7461	77329	5991	81623	4787	87743	2893	108944	1535	93297
20-#18	3.79	MA	46123	10305	78691	7472	88001	6000	93590	4796	101977	2912	127808	1833	106135
6E		MI	42013	10305	71962	7430	80238	5963	85187	4763	92511	2875	115262	1760	96185
20-#18	3.79	MA	44765	10305	76061	7505	84796	6030	89662	4823	96701	2932	120737	1609	102798
7L-5S		MI	43280	10305	74192	7434	83267	5971	88881	4774	97382	2857	121329	1910	98556

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

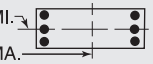


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#18	3.79	MA	43426	10305	73649	7503	81561	6024	85816	4849	91175	2916	114058	1478	99009
8L-4S		MI	44610	10305	76555	7437	86313	5943	92612	4750	102683	2875	127740	2019	101289
22-#11	1.63	MA	43659	8685	69330	6487	76658	5262	79975	4344	83503	2999	101426	2839	50317
2L-11S		MI	34654	8685	54863	6492	58853	5276	59294	4364	57473	3016	68489	2209	42483
22-#11	1.63	MA	42685	8685	67857	6487	74781	5261	77693	4355	80411	3008	97200	2751	50297
3L-10S		MI	35200	8685	55715	6493	59983	5278	60709	4367	59433	3021	70852	2264	43195
22-#11	1.63	MA	42004	8685	66679	6500	73282	5274	75874	4353	78050	3018	94424	2662	50248
4L-9S		MI	35758	8685	56644	6479	61131	5266	62084	4356	61297	3013	73171	2327	43827
22-#11	1.63	MA	41395	8685	65648	6500	71952	5273	74245	4364	75725	3013	91547	2617	50154
5L-8S		MI	36283	8685	57496	6480	62268	5267	63515	4359	63176	3005	75563	2383	44436
22-#11	1.63	MA	40816	8685	64676	6500	70631	5285	72633	4362	73590	3022	88794	2558	49790
6L-7S		MI	36790	8685	58363	6480	63431	5255	64898	4348	65164	3010	77983	2435	44800
22-#11	1.63	MA	40250	8685	63636	6514	69363	5284	71078	4374	71502	3032	85931	2471	49173
7L-6S		MI	37305	8685	59309	6467	64584	5257	66311	4337	67062	3002	80552	2522	45327
22-#11	1.63	MA	39693	8685	62682	6514	68083	5297	69556	4385	69314	3027	83242	2418	48742
8L-5S		MI	37833	8685	60193	6468	65785	5245	67776	4340	69001	2994	83020	2581	45660
22-#11	1.63	MA	39097	8685	61745	6514	66832	5296	67981	4383	67247	3036	80574	2363	48053
9L-4S		MI	38387	8685	61130	6468	66994	5247	69256	4330	71113	2999	85610	2625	45731
22-#11	1.63	MA	38483	8685	60723	6528	65569	5308	66469	4394	65197	3046	77986	2299	47323
10L-3S		MI	39006	8685	62199	6455	68354	5235	70907	4333	73257	2991	88097	2714	45765
22-#11	1.63	MA	37883	8685	59787	6528	64326	5307	64913	4392	63040	3041	75360	2244	46514
11L-2S		MI	39887	8685	63534	6455	70055	5237	72975	4322	76059	2982	91890	2802	45769
22-#14	2.34	MA	44534	9224	72637	6824	80759	5507	84918	4495	90326	2981	111084	2498	71450
4L-9S		MI	36965	9223	59990	6824	65339	5503	67135	4504	68121	2976	82777	2021	60270
22-#14	2.34	MA	43677	9223	71157	6824	78850	5505	82580	4511	86990	2974	106978	2433	70857
5L-8S		MI	37688	9223	61307	6805	66970	5506	69189	4509	70816	2965	86178	2102	61302
22-#14	2.34	MA	42861	9223	69762	6823	76954	5523	80266	4507	83926	2986	103057	2349	69617
6L-7S		MI	38403	9224	62552	6806	68639	5489	71174	4494	73667	2974	89628	2175	62632
22-#14	2.34	MA	42064	9224	68268	6843	75133	5520	78035	4523	80929	2999	98979	2223	68835
7L-6S		MI	39128	9224	63909	6788	70293	5492	73201	4480	76390	2963	93282	2302	63296
22-#14	2.34	MA	41279	9224	66899	6842	73296	5538	75850	4539	77789	2992	95141	2148	67361
8L-5S		MI	39871	9223	65177	6789	72016	5475	75302	4485	79172	2952	96793	2386	64359
22-#14	2.34	MA	40448	9224	65554	6842	71501	5536	73590	4535	74823	3004	91342	2067	66169
9L-4S		MI	40651	9223	66520	6790	73749	5478	77425	4470	82201	2961	100485	2449	64937
22-#14	2.34	MA	39581	9223	64086	6861	69688	5554	71419	4551	71880	3017	87657	1976	64408
10L-3S		MI	41523	9224	68054	6771	75699	5461	79791	4475	85273	2950	104021	2577	65083
22-#18	4.17	MA	47803	10589	82392	7649	92720	6129	99326	4876	109748	2894	138254	1794	116901
6L-7S		MI	42296	10589	72921	7639	81595	6120	86809	4866	94750	2874	118281	1490	103092
22-#18	4.17	MA	46457	10589	79762	7682	89514	6159	95398	4903	104472	2914	131183	1569	113662
7L-6S		MI	43522	10589	75308	7607	84504	6092	90374	4842	99518	2856	124599	1715	105887
22-#18	4.17	MA	45130	10589	77350	7680	86280	6153	91552	4929	98946	2898	124504	1439	109775
8L-5S		MI	44779	10589	77538	7611	87533	6099	94068	4854	104389	2839	130667	1865	108423
24-#11	1.77	MA	43378	8796	69330	6556	76658	5311	79975	4386	83503	3001	101426	2738	54767
3L-11S		MI	35295	8796	56198	6561	60554	5326	61362	4395	60275	3009	72281	2195	46390
24-#11	1.77	MA	42699	8796	68152	6569	75160	5324	78157	4384	81142	3011	98650	2650	54707
4L-10S		MI	35839	8796	57049	6562	61684	5328	62777	4398	62235	3014	74644	2250	47139
24-#11	1.77	MA	42093	8796	67121	6569	73830	5323	76527	4396	78817	3006	95773	2604	54600
5L-9S		MI	36395	8796	57979	6549	62832	5316	64152	4387	64099	3006	76964	2313	47756
24-#11	1.77	MA	41516	8796	66149	6569	72508	5335	74915	4393	76682	3015	93020	2546	54155
6L-8S		MI	36918	8796	58830	6549	63969	5318	65583	4390	65977	2998	79356	2369	48414
24-#11	1.77	MA	40953	8796	65108	6583	71240	5334	73360	4405	74594	3025	90157	2459	53557
7E		MI	37423	8796	59698	6550	65133	5306	66966	4379	67965	3003	81776	2421	48770
24-#11	1.77	MA	40398	8796	64154	6583	69960	5347	71839	4416	72406	3020	87468	2406	53135
8L-6S		MI	37935	8796	60644	6536	66285	5307	68379	4369	69863	2995	84344	2508	49279
24-#11	1.77	MA	39805	8796	63218	6583	68710	5346	70264	4414	70340	3029	84800	2350	52397
9L-5S		MI	38461	8796	61527	6537	67486	5295	69844	4372	71803	2987	86813	2567	49691
24-#11	1.77	MA	39194	8796	62196	6597	67447	5358	68752	4426	68289	3039	82212	2287	51683
10L-4S		MI	39012	8796	62464	6537	68695	5297	71324	4361	73915	2992	89402	2611	49774

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	1.77	MA	38596	8796	61259	6597	66204	5357	67195	4423	66132	3034	79586	2232	50839
11L-3S		MI	39629	8796	63534	6524	70055	5285	72975	4364	76059	2984	91890	2700	49818
24-#11	1.77	MA	38008	8796	60253	6611	64949	5370	65687	4435	64084	3043	76694	2157	49929
12L-2S		MI	40507	8796	64868	6525	71756	5287	75043	4353	78860	2976	95682	2788	49836
24-#14	2.56	MA	44657	9383	73267	6923	81540	5577	85850	4556	91420	2964	113000	2414	77077
5L-9S		MI	37860	9383	61900	6923	67775	5575	70096	4549	72132	2966	88174	1999	65845
24-#14	2.56	MA	43845	9383	71871	6923	79644	5595	83536	4552	88357	2976	109079	2330	75878
6L-8S		MI	38582	9383	63217	6905	69406	5578	72150	4554	74827	2955	91576	2080	66913
24-#14	2.56	MA	43054	9383	70378	6943	77823	5593	81305	4568	85359	2989	105000	2204	75115
7E		MI	39293	9383	64462	6906	71075	5561	74134	4539	77679	2964	95025	2153	68312
24-#14	2.56	MA	42273	9383	69008	6942	75986	5611	79120	4584	82220	2982	101163	2129	73572
8L-6S		MI	40014	9383	65819	6887	72729	5564	76162	4524	80401	2953	98679	2280	68960
24-#14	2.56	MA	41455	9383	67664	6942	74191	5608	76860	4580	79254	2994	97364	2048	72390
9L-5S		MI	40753	9383	67087	6888	74452	5547	78263	4529	83183	2942	102190	2364	69985
24-#14	2.56	MA	40584	9383	66196	6961	72378	5626	74689	4596	76310	3007	93679	1957	70598
10L-4S		MI	41528	9383	68431	6890	76185	5551	80385	4515	86212	2951	105882	2427	70697
24-#18	4.55	MA	48136	10873	83463	7860	94233	6287	101134	4982	112243	2896	141628	1530	124538
7E		MI	43805	10873	76267	7816	85861	6248	91995	4946	101757	2855	127618	1444	112900
24-#18	4.55	MA	46820	10873	81051	7857	90998	6282	97288	5009	106717	2880	134950	1399	120557
8L-6S		MI	45021	10873	78654	7784	88770	6220	95560	4922	106524	2838	133936	1669	115608

RECTANGULAR TIED COLUMNS 46" x 46"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.13	MA	39473	8333	61941	6198	67255	5047	68897	4199	69411	2990	81966	2815	33492
2L-3S		MI	37124	8333	58418	6195	62762	5076	63436	4224	62012	3008	72075	2588	33569
8-#18	1.51	MA	41116	8617	65465	6375	71747	5176	74358	4279	76810	2972	91858	2773	44276
2L-4S		MI	37141	8617	59110	6404	63654	5198	64527	4294	63737	3008	75494	2318	43965
10-#14	1.06	MA	39275	8280	61237	6202	66592	5053	68181	4210	68479	3013	81080	2859	31690
2L-5S		MI	36133	8280	56203	6219	60158	5066	60348	4236	57846	3029	67728	2539	31627
10-#14	1.06	MA	37929	8280	59226	6201	64029	5051	65065	4225	64258	3025	75371	2731	31736
3L-4S		MI	36981	8280	57615	6220	61979	5068	62578	4221	61029	3037	71627	2603	31736
10-#18	1.89	MA	42740	8901	68989	6552	76239	5304	79819	4358	84208	2954	101749	2731	55030
2L-5S		MI	37340	8901	60150	6579	64943	5355	66066	4399	65541	2973	78606	2165	51937
10-#18	1.89	MA	40431	8901	65465	6549	71747	5333	74358	4384	76810	2972	91858	2503	54937
3L-4S		MI	38801	8901	62633	6582	68146	5326	69988	4373	71135	2991	85385	2276	54540

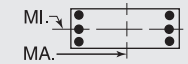
RECTANGULAR TIED COLUMNS 46" x 48"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.09	MA	42812	8659	66945	6462	72711	5264	74433	4383	74804	3132	88398	2961	35112
2L-3S		MI	38622	8659	60651	6441	65100	5278	65719	4396	64065	3140	74348	2716	33627
6-#18	1.09	MA	40339	8659	63244	6460	67993	5294	68697	4410	67033	3151	77952	2733	35189
3L-2S		MI	40974	8659	64175	6444	69593	5250	71180	4371	71464	3122	84240	2943	33538
8-#18	1.45	MA	44547	8942	70646	6639	77430	5393	80169	4463	82575	3114	98844	2921	46436
2L-4S		MI	38638	8942	61343	6651	65992	5400	66810	4466	65790	3141	77767	2446	44080
8-#18	1.45	MA	42095	8942	66945	6637	72711	5423	74433	4490	74804	3133	88398	2694	46429
3E		MI	40287	8942	64175	6618	69593	5407	71180	4476	71464	3122	84240	2673	44339
8-#18	1.45	MA	40366	8942	63974	6670	68933	5417	69847	4480	68850	3153	81555	2466	46125
4L-2S		MI	42619	8942	67699	6621	74085	5378	76641	4451	78862	3104	94131	2901	44329
10-#14	1.02	MA	42597	8605	66196	6466	72004	5271	73668	4394	73808	3155	87420	3003	33209
2L-5S		MI	37629	8605	58429	6467	62497	5270	62635	4410	59906	3162	70013	2668	31706
10-#14	1.02	MA	41182	8605	64086	6466	69314	5269	70398	4410	69378	3168	81398	2875	33255
3L-4S		MI	38479	8605	59840	6468	64317	5272	64865	4394	63088	3170	73911	2732	31792

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

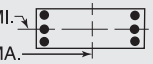


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.02	MA	40187	8605	62397	6485	67165	5287	67789	4407	65991	3180	77446	2747	33255
4L-3S		MI	39428	8605	61452	6449	66367	5255	67353	4399	66318	3158	77655	2860	31779
10-#14	1.02	MA	39297	8605	60917	6485	65256	5284	65452	4423	62655	3173	73340	2682	33146
5L-2S		MI	40775	8605	63462	6450	68930	5257	70468	4383	70539	3146	83365	2988	31729
10-#18	1.81	MA	46262	9226	74347	6817	82148	5522	85905	4543	90345	3096	109290	2882	57730
2L-5S		MI	38836	9226	62383	6825	67282	5558	68349	4571	67594	3106	80880	2293	52288
10-#18	1.81	MA	43831	9226	70646	6814	77430	5551	80169	4569	82575	3116	98844	2654	57637
3L-4S		MI	40300	9226	64867	6828	70484	5529	72271	4546	73188	3123	87659	2404	54665
10-#18	1.81	MA	42118	9226	67675	6848	73652	5546	75583	4560	76621	3135	92001	2427	57240
4L-3S		MI	41933	9226	67699	6796	74085	5536	76641	4556	78862	3105	94131	2631	55016
10-#18	1.81	MA	40584	9226	65071	6845	70293	5575	71470	4587	70753	3119	84854	2315	54719
5L-2S		MI	44247	9226	71222	6799	78577	5507	82102	4530	86261	3087	104023	2859	55086
12-#14	1.22	MA	43599	8765	68306	6566	74694	5343	76938	4439	78238	3145	93442	2984	39663
2L-6S		MI	37792	8765	59107	6566	63250	5359	63543	4450	61204	3164	72006	2563	36980
12-#14	1.22	MA	42191	8765	66196	6565	72004	5341	73668	4455	73808	3158	87420	2856	39692
3L-5S		MI	38598	8765	60439	6567	65059	5342	65750	4455	64127	3152	75722	2647	37770
12-#14	1.22	MA	41202	8765	64506	6585	69855	5359	71059	4452	70421	3170	83468	2728	39653
4E		MI	39442	8765	61851	6568	66880	5345	67981	4439	67309	3160	79620	2711	37892
12-#14	1.22	MA	40317	8765	63027	6584	67946	5357	68722	4468	67085	3163	79362	2663	39507
5L-3S		MI	40385	8765	63462	6549	68930	5327	70468	4443	70539	3148	83365	2839	37916
12-#14	1.22	MA	39473	8765	61631	6584	66050	5374	66408	4464	64021	3175	75441	2579	38656
6L-2S		MI	41726	8765	65472	6549	71493	5330	73584	4428	74759	3136	89074	2967	37883
12-#18	2.17	MA	47961	9510	78048	6994	86867	5650	91640	4623	98116	3079	119735	2842	68983
2L-6S		MI	39111	9510	63563	6999	68590	5680	69927	4641	69851	3106	84340	2101	60664
12-#18	2.17	MA	45549	9510	74347	6992	82148	5680	85905	4649	90345	3098	109290	2615	68825
3L-5S		MI	40494	9510	65907	7002	71774	5686	73810	4651	74992	3088	90771	2251	62573
12-#18	2.17	MA	43852	9510	71376	7025	78370	5674	81319	4640	84392	3118	102447	2387	68348
4E		MI	41944	9510	68390	7005	74976	5658	77732	4625	80587	3105	97550	2361	65241
12-#18	2.17	MA	42332	9510	68772	7023	75012	5704	77206	4666	78524	3102	95300	2275	65534
5L-3S		MI	43563	9510	71222	6973	78577	5664	82102	4636	86261	3087	104023	2589	65671
12-#18	2.17	MA	40883	9510	66315	7020	71673	5698	73134	4657	73132	3121	88505	2125	63482
6L-2S		MI	45858	9510	74746	6976	83070	5635	87563	4610	93660	3069	113914	2816	65809
14-#14	1.43	MA	44593	8925	70416	6666	77384	5416	80208	4484	82668	3135	99463	2965	46107
2L-7S		MI	37978	8925	59692	6685	64075	5429	64529	4510	62565	3166	73849	2417	42070
14-#14	1.43	MA	43192	8925	68306	6665	74694	5413	76938	4500	78238	3148	93442	2837	46109
3L-6S		MI	38759	8925	61117	6666	65813	5432	66658	4495	65425	3154	77715	2543	42897
14-#14	1.43	MA	42209	8925	66616	6685	72545	5431	74329	4496	74851	3160	89489	2709	46041
4L-5S		MI	39559	8925	62449	6667	67622	5414	68866	4499	68348	3142	81431	2627	43827
14-#14	1.43	MA	41330	8925	65137	6684	70636	5429	71992	4512	71515	3153	85383	2644	45863
5L-4S		MI	40399	8925	63861	6668	69443	5417	71096	4484	71530	3150	85330	2691	43982
14-#14	1.43	MA	40491	8925	63741	6684	68740	5447	69678	4509	68452	3165	81462	2560	44871
6L-3S		MI	41337	8925	65472	6648	71493	5400	73584	4488	74759	3138	89074	2819	44037
14-#14	1.43	MA	39673	8925	62248	6703	66919	5445	67447	4525	65454	3178	77384	2434	43980
7L-2S		MI	42670	8925	67482	6649	74055	5402	76699	4473	78980	3126	94783	2947	44025
14-#18	2.54	MA	49643	9793	81749	7171	91585	5779	97376	4703	105887	3061	130181	2803	80217
2L-7S		MI	39429	9793	64579	7209	70026	5837	71642	4746	72218	3107	87537	1834	67709
14-#18	2.54	MA	47250	9793	78048	7169	86867	5808	91640	4729	98116	3080	119735	2575	79999
3L-6S		MI	40766	9793	67087	7177	73083	5808	75388	4720	77250	3088	94232	2058	71061
14-#18	2.54	MA	45568	9793	75077	7202	83089	5803	87055	4720	92163	3100	112893	2347	79451
4L-5S		MI	42136	9793	69431	7180	76266	5815	79271	4731	82391	3070	100663	2208	72887
14-#18	2.54	MA	44063	9793	72473	7200	79730	5832	82942	4746	86295	3084	105746	2235	76379
5L-4S		MI	43573	9793	71914	7183	79469	5786	83193	4705	87985	3088	107442	2319	75811
14-#18	2.54	MA	42627	9793	70016	7198	76392	5827	78870	4737	80903	3104	98951	2086	74412
6L-3S		MI	45177	9793	74746	7150	83070	5793	87563	4715	93660	3069	113914	2547	76312
14-#18	2.54	MA	41227	9793	67386	7231	73187	5857	74942	4764	75628	3123	91880	1861	70877
7L-2S		MI	47455	9793	78269	7153	87562	5764	93024	4690	101058	3051	123806	2774	76507
16-#11	1.13	MA	43208	8693	67327	6539	73571	5326	75622	4432	76476	3160	91246	3011	36878
2L-8S		MI	37513	8693	58197	6550	62247	5346	62399	4461	59557	3176	69763	2576	34201

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis



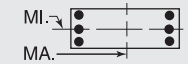
f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.13	MA	42222	8693	65854	6539	71694	5325	73340	4444	73384	3169	87020	2922	36901
3L-7S		MI	38060	8693	59107	6550	63469	5334	63851	4450	61645	3181	72318	2628	34633
16-#11	1.13	MA	41531	8693	64676	6553	70196	5337	71521	4441	71023	3178	84243	2833	36902
4L-6S		MI	38608	8693	60101	6537	64680	5335	65335	4438	63638	3173	75033	2715	35154
16-#11	1.13	MA	40913	8693	63645	6553	68866	5336	69892	4453	68698	3174	81366	2788	36862
5E		MI	39170	8693	61029	6537	65941	5323	66874	4441	65675	3164	77644	2773	35235
16-#11	1.13	MA	40325	8693	62673	6553	67544	5349	68280	4451	66563	3183	78613	2730	36765
6L-4S		MI	39760	8693	62013	6537	67210	5324	68428	4430	67894	3169	80377	2818	35265
16-#11	1.13	MA	39751	8693	61633	6567	66276	5348	66725	4462	64475	3192	75750	2643	36204
7L-3S		MI	40419	8693	63136	6524	68639	5312	70163	4432	70146	3160	83009	2907	35256
16-#11	1.13	MA	39177	8693	60679	6567	64996	5360	65203	4474	62287	3188	73061	2590	35738
8L-2S		MI	41358	8693	64540	6524	70429	5313	72338	4421	73093	3151	87018	2996	35230
16-#14	1.63	MA	45582	9084	72526	6765	80074	5488	83478	4529	87098	3125	105485	2946	52543
2L-8S		MI	38177	9084	60395	6784	64885	5519	65560	4571	63790	3148	75915	2322	46999
16-#14	1.63	MA	44188	9084	70416	6765	77384	5486	80208	4545	82668	3138	99463	2818	52516
3L-7S		MI	38942	9084	61702	6785	66638	5501	67645	4555	66785	3156	79558	2396	48029
16-#14	1.63	MA	43210	9084	68726	6784	75235	5504	77600	4541	79281	3150	95511	2690	52422
4L-6S		MI	39719	9084	63127	6766	68375	5504	69774	4540	69645	3144	83424	2522	48825
16-#14	1.63	MA	42335	9084	67247	6784	73326	5501	75262	4557	75945	3143	91405	2625	52215
5E		MI	40514	9084	64459	6767	70185	5487	71981	4544	72568	3132	87140	2606	49881
16-#14	1.63	MA	41502	9084	65851	6784	71430	5519	72948	4553	72882	3155	87484	2541	51098
6L-4S		MI	41349	9084	65871	6767	72006	5489	74212	4529	75751	3140	91039	2670	50064
16-#14	1.63	MA	40689	9084	64358	6803	69609	5517	70717	4569	69885	3168	83406	2415	50239
7L-3S		MI	42281	9084	67482	6748	74055	5472	76699	4533	78980	3128	94783	2798	50144
16-#14	1.63	MA	39888	9084	62988	6803	67772	5535	68532	4585	66745	3161	79568	2340	49142
8L-2S		MI	43609	9084	69493	6749	76618	5474	79814	4518	83201	3116	100492	2926	50158
16-#18	2.90	MA	51311	10077	85450	7349	96304	5907	103112	4783	113658	3043	140627	2763	91436
2L-8S		MI	39773	10077	65801	7384	71433	5959	73434	4851	74347	3072	91094	1662	74783
16-#18	2.90	MA	48936	10077	81749	7346	91585	5937	97376	4809	105887	3063	130181	2535	91163
3L-7S		MI	41080	10077	68102	7386	74518	5966	77103	4826	79617	3089	97428	1791	77979
16-#18	2.90	MA	47268	10077	78778	7380	87807	5931	92791	4800	99934	3082	123339	2308	90550
4L-6S		MI	42405	10077	70610	7354	77575	5937	80849	4800	84648	3071	104123	2016	81372
16-#18	2.90	MA	45777	10077	76174	7377	84449	5961	88678	4826	94065	3066	116192	2196	87250
5E		MI	43762	10077	72954	7357	80759	5944	84732	4810	89789	3053	110554	2166	83226
16-#18	2.90	MA	44355	10077	73717	7375	81110	5955	84606	4817	88674	3086	109397	2046	85310
6L-4S		MI	45186	10077	75438	7360	83961	5915	88654	4785	95384	3070	117333	2277	86376
16-#18	2.90	MA	42967	10077	71087	7408	77905	5985	80678	4843	83398	3105	102326	1821	81682
7L-3S		MI	46777	10077	78269	7328	87562	5921	93024	4795	101058	3052	123806	2504	86941
16-#18	2.90	MA	41599	10077	68675	7406	74671	5979	76832	4870	77872	3090	95647	1691	78315
8L-2S		MI	49038	10077	81793	7331	92055	5892	98485	4770	108457	3034	133697	2732	87191
18-#11	1.27	MA	43908	8803	68800	6608	75449	5376	77904	4463	79569	3153	95472	2999	41376
2L-9S		MI	37634	8803	58706	6619	62843	5395	63071	4489	60532	3178	71243	2507	37939
18-#11	1.27	MA	42926	8803	67327	6608	73571	5375	75622	4475	76476	3162	91246	2910	41391
3L-8S		MI	38200	8803	59600	6619	64037	5396	64574	4492	62504	3170	73773	2563	38379
18-#11	1.27	MA	42237	8803	66149	6622	72073	5388	73803	4472	74115	3171	88469	2821	41375
4L-7S		MI	38738	8803	60511	6619	65258	5384	66027	4481	64592	3175	76327	2615	38797
18-#11	1.27	MA	41622	8803	65118	6622	70743	5386	72174	4484	71790	3167	85592	2776	41320
5L-6S		MI	39284	8803	61504	6606	66469	5385	67510	4469	66585	3166	79043	2702	39389
18-#11	1.27	MA	41036	8803	64146	6622	69422	5399	70562	4482	69655	3176	82839	2718	41207
6L-5S		MI	39843	8803	62432	6606	67730	5373	69049	4472	68622	3157	81654	2760	39486
18-#11	1.27	MA	40465	8803	63105	6636	68153	5398	69007	4493	67567	3185	79976	2631	40575
7L-4S		MI	40430	8803	63416	6606	68999	5374	70604	4461	70841	3162	84386	2805	39531
18-#11	1.27	MA	39896	8803	62152	6636	66873	5411	67485	4505	65379	3181	77287	2578	40122
8L-3S		MI	41087	8803	64540	6593	70429	5362	72338	4464	73093	3153	87018	2894	39538

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

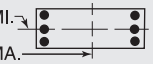


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.27	MA	39300	8803	61215	6636	65623	5409	65911	4503	63313	3190	74620	2522	39646
9L-2S		MI	42023	8803	65943	6593	72218	5363	74514	4452	76040	3144	91028	2983	39520
18-#14	1.83	MA	46564	9244	74636	6865	82764	5560	86748	4574	91528	3115	111507	2927	58962
2L-9S		MI	38348	9244	61122	6883	65735	5588	66519	4611	65180	3150	78024	2220	51694
18-#14	1.83	MA	45177	9244	72526	6865	80074	5558	83478	4590	87098	3128	105485	2799	58916
3L-8S		MI	39140	9244	62405	6884	67448	5591	68675	4616	68010	3138	81624	2301	52881
18-#14	1.83	MA	44204	9244	70836	6884	77925	5576	80870	4586	83712	3140	101532	2671	58798
4L-7S		MI	39901	9244	63712	6885	69201	5574	70760	4600	71006	3146	85268	2376	53995
18-#14	1.83	MA	43335	9244	69357	6884	76016	5574	78532	4602	80376	3133	97427	2606	58564
5L-6S		MI	40672	9244	65138	6865	70938	5576	72889	4585	73866	3134	89134	2502	54764
18-#14	1.83	MA	42507	9244	67961	6883	74120	5591	76218	4598	77312	3146	93506	2522	57335
6L-5S		MI	41463	9244	66469	6866	72748	5559	75097	4589	76789	3122	92850	2586	55930
18-#14	1.83	MA	41699	9244	66468	6903	72299	5589	73987	4614	74315	3158	89427	2396	56504
7L-4S		MI	42293	9244	67881	6867	74569	5561	77327	4574	79971	3130	96748	2650	56140
18-#14	1.83	MA	40902	9244	65098	6902	70462	5607	71802	4630	71175	3151	85590	2321	55324
8L-3S		MI	43221	9244	69493	6848	76618	5544	79814	4578	83201	3118	100492	2778	56243
18-#14	1.83	MA	40060	9244	63754	6902	68667	5605	69542	4627	68209	3163	81791	2240	54054
9L-2S		MI	44541	9244	71503	6849	79181	5547	82930	4563	87422	3106	106202	2906	56281
18-#18	3.26	MA	50608	10361	85450	7524	96304	6066	103112	4889	113658	3045	140627	2496	102318
3L-8S		MI	41420	10361	69325	7561	75925	6088	78895	4931	81745	3054	100986	1620	84970
18-#18	3.26	MA	48954	10361	82479	7557	92525	6060	98527	4880	107705	3065	133785	2268	101556
4L-7S		MI	42715	10361	71626	7564	79010	6094	82564	4905	87015	3071	107320	1749	88268
18-#18	3.26	MA	47476	10361	79875	7555	89167	6090	94414	4906	101836	3049	126638	2156	98142
5L-6S		MI	44029	10361	74134	7531	82067	6066	86310	4880	92047	3053	114015	1974	91552
18-#18	3.26	MA	46066	10361	77418	7552	85829	6084	90342	4897	96445	3068	119843	2007	96023
6L-5S		MI	45374	10361	76478	7534	85251	6072	90193	4890	97188	3035	120446	2124	93587
18-#18	3.26	MA	44691	10361	74788	7585	82624	6114	86414	4923	91169	3088	112772	1782	92506
7L-4S		MI	46786	10361	78961	7537	88454	6043	94115	4865	102782	3052	127225	2235	96759
18-#18	3.26	MA	43335	10361	72376	7583	79389	6108	82568	4949	85643	3072	106093	1651	89037
8L-3S		MI	48364	10361	81793	7505	92055	6050	98485	4875	108457	3034	133697	2462	97562
20-#11	1.41	MA	44605	8914	70272	6678	77326	5426	80187	4494	82661	3146	99697	2987	45870
2L-10S		MI	37724	8914	59134	6702	63427	5457	63803	4532	61521	3180	72798	2430	41355
20-#11	1.41	MA	43626	8914	68800	6678	75449	5425	77904	4506	79569	3155	95472	2898	45872
3L-9S		MI	38313	8914	60110	6688	64633	5445	65246	4520	63479	3171	75252	2493	42063
20-#11	1.41	MA	42940	8914	67622	6691	73951	5438	76086	4504	77207	3164	92695	2809	45843
4L-8S		MI	38877	8914	61004	6688	65826	5446	66749	4523	65451	3163	77782	2549	42560
20-#11	1.41	MA	42328	8914	66591	6691	72621	5437	74457	4515	74882	3160	89818	2764	45774
5L-7S		MI	39413	8914	61914	6688	67048	5434	68202	4512	67539	3168	80336	2602	42966
20-#11	1.41	MA	41744	8914	65619	6691	71299	5449	72844	4513	72747	3169	87065	2706	45602
6E		MI	39956	8914	62908	6675	68258	5435	69686	4501	69532	3159	83052	2689	43570
20-#11	1.41	MA	41175	8914	64578	6705	70031	5448	71290	4524	70659	3178	84202	2618	44951
7L-5S		MI	40513	8914	63836	6675	69520	5423	71224	4503	71569	3150	85663	2747	43733
20-#11	1.41	MA	40614	8914	63624	6705	68751	5461	69768	4536	68471	3174	81513	2566	44511
8L-4S		MI	41098	8914	64820	6675	70789	5424	72779	4492	73788	3155	88396	2792	43791
20-#11	1.41	MA	40015	8914	62688	6705	67501	5460	68193	4534	66405	3183	78846	2510	43978
9L-3S		MI	41752	8914	65943	6662	72218	5412	74514	4495	76040	3146	91028	2881	43816
20-#11	1.41	MA	39398	8914	61665	6719	66237	5472	66681	4545	64354	3192	76258	2447	43220
10L-2S		MI	42684	8914	67347	6662	74007	5413	76689	4483	78987	3137	95037	2970	43805
20-#14	2.04	MA	47541	9403	76746	6965	85454	5633	90018	4619	95959	3105	117528	2908	65375
2L-10S		MI	38477	9403	61731	7002	66567	5678	67563	4672	66592	3152	80241	2108	56128
20-#14	2.04	MA	46160	9403	74636	6964	82764	5630	86748	4635	91528	3118	111507	2780	65310
3L-9S		MI	39310	9403	63132	6983	68298	5661	69634	4656	69401	3140	83733	2200	57617
20-#14	2.04	MA	45193	9403	72946	6984	80615	5648	84140	4631	88142	3130	107554	2652	65169
4L-8S		MI	40096	9403	64415	6984	70011	5663	71791	4661	72231	3128	87333	2281	58772
20-#14	2.04	MA	44328	9403	71467	6983	78706	5646	81802	4647	84806	3123	103448	2587	64898
5L-7S		MI	40853	9403	65722	6984	71764	5646	73876	4645	75227	3136	90977	2355	59966
20-#14	2.04	MA	43505	9403	70071	6983	76810	5664	79488	4643	81742	3136	99527	2503	63581
6E		MI	41620	9403	67148	6965	73501	5648	76005	4630	78087	3124	94843	2481	60712
20-#14	2.04	MA	42702	9403	68577	7003	74989	5662	77257	4659	78745	3148	95449	2377	62775
7L-5S		MI	42406	9403	68480	6966	75311	5631	78212	4634	81010	3112	98559	2566	61935

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

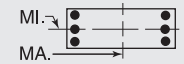


f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.04	MA	41910	9403	67208	7002	73152	5679	75072	4675	75605	3141	91611	2302	61516
8L-4S		MI	43232	9403	69891	6967	77132	5634	80442	4619	84192	3120	102458	2629	62211
20-#14	2.04	MA	41073	9403	65864	7002	71357	5677	72812	4671	72639	3153	87812	2221	60278
9L-3S		MI	44154	9403	71503	6948	79181	5617	82930	4623	87422	3108	106202	2757	62337
20-#14	2.04	MA	40200	9403	64396	7021	69544	5695	70641	4687	69696	3166	84127	2130	58703
10L-2S		MI	45469	9403	73513	6948	81744	5619	86045	4608	91642	3096	111911	2885	62392
20-#18	3.62	MA	50626	10645	86180	7734	97244	6188	104263	4959	115475	3047	144231	2229	112330
4L-8S		MI	43053	10645	72848	7738	80417	6216	84357	5010	89144	3036	110877	1578	95175
20-#18	3.62	MA	49160	10645	83576	7732	93885	6218	100150	4986	109607	3031	137084	2117	109052
5L-7S		MI	44337	10645	75149	7741	83503	6223	88025	4985	94414	3054	117211	1707	98574
20-#18	3.62	MA	47763	10645	81119	7730	90547	6213	96078	4977	104216	3051	130289	1967	106759
6E		MI	45639	10645	77658	7709	86560	6194	91771	4960	99445	3035	123906	1932	101756
20-#18	3.62	MA	46401	10645	78489	7763	87342	6242	92150	5003	98940	3070	123217	1742	103347
7L-5S		MI	46973	10645	80002	7712	89743	6201	95654	4970	104586	3017	130337	2082	103966
20-#18	3.62	MA	45057	10645	76077	7761	84107	6237	88304	5029	93414	3054	116539	1612	99778
8L-4S		MI	48374	10645	82485	7715	92946	6172	99576	4945	110181	3035	137116	2192	107006
22-#11	1.55	MA	45298	9025	71745	6747	79204	5476	82469	4525	85753	3139	103923	2974	50360
2L-11S		MI	37829	9025	59643	6770	64029	5506	64492	4560	62409	3168	74313	2362	44842
22-#11	1.55	MA	44323	9025	70272	6747	77326	5475	80187	4537	82661	3148	99697	2886	50348
3L-10S		MI	38403	9025	60537	6771	65216	5507	65978	4563	64468	3173	76808	2417	45502
22-#11	1.55	MA	43640	9025	69094	6761	75828	5488	78368	4535	80300	3157	96921	2797	50308
4L-9S		MI	38990	9025	61513	6757	66422	5495	67421	4551	66425	3165	79262	2480	46192
22-#11	1.55	MA	43030	9025	68063	6761	74498	5487	76739	4546	77974	3153	94044	2752	50225
5L-8S		MI	39551	9025	62407	6757	67615	5496	68924	4554	68398	3156	81791	2536	46743
22-#11	1.55	MA	42449	9025	67091	6761	73177	5499	75127	4544	75839	3162	91291	2694	49960
6L-7S		MI	40084	9025	63318	6758	68837	5484	70377	4543	70486	3161	84346	2589	47139
22-#11	1.55	MA	41883	9025	66051	6774	71908	5498	73572	4556	73751	3171	88428	2606	49331
7L-6S		MI	40626	9025	64311	6744	70048	5485	71861	4532	72479	3152	87061	2676	47722
22-#11	1.55	MA	41324	9025	65097	6774	70629	5511	72050	4567	71563	3167	85739	2554	48902
8L-5S		MI	41180	9025	65239	6744	71309	5473	73399	4534	74516	3143	89672	2734	47977
22-#11	1.55	MA	40728	9025	64160	6774	69378	5510	70475	4565	69497	3176	83072	2498	48315
9L-4S		MI	41763	9025	66223	6745	72578	5474	74954	4523	76735	3148	92405	2779	48048
22-#11	1.55	MA	40113	9025	63138	6788	68115	5522	68963	4576	67446	3185	80484	2434	47575
10L-3S		MI	42414	9025	67347	6731	74007	5462	76689	4526	78987	3139	95037	2868	48081
22-#11	1.55	MA	39512	9025	62202	6788	66872	5521	67407	4574	65289	3181	77857	2379	46871
11L-2S		MI	43343	9025	68750	6731	75797	5464	78864	4515	81934	3131	99046	2957	48086
22-#14	2.24	MA	47137	9563	76746	7064	85454	5703	90018	4680	95959	3108	117528	2761	71699
3L-10S		MI	39436	9563	63741	7102	69130	5750	70678	4717	70813	3142	85951	2088	62006
22-#14	2.24	MA	46175	9563	75056	7084	83305	5720	87410	4676	92572	3120	113576	2633	71537
4L-9S		MI	40265	9563	65142	7082	70860	5733	72749	4701	73622	3130	89442	2179	63546
22-#14	2.24	MA	45316	9563	73576	7083	81396	5718	85072	4692	89236	3113	109470	2568	71105
5L-8S		MI	41047	9563	66426	7083	72573	5736	74906	4706	76452	3118	93043	2260	64672
22-#14	2.24	MA	44497	9563	72181	7083	79499	5736	82758	4688	86172	3126	105549	2484	69835
6L-7S		MI	41799	9563	67733	7084	74327	5718	76991	4690	79448	3126	96686	2335	65942
22-#14	2.24	MA	43699	9563	70687	7102	77679	5734	80527	4704	83175	3138	101471	2358	69051
7L-6S		MI	42562	9563	69158	7065	76064	5721	79120	4675	82308	3114	100552	2461	66667
22-#14	2.24	MA	42911	9563	69318	7102	75842	5752	78342	4720	80035	3131	97633	2283	67715
8L-5S		MI	43344	9563	70490	7066	77873	5704	81328	4679	85231	3102	104268	2545	67845
22-#14	2.24	MA	42079	9563	67974	7101	74047	5750	76082	4716	77069	3143	93834	2202	66508
9L-4S		MI	44165	9563	71901	7067	79694	5706	83558	4664	88413	3110	108167	2609	68278
22-#14	2.24	MA	41210	9563	66506	7121	72234	5767	73911	4732	74126	3156	90149	2111	64882
10L-3S		MI	45083	9563	73513	7047	81744	5689	86045	4668	91642	3098	111911	2737	68424
22-#18	3.99	MA	50832	10928	87277	7909	98604	6347	105886	5066	117378	3013	147530	2077	119978
5L-8S		MI	44673	10928	76372	7915	84910	6345	89818	5090	96542	3019	120769	1536	105397
22-#18	3.99	MA	49447	10928	84820	7907	95266	6341	101814	5056	111987	3033	140735	1928	117516
6L-7S		MI	45946	10928	78673	7918	87995	6352	93486	5065	101812	3036	127103	1665	108896
22-#18	3.99	MA	48096	10928	82190	7940	92060	6371	97886	5083	106711	3052	133663	1703	114203
7L-6S		MI	47237	10928	81181	7886	91052	6323	97233	5040	106844	3018	133797	1889	111982
22-#18	3.99	MA	46763	10928	79778	7938	88826	6365	94040	5109	101185	3037	126985	1572	110536
8L-5S		MI	48560	10928	83525	7889	94236	6329	101116	5050	111985	3000	140229	2040	114361

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	1.70	MA	45988	9135	73218	6816	81081	5526	84751	4557	88845	3132	108149	2962	54843
2L-12S		MI	37945	9135	60086	6853	64621	5568	65227	4602	63402	3170	75579	2275	48091
24-#11	1.70	MA	45016	9135	71745	6816	79204	5525	82469	4568	85753	3141	103923	2874	54820
3L-11S		MI	38507	9135	61047	6840	65819	5556	66667	4591	65356	3161	78322	2349	48955
24-#11	1.70	MA	44336	9135	70567	6830	77706	5538	80651	4566	83392	3151	101147	2785	54769
4L-10S		MI	39078	9135	61941	6840	67005	5557	68153	4594	67415	3166	80817	2404	49653
24-#11	1.70	MA	43729	9135	69536	6830	76376	5537	79021	4577	81066	3146	98270	2740	54674
5L-9S		MI	39663	9135	62917	6826	68211	5545	69597	4583	69372	3158	83271	2467	50326
24-#11	1.70	MA	43151	9135	68564	6830	75054	5549	77409	4575	78932	3155	95517	2681	54325
6L-8S		MI	40222	9135	63811	6827	69405	5546	71100	4585	71345	3149	85800	2523	50929
24-#11	1.70	MA	42586	9135	67523	6844	73786	5548	75855	4587	76843	3164	92654	2594	53716
7E		MI	40753	9135	64721	6827	70626	5534	72552	4574	73433	3154	88355	2576	51316
24-#11	1.70	MA	42030	9135	66569	6844	72506	5561	74333	4598	74655	3160	89965	2541	53295
8L-6S		MI	41292	9135	65715	6813	71837	5536	74036	4563	75426	3145	91071	2663	51880
24-#11	1.70	MA	41437	9135	65633	6844	71256	5560	72758	4596	72589	3169	87298	2486	52657
9L-5S		MI	41844	9135	66643	6813	73098	5523	75575	4565	77463	3136	93681	2721	52218
24-#11	1.70	MA	40824	9135	64611	6857	69992	5573	71246	4607	70538	3178	84710	2422	51934
10L-4S		MI	42424	9135	67626	6814	74368	5525	77129	4554	79682	3141	96414	2766	52301
24-#11	1.70	MA	40225	9135	63674	6857	68749	5571	69689	4605	68381	3174	82083	2367	51193
11L-3S		MI	43073	9135	68750	6800	75797	5512	78864	4557	81934	3132	99046	2855	52345
24-#11	1.70	MA	39636	9135	62668	6871	67495	5584	68181	4617	66334	3183	79192	2292	50269
12L-2S		MI	43999	9135	70154	6800	77586	5514	81039	4546	84881	3124	103056	2943	52364
24-#14	2.45	MA	47153	9723	77166	7183	85995	5793	90680	4721	97002	3110	119597	2613	77901
4L-10S		MI	40390	9723	65752	7201	71693	5823	73793	4762	75034	3132	91660	2068	67890
24-#14	2.45	MA	46298	9723	75686	7183	84086	5791	88342	4737	93666	3103	115492	2549	77322
5L-9S		MI	41222	9723	67152	7182	73423	5805	75865	4746	77843	3120	95152	2159	69482
24-#14	2.45	MA	45484	9723	74291	7183	82189	5808	86028	4733	90603	3116	111571	2465	76096
6L-8S		MI	41993	9723	68436	7183	75136	5808	78022	4750	80673	3108	98752	2240	70580
24-#14	2.45	MA	44690	9723	72797	7202	80369	5806	83797	4749	87605	3128	107492	2339	75331
7E		MI	42741	9723	69743	7184	76889	5791	80106	4735	83668	3116	102396	2314	71922
24-#14	2.45	MA	43907	9723	71428	7202	78532	5824	81612	4765	84465	3121	103654	2264	73923
8L-6S		MI	43499	9723	71168	7165	78627	5793	82236	4720	86528	3104	106262	2441	72629
24-#14	2.45	MA	43079	9723	70083	7201	76737	5822	79352	4761	81500	3134	99856	2183	72744
9L-5S		MI	44277	9723	72500	7165	80436	5776	84443	4724	89451	3092	109978	2525	73766
24-#14	2.45	MA	42215	9723	68616	7221	74924	5840	77182	4777	78556	3146	96170	2092	71068
10L-4S		MI	45093	9723	73911	7166	82257	5778	86673	4708	92634	3100	113876	2588	74342
24-#18	4.35	MA	51119	11212	88521	8084	99984	6470	107550	5136	119758	3015	151181	1888	128293
6L-8S		MI	46280	11212	79895	8093	89402	6474	95279	5170	103941	3001	130660	1493	115634
24-#18	4.35	MA	49778	11212	85891	8117	96779	6499	103622	5163	114482	3035	144109	1663	125074
7E		MI	47543	11212	82197	8096	92487	6480	98947	5145	109211	3018	136994	1622	119233
24-#18	4.35	MA	48457	11212	83479	8115	93544	6494	99776	5189	108956	3019	137431	1533	121309
8L-6S		MI	48824	11212	84705	8063	95544	6451	102694	5120	114242	3000	143689	1847	122227

RECTANGULAR TIED COLUMNS 48" x 48"

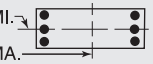
6-#18	1.04	MA	44446	8998	69373	6720	75257	5477	76921	4564	77042	3270	90878	3094	35158
2L-3S		MI	41970	8998	65672	6718	70539	5506	71185	4590	69272	3290	80433	2867	35247
8-#18	1.39	MA	46183	9282	73074	6897	79976	5605	82657	4643	84813	3252	101324	3055	46489
2L-4S		MI	41996	9282	66402	6928	71479	5629	72336	4661	71089	3291	84036	2600	46240
10-#18	1.74	MA	47902	9566	76775	7075	84694	5734	88393	4723	92584	3235	111770	3015	57786
2L-5S		MI	42213	9566	67499	7103	72839	5787	73958	4767	72992	3258	87335	2448	55090
10-#18	1.74	MA	45467	9566	73074	7072	79976	5763	82657	4750	84813	3254	101324	2788	57716
3L-4S		MI	43751	9566	70103	7105	76198	5758	78071	4740	78860	3274	94482	2560	57365

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.63	MA	6948	2870	11203	2038	11892	1651	12021	1359	11923	934	13819	844	6459
2L-3S		MI	6527	2870	10576	2030	11102	1660	11077	1368	10670	942	12200	757	6509
6-#14	2.34	MA	7283	3013	12015	2115	12850	1700	13154	1380	13424	899	15719	778	9036
2L-3S		MI	6691	3013	11125	2103	11739	1712	11825	1393	11661	911	13453	654	9083
6-#18	4.17	MA	8076	3376	13914	2309	15133	1822	15862	1431	17015	804	20208	596	15265
2L-3S		MI	7075	3376	12404	2287	13256	1844	13617	1453	14035	826	16416	375	14920
8-#11	2.17	MA	7221	2977	11829	2105	12682	1698	12965	1385	13176	916	15437	807	8455
2L-4S		MI	6499	2977	10682	2107	11242	1698	11251	1385	10966	934	12766	641	8493
8-#14	3.13	MA	7664	3168	12905	2212	13961	1766	14482	1416	15187	872	17986	722	11848
2L-4S		MI	6649	3168	11273	2213	11935	1766	12070	1416	12078	897	14242	486	11209
8-#18	5.56	MA	8711	3652	15424	2480	17011	1937	18107	1489	19996	750	24000	484	20041
2L-4S		MI	6999	3652	12653	2480	13586	1937	14028	1489	14741	794	17725	72	17318
10-#11	2.71	MA	7493	3085	12456	2173	13472	1745	13909	1410	14429	899	17056	771	10436
2L-5S		MI	6503	3085	10854	2167	11457	1753	11509	1419	11257	908	13269	566	9873
10-#11	2.71	MA	7078	3085	11829	2165	12682	1753	12965	1419	13176	908	15437	684	10458
3L-4S		MI	6776	3085	11308	2174	12032	1745	12195	1410	12219	916	14384	605	10338
10-#14	3.91	MA	8042	3324	13795	2310	15073	1833	15811	1451	16950	845	20252	666	14646
2L-5S		MI	6652	3324	11515	2298	12237	1845	12433	1464	12599	883	14946	373	13186
10-#14	3.91	MA	7460	3324	12905	2297	13961	1845	14482	1464	15187	858	17986	541	14604
3L-4S		MI	7035	3324	12163	2310	13046	1833	13398	1451	13841	870	16508	429	13773
10-#18	6.94	MA	8363	3929	15424	2628	17011	2073	18107	1570	19996	718	24000	150	23318
3L-4S		MI	7647	3929	14163	2650	15463	2051	16274	1547	17721	740	21517	-41	21357

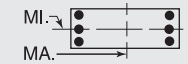
RECTANGULAR TIED COLUMNS 24" x 26"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#11	1.00	MA	7801	2974	12289	2143	12959	1748	12937	1457	12445	1047	14252	977	4861
2E		MI	7181	2974	11353	2123	11896	1730	11842	1441	11351	1033	12947	959	4470
4-#14	1.44	MA	8056	3069	12901	2190	13681	1779	13786	1470	13569	1024	15686	935	6803
2E		MI	7407	3069	11903	2170	12532	1758	12589	1451	12339	1007	14196	913	6234
4-#18	2.56	MA	8664	3311	14387	2317	15415	1857	15833	1502	16278	962	19108	820	11512
2E		MI	7943	3311	13186	2289	14047	1832	14377	1478	14708	939	17152	787	10490
6-#11	1.50	MA	8111	3082	12983	2210	13846	1796	13997	1484	13851	1032	16081	944	7091
2L-3S		MI	7037	3082	11353	2183	11896	1785	11842	1475	11351	1024	12947	837	6548
6-#11	1.50	MA	7645	3082	12289	2203	12959	1805	12937	1492	12445	1040	14252	857	7141
3L-2S		MI	7458	3082	11979	2191	12686	1777	12787	1466	12603	1016	14565	923	6495
6-#14	2.16	MA	8490	3225	13889	2287	14932	1847	15282	1507	15552	1000	18255	884	9947
2L-3S		MI	7200	3225	11903	2255	12532	1837	12589	1499	12339	993	14196	733	9139
6-#14	2.16	MA	7832	3225	12901	2277	13681	1859	13786	1520	13569	1012	15686	760	9994
3L-2S		MI	7794	3225	12794	2267	13643	1825	13918	1487	14102	980	16463	857	9082
6-#18	3.85	MA	9389	3588	16094	2490	17540	1975	18373	1564	19649	913	23435	719	16885
2L-3S		MI	7585	3588	13186	2437	14047	1968	14377	1558	14708	907	17152	453	15244
6-#18	3.85	MA	8275	3588	14387	2468	15415	1997	15833	1587	16278	935	19108	497	16745
3L-2S		MI	8588	3588	14696	2459	15925	1946	16622	1536	17688	884	20944	674	15334
8-#11	2.00	MA	8419	3190	13677	2278	14733	1844	15057	1511	15257	1016	17910	911	9297
2L-4S		MI	7009	3190	11458	2260	12036	1824	12016	1492	11647	1016	13513	721	8556
8-#11	2.00	MA	7955	3190	12983	2271	13846	1853	13997	1519	13851	1025	16081	825	9333
3E		MI	7314	3190	11979	2250	12686	1832	12787	1500	12603	1007	14565	800	8537
8-#11	2.00	MA	7619	3190	12408	2281	13117	1844	13133	1511	12778	1033	14894	743	9335
4L-2S		MI	7732	3190	12606	2258	13476	1824	13731	1492	13856	999	16184	887	8496
8-#14	2.88	MA	8919	3381	14876	2385	16184	1915	16777	1545	17536	976	20825	833	13063
2L-4S		MI	7158	3381	12051	2365	12728	1891	12834	1522	12756	979	14985	564	11419

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

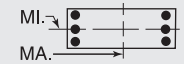


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.88	MA	8267	3381	13889	2374	14932	1928	15282	1557	15552	988	18255	709	13069
3E		MI	7588	3381	12794	2352	13643	1904	13918	1535	14102	966	16463	677	11924
8-#14	2.88	MA	7794	3381	13069	2388	13903	1915	14063	1545	14037	1001	16586	593	12508
4L-2S		MI	8176	3381	13684	2364	14754	1891	15246	1522	15865	954	18729	801	11901
8-#18	5.13	MA	10105	3865	17801	2663	19664	2093	20913	1627	23020	865	27762	617	22201
2L-4S		MI	7506	3865	13435	2630	14377	2060	14789	1594	15413	875	18461	149	17600
8-#18	5.13	MA	9004	3865	16094	2641	17540	2115	18373	1649	19649	887	23435	396	21568
3E		MI	8233	3865	14696	2608	15925	2082	16622	1616	17688	853	20944	340	19454
8-#18	5.13	MA	8204	3865	14670	2663	15790	2093	16300	1627	17076	909	20612	198	19371
4L-2S		MI	9226	3865	16206	2630	17802	2060	18868	1594	20669	830	24736	562	20125
10-#11	2.50	MA	8723	3298	14372	2345	15620	1892	16117	1538	16664	1001	19739	878	11489
2L-5S		MI	7011	3298	11631	2320	12251	1879	12274	1526	11937	990	14016	645	10020
10-#11	2.50	MA	8262	3298	13677	2338	14733	1901	15057	1546	15257	1009	17910	792	11511
3L-4S		MI	7285	3298	12085	2327	12826	1871	12961	1517	12900	998	15131	684	10500
10-#11	2.50	MA	7929	3298	13102	2349	14004	1892	14193	1538	14184	1018	16724	710	11482
4L-3S		MI	7588	3298	12606	2318	13476	1879	13731	1526	13856	990	16184	764	10510
10-#11	2.50	MA	7629	3298	12602	2342	13358	1901	13422	1546	13104	1009	15463	672	10939
5L-2S		MI	8004	3298	13233	2326	14266	1871	14675	1517	15109	981	17803	850	10481
10-#14	3.61	MA	9343	3536	15864	2482	17435	1984	18272	1582	19520	952	23395	783	16164
2L-5S		MI	7160	3536	12294	2450	13030	1970	13197	1570	13277	964	15690	452	13448
10-#14	3.61	MA	8696	3536	14876	2471	16184	1996	16777	1595	17536	964	20825	658	16123
3L-4S		MI	7545	3536	12942	2462	13839	1958	14162	1558	14519	952	17252	508	13980
10-#14	3.61	MA	8228	3536	14056	2486	15154	1984	15558	1582	16021	977	19155	543	15355
4L-3S		MI	7971	3536	13684	2449	14754	1970	15246	1570	15865	939	18729	620	14683
10-#14	3.61	MA	7806	3536	13341	2475	14244	1996	14471	1595	14497	964	17384	487	14721
5L-2S		MI	8555	3536	14574	2461	15866	1958	16575	1558	17628	927	20996	745	14700
10-#18	6.41	MA	9725	4141	17801	2814	19664	2233	20913	1711	23020	838	27762	294	26297
3L-4S		MI	8156	4141	14945	2800	16255	2174	17034	1652	18394	821	22253	37	22035
10-#18	6.41	MA	8934	4141	16377	2836	17915	2210	18841	1689	20447	860	24939	96	24321
4L-3S		MI	8875	4141	16206	2778	17802	2196	18868	1674	20669	799	24736	228	23683
12-#11	3.00	MA	9026	3405	15066	2412	16507	1941	17177	1565	18070	985	21569	845	13671
2L-6S		MI	7027	3405	11797	2397	12464	1918	12566	1560	12321	981	14599	551	11518
12-#11	3.00	MA	8568	3405	14372	2406	15620	1949	16117	1573	16664	994	19739	759	13674
3L-5S		MI	7287	3405	12257	2387	13041	1926	13219	1551	13190	973	15634	609	11874
12-#11	3.00	MA	8237	3405	13797	2416	14891	1941	15253	1565	15590	1002	18553	677	13523
4E		MI	7560	3405	12712	2395	13616	1918	13905	1543	14152	981	16750	648	12321
12-#11	3.00	MA	7938	3405	13296	2410	14245	1949	14482	1573	14510	994	17292	639	12995
5L-3S		MI	7861	3405	13233	2385	14266	1926	14675	1551	15109	973	17803	727	12473
12-#11	3.00	MA	7654	3405	12825	2403	13598	1941	13749	1582	13535	1002	16120	581	12596
6L-2S		MI	8275	3405	13860	2393	15056	1918	15619	1543	16362	964	19421	814	12457
12-#14	4.33	MA	9122	3692	15864	2569	17435	2064	18272	1632	19520	940	23395	608	19165
3L-5S		MI	7546	3692	13184	2548	14142	2037	14525	1605	15040	937	17956	395	15995
12-#14	4.33	MA	8658	3692	15044	2583	16405	2052	17053	1620	18005	953	21725	492	18226
4E		MI	7928	3692	13832	2560	14951	2024	15491	1593	16282	925	19518	452	16563
12-#14	4.33	MA	8239	3692	14329	2572	15495	2064	15966	1632	16481	940	19954	436	17608
5L-3S		MI	8351	3692	14574	2547	15866	2037	16575	1605	17628	913	20996	564	17429
12-#18	7.69	MA	9656	4418	18084	3009	20040	2328	21381	1751	23818	812	29267	-6	29234
4E		MI	8869	4418	16454	2970	18132	2288	19279	1710	21374	767	26045	-76	25700
14-#11	3.50	MA	8870	3513	15066	2473	16507	1997	17177	1600	18070	978	21569	726	15827
3L-6S		MI	7303	3513	12424	2464	13254	1965	13510	1585	13574	964	16218	515	13313
14-#11	3.50	MA	8542	3513	14491	2484	15778	1989	16313	1591	16996	987	20382	644	15547
4L-5S		MI	7561	3513	12884	2455	13831	1973	14163	1577	14443	955	17253	573	13737
14-#11	3.50	MA	8245	3513	13990	2477	15132	1997	15542	1600	15916	978	19121	606	15059
5L-4S		MI	7832	3513	13339	2462	14406	1965	14849	1568	15405	964	18368	611	14146
14-#11	3.50	MA	7962	3513	13519	2470	14485	1989	14809	1609	14941	987	17949	548	14592
6L-3S		MI	8132	3513	13860	2453	15056	1973	15619	1577	16362	955	19421	691	14419
14-#14	5.05	MA	9084	3847	16031	2680	17657	2120	18548	1658	19988	929	24295	441	21116
4L-5S		MI	7929	3847	14074	2645	15253	2103	15854	1641	16803	911	20223	339	18494

RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	5.05	MA	8668	3847	15316	2670	16746	2133	17461	1670	18465	916	22523	385	20395
5L-4S		MI	8309	3847	14722	2657	16062	2091	16820	1628	18045	898	21785	396	19164
16-#11	4.00	MA	8844	3621	15185	2551	16665	2037	17373	1618	18402	971	22212	611	17582
4L-6S		MI	7577	3621	13051	2532	14044	2012	14454	1611	14826	947	17837	478	15120
16-#11	4.00	MA	8550	3621	14684	2544	16019	2046	16602	1627	17322	963	20951	573	17129
5E		MI	7834	3621	13511	2522	14621	2020	15107	1602	15695	938	18871	536	15605
16-#11	4.00	MA	8269	3621	14213	2538	15372	2037	15869	1636	16347	971	19779	515	16599
6L-4S		MI	8103	3621	13965	2530	15196	2012	15794	1594	16658	947	19987	575	15982
16-#14	5.77	MA	9094	4003	16304	2767	17997	2201	18957	1708	20448	892	25093	335	23201
5E		MI	8310	4003	14964	2742	16365	2170	17182	1676	18566	884	22489	283	21012
18-#11	4.50	MA	8852	3729	15378	2612	16906	2094	17663	1654	18728	947	22780	540	19205
5L-6S		MI	7849	3729	13678	2599	14834	2059	15398	1637	16079	929	19455	442	16935
18-#11	4.50	MA	8573	3729	14907	2605	16259	2085	16929	1663	17753	956	21608	482	18616
6L-5S		MI	8105	3729	14138	2590	15411	2067	16051	1628	16948	921	20490	500	17478
20-#11	5.00	MA	8875	3837	15602	2673	17146	2133	17989	1689	19159	940	23437	449	20641
6E		MI	8119	3837	14304	2667	15624	2105	16343	1662	17332	912	21074	405	18758

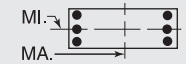
RECTANGULAR TIED COLUMNS 24" x 28"

4-#14	1.34	MA	9301	3281	14798	2362	15756	1923	15880	1594	15598	1121	18057	1034	7411
2E		MI	7917	3281	12682	2322	13325	1883	13353	1557	13017	1089	14939	992	6271
4-#18	2.38	MA	9982	3524	16443	2489	17708	2005	18183	1630	18645	1063	21940	928	12592
2E		MI	8454	3524	13968	2439	14839	1955	15138	1583	15380	1019	17888	865	10546
6-#11	1.39	MA	9361	3294	14884	2382	15909	1939	16105	1608	15901	1129	18481	1042	7723
2L-3S		MI	7546	3294	12130	2336	12689	1911	12608	1582	12031	1107	13694	916	6585
6-#11	1.39	MA	8847	3294	14123	2377	14933	1948	14929	1616	14342	1137	16440	956	7773
3L-2S		MI	7968	3294	12756	2344	13479	1903	13552	1573	13284	1098	15312	1002	6530
6-#14	2.01	MA	9783	3437	15883	2460	17147	1993	17542	1633	17803	1099	20931	987	10859
2L-3S		MI	7710	3437	12682	2407	13325	1962	13353	1605	13017	1074	14939	812	9191
6-#14	2.01	MA	9059	3437	14798	2450	15756	2006	15880	1645	15598	1112	18057	863	10906
3L-2S		MI	8304	3437	13572	2419	14436	1950	14682	1593	14780	1062	17206	936	9127
6-#18	3.57	MA	10791	3800	18323	2662	20081	2126	21019	1696	22408	1020	26805	836	18505
2L-3S		MI	8094	3800	13968	2587	14839	2091	15138	1663	15380	987	17888	531	15353
6-#18	3.57	MA	9561	3800	16443	2643	17708	2148	18183	1718	18645	1042	21940	614	18365
3L-2S		MI	9101	3800	15478	2609	16717	2069	17383	1641	18361	965	21680	752	15400
8-#11	1.86	MA	9702	3402	15646	2450	16885	1987	17281	1636	17461	1115	20522	1012	10139
2L-4S		MI	7518	3402	12235	2413	12829	1950	12782	1598	12327	1098	14259	800	8612
8-#11	1.86	MA	9192	3402	14884	2444	15909	1997	16105	1644	15901	1123	18481	926	10176
3E		MI	7823	3402	12756	2403	13479	1958	13552	1607	13284	1089	15312	880	8581
8-#11	1.86	MA	8825	3402	14256	2455	15108	1989	15147	1636	14710	1132	17160	842	10178
4L-2S		MI	8243	3402	13383	2411	14269	1950	14496	1598	14537	1081	16931	966	8536
8-#14	2.68	MA	10260	3593	16968	2557	18537	2063	19205	1672	20008	1078	23804	941	14278
2L-4S		MI	7667	3593	12830	2517	13521	2016	13598	1628	13434	1060	15728	643	11622
8-#14	2.68	MA	9542	3593	15883	2548	17147	2075	17542	1685	17803	1090	20931	817	14284
3E		MI	8098	3593	13572	2504	14436	2029	14682	1641	14780	1048	17206	755	11989
8-#14	2.68	MA	9025	3593	14985	2563	16004	2063	16188	1672	16119	1102	19068	698	13832
4L-2S		MI	8688	3593	14463	2516	15547	2016	16010	1628	16543	1035	19472	880	11951
8-#18	4.76	MA	11589	4077	20202	2835	22454	2247	23855	1762	26171	976	31671	743	24361
2L-4S		MI	8014	4077	14217	2780	15169	2183	15549	1699	16086	955	19197	227	17873
8-#18	4.76	MA	10374	4077	18323	2816	20081	2269	21019	1784	22408	998	26805	522	24102
3E		MI	8744	4077	15478	2757	16717	2205	17383	1721	18361	933	21680	418	19817

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

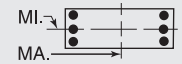


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	4.76	MA	9496	4077	16761	2841	18129	2247	18706	1762	19535	1020	23641	318	21457
4L-2S		MI	9740	4077	16988	2780	18594	2183	19628	1699	21341	911	25472	639	20206
10-#11	2.32	MA	10040	3510	16408	2517	17862	2036	18457	1664	19021	1101	22562	982	12542
2L-5S		MI	7520	3510	12407	2473	13044	2005	13040	1633	12617	1072	14762	725	10160
10-#11	2.32	MA	9533	3510	15646	2511	16885	2045	17281	1672	17461	1109	20522	896	12564
3L-4S		MI	7795	3510	12862	2480	13619	1996	13726	1624	13580	1081	15878	764	10566
10-#11	2.32	MA	9169	3510	15017	2523	16085	2037	16323	1664	16270	1118	19201	812	12535
4L-3S		MI	8099	3510	13383	2471	14269	2005	14496	1633	14537	1072	16931	843	10559
10-#11	2.32	MA	8841	3510	14470	2517	15376	2046	15468	1672	15073	1109	17794	774	12018
5L-2S		MI	8516	3510	14010	2478	15059	1996	15441	1624	15789	1063	18550	930	10525
10-#14	3.35	MA	10732	3748	18052	2654	19928	2133	20867	1712	22213	1056	26678	895	17683
2L-5S		MI	7668	3748	13072	2602	13823	2095	13961	1676	13955	1046	16433	530	13626
10-#14	3.35	MA	10020	3748	16968	2645	18537	2145	19205	1724	20008	1068	23804	771	17642
3L-4S		MI	8054	3748	13720	2614	14632	2083	14926	1664	15197	1033	17995	587	14179
10-#14	3.35	MA	9507	3748	16070	2661	17394	2133	17850	1712	18324	1081	21942	652	16964
4L-3S		MI	8482	3748	14463	2601	15547	2095	16010	1676	16543	1021	19472	699	14757
10-#14	3.35	MA	9046	3748	15289	2651	16382	2145	16642	1724	16631	1068	19961	597	16195
5L-2S		MI	9068	3748	15353	2613	16659	2083	17339	1664	18306	1009	21739	824	14756
10-#18	5.95	MA	11176	4353	20202	2989	22454	2390	23855	1850	26171	954	31671	429	29343
3L-4S		MI	8664	4353	15727	2950	17047	2297	17795	1757	19067	901	22989	115	22304
10-#18	5.95	MA	10309	4353	18640	3014	20501	2367	21542	1827	23298	976	28507	225	26918
4L-3S		MI	9387	4353	16988	2928	18594	2319	19628	1779	21341	879	25472	305	24038
12-#11	2.79	MA	10376	3618	17169	2585	18838	2084	19633	1692	20580	1087	24603	953	14935
2L-6S		MI	7535	3618	12574	2550	13257	2043	13331	1667	13001	1063	15346	631	11744
12-#11	2.79	MA	9872	3618	16408	2579	17862	2093	18457	1701	19021	1095	22562	866	14937
3L-5S		MI	7796	3618	13034	2540	13834	2052	13984	1658	13870	1055	16381	688	12014
12-#11	2.79	MA	9510	3618	15779	2590	17061	2086	17499	1692	17829	1104	21242	782	14883
4E		MI	8070	3618	13489	2548	14409	2043	14671	1650	14833	1063	17497	727	12484
12-#11	2.79	MA	9184	3618	15232	2584	16353	2095	16645	1701	16633	1095	19835	745	14274
5L-3S		MI	8372	3618	14010	2538	15059	2052	15441	1658	15789	1055	18550	807	12526
12-#11	2.79	MA	8874	3618	14718	2578	15642	2087	15831	1709	15551	1104	18525	687	13935
6L-2S		MI	8787	3618	14637	2546	15849	2043	16385	1650	17042	1046	20168	893	12504
12-#14	4.02	MA	10493	3904	18052	2742	19928	2215	20867	1764	22213	1047	26678	725	20988
3L-5S		MI	8055	3904	13962	2699	14935	2162	15289	1712	15718	1019	18700	474	16259
12-#14	4.02	MA	9984	3904	17155	2758	18785	2203	19513	1751	20529	1059	24816	606	20120
4E		MI	8439	3904	14611	2711	15744	2149	16255	1699	16960	1007	20261	531	16760
12-#14	4.02	MA	9527	3904	16374	2749	17773	2215	18304	1764	18836	1047	22835	551	19413
5L-3S		MI	8863	3904	15353	2699	16659	2162	17339	1712	18306	994	21739	643	17510
12-#14	4.02	MA	9091	3904	15639	2739	16758	2203	17154	1776	17307	1059	20992	468	18276
6L-2S		MI	9445	3904	16243	2711	17770	2149	18668	1699	20069	982	24006	768	17549
12-#18	7.14	MA	11112	4630	20520	3187	22874	2488	24379	1893	27061	932	33372	133	32416
4E		MI	9308	4630	17236	3120	18924	2411	20040	1815	22047	847	26781	2	26768
14-#11	3.25	MA	10208	3725	17169	2646	18838	2142	19633	1729	20580	1081	24603	836	17301
3L-6S		MI	7812	3725	13201	2617	14047	2090	14276	1692	14254	1046	16965	594	13536
14-#11	3.25	MA	9848	3725	16541	2658	18037	2134	18675	1720	19389	1090	23283	753	17137
4L-5S		MI	8071	3725	13661	2608	14624	2099	14929	1684	15123	1037	18000	652	13876
14-#11	3.25	MA	9525	3725	15994	2652	17329	2143	17821	1729	18192	1081	21876	715	16540
5L-4S		MI	8343	3725	14116	2615	15199	2090	15615	1675	16086	1046	19115	691	14308
14-#11	3.25	MA	9216	3725	15479	2646	16619	2135	17007	1737	17110	1090	20566	657	16130
6L-3S		MI	8643	3725	14637	2606	15849	2099	16385	1684	17042	1037	20168	770	14482
14-#11	3.25	MA	8915	3725	14917	2657	15940	2145	16149	1729	16053	1099	19331	593	15495
7L-2S		MI	9056	3725	15263	2613	16639	2090	17329	1675	18295	1029	21787	857	14476
14-#14	4.69	MA	10457	4060	18240	2855	20175	2273	21175	1790	22734	1037	27690	560	23296
4L-5S		MI	8439	4060	14853	2797	16046	2228	16618	1747	17481	992	20966	418	18806
14-#14	4.69	MA	10004	4060	17458	2846	19163	2285	19967	1803	21041	1025	25709	505	22642
5L-4S		MI	8820	4060	15501	2809	16855	2216	17584	1735	18723	980	22528	475	19359
14-#14	4.69	MA	9571	4060	16723	2837	18149	2273	18817	1815	19511	1037	23866	422	21418
6L-3S		MI	9242	4060	16243	2796	17770	2228	18668	1747	20069	967	24006	587	20254

RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#11	3.71	MA	10184	3833	17302	2725	19014	2182	19851	1748	20949	1076	25323	723	19370
4L-6S		MI	8086	3833	13828	2685	14837	2137	15220	1718	15507	1029	18584	558	15340
16-#11	3.71	MA	9863	3833	16755	2719	18305	2192	18997	1757	19752	1067	23917	685	18813
5E		MI	8344	3833	14288	2675	15414	2146	15873	1709	16376	1020	19618	615	15745
16-#11	3.71	MA	9556	3833	16241	2713	17595	2184	18183	1765	18670	1076	22607	627	18336
6L-4S		MI	8614	3833	14742	2683	15989	2137	16559	1701	17338	1029	20734	654	16143
16-#11	3.71	MA	9257	3833	15678	2725	16916	2193	17325	1757	17613	1085	21372	563	17733
7L-3S		MI	8913	3833	15263	2673	16639	2146	17329	1709	18295	1020	21787	734	16428
16-#14	5.36	MA	10477	4215	18543	2943	20554	2355	21629	1842	23246	1003	28583	459	25755
5E		MI	8820	4215	15743	2894	17158	2295	17946	1783	19244	966	23233	362	21320
16-#14	5.36	MA	10048	4215	17808	2934	19539	2342	20479	1855	21716	1016	26740	376	24575
6L-4S		MI	9199	4215	16391	2906	17966	2283	18912	1770	20486	953	24795	419	21972
18-#11	4.18	MA	10198	3941	17517	2787	19282	2240	20173	1785	21312	1053	25957	655	21092
5L-6S		MI	8358	3941	14454	2752	15627	2184	16164	1743	16760	1011	20202	521	17154
18-#11	4.18	MA	9894	3941	17003	2781	18571	2232	19359	1793	20230	1062	24647	598	20552
6L-5S		MI	8615	3941	14914	2742	16204	2193	16817	1735	17629	1003	21237	579	17619
18-#11	4.18	MA	9597	3941	16440	2792	17893	2242	18501	1785	19172	1071	23412	533	19979
7L-4S		MI	8884	3941	15369	2750	16779	2184	17503	1726	18591	1011	22352	618	17987
18-#14	6.03	MA	10520	4371	18893	3031	20930	2412	22142	1894	23921	994	29614	330	27744
6L-5S		MI	9199	4371	16633	2991	18269	2362	19275	1818	21007	939	25499	306	23851
20-#11	4.64	MA	10229	4049	17764	2848	19548	2281	20535	1821	21789	1048	26688	568	22776
6E		MI	8630	4049	15081	2819	16417	2231	17108	1769	18012	994	21821	485	18975
20-#11	4.64	MA	9934	4049	17202	2860	18869	2290	19678	1813	20732	1057	25453	503	22230
7L-5S		MI	8885	4049	15541	2810	16994	2240	17761	1760	18881	985	22856	543	19496
22-#11	5.11	MA	10269	4157	17963	2927	19845	2338	20854	1841	22292	1042	27494	473	24448
7L-6S		MI	8899	4157	15708	2887	17207	2278	18053	1794	19265	977	23439	448	20804

RECTANGULAR TIED COLUMNS 24" x 30"

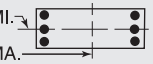
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.25	MA	10632	3494	16816	2535	17933	2065	18106	1717	17749	1217	20565	1131	8018
2E		MI	8427	3494	13461	2474	14118	2008	14117	1663	13694	1170	15682	1071	6307
4-#18	2.22	MA	11387	3736	18619	2662	20135	2152	20666	1756	21135	1164	24912	1033	13672
2E		MI	8965	3736	14750	2589	15631	2078	15898	1688	16053	1100	18624	942	10600
6-#11	1.30	MA	10696	3506	16906	2555	18095	2081	18346	1731	18073	1225	21018	1139	8354
2L-3S		MI	8055	3506	12906	2489	13483	2037	13374	1688	12711	1189	14441	996	6620
6-#11	1.30	MA	10135	3506	16077	2550	17032	2091	17053	1740	16359	1234	18765	1053	8404
3L-2S		MI	8478	3506	13533	2497	14273	2028	14318	1680	13964	1180	16059	1082	6564
6-#14	1.88	MA	11163	3649	17998	2632	19448	2135	19936	1758	20176	1198	23744	1089	11770
2L-3S		MI	8220	3649	13461	2559	14118	2087	14117	1711	13694	1156	15682	890	9240
6-#14	1.88	MA	10372	3649	16816	2624	17933	2149	18106	1770	17749	1210	20565	964	11817
3L-2S		MI	8815	3649	14351	2571	15229	2075	15446	1699	15457	1144	17949	1015	9171
6-#18	3.33	MA	12281	4012	20672	2835	22756	2275	23799	1825	25291	1124	30318	949	20125
2L-3S		MI	8604	4012	14750	2737	15631	2214	15898	1768	16053	1068	18624	608	15453
6-#18	3.33	MA	10934	4012	18619	2818	20135	2298	20666	1847	21135	1146	24912	727	19985
3L-2S		MI	9613	4012	16260	2759	17508	2192	18143	1746	19034	1045	22416	830	15465
8-#11	1.73	MA	11071	3614	17735	2622	19158	2129	19638	1760	19786	1212	23271	1112	10982
2L-4S		MI	8027	3614	13012	2566	13623	2075	13548	1705	13008	1180	15006	880	8662
8-#11	1.73	MA	10514	3614	16906	2617	18095	2139	18346	1769	18073	1221	21018	1026	11018
3E		MI	8333	3614	13533	2556	14273	2084	14318	1714	13964	1171	16059	959	8622
8-#11	1.73	MA	10116	3614	16224	2629	17226	2132	17293	1760	16764	1230	19563	940	11020
4L-2S		MI	8753	3614	14160	2564	15063	2075	15262	1705	15217	1163	17678	1045	8574
8-#14	2.50	MA	11688	3805	19180	2729	20963	2205	21766	1799	22602	1178	26923	1047	15493
2L-4S		MI	8176	3805	13609	2669	14314	2141	14362	1734	14111	1142	16472	722	11818
8-#14	2.50	MA	10904	3805	17998	2721	19448	2219	19936	1811	20176	1190	23744	922	15499
3E		MI	8608	3805	14351	2656	15229	2154	15446	1747	15457	1129	17949	834	12046
8-#14	2.50	MA	10342	3805	17023	2738	18206	2207	18445	1799	18322	1203	21688	801	15180
4L-2S		MI	9199	3805	15241	2668	16340	2141	16774	1734	17221	1117	20216	959	12000
8-#18	4.44	MA	13161	4289	22724	3008	25378	2399	26932	1894	29447	1084	35723	864	26521
2L-4S		MI	8521	4289	14999	2929	15961	2306	16310	1804	16759	1036	19933	305	18136
8-#18	4.44	MA	11831	4289	20672	2990	22756	2421	23799	1916	25291	1106	30318	643	26262
3E		MI	9255	4289	16260	2907	17508	2329	18143	1826	19034	1014	22416	496	20159
8-#18	4.44	MA	10876	4289	18972	3017	20601	2399	21245	1894	22117	1128	26811	433	23574
4L-2S		MI	10254	4289	17770	2929	19386	2306	20389	1804	22014	991	26208	717	20285
10-#11	2.17	MA	11443	3722	18564	2690	20221	2178	20930	1789	21500	1200	25524	1085	13595
2L-5S		MI	8029	3722	13184	2626	13838	2131	13806	1740	13298	1154	15509	804	10294
10-#11	2.17	MA	10890	3722	17735	2685	19158	2188	19638	1798	19786	1208	23271	998	13617
3L-4S		MI	8304	3722	13639	2633	14413	2122	14492	1731	14260	1163	16625	843	10627
10-#11	2.17	MA	10494	3722	17053	2697	18288	2181	18586	1789	18477	1217	21816	913	13588
4L-3S		MI	8609	3722	14160	2624	15063	2131	15262	1740	15217	1154	17678	923	10606
10-#11	2.17	MA	10139	3722	16460	2691	17520	2191	17646	1798	17163	1208	20263	875	13108
5L-2S		MI	9027	3722	14787	2631	15853	2122	16206	1731	16470	1146	19296	1009	10568
10-#14	3.13	MA	12208	3960	20362	2827	22479	2275	23595	1840	25029	1158	30102	1004	19202
2L-5S		MI	8176	3960	13851	2754	14616	2220	14725	1782	14633	1127	17176	609	13796
10-#14	3.13	MA	11430	3960	19180	2818	20963	2288	21766	1852	22602	1171	26923	880	19161
3L-4S		MI	8564	3960	14499	2766	15425	2208	15690	1770	15875	1115	18738	666	14372
10-#14	3.13	MA	10872	3960	18205	2835	19721	2277	20275	1840	20749	1183	24867	758	18596
4L-3S		MI	8993	3960	15241	2753	16340	2220	16774	1782	17221	1103	20216	778	14827
10-#14	3.13	MA	10372	3960	17357	2827	18623	2291	18945	1852	18887	1171	22675	704	17684
5L-2S		MI	9580	3960	16131	2765	17452	2208	18103	1770	18984	1090	22482	903	14810
10-#18	5.56	MA	12716	4566	22724	3163	25378	2544	26932	1985	29447	1066	35723	558	32454
3L-4S		MI	9173	4566	16509	3100	17838	2421	18555	1862	19740	982	23725	192	22564
10-#18	5.56	MA	11772	4566	21024	3190	23222	2522	24379	1963	26273	1088	32217	349	29548
4L-3S		MI	9899	4566	17770	3078	19386	2443	20389	1884	22014	960	26208	383	24382
10-#18	5.56	MA	10926	4566	19543	3173	21314	2544	22101	1985	23082	1066	28491	250	27123
5L-2S		MI	10889	4566	19280	3100	21263	2421	22634	1862	24995	937	30000	605	25052
12-#11	2.60	MA	11812	3830	19393	2757	21284	2226	22223	1818	23214	1187	27776	1057	16198
2L-6S		MI	8044	3830	13351	2703	14051	2169	14097	1774	13682	1145	16093	710	11921
12-#11	2.60	MA	11262	3830	18564	2752	20221	2236	20930	1827	21500	1196	25524	971	16201
3L-5S		MI	8306	3830	13811	2693	14628	2178	14750	1765	14551	1137	17128	768	12148
12-#11	2.60	MA	10869	3830	17882	2764	19351	2229	19878	1818	20191	1204	24069	886	16147
4E		MI	8580	3830	14266	2701	15203	2169	15436	1756	15513	1145	18244	807	12575
12-#11	2.60	MA	10516	3830	17289	2759	18583	2239	18939	1827	18877	1196	22515	848	15565
5L-3S		MI	8883	3830	14787	2691	15853	2178	16206	1765	16470	1137	19296	886	12578
12-#11	2.60	MA	10179	3830	16732	2754	17813	2232	18045	1836	17688	1204	21067	791	15189
6L-2S		MI	9298	3830	15414	2699	16643	2169	17151	1756	17723	1128	20915	972	12551
12-#14	3.75	MA	11951	4116	20362	2916	22479	2358	23595	1893	25029	1151	30102	838	22810
3L-5S		MI	8564	4116	14741	2851	15728	2287	16053	1818	16396	1101	19443	553	16429
12-#14	3.75	MA	11398	4116	19387	2932	21237	2347	22105	1881	23175	1163	28046	716	22039
4E		MI	8949	4116	15389	2863	16537	2274	17019	1805	17638	1088	21005	610	16951
12-#14	3.75	MA	10901	4116	18539	2924	20138	2361	20775	1893	21314	1151	25855	662	21194
5L-3S		MI	9375	4116	16131	2851	17452	2287	18103	1818	18984	1076	22482	722	17587
12-#14	3.75	MA	10429	4116	17742	2916	19037	2350	19509	1906	19630	1163	23813	579	20073
6L-2S		MI	9958	4116	17022	2863	18563	2274	19432	1805	20747	1063	24749	847	17606
12-#18	6.67	MA	12657	4842	23077	3363	25844	2645	27512	2032	30428	1048	37623	264	35561
4E		MI	9818	4842	18019	3270	19716	2535	20800	1920	22720	928	27517	80	27025
12-#18	6.67	MA	11821	4842	21596	3346	23936	2668	25234	2054	27238	1026	33897	166	32956
5L-3S		MI	10538	4842	19280	3248	21263	2557	22634	1942	24995	905	30000	271	28657
14-#11	3.03	MA	11632	3938	19393	2819	21284	2285	22223	1856	23214	1183	27776	944	18776
3L-6S		MI	8320	3938	13978	2770	14841	2216	15041	1799	14934	1128	17712	673	13752

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

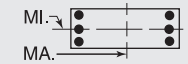
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	3.03	MA	11241	3938	18711	2831	20414	2277	21170	1847	21904	1192	26322	858	18701
4L-5S		MI	8581	3938	14438	2761	15418	2225	15694	1791	15803	1120	18747	731	14010
14-#11	3.03	MA	10890	3938	18118	2826	19646	2288	20231	1856	20590	1183	24768	821	18033
5L-4S		MI	8853	3938	14892	2768	15993	2216	16381	1782	16766	1128	19862	770	14464
14-#11	3.03	MA	10556	3938	17561	2821	18876	2281	19337	1865	19401	1192	23320	764	17679
6L-3S		MI	9155	3938	15414	2759	16643	2225	17151	1791	17723	1120	20915	850	14541
14-#11	3.03	MA	10230	3938	16951	2833	18140	2291	18395	1856	18240	1200	21961	698	16946
7L-2S		MI	9568	3938	16040	2766	17433	2216	18095	1782	18975	1111	22534	936	14525
14-#14	4.38	MA	11919	4272	20569	3030	22752	2417	23935	1922	25602	1144	31226	674	25502
4L-5S		MI	8948	4272	15631	2949	16839	2353	17382	1853	18159	1074	21709	497	19073
14-#14	4.38	MA	11426	4272	19721	3021	21654	2431	22605	1934	23740	1131	29034	620	24717
5L-4S		MI	9331	4272	16280	2961	17648	2341	18348	1841	19401	1061	23271	554	19548
14-#14	4.38	MA	10957	4272	18924	3013	20552	2420	21339	1946	22057	1144	26992	537	23505
6L-3S		MI	9754	4272	17022	2948	18563	2353	19432	1853	20747	1049	24749	666	20337
14-#18	7.78	MA	12706	5119	23648	3519	26558	2791	28367	2123	31393	986	39302	81	38827
5L-4S		MI	10535	5119	19528	3440	21593	2649	23046	1978	25701	874	31309	-33	31138
16-#11	3.47	MA	11611	4046	19540	2899	21477	2326	22463	1876	23618	1179	28574	831	21180
4L-6S		MI	8595	4046	14604	2838	15631	2263	15985	1825	16187	1111	19330	637	15554
16-#11	3.47	MA	11262	4046	18947	2894	20709	2336	21524	1885	22304	1170	27021	793	20509
5E		MI	8854	4046	15065	2828	16208	2272	16638	1816	17056	1102	20365	695	15879
16-#11	3.47	MA	10930	4046	18390	2888	19939	2329	20630	1894	21115	1179	25573	736	20099
6L-4S		MI	9125	4046	15519	2836	16783	2263	17325	1808	18019	1111	21481	734	16298
16-#11	3.47	MA	10606	4046	17780	2901	19203	2339	19687	1885	19953	1187	24214	671	19386
7L-3S		MI	9425	4046	16040	2826	17433	2272	18095	1816	18975	1102	22534	813	16492
16-#14	5.00	MA	11946	4427	20903	3119	23169	2501	24435	1975	26167	1112	32213	578	28249
5E		MI	9330	4427	16522	3046	17950	2420	18710	1889	19922	1047	23976	441	21619
16-#14	5.00	MA	11481	4427	20106	3110	22068	2489	23169	1987	24483	1124	30172	495	26951
6L-4S		MI	9710	4427	17170	3058	18759	2408	19676	1876	21164	1035	25538	498	22160
18-#11	3.90	MA	11631	4153	19776	2961	21772	2384	22816	1914	24017	1157	29274	766	22991
5L-6S		MI	8868	4153	15231	2905	16421	2310	16930	1850	17440	1093	20949	601	17365
18-#11	3.90	MA	11301	4153	19219	2956	21001	2377	21922	1923	22828	1166	27826	709	22515
6L-5S		MI	9126	4153	15691	2895	16998	2319	17583	1842	18309	1085	21984	658	17753
18-#11	3.90	MA	10979	4153	18609	2968	20266	2388	20980	1914	21667	1175	26466	643	21834
7L-4S		MI	9396	4153	16146	2903	17573	2310	18269	1833	19272	1093	23099	697	18141
18-#14	5.63	MA	12001	4583	21288	3208	23583	2559	24999	2028	26910	1104	33351	453	30410
6L-5S		MI	9710	4583	17412	3143	19062	2487	20039	1924	21685	1020	26243	385	24145
20-#11	4.33	MA	11669	4261	20048	3023	22064	2426	23214	1952	24542	1153	30079	682	24939
6E		MI	9140	4261	15858	2972	17211	2357	17874	1876	18693	1076	22568	564	19185
20-#11	4.33	MA	11349	4261	19438	3035	21329	2436	22272	1943	23380	1162	28719	616	24288
7L-5S		MI	9396	4261	16318	2963	17788	2366	18527	1867	19562	1068	23602	622	19631
22-#11	4.77	MA	11718	4369	20267	3103	22391	2484	23565	1972	25094	1149	30972	588	26748
7L-6S		MI	9410	4369	16485	3040	18001	2404	18818	1901	19946	1059	24186	528	21012

RECTANGULAR TIED COLUMNS 24" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.17	MA	12048	3706	18954	2707	20242	2207	20464	1840	20022	1313	23210	1227	8626
2E		MI	8937	3706	14239	2625	14911	2133	14881	1770	14372	1252	16426	1150	6342
4-#18	2.08	MA	12878	3948	20916	2834	22658	2296	23282	1882	23747	1263	28023	1136	14752
2E		MI	9475	3948	15532	2739	16422	2202	16659	1792	16726	1180	19360	1020	10653
6-#11	1.22	MA	12116	3718	19049	2727	20413	2223	20698	1853	20366	1321	23692	1236	8986
2L-3S		MI	8565	3718	13683	2642	14276	2163	14139	1795	13392	1271	15187	1075	6653
6-#11	1.22	MA	11509	3718	18152	2723	19264	2233	19296	1862	18498	1330	21226	1149	9036
3L-2S		MI	8988	3718	14310	2650	15066	2154	15084	1787	14645	1262	16806	1161	6597
6-#14	1.76	MA	12629	3861	20234	2805	21882	2277	22461	1882	22670	1295	26695	1188	12681
2L-3S		MI	8729	3861	14239	2711	14911	2212	14881	1818	14372	1238	16426	969	9287

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

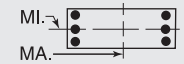
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.76	MA	11770	3861	18954	2797	20242	2292	20464	1895	20022	1308	23210	1064	12728
3L-2S		MI	9325	3861	15130	2723	16022	2200	16210	1805	16135	1225	18692	1094	9213
6-#18	3.13	MA	13857	4224	23142	3007	25511	2420	26712	1953	28297	1227	33970	1058	21745
2L-3S		MI	9113	4224	15532	2887	16422	2338	16659	1872	16726	1148	19360	686	15547
6-#18	3.13	MA	12393	4224	20916	2992	22658	2443	23282	1976	23747	1249	28023	837	21605
3L-2S		MI	10125	4224	17042	2909	18300	2316	18904	1850	19706	1126	23152	908	15528
8-#11	1.63	MA	12526	3826	19945	2795	21562	2271	22100	1882	22233	1310	26157	1210	11824
2L-4S		MI	8536	3826	13789	2719	14416	2201	14313	1812	13688	1262	15753	959	8709
8-#11	1.63	MA	11922	3826	19049	2790	20413	2282	20698	1891	20366	1318	23692	1124	11860
3E		MI	8843	3826	14310	2709	15066	2210	15084	1821	14645	1254	16806	1038	8662
8-#11	1.63	MA	11492	3826	18313	2803	19475	2275	19558	1883	18938	1327	22100	1038	11863
4L-2S		MI	9264	3826	14937	2717	15856	2201	16028	1812	15897	1245	18425	1125	8612
8-#14	2.34	MA	13203	4017	21513	2902	23521	2347	24459	1925	25319	1277	30180	1150	16708
2L-4S		MI	8685	4017	14388	2821	15107	2266	15126	1841	14789	1223	17215	801	12008
8-#14	2.34	MA	12351	4017	20234	2894	21882	2361	22461	1937	22670	1290	26695	1025	16714
3E		MI	9118	4017	15130	2808	16022	2279	16210	1853	16135	1211	18692	913	12101
8-#14	2.34	MA	11744	4017	19181	2912	20540	2351	20835	1925	20647	1302	24445	901	16550
4L-2S		MI	9710	4017	16020	2820	17133	2266	17538	1841	17898	1198	20959	1038	12048
8-#18	4.17	MA	14821	4501	25367	3180	28364	2544	30143	2025	32846	1190	39918	980	28681
2L-4S		MI	9029	4501	15781	3079	16753	2430	17070	1908	17432	1116	20669	383	18392
8-#18	4.17	MA	13375	4501	23142	3165	25511	2567	26712	2047	28297	1212	33970	759	28422
3E		MI	9765	4501	17042	3057	18300	2452	18904	1931	19706	1094	23152	574	20267
8-#18	4.17	MA	12341	4501	21304	3193	23169	2547	23918	2025	24821	1234	30120	545	25721
4L-2S		MI	10767	4501	18552	3079	20178	2430	21149	1908	22687	1072	26944	795	20354
10-#11	2.03	MA	12932	3934	20842	2862	22712	2319	23502	1911	24101	1298	28623	1185	14648
2L-5S		MI	8537	3934	13961	2779	14631	2257	14571	1846	13978	1236	16256	884	10423
10-#11	2.03	MA	12332	3934	19945	2857	21562	2330	22100	1921	22233	1307	26157	1099	14670
3L-4S		MI	8814	3934	14416	2786	15206	2248	15258	1838	14941	1245	17372	923	10680
10-#11	2.03	MA	11905	3934	19209	2870	20624	2324	20960	1912	20806	1315	24565	1013	14641
4L-3S		MI	9119	3934	14937	2777	15856	2257	16028	1846	15897	1236	18425	1002	10651
10-#11	2.03	MA	11522	3934	18570	2866	19796	2335	19943	1922	19374	1307	22868	975	14210
5L-2S		MI	9538	3934	15564	2784	16646	2248	16972	1838	17150	1228	20043	1088	10610
10-#14	2.93	MA	13771	4173	22792	2999	25161	2416	26457	1967	27968	1259	33666	1111	20721
2L-5S		MI	8684	4173	14630	2906	15409	2345	15489	1888	15311	1209	17920	688	13959
10-#14	2.93	MA	12926	4173	21513	2992	23521	2431	24459	1979	25319	1272	30180	986	20679
3L-4S		MI	9073	4173	15278	2918	16218	2333	16454	1876	16552	1197	19481	745	14559
10-#14	2.93	MA	12324	4173	20460	3009	22180	2421	22833	1967	23295	1284	27930	863	20252
4L-3S		MI	9504	4173	16020	2905	17133	2345	17538	1888	17898	1184	20959	857	14893
10-#14	2.93	MA	11783	4173	19546	3002	20996	2436	21381	1979	21264	1272	25527	809	19186
5L-2S		MI	10092	4173	16910	2917	18245	2333	18867	1876	19662	1172	23226	982	14863
10-#18	5.21	MA	14343	4778	25367	3338	28364	2691	30143	2119	32846	1176	39918	681	35223
3L-4S		MI	9681	4778	17291	3250	18630	2544	19316	1966	20412	1062	24461	270	22815
10-#18	5.21	MA	13322	4778	23529	3366	26022	2671	27348	2097	29371	1198	36068	467	32209
4L-3S		MI	10411	4778	18552	3227	20178	2566	21149	1989	22687	1040	26944	461	24719
10-#18	5.21	MA	12407	4778	21930	3351	23951	2694	24855	2119	25880	1176	31968	370	29777
5L-2S		MI	11404	4778	20062	3250	22055	2544	23394	1966	25668	1018	30736	682	25136
12-#11	2.44	MA	13335	4042	21738	2930	23861	2368	24904	1941	25969	1286	31088	1160	17462
2L-6S		MI	8552	4042	14128	2856	14844	2295	14863	1881	14362	1228	16840	789	12043
12-#11	2.44	MA	12739	4042	20842	2925	22712	2379	23502	1950	24101	1295	28623	1074	17464
3L-5S		MI	8815	4042	14588	2846	15421	2304	15516	1872	15231	1219	17875	847	12277
12-#11	2.44	MA	12314	4042	20106	2938	21774	2372	22362	1942	22674	1304	27031	987	17411
4E		MI	9089	4042	15042	2854	15996	2295	16202	1863	16194	1228	18990	886	12638

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

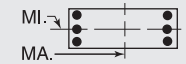
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.44	MA	11934	4042	19467	2933	20946	2383	21345	1951	21242	1295	25333	950	16869
5L-3S		MI	9393	4042	15564	2844	16646	2304	16972	1872	17150	1219	20043	966	12627
12-#11	2.44	MA	11571	4042	18867	2928	20116	2377	20377	1960	19946	1304	23746	893	16431
6L-2S		MI	9810	4042	16190	2852	17436	2295	17916	1863	18403	1210	21662	1052	12596
12-#14	3.52	MA	13495	4328	22792	3089	25161	2501	26457	2021	27968	1254	33666	947	24633
3L-5S		MI	9072	4328	15520	3003	16521	2412	16817	1924	17074	1182	20186	632	16592
12-#14	3.52	MA	12898	4328	21740	3107	23820	2491	24830	2009	25944	1266	31416	824	23981
4E		MI	9459	4328	16168	3015	17330	2399	17783	1912	18316	1170	21748	689	17136
12-#14	3.52	MA	12362	4328	20825	3099	22636	2506	23378	2021	23913	1254	29013	770	22990
5L-3S		MI	9886	4328	16910	3002	18245	2412	18867	1924	19662	1157	23226	801	17660
12-#14	3.52	MA	11852	4328	19966	3092	21448	2496	21996	2034	22075	1266	26772	688	21900
6L-2S		MI	10471	4328	17800	3014	19356	2399	20196	1912	21425	1145	25492	925	17663
12-#18	6.25	MA	14291	5054	25755	3539	28875	2795	30779	2168	33920	1161	42016	389	38737
4E		MI	10328	5054	18801	3420	20508	2658	21561	2025	23393	1008	28253	158	27275
12-#18	6.25	MA	13387	5054	24155	3524	26804	2818	28285	2190	30429	1139	37916	292	36122
5L-3S		MI	11051	5054	20062	3398	22055	2680	23394	2047	25668	986	30736	348	28987
14-#11	2.84	MA	13142	4150	21738	2992	23861	2427	24904	1979	25969	1283	31088	1049	20250
3L-6S		MI	8829	4150	14755	2923	15634	2342	15807	1906	15615	1210	18459	753	13924
14-#11	2.84	MA	12720	4150	21002	3005	22923	2421	23764	1971	24542	1292	29496	962	20175
4L-5S		MI	9090	4150	15215	2914	16211	2351	16460	1897	16484	1202	19494	811	14139
14-#11	2.84	MA	12342	4150	20363	3000	22095	2432	22747	1980	23110	1283	27799	925	19538
5L-4S		MI	9364	4150	15669	2921	16786	2342	17146	1889	17446	1210	20609	850	14583
14-#11	2.84	MA	11982	4150	19763	2996	21265	2425	21779	1990	21814	1292	26212	868	19126
6L-3S		MI	9666	4150	16190	2912	17436	2351	17916	1897	18403	1202	21662	929	14594
14-#11	2.84	MA	11630	4150	19106	3008	20473	2436	20759	1981	20548	1301	24514	777	18415
7L-2S		MI	10081	4150	16817	2919	18226	2342	18861	1889	19656	1193	23281	1015	14573
14-#14	4.10	MA	13467	4484	23019	3204	25460	2561	26828	2051	28592	1248	34901	785	27732
4L-5S		MI	9458	4484	16410	3101	17632	2478	18146	1959	18837	1155	22453	576	19236
14-#14	4.10	MA	12935	4484	22105	3196	24276	2576	25376	2064	26561	1236	32498	731	26806
5L-4S		MI	9842	4484	17058	3113	18441	2466	19112	1947	20079	1143	24015	633	19732
14-#14	4.10	MA	12429	4484	21246	3189	23088	2566	23994	2076	24724	1248	30257	649	25621
6L-3S		MI	10267	4484	17800	3100	19356	2478	20196	1959	21425	1131	25492	745	20416
14-#14	4.10	MA	11937	4484	20305	3207	21954	2581	22538	2064	22928	1261	28155	554	24499
7L-2S		MI	10848	4484	18691	3112	20467	2466	21524	1947	23188	1118	27759	869	20453
14-#18	7.29	MA	14355	5331	26381	3697	29657	2943	31716	2262	34979	1103	43864	214	42506
5L-4S		MI	10969	5331	20310	3590	22385	2772	23806	2083	26373	954	32045	45	31761
16-#11	3.25	MA	13124	4258	21899	3072	24072	2469	25166	2001	26409	1280	31961	937	22935
4L-6S		MI	9104	4258	15381	2991	16424	2389	16751	1932	16868	1193	20077	716	15761
16-#11	3.25	MA	12748	4258	21260	3068	23244	2480	24149	2010	24978	1272	30264	899	22217
5E		MI	9364	4258	15841	2981	17001	2398	17404	1923	17737	1184	21112	774	16009
16-#11	3.25	MA	12389	4258	20659	3063	22414	2474	23181	2019	23682	1280	28677	843	21826
6L-4S		MI	9636	4258	16296	2989	17576	2389	18091	1914	18699	1193	22228	813	16448
16-#11	3.25	MA	12040	4258	20003	3076	21622	2485	22161	2011	22415	1289	26979	752	21058
7L-3S		MI	9937	4258	16817	2979	18226	2398	18861	1923	19656	1184	23281	893	16553
16-#11	3.25	MA	11697	4258	19411	3071	20818	2478	21210	2020	21166	1298	25393	707	20390
8L-2S		MI	10350	4258	17444	2987	19016	2389	19805	1914	20909	1176	24899	979	16544
16-#14	4.69	MA	13503	4639	23384	3294	25916	2646	27374	2106	29210	1218	35983	692	30632
5E		MI	9840	4639	17300	3198	18743	2545	19474	1995	20600	1129	24719	520	21888
16-#14	4.69	MA	13001	4639	22525	3286	24728	2636	25992	2118	27372	1230	33742	610	29358
6L-4S		MI	10222	4639	17948	3210	19552	2533	20440	1982	21842	1116	26281	577	22342
16-#14	4.69	MA	12513	4639	21585	3304	23594	2651	24536	2106	25577	1243	31640	515	28173
7L-3S		MI	10644	4639	18691	3197	20467	2545	21524	1995	23188	1104	27759	689	23162

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

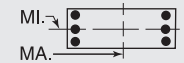
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	3.66	MA	13150	4366	22156	3135	24393	2528	25551	2039	26845	1260	32729	874	24902
5L-6S		MI	9378	4366	16008	3058	17214	2436	17695	1957	18120	1176	21696	680	17570
18-#11	3.66	MA	12794	4366	21556	3131	23564	2522	24583	2048	25549	1269	31143	817	24504
6L-5S		MI	9636	4366	16468	3048	17791	2445	18348	1949	18989	1167	22731	738	17883
18-#11	3.66	MA	12447	4366	20899	3143	22771	2533	23563	2040	24283	1277	29444	727	23708
7L-4S		MI	9907	4366	16923	3056	18366	2436	19035	1940	19952	1176	23846	777	18291
18-#11	3.66	MA	12106	4366	20308	3139	21967	2527	22612	2049	23034	1286	27859	682	22998
8L-3S		MI	10207	4366	17444	3046	19016	2445	19805	1949	20909	1167	24899	856	18501
18-#14	5.27	MA	13569	4795	23804	3384	26368	2706	27989	2160	30021	1212	37227	571	33108
6L-5S		MI	10220	4795	18191	3295	19855	2612	20803	2030	22363	1102	26986	464	24433
18-#14	5.27	MA	13084	4795	22864	3401	25234	2720	26533	2148	28225	1225	35125	476	31862
7L-4S		MI	10600	4795	18839	3307	20664	2599	21769	2018	23605	1090	28548	520	24964
20-#11	4.06	MA	13197	4473	22452	3198	24713	2571	25985	2078	27417	1257	33608	792	27129
6E		MI	9650	4473	16635	3125	18004	2483	18640	1983	19373	1158	23315	643	19388
20-#11	4.06	MA	12852	4473	21796	3211	23920	2581	24965	2070	26151	1266	31910	702	26366
7L-5S		MI	9907	4473	17095	3116	18581	2492	19293	1974	20242	1150	24349	701	19761
20-#11	4.06	MA	12512	4473	21204	3206	23116	2575	24014	2079	24901	1274	30324	657	25614
8L-4S		MI	10177	4473	17550	3123	19156	2483	19979	1965	21205	1158	25465	740	20141
20-#14	5.86	MA	13651	4951	24143	3499	26874	2790	28531	2190	30874	1207	38611	437	35563
7L-5S		MI	10599	4951	19081	3392	20966	2678	22132	2066	24126	1075	29252	408	26971
22-#11	4.47	MA	13253	4581	22692	3278	25070	2630	26367	2099	28018	1254	34375	677	29029
7L-6S		MI	9921	4581	17262	3193	18794	2530	19584	2008	20626	1141	24933	607	21214
22-#11	4.47	MA	12916	4581	22101	3274	24266	2623	25416	2108	26769	1263	32789	632	28236
8L-5S		MI	10177	4581	17722	3183	19371	2539	20237	2000	21495	1132	25968	665	21643
24-#11	4.88	MA	13317	4689	22997	3341	25415	2672	26818	2138	28637	1251	35255	607	30865
8L-6S		MI	10190	4689	17888	3260	19584	2577	20528	2034	21879	1124	26552	571	23045

RECTANGULAR TIED COLUMNS 24" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.10	MA	13549	3918	21214	2880	22682	2349	22928	1961	22415	1409	25992	1323	9233
2E		MI	9446	3918	15018	2777	15703	2258	15645	1876	15050	1334	17169	1229	6376
4-#18	1.96	MA	14456	4160	23334	3007	25294	2437	26030	2007	26481	1362	31271	1237	15832
2E		MI	9986	4160	16314	2889	17214	2325	17419	1897	17399	1261	20096	1098	10704
6-#11	1.15	MA	13622	3930	21312	2900	22863	2364	23169	1973	22779	1417	26502	1331	9618
2L-3S		MI	9074	3930	14460	2795	15070	2289	14905	1902	14072	1353	15934	1154	6685
6-#11	1.15	MA	12967	3930	20348	2896	21627	2376	21661	1983	20757	1425	23824	1244	9668
3L-2S		MI	9497	3930	15087	2802	15860	2280	15849	1894	15325	1344	17553	1241	6629
6-#14	1.65	MA	14180	4074	22590	2977	24447	2419	25081	2004	25286	1392	29783	1287	13592
2L-3S		MI	9238	4074	15018	2863	15703	2337	15645	1924	15050	1319	17169	1048	9331
6-#14	1.65	MA	13254	4074	21214	2970	22682	2434	22928	2017	22415	1405	25992	1162	13639
3L-2S		MI	9835	4074	15908	2875	16815	2325	16974	1911	16813	1307	19436	1173	9253
6-#18	2.94	MA	15520	4437	25732	3180	28369	2561	29759	2081	31425	1328	37763	1165	23365
2L-3S		MI	9623	4437	16314	3037	17214	2461	17419	1977	17399	1229	20096	764	15634
6-#18	2.94	MA	13939	4437	23334	3166	25294	2587	26030	2103	26481	1350	31271	944	23225
3L-2S		MI	10636	4437	17824	3059	19092	2439	19664	1955	20379	1207	23888	985	15589
8-#11	1.53	MA	14066	4038	22276	2967	24099	2413	24676	2002	24801	1406	29180	1308	12667
2L-4S		MI	9045	4038	14566	2872	15210	2327	15079	1919	14368	1344	16500	1039	8752
8-#11	1.53	MA	13416	4038	21312	2963	22863	2424	23169	2012	22779	1415	26502	1221	12703
3E		MI	9352	4038	15087	2862	15860	2336	15849	1928	15325	1336	17553	1118	8700
8-#11	1.53	MA	12954	4038	20522	2976	21857	2419	21946	2005	21234	1423	24769	1135	12705
4L-2S		MI	9774	4038	15714	2870	16650	2327	16793	1919	16578	1327	19172	1204	8648
8-#14	2.21	MA	14803	4229	23967	3074	26212	2488	27233	2046	28157	1376	33575	1251	17923
2L-4S		MI	9194	4229	15166	2973	15900	2391	15890	1947	15467	1305	17958	880	12167
8-#14	2.21	MA	13884	4229	22590	3068	24447	2504	25081	2059	25286	1388	29783	1126	17929
3E		MI	9628	4229	15908	2960	16815	2404	16974	1959	16813	1292	19436	992	12153

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

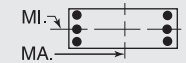


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.21	MA	13232	4229	21460	3086	23007	2495	23331	2048	23092	1401	27334	1002	17797
4L-2S		MI	10221	4229	16799	2972	17926	2391	18302	1947	18576	1280	21702	1117	12095
8-#18	3.92	MA	16568	4713	28131	3352	31443	2686	33487	2155	36369	1295	44254	1093	30841
2L-4S		MI	9537	4713	16563	3229	17544	2553	17831	2013	18105	1197	21406	461	18640
8-#18	3.92	MA	15006	4713	25732	3339	28369	2711	29759	2177	31425	1317	37763	872	30582
3E		MI	10276	4713	17824	3207	19092	2575	19664	2035	20379	1175	23888	651	20369
8-#18	3.92	MA	13894	4713	23756	3369	25851	2692	26722	2155	27648	1339	33568	654	27898
4L-2S		MI	11280	4713	19334	3229	20969	2553	21910	2013	23360	1152	27680	873	20423
10-#11	1.91	MA	14507	4146	23240	3034	25335	2461	26184	2032	26823	1395	31859	1284	15701
2L-5S		MI	9046	4146	14738	2932	15425	2383	15337	1953	14659	1318	17003	963	10548
10-#11	1.91	MA	13860	4146	22276	3030	24099	2473	24676	2042	24801	1404	29180	1198	15723
3L-4S		MI	9323	4146	15193	2939	16000	2374	16023	1945	15621	1327	18119	1002	10730
10-#11	1.91	MA	13401	4146	21486	3044	23092	2467	23453	2034	23256	1413	27447	1112	15694
4L-3S		MI	9629	4146	15714	2930	16650	2383	16793	1953	16578	1318	19172	1081	10694
10-#11	1.91	MA	12990	4146	20801	3039	22204	2478	22362	2044	21707	1404	25609	1073	15323
5L-2S		MI	10048	4146	16340	2937	17440	2374	17738	1945	17831	1310	20790	1168	10650
10-#14	2.76	MA	15420	4385	25343	3171	27976	2558	29386	2088	31028	1359	37367	1215	22239
2L-5S		MI	9193	4385	15408	3058	16202	2470	16253	1995	15989	1291	18663	767	14116
10-#14	2.76	MA	14508	4385	23967	3165	26212	2574	27233	2102	28157	1372	33575	1090	22198
3L-4S		MI	9583	4385	16056	3070	17011	2458	17218	1982	17230	1278	20225	824	14741
10-#14	2.76	MA	13861	4385	22836	3183	24772	2565	25484	2090	25963	1384	31126	966	21930
4L-3S		MI	10014	4385	16799	3057	17926	2470	18302	1995	18576	1266	21702	936	14952
10-#14	2.76	MA	13281	4385	21856	3177	23501	2581	23923	2104	23763	1372	28517	911	20702
5L-2S		MI	10604	4385	17689	3069	19038	2458	19631	1982	20339	1253	23969	1060	14914
10-#18	4.90	MA	16058	4990	28131	3511	31443	2835	33487	2250	36369	1283	44254	800	37923
3L-4S		MI	10190	4990	18073	3399	19422	2667	20076	2071	21085	1143	25197	348	23060
10-#18	4.90	MA	14960	4990	26155	3542	28926	2816	30451	2228	32592	1305	40060	582	34900
4L-3S		MI	10922	4990	19334	3377	20969	2689	21910	2093	23360	1121	27680	539	25047
10-#18	4.90	MA	13976	4990	24437	3528	26701	2842	27741	2250	28799	1283	35584	486	32484
5L-2S		MI	11918	4990	20844	3399	22847	2667	24155	2071	26340	1098	31472	760	25218
12-#11	2.29	MA	14944	4254	24204	3102	26570	2510	27691	2061	28845	1385	34537	1261	18726
2L-6S		MI	9061	4254	14905	3009	15638	2421	15628	1987	15042	1310	17587	869	12161
12-#11	2.29	MA	14301	4254	23240	3098	25335	2521	26184	2071	26823	1393	31859	1175	18728
3L-5S		MI	9324	4254	15365	2999	16215	2430	16281	1979	15911	1301	18622	927	12401
12-#11	2.29	MA	13845	4254	22450	3111	24328	2515	24961	2064	25278	1402	30126	1088	18674
4E		MI	9599	4254	15819	3007	16790	2421	16968	1970	16874	1310	19737	966	12696
12-#11	2.29	MA	13437	4254	21765	3107	23440	2527	23870	2074	23729	1393	28288	1050	18183
5L-3S		MI	9904	4254	16340	2997	17440	2430	17738	1979	17831	1301	20790	1045	12674
12-#11	2.29	MA	13047	4254	21122	3103	22551	2521	22783	2066	22326	1402	26562	993	17681
6L-2S		MI	10321	4254	16967	3005	18230	2421	18682	1970	19083	1292	22409	1131	12639
12-#14	3.31	MA	15126	4540	25343	3262	27976	2644	29386	2144	31028	1355	37367	1055	26455
3L-5S		MI	9581	4540	16299	3155	17314	2537	17581	2030	17752	1264	20929	711	16750
12-#14	3.31	MA	14484	4540	24213	3281	26536	2635	27636	2133	28834	1368	34918	930	25946
4E		MI	9969	4540	16947	3167	18123	2524	18547	2018	18993	1251	22491	768	17315
12-#14	3.31	MA	13909	4540	23232	3274	25265	2651	26075	2146	26634	1355	32309	876	24798
5L-3S		MI	10398	4540	17689	3154	19038	2537	19631	2030	20339	1239	23969	880	17729
12-#14	3.31	MA	13361	4540	22311	3267	23992	2642	24590	2159	24642	1368	29868	794	23755
6L-2S		MI	10984	4540	18579	3166	20149	2524	20960	2018	22102	1227	26235	1004	17718
12-#18	5.88	MA	16012	5267	28553	3715	32000	2941	34180	2302	37536	1272	46551	510	41945
4E		MI	10838	5267	19583	3570	21299	2781	22321	2129	24066	1089	28989	236	27517
12-#18	5.88	MA	15040	5267	26836	3701	29776	2966	31470	2324	33744	1250	42076	414	39344
5L-3S		MI	11564	5267	20844	3548	22847	2804	24155	2151	26340	1067	31472	426	29308
14-#11	2.68	MA	14738	4362	24204	3165	26570	2570	27691	2101	28845	1383	34537	1152	21724
3L-6S		MI	9338	4362	15531	3076	16428	2468	16573	2013	16295	1292	19206	832	14043
14-#11	2.68	MA	14286	4362	23414	3178	25564	2564	26468	2093	27300	1391	32804	1065	21649
4L-5S		MI	9600	4362	15991	3066	17005	2477	17226	2004	17164	1284	20240	890	14264
14-#11	2.68	MA	13880	4362	22729	3174	24676	2575	25377	2103	25751	1383	30966	1027	21055
5L-4S		MI	9874	4362	16446	3074	17580	2468	17912	1996	18127	1292	21356	929	14648

RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

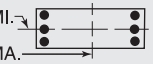


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.68	MA	13493	4362	22086	3170	23786	2570	24291	2096	24348	1391	29240	970	20581
6L-3S		MI	10177	4362	16967	3065	18230	2477	18682	2004	19083	1284	22409	1009	14646
14-#11	2.68	MA	13116	4362	21382	3183	22937	2581	23247	2106	22977	1400	27395	880	19902
7L-2S		MI	10592	4362	17594	3072	19020	2468	19626	1996	20336	1275	24027	1095	14620
14-#14	3.86	MA	15101	4696	25589	3378	28301	2705	29789	2175	31705	1351	38710	894	29986
4L-5S		MI	9967	4696	17189	3253	18425	2603	18910	2066	19515	1237	23196	655	19394
14-#14	3.86	MA	14531	4696	24609	3371	27030	2721	28228	2188	29505	1339	36100	840	28909
5L-4S		MI	10353	4696	17837	3265	19234	2591	19876	2053	20756	1225	24758	712	19909
14-#14	3.86	MA	13987	4696	23688	3365	25757	2712	26743	2202	27513	1351	33659	758	27767
6L-3S		MI	10779	4696	18579	3252	20149	2603	20960	2066	22102	1212	26235	824	20491
14-#14	3.86	MA	13459	4696	22680	3383	24540	2727	25178	2190	25566	1364	31047	627	26626
7L-2S		MI	11361	4696	19469	3264	21260	2591	22288	2053	23866	1200	28502	948	20516
14-#18	6.86	MA	16091	5543	29234	3874	32850	3090	35198	2398	38688	1216	48567	342	46242
5L-4S		MI	11480	5543	21092	3740	23177	2896	24567	2187	27046	1035	32781	123	32001
16-#11	3.06	MA	14723	4470	24378	3246	26799	2612	27976	2123	29322	1381	35482	1042	24620
4L-6S		MI	9613	4470	16158	3143	17218	2515	17517	2039	17548	1275	20824	796	15929
16-#11	3.06	MA	14319	4470	23693	3242	25912	2624	26885	2133	27773	1372	33644	1003	23936
5E		MI	9874	4470	16618	3134	17795	2523	18170	2030	18417	1266	21859	854	16133
16-#11	3.06	MA	13935	4470	23050	3238	25022	2618	25798	2125	26370	1381	31919	947	23486
6L-4S		MI	10147	4470	17073	3142	18370	2515	18856	2021	19380	1275	22975	893	16591
16-#11	3.06	MA	13561	4470	22346	3251	24173	2630	24754	2135	24999	1389	30073	856	22748
7L-3S		MI	10448	4470	17594	3132	19020	2523	19626	2030	20336	1266	24027	972	16610
16-#11	3.06	MA	13192	4470	21712	3247	23311	2624	23735	2145	23540	1381	28356	811	22118
8L-2S		MI	10862	4470	18221	3140	19810	2515	20570	2021	21589	1258	25646	1058	16593
16-#14	4.41	MA	15147	4852	25985	3469	28795	2790	30381	2231	32376	1322	39892	804	33030
5E		MI	10350	4852	18079	3350	19536	2670	20238	2101	21278	1210	25463	599	22046
16-#14	4.41	MA	14608	4852	25064	3462	27521	2781	28895	2244	30384	1335	37451	722	31795
6L-4S		MI	10733	4852	18727	3362	20345	2658	21204	2089	22520	1198	27024	655	22519
16-#14	4.41	MA	14084	4852	24056	3480	26305	2797	27330	2233	28437	1347	34839	592	30642
7L-3S		MI	11157	4852	19469	3349	21260	2670	22288	2101	23866	1185	28502	768	23243
18-#11	3.44	MA	14756	4578	24657	3309	27147	2672	28392	2162	29795	1361	36323	980	26825
5L-6S		MI	9887	4578	16785	3211	18008	2562	18461	2064	18801	1258	22443	759	17769
18-#11	3.44	MA	14374	4578	24014	3305	26258	2666	27306	2155	28392	1370	34597	924	26395
6L-5S		MI	10147	4578	17245	3201	18585	2570	19114	2055	19670	1249	23478	817	18008
18-#11	3.44	MA	14002	4578	23310	3318	25408	2678	26262	2164	27021	1379	32752	833	25601
7L-4S		MI	10419	4578	17700	3209	19160	2562	19800	2047	20632	1258	24593	856	18436
18-#11	3.44	MA	13636	4578	22676	3314	24547	2672	25242	2174	25562	1370	31034	787	24928
8L-3S		MI	10719	4578	18221	3199	19810	2570	20570	2055	21589	1249	25646	936	18563
18-#14	4.96	MA	15224	5007	26441	3559	29286	2851	31048	2287	33255	1318	41243	686	35836
6L-5S		MI	10731	5007	18969	3447	20648	2737	21567	2136	23041	1184	27729	543	24705
18-#14	4.96	MA	14703	5007	25433	3578	28070	2867	29483	2275	31308	1331	38631	556	34622
7L-4S		MI	11112	5007	19617	3459	21457	2724	22533	2124	24283	1171	29291	599	25140
20-#11	3.82	MA	14810	4686	24978	3373	27493	2715	28813	2184	30414	1359	37275	900	29308
6E		MI	10160	4686	17412	3278	18798	2609	19405	2090	20054	1240	24061	723	19586
20-#11	3.82	MA	14440	4686	24274	3386	26644	2726	27769	2194	29043	1368	35430	810	28461
7L-5S		MI	10418	4686	17872	3269	19375	2617	20058	2081	20923	1232	25096	781	19887
20-#11	3.82	MA	14076	4686	23640	3382	25783	2721	26750	2204	27584	1359	33712	764	27746
8L-4S		MI	10689	4686	18326	3276	19950	2609	20745	2072	21885	1240	26212	820	20285
20-#14	5.51	MA	15318	5163	26809	3675	29834	2937	31636	2317	34179	1314	42423	520	38613
7L-5S		MI	11110	5163	19859	3544	21759	2803	22896	2172	24804	1157	29996	486	27248
22-#11	4.21	MA	14876	4794	25238	3453	27880	2775	29277	2223	31065	1357	38108	787	31328
7L-6S		MI	10431	4794	18038	3346	19588	2656	20350	2115	21306	1223	25680	686	21410
22-#11	4.21	MA	14514	4794	24604	3449	27018	2769	28257	2233	29606	1349	36391	741	30571
8L-5S		MI	10689	4794	18499	3336	20165	2664	21003	2107	22175	1215	26715	744	21770
24-#11	4.59	MA	14949	4901	25568	3517	28254	2817	29765	2263	31628	1338	39069	718	33402
8L-6S		MI	10701	4901	18665	3413	20378	2703	21294	2141	22559	1206	27299	650	23240

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



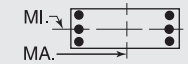
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.04	MA	15136	4130	23593	3052	25255	2491	25517	2082	24930	1504	28910	1417	9841
2E		MI	9956	4130	15797	2929	16496	2383	16409	1982	15728	1415	17912	1308	6409
4-#18	1.85	MA	16119	4372	25872	3179	28062	2579	28899	2131	29336	1460	34658	1337	16912
2E		MI	10496	4372	17097	3039	18006	2448	18180	2002	18072	1341	20833	1176	10753
6-#11	1.08	MA	15213	4143	23696	3072	25445	2506	25771	2094	25314	1512	29449	1425	10250
2L-3S		MI	9583	4143	15237	2948	15863	2414	15671	2009	14753	1435	16681	1234	6715
6-#11	1.08	MA	14511	4143	22665	3068	24123	2518	24158	2104	23138	1520	26557	1339	10300
3L-2S		MI	10007	4143	15864	2955	16653	2406	16615	2000	16005	1427	18300	1320	6660
6-#14	1.56	MA	15816	4286	25067	3149	27144	2560	27822	2124	28023	1489	33009	1384	14504
2L-3S		MI	9748	4286	15797	3015	16496	2462	16409	2030	15728	1401	17912	1127	9374
6-#14	1.56	MA	14823	4286	23593	3143	25255	2577	25517	2138	24930	1501	28910	1259	14551
3L-2S		MI	10346	4286	16687	3027	17608	2450	17738	2017	17491	1388	20179	1252	9293
6-#18	2.78	MA	17270	4649	28444	3352	31358	2703	32920	2206	34675	1429	41694	1270	24985
2L-3S		MI	10132	4649	17097	3187	18006	2584	18180	2082	18072	1309	20833	842	15716
6-#18	2.78	MA	15570	4649	25872	3339	28062	2730	28899	2229	29336	1451	34658	1049	24845
3L-2S		MI	11148	4649	18606	3209	19883	2562	20425	2060	21052	1287	24624	1063	15648
8-#11	1.44	MA	15692	4250	24727	3139	26767	2555	27384	2123	27491	1502	32340	1404	13509
2L-4S		MI	9554	4250	15343	3025	16003	2453	15845	2026	15049	1426	17247	1118	8793
8-#11	1.44	MA	14994	4250	23696	3136	25445	2567	25771	2133	25314	1511	29449	1317	13545
3E		MI	9862	4250	15864	3015	16653	2461	16615	2035	16005	1418	18300	1197	8736
8-#11	1.44	MA	14501	4250	22852	3149	24370	2561	24465	2127	23651	1519	27575	1231	13547
4L-2S		MI	10284	4250	16491	3023	17443	2453	17559	2026	17258	1409	19919	1284	8684
8-#14	2.08	MA	16489	4441	26541	3247	29034	2630	30127	2166	31117	1474	37108	1351	19138
2L-4S		MI	9703	4441	15945	3125	16693	2516	16654	2053	16145	1387	18701	959	12236
8-#14	2.08	MA	15503	4441	25067	3241	27144	2647	27822	2181	28023	1486	33009	1226	19144
3E		MI	10138	4441	16687	3112	17608	2529	17738	2065	17491	1374	20179	1071	12203
8-#14	2.08	MA	14805	4441	23859	3260	25605	2639	25952	2170	25659	1499	30356	1102	19012
4L-2S		MI	10732	4441	17577	3124	18719	2516	19066	2053	19254	1362	22446	1195	12140
8-#18	3.70	MA	18403	4925	31015	3525	34654	2827	36942	2281	40014	1398	48729	1204	33001
2L-4S		MI	10045	4925	17345	3379	18336	2676	18592	2118	18777	1277	22142	539	18881
8-#18	3.70	MA	16724	4925	28444	3512	31358	2855	32920	2304	34675	1420	41694	982	32742
3E		MI	10786	4925	18606	3357	19883	2699	20425	2140	21052	1255	24624	729	20465
8-#18	3.70	MA	15532	4925	26330	3544	28665	2838	29648	2282	30596	1442	37154	761	30103
4L-2S		MI	11793	4925	20116	3379	21761	2676	22670	2118	24033	1233	28416	951	20490
10-#11	1.81	MA	16167	4358	25759	3207	28089	2603	28997	2152	29667	1492	35232	1382	16754
2L-5S		MI	9555	4358	15515	3085	16218	2508	16103	2060	15339	1401	17750	1043	10704
10-#11	1.81	MA	15474	4358	24727	3203	26767	2615	27384	2163	27491	1501	32340	1296	16776
3L-4S		MI	9833	4358	15969	3092	16793	2500	16789	2052	16302	1409	18866	1081	10777
10-#11	1.81	MA	14983	4358	23884	3217	25692	2610	26078	2156	25827	1509	30466	1210	16747
4L-3S		MI	10139	4358	16491	3083	17443	2508	17559	2060	17258	1401	19919	1161	10735
10-#11	1.81	MA	14544	4358	23153	3213	24745	2622	24914	2167	24160	1501	28487	1170	16448
5L-2S		MI	10559	4358	17117	3090	18233	2500	18503	2052	18511	1392	21537	1247	10689
10-#14	2.60	MA	17155	4597	28015	3344	30923	2700	32432	2209	34211	1458	41207	1317	23758
2L-5S		MI	9701	4597	16187	3210	16995	2595	17017	2101	16666	1372	19406	846	14267
10-#14	2.60	MA	16176	4597	26541	3338	29034	2717	30127	2223	31117	1471	37108	1193	23717
3L-4S		MI	10092	4597	16835	3222	17804	2583	17982	2088	17908	1360	20968	903	14917
10-#14	2.60	MA	15484	4597	25333	3357	27495	2709	28257	2213	28753	1483	34455	1068	23536
4L-3S		MI	10525	4597	17577	3209	18719	2595	19066	2101	19254	1347	22446	1015	15008
10-#14	2.60	MA	14864	4597	24286	3351	26138	2725	26590	2227	26382	1471	31643	1013	22231
5L-2S		MI	11115	4597	18467	3221	19831	2583	20395	2088	21017	1335	24712	1139	14964
10-#18	4.63	MA	17861	5202	31015	3685	34654	2979	36942	2379	40014	1389	48729	915	40623
3L-4S		MI	10699	5202	18855	3549	20214	2791	20837	2176	21758	1223	25933	426	23298

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

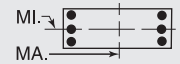


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	4.63	MA	16684	5202	28901	3717	31961	2962	33669	2358	35935	1411	44190	694	37621
4L-3S		MI	11434	5202	20116	3527	21761	2813	22670	2198	24033	1201	28416	617	25182
10-#18	4.63	MA	15631	5202	27066	3705	29583	2989	30748	2380	31841	1389	39339	599	35242
5L-2S		MI	12432	5202	21626	3549	23638	2791	24915	2176	27013	1179	32208	838	25297
12-#11	2.17	MA	16639	4466	26790	3274	29412	2651	30610	2182	31844	1482	38123	1361	19989
2L-6S		MI	9569	4466	15681	3162	16431	2547	16394	2094	15723	1392	18334	948	12273
12-#11	2.17	MA	15949	4466	25759	3271	28089	2663	28997	2192	29667	1491	35232	1274	19992
3L-5S		MI	9833	4466	16142	3152	17008	2555	17047	2086	16592	1383	19369	1006	12521
12-#11	2.17	MA	15462	4466	24915	3284	27014	2658	27691	2186	28004	1500	33358	1188	19938
4E		MI	10109	4466	16596	3160	17583	2547	17733	2077	17554	1392	20484	1045	12748
12-#11	2.17	MA	15025	4466	24184	3281	26067	2670	26527	2196	26336	1491	31379	1149	19509
5L-3S		MI	10414	4466	17117	3150	18233	2555	18503	2086	18511	1383	21537	1124	12720
12-#11	2.17	MA	14610	4466	23498	3277	25118	2665	25367	2189	24826	1500	29514	1092	18938
6L-2S		MI	10832	4466	17744	3158	19023	2547	19448	2077	19764	1375	23156	1211	12682
12-#14	3.13	MA	16843	4753	28015	3435	30923	2787	32432	2266	34211	1456	41207	1160	28278
3L-5S		MI	10090	4753	17077	3307	18107	2662	18345	2136	18430	1345	21673	790	16901
12-#14	3.13	MA	16156	4753	26807	3454	29384	2778	30562	2255	31846	1468	38554	1035	27934
4E		MI	10479	4753	17725	3319	18916	2649	19311	2124	19671	1333	23235	847	17490
12-#14	3.13	MA	15541	4753	25760	3448	28027	2795	28895	2269	29476	1456	35742	979	26621
5L-3S		MI	10909	4753	18467	3306	19831	2662	20395	2136	21017	1321	24712	959	17796
12-#14	3.13	MA	14956	4753	24777	3443	26667	2787	27234	2259	27329	1468	33100	898	25638
6L-2S		MI	11496	4753	19358	3318	20942	2649	21724	2124	22780	1308	26979	1083	17772
12-#18	5.56	MA	17821	5479	31472	3890	35258	3086	37691	2433	41274	1380	51226	627	45182
4E		MI	11348	5479	20365	3720	22091	2905	23082	2234	24739	1169	29725	313	27752
12-#18	5.56	MA	16780	5479	29637	3878	32879	3113	34770	2455	37180	1358	46375	532	42618
5L-3S		MI	12076	5479	21626	3697	23638	2927	24915	2256	27013	1147	32208	504	29623
12-#18	5.56	MA	15791	5479	27913	3865	30496	3096	31989	2478	33476	1380	41849	386	39778
6L-2S		MI	13067	5479	23136	3720	25516	2905	27161	2234	29994	1125	36000	726	30062
14-#11	2.53	MA	16421	4574	26790	3338	29412	2712	30610	2222	31844	1481	38123	1253	23198
3L-6S		MI	9847	4574	16308	3229	17221	2594	17338	2120	16976	1375	19952	912	14157
14-#11	2.53	MA	15936	4574	25946	3352	28336	2707	29304	2215	30180	1490	36249	1166	23123
4L-5S		MI	10109	4574	16768	3219	17798	2602	17991	2111	17845	1366	20987	970	14384
14-#11	2.53	MA	15503	4574	25215	3348	27389	2719	28139	2226	28513	1481	34270	1127	22583
5L-4S		MI	10384	4574	17223	3227	18373	2594	18678	2103	18807	1375	22103	1009	14710
14-#11	2.53	MA	15090	4574	24530	3344	26440	2714	26980	2219	27003	1490	32405	1071	22043
6L-3S		MI	10688	4574	17744	3217	19023	2602	19448	2111	19764	1366	23156	1088	14695
14-#11	2.53	MA	14687	4574	23778	3358	25534	2726	25866	2229	25527	1498	30413	980	21407
7L-2S		MI	11104	4574	18371	3225	19813	2594	20392	2103	21017	1357	24774	1174	14665
14-#14	3.65	MA	16822	4908	28281	3552	31273	2848	32867	2298	34940	1453	42653	1002	32261
4L-5S		MI	10476	4908	17967	3404	19218	2728	19674	2172	20193	1319	23939	734	19546
14-#14	3.65	MA	16212	4908	27234	3546	29916	2865	31200	2312	32570	1440	39841	946	31025
5L-4S		MI	10863	4908	18616	3416	20027	2716	20640	2159	21434	1306	25501	790	20082
14-#14	3.65	MA	15632	4908	26251	3540	28557	2857	29539	2301	30423	1453	37199	865	29941
6L-3S		MI	11290	4908	19358	3404	20942	2728	21724	2172	22780	1294	26979	903	20563
14-#14	3.65	MA	15067	4908	25175	3559	27259	2873	27943	2316	28325	1465	34375	734	28649
7L-2S		MI	11875	4908	20248	3416	22053	2716	23052	2159	24543	1281	29245	1027	20569
14-#18	6.48	MA	17916	5755	32208	4050	36176	3237	38791	2531	42520	1327	53411	465	50031
5L-4S		MI	11991	5755	21875	3890	23969	3019	25327	2292	27719	1115	33517	201	32235
14-#18	6.48	MA	16938	5755	30484	4038	33792	3220	36011	2553	38815	1349	48885	319	47182
6L-3S		MI	12714	5755	23136	3868	25516	3041	27161	2314	29994	1093	36000	392	33930
16-#11	2.89	MA	16408	4682	26978	3419	29659	2755	30917	2244	32357	1480	39141	1145	26305
4L-6S		MI	10122	4682	16935	3296	18011	2641	18282	2145	18228	1357	21571	875	16044
16-#11	2.89	MA	15977	4682	26247	3416	28711	2767	29752	2255	30690	1471	37162	1106	25667
5E		MI	10384	4682	17395	3287	18588	2649	18935	2137	19097	1349	22606	933	16254
16-#11	2.89	MA	15566	4682	25561	3412	27762	2762	28593	2248	29179	1480	35297	1049	25153
6L-4S		MI	10658	4682	17850	3294	19163	2641	19622	2128	20060	1357	23721	972	16657
16-#11	2.89	MA	15167	4682	24810	3426	26856	2774	27479	2259	27703	1489	33304	959	24455
7L-3S		MI	10960	4682	18371	3285	19813	2649	20392	2137	21017	1349	24774	1051	16663

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

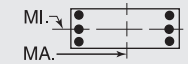
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.89	MA	14773	4682	24134	3422	25937	2769	26391	2269	26134	1480	31455	912	23755
8L-2S		MI	11374	4682	18998	3293	20603	2641	21336	2128	22269	1340	26393	1138	16641
16-#14	4.17	MA	16877	5064	28708	3643	31806	2935	33505	2354	35663	1425	43940	913	35441
5E		MI	10860	5064	18858	3502	20329	2795	21002	2207	21956	1292	26206	678	22199
16-#14	4.17	MA	16301	5064	27725	3637	30446	2927	31843	2344	33517	1438	41298	831	34260
6L-4S		MI	11245	5064	19506	3514	21138	2783	21968	2195	23197	1279	27768	734	22691
16-#14	4.17	MA	15741	5064	26649	3656	29148	2943	30248	2358	31419	1450	38474	701	33022
7L-3S		MI	11670	5064	20248	3501	22053	2795	23052	2207	24543	1267	29245	846	23320
16-#14	4.17	MA	15189	5064	25681	3650	27831	2935	28690	2372	29188	1438	35846	635	31388
8L-2S		MI	12251	5064	21138	3513	23165	2783	24381	2195	26307	1255	31512	971	23356
16-#18	7.41	MA	18073	6032	33056	4211	37088	3344	40032	2629	44154	1318	55920	252	54525
6L-4S		MI	12716	6032	23384	4060	25846	3133	27572	2350	30700	1061	37309	88	36739
18-#11	3.25	MA	16447	4790	27278	3483	30033	2816	31365	2284	32866	1462	40053	1084	28759
5L-6S		MI	10397	4790	17562	3364	18801	2688	19227	2171	19481	1340	23190	839	17934
18-#11	3.25	MA	16040	4790	26592	3479	29084	2810	30206	2278	31356	1470	38188	1028	28269
6L-5S		MI	10657	4790	18022	3354	19378	2696	19880	2162	20350	1331	24225	897	18129
18-#11	3.25	MA	15642	4790	25841	3493	28178	2823	29092	2288	29880	1479	36196	937	27511
7L-4S		MI	10930	4790	18477	3362	19953	2688	20566	2154	21313	1340	25340	936	18577
18-#11	3.25	MA	15251	4790	25166	3489	27259	2817	28004	2299	28310	1470	34346	891	26837
8L-3S		MI	11231	4790	18998	3352	20603	2696	21336	2162	22269	1331	26393	1015	18625
18-#11	3.25	MA	14864	4790	24439	3503	26364	2829	26867	2292	26848	1479	32538	836	25867
9L-2S		MI	11644	4790	19624	3360	21393	2688	22280	2154	23522	1323	28012	1101	18611
18-#14	4.69	MA	16965	5219	29199	3734	32335	2996	34148	2386	36610	1422	45397	798	38593
6L-5S		MI	11242	5219	19748	3599	21441	2862	22331	2243	23719	1265	28472	621	24858
18-#14	4.69	MA	16409	5219	28122	3754	31037	3013	32553	2401	34513	1435	42573	668	37404
7L-4S		MI	11624	5219	20396	3611	22250	2849	23297	2230	24961	1253	30034	678	25311
18-#14	4.69	MA	15862	5219	27154	3748	29720	3005	30995	2415	32281	1422	39945	602	35714
8L-3S		MI	12047	5219	21138	3598	23165	2862	24381	2243	26307	1240	31512	790	26069
20-#11	3.61	MA	16510	4898	27624	3547	30406	2859	31818	2307	33532	1460	41080	1006	31388
6E		MI	10670	4898	18189	3431	19591	2735	20171	2196	20734	1323	24808	802	19778
20-#11	3.61	MA	16115	4898	26872	3560	29500	2871	30705	2318	32056	1469	39087	916	30575
7L-5S		MI	10929	4898	18649	3422	20168	2743	20824	2188	21603	1314	25843	860	20009
20-#11	3.61	MA	15726	4898	26197	3557	28581	2866	29617	2328	30487	1460	37238	869	29906
8L-4S		MI	11200	4898	19103	3429	20743	2735	21510	2179	22566	1323	26959	899	20426
20-#11	3.61	MA	15341	4898	25470	3570	27687	2878	28480	2321	29024	1469	35430	815	28916
9L-3S		MI	11500	4898	19624	3420	21393	2743	22280	2188	23522	1314	28012	979	20573
20-#14	5.21	MA	17072	5375	29596	3851	32927	3083	34858	2443	37606	1420	46672	634	41707
7L-5S		MI	11621	5375	20638	3696	22552	2928	23660	2278	25482	1238	30739	565	27518
20-#14	5.21	MA	16529	5375	28628	3845	31610	3075	33300	2457	35375	1407	44044	568	40049
8L-4S		MI	12002	5375	21286	3708	23361	2916	24626	2266	26724	1226	32301	622	27941
22-#11	3.97	MA	16584	5006	27904	3628	30822	2919	32318	2347	34233	1459	41979	894	33645
7L-6S		MI	10942	5006	18815	3499	20381	2782	21115	2222	21987	1305	26427	766	21600
22-#11	3.97	MA	16198	5006	27228	3624	29903	2914	31230	2358	32664	1451	40129	848	32933
8L-5S		MI	11200	5006	19275	3489	20958	2790	21768	2213	22856	1297	27462	824	21892
22-#11	3.97	MA	15815	5006	26501	3638	29009	2926	30093	2351	31201	1459	38321	793	31971
9L-4S		MI	11470	5006	19730	3497	21533	2782	22455	2205	23818	1305	28577	863	22282
22-#14	5.73	MA	17191	5531	30102	3942	33499	3145	35605	2500	38469	1392	48143	535	44395
8L-5S		MI	11999	5531	21528	3794	23664	2995	24988	2314	27245	1212	33006	509	30063
24-#11	4.33	MA	16666	5114	28260	3692	31225	2963	32843	2387	34840	1441	43021	826	35967
8L-6S		MI	11212	5114	19442	3566	21171	2829	22060	2248	23240	1288	28046	729	23429
24-#11	4.33	MA	16286	5114	27533	3705	30331	2975	31706	2380	33377	1449	41213	772	35032
9L-5S		MI	11470	5114	19902	3557	21748	2837	22712	2239	24109	1279	29080	787	23777

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

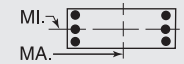


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.75	MA	17868	4584	28531	3351	30962	2721	31855	2251	32313	1557	38181	1436	17992
2E		MI	11006	4584	17879	3189	18798	2572	18940	2107	18744	1422	21569	1254	10802
6-#11	1.03	MA	16889	4355	26201	3244	28159	2648	28505	2214	27970	1607	32532	1519	10882
2L-3S		MI	10093	4355	16014	3101	16657	2540	16436	2116	15433	1517	17428	1313	6745
6-#11	1.03	MA	16140	4355	25102	3241	26750	2661	26787	2225	25639	1615	29427	1433	10932
3L-2S		MI	10517	4355	16641	3108	17447	2532	17381	2107	16686	1509	19047	1400	6690
6-#14	1.48	MA	17539	4498	27665	3322	29974	2702	30695	2245	30882	1585	36371	1480	15415
2L-3S		MI	10257	4498	16575	3167	17289	2587	17173	2136	16406	1482	18656	1206	9415
6-#14	1.48	MA	16477	4498	26094	3316	27960	2720	28238	2260	27565	1597	31964	1356	15462
3L-2S		MI	10856	4498	17466	3179	18401	2575	18502	2124	18169	1470	20922	1331	9332
6-#18	2.63	MA	19106	4861	31276	3524	34480	2845	36147	2326	38048	1528	45763	1374	26605
2L-3S		MI	10642	4861	17879	3337	18798	2708	18940	2187	18744	1390	21569	920	15793
6-#18	2.63	MA	17287	4861	28531	3513	30962	2874	31855	2351	32313	1550	38181	1152	26465
3L-2S		MI	11659	4861	19388	3359	20675	2686	21185	2165	21725	1368	25360	1141	15706
8-#11	1.37	MA	17403	4463	27299	3312	29568	2696	30224	2243	30301	1598	35637	1499	14351
2L-4S		MI	10063	4463	16120	3178	16797	2579	16610	2133	15729	1509	17994	1197	8832
8-#11	1.37	MA	16658	4463	26201	3309	28159	2709	28505	2255	27970	1606	32532	1413	14388
3E		MI	10372	4463	16641	3168	17447	2587	17381	2142	16686	1500	19047	1277	8772
8-#11	1.37	MA	16133	4463	25303	3323	27015	2704	27115	2248	26188	1615	30516	1327	14390
4L-2S		MI	10794	4463	17267	3176	18237	2579	18325	2133	17939	1491	20665	1363	8718
8-#14	1.97	MA	18261	4653	29236	3419	31988	2772	33152	2287	34198	1571	40777	1449	20353
2L-4S		MI	10212	4653	16724	3277	17486	2641	17418	2159	16823	1468	19445	1038	12298
8-#14	1.97	MA	17207	4653	27665	3414	29974	2789	30695	2302	30882	1583	36371	1325	20359
3E		MI	10648	4653	17466	3264	18401	2654	18502	2172	18169	1456	20922	1150	12252
8-#14	1.97	MA	16463	4653	26380	3433	28336	2782	28705	2293	28347	1596	33514	1200	20227
4L-2S		MI	11243	4653	18356	3276	19512	2641	19830	2159	19932	1443	23189	1274	12184
8-#18	3.51	MA	20325	5138	34020	3697	37998	2969	40439	2402	43782	1499	53344	1311	35161
2L-4S		MI	10554	5138	18127	3529	19128	2800	19352	2223	19450	1358	22878	616	19115
8-#18	3.51	MA	18527	5138	31276	3686	34480	2998	36147	2426	38048	1521	45763	1090	34902
3E		MI	11296	5138	19388	3507	20675	2822	21185	2245	21725	1336	25360	807	20557
8-#18	3.51	MA	17256	5138	29024	3719	31611	2982	32661	2406	33665	1544	40863	868	32335
4L-2S		MI	12305	5138	20898	3529	22553	2800	23431	2223	24705	1313	29152	1029	20556
10-#11	1.71	MA	17913	4570	28398	3379	30976	2745	31942	2273	32632	1589	38742	1479	17807
2L-5S		MI	10064	4570	16292	3237	17012	2634	16868	2167	16019	1483	18497	1122	10820
10-#11	1.71	MA	17172	4570	27299	3376	29568	2757	30224	2284	30301	1597	35637	1393	17829
3L-4S		MI	10342	4570	16746	3245	17587	2626	17555	2158	16982	1491	19612	1161	10822
10-#11	1.71	MA	16650	4570	26402	3390	28424	2753	28834	2278	28519	1606	33621	1307	17800
4L-3S		MI	10649	4570	17267	3236	18237	2634	18325	2167	17939	1483	20665	1240	10775
10-#11	1.71	MA	16183	4570	25625	3387	27417	2765	27596	2289	26734	1597	31501	1266	17582
5L-2S		MI	11069	4570	17894	3243	19027	2626	19269	2158	19191	1474	22284	1327	10727
10-#14	2.47	MA	18976	4809	30807	3516	34002	2842	35609	2329	37515	1557	45184	1418	25277
2L-5S		MI	10210	4809	16966	3362	17788	2720	17781	2207	17344	1454	20149	925	14414
10-#14	2.47	MA	17930	4809	29236	3511	31988	2859	33152	2345	34198	1569	40777	1294	25236
3L-4S		MI	10602	4809	17614	3374	18597	2708	18746	2195	18586	1441	21711	982	15070
10-#14	2.47	MA	17192	4809	27951	3531	30350	2852	31162	2335	31663	1582	37921	1169	25055
4L-3S		MI	11035	4809	18356	3361	19512	2720	19830	2207	19932	1429	23189	1094	15062
10-#14	2.47	MA	16532	4809	26837	3525	28907	2869	29389	2350	29123	1569	34905	1112	23773
5L-2S		MI	11627	4809	19246	3373	20624	2708	21159	2195	21695	1416	25455	1218	15013
10-#18	4.39	MA	19750	5414	34020	3859	37998	3122	40439	2502	43782	1493	53344	1028	43323
3L-4S		MI	11208	5414	19637	3699	21005	2914	21597	2281	22431	1304	26669	504	23530
10-#18	4.39	MA	18494	5414	31768	3892	35129	3106	36952	2482	39400	1515	48444	806	40370
4L-3S		MI	11945	5414	20898	3677	22553	2936	23431	2303	24705	1282	29152	695	25285
10-#18	4.39	MA	17372	5414	29815	3881	32597	3135	33843	2506	35005	1493	43232	709	38050
5L-2S		MI	12946	5414	22408	3699	24430	2914	25676	2281	27686	1259	32944	916	25375
12-#11	2.05	MA	18419	4678	29497	3447	32385	2793	33661	2302	34963	1579	41847	1459	21253
2L-6S		MI	10078	4678	16458	3315	17225	2673	17160	2201	16403	1474	19081	1028	12381

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

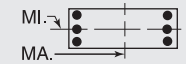
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	2.05	MA	17682	4678	28398	3443	30976	2806	31942	2313	32632	1588	38742	1373	21255
3L-5S		MI	10342	4678	16918	3305	17802	2681	17813	2193	17272	1465	20116	1085	12638
12-#11	2.05	MA	17163	4678	27501	3457	29833	2801	30552	2307	30850	1597	36726	1287	21201
4E		MI	10619	4678	17373	3313	18377	2673	18499	2184	18235	1474	21231	1124	12798
12-#11	2.05	MA	16699	4678	26724	3454	28825	2814	29315	2318	29065	1588	34606	1246	20846
5L-3S		MI	10924	4678	17894	3303	19027	2681	19269	2193	19191	1465	22284	1204	12764
12-#11	2.05	MA	16257	4678	25995	3451	27816	2809	28082	2312	27447	1597	32602	1190	20202
6L-2S		MI	11343	4678	18521	3311	19817	2673	20213	2184	20444	1457	23903	1290	12723
12-#14	2.96	MA	18646	4965	30807	3608	34002	2929	35609	2387	37515	1555	45184	1263	30100
3L-5S		MI	10599	4965	17856	3459	18900	2787	19109	2242	19107	1427	22416	869	17048
12-#14	2.96	MA	17914	4965	29522	3628	32364	2922	33619	2377	34980	1568	42327	1138	29877
4E		MI	10989	4965	18504	3471	19709	2774	20075	2230	20349	1415	23978	925	17659
12-#14	2.96	MA	17260	4965	28408	3623	30921	2939	31846	2393	32440	1555	39312	1081	28456
5L-3S		MI	11420	4965	19246	3458	20624	2787	21159	2242	21695	1402	25455	1038	17860
12-#14	2.96	MA	16637	4965	27364	3618	29475	2932	30080	2383	30138	1568	36470	1000	27548
6L-2S		MI	12008	4965	20136	3470	21735	2774	22488	2230	23458	1390	27722	1162	17825
12-#18	5.26	MA	19716	5691	34512	4065	38647	3231	41244	2557	45134	1486	56026	744	48449
4E		MI	11858	5691	21147	3869	22883	3028	23842	2339	25411	1250	30461	391	27982
12-#18	5.26	MA	18607	5691	32559	4054	36115	3259	38134	2581	40740	1464	50813	646	45943
5L-3S		MI	12588	5691	22408	3847	24430	3050	25676	2361	27686	1228	32944	582	29931
12-#18	5.26	MA	17553	5691	30725	4042	33579	3244	35035	2561	36760	1486	45931	501	42746
6L-2S		MI	13582	5691	23918	3869	26308	3028	27921	2339	30666	1205	36736	803	30146
14-#11	2.39	MA	18189	4786	29497	3511	32385	2854	33661	2343	34963	1579	41847	1353	24672
3L-6S		MI	10355	4786	17085	3382	18015	2720	18104	2227	17656	1457	20699	991	14266
14-#11	2.39	MA	17673	4786	28599	3525	31241	2850	32271	2337	33181	1588	39831	1266	24598
4L-5S		MI	10619	4786	17545	3372	18592	2728	18757	2218	18525	1448	21734	1049	14500
14-#11	2.39	MA	17211	4786	27823	3522	30234	2862	31033	2348	31396	1579	37711	1226	24122
5L-4S		MI	10894	4786	18000	3380	19167	2720	19443	2210	19488	1457	22850	1088	14764
14-#11	2.39	MA	16772	4786	27094	3518	29225	2857	29800	2342	29779	1588	35707	1170	23512
6L-3S		MI	11198	4786	18521	3370	19817	2728	20213	2218	20444	1448	23903	1167	14743
14-#11	2.39	MA	16344	4786	26296	3533	28262	2870	28617	2353	28198	1596	33567	1080	22928
7L-2S		MI	11615	4786	19148	3378	20607	2720	21158	2210	21697	1439	25521	1254	14709
14-#14	3.45	MA	18629	5120	31093	3725	34378	2992	36076	2420	38296	1554	46734	1107	34559
4L-5S		MI	10986	5120	18746	3556	20011	2853	20438	2278	20871	1400	24683	813	19693
14-#14	3.45	MA	17980	5120	29979	3720	32935	3009	34303	2435	35756	1541	43718	1051	33154
5L-4S		MI	11374	5120	19394	3568	20820	2841	21404	2265	22112	1388	26244	869	20251
14-#14	3.45	MA	17362	5120	28935	3715	31489	3002	32537	2425	33455	1554	40876	969	32143
6L-3S		MI	11802	5120	20136	3556	21735	2853	22488	2278	23458	1375	27722	981	20632
14-#14	3.45	MA	16760	5120	27791	3734	30109	3019	30840	2441	31206	1566	37840	839	30692
7L-2S		MI	12387	5120	21027	3568	22846	2841	23816	2265	25221	1363	29989	1106	20625
14-#18	6.14	MA	19828	5968	35303	4226	39633	3383	42426	2657	46474	1435	58394	584	53874
5L-4S		MI	12502	5968	22657	4040	24760	3142	26088	2397	28392	1196	34253	279	32463
14-#18	6.14	MA	18786	5968	33469	4215	37096	3368	39327	2637	42495	1457	53512	439	50824
6L-3S		MI	13227	5968	23918	4018	26308	3164	27921	2419	30666	1173	36736	469	34233
16-#11	2.74	MA	18178	4894	29698	3592	32650	2898	33989	2366	35513	1579	42936	1246	27989
4L-6S		MI	10632	4894	17712	3449	18805	2767	19048	2252	18909	1439	22318	955	16155
16-#11	2.74	MA	17720	4894	28921	3589	31642	2911	32751	2377	33727	1570	40816	1206	27409
5E		MI	10894	4894	18172	3440	19382	2775	19701	2244	19778	1431	23353	1013	16371
16-#11	2.74	MA	17283	4894	28193	3586	30634	2906	31519	2371	32110	1579	38812	1150	26828
6L-4S		MI	11168	4894	18627	3447	19957	2767	20388	2235	20740	1439	24468	1052	16719
16-#11	2.74	MA	16858	4894	27394	3600	29671	2918	30335	2382	30529	1587	36672	1060	26179
7L-3S		MI	11471	4894	19148	3438	20607	2775	21158	2244	21697	1431	25521	1131	16713
16-#11	2.74	MA	16439	4894	26677	3597	28694	2914	29179	2393	28848	1579	34690	1013	25395
8L-2S		MI	11886	4894	19774	3446	21397	2767	22102	2235	22950	1422	27140	1217	16688

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

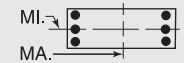


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.95	MA	18694	5276	31550	3817	34949	3079	36760	2477	39073	1527	48125	1020	37865
5E		MI	11370	5276	19636	3654	21122	2920	21766	2313	22634	1373	26949	756	22347
16-#14	3.95	MA	18081	5276	30506	3812	33503	3071	34993	2468	36771	1539	45283	938	36753
6L-4S		MI	11756	5276	20285	3666	21931	2908	22732	2301	23875	1361	28511	813	22858
16-#14	3.95	MA	17484	5276	29362	3832	32123	3089	33297	2483	34522	1552	42246	808	35359
7L-3S		MI	12182	5276	21027	3653	22846	2920	23816	2313	25221	1349	29989	925	23394
16-#14	3.95	MA	16896	5276	28333	3827	30723	3082	31641	2498	32131	1539	39428	741	33726
8L-2S		MI	12765	5276	21917	3665	23958	2908	25145	2301	26984	1336	32255	1050	23420
16-#18	7.02	MA	20004	6244	36213	4388	40614	3492	43619	2712	48230	1429	61094	376	58873
6L-4S		MI	13142	6244	24166	4210	26638	3256	28333	2455	31372	1142	38045	166	36966
18-#11	3.08	MA	18225	5002	30020	3657	33051	2959	34470	2407	36059	1561	43921	1186	30704
5L-6S		MI	10906	5002	18339	3517	19595	2814	19992	2278	20162	1422	23937	918	18046
18-#11	3.08	MA	17791	5002	29291	3653	32042	2954	33237	2400	34441	1570	41917	1130	30149
6L-5S		MI	11168	5002	18799	3507	20172	2822	20645	2269	21031	1413	24971	976	18247
18-#11	3.08	MA	17368	5002	28493	3667	31079	2967	32053	2412	32860	1578	39777	1040	29439
7L-4S		MI	11441	5002	19253	3515	20747	2814	21332	2261	21993	1422	26087	1015	18665
18-#11	3.08	MA	16952	5002	27776	3664	30103	2962	30898	2423	31180	1570	37795	992	28682
8L-3S		MI	11742	5002	19774	3505	21397	2822	22102	2269	22950	1413	27140	1094	18678
18-#11	3.08	MA	16540	5002	27003	3678	29153	2975	29690	2417	29613	1578	35852	938	27729
9L-2S		MI	12156	5002	20401	3513	22187	2814	23046	2261	24203	1405	28758	1181	18661
18-#14	4.44	MA	18793	5432	32077	3909	35517	3141	37450	2510	40088	1525	49690	907	41378
6L-5S		MI	11752	5432	20527	3751	22234	2987	23095	2349	24397	1347	29216	700	25007
18-#14	4.44	MA	18201	5432	30933	3929	34137	3159	35754	2525	37839	1538	46653	777	40037
7L-4S		MI	12136	5432	21175	3763	23043	2974	24061	2336	25638	1334	30778	757	25478
18-#14	4.44	MA	17618	5432	29904	3924	32737	3151	34098	2541	35447	1525	43835	710	38346
8L-3S		MI	12560	5432	21917	3750	23958	2987	25145	2349	26984	1322	32255	869	26148
20-#11	3.42	MA	18295	5110	30390	3721	33451	3003	34955	2430	36772	1561	45022	1110	33475
6E		MI	11180	5110	18965	3584	20385	2860	20937	2303	21414	1405	25555	882	19939
20-#11	3.42	MA	17875	5110	29592	3735	32488	3015	33772	2441	35191	1569	42882	1020	32705
7L-5S		MI	11440	5110	19426	3575	20962	2869	21590	2295	22283	1396	26590	940	20127
20-#11	3.42	MA	17461	5110	28875	3732	31511	3011	32616	2452	33511	1561	40900	972	31974
8L-4S		MI	11712	5110	19880	3582	21537	2860	22276	2286	23246	1405	27706	979	20563
20-#11	3.42	MA	17052	5110	28102	3746	30561	3023	31408	2446	31944	1569	38957	918	30982
9L-3S		MI	12012	5110	20401	3573	22187	2869	23046	2295	24203	1396	28758	1058	20634
20-#11	3.42	MA	16596	5110	27387	3742	29597	3018	30258	2457	30390	1578	37076	857	30042
10L-2S		MI	12424	5110	21028	3580	22977	2860	23990	2286	25455	1387	30377	1144	20629
20-#14	4.93	MA	18913	5587	32504	4026	36151	3229	38211	2568	41155	1524	51059	746	44723
7L-5S		MI	12133	5587	21417	3848	23345	3053	24424	2384	26160	1320	31482	644	27672
20-#14	4.93	MA	18334	5587	31475	4021	34751	3221	36555	2583	38764	1511	48241	679	42976
8L-4S		MI	12514	5587	22065	3860	24154	3041	25390	2372	27401	1308	33044	701	28108
22-#11	3.76	MA	18379	5218	30691	3802	33897	3064	35490	2470	37522	1560	45987	1000	35979
7L-6S		MI	11452	5218	19592	3652	21175	2907	21881	2329	22667	1387	27174	845	21786
22-#11	3.76	MA	17967	5218	29973	3799	32920	3059	34335	2481	35842	1552	44005	952	35271
8L-5S		MI	11711	5218	20052	3642	21752	2916	22534	2320	23536	1379	28209	903	22010
22-#11	3.76	MA	17560	5218	29201	3813	31970	3072	33126	2475	34275	1560	42062	898	34242
9L-4S		MI	11982	5218	20507	3650	22327	2907	23220	2312	24499	1387	29324	942	22418
22-#11	3.76	MA	17119	5218	28485	3810	31006	3067	31977	2486	32722	1569	40181	837	33271
10L-3S		MI	12281	5218	21028	3640	22977	2916	23990	2320	25455	1379	30377	1021	22583
22-#14	5.43	MA	19045	5743	33046	4118	36765	3291	39012	2626	42080	1497	52648	648	47615
8L-5S		MI	12511	5743	22307	3945	24457	3120	25752	2420	27923	1293	33749	588	30325
24-#11	4.11	MA	18470	5326	31072	3866	34329	3107	36053	2511	38173	1542	47110	932	38560
8L-6S		MI	11723	5326	20219	3719	21965	2954	22825	2354	23920	1370	28792	809	23614
24-#11	4.11	MA	18066	5326	30300	3880	33378	3120	34845	2505	36606	1551	45167	878	37507
9L-5S		MI	11981	5326	20679	3710	22542	2963	23478	2346	24789	1361	29827	867	23897
24-#11	4.11	MA	17624	5326	29584	3877	32415	3115	33695	2516	35053	1560	43286	817	36434
10L-4S		MI	12251	5326	21134	3717	23117	2954	24165	2337	25752	1370	30943	906	24279

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

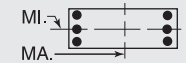
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.67	MA	19702	4796	31311	3524	33994	2863	34943	2372	35411	1653	41842	1534	19072
2E		MI	11516	4796	18661	3339	19589	2695	19701	2211	19417	1502	22305	1332	10849
6-#14	1.41	MA	19346	4710	30383	3494	32935	2844	33700	2365	33861	1681	39869	1576	16326
2L-3S		MI	10767	4710	17354	3318	18082	2712	17937	2242	17084	1564	19399	1285	9454
6-#14	1.41	MA	18216	4710	28715	3489	30796	2862	31091	2381	30322	1693	35154	1451	16373
3L-2S		MI	11366	4710	18244	3330	19194	2700	19266	2230	18847	1552	21666	1409	9370
6-#18	2.50	MA	21028	5073	34228	3697	37733	2987	39505	2447	41542	1627	49970	1475	28225
2L-3S		MI	11151	5073	18661	3487	19589	2831	19701	2291	19417	1470	22305	998	15862
6-#18	2.50	MA	19090	5073	31311	3687	33994	3017	34943	2473	35411	1649	41842	1254	28085
3L-2S		MI	12170	5073	20170	3509	21467	2809	21946	2269	22398	1448	26096	1219	15763
8-#11	1.30	MA	19200	4675	29992	3484	32500	2838	33195	2364	33215	1692	39069	1594	15194
2L-4S		MI	10573	4675	16896	3331	17590	2705	17376	2240	16410	1591	18741	1277	8868
8-#11	1.30	MA	18407	4675	28826	3481	31005	2851	31371	2376	30733	1701	35751	1508	15230
3E		MI	10881	4675	17417	3321	18241	2713	18146	2248	17366	1582	19794	1356	8806
8-#11	1.30	MA	17850	4675	27875	3496	29793	2847	29898	2370	28837	1710	33593	1422	15232
4L-2S		MI	11304	4675	18044	3329	19030	2705	19090	2240	18619	1574	21412	1442	8752
8-#14	1.88	MA	20119	4866	32051	3591	35074	2914	36309	2407	37401	1668	44583	1547	21568
2L-4S		MI	10721	4866	17502	3429	18279	2766	18182	2265	17501	1550	20188	1117	12354
8-#14	1.88	MA	18997	4866	30383	3587	32935	2932	33700	2423	33861	1680	39869	1423	21574
3E		MI	11157	4866	18244	3416	19194	2779	19266	2278	18847	1537	21666	1229	12298
8-#14	1.88	MA	18207	4866	29021	3607	31198	2925	31590	2415	31156	1692	36808	1298	21442
4L-2S		MI	11753	4866	19135	3428	20305	2766	20594	2265	20610	1525	23932	1353	12227
8-#18	3.33	MA	22333	5350	37145	3870	41473	3111	44067	2522	47672	1600	58097	1417	37321
2L-4S		MI	11062	5350	18909	3679	19919	2923	20113	2327	20123	1438	23614	694	19344
8-#18	3.33	MA	20417	5350	34228	3859	37733	3141	39505	2548	41542	1622	49970	1196	37062
3E		MI	11807	5350	20170	3657	21467	2945	21946	2350	22398	1416	26096	885	20644
8-#18	3.33	MA	19066	5350	31839	3894	34689	3127	35805	2530	36856	1644	44708	974	34594
4L-2S		MI	12817	5350	21680	3679	23344	2923	24191	2327	25378	1394	29888	1106	20620
10-#11	1.63	MA	19744	4783	31158	3552	33995	2887	35019	2393	35696	1683	42388	1575	18860
2L-5S		MI	10573	4783	17069	3390	17805	2760	17634	2274	16700	1565	19244	1201	10902
10-#11	1.63	MA	18956	4783	29992	3549	32500	2900	33195	2405	33215	1692	39069	1489	18882
3L-4S		MI	10851	4783	17523	3398	18380	2751	18320	2265	17662	1573	20359	1240	10865
10-#11	1.63	MA	18402	4783	29041	3563	31288	2895	31721	2399	31319	1701	36912	1403	18853
4L-3S		MI	11159	4783	18044	3389	19030	2760	19090	2274	18619	1565	21412	1320	10814
10-#11	1.63	MA	17907	4783	28218	3560	30221	2908	30410	2411	29420	1693	34651	1362	18728
5L-2S		MI	11579	4783	18671	3396	19820	2751	20035	2265	19872	1556	23031	1406	10765
10-#14	2.34	MA	20883	5021	33720	3689	37212	2984	38918	2450	40940	1655	49298	1518	26796
2L-5S		MI	10718	5021	17744	3514	18581	2845	18545	2313	18022	1535	20893	1004	14556
10-#14	2.34	MA	19770	5021	32051	3684	35074	3002	36309	2466	37401	1667	44583	1394	26754
3L-4S		MI	11111	5021	18393	3526	19390	2833	19510	2301	19264	1523	22455	1061	15139
10-#14	2.34	MA	18986	5021	30689	3704	33337	2995	34199	2457	34695	1679	41523	1269	26573
4L-3S		MI	11545	5021	19135	3513	20305	2845	20594	2313	20610	1511	23932	1173	15115
10-#14	2.34	MA	18286	5021	29509	3700	31808	3013	32320	2473	31985	1667	38304	1211	25327
5L-2S		MI	12138	5021	20025	3525	21417	2833	21923	2301	22373	1498	26199	1297	15060
10-#18	4.17	MA	21726	5626	37145	4032	41473	3265	44067	2624	47672	1596	58097	1137	46023
3L-4S		MI	11718	5626	20419	3849	21797	3037	22358	2386	23104	1384	27405	582	23756
10-#18	4.17	MA	20391	5626	34756	4066	38428	3251	40367	2605	42987	1618	52835	916	43146
4L-3S		MI	12456	5626	21680	3827	23344	3059	24191	2408	25378	1362	29888	772	25383
10-#18	4.17	MA	19199	5626	32684	4056	35744	3281	37069	2631	38290	1596	47262	816	40907
5L-2S		MI	13459	5626	23190	3849	25222	3037	26436	2386	28359	1340	33680	994	25442
12-#11	1.95	MA	20285	4891	32324	3619	35490	2935	36842	2423	38178	1675	45707	1557	22516
2L-6S		MI	10586	4891	17235	3467	18018	2798	17925	2308	17084	1556	19828	1107	12486

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

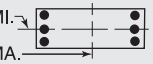


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.95	MA	19501	4891	31158	3616	33995	2948	35019	2434	35696	1683	42388	1470	22519
3L-5S		MI	10851	4891	17695	3458	18595	2807	18578	2299	17953	1548	20862	1165	12799
12-#11	1.95	MA	18951	4891	30207	3631	32783	2944	33545	2429	33800	1692	40230	1384	22465
4E		MI	11128	4891	18150	3466	19170	2798	19265	2291	18915	1556	21978	1204	12845
12-#11	1.95	MA	18458	4891	29384	3628	31716	2957	32234	2440	31902	1684	37970	1343	22193
5L-3S		MI	11434	4891	18671	3456	19820	2807	20035	2299	19872	1548	23031	1283	12807
12-#11	1.95	MA	17990	4891	28613	3625	30647	2953	30928	2435	30181	1693	35826	1287	21473
6L-2S		MI	11854	4891	19298	3464	20610	2798	20979	2291	21125	1539	24650	1370	12764
12-#14	2.81	MA	20535	5177	33720	3781	37212	3072	38918	2508	40940	1654	49298	1365	31923
3L-5S		MI	11108	5177	18635	3611	19693	2912	19873	2349	19785	1509	23159	948	17190
12-#14	2.81	MA	19758	5177	32357	3801	35476	3065	36808	2499	38235	1666	46237	1240	31700
4E		MI	11499	5177	19283	3623	20502	2899	20839	2336	21027	1496	24721	1004	17825
12-#14	2.81	MA	19063	5177	31178	3797	33946	3083	34929	2515	35524	1654	43018	1182	30303
5L-3S		MI	11931	5177	20025	3610	21417	2912	21923	2349	22373	1484	26199	1116	17914
12-#14	2.81	MA	18402	5177	30071	3792	32415	3076	33057	2507	33068	1666	39976	1101	29424
6L-2S		MI	12520	5177	20915	3622	22528	2899	23252	2336	24136	1471	28465	1241	17876
12-#18	5.00	MA	21699	5903	37673	4239	42168	3375	44929	2681	49117	1591	60963	858	51743
4E		MI	12367	5903	21929	4019	23674	3151	24603	2444	26084	1330	31197	469	28206
12-#18	5.00	MA	20521	5903	35602	4229	39483	3405	41631	2706	44421	1569	55390	758	49318
5L-3S		MI	13100	5903	23190	3997	25222	3174	26436	2466	28359	1308	33680	660	30097
12-#18	5.00	MA	19401	5903	33658	4219	36793	3391	38345	2688	40166	1591	50151	613	45748
6L-2S		MI	14096	5903	24700	4019	27099	3151	28682	2444	31339	1286	37472	881	30229
14-#11	2.27	MA	20042	4998	32324	3684	35490	2996	36842	2464	38178	1675	45707	1452	26147
3L-6S		MI	10864	4998	17862	3535	18808	2845	18870	2334	18336	1539	21446	1071	14372
14-#11	2.27	MA	19495	4998	31373	3698	34278	2992	35369	2458	36282	1684	43549	1365	26072
4L-5S		MI	11128	4998	18322	3525	19385	2854	19523	2325	19205	1530	22481	1128	14614
14-#11	2.27	MA	19005	4998	30550	3695	33211	3005	34058	2470	34383	1675	41288	1325	25672
5L-4S		MI	11404	4998	18777	3533	19960	2845	20209	2316	20168	1539	23597	1167	14816
14-#11	2.27	MA	18540	4998	29779	3692	32142	3001	32752	2464	32662	1684	39145	1268	24988
6L-3S		MI	11709	4998	19298	3523	20610	2854	20979	2325	21125	1530	24650	1247	14789
14-#11	2.27	MA	18086	4998	28934	3707	31123	3014	31499	2476	30981	1693	36857	1178	24465
7L-2S		MI	12126	4998	19925	3531	21400	2845	21923	2316	22377	1522	26268	1333	14753
14-#14	3.28	MA	20522	5332	34025	3899	37614	3135	39417	2542	41774	1653	50952	1211	36822
4L-5S		MI	11495	5332	19525	3708	20804	2978	21202	2384	21548	1482	25426	891	19836
14-#14	3.28	MA	19833	5332	32846	3894	36085	3153	37538	2558	39064	1641	47733	1153	35296
5L-4S		MI	11884	5332	20173	3720	21613	2966	22168	2372	22790	1469	26988	948	20415
14-#14	3.28	MA	19178	5332	31740	3889	34553	3146	35666	2549	36608	1653	44690	1072	34371
6L-3S		MI	12313	5332	20915	3707	22528	2978	23252	2384	24136	1457	28465	1060	20699
14-#14	3.28	MA	18539	5332	30528	3910	33092	3164	33869	2565	34207	1666	41440	942	32754
7L-2S		MI	12900	5332	21805	3719	23639	2966	24580	2372	25899	1445	30732	1185	20680
14-#18	5.83	MA	21827	6180	38519	4402	43223	3529	46193	2782	50551	1542	63517	700	57766
5L-4S		MI	13013	6180	23439	4190	25552	3266	26848	2502	29065	1276	34989	356	32686
14-#18	5.83	MA	20720	6180	36575	4392	40533	3515	42907	2763	46297	1564	58279	555	54350
6L-3S		MI	13740	6180	24700	4167	27099	3288	28682	2524	31339	1254	37472	547	34529
16-#11	2.60	MA	20035	5106	32539	3765	35773	3041	37193	2488	38763	1675	46868	1347	29674
4L-6S		MI	11141	5106	18489	3602	19598	2892	19814	2359	19589	1522	23065	1034	16261
16-#11	2.60	MA	19549	5106	31717	3763	34706	3054	35882	2499	36865	1667	44607	1306	29162
5E		MI	11404	5106	18949	3593	20175	2901	20467	2351	20458	1513	24100	1092	16484
16-#11	2.60	MA	19086	5106	30945	3760	33637	3049	34576	2494	35144	1676	42464	1250	28510
6L-4S		MI	11678	5106	19403	3600	20750	2892	21153	2342	21421	1522	25215	1131	16779
16-#11	2.60	MA	18635	5106	30100	3774	32618	3062	33323	2505	33462	1684	40176	1160	27920
7L-3S		MI	11982	5106	19925	3591	21400	2901	21923	2351	22377	1513	26268	1210	16763
16-#11	2.60	MA	18191	5106	29340	3771	31584	3058	32099	2517	31675	1676	38062	1112	27048
8L-2S		MI	12398	5106	20551	3598	22190	2892	22868	2342	23630	1504	27887	1297	16734
16-#14	3.75	MA	20596	5488	34514	3991	38224	3223	40147	2600	42603	1628	52447	1124	40301
5E		MI	11880	5488	20415	3806	21915	3045	22530	2420	23311	1455	27692	835	22490
16-#14	3.75	MA	19946	5488	33408	3987	36692	3216	38275	2591	40147	1640	49405	1043	39274
6L-4S		MI	12267	5488	21063	3818	22724	3033	23496	2407	24553	1443	29254	892	23021

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

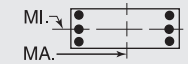
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.75	MA	19313	5488	32196	4007	35230	3234	36478	2607	37747	1653	46155	913	37717
7L-3S		MI	12694	5488	21805	3805	23639	3045	24580	2420	25899	1430	30732	1004	23466
16-#14	3.75	MA	18689	5488	31107	4002	33747	3227	34724	2623	35195	1640	43146	845	36095
8L-2S		MI	13278	5488	22696	3817	24751	3033	25909	2407	27662	1418	32998	1129	23475
16-#18	6.67	MA	22024	6456	39492	4565	44273	3639	47469	2839	52427	1538	66406	497	62976
6L-4S		MI	13654	6456	24949	4360	27430	3380	29093	2560	32045	1222	38781	244	37188
18-#11	2.92	MA	20088	5214	32883	3830	36201	3102	37706	2529	39346	1658	47926	1287	32661
5L-6S		MI	11416	5214	19116	3670	20388	2939	20758	2385	20842	1504	24683	998	18154
18-#11	2.92	MA	19628	5214	32111	3827	35133	3098	36400	2523	37625	1667	45782	1231	32037
6L-5S		MI	11678	5214	19576	3660	20965	2948	21411	2376	21711	1496	25718	1056	18360
18-#11	2.92	MA	19180	5214	31266	3842	34113	3111	35147	2535	35944	1676	43494	1141	31383
7L-4S		MI	11951	5214	20030	3668	21540	2939	22097	2367	22674	1504	26834	1094	18729
18-#11	2.92	MA	18739	5214	30507	3839	33079	3107	33923	2546	34157	1667	41381	1093	30540
8L-3S		MI	12254	5214	20551	3658	22190	2948	22868	2376	23630	1496	27887	1174	18731
18-#11	2.92	MA	18301	5214	29689	3853	32073	3120	32643	2541	32490	1676	39302	1039	29612
9L-2S		MI	12668	5214	21178	3666	22980	2939	23812	2367	24883	1487	29505	1260	18709
18-#14	4.22	MA	20708	5644	35076	4084	38831	3286	40884	2634	43686	1627	54119	1014	44191
6L-5S		MI	12263	5644	21305	3903	23027	3112	23859	2455	25075	1428	29959	779	25151
18-#14	4.22	MA	20079	5644	33864	4104	37369	3304	39087	2650	41286	1640	50870	884	42689
7L-4S		MI	12648	5644	21953	3915	23836	3099	24825	2443	26316	1416	31521	836	25640
18-#14	4.22	MA	19461	5644	32775	4100	35886	3297	37333	2666	38735	1627	47861	816	41009
8L-3S		MI	13073	5644	22696	3902	24751	3112	25909	2455	27662	1403	32998	948	26224
18-#14	4.22	MA	18849	5644	31602	4120	34443	3315	35498	2657	36356	1640	44911	738	39194
9L-2S		MI	13654	5644	23586	3914	25862	3099	27237	2443	29425	1391	35265	1073	26260
20-#11	3.25	MA	20167	5322	33278	3895	36628	3146	38224	2552	40107	1658	49101	1212	35569
6E		MI	11690	5322	19742	3737	21178	2986	21702	2410	22095	1487	26302	961	20049
20-#11	3.25	MA	19721	5322	32432	3909	35608	3159	36970	2564	38425	1667	46813	1122	34853
7L-5S		MI	11951	5322	20202	3728	21755	2995	22355	2402	22964	1478	27337	1019	20241
20-#11	3.25	MA	19283	5322	31673	3906	34574	3155	35747	2576	36638	1659	44699	1074	34037
8L-4S		MI	12223	5322	20657	3735	22330	2986	23042	2393	23926	1487	28452	1058	20674
20-#11	3.25	MA	18845	5322	30855	3921	33568	3168	34467	2570	34972	1668	42621	1020	33070
9L-3S		MI	12524	5322	21178	3726	22980	2995	23812	2402	24883	1478	29505	1137	20693
20-#11	3.25	MA	18354	5322	30098	3918	32547	3164	33250	2582	33319	1677	40608	959	32154
10L-2S		MI	12937	5322	21805	3733	23770	2986	24756	2393	26136	1470	31124	1224	20679
20-#14	4.69	MA	20840	5799	35532	4201	39508	3374	41696	2692	44826	1627	55584	855	47671
7L-5S		MI	12644	5799	22196	4000	24138	3178	25188	2490	26838	1402	32226	723	27817
20-#14	4.69	MA	20226	5799	34443	4197	38025	3367	39942	2708	42274	1614	52575	787	45934
8L-4S		MI	13027	5799	22844	4012	24947	3166	26154	2478	28079	1389	33788	780	28270
20-#14	4.69	MA	19615	5799	33270	4217	36582	3385	38107	2699	39895	1627	49625	709	44081
9L-3S		MI	13450	5799	23586	3999	25862	3178	27237	2490	29425	1377	35265	892	28975
22-#11	3.57	MA	20259	5430	33599	3976	37103	3208	38794	2593	40907	1659	50132	1103	38331
7L-6S		MI	11962	5430	20369	3805	21968	3033	22647	2436	23348	1470	27921	925	21944
22-#11	3.57	MA	19823	5430	32839	3974	36069	3203	37571	2605	39120	1650	48018	1055	37540
8L-5S		MI	12222	5430	20829	3795	22545	3042	23300	2427	24217	1461	28956	983	22126
22-#11	3.57	MA	19386	5430	32021	3988	35063	3216	36291	2599	37453	1659	45940	1001	36534
9L-4S		MI	12494	5430	21284	3803	23120	3033	23986	2419	25179	1470	30071	1022	22551
22-#11	3.57	MA	18900	5430	31264	3985	34042	3212	35074	2611	35801	1668	43927	940	35588
10L-3S		MI	12794	5430	21805	3793	23770	3042	24756	2427	26136	1461	31124	1101	22645
22-#14	5.16	MA	20985	5955	36111	4294	40163	3437	42551	2751	45814	1601	57290	758	50867
8L-5S		MI	13023	5955	23086	4097	25250	3245	26516	2526	28601	1375	34492	667	30487
22-#14	5.16	MA	20375	5955	34939	4314	38721	3455	40716	2742	43435	1614	54340	680	48976
9L-4S		MI	13404	5955	23734	4109	26059	3232	27482	2513	29842	1362	36054	724	30908

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

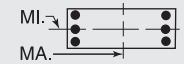
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	3.90	MA	20360	5538	34005	4041	37564	3252	39395	2634	41601	1642	51337	1037	41047
8L-6S		MI	12234	5538	20996	3872	22758	3080	23591	2461	24600	1452	29539	888	23794
24-#11	3.90	MA	19924	5538	33187	4055	36558	3265	38115	2629	39935	1650	49259	983	40003
9L-5S		MI	12493	5538	21456	3862	23335	3089	24244	2453	25469	1444	30574	946	24013
24-#11	3.90	MA	19454	5538	32430	4053	35537	3261	36898	2640	38282	1659	47246	922	39028
10L-4S		MI	12763	5538	21911	3870	23910	3080	24930	2444	26432	1452	31690	985	24412
24-#14	5.63	MA	21130	6111	36607	4412	40859	3525	43325	2784	46974	1601	59054	651	53880
9L-5S		MI	13400	6111	23976	4195	26361	3311	27845	2561	30364	1348	36759	611	33134

RECTANGULAR TIED COLUMNS 24" x 42"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.59	MA	21622	5009	34211	3696	37158	3005	38162	2492	38631	1750	45639	1630	20152
2E		MI	12026	5009	19443	3488	20381	2818	20461	2316	20090	1583	23041	1409	10896
6-#14	1.34	MA	21239	4922	33222	3666	36028	2986	36836	2485	36944	1775	43504	1671	17237
2L-3S		MI	11276	4922	18133	3470	18875	2837	18701	2348	17762	1646	20142	1364	9491
6-#14	1.34	MA	20041	4922	31457	3662	33765	3005	34075	2502	33187	1788	38481	1546	17284
3L-2S		MI	11875	4922	19023	3482	19987	2825	20030	2336	19525	1633	22409	1488	9407
6-#18	2.38	MA	23036	5285	37301	3869	41119	3129	42994	2567	45157	1725	54314	1576	29845
2L-3S		MI	11660	5285	19443	3637	20381	2954	20461	2396	20090	1551	23041	1075	15929
6-#18	2.38	MA	20978	5285	34211	3860	37158	3160	38162	2595	38631	1747	45639	1354	29705
3L-2S		MI	12681	5285	20953	3659	22259	2932	22706	2374	23071	1529	26832	1297	15819
8-#11	1.24	MA	21081	4887	32805	3657	35564	2980	36297	2484	36221	1784	42638	1689	16036
2L-4S		MI	11082	4887	17673	3484	18384	2830	18142	2347	17090	1673	19488	1356	8903
8-#11	1.24	MA	20241	4887	31572	3654	33983	2976	34368	2496	33596	1794	39106	1602	16072
3E		MI	11391	4887	18194	3474	19034	2839	18912	2355	18047	1664	20541	1436	8839
8-#11	1.24	MA	19652	4887	30567	3669	32702	2990	32811	2491	31593	1803	36806	1516	16075
4L-2S		MI	11814	4887	18821	3482	19824	2830	19856	2347	19299	1656	22159	1522	8785
8-#14	1.79	MA	22062	5078	34988	3764	38291	3056	39597	2528	40701	1763	48526	1644	22783
2L-4S		MI	11230	5078	18281	3581	19072	2891	18946	2371	18179	1631	20931	1196	12408
8-#14	1.79	MA	20872	5078	33222	3760	36028	3074	36836	2545	36944	1775	43504	1519	22789
3E		MI	11667	5078	19023	3568	19987	2904	20030	2384	19525	1619	22409	1308	12343
8-#14	1.79	MA	20036	5078	31782	3780	34193	3068	34606	2536	34073	1788	40238	1395	22657
4L-2S		MI	12263	5078	19913	3580	21098	2891	21358	2371	21288	1606	24675	1432	12270
8-#18	3.17	MA	24428	5562	40391	4042	45080	3253	47827	2643	51684	1700	62988	1521	39481
2L-4S		MI	11571	5562	19691	3829	20711	3046	20873	2432	20796	1519	24350	772	19568
8-#18	3.17	MA	22394	5562	37301	4033	41119	3284	42994	2670	45157	1722	54314	1300	39222
3E		MI	12317	5562	20953	3807	22259	3069	22706	2454	23071	1497	26832	963	20727
8-#18	3.17	MA	20962	5562	34774	4068	37898	3271	39081	2653	40169	1744	48689	1078	36879
4L-2S		MI	13329	5562	22462	3829	24136	3046	24952	2432	26051	1475	30624	1184	20683
10-#11	1.55	MA	21661	4995	34039	3724	37146	3028	38226	2514	38846	1776	46171	1671	19913
2L-5S		MI	11082	4995	17845	3543	18599	2886	18400	2381	17380	1647	19991	1281	10950
10-#11	1.55	MA	20826	4995	32805	3721	35564	3025	36297	2526	36221	1785	42638	1585	19935
3L-4S		MI	11361	4995	18300	3551	19174	2877	19086	2372	18343	1656	21106	1320	10905
10-#11	1.55	MA	20240	4995	31800	3736	34284	3038	34741	2521	34218	1795	40339	1498	19906
4L-3S		MI	11668	4995	18821	3541	19824	2886	19856	2381	19299	1647	22159	1399	10852
10-#11	1.55	MA	19716	4995	30932	3734	33157	3034	33356	2533	32213	1787	37937	1457	19788
5L-2S		MI	12090	4995	19448	3549	20614	2877	20800	2372	20552	1638	23778	1485	10801
10-#14	2.23	MA	22876	5233	36753	3861	40555	3125	42358	2570	44457	1750	53549	1617	28314
2L-5S		MI	11227	5233	18523	3666	19374	2970	19309	2419	18700	1617	21636	1083	14695
10-#14	2.23	MA	21695	5233	34988	3857	38291	3144	39597	2587	40701	1763	48526	1492	28273
3L-4S		MI	11621	5233	19171	3678	20183	2958	20274	2407	19942	1605	23198	1139	15203
10-#14	2.23	MA	20866	5233	33548	3878	36456	3138	37367	2579	37830	1776	45261	1368	28092
4L-3S		MI	12055	5233	19913	3665	21098	2970	21358	2419	21288	1592	24675	1251	15166
10-#14	2.23	MA	20125	5233	32302	3873	34841	3157	35382	2596	34956	1764	41839	1309	26893
5L-2S		MI	12649	5233	20804	3677	22210	2958	22687	2407	23051	1580	26942	1376	15107
10-#18	3.97	MA	23789	5839	40391	4206	45080	3408	47827	2745	51684	1697	62988	1245	48723
3L-4S		MI	12227	5839	21201	3999	22589	3161	23118	2490	23776	1465	28142	659	23976

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

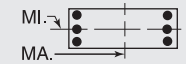
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.97	MA	22374	5839	37864	4241	41860	3395	43913	2728	46695	1719	57364	1024	45948
4L-3S		MI	12967	5839	22462	3977	24136	3183	24952	2512	26051	1443	30624	850	25477
10-#18	3.97	MA	21112	5839	35675	4232	39022	3426	40427	2756	41696	1697	51429	922	43483
5L-2S		MI	13972	5839	23972	3999	26014	3161	27197	2490	29032	1420	34416	1072	25511
12-#11	1.86	MA	22237	5103	35273	3791	38727	3077	40156	2543	41471	1767	49703	1653	23780
2L-6S		MI	11095	5103	18012	3620	18812	2924	18691	2415	17764	1638	20575	1186	12587
12-#11	1.86	MA	21406	5103	34039	3789	37146	3073	38226	2555	38846	1777	46171	1567	23782
3L-5S		MI	11361	5103	18472	3611	19389	2933	19344	2406	18633	1630	21609	1244	12908
12-#11	1.86	MA	20823	5103	33034	3804	35865	3086	36670	2550	36843	1786	43871	1481	23729
4E		MI	11638	5103	18927	3618	19964	2924	20030	2398	19596	1638	22725	1283	12891
12-#11	1.86	MA	20303	5103	32165	3801	34738	3083	35285	2562	34838	1778	41469	1439	23551
5L-3S		MI	11945	5103	19448	3609	20614	2933	20800	2406	20552	1630	23778	1363	12849
12-#11	1.86	MA	19808	5103	31351	3799	33610	3096	33907	2557	33021	1788	39186	1383	22751
6L-2S		MI	12364	5103	20075	3617	21404	2924	21745	2398	21805	1621	25396	1449	12804
12-#14	2.68	MA	22510	5389	36753	3954	40555	3214	42358	2629	44457	1750	53549	1465	33745
3L-5S		MI	11617	5389	19413	3763	20486	3037	20637	2455	20463	1590	23903	1026	17329
12-#14	2.68	MA	21687	5389	35313	3975	38720	3208	40128	2621	41587	1763	50284	1341	33522
4E		MI	12009	5389	20061	3775	21295	3024	21603	2442	21705	1578	25464	1083	17973
12-#14	2.68	MA	20953	5389	34067	3971	37104	3227	38143	2638	38712	1751	46862	1282	32164
5L-3S		MI	12441	5389	20804	3762	22210	3037	22687	2455	23051	1565	26942	1195	17970
12-#14	2.68	MA	20254	5389	32899	3967	35486	3221	36166	2630	36107	1764	43618	1201	31195
6L-2S		MI	13032	5389	21694	3774	23321	3024	24016	2442	24814	1553	29209	1320	17927
12-#18	4.76	MA	23768	6115	40954	4414	45821	3519	48746	2804	53222	1695	66038	969	55064
4E		MI	12877	6115	22711	4169	24466	3275	25363	2548	26757	1411	31933	547	28425
12-#18	4.76	MA	22521	6115	38765	4405	42983	3551	45259	2831	48223	1673	60104	868	52740
5L-3S		MI	13612	6115	23972	4147	26014	3297	27197	2570	29032	1389	34416	738	30200
12-#18	4.76	MA	21335	6115	36711	4396	40140	3537	41785	2814	43694	1695	54509	723	48784
6L-2S		MI	14610	6115	25482	4169	27891	3275	29442	2548	32012	1366	38208	959	30309
14-#11	2.17	MA	21981	5211	35273	3856	38727	3121	40156	2585	41471	1768	49703	1550	27621
3L-6S		MI	11373	5211	18639	3688	19602	2971	19635	2441	19017	1621	22193	1150	14474
14-#11	2.17	MA	21402	5211	34268	3871	37447	3135	38599	2580	39468	1777	47404	1463	27546
4L-5S		MI	11638	5211	19099	3678	20179	2980	20288	2432	19886	1612	23228	1208	14783
14-#11	2.17	MA	20885	5211	33399	3869	36320	3131	37215	2592	37463	1770	45002	1422	27232
5L-4S		MI	11914	5211	19554	3686	20754	2971	20975	2423	20848	1621	24343	1247	14866
14-#11	2.17	MA	20393	5211	32585	3866	35192	3144	35836	2586	35646	1779	42719	1366	26471
6L-3S		MI	12219	5211	20075	3676	21404	2980	21745	2432	21805	1612	25396	1326	14834
14-#11	2.17	MA	19913	5211	31692	3881	34116	3141	34513	2599	33871	1789	40283	1276	25982
7L-2S		MI	12637	5211	20701	3684	22194	2971	22689	2423	23058	1604	27015	1413	14795
14-#14	3.13	MA	22501	5545	37079	4072	40983	3278	42889	2664	45344	1751	55306	1314	38948
4L-5S		MI	12005	5545	20303	3860	21597	3103	21966	2490	22226	1563	26169	970	19975
14-#14	3.13	MA	21772	5545	35833	4068	39367	3296	40904	2680	42469	1739	51884	1255	37450
5L-4S		MI	12394	5545	20952	3872	22406	3091	22932	2478	23468	1551	27731	1027	20575
14-#14	3.13	MA	21079	5545	34665	4064	37750	3290	38927	2672	39864	1751	48640	1174	36525
6L-3S		MI	12825	5545	21694	3859	23321	3103	24016	2490	24814	1539	29209	1139	20764
14-#14	3.13	MA	20404	5545	33385	4085	36206	3309	37029	2689	37318	1764	45178	1044	34836
7L-2S		MI	13412	5545	22584	3871	24432	3091	25344	2478	26577	1526	31475	1264	20734
14-#18	5.56	MA	23912	6392	41855	4578	46944	3675	50092	2907	54750	1648	68778	813	61708
5L-4S		MI	13523	6392	24221	4339	26344	3389	27609	2606	29737	1357	35725	434	32903
14-#18	5.56	MA	22740	6392	39801	4568	44102	3662	46618	2890	50221	1670	63183	668	57910
6L-3S		MI	14253	6392	25482	4317	27891	3411	29442	2629	32012	1335	38208	625	34820
14-#18	5.56	MA	21600	6392	37552	4604	41388	3693	43282	2917	45795	1692	57205	437	53981
7L-2S		MI	15244	6392	26992	4339	29769	3389	31687	2606	34993	1312	41999	846	35072

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

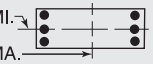


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.48	MA	21977	5318	35501	3938	39028	3183	40528	2609	42093	1769	50936	1446	31359
4L-6S		MI	11650	5318	19266	3755	20392	3018	20579	2466	20270	1604	23812	1113	16365
16-#11	2.48	MA	21463	5318	34633	3936	37901	3179	39144	2621	40088	1761	48534	1404	30925
5E		MI	11913	5318	19726	3746	20969	3027	21232	2457	21139	1595	24847	1171	16594
16-#11	2.48	MA	20974	5318	33818	3933	36773	3193	37765	2616	38271	1771	46251	1348	30199
6L-4S		MI	12189	5318	20180	3753	21544	3018	21919	2449	22101	1604	25962	1210	16832
16-#11	2.48	MA	20497	5318	32926	3948	35697	3189	36442	2628	36496	1780	43816	1258	29677
7L-3S		MI	12493	5318	20701	3744	22194	3027	22689	2457	23058	1595	27015	1290	16811
16-#11	2.48	MA	20028	5318	32125	3946	34605	3202	35150	2640	34609	1772	41570	1210	28713
8L-2S		MI	12909	5318	21328	3751	22984	3018	23633	2449	24311	1586	28634	1376	16779
16-#14	3.57	MA	22585	5700	37599	4165	41631	3366	43665	2723	46226	1726	56907	1228	42751
5E		MI	12390	5700	21194	3958	22708	3170	23294	2526	23989	1537	28436	914	22629
16-#14	3.57	MA	21897	5700	36430	4161	40013	3360	41688	2715	43620	1739	53663	1147	41820
6L-4S		MI	12778	5700	21842	3970	23517	3158	24260	2513	25231	1524	29998	971	23181
16-#14	3.57	MA	21227	5700	35151	4182	38470	3379	39790	2731	41074	1752	50201	1017	40093
7L-3S		MI	13206	5700	22584	3957	24432	3170	25344	2526	26577	1512	31475	1083	23535
16-#14	3.57	MA	20568	5700	34001	4178	36904	3373	37938	2748	38369	1740	47001	948	38494
8L-2S		MI	13791	5700	23474	3969	25544	3158	26673	2513	28340	1499	33742	1208	23532
16-#18	6.35	MA	24130	6668	42891	4741	48063	3786	51450	2965	56747	1645	71858	614	67061
6L-4S		MI	14165	6668	25731	4510	28221	3503	29854	2665	32718	1303	39517	322	37404
16-#18	6.35	MA	23002	6668	40642	4776	45349	3817	48115	2992	52321	1667	65880	382	63025
7L-3S		MI	14890	6668	26992	4488	29769	3525	31687	2687	34993	1280	41999	512	39156
18-#11	2.79	MA	22037	5426	35866	4003	39483	3228	41073	2650	42713	1752	52067	1387	34627
5L-6S		MI	11926	5426	19892	3823	21182	3065	21524	2492	21522	1586	25430	1077	18259
18-#11	2.79	MA	21551	5426	35052	4001	38355	3241	39695	2645	40896	1762	49784	1331	33932
6L-5S		MI	12188	5426	20352	3813	21759	3074	22177	2483	22391	1578	26465	1135	18471
18-#11	2.79	MA	21077	5426	34160	4016	37279	3237	38371	2657	39121	1771	47348	1241	33343
7L-4S		MI	12462	5426	20807	3821	22334	3065	22863	2474	23354	1586	27581	1174	18793
18-#11	2.79	MA	20611	5426	33358	4013	36187	3251	37080	2669	37234	1764	45102	1192	32411
8L-3S		MI	12765	5426	21328	3811	22984	3074	23633	2483	24311	1578	28634	1253	18781
18-#11	2.79	MA	20140	5426	32495	4028	35125	3247	35729	2664	35474	1773	42889	1138	31516
9L-2S		MI	13180	5426	21955	3819	23774	3065	24577	2474	25563	1569	30252	1340	18757
18-#14	4.02	MA	22708	5856	38196	4258	42276	3430	44449	2757	47377	1727	58686	1120	47030
6L-5S		MI	12773	5856	22084	4055	23820	3237	24623	2561	25752	1510	30702	858	25291
18-#14	4.02	MA	22044	5856	36916	4279	40733	3449	42552	2774	44831	1739	55223	990	45362
7L-4S		MI	13159	5856	22732	4067	24629	3224	25589	2549	26994	1497	32264	915	25799
18-#14	4.02	MA	21389	5856	35766	4275	39167	3443	40699	2791	42126	1727	52024	921	43703
8L-3S		MI	13585	5856	23474	4054	25544	3237	26673	2561	28340	1485	33742	1027	26298
18-#14	4.02	MA	20730	5856	34528	4296	37644	3461	38762	2783	39603	1740	48879	843	42050
9L-2S		MI	14168	5856	24364	4066	26655	3224	28001	2549	30103	1473	36008	1151	26324
18-#18	7.14	MA	24389	6945	43732	4949	49311	3941	52947	3068	58848	1642	74554	328	72092
7L-4S		MI	14803	6945	27240	4680	30099	3617	32099	2723	35698	1249	43309	209	41923
20-#11	3.10	MA	22124	5534	36286	4068	39936	3290	41624	2675	43521	1753	53317	1313	37670
6E		MI	12200	5534	20519	3890	21972	3112	22468	2517	22775	1569	27049	1041	20154
20-#11	3.10	MA	21653	5534	35393	4083	38860	3286	40301	2687	41745	1763	50881	1223	37018
7L-5S		MI	12461	5534	20979	3881	22549	3121	23121	2509	23644	1560	28084	1098	20353
20-#11	3.10	MA	21190	5534	34592	4080	37768	3299	39009	2699	39859	1755	48635	1175	36113
8L-4S		MI	12734	5534	21434	3888	23124	3112	23807	2500	24607	1569	29199	1137	20738
20-#11	3.10	MA	20719	5534	33729	4095	36706	3295	37658	2694	38099	1765	46421	1121	35178
9L-3S		MI	13036	5534	21955	3879	23774	3121	24577	2509	25563	1560	30252	1217	20747
20-#11	3.10	MA	20198	5534	32929	4093	35629	3309	36373	2706	36355	1774	44277	1060	34179
10L-2S		MI	13450	5534	22582	3886	24564	3112	25522	2500	26816	1552	31871	1303	20729
20-#14	4.46	MA	22853	6011	38682	4376	42996	3519	45313	2816	48588	1727	60246	963	50639
7L-5S		MI	13155	6011	22974	4152	24931	3303	25952	2597	27516	1483	32969	802	27958
20-#14	4.46	MA	22204	6011	37532	4372	41430	3512	43460	2833	45882	1715	57047	893	48922
8L-4S		MI	13539	6011	23622	4164	25740	3291	26918	2584	28757	1471	34531	859	28428
20-#14	4.46	MA	21546	6011	36293	4393	39907	3531	41523	2825	43359	1728	53901	816	47073
9L-3S		MI	13963	6011	24364	4151	26655	3303	28001	2597	30103	1458	36008	971	29053

RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.40	MA	22226	5642	36627	4150	40442	3334	42230	2716	44370	1754	54413	1206	40699
7L-6S		MI	12473	5642	21146	3958	22762	3159	23412	2543	24028	1552	28668	1004	22052
22-#11	3.40	MA	21765	5642	35825	4148	39350	3348	40938	2728	42484	1746	52168	1157	39821
8L-5S		MI	12733	5642	21606	3948	23339	3168	24065	2534	24897	1543	29702	1062	22238
22-#11	3.40	MA	21295	5642	34962	4163	38288	3344	39588	2723	40724	1756	49954	1103	38846
9L-4S		MI	13005	5642	22061	3956	23914	3159	24752	2525	25860	1552	30818	1101	22681
22-#11	3.40	MA	20778	5642	34163	4160	37211	3357	38303	2735	38980	1765	47809	1042	37871
10L-3S		MI	13306	5642	22582	3946	24564	3168	25522	2534	26816	1543	31871	1180	22708
22-#11	3.40	MA	20280	5642	33377	4158	36155	3353	36969	2730	37120	1758	45620	991	36567
11L-2S		MI	13718	5642	23209	3954	25354	3159	26466	2525	28069	1534	33489	1267	22697
22-#14	4.91	MA	23012	6167	39297	4469	43694	3582	46221	2875	49639	1702	62070	866	54151
8L-5S		MI	13534	6167	23864	4249	26043	3370	27280	2632	29279	1456	35235	746	30629
22-#14	4.91	MA	22355	6167	38059	4490	42171	3601	44284	2867	47116	1715	58924	789	52264
9L-4S		MI	13917	6167	24513	4261	26852	3357	28246	2620	30520	1444	36797	803	31066
24-#11	3.71	MA	22336	5750	37059	4215	40931	3396	42868	2758	45109	1738	55700	1140	43534
8L-6S		MI	12745	5750	21773	4025	23552	3206	24357	2568	25281	1534	30286	968	23950
24-#11	3.71	MA	21867	5750	36196	4230	39869	3392	41517	2753	43349	1747	53487	1086	42520
9L-5S		MI	13004	5750	22233	4015	24129	3215	25010	2560	26150	1526	31321	1026	24125
24-#11	3.71	MA	21355	5750	35397	4228	38792	3406	40232	2765	41605	1757	51342	1025	41567
10L-4S		MI	13275	5750	22687	4023	24704	3206	25696	2551	27112	1534	32437	1065	24542
24-#11	3.71	MA	20860	5750	34611	4225	37736	3402	38899	2759	39745	1749	49152	973	40238
11L-3S		MI	13575	5750	23209	4013	25354	3215	26466	2560	28069	1526	33489	1144	24655
24-#14	5.36	MA	23158	6323	39825	4587	44434	3671	47045	2910	50873	1703	63947	761	57463
9L-5S		MI	13912	6323	24755	4347	27154	3436	28609	2668	31042	1430	37502	690	33303

RECTANGULAR TIED COLUMNS 24" x 44"

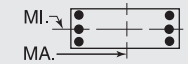
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.52	MA	23628	5221	37232	3869	40454	3146	41512	2612	41971	1846	49573	1726	21232
2E		MI	12536	5221	20225	3638	21173	2942	21222	2421	20763	1663	23777	1487	10941
6-#14	1.28	MA	23217	5134	36182	3839	39253	3128	40104	2606	40116	1868	47274	1765	18149
2L-3S		MI	11785	5134	18912	3622	19668	2962	19465	2455	18440	1727	20886	1443	9528
6-#14	1.28	MA	21950	5134	34319	3835	36865	3122	37190	2623	36152	1881	41943	1641	18196
3L-2S		MI	12385	5134	19802	3634	20780	2950	20794	2442	20203	1715	23152	1567	9443
6-#18	2.27	MA	25130	5497	40495	4041	44636	3271	46615	2688	48894	1822	58795	1675	31465
2L-3S		MI	12170	5497	20225	3786	21173	3078	21222	2501	20763	1631	23777	1153	15993
6-#18	2.27	MA	22951	5497	37232	4033	40454	3303	41512	2716	41971	1845	49573	1454	31325
3L-2S		MI	13192	5497	21735	3809	23050	3056	23467	2479	23743	1609	27568	1375	15873
8-#11	1.18	MA	23048	5099	35739	3829	38760	3122	39531	2605	39349	1877	46343	1782	16879
2L-4S		MI	11591	5099	18450	3637	19178	2956	18908	2454	17770	1755	20235	1436	8937
8-#11	1.18	MA	22161	5099	34438	3827	37093	3118	37496	2617	36580	1887	42596	1696	16915
3E		MI	11900	5099	18971	3627	19828	2965	19678	2462	18727	1746	21287	1515	8871
8-#11	1.18	MA	21539	5099	33380	3842	35743	3132	35856	2613	34470	1897	40155	1610	16917
4L-2S		MI	12323	5099	19598	3635	20618	2956	20622	2454	19980	1738	22906	1601	8817
8-#14	1.70	MA	24090	5290	38045	3936	41641	3197	43017	2648	44080	1855	52606	1740	23998
2L-4S		MI	11739	5290	19060	3732	19865	3016	19710	2478	18857	1713	21675	1274	12459
8-#14	1.70	MA	22832	5290	36182	3932	39253	3192	40104	2666	40116	1869	47274	1616	24004
3E		MI	12177	5290	19802	3720	20780	3029	20794	2490	20203	1700	23152	1387	12387
8-#14	1.70	MA	21950	5290	34664	3954	37319	3211	37753	2658	37091	1882	43804	1491	23872
4L-2S		MI	12774	5290	20692	3732	21891	3016	22122	2478	21966	1688	25419	1511	12311
8-#18	3.03	MA	26609	5774	43758	4214	48819	3395	51718	2763	55817	1799	68017	1624	41641
2L-4S		MI	12079	5774	20473	3979	21503	3170	21634	2537	21469	1599	25086	850	19787
8-#18	3.03	MA	24455	5774	40495	4206	44636	3427	46615	2792	48894	1821	58795	1402	41382
3E		MI	12827	5774	21735	3957	23050	3192	23467	2559	23743	1577	27568	1041	20807

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

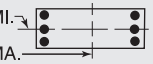


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.03	MA	22943	5774	37830	4242	41240	3415	42488	2776	43602	1843	52807	1181	39189
4L-2S		MI	13841	5774	23244	3979	24928	3170	25712	2537	26724	1555	31360	1262	20745
10-#11	1.48	MA	23663	5207	37040	3896	40428	3170	41566	2634	42117	1868	50090	1766	20966
2L-5S		MI	11591	5207	18622	3696	19393	3012	19165	2488	18061	1729	20738	1360	10995
10-#11	1.48	MA	22780	5207	35739	3894	38760	3167	39531	2647	39349	1878	46343	1680	20988
3L-4S		MI	11870	5207	19077	3704	19968	3003	19852	2479	19023	1738	21853	1399	10945
10-#11	1.48	MA	22162	5207	34681	3909	37411	3181	37891	2642	37238	1888	43901	1593	20959
4L-3S		MI	12178	5207	19598	3694	20618	3012	20622	2488	19980	1729	22906	1479	10889
10-#11	1.48	MA	21611	5207	33766	3907	36225	3177	36433	2655	35126	1881	41358	1551	20841
5L-2S		MI	12600	5207	20225	3702	21408	3003	21566	2479	21233	1721	24525	1565	10837
10-#14	2.13	MA	24954	5446	39907	4033	44029	3267	45930	2691	48043	1843	57937	1715	29833
2L-5S		MI	11736	5446	19302	3818	20167	3095	20073	2526	19378	1699	22379	1162	14829
10-#14	2.13	MA	23706	5446	38045	4030	41641	3262	43017	2708	44080	1856	52606	1590	29792
3L-4S		MI	12130	5446	19950	3830	20976	3083	21038	2513	20620	1686	23941	1218	15261
10-#14	2.13	MA	22831	5446	36527	4051	39707	3281	40666	2701	41055	1870	49136	1466	29611
4L-3S		MI	12566	5446	20692	3817	21891	3095	22122	2526	21966	1674	25419	1330	15215
10-#14	2.13	MA	22050	5446	35215	4047	38006	3275	38575	2718	38026	1859	45510	1406	28471
5L-2S		MI	13160	5446	21582	3829	23003	3083	23451	2513	23729	1661	27685	1455	15153
10-#18	3.79	MA	25938	6051	43758	4379	48819	3551	51718	2867	55817	1798	68017	1351	51423
3L-4S		MI	12736	6051	21983	4149	23380	3284	23879	2595	24449	1545	28878	737	24192
10-#18	3.79	MA	24444	6051	41093	4415	45423	3539	47591	2852	50525	1820	62029	1130	48777
4L-3S		MI	13478	6051	23244	4127	24928	3306	25712	2617	26724	1523	31360	928	25567
10-#18	3.79	MA	23110	6051	38786	4407	42432	3571	43916	2880	45224	1798	55734	1027	46061
5L-2S		MI	14485	6051	24754	4149	26805	3284	27957	2595	29704	1501	35152	1149	25579
12-#11	1.77	MA	24274	5315	38341	3964	42096	3219	43601	2664	44886	1860	53836	1750	25044
2L-6S		MI	11604	5315	18789	3773	19605	3050	19457	2522	18444	1720	21321	1266	12707
12-#11	1.77	MA	23395	5315	37040	3962	40428	3215	41566	2676	42117	1870	50090	1663	25046
3L-5S		MI	11870	5315	19249	3764	20183	3059	20110	2513	19313	1712	22356	1324	12969
12-#11	1.77	MA	22781	5315	35982	3977	39079	3229	39926	2671	40007	1880	47648	1577	24992
4E		MI	12148	5315	19704	3771	20757	3050	20796	2505	20276	1720	23472	1363	12935
12-#11	1.77	MA	22232	5315	35067	3974	37893	3225	38468	2684	37895	1873	45105	1535	24849
5L-3S		MI	12455	5315	20225	3762	21408	3059	21566	2513	21233	1712	24525	1442	12889
12-#11	1.77	MA	21711	5315	34210	3972	36705	3239	37016	2679	35982	1883	42682	1479	24035
6L-2S		MI	12875	5315	20852	3770	22198	3050	22510	2505	22485	1703	26143	1528	12842
12-#14	2.56	MA	24571	5601	39907	4127	44029	3332	45930	2751	48043	1844	57937	1565	35568
3L-5S		MI	12126	5601	20192	3915	21279	3162	21401	2561	21141	1672	24646	1105	17463
12-#14	2.56	MA	23702	5601	38390	4148	42095	3351	43580	2743	45018	1857	54467	1440	35345
4E		MI	12519	5601	20840	3927	22088	3149	22367	2549	22383	1659	26208	1162	18042
12-#14	2.56	MA	22928	5601	37078	4144	40394	3345	41489	2760	41990	1846	50841	1381	34036
5L-3S		MI	12952	5601	21582	3914	23003	3162	23451	2561	23729	1647	27685	1274	18024
12-#14	2.56	MA	22191	5601	35848	4141	38690	3365	39407	2753	39246	1860	47396	1300	32974
6L-2S		MI	13543	5601	22472	3926	24114	3149	24780	2549	25492	1635	29952	1399	17976
12-#18	4.55	MA	25924	6327	44356	4588	49606	3663	52694	2927	57449	1797	71251	1078	58412
4E		MI	13387	6327	23493	4319	25258	3398	26124	2653	27430	1491	32669	625	28639
12-#18	4.55	MA	24607	6327	42049	4580	46615	3696	49019	2955	52147	1775	64956	975	55849
5L-3S		MI	14124	6327	24754	4297	26805	3420	27957	2675	29704	1469	35152	815	30300
12-#18	4.55	MA	23355	6327	39886	4571	43620	3684	45358	2940	47343	1797	59003	831	51854
6L-2S		MI	15124	6327	26264	4319	28683	3398	30203	2653	32685	1447	38944	1037	30388
14-#11	2.07	MA	24006	5423	38341	4029	42096	3264	43601	2706	44886	1861	53836	1647	29095
3L-6S		MI	11882	5423	19416	3841	20395	3097	20401	2547	19697	1703	22940	1229	14572
14-#11	2.07	MA	23395	5423	37283	4044	40747	3277	41961	2701	42775	1871	51395	1560	29020
4L-5S		MI	12147	5423	19876	3831	20972	3106	21054	2539	20566	1694	23975	1287	14888
14-#11	2.07	MA	22850	5423	36368	4042	39561	3274	40503	2713	40663	1864	48851	1518	28802
5L-4S		MI	12424	5423	20330	3839	21547	3097	21740	2530	21529	1703	25090	1326	14914
14-#11	2.07	MA	22331	5423	35511	4040	38373	3288	39051	2709	38750	1874	46429	1463	27961
6L-3S		MI	12730	5423	20852	3829	22198	3106	22510	2539	22485	1694	26143	1406	14878
14-#11	2.07	MA	21826	5423	34572	4055	37240	3284	37658	2721	36881	1884	43845	1373	27429
7L-2S		MI	13148	5423	21478	3837	22988	3097	23455	2530	23738	1686	27762	1492	14837

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

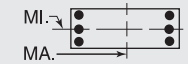
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.98	MA	24566	5757	40253	4245	44483	3421	46493	2785	48982	1845	59798	1415	41074
4L-5S		MI	12514	5757	21082	4012	22390	3228	22730	2596	22904	1645	26912	1049	20109
14-#14	2.98	MA	23797	5757	38941	4242	42782	3415	44402	2803	45954	1834	56172	1355	39617
5L-4S		MI	12905	5757	21730	4024	23199	3216	23696	2584	24146	1633	28474	1106	20732
14-#14	2.98	MA	23066	5757	37711	4238	41078	3434	42320	2795	43210	1847	52727	1274	38602
6L-3S		MI	13336	5757	22472	4011	24114	3228	24780	2596	25492	1620	29952	1218	20820
14-#14	2.98	MA	22354	5757	36363	4259	39453	3429	40321	2813	40528	1861	49051	1144	36936
7L-2S		MI	13924	5757	23363	4023	25225	3216	26108	2584	27255	1608	32218	1343	20787
14-#18	5.30	MA	26085	6604	45312	4753	50798	3820	54122	3031	59070	1752	74177	924	65658
5L-4S		MI	14034	6604	25003	4489	27135	3512	28369	2711	30410	1437	36461	512	33116
14-#18	5.30	MA	24847	6604	43148	4744	47802	3808	50461	3015	54266	1774	68225	780	61504
6L-3S		MI	14766	6604	26264	4467	28683	3534	30203	2733	32685	1415	38944	703	35013
14-#18	5.30	MA	23643	6604	40778	4780	44943	3840	46946	3044	49571	1796	61869	549	57525
7L-2S		MI	15759	6604	27774	4489	30560	3512	32448	2711	35665	1393	42736	924	35157
16-#11	2.36	MA	24005	5531	38584	4111	42415	3326	43995	2730	45544	1863	55141	1544	33044
4L-6S		MI	12159	5531	20042	3908	21185	3144	21345	2573	20950	1686	24559	1193	16465
16-#11	2.36	MA	23463	5531	37669	4109	41229	3322	42538	2743	43432	1855	52598	1502	32698
5E		MI	12423	5531	20503	3899	21762	3153	21998	2564	21819	1677	25593	1251	16702
16-#11	2.36	MA	22947	5531	36812	4107	40041	3336	41086	2738	41519	1865	50175	1446	31894
6L-4S		MI	12699	5531	20957	3906	22337	3144	22685	2556	22782	1686	26709	1290	16884
16-#11	2.36	MA	22445	5531	35873	4122	38908	3333	39693	2751	39650	1875	47592	1356	31379
7L-3S		MI	13003	5531	21478	3897	22988	3153	23455	2564	23738	1677	27762	1369	16858
16-#11	2.36	MA	21951	5531	35029	4120	37759	3346	38333	2763	37663	1868	45213	1307	30391
8L-2S		MI	13421	5531	22105	3904	23778	3144	24399	2556	24991	1669	29381	1455	16823
16-#14	3.41	MA	24659	5912	40804	4339	45170	3485	47315	2845	49917	1821	61504	1330	45213
5E		MI	12900	5912	21972	4109	23501	3295	24058	2632	24667	1618	29179	993	22765
16-#14	3.41	MA	23934	5912	39574	4335	43466	3504	45233	2838	47173	1835	58058	1249	44238
6L-4S		MI	13289	5912	22621	4121	24310	3282	25024	2619	25909	1606	30741	1050	23336
16-#14	3.41	MA	23228	5912	38226	4356	41841	3499	43234	2855	44492	1849	54383	1119	42489
7L-3S		MI	13718	5912	23363	4109	25225	3295	26108	2632	27255	1593	32218	1162	23602
16-#14	3.41	MA	22532	5912	37015	4353	40192	3518	41284	2873	41643	1837	50993	1049	40923
8L-2S		MI	14304	5912	24253	4121	26337	3282	27437	2619	29018	1581	34485	1287	23588
16-#18	6.06	MA	26323	6881	46411	4917	51985	3932	55564	3091	61189	1751	77447	728	71180
6L-4S		MI	14677	6881	26513	4660	29013	3626	30614	2769	33391	1383	40253	400	37616
16-#18	6.06	MA	25132	6881	44041	4953	49126	3964	52049	3119	56494	1773	71091	497	67094
7L-3S		MI	15404	6881	27774	4637	30560	3648	32448	2791	35665	1361	42736	590	39438
18-#11	2.66	MA	24072	5639	38970	4177	42897	3371	44572	2772	46200	1847	56345	1486	36604
5L-6S		MI	12435	5639	20669	3976	21975	3191	22289	2598	22203	1668	26177	1156	18360
18-#11	2.66	MA	23559	5639	38113	4174	41709	3384	43121	2767	44287	1857	53922	1430	35833
6L-5S		MI	12698	5639	21129	3966	22552	3200	22942	2590	23072	1660	27212	1214	18579
18-#11	2.66	MA	23060	5639	37174	4189	40576	3381	41728	2780	42418	1867	51338	1340	35319
7L-4S		MI	12973	5639	21584	3974	23127	3191	23629	2581	24034	1668	28328	1253	18848
18-#11	2.66	MA	22568	5639	36330	4187	39427	3395	40368	2792	40431	1860	48960	1291	34293
8L-3S		MI	13276	5639	22105	3964	23778	3200	24399	2590	24991	1660	29381	1333	18831
18-#11	2.66	MA	22051	5639	35505	4185	38309	3391	38946	2788	38579	1870	46611	1237	33439
9L-2S		MI	13692	5639	22732	3972	24567	3191	25343	2581	26244	1651	30999	1419	18803
18-#14	3.84	MA	24795	6068	41436	4432	45854	3574	48146	2880	51137	1823	63390	1223	49881
6L-5S		MI	13284	6068	22863	4207	24613	3362	25387	2667	26430	1592	31446	937	25427
18-#14	3.84	MA	24094	6068	40089	4454	44229	3568	46148	2898	48456	1836	59714	1094	48053
7L-4S		MI	13671	6068	23511	4219	25422	3349	26353	2655	27672	1579	33007	994	25954
18-#14	3.84	MA	23404	6068	38878	4450	42580	3588	44197	2915	45606	1825	56324	1024	46427
8L-3S		MI	14098	6068	24253	4206	26337	3362	27437	2667	29018	1567	34485	1106	26369
18-#14	3.84	MA	22697	6068	37575	4471	40976	3582	42157	2907	42949	1838	52983	946	44625
9L-2S		MI	14681	6068	25143	4218	27448	3349	28765	2655	30781	1554	36752	1230	26387

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

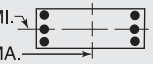
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	6.82	MA	26605	7157	47304	5126	53309	4088	57152	3194	63417	1750	80313	446	76686
7L-4S		MI	15316	7157	28022	4830	30890	3740	32860	2827	36371	1329	44045	287	42135
20-#11	2.95	MA	24167	5746	39414	4242	43377	3433	45155	2797	47056	1848	57669	1413	39778
6E		MI	12710	5746	21296	4043	22765	3238	23234	2624	23456	1651	27796	1120	20257
20-#11	2.95	MA	23671	5746	38475	4257	42244	3429	43762	2809	45186	1858	55085	1323	39198
7L-5S		MI	12972	5746	21756	4034	23342	3247	23887	2615	24325	1643	28831	1178	20461
20-#11	2.95	MA	23182	5746	37632	4255	41095	3443	42403	2822	43200	1851	52707	1274	38202
8L-4S		MI	13245	5746	22211	4041	23917	3238	24573	2607	25287	1651	29946	1217	20801
20-#11	2.95	MA	22678	5746	36806	4252	39977	3440	40981	2817	41348	1861	50358	1220	37306
9L-3S		MI	13548	5746	22732	4032	24567	3247	25343	2615	26244	1643	30999	1296	20799
20-#11	2.95	MA	22127	5746	35882	4267	38843	3453	39628	2830	39512	1871	48081	1159	36212
10L-2S		MI	13962	5746	23359	4039	25357	3238	26287	2607	27497	1634	32618	1383	20777
20-#14	4.26	MA	24953	6224	41952	4551	46617	3638	49061	2940	52419	1824	65045	1068	53627
7L-5S		MI	13666	6224	23753	4304	25724	3428	26716	2703	28193	1565	33712	881	28095
20-#14	4.26	MA	24268	6224	40741	4547	44968	3658	47110	2957	49570	1812	61655	998	51941
8L-4S		MI	14051	6224	24401	4316	26533	3416	27681	2690	29435	1552	35274	938	28583
20-#14	4.26	MA	23562	6224	39437	4568	43364	3652	45070	2950	46913	1826	58315	920	50185
9L-3S		MI	14476	6224	25143	4303	27448	3428	28765	2703	30781	1540	36752	1050	29128
22-#11	3.25	MA	24278	5854	39776	4324	43912	3478	45797	2839	47955	1850	58832	1307	43083
7L-6S		MI	12983	5854	21923	4111	23555	3285	24178	2650	24708	1634	29414	1084	22156
22-#11	3.25	MA	23792	5854	38933	4322	42763	3492	44437	2851	45968	1842	56453	1258	42115
8L-5S		MI	13244	5854	22383	4101	24132	3294	24831	2641	25577	1625	30449	1141	22347
22-#11	3.25	MA	23289	5854	38107	4320	41645	3488	43016	2847	44116	1852	54104	1204	41179
9L-4S		MI	13517	5854	22838	4109	24707	3285	25517	2632	26540	1634	31565	1180	22747
22-#11	3.25	MA	22742	5854	37183	4335	40511	3502	41663	2859	42280	1862	51828	1143	40110
10L-3S		MI	13818	5854	23359	4099	25357	3294	26287	2641	27497	1625	32618	1260	22762
22-#11	3.25	MA	22217	5854	36356	4333	39400	3498	40259	2854	40322	1855	49509	1091	38813
11L-2S		MI	14231	5854	23985	4107	26147	3285	27232	2632	28749	1617	34236	1346	22747
22-#14	4.69	MA	25125	6379	42604	4644	47356	3727	50023	3000	53534	1800	66986	973	57465
8L-5S		MI	14046	6379	24643	4401	26836	3495	28044	2738	29956	1538	35979	825	30767
22-#14	4.69	MA	24420	6379	41300	4666	45752	3722	47984	2992	50877	1814	63646	895	55592
9L-4S		MI	14429	6379	25291	4413	27645	3482	29010	2726	31198	1526	37541	881	31221
24-#11	3.55	MA	24398	5962	40234	4389	44431	3540	46472	2881	48737	1834	60200	1241	46034
8L-6S		MI	13255	5962	22550	4178	24345	3332	25122	2675	25961	1617	31033	1047	24056
24-#11	3.55	MA	23895	5962	39408	4387	43313	3537	45050	2876	46885	1844	57851	1188	45058
9L-5S		MI	13515	5962	23010	4168	24922	3341	25775	2666	26830	1608	32068	1105	24235
24-#11	3.55	MA	23354	5962	38484	4402	42179	3550	43698	2888	45048	1854	55575	1127	44012
10L-4S		MI	13787	5962	23464	4176	25497	3332	26462	2658	27793	1617	33183	1144	24669
24-#11	3.55	MA	22831	5962	37657	4400	41068	3547	42294	2884	43090	1847	53256	1074	42690
11L-3S		MI	14087	5962	23985	4166	26147	3341	27232	2666	28749	1608	34236	1223	24716
24-#14	5.11	MA	25273	6535	43163	4763	48140	3792	50897	3035	54840	1801	68977	870	61087
9L-5S		MI	14424	6535	25533	4498	27947	3561	29373	2774	31720	1511	38245	769	33442

RECTANGULAR TIED COLUMNS 24" x 46"

4-#18	1.45	MA	25718	5433	40374	4041	43881	3288	44994	2733	45414	1940	53643	1822	22312
2E		MI	13046	5433	21007	3788	21964	3065	21982	2526	21436	1744	24513	1565	10985
6-#14	1.22	MA	25281	5347	39262	4011	42610	3269	43503	2726	43409	1960	51181	1860	19060
2L-3S		MI	12295	5347	19690	3774	20461	3087	20229	2561	19117	1809	21629	1522	9563
6-#14	1.22	MA	23945	5347	37302	4008	40098	3264	40437	2744	39238	1975	45541	1735	19107
3L-2S		MI	12895	5347	20580	3786	21573	3075	21558	2548	20881	1796	23895	1646	9479
6-#18	2.17	MA	27310	5710	43810	4214	48286	3412	50368	2808	52725	1918	63413	1774	33085
2L-3S		MI	12679	5710	21007	3936	21964	3201	21982	2606	21436	1712	24513	1231	16054
6-#18	2.17	MA	25010	5710	40374	4206	43881	3446	44994	2838	45414	1941	53643	1552	32945
3L-2S		MI	13702	5710	22517	3959	23842	3179	24228	2584	24416	1690	28305	1452	15927

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



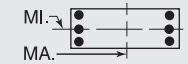
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.13	MA	25101	5311	38794	4001	42089	3264	42896	2725	42596	1970	50184	1876	17721
2L-4S		MI	12100	5311	19227	3790	19971	3082	19673	2560	18451	1837	20981	1515	8969
8-#11	1.13	MA	24165	5311	37425	3999	40334	3260	40756	2738	39685	1980	46223	1789	17757
3E		MI	12410	5311	19748	3780	20621	3091	20443	2569	19407	1829	22034	1594	8903
8-#11	1.13	MA	23511	5311	36313	4015	38917	3275	39033	2734	37467	1991	43639	1703	17759
4L-2S		MI	12833	5311	20375	3788	21411	3082	21387	2560	20660	1820	23653	1681	8849
8-#14	1.63	MA	26204	5502	41222	4108	45123	3339	46568	2769	47579	1948	56821	1836	25213
2L-4S		MI	12248	5502	19838	3884	20658	3141	20474	2584	19535	1794	22418	1353	12507
8-#14	1.63	MA	24878	5502	39262	4105	42610	3334	43503	2787	43409	1962	51181	1711	25219
3E		MI	12686	5502	20580	3872	21573	3154	21558	2596	20881	1782	23895	1465	12429
8-#14	1.63	MA	23950	5502	37667	4127	40578	3354	41032	2780	40229	1976	47506	1587	25087
4L-2S		MI	13284	5502	21471	3884	22684	3141	22886	2584	22644	1770	26162	1590	12351
8-#18	2.90	MA	28876	5986	47246	4387	52690	3537	55741	2884	60036	1896	73183	1725	43801
2L-4S		MI	12588	5986	21255	4129	22295	3293	22394	2642	22142	1680	25822	928	20000
8-#18	2.90	MA	26603	5986	43810	4379	48286	3570	50368	2913	52725	1919	63413	1504	43542
3E		MI	13337	5986	22517	4107	23842	3315	24228	2664	24416	1658	28305	1119	20881
8-#18	2.90	MA	25010	5986	41007	4416	44714	3559	46027	2899	47138	1941	57062	1282	41523
4L-2S		MI	14352	5986	24026	4129	25720	3293	26473	2642	27397	1636	32096	1340	20805
10-#11	1.41	MA	25751	5419	40162	4069	43843	3312	45037	2755	45508	1961	54144	1860	22019
2L-5S		MI	12100	5419	19399	3849	20186	3138	19931	2595	18741	1811	21485	1440	11038
10-#11	1.41	MA	24820	5419	38794	4067	42089	3309	42896	2768	42596	1971	50184	1774	22041
3L-4S		MI	12379	5419	19854	3857	20761	3129	20617	2586	19704	1820	22600	1479	10982
10-#11	1.41	MA	24170	5419	37682	4082	40671	3323	41173	2763	40379	1982	47600	1688	22012
4L-3S		MI	12688	5419	20375	3847	21411	3138	21387	2595	20660	1811	23653	1558	10924
10-#11	1.41	MA	23590	5419	36721	4080	39425	3320	39642	2776	38160	1975	44915	1645	21894
5L-2S		MI	13110	5419	21002	3855	22201	3129	22332	2586	21913	1803	25272	1644	10872
10-#14	2.04	MA	27119	5658	43182	4206	47636	3409	49633	2811	51750	1935	62461	1812	31352
2L-5S		MI	12245	5658	20080	3970	20960	3220	20837	2632	20056	1780	23123	1240	14960
10-#14	2.04	MA	25802	5658	41222	4202	45123	3404	46568	2829	47579	1950	56821	1687	31311
3L-4S		MI	12640	5658	20729	3982	21769	3208	21802	2619	21298	1768	24684	1297	15316
10-#14	2.04	MA	24881	5658	39627	4224	43090	3424	44097	2822	44400	1964	53146	1563	31130
4L-3S		MI	13076	5658	21471	3969	22684	3220	22886	2632	22644	1755	26162	1409	15263
10-#14	2.04	MA	24059	5658	38249	4221	41303	3419	41901	2840	41218	1953	49317	1502	30061
5L-2S		MI	13670	5658	22361	3981	23796	3208	24215	2619	24407	1743	28429	1534	15197
10-#18	3.62	MA	28173	6263	47246	4552	52690	3694	55741	2989	60036	1896	73183	1455	54123
3L-4S		MI	13245	6263	22765	4299	24172	3407	24639	2700	25122	1626	29614	815	24403
10-#18	3.62	MA	26599	6263	44443	4589	49119	3683	51400	2974	54449	1919	66832	1234	51630
4L-3S		MI	13989	6263	24026	4277	25720	3429	26473	2722	27397	1604	32096	1006	25654
10-#18	3.62	MA	25195	6263	42018	4582	45975	3716	47537	3004	48854	1897	60175	1130	48655
5L-2S		MI	14997	6263	25536	4299	27597	3407	28718	2700	30377	1581	35888	1227	25645
12-#11	1.70	MA	26396	5527	41531	4136	45597	3360	47177	2784	48420	1952	58105	1845	26307
2L-6S		MI	12113	5527	19566	3926	20399	3176	20222	2629	19125	1803	22068	1345	12801
12-#11	1.70	MA	25470	5527	40162	4134	43843	3357	45037	2797	45508	1963	54144	1759	26310
3L-5S		MI	12379	5527	20026	3917	20976	3185	20875	2620	19994	1794	23103	1403	13017
12-#11	1.70	MA	24824	5527	39050	4149	42425	3371	43314	2793	43291	1973	51561	1672	26256
4E		MI	12657	5527	20481	3924	21551	3176	21562	2612	20956	1803	24219	1442	12977
12-#11	1.70	MA	24247	5527	38090	4148	41179	3368	41782	2806	41072	1967	48876	1630	26112
5L-3S		MI	12964	5527	21002	3915	22201	3185	22332	2620	21913	1794	25272	1521	12928
12-#11	1.70	MA	23699	5527	37190	4146	39932	3382	40258	2801	39063	1977	46314	1574	25327
6L-2S		MI	13385	5527	21628	3922	22991	3176	23276	2612	23166	1785	26890	1608	12881
12-#14	2.45	MA	26717	5813	43182	4300	47636	3474	49633	2872	51750	1937	62461	1663	37390
3L-5S		MI	12635	5813	20971	4067	22072	3287	22165	2667	21819	1753	25389	1184	17594
12-#14	2.45	MA	25803	5813	41587	4321	45603	3494	47163	2865	48571	1952	58786	1539	37167
4E		MI	13028	5813	21619	4079	22881	3274	23131	2655	23061	1741	26951	1241	18107

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

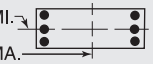


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	2.45	MA	24988	5813	40209	4318	43816	3489	44966	2883	45388	1941	54957	1478	35919
5L-3S		MI	13462	5813	22361	4066	23796	3287	24215	2667	24407	1729	28429	1353	18077
12-#14	2.45	MA	24213	5813	38918	4315	42026	3508	42779	2876	42505	1955	51310	1398	34761
6L-2S		MI	14054	5813	23251	4078	24907	3274	25544	2655	26170	1716	30695	1478	18025
12-#18	4.35	MA	28166	6540	47879	4762	53523	3807	56773	3050	61760	1897	76602	1186	61786
4E		MI	13897	6540	24275	4469	26050	3521	26885	2758	28103	1572	33405	703	28848
12-#18	4.35	MA	26779	6540	45454	4754	50379	3840	52910	3079	56165	1875	69944	1081	58970
5L-3S		MI	14636	6540	25536	4447	27597	3544	28718	2780	30377	1550	35888	893	30395
12-#18	4.35	MA	25461	6540	43181	4747	47231	3829	49062	3065	51094	1898	63635	937	54955
6L-2S		MI	15638	6540	27046	4469	29475	3521	30963	2758	33358	1527	39680	1115	30465
14-#11	1.98	MA	26116	5635	41531	4202	45597	3406	47177	2826	48420	1954	58105	1743	30569
3L-6S		MI	12391	5635	20193	3994	21189	3223	21167	2654	20378	1785	23687	1309	14668
14-#11	1.98	MA	25473	5635	40419	4217	44180	3420	45454	2822	46203	1965	55522	1657	30494
4L-5S		MI	12657	5635	20653	3984	21766	3232	21820	2646	21247	1777	24722	1367	14986
14-#11	1.98	MA	24900	5635	39458	4215	42934	3417	43922	2835	43984	1958	52837	1614	30327
5L-4S		MI	12934	5635	21107	3992	22341	3223	22506	2637	22209	1785	25837	1406	14960
14-#11	1.98	MA	24355	5635	38558	4213	41687	3431	42398	2831	41975	1969	50275	1559	29458
6L-3S		MI	13240	5635	21628	3982	22991	3232	23276	2646	23166	1777	26890	1485	14920
14-#11	1.98	MA	23824	5635	37572	4228	40497	3428	40935	2843	40012	1979	47543	1469	28881
7L-2S		MI	13659	5635	22255	3990	23781	3223	24220	2637	24419	1768	28509	1571	14878
14-#14	2.85	MA	26716	5969	43548	4419	48116	3563	50228	2907	52741	1939	64426	1515	43201
4L-5S		MI	13024	5969	21861	4164	23183	3353	23494	2703	23582	1727	27656	1128	20241
14-#14	2.85	MA	25908	5969	42169	4415	46328	3558	48031	2925	49559	1929	60597	1454	41796
5L-4S		MI	13415	5969	22509	4176	23992	3341	24460	2690	24824	1714	29218	1185	20876
14-#14	2.85	MA	25139	5969	40878	4412	44539	3578	45844	2918	46676	1943	56950	1374	40687
6L-3S		MI	13847	5969	23251	4163	24907	3353	25544	2703	26170	1702	30695	1297	20877
14-#14	2.85	MA	24390	5969	39462	4434	42831	3573	43745	2936	43860	1957	53061	1244	39054
7L-2S		MI	14436	5969	24141	4175	26018	3341	26872	2690	27933	1689	32962	1422	20839
14-#18	5.07	MA	28344	6816	48890	4927	54784	3964	58283	3155	63476	1853	79714	1033	69308
5L-4S		MI	14545	6816	25785	4639	27927	3636	29130	2816	31083	1518	37197	590	33324
14-#18	5.07	MA	27041	6816	46616	4920	51635	3954	54435	3140	58405	1876	73405	889	65131
6L-3S		MI	15279	6816	27046	4617	29475	3658	30963	2838	33358	1496	39680	781	35116
14-#18	5.07	MA	25773	6816	44126	4957	48631	3987	50742	3170	53450	1898	66670	658	61116
7L-2S		MI	16274	6816	28556	4639	31352	3636	33208	2816	36338	1473	43472	1002	35240
16-#11	2.26	MA	26118	5743	41787	4284	45934	3468	47594	2851	49115	1956	59482	1641	34729
4L-6S		MI	12669	5743	20819	4061	21979	3270	22111	2680	21630	1768	25306	1272	16562
16-#11	2.26	MA	25548	5743	40827	4282	44688	3465	46063	2864	46896	1949	56798	1599	34482
5E		MI	12933	5743	21279	4052	22556	3278	22764	2671	22499	1759	26340	1330	16874
16-#11	2.26	MA	25006	5743	39927	4280	43441	3479	44538	2860	44887	1960	54236	1543	33596
6L-4S		MI	13209	5743	21734	4059	23131	3270	23450	2663	23462	1768	27456	1369	16934
16-#11	2.26	MA	24478	5743	38941	4296	42251	3476	43075	2873	42924	1970	51504	1453	33038
7L-3S		MI	13514	5743	22255	4050	23781	3278	24220	2671	24419	1759	28509	1449	16903
16-#11	2.26	MA	23958	5743	38055	4294	41045	3490	41648	2886	40838	1964	48993	1403	32080
8L-2S		MI	13932	5743	22882	4057	24571	3270	25165	2663	25671	1751	30127	1535	16867
16-#14	3.26	MA	26820	6125	44129	4512	48841	3628	51097	2967	53730	1916	66237	1430	47686
5E		MI	13410	6125	22751	4261	24294	3420	24822	2738	25345	1700	29922	1072	22897
16-#14	3.26	MA	26057	6125	42838	4509	47051	3648	48909	2961	50847	1931	62590	1350	46622
6L-4S		MI	13799	6125	23399	4273	25103	3407	25788	2726	26587	1687	31484	1129	23489
16-#14	3.26	MA	25313	6125	41422	4531	45344	3643	46810	2979	48030	1945	58701	1220	44903
7L-3S		MI	14229	6125	24141	4261	26018	3420	26872	2738	27933	1675	32962	1241	23667
16-#14	3.26	MA	24582	6125	40151	4528	43613	3663	44761	2996	45037	1934	55120	1149	43379
8L-2S		MI	14816	6125	25032	4273	27130	3407	28201	2726	29696	1663	35228	1365	23642
16-#18	5.80	MA	28602	7093	50052	5093	56040	4078	59809	3216	65716	1854	83175	841	75332
6L-4S		MI	15188	7093	27295	4809	29805	3750	31375	2874	34064	1464	40989	477	37824
16-#18	5.80	MA	27348	7093	47561	5130	53035	4111	56115	3245	60760	1876	76439	610	71211
7L-3S		MI	15917	7093	28556	4787	31352	3772	33208	2896	36338	1441	43472	668	39714
16-#18	5.80	MA	26115	7093	45323	5122	49988	4100	52509	3275	55495	1855	70216	487	66573
8L-2S		MI	16907	7093	30066	4809	33230	3750	35454	2874	39319	1419	47263	890	39996

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

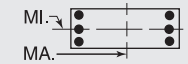
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.54	MA	26192	5851	42195	4350	46443	3514	48203	2894	49808	1941	60759	1583	38591
5L-6S		MI	12945	5851	21446	4129	22769	3317	23055	2705	22883	1751	26924	1236	18458
18-#11	2.54	MA	25653	5851	41295	4348	45195	3528	46678	2889	47799	1951	58196	1528	37741
6L-5S		MI	13208	5851	21906	4119	23346	3325	23708	2697	23752	1742	27959	1294	18684
18-#11	2.54	MA	25128	5851	40309	4363	44006	3524	45215	2902	45836	1962	55465	1438	37200
7L-4S		MI	13483	5851	22361	4127	23921	3317	24394	2688	24715	1751	29074	1333	18901
18-#11	2.54	MA	24611	5851	39423	4361	42799	3539	43788	2915	43750	1955	52954	1388	36188
8L-3S		MI	13787	5851	22882	4117	24571	3325	25165	2697	25671	1742	30127	1412	18879
18-#11	2.54	MA	24058	5851	38557	4359	41626	3535	42295	2911	41805	1966	50469	1334	35378
9L-2S		MI	14203	5851	23509	4125	25361	3317	26109	2688	26924	1733	31746	1498	18849
18-#14	3.67	MA	26967	6280	44798	4606	49564	3718	51975	3003	55017	1918	68230	1326	52563
6L-5S		MI	13794	6280	23641	4359	25406	3486	26151	2774	27108	1673	32189	1016	25560
18-#14	3.67	MA	26229	6280	43382	4628	47857	3713	49875	3021	52201	1932	64341	1196	50763
7L-4S		MI	14182	6280	24290	4371	26215	3474	27117	2761	28350	1661	33751	1073	26106
18-#14	3.67	MA	25503	6280	42111	4625	46125	3733	47827	3039	49207	1922	60760	1125	49179
8L-3S		MI	14610	6280	25032	4358	27130	3486	28201	2774	29696	1648	35228	1185	26438
18-#14	3.67	MA	24749	6280	40867	4622	44441	3727	45684	3032	46417	1936	57224	1048	47214
9L-2S		MI	15194	6280	25922	4370	28241	3474	29529	2761	31459	1636	37495	1309	26438
18-#18	6.52	MA	28907	7369	50997	5303	57440	4235	61488	3321	68071	1854	86209	561	81329
7L-4S		MI	15828	7369	28805	4980	31682	3864	33620	2932	37044	1410	44781	365	42342
18-#18	6.52	MA	27686	7369	48759	5295	54392	4224	57882	3350	62805	1832	79985	438	76632
8L-3S		MI	16553	7369	30066	4958	33230	3886	35454	2954	39319	1387	47263	556	44079
20-#11	2.83	MA	26295	5959	42664	4415	46950	3576	48819	2919	50711	1943	62157	1512	41892
6E		MI	13219	5959	22073	4196	23559	3364	23999	2731	24136	1733	28543	1199	20356
20-#11	2.83	MA	25773	5959	41678	4431	45760	3573	47356	2932	48748	1953	59425	1422	41365
7L-5S		MI	13482	5959	22533	4186	24136	3372	24652	2722	25005	1725	29578	1257	20567
20-#11	2.83	MA	25260	5959	40792	4429	44554	3587	45928	2945	46662	1946	56915	1373	40302
8L-4S		MI	13756	5959	22988	4194	24711	3364	25339	2714	25968	1733	30693	1296	20862
20-#11	2.83	MA	24710	5959	39926	4427	43380	3584	44435	2940	44717	1957	54430	1319	39454
9L-3S		MI	14059	5959	23509	4185	25361	3372	26109	2722	26924	1725	31746	1376	20849
20-#11	2.83	MA	24141	5959	38955	4442	42190	3598	43015	2953	42789	1968	52022	1258	38261
10L-2S		MI	14474	5959	24135	4192	26151	3364	27053	2714	28177	1716	33365	1462	20825
20-#14	4.08	MA	27138	6436	45343	4725	50370	3783	52941	3063	56371	1920	69981	1172	56633
7L-5S		MI	14177	6436	24532	4456	26517	3553	27480	2809	28871	1646	34455	960	28229
20-#14	4.08	MA	26417	6436	44071	4722	48638	3802	50892	3081	53378	1910	66400	1101	54989
8L-4S		MI	14563	6436	25180	4468	27326	3541	28445	2797	30113	1634	36017	1017	28735
20-#14	4.08	MA	25664	6436	42827	4719	46954	3797	48749	3074	50587	1924	62864	1024	53071
9L-3S		MI	14989	6436	25922	4455	28241	3553	29529	2809	31459	1621	37495	1129	29201
20-#14	4.08	MA	24852	6436	41435	4740	45245	3817	46711	3092	47820	1938	59438	936	50748
10L-2S		MI	15570	6436	26812	4467	29352	3541	30858	2797	33222	1609	39761	1253	29228
20-#18	7.25	MA	29242	7646	52195	5468	58797	4348	63256	3426	70116	1810	89755	390	86709
8L-4S		MI	16465	7646	30314	5150	33560	3978	35865	2990	40025	1356	48572	252	46874
22-#11	3.11	MA	26415	6066	43046	4498	47515	3621	49496	2961	51660	1945	63386	1407	45484
7L-6S		MI	13493	6066	22700	4263	24349	3411	24944	2756	25389	1716	30161	1163	22257
22-#11	3.11	MA	25904	6066	42161	4496	46308	3635	48068	2974	49574	1938	60876	1357	44421
8L-5S		MI	13755	6066	23160	4254	24926	3419	25597	2748	26258	1707	31196	1221	22453
22-#11	3.11	MA	25368	6066	41294	4494	45134	3632	46575	2970	47629	1948	58391	1304	43532
9L-4S		MI	14028	6066	23614	4262	25501	3411	26283	2739	27220	1716	32312	1260	22811
22-#11	3.11	MA	24792	6066	40324	4509	43944	3646	45155	2983	45701	1959	55983	1243	42365
10L-3S		MI	14330	6066	24135	4252	26151	3419	27053	2748	28177	1707	33365	1339	22815
22-#11	3.11	MA	24239	6066	39456	4507	42777	3643	43681	2978	43644	1952	53535	1190	41083
11L-2S		MI	14743	6066	24762	4260	26941	3411	27997	2739	29430	1699	34983	1426	22797
22-#14	4.48	MA	27324	6591	46031	4819	51151	3872	53957	3124	57549	1897	72040	1078	60808
8L-5S		MI	14557	6591	25422	4553	27629	3620	28808	2844	30634	1620	36722	904	30902

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

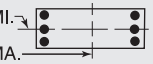
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	4.48	MA	26572	6591	44787	4816	49466	3867	51815	3117	54758	1911	68504	1000	58935
9L-4S		MI	14941	6591	26070	4565	28438	3607	29774	2832	31876	1607	38284	960	31372
22-#14	4.48	MA	25796	6591	43395	4838	47758	3887	49777	3135	51991	1926	65078	912	56576
10L-3S		MI	15366	6591	26812	4552	29352	3620	30858	2844	33222	1595	39761	1072	31957
24-#11	3.39	MA	26545	6174	43529	4563	48062	3684	50208	3003	52486	1929	64836	1342	48546
8L-6S		MI	13766	6174	23326	4331	25139	3458	25888	2782	26642	1699	31780	1126	24158
24-#11	3.39	MA	26009	6174	42663	4562	46889	3681	48715	2999	50541	1940	62352	1288	47616
9L-5S		MI	14026	6174	23786	4321	25716	3466	26541	2773	27511	1690	32815	1184	24342
24-#11	3.39	MA	25438	6174	41692	4577	45698	3695	47295	3012	48613	1950	59944	1227	46473
10L-4S		MI	14299	6174	24241	4329	26291	3458	27227	2765	28473	1699	33930	1223	24756
24-#11	3.39	MA	24888	6174	40824	4575	44531	3692	45821	3008	46556	1944	57495	1175	45165
11L-3S		MI	14600	6174	24762	4319	26941	3466	27997	2773	29430	1690	34983	1303	24777
24-#11	3.39	MA	24348	6174	39871	4590	43349	3706	44404	3021	44629	1954	54737	1098	43927
12L-2S		MI	15012	6174	25389	4327	27731	3458	28942	2765	30683	1681	36602	1389	24765
24-#14	4.89	MA	27473	6747	46747	4913	51979	3937	54880	3159	58929	1899	74144	976	64730
9L-5S		MI	14936	6747	26312	4650	28740	3686	30137	2880	32397	1593	38989	847	33578
24-#14	4.89	MA	26702	6747	45355	4935	50271	3957	52842	3177	56162	1913	70718	888	62410
10L-4S		MI	15319	6747	26960	4662	29549	3674	31103	2867	33639	1580	40551	904	34016

RECTANGULAR TIED COLUMNS 24" x 48"

4-#18	1.39	MA	27894	5645	43636	4213	47441	3430	48608	2853	48938	2033	57849	1917	23392
2E		MI	13556	5645	21789	3938	22756	3188	22743	2630	22108	1824	25249	1643	11029
6-#14	1.17	MA	27429	5559	42463	4184	46100	3411	47033	2847	46822	2053	55224	1953	19971
2L-3S		MI	12804	5559	20469	3926	21254	3212	20993	2667	19795	1890	22372	1600	9598
6-#14	1.17	MA	26025	5559	40406	4181	43462	3407	43816	2865	42444	2068	49275	1829	20018
3L-2S		MI	13405	5559	21359	3938	22366	3200	22322	2654	21558	1878	24639	1725	9513
6-#18	2.08	MA	29575	5922	47245	4386	52067	3554	54252	2929	56617	2011	68168	1871	34705
2L-3S		MI	13189	5922	21789	4086	22756	3324	22743	2710	22108	1792	25249	1309	16114
6-#18	2.08	MA	27155	5922	43636	4380	47441	3588	48608	2960	48938	2035	57849	1650	34565
3L-2S		MI	14213	5922	23299	4108	24634	3302	24988	2688	25089	1770	29041	1530	15979
8-#11	1.08	MA	27238	5523	41969	4174	45549	3405	46393	2846	45965	2062	54160	1969	18563
2L-4S		MI	12609	5523	20004	3942	20765	3208	20439	2667	19131	1919	21728	1594	8999
8-#11	1.08	MA	26255	5523	40533	4172	43708	3403	44148	2859	42909	2073	49985	1883	18600
3E		MI	12919	5523	20525	3933	21415	3216	21209	2676	20088	1911	22781	1674	8933
8-#11	1.08	MA	25568	5523	39368	4187	42222	3417	42341	2855	40585	2084	47259	1796	18602
4L-2S		MI	13343	5523	21152	3941	22205	3208	22153	2667	21341	1902	24400	1760	8880
8-#14	1.56	MA	28403	5714	44521	4281	48737	3481	50251	2889	51200	2040	61173	1931	26428
2L-4S		MI	12757	5714	20617	4036	21451	3266	21238	2690	20212	1876	23161	1432	12553
8-#14	1.56	MA	27009	5714	42463	4278	46100	3476	47033	2908	46822	2055	55224	1806	26434
3E		MI	13196	5714	21359	4023	22366	3279	22322	2702	21558	1864	24639	1544	12470
8-#14	1.56	MA	26034	5714	40791	4300	43968	3497	44443	2901	43488	2070	51344	1682	26302
4L-2S		MI	13794	5714	22249	4035	23477	3266	23650	2690	23322	1851	26905	1669	12391
8-#18	2.78	MA	31230	6198	50854	4559	56693	3678	59895	3004	64296	1989	78486	1826	45961
2L-4S		MI	13097	6198	22037	4279	23086	3416	23155	2746	22814	1760	26558	1006	20210
8-#18	2.78	MA	28836	6198	47245	4552	52067	3712	54252	3035	56617	2013	68168	1604	45702
3E		MI	13847	6198	23299	4257	24634	3439	24988	2769	25089	1738	29041	1196	20950
8-#18	2.78	MA	27162	6198	44305	4590	48320	3702	49697	3021	50756	2036	61453	1383	43881
4L-2S		MI	14864	6198	24809	4279	26511	3416	27233	2746	28069	1716	32832	1418	20864
10-#11	1.35	MA	27923	5631	43405	4241	47390	3454	48639	2875	49020	2053	58335	1954	23072
2L-5S		MI	12609	5631	20176	4002	20980	3263	20697	2701	19421	1893	22231	1519	11078
10-#11	1.35	MA	26945	5631	41969	4239	45549	3451	46393	2888	45965	2064	54160	1868	23094
3L-4S		MI	12889	5631	20631	4010	21555	3255	21383	2693	20384	1902	23347	1558	11019
10-#11	1.35	MA	26263	5631	40803	4255	44063	3465	44587	2884	43640	2075	51434	1782	23065
4L-3S		MI	13197	5631	21152	4000	22205	3263	22153	2701	21341	1893	24400	1637	10959
10-#11	1.35	MA	25654	5631	39797	4253	42757	3463	42982	2898	41315	2069	48608	1739	22947
5L-2S		MI	13620	5631	21778	4008	22995	3255	23097	2693	22593	1885	26018	1724	10907

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



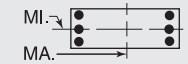
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.95	MA	29368	5870	46578	4378	51374	3551	53468	2932	55577	2028	67121	1908	32871
2L-5S		MI	12753	5870	20859	4122	21753	3345	21601	2738	20734	1862	23866	1319	15088
10-#14	1.95	MA	27983	5870	44521	4375	48737	3546	50251	2950	51200	2043	61173	1784	32829
3L-4S		MI	13149	5870	21507	4134	22562	3333	22566	2725	21976	1849	25428	1376	15369
10-#14	1.95	MA	27016	5870	42848	4397	46605	3567	47660	2944	47866	2058	57293	1659	32648
4L-3S		MI	13585	5870	22249	4121	23477	3345	23650	2738	23322	1837	26905	1488	15310
10-#14	1.95	MA	26154	5870	41404	4394	44732	3562	45357	2962	44529	2048	53260	1598	31661
5L-2S		MI	14181	5870	23140	4133	24589	3333	24979	2725	25085	1824	29172	1613	15241
10-#18	3.47	MA	30494	6475	50854	4725	56693	3837	59895	3110	64296	1990	78486	1559	56823
3L-4S		MI	13754	6475	23547	4449	24964	3531	25400	2805	25795	1706	30350	893	24610
10-#18	3.47	MA	28839	6475	47914	4763	52946	3827	55341	3097	58434	2014	71771	1337	54509
4L-3S		MI	14500	6475	24809	4427	26511	3553	27233	2827	28069	1684	32832	1084	25738
10-#18	3.47	MA	27365	6475	45371	4756	49649	3861	51289	3128	52566	1994	64752	1231	51263
5L-2S		MI	15510	6475	26318	4449	28389	3531	29478	2805	31050	1662	36624	1305	25711
12-#11	1.63	MA	28604	5739	44841	4309	49230	3502	50885	2905	52076	2045	62510	1940	27571
2L-6S		MI	12622	5739	20343	4079	21193	3302	20988	2736	19805	1885	22815	1425	12893
12-#11	1.63	MA	27630	5739	43405	4307	47390	3499	48639	2918	49020	2056	58335	1853	27573
3L-5S		MI	12888	5739	20803	4070	21770	3310	21641	2727	20674	1876	23850	1483	13063
12-#11	1.63	MA	26952	5739	42239	4322	45904	3514	46833	2914	46696	2067	55609	1767	27519
4E		MI	13167	5739	21257	4077	22345	3302	22327	2718	21637	1885	24966	1522	13018
12-#11	1.63	MA	26347	5739	41233	4321	44598	3511	45228	2927	44370	2061	52784	1724	27376
5L-3S		MI	13474	5739	21778	4068	22995	3310	23097	2727	22593	1876	26018	1601	12967
12-#11	1.63	MA	25772	5739	40290	4319	43291	3525	43630	2923	42265	2072	50081	1669	26624
6L-2S		MI	13895	5739	22405	4075	23785	3302	24042	2718	23846	1867	27637	1687	12918
12-#14	2.34	MA	28948	6025	46578	4472	51374	3616	53468	2993	55577	2030	67121	1761	39213
3L-5S		MI	13144	6026	21749	4219	22865	3412	22929	2773	22497	1835	26132	1263	17722
12-#14	2.34	MA	27989	6025	44906	4494	49243	3636	50877	2986	52243	2046	63242	1636	38990
4E		MI	13538	6025	22397	4231	23674	3399	23895	2761	23739	1823	27694	1320	18166
12-#14	2.34	MA	27133	6025	43461	4491	47369	3632	48575	3005	48907	2036	59209	1575	37815
5L-3S		MI	13973	6025	23140	4218	24589	3412	24979	2773	25085	1810	29172	1432	18128
12-#14	2.34	MA	26320	6026	42108	4489	45494	3652	46282	2998	45886	2051	55361	1495	36556
6L-2S		MI	14565	6025	24030	4230	25700	3399	26308	2761	26848	1798	31438	1557	18072
12-#18	4.17	MA	30495	6752	51522	4936	57572	3951	60984	3172	66113	1992	82089	1292	65184
4E		MI	14407	6752	25057	4619	26841	3645	27645	2863	28775	1652	34141	780	29054
12-#18	4.17	MA	29037	6752	48980	4929	54275	3985	56933	3203	60245	1972	75070	1186	62106
5L-3S		MI	15147	6752	26318	4597	28389	3667	29478	2885	31050	1630	36624	971	30488
12-#18	4.17	MA	27652	6752	46597	4922	50974	3975	52898	3189	54927	1996	68403	1042	58087
6L-2S		MI	16151	6752	27828	4619	30266	3645	31724	2863	34030	1608	40416	1193	30530
14-#11	1.90	MA	28311	5847	44841	4374	49230	3548	50885	2947	52076	2047	62510	1839	32043
3L-6S		MI	12900	5847	20969	4147	21983	3349	21932	2761	21058	1867	24434	1388	14792
14-#11	1.90	MA	27636	5847	43675	4390	47744	3562	49078	2943	49751	2058	59785	1753	31969
4L-5S		MI	13166	5847	21430	4137	22560	3357	22585	2753	21927	1859	25469	1446	15037
14-#11	1.90	MA	27035	5847	42669	4388	46439	3559	47474	2956	47426	2052	56959	1710	31802
5L-4S		MI	13444	5847	21884	4145	23135	3349	23272	2744	22890	1867	26584	1485	15005
14-#11	1.90	MA	26463	5847	41726	4386	45132	3574	45876	2952	45320	2063	54256	1654	30960
6L-3S		MI	13750	5847	22405	4135	23785	3357	24042	2753	23846	1859	27637	1564	14962
14-#11	1.90	MA	25906	5847	40693	4402	43886	3571	44343	2966	43264	2074	51377	1564	30337
7L-2S		MI	14170	5847	23032	4143	24575	3349	24986	2744	25099	1850	29256	1651	14918
14-#14	2.73	MA	28952	6181	46963	4592	51880	3706	54095	3029	56621	2033	69191	1614	45327
4L-5S		MI	13533	6181	22640	4316	23976	3478	24258	2809	24260	1808	28399	1207	20369
14-#14	2.73	MA	28104	6181	45518	4589	50007	3702	51792	3047	53285	2023	65158	1553	43986
5L-4S		MI	13925	6181	23288	4328	24785	3466	25224	2796	25502	1796	29961	1264	20944
14-#14	2.73	MA	27297	6181	44165	4586	48131	3722	49500	3041	50263	2038	61309	1472	42780
6L-3S		MI	14358	6181	24030	4315	25700	3478	26308	2809	26848	1783	31438	1376	20932

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

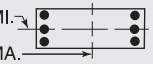


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.73	MA	26511	6181	42682	4608	46342	3717	47300	3059	47311	2053	57207	1343	41190
7L-2S		MI	14948	6181	24920	4327	26811	3466	27636	2796	28611	1771	33705	1500	20890
14-#18	4.86	MA	30689	7028	52589	5102	58901	4109	62577	3278	67923	1950	85389	1140	72973
5L-4S		MI	15055	7028	26567	4789	28719	3759	29890	2921	31756	1598	37933	668	33528
14-#18	4.86	MA	29320	7028	50205	5095	55600	4099	58542	3265	62606	1974	78721	996	68789
6L-3S		MI	15791	7028	27828	4767	30266	3781	31724	2943	34030	1576	40416	859	35216
14-#18	4.86	MA	27988	7028	47594	5133	52450	4133	54669	3296	57410	1998	71607	766	64753
7L-2S		MI	16788	7028	29338	4789	32144	3759	33969	2921	37011	1554	44208	1080	35321
16-#11	2.17	MA	28316	5955	45111	4457	49585	3611	51324	2973	52807	2050	63960	1738	36413
4L-6S		MI	13178	5955	21596	4214	22773	3396	22877	2787	22311	1850	26052	1352	16656
16-#11	2.17	MA	27718	5955	44105	4456	48280	3608	49719	2986	50481	2043	61134	1695	36226
5E		MI	13443	5955	22056	4205	23350	3404	23529	2778	23180	1841	27087	1410	16974
16-#11	2.17	MA	27150	5955	43162	4454	46973	3622	48122	2982	48376	2054	58432	1639	35305
6L-4S		MI	13719	5955	22511	4212	23925	3396	24216	2769	24142	1850	28203	1449	16982
16-#11	2.17	MA	26596	5955	42129	4469	45727	3619	46589	2995	46319	2065	55552	1550	34702
7L-3S		MI	14025	5955	23032	4203	24575	3404	24986	2778	25099	1841	29256	1528	16948
16-#11	2.17	MA	26051	5955	41201	4468	44463	3634	45093	3008	44133	2059	52909	1499	33781
8L-2S		MI	14443	5955	23659	4210	25365	3396	25930	2769	26352	1833	30874	1614	16909
16-#14	3.13	MA	29066	6337	47576	4686	52644	3771	55010	3090	57662	2011	71106	1530	50172
5E		MI	13920	6337	23530	4413	25087	3545	25586	2844	26023	1781	30666	1151	23026
16-#14	3.13	MA	28265	6337	46222	4683	50768	3792	52717	3083	54641	2026	67258	1450	49013
6L-4S		MI	14310	6337	24178	4425	25896	3532	26552	2832	27265	1769	32227	1208	23638
16-#14	3.13	MA	27485	6337	44739	4705	48980	3787	50517	3102	51689	2041	63155	1320	47335
7L-3S		MI	14741	6337	24920	4412	26811	3545	27636	2844	28611	1757	33705	1320	23731
16-#14	3.13	MA	26717	6337	43407	4702	47165	3807	48370	3120	48552	2031	59384	1249	45824
8L-2S		MI	15328	6337	25810	4424	27923	3532	28965	2832	30374	1744	35972	1444	23696
16-#18	5.56	MA	30968	7305	53814	5268	60226	4223	64185	3340	70285	1952	89039	951	79516
6L-4S		MI	15700	7305	28077	4959	30596	3873	32135	2979	34736	1544	41725	555	38027
16-#18	5.56	MA	29651	7305	51203	5306	57076	4257	60312	3371	65089	1976	81925	720	75376
7L-3S		MI	16431	7305	29338	4937	32144	3895	33969	3001	37011	1522	44208	746	39929
16-#18	5.56	MA	28355	7305	48856	5299	53881	4247	56532	3402	59567	1955	75362	595	70660
8L-2S		MI	17422	7305	30848	4959	34021	3873	36214	2979	39992	1500	47999	967	40083
18-#11	2.44	MA	28397	6063	45541	4523	50120	3656	51965	3015	53537	2035	65309	1681	40588
5L-6S		MI	13454	6063	22223	4282	23562	3443	23821	2812	23564	1833	27671	1315	18553
18-#11	2.44	MA	27832	6063	44598	4521	48814	3671	50367	3011	51431	2046	62607	1625	39656
6L-5S		MI	13718	6063	22683	4272	24140	3451	24474	2804	24433	1824	28706	1373	18863
18-#11	2.44	MA	27281	6063	43565	4537	47567	3668	48835	3024	49375	2057	59727	1535	39071
7L-4S		MI	13994	6063	23138	4280	24715	3443	25160	2795	25395	1833	29821	1412	18952
18-#11	2.44	MA	26739	6063	42637	4535	46303	3682	47339	3038	47189	2050	57084	1485	38094
8L-3S		MI	14298	6063	23659	4270	25365	3451	25930	2804	26352	1824	30874	1492	18926
18-#11	2.44	MA	26150	6063	41730	4533	45074	3679	45775	3034	45151	2061	54464	1431	37218
9L-2S		MI	14715	6063	24286	4278	26155	3443	26874	2795	27605	1816	32493	1578	18893
18-#14	3.52	MA	29225	6492	48280	4780	53406	3861	55935	3126	59018	2013	73207	1427	55253
6L-5S		MI	14304	6492	24420	4511	26199	3611	26915	2880	27786	1755	32932	1095	25690
18-#14	3.52	MA	28451	6492	46797	4802	51617	3857	53735	3144	56067	2029	69104	1298	53491
7L-4S		MI	14693	6492	25068	4523	27008	3599	27881	2867	29028	1742	34494	1152	26255
18-#14	3.52	MA	27689	6492	45465	4799	49802	3877	51588	3163	52929	2019	65333	1226	51959
8L-3S		MI	15122	6492	25810	4510	27923	3611	28965	2880	30374	1730	35972	1264	26505
18-#14	3.52	MA	26887	6492	44162	4796	48038	3872	49342	3156	50005	2034	61601	1149	49826
9L-2S		MI	15707	6492	26701	4522	29034	3599	30293	2867	32137	1717	38238	1388	26494
18-#18	6.25	MA	31296	7582	54811	5479	61703	4381	65956	3446	72767	1954	92243	674	86020
7L-4S		MI	16340	7582	29587	5130	32474	3987	34381	3037	37717	1490	45517	443	42545
18-#18	6.25	MA	30013	7582	52465	5472	58508	4371	62176	3477	67246	1933	85680	550	81247
8L-3S		MI	17067	7582	30848	5107	34021	4009	36214	3059	39992	1468	47999	633	44347
20-#11	2.71	MA	28509	6171	46034	4589	50654	3719	52613	3041	54487	2037	66782	1610	44013
6E		MI	13729	6171	22850	4349	24352	3490	24765	2838	24816	1815	29290	1279	20453
20-#11	2.71	MA	27962	6171	45001	4604	49408	3716	51081	3054	52430	2048	63902	1521	43444
7L-5S		MI	13992	6171	23310	4339	24930	3498	25418	2829	25685	1807	30324	1337	20670

RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



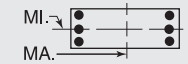
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.71	MA	27423	6171	44073	4602	48144	3731	49585	3067	50244	2042	61259	1470	42414
8L-4S		MI	14267	6171	23764	4347	25505	3490	26104	2821	26648	1815	31440	1376	20916
20-#11	2.71	MA	26838	6171	43166	4601	46915	3728	48021	3063	48207	2053	58639	1417	41560
9L-3S		MI	14570	6171	24286	4337	26155	3498	26874	2829	27605	1807	32493	1455	20899
20-#11	2.71	MA	26240	6171	42149	4616	45668	3742	46533	3076	46186	2064	56099	1356	40326
10L-2S		MI	14986	6171	24912	4345	26945	3490	27819	2821	28857	1798	34112	1541	20872
20-#14	3.91	MA	29409	6648	48854	4900	54254	3927	56952	3186	60444	2016	75053	1275	59657
7L-5S		MI	14687	6648	25310	4608	27310	3678	28244	2915	29549	1728	35199	1039	28359
20-#14	3.91	MA	28652	6648	47522	4897	52440	3947	54805	3205	57307	2006	71281	1203	58065
8L-4S		MI	15074	6648	25958	4620	28119	3666	29209	2903	30791	1716	36761	1095	28883
20-#14	3.91	MA	27852	6648	46219	4894	50675	3942	52560	3199	54382	2021	67550	1126	55979
9L-3S		MI	15501	6648	26701	4607	29034	3678	30293	2915	32137	1703	38238	1207	29272
20-#14	3.91	MA	26997	6648	44760	4916	48885	3962	50424	3217	51483	2036	63934	1038	53649
10L-2S		MI	16084	6648	27591	4619	30145	3666	31622	2903	33900	1691	40505	1332	29291
20-#18	6.94	MA	31655	7858	56074	5645	63134	4495	67820	3553	74924	1911	95999	504	91853
8L-4S		MI	16978	7858	31096	5300	34351	4101	36626	3095	40697	1436	49308	330	47077
22-#11	2.98	MA	28638	6279	46437	4672	51249	3765	53326	3083	55486	2039	68077	1506	47819
7L-6S		MI	14003	6279	23476	4416	25142	3537	25709	2863	26069	1798	30908	1242	22355
22-#11	2.98	MA	28102	6279	45509	4670	49985	3779	51831	3097	53300	2033	65434	1456	46739
8L-5S		MI	14265	6279	23937	4407	25719	3545	26362	2855	26938	1790	31943	1300	22557
22-#11	2.98	MA	27521	6279	44602	4668	48756	3776	50266	3093	51262	2044	62814	1402	45904
9L-4S		MI	14539	6279	24391	4414	26294	3537	27049	2846	27901	1798	33059	1339	22872
22-#11	2.98	MA	26926	6279	43585	4684	47509	3790	48779	3106	49242	2055	60274	1341	44636
10L-3S		MI	14841	6279	24912	4405	26945	3545	27819	2855	28857	1790	34112	1419	22867
22-#11	2.98	MA	26346	6279	42676	4682	46286	3788	47234	3102	47087	2049	57696	1288	43375
11L-2S		MI	15256	6279	25539	4413	27735	3537	28763	2846	30110	1781	35730	1505	22846
22-#14	4.30	MA	29609	6804	49579	4994	55077	4017	58023	3247	61684	1994	77230	1181	64180
8L-5S		MI	15068	6804	26200	4705	28422	3745	29572	2951	31312	1701	37465	983	31033
22-#14	4.30	MA	28809	6804	48276	4991	53312	4012	55777	3241	58760	2009	73499	1104	62141
9L-4S		MI	15454	6804	26849	4717	29230	3732	30538	2938	32554	1689	39027	1039	31520
22-#14	4.30	MA	27965	6804	46817	5013	51522	4032	53642	3260	55860	2024	69882	1016	59774
10L-3S		MI	15879	6804	27591	4704	30145	3745	31622	2951	33900	1676	40505	1151	32032
24-#11	3.25	MA	28778	6387	46945	4737	51826	3827	54076	3126	56355	2025	69609	1441	51070
8L-6S		MI	14276	6387	24103	4484	25932	3584	26654	2889	27322	1781	32527	1206	24257
24-#11	3.25	MA	28200	6387	46038	4736	50596	3825	52512	3122	54317	2036	66989	1388	50193
9L-5S		MI	14537	6387	24563	4474	26509	3592	27307	2880	28191	1772	33562	1264	24447
24-#11	3.25	MA	27608	6387	45021	4751	49349	3839	51024	3135	52297	2046	64449	1327	48950
10L-4S		MI	14810	6387	25018	4482	27084	3584	27993	2872	29154	1781	34677	1303	24820
24-#11	3.25	MA	27030	6387	44112	4749	48127	3836	49480	3131	50143	2040	61871	1274	47663
11L-3S		MI	15112	6387	25539	4472	27735	3592	28763	2880	30110	1772	35730	1382	24830
24-#11	3.25	MA	26464	6387	43114	4765	46889	3850	47995	3144	48124	2051	58964	1197	46378
12L-2S		MI	15525	6387	26166	4480	28525	3584	29707	2872	31363	1764	37349	1468	24815
24-#14	4.69	MA	29760	6959	50334	5088	55950	4082	58995	3283	63138	1996	79448	1081	68309
9L-5S		MI	15448	6959	27091	4802	29533	3811	30901	2986	33075	1674	39732	926	33710
24-#14	4.69	MA	28949	6959	48874	5110	54160	4102	56859	3302	60238	2011	75831	993	65906
10L-4S		MI	15832	6959	27739	4814	30342	3799	31867	2974	34317	1662	41294	983	34165

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

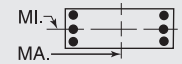
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.38	MA	8710	3312	13892	2377	14778	1934	14898	1601	14654	1122	16964	1031	7127
2L-3S		MI	8242	3312	13197	2371	13891	1942	13838	1609	13248	1130	15134	944	7180
6-#14	2.00	MA	9090	3455	14799	2454	15864	1984	16181	1623	16352	1089	19134	971	9994
2L-3S		MI	8430	3455	13812	2443	14613	1996	14686	1636	14369	1101	16565	846	10050
6-#18	3.55	MA	9991	3818	17009	2654	18470	2110	19269	1679	20444	1001	24306	804	16954
2L-3S		MI	8873	3818	15302	2632	16345	2132	16729	1701	17073	1023	19979	583	16864
8-#11	1.85	MA	9018	3419	14586	2445	15665	1982	15958	1628	16060	1106	18793	998	9338
2L-4S		MI	8217	3419	13317	2449	14049	1982	14034	1628	13580	1123	15777	830	9399
8-#14	2.66	MA	9520	3610	15787	2551	17115	2052	17677	1661	18336	1065	21704	920	13116
2L-4S		MI	8391	3610	13979	2555	14835	2052	14962	1661	14838	1090	17464	680	12742
8-#18	4.73	MA	10710	4094	18715	2827	20595	2228	21809	1742	23815	953	28633	702	22285
2L-4S		MI	8800	4094	15585	2828	16721	2228	17196	1742	17871	997	21483	283	19684
10-#11	2.31	MA	9324	3527	15280	2512	16552	2030	17018	1655	17466	1090	20622	965	11534
2L-5S		MI	8226	3527	13510	2509	14290	2039	14324	1663	13907	1099	16345	758	11099
10-#11	2.31	MA	8862	3527	14586	2506	15665	2039	15958	1663	16060	1099	18793	878	11563
3L-4S		MI	8527	3527	14011	2516	14936	2030	15094	1655	14986	1108	17606	797	11553
10-#14	3.33	MA	9946	3766	16774	2648	18366	2120	19172	1699	20320	1041	24273	869	16219
2L-5S		MI	8402	3766	14252	2641	15175	2133	15371	1711	15297	1053	18263	573	14923
10-#14	3.33	MA	9297	3766	15787	2638	17115	2133	17677	1711	18336	1053	21704	745	16202
3L-4S		MI	8826	3766	14967	2652	16086	2120	16457	1699	16821	1066	20034	629	15585
10-#18	5.92	MA	10327	4371	18715	2978	20595	2368	21809	1826	23815	926	28633	379	26711
3L-4S		MI	9531	4371	17291	3001	18845	2346	19737	1804	21242	949	25811	181	24628

RECTANGULAR TIED COLUMNS 26" x 28"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.24	MA	9995	3529	15851	2543	16837	2072	16926	1720	16531	1218	19082	1127	7449
2E		MI	9253	3529	14722	2523	15545	2052	15586	1702	15169	1202	17443	1108	6879
4-#18	2.20	MA	10678	3771	17500	2668	18788	2152	19225	1755	19572	1159	22957	1021	12650
2E		MI	9863	3771	16216	2646	17276	2128	17625	1732	17868	1138	20850	991	11626
6-#11	1.29	MA	10055	3541	15934	2564	16991	2088	17153	1735	16837	1226	19511	1137	7759
2L-3S		MI	8840	3541	14106	2538	14823	2080	14740	1726	14051	1220	16017	1031	7217
6-#11	1.29	MA	9541	3541	15173	2558	16014	2098	15977	1743	15277	1235	17470	1050	7812
3L-2S		MI	9309	3541	14800	2545	15710	2072	15800	1718	15457	1211	17846	1118	7162
6-#14	1.85	MA	10479	3685	16935	2640	18228	2142	18589	1759	18735	1196	21956	1081	10905
2L-3S		MI	9028	3685	14722	2609	15545	2133	15586	1752	15169	1191	17443	932	10102
6-#14	1.85	MA	9753	3685	15851	2631	16837	2154	16926	1772	16531	1209	19082	957	10961
3L-2S		MI	9689	3685	15710	2620	16796	2121	17081	1740	17152	1178	20013	1057	10038
6-#18	3.30	MA	11489	4048	19380	2841	21161	2273	22062	1820	23335	1116	27823	928	18574
2L-3S		MI	9471	4048	16216	2797	17276	2267	17625	1816	17868	1112	20850	668	16973
6-#18	3.30	MA	10255	4048	17500	2822	18788	2295	19225	1843	19572	1138	22957	707	18484
3L-2S		MI	10593	4048	17923	2819	19401	2245	20165	1794	21239	1090	25177	889	17020
8-#11	1.71	MA	10397	3649	16696	2632	17967	2137	18329	1763	18396	1212	21551	1107	10181
2L-4S		MI	8815	3649	14225	2616	14981	2120	14936	1745	14383	1213	16660	917	9455
8-#11	1.71	MA	9886	3649	15934	2626	16991	2146	17153	1771	16837	1221	19511	1020	10222
3E		MI	9152	3649	14800	2605	15710	2128	15800	1753	15457	1204	17846	998	9423
8-#11	1.71	MA	9518	3649	15306	2637	16190	2138	16195	1763	15645	1230	18190	937	10241
4L-2S		MI	9617	3649	15494	2612	16597	2120	16860	1745	16863	1196	19676	1085	9378
8-#14	2.47	MA	10957	3840	18020	2738	19618	2212	20251	1799	20940	1175	24830	1035	14331
2L-4S		MI	8989	3840	14890	2721	15767	2189	15862	1777	15638	1179	18343	766	12967
8-#14	2.47	MA	10237	3840	16935	2728	18228	2224	18589	1811	18735	1187	21956	911	14354
3E		MI	9464	3840	15710	2707	16796	2201	17081	1790	17152	1167	20013	882	13204
8-#14	2.47	MA	9718	3840	16038	2744	17085	2212	17234	1799	17051	1199	20094	792	14091
4L-2S		MI	10120	3840	16697	2717	18047	2189	18576	1777	19136	1154	22583	1006	13166
8-#18	4.40	MA	12290	4324	21259	3014	23534	2394	24898	1886	27098	1072	32688	836	24445
2L-4S		MI	9396	4324	16499	2992	17651	2363	18093	1856	18665	1085	22354	368	19986
8-#18	4.40	MA	11070	4324	19380	2995	21161	2416	22062	1908	23335	1094	27823	615	24238
3E		MI	10204	4324	17923	2970	19401	2385	20165	1879	21239	1063	25177	566	22203

RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis



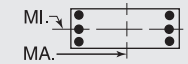
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	4.40	MA	10188	4324	17818	3019	19209	2394	19749	1886	20462	1116	24659	410	21802
4L-2S		MI	11314	4324	19630	2991	21525	2363	22705	1856	24610	1041	29504	788	22366
10-#11	2.14	MA	10736	3757	17458	2699	18943	2185	19505	1791	19956	1198	23592	1077	12587
2L-5S		MI	8823	3757	14418	2677	15223	2176	15225	1780	14710	1189	17228	845	11252
10-#11	2.14	MA	10228	3757	16696	2693	17967	2195	18329	1799	18396	1207	21551	990	12616
3L-4S		MI	9125	3757	14919	2683	15868	2168	15996	1771	15789	1198	18489	884	11619
10-#11	2.14	MA	9863	3757	16067	2704	17166	2187	17371	1791	17205	1216	20231	907	12606
4L-3S		MI	9460	3757	15494	2673	16597	2176	16860	1780	16863	1189	19676	965	11612
10-#11	2.14	MA	9534	3757	15520	2699	16458	2196	16517	1799	16008	1207	18824	869	12191
5L-2S		MI	9924	3757	16188	2680	17484	2168	17920	1771	18269	1180	21505	1052	11578
10-#14	3.09	MA	11430	3996	19105	2835	21009	2281	21913	1838	23145	1153	27704	989	17738
2L-5S		MI	8999	3996	15162	2808	16107	2270	16270	1827	16098	1143	19142	659	15116
10-#14	3.09	MA	10716	3996	18020	2826	19618	2294	20251	1850	20940	1165	24830	865	17721
3L-4S		MI	9424	3996	15877	2818	17018	2257	17357	1815	17621	1155	20913	715	15806
10-#14	3.09	MA	10201	3996	17123	2841	18475	2281	18896	1838	19256	1178	22968	746	17217
4L-3S		MI	9896	3996	16697	2804	18047	2270	18576	1827	19136	1143	22583	831	16276
10-#14	3.09	MA	9738	3996	16341	2832	17463	2294	17688	1850	17564	1165	20986	691	16414
5L-2S		MI	10547	3996	17685	2814	19298	2257	20071	1815	21120	1130	25152	956	16275
10-#18	5.49	MA	11874	4601	21259	3167	23534	2536	24898	1974	27098	1050	32688	522	29809
3L-4S		MI	10129	4601	18206	3165	19776	2481	20633	1919	22036	1037	26682	266	24925
10-#18	5.49	MA	11003	4601	19697	3192	21582	2514	22585	1952	24224	1072	29524	318	27257
4L-3S		MI	10928	4601	19630	3143	21525	2503	22705	1941	24610	1015	29504	465	27113
12-#11	2.57	MA	11073	3865	18219	2766	19920	2234	20681	1819	21516	1184	25633	1047	14984
2L-6S		MI	8847	3865	14641	2737	15462	2216	15552	1816	15140	1182	17885	755	13029
12-#11	2.57	MA	10568	3865	17458	2761	18943	2243	19505	1828	19956	1193	23592	960	15000
3L-5S		MI	9134	3865	15113	2744	16110	2225	16285	1807	16116	1173	19058	812	13305
12-#11	2.57	MA	10204	3865	16829	2772	18143	2235	18547	1819	18765	1202	22272	877	14962
4E		MI	9434	3865	15613	2751	16755	2216	17056	1798	17195	1182	20318	851	13771
12-#11	2.57	MA	9877	3865	16282	2766	17434	2244	17693	1828	17568	1193	20865	839	14446
5L-3S		MI	9767	3865	16188	2740	17484	2225	17920	1807	18269	1173	21505	932	13790
12-#11	2.57	MA	9566	3865	15768	2760	16724	2236	16879	1836	16486	1202	19555	782	14120
6L-2S		MI	10228	3865	16883	2747	18371	2216	18980	1798	19675	1165	23334	1019	13768
12-#14	3.71	MA	11190	4151	19105	2923	21009	2364	21913	1890	23145	1144	27704	818	21074
3L-5S		MI	9433	4151	16150	2905	17358	2338	17765	1865	18081	1119	21712	609	18041
12-#14	3.71	MA	10680	4151	18207	2938	19866	2351	20559	1877	21461	1156	25842	700	20369
4E		MI	9856	4151	16865	2916	18269	2326	18852	1852	19605	1131	23483	665	18671
12-#14	3.71	MA	10220	4151	17426	2929	18854	2364	19350	1890	19769	1144	23860	645	19631
5L-3S		MI	10325	4151	17685	2901	19298	2338	20071	1865	21120	1119	25152	780	19333
12-#14	3.71	MA	9782	4151	16691	2920	17839	2351	18201	1902	18239	1156	22018	562	18623
6L-2S		MI	10971	4151	18672	2912	20549	2326	21567	1852	23103	1106	27722	905	19372
12-#18	6.59	MA	11808	4878	21577	3365	23955	2635	25421	2018	27987	1028	34390	226	32749
4E		MI	10854	4878	19913	3338	21901	2599	23173	1981	25407	988	31009	165	29901
14-#11	3.00	MA	10905	3973	18219	2828	19920	2291	20681	1856	21516	1179	25633	931	17368
3L-6S		MI	9156	3973	15336	2805	16349	2264	16612	1843	16546	1167	19715	722	15099
14-#11	3.00	MA	10544	3973	17590	2839	19119	2283	19723	1847	20324	1188	24312	847	17312
4L-5S		MI	9442	3973	15807	2812	16997	2273	17345	1834	17522	1158	20887	779	15368
14-#11	3.00	MA	10219	3973	17044	2833	18411	2293	18869	1856	19127	1179	22906	809	16711
5L-4S		MI	9740	3973	16308	2818	17642	2264	18116	1825	18601	1167	22148	818	15911
14-#11	3.00	MA	9909	3973	16529	2828	17700	2285	18055	1864	18045	1188	21596	752	16405
6L-3S		MI	10072	3973	16883	2808	18371	2273	18980	1834	19675	1158	23334	900	15956
14-#11	3.00	MA	9607	3973	15967	2839	17021	2294	17197	1856	16988	1196	20361	687	15750
7L-2S		MI	10530	3973	17577	2814	19258	2264	20040	1825	21081	1149	25164	986	15950

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	4.33	MA	11154	4307	19292	3036	21257	2421	22221	1917	23666	1134	28715	654	23542
4L-5S		MI	9865	4307	17137	3002	18609	2406	19261	1902	20065	1095	24281	558	20976
14-#14	4.33	MA	10698	4307	18511	3026	20245	2434	21013	1929	21973	1122	26734	599	22859
5L-4S		MI	10284	4307	17852	3013	19520	2394	20348	1890	21589	1107	26052	614	21555
14-#14	4.33	MA	10263	4307	17776	3017	19230	2421	19863	1942	20444	1134	24892	516	21760
6L-3S		MI	10749	4307	18672	2998	20549	2406	21567	1902	23103	1095	27722	730	22380
16-#11	3.43	MA	10881	4081	18352	2907	20095	2332	20900	1875	21884	1174	26353	817	19572
4L-6S		MI	9464	4081	16030	2872	17236	2312	17672	1869	17952	1151	21544	689	17100
16-#11	3.43	MA	10558	4081	17805	2901	19387	2341	20045	1884	20687	1165	24946	779	18983
5E		MI	9748	4081	16501	2879	17884	2321	18405	1861	18928	1142	22716	747	17439
16-#11	3.43	MA	10249	4081	17291	2895	18677	2333	19231	1892	19605	1174	23636	722	18618
6L-4S		MI	10045	4081	17002	2886	18529	2312	19176	1852	20007	1151	23977	785	17943
16-#11	3.43	MA	9949	4081	16728	2906	17998	2343	18373	1884	18548	1182	22402	657	17986
7L-3S		MI	10374	4081	17577	2875	19258	2321	20040	1861	21081	1142	25164	867	18113
16-#14	4.95	MA	11172	4463	19595	3124	21635	2503	22675	1969	24178	1100	29608	552	26096
5E		MI	10293	4463	18125	3100	19860	2475	20756	1940	22048	1071	26851	507	23905
16-#14	4.95	MA	10740	4463	18861	3114	20620	2491	21525	1981	22649	1113	27766	470	24912
6L-4S		MI	10709	4463	18840	3110	20771	2462	21843	1928	23572	1083	28622	563	24455
18-#11	3.86	MA	10894	4189	18567	2968	20363	2390	21221	1912	22247	1151	26987	749	21262
5L-6S		MI	9770	4189	16724	2940	18123	2360	18732	1896	19358	1135	23373	656	19111
18-#11	3.86	MA	10588	4189	18053	2962	19653	2382	20407	1920	21165	1159	25677	692	20830
6L-5S		MI	10052	4189	17195	2946	18771	2369	19465	1888	20334	1127	24545	714	19515
18-#11	3.86	MA	10289	4189	17490	2974	18974	2391	19550	1912	20108	1168	24442	628	20229
7L-4S		MI	10348	4189	17696	2953	19416	2360	20236	1879	21413	1135	25806	752	19985
18-#14	5.56	MA	11214	4618	19945	3212	22011	2561	23188	2020	24854	1091	30640	423	28077
6L-5S		MI	10718	4618	19112	3197	21111	2543	22251	1978	24032	1047	29421	457	26718
20-#11	4.29	MA	10924	4297	18814	3030	20629	2430	21583	1948	22724	1145	27718	662	23052
6E		MI	10074	4297	17418	3007	19010	2408	19792	1923	20764	1120	25203	623	21131
20-#11	4.29	MA	10627	4297	18252	3041	19951	2439	20726	1940	21667	1154	26483	598	22479
7L-5S		MI	10354	4297	17889	3014	19658	2417	20525	1915	21740	1111	26375	681	21595
22-#11	4.71	MA	10963	4405	19013	3109	20927	2488	21902	1968	23227	1140	28524	568	24734
7L-6S		MI	10376	4405	18112	3075	19897	2457	20852	1950	22170	1104	27032	590	23158

RECTANGULAR TIED COLUMNS 26" x 30"

4-#14	1.15	MA	11429	3759	18020	2730	19175	2226	19310	1853	18824	1322	21749	1232	8057
2E		MI	9852	3759	15633	2689	16476	2189	16485	1818	15969	1292	18322	1194	6915
4-#18	2.05	MA	12186	4001	19829	2855	21375	2311	21866	1891	22204	1268	26087	1134	13730
2E		MI	10462	4001	17131	2810	18206	2263	18521	1847	18663	1226	21721	1076	11680
6-#11	1.20	MA	11493	3771	18108	2751	19337	2242	19551	1868	19151	1331	22206	1241	8391
2L-3S		MI	9438	3771	15014	2705	15755	2218	15641	1843	14854	1310	16900	1118	7251
6-#11	1.20	MA	10931	3771	17279	2746	18275	2252	18259	1877	17437	1339	19953	1155	8443
3L-2S		MI	9907	3771	15708	2712	16642	2209	16701	1835	16260	1301	18729	1204	7196
6-#14	1.73	MA	11961	3914	19202	2827	20690	2295	21140	1894	21251	1302	24928	1190	11816
2L-3S		MI	9626	3914	15633	2776	16476	2270	16485	1868	15969	1280	18322	1019	10152
6-#14	1.73	MA	11168	3914	18020	2819	19175	2309	19310	1907	18824	1315	21749	1065	11873
3L-2S		MI	10288	3914	16620	2786	17727	2257	17981	1856	17953	1268	20892	1143	10082
6-#18	3.08	MA	13082	4278	21881	3028	23997	2434	24999	1960	26359	1228	31493	1049	20194
2L-3S		MI	10069	4278	17131	2961	18206	2403	18521	1931	18663	1200	21721	753	17073
6-#18	3.08	MA	11731	4278	19829	3011	21375	2456	21866	1982	22204	1250	26087	827	20104
3L-2S		MI	11194	4278	18838	2983	20331	2380	21061	1909	22034	1178	26048	975	17085
8-#11	1.60	MA	11869	3879	18937	2818	20400	2290	20844	1897	20864	1318	24459	1214	11023
2L-4S		MI	9412	3879	15133	2783	15913	2257	15837	1861	15186	1303	17543	1003	9505
8-#11	1.60	MA	11311	3879	18108	2813	19337	2301	19551	1906	19151	1326	22206	1128	11064
3E		MI	9750	3879	15708	2773	16642	2266	16701	1870	16260	1294	18729	1085	9464

RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

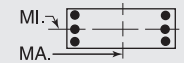
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#11	1.60	MA	10912	3879	17425	2825	18468	2293	18499	1897	17841	1335	20751	1042	11083
4L-2S		MI	10216	3879	16403	2779	17530	2257	17761	1861	17666	1286	20558	1171	9417
8-#14	2.31	MA	12488	4070	20384	2924	22205	2365	22969	1935	23677	1283	28107	1148	15546
2L-4S		MI	9586	4070	15800	2887	16698	2326	16761	1893	16438	1268	19222	852	13185
8-#14	2.31	MA	11701	4070	19202	2916	20690	2379	21140	1948	21251	1295	24928	1023	15569
3E		MI	10063	4070	16620	2873	17727	2338	17981	1906	17953	1256	20892	968	13261
8-#14	2.31	MA	11137	4070	18227	2933	19448	2368	19649	1935	19397	1308	22872	902	15464
4L-2S		MI	10720	4070	17608	2884	18978	2326	19476	1893	19936	1244	23462	1093	13215
8-#18	4.10	MA	13965	4554	23934	3201	26619	2558	28132	2029	30515	1188	36898	964	26605
2L-4S		MI	9993	4554	17414	3156	18582	2498	18989	1971	19460	1173	23226	453	20279
8-#18	4.10	MA	12630	4554	21881	3183	23997	2580	24999	2051	26359	1210	31493	743	26398
3E		MI	10803	4554	18838	3134	20331	2520	21061	1993	22034	1151	26048	651	22319
8-#18	4.10	MA	11670	4554	20181	3210	21841	2558	22445	2029	23186	1232	27986	533	23953
4L-2S		MI	11917	4554	20544	3156	22456	2498	23601	1971	25404	1129	30375	873	22445
10-#11	2.00	MA	12242	3987	19766	2886	21463	2339	22136	1926	22578	1305	26712	1186	13640
2L-5S		MI	9420	3987	15327	2844	16155	2314	16127	1897	15512	1279	18111	932	11398
10-#11	2.00	MA	11687	3987	18937	2881	20400	2349	20844	1935	20864	1314	24459	1100	13669
3L-4S		MI	9724	3987	15828	2851	16800	2305	16897	1888	16592	1287	19372	971	11680
10-#11	2.00	MA	11291	3987	18254	2893	19531	2342	19791	1926	19555	1322	23004	1015	13659
4L-3S		MI	10059	3987	16403	2840	17530	2314	17761	1897	17666	1279	20558	1052	11659
10-#11	2.00	MA	10934	3987	17661	2887	18762	2352	18852	1935	18241	1314	21451	977	13296
5L-2S		MI	10523	3987	17097	2847	18417	2305	18821	1888	19072	1270	22388	1139	11621
10-#14	2.88	MA	13009	4226	21566	3022	23720	2435	24799	1976	26104	1263	31286	1106	19257
2L-5S		MI	9595	4226	16073	2974	17039	2406	17170	1943	16898	1232	20021	746	15301
10-#14	2.88	MA	12229	4226	20384	3013	22205	2449	22969	1989	23677	1275	28107	981	19239
3L-4S		MI	10023	4226	16788	2985	17949	2394	18257	1931	18421	1244	21792	802	16020
10-#14	2.88	MA	11669	4226	19409	3030	20963	2438	21479	1976	21823	1288	26051	860	18874
4L-3S		MI	10496	4226	17608	2970	18978	2406	19476	1943	19936	1232	23462	917	16345
10-#14	2.88	MA	11166	4226	18561	3022	19865	2451	20149	1989	19962	1275	23859	805	17920
5L-2S		MI	11148	4226	18595	2981	20229	2394	20971	1931	21920	1220	26031	1042	16329
10-#18	5.13	MA	13518	4831	23934	3356	26619	2703	28132	2120	30515	1170	36898	658	32672
3L-4S		MI	10727	4831	19120	3329	20706	2616	21529	2034	22831	1125	27553	352	25213
10-#18	5.13	MA	12569	4831	22234	3383	24463	2681	25578	2098	27341	1192	33392	449	29919
4L-3S		MI	11529	4831	20544	3307	22456	2638	23601	2056	25404	1103	30375	550	27504
10-#18	5.13	MA	11717	4831	20753	3366	22555	2703	23301	2120	24150	1170	29666	350	27715
5L-2S		MI	12632	4831	22251	3329	24581	2616	26142	2034	28775	1081	34703	771	27752
12-#11	2.40	MA	12612	4095	20595	2953	22526	2387	23428	1955	24291	1292	28965	1159	16248
2L-6S		MI	9443	4095	15550	2905	16394	2354	16453	1933	15943	1272	18768	842	13167
12-#11	2.40	MA	12061	4095	19766	2948	21463	2397	22136	1964	22578	1301	26712	1073	16263
3L-5S		MI	9731	4095	16021	2911	17042	2362	17187	1924	16918	1263	19940	899	13451
12-#11	2.40	MA	11667	4095	19083	2960	20593	2390	21084	1955	21269	1310	25257	987	16226
4E		MI	10033	4095	16522	2918	17687	2354	17957	1915	17998	1272	21201	938	13839
12-#11	2.40	MA	11312	4095	18491	2955	19825	2400	20145	1964	19954	1301	23704	950	15751
5L-3S		MI	10367	4095	17097	2908	18417	2362	18821	1924	19072	1263	22388	1019	13841
12-#11	2.40	MA	10974	4095	17933	2950	19055	2393	19251	1973	18766	1310	22256	893	15364
6L-2S		MI	10828	4095	17791	2914	19304	2354	19881	1915	20478	1255	24217	1106	13814
12-#14	3.46	MA	12751	4381	21566	3111	23720	2519	24799	2029	26104	1256	31286	939	22897
3L-5S		MI	10031	4381	17060	3071	18290	2475	18665	1981	18881	1208	22590	695	18225
12-#14	3.46	MA	12196	4381	20591	3127	22478	2508	23309	2017	24250	1268	29230	818	22311
4E		MI	10455	4381	17775	3082	19200	2462	19752	1969	20405	1220	24361	751	18882
12-#14	3.46	MA	11697	4381	19743	3119	21380	2521	21979	2029	22388	1256	27038	763	21429
5L-3S		MI	10925	4381	18595	3068	20229	2475	20971	1981	21920	1208	26031	867	19410
12-#14	3.46	MA	11222	4381	18946	3111	20279	2510	20713	2042	20705	1268	24997	681	20455
6L-2S		MI	11573	4381	19583	3078	21480	2462	22466	1969	23904	1196	28601	991	19429

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis

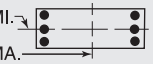


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#18	6.15	MA	13457	5107	24286	3556	27085	2804	28712	2167	31497	1152	38798	364	35925
4E		MI	11453	5107	20827	3502	22831	2734	24069	2096	26202	1076	31880	250	30184
12-#18	6.15	MA	12614	5107	22805	3539	25177	2826	26434	2189	28306	1130	35072	266	33536
5L-3S		MI	12248	5107	22251	3480	24581	2756	26142	2118	28775	1054	34703	448	32268
14-#11	2.80	MA	12432	4203	20595	3015	22526	2446	23428	1993	24291	1288	28965	1045	18842
3L-6S		MI	9754	4203	16244	2972	17281	2402	17514	1959	17349	1256	20597	809	15250
14-#11	2.80	MA	12040	4203	19913	3027	21656	2439	22376	1984	22982	1297	27510	960	18786
4L-5S		MI	10040	4203	16715	2979	17929	2410	18247	1951	18324	1248	21770	866	15514
14-#11	2.80	MA	11687	4203	19320	3022	20888	2449	21437	1993	21668	1288	25957	923	18217
5L-4S		MI	10340	4203	17216	2986	18574	2402	19017	1942	19404	1256	23030	905	15989
14-#11	2.80	MA	11351	4203	18762	3017	20118	2442	20543	2002	20479	1297	24508	866	17854
6L-3S		MI	10672	4203	17791	2975	19304	2410	19881	1951	20478	1248	24217	986	16016
14-#11	2.80	MA	11024	4203	18153	3029	19382	2452	19601	1993	19317	1305	23149	800	17224
7L-2S		MI	11131	4203	18485	2982	20191	2402	20941	1942	21884	1239	26046	1073	15999
14-#14	4.04	MA	12718	4537	21773	3225	23994	2577	25139	2058	26676	1248	32409	775	25771
4L-5S		MI	10463	4537	18048	3169	19541	2543	20160	2019	20865	1184	25160	644	21160
14-#14	4.04	MA	12223	4537	20925	3216	22895	2591	23809	2070	24815	1236	30218	721	24950
5L-4S		MI	10884	4537	18763	3179	20451	2531	21247	2006	22389	1196	26931	700	21764
14-#14	4.04	MA	11752	4537	20128	3208	21794	2580	22543	2083	23131	1248	28176	638	23881
6L-3S		MI	11351	4537	19583	3165	21480	2543	22466	2019	23904	1184	28601	816	22463
14-#18	7.18	MA	13502	5384	24858	3712	27799	2950	29567	2258	32462	1090	40477	181	39397
5L-4S		MI	12173	5384	22534	3675	24956	2851	26609	2158	29573	1028	36207	149	35185
16-#11	3.20	MA	12410	4311	20742	3095	22719	2487	23669	2013	24696	1284	29763	933	21341
4L-6S		MI	10062	4311	16938	3040	18168	2450	18574	1986	18755	1241	22427	776	17337
16-#11	3.20	MA	12060	4311	20149	3090	21951	2497	22729	2022	23382	1275	28209	895	20692
5E		MI	10347	4311	17409	3046	18816	2458	19307	1978	19731	1232	23599	833	17584
16-#11	3.20	MA	11726	4311	19592	3085	21181	2490	21835	2031	22193	1284	26761	838	20349
6L-4S		MI	10645	4311	17910	3053	19461	2450	20077	1969	20810	1241	24860	872	18114
16-#11	3.20	MA	11400	4311	18982	3097	20445	2500	20893	2022	21031	1293	25402	772	19661
7L-3S		MI	10975	4311	18485	3042	20191	2458	20941	1978	21884	1232	26046	954	18176
16-#14	4.62	MA	12745	4692	22107	3314	24411	2661	25639	2111	27241	1216	33397	679	28481
5E		MI	10892	4692	19035	3266	20792	2612	21656	2056	22849	1160	27730	594	24104
16-#14	4.62	MA	12277	4692	21310	3305	23310	2650	24373	2124	25558	1229	31355	596	27322
6L-4S		MI	11310	4692	19750	3276	21702	2599	22743	2044	24372	1172	29501	650	24661
18-#11	3.60	MA	12430	4419	20978	3157	23014	2546	24022	2051	25095	1263	30462	868	23173
5L-6S		MI	10368	4419	17632	3107	19055	2498	19634	2013	20161	1225	24256	743	19346
18-#11	3.60	MA	12098	4419	20421	3152	22244	2539	23128	2060	23906	1271	29014	811	22821
6L-5S		MI	10651	4419	18104	3114	19703	2507	20367	2005	21137	1217	25428	801	19660
18-#11	3.60	MA	11774	4419	19811	3164	21508	2549	22186	2051	22745	1280	27655	745	22107
7L-4S		MI	10948	4419	18604	3120	20348	2498	21137	1996	22216	1225	26689	839	20154
18-#14	5.19	MA	12798	4848	22492	3403	24825	2720	26203	2164	27984	1209	34535	554	30776
6L-5S		MI	11318	4848	20023	3363	22043	2680	23151	2094	24832	1136	30299	543	27049
20-#11	4.00	MA	12468	4526	21250	3219	23306	2587	24420	2089	25620	1259	31267	783	25242
6E		MI	10673	4526	18327	3175	19942	2546	20694	2040	21567	1210	26085	710	21364
20-#11	4.00	MA	12146	4526	20640	3231	22571	2597	23478	2080	24458	1267	29908	718	24559
7L-5S		MI	10955	4526	18798	3181	20590	2555	21427	2032	22543	1201	27258	768	21740
22-#11	4.40	MA	12515	4634	21469	3299	23634	2646	24770	2109	26172	1255	32160	690	27016
7L-6S		MI	10976	4634	19021	3242	20829	2594	21754	2067	22973	1194	27915	677	23389

RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis



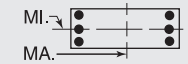
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#14	1.08	MA	12954	3989	20321	2917	21655	2379	21836	1987	21249	1426	24563	1336	8664
2E		MI	10450	3989	16543	2855	17408	2326	17385	1935	16769	1381	19201	1280	6950
4-#18	1.92	MA	13787	4231	22288	3042	24071	2466	24650	2027	24968	1375	29366	1244	14810
2E		MI	11062	4231	18045	2974	19137	2398	19417	1961	19457	1315	22592	1161	11733
6-#11	1.13	MA	13023	4001	20412	2938	21827	2396	22072	2000	21596	1434	25050	1345	9022
2L-3S		MI	10036	4001	15923	2873	16688	2355	16542	1960	15657	1400	17782	1205	7285
6-#11	1.13	MA	12414	4001	19516	2933	20678	2406	20670	2009	19728	1443	22584	1258	9075
3L-2S		MI	10505	4001	16617	2879	17575	2347	17602	1951	17063	1391	19612	1291	7229
6-#14	1.62	MA	13536	4144	21600	3014	23295	2449	23834	2029	23897	1408	28048	1297	12727
2L-3S		MI	10224	4144	16543	2942	17408	2407	17385	1985	16769	1369	19201	1105	10198
6-#14	1.62	MA	12676	4144	20321	3007	21655	2464	21836	2041	21249	1420	24563	1173	12784
3L-2S		MI	10887	4144	17531	2953	18659	2394	18880	1972	18753	1357	21771	1230	10124
6-#18	2.88	MA	14769	4507	24514	3215	26924	2590	28081	2098	29517	1338	35314	1166	21814
2L-3S		MI	10668	4507	18045	3125	19137	2538	19417	2046	19457	1288	22592	838	17167
6-#18	2.88	MA	13300	4507	22288	3199	24071	2614	24650	2120	24968	1360	29366	945	21724
3L-2S		MI	11795	4507	19752	3147	21262	2516	21957	2024	22828	1266	26919	1060	17148
8-#11	1.50	MA	13433	4109	21309	3005	22976	2444	23474	2029	23464	1423	27515	1320	11865
2L-4S		MI	10010	4109	16042	2951	16845	2395	16738	1978	15989	1393	18425	1090	9551
8-#11	1.50	MA	12829	4109	20412	3000	21827	2455	22072	2038	21596	1431	25050	1233	11906
3E		MI	10348	4109	16617	2940	17575	2404	17602	1987	17063	1384	19612	1172	9504
8-#11	1.50	MA	12398	4109	19676	3013	20889	2449	20932	2030	20169	1440	23458	1147	11926
4L-2S		MI	10815	4109	17311	2947	18462	2395	18662	1978	18469	1376	21441	1258	9454
8-#14	2.16	MA	14112	4300	22879	3111	24935	2519	25831	2071	26546	1390	31534	1258	16761
2L-4S		MI	10184	4300	16711	3054	17630	2463	17661	2010	17238	1358	20101	939	13309
8-#14	2.16	MA	13259	4300	21600	3104	23295	2534	23834	2083	23897	1402	28048	1134	16784
3E		MI	10662	4300	17531	3039	18659	2475	18880	2022	18753	1345	21771	1054	13316
8-#14	2.16	MA	12649	4300	20547	3121	21954	2524	22207	2071	21874	1415	25798	1010	16690
4L-2S		MI	11320	4300	18518	3050	19910	2463	20375	2010	20736	1333	24340	1179	13263
8-#18	3.85	MA	15736	4784	26739	3387	29776	2714	31511	2170	34067	1302	41262	1088	28765
2L-4S		MI	10589	4784	18328	3321	19512	2633	19885	2086	20255	1262	24097	539	20562
8-#18	3.85	MA	14285	4784	24514	3372	26924	2738	28081	2192	29517	1324	35314	867	28558
3E		MI	11403	4784	19752	3298	21262	2655	21957	2108	22828	1240	26919	737	22427
8-#18	3.85	MA	13246	4784	22676	3401	24582	2717	25286	2170	26042	1346	31464	653	26135
4L-2S		MI	12519	4784	21459	3320	23386	2633	24497	2086	26199	1217	31246	958	22514
10-#11	1.87	MA	13841	4217	22205	3073	24125	2492	24876	2058	25331	1411	29981	1294	14693
2L-5S		MI	10018	4217	16235	3011	17087	2452	17028	2014	16315	1369	18994	1019	11539
10-#11	1.87	MA	13240	4217	21309	3068	22976	2503	23474	2068	23464	1420	27515	1208	14722
3L-4S		MI	10322	4217	16736	3018	17732	2443	17799	2005	17395	1377	20255	1057	11733
10-#11	1.87	MA	12811	4217	20572	3081	22038	2497	22334	2059	22036	1428	25923	1122	14712
4L-3S		MI	10658	4217	17311	3008	18462	2452	18662	2014	18469	1369	21441	1139	11704
10-#11	1.87	MA	12427	4217	19933	3076	21210	2508	21317	2069	20605	1420	24226	1084	14412
5L-2S		MI	11123	4217	18005	3014	19349	2443	19722	2005	19875	1360	23270	1225	11663
10-#14	2.70	MA	14682	4455	24159	3208	26575	2589	27829	2113	29195	1372	35019	1220	20775
2L-5S		MI	10192	4455	16983	3140	17970	2543	18069	2060	17698	1321	20900	832	15478
10-#14	2.70	MA	13835	4455	22879	3201	24935	2604	25831	2126	26546	1384	31534	1095	20758
3L-4S		MI	10621	4455	17698	3151	18881	2531	19156	2047	19222	1334	22671	888	16227
10-#14	2.70	MA	13230	4455	21827	3219	23594	2594	24205	2113	24522	1397	29284	971	20555
4L-3S		MI	11095	4455	18518	3137	19910	2543	20375	2060	20736	1321	24340	1004	16411
10-#14	2.70	MA	12688	4455	20912	3211	22409	2608	22753	2126	22491	1384	26881	917	19440
5L-2S		MI	11749	4455	19506	3147	21161	2531	21871	2047	22720	1309	26910	1128	16381
10-#18	4.81	MA	15256	5061	26739	3545	29776	2862	31511	2264	34067	1287	41262	789	35372
3L-4S		MI	11324	5061	20035	3493	21637	2751	22425	2148	23626	1213	28424	437	25491

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#18	4.81	MA	14229	5061	24901	3574	27435	2841	28717	2241	30591	1309	37412	575	32614
4L-3S		MI	12130	5061	21459	3471	23386	2773	24497	2170	26199	1191	31246	635	27660
10-#18	4.81	MA	13309	5061	23302	3558	25364	2865	26223	2264	27100	1287	33312	478	30431
5L-2S		MI	13236	5061	23166	3493	25511	2751	27038	2148	29570	1169	35574	857	27836
12-#11	2.25	MA	14245	4325	23102	3140	25275	2541	26278	2088	27199	1399	32446	1269	17511
2L-6S		MI	10040	4325	16458	3072	17326	2491	17355	2049	16746	1362	19651	929	13298
12-#11	2.25	MA	13647	4325	22205	3135	24125	2552	24876	2097	25331	1408	29981	1183	17527
3L-5S		MI	10329	4325	16929	3079	17974	2500	18088	2041	17721	1353	20823	986	13591
12-#11	2.25	MA	13222	4325	21469	3148	23187	2545	23736	2089	23904	1417	28389	1097	17490
4E		MI	10631	4325	17430	3085	18619	2491	18859	2032	18801	1362	22084	1024	13901
12-#11	2.25	MA	12839	4325	20830	3143	22359	2556	22719	2098	22472	1408	26691	1059	17069
5L-3S		MI	10966	4325	18005	3075	19349	2500	19722	2041	19875	1353	23270	1106	13890
12-#11	2.25	MA	12475	4325	20230	3139	21530	2550	21751	2107	21176	1417	25104	1002	16617
6L-2S		MI	11428	4325	18699	3082	20236	2491	20782	2032	21281	1345	25100	1193	13859
12-#14	3.25	MA	14406	4611	24159	3298	26575	2673	27829	2168	29195	1366	35019	1056	24719
3L-5S		MI	10628	4611	17971	3238	19221	2612	19565	2097	19681	1297	23469	781	18402
12-#14	3.25	MA	13806	4611	23106	3316	25234	2663	26203	2155	27171	1379	32769	933	24278
4E		MI	11054	4611	18686	3248	20132	2599	20652	2085	21205	1310	25240	837	19086
12-#14	3.25	MA	13268	4611	22192	3309	24049	2678	24751	2168	25140	1366	30366	879	23241
5L-3S		MI	11525	4611	19506	3234	21161	2612	21871	2097	22720	1297	26910	953	19482
12-#14	3.25	MA	12755	4611	21333	3301	22862	2668	23369	2180	23302	1379	28125	796	22317
6L-2S		MI	12175	4611	20493	3244	22412	2599	23366	2085	24704	1285	29480	1078	19485
12-#18	5.77	MA	15201	5337	27127	3747	30288	2966	32147	2313	35141	1273	43360	497	39134
4E		MI	12052	5337	21742	3666	23761	2869	24965	2211	26997	1165	32751	335	30459
12-#18	5.77	MA	14291	5337	25528	3731	28217	2989	29654	2335	31650	1251	39260	400	36764
5L-3S		MI	12851	5337	23166	3644	25511	2891	27038	2233	29570	1143	35574	533	32641
14-#11	2.63	MA	14052	4433	23102	3203	25275	2600	26278	2126	27199	1396	32446	1158	20316
3L-6S		MI	10351	4433	17152	3140	18213	2539	18415	2076	18152	1346	21480	896	15383
14-#11	2.63	MA	13629	4433	22365	3215	24337	2594	25138	2118	25772	1405	30854	1071	20260
4L-5S		MI	10638	4433	17624	3146	18861	2548	19148	2068	19127	1338	22652	953	15653
14-#11	2.63	MA	13249	4433	21726	3211	23509	2605	24121	2127	24340	1396	29157	1034	19736
5L-4S		MI	10939	4433	18124	3153	19506	2539	19919	2059	20207	1346	23913	992	16057
14-#11	2.63	MA	12887	4433	21126	3206	22679	2598	23153	2137	23044	1405	27570	977	19312
6L-3S		MI	11272	4433	18699	3142	20236	2548	20782	2068	21281	1338	25100	1073	16069
14-#11	2.63	MA	12534	4433	20469	3219	21886	2609	22134	2128	21778	1414	25872	887	18717
7L-2S		MI	11732	4433	19394	3149	21123	2539	21842	2059	22687	1329	26929	1160	16047
14-#14	3.79	MA	14377	4767	24385	3413	26874	2733	28200	2198	29819	1361	36254	894	28025
4L-5S		MI	11061	4767	18958	3335	20472	2680	21060	2135	21665	1273	26039	731	21337
14-#14	3.79	MA	13843	4767	23471	3406	25689	2748	26749	2210	27789	1348	33851	840	27055
5L-4S		MI	11484	4767	19673	3345	21383	2668	22147	2122	23189	1286	27810	787	21966
14-#14	3.79	MA	13334	4767	22612	3399	24502	2738	25367	2222	25951	1361	31610	758	26032
6L-3S		MI	11952	4767	20493	3331	22412	2680	23366	2135	24704	1273	29480	902	22542
14-#14	3.79	MA	12839	4767	21672	3416	23368	2753	23910	2210	24155	1373	29508	662	24997
7L-2S		MI	12599	4767	21481	3342	23663	2668	24861	2122	26687	1261	32049	1027	22579
14-#18	6.73	MA	15261	5614	27753	3904	31070	3113	33084	2407	36199	1214	45208	322	43136
5L-4S		MI	12774	5614	23448	3839	25886	2987	27505	2273	30368	1116	37078	234	35457
16-#11	3.00	MA	14033	4541	23262	3283	25486	2642	26540	2148	27639	1393	33319	1046	23026
4L-6S		MI	10660	4541	17847	3207	19100	2587	19475	2103	19558	1331	23309	863	17471
16-#11	3.00	MA	13656	4541	22623	3278	24658	2653	25523	2157	26208	1385	31622	1009	22413
5E		MI	10945	4541	18318	3214	19748	2596	20208	2095	20533	1322	24482	920	17724
16-#11	3.00	MA	13296	4541	22023	3274	23828	2647	24555	2166	24912	1393	30035	952	22012
6L-4S		MI	11244	4541	18819	3220	20393	2587	20979	2086	21613	1331	25743	959	18207
16-#11	3.00	MA	12945	4541	21366	3286	23036	2658	23536	2158	23646	1402	28337	861	21356
7L-3S		MI	11576	4541	19394	3210	21123	2596	21842	2095	22687	1322	26929	1040	18238
16-#11	3.00	MA	12600	4541	20775	3282	22232	2651	22585	2167	22396	1411	26751	817	20795
8L-2S		MI	12034	4541	20088	3217	22010	2587	22902	2086	24093	1313	28758	1127	18228
16-#14	4.33	MA	14412	4922	24750	3503	27329	2818	28746	2252	30437	1330	37337	801	30880
5E		MI	11491	4922	19946	3432	21723	2748	22555	2172	23649	1249	28609	680	24280

RECTANGULAR TIED COLUMNS 26" x 32"

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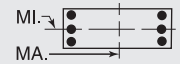


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#14	4.33	MA	13907	4922	23891	3496	26142	2808	27364	2265	28599	1343	35095	719	29763
6L-4S		MI	11911	4922	20661	3443	22634	2736	23642	2160	25173	1262	30380	736	24861
16-#14	4.33	MA	13416	4922	22951	3513	25008	2823	25908	2252	26804	1355	32993	624	28729
7L-3S		MI	12377	4922	21481	3428	23663	2748	24861	2172	26687	1249	32049	852	25592
18-#11	3.37	MA	14059	4648	23519	3346	25807	2702	26925	2186	28075	1373	34087	984	25097
5L-6S		MI	10966	4648	18541	3274	19987	2636	20535	2130	20964	1315	25139	830	19562
18-#11	3.37	MA	13702	4648	22919	3341	24977	2695	25957	2195	26780	1382	32500	927	24716
6L-5S		MI	11251	4648	19012	3281	20635	2644	21268	2122	21939	1307	26311	887	19800
18-#11	3.37	MA	13353	4648	22262	3354	24185	2706	24938	2187	25513	1390	30802	836	24003
7L-4S		MI	11548	4648	19513	3288	21280	2636	22039	2113	23019	1315	27572	926	20319
18-#11	3.37	MA	13010	4648	21671	3349	23381	2700	23987	2196	24264	1399	29217	792	23409
8L-3S		MI	11878	4648	20088	3277	22010	2644	22902	2122	24093	1307	28758	1007	20396
18-#14	4.87	MA	14477	5078	25170	3593	27782	2878	29362	2307	31248	1325	38581	680	33508
6L-5S		MI	11918	5078	20933	3529	22975	2817	24051	2210	25632	1225	31178	629	27231
18-#14	4.87	MA	13988	5078	24230	3611	26648	2893	27906	2294	29453	1337	36479	585	32411
7L-4S		MI	12335	5078	21648	3540	23885	2804	25137	2198	27156	1238	32949	685	27770
20-#11	3.75	MA	14105	4756	23816	3409	26127	2744	27359	2225	28647	1370	34966	902	27423
6E		MI	11272	4756	19235	3342	20874	2684	21595	2157	22370	1300	26968	797	21589
20-#11	3.75	MA	13758	4756	23159	3421	25334	2754	26340	2217	27381	1379	33268	811	26658
7L-5S		MI	11555	4756	19706	3349	21522	2692	22328	2148	23345	1291	28140	854	21881
20-#11	3.75	MA	13417	4756	22568	3417	24530	2748	25389	2226	26132	1387	31682	766	26020
8L-4S		MI	11851	4756	20207	3355	22167	2684	23099	2140	24425	1300	29401	893	22367
20-#14	5.41	MA	14557	5234	25510	3708	28288	2963	29903	2336	32101	1319	39964	546	36105
7L-5S		MI	12342	5234	21921	3627	24226	2885	25546	2248	27616	1201	33748	579	30187
22-#11	4.13	MA	14161	4864	24055	3489	26483	2803	27742	2246	29249	1367	35733	786	29319
7L-6S		MI	11575	4864	19929	3409	21761	2732	22655	2184	23776	1284	28797	764	23612
22-#11	4.13	MA	13822	4864	23464	3484	25679	2797	26791	2255	27999	1376	34147	741	28638
8L-5S		MI	11857	4864	20400	3416	22409	2741	23388	2175	24751	1276	29970	822	23965
24-#11	4.50	MA	14224	4972	24361	3551	26829	2845	28193	2285	29867	1364	36613	716	31264
8L-6S		MI	11878	4972	20623	3477	22648	2780	23715	2211	25182	1269	30627	731	25643

RECTANGULAR TIED COLUMNS 26" x 34"

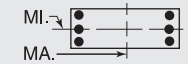
4-#14	1.02	MA	14572	4218	22752	3103	24278	2533	24480	2118	23805	1529	27526	1439	9272
2E		MI	11048	4219	17454	3022	18339	2463	18285	2051	17569	1470	20080	1367	6984
4-#18	1.81	MA	15481	4461	24879	3228	26889	2620	27578	2162	27863	1481	32795	1353	15890
2E		MI	11661	4461	18960	3138	20067	2533	20313	2076	20252	1403	23463	1247	11784
6-#11	1.06	MA	14645	4231	22847	3124	24460	2549	24723	2130	24172	1537	28041	1448	9654
2L-3S		MI	10634	4231	16831	3040	17620	2493	17444	2077	16459	1490	18665	1292	7316
6-#11	1.06	MA	13990	4231	21883	3120	23224	2561	23215	2140	22150	1546	25363	1361	9707
3L-2S		MI	11104	4231	17525	3047	18507	2484	18504	2068	17865	1481	20495	1378	7261
6-#14	1.53	MA	15204	4374	24128	3201	26043	2603	26632	2160	26676	1513	31317	1403	13639
2L-3S		MI	10822	4374	17454	3108	18339	2543	18285	2101	17569	1459	20080	1191	10243
6-#14	1.53	MA	14277	4374	22752	3194	24278	2618	24480	2173	23805	1525	27526	1278	13695
3L-2S		MI	11486	4374	18441	3119	19591	2531	19780	2088	19553	1446	22650	1316	10165
6-#18	2.71	MA	16549	4737	27277	3401	29964	2744	31306	2236	32808	1447	39287	1281	23434
2L-3S		MI	11266	4737	18960	3290	20067	2673	20313	2161	20252	1376	23463	924	17254
6-#18	2.71	MA	14963	4737	24879	3387	26889	2769	27578	2258	27863	1469	32795	1059	23344
3L-2S		MI	12395	4737	20666	3311	22192	2651	22853	2138	23623	1354	27790	1145	17209

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis

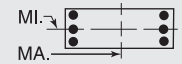


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#11	1.41	MA	15091	4339	23811	3192	25695	2598	26230	2160	26194	1527	30719	1424	12708
2L-4S		MI	10607	4339	16950	3118	17777	2533	17640	2095	16791	1483	19308	1177	9595
8-#11	1.41	MA	14439	4339	22847	3188	24460	2609	24723	2169	24172	1535	28041	1338	12749
3E		MI	10946	4339	17525	3107	18507	2541	18504	2104	17865	1474	20495	1259	9542
8-#11	1.41	MA	13976	4339	22057	3201	23453	2603	23499	2162	22627	1544	26308	1252	12768
4L-2S		MI	11414	4339	18219	3114	19394	2533	19564	2095	19271	1465	22324	1345	9491
8-#14	2.04	MA	15829	4530	25505	3298	27808	2672	28785	2202	29547	1496	35109	1367	17976
2L-4S		MI	10781	4530	17621	3220	18561	2599	18561	2126	18038	1447	20980	1025	13382
8-#14	2.04	MA	14909	4530	24128	3291	26043	2688	26632	2216	26676	1508	31317	1242	17999
3E		MI	11260	4530	18441	3206	19591	2612	19780	2138	19553	1435	22650	1141	13368
8-#14	2.04	MA	14254	4530	22998	3310	24603	2679	24883	2204	24482	1521	28868	1118	17905
4L-2S		MI	11920	4530	19429	3216	20842	2599	21275	2126	21536	1422	25219	1265	13310
8-#18	3.62	MA	17601	5014	29676	3574	33039	2868	35035	2309	37752	1414	45778	1209	30925
2L-4S		MI	11186	5014	19243	3485	20442	2768	20781	2201	21050	1350	24968	624	20837
8-#18	3.62	MA	16033	5014	27277	3560	29964	2893	31306	2332	32808	1436	39287	987	30718
3E		MI	12002	5014	20666	3462	22192	2791	22853	2223	23623	1328	27790	822	22529
8-#18	3.62	MA	14915	5014	25301	3591	27447	2875	28270	2309	29030	1458	35092	769	28348
4L-2S		MI	13121	5014	22373	3484	24317	2768	25393	2201	26994	1306	32118	1043	22583
10-#11	1.76	MA	15532	4447	24775	3259	26931	2646	27738	2189	28216	1516	33398	1401	15746
2L-5S		MI	10615	4447	17144	3179	18019	2589	17929	2131	17118	1459	19876	1106	11675
10-#11	1.76	MA	14884	4447	23811	3255	25695	2658	26230	2199	26194	1525	30719	1315	15775
3L-4S		MI	10919	4447	17644	3185	18664	2581	18700	2122	18198	1467	21137	1144	11783
10-#11	1.76	MA	14424	4447	23021	3268	24689	2652	25007	2191	24649	1533	28986	1228	15765
4L-3S		MI	11257	4447	18219	3175	19394	2589	19564	2131	19271	1459	22324	1226	11747
10-#11	1.76	MA	14012	4447	22336	3264	23801	2663	23916	2201	23100	1525	27148	1190	15541
5L-2S		MI	11722	4447	18913	3182	20281	2581	20624	2122	20677	1450	24153	1312	11703
10-#14	2.55	MA	16448	4685	26881	3395	29572	2742	30938	2245	32418	1480	38901	1331	22294
2L-5S		MI	10789	4685	17894	3307	18902	2680	18969	2176	18498	1411	21779	918	15649
10-#14	2.55	MA	15534	4685	25505	3389	27808	2758	28785	2258	29547	1492	35109	1207	22277
3L-4S		MI	11219	4685	18609	3317	19812	2668	20056	2163	20022	1423	23550	974	16428
10-#14	2.55	MA	14885	4685	24375	3407	26368	2749	27036	2247	27353	1504	32660	1082	22136
4L-3S		MI	11695	4685	19429	3303	20842	2680	21275	2176	21536	1411	25219	1090	16470
10-#14	2.55	MA	14302	4685	23394	3401	25097	2765	25475	2260	25152	1492	30051	1028	20974
5L-2S		MI	12350	4685	20416	3313	22093	2668	22770	2163	23520	1398	27789	1215	16433
10-#18	4.52	MA	17089	5290	29676	3733	33039	3018	35035	2405	37752	1402	45778	915	38072
3L-4S		MI	11922	5290	20949	3658	22567	2886	23321	2263	24421	1301	29295	522	25761
10-#18	4.52	MA	15984	5290	27699	3764	30521	2999	31999	2383	33974	1424	41584	697	35340
4L-3S		MI	12731	5290	22373	3635	24317	2908	25393	2285	26994	1279	32118	720	27774
10-#18	4.52	MA	14995	5290	25982	3750	28296	3024	29289	2405	30182	1402	37108	601	33203
5L-2S		MI	13840	5290	24080	3657	26441	2886	27934	2263	30365	1257	36445	942	27918
12-#11	2.12	MA	15971	4555	25739	3327	28167	2695	29245	2218	30238	1505	36076	1378	18775
2L-6S		MI	10637	4555	17367	3239	18258	2629	18256	2166	17549	1452	20534	1015	13424
12-#11	2.12	MA	15326	4555	24775	3323	26931	2706	27738	2228	28216	1514	33398	1291	18791
3L-5S		MI	10927	4555	17838	3246	18906	2637	18989	2158	18524	1443	21706	1073	13726
12-#11	2.12	MA	14869	4555	23985	3336	25924	2700	26514	2221	26671	1523	31665	1205	18753
4E		MI	11229	4555	18339	3253	19551	2629	19760	2149	19604	1452	22967	1111	13959
12-#11	2.12	MA	14459	4555	23300	3332	25036	2712	25424	2231	25122	1514	29827	1167	18398
5L-3S		MI	11565	4555	18913	3242	20281	2637	20624	2158	20677	1443	24153	1193	13938
12-#11	2.12	MA	14069	4555	22657	3328	24147	2706	24337	2223	23718	1523	28101	1110	17878
6L-2S		MI	12028	4555	19608	3249	21168	2629	21684	2149	22083	1434	25983	1279	13903
12-#14	3.05	MA	16154	4841	26881	3486	29572	2828	30938	2301	32418	1475	38901	1171	26542
3L-5S		MI	11226	4841	18881	3404	20153	2748	20464	2213	20482	1387	24348	868	18572
12-#14	3.05	MA	15509	4841	25751	3504	28132	2819	29188	2289	30224	1488	36452	1046	26269
4E		MI	11653	4841	19596	3414	21064	2736	21551	2201	22005	1399	26119	924	19284
12-#14	3.05	MA	14932	4841	24771	3498	26862	2835	27627	2302	28023	1475	33843	992	25067
5L-3S		MI	12126	4841	20416	3400	22093	2748	22770	2213	23520	1387	27789	1039	19552
12-#14	3.05	MA	14381	4841	23850	3491	25588	2826	26142	2316	26031	1488	31402	910	24210
6L-2S		MI	12777	4841	21404	3411	23344	2736	24266	2201	25504	1374	30359	1164	19541

RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

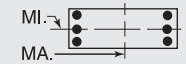
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	5.43	MA	17040	5567	30098	3937	33596	3123	35727	2457	38918	1391	48075	625	42376
4E		MI	12651	5567	22656	3831	24692	3004	25861	2325	27791	1253	33622	421	30726
12-#18	5.43	MA	16061	5567	28381	3923	31371	3148	33017	2479	35126	1369	43600	529	40049
5L-3S		MI	13453	5567	24080	3808	26441	3026	27934	2348	30365	1231	36445	619	33000
14-#11	2.47	MA	15765	4663	25739	3390	28167	2754	29245	2258	30238	1503	36076	1268	21790
3L-6S		MI	10948	4663	18061	3307	19145	2677	19316	2193	18955	1436	22363	983	15509
14-#11	2.47	MA	15311	4663	24949	3403	27160	2749	28022	2250	28693	1512	34343	1182	21734
4L-5S		MI	11236	4663	18532	3314	19793	2686	20049	2185	19930	1427	23535	1040	15788
14-#11	2.47	MA	14903	4663	24264	3399	26272	2760	26931	2260	27144	1503	32505	1143	21267
5L-4S		MI	11538	4663	19033	3320	20438	2677	20820	2176	21010	1436	24796	1078	16122
14-#11	2.47	MA	14515	4663	23621	3395	25383	2755	25844	2253	25740	1512	30779	1087	20777
6L-3S		MI	11871	4663	19608	3310	21168	2686	21684	2185	22083	1427	25983	1160	16120
14-#11	2.47	MA	14137	4663	22917	3408	24533	2766	24801	2263	24369	1521	28934	996	20228
7L-2S		MI	12333	4663	20302	3316	22055	2677	22744	2176	23489	1419	27812	1247	16094
14-#14	3.56	MA	16128	4997	27128	3602	29897	2889	31341	2331	33095	1471	40244	1010	30303
4L-5S		MI	11659	4997	19869	3501	21404	2817	21960	2251	22465	1363	26918	817	21507
14-#14	3.56	MA	15555	4997	26147	3595	28626	2905	29780	2345	30894	1459	37634	956	29175
5L-4S		MI	12084	4997	20584	3512	22315	2804	23047	2239	23989	1375	28689	873	22162
14-#14	3.56	MA	15009	4997	25226	3589	27353	2896	28295	2358	28902	1471	35193	874	28215
6L-3S		MI	12553	4997	21404	3497	23344	2817	24266	2251	25504	1363	30359	989	22617
14-#14	3.56	MA	14477	4997	24218	3607	26136	2911	26730	2347	26956	1484	32581	744	27029
7L-2S		MI	13201	4997	22391	3508	24595	2804	25761	2239	27487	1350	32928	1113	22643
14-#18	6.33	MA	17116	5844	30779	4096	34446	3273	36746	2553	40070	1335	50091	457	46935
5L-4S		MI	13374	5844	24363	4003	26817	3122	28401	2388	31162	1204	37949	319	35721
16-#11	2.82	MA	15749	4770	25913	3471	28396	2797	29529	2280	30715	1501	37021	1159	24711
4L-6S		MI	11257	4770	18755	3374	20032	2725	20376	2220	20361	1421	24192	950	17599
16-#11	2.82	MA	15344	4770	25228	3467	27508	2809	28439	2290	29166	1493	35183	1120	24146
5E		MI	11544	4770	19226	3381	20680	2734	21109	2212	21336	1412	25364	1007	17858
16-#11	2.82	MA	14958	4770	24585	3462	26618	2803	27352	2282	27763	1501	33458	1063	23682
6L-4S		MI	11844	4770	19727	3388	21325	2725	21880	2203	22416	1421	26625	1046	18276
16-#11	2.82	MA	14582	4770	23881	3476	25769	2814	26308	2292	26391	1510	31612	973	23070
7L-3S		MI	12176	4770	20302	3377	22055	2734	22744	2212	23489	1412	27812	1127	18295
16-#11	2.82	MA	14212	4770	23247	3472	24908	2809	25289	2302	24933	1501	29895	927	22429
8L-2S		MI	12635	4770	20996	3384	22942	2725	23804	2203	24896	1403	29641	1214	18278
16-#14	4.07	MA	16173	5152	27524	3692	30391	2974	31933	2387	33765	1442	41426	920	33294
5E		MI	12090	5152	20856	3598	22655	2885	23455	2289	24449	1339	29487	766	24451
16-#14	4.07	MA	15632	5152	26603	3686	29117	2965	30447	2401	31773	1455	38985	838	32236
6L-4S		MI	12511	5152	21571	3609	23566	2873	24542	2276	25973	1351	31259	822	25056
16-#14	4.07	MA	15104	5152	25595	3704	27901	2981	28882	2389	29827	1467	36373	708	31102
7L-3S		MI	12979	5152	22391	3595	24595	2885	25761	2289	27487	1339	32928	938	25673
18-#11	3.18	MA	15782	4878	26192	3534	28744	2857	29946	2319	31188	1482	37861	1097	27034
5L-6S		MI	11565	4878	19449	3442	20919	2773	21436	2247	21767	1405	26022	917	19691
18-#11	3.18	MA	15398	4878	25549	3530	27854	2851	28859	2312	29785	1491	36136	1040	26592
6L-5S		MI	11850	4878	19920	3448	21567	2782	22169	2238	22742	1396	27194	974	19935
18-#11	3.18	MA	15024	4878	24845	3543	27005	2863	27816	2321	28414	1499	34291	950	25919
7L-4S		MI	12149	4878	20421	3455	22212	2773	22940	2230	23822	1405	28455	1013	20425
18-#11	3.18	MA	14656	4878	24211	3539	26143	2857	26796	2331	26955	1491	32573	904	25304
8L-3S		MI	12479	4878	20996	3445	22942	2782	23804	2238	24896	1396	29641	1094	20459
18-#14	4.58	MA	16249	5308	27979	3783	30882	3035	32600	2443	34644	1438	42777	802	36271
6L-5S		MI	12517	5308	21844	3696	23906	2954	24950	2326	26432	1315	32057	716	27402
18-#14	4.58	MA	15725	5308	26971	3801	29666	3051	31035	2431	32698	1451	40165	672	35186
7L-4S		MI	12937	5308	22559	3706	24817	2941	26037	2314	27956	1327	33828	772	27963

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

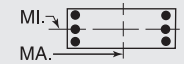
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	3.53	MA	15836	4986	26513	3597	29090	2900	30367	2341	31807	1480	38814	1017	29505
6E		MI	11870	4986	20143	3509	21806	2821	22496	2274	23173	1390	27851	884	21786
20-#11	3.53	MA	15464	4986	25809	3610	28240	2911	29323	2351	30436	1489	36969	927	28776
7L-5S		MI	12154	4986	20615	3516	22454	2830	23230	2265	24148	1381	29023	941	22016
20-#11	3.53	MA	15098	4986	25175	3606	27379	2906	28304	2361	28977	1480	35251	881	28183
8L-4S		MI	12452	4986	21115	3523	23099	2821	24000	2257	25228	1390	30284	980	22525
20-#14	5.09	MA	16342	5463	28348	3899	31430	3121	33188	2474	35569	1434	43957	636	39208
7L-5S		MI	12943	5463	22831	3793	25157	3022	26445	2364	28416	1291	34627	665	30359
22-#11	3.88	MA	15901	5094	26773	3678	29476	2960	30831	2380	32458	1478	39647	903	31640
7L-6S		MI	12175	5094	20838	3577	22693	2870	23556	2301	24579	1374	29680	851	23829
22-#11	3.88	MA	15537	5094	26139	3674	28615	2954	29811	2390	30999	1469	37930	858	31009
8L-5S		MI	12457	5094	21309	3583	23341	2878	24290	2292	25554	1365	30852	908	24101
24-#11	4.24	MA	15973	5202	27103	3741	29850	3002	31319	2420	33021	1459	40608	834	33836
8L-6S		MI	12478	5202	21532	3644	23580	2918	24616	2328	25985	1358	31510	818	25858

RECTANGULAR TIED COLUMNS 26" x 36"

4-#18	1.71	MA	17268	4690	27600	3415	29851	2773	30637	2296	30891	1586	36373	1460	16970
2E		MI	12259	4690	19874	3303	20998	2668	21209	2191	21047	1491	24334	1332	11833
6-#11	1.00	MA	16360	4461	25413	3311	27235	2703	27516	2261	26880	1640	31180	1550	10286
2L-3S		MI	11232	4461	17739	3207	18552	2631	18345	2194	17262	1579	19548	1379	7347
6-#11	1.00	MA	15657	4461	24381	3308	25913	2715	25903	2271	24703	1649	28289	1463	10339
3L-2S		MI	11702	4461	18433	3214	19439	2622	19405	2185	18668	1571	21377	1465	7292
6-#14	1.44	MA	16965	4604	26788	3387	28934	2756	29565	2290	29585	1617	34735	1508	14550
2L-3S		MI	11420	4604	18364	3275	19271	2680	19184	2217	18369	1548	20959	1278	10285
6-#14	1.44	MA	15969	4604	25314	3382	27045	2773	27260	2305	26492	1629	30636	1383	14606
3L-2S		MI	12084	4604	19352	3285	20522	2668	20680	2205	20353	1536	23529	1402	10205
6-#18	2.56	MA	18423	4967	30171	3588	33147	2898	34658	2371	36230	1555	43409	1393	25054
2L-3S		MI	11864	4967	19874	3454	20998	2808	21209	2275	21047	1465	24334	1009	17336
6-#18	2.56	MA	16718	4967	27600	3576	29851	2925	30637	2393	30891	1577	36373	1172	24964
3L-2S		MI	12995	4967	21581	3476	23122	2786	23749	2253	24418	1442	28661	1230	17268
8-#11	1.33	MA	16840	4569	26444	3379	28557	2751	29129	2290	29056	1630	34072	1528	13550
2L-4S		MI	11205	4569	17859	3285	18709	2670	18541	2212	17594	1573	20191	1264	9636
8-#11	1.33	MA	16141	4569	25413	3375	27235	2763	27516	2301	26880	1639	31180	1442	13591
3E		MI	11544	4569	18433	3275	19439	2679	19405	2221	18668	1564	21377	1346	9579
8-#11	1.33	MA	15647	4569	24569	3389	26160	2758	26209	2294	25216	1648	29306	1355	13611
4L-2S		MI	12012	4569	19128	3281	20326	2670	20465	2212	20074	1555	23207	1432	9526
8-#14	1.92	MA	17640	4760	28261	3485	30823	2826	31869	2333	32679	1602	38834	1474	19191
2L-4S		MI	11379	4760	18532	3386	19493	2736	19460	2242	18838	1536	21859	1111	13451
8-#14	1.92	MA	16651	4760	26788	3479	28934	2843	29565	2347	29585	1614	34735	1350	19214
3E		MI	11859	4760	19352	3372	20522	2749	20680	2255	20353	1524	23529	1227	13418
8-#14	1.92	MA	15951	4760	25580	3498	27395	2835	27695	2337	27221	1626	32082	1225	19120
4L-2S		MI	12519	4760	20339	3382	21773	2736	22175	2242	22337	1512	26098	1352	13355
8-#18	3.42	MA	19561	5244	32742	3761	36444	3022	38680	2446	41569	1524	50445	1326	33085
2L-4S		MI	11783	5244	20157	3649	21373	2904	21677	2316	21844	1438	25839	709	21104
8-#18	3.42	MA	17875	5244	30171	3748	33147	3049	34658	2469	36230	1546	43409	1105	32878
3E		MI	12601	5244	21581	3627	23122	2926	23749	2338	24418	1416	28661	907	22625
8-#18	3.42	MA	16678	5244	28057	3780	30454	3032	31386	2447	32151	1569	38870	884	30590
4L-2S		MI	13723	5244	23288	3649	25247	2904	26290	2316	27789	1394	32989	1129	22650
10-#11	1.67	MA	17317	4677	27476	3446	29879	2800	30742	2319	31233	1621	36963	1506	16799
2L-5S		MI	11212	4677	18052	3346	18951	2727	18831	2248	17921	1548	20759	1193	11807
10-#11	1.67	MA	16622	4677	26444	3442	28557	2812	29129	2330	29056	1629	34072	1420	16828
3L-4S		MI	11517	4677	18553	3353	19596	2718	19601	2239	19000	1557	22020	1231	11830
10-#11	1.67	MA	16130	4677	25600	3456	27482	2807	27822	2323	27392	1638	32197	1334	16818
4L-3S		MI	11855	4677	19128	3342	20326	2727	20465	2248	20074	1548	23207	1313	11788

RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

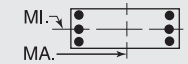
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.67	MA	15690	4677	24869	3452	26534	2819	26658	2334	25725	1629	30218	1294	16681
5L-2S		MI	12321	4677	19822	3349	21213	2718	21525	2239	21480	1540	25036	1399	11742
10-#14	2.40	MA	18308	4915	29735	3582	32713	2896	34174	2375	35773	1586	42933	1441	23813
2L-5S		MI	11386	4915	18805	3473	19834	2817	19869	2292	19298	1500	22657	1005	15814
10-#14	2.40	MA	17326	4915	28261	3576	30823	2913	31869	2390	32679	1599	38834	1317	23796
3L-4S		MI	11817	4915	19519	3483	20744	2805	20956	2280	20822	1512	24428	1061	16516
10-#14	2.40	MA	16632	4915	27054	3595	29284	2904	29999	2379	30315	1611	36181	1192	23655
4L-3S		MI	12294	4915	20339	3469	21773	2817	22175	2292	22337	1500	26098	1176	16527
10-#14	2.40	MA	16009	4915	26007	3589	27927	2921	28332	2393	27944	1599	33369	1136	22522
5L-2S		MI	12950	4915	21327	3480	23024	2805	23670	2280	24320	1488	28668	1301	16483
10-#18	4.27	MA	19016	5520	32742	3921	36444	3173	38680	2544	41569	1515	50445	1038	40772
3L-4S		MI	12520	5520	21864	3822	23498	3021	24217	2378	25215	1390	30166	608	26024
10-#18	4.27	MA	17833	5520	30628	3953	33750	3156	35407	2523	37490	1538	45906	817	38096
4L-3S		MI	13331	5520	23288	3800	25247	3043	26290	2400	27789	1368	32989	806	27882
10-#18	4.27	MA	16774	5520	28793	3941	31372	3183	32486	2545	33396	1515	41055	721	36028
5L-2S		MI	14443	5520	24995	3821	27372	3021	28830	2378	31160	1345	37316	1027	27997
12-#11	2.00	MA	17790	4784	28507	3513	31201	2848	32355	2349	33409	1611	39855	1485	20038
2L-6S		MI	11234	4784	18275	3407	19190	2767	19158	2283	18351	1541	21416	1102	13545
12-#11	2.00	MA	17098	4784	27476	3510	29879	2860	30742	2359	31233	1619	36963	1399	20054
3L-5S		MI	11524	4784	18746	3413	19838	2775	19891	2275	19327	1533	22588	1160	13857
12-#11	2.00	MA	16610	4784	26632	3523	28804	2855	29435	2353	29569	1628	35089	1312	20017
4E		MI	11828	4784	19247	3420	20483	2767	20661	2266	20406	1541	23849	1198	14012
12-#11	2.00	MA	16172	4784	25901	3520	27857	2867	28271	2363	27902	1619	33110	1273	19739
5L-3S		MI	12164	4784	19822	3410	21213	2775	21525	2275	21480	1533	25036	1280	13984
12-#11	2.00	MA	15755	4784	25215	3516	26907	2862	27111	2357	26391	1628	31245	1216	19146
6L-2S		MI	12628	4784	20516	3416	22100	2767	22585	2266	22886	1524	26865	1366	13945
12-#14	2.88	MA	17995	5071	29735	3673	32713	2982	34174	2432	35773	1584	42933	1283	28364
3L-5S		MI	11823	5071	19792	3570	21085	2885	21364	2330	21282	1476	25227	954	18736
12-#14	2.88	MA	17306	5071	28527	3692	31174	2974	32304	2422	33408	1596	40280	1159	28183
4E		MI	12251	5071	20507	3581	21995	2873	22451	2317	22805	1488	26998	1010	19477
12-#14	2.88	MA	16688	5071	27480	3687	29817	2991	30637	2436	31038	1584	37468	1103	26908
5L-3S		MI	12725	5071	21327	3566	23024	2885	23670	2330	24320	1476	28668	1126	19618
12-#14	2.88	MA	16100	5071	26498	3681	28457	2983	28976	2425	28891	1596	34826	1021	26131
6L-2S		MI	13378	5071	22314	3577	24275	2873	25165	2317	26304	1464	31237	1250	19595
12-#18	5.13	MA	18973	5797	33200	4126	37047	3280	39429	2598	42829	1507	52941	750	45648
4E		MI	13250	5797	23571	3995	25622	3139	26757	2440	28586	1341	34493	506	30986
12-#18	5.13	MA	17926	5797	31364	4114	34669	3307	36508	2620	38735	1485	48090	654	43389
5L-3S		MI	14055	5797	24995	3973	27372	3161	28830	2462	31160	1319	37316	704	33117
12-#18	5.13	MA	16931	5797	29640	4101	32285	3290	33727	2643	35031	1507	43564	508	40430
6L-2S		MI	15158	5797	26701	3994	29497	3139	31370	2440	34531	1297	41643	925	33302
14-#11	2.33	MA	17572	4892	28507	3577	31201	2909	32355	2389	33409	1610	39855	1377	23264
3L-6S		MI	11546	4892	18969	3474	20077	2815	20218	2310	19757	1526	23246	1069	15631
14-#11	2.33	MA	17086	4892	27663	3591	30126	2903	31048	2382	31746	1618	37980	1291	23209
4L-5S		MI	11834	4892	19440	3481	20725	2823	20951	2302	20733	1517	24418	1127	15919
14-#11	2.33	MA	16650	4892	26932	3587	29179	2916	29884	2393	30078	1610	36001	1251	22810
5L-4S		MI	12136	4892	19941	3488	21370	2815	21721	2293	21812	1526	25679	1165	16184
14-#11	2.33	MA	16236	4892	26246	3584	28230	2910	28724	2386	28568	1618	34137	1195	22250
6L-3S		MI	12471	4892	20516	3477	22100	2823	22585	2302	22886	1517	26865	1247	16169
14-#11	2.33	MA	15832	4892	25495	3597	27323	2922	27610	2396	27092	1627	32144	1105	21758
7L-2S		MI	12933	4892	21210	3484	22987	2815	23645	2293	24292	1509	28695	1333	16139
14-#14	3.37	MA	17974	5226	30001	3790	33063	3044	34609	2464	36502	1581	44379	1126	32605
4L-5S		MI	12257	5226	20779	3667	22336	2954	22859	2367	23265	1452	27797	903	21671
14-#14	3.37	MA	17361	5226	28954	3784	31706	3061	32942	2478	34132	1568	41567	1070	31309
5L-4S		MI	12683	5226	21494	3678	23246	2941	23946	2355	24789	1464	29568	959	22352

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis

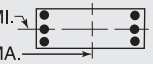


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.37	MA	16778	5226	27972	3778	30346	3053	31281	2468	31985	1581	38925	988	30426
6L-3S		MI	13154	5226	22314	3664	24275	2954	25165	2367	26304	1452	31237	1075	22689
14-#14	3.37	MA	16209	5226	26895	3797	29048	3069	29685	2482	29887	1593	36101	858	29081
7L-2S		MI	13803	5226	23302	3674	25526	2941	26661	2355	28288	1440	33807	1200	22695
14-#18	5.98	MA	19065	6074	33936	4287	37965	3431	40529	2696	44074	1454	55126	587	50789
5L-4S		MI	13975	6074	25277	4168	27747	3257	29297	2503	31957	1293	38821	404	35979
14-#18	5.98	MA	18081	6074	32212	4274	35581	3414	37749	2718	40370	1476	50600	442	47975
6L-3S		MI	14773	6074	26701	4145	29497	3279	31370	2525	34531	1270	41643	602	38157
16-#11	2.67	MA	17558	5000	28694	3658	31448	2952	32661	2412	33922	1608	40872	1269	26395
4L-6S		MI	11855	5000	19663	3542	20964	2863	21278	2337	21163	1510	25075	1037	17721
16-#11	2.67	MA	17126	5000	27964	3655	30501	2964	31497	2422	32255	1600	38893	1230	25891
5E		MI	12142	5000	20135	3548	21612	2871	22011	2328	22139	1502	26247	1094	17989
16-#11	2.67	MA	16714	5000	27278	3651	29552	2959	30337	2415	30745	1608	37028	1173	25360
6L-4S		MI	12443	5000	20635	3555	22258	2863	22781	2320	23218	1510	27508	1132	18342
16-#11	2.67	MA	16312	5000	26527	3665	28646	2971	29223	2426	29269	1617	35035	1083	24801
7L-3S		MI	12776	5000	21210	3544	22987	2871	23645	2328	24292	1502	28695	1214	18347
16-#11	2.67	MA	15917	5000	25851	3661	27727	2966	28136	2436	27699	1608	33186	1036	24077
8L-2S		MI	13236	5000	21904	3551	23874	2863	24705	2320	25698	1493	30524	1300	18326
16-#14	3.85	MA	18028	5382	30428	3881	33595	3131	35247	2521	37225	1553	45666	1037	35722
5E		MI	12689	5382	21767	3765	23587	3022	24355	2405	25249	1428	30366	853	24615
16-#14	3.85	MA	17449	5382	29445	3875	32236	3123	33586	2510	35078	1566	43024	955	34738
6L-4S		MI	13112	5382	22482	3775	24497	3010	25441	2392	26773	1440	32137	909	25245
16-#14	3.85	MA	16885	5382	28369	3894	30938	3139	31990	2525	32981	1578	40200	825	33449
7L-3S		MI	13580	5382	23302	3761	25526	3022	26661	2405	28288	1428	33807	1024	25750
16-#14	3.85	MA	16330	5382	27401	3889	29621	3131	30432	2539	30750	1566	37572	759	31974
8L-2S		MI	14226	5382	24289	3771	26777	3010	28156	2392	30271	1415	36377	1149	25786
16-#18	6.84	MA	19218	6350	34783	4447	38878	3538	41770	2794	45709	1445	57636	375	55516
6L-4S		MI	14694	6350	26984	4341	29872	3375	31837	2565	35328	1244	43148	303	40995
18-#11	3.00	MA	17598	5108	28995	3722	31823	3012	33110	2451	34431	1590	41784	1208	28982
5L-6S		MI	12163	5108	20358	3609	21851	2911	22338	2364	22570	1495	26904	1004	19815
18-#11	3.00	MA	17188	5108	28309	3718	30874	3007	31950	2445	32921	1599	39920	1152	28476
6L-5S		MI	12449	5108	20829	3616	22499	2920	23071	2355	23545	1486	28076	1061	20065
18-#11	3.00	MA	16789	5108	27558	3732	29968	3019	30836	2455	31445	1607	37927	1061	27854
7L-4S		MI	12748	5108	21330	3622	23145	2911	23841	2347	24624	1495	29337	1100	20494
18-#11	3.00	MA	16396	5108	26882	3728	29049	3014	29749	2466	29876	1599	36078	1015	27156
8L-3S		MI	13080	5108	21904	3612	23874	2920	24705	2355	25698	1486	30524	1181	20520
18-#11	3.00	MA	16007	5108	26155	3742	28154	3026	28612	2459	28413	1607	34270	961	26307
9L-2S		MI	13538	5108	22599	3619	24761	2911	25765	2347	27104	1478	32353	1268	20507
18-#14	4.33	MA	18115	5538	30919	3973	34125	3192	35891	2553	38172	1550	47123	922	39065
6L-5S		MI	13117	5538	22754	3862	24838	3090	25850	2442	27233	1404	32936	802	27567
18-#14	4.33	MA	17555	5538	29843	3992	32827	3209	34295	2567	36074	1563	44299	791	37827
7L-4S		MI	13538	5538	23469	3873	25748	3078	26937	2430	28756	1416	34707	858	28151
18-#14	4.33	MA	17004	5538	28875	3986	31510	3201	32737	2581	33843	1550	41671	725	36293
8L-3S		MI	14004	5538	24289	3858	26777	3090	28156	2442	30271	1404	36377	974	28803
20-#11	3.33	MA	17660	5216	29340	3786	32196	3056	33563	2474	35098	1589	42811	1130	31595
6E		MI	12469	5216	21052	3676	22738	2959	23398	2391	23976	1479	28734	971	21911
20-#11	3.33	MA	17263	5216	28589	3800	31290	3068	32449	2485	33622	1597	40819	1040	30914
7L-5S		MI	12754	5216	21523	3683	23386	2968	24131	2382	24951	1471	29906	1028	22147
20-#11	3.33	MA	16872	5216	27914	3796	30371	3063	31362	2495	32052	1589	38969	993	30240
8L-4S		MI	13052	5216	22024	3690	24032	2959	24901	2374	26030	1479	31167	1067	22642
20-#11	3.33	MA	16485	5216	27187	3810	29477	3075	30225	2489	30590	1597	37161	939	29352
9L-3S		MI	13382	5216	22599	3679	24761	2968	25765	2382	27104	1471	32353	1148	22679
20-#14	4.81	MA	18220	5693	31317	4089	34716	3279	36600	2609	39168	1548	48398	758	42214
7L-5S		MI	13543	5693	23742	3959	26089	3159	27345	2480	29216	1380	35506	751	30524
20-#14	4.81	MA	17673	5693	30349	4083	33399	3271	35042	2624	36937	1535	45770	692	40622
8L-4S		MI	13962	5693	24457	3970	26999	3146	28432	2468	30740	1392	37277	807	31069

RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.67	MA	17733	5324	29621	3867	32612	3116	34062	2514	35798	1588	43710	1018	33980
7L-6S		MI	12774	5324	21746	3744	23625	3007	24458	2418	25382	1464	30563	938	24010
22-#11	3.67	MA	17345	5324	28945	3863	31693	3111	32975	2525	34229	1579	41861	972	33330
8L-5S		MI	13058	5324	22217	3751	24273	3016	25191	2409	26357	1455	31735	995	24232
22-#11	3.67	MA	16960	5324	28218	3877	30799	3123	31838	2518	32766	1588	40053	918	32404
9L-4S		MI	13355	5324	22718	3757	24919	3007	25961	2401	27436	1464	32996	1034	24733
22-#14	5.29	MA	18337	5849	31822	4180	35289	3341	37347	2666	40031	1520	49869	659	44961
8L-5S		MI	13967	5849	24729	4057	27340	3227	28840	2518	31200	1356	38075	701	33486
24-#11	4.00	MA	17815	5432	29977	3931	33015	3159	34588	2554	36405	1569	44752	950	36424
8L-6S		MI	13078	5432	22440	3811	24512	3055	25518	2445	26788	1448	32392	905	26068
24-#11	4.00	MA	17432	5432	29249	3944	32121	3171	33451	2547	34943	1578	42944	896	35460
9L-5S		MI	13360	5432	22911	3818	25160	3064	26251	2436	27763	1440	33564	962	26321

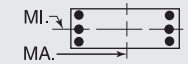
RECTANGULAR TIED COLUMNS 26" x 38"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.62	MA	19148	4920	30452	3602	32956	2927	33795	2426	34050	1691	40100	1566	18050
2E		MI	12858	4920	20789	3467	21928	2803	22105	2306	21841	1579	25205	1417	11882
6-#14	1.37	MA	18818	4834	29577	3574	31968	2910	32639	2421	32626	1721	38300	1611	15461
2L-3S		MI	12018	4834	19275	3441	20203	2817	20084	2333	19169	1637	21838	1364	10326
6-#14	1.37	MA	17754	4834	28006	3569	29954	2927	30182	2436	29310	1733	33893	1487	15518
3L-2S		MI	12683	4834	20262	3451	21454	2805	21579	2321	21153	1625	24407	1489	10243
6-#18	2.43	MA	20390	5197	33196	3775	36474	3051	38086	2502	39785	1663	47681	1504	26674
2L-3S		MI	12462	5197	20789	3618	21928	2943	22105	2390	21841	1553	25205	1094	17413
6-#18	2.43	MA	18566	5197	30452	3764	32956	3080	33795	2526	34050	1685	40100	1282	26584
3L-2S		MI	13595	5197	22495	3640	24053	2921	24645	2368	25212	1531	29532	1316	17326
8-#11	1.26	MA	18683	4799	29208	3565	31562	2905	32170	2421	32049	1734	37572	1631	14393
2L-4S		MI	11803	4799	18767	3453	19642	2808	19443	2329	18397	1662	21073	1351	9674
8-#11	1.26	MA	17936	4799	28109	3562	30153	2918	30451	2432	29718	1742	34467	1545	14434
3E		MI	12142	4799	19342	3442	20371	2817	20307	2338	19471	1654	22260	1433	9614
8-#11	1.26	MA	17410	4799	27212	3576	29010	2913	29061	2426	27936	1751	32451	1458	14453
4L-2S		MI	12611	4799	20036	3449	21258	2808	21367	2329	20877	1645	24089	1519	9561
8-#14	1.82	MA	19543	4989	31148	3671	33982	2980	35096	2463	35943	1706	42706	1580	20406
2L-4S		MI	11976	4989	19442	3553	20425	2873	20360	2358	19638	1626	22738	1198	13513
8-#14	1.82	MA	18487	4989	29577	3666	31968	2997	32639	2479	32626	1719	38300	1456	20429
3E		MI	12457	4989	20262	3538	21454	2885	21579	2371	21153	1613	24407	1313	13467
8-#14	1.82	MA	17740	4989	28292	3686	30330	2990	30649	2469	30091	1731	35443	1331	20335
4L-2S		MI	13118	4989	21250	3549	22705	2873	23074	2358	23137	1601	26977	1438	13399
8-#18	3.24	MA	21614	5474	35940	3948	39992	3175	42378	2577	45519	1634	55262	1441	35245
2L-4S		MI	12380	5474	21072	3813	22303	3039	22573	2430	22639	1526	26710	795	21364
8-#18	3.24	MA	19810	5474	33196	3936	36474	3204	38086	2601	39785	1656	47681	1220	35038
3E		MI	13200	5474	22495	3791	24053	3061	24645	2452	25212	1504	29532	993	22717
8-#18	3.24	MA	18533	5474	30944	3969	33605	3188	34600	2581	35402	1678	42781	999	32860
4L-2S		MI	14324	5474	24202	3813	26178	3039	27186	2430	28583	1482	33860	1214	22716
10-#11	1.58	MA	19194	4906	30307	3633	32971	2953	33888	2450	34380	1725	40677	1611	17852
2L-5S		MI	11810	4906	18960	3513	19883	2865	19732	2365	18724	1638	21642	1280	11903
10-#11	1.58	MA	18452	4906	29208	3630	31562	2966	32170	2461	32049	1733	37572	1525	17881
3L-4S		MI	12115	4906	19461	3520	20529	2856	20503	2356	19803	1647	22903	1318	11875
10-#11	1.58	MA	17928	4906	28311	3644	30418	2961	30780	2455	30267	1742	35556	1438	17871
4L-3S		MI	12453	4906	20036	3509	21258	2865	21367	2365	20877	1638	24089	1400	11828
10-#11	1.58	MA	17459	4906	27534	3640	29411	2974	29542	2466	28482	1733	33436	1398	17786
5L-2S		MI	12920	4906	20730	3516	22145	2856	22427	2356	22283	1630	25919	1486	11780

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis

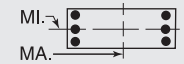


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.28	MA	20260	5145	32719	3769	35996	3050	37553	2506	39259	1692	47113	1550	25332
2L-5S		MI	11983	5145	19715	3639	20765	2954	20768	2408	20098	1589	23536	1091	15974
10-#14	2.28	MA	19212	5145	31148	3763	33982	3067	35096	2521	35943	1705	42706	1425	25314
3L-4S		MI	12415	5145	20430	3650	21676	2941	21855	2396	21622	1602	25307	1147	16589
10-#14	2.28	MA	18471	5145	29863	3783	32344	3060	33106	2511	33408	1717	39850	1300	25174
4L-3S		MI	12893	5145	21250	3635	22705	2954	23074	2408	23137	1589	26977	1263	16581
10-#14	2.28	MA	17809	5145	28750	3778	30901	3077	31333	2527	30868	1705	36834	1244	24083
5L-2S		MI	13550	5145	22237	3646	23956	2941	24570	2396	25120	1577	29547	1387	16531
10-#18	4.05	MA	21037	5750	35940	4109	39992	3328	42378	2677	45519	1627	55262	1158	43472
3L-4S		MI	13118	5750	22778	3986	24428	3157	25113	2493	26010	1478	31037	693	26281
10-#18	4.05	MA	19775	5750	33688	4142	37123	3313	38892	2657	41137	1649	50362	936	40882
4L-3S		MI	13932	5750	24202	3964	26178	3179	27186	2515	28583	1456	33860	891	27985
10-#18	4.05	MA	18646	5750	31735	4131	34591	3341	35782	2681	36742	1627	45150	839	38828
5L-2S		MI	15046	5750	25909	3986	28302	3157	29726	2493	31954	1434	38187	1112	28075
12-#11	1.89	MA	19701	5014	31406	3700	34379	3002	35606	2479	36711	1716	43782	1591	21302
2L-6S		MI	11831	5014	19183	3574	20122	2904	20059	2400	19154	1631	22299	1189	13661
12-#11	1.89	MA	18963	5014	30307	3697	32971	3014	33888	2490	34380	1724	40677	1505	21318
3L-5S		MI	12122	5014	19654	3581	20770	2913	20792	2392	20130	1623	23471	1247	13984
12-#11	1.89	MA	18442	5014	29409	3711	31827	3010	32498	2484	32598	1733	38661	1418	21280
4E		MI	12426	5014	20155	3587	21416	2904	21563	2383	21209	1631	24732	1285	14061
12-#11	1.89	MA	17977	5014	28632	3708	30820	3022	31260	2495	30813	1724	36541	1378	21091
5L-3S		MI	12763	5014	20730	3577	22145	2913	22427	2392	22283	1623	25919	1367	14028
12-#11	1.89	MA	17533	5014	27904	3705	29811	3018	30028	2489	29195	1733	34537	1322	20422
6L-2S		MI	13227	5014	21424	3584	23032	2904	23487	2383	23689	1614	27748	1453	13987
12-#14	2.73	MA	19930	5301	32719	3861	35996	3137	37553	2563	39259	1691	47113	1394	30187
3L-5S		MI	12421	5301	20703	3737	22016	3022	22264	2446	22082	1565	26106	1040	18896
12-#14	2.73	MA	19195	5301	31434	3880	34358	3129	35563	2554	36724	1703	44256	1270	30005
4E		MI	12850	5301	21417	3747	22927	3010	23351	2433	23606	1578	27877	1096	19648
12-#14	2.73	MA	18537	5301	30321	3875	32915	3147	33790	2569	34184	1691	41241	1213	28762
5L-3S		MI	13325	5301	22237	3733	23956	3022	24570	2446	25120	1565	29547	1212	19682
12-#14	2.73	MA	17912	5301	29277	3870	31469	3140	32023	2559	31883	1703	38399	1131	27954
6L-2S		MI	13979	5301	23225	3743	25207	3010	26065	2433	27104	1553	32116	1337	19647
12-#18	4.86	MA	21001	6027	36432	4315	40640	3437	43183	2732	46871	1621	57944	874	48950
4E		MI	13849	6027	24485	4159	26553	3274	27653	2555	29381	1429	35364	591	31239
12-#18	4.86	MA	19885	6027	34479	4304	38109	3465	40074	2756	42477	1599	52731	776	46782
5L-3S		MI	14657	6027	25909	4137	28302	3296	29726	2577	31954	1407	38187	789	33230
12-#18	4.86	MA	18824	6027	32645	4293	35572	3450	36975	2736	38497	1621	47849	631	43450
6L-2S		MI	15763	6027	27616	4159	30427	3274	32266	2555	35325	1385	42514	1011	33386
14-#11	2.21	MA	19471	5122	31406	3764	34379	3063	35606	2520	36711	1715	43782	1484	24739
3L-6S		MI	12143	5122	19878	3641	21010	2952	21119	2427	20560	1616	24128	1156	15748
14-#11	2.21	MA	18953	5122	30508	3778	33236	3058	34216	2514	34929	1724	41766	1398	24683
4L-5S		MI	12432	5122	20349	3648	21657	2961	21852	2418	21536	1607	25301	1214	16045
14-#11	2.21	MA	18490	5122	29731	3775	32228	3071	32979	2525	33144	1715	39646	1358	24364
5L-4S		MI	12735	5122	20849	3655	22303	2952	22623	2410	22615	1616	26561	1252	16238
14-#11	2.21	MA	18049	5122	29003	3772	31219	3066	31746	2519	31527	1724	37642	1302	23731
6L-3S		MI	13070	5122	21424	3644	23032	2961	23487	2418	23689	1607	27748	1334	16217
14-#11	2.21	MA	17620	5122	28204	3786	30257	3079	30562	2530	29946	1732	35502	1212	23304
7L-2S		MI	13533	5122	22119	3651	23919	2952	24547	2410	25095	1599	29577	1420	16184
14-#14	3.19	MA	19912	5456	33005	3978	36372	3199	38020	2596	40041	1689	48663	1239	34832
4L-5S		MI	12856	5456	21690	3834	23267	3090	23759	2483	24065	1541	28676	990	21830
14-#14	3.19	MA	19260	5456	31892	3972	34929	3217	36247	2611	37500	1677	45648	1182	33456
5L-4S		MI	13282	5456	22405	3844	24178	3078	24846	2471	25589	1554	30447	1046	22538
14-#14	3.19	MA	18639	5456	30848	3967	33483	3209	34480	2602	35199	1689	42806	1100	32666
6L-3S		MI	13755	5456	23225	3830	25207	3090	26065	2483	27104	1541	32116	1161	22759
14-#14	3.19	MA	18034	5456	29704	3987	32103	3227	32784	2617	32950	1702	39769	970	31155
7L-2S		MI	14405	5456	24212	3840	26458	3078	27560	2471	29088	1529	34686	1286	22751
14-#18	5.67	MA	21109	6303	37223	4477	41627	3589	44365	2832	48211	1570	60313	714	54699
5L-4S		MI	14575	6303	26192	4332	28678	3392	30193	2617	32752	1381	39692	490	36229

RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

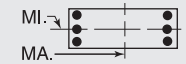
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	5.67	MA	20060	6303	35389	4466	39090	3574	41266	2812	44232	1592	55431	569	51517
6L-3S		MI	15376	6303	27616	4310	30427	3414	32266	2639	35325	1359	42514	688	38459
16-#11	2.53	MA	19460	5230	31607	3846	34644	3107	35935	2543	37261	1715	44871	1378	28080
4L-6S		MI	12453	5230	20572	3709	21897	3000	22179	2454	21966	1600	25958	1123	17839
16-#11	2.53	MA	19000	5230	30830	3843	33637	3119	34697	2554	35475	1706	42751	1338	27648
5E		MI	12741	5230	21043	3716	22544	3009	22912	2445	22942	1592	27130	1181	18115
16-#11	2.53	MA	18562	5230	30101	3839	32628	3114	33464	2548	33858	1715	40747	1282	27046
6L-4S		MI	13042	5230	21544	3722	23190	3000	23683	2437	24021	1600	28391	1219	18404
16-#11	2.53	MA	18135	5230	29303	3853	31665	3127	32281	2559	32277	1723	38607	1191	26551
7L-3S		MI	13376	5230	22119	3712	23919	3009	24547	2445	25095	1592	29577	1301	18398
16-#11	2.53	MA	17714	5230	28586	3850	30689	3122	31125	2570	30597	1715	36625	1144	25738
8L-2S		MI	13837	5230	22813	3718	24806	3000	25607	2437	26501	1583	31407	1387	18373
16-#14	3.64	MA	19976	5612	33463	4070	36943	3287	38704	2654	40817	1663	50054	1151	38164
5E		MI	13287	5612	22677	3931	24518	3159	25254	2521	26049	1517	31245	939	24775
16-#14	3.64	MA	19360	5612	32419	4065	35497	3279	36937	2644	38515	1675	47212	1069	37270
6L-4S		MI	13712	5612	23392	3942	25429	3146	26341	2509	27573	1530	33016	995	25429
16-#14	3.64	MA	18759	5612	31275	4084	34117	3297	35241	2659	36267	1688	44175	939	35817
7L-3S		MI	14182	5612	24212	3927	26458	3159	27560	2521	29088	1517	34686	1111	25824
16-#14	3.64	MA	18169	5612	30246	4079	32718	3289	33585	2675	33875	1675	41357	872	34360
8L-2S		MI	14829	5612	25200	3938	27709	3146	29055	2509	31071	1505	37256	1235	25850
16-#18	6.48	MA	21282	6580	38134	4639	42608	3698	45558	2887	49967	1563	63012	506	59608
6L-4S		MI	15295	6580	27899	4505	30802	3510	32733	2680	36123	1332	44019	388	41244
18-#11	2.84	MA	19507	5338	31929	3910	35046	3167	36416	2584	37807	1697	45856	1318	30941
5L-6S		MI	12761	5338	21266	3776	22784	3049	23239	2481	23372	1585	27787	1090	19934
18-#11	2.84	MA	19071	5338	31200	3907	34037	3163	35183	2578	36189	1706	43852	1262	30367
6L-5S		MI	13048	5338	21737	3783	23431	3057	23972	2472	24348	1576	28959	1148	20192
18-#11	2.84	MA	18646	5338	30402	3921	33074	3175	33999	2589	34608	1714	41712	1171	29806
7L-4S		MI	13348	5338	22238	3790	24077	3049	24743	2464	25427	1585	30220	1186	20561
18-#11	2.84	MA	18228	5338	29684	3918	32097	3171	32844	2600	32928	1706	39730	1124	29022
8L-3S		MI	13681	5338	22813	3779	24806	3057	25607	2472	26501	1576	31407	1268	20574
18-#11	2.84	MA	17814	5338	28912	3932	31147	3183	31635	2594	31361	1714	37787	1070	28203
9L-2S		MI	14140	5338	23507	3786	25693	3049	26667	2464	27907	1568	33236	1354	20556
18-#14	4.10	MA	20075	5767	33990	4162	37511	3349	39394	2687	41832	1661	51619	1038	41887
6L-5S		MI	13717	5767	23665	4028	25769	3227	26749	2559	28033	1493	33815	888	27727
18-#14	4.10	MA	19479	5767	32846	4181	36131	3366	37698	2702	39583	1673	48582	908	40489
7L-4S		MI	14139	5767	24380	4039	26680	3215	27836	2546	29556	1506	35586	944	28334
18-#14	4.10	MA	18892	5767	31817	4176	34732	3359	36042	2717	37192	1661	45764	841	38972
8L-3S		MI	14606	5767	25200	4024	27709	3227	29055	2559	31071	1493	37256	1060	28882
20-#11	3.16	MA	19577	5446	32299	3974	35445	3211	36901	2607	38520	1697	46957	1242	33692
6E		MI	13068	5446	21960	3844	23671	3097	24299	2508	24778	1569	29616	1058	22032
20-#11	3.16	MA	19154	5446	31501	3988	34482	3224	35718	2618	36939	1705	44817	1151	33069
7L-5S		MI	13354	5446	22431	3850	24318	3105	25032	2499	25754	1561	30788	1115	22273
20-#11	3.16	MA	18738	5446	30783	3985	33506	3219	34562	2629	35259	1697	42835	1104	32311
8L-4S		MI	13652	5446	22932	3857	24964	3097	25803	2491	26833	1569	32049	1153	22713
20-#11	3.16	MA	18327	5446	30011	3999	32556	3232	33354	2623	33692	1705	40892	1050	31451
9L-3S		MI	13983	5446	23507	3847	25693	3105	26667	2499	27907	1561	33236	1235	22740
20-#11	3.16	MA	17870	5446	29295	3996	31592	3227	32204	2634	32138	1714	39011	989	30605
10L-2S		MI	14441	5446	24201	3853	26580	3097	27727	2491	29313	1552	35065	1322	22735
20-#14	4.55	MA	20193	5923	34417	4279	38145	3436	40155	2744	42899	1659	52989	877	45171
7L-5S		MI	14144	5923	24652	4126	27020	3296	28245	2596	30016	1469	36384	838	30685
20-#14	4.55	MA	19610	5923	33388	4274	36745	3429	38499	2760	40508	1647	50170	810	43595
8L-4S		MI	14563	5923	25367	4136	27931	3283	29332	2584	31540	1482	38156	894	31251

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

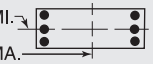
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.47	MA	19659	5554	32600	4056	35891	3272	37436	2647	39270	1696	47922	1131	36339
7L-6S		MI	13373	5554	22654	3911	24558	3145	25359	2535	26184	1554	31446	1025	24131
22-#11	3.47	MA	19246	5554	31882	4053	34914	3268	36280	2659	37590	1688	45940	1084	35605
8L-5S		MI	13658	5554	23126	3918	25205	3153	26092	2526	27160	1545	32618	1082	24359
22-#11	3.47	MA	18837	5554	31110	4067	33964	3280	35072	2652	36023	1696	43997	1030	34706
9L-4S		MI	13955	5554	23626	3925	25851	3145	26863	2518	28239	1554	33879	1121	24860
22-#11	3.47	MA	18382	5554	30394	4063	33000	3275	33923	2664	34470	1705	42116	969	33867
10L-3S		MI	14285	5554	24201	3914	26580	3153	27727	2526	29313	1545	35065	1202	24899
22-#14	5.01	MA	20323	6079	34959	4371	38759	3499	40956	2802	43825	1633	54577	779	48227
8L-5S		MI	14568	6079	25640	4223	28271	3364	29740	2634	32000	1445	38954	787	33648
24-#11	3.79	MA	19750	5662	32981	4120	36323	3316	37999	2688	39921	1679	49045	1064	38904
8L-6S		MI	13677	5662	23349	3979	25445	3193	26419	2562	27590	1538	33275	992	26232
24-#11	3.79	MA	19343	5662	32208	4134	35373	3329	36791	2682	38354	1687	47102	1010	37967
9L-5S		MI	13961	5662	23820	3985	26092	3202	27152	2553	28566	1530	34447	1049	26449
24-#11	3.79	MA	18901	5662	31493	4131	34409	3324	35641	2693	36801	1696	45221	949	37097
10L-4S		MI	14257	5662	24320	3992	26738	3193	27923	2544	29645	1538	35708	1088	26942

RECTANGULAR TIED COLUMNS 26" x 40"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.54	MA	21121	5150	33434	3789	36203	3081	37094	2557	37340	1796	43974	1671	19130
2E		MI	13457	5150	21703	3631	22859	2938	23001	2421	22636	1667	26076	1503	11929
6-#14	1.30	MA	20764	5064	32498	3761	35145	3064	35856	2551	35798	1824	42013	1715	16373
2L-3S		MI	12616	5064	20185	3607	21134	2954	20984	2449	19969	1727	22717	1450	10365
6-#14	1.30	MA	19632	5064	30830	3756	33006	3082	33247	2567	32259	1836	37298	1590	16429
3L-2S		MI	13281	5064	21173	3618	22385	2941	22479	2437	21953	1714	25286	1575	10281
6-#18	2.31	MA	22451	5427	36351	3961	39943	3205	41656	2632	43471	1769	52102	1613	28294
2L-3S		MI	13060	5427	21703	3782	22859	3078	23001	2505	22636	1641	26076	1180	17482
6-#18	2.31	MA	20507	5427	33434	3951	36203	3235	37094	2658	37340	1791	43974	1391	28204
3L-2S		MI	14195	5427	23410	3804	24983	3056	25541	2483	26007	1619	30404	1401	17383
8-#11	1.20	MA	20617	5028	32103	3752	34710	3059	35353	2551	35155	1836	41219	1733	15235
2L-4S		MI	12400	5028	19675	3620	20574	2946	20344	2446	19200	1752	21956	1438	9711
8-#11	1.20	MA	19823	5028	30936	3749	33215	3072	33529	2563	32674	1845	37900	1647	15276
3E		MI	12740	5028	20250	3609	21303	2954	21208	2455	20274	1744	23143	1520	9648
8-#11	1.20	MA	19265	5028	29985	3764	32003	3067	32056	2557	30778	1853	35743	1561	15295
4L-2S		MI	13209	5028	20944	3616	22190	2946	22268	2446	21680	1735	24972	1606	9595
8-#14	1.73	MA	21539	5219	34166	3858	37283	3133	38465	2594	39338	1811	46727	1686	21621
2L-4S		MI	12574	5219	20353	3719	21356	3010	21260	2475	20438	1715	23617	1284	13569
8-#14	1.73	MA	20414	5219	32498	3854	35145	3151	35856	2610	35798	1823	42013	1561	21644
3E		MI	13055	5219	21173	3705	22385	3022	22479	2487	21953	1703	25286	1400	13513
8-#14	1.73	MA	19622	5219	31135	3874	33408	3145	33746	2601	33093	1836	38952	1437	21550
4L-2S		MI	13717	5219	22160	3715	23636	3010	23974	2475	23937	1690	27856	1524	13442
8-#18	3.08	MA	23761	5703	39268	4134	43683	3329	46218	2707	49601	1742	60229	1555	37405
2L-4S		MI	12977	5703	21986	3978	23234	3174	23469	2545	23434	1615	27581	880	21618
8-#18	3.08	MA	21839	5703	36351	4124	39943	3359	41656	2733	43471	1764	52102	1333	37198
3E		MI	13799	5703	23410	3955	24983	3196	25541	2567	26007	1592	30404	1078	22804
8-#18	3.08	MA	20481	5703	33962	4158	36898	3345	37956	2715	38786	1787	46840	1112	35159
4L-2S		MI	14925	5703	25117	3977	27108	3174	28082	2545	29378	1570	34731	1299	22780
10-#11	1.50	MA	21163	5136	33269	3819	36205	3107	37177	2580	37637	1827	44538	1715	18905
2L-5S		MI	12407	5136	19869	3681	20815	3002	20634	2482	19526	1728	22525	1367	11955
10-#11	1.50	MA	20374	5136	32103	3817	34710	3120	35353	2592	35155	1836	41219	1628	18934
3L-4S		MI	12713	5136	20369	3687	21461	2994	21404	2473	20606	1737	23786	1405	11918
10-#11	1.50	MA	19818	5136	31151	3831	33498	3116	33880	2586	33259	1845	39061	1542	18924
4L-3S		MI	13052	5136	20944	3677	22190	3002	22268	2482	21680	1728	24972	1487	11867
10-#11	1.50	MA	19321	5136	30329	3828	32431	3129	32569	2598	31361	1836	36800	1501	18839
5L-2S		MI	13519	5136	21639	3683	23077	2994	23328	2473	23086	1719	26801	1573	11818
10-#14	2.16	MA	22306	5375	35835	3955	39422	3203	41074	2636	42877	1798	51442	1657	26850
2L-5S		MI	12580	5375	20626	3806	21697	3091	21668	2525	20898	1679	24415	1177	16129

RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

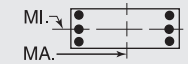
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
10-#14	2.16	MA	21189	5375	34166	3951	37283	3221	38465	2652	39338	1810	46727	1532	26833
3L-4S		MI	13013	5375	21340	3816	22607	3078	22755	2512	22422	1691	26186	1233	16657
10-#14	2.16	MA	20403	5375	32804	3971	35547	3215	36355	2643	36632	1823	43666	1408	26692
4L-3S		MI	13491	5375	22160	3802	23636	3091	23974	2525	23937	1679	27856	1349	16634
10-#14	2.16	MA	19700	5375	31624	3966	34018	3233	34476	2659	33922	1810	40448	1350	25657
5L-2S		MI	14150	5375	23148	3812	24887	3078	25469	2512	25920	1666	30426	1474	16579
10-#18	3.85	MA	23152	5980	39268	4297	43683	3483	46218	2809	49601	1738	60229	1275	46172
3L-4S		MI	13716	5980	23693	4151	25359	3292	26009	2607	26805	1566	31908	778	26531
10-#18	3.85	MA	21810	5980	36879	4331	40638	3469	42518	2790	44916	1760	54967	1053	43696
4L-3S		MI	14532	5980	25117	4128	27108	3314	28082	2630	29378	1544	34731	976	28083
10-#18	3.85	MA	20611	5980	34808	4321	37953	3499	39220	2816	40219	1738	49394	954	41401
5L-2S		MI	15649	5980	26823	4150	29233	3292	30622	2607	32749	1522	39058	1198	28142
12-#11	1.80	MA	21706	5244	34435	3887	37700	3155	39001	2610	40118	1818	47856	1696	22566
2L-6S		MI	12429	5244	20092	3741	21055	3042	20960	2517	19957	1721	23182	1276	13773
12-#11	1.80	MA	20920	5244	33269	3884	36205	3168	37177	2622	37637	1827	44538	1610	22581
3L-5S		MI	12720	5244	20563	3748	21702	3050	21694	2509	20932	1713	24354	1334	14128
12-#11	1.80	MA	20368	5244	32318	3898	34993	3164	35704	2616	35741	1836	42380	1523	22544
4E		MI	13024	5244	21064	3755	22348	3042	22464	2500	22012	1721	25615	1372	14109
12-#11	1.80	MA	19874	5244	31495	3896	33926	3177	34392	2628	33842	1828	40119	1482	22433
5L-3S		MI	13361	5244	21639	3744	23077	3050	23328	2509	23086	1713	26801	1454	14071
12-#11	1.80	MA	19404	5244	30723	3893	32857	3173	33087	2622	32121	1837	37976	1426	21705
6L-2S		MI	13827	5244	22333	3751	23964	3042	24388	2500	24492	1704	28631	1540	14028
12-#14	2.60	MA	21957	5530	35835	4048	39422	3291	41074	2695	42877	1797	51442	1503	32009
3L-5S		MI	13019	5530	21613	3903	22948	3159	23163	2562	22882	1655	26985	1127	19050
12-#14	2.60	MA	21177	5530	34472	4068	37686	3284	38964	2686	40172	1810	48381	1379	31828
4E		MI	13449	5530	22328	3913	23858	3147	24250	2550	24406	1667	28756	1183	19723
12-#14	2.60	MA	20480	5530	33292	4064	36156	3303	37085	2702	37461	1797	45162	1321	30629
5L-3S		MI	13925	5530	23148	3899	24887	3159	25469	2562	25920	1655	30426	1298	19737
12-#14	2.60	MA	19816	5530	32186	4059	34625	3296	35213	2693	35005	1810	42119	1240	29732
6L-2S		MI	14580	5530	24135	3910	26139	3147	26965	2550	27904	1642	32995	1423	19699
12-#18	4.62	MA	23122	6257	39796	4504	44377	3593	47081	2866	51047	1733	63095	995	52282
4E		MI	14448	6257	25400	4323	27483	3409	28549	2670	30176	1518	36235	677	31486
12-#18	4.62	MA	21937	6257	37725	4494	41693	3623	43783	2892	46350	1711	57522	896	50127
5L-3S		MI	15258	6257	26823	4301	29233	3432	30622	2692	32749	1495	39058	875	33337
12-#18	4.62	MA	20810	6257	35781	4484	39003	3609	40496	2873	42096	1733	52284	751	46506
6L-2S		MI	16367	6257	28530	4323	31358	3409	33162	2670	36120	1473	43385	1096	33469
14-#11	2.10	MA	21463	5352	34435	3951	37700	3217	39001	2651	40118	1819	47856	1591	26213
3L-6S		MI	12740	5352	20786	3809	21942	3090	22020	2544	21363	1706	25011	1243	15861
14-#11	2.10	MA	20913	5352	33484	3966	36488	3213	37527	2645	38222	1828	45699	1504	26157
4L-5S		MI	13030	5352	21257	3815	22589	3099	22754	2535	22338	1697	26183	1301	16168
14-#11	2.10	MA	20422	5352	32661	3963	35421	3226	36216	2657	36324	1819	43438	1464	25929
5L-4S		MI	13334	5352	21758	3822	23235	3090	23524	2527	23418	1706	27444	1339	16290
14-#11	2.10	MA	19955	5352	31890	3960	34352	3221	34911	2651	34603	1828	41294	1407	25218
6L-3S		MI	13669	5352	22333	3812	23964	3099	24388	2535	24492	1697	28631	1421	16263
14-#11	2.10	MA	19500	5352	31044	3975	33333	3234	33657	2663	32921	1837	39006	1317	24772
7L-2S		MI	14133	5352	23027	3818	24851	3090	25448	2527	25898	1688	30460	1507	16227
14-#14	3.03	MA	21944	5686	36140	4166	39824	3354	41573	2728	43711	1797	53095	1350	36958
4L-5S		MI	13454	5686	22601	4000	24199	3227	24659	2600	24865	1631	29554	1076	21985
14-#14	3.03	MA	21252	5686	34961	4161	38295	3372	39694	2744	41001	1784	49877	1292	35617
5L-4S		MI	13881	5686	23315	4011	25109	3215	25746	2587	26389	1643	31325	1132	22719
14-#14	3.03	MA	20593	5686	33854	4156	36763	3366	37822	2735	38544	1797	46834	1211	34762
6L-3S		MI	14355	5686	24135	3996	26139	3227	26965	2600	27904	1631	32995	1248	22825
14-#14	3.03	MA	19951	5686	32642	4176	35301	3384	36025	2752	36144	1809	43584	1081	33249
7L-2S		MI	15007	5686	25123	4007	27390	3215	28460	2587	29888	1618	35565	1372	22807

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis

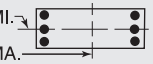


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#18	5.38	MA	23247	6533	40642	4667	45432	3747	48345	2967	52480	1685	65649	837	58661
5L-4S		MI	15175	6533	27106	4496	29608	3527	31089	2732	33547	1469	40563	575	36474
14-#18	5.38	MA	22132	6533	38698	4657	42743	3733	45058	2949	48226	1707	60411	692	55095
6L-3S		MI	15978	6533	28530	4474	31358	3549	33162	2754	36120	1447	43385	773	38575
16-#11	2.40	MA	21455	5460	34650	4033	37983	3261	39351	2675	40704	1819	49017	1486	29765
4L-6S		MI	13051	5460	21480	3876	22829	3138	23081	2571	22769	1690	26840	1210	17953
16-#11	2.40	MA	20967	5460	33827	4030	36916	3274	38040	2686	38805	1811	46757	1445	29416
5E		MI	13339	5460	21951	3883	23476	3147	23814	2562	23744	1682	28013	1268	18238
16-#11	2.40	MA	20502	5460	33056	4028	35847	3270	36734	2681	37084	1819	44613	1389	28739
6L-4S		MI	13641	5460	22452	3890	24122	3138	24584	2554	24824	1690	29274	1306	18464
16-#11	2.40	MA	20050	5460	32211	4042	34828	3283	35481	2692	35403	1828	42325	1299	28307
7L-3S		MI	13976	5460	23027	3879	24851	3147	25448	2562	25898	1682	30460	1388	18448
16-#11	2.40	MA	19604	5460	31451	4039	33794	3279	34257	2704	33616	1820	40211	1251	27412
8L-2S		MI	14438	5460	23721	3886	25738	3138	26508	2554	27304	1673	32289	1474	18419
16-#14	3.46	MA	22017	5842	36629	4258	40434	3442	42303	2787	44540	1771	54591	1263	40619
5E		MI	13886	5842	23588	4097	25450	3296	26154	2637	26849	1607	32124	1025	24929
16-#14	3.46	MA	21363	5842	35523	4254	38902	3436	40431	2778	42084	1784	51548	1182	39801
6L-4S		MI	14312	5842	24303	4108	26360	3283	27241	2625	28373	1619	33895	1081	25608
16-#14	3.46	MA	20727	5842	34311	4274	37440	3454	38634	2794	39683	1796	48299	1052	38205
7L-3S		MI	14783	5842	25123	4094	27390	3296	28460	2637	29888	1607	35565	1197	25896
16-#14	3.46	MA	20100	5842	33221	4269	35957	3447	36880	2810	37132	1784	45290	984	36777
8L-2S		MI	15431	5842	26110	4104	28641	3283	29955	2625	31871	1594	38134	1322	25905
16-#18	6.15	MA	23440	6810	41615	4830	46482	3857	49620	3024	54357	1680	68539	634	63710
6L-4S		MI	15896	6810	28813	4669	31733	3645	33629	2794	36918	1421	44890	473	41487
18-#11	2.70	MA	21508	5568	34993	4098	38411	3322	39864	2716	41287	1802	50075	1426	32912
5L-6S		MI	13359	5568	22174	3944	23716	3186	24141	2598	24175	1675	28670	1177	20049
18-#11	2.70	MA	21046	5568	34222	4095	37343	3318	38558	2710	39566	1811	47932	1370	32265
6L-5S		MI	13647	5568	22645	3950	24363	3195	24874	2589	25150	1666	29842	1235	20314
18-#11	2.70	MA	20596	5568	33377	4109	36323	3331	37305	2722	37884	1820	45644	1280	31775
7L-4S		MI	13948	5568	23146	3957	25009	3186	25644	2581	26230	1675	31103	1273	20624
18-#11	2.70	MA	20153	5568	32617	4107	35289	3327	36081	2733	36097	1811	43530	1232	30901
8L-3S		MI	14281	5568	23721	3947	25738	3195	26508	2589	27304	1666	32289	1355	20626
18-#11	2.70	MA	19714	5568	31799	4121	34283	3340	34802	2728	34431	1820	41452	1178	30120
9L-2S		MI	14741	5568	24415	3953	26625	3186	27568	2581	28710	1657	34119	1441	20605
18-#14	3.89	MA	22127	5997	37191	4351	41041	3505	43040	2820	45623	1771	56263	1153	44739
6L-5S		MI	14316	5997	24575	4195	26701	3364	27649	2675	28833	1583	34694	975	27882
18-#14	3.89	MA	21495	5997	35979	4371	39579	3523	41243	2836	43223	1783	53013	1023	43172
7L-4S		MI	14739	5997	25290	4205	27612	3352	28736	2662	30357	1595	36465	1031	28513
18-#14	3.89	MA	20873	5997	34890	4366	38096	3517	39489	2852	40672	1771	50005	955	41683
8L-3S		MI	15208	5997	26110	4191	28641	3364	29955	2675	31871	1583	38134	1146	28958
18-#14	3.89	MA	20258	5997	33717	4387	36653	3535	37654	2844	38293	1783	47054	877	40139
9L-2S		MI	15854	5997	27098	4201	29892	3352	31450	2662	33855	1570	40704	1271	28993
20-#11	3.00	MA	21586	5676	35388	4162	38838	3367	40382	2740	42047	1802	51251	1351	35797
6E		MI	13667	5676	22869	4011	24603	3234	25201	2625	25581	1659	30499	1144	22148
20-#11	3.00	MA	21139	5676	34543	4177	37818	3380	39129	2751	40366	1811	48963	1261	35242
7L-5S		MI	13953	5676	23340	4018	25250	3243	25934	2616	26556	1650	31671	1202	22397
20-#11	3.00	MA	20698	5676	33783	4174	36784	3375	37905	2763	38579	1803	46849	1213	34395
8L-4S		MI	14253	5676	23840	4024	25896	3234	26704	2608	27636	1659	32932	1240	22780
20-#11	3.00	MA	20260	5676	32966	4188	35778	3388	36626	2757	36912	1812	44771	1159	33572
9L-3S		MI	14584	5676	24415	4014	26625	3243	27568	2616	28710	1650	34119	1322	22799
20-#11	3.00	MA	19766	5676	32208	4186	34757	3384	35408	2769	35260	1820	42758	1098	32633
10L-2S		MI	15043	5676	25110	4021	27512	3234	28628	2608	30116	1642	35948	1408	22785
20-#14	4.33	MA	22258	6153	37647	4468	41717	3593	43852	2879	46762	1770	57728	994	48149
7L-5S		MI	14744	6153	25563	4292	27952	3432	29144	2712	30816	1559	37263	924	30840
20-#14	4.33	MA	21641	6153	36558	4464	40235	3587	42098	2895	44211	1758	54719	926	46600
8L-4S		MI	15165	6153	26278	4302	28863	3420	30231	2700	32340	1571	39034	980	31428
20-#14	4.33	MA	21029	6153	35385	4484	38792	3605	40263	2886	41832	1770	51769	848	45072
9L-3S		MI	15631	6153	27098	4288	29892	3432	31450	2712	33855	1559	40704	1096	32013

RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.30	MA	21678	5784	35709	4244	39313	3428	40953	2781	42847	1802	52281	1243	38715
7L-6S		MI	13972	5784	23563	4079	25490	3282	26261	2652	26987	1644	32328	1112	24249
22-#11	3.30	MA	21240	5784	34950	4241	38279	3424	39729	2792	41060	1794	50168	1195	37895
8L-5S		MI	14258	5784	24034	4085	26137	3291	26994	2643	27963	1635	33501	1169	24483
22-#11	3.30	MA	20802	5784	34132	4256	37273	3437	38449	2787	39394	1803	48089	1141	37031
9L-4S		MI	14556	5784	24535	4092	26783	3282	27764	2634	29042	1644	34761	1207	24931
22-#11	3.30	MA	20313	5784	33374	4253	36252	3433	37232	2798	37741	1812	46076	1079	36116
10L-3S		MI	14887	5784	25110	4081	27512	3291	28628	2643	30116	1635	35948	1289	24961
22-#14	4.76	MA	22402	6309	38226	4561	42373	3656	44707	2937	47751	1745	59434	897	51526
8L-5S		MI	15169	6309	26550	4389	29203	3501	30640	2750	32800	1535	39833	873	33804
22-#14	4.76	MA	21791	6309	37053	4581	40931	3675	42872	2928	45372	1757	56483	819	49818
9L-4S		MI	15588	6309	27265	4400	30114	3488	31727	2738	34324	1547	41604	929	34354
24-#11	3.60	MA	21779	5891	36116	4309	39774	3472	41553	2822	43542	1785	53486	1176	41399
8L-6S		MI	14277	5891	24257	4146	26377	3331	27321	2679	28393	1628	34158	1079	26351
24-#11	3.60	MA	21341	5891	35298	4323	38768	3485	40273	2816	41875	1794	51408	1122	40496
9L-5S		MI	14561	5891	24728	4153	27024	3339	28054	2670	29369	1619	35330	1136	26573
24-#11	3.60	MA	20857	5891	34541	4320	37747	3481	39056	2828	40223	1803	49395	1061	39603
10L-4S		MI	14858	5891	25229	4159	27670	3331	28824	2661	30448	1628	36591	1175	27078
24-#14	5.19	MA	22548	6464	38722	4678	43069	3744	45482	2971	48911	1744	61198	790	54714
9L-5S		MI	15592	6464	27538	4486	30454	3569	32135	2788	34784	1511	42403	823	36771

RECTANGULAR TIED COLUMNS 26" x 42"

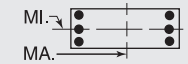
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.47	MA	23186	5380	36547	3975	39594	3234	40537	2687	40762	1900	47997	1775	20210
2E		MI	14055	5380	22618	3796	23789	3074	23897	2535	23431	1756	26947	1588	11976
6-#14	1.24	MA	22802	5293	35549	3948	38465	3217	39215	2682	39083	1926	45873	1817	17284
2L-3S		MI	13214	5293	21096	3774	22066	3091	21883	2566	20770	1816	23595	1537	10403
6-#14	1.24	MA	21601	5293	33784	3943	36201	3236	36454	2699	35327	1939	40850	1692	17340
3L-2S		MI	13880	5293	22083	3784	23317	3078	23378	2553	22753	1803	26165	1661	10318
6-#18	2.20	MA	24604	5657	39637	4148	43555	3358	45369	2762	47289	1875	56671	1721	29914
2L-3S		MI	13658	5657	22618	3947	23789	3213	23897	2620	23431	1729	26947	1265	17549
6-#18	2.20	MA	22540	5657	36547	4139	39594	3390	40537	2790	40762	1897	47997	1499	29824
3L-2S		MI	14795	5657	24324	3968	25914	3191	26437	2598	26802	1707	31275	1486	17439
8-#11	1.14	MA	22644	5258	35128	3939	38001	3212	38679	2682	38365	1936	45014	1835	16077
2L-4S		MI	12998	5258	20584	3787	21506	3083	21245	2563	20003	1842	22839	1525	9746
8-#11	1.14	MA	21803	5258	33894	3936	36419	3208	36749	2694	35740	1945	41481	1749	16118
3E		MI	13338	5258	21159	3777	22235	3092	22109	2572	21076	1833	24025	1606	9681
8-#11	1.14	MA	21212	5258	32889	3951	35139	3222	35193	2689	33737	1955	39182	1662	16138
4L-2S		MI	13808	5258	21853	3783	23122	3083	23169	2563	22483	1825	25855	1693	9628
8-#14	1.65	MA	23627	5449	37315	4045	40728	3287	41977	2724	42840	1914	50896	1790	22836
2L-4S		MI	13172	5449	21263	3885	22288	3147	22159	2591	21238	1804	24495	1370	13623
8-#14	1.65	MA	22435	5449	35549	4041	38465	3306	39215	2741	39083	1926	45873	1665	22859
3E		MI	13653	5449	22083	3871	23317	3159	23378	2603	22753	1792	26165	1486	13558
8-#14	1.65	MA	21596	5449	34109	4061	36629	3300	36985	2733	36213	1939	42608	1541	22765
4L-2S		MI	14316	5449	23071	3881	24568	3147	24874	2591	24737	1779	28735	1611	13485
8-#18	2.93	MA	26002	5933	42727	4321	47516	3483	50202	2838	53815	1850	65346	1666	39565
2L-4S		MI	13574	5933	22900	4142	24164	3309	24365	2660	24228	1703	28452	965	21866
8-#18	2.93	MA	23960	5933	39637	4312	43555	3514	45369	2865	47289	1872	56671	1445	39358
3E		MI	14398	5933	24324	4120	25914	3331	26437	2682	26802	1681	31275	1163	22887
8-#18	2.93	MA	22522	5933	37110	4347	40335	3501	41455	2848	42300	1894	51047	1223	37484
4L-2S		MI	15526	5933	26031	4141	28039	3309	28978	2660	30173	1659	35602	1385	22843

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis

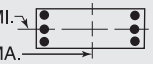


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.43	MA	23225	5366	36362	4006	39582	3261	40608	2711	40990	1927	48546	1818	19958
2L-5S		MI	13005	5366	20777	3848	21747	3140	21535	2599	20329	1818	23407	1453	12003
10-#11	1.43	MA	22388	5366	35128	4004	38001	3257	38679	2723	38365	1937	45014	1731	19987
3L-4S		MI	13311	5366	21278	3855	22393	3131	22305	2590	21409	1827	24668	1492	11958
10-#11	1.43	MA	21801	5366	34123	4018	36720	3270	37122	2718	36362	1946	42714	1645	19977
4L-3S		MI	13650	5366	21853	3844	23122	3140	23169	2599	22483	1818	25855	1573	11905
10-#11	1.43	MA	21276	5366	33254	4016	35593	3266	35738	2730	34356	1939	40312	1603	19892
5L-2S		MI	14118	5366	22547	3851	24009	3131	24229	2590	23889	1809	27684	1660	11854
10-#14	2.06	MA	24444	5605	39080	4142	42991	3357	44738	2767	46597	1901	55919	1763	28369
2L-5S		MI	13178	5605	21536	3972	22628	3227	22568	2641	21698	1768	25294	1264	16280
10-#14	2.06	MA	23260	5605	37315	4138	40728	3376	41977	2784	42840	1914	50896	1638	28352
3L-4S		MI	13611	5605	22251	3982	23539	3215	23655	2628	23222	1780	27065	1320	16722
10-#14	2.06	MA	22428	5605	35875	4159	38893	3369	39746	2775	39970	1927	47631	1514	28211
4L-3S		MI	14090	5605	23071	3968	24568	3227	24874	2641	24737	1768	28735	1435	16685
10-#14	2.06	MA	21685	5605	34629	4155	37277	3388	37761	2792	37095	1915	44208	1455	27244
5L-2S		MI	14750	5605	24058	3979	25819	3215	26369	2628	26721	1755	31304	1560	16626
10-#18	3.66	MA	25361	6210	42727	4485	47516	3638	50202	2941	53815	1847	65346	1390	48872
3L-4S		MI	14314	6210	24607	4315	26289	3427	26905	2722	27599	1654	32779	864	26775
10-#18	3.66	MA	23939	6210	40200	4520	44296	3625	46288	2924	48827	1869	59721	1169	46538
4L-3S		MI	15132	6210	26031	4292	28039	3449	28978	2744	30173	1632	35602	1062	28177
10-#18	3.66	MA	22670	6210	38011	4511	41458	3656	42801	2951	43828	1847	53787	1067	43991
5L-2S		MI	16251	6210	27738	4314	30163	3427	31518	2722	33544	1610	39929	1283	28211
12-#11	1.71	MA	23803	5474	37595	4074	41164	3309	42537	2740	43615	1919	52079	1800	23829
2L-6S		MI	13026	5474	21000	3909	21987	3179	21862	2634	20760	1811	24065	1363	13881
12-#11	1.71	MA	22970	5474	36362	4071	39582	3305	40608	2752	40990	1928	48546	1714	23845
3L-5S		MI	13317	5474	21471	3915	22634	3188	22595	2625	21735	1802	25237	1421	14182
12-#11	1.71	MA	22385	5474	35357	4086	38302	3319	39052	2747	38987	1938	46247	1627	23808
4E		MI	13622	5474	21972	3922	23280	3179	23365	2617	22815	1811	26498	1459	14155
12-#11	1.71	MA	21863	5474	34488	4083	37175	3315	37667	2759	36981	1930	43845	1586	23697
5L-3S		MI	13960	5474	22547	3912	24009	3188	24229	2625	23889	1802	27684	1541	14112
12-#11	1.71	MA	21367	5474	33674	4081	36047	3328	36288	2754	35164	1939	41562	1530	22995
6L-2S		MI	14426	5474	23241	3918	24896	3179	25289	2617	25295	1794	29513	1627	14067
12-#14	2.47	MA	24077	5760	39080	4235	42991	3445	44738	2826	46597	1902	55919	1611	33832
3L-5S		MI	13616	5760	22524	4069	23879	3296	24063	2678	23682	1744	27864	1213	19200
12-#14	2.47	MA	23252	5760	37640	4256	41156	3439	42507	2818	43726	1914	52653	1487	33650
4E		MI	14047	5760	23238	4080	24790	3283	25150	2666	25206	1756	29635	1269	19795
12-#14	2.47	MA	22514	5760	36395	4252	39541	3458	40522	2835	40852	1902	49231	1428	32509
5L-3S		MI	14524	5760	24058	4065	25819	3296	26369	2678	26721	1744	31304	1385	19793
12-#14	2.47	MA	21812	5760	35226	4248	37923	3452	38545	2826	38246	1915	45987	1347	31518
6L-2S		MI	15180	5760	25046	4076	27070	3283	27864	2666	28704	1731	33874	1509	19749
12-#18	4.40	MA	25338	6486	43290	4693	48257	3749	51120	2999	55354	1845	68396	1114	55642
4E		MI	15047	6486	26314	4488	28414	3545	29445	2785	30970	1606	37107	762	31727
12-#18	4.40	MA	24083	6486	41101	4684	45419	3780	47634	3026	50355	1822	62461	1013	53243
5L-3S		MI	15859	6486	27738	4465	30163	3567	31518	2807	33544	1584	39929	960	33440
12-#18	4.40	MA	22889	6486	39047	4675	42577	3767	44160	3009	45825	1845	56866	868	49597
6L-2S		MI	16970	6486	29445	4487	32288	3545	34058	2785	36915	1562	44256	1181	33549
14-#11	2.00	MA	23547	5582	37595	4139	41164	3354	42537	2782	43615	1920	52079	1696	27687
3L-6S		MI	13338	5582	21694	3976	22874	3228	22922	2661	22166	1796	25894	1330	15970
14-#11	2.00	MA	22966	5582	36590	4153	39883	3367	40981	2777	41612	1929	49779	1610	27631
4L-5S		MI	13628	5582	22165	3983	23521	3236	23655	2652	23141	1787	27066	1388	16288
14-#11	2.00	MA	22447	5582	35722	4151	38756	3363	39596	2789	39606	1921	47377	1568	27498
5L-4S		MI	13932	5582	22666	3990	24167	3228	24426	2644	24221	1796	28327	1426	16340
14-#11	2.00	MA	21953	5582	34907	4148	37628	3377	38218	2784	37789	1931	45094	1512	26713
6L-3S		MI	14268	5582	23241	3979	24896	3236	25289	2652	25295	1787	29513	1508	16308
14-#11	2.00	MA	21472	5582	34015	4163	36552	3373	36894	2796	36014	1940	42659	1422	26223
7L-2S		MI	14732	5582	23935	3986	25783	3228	26349	2644	26701	1778	31343	1594	16270
14-#14	2.88	MA	24068	5916	39406	4353	43419	3509	45268	2860	47483	1902	57676	1460	39084
4L-5S		MI	14052	5916	23511	4166	25130	3364	25558	2716	25666	1720	30433	1162	22135

RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

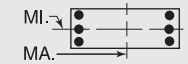
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.88	MA	23336	5916	38160	4349	41804	3528	43284	2877	44609	1890	54254	1401	37791
5L-4S		MI	14481	5916	24226	4177	26041	3352	26645	2703	27189	1732	32204	1218	22856
14-#14	2.88	MA	22640	5916	36992	4345	40186	3522	41307	2869	42003	1902	51010	1320	36846
6L-3S		MI	14955	5916	25046	4163	27070	3364	27864	2716	28704	1720	33874	1334	22890
14-#14	2.88	MA	21961	5916	35712	4366	38643	3540	39409	2886	39457	1915	47547	1190	35363
7L-2S		MI	15608	5916	26033	4173	28321	3352	29360	2703	30688	1707	36444	1459	22860
14-#18	5.13	MA	25479	6763	44191	4857	49381	3904	52466	3102	56881	1798	71136	958	62518
5L-4S		MI	15775	6763	28021	4661	30538	3662	31985	2847	34341	1557	41434	660	36713
14-#18	5.13	MA	24299	6763	42137	4848	46538	3891	48993	3085	52352	1820	65541	813	58709
6L-3S		MI	16581	6763	29445	4638	32288	3684	34058	2869	36915	1535	44256	858	38686
14-#18	5.13	MA	23151	6763	39888	4883	43824	3923	45657	3112	47926	1842	59563	582	55067
7L-2S		MI	17684	6763	31152	4660	34413	3662	36598	2847	40286	1513	48584	1080	38852
16-#11	2.29	MA	23543	5690	37824	4221	41465	3415	42910	2806	44237	1920	53312	1592	31450
4L-6S		MI	13648	5690	22389	4044	23761	3276	23982	2688	23572	1780	27723	1297	18063
16-#11	2.29	MA	23027	5690	36955	4218	40338	3412	41526	2818	42231	1913	50910	1551	31195
5E		MI	13938	5690	22860	4050	24408	3284	24715	2679	24547	1771	28895	1355	18357
16-#11	2.29	MA	22535	5690	36141	4216	39210	3425	40147	2813	40414	1922	48627	1495	30439
6L-4S		MI	14240	5690	23360	4057	25054	3276	25486	2671	25627	1780	30156	1393	18517
16-#11	2.29	MA	22057	5690	35249	4230	38134	3421	38824	2825	38639	1932	46191	1405	29966
7L-3S		MI	14575	5690	23935	4046	25783	3284	26349	2679	26701	1771	31343	1475	18496
16-#11	2.29	MA	21586	5690	34447	4228	37042	3435	37532	2837	36752	1924	43945	1356	29099
8L-2S		MI	15038	5690	24630	4053	26670	3276	27409	2671	28107	1763	33172	1561	18464
16-#14	3.30	MA	24151	6072	39926	4446	44067	3598	46045	2919	48365	1877	59277	1374	43087
5E		MI	14485	6072	24499	4264	26382	3432	27054	2753	27649	1696	33003	1112	25079
16-#14	3.30	MA	23460	6072	38758	4442	42450	3592	44068	2911	45760	1890	56033	1293	42182
6L-4S		MI	14911	6072	25213	4274	27292	3420	28140	2741	29173	1708	34774	1168	25784
16-#14	3.30	MA	22786	6072	37478	4463	40906	3610	42170	2928	43214	1903	52570	1163	40614
7L-3S		MI	15383	6072	26033	4260	28321	3432	29360	2753	30688	1696	36444	1283	25965
16-#14	3.30	MA	22124	6072	36328	4459	39340	3604	40317	2945	40508	1891	49371	1094	39226
8L-2S		MI	16033	6072	27021	4270	29572	3420	30855	2741	32671	1683	39013	1408	25962
16-#18	5.86	MA	25692	7040	45227	5021	50499	4015	53825	3160	58879	1795	74215	759	67847
6L-4S		MI	16497	7040	29728	4833	32663	3780	34525	2909	37712	1509	45761	559	41725
16-#18	5.86	MA	24556	7040	42978	5056	47786	4047	50490	3187	54453	1817	68237	527	64097
7L-3S		MI	17298	7040	31152	4811	34413	3802	36598	2931	40286	1487	48584	757	43918
18-#11	2.57	MA	23602	5798	38189	4286	41919	3460	43455	2848	44856	1904	54443	1533	34894
5L-6S		MI	13958	5798	23083	4111	24648	3324	25042	2715	24978	1764	29553	1264	20160
18-#11	2.57	MA	23114	5798	37375	4283	40791	3473	42076	2842	43039	1914	52160	1477	34171
6L-5S		MI	14246	5798	23554	4118	25295	3332	25775	2706	25953	1756	30725	1322	20434
18-#11	2.57	MA	22638	5798	36482	4298	39715	3470	40753	2855	41264	1923	49724	1387	33712
7L-4S		MI	14547	5798	24055	4124	25941	3324	26546	2698	27033	1764	31986	1360	20689
18-#11	2.57	MA	22170	5798	35681	4295	38623	3483	39461	2867	39377	1915	47478	1339	32793
8L-3S		MI	14881	5798	24630	4114	26670	3332	27409	2706	28107	1756	33172	1442	20677
18-#11	2.57	MA	21687	5798	34817	4310	37562	3479	38111	2862	37618	1925	45264	1285	32058
9L-2S		MI	15341	5798	25324	4121	27557	3324	28469	2698	29513	1747	35001	1528	20652
18-#14	3.71	MA	24273	6227	40523	4540	44713	3661	46829	2954	49517	1878	61056	1266	47525
6L-5S		MI	14915	6227	25486	4361	27633	3501	28549	2791	29633	1672	35573	1061	28032
18-#14	3.71	MA	23605	6227	39243	4560	43169	3680	44931	2970	46971	1890	57593	1136	45876
7L-4S		MI	15340	6227	26201	4371	28543	3488	29636	2779	31157	1684	37344	1117	28687
18-#14	3.71	MA	22947	6227	38093	4556	41604	3674	43078	2987	44265	1878	54394	1067	44426
8L-3S		MI	15810	6227	27021	4357	29572	3501	30855	2791	32671	1672	39013	1233	29031
18-#14	3.71	MA	22287	6227	36855	4577	40080	3693	41141	2979	41742	1891	51248	989	42722
9L-2S		MI	16456	6227	28008	4368	30823	3488	32350	2779	34655	1659	41583	1357	29058
18-#18	6.59	MA	25947	7316	46068	5229	51747	4171	55322	3263	60980	1792	76912	473	73150
7L-4S		MI	17216	7316	31434	5006	34788	3898	37066	2972	41083	1460	50088	457	46756

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

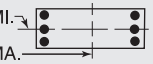
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.86	MA	23689	5906	38608	4351	42373	3522	44006	2872	45664	1905	55692	1460	37909
6E		MI	14265	5906	23777	4178	25535	3372	26102	2742	26384	1749	31382	1231	22260
20-#11	2.86	MA	23216	5906	37716	4365	41297	3518	42682	2884	43889	1914	53257	1370	37432
7L-5S		MI	14552	5906	24248	4185	26182	3381	26835	2733	27359	1740	32554	1289	22516
20-#11	2.86	MA	22750	5906	36914	4363	40205	3531	41391	2896	42002	1907	51011	1321	36492
8L-4S		MI	14852	5906	24749	4192	26828	3372	27606	2724	28439	1749	33815	1327	22844
20-#11	2.86	MA	22279	5906	36051	4377	39143	3528	40040	2891	40243	1916	48797	1267	35715
9L-3S		MI	15185	5906	25324	4181	27557	3381	28469	2733	29513	1740	35001	1409	22853
20-#11	2.86	MA	21755	5906	35252	4375	38066	3541	38755	2903	38499	1926	46652	1206	34680
10L-2S		MI	15644	5906	26018	4188	28444	3372	29530	2724	30919	1732	36831	1495	22835
20-#14	4.12	MA	24417	6383	41009	4657	45433	3750	47692	3013	50727	1878	62616	1109	51148
7L-5S		MI	15344	6383	26473	4458	28884	3569	30044	2829	31617	1648	38142	1010	30991
20-#14	4.12	MA	23764	6383	39859	4653	43867	3744	45840	3030	48022	1866	59416	1040	49637
8L-4S		MI	15766	6383	27188	4469	29794	3557	31131	2816	33140	1660	39913	1066	31602
20-#14	4.12	MA	23105	6383	38621	4674	42344	3763	43902	3021	45499	1879	56271	962	47978
9L-3S		MI	16234	6383	28008	4454	30823	3569	32350	2829	34655	1648	41583	1182	32090
22-#11	3.14	MA	23790	6013	38950	4433	42878	3566	44612	2913	46514	1906	56789	1352	41109
7L-6S		MI	14571	6013	24471	4246	26422	3420	27162	2769	27790	1733	33211	1198	24362
22-#11	3.14	MA	23327	6013	38148	4430	41786	3580	43320	2925	44627	1898	54543	1304	40197
8L-5S		MI	14857	6013	24942	4253	27069	3429	27895	2760	28765	1725	34383	1256	24603
22-#11	3.14	MA	22856	6013	37285	4445	40724	3576	41969	2920	42868	1907	52330	1250	39378
9L-4S		MI	15156	6013	25443	4259	27715	3420	28666	2751	29845	1733	35644	1294	24999
22-#11	3.14	MA	22337	6013	36486	4442	39647	3589	40684	2932	41123	1917	50185	1189	38367
10L-3S		MI	15488	6013	26018	4249	28444	3429	29530	2760	30919	1725	36831	1376	25024
22-#11	3.14	MA	21836	6013	35700	4440	38591	3586	39351	2927	39263	1909	47995	1137	37205
11L-2S		MI	15945	6013	26712	4255	29331	3420	30590	2751	32325	1716	38660	1462	25013
22-#14	4.53	MA	24575	6538	41624	4751	46130	3814	48601	3072	51779	1853	64439	1012	54858
8L-5S		MI	15770	6538	27461	4555	30135	3638	31539	2866	33600	1624	40712	960	33956
22-#14	4.53	MA	23916	6538	40386	4771	44607	3832	46664	3064	49255	1866	61294	935	53242
9L-4S		MI	16190	6538	28176	4566	31045	3625	32626	2854	35124	1636	42483	1016	34527
24-#11	3.43	MA	23900	6121	39382	4498	43368	3628	45249	2955	47252	1889	58076	1286	43907
8L-6S		MI	14876	6121	25165	4313	27309	3468	28222	2796	29196	1718	35040	1165	26466
24-#11	3.43	MA	23430	6121	38518	4512	42306	3624	43899	2950	45493	1899	55862	1232	43047
9L-5S		MI	15161	6121	25636	4320	27956	3477	28955	2787	30171	1709	36213	1223	26693
24-#11	3.43	MA	22915	6121	37719	4510	41229	3638	42614	2962	43748	1908	53718	1171	42060
10L-4S		MI	15459	6121	26137	4327	28602	3468	29726	2778	31251	1718	37474	1261	27149
24-#11	3.43	MA	22417	6121	36933	4507	40173	3634	41280	2957	41888	1901	51528	1120	40871
11L-3S		MI	15789	6121	26712	4316	29331	3477	30590	2787	32325	1709	38660	1343	27182
24-#14	4.95	MA	24722	6694	42152	4869	46870	3902	49425	3106	53012	1854	66317	908	58503
9L-5S		MI	16194	6694	28448	4653	31386	3706	33035	2904	35584	1600	43282	909	36924

RECTANGULAR TIED COLUMNS 26" x 44"

4-#18	1.40	MA	25344	5610	39791	4162	43128	3388	44121	2818	44315	2003	52167	1879	21290
2E		MI	14654	5610	23532	3960	24719	3209	24793	2650	24225	1844	27819	1673	12021
6-#14	1.18	MA	24932	5523	38731	4134	41927	3371	42717	2812	42468	2026	49881	1919	18195
2L-3S		MI	13811	5523	22006	3940	22998	3227	22783	2682	21570	1905	24474	1623	10439
6-#14	1.18	MA	23663	5523	36869	4131	39539	3365	39804	2830	38504	2040	44550	1794	18251
3L-2S		MI	14478	5523	22994	3950	24249	3215	24278	2669	23553	1893	27044	1748	10354
6-#18	2.10	MA	26851	5886	43054	4335	47310	3512	49224	2893	51238	1980	61389	1828	31534
2L-3S		MI	14256	5886	23532	4111	24719	3349	24793	2735	24225	1817	27819	1350	17613
6-#18	2.10	MA	24666	5886	39791	4327	43128	3544	44121	2922	44315	2002	52167	1606	31444
3L-2S		MI	15394	5886	25239	4133	26844	3326	27334	2712	27596	1795	32146	1572	17493
8-#11	1.09	MA	24763	5488	38284	4126	41435	3366	42147	2812	41705	2036	48956	1936	16920
2L-4S		MI	13596	5488	21492	3955	22438	3221	22147	2680	20805	1932	23722	1612	9779
8-#11	1.09	MA	23874	5488	36983	4123	39767	3362	40112	2825	38936	2046	45209	1850	16961
3E		MI	13936	5488	22067	3944	23167	3229	23011	2689	21879	1923	24908	1693	9714

RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis



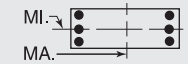
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.09	MA	23251	5488	35924	4138	38417	3376	38472	2820	36826	2056	42768	1764	16980
4L-2S		MI	14406	5488	22761	3951	24054	3221	24071	2680	23285	1915	26738	1780	9660
8-#14	1.57	MA	25808	5679	40594	4232	44315	3441	45631	2855	46432	2014	55212	1894	24051
2L-4S		MI	13769	5679	22174	4051	23219	3283	23059	2707	22039	1894	25374	1457	13674
8-#14	1.57	MA	24547	5679	38731	4228	41927	3435	42717	2872	42468	2027	49881	1769	24074
3E		MI	14252	5679	22994	4037	24249	3296	24278	2719	23553	1881	27044	1572	13602
8-#14	1.57	MA	23663	5679	37214	4249	39993	3454	40367	2865	39443	2041	46411	1644	23980
4L-2S		MI	14915	5679	23981	4048	25500	3283	25773	2707	25537	1869	29614	1697	13526
8-#18	2.80	MA	28336	6163	46317	4508	51493	3636	54327	2968	58161	1957	70611	1776	41725
2L-4S		MI	14171	6163	23815	4306	25095	3444	25261	2775	25023	1791	29323	1051	22108
8-#18	2.80	MA	26175	6163	43054	4500	47310	3668	49224	2997	51238	1979	61389	1555	41518
3E		MI	14997	6163	25239	4284	26844	3466	27334	2797	27596	1769	32146	1249	22967
8-#18	2.80	MA	24656	6163	40389	4536	43914	3657	45097	2981	45946	2001	55401	1333	39835
4L-2S		MI	16127	6163	26946	4306	28969	3444	29874	2775	30967	1747	36473	1470	22905
10-#11	1.36	MA	25380	5596	39585	4193	43102	3414	44182	2841	44473	2028	52703	1920	21011
2L-5S		MI	13602	5596	21685	4015	22679	3278	22436	2715	21132	1908	24290	1540	12048
10-#11	1.36	MA	24495	5596	38284	4191	41435	3411	42147	2854	41705	2038	48956	1834	21040
3L-4S		MI	13909	5596	22186	4022	23325	3269	23207	2707	22211	1916	25551	1579	11998
10-#11	1.36	MA	23875	5596	37225	4206	40085	3425	40507	2849	39595	2048	46514	1747	21030
4L-3S		MI	14248	5596	22761	4011	24054	3278	24071	2715	23285	1908	26738	1660	11942
10-#11	1.36	MA	23322	5596	36311	4204	38899	3421	39049	2862	37483	2040	43971	1705	20945
5L-2S		MI	14716	5596	23455	4018	24941	3269	25131	2707	24691	1899	28567	1747	11890
10-#14	1.97	MA	26675	5835	42457	4329	46703	3510	48544	2897	50396	2001	60543	1868	29888
2L-5S		MI	13775	5835	22447	4138	23560	3364	23467	2757	22498	1857	26173	1350	16426
10-#14	1.97	MA	25423	5835	40594	4325	44315	3505	45631	2915	46432	2015	55212	1744	29871
3L-4S		MI	14209	5835	23161	4149	24471	3352	24554	2744	24022	1870	27944	1406	16779
10-#14	1.97	MA	24545	5835	39077	4346	42381	3524	43280	2907	43407	2029	51742	1619	29730
4L-3S		MI	14689	5835	23981	4134	25500	3364	25773	2757	25537	1857	29614	1522	16734
10-#14	1.97	MA	23761	5835	37765	4343	40680	3519	41189	2925	40378	2017	48117	1559	28843
5L-2S		MI	15349	5835	24969	4145	26751	3352	27269	2744	27521	1845	32183	1646	16671
10-#18	3.50	MA	27662	6440	46317	4673	51493	3793	54327	3072	58161	1956	70611	1503	51572
3L-4S		MI	14912	6440	25522	4479	27219	3562	27801	2837	28394	1743	33650	949	27013
10-#18	3.50	MA	26161	6440	43652	4709	48097	3781	50200	3057	52869	1978	64623	1282	49407
4L-3S		MI	15731	6440	26946	4457	28969	3584	29874	2859	30967	1720	36473	1147	28267
10-#18	3.50	MA	24821	6440	41345	4700	45106	3813	46525	3085	47568	1956	58328	1179	46597
5L-2S		MI	16853	6440	28652	4479	31094	3562	32414	2837	34338	1698	40800	1368	28279
12-#11	1.64	MA	25992	5704	40886	4260	44770	3463	46217	2871	47242	2019	56449	1904	25093
2L-6S		MI	13623	5704	21909	4076	22919	3317	22763	2751	21563	1901	24947	1450	13987
12-#11	1.64	MA	25111	5704	39585	4258	43102	3459	44182	2883	44473	2029	52703	1817	25109
3L-5S		MI	13915	5704	22380	4083	23566	3326	23496	2742	22538	1892	26119	1507	14233
12-#11	1.64	MA	24495	5704	38526	4273	41753	3473	42542	2879	42363	2039	50261	1731	25071
4E		MI	14221	5704	22880	4089	24212	3317	24267	2734	23617	1901	27380	1546	14199
12-#11	1.64	MA	23945	5704	37612	4271	40567	3469	41084	2891	40251	2032	47718	1689	24960
5L-3S		MI	14559	5704	23455	4079	24941	3326	25131	2742	24691	1892	28567	1627	14153
12-#11	1.64	MA	23422	5704	36755	4269	39379	3483	39632	2886	38338	2042	45295	1633	24292
6L-2S		MI	15025	5704	24150	4086	25828	3317	26191	2734	26097	1884	30396	1714	14106
12-#14	2.36	MA	26290	5990	42457	4422	46703	3575	48544	2957	50396	2003	60543	1718	35654
3L-5S		MI	14214	5990	23434	4235	24811	3433	24963	2795	24482	1833	28742	1300	19346
12-#14	2.36	MA	25419	5990	40939	4444	44769	3594	46193	2950	47371	2016	57074	1594	35473
4E		MI	14645	5990	24149	4246	25722	3420	26050	2782	26006	1846	30514	1355	19864
12-#14	2.36	MA	24641	5990	39627	4440	43068	3588	44102	2967	44342	2005	53448	1534	34401
5L-3S		MI	15123	5990	24969	4232	26751	3433	27269	2795	27521	1833	32183	1471	19847
12-#14	2.36	MA	23901	5990	38398	4436	41364	3608	42020	2959	41598	2019	50003	1453	33312
6L-2S		MI	15780	5990	25956	4242	28002	3420	28764	2782	29504	1821	34753	1596	19799

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

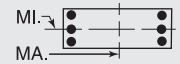


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	4.20	MA	27647	6716	46915	4881	52280	3905	55303	3132	59792	1955	73845	1231	59029
4E		MI	15646	6716	27229	4652	29344	3680	30341	2899	31765	1694	37978	847	31963
12-#18	4.20	MA	26321	6716	44608	4873	49289	3937	51628	3161	54491	1933	67550	1128	56376
5L-3S		MI	16460	6716	28652	4630	31094	3702	32414	2922	34338	1672	40800	1045	33540
12-#18	4.20	MA	25062	6716	42444	4865	46293	3925	47967	3145	49687	1955	61598	983	52722
6L-2S		MI	17573	6716	30359	4651	33218	3680	34954	2899	37709	1650	45127	1267	33628
14-#11	1.91	MA	25724	5812	40886	4326	44770	3508	46217	2913	47242	2020	56449	1801	29161
3L-6S		MI	13935	5812	22603	4143	23806	3365	23823	2778	22969	1885	26777	1417	16076
14-#11	1.91	MA	25111	5812	39828	4341	43421	3521	44577	2908	45132	2030	54008	1714	29105
4L-5S		MI	14226	5812	23074	4150	24453	3374	24556	2769	23944	1877	27949	1474	16408
14-#11	1.91	MA	24564	5812	38913	4338	42235	3518	43119	2921	43020	2023	51465	1672	28972
5L-4S		MI	14531	5812	23575	4157	25099	3365	25327	2761	25023	1885	29210	1513	16388
14-#11	1.91	MA	24044	5812	38056	4336	41047	3532	41667	2916	41106	2033	49042	1617	28215
6L-3S		MI	14867	5812	24150	4146	25828	3374	26191	2769	26097	1877	30396	1595	16352
14-#11	1.91	MA	23537	5812	37117	4351	39914	3528	40274	2928	39237	2043	46458	1527	27680
7L-2S		MI	15332	5812	24844	4153	26715	3365	27251	2761	27503	1868	32226	1681	16311
14-#14	2.75	MA	26285	6146	42802	4541	47157	3664	49107	2992	51334	2004	62405	1568	41210
4L-5S		MI	14650	6146	24422	4333	26062	3501	26458	2832	26466	1809	31312	1249	22280
14-#14	2.75	MA	25513	6146	41490	4537	45456	3658	47016	3009	48306	1993	58779	1509	39977
5L-4S		MI	15079	6146	25136	4343	26973	3489	27545	2820	27990	1822	33083	1305	22930
14-#14	2.75	MA	24779	6146	40260	4534	43752	3678	44933	3002	45562	2006	55334	1428	38938
6L-3S		MI	15555	6146	25956	4329	28002	3501	28764	2832	29504	1809	34753	1420	22946
14-#14	2.75	MA	24064	6146	38913	4555	42127	3672	42935	3019	42880	2020	51658	1298	37497
7L-2S		MI	16209	6146	26944	4339	29253	3489	30259	2820	31488	1797	37323	1545	22913
14-#18	4.90	MA	27804	6993	47871	5046	53472	4061	56730	3236	61414	1910	76772	1076	66179
5L-4S		MI	16375	6993	28935	4825	31469	3797	32881	2962	35136	1645	42305	746	36947
14-#18	4.90	MA	26559	6993	45707	5038	50476	4049	53070	3220	56610	1932	70819	932	62359
6L-3S		MI	17183	6993	30359	4802	33218	3820	34954	2984	37709	1623	45127	944	38793
14-#18	4.90	MA	25346	6993	43337	5074	47617	4082	49555	3249	51915	1954	64463	701	58693
7L-2S		MI	18289	6993	32066	4824	35343	3797	37494	2962	41080	1601	49455	1165	38937
16-#11	2.18	MA	25723	5920	41129	4408	45089	3570	46611	2937	47900	2022	57754	1698	33135
4L-6S		MI	14246	5920	23297	4211	24693	3413	24883	2805	24375	1870	28606	1384	18170
16-#11	2.18	MA	25179	5920	40214	4406	43903	3566	45154	2950	45788	2015	55211	1656	32981
5E		MI	14536	5920	23768	4218	25340	3422	25616	2796	25350	1861	29778	1442	18474
16-#11	2.18	MA	24661	5920	39357	4404	42715	3580	43702	2945	43875	2025	52788	1600	32146
6L-4S		MI	14839	5920	24269	4224	25986	3413	26387	2788	26430	1870	31039	1480	18569
16-#11	2.18	MA	24157	5920	38418	4419	41582	3577	42309	2958	42006	2035	50205	1510	31629
7L-3S		MI	15175	5920	24844	4214	26715	3422	27251	2796	27503	1861	32226	1562	18542
16-#11	2.18	MA	23661	5920	37574	4416	40433	3590	40949	2970	40019	2027	47826	1461	30799
8L-2S		MI	15638	5920	25538	4220	27602	3413	28311	2788	28909	1853	34055	1648	18508
16-#14	3.15	MA	26378	6301	43353	4634	47844	3728	49929	3052	52269	1980	64110	1483	45568
5E		MI	15083	6301	25409	4430	27313	3569	27953	2870	28449	1785	33882	1198	25225
16-#14	3.15	MA	25649	6301	42123	4631	46140	3747	47847	3044	49525	1994	60665	1402	44572
6L-4S		MI	15511	6301	26124	4440	28224	3557	29040	2857	29973	1798	35653	1254	25955
16-#14	3.15	MA	24939	6301	40776	4652	44515	3742	45848	3062	46844	2007	56989	1273	43042
7L-3S		MI	15984	6301	26944	4426	29253	3569	30259	2870	31488	1785	37323	1370	26032
16-#14	3.15	MA	24240	6301	39565	4648	42866	3761	43897	3079	43995	1996	53599	1202	41705
8L-2S		MI	16635	6301	27931	4437	30504	3557	31754	2857	33472	1773	39892	1494	26018
16-#18	5.59	MA	28039	7270	48970	5211	54659	4173	58173	3296	63533	1909	80041	881	72021
6L-4S		MI	17098	7270	30642	4998	33594	3915	35422	3024	38507	1597	46632	644	41957
16-#18	5.59	MA	26839	7270	46600	5247	51800	4206	54658	3324	58838	1931	73685	650	68247
7L-3S		MI	17901	7270	32066	4975	35343	3937	37494	3046	41080	1575	49455	842	44032
18-#11	2.45	MA	25789	6027	41515	4473	45571	3615	47188	2979	48557	2006	58958	1640	36887
5L-6S		MI	14556	6027	23991	4278	25580	3462	25943	2832	25781	1854	30435	1351	20268
18-#11	2.45	MA	25275	6027	40658	4471	44383	3629	45737	2975	46643	2016	56535	1584	36084
6L-5S		MI	14844	6027	24462	4285	26227	3470	26676	2823	26756	1846	31607	1409	20550
18-#11	2.45	MA	24773	6027	39719	4486	43250	3625	44344	2987	44774	2026	53951	1494	35583
7L-4S		MI	15146	6027	24963	4292	26873	3462	27447	2814	27836	1854	32868	1447	20743

RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

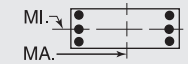


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.45	MA	24280	6027	38875	4484	42101	3639	42984	3000	42788	2019	51573	1445	34697
8L-3S		MI	15481	6027	25538	4281	27602	3470	28311	2823	28909	1846	34055	1529	20726
18-#11	2.45	MA	23761	6027	38050	4482	40983	3635	41562	2995	40936	2029	49224	1391	33935
9L-2S		MI	15942	6027	26232	4288	28489	3462	29371	2814	30315	1837	35884	1615	20699
18-#14	3.54	MA	26512	6457	43986	4728	48528	3817	50760	3087	53489	1981	65996	1377	50214
6L-5S		MI	15515	6457	26397	4527	28564	3638	29448	2907	30433	1761	36451	1147	28179
18-#14	3.54	MA	25807	6457	42638	4749	46903	3812	48761	3104	50808	1995	62321	1247	48600
7L-4S		MI	15940	6457	27111	4538	29475	3625	30535	2895	31957	1774	38222	1203	28857
18-#14	3.54	MA	25114	6457	41428	4746	45254	3831	46811	3122	47958	1984	58930	1177	47200
8L-3S		MI	16411	6457	27931	4523	30504	3638	31754	2907	33472	1761	39892	1319	29103
18-#14	3.54	MA	24406	6457	40124	4767	43650	3825	44771	3114	45301	1997	55590	1099	45330
9L-2S		MI	17059	6457	28919	4534	31755	3625	33250	2895	35455	1749	42462	1444	29121
18-#18	6.29	MA	28316	7546	49863	5420	55983	4330	59761	3400	65761	1908	82907	598	77824
7L-4S		MI	17818	7546	32349	5171	35718	4033	37962	3086	41878	1548	50959	542	46988
20-#11	2.73	MA	25884	6135	41959	4538	46051	3677	47771	3004	49412	2007	60282	1567	40027
6E		MI	14864	6135	24685	4346	26467	3510	27003	2859	27187	1839	32265	1318	22369
20-#11	2.73	MA	25386	6135	41020	4553	44918	3673	46378	3017	47543	2017	57698	1477	39541
7L-5S		MI	15151	6135	25156	4352	27114	3518	27736	2850	28162	1830	33437	1376	22633
20-#11	2.73	MA	24895	6135	40176	4551	43769	3687	45019	3029	45556	2010	55320	1428	38602
8L-4S		MI	15452	6135	25657	4359	27760	3510	28507	2841	29242	1839	34698	1414	22907
20-#11	2.73	MA	24379	6135	39351	4549	42651	3684	43597	3024	43704	2020	52971	1374	37860
9L-3S		MI	15785	6135	26232	4349	28489	3518	29371	2850	30315	1830	35884	1496	22905
20-#11	2.73	MA	23836	6135	38427	4564	41518	3697	42244	3037	41868	2030	50694	1313	36743
10L-2S		MI	16245	6135	26926	4355	29376	3510	30431	2841	31721	1822	37713	1582	22883
20-#14	3.93	MA	26669	6613	44501	4846	49291	3881	51675	3147	54771	1982	67652	1222	54167
7L-5S		MI	15944	6613	27384	4624	29815	3706	30944	2945	32417	1737	39021	1097	31138
20-#14	3.93	MA	25980	6613	43291	4843	47642	3901	49724	3164	51922	1971	64262	1152	52706
8L-4S		MI	16367	6613	28099	4635	30726	3694	32031	2932	33940	1750	40792	1153	31771
20-#14	3.93	MA	25273	6613	41987	4864	46038	3895	47684	3156	49265	1985	60921	1074	50882
9L-3S		MI	16836	6613	28919	4621	31755	3706	33250	2945	35455	1737	42462	1268	32166
22-#11	3.00	MA	25994	6243	42321	4621	46586	3722	48413	3046	50311	2009	61445	1461	43501
7L-6S		MI	15170	6243	25380	4413	27354	3558	28063	2886	28593	1823	34094	1285	24472
22-#11	3.00	MA	25506	6243	41477	4619	45437	3736	47053	3059	48325	2002	59066	1412	42512
8L-5S		MI	15457	6243	25851	4420	28001	3566	28797	2877	29568	1815	35266	1343	24720
22-#11	3.00	MA	25002	6243	40652	4616	44319	3732	45632	3054	46473	2012	56717	1358	41746
9L-4S		MI	15757	6243	26351	4427	28647	3558	29567	2868	30648	1823	36527	1381	25064
22-#11	3.00	MA	24453	6243	39728	4631	43185	3746	44279	3066	44636	2022	54441	1297	40636
10L-3S		MI	16088	6243	26926	4416	29376	3566	30431	2877	31721	1815	37713	1463	25079
22-#11	3.00	MA	23925	6243	38901	4629	42074	3742	42875	3062	42678	2014	52122	1245	39494
11L-2S		MI	16547	6243	27621	4423	30263	3558	31491	2868	33128	1806	39543	1549	25064
22-#14	4.33	MA	26840	6768	45153	4940	50030	3971	52637	3206	55886	1959	69593	1126	58221
8L-5S		MI	16370	6768	28371	4722	31066	3774	32439	2982	34400	1713	41591	1046	34103
22-#14	4.33	MA	26135	6768	43850	4961	48426	3965	50597	3199	53229	1972	66253	1049	56442
9L-4S		MI	16792	6768	29086	4732	31977	3762	33526	2970	35924	1726	43362	1102	34696
24-#11	3.27	MA	26114	6351	42778	4686	47105	3784	49088	3088	51093	1993	62813	1395	46427
8L-6S		MI	15476	6351	26074	4481	28241	3606	29123	2912	29999	1808	35923	1252	26577
24-#11	3.27	MA	25611	6351	41953	4684	45987	3781	47666	3083	49241	2003	60464	1342	45619
9L-5S		MI	15761	6351	26545	4487	28888	3615	29857	2904	30974	1799	37095	1310	26811
24-#11	3.27	MA	25066	6351	41029	4699	44853	3794	46314	3096	47405	2013	58188	1281	44534
10L-4S		MI	16060	6351	27046	4494	29534	3606	30627	2895	32054	1808	38356	1348	27217
24-#11	3.27	MA	24541	6351	40202	4697	43742	3791	44910	3091	45446	2006	55869	1228	43365
11L-3S		MI	16391	6351	27621	4483	30263	3615	31491	2904	33128	1799	39543	1430	27243
24-#14	4.72	MA	26990	6924	45712	5058	50815	4035	53511	3241	57192	1960	71584	1023	62010
9L-5S		MI	16795	6924	29359	4819	32317	3843	33934	3020	36384	1689	44160	995	37072

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

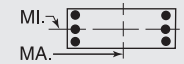
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.34	MA	27594	5840	43166	4349	46804	3542	47848	2948	47980	2106	56485	1982	22370
2E		MI	15252	5840	24447	4124	25650	3344	25689	2765	25020	1932	28690	1759	12065
6-#14	1.13	MA	27155	5753	42044	4321	45533	3524	46362	2943	45984	2127	54036	2020	19106
2L-3S		MI	14409	5753	22917	4106	23929	3364	23683	2798	22370	1995	25353	1709	10475
6-#14	1.13	MA	25817	5753	40084	4318	43020	3519	43296	2961	41813	2141	48396	1896	19163
3L-2S		MI	15076	5753	23904	4117	25180	3352	25178	2786	24353	1982	27923	1834	10390
6-#18	2.01	MA	29190	6116	46602	4522	51209	3666	53222	3023	55291	2083	66255	1933	33154
2L-3S		MI	14854	6116	24447	4275	25650	3484	25689	2849	25020	1906	28690	1435	17674
6-#18	2.01	MA	26884	6116	43166	4514	46804	3699	47848	3053	47980	2106	56485	1712	33064
3L-2S		MI	15993	6116	26153	4297	27775	3462	28230	2827	28391	1884	33017	1657	17547
8-#11	1.04	MA	26974	5718	41571	4312	45011	3519	45758	2943	45176	2137	53045	2037	17762
2L-4S		MI	14193	5718	22400	4122	23370	3358	23048	2797	21608	2022	24604	1698	9811
8-#11	1.04	MA	26038	5718	40202	4310	43257	3516	43617	2955	42264	2147	49084	1951	17803
3E		MI	14534	5718	22975	4111	24099	3367	23912	2805	22682	2013	25791	1780	9745
8-#11	1.04	MA	25382	5718	39090	4326	41839	3530	41894	2951	40046	2158	46501	1865	17823
4L-2S		MI	15004	5718	23670	4118	24986	3358	24972	2797	24088	2005	27620	1867	9691
8-#14	1.51	MA	28081	5909	44004	4418	48046	3594	49427	2985	50154	2114	59676	1997	25266
2L-4S		MI	14367	5909	23084	4218	24151	3420	23959	2823	22839	1983	26253	1543	13722
8-#14	1.51	MA	26752	5909	42044	4415	45533	3589	46362	3003	45984	2129	54036	1872	25289
3E		MI	14850	5909	23904	4203	25180	3433	25178	2836	24353	1971	27923	1659	13644
8-#14	1.51	MA	25821	5909	40449	4437	43500	3609	43891	2996	42804	2143	50361	1747	25195
4L-2S		MI	15514	5909	24892	4214	26431	3420	26673	2823	26337	1958	30492	1783	13566
8-#18	2.68	MA	30763	6393	50038	4695	55613	3790	58595	3099	62602	2061	76025	1885	43885
2L-4S		MI	14768	6393	24729	4470	26025	3579	26157	2890	25818	1879	30194	1136	22345
8-#18	2.68	MA	28482	6393	46602	4687	51209	3823	53222	3129	55291	2084	66255	1664	43678
3E		MI	15596	6393	26153	4448	27775	3601	28230	2912	28391	1857	33017	1334	23041
8-#18	2.68	MA	26882	6393	43799	4724	47637	3812	48881	3114	49704	2106	59904	1442	42212
4L-2S		MI	16727	6393	27860	4470	29899	3579	30770	2890	31762	1835	37344	1555	22965
10-#11	1.30	MA	27626	5826	42939	4380	46766	3568	47898	2972	48087	2128	57006	2022	22064
2L-5S		MI	14200	5826	22594	4183	23611	3415	23338	2832	21935	1998	25173	1627	12091
10-#11	1.30	MA	26694	5826	41571	4378	45011	3565	45758	2985	45176	2138	53045	1935	22093
3L-4S		MI	14507	5826	23095	4189	24257	3407	24108	2824	23014	2006	26434	1666	12035
10-#11	1.30	MA	26042	5826	40458	4393	43594	3579	44035	2981	42958	2149	50462	1849	22083
4L-3S		MI	14846	5826	23670	4179	24986	3415	24972	2832	24088	1998	27620	1747	11977
10-#11	1.30	MA	25461	5826	39498	4391	42348	3576	42503	2993	40739	2142	47777	1807	21998
5L-2S		MI	15315	5826	24364	4185	25873	3407	26032	2824	25494	1989	29450	1834	11925
10-#14	1.88	MA	28999	6064	45964	4516	50559	3664	52492	3028	54325	2102	65316	1973	31407
2L-5S		MI	14372	6064	23357	4304	24492	3501	24367	2873	23299	1946	27052	1437	16569
10-#14	1.88	MA	27678	6064	44004	4512	48046	3659	49427	3046	50154	2116	59676	1848	31389
3L-4S		MI	14807	6064	24072	4315	25402	3489	25454	2861	24822	1959	28823	1492	16835
10-#14	1.88	MA	26754	6064	42409	4534	46013	3679	46956	3039	46975	2130	56001	1724	31249
4L-3S		MI	15287	6064	24892	4301	26431	3501	26673	2873	26337	1946	30492	1608	16782
10-#14	1.88	MA	25930	6064	41031	4531	44226	3674	44760	3057	43792	2120	52172	1663	30454
5L-2S		MI	15948	6064	25879	4311	27682	3489	28168	2861	28321	1934	33062	1733	16716
10-#18	3.34	MA	30057	6670	50038	4860	55613	3947	58595	3204	62602	2062	76025	1615	54272
3L-4S		MI	15510	6670	26436	4643	28150	3697	28697	2952	29189	1831	34521	1034	27247
10-#18	3.34	MA	28475	6670	47235	4897	52041	3936	54254	3189	57015	2084	69674	1394	52302
4L-3S		MI	16331	6670	27860	4621	29899	3719	30770	2974	31762	1809	37344	1232	28354
10-#18	3.34	MA	27064	6670	44810	4889	48897	3970	50391	3219	51421	2063	63017	1289	49219
5L-2S		MI	17454	6670	29567	4643	32024	3697	33310	2952	35133	1787	41671	1454	28345
12-#11	1.57	MA	28274	5934	44308	4447	48520	3616	50038	3001	50999	2119	60967	2006	26356
2L-6S		MI	14220	5934	22817	4243	23851	3455	23665	2868	22365	1991	25830	1537	14114

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

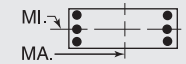
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.57	MA	27346	5934	42939	4445	46766	3613	47898	3014	48087	2130	57006	1920	26372
3L-5S		MI	14513	5934	23288	4250	24498	3463	24398	2859	23341	1982	27002	1594	14281
12-#11	1.57	MA	26697	5934	41827	4460	45348	3627	46175	3010	45870	2140	54422	1834	26335
4E		MI	14819	5934	23789	4257	25144	3455	25168	2851	24420	1991	28263	1633	14241
12-#11	1.57	MA	26119	5934	40866	4458	44102	3624	44644	3023	43651	2134	51738	1791	26224
5L-3S		MI	15157	5934	24364	4246	25873	3463	26032	2859	25494	1982	29450	1714	14192
12-#11	1.57	MA	25569	5934	39966	4457	42855	3638	43119	3018	41642	2144	49176	1735	25596
6L-2S		MI	15624	5934	25058	4253	26760	3455	27092	2851	26900	1974	31279	1801	14144
12-#14	2.26	MA	28596	6220	45964	4610	50559	3729	52492	3088	54325	2104	65316	1824	37477
3L-5S		MI	14811	6220	24345	4402	25743	3569	25862	2911	25282	1922	29621	1386	19488
12-#14	2.26	MA	27679	6220	44369	4631	48526	3749	50022	3081	51145	2118	61641	1700	37295
4E		MI	15244	6220	25059	4412	26653	3557	26949	2898	26806	1935	31392	1442	19930
12-#14	2.26	MA	26861	6220	42991	4628	46738	3744	47825	3099	47963	2108	57812	1639	36305
5L-3S		MI	15722	6220	25879	4398	27682	3569	28168	2911	28321	1922	33062	1557	19899
12-#14	2.26	MA	26083	6220	41699	4625	44949	3763	45637	3092	45080	2122	54165	1559	35115
6L-2S		MI	16380	6220	26867	4408	28933	3557	29664	2898	30304	1910	35632	1682	19847
12-#18	4.01	MA	30049	6946	50671	5070	56446	4060	59627	3265	64326	2062	79444	1346	62443
4E		MI	16245	6946	28143	4816	30275	3815	31237	3014	32560	1782	38849	933	32194
12-#18	4.01	MA	28653	6946	48246	5062	53302	4094	55764	3295	58731	2041	72786	1241	59525
5L-3S		MI	17061	6946	29567	4794	32024	3837	33310	3036	35133	1760	41671	1131	33635
12-#18	4.01	MA	27327	6946	45973	5055	50153	4083	51916	3280	53660	2063	66477	1097	55881
6L-2S		MI	18176	6946	31274	4816	34149	3815	35850	3014	38504	1738	45999	1352	33705
14-#11	1.83	MA	27993	6042	44308	4513	48520	3662	50038	3044	50999	2121	60967	1905	30635
3L-6S		MI	14533	6042	23511	4311	24738	3503	24725	2895	23771	1975	27659	1504	16178
14-#11	1.83	MA	27348	6042	43195	4528	47102	3676	48315	3039	48782	2132	58383	1818	30580
4L-5S		MI	14824	6042	23982	4317	25385	3512	25458	2886	24747	1967	28831	1561	16461
14-#11	1.83	MA	26773	6042	42235	4526	45856	3673	46784	3052	46563	2125	55699	1776	30446
5L-4S		MI	15129	6042	24483	4324	26031	3503	26228	2878	25826	1975	30092	1600	16434
14-#11	1.83	MA	26226	6042	41335	4524	44609	3687	45259	3048	44554	2136	53136	1720	29724
6L-3S		MI	15466	6042	25058	4314	26760	3512	27092	2886	26900	1967	31279	1681	16395
14-#11	1.83	MA	25693	6042	40349	4539	43420	3683	43796	3061	42591	2146	50405	1630	29141
7L-2S		MI	15931	6042	25752	4320	27647	3503	28152	2878	28306	1958	33108	1768	16352
14-#14	2.63	MA	28595	6376	46329	4728	51038	3818	53087	3124	55316	2106	67281	1676	43337
4L-5S		MI	15248	6376	25332	4499	26994	3638	27358	2948	27266	1898	32191	1335	22423
14-#14	2.63	MA	27783	6376	44951	4725	49251	3813	50890	3142	52134	2095	63452	1615	42176
5L-4S		MI	15678	6376	26047	4510	27904	3625	28444	2936	28790	1911	33962	1391	23002
14-#14	2.63	MA	27011	6376	43660	4722	47461	3833	48703	3135	49251	2109	59805	1535	41038
6L-3S		MI	16154	6376	26867	4495	28933	3638	29664	2948	30304	1898	35632	1507	23003
14-#14	2.63	MA	26258	6376	42244	4743	45754	3828	46604	3153	46434	2124	55916	1405	39649
7L-2S		MI	16809	6376	27854	4506	30184	3625	31159	2936	32288	1886	38201	1631	22965
14-#18	4.68	MA	30223	7223	51682	5235	57706	4218	61137	3370	66042	2019	82556	1193	69856
5L-4S		MI	16974	7223	29850	4989	32399	3933	33777	3077	35931	1734	43176	831	37176
14-#18	4.68	MA	28912	7223	49408	5228	54558	4207	57289	3355	60971	2041	76247	1049	66042
6L-3S		MI	17785	7223	31274	4967	34149	3955	35850	3099	38504	1712	45999	1029	38896
14-#18	4.68	MA	27635	7223	46918	5265	51553	4240	53596	3385	56016	2064	69511	818	62367
7L-2S		MI	18893	7223	32980	4989	36274	3933	38390	3077	41875	1689	50326	1250	39020
16-#11	2.09	MA	27995	6149	44564	4595	48857	3724	50455	3069	51694	2123	62344	1803	34819
4L-6S		MI	14844	6149	24205	4378	25625	3551	25785	2922	25177	1960	29489	1471	18273
16-#11	2.09	MA	27423	6149	43603	4593	47611	3721	48924	3082	49475	2116	59660	1760	34666
5E		MI	15134	6149	24676	4385	26272	3560	26518	2913	26153	1951	30661	1528	18632
16-#11	2.09	MA	26879	6149	42704	4591	46364	3735	47399	3077	47466	2127	57097	1705	33861
6L-4S		MI	15438	6149	25177	4392	26918	3551	27288	2904	27232	1960	31922	1567	18618
16-#11	2.09	MA	26349	6149	41717	4607	45174	3732	45936	3090	45503	2137	54365	1615	33298
7L-3S		MI	15774	6149	25752	4381	27647	3560	28152	2913	28306	1951	33108	1649	18588

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis

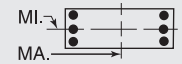


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.09	MA	25827	6149	40832	4605	43967	3746	44509	3103	43417	2131	51855	1565	32511
8L-2S		MI	16237	6149	26446	4388	28534	3551	29212	2904	29712	1942	34938	1735	18551
16-#14	3.01	MA	28698	6531	46911	4822	51764	3883	53956	3184	56304	2083	69092	1591	48061
5E		MI	15682	6531	26320	4596	28245	3706	28853	2986	29249	1874	34761	1285	25368
16-#14	3.01	MA	27931	6531	45620	4819	49974	3903	51768	3177	53421	2097	65445	1511	46970
6L-4S		MI	16110	6531	27034	4607	29155	3694	29940	2973	30773	1887	36532	1340	26064
16-#14	3.01	MA	27184	6531	44204	4841	48267	3898	49669	3195	50605	2111	61556	1381	45490
7L-3S		MI	16584	6531	27854	4592	30184	3706	31159	2986	32288	1874	38201	1456	26097
16-#14	3.01	MA	26449	6531	42933	4837	46535	3918	47620	3213	47612	2101	57975	1310	44056
8L-2S		MI	17236	6531	28842	4603	31435	3694	32654	2973	34272	1862	40771	1581	26072
16-#18	5.35	MA	30478	7499	52844	5401	58962	4331	62663	3431	68282	2019	86017	1000	76229
6L-4S		MI	17699	7499	31557	5162	34524	4050	36318	3139	39302	1685	47503	729	42184
16-#18	5.35	MA	29215	7499	50353	5438	55958	4364	58969	3460	63327	2042	79281	769	72447
7L-3S		MI	18504	7499	32980	5140	36274	4072	38390	3161	41875	1663	50326	927	44142
16-#18	5.35	MA	27972	7499	48115	5430	52910	4353	55363	3490	58061	2020	73057	646	68113
8L-2S		MI	19606	7499	34687	5162	38398	4050	40930	3139	45246	1641	54653	1149	44316
18-#11	2.35	MA	28069	6257	44972	4661	49365	3769	51064	3111	52387	2108	63620	1745	38883
5L-6S		MI	15154	6257	24899	4446	26512	3599	26845	2949	26583	1944	31318	1438	20372
18-#11	2.35	MA	27528	6257	44072	4659	48118	3783	49540	3107	50378	2118	61058	1689	38004
6L-5S		MI	15443	6257	25371	4452	27159	3608	27578	2940	27559	1936	32490	1496	20664
18-#11	2.35	MA	27001	6257	43086	4674	46928	3780	48077	3120	48415	2129	58326	1599	37459
7L-4S		MI	15745	6257	25871	4459	27805	3599	28348	2931	28638	1944	33751	1534	20796
18-#11	2.35	MA	26482	6257	42200	4672	45722	3794	46649	3132	46329	2122	55816	1550	36614
8L-3S		MI	16080	6257	26446	4448	28534	3608	29212	2940	29712	1936	34938	1616	20774
18-#11	2.35	MA	25927	6257	41334	4670	44548	3791	45156	3128	44384	2133	53331	1496	35786
9L-2S		MI	16542	6257	27141	4455	29421	3599	30272	2931	31118	1927	36767	1702	20744
18-#14	3.39	MA	28844	6687	47580	4916	52487	3973	54834	3220	57592	2085	71085	1487	52910
6L-5S		MI	16114	6687	27307	4693	29496	3774	30348	3023	31233	1850	37330	1234	28321
18-#14	3.39	MA	28103	6687	46164	4938	50780	3968	52734	3238	54776	2099	67196	1357	51343
7L-4S		MI	16540	6687	28022	4704	30406	3762	31435	3011	32757	1863	39101	1290	29024
18-#14	3.39	MA	27373	6687	44893	4935	49048	3988	50685	3256	51782	2088	63615	1286	49952
8L-3S		MI	17012	6687	28842	4690	31435	3774	32654	3023	34272	1850	40771	1405	29172
18-#14	3.39	MA	26618	6687	43649	4931	47364	3982	48543	3249	48991	2103	60079	1209	47962
9L-2S		MI	17661	6687	29829	4700	32687	3762	34149	3011	36255	1838	43341	1530	29171
18-#18	6.02	MA	30779	7776	53789	5610	60363	4488	64342	3536	70637	2019	89051	721	82549
7L-4S		MI	18419	7776	33263	5335	36649	4168	38858	3201	42673	1637	51830	628	47214
18-#18	6.02	MA	29549	7776	51551	5603	57315	4477	60736	3566	65371	1998	82827	598	78156
8L-3S		MI	19219	7776	34687	5313	38398	4190	40930	3223	45246	1615	54653	826	49376
20-#11	2.61	MA	28172	6365	45441	4726	49872	3832	51680	3136	53290	2110	65019	1674	42153
6E		MI	15462	6365	25594	4513	27399	3647	27905	2976	27989	1929	33147	1405	22474
20-#11	2.61	MA	27648	6365	44454	4742	48683	3829	50217	3149	51327	2120	62287	1584	41624
7L-5S		MI	15750	6365	26065	4520	28046	3656	28638	2967	28965	1920	34319	1463	22747
20-#11	2.61	MA	27132	6365	43569	4740	47476	3843	48789	3162	49241	2113	59776	1534	40724
8L-4S		MI	16052	6365	26566	4526	28692	3647	29408	2958	30044	1929	35580	1501	22968
20-#11	2.61	MA	26581	6365	42702	4738	46303	3840	47296	3158	47296	2124	57292	1480	39917
9L-3S		MI	16385	6365	27141	4516	29421	3656	30272	2967	31118	1920	36767	1583	22955
20-#11	2.61	MA	26009	6365	41732	4753	45112	3854	45876	3170	45368	2135	54884	1420	38823
10L-2S		MI	16846	6365	27835	4523	30308	3647	31332	2958	32524	1911	38596	1669	22931
20-#14	3.76	MA	29014	6842	48124	5035	53292	4038	55800	3280	58946	2087	72836	1333	57206
7L-5S		MI	16543	6842	28295	4791	30747	3843	31843	3061	33217	1826	39900	1183	31282
20-#14	3.76	MA	28289	6842	46853	5032	51561	4057	53751	3298	55953	2076	69255	1262	55804
8L-4S		MI	16968	6842	29009	4801	31657	3830	32930	3049	34741	1839	41671	1239	31937
20-#14	3.76	MA	27535	6842	45609	5029	49876	4052	51608	3291	53162	2090	65719	1185	53811
9L-3S		MI	17437	6842	29829	4787	32687	3843	34149	3061	36255	1826	43341	1355	32238
20-#14	3.76	MA	26718	6842	44217	5050	48168	4072	49570	3309	50395	2105	62293	1097	51698
10L-2S		MI	18084	6842	30817	4797	33938	3830	35645	3049	38239	1814	45910	1479	32265
20-#18	6.69	MA	31109	8053	54987	5776	61719	4602	66110	3641	72682	1976	92597	550	88218
8L-4S		MI	19136	8053	34970	5508	38774	4286	41398	3263	46044	1588	56158	526	52260

RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.87	MA	28292	6473	45823	4809	50437	3877	52357	3178	54239	2112	66248	1568	45792
7L-6S		MI	15769	6473	26288	4580	28286	3695	28965	3002	29395	1913	34977	1372	24579
22-#11	2.87	MA	27778	6473	44937	4807	49230	3891	50930	3191	52153	2105	63737	1519	44840
8L-5S		MI	16056	6473	26759	4587	28933	3704	29698	2994	30371	1905	36149	1430	24834
22-#11	2.87	MA	27231	6473	44071	4805	48057	3888	49436	3187	50208	2115	61253	1465	44053
9L-4S		MI	16357	6473	27260	4594	29579	3695	30468	2985	31450	1913	37410	1468	25127
22-#11	2.87	MA	26662	6473	43100	4820	46867	3902	48016	3200	48280	2126	58845	1404	42922
10L-3S		MI	16689	6473	27835	4583	30308	3704	31332	2994	32524	1905	38596	1550	25131
22-#11	2.87	MA	26106	6473	42232	4818	45699	3899	46542	3196	46223	2119	56396	1351	41889
11L-2S		MI	17148	6473	28529	4590	31195	3695	32392	2985	33930	1896	40426	1636	25114
22-#14	4.14	MA	29199	6998	48813	5129	54073	4127	56816	3340	60123	2064	74895	1238	61615
8L-5S		MI	16971	6998	29282	4888	31998	3911	33339	3099	35200	1802	42470	1133	34247
22-#14	4.14	MA	28446	6998	47569	5126	52389	4122	54674	3333	57333	2078	71359	1161	59668
9L-4S		MI	17393	6998	29997	4899	32908	3899	34426	3086	36724	1815	44241	1188	34861
22-#14	4.14	MA	27638	6998	46177	5148	50681	4142	52636	3351	54566	2092	67933	1073	57517
10L-3S		MI	17861	6998	30817	4884	33938	3911	35645	3099	38239	1802	45910	1304	35299
24-#11	3.13	MA	28421	6581	46306	4874	50985	3940	53070	3221	55065	2096	67698	1503	48961
8L-6S		MI	16075	6581	26982	4648	29173	3744	30025	3029	30802	1898	36806	1339	26684
24-#11	3.13	MA	27884	6581	45439	4872	49811	3936	51577	3216	53120	2107	65214	1450	48192
9L-5S		MI	16361	6581	27453	4655	29821	3752	30758	3021	31777	1889	37978	1397	26926
24-#11	3.13	MA	27310	6581	44469	4888	48621	3951	50157	3229	51192	2117	62805	1389	47026
10L-4S		MI	16660	6581	27954	4661	30466	3744	31528	3012	32856	1898	39239	1435	27283
24-#11	3.13	MA	26757	6581	43601	4886	47454	3947	48683	3225	49135	2111	60357	1336	45883
11L-3S		MI	16992	6581	28529	4651	31195	3752	32392	3021	33930	1889	40426	1517	27304
24-#11	3.13	MA	26215	6581	42648	4901	46272	3962	47265	3238	47208	2121	57599	1259	44656
12L-2S		MI	17450	6581	29223	4657	32082	3744	33452	3012	35336	1880	42255	1603	27292
24-#14	4.52	MA	29350	7154	49529	5223	54902	4192	57739	3376	61503	2065	76999	1137	65532
9L-5S		MI	17396	7154	30270	4985	33249	3980	34834	3136	37184	1778	45039	1082	37217
24-#14	4.52	MA	28574	7154	48137	5245	53193	4212	55701	3394	58736	2080	73573	1049	63343
10L-4S		MI	17817	7154	30984	4996	34160	3967	35921	3124	38708	1791	46810	1138	37793

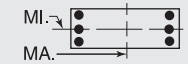
RECTANGULAR TIED COLUMNS 26" x 48"

4-#18	1.28	MA	29936	6069	46671	4536	50624	3695	51718	3079	51737	2206	60950	2084	23450
2E		MI	15851	6069	25361	4288	26580	3479	26585	2880	25815	2020	29561	1844	12109
6-#14	1.08	MA	29470	5983	45487	4508	49282	3678	50148	3073	49629	2227	58339	2122	20018
2L-3S		MI	15007	5983	23827	4272	24861	3501	24582	2914	23170	2084	26232	1796	10509
6-#14	1.08	MA	28063	5983	43430	4505	46644	3673	46931	3092	45252	2242	52390	1997	20074
3L-2S		MI	15675	5983	24815	4283	26112	3489	26077	2902	25154	2071	28802	1920	10425
6-#18	1.92	MA	31622	6346	50280	4708	55250	3819	57362	3154	59415	2184	71269	2039	34774
2L-3S		MI	15452	6346	25361	4439	26580	3619	26585	2964	25815	1994	29561	1521	17734
6-#18	1.92	MA	29195	6346	46671	4702	50624	3853	51718	3185	51737	2208	60950	1817	34684
3L-2S		MI	16592	6346	27068	4461	28705	3597	29126	2942	29186	1972	33888	1742	17599
8-#11	1.00	MA	29278	5948	44988	4499	48731	3673	49511	3073	48777	2237	57282	2138	18605
2L-4S		MI	14791	5948	23309	4289	24302	3496	23950	2914	22411	2112	25487	1785	9842
8-#11	1.00	MA	28293	5948	43552	4497	46890	3670	47265	3086	45721	2248	53107	2051	18646
3E		MI	15132	5948	23884	4279	25031	3505	24814	2922	23485	2103	26674	1867	9775
8-#11	1.00	MA	27606	5948	42386	4513	45404	3685	45459	3082	43397	2259	50381	1965	18665
4L-2S		MI	15602	5948	24578	4285	25918	3496	25874	2914	24891	2094	28503	1953	9722
8-#14	1.44	MA	30447	6139	47545	4605	51919	3748	53366	3116	54007	2214	64287	2099	26481
2L-4S		MI	14964	6139	23995	4384	25083	3557	24858	2939	23639	2072	27132	1629	13768
8-#14	1.44	MA	29049	6139	45487	4602	49282	3743	50148	3134	49629	2230	58339	1974	26504
3E		MI	15448	6139	24815	4370	26112	3569	26077	2952	25154	2060	28802	1745	13685

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

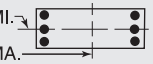


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.44	MA	28072	6139	43815	4624	47150	3763	47558	3128	46295	2245	54459	1850	26410
4L-2S		MI	16112	6139	25802	4380	27363	3557	27573	2939	27137	2047	31371	1870	13606
8-#18	2.56	MA	33283	6623	53889	4881	59876	3943	63005	3229	67094	2162	81587	1993	46045
2L-4S		MI	15365	6623	25644	4635	26956	3715	27053	3004	26612	1967	31065	1221	22577
8-#18	2.56	MA	30882	6623	50280	4875	55250	3978	57362	3260	59415	2186	71269	1772	45838
3E		MI	16194	6623	27068	4612	28705	3737	29126	3026	29186	1945	33888	1419	23110
8-#18	2.56	MA	29201	6623	47340	4912	51502	3968	52807	3247	53554	2210	64554	1550	44613
4L-2S		MI	17327	6623	28775	4634	30830	3715	31666	3004	32557	1923	38215	1641	23024
10-#11	1.25	MA	29965	6056	46424	4566	50572	3722	51756	3102	51832	2228	61457	2123	23117
2L-5S		MI	14797	6056	23502	4350	24543	3553	24239	2949	22737	2088	26056	1714	12131
10-#11	1.25	MA	28985	6056	44988	4565	48731	3719	49511	3116	48777	2239	57282	2037	23146
3L-4S		MI	15104	6056	24003	4357	25189	3544	25010	2941	23817	2096	27316	1752	12072
10-#11	1.25	MA	28301	6056	43822	4580	47245	3733	47704	3112	46452	2250	54556	1951	23136
4L-3S		MI	15444	6056	24578	4346	25918	3553	25874	2949	24891	2088	28503	1834	12012
10-#11	1.25	MA	27691	6056	42816	4579	45939	3730	46100	3125	44127	2244	51730	1908	23051
5L-2S		MI	15913	6056	25272	4353	26805	3544	26934	2941	26297	2079	30332	1920	11960
10-#14	1.80	MA	31415	6294	49602	4702	54557	3818	56583	3158	58385	2202	70236	2076	32925
2L-5S		MI	14969	6294	24268	4471	25423	3638	25267	2989	24099	2036	27931	1523	16709
10-#14	1.80	MA	30026	6294	47545	4699	51919	3813	53366	3177	54007	2217	64287	1952	32908
3L-4S		MI	15405	6294	24982	4481	26334	3625	26354	2977	25622	2048	29702	1579	16888
10-#14	1.80	MA	29056	6294	45873	4721	49788	3833	50775	3170	50673	2232	60408	1827	32767
4L-3S		MI	15886	6294	25802	4467	27363	3638	27573	2989	27137	2036	31371	1694	16828
10-#14	1.80	MA	28191	6294	44428	4719	47914	3829	48472	3189	47337	2222	56375	1766	32076
5L-2S		MI	16547	6294	26790	4477	28614	3625	29068	2977	29121	2023	33941	1819	16760
10-#18	3.21	MA	32545	6899	53889	5048	59876	4102	63005	3336	67094	2163	81587	1726	56972
3L-4S		MI	16108	6899	27351	4808	29080	3832	29593	3067	29983	1919	35393	1119	27475
10-#18	3.21	MA	30883	6899	50949	5085	56129	4092	58451	3322	61233	2187	74872	1504	55223
4L-3S		MI	16931	6899	28775	4785	30830	3854	31666	3089	32557	1897	38215	1317	28438
10-#18	3.21	MA	29401	6899	48406	5078	52832	4126	54399	3353	55365	2167	67853	1399	51856
5L-2S		MI	18056	6899	30481	4807	32955	3832	34206	3067	35928	1875	42542	1539	28411
12-#11	1.50	MA	30648	6163	47860	4634	52413	3770	54002	3132	54888	2220	65632	2109	27620
2L-6S		MI	14818	6163	23725	4411	24783	3592	24566	2985	23168	2081	26713	1624	14213
12-#11	1.50	MA	29672	6163	46424	4632	50572	3767	51756	3145	51832	2231	61457	2022	27636
3L-5S		MI	15110	6163	24196	4417	25431	3601	25299	2976	24143	2072	27885	1681	14327
12-#11	1.50	MA	28992	6163	45258	4648	49086	3781	49950	3141	49508	2242	58731	1936	27598
4E		MI	15417	6163	24697	4424	26076	3592	26070	2968	25223	2081	29146	1719	14282
12-#11	1.50	MA	28386	6163	44252	4646	47780	3779	48345	3154	47182	2235	55905	1893	27487
5L-3S		MI	15755	6163	25272	4413	26805	3601	26934	2976	26297	2072	30332	1801	14230
12-#11	1.50	MA	27809	6163	43309	4644	46473	3793	46748	3150	45077	2246	53203	1837	26907
6L-2S		MI	16223	6163	25966	4420	27692	3592	27994	2968	27703	2063	32162	1888	14181
12-#14	2.16	MA	30994	6450	49602	4797	54557	3883	56583	3219	58385	2205	70236	1929	39299
3L-5S		MI	15409	6450	25255	4568	26674	3706	26762	3027	26082	2012	30500	1472	19627
12-#14	2.16	MA	30031	6450	47930	4819	52425	3903	53993	3213	55051	2220	66357	1805	39118
4E		MI	15842	6450	25970	4579	27585	3694	27849	3014	27606	2024	32271	1528	19989
12-#14	2.16	MA	29173	6450	46485	4816	50552	3899	51690	3231	51714	2210	62324	1744	38222
5L-3S		MI	16321	6450	26790	4564	28614	3706	29068	3027	29121	2012	33941	1644	19951
12-#14	2.16	MA	28356	6450	45132	4813	48676	3919	49397	3225	48693	2225	58475	1663	36925
6L-2S		MI	16980	6450	27777	4575	29865	3694	30563	3014	31105	1999	36511	1768	19895
12-#18	3.85	MA	32544	7176	54557	5258	60755	4216	64094	3397	68911	2165	85190	1459	65883
4E		MI	16843	7176	29057	4981	31205	3950	32133	3129	33354	1870	39720	1018	32420
12-#18	3.85	MA	31078	7176	52015	5251	57458	4250	60043	3428	63043	2145	78171	1353	62690
5L-3S		MI	17661	7176	30481	4958	32955	3972	34206	3151	35928	1848	42542	1216	33728
12-#18	3.85	MA	29685	7176	49631	5245	54156	4240	56008	3415	57726	2169	71504	1209	59073
6L-2S		MI	18779	7176	32188	4980	35079	3950	36746	3129	39299	1826	46870	1437	33770
14-#11	1.75	MA	30355	6271	47860	4700	52413	3816	54002	3175	54888	2222	65632	2008	32110
3L-6S		MI	15130	6271	24419	4478	25670	3641	25626	3012	24574	2065	28542	1591	16314
14-#11	1.75	MA	29678	6271	46694	4715	50927	3830	52196	3171	52563	2233	62906	1922	32054
4L-5S		MI	15422	6271	24891	4485	26318	3649	26359	3003	25549	2056	29714	1648	16511

RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

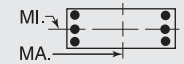


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.75	MA	29075	6271	45688	4713	49621	3827	50591	3184	50238	2227	60080	1879	31920
5L-4S		MI	15727	6271	25391	4491	26963	3641	27130	2994	26629	2065	30975	1687	16479
14-#11	1.75	MA	28501	6271	44745	4712	48314	3841	48994	3180	48132	2238	57378	1823	31240
6L-3S		MI	16065	6271	25966	4481	27692	3649	27994	3003	27703	2056	32162	1768	16436
14-#11	1.75	MA	27942	6271	43712	4727	47068	3839	47461	3193	46076	2249	54498	1733	30607
7L-2S		MI	16531	6271	26661	4488	28579	3641	29054	2994	29109	2048	33991	1855	16392
14-#14	2.52	MA	30998	6605	49987	4916	55062	3973	57210	3255	59428	2207	72305	1782	45463
4L-5S		MI	15846	6605	26243	4665	27925	3775	28257	3065	28066	1988	33070	1422	22561
14-#14	2.52	MA	30146	6605	48543	4913	53189	3968	54907	3274	56092	2197	68272	1721	44387
5L-4S		MI	16277	6605	26957	4676	28836	3762	29344	3052	29590	2000	34841	1477	23071
14-#14	2.52	MA	29335	6605	47189	4910	51313	3989	52615	3267	53071	2212	64424	1641	43146
6L-3S		MI	16754	6605	27777	4661	29865	3775	30563	3065	31105	1988	36511	1593	23058
14-#14	2.52	MA	28546	6605	45706	4932	49524	3984	50415	3286	50119	2228	60321	1511	41820
7L-2S		MI	17410	6605	28765	4672	31116	3762	32058	3052	33088	1975	39080	1718	23016
14-#18	4.49	MA	32736	7453	55623	5424	62084	4374	65687	3504	70722	2123	88490	1307	73549
5L-4S		MI	17574	7453	30764	5153	33330	4068	34673	3191	36725	1822	44047	916	37400
14-#18	4.49	MA	31358	7453	53240	5418	58782	4364	61652	3490	65404	2147	81822	1164	69759
6L-3S		MI	18386	7453	32188	5131	35079	4090	36746	3213	39299	1800	46870	1114	38996
14-#18	4.49	MA	30017	7453	50629	5455	55633	4398	57779	3521	60209	2171	74708	933	66090
7L-2S		MI	19497	7453	33895	5153	37204	4068	39286	3191	42670	1778	51197	1336	39101
16-#11	2.00	MA	30360	6379	48130	4783	52767	3878	54442	3200	55618	2224	67081	1907	36504
4L-6S		MI	15442	6379	25114	4545	26557	3689	26686	3039	25980	2050	30371	1558	18374
16-#11	2.00	MA	29760	6379	47124	4781	51462	3875	52837	3213	53293	2218	64256	1864	36350
5E		MI	15733	6379	25585	4552	27205	3697	27419	3030	26956	2041	31544	1615	18687
16-#11	2.00	MA	29189	6379	46181	4779	50155	3890	51239	3209	51188	2229	61553	1808	35582
6L-4S		MI	16037	6379	26086	4559	27850	3689	28190	3021	28035	2050	32804	1654	18666
16-#11	2.00	MA	28634	6379	45148	4795	48909	3887	49707	3222	49131	2240	58673	1719	34971
7L-3S		MI	16373	6379	26661	4548	28579	3697	29054	3030	29109	2041	33991	1735	18633
16-#11	2.00	MA	28086	6379	44220	4793	47645	3901	48211	3236	46945	2234	56030	1668	34235
8L-2S		MI	16837	6379	27355	4555	29466	3689	30114	3021	30515	2032	35820	1822	18594
16-#14	2.88	MA	31111	6761	50600	5010	55826	4038	58125	3316	60470	2185	74221	1699	50567
5E		MI	16281	6761	27230	4763	29176	3843	29752	3102	30050	1964	35640	1371	25507
16-#14	2.88	MA	30306	6761	49247	5007	53951	4058	55832	3310	57448	2200	70373	1618	49376
6L-4S		MI	16710	6761	27945	4773	30087	3831	30839	3090	31573	1976	37411	1427	26137
16-#14	2.88	MA	29522	6761	47764	5029	52162	4054	53632	3328	54496	2215	66270	1489	47956
7L-3S		MI	17184	6761	28765	4759	31116	3843	32058	3102	33088	1964	39080	1542	26161
16-#14	2.88	MA	28751	6761	46432	5026	50347	4074	51485	3347	51359	2205	62498	1417	46401
8L-2S		MI	17838	6761	29752	4769	32367	3831	33554	3090	35072	1951	41650	1667	26126
16-#18	5.13	MA	33012	7729	56849	5590	63409	4488	67295	3566	73083	2125	92140	1118	80471
6L-4S		MI	18300	7729	32471	5326	35455	4185	37214	3254	40096	1773	48374	815	42407
16-#18	5.13	MA	31684	7729	54238	5628	60259	4522	63423	3596	67887	2149	85026	887	76695
7L-3S		MI	19107	7729	33895	5304	37204	4208	39286	3276	42670	1751	51197	1013	44249
16-#18	5.13	MA	30379	7729	51891	5621	57064	4512	59642	3627	62366	2128	78463	763	72281
8L-2S		MI	20211	7729	35602	5326	39329	4185	41826	3254	46041	1729	55524	1234	44403
18-#11	2.25	MA	30441	6487	48560	4848	53303	3924	55083	3243	56349	2209	68431	1850	40778
5L-6S		MI	15752	6487	25808	4613	27444	3737	27746	3066	27386	2034	32201	1525	20474
18-#11	2.25	MA	29873	6487	47617	4847	51996	3938	53485	3239	54243	2220	65728	1794	39931
6L-5S		MI	16042	6487	26279	4620	28092	3745	28479	3057	28362	2025	33373	1582	20775
18-#11	2.25	MA	29320	6487	46584	4862	50750	3935	51952	3252	52187	2231	62848	1704	39340
7L-4S		MI	16344	6487	26780	4626	28737	3737	29250	3048	29441	2034	34634	1621	20847
18-#11	2.25	MA	28776	6487	45656	4860	49485	3950	50457	3265	50001	2225	60205	1654	38544
8L-3S		MI	16680	6487	27355	4616	29466	3745	30114	3057	30515	2025	35820	1702	20822
18-#11	2.25	MA	28186	6487	44749	4859	48256	3947	48892	3261	47963	2236	57585	1600	37646
9L-2S		MI	17142	6487	28049	4622	30353	3737	31174	3048	31921	2017	37650	1789	20789
18-#14	3.25	MA	31269	6917	51304	5105	56588	4128	59050	3352	61826	2188	76322	1596	55615
6L-5S		MI	16713	6917	28218	4860	30427	3911	31248	3140	32033	1940	38209	1320	28461
18-#14	3.25	MA	30491	6917	49821	5127	54799	4124	56850	3371	58874	2203	72219	1466	54105
7L-4S		MI	17140	6917	28932	4870	31338	3899	32335	3127	33557	1952	39980	1376	29187

RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

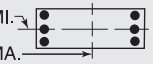


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	3.25	MA	29725	6917	48489	5124	52985	4144	54703	3389	55737	2193	68447	1394	52594
8L-3S		MI	17613	6917	29752	4856	32367	3911	33554	3140	35072	1940	41650	1492	29239
18-#14	3.25	MA	28922	6917	47186	5121	51220	4139	52458	3383	52812	2208	64716	1317	50618
9L-2S		MI	18263	6917	30740	4867	33618	3899	35049	3127	37055	1927	44220	1616	29228
18-#18	5.77	MA	33335	8006	57846	5801	64885	4646	69066	3672	75566	2127	95344	842	87323
7L-4S		MI	19021	8006	34178	5499	37579	4303	39754	3316	43467	1725	52702	713	47436
18-#18	5.77	MA	32042	8006	55500	5794	61690	4636	65286	3702	70044	2106	88782	717	82880
8L-3S		MI	19823	8006	35602	5477	39329	4325	41826	3338	46041	1703	55524	911	49489
20-#11	2.50	MA	30553	6595	49053	4914	53837	3987	55731	3268	57299	2212	69903	1779	44286
6E		MI	16060	6595	26502	4680	28331	3785	28806	3092	28792	2019	34030	1492	22577
20-#11	2.50	MA	30003	6595	48020	4929	52590	3984	54198	3281	55242	2223	67024	1689	43712
7L-5S		MI	16349	6595	26973	4687	28979	3794	29539	3084	29768	2010	35202	1549	22858
20-#11	2.50	MA	29461	6595	47092	4928	51326	3998	52702	3294	53056	2216	64381	1639	42859
8L-4S		MI	16651	6595	27474	4694	29624	3785	30310	3075	30847	2019	36463	1588	23022
20-#11	2.50	MA	28875	6595	46184	4926	50097	3995	51138	3291	51018	2227	61760	1586	41984
9L-3S		MI	16985	6595	28049	4683	30353	3794	31174	3084	31921	2010	37650	1670	23005
20-#11	2.50	MA	28275	6595	45168	4942	48850	4010	49650	3304	48998	2238	59220	1525	40920
10L-2S		MI	17446	6595	28743	4690	31240	3785	32234	3075	33327	2001	39479	1756	22978
20-#14	3.61	MA	31452	7072	51878	5224	57437	4193	60067	3413	63252	2190	78168	1443	60264
7L-5S		MI	17143	7072	29205	4957	31678	3980	32743	3177	34017	1916	40779	1270	31422
20-#14	3.61	MA	30691	7072	50546	5221	55622	4214	57920	3432	60114	2180	74396	1372	58795
8L-4S		MI	17568	7072	29920	4968	32589	3967	33830	3165	35541	1928	42550	1325	32100
20-#14	3.61	MA	29889	7072	49243	5218	53857	4209	55675	3425	57190	2195	70665	1295	56764
9L-3S		MI	18039	7072	30740	4953	33618	3980	35049	3177	37055	1916	44220	1441	32309
20-#14	3.61	MA	29029	7072	47784	5240	52067	4229	53539	3444	54290	2211	67048	1207	54660
10L-2S		MI	18687	7072	31727	4964	34869	3967	36544	3165	39039	1903	46789	1566	32329
20-#18	6.41	MA	33689	8283	59109	5967	66316	4761	70930	3778	77723	2084	99100	672	93470
8L-4S		MI	19739	8283	35885	5672	39704	4421	42294	3378	46838	1676	57029	611	52482
22-#11	2.75	MA	30681	6703	49456	4997	54431	4032	56444	3311	58297	2214	71199	1675	48088
7L-6S		MI	16368	6703	27196	4748	29218	3833	29866	3119	30198	2003	35859	1459	24682
22-#11	2.75	MA	30143	6703	48528	4995	53167	4047	54948	3324	56111	2208	68556	1625	47180
8L-5S		MI	16656	6703	27667	4754	29866	3842	30599	3111	31174	1994	37032	1517	24946
22-#11	2.75	MA	29560	6703	47620	4993	51938	4044	53384	3320	54074	2219	65935	1571	46326
9L-4S		MI	16957	6703	28168	4761	30511	3833	31370	3102	32253	2003	38292	1555	25188
22-#11	2.75	MA	28963	6703	46604	5009	50691	4058	51896	3333	52054	2230	63395	1510	45224
10L-3S		MI	17290	6703	28743	4751	31240	3842	32234	3111	33327	1994	39479	1637	25183
22-#11	2.75	MA	28380	6703	45695	5007	49468	4055	50352	3329	49899	2224	60818	1457	44206
11L-2S		MI	17749	6703	29437	4757	32127	3833	33294	3102	34733	1986	41308	1723	25162
22-#14	3.97	MA	31651	7228	52604	5318	58259	4284	61138	3474	64492	2168	80345	1349	65002
8L-5S		MI	17571	7228	30193	5054	32930	4048	34238	3215	36001	1892	43348	1219	34388
22-#14	3.97	MA	30850	7228	51301	5315	56495	4279	58892	3468	61567	2183	76614	1272	62918
9L-4S		MI	17995	7228	30907	5065	33840	4036	35325	3202	37524	1904	45120	1275	35023
22-#14	3.97	MA	29999	7228	49841	5337	54705	4299	56757	3486	58668	2198	72997	1184	60776
10L-3S		MI	18463	7228	31727	5050	34869	4048	36544	3215	39039	1892	46789	1390	35373
24-#11	3.00	MA	30820	6811	49964	5063	55008	4095	57194	3353	59167	2199	72731	1610	51506
8L-6S		MI	16674	6811	27890	4815	30105	3881	30926	3146	31604	1987	37689	1426	26789
24-#11	3.00	MA	30241	6811	49056	5061	53779	4092	55629	3349	57129	2210	70111	1557	50673
9L-5S		MI	16961	6811	28362	4822	30753	3890	31659	3138	32580	1979	38861	1484	27038
24-#11	3.00	MA	29646	6811	48040	5076	52532	4107	54142	3363	55109	2221	67570	1496	49534
10L-4S		MI	17261	6811	28862	4829	31398	3881	32430	3129	33659	1987	40122	1522	27347
24-#11	3.00	MA	29066	6811	47131	5075	51309	4104	52598	3359	52955	2215	64993	1443	48424
11L-3S		MI	17593	6811	29437	4818	32127	3890	33294	3138	34733	1979	41308	1604	27358
24-#11	3.00	MA	28497	6811	46133	5090	50071	4118	51112	3372	50936	2226	62085	1366	47094
12L-2S		MI	18051	6811	30132	4825	33015	3881	34354	3129	36139	1970	43138	1690	27343
24-#14	4.33	MA	31804	7383	53358	5413	59132	4349	62110	3510	65945	2171	82562	1249	69079
9L-5S		MI	17997	7383	31180	5152	34181	4116	35733	3252	37984	1868	45918	1168	37358
24-#14	4.33	MA	30963	7383	51899	5435	57342	4369	59974	3529	63045	2186	78946	1162	66899
10L-4S		MI	18419	7383	31895	5162	35091	4104	36820	3240	39508	1880	47689	1224	37955

RECTANGULAR TIED COLUMNS 28" x 28"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.19	MA	10749	3789	16984	2746	18072	2238	18201	1862	17772	1324	20541	1231	7794
2L-3S		MI	10234	3789	16223	2740	17096	2247	17025	1870	16212	1333	18500	1145	7848
6-#14	1.72	MA	11174	3932	17988	2821	19309	2290	19635	1886	19668	1293	22982	1175	10950
2L-3S		MI	10447	3932	16903	2812	17918	2303	17973	1898	17463	1306	20108	1051	11014
6-#18	3.06	MA	12187	4295	20437	3020	22241	2420	23104	1945	24262	1211	28840	1021	18640
2L-3S		MI	10949	4295	18557	3000	19868	2442	20268	1967	20499	1234	23975	800	18593
8-#11	1.59	MA	11092	3897	17746	2813	19049	2286	19377	1890	19332	1310	22581	1201	10221
2L-4S		MI	10211	3897	16356	2819	17271	2288	17243	1890	16580	1327	19220	1031	10297
8-#14	2.30	MA	11653	4088	19073	2918	20700	2360	21297	1925	21873	1272	25856	1129	14381
2L-4S		MI	10411	4088	17090	2925	18166	2360	18280	1925	17984	1296	21119	886	14339
8-#18	4.08	MA	12990	4572	22316	3193	24614	2541	25940	2011	28024	1168	33706	929	24526
2L-4S		MI	10880	4572	18874	3198	20289	2541	20791	2011	21388	1212	25676	503	22135
10-#11	1.99	MA	11432	4005	18508	2881	20025	2335	20553	1918	20891	1296	24622	1171	12631
2L-5S		MI	10226	4005	16570	2880	17539	2345	17565	1926	16943	1305	19854	963	12357
10-#11	1.99	MA	10923	4005	17746	2875	19049	2344	19377	1926	19332	1305	22581	1085	12665
3L-4S		MI	10556	4005	17117	2886	18248	2336	18419	1918	18140	1313	21261	1001	12672
10-#14	2.87	MA	12128	4243	20157	3016	22090	2430	22960	1964	24078	1250	28730	1083	17793
2L-5S		MI	10430	4243	17394	3013	18545	2443	18734	1977	18496	1262	22012	784	16623
10-#14	2.87	MA	11411	4243	19073	3006	20700	2443	21297	1977	21873	1262	25856	958	17794
3L-4S		MI	10895	4243	18175	3022	19557	2430	19943	1964	20189	1275	23993	840	17461
10-#18	5.10	MA	12572	4848	22316	3346	24614	2683	25940	2099	28024	1146	33706	615	30111
3L-4S		MI	11696	4848	20754	3371	22662	2661	23628	2077	25151	1168	30542	411	27583

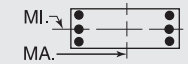
RECTANGULAR TIED COLUMNS 28" x 30"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#14	1.07	MA	12225	4024	19225	2925	20417	2386	20514	1990	19899	1427	22933	1333	8094
2E		MI	11383	4024	17955	2904	19000	2369	19019	1972	18395	1412	21134	1315	7522
4-#18	1.90	MA	12984	4266	21038	3048	22616	2470	23066	2026	23272	1371	27262	1234	13786
2E		MI	12068	4266	19614	3025	20949	2446	21310	2004	21425	1351	24992	1206	12760
6-#11	1.11	MA	12289	4036	19309	2947	20580	2403	20757	2005	20228	1436	23394	1343	8426
2L-3S		MI	10928	4036	17273	2922	18178	2397	18073	1997	17147	1430	19530	1239	7883
6-#11	1.11	MA	11727	4036	18480	2942	19517	2413	19465	2014	18515	1444	21142	1257	8480
3L-2S		MI	11443	4036	18034	2928	19154	2387	19249	1989	18707	1421	21570	1325	7828
6-#14	1.61	MA	12759	4180	20407	3022	21932	2456	22343	2031	22325	1407	26112	1291	11861
2L-3S		MI	11140	4180	17955	2992	19000	2451	19019	2024	18395	1403	21134	1144	11063
6-#14	1.61	MA	11965	4180	19225	3014	20417	2470	20514	2043	19899	1420	22933	1167	11925
3L-2S		MI	11869	4180	19040	3002	20390	2439	20681	2012	20600	1390	24008	1269	10993
6-#18	2.86	MA	13883	4543	23091	3221	25238	2593	26199	2095	27428	1331	32668	1149	20260
2L-3S		MI	11643	4543	19614	3179	20949	2589	21310	2092	21425	1329	24992	893	18693
6-#18	2.86	MA	12528	4543	21038	3204	22616	2615	23066	2117	23272	1353	27262	928	20213
3L-2S		MI	12884	4543	21494	3198	23322	2567	24147	2070	25188	1307	29858	1114	18705
8-#11	1.49	MA	12666	4144	20139	3014	21642	2452	22049	2034	21942	1423	25647	1316	11063
2L-4S		MI	10904	4144	17406	3000	18353	2437	18291	2017	17516	1425	20250	1125	10347
8-#11	1.49	MA	12108	4144	19309	3009	20580	2462	20757	2043	20228	1432	23394	1229	11108
3E		MI	11274	4144	18034	2989	19154	2445	19249	2025	18707	1416	21570	1209	10307
8-#11	1.49	MA	11708	4144	18627	3021	19710	2455	19705	2034	18919	1440	21940	1144	11139
4L-2S		MI	11786	4144	18796	2995	20130	2436	20425	2017	20267	1407	23611	1295	10259
8-#14	2.14	MA	13287	4335	21589	3119	23447	2526	24173	2072	24752	1387	29291	1249	15596
2L-4S		MI	11104	4335	18143	3105	19247	2509	19327	2051	18916	1393	22145	979	14444
8-#14	2.14	MA	12499	4335	20407	3111	21932	2539	22343	2084	22325	1400	26112	1125	15634
3E		MI	11626	4335	19040	3090	20390	2521	20681	2064	20600	1381	24008	1098	14476

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis

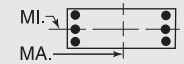


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.14	MA	11933	4335	19432	3128	20690	2528	20853	2072	20472	1412	24056	1003	15571
4L-2S		MI	12349	4335	20125	3099	21781	2509	22344	2051	22805	1369	26882	1223	14430
8-#18	3.81	MA	14769	4819	25144	3394	27860	2716	29332	2164	31584	1291	38073	1064	26686
2L-4S		MI	11572	4819	19931	3377	21369	2688	21834	2136	22315	1308	26694	596	22458
8-#18	3.81	MA	13429	4819	23091	3376	25238	2738	26199	2186	27428	1313	32668	843	26523
3E		MI	12461	4819	21494	3352	23322	2710	24147	2158	25188	1286	29858	800	24479
8-#18	3.81	MA	12465	4819	21391	3403	23082	2716	23645	2164	24254	1336	29161	634	24318
4L-2S		MI	13689	4819	23373	3371	25694	2688	26983	2136	28951	1264	34723	1021	24605
10-#11	1.86	MA	13040	4252	20968	3082	22705	2500	23342	2063	23655	1410	27900	1288	13684
2L-5S		MI	10919	4252	17620	3062	18621	2495	18613	2053	17879	1402	20884	1057	12516
10-#11	1.86	MA	12485	4252	20139	3077	21642	2510	22049	2072	21942	1419	25647	1202	13718
3L-4S		MI	11250	4252	18167	3068	19330	2486	19467	2045	19075	1411	22291	1095	12733
10-#11	1.86	MA	12087	4252	19456	3089	20773	2503	20997	2063	20633	1428	24192	1117	13725
4L-3S		MI	11617	4252	18796	3056	20130	2493	20425	2053	20267	1402	23611	1179	12712
10-#11	1.86	MA	11729	4252	18863	3083	20005	2513	20058	2072	19319	1419	22639	1079	13475
5L-2S		MI	12127	4252	19558	3062	21107	2484	21602	2045	21826	1393	25652	1265	12674
10-#14	2.68	MA	13810	4491	22771	3217	24962	2595	26003	2112	27178	1368	32470	1207	19312
2L-5S		MI	11122	4491	18446	3193	19626	2591	19781	2103	19428	1359	23038	878	16823
10-#14	2.68	MA	13027	4491	21589	3208	23447	2609	24173	2125	24752	1380	29291	1082	19313
3L-4S		MI	11589	4491	19227	3203	20638	2579	20989	2091	21121	1372	25019	933	17696
10-#14	2.68	MA	12466	4491	20614	3225	22205	2598	22683	2112	22898	1393	27235	961	19141
4L-3S		MI	12107	4491	20125	3187	21781	2591	22344	2103	22805	1359	26882	1052	17864
10-#14	2.68	MA	11961	4491	19766	3217	21107	2612	21353	2125	21036	1380	25043	907	18145
5L-2S		MI	12825	4491	21210	3196	23171	2579	24006	2091	25010	1347	29756	1177	17848
10-#18	4.76	MA	14319	5096	25144	3549	27860	2862	29332	2255	31584	1274	38073	758	32811
3L-4S		MI	12390	5096	21811	3550	23742	2808	24670	2202	26078	1264	31559	503	27900
10-#18	4.76	MA	13366	5096	23443	3576	25704	2840	26778	2233	28410	1296	34567	549	30277
4L-3S		MI	13270	5096	23373	3525	25694	2830	26983	2224	28951	1242	34723	708	30239
10-#18	4.76	MA	12509	5096	21962	3559	23796	2862	24501	2255	25219	1274	30841	451	28289
5L-2S		MI	14486	5096	25253	3544	28067	2808	29819	2202	32714	1220	39588	929	30452
12-#11	2.23	MA	13412	4360	21797	3149	23768	2549	24634	2092	25369	1398	30153	1261	16295
2L-6S		MI	10950	4360	17868	3124	18887	2535	18975	2090	18356	1397	21615	970	14423
12-#11	2.23	MA	12859	4360	20968	3144	22705	2559	23342	2101	23655	1406	27900	1175	16317
3L-5S		MI	11264	4360	18382	3129	19598	2543	19789	2081	19438	1388	22925	1028	14768
12-#11	2.23	MA	12464	4360	20285	3156	21836	2552	22290	2092	22346	1415	26445	1089	16299
4E		MI	11593	4360	18929	3135	20306	2534	20644	2073	20635	1397	24331	1065	15102
12-#11	2.23	MA	12108	4360	19692	3151	21067	2562	21350	2101	21032	1406	24892	1052	15929
5L-3S		MI	11958	4360	19558	3124	21107	2542	21602	2081	21826	1388	25652	1149	15105
12-#11	2.23	MA	11769	4360	19135	3146	20297	2555	20456	2110	19843	1415	23444	995	15530
6L-2S		MI	12466	4360	20319	3130	22083	2533	22778	2073	23386	1379	27693	1236	15078
12-#14	3.21	MA	14329	4646	23953	3314	26478	2665	27833	2153	29605	1348	35649	1165	23017
2L-6S		MI	11164	4646	18796	3281	20002	2649	20293	2155	20104	1350	24069	749	19281
12-#14	3.21	MA	13551	4646	22771	3306	24962	2679	26003	2166	27178	1360	32470	1040	22978
3L-5S		MI	11606	4646	19531	3291	21017	2661	21443	2142	21633	1338	25912	832	20037
12-#14	3.21	MA	12994	4646	21796	3322	23720	2668	24513	2153	25325	1373	30414	919	22574
4E		MI	12069	4646	20312	3300	22028	2649	22651	2130	23326	1350	27893	887	20841
12-#14	3.21	MA	12493	4646	20948	3314	22622	2682	23183	2166	23463	1360	28222	864	21652
5L-3S		MI	12584	4646	21210	3284	23171	2661	24006	2142	25010	1338	29756	1006	21232
12-#14	3.21	MA	12016	4646	20151	3306	21521	2671	21917	2178	21780	1373	26181	782	20823
6L-2S		MI	13298	4646	22294	3294	24562	2648	25668	2130	27215	1325	32630	1131	21251
12-#18	5.71	MA	14256	5373	25496	3749	28326	2963	29912	2302	32566	1256	39973	464	36277
4E		MI	13199	5373	23691	3722	26115	2929	27506	2268	29841	1220	36425	411	33382
12-#18	5.71	MA	13408	5373	24015	3732	26418	2985	27634	2324	29375	1234	36247	366	34100
5L-3S		MI	14070	5373	25253	3698	28067	2951	29819	2290	32714	1198	39588	615	35957
14-#11	2.60	MA	13781	4468	22626	3217	24831	2597	25927	2121	27083	1385	32406	1234	18898
2L-7S		MI	10990	4468	18067	3202	19185	2593	19294	2110	18859	1391	22420	876	16230
14-#11	2.60	MA	13231	4468	21797	3211	23768	2607	24634	2130	25369	1393	30153	1147	18904
3L-6S		MI	11294	4468	18629	3191	19864	2584	20151	2118	19916	1383	23655	940	16709

RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

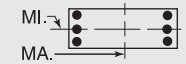
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.60	MA	12838	4468	21114	3224	22899	2600	23582	2121	24060	1402	28698	1062	18865
4L-5S		MI	11607	4468	19144	3197	20574	2592	20965	2110	20998	1374	24965	998	17031
14-#11	2.60	MA	12484	4468	20521	3218	22130	2610	22643	2130	22746	1393	27145	1024	18393
5L-4S		MI	11934	4468	19690	3203	21282	2582	21820	2101	22195	1383	26372	1036	17463
14-#11	2.60	MA	12147	4468	19964	3213	21360	2603	21749	2139	21557	1402	25697	967	18020
6L-3S		MI	12297	4468	20319	3191	22083	2590	22778	2110	23386	1374	27693	1119	17490
14-#11	2.60	MA	11818	4468	19354	3225	20625	2613	20806	2130	20395	1411	24337	901	17491
7L-2S		MI	12802	4468	21081	3197	23060	2581	23954	2101	24946	1365	29734	1206	17473
14-#14	3.75	MA	14071	4802	23953	3403	26478	2749	27833	2207	29605	1341	35649	998	26633
3L-6S		MI	11647	4802	19881	3379	21392	2719	21956	2194	22309	1328	26943	703	22409
14-#14	3.75	MA	13518	4802	22978	3420	25236	2738	26343	2194	27751	1353	33593	877	26030
4L-5S		MI	12086	4802	20616	3388	22407	2731	23105	2182	23838	1316	28786	786	23264
14-#14	3.75	MA	13021	4802	22130	3411	24137	2752	25013	2207	25889	1341	31402	822	25172
5L-4S		MI	12546	4802	21397	3397	23419	2718	24314	2169	25531	1328	30767	841	24008
14-#14	3.75	MA	12547	4802	21333	3403	23036	2740	23747	2219	24206	1353	29360	740	24243
6L-3S		MI	13057	4802	22294	3381	24562	2731	25668	2182	27215	1316	32630	960	24589
14-#18	6.67	MA	14298	5649	26068	3905	29039	3108	30767	2393	33531	1194	41652	281	39951
5L-4S		MI	14000	5649	25570	3895	28488	3050	30342	2334	33603	1176	41290	319	38896
16-#11	2.97	MA	13600	4576	22626	3279	24831	2656	25927	2159	27083	1381	32406	1120	21482
3L-7S		MI	11334	4576	18828	3270	20161	2641	20470	2138	20418	1377	24461	846	18462
16-#11	2.97	MA	13209	4576	21943	3291	23961	2648	24874	2150	25773	1389	30951	1034	21425
4L-6S		MI	11636	4576	19391	3258	20840	2632	21327	2146	21476	1369	25696	910	19001
16-#11	2.97	MA	12858	4576	21350	3286	23193	2659	23935	2159	24459	1381	29398	997	20867
5E		MI	11947	4576	19905	3264	21550	2640	22141	2138	22558	1360	27006	968	19303
16-#11	2.97	MA	12522	4576	20793	3281	22423	2652	23041	2168	23270	1389	27950	940	20515
6L-4S		MI	12272	4576	20452	3270	22259	2631	22996	2129	23754	1369	28413	1006	19818
16-#11	2.97	MA	12195	4576	20183	3293	21687	2662	22099	2159	22109	1398	26590	874	19925
7L-3S		MI	12634	4576	21081	3259	23060	2639	23954	2138	24946	1360	29734	1089	19861
16-#14	4.29	MA	14037	4958	24160	3517	26751	2808	28172	2235	30178	1333	36772	834	29504
4L-6S		MI	12127	4958	20965	3476	22783	2788	23618	2233	24513	1307	29817	657	25552
16-#14	4.29	MA	13544	4958	23312	3509	25653	2821	26842	2247	28316	1321	34581	780	28702
5E		MI	12562	4958	21700	3485	23798	2801	24768	2221	26043	1294	31660	740	26500
16-#14	4.29	MA	13073	4958	22515	3500	24551	2810	25577	2260	26633	1333	32539	698	27679
6L-4S		MI	13020	4958	22482	3494	24810	2788	25976	2209	27736	1307	33641	795	27192
18-#11	3.34	MA	13578	4684	22772	3358	25024	2697	26167	2180	27487	1377	33204	1007	23981
4L-7S		MI	11675	4684	19590	3337	21138	2690	21646	2166	21978	1363	26502	816	20701
18-#11	3.34	MA	13229	4684	22179	3353	24256	2707	25227	2188	26173	1368	31651	970	23348
5L-6S		MI	11976	4684	20153	3326	21816	2681	22503	2174	23035	1355	27737	881	21296
18-#11	3.34	MA	12895	4684	21622	3348	23486	2700	24333	2197	24984	1377	30202	913	23015
6L-5S		MI	12285	4684	20667	3332	22527	2689	23317	2166	24117	1346	29047	938	21581
18-#11	3.34	MA	12570	4684	21012	3360	22750	2710	23391	2188	23822	1385	28843	847	22368
7L-4S		MI	12609	4684	21214	3338	23235	2679	24172	2157	25314	1355	30454	976	22169
18-#14	4.82	MA	14063	5113	24494	3606	27168	2891	28672	2288	30743	1301	37760	738	32240
5L-6S		MI	12602	5113	22050	3573	24173	2858	25280	2273	26718	1285	32691	611	28710
18-#14	4.82	MA	13596	5113	23697	3598	26067	2880	27407	2301	29059	1314	35718	655	31129
6L-5S		MI	13036	5113	22785	3582	25188	2871	26430	2260	28248	1273	34534	694	29744
20-#11	3.71	MA	13598	4792	23008	3421	25319	2755	26520	2217	27886	1355	33903	942	25834
5L-7S		MI	12015	4792	20352	3405	22114	2738	22822	2194	23538	1349	28543	786	22947
20-#11	3.71	MA	13266	4792	22451	3415	24549	2748	25626	2226	26697	1364	32455	885	25517
6E		MI	12314	4792	20914	3393	22793	2729	23680	2202	24595	1341	29778	851	23574
20-#11	3.71	MA	12943	4792	21841	3427	23813	2759	24684	2217	25536	1373	31096	819	24818
7L-5S		MI	12622	4792	21428	3399	23503	2737	24493	2194	25677	1332	31088	908	23864

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

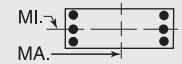
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	5.36	MA	14114	5269	24879	3695	27582	2950	29236	2342	31486	1294	38898	613	34592
6E		MI	13075	5269	23135	3670	25564	2928	26943	2312	28923	1263	35565	565	31879
22-#11	4.09	MA	13634	4900	23280	3483	25612	2797	26918	2255	28411	1351	34708	858	27959
6L-7S		MI	12352	4900	21113	3472	23090	2787	23998	2222	25097	1335	30584	756	25199
22-#11	4.09	MA	13313	4900	22670	3495	24876	2807	25976	2246	27249	1360	33349	792	27274
7L-6S		MI	12650	4900	21676	3461	23769	2777	24856	2230	26154	1327	31819	821	25798
24-#11	4.46	MA	13681	5007	23500	3562	25939	2855	27268	2275	28963	1347	35602	765	29735
7E		MI	12688	5007	21875	3539	24067	2835	25174	2250	26657	1321	32624	726	27457

RECTANGULAR TIED COLUMNS 28" x 32"

4-#14	1.00	MA	13861	4272	21687	3126	23068	2551	23209	2133	22476	1538	25916	1445	8701
2E		MI	12077	4272	19008	3085	20081	2518	20065	2099	19328	1509	22159	1409	7557
4-#18	1.79	MA	14695	4514	23661	3249	25483	2637	26018	2172	26188	1486	30710	1352	14866
2E		MI	12763	4514	20671	3204	22029	2593	22353	2129	22352	1447	26010	1299	12813
6-#11	1.04	MA	13929	4284	21775	3148	23241	2569	23446	2147	22826	1547	26408	1454	9057
2L-3S		MI	11621	4284	18323	3103	19259	2546	19121	2124	18083	1528	20559	1333	7916
6-#11	1.04	MA	13320	4284	20879	3143	22091	2580	22044	2156	20958	1556	23942	1368	9112
3L-2S		MI	12137	4284	19084	3109	20236	2537	20297	2116	19642	1519	22600	1420	7861
6-#14	1.51	MA	14444	4427	22966	3223	24708	2621	25206	2175	25124	1520	29402	1406	12772
2L-3S		MI	11834	4427	19008	3173	20081	2600	20065	2150	19328	1500	22159	1238	11110
6-#14	1.51	MA	13582	4427	21687	3216	23068	2636	23209	2188	22476	1533	25916	1281	12836
3L-2S		MI	12563	4427	20093	3182	21472	2588	21727	2138	21533	1487	25033	1363	11035
6-#18	2.68	MA	15679	4790	25886	3422	28336	2761	29449	2243	30738	1449	36658	1274	21880
2L-3S		MI	12337	4790	20671	3358	22029	2736	22353	2217	22352	1425	26010	985	18787
6-#18	2.68	MA	14207	4790	23661	3406	25483	2784	26018	2265	26188	1472	30710	1052	21833
3L-2S		MI	13581	4790	22551	3377	24402	2714	25189	2195	26115	1403	30875	1207	18768
8-#11	1.39	MA	14341	4392	22672	3215	24390	2617	24848	2176	24694	1536	28873	1429	11905
2L-4S		MI	11598	4392	18455	3182	19435	2587	19339	2144	18451	1522	21280	1220	10394
8-#11	1.39	MA	13735	4392	21775	3211	23241	2628	23446	2185	22826	1544	26408	1343	11950
3E		MI	11967	4392	19084	3171	20236	2594	20297	2152	19642	1514	22600	1303	10346
8-#11	1.39	MA	13303	4392	21039	3224	22303	2622	22307	2177	21399	1553	24816	1256	11982
4L-2S		MI	12481	4392	19846	3177	21212	2585	21474	2144	21202	1505	24641	1390	10297
8-#14	2.01	MA	15021	4583	24246	3321	26348	2691	27204	2217	27773	1502	32887	1367	16811
2L-4S		MI	11797	4583	19195	3286	20328	2658	20373	2177	19849	1490	23171	1073	14524
8-#14	2.01	MA	14166	4583	22966	3313	24708	2706	25206	2230	25124	1515	29402	1242	16849
3E		MI	12320	4583	20093	3270	21472	2670	21727	2190	21533	1478	25033	1192	14531
8-#14	2.01	MA	13555	4583	21914	3331	23367	2696	23580	2217	23101	1527	27152	1119	16786
4L-2S		MI	13045	4583	21177	3280	22862	2657	23390	2177	23737	1466	27907	1317	14478
8-#18	3.57	MA	16650	5067	28112	3595	31189	2885	32880	2315	35287	1413	42606	1196	28846
2L-4S		MI	12265	5067	20988	3555	22449	2835	22876	2261	23242	1404	27711	689	22770
8-#18	3.57	MA	15194	5067	25886	3579	28336	2909	29449	2337	30738	1435	36658	974	28683
3E		MI	13157	5067	22551	3530	24402	2857	25189	2283	26115	1382	30875	893	24587
8-#18	3.57	MA	14151	5067	24048	3608	25995	2888	26654	2315	27263	1457	32808	761	26534
4L-2S		MI	14388	5067	24430	3550	26775	2835	28025	2261	29878	1359	35740	1114	24674
10-#11	1.74	MA	14749	4500	23568	3283	25539	2666	26251	2206	26561	1524	31338	1404	14737
2L-5S		MI	11612	4500	18670	3244	19703	2644	19661	2180	18814	1500	21914	1152	12669
10-#11	1.74	MA	14147	4500	22672	3278	24390	2676	24848	2215	24694	1533	28873	1317	14771
3L-4S		MI	11944	4500	19217	3250	20411	2635	20516	2172	20011	1508	23320	1190	12786
10-#11	1.74	MA	13717	4500	21936	3291	23452	2670	23709	2207	23267	1541	27281	1231	14778
4L-3S		MI	12311	4500	19846	3238	21212	2643	21474	2180	21202	1500	24641	1273	12757
10-#11	1.74	MA	13332	4500	21297	3286	22624	2681	22692	2216	21835	1533	25584	1193	14606
5L-2S		MI	12822	4500	20608	3244	22188	2634	22650	2172	22762	1491	26682	1360	12716
10-#14	2.51	MA	15593	4738	25525	3418	27988	2761	29201	2259	30422	1484	36372	1328	20831
2L-5S		MI	11815	4738	19498	3374	20707	2740	20827	2229	20361	1456	24064	972	17015

RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

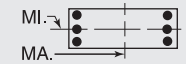
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.51	MA	14743	4738	24246	3411	26348	2776	27204	2272	27773	1497	32887	1204	20832
3L-4S		MI	12283	4738	20280	3383	21719	2727	22035	2217	22053	1469	26045	1027	17874
10-#14	2.51	MA	14137	4738	23193	3428	25007	2766	25577	2259	25749	1509	30637	1080	20725
4L-3S		MI	12802	4738	21177	3368	22862	2740	23390	2229	23737	1456	27907	1146	17930
10-#14	2.51	MA	13593	4738	22279	3421	23823	2781	24126	2272	23718	1497	28234	1026	19682
5L-2S		MI	13522	4738	22262	3377	24253	2727	25052	2217	25942	1444	30781	1271	17900
10-#18	4.46	MA	16168	5344	28112	3752	31189	3033	32880	2408	35287	1399	42606	897	35511
3L-4S		MI	13084	5344	22868	3728	24822	2955	25713	2327	27004	1360	32576	596	28206
10-#18	4.46	MA	15137	5344	26273	3781	28848	3012	30085	2386	31812	1421	38756	683	33004
4L-3S		MI	13967	5344	24430	3703	26775	2977	28025	2349	29878	1338	35740	800	30360
10-#18	4.46	MA	14211	5344	24674	3766	26777	3035	27591	2408	28321	1399	34656	585	31066
5L-2S		MI	15187	5344	26310	3723	29147	2955	30861	2327	33640	1316	40606	1022	30536
12-#11	2.09	MA	15155	4608	24465	3350	26689	2714	27653	2235	28429	1512	33804	1379	17559
2L-6S		MI	11643	4608	18918	3305	19969	2685	20023	2217	19291	1494	22644	1065	14563
12-#11	2.09	MA	14555	4608	23568	3346	25539	2725	26251	2244	26561	1521	31338	1292	17581
3L-5S		MI	11957	4608	19432	3311	20679	2693	20837	2208	20373	1486	23954	1122	14920
12-#11	2.09	MA	14128	4608	22832	3358	24601	2719	25111	2236	25134	1530	29747	1206	17562
4E		MI	12287	4608	19979	3317	21388	2683	21692	2200	21570	1494	25361	1160	15165
12-#11	2.09	MA	13745	4608	22193	3354	23773	2729	24094	2245	23703	1521	28049	1168	17260
5L-3S		MI	12653	4608	20608	3306	22188	2691	22650	2208	22762	1486	26682	1243	15154
12-#11	2.09	MA	13380	4608	21593	3349	22943	2723	23126	2254	22407	1530	26462	1111	16793
6L-2S		MI	13162	4608	21369	3311	23165	2682	23826	2200	24321	1477	28723	1330	15123
12-#14	3.01	MA	16160	4894	26804	3515	29628	2831	31199	2302	33070	1466	39857	1289	24839
2L-6S		MI	11856	4894	19848	3462	21083	2797	21339	2281	21036	1447	25095	843	19594
12-#14	3.01	MA	15316	4894	25525	3508	27988	2846	29201	2314	30422	1479	36372	1165	24800
3L-5S		MI	12299	4894	20583	3471	22098	2810	22489	2269	22566	1435	26938	926	20228
12-#14	3.01	MA	14714	4894	24472	3525	26647	2836	27575	2302	28398	1491	34122	1041	24565
4E		MI	12764	4894	21365	3480	23110	2797	23698	2256	24258	1447	28919	981	21066
12-#14	3.01	MA	14174	4894	23558	3518	25463	2851	26123	2314	26367	1479	31719	987	23481
5L-3S		MI	13280	4894	22262	3465	24253	2810	25052	2269	25942	1435	30781	1100	21305
12-#14	3.01	MA	13659	4894	22699	3511	24275	2841	24741	2327	24529	1491	29478	905	22720
6L-2S		MI	13996	4894	23347	3474	25643	2797	26715	2256	28147	1422	33655	1224	21308
12-#18	5.36	MA	16111	5620	28499	3954	31701	3136	33515	2458	36362	1384	44704	605	39517
4E		MI	13894	5620	24748	3901	27195	3076	28549	2393	30767	1316	37442	504	33684
12-#18	5.36	MA	15195	5620	26900	3939	29629	3160	31022	2480	32870	1362	40604	507	37387
5L-3S		MI	14769	5620	26310	3876	29147	3098	30861	2415	33640	1294	40606	708	36115
14-#11	2.44	MA	15558	4716	25361	3418	27838	2762	29055	2264	30297	1501	36269	1353	20372
2L-7S		MI	11682	4716	19117	3384	20266	2743	20342	2236	19794	1489	23450	970	16457
14-#11	2.44	MA	14961	4716	24465	3413	26689	2773	27653	2273	28429	1509	33804	1267	20379
3L-6S		MI	11987	4716	19679	3373	20945	2733	21199	2245	20851	1480	24685	1035	16850
14-#11	2.44	MA	14537	4716	23729	3426	25750	2767	26513	2265	27002	1518	32212	1181	20339
4L-5S		MI	12300	4716	20193	3379	21656	2741	22013	2236	21933	1472	25995	1092	17182
14-#11	2.44	MA	14155	4716	23090	3421	24922	2778	25496	2274	25570	1509	30514	1143	19926
5L-4S		MI	12629	4716	20740	3384	22364	2732	22868	2228	23130	1480	27402	1130	17532
14-#11	2.44	MA	13792	4716	22490	3417	24093	2771	24528	2284	24274	1518	28928	1086	19488
6L-3S		MI	12993	4716	21369	3373	23165	2740	23826	2236	24321	1472	28723	1214	17543
14-#11	2.44	MA	13438	4716	21833	3429	23300	2782	23508	2275	23008	1527	27230	996	19006
7L-2S		MI	13499	4716	22131	3379	24141	2730	25002	2228	25881	1463	30763	1300	17521
14-#14	3.52	MA	15884	5050	26804	3605	29628	2915	31199	2356	33070	1461	39857	1126	28759
3L-6S		MI	12340	5050	20933	3559	22474	2867	23002	2320	23241	1425	27969	797	22718
14-#14	3.52	MA	15286	5050	25751	3623	28287	2905	29573	2344	31047	1473	37607	1002	28307
4L-5S		MI	12780	5050	21668	3568	23488	2880	24152	2308	24771	1413	29812	880	23454
14-#14	3.52	MA	14750	5050	24837	3615	27103	2920	28121	2356	29016	1461	35205	949	27293
5L-4S		MI	13242	5050	22449	3578	24500	2867	25360	2295	26463	1425	31793	935	24230

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis

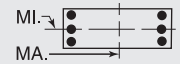


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	3.52	MA	14239	5050	23978	3608	25915	2910	26739	2369	27178	1473	32963	866	26429
6L-3S		MI	13755	5050	23347	3562	25643	2879	26715	2308	28147	1413	33655	1054	24668
14-#14	3.52	MA	13741	5050	23038	3626	24781	2925	25283	2356	25382	1486	30861	771	25355
7L-2S		MI	14466	5050	24432	3571	27034	2867	28377	2295	30352	1401	36529	1178	24705
14-#18	6.25	MA	16168	5897	29125	4111	32482	3284	34453	2551	37420	1325	46552	430	43748
5L-4S		MI	14698	5897	26627	4074	29568	3197	31385	2458	34530	1272	42307	411	39194
16-#11	2.79	MA	15364	4823	25361	3481	27838	2822	29055	2303	30297	1498	36269	1242	23167
3L-7S		MI	12026	4823	19878	3451	21243	2791	21518	2265	21354	1475	25491	940	18686
16-#11	2.79	MA	14942	4823	24625	3493	26900	2815	27915	2295	28870	1506	34677	1156	23110
4L-6S		MI	12330	4823	20441	3440	21922	2782	22375	2273	22411	1466	26726	1005	19143
16-#11	2.79	MA	14563	4823	23986	3489	26072	2826	26898	2304	27438	1498	32980	1118	22601
5E		MI	12641	4823	20955	3446	22632	2790	23189	2265	23493	1458	28036	1062	19453
16-#11	2.79	MA	14202	4823	23386	3484	25242	2820	25930	2313	26142	1506	31393	1061	22188
6L-4S		MI	12968	4823	21502	3452	23340	2780	24044	2256	24689	1466	29443	1100	19892
16-#11	2.79	MA	13850	4823	22729	3497	24449	2831	24910	2305	24876	1515	29695	971	21642
7L-3S		MI	13330	4823	22131	3440	24141	2788	25002	2265	25881	1458	30763	1184	19922
16-#11	2.79	MA	13503	4823	22138	3492	23645	2824	23959	2314	23626	1524	28109	926	21064
8L-2S		MI	13834	4823	22892	3446	25118	2779	26178	2256	27441	1449	32804	1270	19913
16-#14	4.02	MA	15854	5205	27031	3720	29927	2975	31570	2386	33695	1455	41093	964	32068
4L-6S		MI	12820	5205	22018	3656	23864	2937	24664	2360	25446	1404	30843	751	25858
16-#14	4.02	MA	15321	5205	26116	3713	28743	2990	30119	2398	31664	1443	38690	910	31117
5E		MI	13258	5205	22753	3666	24879	2949	25814	2347	26975	1391	32686	834	26690
16-#14	4.02	MA	14814	5205	25258	3705	27555	2980	28737	2411	29826	1455	36449	828	30154
6L-4S		MI	13716	5205	23534	3675	25891	2937	27022	2335	28668	1404	34667	889	27411
16-#14	4.02	MA	14319	5205	24317	3723	26421	2995	27280	2398	28031	1468	34347	732	29131
7L-3S		MI	14226	5205	24432	3659	27034	2949	28377	2347	30352	1391	36529	1008	28022
18-#11	3.13	MA	15345	4931	25522	3561	28049	2864	29317	2324	30737	1495	37143	1130	25877
4L-7S		MI	12368	4931	20640	3519	22219	2839	22694	2293	22913	1461	27532	911	20924
18-#11	3.13	MA	14968	4931	24883	3556	27221	2875	28300	2333	29306	1486	35445	1093	25284
5L-6S		MI	12670	4931	21203	3507	22898	2830	23552	2301	23970	1452	28767	975	21439
18-#11	3.13	MA	14609	4931	24283	3551	26391	2868	27332	2342	28010	1495	33858	1036	24892
6L-5S		MI	12980	4931	21717	3513	23608	2838	24365	2293	25052	1444	30077	1032	21731
18-#11	3.13	MA	14259	4931	23626	3564	25599	2879	26312	2334	26743	1503	32160	945	24286
7L-4S		MI	13305	4931	22264	3519	24317	2829	25220	2284	26249	1452	31484	1070	22247
18-#11	3.13	MA	13914	4931	23034	3560	24795	2873	25361	2343	25494	1512	30575	901	23732
8L-3S		MI	13666	4931	22892	3508	25118	2837	26178	2293	27441	1444	32804	1154	22292
18-#14	4.52	MA	15888	5361	27396	3810	30383	3060	32116	2441	34313	1425	42175	871	34949
5L-6S		MI	13297	5361	23102	3754	25255	3007	26327	2399	27651	1382	33717	705	29012
18-#14	4.52	MA	15384	5361	26537	3802	29195	3050	30734	2453	32475	1437	39934	789	33894
6L-5S		MI	13732	5361	23837	3763	26270	3019	27476	2387	29180	1370	35559	788	29935
18-#14	4.52	MA	14893	5361	25597	3820	28061	3065	29278	2441	30680	1450	37832	693	32917
7L-4S		MI	14188	5361	24619	3772	27281	3007	28685	2374	30873	1382	37541	843	30607
20-#11	3.48	MA	15371	5039	25779	3624	28370	2923	29702	2363	31173	1474	37911	1068	27974
5L-7S		MI	12708	5039	21402	3586	23196	2888	23870	2321	24473	1447	29573	881	23168
20-#11	3.48	MA	15013	5039	25179	3619	27540	2917	28734	2372	29877	1483	36324	1011	27600
6E		MI	13009	5039	21964	3575	23874	2878	24728	2329	25530	1438	30808	945	23738
20-#11	3.48	MA	14665	5039	24522	3632	26748	2928	27714	2364	28611	1492	34626	920	26938
7L-5S		MI	13318	5039	22478	3581	24585	2886	25541	2321	26612	1430	32118	1002	24014
20-#11	3.48	MA	14322	5039	23931	3627	25944	2921	26763	2373	27362	1500	33040	876	26406
8L-4S		MI	13641	5039	23025	3587	25293	2877	26396	2312	27809	1438	33524	1040	24597
20-#14	5.02	MA	15951	5516	27816	3900	30835	3120	32732	2495	35124	1419	43419	750	37646
6E		MI	13770	5516	24187	3851	26645	3077	27989	2438	29856	1360	36591	659	32178
20-#14	5.02	MA	15463	5516	26876	3917	29701	3135	31276	2483	33328	1431	41317	655	36630
7L-5S		MI	14203	5516	24922	3860	27660	3089	29139	2426	31385	1348	38433	742	33185
22-#11	3.83	MA	15415	5147	26076	3686	28690	2965	30136	2401	31745	1471	38789	986	30311
6L-7S		MI	13046	5147	22163	3654	24172	2936	25046	2349	26033	1433	31614	851	25419

RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.83	MA	15069	5147	25419	3699	27897	2976	29116	2393	30479	1480	37091	895	29597
7L-6S		MI	13346	5147	22726	3642	24851	2927	25904	2357	27090	1424	32848	915	26039
22-#11	3.83	MA	14728	5147	24827	3694	27093	2970	28165	2402	29230	1489	35505	851	29026
8L-5S		MI	13653	5147	23240	3648	25561	2935	26717	2349	28172	1416	34158	972	26302
22-#14	5.52	MA	16029	5672	28155	4015	31341	3205	33273	2525	35977	1413	44802	616	40331
7L-6S		MI	14241	5672	25272	3948	28036	3146	29651	2478	32060	1339	39465	613	35355
24-#11	4.18	MA	15471	5255	26315	3766	29046	3024	30518	2423	32347	1468	39556	870	32261
7E		MI	13383	5255	22925	3721	25148	2985	26222	2377	27592	1419	33654	821	27675
24-#11	4.18	MA	15131	5255	25724	3762	28242	3018	29567	2432	31097	1477	37971	825	31648
8L-6S		MI	13681	5255	23487	3710	25827	2975	27080	2385	28649	1410	34889	885	28274

RECTANGULAR TIED COLUMNS 28" x 34"

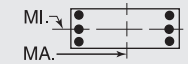
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.68	MA	16506	4761	26424	3450	28485	2802	29126	2317	29246	1600	34319	1468	15946
2E		MI	13458	4761	21728	3383	23109	2740	23395	2254	23279	1543	27027	1392	12864
6-#14	1.42	MA	16229	4675	25667	3424	27639	2787	28184	2316	28065	1633	32851	1519	13683
2L-3S		MI	12527	4675	20060	3354	21162	2749	21111	2277	20260	1597	23185	1332	11154
6-#14	1.42	MA	15299	4675	24290	3418	25874	2803	26032	2330	25194	1645	29060	1395	13747
3L-2S		MI	13258	4675	21145	3363	22553	2736	22774	2264	22465	1584	26059	1456	11076
6-#18	2.52	MA	17577	5038	28822	3623	31559	2926	32854	2391	34190	1566	40811	1396	23500
2L-3S		MI	13031	5038	21728	3536	23109	2883	23395	2342	23279	1521	27027	1078	18874
6-#18	2.52	MA	15986	5038	26424	3609	28485	2952	29126	2413	29246	1588	34319	1174	23453
3L-2S		MI	14277	5038	23607	3556	25482	2861	26232	2320	27041	1499	31892	1299	18829
8-#11	1.31	MA	16115	4639	25346	3417	27292	2783	27784	2317	27587	1647	32258	1541	12748
2L-4S		MI	12291	4639	19505	3364	20516	2736	20388	2271	19386	1620	22310	1314	10437
8-#11	1.31	MA	15462	4639	24382	3413	26056	2794	26277	2327	25565	1656	29580	1455	12793
3E		MI	12661	4639	20134	3352	21317	2744	21346	2279	20578	1611	23630	1398	10385
8-#11	1.31	MA	14998	4639	23592	3426	25049	2788	25053	2319	24020	1665	27847	1368	12824
4L-2S		MI	13175	4639	20896	3358	22294	2735	22522	2271	22137	1603	25671	1484	10333
8-#14	1.89	MA	16855	4830	27043	3522	29404	2857	30337	2359	30936	1616	36643	1483	18026
2L-4S		MI	12490	4830	20247	3467	21410	2806	21419	2304	20781	1587	24196	1167	14597
8-#14	1.89	MA	15933	4830	25667	3515	27639	2872	28184	2372	28065	1629	32851	1359	18064
3E		MI	13014	4830	21145	3451	22553	2819	22774	2316	22465	1575	26059	1286	14583
8-#14	1.89	MA	15276	4830	24537	3534	26199	2863	26435	2361	25871	1641	30402	1234	18001
4L-2S		MI	13740	4830	22230	3460	23943	2806	24436	2304	24670	1563	28933	1410	14525
8-#18	3.36	MA	18633	5314	31220	3796	34634	3050	36583	2464	39134	1533	47302	1324	31006
2L-4S		MI	12957	5314	22045	3734	23530	2981	23919	2386	24168	1500	28728	781	23073
8-#18	3.36	MA	17059	5314	28822	3782	31559	3076	32854	2487	34190	1555	40811	1102	30843
3E		MI	13852	5314	23607	3709	25482	3004	26232	2408	27041	1477	31892	986	24689
8-#18	3.36	MA	15937	5314	26846	3812	29042	3057	29818	2464	30413	1577	36616	885	28781
4L-2S		MI	15087	5314	25487	3728	27855	2981	29068	2386	30804	1455	36758	1207	24743
10-#11	1.64	MA	16558	4747	26310	3484	28527	2831	29292	2346	29609	1637	34937	1518	15790
2L-5S		MI	12305	4747	19720	3425	20784	2794	20709	2307	19749	1597	22943	1246	12818
10-#11	1.64	MA	15908	4747	25346	3480	27292	2843	27784	2356	27587	1645	32258	1431	15824
3L-4S		MI	12637	4747	20267	3431	21493	2784	21564	2299	20946	1606	24350	1284	12836
10-#11	1.64	MA	15447	4747	24556	3493	26285	2837	26561	2349	26042	1654	30525	1345	15831
4L-3S		MI	13006	4747	20896	3420	22294	2792	22522	2307	22137	1597	25671	1368	12800
10-#11	1.64	MA	15034	4747	23871	3489	25397	2848	25470	2358	24492	1645	28687	1306	15749
5L-2S		MI	13517	4747	21657	3426	23270	2783	23698	2299	23697	1589	27712	1454	12756
10-#14	2.36	MA	17476	4986	28420	3619	31168	2926	32490	2401	33807	1600	40435	1447	22350
2L-5S		MI	12507	4986	20551	3555	21788	2888	21873	2355	21293	1553	25089	1066	17201

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis

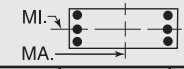


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	2.36	MA	16560	4986	27043	3612	29404	2942	30337	2414	30936	1612	36643	1323	22351
3L-4S		MI	12976	4986	21332	3564	22800	2876	23081	2343	22986	1566	27070	1121	17958
10-#14	2.36	MA	15908	4986	25913	3631	27964	2933	28587	2403	28742	1625	34194	1198	22243
4L-3S		MI	13497	4986	22230	3548	23943	2888	24436	2355	24670	1553	28933	1240	17989
10-#14	2.36	MA	15324	4986	24932	3624	26693	2949	27026	2416	26542	1612	31585	1144	21234
5L-2S		MI	14218	4986	23314	3558	25334	2876	26098	2343	26875	1541	31807	1364	17951
10-#18	4.20	MA	18119	5591	31220	3955	34634	3200	36583	2560	39134	1521	47302	1030	38211
3L-4S		MI	13778	5591	23925	3907	25902	3102	26755	2452	27931	1456	33594	689	28503
10-#18	4.20	MA	17009	5591	29244	3985	32117	3181	33546	2538	35357	1543	43108	812	35764
4L-3S		MI	14664	5591	25487	3882	27855	3124	29068	2474	30804	1434	36758	893	30474
10-#18	4.20	MA	16014	5591	27527	3972	29892	3207	30837	2560	31565	1521	38632	716	33900
5L-2S		MI	15888	5591	27367	3901	30228	3102	31904	2452	34567	1412	41623	1115	30618
12-#11	1.97	MA	16998	4855	27274	3551	29763	2879	30799	2375	31631	1626	37615	1495	18822
2L-6S		MI	12335	4855	19968	3487	21051	2834	21071	2344	20227	1592	23674	1159	14698
12-#11	1.97	MA	16351	4855	26310	3547	28527	2891	29292	2385	29609	1635	34937	1408	18844
3L-5S		MI	12651	4855	20482	3493	21761	2842	21885	2335	21309	1583	24984	1216	15067
12-#11	1.97	MA	15893	4855	25520	3561	27521	2885	28068	2378	28064	1643	33204	1322	18826
4E		MI	12981	4855	21029	3499	22469	2833	22740	2327	22505	1592	26391	1254	15223
12-#11	1.97	MA	15482	4855	24835	3556	26633	2897	26978	2388	26514	1635	31366	1283	18603
5L-3S		MI	13348	4855	21657	3487	23270	2841	23698	2335	23697	1583	27712	1338	15201
12-#11	1.97	MA	15090	4855	24192	3552	25743	2891	25891	2380	25111	1643	29640	1227	18064
6L-2S		MI	13857	4855	22419	3493	24247	2831	24874	2327	25256	1575	29752	1424	15166
12-#14	2.84	MA	18092	5142	29796	3716	32933	2996	34643	2444	36678	1583	44227	1412	26662
2L-6S		MI	12548	5142	20901	3643	22164	2946	22386	2407	21969	1544	26121	937	19898
12-#14	2.84	MA	17181	5142	28420	3710	31168	3012	32490	2457	33807	1596	40435	1287	26623
3L-5S		MI	12993	5141	21636	3652	23179	2958	23536	2395	23498	1532	27963	1020	20412
12-#14	2.84	MA	16534	5142	27290	3728	29728	3003	30740	2445	31613	1608	37986	1162	26476
4E		MI	13459	5142	22417	3661	24191	2946	24744	2382	25191	1544	29944	1075	21284
12-#14	2.84	MA	15954	5141	26309	3722	28458	3019	29179	2459	29413	1596	35377	1108	25324
5L-3S		MI	13976	5142	23314	3646	25334	2958	26098	2395	26875	1532	31807	1194	21374
12-#14	2.84	MA	15402	5142	25388	3715	27184	3010	27694	2472	27421	1608	32935	1026	24648
6L-2S		MI	14693	5141	24399	3655	26725	2946	27761	2382	29080	1519	34681	1318	21363
12-#18	5.04	MA	18067	5868	31643	4158	35191	3305	37275	2612	40301	1510	49599	740	42791
4E		MI	14590	5868	25805	4080	28275	3223	29591	2517	31694	1412	38459	597	33977
12-#18	5.04	MA	17083	5868	29925	4144	32966	3331	34565	2634	36509	1488	45124	644	40734
5L-3S		MI	15468	5868	27367	4055	30228	3245	31904	2540	34567	1390	41623	801	36240
14-#11	2.29	MA	17435	4963	28238	3619	30999	2928	32307	2405	33653	1615	40293	1471	21847
2L-7S		MI	12374	4963	20167	3566	21348	2892	21390	2363	20729	1586	24480	1065	16677
14-#11	2.29	MA	16792	4963	27274	3615	29763	2939	30799	2415	31631	1624	37615	1385	21853
3L-6S		MI	12680	4963	20729	3554	22027	2883	22247	2372	21786	1578	25715	1129	16986
14-#11	2.29	MA	16336	4963	26484	3628	28756	2934	29576	2407	30086	1633	35882	1299	21813
4L-5S		MI	12994	4963	21243	3560	22737	2891	23061	2363	22868	1569	27025	1186	17328
14-#11	2.29	MA	15927	4963	25799	3624	27869	2945	28485	2417	28536	1624	34044	1260	21470
5L-4S		MI	13323	4963	21790	3566	23446	2881	23916	2355	24065	1578	28432	1224	17596
14-#11	2.29	MA	15537	4963	25156	3620	26979	2939	27398	2410	27133	1633	32318	1203	20963
6L-3S		MI	13688	4963	22419	3555	24247	2889	24874	2363	25256	1569	29752	1308	17594
14-#11	2.29	MA	15158	4963	24452	3633	26130	2951	26354	2420	25762	1641	30473	1113	20541
7L-2S		MI	14195	4963	23181	3561	25223	2880	26050	2355	26816	1561	31793	1394	17568
14-#14	3.31	MA	17797	5297	29796	3807	32933	3082	34643	2499	36678	1579	44227	1251	30885
3L-6S		MI	13032	5297	21985	3740	23555	3016	24048	2447	24173	1522	28995	891	23018
14-#14	3.31	MA	17155	5297	28666	3825	31493	3073	32893	2488	34484	1592	41778	1127	30609
4L-5S		MI	13474	5297	22720	3749	24570	3028	25198	2434	25703	1510	30837	974	23638
14-#14	3.31	MA	16579	5297	27686	3819	30222	3089	31332	2501	32284	1579	39168	1072	29429
5L-4S		MI	13937	5297	23502	3758	25581	3016	26406	2422	27395	1522	32818	1029	24445
14-#14	3.31	MA	16031	5297	26765	3812	28949	3080	29846	2514	30292	1592	36727	990	28646
6L-3S		MI	14452	5297	24399	3743	26725	3028	27761	2434	29080	1510	34681	1148	24743
14-#14	3.31	MA	15497	5297	25757	3831	27733	3096	28281	2503	28345	1604	34115	860	27414
7L-2S		MI	15165	5297	25484	3752	28115	3016	29423	2422	31284	1498	37555	1272	24769

RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	5.88	MA	18141	6144	32324	4317	36041	3455	38294	2708	41453	1454	51615	572	47607
5L-4S		MI	15395	6144	27684	4253	30648	3344	32428	2583	35457	1368	43325	504	39483
16-#11	2.62	MA	17229	5071	28238	3682	30999	2988	32307	2444	33653	1613	40293	1362	24852
3L-7S		MI	12719	5071	20928	3633	22325	2940	22566	2391	22289	1572	26521	1035	18904
16-#11	2.62	MA	16775	5071	27448	3695	29992	2982	31083	2437	32108	1622	38560	1275	24795
4L-6S		MI	13023	5071	21491	3622	23003	2931	23424	2400	23346	1564	27756	1099	19279
16-#11	2.62	MA	16369	5071	26763	3691	29104	2994	29993	2447	30558	1613	36722	1237	24348
5E		MI	13336	5071	22005	3628	23714	2939	24237	2391	24428	1555	29066	1156	19599
16-#11	2.62	MA	15981	5071	26120	3687	28215	2988	28906	2439	29155	1622	34996	1180	23868
6L-4S		MI	13663	5071	22552	3633	24422	2930	25092	2383	25625	1564	30473	1194	19961
16-#11	2.62	MA	15604	5071	25416	3700	27365	2999	27862	2449	27784	1631	33151	1090	23378
7L-3S		MI	14026	5071	23181	3622	25223	2938	26050	2391	26816	1555	31793	1278	19980
16-#11	2.62	MA	15232	5071	24782	3696	26504	2994	26843	2459	26326	1622	31434	1044	22716
8L-2S		MI	14531	5071	23942	3628	26199	2928	27226	2383	28376	1547	33834	1364	19963
16-#14	3.78	MA	17771	5453	30043	3923	33258	3143	35046	2530	37355	1575	45570	1091	34658
4L-6S		MI	13513	5453	23070	3837	24945	3086	25711	2486	26378	1501	31869	845	26154
16-#14	3.78	MA	17199	5453	29062	3916	31987	3159	33485	2544	35155	1563	42960	1036	33546
5E		MI	13952	5453	23805	3846	25960	3098	26860	2474	27908	1488	33711	928	26874
16-#14	3.78	MA	16655	5453	28141	3910	30713	3150	31999	2557	33163	1575	40519	954	32661
6L-4S		MI	14413	5453	24586	3856	26972	3086	28069	2461	29600	1501	35692	983	27624
16-#14	3.78	MA	16124	5453	27133	3928	29497	3165	30434	2545	31216	1587	37907	824	31483
7L-3S		MI	14924	5453	25484	3840	28115	3098	29423	2474	31284	1488	37555	1102	28103
18-#11	2.95	MA	17212	5179	28412	3763	31228	3030	32591	2466	34130	1611	41239	1252	27772
4L-7S		MI	13061	5179	21690	3701	23301	2989	23742	2420	23848	1558	28562	1005	21139
18-#11	2.95	MA	16808	5179	27727	3759	30340	3042	31500	2476	32580	1603	39400	1214	27233
5L-6S		MI	13364	5179	22253	3689	23980	2980	24600	2428	24906	1550	29797	1069	21576
18-#11	2.95	MA	16422	5179	27084	3755	29450	3036	30413	2469	31177	1611	37675	1157	26778
6L-5S		MI	13675	5179	22767	3695	24690	2987	25413	2420	25988	1541	31107	1126	21876
18-#11	2.95	MA	16047	5179	26380	3768	28601	3048	29369	2479	29806	1620	35829	1067	26225
7L-4S		MI	14001	5179	23314	3701	25398	2978	26268	2411	27184	1550	32514	1164	22320
18-#11	2.95	MA	15677	5179	25746	3764	27740	3042	28350	2488	28348	1611	34112	1021	25589
8L-3S		MI	14363	5179	23942	3690	26199	2986	27226	2420	28376	1541	33834	1248	22354
18-#14	4.25	MA	17815	5608	30439	4013	33752	3228	35637	2586	38026	1546	46752	1000	37673
5L-6S		MI	13991	5608	24155	3934	26336	3155	27373	2525	28583	1479	34743	799	29305
18-#14	4.25	MA	17274	5608	29518	4007	32478	3219	34152	2599	36034	1558	44311	919	36691
6L-5S		MI	14428	5608	24890	3944	27351	3168	28523	2513	30113	1467	36585	882	30118
18-#14	4.25	MA	16747	5608	28510	4025	31262	3235	32587	2588	34087	1571	41699	788	35563
7L-4S		MI	14885	5608	25671	3953	28363	3155	29731	2500	31805	1479	38566	937	30818
20-#11	3.28	MA	17244	5287	28691	3826	31576	3090	33008	2505	34602	1592	42079	1190	30126
5L-7S		MI	13402	5287	22452	3768	24277	3037	24918	2448	25408	1544	30603	975	23382
20-#11	3.28	MA	16861	5287	28048	3822	30686	3085	31921	2498	33199	1601	40353	1134	29691
6E		MI	13704	5287	23014	3757	24956	3028	25776	2456	26465	1536	31837	1039	23875
20-#11	3.28	MA	16488	5287	27344	3835	29837	3096	30877	2508	31828	1609	38508	1043	29079
7L-5S		MI	14013	5287	23528	3762	25666	3036	26589	2448	27547	1527	33147	1097	24160
20-#11	3.28	MA	16120	5287	26710	3831	28975	3090	29858	2518	30370	1601	36790	998	28466
8L-4S		MI	14338	5287	24075	3768	26375	3027	27444	2439	28744	1536	34554	1134	24675
20-#14	4.73	MA	17888	5764	30894	4104	34243	3289	36305	2642	38904	1542	48103	883	40733
6E		MI	14465	5764	25240	4032	27727	3225	29035	2565	30788	1457	37617	753	32468
20-#14	4.73	MA	17365	5764	29886	4122	33026	3305	34740	2630	36958	1554	45491	752	39652
7L-5S		MI	14900	5764	25975	4041	28741	3238	30185	2552	32317	1445	39459	836	33368
22-#11	3.61	MA	17297	5395	29012	3890	31922	3133	33428	2528	35221	1590	43031	1110	32608
6L-7S		MI	13741	5395	23213	3835	25254	3086	26094	2476	26968	1530	32643	945	25632

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

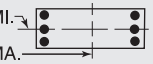
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.61	MA	16925	5395	28308	3903	31073	3145	32384	2537	33850	1599	41186	1020	31940
7L-6S		MI	14041	5395	23776	3824	25932	3076	26952	2484	28025	1522	33878	1009	26178
22-#11	3.61	MA	16560	5395	27674	3899	30211	3139	31365	2547	32392	1590	39468	974	31349
8L-5S		MI	14349	5395	24290	3830	26643	3084	27765	2476	29107	1513	35188	1067	26447
22-#14	5.20	MA	17979	5920	31263	4220	34791	3375	36892	2673	39829	1538	49283	716	43749
7L-6S		MI	14937	5920	26324	4129	29117	3295	30698	2604	32993	1436	40491	707	35642
24-#11	3.93	MA	17361	5503	29272	3970	32308	3193	33892	2567	35872	1588	43864	997	34807
7E		MI	14078	5503	23975	3903	26230	3134	27270	2504	28527	1516	34684	915	27887
24-#11	3.93	MA	16997	5503	28638	3966	31447	3187	32873	2577	34414	1579	42147	951	34236
8L-6S		MI	14377	5503	24537	3891	26909	3125	28128	2512	29585	1508	35919	979	28482

RECTANGULAR TIED COLUMNS 28" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.59	MA	18417	5009	29327	3651	31640	2968	32375	2461	32446	1713	38089	1582	17026
2E		MI	14152	5009	22785	3561	24189	2887	24438	2379	24205	1639	28044	1485	12913
6-#14	1.34	MA	18113	4922	28508	3626	30724	2952	31307	2457	31147	1745	36461	1631	14595
2L-3S		MI	13221	4922	21113	3534	22243	2897	22158	2403	21192	1694	24211	1426	11196
6-#14	1.34	MA	17116	4922	27034	3620	28834	2969	29002	2471	28054	1757	32362	1507	14659
3L-2S		MI	13952	4922	22197	3544	23634	2885	23820	2391	23397	1681	27085	1550	11116
6-#18	2.38	MA	19575	5285	31899	3824	34936	3092	36397	2536	37785	1682	45125	1516	25120
2L-3S		MI	13725	5285	22785	3715	24189	3030	24438	2467	24205	1617	28044	1171	18956
6-#18	2.38	MA	17866	5285	29327	3812	31640	3119	32375	2558	32446	1704	38089	1294	25073
3L-2S		MI	14973	5285	24664	3734	26562	3008	27274	2445	27968	1595	32910	1392	18888
8-#11	1.24	MA	17988	4887	28161	3618	30347	2948	30873	2457	30621	1759	35803	1652	13590
2L-4S		MI	12984	4887	20555	3545	21598	2886	21436	2398	20321	1717	23339	1408	10478
8-#11	1.24	MA	17288	4887	27130	3614	29025	2960	29260	2468	28445	1767	32911	1566	13635
3E		MI	13355	4887	21184	3534	22399	2893	22394	2406	21513	1709	24660	1492	10421
8-#11	1.24	MA	16793	4887	26286	3628	27950	2955	27953	2461	26781	1776	31037	1479	13667
4L-2S		MI	13869	4887	21946	3540	23375	2884	23570	2398	23072	1700	26701	1578	10369
8-#14	1.79	MA	18790	5078	29982	3723	32613	3022	33612	2499	34241	1729	40560	1598	19241
2L-4S		MI	13183	5078	21300	3647	22491	2955	22465	2430	21713	1685	25222	1261	14666
8-#14	1.79	MA	17799	5078	28508	3717	30724	3039	31307	2514	31147	1742	36461	1473	19279
3E		MI	13708	5078	22197	3632	23634	2967	23820	2442	23397	1672	27085	1380	14633
8-#14	1.79	MA	17097	5078	27300	3736	29185	3031	29437	2503	28783	1754	33808	1349	19216
4L-2S		MI	14435	5078	23282	3641	25025	2955	25482	2430	25602	1660	29959	1504	14570
8-#18	3.17	MA	20717	5562	34470	3997	38233	3216	40418	2611	43124	1651	52160	1449	33166
2L-4S		MI	13650	5562	23102	3913	24610	3128	24961	2511	25095	1596	29746	874	23367
8-#18	3.17	MA	19026	5562	31899	3985	34936	3243	36397	2634	37785	1673	45125	1227	33003
3E		MI	14547	5562	24664	3888	26562	3151	27274	2533	27968	1573	32910	1078	24785
8-#18	3.17	MA	17824	5562	29785	4016	32243	3226	33124	2612	33705	1695	40585	1006	31059
4L-2S		MI	15784	5562	26544	3907	28935	3128	30110	2511	31731	1551	37775	1300	24810
10-#11	1.55	MA	18466	4995	29192	3685	31669	2996	32486	2487	32798	1749	38694	1631	16843
2L-5S		MI	12998	4995	20770	3607	21866	2943	21757	2434	20684	1695	23973	1341	12900
10-#11	1.55	MA	17770	4995	28161	3682	30347	3009	30873	2497	30621	1758	35803	1544	16877
3L-4S		MI	13331	4995	21317	3613	22575	2934	22612	2426	21881	1703	25380	1378	12883
10-#11	1.55	MA	17277	4995	27317	3695	29272	3003	29566	2490	28958	1766	33928	1458	16884
4L-3S		MI	13700	4995	21946	3602	23375	2942	23570	2434	23072	1695	26701	1462	12841
10-#11	1.55	MA	16835	4995	26586	3692	28324	3015	28402	2501	27291	1758	31950	1419	16825
5L-2S		MI	14212	4995	22707	3607	24352	2933	24746	2426	24632	1686	28742	1548	12795
10-#14	2.23	MA	19460	5233	31456	3820	34502	3092	35917	2542	37334	1714	44659	1565	23868
2L-5S		MI	13200	5233	21603	3735	22870	3037	22919	2482	22226	1650	26115	1160	17380
10-#14	2.23	MA	18476	5233	29982	3814	32613	3109	33612	2556	34241	1727	40560	1440	23869
3L-4S		MI	13670	5233	22385	3745	23882	3025	24128	2469	23918	1663	28096	1215	18035
10-#14	2.23	MA	17779	5233	28774	3833	31074	3100	31742	2546	31877	1739	37907	1316	23762
4L-3S		MI	14192	5233	23282	3729	25025	3037	25482	2482	25602	1650	29959	1334	18046
10-#14	2.23	MA	17155	5233	27727	3827	29717	3117	30075	2560	29506	1727	35095	1260	22800
5L-2S		MI	14914	5233	24367	3738	26415	3025	27145	2469	27807	1638	32833	1458	18001

RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis



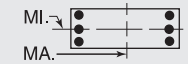
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.97	MA	20170	5839	34470	4157	38233	3367	40418	2709	43124	1642	52160	1160	40911
3L-4S		MI	14471	5839	24982	4086	26983	3249	27798	2576	28858	1552	34611	782	28793
10-#18	3.97	MA	18982	5839	32356	4189	35539	3350	37145	2688	39044	1664	47621	939	38555
4L-3S		MI	15361	5839	26544	4061	28935	3271	30110	2598	31731	1530	37775	986	30582
10-#18	3.97	MA	17917	5839	30521	4177	33161	3377	34224	2710	34951	1642	42770	844	36678
5L-2S		MI	16587	5839	28424	4080	31308	3249	32947	2576	35494	1507	42641	1207	30697
12-#11	1.86	MA	18940	5103	30224	3753	32991	3045	34099	2516	34974	1739	41586	1609	20086
2L-6S		MI	13028	5103	21018	3669	22132	2984	22119	2471	21162	1689	24704	1253	14827
12-#11	1.86	MA	18247	5103	29192	3749	31669	3057	32486	2527	32798	1748	38694	1523	20108
3L-5S		MI	13344	5103	21532	3674	22843	2992	22933	2462	22244	1681	26014	1311	15209
12-#11	1.86	MA	17757	5103	28349	3763	30594	3052	31179	2520	31134	1756	36820	1436	20089
4E		MI	13675	5103	22079	3680	23551	2982	23788	2454	23441	1689	27421	1348	15275
12-#11	1.86	MA	17318	5103	27618	3759	29646	3064	30015	2530	29467	1748	34841	1397	19959
5L-3S		MI	14042	5103	22707	3669	24352	2990	24746	2462	24632	1681	28742	1432	15247
12-#11	1.86	MA	16900	5103	26932	3755	28697	3059	28855	2524	27957	1756	32976	1341	19344
6L-2S		MI	14553	5103	23469	3675	25328	2981	25922	2454	26192	1672	30782	1519	15209
12-#14	2.68	MA	20124	5389	32929	3917	36392	3162	38221	2584	40428	1699	48758	1531	28484
2L-6S		MI	13240	5389	21953	3823	23245	3095	23432	2533	22901	1641	27147	1031	20153
12-#14	2.68	MA	19147	5389	31456	3911	34502	3178	35917	2598	37334	1711	44659	1407	28445
3L-5S		MI	13686	5389	22688	3833	24260	3107	24582	2521	24430	1629	28989	1114	20590
12-#14	2.68	MA	18455	5389	30248	3931	32963	3170	34047	2588	34970	1724	42006	1282	28299
4E		MI	14153	5389	23469	3842	25272	3094	25790	2509	26123	1641	30970	1169	21390
12-#14	2.68	MA	17835	5389	29201	3925	31606	3187	32380	2602	32600	1711	39194	1227	27182
5L-3S		MI	14672	5389	24367	3826	26415	3107	27145	2521	27807	1629	32833	1288	21441
12-#14	2.68	MA	17245	5389	28218	3919	30247	3179	30718	2592	30453	1724	36552	1145	26449
6L-2S		MI	15390	5389	25452	3836	27806	3094	28807	2509	30012	1616	35707	1412	21417
12-#18	4.76	MA	20125	6115	34927	4362	38836	3474	41167	2763	44383	1633	54657	872	46097
4E		MI	15285	6115	26862	4258	29355	3370	30634	2642	32621	1508	39477	689	34262
12-#18	4.76	MA	19072	6115	33092	4350	36458	3501	38246	2785	40290	1611	49806	777	44137
5L-3S		MI	16166	6115	28424	4234	31308	3392	32947	2664	35494	1486	42641	893	36357
12-#18	4.76	MA	18071	6115	31368	4337	34074	3484	35465	2808	36586	1633	45280	631	41060
6L-2S		MI	17383	6115	30304	4253	33681	3370	35783	2642	39257	1464	47506	1115	36542
14-#11	2.17	MA	19412	5211	31255	3820	34314	3093	35712	2545	37151	1729	44477	1588	23321
2L-7S		MI	13066	5211	21217	3747	22430	3041	22438	2490	21664	1684	25510	1159	16890
14-#11	2.17	MA	18722	5211	30224	3816	32991	3105	34099	2556	34974	1738	41586	1501	23327
3L-6S		MI	13373	5211	21779	3736	23109	3032	23296	2499	22722	1675	26745	1223	17115
14-#11	2.17	MA	18234	5211	29380	3830	31916	3100	32792	2549	33311	1747	39712	1415	23287
4L-5S		MI	13688	5211	22293	3742	23819	3040	24109	2490	23804	1667	28055	1281	17469
14-#11	2.17	MA	17798	5211	28649	3826	30969	3112	31628	2560	31644	1738	37733	1375	23027
5L-4S		MI	14018	5211	22840	3748	24527	3031	24964	2482	25000	1675	29462	1319	17659
14-#11	2.17	MA	17382	5211	27963	3823	30019	3107	30468	2553	30133	1747	35868	1319	22447
6L-3S		MI	14383	5211	23469	3736	25328	3039	25922	2490	26192	1667	30782	1402	17643
14-#11	2.17	MA	16977	5211	27212	3836	29113	3119	29355	2564	28657	1755	33875	1229	22082
7L-2S		MI	14891	5211	24231	3742	26305	3029	27098	2482	27751	1658	32823	1489	17613
14-#14	3.13	MA	19812	5545	32929	4009	36392	3248	38221	2641	40428	1696	48758	1374	33011
3L-6S		MI	13725	5545	23038	3921	24636	3164	25094	2573	25106	1619	30020	985	23309
14-#14	3.13	MA	19125	5545	31722	4028	34853	3240	36351	2630	38064	1709	46105	1249	32829
4L-5S		MI	14168	5545	23773	3930	25651	3177	26244	2560	26635	1607	31863	1068	23815
14-#14	3.13	MA	18509	5545	30675	4022	33496	3257	34684	2645	35693	1696	43293	1193	31580
5L-4S		MI	14633	5545	24554	3939	26663	3164	27453	2548	28328	1619	33844	1123	24654
14-#14	3.13	MA	17923	5545	29692	4016	32136	3249	33023	2634	33547	1709	40651	1112	30884
6L-3S		MI	15148	5545	25452	3923	27806	3177	28807	2560	30012	1607	35707	1241	24815
14-#14	3.13	MA	17353	5545	28616	4035	30838	3265	31428	2649	31449	1721	37827	981	29496
7L-2S		MI	15863	5545	26536	3933	29196	3164	30469	2548	32217	1595	38581	1366	24822

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis

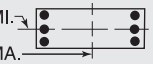


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	5.56	MA	20215	6392	35663	4523	39754	3626	42267	2861	45629	1580	56842	710	51525
5L-4S		MI	16091	6392	28741	4431	31728	3491	33470	2708	36383	1464	44342	597	39765
14-#18	5.56	MA	19224	6392	33939	4510	37370	3609	39487	2883	41925	1602	52316	564	48594
6L-3S		MI	16966	6392	30304	4406	33681	3513	35783	2730	39257	1442	47506	801	42118
16-#11	2.48	MA	19193	5318	31255	3884	34314	3154	35712	2585	37151	1728	44477	1480	26537
3L-7S		MI	13411	5318	21978	3815	23406	3090	23614	2518	23224	1670	27551	1129	19114
16-#11	2.48	MA	18708	5318	30411	3897	33238	3149	34405	2579	35487	1737	42603	1393	26479
4L-6S		MI	13717	5318	22541	3803	24085	3081	24472	2527	24281	1661	28786	1193	19409
16-#11	2.48	MA	18274	5318	29680	3894	32291	3161	33241	2589	33820	1728	40624	1354	26106
5E		MI	14030	5318	23055	3809	24795	3089	25285	2518	25363	1653	30096	1251	19739
16-#11	2.48	MA	17861	5318	28995	3890	31342	3156	32081	2582	32310	1737	38759	1297	25556
6L-4S		MI	14358	5318	23602	3815	25504	3079	26140	2510	26560	1661	31503	1289	20026
16-#11	2.48	MA	17458	5318	28243	3904	30436	3168	30968	2593	30834	1745	36767	1207	25134
7L-3S		MI	14722	5318	24231	3804	26305	3087	27098	2518	27751	1653	32823	1372	20032
16-#11	2.48	MA	17061	5318	27568	3900	29516	3162	29880	2604	29265	1737	34917	1161	24383
8L-2S		MI	15228	5318	24992	3810	27281	3078	28274	2510	29311	1644	34864	1459	20011
16-#14	3.57	MA	19789	5700	33195	4125	36742	3310	38656	2673	41157	1693	50204	1216	37273
4L-6S		MI	14206	5700	24123	4018	26027	3234	26757	2612	27311	1598	32894	939	26442
16-#14	3.57	MA	19178	5700	32148	4119	35385	3327	36989	2687	38787	1681	47392	1160	35991
5E		MI	14647	5700	24857	4027	27041	3247	27907	2600	28840	1585	34737	1021	27051
16-#14	3.57	MA	18596	5700	31166	4113	34025	3318	35328	2677	36640	1693	44750	1079	35199
6L-4S		MI	15109	5700	25639	4036	28053	3234	29115	2587	30533	1598	36718	1077	27831
16-#14	3.57	MA	18030	5700	30090	4132	32727	3335	33733	2691	34543	1706	41926	948	33858
7L-3S		MI	15622	5700	26536	4021	29196	3247	30469	2600	32217	1585	38581	1195	28180
16-#14	3.57	MA	17472	5700	29122	4127	31411	3327	32175	2705	32312	1693	39298	882	32540
8L-2S		MI	16333	5700	27621	4030	30587	3234	32132	2587	34422	1573	41455	1320	28216
16-#18	6.35	MA	20364	6668	36511	4683	40667	3733	43508	2959	47264	1571	59351	497	56154
6L-4S		MI	16891	6668	30621	4604	34101	3612	36306	2774	40146	1420	49208	504	45295
18-#11	2.79	MA	19180	5426	31443	3965	34560	3197	36018	2608	37664	1727	45495	1372	29667
4L-7S		MI	13754	5426	22740	3882	24383	3138	24790	2547	24784	1656	29592	1099	21348
18-#11	2.79	MA	18748	5426	30712	3961	33613	3209	34854	2619	35997	1718	43516	1332	29195
5L-6S		MI	14058	5426	23303	3871	25061	3129	25648	2555	25841	1647	30827	1164	21707
18-#11	2.79	MA	18336	5426	30026	3958	32664	3204	33694	2612	34486	1727	41651	1276	28671
6L-5S		MI	14370	5426	23817	3877	25772	3137	26461	2547	26923	1639	32137	1221	22017
18-#11	2.79	MA	17935	5426	29275	3971	31758	3216	32581	2622	33010	1736	39658	1186	28182
7L-4S		MI	14697	5426	24364	3883	26480	3128	27316	2538	28120	1647	33543	1259	22390
18-#11	2.79	MA	17541	5426	28599	3968	30839	3211	31493	2633	31441	1727	37809	1139	27460
8L-3S		MI	15059	5426	24992	3871	27281	3136	28274	2547	29311	1639	34864	1342	22415
18-#11	2.79	MA	17150	5426	27872	3981	29944	3223	30356	2626	29978	1736	36001	1085	26731
9L-2S		MI	15563	5426	25754	3877	28257	3126	29450	2538	30871	1630	36905	1429	22402
18-#14	4.02	MA	19842	5856	33622	4217	37274	3396	39294	2730	41881	1666	51491	1127	40412
5L-6S		MI	14685	5856	25207	4115	27417	3304	28419	2652	29515	1576	35768	893	29589
18-#14	4.02	MA	19264	5856	32640	4211	35915	3388	37633	2719	39734	1678	48849	1045	39519
6L-5S		MI	15123	5856	25942	4124	28432	3316	29569	2639	31045	1564	37611	975	30295
18-#14	4.02	MA	18702	5856	31563	4230	34617	3405	36037	2733	37636	1691	46025	915	38231
7L-4S		MI	15583	5856	26724	4134	29444	3304	30777	2627	32738	1576	39592	1030	31024
18-#14	4.02	MA	18148	5856	30595	4224	33300	3397	34480	2748	35405	1678	43397	849	36852
8L-3S		MI	16092	5856	27621	4118	30587	3316	32132	2639	34422	1564	41455	1149	31537
20-#11	3.10	MA	19218	5534	31743	4029	34935	3258	36467	2648	38173	1709	46407	1311	32290
5L-7S		MI	14095	5534	23501	3950	25359	3187	25966	2575	26343	1642	31632	1069	23590
20-#11	3.10	MA	18809	5534	31057	4025	33986	3252	35307	2641	36663	1717	44542	1254	31791
6E		MI	14398	5534	24064	3938	26038	3177	26824	2583	27400	1633	32867	1134	24008
20-#11	3.10	MA	18410	5534	30306	4039	33080	3264	34193	2652	35187	1726	42550	1164	31239
7L-5S		MI	14709	5534	24578	3944	26748	3185	27637	2575	28482	1625	34177	1191	24300
20-#11	3.10	MA	18018	5534	29631	4035	32161	3259	33106	2662	33618	1717	40700	1118	30542
8L-4S		MI	15034	5534	25125	3950	27456	3176	28492	2566	29679	1633	35584	1229	24748
20-#11	3.10	MA	17629	5534	28904	4049	31266	3271	31969	2656	32155	1726	38892	1063	29771
9L-3S		MI	15395	5534	25754	3939	28257	3184	29450	2575	30871	1625	36905	1312	24785

RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	4.46	MA	19927	6011	34113	4308	37804	3458	39938	2761	42828	1663	52948	1012	43853
6E		MI	15161	6011	26292	4212	28808	3374	30082	2691	31720	1554	38642	846	32750
20-#14	4.46	MA	19368	6011	33037	4327	36506	3475	38342	2776	40730	1675	50124	882	42614
7L-5S		MI	15596	6011	27027	4222	29823	3386	31231	2678	33250	1542	40485	929	33545
20-#14	4.46	MA	18818	6011	32069	4321	35189	3467	36784	2790	38499	1663	47496	816	41175
8L-4S		MI	16053	6011	27808	4231	30835	3374	32440	2666	34942	1554	42466	984	34229
22-#11	3.40	MA	19279	5642	32089	4092	35308	3301	36920	2671	38839	1707	47434	1233	34914
6L-7S		MI	14435	5642	24263	4017	26335	3235	27142	2603	27903	1628	33673	1039	25838
22-#11	3.40	MA	18882	5642	31337	4106	34402	3313	35806	2681	37364	1716	45441	1143	34302
7L-6S		MI	14736	5642	24826	4006	27014	3226	28000	2611	28960	1619	34908	1104	26311
22-#11	3.40	MA	18492	5642	30662	4102	33483	3308	34719	2692	35794	1707	43592	1096	33629
8L-5S		MI	15046	5642	25340	4012	27724	3234	28813	2603	30042	1611	36218	1161	26588
22-#11	3.40	MA	18105	5642	29935	4116	32589	3320	33582	2685	34331	1716	41784	1042	32819
9L-4S		MI	15369	5642	25887	4017	28433	3224	29668	2594	31239	1619	37625	1199	27103
22-#14	4.91	MA	20031	6167	34511	4424	38395	3545	40647	2818	43824	1660	54223	848	47006
7L-6S		MI	15633	6167	27377	4310	30198	3444	31744	2730	33925	1533	41516	800	35922
22-#14	4.91	MA	19484	6167	33543	4418	37078	3536	39089	2833	41592	1648	51595	782	45508
8L-5S		MI	16067	6167	28112	4319	31213	3456	32894	2718	35455	1520	43359	883	36802
24-#11	3.71	MA	19352	5750	32369	4174	35724	3361	37419	2711	39540	1706	48333	1121	37372
7E		MI	14773	5750	25025	4084	27312	3284	28318	2631	29463	1614	35714	1009	28092
24-#11	3.71	MA	18963	5750	31693	4170	34805	3356	36332	2721	37971	1698	46483	1074	36721
8L-6S		MI	15073	5750	25587	4073	27990	3274	29176	2639	30520	1605	36949	1074	28616
24-#11	3.71	MA	18579	5750	30966	4184	33911	3368	35195	2714	36508	1706	44675	1020	35872
9L-5S		MI	15381	5750	26102	4079	28701	3282	29989	2631	31602	1597	38259	1131	28880
24-#14	5.36	MA	20146	6323	35017	4516	38968	3606	41394	2875	44686	1633	55694	749	49850
8L-6S		MI	16104	6323	28462	4407	31589	3514	33406	2770	36130	1511	44390	754	39103

RECTANGULAR TIED COLUMNS 28" x 38"

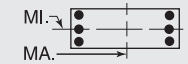
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.50	MA	20428	5256	32372	3852	34950	3133	35734	2601	35787	1826	42018	1696	18106
2E		MI	14847	5256	23842	3740	25269	3034	25481	2504	25132	1735	29062	1577	12962
6-#14	1.27	MA	20098	5170	31490	3827	33962	3118	34583	2597	34371	1856	40229	1743	15506
2L-3S		MI	13914	5170	22165	3715	23325	3046	23204	2529	22125	1791	25237	1520	11237
6-#14	1.27	MA	19032	5170	29919	3821	31948	3135	32126	2613	31054	1869	35822	1618	15570
3L-2S		MI	14646	5170	23250	3724	24715	3034	24866	2517	24330	1778	28111	1644	11155
6-#18	2.26	MA	21674	5533	35116	4025	38467	3257	40026	2677	41522	1797	49599	1634	26740
2L-3S		MI	14418	5533	23842	3893	25269	3177	25481	2592	25132	1713	29062	1264	19033
6-#18	2.26	MA	19845	5533	32372	4014	34950	3286	35734	2701	35787	1819	42018	1412	26693
3L-2S		MI	15669	5533	25721	3913	27642	3155	28317	2569	28895	1691	33927	1485	18946
8-#11	1.17	MA	19962	5134	31117	3819	33557	3113	34115	2598	33797	1870	39506	1763	14433
2L-4S		MI	13677	5134	21605	3727	22680	3035	22484	2524	21257	1815	24369	1503	10517
8-#11	1.17	MA	19214	5134	30018	3816	32148	3126	32397	2609	31466	1878	36401	1676	14477
3E		MI	14048	5134	22234	3716	23481	3043	23442	2533	22448	1806	25690	1586	10457
8-#11	1.17	MA	18686	5134	29120	3830	31004	3121	31007	2603	29684	1887	34385	1590	14509
4L-2S		MI	14563	5134	22996	3722	24457	3034	24618	2524	24008	1798	27731	1673	10403
8-#14	1.69	MA	20824	5325	33061	3924	35976	3187	37040	2640	37687	1842	44636	1712	20456
2L-4S		MI	13876	5325	22352	3828	23572	3103	23512	2556	22646	1782	26248	1355	14728
8-#14	1.69	MA	19766	5325	31490	3919	33962	3205	34583	2655	34371	1855	40229	1587	20494
3E		MI	14402	5325	23250	3812	24715	3116	24866	2569	24330	1769	28111	1473	14682
8-#14	1.69	MA	19017	5325	30205	3938	32325	3198	32593	2645	31836	1867	37372	1463	20431
4L-2S		MI	15130	5325	24334	3822	26106	3103	26529	2556	26535	1757	30985	1598	14614

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	3.01	MA	22902	5809	37860	4198	41985	3381	44317	2752	47256	1768	57181	1571	35326
2L-4S		MI	14342	5809	24159	4091	25690	3275	26004	2635	26022	1691	30763	967	23654
8-#18	3.01	MA	21092	5809	35116	4187	38467	3410	40026	2776	41522	1790	49599	1350	35163
3E		MI	15242	5809	25721	4066	27642	3298	28317	2657	28895	1669	33927	1171	24877
8-#18	3.01	MA	19810	5809	32864	4220	35598	3394	36539	2756	37139	1813	44699	1129	33367
4L-2S		MI	16482	5809	27601	4086	30015	3275	31153	2635	32658	1647	38793	1393	24876
10-#11	1.47	MA	20474	5242	32215	3886	34965	3162	35834	2627	36128	1861	42611	1743	17896
2L-5S		MI	13691	5242	21820	3789	22948	3093	22805	2561	21619	1792	25003	1435	12956
10-#11	1.47	MA	19730	5242	31117	3883	33557	3174	34115	2638	33797	1869	39506	1656	17930
3L-4S		MI	14024	5242	22367	3795	23656	3083	23660	2553	22816	1801	26410	1473	12928
10-#11	1.47	MA	19206	5242	30219	3897	32413	3170	32725	2632	32015	1878	37490	1570	17937
4L-3S		MI	14394	5242	22996	3783	24457	3091	24618	2561	24008	1792	27731	1556	12881
10-#11	1.47	MA	18736	5242	29442	3894	31406	3182	31488	2643	30230	1869	35370	1530	17878
5L-2S		MI	14907	5242	23757	3789	25433	3082	25794	2553	25567	1784	29771	1643	12833
10-#14	2.11	MA	21544	5481	34632	4021	37990	3257	39497	2682	41003	1828	49042	1681	25387
2L-5S		MI	13892	5481	22656	3916	23951	3186	23966	2608	23158	1747	27141	1254	17553
10-#14	2.11	MA	20492	5481	33061	4016	35976	3275	37040	2697	37687	1840	44636	1556	25388
3L-4S		MI	14364	5481	23437	3925	24963	3173	25174	2595	24850	1760	29122	1309	18108
10-#14	2.11	MA	19750	5481	31776	4036	34339	3267	35050	2688	35152	1853	41779	1432	25281
4L-3S		MI	14886	5481	24334	3910	26106	3186	26529	2608	26535	1747	30985	1427	18100
10-#14	2.11	MA	19085	5481	30663	4030	32895	3285	33277	2703	32612	1840	38764	1375	24380
5L-2S		MI	15610	5481	25419	3919	27496	3173	28191	2595	28739	1735	33858	1552	18050
10-#18	3.76	MA	22323	6086	37860	4360	41985	3534	44317	2852	47256	1762	57181	1288	43611
3L-4S		MI	15165	6086	26039	4264	28063	3396	28840	2701	29784	1648	35629	875	29074
10-#18	3.76	MA	21055	6086	35608	4393	39116	3519	40831	2832	42874	1784	52281	1066	41376
4L-3S		MI	16057	6086	27601	4239	30015	3418	31153	2723	32658	1625	38793	1079	30685
10-#18	3.76	MA	19921	6086	33655	4382	36585	3547	37721	2856	38479	1762	47068	969	39259
5L-2S		MI	17287	6086	29481	4259	32388	3396	33989	2701	36420	1603	43658	1300	30775
12-#11	1.76	MA	20983	5350	33314	3954	36374	3210	37552	2657	38459	1852	45716	1722	21350
2L-6S		MI	13720	5350	22068	3850	23214	3133	23168	2598	22097	1787	25734	1348	14951
12-#11	1.76	MA	20243	5350	32215	3950	34965	3223	35834	2668	36128	1860	42611	1636	21372
3L-5S		MI	14037	5350	22582	3856	23924	3141	23981	2589	23179	1778	27044	1405	15331
12-#11	1.76	MA	19721	5350	31318	3964	33821	3218	34444	2662	34346	1869	40595	1550	21353
4E		MI	14369	5350	23129	3862	24633	3132	24836	2581	24376	1787	28451	1443	15325
12-#11	1.76	MA	19254	5350	30541	3961	32814	3231	33206	2673	32561	1860	38475	1510	21269
5L-3S		MI	14737	5350	23757	3851	25433	3140	25794	2589	25567	1778	29771	1526	15291
12-#11	1.76	MA	18809	5350	29812	3958	31805	3226	31973	2666	30943	1869	36471	1453	20631
6L-2S		MI	15248	5350	24519	3857	26410	3130	26970	2581	27127	1770	31812	1613	15251
12-#14	2.54	MA	22257	5637	36203	4118	40004	3327	41954	2725	44320	1814	53449	1650	30307
2L-6S		MI	13932	5637	23005	4004	24327	3243	24478	2660	23833	1738	28172	1125	20318
12-#14	2.54	MA	21212	5637	34632	4113	37990	3345	39497	2740	41003	1826	49042	1525	30268
3L-5S		MI	14379	5637	23740	4013	25341	3256	25628	2647	25363	1726	30015	1207	20762
12-#14	2.54	MA	20475	5637	33347	4133	36353	3337	37507	2730	38469	1839	46186	1401	30121
4E		MI	14847	5637	24522	4022	26353	3243	26836	2635	27055	1738	31996	1263	21470
12-#14	2.54	MA	19815	5637	32234	4128	34909	3355	35734	2745	35928	1826	43170	1344	29054
5L-3S		MI	15367	5637	25419	4007	27496	3255	28191	2647	28739	1726	33858	1381	21505
12-#14	2.54	MA	19187	5637	31189	4123	33464	3347	33967	2736	33627	1839	40328	1262	28231
6L-2S		MI	16087	5637	26504	4016	28887	3243	29853	2635	30944	1713	36732	1506	21470
12-#18	4.51	MA	22285	6363	38353	4566	42634	3643	45123	2907	48608	1755	59862	1004	49434
4E		MI	15980	6363	27919	4437	30436	3517	31676	2767	33547	1604	40494	782	34540
12-#18	4.51	MA	21162	6363	36399	4555	40103	3671	42013	2931	44214	1733	54650	906	47453
5L-3S		MI	16864	6363	29481	4412	32388	3539	33989	2789	36420	1582	43658	986	36470
12-#18	4.51	MA	20095	6363	34565	4543	37566	3656	38914	2911	40234	1755	49768	761	44130
6L-2S		MI	18084	6363	31360	4432	34761	3517	36825	2767	40183	1559	48524	1208	36626
14-#11	2.05	MA	21489	5458	34413	4021	37782	3259	39271	2686	40790	1843	48821	1702	24795
2L-7S		MI	13759	5458	22267	3929	23511	3191	23486	2617	22600	1782	26540	1253	17032
14-#11	2.05	MA	20752	5458	33314	4018	36374	3271	37552	2697	38459	1851	45716	1616	24801
3L-6S		MI	14066	5458	22829	3918	24190	3182	24344	2626	23657	1773	27775	1318	17240

RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

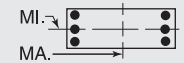
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.05	MA	20233	5458	32417	4032	35230	3267	36162	2691	36677	1860	43700	1530	24761
4L-5S		MI	14382	5458	23343	3924	24901	3190	25157	2617	24739	1764	29085	1375	17606
14-#11	2.05	MA	19769	5458	31640	4029	34223	3279	34925	2702	34892	1851	41581	1490	24596
5L-4S		MI	14712	5458	23890	3929	25609	3180	26012	2609	25935	1773	30492	1413	17713
14-#11	2.05	MA	19326	5458	30911	4025	33214	3275	33692	2696	33275	1860	39576	1433	23938
6L-3S		MI	15078	5458	24519	3918	26410	3188	26970	2617	27127	1764	31812	1497	17691
14-#11	2.05	MA	18895	5458	30113	4040	32251	3287	32508	2707	31694	1869	37436	1343	23532
7L-2S		MI	15587	5458	25281	3924	27386	3179	28146	2609	28687	1756	33853	1583	17658
14-#14	2.96	MA	21927	5792	36203	4210	40004	3414	41954	2782	44320	1812	53449	1494	35138
3L-6S		MI	14417	5792	24090	4101	25717	3313	26141	2699	26038	1716	31046	1078	23572
14-#14	2.96	MA	21194	5792	34918	4230	38366	3407	39963	2773	41785	1825	50592	1370	34956
4L-5S		MI	14862	5792	24825	4110	26732	3325	27290	2687	27568	1704	32889	1161	23987
14-#14	2.96	MA	20539	5792	33805	4225	36923	3424	38190	2788	39245	1812	47577	1313	33745
5L-4S		MI	15328	5792	25606	4120	27744	3313	28499	2674	29260	1716	34870	1216	24821
14-#14	2.96	MA	19916	5792	32760	4220	35478	3417	36424	2778	36943	1825	44735	1231	32963
6L-3S		MI	15845	5792	26504	4104	28887	3325	29853	2687	30944	1704	36732	1335	24885
14-#14	2.96	MA	19308	5792	31616	4239	34098	3435	34728	2793	34694	1837	41698	1101	31599
7L-2S		MI	16561	5792	27589	4113	30278	3313	31516	2674	33149	1692	39606	1460	24878
14-#18	5.26	MA	22390	6639	39144	4727	43621	3796	46305	3007	49948	1704	62231	844	55499
5L-4S		MI	16788	6639	29798	4610	32809	3638	34513	2833	37310	1560	45360	690	40040
14-#18	5.26	MA	21334	6639	37310	4716	41084	3780	43206	2987	45969	1727	57349	699	52185
6L-3S		MI	17665	6639	31360	4585	34761	3660	36825	2855	40183	1538	48524	894	42239
16-#11	2.35	MA	21258	5566	34413	4085	37782	3320	39271	2726	40790	1842	48821	1596	28221
3L-7S		MI	14104	5566	23028	3996	24488	3239	24662	2645	24159	1768	28581	1224	19319
16-#11	2.35	MA	20742	5566	33516	4099	36639	3315	37881	2720	39009	1851	46805	1510	28164
4L-6S		MI	14410	5566	23591	3985	25167	3230	25520	2654	25216	1759	29816	1288	19534
16-#11	2.35	MA	20280	5566	32739	4096	35631	3328	36643	2731	37224	1842	44686	1470	27877
5E		MI	14724	5566	24105	3991	25877	3238	26333	2645	26298	1750	31126	1345	19876
16-#11	2.35	MA	19840	5566	32010	4093	34623	3323	35410	2725	35606	1851	42681	1413	27252
6L-4S		MI	15053	5566	24652	3997	26585	3229	27188	2637	27495	1759	32532	1383	20089
16-#11	2.35	MA	19411	5566	31212	4107	33660	3336	34227	2736	34025	1860	40541	1323	26862
7L-3S		MI	15418	5566	25281	3986	27386	3237	28146	2645	28687	1750	33853	1467	20083
16-#11	2.35	MA	18989	5566	30494	4104	32683	3331	33071	2748	32345	1851	38560	1276	26064
8L-2S		MI	15925	5566	26042	3991	28363	3227	29322	2637	30246	1742	35894	1553	20058
16-#14	3.38	MA	21908	5948	36489	4327	40380	3477	42420	2815	45102	1811	54999	1339	39786
4L-6S		MI	14900	5948	25175	4198	27108	3383	27803	2738	28243	1695	33920	1032	26722
16-#14	3.38	MA	21258	5948	35376	4322	38937	3494	40647	2830	42561	1798	51983	1282	38449
5E		MI	15342	5948	25910	4208	28123	3395	28953	2726	29773	1682	35763	1115	27222
16-#14	3.38	MA	20638	5948	34331	4317	37492	3487	38881	2821	40260	1811	49141	1200	37703
6L-4S		MI	15805	5948	26691	4217	29135	3383	30161	2714	31465	1695	37744	1170	28033
16-#14	3.38	MA	20035	5948	33187	4337	36112	3504	37185	2836	38011	1823	46105	1070	36255
7L-3S		MI	16319	5948	27589	4201	30278	3395	31516	2726	33149	1682	39606	1289	28254
16-#14	3.38	MA	19442	5948	32158	4332	34712	3497	35528	2851	35620	1811	43286	1003	34971
8L-2S		MI	17032	5948	28673	4211	31668	3383	33178	2714	35354	1670	42480	1414	28280
16-#18	6.02	MA	22560	6916	40054	4889	44602	3904	47497	3062	51704	1698	64930	636	60266
6L-4S		MI	17589	6916	31678	4783	35181	3758	37349	2899	41073	1516	50225	597	45567
18-#11	2.64	MA	21247	5674	34614	4167	38047	3363	39599	2750	41340	1842	49910	1490	31563
4L-7S		MI	14447	5674	23790	4064	25464	3288	25838	2673	25719	1754	30622	1194	21551
18-#11	2.64	MA	20788	5674	33837	4164	37040	3376	38362	2761	39555	1833	47791	1449	31168
5L-6S		MI	14752	5674	24352	4053	26143	3278	26696	2682	26776	1745	31856	1258	21833
18-#11	2.64	MA	20350	5674	33109	4160	36031	3371	37129	2755	37937	1842	45787	1393	30573
6L-5S		MI	15065	5674	24867	4058	26853	3286	27509	2673	27858	1736	33166	1315	22153
18-#11	2.64	MA	19924	5674	32311	4174	35068	3384	35945	2766	36356	1850	43646	1303	30158
7L-4S		MI	15392	5674	25414	4064	27562	3277	28364	2665	29055	1745	34573	1353	22456

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

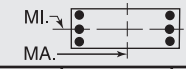


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.64	MA	19504	5674	31593	4171	34092	3379	34790	2777	34676	1842	41665	1256	29345
8L-3S		MI	15756	5674	26042	4053	28363	3285	29322	2673	30246	1736	35894	1437	22469
18-#11	2.64	MA	19088	5674	30821	4185	33141	3392	33581	2771	33109	1850	39722	1202	28658
9L-2S		MI	16261	5674	26804	4059	29339	3276	30498	2665	31806	1728	37935	1523	22452
18-#14	3.81	MA	21970	6103	36947	4419	40951	3564	43104	2873	45878	1784	56390	1251	43165
5L-6S		MI	15379	6103	26260	4296	28498	3453	29465	2778	30448	1673	36794	986	29867
18-#14	3.81	MA	21355	6103	35902	4414	39506	3557	41338	2863	43576	1797	53548	1169	42378
6L-5S		MI	15819	6103	26995	4305	29513	3465	30615	2765	31977	1661	38637	1069	30466
18-#14	3.81	MA	20756	6103	34758	4434	38126	3574	39642	2878	41327	1809	50511	1039	40923
7L-4S		MI	16280	6103	27776	4314	30525	3453	31824	2753	33670	1673	40618	1124	31224
18-#14	3.81	MA	20167	6103	33729	4429	36726	3567	37985	2894	38936	1797	47693	972	39576
8L-3S		MI	16791	6103	28673	4299	31668	3465	33178	2765	35354	1661	42480	1243	31616
20-#11	2.93	MA	21293	5782	34936	4231	38449	3424	40080	2790	41886	1824	50896	1429	34467
5L-7S		MI	14789	5782	24551	4131	26441	3336	27014	2702	27279	1740	32662	1164	23791
20-#11	2.93	MA	20857	5782	34208	4228	37440	3420	38847	2784	40268	1833	48892	1373	33898
6E		MI	15093	5782	25114	4120	27119	3327	27872	2710	28336	1731	33897	1228	24135
20-#11	2.93	MA	20433	5782	33409	4242	36477	3432	37663	2795	38687	1841	46751	1283	33418
7L-5S		MI	15404	5782	25628	4126	27830	3335	28685	2702	29418	1722	35207	1285	24436
20-#11	2.93	MA	20016	5782	32692	4239	35500	3428	36508	2806	37007	1833	44770	1236	32632
8L-4S		MI	15730	5782	26175	4132	28538	3325	29540	2693	30614	1731	36614	1323	24819
20-#11	2.93	MA	19602	5782	31919	4253	34550	3440	35300	2800	35440	1841	42827	1182	31902
9L-3S		MI	16092	5782	26804	4120	29339	3333	30498	2702	31806	1722	37935	1407	24846
20-#11	2.93	MA	19144	5782	31204	4249	33586	3436	34150	2811	33886	1850	40945	1120	31028
10L-2S		MI	16595	5782	27566	4126	30315	3324	31674	2693	33365	1714	39975	1493	24841
20-#14	4.23	MA	22067	6259	37473	4512	41520	3627	43795	2905	46893	1783	57955	1139	47003
6E		MI	15855	6259	27344	4393	29889	3523	31128	2817	32653	1651	39668	940	33025
20-#14	4.23	MA	21472	6259	36329	4531	40140	3644	42098	2921	44644	1795	54918	1008	45600
7L-5S		MI	16293	6259	28079	4402	30904	3535	32278	2805	34182	1639	41511	1023	33717
20-#14	4.23	MA	20887	6259	35301	4526	38740	3637	40442	2936	42253	1783	52100	941	44192
8L-4S		MI	16751	6259	28861	4412	31916	3522	33486	2792	35875	1651	43492	1078	34427
22-#11	3.23	MA	21362	5890	35306	4295	38848	3468	40565	2814	42599	1824	51997	1353	37227
6L-7S		MI	15129	5890	25313	4199	27417	3385	28190	2730	28838	1725	34703	1134	26038
22-#11	3.23	MA	20940	5890	34508	4309	37885	3481	39382	2825	41018	1832	49856	1263	36684
7L-6S		MI	15431	5890	25876	4187	28096	3375	29048	2738	29895	1717	35938	1198	26439
22-#11	3.23	MA	20524	5890	33791	4306	36909	3476	38226	2836	39338	1824	47875	1216	35924
8L-5S		MI	15742	5890	26390	4193	28806	3383	29861	2730	30977	1708	37248	1255	26724
22-#11	3.23	MA	20113	5890	33018	4320	35959	3489	37018	2830	37771	1832	45932	1162	35152
9L-4S		MI	16066	5890	26937	4199	29514	3374	30716	2721	32174	1717	38655	1293	27177
22-#11	3.23	MA	19657	5890	32303	4317	34995	3484	35868	2841	36218	1841	44050	1100	34301
10L-3S		MI	16427	5890	27566	4188	30315	3382	31674	2730	33365	1708	39975	1377	27216
22-#14	4.65	MA	22183	6415	37900	4628	42154	3714	44555	2963	47960	1781	59324	977	50286
7L-6S		MI	16329	6415	28429	4490	31280	3592	32790	2857	34858	1630	42542	894	36194
22-#14	4.65	MA	21601	6415	36872	4623	40754	3706	42899	2978	45569	1768	56506	910	48818
8L-5S		MI	16764	6415	29164	4499	32294	3605	33940	2844	36387	1617	44385	977	36974
24-#11	3.52	MA	21443	5998	35607	4377	39294	3529	41100	2854	43349	1823	52961	1243	39957
7E		MI	15467	5998	26075	4266	28393	3433	29366	2758	30398	1711	36744	1104	28291
24-#11	3.52	MA	21030	5998	34889	4373	38317	3525	39945	2865	41669	1815	50980	1196	39221
8L-6S		MI	15769	5998	26637	4255	29072	3424	30224	2766	31455	1703	37979	1168	28746
24-#11	3.52	MA	20621	5998	34117	4387	37367	3537	38737	2859	40102	1823	49037	1141	38409
9L-5S		MI	16078	5998	27152	4261	29782	3432	31038	2758	32537	1694	39289	1225	29017
24-#11	3.52	MA	20168	5998	33402	4384	36403	3532	37587	2870	38549	1832	47155	1080	37580
10L-4S		MI	16401	5998	27698	4267	30491	3422	31892	2749	33734	1703	40696	1263	29531
24-#14	5.08	MA	22311	6570	38443	4721	42768	3776	45356	3021	48886	1754	60913	879	53453
8L-6S		MI	16801	6570	29514	4587	32670	3662	34453	2896	37062	1608	45416	848	39373

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

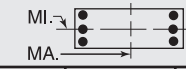
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#18	1.43	MA	22539	5504	35557	4053	38413	3299	39246	2742	39270	1938	46106	1809	19186
2E		MI	15541	5504	24899	3919	26350	3181	26523	2628	26059	1831	30079	1670	13009
6-#14	1.21	MA	22181	5417	34613	4028	37355	3283	38012	2738	37735	1967	44157	1853	16417
2L-3S		MI	14607	5417	23217	3896	24406	3195	24250	2655	23057	1888	26262	1613	11276
6-#14	1.21	MA	21047	5417	32945	4023	35216	3301	35403	2754	34196	1980	39442	1729	16481
3L-2S		MI	15340	5417	24302	3905	25796	3182	25913	2643	25262	1875	29136	1738	11192
6-#18	2.14	MA	23873	5780	38474	4226	42153	3423	43808	2817	45400	1911	54234	1750	28360
2L-3S		MI	15112	5780	24899	4072	26350	3324	26523	2716	26059	1809	30079	1356	19102
6-#18	2.14	MA	21924	5780	35557	4216	38413	3453	39246	2843	39270	1933	46106	1529	28313
3L-2S		MI	16364	5780	26778	4091	28722	3302	29359	2694	29821	1787	34945	1578	19003
8-#11	1.11	MA	22034	5382	34213	4020	36920	3279	37511	2738	37096	1980	43369	1872	15275
2L-4S		MI	14370	5382	22655	3909	23761	3184	23532	2651	22192	1913	25399	1597	10553
8-#11	1.11	MA	21239	5382	33047	4017	35425	3292	35687	2750	34615	1988	40050	1786	15320
3E		MI	14742	5382	23284	3897	24562	3192	24490	2660	23383	1904	26720	1681	10491
8-#11	1.11	MA	20679	5382	32096	4031	34213	3288	34214	2744	32719	1997	37892	1700	15351
4L-2S		MI	15257	5382	24046	3903	25539	3183	25666	2651	24943	1895	28761	1767	10437
8-#14	1.61	MA	22958	5573	36281	4125	39493	3353	40621	2780	41274	1954	48871	1824	21671
2L-4S		MI	14569	5573	23405	4009	24653	3252	24558	2682	23578	1879	27274	1448	14784
8-#14	1.61	MA	21831	5573	34613	4120	37355	3371	38012	2796	37735	1967	44157	1700	21709
3E		MI	15096	5573	24302	3993	25796	3264	25913	2695	25262	1866	29136	1567	14728
8-#14	1.61	MA	21037	5573	33250	4141	35618	3364	35902	2788	35029	1979	41096	1575	21646
4L-2S		MI	15825	5573	25387	4002	27187	3252	27575	2682	27467	1854	32010	1692	14657
8-#18	2.86	MA	25188	6057	41391	4399	45892	3547	48370	2892	51531	1885	62362	1692	37486
2L-4S		MI	15035	6057	25216	4270	26770	3422	27047	2760	26948	1787	31781	1060	23934
8-#18	2.86	MA	23259	6057	38474	4389	42153	3577	43808	2918	45400	1907	54234	1471	37323
3E		MI	15937	6057	26778	4245	28722	3444	29359	2782	29821	1765	34945	1264	24964
8-#18	2.86	MA	21896	6057	36085	4423	39108	3563	40108	2900	40715	1929	48972	1249	35703
4L-2S		MI	17179	6057	28658	4264	31095	3422	32195	2760	33584	1743	39810	1485	24940
10-#11	1.39	MA	22582	5490	35379	4087	38415	3327	39335	2768	39578	1971	46687	1854	18949
2L-5S		MI	14384	5490	22870	3970	24029	3242	23853	2688	22555	1890	26033	1529	13008
10-#11	1.39	MA	21791	5490	34213	4085	36920	3340	37511	2779	37096	1980	43369	1767	18983
3L-4S		MI	14717	5490	23417	3976	24738	3233	24708	2680	23751	1899	27440	1567	12971
10-#11	1.39	MA	21234	5490	33262	4099	35708	3336	36038	2774	35200	1989	41211	1681	18990
4L-3S		MI	15087	5490	24046	3965	25539	3241	25666	2688	24943	1890	28761	1651	12920
10-#11	1.39	MA	20736	5490	32439	4096	34641	3349	34727	2785	33302	1980	38950	1640	18931
5L-2S		MI	15601	5490	24807	3971	26515	3231	26842	2680	26502	1881	30801	1737	12871
10-#14	2.01	MA	23727	5728	37949	4222	41632	3423	43230	2823	44814	1941	53586	1795	26906
2L-5S		MI	14585	5728	23708	4097	25032	3334	25012	2734	24090	1844	28167	1347	17721
10-#14	2.01	MA	22608	5728	36281	4218	39493	3441	40621	2839	41274	1954	48871	1671	26907
3L-4S		MI	15057	5728	24489	4106	26044	3322	26220	2722	25783	1857	30148	1402	18176
10-#14	2.01	MA	21820	5728	34919	4238	37757	3434	38511	2830	38569	1966	45810	1546	26800
4L-3S		MI	15581	5728	25387	4090	27187	3334	27575	2734	27467	1844	32010	1521	18152
10-#14	2.01	MA	21115	5728	33739	4233	36228	3452	36632	2846	35859	1954	42591	1488	25973
5L-2S		MI	16306	5728	26472	4100	28578	3322	29237	2722	29672	1832	34884	1646	18098
10-#18	3.57	MA	24577	6334	41391	4562	45892	3701	48370	2994	51531	1880	62362	1412	46311
3L-4S		MI	15859	6334	27096	4443	29143	3543	29883	2826	30711	1744	36646	967	29349
10-#18	3.57	MA	23229	6334	39002	4596	42847	3687	44670	2975	46845	1902	57100	1191	44228
4L-3S		MI	16753	6334	28658	4418	31095	3565	32195	2848	33584	1721	39810	1171	30783
10-#18	3.57	MA	22024	6334	36931	4586	40163	3717	41372	3001	42148	1880	51526	1091	41858
5L-2S		MI	17985	6334	30538	4437	33468	3543	35032	2826	37347	1699	44676	1393	30842
12-#11	1.67	MA	23126	5598	36546	4155	39910	3376	41159	2797	42059	1962	50006	1835	22613
2L-6S		MI	14413	5598	23118	4032	24296	3283	24216	2725	23032	1885	26764	1442	15071

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis

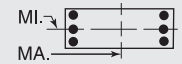


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#11	1.67	MA	22338	5598	35379	4152	38415	3389	39335	2809	39578	1971	46687	1749	22635
3L-5S		MI	14730	5598	23632	4038	25006	3291	25029	2716	24114	1876	28074	1499	15392
12-#11	1.67	MA	21784	5598	34428	4166	37203	3385	37862	2803	37682	1980	44530	1662	22617
4E		MI	15063	5598	24179	4044	25714	3281	25884	2708	25311	1885	29481	1537	15373
12-#11	1.67	MA	21289	5598	33605	4163	36136	3398	36551	2815	35783	1972	42269	1621	22533
5L-3S		MI	15431	5598	24807	4032	26515	3289	26842	2716	26502	1876	30801	1621	15334
12-#11	1.67	MA	20818	5598	32834	4161	35067	3393	35245	2809	34062	1981	40125	1565	21925
6L-2S		MI	15943	5598	25569	4038	27492	3280	28018	2708	28062	1867	32842	1707	15291
12-#14	2.41	MA	24490	5884	39618	4320	43771	3493	45839	2865	48353	1928	58300	1766	32129
2L-6S		MI	14624	5884	24058	4185	25408	3392	25525	2786	24766	1835	29198	1218	20476
12-#14	2.41	MA	23378	5884	37949	4315	41632	3511	43230	2881	44814	1941	53586	1642	32090
3L-5S		MI	15072	5884	24793	4194	26423	3404	26674	2774	26295	1823	31041	1301	20929
12-#14	2.41	MA	22595	5884	36587	4335	39896	3504	41120	2872	42108	1953	50525	1517	31944
4E		MI	15542	5884	25574	4203	27435	3392	27883	2761	27988	1835	33022	1356	21546
12-#14	2.41	MA	21895	5884	35407	4330	38366	3522	39241	2888	39398	1941	47306	1459	30940
5L-3S		MI	16062	5884	26472	4188	28578	3404	29237	2774	29672	1823	34884	1475	21559
12-#14	2.41	MA	21229	5884	34301	4326	36835	3515	37369	2880	36942	1953	44263	1378	30023
6L-2S		MI	16784	5884	27556	4197	29968	3392	30900	2761	31877	1810	37758	1600	21521
12-#18	4.29	MA	24545	6610	41919	4769	46587	3811	49232	3051	52976	1875	65227	1133	52802
4E		MI	16675	6610	28976	4616	31516	3664	32719	2892	34474	1700	41512	875	34811
12-#18	4.29	MA	23353	6610	39848	4759	43902	3841	45934	3077	48279	1853	59654	1033	50577
5L-3S		MI	17562	6610	30538	4591	33468	3686	35032	2914	37347	1678	44676	1079	36577
12-#18	4.29	MA	22220	6610	37904	4749	41213	3827	42648	3058	44025	1875	54416	888	47237
6L-2S		MI	18785	6610	32417	4610	35841	3664	37868	2892	41110	1655	49541	1300	36709
14-#11	1.95	MA	23666	5706	37712	4222	41405	3424	42983	2826	44541	1954	53325	1816	26269
2L-7S		MI	14451	5706	23316	4111	24593	3340	24534	2744	23535	1879	27570	1348	17151
14-#11	1.95	MA	22882	5706	36546	4219	39910	3437	41159	2838	42059	1963	50006	1730	26275
3L-6S		MI	14759	5706	23879	4099	25272	3331	25392	2753	24592	1871	28805	1412	17360
14-#11	1.95	MA	22331	5706	35594	4234	38698	3433	39686	2832	40163	1971	47848	1644	26236
4L-5S		MI	15075	5706	24393	4105	25982	3339	26205	2744	25674	1862	30115	1469	17739
14-#11	1.95	MA	21839	5706	34772	4231	37631	3446	38375	2844	38265	1963	45587	1603	26130
5L-4S		MI	15406	5706	24940	4111	26691	3330	27060	2736	26871	1871	31522	1507	17764
14-#11	1.95	MA	21370	5706	34000	4228	36562	3442	37069	2839	36544	1972	43444	1547	25437
6L-3S		MI	15773	5706	25569	4100	27492	3338	28018	2744	28062	1862	32842	1591	17737
14-#11	1.95	MA	20913	5706	33155	4242	35543	3455	35815	2850	34862	1981	41156	1457	24988
7L-2S		MI	16283	5706	26331	4106	28468	3328	29194	2736	29622	1853	34883	1677	17701
14-#14	2.81	MA	24142	6040	39618	4412	43771	3581	45839	2924	48353	1928	58300	1613	37264
3L-6S		MI	15110	6040	25143	4282	26798	3462	27187	2825	26971	1813	32072	1172	23731
14-#14	2.81	MA	23364	6040	38255	4432	42034	3574	43729	2915	45648	1940	55239	1488	37082
4L-5S		MI	15556	6040	25877	4291	27813	3474	28337	2813	28500	1801	33914	1255	24153
14-#14	2.81	MA	22669	6040	37076	4428	40505	3592	41850	2931	42938	1928	52021	1430	35924
5L-4S		MI	16023	6040	26659	4300	28825	3462	29545	2800	30193	1813	35896	1310	24904
14-#14	2.81	MA	22008	6040	35969	4423	38973	3585	39978	2922	40481	1940	48978	1349	35052
6L-3S		MI	16541	6040	27556	4285	29968	3474	30900	2813	31877	1801	37758	1429	24952
14-#14	2.81	MA	21364	6040	34757	4443	37511	3603	38181	2938	38081	1952	45728	1219	33724
7L-2S		MI	17258	6040	28641	4294	31359	3461	32562	2800	34081	1789	40632	1554	24933
14-#18	5.00	MA	24667	6887	42765	4932	47642	3965	50496	3152	54409	1827	67782	975	59320
5L-4S		MI	17484	6887	30855	4789	33889	3785	35555	2958	38237	1656	46377	782	40308
14-#18	5.00	MA	23546	6887	40821	4922	44952	3951	47210	3134	50155	1849	62543	830	55814
6L-3S		MI	18364	6887	32417	4764	35841	3807	37868	2980	41110	1634	49541	987	42355
16-#11	2.23	MA	23423	5814	37712	4287	41405	3486	42983	2867	44541	1954	53325	1711	29906
3L-7S		MI	14797	5814	24078	4178	25569	3389	25710	2772	25094	1865	29611	1318	19458
16-#11	2.23	MA	22875	5814	36761	4301	40193	3481	41510	2862	42645	1963	51167	1625	29849
4L-6S		MI	15104	5814	24641	4167	26248	3380	26568	2781	26152	1856	30846	1382	19656
16-#11	2.23	MA	22385	5814	35938	4298	39126	3494	40198	2874	40746	1954	48906	1584	29660
5E		MI	15418	5814	25155	4173	26959	3387	27381	2772	27234	1848	32155	1439	20008
16-#11	2.23	MA	21919	5814	35166	4295	38057	3490	38893	2868	39025	1963	46763	1528	28956
6L-4S		MI	15748	5814	25702	4179	27667	3378	28236	2764	28430	1856	33562	1477	20149

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

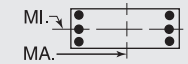
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	2.23	MA	21464	5814	34321	4310	37038	3503	37639	2880	37344	1972	44475	1438	28524
7L-3S		MI	16113	5814	26331	4167	28468	3386	29194	2772	29622	1848	34883	1561	20132
16-#11	2.23	MA	21017	5814	33562	4307	36004	3499	36416	2891	35557	1964	42361	1390	27759
8L-2S		MI	16621	5814	27092	4173	29444	3377	30370	2764	31181	1839	36924	1647	20104
16-#14	3.21	MA	24127	6195	39923	4530	44173	3644	46338	2957	49187	1927	59954	1460	42216
4L-6S		MI	15593	6195	26227	4379	28189	3532	28849	2865	29175	1792	34946	1126	26993
16-#14	3.21	MA	23437	6195	38744	4525	42644	3662	44459	2973	46477	1915	56735	1402	40922
5E		MI	16036	6195	26962	4388	29204	3544	29999	2852	30705	1779	36788	1209	27388
16-#14	3.21	MA	22780	6195	37638	4520	41112	3655	42587	2964	44021	1927	53692	1320	40089
6L-4S		MI	16501	6195	27744	4398	30216	3531	31207	2840	32397	1792	38769	1264	28230
16-#14	3.21	MA	22141	6195	36426	4541	39650	3673	40790	2980	41620	1939	50443	1190	38674
7L-3S		MI	17016	6195	28641	4382	31359	3544	32562	2852	34081	1779	40632	1383	28326
16-#14	3.21	MA	21511	6195	35336	4536	38167	3666	39036	2996	39069	1927	47434	1122	37435
8L-2S		MI	17730	6195	29726	4391	32749	3531	34224	2840	36286	1767	43506	1508	28335
16-#18	5.71	MA	24857	7164	43738	5095	48692	4075	51772	3209	56286	1822	70671	772	64418
6L-4S		MI	18287	7164	32735	4961	36262	3905	38391	3024	41999	1612	51242	690	45832
18-#11	2.51	MA	23415	5921	37927	4369	41688	3530	43333	2891	45126	1954	54486	1606	33458
4L-7S		MI	15140	5921	24840	4246	26546	3437	26886	2800	26654	1851	31651	1288	21748
18-#11	2.51	MA	22927	5921	37104	4366	40621	3543	42022	2903	43228	1946	52225	1565	33153
5L-6S		MI	15446	5921	25402	4234	27225	3428	27744	2809	27711	1842	32886	1352	21955
18-#11	2.51	MA	22464	5921	36333	4363	39552	3539	40717	2897	41507	1955	50081	1509	32482
6L-5S		MI	15760	5921	25917	4240	27935	3436	28557	2800	28793	1834	34196	1409	22285
18-#11	2.51	MA	22012	5921	35487	4377	38533	3552	39463	2909	39825	1964	47793	1419	32063
7L-4S		MI	16088	5921	26463	4246	28643	3427	29412	2792	29990	1842	35603	1447	22520
18-#11	2.51	MA	21567	5921	34728	4374	37499	3547	38239	2921	38038	1955	45680	1371	31244
8L-3S		MI	16452	5921	27092	4235	29444	3434	30370	2800	31181	1834	36924	1531	22521
18-#11	2.51	MA	21126	5921	33910	4389	36493	3560	36960	2915	36372	1964	43601	1317	30597
9L-2S		MI	16958	5921	27854	4241	30421	3425	31546	2792	32741	1825	38964	1617	22500
18-#14	3.62	MA	24199	6351	40412	4622	44782	3732	47068	3016	50017	1901	61450	1373	45932
5L-6S		MI	16073	6351	27312	4476	29580	3601	30512	2904	31380	1770	37820	1080	30138
18-#14	3.62	MA	23547	6351	39306	4618	43251	3725	45196	3007	47560	1914	58407	1292	45133
6L-5S		MI	16514	6351	28047	4486	30595	3614	31661	2892	32910	1758	39662	1163	30632
18-#14	3.62	MA	22911	6351	38094	4638	41789	3743	43399	3023	45160	1926	55157	1161	43635
7L-4S		MI	16976	6351	28828	4495	31606	3601	32870	2879	34602	1770	41643	1218	31419
18-#14	3.62	MA	22286	6351	37005	4633	40306	3736	41645	3039	42609	1914	52148	1093	42333
8L-3S		MI	17489	6351	29726	4479	32749	3614	34224	2892	36286	1758	43506	1337	31692
18-#14	3.62	MA	21667	6351	35832	4653	38863	3754	39810	3030	40230	1926	49198	1015	40734
9L-2S		MI	18199	6351	30811	4489	34140	3601	35887	2879	38491	1745	46380	1461	31727
20-#11	2.79	MA	23467	6029	38270	4433	42116	3591	43846	2932	45709	1937	55544	1547	36655
5L-7S		MI	15483	6029	25601	4313	27522	3486	28062	2829	28214	1837	33692	1258	23987
20-#11	2.79	MA	23005	6029	37499	4430	41048	3587	42540	2927	43988	1946	53400	1490	36012
6E		MI	15787	6029	26164	4302	28201	3476	28920	2837	29271	1828	34927	1322	24258
20-#11	2.79	MA	22556	6029	36654	4445	40028	3600	41287	2938	42307	1955	51112	1400	35606
7L-5S		MI	16099	6029	26678	4308	28911	3484	29733	2829	30353	1820	36237	1380	24568
20-#11	2.79	MA	22113	6029	35894	4442	38994	3596	40063	2950	40520	1947	48998	1352	34736
8L-4S		MI	16426	6029	27225	4313	29620	3475	30588	2820	31550	1828	37644	1417	24886
20-#11	2.79	MA	21675	6029	35076	4456	37988	3609	38784	2944	38853	1955	46920	1298	34055
9L-3S		MI	16789	6029	27854	4302	30421	3483	31546	2829	32741	1820	38964	1501	24905
20-#11	2.79	MA	21178	6029	34319	4453	36967	3605	37567	2956	37201	1964	44907	1237	33084
10L-2S		MI	17293	6029	28616	4308	31397	3474	32722	2820	34301	1811	41005	1588	24891
20-#14	4.02	MA	24307	6506	40974	4715	45389	3795	47805	3049	51100	1901	63121	1263	50183
6E		MI	16550	6507	28397	4574	30970	3671	32174	2943	33585	1748	40694	1034	33293
20-#14	4.02	MA	23676	6506	39762	4735	43927	3813	46008	3065	48699	1913	59872	1133	48607
7L-5S		MI	16989	6507	29132	4583	31985	3684	33324	2931	35115	1736	42536	1117	33883

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

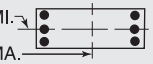
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	4.02	MA	23055	6507	38673	4730	42445	3806	44254	3081	46148	1901	56863	1064	47242
8L-4S		MI	17449	6507	29913	4592	32997	3671	34532	2919	36807	1748	44517	1172	34621
20-#14	4.02	MA	22441	6506	37500	4751	41002	3824	42419	3072	43769	1913	53913	986	45688
9L-3S		MI	17959	6506	30811	4577	34140	3683	35887	2931	38491	1736	46380	1291	35050
22-#11	3.06	MA	23544	6137	38665	4498	42543	3635	44364	2956	46470	1937	56719	1472	39547
6L-7S		MI	15823	6137	26363	4380	28499	3534	29238	2857	29773	1823	35733	1228	26232
22-#11	3.06	MA	23097	6137	37820	4512	41523	3648	43111	2968	44788	1946	54431	1382	39084
7L-6S		MI	16126	6137	26926	4369	29177	3525	30096	2865	30831	1814	36968	1292	26563
22-#11	3.06	MA	22656	6137	37060	4509	40489	3644	41887	2979	43001	1938	52317	1334	38232
8L-5S		MI	16437	6137	27440	4375	29888	3533	30910	2857	31913	1806	38278	1350	26857
22-#11	3.06	MA	22218	6137	36242	4524	39483	3657	40608	2974	41335	1947	50239	1280	37509
9L-4S		MI	16763	6137	27987	4381	30596	3523	31764	2848	33109	1814	39685	1388	27247
22-#11	3.06	MA	21727	6137	35485	4521	38462	3653	39390	2985	39682	1956	48226	1218	36562
10L-3S		MI	17124	6137	28616	4369	31397	3531	32722	2857	34301	1806	41005	1471	27278
22-#14	4.42	MA	24436	6662	41430	4832	46066	3883	48617	3108	52239	1900	64586	1104	53588
7L-6S		MI	17025	6662	29482	4671	32361	3741	33836	2983	35790	1727	43568	988	36459
22-#14	4.42	MA	23819	6662	40341	4828	44583	3876	46863	3124	49688	1888	61577	1035	52162
8L-5S		MI	17462	6662	30216	4680	33376	3753	34986	2970	37319	1714	45410	1071	37141
22-#14	4.42	MA	23207	6662	39168	4848	43141	3894	45029	3115	47309	1900	58627	957	50650
9L-4S		MI	17919	6662	30998	4689	34388	3741	36195	2958	39012	1727	47391	1126	37834
24-#11	3.34	MA	23635	6245	38986	4580	43018	3697	44935	2997	47270	1938	57750	1363	42560
7E		MI	16162	6245	27125	4448	29475	3583	30414	2885	31333	1809	37774	1198	28484
24-#11	3.34	MA	23197	6245	38226	4577	41984	3693	43711	3009	45483	1929	55636	1315	41734
8L-6S		MI	16464	6245	27687	4436	30154	3573	31272	2893	32390	1800	39009	1262	28871
24-#11	3.34	MA	22759	6245	37409	4591	40978	3706	42432	3003	43816	1938	53558	1261	40970
9L-5S		MI	16774	6245	28201	4442	30864	3581	32086	2885	33472	1792	40319	1320	29149
24-#11	3.34	MA	22272	6245	36651	4588	39957	3701	41214	3015	42164	1947	51545	1200	40046
10L-4S		MI	17098	6245	28748	4448	31572	3572	32940	2876	34669	1800	41726	1358	29605
24-#14	4.82	MA	24578	6818	42009	4925	46722	3946	49472	3166	53227	1875	66292	1006	57091
8L-6S		MI	17497	6818	30566	4768	33751	3811	35499	3022	37995	1705	46442	942	39637
24-#14	4.82	MA	23966	6818	40837	4945	45279	3964	47638	3157	50848	1887	63342	928	55619
9L-5S		MI	17932	6818	31301	4777	34766	3823	36649	3010	39524	1693	48284	1025	40402

RECTANGULAR TIED COLUMNS 28" x 42"

4-#18	1.36	MA	24749	5751	38883	4255	42030	3464	42911	2882	42893	2050	50354	1920	20266
2E		MI	16235	5751	25956	4097	27430	3328	27566	2753	26985	1927	31097	1763	13056
6-#14	1.15	MA	24364	5665	37876	4229	40901	3449	41595	2878	41223	2077	48243	1963	17328
2L-3S		MI	15301	5665	24270	4076	25487	3343	25296	2782	23990	1985	27288	1707	11314
6-#14	1.15	MA	23162	5665	36111	4225	38638	3467	38834	2895	37466	2090	43220	1839	17392
3L-2S		MI	16034	5665	25355	4086	26878	3331	26959	2769	26194	1972	30162	1832	11229
6-#18	2.04	MA	26172	6028	41973	4427	45991	3588	47744	2958	49420	2025	59029	1866	29980
2L-3S		MI	15806	6028	25956	4251	27430	3471	27566	2841	26985	1905	31097	1449	19169
6-#18	2.04	MA	24102	6028	38883	4418	42030	3619	42911	2985	42893	2047	50354	1644	29933
3L-2S		MI	17060	6028	27835	4270	29803	3449	30402	2819	30748	1883	35962	1670	19059
8-#11	1.06	MA	24206	5629	37450	4221	40437	3444	41060	2879	40508	2088	47389	1982	16117
2L-4S		MI	15063	5629	23705	4091	24843	3334	24580	2778	23127	2010	26429	1691	10588
8-#11	1.06	MA	23363	5629	36217	4219	38856	3441	39131	2891	37883	2097	43857	1895	16162
3E		MI	15435	5629	24334	4079	25644	3342	25538	2787	24318	2002	27750	1775	10524
8-#11	1.06	MA	22772	5629	35212	4233	37575	3454	37575	2886	35880	2106	41557	1809	16194
4L-2S		MI	15951	5629	25096	4085	26620	3333	26714	2778	25878	1993	29790	1861	10470
8-#14	1.53	MA	25191	5820	39642	4326	43164	3518	44356	2921	44980	2065	53266	1936	22886
2L-4S		MI	15263	5820	24457	4189	25735	3401	25604	2809	24510	1976	28299	1542	14838
8-#14	1.53	MA	23997	5820	37876	4322	40901	3537	41595	2938	41223	2077	48243	1811	22924
3E		MI	15790	5820	25355	4174	26878	3413	26959	2821	26194	1963	30162	1661	14773
8-#14	1.53	MA	23156	5820	36436	4343	39066	3531	39364	2929	38352	2090	44977	1687	22861
4L-2S		MI	16519	5820	26439	4183	28268	3401	28621	2809	28399	1951	33036	1786	14700

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

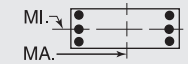
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	2.72	MA	27574	6304	45063	4600	49953	3712	52576	3033	55947	2000	67703	1811	39646
2L-4S		MI	15728	6304	26273	4449	27850	3569	28089	2885	27875	1883	32798	1152	24207
8-#18	2.72	MA	25526	6304	41973	4591	45991	3743	47744	3060	49420	2022	59029	1590	39483
3E		MI	16631	6304	27835	4424	29803	3591	30402	2907	30748	1861	35962	1357	25047
8-#18	2.72	MA	24083	6304	39446	4626	42771	3730	43830	3043	44432	2044	53404	1368	38067
4L-2S		MI	17875	6304	29715	4443	32176	3569	33238	2885	34511	1839	40827	1578	25003
10-#11	1.33	MA	24789	5737	38684	4288	42019	3493	42990	2908	43133	2079	50922	1964	20002
2L-5S		MI	15077	5737	23920	4152	25111	3392	24901	2815	23490	1987	27063	1624	13056
10-#11	1.33	MA	23950	5737	37450	4286	40437	3489	41060	2920	40508	2088	47389	1878	20036
3L-4S		MI	15411	5737	24467	4158	25819	3382	25756	2806	24687	1996	28470	1661	13011
10-#11	1.33	MA	23361	5737	36446	4301	39157	3502	39504	2915	38505	2098	45090	1791	20043
4L-3S		MI	15781	5737	25096	4147	26620	3390	26714	2815	25878	1987	29790	1745	12958
10-#11	1.33	MA	22835	5737	35577	4298	38030	3499	38119	2927	36500	2090	42688	1750	19984
5L-2S		MI	16295	5737	25857	4152	27597	3381	27890	2806	27438	1979	31831	1831	12907
10-#14	1.91	MA	26011	5976	41407	4423	45428	3588	47117	2963	48736	2052	58288	1909	28425
2L-5S		MI	15278	5976	24760	4277	26113	3483	26058	2860	25023	1941	29192	1441	17885
10-#14	1.91	MA	24824	5976	39642	4419	43164	3607	44356	2980	44980	2065	53266	1784	28426
3L-4S		MI	15751	5976	25542	4287	27125	3471	27267	2848	26715	1954	31173	1496	18241
10-#14	1.91	MA	23990	5976	38202	4440	41329	3601	42126	2972	42109	2078	50000	1660	28318
4L-3S		MI	16275	5976	26439	4271	28268	3483	28621	2860	28399	1941	33036	1615	18203
10-#14	1.91	MA	23244	5976	36956	4436	39714	3620	40141	2989	39235	2066	46578	1601	27579
5L-2S		MI	17001	5976	27524	4280	29659	3470	30284	2848	30604	1929	35910	1740	18144
10-#18	3.40	MA	26931	6581	45063	4764	49953	3868	52576	3136	55947	1997	67703	1535	49011
3L-4S		MI	16553	6581	28153	4621	30223	3690	30925	2951	31638	1839	37664	1060	29618
10-#18	3.40	MA	25503	6581	42536	4799	46732	3855	48663	3119	50958	2019	62079	1314	47107
4L-3S		MI	17449	6581	29715	4597	32176	3712	33238	2973	34511	1817	40827	1264	30877
10-#18	3.40	MA	24228	6581	40347	4790	43894	3886	45176	3146	45959	1997	56144	1212	44474
5L-2S		MI	18684	6581	31595	4616	34548	3690	36074	2951	38274	1795	45693	1486	30911
12-#11	1.59	MA	25368	5845	39918	4356	43600	3541	44919	2938	45758	2070	54455	1947	23877
2L-6S		MI	15106	5845	24167	4214	25377	3432	25264	2852	23968	1982	27794	1536	15187
12-#11	1.59	MA	24533	5845	38684	4353	42019	3537	42990	2950	43133	2080	50922	1860	23899
3L-5S		MI	15424	5845	24682	4219	26088	3440	26077	2843	25050	1973	29104	1594	15446
12-#11	1.59	MA	23947	5845	37679	4368	40738	3551	41433	2945	41130	2089	48623	1774	23880
4E		MI	15756	5845	25229	4225	26796	3431	26932	2835	26246	1982	30511	1631	15418
12-#11	1.59	MA	23424	5845	36811	4366	39611	3547	40049	2957	39125	2081	46221	1732	23796
5L-3S		MI	16125	5845	25857	4214	27597	3439	27890	2843	27438	1973	31831	1715	15376
12-#11	1.59	MA	22926	5845	35996	4363	38483	3560	38670	2952	37308	2091	43938	1676	23227
6L-2S		MI	16638	5845	26619	4220	28573	3429	29066	2835	28997	1965	33872	1802	15331
12-#14	2.30	MA	26824	6132	43173	4521	47691	3658	49878	3006	52493	2040	63311	1882	33952
2L-6S		MI	15316	6132	25110	4365	26489	3540	26571	2912	25698	1932	30224	1312	20629
12-#14	2.30	MA	25644	6132	41407	4516	45428	3677	47117	3022	48736	2053	58288	1757	33913
3L-5S		MI	15765	6132	25845	4375	27504	3553	27721	2900	27228	1920	32066	1395	21092
12-#14	2.30	MA	24815	6132	39967	4537	43593	3671	44887	3014	45866	2065	55023	1633	33766
4E		MI	16236	6132	26627	4384	28516	3540	28929	2887	28920	1932	34047	1450	21618
12-#14	2.30	MA	24075	6132	38722	4533	41977	3689	42902	3031	42991	2053	51601	1574	32839
5L-3S		MI	16758	6132	27524	4368	29659	3553	30284	2900	30604	1920	35910	1569	21615
12-#14	2.30	MA	23371	6132	37554	4529	40359	3683	40925	3023	40386	2066	48357	1493	31823
6L-2S		MI	17480	6132	28609	4378	31050	3540	31946	2887	32809	1907	38784	1693	21572
12-#18	4.08	MA	26906	6858	45626	4972	50693	3979	53495	3194	57485	1995	70753	1259	56198
4E		MI	17370	6858	30033	4794	32596	3811	33761	3017	35400	1796	42529	968	35075
12-#18	4.08	MA	25644	6858	43437	4963	47856	4010	50009	3221	52486	1972	64819	1158	53719
5L-3S		MI	18259	6858	31595	4769	34548	3833	36074	3039	38274	1773	45693	1172	36680
12-#18	4.08	MA	24445	6858	41383	4954	45013	3997	46535	3204	47957	1995	59224	1013	50381
6L-2S		MI	19485	6858	33474	4789	36921	3811	38910	3017	42037	1751	50558	1393	36789

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis

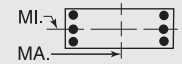


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.86	MA	25943	5953	41151	4423	45182	3590	46848	2967	48383	2062	57987	1929	27743
2L-7S		MI	15143	5953	24366	4292	25675	3490	25582	2871	24470	1977	28600	1442	17265
14-#11	1.86	MA	25112	5953	39918	4421	43600	3586	44919	2979	45758	2071	54455	1843	27750
3L-6S		MI	15452	5953	24929	4281	26354	3481	26440	2880	25527	1968	29835	1506	17477
14-#11	1.86	MA	24529	5953	38913	4436	42320	3599	43362	2974	43755	2081	52155	1756	27710
4L-5S		MI	15769	5953	25443	4287	27064	3488	27253	2871	26609	1959	31145	1564	17823
14-#11	1.86	MA	24009	5953	38044	4433	41193	3595	41978	2986	41750	2073	49753	1715	27604
5L-4S		MI	16100	5953	25990	4293	27772	3479	28108	2863	27806	1968	32551	1602	17814
14-#11	1.86	MA	23513	5953	37230	4430	40065	3609	40599	2981	39933	2082	47470	1659	26943
6L-3S		MI	16468	5953	26619	4281	28573	3487	29066	2871	28997	1959	33872	1685	17782
14-#11	1.86	MA	23031	5953	36338	4445	38989	3605	39276	2993	38157	2092	45034	1569	26448
7L-2S		MI	16978	5953	27381	4287	29550	3478	30242	2863	30557	1951	35913	1772	17744
14-#14	2.68	MA	26457	6287	43173	4614	47691	3747	49878	3065	52493	2040	63311	1730	39390
3L-6S		MI	15803	6287	26195	4463	27880	3610	28233	2952	27903	1911	33098	1266	23885
14-#14	2.68	MA	25634	6287	41733	4634	45856	3740	47648	3057	49623	2053	60046	1606	39208
4L-5S		MI	16250	6287	26930	4472	28895	3623	29383	2939	29432	1898	34940	1349	24315
14-#14	2.68	MA	24899	6287	40487	4630	44241	3759	45663	3073	46748	2041	56624	1547	38116
5L-4S		MI	16718	6287	27711	4481	29906	3610	30591	2927	31125	1911	36921	1404	24982
14-#14	2.68	MA	24200	6287	39319	4626	42623	3753	43686	3065	44143	2054	53380	1466	37149
6L-3S		MI	17237	6287	28609	4465	31050	3623	31946	2939	32809	1898	38784	1523	25016
14-#14	2.68	MA	23519	6287	38039	4647	41079	3772	41788	3082	41597	2066	49917	1336	35869
7L-2S		MI	17955	6287	29694	4475	32440	3610	33608	2927	35014	1886	41658	1647	24987
14-#18	4.76	MA	27045	7134	46527	5136	51817	4134	54841	3297	59013	1948	73493	1103	62988
5L-4S		MI	18180	7134	31912	4967	34969	3932	36598	3083	39163	1752	47394	875	40569
14-#18	4.76	MA	25858	7134	44473	5127	48974	4121	51367	3280	54484	1970	67898	958	59481
6L-3S		MI	19063	7134	33474	4942	36921	3954	38910	3105	42037	1730	50558	1079	42466
14-#18	4.76	MA	24702	7134	42224	5162	46261	4152	48032	3307	50058	1992	61920	727	56121
7L-2S		MI	20280	7134	35354	4962	39294	3932	41747	3083	45799	1707	55424	1301	42632
16-#11	2.12	MA	25687	6061	41151	4488	45182	3634	46848	3009	48383	2063	57987	1825	31591
3L-7S		MI	15489	6061	25128	4360	26651	3538	26758	2899	26030	1963	30640	1412	19573
16-#11	2.12	MA	25107	6061	40147	4503	43901	3648	45292	3003	46380	2072	55688	1739	31534
4L-6S		MI	15797	6061	25691	4348	27330	3529	27616	2908	27087	1954	31875	1476	19773
16-#11	2.12	MA	24590	6061	39278	4500	42774	3644	43907	3015	44375	2064	53286	1697	31408
5E		MI	16112	6061	26205	4354	28040	3537	28429	2899	28169	1945	33185	1534	20137
16-#11	2.12	MA	24097	6061	38463	4498	41646	3657	42529	3010	42558	2074	51003	1641	30667
6L-4S		MI	16442	6061	26752	4360	28749	3528	29284	2891	29366	1954	34592	1572	20202
16-#11	2.12	MA	23617	6061	37571	4513	40570	3653	41205	3022	40782	2083	48567	1551	30191
7L-3S		MI	16808	6061	27381	4349	29550	3536	30242	2899	30557	1945	35913	1655	20180
16-#11	2.12	MA	23144	6061	36770	4510	39478	3667	39914	3035	38896	2075	46321	1503	29467
8L-2S		MI	17317	6061	28142	4355	30526	3526	31418	2891	32117	1937	37954	1742	20149
16-#14	3.06	MA	26447	6443	43499	4732	48119	3810	50409	3099	53379	2040	65068	1579	44646
4L-6S		MI	16286	6443	27280	4560	29270	3680	29896	2991	30108	1889	35972	1220	27147
16-#14	3.06	MA	25717	6443	42253	4728	46504	3829	48424	3116	50505	2028	61646	1520	43408
5E		MI	16731	6443	28015	4569	30285	3693	31045	2978	31637	1876	37814	1303	27550
16-#14	3.06	MA	25022	6443	41085	4723	44886	3823	46447	3108	47899	2041	58402	1439	42484
6L-4S		MI	17197	6443	28796	4578	31297	3680	32254	2966	33330	1889	39795	1358	28336
16-#14	3.06	MA	24346	6443	39805	4744	43343	3842	44549	3125	45353	2054	54940	1309	41113
7L-3S		MI	17713	6443	29694	4563	32440	3692	33608	2978	35014	1876	41658	1477	28395
16-#14	3.06	MA	23680	6443	38655	4740	41777	3836	42697	3141	42648	2042	51740	1240	39880
8L-2S		MI	18428	6443	30778	4572	33831	3680	35271	2966	37219	1864	44532	1601	28392
16-#18	5.44	MA	27255	7411	47563	5300	52935	4245	56200	3355	61010	1945	76573	904	68607
6L-4S		MI	18985	7411	33792	5140	37342	4052	39434	3149	42926	1708	52260	783	46091
16-#18	5.44	MA	26111	7411	45314	5335	50222	4276	52864	3382	56584	1967	70595	672	65137
7L-3S		MI	19861	7411	35354	5115	39294	4075	41747	3171	45799	1686	55424	987	48238
18-#11	2.39	MA	25682	6169	41380	4570	45483	3696	47221	3033	49005	2063	59220	1721	35354
4L-7S		MI	15834	6169	25890	4427	27628	3587	27934	2927	27589	1949	32681	1382	21884
18-#11	2.39	MA	25167	6169	40511	4568	44356	3692	45837	3045	47000	2056	56818	1680	35150
5L-6S		MI	16140	6169	26452	4416	28306	3577	28792	2936	28646	1940	33916	1447	22073

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

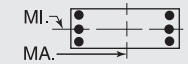
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.39	MA	24677	6169	39697	4565	43228	3706	44458	3040	45183	2065	54535	1624	34398
6L-5S		MI	16454	6169	26967	4422	29017	3585	29605	2927	29728	1931	35226	1504	22414
18-#11	2.39	MA	24199	6169	38805	4580	42152	3702	43135	3052	43407	2075	52100	1534	33938
7L-4S		MI	16783	6169	27513	4428	29725	3576	30460	2919	30925	1940	36633	1542	22584
18-#11	2.39	MA	23729	6169	38003	4578	41060	3715	41843	3064	41521	2067	49854	1485	33157
8L-3S		MI	17148	6169	28142	4416	30526	3584	31418	2927	32117	1931	37954	1625	22572
18-#11	2.39	MA	23245	6169	37140	4592	39998	3711	40492	3059	39761	2076	47640	1431	32445
9L-2S		MI	17654	6169	28904	4422	31502	3575	32594	2919	33676	1923	39994	1712	22547
18-#14	3.44	MA	26528	6598	44018	4825	48767	3899	51185	3158	54262	2016	66669	1493	48713
5L-6S		MI	16767	6598	28364	4657	30661	3750	31558	3030	32313	1867	38846	1174	30402
18-#14	3.44	MA	25838	6598	42850	4821	47149	3893	49208	3150	51656	2029	63425	1412	47826
6L-5S		MI	17209	6598	29099	4666	31676	3762	32708	3018	33842	1855	40688	1257	30794
18-#14	3.44	MA	25166	6598	41570	4841	45606	3911	47310	3167	49110	2041	59963	1282	46369
7L-4S		MI	17673	6598	29881	4676	32688	3750	33916	3005	35535	1867	42669	1312	31609
18-#14	3.44	MA	24505	6598	40420	4837	44040	3905	45458	3184	46405	2029	56763	1213	45123
8L-3S		MI	18186	6598	30778	4660	33831	3762	35271	3018	37219	1855	44532	1431	31765
18-#14	3.44	MA	23844	6598	39182	4858	42517	3924	43521	3176	43881	2042	53618	1135	43358
9L-2S		MI	18899	6598	31863	4669	35221	3750	36933	3005	39424	1842	47406	1555	31792
18-#18	6.12	MA	27507	7688	48404	5508	54183	4400	57697	3458	63111	1942	79269	618	74176
7L-4S		MI	19784	7688	35672	5313	39715	4173	42270	3214	46689	1664	57125	690	51636
20-#11	2.65	MA	25741	6277	41745	4635	45937	3741	47766	3074	49625	2047	60351	1662	38855
5L-7S		MI	16176	6277	26651	4495	28604	3635	29110	2955	29149	1935	34722	1352	24177
20-#11	2.65	MA	25253	6277	40931	4633	44809	3754	46387	3069	47808	2056	58068	1606	38135
6E		MI	16481	6277	27214	4483	29283	3626	29968	2964	30206	1926	35957	1417	24377
20-#11	2.65	MA	24778	6277	40039	4647	43733	3750	45064	3081	46032	2066	55632	1516	37688
7L-5S		MI	16794	6277	27728	4489	29993	3634	30782	2955	31288	1917	37267	1474	24697
20-#11	2.65	MA	24310	6277	39237	4645	42641	3764	43772	3093	44146	2058	53386	1468	36853
8L-4S		MI	17122	6277	28275	4495	30701	3624	31636	2947	32485	1926	38674	1512	24950
20-#11	2.65	MA	23829	6277	38374	4660	41580	3760	42422	3088	42386	2068	51173	1414	36161
9L-3S		MI	17485	6277	28904	4484	31502	3632	32594	2955	33676	1917	39994	1595	24959
20-#11	2.65	MA	23312	6277	37575	4657	40502	3773	41137	3100	40642	2077	49028	1353	35158
10L-2S		MI	17990	6277	29665	4490	32479	3623	33770	2947	35236	1909	42035	1682	24941
20-#14	3.83	MA	26648	6754	44616	4918	49413	3963	51969	3193	55413	2016	68448	1385	53174
6E		MI	17245	6754	29449	4754	32051	3820	33220	3070	34517	1845	41719	1128	33554
20-#14	3.83	MA	25981	6754	43336	4939	47869	3981	50072	3209	52867	2029	64985	1255	51636
7L-5S		MI	17685	6754	30184	4764	33066	3832	34370	3057	36047	1833	43562	1211	34045
20-#14	3.83	MA	25324	6754	42186	4935	46303	3975	48219	3226	50161	2017	61786	1186	50327
8L-4S		MI	18146	6754	30965	4773	34078	3820	35578	3045	37739	1845	45543	1266	34810
20-#14	3.83	MA	24664	6754	40948	4955	44780	3994	46282	3218	47638	2030	58641	1108	48607
9L-3S		MI	18657	6754	31863	4757	35221	3832	36933	3057	39424	1833	47406	1385	35128
22-#11	2.92	MA	25827	6385	42164	4700	46391	3802	48317	3099	50433	2048	61601	1589	41876
6L-7S		MI	16517	6385	27413	4562	29580	3684	30286	2984	30709	1921	36763	1322	26422
22-#11	2.92	MA	25354	6385	41272	4715	45315	3799	46993	3111	48657	2057	59165	1499	41441
7L-6S		MI	16821	6385	27976	4551	30259	3674	31144	2992	31766	1912	37998	1387	26683
22-#11	2.92	MA	24888	6385	40471	4712	44223	3812	45702	3123	46771	2050	56919	1450	40555
8L-5S		MI	17133	6385	28490	4557	30969	3682	31958	2984	32848	1903	39308	1444	26986
22-#11	2.92	MA	24417	6385	39607	4727	43161	3808	44351	3118	45011	2059	54705	1396	39881
9L-4S		MI	17459	6385	29037	4563	31678	3673	32812	2975	34044	1912	40715	1482	27315
22-#11	2.92	MA	23896	6385	38808	4725	42084	3822	43066	3130	43267	2069	52561	1335	38842
10L-3S		MI	17821	6385	29665	4551	32479	3681	33770	2984	35236	1903	42035	1566	27341
22-#11	2.92	MA	23393	6385	38022	4722	41028	3818	41732	3125	41407	2061	50371	1284	37891
11L-2S		MI	18324	6385	30427	4557	33455	3671	34946	2975	36796	1895	44076	1652	27330
22-#14	4.21	MA	26790	6910	45102	5036	50133	4051	52833	3252	56624	2017	70008	1228	56912
7L-6S		MI	17720	6910	30534	4852	33442	3890	34883	3109	36722	1824	44593	1082	36719

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	4.21	MA	26137	6910	43952	5032	48567	4045	50980	3268	53918	2004	66809	1158	55540
8L-5S		MI	18159	6910	31269	4861	34457	3902	36032	3097	38252	1811	46436	1165	37303
22-#14	4.21	MA	25478	6910	42713	5053	47044	4064	49043	3260	51395	2017	63663	1081	53864
9L-4S		MI	18617	6910	32050	4870	35469	3890	37241	3084	39944	1824	48417	1220	38022
24-#11	3.18	MA	25926	6493	42506	4782	46896	3847	48923	3140	51282	2049	62697	1481	45182
7E		MI	16857	6493	28175	4630	30557	3732	31462	3012	32268	1907	38804	1292	28672
24-#11	3.18	MA	25463	6493	41704	4780	45804	3860	47631	3152	49396	2041	60451	1433	44262
8L-6S		MI	17160	6493	28737	4618	31235	3723	32320	3020	33325	1898	40039	1357	28992
24-#11	3.18	MA	24993	6493	40841	4795	44742	3857	46280	3147	47636	2050	58238	1379	43553
9L-5S		MI	17470	6493	29251	4624	31946	3731	33134	3012	34407	1889	41349	1414	29278
24-#11	3.18	MA	24475	6493	40042	4792	43665	3870	44995	3159	45892	2060	56093	1318	42531
10L-4S		MI	17795	6493	29798	4630	32654	3721	33988	3003	35604	1898	42755	1452	29676
24-#11	3.18	MA	23975	6493	39256	4789	42609	3866	43662	3154	44032	2052	53903	1266	41550
11L-3S		MI	18156	6493	30427	4619	33455	3729	34946	3012	36796	1889	44076	1536	29709
24-#14	4.59	MA	26945	7065	45717	5129	50830	4115	53741	3311	57675	1992	71831	1131	60763
8L-6S		MI	18194	7065	31619	4949	34833	3959	36545	3148	38927	1802	47467	1036	39894
24-#14	4.59	MA	26286	7065	44479	5150	49307	4134	51804	3303	55152	2005	68686	1054	59130
9L-5S		MI	18630	7065	32354	4958	35848	3972	37695	3136	40457	1790	49310	1119	40565

RECTANGULAR TIED COLUMNS 28" x 44"

4-#18	1.30	MA	27059	5999	42350	4456	45802	3629	46730	3023	46659	2161	54761	2031	21346
2E		MI	16929	5999	27013	4276	28510	3475	28608	2878	27912	2023	32114	1856	13101
6-#14	1.10	MA	26647	5912	41281	4430	44601	3614	45331	3019	44820	2185	52488	2072	18240
2L-3S		MI	15994	5912	25322	4257	26568	3492	26343	2908	24922	2082	28314	1801	11350
6-#14	1.10	MA	25376	5912	39418	4426	42213	3608	42418	3036	40857	2199	47156	1948	18304
3L-2S		MI	16728	5912	26407	4266	27959	3479	28005	2896	27127	2069	31188	1926	11266
6-#18	1.95	MA	28571	6275	45613	4629	49984	3754	51833	3098	53582	2138	63983	1980	31600
2L-3S		MI	16499	6275	27013	4429	28510	3618	28608	2966	27912	2001	32114	1542	19233
6-#18	1.95	MA	26380	6275	42350	4620	45802	3786	46730	3127	46659	2160	54761	1759	31553
3L-2S		MI	17755	6275	28892	4449	30883	3596	31444	2944	31675	1979	36979	1763	19113
8-#11	1.01	MA	26477	5877	40828	4422	44109	3610	44763	3019	44061	2196	51569	2090	16960
2L-4S		MI	15756	5877	24755	4272	25925	3483	25628	2905	24062	2108	27459	1786	10621
8-#11	1.01	MA	25587	5877	39527	4420	42441	3606	42728	3032	41293	2206	47822	2004	17005
3E		MI	16129	5877	25384	4261	26726	3491	26586	2914	25254	2099	28779	1869	10556
8-#11	1.01	MA	24963	5877	38469	4435	41092	3620	41088	3027	39182	2216	45381	1918	17036
4L-2S		MI	16645	5877	26146	4267	27702	3482	27762	2905	26813	2090	30820	1956	10502
8-#14	1.46	MA	27525	6068	43144	4527	46989	3684	48244	3061	48784	2173	57819	2047	24101
2L-4S		MI	15956	6068	25509	4370	26816	3549	26650	2935	25443	2073	29325	1636	14889
8-#14	1.46	MA	26261	6068	41281	4524	44601	3678	45331	3079	44820	2186	52488	1923	24139
3E		MI	16484	6068	26407	4354	27959	3562	28005	2947	27127	2060	31188	1755	14817
8-#14	1.46	MA	25375	6068	39763	4545	42667	3698	42980	3071	41795	2200	49018	1798	24076
4L-2S		MI	17214	6068	27492	4364	29350	3549	29667	2935	29332	2048	34062	1879	14741
8-#18	2.60	MA	30061	6552	48876	4801	54167	3878	56936	3174	60505	2115	73205	1929	41806
2L-4S		MI	16421	6552	27330	4627	28931	3716	29132	3010	28801	1979	33815	1245	24474
8-#18	2.60	MA	27893	6552	45613	4793	49984	3910	51833	3202	53582	2137	63983	1707	41643
3E		MI	17326	6552	28892	4602	30883	3738	31444	3032	31675	1957	36979	1449	25127
8-#18	2.60	MA	26369	6552	42948	4829	46588	3898	47706	3186	48290	2159	57996	1486	40458
4L-2S		MI	18572	6552	30772	4622	33256	3716	34281	3010	35438	1935	41845	1671	25065
10-#11	1.27	MA	27095	5985	42130	4490	45777	3658	46798	3049	46830	2187	55316	2074	21055
2L-5S		MI	15770	5985	24970	4334	26193	3541	25949	2942	24425	2085	28093	1718	13101
10-#11	1.27	MA	26209	5985	40828	4487	44109	3655	44763	3061	44061	2197	51569	1988	21089
3L-4S		MI	16104	5985	25517	4340	26901	3532	26804	2933	25622	2094	29500	1756	13051
10-#11	1.27	MA	25588	5985	39770	4502	42759	3669	43123	3057	41951	2207	49127	1901	21096
4L-3S		MI	16475	5985	26146	4328	27702	3540	27762	2942	26813	2085	30820	1839	12995
10-#11	1.27	MA	25034	5985	38855	4500	41573	3665	41665	3069	39839	2200	46584	1859	21037
5L-2S		MI	16990	5985	26907	4334	28678	3530	28938	2933	28373	2076	32861	1926	12943

RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

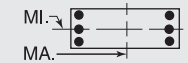
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.83	MA	28394	6223	45006	4624	49378	3754	51158	3104	52748	2160	63150	2022	29943
2L-5S		MI	15971	6223	25813	4458	27195	3632	27105	2987	25955	2038	30218	1535	18044
10-#14	1.83	MA	27139	6223	43144	4621	46989	3748	48244	3121	48784	2174	57819	1897	29944
3L-4S		MI	16444	6223	26594	4467	28206	3619	28313	2974	27648	2051	32199	1590	18298
10-#14	1.83	MA	26259	6223	41626	4642	45055	3767	45894	3114	45759	2187	54349	1773	29837
4L-3S		MI	16970	6223	27492	4452	29350	3632	29667	2987	29332	2038	34062	1709	18253
10-#14	1.83	MA	25473	6223	40314	4638	43354	3762	43803	3131	42730	2176	50723	1713	29198
5L-2S		MI	17696	6223	28576	4461	30740	3619	31330	2974	31537	2026	36936	1833	18190
10-#18	3.25	MA	29385	6829	48876	4966	54167	4034	56936	3277	60505	2114	73205	1656	51711
3L-4S		MI	17246	6829	29210	4800	31303	3837	31968	3076	32564	1935	38681	1153	29880
10-#18	3.25	MA	27877	6829	46211	5002	50771	4022	52809	3262	55213	2136	67218	1435	50015
4L-3S		MI	18145	6829	30772	4775	33256	3859	34281	3098	35438	1913	41845	1357	30967
10-#18	3.25	MA	26531	6829	43904	4994	47780	4054	49134	3290	49912	2114	60922	1331	47107
5L-2S		MI	19382	6829	32652	4795	35629	3837	37117	3076	39200	1891	46710	1578	30979
12-#11	1.52	MA	27709	6093	43431	4557	47444	3707	48832	3078	49598	2178	59062	2058	25140
2L-6S		MI	15799	6093	25217	4395	26459	3582	26312	2979	24903	2080	28824	1631	15300
12-#11	1.52	MA	26827	6093	42130	4555	45777	3703	46798	3091	46830	2188	55316	1971	25162
3L-5S		MI	16117	6093	25732	4401	27169	3590	27125	2970	25985	2071	30134	1688	15496
12-#11	1.52	MA	26209	6093	41071	4570	44427	3717	45158	3086	44719	2198	52874	1885	25144
4E		MI	16450	6093	26278	4407	27878	3580	27980	2962	27181	2080	31540	1726	15462
12-#11	1.52	MA	25658	6093	40156	4568	43241	3713	43700	3098	42607	2191	50331	1843	25060
5L-3S		MI	16820	6093	26907	4396	28678	3588	28938	2970	28373	2071	32861	1810	15416
12-#11	1.52	MA	25133	6093	39299	4565	42053	3727	42248	3094	40694	2201	47908	1787	24536
6L-2S		MI	17332	6093	27669	4402	29655	3579	30114	2962	29933	2062	34902	1896	15370
12-#14	2.19	MA	29257	6379	46869	4722	51766	3823	54071	3146	56711	2148	68481	1996	35774
2L-6S		MI	16008	6379	26163	4546	27570	3689	27617	3038	26630	2029	31249	1406	20776
12-#14	2.19	MA	28009	6379	45006	4718	49378	3818	51158	3164	52748	2161	63150	1872	35735
3L-5S		MI	16459	6379	26898	4555	28585	3701	28767	3026	28160	2017	33092	1489	21250
12-#14	2.19	MA	27135	6379	43489	4739	47444	3837	48807	3156	49723	2175	59680	1747	35589
4E		MI	16930	6379	27679	4564	29597	3689	29975	3014	29852	2029	35073	1544	21687
12-#14	2.19	MA	26355	6379	42177	4736	45742	3832	46716	3174	46694	2164	56055	1687	34750
5L-3S		MI	17452	6379	28576	4549	30740	3701	31330	3026	31537	2017	36936	1663	21669
12-#14	2.19	MA	25612	6379	40947	4732	44038	3851	44634	3166	43950	2177	52609	1607	33632
6L-2S		MI	18176	6379	29661	4558	32131	3689	32992	3014	33741	2004	39810	1787	21621
12-#18	3.90	MA	29368	7105	49474	5175	54954	4146	57911	3337	62136	2112	76439	1383	59623
4E		MI	18065	7105	31090	4973	33676	3958	34804	3142	36327	1892	43546	1060	35334
12-#18	3.90	MA	28036	7105	47167	5167	51963	4179	54237	3366	56835	2090	70144	1280	56878
5L-3S		MI	18956	7105	32652	4948	35629	3980	37117	3164	39200	1869	46710	1264	36780
12-#18	3.90	MA	26770	7105	45003	5159	48967	4167	50576	3350	52030	2112	64192	1136	53561
6L-2S		MI	20185	7105	34531	4967	38001	3958	39953	3142	42963	1847	51576	1486	36868
14-#11	1.77	MA	28319	6201	44732	4624	49112	3755	50867	3108	52367	2170	62809	2041	29218
2L-7S		MI	15836	6201	25416	4474	26756	3639	26630	2998	25405	2074	29630	1536	17375
14-#11	1.77	MA	27441	6201	43431	4622	47444	3752	48832	3120	49598	2180	59062	1955	29224
3L-6S		MI	16145	6201	25979	4463	27435	3630	27488	3007	26462	2066	30864	1601	17590
14-#11	1.77	MA	26826	6201	42372	4637	46095	3765	47193	3115	47488	2190	56621	1868	29184
4L-5S		MI	16462	6201	26493	4469	28146	3638	28301	2998	27544	2057	32174	1658	17882
14-#11	1.77	MA	26278	6201	41457	4635	44909	3762	45735	3128	45376	2183	54078	1826	29078
5L-4S		MI	16794	6201	27040	4474	28854	3629	29156	2990	28741	2066	33581	1696	17862
14-#11	1.77	MA	25756	6201	40600	4633	43721	3776	44283	3123	43463	2193	51655	1771	28457
6L-3S		MI	17162	6201	27669	4463	29655	3637	30114	2998	29933	2057	34902	1780	17826
14-#11	1.77	MA	25247	6201	39661	4648	42588	3772	42890	3136	41594	2203	49071	1681	27914
7L-2S		MI	17673	6201	28431	4469	30631	3627	31290	2990	31492	2048	36943	1866	17785
14-#14	2.56	MA	28872	6535	46869	4815	51766	3888	54071	3206	56711	2149	68481	1846	41516
3L-6S		MI	16496	6535	27247	4643	28961	3759	29279	3078	28835	2008	34123	1360	24033

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

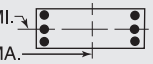


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.56	MA	28004	6535	45352	4836	49832	3907	51720	3199	53686	2163	65011	1722	41334
4L-5S		MI	16943	6535	27982	4652	29976	3771	30429	3065	30365	1995	35966	1443	24472
14-#14	2.56	MA	27229	6535	44040	4833	48130	3901	49629	3216	50658	2151	61386	1662	40321
5L-4S		MI	17412	6535	28764	4662	30988	3759	31638	3053	32057	2008	37947	1498	25057
14-#14	2.56	MA	26492	6535	42810	4829	46426	3921	47547	3208	47914	2165	57941	1581	39255
6L-3S		MI	17932	6535	29661	4646	32131	3771	32992	3065	33741	1995	39810	1617	25073
14-#14	2.56	MA	25773	6535	41462	4850	44801	3915	45549	3226	45232	2178	54265	1451	38034
7L-2S		MI	18652	6535	30746	4655	33521	3759	34655	3053	35946	1983	42684	1741	25039
14-#18	4.55	MA	29523	7382	50430	5340	56146	4303	59339	3441	63758	2067	79366	1229	66674
5L-4S		MI	18876	7382	32969	5146	36049	4079	37640	3207	40090	1848	48412	968	40825
14-#18	4.55	MA	28270	7382	48266	5331	53150	4291	55679	3425	58953	2089	73414	1085	63183
6L-3S		MI	19762	7382	34531	5121	38001	4101	39953	3230	42963	1826	51576	1172	42573
14-#18	4.55	MA	27050	7382	45896	5367	50291	4323	52164	3454	54258	2111	67057	853	59825
7L-2S		MI	20982	7382	36411	5140	40374	4079	42789	3207	46726	1803	56441	1393	42717
16-#11	2.03	MA	28051	6309	44732	4690	49112	3800	50867	3149	52367	2171	62809	1938	33276
3L-7S		MI	16182	6309	26178	4541	27733	3688	27806	3026	26965	2060	31670	1507	19685
16-#11	2.03	MA	27440	6309	43673	4705	47763	3814	49227	3145	50256	2181	60367	1852	33219
4L-6S		MI	16490	6309	26741	4530	28412	3678	28664	3035	28022	2052	32905	1571	19886
16-#11	2.03	MA	26894	6309	42759	4702	46577	3810	47770	3157	48144	2174	57824	1810	33093
5E		MI	16806	6309	27255	4536	29122	3686	29477	3026	29104	2043	34215	1628	20255
16-#11	2.03	MA	26375	6309	41901	4700	45389	3824	46318	3153	46231	2184	55401	1754	32386
6L-4S		MI	17137	6309	27802	4542	29830	3677	30332	3018	30301	2052	35622	1666	20253
16-#11	2.03	MA	25869	6309	40962	4715	44256	3821	44925	3165	44362	2194	52818	1664	31863
7L-3S		MI	17504	6309	28431	4531	30631	3685	31290	3026	31492	2043	36943	1750	20227
16-#11	2.03	MA	25371	6309	40119	4713	43107	3834	43565	3178	42375	2187	50440	1615	31188
8L-2S		MI	18013	6309	29192	4536	31608	3676	32466	3018	33052	2034	38983	1836	20193
16-#14	2.92	MA	28866	6690	47215	4934	52220	3977	54633	3241	57650	2150	70343	1696	47076
4L-6S		MI	16980	6690	28332	4740	30352	3829	30942	3117	31040	1986	36997	1314	27297
16-#14	2.92	MA	28096	6690	45902	4930	50518	3971	52543	3258	54622	2139	66717	1637	45908
5E		MI	17425	6690	29067	4750	31366	3841	32092	3105	32570	1973	38840	1397	27707
16-#14	2.92	MA	27364	6690	44673	4926	48814	3991	50460	3251	51877	2152	63272	1556	44887
6L-4S		MI	17892	6690	29848	4759	32378	3829	33300	3092	34262	1986	40821	1452	28417
16-#14	2.92	MA	26651	6690	43325	4948	47189	3985	48462	3268	49196	2166	59596	1426	43573
7L-3S		MI	18409	6690	30746	4743	33521	3841	34655	3105	35946	1973	42684	1571	28462
16-#14	2.92	MA	25949	6690	42114	4944	45540	4004	46511	3286	46347	2155	56206	1356	42221
8L-2S		MI	19126	6690	31831	4753	34912	3829	36317	3092	38151	1961	45558	1695	28448
16-#18	5.19	MA	29754	7659	51529	5504	57333	4415	60781	3501	65877	2066	82635	1033	72833
6L-4S		MI	19682	7659	34849	5319	38422	4199	40476	3273	43853	1804	53277	875	46345
16-#18	5.19	MA	28547	7659	49159	5540	54474	4447	57267	3529	61181	2088	76279	802	69364
7L-3S		MI	20561	7659	36411	5294	40374	4221	42789	3295	46726	1782	56441	1080	48352
18-#11	2.28	MA	28049	6416	44974	4772	49431	3862	51262	3174	53025	2172	64114	1836	37249
4L-7S		MI	16527	6416	26940	4609	28709	3736	28982	3054	28525	2046	33711	1477	21996
18-#11	2.28	MA	27506	6416	44060	4770	48245	3859	49804	3187	50913	2165	61571	1794	37105
5L-6S		MI	16834	6416	27502	4598	29388	3727	29840	3063	29582	2038	34946	1541	22187
18-#11	2.28	MA	26990	6416	43202	4768	47057	3873	48353	3182	49000	2175	59148	1738	36322
6L-5S		MI	17148	6416	28016	4603	30098	3735	30653	3054	30664	2029	36256	1598	22539
18-#11	2.28	MA	26486	6416	42263	4783	45924	3869	46960	3194	47130	2185	56564	1648	35817
7L-4S		MI	17478	6416	28563	4609	30807	3725	31508	3046	31860	2038	37663	1636	22639
18-#11	2.28	MA	25991	6416	41420	4780	44775	3883	45600	3207	45144	2178	54186	1599	35083
8L-3S		MI	17843	6416	29192	4598	31608	3733	32466	3054	33052	2029	38983	1720	22622
18-#11	2.28	MA	25471	6416	40594	4778	43657	3879	44178	3202	43292	2188	51837	1545	34303
9L-2S		MI	18351	6416	29954	4604	32584	3724	33642	3046	34611	2020	41024	1806	22594
18-#14	3.29	MA	28957	6846	47765	5027	52906	4041	55456	3301	58585	2126	72048	1611	51507
5L-6S		MI	17461	6846	29417	4838	31742	3899	32604	3157	33245	1964	39871	1268	30566
18-#14	3.29	MA	28230	6846	46535	5024	51202	4060	53374	3293	55841	2140	68603	1530	50527
6L-5S		MI	17904	6846	30152	4847	32757	3911	33754	3144	34774	1952	41714	1351	30951
18-#14	3.29	MA	27521	6846	45188	5045	49577	4055	51375	3311	53160	2154	64927	1401	49124
7L-4S		MI	18369	6846	30933	4856	33769	3899	34962	3132	36467	1964	43695	1406	31769

RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

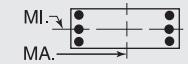


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	3.29	MA	26824	6846	43977	5041	47928	4074	49424	3328	50310	2142	61537	1331	47814
8L-3S		MI	18884	6846	31831	4841	34912	3911	36317	3144	38151	1952	45558	1525	31836
18-#14	3.29	MA	26115	6846	42673	5062	46325	4069	47384	3321	47653	2156	58197	1253	46007
9L-2S		MI	19597	6846	32915	4850	36303	3898	37979	3132	40356	1939	48431	1649	31855
18-#18	5.84	MA	30028	7935	52422	5713	58657	4571	62370	3605	68105	2065	85501	751	78927
7L-4S		MI	20483	7935	36729	5492	40795	4320	43313	3339	47616	1760	58143	783	51888
20-#11	2.53	MA	28115	6524	45361	4837	49913	3907	51839	3216	53681	2157	65317	1777	41066
5L-7S		MI	16870	6524	27701	4676	29686	3785	30158	3082	30084	2032	35752	1447	24310
20-#11	2.53	MA	27601	6524	44504	4835	48725	3921	50387	3211	51768	2167	62895	1721	40264
6E		MI	17176	6524	28264	4665	30364	3775	31016	3091	31141	2024	36987	1511	24492
20-#11	2.53	MA	27100	6524	43564	4850	47592	3917	48994	3224	49899	2177	60311	1631	39775
7L-5S		MI	17489	6524	28778	4671	31075	3783	31830	3082	32223	2015	38297	1568	24823
20-#11	2.53	MA	26607	6524	42721	4848	46443	3931	47635	3236	47912	2169	57933	1582	38983
8L-4S		MI	17817	6524	29325	4677	31783	3774	32684	3074	33420	2024	39704	1606	25013
20-#11	2.53	MA	26091	6524	41895	4846	45325	3928	46213	3232	46060	2180	55584	1528	38225
9L-3S		MI	18181	6524	29954	4665	32584	3782	33642	3082	34611	2015	41024	1690	25011
20-#11	2.53	MA	25546	6524	40971	4861	44192	3942	44860	3244	44224	2190	53307	1467	37251
10L-2S		MI	18687	6524	30715	4671	33560	3772	34818	3074	36171	2006	43065	1776	24989
20-#14	3.65	MA	29089	7002	48398	5121	53590	4130	56287	3336	59805	2128	73934	1505	56174
6E		MI	17940	7002	30502	4935	33133	3968	34267	3196	35450	1942	42745	1222	33810
20-#14	3.65	MA	28385	7002	47051	5142	51965	4125	54288	3353	57124	2141	70258	1375	54685
7L-5S		MI	18381	7002	31237	4944	34148	3981	35416	3183	36979	1930	44588	1305	34203
20-#14	3.65	MA	27693	7002	45840	5138	50316	4144	52338	3370	54274	2130	66868	1305	53415
8L-4S		MI	18843	7002	32018	4953	35159	3968	36625	3171	38672	1942	46569	1360	34995
20-#14	3.65	MA	26985	7002	44536	5160	48713	4138	50298	3363	51617	2143	63528	1227	51552
9L-3S		MI	19356	7002	32915	4938	36303	3981	37979	3183	40356	1930	48431	1478	35203
22-#11	2.79	MA	28209	6632	45805	4902	50393	3969	52422	3241	54537	2158	66641	1705	44211
6L-7S		MI	17211	6632	28463	4744	30662	3833	31334	3111	31644	2018	37793	1417	26606
22-#11	2.79	MA	27711	6632	44865	4917	49260	3966	51029	3253	52667	2168	64058	1615	43735
7L-6S		MI	17516	6632	29026	4732	31341	3824	32192	3119	32701	2010	39028	1481	26799
22-#11	2.79	MA	27220	6632	44022	4915	48111	3980	49669	3266	50681	2161	61679	1566	42890
8L-5S		MI	17828	6632	29540	4738	32051	3832	33006	3111	33783	2001	40338	1538	27111
22-#11	2.79	MA	26707	6632	43196	4913	46993	3976	48248	3261	48829	2171	59330	1512	42152
9L-4S		MI	18155	6632	30087	4744	32759	3822	33860	3102	34980	2010	41744	1576	27381
22-#11	2.79	MA	26164	6632	42272	4928	45860	3990	46895	3274	46992	2181	57054	1451	41140
10L-3S		MI	18518	6632	30715	4733	33560	3830	34818	3111	36171	2001	43065	1660	27395
22-#11	2.79	MA	25634	6632	41445	4926	44748	3986	45491	3269	45034	2174	54735	1399	40224
11L-2S		MI	19022	6632	31477	4739	34537	3821	35995	3102	37731	1992	45106	1746	27381
22-#14	4.02	MA	29244	7157	48913	5239	54353	4194	57202	3395	61087	2129	75590	1350	60257
7L-6S		MI	18416	7157	31586	5032	34523	4038	35929	3235	37655	1921	45619	1176	36973
22-#14	4.02	MA	28555	7157	47703	5236	52704	4214	55251	3413	58238	2117	72200	1280	58951
8L-5S		MI	18855	7157	32321	5041	35538	4051	37079	3223	39184	1908	47462	1258	37460
22-#14	4.02	MA	27849	7157	46399	5257	51101	4208	53211	3405	55581	2131	68859	1202	57105
9L-4S		MI	19315	7157	33103	5051	36550	4038	38287	3210	40877	1921	49443	1314	38206
24-#11	3.04	MA	28318	6740	46166	4985	50928	4014	53064	3283	55436	2159	67804	1598	47699
7E		MI	17551	6740	29225	4811	31638	3881	32510	3139	33203	2004	39834	1387	28856
24-#11	3.04	MA	27830	6740	45323	4983	49779	4028	51704	3295	53449	2152	65426	1549	46802
8L-6S		MI	17855	6740	29787	4800	32317	3872	33368	3147	34261	1996	41068	1451	29109
24-#11	3.04	MA	27326	6740	44497	4980	48661	4025	50282	3290	51597	2162	63077	1496	46083
9L-5S		MI	18166	6740	30301	4806	33027	3880	34182	3139	35343	1987	42378	1508	29404
24-#11	3.04	MA	26779	6740	43573	4995	47527	4038	48930	3303	49761	2172	60801	1435	45034
10L-4S		MI	18492	6740	30848	4812	33736	3871	35037	3130	36539	1996	43785	1546	29745
24-#11	3.04	MA	26251	6740	42746	4993	46416	4035	47526	3298	47803	2165	58482	1382	44087
11L-3S		MI	18853	6740	31477	4800	34537	3879	35995	3139	37731	1987	45106	1630	29770
24-#14	4.38	MA	29412	7313	49566	5333	55092	4284	58164	3455	62201	2105	77531	1254	64469
8L-6S		MI	18890	7313	32671	5129	35914	4108	37591	3275	39860	1899	48493	1130	40146
24-#14	4.38	MA	28706	7313	48262	5354	53489	4278	56124	3448	59544	2119	74190	1177	62666
9L-5S		MI	19327	7313	33406	5139	36929	4120	38741	3262	41389	1887	50336	1212	40723

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

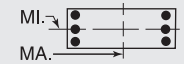
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.24	MA	29469	6246	45958	4657	49727	3795	50702	3163	50546	2271	59327	2142	22426
2E		MI	17623	6246	28070	4455	29590	3622	29651	3003	28839	2119	33131	1948	13145
6-#14	1.05	MA	29029	6160	44826	4631	48456	3779	49221	3160	48558	2293	56891	2181	19151
2L-3S		MI	16687	6160	26375	4438	27650	3641	27389	3034	25854	2179	29340	1895	11386
6-#14	1.05	MA	27689	6160	42866	4628	45943	3774	46155	3177	44388	2307	51251	2057	19215
3L-2S		MI	17422	6160	27459	4447	29040	3628	29051	3022	28059	2166	32213	2019	11301
6-#18	1.86	MA	31069	6523	49394	4830	54131	3919	56076	3239	57857	2249	69097	2093	33220
2L-3S		MI	17193	6523	28070	4608	29590	3765	29651	3091	28839	2097	33131	1635	19294
6-#18	1.86	MA	28758	6523	45958	4822	49727	3952	50702	3268	50546	2271	59327	1872	33173
3L-2S		MI	18450	6523	29949	4627	31963	3743	32487	3069	32601	2075	37997	1856	19167
8-#14	1.40	MA	29957	6315	46786	4728	50969	3849	52286	3202	52729	2281	62531	2157	25316
2L-4S		MI	16649	6315	26562	4551	27897	3698	27697	3061	26375	2170	30351	1730	14937
8-#14	1.40	MA	28625	6315	44826	4725	48456	3844	49221	3220	48558	2295	56891	2033	25354
3E		MI	17177	6315	27459	4535	29040	3710	29051	3074	28059	2157	32213	1849	14859
8-#14	1.40	MA	27693	6315	43231	4747	46423	3864	46750	3213	45379	2309	53217	1908	25291
4L-2S		MI	17908	6315	28544	4544	30431	3698	30714	3061	30264	2145	35087	1973	14781
8-#18	2.48	MA	32648	6800	52829	5003	58536	4043	61449	3314	65168	2227	78867	2045	43966
2L-4S		MI	17114	6800	28387	4806	30011	3863	30174	3135	29728	2075	34833	1338	24735
8-#18	2.48	MA	30360	6800	49394	4995	54131	4076	56076	3344	57857	2249	69097	1824	43803
3E		MI	18020	6800	29949	4781	31963	3885	32487	3157	32601	2053	37997	1542	25201
8-#18	2.48	MA	28754	6800	46591	5032	50560	4065	51735	3329	52270	2272	62746	1602	42875
4L-2S		MI	19268	6800	31829	4800	34336	3863	35323	3135	36364	2031	42862	1764	25125
10-#11	1.21	MA	29501	6232	45716	4691	49688	3824	50759	3189	50667	2295	59868	2183	22108
2L-5S		MI	16463	6232	26020	4515	27274	3691	26997	3069	25360	2183	29123	1812	13144
10-#11	1.21	MA	28567	6232	44347	4689	47934	3821	48619	3202	47755	2305	55907	2097	22142
3L-4S		MI	16797	6232	26567	4521	27983	3681	27852	3060	26557	2191	30530	1850	13088
10-#11	1.21	MA	27914	6232	43235	4704	46516	3835	46896	3198	45537	2316	53323	2011	22149
4L-3S		MI	17169	6232	27196	4510	28784	3689	28810	3069	27748	2183	31850	1934	13030
10-#11	1.21	MA	27332	6232	42275	4702	45270	3832	45365	3211	43319	2309	50639	1968	22090
5L-2S		MI	17684	6232	27957	4516	29760	3680	29986	3060	29308	2174	33891	2020	12978
10-#14	1.75	MA	30877	6471	48746	4826	53481	3919	55351	3244	56900	2268	68171	2134	31462
2L-5S		MI	16663	6471	26865	4639	28276	3780	28151	3113	26887	2136	31244	1629	18199
10-#14	1.75	MA	29554	6471	46786	4822	50969	3914	52286	3262	52729	2283	62531	2009	31463
3L-4S		MI	17138	6471	27647	4648	29288	3768	29359	3100	28580	2148	33225	1684	18354
10-#14	1.75	MA	28628	6471	45191	4844	48936	3934	49815	3255	49549	2297	58856	1885	31356
4L-3S		MI	17664	6471	28544	4632	30431	3780	30714	3113	30264	2136	35087	1803	18300
10-#14	1.75	MA	27801	6471	43813	4841	47148	3929	47618	3273	46367	2286	55027	1824	30830
5L-2S		MI	18391	6471	29629	4642	31821	3768	32376	3100	32469	2123	37961	1927	18235
10-#18	3.11	MA	31940	7076	52829	5168	58536	4201	61449	3419	65168	2227	78867	1775	54411
3L-4S		MI	17940	7076	30267	4979	32384	3984	33010	3201	33491	2031	39698	1246	30137
10-#18	3.11	MA	30352	7076	50027	5205	54964	4190	57108	3405	59581	2250	72516	1554	52950
4L-3S		MI	18840	7076	31829	4954	34336	4006	35323	3223	36364	2009	42862	1450	31054
10-#18	3.11	MA	28934	7076	47602	5197	51820	4223	53245	3434	53987	2228	65858	1449	49756
5L-2S		MI	20079	7076	33709	4973	36709	3984	38159	3201	40127	1987	47728	1671	31045
12-#11	1.45	MA	30150	6340	47084	4758	51443	3872	52899	3219	53578	2286	63829	2168	26404
2L-6S		MI	16491	6340	26267	4577	27541	3731	27360	3106	25838	2177	29854	1725	15439
12-#11	1.45	MA	29221	6340	45716	4756	49688	3869	50759	3232	50667	2297	59868	2082	26426
3L-5S		MI	16810	6340	26782	4583	28251	3739	28173	3097	26920	2169	31163	1782	15545
12-#11	1.45	MA	28571	6340	44604	4771	48271	3883	49036	3227	48449	2307	57284	1995	26407
4E		MI	17144	6340	27328	4589	28959	3730	29028	3088	28117	2177	32570	1820	15504
12-#11	1.45	MA	27991	6340	43643	4769	47025	3880	47505	3240	46230	2301	54600	1953	26323
5L-3S		MI	17514	6340	27957	4577	29760	3738	29986	3097	29308	2169	33891	1904	15456

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

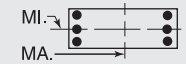
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.45	MA	27440	6340	42743	4768	45777	3894	45980	3236	44221	2311	52037	1897	25853
6L-2S		MI	18027	6340	28719	4583	30736	3728	31162	3088	30868	2160	35932	1990	15408
12-#14	2.10	MA	31790	6627	50706	4923	55994	3989	58417	3287	61070	2256	73811	2110	37597
2L-6S		MI	16701	6627	27215	4727	28652	3838	28663	3165	27563	2126	32275	1500	20919
12-#14	2.10	MA	30474	6627	48746	4920	53481	3984	55351	3305	56900	2270	68171	1985	37558
3L-5S		MI	17152	6627	27950	4736	29666	3850	29813	3152	29092	2114	34118	1583	21404
12-#14	2.10	MA	29554	6627	47151	4941	51448	4004	52881	3298	53720	2284	64496	1861	37411
4E		MI	17624	6627	28731	4745	30678	3838	31021	3140	30785	2126	36099	1638	21752
12-#14	2.10	MA	28733	6627	45773	4938	49661	3999	50684	3316	50538	2274	60667	1800	36675
5L-3S		MI	18147	6627	29629	4730	31821	3850	32376	3152	32469	2114	37961	1757	21722
12-#14	2.10	MA	27953	6627	44481	4935	47871	4018	48496	3309	47655	2288	57021	1720	35449
6L-2S		MI	18871	6627	30714	4739	33212	3838	34038	3140	34674	2101	40835	1881	21670
12-#18	3.73	MA	31930	7353	53463	5378	59369	4314	62481	3480	66892	2228	82286	1505	63077
4E		MI	18759	7353	32147	5152	34756	4105	35847	3266	37254	1987	44564	1153	35587
12-#18	3.73	MA	30528	7353	51038	5370	56225	4347	58618	3510	61297	2206	75628	1401	60054
5L-3S		MI	19653	7353	33709	5127	36709	4127	38159	3289	40127	1965	47728	1357	36875
12-#18	3.73	MA	29194	7353	48764	5363	53076	4336	54770	3495	56226	2229	69319	1257	56775
6L-2S		MI	20884	7353	35588	5146	39082	4105	40995	3266	43890	1943	52593	1579	36945
14-#11	1.70	MA	30795	6448	48453	4826	53197	3921	55040	3248	56490	2278	67789	2152	30692
2L-7S		MI	16528	6448	26466	4656	27838	3789	27678	3125	26340	2172	30659	1631	17481
14-#11	1.70	MA	29870	6448	47084	4824	51443	3917	52899	3261	53578	2288	63829	2066	30698
3L-6S		MI	16838	6448	27029	4644	28517	3780	28536	3134	27398	2163	31894	1695	17700
14-#11	1.70	MA	29223	6448	45972	4839	50025	3931	51176	3257	51361	2299	61245	1980	30658
4L-5S		MI	17156	6448	27543	4650	29227	3787	29349	3125	28480	2155	33204	1752	17935
14-#11	1.70	MA	28646	6448	45012	4837	48779	3928	49645	3270	49142	2292	58561	1937	30552
5L-4S		MI	17488	6448	28090	4656	29936	3778	30204	3117	29676	2163	34611	1790	17908
14-#11	1.70	MA	28098	6448	44112	4835	47532	3942	48120	3265	47133	2303	55998	1881	29978
6L-3S		MI	17857	6448	28719	4645	30736	3786	31162	3125	30868	2155	35932	1874	17869
14-#11	1.70	MA	27563	6448	43125	4850	46342	3939	46658	3278	45170	2313	53266	1792	29384
7L-2S		MI	18368	6448	29480	4651	31713	3777	32338	3117	32427	2146	37972	1960	17826
14-#14	2.45	MA	31387	6782	50706	5017	55994	4054	58417	3347	61070	2258	73811	1961	43643
3L-6S		MI	17188	6782	28300	4824	30042	3908	30326	3204	29768	2105	35149	1454	24177
14-#14	2.45	MA	30473	6782	49111	5038	53961	4073	55946	3340	57891	2272	70136	1837	43461
4L-5S		MI	17637	6782	29035	4833	31057	3920	31476	3192	31297	2092	36992	1537	24626
14-#14	2.45	MA	29658	6782	47733	5035	52174	4068	53749	3358	54708	2262	66307	1776	42539
5L-4S		MI	18107	6782	29816	4842	32069	3907	32684	3179	32990	2105	38973	1592	25128
14-#14	2.45	MA	28883	6782	46441	5032	50384	4088	51562	3351	51826	2276	62660	1696	41369
6L-3S		MI	18628	6782	30714	4827	33212	3920	34038	3192	34674	2092	40835	1710	25129
14-#14	2.45	MA	28127	6782	45026	5053	48677	4083	49463	3369	49009	2290	58771	1566	40219
7L-2S		MI	19349	6782	31798	4836	34603	3907	35701	3179	36879	2080	43709	1835	25091
14-#18	4.35	MA	32102	7629	54474	5543	60629	4471	63991	3585	68608	2184	85398	1353	70377
5L-4S		MI	19572	7629	34026	5325	37129	4226	38683	3332	41017	1944	49429	1061	41075
14-#18	4.35	MA	30783	7629	52200	5536	57481	4460	60143	3571	63537	2206	79089	1209	66921
6L-3S		MI	20460	7629	35588	5300	39082	4248	40995	3354	43890	1921	52593	1265	42676
14-#18	4.35	MA	29499	7629	49709	5573	54476	4493	56450	3600	58582	2229	72353	978	63580
7L-2S		MI	21682	7629	37468	5319	41455	4226	43832	3332	47653	1899	57459	1486	42800
16-#11	1.94	MA	30515	6556	48453	4891	53197	3966	55040	3290	56490	2280	67789	2051	34961
3L-7S		MI	16875	6556	27228	4723	28814	3837	28854	3153	27900	2158	32700	1601	19792
16-#11	1.94	MA	29871	6556	47341	4906	51779	3980	53317	3286	54273	2290	65206	1964	34903
4L-6S		MI	17184	6556	27791	4712	29493	3828	29712	3162	28957	2149	33935	1665	19997
16-#11	1.94	MA	29298	6556	46380	4904	50533	3977	51785	3299	52054	2283	62521	1922	34778
5E		MI	17500	6556	28305	4718	30204	3836	30525	3153	30039	2141	35245	1722	20317
16-#11	1.94	MA	28752	6556	45480	4902	49286	3991	50261	3295	50045	2294	59959	1866	34112
6L-4S		MI	17831	6556	28852	4724	30912	3827	31380	3145	31236	2149	36652	1760	20303

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.94	MA	28220	6556	44494	4918	48097	3988	48798	3307	48082	2304	57227	1776	33541
7L-3S		MI	18198	6556	29480	4712	31713	3834	32338	3153	32427	2141	37972	1844	20273
16-#11	1.94	MA	27697	6556	43608	4916	46890	4002	47370	3320	45996	2298	54717	1726	32922
8L-2S		MI	18708	6556	30242	4718	32689	3825	33514	3145	33987	2132	40013	1930	20236
16-#14	2.80	MA	31385	6938	51071	5136	56474	4143	59011	3383	62061	2260	75776	1813	49506
4L-6S		MI	17673	6938	29385	4921	31433	3977	31988	3243	31972	2083	38023	1408	27442
16-#14	2.80	MA	30576	6938	49693	5132	54686	4138	56814	3401	58879	2249	71947	1752	48420
5E		MI	18120	6938	30119	4930	32448	3990	33138	3231	33502	2070	39866	1491	27860
16-#14	2.80	MA	29805	6938	48401	5129	52897	4158	54627	3394	55996	2263	68300	1672	47299
6L-4S		MI	18587	6938	30901	4940	33459	3977	34346	3219	35195	2083	41847	1546	28494
16-#14	2.80	MA	29055	6938	46986	5151	51190	4153	52528	3412	53180	2278	64411	1542	46053
7L-3S		MI	19106	6938	31798	4924	34603	3990	35701	3231	36879	2070	43709	1664	28527
16-#14	2.80	MA	28317	6938	45715	5147	49458	4173	50479	3430	50186	2267	60830	1471	44578
8L-2S		MI	19823	6938	32883	4933	35993	3977	37363	3219	39083	2058	46583	1789	28502
16-#18	4.97	MA	32354	7906	55636	5709	61885	4584	65517	3646	70848	2184	88858	1160	77095
6L-4S		MI	20379	7906	35906	5497	39502	4346	41519	3398	44779	1900	54295	968	46593
16-#18	4.97	MA	31083	7906	53145	5746	58881	4618	61823	3676	65893	2207	82123	929	73644
7L-3S		MI	21261	7906	37468	5473	41455	4368	43832	3420	47653	1878	57459	1172	48462
16-#18	4.97	MA	29832	7906	50907	5738	55833	4607	58217	3705	60627	2185	75899	806	69448
8L-2S		MI	22476	7906	39348	5492	43827	4346	46668	3398	51416	1855	62324	1394	48636
18-#11	2.18	MA	30516	6664	48709	4974	53534	4028	55457	3315	57185	2281	69167	1949	39144
4L-7S		MI	17220	6664	27990	4791	29791	3886	30030	3181	29460	2144	34741	1571	22105
18-#11	2.18	MA	29945	6664	47749	4972	52288	4025	53925	3328	54966	2275	66482	1906	39001
5L-6S		MI	17527	6664	28552	4779	30470	3876	30888	3190	30517	2135	35976	1635	22298
18-#11	2.18	MA	29402	6664	46849	4970	51041	4039	52401	3324	52957	2285	63920	1851	38253
6L-5S		MI	17843	6664	29066	4785	31180	3884	31702	3181	31599	2127	37286	1693	22662
18-#11	2.18	MA	28873	6664	45862	4985	49851	4036	50938	3337	50994	2296	61188	1761	37702
7L-4S		MI	18173	6664	29613	4791	31888	3875	32556	3173	32796	2135	38693	1730	22691
18-#11	2.18	MA	28352	6664	44977	4983	48644	4050	49510	3350	48908	2289	58677	1711	37021
8L-3S		MI	18538	6664	30242	4780	32689	3883	33514	3181	33987	2127	40013	1814	22670
18-#11	2.18	MA	27797	6664	44110	4981	47471	4047	48017	3345	46963	2300	56193	1657	36172
9L-2S		MI	19047	6664	31004	4786	33666	3874	34690	3173	35547	2118	42054	1900	22639
18-#14	3.14	MA	31486	7093	51653	5230	57199	4208	59880	3443	63050	2237	77587	1728	54314
5L-6S		MI	18155	7093	30469	5018	32823	4047	33650	3283	34177	2061	40897	1362	30712
18-#14	3.14	MA	30721	7093	50361	5226	55409	4228	57692	3436	60167	2251	73940	1648	53237
6L-5S		MI	18599	7093	31204	5028	33838	4060	34800	3270	35707	2049	42740	1444	31104
18-#14	3.14	MA	29976	7093	48946	5248	53702	4223	55593	3454	57350	2265	70051	1518	51899
7L-4S		MI	19065	7093	31986	5037	34850	4047	36009	3258	37399	2061	44721	1500	31850
18-#14	3.14	MA	29243	7093	47675	5245	51971	4243	53544	3472	54357	2255	66470	1447	50468
8L-3S		MI	19581	7093	32883	5021	35993	4060	37363	3270	39083	2049	46583	1618	31906
18-#14	3.14	MA	28486	7093	46431	5241	50286	4237	51402	3465	51566	2269	62934	1370	48681
9L-2S		MI	20296	7093	33968	5031	37384	4047	39026	3258	41288	2036	49457	1743	31905
18-#18	5.59	MA	32651	8183	56581	5918	63285	4742	67196	3751	73203	2185	91893	881	83731
7L-4S		MI	21181	8183	37786	5670	41875	4467	44355	3464	48542	1856	59160	876	52135
18-#18	5.59	MA	31412	8183	54343	5911	60238	4731	63590	3781	67938	2163	85669	758	79638
8L-3S		MI	22057	8183	39348	5645	43827	4489	46668	3486	51416	1834	62324	1080	54236
20-#11	2.42	MA	30589	6772	49117	5039	54042	4074	56066	3358	57878	2266	70443	1891	43221
5L-7S		MI	17563	6772	28751	4858	30767	3934	31206	3209	31019	2130	36782	1541	24420
20-#11	2.42	MA	30048	6772	48217	5037	52795	4088	54541	3353	55869	2277	67881	1835	42401
6E		MI	17870	6772	29314	4847	31446	3925	32064	3218	32077	2121	38017	1605	24604
20-#11	2.42	MA	29522	6772	47231	5053	51605	4085	53078	3366	53906	2287	65149	1745	41867
7L-5S		MI	18184	6772	29828	4853	32156	3933	32878	3209	33159	2113	39327	1663	24945
20-#11	2.42	MA	29004	6772	46345	5051	50399	4099	51651	3379	51820	2280	62638	1696	41127
8L-4S		MI	18513	6772	30375	4858	32865	3923	33732	3201	34355	2121	40734	1700	25074
20-#11	2.42	MA	28452	6772	45479	5049	49225	4095	50157	3375	49875	2291	60154	1642	40300
9L-3S		MI	18877	6772	31004	4847	33666	3931	34690	3209	35547	2113	42054	1784	25061
20-#11	2.42	MA	27878	6772	44509	5064	48035	4110	48737	3388	47947	2302	57745	1581	39361
10L-2S		MI	19384	6772	31765	4853	34642	3922	35867	3201	37106	2104	44095	1871	25037

RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

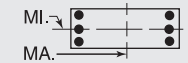
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	3.49	MA	31630	7249	52322	5324	57922	4298	60758	3479	64337	2239	79580	1624	59183
6E		MI	18634	7249	31554	5116	34214	4117	35313	3322	36382	2039	43771	1315	33985
20-#14	3.49	MA	30890	7249	50906	5345	56215	4293	58659	3497	61521	2253	75691	1494	57755
7L-5S		MI	19077	7249	32289	5125	35229	4129	36463	3310	37912	2027	45613	1398	34356
20-#14	3.49	MA	30161	7249	49635	5342	54483	4312	56610	3515	58528	2242	72110	1423	56366
8L-4S		MI	19540	7249	33070	5134	36241	4117	37671	3297	39604	2039	47595	1453	35176
20-#14	3.49	MA	29406	7249	48391	5339	52799	4307	54467	3508	55737	2257	68574	1346	54522
9L-3S		MI	20054	7249	33968	5119	37384	4129	39026	3310	41288	2027	49457	1572	35276
20-#14	3.49	MA	28585	7249	46998	5360	51091	4327	52429	3526	52970	2271	65148	1258	52615
10L-2S		MI	20765	7249	35053	5128	38774	4117	40688	3297	43493	2015	52331	1697	35303
20-#18	6.21	MA	32977	8459	57778	6084	64642	4855	68964	3856	75248	2141	95439	710	89685
8L-4S		MI	21978	8459	39665	5843	44248	4588	47191	3530	52305	1812	64026	783	57696
22-#11	2.66	MA	30691	6880	49586	5105	54549	4136	56681	3383	58781	2268	71841	1820	46554
6L-7S		MI	17905	6880	29513	4925	31744	3982	32382	3237	32579	2116	38823	1511	26736
22-#11	2.66	MA	30167	6880	48599	5120	53360	4133	55218	3396	56818	2279	69110	1730	46035
7L-6S		MI	18210	6880	30076	4914	32422	3973	33240	3246	33636	2107	40057	1575	26912
22-#11	2.66	MA	29652	6880	47714	5118	52153	4147	53791	3409	54732	2272	66599	1680	45239
8L-5S		MI	18523	6880	30590	4920	33133	3981	34054	3237	34718	2099	41367	1633	27234
22-#11	2.66	MA	29103	6880	46847	5116	50980	4144	52298	3404	52787	2282	64114	1626	44433
9L-4S		MI	18851	6880	31137	4926	33841	3972	34909	3229	35915	2107	42774	1671	27444
22-#11	2.66	MA	28532	6880	45877	5131	49789	4158	50878	3417	50859	2293	61706	1566	43455
10L-3S		MI	19214	6880	31765	4915	34642	3980	35867	3237	37106	2099	44095	1754	27448
22-#11	2.66	MA	27975	6880	45009	5129	48622	4155	49404	3413	48802	2286	59258	1513	42490
11L-2S		MI	19719	6880	32527	4920	35618	3970	37043	3229	38666	2090	46136	1841	27430
22-#14	3.84	MA	31798	7405	52866	5442	58728	4362	61724	3539	65692	2241	81331	1470	63622
7L-6S		MI	19111	7405	32639	5213	35605	4187	36975	3361	38587	2018	46645	1269	37221
22-#14	3.84	MA	31074	7405	51595	5439	56996	4382	59675	3557	62698	2230	77750	1399	62271
8L-5S		MI	19552	7405	33374	5222	36619	4199	38125	3349	40117	2005	48487	1352	37614
22-#14	3.84	MA	30320	7405	50351	5436	55312	4377	57532	3550	59907	2244	74214	1322	60372
9L-4S		MI	20013	7405	34155	5231	37631	4187	39333	3337	41809	2018	50468	1407	38386
22-#14	3.84	MA	29507	7405	48958	5458	53603	4397	55494	3568	57140	2259	70788	1234	58425
10L-3S		MI	20524	7405	35053	5216	38774	4199	40688	3349	43493	2005	52331	1526	38640
24-#11	2.91	MA	30809	6988	49968	5187	55114	4181	57359	3425	59730	2270	73070	1714	50206
7E		MI	18245	6988	30275	4993	32720	4031	33559	3266	34139	2102	40863	1481	29035
24-#11	2.91	MA	30296	6988	49082	5185	53907	4195	55931	3438	57644	2263	70560	1665	49356
8L-6S		MI	18550	6988	30837	4982	33399	4022	34416	3274	35196	2093	42098	1545	29223
24-#11	2.91	MA	29750	6988	48216	5183	52734	4192	54438	3434	55699	2274	68075	1611	48571
9L-5S		MI	18862	6988	31351	4987	34109	4030	35230	3266	36278	2085	43408	1603	29527
24-#11	2.91	MA	29182	6988	47246	5199	51544	4206	53018	3447	53771	2284	65667	1550	47554
10L-4S		MI	19188	6988	31898	4993	34817	4020	36085	3257	37475	2093	44815	1641	29811
24-#11	2.91	MA	28627	6988	46377	5197	50376	4203	51544	3442	51714	2278	63219	1497	46609
11L-3S		MI	19550	6988	32527	4982	35618	4028	37043	3266	38666	2085	46136	1724	29831
24-#11	2.91	MA	28082	6988	45425	5212	49194	4217	50126	3455	49787	2288	60460	1421	45304
12L-2S		MI	20054	6988	33289	4988	36595	4019	38219	3257	40226	2076	48176	1811	29819
24-#14	4.19	MA	31980	7560	53555	5536	59509	4452	62740	3599	66869	2218	83390	1376	68183
8L-6S		MI	19586	7560	33724	5310	36995	4257	38638	3401	40792	1996	49519	1223	40392
24-#14	4.19	MA	31227	7560	52311	5533	57824	4447	60598	3592	64078	2232	79854	1298	66229
9L-5S		MI	20024	7560	34458	5319	38010	4269	39787	3388	42321	1984	51361	1306	40878
24-#14	4.19	MA	30423	7560	50919	5555	56116	4467	58560	3610	61311	2246	76428	1210	64244
10L-4S		MI	20483	7560	35240	5329	39022	4257	40996	3376	44014	1996	53342	1361	41606

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

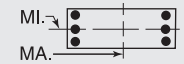


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.19	MA	31977	6494	49706	4858	53806	3960	54828	3304	54535	2379	64051	2252	23506
2E		MI	18317	6494	29127	4633	30670	3769	30693	3128	29765	2215	34149	2041	13189
6-#14	1.00	MA	31510	6407	48512	4832	52464	3945	53264	3300	52437	2401	61453	2290	20062
2L-3S		MI	17381	6407	27427	4618	28731	3789	28435	3160	26787	2276	30365	1989	11420
6-#14	1.00	MA	30101	6407	46454	4829	49827	3940	50046	3319	48059	2416	55504	2165	20126
3L-2S		MI	18115	6407	28512	4628	30121	3777	30098	3148	28992	2263	33239	2113	11336
6-#18	1.79	MA	33668	6770	53315	5031	58432	4084	60472	3379	62214	2357	74370	2206	34840
2L-3S		MI	17886	6770	29127	4787	30670	3912	30693	3216	29765	2193	34149	1727	19354
6-#18	1.79	MA	31235	6770	49706	5024	53806	4119	54828	3410	54535	2381	64051	1985	34793
3L-2S		MI	19145	6770	31006	4806	33043	3889	33529	3194	33528	2171	39014	1949	19219
8-#14	1.34	MA	32489	6563	50569	4929	55101	4015	56481	3342	56815	2389	67402	2267	26531
2L-4S		MI	17342	6563	27614	4731	28978	3847	28743	3187	27308	2267	31377	1824	14983
8-#14	1.34	MA	31089	6563	48512	4927	52464	4010	53264	3361	52437	2404	61453	2143	26569
3E		MI	17871	6563	28512	4716	30121	3859	30098	3200	28992	2254	33239	1943	14900
8-#14	1.34	MA	30110	6563	46840	4948	50333	4030	50673	3355	49103	2419	57574	2018	26506
4L-2S		MI	18602	6563	29596	4725	31512	3847	31760	3187	31196	2242	36113	2067	14821
8-#18	2.38	MA	35335	7047	56924	5204	63058	4209	66115	3455	69892	2335	84688	2160	46126
2L-4S		MI	17806	7047	29444	4984	31091	4010	31217	3260	30655	2171	35850	1431	24991
8-#18	2.38	MA	32926	7047	53315	5197	58432	4243	60472	3485	62214	2359	74370	1939	45963
3E		MI	18715	7047	31006	4960	33043	4032	33529	3282	33528	2149	39014	1635	25270
8-#18	2.38	MA	31239	7047	50375	5235	54685	4233	55917	3472	56353	2383	67655	1717	45292
4L-2S		MI	19964	7047	32886	4979	35416	4010	36366	3260	37291	2127	43880	1856	25184
10-#11	1.16	MA	32006	6480	49443	4892	53754	3989	54874	3330	54644	2403	64578	2292	23161
2L-5S		MI	17156	6480	27070	4697	28356	3840	28045	3196	26296	2280	30153	1907	13184
10-#11	1.16	MA	31025	6480	48007	4890	51913	3986	52628	3343	51589	2414	60403	2206	23195
3L-4S		MI	17491	6480	27617	4703	29064	3831	28900	3187	27492	2289	31559	1944	13125
10-#11	1.16	MA	30340	6480	46841	4906	50427	4001	50822	3339	49264	2425	57677	2120	23202
4L-3S		MI	17862	6480	28246	4692	29865	3839	29858	3196	28684	2280	32880	2028	13065
10-#11	1.16	MA	29729	6480	45835	4904	49121	3998	49217	3352	46939	2419	54852	2077	23143
5L-2S		MI	18378	6480	29007	4698	30842	3829	31034	3187	30243	2272	34921	2114	13013
10-#14	1.67	MA	33460	6719	52626	5027	57739	4085	59698	3385	61192	2376	73351	2245	32981
2L-5S		MI	17356	6719	27918	4819	29357	3929	29197	3239	27820	2233	32269	1723	18350
10-#14	1.67	MA	32068	6719	50569	5024	55101	4080	56481	3403	56815	2391	67402	2120	32982
3L-4S		MI	17831	6719	28699	4829	30369	3916	30405	3227	29512	2245	34251	1778	18407
10-#14	1.67	MA	31096	6719	48897	5046	52970	4100	53890	3397	53480	2406	63522	1996	32875
4L-3S		MI	18358	6719	29596	4813	31512	3929	31760	3239	31196	2233	36113	1896	18347
10-#14	1.67	MA	30228	6719	47452	5043	51096	4096	51588	3416	50144	2396	59490	1935	32474
5L-2S		MI	19086	6719	30681	4822	32903	3916	33422	3227	33401	2220	38987	2021	18279
10-#18	2.98	MA	34595	7324	56924	5370	63058	4367	66115	3561	69892	2337	84688	1893	57111
3L-4S		MI	18634	7324	31324	5157	33464	4131	34053	3325	34418	2127	40716	1338	30388
10-#18	2.98	MA	32926	7324	53983	5407	59311	4357	61561	3547	64031	2361	77973	1672	55912
4L-3S		MI	19536	7324	32886	5132	35416	4153	36366	3347	37291	2105	43880	1542	31138
10-#18	2.98	MA	31437	7324	51441	5401	56014	4391	57509	3578	58163	2340	70954	1566	52422
5L-2S		MI	20776	7324	34766	5152	37789	4131	39202	3325	41054	2083	48745	1764	31111
12-#11	1.39	MA	32691	6588	50879	4959	55595	4038	57120	3359	57699	2394	68754	2278	27668
2L-6S		MI	17184	6588	27317	4759	28622	3881	28408	3233	26773	2275	30883	1819	15545
12-#11	1.39	MA	31713	6588	49443	4958	53754	4035	54874	3372	54644	2405	64578	2191	27690
3L-5S		MI	17503	6588	27832	4765	29332	3888	29221	3224	27855	2266	32193	1877	15591
12-#11	1.39	MA	31032	6588	48277	4973	52268	4049	53068	3368	52320	2416	61853	2105	27671
4E		MI	17837	6588	28378	4770	30041	3879	30076	3215	29052	2275	33600	1914	15545
12-#11	1.39	MA	30424	6588	47271	4971	50962	4046	51463	3382	49994	2410	59027	2062	27587
5L-3S		MI	18208	6588	29007	4759	30842	3887	31034	3224	30243	2266	34921	1998	15494
12-#11	1.39	MA	29845	6588	46328	4970	49655	4061	49866	3378	47889	2421	56325	2006	27176
6L-2S		MI	18721	6588	29769	4765	31818	3878	32210	3215	31803	2258	36962	2085	15445
12-#14	2.01	MA	34423	6874	54684	5124	60376	4154	62916	3427	65570	2364	79300	2222	39419
2L-6S		MI	17393	6874	28267	4907	29733	3986	29710	3291	28495	2223	33301	1594	21057

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

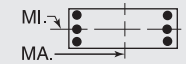
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#14	2.01	MA	33039	6874	52626	5121	57739	4150	59698	3446	61192	2379	73351	2098	39380
3L-5S		MI	17845	6874	29002	4917	30748	3999	30859	3279	30025	2211	35143	1676	21554
12-#14	2.01	MA	32073	6874	50954	5143	55607	4170	57108	3439	57858	2394	69471	1973	39234
4E		MI	18318	6874	29784	4926	31760	3986	32068	3266	31717	2223	37124	1732	21811
12-#14	2.01	MA	31212	6874	49510	5140	53734	4165	54805	3458	54522	2384	65438	1912	38612
5L-3S		MI	18842	6874	30681	4910	32903	3999	33422	3279	33401	2211	38987	1850	21773
12-#14	2.01	MA	30392	6874	48156	5137	51858	4186	52512	3452	51500	2399	61590	1832	37275
6L-2S		MI	19567	6874	31766	4919	34293	3986	35085	3266	35606	2198	41861	1975	21717
12-#18	3.57	MA	34592	7600	57592	5580	63937	4481	67205	3623	71710	2338	88292	1626	66557
4E		MI	19454	7600	33204	5330	35837	4252	36889	3391	38180	2083	45581	1246	35835
12-#18	3.57	MA	33119	7600	55050	5574	60640	4515	63153	3653	65842	2318	81272	1520	63246
5L-3S		MI	20350	7600	34766	5305	37789	4274	39202	3413	41054	2061	48745	1450	36968
12-#18	3.57	MA	31719	7600	52666	5567	57339	4505	59118	3640	60524	2342	74605	1377	60023
6L-2S		MI	21582	7600	36645	5325	40162	4252	42038	3391	44816	2039	53611	1671	37010
14-#11	1.63	MA	33371	6696	52315	5027	57436	4086	59365	3389	60755	2386	72929	2263	32166
2L-7S		MI	17221	6696	27516	4837	28920	3938	28726	3252	27276	2269	31689	1725	17583
14-#11	1.63	MA	32398	6696	50879	5025	55595	4083	57120	3402	57699	2397	68754	2177	32172
3L-6S		MI	17531	6696	28079	4826	29599	3929	29584	3261	28333	2261	32924	1789	17807
14-#11	1.63	MA	31719	6696	49713	5040	54109	4098	55313	3398	55375	2408	66028	2090	32132
4L-5S		MI	17849	6696	28593	4832	30309	3937	30397	3252	29415	2252	34234	1847	17985
14-#11	1.63	MA	31114	6696	48707	5039	52803	4095	53709	3411	53050	2401	63202	2048	32027
5L-4S		MI	18182	6696	29140	4838	31017	3928	31252	3244	30612	2261	35641	1885	17953
14-#11	1.63	MA	30539	6696	47764	5037	51496	4109	52111	3407	50944	2412	60500	1992	31506
6L-3S		MI	18551	6696	29769	4826	31818	3935	32210	3252	31803	2252	36962	1968	17910
14-#11	1.63	MA	29979	6696	46731	5053	50250	4106	50579	3420	48888	2423	57620	1902	30860
7L-2S		MI	19063	6696	30530	4832	32795	3926	33386	3244	33363	2244	39002	2055	17866
14-#14	2.34	MA	34002	7030	54684	5218	60376	4220	62916	3488	65570	2366	79300	2075	45769
3L-6S		MI	17881	7030	29352	5004	31123	4056	31372	3330	30700	2202	36175	1548	24316
14-#14	2.34	MA	33042	7030	53011	5240	58245	4240	60325	3482	62236	2381	75420	1951	45587
4L-5S		MI	18331	7030	30087	5014	32138	4069	32522	3318	32230	2189	38017	1630	24775
14-#14	2.34	MA	32187	7030	51567	5237	56371	4235	58022	3500	58899	2372	71387	1890	44770
5L-4S		MI	18802	7030	30868	5023	33150	4056	33730	3305	33922	2202	39998	1685	25197
14-#14	2.34	MA	31373	7030	50214	5234	54496	4255	55730	3494	55878	2387	67539	1809	43492
6L-3S		MI	19323	7030	31766	5007	34293	4068	35085	3318	35606	2189	41861	1804	25185
14-#14	2.34	MA	30581	7030	48731	5256	52707	4251	53530	3512	52926	2402	63436	1679	42423
7L-2S		MI	20045	7030	32851	5017	35684	4056	36747	3305	37811	2177	44735	1929	25142
14-#18	4.17	MA	34782	7877	58658	5747	65266	4639	68797	3729	73520	2296	91591	1475	74097
5L-4S		MI	20268	7877	35083	5503	38210	4373	39725	3457	41943	2039	50447	1153	41321
14-#18	4.17	MA	33396	7877	56275	5740	61965	4629	64762	3715	68203	2320	84923	1331	70694
6L-3S		MI	21158	7877	36645	5478	40162	4395	42038	3479	44816	2017	53611	1358	42776
14-#18	4.17	MA	32047	7877	53664	5777	58815	4663	60889	3746	63007	2344	77809	1100	67385
7L-2S		MI	22383	7877	38525	5498	42535	4373	44874	3457	48579	1995	58476	1579	42881
16-#11	1.86	MA	33078	6804	52315	5092	57436	4132	59365	3431	60755	2388	72929	2162	36645
3L-7S		MI	17568	6804	28278	4905	29896	3987	29902	3280	28835	2255	33730	1695	19895
16-#11	1.86	MA	32403	6804	51149	5108	55949	4146	57559	3427	58430	2399	70203	2076	36588
4L-6S		MI	17877	6804	28841	4893	30575	3977	30760	3289	29892	2247	34965	1759	20104
16-#11	1.86	MA	31801	6804	50142	5106	54644	4143	55954	3441	56105	2393	67377	2033	36463
5E		MI	18194	6804	29355	4899	31285	3985	31574	3280	30974	2238	36275	1817	20372
16-#11	1.86	MA	31229	6804	49200	5104	53337	4157	54357	3437	54000	2404	64675	1977	35845
6L-4S		MI	18526	6804	29902	4905	31994	3976	32428	3272	32171	2247	37682	1855	20351
16-#11	1.86	MA	30671	6804	48166	5120	52091	4155	52824	3450	51943	2415	61795	1887	35223
7L-3S		MI	18893	6804	30530	4894	32795	3984	33386	3280	33363	2238	39002	1938	20317
16-#11	1.86	MA	30122	6804	47239	5118	50827	4169	51329	3463	49757	2408	59152	1837	34669
8L-2S		MI	19404	6804	31292	4900	33771	3975	34562	3272	34922	2230	41043	2025	20279

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

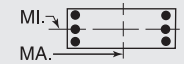


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#14	2.68	MA	34005	7185	55069	5338	60882	4310	63543	3524	66613	2369	81369	1928	51936
4L-6S		MI	18366	7185	30437	5102	32514	4126	33034	3370	32905	2180	39049	1501	27582
16-#14	2.68	MA	33155	7185	53624	5335	59009	4305	61240	3543	63277	2359	77336	1867	50945
5E		MI	18814	7185	31172	5111	33529	4138	34184	3357	34434	2167	40891	1584	28009
16-#14	2.68	MA	32347	7185	52271	5332	57133	4325	58947	3536	60256	2374	73488	1787	49720
6L-4S		MI	19282	7185	31953	5120	34541	4126	35392	3345	36127	2180	42872	1639	28567
16-#14	2.68	MA	31560	7185	50788	5354	55344	4321	56747	3555	57304	2389	69385	1657	48552
7L-3S		MI	19802	7185	32851	5105	35684	4138	36747	3357	37811	2167	44735	1758	28591
16-#14	2.68	MA	30785	7185	49456	5351	53530	4341	54601	3573	54167	2379	65613	1585	46949
8L-2S		MI	20520	7185	33935	5114	37074	4126	38409	3345	40016	2155	47609	1883	28556
16-#18	4.76	MA	35055	8154	59884	5913	66591	4753	70405	3791	75881	2298	95242	1285	81392
6L-4S		MI	21076	8154	36963	5676	40582	4493	42561	3523	45706	1996	55312	1061	46837
16-#18	4.76	MA	33719	8154	57272	5950	63441	4787	66533	3821	70686	2322	88127	1055	77974
7L-3S		MI	21960	8154	38525	5651	42535	4515	44874	3545	48579	1974	58476	1265	48569
16-#18	4.76	MA	32405	8154	54926	5944	60246	4777	62752	3852	65164	2302	81564	930	73633
8L-2S		MI	23178	8154	40405	5671	44908	4493	47710	3523	52342	1951	63342	1486	48723
18-#11	2.09	MA	33082	6911	52585	5175	57790	4194	59805	3457	61486	2390	74378	2061	41040
4L-7S		MI	17913	6911	29040	4972	30873	4035	31078	3308	30395	2241	35771	1665	22210
18-#11	2.09	MA	32483	6911	51578	5174	56485	4192	58200	3470	59161	2384	71552	2018	40896
5L-6S		MI	18221	6911	29602	4961	31551	4026	31936	3317	31452	2233	37006	1730	22406
18-#11	2.09	MA	31914	6911	50636	5172	55178	4206	56603	3466	57055	2395	68850	1963	40192
6L-5S		MI	18537	6911	30116	4967	32262	4034	32750	3308	32534	2224	38316	1787	22747
18-#11	2.09	MA	31359	6911	49602	5187	53932	4203	55070	3479	54999	2406	65970	1873	39591
7L-4S		MI	18867	6911	30663	4973	32970	4024	33604	3300	33731	2233	39723	1825	22742
18-#11	2.09	MA	30813	6911	48675	5186	52668	4217	53574	3492	52813	2400	63327	1823	38972
8L-3S		MI	19234	6911	31292	4961	33771	4032	34562	3308	34922	2224	41043	1908	22717
18-#11	2.09	MA	30222	6911	47767	5184	51438	4215	52010	3488	50775	2411	60707	1769	38050
9L-2S		MI	19743	6911	32054	4967	34747	4023	35739	3300	36482	2216	43084	1995	22684
18-#14	3.01	MA	34115	7341	55682	5432	61646	4375	64457	3585	67655	2347	83285	1845	57134
5L-6S		MI	18849	7341	31522	5199	33905	4196	34697	3409	35110	2158	41923	1455	30853
18-#14	3.01	MA	33312	7341	54328	5429	59770	4395	62165	3579	64633	2362	79437	1764	55956
6L-5S		MI	19294	7341	32257	5208	34919	4208	35847	3397	36639	2146	43765	1538	31254
18-#14	3.01	MA	32531	7341	52845	5451	57981	4390	59965	3597	61681	2377	75334	1634	54693
7L-4S		MI	19761	7341	33038	5218	35931	4196	37055	3384	38332	2158	45746	1593	31929
18-#14	3.01	MA	31761	7341	51513	5448	56167	4411	57818	3616	58544	2367	71562	1563	53137
8L-3S		MI	20278	7341	33935	5202	37074	4208	38409	3397	40016	2146	47609	1712	31973
18-#14	3.01	MA	30935	7341	50210	5445	54402	4406	55573	3609	55620	2382	67831	1485	51380
9L-2S		MI	20994	7341	35020	5211	38465	4196	40072	3384	42221	2133	50483	1837	31962
18-#18	5.36	MA	35374	8430	60881	6123	68067	4912	72176	3897	78364	2300	98446	1009	88586
7L-4S		MI	21879	8430	38843	5849	42955	4614	45398	3589	49469	1952	60178	968	52377
18-#18	5.36	MA	34073	8430	58535	6117	64872	4902	68396	3928	72843	2279	91883	885	84153
8L-3S		MI	22758	8430	40405	5824	44908	4636	47710	3611	52342	1930	63342	1173	54349
20-#11	2.32	MA	33162	7019	53014	5241	58326	4240	60446	3499	62216	2376	75727	2004	45327
5L-7S		MI	18257	7019	29801	5040	31849	4084	32254	3336	31955	2227	37812	1635	24527
20-#11	2.32	MA	32595	7019	52072	5239	57019	4254	58848	3495	60111	2386	73025	1948	44545
6E		MI	18564	7019	30364	5028	32528	4074	33112	3345	33012	2219	39047	1700	24712
20-#11	2.32	MA	32043	7019	51038	5255	55772	4251	57316	3509	58054	2397	70145	1858	43963
7L-5S		MI	18878	7019	30878	5034	33238	4082	33926	3336	34094	2210	40357	1757	25064
20-#11	2.32	MA	31500	7019	50111	5253	54508	4266	55820	3522	55868	2391	67502	1808	43283
8L-4S		MI	19208	7019	31425	5040	33946	4073	34781	3328	35290	2219	41763	1795	25128
20-#11	2.32	MA	30912	7019	49203	5251	53279	4263	54256	3518	53830	2402	64882	1755	42385
9L-3S		MI	19573	7019	32054	5029	34747	4081	35739	3336	36482	2210	43084	1878	25111
20-#11	2.32	MA	30310	7019	48187	5267	52032	4277	52768	3531	51810	2413	62342	1694	41488
10L-2S		MI	20080	7019	32815	5035	35724	4071	36915	3328	38042	2201	45125	1965	25084
20-#14	3.35	MA	34272	7497	56386	5526	62408	4465	65382	3621	69011	2349	85385	1742	62199
6E		MI	19329	7497	32606	5296	35295	4266	36359	3448	37315	2137	44797	1409	34128
20-#14	3.35	MA	33495	7497	54903	5548	60619	4460	63182	3640	66059	2364	81283	1612	60845
7L-5S		MI	19772	7497	33341	5306	36310	4278	37509	3436	38844	2124	46639	1492	34506

RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

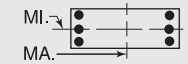
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	3.35	MA	32730	7497	53571	5545	58804	4481	61035	3658	62922	2355	77511	1540	59332
8L-4S		MI	20237	7497	34123	5315	37322	4266	38717	3424	40537	2137	48620	1547	35283
20-#14	3.35	MA	31927	7497	52268	5542	57040	4476	58790	3652	59997	2370	73780	1463	57517
9L-3S		MI	20751	7497	35020	5299	38465	4278	40072	3436	42221	2124	50483	1666	35347
20-#14	3.35	MA	31062	7497	50808	5564	55249	4496	56655	3670	57098	2385	70163	1375	55634
10L-2S		MI	21464	7497	36105	5309	39856	4266	41734	3424	44426	2112	53357	1791	35366
20-#18	5.95	MA	35725	8707	62144	6289	69499	5026	74040	4003	80521	2257	102201	839	94904
8L-4S		MI	22678	8707	40722	6022	45328	4735	48234	3655	53232	1908	65043	876	57936
22-#11	2.55	MA	33273	7127	53508	5307	58860	4303	61094	3525	63166	2378	77200	1934	48904
6L-7S		MI	18599	7127	30563	5107	32825	4132	33431	3364	33514	2213	39852	1605	26844
22-#11	2.55	MA	32724	7127	52474	5322	57613	4300	59561	3538	61109	2389	74320	1844	48339
7L-6S		MI	18905	7127	31126	5096	33504	4123	34288	3373	34571	2205	41087	1670	27022
22-#11	2.55	MA	32183	7127	51547	5321	56349	4314	58066	3551	58923	2383	71677	1794	47600
8L-5S		MI	19218	7127	31640	5102	34214	4131	35102	3364	35653	2196	42397	1727	27353
22-#11	2.55	MA	31598	7127	50639	5319	55120	4311	56501	3547	56886	2394	69057	1740	46725
9L-4S		MI	19547	7127	32187	5108	34923	4121	35957	3356	36850	2205	43804	1765	27505
22-#11	2.55	MA	30999	7127	49623	5334	53873	4326	55014	3560	54866	2405	66517	1679	45787
10L-3S		MI	19911	7127	32815	5096	35724	4129	36915	3364	38042	2196	45125	1849	27500
22-#11	2.55	MA	30414	7127	48714	5333	52650	4323	53469	3557	52711	2398	63939	1626	44742
11L-2S		MI	20416	7127	33577	5102	36700	4120	38091	3356	39601	2187	47166	1935	27479
22-#14	3.68	MA	34452	7652	56960	5645	63256	4530	66400	3682	70437	2352	87231	1589	67007
7L-6S		MI	19806	7652	33691	5394	36686	4336	38022	3488	39519	2115	47671	1363	37407
22-#14	3.68	MA	33692	7652	55628	5643	61442	4550	64253	3701	67299	2342	83460	1518	65535
8L-5S		MI	20248	7652	34426	5403	37701	4348	39171	3475	41049	2102	49513	1446	37764
22-#14	3.68	MA	32890	7652	54325	5640	59677	4546	62008	3694	64375	2357	79728	1440	63664
9L-4S		MI	20710	7652	35207	5412	38713	4335	40380	3463	42741	2115	51494	1501	38562
22-#14	3.68	MA	32035	7652	52866	5662	57887	4566	59872	3713	61475	2372	76112	1353	61742
10L-3S		MI	21223	7652	36105	5396	39856	4348	41734	3475	44426	2102	53357	1620	38714
24-#11	2.79	MA	33400	7235	53910	5390	59454	4348	61807	3567	64165	2380	78496	1829	52718
7E		MI	18940	7235	31324	5175	33802	4180	34607	3392	35074	2199	41893	1575	29163
24-#11	2.79	MA	32862	7235	52983	5388	58190	4363	60311	3581	61979	2374	75852	1779	51923
8L-6S		MI	19245	7235	31887	5163	34480	4171	35464	3401	36131	2191	43128	1640	29333
24-#11	2.79	MA	32281	7235	52075	5386	56961	4360	58747	3577	59941	2385	73232	1726	51069
9L-5S		MI	19557	7235	32401	5169	35191	4179	36278	3392	37213	2182	44438	1697	29647
24-#11	2.79	MA	31684	7235	51059	5402	55714	4374	57259	3590	57921	2396	70692	1665	50092
10L-4S		MI	19884	7235	32948	5175	35899	4170	37133	3384	38410	2191	45845	1735	29874
24-#11	2.79	MA	31102	7235	50150	5400	54491	4371	55715	3586	55766	2390	68114	1612	49067
11L-3S		MI	20247	7235	33577	5164	36700	4178	38091	3392	39601	2182	47166	1819	29885
24-#11	2.79	MA	30530	7235	49152	5416	53253	4386	54230	3599	53747	2401	65207	1535	47780
12L-2S		MI	20751	7235	34339	5170	37676	4168	39267	3384	41161	2173	49206	1905	29870
24-#14	4.02	MA	34648	7808	57685	5740	64079	4620	67470	3743	71677	2330	89409	1495	71744
8L-6S		MI	20282	7808	34776	5491	38076	4405	39684	3527	41724	2093	50545	1317	40633
24-#14	4.02	MA	33847	7808	56382	5737	62314	4616	65225	3737	68752	2345	85677	1418	69818
9L-5S		MI	20721	7808	35511	5500	39091	4418	40834	3515	43254	2081	52387	1400	41028
24-#14	4.02	MA	33001	7808	54923	5759	60524	4636	63089	3755	65853	2360	82061	1330	67856
10L-4S		MI	21182	7808	36292	5509	40103	4405	42042	3502	44946	2093	54368	1455	41782

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

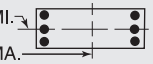
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.04	MA	13086	4302	20511	3143	21822	2565	21963	2142	21306	1541	24583	1445	8460
2L-3S		MI	12523	4302	19682	3138	20759	2575	20670	2151	19592	1550	22330	1358	8515
6-#14	1.50	MA	13556	4445	21611	3217	23174	2616	23547	2167	23400	1512	27296	1392	11904
2L-3S		MI	12761	4445	20429	3209	21658	2630	21717	2179	20973	1524	24116	1268	11974
6-#18	2.67	MA	14683	4808	24300	3414	26479	2752	27399	2230	28497	1435	33843	1249	20325
2L-3S		MI	13325	4808	22248	3397	23857	2774	24266	2252	24341	1457	28437	1028	20313
8-#11	1.39	MA	13464	4410	21340	3210	22885	2613	23255	2171	23020	1528	26836	1417	11102
2L-4S		MI	12503	4410	19829	3217	20952	2616	20911	2171	19997	1546	23128	1246	11190
8-#14	2.00	MA	14086	4600	22793	3314	24689	2686	25377	2208	25826	1492	30475	1350	15645
2L-4S		MI	12729	4600	20636	3323	21932	2689	22057	2208	21546	1517	25239	1104	15659
8-#18	3.56	MA	15572	5085	26353	3587	29101	2875	30532	2299	32652	1395	39249	1165	26765
2L-4S		MI	13260	5085	22600	3596	24323	2875	24845	2299	25323	1439	30336	734	24672
10-#11	1.73	MA	13839	4517	22169	3278	23947	2661	24548	2200	24733	1516	29088	1390	13727
2L-5S		MI	12525	4517	20065	3280	21247	2675	21264	2209	20396	1524	23827	1181	13648
10-#11	1.73	MA	13282	4517	21340	3273	22885	2672	23255	2209	23020	1524	26836	1304	13765
3L-4S		MI	12883	4517	20658	3285	22015	2664	22203	2200	21710	1533	25381	1218	13786
10-#14	2.50	MA	14610	4756	23975	3412	26204	2756	27207	2249	28253	1472	33654	1308	19366
2L-5S		MI	12756	4756	20970	3412	22349	2772	22557	2261	22111	1485	26227	1008	18361
10-#14	2.50	MA	13826	4756	22793	3404	24689	2770	25377	2261	25826	1485	30475	1184	19383
3L-4S		MI	13263	4756	21818	3420	23447	2759	23887	2249	23973	1497	28419	1062	19303
10-#18	4.44	MA	16451	5361	28406	3760	31722	2998	33665	2368	36808	1355	44654	1080	33152
2L-5S		MI	13302	5361	23172	3752	25037	3021	25701	2390	26288	1377	32016	551	28847
10-#18	4.44	MA	15120	5361	26353	3742	29101	3021	30532	2390	32652	1377	39249	859	32939
3L-4S		MI	14163	5361	24653	3769	26945	2998	27978	2368	29479	1399	35742	649	30623

RECTANGULAR TIED COLUMNS 30" x 32"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.67	MA	15603	4796	25033	3456	26896	2807	27387	2317	27409	1597	32054	1459	14920
2E		MI	14579	4796	23457	3434	25098	2787	25466	2296	25410	1579	29612	1434	13893
6-#14	1.41	MA	15351	4710	24333	3433	26122	2794	26579	2321	26351	1633	30755	1515	12816
2L-3S		MI	13557	4710	21633	3404	22900	2790	22921	2316	22048	1629	25300	1369	12021
6-#14	1.41	MA	14488	4710	23053	3425	24482	2808	24581	2334	23703	1645	27270	1390	12885
3L-2S		MI	14354	4710	22815	3412	24415	2777	24751	2303	24475	1617	28479	1494	11946
6-#18	2.50	MA	16590	5073	27258	3629	29749	2931	30817	2388	31958	1561	38002	1381	21945
2L-3S		MI	14121	5073	23457	3590	25098	2933	25466	2387	25410	1561	29612	1128	20407
6-#18	2.50	MA	15114	5073	25033	3614	26896	2955	27387	2410	27409	1583	32054	1160	21933
3L-2S		MI	15482	5073	25510	3607	27720	2911	28599	2365	29565	1539	35018	1350	20388
8-#11	1.30	MA	15248	4675	24035	3426	25804	2790	26223	2323	25924	1649	30231	1538	11944
2L-4S		MI	13299	4675	21030	3413	22195	2777	22116	2308	21074	1651	24316	1347	11236
8-#11	1.30	MA	14641	4675	23139	3421	24655	2801	24821	2332	24056	1657	27766	1452	11992
3E		MI	13700	4675	21713	3401	23064	2784	23169	2317	22384	1642	25771	1433	11189
8-#11	1.30	MA	14209	4675	22402	3434	23716	2795	23681	2324	22629	1666	26174	1365	12032
4L-2S		MI	14261	4675	22542	3406	24127	2774	24461	2308	24097	1634	28024	1519	11139
8-#14	1.88	MA	15930	4866	25612	3530	27762	2863	28576	2364	29000	1615	34240	1476	16860
2L-4S		MI	13524	4866	21840	3518	23173	2849	23261	2344	22621	1622	26423	1206	15739
8-#14	1.88	MA	15073	4866	24333	3523	26122	2878	26579	2376	26351	1627	30755	1351	16906
3E		MI	14093	4866	22815	3501	24415	2860	24751	2357	24475	1609	28479	1327	15746
8-#14	1.88	MA	14460	4866	23280	3540	24781	2868	24952	2364	24328	1640	28505	1228	16874
4L-2S		MI	14884	4866	23997	3510	25931	2847	26581	2344	26901	1597	31659	1452	15693
8-#18	3.33	MA	17563	5350	29484	3802	32602	3056	34248	2460	36508	1524	43950	1303	28925
2L-4S		MI	14056	5350	23810	3789	25564	3034	26045	2434	26391	1543	31511	834	25014
8-#18	3.33	MA	16103	5350	27258	3787	29749	3079	30817	2482	31958	1546	38002	1082	28799
3E		MI	15026	5350	25510	3762	27720	3056	28599	2456	29565	1521	35018	1043	26747
8-#18	3.33	MA	15056	5350	25420	3816	27407	3058	28023	2460	28483	1569	34152	868	26920
4L-2S		MI	16374	5350	27563	3780	30342	3034	31732	2434	33721	1499	40424	1265	26834

RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

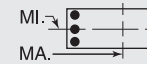
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.63	MA	15657	4783	24932	3493	26953	2839	27625	2353	27792	1637	32696	1513	14780
2L-5S		MI	13320	4783	21266	3476	22489	2836	22469	2346	21474	1630	25016	1283	13814
10-#11	1.63	MA	15054	4783	24035	3489	25804	2850	26223	2362	25924	1646	30231	1427	14818
3L-4S		MI	13679	4783	21859	3481	23257	2826	23409	2337	22788	1638	26569	1320	13839
10-#11	1.63	MA	14623	4783	23299	3501	24866	2843	25083	2354	24497	1654	28639	1340	14839
4L-3S		MI	14079	4783	22542	3469	24127	2833	24461	2346	24097	1630	28024	1406	13810
10-#11	1.63	MA	14237	4783	22660	3497	24038	2854	24066	2363	23065	1646	26942	1303	14792
5L-2S		MI	14637	4783	23371	3474	25190	2823	25753	2337	25811	1621	30277	1492	13769
10-#14	2.34	MA	16503	5021	26891	3627	29402	2933	30574	2406	31649	1597	37725	1437	20885
2L-5S		MI	13551	5021	22174	3607	23590	2933	23761	2397	23186	1590	27411	1109	18569
10-#14	2.34	MA	15652	5021	25612	3620	27762	2948	28576	2418	29000	1609	34240	1312	20902
3L-4S		MI	14059	5021	23022	3615	24689	2919	25091	2385	25047	1602	29603	1163	19393
10-#14	2.34	MA	15044	5021	24559	3637	26421	2938	26950	2406	26976	1622	31990	1189	20822
4L-3S		MI	14623	5021	23997	3599	25931	2930	26581	2397	26901	1590	31659	1285	19449
10-#14	2.34	MA	14497	5021	23645	3630	25236	2953	25498	2418	24945	1609	29587	1135	19915
5L-2S		MI	15410	5021	25179	3607	27446	2916	28411	2385	29328	1577	34838	1409	19419
10-#18	4.17	MA	18526	5626	31709	3975	35455	3180	37679	2531	41058	1488	49898	1226	35852
2L-5S		MI	14095	5626	24381	3945	26278	3179	26901	2525	27356	1481	33191	651	29391
10-#18	4.17	MA	17079	5626	29484	3960	32602	3203	34248	2553	36508	1510	43950	1004	35639
3L-4S		MI	14959	5626	25862	3962	28186	3157	29178	2502	30547	1503	36917	749	30958
10-#18	4.17	MA	16044	5626	27645	3988	30260	3183	31453	2531	33033	1532	40100	790	33381
4L-3S		MI	15921	5626	27563	3935	30342	3179	31732	2525	33721	1481	40424	959	33060
10-#18	4.17	MA	15114	5626	26046	3973	28189	3206	28960	2553	29541	1510	36000	693	31682
5L-2S		MI	17256	5626	29615	3953	32963	3157	34865	2502	37877	1459	45829	1180	33236
12-#11	1.95	MA	16064	4891	25828	3561	28102	2887	29027	2382	29659	1625	35162	1488	17605
2L-6S		MI	13359	4891	21538	3538	22782	2877	22868	2384	21999	1625	25820	1198	15837
12-#11	1.95	MA	15463	4891	24932	3556	26953	2898	27625	2391	27792	1634	32696	1401	17632
3L-5S		MI	13700	4891	22095	3543	23552	2884	23762	2375	23187	1617	27269	1255	16263
12-#11	1.95	MA	15035	4891	24195	3569	26015	2892	26485	2383	26364	1643	31105	1315	17629
4E		MI	14057	4891	22688	3548	24320	2874	24701	2366	24502	1625	28822	1293	16428
12-#11	1.95	MA	14651	4891	23556	3564	25187	2902	25468	2392	24933	1634	29407	1278	17443
5L-3S		MI	14455	4891	23371	3536	25190	2881	25753	2375	25811	1617	30277	1378	16418
12-#11	1.95	MA	14284	4891	22956	3560	24357	2896	24500	2401	23637	1643	27820	1221	16960
6L-2S		MI	15010	4891	24200	3541	26253	2871	27046	2366	27524	1608	32530	1464	16386
12-#14	2.81	MA	17072	5177	28170	3724	31042	3003	32571	2448	34297	1579	41211	1398	24896
2L-6S		MI	13604	5177	22559	3696	24005	2992	24325	2451	23929	1582	28549	984	21523
12-#14	2.81	MA	16226	5177	26891	3717	29402	3018	30574	2460	31649	1591	37725	1274	24877
3L-5S		MI	14085	5177	23356	3704	25106	3003	25590	2438	25612	1570	30590	1067	22072
12-#14	2.81	MA	15622	5177	25839	3735	28061	3008	28947	2448	29625	1604	35476	1150	24760
4E		MI	14589	5177	24204	3712	26204	2989	26920	2426	27474	1582	32782	1121	23036
12-#14	2.81	MA	15080	5177	24924	3727	26876	3023	27496	2460	27594	1591	33073	1096	23711
5L-3S		MI	15150	5177	25179	3696	27446	3000	28411	2438	29328	1570	34838	1243	23127
12-#14	2.81	MA	14563	5177	24065	3720	25689	3013	26114	2473	25756	1604	30832	1014	23109
6L-2S		MI	15932	5177	26361	3704	28961	2986	30241	2426	31754	1558	38017	1367	23130
12-#18	5.00	MA	18045	5903	31709	4133	35455	3327	37679	2625	41058	1473	49898	926	42464
3L-5S		MI	14998	5903	26434	4118	28900	3303	30034	2594	31512	1441	38597	566	35182
12-#18	5.00	MA	17020	5903	29871	4161	33113	3307	34884	2603	37582	1495	46048	712	39888
4E		MI	15854	5903	27915	4135	30808	3281	32311	2571	34703	1463	42323	665	36947
12-#18	5.00	MA	16100	5903	28272	4146	31042	3330	32390	2625	34091	1473	41948	615	37993
5L-3S		MI	16806	5903	29615	4108	32963	3303	34865	2594	37877	1441	45829	874	39355
14-#11	2.27	MA	16468	4998	26725	3628	29252	2935	30429	2411	31527	1614	37627	1463	20422
2L-7S		MI	13407	4998	21757	3617	23109	2936	23218	2404	22551	1621	26714	1105	17995
14-#11	2.27	MA	15870	4998	25828	3624	28102	2946	29027	2420	29659	1622	35162	1376	20438
3L-6S		MI	13738	4998	22367	3605	23845	2926	24160	2413	23712	1613	28073	1171	18328

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis

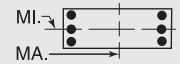


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.27	MA	15444	4998	25092	3636	27164	2940	27887	2412	28232	1631	33570	1290	20412
4L-5S		MI	14077	4998	22924	3610	24615	2933	25054	2404	24901	1604	29521	1228	18726
14-#11	2.27	MA	15062	4998	24453	3632	26336	2951	26870	2422	26800	1622	31872	1252	20107
5L-4S		MI	14433	4998	23517	3616	25383	2923	25993	2395	26215	1613	31075	1265	19006
14-#11	2.27	MA	14697	4998	23853	3627	25506	2945	25902	2431	25505	1631	30286	1196	19654
6L-3S		MI	14828	4998	24200	3604	26253	2930	27046	2404	27524	1604	32530	1351	19017
14-#11	2.27	MA	14342	4998	23196	3640	24714	2955	24882	2423	24238	1640	28587	1105	19284
7L-2S		MI	15381	4998	25029	3609	27315	2920	28338	2395	29238	1595	34782	1437	18995
14-#14	3.28	MA	16795	5332	28170	3814	31042	3088	32571	2503	34297	1573	41211	1235	28842
3L-6S		MI	14137	5332	23741	3793	25520	3061	26155	2492	26355	1563	31728	942	24933
14-#14	3.28	MA	16195	5332	27118	3832	29701	3078	30945	2490	32274	1586	38961	1111	28580
4L-5S		MI	14614	5332	24538	3801	26621	3072	27420	2479	28039	1550	33769	1025	25589
14-#14	3.28	MA	15657	5332	26204	3825	28516	3093	29493	2503	30243	1573	36558	1057	27521
5L-4S		MI	15115	5332	25386	3810	27719	3059	28750	2467	29900	1563	35961	1079	26523
14-#14	3.28	MA	15144	5332	25345	3817	27329	3083	28111	2515	28405	1586	34317	975	26812
6L-3S		MI	15672	5332	26361	3793	28961	3070	30241	2479	31754	1550	38017	1201	26794
14-#14	3.28	MA	14644	5332	24404	3835	26195	3098	26655	2503	26609	1598	32215	880	25698
7L-2S		MI	16450	5332	27543	3801	30477	3056	32071	2467	34181	1538	41196	1325	26832
14-#18	5.83	MA	17987	6180	32096	4334	35966	3431	38314	2674	42132	1459	51996	635	46430
4L-5S		MI	15891	6180	28487	4291	31521	3426	33167	2662	35668	1401	44002	482	41014
14-#18	5.83	MA	17075	6180	30497	4319	33895	3454	35821	2696	38641	1437	47895	537	44344
5L-4S		MI	16739	6180	29967	4308	33429	3404	35445	2640	38859	1423	47729	580	42970
16-#11	2.60	MA	16274	5106	26725	3691	29252	2995	30429	2450	31527	1611	37627	1351	23231
3L-7S		MI	13786	5106	22586	3685	24172	2984	24510	2433	24264	1609	28967	1078	20424
16-#11	2.60	MA	15851	5106	25988	3704	28313	2988	29289	2442	30100	1619	36035	1265	23188
4L-6S		MI	14115	5106	23196	3673	24908	2974	25452	2442	25426	1600	30326	1144	20824
16-#11	2.60	MA	15470	5106	25349	3699	27485	2999	28272	2451	28668	1611	34338	1227	22782
5E		MI	14452	5106	23753	3678	25678	2981	26346	2433	26615	1591	31774	1201	21197
16-#11	2.60	MA	15108	5106	24749	3694	26656	2993	27304	2460	27372	1619	32751	1170	22355
6L-4S		MI	14806	5106	24346	3683	26446	2971	27286	2424	27929	1600	33328	1238	21577
16-#11	2.60	MA	14754	5106	24092	3707	25863	3004	26284	2452	26106	1628	31053	1080	21917
7L-3S		MI	15200	5106	25029	3671	27315	2978	28338	2433	29238	1591	34782	1323	21607
16-#11	2.60	MA	14407	5106	23501	3703	25059	2998	25333	2461	24857	1637	29467	1035	21320
8L-2S		MI	15750	5106	25858	3676	28378	2968	29630	2424	30951	1583	37035	1410	21598
16-#14	3.75	MA	16764	5488	28397	3929	31341	3148	32943	2532	34922	1568	42446	1072	32337
4L-6S		MI	14665	5488	24923	3891	27035	3131	27984	2532	28782	1543	34907	900	28360
16-#14	3.75	MA	16229	5488	27483	3922	30156	3162	31491	2545	32891	1555	40043	1019	31343
5E		MI	15140	5488	25720	3899	28136	3142	29250	2520	30465	1530	36948	983	29118
16-#14	3.75	MA	15720	5488	26624	3915	28969	3152	30109	2557	31054	1568	37802	936	30532
6L-4S		MI	15638	5488	26568	3907	29235	3129	30580	2508	32327	1543	39140	1037	29990
16-#14	3.75	MA	15223	5488	25684	3932	27835	3167	28653	2545	29258	1580	35700	841	29470
7L-3S		MI	16191	5488	27543	3890	30477	3140	32071	2520	34181	1530	41196	1158	30452
16-#18	6.67	MA	18042	6456	32723	4492	36748	3579	39252	2768	43190	1400	53843	459	50730
5E		MI	16777	6456	30539	4464	34143	3549	36300	2731	39824	1361	49408	397	46882
18-#11	2.92	MA	16255	5214	26885	3771	29463	3037	30691	2471	31968	1608	38501	1240	25959
4L-7S		MI	14162	5214	23416	3752	25235	3033	25803	2462	25978	1596	31219	1050	22862
18-#11	2.92	MA	15876	5214	26246	3766	28635	3048	29674	2480	30536	1599	36803	1202	25464
5L-6S		MI	14489	5214	24025	3740	25970	3023	26745	2471	27139	1587	32579	1116	23325
18-#11	2.92	MA	15516	5214	25646	3762	27805	3041	28706	2489	29240	1608	35216	1145	25060
6L-5S		MI	14825	5214	24582	3745	26740	3030	27639	2462	28328	1579	34027	1173	23677
18-#11	2.92	MA	15164	5214	24989	3775	27012	3052	27686	2481	27974	1616	33518	1055	24559
7L-4S		MI	15177	5214	25175	3750	27509	3019	28578	2454	29642	1587	35580	1211	24142
18-#11	2.92	MA	14818	5214	24398	3770	26208	3046	26735	2490	26724	1625	31932	1010	23986
8L-3S		MI	15569	5214	25858	3738	28378	3027	29630	2462	30951	1579	37035	1296	24187
18-#14	4.22	MA	16798	5644	28762	4019	31796	3232	33489	2587	35540	1537	43528	980	35175
5L-6S		MI	15190	5644	26105	3988	28550	3201	29814	2573	31208	1523	38086	858	31802
18-#14	4.22	MA	16292	5644	27903	4012	30609	3222	32107	2599	33702	1550	41287	898	34267
6L-5S		MI	15662	5644	26902	3996	29652	3212	31080	2561	32892	1511	40128	940	32655

RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
18-#14	4.22	MA	15798	5644	26963	4029	29474	3237	30650	2587	31907	1562	39185	802	33253
7L-4S		MI	16156	5644	27750	4004	30750	3198	32410	2548	34754	1523	42319	995	33474
20-#11	3.25	MA	16280	5322	27142	3834	29784	3096	31076	2510	32404	1587	39269	1177	28153
5L-7S		MI	14536	5322	24245	3820	26297	3081	27095	2491	27691	1583	33472	1023	25307
20-#11	3.25	MA	15921	5322	26542	3829	28954	3090	30108	2519	31108	1596	37682	1120	27768
6E		MI	14862	5322	24854	3808	27033	3071	28037	2500	28853	1574	34832	1089	25829
20-#11	3.25	MA	15571	5322	25885	3842	28162	3101	29088	2511	29841	1605	35984	1030	27208
7L-5S		MI	15196	5322	25412	3813	27803	3078	28931	2491	30042	1566	36280	1146	26163
20-#11	3.25	MA	15227	5322	25294	3837	27358	3094	28137	2520	28592	1613	34398	985	26659
8L-4S		MI	15546	5322	26004	3818	28571	3068	29870	2483	31356	1574	37833	1183	26703
20-#14	4.69	MA	16860	5799	29182	4109	32249	3292	34104	2642	36351	1532	44772	859	38015
6E		MI	15711	5799	27287	4085	30066	3271	31644	2614	33635	1503	41265	816	35257
20-#14	4.69	MA	16370	5799	28242	4127	31114	3307	32648	2629	34555	1544	42670	763	37045
7L-5S		MI	16180	5799	28084	4093	31167	3282	32910	2602	35318	1491	43307	898	36200
22-#11	3.57	MA	16324	5430	27439	3897	30103	3138	31510	2548	32975	1584	40147	1095	30480
6L-7S		MI	14908	5430	25074	3887	27360	3130	28387	2520	29405	1570	35725	996	27760
22-#11	3.57	MA	15976	5430	26782	3909	29311	3149	30490	2540	31709	1593	38449	1004	29864
7L-6S		MI	15232	5430	25683	3875	28096	3119	29329	2529	30566	1562	37085	1061	28335
22-#11	3.57	MA	15634	5430	26191	3905	28507	3143	29539	2549	30460	1602	36863	960	29336
8L-5S		MI	15565	5430	26241	3880	28866	3126	30224	2520	31755	1553	38533	1118	28653
22-#14	5.16	MA	16937	5955	29521	4224	32754	3377	34646	2671	37204	1526	46156	725	40835
7L-6S		MI	16230	5955	28469	4182	31581	3341	33474	2655	36062	1484	44445	774	38723
24-#11	3.90	MA	16379	5538	27678	3977	30460	3198	31892	2570	33577	1581	40914	979	32526
7E		MI	15278	5538	25903	3954	28423	3178	29680	2549	31118	1558	37978	968	30218
24-#11	3.90	MA	16038	5538	27087	3972	29656	3191	30941	2579	32327	1590	39329	935	32017
8L-6S		MI	15600	5538	26513	3942	29159	3168	30622	2558	32280	1549	39338	1034	30844

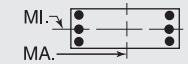
RECTANGULAR TIED COLUMNS 30" x 34"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
4-#18	1.57	MA	17531	5062	27968	3672	30080	2985	30673	2472	30629	1719	35843	1583	16000
2E		MI	15377	5062	24667	3627	26339	2946	26666	2431	26478	1682	30787	1534	13944
6-#14	1.32	MA	17253	4975	27205	3648	29235	2971	29736	2473	29455	1753	34385	1635	13727
2L-3S		MI	14353	4975	22838	3599	24142	2951	24125	2452	23123	1734	26484	1470	12065
6-#14	1.32	MA	16322	4975	25829	3642	27471	2987	27583	2486	26584	1765	30594	1511	13797
3L-2S		MI	15151	4975	24020	3607	25657	2937	25955	2439	25549	1721	29663	1595	11987
6-#18	2.35	MA	18604	5338	30367	3845	33155	3109	34402	2546	35573	1685	42335	1511	23565
2L-3S		MI	14918	5338	24667	3783	26339	3091	26666	2522	26478	1664	30787	1228	20494
6-#18	2.35	MA	17010	5338	27968	3831	30080	3134	30673	2568	30629	1708	35843	1289	23553
3L-2S		MI	16282	5338	26719	3800	28961	3069	29799	2500	30634	1642	36193	1450	20449
8-#11	1.22	MA	17139	4940	26881	3641	28888	2968	29338	2474	28980	1768	33797	1658	12786
2L-4S		MI	14095	4940	22232	3609	23437	2939	23322	2445	22152	1756	25504	1449	11280
8-#11	1.22	MA	16485	4940	25917	3637	27652	2979	27830	2484	26958	1777	31119	1571	12834
3E		MI	14497	4940	22914	3597	24306	2946	24374	2454	23461	1748	26959	1535	11227
8-#11	1.22	MA	16020	4940	25127	3650	26646	2973	26607	2476	25412	1785	29386	1485	12874
4L-2S		MI	15058	4940	23743	3603	25369	2936	25667	2445	25175	1739	29212	1621	11176
8-#14	1.76	MA	17881	5131	28582	3745	31000	3041	31889	2515	32326	1736	38177	1599	18075
2L-4S		MI	14320	5131	23045	3713	24415	3010	24465	2480	23696	1727	27607	1307	15812
8-#14	1.76	MA	16956	5131	27205	3739	29235	3056	29736	2528	29455	1749	34385	1475	18121
3E		MI	14889	5131	24020	3696	25657	3021	25955	2493	25549	1714	29663	1428	15798
8-#14	1.76	MA	16298	5131	26075	3757	27795	3047	27986	2517	27261	1761	31936	1350	18089
4L-2S		MI	15682	5131	25202	3705	27173	3007	27785	2480	27976	1702	32843	1553	15740

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis

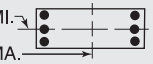


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
8-#18	3.14	MA	19664	5615	32765	4018	36229	3233	38131	2619	40517	1652	48826	1439	31085
2L-4S		MI	14851	5615	25019	3982	26805	3193	27245	2568	27460	1647	32686	934	25346
8-#18	3.14	MA	18085	5615	30367	4004	33155	3258	34402	2641	35573	1674	42335	1217	30959
3E		MI	15825	5615	26719	3955	28961	3215	29799	2591	30634	1624	36193	1144	26849
8-#18	3.14	MA	16959	5615	28391	4034	30637	3240	31366	2619	31796	1696	38140	1000	29201
4L-2S		MI	17175	5615	28772	3973	31583	3193	32932	2568	34790	1602	41599	1365	26903
10-#11	1.53	MA	17583	5048	27845	3709	30124	3016	30845	2503	31002	1757	36476	1634	15833
2L-5S		MI	14116	5048	22468	3672	23731	2997	23675	2483	22552	1735	26204	1384	13890
10-#11	1.53	MA	16932	5048	26881	3705	28888	3027	29338	2513	28980	1766	33797	1548	15871
3L-4S		MI	14476	5048	23061	3677	24500	2987	24614	2474	23866	1743	27757	1422	13889
10-#11	1.53	MA	16470	5048	26091	3718	27881	3022	28115	2506	27434	1775	32064	1462	15892
4L-3S		MI	14876	5048	23743	3665	25369	2994	25667	2483	25175	1735	29212	1507	13853
10-#11	1.53	MA	16056	5048	25406	3714	26993	3033	27024	2516	25885	1766	30226	1423	15854
5L-2S		MI	15434	5048	24572	3670	26432	2984	26959	2474	26888	1726	31465	1594	13809
10-#14	2.21	MA	18504	5286	29958	3843	32764	3110	34042	2557	35197	1720	41969	1564	22404
2L-5S		MI	14347	5286	23379	3802	24832	3093	24964	2534	24261	1694	28595	1210	18769
10-#14	2.21	MA	17585	5286	28582	3836	31000	3126	31889	2571	32326	1732	38177	1439	22420
3L-4S		MI	14856	5286	24227	3810	25931	3079	26294	2521	26122	1707	30786	1265	19476
10-#14	2.21	MA	16931	5286	27452	3855	29560	3117	30139	2559	30132	1745	35728	1314	22341
4L-3S		MI	15421	5286	25202	3794	27173	3091	27785	2534	27976	1694	32843	1386	19508
10-#14	2.21	MA	16345	5286	26471	3848	28289	3133	28578	2573	27931	1732	33119	1260	21484
5L-2S		MI	16209	5286	26384	3802	28688	3077	29615	2521	30402	1682	36022	1511	19470
10-#18	3.92	MA	20710	5892	35163	4191	39304	3357	41859	2693	45461	1618	55317	1367	38552
2L-5S		MI	14889	5892	25591	4138	27519	3338	28101	2659	28425	1584	34366	751	29921
10-#18	3.92	MA	19147	5892	32765	4177	36229	3382	38131	2715	40517	1640	48826	1145	38339
3L-4S		MI	15756	5892	27072	4155	29427	3316	30378	2637	31616	1607	38092	850	31284
10-#18	3.92	MA	18033	5892	30789	4207	33712	3364	35094	2693	36740	1662	44632	928	36173
4L-3S		MI	16721	5892	28772	4128	31583	3338	32932	2659	34790	1584	41599	1059	33174
10-#18	3.92	MA	17034	5892	29072	4193	31487	3389	32384	2715	32948	1640	40156	831	34479
5L-2S		MI	18060	5892	30825	4146	34204	3316	36065	2637	38946	1562	47004	1280	33318
12-#11	1.84	MA	18024	5156	28809	3776	31359	3064	32353	2533	33024	1747	39154	1611	18869
2L-6S		MI	14154	5156	22740	3734	24024	3039	24073	2521	23076	1731	27009	1300	15980
12-#11	1.84	MA	17376	5156	27845	3772	30124	3076	30845	2542	31002	1755	36476	1525	18896
3L-5S		MI	14496	5156	23297	3739	24794	3046	24967	2512	24265	1722	28457	1357	16422
12-#11	1.84	MA	16917	5156	27055	3785	29117	3070	29622	2535	29456	1764	34743	1439	18893
4E		MI	14854	5156	23890	3744	25562	3035	25907	2503	25579	1731	30010	1395	16487
12-#11	1.84	MA	16504	5156	26370	3781	28229	3082	28532	2545	27907	1755	32904	1400	18801
5L-3S		MI	15252	5156	24572	3732	26432	3043	26959	2512	26888	1722	31465	1480	16465
12-#11	1.84	MA	16112	5156	25727	3777	27340	3076	27445	2538	26504	1764	31179	1343	18242
6L-2S		MI	15808	5156	25401	3737	27495	3032	28251	2503	28602	1713	33718	1566	16430
12-#14	2.65	MA	19121	5442	31335	3940	34529	3180	36194	2600	38068	1703	45761	1528	26719
2L-6S		MI	14399	5442	23764	3891	25246	3152	25529	2587	25004	1687	29732	1086	21760
12-#14	2.65	MA	18208	5442	29958	3933	32764	3196	34042	2613	35197	1716	41969	1403	26700
3L-5S		MI	14881	5442	24561	3899	26348	3163	26794	2575	26687	1675	31774	1168	22270
12-#14	2.65	MA	17559	5442	28828	3952	31324	3187	32292	2602	33003	1728	39520	1279	26583
4E		MI	15387	5442	25409	3907	27446	3149	28124	2562	28549	1687	33966	1223	23127
12-#14	2.65	MA	16977	5442	27847	3945	30054	3203	30731	2615	30802	1716	36911	1224	25570
5L-3S		MI	15949	5442	26384	3891	28688	3160	29615	2575	30402	1675	36022	1344	23197
12-#14	2.65	MA	16423	5442	26927	3939	28780	3194	29246	2628	28810	1728	34469	1142	24911
6L-2S		MI	16732	5442	27566	3899	30203	3147	31444	2562	32829	1662	39201	1469	23186
12-#18	4.71	MA	20198	6168	35163	4350	39304	3507	41859	2789	45461	1607	55317	1073	45704
3L-5S		MI	15793	6168	27643	4311	30141	3461	31234	2728	32581	1545	39772	667	35703
12-#18	4.71	MA	19094	6168	33187	4380	36787	3488	38823	2767	41684	1629	51123	856	43193
4E		MI	16652	6168	29124	4328	32049	3439	33511	2706	35772	1567	43498	765	37267
12-#18	4.71	MA	18105	6168	31470	4366	34562	3513	36113	2789	37892	1607	46648	759	41399
5L-3S		MI	17608	6168	30825	4301	34204	3461	36065	2728	38946	1545	47004	974	39480
14-#11	2.14	MA	18462	5264	29773	3844	32595	3113	33860	2562	35046	1736	41832	1588	21896
2L-7S		MI	14202	5264	22959	3813	24351	3097	24424	2541	23628	1727	27902	1207	18226

RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

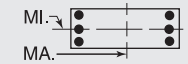
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	2.14	MA	17817	5264	28809	3840	31359	3124	32353	2572	33024	1745	39154	1502	21912
3L-6S		MI	14534	5264	23569	3801	25087	3087	25366	2550	24790	1718	29261	1273	18471
14-#11	2.14	MA	17360	5264	28019	3853	30353	3119	31130	2564	31478	1753	37421	1415	21886
4L-5S		MI	14874	5264	24126	3806	25857	3094	26260	2541	25979	1709	30710	1330	18883
14-#11	2.14	MA	16950	5264	27334	3849	29465	3130	30039	2574	29929	1745	35583	1377	21665
5L-4S		MI	15230	5264	24719	3812	26625	3084	27199	2532	27293	1718	32263	1367	19070
14-#11	2.14	MA	16559	5264	26691	3845	28575	3124	28952	2567	28526	1753	33857	1320	21140
6L-3S		MI	15626	5264	25401	3800	27495	3091	28251	2541	28602	1709	33718	1453	19068
14-#11	2.14	MA	16178	5264	25987	3858	27726	3136	27908	2577	27155	1762	32012	1230	20816
7L-2S		MI	16180	5264	26231	3805	28558	3081	29544	2532	30316	1701	35971	1539	19042
14-#14	3.09	MA	18826	5598	31335	4031	34529	3266	36194	2656	38068	1699	45761	1367	30968
3L-6S		MI	14932	5598	24946	3988	26762	3222	27358	2628	27430	1667	32912	1044	25263
14-#14	3.09	MA	18181	5598	30205	4049	33089	3257	34445	2644	35874	1712	43312	1243	30817
4L-5S		MI	15411	5598	25743	3997	27863	3233	28624	2615	29114	1655	34953	1126	25786
14-#14	3.09	MA	17603	5598	29224	4043	31818	3273	32884	2657	33673	1699	40702	1188	29673
5L-4S		MI	15914	5598	26591	4005	28961	3219	29954	2603	30975	1667	37145	1180	26758
14-#14	3.09	MA	17053	5598	28303	4036	30545	3264	31398	2671	31681	1712	38261	1106	29049
6L-3S		MI	16472	5598	27566	3988	30203	3230	31444	2615	32829	1655	39201	1302	26870
14-#14	3.09	MA	16516	5598	27295	4054	29329	3280	29833	2659	29734	1724	35649	976	27785
7L-2S		MI	17252	5598	28748	3996	31718	3216	33274	2603	35255	1643	42380	1426	26895
14-#18	5.49	MA	20145	6445	35586	4553	39861	3612	42551	2841	46628	1595	57614	784	50250
4L-5S		MI	16688	6445	29696	4484	32762	3585	34367	2797	36736	1505	45177	582	41526
14-#18	5.49	MA	19165	6445	33868	4539	37637	3637	39842	2863	42836	1573	53139	687	48261
5L-4S		MI	17540	6445	31177	4501	34670	3563	36645	2775	39927	1527	48904	680	43286
16-#11	2.45	MA	18256	5372	29773	3907	32595	3173	33860	2601	35046	1734	41832	1478	24916
3L-7S		MI	14581	5372	23788	3881	25414	3146	25716	2570	25342	1714	30155	1179	20661
16-#11	2.45	MA	17801	5372	28983	3920	31588	3167	32637	2594	33501	1743	40099	1392	24873
4L-6S		MI	14911	5372	24398	3869	26150	3135	26658	2579	26503	1705	31514	1245	20968
16-#11	2.45	MA	17393	5372	28298	3916	30701	3179	31547	2604	31951	1734	38261	1353	24541
5E		MI	15249	5372	24955	3874	26920	3142	27552	2570	27692	1697	32963	1302	21354
16-#11	2.45	MA	17004	5372	27655	3912	29811	3173	30460	2596	30548	1743	36535	1297	24044
6L-4S		MI	15604	5372	25548	3879	27688	3132	28491	2561	29006	1705	34516	1340	21646
16-#11	2.45	MA	16625	5372	26951	3925	28962	3184	29416	2606	29177	1751	34690	1207	23676
7L-3S		MI	15999	5372	26231	3867	28558	3139	29544	2570	30316	1697	35971	1425	21664
16-#11	2.45	MA	16252	5372	26317	3921	28100	3179	28397	2616	27719	1743	32973	1161	22991
8L-2S		MI	16550	5372	27060	3872	29620	3129	30836	2561	32029	1688	38224	1512	21647
16-#14	3.53	MA	18799	5753	31581	4146	34854	3327	36597	2687	38745	1695	47104	1207	34950
4L-6S		MI	15461	5753	26128	4086	28277	3292	29188	2669	29857	1648	36091	1001	28685
16-#14	3.53	MA	18225	5753	30600	4140	33583	3343	35037	2700	36544	1683	44494	1152	33788
5E		MI	15938	5753	26925	4094	29378	3303	30454	2656	31540	1635	38132	1084	29314
16-#14	3.53	MA	17678	5753	29680	4133	32309	3334	33551	2713	34552	1695	42053	1071	33072
6L-4S		MI	16437	5753	27773	4102	30476	3289	31784	2644	33402	1648	40324	1138	30223
16-#14	3.53	MA	17145	5753	28671	4152	31093	3349	31986	2702	32605	1708	39441	940	31849
7L-3S		MI	16993	5753	28748	4085	31718	3300	33274	2656	35255	1635	42380	1260	30533
16-#18	6.27	MA	20215	6722	36267	4712	40711	3762	43570	2937	47780	1540	59630	615	55159
5E		MI	17575	6722	31749	4657	35384	3708	37500	2866	40892	1465	50583	497	47386
18-#11	2.75	MA	18239	5479	29947	3988	32824	3215	34145	2623	35523	1732	42778	1369	27855
4L-7S		MI	14958	5479	24617	3948	26477	3194	27008	2599	27055	1701	32408	1152	23096
18-#11	2.75	MA	17833	5479	29262	3984	31936	3227	33054	2633	33973	1723	40939	1330	27425
5L-6S		MI	15286	5479	25227	3936	27213	3184	27950	2608	28217	1692	33767	1218	23469
18-#11	2.75	MA	17446	5479	28619	3979	31047	3221	31967	2626	32570	1732	39214	1274	26954
6L-5S		MI	15623	5479	25784	3941	27983	3191	28845	2599	29406	1684	35215	1275	23833
18-#11	2.75	MA	17070	5479	27915	3993	30197	3233	30923	2636	31199	1741	37368	1183	26519
7L-4S		MI	15976	5479	26377	3947	28751	3181	29784	2591	30720	1692	36769	1312	24215

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

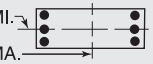
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.75	MA	16698	5479	27281	3989	29336	3227	29904	2646	29741	1732	35651	1138	25861
8L-3S		MI	16369	5479	27060	3934	29620	3188	30836	2599	32029	1684	38224	1398	24249
18-#14	3.97	MA	18842	5909	31977	4237	35348	3412	37189	2742	39415	1666	48286	1117	37914
5L-6S		MI	15987	5909	27310	4183	29792	3362	31018	2710	32283	1628	39270	959	32123
18-#14	3.97	MA	18299	5909	31056	4231	34074	3403	35704	2756	37423	1679	45845	1035	37097
6L-5S		MI	16461	5909	28107	4191	30893	3373	32284	2697	33967	1616	41312	1042	32851
18-#14	3.97	MA	17769	5909	30048	4249	32858	3419	34139	2744	35476	1691	43233	904	35925
7L-4S		MI	16957	5909	28955	4199	31992	3359	33614	2685	35828	1628	43503	1096	33704
20-#11	3.06	MA	18271	5587	30226	4051	33172	3275	34562	2663	35995	1713	43618	1307	30317
5L-7S		MI	15332	5587	25446	4016	27540	3242	28301	2628	28769	1688	34661	1125	25540
20-#11	3.06	MA	17886	5587	29583	4047	32282	3270	33475	2655	34592	1721	41892	1250	29868
6E		MI	15659	5587	26056	4004	28275	3232	29243	2637	29930	1680	36020	1191	25974
20-#11	3.06	MA	17511	5587	28879	4060	31433	3281	32431	2665	33221	1730	40047	1160	29370
7L-5S		MI	15994	5587	26613	4009	29045	3239	30137	2628	31119	1671	37468	1248	26318
20-#11	3.06	MA	17142	5587	28245	4056	30572	3275	31412	2675	31763	1721	38329	1114	28737
8L-4S		MI	16346	5587	27206	4014	29814	3229	31076	2620	32433	1680	39022	1285	26781
20-#14	4.41	MA	18915	6064	32433	4328	35839	3473	37857	2798	40294	1662	49637	999	41135
6E		MI	16510	6065	28492	4280	31308	3431	32848	2750	34710	1608	42449	917	35575
20-#14	4.41	MA	18389	6064	31424	4346	34622	3489	36292	2787	38347	1675	47025	868	40010
7L-5S		MI	16981	6064	29289	4288	32409	3442	34114	2738	36393	1596	44491	1000	36395
22-#11	3.36	MA	18323	5695	30547	4114	33518	3318	34982	2685	36614	1711	44570	1227	32786
6L-7S		MI	15705	5695	26275	4083	28603	3291	29593	2657	30482	1676	36913	1097	27990
22-#11	3.36	MA	17950	5695	29843	4127	32669	3330	33938	2694	35243	1719	42725	1137	32228
7L-6S		MI	16030	5695	26885	4071	29338	3281	30535	2666	31644	1667	38273	1163	28482
22-#11	3.36	MA	17583	5695	29209	4123	31807	3324	32919	2704	33785	1711	41007	1091	31618
8L-5S		MI	16364	5695	27442	4076	30108	3288	31429	2657	32833	1658	39721	1220	28809
22-#14	4.85	MA	19005	6220	32801	4443	36387	3559	38444	2829	41218	1658	50817	833	44104
7L-6S		MI	17029	6220	29674	4377	32823	3501	34678	2791	37136	1589	45628	875	39038
24-#11	3.67	MA	18387	5803	30807	4195	33905	3378	35446	2724	37265	1709	45403	1114	35093
7E		MI	16075	5803	27104	4150	29665	3339	30885	2686	32196	1663	39166	1070	30447
24-#11	3.67	MA	18021	5803	30173	4191	33043	3372	34427	2734	35807	1700	43686	1068	34504
8L-6S		MI	16400	5803	27714	4138	30401	3329	31828	2695	33358	1654	40526	1136	30992

RECTANGULAR TIED COLUMNS 30" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.48	MA	19566	5327	31055	3887	33429	3162	34113	2626	34001	1840	39804	1705	17080
2E		MI	16174	5327	25876	3820	27580	3105	27866	2565	27547	1786	31962	1635	13993
6-#14	1.25	MA	19261	5240	30229	3864	32513	3148	33049	2623	32709	1873	38187	1755	14638
2L-3S		MI	15149	5240	24042	3794	25384	3111	25329	2588	24197	1839	27668	1572	12108
6-#14	1.25	MA	18262	5240	28755	3858	30624	3165	30744	2638	29615	1885	34088	1630	14708
3L-2S		MI	15948	5240	25224	3802	26899	3098	27159	2576	26624	1826	30847	1696	12027
6-#18	2.22	MA	20727	5604	33626	4060	36726	3286	38135	2701	39340	1809	46840	1638	25185
2L-3S		MI	15714	5604	25876	3976	27580	3250	27866	2657	27547	1768	31962	1329	20576
6-#18	2.22	MA	19013	5604	31055	4048	33429	3313	34113	2723	34001	1831	39804	1417	25173
3L-2S		MI	17081	5604	27929	3993	30202	3228	30999	2634	31703	1746	37368	1550	20508
8-#11	1.16	MA	19136	5205	29878	3857	32137	3145	32617	2624	32187	1887	37534	1776	13629
2L-4S		MI	14890	5205	23433	3805	24679	3100	24528	2582	23230	1861	26693	1551	11320
8-#11	1.16	MA	18435	5205	28846	3853	30815	3157	31004	2635	30010	1896	34642	1690	13676
3E		MI	15293	5205	24116	3793	25548	3107	25580	2591	24539	1853	28148	1636	11264
8-#11	1.16	MA	17939	5205	28003	3867	29740	3152	29698	2628	28347	1904	32768	1604	13717
4L-2S		MI	15855	5205	24945	3799	26611	3097	26872	2582	26253	1844	30400	1723	11211
8-#14	1.67	MA	19939	5396	31702	3961	34403	3218	35354	2666	35803	1857	42286	1722	19290
2L-4S		MI	15116	5396	24249	3908	25657	3170	25668	2617	24770	1831	28791	1408	15881
8-#14	1.67	MA	18947	5396	30229	3955	32513	3235	33049	2680	32709	1870	38187	1597	19336
3E		MI	15686	5396	25224	3891	26899	3181	27159	2629	26624	1819	30847	1530	15848

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

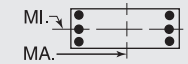
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.67	MA	18243	5396	29021	3974	30975	3226	31179	2669	30345	1882	35534	1473	19304
4L-2S		MI	16480	5396	26406	3900	28414	3167	28989	2617	29051	1806	34026	1654	15785
8-#18	2.96	MA	21872	5880	36197	4233	40022	3410	42156	2776	44679	1778	53876	1571	33245
2L-4S		MI	15646	5880	26229	4175	28046	3351	28445	2703	28529	1750	33861	1035	25669
8-#18	2.96	MA	20176	5880	33626	4221	36726	3437	38135	2799	39340	1800	46840	1350	33119
3E		MI	16623	5880	27929	4148	30202	3374	30999	2725	31703	1728	37368	1244	26945
8-#18	2.96	MA	18970	5880	31512	4252	34032	3420	34862	2777	35260	1822	42301	1129	31513
4L-2S		MI	17976	5880	29982	4166	32823	3351	34132	2703	35858	1706	42774	1465	26970
10-#11	1.44	MA	19615	5313	30909	3924	33459	3193	34230	2654	34363	1877	40426	1755	16886
2L-5S		MI	14911	5313	23669	3868	24974	3158	24881	2620	23629	1840	27392	1486	13953
10-#11	1.44	MA	18917	5313	29878	3921	32137	3205	32617	2664	32187	1886	37534	1668	16924
3L-4S		MI	15272	5313	24262	3873	25742	3148	25820	2611	24943	1849	28945	1524	13936
10-#11	1.44	MA	18423	5313	29034	3934	31062	3200	31311	2658	30523	1895	35660	1582	16945
4L-3S		MI	15672	5313	24945	3861	26611	3155	26872	2620	26253	1840	30400	1609	13894
10-#11	1.44	MA	17981	5313	28303	3931	30114	3212	30147	2668	28856	1886	33681	1543	16907
5L-2S		MI	16232	5313	25774	3866	27674	3145	28165	2611	27966	1831	32653	1695	13848
10-#14	2.08	MA	20611	5552	33176	4058	36292	3288	37659	2708	38896	1842	46385	1688	23923
2L-5S		MI	15142	5552	24583	3997	26074	3254	26168	2670	25335	1799	29779	1312	18962
10-#14	2.08	MA	19625	5552	31702	4052	34403	3304	35354	2722	35803	1855	42286	1564	23939
3L-4S		MI	15652	5552	25431	4005	27172	3240	27498	2658	27197	1812	31970	1366	19554
10-#14	2.08	MA	18926	5552	30495	4071	32864	3296	33484	2712	33438	1867	39633	1439	23860
4L-3S		MI	16219	5552	26406	3989	28414	3251	28989	2670	29051	1799	34026	1487	19564
10-#14	2.08	MA	18300	5552	29448	4066	31507	3313	31817	2726	31068	1855	36821	1384	23067
5L-2S		MI	17008	5552	27588	3997	29930	3237	30818	2658	31477	1787	37206	1612	19520
10-#18	3.70	MA	23004	6157	38769	4406	43318	3534	46177	2852	50018	1747	60912	1504	41252
2L-5S		MI	15683	6157	26800	4331	28760	3497	29301	2794	29494	1688	35541	851	30246
10-#18	3.70	MA	21324	6157	36197	4394	40022	3561	42156	2874	44679	1769	53876	1283	41039
3L-4S		MI	16553	6157	28281	4348	30668	3475	31578	2772	32684	1710	39267	950	31601
10-#18	3.70	MA	20130	6157	34083	4425	37329	3544	38883	2853	40599	1791	49337	1062	38998
4L-3S		MI	17521	6157	29982	4321	32823	3497	34132	2794	35858	1688	42774	1159	33282
10-#18	3.70	MA	19061	6157	32248	4413	34951	3572	35963	2875	36506	1769	44486	966	37066
5L-2S		MI	18863	6157	32034	4339	35445	3475	37265	2772	40014	1666	48179	1381	33397
12-#11	1.73	MA	20090	5421	31941	3992	34781	3242	35843	2683	36540	1868	43317	1733	20132
2L-6S		MI	14949	5421	23941	3930	25266	3200	25279	2658	24154	1836	28197	1402	16118
12-#11	1.73	MA	19396	5421	30909	3988	33459	3254	34230	2694	34363	1876	40426	1647	20159
3L-5S		MI	15292	5421	24498	3935	26036	3207	26173	2649	25343	1827	29645	1459	16530
12-#11	1.73	MA	18905	5421	30065	4002	32384	3249	32924	2687	32700	1885	38551	1561	20157
4E		MI	15651	5421	25091	3940	26805	3197	27112	2640	26657	1836	31198	1496	16539
12-#11	1.73	MA	18465	5421	29334	3998	31436	3261	31760	2697	31033	1876	36572	1521	20095
5L-3S		MI	16050	5421	25774	3928	27674	3204	28165	2649	27966	1827	32653	1582	16511
12-#11	1.73	MA	18045	5421	28649	3994	30487	3255	30600	2691	29522	1885	34707	1465	19531
6L-2S		MI	16606	5421	26603	3933	28737	3194	29457	2640	29680	1819	34906	1668	16473
12-#14	2.50	MA	21278	5707	34650	4155	38181	3358	39964	2750	41990	1827	50484	1655	28541
2L-6S		MI	15193	5707	24968	4086	26488	3312	26732	2723	26078	1792	30916	1187	21942
12-#14	2.50	MA	20298	5707	33176	4150	36292	3374	37659	2765	38896	1839	46385	1531	28522
3L-5S		MI	15677	5707	25765	4094	27589	3324	27998	2711	27762	1779	32958	1269	22462
12-#14	2.50	MA	19604	5707	31968	4169	34753	3366	35789	2754	36532	1852	43732	1406	28405
4E		MI	16184	5707	26613	4103	28688	3310	29328	2698	29623	1792	35150	1324	23212
12-#14	2.50	MA	18982	5707	30921	4163	33396	3383	34122	2769	34162	1839	40920	1350	27445
5L-3S		MI	16747	5707	27588	4086	29930	3321	30818	2711	31477	1779	37206	1445	23263
12-#14	2.50	MA	18389	5707	29939	4157	32037	3375	32461	2758	32015	1852	38278	1269	26697
6L-2S		MI	17532	5707	28770	4094	31445	3307	32648	2698	33904	1767	40385	1570	23240
12-#18	4.44	MA	22459	6433	38769	4566	43318	3686	46177	2950	50018	1738	60912	1216	48944
3L-5S		MI	16588	6433	28853	4504	31381	3620	32434	2863	33649	1648	40947	767	36211

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis

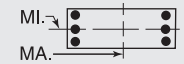


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	4.44	MA	21277	6433	36655	4598	40625	3669	42905	2928	45938	1760	56372	995	46531
4E		MI	17451	6433	30334	4521	33289	3598	34711	2841	36840	1670	44673	865	37579
12-#18	4.44	MA	20219	6433	34819	4586	38247	3696	39984	2950	41845	1738	51521	899	44730
5L-3S		MI	18410	6433	32034	4494	35445	3620	37265	2863	40014	1648	48179	1075	39597
12-#18	4.44	MA	19212	6433	33095	4573	35863	3679	37204	2973	38141	1760	46995	754	41669
6L-2S		MI	19741	6433	34087	4511	38067	3598	40398	2841	44170	1626	53585	1296	39782
14-#11	2.02	MA	20563	5529	32972	4059	36103	3290	37456	2713	38716	1858	46209	1712	23370
2L-7S		MI	14997	5529	24161	4009	25593	3258	25629	2678	24706	1832	29090	1309	18364
14-#11	2.02	MA	19872	5529	31941	4056	34781	3302	35843	2723	36540	1866	43317	1625	23387
3L-6S		MI	15329	5529	24770	3997	26329	3248	26571	2687	25868	1823	30450	1375	18609
14-#11	2.02	MA	19383	5529	31097	4069	33706	3297	34537	2716	34876	1875	41443	1539	23360
4L-5S		MI	15670	5529	25328	4003	27099	3255	27466	2678	27056	1815	31898	1432	19035
14-#11	2.02	MA	18945	5529	30366	4066	32759	3309	33373	2727	33209	1866	39464	1500	23236
5L-4S		MI	16027	5529	25920	4008	27867	3245	28405	2669	28371	1823	33451	1469	19133
14-#11	2.02	MA	18528	5529	29680	4062	31809	3304	32213	2720	31699	1875	37599	1443	22633
6L-3S		MI	16424	5529	26603	3996	28737	3252	29457	2678	29680	1815	34906	1554	19117
14-#11	2.02	MA	18121	5529	28929	4076	30903	3316	31099	2731	30223	1884	35606	1353	22269
7L-2S		MI	16979	5529	27432	4001	29800	3242	30749	2669	31393	1806	37159	1641	19088
14-#14	2.92	MA	20965	5863	34650	4247	38181	3444	39964	2807	41990	1824	50484	1497	33094
3L-6S		MI	15727	5863	26150	4183	28004	3382	28562	2764	28505	1772	34095	1145	25490
14-#14	2.92	MA	20275	5863	33442	4266	36642	3436	38094	2797	39626	1837	47831	1373	32943
4L-5S		MI	16208	5863	26947	4192	29105	3393	29828	2752	30188	1760	36137	1227	25977
14-#14	2.92	MA	19657	5863	32395	4260	35285	3453	36427	2811	37255	1824	45019	1317	31840
5L-4S		MI	16712	5863	27795	4200	30203	3380	31158	2739	32050	1772	38329	1282	26861
14-#14	2.92	MA	19069	5863	31413	4254	33926	3444	34766	2801	35109	1837	42377	1235	31132
6L-3S		MI	17272	5863	28770	4183	31445	3391	32648	2752	33904	1760	40385	1403	26942
14-#14	2.92	MA	18496	5863	30336	4273	32628	3461	33170	2815	33011	1849	39553	1105	29894
7L-2S		MI	18053	5863	29952	4191	32960	3377	34478	2739	36330	1747	43564	1528	26948
14-#18	5.19	MA	22412	6710	39226	4771	43921	3793	46926	3003	51277	1729	63408	928	54104
4L-5S		MI	17484	6710	30906	4677	34003	3744	35567	2932	37805	1608	46352	682	42026
14-#18	5.19	MA	21364	6710	37391	4759	41543	3820	44005	3026	47184	1707	58557	833	52239
5L-4S		MI	18340	6710	32387	4694	35911	3721	37844	2910	40996	1630	50079	781	43593
14-#18	5.19	MA	20367	6710	35667	4746	39160	3803	41225	3048	43480	1729	54031	687	49193
6L-3S		MI	19291	6710	34087	4667	38067	3744	40398	2932	44170	1608	53585	990	45898
16-#11	2.31	MA	20344	5637	32972	4123	36103	3351	37456	2752	38716	1857	46209	1604	26600
3L-7S		MI	15376	5637	24990	4077	26656	3307	26922	2707	26419	1819	31343	1281	20872
16-#11	2.31	MA	19858	5637	32128	4137	35028	3345	36150	2746	37053	1865	44334	1517	26558
4L-6S		MI	15707	5637	25599	4065	27392	3297	27864	2716	27581	1811	32703	1347	21106
16-#11	2.31	MA	19423	5637	31397	4133	34081	3357	34986	2756	35386	1857	42355	1478	26313
5E		MI	16046	5637	26157	4070	28162	3304	28758	2707	28770	1802	34151	1404	21505
16-#11	2.31	MA	19008	5637	30711	4129	33131	3352	33826	2750	33875	1865	40491	1422	25743
6L-4S		MI	16402	5637	26750	4075	28930	3294	29697	2698	30084	1811	35704	1442	21711
16-#11	2.31	MA	18603	5637	29960	4143	32225	3364	32712	2760	32399	1874	38498	1331	25392
7L-3S		MI	16797	5637	27432	4063	29800	3301	30749	2707	31393	1802	37159	1527	21717
16-#11	2.31	MA	18205	5637	29285	4139	31306	3359	31624	2771	30830	1865	36648	1285	24677
8L-2S		MI	17350	5637	28261	4068	30863	3291	32042	2698	33107	1793	39412	1613	21696
16-#14	3.33	MA	20942	6018	34916	4363	38532	3506	40399	2839	42719	1821	51930	1340	37476
4L-6S		MI	16258	6018	27332	4281	29519	3452	30392	2805	30931	1752	37275	1103	29002
16-#14	3.33	MA	20328	6018	33869	4357	37175	3522	38732	2853	40349	1809	49118	1284	36249
5E		MI	16736	6018	28129	4289	30620	3463	31658	2793	32615	1740	39316	1185	29504
16-#14	3.33	MA	19744	6018	32886	4352	35815	3514	37070	2843	38202	1821	46476	1202	35574
6L-4S		MI	17237	6018	28977	4297	31718	3449	32988	2780	34476	1752	41508	1240	30449
16-#14	3.33	MA	19175	6018	31810	4371	34517	3531	35475	2857	36105	1834	43652	1072	34252
7L-3S		MI	17793	6018	29952	4280	32960	3461	34478	2793	36330	1740	43564	1361	30610
16-#14	3.33	MA	18615	6018	30842	4365	33200	3523	33917	2872	33873	1821	41024	1006	33087
8L-2S		MI	18570	6018	31134	4289	34476	3447	36308	2780	38757	1728	46743	1485	30646
16-#18	5.93	MA	22498	6987	39962	4932	44839	3944	48026	3101	52523	1676	65593	766	59650
5E		MI	18374	6987	32958	4850	36625	3867	38700	3001	41961	1568	51758	598	47879

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

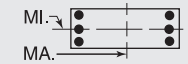
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	5.93	MA	21511	6987	38238	4919	42456	3927	45246	3124	48819	1698	61067	620	56744
6L-4S		MI	19222	6987	34439	4867	38533	3845	40978	2979	45152	1590	55484	696	49636
18-#11	2.60	MA	20331	5745	33159	4204	36350	3394	37763	2775	39229	1855	47226	1496	29750
4L-7S		MI	15753	5745	25819	4144	27719	3355	28214	2736	28133	1806	33596	1254	23324
18-#11	2.60	MA	19897	5745	32429	4200	35403	3406	36598	2786	37562	1847	45247	1456	29399
5L-6S		MI	16083	5745	26429	4132	28455	3345	29156	2745	29295	1798	34955	1320	23608
18-#11	2.60	MA	19484	5745	31743	4197	34454	3401	35439	2779	36052	1855	43382	1400	28857
6L-5S		MI	16421	5745	26986	4137	29225	3352	30050	2736	30484	1789	36404	1377	23984
18-#11	2.60	MA	19082	5745	30992	4210	33548	3413	34325	2789	34576	1864	41389	1310	28499
7L-4S		MI	16775	5745	27579	4143	29993	3342	30989	2727	31798	1798	37957	1414	24285
18-#11	2.60	MA	18686	5745	30316	4207	32628	3408	33237	2800	33007	1855	39540	1263	27750
8L-3S		MI	17168	5745	28261	4131	30863	3349	32042	2736	33107	1789	39412	1500	24311
18-#11	2.60	MA	18294	5745	29589	4220	31734	3420	32101	2793	31544	1864	37732	1209	27138
9L-2S		MI	17718	5745	29090	4136	31925	3339	33334	2727	34820	1781	41665	1586	24298
18-#14	3.75	MA	20994	6174	35343	4455	39064	3592	41036	2896	43443	1794	53217	1251	40668
5L-6S		MI	16784	6174	28514	4378	31034	3522	32222	2846	33358	1733	40454	1060	32436
18-#14	3.75	MA	20413	6174	34360	4449	37704	3584	39375	2885	41296	1806	50575	1169	39959
6L-5S		MI	17260	6174	29311	4386	32135	3533	33488	2833	35041	1720	42495	1143	33040
18-#14	3.75	MA	19848	6174	33284	4468	36406	3601	37780	2900	39198	1819	47751	1039	38621
7L-4S		MI	17758	6174	30159	4394	33233	3519	34818	2821	36903	1733	44687	1197	33927
18-#14	3.75	MA	19292	6174	32316	4462	35090	3593	36222	2914	36967	1806	45123	973	37393
8L-3S		MI	18312	6174	31134	4378	34476	3530	36308	2833	38757	1720	46743	1319	34271
18-#18	6.67	MA	22644	7263	40809	5092	45752	4051	49267	3199	54158	1667	68103	553	64319
6L-5S		MI	19256	7263	35011	5023	39247	3990	41833	3070	46117	1528	57164	513	53763
20-#11	2.89	MA	20369	5852	33460	4268	36725	3454	38211	2815	39739	1837	48138	1435	32494
5L-7S		MI	16128	5852	26648	4212	28782	3404	29506	2765	29847	1794	35849	1227	25765
20-#11	2.89	MA	19958	5852	32774	4264	35776	3449	37052	2808	38228	1846	46274	1379	31977
6E		MI	16457	5852	27258	4200	29518	3394	30449	2774	31008	1785	37208	1292	26114
20-#11	2.89	MA	19558	5852	32023	4278	34870	3461	35938	2819	36752	1854	44281	1288	31552
7L-5S		MI	16793	5852	27815	4205	30288	3401	31343	2765	32197	1776	38657	1349	26469
20-#11	2.89	MA	19164	5852	31347	4274	33951	3456	34850	2829	35183	1846	42431	1242	30830
8L-4S		MI	17145	5852	28408	4210	31056	3390	32282	2757	33511	1785	40210	1387	26854
20-#11	2.89	MA	18773	5852	30620	4288	33056	3468	33713	2823	33720	1854	40623	1187	30175
9L-3S		MI	17537	5852	29090	4198	31925	3397	33334	2765	34820	1776	41665	1472	26891
20-#14	4.17	MA	21078	6330	35834	4546	39594	3654	41680	2928	44389	1791	54674	1136	44287
6E		MI	17308	6330	29696	4475	32549	3592	34052	2887	35784	1713	43633	1018	35884
20-#14	4.17	MA	20516	6330	34758	4565	38296	3671	40085	2942	42292	1803	51850	1005	43000
7L-5S		MI	17780	6330	30493	4483	33651	3603	35318	2874	37468	1701	45675	1101	36585
20-#14	4.17	MA	19964	6330	33790	4559	36979	3663	38527	2956	40061	1791	49222	939	41710
8L-4S		MI	18276	6330	31341	4492	34749	3589	36648	2862	39329	1713	47866	1155	37420
22-#11	3.18	MA	20430	5960	33805	4332	37098	3498	38665	2838	40405	1836	49165	1357	35100
6L-7S		MI	16502	5960	27477	4279	29845	3452	30799	2794	31560	1781	38102	1199	28214
22-#11	3.18	MA	20031	5960	33054	4345	36192	3510	37551	2848	38929	1845	47172	1267	34612
7L-6S		MI	16828	5960	28087	4267	30580	3442	31741	2803	32722	1772	39461	1265	28622
22-#11	3.18	MA	19639	5960	32379	4342	35273	3504	36463	2859	37360	1836	45323	1220	33916
8L-5S		MI	17163	5960	28644	4272	31351	3449	32635	2794	33911	1764	40909	1322	28959
22-#11	3.18	MA	19251	5960	31652	4355	34378	3517	35326	2852	35897	1845	43515	1166	33219
9L-4S		MI	17514	5960	29237	4277	32119	3439	33574	2786	35225	1772	42463	1359	29420
22-#14	4.58	MA	21180	6485	36231	4662	40185	3741	42389	2985	45385	1788	55949	972	47388
7L-6S		MI	17828	6485	30878	4572	34065	3662	35882	2928	38211	1693	46812	976	39344
22-#14	4.58	MA	20631	6485	35263	4657	38868	3732	40832	2999	43154	1776	53321	906	46037
8L-5S		MI	18298	6485	31675	4581	35166	3673	37147	2915	39894	1681	48854	1059	40135

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

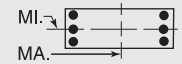
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	3.47	MA	20502	6068	34086	4413	37514	3558	39164	2878	41105	1835	50064	1245	37680
7E		MI	16873	6068	28306	4347	30908	3501	32091	2823	33274	1768	40355	1172	30669
24-#11	3.47	MA	20112	6068	33410	4409	36595	3553	38076	2888	39536	1826	48214	1199	37006
8L-6S		MI	17198	6068	28916	4334	31643	3490	33033	2832	34435	1760	41714	1238	31133
24-#11	3.47	MA	19725	6068	32683	4423	35701	3565	36939	2882	38073	1835	46407	1144	36268
9L-5S		MI	17532	6068	29473	4340	32413	3497	33927	2823	35624	1751	43162	1295	31454
24-#14	5.00	MA	21294	6641	36737	4754	40757	3802	43136	3041	46248	1760	57420	873	50374
8L-6S		MI	18346	6641	32060	4670	35580	3731	37712	2969	40637	1674	49992	934	42814

RECTANGULAR TIED COLUMNS 30" x 38"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.40	MA	21708	5592	34292	4103	36943	3339	37673	2776	37524	1960	43936	1826	18160
2E		MI	16971	5592	27086	4013	28821	3264	29066	2700	28615	1889	33137	1735	14042
6-#14	1.18	MA	21377	5506	33403	4079	35956	3325	36526	2774	36115	1992	42158	1874	15549
2L-3S		MI	15945	5506	25246	3989	26626	3272	26533	2724	25272	1943	28852	1673	12148
6-#14	1.18	MA	20309	5506	31832	4074	33942	3343	34070	2789	32798	2004	37752	1749	15619
3L-2S		MI	16744	5506	26428	3997	28141	3258	28363	2712	27699	1931	32031	1798	12066
6-#18	2.11	MA	22957	5869	37036	4276	40461	3463	41965	2852	43259	1932	51517	1764	26805
2L-3S		MI	16511	5869	27086	4169	28821	3409	29066	2791	28615	1872	33137	1429	20653
6-#18	2.11	MA	21123	5869	34292	4264	36943	3492	37673	2876	37524	1954	43936	1542	26793
3L-2S		MI	17879	5869	29139	4186	31443	3387	32199	2769	32771	1850	38543	1650	20566
8-#11	1.09	MA	21240	5470	33025	4072	35551	3322	36061	2775	35545	2006	41441	1894	14471
2L-4S		MI	15686	5470	24635	4001	25921	3261	25733	2719	24308	1967	27881	1653	11359
8-#11	1.09	MA	20492	5470	31927	4069	34142	3335	34343	2786	33214	2015	38336	1808	14519
3E		MI	16089	5470	25317	3989	26791	3268	26786	2728	25617	1958	29336	1738	11299
8-#11	1.09	MA	19963	5470	31029	4083	32999	3330	32953	2780	31432	2023	36320	1722	14559
4L-2S		MI	16651	5470	26147	3995	27854	3258	28078	2719	27330	1949	31589	1825	11246
8-#14	1.58	MA	22105	5661	34974	4176	37970	3395	38983	2816	39431	1978	46565	1843	20505
2L-4S		MI	15912	5661	25453	4103	26899	3331	26872	2753	25845	1936	29975	1509	15943
8-#14	1.58	MA	21044	5661	33403	4171	35956	3413	36526	2831	36115	1990	42158	1718	20551
3E		MI	16483	5661	26428	4086	28141	3342	28363	2765	27699	1924	32031	1631	15897
8-#14	1.58	MA	20294	5661	32118	4191	34319	3405	34536	2822	33580	2003	39302	1594	20519
4L-2S		MI	17278	5661	27610	4095	29656	3328	30192	2753	30125	1911	35210	1755	15829
8-#18	2.81	MA	24189	6145	39781	4449	43979	3587	46257	2927	48993	1903	59099	1701	35405
2L-4S		MI	16442	6145	27438	4368	29287	3510	29645	2838	29597	1854	35036	1135	25984
8-#18	2.81	MA	22374	6145	37036	4437	40461	3616	41965	2951	43259	1925	51517	1480	35279
3E		MI	17420	6145	29139	4341	31443	3532	32199	2860	32771	1832	38543	1344	27037
8-#18	2.81	MA	21087	6145	34785	4470	37592	3601	38479	2931	38876	1947	46618	1259	33856
4L-2S		MI	18777	6145	31191	4359	34064	3510	35332	2838	36927	1810	43949	1566	27036
10-#11	1.37	MA	21754	5578	34124	4140	36960	3370	37780	2804	37876	1997	44546	1874	17939
2L-5S		MI	15707	5578	24871	4064	26216	3320	26086	2757	24707	1945	28581	1588	14009
10-#11	1.37	MA	21009	5578	33025	4137	35551	3383	36061	2815	35545	2006	41441	1788	17977
3L-4S		MI	16068	5578	25464	4069	26984	3310	27026	2748	26021	1954	30134	1625	13981
10-#11	1.37	MA	20483	5578	32128	4151	34407	3378	34671	2809	33763	2014	39425	1701	17998
4L-3S		MI	16469	5578	26147	4057	27854	3317	28078	2757	27330	1945	31589	1711	13934
10-#11	1.37	MA	20013	5578	31351	4147	33400	3391	33434	2820	31978	2006	37305	1661	17960
5L-2S		MI	17029	5578	26976	4062	28916	3307	29370	2748	29044	1937	33842	1797	13886
10-#14	1.97	MA	22826	5817	36545	4274	39984	3465	41440	2859	42748	1964	50972	1812	25441
2L-5S		MI	15937	5817	25787	4192	27316	3414	27372	2806	26410	1904	30962	1413	19150
10-#14	1.97	MA	21773	5817	34974	4268	37970	3482	38983	2874	39431	1976	46565	1687	25458
3L-4S		MI	16448	5817	26635	4200	28414	3400	28702	2794	28271	1916	33154	1467	19626
10-#14	1.97	MA	21028	5817	33689	4288	36333	3475	36993	2864	36897	1988	43708	1563	25378
4L-3S		MI	17016	5817	27610	4184	29656	3411	30192	2806	30125	1904	35210	1589	19619
10-#14	1.97	MA	20361	5817	32575	4283	34890	3493	35220	2879	34356	1976	40693	1506	24665
5L-2S		MI	17807	5817	28792	4192	31172	3398	32022	2794	32552	1891	38389	1713	19569
10-#18	3.51	MA	25406	6422	42525	4621	47497	3712	50548	3002	54728	1874	66680	1639	43952
2L-5S		MI	16476	6422	28010	4524	30001	3656	30501	2929	30562	1792	36716	952	30518

RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis



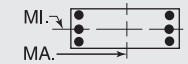
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	3.51	MA	23608	6422	39781	4610	43979	3740	46257	3027	48993	1896	59099	1418	43739
3L-4S		MI	17350	6422	29491	4541	31909	3634	32778	2907	33753	1814	40442	1050	31909
10-#18	3.51	MA	22335	6422	37529	4643	41110	3725	42770	3007	44611	1918	54199	1196	41854
4L-3S		MI	18320	6422	31191	4514	34064	3656	35332	2929	36927	1792	43949	1259	33385
10-#18	3.51	MA	21196	6422	35575	4632	38579	3753	39661	3031	40216	1896	48986	1099	39670
5L-2S		MI	19665	6422	33244	4532	36686	3634	38465	2907	41083	1770	49354	1481	33475
12-#11	1.64	MA	22264	5686	35223	4207	38368	3419	39498	2834	40207	1988	47651	1854	21396
2L-6S		MI	15745	5686	25143	4126	26509	3361	26485	2795	25232	1941	29385	1504	16251
12-#11	1.64	MA	21523	5686	34124	4204	36960	3431	37780	2845	37876	1997	44546	1768	21423
3L-5S		MI	16088	5686	25700	4131	27279	3368	27379	2786	26421	1933	30833	1561	16595
12-#11	1.64	MA	21000	5686	33227	4218	35816	3427	36390	2839	36094	2005	42530	1681	21420
4E		MI	16447	5686	26293	4136	28047	3358	28318	2777	27735	1941	32387	1598	16589
12-#11	1.64	MA	20531	5686	32450	4215	34809	3439	35152	2850	34309	1997	40410	1641	21359
5L-3S		MI	16847	5686	26976	4124	28916	3365	29370	2786	29044	1933	33842	1684	16555
12-#11	1.64	MA	20085	5686	31721	4212	33800	3435	33919	2844	32691	2005	38406	1585	20829
6L-2S		MI	17404	5686	27805	4129	29979	3355	30663	2777	30757	1924	36094	1770	16514
12-#14	2.37	MA	23542	5972	38116	4371	41998	3535	43897	2901	46064	1950	55378	1781	30364
2L-6S		MI	15988	5972	26172	4281	27730	3473	27936	2860	27153	1897	32100	1288	22117
12-#14	2.37	MA	22495	5972	36545	4366	39984	3552	41440	2916	42748	1962	50972	1656	30345
3L-5S		MI	16473	5972	26969	4289	28831	3484	29202	2847	28836	1884	34142	1371	22648
12-#14	2.37	MA	21755	5972	35260	4385	38347	3545	39450	2907	40213	1974	48115	1532	30228
4E		MI	16981	5972	27817	4298	29930	3470	30532	2835	30698	1897	36333	1425	23293
12-#14	2.37	MA	21093	5972	34146	4380	36904	3562	37677	2922	37673	1962	45099	1475	29335
5L-3S		MI	17546	5972	28792	4281	31172	3481	32022	2847	32552	1884	38389	1547	23327
12-#14	2.37	MA	20463	5972	33102	4375	35458	3555	35911	2912	35371	1974	42257	1393	28493
6L-2S		MI	18332	5972	29974	4289	32687	3468	33852	2835	34978	1872	41569	1671	23292
12-#18	4.21	MA	24828	6699	42525	4783	47497	3864	50548	3102	54728	1868	66680	1355	52184
3L-5S		MI	17383	6699	30062	4697	32622	3779	33634	2998	34718	1752	42122	867	36605
12-#18	4.21	MA	23568	6699	40273	4816	44628	3849	47062	3082	50345	1890	61780	1134	49902
4E		MI	18249	6699	31543	4714	34530	3757	35911	2976	37909	1774	45848	965	37882
12-#18	4.21	MA	22440	6699	38320	4805	42097	3877	43952	3106	45951	1868	56568	1036	47860
5L-3S		MI	19211	6699	33244	4687	36686	3779	38465	2998	41083	1752	49354	1175	39710
12-#18	4.21	MA	21368	6699	36486	4794	39560	3862	40853	3086	41971	1890	51686	891	44787
6L-2S		MI	20546	6699	35296	4704	39308	3757	41598	2976	45239	1730	54760	1396	39866
14-#11	1.92	MA	22771	5794	36322	4275	39777	3467	41216	2863	42539	1979	50756	1834	24844
2L-7S		MI	15792	5794	25362	4205	26836	3420	26835	2815	25784	1937	30279	1410	18494
14-#11	1.92	MA	22033	5794	35223	4271	38368	3480	39498	2874	40207	1987	47651	1748	24861
3L-6S		MI	16125	5794	25972	4193	27571	3410	27777	2824	26945	1929	31638	1476	18742
14-#11	1.92	MA	21513	5794	34325	4285	37224	3475	38108	2868	38425	1996	45635	1661	24834
4L-5S		MI	16467	5794	26529	4199	28341	3417	28671	2815	28134	1920	33086	1533	19170
14-#11	1.92	MA	21047	5794	33549	4282	36217	3488	36871	2879	36640	1987	43515	1621	24752
5L-4S		MI	16824	5794	27122	4204	29110	3406	29610	2806	29448	1929	34639	1571	19187
14-#11	1.92	MA	20603	5794	32820	4279	35208	3483	35638	2873	35023	1996	41511	1565	24135
6L-3S		MI	17222	5794	27805	4192	29979	3414	30663	2815	30757	1920	36094	1656	19165
14-#11	1.92	MA	20171	5794	32022	4293	34246	3496	34454	2884	33442	2005	39371	1475	23727
7L-2S		MI	17778	5794	28634	4197	31042	3403	31955	2806	32471	1911	38347	1743	19132
14-#14	2.76	MA	23211	6128	38116	4463	41998	3622	43897	2959	46064	1948	55378	1625	35220
3L-6S		MI	16523	6128	27354	4378	29245	3543	29766	2900	29579	1877	35279	1246	25666
14-#14	2.76	MA	22476	6128	36831	4483	40361	3615	41907	2949	43529	1960	52521	1501	35070
4L-5S		MI	17005	6128	28151	4387	30347	3554	31032	2888	31263	1864	37321	1329	26161
14-#14	2.76	MA	21819	6128	35717	4477	38918	3632	40134	2964	40989	1948	49506	1444	34022
5L-4S		MI	17510	6128	28999	4395	31445	3540	32362	2876	33125	1877	39513	1383	26948
14-#14	2.76	MA	21193	6128	34673	4472	37472	3625	38368	2955	38688	1960	46664	1362	33224
6L-3S		MI	18072	6128	29974	4378	32687	3551	33852	2888	34978	1864	41569	1504	27011

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis

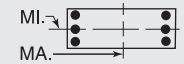


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.76	MA	20583	6128	33529	4492	36092	3642	36671	2970	36439	1973	43627	1232	32026
7L-2S		MI	18854	6128	31156	4386	34202	3537	35682	2876	37405	1852	44748	1629	27004
14-#18	4.91	MA	24788	6975	43017	4989	48146	3973	51354	3157	56080	1861	69362	1072	57990
4L-5S		MI	18281	6975	32115	4870	35244	3902	36767	3067	38874	1712	47527	782	42515
14-#18	4.91	MA	23671	6975	41064	4978	45615	4002	48244	3182	51685	1839	64149	974	56071
5L-4S		MI	19140	6975	33596	4887	37152	3880	39044	3045	42065	1734	51254	881	43892
14-#18	4.91	MA	22609	6975	39230	4967	43078	3986	45145	3162	47706	1861	59267	829	52832
6L-3S		MI	20094	6975	35296	4860	39308	3902	41598	3067	45239	1712	54760	1090	46019
16-#11	2.19	MA	22540	5902	36322	4339	39777	3528	41216	2904	42539	1978	50756	1728	28285
3L-7S		MI	16171	5902	26191	4273	27898	3468	28127	2844	27497	1924	32531	1383	21005
16-#11	2.19	MA	22022	5902	35424	4353	38633	3524	39827	2897	40757	1987	48740	1641	28242
4L-6S		MI	16503	5902	26801	4261	28634	3458	29070	2853	28659	1916	33891	1449	21240
16-#11	2.19	MA	21559	5902	34647	4350	37626	3536	38589	2909	38972	1978	46620	1601	28097
5E		MI	16843	5902	27358	4266	29404	3465	29964	2844	29848	1907	35339	1506	21652
16-#11	2.19	MA	21118	5902	33919	4346	36617	3532	37356	2902	37354	1987	44616	1545	27449
6L-4S		MI	17200	5902	27951	4271	30172	3455	30903	2835	31162	1916	36892	1543	21773
16-#11	2.19	MA	20688	5902	33121	4360	35654	3544	36172	2914	35773	1996	42476	1455	27057
7L-3S		MI	17596	5902	28634	4259	31042	3462	31955	2844	32471	1907	38347	1629	21768
16-#11	2.19	MA	20264	5902	32403	4357	34677	3539	35017	2925	34093	1987	40494	1407	26377
8L-2S		MI	18149	5902	29463	4264	32105	3452	33247	2835	34185	1899	40600	1715	21743
16-#14	3.16	MA	23192	6284	38402	4580	42375	3685	44364	2991	46846	1946	56928	1470	39906
4L-6S		MI	17054	6284	28536	4476	30761	3613	31596	2941	32006	1857	38459	1204	29221
16-#14	3.16	MA	22539	6284	37288	4575	40932	3702	42591	3007	44306	1934	53913	1413	38724
5E		MI	17533	6284	29333	4484	31862	3624	32862	2929	33689	1845	40500	1286	29688
16-#14	3.16	MA	21917	6284	36244	4570	39486	3695	40825	2997	42004	1946	51071	1332	37963
6L-4S		MI	18036	6284	30181	4492	32960	3610	34192	2916	35551	1857	42692	1341	30594
16-#14	3.16	MA	21311	6284	35100	4589	38106	3712	39128	3012	39755	1959	48034	1201	36677
7L-3S		MI	18594	6284	31156	4475	34202	3621	35682	2929	37405	1845	44748	1462	30684
16-#14	3.16	MA	20715	6284	34071	4584	36706	3705	37472	3028	37364	1946	45216	1134	35561
8L-2S		MI	19372	6284	32338	4484	35717	3607	37512	2916	39831	1832	47927	1587	30710
16-#18	5.61	MA	24890	7252	43808	5151	49133	4126	52536	3257	57420	1810	71730	912	64202
5E		MI	19172	7252	34168	5043	37866	4026	39900	3136	43029	1672	52933	698	48360
16-#18	5.61	MA	23838	7252	41974	5140	46596	4110	49437	3237	53441	1832	66848	766	60903
6L-4S		MI	20024	7252	35649	5060	39774	4004	42178	3114	46220	1694	56659	796	49932
18-#11	2.46	MA	22529	6010	36523	4420	40042	3572	41545	2927	43088	1978	51845	1621	31646
4L-7S		MI	16549	6010	27020	4340	28961	3517	29420	2873	29211	1912	34784	1356	23517
18-#11	2.46	MA	22068	6010	35746	4417	39034	3585	40307	2938	41303	1969	49725	1581	31386
5L-6S		MI	16879	6010	27630	4328	29697	3506	30362	2882	30372	1903	36144	1422	23742
18-#11	2.46	MA	21629	6010	35017	4414	38026	3580	39075	2932	39685	1978	47721	1525	30768
6L-5S		MI	17218	6010	28187	4333	30467	3513	31256	2873	31561	1894	37592	1479	24130
18-#11	2.46	MA	21201	6010	34219	4428	37063	3593	37891	2943	38104	1987	45581	1435	30390
7L-4S		MI	17573	6010	28780	4339	31235	3503	32195	2864	32875	1903	39145	1516	24352
18-#11	2.46	MA	20780	6010	33502	4425	36086	3588	36735	2954	36424	1978	43599	1387	29655
8L-3S		MI	17967	6010	29463	4327	32105	3510	33247	2873	34185	1894	40600	1601	24365
18-#11	2.46	MA	20363	6010	32729	4439	35136	3600	35527	2948	34857	1987	41656	1333	29059
9L-2S		MI	18519	6010	30292	4332	33168	3500	34540	2864	35898	1886	42853	1688	24347
18-#14	3.55	MA	23253	6439	38859	4672	42946	3772	45048	3049	47622	1920	58319	1382	43437
5L-6S		MI	17581	6439	29718	4573	32276	3682	33426	2982	34433	1837	41638	1162	32741
18-#14	3.55	MA	22636	6439	37815	4667	41500	3764	43282	3040	45321	1932	55477	1301	42709
6L-5S		MI	18058	6439	30515	4581	33377	3694	34692	2970	36116	1825	43679	1244	33224
18-#14	3.55	MA	22034	6439	36671	4686	40120	3782	41585	3055	43072	1945	52440	1170	41339
7L-4S		MI	18558	6439	31363	4589	34475	3680	36022	2957	37978	1837	45871	1299	34145
18-#14	3.55	MA	21442	6439	35642	4681	38720	3775	39929	3070	40681	1932	49622	1103	40159
8L-3S		MI	19113	6439	32338	4573	35717	3691	37512	2970	39831	1825	47927	1420	34349
18-#18	6.32	MA	25056	7529	44718	5312	50114	4234	53728	3313	59175	1804	74430	704	68999
6L-5S		MI	20056	7529	36220	5216	40487	4149	43033	3205	47185	1632	58339	613	54238
20-#11	2.74	MA	22574	6118	36845	4485	40443	3633	42026	2967	43634	1960	52830	1561	34683
5L-7S		MI	16925	6118	27849	4408	30024	3565	30712	2902	30924	1899	37037	1328	25984

RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

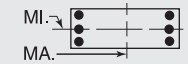
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.74	MA	22138	6118	36116	4481	39434	3628	40793	2961	42016	1969	50826	1505	34093
6E		MI	17254	6118	28459	4396	30760	3555	31654	2911	32086	1890	38397	1394	26248
20-#11	2.74	MA	21712	6118	35318	4495	38471	3641	39609	2972	40435	1978	48686	1415	33727
7L-5S		MI	17591	6118	29016	4401	31530	3562	32548	2902	33275	1882	39845	1451	26615
20-#11	2.74	MA	21293	6118	34601	4492	37495	3636	38454	2983	38755	1969	46704	1367	32939
8L-4S		MI	17944	6118	29609	4406	32298	3552	33488	2894	34589	1890	41398	1489	26925
20-#11	2.74	MA	20878	6118	33828	4506	36544	3649	37246	2977	37188	1978	44761	1313	32336
9L-3S		MI	18337	6118	30292	4394	33168	3559	34540	2902	35898	1882	42853	1574	26952
20-#11	2.74	MA	20419	6118	33113	4503	35581	3644	36096	2988	35634	1986	42880	1252	31433
10L-2S		MI	18886	6118	31121	4399	34230	3549	35832	2894	37612	1873	45106	1660	26947
20-#14	3.95	MA	23349	6595	39386	4764	43514	3834	45739	3082	48637	1918	59884	1270	47461
6E		MI	18106	6595	30900	4670	33791	3752	35256	3023	36859	1818	44817	1120	36185
20-#14	3.95	MA	22752	6595	38242	4784	42134	3852	44042	3097	46388	1931	56847	1139	46012
7L-5S		MI	18580	6595	31697	4678	34892	3763	36521	3011	38543	1805	46858	1202	36768
20-#14	3.95	MA	22163	6595	37213	4779	40734	3844	42386	3112	43997	1918	54029	1072	44769
8L-4S		MI	19077	6595	32545	4687	35991	3750	37851	2998	40404	1818	49050	1256	37636
22-#11	3.01	MA	22643	6226	37215	4549	40843	3677	42511	2991	44347	1960	53931	1485	37422
6L-7S		MI	17299	6226	28678	4475	31087	3613	32005	2931	32638	1886	39290	1301	28431
22-#11	3.01	MA	22220	6226	36417	4563	39880	3689	41328	3002	42766	1969	51791	1395	37016
7L-6S		MI	17626	6226	29288	4463	31823	3603	32947	2940	33799	1878	40649	1367	28758
22-#11	3.01	MA	21802	6226	35699	4560	38903	3685	40172	3013	41086	1960	49809	1347	36229
8L-5S		MI	17962	6226	29845	4468	32593	3610	33841	2931	34988	1869	42098	1424	29105
22-#11	3.01	MA	21389	6226	34927	4574	37953	3697	38964	3007	39519	1969	47866	1293	35582
9L-4S		MI	18314	6226	30438	4473	33361	3600	34780	2923	36302	1878	43651	1461	29493
22-#11	3.01	MA	20933	6226	34211	4570	36989	3693	37814	3018	37966	1977	45985	1232	34703
10L-3S		MI	18705	6226	31121	4461	34230	3607	35832	2931	37612	1869	45106	1547	29533
22-#14	4.34	MA	23464	6751	39813	4881	44148	3922	46499	3140	49705	1917	61254	1108	50694
7L-6S		MI	18627	6751	32082	4767	35307	3822	37086	3064	39286	1798	47996	1077	39642
22-#14	4.34	MA	22880	6751	38784	4876	42748	3914	44843	3155	47314	1904	58435	1041	49389
8L-5S		MI	19099	6751	32879	4776	36408	3833	38351	3051	40969	1786	50038	1160	40318
24-#11	3.28	MA	22725	6333	37516	4630	41289	3738	43046	3031	45097	1960	54896	1375	40286
7E		MI	17671	6333	29507	4543	32150	3662	33297	2960	34351	1873	41543	1274	30885
24-#11	3.28	MA	22309	6333	36798	4627	40312	3733	41891	3042	43417	1951	52914	1327	39524
8L-6S		MI	17997	6333	30117	4531	32885	3652	34239	2969	35513	1865	42902	1339	31269
24-#11	3.28	MA	21898	6333	36026	4641	39362	3746	40682	3036	41850	1960	50971	1273	38835
9L-5S		MI	18332	6333	30674	4536	33656	3659	35133	2960	36702	1856	44351	1396	31600
24-#11	3.28	MA	21444	6333	35310	4638	38398	3741	39533	3047	40297	1968	49090	1212	37978
10L-4S		MI	18682	6333	31267	4541	34424	3649	36072	2952	38016	1865	45904	1434	32059
24-#14	4.74	MA	23591	6906	40355	4973	44762	3984	47300	3197	50630	1890	62842	1010	54019
8L-6S		MI	19146	6906	33264	4865	36822	3892	38915	3105	41712	1778	51175	1035	43110

RECTANGULAR TIED COLUMNS 30" x 40"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.33	MA	23957	5857	37680	4318	40623	3516	41397	2927	41199	2080	48239	1946	19240
2E		MI	17768	5857	28295	4206	30062	3422	30266	2835	29684	1993	34312	1835	14089
6-#14	1.13	MA	23598	5771	36728	4295	39565	3503	40168	2924	39672	2111	46300	1992	16461
2L-3S		MI	16741	5771	26451	4184	27868	3432	27737	2861	26347	2048	30036	1774	12187
6-#14	1.13	MA	22463	5771	35059	4290	37426	3521	37559	2940	36132	2123	41586	1867	16530
3L-2S		MI	17541	5771	27633	4192	29383	3419	29566	2848	28773	2036	33215	1899	12104
6-#18	2.00	MA	25294	6134	40597	4491	44362	3641	45960	3002	47329	2053	56366	1888	28425
2L-3S		MI	17307	6134	28295	4362	30062	3568	30266	2926	29684	1975	34312	1529	20722
6-#18	2.00	MA	23340	6134	37680	4481	40623	3671	41397	3028	41199	2076	48239	1666	28413
3L-2S		MI	18678	6134	30348	4379	32684	3546	33399	2904	33840	1953	39718	1750	20623
8-#11	1.04	MA	23451	5736	36324	4288	39130	3499	39669	2925	39037	2123	45518	2011	15314
2L-4S		MI	16482	5736	25836	4198	27163	3422	26939	2856	25385	2072	29069	1755	11396
8-#11	1.04	MA	22655	5736	35158	4285	37635	3512	37846	2937	36555	2132	42199	1925	15361
3E		MI	16885	5736	26519	4185	28033	3430	27991	2865	26694	2063	30524	1840	11333

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

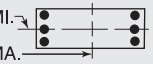
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	1.04	MA	22094	5736	34206	4299	36423	3508	36372	2931	34659	2141	40042	1839	15402
4L-2S		MI	17448	5736	27348	4191	29096	3419	29284	2856	28408	2055	32777	1926	11279
8-#14	1.50	MA	24377	5926	38396	4392	41703	3572	42777	2967	43211	2098	51015	1963	21720
2L-4S		MI	16707	5926	26658	4298	28141	3491	28076	2889	26920	2041	31159	1611	15999
8-#14	1.50	MA	23248	5926	36728	4387	39565	3591	40168	2983	39672	2110	46300	1838	21766
3E		MI	17279	5926	27633	4281	29383	3502	29566	2902	28773	2028	33215	1732	15943
8-#14	1.50	MA	22452	5926	35365	4407	37828	3584	38058	2974	36966	2122	43239	1714	21734
4L-2S		MI	18075	5926	28815	4290	30898	3488	31396	2889	31200	2016	36394	1857	15872
8-#18	2.67	MA	26613	6411	43514	4664	48102	3765	50522	3078	53460	2027	64494	1830	37565
2L-4S		MI	17237	6411	28648	4561	30528	3669	30845	2973	30666	1957	36211	1235	26291
8-#18	2.67	MA	24679	6411	40597	4654	44362	3795	45960	3103	47329	2049	56366	1608	37439
3E		MI	18218	6411	30348	4534	32684	3691	33399	2995	33840	1935	39718	1444	27124
8-#18	2.67	MA	23312	6411	38208	4688	41317	3780	42260	3085	42644	2071	51104	1387	36228
4L-2S		MI	19577	6411	32401	4552	35305	3669	36532	2973	37996	1913	45124	1666	27100
10-#11	1.30	MA	24000	5843	37490	4355	40625	3548	41493	2955	41518	2115	48837	1993	18992
2L-5S		MI	16502	5843	26073	4260	27458	3481	27292	2894	25785	2051	29769	1690	14061
10-#11	1.30	MA	23207	5843	36324	4352	39130	3561	39669	2966	39037	2124	45518	1906	19030
3L-4S		MI	16864	5843	26666	4265	28226	3471	28231	2885	27099	2059	31322	1727	14024
10-#11	1.30	MA	22649	5843	35373	4367	37918	3557	38196	2961	37141	2133	43360	1820	19051
4L-3S		MI	17266	5843	27348	4253	29096	3478	29284	2894	28408	2051	32777	1813	13973
10-#11	1.30	MA	22151	5843	34550	4364	36851	3570	36885	2972	35242	2124	41100	1779	19013
5L-2S		MI	17826	5843	28177	4258	30159	3468	30576	2885	30122	2042	35030	1899	13924
10-#14	1.88	MA	25148	6082	40064	4489	43842	3642	45386	3009	46751	2084	55729	1934	26960
2L-5S		MI	16732	6082	26992	4387	28558	3575	28576	2943	27485	2009	32146	1514	19332
10-#14	1.88	MA	24027	6082	38396	4484	41703	3660	42777	3025	43211	2097	51015	1809	26977
3L-4S		MI	17245	6082	27840	4395	29656	3561	29906	2930	29346	2021	34338	1569	19695
10-#14	1.88	MA	23236	6082	37033	4505	39967	3654	40667	3016	40506	2109	47954	1685	26897
4L-3S		MI	17813	6082	28815	4379	30898	3572	31396	2943	31200	2009	36394	1690	19671
10-#14	1.88	MA	22529	6082	35854	4500	38437	3672	38788	3032	37796	2097	44735	1627	26276
5L-2S		MI	18605	6082	29997	4387	32413	3558	33226	2930	33626	1996	39573	1815	19617
10-#18	3.33	MA	27916	6687	46432	4837	51841	3889	55084	3153	59590	2000	72621	1771	46652
2L-5S		MI	17271	6687	29219	4717	31242	3814	31701	3064	31631	1895	37891	1052	30781
10-#18	3.33	MA	26000	6687	43514	4827	48102	3919	50522	3179	53460	2022	64494	1550	46439
3L-4S		MI	18146	6687	30700	4734	33150	3792	33978	3042	34822	1918	41617	1150	32210
10-#18	3.33	MA	24647	6687	41125	4861	45057	3905	46822	3160	48774	2044	59232	1328	44741
4L-3S		MI	19119	6687	32401	4707	35305	3814	36532	3064	37996	1895	45124	1360	33483
10-#18	3.33	MA	23437	6687	39054	4851	42372	3935	43524	3186	44078	2022	53659	1229	42294
5L-2S		MI	20468	6687	34453	4725	37927	3792	39665	3042	42151	1873	50529	1581	33542
12-#11	1.56	MA	24545	5951	38656	4423	42120	3596	43317	2984	44000	2106	52155	1974	22659
2L-6S		MI	16540	5951	26345	4322	27751	3522	27691	2932	26309	2047	30573	1605	16380
12-#11	1.56	MA	23756	5951	37490	4420	40625	3609	41493	2996	41518	2115	48837	1888	22686
3L-5S		MI	16884	5951	26902	4327	28521	3529	28585	2923	27498	2038	32022	1662	16655
12-#11	1.56	MA	23201	5951	36539	4434	39413	3605	40020	2990	39622	2124	46679	1801	22684
4E		MI	17244	5951	27495	4332	29289	3519	29524	2914	28812	2047	33575	1700	16636
12-#11	1.56	MA	22705	5951	35716	4431	38346	3618	38709	3002	37724	2116	44418	1761	22622
5L-3S		MI	17644	5951	28177	4320	30159	3526	30576	2923	30122	2038	35030	1785	16598
12-#11	1.56	MA	22232	5951	34944	4428	37277	3614	37403	2996	36003	2124	42275	1704	22135
6L-2S		MI	18202	5951	29006	4326	31221	3516	31868	2914	31835	2029	37283	1872	16555
12-#14	2.25	MA	25913	6238	41733	4586	45981	3712	47995	3052	50290	2071	60444	1905	32186
2L-6S		MI	16783	6238	27377	4476	28972	3633	29140	2996	28228	2001	33284	1389	22285
12-#14	2.25	MA	24799	6238	40064	4582	43842	3730	45386	3068	46751	2084	55729	1780	32167
3L-5S		MI	17269	6238	28174	4484	30073	3644	30406	2983	29911	1989	35326	1472	22828
12-#14	2.25	MA	24013	6238	38702	4602	42105	3724	43276	3059	44045	2096	52668	1656	32050
4E		MI	17778	6238	29022	4493	31171	3631	31736	2971	31773	2001	37517	1526	23368

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis



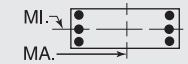
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	2.25	MA	23311	6238	37522	4597	40576	3742	41397	3075	41335	2084	49450	1598	31238
5L-3S		MI	18344	6238	29997	4476	32413	3642	33226	2983	33626	1989	39573	1648	23382
12-#14	2.25	MA	22643	6238	36416	4593	39044	3735	39525	3066	38879	2096	46407	1517	30298
6L-2S		MI	19131	6238	31179	4484	33929	3628	35056	2971	36053	1976	42753	1772	23344
12-#18	4.00	MA	27307	6964	46432	5000	51841	4043	55084	3254	59590	1996	72621	1492	55424
3L-5S		MI	18178	6964	31272	4890	33863	3938	34834	3133	35787	1855	43297	967	36867
12-#18	4.00	MA	25967	6964	44042	5034	48796	4029	51384	3236	54905	2018	67359	1270	53304
4E		MI	19047	6964	32753	4907	35771	3916	37111	3111	38977	1878	47023	1066	38178
12-#18	4.00	MA	24769	6964	41971	5024	46112	4059	48086	3262	50208	1996	61786	1171	51008
5L-3S		MI	20012	6964	34453	4880	37927	3938	39665	3133	42151	1855	50529	1275	39817
12-#18	4.00	MA	23630	6964	40027	5014	43422	4044	44799	3243	45954	2018	56548	1026	47944
6L-2S		MI	21350	6964	36506	4897	40549	3916	42798	3111	46307	1833	55935	1496	39949
14-#11	1.82	MA	25087	6059	39822	4490	43615	3645	45141	3014	46481	2098	55474	1955	26319
2L-7S		MI	16587	6059	26564	4401	28078	3581	28041	2952	26861	2042	31467	1512	18620
14-#11	1.82	MA	24301	6059	38656	4487	42120	3658	43317	3025	44000	2106	52155	1869	26335
3L-6S		MI	16921	6059	27174	4389	28814	3571	28983	2961	28023	2034	32826	1578	18871
14-#11	1.82	MA	23749	6059	37705	4502	40908	3653	41844	3020	42104	2115	49998	1783	26309
4L-5S		MI	17263	6059	27731	4395	29584	3578	29877	2952	29212	2025	34275	1635	19235
14-#11	1.82	MA	23255	6059	36882	4499	39841	3666	40533	3031	40205	2107	47737	1742	26226
5L-4S		MI	17621	6059	28324	4400	30352	3568	30816	2943	30526	2034	35828	1673	19239
14-#11	1.82	MA	22785	6059	36111	4496	38772	3662	39227	3026	38484	2116	45593	1686	25645
6L-3S		MI	18020	6059	29006	4388	31221	3575	31868	2952	31835	2025	37283	1758	19212
14-#11	1.82	MA	22327	6059	35265	4510	37753	3675	37974	3037	36803	2125	43306	1596	25191
7L-2S		MI	18576	6059	29835	4393	32284	3565	33161	2943	33549	2017	39536	1844	19176
14-#14	2.63	MA	25564	6393	41733	4679	45981	3800	47995	3110	50290	2071	60444	1752	37347
3L-6S		MI	17318	6393	28559	4573	30487	3703	30970	3037	30654	1982	36463	1347	25834
14-#14	2.63	MA	24784	6393	40370	4699	44244	3793	45885	3101	47585	2083	57383	1627	37196
4L-5S		MI	17801	6393	29356	4582	31588	3714	32236	3024	32338	1969	38505	1430	26341
14-#14	2.63	MA	24087	6393	39190	4695	42715	3811	44006	3117	44875	2071	54164	1569	36218
5L-4S		MI	18308	6393	30204	4590	32687	3701	33566	3012	34199	1982	40696	1484	27030
14-#14	2.63	MA	23423	6393	38084	4690	41183	3805	42134	3108	42418	2083	51121	1488	35325
6L-3S		MI	18871	6393	31179	4573	33929	3712	35056	3024	36053	1969	42753	1606	27078
14-#14	2.63	MA	22776	6393	36872	4710	39721	3823	40337	3124	40018	2096	47872	1358	34180
7L-2S		MI	19654	6393	32361	4581	35444	3698	36886	3012	38480	1957	45932	1730	27059
14-#18	4.67	MA	27273	7240	46959	5207	52536	4153	55946	3311	61035	1991	75487	1212	61909
4L-5S		MI	19078	7240	33325	5063	36485	4061	37967	3202	39942	1816	48702	883	42973
14-#18	4.67	MA	26087	7240	44888	5197	49851	4183	52648	3337	56339	1969	69914	1112	59745
5L-4S		MI	19940	7240	34806	5080	38393	4039	40244	3180	43133	1838	52429	981	44184
14-#18	4.67	MA	24959	7240	42944	5187	47162	4169	49361	3319	52085	1991	64676	967	56510
6L-3S		MI	20897	7240	36506	5053	40549	4061	42798	3202	46307	1816	55935	1190	46135
16-#11	2.08	MA	24843	6167	39822	4555	43615	3706	45141	3055	46481	2098	55474	1850	29970
3L-7S		MI	16967	6167	27393	4469	29141	3629	29333	2981	28575	2030	33720	1485	21131
16-#11	2.08	MA	24294	6167	38871	4569	42403	3702	43668	3049	44585	2107	53317	1764	29927
4L-6S		MI	17299	6167	28003	4457	29876	3619	30275	2990	29736	2021	35079	1551	21368
16-#11	2.08	MA	23802	6167	38048	4566	41336	3715	42357	3061	42687	2098	51056	1723	29826
5E		MI	17640	6167	28560	4462	30646	3626	31169	2981	30925	2012	36527	1608	21795
16-#11	2.08	MA	23335	6167	37277	4563	40267	3711	41051	3055	40966	2107	48912	1667	29163
6L-4S		MI	17997	6167	29153	4467	31415	3616	32109	2972	32239	2021	38081	1645	21833
16-#11	2.08	MA	22879	6167	36432	4578	39248	3724	39797	3067	39284	2116	46624	1577	28727
7L-3S		MI	18394	6167	29835	4455	32284	3623	33161	2981	33549	2012	39536	1731	21817
16-#11	2.08	MA	22430	6167	35672	4575	38214	3719	38574	3078	37497	2108	44511	1529	28091
8L-2S		MI	18948	6167	30664	4460	33347	3613	34453	2972	35262	2004	41788	1817	21789
16-#14	3.00	MA	25549	6549	42038	4796	46383	3863	48494	3144	51124	2070	62098	1598	42336
4L-6S		MI	17850	6549	29741	4671	32003	3773	32800	3078	33081	1962	39642	1305	29391

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis

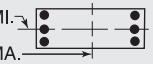


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	3.00	MA	24857	6549	40859	4792	44853	3881	46615	3160	48414	2058	58879	1540	41213
5E		MI	18331	6549	30538	4679	33104	3784	34066	3065	34764	1949	41684	1388	29866
16-#14	3.00	MA	24197	6549	39752	4787	43322	3875	44743	3151	45958	2070	55836	1459	40362
6L-4S		MI	18834	6549	31386	4687	34202	3770	35396	3053	36626	1962	43876	1442	30682
16-#14	3.00	MA	23555	6549	38540	4807	41860	3893	42946	3167	43557	2083	52586	1329	39124
7L-3S		MI	19394	6549	32361	4670	35444	3781	36886	3065	38480	1949	45932	1563	30756
16-#14	3.00	MA	22922	6549	37451	4803	40377	3886	41192	3183	41006	2070	49578	1261	37977
8L-2S		MI	20174	6549	33543	4679	36959	3768	38716	3053	40906	1937	49111	1688	30765
16-#18	5.33	MA	27391	7517	47805	5370	53591	4307	57210	3412	62469	1942	78041	1054	68502
5E		MI	19970	7517	35377	5236	39107	4184	41100	3271	44098	1776	54108	798	48832
16-#18	5.33	MA	26274	7517	45861	5359	50901	4293	53923	3394	58215	1964	72803	909	65103
6L-4S		MI	20826	7517	36858	5253	41015	4162	43377	3249	47289	1798	57834	896	50221
18-#11	2.34	MA	24835	6275	40037	4636	43898	3750	45492	3078	47067	2098	56635	1745	33541
4L-7S		MI	17345	6275	28222	4536	30204	3678	30626	3010	30288	2017	35973	1458	23645
18-#11	2.34	MA	24346	6275	39215	4634	42831	3763	44181	3090	45168	2090	54374	1704	33385
5L-6S		MI	17676	6275	28832	4524	30939	3668	31568	3019	31450	2008	37332	1523	23871
18-#11	2.34	MA	23881	6275	38443	4631	41762	3759	42875	3085	43447	2099	52231	1648	32688
6L-5S		MI	18015	6275	29389	4529	31709	3675	32462	3010	32639	2000	38780	1580	24272
18-#11	2.34	MA	23427	6275	37598	4645	40743	3772	41621	3096	41766	2107	49943	1558	32267
7L-4S		MI	18371	6275	29982	4535	32478	3665	33401	3001	33953	2008	40333	1618	24415
18-#11	2.34	MA	22981	6275	36838	4642	39709	3768	40398	3108	39979	2099	47829	1510	31573
8L-3S		MI	18766	6275	30664	4523	33347	3672	34453	3010	35262	2000	41788	1703	24417
18-#11	2.34	MA	22527	6275	36020	4657	38703	3781	39118	3102	38312	2108	45751	1456	30912
9L-2S		MI	19318	6275	31493	4528	34410	3661	35746	3001	36976	1991	44041	1790	24396
18-#14	3.38	MA	25621	6704	42527	4889	46992	3951	49224	3202	51953	2045	63593	1511	46221
5L-6S		MI	18378	6704	30923	4768	33518	3843	34630	3118	35507	1942	42822	1263	32952
18-#14	3.38	MA	24965	6704	41421	4884	45460	3944	47352	3193	49497	2057	60551	1430	45405
6L-5S		MI	18857	6704	31720	4776	34619	3854	35895	3106	37191	1930	44863	1345	33402
18-#14	3.38	MA	24327	6704	40209	4905	43999	3963	45555	3209	47097	2070	57301	1300	44081
7L-4S		MI	19358	6704	32568	4784	35717	3840	37225	3094	39052	1942	47055	1400	34328
18-#14	3.38	MA	23699	6704	39119	4900	42516	3956	43801	3225	44546	2057	54292	1232	42961
8L-3S		MI	19914	6704	33543	4768	36959	3851	38716	3106	40906	1930	49111	1521	34425
18-#14	3.38	MA	23077	6704	37947	4920	41073	3974	41967	3216	42167	2070	51342	1154	41307
9L-2S		MI	20691	6704	34725	4776	38475	3838	40546	3094	43333	1917	52290	1646	34461
18-#18	6.00	MA	27577	7794	48778	5532	54641	4417	58485	3469	64345	1938	80931	851	73720
6L-5S		MI	20856	7794	37430	5409	41728	4308	44233	3340	48254	1736	59514	713	54703
20-#11	2.60	MA	24887	6383	40381	4701	44326	3812	46004	3120	47650	2081	57693	1686	36885
5L-7S		MI	17721	6383	29051	4604	31266	3726	31918	3039	32002	2004	38225	1430	26161
20-#11	2.60	MA	24424	6383	39609	4698	43258	3807	44699	3114	45929	2090	55550	1630	36218
6E		MI	18051	6383	29661	4592	32002	3716	32860	3048	33164	1996	39585	1496	26378
20-#11	2.60	MA	23973	6383	38764	4713	42238	3820	43445	3126	44247	2099	53262	1539	35811
7L-5S		MI	18389	6383	30218	4597	32772	3723	33754	3039	34352	1987	41033	1553	26757
20-#11	2.60	MA	23528	6383	38005	4710	41204	3816	42222	3137	42460	2090	51148	1491	35062
8L-4S		MI	18743	6383	30811	4602	33540	3713	34693	3031	35667	1996	42586	1590	26992
20-#11	2.60	MA	23088	6383	37187	4724	40198	3829	40942	3132	40794	2099	49070	1437	34421
9L-3S		MI	19137	6383	31493	4590	34410	3720	35746	3039	36976	1987	44041	1676	27011
20-#11	2.60	MA	22591	6383	36429	4721	39177	3825	39725	3143	39141	2108	47057	1376	33516
10L-2S		MI	19687	6383	32322	4595	35473	3710	37038	3031	38689	1978	46294	1762	26997
20-#14	3.75	MA	25728	6860	43089	4982	47599	4014	49961	3236	53037	2044	65265	1401	50455
6E		MI	18904	6860	32105	4865	35033	3913	36459	3159	37934	1922	46001	1221	36479
20-#14	3.75	MA	25094	6860	41877	5002	46137	4032	48164	3252	50636	2057	62015	1271	49048
7L-5S		MI	19379	6860	32902	4873	36134	3924	37725	3147	39617	1910	48042	1303	36946
20-#14	3.75	MA	24470	6860	40788	4997	44654	4026	46410	3268	48085	2044	59007	1203	47864
8L-4S		MI	19878	6860	33750	4882	37232	3910	39055	3134	41479	1922	50234	1358	37846
20-#14	3.75	MA	23852	6860	39615	5018	43212	4044	44576	3259	45706	2057	56056	1125	46255
9L-3S		MI	20432	6860	34725	4865	38475	3921	40546	3147	43333	1910	52290	1479	38088
22-#11	2.86	MA	24964	6491	40776	4766	44753	3856	46523	3143	48410	2081	58868	1611	39752
6L-7S		MI	18096	6491	29880	4671	32329	3775	33210	3068	33715	1992	40478	1403	28643

RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.86	MA	24515	6491	39930	4780	43733	3869	45269	3155	46729	2090	56580	1521	39357
7L-6S		MI	18424	6491	30490	4659	33065	3764	34152	3077	34877	1983	41838	1469	28888
22-#11	2.86	MA	24073	6491	39171	4777	42699	3865	44045	3167	44942	2082	54467	1473	38556
8L-5S		MI	18761	6491	31047	4664	33835	3772	35046	3068	36066	1974	43286	1526	29247
22-#11	2.86	MA	23634	6491	38353	4792	41693	3878	42766	3161	43275	2091	52388	1419	37933
9L-4S		MI	19114	6491	31640	4670	34603	3761	35986	3060	37380	1983	44839	1563	29564
22-#11	2.86	MA	23140	6491	37596	4789	40672	3873	41549	3173	41623	2100	50376	1358	36991
10L-3S		MI	19506	6491	32322	4657	35473	3768	37038	3068	38689	1974	46294	1648	29595
22-#14	4.13	MA	25856	7016	43545	5099	48276	4102	50773	3294	54176	2044	66730	1242	54024
7L-6S		MI	19426	7016	33287	4962	36548	3983	38289	3200	40360	1903	49180	1179	39933
22-#14	4.13	MA	25236	7016	42456	5095	46793	4095	49019	3310	51625	2031	63721	1174	52777
8L-5S		MI	19900	7016	34084	4971	37650	3994	39555	3188	42044	1890	51222	1261	40496
22-#14	4.13	MA	24622	7016	41283	5115	45350	4114	47185	3301	49246	2044	60771	1096	51212
9L-4S		MI	20396	7016	34932	4979	38748	3980	40885	3175	43905	1903	53413	1316	41347
24-#11	3.12	MA	25054	6599	41097	4847	45228	3917	47093	3184	49210	2082	59899	1502	42906
7E		MI	18468	6599	30709	4739	33392	3823	34503	3097	35429	1979	42731	1375	31095
24-#11	3.12	MA	24614	6599	40337	4845	44194	3913	45869	3196	47423	2073	57785	1454	42055
8L-6S		MI	18796	6599	31319	4727	34128	3813	35445	3106	36591	1970	44091	1441	31401
24-#11	3.12	MA	24176	6599	39519	4859	43188	3926	44590	3190	45757	2082	55707	1400	41426
9L-5S		MI	19131	6599	31876	4732	34898	3820	36339	3097	37780	1962	45539	1498	31742
24-#11	3.12	MA	23687	6599	38762	4856	42167	3922	43373	3202	44104	2091	53694	1339	40471
10L-4S		MI	19482	6599	32469	4737	35666	3810	37278	3089	39094	1970	47092	1536	32132
24-#14	4.50	MA	25997	7171	44124	5192	48932	4165	51628	3353	55164	2018	68436	1145	57700
8L-6S		MI	19946	7171	34469	5060	38064	4052	40119	3241	42787	1883	52359	1137	43398
24-#14	4.50	MA	25384	7171	42951	5212	47489	4183	49794	3344	52785	2031	65486	1067	56176
9L-5S		MI	20417	7171	35266	5068	39165	4063	41385	3229	44470	1871	54401	1219	44053

RECTANGULAR TIED COLUMNS 30" x 42"

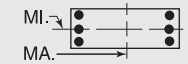
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.27	MA	26312	6122	41219	4534	44467	3694	45286	3077	45025	2199	52712	2065	20320
2E		MI	18565	6122	29505	4399	31303	3581	31466	2970	30753	2097	35487	1935	14136
6-#14	1.07	MA	25926	6036	40204	4510	43338	3680	43974	3075	43362	2228	50612	2109	17372
2L-3S		MI	17537	6036	27655	4379	29109	3593	28940	2997	27422	2153	31220	1876	12225
6-#14	1.07	MA	24722	6036	38438	4506	41074	3699	41213	3092	39606	2241	45590	1985	17442
3L-2S		MI	18338	6036	28837	4387	30625	3579	30770	2985	29848	2140	34399	2000	12141
6-#18	1.90	MA	27738	6399	44309	4707	48428	3818	50119	3153	51552	2175	61386	2011	30045
2L-3S		MI	18104	6399	29505	4555	31303	3727	31466	3061	30753	2079	35487	1629	20789
6-#18	1.90	MA	25664	6399	41219	4698	44467	3849	45286	3180	45025	2197	52712	1789	30033
3L-2S		MI	19476	6399	31558	4572	33925	3704	34599	3039	34909	2057	40893	1851	20679
8-#14	1.43	MA	26755	6192	41969	4607	45601	3750	46735	3117	47119	2216	55635	2082	22935
2L-4S		MI	17503	6192	27862	4493	29383	3651	29280	3026	27994	2145	32343	1712	16053
8-#14	1.43	MA	25559	6192	40204	4603	43338	3768	43974	3134	43362	2228	50612	1957	22981
3E		MI	18076	6192	28837	4476	30625	3663	30770	3038	29848	2133	34399	1833	15988
8-#14	1.43	MA	24717	6192	38764	4624	41502	3762	41744	3126	40492	2241	47347	1833	22949
4L-2S		MI	18872	6192	30019	4485	32140	3649	32600	3026	32275	2121	37578	1958	15915
8-#18	2.54	MA	29145	6676	47399	4880	52389	3942	54951	3228	58078	2150	70061	1956	39725
2L-4S		MI	18032	6676	29857	4754	31769	3828	32045	3108	31735	2061	37386	1335	26590
8-#18	2.54	MA	27091	6676	44309	4870	48428	3973	50119	3255	51552	2172	61386	1735	39599
3E		MI	19015	6676	31558	4727	33925	3850	34599	3130	34909	2039	40893	1545	27207
8-#18	2.54	MA	25643	6676	41782	4906	45207	3960	46205	3238	46563	2194	55762	1513	38630
4L-2S		MI	20377	6676	33610	4745	36546	3828	37732	3108	39064	2017	46299	1766	27163

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.24	MA	26352	6109	41007	4571	44455	3725	45371	3105	45277	2230	53298	2111	20045
2L-5S		MI	17298	6109	27274	4456	28700	3642	28498	3031	26862	2156	30957	1792	14109
10-#11	1.24	MA	25512	6109	39773	4568	42874	3721	43442	3118	42652	2240	49765	2024	20083
3L-4S		MI	17660	6109	27867	4461	29468	3632	29437	3022	28176	2165	32510	1829	14064
10-#11	1.24	MA	24922	6109	38768	4583	41593	3735	41885	3112	40649	2249	47466	1938	20104
4L-3S		MI	18062	6109	28550	4449	30338	3639	30489	3031	29486	2156	33965	1914	14011
10-#11	1.24	MA	24395	6109	37899	4580	40467	3731	40501	3124	38643	2242	45064	1897	20066
5L-2S		MI	18623	6109	29379	4454	31401	3629	31782	3022	31199	2147	36218	2001	13960
10-#14	1.79	MA	27577	6347	43735	4705	47864	3820	49497	3160	50876	2203	60658	2055	28479
2L-5S		MI	17528	6347	28196	4582	29800	3735	29780	3079	28559	2113	33330	1615	19509
10-#14	1.79	MA	26387	6347	41969	4700	45601	3838	46735	3177	47119	2216	55635	1930	28495
3L-4S		MI	18041	6347	29044	4590	30898	3721	31110	3066	30421	2126	35522	1670	19760
10-#14	1.79	MA	25551	6347	40529	4721	43766	3832	44505	3168	44249	2229	52370	1806	28416
4L-3S		MI	18611	6347	30019	4574	32140	3732	32600	3079	32275	2113	37578	1791	19722
10-#14	1.79	MA	24804	6347	39283	4717	42150	3851	42520	3185	41374	2217	48948	1747	27902
5L-2S		MI	19403	6347	31201	4582	33655	3719	34430	3066	34701	2101	40757	1916	19663
10-#18	3.17	MA	30535	6952	50489	5052	56350	4066	59783	3303	64605	2125	78735	1901	49352
2L-5S		MI	18065	6952	30429	4910	32483	3973	32901	3199	32699	1999	39066	1152	31036
10-#18	3.17	MA	28500	6952	47399	5043	52389	4097	54951	3331	58078	2147	70061	1680	49139
3L-4S		MI	18943	6952	31910	4927	34391	3951	35178	3177	35890	2021	42792	1251	32504
10-#18	3.17	MA	27067	6952	44872	5078	49169	4084	51037	3314	53090	2169	64436	1459	47657
4L-3S		MI	19918	6952	33610	4900	36546	3973	37732	3199	39064	1999	46299	1460	33577
10-#18	3.17	MA	25786	6952	42683	5069	46331	4115	47551	3341	48091	2147	58502	1357	44935
5L-2S		MI	21269	6952	35663	4918	39168	3951	40865	3177	43220	1977	51704	1681	33611
12-#11	1.49	MA	26932	6217	42240	4638	46037	3773	47301	3135	47902	2222	56830	2093	23923
2L-6S		MI	17335	6217	27546	4518	28993	3684	28896	3069	27387	2152	31762	1707	16504
12-#11	1.49	MA	26096	6217	41007	4636	44455	3770	45371	3147	45277	2231	53298	2007	23950
3L-5S		MI	17679	6217	28103	4523	29763	3691	29790	3060	28576	2143	33210	1764	16709
12-#11	1.49	MA	25509	6217	40002	4650	43175	3783	43815	3142	43274	2241	50998	1920	23947
4E		MI	18040	6217	28696	4528	30531	3681	30730	3051	29890	2152	34763	1802	16682
12-#11	1.49	MA	24984	6217	39133	4648	42048	3779	42430	3154	41268	2233	48596	1879	23886
5L-3S		MI	18441	6217	29379	4516	31401	3688	31782	3060	31199	2143	36218	1887	16639
12-#11	1.49	MA	24485	6217	38319	4645	40920	3793	41052	3149	39451	2243	46313	1823	23448
6L-2S		MI	18999	6217	30208	4522	32464	3678	33074	3051	32913	2135	38471	1973	16594
12-#14	2.14	MA	28392	6503	45500	4802	50128	3889	52258	3202	54633	2191	65681	2028	34009
2L-6S		MI	17578	6503	28581	4671	30214	3794	30344	3132	29302	2106	34468	1491	22448
12-#14	2.14	MA	27209	6503	43735	4798	47864	3908	49497	3219	50876	2204	60658	1903	33990
3L-5S		MI	18065	6503	29378	4679	31315	3805	31610	3120	30986	2094	36509	1573	23003
12-#14	2.14	MA	26379	6503	42295	4818	46029	3902	47266	3211	48005	2216	57393	1779	33873
4E		MI	18575	6503	30226	4688	32413	3791	32940	3107	32847	2106	38701	1628	23440
12-#14	2.14	MA	25636	6503	41049	4814	44414	3921	45281	3228	45131	2204	53970	1720	33155
5L-3S		MI	19142	6503	31201	4671	33655	3802	34430	3120	34701	2094	40757	1749	23438
12-#14	2.14	MA	24930	6503	39881	4810	42796	3915	43304	3219	42525	2217	50727	1639	32112
6L-2S		MI	19930	6503	32383	4679	35171	3788	36260	3107	37128	2081	43936	1874	23394
12-#18	3.81	MA	29893	7229	50489	5216	56350	4221	59783	3406	64605	2122	78735	1625	58664
3L-5S		MI	18974	7229	32482	5083	35104	4097	36034	3268	36855	1959	44472	1067	37120
12-#18	3.81	MA	28474	7229	47962	5251	53130	4208	55870	3389	59616	2144	73111	1404	56736
4E		MI	19845	7229	33962	5100	37012	4074	38311	3246	40046	1981	48198	1166	38467
12-#18	3.81	MA	27206	7229	45773	5242	50292	4240	52383	3416	54617	2122	67176	1303	54174
5L-3S		MI	20812	7229	35663	5073	39168	4097	40865	3268	43220	1959	51704	1375	39920
12-#18	3.81	MA	26001	7229	43719	5233	47449	4227	48910	3399	50088	2144	61581	1158	51139
6L-2S		MI	22154	7229	37715	5090	41790	4074	43998	3246	47376	1937	57110	1597	40029
14-#11	1.73	MA	27509	6324	43474	4706	47618	3822	49230	3164	50527	2213	60363	2076	27793
2L-7S		MI	17382	6324	27765	4597	29320	3742	29246	3089	27939	2148	32655	1614	18740
14-#11	1.73	MA	26676	6324	42240	4703	46037	3818	47301	3176	47902	2223	56830	1989	27809
3L-6S		MI	17716	6324	28375	4585	30056	3732	30189	3098	29101	2139	34015	1680	18995
14-#11	1.73	MA	26092	6324	41235	4718	44756	3831	45744	3171	45899	2232	54531	1903	27783
4L-5S		MI	18059	6324	28932	4591	30826	3739	31083	3089	30289	2130	35463	1737	19298

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

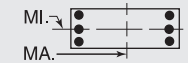
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.73	MA	25570	6324	40367	4715	43629	3828	44360	3183	43893	2224	52129	1861	27700
5L-4S		MI	18418	6324	29525	4596	31594	3729	32022	3080	31604	2139	37016	1774	19288
14-#11	1.73	MA	25073	6324	39552	4713	42501	3841	42981	3178	42076	2234	49846	1805	27162
6L-3S		MI	18817	6324	30208	4584	32464	3736	33074	3089	32913	2130	38471	1860	19257
14-#11	1.73	MA	24589	6324	38660	4727	41425	3837	41658	3190	40301	2243	47410	1715	26660
7L-2S		MI	19374	6324	31037	4589	33526	3726	34367	3080	34626	2122	40724	1946	19218
14-#14	2.50	MA	28025	6658	45500	4895	50128	3978	52258	3261	54633	2191	65681	1876	39473
3L-6S		MI	18114	6658	29763	4768	31729	3864	32174	3173	31729	2086	37647	1449	25997
14-#14	2.50	MA	27199	6658	44060	4916	48292	3972	50027	3253	51762	2204	62415	1752	39322
4L-5S		MI	18598	6658	30560	4777	32830	3875	33440	3161	33412	2074	39689	1531	26515
14-#14	2.50	MA	26462	6658	42814	4912	46677	3991	48042	3270	48888	2192	58993	1693	38428
5L-4S		MI	19106	6658	31408	4785	33929	3861	34770	3148	35274	2086	41880	1586	27108
14-#14	2.50	MA	25760	6658	41646	4907	45059	3984	46065	3262	46282	2205	55749	1612	37436
6L-3S		MI	19669	6658	32383	4768	35171	3872	36260	3161	37128	2074	43936	1707	27142
14-#14	2.50	MA	25077	6658	40367	4928	43516	4003	44167	3279	43736	2217	52287	1482	36355
7L-2S		MI	20454	6658	33565	4776	36686	3858	38090	3148	39554	2061	47116	1831	27113
14-#18	4.44	MA	29866	7506	51052	5424	57091	4333	60702	3465	66143	2120	81785	1349	65858
4L-5S		MI	19875	7506	34534	5256	37726	4220	39167	3337	41011	1919	49877	983	43226
14-#18	4.44	MA	28610	7506	48863	5415	54253	4364	57216	3492	61144	2098	75851	1248	63438
5L-4S		MI	20739	7506	36015	5273	39634	4198	41444	3315	44202	1941	53604	1081	44470
14-#18	4.44	MA	27417	7506	46809	5406	51410	4351	53742	3475	56615	2120	70256	1103	60226
6L-3S		MI	21699	7506	37715	5246	41790	4220	43998	3337	47376	1919	57110	1291	46246
14-#18	4.44	MA	26255	7506	44560	5441	48697	4382	50407	3502	52189	2142	64278	872	57144
7L-2S		MI	23031	7506	39768	5263	44411	4198	47131	3315	51532	1897	62516	1512	46412
16-#11	1.98	MA	27253	6432	43474	4770	47618	3866	49230	3206	50527	2214	60363	1972	31655
3L-7S		MI	17762	6432	28594	4665	30383	3791	30539	3118	29653	2135	34908	1587	21253
16-#11	1.98	MA	26671	6432	42469	4785	46338	3880	47673	3201	48524	2224	58063	1885	31612
4L-6S		MI	18095	6432	29204	4653	31119	3781	31481	3127	30814	2126	36267	1653	21493
16-#11	1.98	MA	26152	6432	41600	4783	45211	3876	46289	3213	46518	2216	55661	1844	31510
5E		MI	18437	6432	29761	4658	31889	3788	32375	3118	32003	2118	37716	1710	21876
16-#11	1.98	MA	25658	6432	40786	4780	44083	3889	44910	3208	44701	2225	53378	1788	30885
6L-4S		MI	18794	6432	30354	4663	32657	3777	33314	3109	33317	2126	39269	1747	21887
16-#11	1.98	MA	25177	6432	39894	4795	43007	3886	43587	3220	42926	2235	50943	1698	30402
7L-3S		MI	19192	6432	31037	4651	33526	3785	34367	3118	34626	2118	40724	1832	21865
16-#11	1.98	MA	24702	6432	39092	4792	41915	3899	42295	3232	41039	2227	48697	1649	29820
8L-2S		MI	19747	6432	31866	4656	34589	3774	35659	3109	36340	2109	42977	1919	21834
16-#14	2.86	MA	28014	6814	45826	5013	50556	4042	52788	3296	55519	2191	67438	1725	44766
4L-6S		MI	18646	6814	30945	4866	33244	3933	34004	3214	34155	2067	40826	1406	29554
16-#14	2.86	MA	27282	6814	44580	5009	48940	4060	50803	3312	52644	2179	64016	1666	43717
5E		MI	19128	6814	31742	4874	34346	3945	35269	3201	35839	2054	42868	1489	30039
16-#14	2.86	MA	26584	6814	43412	5005	47323	4054	48826	3304	50039	2192	60772	1585	42769
6L-4S		MI	19633	6814	32590	4882	35444	3931	36599	3189	37700	2067	45060	1543	30766
16-#14	2.86	MA	25905	6814	42132	5025	45779	4073	46929	3321	47493	2205	57309	1455	41593
7L-3S		MI	20194	6814	33565	4865	36686	3942	38090	3201	39554	2054	47116	1665	30825
16-#14	2.86	MA	25237	6814	40982	5021	44213	4067	45076	3338	44787	2193	54110	1386	40327
8L-2S		MI	20975	6814	34747	4874	38201	3928	39920	3189	41981	2042	50295	1789	30822
16-#18	5.08	MA	30001	7782	51953	5588	58214	4488	62048	3567	67671	2073	84525	1193	72722
5E		MI	20768	7782	36587	5429	40348	4343	42300	3406	45167	1879	55283	898	49294
16-#18	5.08	MA	28818	7782	49899	5579	55372	4475	58575	3550	63142	2095	78930	1049	69341
6L-4S		MI	21627	7782	38068	5446	42256	4321	44577	3384	48358	1901	59009	997	50503
16-#18	5.08	MA	27668	7782	47650	5614	52658	4506	55239	3578	58716	2117	72952	817	66146
7L-3S		MI	22580	7782	39768	5419	44411	4343	47131	3406	51532	1879	62516	1206	52558
18-#11	2.23	MA	27248	6540	43703	4853	47919	3928	49603	3230	51149	2215	61596	1868	35436
4L-7S		MI	18141	6540	29423	4732	31446	3839	31831	3147	31366	2122	37161	1559	23768

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis

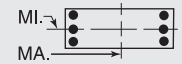


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.23	MA	26731	6540	42834	4850	46792	3924	48218	3242	49143	2207	59194	1826	35317
5L-6S		MI	18473	6540	30033	4720	32181	3829	32773	3156	32528	2114	38520	1625	23996
18-#11	2.23	MA	26239	6540	42020	4848	45664	3938	46840	3237	47326	2217	56911	1770	34615
6L-5S		MI	18813	6540	30590	4726	32952	3836	33667	3147	33717	2105	39969	1682	24410
18-#11	2.23	MA	25760	6540	41127	4862	44588	3934	45516	3249	45551	2226	54475	1680	34150
7L-4S		MI	19169	6540	31183	4731	33720	3826	34607	3138	35031	2114	41522	1720	24479
18-#11	2.23	MA	25288	6540	40326	4860	43496	3947	44225	3261	43664	2218	52229	1632	33506
8L-3S		MI	19565	6540	31866	4719	34589	3833	35659	3147	36340	2105	42977	1805	24468
18-#11	2.23	MA	24803	6540	39463	4874	42435	3944	42874	3256	41905	2228	50016	1578	32777
9L-2S		MI	20118	6540	32695	4724	35652	3823	36951	3138	38053	2096	45230	1891	24443
18-#14	3.21	MA	28095	6970	46345	5106	51204	4130	53565	3355	56401	2167	69039	1639	49018
5L-6S		MI	19175	6970	32127	4963	34760	4003	35833	3255	36582	2047	44005	1364	33117
18-#14	3.21	MA	27402	6970	45177	5102	49586	4124	51588	3347	53796	2180	65795	1558	48111
6L-5S		MI	19655	6970	32924	4971	35861	4014	37099	3242	38265	2034	46047	1447	33575
18-#14	3.21	MA	26728	6970	43898	5123	48042	4143	49690	3363	51250	2192	62332	1428	46844
7L-4S		MI	20157	6970	33772	4979	36959	4001	38429	3230	40127	2047	48239	1501	34417
18-#14	3.21	MA	26063	6970	42748	5119	46477	4137	47837	3380	48544	2180	59133	1359	45619
8L-3S		MI	20715	6970	34747	4963	38201	4012	39920	3242	41981	2034	50295	1623	34499
18-#14	3.21	MA	25402	6970	41509	5139	44953	4155	45900	3372	46021	2193	55988	1281	43969
9L-2S		MI	21493	6970	35929	4971	39716	3998	41749	3230	44407	2022	53474	1747	34525
18-#18	5.71	MA	30206	8059	52989	5752	59333	4599	63407	3626	69668	2070	87605	994	78480
6L-5S		MI	21656	8059	38639	5602	42969	4467	45433	3475	49322	1839	60689	814	55159
18-#18	5.71	MA	29066	8059	50740	5787	56619	4630	60072	3653	65242	2092	81627	763	75173
7L-4S		MI	22508	8059	40120	5619	44877	4445	47711	3453	52513	1861	64415	912	56562
20-#11	2.48	MA	27307	6648	44068	4918	48374	3973	50148	3271	51768	2199	62727	1809	39098
5L-7S		MI	18518	6648	30253	4800	32509	3888	33124	3176	33080	2110	39414	1532	26286
20-#11	2.48	MA	26817	6648	43253	4915	47246	3986	48769	3266	49951	2208	60444	1753	38350
6E		MI	18848	6648	30862	4788	33244	3877	34066	3185	34241	2101	40773	1598	26504
20-#11	2.48	MA	26340	6648	42361	4930	46170	3982	47446	3278	48176	2218	58008	1663	37900
7L-5S		MI	19187	6648	31419	4793	34014	3884	34960	3176	35430	2092	42221	1655	26895
20-#11	2.48	MA	25871	6648	41559	4927	45078	3996	46154	3291	46289	2210	55762	1614	37198
8L-4S		MI	19542	6648	32012	4798	34783	3874	35899	3168	36744	2101	43775	1692	27056
20-#11	2.48	MA	25389	6648	40696	4942	44016	3992	44803	3285	44530	2219	53548	1560	36491
9L-3S		MI	19936	6648	32695	4786	35652	3881	36951	3176	38053	2092	45230	1778	27065
20-#11	2.48	MA	24870	6648	39897	4939	42939	4005	43518	3298	42785	2229	51404	1499	35618
10L-2S		MI	20487	6648	33524	4791	36715	3871	38244	3168	39767	2084	47482	1864	27047
20-#14	3.57	MA	28215	7125	46943	5199	51849	4194	54349	3389	57552	2167	70818	1531	53458
6E		MI	19702	7125	33309	5060	36275	4073	37663	3296	39008	2027	47185	1322	36684
20-#14	3.57	MA	27544	7125	45663	5220	50306	4213	52451	3406	55006	2180	67355	1401	52105
7L-5S		MI	20179	7125	34106	5068	37376	4084	38929	3283	40692	2015	49226	1405	37119
20-#14	3.57	MA	26884	7125	44513	5216	48740	4207	50598	3423	52301	2168	64156	1332	50919
8L-4S		MI	20678	7125	34954	5077	38474	4070	40259	3271	42554	2027	51418	1459	38052
20-#14	3.57	MA	26223	7125	43275	5237	47217	4225	48661	3414	49778	2181	61010	1254	49212
9L-3S		MI	21234	7125	35929	5060	39716	4082	41749	3283	44407	2015	53474	1580	38165
20-#18	6.35	MA	30453	8336	53830	5960	60581	4754	64904	3728	71769	2067	90301	708	84222
7L-5S		MI	22537	8336	40692	5775	45591	4590	48566	3544	53478	1799	66095	729	61053
22-#11	2.72	MA	27392	6756	44487	4982	48827	4035	50698	3296	52576	2199	63976	1735	42090
6L-7S		MI	18893	6756	31082	4867	33571	3936	34416	3205	34793	2097	41667	1505	28805
22-#11	2.72	MA	26917	6756	43595	4997	47751	4031	49375	3308	50801	2209	61540	1645	41654
7L-6S		MI	19222	6756	31691	4855	34307	3926	35358	3214	35955	2088	43026	1570	29015
22-#11	2.72	MA	26450	6756	42793	4995	46659	4044	48083	3320	48914	2201	59294	1597	40897
8L-5S		MI	19559	6756	32249	4860	35077	3933	36252	3205	37144	2080	44474	1627	29385
22-#11	2.72	MA	25979	6756	41930	5009	45598	4040	46733	3315	47155	2211	57081	1543	40210
9L-4S		MI	19913	6756	32842	4866	35845	3923	37191	3197	38458	2088	46027	1665	29632
22-#11	2.72	MA	25454	6756	41131	5007	44520	4054	45448	3327	45410	2220	54936	1482	39297
10L-3S		MI	20306	6756	33524	4854	36715	3930	38244	3205	39767	2080	47482	1750	29658
22-#11	2.72	MA	24950	6756	40345	5004	43464	4050	44114	3322	43550	2212	52746	1430	38466
11L-2S		MI	20855	6756	34353	4859	37778	3920	39536	3197	41481	2071	49735	1837	29647

RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.93	MA	28355	7281	47429	5317	52569	4283	55212	3448	58763	2168	72378	1374	57376
7L-6S		MI	20225	7281	34491	5157	37790	4143	39493	3336	41435	2007	50364	1280	40217
22-#14	3.93	MA	27699	7281	46279	5313	51003	4276	53359	3465	56058	2155	69178	1304	56200
8L-5S		MI	20700	7281	35288	5166	38891	4154	40759	3324	43118	1995	52405	1362	40669
22-#14	3.93	MA	27039	7281	45040	5334	49480	4295	51422	3457	53534	2168	66033	1227	54464
9L-4S		MI	21197	7281	36136	5174	39990	4140	42089	3312	44980	2007	54597	1417	41551
24-#11	2.97	MA	27491	6864	44828	5065	49333	4079	51304	3337	53426	2200	65073	1628	45410
7E		MI	19266	6864	31911	4935	34634	3984	35708	3234	36507	2084	43919	1477	31299
24-#11	2.97	MA	27026	6864	44027	5062	48241	4093	50013	3349	51539	2193	62827	1579	44602
8L-6S		MI	19594	6864	32521	4923	35370	3974	36650	3243	37668	2075	45279	1543	31528
24-#11	2.97	MA	26555	6864	43164	5077	47179	4089	48662	3344	49780	2202	60613	1525	43932
9L-5S		MI	19930	6864	33078	4928	36140	3981	37544	3234	38857	2067	46727	1600	31880
24-#11	2.97	MA	26035	6864	42364	5074	46102	4102	47377	3356	48035	2211	58469	1464	42982
10L-4S		MI	20282	6864	33671	4933	36908	3971	38484	3226	40171	2075	48280	1637	32203
24-#11	2.97	MA	25533	6864	41578	5072	45046	4098	46043	3351	46175	2204	56279	1413	42134
11L-3S		MI	20674	6864	34353	4921	37778	3978	39536	3234	41481	2067	49735	1723	32236
24-#14	4.29	MA	28509	7437	48044	5410	53267	4346	56121	3507	59814	2143	74201	1277	61417
8L-6S		MI	20746	7437	35673	5255	39305	4213	41323	3377	43862	1988	53543	1238	43680
24-#14	4.29	MA	27850	7437	46806	5431	51743	4365	54183	3499	57291	2156	71056	1200	59724
9L-5S		MI	21218	7437	36470	5263	40407	4224	42589	3365	45545	1975	55585	1320	44226

RECTANGULAR TIED COLUMNS 30" x 44"

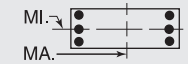
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.21	MA	28774	6388	44909	4749	48476	3871	49339	3228	49002	2319	57355	2184	21400
2E		MI	19362	6388	30714	4592	32544	3740	32666	3105	31821	2200	36662	2035	14181
6-#14	1.02	MA	28361	6301	43830	4726	47276	3857	47945	3226	47172	2344	55094	2226	18283
2L-3S		MI	18333	6301	28859	4574	30351	3753	30144	3133	28496	2258	32403	1977	12262
6-#14	1.02	MA	27088	6301	41967	4722	44888	3852	45031	3243	43209	2357	49763	2101	18353
3L-2S		MI	19134	6301	30041	4582	31867	3739	31974	3121	30923	2245	35583	2101	12177
6-#18	1.82	MA	30289	6664	48172	4922	52658	3995	54442	3303	55925	2295	66577	2132	31665
2L-3S		MI	18900	6664	30714	4748	32544	3885	32666	3196	31821	2183	36662	1729	20853
6-#18	1.82	MA	28094	6664	44909	4914	48476	4027	49339	3332	49002	2317	57355	1911	31653
3L-2S		MI	20274	6664	32767	4765	35166	3863	35799	3174	35977	2160	42068	1951	20733
8-#14	1.36	MA	29241	6457	45693	4823	49664	3927	50858	3268	51136	2331	60426	2201	24150
2L-4S		MI	18299	6457	29066	4688	30625	3812	30484	3162	29069	2250	33527	1813	16104
8-#14	1.36	MA	27975	6457	43830	4819	47276	3921	47945	3285	47172	2345	55094	2076	24196
3E		MI	18872	6457	30041	4671	31867	3823	31974	3174	30923	2238	35583	1935	16032
8-#14	1.36	MA	27087	6457	42313	4840	45342	3941	45594	3278	44147	2359	51624	1951	24164
4L-2S		MI	19670	6457	31223	4680	33382	3809	33804	3162	33349	2225	38762	2059	15956
8-#18	2.42	MA	31784	6941	51435	5095	56841	4119	59545	3379	62849	2272	75799	2081	41885
2L-4S		MI	18828	6941	31067	4947	33010	3987	33245	3243	32803	2165	38561	1435	26883
8-#18	2.42	MA	29610	6941	48172	5087	52658	4152	54442	3407	55925	2294	66577	1860	41759
3E		MI	19813	6941	32767	4920	35166	4009	35799	3265	35977	2143	42068	1645	27287
8-#18	2.42	MA	28081	6941	45507	5123	49262	4140	50315	3392	50633	2316	60590	1638	41060
4L-2S		MI	21176	6941	34820	4938	37787	3987	38932	3243	40133	2121	47474	1866	27225
10-#11	1.18	MA	28810	6374	44674	4786	48451	3902	49414	3256	49186	2346	57929	2228	21098
2L-5S		MI	18093	6374	28476	4652	29942	3804	29704	3168	27940	2261	32145	1893	14154
10-#11	1.18	MA	27923	6374	43373	4784	46783	3899	47379	3269	46417	2356	54182	2142	21136
3L-4S		MI	18456	6374	29069	4657	30711	3793	30643	3159	29254	2270	33699	1931	14104
10-#11	1.18	MA	27301	6374	42315	4799	45434	3913	45739	3264	44307	2366	51740	2055	21157
4L-3S		MI	18858	6374	29751	4645	31580	3801	31695	3168	30563	2261	35154	2016	14048

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

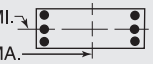


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.18	MA	26745	6374	41400	4797	44247	3909	44281	3276	42195	2359	49197	2013	21119
5L-2S		MI	19420	6374	30580	4650	32643	3790	32988	3159	32277	2253	37406	2103	13996
10-#14	1.70	MA	30113	6612	47556	4920	52052	3997	53771	3310	55100	2319	65757	2175	29998
2L-5S		MI	18323	6612	29400	4777	31042	3896	30984	3215	29634	2218	34514	1717	19681
10-#14	1.70	MA	28855	6612	45693	4916	49664	3991	50858	3328	51136	2333	60426	2051	30014
3L-4S		MI	18837	6612	30248	4785	32140	3882	32314	3203	31496	2231	36706	1771	19817
10-#14	1.70	MA	27973	6612	44176	4938	47730	4011	48507	3320	48111	2346	56956	1926	29935
4L-3S		MI	19407	6612	31223	4769	33382	3893	33804	3215	33349	2218	38762	1892	19771
10-#14	1.70	MA	27185	6612	42864	4934	46028	4005	46416	3338	45083	2335	53330	1866	29540
5L-2S		MI	20201	6612	32405	4777	34897	3879	35634	3203	35776	2206	41941	2017	19709
10-#18	3.03	MA	33261	7218	54698	5268	61024	4243	64648	3454	69772	2249	85021	2030	52052
2L-5S		MI	18859	7218	31638	5103	33723	4132	34101	3334	33768	2103	40241	1252	31283
10-#18	3.03	MA	31107	7218	51435	5260	56841	4276	59545	3483	62849	2271	75799	1808	51839
3L-4S		MI	19740	7218	33119	5120	35632	4110	36378	3312	36959	2125	43967	1351	32791
10-#18	3.03	MA	29594	7218	48770	5296	53445	4264	55417	3467	57557	2293	69812	1587	50603
4L-3S		MI	20717	7218	34820	5093	37787	4132	38932	3334	40133	2103	47474	1560	33667
10-#18	3.03	MA	28242	7218	46463	5287	50454	4296	51743	3495	52255	2271	63516	1484	47594
5L-2S		MI	22070	7218	36872	5111	40409	4110	42065	3312	44289	2081	52879	1782	33679
12-#11	1.42	MA	29426	6482	45975	4854	50118	3951	51448	3285	51954	2338	61675	2212	25187
2L-6S		MI	18131	6482	28748	4714	30235	3845	30102	3206	28465	2257	32950	1809	16625
12-#11	1.42	MA	28542	6482	44674	4851	48451	3947	49414	3298	49186	2348	57929	2125	25214
3L-5S		MI	18475	6482	29305	4719	31005	3852	30996	3197	29654	2248	34398	1866	16760
12-#11	1.42	MA	27923	6482	43616	4866	47101	3961	47774	3293	47076	2358	55487	2039	25211
4E		MI	18836	6482	29898	4724	31774	3842	31935	3188	30968	2257	35951	1903	16726
12-#11	1.42	MA	27370	6482	42701	4864	45915	3958	46316	3306	44964	2350	52944	1997	25150
5L-3S		MI	19237	6482	30580	4712	32643	3849	32988	3197	32277	2248	37406	1989	16680
12-#11	1.42	MA	26845	6482	41844	4862	44727	3971	44864	3301	43050	2360	50521	1941	24769
6L-2S		MI	19797	6482	31409	4718	33706	3839	34280	3188	33990	2240	39659	2075	16633
12-#14	2.05	MA	30978	6768	49419	5017	54440	4067	56684	3353	59063	2307	71088	2150	35831
2L-6S		MI	18373	6768	29785	4866	31456	3954	31548	3268	30377	2211	35652	1592	22604
12-#14	2.05	MA	29727	6768	47556	5014	52052	4061	53771	3370	55100	2320	65757	2025	35812
3L-5S		MI	18861	6768	30582	4874	32557	3965	32814	3256	32060	2198	37693	1674	23174
12-#14	2.05	MA	28851	6768	46038	5035	50118	4080	51421	3363	52075	2334	62287	1901	35695
4E		MI	19372	6768	31430	4883	33655	3952	34143	3244	33922	2211	39885	1729	23509
12-#14	2.05	MA	28068	6768	44726	5031	48416	4075	49330	3380	49046	2322	58661	1841	35086
5L-3S		MI	19939	6768	32405	4866	34897	3963	35634	3256	35776	2198	41941	1850	23492
12-#14	2.05	MA	27323	6768	43496	5027	46712	4094	47247	3373	46302	2336	55216	1760	33935
6L-2S		MI	20729	6768	33587	4874	36412	3949	37464	3244	38202	2186	45120	1975	23444
12-#18	3.64	MA	32587	7494	54698	5433	61024	4400	64648	3558	69772	2248	85021	1757	61904
3L-5S		MI	19769	7494	33691	5276	36345	4255	37234	3403	37924	2063	45647	1168	37367
12-#18	3.64	MA	31088	7494	52033	5469	57628	4388	60520	3542	64480	2270	79034	1536	60198
4E		MI	20643	7494	35172	5293	38253	4233	39511	3381	41115	2085	49373	1266	38750
12-#18	3.64	MA	29750	7494	49726	5460	54637	4420	56845	3571	59178	2248	72738	1433	57358
5L-3S		MI	21613	7494	36872	5266	40409	4255	42065	3403	44289	2063	52879	1475	40020
12-#18	3.64	MA	28478	7494	47562	5452	51641	4408	53185	3555	54374	2270	66786	1288	54371
6L-2S		MI	22957	7494	38925	5284	43031	4233	45198	3381	48444	2041	58285	1697	40108
14-#11	1.65	MA	30038	6590	47276	4921	51786	3999	53483	3315	54723	2329	65422	2195	29267
2L-7S		MI	18177	6590	28967	4794	30562	3904	30452	3226	29017	2253	33843	1716	18856
14-#11	1.65	MA	29157	6590	45975	4919	50118	3996	51448	3327	51954	2339	61675	2109	29283
3L-6S		MI	18512	6590	29577	4781	31298	3893	31394	3235	30178	2244	35203	1782	19116
14-#11	1.65	MA	28541	6590	44917	4934	48769	4009	49809	3323	49844	2349	59234	2022	29257
4L-5S		MI	18855	6590	30134	4787	32068	3900	32288	3226	31367	2236	36651	1839	19356
14-#11	1.65	MA	27991	6590	44002	4932	47583	4006	48351	3335	47732	2342	56691	1980	29174
5L-4S		MI	19215	6590	30727	4792	32836	3890	33228	3217	32681	2244	38204	1876	19336
14-#11	1.65	MA	27468	6590	43145	4929	46395	4020	46899	3330	45819	2352	54268	1925	28687
6L-3S		MI	19614	6590	31409	4780	33706	3897	34280	3226	33990	2236	39659	1962	19300
14-#11	1.65	MA	26958	6590	42206	4944	45262	4016	45506	3343	43950	2362	51684	1835	28134
7L-2S		MI	20172	6590	32238	4785	34769	3887	35572	3217	35704	2227	41912	2048	19260

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

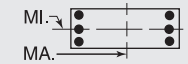
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.39	MA	30593	6924	49419	5111	54440	4131	56684	3413	59063	2308	71088	2000	41599
3L-6S		MI	18909	6924	30967	4963	32971	4024	33378	3309	32804	2191	38831	1550	26155
14-#14	2.39	MA	29722	6924	47901	5132	52506	4150	54334	3405	56038	2321	67618	1875	41448
4L-5S		MI	19395	6924	31764	4972	34072	4035	34643	3297	34487	2179	40872	1632	26684
14-#14	2.39	MA	28944	6924	46589	5128	50804	4145	52243	3422	53010	2310	63993	1816	40652
5L-4S		MI	19903	6924	32612	4980	35170	4021	35973	3284	36349	2191	43064	1687	27183
14-#14	2.39	MA	28204	6924	45359	5125	49101	4164	50161	3415	50266	2324	60547	1735	39555
6L-3S		MI	20468	6924	33587	4963	36412	4033	37464	3297	38202	2179	45120	1808	27199
14-#14	2.39	MA	27483	6924	44012	5146	47475	4158	48162	3432	47585	2337	56871	1605	38552
7L-2S		MI	21254	6924	34769	4971	37928	4019	39294	3284	40629	2166	48299	1933	27166
14-#18	4.24	MA	32567	7771	55296	5641	61811	4512	65623	3618	71403	2247	88255	1484	69837
4L-5S		MI	20671	7771	35744	5449	38967	4379	40367	3472	42080	2023	51053	1083	43472
14-#18	4.24	MA	31242	7771	52989	5633	58820	4544	61948	3646	66102	2225	81960	1381	67148
5L-4S		MI	21539	7771	37225	5466	40875	4357	42644	3450	45270	2045	54779	1181	44749
14-#18	4.24	MA	29982	7771	50825	5625	55824	4532	58288	3631	61297	2247	76008	1237	63981
6L-3S		MI	22501	7771	38925	5439	43031	4379	45198	3472	48444	2023	58285	1391	46353
14-#18	4.24	MA	28756	7771	48455	5661	52965	4565	54773	3659	56602	2269	69651	1006	60924
7L-2S		MI	23836	7771	40977	5456	45652	4357	48331	3450	52600	2001	63691	1612	46497
16-#11	1.89	MA	29769	6698	47276	4986	51786	4044	53483	3357	54723	2330	65422	2092	33340
3L-7S		MI	18558	6698	29796	4861	31625	3952	31745	3255	30730	2240	36096	1688	21370
16-#11	1.89	MA	29156	6698	46218	5001	50437	4058	51843	3352	52613	2340	62980	2006	33297
4L-6S		MI	18891	6698	30406	4849	32361	3942	32687	3264	31892	2232	37456	1754	21614
16-#11	1.89	MA	28609	6698	45303	4999	49251	4054	50386	3365	50501	2333	60437	1964	33195
5E		MI	19233	6698	30963	4854	33131	3949	33581	3255	33081	2223	38904	1811	21939
16-#11	1.89	MA	28088	6698	44446	4997	48063	4068	48934	3360	48587	2343	58015	1908	32615
6L-4S		MI	19592	6698	31556	4859	33899	3939	34520	3246	34395	2232	40457	1849	21938
16-#11	1.89	MA	27581	6698	43507	5012	46930	4065	47541	3372	46718	2353	55431	1818	32083
7L-3S		MI	19990	6698	32238	4847	34769	3946	35572	3255	35704	2223	41912	1934	21912
16-#11	1.89	MA	27081	6698	42663	5010	45781	4078	46181	3385	44732	2346	53053	1769	31561
8L-2S		MI	20545	6698	33068	4852	35832	3936	36865	3246	37418	2214	44165	2021	21878
16-#14	2.73	MA	30586	7079	49764	5229	54894	4220	57247	3448	60002	2309	72949	1850	47196
4L-6S		MI	19442	7079	32149	5061	34486	4094	35207	3350	35230	2171	42010	1508	29713
16-#14	2.73	MA	29813	7079	48452	5226	53192	4214	55156	3465	56974	2298	69324	1790	46234
5E		MI	19925	7079	32946	5069	35587	4105	36473	3338	36914	2159	44052	1590	30208
16-#14	2.73	MA	29078	7079	47222	5222	51489	4234	53074	3457	54230	2311	65879	1709	45186
6L-4S		MI	20431	7079	33794	5077	36686	4091	37803	3325	38775	2171	46243	1645	30847
16-#14	2.73	MA	28362	7079	45875	5243	49863	4228	51075	3475	51548	2325	62203	1580	44084
7L-3S		MI	20993	7079	34769	5060	37928	4102	39294	3338	40629	2159	48299	1766	30892
16-#14	2.73	MA	27658	7079	44664	5239	48214	4247	49125	3492	48699	2313	58813	1509	42693
8L-2S		MI	21776	7079	35951	5069	39443	4089	41123	3325	43055	2146	51479	1891	30878
16-#18	4.85	MA	32718	8048	56252	5806	63003	4668	67051	3722	73025	2202	91182	1330	76959
5E		MI	21566	8048	37796	5622	41589	4502	43500	3541	46235	1983	56458	998	49595
16-#18	4.85	MA	31470	8048	54088	5798	60007	4656	63390	3706	68220	2224	85230	1186	73618
6L-4S		MI	22427	8048	39277	5639	43497	4480	45777	3518	49426	2005	60184	1097	50779
16-#18	4.85	MA	30256	8048	51718	5834	57148	4689	59876	3734	63525	2246	78873	954	70449
7L-3S		MI	23384	8048	40977	5612	45652	4502	48331	3541	52600	1983	63691	1306	52672
18-#11	2.13	MA	29767	6805	47519	5069	52105	4106	53878	3381	55381	2332	66727	1990	37332
4L-7S		MI	18937	6805	30625	4928	32688	4000	33037	3284	32444	2228	38349	1661	23887
18-#11	2.13	MA	29223	6805	46604	5066	50919	4103	52420	3394	53269	2325	64184	1948	37213
5L-6S		MI	19269	6805	31235	4916	33424	3990	33979	3293	33605	2219	39709	1727	24118
18-#11	2.13	MA	28704	6805	45747	5064	49731	4117	50969	3389	51356	2335	61761	1892	36549
6L-5S		MI	19610	6805	31792	4922	34194	3997	34873	3284	34794	2210	41157	1784	24516
18-#11	2.13	MA	28200	6805	44808	5079	48598	4113	49576	3402	49487	2345	59177	1802	36037
7L-4S		MI	19967	6805	32385	4927	34962	3987	35812	3275	36108	2219	42710	1821	24534

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

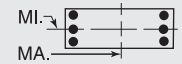


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.13	MA	27702	6805	43964	5077	47449	4127	48216	3414	47500	2337	56799	1753	35452
8L-3S		MI	20363	6805	33068	4915	35832	3994	36865	3284	37418	2210	44165	1907	24517
18-#11	2.13	MA	27182	6805	43139	5075	46331	4123	46794	3410	45648	2347	54450	1699	34653
9L-2S		MI	20917	6805	33897	4920	36894	3984	38157	3275	39131	2202	46418	1993	24489
18-#14	3.07	MA	30677	7235	50315	5323	55580	4284	58069	3507	60937	2285	74655	1765	51829
5L-6S		MI	19972	7235	33331	5158	36002	4164	37037	3391	37657	2152	45189	1466	33276
18-#14	3.07	MA	29946	7235	49085	5319	53877	4304	55987	3500	58193	2299	71210	1684	50825
6L-5S		MI	20453	7235	34128	5166	37103	4175	38303	3379	39340	2139	47231	1548	33743
18-#14	3.07	MA	29235	7235	47737	5340	52251	4298	53989	3517	55512	2312	67534	1554	49628
7L-4S		MI	20956	7235	34976	5174	38201	4161	39633	3366	41202	2152	49423	1602	34502
18-#14	3.07	MA	28535	7235	46527	5337	50602	4317	52038	3535	52662	2301	64144	1484	48282
8L-3S		MI	21516	7235	35951	5158	39443	4172	41123	3379	43055	2139	51479	1724	34570
18-#14	3.07	MA	27825	7235	45223	5358	48999	4312	49998	3527	50005	2315	60803	1406	46658
9L-2S		MI	22295	7235	37133	5166	40958	4158	42953	3366	45482	2127	54658	1848	34588
18-#18	5.45	MA	32945	8324	57351	5971	64190	4781	68493	3781	75144	2201	94451	1134	83280
6L-5S		MI	22455	8324	39849	5795	44210	4625	46633	3609	50391	1943	61864	914	55605
18-#18	5.45	MA	31741	8324	54981	6007	61331	4813	64979	3810	70448	2223	88095	903	79999
7L-4S		MI	23310	8324	41330	5812	46118	4603	48910	3587	53582	1965	65590	1012	56835
20-#11	2.36	MA	29833	6913	47905	5134	52587	4151	54455	3423	56037	2316	67931	1931	41228
5L-7S		MI	19314	6913	31454	4996	33751	4049	34329	3313	34157	2215	40602	1634	26406
20-#11	2.36	MA	29317	6913	47048	5132	51399	4165	53003	3419	54124	2326	65508	1875	40490
6E		MI	19645	6913	32064	4984	34486	4039	35271	3322	35319	2206	41961	1700	26626
20-#11	2.36	MA	28815	6913	46109	5147	50266	4161	51610	3431	52255	2336	62924	1785	39995
7L-5S		MI	19984	6913	32621	4989	35257	4046	36165	3313	36508	2198	43410	1757	27029
20-#11	2.36	MA	28320	6913	45265	5144	49117	4175	50251	3444	50269	2329	60546	1736	39349
8L-4S		MI	20340	6913	33214	4994	36025	4036	37105	3305	37822	2206	44963	1794	27119
20-#11	2.36	MA	27803	6913	44440	5142	47999	4172	48829	3439	48417	2339	58197	1682	38572
9L-3S		MI	20735	6913	33897	4982	36894	4043	38157	3313	39131	2198	46418	1879	27117
20-#11	2.36	MA	27256	6913	43516	5157	46866	4186	47476	3451	46580	2349	55920	1621	37738
10L-2S		MI	21287	6913	34726	4987	37957	4032	39449	3305	40845	2189	48671	1966	27095
20-#14	3.41	MA	30808	7391	50948	5416	56265	4373	58900	3542	62157	2286	76541	1659	56471
6E		MI	20499	7391	34513	5255	37517	4234	38867	3432	40083	2132	48369	1423	36845
20-#14	3.41	MA	30101	7390	49600	5438	54639	4368	56902	3560	59476	2300	72865	1529	55184
7L-5S		MI	20977	7391	35310	5263	38618	4245	40133	3419	41767	2119	50410	1506	37287
20-#14	3.41	MA	29405	7390	48389	5434	52990	4387	54951	3577	56626	2289	69475	1459	53879
8L-4S		MI	21479	7391	36158	5272	39716	4231	41463	3407	43628	2132	52602	1560	38152
20-#14	3.41	MA	28697	7391	47086	5455	51387	4382	52911	3570	53969	2302	66135	1381	52196
9L-3S		MI	22035	7391	37133	5255	40958	4242	42953	3419	45482	2119	54658	1682	38241
20-#18	6.06	MA	33213	8601	58244	6180	65514	4937	70081	3885	77372	2200	97317	852	89570
7L-5S		MI	23338	8601	41901	5968	46832	4749	49766	3678	54547	1903	67270	829	61494
22-#11	2.60	MA	29927	7021	48349	5199	53067	4213	55038	3448	56893	2317	69254	1859	44436
6L-7S		MI	19689	7021	32283	5063	34814	4097	35622	3342	35871	2202	42855	1606	28926
22-#11	2.60	MA	29427	7021	47410	5214	51934	4210	53645	3461	55024	2327	66671	1769	43956
7L-6S		MI	20019	7021	32893	5051	35549	4087	36564	3351	37032	2193	44214	1672	29137
22-#11	2.60	MA	28934	7021	46566	5212	50785	4224	52285	3473	53037	2320	64292	1720	43253
8L-5S		MI	20357	7021	33450	5056	36319	4094	37458	3342	38221	2185	45663	1729	29519
22-#11	2.60	MA	28420	7021	45741	5210	49667	4220	50864	3468	51185	2330	61943	1666	42497
9L-4S		MI	20712	7021	34043	5062	37088	4084	38397	3334	39535	2193	47216	1767	29697
22-#11	2.60	MA	27875	7021	44817	5225	48534	4234	49511	3481	49349	2340	59667	1605	41623
10L-3S		MI	21105	7021	34726	5050	37957	4091	39449	3342	40845	2185	48671	1852	29712
22-#11	2.60	MA	27343	7021	43990	5222	47422	4230	48107	3476	47390	2333	57348	1553	40713
11L-2S		MI	21656	7021	35555	5055	39020	4081	40742	3334	42558	2176	50923	1938	29697
22-#14	3.75	MA	30962	7546	51463	5535	57027	4438	59815	3602	63439	2287	78196	1503	60750
7L-6S		MI	21023	7546	35695	5352	39032	4303	40697	3473	42510	2112	51548	1381	40417
22-#14	3.75	MA	30270	7546	50252	5531	55378	4457	57864	3619	60590	2276	74806	1433	59483
8L-5S		MI	21499	7546	36492	5361	40133	4315	41963	3460	44193	2100	53589	1464	40838
22-#14	3.75	MA	29563	7546	48949	5552	53775	4451	55825	3612	57933	2290	71466	1356	57744
9L-4S		MI	21998	7546	37340	5369	41231	4301	43293	3448	46055	2112	55781	1518	41751

RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.84	MA	30035	7129	48711	5282	53602	4258	55680	3490	57792	2319	70417	1752	47920
7E		MI	20063	7129	33112	5131	35876	4146	36914	3371	37584	2189	45108	1579	31448
24-#11	2.84	MA	29545	7129	47867	5279	52453	4272	54320	3502	55806	2312	68039	1703	47162
8L-6S		MI	20392	7129	33722	5119	36612	4135	37856	3380	38746	2181	46467	1645	31652
24-#11	2.84	MA	29034	7129	47042	5277	51335	4269	52898	3498	53953	2322	65690	1650	46426
9L-5S		MI	20729	7129	34279	5124	37382	4143	38750	3371	39935	2172	47915	1702	32014
24-#11	2.84	MA	28491	7129	46118	5292	50202	4282	51546	3510	52117	2332	63414	1589	45513
10L-4S		MI	21082	7129	34872	5129	38150	4132	39689	3363	41249	2181	49469	1739	32272
24-#11	2.84	MA	27962	7129	45291	5290	49090	4279	50142	3506	50159	2324	61095	1536	44622
11L-3S		MI	21474	7129	35555	5117	39020	4139	40742	3371	42558	2172	50923	1825	32297
24-#14	4.09	MA	31130	7702	52115	5628	57766	4527	60778	3662	64554	2264	80138	1408	65093
8L-6S		MI	21545	7702	36877	5450	40547	4373	42527	3514	44936	2092	54727	1339	43955
24-#14	4.09	MA	30423	7702	50811	5650	56163	4521	58738	3654	61897	2277	76797	1330	63299
9L-5S		MI	22019	7702	37674	5458	41648	4384	43793	3501	46620	2080	56769	1422	44394

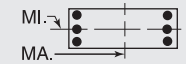
RECTANGULAR TIED COLUMNS 30" x 46"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.16	MA	31343	6653	48750	4965	52649	4048	53556	3378	53112	2436	62169	2302	22480
2E		MI	20158	6653	31924	4785	33785	3899	33866	3240	32890	2304	37837	2136	14225
6-#18	1.74	MA	32948	6930	52186	5138	57054	4172	58930	3454	60423	2414	71939	2253	33285
2L-3S		MI	19696	6930	31924	4941	33785	4044	33866	3331	32890	2286	37837	1830	20914
6-#18	1.74	MA	30631	6930	48750	5130	52649	4206	53556	3484	53112	2437	62169	2032	33273
3L-2S		MI	21071	6930	33977	4958	36406	4022	36999	3309	37046	2264	43243	2051	20787
8-#14	1.30	MA	31833	6722	49568	5038	53891	4104	55145	3419	55304	2447	65386	2318	25365
2L-4S		MI	19094	6722	30271	4883	31866	3972	31688	3298	30144	2355	34710	1915	16152
8-#14	1.30	MA	30499	6722	47608	5035	51378	4099	52079	3436	51133	2461	59746	2194	25411
3E		MI	19668	6722	31246	4866	33108	3983	33178	3311	31997	2343	36766	2036	16074
8-#14	1.30	MA	29564	6722	46013	5057	49346	4119	49609	3430	47953	2476	56072	2069	25379
4L-2S		MI	20467	6722	32428	4875	34624	3970	35008	3298	34424	2330	39946	2160	15996
8-#18	2.32	MA	34531	7206	55621	5310	61458	4297	64303	3529	67734	2392	81709	2205	44045
2L-4S		MI	19623	7206	32276	5140	34251	4145	34445	3378	33872	2268	39736	1536	27169
8-#18	2.32	MA	32237	7206	52186	5303	57054	4330	58930	3559	60423	2415	71939	1983	43919
3E		MI	20610	7206	33977	5113	36406	4167	36999	3400	37046	2246	43243	1745	27361
8-#18	2.32	MA	30626	7206	49383	5340	53482	4319	54589	3544	54836	2437	65588	1762	43351
4L-2S		MI	21975	7206	36029	5131	39028	4145	40132	3378	41202	2224	48649	1966	27285
10-#11	1.13	MA	31376	6639	48492	5002	52611	4080	53620	3407	53246	2462	62729	2345	22151
2L-5S		MI	18889	6639	29677	4848	31185	3965	30909	3305	29018	2367	33334	1995	14197
10-#11	1.13	MA	30440	6639	47124	5000	50856	4076	51480	3419	50334	2472	58769	2258	22189
3L-4S		MI	19252	6639	30270	4853	31953	3955	31849	3296	30332	2375	34887	2033	14141
10-#11	1.13	MA	29786	6639	46012	5015	49439	4090	49757	3415	48116	2483	56185	2172	22210
4L-3S		MI	19655	6639	30953	4841	32822	3962	32901	3305	31641	2367	36342	2118	14083
10-#11	1.13	MA	29202	6639	45051	5013	48193	4087	48226	3428	45898	2476	53501	2130	22172
5L-2S		MI	20217	6639	31782	4846	33885	3952	34193	3296	33355	2358	38595	2204	14031
10-#14	1.63	MA	32755	6878	51528	5136	56404	4174	58210	3461	59474	2435	71026	2295	31516
2L-5S		MI	19119	6878	30605	4972	32283	4056	32188	3351	30709	2323	35698	1818	19849
10-#14	1.63	MA	31429	6878	49568	5132	53891	4169	55145	3479	55304	2449	65386	2170	31533
3L-4S		MI	19633	6878	31453	4980	33382	4042	33517	3339	32570	2335	37890	1872	19872
10-#14	1.63	MA	30500	6878	47973	5154	51858	4189	52674	3472	52124	2463	61712	2045	31453
4L-3S		MI	20204	6878	32428	4964	34624	4053	35008	3351	34424	2323	39946	1994	19819
10-#14	1.63	MA	29672	6878	46595	5151	50071	4184	50477	3490	48942	2453	57882	1985	31191
5L-2S		MI	20999	6878	33610	4972	36139	4040	36838	3339	36851	2310	43125	2118	19754
10-#18	2.90	MA	36096	7483	59057	5483	65863	4421	69676	3605	75044	2370	91478	2157	54752
2L-5S		MI	19654	7483	32848	5296	34964	4291	35301	3469	34837	2206	41416	1353	31524

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

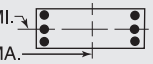


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	2.90	MA	33822	7483	55621	5476	61458	4454	64303	3634	67734	2393	81709	1935	54539
3L-4S		MI	20536	7483	34329	5313	36872	4269	37578	3447	38028	2228	45142	1451	33071
10-#18	2.90	MA	32227	7483	52819	5513	57887	4443	59962	3620	62147	2415	75358	1714	53576
4L-3S		MI	21515	7483	36029	5286	39028	4291	40132	3469	41202	2206	48649	1660	33754
10-#18	2.90	MA	30805	7483	50394	5505	54743	4476	56099	3649	56553	2393	68700	1609	50270
5L-2S		MI	22871	7483	38082	5304	41650	4269	43265	3447	45357	2184	54054	1882	33745
12-#11	1.36	MA	32026	6747	49861	5069	54365	4128	55761	3436	56158	2453	66690	2329	26450
2L-6S		MI	18926	6747	29949	4910	31477	4006	31308	3343	29542	2362	34138	1911	16742
12-#11	1.36	MA	31095	6747	48492	5067	52611	4125	53620	3449	53246	2464	62729	2243	26477
3L-5S		MI	19271	6747	30506	4915	32248	4013	32202	3334	30731	2354	35587	1968	16808
12-#11	1.36	MA	30444	6747	47380	5082	51193	4139	51897	3445	51028	2474	60146	2157	26475
4E		MI	19633	6747	31099	4921	33016	4003	33141	3325	32045	2362	37140	2005	16768
12-#11	1.36	MA	29863	6747	46420	5080	49947	4136	50366	3457	48810	2468	57461	2114	26413
5L-3S		MI	20034	6747	31782	4908	33885	4010	34193	3334	33355	2354	38595	2091	16719
12-#11	1.36	MA	29310	6747	45520	5078	48700	4150	48842	3453	46800	2478	54899	2058	26098
6L-2S		MI	20594	6747	32611	4914	34948	4000	35486	3325	35068	2345	40847	2177	16671
12-#14	1.96	MA	33671	7033	53488	5233	58917	4244	61276	3503	63645	2422	76666	2271	37654
2L-6S		MI	19168	7033	30990	5061	32698	4115	32752	3405	31452	2316	36836	1693	22756
12-#14	1.96	MA	32352	7033	51528	5230	56404	4239	58210	3521	59474	2437	71026	2146	37635
3L-5S		MI	19656	7033	31787	5069	33799	4126	34017	3392	33135	2303	38877	1776	23340
12-#14	1.96	MA	31429	7033	49933	5251	54371	4259	55739	3514	56295	2451	67352	2022	37518
4E		MI	20168	7033	32635	5078	34897	4112	35347	3380	34997	2316	41069	1830	23575
12-#14	1.96	MA	30606	7033	48555	5248	52584	4254	53543	3532	53112	2440	63522	1961	37030
5L-3S		MI	20737	7033	33610	5061	36139	4123	36838	3392	36851	2303	43125	1952	23544
12-#14	1.96	MA	29823	7033	47263	5245	50794	4273	51355	3526	50230	2455	59876	1880	35766
6L-2S		MI	21528	7033	34792	5069	37654	4109	38668	3380	39277	2291	46304	2076	23492
12-#18	3.48	MA	35389	7759	59057	5649	65863	4578	69676	3710	75044	2370	91478	1887	65144
3L-5S		MI	20565	7759	34901	5469	37586	4414	38434	3538	38992	2166	46822	1268	37606
12-#18	3.48	MA	33810	7759	56255	5686	62291	4567	65335	3695	69458	2393	85128	1665	63689
4E		MI	21441	7759	36382	5486	39494	4392	40711	3516	42183	2189	50548	1366	39026
12-#18	3.48	MA	32401	7759	53830	5678	59147	4600	61472	3725	63863	2371	78470	1561	60560
5L-3S		MI	22412	7759	38082	5459	41650	4414	43265	3538	45357	2166	54054	1576	40115
12-#18	3.48	MA	31062	7759	51556	5671	55999	4589	57624	3710	58793	2394	72161	1417	57639
6L-2S		MI	23759	7759	40134	5477	44272	4392	46398	3516	49513	2144	59460	1797	40185
14-#11	1.58	MA	32673	6855	51229	5137	56120	4176	57901	3465	59069	2445	70651	2314	30741
2L-7S		MI	18972	6855	30169	4990	31805	4065	31658	3363	30094	2358	35032	1818	18967
14-#11	1.58	MA	31745	6855	49861	5135	54365	4173	55761	3478	56158	2455	66690	2228	30758
3L-6S		MI	19308	6855	30778	4978	32540	4055	32600	3372	31256	2350	36391	1883	19233
14-#11	1.58	MA	31097	6855	48749	5150	52948	4187	54038	3474	53940	2466	64107	2141	30731
4L-5S		MI	19651	6855	31335	4983	33310	4062	33494	3363	32445	2341	37839	1940	19409
14-#11	1.58	MA	30519	6855	47788	5148	51702	4184	52506	3487	51721	2459	61422	2099	30649
5L-4S		MI	20012	6855	31928	4988	34079	4052	34433	3354	33759	2350	39393	1978	19382
14-#11	1.58	MA	29969	6855	46888	5146	50454	4198	50982	3482	49712	2470	58860	2043	30220
6L-3S		MI	20412	6855	32611	4976	34948	4059	35486	3363	35068	2341	40847	2063	19343
14-#11	1.58	MA	29434	6855	45902	5161	49265	4195	49519	3495	47749	2480	56128	1953	29614
7L-2S		MI	20970	6855	33440	4981	36011	4049	36778	3354	36782	2332	43100	2150	19300
14-#14	2.28	MA	33267	7189	53488	5327	58917	4309	61276	3564	63645	2424	76666	2122	43725
3L-6S		MI	19705	7189	32172	5158	34213	4185	34581	3446	33878	2296	40015	1651	26307
14-#14	2.28	MA	32350	7189	51893	5348	56884	4328	58805	3557	60465	2439	72991	1998	43575
4L-5S		MI	20191	7189	32969	5167	35314	4196	35847	3433	35562	2283	42056	1734	26849
14-#14	2.28	MA	31533	7189	50515	5345	55096	4323	56608	3575	57283	2428	69162	1937	42889
5L-4S		MI	20700	7189	33817	5175	36412	4182	37177	3421	37423	2296	44248	1788	27255
14-#14	2.28	MA	30755	7189	49223	5342	53307	4343	54421	3568	54400	2442	65516	1857	41684
6L-3S		MI	21266	7189	34792	5158	37654	4193	38668	3433	39277	2283	46304	1909	27256
14-#14	2.28	MA	29997	7189	47808	5363	51600	4338	52321	3586	51584	2457	61626	1727	40768
7L-2S		MI	22054	7189	35974	5166	39170	4179	40497	3421	41704	2271	49483	2034	27218
14-#18	4.06	MA	35376	8036	59690	5859	66696	4691	70709	3771	76769	2371	94897	1617	73846
4L-5S		MI	21468	8036	36953	5642	40208	4538	41567	3607	43148	2126	52228	1183	43711

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

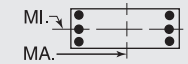
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	4.06	MA	33981	8036	57266	5851	63552	4724	66845	3800	71174	2349	88240	1512	70876
5L-4S		MI	22338	8036	38434	5659	42116	4515	43844	3584	46339	2149	55954	1282	45022
14-#18	4.06	MA	32654	8036	54992	5844	60403	4714	62997	3786	66103	2372	81931	1369	67771
6L-3S		MI	23303	8036	40134	5632	44272	4538	46398	3607	49513	2126	59460	1491	46456
14-#18	4.06	MA	31363	8036	52501	5881	57399	4747	59304	3815	61148	2394	75195	1138	64700
7L-2S		MI	24641	8036	42187	5649	46893	4515	49531	3584	53669	2104	64866	1712	46580
16-#11	1.81	MA	32392	6963	51229	5202	56120	4222	57901	3508	59069	2447	70651	2212	35024
3L-7S		MI	19353	6963	30998	5057	32867	4113	32950	3392	31808	2346	37285	1790	21483
16-#11	1.81	MA	31747	6963	50117	5217	54702	4236	56178	3503	56852	2457	68067	2126	34982
4L-6S		MI	19687	6963	31607	5045	33603	4103	33892	3401	32970	2337	38644	1856	21731
16-#11	1.81	MA	31172	6963	49157	5215	53456	4233	54647	3516	54633	2450	65383	2083	34880
5E		MI	20030	6963	32165	5050	34373	4110	34786	3392	34158	2328	40092	1913	22002
16-#11	1.81	MA	30625	6963	48257	5213	52209	4247	53122	3512	52624	2461	62821	2027	34352
6L-4S		MI	20389	6963	32758	5055	35141	4100	35726	3383	35473	2337	41645	1951	21988
16-#11	1.81	MA	30091	6963	47271	5229	51019	4244	51659	3525	50661	2471	60089	1938	33770
7L-3S		MI	20787	6963	33440	5043	36011	4107	36778	3392	36782	2328	43100	2036	21958
16-#11	1.81	MA	29566	6963	46385	5227	49813	4258	50231	3538	48575	2465	57578	1888	33316
8L-2S		MI	21344	6963	34269	5049	37074	4097	38070	3383	38495	2320	45353	2122	21921
16-#14	2.61	MA	33265	7344	53853	5446	59397	4398	61870	3599	64636	2426	78631	1974	49626
4L-6S		MI	20238	7344	33354	5256	35728	4254	36411	3486	36305	2276	43194	1609	29866
16-#14	2.61	MA	32452	7344	52475	5442	57609	4393	59673	3617	61454	2416	74802	1913	48765
5E		MI	20722	7344	34151	5264	36829	4265	37677	3474	37988	2264	45236	1691	30373
16-#14	2.61	MA	31679	7344	51183	5439	55819	4413	57486	3610	58571	2430	71155	1833	47611
6L-4S		MI	21229	7344	34999	5272	37927	4252	39007	3462	39850	2276	47427	1746	30924
16-#14	2.61	MA	30926	7344	49768	5461	54112	4408	55387	3628	55754	2444	67266	1703	46594
7L-3S		MI	21792	7344	35974	5256	39170	4263	40497	3474	41704	2264	49483	1867	30957
16-#14	2.61	MA	30185	7344	48497	5457	52381	4428	53338	3646	52761	2434	63685	1632	45075
8L-2S		MI	22576	7344	37156	5264	40685	4249	42327	3462	44130	2251	52663	1992	30932
16-#18	4.64	MA	35544	8313	60701	6024	67956	4849	72219	3876	78485	2327	98010	1464	81214
5E		MI	22364	8313	39006	5815	42829	4661	44700	3675	47304	2087	57633	1099	49834
16-#18	4.64	MA	34230	8313	58428	6017	64808	4838	68371	3861	73414	2350	91700	1320	77932
6L-4S		MI	23228	8313	40487	5832	44738	4639	46977	3653	50495	2109	61360	1197	51049
16-#18	4.64	MA	32951	8313	55937	6053	61803	4871	64677	3891	68459	2372	84965	1089	74806
7L-3S		MI	24187	8313	42187	5805	46893	4661	49531	3675	53669	2087	64866	1406	52782
16-#18	4.64	MA	31693	8313	53699	6046	58756	4860	61071	3921	63193	2351	78741	966	70680
8L-2S		MI	25516	8313	44239	5822	49515	4639	52664	3653	57825	2064	70272	1628	52956
18-#11	2.03	MA	32393	7071	51486	5285	56456	4284	58318	3533	59764	2448	72028	2110	39227
4L-7S		MI	19732	7071	31827	5124	33930	4162	34243	3421	33521	2333	39537	1763	24001
18-#11	2.03	MA	31821	7071	50525	5283	55210	4281	56787	3546	57545	2442	69344	2068	39108
5L-6S		MI	20065	7071	32437	5112	34666	4152	35185	3430	34683	2324	40897	1829	24236
18-#11	2.03	MA	31276	7071	49625	5281	53963	4295	55262	3541	55536	2452	66781	2012	38491
6L-5S		MI	20407	7071	32994	5118	35436	4159	36079	3421	35872	2316	42345	1886	24581
18-#11	2.03	MA	30745	7071	48639	5296	52774	4292	53799	3554	53573	2463	64050	1922	37930
7L-4S		MI	20764	7071	33587	5123	36204	4148	37018	3412	37186	2324	43898	1923	24587
18-#11	2.03	MA	30223	7071	47753	5294	51567	4306	52372	3567	51487	2456	61539	1872	37411
8L-3S		MI	21161	7071	34269	5111	37074	4156	38070	3421	38495	2316	45353	2009	24565
18-#11	2.03	MA	29667	7071	46887	5292	50393	4303	50879	3563	49542	2467	59054	1819	36538
9L-2S		MI	21716	7071	35098	5116	38137	4145	39363	3412	40209	2307	47606	2095	24535
18-#14	2.93	MA	33366	7500	54435	5540	60122	4463	62739	3660	65624	2403	80442	1889	54654
5L-6S		MI	20769	7500	34536	5353	37243	4324	38241	3527	38731	2256	46373	1567	33431
18-#14	2.93	MA	32597	7500	53143	5536	58332	4483	60551	3653	62742	2417	76795	1809	53548
6L-5S		MI	21251	7500	35333	5361	38345	4335	39507	3515	40415	2244	48415	1649	33907
18-#14	2.93	MA	31849	7500	51728	5558	56625	4478	58452	3671	59925	2432	72906	1679	52434
7L-4S		MI	21755	7500	36181	5369	39443	4322	40837	3502	42276	2256	50606	1704	34584

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

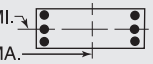


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.93	MA	31113	7500	50457	5555	54893	4498	56403	3689	56932	2421	69325	1608	50961
8L-3S		MI	22316	7500	37156	5353	40685	4333	42327	3515	44130	2244	52663	1825	34639
18-#14	2.93	MA	30337	7500	49213	5551	53209	4492	54261	3682	54141	2436	65790	1531	49373
9L-2S		MI	23096	7500	38338	5361	42200	4319	44157	3502	46557	2232	55842	1950	34639
18-#18	5.22	MA	35791	8589	61864	6190	69212	4962	73744	3937	80725	2328	101470	1272	88117
6L-5S		MI	23255	8589	41058	5988	45451	4784	47833	3744	51460	2047	63039	1014	55970
18-#18	5.22	MA	34524	8589	59373	6226	66208	4995	70050	3966	75769	2350	94735	1041	84879
7L-4S		MI	24112	8589	42539	6005	47359	4762	50110	3722	54651	2069	66765	1112	57103
18-#18	5.22	MA	33277	8589	57134	6219	63160	4984	66444	3996	70504	2329	88511	918	80865
8L-3S		MI	25065	8589	44239	5978	49515	4784	52664	3744	57825	2047	70272	1322	59096
20-#11	2.26	MA	32466	7178	51894	5350	56965	4329	58927	3575	60457	2433	73305	2052	43334
5L-7S		MI	20110	7178	32656	5192	34993	4210	35535	3450	35235	2320	41790	1736	26521
20-#11	2.26	MA	31924	7178	50994	5348	55718	4344	57402	3571	58448	2444	70742	1997	42637
6E		MI	20442	7178	33266	5180	35729	4200	36477	3459	36397	2311	43150	1801	26744
20-#11	2.26	MA	31396	7178	50008	5363	54528	4340	55940	3584	56485	2454	68011	1907	42095
7L-5S		MI	20782	7178	33823	5185	36499	4207	37371	3450	37586	2303	44598	1858	27156
20-#11	2.26	MA	30876	7178	49122	5362	53321	4354	54512	3597	54399	2447	65500	1857	41513
8L-4S		MI	21138	7178	34416	5190	37267	4197	38310	3442	38900	2311	46151	1896	27180
20-#11	2.26	MA	30323	7178	48256	5360	52148	4351	53019	3592	52454	2458	63015	1803	40664
9L-3S		MI	21534	7178	35098	5178	38137	4204	39363	3450	40209	2303	47606	1981	27167
20-#11	2.26	MA	29748	7178	47285	5375	50957	4365	51599	3605	50526	2469	60607	1742	39877
10L-2S		MI	22087	7178	35927	5183	39199	4194	40655	3442	41922	2294	49859	2068	27143
20-#14	3.26	MA	33509	7656	55103	5634	60845	4553	63617	3695	66912	2405	82435	1785	59492
6E		MI	21297	7656	35718	5450	38759	4394	40071	3568	41158	2237	49552	1525	37000
20-#14	3.26	MA	32766	7656	53688	5655	59138	4548	61517	3713	64096	2419	78546	1655	58284
7L-5S		MI	21776	7656	36515	5458	39860	4405	41337	3556	42841	2224	51594	1607	37451
20-#14	3.26	MA	32034	7656	52417	5652	57406	4567	59469	3731	61102	2409	74965	1584	56854
8L-4S		MI	22278	7656	37363	5467	40958	4391	42667	3543	44703	2237	53786	1662	38238
20-#14	3.26	MA	31278	7656	51173	5649	55722	4562	57326	3724	58312	2423	71429	1507	55207
9L-3S		MI	22836	7656	38338	5450	42200	4402	44157	3556	46557	2224	55842	1783	38313
20-#14	3.26	MA	30452	7656	49780	5670	54013	4582	55288	3742	55544	2438	68003	1419	53628
10L-2S		MI	23614	7656	39520	5458	43715	4389	45987	3543	48983	2212	59021	1907	38340
20-#18	5.80	MA	36082	8866	62809	6399	70612	5119	75423	4042	83080	2328	104505	992	94975
7L-5S		MI	24139	8866	43111	6161	48073	4908	50966	3813	55616	2007	68445	929	61927
20-#18	5.80	MA	34847	8866	60570	6392	67565	5108	71818	4071	77814	2306	98281	870	90888
8L-4S		MI	24991	8866	44592	6178	49981	4885	53244	3791	58806	2029	72171	1028	63178
22-#11	2.49	MA	32568	7286	52362	5416	57472	4392	59543	3600	61360	2435	74703	1981	46789
6L-7S		MI	20486	7286	33485	5259	36056	4259	36827	3479	36949	2307	44043	1708	29043
22-#11	2.49	MA	32043	7286	51376	5431	56282	4389	58080	3613	59397	2446	71971	1891	46263
7L-6S		MI	20817	7286	34095	5247	36792	4248	37769	3488	38110	2299	45403	1774	29257
22-#11	2.49	MA	31525	7286	50490	5429	55076	4403	56652	3626	57311	2439	69461	1842	45621
8L-5S		MI	21155	7286	34652	5252	37562	4255	38664	3479	39299	2290	46851	1831	29650
22-#11	2.49	MA	30975	7286	49624	5427	53902	4400	55159	3622	55366	2449	66976	1788	44795
9L-4S		MI	21510	7286	35245	5258	38330	4245	39603	3471	40613	2299	48404	1868	29760
22-#11	2.49	MA	30402	7286	48654	5442	52712	4414	53739	3634	53438	2460	64568	1727	43966
10L-3S		MI	21905	7286	35927	5246	39199	4252	40655	3479	41922	2290	49859	1954	29765
22-#11	2.49	MA	29843	7286	47786	5440	51545	4411	52265	3630	51381	2453	62120	1674	42976
11L-2S		MI	22456	7286	36756	5251	40262	4242	41947	3471	43636	2282	52112	2040	29747
22-#14	3.59	MA	33676	7811	55648	5752	61650	4617	64583	3756	68266	2407	84186	1631	64145
7L-6S		MI	21822	7811	36900	5547	40274	4464	41901	3609	43584	2217	52732	1482	40573
22-#14	3.59	MA	32948	7811	54377	5749	59919	4637	62534	3774	65273	2396	80605	1560	62755
8L-5S		MI	22299	7811	37697	5556	41375	4475	43167	3597	45268	2205	54773	1565	41002
22-#14	3.59	MA	32193	7811	53133	5746	58234	4632	60391	3767	62482	2411	77069	1483	61050
9L-4S		MI	22799	7811	38545	5564	42473	4461	44497	3584	47129	2217	56965	1619	41886
22-#14	3.59	MA	31376	7811	51740	5767	56526	4652	58353	3785	59715	2425	73643	1395	59303
10L-3S		MI	23354	7811	39520	5547	43715	4472	45987	3597	48983	2205	59021	1741	41981
22-#18	6.38	MA	36402	9143	64006	6565	71969	5232	77191	4147	85125	2284	108051	821	101114
8L-5S		MI	25018	9143	45163	6333	50695	5031	54099	3882	59771	1967	73851	845	67837

RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.71	MA	32686	7394	52745	5498	58037	4437	60220	3642	62309	2437	75932	1876	50435
7E		MI	20860	7394	34314	5327	37119	4307	38120	3508	38662	2295	46296	1681	31567
24-#11	2.71	MA	32171	7394	51859	5496	56830	4451	58792	3655	60223	2430	73422	1826	49736
8L-6S		MI	21190	7394	34924	5315	37854	4297	39062	3517	39824	2286	47655	1747	31772
24-#11	2.71	MA	31624	7394	50993	5494	55657	4448	57299	3651	58278	2441	70937	1773	48930
9L-5S		MI	21528	7394	35481	5320	38624	4304	39956	3508	41013	2277	49104	1804	32145
24-#11	2.71	MA	31053	7394	50022	5510	54466	4462	55879	3664	56350	2451	68529	1712	48061
10L-4S		MI	21881	7394	36074	5325	39393	4294	40895	3500	42327	2286	50657	1841	32338
24-#11	2.71	MA	30496	7394	49154	5508	53299	4459	54405	3660	54293	2445	66080	1659	47091
11L-3S		MI	22274	7394	36756	5313	40262	4301	41947	3508	43636	2277	52112	1927	32358
24-#11	2.71	MA	29950	7394	48201	5523	52117	4473	52987	3672	52366	2455	63322	1582	45927
12L-2S		MI	22824	7394	37585	5318	41325	4291	43240	3500	45349	2269	54365	2013	32346
24-#14	3.91	MA	33857	7967	56337	5846	62431	4707	65599	3816	69444	2384	86245	1536	68663
8L-6S		MI	22344	7967	38082	5645	41789	4534	43731	3650	46011	2197	55911	1440	44150
24-#14	3.91	MA	33103	7967	55093	5843	60747	4702	63457	3809	66653	2398	82709	1459	66901
9L-5S		MI	22819	7967	38879	5653	42890	4545	44997	3638	47694	2185	57952	1523	44558
24-#14	3.91	MA	32295	7967	53700	5865	59039	4722	61419	3827	63886	2413	79283	1371	65114
10L-4S		MI	23317	7967	39727	5661	43989	4531	46326	3625	49556	2197	60144	1577	45454

RECTANGULAR TIED COLUMNS 30" x 48"

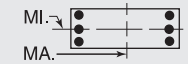
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.11	MA	34018	6918	52741	5180	56988	4225	57938	3529	57334	2552	67153	2419	23560
2E		MI	20955	6918	33133	4978	35026	4057	35066	3375	33959	2408	39012	2236	14269
6-#18	1.67	MA	35712	7195	56350	5353	61615	4350	63582	3604	65012	2530	77471	2373	34905
2L-3S		MI	20492	7195	33133	5134	35026	4203	35066	3466	33959	2390	39012	1930	20974
6-#18	1.67	MA	33275	7195	52741	5346	56988	4384	57938	3635	57334	2554	67153	2152	34893
3L-2S		MI	21869	7195	35186	5151	37647	4181	38199	3444	38114	2368	44418	2151	20839
8-#14	1.25	MA	34531	6987	53593	5254	58284	4282	59596	3569	59622	2563	70517	2436	26580
2L-4S		MI	19890	6987	31475	5078	33108	4133	32891	3434	31218	2460	35894	2016	16198
8-#14	1.25	MA	33128	6987	51536	5251	55646	4277	56379	3588	55244	2578	64568	2311	26626
3E		MI	20465	6987	32450	5062	34350	4144	34382	3447	33072	2447	37950	2137	16115
8-#14	1.25	MA	32147	6987	49864	5273	53515	4297	53788	3581	51910	2593	60688	2187	26594
4L-2S		MI	21264	6987	33632	5070	35866	4130	36212	3434	35499	2435	41130	2262	16036
8-#18	2.22	MA	37385	7471	59959	5526	66241	4474	69225	3680	72691	2508	87789	2328	46205
2L-4S		MI	20419	7471	33486	5333	35492	4304	35645	3513	34940	2372	40911	1636	27360
8-#18	2.22	MA	34970	7471	56350	5519	61615	4508	63582	3711	65012	2532	77471	2106	46079
3E		MI	21407	7471	35186	5306	37647	4326	38199	3535	38114	2350	44418	1845	27430
8-#18	2.22	MA	33278	7471	53410	5557	57867	4498	59027	3697	59151	2556	70756	1885	45511
4L-2S		MI	22774	7471	37239	5324	40269	4304	41332	3513	42270	2328	49824	2067	27344
10-#11	1.08	MA	34047	6904	52462	5217	56936	4257	57992	3557	57456	2578	67700	2461	23204
2L-5S		MI	19684	6904	30879	5044	32427	4126	32115	3442	30095	2472	34522	2097	14237
10-#11	1.08	MA	33064	6904	51026	5215	55095	4254	55746	3570	54401	2589	63525	2375	23242
3L-4S		MI	20048	6904	31472	5049	33195	4116	33054	3433	31410	2480	36075	2134	14178
10-#11	1.08	MA	32378	6904	49860	5231	53609	4268	53940	3566	52076	2600	60799	2288	23263
4L-3S		MI	20451	6904	32154	5037	34065	4123	34107	3442	32719	2472	37530	2220	14118
10-#11	1.08	MA	31766	6904	48853	5229	52304	4265	52335	3580	49751	2593	57973	2246	23225
5L-2S		MI	21013	6904	32984	5042	35127	4113	35399	3433	34432	2463	39783	2306	14066
10-#14	1.56	MA	35504	7143	55651	5351	60921	4351	62814	3612	64000	2550	76466	2413	33035
2L-5S		MI	19914	7143	31809	5167	33525	4216	33391	3488	31783	2428	36882	1919	19940
10-#14	1.56	MA	34110	7143	53593	5348	58284	4347	59596	3630	59622	2565	70517	2289	33052
3L-4S		MI	20429	7143	32657	5175	34624	4203	34721	3475	33645	2440	39073	1974	19926
10-#14	1.56	MA	33135	7143	51921	5370	56152	4367	57005	3624	56288	2580	66637	2164	32972
4L-3S		MI	21001	7143	33632	5159	35866	4214	36212	3488	35499	2428	41130	2095	19866

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

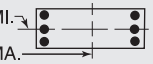


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.56	MA	32265	7143	50477	5367	54279	4362	54703	3642	52952	2571	62604	2103	32729
5L-2S		MI	21796	7143	34814	5167	37381	4200	38042	3475	37925	2415	44309	2220	19797
10-#18	2.78	MA	39037	7748	63567	5699	70867	4598	74869	3755	80370	2486	98107	2282	57452
2L-5S		MI	20449	7748	34057	5489	36205	4450	36501	3604	35905	2310	42591	1453	31759
10-#18	2.78	MA	36643	7748	59959	5692	66241	4632	69225	3786	72691	2510	87789	2061	57239
3L-4S		MI	21333	7748	35538	5506	38113	4428	38778	3581	39096	2332	46317	1551	33347
10-#18	2.78	MA	34968	7748	57018	5730	62493	4622	64671	3772	66830	2534	81074	1839	56568
4L-3S		MI	22313	7748	37239	5479	40269	4450	41332	3604	42270	2310	49824	1761	33838
10-#18	2.78	MA	33474	7748	54476	5723	59196	4656	60619	3803	60961	2513	74055	1733	52963
5L-2S		MI	23671	7748	39291	5497	42891	4428	44465	3581	46426	2288	55229	1982	33811
12-#11	1.30	MA	34733	7012	53898	5285	58777	4305	60237	3587	60511	2569	71875	2447	27714
2L-6S		MI	19721	7012	31151	5106	32720	4168	32513	3480	30620	2468	35327	2013	16879
12-#11	1.30	MA	33754	7012	52462	5283	56936	4302	57992	3600	57456	2580	67700	2360	27741
3L-5S		MI	20067	7012	31708	5111	33490	4175	33407	3471	31809	2459	36775	2070	16854
12-#11	1.30	MA	33071	7012	51296	5298	55450	4317	56185	3596	55131	2591	64974	2274	27738
4E		MI	20429	7012	32301	5117	34258	4164	34347	3462	33123	2468	38328	2107	16809
12-#11	1.30	MA	32462	7012	50289	5297	54144	4314	54581	3609	52806	2585	62148	2231	27677
5L-3S		MI	20831	7012	32984	5105	35127	4172	35399	3471	34432	2459	39783	2192	16758
12-#11	1.30	MA	31882	7012	49347	5295	52838	4328	52983	3605	50701	2596	59446	2175	27433
6L-2S		MI	21391	7012	33813	5110	36190	4161	36691	3462	36146	2450	42036	2279	16709
12-#14	1.88	MA	36470	7298	57708	5448	63559	4421	66031	3654	68377	2538	82414	2391	39476
2L-6S		MI	19963	7298	32194	5256	33939	4275	33955	3541	32526	2420	38019	1795	22904
12-#14	1.88	MA	35083	7298	55651	5445	60921	4417	62814	3672	64000	2553	76466	2266	39457
3L-5S		MI	20452	7298	32991	5264	35041	4286	35221	3529	34210	2408	40061	1877	23502
12-#14	1.88	MA	34114	7298	53978	5467	58790	4437	60223	3666	60665	2568	72586	2142	39340
4E		MI	20965	7298	33839	5273	36139	4272	36551	3516	36071	2420	42253	1931	23634
12-#14	1.88	MA	33250	7298	52534	5464	56916	4432	57920	3685	57329	2558	68553	2081	38987
5L-3S		MI	21534	7298	34814	5256	37381	4284	38042	3529	37925	2408	44309	2053	23596
12-#14	1.88	MA	32429	7298	51181	5462	55041	4452	55628	3678	54308	2573	64705	2000	37606
6L-2S		MI	22326	7298	35996	5264	38896	4270	39871	3516	40352	2395	47488	2177	23540
12-#18	3.33	MA	38298	8025	63567	5865	70867	4756	74869	3861	80370	2488	98107	2015	68384
3L-5S		MI	21360	8025	36110	5662	38827	4573	39634	3672	40061	2270	47997	1368	37840
12-#18	3.33	MA	36639	8025	60627	5903	67120	4746	70315	3848	74508	2511	91393	1794	67208
4E		MI	22238	8025	37591	5679	40735	4551	41911	3650	43252	2292	51723	1467	39297
12-#18	3.33	MA	35160	8025	58085	5896	63822	4780	66263	3879	68640	2491	84374	1688	63779
5L-3S		MI	23212	8025	39291	5652	42891	4573	44465	3672	46426	2270	55229	1676	40208
12-#18	3.33	MA	33753	8025	55701	5889	60521	4770	62228	3865	63323	2515	77706	1544	60941
6L-2S		MI	24561	8025	41344	5670	45512	4551	47598	3650	50582	2248	60635	1897	40250
14-#11	1.52	MA	35415	7120	55333	5352	60618	4354	62483	3616	63567	2560	76050	2432	32215
2L-7S		MI	19767	7120	31370	5186	33047	4226	32864	3500	31172	2464	36220	1919	19075
14-#11	1.52	MA	34440	7120	53898	5350	58777	4351	60237	3629	60511	2571	71875	2346	32232
3L-6S		MI	20103	7120	31980	5174	33782	4216	33806	3509	32334	2455	37579	1985	19347
14-#11	1.52	MA	33760	7120	52732	5366	57291	4365	58431	3625	58187	2582	69149	2259	32205
4L-5S		MI	20448	7120	32537	5179	34553	4223	34700	3500	33523	2446	39028	2042	19459
14-#11	1.52	MA	33154	7120	51725	5364	55985	4362	56826	3638	55862	2576	66324	2216	32123
5L-4S		MI	20808	7120	33130	5184	35321	4213	35639	3491	34837	2455	40581	2080	19427
14-#11	1.52	MA	32577	7120	50783	5362	54678	4377	55229	3634	53756	2587	63621	2161	31760
6L-3S		MI	21209	7120	33813	5172	36190	4220	36691	3500	36146	2446	42036	2165	19385
14-#11	1.52	MA	32015	7120	49749	5378	53432	4374	53696	3648	51700	2598	60741	2071	31099
7L-2S		MI	21767	7120	34642	5177	37253	4210	37984	3491	37859	2438	44289	2251	19340
14-#14	2.19	MA	36049	7454	57708	5543	63559	4486	66031	3715	68377	2541	82414	2244	45852
3L-6S		MI	20500	7454	33376	5353	35455	4345	35785	3582	34953	2401	41199	1752	26455
14-#14	2.19	MA	35086	7454	56036	5565	61427	4507	63440	3708	65043	2556	78535	2119	45701
4L-5S		MI	20987	7454	34173	5362	36556	4356	37051	3569	36636	2388	43240	1835	27011
14-#14	2.19	MA	34228	7454	54591	5562	59553	4502	61138	3727	61707	2546	74502	2058	45139
5L-4S		MI	21498	7454	35021	5370	37654	4342	38381	3557	38498	2401	45432	1889	27323
14-#14	2.19	MA	33412	7454	53238	5559	57678	4522	58845	3721	58685	2561	70654	1977	43821
6L-3S		MI	22064	7454	35996	5353	38896	4353	39871	3569	40352	2388	47488	2011	27311

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

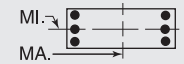
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.19	MA	32617	7454	51755	5581	55889	4518	56645	3739	55734	2576	66551	1848	42960
7L-2S		MI	22853	7454	37178	5362	40411	4340	41701	3557	42778	2376	50667	2135	27268
14-#18	3.89	MA	38292	8301	64236	6076	71746	4870	75958	3923	82187	2489	101711	1748	77883
4L-5S		MI	22265	8301	38163	5835	41449	4696	42767	3741	44217	2230	53403	1283	43944
14-#18	3.89	MA	36827	8301	61693	6069	68449	4904	71907	3954	76319	2469	94692	1642	74622
5L-4S		MI	23136	8301	39644	5852	43357	4674	45044	3719	47408	2252	57129	1382	45289
14-#18	3.89	MA	35434	8301	59310	6062	65147	4894	67872	3941	71001	2493	88024	1498	71598
6L-3S		MI	24104	8301	41344	5825	45512	4696	47598	3741	50582	2230	60635	1591	46556
14-#18	3.89	MA	34078	8301	56699	6100	61997	4928	63999	3971	65805	2517	80910	1268	68255
7L-2S		MI	25444	8301	43396	5842	48134	4674	50731	3719	54737	2208	66041	1813	46661
16-#11	1.73	MA	35122	7228	55333	5418	60618	4399	62483	3659	63567	2563	76050	2331	36709
3L-7S		MI	20149	7228	32199	5253	34110	4275	34156	3529	32886	2451	38473	1892	21592
16-#11	1.73	MA	34445	7228	54168	5433	59132	4414	60677	3655	61242	2574	73325	2245	36666
4L-6S		MI	20483	7228	32809	5241	34845	4264	35098	3538	34047	2442	39832	1958	21846
16-#11	1.73	MA	33841	7228	53161	5431	57826	4411	59072	3668	58917	2567	70499	2202	36565
5E		MI	20826	7228	33366	5246	35615	4271	35992	3529	35236	2434	41281	2015	22056
16-#11	1.73	MA	33268	7228	52219	5430	56519	4425	57474	3664	56812	2578	67796	2146	36096
6L-4S		MI	21186	7228	33959	5251	36384	4261	36931	3520	36550	2442	42834	2052	22036
16-#11	1.73	MA	32708	7228	51185	5445	55273	4422	55942	3677	54755	2589	64917	2056	35461
7L-3S		MI	21585	7228	34642	5239	37253	4268	37984	3529	37859	2434	44289	2138	22002
16-#11	1.73	MA	32158	7228	50258	5444	54009	4437	54446	3690	52569	2583	62274	2006	34996
8L-2S		MI	22142	7228	35471	5245	38316	4258	39276	3520	39573	2425	46541	2224	21963
16-#14	2.50	MA	36051	7610	58093	5662	64064	4576	66658	3751	69421	2543	84484	2097	52056
4L-6S		MI	21034	7610	34558	5451	36970	4415	37615	3623	37379	2381	44378	1710	30015
16-#14	2.50	MA	35198	7610	56649	5659	62191	4572	64355	3769	66084	2533	80451	2035	51308
5E		MI	21519	7610	35355	5459	38071	4426	38881	3610	39063	2368	46419	1793	30533
16-#14	2.50	MA	34387	7610	55295	5656	60315	4592	62062	3763	63063	2548	76603	1955	50046
6L-4S		MI	22027	7610	36203	5467	39169	4412	40211	3598	40925	2381	48611	1847	30997
16-#14	2.50	MA	33597	7610	53812	5678	58526	4587	59863	3782	60111	2563	72500	1825	49125
7L-3S		MI	22591	7610	37178	5451	40411	4423	41701	3610	42778	2368	50667	1969	31021
16-#14	2.50	MA	32819	7610	52480	5675	56712	4608	57716	3800	56974	2554	68728	1754	47473
8L-2S		MI	23376	7610	38360	5459	41927	4409	43531	3598	45205	2356	53846	2093	30986
16-#18	4.44	MA	38477	8578	65302	6242	73075	5029	77550	4029	83997	2447	105010	1596	85487
5E		MI	23162	8578	40215	6008	44070	4820	45900	3810	48373	2190	58808	1199	50066
16-#18	4.44	MA	37098	8578	62919	6235	69773	5019	73515	4016	78680	2471	98343	1453	82282
6L-4S		MI	24028	8578	41696	6025	45978	4798	48177	3788	51563	2212	62535	1297	51314
16-#18	4.44	MA	35754	8578	60307	6273	66624	5053	69643	4047	73484	2495	91228	1222	79053
7L-3S		MI	24989	8578	43396	5998	48134	4820	50731	3810	54737	2190	66041	1507	52889
16-#18	4.44	MA	34433	8578	57961	6266	63429	5043	65862	4077	67962	2475	84665	1098	74725
8L-2S		MI	26322	8578	45449	6015	50756	4798	53864	3788	58893	2168	71447	1728	53043
18-#11	1.95	MA	35126	7336	55604	5501	60972	4462	62922	3684	64298	2565	77500	2230	41123
4L-7S		MI	20528	7336	33028	5320	35172	4323	35448	3558	34599	2438	40726	1865	24111
18-#11	1.95	MA	34526	7336	54597	5499	59667	4459	61318	3697	61972	2559	74674	2187	41003
5L-6S		MI	20862	7336	33638	5308	35908	4313	36390	3567	35761	2429	42085	1931	24350
18-#11	1.95	MA	33954	7336	53654	5497	58360	4474	59720	3693	59867	2570	71972	2132	40441
6L-5S		MI	21204	7336	34195	5314	36678	4320	37285	3558	36950	2421	43533	1988	24643
18-#11	1.95	MA	33398	7336	52621	5513	57114	4471	58187	3707	57810	2581	69092	2042	39828
7L-4S		MI	21562	7336	34788	5319	37446	4310	38224	3549	38264	2429	45087	2025	24638
18-#11	1.95	MA	32850	7336	51694	5511	55850	4485	56692	3720	55624	2575	66449	1992	39374
8L-3S		MI	21959	7336	35471	5307	38316	4317	39276	3558	39573	2421	46541	2110	24612
18-#11	1.95	MA	32258	7336	50786	5509	54620	4482	55128	3716	53587	2586	63828	1938	38435
9L-2S		MI	22515	7336	36300	5312	39379	4307	40568	3549	41287	2412	48794	2197	24580
18-#14	2.81	MA	36161	7765	58706	5756	64828	4642	67572	3812	70462	2521	86400	2013	57493
5L-6S		MI	21566	7765	35740	5548	38485	4485	39445	3664	39806	2361	47557	1668	33580

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

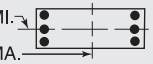


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.81	MA	35355	7765	57353	5753	62953	4662	65280	3805	67441	2536	82551	1932	56280
6L-5S		MI	22048	7765	36537	5556	39586	4496	40711	3651	41489	2349	49599	1751	34068
18-#14	2.81	MA	34570	7765	55869	5775	61164	4657	63080	3824	64489	2551	78449	1803	55259
7L-4S		MI	22554	7765	37385	5564	40685	4482	42041	3639	43351	2361	51790	1805	34663
18-#14	2.81	MA	33797	7765	54538	5772	59349	4677	60933	3842	61352	2541	74677	1731	53655
8L-3S		MI	23115	7765	38360	5548	41927	4493	43531	3651	45205	2349	53846	1926	34707
18-#14	2.81	MA	32970	7765	53235	5769	57584	4673	58688	3836	58427	2556	70946	1654	52113
9L-2S		MI	23897	7765	39542	5556	43442	4479	45361	3639	47631	2336	57026	2051	34695
18-#18	5.00	MA	38745	8855	66527	6408	74400	5143	79159	4091	86359	2449	108661	1407	92992
6L-5S		MI	24054	8855	42268	6181	46692	4943	49033	3879	52528	2150	64214	1114	56203
18-#18	5.00	MA	37414	8855	63916	6445	71250	5177	75286	4122	81163	2473	101547	1176	89813
7L-4S		MI	24914	8855	43749	6198	48600	4921	51310	3857	55719	2172	67940	1213	57365
18-#18	5.00	MA	36105	8855	61570	6439	68055	5167	71506	4153	75641	2453	94984	1052	85437
8L-3S		MI	25869	8855	45449	6171	50756	4943	53864	3879	58893	2150	71447	1422	59209
20-#11	2.17	MA	35206	7444	56033	5566	61508	4508	63563	3727	65028	2550	78849	2173	45440
5L-7S		MI	20906	7444	33857	5388	36235	4371	36741	3587	36313	2425	42979	1837	26633
20-#11	2.17	MA	34637	7444	55090	5565	60201	4522	61966	3723	62923	2561	76147	2117	44792
6E		MI	21239	7444	34467	5376	36971	4361	37683	3596	37474	2417	44338	1903	26860
20-#11	2.17	MA	34083	7444	54057	5580	58955	4519	60433	3736	60866	2572	73267	2027	44200
7L-5S		MI	21579	7444	35024	5381	37741	4368	38577	3587	38663	2408	45786	1960	27221
20-#11	2.17	MA	33538	7444	53130	5578	57691	4533	58937	3749	58680	2566	70624	1977	43690
8L-4S		MI	21936	7444	35617	5386	38509	4358	39516	3579	39977	2417	47339	1998	27234
20-#11	2.17	MA	32949	7444	52222	5577	56461	4531	57373	3745	56642	2577	68004	1924	42767
9L-3S		MI	22333	7444	36300	5374	39379	4365	40568	3587	41287	2408	48794	2083	27217
20-#11	2.17	MA	32346	7444	51206	5592	55214	4545	55886	3758	54622	2588	65463	1863	42033
10L-2S		MI	22886	7444	37129	5379	40442	4355	41861	3579	43000	2400	51047	2169	27190
20-#14	3.13	MA	36317	7921	59410	5851	65590	4732	68497	3848	71818	2524	88500	1910	62522
6E		MI	22094	7921	36922	5645	40001	4554	41275	3704	42233	2341	50736	1626	37151
20-#14	3.13	MA	35537	7921	57927	5873	63801	4727	66297	3866	68867	2539	84397	1780	61405
7L-5S		MI	22575	7921	37719	5653	41102	4566	42541	3692	43916	2329	52778	1708	37611
20-#14	3.13	MA	34769	7921	56595	5870	61987	4747	64150	3885	65729	2529	80626	1709	59846
8L-4S		MI	23078	7921	38567	5662	42200	4552	43871	3680	45778	2341	54970	1763	38321
20-#14	3.13	MA	33947	7921	55292	5867	60222	4743	61905	3879	62805	2544	76894	1631	58243
9L-3S		MI	23637	7921	39542	5645	43442	4563	45361	3692	47631	2329	57026	1884	38384
20-#14	3.13	MA	33095	7921	53833	5889	58432	4763	59770	3897	59905	2559	73278	1543	56531
10L-2S		MI	24416	7921	40724	5653	44957	4549	47191	3680	50058	2317	60205	2009	38404
20-#18	5.56	MA	39059	9131	67525	6618	75876	5301	80930	4197	88841	2451	111865	1131	100433
7L-5S		MI	24940	9131	44320	6354	49314	5066	52166	3948	56684	2110	69620	1030	62350
20-#18	5.56	MA	37761	9131	65179	6612	72681	5291	77150	4228	83320	2430	105302	1006	96167
8L-4S		MI	25795	9131	45801	6371	51222	5044	54443	3926	59875	2132	73346	1128	63438
22-#11	2.38	MA	35317	7552	56526	5632	62042	4570	64211	3752	65978	2553	80322	2103	49150
6L-7S		MI	21283	7552	34686	5455	37298	4420	38033	3616	38026	2413	45231	1810	29156
22-#11	2.38	MA	34765	7552	55493	5648	60795	4568	62679	3765	63921	2564	77442	2013	48576
7L-6S		MI	21614	7552	35296	5443	38034	4410	38975	3625	39188	2404	46591	1876	29372
22-#11	2.38	MA	34223	7552	54565	5646	59531	4582	61183	3779	61735	2557	74799	1963	48003
8L-5S		MI	21953	7552	35853	5449	38804	4417	39869	3616	40377	2395	48039	1933	29778
22-#11	2.38	MA	33637	7552	53658	5644	58302	4579	59619	3775	59698	2568	72179	1909	47104
9L-4S		MI	22309	7552	36446	5454	39572	4407	40809	3608	41691	2404	49592	1970	29821
22-#11	2.38	MA	33036	7552	52642	5660	57055	4593	58131	3788	57678	2579	69639	1848	46328
10L-3S		MI	22704	7552	37129	5442	40442	4414	41861	3616	43000	2395	51047	2056	29816
22-#11	2.38	MA	32449	7552	51732	5658	55832	4591	56587	3784	55523	2573	67061	1795	45253
11L-2S		MI	23256	7552	37958	5447	41504	4403	43153	3608	44714	2387	53300	2142	29795
22-#14	3.44	MA	36497	8077	59984	5970	66439	4797	69515	3909	73244	2526	90346	1758	67561
7L-6S		MI	22620	8077	38104	5743	41516	4624	43105	3745	44659	2322	53915	1584	40725
22-#14	3.44	MA	35733	8077	58652	5967	64624	4817	67368	3927	70107	2516	86574	1686	66044
8L-5S		MI	23098	8077	38901	5751	42617	4635	44371	3733	46343	2309	55957	1666	41162
22-#14	3.44	MA	34931	8077	57349	5964	62859	4813	65123	3921	67182	2531	82843	1609	64382
9L-4S		MI	23599	8077	39749	5759	43715	4622	45700	3720	48204	2322	58149	1721	41973

RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.44	MA	34070	8077	55890	5986	61069	4833	62987	3939	64283	2546	79227	1521	62707
10L-3S		MI	24156	8077	40724	5742	44957	4633	47191	3733	50058	2309	60205	1842	42055
22-#18	6.11	MA	39403	9408	68787	6785	77307	5415	82793	4304	90998	2408	115620	961	106913
8L-5S		MI	25820	9408	46373	6527	51935	5190	55299	4017	60840	2070	75026	945	68258
24-#11	2.60	MA	35444	7659	56929	5715	62636	4616	64924	3795	66977	2555	81617	1998	52955
7E		MI	21657	7659	35515	5523	38361	4468	39325	3645	39740	2400	47484	1783	31681
24-#11	2.60	MA	34904	7659	56001	5713	61372	4630	63429	3808	64791	2549	78974	1948	52323
8L-6S		MI	21988	7659	36125	5511	39097	4458	40268	3654	40901	2391	48844	1848	31888
24-#11	2.60	MA	34321	7659	55094	5712	60143	4627	61865	3804	62753	2560	76354	1894	51445
9L-5S		MI	22326	7659	36682	5516	39867	4465	41162	3645	42090	2383	50292	1905	32273
24-#11	2.60	MA	33722	7659	54077	5727	58896	4642	60377	3817	60733	2571	73814	1834	50628
10L-4S		MI	22680	7659	37275	5521	40635	4455	42101	3637	43404	2391	51845	1943	32402
24-#11	2.60	MA	33138	7659	53168	5725	57673	4639	58833	3813	58578	2564	71236	1781	49575
11L-3S		MI	23074	7659	37958	5509	41504	4462	43153	3645	44714	2383	53300	2028	32412
24-#11	2.60	MA	32564	7659	52170	5741	56435	4653	57348	3826	56559	2575	68329	1704	48439
12L-2S		MI	23624	7659	38787	5514	42567	4452	44446	3637	46427	2374	55553	2115	32397
24-#14	3.75	MA	36692	8232	60710	6064	67261	4887	70585	3970	74484	2504	92523	1664	72249
8L-6S		MI	23143	8232	39286	5840	43031	4694	44935	3786	47086	2302	57095	1542	44303
24-#14	3.75	MA	35890	8232	59406	6061	65497	4882	68340	3963	71560	2519	88792	1586	70530
9L-5S		MI	23619	8232	40083	5848	44132	4705	46200	3774	48769	2290	59136	1624	44719
24-#14	3.75	MA	35039	8232	57947	6083	63707	4903	66205	3982	68660	2534	85176	1498	68890
10L-4S		MI	24118	8232	40931	5856	45230	4691	47530	3761	50631	2302	61328	1678	45621

RECTANGULAR TIED COLUMNS 32" x 32"

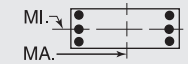
6-#14	1.32	MA	16258	4993	25699	3642	27535	2966	27951	2468	27579	1745	32108	1623	12858
2L-3S		MI	15394	4993	24420	3635	25895	2981	25953	2480	24930	1758	28623	1499	12932
6-#18	2.34	MA	17499	5356	28630	3837	31161	3102	32186	2533	33179	1672	39346	1489	22008
2L-3S		MI	16020	5356	26405	3821	28309	3126	28755	2555	28630	1694	33398	1268	22027
8-#11	1.22	MA	16155	4958	25398	3636	27218	2963	27597	2470	27154	1762	31589	1647	11982
2L-4S		MI	15114	4958	23766	3644	25130	2968	25055	2471	23859	1779	27532	1475	12079
8-#14	1.76	MA	16838	5149	26978	3739	29175	3036	29949	2510	30227	1727	35593	1584	16908
2L-4S		MI	15366	5149	24646	3750	26194	3041	26325	2510	25555	1752	29858	1336	16954
8-#18	3.13	MA	18476	5633	30856	4010	34014	3226	35616	2605	37729	1636	45294	1411	28994
2L-4S		MI	15961	5633	26792	4023	28820	3229	29391	2605	29704	1680	35496	976	27293
10-#11	1.52	MA	16565	5066	26295	3704	28367	3012	28999	2500	29022	1750	34054	1622	14822
2L-5S		MI	15142	5066	24023	3707	25451	3027	25440	2510	24295	1759	28300	1412	14876
10-#11	1.52	MA	15960	5066	25398	3699	27218	3023	27597	2509	27154	1759	31589	1536	14863
3L-4S		MI	15529	5066	24662	3712	26279	3016	26457	2501	25727	1767	29997	1450	14892
10-#14	2.20	MA	17413	5304	28258	3837	30815	3105	31946	2552	32876	1709	39079	1546	20938
2L-5S		MI	15402	5304	25011	3840	26650	3125	26870	2565	26172	1722	30941	1244	20138
10-#14	2.20	MA	16559	5304	26978	3829	29175	3120	29949	2565	30227	1722	35593	1421	20968
3L-4S		MI	15950	5304	25926	3847	27834	3110	28322	2552	28203	1734	33344	1297	20912
10-#18	3.91	MA	19441	5909	33081	4182	36867	3350	39047	2676	42278	1599	51242	1333	35936
2L-5S		MI	16017	5909	27418	4180	29602	3377	30328	2698	30762	1621	37344	801	32239
10-#18	3.91	MA	17990	5909	30856	4167	34014	3374	35616	2698	37729	1621	45294	1112	35760
3L-4S		MI	16951	5909	29018	4196	31673	3353	32822	2676	34253	1643	41444	898	33747

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.47	MA	18555	5362	29513	3894	31675	3167	32221	2627	32012	1838	37368	1698	16053
2E		MI	17417	5362	27777	3871	29721	3149	30124	2606	29850	1820	34742	1675	15024
6-#14	1.24	MA	18277	5276	28744	3872	30831	3155	31288	2629	30844	1873	35919	1751	13769
2L-3S		MI	16300	5276	25786	3844	27309	3153	27326	2626	26157	1870	29976	1607	12976
6-#14	1.24	MA	17345	5276	27367	3865	29067	3171	29135	2642	27973	1886	32128	1627	13843
3L-2S		MI	17165	5276	27065	3851	28949	3138	29323	2614	28806	1858	33462	1732	12898
6-#18	2.21	MA	19631	5639	31911	4066	34750	3291	35950	2701	36956	1805	43859	1626	23628
2L-3S		MI	16927	5639	27777	4029	29721	3296	30124	2700	29850	1806	34742	1375	22114
6-#18	2.21	MA	18033	5639	29513	4053	31675	3317	32221	2723	32012	1827	37368	1405	23647
3L-2S		MI	18409	5639	30002	4044	32574	3273	33554	2678	34400	1784	40690	1597	22069
8-#11	1.15	MA	18162	5241	28416	3866	30484	3152	30892	2631	30372	1889	35336	1774	12824
2L-4S		MI	16019	5241	25129	3855	26544	3141	26429	2618	25089	1892	28890	1584	12122
8-#11	1.15	MA	17508	5241	27452	3862	29249	3164	29384	2641	28350	1897	32658	1688	12874
3E		MI	16453	5241	25865	3842	27482	3147	27569	2626	26517	1883	30482	1670	12069
8-#11	1.15	MA	17043	5241	26662	3875	28242	3158	28161	2633	26805	1906	30925	1602	12921
4L-2S		MI	17061	5241	26762	3847	28631	3136	28971	2617	28384	1875	32947	1757	12018
8-#14	1.65	MA	18906	5431	30120	3969	32596	3225	33441	2671	33715	1857	39711	1716	18123
2L-4S		MI	16271	5431	26013	3959	27608	3213	27697	2656	26782	1865	31212	1445	17027
8-#14	1.65	MA	17980	5431	28744	3963	30831	3241	31288	2685	30844	1869	35919	1591	18176
3E		MI	16886	5431	27065	3941	28949	3223	29323	2669	28806	1852	33462	1569	17013
8-#14	1.65	MA	17321	5431	27613	3981	29391	3232	29538	2673	28650	1881	33470	1467	18169
4L-2S		MI	17746	5431	28345	3949	30589	3208	31321	2656	31454	1840	36947	1693	16955
8-#18	2.94	MA	20693	5916	34310	4239	37825	3415	39678	2774	41900	1771	50350	1554	31154
2L-4S		MI	16866	5916	28164	4230	30233	3400	30760	2750	30924	1791	36840	1084	27656
8-#18	2.94	MA	19111	5916	31911	4226	34750	3441	35950	2796	36956	1793	43859	1333	31067
3E		MI	17919	5916	30002	4201	32574	3420	33554	2772	34400	1769	40690	1297	29009
8-#18	2.94	MA	17981	5916	29935	4256	32233	3422	32913	2774	33178	1815	39664	1115	29607
4L-2S		MI	19388	5916	32228	4217	35427	3397	36985	2750	38949	1747	46638	1519	29063
10-#11	1.43	MA	18607	5348	29380	3934	31720	3201	32399	2660	32395	1878	38015	1751	15875
2L-5S		MI	16047	5348	25386	3918	26865	3200	26814	2657	25526	1872	29658	1521	14943
10-#11	1.43	MA	17956	5348	28416	3930	30484	3212	30892	2670	30372	1887	35336	1665	15916
3L-4S		MI	16435	5348	26025	3922	27693	3189	27832	2648	26957	1880	31355	1559	14942
10-#11	1.43	MA	17493	5348	27626	3943	29478	3207	29669	2663	28827	1895	33603	1578	15945
4L-3S		MI	16867	5348	26762	3910	28631	3196	28971	2656	28384	1872	32947	1645	14906
10-#11	1.43	MA	17078	5348	26941	3939	28590	3218	28578	2673	27278	1887	31765	1540	15929
5L-2S		MI	17472	5348	27658	3914	29781	3185	30373	2647	30252	1863	35412	1731	14862
10-#14	2.07	MA	19530	5587	31497	4066	34361	3295	35594	2714	36586	1840	43503	1680	22456
2L-5S		MI	16307	5587	26378	4049	28063	3298	28243	2711	27399	1834	32294	1352	20354
10-#14	2.07	MA	18610	5587	30120	4060	32596	3310	33441	2727	33715	1852	39711	1555	22486
3L-4S		MI	16856	5587	27292	4056	29248	3283	29695	2698	29430	1846	34697	1406	20995
10-#14	2.07	MA	17955	5587	28990	4078	31156	3301	31691	2716	31521	1865	37262	1431	22431
4L-3S		MI	17467	5587	28345	4039	30589	3293	31321	2711	31454	1834	36947	1530	21027
10-#14	2.07	MA	17367	5587	28009	4072	29885	3317	30130	2729	29321	1852	34653	1376	21724
5L-2S		MI	18322	5587	29624	4046	32229	3278	33319	2698	34103	1822	40432	1654	20989
10-#18	3.68	MA	21744	6192	36708	4412	40899	3539	43407	2848	46844	1737	56842	1482	38636
2L-5S		MI	16920	6192	28790	4388	31014	3547	31697	2843	31983	1733	38687	908	32553
10-#18	3.68	MA	20176	6192	34310	4398	37825	3565	39678	2870	41900	1759	50350	1261	38460
3L-4S		MI	17857	6192	30390	4403	33086	3524	34190	2821	35474	1755	42788	1006	34102
10-#18	3.68	MA	19057	6192	32334	4429	35307	3546	36642	2848	38122	1782	46156	1043	36570
4L-3S		MI	18901	6192	32228	4374	35427	3544	36985	2843	38949	1733	46638	1220	35874
10-#18	3.68	MA	18054	6192	30616	4415	33083	3572	33932	2870	34330	1759	41680	946	34828
5L-2S		MI	20356	6192	34453	4390	38280	3521	40415	2821	43499	1711	52586	1441	36018
12-#11	1.72	MA	19049	5456	30344	4001	32956	3249	33907	2690	34417	1868	40693	1728	18914
2L-6S		MI	16094	5456	25683	3980	27185	3242	27249	2695	26097	1869	30536	1439	17272
12-#11	1.72	MA	18400	5456	29380	3997	31720	3261	32399	2699	32395	1876	38015	1642	18945
3L-5S		MI	16462	5456	26283	3985	28014	3249	28217	2686	27393	1860	32123	1496	17725

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

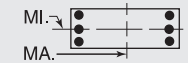
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#11	1.72	MA	17940	5456	28590	4010	30713	3255	31176	2692	30849	1885	36282	1555	18956
4E		MI	16848	5456	26922	3990	28843	3238	29234	2677	28825	1869	33820	1534	17750
12-#11	1.72	MA	17527	5456	27905	4006	29825	3267	30085	2702	29300	1876	34443	1517	18913
5L-3S		MI	17278	5456	27658	3977	29781	3244	30373	2685	30252	1860	35412	1620	17729
12-#11	1.72	MA	17133	5456	27262	4002	28936	3261	28999	2695	27897	1885	32718	1460	18411
6L-2S		MI	17881	5456	28555	3982	30930	3233	31775	2676	32120	1851	37878	1706	17694
12-#14	2.48	MA	20149	5743	32873	4164	36125	3364	37746	2756	39457	1824	47295	1644	26775
2L-6S		MI	16371	5743	26798	4139	28516	3357	28858	2765	28210	1828	33538	1231	23549
12-#14	2.48	MA	19234	5743	31497	4157	34361	3380	35594	2770	36586	1836	43503	1519	26772
3L-5S		MI	16891	5743	27657	4146	29703	3367	30240	2753	30048	1816	35779	1314	24145
12-#14	2.48	MA	18583	5743	30366	4176	32921	3371	33844	2758	34392	1848	41054	1395	26681
4E		MI	17436	5743	28571	4154	30888	3352	31692	2741	32079	1828	38182	1367	24949
12-#14	2.48	MA	18000	5743	29386	4169	31650	3387	32283	2771	32192	1836	38444	1340	25807
5L-3S		MI	18044	5743	29624	4136	32229	3362	33319	2753	34103	1816	40432	1491	25019
12-#14	2.48	MA	17443	5743	28465	4163	30376	3378	30797	2785	30199	1848	36003	1259	25135
6L-2S		MI	18894	5743	30903	4143	33869	3348	35316	2741	36751	1804	43917	1616	25008
12-#18	4.41	MA	21229	6469	36708	4571	40899	3689	43407	2944	46844	1726	56842	1188	45835
3L-5S		MI	17910	6469	31016	4561	33867	3671	35127	2915	36532	1696	44635	830	39157
12-#18	4.41	MA	20121	6469	34732	4602	38382	3670	40371	2922	43067	1748	52647	971	43582
4E		MI	18838	6469	32615	4576	35939	3648	37621	2893	40024	1718	48736	928	40595
12-#18	4.41	MA	19127	6469	33015	4588	36157	3696	37661	2944	39274	1726	48172	874	41965
5L-3S		MI	19872	6469	34453	4547	38280	3669	40415	2915	43499	1696	52586	1142	42720
14-#11	2.01	MA	19488	5564	31308	4068	34191	3298	35414	2719	36439	1857	43371	1705	21944
2L-7S		MI	16151	5564	25922	4061	27541	3302	27631	2717	26699	1866	31303	1324	19682
14-#11	2.01	MA	18843	5564	30344	4064	32956	3309	33907	2729	34417	1865	40693	1618	21965
3L-6S		MI	16508	5564	26579	4048	28334	3291	28651	2725	27965	1857	33002	1414	19966
14-#11	2.01	MA	18384	5564	29554	4078	31949	3303	32684	2722	32871	1874	38960	1532	21954
4L-5S		MI	16875	5564	27179	4052	29164	3297	29619	2716	29261	1848	34588	1471	20452
14-#11	2.01	MA	17973	5564	28869	4073	31061	3315	31593	2731	31322	1865	37122	1493	21853
5L-4S		MI	17259	5564	27818	4057	29992	3286	30636	2706	30693	1857	36286	1508	20544
14-#11	2.01	MA	17582	5564	28226	4069	30172	3309	30506	2724	29919	1874	35396	1437	21309
6L-3S		MI	17686	5564	28555	4044	30930	3293	31775	2715	32120	1848	37878	1595	20542
14-#11	2.01	MA	17200	5564	27522	4083	29322	3321	29462	2734	28548	1883	33551	1346	20984
7L-2S		MI	18287	5564	29451	4049	32079	3282	33178	2705	33987	1840	40343	1681	20516
14-#14	2.90	MA	20764	5898	34250	4261	37890	3434	39899	2799	42328	1807	51087	1608	31084
2L-7S		MI	16450	5898	27137	4254	29022	3442	29400	2795	29064	1823	34921	1097	26349
14-#14	2.90	MA	19854	5898	32873	4254	36125	3450	37746	2812	39457	1819	47295	1484	31047
3L-6S		MI	16954	5898	28077	4236	30156	3427	30856	2808	30859	1810	37023	1193	27391
14-#14	2.90	MA	19207	5898	31743	4273	34685	3441	35997	2801	37263	1832	44846	1359	30923
4L-5S		MI	17470	5898	28936	4243	31343	3437	32238	2795	32697	1798	39264	1275	27952
14-#14	2.90	MA	18627	5898	30762	4266	33414	3457	34436	2814	35063	1819	42236	1305	29908
5L-4S		MI	18012	5898	29850	4251	32528	3422	33690	2783	34728	1810	41667	1329	28895
14-#14	2.90	MA	18075	5898	29841	4260	32141	3448	32950	2827	33070	1832	39795	1223	29273
6L-3S		MI	18616	5898	30903	4233	33869	3432	35316	2795	36751	1798	43917	1452	28996
14-#14	2.90	MA	17536	5898	28833	4278	30925	3464	31385	2816	31124	1844	37183	1092	28142
7L-2S		MI	19461	5898	32182	4241	35509	3417	37314	2783	39400	1786	47403	1577	29021
14-#18	5.15	MA	21174	6745	37131	4775	41457	3794	44099	2996	48011	1714	59138	899	50633
4L-5S		MI	18889	6745	33241	4734	36720	3796	38558	2986	41082	1660	50583	753	45489
14-#18	5.15	MA	20190	6745	35413	4761	39232	3820	41389	3018	44218	1692	54663	802	48898
5L-4S		MI	19809	6745	34841	4749	38792	3772	41051	2964	44573	1682	54683	850	47126
16-#11	2.29	MA	19925	5672	32272	4136	35427	3346	36922	2748	38461	1846	46049	1681	24968
2L-8S		MI	16214	5672	26228	4123	27887	3344	28082	2755	27317	1863	32183	1254	21802
16-#11	2.29	MA	19282	5672	31308	4132	34191	3358	35414	2758	36439	1855	43371	1595	24977
3L-7S		MI	16564	5672	26819	4128	28691	3350	29033	2746	28566	1854	33769	1298	22395

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis

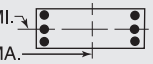


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#11	2.29	MA	18826	5672	30518	4145	33185	3352	34191	2751	34893	1863	41638	1509	24946
4L-6S		MI	16920	5672	27476	4115	29483	3339	30053	2754	29833	1845	35467	1389	22667
16-#11	2.29	MA	18417	5672	29833	4141	32297	3363	33100	2761	33344	1855	39800	1470	24727
5E		MI	17285	5672	28076	4120	30313	3346	31021	2745	31129	1837	37054	1446	23124
16-#11	2.29	MA	18027	5672	29190	4137	31407	3358	32014	2753	31941	1863	38074	1414	24213
6L-4S		MI	17667	5672	28715	4124	31141	3335	32038	2736	32560	1845	38751	1483	23330
16-#11	2.29	MA	17647	5672	28486	4150	30558	3369	30970	2763	30570	1872	36229	1323	23902
7L-3S		MI	18093	5672	29451	4112	32079	3341	33178	2744	33987	1837	40343	1570	23349
16-#11	2.29	MA	17273	5672	27852	4146	29697	3364	29950	2773	29111	1863	34511	1278	23254
8L-2S		MI	18690	5672	30348	4116	33228	3330	34580	2735	35855	1828	42809	1656	23332
16-#14	3.31	MA	20469	6054	34250	4352	37890	3520	39899	2854	42328	1803	51087	1448	35312
3L-7S		MI	17032	6054	28416	4351	30661	3512	31398	2837	31712	1805	38407	1058	30114
16-#14	3.31	MA	19826	6054	33119	4370	36450	3511	38149	2843	40134	1815	48638	1323	35158
4L-6S		MI	17532	6054	29357	4333	31796	3497	32854	2850	33508	1792	40509	1154	31241
16-#14	3.31	MA	19250	6054	32139	4364	35179	3527	36588	2856	37934	1803	46028	1269	34021
5E		MI	18046	6054	30215	4341	32983	3507	34236	2837	35345	1780	42750	1236	31772
16-#14	3.31	MA	18701	6054	31218	4357	33906	3518	35103	2870	35941	1815	43587	1187	33419
6L-4S		MI	18584	6054	31130	4348	34168	3492	35687	2825	37376	1792	45153	1290	32833
16-#14	3.31	MA	18166	6054	30210	4375	32689	3534	33538	2858	33995	1828	40975	1056	32202
7L-3S		MI	19184	6054	32182	4330	35509	3502	37314	2837	39400	1780	47403	1414	32963
16-#18	5.88	MA	21242	7022	37812	4934	42307	3944	45118	3092	49162	1659	61154	730	55786
5E		MI	19860	7022	35467	4906	39573	3920	41988	3058	45631	1623	56531	675	51857
18-#11	2.58	MA	19719	5780	32272	4199	35427	3406	36922	2788	38461	1844	46049	1572	27978
3L-8S		MI	16627	5780	27124	4191	29036	3392	29484	2785	29185	1851	34648	1229	24465
18-#11	2.58	MA	19265	5780	31482	4212	34420	3400	35698	2780	36915	1853	44316	1486	27933
4L-7S		MI	16975	5780	27715	4195	29840	3398	30435	2775	30434	1842	36234	1273	25076
18-#11	2.58	MA	18858	5780	30797	4208	33533	3412	34608	2790	35366	1844	42478	1447	27610
5L-6S		MI	17329	5780	28372	4183	30632	3388	31455	2784	31700	1834	37932	1364	25372
18-#11	2.58	MA	18470	5780	30154	4204	32643	3406	33521	2783	33963	1853	40753	1390	27123
6L-5S		MI	17692	5780	28972	4187	31462	3394	32423	2774	32996	1825	39519	1421	25804
18-#11	2.58	MA	18092	5780	29450	4217	31794	3418	32477	2793	32592	1861	38907	1300	26803
7L-4S		MI	18073	5780	29611	4192	32290	3383	33440	2765	34428	1834	41217	1458	26111
18-#11	2.58	MA	17720	5780	28816	4213	30932	3412	31458	2803	31133	1853	37190	1254	26122
8L-3S		MI	18497	5780	30348	4179	33228	3389	34580	2773	35855	1825	42809	1544	26145
18-#14	3.72	MA	20441	6209	34496	4467	38214	3581	40302	2885	43005	1799	52430	1287	39290
4L-7S		MI	17609	6209	29696	4448	32301	3582	33395	2880	34361	1787	41892	1020	33890
18-#14	3.72	MA	19869	6209	33515	4461	36944	3597	38741	2899	40804	1786	49820	1233	38145
5L-6S		MI	18106	6209	30636	4431	33436	3567	34851	2892	36156	1774	43994	1115	34980
18-#14	3.72	MA	19323	6209	32595	4454	35670	3588	37256	2912	38812	1799	47379	1151	37490
6L-5S		MI	18617	6209	31495	4438	34623	3577	36233	2880	37994	1762	46235	1197	35601
18-#14	3.72	MA	18792	6209	31586	4473	34454	3603	35691	2901	36866	1811	44767	1020	36274
7L-4S		MI	19152	6209	32409	4445	35808	3562	37685	2867	40025	1774	48638	1251	36618
20-#11	2.87	MA	19702	5888	32446	4280	35656	3449	37206	2810	38937	1842	46995	1462	30915
4L-8S		MI	17037	5888	28021	4258	30185	3441	30886	2814	31052	1839	37114	1203	27134
20-#11	2.87	MA	19297	5888	31761	4276	34768	3460	36115	2820	37388	1834	45157	1424	30501
5L-7S		MI	17384	5888	28612	4263	30989	3447	31837	2805	32302	1831	38700	1248	27720
20-#11	2.87	MA	18911	5888	31118	4272	33879	3455	35029	2812	35985	1842	43431	1367	30037
6E		MI	17736	5888	29269	4250	31782	3436	32857	2813	33568	1822	40398	1339	28082
20-#11	2.87	MA	18534	5888	30414	4285	33029	3466	33985	2822	34614	1851	41586	1277	29651
7L-5S		MI	18098	5888	29869	4255	32612	3442	33825	2804	34864	1813	41985	1395	28491
20-#11	2.87	MA	18164	5888	29780	4281	32168	3460	32965	2832	33156	1842	39868	1231	28996
8L-4S		MI	18476	5888	30508	4259	33440	3431	34842	2795	36296	1822	43682	1433	28887
20-#14	4.14	MA	20483	6365	34892	4558	38708	3666	40894	2941	43675	1770	53612	1197	42278
5L-7S		MI	18182	6365	30975	4545	33941	3652	35393	2922	37009	1769	45377	981	37677
20-#14	4.14	MA	19941	6365	33971	4552	37435	3657	39408	2954	41683	1782	51171	1115	41523
6E		MI	18677	6365	31915	4528	35076	3637	36849	2934	38805	1756	47479	1076	38719
20-#14	4.14	MA	19413	6365	32963	4570	36219	3673	37843	2943	39737	1795	48559	985	40356
7L-5S		MI	19185	6365	32774	4535	36263	3647	38231	2922	40642	1744	49720	1158	39440

RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	3.15	MA	19733	5996	32725	4343	36004	3509	37623	2849	39410	1823	47835	1400	33397
5L-8S		MI	17445	5996	28917	4326	31335	3489	32288	2843	32920	1828	39579	1178	29809
22-#11	3.15	MA	19349	5996	32082	4339	35115	3503	36536	2842	38007	1832	46109	1344	32955
6L-7S		MI	17791	5996	29508	4330	32138	3495	33239	2834	34169	1819	41165	1223	30372
22-#11	3.15	MA	18974	5996	31378	4352	34265	3514	35492	2852	36636	1840	44264	1253	32507
7L-6S		MI	18141	5996	30165	4318	32931	3484	34259	2842	35436	1810	42863	1313	30795
22-#11	3.15	MA	18606	5996	30744	4348	33404	3509	34473	2861	35178	1832	42546	1208	31876
8L-5S		MI	18501	5996	30765	4322	33761	3491	35227	2833	36732	1802	44450	1370	31185
22-#14	4.55	MA	20555	6521	35348	4649	39199	3727	41561	2997	44554	1766	54963	1079	45568
6L-7S		MI	18753	6521	32254	4643	35581	3721	37391	2964	39658	1751	48862	942	41472
22-#14	4.55	MA	20030	6521	34339	4667	37983	3743	39996	2985	42608	1778	52351	949	44447
7L-6S		MI	19244	6521	33194	4625	36716	3707	38847	2976	41453	1738	50964	1037	42471
24-#11	3.44	MA	19785	6104	33046	4407	36350	3551	38044	2871	40029	1821	48788	1321	35876
6L-8S		MI	17852	6104	29814	4393	32484	3537	33690	2873	34788	1816	42045	1153	32488
24-#11	3.44	MA	19412	6104	32342	4420	35501	3563	37000	2881	38658	1829	46942	1230	35369
7E		MI	18195	6104	30405	4398	33288	3544	34641	2864	36037	1807	43630	1198	33030
24-#11	3.44	MA	19045	6104	31708	4416	34639	3557	35980	2891	37200	1821	45225	1185	34760
8L-6S		MI	18544	6104	31062	4385	34080	3533	35661	2872	37303	1799	45329	1288	33511
24-#14	4.96	MA	20643	6676	35716	4764	39748	3813	42149	3028	45479	1762	56143	913	48546
7E		MI	19319	6676	33533	4740	37221	3791	39388	3006	42307	1733	52348	903	45275

RECTANGULAR TIED COLUMNS 32" x 36"

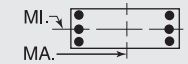
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.39	MA	20714	5645	32782	4123	35218	3356	35851	2791	35556	1967	41520	1828	17133
2E		MI	18324	5645	29149	4078	31134	3319	31492	2751	31071	1931	36086	1782	15073
6-#14	1.17	MA	20409	5559	31949	4102	34303	3344	34791	2790	34271	2000	39913	1879	14680
2L-3S		MI	17205	5559	27152	4054	28722	3325	28698	2773	27384	1983	31330	1716	13019
6-#14	1.17	MA	19409	5559	30475	4096	32414	3361	32487	2804	31177	2013	35814	1754	14755
3L-2S		MI	18072	5559	28432	4061	30362	3310	30696	2760	30033	1970	34815	1841	12938
6-#18	2.08	MA	21878	5922	35354	4296	38515	3480	39873	2866	40895	1936	48556	1761	25248
2L-3S		MI	17833	5922	29149	4236	31134	3467	31492	2845	31071	1917	36086	1483	22196
6-#18	2.08	MA	20161	5922	32782	4284	35218	3507	35851	2888	35556	1958	41520	1539	25267
3L-2S		MI	19317	5922	31375	4251	33987	3443	34923	2823	35620	1895	42034	1704	22128
8-#11	1.08	MA	20284	5523	31595	4096	33927	3342	34362	2791	33752	2016	39265	1901	13666
2L-4S		MI	16925	5523	26492	4065	27958	3314	27804	2765	26320	2005	30248	1693	12163
8-#11	1.08	MA	19582	5523	30563	4092	32605	3354	32749	2802	31576	2024	36374	1814	13716
3E		MI	17359	5523	27229	4053	28896	3320	28944	2773	27747	1996	31840	1780	12106
8-#11	1.08	MA	19085	5523	29720	4106	31529	3348	31442	2795	29912	2033	34499	1728	13763
4L-2S		MI	17968	5523	28125	4057	30045	3310	30346	2764	29615	1988	34305	1866	12053
8-#14	1.56	MA	21089	5714	33423	4199	36192	3414	37096	2832	37365	1985	44012	1845	19338
2L-4S		MI	17176	5714	27379	4168	29021	3385	29069	2803	28009	1977	32565	1554	17096
8-#14	1.56	MA	20094	5714	31949	4193	34303	3431	34791	2846	34271	1998	39913	1721	19391
3E		MI	17792	5714	28432	4151	30362	3395	30696	2815	30033	1965	34815	1677	17063
8-#14	1.56	MA	19389	5714	30741	4212	32764	3422	32922	2836	31907	2010	37260	1596	19384
4L-2S		MI	18654	5714	29711	4158	32002	3380	32693	2803	32681	1952	38300	1802	17000
8-#18	2.78	MA	23026	6198	37925	4469	41811	3604	43894	2941	46234	1905	55591	1694	33314
2L-4S		MI	17771	6198	29536	4438	31645	3570	32128	2894	32145	1903	38184	1191	28009
8-#18	2.78	MA	21326	6198	35354	4457	38515	3632	39873	2964	40895	1927	48556	1472	33227
3E		MI	18827	6198	31375	4409	33987	3591	34923	2917	35620	1881	42034	1405	29105
8-#18	2.78	MA	20116	6198	33240	4489	35821	3614	36600	2942	36815	1949	44016	1251	31952
4L-2S		MI	20299	6198	33600	4424	36840	3567	38353	2894	40170	1858	47982	1627	29130

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.35	MA	20763	5631	32626	4163	35249	3390	35975	2821	35929	2006	42157	1879	16928
2L-5S		MI	16952	5631	26750	4128	28279	3373	28189	2804	26756	1985	31016	1630	15006
10-#11	1.35	MA	20065	5631	31595	4160	33927	3402	34362	2831	33752	2014	39265	1793	16969
3L-4S		MI	17341	5631	27389	4133	29107	3363	29206	2795	28187	1993	32713	1668	14989
10-#11	1.35	MA	19570	5631	30751	4173	32852	3397	33055	2825	32089	2023	37391	1706	16998
4L-3S		MI	17773	5631	28125	4120	30045	3369	30346	2803	29615	1985	34305	1754	14947
10-#11	1.35	MA	19127	5631	30020	4170	31904	3409	31891	2835	30421	2014	35412	1667	16982
5L-2S		MI	18379	5631	29022	4125	31194	3358	31748	2794	31482	1976	36770	1841	14901
10-#14	1.95	MA	21762	5870	34897	4296	38082	3484	39401	2874	40458	1970	48111	1812	23975
2L-5S		MI	17212	5870	27744	4258	29477	3470	29615	2857	28627	1947	33647	1461	20562
10-#14	1.95	MA	20774	5870	33423	4290	36192	3500	37096	2889	37365	1982	44012	1687	24005
3L-4S		MI	17762	5870	28658	4266	30661	3455	31067	2845	30658	1959	36050	1515	21073
10-#14	1.95	MA	20073	5870	32215	4310	34654	3492	35226	2878	35000	1995	41359	1563	23949
4L-3S		MI	18374	5870	29711	4248	32002	3465	32693	2857	32681	1947	38300	1639	21083
10-#14	1.95	MA	19446	5870	31168	4304	33297	3509	33559	2893	32630	1982	38546	1507	23324
5L-2S		MI	19231	5870	30990	4255	33642	3450	34691	2845	35330	1934	41785	1763	21039
10-#18	3.47	MA	24162	6475	40496	4642	45107	3729	47915	3017	51573	1874	62627	1627	41336
2L-5S		MI	17824	6475	30163	4595	32427	3718	33065	2988	33203	1844	40031	1016	32854
10-#18	3.47	MA	22476	6475	37925	4630	41811	3756	43894	3039	46234	1896	55591	1406	41160
3L-4S		MI	18764	6475	31762	4611	34498	3694	35558	2966	36695	1866	44132	1113	34447
10-#18	3.47	MA	21278	6475	35811	4661	39118	3739	40621	3018	42154	1918	51052	1184	39427
4L-3S		MI	19811	6475	33600	4582	36840	3715	38353	2988	40170	1844	47982	1327	35982
10-#18	3.47	MA	20205	6475	33976	4649	36740	3766	37701	3040	38061	1896	46201	1089	37437
5L-2S		MI	21270	6475	35825	4597	39693	3692	41784	2966	44720	1822	53930	1549	36097
12-#11	1.63	MA	21240	5739	33657	4231	36571	3438	37588	2850	38105	1996	45048	1857	20177
2L-6S		MI	16999	5739	27046	4191	28598	3415	28623	2842	27327	1982	31894	1548	17419
12-#11	1.63	MA	20544	5739	32626	4227	35249	3450	35975	2861	35929	2005	42157	1771	20208
3L-5S		MI	17368	5739	27646	4195	29428	3422	29591	2833	28623	1973	33481	1605	17794
12-#11	1.63	MA	20052	5739	31782	4241	34174	3445	34668	2854	34265	2013	40282	1685	20219
4E		MI	17755	5739	28285	4200	30256	3411	30608	2824	30055	1982	35178	1643	17802
12-#11	1.63	MA	19611	5739	31051	4237	33226	3457	33504	2865	32598	2005	38303	1645	20177
5L-3S		MI	18185	5739	29022	4187	31194	3417	31748	2832	31482	1973	36770	1729	17774
12-#11	1.63	MA	19191	5739	30365	4234	32277	3452	32344	2858	31088	2013	36439	1589	19711
6L-2S		MI	18789	5739	29918	4192	32344	3406	33150	2823	33350	1964	39236	1816	17736
12-#14	2.34	MA	22430	6026	36370	4394	39971	3553	41706	2917	43552	1955	52210	1779	28598
2L-6S		MI	17275	6026	28164	4348	29929	3530	30231	2912	29437	1941	34891	1340	23742
12-#14	2.34	MA	21448	6026	34897	4388	38082	3570	39401	2931	40458	1967	48111	1654	28595
3L-5S		MI	17797	6025	29023	4356	31117	3540	31613	2899	31275	1928	37132	1422	24351
12-#14	2.34	MA	20752	6025	33689	4407	36543	3562	37531	2921	38094	1980	45458	1530	28503
4E		MI	18344	6026	29938	4363	32301	3525	33065	2887	33306	1941	39535	1476	25035
12-#14	2.34	MA	20128	6025	32642	4401	35186	3579	35864	2935	35724	1967	42646	1474	27699
5L-3S		MI	18952	6025	30990	4345	33642	3535	34691	2899	35330	1928	41785	1600	25086
12-#14	2.34	MA	19534	6026	31659	4395	33826	3571	34203	2925	33577	1980	40004	1392	26933
6L-2S		MI	19804	6025	32269	4353	35282	3520	36689	2887	37978	1916	45271	1724	25062
12-#18	4.17	MA	23615	6752	40496	4803	45107	3880	47915	3115	51573	1865	62627	1339	49075
3L-5S		MI	18815	6752	32388	4768	35280	3842	36496	3060	37753	1807	45979	938	39464
12-#18	4.17	MA	22428	6752	38382	4834	42414	3863	44643	3093	47493	1887	58088	1118	46952
4E		MI	19747	6752	33987	4783	37351	3819	38989	3038	41244	1830	50079	1035	40934
12-#18	4.17	MA	21365	6752	36547	4822	40036	3890	41722	3115	43400	1865	53237	1022	45097
5L-3S		MI	20784	6752	35825	4755	39693	3839	41784	3060	44720	1807	53930	1249	42837
12-#18	4.17	MA	20354	6752	34823	4809	37652	3873	38942	3138	39695	1887	48711	876	42259
6L-2S		MI	22231	6752	38051	4770	42546	3816	45214	3038	49269	1785	59877	1471	43022
14-#11	1.90	MA	21714	5847	34689	4298	37893	3487	39201	2880	40282	1986	47940	1836	23418
2L-7S		MI	17055	5847	27286	4271	28955	3475	29005	2864	27929	1979	32661	1433	19826
14-#11	1.90	MA	21021	5847	33657	4295	36571	3499	37588	2890	38105	1995	45048	1750	23440
3L-6S		MI	17414	5847	27943	4258	29748	3464	30025	2872	29195	1970	34360	1523	20113
14-#11	1.90	MA	20531	5847	32814	4308	35496	3494	36281	2883	36442	2004	43174	1663	23428
4L-5S		MI	17781	5847	28543	4263	30578	3470	30993	2863	30491	1961	35946	1580	20574

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

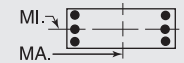
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.90	MA	20092	5847	32083	4305	34548	3506	35117	2894	34775	1995	41195	1624	23366
5L-4S		MI	18166	5847	29182	4267	31406	3459	32010	2853	31923	1970	37644	1618	20607
14-#11	1.90	MA	19674	5847	31397	4301	33599	3501	33957	2887	33264	2004	39330	1567	22812
6L-3S		MI	18594	5847	29918	4255	32344	3466	33150	2862	33350	1961	39236	1704	20592
14-#11	1.90	MA	19266	5847	30646	4315	32693	3513	32843	2898	31788	2012	37338	1477	22444
7L-2S		MI	19195	5847	30815	4259	33493	3455	34552	2852	35218	1953	41701	1790	20562
14-#14	2.73	MA	23093	6181	37844	4491	41860	3623	44011	2959	46645	1940	56309	1746	33210
2L-7S		MI	17354	6181	28503	4463	30435	3614	30772	2942	30291	1935	36275	1206	26659
14-#14	2.73	MA	22117	6181	36370	4485	39971	3640	41706	2974	43552	1952	52210	1621	33173
3L-6S		MI	17859	6181	29444	4446	31569	3599	32228	2954	32086	1923	38377	1301	27585
14-#14	2.73	MA	21425	6181	35163	4504	38432	3632	39836	2963	41188	1964	49557	1496	33049
4L-5S		MI	18377	6181	30303	4453	32757	3609	33610	2942	33924	1910	40618	1383	28156
14-#14	2.73	MA	20805	6181	34116	4498	37075	3649	38169	2977	38817	1952	46745	1441	32091
5L-4S		MI	18921	6181	31217	4460	33941	3595	35062	2929	35955	1923	43021	1437	28987
14-#14	2.73	MA	20215	6181	33133	4492	35716	3640	36508	2967	36671	1964	44103	1359	31367
6L-3S		MI	19525	6181	32269	4443	35282	3605	36689	2942	37978	1910	45271	1561	29068
14-#14	2.73	MA	19640	6181	32057	4511	34417	3657	34912	2981	34573	1977	41279	1229	30278
7L-2S		MI	20373	6181	33549	4450	36922	3590	38686	2929	40627	1898	48756	1686	29074
14-#18	4.86	MA	23566	7028	40953	5007	45710	3987	48664	3168	52832	1856	65124	1051	54517
4L-5S		MI	19796	7028	34614	4941	38133	3966	39926	3131	42303	1771	51927	860	46040
14-#18	4.86	MA	22513	7028	39118	4995	43332	4014	45743	3191	48739	1834	60273	955	52780
5L-4S		MI	20720	7028	36213	4956	40204	3943	42420	3109	45794	1793	56027	958	47460
14-#18	4.86	MA	21511	7028	37394	4982	40949	3997	42963	3213	45034	1856	55747	809	49774
6L-3S		MI	21749	7028	38051	4928	42546	3963	45214	3131	49269	1771	59877	1171	49678
16-#11	2.17	MA	22185	5955	35720	4366	39215	3535	40814	2909	42458	1976	50831	1814	26652
2L-8S		MI	17118	5955	27591	4334	29301	3517	29456	2902	28547	1976	33541	1363	22030
16-#11	2.17	MA	21495	5955	34689	4362	37893	3547	39201	2920	40282	1985	47940	1728	26662
3L-7S		MI	17469	5955	28182	4338	30104	3523	30407	2893	29797	1967	35127	1408	22540
16-#11	2.17	MA	21007	5955	33845	4376	36818	3542	37894	2913	38618	1994	46065	1642	26631
4L-6S		MI	17826	5955	28839	4326	30897	3512	31427	2901	31063	1958	36825	1498	22813
16-#11	2.17	MA	20571	5955	33114	4372	35871	3554	36730	2923	36951	1985	44086	1602	26512
5E		MI	18191	5955	29439	4330	31727	3519	32395	2892	32359	1950	38412	1555	23286
16-#11	2.17	MA	20154	5955	32428	4368	34921	3549	35570	2917	35441	1994	42222	1546	25921
6L-4S		MI	18575	5955	30078	4335	32555	3508	33412	2883	33790	1958	40109	1593	23396
16-#11	2.17	MA	19749	5955	31677	4382	34015	3561	34456	2927	33965	2002	40229	1456	25568
7L-3S		MI	19001	5955	30815	4322	33493	3514	34552	2891	35218	1950	41701	1679	23402
16-#11	2.17	MA	19349	5955	31002	4378	33096	3556	33369	2938	32395	1994	38380	1409	24958
8L-2S		MI	19600	5955	31711	4327	34642	3503	35954	2882	37085	1941	44167	1765	23380
16-#14	3.13	MA	22781	6337	37844	4582	41860	3710	44011	3016	46645	1937	56309	1588	37742
3L-7S		MI	17936	6337	29783	4560	32075	3684	32770	2984	32939	1917	39760	1167	30420
16-#14	3.13	MA	22093	6337	36636	4601	40321	3702	42141	3006	44281	1949	53656	1463	37588
4L-6S		MI	18438	6337	30723	4543	33209	3669	34226	2996	34735	1905	41862	1263	31435
16-#14	3.13	MA	21478	6337	35589	4595	38964	3718	40474	3020	41911	1937	50844	1407	36497
5E		MI	18953	6337	31582	4550	34397	3679	35608	2984	36572	1892	44103	1345	31975
16-#14	3.13	MA	20891	6337	34607	4590	37605	3710	38813	3009	39764	1949	48202	1326	35810
6L-4S		MI	19494	6337	32496	4557	35581	3664	37060	2971	38603	1905	46506	1399	32931
16-#14	3.13	MA	20320	6337	33531	4609	36307	3727	37217	3024	37666	1962	45378	1196	34631
7L-3S		MI	20095	6337	33549	4540	36922	3674	38686	2984	40627	1892	48756	1522	33040
16-#14	3.13	MA	19757	6337	32563	4603	34990	3719	35659	3038	35435	1949	42750	1130	33617
8L-2S		MI	20938	6337	34828	4547	38562	3660	40684	2971	43276	1880	52241	1647	33076
16-#18	5.56	MA	23650	7305	41689	5168	46628	4138	49764	3266	54078	1803	67309	888	60335
5E		MI	20769	7305	36839	5114	40986	4090	43357	3203	46852	1734	57875	782	52400
16-#18	5.56	MA	22657	7305	39966	5155	44245	4121	46984	3289	50373	1825	62782	742	57317
6L-4S		MI	21685	7305	38438	5129	43057	4067	45850	3181	50343	1756	61975	880	54017

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

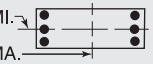


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.44	MA	21966	6063	35720	4430	39215	3596	40814	2949	42458	1975	50831	1706	29873
3L-8S		MI	17532	6063	28487	4401	30450	3565	30858	2932	30415	1964	36006	1338	24691
18-#11	2.44	MA	21481	6063	34876	4443	38140	3591	39507	2942	40795	1984	48957	1620	29828
4L-7S		MI	17881	6063	29079	4406	31254	3572	31809	2922	31664	1955	37592	1382	25257
18-#11	2.44	MA	21046	6063	34145	4440	37193	3603	38343	2953	39128	1975	46978	1581	29597
5L-6S		MI	18236	6063	29736	4393	32046	3561	32829	2931	32931	1947	39290	1473	25519
18-#11	2.44	MA	20632	6063	33460	4436	36244	3597	37183	2946	37617	1984	45113	1524	29035
6L-5S		MI	18600	6063	30336	4398	32876	3567	33797	2921	34227	1938	40877	1530	25965
18-#11	2.44	MA	20228	6063	32708	4450	35337	3610	36069	2957	36141	1993	43121	1434	28696
7L-4S		MI	18981	6063	30975	4402	33704	3556	34814	2912	35658	1947	42575	1567	26181
18-#11	2.44	MA	19831	6063	32033	4446	34418	3604	34982	2967	34572	1984	41271	1387	28029
8L-3S		MI	19406	6063	31711	4390	34642	3563	35954	2920	37085	1938	44167	1654	26206
18-#11	2.44	MA	19437	6063	31306	4460	33524	3616	33845	2960	33109	1993	39463	1333	27486
9L-2S		MI	20003	6063	32608	4394	35791	3552	37356	2911	38953	1929	46632	1740	26193
18-#14	3.52	MA	22757	6492	38110	4699	42211	3772	44446	3048	47375	1934	57755	1430	42123
4L-7S		MI	18514	6492	31062	4658	33715	3754	34768	3026	35588	1899	43245	1128	34194
18-#14	3.52	MA	22145	6492	37063	4693	40854	3788	42779	3062	45004	1922	54943	1374	40914
5L-6S		MI	19014	6492	32002	4640	34849	3739	36224	3038	37383	1887	45347	1224	35291
18-#14	3.52	MA	21562	6492	36081	4687	39494	3780	41118	3052	42858	1934	52301	1293	40258
6L-5S		MI	19526	6492	32861	4647	36037	3749	37606	3026	39221	1874	47588	1306	35804
18-#14	3.52	MA	20994	6492	35004	4706	38196	3797	39522	3066	40760	1946	49477	1162	38996
7L-4S		MI	20063	6492	33775	4655	37221	3734	39058	3013	41252	1887	49991	1360	36861
18-#14	3.52	MA	20435	6492	34036	4700	36879	3789	37964	3080	38529	1934	46849	1096	37916
8L-3S		MI	20661	6492	34828	4637	38562	3744	40684	3026	43276	1874	52241	1483	37004
18-#18	6.25	MA	23793	7582	42537	5328	47541	4245	51005	3364	55713	1794	69818	676	64883
6L-5S		MI	21734	7582	39065	5287	43839	4215	46787	3274	51402	1698	63823	704	58793
20-#11	2.71	MA	21952	6171	35908	4511	39462	3639	41120	2972	42971	1974	51849	1599	33021
4L-8S		MI	17942	6171	29384	4469	31599	3614	32260	2961	32283	1952	38472	1313	27359
20-#11	2.71	MA	21519	6171	35177	4507	38515	3651	39956	2982	41304	1965	49870	1559	32690
5L-7S		MI	18290	6171	29975	4473	32403	3620	33211	2952	33532	1944	40058	1357	27964
20-#11	2.71	MA	21107	6171	34491	4503	37566	3646	38796	2975	39794	1974	48005	1503	32154
6E		MI	18644	6171	30632	4461	33196	3609	34231	2960	34798	1935	41756	1448	28229
20-#11	2.71	MA	20705	6171	33740	4517	36660	3658	37682	2986	38318	1983	46012	1412	31826
7L-5S		MI	19006	6171	31232	4465	34025	3615	35199	2951	36094	1926	43343	1505	28652
20-#11	2.71	MA	20310	6171	33064	4513	35740	3653	36595	2997	36749	1974	44163	1366	31107
8L-4S		MI	19386	6171	31871	4470	34853	3605	36216	2942	37526	1935	45040	1542	28960
20-#11	2.71	MA	19918	6171	32337	4527	34846	3665	35458	2990	35286	1983	42355	1312	30565
9L-3S		MI	19809	6171	32608	4457	35791	3611	37356	2950	38953	1926	46632	1629	28997
20-#14	3.91	MA	22808	6648	38537	4790	42743	3858	45084	3105	48098	1906	59042	1341	45341
5L-7S		MI	19089	6648	32341	4755	35355	3824	36765	3068	38236	1881	46730	1090	37978
20-#14	3.91	MA	22229	6648	37554	4784	41383	3850	43422	3094	45951	1919	56400	1259	44708
6E		MI	19585	6648	33281	4737	36489	3809	38221	3081	40032	1869	48832	1185	39057
20-#14	3.91	MA	21664	6648	36478	4803	40085	3867	41827	3109	43854	1931	53576	1129	43371
7L-5S		MI	20095	6648	34140	4745	37676	3819	39603	3068	41870	1856	51073	1267	39641
20-#14	3.91	MA	21109	6648	35510	4797	38769	3858	40269	3123	41623	1919	50948	1063	42228
8L-4S		MI	20629	6648	35055	4752	38861	3804	41055	3056	43901	1869	53476	1321	40641
22-#11	2.98	MA	21990	6279	36208	4574	39837	3699	41569	3012	43481	1956	52761	1538	35790
5L-8S		MI	18351	6279	30280	4536	32748	3662	33662	2990	34150	1941	40937	1288	30033
22-#11	2.98	MA	21579	6279	35522	4571	38888	3694	40409	3005	41970	1964	50896	1481	35278
6L-7S		MI	18698	6279	30872	4541	33552	3668	34613	2981	35400	1932	42523	1332	30614
22-#11	2.98	MA	21180	6279	34771	4584	37982	3706	39295	3015	40494	1973	48904	1391	34912
7L-6S		MI	19050	6279	31529	4528	34345	3658	35633	2989	36666	1923	44221	1423	30943
22-#11	2.98	MA	20786	6279	34096	4581	37063	3701	38208	3026	38925	1964	47054	1344	34191
8L-5S		MI	19410	6279	32129	4533	35175	3664	36601	2980	37962	1915	45808	1479	31345
22-#11	2.98	MA	20396	6279	33369	4594	36168	3713	37071	3019	37462	1973	45246	1290	33605
9L-4S		MI	19788	6279	32768	4537	36003	3653	37618	2971	39394	1923	47505	1517	31736
22-#14	4.30	MA	22891	6804	39028	4881	43273	3920	45727	3137	49045	1904	60499	1226	49044
6L-7S		MI	19660	6804	33620	4852	36995	3894	38763	3110	40885	1863	50216	1051	41771

RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	4.30	MA	22330	6804	37952	4901	41975	3936	44132	3151	46947	1916	57675	1096	47756
7L-6S		MI	20154	6804	34561	4835	38129	3879	40219	3123	42680	1851	52318	1146	42805
22-#14	4.30	MA	21778	6804	36984	4895	40658	3928	42574	3165	44716	1904	55047	1030	46550
8L-5S		MI	20660	6804	35420	4842	39316	3889	41601	3110	44518	1838	54559	1228	43486
24-#11	3.25	MA	22049	6387	36554	4638	40210	3743	42022	3034	44147	1955	53788	1460	38405
6L-8S		MI	18758	6387	31177	4603	33898	3711	35064	3020	36018	1929	43403	1262	32711
24-#11	3.25	MA	21651	6387	35802	4652	39304	3755	40908	3045	42671	1963	51795	1369	37976
7E		MI	19103	6387	31768	4608	34702	3717	36015	3011	37267	1920	44988	1307	33271
24-#11	3.25	MA	21260	6387	35127	4648	38385	3750	39821	3055	41102	1955	49946	1323	37279
8L-6S		MI	19453	6387	32425	4595	35494	3706	37035	3019	38534	1912	46686	1398	33659
24-#11	3.25	MA	20872	6387	34400	4662	37490	3762	38684	3049	39639	1963	48138	1269	36651
9L-5S		MI	19813	6387	33025	4600	36324	3712	38003	3010	39830	1903	48273	1454	34043
24-#14	4.69	MA	22992	6959	39426	4998	43864	4006	46437	3193	50041	1901	61774	1063	52148
7E		MI	20228	6959	34900	4949	38635	3964	40761	3152	43534	1845	53701	1012	45572
24-#14	4.69	MA	22443	6959	38458	4992	42547	3998	44879	3208	47810	1888	59146	997	50882
8L-6S		MI	20719	6959	35840	4932	39769	3949	42217	3165	45329	1833	55803	1107	46564

RECTANGULAR TIED COLUMNS 32" x 38"

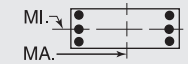
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.32	MA	22987	5928	36212	4353	38937	3545	39613	2951	39261	2095	45854	1956	18213
2E		MI	19231	5928	30521	4286	32547	3490	32860	2896	32292	2043	37430	1890	15122
6-#14	1.11	MA	22655	5842	35315	4332	37951	3533	38470	2950	37859	2127	44088	2005	15591
2L-3S		MI	18111	5842	28519	4263	30136	3497	30070	2919	28611	2095	32683	1825	13060
6-#14	1.11	MA	21587	5842	33744	4326	35937	3551	36013	2965	34543	2140	39681	1880	15666
3L-2S		MI	18978	5842	29798	4270	31776	3483	32068	2907	31260	2083	36168	1949	12977
6-#18	1.97	MA	24239	6205	38957	4526	42455	3669	43904	3027	44996	2066	53436	1894	26868
2L-3S		MI	18739	6205	30521	4443	32547	3637	32860	2990	32292	2028	37430	1591	22273
6-#18	1.97	MA	22402	6205	36212	4515	38937	3698	39613	3051	39261	2088	45854	1672	26887
3L-2S		MI	20226	6205	32747	4459	35399	3614	36291	2968	36841	2006	43378	1812	22186
8-#11	1.03	MA	22519	5806	34934	4326	37545	3531	38007	2952	37293	2142	43376	2026	14509
2L-4S		MI	17830	5806	27856	4276	29372	3487	29178	2912	27550	2118	31606	1802	12201
8-#11	1.03	MA	21769	5806	33835	4323	36137	3543	36289	2963	34962	2151	40271	1940	14558
3E		MI	18265	5806	28592	4263	30310	3494	30318	2920	28977	2109	33198	1889	12141
8-#11	1.03	MA	21240	5806	32938	4337	34993	3539	34899	2957	33180	2159	38255	1853	14606
4L-2S		MI	18874	5806	29488	4268	31459	3483	31720	2911	30845	2100	35663	1975	12088
8-#14	1.48	MA	23385	5997	36886	4429	39965	3603	40927	2993	41176	2113	48494	1974	20553
2L-4S		MI	18082	5997	28745	4378	30435	3557	30442	2949	29236	2089	33918	1662	17158
8-#14	1.48	MA	22323	5997	35315	4424	37951	3620	38470	3008	37859	2126	44088	1849	20606
3E		MI	18699	5997	29798	4360	31776	3567	32068	2961	31260	2077	36168	1786	17112
8-#14	1.48	MA	21571	5997	34030	4443	36313	3613	36480	2998	35324	2138	41231	1725	20599
4L-2S		MI	19561	5997	31077	4368	33416	3552	34066	2949	33908	2065	39653	1911	17044
8-#18	2.63	MA	25474	6481	41701	4699	45973	3793	48196	3102	50730	2037	61017	1831	35474
2L-4S		MI	18677	6481	30908	4645	33058	3741	33496	3039	33366	2014	39528	1299	28352
8-#18	2.63	MA	23655	6481	38957	4688	42455	3822	43904	3126	44996	2059	53436	1610	35387
3E		MI	19735	6481	32747	4616	35399	3762	36291	3061	36841	1992	43378	1513	29197
8-#18	2.63	MA	22364	6481	36705	4721	39586	3807	40418	3106	40613	2082	48536	1389	34330
4L-2S		MI	21209	6481	34972	4632	38252	3738	39721	3039	41391	1970	49326	1734	29196
10-#11	1.28	MA	23033	5914	36033	4393	38954	3579	39725	2981	39624	2133	46481	2006	17981
2L-5S		MI	17858	5914	28113	4338	29693	3546	29563	2951	27986	2097	32374	1740	15062
10-#11	1.28	MA	22287	5914	34934	4390	37545	3592	38007	2993	37293	2142	43376	1919	18022
3L-4S		MI	18247	5914	28752	4343	30521	3536	30580	2942	29418	2106	34071	1777	15034

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

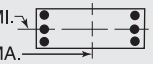


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.28	MA	21761	5914	34037	4404	36402	3587	36617	2986	35511	2150	41360	1833	18051
4L-3S		MI	18680	5914	29488	4330	31459	3542	31720	2950	30845	2097	35663	1864	14987
10-#11	1.28	MA	21289	5914	33260	4401	35394	3599	35380	2998	33726	2142	39240	1793	18035
5L-2S		MI	19286	5914	30385	4335	32608	3531	33122	2941	32712	2089	38128	1950	14939
10-#14	1.85	MA	24108	6153	38457	4526	41979	3673	43384	3035	44492	2099	52901	1943	25494
2L-5S		MI	18117	6153	29110	4468	30890	3642	30987	3004	29854	2059	35000	1570	20764
10-#14	1.85	MA	23052	6153	36886	4521	39965	3690	40927	3050	41176	2112	48494	1818	25524
3L-4S		MI	18668	6153	30025	4475	32075	3627	32439	2991	31885	2071	37403	1624	21145
10-#14	1.85	MA	22306	6153	35601	4541	38327	3683	38937	3041	38641	2124	45637	1694	25468
4L-3S		MI	19282	6153	31077	4457	33416	3637	34066	3004	33908	2059	39653	1747	21137
10-#14	1.85	MA	21638	6153	34488	4535	36884	3700	37164	3056	36101	2112	42622	1637	24939
5L-2S		MI	20139	6153	32356	4465	35056	3622	36063	2991	36557	2047	43139	1872	21088
10-#18	3.29	MA	26696	6758	44445	4872	49491	3918	52488	3177	56465	2009	68598	1769	44036
2L-5S		MI	18728	6758	31535	4802	33840	3889	34433	3133	34424	1955	41375	1124	33146
10-#18	3.29	MA	24892	6758	41701	4861	45973	3946	48196	3202	50730	2031	61017	1548	43860
3L-4S		MI	19671	6758	33134	4818	35911	3865	36927	3111	37915	1977	45475	1221	34783
10-#18	3.29	MA	23615	6758	39449	4894	43104	3931	44710	3182	46348	2053	56117	1326	42317
4L-3S		MI	20720	6758	34972	4789	38252	3886	39721	3133	41391	1955	49326	1435	36085
10-#18	3.29	MA	22471	6758	37496	4883	40573	3959	41600	3206	41953	2031	50905	1229	40065
5L-2S		MI	22183	6758	37198	4805	41105	3862	43152	3111	45940	1933	55273	1656	36175
12-#11	1.54	MA	23545	6022	37132	4461	40363	3627	41444	3011	41955	2124	49586	1986	21441
2L-6S		MI	17904	6022	28409	4401	30012	3589	29997	2989	28558	2094	33252	1658	17561
12-#11	1.54	MA	22802	6022	36033	4457	38954	3640	39725	3022	39624	2133	46481	1899	21472
3L-5S		MI	18273	6022	29010	4406	30842	3595	30965	2980	29854	2086	34839	1715	17858
12-#11	1.54	MA	22278	6022	35135	4472	37810	3635	38336	3016	37842	2141	44465	1813	21483
4E		MI	18661	6022	29649	4410	31670	3584	31982	2971	31285	2094	36536	1752	17852
12-#11	1.54	MA	21809	6022	34358	4468	36803	3648	37098	3027	36057	2133	42345	1773	21440
5L-3S		MI	19092	6022	30385	4398	32608	3590	33122	2979	32712	2086	38128	1838	17819
12-#11	1.54	MA	21362	6022	33630	4465	35794	3643	35865	3021	34440	2141	40341	1717	21019
6L-2S		MI	19696	6022	31281	4402	33757	3579	34524	2970	34580	2077	40594	1925	17778
12-#14	2.22	MA	24826	6308	40028	4623	43993	3743	45841	3077	47809	2085	57307	1912	30420
2L-6S		MI	18180	6308	29531	4558	31343	3702	31603	3058	30665	2053	36245	1449	23928
12-#14	2.22	MA	23776	6308	38457	4618	41979	3760	43384	3093	44492	2098	52901	1787	30417
3L-5S		MI	18702	6308	30390	4565	32530	3712	32985	3046	32502	2041	38486	1531	24551
12-#14	2.22	MA	23035	6308	37172	4638	40341	3753	41394	3083	41957	2110	50044	1663	30326
4E		MI	19250	6308	31304	4572	33715	3697	34437	3033	34533	2053	40889	1585	25115
12-#14	2.22	MA	22371	6308	36059	4633	38898	3770	39621	3098	39417	2098	47029	1606	29605
5L-3S		MI	19860	6308	32356	4555	35056	3707	36063	3046	36557	2041	43139	1709	25150
12-#14	2.22	MA	21738	6308	35014	4628	37452	3763	37854	3089	37116	2110	44187	1525	28742
6L-2S		MI	20713	6308	33636	4562	36696	3692	38061	3033	39205	2029	46624	1833	25115
12-#18	3.95	MA	26116	7035	44445	5034	49491	4070	52488	3277	56465	2002	68598	1485	52315
3L-5S		MI	19720	7035	33760	4975	36693	4013	37864	3205	38974	1919	47323	1046	39753
12-#18	3.95	MA	24851	7035	42193	5067	46622	4055	49001	3257	52082	2024	63698	1264	50355
4E		MI	20655	7035	35359	4991	38764	3989	40357	3182	42465	1941	51423	1143	41265
12-#18	3.95	MA	23718	7035	40240	5055	44091	4083	45892	3281	47688	2002	58486	1166	48249
5L-3S		MI	21696	7035	37198	4962	41105	4010	43152	3205	45940	1919	55273	1357	42950
12-#18	3.95	MA	22640	7035	38406	5044	41554	4068	42793	3261	43708	2024	53604	1021	45424
6L-2S		MI	23147	7035	39423	4977	43958	3986	46583	3182	50490	1897	61221	1578	43106
14-#11	1.80	MA	24053	6130	38230	4528	41771	3676	43162	3040	44287	2115	52691	1966	24892
2L-7S		MI	17960	6130	28649	4481	30369	3648	30379	3011	29159	2091	34019	1542	19963
14-#11	1.80	MA	23313	6130	37132	4525	40363	3688	41444	3051	41955	2124	49586	1879	24914
3L-6S		MI	18319	6130	29306	4469	31162	3637	31399	3019	30425	2083	35717	1633	20254
14-#11	1.80	MA	22792	6130	36234	4539	39219	3684	40054	3045	40173	2132	47570	1793	24903
4L-5S		MI	18687	6130	29906	4473	31991	3643	32367	3010	31721	2074	37304	1689	20644
14-#11	1.80	MA	22325	6130	35457	4536	38212	3696	38816	3056	38388	2124	45450	1753	24840
5L-4S		MI	19073	6130	30545	4478	32819	3632	33384	3001	33153	2083	39002	1727	20661
14-#11	1.80	MA	21880	6130	34729	4533	37203	3692	37584	3050	36771	2132	43446	1697	24324
6L-3S		MI	19502	6130	31281	4465	33757	3639	34524	3009	34580	2074	40594	1813	20639

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

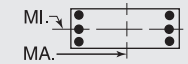
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.80	MA	21447	6130	33930	4547	36240	3704	36400	3061	35190	2141	41306	1606	23911
7L-2S		MI	20104	6130	32178	4470	34907	3628	35926	2999	36448	2066	43059	1900	20606
14-#14	2.59	MA	25538	6464	41599	4721	46007	3812	48298	3120	51125	2071	61714	1881	35337
2L-7S		MI	18257	6464	29870	4673	31848	3787	32145	3088	31518	2048	37628	1315	26959
14-#14	2.59	MA	24494	6464	40028	4715	43993	3830	45841	3135	47809	2084	57307	1756	35299
3L-6S		MI	18764	6464	30810	4655	32983	3772	33601	3100	33313	2035	39730	1410	27771
14-#14	2.59	MA	23757	6464	38743	4735	42355	3822	43851	3126	45274	2096	54451	1632	35175
4L-5S		MI	19284	6464	31669	4662	34170	3782	34983	3088	35151	2023	41971	1492	28354
14-#14	2.59	MA	23098	6464	37630	4730	40912	3840	42078	3141	42734	2084	51435	1575	34289
5L-4S		MI	19829	6464	32583	4670	35355	3767	36435	3075	37182	2035	44374	1546	29074
14-#14	2.59	MA	22470	6464	36585	4725	39466	3833	40311	3131	40432	2096	48593	1494	33472
6L-3S		MI	20435	6464	33636	4652	36696	3777	38061	3088	39205	2023	46624	1670	29137
14-#14	2.59	MA	21858	6464	35441	4744	38086	3850	38615	3146	38183	2108	45556	1363	32438
7L-2S		MI	21284	6464	34915	4659	38336	3762	40059	3075	41854	2011	50109	1794	29130
14-#18	4.61	MA	26074	7311	44937	5240	50140	4179	53293	3332	57817	1996	71280	1202	58435
4L-5S		MI	20703	7311	35986	5148	39546	4137	41295	3276	43523	1882	53271	968	46383
14-#18	4.61	MA	24952	7311	42984	5228	47609	4208	50183	3357	53422	1973	66067	1104	56457
5L-4S		MI	21631	7311	37585	5164	41617	4113	43788	3254	47014	1904	57371	1065	47786
14-#18	4.61	MA	23885	7311	41150	5217	45072	4192	47084	3337	49443	1996	61185	959	53459
6L-3S		MI	22663	7311	39423	5135	43958	4134	46583	3276	50490	1882	61221	1279	49799
16-#11	2.05	MA	24559	6238	39329	4596	43180	3724	44881	3070	46618	2106	55796	1946	28337
2L-8S		MI	18023	6238	28954	4544	30714	3690	30830	3049	29778	2088	34899	1472	22251
16-#11	2.05	MA	23822	6238	38230	4592	41771	3737	43162	3081	44287	2115	52691	1859	28346
3L-7S		MI	18374	6238	29545	4549	31518	3696	31782	3040	31027	2080	36485	1517	22679
16-#11	2.05	MA	23303	6238	37333	4606	40627	3732	41772	3075	42505	2123	50675	1773	28316
4L-6S		MI	18732	6238	30202	4536	32311	3685	32801	3048	32293	2071	38183	1607	22955
16-#11	2.05	MA	22838	6238	36556	4603	39620	3745	40535	3086	40720	2115	48555	1733	28234
5E		MI	19098	6238	30803	4541	33141	3692	33769	3039	33589	2063	39770	1664	23423
16-#11	2.05	MA	22396	6238	35827	4600	38611	3740	39302	3080	39102	2123	46551	1677	27637
6L-4S		MI	19482	6238	31441	4545	33969	3681	34786	3030	35021	2071	41467	1702	23458
16-#11	2.05	MA	21964	6238	35029	4614	37649	3753	38118	3091	37521	2132	44411	1586	27241
7L-3S		MI	19910	6238	32178	4533	34907	3687	35926	3038	36448	2063	43059	1788	23453
16-#11	2.05	MA	21540	6238	34312	4611	36672	3748	36963	3102	35841	2123	42429	1539	26677
8L-2S		MI	20509	6238	33074	4537	36056	3676	37328	3029	38316	2054	45524	1874	23427
16-#14	2.96	MA	25207	6620	41599	4813	46007	3900	48298	3178	51125	2069	61714	1725	40172
3L-7S		MI	18841	6620	31149	4770	33488	3856	34142	3130	34166	2030	41113	1276	30717
16-#14	2.96	MA	24475	6620	40314	4832	44369	3892	46308	3168	48590	2082	58857	1601	40018
4L-6S		MI	19344	6620	32089	4752	34623	3842	35598	3142	35962	2017	43215	1371	31621
16-#14	2.96	MA	23819	6620	39201	4827	42926	3910	44535	3183	46050	2069	55842	1544	38988
5E		MI	19861	6620	32948	4760	35810	3852	36980	3130	37799	2005	45456	1453	32172
16-#14	2.96	MA	23195	6620	38157	4822	41480	3902	42768	3174	43749	2082	53000	1463	38210
6L-4S		MI	20403	6620	33862	4767	36995	3837	38432	3118	39830	2017	47859	1507	33024
16-#14	2.96	MA	22587	6620	37012	4842	40100	3920	41072	3189	41500	2094	49963	1332	37084
7L-3S		MI	21006	6620	34915	4749	38336	3847	40059	3130	41854	2005	50109	1631	33114
16-#14	2.96	MA	21989	6620	35984	4837	38700	3912	39416	3204	39109	2082	47145	1265	36026
8L-2S		MI	21850	6620	36194	4757	39976	3832	42056	3118	44503	1992	53594	1755	33140
16-#18	5.26	MA	26174	7588	45728	5401	51126	4332	54475	3432	59157	1945	73649	1042	64684
5E		MI	21678	7588	38211	5321	42399	4261	44725	3348	48073	1846	59219	890	52932
16-#18	5.26	MA	25116	7588	43894	5390	48590	4316	51376	3412	55178	1967	68767	896	61521
6L-4S		MI	22598	7588	39810	5337	44470	4237	47219	3325	51564	1868	63319	987	54338
18-#11	2.31	MA	24328	6346	39329	4660	43180	3785	44881	3110	46618	2106	55796	1839	31769
3L-8S		MI	18436	6346	29851	4612	31864	3738	32232	3079	31645	2077	37364	1447	24910
18-#11	2.31	MA	23811	6346	38432	4674	42036	3781	43491	3104	44836	2114	53780	1753	31724
4L-7S		MI	18787	6346	30442	4616	32668	3745	33184	3069	32895	2068	38950	1492	25397

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

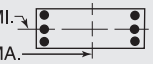


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.31	MA	23348	6346	37655	4671	41029	3793	42253	3115	43051	2106	51660	1713	31596
5L-6S		MI	19142	6346	31099	4604	33460	3734	34203	3078	34161	2060	40648	1582	25661
18-#11	2.31	MA	22908	6346	36926	4667	40020	3789	41020	3109	41433	2114	49656	1656	30956
6L-5S		MI	19507	6346	31699	4608	34290	3740	35171	3068	35457	2051	42235	1639	26122
18-#11	2.31	MA	22479	6346	36128	4681	39057	3801	39837	3120	39852	2123	47516	1566	30575
7L-4S		MI	19889	6346	32338	4613	35118	3729	36188	3059	36888	2060	43933	1677	26247
18-#11	2.31	MA	22056	6346	35410	4678	38081	3796	38681	3131	38172	2114	45534	1519	29952
8L-3S		MI	20315	6346	33074	4600	36056	3736	37328	3067	38316	2051	45524	1763	26260
18-#11	2.31	MA	21638	6346	34638	4692	37130	3809	37473	3125	36605	2123	43591	1465	29344
9L-2S		MI	20913	6346	33971	4605	37205	3725	38730	3058	40183	2042	47990	1849	26243
18-#14	3.33	MA	25187	6775	41885	4930	46383	3962	48765	3210	51907	2068	63264	1570	44857
4L-7S		MI	19420	6775	32428	4867	35128	3926	36140	3172	36815	2012	44598	1237	34488
18-#14	3.33	MA	24536	6775	40772	4924	44940	3980	46992	3226	49366	2055	60248	1513	43699
5L-6S		MI	19921	6775	33368	4849	36263	3911	37596	3185	38610	1999	46700	1332	35478
18-#14	3.33	MA	23916	6775	39728	4919	43494	3972	45225	3216	47065	2068	57406	1432	42956
6L-5S		MI	20434	6775	34227	4857	37450	3921	38978	3172	40448	1987	48941	1415	36000
18-#14	3.33	MA	23312	6775	38584	4939	42114	3990	43529	3231	44816	2080	54370	1301	41741
7L-4S		MI	20973	6775	35142	4864	38635	3907	40430	3160	42479	1999	51344	1469	36968
18-#14	3.33	MA	22717	6775	37555	4934	40714	3982	41873	3246	42425	2068	51551	1234	40722
8L-3S		MI	21573	6775	36194	4847	39976	3916	42056	3172	44503	1987	53594	1592	37083
18-#18	5.92	MA	26337	7864	46638	5563	52108	4440	55668	3488	60912	1938	76348	834	69608
6L-5S		MI	22645	7864	40437	5494	45252	4385	48156	3419	52622	1809	65167	812	59317
20-#11	2.57	MA	24316	6454	39531	4741	43445	3829	45209	3133	47167	2105	56885	1733	35127
4L-8S		MI	18848	6454	30747	4679	33013	3787	33634	3108	33513	2065	39830	1422	27577
20-#11	2.57	MA	23856	6454	38754	4738	42437	3842	43972	3145	45382	2096	54765	1693	34892
5L-7S		MI	19197	6454	31338	4684	33817	3793	34586	3099	34762	2057	41416	1467	28118
20-#11	2.57	MA	23418	6454	38025	4735	41429	3837	42739	3138	43764	2105	52761	1636	34280
6E		MI	19551	6454	31995	4671	34609	3782	35605	3107	36028	2048	43114	1557	28372
20-#11	2.57	MA	22990	6454	37227	4749	40466	3849	41555	3150	42183	2114	50621	1546	33912
7L-5S		MI	19914	6454	32596	4676	35439	3789	36573	3098	37324	2039	44700	1614	28808
20-#11	2.57	MA	22570	6454	36509	4746	39489	3845	40400	3161	40503	2105	48639	1499	33234
8L-4S		MI	20295	6454	33234	4680	36267	3778	37590	3089	38756	2048	46398	1651	29031
20-#11	2.57	MA	22153	6454	35737	4760	38539	3857	39191	3155	38936	2114	46696	1445	32645
9L-3S		MI	20719	6454	33971	4668	37205	3784	38730	3097	40183	2039	47990	1738	29058
20-#11	2.57	MA	21694	6454	35021	4756	37575	3853	38042	3166	37383	2122	44815	1384	31822
10L-2S		MI	21314	6454	34867	4672	38355	3773	40132	3088	42051	2031	50455	1824	29053
20-#14	3.70	MA	25248	6931	42343	5022	46954	4049	49449	3268	52683	2041	64655	1482	48420
5L-7S		MI	19995	6931	33707	4964	36768	3996	38138	3214	39463	1994	48084	1198	38269
20-#14	3.70	MA	24631	6931	41299	5017	45508	4042	47682	3258	50382	2054	61813	1401	47708
6E		MI	20493	6931	34648	4947	37903	3981	39594	3227	41259	1981	50186	1294	39340
20-#14	3.70	MA	24031	6931	40155	5036	44128	4059	45986	3274	48133	2066	58776	1271	46410
7L-5S		MI	21005	6931	35507	4954	39090	3991	40976	3214	43097	1969	52427	1376	39837
20-#14	3.70	MA	23440	6931	39126	5031	42728	4052	44330	3289	45741	2054	55958	1203	45329
8L-4S		MI	21541	6931	36421	4961	40274	3976	42428	3202	45128	1981	54830	1430	40875
22-#11	2.82	MA	24361	6562	39852	4805	43846	3890	45690	3174	47713	2087	57870	1673	38194
5L-8S		MI	19257	6562	31644	4746	34162	3835	35036	3137	35381	2054	42295	1397	30249
22-#11	2.82	MA	23924	6562	39124	4802	42837	3885	44457	3168	46095	2096	55866	1616	37609
6L-7S		MI	19605	6562	32235	4751	34966	3842	35988	3128	36630	2045	43881	1441	30841
22-#11	2.82	MA	23499	6562	38326	4816	41874	3898	43274	3179	44514	2105	53726	1526	37252
7L-6S		MI	19957	6562	32892	4738	35759	3831	37007	3136	37896	2036	45579	1532	31086
22-#11	2.82	MA	23080	6562	37608	4813	40898	3893	42118	3190	42834	2096	51744	1479	36521
8L-5S		MI	20319	6562	33492	4743	36588	3837	37975	3127	39192	2028	47166	1589	31501
22-#11	2.82	MA	22666	6562	36836	4827	39948	3906	40910	3184	41267	2105	49801	1425	35950
9L-4S		MI	20698	6562	34131	4748	37416	3826	38992	3118	40624	2036	48863	1626	31810
22-#11	2.82	MA	22209	6562	36120	4824	38984	3901	39760	3195	39714	2113	47920	1363	35089
10L-3S		MI	21121	6562	34867	4735	38355	3832	40132	3126	42051	2028	50455	1713	31849
22-#14	4.07	MA	25342	7086	42870	5114	47522	4112	50139	3301	53698	2040	66220	1370	52465
6L-7S		MI	20568	7086	34987	5062	38408	4066	40135	3257	42112	1976	51569	1160	42060

RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	4.07	MA	24745	7086	41726	5133	46142	4129	48443	3316	51449	2052	63183	1240	51088
7L-6S		MI	21063	7086	35927	5044	39543	4051	41591	3269	43908	1963	53671	1255	43131
22-#14	4.07	MA	24158	7086	40697	5128	44742	4122	46787	3331	49058	2040	60365	1172	49943
8L-5S		MI	21571	7086	36786	5051	40730	4061	42973	3257	45745	1951	55912	1337	43681
24-#11	3.08	MA	24429	6669	40223	4870	44246	3934	46176	3197	48426	2087	58971	1596	40942
6L-8S		MI	19665	6669	32540	4814	35311	3884	36439	3167	37248	2042	44761	1372	32926
24-#11	3.08	MA	24005	6669	39424	4884	43283	3946	44992	3208	46845	2096	56831	1506	40594
7E		MI	20011	6669	33131	4818	36115	3890	37390	3158	38498	2033	46346	1416	33504
24-#11	3.08	MA	23589	6669	38707	4880	42306	3942	43836	3219	45165	2087	54849	1459	39814
8L-6S		MI	20362	6669	33788	4806	36908	3879	38409	3166	39764	2025	48044	1507	33803
24-#11	3.08	MA	23176	6669	37934	4895	41356	3954	42628	3213	43598	2096	52906	1405	39246
9L-5S		MI	20722	6669	34388	4810	37738	3885	39377	3157	41060	2016	49631	1564	34199
24-#11	3.08	MA	22721	6669	37219	4891	40392	3950	41479	3224	42045	2104	51025	1343	38362
10L-4S		MI	21100	6669	35027	4815	38566	3875	40394	3148	42491	2025	51329	1601	34586
24-#14	4.44	MA	25456	7242	43297	5231	48156	4199	50900	3358	54765	2038	67589	1209	55775
7E		MI	21137	7242	36266	5159	40048	4136	42133	3299	44761	1958	55054	1121	45859
24-#14	4.44	MA	24871	7242	42268	5226	46756	4192	49244	3374	52374	2026	64771	1141	54567
8L-6S		MI	21630	7242	37206	5141	41182	4121	43589	3311	46556	1945	57156	1216	46887

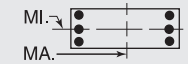
RECTANGULAR TIED COLUMNS 32" x 40"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.25	MA	25374	6211	39803	4583	42832	3734	43549	3112	43128	2222	50371	2084	19293
2E		MI	20138	6211	31893	4493	33959	3660	34229	3041	33512	2154	38774	1998	15169
6-#14	1.05	MA	25015	6124	38843	4561	41774	3722	42324	3111	41609	2254	48444	2130	16503
2L-3S		MI	19017	6124	29885	4472	31549	3670	31443	3065	29838	2207	34036	1934	13099
6-#14	1.05	MA	23878	6124	37174	4557	39636	3740	39715	3127	38069	2266	43730	2006	16577
3L-2S		MI	19885	6124	31164	4480	33189	3655	33440	3053	32487	2195	37521	2058	13015
6-#18	1.88	MA	26714	6488	42720	4756	46572	3858	48111	3187	49259	2196	58498	2025	28488
2L-3S		MI	19645	6488	31893	4651	33959	3808	34229	3135	33512	2140	38774	1698	22342
6-#18	1.88	MA	24757	6488	39803	4746	42832	3888	43549	3213	43128	2218	50371	1804	28507
3L-2S		MI	21134	6488	34119	4666	36812	3784	37659	3113	38062	2118	44722	1920	22243
8-#14	1.41	MA	25795	6280	40511	4659	43913	3792	44933	3153	45148	2241	53159	2101	21768
2L-4S		MI	18987	6280	30112	4587	31848	3730	31814	3095	30463	2202	35271	1771	17214
8-#14	1.41	MA	24665	6280	38843	4654	41774	3810	42324	3169	41609	2253	48444	1977	21821
3E		MI	19605	6280	31164	4570	33189	3740	33440	3108	32487	2189	37521	1895	17158
8-#14	1.41	MA	23867	6280	37480	4674	40038	3803	40214	3160	38903	2266	45383	1852	21814
4L-2S		MI	20468	6280	32444	4577	34829	3725	35438	3095	35135	2177	41007	2019	17087
8-#18	2.50	MA	28037	6764	45638	4929	50311	3983	52673	3263	55389	2169	66626	1967	37634
2L-4S		MI	19582	6764	32281	4852	34471	3911	34865	3184	34586	2125	40871	1407	28686
8-#18	2.50	MA	26098	6764	42720	4919	46572	4013	48111	3288	49259	2191	58498	1746	37547
3E		MI	20643	6764	34119	4824	36812	3932	37659	3206	38062	2103	44722	1620	29284
8-#18	2.50	MA	24727	6764	40331	4953	43527	3998	44411	3270	44573	2213	53237	1524	36738
4L-2S		MI	22120	6764	36344	4839	39665	3909	41090	3184	42611	2081	50669	1842	29260
10-#11	1.22	MA	25417	6197	39601	4623	42835	3768	43652	3142	43459	2259	50986	2132	19034
2L-5S		MI	18763	6197	29476	4549	31107	3720	30937	3098	29216	2210	33732	1849	15114
10-#11	1.22	MA	24623	6197	38434	4620	41340	3781	41828	3154	40978	2267	47668	2045	19075
3L-4S		MI	19152	6197	30115	4553	31935	3709	31954	3089	30648	2219	35429	1887	15077
10-#11	1.22	MA	24065	6197	37483	4635	40128	3777	40354	3148	39082	2276	45510	1959	19104
4L-3S		MI	19586	6197	30852	4541	32873	3715	33094	3097	32075	2210	37021	1973	15026
10-#11	1.22	MA	23565	6197	36660	4632	39061	3790	39043	3160	37183	2268	43249	1918	19088
5L-2S		MI	20193	6197	31748	4545	34022	3704	34496	3088	33943	2202	39486	2059	14977

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

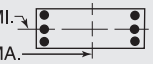


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.76	MA	26568	6436	42179	4756	46052	3862	47542	3196	48688	2228	57873	2072	27013
2L-5S		MI	19022	6436	30477	4677	32304	3814	32360	3150	31081	2171	36354	1678	20961
10-#14	1.76	MA	25445	6436	40511	4751	43913	3880	44933	3212	45148	2240	53159	1948	27043
3L-4S		MI	19574	6436	31391	4684	33488	3799	33812	3137	33112	2184	38757	1732	21214
10-#14	1.76	MA	24652	6436	39148	4772	42177	3873	42823	3203	42443	2253	50098	1823	26987
4L-3S		MI	20189	6436	32444	4667	34829	3809	35438	3150	35135	2171	41007	1856	21190
10-#14	1.76	MA	23944	6436	37969	4767	40647	3891	40944	3219	39732	2240	46879	1765	26569
5L-2S		MI	21048	6436	33723	4674	36469	3795	37436	3137	37784	2159	44492	1981	21135
10-#18	3.13	MA	29345	7041	48555	5102	54051	4107	57235	3338	61519	2142	74754	1909	46736
2L-5S		MI	19632	7041	32907	5010	35252	4059	35802	3278	35645	2067	42719	1231	33428
10-#18	3.13	MA	27423	7041	45638	5092	50311	4137	52673	3364	55389	2164	66626	1687	46560
3L-4S		MI	20578	7041	34506	5025	37324	4036	38295	3256	39136	2089	46819	1329	35111
10-#18	3.13	MA	26065	7041	43248	5126	47266	4122	48973	3345	50704	2187	61364	1466	45238
4L-3S		MI	21630	7041	36344	4996	39665	4056	41090	3278	42611	2067	50669	1543	36183
10-#18	3.13	MA	24851	7041	41177	5116	44582	4152	45675	3371	46007	2164	55791	1366	42712
5L-2S		MI	23095	7041	38570	5012	42518	4033	44520	3256	47161	2045	56617	1764	36242
12-#11	1.46	MA	25963	6305	40767	4691	44330	3817	45475	3171	45941	2250	54305	2113	22704
2L-6S		MI	18809	6305	29773	4612	31426	3762	31372	3136	29788	2207	34610	1767	17698
12-#11	1.46	MA	25173	6305	39601	4688	42835	3830	43652	3183	43459	2259	50986	2027	22736
3L-5S		MI	19179	6305	30373	4616	32256	3768	32339	3127	31084	2199	36197	1824	17919
12-#11	1.46	MA	24617	6305	38649	4702	41623	3825	42178	3177	41563	2268	48829	1940	22746
4E		MI	19567	6305	31012	4621	33084	3757	33356	3118	32515	2207	37894	1861	17900
12-#11	1.46	MA	24120	6305	37827	4699	40556	3838	40867	3189	39664	2259	46568	1900	22704
5L-3S		MI	19999	6305	31748	4608	34022	3763	34496	3126	33943	2199	39486	1948	17861
12-#11	1.46	MA	23646	6305	37055	4696	39487	3834	39561	3183	37944	2268	44424	1843	22336
6L-2S		MI	20604	6305	32645	4613	35171	3753	35898	3117	35810	2190	41952	2034	17818
12-#14	2.11	MA	27336	6591	43847	4853	48190	3932	50151	3238	52227	2215	62588	2044	32243
2L-6S		MI	19084	6591	30897	4767	32756	3874	32975	3204	31892	2166	37598	1558	24106
12-#14	2.11	MA	26218	6591	42179	4849	46052	3950	47542	3254	48688	2227	57873	1919	32240
3L-5S		MI	19608	6591	31756	4774	33944	3884	34357	3192	33729	2153	39839	1640	24745
12-#14	2.11	MA	25431	6591	40817	4869	44315	3943	45432	3245	45982	2240	54812	1794	32148
4E		MI	20157	6591	32670	4782	35128	3869	35809	3180	35760	2166	42242	1694	25191
12-#14	2.11	MA	24727	6591	39637	4864	42786	3961	43553	3261	43272	2227	51594	1736	31525
5L-3S		MI	20768	6591	33723	4764	36469	3879	37436	3192	37784	2153	44492	1817	25204
12-#14	2.11	MA	24057	6591	38531	4860	41254	3954	41681	3253	40816	2240	48551	1655	30559
6L-2S		MI	21623	6591	35002	4771	38109	3864	39433	3180	40432	2141	47977	1942	25166
12-#18	3.75	MA	28733	7317	48555	5265	54051	4261	57235	3439	61519	2138	74754	1629	55555
3L-5S		MI	20626	7317	35132	5183	38105	4183	39232	3349	40194	2030	48667	1153	40033
12-#18	3.75	MA	27388	7317	46165	5299	51006	4247	53535	3421	56834	2160	69492	1408	53791
4E		MI	21564	7317	36731	5198	40177	4160	41726	3327	43686	2052	52767	1251	41587
12-#18	3.75	MA	26186	7317	44094	5289	48321	4277	50237	3447	52137	2138	63918	1308	51420
5L-3S		MI	22607	7317	38570	5169	42518	4180	44520	3349	47161	2030	56617	1465	43057
12-#18	3.75	MA	25042	7317	42150	5279	45632	4262	46951	3428	47883	2160	58680	1163	48630
6L-2S		MI	24061	7317	40795	5185	45371	4157	47951	3327	51710	2008	62565	1686	43189
14-#11	1.71	MA	26507	6413	41933	4758	45825	3865	47299	3201	48422	2241	57624	2094	26366
2L-7S		MI	18865	6413	30012	4692	31783	3821	31754	3158	30389	2204	35377	1651	20095
14-#11	1.71	MA	25720	6413	40767	4755	44330	3878	45475	3212	45941	2250	54305	2008	26388
3L-6S		MI	19224	6413	30669	4679	32575	3810	32774	3166	31656	2196	37075	1742	20391
14-#11	1.71	MA	25166	6413	39816	4769	43118	3874	44002	3207	44045	2259	52147	1922	26377
4L-5S		MI	19593	6413	31269	4684	33405	3816	33741	3157	32952	2187	38662	1799	20710
14-#11	1.71	MA	24671	6413	38993	4767	42051	3887	42691	3218	42146	2251	49886	1881	26314
5L-4S		MI	19979	6413	31908	4688	34233	3806	34759	3148	34383	2196	40360	1836	20713
14-#11	1.71	MA	24200	6413	38221	4764	40982	3883	41385	3213	40425	2260	47743	1825	25844
6L-3S		MI	20409	6413	32645	4676	35171	3812	35898	3156	35810	2187	41952	1923	20686
14-#11	1.71	MA	23741	6413	37376	4778	39963	3896	40132	3225	38744	2269	45455	1735	25382
7L-2S		MI	21012	6413	33541	4680	36321	3801	37300	3147	37678	2179	44417	2009	20650
14-#14	2.46	MA	28097	6747	45516	4950	50329	4001	52760	3281	55767	2202	67302	2015	37463
2L-7S		MI	19161	6747	31236	4882	33262	3959	33517	3234	32745	2160	38981	1423	27251

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

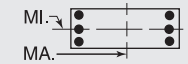
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.46	MA	26986	6747	43847	4946	48190	4020	50151	3297	52227	2214	62588	1890	37426
3L-6S		MI	19669	6747	32176	4864	34396	3944	34973	3247	34540	2148	41083	1519	27950
14-#14	2.46	MA	26204	6747	42485	4966	46454	4013	48041	3288	49522	2227	59527	1766	37301
4L-5S		MI	20190	6747	33035	4872	35584	3954	36355	3234	36378	2135	43324	1601	28547
14-#14	2.46	MA	25504	6747	41305	4961	44925	4031	46162	3304	46811	2214	56308	1708	36502
5L-4S		MI	20736	6747	33949	4879	36768	3939	37807	3222	38409	2148	45727	1655	29156
14-#14	2.46	MA	24838	6747	40199	4957	43393	4024	44290	3295	44355	2227	53265	1626	35586
6L-3S		MI	21344	6747	35002	4861	38109	3949	39433	3234	40432	2135	47977	1778	29204
14-#14	2.46	MA	24189	6747	38987	4977	41931	4042	42493	3311	41955	2239	50016	1496	34620
7L-2S		MI	22194	6747	36281	4869	39749	3934	41431	3222	43081	2123	51462	1903	29185
14-#18	4.38	MA	28698	7594	49082	5472	54746	4371	58097	3496	62965	2133	77619	1349	62386
4L-5S		MI	21610	7594	37358	5356	40958	4307	42663	3421	44744	1994	54615	1076	46662
14-#18	4.38	MA	27506	7594	47011	5461	52061	4401	54799	3522	58268	2111	72046	1250	60153
5L-4S		MI	22541	7594	38957	5371	43030	4284	45156	3399	48235	2016	58715	1173	48103
14-#18	4.38	MA	26373	7594	45067	5451	49371	4387	51513	3504	54014	2133	66808	1105	57184
6L-3S		MI	23576	7594	40795	5342	45371	4305	47951	3421	51710	1994	62565	1387	49915
16-#11	1.95	MA	27047	6521	43099	4825	47320	3913	49123	3230	50904	2233	60942	2076	30022
2L-8S		MI	18927	6521	30317	4755	32128	3863	32205	3196	31008	2201	36257	1582	22464
16-#11	1.95	MA	26263	6521	41933	4823	45825	3926	47299	3242	48422	2242	57624	1989	30031
3L-7S		MI	19280	6521	30909	4759	32932	3869	33156	3187	32257	2193	37843	1626	22812
16-#11	1.95	MA	25712	6521	40982	4837	44613	3922	45826	3236	46526	2251	55466	1903	30001
4L-6S		MI	19638	6521	31566	4747	33725	3859	34176	3195	33523	2184	39541	1717	23092
16-#11	1.95	MA	25219	6521	40159	4834	43546	3935	44515	3248	44627	2242	53205	1862	29919
5E		MI	20005	6521	32166	4751	34554	3865	35144	3186	34819	2176	41128	1773	23494
16-#11	1.95	MA	24750	6521	39388	4831	42477	3931	43209	3242	42907	2251	51062	1806	29361
6L-4S		MI	20389	6521	32805	4756	35382	3854	36161	3177	36251	2184	42825	1811	23518
16-#11	1.95	MA	24293	6521	38542	4846	41458	3944	41956	3254	41225	2260	48774	1716	28919
7L-3S		MI	20818	6521	33541	4743	36321	3860	37300	3185	37678	2176	44417	1897	23502
16-#11	1.95	MA	23843	6521	37783	4843	40424	3940	40732	3266	39438	2252	46660	1668	28411
8L-2S		MI	21418	6521	34438	4748	37470	3849	38702	3176	39546	2167	46882	1984	23473
16-#14	2.81	MA	27748	6902	45516	5043	50329	4089	52760	3339	55767	2201	67302	1861	42602
3L-7S		MI	19745	6902	32515	4979	34902	4029	35515	3276	35393	2142	42466	1385	31006
16-#14	2.81	MA	26971	6902	44153	5063	48593	4083	50650	3330	53061	2214	64241	1737	42448
4L-6S		MI	20250	6902	33456	4962	36036	4014	36971	3289	37189	2130	44568	1480	31801
16-#14	2.81	MA	26276	6902	42974	5059	47063	4101	48771	3346	50351	2201	61023	1679	41493
5E		MI	20768	6902	34314	4969	37224	4024	38353	3276	39026	2117	46809	1562	32363
16-#14	2.81	MA	25614	6902	41867	5054	45532	4094	46899	3337	47895	2214	57980	1598	40621
6L-4S		MI	21311	6902	35229	4976	38408	4009	39805	3264	41057	2130	49212	1616	33112
16-#14	2.81	MA	24969	6902	40655	5074	44070	4112	45102	3353	45494	2226	54730	1467	39559
7L-3S		MI	21916	6902	36281	4959	39749	4019	41431	3276	43081	2117	51462	1740	33186
16-#14	2.81	MA	24334	6902	39566	5070	42587	4106	43348	3369	42943	2214	51721	1399	38382
8L-2S		MI	22762	6902	37561	4966	41389	4004	43429	3264	45730	2105	54948	1864	33195
16-#18	5.00	MA	28814	7871	49928	5634	55801	4525	59361	3597	64398	2085	80174	1192	68907
5E		MI	22587	7871	39583	5529	43811	4432	46093	3492	49293	1957	60563	998	53307
16-#18	5.00	MA	27691	7871	47984	5624	53111	4511	56075	3579	60144	2107	74935	1047	65767
6L-4S		MI	23510	7871	41182	5544	45883	4408	48587	3470	52785	1979	64663	1095	54652
18-#11	2.19	MA	26803	6629	43099	4890	47320	3975	49123	3271	50904	2233	60942	1971	33664
3L-8S		MI	19341	6629	31214	4822	33277	3911	33607	3226	32875	2190	38722	1556	25122
18-#11	2.19	MA	26255	6629	42148	4904	46108	3971	47650	3266	49008	2242	58785	1884	33619
4L-7S		MI	19692	6629	31805	4827	34081	3918	34558	3217	34125	2181	40308	1601	25531
18-#11	2.19	MA	25765	6629	41325	4902	45041	3984	46339	3277	47109	2234	56524	1843	33521
5L-6S		MI	20049	6629	32462	4814	34874	3907	35578	3225	35391	2173	42006	1691	25798
18-#11	2.19	MA	25298	6629	40554	4899	43972	3979	45033	3272	45388	2242	54380	1787	32885
6L-5S		MI	20414	6629	33062	4819	35704	3913	36546	3215	36687	2164	43593	1748	26272

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

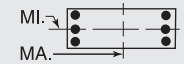


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.19	MA	24843	6629	39709	4913	42953	3992	43780	3283	43707	2251	52093	1697	32460
7L-4S		MI	20797	6629	33701	4823	36532	3902	37563	3206	38119	2173	45291	1786	26311
18-#11	2.19	MA	24395	6629	38949	4910	41919	3988	42556	3295	41920	2243	49979	1649	31889
8L-3S		MI	21224	6629	34438	4811	37470	3909	38702	3214	39546	2164	46882	1872	26312
18-#11	2.19	MA	23939	6629	38131	4925	40913	4001	41277	3289	40253	2252	47901	1595	31213
9L-2S		MI	21823	6629	35334	4815	38619	3898	40105	3205	41413	2155	49348	1959	26291
18-#14	3.16	MA	27733	7058	45821	5161	50731	4153	53259	3373	56601	2201	68956	1708	47590
4L-7S		MI	20325	7058	33795	5076	36542	4099	37512	3319	38042	2124	45952	1346	34774
18-#14	3.16	MA	27042	7058	44642	5156	49202	4171	51380	3389	53890	2188	65737	1650	46498
5L-6S		MI	20827	7058	34735	5059	37676	4084	38968	3331	39837	2112	48054	1441	35658
18-#14	3.16	MA	26384	7058	43536	5151	47670	4164	49508	3380	51434	2201	62694	1569	45664
6L-5S		MI	21343	7058	35594	5066	38863	4094	40350	3319	41675	2099	50295	1523	36190
18-#14	3.16	MA	25743	7058	42324	5172	46209	4182	47711	3396	49034	2213	59445	1439	44510
7L-4S		MI	21883	7058	36508	5073	40048	4079	41802	3306	43706	2112	52698	1577	37062
18-#14	3.16	MA	25112	7058	41234	5167	44726	4175	45957	3412	46482	2201	56436	1370	43374
8L-3S		MI	22485	7058	37561	5056	41389	4089	43429	3319	45730	2099	54948	1701	37159
18-#14	3.16	MA	24488	7058	40061	5187	43283	4193	44123	3403	44103	2213	53486	1292	41861
9L-2S		MI	23327	7058	38840	5063	43029	4074	45426	3306	48378	2087	58433	1825	37195
18-#18	5.63	MA	28997	8147	50901	5797	56850	4635	60637	3655	66275	2080	83063	988	74374
6L-5S		MI	23556	8147	41809	5701	46664	4556	49524	3564	53843	1921	66511	920	59830
20-#11	2.44	MA	26795	6736	43314	4972	47603	4019	49474	3295	51489	2233	62104	1866	37233
4L-8S		MI	19753	6736	32110	4889	34427	3960	35009	3255	34743	2178	41188	1531	27787
20-#11	2.44	MA	26307	6736	42491	4969	46536	4032	48163	3307	49590	2225	59843	1825	37106
5L-7S		MI	20103	6736	32702	4894	35231	3966	35960	3246	35992	2170	42773	1576	28254
20-#11	2.44	MA	25842	6736	41720	4966	45467	4028	46857	3301	47870	2234	57699	1769	36414
6E		MI	20458	6736	33359	4881	36023	3955	36980	3254	37259	2161	44472	1666	28509
20-#11	2.44	MA	25389	6736	40875	4980	44448	4041	45603	3313	46188	2243	55411	1679	36004
7L-5S		MI	20822	6736	33959	4886	36853	3962	37948	3245	38555	2152	46058	1723	28960
20-#11	2.44	MA	24944	6736	40115	4978	43414	4037	44380	3324	44401	2234	53298	1631	35375
8L-4S		MI	21204	6736	34598	4891	37681	3951	38965	3236	39986	2161	47756	1761	29098
20-#11	2.44	MA	24502	6736	39297	4992	42408	4050	43100	3319	42735	2243	51219	1577	34720
9L-3S		MI	21628	6736	35334	4878	38619	3957	40105	3244	41413	2152	49348	1847	29117
20-#11	2.44	MA	24004	6736	38540	4989	41387	4045	41883	3330	41082	2252	49206	1515	33931
10L-2S		MI	22225	6736	36231	4883	39768	3946	41507	3235	43281	2144	51813	1933	29103
20-#14	3.52	MA	27802	7214	46310	5253	51341	4241	53989	3431	57430	2175	70452	1621	51514
5L-7S		MI	20902	7214	35074	5174	38182	4168	39510	3361	40690	2106	49437	1307	38553
20-#14	3.52	MA	27149	7214	45204	5249	49809	4234	52117	3422	54974	2188	67409	1540	50714
6E		MI	21401	7214	36014	5156	39316	4154	40966	3373	42486	2094	51539	1402	39521
20-#14	3.52	MA	26512	7214	43992	5269	48347	4252	50320	3438	52573	2200	64159	1410	49472
7L-5S		MI	21914	7214	36873	5163	40503	4163	42348	3361	44324	2081	53780	1485	40027
20-#14	3.52	MA	25885	7214	42903	5264	46864	4245	48566	3454	50022	2188	61150	1341	48374
8L-4S		MI	22452	7214	37787	5171	41688	4149	43800	3348	46355	2094	56183	1538	41006
20-#14	3.52	MA	25264	7214	41730	5284	45422	4263	46732	3445	47643	2200	58200	1263	46803
9L-3S		MI	23050	7214	38840	5153	43029	4159	45426	3361	48378	2081	58433	1662	41125
22-#11	2.68	MA	26846	6844	43658	5036	48031	4080	49987	3336	52072	2216	63161	1806	40612
5L-8S		MI	20163	6844	33007	4957	35576	4008	36411	3284	36611	2167	43653	1506	30458
22-#11	2.68	MA	26383	6844	42886	5034	46963	4076	48681	3331	50351	2225	61018	1750	39948
6L-7S		MI	20511	6844	33598	4961	36380	4015	37362	3275	37860	2158	45239	1551	30978
22-#11	2.68	MA	25933	6844	42041	5048	45943	4089	47427	3342	48670	2234	58730	1660	39551
7L-6S		MI	20865	6844	34255	4949	37172	4004	38382	3283	39126	2149	46937	1641	31224
22-#11	2.68	MA	25489	6844	41281	5045	44909	4085	46204	3354	46883	2226	56616	1612	38866
8L-5S		MI	21228	6844	34855	4953	38002	4010	39350	3274	40422	2141	48524	1698	31652
22-#11	2.68	MA	25050	6844	40464	5059	43903	4098	44924	3348	45216	2235	54538	1558	38231
9L-4S		MI	21608	6844	35494	4958	38830	3999	40367	3265	41854	2149	50221	1736	31881
22-#11	2.68	MA	24554	6844	39706	5057	42882	4094	43707	3360	43564	2243	52525	1497	37403
10L-3S		MI	22031	6844	36231	4945	39768	4006	41507	3273	43281	2141	51813	1822	31911
22-#14	3.87	MA	27909	7369	46872	5346	51948	4304	54727	3465	58513	2174	72123	1511	55769
6L-7S		MI	21475	7369	36353	5271	39822	4238	41508	3403	43339	2088	52922	1268	42341

RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.87	MA	27276	7369	45660	5366	50486	4322	52929	3481	56113	2187	68874	1381	54445
7L-6S		MI	21972	7369	37293	5253	40956	4223	42964	3415	45135	2076	55024	1364	43388
22-#14	3.87	MA	26652	7369	44571	5361	49003	4315	51175	3497	53561	2174	65865	1312	53373
8L-5S		MI	22482	7369	38152	5261	42143	4233	44346	3403	46972	2063	57265	1446	43871
22-#14	3.87	MA	26036	7369	43398	5382	47560	4333	49341	3488	51182	2187	62915	1234	51754
9L-4S		MI	23017	7369	39066	5268	43328	4218	45798	3391	49003	2076	59668	1500	44892
24-#11	2.92	MA	26922	6952	44052	5101	48458	4125	50505	3360	52833	2217	64337	1731	43487
6L-8S		MI	20571	6952	33903	5024	36725	4057	37813	3314	38479	2155	46118	1481	33135
24-#11	2.92	MA	26474	6952	43207	5115	47438	4138	49251	3372	51151	2225	62049	1641	43100
7E		MI	20918	6952	34495	5029	37529	4063	38764	3305	39728	2146	47704	1526	33703
24-#11	2.92	MA	26032	6952	42448	5112	46404	4133	48028	3383	49364	2217	59935	1593	42364
8L-6S		MI	21271	6952	35152	5016	38322	4052	39784	3313	40994	2138	49402	1616	33941
24-#11	2.92	MA	25593	6952	41630	5127	45398	4146	46748	3378	47698	2226	57857	1539	41746
9L-5S		MI	21632	6952	35752	5021	39151	4059	40752	3304	42290	2129	50989	1673	34350
24-#11	2.92	MA	25101	6952	40872	5124	44377	4142	45531	3389	46045	2235	55844	1478	40879
10L-4S		MI	22010	6952	36391	5025	39979	4048	41769	3295	43722	2138	52687	1710	34660
24-#14	4.22	MA	28035	7525	47328	5463	52625	4392	55538	3523	59652	2174	73588	1352	59426
7E		MI	22045	7525	37632	5368	41462	4308	43505	3445	45988	2070	56407	1229	46138
24-#14	4.22	MA	27415	7525	46239	5459	51142	4385	53784	3539	57101	2161	70580	1284	58290
8L-6S		MI	22540	7525	38573	5351	42596	4293	44961	3458	47783	2058	58509	1325	47201
24-#14	4.22	MA	26802	7525	45066	5479	49699	4403	51950	3530	54722	2174	67629	1206	56713
9L-5S		MI	23047	7525	39431	5358	43783	4303	46343	3445	49621	2045	60750	1407	47721

RECTANGULAR TIED COLUMNS 32" x 42"

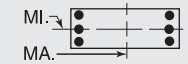
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.19	MA	27874	6494	43555	4813	46903	3923	47661	3272	47156	2349	55069	2210	20373
2E		MI	21044	6494	33265	4701	35372	3831	35597	3186	34733	2266	40118	2105	15216
6-#14	1.00	MA	27488	6407	42531	4791	45774	3911	46354	3271	45502	2379	52982	2255	17414
2L-3S		MI	19922	6407	31251	4682	32963	3842	32815	3212	31065	2320	35389	2042	13136
6-#14	1.00	MA	26282	6407	40765	4787	43511	3930	43593	3288	41745	2392	47959	2131	17488
3L-2S		MI	20791	6407	32531	4689	34603	3827	34813	3199	33714	2307	38875	2167	13052
6-#18	1.79	MA	29304	6770	46645	4986	50864	4048	52493	3348	53683	2325	63744	2156	30108
2L-3S		MI	20551	6770	33265	4858	35372	3979	35597	3280	34733	2251	40118	1806	22409
6-#18	1.79	MA	27226	6770	43555	4977	46903	4079	47661	3375	47156	2347	55069	1934	30127
3L-2S		MI	22042	6770	35491	4873	38225	3955	39028	3258	39282	2229	46065	2027	22299
8-#14	1.34	MA	28319	6563	44296	4889	48037	3981	49115	3314	49259	2367	58005	2228	22983
2L-4S		MI	19893	6563	31478	4797	33262	3902	33186	3242	31690	2314	36625	1880	17268
8-#14	1.34	MA	27120	6563	42531	4884	45774	4000	46354	3331	45502	2379	52982	2103	23036
3E		MI	20511	6563	32531	4779	34603	3912	34813	3254	33714	2302	38875	2004	17203
8-#14	1.34	MA	26276	6563	41091	4905	43939	3994	44123	3323	42631	2392	49717	1979	23029
4L-2S		MI	21375	6563	33810	4786	36243	3897	36810	3242	36362	2289	42360	2128	17130
8-#18	2.38	MA	30715	7047	49735	5159	54825	4172	57326	3423	60210	2300	72418	2101	39794
2L-4S		MI	20487	7047	33653	5060	35883	4082	36233	3329	35807	2237	42215	1514	29013
8-#18	2.38	MA	28656	7047	46645	5150	50864	4203	52493	3450	53683	2322	63744	1880	39707
3E		MI	21550	7047	35491	5031	38225	4103	39028	3351	39282	2215	46065	1728	29367
8-#18	2.38	MA	27203	7047	44118	5185	47644	4190	48580	3433	48695	2344	58119	1658	39175
4L-2S		MI	23029	7047	37716	5046	41078	4079	42458	3329	43832	2193	52013	1950	29323
10-#11	1.16	MA	27914	6480	43329	4853	46892	3957	47753	3303	47420	2382	55673	2257	20087
2L-5S		MI	19668	6480	30840	4759	32520	3893	32312	3245	30446	2323	35089	1958	15162
10-#11	1.16	MA	27073	6480	42096	4850	45310	3953	45824	3315	44795	2392	52141	2171	20128
3L-4S		MI	20058	6480	31479	4764	33348	3882	33329	3236	31878	2332	36787	1996	15117

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

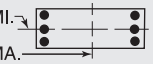


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.16	MA	26482	6480	41091	4865	44030	3967	44267	3310	42792	2401	49841	2084	20157
4L-3S		MI	20492	6480	32215	4751	34286	3888	34469	3244	33305	2323	38379	2082	15064
10-#11	1.16	MA	25954	6480	40222	4863	42903	3963	42883	3322	40787	2393	47439	2043	20141
5L-2S		MI	21100	6480	33111	4756	35436	3877	35871	3235	35173	2315	40844	2168	15013
10-#14	1.67	MA	29142	6719	46062	4986	50301	4051	51876	3356	53015	2354	63027	2201	28531
2L-5S		MI	19927	6719	31843	4887	33717	3987	33732	3296	32308	2284	37707	1787	21151
10-#14	1.67	MA	27951	6719	44296	4982	48037	4070	49115	3373	49259	2367	58005	2076	28561
3L-4S		MI	20480	6719	32757	4894	34902	3972	35184	3284	34339	2296	40110	1841	21278
10-#14	1.67	MA	27112	6719	42856	5002	46202	4064	46884	3365	46388	2380	54739	1952	28506
4L-3S		MI	21095	6719	33810	4876	36243	3982	36810	3296	36362	2284	42360	1965	21241
10-#14	1.67	MA	26363	6719	41610	4998	44587	4082	44899	3382	43513	2368	51317	1893	28212
5L-2S		MI	21955	6719	35089	4884	37883	3967	38808	3284	39011	2271	45845	2089	21182
10-#18	2.98	MA	32109	7324	52825	5332	58786	4296	62158	3499	66736	2275	81093	2046	49436
2L-5S		MI	20536	7324	34279	5217	36665	4230	37170	3423	36865	2178	44063	1339	33702
10-#18	2.98	MA	30068	7324	49735	5323	54825	4327	57326	3526	60210	2297	72418	1825	49260
3L-4S		MI	21484	7324	35878	5233	38736	4206	39664	3401	40357	2200	48163	1436	35431
10-#18	2.98	MA	28630	7324	47208	5358	51605	4314	53412	3509	55221	2319	66794	1604	48190
4L-3S		MI	22538	7324	37716	5204	41078	4227	42458	3423	43832	2178	52013	1650	36277
10-#18	2.98	MA	27345	7324	45019	5348	48767	4345	49926	3536	50222	2297	60859	1502	45378
5L-2S		MI	24007	7324	39942	5219	43931	4203	45889	3401	48382	2156	57961	1872	36311
12-#11	1.39	MA	28496	6588	44563	4920	48473	4006	49682	3332	50045	2373	59206	2240	23968
2L-6S		MI	19714	6588	31136	4822	32840	3935	32746	3283	31018	2320	35968	1876	17831
12-#11	1.39	MA	27658	6588	43329	4918	46892	4002	47753	3344	47420	2383	55673	2153	23999
3L-5S		MI	20084	6588	31736	4827	33670	3941	33714	3274	32314	2312	37555	1933	17973
12-#11	1.39	MA	27070	6588	42324	4933	45611	4015	46196	3339	45417	2392	53374	2067	24010
4E		MI	20473	6588	32375	4831	34498	3930	34731	3265	33746	2320	39252	1971	17945
12-#11	1.39	MA	26545	6588	41456	4930	44485	4011	44812	3351	43412	2385	50972	2026	23968
5L-3S		MI	20905	6588	33111	4819	35436	3937	35871	3273	35173	2312	40844	2057	17903
12-#11	1.39	MA	26044	6588	40641	4928	43356	4025	43433	3346	41595	2394	48689	1970	23660
6L-2S		MI	21511	6588	34008	4823	36585	3926	37273	3264	37041	2303	43310	2143	17858
12-#14	2.01	MA	29960	6874	47827	5083	52564	4121	54637	3399	56772	2342	68050	2174	34065
2L-6S		MI	19989	6874	32263	4976	34170	4046	34348	3351	33119	2278	38951	1666	24279
12-#14	2.01	MA	28774	6874	46062	5079	50301	4139	51876	3415	53015	2355	63027	2049	34062
3L-5S		MI	20514	6874	33122	4984	35357	4056	35730	3338	34956	2266	41192	1748	24933
12-#14	2.01	MA	27941	6874	44622	5100	48466	4133	49645	3407	50145	2367	59762	1925	33971
4E		MI	21064	6874	34036	4991	36542	4042	37182	3326	36987	2278	43595	1802	25263
12-#14	2.01	MA	27197	6874	43376	5096	46850	4152	47661	3424	47270	2355	56340	1866	33461
5L-3S		MI	21676	6874	35089	4974	37883	4052	38808	3338	39011	2266	45845	1926	25260
12-#14	2.01	MA	26489	6874	42208	5091	45232	4146	45684	3416	44665	2368	53096	1785	32387
6L-2S		MI	22532	6874	36368	4981	39523	4037	40806	3326	41660	2253	49330	2051	25217
12-#18	3.57	MA	31465	7600	52825	5495	58786	4451	62158	3601	66736	2272	81093	1770	58795
3L-5S		MI	21531	7600	36504	5390	39518	4354	40601	3494	41415	2142	50011	1261	40305
12-#18	3.57	MA	30041	7600	50298	5531	55566	4438	58245	3584	61748	2294	75468	1549	57258
4E		MI	22472	7600	38104	5406	41589	4330	43094	3472	44906	2164	54111	1358	41901
12-#18	3.57	MA	28768	7600	48109	5521	52728	4469	54758	3612	56749	2272	69534	1448	54611
5L-3S		MI	23518	7600	39942	5377	43931	4351	45889	3494	48382	2142	57961	1572	43160
12-#18	3.57	MA	27557	7600	46055	5512	49886	4456	51284	3595	52220	2294	63939	1303	51874
6L-2S		MI	24975	7600	42167	5392	46784	4328	49319	3472	52931	2119	63909	1794	43269
14-#11	1.63	MA	29074	6696	45796	4988	50055	4054	51612	3361	52670	2365	62739	2222	27841
2L-7S		MI	19769	6696	31376	4902	33197	3994	33128	3305	31620	2317	36735	1761	20222
14-#11	1.63	MA	28240	6696	44563	4985	48473	4050	49682	3374	50045	2374	59206	2136	27862
3L-6S		MI	20130	6696	32033	4890	33989	3983	34148	3313	32886	2309	38433	1851	20523
14-#11	1.63	MA	27654	6696	43558	5000	47193	4064	48126	3368	48042	2384	56906	2049	27851
4L-5S		MI	20499	6696	32633	4894	34819	3990	35116	3304	34182	2300	40020	1908	20772
14-#11	1.63	MA	27131	6696	42689	4997	46066	4060	46741	3381	46037	2376	54504	2008	27788
5L-4S		MI	20886	6696	33272	4899	35647	3979	36133	3295	35613	2309	41718	1945	20762
14-#11	1.63	MA	26633	6696	41875	4995	44938	4073	45363	3375	44220	2385	52221	1952	27372
6L-3S		MI	21316	6696	34008	4886	36585	3985	37273	3303	37041	2300	43310	2032	20731

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

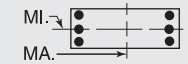
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.63	MA	26148	6696	40983	5010	43862	4069	44039	3387	42444	2395	49786	1862	26860
7L-2S		MI	21920	6696	34904	4891	37734	3974	38675	3294	38908	2292	45775	2118	20692
14-#14	2.34	MA	30771	7030	49593	5180	54827	4191	57398	3441	60529	2329	73073	2147	39589
2L-7S		MI	20065	7030	32602	5091	34675	4131	34889	3381	33972	2273	40334	1532	27535
14-#14	2.34	MA	29592	7030	47827	5176	52564	4209	54637	3458	56772	2342	68050	2022	39552
3L-6S		MI	20574	7030	33543	5074	35810	4116	36346	3393	35767	2260	42436	1628	28122
14-#14	2.34	MA	28764	7030	46387	5197	50729	4203	52407	3450	53902	2355	64785	1898	39428
4L-5S		MI	21096	7030	34401	5081	36997	4126	37728	3381	37605	2248	44678	1710	28733
14-#14	2.34	MA	28025	7030	45141	5193	49114	4222	50422	3466	51027	2343	61363	1839	38729
5L-4S		MI	21644	7030	35316	5088	38182	4111	39179	3368	39636	2260	47080	1764	29235
14-#14	2.34	MA	27320	7030	43973	5189	47496	4216	48445	3458	48422	2356	58119	1758	37709
6L-3S		MI	22253	7030	36368	5071	39523	4121	40806	3381	41660	2248	49330	1887	29269
14-#14	2.34	MA	26635	7030	42694	5209	45952	4235	46547	3475	45876	2368	54656	1628	36825
7L-2S		MI	23104	7030	37648	5078	41163	4106	42803	3368	44308	2235	52816	2012	29239
14-#18	4.17	MA	31437	7877	53388	5703	59527	4562	63077	3660	68275	2270	84143	1494	66370
4L-5S		MI	22517	7877	38730	5563	42371	4478	44031	3566	45965	2105	55959	1183	46932
14-#18	4.17	MA	30176	7877	51199	5694	56689	4593	59590	3687	63276	2248	78208	1393	63869
5L-4S		MI	23451	7877	40329	5578	44442	4455	46525	3544	49456	2127	60059	1281	48413
14-#18	4.17	MA	28976	7877	49145	5685	53847	4580	56117	3670	58746	2270	72613	1248	60949
6L-3S		MI	24489	7877	42167	5550	46784	4475	49319	3566	52931	2105	63909	1494	50026
14-#18	4.17	MA	27809	7877	46896	5720	51133	4612	52781	3697	54320	2292	66635	1017	58140
7L-2S		MI	25936	7877	44393	5565	49637	4452	52750	3544	57481	2083	69857	1716	50192
16-#11	1.86	MA	29649	6804	47030	5055	51636	4102	53541	3391	55295	2356	66271	2205	31707
2L-8S		MI	19831	6804	31681	4965	33542	4036	33579	3343	32238	2314	37615	1691	22672
16-#11	1.86	MA	28818	6804	45796	5053	50055	4099	51612	3403	52670	2366	62739	2118	31716
3L-7S		MI	20185	6804	32272	4970	34346	4042	34530	3334	33487	2306	39201	1735	22939
16-#11	1.86	MA	28235	6804	44792	5067	48774	4112	50055	3398	50667	2375	60439	2032	31685
4L-6S		MI	20543	6804	32929	4957	35138	4032	35550	3342	34754	2297	40899	1826	23224
16-#11	1.86	MA	27715	6804	43923	5065	47647	4108	48671	3410	48662	2367	58037	1991	31604
5E		MI	20911	6804	33529	4962	35968	4038	36518	3333	36049	2289	42486	1883	23561
16-#11	1.86	MA	27219	6804	43109	5062	46519	4122	47292	3405	46845	2377	55754	1935	31093
6L-4S		MI	21296	6804	34168	4966	36796	4027	37535	3324	37481	2297	44183	1920	23572
16-#11	1.86	MA	26736	6804	42216	5077	45443	4118	45969	3417	45069	2386	53318	1845	30602
7L-3S		MI	21725	6804	34904	4953	37734	4033	38675	3332	38908	2289	45775	2007	23550
16-#11	1.86	MA	26261	6804	41415	5075	44352	4131	44677	3429	43183	2379	51072	1796	30158
8L-2S		MI	22327	6804	35801	4958	38884	4023	40077	3323	40776	2280	48240	2093	23518
16-#14	2.68	MA	30404	7185	49593	5273	54827	4279	57398	3500	60529	2330	73073	1995	45032
3L-7S		MI	20650	7185	33882	5189	36315	4201	36887	3423	36620	2255	43820	1493	31287
16-#14	2.68	MA	29581	7185	48153	5294	52992	4273	55168	3492	57658	2342	69808	1871	44878
4L-6S		MI	21156	7185	34822	5171	37450	4186	38343	3435	38416	2242	45922	1589	31974
16-#14	2.68	MA	28846	7185	46907	5290	51377	4292	53183	3509	54784	2330	66386	1812	44014
5E		MI	21675	7185	35681	5178	38637	4196	39725	3423	40253	2230	48163	1671	32549
16-#14	2.68	MA	28146	7185	45739	5286	49759	4286	51206	3501	52178	2343	63142	1731	43041
6L-4S		MI	22220	7185	36595	5186	39822	4181	41177	3410	42284	2242	50566	1725	33196
16-#14	2.68	MA	27465	7185	44459	5307	48216	4304	49308	3518	49632	2356	59679	1601	42057
7L-3S		MI	22826	7185	37648	5168	41163	4191	42803	3423	44308	2230	52816	1848	33255
16-#14	2.68	MA	26794	7185	43309	5303	46650	4298	47455	3534	46927	2344	56480	1532	40756
8L-2S		MI	23674	7185	38927	5175	42803	4176	44801	3410	46957	2217	56301	1973	33252
16-#18	4.76	MA	31570	8154	54289	5867	60651	4718	64423	3762	69802	2223	86883	1338	73148
5E		MI	23495	8154	40955	5736	45224	4602	47462	3637	50514	2068	61907	1105	53577
16-#18	4.76	MA	30381	8154	52235	5858	57808	4705	60949	3745	65273	2245	81288	1194	70053
6L-4S		MI	24422	8154	42555	5751	47295	4579	49955	3615	54005	2091	66007	1203	54958
16-#18	4.76	MA	29224	8154	49985	5893	55094	4736	57614	3773	60847	2267	75310	962	67129
7L-3S		MI	25453	8154	44393	5723	49637	4599	52750	3637	57481	2068	69857	1417	56878

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

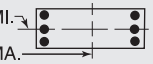


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.09	MA	29393	6911	47030	5120	51636	4147	53541	3432	55295	2357	66271	2101	35560
3L-8S		MI	20246	6911	32577	5032	34691	4085	34981	3373	34106	2303	40080	1666	25328
18-#11	2.09	MA	28813	6911	46025	5135	50356	4160	51984	3427	53292	2367	63972	2014	35514
4L-7S		MI	20598	6911	33169	5037	35495	4091	35932	3364	35355	2294	41666	1710	25660
18-#11	2.09	MA	28295	6911	45157	5132	49229	4157	50600	3439	51287	2359	61570	1973	35416
5L-6S		MI	20955	6911	33826	5024	36288	4080	36952	3372	36621	2286	43364	1801	25930
18-#11	2.09	MA	27801	6911	44342	5130	48101	4170	49221	3434	49470	2368	59287	1917	34822
6L-5S		MI	21321	6911	34426	5029	37117	4086	37920	3363	37917	2277	44951	1858	26343
18-#11	2.09	MA	27321	6911	43450	5145	47025	4166	47898	3446	47694	2378	56851	1827	34350
7L-4S		MI	21705	6911	35065	5034	37945	4075	38937	3353	39349	2286	46649	1895	26375
18-#11	2.09	MA	26848	6911	42648	5142	45933	4180	46606	3458	45808	2370	54605	1778	33841
8L-3S		MI	22133	6911	35801	5021	38884	4082	40077	3362	40776	2277	48240	1981	26363
18-#11	2.09	MA	26362	6911	41785	5157	44871	4176	45256	3453	44048	2379	52391	1725	33094
9L-2S		MI	22732	6911	36697	5026	40033	4071	41479	3352	42644	2268	50706	2068	26338
18-#14	3.01	MA	30392	7341	49918	5391	55256	4343	57929	3535	61415	2330	74830	1844	50324
4L-7S		MI	21231	7341	35161	5286	37955	4271	38885	3465	39269	2237	47305	1455	35052
18-#14	3.01	MA	29662	7341	48673	5387	53640	4362	55944	3551	58541	2318	71408	1785	49312
5L-6S		MI	21734	7341	36101	5268	39090	4256	40341	3477	41064	2224	49407	1550	35832
18-#14	3.01	MA	28966	7341	47504	5383	52022	4355	53967	3543	55935	2331	68164	1704	48381
6L-5S		MI	22251	7341	36960	5276	40277	4266	41723	3465	42902	2212	51648	1632	36375
18-#14	3.01	MA	28289	7341	46225	5404	50479	4374	52069	3560	53389	2343	64702	1574	47301
7L-4S		MI	22793	7341	37874	5283	41461	4251	43175	3452	44933	2224	54051	1686	37151
18-#14	3.01	MA	27622	7341	45075	5400	48913	4368	50217	3577	50684	2331	61502	1505	46044
8L-3S		MI	23395	7341	38927	5265	42803	4261	44801	3465	46957	2212	56301	1810	37233
18-#14	3.01	MA	26960	7341	43836	5420	47390	4387	48279	3569	48160	2344	58357	1427	44560
9L-2S		MI	24240	7341	40206	5273	44442	4246	46799	3452	49605	2199	59786	1934	37259
18-#18	5.36	MA	31773	8430	55325	6031	61769	4829	65782	3821	71800	2220	89962	1139	79182
6L-5S		MI	24466	8430	43181	5909	48077	4726	50892	3709	55064	2032	67855	1027	60237
18-#18	5.36	MA	30626	8430	53075	6066	59056	4860	62446	3848	67374	2242	83984	908	76143
7L-4S		MI	25386	8430	44780	5924	50148	4703	53386	3687	58555	2054	71955	1125	61530
20-#11	2.32	MA	29387	7019	47259	5202	51937	4209	53914	3457	55917	2358	67504	1997	39339
4L-8S		MI	20658	7019	33474	5100	35840	4133	36383	3402	35973	2291	42546	1640	27992
20-#11	2.32	MA	28871	7019	46390	5200	50810	4205	52529	3469	53912	2350	65102	1956	39225
5L-7S		MI	21009	7019	34065	5104	36644	4139	37334	3393	37223	2283	44131	1685	28384
20-#11	2.32	MA	28381	7019	45576	5197	49682	4218	51150	3464	52095	2360	62819	1900	38556
6E		MI	21365	7019	34722	5092	37437	4128	38354	3401	38489	2274	45830	1776	28642
20-#11	2.32	MA	27902	7019	44684	5212	48606	4215	49827	3476	50319	2369	60383	1810	38101
7L-5S		MI	21730	7019	35322	5096	38267	4135	39322	3392	39785	2265	47416	1832	29108
20-#11	2.32	MA	27431	7019	43882	5209	47514	4228	48536	3488	48433	2361	58137	1761	37530
8L-4S		MI	22112	7019	35961	5101	39095	4124	40339	3383	41216	2274	49114	1870	29162
20-#11	2.32	MA	26948	7019	43019	5224	46453	4224	47185	3483	46673	2371	55924	1707	36806
9L-3S		MI	22538	7019	36697	5088	40033	4130	41479	3391	42644	2265	50706	1956	29171
20-#11	2.32	MA	26428	7019	42220	5222	45375	4238	45900	3495	44929	2380	53779	1646	36060
10L-2S		MI	23135	7019	37594	5093	41182	4119	42881	3382	44511	2257	53171	2043	29153
20-#14	3.35	MA	30472	7497	50438	5485	55904	4431	58705	3594	62297	2306	76431	1758	54622
5L-7S		MI	21808	7497	36440	5383	39595	4341	40882	3507	41917	2219	50790	1416	38829
20-#14	3.35	MA	29781	7497	49270	5480	54286	4425	56728	3586	59692	2318	73187	1677	53729
6E		MI	22309	7497	37380	5366	40730	4326	42338	3520	43713	2206	52892	1511	39695
20-#14	3.35	MA	29107	7497	47990	5501	52742	4444	54830	3602	57146	2331	69724	1547	52558
7L-5S		MI	22823	7497	38239	5373	41917	4336	43720	3507	45551	2194	55133	1593	40211
20-#14	3.35	MA	28444	7497	46840	5497	51176	4438	52978	3619	54440	2319	66525	1478	51340
8L-4S		MI	23362	7497	39154	5380	43101	4321	45172	3495	47582	2206	57536	1647	41099
20-#14	3.35	MA	27783	7497	45602	5518	49653	4457	51041	3611	51917	2332	63380	1400	49797
9L-3S		MI	23962	7497	40206	5363	44442	4331	46799	3507	49605	2194	59786	1771	41203
20-#18	5.95	MA	32016	8707	56165	6239	63017	4984	67279	3923	73901	2217	92659	853	85181
7L-5S		MI	25430	8707	45406	6082	50930	4850	54323	3780	59613	1995	73802	950	66734
22-#11	2.55	MA	29445	7127	47624	5267	52392	4253	54459	3498	56537	2342	68635	1938	43032
5L-8S		MI	21069	7127	34370	5167	36990	4181	37785	3431	37841	2280	45011	1615	30662

RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.55	MA	28957	7127	46810	5265	51264	4267	53080	3493	54720	2351	66352	1882	42296
6L-7S		MI	21418	7127	34962	5172	37794	4188	38736	3422	39090	2271	46597	1660	31109
22-#11	2.55	MA	28481	7127	45917	5279	50188	4263	51757	3505	52944	2360	63916	1792	41855
7L-6S		MI	21773	7127	35619	5159	38586	4177	39756	3430	40357	2262	48295	1750	31357
22-#11	2.55	MA	28012	7127	45116	5277	49096	4276	50465	3517	51058	2353	61670	1743	41226
8L-5S		MI	22136	7127	36219	5164	39416	4183	40724	3421	41653	2254	49882	1807	31800
22-#11	2.55	MA	27532	7127	44252	5292	48034	4273	49114	3512	49298	2362	59457	1689	40523
9L-4S		MI	22517	7127	36858	5168	40244	4172	41741	3412	43084	2262	51579	1845	31949
22-#11	2.55	MA	27013	7127	43453	5289	46957	4286	47829	3524	47554	2372	57312	1628	39736
10L-3S		MI	22941	7127	37594	5156	41182	4179	42881	3420	44511	2254	53171	1931	31974
22-#11	2.55	MA	26508	7127	42667	5287	45901	4282	46496	3519	45694	2364	55122	1577	38884
11L-2S		MI	23537	7127	38490	5160	42331	4168	44283	3411	46379	2245	55637	2018	31963
22-#14	3.68	MA	30590	7652	51036	5578	56549	4495	59489	3628	63449	2306	78210	1650	59082
6L-7S		MI	22382	7652	37719	5480	41235	4410	42880	3549	44566	2201	54275	1377	42615
22-#14	3.68	MA	29920	7652	49756	5598	55006	4514	57591	3645	60903	2319	74747	1520	57824
7L-6S		MI	22881	7652	38660	5463	42369	4396	44336	3562	46362	2188	56377	1472	43563
22-#14	3.68	MA	29261	7652	48606	5594	53440	4508	55739	3662	58197	2306	71548	1450	56643
8L-5S		MI	23392	7652	39519	5470	43557	4406	45718	3549	48199	2176	58618	1555	44055
22-#14	3.68	MA	28601	7652	47367	5615	51917	4526	53802	3653	55674	2319	68403	1373	55043
9L-4S		MI	23929	7652	40433	5477	44741	4391	47170	3537	50230	2188	61021	1608	45043
24-#11	2.79	MA	29530	7235	48043	5332	52845	4315	55009	3522	57345	2342	69884	1864	46040
6L-8S		MI	21478	7235	35267	5235	38139	4230	39187	3461	39709	2268	47476	1590	33337
24-#11	2.79	MA	29056	7235	47151	5347	51769	4311	53686	3534	55569	2352	67449	1774	45612
7E		MI	21826	7235	35858	5239	38943	4236	40138	3452	40958	2259	49062	1635	33836
24-#11	2.79	MA	28589	7235	46349	5344	50677	4325	52394	3547	53683	2344	65203	1726	44928
8L-6S		MI	22179	7235	36515	5227	39735	4225	41158	3460	42224	2251	50760	1725	34075
24-#11	2.79	MA	28118	7235	45486	5359	49616	4321	51044	3541	51923	2354	62989	1672	44244
9L-5S		MI	22541	7235	37115	5231	40565	4232	42126	3451	43520	2242	52347	1782	34497
24-#11	2.79	MA	27595	7235	44687	5356	48538	4334	49759	3554	50179	2363	60845	1611	43417
10L-4S		MI	22920	7235	37754	5236	41393	4221	43143	3442	44952	2251	54045	1820	34731
24-#11	2.79	MA	27092	7235	43901	5354	47482	4331	48425	3548	48319	2355	58655	1559	42584
11L-3S		MI	23343	7235	38490	5223	42331	4227	44283	3450	46379	2242	55637	1906	34764
24-#14	4.02	MA	30729	7808	51521	5696	57269	4584	60353	3687	64659	2306	79770	1493	63099
7E		MI	22953	7808	38999	5578	42875	4480	44878	3591	47215	2183	57761	1338	46410
24-#14	4.02	MA	30074	7808	50371	5692	55703	4578	58500	3704	61954	2294	76571	1423	61954
8L-6S		MI	23450	7808	39939	5560	44009	4465	46334	3604	49010	2170	59863	1434	47434
24-#14	4.02	MA	29413	7808	49133	5712	54180	4596	56563	3696	59431	2307	73425	1346	60297
9L-5S		MI	23959	7808	40798	5567	45197	4475	47716	3591	50848	2158	62104	1516	47905

RECTANGULAR TIED COLUMNS 32" x 44"

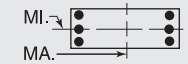
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.14	MA	30489	6777	47468	5043	51150	4112	51948	3433	51346	2476	59949	2336	21453
2E		MI	21951	6777	34637	4908	36784	4002	36965	3331	35954	2377	41461	2213	15261
6-#18	1.70	MA	32007	7053	50731	5216	55332	4237	57051	3508	58269	2453	69171	2285	31728
2L-3S		MI	21457	7053	34637	5065	36784	4149	36965	3425	35954	2363	41461	1914	22473
6-#18	1.70	MA	29808	7053	47468	5207	51150	4269	51948	3537	51346	2475	59949	2063	31747
3L-2S		MI	22950	7053	36863	5081	39637	4126	40396	3403	40503	2340	47409	2135	22353
8-#14	1.28	MA	30956	6846	48242	5118	52338	4170	53472	3475	53488	2490	63032	2354	24198
2L-4S		MI	20798	6846	32844	5006	34675	4074	34559	3388	32917	2427	37978	1989	17319
8-#14	1.28	MA	29689	6846	46380	5115	49950	4165	50558	3492	49524	2504	57701	2229	24251
3E		MI	21417	6846	33897	4988	36016	4084	36185	3400	34941	2414	40228	2112	17247
8-#14	1.28	MA	28799	6846	44862	5136	48016	4184	48208	3484	46499	2517	54231	2105	24244
4L-2S		MI	22282	6846	35176	4996	37656	4069	38183	3388	37589	2402	43713	2237	17171

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

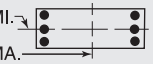


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	2.27	MA	33507	7330	53994	5389	59515	4361	62154	3584	65192	2430	78393	2233	41954
2L-4S		MI	21392	7330	35025	5267	37296	4253	37601	3474	37028	2348	43559	1622	29302
8-#18	2.27	MA	31327	7330	50731	5380	55332	4393	57051	3612	58269	2452	69171	2012	41867
3E		MI	22457	7330	36863	5238	39637	4273	40396	3496	40503	2326	47409	1836	29447
8-#18	2.27	MA	29794	7330	48066	5416	51936	4381	52924	3597	52977	2474	63184	1791	41387
4L-2S		MI	23939	7330	39088	5254	42490	4250	43827	3474	45053	2304	53357	2057	29385
10-#11	1.11	MA	30525	6763	47219	5083	51125	4146	52030	3463	51542	2505	60542	2382	21140
2L-5S		MI	20573	6763	32203	4970	33934	4066	33686	3392	31677	2436	36447	2067	15207
10-#11	1.11	MA	29636	6763	45918	5081	49457	4143	49995	3476	48774	2516	56795	2296	21181
3L-4S		MI	20964	6763	32842	4974	34762	4055	34703	3383	33108	2445	38145	2105	15157
10-#11	1.11	MA	29013	6763	44859	5096	48108	4157	48355	3471	46663	2526	54353	2209	21210
4L-3S		MI	21398	6763	33578	4962	35700	4061	35843	3391	34535	2436	39737	2191	15101
10-#11	1.11	MA	28457	6763	43944	5093	46921	4153	46897	3484	44551	2518	51810	2167	21194
5L-2S		MI	22007	6763	34475	4966	36850	4050	37245	3382	36403	2428	42202	2278	15049
10-#14	1.60	MA	31830	7001	50105	5216	54726	4240	56385	3517	57452	2478	68364	2329	30050
2L-5S		MI	20832	7001	33209	5096	35131	4159	35105	3442	33535	2396	39060	1896	21312
10-#14	1.60	MA	30570	7001	48242	5212	52338	4234	53472	3534	53488	2491	63032	2204	30080
3L-4S		MI	21386	7001	34124	5103	36315	4144	36556	3430	35566	2409	41463	1950	21336
10-#14	1.60	MA	29686	7001	46725	5233	50404	4254	51121	3527	50463	2505	59562	2080	30024
4L-3S		MI	22002	7001	35176	5086	37656	4154	38183	3442	37589	2396	43713	2073	21290
10-#14	1.60	MA	28896	7001	45413	5229	48702	4248	49030	3544	47435	2494	55937	2020	29828
5L-2S		MI	22863	7001	36455	5093	39296	4139	40180	3430	40238	2384	47198	2198	21228
10-#18	2.84	MA	34988	7607	57257	5561	63698	4485	67257	3659	72116	2407	87615	2182	52136
2L-5S		MI	21440	7607	35651	5425	38078	4400	38539	3568	38086	2289	45407	1447	33967
10-#18	2.84	MA	32828	7607	53994	5553	59515	4517	62154	3688	65192	2429	78393	1961	51960
3L-4S		MI	22391	7607	37250	5440	40149	4377	41032	3546	41577	2312	49507	1544	35744
10-#18	2.84	MA	31309	7607	51329	5589	56119	4505	58026	3672	59900	2451	72406	1739	51172
4L-3S		MI	23447	7607	39088	5411	42490	4397	43827	3568	45053	2289	53357	1758	36367
10-#18	2.84	MA	29953	7607	49022	5581	53128	4537	54351	3701	54599	2429	66110	1636	48062
5L-2S		MI	24918	7607	41314	5427	45343	4374	47257	3546	49602	2267	59305	1979	36379
12-#11	1.33	MA	31142	6871	48520	5150	52793	4195	54064	3493	54311	2497	64288	2366	25232
2L-6S		MI	20619	6871	32499	5032	34254	4108	34120	3430	32248	2433	37326	1985	17960
12-#11	1.33	MA	30257	6871	47219	5148	51125	4191	52030	3505	51542	2507	60542	2279	25263
3L-5S		MI	20990	6871	33099	5037	35083	4114	35088	3421	33544	2425	38913	2042	18024
12-#11	1.33	MA	29637	6871	46160	5163	49776	4205	50390	3500	49432	2517	58100	2193	25274
4E		MI	21379	6871	33738	5042	35911	4103	36105	3412	34976	2433	40610	2080	17989
12-#11	1.33	MA	29083	6871	45246	5161	48589	4202	48932	3513	47320	2510	55557	2151	25231
5L-3S		MI	21812	6871	34475	5029	36850	4110	37245	3420	36403	2425	42202	2166	17943
12-#11	1.33	MA	28556	6871	44388	5159	47402	4215	47480	3508	45407	2520	53134	2095	24992
6L-2S		MI	22418	6871	35371	5034	37999	4099	38647	3411	38271	2416	44668	2253	17897
12-#14	1.92	MA	32698	7157	51968	5313	57114	4310	59298	3559	61415	2465	73695	2303	35888
2L-6S		MI	20894	7157	33630	5186	35583	4219	35720	3497	34346	2391	40305	1775	24445
12-#14	1.92	MA	31445	7157	50105	5309	54726	4304	56385	3577	57452	2479	68364	2179	35885
3L-5S		MI	21419	7157	34489	5193	36771	4229	37102	3485	36183	2378	42546	1857	25117
12-#14	1.92	MA	30566	7157	48588	5330	52792	4324	54034	3569	54427	2492	64894	2054	35793
4E		MI	21971	7157	35403	5200	37955	4214	38554	3472	38214	2391	44948	1911	25332
12-#14	1.92	MA	29781	7157	47276	5327	51090	4318	51943	3587	51398	2481	61268	1994	35409
5L-3S		MI	22583	7157	36455	5183	39296	4224	40180	3485	40238	2378	47198	2035	25314
12-#14	1.92	MA	29034	7157	46046	5323	49387	4337	49861	3579	48654	2495	57823	1914	34223
6L-2S		MI	23440	7157	37735	5190	40936	4209	42178	3472	42887	2366	50684	2159	25266
12-#18	3.41	MA	34312	7883	57257	5726	63698	4641	67257	3763	72116	2406	87615	1909	62035
3L-5S		MI	22437	7883	37877	5597	40931	4524	41969	3639	42636	2253	51355	1369	40569
12-#18	3.41	MA	32808	7883	54592	5762	60302	4629	63129	3747	66823	2428	81628	1688	60755
4E		MI	23380	7883	39476	5613	43002	4501	44463	3617	46127	2275	55455	1466	42209
12-#18	3.41	MA	31464	7883	52285	5754	57311	4662	59454	3776	61522	2406	75332	1585	57819
5L-3S		MI	24428	7883	41314	5584	45343	4522	47257	3639	49602	2253	59305	1680	43260
12-#18	3.41	MA	30187	7883	50121	5746	54315	4650	55794	3760	56718	2428	69380	1441	55156
6L-2S		MI	25889	7883	43539	5600	48196	4498	50688	3617	54152	2231	65253	1901	43348

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

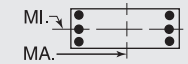
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.55	MA	31755	6979	49821	5218	54460	4243	56099	3522	57079	2488	68035	2349	29315
2L-7S		MI	20674	6979	32739	5113	34610	4167	34502	3452	32850	2430	38093	1870	20344
14-#11	1.55	MA	30873	6979	48520	5215	52793	4240	54064	3535	54311	2498	64288	2263	29336
3L-6S		MI	21035	6979	33396	5100	35403	4156	35522	3460	34116	2422	39791	1960	20652
14-#11	1.55	MA	30256	6979	47461	5230	51443	4253	52425	3530	52200	2508	61847	2176	29325
4L-5S		MI	21405	6979	33996	5105	36233	4163	36490	3451	35412	2413	41378	2017	20830
14-#11	1.55	MA	29705	6979	46547	5228	50257	4250	50967	3542	50088	2501	59304	2134	29262
5L-4S		MI	21792	6979	34635	5109	37061	4152	37507	3442	36844	2422	43076	2055	20810
14-#11	1.55	MA	29180	6979	45689	5226	49069	4264	49515	3538	48175	2511	56881	2079	28908
6L-3S		MI	22223	6979	35371	5096	37999	4158	38647	3450	38271	2413	44668	2141	20775
14-#11	1.55	MA	28669	6979	44750	5241	47937	4260	48122	3550	46306	2521	54297	1989	28343
7L-2S		MI	22828	6979	36268	5101	39148	4147	40049	3441	40138	2405	47133	2227	20734
14-#14	2.24	MA	33559	7313	53831	5410	59502	4380	62211	3602	65379	2453	79026	2278	41715
2L-7S		MI	20970	7313	33969	5301	36089	4303	36262	3527	35199	2385	41688	1641	27812
14-#14	2.24	MA	32312	7313	51968	5406	57114	4374	59298	3619	61415	2466	73695	2153	41678
3L-6S		MI	21480	7313	34909	5283	37223	4289	37718	3539	36994	2373	43790	1736	28289
14-#14	2.24	MA	31439	7313	50451	5428	55180	4393	56948	3612	58390	2480	70225	2029	41554
4L-5S		MI	22003	7313	35768	5290	38410	4299	39100	3527	38832	2360	46031	1818	28915
14-#14	2.24	MA	30659	7313	49139	5424	53478	4388	54857	3629	55362	2469	66599	1969	40970
5L-4S		MI	22551	7313	36682	5298	39595	4284	40552	3514	40863	2373	48434	1872	29309
14-#14	2.24	MA	29917	7313	47909	5420	51775	4407	52774	3622	52618	2482	63154	1888	39842
6L-3S		MI	23161	7313	37735	5280	40936	4294	42178	3527	42887	2360	50684	1996	29325
14-#14	2.24	MA	29194	7313	46561	5441	50149	4401	50776	3639	49937	2496	59478	1758	39051
7L-2S		MI	24014	7313	39014	5287	42576	4279	44176	3514	45535	2348	54169	2120	29292
14-#18	3.98	MA	34291	8160	57855	5935	64485	4754	68232	3823	73747	2405	90850	1637	70384
4L-5S		MI	23424	8160	40102	5770	43784	4649	45400	3711	47185	2216	57303	1291	47194
14-#18	3.98	MA	32960	8160	55548	5927	61494	4786	64557	3851	68445	2383	84554	1534	67603
5L-4S		MI	24360	8160	41701	5786	45855	4625	47893	3689	50676	2238	61403	1388	48716
14-#18	3.98	MA	31694	8160	53384	5919	58498	4774	60896	3836	63641	2405	78602	1389	64753
6L-3S		MI	25401	8160	43539	5757	48196	4646	50688	3711	54152	2216	65253	1602	50133
14-#18	3.98	MA	30462	8160	51014	5955	55639	4806	57382	3864	58946	2427	72245	1158	61866
7L-2S		MI	26852	8160	45765	5772	51049	4622	54118	3689	58701	2194	71201	1823	50277
16-#11	1.77	MA	32365	7086	51122	5285	56128	4292	58134	3551	59847	2480	71782	2333	33392
2L-8S		MI	20736	7086	33044	5175	34956	4209	34953	3490	33468	2427	38973	1800	22867
16-#11	1.77	MA	31487	7086	49821	5283	54460	4288	56099	3564	57079	2490	68035	2246	33401
3L-7S		MI	21090	7086	33635	5180	35760	4216	35904	3481	34717	2419	40559	1845	23062
16-#11	1.77	MA	30872	7086	48762	5298	53111	4302	54459	3559	54969	2500	65593	2160	33370
4L-6S		MI	21449	7086	34292	5167	36552	4205	36924	3489	35984	2410	42257	1935	23352
16-#11	1.77	MA	30323	7086	47848	5296	51925	4298	53002	3572	52857	2492	63050	2118	33289
5E		MI	21817	7086	34892	5172	37382	4211	37892	3480	37280	2402	43844	1992	23624
16-#11	1.77	MA	29801	7086	46991	5293	50737	4312	51550	3567	50944	2502	60628	2062	32833
6L-4S		MI	22203	7086	35531	5177	38210	4200	38909	3471	38711	2410	45541	2030	23623
16-#11	1.77	MA	29293	7086	46051	5308	49604	4309	50157	3580	49074	2513	58044	1972	32292
7L-3S		MI	22633	7086	36268	5164	39148	4207	40049	3479	40138	2402	47133	2116	23597
16-#11	1.77	MA	28792	7086	45208	5306	48455	4322	48797	3592	47088	2505	55666	1923	31896
8L-2S		MI	23235	7086	37164	5168	40297	4196	41451	3470	42006	2393	49598	2202	23563
16-#14	2.56	MA	33174	7468	53831	5504	59502	4444	62211	3662	65379	2454	79026	2128	47462
3L-7S		MI	21555	7468	35248	5398	37729	4373	38259	3569	37847	2367	45173	1602	31561
16-#14	2.56	MA	32305	7468	52313	5525	57568	4463	59861	3654	62354	2468	75556	2003	47308
4L-6S		MI	22062	7468	36188	5380	38863	4358	39716	3581	39643	2355	47275	1697	32141
16-#14	2.56	MA	31530	7468	51001	5521	55866	4458	57770	3671	59326	2456	71931	1944	46548
5E		MI	22583	7468	37047	5388	40050	4368	41098	3569	41481	2342	49516	1780	32729
16-#14	2.56	MA	30793	7468	49772	5518	54163	4477	55688	3664	56582	2470	68485	1863	45471
6L-4S		MI	23128	7468	37961	5395	41235	4353	42549	3557	43511	2355	51919	1833	33277

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

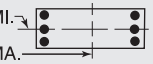


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	2.56	MA	30074	7468	48424	5539	52537	4471	53689	3681	53900	2483	64809	1733	44576
7L-3S		MI	23735	7468	39014	5377	42576	4363	44176	3569	45535	2342	54169	1957	33322
16-#14	2.56	MA	29367	7468	47213	5535	50888	4491	51738	3699	51051	2472	61419	1663	43146
8L-2S		MI	24584	7468	40293	5385	44216	4349	46173	3557	48184	2330	57654	2082	33308
16-#18	4.55	MA	34440	8436	58811	6100	65677	4910	69660	3927	75369	2359	93776	1482	77409
5E		MI	24404	8436	42328	5943	46637	4773	48830	3782	51735	2180	63251	1213	53839
16-#18	4.55	MA	33186	8436	56647	6091	62681	4898	65999	3911	70564	2382	87824	1338	74379
6L-4S		MI	25333	8436	43927	5959	48708	4749	51324	3760	55226	2202	67351	1310	55258
16-#18	4.55	MA	31965	8436	54277	6127	59822	4930	62485	3940	65869	2404	81467	1107	71505
7L-3S		MI	26367	8436	45765	5930	51049	4770	54118	3782	58701	2180	71201	1524	56992
18-#11	1.99	MA	32096	7194	51122	5350	56128	4336	58134	3593	59847	2481	71782	2230	37455
3L-8S		MI	21151	7194	33941	5243	36105	4258	36355	3520	35336	2416	41438	1775	25529
18-#11	1.99	MA	31484	7194	50063	5365	54779	4350	56494	3589	57737	2491	69340	2144	37410
4L-7S		MI	21503	7194	34532	5247	36909	4264	37306	3511	36585	2407	43024	1819	25784
18-#11	1.99	MA	30938	7194	49149	5363	53593	4347	55036	3601	55625	2484	66797	2102	37311
5L-6S		MI	21861	7194	35189	5235	37701	4253	38326	3519	37851	2399	44722	1910	26059
18-#11	1.99	MA	30419	7194	48292	5361	52405	4361	53585	3596	53712	2494	64374	2046	36766
6L-5S		MI	22228	7194	35789	5239	38531	4259	39294	3510	39147	2390	46309	1967	26411
18-#11	1.99	MA	29912	7194	47352	5376	51272	4357	52192	3609	51843	2504	61790	1956	36245
7L-4S		MI	22613	7194	36428	5244	39359	4249	40311	3500	40579	2399	48006	2004	26429
18-#11	1.99	MA	29414	7194	46509	5374	50123	4371	50832	3622	49856	2497	59412	1907	35806
8L-3S		MI	23041	7194	37164	5231	40297	4255	41451	3509	42006	2390	49598	2091	26412
18-#11	1.99	MA	28893	7194	45683	5371	49006	4367	49410	3617	48004	2507	57063	1853	34986
9L-2S		MI	23641	7194	38061	5236	41447	4244	42853	3499	43874	2381	52064	2177	26385
18-#14	2.88	MA	33166	7624	54176	5622	59956	4533	62774	3696	66318	2455	80887	1978	53058
4L-7S		MI	22136	7624	36527	5495	39369	4443	40257	3611	40496	2349	48658	1563	35323
18-#14	2.88	MA	32396	7624	52864	5618	58254	4527	60683	3714	63289	2444	77262	1918	52140
5L-6S		MI	22641	7624	37467	5478	40503	4428	41713	3624	42291	2337	50760	1659	36000
18-#14	2.88	MA	31663	7624	51634	5615	56551	4547	58601	3706	60545	2457	73817	1837	51108
6L-5S		MI	23159	7624	38326	5485	41690	4438	43095	3611	44129	2324	53001	1741	36555
18-#14	2.88	MA	30948	7624	50287	5636	54925	4541	56602	3724	57864	2471	70141	1708	50115
7L-4S		MI	23702	7624	39241	5492	42875	4423	44547	3599	46160	2337	55404	1795	37236
18-#14	2.88	MA	30245	7624	49076	5632	53277	4560	54652	3741	55015	2460	66751	1637	48730
8L-3S		MI	24306	7624	40293	5475	44216	4433	46173	3611	48184	2324	57654	1918	37304
18-#14	2.88	MA	29535	7624	47772	5653	51673	4555	52612	3734	52358	2473	63410	1560	47287
9L-2S		MI	25152	7624	41573	5482	45856	4418	48171	3599	50832	2312	61139	2043	37322
18-#18	5.11	MA	34664	8713	59910	6264	66864	5022	71102	3986	77487	2358	97046	1287	84031
6L-5S		MI	25376	8713	44553	6116	49490	4897	52261	3854	56284	2143	69198	1135	60498
18-#18	5.11	MA	33454	8713	57540	6300	64005	5054	67587	4015	72792	2380	90689	1056	81041
7L-4S		MI	26299	8713	46152	6132	51561	4873	54754	3832	59776	2165	73299	1232	61826
20-#11	2.22	MA	32094	7302	51365	5433	56447	4399	58529	3618	60506	2482	73087	2127	41445
4L-8S		MI	21564	7302	34837	5310	37254	4306	37757	3549	37204	2404	43904	1750	28191
20-#11	2.22	MA	31550	7302	50450	5430	55261	4395	57071	3631	58394	2475	70544	2085	41331
5L-7S		MI	21915	7302	35428	5315	38058	4312	38709	3540	38453	2396	45489	1794	28509
20-#11	2.22	MA	31033	7302	49593	5428	54073	4409	55619	3626	56481	2485	68121	2029	40706
6E		MI	22272	7302	36085	5302	38851	4302	39728	3548	39719	2387	47188	1885	28771
20-#11	2.22	MA	30529	7302	48653	5443	52940	4405	54226	3638	54611	2495	65537	1939	40203
7L-5S		MI	22637	7302	36685	5307	39680	4308	40696	3539	41015	2378	48774	1942	29193
20-#11	2.22	MA	30033	7302	47810	5441	51791	4419	52867	3651	52625	2488	63159	1890	39700
8L-4S		MI	23020	7302	37324	5311	40508	4297	41713	3530	42447	2387	50472	1979	29225
20-#11	2.22	MA	29514	7302	46984	5439	50673	4416	51445	3646	50773	2498	60810	1836	38904
9L-3S		MI	23447	7302	38061	5299	41447	4303	42853	3538	43874	2378	52064	2066	29223
20-#11	2.22	MA	28966	7302	46060	5454	49540	4430	50092	3659	48936	2508	58533	1775	38207
10L-2S		MI	24045	7302	38957	5303	42596	4292	44255	3529	45742	2370	54529	2152	29201
20-#14	3.20	MA	33256	7779	54727	5716	60642	4597	63596	3756	67253	2431	82593	1893	57744
5L-7S		MI	22714	7779	37806	5592	41009	4513	42255	3653	43145	2331	52143	1524	39098
20-#14	3.20	MA	32527	7779	53497	5712	58939	4617	61514	3749	64509	2445	79148	1812	56753
6E		MI	23217	7779	38747	5575	42143	4498	43711	3666	44940	2319	54245	1620	39864

RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

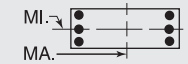
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	3.20	MA	31817	7779	52150	5733	57313	4611	59516	3766	61828	2459	75472	1682	55665
7L-5S		MI	23732	7779	39606	5582	43330	4508	45093	3653	46778	2306	56487	1702	40391
20-#14	3.20	MA	31118	7779	50939	5730	55665	4630	57565	3784	58978	2447	72082	1612	54323
8L-4S		MI	24273	7779	40520	5590	44515	4493	46545	3641	48809	2319	58889	1756	41189
20-#14	3.20	MA	30409	7779	49635	5751	54061	4625	55525	3776	56321	2461	68741	1534	52819
9L-3S		MI	24874	7779	41573	5572	45856	4503	48171	3653	50832	2306	61139	1880	41278
20-#18	5.68	MA	34930	8990	60802	6473	68188	5179	72690	4090	79715	2357	99911	1004	90601
7L-5S		MI	26342	8990	46778	6289	52343	5021	55691	3925	60834	2107	75146	1057	67170
22-#11	2.44	MA	32159	7410	51751	5498	56929	4444	59106	3660	61162	2467	74290	2069	45348
5L-8S		MI	21975	7410	35734	5378	38403	4354	39159	3579	39071	2393	46369	1725	30860
22-#11	2.44	MA	31644	7410	50894	5496	55741	4457	57654	3655	59249	2477	71868	2013	44651
6L-7S		MI	22325	7410	36325	5382	39207	4361	40111	3569	40321	2384	47955	1769	31236
22-#11	2.44	MA	31142	7410	49955	5511	54608	4454	56261	3668	57380	2487	69284	1923	44165
7L-6S		MI	22680	7410	36982	5370	40000	4350	41130	3578	41587	2375	49653	1860	31486
22-#11	2.44	MA	30648	7410	49111	5508	53459	4468	54901	3680	55393	2479	66906	1874	43601
8L-5S		MI	23044	7410	37582	5374	40830	4356	42098	3568	42883	2367	51240	1916	31943
22-#11	2.44	MA	30133	7410	48286	5506	52341	4464	53480	3676	53541	2489	64556	1820	42826
9L-4S		MI	23426	7410	38221	5379	41658	4345	43115	3559	44314	2375	52937	1954	32014
22-#11	2.44	MA	29586	7410	47361	5521	51208	4478	52127	3688	51705	2500	62280	1759	42088
10L-3S		MI	23851	7410	38957	5366	42596	4352	44255	3567	45742	2367	54529	2040	32028
22-#11	2.44	MA	29053	7410	46534	5519	50096	4474	50723	3683	49747	2492	59961	1707	41155
11L-2S		MI	24448	7410	39854	5371	43745	4341	45657	3558	47609	2358	56995	2127	32014
22-#14	3.52	MA	33386	7935	55360	5809	61327	4686	64427	3791	68473	2433	84479	1787	62404
6L-7S		MI	23289	7935	39086	5690	42649	4583	44252	3696	45793	2313	55629	1486	42882
22-#14	3.52	MA	32680	7935	54012	5830	59701	4681	62429	3809	65791	2446	80803	1657	61226
7L-6S		MI	23789	7935	40026	5672	43783	4568	45708	3708	47589	2301	57731	1581	43733
22-#14	3.52	MA	31985	7935	52802	5827	58053	4700	60478	3826	62942	2435	77413	1587	59923
8L-5S		MI	24302	7935	40885	5679	44970	4578	47090	3696	49426	2288	59972	1663	44234
22-#14	3.52	MA	31277	7935	51498	5848	56449	4695	58438	3819	60285	2449	74073	1509	58360
9L-4S		MI	24840	7935	41799	5687	46155	4563	48542	3683	51457	2301	62375	1717	45137
24-#11	2.66	MA	32252	7518	52195	5563	57409	4506	59689	3685	62017	2468	75614	1996	48601
6L-8S		MI	22384	7518	36630	5445	39553	4403	40561	3608	40939	2381	48834	1699	33534
24-#11	2.66	MA	31752	7518	51256	5578	56276	4502	58296	3697	60148	2478	73030	1906	48129
7E		MI	22733	7518	37221	5450	40357	4409	41513	3599	42188	2372	50420	1744	33964
24-#11	2.66	MA	31260	7518	50412	5576	55127	4516	56936	3710	58162	2471	70652	1857	47507
8L-6S		MI	23087	7518	37878	5437	41149	4398	42532	3607	43454	2364	52118	1835	34205
24-#11	2.66	MA	30748	7518	49587	5574	54009	4513	55514	3705	56310	2481	68303	1804	46753
9L-5S		MI	23450	7518	38478	5442	41979	4405	43500	3598	44750	2355	53705	1891	34640
24-#11	2.66	MA	30203	7518	48662	5589	52876	4526	54162	3718	54473	2491	66027	1743	45974
10L-4S		MI	23830	7518	39117	5446	42807	4394	44517	3589	46182	2364	55403	1929	34799
24-#11	2.66	MA	29672	7518	47835	5586	51764	4523	52758	3713	52515	2484	63708	1690	45061
11L-3S		MI	24254	7518	39854	5434	43745	4400	45657	3597	47609	2355	56995	2015	34825
24-#14	3.84	MA	33537	8091	55875	5928	62089	4751	65342	3851	69755	2434	86134	1631	66796
7E		MI	23861	8091	40365	5787	44289	4653	46250	3738	48442	2295	59114	1447	46675
24-#14	3.84	MA	32846	8091	54665	5924	60441	4770	63391	3868	66906	2423	82744	1561	65530
8L-6S		MI	24359	8091	41305	5769	45423	4638	47706	3750	50237	2283	61216	1542	47605
24-#14	3.84	MA	32139	8091	53361	5945	58837	4764	61352	3861	64249	2436	79404	1484	63910
9L-5S		MI	24870	8091	42164	5777	46610	4648	49088	3738	52075	2270	63457	1624	48084

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

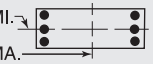


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.09	MA	33217	7060	51542	5273	55572	4302	56410	3594	55678	2602	65011	2461	22533
2E		MI	22857	7060	36010	5115	38197	4172	38334	3476	37174	2488	42805	2321	15305
6-#18	1.63	MA	34825	7336	54977	5445	59977	4426	61784	3669	62989	2580	74781	2413	33348
2L-3S		MI	22363	7336	36010	5273	38197	4320	38334	3570	37174	2474	42805	2021	22534
6-#18	1.63	MA	32504	7336	51542	5438	55572	4459	56410	3699	55678	2602	65011	2192	33367
3L-2S		MI	23858	7336	38235	5288	41050	4296	41764	3547	41724	2452	48753	2243	22407
8-#14	1.22	MA	33707	7129	52350	5348	56814	4359	58004	3635	57878	2614	68241	2479	25413
2L-4S		MI	21703	7129	34211	5215	36089	4246	35931	3534	34144	2539	39331	2097	17367
8-#14	1.22	MA	32372	7129	50390	5345	54301	4354	54938	3653	53708	2628	62601	2355	25466
3E		MI	22323	7129	35263	5198	37430	4256	37558	3547	36168	2527	41581	2221	17289
8-#14	1.22	MA	31435	7129	48795	5367	52268	4374	52468	3646	50528	2642	58927	2230	25459
4L-2S		MI	23189	7129	36543	5205	39070	4242	39555	3534	38816	2514	45066	2346	17211
8-#18	2.17	MA	36413	7613	58413	5618	64381	4550	67157	3744	70300	2557	84551	2365	44114
2L-4S		MI	22298	7613	36397	5474	38709	4423	38970	3619	38248	2459	44903	1730	29414
8-#18	2.17	MA	34113	7613	54977	5611	59977	4583	61784	3774	62989	2580	74781	2143	44027
3E		MI	23364	7613	38235	5446	41050	4444	41764	3641	41724	2437	48753	1943	29521
8-#18	2.17	MA	32498	7613	52175	5648	56405	4572	57443	3760	57403	2603	68430	1922	43547
4L-2S		MI	24848	7613	40461	5461	43903	4420	45195	3619	46273	2415	54701	2165	29445
10-#11	1.06	MA	33250	7046	51269	5313	55533	4335	56482	3624	55825	2629	65591	2506	22193
2L-5S		MI	21478	7046	33566	5180	35348	4239	35060	3539	32907	2549	37805	2177	15250
10-#11	1.06	MA	32313	7046	49901	5311	53779	4332	54342	3637	52913	2639	61630	2420	22234
3L-4S		MI	21869	7046	34205	5185	36176	4228	36077	3530	34338	2558	39503	2214	15194
10-#11	1.06	MA	31658	7046	48788	5326	52361	4346	52618	3632	50695	2650	59047	2334	22263
4L-3S		MI	22304	7046	34941	5172	37114	4234	37217	3538	35766	2549	41095	2301	15136
10-#11	1.06	MA	31073	7046	47828	5324	51116	4343	51087	3645	48477	2643	56362	2291	22247
5L-2S		MI	22913	7046	35838	5177	38263	4223	38619	3529	37633	2541	43560	2387	15084
10-#14	1.53	MA	34632	7284	54310	5445	59327	4429	61069	3678	62049	2601	73881	2455	31569
2L-5S		MI	21737	7284	34576	5305	36544	4331	36477	3589	34762	2509	40414	2005	21387
10-#14	1.53	MA	33304	7284	52350	5442	56814	4424	58004	3695	57878	2615	68241	2331	31599
3L-4S		MI	22292	7284	35490	5313	37729	4316	37929	3576	36793	2521	42817	2059	21391
10-#14	1.53	MA	32373	7284	50755	5464	54781	4444	55533	3689	54699	2630	64567	2206	31543
4L-3S		MI	22909	7284	36543	5295	39070	4326	39555	3589	38816	2509	45066	2182	21338
10-#14	1.53	MA	31543	7284	49377	5461	52994	4439	53336	3707	51517	2619	60737	2146	31346
5L-2S		MI	23771	7284	37822	5302	40710	4311	41553	3576	41465	2496	48552	2307	21272
10-#18	2.72	MA	37982	7889	61849	5791	68786	4674	72530	3820	77610	2535	94320	2316	54836
2L-5S		MI	22345	7889	37023	5632	39490	4571	39907	3713	39307	2401	46751	1554	34226
10-#18	2.72	MA	35702	7889	58413	5784	64381	4707	67157	3849	70300	2558	84551	2095	54660
3L-4S		MI	23297	7889	38622	5647	41562	4547	42400	3691	42798	2423	50851	1652	36050
10-#18	2.72	MA	34103	7889	55611	5821	60809	4696	62816	3835	64713	2580	78200	1874	54078
4L-3S		MI	24356	7889	40461	5619	43903	4568	45195	3713	46273	2401	54701	1866	36454
10-#18	2.72	MA	32675	7889	53186	5813	57665	4730	58953	3865	59119	2559	71542	1769	50764
5L-2S		MI	25829	7889	42686	5634	46756	4545	48626	3691	50823	2379	60649	2087	36445
12-#11	1.27	MA	33902	7154	52638	5380	57288	4384	58622	3653	58737	2620	69552	2491	26495
2L-6S		MI	21524	7154	33863	5243	35667	4281	35494	3578	33479	2546	38684	2095	18085
12-#11	1.27	MA	32969	7154	51269	5378	55533	4381	56482	3666	55825	2631	65591	2404	26526
3L-5S		MI	21895	7154	34463	5247	36497	4287	36462	3568	34774	2538	40271	2152	18072
12-#11	1.27	MA	32316	7154	50157	5393	54116	4395	54759	3662	53607	2641	63007	2318	26537
4E		MI	22285	7154	35102	5252	37325	4276	37479	3559	36206	2546	41968	2189	18032
12-#11	1.27	MA	31734	7154	49196	5391	52870	4392	53227	3675	51389	2635	60323	2276	26495
5L-3S		MI	22718	7154	35838	5239	38263	4283	38619	3567	37633	2538	43560	2275	17983
12-#11	1.27	MA	31181	7154	48296	5389	51623	4406	51703	3670	49379	2645	57761	2220	26332
6L-2S		MI	23325	7154	36734	5244	39413	4272	40021	3558	39501	2529	46026	2362	17935
12-#14	1.83	MA	35550	7440	56270	5543	61839	4499	64134	3720	66220	2589	79521	2432	37710
2L-6S		MI	21798	7440	34996	5395	36997	4391	37093	3643	35573	2503	41658	1884	24607
12-#14	1.83	MA	34228	7440	54310	5539	59327	4494	61069	3738	62049	2603	73881	2307	37707
3L-5S		MI	22325	7440	35855	5403	38184	4401	38475	3631	37410	2491	43899	1966	25295

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

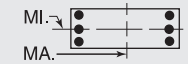
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.83	MA	33304	7440	52715	5561	57294	4514	58598	3731	58869	2617	70207	2182	37616
4E		MI	22877	7440	36769	5410	39369	4386	39926	3619	39441	2503	46302	2020	25397
12-#14	1.83	MA	32478	7440	51337	5558	55506	4509	56402	3749	55687	2607	66377	2122	37372
5L-3S		MI	23491	7440	37822	5392	40710	4396	41553	3631	41465	2491	48552	2143	25367
12-#14	1.83	MA	31693	7440	50045	5555	53717	4528	54214	3742	52804	2621	62731	2041	36069
6L-2S		MI	24349	7440	39101	5400	42350	4381	43550	3619	44114	2478	52037	2268	25315
12-#18	3.26	MA	37274	8166	61849	5957	68786	4831	72530	3925	77610	2536	94320	2047	65275
3L-5S		MI	23342	8166	39249	5805	42343	4695	43337	3784	43856	2364	52699	1477	40825
12-#18	3.26	MA	35689	8166	59046	5994	65214	4820	68189	3910	72024	2558	87970	1825	64282
4E		MI	24287	8166	40848	5820	44415	4672	45831	3762	47348	2386	56799	1574	42510
12-#18	3.26	MA	34275	8166	56622	5986	62070	4854	64326	3940	66429	2537	81312	1721	61046
5L-3S		MI	25338	8166	42686	5791	46756	4692	48626	3784	50823	2364	60649	1788	43355
12-#18	3.26	MA	32930	8166	54348	5979	58921	4843	60478	3926	61359	2559	75003	1577	58476
6L-2S		MI	26802	8166	44912	5807	49609	4669	52056	3762	55372	2342	66597	2009	43425
14-#11	1.48	MA	34550	7261	54006	5447	59042	4432	60762	3683	61649	2612	73513	2475	30789
2L-7S		MI	21579	7261	34102	5323	36024	4340	35877	3599	34080	2543	39451	1979	20462
14-#11	1.48	MA	33621	7261	52638	5446	57288	4429	58622	3696	58737	2622	69552	2389	30811
3L-6S		MI	21940	7261	34759	5310	36817	4329	36896	3607	35346	2535	41149	2070	20777
14-#11	1.48	MA	32971	7261	51525	5461	55870	4443	56899	3691	56519	2633	66968	2303	30799
4L-5S		MI	22311	7261	35359	5315	37646	4336	37864	3598	36642	2526	42736	2126	20883
14-#11	1.48	MA	32392	7261	50565	5459	54624	4440	55368	3704	54301	2626	64284	2260	30737
5L-4S		MI	22699	7261	35998	5320	38474	4325	38881	3589	38074	2535	44434	2164	20857
14-#11	1.48	MA	31841	7261	49665	5457	53377	4454	53843	3700	52291	2637	61721	2204	30452
6L-3S		MI	23130	7261	36734	5307	39413	4331	40021	3597	39501	2526	46026	2250	20817
14-#11	1.48	MA	31304	7261	48679	5472	52187	4451	52380	3713	50328	2647	58990	2115	29831
7L-2S		MI	23735	7261	37631	5311	40562	4320	41423	3588	41369	2518	48491	2337	20775
14-#14	2.14	MA	36461	7596	58230	5640	64352	4569	67200	3762	70390	2576	85161	2408	43842
2L-7S		MI	21874	7596	35335	5510	37502	4476	37634	3673	36426	2498	43041	1750	28067
14-#14	2.14	MA	35146	7596	56270	5637	61839	4564	64134	3780	66220	2591	79521	2283	43804
3L-6S		MI	22385	7596	36275	5493	38637	4461	39090	3686	38221	2485	45143	1845	28450
14-#14	2.14	MA	34227	7596	54675	5658	59807	4583	61664	3773	63040	2605	75847	2159	43680
4L-5S		MI	22909	7596	37134	5500	39824	4471	40472	3673	40059	2473	47384	1927	29093
14-#14	2.14	MA	33407	7596	53297	5655	58019	4578	59467	3791	59858	2594	72017	2098	43225
5L-4S		MI	23458	7596	38048	5507	41009	4456	41924	3661	42090	2485	49787	1981	29381
14-#14	2.14	MA	32626	7596	52005	5652	56229	4598	57280	3785	56975	2609	68371	2017	41983
6L-3S		MI	24069	7596	39101	5490	42350	4466	43550	3673	44114	2473	52037	2105	29382
14-#14	2.14	MA	31866	7596	50590	5673	54522	4593	55180	3802	54159	2623	64481	1888	41186
7L-2S		MI	24924	7596	40380	5497	43990	4451	45548	3661	46762	2460	55522	2229	29344
14-#18	3.80	MA	37259	8443	62482	6166	69618	4945	73563	3986	79335	2536	97739	1777	74428
4L-5S		MI	24331	8443	41474	5978	45196	4819	46768	3856	48406	2328	58647	1399	47450
14-#18	3.80	MA	35858	8443	60057	6159	66475	4978	69699	4015	73740	2515	91082	1672	71355
5L-4S		MI	25269	8443	43073	5993	47268	4796	49261	3834	51897	2350	62747	1496	49013
14-#18	3.80	MA	34526	8443	57784	6152	63326	4967	65851	4001	68669	2537	84773	1528	68595
6L-3S		MI	26313	8443	44912	5964	49609	4816	52056	3856	55372	2328	66597	1710	50236
14-#18	3.80	MA	33229	8443	55293	6188	60322	5000	62158	4031	63714	2560	78037	1297	65436
7L-2S		MI	27767	8443	47137	5980	52462	4793	55487	3834	59922	2306	72545	1931	50360
16-#11	1.70	MA	35195	7369	55375	5515	60797	4481	62902	3712	64560	2603	77474	2460	35076
2L-8S		MI	21640	7369	34407	5386	36369	4382	36328	3637	34698	2540	40331	1909	22987
16-#11	1.70	MA	34269	7369	54006	5513	59042	4477	60762	3725	61649	2614	73513	2374	35086
3L-7S		MI	21995	7369	34999	5390	37173	4389	37279	3628	35948	2532	41917	1954	23181
16-#11	1.70	MA	33622	7369	52894	5528	57625	4492	59039	3721	59431	2624	70929	2287	35055
4L-6S		MI	22355	7369	35656	5378	37966	4378	38299	3636	37214	2523	43615	2044	23477
16-#11	1.70	MA	33046	7369	51933	5526	56379	4488	57508	3734	57212	2617	68245	2245	34974
5E		MI	22724	7369	36256	5382	38796	4384	39266	3627	38510	2515	45202	2101	23687

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

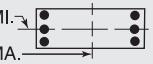


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.70	MA	32497	7369	51033	5524	55131	4503	55983	3729	55203	2628	65682	2189	34581
6L-4S		MI	23110	7369	36895	5387	39624	4373	40283	3618	39942	2523	46899	2139	23673
16-#11	1.70	MA	31962	7369	50047	5540	53942	4499	54520	3742	53240	2638	62951	2099	33986
7L-3S		MI	23540	7369	37631	5374	40562	4380	41423	3626	41369	2515	48491	2225	23642
16-#11	1.70	MA	31436	7369	49162	5538	52735	4513	53093	3755	51154	2632	60440	2049	33559
8L-2S		MI	24143	7369	38527	5379	41711	4369	42825	3617	43236	2506	50956	2311	23606
16-#14	2.45	MA	36058	7751	58230	5734	64352	4634	67200	3823	70390	2578	85161	2259	49892
3L-7S		MI	22459	7751	36614	5607	39142	4546	39632	3715	39074	2480	46526	1711	31828
16-#14	2.45	MA	35144	7751	56635	5756	62319	4653	64729	3816	67211	2593	81486	2135	49738
4L-6S		MI	22968	7751	37554	5590	40277	4531	41088	3728	40870	2467	48628	1806	32303
16-#14	2.45	MA	34329	7751	55257	5752	60532	4648	62532	3834	64028	2582	77657	2074	49096
5E		MI	23490	7751	38413	5597	41464	4541	42470	3715	42708	2455	50869	1888	32906
16-#14	2.45	MA	33553	7751	53965	5749	58742	4668	60345	3827	61146	2596	74011	1994	47909
6L-4S		MI	24036	7751	39328	5604	42648	4526	43922	3703	44739	2467	53272	1942	33354
16-#14	2.45	MA	32797	7751	52550	5771	57035	4663	58246	3845	58329	2611	70121	1864	47117
7L-3S		MI	24644	7751	40380	5587	43990	4536	45548	3715	46762	2455	55522	2066	33387
16-#14	2.45	MA	32054	7751	51278	5767	55303	4683	56197	3863	55336	2600	66540	1793	45552
8L-2S		MI	25495	7751	41660	5594	45629	4521	47546	3703	49411	2442	59007	2190	33362
16-#18	4.35	MA	37426	8719	63493	6332	70879	5102	75073	4091	81051	2493	100852	1624	81688
5E		MI	25312	8719	43700	6151	48049	4943	50199	3927	52955	2291	64594	1321	54093
16-#18	4.35	MA	36106	8719	61220	6325	67730	5091	71225	4076	75980	2515	94542	1480	78744
6L-4S		MI	26244	8719	45299	6166	50121	4920	52692	3905	56447	2313	68695	1418	55551
16-#18	4.35	MA	34820	8719	58729	6361	64726	5124	67531	4106	71025	2538	87807	1249	75696
7L-3S		MI	27281	8719	47137	6137	52462	4941	55487	3927	59922	2291	72545	1632	57102
16-#18	4.35	MA	33556	8719	56491	6354	61679	5113	63925	4136	65759	2516	81583	1126	71676
8L-2S		MI	28725	8719	49363	6153	55315	4917	58917	3905	64471	2269	78493	1853	57276
18-#11	1.91	MA	34914	7477	55375	5580	60797	4526	62902	3754	64560	2605	77474	2358	39350
3L-8S		MI	22056	7477	35304	5453	37519	4431	37730	3667	36566	2529	42796	1884	25717
18-#11	1.91	MA	34270	7477	54262	5596	59379	4540	61179	3750	62343	2615	74890	2272	39305
4L-7S		MI	22409	7477	35895	5458	38323	4437	38681	3658	37815	2520	44382	1929	25904
18-#11	1.91	MA	33696	7477	53302	5594	58133	4537	59648	3763	60124	2609	72206	2229	39207
5L-6S		MI	22767	7477	36552	5445	39115	4426	39701	3666	39082	2512	46080	2019	26184
18-#11	1.91	MA	33150	7477	52402	5592	56886	4551	58123	3759	58115	2619	69643	2174	38719
6L-5S		MI	23135	7477	37152	5450	39945	4433	40668	3657	40378	2503	47667	2076	26476
18-#11	1.91	MA	32618	7477	51416	5607	55696	4548	56661	3772	56152	2630	66911	2084	38147
7L-4S		MI	23520	7477	37791	5454	40773	4422	41686	3647	41809	2512	49364	2114	26482
18-#11	1.91	MA	32094	7477	50530	5605	54490	4562	55233	3784	54066	2623	64401	2034	37729
8L-3S		MI	23949	7477	38527	5442	41711	4428	42825	3656	43236	2503	50956	2200	26461
18-#11	1.91	MA	31537	7477	49664	5603	53316	4559	53740	3780	52121	2634	61916	1980	36889
9L-2S		MI	24550	7477	39424	5446	42860	4417	44227	3646	45104	2494	53422	2286	26430
18-#14	2.75	MA	36055	7907	58595	5853	64832	4723	67794	3858	71381	2580	87126	2111	55792
4L-7S		MI	23042	7907	37894	5705	40782	4615	41629	3758	41723	2462	50011	1672	35588
18-#14	2.75	MA	35244	7907	57217	5850	63044	4718	65598	3876	68199	2570	83297	2050	54982
5L-6S		MI	23548	7907	38834	5687	41917	4600	43086	3770	43518	2449	52114	1767	36163
18-#14	2.75	MA	34473	7907	55925	5846	61255	4738	63410	3869	65316	2584	79651	1970	53844
6L-5S		MI	24067	7907	39693	5694	43104	4610	44468	3758	45356	2437	54355	1850	36731
18-#14	2.75	MA	33722	7907	54510	5868	59548	4733	61311	3887	62500	2598	75761	1840	52950
7L-4S		MI	24611	7907	40607	5702	44288	4596	45919	3745	47387	2449	56757	1903	37318
18-#14	2.75	MA	32983	7907	53239	5865	57816	4753	59262	3905	59506	2588	72180	1769	51433
8L-3S		MI	25216	7907	41660	5684	45629	4606	47546	3758	49411	2437	59007	2027	37373
18-#14	2.75	MA	32205	7907	51995	5861	56132	4747	57120	3898	56716	2602	68645	1692	50041
9L-2S		MI	26063	7907	42939	5691	47269	4591	49543	3745	52059	2424	62493	2152	37373
18-#18	4.89	MA	37671	8996	64656	6497	72135	5215	76598	4152	83291	2493	104312	1432	88918
6L-5S		MI	26286	8996	45925	6324	50902	5068	53629	3999	57505	2255	70542	1243	60752
18-#18	4.89	MA	36397	8996	62165	6534	69131	5248	72904	4181	78335	2516	97577	1201	85976
7L-4S		MI	27212	8996	47524	6339	52974	5044	56123	3977	60996	2277	74643	1340	62117
18-#18	4.89	MA	35143	8996	59926	6527	66083	5237	69298	4211	73070	2494	91353	1078	81849
8L-3S		MI	28242	8996	49363	6310	55315	5065	58917	3999	64471	2255	78493	1554	63956

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

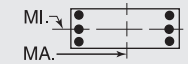
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.12	MA	34914	7585	55631	5663	61133	4588	63320	3779	65255	2607	78851	2256	43551
4L-8S		MI	22469	7585	36200	5521	38668	4479	39132	3696	38434	2517	45262	1859	28384
20-#11	2.12	MA	34343	7585	54670	5661	59887	4585	61788	3792	63036	2600	76166	2214	43437
5L-7S		MI	22821	7585	36792	5525	39472	4486	40083	3687	39683	2509	46847	1904	28630
20-#11	2.12	MA	33799	7585	53771	5659	58640	4599	60264	3788	61027	2611	73604	2158	42864
6E		MI	23178	7585	37449	5513	40264	4475	41103	3695	40949	2500	48546	1994	28896
20-#11	2.12	MA	33269	7585	52784	5674	57451	4596	58801	3801	59064	2621	70872	2068	42311
7L-5S		MI	23544	7585	38049	5517	41094	4481	42071	3686	42245	2491	50132	2051	29262
20-#11	2.12	MA	32748	7585	51899	5672	56244	4610	57373	3814	56978	2614	68362	2018	41884
8L-4S		MI	23928	7585	38688	5522	41922	4470	43088	3677	43677	2500	51830	2088	29286
20-#11	2.12	MA	32194	7585	51032	5671	55070	4607	55880	3809	55033	2625	65877	1965	41012
9L-3S		MI	24355	7585	39424	5509	42860	4476	44227	3685	45104	2491	53422	2175	29273
20-#11	2.12	MA	31617	7585	50062	5686	53880	4621	54460	3822	53105	2636	63469	1904	40346
10L-2S		MI	24955	7585	40320	5514	44010	4466	45630	3676	46972	2483	55887	2261	29249
20-#14	3.06	MA	36154	8062	59177	5947	65557	4788	68663	3919	72370	2557	88937	2026	60881
5L-7S		MI	23620	8062	39173	5802	42422	4685	43627	3800	44372	2444	53497	1633	39360
20-#14	3.06	MA	35387	8062	57885	5944	63767	4808	66476	3912	69487	2572	85290	1946	59786
6E		MI	24124	8062	40113	5784	43556	4670	45083	3812	46167	2431	55599	1729	40028
20-#14	3.06	MA	34641	8062	56470	5965	62060	4803	64376	3930	66670	2586	81401	1816	58794
7L-5S		MI	24641	8062	40972	5792	44744	4680	46465	3800	48005	2419	57840	1811	40566
20-#14	3.06	MA	33906	8062	55199	5962	60329	4822	62328	3948	63677	2575	77820	1745	57322
8L-4S		MI	25183	8062	41886	5799	45928	4665	47917	3787	50036	2431	60243	1865	41275
20-#14	3.06	MA	33149	8062	53955	5959	58644	4817	60185	3941	60886	2590	74285	1668	55868
9L-3S		MI	25785	8062	42939	5781	47269	4675	49543	3800	52059	2419	62493	1988	41351
20-#14	3.06	MA	32320	8062	52562	5980	56936	4837	58147	3959	58119	2604	70858	1580	54247
10L-2S		MI	26629	8062	44218	5789	48909	4661	51541	3787	54708	2406	65978	2113	41378
20-#18	5.43	MA	37959	9273	65601	6707	73535	5373	78277	4257	85646	2493	107347	1152	96078
7L-5S		MI	27254	9273	48151	6496	53755	5192	57060	4070	62054	2218	76490	1165	67424
20-#18	5.43	MA	36716	9273	63362	6700	70488	5362	74672	4286	80380	2472	101123	1029	92040
8L-4S		MI	28174	9273	49750	6512	55827	5168	59553	4048	65546	2240	80590	1262	68706
22-#11	2.33	MA	34986	7693	56039	5729	61642	4634	63929	3822	65948	2592	80127	2198	47665
5L-8S		MI	22880	7693	37097	5588	39817	4528	40534	3726	40301	2506	47727	1834	31052
22-#11	2.33	MA	34445	7693	55139	5727	60394	4648	62404	3817	63939	2602	77565	2143	47015
6L-7S		MI	23231	7693	37688	5593	40621	4534	41485	3716	41551	2497	49313	1878	31358
22-#11	2.33	MA	33918	7693	54153	5742	59205	4645	60941	3830	61976	2613	74833	2053	46480
7L-6S		MI	23587	7693	38345	5580	41414	4523	42505	3725	42817	2488	51011	1969	31612
22-#11	2.33	MA	33398	7693	53267	5740	57998	4659	59513	3843	59890	2606	72322	2003	45989
8L-5S		MI	23952	7693	38945	5585	42244	4529	43473	3715	44113	2480	52598	2026	32042
22-#11	2.33	MA	32847	7693	52401	5738	56825	4656	58020	3839	57945	2616	69838	1949	45140
9L-4S		MI	24335	7693	39584	5589	43072	4519	44490	3706	45545	2488	54295	2063	32077
22-#11	2.33	MA	32273	7693	51430	5753	55634	4670	56600	3852	56017	2627	67430	1889	44459
10L-3S		MI	24760	7693	40320	5577	44010	4525	45630	3714	46972	2480	55887	2150	32081
22-#11	2.33	MA	31712	7693	50562	5751	54467	4666	55126	3847	53960	2620	64981	1836	43441
11L-2S		MI	25358	7693	41217	5581	45159	4514	47032	3705	48839	2471	58353	2236	32063
22-#14	3.36	MA	36296	8218	59845	6041	66280	4877	69541	3954	73658	2559	90930	1922	65735
6L-7S		MI	24196	8218	40452	5899	44062	4755	45625	3842	47020	2426	56982	1594	43143
22-#14	3.36	MA	35553	8218	58430	6062	64573	4872	67442	3972	70841	2573	87041	1792	64649
7L-6S		MI	24698	8218	41392	5882	45196	4740	47081	3854	48816	2413	59084	1690	43897
22-#14	3.36	MA	34823	8218	57159	6059	62841	4892	65393	3990	67848	2563	83460	1721	63219
8L-5S		MI	25212	8218	42251	5889	46384	4750	48463	3842	50653	2401	61325	1772	44409
22-#14	3.36	MA	34067	8218	55915	6056	61157	4887	63250	3983	65057	2577	79924	1644	61705
9L-4S		MI	25751	8218	43165	5896	47568	4735	49915	3829	52684	2413	63728	1826	45227
22-#14	3.36	MA	33246	8218	54522	6077	59449	4907	61212	4001	62290	2592	76498	1556	60121
10L-3S		MI	26351	8218	44218	5879	48909	4745	51541	3842	54708	2401	65978	1950	45322

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#18	5.98	MA	38276	9549	66798	6873	74892	5486	80045	4362	87691	2450	110893	981	102248
8L-5S		MI	28215	9549	50376	6669	56608	5316	60490	4142	66604	2182	82438	1087	74106
24-#11	2.54	MA	35088	7801	56508	5794	62149	4696	64544	3847	66851	2593	81526	2127	51170
6L-8S		MI	23290	7801	37993	5656	40966	4576	41936	3755	42169	2494	50192	1809	33725
24-#11	2.54	MA	34563	7801	55521	5809	60959	4693	63081	3860	64888	2604	78794	2037	50651
7E		MI	23640	7801	38585	5660	41770	4582	42887	3746	43418	2485	51778	1853	34087
24-#11	2.54	MA	34046	7801	54636	5807	59753	4707	61654	3873	62802	2597	76283	1988	50100
8L-6S		MI	23995	7801	39242	5647	42563	4571	43907	3754	44685	2477	53476	1944	34332
24-#11	2.54	MA	33497	7801	53769	5805	58579	4704	60161	3868	60857	2608	73799	1934	49273
9L-5S		MI	24358	7801	39842	5652	43393	4578	44875	3745	45981	2468	55063	2001	34780
24-#11	2.54	MA	32925	7801	52799	5821	57389	4718	58740	3881	58929	2618	71390	1873	48550
10L-4S		MI	24739	7801	40481	5657	44221	4567	45892	3736	47412	2477	56761	2038	34865
24-#11	2.54	MA	32366	7801	51931	5819	56222	4715	57266	3877	56872	2612	68942	1820	47553
11L-3S		MI	25164	7801	41217	5644	45159	4573	47032	3744	48839	2468	58353	2124	34885
24-#11	2.54	MA	31818	7801	50978	5834	55040	4729	55849	3890	54945	2622	66184	1744	46595
12L-2S		MI	25759	7801	42113	5649	46308	4562	48434	3735	50707	2460	60818	2211	34874
24-#14	3.67	MA	36461	8374	60390	6160	67086	4942	70507	4015	75012	2561	92681	1768	70514
7E		MI	24769	8374	41731	5996	45702	4825	47622	3884	49669	2408	60467	1556	46934
24-#14	3.67	MA	35734	8374	59119	6156	65354	4962	68458	4033	72018	2550	89100	1697	69123
8L-6S		MI	25269	8374	42672	5979	46836	4810	49078	3897	51464	2395	62569	1651	47770
24-#14	3.67	MA	34979	8374	57875	6153	63670	4957	66316	4026	69228	2565	85564	1620	67550
9L-5S		MI	25781	8374	43530	5986	48024	4820	50460	3884	53302	2383	64810	1733	48259
24-#14	3.67	MA	34166	8374	56482	6175	61961	4977	64278	4044	66460	2579	82138	1532	66001
10L-4S		MI	26317	8374	44445	5993	49208	4805	51912	3872	55333	2395	67213	1787	49175

RECTANGULAR TIED COLUMNS 32" x 48"

4-#18	1.04	MA	36058	7342	55776	5502	60171	4491	61048	3754	60132	2725	70254	2586	23613
2E		MI	23763	7342	37382	5323	39610	4343	39702	3621	38395	2600	44149	2428	15349
6-#18	1.56	MA	37756	7619	59385	5675	64797	4615	66692	3830	67811	2703	80572	2541	34968
2L-3S		MI	23269	7619	37382	5480	39610	4490	39702	3714	38395	2585	44149	2129	22594
6-#18	1.56	MA	35314	7619	55776	5669	60171	4649	61048	3860	60132	2727	70254	2319	34987
3L-2S		MI	24765	7619	39607	5496	42463	4467	43133	3692	42944	2563	50097	2350	22459
8-#14	1.17	MA	36572	7412	56618	5578	61466	4548	62711	3796	62429	2737	73632	2604	26628
2L-4S		MI	22609	7412	35577	5425	37502	4419	37304	3681	35371	2652	40685	2206	17413
8-#14	1.17	MA	35168	7412	54560	5575	58829	4544	59494	3814	58052	2752	67683	2480	26681
3E		MI	23229	7412	36630	5407	38843	4429	38930	3693	37395	2639	42935	2330	17330
8-#14	1.17	MA	34185	7412	52888	5597	56697	4564	56903	3808	54718	2767	63803	2355	26674
4L-2S		MI	24096	7412	37909	5415	40483	4414	40928	3681	40043	2627	46420	2454	17251
8-#18	2.08	MA	39433	7896	62994	5848	69423	4739	72335	3905	75489	2681	90890	2495	46274
2L-4S		MI	23203	7896	37769	5682	40121	4594	40338	3764	39469	2571	46247	1837	29520
8-#18	2.08	MA	37013	7896	59385	5842	64797	4773	66692	3936	67811	2705	80572	2274	46187
3E		MI	24271	7896	39607	5653	42463	4615	43133	3786	42944	2549	50097	2051	29590
8-#18	2.08	MA	35316	7896	56445	5879	61050	4763	62137	3922	61949	2729	73857	2052	45707
4L-2S		MI	25757	7896	41833	5668	45316	4591	46563	3764	47494	2527	56045	2273	29504
10-#11	1.02	MA	36087	7329	55480	5542	60118	4524	61109	3784	60268	2752	70822	2630	23246
2L-5S		MI	22383	7329	34929	5390	36762	4412	36435	3686	34137	2662	39163	2286	15290
10-#11	1.02	MA	35103	7329	54044	5541	58277	4522	58863	3798	57212	2763	66647	2544	23287
3L-4S		MI	22775	7329	35568	5395	37590	4401	37452	3677	35569	2671	40861	2324	15231
10-#11	1.02	MA	34416	7329	52879	5556	56791	4536	57057	3794	54888	2774	63921	2457	23316
4L-3S		MI	23210	7329	36305	5382	38528	4407	38592	3685	36996	2662	42453	2410	15171
10-#11	1.02	MA	33803	7329	51872	5555	55486	4533	55452	3807	52563	2768	61095	2414	23300
5L-2S		MI	23819	7329	37201	5387	39677	4397	39994	3676	38864	2654	44918	2496	15119
10-#14	1.46	MA	37548	7567	58675	5675	64103	4618	65929	3838	66807	2725	79580	2582	33088
2L-5S		MI	22642	7567	35942	5515	37958	4503	37849	3735	35989	2621	41767	2113	21458
10-#14	1.46	MA	36150	7567	56618	5672	61466	4614	62711	3857	62429	2740	73632	2457	33118
3L-4S		MI	23198	7567	36856	5522	39142	4489	39301	3723	38020	2634	44170	2167	21444

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

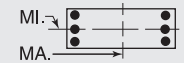
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.46	MA	35174	7567	54945	5694	59335	4634	60120	3850	59095	2755	69752	2333	33062
4L-3S		MI	23815	7567	37909	5504	40483	4498	40928	3735	40043	2621	46420	2291	21385
10-#14	1.46	MA	34303	7567	53501	5691	57461	4629	57818	3869	55759	2745	65719	2271	32865
5L-2S		MI	24678	7567	39188	5512	42123	4484	42925	3723	42692	2609	49905	2415	21316
10-#18	2.60	MA	41091	8172	66602	6021	74049	4863	77979	3980	83168	2659	101208	2449	57536
2L-5S		MI	23249	8172	38395	5839	40903	4742	41275	3858	40527	2512	48095	1662	34478
10-#18	2.60	MA	38691	8172	62994	6014	69423	4897	72335	4011	75489	2683	90890	2228	57360
3L-4S		MI	24203	8172	39994	5855	42974	4718	43769	3835	44019	2534	52195	1759	36349
10-#18	2.60	MA	37010	8172	60053	6052	65676	4887	67781	3998	69628	2707	84176	2007	56778
4L-3S		MI	25264	8172	41833	5826	45316	4739	46563	3858	47494	2512	56045	1973	36538
10-#18	2.60	MA	35511	8172	57511	6045	62379	4921	63729	4028	63760	2686	77156	1901	53483
5L-2S		MI	26739	8172	44058	5841	48169	4715	49994	3835	52044	2490	61993	2195	36511
12-#11	1.22	MA	36775	7436	56916	5610	61959	4573	63355	3814	63323	2744	74997	2616	27759
2L-6S		MI	22429	7436	35226	5453	37081	4454	36869	3725	34709	2659	40042	2204	18142
12-#11	1.22	MA	35794	7436	55480	5608	60118	4570	61109	3827	60268	2755	70822	2529	27790
3L-5S		MI	22801	7436	35826	5458	37911	4460	37837	3715	36005	2651	41629	2261	18118
12-#11	1.22	MA	35110	7436	54315	5624	58632	4584	59303	3823	57943	2766	68096	2443	27801
4E		MI	23191	7436	36465	5463	38739	4450	38854	3706	37436	2659	43326	2298	18072
12-#11	1.22	MA	34499	7436	53308	5622	57327	4582	57698	3836	55618	2759	65270	2400	27758
5L-3S		MI	23624	7436	37201	5450	39677	4456	39994	3714	38864	2651	44918	2385	18021
12-#11	1.22	MA	33919	7436	52365	5620	56020	4596	56101	3832	53513	2770	62568	2344	27642
6L-2S		MI	24232	7436	38098	5454	40826	4445	41396	3705	40731	2642	47384	2471	17972
12-#14	1.76	MA	38516	7723	60732	5773	66741	4688	69146	3881	71185	2712	85529	2559	39533
2L-6S		MI	22703	7723	36362	5605	38410	4563	38465	3790	36800	2616	43011	1992	24764
12-#14	1.76	MA	37126	7723	58675	5770	64103	4683	65929	3899	66807	2727	79580	2435	39530
3L-5S		MI	23231	7723	37221	5612	39597	4573	39847	3777	38637	2603	45252	2075	25431
12-#14	1.76	MA	36155	7723	57003	5792	61972	4704	63338	3893	63473	2742	75701	2310	39438
4E		MI	23783	7723	38135	5619	40782	4558	41299	3765	40668	2616	47655	2128	25456
12-#14	1.76	MA	35289	7723	55558	5789	60098	4699	61035	3911	60137	2732	71668	2249	39201
5L-3S		MI	24398	7723	39188	5602	42123	4568	42925	3777	42692	2603	49905	2252	25418
12-#14	1.76	MA	34465	7723	54205	5786	58223	4719	58743	3905	57115	2747	67820	2168	37923
6L-2S		MI	25257	7723	40467	5609	43763	4553	44923	3765	45341	2591	53390	2377	25362
12-#18	3.13	MA	40350	8449	66602	6187	74049	5021	77979	4087	83168	2661	101208	2182	68515
3L-5S		MI	24247	8449	40621	6012	43756	4866	44706	3929	45077	2476	54043	1584	41075
12-#18	3.13	MA	38685	8449	63662	6225	70302	5011	73425	4073	77307	2685	94494	1961	67838
4E		MI	25195	8449	42220	6028	45827	4842	47199	3907	48568	2498	58143	1681	42804
12-#18	3.13	MA	37200	8449	61120	6218	67005	5045	69373	4104	71438	2664	87475	1855	64290
5L-3S		MI	26248	8449	44058	5999	48169	4863	49994	3929	52044	2476	61993	1895	43448
12-#18	3.13	MA	35788	8449	58736	6212	63704	5035	65338	4090	66121	2688	80807	1711	61831
6L-2S		MI	27714	8449	46284	6014	51022	4839	53425	3907	56593	2454	67941	2117	43490
14-#11	1.42	MA	37458	7544	58352	5677	63800	4621	65600	3843	66379	2735	79172	2601	32263
2L-7S		MI	22484	7544	35465	5533	37438	4513	37251	3746	35310	2656	40809	2088	20576
14-#11	1.42	MA	36482	7544	56916	5676	61959	4618	63355	3857	63323	2746	74997	2515	32285
3L-6S		MI	22846	7544	36122	5521	38230	4503	38271	3754	36576	2648	42507	2179	20898
14-#11	1.42	MA	35800	7544	55751	5691	60473	4633	61548	3853	60999	2757	72271	2428	32274
4L-5S		MI	23216	7544	36722	5525	39060	4509	39239	3745	37872	2639	44094	2236	20934
14-#11	1.42	MA	35192	7544	54744	5689	59167	4630	59944	3866	58674	2751	69445	2385	32211
5L-4S		MI	23605	7544	37361	5530	39888	4498	40256	3736	39304	2648	45792	2273	20901
14-#11	1.42	MA	34615	7544	53801	5688	57861	4644	58346	3862	56568	2762	66743	2330	32003
6L-3S		MI	24037	7544	38098	5517	40826	4504	41396	3744	40731	2639	47384	2360	20859
14-#11	1.42	MA	34052	7544	52768	5703	56614	4642	56814	3875	54512	2773	63863	2240	31325
7L-2S		MI	24643	7544	38994	5522	41976	4493	42798	3735	42599	2631	49849	2446	20815
14-#14	2.05	MA	39477	7878	62790	5870	69378	4758	72363	3923	75562	2700	91478	2537	45968
2L-7S		MI	22778	7878	36701	5719	38916	4648	39007	3820	37653	2610	44394	1858	28223

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

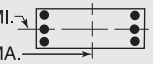


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.05	MA	38094	7878	60732	5867	66741	4753	69146	3941	71185	2715	85529	2412	45931
3L-6S		MI	23290	7878	37642	5702	40050	4633	40463	3832	39448	2598	46496	1954	28607
14-#14	2.05	MA	37129	7878	59060	5889	64609	4773	66555	3935	67850	2730	81650	2288	45806
4L-5S		MI	23815	7878	38500	5709	41237	4643	41845	3820	41286	2585	48737	2036	29266
14-#14	2.05	MA	36268	7878	57616	5886	62736	4769	64253	3954	64514	2720	77617	2226	45494
5L-4S		MI	24365	7878	39415	5717	42422	4628	43296	3807	43317	2598	51140	2090	29449
14-#14	2.05	MA	35450	7878	56262	5883	60860	4789	61960	3947	61493	2735	73769	2146	44134
6L-3S		MI	24977	7878	40467	5699	43763	4638	44923	3820	45341	2585	53390	2213	29437
14-#14	2.05	MA	34652	7878	54779	5905	59071	4784	59760	3966	58541	2750	69666	2016	43274
7L-2S		MI	25833	7878	41747	5706	45403	4623	46921	3807	47989	2573	56875	2338	29395
14-#18	3.65	MA	40343	8726	67271	6398	74928	5135	79068	4148	84985	2662	104812	1915	78501
4L-5S		MI	25238	8726	42846	6185	46609	4990	48136	4001	49626	2439	59990	1506	47698
14-#18	3.65	MA	38871	8726	64728	6391	71631	5170	75017	4179	79117	2642	97793	1809	75125
5L-4S		MI	26179	8726	44445	6201	48680	4966	50630	3978	53118	2461	64091	1604	49303
14-#18	3.65	MA	37472	8726	62345	6384	68330	5160	70982	4166	73800	2666	91125	1666	72474
6L-3S		MI	27224	8726	46284	6172	51022	4987	53425	4001	56593	2439	67941	1817	50336
14-#18	3.65	MA	36110	8726	59734	6422	65180	5194	67109	4196	68604	2690	84011	1435	69032
7L-2S		MI	28681	8726	48509	6187	53875	4963	56855	3978	61143	2417	73889	2039	50441
16-#11	1.63	MA	38138	7652	59788	5745	65641	4670	67846	3873	69434	2726	83347	2586	36761
2L-8S		MI	22545	7652	35771	5596	37783	4555	37702	3784	35929	2653	41689	2019	23103
16-#11	1.63	MA	37165	7652	58352	5743	63800	4667	65600	3886	66379	2737	79172	2500	36770
3L-7S		MI	22900	7652	36362	5601	38587	4562	38653	3775	37178	2645	43275	2063	23296
16-#11	1.63	MA	36486	7652	57186	5759	62314	4681	63794	3882	64054	2748	76446	2414	36740
4L-6S		MI	23260	7652	37019	5588	39380	4551	39673	3783	38444	2636	44973	2154	23598
16-#11	1.63	MA	35882	7652	56180	5757	61008	4678	62189	3895	61729	2742	73620	2371	36658
5E		MI	23630	7652	37619	5593	40210	4557	40641	3774	39740	2628	46560	2210	23741
16-#11	1.63	MA	35306	7652	55237	5755	59701	4693	60592	3891	59624	2753	70918	2315	36337
6L-4S		MI	24017	7652	38258	5597	41038	4546	41658	3765	41172	2636	48257	2248	23721
16-#11	1.63	MA	34746	7652	54204	5771	58455	4690	59059	3904	57567	2764	68038	2225	35686
7L-3S		MI	24448	7652	38994	5585	41976	4553	42798	3773	42599	2628	49849	2334	23687
16-#11	1.63	MA	34185	7652	53276	5769	57191	4704	57564	3918	55381	2758	65395	2175	35226
8L-2S		MI	25051	7652	39891	5589	43125	4542	44200	3764	44467	2619	52314	2421	23648
16-#14	2.34	MA	39056	8034	62790	5964	69378	4823	72363	3984	75562	2702	91478	2390	52322
3L-7S		MI	23364	8034	37981	5817	40556	4718	41004	3862	40301	2592	47880	1820	32090
16-#14	2.34	MA	38096	8034	61117	5986	67247	4843	69773	3978	72228	2717	87598	2265	52168
4L-6S		MI	23874	8034	38921	5799	41690	4703	42460	3874	42097	2580	49982	1915	32460
16-#14	2.34	MA	37241	8034	59673	5983	65373	4839	67470	3996	68892	2708	83566	2204	51658
5E		MI	24396	8034	39780	5806	42877	4713	43842	3862	43935	2567	52223	1997	33078
16-#14	2.34	MA	36427	8034	58320	5980	63498	4859	65177	3990	65871	2723	79717	2123	50357
6L-4S		MI	24944	8034	40694	5814	44062	4698	45294	3849	45966	2580	54626	2051	33427
16-#14	2.34	MA	35634	8034	56836	6002	61709	4854	62978	4008	62919	2738	75615	1994	49523
7L-3S		MI	25553	8034	41747	5796	45403	4708	46921	3862	47989	2567	56875	2175	33451
16-#14	2.34	MA	34854	8034	55505	5999	59894	4874	60831	4027	59782	2728	71843	1922	47975
8L-2S		MI	26405	8034	43026	5804	47043	4693	48918	3849	50638	2555	60361	2299	33416
16-#18	4.17	MA	40527	9002	68337	6564	76257	5294	80660	4255	86796	2620	108111	1764	85984
5E		MI	26220	9002	45072	6358	49462	5114	51567	4072	54176	2403	65938	1428	54341
16-#18	4.17	MA	39140	9002	65954	6557	72956	5284	76626	4241	81478	2644	101444	1620	83146
6L-4S		MI	27155	9002	46671	6373	51533	5090	54060	4050	57667	2425	70039	1526	55838
16-#18	4.17	MA	37790	9002	63342	6595	69806	5318	72753	4272	76283	2668	94329	1389	79821
7L-3S		MI	28194	9002	48509	6345	53875	5111	56855	4072	61143	2403	73889	1740	57209
16-#18	4.17	MA	36462	9002	60996	6588	66611	5308	68973	4303	70761	2648	87767	1265	75784
8L-2S		MI	29642	9002	50735	6360	56728	5088	60286	4050	65692	2380	79837	1961	57363
18-#11	1.83	MA	37845	7760	59788	5810	65641	4715	67846	3915	69434	2729	83347	2486	41246
3L-8S		MI	22961	7760	36667	5664	38932	4604	39104	3814	37796	2642	44154	1993	25834
18-#11	1.83	MA	37169	7760	58622	5826	64155	4730	66040	3911	67110	2740	80621	2399	41201
4L-7S		MI	23314	7760	37258	5668	39736	4610	40055	3805	39046	2633	45740	2038	26020
18-#11	1.83	MA	36567	7760	57616	5824	62849	4727	64435	3925	64784	2734	77796	2356	41102
5L-6S		MI	23674	7760	37915	5656	40529	4599	41075	3813	40312	2625	47438	2129	26305

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

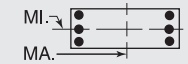
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.83	MA	35994	7760	56673	5823	61542	4741	62838	3921	62679	2745	75093	2301	40680
6L-5S		MI	24042	7760	38515	5660	41359	4606	42043	3804	41608	2616	49025	2185	26538
18-#11	1.83	MA	35436	7760	55640	5838	60296	4738	61305	3934	60622	2756	72213	2211	40053
7L-4S		MI	24427	7760	39154	5665	42187	4595	43060	3795	43039	2625	50722	2223	26533
18-#11	1.83	MA	34887	7760	54712	5836	59032	4753	59809	3947	58436	2749	69570	2161	39605
8L-3S		MI	24857	7760	39891	5652	43125	4601	44200	3803	44467	2616	52314	2309	26508
18-#11	1.83	MA	34294	7760	53805	5835	57802	4750	58245	3943	56399	2760	66950	2107	38802
9L-2S		MI	25458	7760	40787	5657	44274	4590	45602	3793	46334	2607	54780	2396	26475
18-#14	2.64	MA	39057	8190	63175	6083	69884	4913	72990	4020	76606	2705	93547	2242	58525
4L-7S		MI	23947	8190	39260	5914	42196	4788	43002	3904	42950	2574	51365	1781	35847
18-#14	2.64	MA	38207	8190	61730	6081	68010	4908	70688	4038	73270	2695	89514	2181	57838
5L-6S		MI	24454	8190	40200	5896	43330	4773	44458	3916	44746	2562	53467	1876	36320
18-#14	2.64	MA	37398	8190	60377	6078	66135	4929	68395	4032	70248	2710	85666	2101	56589
6L-5S		MI	24974	8190	41059	5904	44517	4783	45840	3904	46583	2549	55708	1958	36902
18-#14	2.64	MA	36610	8190	58894	6100	64346	4924	66195	4051	67296	2725	81563	1971	55778
7L-4S		MI	25520	8190	41973	5911	45702	4768	47292	3891	48614	2562	58111	2012	37397
18-#14	2.64	MA	35834	8190	57562	6097	62532	4944	64048	4069	64159	2715	77792	1900	54152
8L-3S		MI	26126	8190	43026	5893	47043	4778	48918	3904	50638	2549	60361	2136	37440
18-#14	2.64	MA	35005	8190	56259	6094	60767	4940	61803	4063	61235	2730	74060	1822	52821
9L-2S		MI	26974	8190	44305	5901	48683	4763	50916	3891	53286	2537	63846	2260	37429
18-#18	4.69	MA	40792	9279	69562	6730	77582	5408	82269	4317	89157	2622	111762	1574	93843
6L-5S		MI	27196	9279	47297	6531	52315	5238	54998	4144	58726	2366	71886	1350	61000
18-#18	4.69	MA	39454	9279	66951	6768	74432	5442	78396	4347	83961	2646	104648	1344	90627
7L-4S		MI	28124	9279	48896	6546	54386	5215	57491	4122	62217	2388	75986	1448	62401
18-#18	4.69	MA	38137	9279	64605	6761	71237	5432	74616	4378	78439	2626	98085	1219	86483
8L-3S		MI	29157	9279	50735	6518	56728	5235	60286	4144	65692	2366	79837	1662	64069
20-#11	2.03	MA	37849	7868	60058	5893	65995	4778	68286	3941	70165	2731	84796	2385	45657
4L-8S		MI	23374	7868	37564	5731	40082	4652	40506	3843	39664	2630	46620	1968	28566
20-#11	2.03	MA	37249	7868	59052	5892	64690	4775	66681	3954	67840	2725	81971	2342	45543
5L-7S		MI	23727	7868	38155	5736	40886	4659	41457	3834	40913	2622	48205	2013	28747
20-#11	2.03	MA	36679	7868	58109	5890	63383	4790	65083	3950	65734	2736	79268	2286	45029
6E		MI	24085	7868	38812	5723	41678	4648	42477	3842	42180	2613	49904	2103	29018
20-#11	2.03	MA	36123	7868	57076	5905	62137	4787	63551	3963	63678	2747	76388	2196	44425
7L-5S		MI	24452	7868	39412	5728	42508	4654	43445	3833	43475	2604	51490	2160	29327
20-#11	2.03	MA	35576	7868	56148	5904	60873	4801	62055	3977	61492	2741	73745	2146	43986
8L-4S		MI	24836	7868	40051	5732	43336	4643	44462	3824	44907	2613	53188	2198	29340
20-#11	2.03	MA	34987	7868	55241	5902	59643	4798	60491	3973	59454	2752	71125	2092	43131
9L-3S		MI	25264	7868	40787	5720	44274	4650	45602	3832	46334	2604	54780	2284	29323
20-#11	2.03	MA	34382	7868	54224	5918	58396	4813	59003	3986	57434	2763	68585	2032	42412
10L-2S		MI	25864	7868	41684	5724	45423	4639	47004	3823	48202	2596	57245	2370	29296
20-#14	2.93	MA	39166	8345	63788	6178	70648	4978	73905	4081	77647	2683	95463	2159	64031
5L-7S		MI	24527	8345	40539	6011	43836	4857	44999	3946	45599	2556	54850	1742	39617
20-#14	2.93	MA	38362	8345	62434	6175	68772	4999	71612	4074	74626	2698	91615	2078	62829
6E		MI	25032	8345	41479	5994	44970	4843	46456	3958	47394	2544	56952	1837	40186
20-#14	2.93	MA	37578	8345	60951	6197	66983	4994	69412	4093	71674	2713	87512	1949	61945
7L-5S		MI	25549	8345	42338	6001	46157	4853	47838	3946	49232	2531	59193	1919	40737
20-#14	2.93	MA	36807	8345	59619	6194	65169	5014	67266	4111	68537	2703	83740	1877	60338
8L-4S		MI	26092	8345	43253	6008	47342	4838	49289	3934	51263	2544	61596	1973	41358
20-#14	2.93	MA	35984	8345	58316	6191	63404	5010	65020	4105	65612	2718	80009	1800	58944
9L-3S		MI	26696	8345	44305	5991	48683	4848	50916	3946	53286	2531	63846	2097	41422
20-#14	2.93	MA	35130	8345	56857	6213	61614	5030	62885	4124	62713	2733	76393	1712	57184
10L-2S		MI	27541	8345	45584	5998	50323	4833	52913	3934	55935	2519	67331	2222	41441
20-#18	5.21	MA	41104	9556	70560	6941	79058	5566	84040	4423	91640	2624	114966	1298	101451
7L-5S		MI	28165	9556	49523	6704	55168	5362	58428	4215	63275	2329	77834	1273	67672

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

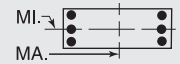


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#18	5.21	MA	39798	9556	68213	6934	75863	5556	80260	4453	86118	2604	108403	1174	97201
8L-4S		MI	29088	9556	51122	6719	57239	5339	60922	4193	66766	2352	81934	1370	68987
22-#11	2.23	MA	37928	7976	60488	5959	66531	4824	68926	3983	70895	2716	86146	2327	49982
5L-8S		MI	23786	7976	38460	5799	41231	4701	41908	3873	41532	2619	49085	1943	31240
22-#11	2.23	MA	37360	7976	59545	5957	65224	4838	67329	3979	68790	2727	83443	2271	49385
6L-7S		MI	24138	7976	39051	5803	42035	4707	42859	3863	42781	2610	50671	1988	31476
22-#11	2.23	MA	36807	7976	58512	5973	63978	4835	65796	3993	66733	2738	80564	2182	48800
7L-6S		MI	24494	7976	39708	5790	42827	4696	43879	3872	44047	2601	52369	2078	31734
22-#11	2.23	MA	36262	7976	57584	5971	62713	4850	64301	4006	64547	2732	77921	2131	48369
8L-5S		MI	24860	7976	40308	5795	43657	4703	44847	3862	45343	2593	53956	2135	32112
22-#11	2.23	MA	35675	7976	56677	5969	61484	4847	62736	4002	62510	2743	75300	2078	47465
9L-4S		MI	25243	7976	40947	5800	44485	4692	45864	3853	46775	2601	55653	2173	32138
22-#11	2.23	MA	35073	7976	55660	5985	60237	4861	61249	4015	60490	2754	72760	2017	46762
10L-3S		MI	25669	7976	41684	5787	45423	4698	47004	3861	48202	2593	57245	2259	32133
22-#11	2.23	MA	34484	7976	54751	5983	59015	4858	59705	4011	58335	2748	70183	1964	45743
11L-2S		MI	26268	7976	42580	5792	46573	4687	48406	3852	50070	2584	59711	2345	32112
22-#14	3.22	MA	39320	8501	64491	6272	71410	5068	74830	4117	79003	2685	97564	2056	69076
6L-7S		MI	25103	8501	41818	6109	45476	4927	46997	3988	48247	2538	58335	1703	43397
22-#14	3.22	MA	38541	8501	63008	6294	69621	5064	72630	4135	76052	2700	93461	1926	68095
7L-6S		MI	25606	8501	42759	6091	46610	4912	48453	4001	50043	2526	60437	1799	44057
22-#14	3.22	MA	37774	8501	61677	6291	67806	5084	70483	4154	72914	2691	89689	1855	66532
8L-5S		MI	26122	8501	43617	6098	47797	4922	49835	3988	51880	2513	62678	1881	44580
22-#14	3.22	MA	36971	8501	60373	6288	66041	5079	68238	4148	69990	2706	85958	1777	65076
9L-4S		MI	26662	8501	44532	6106	48982	4908	51287	3976	53911	2526	65081	1935	45315
22-#14	3.22	MA	36106	8501	58914	6310	64251	5100	66102	4166	67090	2721	82342	1689	63355
10L-3S		MI	27263	8501	45584	6088	50323	4917	52913	3988	55935	2513	67331	2058	45397
22-#18	5.73	MA	41445	9832	71822	7107	80490	5680	85903	4529	93797	2581	118721	1128	107936
8L-5S		MI	29128	9832	51748	6877	58021	5486	61859	4287	67825	2293	83782	1195	74354
24-#11	2.44	MA	38038	8084	60981	6025	67065	4886	69575	4009	71845	2719	87619	2257	53747
6L-8S		MI	24197	8084	39357	5866	42380	4749	43310	3902	43399	2607	51550	1918	33912
24-#11	2.44	MA	37487	8084	59948	6040	65818	4884	68042	4022	69789	2730	84739	2167	53179
7E		MI	24547	8084	39948	5871	43184	4755	44261	3893	44649	2598	53136	1963	34207
24-#11	2.44	MA	36945	8084	59020	6039	64554	4898	66546	4035	67603	2723	82096	2117	52707
8L-6S		MI	24902	8084	40605	5858	43977	4745	45281	3901	45915	2590	54834	2053	34454
24-#11	2.44	MA	36361	8084	58113	6037	63325	4895	64982	4031	65565	2734	79475	2063	51804
9L-5S		MI	25267	8084	41205	5862	44807	4751	46249	3892	47211	2581	56421	2110	34892
24-#11	2.44	MA	35760	8084	57096	6052	62078	4910	63494	4045	63545	2745	76935	2003	51116
10L-4S		MI	25648	8084	41844	5867	45635	4740	47266	3883	48642	2590	58119	2147	34929
24-#11	2.44	MA	35174	8084	56187	6051	60855	4907	61950	4041	61390	2739	74358	1949	50061
11L-3S		MI	26073	8084	42580	5854	46573	4746	48406	3891	50070	2581	59711	2234	34939
24-#11	2.44	MA	34599	8084	55189	6066	59617	4921	60465	4054	59371	2750	71450	1873	49144
12L-2S		MI	26670	8084	43477	5859	47722	4736	49808	3882	51937	2573	62176	2320	34924
24-#14	3.52	MA	39498	8656	65066	6391	72258	5134	75847	4178	80429	2688	99410	1904	74255
7E		MI	25677	8656	43098	6206	47116	4997	48995	4030	50896	2520	61820	1664	47187
24-#14	3.52	MA	38736	8656	63734	6388	70444	5154	73700	4196	77292	2678	95638	1832	72733
8L-6S		MI	26178	8656	44038	6188	48250	4982	50451	4043	52691	2508	63923	1760	47931
24-#14	3.52	MA	37933	8656	62431	6386	68679	5149	71455	4190	74367	2693	91907	1755	71217
9L-5S		MI	26691	8656	44897	6196	49437	4992	51833	4030	54529	2495	66164	1842	48430
24-#14	3.52	MA	37077	8656	60972	6407	66889	5169	69320	4208	71468	2708	88290	1667	69532
10L-4S		MI	27229	8656	45811	6203	50622	4977	53285	4018	56560	2508	68567	1896	49266

RECTANGULAR TIED COLUMNS 34" x 34"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.17	MA	19300	5576	30282	4096	32427	3339	32840	2785	32233	1993	37453	1868	13810
2L-3S		MI	18367	5576	28905	4089	30663	3355	30687	2799	29362	2006	33662	1743	13888
6-#18	2.08	MA	20658	5939	33456	4288	36345	3474	37497	2855	38338	1924	45383	1741	23689
2L-3S		MI	19057	5939	31058	4274	33271	3499	33769	2878	33394	1946	38892	1520	23734
8-#11	1.08	MA	19186	5541	29951	4091	32081	3337	32446	2788	31765	2010	36875	1891	12860
2L-4S		MI	18065	5541	28197	4100	29838	3343	29715	2790	28198	2027	32464	1718	12964
8-#14	1.56	MA	19931	5732	31658	4193	34192	3409	34993	2828	35104	1977	41245	1832	18170
2L-4S		MI	18343	5732	29152	4205	30987	3416	31090	2830	30040	2002	35004	1583	18242
8-#18	2.77	MA	21723	6216	35855	4461	39420	3598	41226	2929	43282	1890	51874	1669	31223
2L-4S		MI	19003	6216	31480	4478	33828	3604	34461	2929	34561	1934	41188	1230	30001
10-#11	1.35	MA	19631	5649	30915	4158	33316	3386	33953	2817	33787	1999	39553	1868	15915
2L-5S		MI	18099	5649	28476	4163	30186	3403	30132	2830	28671	2007	33304	1657	15996
10-#11	1.35	MA	18979	5649	29951	4154	32081	3397	32446	2827	31765	2007	36875	1782	15959
3L-4S		MI	18515	5649	29161	4167	31074	3392	31222	2820	30220	2016	35142	1695	15995
10-#14	1.95	MA	20556	5888	33035	4290	35957	3479	37145	2870	37975	1960	45037	1796	22508
2L-5S		MI	18389	5888	29548	4296	31481	3501	31682	2885	30710	1973	36187	1492	21955
10-#14	1.95	MA	19634	5888	31658	4284	34192	3494	34993	2884	35104	1973	41245	1671	22545
3L-4S		MI	18978	5888	30528	4302	32752	3485	33243	2872	32911	1985	38796	1547	22514
10-#18	3.46	MA	22776	6493	38253	4634	42495	3722	44955	3003	48226	1856	58366	1597	38718
2L-5S		MI	19074	6493	32161	4637	34678	3754	35480	3025	35713	1879	43205	1062	35163
10-#18	3.46	MA	21203	6493	35855	4620	39420	3747	41226	3025	43282	1879	51874	1376	38574
3L-4S		MI	20081	6493	33879	4651	36903	3729	38190	3003	39505	1901	47680	1158	36956

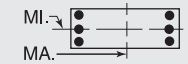
RECTANGULAR TIED COLUMNS 34" x 36"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.31	MA	21862	5963	34510	4359	37008	3550	37589	2956	37110	2094	43235	1950	17184
2E		MI	20603	5963	32603	4337	34866	3532	35317	2937	34777	2076	40416	1928	16153
6-#14	1.10	MA	21557	5877	33669	4340	36093	3540	36534	2956	35833	2128	41639	2002	14721
2L-3S		MI	19390	5877	30444	4313	32259	3539	32239	2955	30752	2126	35196	1859	13930
6-#14	1.10	MA	20555	5877	32196	4334	34203	3557	34229	2970	32739	2141	37540	1878	14799
3L-2S		MI	20324	5877	31820	4319	34023	3523	34392	2942	33623	2113	38987	1984	13850
6-#18	1.96	MA	23028	6240	37081	4532	40304	3674	41611	3031	42449	2063	50271	1883	25309
2L-3S		MI	20080	6240	32603	4496	34866	3681	35317	3033	34777	2065	40416	1635	23816
6-#18	1.96	MA	21308	6240	34510	4520	37008	3702	37589	3053	37110	2085	43235	1662	25354
3L-2S		MI	21683	6240	35001	4510	37941	3656	39045	3010	39721	2043	46907	1856	23748
8-#11	1.02	MA	21431	5842	33311	4335	35717	3538	36106	2959	35318	2144	40996	2025	13703
2L-4S		MI	19087	5842	29732	4325	31435	3528	31269	2947	29591	2147	34003	1835	13005
8-#11	1.02	MA	20728	5842	32280	4332	34395	3550	34493	2969	33141	2153	38105	1938	13754
3E		MI	19553	5842	30522	4312	32441	3534	32492	2955	31136	2139	35736	1921	12948
8-#11	1.02	MA	20230	5842	31436	4345	33319	3545	33187	2962	31477	2161	36231	1852	13807
4L-2S		MI	20209	5842	31486	4316	33677	3522	34000	2945	33158	2130	38414	2008	12896
8-#14	1.47	MA	22237	6033	35143	4437	37982	3610	38839	2998	38926	2113	45738	1969	19385
2L-4S		MI	19365	6033	30690	4429	32583	3600	32642	2986	31429	2122	36538	1699	18311
8-#14	1.47	MA	21242	6033	33669	4431	36093	3626	36534	3013	35833	2126	41639	1844	19443
3E		MI	20027	6033	31820	4410	34023	3609	34392	2998	33623	2109	38987	1823	18278
8-#14	1.47	MA	20535	6033	32462	4450	34554	3618	34664	3002	33469	2138	38986	1720	19457
4L-2S		MI	20956	6033	33197	4417	35788	3593	36545	2984	36494	2097	42779	1948	18215
8-#18	2.61	MA	24180	6517	39652	4705	43600	3799	45632	3106	47789	2032	57307	1816	33383
2L-4S		MI	20025	6517	33025	4699	35424	3787	36009	3084	35944	2053	42713	1345	30384
8-#18	2.61	MA	22475	6517	37081	4693	40304	3826	41611	3129	42449	2054	50271	1595	33329
3E		MI	21161	6517	35001	4669	37941	3806	39045	3106	39721	2031	46907	1563	31265

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

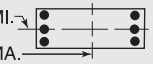


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	2.61	MA	21262	6517	34967	4725	37611	3809	38338	3107	38370	2076	45732	1374	32379
4L-2S		MI	22751	6517	37399	4683	41016	3780	42774	3084	44665	2009	53398	1784	31290
10-#11	1.27	MA	21911	5950	34343	4403	37039	3587	37719	2988	37494	2134	43888	2003	16968
2L-5S		MI	19121	5950	30011	4388	31782	3588	31686	2987	30063	2128	34843	1773	16059
10-#11	1.27	MA	21212	5950	33311	4399	35717	3599	36106	2998	35318	2143	40996	1917	17012
3L-4S		MI	19538	5950	30696	4392	32670	3576	32776	2977	31613	2137	36681	1812	16042
10-#11	1.27	MA	20716	5950	32468	4413	34642	3594	34800	2992	33654	2152	39122	1830	17048
4L-3S		MI	20002	5950	31486	4379	33677	3582	34000	2984	33158	2128	38414	1898	16000
10-#11	1.27	MA	20272	5950	31737	4409	33694	3606	33635	3002	31987	2143	37143	1791	17049
5L-2S		MI	20655	5950	32450	4383	34913	3571	35507	2974	35180	2120	41092	1985	15954
10-#14	1.84	MA	22912	6188	36617	4534	39871	3680	41143	3041	42020	2098	49837	1936	24026
2L-5S		MI	19410	6188	31086	4519	33077	3685	33234	3042	32099	2093	37721	1609	22179
10-#14	1.84	MA	21922	6188	35143	4529	37982	3696	38839	3055	38926	2110	45738	1811	24064
3L-4S		MI	20001	6188	32067	4526	34348	3670	34795	3028	34300	2105	40330	1663	22591
10-#14	1.84	MA	21220	6188	33936	4548	36443	3688	36969	3045	36562	2123	43085	1687	24033
4L-3S		MI	20658	6188	33197	4507	35788	3679	36545	3040	36494	2093	42779	1788	22602
10-#14	1.84	MA	20591	6188	32889	4542	35086	3705	35302	3059	34192	2110	40272	1631	23572
5L-2S		MI	21582	6188	34573	4514	37553	3663	38697	3027	39365	2080	46571	1912	22558
10-#18	3.27	MA	25318	6793	42224	4878	46896	3923	49653	3182	53128	2001	64343	1750	41418
2L-5S		MI	20095	6793	33706	4858	36273	3936	37028	3180	37096	1998	44729	1177	35485
10-#18	3.27	MA	23628	6793	39652	4866	43600	3950	45632	3204	47789	2023	57307	1528	41274
3L-4S		MI	21105	6793	35423	4872	38498	3911	39737	3158	40888	2020	49204	1273	37330
10-#18	3.27	MA	22427	6793	37538	4898	40907	3933	42360	3183	43709	2045	52768	1307	39844
4L-3S		MI	22231	6793	37399	4842	41016	3930	42774	3180	44665	1998	53398	1491	38682
10-#18	3.27	MA	21349	6793	35703	4885	38529	3960	39439	3205	39616	2023	47917	1212	37793
5L-2S		MI	23807	6793	39798	4856	44090	3904	46502	3158	49609	1976	59890	1712	38797
12-#11	1.53	MA	22389	6057	35374	4470	38361	3635	39332	3017	39671	2124	46779	1982	20221
2L-6S		MI	19176	6057	30332	4451	32129	3631	32106	3009	30682	2126	35796	1693	18730
12-#11	1.53	MA	21692	6057	34343	4466	37039	3647	37719	3028	37494	2133	43888	1895	20256
3L-5S		MI	19572	6057	30975	4456	33018	3636	33193	3016	32085	2118	37521	1750	19057
12-#11	1.53	MA	21199	6057	33499	4480	35964	3642	36412	3021	35831	2142	42014	1809	20277
4E		MI	19986	6057	31660	4460	33906	3625	34284	3006	33635	2126	39359	1789	19066
12-#11	1.53	MA	20757	6057	32768	4476	35016	3654	35248	3032	34163	2133	40035	1769	20252
5L-3S		MI	20449	6057	32450	4446	34913	3631	35507	3014	35180	2118	41092	1875	19038
12-#11	1.53	MA	20336	6057	32082	4473	34067	3649	34089	3025	32653	2142	38170	1713	19883
6L-2S		MI	21099	6057	33414	4451	36148	3619	37014	3004	37202	2109	43771	1961	19000
12-#14	2.21	MA	23582	6344	38091	4632	41761	3749	43448	3083	45114	2083	53936	1902	28653
2L-6S		MI	19486	6344	31542	4610	33568	3746	33901	3098	32978	2089	39071	1491	25553
12-#14	2.21	MA	22598	6344	36617	4626	39871	3766	41143	3098	42020	2095	49837	1778	28664
3L-5S		MI	20045	6344	32463	4617	34842	3755	35387	3084	34970	2076	41512	1573	26257
12-#14	2.21	MA	21900	6344	35409	4645	38333	3758	39274	3087	39656	2108	47184	1653	28594
4E		MI	20632	6344	33443	4623	36113	3739	36948	3071	37171	2089	44122	1627	26857
12-#14	2.21	MA	21275	6344	34362	4639	36976	3775	37607	3101	37285	2095	44371	1598	27943
5L-3S		MI	21285	6344	34573	4605	37553	3748	38697	3082	39365	2076	46571	1752	26908
12-#14	2.21	MA	20679	6344	33380	4633	35616	3766	35945	3091	35139	2108	41730	1516	27159
6L-2S		MI	22204	6344	35950	4611	39317	3733	40850	3069	42236	2064	50363	1876	26885
12-#18	3.92	MA	24770	7070	42224	5039	46896	4074	49653	3280	53128	1992	64343	1461	49200
3L-5S		MI	21172	7070	36104	5031	39348	4061	40756	3254	42040	1964	51220	1105	42616
12-#18	3.92	MA	23579	7070	40110	5070	44203	4057	46381	3258	49048	2014	59803	1240	47361
4E		MI	22173	7070	37822	5045	41573	4035	43466	3232	45832	1986	55695	1201	44328
12-#18	3.92	MA	22512	7070	38274	5058	41825	4084	43460	3280	44955	1992	54952	1145	45450
5L-3S		MI	23289	7070	39798	5015	44090	4054	46502	3254	49609	1964	59890	1419	46077
12-#18	3.92	MA	21496	7070	36550	5046	39441	4067	40680	3303	41250	2014	50426	999	42833
6L-2S		MI	24852	7070	42196	5029	47165	4028	50231	3232	54553	1942	66381	1640	46262
14-#11	1.78	MA	22864	6165	36406	4537	39683	3684	40945	3047	41847	2115	49671	1960	23465
2L-7S		MI	19242	6165	30592	4532	32515	3691	32570	3048	31333	2124	36629	1580	21294
14-#11	1.78	MA	22170	6165	35374	4534	38361	3696	39332	3057	39671	2123	46779	1874	23491
3L-6S		MI	19626	6165	31296	4519	33364	3679	33614	3038	32704	2116	38474	1670	21626

RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis



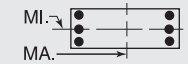
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.78	MA	21679	6165	34530	4547	37286	3690	38025	3051	38007	2132	44905	1787	23493
4L-5S		MI	20019	6165	31939	4523	34254	3685	34701	3046	34107	2107	40200	1727	22048
14-#11	1.78	MA	21239	6165	33799	4544	36338	3703	36861	3061	36340	2123	42926	1748	23447
5L-4S		MI	20432	6165	32624	4527	35142	3673	35791	3036	35657	2116	42038	1765	22081
14-#11	1.78	MA	20820	6165	33114	4540	35389	3697	35701	3054	34830	2132	41061	1692	22983
6L-3S		MI	20892	6165	33414	4514	36148	3679	37014	3043	37202	2107	43771	1852	22066
14-#11	1.78	MA	20411	6165	32363	4554	34483	3709	34588	3065	33354	2141	39069	1601	22611
7L-2S		MI	21540	6165	34378	4518	37384	3668	38522	3033	39224	2098	46449	1938	22036
14-#14	2.57	MA	24247	6499	39565	4729	43650	3819	45753	3126	48207	2067	58035	1869	33274
2L-7S		MI	19577	6499	31910	4726	34117	3832	34489	3128	33903	2085	40251	1325	28821
14-#14	2.57	MA	23268	6499	38091	4723	41761	3836	43448	3140	45114	2080	53936	1745	33248
3L-6S		MI	20119	6499	32918	4707	35333	3816	36054	3140	35849	2072	42863	1455	29691
14-#14	2.57	MA	22575	6499	36883	4742	40222	3828	41578	3130	42749	2092	51283	1620	33147
4L-5S		MI	20675	6499	33839	4714	36607	3825	37539	3127	37841	2060	45304	1537	30353
14-#14	2.57	MA	21953	6499	35836	4736	38865	3844	39911	3144	40379	2080	48471	1564	32332
5L-4S		MI	21258	6499	34820	4720	37877	3809	39100	3113	40042	2072	47914	1591	31113
14-#14	2.57	MA	21361	6499	34853	4731	37505	3836	38250	3133	38232	2092	45829	1483	31592
6L-3S		MI	21908	6499	35950	4702	39317	3818	40850	3125	42236	2060	50363	1716	31194
14-#14	2.57	MA	20784	6499	33777	4750	36207	3853	36655	3148	36135	2105	43005	1352	30650
7L-2S		MI	22822	6499	37326	4708	41082	3802	43003	3111	45107	2047	54155	1840	31200
14-#18	4.58	MA	24720	7347	42681	5243	47499	4181	50402	3333	54387	1983	66839	1173	54919
4L-5S		MI	22239	7347	38503	5204	42423	4185	44485	3328	46984	1930	57711	1033	49770
14-#18	4.58	MA	23662	7347	40846	5231	45121	4208	47481	3356	50294	1961	61988	1078	53130
5L-4S		MI	23231	7347	40220	5218	44647	4159	47195	3306	50776	1953	62187	1129	51366
14-#18	4.58	MA	22656	7347	39122	5218	42738	4191	44701	3378	46589	1983	57462	932	50338
6L-3S		MI	24338	7347	42196	5188	47165	4178	50231	3328	54553	1930	66381	1347	53458
16-#11	2.04	MA	23336	6273	37437	4605	41005	3732	42558	3076	44024	2105	52563	1938	26702
2L-8S		MI	19315	6273	30923	4595	32889	3733	33058	3087	31897	2105	37589	1511	23752
16-#11	2.04	MA	22645	6273	36406	4601	39683	3744	40945	3087	41847	2114	49671	1852	26719
3L-7S		MI	19691	6273	31556	4600	33751	3739	34077	3077	33355	2113	39307	1557	24214
16-#11	2.04	MA	22156	6273	35562	4615	38608	3739	39638	3080	40184	2122	47797	1766	26700
4L-6S		MI	20073	6273	32260	4586	34600	3728	35121	3068	34726	2105	41152	1647	24530
16-#11	2.04	MA	21718	6273	34831	4611	37660	3751	38474	3090	38516	2114	45818	1726	26636
5E		MI	20465	6273	32903	4590	35490	3733	36208	3075	36129	2096	42878	1704	25032
16-#11	2.04	MA	21301	6273	34145	4608	36711	3746	37314	3084	37006	2122	43953	1670	26091
6L-4S		MI	20876	6273	33588	4595	36377	3722	37299	3065	37679	2105	44716	1742	25081
16-#11	2.04	MA	20894	6273	33394	4621	35805	3758	36201	3094	35530	2131	41960	1580	25736
7L-3S		MI	21334	6273	34378	4581	37384	3727	38522	3072	39224	2096	46449	1829	25087
16-#11	2.04	MA	20494	6273	32718	4618	34886	3753	35113	3105	33961	2122	40111	1533	25229
8L-2S		MI	21979	6273	35342	4585	38620	3716	40029	3063	41246	2088	49127	1915	25065
16-#14	2.94	MA	23934	6655	39565	4820	43650	3906	45753	3182	48207	2065	58035	1711	37823
3L-7S		MI	20209	6655	33287	4823	35881	3902	36642	3171	36774	2068	44043	1289	32874
16-#14	2.94	MA	23244	6655	38357	4839	42111	3898	43883	3172	45843	2077	55382	1587	37693
4L-6S		MI	20747	6655	34295	4805	37098	3886	38207	3182	38720	2056	46655	1419	33837
16-#14	2.94	MA	22627	6655	37310	4834	40754	3914	42216	3186	43473	2065	52570	1531	36736
5E		MI	21300	6655	35216	4811	38371	3895	39692	3169	40712	2043	49096	1501	34463
16-#14	2.94	MA	22038	6655	36327	4828	39395	3906	40555	3176	41326	2077	49928	1449	36034
6L-4S		MI	21880	6655	36196	4818	39642	3879	41253	3156	42913	2056	51706	1556	35361
16-#14	2.94	MA	21465	6655	35251	4847	38096	3923	38960	3190	39228	2090	47104	1319	34998
7L-3S		MI	22526	6655	37326	4799	41082	3888	43003	3167	45107	2043	54155	1680	35470
16-#14	2.94	MA	20900	6655	34283	4841	36780	3915	37402	3204	36997	2077	44476	1253	34032
8L-2S		MI	23436	6655	38703	4806	42847	3872	45155	3154	47978	2031	57947	1805	35506
16-#18	5.23	MA	24802	7623	43417	5404	48418	4332	51502	3431	55633	1930	69024	1011	60829
5E		MI	23296	7623	40901	5377	45497	4309	48213	3402	51928	1897	64203	961	56942

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

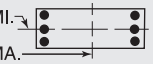


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	5.23	MA	23804	7623	41693	5391	46034	4315	48722	3454	51928	1952	64498	865	57873
6L-4S		MI	24280	7623	42618	5391	47722	4283	50923	3379	55720	1919	68678	1057	58437
18-#11	2.29	MA	23117	6381	37437	4669	41005	3792	42558	3116	44024	2104	52563	1831	29936
3L-8S		MI	19762	6381	31886	4663	34125	3782	34566	3117	33919	2094	40268	1488	26616
18-#11	2.29	MA	22631	6381	36593	4682	39930	3787	41251	3109	42360	2112	50688	1744	29902
4L-7S		MI	20137	6381	32520	4667	34986	3787	35585	3107	35377	2103	41985	1533	27138
18-#11	2.29	MA	22195	6381	35862	4679	38983	3799	40087	3120	40693	2104	48709	1705	29787
5L-6S		MI	20517	6381	33224	4654	35836	3776	36629	3097	36748	2094	43831	1624	27440
18-#11	2.29	MA	21780	6381	35176	4675	38033	3794	38927	3113	39183	2112	46844	1648	29206
6L-5S		MI	20907	6381	33867	4658	36725	3782	37716	3104	38152	2086	45556	1680	27962
18-#11	2.29	MA	21375	6381	34425	4689	37127	3806	37814	3124	37707	2121	44852	1558	28864
7L-4S		MI	21317	6381	34552	4662	37613	3770	38806	3094	39701	2094	47394	1719	28076
18-#11	2.29	MA	20976	6381	33750	4685	36208	3801	36726	3134	36137	2112	43002	1512	28298
8L-3S		MI	21773	6381	35342	4649	38620	3776	40029	3102	41246	2086	49127	1805	28102
18-#11	2.29	MA	20582	6381	33023	4699	35314	3813	35589	3128	34675	2121	41194	1457	27744
9L-2S		MI	22416	6381	36306	4653	39855	3764	41537	3092	43268	2077	51806	1892	28088
18-#14	3.31	MA	23910	6811	39831	4937	44000	3967	46188	3214	48937	2062	59481	1554	42233
4L-7S		MI	20836	6811	34663	4920	37646	3972	38794	3213	39645	2052	47835	1253	36939
18-#14	3.31	MA	23296	6811	38784	4931	42643	3984	44521	3229	46566	2049	56669	1498	41152
5L-6S		MI	21372	6811	35671	4902	38862	3956	40359	3225	41591	2039	50447	1383	37990
18-#14	3.31	MA	22711	6811	37801	4925	41284	3976	42860	3218	44420	2062	54027	1416	40483
6L-5S		MI	21921	6811	36592	4908	40136	3965	41845	3211	43583	2027	52888	1465	38585
18-#14	3.31	MA	22141	6811	36725	4944	39986	3993	41264	3233	42322	2074	51203	1286	39359
7L-4S		MI	22498	6811	37573	4915	41407	3949	43406	3198	45784	2039	55498	1520	39604
18-#14	3.31	MA	21580	6811	35757	4938	38669	3985	39706	3247	40091	2062	48575	1220	38425
8L-3S		MI	23141	6811	38703	4896	42847	3958	45155	3210	47978	2027	57947	1644	39738
18-#18	5.88	MA	24943	7900	44264	5564	49330	4440	52743	3529	57267	1921	71534	798	65431
6L-5S		MI	24344	7900	43300	5550	48572	4433	51942	3475	56872	1863	70694	889	63896
20-#11	2.55	MA	23103	6489	37624	4750	41252	3836	42864	3139	44537	2103	53580	1723	33099
4L-8S		MI	20208	6489	32850	4730	35361	3830	36073	3146	35941	2084	42946	1465	29487
20-#11	2.55	MA	22669	6489	36894	4746	40305	3848	41700	3149	42869	2094	51601	1683	32879
5L-7S		MI	20581	6489	33484	4734	36222	3836	37092	3136	37399	2092	44664	1510	30064
20-#11	2.55	MA	22256	6489	36208	4742	39356	3843	40540	3143	41359	2103	49736	1627	32325
6E		MI	20960	6489	34188	4721	37071	3824	38136	3126	38770	2084	46509	1601	30355
20-#11	2.55	MA	21853	6489	35457	4756	38449	3855	39427	3153	39883	2111	47743	1537	31996
7L-5S		MI	21348	6489	34831	4725	37961	3830	39223	3134	40174	2075	48234	1657	30850
20-#11	2.55	MA	21456	6489	34781	4752	37530	3850	38339	3164	38314	2103	45894	1490	31374
8L-4S		MI	21755	6489	35516	4729	38849	3819	40314	3124	41723	2084	50073	1696	31066
20-#11	2.55	MA	21063	6489	34054	4766	36636	3862	37202	3157	36851	2111	44086	1436	30838
9L-3S		MI	22210	6489	36306	4716	39855	3824	41537	3131	43268	2075	51806	1782	31103
20-#14	3.68	MA	23960	6966	40257	5028	44533	4054	46826	3271	49660	2034	60768	1465	45578
5L-7S		MI	21460	6966	36040	5017	39411	4041	40947	3256	42516	2035	51627	1217	41015
20-#14	3.68	MA	23379	6966	39275	5022	43173	4046	45165	3261	47513	2047	58126	1383	44938
6E		MI	21992	6966	37048	4999	40627	4026	42512	3267	44462	2023	54239	1348	42147
20-#14	3.68	MA	22812	6966	38199	5041	41875	4063	43569	3275	45416	2059	55302	1253	43730
7L-5S		MI	22539	6966	37969	5006	41900	4035	43998	3254	46454	2010	56680	1429	42715
20-#14	3.68	MA	22254	6966	37231	5036	40558	4054	42011	3289	43184	2047	52674	1187	42731
8L-4S		MI	23112	6966	38949	5012	43171	4019	45559	3240	48655	2023	59289	1484	43841
22-#11	2.80	MA	23141	6597	37925	4814	41627	3896	43313	3179	45046	2084	54492	1662	35978
5L-8S		MI	20651	6597	33814	4798	36596	3879	37581	3176	37963	2073	45624	1441	32363
22-#11	2.80	MA	22729	6597	37239	4810	40678	3891	42153	3172	43536	2093	52628	1605	35448
6L-7S		MI	21023	6597	34448	4802	37458	3884	38600	3166	39421	2082	47342	1487	32992
22-#11	2.80	MA	22328	6597	36488	4824	39772	3903	41040	3183	42060	2101	50635	1515	35130
7L-6S		MI	21400	6597	35152	4789	38307	3873	39644	3156	40792	2073	49187	1577	33273
22-#11	2.80	MA	21933	6597	35812	4820	38853	3898	39952	3193	40490	2093	48785	1469	34455
8L-5S		MI	21786	6597	35795	4793	39197	3879	40731	3163	42196	2064	50913	1634	33746
22-#11	2.80	MA	21542	6597	35085	4834	37958	3910	38815	3186	39028	2101	46977	1414	33937
9L-4S		MI	22192	6597	36480	4797	40085	3867	41821	3153	43745	2073	52751	1672	34053

RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	4.04	MA	24043	7122	40749	5120	45062	4116	47470	3303	50607	2031	62225	1350	49397
6L-7S		MI	22080	7122	37416	5115	41175	4111	43100	3298	45387	2018	55419	1181	45100
22-#14	4.04	MA	23479	7122	39672	5139	43764	4132	45874	3317	48509	2044	59401	1219	48111
7L-6S		MI	22609	7122	38424	5096	42392	4095	44665	3310	47333	2006	58031	1312	46305
22-#14	4.04	MA	22925	7122	38704	5133	42448	4124	44316	3332	46278	2031	56773	1153	47048
8L-5S		MI	23153	7122	39345	5103	43665	4104	46150	3296	49325	1994	60472	1394	46854
24-#11	3.06	MA	23200	6705	38270	4877	42000	3939	43766	3201	45712	2083	55519	1584	38575
6L-8S		MI	21092	6705	34778	4865	37832	3927	39088	3205	39985	2062	48303	1418	35245
24-#11	3.06	MA	22801	6705	37519	4891	41094	3952	42652	3212	44236	2092	53526	1493	38263
7E		MI	21462	6705	35412	4869	38694	3933	40107	3195	41443	2071	50020	1464	35895
24-#11	3.06	MA	22407	6705	36844	4887	40175	3946	41565	3222	42667	2083	51677	1447	37542
8L-6S		MI	21837	6705	36116	4856	39543	3921	41151	3185	42815	2062	51865	1554	36195
24-#11	3.06	MA	22018	6705	36117	4901	39280	3958	40428	3216	41204	2092	49869	1393	37022
9L-5S		MI	22223	6705	36759	4860	40432	3927	42238	3193	44218	2054	53591	1611	36647
24-#14	4.41	MA	24143	7277	41146	5236	45654	4202	48179	3360	51603	2029	63500	1186	52501
7E		MI	22696	7277	38793	5212	42940	4181	45253	3340	48258	2002	59211	1145	49194
24-#14	4.41	MA	23591	7277	40178	5230	44337	4194	46621	3374	49372	2016	60872	1120	51375
8L-6S		MI	23222	7277	39801	5194	44156	4165	46818	3352	50204	1990	61823	1276	50353

RECTANGULAR TIED COLUMNS 34" x 38"

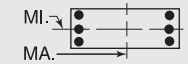
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.24	MA	24266	6264	38133	4604	40931	3751	41552	3126	40998	2229	47773	2086	18264
2E		MI	21626	6264	34147	4559	36462	3714	36864	3092	36160	2195	41940	2043	16202
6-#14	1.04	MA	23934	6177	37228	4584	39945	3741	40414	3127	39604	2263	46017	2136	15632
2L-3S		MI	20412	6177	31982	4537	33855	3723	33791	3111	32141	2246	36729	1975	13971
6-#14	1.04	MA	22864	6177	35657	4579	37931	3758	37957	3142	36287	2275	41610	2011	15710
3L-2S		MI	21347	6177	33359	4543	35619	3707	35944	3098	35012	2234	40521	2100	13888
6-#18	1.86	MA	25520	6541	40877	4777	44449	3875	45844	3202	46733	2201	55354	2024	26929
2L-3S		MI	21103	6541	34147	4718	36462	3864	36864	3187	36160	2184	41940	1750	23893
6-#18	1.86	MA	23680	6541	38133	4765	40931	3904	41552	3226	40998	2223	47773	1802	26974
3L-2S		MI	22709	6541	36546	4732	39536	3838	40593	3165	41104	2162	48431	1971	23806
8-#14	1.39	MA	24665	6333	38799	4681	41959	3811	42871	3169	42920	2249	50423	2105	20600
2L-4S		MI	20387	6333	32228	4652	34180	3784	34194	3142	32818	2242	38072	1815	18373
8-#14	1.39	MA	23601	6333	37228	4676	39945	3828	40414	3184	39604	2261	46017	1980	20658
3E		MI	21050	6333	33359	4634	35619	3793	35944	3154	35012	2229	40521	1940	18327
8-#14	1.39	MA	22848	6333	35943	4696	38307	3821	38424	3175	37069	2274	43160	1856	20672
4L-2S		MI	21980	6333	34735	4640	37384	3777	38096	3141	37883	2217	44313	2064	18259
8-#18	2.48	MA	26759	6817	43621	4949	47967	4000	50135	3277	52467	2172	62935	1962	35543
2L-4S		MI	21047	6817	34570	4921	37019	3969	37557	3239	37327	2172	44237	1460	30756
8-#18	2.48	MA	24935	6817	40877	4938	44449	4028	45844	3301	46733	2194	55354	1740	35489
3E		MI	22186	6817	36546	4891	39536	3988	40593	3261	41104	2150	48431	1678	31357
8-#18	2.48	MA	23641	6817	38625	4971	41580	4013	42357	3281	42350	2216	50454	1519	34789
4L-2S		MI	23779	6817	38944	4905	42611	3963	44321	3239	46048	2128	54922	1899	31356
10-#11	1.21	MA	24312	6250	37942	4647	40948	3788	41671	3159	41372	2269	48415	2137	18021
2L-5S		MI	20143	6250	31546	4613	33379	3773	33240	3144	31456	2249	36382	1890	16115
10-#11	1.21	MA	23565	6250	36843	4644	39540	3800	39953	3170	39041	2278	45310	2051	18065
3L-4S		MI	20560	6250	32231	4617	34267	3761	34330	3134	33006	2258	38220	1929	16087
10-#11	1.21	MA	23038	6250	35945	4658	38396	3795	38563	3164	37259	2286	43295	1965	18101
4L-3S		MI	21025	6250	33021	4604	35273	3767	35553	3141	34551	2249	39953	2015	16040
10-#11	1.21	MA	22566	6250	35168	4654	37389	3808	37325	3175	35474	2278	41175	1925	18102
5L-2S		MI	21679	6250	33985	4608	36509	3756	37061	3131	36573	2240	42631	2101	15992

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.74	MA	25389	6489	40370	4779	43973	3880	45328	3212	46237	2235	54830	2074	25545
2L-5S		MI	20432	6489	32624	4743	34673	3869	34786	3198	33489	2213	39255	1725	22396
10-#14	1.74	MA	24332	6489	38799	4773	41959	3898	42871	3227	42920	2247	50423	1949	25583
3L-4S		MI	21024	6489	33605	4750	35944	3854	36347	3185	35689	2225	41864	1779	22664
10-#14	1.74	MA	23584	6489	37514	4793	40321	3891	40881	3217	40385	2260	47567	1825	25551
4L-3S		MI	21682	6489	34735	4731	37384	3863	38096	3196	37883	2213	44313	1904	22656
10-#14	1.74	MA	22914	6489	36401	4788	38878	3908	39108	3232	37845	2247	44551	1768	25204
5L-2S		MI	22608	6489	36112	4738	39149	3847	40249	3183	40754	2201	48105	2028	22606
10-#18	3.10	MA	27984	7094	46365	5122	51485	4124	54427	3352	58202	2143	70517	1899	44118
2L-5S		MI	21115	7094	35251	5080	37869	4119	38575	3335	38479	2117	46253	1292	35797
10-#18	3.10	MA	26176	7094	43621	5111	47967	4152	50135	3377	52467	2165	62935	1678	43974
3L-4S		MI	22129	7094	36968	5094	40094	4093	41285	3313	42271	2139	50728	1388	37695
10-#18	3.10	MA	24894	7094	41369	5144	45098	4137	46649	3357	48085	2187	58035	1456	42766
4L-3S		MI	23257	7094	38944	5064	42611	4112	44321	3335	46048	2117	54922	1606	38785
10-#18	3.10	MA	23746	7094	39416	5133	42567	4165	43539	3381	43690	2165	52823	1359	40444
5L-2S		MI	24837	7094	41343	5077	45686	4087	48050	3313	50992	2095	61414	1827	38875
12-#11	1.45	MA	24825	6358	39040	4714	42357	3836	43390	3188	43703	2260	51520	2117	21484
2L-6S		MI	20198	6358	31867	4676	33725	3816	33660	3166	32075	2247	37335	1810	18881
12-#11	1.45	MA	24081	6358	37942	4711	40948	3849	41671	3199	41372	2269	48415	2031	21519
3L-5S		MI	20594	6358	32510	4680	34615	3821	34747	3173	33478	2238	39060	1867	19122
12-#11	1.45	MA	23556	6358	37044	4725	39805	3844	40281	3193	39590	2277	46400	1945	21541
4E		MI	21009	6358	33195	4684	35502	3810	35838	3163	35028	2247	40898	1905	19116
12-#11	1.45	MA	23086	6358	36267	4722	38797	3856	39044	3204	37805	2269	44280	1905	21515
5L-3S		MI	21472	6358	33985	4671	36509	3816	37061	3171	36573	2238	42631	1992	19082
12-#11	1.45	MA	22638	6358	35538	4719	37789	3852	37811	3198	36188	2277	42276	1848	21202
6L-2S		MI	22124	6358	34949	4675	37745	3804	38568	3161	38595	2230	45310	2078	19041
12-#14	2.09	MA	26109	6644	41941	4876	45987	3950	47785	3254	49553	2221	59237	2043	30476
2L-6S		MI	20507	6644	33080	4834	35165	3930	35453	3254	34368	2209	40605	1607	25750
12-#14	2.09	MA	25057	6644	40370	4871	43973	3968	45328	3269	46237	2233	54830	1918	30487
3L-5S		MI	21067	6644	34001	4840	36438	3939	36938	3241	36360	2196	43046	1689	26471
12-#14	2.09	MA	24314	6644	39085	4890	42335	3960	43338	3260	43702	2246	51973	1794	30417
4E		MI	21655	6644	34982	4847	37709	3923	38499	3227	38560	2209	45656	1743	26938
12-#14	2.09	MA	23648	6644	37972	4885	40892	3978	41565	3275	41161	2233	48958	1737	29865
5L-3S		MI	22311	6644	36112	4828	39149	3932	40249	3239	40754	2196	48105	1868	26972
12-#14	2.09	MA	23014	6644	36927	4880	39447	3970	39798	3265	38860	2246	46116	1656	28979
6L-2S		MI	23231	6644	37488	4835	40913	3917	42402	3225	43625	2184	51897	1992	26937
12-#18	3.72	MA	27403	7370	46365	5284	51485	4276	54427	3452	58202	2137	70517	1615	52440
3L-5S		MI	22194	7370	37649	5253	40943	4243	42304	3409	43423	2083	52744	1220	42925
12-#18	3.72	MA	26133	7370	44113	5317	48616	4261	50941	3432	53819	2159	65617	1394	50795
4E		MI	23199	7370	39366	5267	43168	4218	45014	3387	47215	2105	57219	1316	44686
12-#18	3.72	MA	24996	7370	42160	5306	46084	4290	47831	3456	49425	2137	60404	1297	48624
5L-3S		MI	24318	7370	41343	5237	45686	4236	48050	3409	50992	2083	61414	1534	46190
12-#18	3.72	MA	23914	7370	40326	5295	43548	4274	44732	3436	45445	2159	55522	1151	46043
6L-2S		MI	25886	7370	43741	5250	48760	4211	51779	3387	55936	2061	67905	1755	46346
14-#11	1.69	MA	25334	6466	40139	4782	43766	3884	45108	3217	46035	2251	54625	2097	24939
2L-7S		MI	20263	6466	32127	4757	34111	3876	34124	3205	32726	2245	38168	1697	21439
14-#11	1.69	MA	24593	6466	39040	4778	42357	3897	43390	3228	43703	2260	51520	2011	24965
3L-6S		MI	20648	6466	32831	4744	34961	3864	35168	3195	34097	2236	40013	1787	21776
14-#11	1.69	MA	24071	6466	38143	4792	41213	3892	42000	3222	41921	2268	49505	1925	24967
4L-5S		MI	21042	6466	33474	4748	35850	3870	36254	3203	35500	2228	41739	1844	22118
14-#11	1.69	MA	23603	6466	37366	4789	40206	3905	40762	3233	40136	2260	47385	1884	24921
5L-4S		MI	21456	6466	34159	4752	36738	3858	37345	3193	37050	2236	43577	1882	22135
14-#11	1.69	MA	23157	6466	36637	4786	39197	3900	39529	3227	38519	2268	45381	1828	24505
6L-3S		MI	21917	6466	34949	4739	37745	3864	38568	3200	38595	2228	45310	1968	22114
14-#11	1.69	MA	22723	6466	35839	4800	38234	3913	38346	3238	36938	2277	43240	1738	24085
7L-2S		MI	22566	6466	35913	4743	38980	3852	40076	3190	40617	2219	47988	2055	22081
14-#14	2.44	MA	26823	6800	43512	4973	48001	4020	50242	3296	52870	2207	63643	2012	35400
2L-7S		MI	20598	6800	33448	4949	35713	4016	36041	3285	35292	2205	41785	1441	29146

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

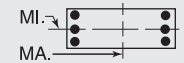
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.44	MA	25777	6800	41941	4968	45987	4038	47785	3312	49553	2219	59237	1887	35375
3L-6S		MI	21141	6800	34457	4931	36929	4000	37606	3296	37239	2192	44397	1571	29887
14-#14	2.44	MA	25038	6800	40656	4988	44349	4030	45795	3302	47018	2232	56380	1763	35273
4L-5S		MI	21698	6800	35377	4938	38203	4009	39091	3283	39231	2180	46838	1653	30565
14-#14	2.44	MA	24377	6800	39543	4982	42906	4048	44022	3317	44478	2219	53364	1706	34546
5L-4S		MI	22283	6800	36358	4944	39473	3993	40652	3270	41431	2192	49448	1708	31200
14-#14	2.44	MA	23747	6800	38498	4977	41461	4040	42255	3308	42177	2232	50522	1625	33708
6L-3S		MI	22934	6800	37488	4926	40913	4002	42402	3281	43625	2180	51897	1832	31264
14-#14	2.44	MA	23133	6800	37354	4997	40081	4058	40559	3323	39928	2244	47486	1495	32836
7L-2S		MI	23850	6800	38865	4932	42678	3986	44555	3268	46496	2167	55689	1957	31256
14-#18	4.33	MA	27359	7647	46858	5490	52134	4385	55232	3508	59554	2130	73198	1332	58868
4L-5S		MI	23263	7647	40048	5426	44018	4367	46032	3483	48367	2050	59235	1148	50077
14-#18	4.33	MA	26233	7647	44904	5479	49602	4414	52123	3532	55159	2108	67986	1234	56828
5L-4S		MI	24259	7647	41765	5440	46243	4342	48742	3461	52159	2072	63711	1244	51719
14-#18	4.33	MA	25160	7647	43070	5468	47066	4398	49024	3512	51180	2130	63104	1089	54068
6L-3S		MI	25369	7647	43741	5409	48760	4360	51779	3483	55936	2050	67905	1462	53579
16-#11	1.93	MA	25841	6574	41238	4849	45174	3933	46827	3247	48366	2242	57731	2077	28387
2L-8S		MI	20336	6574	32458	4820	34486	3918	34612	3244	33290	2226	39128	1628	23989
16-#11	1.93	MA	25103	6574	40139	4846	43766	3945	45108	3258	46035	2251	54625	1991	28404
3L-7S		MI	20713	6574	33091	4824	35347	3924	35631	3235	34748	2234	40846	1673	24360
16-#11	1.93	MA	24583	6574	39242	4860	42622	3941	43718	3252	44253	2259	52610	1905	28385
4L-6S		MI	21095	6574	33795	4811	36196	3912	36675	3225	36119	2226	42691	1764	24680
16-#11	1.93	MA	24117	6574	38465	4857	41615	3953	42481	3263	42468	2251	50490	1864	28321
5E		MI	21488	6574	34438	4815	37086	3918	37762	3232	37522	2217	44417	1820	25107
16-#11	1.93	MA	23673	6574	37736	4853	40606	3949	41248	3257	40850	2259	48486	1808	27817
6L-4S		MI	21900	6574	35123	4819	37974	3907	38853	3222	39072	2226	46255	1859	25143
16-#11	1.93	MA	23241	6574	36938	4867	39643	3961	40064	3268	39269	2268	46345	1718	27415
7L-3S		MI	22359	6574	35913	4806	38980	3912	40076	3230	40617	2217	47988	1945	25137
16-#11	1.93	MA	22815	6574	36220	4864	38666	3957	38909	3279	37589	2259	44364	1671	26966
8L-2S		MI	23005	6574	36877	4810	40216	3901	41583	3220	42639	2208	50666	2032	25112
16-#14	2.79	MA	26492	6956	43512	5065	48001	4107	50242	3354	52870	2205	63643	1857	40253
3L-7S		MI	21230	6956	34825	5047	37478	4086	38194	3327	38163	2188	45577	1405	33194
16-#14	2.79	MA	25757	6956	42227	5085	46363	4100	48252	3344	50335	2217	60787	1732	40123
4L-6S		MI	21770	6956	35833	5028	38694	4070	39759	3339	40110	2176	48189	1535	34033
16-#14	2.79	MA	25100	6956	41114	5080	44920	4117	46479	3360	47794	2205	57771	1675	39242
5E		MI	22325	6956	36754	5035	39967	4079	41244	3325	42102	2163	50630	1617	34673
16-#14	2.79	MA	24474	6956	40069	5075	43475	4110	44712	3350	45493	2217	54929	1594	38447
6L-4S		MI	22906	6956	37735	5041	41238	4063	42805	3312	44302	2176	53240	1672	35454
16-#14	2.79	MA	23864	6956	38925	5094	42095	4128	43016	3365	43244	2230	51892	1464	37477
7L-3S		MI	23554	6956	38865	5023	42678	4072	44555	3324	46496	2163	55689	1796	35544
16-#14	2.79	MA	23263	6956	37896	5089	40695	4120	41360	3380	40853	2217	49074	1396	36392
8L-2S		MI	24465	6956	40241	5029	44443	4056	46707	3310	49367	2151	59481	1921	35570
16-#18	4.95	MA	27458	7924	47648	5652	53120	4538	56414	3607	60894	2079	75567	1172	65052
5E		MI	24322	7924	42446	5599	47093	4491	49761	3556	53311	2016	65727	1076	57247
16-#18	4.95	MA	26395	7924	45815	5641	50584	4522	53315	3587	56915	2101	70685	1026	62121
6L-4S		MI	25311	7924	44163	5613	49317	4466	52471	3534	57103	2038	70202	1172	58785
18-#11	2.17	MA	25610	6682	41238	4913	45174	3994	46827	3287	48366	2242	57731	1971	31831
3L-8S		MI	20784	6682	33421	4888	35721	3967	36119	3274	35312	2215	41807	1604	26851
18-#11	2.17	MA	25092	6682	40340	4927	44031	3989	45437	3281	46584	2250	55715	1885	31797
4L-7S		MI	21159	6682	34055	4892	36583	3972	37139	3264	36770	2224	43524	1650	27284
18-#11	2.17	MA	24628	6682	39564	4924	43023	4002	44199	3292	44799	2242	53595	1844	31717
5L-6S		MI	21541	6682	34759	4879	37432	3961	38183	3254	38141	2215	45369	1740	27590
18-#11	2.17	MA	24187	6682	38835	4921	42014	3997	42966	3286	43181	2250	51591	1788	31135
6L-5S		MI	21932	6682	35402	4883	38322	3967	39269	3261	39544	2206	47095	1797	28092

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

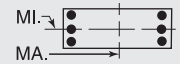


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	2.17	MA	23756	6682	38037	4935	41052	4010	41783	3297	41600	2259	49450	1698	30750
7L-4S		MI	22342	6682	36087	4887	39209	3955	40360	3252	41094	2215	48933	1836	28142
18-#11	2.17	MA	23332	6682	37319	4932	40075	4005	40627	3308	39920	2250	47469	1651	30238
8L-3S		MI	22799	6682	36877	4874	40216	3961	41583	3259	42639	2206	50666	1922	28155
18-#11	2.17	MA	22913	6682	36547	4946	39125	4018	39419	3302	38353	2259	45526	1596	29616
9L-2S		MI	23443	6682	37841	4878	41452	3949	43091	3249	44661	2198	53345	2008	28138
18-#14	3.13	MA	26472	7111	43798	5182	48377	4170	50709	3387	53651	2203	65193	1701	44967
4L-7S		MI	21859	7111	36201	5144	39242	4156	40346	3370	41034	2172	49369	1369	37256
18-#14	3.13	MA	25818	7111	42685	5177	46934	4187	48935	3402	51111	2191	62178	1644	43951
5L-6S		MI	22396	7111	37210	5126	40458	4140	41911	3381	42981	2159	51981	1500	38186
18-#14	3.13	MA	25196	7111	41640	5172	45489	4180	47169	3392	48809	2203	59336	1563	43192
6L-5S		MI	22947	7111	38130	5132	41732	4149	43397	3368	44973	2147	54422	1581	38794
18-#14	3.13	MA	24589	7111	40496	5191	44109	4197	45473	3408	46560	2216	56299	1433	42130
7L-4S		MI	23525	7111	39111	5139	43003	4133	44958	3354	47173	2159	57032	1636	39702
18-#14	3.13	MA	23992	7111	39467	5186	42709	4190	43816	3423	44169	2203	53481	1365	41085
8L-3S		MI	24170	7111	40241	5120	44443	4142	46707	3366	49367	2147	59481	1760	39817
18-#18	5.57	MA	27618	8200	48559	5813	54102	4646	57607	3663	62649	2073	78266	964	70199
6L-5S		MI	25373	8200	44844	5772	50167	4615	53490	3630	58255	1982	72218	1004	64433
20-#11	2.41	MA	25598	6790	41439	4995	45439	4038	47155	3311	48915	2241	58820	1864	35205
4L-8S		MI	21230	6790	34385	4955	36957	4015	37627	3303	37334	2204	44485	1581	29720
20-#11	2.41	MA	25137	6790	40662	4992	44432	4050	45917	3322	47130	2233	56700	1824	35093
5L-7S		MI	21604	6790	35019	4959	37819	4021	38646	3293	38792	2213	46202	1627	30211
20-#11	2.41	MA	24697	6790	39934	4988	43423	4045	44685	3316	45512	2241	54696	1768	34459
6E		MI	21984	6790	35723	4946	38668	4009	39690	3283	40163	2204	48048	1717	30505
20-#11	2.41	MA	24269	6790	39135	5002	42460	4058	43501	3327	43931	2250	52555	1678	34088
7L-5S		MI	22373	6790	36366	4950	39557	4015	40777	3291	41566	2196	49773	1774	31017
20-#11	2.41	MA	23847	6790	38418	4999	41484	4053	42345	3338	42251	2241	50574	1631	33517
8L-4S		MI	22781	6790	37051	4954	40445	4004	41868	3281	43116	2204	51612	1812	31137
20-#11	2.41	MA	23429	6790	37645	5013	40533	4066	41137	3332	40684	2250	48631	1576	32916
9L-3S		MI	23237	6790	37841	4941	41452	4009	43091	3288	44661	2196	53345	1899	31164
20-#11	2.41	MA	22969	6790	36930	5010	39570	4061	39988	3343	39131	2258	46749	1515	32198
10L-2S		MI	23879	6790	38805	4945	42688	3998	44598	3278	46683	2187	56023	1985	31159
20-#14	3.48	MA	26532	7267	44256	5274	48948	4257	51392	3444	54427	2177	66584	1613	48671
5L-7S		MI	22483	7267	37578	5241	41007	4226	42499	3412	43905	2155	53161	1333	41329
20-#14	3.48	MA	25913	7267	43211	5269	47503	4250	49626	3435	52126	2189	63742	1532	47944
6E		MI	23018	7267	38586	5223	42223	4210	44064	3424	45852	2143	55773	1464	42345
20-#14	3.48	MA	25310	7267	42067	5289	46123	4267	47930	3450	49877	2202	60706	1402	46795
7L-5S		MI	23566	7267	39507	5229	43497	4219	45549	3410	47844	2130	58214	1546	42924
20-#14	3.48	MA	24716	7267	41038	5284	44723	4260	46273	3465	47486	2189	57887	1334	45786
8L-4S		MI	24141	7267	40488	5236	44767	4203	47110	3397	50044	2143	60823	1600	43945
22-#11	2.66	MA	25643	6897	41761	5059	45840	4099	47636	3351	49461	2224	59805	1804	38394
5L-8S		MI	21674	6897	35349	5023	38193	4064	39134	3333	39356	2194	47163	1558	32595
22-#11	2.66	MA	25205	6897	41032	5056	44832	4094	46403	3345	47843	2232	57801	1748	37788
6L-7S		MI	22046	6897	35983	5027	39054	4069	40154	3323	40814	2202	48881	1604	33140
22-#11	2.66	MA	24779	6897	40234	5070	43869	4106	45219	3356	46262	2241	55661	1658	37429
7L-6S		MI	22424	6897	36687	5013	39904	4058	41198	3313	42185	2194	50726	1694	33423
22-#11	2.66	MA	24358	6897	39517	5067	42892	4102	44064	3367	44582	2232	53679	1611	36803
8L-5S		MI	22812	6897	37330	5018	40793	4063	42284	3320	43588	2185	52452	1751	33912
22-#11	2.66	MA	23943	6897	38744	5081	41942	4114	42856	3361	43015	2241	51736	1556	36220
9L-4S		MI	23219	6897	38015	5022	41681	4052	43375	3310	45138	2194	54290	1789	34127
22-#11	2.66	MA	23485	6897	38029	5077	40978	4110	41706	3372	41462	2249	49854	1495	35462
10L-3S		MI	23672	6897	38805	5008	42688	4058	44598	3318	46683	2185	56023	1876	34166
22-#14	3.83	MA	26626	7422	44782	5366	49517	4320	52083	3477	55442	2175	68149	1501	52701
6L-7S		MI	23104	7422	38954	5338	42771	4295	44652	3454	46776	2139	56953	1297	45412
22-#14	3.83	MA	26026	7422	43638	5386	48137	4337	50387	3492	53193	2188	65112	1371	51469
7L-6S		MI	23636	7422	39963	5320	43988	4279	46217	3466	48723	2126	59565	1428	46508
22-#14	3.83	MA	25436	7422	42609	5381	46737	4330	48730	3508	50802	2175	62294	1303	50481
8L-5S		MI	24181	7422	40883	5327	45261	4289	47702	3453	50715	2114	62006	1510	47062

RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.90	MA	25711	7005	42131	5123	46240	4142	48121	3374	50174	2223	60906	1728	41121
6L-8S		MI	22116	7005	36313	5090	39428	4112	40642	3362	41378	2183	49841	1535	35475
24-#11	2.90	MA	25286	7005	41333	5137	45277	4155	46938	3385	48594	2232	58766	1638	40772
7E		MI	22487	7005	36947	5094	40290	4118	41661	3352	42836	2192	51559	1580	36072
24-#11	2.90	MA	24868	7005	40615	5134	44301	4150	45782	3397	46913	2223	56784	1590	40094
8L-6S		MI	22863	7005	37651	5081	41139	4106	42705	3342	44207	2183	53404	1671	36346
24-#11	2.90	MA	24453	7005	39843	5148	43351	4163	44574	3390	45346	2232	54841	1536	39528
9L-5S		MI	23249	7005	38294	5085	42029	4112	43792	3350	45610	2174	55130	1727	36812
24-#11	2.90	MA	23998	7005	39128	5145	42387	4158	43424	3402	43793	2240	52959	1475	38731
10L-4S		MI	23655	7005	38979	5089	42917	4100	44883	3340	47160	2183	56968	1766	37113
24-#14	4.18	MA	26738	7578	45209	5483	50151	4407	52844	3535	56510	2174	69519	1340	56153
7E		MI	23722	7578	40331	5436	44536	4365	46805	3497	49647	2122	60745	1262	49503
24-#14	4.18	MA	26151	7578	44181	5478	48751	4399	51187	3550	54119	2161	66701	1273	55099
8L-6S		MI	24250	7578	41339	5417	45752	4349	48370	3508	51594	2110	63357	1392	50674

RECTANGULAR TIED COLUMNS 34" x 40"

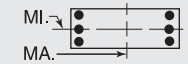
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.18	MA	26791	6564	41926	4848	45042	3952	45701	3297	45057	2365	52503	2221	19344
2E		MI	22650	6564	35692	4780	38057	3897	38412	3247	37543	2314	43464	2159	16249
6-#18	1.76	MA	28134	6841	44844	5021	48781	4076	50263	3372	51188	2338	60631	2163	28549
2L-3S		MI	22126	6841	35692	4940	38057	4046	38412	3342	37543	2303	43464	1865	23962
6-#18	1.76	MA	26173	6841	41926	5011	45042	4106	45701	3398	45057	2360	52503	1941	28594
3L-2S		MI	23734	6841	38091	4953	41132	4021	42141	3320	42487	2281	49955	2087	23863
8-#14	1.32	MA	27213	6634	42626	4926	46123	4012	47089	3340	47085	2384	55302	2240	21815
2L-4S		MI	21409	6634	33767	4876	35776	3968	35746	3299	34208	2362	39606	1931	18429
8-#14	1.32	MA	26081	6634	40957	4921	43984	4030	44480	3356	43546	2397	50588	2115	21873
3E		MI	22073	6634	34897	4858	37216	3977	37495	3310	36402	2350	42055	2056	18373
8-#14	1.32	MA	25282	6634	39595	4941	42248	4023	42370	3347	40840	2409	47527	1991	21887
4L-2S		MI	23004	6634	36274	4864	38980	3961	39648	3297	39273	2337	45847	2180	18302
8-#18	2.35	MA	29460	7118	47761	5194	52521	4200	54825	3448	57318	2311	68758	2105	37703
2L-4S		MI	22069	7118	36114	5143	38614	4152	39104	3394	38709	2291	45761	1575	31120
8-#18	2.35	MA	27517	7118	44844	5184	48781	4230	50263	3473	51188	2333	60631	1883	37649
3E		MI	23211	7118	38091	5112	41132	4170	42141	3416	42487	2269	49955	1793	31444
8-#18	2.35	MA	26142	7118	42454	5218	45736	4216	46563	3455	46502	2355	55369	1662	37232
4L-2S		MI	24806	7118	40489	5126	44206	4145	45869	3394	47431	2247	56446	2014	31420
10-#11	1.15	MA	26834	6551	41711	4891	45045	3988	45810	3329	45400	2402	53136	2271	19074
2L-5S		MI	21165	6551	33081	4838	34975	3958	34793	3301	32849	2370	37921	2007	16167
10-#11	1.15	MA	26040	6551	40545	4888	43550	4002	43986	3341	42918	2411	49817	2185	19118
3L-4S		MI	21583	6551	33766	4842	35863	3946	35884	3291	34398	2378	39759	2045	16130
10-#11	1.15	MA	25480	6551	39594	4903	42338	3997	42513	3335	41022	2420	47659	2098	19154
4L-3S		MI	22048	6551	34556	4829	36870	3952	37107	3298	35944	2370	41492	2132	16079
10-#11	1.15	MA	24980	6551	38771	4900	41271	4010	41202	3347	39124	2412	45399	2057	19155
5L-2S		MI	22703	6551	35520	4833	38105	3941	38615	3288	37966	2361	44170	2218	16030
10-#14	1.65	MA	27988	6789	44294	5023	48262	4081	49698	3382	50625	2371	60017	2211	27064
2L-5S		MI	21454	6789	34163	4967	36269	4054	36338	3354	34878	2333	40789	1841	22607
10-#14	1.65	MA	26862	6789	42626	5018	46123	4099	47089	3398	47085	2384	55302	2086	27102
3L-4S		MI	22046	6789	35143	4973	37540	4038	37899	3341	37079	2346	43398	1895	22732
10-#14	1.65	MA	26068	6789	41263	5038	44387	4093	44979	3389	44380	2396	52241	1962	27070
4L-3S		MI	22706	6789	36274	4955	38980	4047	39648	3353	39273	2333	45847	2020	22709
10-#14	1.65	MA	25358	6789	40084	5034	42857	4111	43100	3405	41669	2384	49023	1904	26851
5L-2S		MI	23633	6789	37650	4961	40745	4031	41801	3339	42144	2321	49639	2144	22654
10-#18	2.94	MA	30772	7394	50678	5367	56260	4325	59387	3523	63449	2285	76886	2046	46818
2L-5S		MI	22136	7394	36796	5302	39464	4301	40123	3490	39861	2236	47777	1407	36098

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis

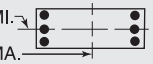


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	2.94	MA	28845	7394	47761	5357	52521	4355	54825	3549	57318	2307	68758	1825	46674
3L-4S		MI	23152	7394	38513	5316	41689	4276	42833	3468	43653	2258	52252	1503	38051
10-#18	2.94	MA	27483	7394	45371	5391	49476	4340	51125	3531	52633	2329	63496	1604	45721
4L-3S		MI	24284	7394	40489	5285	44206	4295	45869	3490	47431	2236	56446	1721	38883
10-#18	2.94	MA	26264	7394	43300	5381	46791	4370	47827	3556	47936	2307	57923	1504	43115
5L-2S		MI	25867	7394	42887	5299	47281	4269	49598	3468	52375	2214	62938	1942	38942
12-#11	1.38	MA	27382	6659	42877	4958	46540	4037	47634	3359	47881	2394	56455	2252	22748
2L-6S		MI	21220	6659	33402	4901	35321	4001	35214	3323	33468	2368	38873	1927	19026
12-#11	1.38	MA	26590	6659	41711	4956	45045	4050	45810	3370	45400	2403	53136	2166	22783
3L-5S		MI	21616	6659	34045	4905	36211	4006	36301	3330	34871	2359	40599	1984	19183
12-#11	1.38	MA	26033	6659	40760	4970	43833	4046	44337	3365	43504	2412	50978	2080	22805
4E		MI	22032	6659	34730	4909	37099	3995	37391	3320	36420	2368	42437	2022	19163
12-#11	1.38	MA	25535	6659	39937	4967	42766	4059	43026	3376	41605	2403	48717	2039	22779
5L-3S		MI	22496	6659	35520	4896	38105	4000	38615	3328	37966	2359	44170	2108	19125
12-#11	1.38	MA	25061	6659	39166	4964	41697	4054	41720	3371	39884	2412	46574	1983	22529
6L-2S		MI	23148	6659	36484	4900	39341	3989	40122	3318	39988	2350	46849	2195	19082
12-#14	1.99	MA	28757	6945	45962	5120	50400	4151	52307	3425	54164	2358	64731	2182	32298
2L-6S		MI	21528	6945	34618	5058	36761	4114	37005	3410	35757	2329	42139	1723	25939
12-#14	1.99	MA	27637	6945	44294	5115	48262	4169	49698	3441	50625	2371	60017	2058	32309
3L-5S		MI	22090	6945	35539	5064	38034	4123	38490	3397	37749	2317	44580	1805	26679
12-#14	1.99	MA	26848	6945	42931	5136	46525	4163	47588	3432	47919	2383	56956	1933	32239
4E		MI	22679	6945	36520	5071	39305	4108	40051	3384	39950	2329	47190	1860	27013
12-#14	1.99	MA	26143	6945	41752	5131	44996	4181	45709	3448	45209	2371	53737	1875	31803
5L-3S		MI	23335	6945	37650	5052	40745	4117	41801	3395	42144	2317	49639	1984	27027
12-#14	1.99	MA	25471	6945	40646	5126	43464	4174	43837	3439	42753	2383	50694	1794	30810
6L-2S		MI	24257	6945	39027	5059	42509	4101	43954	3382	45015	2304	53431	2109	26989
12-#18	3.53	MA	30159	7671	50678	5529	56260	4479	59387	3624	63449	2280	76886	1767	55680
3L-5S		MI	23217	7671	39194	5475	42539	4425	43852	3564	44805	2202	54268	1335	43224
12-#18	3.53	MA	28809	7671	48288	5564	53216	4464	55687	3606	58763	2302	71624	1545	54263
4E		MI	24224	7671	40911	5489	44764	4400	46562	3542	48597	2224	58743	1431	45035
12-#18	3.53	MA	27602	7671	46217	5553	50531	4494	52389	3632	54066	2280	66051	1446	51817
5L-3S		MI	25347	7671	42887	5458	47281	4419	49598	3564	52375	2202	62938	1649	46297
12-#18	3.53	MA	26453	7671	44273	5543	47841	4480	49102	3613	49812	2302	60812	1301	49295
6L-2S		MI	26918	7671	45286	5472	50356	4393	53326	3542	57319	2180	69429	1870	46429
14-#11	1.61	MA	27926	6766	44044	5026	48035	4085	49458	3388	50363	2385	59773	2234	26413
2L-7S		MI	21285	6766	33662	4982	35708	4060	35678	3362	34119	2366	39706	1813	21578
14-#11	1.61	MA	27138	6766	42877	5023	46540	4098	47634	3400	47881	2394	56455	2147	26439
3L-6S		MI	21670	6766	34366	4968	36557	4049	36722	3352	35490	2357	41552	1904	21921
14-#11	1.61	MA	26583	6766	41926	5037	45328	4094	46160	3394	45985	2403	54297	2061	26441
4L-5S		MI	22065	6766	35009	4973	37447	4055	37808	3360	36893	2348	43277	1960	22184
14-#11	1.61	MA	26087	6766	41103	5035	44261	4107	44849	3406	44087	2395	52036	2020	26395
5L-4S		MI	22479	6766	35694	4977	38334	4043	38899	3350	38442	2357	45116	1999	22187
14-#11	1.61	MA	25615	6766	40332	5032	43192	4103	43544	3400	42366	2403	49893	1964	26035
6L-3S		MI	22941	6766	36484	4963	39341	4049	40122	3357	39988	2348	46849	2085	22160
14-#11	1.61	MA	25155	6766	39487	5046	42173	4116	42290	3412	40684	2412	47605	1874	25565
7L-2S		MI	23591	6766	37448	4968	40577	4037	41630	3347	42010	2340	49527	2172	22124
14-#14	2.32	MA	29521	7100	47631	5217	52539	4221	54917	3467	57704	2345	69446	2153	37526
2L-7S		MI	21618	7100	34987	5173	37309	4200	37593	3441	36682	2325	43319	1557	29461
14-#14	2.32	MA	28407	7100	45962	5213	50400	4239	52307	3483	54164	2357	64731	2029	37501
3L-6S		MI	22163	7100	35995	5155	38525	4184	39158	3453	38628	2313	45931	1687	30076
14-#14	2.32	MA	27623	7100	44600	5233	48664	4232	50197	3474	51459	2370	61671	1904	37400
4L-5S		MI	22722	7100	36916	5161	39799	4193	40643	3439	40620	2300	48372	1769	30771
14-#14	2.32	MA	26921	7100	43420	5228	47135	4251	48318	3490	48748	2357	58452	1846	36775
5L-4S		MI	23308	7100	37896	5168	41070	4177	42204	3426	42821	2313	50982	1824	31282
14-#14	2.32	MA	26253	7100	42314	5224	45603	4244	46446	3481	46292	2370	55409	1765	35834
6L-3S		MI	23960	7100	39027	5149	42509	4186	43954	3437	45015	2300	53431	1948	31330
14-#14	2.32	MA	25602	7100	41102	5244	44141	4262	44649	3497	43892	2382	52159	1635	35046
7L-2S		MI	24878	7100	40403	5156	44274	4171	46106	3424	47886	2288	57223	2073	31312

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis



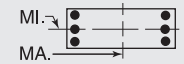
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	4.12	MA	30122	7948	51205	5736	56955	4589	60249	3681	64894	2276	79752	1487	62850
4L-5S		MI	24287	7948	41592	5648	45613	4550	47580	3638	49749	2169	60759	1263	50374
14-#18	4.12	MA	28925	7948	49134	5726	54271	4619	56951	3707	60197	2253	74178	1387	60546
5L-4S		MI	25287	7948	43310	5662	47838	4524	50290	3616	53541	2191	65235	1359	52062
14-#18	4.12	MA	27787	7948	47190	5716	51581	4604	53664	3689	55943	2276	68940	1242	57839
6L-3S		MI	26400	7948	45286	5631	50356	4543	53326	3638	57319	2169	69429	1577	53695
16-#11	1.84	MA	28467	6874	45210	5093	49530	4134	51281	3417	52844	2377	63092	2215	30071
2L-8S		MI	21357	6874	33993	5045	36082	4103	36166	3401	34683	2346	40667	1744	24218
16-#11	1.84	MA	27682	6874	44044	5090	48035	4147	49458	3429	50363	2385	59773	2128	30088
3L-7S		MI	21735	6874	34626	5049	36943	4109	37185	3392	36141	2355	42385	1790	24499
16-#11	1.84	MA	27130	6874	43092	5105	46823	4143	47984	3423	48467	2394	57616	2042	30070
4L-6S		MI	22118	6874	35330	5036	37793	4097	38229	3382	37512	2346	44230	1880	24825
16-#11	1.84	MA	26636	6874	42270	5102	45756	4156	46673	3435	46568	2386	55355	2001	30006
5E		MI	22512	6874	35973	5040	38682	4103	39316	3389	38915	2338	45956	1937	25178
16-#11	1.84	MA	26166	6874	41498	5099	44687	4151	45367	3429	44847	2395	53211	1945	29551
6L-4S		MI	22924	6874	36658	5044	39570	4092	40406	3379	40464	2346	47794	1976	25203
16-#11	1.84	MA	25708	6874	40653	5113	43668	4164	44114	3441	43166	2404	50923	1855	29101
7L-3S		MI	23384	6874	37448	5031	40577	4097	41630	3387	42010	2338	49527	2062	25187
16-#11	1.84	MA	25257	6874	39893	5111	42634	4160	42890	3453	41379	2395	48810	1807	28718
8L-2S		MI	24031	6874	38412	5035	41812	4086	43137	3377	44032	2329	52205	2148	25158
16-#14	2.65	MA	29171	7256	47631	5310	52539	4309	54917	3525	57704	2344	69446	2000	42683
3L-7S		MI	22252	7256	36363	5270	39074	4270	39745	3484	39553	2308	47111	1521	33506
16-#14	2.65	MA	28392	7256	46268	5330	50803	4302	52806	3517	54998	2357	66385	1875	42553
4L-6S		MI	22793	7256	37371	5252	40290	4254	41310	3495	41499	2296	49723	1652	34223
16-#14	2.65	MA	27694	7256	45088	5326	49273	4320	50927	3533	52288	2344	63166	1817	41764
5E		MI	23349	7256	38292	5259	41563	4263	42796	3482	43491	2284	52164	1733	34878
16-#14	2.65	MA	27030	7256	43982	5321	47742	4314	49055	3524	49831	2357	60124	1736	40869
6L-4S		MI	23932	7256	39273	5265	42834	4247	44357	3468	45692	2296	54774	1788	35542
16-#14	2.65	MA	26383	7256	42770	5341	46280	4332	47258	3540	47431	2369	56874	1606	39979
7L-3S		MI	24581	7256	40403	5247	44274	4256	46106	3480	47886	2284	57223	1912	35616
16-#14	2.65	MA	25747	7256	41681	5337	44797	4325	45504	3556	44880	2357	53865	1538	38771
8L-2S		MI	25494	7256	41780	5253	46039	4240	48259	3467	50757	2271	61015	2037	35625
16-#18	4.71	MA	30237	8224	52051	5899	58010	4743	61513	3783	66327	2227	82306	1329	69296
5E		MI	25349	8224	43991	5821	48688	4674	51309	3711	54693	2135	67251	1191	57543
16-#18	4.71	MA	29108	8224	50107	5889	55320	4729	58226	3764	62073	2249	77068	1184	66412
6L-4S		MI	26340	8224	45708	5834	50913	4648	54019	3689	58485	2157	71726	1287	59124
18-#11	2.06	MA	28224	6982	45210	5158	49530	4195	51281	3458	52844	2377	63092	2110	33727
3L-8S		MI	21806	6982	34956	5112	37318	4152	37673	3431	36705	2336	43346	1721	27078
18-#11	2.06	MA	27674	6982	44259	5172	48318	4191	49808	3453	50948	2386	60934	2023	33692
4L-7S		MI	22182	6982	35590	5117	38179	4157	38693	3421	38163	2344	45063	1767	27424
18-#11	2.06	MA	27183	6982	43436	5169	47251	4204	48497	3464	49050	2377	58673	1983	33612
5L-6S		MI	22564	6982	36294	5103	39028	4146	39737	3411	39534	2336	46908	1857	27734
18-#11	2.06	MA	26715	6982	42664	5167	46182	4200	47191	3459	47329	2386	56530	1926	33074
6L-5S		MI	22956	6982	36937	5107	39918	4152	40823	3418	40937	2327	48634	1914	28167
18-#11	2.06	MA	26258	6982	41819	5181	45163	4213	45938	3471	45647	2395	54242	1836	32642
7L-4S		MI	23367	6982	37622	5111	40806	4140	41914	3409	42486	2336	50472	1952	28206
18-#11	2.06	MA	25809	6982	41060	5178	44129	4209	44714	3482	43860	2387	52128	1788	32194
8L-3S		MI	23825	6982	38412	5098	41812	4146	43137	3416	44032	2327	52205	2039	28208
18-#11	2.06	MA	25352	6982	40242	5192	43123	4222	43435	3477	42194	2396	50050	1734	31501
9L-2S		MI	24470	6982	39376	5102	43048	4134	44645	3406	46054	2318	54884	2125	28186
18-#14	2.98	MA	29155	7412	47936	5427	52941	4372	55415	3559	58538	2344	71100	1846	47701
4L-7S		MI	22881	7412	37740	5368	40838	4340	41898	3526	42424	2292	50903	1485	37564
18-#14	2.98	MA	28462	7412	46757	5423	51412	4390	53536	3575	55827	2331	67881	1788	46766
5L-6S		MI	23420	7412	38748	5349	42055	4324	43463	3537	44370	2279	53515	1616	38376

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis

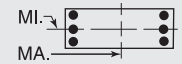


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.98	MA	27802	7412	45650	5418	49880	4383	51664	3566	53371	2344	64838	1707	45911
6L-5S		MI	23973	7412	39669	5356	43328	4333	44949	3524	46362	2267	55956	1698	38997
18-#14	2.98	MA	27159	7412	44438	5438	48418	4402	49867	3582	50971	2356	61588	1577	44925
7L-4S		MI	24552	7412	40649	5362	44599	4317	46510	3511	48563	2279	58566	1752	39796
18-#14	2.98	MA	26526	7412	43349	5434	46936	4395	48113	3598	48419	2344	58580	1509	43759
8L-3S		MI	25199	7412	41780	5344	46039	4326	48259	3522	50757	2267	61015	1877	39893
18-#14	2.98	MA	25899	7412	42176	5454	45493	4413	46279	3589	46040	2356	55629	1431	42396
9L-2S		MI	26107	7412	43156	5351	47803	4310	50412	3509	53628	2255	64807	2001	39928
18-#18	5.29	MA	30417	8501	53024	6062	59060	4853	62789	3840	68204	2222	85195	1126	75010
6L-5S		MI	26402	8501	46389	5994	51763	4798	55037	3785	59637	2101	73742	1119	64727
20-#11	2.29	MA	28215	7090	45425	5240	49813	4239	51632	3482	53430	2377	64253	2005	37311
4L-8S		MI	22252	7090	35920	5180	38553	4200	39181	3460	38727	2325	46024	1698	29945
20-#11	2.29	MA	27726	7090	44602	5237	48746	4252	50321	3494	51531	2369	61992	1964	37215
5L-7S		MI	22627	7090	36554	5184	39415	4206	40200	3450	40185	2334	47741	1744	30353
20-#11	2.29	MA	27260	7090	43831	5234	47677	4248	49015	3488	49810	2378	59849	1908	36603
6E		MI	23008	7090	37258	5171	40264	4194	41244	3441	41556	2325	49587	1834	30649
20-#11	2.29	MA	26806	7090	42985	5248	46658	4261	47762	3500	48129	2387	57561	1818	36187
7L-5S		MI	23398	7090	37901	5175	41154	4200	42331	3448	42959	2316	51312	1891	31151
20-#11	2.29	MA	26359	7090	42226	5246	45624	4257	46538	3512	46342	2378	55447	1770	35676
8L-4S		MI	23807	7090	38586	5179	42041	4188	43421	3438	44508	2325	53151	1929	31204
20-#11	2.29	MA	25906	7090	41408	5260	44618	4270	45259	3506	44675	2387	53369	1716	35006
9L-3S		MI	24263	7090	39376	5166	43048	4194	44645	3445	46054	2316	54884	2015	31223
20-#11	2.29	MA	25417	7090	40651	5257	43597	4266	44041	3518	43023	2396	51356	1654	34332
10L-2S		MI	24906	7090	40340	5170	44284	4183	46152	3436	48076	2308	57562	2102	31209
20-#14	3.31	MA	29225	7567	48425	5520	53551	4460	56145	3617	59367	2318	72595	1759	51779
5L-7S		MI	23507	7567	39116	5465	42603	4410	44051	3568	45295	2275	54695	1449	41634
20-#14	3.31	MA	28569	7567	47319	5515	52019	4453	54274	3609	56910	2331	69553	1678	50961
6E		MI	24043	7567	40125	5447	43819	4394	45616	3580	47241	2263	57307	1580	42535
20-#14	3.31	MA	27929	7567	46107	5536	50557	4471	52476	3625	54510	2343	66303	1548	49883
7L-5S		MI	24593	7567	41045	5453	45093	4403	47101	3567	49233	2250	59748	1662	43126
20-#14	3.31	MA	27300	7567	45017	5531	49074	4465	50722	3641	51959	2331	63294	1480	48756
8L-4S		MI	25169	7567	42026	5460	46363	4387	48662	3553	51434	2263	62357	1716	44043
20-#14	3.31	MA	26677	7567	43845	5551	47632	4483	48888	3632	49580	2343	60344	1402	47333
9L-3S		MI	25812	7567	43156	5441	47803	4396	50412	3565	53628	2250	64807	1841	44163
22-#11	2.52	MA	28266	7198	45768	5304	50241	4301	52145	3523	54013	2360	65311	1945	40816
5L-8S		MI	22697	7198	36884	5247	39789	4248	40688	3490	40749	2314	48702	1675	32819
22-#11	2.52	MA	27802	7198	44997	5301	49173	4297	50839	3518	52292	2369	63167	1889	40136
6L-7S		MI	23070	7198	37518	5251	40651	4254	41708	3480	42207	2323	50420	1720	33283
22-#11	2.52	MA	27350	7198	44152	5316	48153	4310	49586	3529	50610	2378	60880	1799	39735
7L-6S		MI	23449	7198	38222	5238	41500	4243	42752	3470	43578	2314	52265	1811	33569
22-#11	2.52	MA	26905	7198	43392	5313	47119	4305	48362	3541	48823	2370	58766	1751	39166
8L-5S		MI	23838	7198	38865	5242	42389	4248	43838	3477	44981	2306	53991	1867	34073
22-#11	2.52	MA	26464	7198	42574	5327	46113	4318	47083	3535	47157	2378	56688	1697	38515
9L-4S		MI	24246	7198	39550	5246	43277	4237	44929	3467	46530	2314	55829	1906	34197
22-#11	2.52	MA	25968	7198	41817	5324	45092	4314	45865	3547	45504	2387	54675	1636	37800
10L-3S		MI	24700	7198	40340	5233	44284	4243	46152	3475	48076	2306	57562	1992	34228
22-#14	3.64	MA	29331	7723	48987	5613	54158	4523	56883	3651	60450	2318	74267	1649	56015
6L-7S		MI	24129	7723	40493	5562	44368	4479	46204	3611	48166	2259	58487	1414	45715
22-#14	3.64	MA	28695	7723	47775	5633	52696	4541	55085	3667	58050	2330	71017	1519	54851
7L-6S		MI	24662	7723	41501	5544	45584	4464	47769	3622	50112	2246	61099	1544	46699
22-#14	3.64	MA	28069	7723	46686	5628	51213	4535	53331	3683	55498	2318	68009	1451	53761
8L-5S		MI	25209	7723	42422	5550	46857	4473	49254	3609	52104	2234	63540	1626	47263
22-#14	3.64	MA	27450	7723	45513	5649	49770	4553	51497	3674	53119	2330	65059	1373	52279
9L-4S		MI	25783	7723	43402	5557	48128	4457	50815	3596	54305	2246	66149	1680	48286
24-#11	2.75	MA	28342	7306	46163	5369	50668	4345	52663	3547	54773	2360	66486	1870	43675
6L-8S		MI	23139	7306	37848	5315	41025	4297	42196	3519	42771	2304	51380	1651	35698
24-#11	2.75	MA	27892	7306	45318	5383	49648	4358	51409	3559	53092	2369	64198	1780	43285
7E		MI	23511	7306	38482	5319	41886	4303	43215	3509	44229	2312	53098	1697	36216

RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.75	MA	27449	7306	44558	5380	48614	4354	50186	3570	51305	2361	62085	1732	42661
8L-6S		MI	23889	7306	39186	5306	42736	4291	44259	3499	45600	2304	54943	1787	36491
24-#11	2.75	MA	27010	7306	43740	5395	47608	4367	48906	3565	49638	2370	60006	1678	42029
9L-5S		MI	24276	7306	39829	5310	43625	4297	45346	3507	47003	2295	56669	1844	36973
24-#11	2.75	MA	26516	7306	42983	5392	46587	4363	47689	3576	47986	2379	57993	1617	41274
10L-4S		MI	24682	7306	40514	5314	44513	4285	46436	3497	48553	2304	58507	1883	37187
24-#14	3.97	MA	29456	7879	49443	5730	54834	4611	57695	3709	61589	2317	75732	1490	59828
7E		MI	24747	7879	41869	5659	46132	4549	48356	3653	51037	2242	62279	1378	49804
24-#14	3.97	MA	28833	7879	48354	5726	53352	4604	55940	3726	59038	2305	72723	1422	58771
8L-6S		MI	25278	7879	42878	5641	47348	4533	49921	3665	52983	2230	64891	1508	50866
24-#14	3.97	MA	28217	7879	47181	5746	51909	4623	54106	3717	56659	2317	69773	1344	57233
9L-5S		MI	25822	7879	43798	5648	48622	4542	51407	3651	54975	2217	67332	1590	51408

RECTANGULAR TIED COLUMNS 34" x 42"

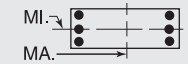
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.12	MA	29436	6865	45891	5092	49339	4153	50036	3467	49288	2499	57427	2355	20424
2E		MI	23673	6865	37237	5002	39652	4079	39960	3401	38925	2434	44988	2274	16296
6-#18	1.68	MA	30869	7142	48981	5265	53300	4277	54868	3543	55814	2475	66101	2301	30169
2L-3S		MI	23149	7142	37237	5161	39652	4229	39960	3497	38925	2422	44988	1980	24029
6-#18	1.68	MA	28787	7142	45891	5256	49339	4308	50036	3570	49288	2497	57427	2079	30214
3L-2S		MI	24759	7142	39635	5175	42727	4203	43688	3475	43869	2400	51479	2202	23919
8-#14	1.26	MA	29882	6934	46623	5170	50474	4212	51494	3510	51398	2518	60374	2374	23030
2L-4S		MI	22431	6934	35305	5100	37372	4152	37298	3455	35597	2482	41140	2047	18483
8-#14	1.26	MA	28681	6934	44858	5166	48211	4231	48733	3527	47641	2530	55352	2250	23088
3E		MI	23096	6934	36435	5081	38812	4161	39047	3467	37791	2470	43589	2172	18418
8-#14	1.26	MA	27836	6934	43418	5186	46375	4225	46503	3519	44771	2543	52086	2125	23102
4L-2S		MI	24028	6934	37812	5088	40576	4145	41200	3453	40662	2457	47381	2296	18345
8-#18	2.24	MA	32283	7418	52071	5438	57262	4401	59700	3618	62341	2450	74776	2246	39863
2L-4S		MI	23092	7418	37659	5365	40210	4334	40652	3549	40092	2411	47285	1690	31343
8-#18	2.24	MA	30220	7418	48981	5429	53300	4433	54868	3646	55814	2472	66101	2025	39809
3E		MI	24235	7418	39635	5334	42727	4353	43688	3571	43869	2388	51479	1908	31527
8-#18	2.24	MA	28764	7418	46454	5464	50080	4420	50954	3629	50826	2494	60477	1803	39406
4L-2S		MI	25833	7418	42034	5348	45802	4327	47417	3549	48813	2366	57970	2130	31483
10-#11	1.09	MA	29477	6851	45652	5135	49328	4189	50135	3500	49564	2534	58049	2404	20127
2L-5S		MI	22187	6851	34616	5062	36571	4143	36347	3458	34242	2490	39460	2123	16215
10-#11	1.09	MA	28634	6851	44418	5133	47747	4186	48205	3512	46939	2543	54516	2317	20171
3L-4S		MI	22605	6851	35301	5067	37459	4131	37438	3448	35791	2499	41298	2162	16170
10-#11	1.09	MA	28043	6851	43413	5147	46466	4199	46649	3507	44936	2553	52217	2231	20207
4L-3S		MI	23071	6851	36091	5053	38466	4137	38661	3455	37336	2490	43031	2248	16117
10-#11	1.09	MA	27514	6851	42545	5145	45340	4195	45264	3519	42930	2545	49815	2190	20208
5L-2S		MI	23726	6851	37055	5057	39702	4125	40169	3446	39358	2482	45709	2335	16066
10-#14	1.58	MA	30707	7090	48389	5267	52737	4282	54255	3553	55155	2505	65397	2347	28583
2L-5S		MI	22476	7090	35701	5191	37866	4238	37889	3511	36268	2453	42323	1957	22750
10-#14	1.58	MA	29513	7090	46623	5263	50474	4301	51494	3570	51398	2518	60374	2222	28620
3L-4S		MI	23069	7090	36682	5197	39136	4222	39450	3497	38468	2466	44932	2012	22797
10-#14	1.58	MA	28673	7090	45183	5284	48639	4295	49264	3561	48528	2531	57109	2098	28589
4L-3S		MI	23730	7090	37812	5179	40576	4231	41200	3509	40662	2453	47381	2136	22760
10-#14	1.58	MA	27923	7090	43938	5279	47023	4314	47279	3578	45653	2519	53687	2039	28431
5L-2S		MI	24658	7090	39188	5185	42341	4215	43353	3496	43533	2441	51173	2261	22701
10-#18	2.80	MA	33682	7695	55161	5611	61223	4526	64533	3694	68868	2425	83450	2191	49518
2L-5S		MI	23157	7695	38340	5524	41060	4484	41671	3645	41244	2355	49301	1522	36391
10-#18	2.80	MA	31636	7695	52071	5602	57262	4557	59700	3721	62341	2447	74776	1970	49374
3L-4S		MI	24176	7695	40058	5537	43284	4458	44381	3623	45036	2377	53776	1618	38398

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

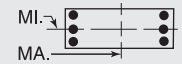


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	2.80	MA	30193	7695	49544	5637	54041	4544	55787	3704	57353	2469	69151	1749	48707
4L-3S		MI	25310	7695	42034	5507	45802	4477	47417	3645	48813	2355	57970	1836	38977
10-#18	2.80	MA	28904	7695	47355	5628	51203	4575	52300	3731	52354	2447	63217	1647	45804
5L-2S		MI	26896	7695	44432	5521	48876	4452	51146	3623	53757	2333	64462	2058	39011
12-#11	1.31	MA	30059	6959	46885	5203	50910	4238	52064	3529	52189	2525	61582	2386	24012
2L-6S		MI	22241	6959	34937	5126	36918	4185	36768	3480	34861	2488	40412	2044	19168
12-#11	1.31	MA	29220	6959	45652	5200	49328	4234	50135	3541	49564	2534	58049	2300	24047
3L-5S		MI	22639	6959	35580	5130	37807	4191	37855	3487	36264	2480	42138	2100	19236
12-#11	1.31	MA	28631	6959	44647	5215	48048	4247	48578	3536	47561	2544	55749	2214	24068
4E		MI	23055	6959	36265	5134	38695	4180	38945	3477	37813	2488	43976	2139	19209
12-#11	1.31	MA	28105	6959	43778	5212	46921	4244	47194	3548	45555	2536	53347	2172	24043
5L-3S		MI	23519	6959	37055	5121	39702	4185	40169	3485	39358	2480	45709	2225	19167
12-#11	1.31	MA	27604	6959	42964	5210	45793	4257	45815	3543	43738	2546	51064	2116	23864
6L-2S		MI	24172	6959	38019	5125	40937	4174	41676	3475	41380	2471	48388	2311	19122
12-#14	1.89	MA	31526	7245	50154	5364	55001	4352	57016	3595	58911	2493	70420	2320	34121
2L-6S		MI	22550	7245	36157	5281	38357	4298	38557	3567	37147	2449	43673	1839	26122
12-#14	1.89	MA	30339	7245	48389	5360	52737	4371	54255	3612	55155	2506	65397	2195	34132
3L-5S		MI	23112	7245	37078	5288	39630	4308	40042	3553	39139	2437	46114	1921	26881
12-#14	1.89	MA	29504	7245	46949	5381	50902	4365	52025	3604	52284	2518	62132	2071	34062
4E		MI	23703	7245	38058	5294	40901	4292	41603	3540	41339	2449	48724	1976	27085
12-#14	1.89	MA	28758	7245	45703	5377	49287	4383	50040	3621	49410	2506	58710	2012	33755
5L-3S		MI	24360	7245	39188	5276	42341	4301	43353	3551	43533	2437	51173	2100	27083
12-#14	1.89	MA	28047	7245	44535	5373	47669	4377	48063	3612	46804	2519	55466	1931	32650
6L-2S		MI	25283	7245	40565	5282	44106	4285	45506	3538	46404	2424	54965	2225	27039
12-#18	3.36	MA	33036	7972	55161	5775	61223	4681	64533	3796	68868	2422	83450	1915	58920
3L-5S		MI	24239	7972	40739	5697	44134	4608	45399	3719	46188	2321	55792	1450	43514
12-#18	3.36	MA	31607	7972	52634	5810	58002	4668	60619	3779	63879	2444	77826	1694	57764
4E		MI	25250	7972	42456	5710	46359	4582	48109	3697	49980	2343	60267	1546	45376
12-#18	3.36	MA	30329	7972	50445	5801	55164	4699	57133	3807	58880	2422	71891	1593	55031
5L-3S		MI	26375	7972	44432	5680	48876	4601	51146	3719	53757	2321	64462	1764	46400
12-#18	3.36	MA	29114	7972	48391	5791	52322	4686	53659	3790	54351	2444	66296	1448	52587
6L-2S		MI	27950	7972	46831	5694	51951	4576	54874	3697	58701	2299	70953	1986	46509
14-#11	1.53	MA	30639	7067	48119	5270	52491	4286	53993	3559	54814	2516	65114	2369	27887
2L-7S		MI	22306	7067	35197	5206	37304	4245	37232	3519	35512	2486	41245	1930	21711
14-#11	1.53	MA	29803	7067	46885	5268	50910	4282	52064	3571	52189	2526	61582	2282	27913
3L-6S		MI	22692	7067	35901	5193	38153	4234	38275	3509	36883	2478	43091	2020	22062
14-#11	1.53	MA	29216	7067	45881	5282	49629	4296	50507	3566	50186	2535	59282	2196	27915
4L-5S		MI	23088	7067	36544	5197	39043	4240	39362	3517	38286	2469	44816	2077	22246
14-#11	1.53	MA	28692	7067	45012	5280	48503	4292	49123	3578	48180	2528	56880	2155	27869
5L-4S		MI	23503	7067	37229	5201	39931	4228	40453	3507	39835	2478	46655	2116	22237
14-#11	1.53	MA	28193	7067	44197	5277	47374	4305	47744	3573	46363	2537	54597	2099	27574
6L-3S		MI	23965	7067	38019	5188	40937	4234	41676	3514	41380	2469	48388	2202	22205
14-#11	1.53	MA	27707	7067	43305	5292	46298	4302	46421	3585	44588	2547	52161	2009	27050
7L-2S		MI	24616	7067	38983	5192	42173	4222	43184	3504	43402	2460	51066	2288	22166
14-#14	2.21	MA	32340	7401	51920	5462	57264	4422	59778	3638	62668	2480	75443	2293	39653
2L-7S		MI	22639	7401	36525	5397	38905	4384	39145	3597	38071	2445	44853	1673	29768
14-#14	2.21	MA	31158	7401	50154	5457	55001	4441	57016	3654	58911	2493	70420	2168	39627
3L-6S		MI	23185	7401	37533	5379	40121	4368	40710	3609	40018	2433	47465	1804	30259
14-#14	2.21	MA	30328	7401	48714	5478	53165	4435	54786	3646	56041	2506	67155	2044	39526
4L-5S		MI	23745	7401	38454	5385	41395	4377	42195	3596	42010	2420	49906	1885	30971
14-#14	2.21	MA	29587	7401	47469	5474	51550	4453	52801	3663	53166	2494	63732	1985	39019
5L-4S		MI	24332	7401	39435	5392	42666	4361	43756	3582	44210	2433	52516	1940	31361
14-#14	2.21	MA	28881	7401	46300	5470	49932	4447	50824	3655	50561	2507	60488	1904	37970
6L-3S		MI	24986	7401	40565	5373	44106	4371	45506	3594	46404	2420	54965	2064	31395
14-#14	2.21	MA	28193	7401	45021	5491	48389	4466	48926	3672	48015	2519	57026	1774	37278
7L-2S		MI	25905	7401	41941	5380	45870	4355	47658	3580	49275	2408	58757	2189	31365
14-#18	3.92	MA	33007	8248	55724	5983	61963	4792	65452	3855	70406	2420	86500	1639	66866
4L-5S		MI	25311	8248	43137	5869	47209	4732	49128	3793	51132	2288	62283	1378	50661

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

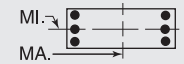
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.92	MA	31740	8248	53535	5973	59126	4823	61965	3882	65407	2397	80566	1538	64284
5L-4S		MI	26314	8248	44854	5883	49434	4707	51838	3770	54924	2310	66759	1474	52398
14-#18	3.92	MA	30536	8248	51481	5964	56283	4810	58492	3865	60878	2420	74971	1393	61651
6L-3S		MI	27431	8248	46831	5853	51951	4725	54874	3793	58701	2288	70953	1692	53806
14-#18	3.92	MA	29363	8248	49231	5999	53569	4841	55156	3892	56452	2442	68993	1162	58957
7L-2S		MI	28995	8248	49229	5867	55026	4700	58603	3770	63645	2266	77444	1913	53972
16-#11	1.75	MA	31215	7175	49353	5337	54073	4335	55923	3588	57439	2508	68647	2351	31756
2L-8S		MI	22378	7175	35528	5270	37678	4288	37720	3559	36075	2467	42206	1861	24407
16-#11	1.75	MA	30382	7175	48119	5335	52491	4331	53993	3600	54814	2517	65114	2265	31773
3L-7S		MI	22756	7175	36161	5274	38540	4294	38739	3549	37534	2476	43924	1907	24633
16-#11	1.75	MA	29798	7175	47114	5350	51211	4344	52437	3595	52811	2527	62815	2179	31754
4L-6S		MI	23141	7175	36865	5261	39389	4282	39783	3539	38905	2467	45769	1997	24965
16-#11	1.75	MA	29277	7175	46245	5347	50084	4340	51052	3607	50805	2519	60413	2137	31691
5E		MI	23535	7175	37508	5265	40279	4288	40870	3546	40308	2458	47495	2054	25245
16-#11	1.75	MA	28780	7175	45431	5345	48956	4354	49674	3602	48988	2528	58130	2081	31293
6L-4S		MI	23948	7175	38193	5269	41166	4277	41960	3536	41857	2467	49333	2092	25256
16-#11	1.75	MA	28296	7175	44539	5359	47880	4350	48350	3614	47213	2538	55694	1991	30793
7L-3S		MI	24409	7175	38983	5256	42173	4282	43184	3544	43402	2458	51066	2179	25235
16-#11	1.75	MA	27819	7175	43737	5357	46788	4363	47059	3626	45326	2530	53448	1942	30433
8L-2S		MI	25057	7175	39947	5260	43409	4271	44691	3534	45424	2450	53744	2265	25203
16-#14	2.52	MA	31973	7557	51920	5555	57264	4511	59778	3697	62668	2481	75443	2141	45113
3L-7S		MI	23273	7557	37902	5494	40670	4454	41297	3640	40942	2429	48645	1637	33809
16-#14	2.52	MA	31147	7557	50480	5575	55429	4504	57547	3689	59798	2493	72177	2017	44983
4L-6S		MI	23816	7557	38910	5476	41886	4438	42862	3651	42889	2416	51257	1768	34405
16-#14	2.52	MA	30410	7557	49234	5571	53813	4523	55562	3705	56923	2481	68755	1958	44300
5E		MI	24373	7557	39831	5482	43159	4447	44348	3638	44881	2404	53698	1850	35076
16-#14	2.52	MA	29708	7557	48066	5567	52196	4517	53585	3697	54318	2494	65511	1877	43301
6L-4S		MI	24957	7557	40811	5489	44430	4431	45909	3625	47081	2416	56308	1904	35626
16-#14	2.52	MA	29024	7557	46786	5588	50652	4536	51687	3714	51772	2507	62049	1747	42505
7L-3S		MI	25608	7557	41941	5471	45870	4440	47658	3636	49275	2404	58757	2029	35685
16-#14	2.52	MA	28351	7557	45636	5584	49086	4530	49835	3731	49066	2495	58849	1678	41167
8L-2S		MI	26523	7557	43318	5477	47635	4424	49811	3623	52146	2391	62549	2153	35682
16-#18	4.48	MA	33138	8525	56625	6146	63087	4947	66798	3957	71934	2373	89240	1483	73559
5E		MI	26375	8525	45535	6042	50283	4856	52857	3866	56076	2254	68775	1306	57829
16-#18	4.48	MA	31944	8525	54571	6137	60244	4934	63324	3940	67405	2395	83645	1339	70745
6L-4S		MI	27370	8525	47253	6056	52508	4831	55566	3844	59868	2276	73250	1402	59455
16-#18	4.48	MA	30781	8525	52321	6172	57531	4965	59989	3968	62979	2417	77667	1107	68087
7L-3S		MI	28478	8525	49229	6026	55026	4849	58603	3866	63645	2254	77444	1620	61198
18-#11	1.97	MA	30959	7283	49353	5402	54073	4379	55923	3630	57439	2509	68647	2247	35622
3L-8S		MI	22827	7283	36492	5337	38914	4337	39227	3588	38097	2456	44884	1838	27299
18-#11	1.97	MA	30377	7283	48348	5417	52792	4393	54366	3624	55436	2518	66347	2161	35588
4L-7S		MI	23204	7283	37125	5341	39775	4342	40247	3578	39556	2465	46602	1884	27559
18-#11	1.97	MA	29858	7283	47479	5415	51665	4389	52982	3637	53430	2510	63945	2120	35508
5L-6S		MI	23587	7283	37829	5328	40625	4331	41290	3568	40927	2456	48447	1974	27875
18-#11	1.97	MA	29363	7283	46665	5412	50537	4402	51603	3631	51613	2520	61662	2064	35020
6L-5S		MI	23980	7283	38472	5332	41514	4336	42377	3576	42330	2448	50173	2030	28239
18-#11	1.97	MA	28881	7283	45773	5427	49461	4398	50280	3643	49838	2529	59226	1974	34540
7L-4S		MI	24391	7283	39157	5336	42402	4325	43468	3566	43879	2456	52011	2069	28270
18-#11	1.97	MA	28407	7283	44971	5424	48370	4412	48988	3656	47951	2522	56981	1925	34164
8L-3S		MI	24850	7283	39947	5323	43409	4331	44691	3573	45424	2448	53744	2155	28258
18-#11	1.97	MA	27921	7283	44108	5439	47308	4408	47637	3650	46192	2531	54767	1871	33398
9L-2S		MI	25496	7283	40911	5327	44644	4319	46199	3563	47447	2439	56422	2242	28234
18-#14	2.84	MA	31961	7712	52245	5673	57692	4574	60308	3731	63555	2481	77200	1990	50435
4L-7S		MI	23904	7712	39278	5591	42434	4524	43450	3682	43813	2412	52437	1601	37865

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

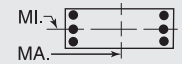


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.84	MA	31227	7712	51000	5669	56077	4593	58323	3748	60680	2469	73778	1931	49596
5L-6S		MI	24444	7712	40286	5573	43651	4508	45015	3694	45760	2400	55049	1732	38559
18-#14	2.84	MA	30530	7712	49832	5664	54459	4587	56346	3740	58075	2482	70534	1850	48640
6L-5S		MI	24998	7712	41207	5580	44924	4517	46500	3680	47752	2387	57490	1814	39194
18-#14	2.84	MA	29850	7712	48552	5685	52915	4606	54449	3756	55529	2494	67071	1720	47744
7L-4S		MI	25579	7712	42188	5586	46195	4501	48061	3667	49952	2400	60100	1868	39885
18-#14	2.84	MA	29181	7712	47402	5681	51350	4599	52596	3773	52823	2482	63872	1651	46451
8L-3S		MI	26227	7712	43318	5568	47635	4510	49811	3679	52146	2387	62549	1993	39966
18-#14	2.84	MA	28518	7712	46164	5702	49826	4618	50659	3765	50300	2495	60727	1573	45131
9L-2S		MI	27137	7712	44695	5574	49399	4494	51964	3665	55017	2375	66341	2117	39993
18-#18	5.04	MA	33339	8802	57661	6310	64205	5058	68157	4016	73931	2370	92320	1284	79864
6L-5S		MI	27430	8802	47934	6215	53358	4980	56585	3940	61020	2221	75266	1234	65013
18-#18	5.04	MA	32187	8802	55411	6345	61492	5090	64821	4043	69505	2392	86342	1053	77089
7L-4S		MI	28418	8802	49651	6229	55583	4955	59295	3918	64812	2243	79741	1330	66541
20-#11	2.18	MA	30953	7391	49582	5485	54374	4441	56295	3654	58061	2509	69880	2144	39417
4L-8S		MI	23274	7391	37455	5405	40150	4385	40735	3617	40119	2446	47563	1815	30165
20-#11	2.18	MA	30436	7391	48713	5482	53247	4437	54911	3666	56055	2502	67478	2102	39321
5L-7S		MI	23650	7391	38089	5409	41011	4391	41754	3607	41578	2454	49280	1860	30488
20-#11	2.18	MA	29944	7391	47898	5479	52119	4451	53532	3661	54238	2511	65195	2046	38754
6E		MI	24031	7391	38793	5396	41860	4379	42798	3598	42949	2446	51126	1951	30790
20-#11	2.18	MA	29464	7391	47006	5494	51043	4447	52209	3673	52463	2521	62759	1956	38291
7L-5S		MI	24422	7391	39436	5400	42750	4385	43885	3605	44352	2437	52851	2007	31227
20-#11	2.18	MA	28991	7391	46205	5492	49951	4460	50917	3685	50576	2513	60513	1907	37850
8L-4S		MI	24832	7391	40121	5404	43638	4373	44975	3595	45901	2446	54689	2046	31268
20-#11	2.18	MA	28508	7391	45341	5506	48889	4456	49567	3680	48817	2522	58300	1854	37108
9L-3S		MI	25290	7391	40911	5391	44644	4379	46199	3602	47447	2437	56422	2132	31277
20-#11	2.18	MA	27986	7391	44542	5504	47812	4470	48282	3692	47072	2532	56155	1792	36486
10L-2S		MI	25934	7391	41875	5395	45880	4368	47706	3593	49469	2428	59101	2219	31259
20-#14	3.15	MA	32040	7868	52765	5766	58340	4663	61085	3790	64437	2457	78801	1904	54903
5L-7S		MI	24530	7868	40655	5689	44199	4594	45603	3725	46684	2396	56229	1566	41932
20-#14	3.15	MA	31346	7868	51597	5762	56722	4657	59107	3782	61831	2469	75557	1823	53987
6E		MI	25068	7868	41663	5670	45415	4578	47168	3736	48631	2383	58841	1696	42718
20-#14	3.15	MA	30670	7868	50317	5782	55179	4675	57210	3799	59285	2482	72094	1693	52995
7L-5S		MI	25619	7868	42584	5677	46689	4587	48653	3723	50623	2371	61282	1778	43322
20-#14	3.15	MA	30005	7868	49167	5778	53613	4669	55357	3816	56580	2470	68895	1624	51744
8L-4S		MI	26197	7868	43564	5683	47960	4571	50214	3710	52823	2383	63891	1832	44137
20-#14	3.15	MA	29343	7868	47929	5799	52090	4688	53420	3808	54057	2483	65750	1546	50363
9L-3S		MI	26842	7868	44695	5665	49399	4580	51964	3721	55017	2371	66341	1957	44240
20-#18	5.60	MA	33580	9078	58501	6518	65453	5214	69653	4119	76032	2367	95016	998	86115
7L-5S		MI	28477	9078	50332	6388	56433	5104	60314	4014	65964	2187	81757	1162	72210
22-#11	2.40	MA	31011	7499	49946	5549	54828	4486	56840	3695	58680	2493	71010	2085	43132
5L-8S		MI	23719	7499	38419	5472	41385	4433	42242	3647	42141	2435	50241	1791	33037
22-#11	2.40	MA	30521	7499	49132	5547	53700	4499	55461	3690	56863	2503	68727	2029	42493
6L-7S		MI	24094	7499	39053	5476	42247	4439	43262	3637	43600	2444	51959	1837	33420
22-#11	2.40	MA	30043	7499	48240	5562	52624	4495	54138	3702	55088	2512	66292	1939	42046
7L-6S		MI	24474	7499	39757	5463	43096	4428	44305	3627	44971	2435	53804	1927	33709
22-#11	2.40	MA	29573	7499	47438	5559	51532	4509	52847	3714	53201	2504	64046	1890	41544
8L-5S		MI	24863	7499	40400	5467	43986	4433	45392	3634	46374	2426	55530	1984	34211
22-#11	2.40	MA	29092	7499	46575	5574	50471	4505	51496	3709	51442	2514	61832	1836	40822
9L-4S		MI	25272	7499	41085	5471	44874	4422	46483	3625	47923	2435	57368	2023	34265
22-#11	2.40	MA	28572	7499	45776	5571	49393	4518	50211	3721	49697	2523	59688	1775	40159
10L-3S		MI	25727	7499	41875	5458	45880	4427	47706	3632	49469	2426	59101	2109	34291
22-#11	2.40	MA	28065	7499	44990	5569	48337	4514	48877	3716	47837	2516	57498	1723	39286
11L-2S		MI	26369	7499	42839	5462	47116	4416	49214	3622	51491	2418	61779	2195	34280
22-#14	3.47	MA	32157	8023	53363	5859	58986	4726	61869	3825	65588	2457	80580	1796	59339
6L-7S		MI	25153	8023	42031	5786	45964	4664	47755	3767	49555	2379	60021	1530	46009
22-#14	3.47	MA	31485	8023	52083	5880	57442	4745	59971	3841	63042	2470	77117	1666	58257
7L-6S		MI	25688	8023	43039	5768	47180	4648	49320	3779	51502	2367	62633	1660	46883

RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

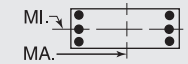
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.47	MA	30824	8023	50933	5875	55876	4739	58118	3858	60337	2458	73918	1597	57045
8L-5S		MI	26237	8023	43960	5774	48453	4657	50806	3765	53494	2354	65074	1742	47459
22-#14	3.47	MA	30162	8023	49695	5896	54353	4758	56181	3850	57813	2470	70772	1519	55603
9L-4S		MI	26812	8023	44941	5781	49724	4641	52367	3752	55694	2367	67683	1797	48384
24-#11	2.62	MA	31096	7606	50366	5614	55282	4547	57391	3720	59488	2494	72260	2011	46237
6L-8S		MI	24163	7606	39383	5539	42621	4482	43750	3676	44163	2424	52919	1768	35915
24-#11	2.62	MA	30620	7606	49474	5629	54206	4544	56067	3732	57713	2503	69824	1921	45803
7E		MI	24535	7606	40017	5544	43483	4488	44769	3666	45622	2433	54637	1814	36354
24-#11	2.62	MA	30152	7606	48672	5627	53114	4557	54776	3744	55826	2496	67578	1872	45243
8L-6S		MI	24914	7606	40721	5530	44332	4476	45813	3656	46993	2424	56482	1904	36632
24-#11	2.62	MA	29673	7606	47809	5641	52052	4553	53425	3739	54067	2505	65365	1819	44542
9L-5S		MI	25302	7606	41364	5534	45221	4482	46900	3664	48396	2416	58208	1961	37130
24-#11	2.62	MA	29155	7606	47009	5639	50975	4567	52140	3751	52322	2515	63220	1757	43836
10L-4S		MI	25709	7606	42049	5539	46109	4470	47990	3654	49945	2424	60046	1999	37258
24-#11	2.62	MA	28650	7606	46224	5636	49919	4563	50807	3746	50462	2507	61030	1706	42983
11L-3S		MI	26163	7606	42839	5525	47116	4476	49214	3661	51491	2416	61779	2086	37291
24-#14	3.78	MA	32295	8179	53848	5977	59705	4815	62732	3884	66799	2457	82140	1639	63528
7E		MI	25773	8179	43408	5883	47728	4733	49908	3810	52426	2362	63813	1494	50096
24-#14	3.78	MA	31637	8179	52698	5973	58140	4809	60879	3900	64093	2445	78940	1569	62352
8L-6S		MI	26305	8179	44416	5865	48944	4717	51473	3821	54373	2350	66425	1624	51051
24-#14	3.78	MA	30977	8179	51460	5993	56616	4828	58942	3892	61570	2458	75795	1492	60852
9L-5S		MI	26851	8179	45337	5871	50218	4727	52959	3808	56365	2338	68866	1706	51603

RECTANGULAR TIED COLUMNS 34" x 44"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.07	MA	32203	7166	50027	5336	53823	4354	54557	3638	53690	2634	62543	2489	21504
2E		MI	24697	7166	38782	5224	41248	4262	41507	3556	40308	2553	46512	2389	16341
6-#18	1.60	MA	33725	7442	53290	5509	58006	4478	59660	3714	60613	2611	71765	2437	31789
2L-3S		MI	24171	7442	38782	5383	41248	4411	41507	3652	40308	2541	46512	2095	24093
6-#18	1.60	MA	31522	7442	50027	5501	53823	4510	54557	3742	53690	2633	62543	2216	31834
3L-2S		MI	25784	7442	41180	5397	44322	4386	45236	3630	45252	2519	53003	2317	23973
8-#14	1.20	MA	32671	7235	50792	5414	55012	4413	56085	3681	55840	2649	65639	2507	24245
2L-4S		MI	23453	7235	36844	5324	38968	4336	38850	3611	36987	2602	42674	2164	18534
8-#14	1.20	MA	31402	7235	48929	5410	52624	4408	53172	3698	51876	2662	60308	2383	24303
3E		MI	24119	7235	37974	5305	40408	4345	40599	3623	39181	2590	45123	2288	18462
8-#14	1.20	MA	30511	7235	47412	5431	50690	4427	50821	3691	48851	2676	56838	2258	24317
4L-2S		MI	25051	7235	39350	5312	42172	4329	42752	3610	42052	2578	48915	2413	18386
8-#18	2.14	MA	35228	7719	56553	5682	62189	4602	64763	3789	67536	2588	80987	2386	42023
2L-4S		MI	24114	7719	39204	5586	41805	4517	42200	3704	41475	2530	48809	1806	31462
8-#18	2.14	MA	33044	7719	53290	5674	58006	4635	59660	3817	60613	2610	71765	2165	41969
3E		MI	25259	7719	41180	5556	44322	4535	45236	3726	45252	2508	53003	2023	31607
8-#18	2.14	MA	31506	7719	50625	5710	54610	4623	55532	3802	55321	2632	65778	1943	41566
4L-2S		MI	26859	7719	43579	5570	47397	4510	48965	3704	50196	2485	59495	2245	31545
10-#11	1.04	MA	32240	7152	49763	5379	53799	4390	54646	3671	53898	2665	63155	2536	21180
2L-5S		MI	23209	7152	36151	5287	38168	4328	37901	3615	35634	2611	40999	2240	16260
10-#11	1.04	MA	31350	7152	48462	5377	52131	4387	52611	3683	51130	2675	59408	2450	21224
3L-4S		MI	23628	7152	36836	5291	39056	4316	38992	3605	37184	2620	42837	2279	16210
10-#11	1.04	MA	30726	7152	47404	5392	50782	4401	50971	3678	49020	2685	56966	2363	21260
4L-3S		MI	24094	7152	37626	5278	40062	4322	40215	3613	38729	2611	44570	2365	16154
10-#11	1.04	MA	30169	7152	46489	5390	49595	4397	49513	3691	46908	2678	54423	2321	21261
5L-2S		MI	24750	7152	38590	5282	41298	4310	41722	3603	40751	2602	47248	2451	16102
10-#14	1.50	MA	33547	7390	52655	5511	57400	4483	58999	3723	59804	2636	70970	2482	30101
2L-5S		MI	23498	7390	37239	5414	39462	4422	39441	3667	37657	2573	43857	2073	22831
10-#14	1.50	MA	32285	7390	50792	5508	55012	4478	56085	3741	55840	2650	65639	2358	30139
3L-4S		MI	24092	7390	38220	5421	40732	4406	41002	3654	39858	2586	46466	2128	22854
10-#14	1.50	MA	31399	7390	49274	5529	53078	4497	53735	3733	52815	2664	62169	2233	30108
4L-3S		MI	24754	7390	39350	5402	42172	4415	42752	3665	42052	2573	48915	2252	22809

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

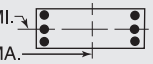
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.50	MA	30608	7390	47962	5525	51376	4491	51644	3751	49787	2652	58544	2173	29950
5L-2S		MI	25682	7390	40727	5409	43937	4399	44905	3652	44923	2561	52707	2377	22746
10-#18	2.67	MA	36714	7996	59816	5855	66372	4726	69865	3864	74459	2564	90209	2335	52218
2L-5S		MI	24178	7996	39885	5745	42655	4666	43218	3800	42627	2474	50825	1637	36675
10-#18	2.67	MA	34548	7996	56553	5847	62189	4759	64763	3893	67536	2586	80987	2113	52074
3L-4S		MI	25199	7996	41602	5759	44880	4641	45928	3778	46419	2496	55300	1734	38738
10-#18	2.67	MA	33025	7996	53888	5883	58793	4747	60635	3877	62244	2609	75000	1892	51570
4L-3S		MI	26336	7996	43579	5729	47397	4659	48965	3800	50196	2474	59495	1951	39067
10-#18	2.67	MA	31664	7996	51581	5875	55802	4779	56960	3906	56943	2586	68704	1789	48513
5L-2S		MI	27925	7996	45977	5743	50472	4634	52693	3778	55140	2452	65986	2173	39079
12-#11	1.25	MA	32857	7260	51064	5447	55467	4439	56680	3700	56667	2656	66901	2520	25275
2L-6S		MI	23263	7260	36472	5351	38514	4370	38322	3637	36253	2609	41951	2160	19287
12-#11	1.25	MA	31971	7260	49763	5445	53799	4435	54646	3712	53898	2666	63155	2433	25310
3L-5S		MI	23661	7260	37115	5355	39404	4376	39409	3644	37657	2600	43677	2217	19287
12-#11	1.25	MA	31350	7260	48705	5460	52450	4449	53006	3708	51788	2676	60713	2347	25332
4E		MI	24078	7260	37800	5359	40291	4365	40499	3635	39206	2609	45515	2256	19253
12-#11	1.25	MA	30795	7260	47790	5457	51263	4446	51548	3720	49676	2669	58170	2305	25306
5L-3S		MI	24542	7260	38590	5346	41298	4370	41722	3642	40751	2600	47248	2342	19207
12-#11	1.25	MA	30267	7260	46933	5455	50076	4459	50096	3716	47763	2679	55747	2249	25207
6L-2S		MI	25196	7260	39554	5350	42534	4359	43230	3632	42773	2592	49926	2428	19160
12-#14	1.80	MA	34417	7546	54518	5608	59788	4553	61912	3766	63768	2624	76302	2457	35943
2L-6S		MI	23571	7546	37695	5505	39953	4483	40109	3723	38536	2569	45207	1956	26298
12-#14	1.80	MA	33161	7546	52655	5605	57400	4547	58999	3783	59804	2638	70970	2332	35954
3L-5S		MI	24135	7546	38616	5512	41226	4492	41594	3710	40528	2557	47648	2037	27078
12-#14	1.80	MA	32280	7546	51137	5626	55466	4567	56648	3776	56779	2651	67500	2208	35884
4E		MI	24726	7546	39597	5518	42497	4476	43155	3696	42729	2569	50258	2092	27154
12-#14	1.80	MA	31494	7546	49825	5622	53764	4561	54557	3793	53750	2640	63875	2148	35687
5L-3S		MI	25384	7546	40727	5500	43937	4485	44905	3708	44923	2557	52707	2216	27137
12-#14	1.80	MA	30745	7546	48595	5619	52061	4580	52475	3786	51006	2654	60430	2067	34500
6L-2S		MI	26309	7546	42103	5506	45702	4469	47057	3694	47794	2545	56499	2341	27089
12-#18	3.21	MA	36036	8272	59816	6020	66372	4883	69865	3968	74459	2563	90209	2062	62160
3L-5S		MI	25262	8272	42283	5918	45730	4790	46947	3874	47571	2440	57316	1565	43795
12-#18	3.21	MA	34527	8272	57151	6056	62976	4871	65738	3953	69167	2585	84222	1840	61295
4E		MI	26275	8272	44001	5932	47954	4765	49657	3852	51363	2462	61791	1661	45710
12-#18	3.21	MA	33178	8272	54844	6047	59985	4903	62063	3981	63866	2563	77926	1737	58263
5L-3S		MI	27403	8272	45977	5902	50472	4784	52693	3874	55140	2440	65986	1879	46500
12-#18	3.21	MA	31896	8272	52680	6039	56989	4891	58402	3965	59061	2585	71974	1593	55918
6L-2S		MI	28980	8272	48375	5916	53546	4758	56422	3852	60084	2418	72477	2101	46588
14-#11	1.46	MA	33472	7368	52365	5514	57135	4487	58715	3729	59435	2648	70648	2503	29362
2L-7S		MI	23328	7368	36732	5431	38900	4430	38785	3676	36904	2607	42784	2047	21839
14-#11	1.46	MA	32589	7368	51064	5512	55467	4484	56680	3742	56667	2658	66901	2417	29388
3L-6S		MI	23714	7368	37436	5418	39750	4419	39829	3666	38275	2598	44630	2137	22199
14-#11	1.46	MA	31970	7368	50006	5527	54117	4497	55041	3737	54557	2668	64460	2330	29390
4L-5S		MI	24111	7368	38079	5422	40639	4425	40916	3674	39679	2590	46355	2194	22304
14-#11	1.46	MA	31418	7368	49091	5525	52931	4494	53583	3750	52445	2660	61917	2288	29344
5L-4S		MI	24526	7368	38764	5426	41527	4413	42007	3664	41228	2598	48193	2232	22285
14-#11	1.46	MA	30892	7368	48234	5523	51744	4508	52131	3745	50531	2670	59494	2233	29120
6L-3S		MI	24989	7368	39554	5413	42534	4419	43230	3671	42773	2590	49926	2319	22249
14-#11	1.46	MA	30380	7368	47295	5538	50611	4504	50738	3757	48662	2680	56910	2143	28541
7L-2S		MI	25640	7368	40518	5417	43769	4407	44737	3661	44795	2581	52605	2405	22208
14-#14	2.11	MA	35280	7702	56380	5706	62176	4623	64825	3808	67731	2612	81633	2431	41779
2L-7S		MI	23660	7702	38064	5621	40501	4568	40696	3754	39461	2565	46387	1789	29995
14-#14	2.11	MA	34031	7702	54518	5702	59788	4617	61912	3826	63768	2625	76302	2307	41753
3L-6S		MI	24207	7702	39072	5602	41717	4552	42261	3765	41407	2553	48999	1920	30435

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis



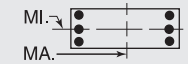
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.11	MA	33155	7702	53000	5723	57854	4637	59561	3818	60743	2639	72832	2182	41652
4L-5S		MI	24768	7702	39993	5609	42991	4561	43747	3752	43399	2540	51440	2002	31166
14-#14	2.11	MA	32373	7702	51688	5720	56152	4631	57470	3836	57714	2627	69206	2122	41278
5L-4S		MI	25356	7702	40973	5615	44262	4546	45308	3739	45600	2553	54050	2056	31435
14-#14	2.11	MA	31629	7702	50458	5716	54449	4650	55388	3828	54970	2641	65761	2042	40116
6L-3S		MI	26011	7702	42103	5597	45702	4555	47057	3750	47794	2540	56499	2181	31451
14-#14	2.11	MA	30904	7702	49111	5737	52823	4645	53390	3846	52289	2655	62085	1912	39379
7L-2S		MI	26932	7702	43480	5604	47466	4539	49210	3737	50665	2528	60291	2305	31418
14-#18	3.74	MA	36013	8549	60413	6229	67159	4995	70841	4028	76090	2562	93444	1789	70914
4L-5S		MI	26335	8549	44682	6091	48804	4914	50676	3948	52515	2407	63807	1493	50941
14-#18	3.74	MA	34677	8549	58107	6220	64168	5027	67166	4057	70789	2540	87148	1686	68041
5L-4S		MI	27341	8549	46399	6105	51029	4889	53386	3925	56307	2429	68283	1589	52726
14-#18	3.74	MA	33406	8549	55943	6212	61172	5015	63505	4041	65985	2562	81196	1542	65504
6L-3S		MI	28460	8549	48375	6075	53546	4908	56422	3948	60084	2407	72477	1807	53913
14-#18	3.74	MA	32168	8549	53573	6248	58313	5048	59991	4069	61289	2584	74839	1311	62537
7L-2S		MI	30028	8549	50774	6088	56621	4882	60151	3925	65028	2385	78969	2029	54057
16-#11	1.67	MA	34083	7475	53667	5582	58802	4536	60750	3759	62204	2639	74395	2487	33441
2L-8S		MI	23399	7475	37063	5495	39275	4473	39274	3716	37468	2588	43745	1978	24538
16-#11	1.67	MA	33203	7475	52365	5579	57135	4532	58715	3771	59435	2649	70648	2400	33458
3L-7S		MI	23778	7475	37696	5499	40136	4479	40293	3706	38926	2596	45463	2023	24762
16-#11	1.67	MA	32587	7475	51307	5594	55785	4546	57075	3767	57325	2659	68206	2314	33439
4L-6S		MI	24163	7475	38400	5485	40985	4467	41337	3696	40297	2588	47308	2114	25101
16-#11	1.67	MA	32038	7475	50392	5592	54599	4542	55618	3779	55213	2652	65663	2272	33375
5E		MI	24558	7475	39043	5490	41875	4473	42424	3703	41701	2579	49034	2170	25309
16-#11	1.67	MA	31514	7475	49535	5590	53411	4556	54166	3774	53300	2662	63241	2216	33044
6L-4S		MI	24972	7475	39728	5494	42763	4461	43514	3693	43250	2588	50872	2209	25308
16-#11	1.67	MA	31004	7475	48596	5605	52279	4553	52773	3787	51431	2672	60657	2126	32490
7L-3S		MI	25433	7475	40518	5480	43769	4467	44737	3701	44795	2579	52605	2295	25282
16-#11	1.67	MA	30502	7475	47752	5603	51129	4566	51413	3799	49444	2665	58279	2077	32099
8L-2S		MI	26082	7475	41482	5485	45005	4456	46245	3691	46817	2570	55283	2382	25247
16-#14	2.41	MA	34895	7857	56380	5799	62176	4687	64825	3868	67731	2613	81633	2281	47543
3L-7S		MI	24295	7857	39440	5718	42266	4638	42849	3796	42332	2549	50179	1753	34105
16-#14	2.41	MA	34024	7857	54863	5820	60242	4706	62474	3861	64706	2626	78163	2157	47413
4L-6S		MI	24839	7857	40448	5700	43482	4622	44414	3808	44278	2536	52791	1884	34582
16-#14	2.41	MA	33247	7857	53551	5817	58540	4701	60384	3878	61678	2615	74537	2097	46852
5E		MI	25397	7857	41369	5706	44756	4631	45900	3794	46270	2524	55232	1966	35270
16-#14	2.41	MA	32507	7857	52321	5813	56837	4720	58301	3871	58934	2629	71092	2016	45743
6L-4S		MI	25983	7857	42350	5713	46026	4615	47461	3781	48471	2536	57842	2020	35707
16-#14	2.41	MA	31786	7857	50973	5834	55211	4715	56303	3888	56252	2642	67416	1886	45030
7L-3S		MI	26635	7857	43480	5694	47466	4624	49210	3793	50665	2524	60291	2145	35752
16-#14	2.41	MA	31076	7857	49763	5831	53563	4734	54352	3905	53403	2631	64026	1816	43581
8L-2S		MI	27551	7857	44856	5701	49231	4609	51363	3779	53536	2511	64083	2269	35738
16-#18	4.28	MA	36161	8825	61369	6393	68351	5151	72269	4132	77712	2517	96370	1635	77842
5E		MI	27400	8825	47080	6264	51879	5039	54404	4021	57459	2373	70299	1421	58108
16-#18	4.28	MA	34901	8825	59206	6385	65355	5139	68608	4116	72908	2539	90418	1490	75119
6L-4S		MI	28399	8825	48798	6278	54104	5013	57114	3999	61251	2395	74774	1517	59779
16-#18	4.28	MA	33675	8825	56836	6421	62496	5172	65093	4145	68213	2561	84061	1259	72262
7L-3S		MI	29510	8825	50774	6248	56621	5032	60151	4021	65028	2373	78969	1735	61312
18-#11	1.88	MA	33815	7583	53667	5647	58802	4581	60750	3801	62204	2640	74395	2384	37517
3L-8S		MI	23849	7583	38027	5562	40510	4521	40781	3745	39490	2577	46423	1955	27472
18-#11	1.88	MA	33201	7583	52608	5662	57453	4594	59110	3796	60093	2650	71953	2298	37483
4L-7S		MI	24227	7583	38660	5566	41372	4527	41800	3735	40948	2586	48141	2000	27689
18-#11	1.88	MA	32654	7583	51693	5660	56267	4591	57652	3808	57981	2643	69410	2256	37403
5L-6S		MI	24610	7583	39364	5553	42221	4516	42844	3725	42320	2577	49986	2091	28011

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis

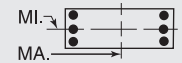


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.88	MA	32133	7583	50836	5657	55079	4605	56201	3804	56068	2653	66987	2200	36975
6L-5S		MI	25003	7583	40007	5557	43111	4521	43931	3733	43723	2568	51712	2147	28307
18-#11	1.88	MA	31625	7583	49897	5672	53946	4601	54808	3816	54199	2663	64404	2110	36443
7L-4S		MI	25416	7583	40692	5561	43998	4510	45022	3723	45272	2577	53550	2186	28325
18-#11	1.88	MA	31125	7583	49053	5670	52797	4615	53448	3829	52213	2656	62025	2061	36062
8L-3S		MI	25875	7583	41482	5548	45005	4516	46245	3730	46817	2568	55283	2272	28308
18-#11	1.88	MA	30603	7583	48228	5668	51680	4611	52026	3824	50361	2666	59676	2007	35306
9L-2S		MI	26522	7583	42446	5552	46241	4504	47752	3720	48839	2560	57961	2358	28280
18-#14	2.71	MA	34887	8013	56726	5918	62630	4776	65388	3903	68670	2614	83494	2131	53168
4L-7S		MI	24926	8013	40817	5815	44030	4708	45002	3839	45203	2532	53971	1718	38157
18-#14	2.71	MA	34114	8013	55414	5914	60928	4771	63297	3920	65642	2603	79868	2072	52440
5L-6S		MI	25467	8013	41825	5797	45247	4692	46567	3850	47149	2520	56583	1848	38736
18-#14	2.71	MA	33378	8013	54184	5910	59225	4790	61215	3913	62897	2616	76423	1991	51379
6L-5S		MI	26023	8013	42746	5803	46520	4701	48052	3837	49141	2507	59024	1930	39386
18-#14	2.71	MA	32662	8013	52836	5932	57599	4784	59216	3930	60216	2630	72747	1861	50585
7L-4S		MI	26605	8013	43726	5810	47791	4685	49613	3824	51342	2520	61634	1984	39970
18-#14	2.71	MA	31956	8013	51626	5928	55951	4804	57265	3948	57367	2619	69357	1791	49161
8L-3S		MI	27254	8013	44856	5792	49231	4694	51363	3835	53536	2507	64083	2109	40038
18-#14	2.71	MA	31229	8013	50322	5949	54347	4798	55225	3940	54710	2632	66017	1713	47895
9L-2S		MI	28167	8013	46233	5798	50996	4678	53516	3822	56407	2495	67875	2233	40056
18-#18	4.81	MA	36383	9102	62469	6558	69538	5264	73711	4192	79831	2516	99640	1439	84759
6L-5S		MI	28457	9102	49479	6437	54953	5163	58133	4095	62403	2340	76790	1349	65291
18-#18	4.81	MA	35167	9102	60099	6594	66679	5296	70196	4220	75136	2538	93283	1208	82006
7L-4S		MI	29449	9102	51196	6451	57178	5137	60843	4073	66195	2362	81265	1445	66861
20-#11	2.09	MA	33812	7691	53909	5729	59121	4643	61145	3825	62862	2642	75700	2281	41523
4L-8S		MI	24296	7691	38990	5629	41746	4570	42289	3774	41512	2566	49102	1931	30378
20-#11	2.09	MA	33267	7691	52994	5727	57935	4639	59687	3838	60750	2635	73157	2239	41427
5L-7S		MI	24673	7691	39624	5633	42608	4576	43308	3765	42970	2575	50819	1977	30619
20-#11	2.09	MA	32748	7691	52137	5725	56747	4653	58235	3833	58837	2645	70734	2183	40914
6E		MI	25055	7691	40328	5620	43457	4564	44352	3755	44342	2566	52665	2067	30926
20-#11	2.09	MA	32243	7691	51198	5740	55614	4649	56842	3846	56968	2655	68150	2093	40401
7L-5S		MI	25447	7691	40971	5624	44346	4570	45439	3762	45745	2558	54390	2124	31299
20-#11	2.09	MA	31745	7691	50354	5738	54465	4663	55483	3858	54981	2647	65772	2044	40028
8L-4S		MI	25858	7691	41656	5628	45234	4558	46529	3752	47294	2566	56228	2163	31331
20-#11	2.09	MA	31226	7691	49529	5735	53348	4660	54061	3853	53129	2657	63423	1990	39221
9L-3S		MI	26316	7691	42446	5615	46241	4564	47752	3760	48839	2558	57961	2249	31329
20-#11	2.09	MA	30676	7691	48605	5750	52214	4674	52708	3866	51293	2667	61146	1929	38600
10L-2S		MI	26961	7691	43410	5619	47477	4552	49260	3750	50861	2549	60640	2335	31307
20-#14	3.01	MA	34976	8168	57276	6011	63316	4840	66210	3963	69605	2590	85200	2046	58041
5L-7S		MI	25553	8168	42193	5912	45795	4778	47155	3881	48074	2516	57763	1682	42222
20-#14	3.01	MA	34245	8168	56047	6008	61613	4860	64128	3955	66861	2604	81754	1965	57023
6E		MI	26092	8168	43201	5894	47011	4762	48720	3893	50020	2503	60375	1812	42896
20-#14	3.01	MA	33532	8168	54699	6029	59987	4854	62129	3973	64180	2617	78079	1836	56130
7L-5S		MI	26645	8168	44122	5901	48285	4771	50205	3879	52012	2491	62816	1894	43514
20-#14	3.01	MA	32831	8168	53488	6025	58339	4873	60179	3990	61330	2606	74689	1766	54749
8L-4S		MI	27225	8168	45103	5907	49556	4755	51766	3866	54213	2503	65425	1949	44227
20-#14	3.01	MA	32121	8168	52185	6046	56735	4868	58139	3983	58673	2620	71348	1688	53421
9L-3S		MI	27871	8168	46233	5889	50996	4764	53516	3877	56407	2491	67875	2073	44316
20-#18	5.35	MA	36647	9379	63361	6767	70862	5420	75299	4296	82059	2515	102505	1157	91605
7L-5S		MI	29507	9379	51877	6610	58028	5287	61862	4169	67347	2306	83281	1277	72487
22-#11	2.29	MA	33877	7799	54296	5795	59603	4688	61722	3867	63518	2626	76903	2223	45449
5L-8S		MI	24742	7799	39954	5697	42982	4618	43796	3804	43534	2556	51780	1908	33249
22-#11	2.29	MA	33361	7799	53438	5792	58415	4701	60270	3863	61605	2636	74481	2167	44858
6L-7S		MI	25117	7799	40588	5701	43843	4624	44815	3794	44993	2564	53498	1954	33552
22-#11	2.29	MA	32857	7799	52499	5807	57282	4698	58877	3875	59736	2646	71897	2077	44363
7L-6S		MI	25498	7799	41292	5688	44693	4612	45859	3784	46364	2556	55343	2044	33846
22-#11	2.29	MA	32362	7799	51656	5805	56133	4712	57517	3888	57750	2639	69519	2028	43936
8L-5S		MI	25888	7799	41935	5692	45582	4618	46946	3791	47767	2547	57069	2101	34287

RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.29	MA	31845	7799	50830	5803	55015	4708	56096	3883	55897	2649	67169	1974	43141
9L-4S		MI	26298	7799	42620	5696	46470	4607	48037	3782	49316	2556	58907	2139	34330
22-#11	2.29	MA	31297	7799	49906	5818	53882	4722	54743	3895	54061	2659	64893	1913	42535
10L-3S		MI	26754	7799	43410	5683	47477	4612	49260	3789	50861	2547	60640	2226	34345
22-#11	2.29	MA	30763	7799	49079	5816	52770	4718	53339	3891	52103	2652	62574	1861	41579
11L-2S		MI	27397	7799	44374	5687	48712	4601	50767	3779	52883	2539	63318	2312	34330
22-#14	3.31	MA	35106	8324	57909	6105	64001	4930	67041	3998	70825	2591	87086	1940	62673
6L-7S		MI	26177	8324	43570	6010	47560	4848	49307	3924	50944	2499	61555	1646	46297
22-#14	3.31	MA	34397	8324	56562	6126	62375	4924	65043	4015	68144	2605	83410	1810	61686
7L-6S		MI	26714	8324	44578	5991	48776	4832	50872	3935	52891	2487	64167	1776	47061
22-#14	3.31	MA	33699	8324	55351	6122	60727	4943	63092	4033	65294	2594	80020	1740	60346
8L-5S		MI	27264	8324	45499	5998	50049	4841	52358	3922	54883	2474	66608	1858	47650
22-#14	3.31	MA	32990	8324	54047	6144	59123	4938	61052	4025	62637	2607	76679	1662	58957
9L-4S		MI	27841	8324	46479	6004	51320	4825	53919	3908	57084	2487	69217	1913	48478
24-#11	2.50	MA	33970	7907	54739	5860	60083	4750	62305	3892	64374	2627	78227	2150	48807
6L-8S		MI	25186	7907	40918	5764	44217	4667	45304	3833	45556	2545	54458	1885	36125
24-#11	2.50	MA	33469	7907	53800	5875	58950	4746	60912	3904	62505	2637	75643	2061	48328
7E		MI	25560	7907	41552	5768	45079	4672	46323	3823	47015	2554	56176	1931	36487
24-#11	2.50	MA	32975	7907	52957	5872	57801	4760	59552	3917	60518	2630	73265	2011	47840
8L-6S		MI	25939	7907	42256	5755	45928	4661	47367	3813	48386	2545	58021	2021	36769
24-#11	2.50	MA	32461	7907	52131	5870	56683	4757	58130	3912	58666	2640	70916	1958	47066
9L-5S		MI	26328	7907	42899	5759	46818	4667	48454	3821	49789	2537	59747	2077	37271
24-#11	2.50	MA	31916	7907	51207	5885	55550	4770	56778	3925	56830	2650	68640	1897	46419
10L-4S		MI	26736	7907	43584	5763	47706	4655	49544	3811	51338	2545	61585	2116	37326
24-#11	2.50	MA	31383	7907	50380	5883	54438	4767	55374	3920	54871	2643	66321	1844	45482
11L-3S		MI	27191	7907	44374	5750	48712	4661	50767	3818	52883	2537	63318	2202	37352
24-#14	3.61	MA	35257	8480	58425	6223	64763	4994	67956	4058	72107	2593	88741	1785	67252
7E		MI	26798	8480	44946	6107	49324	4917	51460	3966	53815	2483	65347	1610	50382
24-#14	3.61	MA	34563	8480	57214	6220	63115	5013	66005	4075	69258	2581	85351	1715	65950
8L-6S		MI	27332	8480	45954	6089	50541	4902	53025	3977	55762	2470	67959	1741	51230
24-#14	3.61	MA	33855	8480	55910	6241	61511	5008	63965	4067	66601	2595	82011	1637	64501
9L-5S		MI	27880	8480	46875	6095	51814	4911	54511	3964	57754	2458	70400	1822	51794

RECTANGULAR TIED COLUMNS 34" x 46"

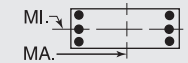
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.02	MA	35090	7466	54334	5581	58495	4555	59264	3809	58244	2767	67853	2621	22584
2E		MI	25720	7466	40327	5446	42843	4444	43055	3711	41691	2672	48036	2504	16385
6-#18	1.53	MA	36702	7743	57769	5753	62899	4679	64638	3884	65555	2745	77623	2573	33409
2L-3S		MI	25194	7743	40327	5605	42843	4594	43055	3807	41691	2660	48036	2211	24154
6-#18	1.53	MA	34377	7743	54334	5746	58495	4712	59264	3914	58244	2768	67853	2352	33454
3L-2S		MI	26808	7743	42725	5619	45918	4568	46784	3785	46635	2638	54527	2432	24027
8-#14	1.15	MA	35582	7535	55131	5658	59737	4614	60863	3852	60453	2780	71096	2640	25460
2L-4S		MI	24475	7535	38382	5547	40564	4520	40401	3768	38376	2723	44208	2280	18582
8-#14	1.15	MA	34244	7535	53171	5655	57224	4609	57797	3870	56282	2794	65457	2516	25518
3E		MI	25141	7535	39512	5529	42004	4529	42151	3779	40570	2710	46657	2404	18504
8-#14	1.15	MA	33307	7535	51577	5676	55191	4629	55327	3863	53103	2809	61782	2391	25532
4L-2S		MI	26075	7535	40889	5536	43768	4513	44304	3766	43441	2698	50449	2529	18426
8-#18	2.05	MA	38293	8019	61205	5926	67304	4803	70011	3960	72866	2723	87392	2525	44183
2L-4S		MI	25136	8019	40749	5808	43401	4699	43748	3859	42858	2649	50333	1921	31574
8-#18	2.05	MA	35989	8019	57769	5919	62899	4836	64638	3989	65555	2745	77623	2303	44129
3E		MI	26283	8019	42725	5778	45918	4718	46784	3881	46635	2627	54527	2138	31681
8-#18	2.05	MA	34370	8019	54967	5956	59328	4825	60297	3975	59969	2768	71272	2082	43726
4L-2S		MI	27885	8019	45123	5791	48992	4692	50512	3859	51579	2604	61019	2360	31605

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

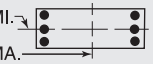


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.44	MA	36509	7691	57091	5755	62249	4684	63928	3894	64624	2768	76736	2616	31620
2L-5S		MI	24519	7691	38778	5638	41058	4606	40993	3824	39047	2694	45390	2189	22906
10-#14	1.44	MA	35178	7691	55131	5752	59737	4679	60863	3912	60453	2782	71096	2492	31658
3L-4S		MI	25115	7691	39759	5645	42329	4590	42554	3810	41247	2706	48000	2244	22910
10-#14	1.44	MA	34246	7691	53537	5774	57704	4699	58392	3905	57274	2796	67422	2367	31626
4L-3S		MI	25777	7691	40889	5626	43768	4599	44304	3822	43441	2694	50449	2368	22857
10-#14	1.44	MA	33413	7691	52158	5770	55916	4694	56195	3923	54091	2786	63593	2307	31469
5L-2S		MI	26707	7691	42265	5633	45533	4583	46457	3808	46312	2681	54241	2493	22791
10-#18	2.56	MA	39868	8296	64641	6099	71708	4927	75384	4035	80177	2701	97162	2476	54918
2L-5S		MI	25200	8296	41430	5967	44250	4849	44766	3955	44009	2593	52349	1752	36952
10-#18	2.56	MA	37582	8296	61205	6092	67304	4961	70011	4065	72866	2723	87392	2255	54774
3L-4S		MI	26223	8296	43147	5981	46475	4823	47476	3933	47802	2615	56824	1849	38957
10-#18	2.56	MA	35978	8296	58402	6129	63732	4950	65670	4050	67279	2746	81042	2033	54270
4L-3S		MI	27361	8296	45123	5951	48992	4842	50512	3955	51579	2593	61019	2066	39154
10-#18	2.56	MA	34545	8296	55978	6121	60588	4983	61807	4080	61685	2724	74384	1929	51239
5L-2S		MI	28953	8296	47522	5964	52067	4816	54241	3933	56523	2571	67510	2288	39145
12-#11	1.20	MA	35776	7560	55414	5691	60210	4640	61483	3871	61316	2787	72414	2652	26539
2L-6S		MI	24285	7560	38007	5575	40110	4555	39876	3794	37646	2730	43490	2277	19349
12-#11	1.20	MA	34842	7560	54046	5689	58456	4636	59343	3883	58404	2798	68453	2566	26574
3L-5S		MI	24683	7560	38650	5579	41000	4561	40962	3801	39049	2721	45216	2334	19335
12-#11	1.20	MA	34189	7560	52934	5704	57038	4651	57620	3879	56186	2808	65869	2480	26595
4E		MI	25101	7560	39335	5584	41888	4550	42053	3792	40599	2730	47054	2372	19295
12-#11	1.20	MA	33606	7560	51973	5702	55792	4647	56089	3892	53968	2802	63185	2437	26570
5L-3S		MI	25566	7560	40125	5570	42894	4555	43276	3799	42144	2721	48787	2459	19246
12-#11	1.20	MA	33051	7560	51073	5700	54545	4662	54564	3888	51958	2812	60622	2381	26479
6L-2S		MI	26220	7560	41089	5574	44130	4544	44784	3789	44166	2713	51465	2545	19199
12-#14	1.73	MA	37428	7847	59052	5853	64762	4754	66993	3937	68794	2755	82376	2592	37766
2L-6S		MI	24592	7847	39234	5729	41549	4667	41660	3879	39926	2690	46741	2072	26470
12-#14	1.73	MA	36104	7847	57091	5849	62249	4749	63928	3955	64624	2769	76736	2468	37777
3L-5S		MI	25157	7847	40154	5735	42822	4676	43146	3866	41918	2677	49182	2154	27175
12-#14	1.73	MA	35178	7847	55497	5871	60217	4769	61457	3948	61444	2784	73062	2343	37707
4E		MI	25749	7847	41135	5742	44093	4660	44707	3853	44118	2690	51792	2208	27220
12-#14	1.73	MA	34350	7847	54118	5868	58429	4764	59260	3966	58262	2773	69232	2283	37510
5L-3S		MI	26409	7847	42265	5724	45533	4669	46457	3864	46312	2677	54241	2333	27189
12-#14	1.73	MA	33563	7847	52827	5864	56639	4783	57073	3959	55379	2788	65586	2202	36358
6L-2S		MI	27334	7847	43642	5730	47298	4653	48609	3851	49183	2665	58033	2457	27137
12-#18	3.07	MA	39158	8573	64641	6265	71708	5085	75384	4140	80177	2701	97162	2207	65400
3L-5S		MI	26284	8573	43828	6140	47325	4973	48495	4029	48954	2559	58840	1680	44069
12-#18	3.07	MA	37568	8573	61838	6302	68137	5074	71043	4126	74590	2724	90811	1985	64808
4E		MI	27300	8573	45546	6154	49550	4947	51205	4007	52746	2582	63315	1777	46036
12-#18	3.07	MA	36149	8573	59414	6294	64993	5107	67180	4155	68995	2702	84154	1881	61514
5L-3S		MI	28430	8573	47522	6123	52067	4966	54241	4029	56523	2559	67510	1994	46595
12-#18	3.07	MA	34799	8573	57140	6287	61844	5096	63332	4141	63925	2725	77845	1737	59288
6L-2S		MI	30011	8573	49920	6137	55142	4941	57970	4007	61467	2537	74001	2216	46665
14-#11	1.40	MA	36426	7668	56783	5758	61965	4688	63623	3900	64228	2779	76374	2637	30836
2L-7S		MI	24349	7668	38267	5656	40497	4615	40339	3833	38297	2728	44323	2163	21963
14-#11	1.40	MA	35495	7668	55414	5756	60210	4685	61483	3913	61316	2789	72414	2550	30862
3L-6S		MI	24736	7668	38971	5643	41346	4604	41383	3824	39668	2719	46169	2254	22331
14-#11	1.40	MA	34845	7668	54302	5772	58793	4699	59760	3909	59098	2800	69830	2464	30864
4L-5S		MI	25133	7668	39614	5647	42236	4609	42470	3831	41071	2710	47894	2310	22357
14-#11	1.40	MA	34264	7668	53342	5770	57547	4696	58229	3921	56880	2793	67146	2422	30818
5L-4S		MI	25549	7668	40299	5651	43123	4598	43561	3821	42621	2719	49732	2349	22331
14-#11	1.40	MA	33712	7668	52442	5768	56300	4710	56704	3917	54870	2804	64583	2366	30675
6L-3S		MI	26013	7668	41089	5638	44130	4604	44784	3828	44166	2710	51465	2435	22291
14-#11	1.40	MA	33174	7668	51455	5783	55110	4707	55241	3930	52907	2814	61851	2276	30038
7L-2S		MI	26665	7668	42053	5642	45366	4592	46291	3819	46188	2702	54144	2522	22249
14-#14	2.01	MA	38342	8002	61012	5950	67275	4824	70059	3979	72965	2743	88016	2569	43905
2L-7S		MI	24681	8002	39602	5844	42097	4752	42248	3910	40850	2685	47921	1905	30165

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis



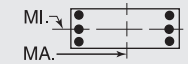
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
14-#14	2.01	MA	37025	8002	59052	5947	64762	4819	66993	3997	68794	2757	82376	2444	43880
3L-6S		MI	25229	8002	40610	5826	43313	4736	43813	3922	42797	2673	50533	2036	30606
14-#14	2.01	MA	36103	8002	57457	5968	62729	4838	64523	3990	65615	2771	78702	2320	43778
4L-5S		MI	25791	8002	41531	5833	44587	4746	45299	3908	44789	2661	52974	2118	31356
14-#14	2.01	MA	35281	8002	56078	5965	60942	4833	62326	4008	62433	2761	74872	2259	43547
5L-4S		MI	26380	8002	42512	5839	45858	4730	46860	3895	46989	2673	55584	2172	31507
14-#14	2.01	MA	34498	8002	54787	5962	59152	4853	60138	4001	59550	2775	71226	2178	42270
6L-3S		MI	27037	8002	43642	5821	47298	4739	48609	3907	49183	2661	58033	2297	31508
14-#14	2.01	MA	33736	8002	53372	5983	57445	4848	58039	4019	56733	2790	67337	2049	41471
7L-2S		MI	27958	8002	45018	5827	49062	4723	50762	3893	52054	2648	61825	2421	31470
14-#18	3.58	MA	39142	8849	65274	6474	72541	5198	76417	4201	81901	2702	100581	1937	74992
4L-5S		MI	27359	8849	46227	6313	50400	5097	52223	4102	53898	2526	65332	1608	51213
14-#18	3.58	MA	37735	8849	62849	6467	69397	5231	72553	4231	76306	2680	93924	1832	71816
5L-4S		MI	28367	8849	47944	6327	52624	5071	54933	4080	57690	2548	69807	1705	53047
14-#18	3.58	MA	36398	8849	60576	6460	66249	5220	68705	4216	71235	2703	87614	1688	69395
6L-3S		MI	29490	8849	49920	6296	55142	5090	57970	4102	61467	2526	74001	1922	54016
14-#18	3.58	MA	35095	8849	58085	6496	63244	5253	65012	4246	66280	2725	80879	1457	66146
7L-2S		MI	31060	8849	52318	6310	58216	5065	61698	4080	66411	2504	80493	2144	54140
16-#11	1.60	MA	37072	7776	58151	5826	63719	4736	65764	3929	67140	2770	80335	2621	35126
2L-8S		MI	24420	7776	38598	5719	40871	4658	40827	3873	38861	2708	45284	2095	24663
16-#11	1.60	MA	36145	7776	56783	5824	61965	4733	63623	3942	64228	2781	76374	2535	35143
3L-7S		MI	24800	7776	39231	5723	41732	4664	41847	3863	40319	2717	47002	2140	24887
16-#11	1.60	MA	35497	7776	55671	5839	60547	4747	61900	3938	62010	2791	73791	2449	35124
4L-6S		MI	25186	7776	39935	5710	42582	4652	42891	3853	41690	2708	48847	2231	25233
16-#11	1.60	MA	34919	7776	54710	5837	59301	4744	60369	3951	59792	2784	71106	2406	35060
5E		MI	25581	7776	40578	5714	43471	4658	43977	3860	43093	2700	50573	2287	25372
16-#11	1.60	MA	34369	7776	53810	5835	58054	4758	58845	3947	57782	2795	68544	2350	34802
6L-4S		MI	25996	7776	41263	5718	44359	4646	45068	3850	44643	2708	52411	2326	25358
16-#11	1.60	MA	33834	7776	52824	5851	56864	4755	57382	3959	55819	2805	65812	2261	34193
7L-3S		MI	26457	7776	42053	5705	45366	4652	46291	3858	46188	2700	54144	2412	25327
16-#11	1.60	MA	33306	7776	51938	5849	55658	4769	55954	3972	53733	2799	63302	2211	33769
8L-2S		MI	27107	7776	43017	5709	46601	4641	47799	3848	48210	2691	56822	2498	25291
16-#14	2.30	MA	37939	8158	61012	6044	67275	4888	70059	4039	72965	2745	88016	2420	49973
3L-7S		MI	25317	8158	40978	5942	43862	4822	44401	3953	43721	2669	51713	1870	34331
16-#14	2.30	MA	37022	8158	59417	6066	65242	4908	67588	4032	69786	2759	84342	2296	49843
4L-6S		MI	25862	8158	41987	5923	45078	4806	45966	3964	45668	2656	54325	2000	34753
16-#14	2.30	MA	36204	8158	58039	6062	63454	4903	65391	4050	66603	2748	80512	2235	49417
5E		MI	26421	8158	42907	5930	46352	4815	47451	3951	47660	2644	56766	2082	35458
16-#14	2.30	MA	35426	8158	56747	6059	61665	4923	63204	4044	63720	2763	76866	2155	48194
6L-4S		MI	27008	8158	43888	5936	47622	4799	49012	3937	49860	2656	59376	2136	35784
16-#14	2.30	MA	34669	8158	55332	6081	59958	4918	61105	4061	60904	2777	72976	2025	47421
7L-3S		MI	27661	8158	45018	5918	49062	4809	50762	3949	52054	2644	61825	2261	35817
16-#14	2.30	MA	33922	8158	54060	6077	58226	4938	59056	4079	57911	2767	69396	1954	46011
8L-2S		MI	28578	8158	46395	5925	50827	4793	52915	3936	54925	2632	65617	2386	35792
16-#18	4.09	MA	39307	9126	66285	6640	73802	5355	77927	4306	83617	2658	103694	1784	82143
5E		MI	28426	9126	48625	6486	53474	5221	55952	4176	58842	2492	71823	1536	58379
16-#18	4.09	MA	37981	9126	64012	6632	70653	5344	74079	4292	78546	2680	97384	1640	79532
6L-4S		MI	29427	9126	50342	6500	55699	5196	58662	4154	62634	2514	76298	1633	60096
16-#18	4.09	MA	36690	9126	61521	6669	67649	5378	70385	4321	73591	2703	90649	1409	76397
7L-3S		MI	30542	9126	52318	6469	58216	5214	61698	4176	66411	2492	80493	1850	61422
16-#18	4.09	MA	35419	9126	59282	6662	64601	5367	66779	4351	68325	2681	84425	1286	72643
8L-2S		MI	32103	9126	54717	6483	61291	5189	65427	4154	71355	2470	86984	2072	61596
18-#11	1.80	MA	36791	7884	58151	5891	63719	4782	65764	3972	67140	2772	80335	2520	39413
3L-8S		MI	24870	7884	39562	5787	42107	4706	42335	3902	40883	2698	47962	2071	27599

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

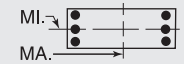


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
18-#11	1.80	MA	36146	7884	57039	5907	62302	4796	64041	3967	64922	2782	77752	2433	39379
4L-7S		MI	25249	7884	40195	5791	42968	4712	43354	3892	42341	2706	49680	2117	27815
18-#11	1.80	MA	35571	7884	56079	5905	61056	4793	62509	3980	62703	2776	75067	2391	39298
5L-6S		MI	25633	7884	40899	5778	43817	4701	44398	3882	43712	2698	51525	2207	28143
18-#11	1.80	MA	35023	7884	55179	5903	59808	4807	60985	3976	60694	2786	72505	2335	38938
6L-5S		MI	26027	7884	41542	5782	44707	4706	45485	3890	45115	2689	53251	2264	28371
18-#11	1.80	MA	34490	7884	54192	5918	58619	4804	59522	3989	58731	2797	69773	2245	38353
7L-4S		MI	26440	7884	42227	5786	45595	4695	46576	3880	46665	2698	55089	2302	28378
18-#11	1.80	MA	33964	7884	53307	5916	57412	4818	58094	4002	56645	2790	67262	2195	37940
8L-3S		MI	26900	7884	43017	5773	46601	4700	47799	3887	48210	2689	56822	2389	28356
18-#11	1.80	MA	33407	7884	52440	5914	56239	4815	56601	3997	54700	2801	64778	2142	37225
9L-2S		MI	27548	7884	43981	5777	47837	4689	49306	3877	50232	2681	59500	2475	28326
18-#14	2.59	MA	37935	8313	61377	6163	67755	4978	70653	4075	73956	2747	89982	2272	55902
4L-7S		MI	25948	8313	42355	6039	45627	4892	46554	3995	46592	2652	55505	1834	38443
18-#14	2.59	MA	37122	8313	59999	6159	65967	4973	68457	4093	70774	2736	86152	2211	55299
5L-6S		MI	26491	8313	43363	6021	46843	4876	48119	4007	48538	2640	58117	1964	38907
18-#14	2.59	MA	36348	8313	58707	6156	64177	4993	66269	4086	67891	2750	82506	2131	54127
6L-5S		MI	27048	8313	44284	6027	48116	4885	49604	3993	50531	2628	60558	2046	39574
18-#14	2.59	MA	35595	8313	57292	6178	62470	4988	64170	4104	65075	2765	78616	2001	53377
7L-4S		MI	27631	8313	45265	6034	49387	4869	51165	3980	52731	2640	63167	2101	40052
18-#14	2.59	MA	34853	8313	56020	6175	60739	5008	62121	4122	62081	2754	75036	1930	51887
8L-3S		MI	28282	8313	46395	6015	50827	4878	52915	3991	54925	2628	65617	2225	40107
18-#14	2.59	MA	34074	8313	54776	6171	59054	5002	59978	4115	59290	2769	71500	1852	50687
9L-2S		MI	29196	8313	47771	6022	52592	4862	55068	3978	57796	2615	69409	2350	40106
18-#18	4.60	MA	39550	9403	67447	6805	75058	5468	79452	4367	85857	2658	107154	1592	89695
6L-5S		MI	29485	9403	51023	6659	56549	5345	59681	4250	63786	2459	78314	1464	65561
18-#18	4.60	MA	38270	9403	64957	6842	72053	5502	75758	4397	80901	2681	100419	1361	86668
7L-4S		MI	30479	9403	52741	6673	58774	5320	62391	4228	67578	2481	82789	1560	67174
18-#18	4.60	MA	37010	9403	62718	6835	69006	5491	72152	4426	75636	2659	94195	1238	82804
8L-3S		MI	31586	9403	54717	6642	61291	5338	65427	4250	71355	2459	86984	1778	68816
20-#11	1.99	MA	36792	7992	58408	5974	64056	4844	66181	3997	67834	2774	81713	2418	43629
4L-8S		MI	25319	7992	40525	5854	43342	4755	43842	3932	42905	2687	50641	2048	30536
20-#11	1.99	MA	36219	7992	57447	5972	62810	4841	64650	4010	65615	2767	79028	2375	43533
5L-7S		MI	25696	7992	41159	5858	44204	4761	44862	3922	44363	2696	52358	2094	30746
20-#11	1.99	MA	35674	7992	56547	5970	61563	4855	63125	4005	63606	2778	76466	2320	43081
6E		MI	26078	7992	41863	5845	45053	4749	45906	3912	45734	2687	54204	2184	31058
20-#11	1.99	MA	35142	7992	55561	5985	60373	4852	61662	4018	61643	2788	73734	2230	42517
7L-5S		MI	26471	7992	42506	5849	45943	4755	46992	3919	47137	2679	55929	2241	31368
20-#11	1.99	MA	34619	7992	54675	5983	59167	4866	60234	4031	59557	2781	71223	2180	42113
8L-4S		MI	26883	7992	43191	5853	46830	4743	48083	3909	48687	2687	57767	2279	31392
20-#11	1.99	MA	34065	7992	53809	5981	57993	4863	58741	4027	57612	2792	68739	2126	41345
9L-3S		MI	27341	7992	43981	5840	47837	4749	49306	3917	50232	2679	59500	2366	31379
20-#11	1.99	MA	33487	7992	52839	5997	56803	4877	57321	4040	55684	2803	66330	2065	40671
10L-2S		MI	27987	7992	44945	5844	49073	4737	50814	3907	52254	2670	62179	2452	31355
20-#14	2.88	MA	38034	8469	61959	6257	68480	5043	71522	4135	74944	2724	91792	2187	61194
5L-7S		MI	26577	8469	43731	6136	47391	4962	48706	4037	49463	2636	59297	1798	42505
20-#14	2.88	MA	37265	8469	60667	6253	66690	5063	69334	4128	72062	2738	88146	2107	60068
6E		MI	27117	8469	44740	6118	48607	4946	50271	4049	51409	2623	61909	1928	43068
20-#14	2.88	MA	36515	8469	59252	6275	64983	5058	67235	4146	69245	2752	84256	1977	59288
7L-5S		MI	27671	8469	45660	6124	49881	4955	51757	4036	53402	2611	64350	2010	43700
20-#14	2.88	MA	35778	8469	57980	6272	63251	5077	65186	4164	66252	2742	80675	1906	57772
8L-4S		MI	28252	8469	46641	6131	51152	4939	53318	4022	55602	2623	66959	2065	44313
20-#14	2.88	MA	35004	8469	56737	6269	61567	5072	63044	4157	63461	2756	77140	1829	56508
9L-3S		MI	28899	8469	47771	6113	52592	4948	55068	4034	57796	2611	69409	2189	44389
20-#14	2.88	MA	34188	8469	55344	6290	59859	5092	61006	4175	60694	2771	73713	1741	54844
10L-2S		MI	29809	8469	49148	6119	54356	4932	57220	4020	60667	2599	73201	2314	44415
20-#18	5.12	MA	39836	9679	68392	7015	76458	5626	81131	4472	88212	2659	110189	1312	96956
7L-5S		MI	30536	9679	53422	6832	59623	5469	63409	4324	68730	2425	84806	1392	72756
20-#18	5.12	MA	38586	9679	66154	7008	73410	5615	77526	4502	82946	2637	103965	1189	92984
8L-4S		MI	31524	9679	55139	6845	61848	5444	66119	4302	72522	2447	89281	1488	74278

RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

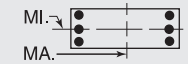
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.19	MA	36864	8100	58816	6040	64564	4890	66790	4039	68527	2759	82989	2360	47765
5L-8S		MI	25765	8100	41489	5922	44578	4803	45350	3961	44927	2676	53319	2025	33455
22-#11	2.19	MA	36321	8100	57916	6038	63317	4904	65265	4035	66518	2769	80426	2304	47231
6L-7S		MI	26141	8100	42123	5926	45440	4809	46369	3951	46385	2685	55037	2070	33680
22-#11	2.19	MA	35792	8100	56929	6053	62128	4900	63802	4048	64555	2780	77695	2214	46686
7L-6S		MI	26522	8100	42827	5913	46289	4797	47413	3941	47756	2676	56882	2161	33978
22-#11	2.19	MA	35271	8100	56044	6051	60921	4915	62375	4061	62469	2773	75184	2164	46290
8L-5S		MI	26913	8100	43470	5917	47178	4803	48500	3949	49159	2668	58607	2217	34359
22-#11	2.19	MA	34719	8100	55177	6049	59747	4911	60882	4056	60524	2783	72699	2111	45471
9L-4S		MI	27323	8100	44155	5921	48066	4792	49591	3939	50709	2676	60446	2256	34394
22-#11	2.19	MA	34143	8100	54207	6064	58557	4925	59461	4069	58596	2794	70291	2050	44813
10L-3S		MI	27780	8100	44945	5908	49073	4797	50814	3946	52254	2668	62179	2342	34398
22-#11	2.19	MA	33581	8100	53339	6062	57390	4922	57987	4065	56539	2787	67843	1997	43889
11L-2S		MI	28424	8100	45909	5912	50309	4786	52321	3936	54276	2659	64857	2429	34380
22-#14	3.16	MA	38175	8625	62627	6351	69203	5132	72400	4171	76232	2726	93785	2083	66016
6L-7S		MI	27201	8625	45108	6233	49156	5032	50859	4080	52334	2619	63089	1762	46577
22-#14	3.16	MA	37430	8625	61212	6372	67496	5127	70301	4189	73416	2740	89896	1953	65138
7L-6S		MI	27739	8625	46116	6215	50372	5016	52424	4091	54280	2607	65701	1893	47234
22-#14	3.16	MA	36697	8625	59940	6369	65764	5147	68252	4207	70422	2729	86315	1882	63665
8L-5S		MI	28291	8625	47037	6222	51646	5025	53910	4078	56273	2594	68142	1974	47836
22-#14	3.16	MA	35940	8625	58697	6366	64080	5142	66109	4200	67632	2744	82780	1805	62339
9L-4S		MI	28869	8625	48018	6228	52916	5009	55471	4065	58473	2607	70751	2029	48569
22-#14	3.16	MA	35115	8625	57304	6387	62371	5162	64071	4218	64865	2758	79353	1717	60712
10L-3S		MI	29514	8625	49148	6210	54356	5018	57220	4076	60667	2594	73201	2153	48664
22-#18	5.63	MA	40150	9956	69590	7181	77815	5739	82899	4577	90257	2615	113735	1141	103182
8L-5S		MI	31581	9956	55820	7005	62698	5593	67138	4398	73674	2392	91297	1320	79964
24-#11	2.39	MA	36965	8208	59284	6105	65071	4952	67405	4064	69430	2760	84387	2289	51386
6L-8S		MI	26209	8208	42453	5989	45814	4852	46857	3990	46949	2666	55997	2002	36330
24-#11	2.39	MA	36439	8208	58298	6120	63882	4949	65943	4077	67467	2771	81656	2199	50857
7E		MI	26584	8208	43087	5993	46675	4857	47877	3980	48407	2674	57715	2047	36615
24-#11	2.39	MA	35920	8208	57412	6118	62675	4963	64515	4090	65381	2764	79145	2149	50451
8L-6S		MI	26964	8208	43791	5980	47525	4846	48921	3971	49778	2666	59560	2138	36902
24-#11	2.39	MA	35371	8208	56546	6116	61502	4960	63022	4086	63436	2775	76660	2095	49602
9L-5S		MI	27353	8208	44434	5984	48414	4852	50007	3978	51181	2657	61286	2194	37347
24-#11	2.39	MA	34797	8208	55576	6132	60311	4974	61602	4098	61508	2785	74252	2035	48959
10L-4S		MI	27762	8208	45119	5988	49302	4840	51098	3968	52731	2666	63124	2233	37392
24-#11	2.39	MA	34236	8208	54707	6130	59144	4971	60128	4094	59451	2779	71804	1982	47998
11L-3S		MI	28218	8208	45909	5975	50309	4846	52321	3975	54276	2657	64857	2319	37413
24-#11	2.39	MA	33687	8208	53755	6145	57962	4985	58710	4107	57524	2789	69045	1905	47171
12L-2S		MI	28860	8208	46873	5979	51544	4834	53829	3966	56298	2649	67535	2405	37401
24-#14	3.45	MA	38340	8780	63172	6470	70008	5197	73366	4231	77586	2727	95536	1929	70998
7E		MI	27823	8780	46484	6331	50920	5102	53012	4122	55205	2603	66881	1726	50660
24-#14	3.45	MA	37610	8780	61901	6466	68277	5217	71317	4249	74593	2717	91955	1858	69566
8L-6S		MI	28359	8780	47493	6312	52137	5086	54577	4134	57151	2590	69493	1857	51403
24-#14	3.45	MA	36854	8780	60657	6463	66593	5212	69175	4242	71802	2731	88419	1781	68178
9L-5S		MI	28908	8780	48413	6319	53410	5095	56062	4120	59144	2578	71934	1939	51979
24-#14	3.45	MA	36037	8780	59264	6485	64884	5232	67136	4260	69035	2746	84993	1693	66587
10L-4S		MI	29483	8780	49394	6325	54681	5079	57623	4107	61344	2590	74543	1993	52820

RECTANGULAR TIED COLUMNS 34" x 48"

6-#18	1.47	MA	39799	8043	62420	5998	67979	4880	69802	4055	70609	2876	83673	2708	35029
2L-3S		MI	26217	8043	41871	5827	44439	4776	44603	3962	43073	2779	49560	2326	24214
6-#18	1.47	MA	37353	8043	58811	5991	63353	4914	64158	4086	62930	2900	73355	2487	35074
3L-2S		MI	27832	8043	44270	5840	47513	4751	48332	3940	48018	2757	56051	2547	24079
8-#14	1.10	MA	38613	7836	59642	5902	64648	4815	65826	4022	65237	2911	76746	2773	26675
2L-4S		MI	25498	7836	39920	5771	42160	4704	41953	3924	39766	2843	45742	2396	18628
8-#14	1.10	MA	37206	7836	57585	5899	62011	4811	62609	4041	60859	2926	70798	2648	26733
3E		MI	26164	7836	41051	5753	43600	4713	43703	3936	41960	2830	48191	2521	18545

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

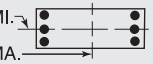
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.10	MA	36222	7836	55912	5921	59879	4831	60018	4034	57525	2941	66918	2524	26747
4L-2S		MI	27098	7836	42427	5759	45365	4697	45856	3922	44831	2818	51983	2645	18466
8-#18	1.96	MA	41480	8320	66028	6171	72605	5004	75446	4130	78288	2854	93991	2662	46343
2L-4S		MI	26158	8320	42294	6030	44996	4881	45295	4014	44240	2768	51857	2036	31680
8-#18	1.96	MA	39055	8320	62420	6164	67979	5038	69802	4161	70609	2878	83673	2441	46289
3E		MI	27307	8320	44270	5999	47513	4900	48332	4036	48018	2746	56051	2254	31750
8-#18	1.96	MA	37354	8320	59480	6201	64232	5028	65247	4148	64748	2902	76958	2220	45886
4L-2S		MI	28911	8320	46668	6013	50588	4875	52060	4014	52962	2724	62543	2475	31664
10-#14	1.38	MA	39590	7991	61699	6000	67286	4885	69044	4065	69614	2899	82695	2750	33139
2L-5S		MI	25541	7991	40316	5862	42654	4790	42545	3980	40436	2814	46924	2306	22977
10-#14	1.38	MA	38191	7991	59642	5997	64648	4880	65826	4083	65237	2914	76746	2626	33177
3L-4S		MI	26137	7991	41297	5868	43925	4774	44106	3967	42637	2826	49534	2360	22963
10-#14	1.38	MA	37213	7991	57970	6019	62517	4901	63235	4077	61903	2929	72867	2501	33145
4L-3S		MI	26800	7991	42427	5850	45365	4783	45856	3978	44831	2814	51983	2485	22903
10-#14	1.38	MA	36340	7991	56525	6016	60643	4896	60933	4095	58567	2919	68834	2440	32987
5L-2S		MI	27731	7991	43804	5857	47129	4767	48008	3965	47702	2801	55775	2609	22835
10-#18	2.45	MA	43143	8597	69637	6343	77232	5128	81089	4206	85966	2832	104309	2617	57618
2L-5S		MI	26221	8597	42975	6189	45846	5031	46314	4110	45392	2712	53873	1867	37222
10-#18	2.45	MA	40737	8597	66028	6337	72605	5162	75446	4236	78288	2856	93991	2395	57474
3L-4S		MI	27246	8597	44692	6203	48071	5006	49024	4088	49184	2734	58348	1964	39075
10-#18	2.45	MA	39051	8597	63088	6374	68858	5152	70891	4223	72426	2880	87277	2174	56970
4L-3S		MI	28386	8597	46668	6172	50588	5024	52060	4110	52962	2712	62543	2182	39238
10-#18	2.45	MA	37548	8597	60546	6368	65561	5186	66839	4254	66558	2859	80257	2068	53984
5L-2S		MI	29980	8597	49066	6186	53662	4999	55789	4088	57906	2690	69034	2403	39211
12-#11	1.15	MA	38816	7861	59935	5935	65141	4841	66472	4041	66135	2918	78118	2784	27802
2L-6S		MI	25307	7861	39542	5800	41707	4740	41429	3951	39039	2850	45029	2394	19406
12-#11	1.15	MA	37834	7861	58499	5933	63300	4838	64227	4054	63080	2929	73943	2698	27837
3L-5S		MI	25705	7861	40185	5804	42596	4746	42516	3959	40442	2842	46755	2450	19381
12-#11	1.15	MA	37149	7861	57333	5949	61814	4852	62420	4050	60755	2940	71218	2612	27859
4E		MI	26123	7861	40870	5808	43484	4734	43607	3949	41991	2850	48593	2489	19336
12-#11	1.15	MA	36537	7861	56327	5947	60509	4849	60816	4064	58430	2934	68392	2569	27833
5L-3S		MI	26589	7861	41660	5795	44491	4740	44830	3956	43537	2842	50326	2575	19285
12-#11	1.15	MA	35956	7861	55384	5946	59202	4864	59218	4060	56325	2945	65689	2513	27743
6L-2S		MI	27243	7861	42624	5799	45726	4729	46338	3946	45559	2833	53004	2662	19236
12-#14	1.65	MA	40561	8147	63757	6097	69923	4955	72261	4107	73992	2886	88644	2728	39588
2L-6S		MI	25614	8147	40772	5953	43145	4851	43212	4036	41315	2810	48275	2188	26636
12-#14	1.65	MA	39168	8147	61699	6094	67286	4950	69044	4126	69614	2901	82695	2603	39599
3L-5S		MI	26180	8147	41693	5959	44418	4860	44698	4022	43307	2797	50716	2270	27253
12-#14	1.65	MA	38195	8147	60027	6116	65154	4970	66453	4119	66280	2916	78816	2478	39529
4E		MI	26773	8147	42673	5966	45689	4844	46259	4009	45508	2810	53326	2324	27279
12-#14	1.65	MA	37328	8147	58583	6113	63281	4966	64150	4138	62944	2907	74783	2417	39332
5L-3S		MI	27433	8147	43804	5947	47129	4853	48008	4021	47702	2797	55775	2449	27241
12-#14	1.65	MA	36502	8147	57229	6110	61405	4986	61858	4131	59923	2922	70934	2337	38227
6L-2S		MI	28359	8147	45180	5954	48894	4837	50161	4007	50573	2785	59567	2573	27185
12-#18	2.94	MA	42401	8873	69637	6510	77232	5287	81089	4312	85966	2834	104309	2350	68640
3L-5S		MI	27307	8873	45373	6362	48920	5155	50043	4184	50336	2679	60364	1795	44336
12-#18	2.94	MA	40730	8873	66697	6547	73484	5276	76535	4298	80105	2858	97595	2128	68048
4E		MI	28324	8873	47090	6376	51145	5130	52752	4162	54128	2701	64840	1892	46355
12-#18	2.94	MA	39240	8873	64154	6541	70187	5311	72483	4329	74237	2837	90576	2022	64782
5L-3S		MI	29457	8873	49066	6345	53662	5148	55789	4184	57906	2679	69034	2110	46688
12-#18	2.94	MA	37823	8873	61771	6534	66886	5301	68448	4316	68919	2861	83908	1879	62695
6L-2S		MI	31040	8873	51465	6359	56737	5123	59517	4162	62850	2656	75525	2331	46730

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

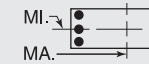


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.34	MA	39501	7969	61371	6003	66982	4889	68718	4071	69191	2910	82294	2770	32310
2L-7S		MI	25371	7969	39802	5881	42093	4800	41893	3990	39690	2848	45862	2280	22083
14-#11	1.34	MA	38523	7969	59935	6001	65141	4886	66472	4084	66135	2921	78118	2684	32336
3L-6S		MI	25758	7969	40506	5868	42942	4789	42937	3981	41061	2840	47708	2371	22412
14-#11	1.34	MA	37840	7969	58769	6016	63655	4900	64666	4080	63811	2932	75393	2597	32338
4L-5S		MI	26156	7969	41149	5872	43832	4794	44024	3988	42464	2831	49433	2427	22408
14-#11	1.34	MA	37231	7969	57763	6015	62349	4898	63061	4093	61485	2926	72567	2554	32292
5L-4S		MI	26572	7969	41834	5876	44720	4783	45114	3978	44013	2840	51271	2466	22376
14-#11	1.34	MA	36652	7969	56820	6013	61043	4912	61464	4089	59380	2936	69865	2499	32180
6L-3S		MI	27036	7969	42624	5863	45726	4789	46338	3985	45559	2831	53004	2552	22333
14-#11	1.34	MA	36088	7969	55787	6029	59796	4909	59931	4102	57323	2947	66985	2409	31541
7L-2S		MI	27689	7969	43588	5867	46962	4777	47845	3976	47581	2823	55683	2638	22289
14-#14	1.93	MA	41525	8303	65814	6194	72560	5025	75479	4150	78370	2874	94593	2705	46031
2L-7S		MI	25702	8303	41140	6068	43693	4936	43800	4067	42239	2806	49455	2022	30329
14-#14	1.93	MA	40139	8303	63757	6191	69923	5020	72261	4168	73992	2889	88644	2580	46006
3L-6S		MI	26251	8303	42148	6050	44910	4921	45365	4078	44186	2793	52067	2152	30773
14-#14	1.93	MA	39171	8303	62084	6213	67792	5040	69670	4162	70658	2904	84764	2456	45905
4L-5S		MI	26814	8303	43069	6056	46183	4930	46851	4065	46178	2781	54508	2234	31517
14-#14	1.93	MA	38309	8303	60640	6210	65918	5036	67368	4180	67322	2894	80731	2395	45673
5L-4S		MI	27404	8303	44050	6063	47454	4914	48411	4051	48379	2793	57118	2288	31576
14-#14	1.93	MA	37488	8303	59287	6207	64042	5056	65075	4174	64300	2909	76883	2314	44435
6L-3S		MI	28061	8303	45180	6045	48894	4923	50161	4063	50573	2781	59567	2413	31563
14-#14	1.93	MA	36688	8303	57803	6229	62254	5051	62875	4192	61349	2924	72781	2185	43569
7L-2S		MI	28984	8303	46557	6051	50658	4907	52314	4050	53443	2768	63359	2538	31521
14-#18	3.43	MA	42393	9150	70306	6720	78110	5401	82178	4374	87784	2836	107913	2083	79101
4L-5S		MI	28383	9150	47771	6535	51995	5279	53771	4257	55280	2645	66856	1723	51479
14-#18	3.43	MA	40915	9150	67763	6713	74813	5435	78127	4404	81916	2815	100894	1977	75611
5L-4S		MI	29394	9150	49489	6548	54220	5254	56481	4235	59072	2667	71331	1820	53362
14-#18	3.43	MA	39511	9150	65380	6707	71512	5425	74092	4391	76598	2839	94227	1833	73325
6L-3S		MI	30519	9150	51465	6518	56737	5273	59517	4257	62850	2645	75525	2037	54116
14-#18	3.43	MA	38143	9150	62769	6744	68362	5459	70219	4422	71402	2863	87112	1602	69783
7L-2S		MI	32092	9150	53863	6532	59812	5247	63246	4235	67794	2623	82017	2259	54221
16-#11	1.53	MA	40183	8077	62807	6070	68823	4937	70964	4100	72246	2901	86469	2755	36811
2L-8S		MI	25442	8077	40133	5944	42467	4843	42381	4030	40254	2829	46823	2211	24784
16-#11	1.53	MA	39208	8077	61371	6068	66982	4935	68718	4113	69191	2912	82294	2669	36828
3L-7S		MI	25822	8077	40766	5948	43329	4849	43401	4020	41712	2838	48541	2257	25008
16-#11	1.53	MA	38528	8077	60205	6084	65496	4949	66912	4109	66866	2923	79568	2583	36809
4L-6S		MI	26208	8077	41470	5935	44178	4837	44444	4010	43083	2829	50386	2347	25362
16-#11	1.53	MA	37921	8077	59199	6082	64190	4946	65307	4123	64541	2917	76742	2540	36745
5E		MI	26604	8077	42113	5939	45068	4843	45531	4017	44486	2821	52112	2404	25426
16-#11	1.53	MA	37345	8077	58256	6080	62883	4960	63710	4119	62435	2928	74040	2484	36569
6L-4S		MI	27019	8077	42798	5943	45955	4831	46622	4008	46035	2829	53950	2442	25406
16-#11	1.53	MA	36783	8077	57223	6096	61637	4958	62177	4132	60379	2939	71160	2394	35901
7L-3S		MI	27481	8077	43588	5930	46962	4837	47845	4015	47581	2821	55683	2529	25372
16-#11	1.53	MA	36221	8077	56295	6094	60373	4972	60681	4145	58193	2933	68517	2344	35443
8L-2S		MI	28132	8077	44552	5934	48198	4825	49353	4005	49603	2812	58361	2615	25333
16-#14	2.21	MA	41103	8458	65814	6289	72560	5090	75479	4211	78370	2876	94593	2558	52403
3L-7S		MI	26338	8458	42517	6165	45458	5006	45953	4109	45110	2789	53247	1986	34496
16-#14	2.21	MA	40141	8458	64142	6310	70429	5110	72888	4204	75036	2892	90713	2433	52273
4L-6S		MI	26885	8458	43525	6147	46674	4990	47518	4121	47057	2777	55859	2116	34919
16-#14	2.21	MA	39283	8458	62697	6308	68555	5105	70585	4223	71699	2882	86680	2372	51997
5E		MI	27445	8458	44446	6154	47948	4999	49003	4107	49049	2764	58300	2198	35642
16-#14	2.21	MA	38467	8458	61344	6305	66680	5126	68293	4216	68678	2897	82832	2292	50654
6L-4S		MI	28032	8458	45426	6160	49219	4984	50564	4094	51250	2777	60910	2253	35857
16-#14	2.21	MA	37672	8458	59861	6327	64891	5121	66093	4235	65726	2912	78729	2162	49818
7L-3S		MI	28687	8458	46557	6142	50658	4993	52314	4105	53443	2764	63359	2377	35881
16-#14	2.21	MA	36889	8458	58529	6324	63076	5141	63946	4253	62589	2902	74958	2091	48458
8L-2S		MI	29606	8458	47933	6148	52423	4977	54467	4092	56314	2752	67151	2502	35846
16-#18	3.92	MA	42575	9427	71372	6886	79440	5559	83770	4480	89594	2793	111212	1931	86463
5E		MI	29451	9427	50170	6708	55070	5403	57500	4331	60224	2611	73347	1651	58643

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

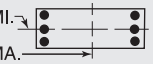
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	3.92	MA	41182	9427	68989	6880	76138	5549	79736	4466	84277	2817	104545	1787	83984
6L-4S		MI	30455	9427	51887	6721	57294	5378	60210	4309	64016	2633	77822	1748	60406
16-#18	3.92	MA	39826	9427	66377	6917	72988	5583	75863	4497	79081	2841	97431	1557	80561
7L-3S		MI	31573	9427	53863	6691	59812	5397	63246	4331	67794	2611	82017	1965	61529
16-#18	3.92	MA	38492	9427	64031	6910	69793	5573	72083	4528	73559	2821	90868	1432	76812
8L-2S		MI	33137	9427	56262	6705	62886	5371	66975	4309	72738	2589	88508	2187	61683
18-#11	1.72	MA	39889	8184	62807	6136	68823	4983	70964	4143	72246	2904	86469	2654	41308
3L-8S		MI	25892	8184	41097	6012	43703	4891	43889	4059	42276	2819	49501	2188	27721
18-#11	1.72	MA	39212	8184	61641	6151	67337	4997	69157	4139	69922	2915	83743	2568	41274
4L-7S		MI	26271	8184	41730	6016	44564	4897	44908	4049	43734	2827	51219	2234	27936
18-#11	1.72	MA	38608	8184	60635	6150	66031	4994	67553	4152	67596	2908	80917	2525	41194
5L-6S		MI	26656	8184	42434	6002	45414	4886	45952	4039	45105	2819	53064	2324	28272
18-#11	1.72	MA	38034	8184	59692	6148	64724	5009	65955	4148	65491	2919	78215	2469	40909
6L-5S		MI	27051	8184	43077	6007	46303	4891	47039	4047	46508	2810	54790	2381	28433
18-#11	1.72	MA	37475	8184	58659	6163	63478	5006	64423	4161	63434	2930	75335	2380	40267
7L-4S		MI	27464	8184	43762	6011	47191	4880	48129	4037	48058	2819	56628	2419	28429
18-#11	1.72	MA	36924	8184	57731	6162	62214	5020	62927	4174	61248	2924	72692	2329	39821
8L-3S		MI	27925	8184	44552	5997	48198	4885	49353	4044	49603	2810	58361	2506	28403
18-#11	1.72	MA	36330	8184	56824	6160	60985	5018	61363	4170	59211	2935	70072	2276	39155
9L-2S		MI	28574	8184	45516	6002	49433	4874	50860	4034	51625	2801	61039	2592	28370
18-#14	2.48	MA	41104	8614	66199	6408	73066	5180	76105	4247	79413	2879	96662	2411	58636
4L-7S		MI	26971	8614	43893	6263	47223	5076	48106	4151	47981	2773	57039	1950	38667
18-#14	2.48	MA	40251	8614	64754	6405	71193	5175	73803	4265	76077	2869	92629	2350	58172
5L-6S		MI	27515	8614	44902	6244	48439	5060	49671	4163	49928	2760	59651	2080	39074
18-#14	2.48	MA	39439	8614	63401	6402	69317	5196	71510	4259	73056	2884	88781	2269	56884
6L-5S		MI	28072	8614	45822	6251	49712	5069	51156	4150	51920	2748	62092	2162	39757
18-#14	2.48	MA	38649	8614	61918	6424	67528	5191	69310	4277	70104	2899	84678	2140	56074
7L-4S		MI	28657	8614	46803	6257	50983	5053	52717	4136	54121	2760	64701	2217	40130
18-#14	2.48	MA	37871	8614	60586	6421	65714	5211	67163	4296	66967	2890	80906	2068	54630
8L-3S		MI	29309	8614	47933	6239	52423	5062	54467	4148	56314	2748	67151	2341	40174
18-#14	2.48	MA	37041	8614	59283	6418	63949	5206	64918	4289	64042	2905	77175	1991	53409
9L-2S		MI	30224	8614	49310	6246	54188	5047	56619	4134	59185	2735	70943	2466	40163
18-#18	4.41	MA	42839	9703	72597	7053	80764	5673	85379	4542	91955	2795	114863	1742	94669
6L-5S		MI	30512	9703	52568	6880	58144	5528	61228	4405	65168	2578	79838	1579	65824
18-#18	4.41	MA	41494	9703	69986	7090	77615	5707	81506	4573	86760	2819	107749	1511	91359
7L-4S		MI	31509	9703	54285	6894	60369	5502	63938	4383	68960	2600	84314	1676	67481
18-#18	4.41	MA	40171	9703	67640	7083	74420	5697	77726	4603	81238	2799	101186	1387	87500
8L-3S		MI	32619	9703	56262	6864	62886	5521	66975	4405	72738	2578	88508	1893	68929
20-#11	1.91	MA	39893	8292	63077	6219	69177	5046	71403	4168	72977	2906	87918	2554	45735
4L-8S		MI	26341	8292	42061	6079	44939	4940	45396	4089	44298	2808	52180	2165	30660
20-#11	1.91	MA	39292	8292	62071	6217	67872	5043	69798	4181	70652	2900	85092	2511	45639
5L-7S		MI	26718	8292	42694	6083	45800	4945	46416	4079	45756	2816	53897	2210	30868
20-#11	1.91	MA	38720	8292	61128	6215	66565	5057	68201	4177	68546	2911	82390	2455	45257
6E		MI	27102	8292	43398	6070	46650	4934	47459	4069	47127	2808	55742	2301	31187
20-#11	1.91	MA	38163	8292	60095	6231	65319	5054	66668	4191	66490	2922	79510	2365	44638
7L-5S		MI	27495	8292	44041	6074	47539	4940	48546	4076	48530	2799	57468	2357	31433
20-#11	1.91	MA	37614	8292	59167	6229	64055	5069	65173	4204	64304	2915	76867	2315	44203
8L-4S		MI	27907	8292	44726	6078	48427	4928	49637	4066	50080	2808	59306	2396	31446
20-#11	1.91	MA	37024	8292	58260	6227	62825	5066	63608	4200	62266	2926	74247	2261	43481
9L-3S		MI	28367	8292	45516	6065	49433	4934	50860	4074	51625	2799	61039	2482	31429
20-#11	1.91	MA	36417	8292	57243	6243	61578	5080	62121	4213	60246	2937	71707	2201	42751
10L-2S		MI	29013	8292	46480	6069	50669	4922	52368	4064	53647	2791	63718	2569	31402
20-#14	2.76	MA	41213	8770	66812	6502	73830	5245	77020	4307	80455	2857	98578	2327	64361
5L-7S		MI	27600	8770	45270	6360	48987	5146	50258	4194	50852	2756	60831	1914	42781

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

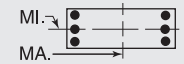
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.76	MA	40406	8770	65458	6499	71955	5265	74727	4301	77433	2872	94730	2247	63123
6E		MI	28141	8770	46278	6342	50203	5130	51823	4205	52799	2744	63443	2045	43235
20-#14	2.76	MA	39620	8770	63975	6521	70166	5261	72528	4320	74481	2887	90627	2117	62334
7L-5S		MI	28696	8770	47199	6348	51477	5139	53309	4192	54791	2731	65884	2126	43883
20-#14	2.76	MA	38846	8770	62643	6518	68351	5281	70381	4338	71344	2877	86855	2045	60811
8L-4S		MI	29279	8770	48179	6355	52748	5123	54870	4179	56992	2744	68493	2181	44396
20-#14	2.76	MA	38021	8770	61340	6515	66586	5276	68135	4332	68420	2892	83124	1968	59621
9L-3S		MI	29927	8770	49310	6336	54188	5132	56619	4190	59185	2731	70943	2305	44459
20-#14	2.76	MA	37164	8770	59881	6537	64796	5297	66000	4350	65520	2907	79507	1880	57814
10L-2S		MI	30839	8770	50686	6343	55952	5116	58772	4177	62056	2719	74735	2430	44479
20-#18	4.90	MA	43148	9980	73595	7263	82241	5831	87150	4648	94438	2797	118067	1465	102174
7L-5S		MI	31565	9980	54967	7053	61219	5652	64957	4479	70112	2544	86330	1507	73019
20-#18	4.90	MA	41835	9980	71248	7256	79046	5821	83370	4679	88916	2777	111504	1341	98206
8L-4S		MI	32556	9980	56684	7067	63444	5626	67667	4457	73904	2566	90805	1604	74581
22-#11	2.10	MA	39972	8400	63507	6284	69713	5091	72044	4211	73707	2891	89267	2496	50082
5L-8S		MI	26787	8400	43024	6146	46174	4988	46904	4118	46320	2797	54858	2142	33600
22-#11	2.10	MA	39402	8400	62564	6283	68406	5106	70447	4207	71602	2902	86565	2440	49612
6L-7S		MI	27164	8400	43658	6150	47036	4994	47923	4108	47778	2806	56575	2187	33803
22-#11	2.10	MA	38848	8400	61531	6298	67160	5103	68914	4220	69545	2913	83685	2351	49014
7L-6S		MI	27546	8400	44362	6137	47885	4982	48967	4098	49149	2797	58421	2278	34107
22-#11	2.10	MA	38301	8400	60603	6297	65896	5117	67418	4233	67359	2907	81042	2300	48587
8L-5S		MI	27938	8400	45005	6141	48775	4988	50054	4106	50552	2789	60146	2334	34428
22-#11	2.10	MA	37714	8400	59696	6295	64666	5114	65854	4229	65322	2918	78422	2247	47812
9L-4S		MI	28349	8400	45690	6145	49663	4977	51144	4096	52102	2797	61985	2373	34455
22-#11	2.10	MA	37109	8400	58679	6310	63419	5129	64366	4243	63302	2929	75882	2186	47100
10L-3S		MI	28806	8400	46480	6132	50669	4982	52368	4103	53647	2789	63718	2459	34450
22-#11	2.10	MA	36520	8400	57770	6309	62197	5126	62822	4239	61147	2922	73304	2133	46214
11L-2S		MI	29451	8400	47444	6136	51905	4971	53875	4093	55669	2780	66396	2545	34429
22-#14	3.03	MA	41367	8925	67516	6596	74592	5335	77945	4344	81811	2859	100679	2224	69369
6L-7S		MI	28225	8925	46646	6457	50752	5216	52411	4236	53723	2739	64623	1878	46852
22-#14	3.03	MA	40585	8925	66033	6618	72803	5331	75745	4362	78859	2874	96576	2095	68599
7L-6S		MI	28764	8925	47655	6439	51968	5200	53976	4248	55670	2727	67235	2009	47401
22-#14	3.03	MA	39815	8925	64701	6615	70989	5351	73598	4381	75722	2865	92804	2023	67001
8L-5S		MI	29317	8925	48575	6445	53242	5209	55462	4234	57662	2715	69676	2091	48018
22-#14	3.03	MA	38996	8925	63398	6613	69224	5346	71353	4374	72797	2880	89073	1946	65748
9L-4S		MI	29897	8925	49556	6452	54512	5193	57022	4221	59863	2727	72285	2145	48656
22-#14	3.03	MA	38142	8925	61939	6635	67434	5366	69217	4393	69898	2895	85456	1858	63979
10L-3S		MI	30543	8925	50686	6434	55952	5202	58772	4233	62056	2715	74735	2270	48738
22-#18	5.39	MA	43486	10256	74857	7429	83672	5945	89014	4754	96595	2754	121822	1295	108930
8L-5S		MI	32612	10256	57365	7226	64293	5776	68686	4553	75056	2511	92821	1435	80226
24-#11	2.29	MA	40082	8508	64000	6350	70247	5154	72692	4236	74657	2893	90740	2426	53972
6L-8S		MI	27232	8508	43988	6214	47410	5037	48411	4147	48342	2787	57536	2118	36530
24-#11	2.29	MA	39529	8508	62967	6366	69000	5151	71160	4249	72601	2904	87860	2336	53392
7E		MI	27607	8508	44622	6218	48272	5042	49431	4138	49800	2795	59254	2164	36740
24-#11	2.29	MA	38985	8508	62039	6364	67736	5166	69664	4263	70415	2898	85217	2286	52974
8L-6S		MI	27988	8508	45326	6205	49121	5031	50474	4128	51171	2787	61099	2254	37032
24-#11	2.29	MA	38400	8508	61132	6362	66507	5163	68100	4259	68377	2909	82597	2232	52149
9L-5S		MI	28379	8508	45969	6209	50010	5036	51561	4135	52574	2778	62825	2311	37419
24-#11	2.29	MA	37798	8508	60115	6378	65260	5177	66612	4272	66357	2920	80057	2172	51452
10L-4S		MI	28788	8508	46654	6213	50898	5025	52652	4125	54124	2787	64663	2349	37456
24-#11	2.29	MA	37210	8508	59206	6376	64038	5174	65068	4268	64202	2914	77479	2118	50529
11L-3S		MI	29245	8508	47444	6200	51905	5031	53875	4132	55669	2778	66396	2436	37466
24-#11	2.29	MA	36634	8508	58208	6392	62799	5189	63583	4281	62183	2925	74572	2042	49643
12L-2S		MI	29888	8508	48408	6204	53141	5019	55383	4123	57691	2769	69074	2522	37451

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

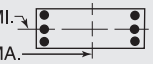


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#14	3.31	MA	41544	9081	68090	6716	75440	5400	78962	4404	83237	2862	102525	2072	74766
7E		MI	28848	9081	48023	6555	52517	5286	54564	4279	56594	2723	68415	1842	50932
24-#14	3.31	MA	40778	9081	66758	6713	73626	5421	76816	4423	80099	2852	98753	2000	73198
8L-6S		MI	29385	9081	49031	6536	53733	5270	56129	4290	58541	2711	71027	1973	51572
24-#14	3.31	MA	39975	9081	65455	6710	71861	5416	74570	4417	77175	2867	95022	1923	71883
9L-5S		MI	29935	9081	49952	6543	55006	5279	57614	4277	60533	2698	73468	2055	52161
24-#14	3.31	MA	39115	9081	63996	6732	70071	5436	72435	4435	74275	2882	91405	1835	70151
10L-4S		MI	30512	9081	50932	6549	56277	5263	59175	4263	62734	2711	76077	2109	52911
RECTANGULAR TIED COLUMNS 36" x 36"															
6-#14	1.04	MA	22704	6195	35390	4578	37882	3736	38276	3122	37395	2256	43365	2126	14761
2L-3S		MI	21701	6195	33916	4572	35993	3752	35971	3137	34301	2269	39266	2001	14841
6-#18	1.85	MA	24178	6558	38809	4768	42093	3869	43349	3196	44004	2189	51987	2006	25368
2L-3S		MI	22455	6558	36237	4756	38797	3896	39327	3218	38665	2211	44951	1785	25436
8-#14	1.39	MA	23386	6351	36864	4675	39772	3806	40581	3165	40488	2241	47464	2093	19430
2L-4S		MI	21681	6351	34182	4689	36344	3814	36406	3169	35030	2266	40712	1843	19526
8-#18	2.47	MA	25332	6835	41380	4941	45389	3993	47370	3271	49343	2158	59022	1939	33450
2L-4S		MI	22408	6835	36695	4961	39400	4003	40076	3272	39925	2203	47447	1496	32793
10-#11	1.20	MA	23059	6268	36060	4642	38829	3783	39463	3155	39059	2263	45619	2127	17007
2L-5S		MI	21418	6268	33454	4648	35484	3802	35380	3169	33552	2271	38874	1915	17112
10-#11	1.20	MA	22359	6268	35028	4638	37507	3795	37851	3166	36883	2271	42728	2041	17053
3L-4S		MI	21863	6268	34185	4652	36431	3790	36544	3159	35219	2280	40853	1955	17095
10-#14	1.74	MA	24062	6506	38338	4773	41661	3875	42886	3207	43582	2226	51563	2059	24076
2L-5S		MI	21737	6506	34609	4780	36876	3901	37044	3225	35754	2238	41998	1754	23812
10-#14	1.74	MA	23071	6506	36864	4767	39772	3892	40581	3222	40488	2238	47464	1935	24121
3L-4S		MI	22367	6506	35656	4786	38233	3884	38711	3211	38124	2251	44811	1810	24110
10-#18	3.09	MA	26474	7112	43951	5114	48685	4117	51391	3347	54682	2127	66058	1872	41497
2L-5S		MI	22494	7112	37431	5121	40318	4154	41177	3370	41170	2149	49632	1334	38137
10-#18	3.09	MA	24780	7112	41380	5102	45389	4144	47370	3369	49343	2149	59022	1651	41382
3L-4S		MI	23575	7112	39266	5134	42696	4127	44098	3348	45264	2172	54483	1430	40249
RECTANGULAR TIED COLUMNS 36" x 38"															
4-#18	1.17	MA	25545	6600	40053	4854	42925	3957	43491	3301	42735	2364	49691	2216	18313
2E		MI	24157	6600	37965	4832	40586	3939	41066	3286	40220	2347	46666	2195	17282
6-#18	1.75	MA	26801	6876	42797	5027	46443	4081	47783	3377	48470	2335	57272	2154	26988
2L-3S		MI	23602	6876	37965	4992	40586	4090	41066	3383	40220	2338	46666	1907	25513
6-#18	1.75	MA	24958	6876	40053	5016	42925	4110	43491	3401	42735	2357	49691	1932	27056
3L-2S		MI	25328	6876	40536	5005	43882	4063	45087	3361	45559	2316	53702	2129	25426
8-#14	1.32	MA	25944	6669	40712	4934	43953	4018	44815	3346	44664	2384	52353	2236	20645
2L-4S		MI	22827	6669	35903	4927	38133	4010	38148	3335	36592	2394	42438	1967	19588
8-#14	1.32	MA	24879	6669	39141	4929	41939	4036	42358	3361	41348	2397	47946	2111	20708
3E		MI	23536	6669	37110	4908	39672	4018	40018	3346	38957	2381	45091	2092	19542
8-#14	1.32	MA	24125	6669	37855	4948	40302	4028	40367	3351	38813	2409	45089	1987	20741
4L-2S		MI	24534	6669	38584	4913	41561	4002	42323	3331	42050	2369	49190	2216	19474
8-#18	2.34	MA	28043	7153	45541	5200	49961	4206	52075	3452	54204	2306	64853	2092	35610
2L-4S		MI	23554	7153	38422	5197	41189	4197	41814	3437	41480	2329	49163	1619	33197
8-#18	2.34	MA	26215	7153	42797	5189	46443	4234	47783	3476	48470	2329	57272	1870	35585
3E		MI	24773	7153	40536	5165	43882	4214	45087	3459	45559	2307	53702	1840	33517
8-#18	2.34	MA	24918	7153	40545	5222	43574	4219	44297	3456	44087	2351	52372	1649	35236
4L-2S		MI	26484	7153	43107	5177	47178	4187	49108	3436	50898	2285	60738	2062	33516
10-#11	1.14	MA	25591	6586	39850	4900	42943	3996	43617	3336	43120	2405	50350	2269	18060
2L-5S		MI	22564	6586	35170	4887	37274	3999	37124	3336	35118	2400	40605	2039	17168
10-#11	1.14	MA	24843	6586	38751	4897	41534	4009	41899	3347	40789	2414	47245	2183	18106
3L-4S		MI	23009	6586	35901	4891	38221	3987	38288	3326	36785	2408	42584	2079	17140

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis



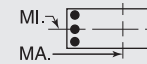
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#11	1.14	MA	24315	6586	37854	4911	40391	4004	40509	3341	39007	2423	45229	2096	18148
4L-3S		MI	23506	6586	36745	4877	39297	3992	39595	3333	38448	2400	44459	2165	17093
10-#11	1.14	MA	23842	6586	37077	4908	39383	4017	39271	3352	37222	2414	43109	2056	18165
5L-2S		MI	24207	6586	37776	4881	40619	3980	41208	3322	40625	2391	47350	2251	17045
10-#14	1.64	MA	26670	6825	42283	5031	45967	4088	47272	3388	47981	2370	56759	2205	25595
2L-5S		MI	22882	6825	36330	5018	38666	4097	38786	3392	37316	2366	43724	1878	24044
10-#14	1.64	MA	25611	6825	40712	5026	43953	4106	44815	3403	44664	2383	52353	2081	25639
3L-4S		MI	23514	6825	37377	5024	40023	4080	40453	3378	39686	2379	46537	1934	24183
10-#14	1.64	MA	24862	6825	39426	5046	42316	4098	42824	3394	42130	2395	49496	1956	25629
4L-3S		MI	24219	6825	38584	5005	41561	4088	42323	3388	42050	2366	49190	2058	24175
10-#14	1.64	MA	24191	6825	38313	5040	40873	4116	41051	3409	39589	2383	46480	1899	25460
5L-2S		MI	25212	6825	40058	5011	43451	4071	44628	3374	45144	2354	53289	2183	24125
10-#18	2.92	MA	29271	7430	48285	5373	53479	4330	56366	3527	59939	2278	72435	2029	44197
2L-5S		MI	23639	7430	39158	5357	42107	4348	42915	3535	42725	2276	51348	1457	38469
10-#18	2.92	MA	27459	7430	45541	5362	49961	4358	52075	3552	54204	2300	64853	1808	44082
3L-4S		MI	24723	7430	40993	5370	44485	4321	45836	3513	46819	2298	56199	1552	40644
10-#18	2.92	MA	26173	7430	43289	5395	47092	4343	48588	3532	49822	2322	59954	1586	43203
4L-3S		MI	25931	7430	43107	5338	47178	4338	49108	3534	50898	2276	60738	1773	41485
10-#18	2.92	MA	25022	7430	41336	5383	44560	4371	45479	3556	45427	2300	54741	1489	40810
5L-2S		MI	27629	7430	45679	5350	50475	4311	53129	3512	56237	2254	67774	1995	41575
12-#11	1.37	MA	26105	6694	40949	4968	44351	4045	45336	3365	45451	2396	53455	2249	21527
2L-6S		MI	22627	6694	35516	4951	37647	4042	37577	3359	35784	2399	41632	1961	20209
12-#11	1.37	MA	25360	6694	39850	4964	42943	4057	43617	3376	43120	2405	50350	2163	21565
3L-5S		MI	23050	6694	36202	4955	38596	4048	38737	3366	37294	2390	43497	2018	20385
12-#11	1.37	MA	24834	6694	38953	4979	41799	4052	42227	3370	41338	2414	48334	2076	21593
4E		MI	23493	6694	36933	4958	39543	4035	39901	3355	38961	2399	45476	2057	20379
12-#11	1.37	MA	24363	6694	38176	4975	40792	4065	40990	3381	39553	2405	46214	2036	21585
5L-3S		MI	23988	6694	37776	4945	40619	4041	41208	3362	40625	2390	47350	2144	20346
12-#11	1.37	MA	23914	6694	37447	4972	39783	4060	39757	3375	37936	2414	44210	1980	21378
6L-2S		MI	24686	6694	38808	4948	41941	4029	42821	3352	42801	2381	50242	2230	20305
12-#14	1.97	MA	27391	6980	43854	5128	47981	4158	49728	3430	51297	2356	61166	2174	30530
2L-6S		MI	22969	6980	36821	5110	39195	4158	39430	3424	38263	2363	45182	1763	27583
12-#14	1.97	MA	26338	6980	42283	5123	45967	4175	47272	3446	47981	2369	56759	2050	30553
3L-5S		MI	23568	6980	37803	5115	40555	4166	41091	3434	40409	2351	47823	1845	28408
12-#14	1.97	MA	25593	6980	40998	5143	44330	4168	45281	3436	45446	2381	53903	1925	30502
4E		MI	24196	6980	38850	5121	41912	4150	42758	3420	42780	2363	50636	1901	28760
12-#14	1.97	MA	24926	6980	39884	5138	42887	4186	43508	3451	42906	2369	50887	1868	30118
5L-3S		MI	24897	6980	40058	5102	43451	4158	44628	3430	45144	2351	53289	2025	28795
12-#14	1.97	MA	24290	6980	38840	5132	41441	4178	41742	3442	40604	2381	48045	1787	29207
6L-2S		MI	25884	6980	41532	5108	45340	4141	46933	3416	48237	2338	57388	2150	28760
12-#18	3.51	MA	30487	7706	51030	5546	56997	4454	60658	3603	65673	2249	80016	1967	52742
2L-6S		MI	23782	7706	40005	5518	43020	4456	44156	3633	44360	2267	53857	1244	43934
12-#18	3.51	MA	28689	7706	48285	5535	53479	4483	56366	3627	59939	2271	72435	1745	52557
3L-5S		MI	24805	7706	41729	5530	45403	4473	46936	3610	48064	2245	58383	1390	46119
12-#18	3.51	MA	27415	7706	46034	5568	50610	4467	52880	3607	55556	2293	67535	1524	51223
4E		MI	25879	7706	43565	5543	47781	4445	49857	3588	52158	2267	63234	1485	48145
12-#18	3.51	MA	26274	7706	44080	5556	48078	4496	49770	3631	51162	2271	62322	1427	48985
5L-3S		MI	27078	7706	45679	5511	50475	4463	53129	3610	56237	2245	67774	1706	49430
12-#18	3.51	MA	25188	7706	42246	5545	45542	4480	46671	3611	47182	2293	57440	1281	46645
6L-2S		MI	28763	7706	48250	5523	53771	4435	57151	3587	61576	2223	74810	1928	49586
14-#11	1.60	MA	26615	6802	42048	5035	45760	4093	47054	3395	47783	2387	56560	2229	24984
2L-7S		MI	22702	6802	35796	5032	38063	4103	38076	3399	36484	2397	42531	1850	22921
14-#11	1.60	MA	25873	6802	40949	5032	44351	4106	45336	3406	45451	2396	53455	2143	25014
3L-6S		MI	23112	6802	36547	5018	38969	4091	39190	3389	37960	2389	44524	1940	23308

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis

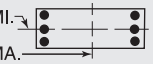


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.60	MA	25349	6802	40052	5046	43208	4101	43946	3400	43670	2405	51439	2056	25030
4L-5S		MI	23533	6802	37233	5022	39918	4096	40350	3395	39471	2380	46389	1996	23592
14-#11	1.60	MA	24881	6802	39275	5043	42201	4113	42708	3411	41884	2396	49319	2016	24996
5L-4S		MI	23974	6802	37964	5026	40866	4084	41514	3385	41138	2389	48367	2036	23609
14-#11	1.60	MA	24434	6802	38546	5040	41192	4109	41475	3404	40267	2405	47315	1960	24680
6L-3S		MI	24467	6802	38808	5012	41941	4089	42821	3391	42801	2380	50242	2122	23588
14-#11	1.60	MA	23999	6802	37748	5054	40229	4121	40292	3416	38686	2413	45175	1870	24251
7L-2S		MI	25163	6802	39839	5016	43263	4077	44434	3381	44978	2372	53133	2208	23555
14-#14	2.30	MA	28108	7136	45425	5226	49995	4228	52185	3473	54614	2342	65572	2143	35453
2L-7S		MI	23073	7136	37218	5226	39787	4245	40139	3481	39259	2360	46457	1600	31358
14-#14	2.30	MA	27059	7136	43854	5220	47981	4245	49728	3488	51297	2355	61166	2019	35447
3L-6S		MI	23653	7136	38294	5207	41085	4228	41735	3466	41356	2348	49281	1730	32015
14-#14	2.30	MA	26318	7136	42569	5240	46344	4238	47738	3478	48763	2367	58309	1894	35366
4L-5S		MI	24248	7136	39277	5213	42444	4236	43396	3477	43503	2336	51922	1812	32792
14-#14	2.30	MA	25655	7136	41455	5235	44901	4255	45965	3494	46222	2355	55294	1837	34795
5L-4S		MI	24873	7136	40324	5218	43801	4220	45063	3462	45873	2348	54735	1867	33326
14-#14	2.30	MA	25024	7136	40411	5230	43455	4248	44199	3484	43921	2367	52452	1756	33935
6L-3S		MI	25570	7136	41532	5199	45340	4228	46933	3473	48237	2336	57388	1992	33390
14-#14	2.30	MA	24408	7136	39267	5249	42075	4265	42502	3499	41672	2380	49415	1626	33222
7L-2S		MI	26553	7136	43006	5205	47229	4211	49238	3458	51331	2323	61487	2116	33383
14-#18	4.09	MA	29908	7983	51030	5707	56997	4607	60658	3702	65673	2242	80016	1683	61018
3L-6S		MI	24945	7983	42577	5691	46316	4580	48177	3708	49699	2236	60893	1177	51422
14-#18	4.09	MA	28644	7983	48778	5740	54128	4591	57172	3683	61291	2265	75116	1462	59288
4L-5S		MI	25960	7983	44301	5703	48700	4597	50957	3686	53403	2214	65419	1323	53793
14-#18	4.09	MA	27513	7983	46825	5729	51596	4620	54062	3707	56896	2242	69904	1364	57186
5L-4S		MI	27025	7983	46136	5716	51078	4570	53878	3663	57497	2236	70270	1418	55690
14-#18	4.09	MA	26436	7983	44991	5718	49060	4604	50963	3687	52917	2265	65022	1219	54660
6L-3S		MI	28214	7983	48250	5684	53771	4587	57151	3685	61576	2214	74810	1640	57359
16-#11	1.82	MA	27123	6910	43147	5103	47169	4141	48772	3424	50114	2378	59665	2209	28435
2L-8S		MI	22784	6910	36152	5096	38466	4146	38602	3439	37092	2379	43573	1781	25744
16-#11	1.82	MA	26384	6910	42048	5099	45760	4154	47054	3435	47783	2387	56560	2123	28456
3L-7S		MI	23186	6910	36828	5100	39385	4151	39689	3429	38661	2388	45423	1828	26047
16-#11	1.82	MA	25862	6910	41150	5113	44616	4149	45664	3429	46001	2395	54544	2036	28450
4L-6S		MI	23594	6910	37579	5086	40291	4139	40803	3418	40137	2379	47415	1918	26414
16-#11	1.82	MA	25396	6910	40373	5110	43609	4162	44426	3440	44216	2387	52424	1996	28402
5E		MI	24014	6910	38264	5090	41240	4144	41963	3425	41647	2370	49280	1975	26792
16-#11	1.82	MA	24951	6910	39645	5107	42600	4157	43194	3434	42598	2395	50420	1940	27990
6L-4S		MI	24453	6910	38995	5093	42188	4132	43127	3414	43314	2379	51259	2014	26828
16-#11	1.82	MA	24518	6910	38847	5121	41637	4170	42010	3445	41017	2404	48280	1850	27582
7L-3S		MI	24944	6910	39839	5080	43263	4137	44434	3421	44978	2370	53133	2100	26822
16-#11	1.82	MA	24091	6910	38129	5118	40661	4165	40854	3456	39337	2395	46299	1802	27245
8L-2S		MI	25637	6910	40871	5083	44585	4125	46047	3410	47154	2362	56025	2187	26797
16-#14	2.63	MA	28819	7291	46996	5323	52009	4298	54642	3515	57930	2328	69979	2112	40366
2L-8S		MI	23188	7291	37724	5317	40359	4306	40886	3537	40121	2333	47928	1500	34684
16-#14	2.63	MA	27776	7291	45425	5318	49995	4315	52185	3530	54614	2341	65572	1988	40330
3L-7S		MI	23756	7291	38692	5323	41676	4315	42444	3523	42352	2345	50556	1566	35698
16-#14	2.63	MA	27039	7291	44140	5337	48358	4308	50195	3521	52079	2353	62716	1863	40221
4L-6S		MI	24332	7291	39768	5304	42974	4298	44040	3509	44450	2333	53380	1697	36457
16-#14	2.63	MA	26380	7291	43026	5332	46915	4325	48422	3536	49539	2341	59700	1806	39489
5E		MI	24924	7291	40751	5310	44334	4306	45701	3519	46596	2320	56022	1778	37192
16-#14	2.63	MA	25752	7291	41982	5327	45469	4318	46656	3526	47237	2353	56858	1725	38673
6L-4S		MI	25545	7291	41798	5316	45691	4289	47368	3505	48967	2333	58834	1834	37884
16-#14	2.63	MA	25140	7291	40838	5347	44089	4335	44959	3542	44988	2366	53822	1595	37857
7L-3S		MI	26239	7291	43006	5297	47229	4298	49238	3515	51331	2320	61487	1959	37974
16-#14	2.63	MA	24537	7291	39809	5341	42689	4328	43303	3557	42597	2353	51003	1527	36745
8L-2S		MI	27217	7291	44479	5302	49119	4281	51543	3501	54425	2308	65586	2083	38000
16-#18	4.68	MA	29863	8260	51522	5913	57646	4715	61463	3758	67026	2236	82698	1399	67388
4L-6S		MI	26098	8260	45148	5864	49612	4704	52198	3784	55038	2205	67929	1110	58941
16-#18	4.68	MA	28741	8260	49569	5902	55114	4744	58354	3782	62631	2214	77485	1302	65407
5E		MI	27104	8260	46872	5876	51996	4721	54979	3761	58742	2183	72455	1256	61488

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

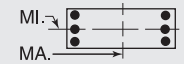
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	4.68	MA	27673	8260	47735	5891	52577	4728	55255	3762	58652	2236	72603	1157	62704
6L-4S		MI	28161	8260	48707	5888	54374	4694	57899	3739	62836	2205	77306	1351	63269
18-#11	2.05	MA	27628	7018	44245	5170	48577	4190	50491	3453	52445	2369	62770	2189	31879
2L-9S		MI	22870	7018	36456	5177	38894	4207	39078	3462	37805	2378	44657	1706	28229
18-#11	2.05	MA	26892	7018	43147	5167	47169	4202	48772	3464	50114	2378	59665	2103	31892
3L-8S		MI	23267	7018	37183	5163	39788	4195	40215	3468	39268	2369	46465	1760	28808
18-#11	2.05	MA	26372	7018	42249	5181	46025	4198	47382	3458	48332	2386	57649	2016	31867
4L-7S		MI	23668	7018	37859	5167	40707	4200	41302	3458	40837	2378	48314	1806	29177
18-#11	2.05	MA	25908	7018	41472	5178	45018	4210	46145	3469	46547	2378	55529	1976	31802
5L-6S		MI	24074	7018	38610	5153	41613	4188	42416	3447	42313	2369	50307	1897	29528
18-#11	2.05	MA	25465	7018	40744	5174	44009	4206	44912	3463	44929	2386	53525	1920	31308
6L-5S		MI	24492	7018	39296	5157	42562	4193	43576	3454	43824	2361	52172	1953	29987
18-#11	2.05	MA	25034	7018	39945	5188	43046	4218	43728	3474	43348	2395	51385	1830	30917
7L-4S		MI	24930	7018	40027	5161	43510	4181	44740	3444	45491	2369	54151	1993	30038
18-#11	2.05	MA	24609	7018	39228	5185	42069	4214	42573	3486	41668	2386	49404	1782	30515
8L-3S		MI	25418	7018	40871	5147	44585	4186	46047	3450	47154	2361	56025	2079	30051
18-#11	2.05	MA	24178	7018	38455	5199	41119	4226	41365	3479	40101	2395	47461	1728	29878
9L-2S		MI	26109	7018	41902	5151	45907	4174	47660	3440	49331	2352	58916	2165	30033
18-#14	2.96	MA	28488	7447	46996	5415	52009	4385	54642	3573	57930	2327	69979	1957	45206
3L-8S		MI	23869	7447	39198	5415	42248	4376	43191	3580	43215	2318	52027	1467	39076
18-#14	2.96	MA	27755	7447	45711	5435	50372	4378	52652	3563	55395	2339	67122	1832	45071
4L-7S		MI	24434	7447	40166	5420	43565	4384	44749	3565	45446	2330	54655	1533	40051
18-#14	2.96	MA	27100	7447	44597	5429	48929	4395	50879	3578	52855	2327	64107	1775	44196
5L-6S		MI	25007	7447	41242	5401	44863	4368	46344	3551	47543	2318	57479	1664	40906
18-#14	2.96	MA	26475	7447	43553	5424	47483	4388	49113	3569	50554	2339	61265	1694	43418
6L-5S		MI	25596	7447	42225	5407	46223	4376	48006	3562	49690	2305	60121	1745	41605
18-#14	2.96	MA	25867	7447	42409	5444	46103	4405	47416	3584	48305	2351	58228	1564	42506
7L-4S		MI	26214	7447	43272	5413	47580	4359	49673	3547	52060	2318	62933	1801	42436
18-#14	2.96	MA	25268	7447	41380	5439	44703	4398	45760	3599	45914	2339	55410	1496	41435
8L-3S		MI	26903	7447	44479	5394	49119	4367	51543	3558	54425	2305	65586	1925	42551
18-#18	5.26	MA	29959	8536	52313	6075	58632	4868	62645	3858	68365	2185	85066	1240	73645
5L-6S		MI	27241	8536	47719	6036	52909	4828	56220	3859	60377	2174	74965	1043	66485
18-#18	5.26	MA	28900	8536	50479	6064	56095	4852	59546	3838	64386	2207	80185	1094	70775
6L-5S		MI	28240	8536	49443	6049	55292	4845	59000	3837	64082	2152	79491	1189	69199
20-#11	2.28	MA	27397	7125	44245	5234	48577	4251	50491	3494	52445	2369	62770	2082	35315
3L-9S		MI	23353	7125	37488	5244	40216	4255	40691	3491	39982	2368	47548	1684	31320
20-#11	2.28	MA	26880	7125	43348	5248	47434	4246	49101	3488	50663	2377	60754	1996	35278
4L-8S		MI	23748	7125	38215	5231	41110	4243	41828	3498	41445	2359	49356	1738	31880
20-#11	2.28	MA	26417	7125	42571	5245	46426	4259	47863	3499	48878	2369	58634	1956	35199
5L-7S		MI	24147	7125	38890	5234	42029	4248	42915	3487	43014	2368	51206	1785	32311
20-#11	2.28	MA	25977	7125	41842	5242	45417	4254	46630	3493	47260	2377	56630	1900	34632
6E		MI	24552	7125	39641	5221	42935	4236	44029	3477	44490	2359	53198	1875	32647
20-#11	2.28	MA	25547	7125	41044	5256	44455	4267	45447	3504	45679	2386	54490	1810	34256
7L-5S		MI	24968	7125	40327	5224	43885	4241	45189	3484	46000	2351	55063	1932	33178
20-#11	2.28	MA	25124	7125	40327	5253	43478	4262	44291	3515	43999	2377	52509	1762	33791
8L-4S		MI	25404	7125	41058	5228	44832	4229	46353	3473	47667	2359	57042	1971	33243
20-#11	2.28	MA	24705	7125	39554	5267	42528	4275	43083	3509	42432	2386	50566	1708	33176
9L-3S		MI	25890	7125	41902	5214	45907	4234	47660	3480	49331	2351	58916	2057	33270
20-#11	2.28	MA	24244	7125	38839	5263	41564	4270	41933	3520	40879	2395	48684	1647	32562
10L-2S		MI	26579	7125	42933	5218	47229	4222	49273	3469	51507	2342	61808	2144	33265
20-#14	3.29	MA	28467	7603	47282	5532	52386	4447	55109	3606	58712	2325	71529	1801	49916
4L-8S		MI	24546	7603	40672	5512	44138	4446	45496	3622	46308	2302	56126	1434	43477
20-#14	3.29	MA	27815	7603	46168	5527	50943	4465	53336	3621	56172	2313	68514	1744	48913
5L-7S		MI	25108	7603	41640	5518	45454	4454	47054	3608	48539	2315	58754	1500	44416

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

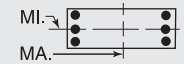
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	3.29	MA	27194	7603	45124	5522	49497	4457	51570	3611	53870	2325	65672	1663	48170
6E		MI	25678	7603	42716	5499	46753	4438	48649	3593	50637	2302	61578	1630	45361
20-#14	3.29	MA	26589	7603	43980	5541	48117	4475	49873	3626	51621	2337	62635	1533	47167
7L-5S		MI	26264	7603	43698	5504	48112	4446	50311	3604	52784	2290	64220	1712	46028
20-#14	3.29	MA	25993	7603	42951	5536	46717	4468	48217	3642	49230	2325	59817	1466	46134
8L-4S		MI	26878	7603	44745	5510	49469	4429	51978	3590	55154	2302	67032	1768	46982
20-#18	5.85	MA	30116	8813	53223	6237	59613	4977	63838	3913	70121	2178	87766	1032	78868
6E		MI	28376	8813	50291	6209	56205	4952	60241	3934	65716	2143	82001	976	74052
22-#11	2.51	MA	27385	7233	44447	5316	48842	4295	50819	3517	52994	2368	63859	1976	38686
4L-9S		MI	23833	7233	38519	5312	41538	4303	42304	3521	42158	2358	50440	1663	34417
22-#11	2.51	MA	26924	7233	43670	5312	47835	4307	49582	3528	51209	2360	61739	1936	38588
5L-8S		MI	24226	7233	39246	5298	42432	4291	43441	3527	43621	2350	52248	1717	34958
22-#11	2.51	MA	26485	7233	42941	5309	46826	4302	48349	3522	49591	2368	59735	1880	37961
6L-7S		MI	24624	7233	39922	5302	43351	4297	44528	3517	45190	2358	54097	1763	35447
22-#11	2.51	MA	26058	7233	42143	5323	45863	4315	47165	3533	48010	2377	57595	1789	37598
7L-6S		MI	25027	7233	40673	5288	44258	4284	45642	3506	46666	2350	56090	1854	35771
22-#11	2.51	MA	25636	7233	41425	5320	44887	4310	46010	3544	46330	2368	55614	1742	37075
8L-5S		MI	25441	7233	41359	5292	45207	4290	46802	3513	48177	2341	57955	1910	36337
22-#11	2.51	MA	25219	7233	40653	5334	43936	4323	44802	3538	44763	2377	53671	1688	36479
9L-4S		MI	25875	7233	42089	5295	46154	4278	47966	3502	49844	2350	59934	1949	36443
22-#11	2.51	MA	24761	7233	39937	5331	42973	4318	43652	3549	43210	2386	51789	1627	35822
10L-3S		MI	26360	7233	42933	5282	47229	4283	49273	3509	51507	2341	61808	2036	36482
22-#14	3.62	MA	28526	7758	47739	5624	52957	4535	55793	3663	59488	2298	72920	1713	53640
5L-8S		MI	25219	7758	42145	5609	46027	4516	47801	3665	49402	2287	60225	1401	47886
22-#14	3.62	MA	27908	7758	46695	5619	51511	4527	54027	3654	57187	2311	70078	1632	52927
6L-7S		MI	25777	7758	43113	5615	47344	4524	49359	3650	51633	2300	62853	1467	48791
22-#14	3.62	MA	27307	7758	45551	5638	50131	4545	52330	3669	54938	2323	67041	1502	51838
7L-6S		MI	26345	7758	44190	5596	48642	4507	50954	3636	53731	2287	65677	1597	49821
22-#14	3.62	MA	26714	7758	44522	5633	48731	4537	50674	3684	52547	2311	64223	1435	50839
8L-5S		MI	26927	7758	45172	5602	50001	4516	52615	3646	55877	2275	68319	1679	50460
24-#11	2.74	MA	27429	7341	44769	5380	49244	4356	51300	3558	53540	2351	64844	1916	41895
5L-9S		MI	24311	7341	39550	5379	42860	4352	43917	3550	44335	2348	53331	1641	37518
24-#11	2.74	MA	26992	7341	44040	5377	48235	4351	50067	3552	51922	2359	62840	1860	41293
6L-8S		MI	24703	7341	40277	5366	43754	4340	45054	3557	45798	2340	55139	1695	38042
24-#11	2.74	MA	26566	7341	43242	5391	47272	4363	48884	3563	50342	2368	60700	1769	40942
7E		MI	25098	7341	40953	5369	44674	4345	46141	3546	47367	2348	56989	1742	38585
24-#11	2.74	MA	26146	7341	42524	5387	46295	4359	47728	3574	48661	2359	58719	1722	40364
8L-6S		MI	25500	7341	41704	5356	45580	4333	47255	3536	48843	2340	58981	1832	38898
24-#11	2.74	MA	25731	7341	41752	5402	45345	4371	46520	3568	47094	2368	56776	1668	39786
9L-5S		MI	25913	7341	42390	5359	46529	4338	48415	3542	50353	2331	60846	1889	39440
24-#11	2.74	MA	25275	7341	41036	5398	44381	4367	45370	3579	45541	2377	54894	1607	39089
10L-4S		MI	26345	7341	43121	5363	47476	4326	49579	3532	52020	2340	62825	1928	39640
24-#14	3.95	MA	28619	7914	48266	5716	53525	4597	56484	3696	60503	2297	74485	1601	57689
6L-8S		MI	25888	7914	43619	5706	47916	4586	50106	3707	52495	2272	64324	1367	52301
24-#14	3.95	MA	28020	7914	47122	5736	52145	4615	54787	3711	58254	2309	71448	1471	56518
7E		MI	26444	7914	44587	5712	49233	4594	51664	3693	54727	2284	66952	1433	53175
24-#14	3.95	MA	27431	7914	46093	5731	50745	4607	53131	3727	55863	2297	68630	1404	55552
8L-6S		MI	27008	7914	45663	5693	50531	4577	53259	3678	56824	2272	69776	1564	54285

RECTANGULAR TIED COLUMNS 36" x 40"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.11	MA	28207	6918	44050	5113	47251	4170	47852	3482	46986	2507	54635	2359	19393
2E		MI	25305	6918	39692	5068	42375	4133	42804	3451	41775	2474	48382	2318	17329
6-#18	1.67	MA	29553	7195	46967	5286	50991	4294	52414	3557	53117	2480	62763	2300	28608
2L-3S		MI	24749	7195	39692	5228	42375	4284	42804	3548	41775	2465	48382	2030	25582
6-#18	1.67	MA	27589	7195	44050	5276	47251	4324	47852	3583	46986	2502	54635	2079	28676
3L-2S		MI	26477	7195	42264	5241	45671	4257	46825	3526	47114	2443	55418	2251	25483

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

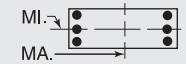
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	1.25	MA	28630	6987	44741	5192	48333	4231	49245	3526	49022	2527	57446	2378	21860
2L-4S		MI	23973	6987	37623	5165	39923	4206	39891	3501	38154	2522	44164	2091	19644
8-#14	1.25	MA	27497	6987	43072	5188	46194	4249	46636	3542	45483	2540	52732	2254	21923
3E		MI	24683	6987	38831	5146	41462	4214	41761	3512	40519	2509	46816	2215	19588
8-#14	1.25	MA	26697	6987	41710	5208	44458	4242	44526	3533	42777	2552	49671	2129	21956
4L-2S		MI	25682	6987	40305	5152	43351	4197	44066	3498	43612	2497	50916	2340	19517
8-#18	2.22	MA	30883	7471	49884	5459	54730	4418	56976	3633	59247	2453	70891	2242	37770
2L-4S		MI	24700	7471	40150	5433	42978	4391	43552	3602	43034	2456	50878	1742	33375
8-#18	2.22	MA	28935	7471	46967	5448	50991	4448	52414	3659	53117	2476	62763	2021	37745
3E		MI	25921	7471	42264	5401	45671	4408	46825	3624	47114	2434	55418	1963	33604
8-#18	2.22	MA	27557	7471	44577	5483	47946	4434	48714	3640	48432	2498	57501	1799	37408
4L-2S		MI	27636	7471	44835	5414	48967	4381	50846	3601	52453	2412	62453	2184	33580
10-#11	1.08	MA	28251	6904	43822	5159	47255	4209	47968	3516	47340	2546	55285	2410	19113
2L-5S		MI	23709	6904	36887	5126	39064	4196	38869	3504	36683	2528	42337	2164	17220
10-#11	1.08	MA	27456	6904	42656	5156	45760	4222	46144	3528	44859	2555	51967	2324	19159
3L-4S		MI	24155	6904	37618	5130	40011	4184	40033	3493	38350	2537	44316	2203	17183
10-#11	1.08	MA	26895	6904	41704	5170	44548	4218	44671	3522	42963	2564	49809	2237	19201
4L-3S		MI	24653	6904	38462	5116	41086	4189	41339	3500	40014	2528	46190	2289	17132
10-#11	1.08	MA	26394	6904	40882	5168	43481	4231	43360	3534	41064	2556	47548	2196	19218
5L-2S		MI	25355	6904	39493	5120	42409	4177	42952	3489	42190	2520	49082	2376	17083
10-#14	1.56	MA	29407	7143	46409	5290	50472	4301	51855	3569	52562	2514	62161	2350	27114
2L-5S		MI	24028	7143	38050	5256	40455	4293	40529	3558	38878	2494	45450	2002	24182
10-#14	1.56	MA	28279	7143	44741	5285	48333	4319	49245	3585	49022	2527	57446	2225	27158
3L-4S		MI	24661	7143	39097	5262	41812	4276	42196	3544	41248	2506	48263	2058	24251
10-#14	1.56	MA	27484	7143	43378	5305	46596	4312	47135	3576	46317	2539	54385	2100	27148
4L-3S		MI	25366	7143	40305	5243	43351	4284	44066	3554	43612	2494	50916	2182	24227
10-#14	1.56	MA	26773	7143	42198	5301	45067	4330	45256	3592	43606	2527	51167	2043	27024
5L-2S		MI	26361	7143	41778	5249	45240	4267	46370	3540	46706	2482	55015	2307	24173
10-#18	2.78	MA	32198	7748	52801	5631	58470	4542	61538	3708	65378	2427	79018	2184	46897
2L-5S		MI	24784	7748	40885	5593	43896	4543	44653	3700	44280	2403	53063	1579	38791
10-#18	2.78	MA	30266	7748	49884	5621	54730	4572	56976	3734	59247	2449	70891	1962	46782
3L-4S		MI	25870	7748	42721	5606	46274	4516	47574	3677	48373	2425	57914	1675	41028
10-#18	2.78	MA	28900	7748	47494	5655	51686	4558	53276	3716	54562	2471	65629	1741	46190
4L-3S		MI	27082	7748	44835	5574	48967	4533	50846	3699	52453	2403	62453	1896	41583
10-#18	2.78	MA	27678	7748	45423	5645	49001	4588	49978	3741	49865	2449	60055	1641	43503
5L-2S		MI	28783	7748	47406	5586	52264	4506	54867	3677	57792	2381	69489	2117	41642
12-#11	1.30	MA	28799	7012	44988	5226	48750	4257	49792	3546	49822	2538	58604	2391	22791
2L-6S		MI	23772	7012	37233	5190	39437	4239	39322	3526	37349	2527	43363	2086	20364
12-#11	1.30	MA	28007	7012	43822	5223	47255	4270	47968	3557	47340	2547	55285	2305	22829
3L-5S		MI	24196	7012	37919	5194	40386	4244	40482	3533	38860	2518	45228	2142	20446
12-#11	1.30	MA	27449	7012	42871	5238	46043	4266	46495	3552	45445	2555	53128	2219	22857
4E		MI	24640	7012	38650	5197	41333	4232	41646	3522	40527	2527	47207	2181	20427
12-#11	1.30	MA	26950	7012	42048	5235	44976	4279	45184	3563	43546	2547	50867	2178	22848
5L-3S		MI	25135	7012	39493	5184	42409	4237	42952	3529	42190	2518	49082	2268	20389
12-#11	1.30	MA	26475	7012	41276	5232	43907	4275	43878	3558	41825	2556	48723	2122	22715
6L-2S		MI	25835	7012	40525	5187	43731	4225	44565	3519	44367	2510	51973	2354	20346
12-#14	1.88	MA	30178	7298	48077	5387	52610	4371	54464	3611	56101	2501	66875	2321	32352
2L-6S		MI	24114	7298	38541	5348	40985	4354	41172	3590	39824	2491	46908	1887	27783
12-#14	1.88	MA	29056	7298	46409	5382	50472	4389	51855	3627	52562	2514	62161	2196	32376
3L-5S		MI	24714	7298	39524	5353	42345	4362	42833	3601	41971	2479	49549	1969	28631
12-#14	1.88	MA	28266	7298	45046	5403	48735	4382	49744	3618	49856	2526	59100	2072	32325
4E		MI	25343	7298	40571	5359	43702	4346	44500	3586	44341	2491	52362	2024	28836
12-#14	1.88	MA	27558	7298	43867	5398	47206	4400	47865	3634	47146	2514	55881	2014	32071
5L-3S		MI	26045	7298	41778	5340	45240	4354	46370	3597	46706	2479	55015	2149	28849

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

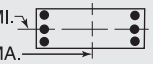


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.88	MA	26884	7298	42760	5393	45674	4394	45993	3625	44689	2526	52838	1932	31050
6L-2S		MI	27035	7298	43252	5346	47130	4337	48675	3582	49799	2466	59114	2273	28811
12-#18	3.33	MA	33500	8025	55718	5804	62209	4667	66100	3784	71508	2400	87146	2126	55982
2L-6S		MI	24925	8025	41733	5754	44809	4650	45894	3798	45915	2394	55573	1367	44463
12-#18	3.33	MA	31583	8025	52801	5794	58470	4697	61538	3809	65378	2422	79018	1904	55797
3L-5S		MI	25951	8025	43457	5766	47192	4667	48674	3775	49619	2372	60099	1512	46437
12-#18	3.33	MA	30229	8025	50411	5828	55425	4682	57838	3791	60693	2444	73756	1683	54723
4E		MI	27029	8025	45292	5779	49570	4640	51595	3753	53713	2394	64950	1608	48522
12-#18	3.33	MA	29018	8025	48340	5818	52740	4712	54540	3817	55996	2422	68183	1583	52200
5L-3S		MI	28231	8025	47406	5747	52264	4657	54867	3775	57792	2372	69489	1829	49537
12-#18	3.33	MA	27865	8025	46396	5808	50051	4698	51254	3798	51742	2444	62945	1438	49942
6L-2S		MI	29920	8025	49977	5759	55560	4630	58889	3752	63131	2350	76525	2050	49669
14-#11	1.52	MA	29345	7120	46154	5294	50245	4306	51616	3575	52304	2529	61923	2373	26459
2L-7S		MI	23847	7120	37513	5271	39853	4300	39821	3566	38050	2526	44262	1974	23067
14-#11	1.52	MA	28555	7120	44988	5291	48750	4319	49792	3587	49822	2538	58604	2286	26488
3L-6S		MI	24258	7120	38264	5258	40759	4288	40935	3556	39526	2517	46255	2064	23461
14-#11	1.52	MA	28000	7120	44037	5305	47538	4314	48319	3581	47926	2547	56446	2200	26504
4L-5S		MI	24680	7120	38950	5261	41708	4293	42094	3562	41036	2509	48120	2120	23658
14-#11	1.52	MA	27503	7120	43214	5302	46471	4327	47008	3593	46027	2538	54186	2159	26470
5L-4S		MI	25122	7120	39681	5265	42656	4281	43259	3552	42703	2517	50099	2160	23661
14-#11	1.52	MA	27030	7120	42442	5300	45402	4323	45702	3587	44307	2547	52042	2103	26220
6L-3S		MI	25615	7120	40525	5251	43731	4286	44565	3559	44367	2509	51973	2246	23634
14-#11	1.52	MA	26569	7120	41597	5314	44383	4336	44448	3599	42625	2556	49754	2013	25738
7L-2S		MI	26312	7120	41556	5255	45053	4274	46178	3548	46543	2500	54865	2333	23598
14-#14	2.19	MA	30944	7454	49745	5484	54749	4441	57073	3653	59641	2488	71590	2292	37579
2L-7S		MI	24218	7454	38939	5464	41576	4441	41882	3647	40820	2488	48183	1723	31697
14-#14	2.19	MA	29828	7454	48077	5480	52610	4459	54464	3670	56101	2501	66875	2167	37573
3L-6S		MI	24799	7454	40015	5445	42874	4424	43477	3633	42918	2476	51007	1854	32214
14-#14	2.19	MA	29041	7454	46715	5500	50874	4452	52353	3661	53396	2513	63814	2043	37492
4L-5S		MI	25396	7454	40998	5451	44234	4432	45138	3643	45065	2464	53648	1935	33012
14-#14	2.19	MA	28338	7454	45535	5495	49345	4470	50474	3677	50685	2501	60596	1985	37040
5L-4S		MI	26022	7454	42045	5457	45591	4415	46805	3629	47435	2476	56461	1991	33409
14-#14	2.19	MA	27668	7454	44429	5491	47813	4463	48602	3668	48229	2513	57553	1904	36073
6L-3S		MI	26720	7454	43252	5437	47130	4424	48675	3639	49799	2464	59114	2116	33457
14-#14	2.19	MA	27016	7454	43217	5511	46351	4482	46805	3684	45828	2526	54303	1774	35457
7L-2S		MI	27705	7454	44726	5443	49019	4407	50980	3625	52893	2451	63213	2240	33438
14-#18	3.89	MA	32888	8301	55718	5967	62209	4821	66100	3885	71508	2396	87146	1846	64798
3L-6S		MI	26090	8301	44304	5927	48105	4774	49915	3873	51254	2363	62609	1300	51944
14-#18	3.89	MA	31545	8301	53328	6001	59165	4807	62400	3866	66823	2418	81884	1624	63301
4L-5S		MI	27108	8301	46028	5939	50489	4791	52695	3851	54958	2341	67135	1446	54109
14-#18	3.89	MA	30344	8301	51257	5991	56480	4836	59102	3892	62126	2396	76310	1525	60925
5L-4S		MI	28177	8301	47863	5952	52867	4764	55616	3828	59052	2363	71986	1541	56061
14-#18	3.89	MA	29201	8301	49313	5981	53790	4822	55816	3874	57872	2418	71072	1380	58476
6L-3S		MI	29370	8301	49977	5920	55560	4781	58889	3850	63131	2341	76525	1762	57475
16-#11	1.73	MA	29888	7228	47320	5361	51740	4354	53440	3605	54785	2520	65242	2354	30120
2L-8S		MI	23928	7228	37869	5335	40256	4343	40346	3606	38657	2507	45304	1906	25935
16-#11	1.73	MA	29101	7228	46154	5358	50245	4367	51616	3616	52304	2529	61923	2268	30141
3L-7S		MI	24332	7228	38544	5339	41175	4348	41434	3596	40226	2516	47154	1952	26193
16-#11	1.73	MA	28548	7228	45203	5373	49033	4363	50143	3611	50408	2538	59765	2181	30135
4L-6S		MI	24741	7228	39295	5325	42081	4336	42548	3585	41702	2507	49146	2042	26567
16-#11	1.73	MA	28053	7228	44380	5370	47966	4376	48832	3622	48509	2530	57504	2140	30086
5E		MI	25161	7228	39981	5329	43030	4341	43707	3592	43213	2499	51011	2099	26863
16-#11	1.73	MA	27582	7228	43609	5367	46897	4372	47526	3617	46788	2539	55361	2084	29734
6L-4S		MI	25601	7228	40712	5332	43978	4329	44872	3581	44880	2507	52990	2138	26888
16-#11	1.73	MA	27123	7228	42763	5381	45878	4385	46272	3628	45106	2548	53073	1994	29275
7L-3S		MI	26093	7228	41556	5319	45053	4334	46178	3588	46543	2499	54865	2225	26872
16-#11	1.73	MA	26670	7228	42004	5379	44844	4380	45049	3640	43319	2539	50959	1946	28950
8L-2S		MI	26787	7228	42587	5322	46375	4322	47791	3577	48720	2490	57756	2311	26843

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

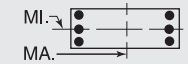
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	2.50	MA	31704	7610	51414	5581	56888	4510	59682	3696	63180	2475	76304	2263	42796
2L-8S		MI	24332	7610	39445	5555	42149	4502	42629	3704	41683	2461	49654	1624	34994
16-#14	2.50	MA	30594	7610	49745	5577	54749	4529	57073	3712	59641	2488	71590	2138	42760
3L-7S		MI	24901	7610	40413	5561	43466	4511	44186	3689	43914	2473	52282	1690	36033
16-#14	2.50	MA	29812	7610	48383	5597	53012	4522	54962	3703	56935	2500	68529	2014	42651
4L-6S		MI	25479	7610	41489	5542	44764	4494	45782	3675	46012	2461	55106	1820	36656
16-#14	2.50	MA	29112	7610	47203	5592	51483	4540	53083	3719	54225	2488	65310	1956	42026
5E		MI	26073	7610	42471	5548	46123	4502	47443	3685	48158	2448	57747	1902	37410
16-#14	2.50	MA	28447	7610	46097	5588	49952	4533	51212	3710	51768	2500	62267	1875	41107
6L-4S		MI	26695	7610	43518	5554	47480	4485	49110	3671	50529	2461	60560	1958	37972
16-#14	2.50	MA	27798	7610	44885	5608	48490	4551	49414	3726	49368	2513	59018	1745	40386
7L-3S		MI	27390	7610	44726	5535	49019	4493	50980	3682	52893	2448	63213	2082	38046
16-#14	2.50	MA	27159	7610	43796	5603	47007	4545	47660	3742	46817	2500	56009	1676	39146
8L-2S		MI	28370	7610	46200	5541	50908	4477	53285	3667	55987	2436	67312	2207	38055
16-#18	4.44	MA	32849	8578	56245	6174	62904	4931	66962	3942	72953	2391	90011	1566	71917
4L-6S		MI	27245	8578	46875	6100	51401	4898	53936	3949	56593	2332	69644	1233	59455
16-#18	4.44	MA	31658	8578	54174	6164	60220	4961	63664	3968	68257	2369	84438	1467	69671
5E		MI	28255	8578	48599	6112	53785	4915	56717	3926	60297	2310	74171	1379	61801
16-#18	4.44	MA	30525	8578	52230	6154	57530	4946	60378	3949	64003	2391	79200	1322	67040
6L-4S		MI	29316	8578	50435	6125	56163	4888	59637	3904	64391	2332	79022	1474	63635
18-#11	1.95	MA	30428	7336	48487	5429	53235	4403	55264	3634	57267	2512	68560	2335	33775
2L-9S		MI	24015	7336	38173	5416	40684	4403	40822	3629	39371	2506	46388	1830	28458
18-#11	1.95	MA	29644	7336	47320	5426	51740	4416	53440	3646	54785	2521	65242	2249	33788
3L-8S		MI	24412	7336	38900	5402	41578	4391	41959	3636	40833	2498	48196	1884	29051
18-#11	1.95	MA	29093	7336	46369	5440	50528	4411	51966	3640	52889	2530	63084	2162	33762
4L-7S		MI	24814	7336	39576	5406	42497	4396	43047	3625	42403	2506	50045	1931	29324
18-#11	1.95	MA	28600	7336	45546	5437	49461	4424	50655	3652	50990	2521	60823	2122	33698
5L-6S		MI	25222	7336	40327	5392	43403	4384	44161	3615	43879	2498	52038	2021	29681
18-#11	1.95	MA	28131	7336	44775	5434	48392	4420	49350	3646	49270	2530	58680	2066	33256
6L-5S		MI	25640	7336	41013	5396	44352	4390	45320	3621	45389	2489	53903	2077	30063
18-#11	1.95	MA	27674	7336	43930	5449	47373	4433	48096	3658	47588	2539	56392	1975	32816
7L-4S		MI	26078	7336	41744	5400	45300	4377	46484	3611	47056	2498	55882	2117	30101
18-#11	1.95	MA	27224	7336	43170	5446	46339	4429	46873	3669	45801	2531	54278	1927	32488
8L-3S		MI	26568	7336	42587	5386	46375	4383	47791	3617	48720	2489	57756	2203	30103
18-#11	1.95	MA	26765	7336	42352	5460	45333	4442	45593	3664	44134	2539	52200	1873	31778
9L-2S		MI	27260	7336	43619	5390	47697	4371	49404	3607	50896	2480	60648	2289	30082
18-#14	2.81	MA	31355	7765	51414	5674	56888	4598	59682	3754	63180	2475	76304	2109	47939
3L-8S		MI	25014	7765	40918	5653	44038	4572	44933	3746	44777	2445	53753	1591	39384
18-#14	2.81	MA	30577	7765	50051	5694	55151	4592	57571	3745	60474	2487	73243	1985	47805
4L-7S		MI	25580	7765	41886	5659	45355	4580	46491	3732	47008	2458	56381	1657	40382
18-#14	2.81	MA	29882	7765	48872	5690	53622	4610	55692	3762	57764	2475	70025	1927	47025
5L-6S		MI	26155	7765	42962	5639	46653	4564	48087	3717	49105	2445	59205	1787	41105
18-#14	2.81	MA	29220	7765	47765	5685	52090	4603	53821	3753	55308	2487	66982	1846	46148
6L-5S		MI	26746	7765	43945	5645	48013	4572	49748	3728	51252	2433	61847	1869	41821
18-#14	2.81	MA	28575	7765	46553	5705	50628	4621	52023	3769	52907	2500	63732	1716	45328
7L-4S		MI	27365	7765	44992	5651	49370	4555	51415	3714	53622	2445	64659	1925	42529
18-#14	2.81	MA	27939	7765	45464	5701	49146	4614	50269	3785	50356	2487	60724	1647	44131
8L-3S		MI	28056	7765	46200	5632	50908	4563	53285	3724	55987	2433	67312	2049	42627
18-#14	2.81	MA	27311	7765	44291	5721	47703	4633	48435	3776	47977	2500	57773	1569	42915
9L-2S		MI	29032	7765	47674	5638	52798	4547	55590	3710	59080	2421	71411	2174	42662
18-#18	5.00	MA	32962	8855	57091	6337	63959	5085	68226	4043	74387	2342	92566	1408	78435
5L-6S		MI	28390	8855	49447	6273	54698	5022	57958	4024	61932	2301	76680	1166	66993
18-#18	5.00	MA	31837	8855	55147	6327	61269	5071	64940	4025	70133	2364	87327	1263	75629
6L-5S		MI	29393	8855	51171	6285	57081	5039	60738	4002	65636	2279	81207	1312	69511

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

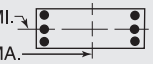


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	2.17	MA	30184	7444	48487	5493	53235	4464	55264	3675	57267	2512	68560	2230	37421
3L-9S		MI	24498	7444	39205	5484	42006	4452	42435	3658	41547	2496	49279	1808	31549
20-#11	2.17	MA	29635	7444	47535	5508	52023	4460	53790	3669	55371	2521	66403	2144	37384
4L-8S		MI	24894	7444	39932	5470	42900	4440	43572	3665	43010	2488	51087	1863	32121
20-#11	2.17	MA	29144	7444	46713	5505	50956	4473	52479	3681	53472	2513	64142	2103	37305
5L-7S		MI	25294	7444	40607	5474	43819	4445	44660	3654	44579	2496	52937	1909	32458
20-#11	2.17	MA	28677	7444	45941	5502	49887	4469	51173	3675	51751	2521	61998	2047	36784
6E		MI	25700	7444	41358	5460	44725	4433	45773	3644	46055	2488	54930	1999	32800
20-#11	2.17	MA	28222	7444	45096	5516	48868	4482	49920	3687	50069	2530	59710	1957	36362
7L-5S		MI	26116	7444	42044	5464	45674	4438	46933	3651	47566	2479	56794	2056	33257
20-#11	2.17	MA	27774	7444	44336	5513	47834	4477	48696	3699	48282	2522	57597	1909	35968
8L-4S		MI	26553	7444	42775	5467	46622	4426	48097	3640	49233	2488	58773	2095	33310
20-#11	2.17	MA	27319	7444	43518	5528	46828	4490	47417	3693	46616	2531	55518	1855	35280
9L-3S		MI	27041	7444	43619	5454	47697	4431	49404	3647	50896	2479	60648	2182	33329
20-#11	2.17	MA	26831	7444	42761	5525	45807	4486	46200	3705	44964	2540	53505	1794	34720
10L-2S		MI	27731	7444	44650	5457	49019	4419	51017	3636	53073	2471	63539	2268	33315
20-#14	3.13	MA	31338	7921	51719	5792	57290	4661	60180	3788	64014	2474	77958	1956	52954
4L-8S		MI	25692	7921	42392	5750	45927	4642	47238	3789	47870	2430	57852	1558	43782
20-#14	3.13	MA	30647	7921	50540	5787	55761	4680	58301	3804	61304	2462	74739	1898	52036
5L-7S		MI	26255	7921	43360	5756	47244	4650	48796	3774	50101	2443	60480	1624	44744
20-#14	3.13	MA	29988	7921	49434	5782	54229	4673	56430	3795	58847	2474	71696	1817	51197
6E		MI	26827	7921	44436	5737	48542	4634	50392	3760	52199	2430	63304	1754	45560
20-#14	3.13	MA	29347	7921	48222	5803	52767	4691	54633	3811	56447	2487	68447	1687	50281
7L-5S		MI	27415	7921	45419	5743	49902	4642	52053	3770	54346	2418	65946	1836	46243
20-#14	3.13	MA	28715	7921	47132	5798	51284	4684	52878	3827	53896	2474	65438	1619	49124
8L-4S		MI	28031	7921	46466	5748	51259	4625	53720	3756	56716	2430	68758	1891	47081
20-#14	3.13	MA	28090	7921	45959	5818	49842	4702	51044	3818	51517	2487	62488	1540	47846
9L-3S		MI	28719	7921	47674	5729	52798	4633	55590	3766	59080	2418	71411	2016	47200
20-#18	5.56	MA	33139	9131	58064	6500	65009	5195	69502	4100	76263	2338	95455	1205	84243
6E		MI	29527	9131	52018	6445	57994	5146	61979	4099	67271	2270	83716	1099	74554
22-#11	2.38	MA	30175	7552	48702	5575	53518	4508	55614	3699	57852	2512	69721	2125	41003
4L-9S		MI	24979	7552	40236	5551	43328	4500	44048	3688	43724	2487	52171	1787	34644
22-#11	2.38	MA	29686	7552	47879	5572	52451	4521	54303	3710	55953	2504	67460	2084	40909
5L-8S		MI	25373	7552	40963	5537	44222	4488	45185	3694	45187	2478	53979	1841	35197
22-#11	2.38	MA	29221	7552	47107	5569	51382	4517	52997	3705	54233	2513	65317	2028	40318
6L-7S		MI	25771	7552	41638	5541	45141	4493	46273	3684	46756	2487	55828	1888	35595
22-#11	2.38	MA	28768	7552	46262	5584	50363	4530	51744	3717	52551	2522	63029	1938	39910
7L-6S		MI	26176	7552	42390	5527	46047	4481	47386	3673	48232	2478	57821	1978	35923
22-#11	2.38	MA	28321	7552	45503	5581	49329	4526	50520	3728	50764	2513	60915	1890	39455
8L-5S		MI	26591	7552	43075	5531	46997	4486	48546	3680	49742	2469	59686	2034	36448
22-#11	2.38	MA	27871	7552	44685	5595	48323	4539	49241	3723	49098	2522	58837	1836	38788
9L-4S		MI	27026	7552	43806	5535	47944	4474	49710	3670	51409	2478	61665	2074	36514
22-#11	2.38	MA	27382	7552	43927	5592	47302	4535	48024	3734	47445	2531	56824	1775	38185
10L-3S		MI	27512	7552	44650	5521	49019	4479	51017	3676	53073	2469	63539	2160	36544
22-#14	3.44	MA	31407	8077	52208	5884	57899	4749	60910	3846	64843	2449	79454	1869	57057
5L-8S		MI	26366	8077	43866	5847	47817	4712	49543	3831	50964	2415	61951	1524	48189
22-#14	3.44	MA	30752	8077	51102	5880	56368	4743	59039	3838	62387	2461	76411	1788	56252
6L-7S		MI	26926	8077	44834	5853	49133	4720	51101	3817	53195	2427	64579	1590	49116
22-#14	3.44	MA	30114	8077	49890	5900	54906	4761	57242	3854	59986	2474	73161	1658	55245
7L-6S		MI	27496	8077	45910	5834	50432	4703	52696	3802	55293	2415	67403	1721	50021
22-#14	3.44	MA	29485	8077	48801	5895	53423	4754	55487	3870	57435	2461	70153	1590	54126
8L-5S		MI	28080	8077	46893	5840	51791	4712	54358	3813	57439	2403	70045	1802	50674
22-#14	3.44	MA	28864	8077	47628	5915	51980	4772	53653	3861	55056	2474	67202	1512	52787
9L-4S		MI	28693	8077	47940	5846	53148	4695	56025	3798	59810	2415	72857	1858	51627
24-#11	2.60	MA	30225	7659	49045	5640	53946	4570	56127	3740	58435	2495	70779	2066	44511
5L-9S		MI	25457	7659	41267	5618	44650	4549	45661	3717	45900	2477	55062	1765	37744
24-#11	2.60	MA	29762	7659	48274	5637	52878	4565	54821	3734	56714	2504	68636	2009	43855
6L-8S		MI	25850	7659	41994	5605	45544	4537	46798	3724	47363	2468	56870	1819	38280

RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.60	MA	29311	7659	47428	5651	51858	4578	53568	3746	55032	2513	66348	1919	43461
7E		MI	26247	7659	42670	5608	46463	4542	47886	3713	48932	2477	58720	1866	38734
24-#11	2.60	MA	28866	7659	46669	5648	50824	4574	52344	3758	53246	2505	64234	1871	42947
8L-6S		MI	26650	7659	43421	5595	47370	4530	48999	3703	50408	2468	60713	1956	39051
24-#11	2.60	MA	28426	7659	45851	5663	49818	4587	51065	3752	51579	2514	62156	1817	42301
9L-5S		MI	27063	7659	44107	5598	48319	4535	50159	3709	51919	2460	62577	2013	39611
24-#11	2.60	MA	27931	7659	45094	5660	48797	4583	49847	3764	49927	2522	60143	1756	41655
10L-4S		MI	27497	7659	44838	5602	49266	4523	51323	3699	53586	2468	64556	2052	39714
24-#14	3.75	MA	31511	8232	52770	5977	58506	4813	61648	3880	65926	2448	81125	1759	61312
6L-8S		MI	27036	8232	45340	5944	49706	4782	51848	3873	54057	2400	66050	1491	52602
24-#14	3.75	MA	30876	8232	51558	5997	57044	4831	59851	3896	63526	2460	77876	1629	60219
7E		MI	27594	8232	46308	5950	51023	4790	53406	3859	56288	2412	68678	1557	53497
24-#14	3.75	MA	30252	8232	50469	5992	55561	4824	58096	3912	60975	2448	74867	1561	59134
8L-6S		MI	28160	8232	47384	5931	52321	4773	55001	3845	58386	2400	71502	1687	54486
24-#14	3.75	MA	29633	8232	49296	6013	54119	4842	56262	3903	58596	2460	71917	1483	57737
9L-5S		MI	28742	8232	48366	5937	53680	4781	56663	3855	60533	2387	74144	1769	55112

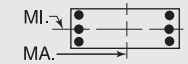
RECTANGULAR TIED COLUMNS 36" x 42"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.06	MA	30998	7236	48227	5371	51775	4383	52410	3663	51419	2649	59784	2500	20473
2E		MI	26452	7236	41420	5304	44164	4327	44542	3615	43330	2601	50097	2441	17376
6-#18	1.59	MA	32433	7513	51317	5544	55737	4507	57243	3738	57946	2624	68459	2446	30228
2L-3S		MI	25895	7513	41420	5464	44164	4479	44542	3713	43330	2592	50097	2152	25649
6-#18	1.59	MA	30348	7513	48227	5535	51775	4538	52410	3765	51419	2647	59784	2224	30296
3L-2S		MI	27626	7513	43991	5477	47460	4451	48563	3691	48669	2570	57133	2374	25539
8-#14	1.19	MA	31444	7305	48950	5451	52910	4444	53874	3707	53537	2669	62744	2520	23075
2L-4S		MI	25119	7305	39344	5403	41713	4402	41633	3668	39716	2649	45890	2214	19698
8-#14	1.19	MA	30242	7305	47185	5447	50647	4463	51112	3724	49781	2681	57721	2396	23138
3E		MI	25829	7305	40551	5384	43252	4410	43503	3678	42080	2637	48542	2339	19633
8-#14	1.19	MA	29396	7305	45745	5468	48812	4456	48882	3716	46910	2694	54456	2271	23171
4L-2S		MI	26830	7305	42025	5390	45141	4393	45808	3664	45174	2625	52641	2463	19560
8-#18	2.12	MA	33851	7790	54407	5717	59698	4631	62075	3813	64473	2600	77133	2391	39930
2L-4S		MI	25846	7790	41877	5669	44767	4586	45290	3767	44589	2583	52594	1864	33503
8-#18	2.12	MA	31783	7790	51317	5708	55737	4662	57243	3841	57946	2622	68459	2170	39905
3E		MI	27070	7790	43991	5637	47460	4603	48563	3789	48669	2561	57133	2085	33687
8-#18	2.12	MA	30324	7790	48790	5743	52516	4649	53329	3824	52957	2644	62834	1948	39568
4L-2S		MI	28787	7790	46562	5650	50757	4576	52584	3766	54008	2539	64169	2307	33643
10-#11	1.03	MA	31039	7222	47974	5417	51765	4422	52516	3697	51707	2685	60425	2550	20166
2L-5S		MI	24855	7222	38604	5366	40854	4393	40613	3671	38248	2657	44068	2288	17268
10-#11	1.03	MA	30195	7222	46741	5415	50183	4418	50587	3709	49082	2695	56892	2464	20212
3L-4S		MI	25301	7222	39335	5369	41801	4381	41777	3660	39916	2665	46047	2327	17223
10-#11	1.03	MA	29603	7222	45736	5430	48903	4431	49030	3704	47079	2704	54592	2378	20254
4L-3S		MI	25799	7222	40179	5356	42876	4386	43084	3667	41579	2657	47921	2413	17170
10-#11	1.03	MA	29073	7222	44867	5427	47776	4427	47646	3716	45074	2696	52190	2336	20271
5L-2S		MI	26502	7222	41210	5359	44198	4374	44697	3656	43756	2648	50813	2500	17119
10-#14	1.49	MA	32271	7461	50716	5548	55174	4514	56635	3749	57294	2656	67767	2493	28633
2L-5S		MI	25173	7461	39771	5494	42245	4488	42271	3725	40439	2622	47176	2125	24269
10-#14	1.49	MA	31076	7461	48950	5544	52910	4532	53874	3766	53537	2669	62744	2368	28677
3L-4S		MI	25807	7461	40817	5500	43602	4472	43938	3710	42810	2634	49989	2181	24316
10-#14	1.49	MA	30234	7461	47510	5565	51075	4526	51643	3758	50667	2682	59479	2244	28666
4L-3S		MI	26514	7461	42025	5481	45141	4480	45808	3721	45174	2622	52641	2306	24278
10-#14	1.49	MA	29482	7461	46265	5561	49460	4545	49658	3775	47792	2670	56057	2185	28542
5L-2S		MI	27509	7461	43499	5487	47030	4463	48113	3706	48268	2609	56741	2430	24219

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

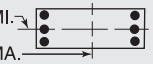


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	2.65	MA	35253	8066	57497	5890	63659	4755	66908	3889	70999	2575	85808	2336	49597
2L-5S		MI	25929	8066	42613	5830	45685	4737	46391	3865	45835	2530	54779	1702	39104
10-#18	2.65	MA	33202	8066	54407	5881	59698	4786	62075	3916	64473	2597	77133	2115	49482
3L-4S		MI	27018	8066	44448	5842	48063	4710	49312	3842	49928	2552	59630	1797	41401
10-#18	2.65	MA	31756	8066	51880	5916	56477	4773	58162	3899	59484	2619	71509	1893	49046
4L-3S		MI	28232	8066	46562	5810	50757	4727	52584	3864	54008	2530	64169	2019	41677
10-#18	2.65	MA	30463	8066	49691	5907	53640	4805	54675	3926	54485	2597	65574	1792	46216
5L-2S		MI	29937	8066	49134	5823	54053	4700	56605	3842	59347	2508	71205	2240	41711
12-#11	1.24	MA	31622	7330	49208	5485	53346	4470	54446	3726	54332	2677	63957	2533	24054
2L-6S		MI	24918	7330	38950	5429	41227	4436	41066	3693	38915	2655	45095	2210	20485
12-#11	1.24	MA	30782	7330	47974	5482	51765	4466	52516	3739	51707	2686	60425	2446	24092
3L-5S		MI	25342	7330	39635	5433	42176	4441	42226	3700	40425	2647	46959	2266	20500
12-#11	1.24	MA	30192	7330	46969	5497	50484	4480	50960	3733	49704	2696	58125	2360	24120
4E		MI	25786	7330	40366	5437	43123	4429	43390	3690	42092	2655	48938	2306	20473
12-#11	1.24	MA	29665	7330	46101	5495	49358	4476	49575	3746	47699	2688	55723	2319	24112
5L-3S		MI	26282	7330	41210	5423	44198	4434	44697	3696	43756	2647	50813	2392	20430
12-#11	1.24	MA	29163	7330	45286	5492	48229	4489	48197	3740	45882	2697	53440	2263	24044
6L-2S		MI	26983	7330	42241	5427	45521	4422	46310	3686	45932	2638	53704	2478	20385
12-#14	1.79	MA	33092	7617	52482	5645	57437	4583	59396	3792	61051	2644	72789	2466	34175
2L-6S		MI	25259	7617	40262	5586	42775	4550	42915	3757	41386	2619	48634	2011	27976
12-#14	1.79	MA	31903	7617	50716	5641	55174	4602	56635	3808	57294	2657	67767	2341	34198
3L-5S		MI	25860	7617	41244	5592	44134	4558	44576	3767	43533	2607	51275	2092	28825
12-#14	1.79	MA	31066	7617	49276	5662	53339	4596	54404	3800	54424	2669	64501	2217	34147
4E		MI	26491	7617	42291	5597	45491	4542	46243	3753	45903	2619	54088	2148	28908
12-#14	1.79	MA	30318	7617	48030	5658	51723	4615	52419	3817	51549	2657	61079	2158	33985
5L-3S		MI	27194	7617	43499	5578	47030	4550	48113	3763	48268	2607	56741	2272	28905
12-#14	1.79	MA	29606	7617	46862	5654	50105	4609	50442	3809	48944	2670	57835	2077	32902
6L-2S		MI	28185	7617	44973	5584	48919	4533	50418	3749	51361	2594	60840	2397	28862
12-#18	3.17	MA	36642	8343	60587	6063	67620	4879	71740	3964	77526	2550	94482	2282	59222
2L-6S		MI	26069	8343	43460	5990	46598	4844	47632	3963	47470	2521	57288	1489	44981
12-#18	3.17	MA	34607	8343	57497	6054	63659	4911	66908	3991	70999	2572	85808	2060	59037
3L-5S		MI	27098	8343	45184	6002	48981	4861	50412	3940	51174	2499	61814	1635	46746
12-#18	3.17	MA	33173	8343	54970	6089	60439	4897	62994	3974	66011	2594	80183	1839	58256
4E		MI	28179	8343	47020	6015	51360	4834	53333	3918	55267	2521	66665	1730	48891
12-#18	3.17	MA	31891	8343	52781	6080	57601	4929	59508	4002	61012	2572	74249	1737	55436
5L-3S		MI	29383	8343	49134	5983	54053	4851	56605	3940	59347	2499	71205	1952	49640
12-#18	3.17	MA	30671	8343	50727	6071	54758	4916	56034	3985	56483	2594	68654	1593	53281
6L-2S		MI	31076	8343	51705	5995	57349	4824	60627	3917	64686	2477	78241	2173	49749
14-#11	1.44	MA	32203	7438	50442	5552	54928	4518	56375	3756	56957	2668	67490	2515	27933
2L-7S		MI	24992	7438	39230	5510	41643	4496	41565	3733	39615	2654	45993	2098	23207
14-#11	1.44	MA	31366	7438	49208	5550	53346	4515	54446	3768	54332	2677	63957	2429	27963
3L-6S		MI	25404	7438	39981	5497	42549	4484	42679	3723	41091	2646	47986	2188	23611
14-#11	1.44	MA	30778	7438	48203	5564	52066	4528	52889	3763	52329	2687	61658	2343	27978
4L-5S		MI	25826	7438	40667	5500	43498	4489	43839	3730	42601	2637	49851	2245	23720
14-#11	1.44	MA	30253	7438	47334	5562	50939	4524	51505	3775	50324	2679	59256	2301	27945
5L-4S		MI	26269	7438	41398	5504	44445	4477	45003	3719	44269	2646	51830	2284	23711
14-#11	1.44	MA	29753	7438	46520	5559	49811	4538	50126	3770	48507	2689	56973	2245	27768
6L-3S		MI	26763	7438	42241	5490	45521	4483	46310	3726	45932	2637	53704	2370	23679
14-#11	1.44	MA	29266	7438	45628	5574	48735	4534	48803	3782	46731	2698	54537	2155	27232
7L-2S		MI	27461	7438	43273	5494	46843	4470	47922	3715	48109	2628	56596	2457	23641
14-#14	2.08	MA	33908	7772	54247	5743	59700	4653	62157	3834	64808	2631	77812	2439	39705
2L-7S		MI	25362	7772	40659	5702	43366	4637	43624	3813	42382	2616	49909	1847	31909
14-#14	2.08	MA	32724	7772	52482	5739	57437	4672	59396	3851	61051	2644	72789	2314	39699
3L-6S		MI	25945	7772	41735	5683	44664	4620	45219	3799	44480	2604	52733	1977	32407
14-#14	2.08	MA	31892	7772	51042	5759	55602	4666	57165	3843	58180	2657	69524	2190	39618
4L-5S		MI	26543	7772	42718	5689	46024	4628	46881	3809	46627	2591	55374	2059	33226
14-#14	2.08	MA	31149	7772	49796	5755	53987	4685	55180	3860	55306	2645	66102	2131	39300
5L-4S		MI	27170	7772	43765	5695	47381	4611	48548	3795	48997	2604	58187	2115	33487

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis



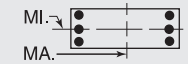
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.08	MA	30441	7772	48628	5751	52369	4679	53203	3851	52701	2658	62858	2050	38221
6L-3S		MI	27870	7772	44973	5676	48919	4620	50418	3806	51361	2591	60840	2239	33521
14-#14	2.08	MA	29751	7772	47348	5772	50825	4697	51306	3868	50155	2670	59395	1920	37545
7L-2S		MI	28856	7772	46446	5681	50809	4603	52722	3791	54455	2579	64939	2364	33492
14-#18	3.70	MA	35998	8620	60587	6227	67620	5035	71740	4067	77526	2547	94482	2006	68578
3L-6S		MI	27235	8620	46032	6163	49894	4968	51653	4038	52809	2490	64324	1422	52454
14-#18	3.70	MA	34576	8620	58060	6262	64400	5022	67826	4050	72537	2569	88858	1784	67349
4L-5S		MI	28257	8620	47756	6175	52278	4985	54433	4016	56513	2468	68850	1568	54415
14-#18	3.70	MA	33305	8620	55871	6253	61562	5053	64340	4077	67538	2547	82923	1683	64684
5L-4S		MI	29329	8620	49591	6188	54656	4958	57354	3993	60606	2490	73701	1664	56423
14-#18	3.70	MA	32095	8620	53817	6244	58719	5040	60866	4060	63009	2569	77328	1538	62334
6L-3S		MI	30525	8620	51705	6156	57349	4975	60627	4015	64686	2468	78241	1885	57586
14-#18	3.70	MA	30918	8620	51567	6279	56006	5071	57531	4087	58583	2592	71350	1307	59568
7L-2S		MI	32205	8620	54276	6168	60645	4948	64648	3992	70025	2446	85277	2106	57752
16-#11	1.65	MA	32780	7546	51675	5620	56509	4567	58304	3785	59582	2659	71022	2498	31804
2L-8S		MI	25073	7546	39586	5574	42046	4540	42091	3773	40222	2636	47036	2030	26077
16-#11	1.65	MA	31946	7546	50442	5617	54928	4563	56375	3797	56957	2669	67490	2411	31826
3L-7S		MI	25477	7546	40261	5578	42965	4545	43178	3763	41792	2644	48885	2076	26334
16-#11	1.65	MA	31361	7546	49437	5632	53647	4576	54818	3792	54954	2678	65190	2325	31820
4L-6S		MI	25887	7546	41012	5564	43871	4533	44292	3752	43268	2636	50878	2167	26716
16-#11	1.65	MA	30838	7546	48568	5629	52521	4573	53434	3804	52949	2671	62788	2284	31771
5E		MI	26308	7546	41698	5568	44820	4538	45452	3759	44778	2627	52742	2223	26930
16-#11	1.65	MA	30341	7546	47754	5627	51392	4586	52055	3799	51132	2680	60505	2228	31486
6L-4S		MI	26749	7546	42429	5571	45768	4526	46616	3748	46445	2636	54721	2262	26941
16-#11	1.65	MA	29856	7546	46861	5642	50316	4582	50732	3811	49356	2689	58070	2138	30974
7L-3S		MI	27241	7546	43273	5558	46843	4531	47922	3755	48109	2627	56596	2349	26920
16-#11	1.65	MA	29378	7546	46060	5639	49225	4596	49440	3823	47469	2682	55824	2089	30618
8L-2S		MI	27937	7546	44304	5561	48165	4519	49535	3745	50285	2619	59487	2435	26888
16-#14	2.38	MA	34718	7928	56013	5840	61964	4723	64918	3877	68564	2619	82835	2412	45226
2L-8S		MI	25476	7928	41165	5794	43938	4698	44371	3870	43245	2589	51380	1748	35294
16-#14	2.38	MA	33540	7928	54247	5836	59700	4742	62157	3893	64808	2632	77812	2287	45190
3L-7S		MI	26046	7928	42133	5799	45255	4706	45929	3856	45476	2601	54008	1814	36359
16-#14	2.38	MA	32713	7928	52807	5857	57865	4736	59927	3885	61937	2645	74547	2163	45081
4L-6S		MI	26626	7928	43209	5780	46553	4690	47524	3841	47574	2589	56832	1944	36848
16-#14	2.38	MA	31973	7928	51561	5852	56250	4754	57942	3902	59063	2632	71125	2104	44578
5E		MI	27221	7928	44192	5786	47913	4698	49185	3852	49720	2576	59473	2026	37622
16-#14	2.38	MA	31270	7928	50393	5848	54632	4748	55965	3894	56457	2645	67881	2023	43550
6L-4S		MI	27845	7928	45239	5792	49270	4681	50852	3838	52091	2589	62286	2081	38056
16-#14	2.38	MA	30584	7928	49113	5869	53089	4767	54067	3911	53911	2658	64418	1893	42898
7L-3S		MI	28541	7928	46446	5773	50809	4689	52722	3848	54455	2576	64939	2206	38115
16-#14	2.38	MA	29909	7928	47963	5865	51523	4761	52214	3927	51206	2646	61219	1824	41564
8L-2S		MI	29523	7928	47920	5779	52698	4673	55027	3834	57548	2564	69038	2330	38112
16-#18	4.23	MA	35966	8896	61150	6435	68361	5146	72659	4125	79064	2545	97532	1730	76481
4L-6S		MI	28392	8896	48603	6336	53190	5092	55674	4114	58148	2459	71360	1355	59957
16-#18	4.23	MA	34706	8896	58961	6426	65523	5177	69172	4153	74065	2523	91598	1628	73955
5E		MI	29406	8896	50327	6348	55574	5109	58455	4091	61852	2437	75886	1501	62105
16-#18	4.23	MA	33506	8896	56907	6416	62680	5164	65699	4136	69536	2545	86003	1484	71418
6L-4S		MI	30470	8896	52162	6361	57952	5082	61375	4069	65945	2459	80737	1597	63992
16-#18	4.23	MA	32339	8896	54657	6452	59967	5195	62363	4163	65110	2567	80025	1252	68760
7L-3S		MI	31657	8896	54276	6329	60645	5099	64648	4090	70025	2437	85277	1818	65518
18-#11	1.86	MA	33355	7654	52909	5687	58091	4615	60234	3815	62207	2651	74555	2480	35670
2L-9S		MI	25159	7654	39890	5655	42473	4600	42567	3796	40936	2635	48119	1954	28680
18-#11	1.86	MA	32524	7654	51675	5685	56509	4611	58304	3827	59582	2660	71022	2394	35683
3L-8S		MI	25558	7654	40617	5642	43368	4588	43704	3803	42399	2626	49927	2008	29217

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.86	MA	31941	7654	50670	5699	55229	4625	56748	3822	57579	2670	68723	2308	35658
4L-7S		MI	25960	7654	41293	5645	44287	4593	44791	3792	43968	2635	51777	2055	29465
18-#11	1.86	MA	31420	7654	49802	5697	54102	4621	55363	3834	55574	2662	66321	2266	35593
5L-6S		MI	26369	7654	42044	5632	45193	4581	45905	3782	45444	2626	53769	2145	29829
18-#11	1.86	MA	30925	7654	48987	5694	52974	4634	53984	3829	53757	2671	64038	2210	35212
6L-5S		MI	26788	7654	42729	5635	46142	4586	47065	3788	46954	2617	55634	2202	30134
18-#11	1.86	MA	30442	7654	48095	5709	51898	4631	52661	3841	51981	2681	61602	2120	34722
7L-4S		MI	27227	7654	43460	5639	47090	4574	48229	3778	48622	2626	57613	2241	30166
18-#11	1.86	MA	29966	7654	47294	5706	50806	4644	51370	3853	50094	2673	59356	2071	34374
8L-3S		MI	27717	7654	44304	5625	48165	4579	49535	3785	50285	2617	59487	2327	30154
18-#11	1.86	MA	29479	7654	46430	5721	49744	4640	50019	3848	48335	2683	57143	2018	33689
9L-2S		MI	28411	7654	45336	5629	49487	4567	51148	3774	52462	2609	62379	2414	30129
18-#14	2.68	MA	34351	8084	56013	5933	61964	4812	64918	3936	68564	2619	82835	2260	50673
3L-8S		MI	26159	8084	42639	5891	45828	4768	46676	3912	46338	2573	55479	1714	39681
18-#14	2.68	MA	33528	8084	54573	5954	60129	4806	62688	3928	65694	2632	79570	2136	50539
4L-7S		MI	26726	8084	43607	5897	47145	4776	48234	3898	48570	2586	58107	1780	40705
18-#14	2.68	MA	32793	8084	53327	5950	58513	4824	60703	3944	62819	2620	76148	2077	49870
5L-6S		MI	27303	8084	44683	5878	48443	4760	49829	3884	50667	2573	60931	1911	41297
18-#14	2.68	MA	32093	8084	52159	5946	56896	4818	58726	3936	60214	2633	72904	1996	48889
6L-5S		MI	27895	8084	45666	5883	49802	4768	51490	3894	52814	2561	63572	1992	42031
18-#14	2.68	MA	31411	8084	50879	5966	55352	4837	56828	3953	57668	2645	69441	1866	48173
7L-4S		MI	28516	8084	46713	5889	51159	4751	53157	3880	55184	2573	66385	2048	42618
18-#14	2.68	MA	30739	8084	49729	5962	53786	4831	54975	3970	54962	2633	66242	1797	46844
8L-3S		MI	29209	8084	47920	5870	52698	4759	55027	3890	57548	2561	69038	2173	42700
18-#14	2.68	MA	30075	8084	48491	5983	52263	4850	53038	3962	52439	2646	63096	1719	45686
9L-2S		MI	30186	8084	49394	5876	54587	4742	57332	3876	60642	2549	73137	2297	42727
18-#18	4.76	MA	36095	9173	62051	6598	69484	5301	74005	4228	80592	2498	100272	1574	83245
5L-6S		MI	29539	9173	51174	6509	56487	5216	59696	4189	63487	2428	78396	1289	67489
18-#18	4.76	MA	34905	9173	59997	6589	66642	5288	70531	4211	76063	2520	94677	1429	80528
6L-5S		MI	30546	9173	52898	6521	58870	5234	62476	4167	67191	2406	82922	1434	69813
18-#18	4.76	MA	33747	9173	57747	6624	63928	5319	67196	4238	71637	2542	88699	1198	77970
7L-4S		MI	31602	9173	54733	6534	61248	5206	65397	4144	71285	2428	87773	1530	71592
20-#11	2.06	MA	33099	7762	52909	5752	58091	4660	60234	3856	62207	2652	74555	2376	39527
3L-9S		MI	25643	7762	40921	5723	43796	4649	44180	3825	43113	2625	51011	1932	31769
20-#11	2.06	MA	32518	7762	51904	5767	56810	4673	58677	3851	60204	2661	72256	2290	39490
4L-8S		MI	26040	7762	41648	5709	44690	4636	45317	3832	44575	2616	52819	1987	32355
20-#11	2.06	MA	32000	7762	51035	5764	55684	4669	57293	3863	58199	2653	69854	2249	39411
5L-7S		MI	26441	7762	42324	5713	45609	4642	46404	3822	46145	2625	54668	2033	32600
20-#11	2.06	MA	31506	7762	50221	5762	54555	4683	55914	3858	56382	2663	67571	2193	38945
6E		MI	26848	7762	43075	5699	46515	4630	47518	3811	47621	2616	56661	2124	32948
20-#11	2.06	MA	31025	7762	49329	5776	53479	4679	54590	3870	54606	2672	65135	2103	38473
7L-5S		MI	27265	7762	43761	5703	47464	4635	48678	3818	49131	2608	58526	2180	33333
20-#11	2.06	MA	30552	7762	48527	5774	52388	4692	53299	3882	52719	2664	62889	2054	38134
8L-4S		MI	27703	7762	44492	5706	48412	4623	49842	3807	50798	2616	60504	2219	33374
20-#11	2.06	MA	30067	7762	47664	5789	51326	4689	51948	3877	50960	2674	60675	2000	37397
9L-3S		MI	28191	7762	45336	5693	49487	4628	51148	3814	52462	2608	62379	2306	33383
20-#11	2.06	MA	29545	7762	46865	5786	50249	4702	50663	3889	49216	2683	58531	1939	36823
10L-2S		MI	28882	7762	46367	5696	50809	4616	52761	3803	54638	2599	65270	2392	33365
20-#14	2.98	MA	34338	8239	56338	6051	62392	4875	65449	3970	69451	2620	84592	2109	55991
4L-8S		MI	26837	8239	44113	5988	47717	4838	48981	3955	49432	2558	59578	1681	44078
20-#14	2.98	MA	33607	8239	55092	6047	60777	4894	63464	3987	66576	2608	81170	2050	55175
5L-7S		MI	27402	8239	45081	5994	49034	4846	50538	3941	51663	2571	62206	1747	45063
20-#14	2.98	MA	32911	8239	53924	6043	59159	4888	61487	3979	63971	2620	77926	1969	54235
6E		MI	27976	8239	46157	5975	50332	4829	52134	3926	53761	2558	65030	1878	45753
20-#14	2.98	MA	32233	8239	52645	6064	57615	4907	59589	3995	61425	2633	74464	1839	53419
7L-5S		MI	28565	8239	47139	5981	51692	4838	53795	3937	55907	2546	67672	1959	46452
20-#14	2.98	MA	31565	8239	51494	6059	56049	4901	57736	4012	58719	2621	71264	1770	52134
8L-4S		MI	29183	8239	48186	5986	53049	4821	55462	3922	58278	2558	70484	2015	47174
20-#14	2.98	MA	30902	8239	50256	6080	54526	4919	55799	4004	56196	2634	68119	1692	50911
9L-3S		MI	29872	8239	49394	5967	54587	4829	57332	3933	60642	2546	73137	2139	47278

RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

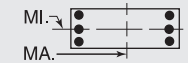
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#18	5.29	MA	36293	9449	63087	6762	70603	5412	75364	4286	82589	2495	103352	1374	89662
6E		MI	30678	9449	53745	6682	59783	5341	63717	4264	68826	2397	85432	1222	75044
20-#18	5.29	MA	35144	9449	60837	6797	67889	5443	72028	4314	78163	2517	97374	1143	87027
7L-5S		MI	31678	9449	55469	6694	62167	5358	66497	4242	72530	2375	89958	1367	77535
22-#11	2.27	MA	33093	7870	53138	5834	58392	4722	60606	3880	62829	2652	75788	2273	43319
4L-9S		MI	26124	7870	41953	5790	45118	4697	45793	3855	45289	2615	53902	1911	34864
22-#11	2.27	MA	32576	7870	52269	5832	57265	4718	59222	3893	60824	2645	73386	2231	43226
5L-8S		MI	26520	7870	42680	5776	46012	4685	46930	3862	46752	2606	55710	1965	35430
22-#11	2.27	MA	32085	7870	51455	5829	56137	4731	57843	3887	59007	2654	71103	2175	42683
6L-7S		MI	26919	7870	43355	5780	46931	4690	48017	3851	48321	2615	57560	2012	35738
22-#11	2.27	MA	31606	7870	50562	5844	55061	4727	56520	3900	57231	2664	68667	2085	42228
7L-6S		MI	27324	7870	44106	5766	47837	4678	49131	3840	49797	2606	59552	2102	36072
22-#11	2.27	MA	31134	7870	49761	5841	53969	4741	55228	3912	55344	2656	66421	2036	41850
8L-5S		MI	27740	7870	44792	5770	48786	4683	50291	3847	51308	2598	61417	2158	36528
22-#11	2.27	MA	30652	7870	48898	5856	52907	4737	53877	3906	53585	2665	64208	1983	41110
9L-4S		MI	28176	7870	45523	5774	49734	4671	51455	3837	52975	2606	63396	2198	36582
22-#11	2.27	MA	30132	7870	48098	5854	51830	4750	52593	3919	51841	2675	62063	1922	40550
10L-3S		MI	28663	7870	46367	5760	50809	4676	52761	3843	54638	2598	65270	2284	36607
22-#11	2.27	MA	29623	7870	47313	5851	50774	4747	51259	3913	49981	2667	59873	1870	39672
11L-2S		MI	29352	7870	47398	5764	52131	4664	54374	3833	56815	2589	68162	2371	36596
22-#14	3.27	MA	34416	8395	56858	6144	63040	4964	66225	4029	70333	2595	86193	2023	60490
5L-8S		MI	27512	8395	45586	6085	49606	4908	51285	3997	52526	2543	63677	1648	48483
22-#14	3.27	MA	33724	8395	55690	6140	61422	4958	64248	4021	67728	2608	82949	1942	59587
6L-7S		MI	28075	8395	46554	6091	50923	4916	52843	3983	54757	2555	66305	1714	49432
22-#14	3.27	MA	33049	8395	54410	6161	59879	4977	62350	4038	65182	2621	79486	1812	58677
7L-6S		MI	28646	8395	47630	6072	52221	4899	54439	3969	56854	2543	69129	1844	50214
22-#14	3.27	MA	32385	8395	53260	6157	58313	4970	60498	4055	62476	2609	76287	1743	57431
8L-5S		MI	29232	8395	48613	6078	53581	4907	56100	3979	59001	2530	71771	1926	50882
22-#14	3.27	MA	31723	8395	52022	6177	56790	4989	58560	4046	59953	2621	73142	1665	56146
9L-4S		MI	29847	8395	49660	6084	54938	4891	57767	3965	61371	2543	74583	1982	51725
22-#18	5.82	MA	36529	9726	63927	6970	71851	5568	76861	4389	84690	2492	106048	1088	96064
7L-6S		MI	31810	9726	56317	6854	63079	5465	67738	4340	74165	2366	92468	1155	82620
24-#11	2.48	MA	33150	7978	53503	5899	58846	4766	61151	3922	63449	2636	76919	2214	47039
5L-9S		MI	26604	7978	42984	5858	46440	4745	47406	3884	47466	2605	56794	1889	37963
24-#11	2.48	MA	32661	7978	52688	5897	57718	4780	59772	3917	61632	2646	74636	2158	46426
6L-8S		MI	26997	7978	43711	5844	47334	4733	48543	3891	48928	2597	58602	1944	38511
24-#11	2.48	MA	32184	7978	51796	5911	56642	4776	58449	3929	59856	2655	72200	2068	45986
7E		MI	27395	7978	44387	5848	48253	4738	49630	3880	50498	2605	60451	1990	38878
24-#11	2.48	MA	31714	7978	50994	5909	55550	4789	57157	3941	57969	2647	69954	2019	45547
8L-6S		MI	27799	7978	45138	5834	49159	4726	50744	3870	51974	2597	62444	2080	39199
24-#11	2.48	MA	31235	7978	50131	5923	54489	4785	55807	3936	56210	2657	67740	1965	44828
9L-5S		MI	28213	7978	45824	5838	50109	4732	51904	3877	53484	2588	64309	2137	39719
24-#11	2.48	MA	30716	7978	49332	5921	53412	4799	54522	3948	54466	2666	65596	1904	44242
10L-4S		MI	28648	7978	46555	5841	51056	4719	53068	3866	55151	2597	66288	2176	39785
24-#11	2.48	MA	30209	7978	48546	5918	52355	4795	53188	3943	52606	2658	63406	1852	43367
11L-3S		MI	29133	7978	47398	5828	52131	4725	54374	3873	56815	2588	68162	2263	39818
24-#14	3.57	MA	34533	8550	57455	6237	63686	5028	67009	4063	71484	2595	87972	1915	64944
6L-8S		MI	28184	8550	47060	6183	51496	4978	53590	4040	55619	2528	67776	1615	52895
24-#14	3.57	MA	33862	8550	56176	6258	62142	5046	65111	4080	68938	2608	84509	1785	63944
7E		MI	28743	8550	48028	6188	52812	4986	55148	4025	57850	2540	70404	1681	53811
24-#14	3.57	MA	33201	8550	55026	6254	60576	5040	63259	4097	66233	2596	81310	1715	62736
8L-6S		MI	29312	8550	49104	6169	54111	4969	56744	4011	59948	2528	73228	1811	54680
24-#14	3.57	MA	32540	8550	53787	6275	59053	5059	61322	4089	63710	2609	78165	1638	61390
9L-5S		MI	29895	8550	50087	6175	55470	4977	58405	4022	62095	2515	75870	1893	55319

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis

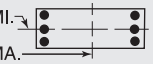


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.01	MA	33917	7555	52586	5630	56497	4595	57166	3843	56033	2791	65137	2641	21553
2E		MI	27599	7555	43147	5540	45953	4522	46280	3780	44885	2727	51813	2563	17421
6-#18	1.52	MA	35441	7831	55849	5803	60680	4720	62269	3919	62957	2768	74359	2590	31848
2L-3S		MI	27042	7831	43147	5700	45953	4673	46280	3878	44885	2719	51813	2275	25713
6-#18	1.52	MA	33235	7831	52586	5795	56497	4752	57166	3947	56033	2790	65137	2368	31916
3L-2S		MI	28774	7831	45719	5713	49249	4646	50301	3856	50224	2697	58849	2496	25593
8-#14	1.14	MA	34386	7624	53341	5710	57686	4657	58699	3888	58192	2808	68246	2661	24290
2L-4S		MI	26265	7624	41064	5641	43502	4598	43375	3834	41278	2777	47616	2338	19749
8-#14	1.14	MA	33116	7624	51479	5706	55298	4651	55786	3905	54229	2821	62915	2536	24353
3E		MI	26976	7624	42272	5622	45041	4606	45245	3845	43642	2765	50268	2463	19677
8-#14	1.14	MA	32223	7624	49961	5727	53364	4670	53435	3898	51204	2835	59445	2412	24386
4L-2S		MI	27977	7624	43746	5628	46931	4589	47550	3830	46736	2753	54367	2587	19601
8-#18	2.02	MA	36948	8108	59112	5976	64863	4844	67371	3994	69880	2745	83581	2538	42090
2L-4S		MI	26992	8108	43605	5905	46556	4780	47029	3932	46144	2710	54309	1987	33622
8-#18	2.02	MA	34760	8108	55849	5967	60680	4876	62269	4023	62957	2767	74359	2317	42065
3E		MI	28218	8108	45719	5873	49249	4797	50301	3954	50224	2688	58849	2208	33767
8-#18	2.02	MA	33219	8108	53184	6003	57284	4864	58141	4007	57665	2789	68372	2096	41728
4L-2S		MI	29937	8108	48290	5886	52546	4770	54322	3931	55563	2666	65884	2429	33705
10-#14	1.42	MA	35264	7779	55204	5807	60074	4726	61612	3930	62156	2795	73577	2636	30151
2L-5S		MI	26319	7779	41491	5732	44035	4684	44013	3891	42001	2750	48902	2249	24349
10-#14	1.42	MA	34000	7779	53341	5803	57686	4721	58699	3947	58192	2809	68246	2511	30196
3L-4S		MI	26954	7779	42538	5738	45392	4668	45680	3877	44372	2762	51715	2305	24373
10-#14	1.42	MA	33112	7779	51824	5824	55752	4740	56348	3940	55167	2822	64776	2386	30185
4L-3S		MI	27661	7779	43746	5719	46931	4676	47550	3887	46736	2750	54367	2429	24328
10-#14	1.42	MA	32319	7779	50512	5821	54050	4734	54257	3957	52139	2811	61150	2327	30061
5L-2S		MI	28658	7779	45219	5725	48820	4659	49855	3873	49830	2737	58467	2554	24265
10-#18	2.53	MA	38438	8384	62374	6149	69046	4968	72474	4069	76803	2722	92803	2487	52297
2L-5S		MI	27074	8384	44340	6066	47474	4931	48129	4030	47390	2657	56494	1824	39407
10-#18	2.53	MA	36267	8384	59112	6140	64863	5000	67371	4098	69880	2744	83581	2266	52182
3L-4S		MI	28165	8384	46176	6078	49852	4904	51050	4007	51483	2679	61345	1920	41533
10-#18	2.53	MA	34740	8384	56447	6176	61467	4988	63244	4082	64588	2766	77594	2044	51746
4L-3S		MI	29382	8384	48290	6046	52546	4921	54322	4029	55563	2657	65884	2141	41767
10-#18	2.53	MA	33375	8384	54140	6168	58476	5020	59569	4111	59286	2744	71298	1941	48948
5L-2S		MI	31089	8384	50861	6059	55842	4894	58343	4007	60902	2635	72920	2363	41779
12-#11	1.18	MA	34573	7649	53609	5743	58141	4683	59296	3907	59023	2815	69514	2674	25318
2L-6S		MI	26063	7649	40666	5668	43016	4633	42810	3861	40480	2784	46826	2334	20551
12-#11	1.18	MA	33685	7649	52308	5741	56473	4679	57262	3920	56255	2825	65768	2587	25356
3L-5S		MI	26488	7649	41352	5672	43966	4638	43970	3867	41990	2775	48691	2390	20551
12-#11	1.18	MA	33063	7649	51249	5756	55124	4693	55622	3915	54144	2835	63326	2501	25384
4E		MI	26933	7649	42083	5676	44913	4626	45134	3857	43657	2784	50670	2430	20517
12-#11	1.18	MA	32507	7649	50335	5754	53937	4690	54164	3927	52032	2828	60783	2459	25375
5L-3S		MI	27430	7649	42927	5662	45988	4631	46441	3863	45321	2775	52544	2516	20471
12-#11	1.18	MA	31979	7649	49478	5752	52750	4703	52712	3923	50119	2838	58360	2403	25308
6L-2S		MI	28130	7649	43958	5666	47310	4619	48054	3853	47498	2767	55435	2602	20424
12-#14	1.70	MA	36135	7935	57067	5904	62462	4796	64525	3972	66120	2783	78908	2610	35997
2L-6S		MI	26405	7935	41982	5824	44564	4746	44657	3923	42948	2747	50360	2134	28163
12-#14	1.70	MA	34877	7935	55204	5900	60074	4791	61612	3990	62156	2796	73577	2486	36021
3L-5S		MI	27007	7935	42965	5830	45924	4754	46318	3933	45095	2734	53001	2216	28914
12-#14	1.70	MA	33995	7935	53687	5922	58140	4810	59262	3982	59131	2810	70107	2361	35970
4E		MI	27638	7935	44012	5836	47281	4737	47985	3919	47465	2747	55814	2272	28977
12-#14	1.70	MA	33207	7935	52375	5918	56438	4804	57171	4000	56102	2799	66481	2301	35807
5L-3S		MI	28342	7935	45219	5816	48820	4746	49855	3930	49830	2734	58467	2396	28959
12-#14	1.70	MA	32456	7935	51145	5914	54735	4824	55088	3992	53358	2812	63036	2221	34765
6L-2S		MI	29334	7935	46693	5822	50709	4729	52160	3915	52923	2722	62566	2521	28911
12-#18	3.03	MA	39914	8661	65637	6321	73229	5092	77577	4145	83726	2699	102025	2436	62462
2L-6S		MI	27212	8661	45188	6226	48387	5038	49370	4128	49024	2648	59004	1612	45487

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis



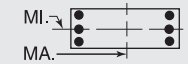
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	3.03	MA	37759	8661	62374	6313	69046	5124	72474	4173	76803	2721	92803	2214	62277
3L-5S		MI	28244	8661	46912	6239	50771	5055	52150	4105	52729	2626	63530	1758	47046
12-#18	3.03	MA	36245	8661	59709	6349	65650	5112	68347	4158	71511	2743	86816	1993	61756
4E		MI	29328	8661	48747	6251	53149	5028	55071	4083	56822	2648	68381	1853	49251
12-#18	3.03	MA	34892	8661	57403	6341	62659	5145	64672	4186	66210	2721	80520	1890	58691
5L-3S		MI	30535	8661	50861	6219	55842	5045	58343	4105	60902	2626	72920	2074	49740
12-#18	3.03	MA	33605	8661	55239	6333	59663	5133	61011	4171	61405	2743	74568	1746	56660
6L-2S		MI	32231	8661	53432	6232	59138	5018	62365	4082	66241	2604	79956	2296	49828
14-#11	1.38	MA	35188	7757	54910	5811	59809	4731	61331	3937	61791	2807	73261	2657	29407
2L-7S		MI	26138	7757	40947	5750	43432	4693	43310	3900	41180	2783	47725	2222	23342
14-#11	1.38	MA	34304	7757	53609	5809	58141	4728	59296	3949	59023	2817	69514	2571	29437
3L-6S		MI	26550	7757	41698	5736	44339	4681	44423	3890	42656	2774	49717	2312	23755
14-#11	1.38	MA	33684	7757	52550	5824	56792	4741	57657	3944	56913	2827	67073	2484	29452
4L-5S		MI	26973	7757	42384	5740	45288	4686	45583	3897	44167	2765	51582	2369	23779
14-#11	1.38	MA	33131	7757	51636	5821	55605	4738	56199	3957	54801	2820	64530	2442	29419
5L-4S		MI	27416	7757	43115	5743	46235	4674	46747	3886	45834	2774	53561	2408	23759
14-#11	1.38	MA	32605	7757	50779	5819	54418	4752	54747	3952	52888	2830	62107	2387	29325
6L-3S		MI	27911	7757	43958	5730	47310	4679	48054	3893	47498	2765	55435	2495	23723
14-#11	1.38	MA	32091	7757	49839	5834	53285	4748	53354	3965	51018	2840	59523	2297	28731
7L-2S		MI	28609	7757	44990	5733	48633	4667	49667	3882	49674	2757	58327	2581	23682
14-#14	1.99	MA	37001	8091	58930	6001	64850	4866	67439	4015	70083	2770	84239	2585	41832
2L-7S		MI	26507	8091	42380	5940	45156	4833	45366	3980	43944	2744	51635	1971	32094
14-#14	1.99	MA	35749	8091	57067	5998	62462	4860	64525	4032	66120	2784	78908	2460	41825
3L-6S		MI	27091	8091	43456	5921	46454	4816	46962	3965	46042	2732	54459	2101	32594
14-#14	1.99	MA	34871	8091	55550	6019	60528	4880	62175	4025	63095	2797	75438	2336	41744
4L-5S		MI	27690	8091	44439	5927	47813	4824	48623	3976	48189	2719	57100	2183	33434
14-#14	1.99	MA	34087	8091	54238	6015	58826	4874	60084	4042	60066	2786	71813	2276	41548
5L-4S		MI	28318	8091	45486	5933	49170	4807	50290	3962	50559	2732	59913	2238	33562
14-#14	1.99	MA	33341	8091	53008	6011	57123	4893	58002	4035	57322	2800	68368	2195	40379
6L-3S		MI	29019	8091	46693	5914	50709	4815	52160	3972	52923	2719	62566	2363	33578
14-#14	1.99	MA	32614	8091	51660	6033	55497	4888	56003	4052	54641	2813	64692	2065	39640
7L-2S		MI	30007	8091	48167	5920	52598	4799	54465	3958	56017	2707	66665	2487	33544
14-#18	3.54	MA	39237	8938	65637	6486	73229	5248	77577	4249	83726	2698	102025	2163	72358
3L-6S		MI	28381	8938	47759	6399	51683	5162	53391	4203	54363	2617	66040	1545	52952
14-#18	3.54	MA	37735	8938	62972	6522	69833	5237	73450	4233	78434	2720	96038	1942	71429
4L-5S		MI	29405	8938	49483	6411	54067	5179	56171	4181	58068	2595	70566	1691	54712
14-#18	3.54	MA	36394	8938	60665	6514	66842	5269	69775	4262	73133	2698	89742	1839	68463
5L-4S		MI	30480	8938	51318	6424	56445	5152	59092	4158	62161	2617	75417	1786	56777
14-#18	3.54	MA	35118	8938	58502	6506	63846	5257	66114	4246	68328	2720	83790	1694	66234
6L-3S		MI	31679	8938	53432	6392	59138	5169	62365	4180	66241	2595	79956	2007	57693
14-#18	3.54	MA	33876	8938	56132	6542	60987	5289	62600	4274	63633	2742	77433	1463	63186
7L-2S		MI	33363	8938	56004	6404	62434	5142	66386	4157	71580	2573	86992	2229	57837
16-#11	1.58	MA	35801	7864	56211	5878	61477	4780	63366	3966	64560	2798	77008	2641	33489
2L-8S		MI	26218	7864	41303	5813	43836	4736	43835	3940	41788	2764	48767	2154	26214
16-#11	1.58	MA	34919	7864	54910	5876	59809	4776	61331	3979	61791	2808	73261	2554	33511
3L-7S		MI	26623	7864	41978	5817	44755	4742	44923	3930	43357	2773	50616	2201	26469
16-#11	1.58	MA	34302	7864	53852	5891	58459	4790	59691	3974	59681	2818	70819	2468	33505
4L-6S		MI	27034	7864	42729	5803	45661	4729	46036	3919	44833	2764	52609	2291	26860
16-#11	1.58	MA	33751	7864	52937	5889	57273	4786	58234	3986	57569	2811	68276	2426	33456
5E		MI	27455	7864	43415	5807	46610	4735	47196	3926	46343	2756	54474	2347	26994
16-#11	1.58	MA	33227	7864	52080	5887	56086	4800	56782	3982	55656	2821	65854	2370	33246
6L-4S		MI	27897	7864	44146	5811	47557	4723	48360	3916	48010	2764	56453	2387	26993
16-#11	1.58	MA	32716	7864	51140	5902	54953	4797	55389	3994	53787	2831	63270	2280	32679
7L-3S		MI	28390	7864	44990	5797	48633	4728	49667	3922	49674	2756	58327	2473	26966

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis

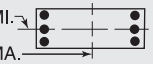


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.58	MA	32213	7864	50297	5899	53803	4810	54029	4007	51800	2824	60892	2231	32290
8L-2S		MI	29086	7864	46021	5801	49955	4716	51280	3912	51851	2747	61218	2559	26932
16-#14	2.27	MA	37861	8246	60793	6099	67238	4936	70352	4057	74047	2758	89571	2559	47656
2L-8S		MI	26620	8246	42885	6032	45728	4894	46113	4036	44807	2716	53106	1871	35585
16-#14	2.27	MA	36615	8246	58930	6095	64850	4930	67439	4075	70083	2771	84239	2435	47620
3L-7S		MI	27192	8246	43854	6037	47045	4902	47671	4022	47038	2729	55734	1937	36556
16-#14	2.27	MA	35742	8246	57412	6116	62916	4950	65088	4067	67058	2785	80770	2310	47511
4L-6S		MI	27773	8246	44930	6018	48343	4886	49267	4008	49135	2716	58558	2068	37034
16-#14	2.27	MA	34962	8246	56100	6112	61214	4944	62997	4085	64030	2774	77144	2251	47145
5E		MI	28369	8246	45912	6024	49703	4894	50928	4018	51282	2704	61199	2149	37828
16-#14	2.27	MA	34221	8246	54870	6109	59511	4963	60915	4077	61286	2787	73699	2170	46004
6L-4S		MI	28994	8246	46959	6030	51060	4877	52595	4004	53652	2716	64012	2205	38137
16-#14	2.27	MA	33498	8246	53523	6130	57885	4958	58916	4094	58605	2801	70023	2040	45291
7L-3S		MI	29692	8246	48167	6011	52598	4885	54465	4014	56017	2704	66665	2330	38182
16-#14	2.27	MA	32786	8246	52312	6126	56237	4977	56966	4112	55755	2790	66633	1970	44000
8L-2S		MI	30675	8246	49641	6017	54488	4869	56770	4000	59110	2692	70764	2454	38168
16-#18	4.04	MA	39212	9214	66235	6695	74016	5361	78553	4309	85357	2697	105260	1890	81077
4L-6S		MI	29539	9214	50330	6572	54980	5287	57412	4279	59702	2586	73075	1478	60449
16-#18	4.04	MA	37882	9214	63928	6687	71025	5393	74878	4337	80056	2675	98964	1787	78260
5E		MI	30556	9214	52054	6584	57363	5304	60193	4256	63407	2564	77602	1624	62401
16-#18	4.04	MA	36617	9214	61765	6679	68029	5381	71217	4321	75252	2697	93012	1643	75838
6L-4S		MI	31623	9214	53890	6597	59741	5276	63114	4234	67500	2586	82453	1719	64341
16-#18	4.04	MA	35385	9214	59395	6715	65170	5413	67702	4350	70556	2719	86655	1412	72902
7L-3S		MI	32814	9214	56004	6565	62434	5294	66386	4255	71580	2564	86992	1940	65632
18-#11	1.77	MA	36411	7972	57512	5946	63144	4828	65401	3995	67328	2790	80754	2624	37565
2L-9S		MI	26296	7972	41607	5894	44263	4797	44311	3963	42501	2763	49850	2078	28895
18-#11	1.77	MA	35532	7972	56211	5943	61477	4825	63366	4008	64560	2800	77008	2538	37579
3L-8S		MI	26703	7972	42334	5881	45158	4785	45448	3970	43964	2754	51658	2132	29354
18-#11	1.77	MA	34917	7972	55153	5958	60127	4838	61726	4003	62450	2810	74566	2452	37553
4L-7S		MI	27106	7972	43009	5884	46077	4790	46535	3959	45534	2763	53508	2179	29601
18-#11	1.77	MA	34369	7972	54238	5956	58941	4835	60268	4016	60338	2802	72023	2410	37488
5L-6S		MI	27516	7972	43760	5871	46983	4778	47649	3949	47009	2754	55500	2269	29973
18-#11	1.77	MA	33847	7972	53381	5954	57753	4849	58817	4011	58425	2812	69600	2354	37176
6L-5S		MI	27935	7972	44446	5874	47932	4783	48809	3955	48520	2746	57365	2326	30202
18-#11	1.77	MA	33338	7972	52442	5969	56621	4845	57424	4024	56555	2822	67017	2264	36633
7L-4S		MI	28375	7972	45177	5878	48880	4771	49973	3945	50187	2754	59344	2365	30220
18-#11	1.77	MA	32837	7972	51598	5967	55471	4859	56064	4036	54569	2815	64638	2215	36254
8L-3S		MI	28867	7972	46021	5864	49955	4776	51280	3952	51851	2746	61218	2451	30203
18-#11	1.77	MA	32314	7972	50773	5965	54354	4855	54642	4031	52717	2825	62289	2161	35613
9L-2S		MI	29561	7972	47052	5868	51277	4764	52893	3941	54027	2737	64110	2538	30176
18-#14	2.56	MA	37476	8402	60793	6192	67238	5000	70352	4117	74047	2759	89571	2409	53407
3L-8S		MI	27304	8402	44359	6129	47617	4964	48418	4079	47900	2701	57205	1838	39971
18-#14	2.56	MA	36607	8402	59275	6213	65304	5019	68001	4110	71022	2773	86101	2285	53272
4L-7S		MI	27873	8402	45327	6135	48934	4972	49976	4065	50131	2714	59833	1904	41020
18-#14	2.56	MA	35832	8402	57963	6210	63603	5014	65910	4127	67994	2761	82475	2225	52731
5L-6S		MI	28451	8402	46403	6116	50232	4955	51571	4050	52229	2701	62657	2034	41484
18-#14	2.56	MA	35094	8402	56733	6206	61899	5033	63828	4119	65249	2775	79030	2144	51639
6L-5S		MI	29044	8402	47386	6122	51592	4964	53233	4061	54376	2689	65298	2116	42236
18-#14	2.56	MA	34375	8402	55386	6227	60273	5028	61830	4137	62568	2789	75354	2015	50948
7L-4S		MI	29666	8402	48433	6127	52949	4947	54900	4046	56746	2701	68111	2172	42704
18-#14	2.56	MA	33667	8402	54175	6223	58625	5047	59879	4154	59719	2777	71964	1944	49576
8L-3S		MI	30360	8402	49641	6108	54488	4955	56770	4057	59110	2689	70764	2296	42771
18-#14	2.56	MA	32939	8402	52871	6245	57021	5041	57839	4147	57062	2791	68624	1867	48485
9L-2S		MI	31340	8402	51115	6114	56377	4938	59074	4043	62204	2676	74863	2421	42790
18-#18	4.55	MA	39357	9491	67191	6860	75208	5517	79981	4412	86979	2652	108186	1736	88076
5L-6S		MI	30688	9491	52902	6745	58276	5411	61434	4354	65042	2555	80111	1411	67973
18-#18	4.55	MA	38102	9491	65028	6852	72212	5505	76320	4397	82175	2674	102234	1592	85469
6L-5S		MI	31698	9491	54626	6757	60659	5428	64214	4332	68746	2533	84638	1557	70107
18-#18	4.55	MA	36880	9491	62657	6887	69353	5537	72805	4425	77480	2696	95877	1360	82639
7L-4S		MI	32758	9491	56461	6770	63038	5401	67135	4309	72839	2555	89489	1652	71937

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis

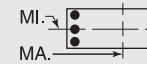


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.97	MA	36142	8080	57512	6011	63144	4873	65401	4037	67328	2791	80754	2522	41633
3L-9S		MI	26788	8080	42638	5962	45586	4845	45924	3992	44678	2753	52742	2057	31983
20-#11	1.97	MA	35530	8080	56454	6026	61795	4887	63761	4033	65218	2801	78313	2435	41596
4L-8S		MI	27186	8080	43365	5948	46480	4833	47061	3999	46141	2745	54550	2111	32497
20-#11	1.97	MA	34983	8080	55539	6024	60609	4883	62303	4045	63106	2794	75770	2393	41517
5L-7S		MI	27587	8080	44041	5952	47399	4838	48148	3989	47710	2753	56399	2157	32737
20-#11	1.97	MA	34463	8080	54682	6021	59421	4897	60851	4040	61193	2804	73347	2337	41114
6E		MI	27995	8080	44792	5938	48305	4826	49262	3978	49186	2745	58392	2248	33091
20-#11	1.97	MA	33956	8080	53743	6036	58288	4894	59458	4053	59324	2814	70763	2247	40591
7L-5S		MI	28413	8080	45478	5942	49254	4831	50422	3985	50696	2736	60257	2304	33405
20-#11	1.97	MA	33457	8080	52899	6034	57139	4907	58099	4065	57337	2807	68385	2198	40221
8L-4S		MI	28852	8080	46209	5945	50202	4819	51586	3974	52364	2745	62236	2344	33437
20-#11	1.97	MA	32938	8080	52074	6032	56022	4904	56677	4061	55485	2817	66036	2144	39526
9L-3S		MI	29341	8080	47052	5932	51277	4825	52893	3981	54027	2736	64110	2430	33435
20-#11	1.97	MA	32387	8080	51149	6047	54888	4918	55324	4073	53649	2827	63759	2083	38898
10L-2S		MI	30033	8080	48084	5935	52599	4812	54506	3970	56204	2727	67002	2516	33413
20-#14	2.84	MA	37467	8557	61138	6311	67692	5089	70915	4152	74986	2760	91432	2259	59029
4L-8S		MI	27983	8557	45833	6226	49507	5034	50723	4121	50994	2686	61304	1805	44365
20-#14	2.84	MA	36696	8557	59826	6307	65991	5084	68824	4169	71957	2749	87806	2200	58329
5L-7S		MI	28550	8557	46801	6232	50824	5042	52281	4107	53225	2698	63932	1871	45375
20-#14	2.84	MA	35962	8557	58596	6303	64287	5103	66741	4162	69213	2763	84361	2119	57282
6E		MI	29125	8557	47877	6213	52122	5025	53876	4093	55323	2686	66756	2001	45939
20-#14	2.84	MA	35247	8557	57248	6324	62661	5097	64743	4179	66532	2776	80685	1989	56581
7L-5S		MI	29715	8557	48860	6219	53481	5033	55537	4103	57469	2674	69397	2083	46655
20-#14	2.84	MA	34543	8557	56038	6321	61013	5117	62792	4197	63682	2765	77295	1919	55161
8L-4S		MI	30335	8557	49907	6225	54838	5017	57204	4089	59840	2686	72210	2139	47264
20-#14	2.84	MA	33833	8557	54734	6342	59409	5111	60752	4189	61025	2778	73955	1841	54006
9L-3S		MI	31026	8557	51115	6206	56377	5025	59074	4099	62204	2674	74863	2263	47353
20-#18	5.05	MA	39576	9768	68290	7024	76395	5629	81423	4472	89098	2651	111456	1540	95124
6E		MI	31829	9768	55473	6918	61572	5535	65455	4429	70381	2524	87147	1344	75523
20-#18	5.05	MA	38363	9768	65920	7060	73536	5662	77908	4501	84403	2673	105099	1309	92393
7L-5S		MI	32832	9768	57197	6930	63956	5552	68235	4407	74085	2502	91673	1490	77829
22-#11	2.17	MA	36139	8188	57755	6093	63463	4935	65796	4062	67987	2792	82059	2419	45636
4L-9S		MI	27270	8188	43670	6029	46908	4894	47537	4022	46855	2744	55633	2035	35077
22-#11	2.17	MA	35595	8188	56840	6091	62277	4932	64338	4075	65875	2785	79516	2377	45543
5L-8S		MI	27666	8188	44397	6016	47802	4882	48674	4029	48317	2735	57441	2089	35641
22-#11	2.17	MA	35077	8188	55983	6089	61089	4945	62886	4070	63961	2795	77094	2321	45057
6L-7S		MI	28066	8188	45072	6019	48721	4887	49761	4018	49887	2744	59291	2136	35876
22-#11	2.17	MA	34572	8188	55044	6104	59956	4942	61493	4082	62092	2805	74510	2231	44552
7L-6S		MI	28473	8188	45823	6006	49627	4875	50875	4008	51363	2735	61283	2226	36215
22-#11	2.17	MA	34075	8188	54200	6102	58807	4956	60133	4095	60106	2798	72132	2182	44191
8L-5S		MI	28889	8188	46509	6009	50576	4880	52035	4014	52873	2726	63148	2283	36603
22-#11	2.17	MA	33558	8188	53375	6099	57690	4952	58712	4090	58254	2808	69783	2128	43444
9L-4S		MI	29326	8188	47240	6013	51524	4868	53199	4004	54540	2735	65127	2322	36647
22-#11	2.17	MA	33009	8188	52451	6114	56556	4966	57359	4103	56417	2818	67506	2067	42832
10L-3S		MI	29814	8188	48084	5999	52599	4873	54506	4010	56204	2726	67002	2408	36662
22-#11	2.17	MA	32473	8188	51624	6112	55444	4963	55955	4098	54459	2811	65187	2015	41988
11L-2S		MI	30504	8188	49115	6003	53921	4861	56119	4000	58380	2718	69893	2495	36647
22-#14	3.13	MA	37555	8713	61689	6404	68379	5153	71737	4212	75921	2736	93138	2174	63938
5L-8S		MI	28659	8713	47307	6323	51396	5104	53028	4164	54088	2671	65403	1772	48768
22-#14	3.13	MA	36825	8713	60459	6400	66675	5173	69655	4204	73177	2750	89692	2094	62931
6L-7S		MI	29223	8713	48275	6329	52713	5112	54586	4149	56319	2683	68031	1838	49741
22-#14	3.13	MA	36114	8713	59111	6422	65049	5167	67656	4222	70496	2764	86017	1964	62132
7L-6S		MI	29796	8713	49351	6310	54011	5095	56181	4135	58416	2671	70855	1968	50401
22-#14	3.13	MA	35414	8713	57901	6418	63401	5186	65705	4239	67646	2752	82627	1894	60754
8L-5S		MI	30383	8713	50334	6316	55371	5103	57842	4146	60563	2658	73497	2050	51084
22-#14	3.13	MA	34704	8713	56597	6439	61797	5181	63666	4232	64989	2766	79286	1816	59535
9L-4S		MI	31000	8713	51381	6322	56728	5087	59509	4131	62933	2671	76309	2105	51820
22-#18	5.56	MA	39835	10044	69183	7233	77719	5786	83011	4576	91326	2649	114321	1258	102143
7L-6S		MI	32963	10044	58044	7091	64868	5659	69476	4505	75720	2493	94183	1277	83093

RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.36	MA	36203	8296	58141	6159	63945	4980	66373	4104	68643	2777	83263	2360	49566
5L-9S		MI	27750	8296	44701	6097	48230	4942	49150	4051	49031	2734	58525	2014	38175
24-#11	2.36	MA	35687	8296	57284	6156	62757	4994	64921	4099	66730	2787	80840	2304	49006
6L-8S		MI	28145	8296	45428	6083	49124	4930	50287	4058	50494	2725	60333	2068	38735
24-#11	2.36	MA	35185	8296	56345	6171	61624	4990	63528	4112	64861	2797	78256	2215	48517
7E		MI	28543	8296	46103	6087	50043	4935	51374	4047	52063	2734	62182	2114	39017
24-#11	2.36	MA	34690	8296	55501	6169	60475	5004	62168	4124	62874	2789	75878	2165	48161
8L-6S		MI	28948	8296	46855	6073	50949	4923	52488	4037	53539	2725	64175	2205	39343
24-#11	2.36	MA	34175	8296	54676	6167	59357	5001	60746	4120	61022	2799	73529	2112	47367
9L-5S		MI	29363	8296	47540	6077	51899	4928	53648	4044	55049	2716	66040	2261	39798
24-#11	2.36	MA	33628	8296	53752	6182	58224	5014	59394	4132	59186	2809	71253	2051	46769
10L-4S		MI	29799	8296	48271	6080	52846	4916	54812	4033	56717	2725	68019	2300	39853
24-#11	2.36	MA	33094	8296	52925	6180	57112	5011	57990	4127	57228	2802	68934	1998	45888
11L-3S		MI	30285	8296	49115	6067	53921	4921	56119	4040	58380	2716	69893	2387	39879
24-#14	3.41	MA	37683	8869	62322	6498	69063	5243	72568	4247	77141	2738	95024	2068	68587
6L-8S		MI	29332	8869	48781	6421	53285	5174	55333	4206	57181	2656	69502	1738	53178
24-#14	3.41	MA	36976	8869	60974	6519	67437	5237	70569	4264	74459	2751	91348	1938	67693
7E		MI	29893	8869	49749	6427	54602	5182	56890	4192	59412	2668	72130	1804	54117
24-#14	3.41	MA	36279	8869	59763	6515	65789	5256	68619	4282	71610	2740	87958	1868	66355
8L-6S		MI	30463	8869	50825	6407	55900	5165	58486	4177	61510	2656	74954	1935	54867
24-#14	3.41	MA	35570	8869	58460	6536	64185	5251	66579	4274	68953	2754	84617	1791	65074
9L-5S		MI	31048	8869	51807	6413	57260	5173	60147	4188	63657	2643	77596	2016	55521

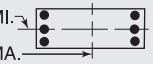
RECTANGULAR TIED COLUMNS 36" x 46"

6-#18	1.45	MA	38578	8149	60561	6061	65822	4932	67492	4099	68121	2910	80465	2733	33468
2L-3S		MI	28189	8149	44875	5937	47742	4867	48018	4043	46439	2845	53528	2398	25774
6-#18	1.45	MA	36250	8149	57125	6054	61418	4966	62118	4129	60810	2933	70695	2511	33536
3L-2S		MI	29923	8149	47446	5949	51038	4840	52039	4021	51778	2823	60564	2619	25647
8-#14	1.09	MA	37456	7942	57913	5968	62659	4869	63722	4068	63028	2946	73952	2801	25505
2L-4S		MI	27411	7942	42785	5879	45292	4794	45118	4001	42840	2905	49342	2462	19797
8-#14	1.09	MA	36117	7942	55953	5965	60147	4864	60656	4086	58857	2961	68312	2677	25568
3E		MI	28123	7942	43992	5860	46831	4802	46988	4011	45204	2893	51994	2586	19719
8-#14	1.09	MA	35178	7942	54358	5986	58114	4884	58185	4079	55678	2975	64637	2552	25601
4L-2S		MI	29125	7942	45466	5866	48720	4785	49292	3997	48298	2880	56093	2711	19641
8-#18	1.93	MA	40173	8426	63997	6234	70227	5057	72865	4175	75432	2888	90234	2685	44250
2L-4S		MI	28138	8426	45332	6141	48345	4974	48767	4097	47699	2837	56025	2109	33734
8-#18	1.93	MA	37864	8426	60561	6227	65822	5090	67492	4204	68121	2911	80465	2463	44225
3E		MI	29366	8426	47446	6109	51038	4991	52039	4119	51778	2814	60564	2331	33841
8-#18	1.93	MA	36242	8426	57759	6264	62250	5079	63151	4190	62535	2933	74114	2242	43888
4L-2S		MI	31088	8426	50017	6122	54335	4964	56060	4096	57118	2792	67600	2552	33765
10-#14	1.36	MA	38384	8098	59873	6065	65172	4939	66787	4111	67199	2934	79592	2777	31670
2L-5S		MI	27465	8098	43211	5971	45824	4880	45756	4057	43563	2878	50628	2373	24425
10-#14	1.36	MA	37052	8098	57913	6062	62659	4934	63722	4129	63028	2948	73952	2653	31714
3L-4S		MI	28100	8098	44258	5976	47181	4864	47423	4043	45934	2890	53441	2428	24429
10-#14	1.36	MA	36118	8098	56318	6084	60627	4954	61251	4122	59848	2963	70277	2528	31704
4L-3S		MI	28809	8098	45466	5957	48720	4872	49292	4054	48298	2878	56093	2553	24375
10-#14	1.36	MA	35284	8098	54940	6080	58839	4949	59054	4140	56666	2952	66448	2468	31580
5L-2S		MI	29806	8098	46940	5963	50610	4855	51597	4039	51391	2865	60192	2678	24310
10-#18	2.42	MA	41752	8703	67433	6407	74631	5181	78238	4250	82743	2866	100004	2636	54997
2L-5S		MI	28219	8703	46068	6302	49263	5125	49867	4195	48945	2783	58210	1947	39703
10-#18	2.42	MA	39460	8703	63997	6400	70227	5214	72865	4280	75432	2889	90234	2415	54882
3L-4S		MI	29313	8703	47903	6314	51642	5098	52788	4172	53038	2806	63061	2043	41657

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

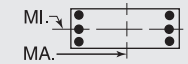
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	2.42	MA	37852	8703	61194	6437	66655	5203	68524	4265	69845	2911	83884	2193	54446
4L-3S		MI	30531	8703	50017	6282	54335	5115	56060	4194	57118	2783	67600	2264	41854
10-#18	2.42	MA	36416	8703	58770	6429	63511	5236	64661	4295	64251	2890	77226	2089	51699
5L-2S		MI	32242	8703	52589	6295	57631	5088	60082	4172	62457	2761	74636	2485	41845
12-#11	1.13	MA	37651	7967	58191	6002	63133	4895	64345	4088	63895	2954	75275	2814	26581
2L-6S		MI	27209	7967	42383	5908	44806	4829	44555	4028	42045	2912	48557	2458	20613
12-#11	1.13	MA	36715	7967	56822	6000	61379	4892	62204	4101	60983	2965	71314	2727	26620
3L-5S		MI	27634	7967	43069	5911	45755	4835	45715	4034	43556	2904	50422	2514	20599
12-#11	1.13	MA	36061	7967	55710	6015	59961	4906	60481	4096	58765	2975	68731	2641	26648
4E		MI	28080	7967	43800	5915	46703	4822	46879	4024	45223	2912	52401	2554	20559
12-#11	1.13	MA	35477	7967	54750	6013	58715	4903	58950	4109	56547	2969	66046	2599	26639
5L-3S		MI	28577	7967	44644	5901	47778	4828	48185	4031	46886	2904	54275	2640	20510
12-#11	1.13	MA	34922	7967	53850	6011	57468	4917	57425	4105	54537	2979	63484	2543	26571
6L-2S		MI	29278	7967	45675	5905	49100	4816	49798	4020	49063	2895	57167	2727	20462
12-#14	1.63	MA	39306	8253	61833	6163	67685	5009	69852	4153	71369	2922	85231	2753	37820
2L-6S		MI	27550	8253	43703	6062	46354	4942	46399	4089	44510	2875	52086	2258	28345
12-#14	1.63	MA	37980	8253	59873	6159	65172	5004	66787	4171	67199	2936	79592	2629	37843
3L-5S		MI	28153	8253	44685	6068	47714	4950	48060	4100	46657	2862	54727	2339	28997
12-#14	1.63	MA	37051	8253	58278	6181	63139	5024	64316	4164	64019	2950	75917	2504	37792
4E		MI	28785	8253	45732	6074	49071	4933	49727	4086	49027	2875	57540	2395	29042
12-#14	1.63	MA	36222	8253	56900	6178	61352	5019	62119	4182	60837	2940	72088	2444	37630
5L-3S		MI	29490	8253	46940	6055	50610	4942	51597	4096	51391	2862	60192	2520	29012
12-#14	1.63	MA	35434	8253	55609	6174	59562	5038	59932	4175	57954	2954	68441	2363	36637
6L-2S		MI	30484	8253	48414	6060	52499	4925	53902	4082	54485	2850	64292	2644	28960
12-#18	2.90	MA	43315	8979	70869	6580	79036	5305	83611	4326	90053	2844	109774	2588	65702
2L-6S		MI	28356	8979	46915	6462	50176	5233	51108	4293	50579	2775	60719	1734	45982
12-#18	2.90	MA	41041	8979	67433	6573	74631	5338	78238	4355	82743	2867	100004	2366	65517
3L-5S		MI	29391	8979	48639	6475	52560	5250	53888	4270	54284	2752	65245	1880	47338
12-#18	2.90	MA	39446	8979	64630	6609	71059	5327	73897	4341	77156	2889	93653	2145	64996
4E		MI	30477	8979	50475	6487	54938	5222	56809	4248	58377	2775	70096	1976	49562
12-#18	2.90	MA	38022	8979	62205	6602	67915	5360	70034	4370	71562	2867	86996	2040	61965
5L-3S		MI	31687	8979	52589	6455	57631	5240	60082	4270	62457	2752	74636	2197	49835
12-#18	2.90	MA	36668	8979	59932	6595	64767	5349	66186	4356	66491	2890	80687	1897	60078
6L-2S		MI	33386	8979	55160	6468	60927	5212	64103	4247	67796	2730	81672	2418	49905
14-#11	1.32	MA	38302	8075	59559	6069	64887	4944	66485	4117	66807	2946	79236	2798	30881
2L-7S		MI	27283	8075	42663	5989	45222	4890	45054	4068	42746	2911	49456	2346	23472
14-#11	1.32	MA	37370	8075	58191	6067	63133	4941	64345	4130	63895	2956	75275	2712	30911
3L-6S		MI	27696	8075	43415	5975	46128	4878	46168	4057	44222	2902	51449	2437	23823
14-#11	1.32	MA	36718	8075	57079	6083	61715	4955	62621	4126	61677	2967	72692	2626	30926
4L-5S		MI	28119	8075	44100	5979	47078	4883	47328	4064	45732	2894	53313	2493	23832
14-#11	1.32	MA	36137	8075	56118	6081	60469	4952	61090	4139	59459	2960	70007	2583	30893
5L-4S		MI	28563	8075	44831	5982	48025	4871	48492	4053	47399	2902	55292	2532	23805
14-#11	1.32	MA	35583	8075	55218	6079	59222	4966	59566	4134	57449	2971	67445	2527	30804
6L-3S		MI	29058	8075	45675	5969	49100	4876	49798	4060	49063	2894	57167	2619	23766
14-#11	1.32	MA	35044	8075	54232	6094	58033	4963	58103	4147	55487	2981	64713	2437	30236
7L-2S		MI	29758	8075	46706	5972	50423	4864	51411	4049	51239	2885	60058	2705	23723
14-#14	1.90	MA	40222	8409	63793	6260	70197	5079	72918	4196	75540	2909	90871	2730	43958
2L-7S		MI	27652	8409	44100	6178	46945	5028	47109	4146	45506	2872	53361	2094	32272
14-#14	1.90	MA	38902	8409	61833	6257	67685	5074	69852	4214	71369	2924	85231	2605	43952
3L-6S		MI	28237	8409	45176	6159	48243	5012	48704	4132	47604	2860	56185	2225	32775
14-#14	1.90	MA	37978	8409	60239	6278	65652	5093	67382	4207	68190	2938	81557	2480	43871
4L-5S		MI	28837	8409	46159	6165	49603	5020	50365	4142	49750	2847	58826	2306	33558
14-#14	1.90	MA	37154	8409	58860	6275	63864	5088	65185	4225	65007	2927	77728	2420	43674
5L-4S		MI	29466	8409	47206	6171	50960	5003	52032	4128	52121	2860	61639	2362	33633

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	1.90	MA	36370	8409	57569	6272	62075	5108	62997	4218	62125	2942	74081	2339	42546
6L-3S		MI	30168	8409	48414	6152	52499	5011	53902	4138	54485	2847	64292	2486	33634
14-#14	1.90	MA	35605	8409	56153	6293	60368	5103	60898	4236	59308	2956	70192	2210	41742
7L-2S		MI	31157	8409	49887	6158	54388	4995	56207	4124	57579	2835	68391	2611	33596
14-#18	3.38	MA	42606	9256	70869	6746	79036	5462	83611	4431	90053	2844	109774	2318	76138
3L-6S		MI	29526	9256	49487	6635	53472	5357	55129	4368	55918	2744	67755	1667	53439
14-#18	3.38	MA	41024	9256	68066	6782	75464	5451	79270	4416	84467	2867	103423	2097	75540
4L-5S		MI	30553	9256	51211	6648	55856	5374	57909	4346	59623	2721	72281	1813	55002
14-#18	3.38	MA	39612	9256	65641	6775	72320	5484	75407	4446	78872	2845	96766	1992	72262
5L-4S		MI	31631	9256	53046	6660	58234	5347	60830	4323	63716	2744	77132	1909	57124
14-#18	3.38	MA	38269	9256	63368	6768	69171	5473	71559	4431	73801	2868	90456	1848	70173
6L-3S		MI	32833	9256	55160	6628	60927	5364	64103	4345	67796	2721	81672	2130	57796
14-#18	3.38	MA	36962	9256	60877	6804	66167	5507	67866	4461	68846	2891	83721	1617	66833
7L-2S		MI	34521	9256	57731	6641	64224	5337	68124	4322	73135	2699	88708	2351	57920
16-#11	1.51	MA	38949	8183	60928	6137	66642	4992	68625	4147	69719	2937	83197	2783	35174
2L-8S		MI	27364	8183	43019	6052	45625	4933	45579	4108	43353	2893	50498	2278	26344
16-#11	1.51	MA	38021	8183	59559	6135	64887	4989	66485	4160	66807	2948	79236	2696	35195
3L-7S		MI	27769	8183	43695	6056	46545	4938	46667	4097	44922	2901	52347	2325	26600
16-#11	1.51	MA	37371	8183	58447	6150	63470	5003	64762	4155	64589	2958	76653	2610	35190
4L-6S		MI	28180	8183	44446	6042	47451	4926	47781	4086	46398	2893	54340	2415	27000
16-#11	1.51	MA	36792	8183	57487	6148	62224	5000	63230	4168	62371	2951	73968	2568	35141
5E		MI	28602	8183	45132	6046	48400	4931	48941	4093	47909	2884	56205	2471	27056
16-#11	1.51	MA	36241	8183	56587	6146	60977	5014	61706	4164	60361	2962	71406	2512	35015
6L-4S		MI	29044	8183	45863	6050	49347	4919	50105	4083	49576	2893	58184	2511	27042
16-#11	1.51	MA	35705	8183	55601	6162	59787	5011	60243	4177	58398	2972	68674	2422	34390
7L-3S		MI	29538	8183	46706	6036	50423	4924	51411	4089	51239	2884	60058	2597	27012
16-#11	1.51	MA	35176	8183	54715	6160	58580	5025	58815	4190	56312	2966	66163	2372	33967
8L-2S		MI	30235	8183	47738	6040	51745	4912	53024	4079	53416	2875	62950	2684	26975
16-#14	2.17	MA	41132	8564	65753	6357	72710	5149	75983	4238	79710	2897	96511	2706	50086
2L-8S		MI	27764	8564	44606	6270	47518	5090	47855	4203	46369	2844	54832	1995	35869
16-#14	2.17	MA	39818	8564	63793	6354	70197	5143	72918	4256	75540	2911	90871	2581	50050
3L-7S		MI	28338	8564	45574	6276	48835	5098	49413	4189	48600	2857	57460	2061	36735
16-#14	2.17	MA	38899	8564	62199	6375	68165	5163	70447	4249	72360	2925	87197	2457	49941
4L-6S		MI	28920	8564	46650	6257	50133	5082	51009	4174	50697	2844	60284	2191	37215
16-#14	2.17	MA	38079	8564	60820	6372	66377	5158	68250	4267	69178	2915	83367	2396	49714
5E		MI	29517	8564	47633	6262	51492	5090	52670	4185	52844	2832	62925	2273	38029
16-#14	2.17	MA	37299	8564	59529	6369	64587	5178	66063	4260	66295	2929	79721	2315	48467
6L-4S		MI	30143	8564	48680	6268	52849	5073	54337	4170	55214	2844	65738	2329	38214
16-#14	2.17	MA	36540	8564	58113	6391	62880	5173	63963	4278	63479	2944	75832	2186	47692
7L-3S		MI	30842	8564	49887	6249	54388	5081	56207	4181	57579	2832	68391	2453	38247
16-#14	2.17	MA	35791	8564	56842	6387	61149	5193	61915	4296	60485	2933	72251	2115	46454
8L-2S		MI	31827	8564	51361	6255	56277	5064	58512	4167	60672	2819	72490	2578	38222
16-#18	3.86	MA	42588	9533	71502	6955	79868	5575	84644	4492	91778	2845	113193	2048	85706
4L-6S		MI	30686	9533	52058	6808	56769	5481	59150	4444	61257	2713	74791	1601	60930
16-#18	3.86	MA	41188	9533	69077	6948	76724	5609	80781	4521	86183	2823	106536	1944	82583
5E		MI	31706	9533	53782	6820	59152	5498	61931	4421	64962	2690	79317	1746	62689
16-#18	3.86	MA	39856	9533	66803	6940	73576	5598	76933	4507	81112	2846	100226	1800	80298
6L-4S		MI	32776	9533	55617	6833	61530	5471	64852	4399	69055	2713	84168	1842	64683
16-#18	3.86	MA	38559	9533	64313	6977	70571	5631	73239	4536	76157	2868	93491	1569	77076
7L-3S		MI	33970	9533	57731	6801	64224	5488	68124	4420	73135	2690	88708	2063	65742
16-#18	3.86	MA	37283	9533	62074	6970	67524	5620	69633	4566	70891	2847	87267	1446	73583
8L-2S		MI	35647	9533	60302	6813	67520	5461	72145	4398	78474	2668	95743	2284	65916
18-#11	1.70	MA	39594	8291	62296	6204	68396	5041	70765	4176	72631	2928	87158	2767	39461
2L-9S		MI	27441	8291	43324	6134	46053	4994	46056	4130	44067	2892	51581	2202	29103
18-#11	1.70	MA	38668	8291	60928	6202	66642	5038	68625	4189	69719	2939	83197	2681	39474
3L-8S		MI	27849	8291	44051	6120	46948	4982	47192	4137	45530	2883	53389	2257	29486
18-#11	1.70	MA	38022	8291	59816	6218	65224	5052	66902	4185	67501	2949	80613	2595	39448
4L-7S		MI	28253	8291	44726	6124	47867	4987	48280	4126	47099	2892	55239	2303	29733

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

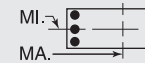
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.70	MA	37445	8291	58855	6216	63978	5049	65371	4198	65283	2943	77929	2552	39384
5L-6S		MI	28662	8291	45477	6110	48773	4975	49394	4116	48575	2883	57232	2393	30113
18-#11	1.70	MA	36896	8291	57955	6214	62731	5063	63846	4193	63273	2953	75366	2496	39149
6L-5S		MI	29083	8291	46163	6114	49722	4980	50553	4123	50085	2874	59096	2450	30267
18-#11	1.70	MA	36362	8291	56969	6229	61541	5059	62383	4206	61310	2964	72635	2407	38549
7L-4S		MI	29524	8291	46894	6117	50669	4968	51718	4112	51752	2883	61075	2489	30273
18-#11	1.70	MA	35835	8291	56083	6227	60335	5074	60955	4219	59224	2957	70124	2357	38138
8L-3S		MI	30016	8291	47738	6104	51745	4973	53024	4119	53416	2874	62950	2576	30251
18-#11	1.70	MA	35277	8291	55217	6225	59161	5070	59462	4215	57279	2968	67639	2303	37548
9L-2S		MI	30710	8291	48769	6107	53067	4961	54637	4108	55592	2866	65841	2662	30221
18-#14	2.45	MA	40729	8720	65753	6451	72710	5213	75983	4298	79710	2899	96511	2557	56141
3L-8S		MI	28449	8720	46080	6367	49407	5160	50160	4245	49462	2829	58931	1962	40252
18-#14	2.45	MA	39815	8720	64159	6473	70677	5233	73512	4291	76531	2913	92837	2433	56006
4L-7S		MI	29019	8720	47048	6373	50724	5168	51718	4231	51693	2842	61559	2028	41202
18-#14	2.45	MA	38999	8720	62780	6469	68890	5228	71315	4309	73349	2902	89007	2372	55606
5L-6S		MI	29599	8720	48124	6354	52022	5151	53314	4217	53791	2829	64383	2158	41664
18-#14	2.45	MA	38223	8720	61489	6466	67100	5248	69128	4303	70466	2917	85361	2292	54399
6L-5S		MI	30193	8720	49107	6360	53382	5160	54975	4227	55938	2817	67024	2240	42436
18-#14	2.45	MA	37468	8720	60073	6488	65393	5243	67029	4320	67649	2931	81471	2162	53648
7L-4S		MI	30816	8720	50154	6365	54739	5143	56642	4213	58308	2829	69837	2295	42785
18-#14	2.45	MA	36723	8720	58802	6484	63661	5262	64980	4338	64656	2921	77891	2091	52325
8L-3S		MI	31512	8720	51361	6346	56277	5151	58512	4223	60672	2817	72490	2420	42841
18-#14	2.45	MA	35944	8720	57558	6481	61977	5257	62837	4332	61865	2935	74355	2013	51179
9L-2S		MI	32493	8720	52835	6352	58167	5134	60817	4209	63766	2804	76589	2545	42840
18-#18	4.35	MA	42750	9809	72513	7121	81129	5733	86154	4597	93494	2801	116306	1895	92926
5L-6S		MI	31837	9809	54629	6981	60065	5605	63172	4519	66596	2682	81827	1534	68448
18-#18	4.35	MA	41429	9809	70239	7113	77980	5722	82306	4582	88423	2824	109996	1751	90451
6L-5S		MI	32850	9809	56353	6993	62449	5622	65952	4497	70301	2659	86353	1680	70394
18-#18	4.35	MA	40143	9809	67749	7150	74976	5755	78612	4612	83468	2846	103261	1520	87338
7L-4S		MI	33913	9809	58188	7006	64827	5595	68873	4474	74394	2682	91204	1775	72274
18-#18	4.35	MA	38877	9809	65510	7143	71928	5744	75006	4641	78202	2825	97037	1398	83734
8L-3S		MI	35099	9809	60302	6974	67520	5612	72145	4496	78474	2659	95743	1996	73676
20-#11	1.88	MA	39313	8398	62296	6270	68396	5086	70765	4218	72631	2930	87158	2666	43739
3L-9S		MI	27933	8398	44355	6201	47375	5042	47668	4160	46243	2882	54473	2181	32190
20-#11	1.88	MA	38669	8398	61184	6285	66978	5100	69042	4214	70413	2941	84574	2579	43702
4L-8S		MI	28332	8398	45082	6187	48270	5030	48805	4166	47706	2873	56281	2235	32631
20-#11	1.88	MA	38094	8398	60224	6283	65733	5097	67511	4227	68195	2934	81890	2537	43623
5L-7S		MI	28734	8398	45758	6191	49189	5035	49893	4156	49275	2882	58130	2282	32869
20-#11	1.88	MA	37548	8398	59324	6281	64485	5111	65986	4223	66185	2945	79327	2481	43291
6E		MI	29143	8398	46509	6177	50095	5023	51007	4145	50751	2873	60123	2372	33231
20-#11	1.88	MA	37015	8398	58338	6296	63296	5108	64523	4236	64222	2955	76596	2391	42714
7L-5S		MI	29561	8398	47194	6181	51044	5028	52166	4152	52262	2864	61988	2428	33474
20-#11	1.88	MA	36491	8398	57452	6294	62089	5122	63096	4248	62136	2948	74085	2341	42313
8L-4S		MI	30001	8398	47925	6185	51992	5016	53331	4141	53929	2873	63967	2468	33498
20-#11	1.88	MA	35936	8398	56585	6292	60916	5119	61603	4244	60191	2959	71600	2288	41666
9L-3S		MI	30491	8398	48769	6171	53067	5021	54637	4148	55592	2864	65841	2554	33485
20-#11	1.88	MA	35356	8398	55615	6308	59725	5133	60183	4257	58263	2970	69192	2227	40982
10L-2S		MI	31184	8398	49801	6175	54389	5009	56250	4138	57769	2856	68733	2640	33461
20-#14	2.72	MA	40724	8876	66119	6570	73190	5303	76578	4334	80702	2901	98477	2409	62066
4L-8S		MI	29129	8876	47553	6464	51296	5230	52465	4288	52556	2814	63030	1929	44644
20-#14	2.72	MA	39913	8876	64740	6567	71403	5298	74381	4352	77519	2890	94647	2348	61497
5L-7S		MI	29697	8876	48522	6470	52613	5238	54023	4273	54787	2826	65658	1995	45674
20-#14	2.72	MA	39142	8876	63449	6563	69613	5318	72193	4345	74636	2904	91001	2268	60339
6E		MI	30274	8876	49598	6451	53911	5221	55619	4259	56885	2814	68482	2125	46120

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

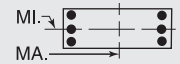


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.72	MA	38390	8876	62034	6585	67906	5313	70094	4363	71820	2919	87111	2138	59609
7L-5S		MI	30865	8876	50580	6457	55271	5229	57280	4270	59031	2801	71123	2206	46854
20-#14	2.72	MA	37650	8876	60762	6582	66174	5332	68045	4381	68827	2908	83531	2067	58206
8L-4S		MI	31486	8876	51627	6463	56628	5213	58947	4255	61402	2814	73936	2262	47350
20-#14	2.72	MA	36875	8876	59518	6578	64490	5327	65903	4374	66036	2923	79995	1990	57091
9L-3S		MI	32178	8876	52835	6444	58167	5221	60817	4266	63766	2801	76589	2387	47426
20-#14	2.72	MA	36056	8876	58126	6600	62781	5347	63865	4392	63269	2937	76568	1902	55420
10L-2S		MI	33156	8876	54309	6449	60056	5204	63122	4251	66859	2789	80688	2511	47453
20-#18	4.83	MA	42989	10086	73675	7286	82385	5846	87679	4657	95734	2802	119766	1703	100628
6E		MI	32980	10086	57200	7154	63361	5729	67193	4594	71935	2651	88863	1467	75992
20-#18	4.83	MA	41713	10086	71184	7323	79381	5879	83985	4687	90778	2824	113031	1472	97618
7L-5S		MI	33986	10086	58924	7166	65745	5746	69973	4572	75640	2628	93389	1613	78114
20-#18	4.83	MA	40457	10086	68946	7316	76333	5868	80380	4717	85512	2803	106807	1349	93903
8L-4S		MI	35043	10086	60760	7179	68123	5719	72894	4549	79733	2651	98240	1708	79892
22-#11	2.07	MA	39313	8506	62553	6352	68733	5148	71182	4243	73325	2932	88535	2564	47952
4L-9S		MI	28416	8506	45386	6268	48698	5090	49281	4189	48420	2872	57365	2159	35283
22-#11	2.07	MA	38741	8506	61592	6350	67487	5145	69651	4256	71106	2926	85851	2521	47859
5L-8S		MI	28813	8506	46113	6255	49592	5078	50418	4196	49883	2863	59172	2214	35776
22-#11	2.07	MA	38196	8506	60692	6349	66240	5159	68127	4252	69097	2936	83288	2466	47439
6L-7S		MI	29214	8506	46789	6258	50511	5084	51506	4185	51452	2872	61022	2260	36009
22-#11	2.07	MA	37666	8506	59706	6364	65050	5156	66664	4265	67134	2947	80556	2376	46882
7L-6S		MI	29621	8506	47540	6245	51417	5071	52620	4175	52928	2863	63015	2350	36355
22-#11	2.07	MA	37144	8506	58820	6362	63843	5170	65236	4278	65048	2940	78046	2326	46490
8L-5S		MI	30038	8506	48226	6248	52366	5077	53779	4181	54438	2855	64879	2407	36676
22-#11	2.07	MA	36591	8506	57954	6360	62670	5167	63743	4273	63103	2950	75561	2272	45789
9L-4S		MI	30476	8506	48957	6252	53314	5065	54943	4171	56105	2863	66858	2446	36710
22-#11	2.07	MA	36014	8506	56984	6375	61480	5181	62323	4286	61175	2961	73153	2211	45123
10L-3S		MI	30965	8506	49801	6238	54389	5070	56250	4178	57769	2855	68733	2533	36714
22-#11	2.07	MA	35450	8506	56116	6373	60312	5178	60849	4282	59118	2954	70705	2159	44320
11L-2S		MI	31655	8506	50832	6242	55711	5058	57863	4167	59946	2846	71624	2619	36697
22-#14	2.99	MA	40822	9031	66701	6664	73915	5368	77446	4394	81690	2878	100287	2324	67401
5L-8S		MI	29806	9031	49027	6562	53186	5300	54770	4330	55649	2799	67129	1895	49046
22-#14	2.99	MA	40054	9031	65409	6661	72126	5387	75259	4387	78807	2892	96641	2244	66286
6L-7S		MI	30371	9031	49995	6567	54503	5308	56328	4316	57881	2811	69757	1961	50042
22-#14	2.99	MA	39307	9031	63994	6682	70418	5382	73159	4405	75991	2906	92751	2114	65574
7L-6S		MI	30945	9031	51071	6548	55801	5291	57923	4301	59978	2799	72581	2092	50582
22-#14	2.99	MA	38570	9031	62722	6679	68687	5402	71111	4423	72997	2896	89170	2043	64095
8L-5S		MI	31534	9031	52054	6554	57160	5299	59585	4312	62125	2786	75223	2173	51282
22-#14	2.99	MA	37813	9031	61478	6676	67002	5397	68968	4416	70206	2910	85635	1966	62953
9L-4S		MI	32152	9031	53101	6560	58517	5283	61252	4298	64495	2799	78035	2229	51910
22-#14	2.99	MA	36985	9031	60086	6697	65294	5417	66930	4434	67439	2925	82208	1878	61283
10L-3S		MI	32842	9031	54309	6541	60056	5291	63122	4308	66859	2786	80688	2353	52005
22-#18	5.31	MA	43271	10363	74620	7496	83785	6003	89359	4763	98089	2802	122801	1424	107915
7L-6S		MI	34116	10363	59772	7327	66658	5853	71214	4670	77275	2620	95899	1400	83557
22-#18	5.31	MA	42025	10363	72382	7489	80737	5992	85753	4792	92823	2780	116577	1301	104091
8L-5S		MI	35115	10363	61496	7339	69041	5870	73994	4647	80979	2598	100425	1546	85847
24-#11	2.26	MA	39384	8614	62961	6418	69241	5194	71791	4286	74018	2917	89811	2506	52093
5L-9S		MI	28896	8614	46418	6336	50020	5139	50894	4218	50596	2862	60256	2138	38381
24-#11	2.26	MA	38842	8614	62061	6416	67994	5208	70267	4281	72009	2927	87249	2450	51593
6L-8S		MI	29292	8614	47145	6322	50914	5127	52031	4225	52059	2854	62064	2192	38923
24-#11	2.26	MA	38314	8614	61075	6431	66804	5205	68804	4294	70046	2938	84517	2360	51054
7E		MI	29691	8614	47820	6326	51833	5132	53119	4215	53628	2862	63914	2239	39151
24-#11	2.26	MA	37794	8614	60189	6429	65598	5219	67376	4307	67960	2931	82007	2311	50670
8L-6S		MI	30097	8614	48571	6312	52739	5120	54232	4204	55104	2854	65906	2329	39483
24-#11	2.26	MA	37243	8614	59323	6427	64424	5216	65883	4303	66015	2942	79522	2257	49918
9L-5S		MI	30513	8614	49257	6316	53688	5125	55392	4211	56615	2845	67771	2385	39874
24-#11	2.26	MA	36668	8614	58352	6443	63234	5230	64463	4316	64087	2952	77114	2196	49267
10L-4S		MI	30949	8614	49988	6319	54636	5113	56556	4200	58282	2854	69750	2425	39919

RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.26	MA	36106	8614	57484	6441	62067	5227	62989	4311	62030	2946	74666	2143	48426
11L-3S		MI	31436	8614	50832	6306	55711	5118	57863	4207	59946	2845	71624	2511	39940
24-#11	2.26	MA	35555	8614	56531	6456	60885	5241	61571	4324	60103	2956	71907	2066	47592
12L-2S		MI	32125	8614	51863	6309	57033	5106	59476	4196	62122	2836	74516	2597	39928
24-#14	3.26	MA	40962	9187	67369	6758	74638	5457	78324	4430	82978	2880	102280	2220	72239
6L-8S		MI	30479	9187	50501	6659	55075	5369	57075	4373	58743	2783	71228	1862	53454
24-#14	3.26	MA	40218	9187	65954	6780	72931	5452	76225	4448	80161	2894	98391	2090	71466
7E		MI	31042	9187	51469	6665	56392	5378	58633	4358	60974	2796	73856	1928	54416
24-#14	3.26	MA	39486	9187	64682	6776	71199	5472	74176	4466	77168	2883	94810	2019	69992
8L-6S		MI	31614	9187	52545	6646	57690	5361	60228	4344	63072	2783	76680	2058	55049
24-#14	3.26	MA	38729	9187	63438	6773	69515	5467	72033	4459	74377	2898	91275	1942	68787
9L-5S		MI	32200	9187	53528	6651	59050	5369	61889	4354	65218	2771	79322	2140	55718
24-#14	3.26	MA	37909	9187	62046	6795	67807	5487	69995	4477	71610	2912	87848	1854	67154
10L-4S		MI	32815	9187	54575	6657	60407	5352	63556	4340	67589	2783	82134	2196	56465
24-#18	5.80	MA	43581	10639	75817	7661	85142	6117	91126	4868	100134	2758	126347	1252	114295
8L-6S		MI	35244	10639	62343	7500	69954	5977	75235	4745	82614	2589	102934	1333	91143

RECTANGULAR TIED COLUMNS 36" x 48"

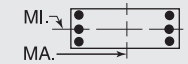
6-#18	1.39	MA	41842	8468	65455	6320	71162	5145	72912	4280	73408	3049	86774	2875	35088
2L-3S		MI	29335	8468	46602	6173	49531	5061	49756	4208	47994	2972	55244	2520	25834
6-#18	1.39	MA	39392	8468	61846	6313	66536	5179	67268	4311	65729	3073	76456	2654	35156
3L-2S		MI	31071	8468	49173	6185	52828	5034	53777	4186	53333	2950	62280	2741	25699
8-#14	1.04	MA	40653	8260	62666	6227	67831	5082	68941	4249	68044	3085	79861	2941	26720
2L-4S		MI	28557	8260	44505	6117	47082	4990	46860	4167	44402	3033	51068	2585	19843
8-#14	1.04	MA	39245	8260	60609	6224	65193	5077	65724	4267	63667	3100	73912	2816	26783
3E		MI	29269	8260	45713	6098	48621	4998	48730	4178	46766	3021	53720	2710	19760
8-#14	1.04	MA	38260	8260	58937	6246	63062	5098	63133	4261	60333	3115	70033	2692	26816
4L-2S		MI	30272	8260	47187	6104	50510	4981	51035	4163	49860	3008	57819	2834	19681
8-#18	1.85	MA	43527	8744	69063	6493	75788	5269	78556	4355	81086	3027	97092	2830	46410
2L-4S		MI	29284	8744	47059	6377	50134	5168	50505	4262	49254	2963	57740	2232	33840
8-#18	1.85	MA	41097	8744	65455	6486	71162	5303	72912	4386	73408	3051	86774	2608	46385
3E		MI	30513	8744	49173	6346	52828	5185	53777	4284	53333	2941	62280	2453	33910
8-#18	1.85	MA	39392	8744	62514	6524	67414	5293	68357	4373	67546	3075	80059	2387	46048
4L-2S		MI	32238	8744	51745	6358	56124	5158	57798	4261	58672	2919	69315	2675	33824
10-#14	1.30	MA	41633	8416	64723	6324	70468	5152	72159	4291	72422	3073	85810	2918	33189
2L-5S		MI	28610	8416	44932	6209	47614	5076	47498	4224	45125	3005	52354	2496	24496
10-#14	1.30	MA	40231	8416	62666	6321	67831	5147	68941	4310	68044	3088	79861	2794	33233
3L-4S		MI	29247	8416	45979	6215	48971	5059	49165	4210	47495	3018	55167	2552	24482
10-#14	1.30	MA	39251	8416	60994	6343	65699	5167	66351	4304	64710	3103	75982	2669	33223
4L-3S		MI	29956	8416	47187	6195	50510	5068	51035	4220	49860	3005	57819	2677	24422
10-#14	1.30	MA	38377	8416	59550	6340	63826	5163	64048	4322	61374	3093	71949	2608	33099
5L-2S		MI	30954	8416	48660	6201	52399	5051	53340	4206	52953	2993	61918	2801	24354
10-#18	2.31	MA	45194	9021	72672	6666	80414	5393	84199	4431	88765	3005	107410	2784	57697
2L-5S		MI	29364	9021	47795	6538	51053	5320	51605	4360	50499	2910	59925	2070	39991
10-#18	2.31	MA	42782	9021	69063	6659	75788	5428	78556	4462	81086	3029	97092	2563	57582
3L-4S		MI	30460	9021	49631	6550	53431	5293	54526	4337	54593	2932	64776	2165	41775
10-#18	2.31	MA	41092	9021	66123	6697	72041	5417	74001	4448	75225	3053	90378	2341	57146
4L-3S		MI	31681	9021	51745	6518	56124	5310	57798	4359	58672	2910	69315	2386	41938
10-#18	2.31	MA	39584	9021	63581	6690	68744	5452	69950	4479	69357	3033	83359	2235	54468
5L-2S		MI	33393	9021	54316	6531	59420	5282	61820	4337	64011	2888	76351	2608	41911
12-#11	1.08	MA	40857	8285	62954	6261	68323	5108	69590	4269	68947	3093	81240	2953	27845
2L-6S		MI	28355	8285	44100	6147	46596	5026	46299	4195	43611	3041	50288	2582	20670

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

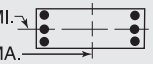


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.08	MA	39874	8285	61518	6259	66482	5105	67344	4282	65892	3104	77065	2867	27883
3L-5S		MI	28780	8285	44786	6150	47545	5031	47459	4201	45121	3032	52153	2639	20645
12-#11	1.08	MA	39187	8285	60352	6274	64996	5120	65538	4278	63567	3115	74339	2781	27911
4E		MI	29226	8285	45517	6154	48493	5019	48623	4191	46788	3041	54132	2678	20600
12-#11	1.08	MA	38575	8285	59346	6273	63691	5117	63933	4291	61242	3109	71513	2738	27903
5L-3S		MI	29723	8285	46361	6140	49568	5024	49930	4198	48452	3032	56006	2764	20548
12-#11	1.08	MA	37992	8285	58403	6271	62384	5131	62336	4287	59137	3120	68811	2682	27835
6L-2S		MI	30425	8285	47392	6144	50890	5012	51543	4187	50628	3023	58898	2851	20499
12-#14	1.56	MA	42605	8571	66781	6421	73105	5222	75376	4334	76799	3060	91759	2896	39642
2L-6S		MI	28695	8571	45423	6300	48144	5138	48141	4256	46072	3003	53812	2381	28522
12-#14	1.56	MA	41210	8571	64723	6418	70468	5217	72159	4352	72422	3076	85810	2771	39666
3L-5S		MI	29299	8571	46406	6306	49503	5146	49803	4266	48219	2990	56453	2463	29076
12-#14	1.56	MA	40236	8571	63051	6440	68336	5237	69568	4346	69088	3091	81930	2647	39615
4E		MI	29933	8571	47453	6312	50860	5129	51470	4252	50589	3003	59266	2519	29101
12-#14	1.56	MA	39366	8571	61607	6437	66463	5233	67265	4364	65752	3081	77897	2586	39452
5L-3S		MI	30638	8571	48660	6293	52399	5137	53340	4262	52953	2990	61918	2643	29063
12-#14	1.56	MA	38539	8571	60253	6434	64587	5253	64973	4358	62730	3096	74049	2505	38518
6L-2S		MI	31633	8571	50134	6299	54289	5121	55644	4248	56047	2978	66017	2768	29007
12-#18	2.78	MA	46845	9298	76281	6839	85040	5518	89843	4506	96443	2983	117729	2738	68942
2L-6S		MI	29500	9298	48643	6698	51965	5427	52846	4458	52134	2901	62435	1857	46440
12-#18	2.78	MA	44451	9298	72672	6832	80414	5552	84199	4537	88765	3007	107410	2517	68757
3L-5S		MI	30537	9298	50367	6711	54349	5444	55626	4435	55839	2879	66961	2003	47623
12-#18	2.78	MA	42775	9298	69732	6869	76667	5542	79645	4524	82904	3031	100696	2296	68236
4E		MI	31626	9298	52202	6723	56727	5417	58547	4413	59932	2901	71812	2098	49690
12-#18	2.78	MA	41280	9298	67189	6863	73370	5576	75593	4554	77035	3010	93677	2190	65258
5L-3S		MI	32838	9298	54316	6691	59420	5434	61820	4435	64011	2879	76351	2319	49928
12-#18	2.78	MA	39858	9298	64806	6856	70068	5566	71558	4541	71718	3034	87009	2046	63251
6L-2S		MI	34540	9298	56887	6704	62716	5407	65841	4412	69351	2857	83387	2541	49970
14-#11	1.26	MA	41543	8393	64390	6328	70164	5157	71836	4298	72003	3085	85415	2939	32355
2L-7S		MI	28428	8393	44380	6228	47012	5087	46798	4235	44311	3040	51187	2470	23599
14-#11	1.26	MA	40563	8393	62954	6326	68323	5154	69590	4311	68947	3096	81240	2852	32385
3L-6S		MI	28842	8393	45131	6214	47918	5075	47912	4224	45787	3031	53180	2561	23887
14-#11	1.26	MA	39879	8393	61788	6342	66837	5168	67784	4307	66623	3106	78514	2766	32401
4L-5S		MI	29265	8393	45817	6218	48868	5080	49072	4231	47298	3022	55045	2617	23882
14-#11	1.26	MA	39270	8393	60782	6340	65532	5165	66179	4320	64297	3100	75688	2723	32367
5L-4S		MI	29710	8393	46548	6221	49815	5068	50236	4220	48965	3031	57023	2657	23850
14-#11	1.26	MA	38690	8393	59839	6338	64225	5180	64581	4316	62192	3111	72986	2667	32278
6L-3S		MI	30206	8393	47392	6208	50890	5073	51543	4227	50628	3022	58898	2743	23807
14-#11	1.26	MA	38124	8393	58806	6354	62979	5177	63049	4330	60135	3122	70106	2578	31747
7L-2S		MI	30906	8393	48423	6211	52212	5061	53156	4217	52805	3014	61789	2829	23763
14-#14	1.82	MA	43571	8727	68838	6518	75743	5291	78594	4376	81177	3048	97708	2873	46084
2L-7S		MI	28797	8727	45821	6416	48735	5224	48851	4313	47068	3000	55087	2218	32443
14-#14	1.82	MA	42183	8727	66781	6516	73105	5287	75376	4395	76799	3063	91759	2749	46078
3L-6S		MI	29383	8727	46897	6397	50033	5208	50446	4298	49166	2987	57911	2348	32950
14-#14	1.82	MA	41213	8727	65109	6538	70974	5307	72785	4388	73465	3078	87879	2624	45997
4L-5S		MI	29984	8727	47880	6403	51393	5216	52108	4309	51312	2975	60552	2430	33644
14-#14	1.82	MA	40348	8727	63664	6535	69100	5302	70483	4407	70129	3068	83846	2563	45800
5L-4S		MI	30614	8727	48926	6409	52750	5199	53775	4294	53683	2987	63365	2486	33702
14-#14	1.82	MA	39526	8727	62311	6532	67225	5323	68190	4401	67108	3083	79998	2483	44723
6L-3S		MI	31317	8727	50134	6390	54289	5207	55644	4305	56047	2975	66017	2610	33690
14-#14	1.82	MA	38724	8727	60828	6554	65436	5318	65990	4419	64156	3098	75895	2353	43850
7L-2S		MI	32307	8727	51608	6396	56178	5191	57949	4291	59141	2963	70117	2735	33647
14-#18	3.24	MA	46104	9574	76281	7005	85040	5676	89843	4612	96443	2985	117729	2471	79918
3L-6S		MI	30671	9574	51214	6871	55262	5551	56867	4533	57473	2870	69471	1790	53917
14-#18	3.24	MA	44441	9574	73341	7042	81293	5666	85288	4599	90582	3009	111014	2250	79320
4L-5S		MI	31701	9574	52938	6884	57645	5568	59648	4511	61178	2848	73997	1936	55284
14-#18	3.24	MA	42959	9574	70798	7036	77996	5700	81237	4630	84714	2988	103995	2144	76079
5L-4S		MI	32782	9574	54773	6896	60023	5541	62568	4488	65271	2870	78848	2031	57463
14-#18	3.24	MA	41549	9574	68415	7029	74694	5690	77202	4616	79397	3012	97328	2000	74152
6L-3S		MI	33986	9574	56887	6864	62716	5558	65841	4510	69351	2848	83387	2253	57896

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

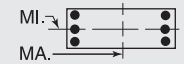
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.24	MA	40176	9574	65803	7067	71545	5724	73329	4647	74201	3036	90213	1770	70509
7L-2S		MI	35677	9574	59459	6877	66013	5531	69862	4487	74690	2826	90423	2474	58001
16-#11	1.44	MA	42226	8501	65826	6395	72005	5205	74081	4327	75058	3076	89590	2924	36859
2L-8S		MI	28509	8501	44736	6292	47415	5130	47324	4275	44918	3021	52229	2402	26470
16-#11	1.44	MA	41249	8501	64390	6394	70164	5202	71836	4341	72003	3087	85415	2838	36880
3L-7S		MI	28915	8501	45412	6295	48334	5135	48411	4264	46488	3030	54079	2449	26727
16-#11	1.44	MA	40568	8501	63224	6409	68678	5217	70029	4337	69678	3098	82689	2752	36874
4L-6S		MI	29326	8501	46163	6282	49240	5123	49525	4254	47964	3021	56071	2539	27095
16-#11	1.44	MA	39961	8501	62218	6407	67372	5214	68425	4350	67353	3092	79864	2709	36826
5E		MI	29749	8501	46849	6285	50190	5128	50685	4260	49474	3013	57936	2596	27111
16-#11	1.44	MA	39383	8501	61275	6406	66066	5228	66827	4346	65247	3103	77161	2653	36718
6L-4S		MI	30192	8501	47580	6289	51137	5116	51849	4250	51141	3021	59915	2635	27090
16-#11	1.44	MA	38820	8501	60242	6421	64819	5225	65294	4359	63191	3114	74281	2563	36106
7L-3S		MI	30686	8501	48423	6275	52212	5121	53156	4256	52805	3013	61789	2721	27057
16-#11	1.44	MA	38257	8501	59314	6420	63555	5240	63799	4372	61005	3107	71638	2513	35647
8L-2S		MI	31384	8501	49455	6279	53535	5109	54769	4246	54981	3004	64681	2808	27018
16-#14	2.08	MA	44532	8883	70895	6616	78380	5361	81811	4419	85555	3036	103656	2851	52516
2L-8S		MI	28909	8883	46326	6508	49307	5286	49598	4369	47930	2972	56558	2119	36145
16-#14	2.08	MA	43150	8883	68838	6613	75743	5357	78594	4437	81177	3051	97708	2726	52480
3L-7S		MI	29483	8883	47294	6514	50624	5294	51156	4355	50162	2985	59186	2185	36907
16-#14	2.08	MA	42185	8883	67166	6635	73611	5377	76003	4431	77843	3066	93828	2602	52371
4L-6S		MI	30066	8883	48371	6495	51922	5277	52751	4341	52259	2972	62010	2315	37390
16-#14	2.08	MA	41325	8883	65721	6632	71738	5372	73700	4449	74507	3056	89795	2541	52144
5E		MI	30665	8883	49353	6500	53282	5286	54412	4351	54406	2960	64651	2397	38203
16-#14	2.08	MA	40506	8883	64368	6629	69862	5392	71408	4443	71485	3071	85947	2460	50941
6L-4S		MI	31292	8883	50400	6506	54639	5269	56079	4337	56776	2972	67464	2452	38287
16-#14	2.08	MA	39709	8883	62885	6651	68073	5388	69208	4461	68534	3086	81844	2331	50098
7L-3S		MI	31992	8883	51608	6487	56178	5277	57949	4347	59141	2960	70117	2577	38311
16-#14	2.08	MA	38924	8883	61553	6648	66259	5408	67061	4480	65396	3076	78072	2259	48924
8L-2S		MI	32978	8883	53082	6493	58067	5260	60254	4333	62234	2947	74216	2701	38276
16-#18	3.70	MA	46093	9851	76949	7215	85919	5790	90932	4674	98261	2987	121332	2204	90367
4L-6S		MI	31833	9851	53785	7044	58558	5675	60889	4609	62812	2839	76506	1723	61401
16-#18	3.70	MA	44622	9851	74407	7209	82622	5824	86881	4705	92393	2966	114313	2098	86926
5E		MI	32856	9851	55509	7057	60941	5692	63669	4586	66517	2817	81033	1869	62969
16-#18	3.70	MA	43224	9851	72023	7202	79321	5814	82846	4692	87075	2990	107646	1955	84799
6L-4S		MI	33929	9851	57345	7069	63319	5665	66590	4564	70610	2839	85884	1964	65017
16-#18	3.70	MA	41862	9851	69412	7239	76171	5848	78973	4722	81879	3014	100532	1724	81278
7L-3S		MI	35125	9851	59459	7037	66013	5682	69862	4585	74690	2817	90423	2186	65849
16-#18	3.70	MA	40522	9851	67066	7233	72976	5838	75193	4753	76358	2994	93969	1600	77813
8L-2S		MI	36806	9851	62030	7050	69309	5655	73883	4563	80029	2795	97459	2407	66003
18-#11	1.63	MA	42906	8609	67262	6463	73846	5253	76327	4357	78113	3067	93765	2910	41356
2L-9S		MI	28585	8609	45040	6373	47843	5190	47800	4297	45632	3020	53313	2327	29306
18-#11	1.63	MA	41932	8609	65826	6461	72005	5251	74081	4370	75058	3078	89590	2823	41369
3L-8S		MI	28994	8609	45768	6359	48737	5178	48937	4304	47095	3011	55121	2381	29614
18-#11	1.63	MA	41254	8609	64660	6477	70519	5265	72275	4366	72734	3089	86865	2737	41344
4L-7S		MI	29399	8609	46443	6363	49657	5183	50024	4293	48664	3020	56970	2427	29860
18-#11	1.63	MA	40649	8609	63654	6475	69213	5262	70670	4379	70408	3083	84039	2694	41279
5L-6S		MI	29809	8609	47194	6349	50563	5171	51138	4283	50140	3011	58963	2518	30249
18-#11	1.63	MA	40073	8609	62711	6473	67906	5276	69073	4375	68303	3094	81336	2638	41130
6L-5S		MI	30230	8609	47880	6353	51512	5177	52298	4290	51651	3003	60828	2574	30329
18-#11	1.63	MA	39513	8609	61678	6489	66660	5274	67540	4389	66246	3105	78457	2549	40472
7L-4S		MI	30672	8609	48611	6356	52459	5164	53462	4279	53318	3011	62807	2613	30324
18-#11	1.63	MA	38954	8609	60750	6487	65396	5288	66044	4402	64060	3099	75814	2498	40026
8L-3S		MI	31164	8609	49455	6343	53535	5170	54769	4286	54981	3003	64681	2700	30299

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

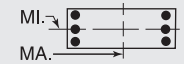


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.63	MA	38367	8609	59842	6485	64167	5285	64480	4398	62023	3110	73193	2445	39494
9L-2S		MI	31860	8609	50486	6346	54857	5158	56382	4275	57158	2994	67572	2786	30266
18-#14	2.34	MA	44110	9038	70895	6710	78380	5427	81811	4480	85555	3038	103656	2704	58874
3L-8S		MI	29594	9038	47800	6605	51197	5356	51903	4412	51024	2957	60657	2085	40526
18-#14	2.34	MA	43150	9038	69223	6732	76249	5447	79220	4473	82221	3053	99777	2579	58740
4L-7S		MI	30165	9038	48768	6611	52514	5364	53461	4397	53255	2969	63285	2151	41376
18-#14	2.34	MA	42295	9038	67779	6729	74375	5442	76918	4492	78884	3043	95744	2518	58484
5L-6S		MI	30746	9038	49844	6592	53812	5347	55056	4383	55353	2957	66109	2282	41840
18-#14	2.34	MA	41481	9038	66425	6726	72500	5462	74625	4485	75863	3058	91896	2438	57168
6L-5S		MI	31342	9038	50827	6598	55171	5355	56717	4394	57500	2945	68750	2363	42631
18-#14	2.34	MA	40688	9038	64942	6748	70711	5458	72425	4504	72911	3074	87793	2308	56354
7L-4S		MI	31966	9038	51874	6604	56528	5339	58384	4379	59870	2957	71563	2419	42864
18-#14	2.34	MA	39907	9038	63610	6745	68896	5478	70278	4522	69774	3064	84021	2236	55091
8L-3S		MI	32663	9038	53082	6585	58067	5347	60254	4390	62234	2945	74216	2544	42908
18-#14	2.34	MA	39076	9038	62307	6742	67131	5473	68033	4516	66849	3079	80290	2159	53849
9L-2S		MI	33645	9038	54555	6590	59956	5330	62559	4375	65328	2932	78315	2668	42897
18-#18	4.17	MA	46272	10128	78015	7381	87248	5948	92524	4780	100071	2944	124631	2053	97795
5L-6S		MI	32986	10128	56357	7217	61854	5799	64910	4684	68151	2808	83542	1656	68913
18-#18	4.17	MA	44884	10128	75632	7375	83947	5938	88489	4767	94754	2968	117964	1909	95473
6L-5S		MI	34002	10128	58081	7229	64238	5816	67690	4662	71856	2786	88069	1802	70673
18-#18	4.17	MA	43534	10128	73021	7412	80797	5972	84616	4798	89558	2992	110850	1678	92067
7L-4S		MI	35068	10128	59916	7242	66616	5789	70611	4639	75949	2808	92920	1898	72605
18-#18	4.17	MA	42205	10128	70675	7406	77602	5962	80836	4828	84036	2972	104287	1554	88488
8L-3S		MI	36256	10128	62030	7210	69309	5806	73883	4661	80029	2786	97459	2119	73789
20-#11	1.81	MA	42612	8717	67262	6529	73846	5299	76327	4399	78113	3070	93765	2809	45845
3L-9S		MI	29072	8717	46072	6440	49165	5239	49413	4327	47809	3010	56204	2305	32392
20-#11	1.81	MA	41936	8717	66096	6544	72360	5313	74521	4395	75789	3081	91040	2723	45808
4L-8S		MI	29478	8717	46799	6426	50060	5227	50550	4333	49272	3002	58012	2359	32759
20-#11	1.81	MA	41334	8717	65089	6542	71054	5311	72916	4409	73464	3074	88214	2680	45729
5L-7S		MI	29881	8717	47474	6430	50979	5232	51637	4323	50841	3010	59862	2406	32997
20-#11	1.81	MA	40760	8717	64147	6541	69747	5325	71318	4405	71358	3085	85512	2624	45477
6E		MI	30290	8717	48226	6416	51885	5220	52751	4312	52317	3002	61854	2496	33367
20-#11	1.81	MA	40202	8717	63114	6556	68501	5322	69786	4418	69302	3096	82632	2534	44843
7L-5S		MI	30709	8717	48911	6420	52834	5225	53911	4319	53827	2993	63719	2552	33539
20-#11	1.81	MA	39652	8717	62186	6554	67237	5336	68290	4431	67116	3090	79989	2484	44409
8L-4S		MI	31149	8717	49642	6424	53782	5213	55075	4309	55494	3002	65698	2592	33552
20-#11	1.81	MA	39061	8717	61278	6553	66008	5334	66726	4427	65078	3101	77368	2430	43817
9L-3S		MI	31640	8717	50486	6410	54857	5218	56382	4315	57158	2993	67572	2678	33535
20-#11	1.81	MA	38453	8717	60262	6568	64761	5348	65238	4440	63058	3112	74828	2370	43076
10L-2S		MI	32334	8717	51517	6414	56179	5206	57994	4305	59334	2984	70464	2765	33508
20-#14	2.60	MA	44110	9194	71281	6829	78886	5517	82438	4516	86598	3041	105726	2557	65104
4L-8S		MI	30275	9194	49274	6702	53086	5426	54207	4454	54118	2942	64756	2052	44916
20-#14	2.60	MA	43259	9194	69836	6826	77012	5512	80135	4534	83262	3031	101693	2496	64681
5L-7S		MI	30844	9194	50242	6708	54403	5434	55765	4440	56349	2954	67384	2118	45849
20-#14	2.60	MA	42449	9194	68483	6823	75137	5532	77843	4528	80241	3046	97844	2415	63405
6E		MI	31422	9194	51318	6689	55701	5417	57361	4425	58446	2942	70208	2248	46296
20-#14	2.60	MA	41661	9194	67000	6845	73348	5528	75643	4546	77289	3061	93742	2285	62614
7L-5S		MI	32015	9194	52301	6695	57061	5425	59022	4436	60593	2929	72849	2330	47048
20-#14	2.60	MA	40884	9194	65668	6843	71533	5548	73496	4565	74152	3051	89970	2214	61268
8L-4S		MI	32637	9194	53348	6701	58418	5409	60689	4422	62963	2942	75662	2386	47433
20-#14	2.60	MA	40058	9194	64365	6840	69769	5543	71250	4558	71227	3066	86239	2136	60059
9L-3S		MI	33331	9194	54555	6682	59956	5417	62559	4432	65328	2929	78315	2510	47497
20-#14	2.60	MA	39199	9194	62905	6862	67979	5563	69115	4577	68327	3081	82622	2049	58422
10L-2S		MI	34309	9194	56029	6688	61846	5400	64864	4418	68421	2917	82414	2635	47516
20-#18	4.63	MA	46532	10404	79241	7548	88573	6062	94133	4842	102432	2946	128282	1863	106172
6E		MI	34131	10404	58928	7390	65150	5923	68931	4759	73490	2777	90578	1589	76451
20-#18	4.63	MA	45191	10404	76629	7585	85423	6096	90260	4873	97237	2970	121168	1633	102874
7L-5S		MI	35140	10404	60652	7402	67534	5940	71711	4737	77195	2755	95104	1735	78392
20-#18	4.63	MA	43873	10404	74283	7579	82228	6086	86480	4904	91715	2950	114605	1508	99183
8L-4S		MI	36199	10404	62487	7415	69912	5913	74632	4714	81288	2777	99955	1831	80219

RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

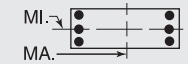


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.99	MA	42615	8825	67532	6612	74200	5362	76766	4425	78844	3072	95215	2708	50269
4L-9S		MI	29562	8825	47103	6508	50487	5287	51026	4356	49985	3000	59096	2283	35484
22-#11	1.99	MA	42015	8825	66525	6610	72895	5359	75162	4438	76519	3066	92389	2665	50176
5L-8S		MI	29959	8825	47830	6494	51382	5275	52163	4363	51448	2992	60904	2338	35906
22-#11	1.99	MA	41444	8825	65583	6608	71588	5373	73564	4434	74414	3077	89687	2609	49830
6L-7S		MI	30361	8825	48506	6498	52301	5280	53250	4352	53017	3000	62753	2384	36138
22-#11	1.99	MA	40888	8825	64549	6624	70342	5370	72031	4447	72357	3088	86807	2520	49218
7L-6S		MI	30769	8825	49257	6484	53207	5268	54364	4342	54493	2992	64746	2474	36491
22-#11	1.99	MA	40341	8825	63622	6622	69078	5385	70536	4461	70171	3081	84164	2469	48794
8L-5S		MI	31187	8825	49943	6488	54156	5273	55524	4348	56004	2983	66611	2531	36745
22-#11	1.99	MA	39752	8825	62714	6620	67848	5382	68972	4457	68134	3092	81544	2416	48146
9L-4S		MI	31625	8825	50674	6491	55104	5261	56688	4338	57671	2992	68590	2570	36771
22-#11	1.99	MA	39146	8825	61698	6636	66601	5396	67484	4470	66113	3103	79003	2355	47423
10L-3S		MI	32115	8825	51517	6478	56179	5266	57994	4345	59334	2983	70464	2657	36766
22-#11	1.99	MA	38555	8825	60789	6634	65379	5394	65940	4466	63959	3097	76426	2302	46669
11L-2S		MI	32807	8825	52549	6481	57501	5254	59607	4334	61511	2975	73355	2743	36745
22-#14	2.86	MA	44218	9349	71893	6924	79650	5582	83353	4577	87640	3019	107642	2473	70879
5L-8S		MI	30953	9349	50748	6800	54975	5496	56512	4497	57211	2927	68855	2019	49316
22-#14	2.86	MA	43412	9349	70540	6921	77774	5602	81060	4570	84618	3034	103793	2393	69650
6L-7S		MI	31519	9349	51716	6806	56292	5504	58070	4482	59442	2939	71483	2085	50325
22-#14	2.86	MA	42628	9349	69057	6943	75985	5597	78860	4589	81666	3049	99691	2263	68879
7L-6S		MI	32095	9349	52792	6786	57590	5487	59666	4468	61540	2927	74307	2215	50758
22-#14	2.86	MA	41855	9349	67725	6940	74171	5618	76713	4607	78529	3039	95919	2191	67454
8L-5S		MI	32685	9349	53775	6792	58950	5495	61327	4478	63687	2914	76948	2297	51475
22-#14	2.86	MA	41034	9349	66422	6937	72406	5613	74468	4601	75605	3054	92188	2114	66275
9L-4S		MI	33304	9349	54822	6798	60307	5478	62994	4464	66057	2927	79761	2353	51997
22-#14	2.86	MA	40179	9349	64963	6959	70616	5633	72332	4619	72705	3069	88571	2026	64582
10L-3S		MI	33995	9349	56029	6779	61846	5487	64864	4474	68421	2914	82414	2477	52079
22-#18	5.09	MA	46836	10681	80238	7758	90049	6221	95904	4949	104915	2948	131486	1587	113697
7L-6S		MI	35268	10681	61499	7563	68447	6047	72952	4835	78829	2746	97614	1522	84012
22-#18	5.09	MA	45527	10681	77892	7751	86854	6210	92124	4979	99394	2928	124923	1463	109896
8L-5S		MI	36271	10681	63223	7575	70830	6065	75733	4812	82534	2724	102140	1668	86124
24-#11	2.17	MA	42694	8932	67961	6677	74736	5407	77407	4467	79575	3057	96564	2651	54620
5L-9S		MI	30042	8932	48135	6575	51810	5336	52639	4386	52162	2991	61987	2262	38581
24-#11	2.17	MA	42125	8932	67019	6675	73429	5422	75810	4464	77469	3068	93862	2595	54189
6L-8S		MI	30439	8932	48862	6561	52704	5324	53776	4392	53625	2982	63795	2316	39055
24-#11	2.17	MA	41571	8932	65985	6691	72183	5419	74277	4477	75413	3079	90982	2505	53596
7E		MI	30839	8932	49537	6565	53623	5329	54863	4382	55194	2991	65645	2363	39280
24-#11	2.17	MA	41026	8932	65058	6689	70919	5433	72781	4490	73226	3073	88339	2455	53181
8L-6S		MI	31245	8932	50288	6551	54529	5317	55977	4371	56670	2982	67637	2453	39619
24-#11	2.17	MA	40440	8932	64150	6688	69689	5430	71217	4486	71189	3084	85719	2401	52480
9L-5S		MI	31662	8932	50974	6555	55478	5322	57137	4378	58180	2973	69502	2509	39946
24-#11	2.17	MA	39836	8932	63134	6703	68442	5445	69730	4499	69169	3095	83179	2340	51773
10L-4S		MI	32099	8932	51705	6559	56426	5310	58301	4367	59847	2982	71481	2549	39983
24-#11	2.17	MA	39247	8932	62225	6701	67220	5442	68185	4495	67014	3089	80601	2287	50980
11L-3S		MI	32587	8932	52549	6545	57501	5315	59607	4374	61511	2973	73355	2635	39994
24-#11	2.17	MA	38668	8932	61227	6717	65981	5456	66700	4509	64995	3099	77693	2211	50077
12L-2S		MI	33277	8932	53580	6549	58823	5303	61220	4364	63687	2965	76247	2721	39979
24-#14	3.13	MA	44370	9505	72597	7018	80412	5672	84277	4613	88996	3021	109742	2370	75901
6L-8S		MI	31627	9505	52222	6897	56865	5565	58817	4539	60305	2911	72954	1986	53723
24-#14	3.13	MA	43589	9505	71114	7040	78623	5667	82078	4631	86044	3036	105639	2240	75149
7E		MI	32191	9505	53190	6903	58182	5574	60375	4525	62536	2924	75582	2052	54708
24-#14	3.13	MA	42821	9505	69782	7037	76808	5687	79931	4650	82907	3026	101868	2169	73647
8L-6S		MI	32764	9505	54266	6884	59480	5557	61971	4510	64634	2911	78406	2182	55225
24-#14	3.13	MA	42005	9505	68479	7034	75043	5683	77685	4643	79982	3041	98136	2091	72497
9L-5S		MI	33352	9505	55248	6890	60839	5565	63632	4521	66780	2899	81048	2264	55911
24-#14	3.13	MA	41153	9505	67020	7056	73253	5703	75550	4662	77083	3057	94520	2004	70749
10L-4S		MI	33969	9505	56295	6895	62196	5548	65299	4506	69151	2911	83860	2319	56556
24-#18	5.56	MA	47170	10957	81501	7924	91481	6335	97767	5055	107072	2905	135242	1417	120626
8L-6S		MI	36399	10957	64071	7736	71743	6172	76974	4910	84168	2715	104650	1456	91592

RECTANGULAR TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.66	MA	28082	7212	44717	5278	48437	4288	49722	3552	50207	2470	59190	2284	27046
2L-3S		MI	26236	7212	41973	5266	44919	4316	45431	3576	44472	2492	51609	2063	27133
8-#14	1.25	MA	27223	7005	42624	5186	45948	4226	46758	3522	46409	2520	54282	2367	20689
2L-4S		MI	25402	7005	39768	5201	42296	4236	42311	3528	40558	2545	47019	2118	20803
8-#18	2.22	MA	29326	7489	47462	5450	51955	4412	54014	3627	55941	2441	66772	2222	35676
2L-4S		MI	26195	7489	42466	5472	45568	4425	46236	3631	45824	2485	54290	1779	35397
10-#11	1.08	MA	26870	6922	41759	5154	44937	4205	45563	3513	44868	2542	52285	2401	18098
2L-5S		MI	25119	6922	38986	5161	41378	4225	41217	3529	38970	2550	45044	2188	18221
10-#11	1.08	MA	26121	6922	40660	5151	43529	4217	43845	3524	42537	2550	49180	2314	18146
3L-4S		MI	25592	6922	39763	5165	42385	4213	42455	3518	40755	2559	47164	2228	18193
10-#14	1.56	MA	27951	7161	44195	5284	47962	4296	49215	3564	49725	2506	58688	2336	25644
2L-5S		MI	25467	7161	40226	5293	42867	4323	42995	3585	41334	2518	48410	2030	25607
10-#14	1.56	MA	26890	7161	42624	5278	45948	4313	46758	3580	46409	2518	54282	2212	25694
3L-4S		MI	26140	7161	41339	5298	44310	4306	44768	3570	43874	2531	51425	2087	25701
10-#18	2.77	MA	30558	7766	50206	5623	55473	4536	58305	3702	61676	2412	74353	2159	44275
2L-5S		MI	26298	7766	43256	5634	46554	4578	47418	3731	47164	2434	56659	1619	41163
10-#18	2.77	MA	28741	7766	47462	5612	51955	4564	54014	3727	55941	2434	66772	1938	44185
3L-4S		MI	27452	7766	45210	5645	49086	4549	50528	3707	51559	2456	61872	1716	43628

RECTANGULAR TIED COLUMNS 38" x 40"

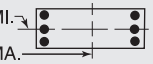
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.05	MA	29624	7272	46173	5378	49461	4388	50004	3667	48916	2649	56768	2496	19442
2E		MI	28101	7272	43893	5355	46913	4369	47370	3651	46209	2633	53527	2476	18409
6-#18	1.58	MA	30972	7548	49090	5550	53200	4512	54566	3742	55046	2622	64895	2438	28666
2L-3S		MI	27514	7548	43893	5517	46913	4522	47370	3751	46209	2626	53527	2193	27202
6-#18	1.58	MA	29005	7548	46173	5540	49461	4542	50004	3768	48916	2644	56768	2216	28753
3L-2S		MI	29362	7548	46638	5528	50431	4494	51662	3727	51944	2604	61109	2414	27103
8-#14	1.18	MA	30047	7341	46855	5459	50543	4451	51402	3713	50959	2671	59590	2517	21904
2L-4S		MI	26679	7341	41681	5453	44290	4444	44255	3704	42302	2681	48948	2249	20859
8-#14	1.18	MA	28913	7341	45187	5455	48404	4469	48792	3729	47419	2683	54875	2392	21972
3E		MI	27435	7341	42966	5434	45928	4451	46245	3714	44837	2668	51804	2374	20803
8-#14	1.18	MA	28112	7341	43825	5475	46668	4462	46682	3720	44714	2696	51814	2268	22018
4L-2S		MI	28502	7341	44537	5439	47942	4434	48702	3698	48153	2656	56211	2498	20732
8-#18	2.11	MA	32304	7825	52007	5723	56940	4636	59128	3818	61177	2596	73023	2380	37836
2L-4S		MI	27472	7825	44386	5723	47562	4631	48175	3806	47561	2620	56209	1909	35535
8-#18	2.11	MA	30353	7825	49090	5713	53200	4666	54566	3844	55046	2618	64895	2158	37837
3E		MI	28775	7825	46638	5690	50431	4646	51662	3826	51944	2598	61109	2130	35764
8-#18	2.11	MA	28972	7825	46700	5747	50156	4652	50866	3825	50361	2640	59633	1937	37557
4L-2S		MI	30609	7825	49382	5701	53948	4618	55953	3802	57678	2575	68690	2352	35740
10-#11	1.03	MA	29668	7258	45932	5427	49465	4429	50126	3704	49281	2690	57435	2549	19151
2L-5S		MI	26395	7258	40894	5415	43372	4434	43163	3706	40718	2686	46979	2319	18273
10-#11	1.03	MA	28871	7258	44766	5424	47970	4442	48303	3715	46800	2699	54116	2463	19199
3L-4S		MI	26869	7258	41671	5418	44379	4421	44401	3695	42503	2695	49099	2360	18236
10-#11	1.03	MA	28310	7258	43815	5438	46758	4438	46829	3710	44904	2708	51959	2376	19246
4L-3S		MI	27399	7258	42569	5404	45523	4426	45790	3701	44285	2686	51115	2446	18185
10-#11	1.03	MA	27809	7258	42992	5435	45691	4451	45518	3721	43005	2700	49698	2336	19274
5L-2S		MI	28148	7258	43668	5407	46932	4413	47509	3690	46616	2678	54220	2532	18136
10-#14	1.48	MA	30825	7496	48524	5557	52681	4520	54011	3755	54498	2658	64304	2488	27163
2L-5S		MI	26744	7496	42139	5545	44861	4531	44939	3762	43078	2654	50339	2161	25700
10-#14	1.48	MA	29696	7496	46855	5552	50543	4539	51402	3771	50959	2670	59590	2364	27212
3L-4S		MI	27417	7496	43252	5551	46304	4514	46712	3746	45618	2666	53354	2218	25770

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis



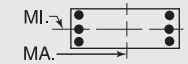
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.48	MA	28900	7496	45493	5572	48806	4532	49291	3762	48253	2683	56529	2239	27220
4L-3S		MI	28169	7496	44537	5531	47942	4521	48702	3756	48153	2654	56211	2343	25746
10-#14	1.48	MA	28187	7496	44313	5568	47277	4550	47412	3778	45543	2670	53310	2181	27125
5L-2S		MI	29231	7496	46108	5536	49956	4504	51159	3741	51470	2642	60618	2467	25692
10-#18	2.63	MA	33623	8102	54924	5896	60679	4760	63690	3893	67307	2569	81150	2321	46975
2L-5S		MI	27574	8102	45177	5884	48548	4784	49357	3906	48901	2569	58578	1749	41506
10-#18	2.63	MA	31687	8102	52007	5886	56940	4790	59128	3919	61177	2591	73023	2100	46885
3L-4S		MI	28731	8102	47130	5896	51079	4755	52467	3882	53296	2591	63790	1847	43960
10-#18	2.63	MA	30318	8102	49617	5920	53895	4776	55428	3901	56491	2613	67761	1879	46509
4L-3S		MI	30023	8102	49382	5863	53948	4771	55953	3902	57678	2569	68690	2068	44283
10-#18	2.63	MA	29092	8102	47546	5910	51210	4806	52130	3926	51794	2591	62188	1779	43878
5L-2S		MI	31843	8102	52126	5874	57466	4742	60245	3877	63413	2547	76271	2289	44342
12-#11	1.23	MA	30217	7366	47099	5494	50960	4478	51950	3733	51763	2682	60754	2530	22832
2L-6S		MI	26467	7366	41265	5479	43772	4477	43649	3729	41432	2686	48080	2243	21678
12-#11	1.23	MA	29424	7366	45932	5491	49465	4491	50126	3745	49281	2690	57435	2444	22873
3L-5S		MI	26917	7366	41993	5482	44781	4482	44881	3736	43049	2677	50084	2299	21710
12-#11	1.23	MA	28865	7366	44981	5506	48253	4486	48653	3739	47385	2699	55277	2358	22907
4E		MI	27389	7366	42770	5486	45788	4470	46119	3724	44834	2686	52204	2340	21691
12-#11	1.23	MA	28365	7366	44158	5503	47186	4499	47342	3751	45487	2691	53016	2317	22913
5L-3S		MI	27917	7366	43668	5472	46932	4474	47509	3731	46616	2677	54220	2426	21652
12-#11	1.23	MA	27889	7366	43387	5500	46117	4495	46036	3745	43766	2700	50873	2261	22864
6L-2S		MI	28663	7366	44766	5475	48340	4462	49227	3719	48947	2669	57325	2512	21609
12-#14	1.78	MA	31598	7652	50192	5654	54820	4590	56620	3798	58038	2645	69019	2459	32405
2L-6S		MI	26842	7652	42665	5637	45429	4594	45629	3794	44093	2652	51904	2049	29638
12-#14	1.78	MA	30475	7652	48524	5649	52681	4608	54011	3814	54498	2657	64304	2335	32440
3L-5S		MI	27480	7652	43710	5643	46875	4601	47396	3804	46395	2640	54746	2130	30552
12-#14	1.78	MA	29682	7652	47161	5669	50945	4602	51900	3805	51793	2670	61244	2210	32405
4E		MI	28150	7652	44823	5648	48318	4584	49169	3789	48935	2652	57761	2187	30658
12-#14	1.78	MA	28974	7652	45982	5665	49416	4620	50021	3821	49083	2657	58025	2152	32273
5L-3S		MI	28898	7652	46108	5628	49956	4591	51159	3798	51470	2640	60618	2312	30672
12-#14	1.78	MA	28298	7652	44875	5660	47884	4613	48149	3812	46626	2670	54982	2071	31281
6L-2S		MI	29955	7652	47679	5633	51970	4573	53616	3783	54786	2628	65024	2436	30634
12-#18	3.16	MA	34928	8378	57841	6069	64419	4885	68252	3969	73437	2542	89278	2263	56066
2L-6S		MI	27736	8378	46087	6046	49529	4892	50550	3962	50656	2562	61277	1541	47803
12-#18	3.16	MA	33007	8378	54924	6059	60679	4914	63690	3994	67307	2565	81150	2042	55910
3L-5S		MI	28829	8378	47921	6057	52066	4908	53649	3981	54636	2540	66159	1687	49672
12-#18	3.16	MA	31649	8378	52534	6093	57635	4900	59990	3976	62622	2587	75888	1820	55170
4E		MI	29977	8378	49874	6069	54597	4879	56759	3957	59030	2562	71371	1784	52046
12-#18	3.16	MA	30434	8378	50463	6083	54950	4930	56692	4002	57925	2565	70315	1721	52571
5L-3S		MI	31259	8378	52126	6035	57466	4895	60245	3977	63413	2540	76271	2006	52777
12-#18	3.16	MA	29277	8378	48519	6073	52260	4916	53405	3984	53671	2587	65077	1576	50572
6L-2S		MI	33066	8378	54870	6047	60984	4866	64536	3953	69147	2518	83853	2227	52909
14-#11	1.44	MA	30763	7474	48265	5562	52455	4526	53774	3762	54244	2673	64072	2512	26503
2L-7S		MI	26551	7474	41565	5561	44218	4538	44183	3770	42182	2685	49045	2133	24562
14-#11	1.44	MA	29973	7474	47099	5559	50960	4539	51950	3774	51763	2682	60754	2425	26536
3L-6S		MI	26988	7474	42363	5547	45181	4526	45367	3759	43763	2677	51185	2223	25011
14-#11	1.44	MA	29416	7474	46147	5573	49748	4535	50477	3768	49867	2691	58596	2339	26558
4L-5S		MI	27436	7474	43092	5550	46189	4531	46600	3765	45381	2668	53189	2279	25132
14-#11	1.44	MA	28919	7474	45325	5570	48681	4548	49166	3780	47968	2682	56335	2298	26541
5L-4S		MI	27906	7474	43869	5553	47197	4518	47837	3754	47166	2677	55309	2320	25135
14-#11	1.44	MA	28445	7474	44553	5567	47612	4544	47860	3774	46247	2691	54192	2242	26397
6L-3S		MI	28432	7474	44766	5539	48340	4523	49227	3760	48947	2668	57325	2406	25108
14-#11	1.44	MA	27983	7474	43708	5582	46593	4557	46607	3786	44566	2700	51904	2152	25905
7L-2S		MI	29176	7474	45865	5542	49749	4510	50946	3749	51279	2660	60430	2492	25072

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	2.07	MA	32365	7808	51860	5751	56959	4660	59229	3840	61577	2632	73734	2430	37635
2L-7S		MI	26959	7808	43092	5754	46063	4681	46390	3852	45161	2651	53273	1888	33808
14-#14	2.07	MA	31247	7808	50192	5746	54820	4678	56620	3856	58038	2644	69019	2306	37642
3L-6S		MI	27578	7808	44236	5735	47443	4663	48086	3837	47410	2638	56310	2018	34364
14-#14	2.07	MA	30459	7808	48829	5767	53084	4672	54509	3847	55332	2657	65958	2181	37579
4L-5S		MI	28212	7808	45281	5740	48889	4671	49853	3847	49711	2626	59152	2099	35271
14-#14	2.07	MA	29755	7808	47650	5762	51554	4690	52630	3863	52622	2644	62739	2123	37297
5L-4S		MI	28878	7808	46394	5745	50332	4653	51626	3831	52251	2638	62168	2156	35535
14-#14	2.07	MA	29083	7808	46544	5757	50023	4683	50759	3854	50166	2657	59697	2042	36303
6L-3S		MI	29622	7808	47679	5725	51970	4661	53616	3841	54786	2626	65024	2281	35583
14-#14	2.07	MA	28429	7808	45332	5778	48561	4701	48961	3870	47765	2669	56447	1912	35687
7L-2S		MI	30674	7808	49250	5731	53984	4643	56073	3826	58103	2613	69431	2405	35564
14-#18	3.68	MA	34315	8655	57841	6232	64419	5039	68252	4070	73437	2538	89278	1983	64919
3L-6S		MI	28989	8655	48831	6219	53047	5016	54842	4037	56391	2534	68858	1479	55800
14-#18	3.68	MA	32968	8655	55451	6266	61374	5024	64552	4051	68752	2560	84016	1762	63741
4L-5S		MI	30073	8655	50665	6230	55584	5032	57941	4057	60370	2511	73740	1624	57866
14-#18	3.68	MA	31763	8655	53380	6256	58690	5054	61254	4077	64055	2538	78443	1662	61291
5L-4S		MI	31212	8655	52618	6241	58115	5003	61050	4033	64765	2534	78953	1722	60096
14-#18	3.68	MA	30616	8655	51436	6246	56000	5040	57968	4059	59801	2560	73205	1517	59096
6L-3S		MI	32483	8655	54870	6208	60984	5019	64536	4053	69147	2511	83853	1943	61255
16-#11	1.64	MA	31307	7582	49431	5629	53950	4574	55598	3792	56726	2664	67391	2493	30167
2L-8S		MI	26642	7582	41946	5625	44650	4582	44746	3810	42833	2668	50168	2066	27605
16-#11	1.64	MA	30519	7582	48265	5626	52455	4588	53774	3803	54244	2673	64072	2407	30192
3L-7S		MI	27071	7582	42664	5628	45626	4587	45902	3799	44513	2676	52150	2113	27894
16-#11	1.64	MA	29965	7582	47314	5641	51243	4583	52301	3798	52348	2682	61915	2320	30197
4L-6S		MI	27506	7582	43462	5614	46589	4574	47085	3788	46094	2668	54290	2203	28320
16-#11	1.64	MA	29469	7582	46491	5638	50176	4596	50990	3809	50450	2674	59654	2279	30162
5E		MI	27952	7582	44191	5617	47598	4579	48318	3794	47712	2659	56294	2259	28548
16-#11	1.64	MA	28997	7582	45719	5635	49107	4592	49684	3804	48729	2683	57510	2223	29910
6L-4S		MI	28421	7582	44968	5620	48605	4566	49556	3783	49497	2668	58414	2299	28573
16-#11	1.64	MA	28537	7582	44874	5649	48088	4605	48431	3815	47047	2691	55222	2133	29441
7L-3S		MI	28944	7582	45865	5606	49749	4571	50946	3789	51279	2659	60430	2386	28556
16-#11	1.64	MA	28084	7582	44114	5646	47054	4601	47207	3827	45260	2683	53109	2085	29119
8L-2S		MI	29686	7582	46964	5610	51158	4559	52664	3778	53610	2651	63535	2472	28528
16-#14	2.37	MA	33128	7963	53529	5848	59097	4730	61838	3882	65117	2619	78448	2401	42860
2L-8S		MI	27087	7963	43634	5846	46678	4743	47191	3910	46086	2624	54862	1790	37416
16-#14	2.37	MA	32015	7963	51860	5844	56959	4748	59229	3898	61577	2631	73734	2277	42834
3L-7S		MI	27693	7963	44663	5852	48077	4751	48847	3895	48477	2637	57680	1857	38565
16-#14	2.37	MA	31231	7963	50498	5864	55222	4741	57118	3890	58872	2644	70673	2152	42744
4L-6S		MI	28308	7963	45807	5832	49457	4733	50543	3879	50726	2624	60717	1987	39100
16-#14	2.37	MA	30530	7963	49318	5859	53693	4759	55239	3906	56162	2631	67454	2094	42279
5E		MI	28939	7963	46852	5837	50903	4741	52310	3889	53028	2612	63559	2068	39959
16-#14	2.37	MA	29863	7963	48212	5855	52161	4753	53368	3897	53705	2644	64411	2013	41335
6L-4S		MI	29602	7963	47965	5842	52346	4723	54083	3874	55568	2624	66574	2125	40402
16-#14	2.37	MA	29212	7963	47000	5875	50700	4771	51570	3913	51305	2656	61161	1883	40742
7L-3S		MI	30342	7963	49250	5823	53984	4731	56073	3883	58103	2612	69431	2250	40476
16-#14	2.37	MA	28572	7963	45911	5870	49217	4764	49816	3929	48754	2644	58153	1815	39507
8L-2S		MI	31389	7963	50821	5828	55998	4713	58530	3868	61419	2599	73838	2374	40485
16-#18	4.21	MA	34275	8932	58368	6439	65114	5149	69114	4127	74883	2533	92144	1704	72350
4L-6S		MI	30230	8932	51575	6392	56565	5140	59133	4112	62126	2505	76440	1417	63828
16-#18	4.21	MA	33080	8932	56297	6429	62429	5179	65816	4153	70186	2511	86570	1604	70034
5E		MI	31306	8932	53409	6403	59102	5156	62232	4132	66105	2483	81322	1562	66082
16-#18	4.21	MA	31942	8932	54353	6419	59739	5164	62530	4134	65932	2533	81332	1459	67651
6L-4S		MI	32436	8932	55363	6414	61633	5127	65342	4108	70500	2505	86534	1660	68185
18-#11	1.85	MA	31848	7689	50597	5696	55445	4623	57422	3821	59207	2656	70710	2474	33824
2L-9S		MI	26728	7689	42273	5706	45108	4643	45256	3834	43597	2667	51330	1991	30373
18-#11	1.85	MA	31063	7689	49431	5694	53950	4636	55598	3833	56726	2665	67391	2388	33842
3L-8S		MI	27161	7689	43045	5692	46058	4631	46465	3840	45164	2659	53273	2045	30950

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

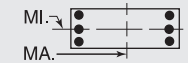
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.85	MA	30511	7689	48480	5708	52738	4632	54125	3827	54830	2673	65233	2302	33829
4L-7S		MI	27588	7689	43763	5695	47035	4635	47620	3829	46844	2667	55255	2093	31230
18-#11	1.85	MA	30017	7689	47657	5705	51671	4645	52814	3839	52931	2665	62973	2261	33778
5L-6S		MI	28021	7689	44561	5681	47998	4623	48804	3818	48425	2659	57395	2183	31636
18-#11	1.85	MA	29547	7689	46886	5702	50602	4640	51508	3833	51210	2674	60829	2205	33431
6L-5S		MI	28466	7689	45290	5685	49007	4627	50037	3824	50043	2650	59399	2239	31958
18-#11	1.85	MA	29089	7689	46040	5717	49583	4653	50254	3845	49529	2683	58541	2115	32983
7L-4S		MI	28933	7689	46066	5688	50014	4615	51274	3813	51828	2659	61519	2279	31997
18-#11	1.85	MA	28638	7689	45281	5714	48549	4649	49031	3857	47742	2674	56427	2066	32670
8L-3S		MI	29454	7689	46964	5674	51158	4620	52664	3819	53610	2650	63535	2366	31998
18-#11	1.85	MA	28178	7689	44463	5728	47543	4662	47751	3851	46075	2683	54349	2013	32044
9L-2S		MI	30193	7689	48063	5677	52566	4607	54382	3808	55941	2641	66640	2452	31977
18-#14	2.66	MA	32778	8119	53529	5941	59097	4818	61838	3941	65117	2618	78448	2248	48018
3L-8S		MI	27819	8119	45205	5944	48692	4813	49648	3952	49402	2610	59268	1759	42100
18-#14	2.66	MA	31999	8119	52166	5961	57361	4811	59727	3932	62411	2630	75387	2123	47903
4L-7S		MI	28422	8119	46234	5949	50091	4821	51304	3937	51794	2623	62087	1826	43227
18-#14	2.66	MA	31301	8119	50986	5957	55832	4829	57848	3948	59701	2618	72168	2065	47276
5L-6S		MI	29034	8119	47378	5929	51471	4803	53000	3922	54043	2610	65123	1956	43845
18-#14	2.66	MA	30637	8119	49880	5952	54300	4823	55977	3939	57245	2630	69126	1984	46376
6L-5S		MI	29662	8119	48423	5934	52917	4810	54767	3931	56344	2598	67965	2037	44662
18-#14	2.66	MA	29990	8119	48668	5972	52838	4841	54180	3955	54844	2643	65876	1854	45718
7L-4S		MI	30321	8119	49536	5940	54360	4793	56540	3916	58884	2610	70981	2094	45263
18-#14	2.66	MA	29353	8119	47579	5967	51355	4834	52425	3971	52293	2630	62867	1786	44489
8L-3S		MI	31057	8119	50821	5920	55998	4800	58530	3926	61419	2598	73838	2219	45360
18-#14	2.66	MA	28723	8119	46406	5988	49913	4852	50591	3962	49914	2643	59917	1708	43419
9L-2S		MI	32100	8119	52392	5925	58012	4783	60987	3910	64736	2585	78244	2343	45396
18-#18	4.74	MA	34386	9208	59214	6602	66169	5303	70378	4228	76316	2485	94698	1546	78795
5L-6S		MI	31461	9208	54319	6565	60083	5265	63425	4188	67860	2476	84021	1354	71883
18-#18	4.74	MA	33257	9208	57270	6592	63479	5288	67092	4210	72062	2507	89460	1401	76232
6L-5S		MI	32529	9208	56153	6576	62620	5280	66524	4208	71839	2454	88903	1500	74316
20-#11	2.05	MA	32387	7797	51763	5764	56940	4671	59246	3851	61689	2647	74029	2456	37477
2L-10S		MI	26795	7797	42656	5770	45553	4687	45825	3874	44375	2667	52554	1910	33187
20-#11	2.05	MA	31605	7797	50597	5761	55445	4684	57422	3862	59207	2656	70710	2369	37482
3L-9S		MI	27248	7797	43371	5774	46517	4692	46975	3863	45928	2658	54435	1971	33668
20-#11	2.05	MA	31054	7797	49646	5775	54233	4680	55949	3857	57311	2665	68552	2283	37455
4L-8S		MI	27678	7797	44144	5760	47467	4679	48183	3869	47495	2650	56378	2025	34297
20-#11	2.05	MA	30563	7797	48823	5773	53166	4693	54638	3868	55413	2656	66291	2242	37390
5L-7S		MI	28103	7797	44861	5763	48444	4684	49338	3858	49175	2658	58360	2073	34571
20-#11	2.05	MA	30095	7797	48052	5770	52097	4689	53332	3863	53692	2665	64148	2186	36959
6E		MI	28535	7797	45660	5749	49406	4671	50522	3847	50756	2650	60500	2163	34959
20-#11	2.05	MA	29638	7797	47207	5784	51078	4702	52078	3874	52010	2674	61860	2096	36529
7L-5S		MI	28977	7797	46388	5752	50415	4676	51755	3853	52374	2641	62504	2219	35363
20-#11	2.05	MA	29189	7797	46447	5781	50044	4698	50855	3886	50223	2666	59746	2048	36223
8L-4S		MI	29442	7797	47165	5755	51422	4663	52993	3842	54159	2650	64624	2259	35416
20-#11	2.05	MA	28733	7797	45629	5796	49038	4711	49575	3880	48557	2675	57668	1994	35545
9L-3S		MI	29962	7797	48063	5741	52566	4668	54382	3848	55941	2641	66640	2346	35435
20-#11	2.05	MA	28244	7797	44872	5793	48017	4706	48358	3892	46904	2684	55655	1933	35017
10L-2S		MI	30698	7797	49162	5744	53975	4655	56101	3837	58272	2632	69745	2432	35421
20-#14	2.96	MA	32761	8274	53834	6058	59500	4881	62336	3974	65951	2617	80102	2094	53057
4L-8S		MI	28547	8275	46776	6041	50706	4883	52105	3995	52719	2596	63675	1728	46793
20-#14	2.96	MA	32068	8274	52655	6054	57970	4899	60457	3990	63241	2605	76883	2037	52286
5L-7S		MI	29146	8275	47805	6046	52105	4890	53761	3979	55110	2609	66493	1795	47880
20-#14	2.96	MA	31407	8275	51548	6049	56439	4892	58586	3982	60784	2617	73840	1955	51425
6E		MI	29755	8275	48949	6026	53485	4873	55457	3964	57359	2596	69530	1925	48597

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.96	MA	30764	8275	50336	6069	54977	4911	56789	3998	58384	2630	70591	1825	50667
7L-5S		MI	30380	8275	49994	6032	54931	4880	57224	3974	59660	2584	72372	2006	49377
20-#14	2.96	MA	30130	8275	49247	6065	53494	4904	55034	4014	55833	2617	67582	1757	49480
8L-4S		MI	31036	8275	51107	6037	56374	4863	58997	3959	62201	2596	75387	2063	50118
20-#14	2.96	MA	29503	8275	48074	6085	52051	4922	53200	4005	53454	2630	64632	1679	48345
9L-3S		MI	31768	8275	52392	6017	58012	4870	60987	3968	64736	2584	78244	2188	50238
20-#18	5.26	MA	34562	9485	60188	6765	67219	5413	71654	4285	78193	2480	97587	1343	84838
6E		MI	32683	9485	57064	6738	63601	5389	67717	4263	73595	2447	91602	1292	79962
22-#11	2.26	MA	32143	7905	51763	5828	56940	4733	59246	3892	61689	2647	74029	2350	41116
3L-10S		MI	27313	7905	43755	5838	46961	4735	47544	3904	46706	2658	55659	1890	36500
22-#11	2.26	MA	31595	7905	50812	5843	55728	4729	57772	3886	59793	2656	71871	2264	41076
4L-9S		MI	27772	7905	44470	5841	47925	4740	48693	3893	48259	2649	57540	1951	36968
22-#11	2.26	MA	31106	7905	49989	5840	54661	4742	56461	3898	57894	2648	69610	2223	40998
5L-8S		MI	28192	7905	45243	5827	48875	4727	49901	3899	49826	2641	59483	2005	37593
22-#11	2.26	MA	30639	7905	49218	5837	53592	4737	55156	3892	56173	2657	67467	2167	40492
6L-7S		MI	28615	7905	45960	5830	49852	4732	51057	3888	51506	2649	61465	2053	37914
22-#11	2.26	MA	30185	7905	48373	5852	52573	4750	53902	3904	54492	2666	65179	2077	40078
7L-6S		MI	29045	7905	46758	5816	50815	4720	52241	3876	53087	2641	63605	2143	38288
22-#11	2.26	MA	29737	7905	47613	5849	51539	4746	52679	3915	52705	2657	63065	2029	39734
8L-5S		MI	29486	7905	47487	5819	51824	4724	53473	3883	54705	2632	65609	2199	38765
22-#11	2.26	MA	29285	7905	46795	5863	50533	4759	51399	3910	51038	2666	60987	1975	39051
9L-4S		MI	29949	7905	48264	5823	52831	4712	54711	3871	56490	2641	67729	2239	38830
22-#11	2.26	MA	28796	7905	46038	5860	49512	4755	50182	3921	49386	2675	58974	1914	38537
10L-3S		MI	30467	7905	49162	5809	53975	4716	56101	3878	58272	2632	69745	2326	38861
22-#14	3.26	MA	32830	8430	54323	6151	60109	4969	63067	4033	66780	2592	81598	2008	57305
5L-8S		MI	29270	8430	48347	6138	52720	4953	54562	4037	56035	2582	68082	1697	51495
22-#14	3.26	MA	32173	8430	53217	6146	58577	4962	61195	4024	64324	2604	78555	1926	56479
6L-7S		MI	29867	8430	49376	6143	54119	4960	56218	4022	58426	2594	70900	1764	52544
22-#14	3.26	MA	31532	8430	52005	6167	57116	4980	59398	4040	61923	2617	75305	1796	55628
7L-6S		MI	30473	8430	50520	6124	55499	4943	57914	4007	60675	2582	73937	1894	53354
22-#14	3.26	MA	30902	8430	50915	6162	55633	4974	57643	4056	59372	2604	72296	1728	54479
8L-5S		MI	31094	8430	51565	6129	56945	4950	59681	4016	62977	2570	76779	1976	54101
22-#14	3.26	MA	30278	8430	49743	6182	54190	4992	55809	4047	56993	2617	69346	1650	53282
9L-4S		MI	31747	8430	52678	6134	58388	4933	61454	4001	65517	2582	79794	2032	54968
24-#11	2.46	MA	32134	8013	51979	5910	57223	4777	59596	3915	62274	2648	75190	2245	44695
4L-10S		MI	27828	8013	44854	5905	48370	4784	49262	3933	49037	2649	58764	1870	39772
24-#11	2.46	MA	31646	8013	51156	5907	56156	4790	58285	3927	60376	2639	72929	2205	44603
5L-9S		MI	28286	8013	45569	5909	49334	4788	50412	3922	50591	2640	60645	1931	40273
24-#11	2.46	MA	31181	8013	50384	5905	55088	4786	56979	3921	58655	2648	70785	2148	44030
6L-8S		MI	28704	8013	46342	5895	50284	4776	51620	3928	52157	2632	62588	1985	40878
24-#11	2.46	MA	30729	8013	49539	5919	54068	4799	55726	3933	56973	2657	68497	2058	43630
7E		MI	29125	8013	47059	5898	51261	4781	52775	3917	53838	2640	64570	2033	41260
24-#11	2.46	MA	30283	8013	48779	5916	53034	4795	54502	3945	55186	2649	66384	2010	43225
8L-6S		MI	29554	8013	47857	5884	52224	4768	53959	3906	55419	2632	66710	2123	41620
24-#11	2.46	MA	29841	8013	47962	5930	52028	4808	53223	3939	53520	2657	64305	1956	42562
9L-5S		MI	29993	8013	48586	5887	53232	4773	55192	3912	57036	2623	68714	2179	42163
24-#11	2.46	MA	29346	8013	47204	5928	51007	4803	52006	3951	51867	2666	62292	1895	42024
10L-4S		MI	30455	8013	49363	5890	54240	4760	56429	3901	58821	2632	70834	2219	42241
24-#14	3.55	MA	32934	8586	54885	6244	60716	5032	63804	4066	67863	2591	83269	1898	61539
6L-8S		MI	29990	8586	49918	6235	54734	5023	57018	4079	59352	2568	72488	1666	56203
24-#14	3.55	MA	32297	8586	53673	6264	59254	5050	62007	4082	65463	2604	80020	1768	60598
7E		MI	30583	8586	50947	6241	56133	5030	58675	4064	61743	2580	75306	1733	57218
24-#14	3.55	MA	31670	8586	52584	6259	57771	5043	60252	4098	62912	2591	77011	1699	59485
8L-6S		MI	31186	8586	52091	6221	57513	5013	60371	4049	63992	2568	78343	1863	58117
24-#14	3.55	MA	31049	8586	51411	6280	56329	5062	58418	4090	60533	2604	74061	1621	58227
9L-5S		MI	31805	8586	53136	6226	58959	5020	62137	4059	66293	2556	81185	1945	58834

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

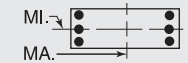
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
4-#18	1.00	MA	32560	7608	50563	5650	54212	4612	54785	3858	53551	2799	62142	2645	20522
2E		MI	29379	7608	45814	5606	48906	4575	49309	3826	47946	2767	55445	2606	18456
6-#18	1.50	MA	33997	7884	53653	5823	58173	4737	59618	3933	60077	2774	70816	2591	30286
2L-3S		MI	28791	7884	45814	5767	48906	4728	49309	3926	47946	2761	55445	2323	27269
6-#18	1.50	MA	31909	7884	50563	5814	54212	4768	54785	3960	53551	2797	62142	2369	30373
3L-2S		MI	30642	7884	48558	5778	52424	4700	53601	3902	53681	2739	63027	2544	27159
8-#14	1.13	MA	33007	7677	51278	5732	55347	4675	56253	3903	55677	2820	65114	2666	23119
2L-4S		MI	27956	7677	43593	5706	46285	4652	46199	3880	44046	2816	50877	2380	20913
8-#14	1.13	MA	31803	7677	49512	5728	53084	4694	53492	3920	51920	2833	60091	2542	23187
3E		MI	28712	7677	44879	5686	47922	4659	48189	3890	46581	2804	53734	2505	20848
8-#14	1.13	MA	30956	7677	48072	5749	51248	4688	51261	3912	49050	2845	56825	2417	23233
4L-2S		MI	29781	7677	46450	5691	49936	4642	50646	3875	49898	2791	58140	2629	20775
8-#18	2.01	MA	35418	8161	56743	5996	62134	4861	64450	4008	66604	2750	79491	2536	39996
2L-4S		MI	28749	8161	46306	5973	49555	4837	50115	3981	49298	2754	58127	2039	35663
8-#18	2.01	MA	33347	8161	53653	5987	58173	4892	59618	4036	60077	2772	70816	2314	39997
3E		MI	30054	8161	48558	5940	52424	4852	53601	4001	53681	2732	63027	2260	35847
8-#18	2.01	MA	31884	8161	51126	6022	54952	4879	55704	4019	55089	2794	65192	2093	39717
4L-2S		MI	31891	8161	51302	5951	55942	4824	57892	3977	59415	2710	70608	2482	35803
10-#14	1.41	MA	33835	7832	53043	5829	57610	4745	59014	3946	59434	2807	70136	2639	28681
2L-5S		MI	28020	7832	44051	5798	46855	4739	46883	3938	44822	2790	52268	2292	25787
10-#14	1.41	MA	32638	7832	51278	5825	55347	4764	56253	3963	55677	2820	65114	2514	28731
3L-4S		MI	28695	7832	45164	5803	48299	4721	48656	3923	47363	2802	55284	2349	25835
10-#14	1.41	MA	31795	7832	49838	5846	53512	4758	54023	3954	52806	2833	61848	2390	28739
4L-3S		MI	29447	7832	46450	5783	49936	4729	50646	3933	49898	2790	58140	2474	25797
10-#14	1.41	MA	31042	7832	48592	5842	51896	4776	52038	3971	49932	2821	58426	2331	28644
5L-2S		MI	30511	7832	48021	5789	51950	4711	53103	3917	53214	2777	62547	2598	25738
10-#18	2.51	MA	36824	8438	59833	6169	66095	4985	69282	4084	73131	2725	88165	2481	49675
2L-5S		MI	28849	8438	47097	6135	50542	4990	51297	4081	50638	2703	60496	1879	41839
10-#18	2.51	MA	34768	8438	56743	6160	62134	5016	64450	4111	66604	2747	79491	2260	49585
3L-4S		MI	30010	8438	49050	6146	53073	4961	54406	4057	55033	2725	65708	1977	44101
10-#18	2.51	MA	33319	8438	54216	6195	58914	5003	60536	4094	61616	2769	73866	2038	49209
4L-3S		MI	31304	8438	51302	6113	55942	4977	57892	4077	59415	2703	70608	2198	44377
10-#18	2.51	MA	32022	8438	52027	6186	56076	5034	57050	4121	56617	2747	67932	1937	46614
5L-2S		MI	33128	8438	54046	6124	59460	4948	62184	4052	65150	2681	78189	2419	44411
12-#11	1.17	MA	33185	7702	51531	5767	55783	4702	56827	3924	56476	2828	66333	2679	24096
2L-6S		MI	27743	7702	43173	5733	45766	4686	45594	3907	43180	2822	50015	2375	21749
12-#11	1.17	MA	32344	7702	50297	5765	54201	4698	54898	3936	53851	2838	62800	2593	24137
3L-5S		MI	28194	7702	43902	5736	46775	4691	46827	3913	44797	2813	52019	2431	21764
12-#11	1.17	MA	31753	7702	49292	5779	52921	4712	53341	3931	51847	2847	60501	2507	24170
4E		MI	28667	7702	44679	5739	47782	4678	48065	3902	46582	2822	54138	2471	21736
12-#11	1.17	MA	31225	7702	48423	5777	51794	4708	51957	3943	49842	2839	58099	2465	24176
5L-3S		MI	29195	7702	45576	5725	48926	4683	49455	3908	48364	2813	56154	2558	21694
12-#11	1.17	MA	30722	7702	47609	5774	50666	4721	50578	3938	48025	2849	55816	2409	24128
6L-2S		MI	29942	7702	46675	5728	50335	4670	51173	3897	50696	2805	59259	2644	21649
12-#14	1.69	MA	34658	7988	54809	5927	59874	4815	61775	3988	63190	2795	75159	2612	34227
2L-6S		MI	28119	7988	44578	5890	47424	4801	47573	3971	45838	2788	53833	2180	29842
12-#14	1.69	MA	33466	7988	53043	5923	57610	4834	59014	4005	59434	2808	70136	2487	34262
3L-5S		MI	28758	7988	45622	5895	48869	4809	49339	3981	48139	2776	56675	2261	30647
12-#14	1.69	MA	32628	7988	51603	5943	55775	4827	56784	3997	56563	2820	66871	2363	34228
4E		MI	29429	7988	46735	5900	50313	4791	51113	3965	50679	2788	59690	2318	30730
12-#14	1.69	MA	31879	7988	50357	5939	54160	4846	54799	4014	53689	2808	63449	2304	34095
5L-3S		MI	30177	7988	48021	5881	51950	4799	53103	3975	53214	2776	62547	2443	30728

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.69	MA	31166	7988	49189	5935	52542	4840	52822	4006	51083	2821	60205	2223	33146
6L-2S		MI	31236	7988	49592	5886	53964	4781	55560	3960	56531	2763	66954	2567	30684
12-#18	3.01	MA	38216	8714	62923	6342	70057	5109	74115	4159	79657	2700	96840	2427	59306
2L-6S		MI	29011	8714	48007	6297	51523	5098	52489	4137	52393	2697	63195	1671	48361
12-#18	3.01	MA	36176	8714	59833	6333	66095	5140	69282	4187	73131	2722	88165	2205	59150
3L-5S		MI	30107	8714	49841	6308	54060	5114	55588	4156	56373	2675	68077	1817	50001
12-#18	3.01	MA	34738	8714	57306	6368	62875	5127	65369	4170	68142	2744	82541	1984	58690
4E		MI	31258	8714	51794	6319	56591	5085	58698	4132	60767	2697	73290	1914	52443
12-#18	3.01	MA	33452	8714	55117	6359	60037	5158	61882	4197	63143	2722	76606	1882	55828
5L-3S		MI	32542	8714	54046	6286	59460	5101	62184	4152	65150	2675	78189	2136	52880
12-#18	3.01	MA	32228	8714	53063	6350	57194	5145	58409	4180	58614	2744	71011	1738	53956
6L-2S		MI	34353	8714	56790	6297	62978	5072	66476	4128	70884	2653	85771	2357	52989
14-#11	1.37	MA	33766	7810	52764	5835	57364	4751	58757	3953	59101	2820	69865	2662	27977
2L-7S		MI	27827	7810	43474	5814	46212	4747	46129	3947	43930	2822	50979	2265	24709
14-#11	1.37	MA	32928	7810	51531	5832	55783	4747	56827	3965	56476	2829	66333	2575	28010
3L-6S		MI	28265	7810	44272	5800	47175	4734	47313	3936	45511	2813	53120	2355	25158
14-#11	1.37	MA	32340	7810	50526	5847	54502	4760	55271	3960	54472	2838	64033	2489	28032
4L-5S		MI	28713	7810	45001	5803	48184	4739	48546	3942	47129	2804	55124	2411	25194
14-#11	1.37	MA	31814	7810	49657	5844	53376	4756	53886	3972	52467	2831	61631	2448	28015
5L-4S		MI	29184	7810	45778	5806	49191	4727	49783	3931	48914	2813	57243	2451	25185
14-#11	1.37	MA	31313	7810	48843	5842	52248	4770	52507	3967	50650	2840	59348	2392	27946
6L-3S		MI	29710	7810	46675	5792	50335	4731	51173	3937	50696	2804	59259	2537	25153
14-#11	1.37	MA	30825	7810	47950	5856	51171	4766	51184	3979	48875	2850	56913	2302	27406
7L-2S		MI	30455	7810	47774	5796	51743	4719	52892	3926	53027	2796	62364	2624	25115
14-#14	1.97	MA	35475	8144	56574	6024	62137	4885	64536	4031	66947	2782	80182	2585	39761
2L-7S		MI	28235	8144	45005	6007	48058	4889	48334	4029	46905	2786	55203	2019	34009
14-#14	1.97	MA	34289	8144	54809	6020	59874	4903	61775	4047	63190	2795	75159	2460	39769
3L-6S		MI	28854	8144	46149	5987	49438	4871	50030	4013	49154	2774	58239	2149	34567
14-#14	1.97	MA	33456	8144	53369	6041	58038	4897	59545	4039	60320	2808	71894	2336	39705
4L-5S		MI	29490	8144	47193	5992	50883	4879	51796	4023	51455	2761	61081	2230	35498
14-#14	1.97	MA	32710	8144	52123	6036	56423	4916	57560	4056	57445	2796	68472	2277	39539
5L-4S		MI	30158	8144	48306	5998	52327	4861	53569	4008	53996	2774	64097	2287	35613
14-#14	1.97	MA	32001	8144	50955	6032	54805	4910	55583	4048	54840	2809	65228	2196	38462
6L-3S		MI	30903	8144	49592	5978	53964	4868	55560	4017	56531	2761	66954	2412	35647
14-#14	1.97	MA	31310	8144	49675	6053	53262	4929	53685	4065	52294	2821	61765	2066	37784
7L-2S		MI	31957	8144	51163	5983	55978	4851	58017	4002	59847	2749	71360	2536	35618
14-#18	3.51	MA	37571	8991	62923	6506	70057	5264	74115	4262	79657	2697	96840	2151	68699
3L-6S		MI	30265	8991	50751	6469	55041	5222	56781	4212	58128	2668	70777	1609	56350
14-#18	3.51	MA	36144	8991	60396	6541	66836	5251	70201	4245	74669	2719	91215	1929	67819
4L-5S		MI	31353	8991	52585	6481	57578	5238	59880	4232	62107	2646	75658	1754	58191
14-#18	3.51	MA	34869	8991	58207	6532	63998	5283	66715	4272	69670	2697	85281	1828	65071
5L-4S		MI	32495	8991	54539	6492	60109	5209	62990	4208	66502	2668	80871	1852	60486
14-#18	3.51	MA	33655	8991	56153	6523	61156	5269	63241	4255	65141	2719	79686	1683	62999
6L-3S		MI	33770	8991	56790	6459	62978	5225	66476	4228	70884	2646	85771	2073	61366
14-#18	3.51	MA	32474	8991	53903	6558	58442	5301	59906	4283	60715	2742	73708	1452	60160
7L-2S		MI	35568	8991	59535	6470	66496	5196	70767	4203	76619	2624	93352	2295	61532
16-#11	1.56	MA	34345	7917	53998	5902	58946	4799	60686	3983	61726	2811	73398	2644	31851
2L-8S		MI	27918	7917	43855	5878	46644	4791	46692	3988	44581	2804	52103	2197	27753
16-#11	1.56	MA	33510	7917	52764	5899	57364	4795	58757	3995	59101	2820	69865	2558	31877
3L-7S		MI	28347	7917	44573	5881	47621	4795	47848	3976	46261	2813	54084	2245	28041
16-#11	1.56	MA	32924	7917	51759	5914	56084	4809	57200	3989	57097	2830	67566	2472	31882
4L-6S		MI	28783	7917	45371	5867	48584	4783	49031	3965	47842	2804	56225	2335	28477
16-#11	1.56	MA	32400	7917	50891	5912	54957	4805	55816	4002	55092	2822	65164	2430	31847
5E		MI	29230	7917	46099	5871	49592	4788	50264	3971	49460	2795	58229	2391	28615
16-#11	1.56	MA	31901	7917	50076	5909	53829	4818	54437	3996	53275	2832	62881	2374	31672
6L-4S		MI	29700	7917	46876	5874	50600	4775	51502	3960	51245	2804	60348	2431	28626
16-#11	1.56	MA	31415	7917	49184	5924	52753	4814	53114	4009	51500	2841	60445	2284	31148
7L-3S		MI	30224	7917	47774	5860	51743	4780	52892	3966	53027	2795	62364	2517	28604

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

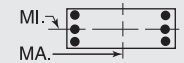
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.56	MA	30937	7917	48382	5921	51661	4828	51822	4021	49613	2833	58199	2236	30793
8L-2S		MI	30966	7917	48873	5863	53152	4767	54610	3955	55358	2787	65469	2604	28573
16-#14	2.26	MA	36288	8299	58340	6121	64400	4954	67298	4073	70704	2770	85205	2558	45290
2L-8S		MI	28362	8299	45547	6099	48672	4951	49134	4086	47830	2760	56791	1921	37736
16-#14	2.26	MA	35107	8299	56574	6117	62137	4973	64536	4090	66947	2783	80182	2433	45264
3L-7S		MI	28969	8299	46576	6104	50072	4958	50791	4071	50221	2772	59609	1988	38767
16-#14	2.26	MA	34278	8299	55134	6138	60302	4967	62306	4082	64077	2796	76916	2309	45174
4L-6S		MI	29586	8299	47720	6084	51452	4941	52487	4056	52470	2760	62646	2118	39303
16-#14	2.26	MA	33537	8299	53888	6134	58686	4986	60321	4098	61202	2783	73494	2250	44847
5E		MI	30218	8299	48764	6090	52897	4948	54253	4065	54772	2747	65488	2199	40185
16-#14	2.26	MA	32831	8299	52720	6130	57069	4980	58344	4090	58597	2796	70250	2169	43790
6L-4S		MI	30882	8299	49878	6095	54341	4931	56026	4050	57312	2760	68503	2256	40486
16-#14	2.26	MA	32143	8299	51441	6150	55525	4998	56446	4107	56051	2809	66788	2039	43137
7L-3S		MI	31624	8299	51163	6075	55978	4938	58017	4060	59847	2747	71360	2381	40545
16-#14	2.26	MA	31466	8299	50291	6146	53959	4992	54594	4124	53345	2797	63588	1970	41947
8L-2S		MI	32673	8299	52734	6080	57992	4921	60473	4045	63163	2735	75767	2505	40542
16-#18	4.01	MA	37538	9267	63486	6714	70797	5375	75034	4320	81196	2695	99890	1875	76943
4L-6S		MI	31509	9267	53496	6642	58559	5347	61073	4287	63863	2639	78358	1547	64370
16-#18	4.01	MA	36273	9267	61297	6705	67959	5407	71547	4348	76197	2673	93955	1773	74338
5E		MI	32588	9267	55329	6654	61096	5362	64172	4307	67842	2617	83240	1692	66405
16-#18	4.01	MA	35069	9267	59243	6696	65117	5394	68074	4331	71667	2695	88360	1629	72073
6L-4S		MI	33722	9267	57283	6665	63627	5333	67281	4283	72237	2639	88452	1790	68568
16-#18	4.01	MA	33897	9267	56993	6731	62403	5425	64738	4358	67241	2717	82382	1397	69345
7L-3S		MI	34987	9267	59535	6632	66496	5349	70767	4303	76619	2617	93352	2011	69838
18-#11	1.76	MA	34921	8025	55231	5969	60527	4847	62615	4012	64351	2802	76931	2627	35720
2L-9S		MI	28004	8025	44181	5960	47103	4852	47202	4011	45345	2803	53265	2123	30608
18-#11	1.76	MA	34089	8025	53998	5967	58946	4844	60686	4024	61726	2812	73398	2540	35737
3L-8S		MI	28438	8025	44954	5946	48053	4839	48410	4017	46912	2795	55208	2177	31099
18-#11	1.76	MA	33505	8025	52993	5982	57665	4857	59129	4019	59722	2821	71099	2454	35724
4L-7S		MI	28865	8025	45671	5949	49029	4844	49566	4006	48592	2803	57189	2224	31378
18-#11	1.76	MA	32983	8025	52124	5979	56539	4853	57745	4031	57717	2813	68697	2413	35673
5L-6S		MI	29299	8025	46470	5935	49992	4831	50750	3995	50173	2795	59330	2315	31793
18-#11	1.76	MA	32486	8025	51310	5977	55410	4867	56366	4026	55900	2823	66414	2357	35397
6L-5S		MI	29745	8025	47198	5938	51001	4836	51982	4001	51791	2786	61334	2371	32029
18-#11	1.76	MA	32002	8025	50418	5991	54334	4863	55043	4038	54125	2832	63978	2267	34895
7L-4S		MI	30212	8025	47975	5941	52008	4823	53220	3990	53576	2795	63454	2411	32061
18-#11	1.76	MA	31526	8025	49616	5989	53243	4876	53751	4050	52238	2825	61732	2218	34551
8L-3S		MI	30734	8025	48873	5927	53152	4828	54610	3996	55358	2786	65469	2497	32049
18-#11	1.76	MA	31038	8025	48753	6003	52181	4872	52401	4045	50479	2834	59518	2164	33970
9L-2S		MI	31475	8025	49971	5931	54561	4815	56328	3985	57689	2778	68574	2584	32024
18-#14	2.54	MA	35920	8455	58340	6214	64400	5043	67298	4132	70704	2770	85205	2406	50752
3L-8S		MI	29095	8455	47118	6196	50686	5021	51591	4129	51147	2746	61198	1890	42417
18-#14	2.54	MA	35095	8455	56900	6235	62565	5037	65067	4124	67833	2783	81939	2282	50637
4L-7S		MI	29699	8455	48147	6201	52086	5028	53248	4113	53538	2758	64016	1957	43530
18-#14	2.54	MA	34357	8455	55654	6231	60950	5056	63082	4141	64959	2771	78517	2223	50136
5L-6S		MI	30313	8455	49291	6182	53466	5011	54944	4098	55787	2746	67053	2087	44047
18-#14	2.54	MA	33656	8455	54486	6227	59332	5050	61105	4133	62354	2784	75273	2142	49128
6L-5S		MI	30942	8455	50335	6187	54911	5018	56710	4108	58088	2733	69895	2169	44886
18-#14	2.54	MA	32972	8455	53206	6248	57788	5068	59207	4149	59807	2797	71811	2012	48496
7L-4S		MI	31603	8455	51449	6192	56355	5001	58483	4093	60629	2746	72910	2225	45352
18-#14	2.54	MA	32298	8455	52056	6243	56223	5062	57355	4166	57102	2784	68611	1943	47224
8L-3S		MI	32341	8455	52734	6172	57992	5008	60473	4102	63163	2733	75767	2350	45434
18-#14	2.54	MA	31632	8455	50818	6264	54699	5081	55418	4158	54579	2797	65466	1865	46224
9L-2S		MI	33386	8455	54305	6178	60006	4991	62930	4087	66480	2721	80173	2475	45460

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

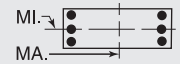


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	4.51	MA	37665	9544	64387	6878	71921	5531	76380	4423	82723	2648	102630	1719	83625
5L-6S		MI	32742	9544	56240	6815	62077	5471	65364	4363	69597	2611	85939	1484	72418
18-#18	4.51	MA	36471	9544	62333	6869	69078	5518	72906	4406	78194	2670	97035	1574	81174
6L-5S		MI	33814	9544	58074	6826	64614	5486	68463	4383	73576	2589	90821	1630	74637
18-#18	4.51	MA	35308	9544	60083	6904	66364	5549	69571	4433	73768	2692	91057	1343	78548
7L-4S		MI	34939	9544	60027	6838	67145	5458	71573	4358	77971	2611	96034	1727	76683
20-#11	1.95	MA	35494	8133	56465	6037	62109	4896	64545	4041	66976	2794	80463	2609	39583
2L-10S		MI	28071	8133	44565	6024	47547	4896	47771	4051	46123	2803	54488	2042	33415
20-#11	1.95	MA	34665	8133	55231	6034	60527	4892	62615	4053	64351	2803	76931	2523	39588
3L-9S		MI	28524	8133	45280	6027	48511	4900	48921	4040	47676	2794	56370	2103	33902
20-#11	1.95	MA	34083	8133	54227	6049	59247	4905	61059	4048	62347	2813	74631	2437	39561
4L-8S		MI	28955	8133	46053	6013	49461	4888	50129	4046	49243	2786	58313	2157	34448
20-#11	1.95	MA	33563	8133	53358	6046	58120	4902	59674	4060	60342	2805	72229	2395	39496
5L-7S		MI	29381	8133	46770	6016	50438	4892	51284	4035	50923	2794	60294	2204	34719
20-#11	1.95	MA	33069	8133	52544	6044	56992	4915	58295	4055	58525	2814	69946	2339	39129
6E		MI	29813	8133	47568	6002	51401	4880	52468	4024	52504	2786	62435	2295	35115
20-#11	1.95	MA	32587	8133	51651	6059	55916	4911	56972	4067	56750	2824	67510	2249	38647
7L-5S		MI	30257	8133	48297	6006	52410	4884	53701	4030	54122	2777	64439	2351	35439
20-#11	1.95	MA	32112	8133	50850	6056	54824	4925	55681	4079	54863	2816	65264	2200	38311
8L-4S		MI	30723	8133	49074	6009	53417	4872	54938	4019	55907	2786	66559	2391	35480
20-#11	1.95	MA	31627	8133	49986	6071	53762	4921	54330	4074	53104	2826	63051	2147	37676
9L-3S		MI	31243	8133	49971	5995	54561	4876	56328	4025	57689	2777	68574	2477	35489
20-#11	1.95	MA	31103	8133	49187	6068	52685	4934	53045	4086	51359	2835	60906	2086	37095
10L-2S		MI	31981	8133	51070	5998	55969	4864	58047	4014	60020	2769	71679	2564	35471
20-#14	2.82	MA	35907	8610	58665	6332	64828	5107	67828	4167	71590	2771	86962	2255	56095
4L-8S		MI	29824	8610	48689	6293	52700	5091	54048	4171	54463	2732	65604	1859	47108
20-#14	2.82	MA	35173	8610	57419	6328	63213	5126	65843	4183	68716	2759	83540	2196	55439
5L-7S		MI	30425	8610	49718	6299	54100	5098	55704	4156	56854	2744	68422	1926	48223
20-#14	2.82	MA	34475	8610	56251	6324	61595	5119	63866	4175	66110	2771	80296	2115	54473
6E		MI	31035	8610	50862	6279	55480	5081	57401	4141	59103	2732	71459	2056	48799
20-#14	2.82	MA	33795	8610	54972	6345	60052	5138	61968	4192	63564	2784	76833	1985	53831
7L-5S		MI	31662	8610	51906	6284	56925	5088	59167	4150	61405	2719	74301	2138	49599
20-#14	2.82	MA	33125	8610	53822	6341	58486	5132	60116	4209	60859	2772	73634	1916	52510
8L-4S		MI	32319	8610	53020	6289	58369	5071	60940	4135	63945	2732	77317	2194	50212
20-#14	2.82	MA	32462	8610	52583	6361	56963	5151	58179	4201	58336	2785	70489	1838	51444
9L-3S		MI	33054	8610	54305	6270	60006	5078	62930	4145	66480	2719	80173	2319	50315
20-#18	5.01	MA	37861	9821	65423	7041	73039	5642	77738	4481	84721	2645	105709	1519	90300
6E		MI	33966	9821	58984	6988	65595	5595	69656	4438	75332	2582	93521	1422	80490
20-#18	5.01	MA	36707	9821	63173	7077	70326	5673	74403	4509	80295	2667	99731	1288	87770
7L-5S		MI	35030	9821	60818	6999	68131	5610	72755	4458	79311	2560	98402	1567	82884
22-#11	2.15	MA	35238	8241	56465	6102	62109	4940	64545	4083	66976	2795	80463	2505	43432
3L-10S		MI	28589	8241	45664	6091	48956	4944	49489	4081	48454	2794	57593	2022	36728
22-#11	2.15	MA	34659	8241	55460	6116	60828	4954	62988	4078	64972	2804	78164	2419	43393
4L-9S		MI	29042	8241	46379	6095	49920	4949	50639	4070	50007	2785	59475	2083	37201
22-#11	2.15	MA	34141	8241	54592	6114	59702	4950	61604	4090	62967	2796	75762	2378	43314
5L-8S		MI	29469	8241	47151	6081	50870	4936	51847	4076	51574	2777	61418	2137	37798
22-#11	2.15	MA	33648	8241	53777	6111	58573	4963	60225	4085	61150	2806	73479	2322	42866
6L-7S		MI	29894	8241	47869	6084	51847	4941	53003	4065	53254	2785	63399	2184	38063
22-#11	2.15	MA	33168	8241	52885	6126	57497	4960	58901	4097	59375	2815	71043	2232	42403
7L-6S		MI	30325	8241	48667	6070	52809	4928	54186	4054	54835	2777	65540	2275	38444
22-#11	2.15	MA	32695	8241	52083	6124	56406	4973	57610	4109	57488	2807	68797	2183	42074
8L-5S		MI	30767	8241	49396	6073	53818	4933	55419	4060	56453	2768	67544	2331	38844
22-#11	2.15	MA	32213	8241	51220	6138	55344	4969	56259	4104	55729	2817	66583	2129	41387
9L-4S		MI	31231	8241	50173	6076	54825	4920	56657	4049	58238	2777	69664	2371	38898
22-#11	2.15	MA	31691	8241	50421	6136	54267	4983	54974	4116	53984	2826	64439	2068	40821
10L-3S		MI	31749	8241	51070	6062	55969	4925	58047	4055	60020	2768	71679	2457	38924
22-#11	2.15	MA	31181	8241	49635	6133	53210	4979	53641	4111	52124	2819	62249	2017	40046
11L-2S		MI	32485	8241	52169	6065	57378	4912	59765	4044	62351	2760	74784	2544	38913

RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	3.10	MA	35985	8766	59185	6425	65476	5195	68604	4226	72472	2746	88563	2169	60752
5L-8S		MI	30548	8766	50260	6391	54714	5161	56505	4213	57780	2718	70011	1828	51807
22-#14	3.10	MA	35290	8766	58017	6421	63859	5189	66627	4218	69867	2759	85319	2088	59825
6L-7S		MI	31147	8766	51289	6396	56114	5168	58161	4198	60171	2730	72829	1895	52883
22-#14	3.10	MA	34613	8766	56737	6442	62315	5208	64730	4234	67321	2772	81856	1958	59084
7L-6S		MI	31754	8766	52433	6376	57494	5150	59858	4183	62420	2718	75866	2025	53557
22-#14	3.10	MA	33947	8766	55587	6438	60749	5202	62877	4251	64615	2760	78657	1889	57804
8L-5S		MI	32377	8766	53477	6381	58939	5158	61624	4193	64721	2705	78708	2107	54322
22-#14	3.10	MA	33285	8766	54349	6459	59226	5221	60940	4243	62092	2772	75511	1811	56674
9L-4S		MI	33032	8766	54591	6387	60383	5140	63397	4177	67262	2718	81723	2164	55067
22-#18	5.51	MA	38096	10097	66263	7249	74287	5797	79235	4584	86822	2642	108406	1233	96946
7L-6S		MI	35182	10097	61728	7161	69113	5719	73948	4514	81066	2553	101102	1360	88585
24-#11	2.35	MA	35232	8349	56694	6184	62410	5002	64917	4107	67597	2795	81696	2402	47222
4L-10S		MI	29105	8349	46762	6159	50365	4992	51208	4110	50785	2785	60698	2002	40044
24-#11	2.35	MA	34716	8349	55825	6181	61283	4998	63533	4119	65592	2788	79294	2360	47131
5L-9S		MI	29563	8349	47478	6162	51328	4997	52357	4099	52339	2776	62580	2063	40504
24-#11	2.35	MA	34225	8349	55011	6179	60155	5012	62154	4114	63775	2797	77011	2304	46609
6L-8S		MI	29982	8349	48250	6148	52278	4984	53566	4105	53905	2768	64523	2117	41124
24-#11	2.35	MA	33747	8349	54119	6194	59079	5008	60831	4126	62000	2807	74576	2214	46161
7E		MI	30405	8349	48968	6151	53255	4989	54721	4094	55586	2776	66504	2164	41409
24-#11	2.35	MA	33276	8349	53317	6191	57987	5021	59539	4138	60113	2799	72330	2165	45839
8L-6S		MI	30834	8349	49766	6137	54218	4977	55905	4083	57167	2768	68645	2254	41776
24-#11	2.35	MA	32796	8349	52454	6206	56925	5018	58188	4133	58354	2808	70116	2112	45103
9L-5S		MI	31275	8349	50495	6140	55227	4981	57138	4089	58784	2759	70649	2311	42246
24-#11	2.35	MA	32276	8349	51655	6203	55848	5031	56904	4145	56609	2818	67971	2051	44551
10L-4S		MI	31737	8349	51272	6144	56234	4969	58375	4078	60569	2768	72769	2351	42312
24-#11	2.35	MA	31768	8349	50869	6201	54792	5027	55570	4140	54749	2810	65782	1999	43738
11L-3S		MI	32254	8349	52169	6130	57378	4973	59765	4084	62351	2759	74784	2437	42345
24-#14	3.38	MA	36101	8922	59782	6519	66122	5259	69389	4260	73624	2746	90341	2061	65182
6L-8S		MI	31269	8922	51831	6488	56728	5230	58962	4256	61096	2704	74417	1797	56513
24-#14	3.38	MA	35427	8922	58503	6539	64578	5278	67491	4277	71078	2759	86879	1931	64347
7E		MI	31865	8922	52860	6493	58128	5238	60618	4241	63487	2716	77236	1864	57554
24-#14	3.38	MA	34764	8922	57353	6535	63013	5272	65638	4293	68372	2747	83680	1861	63106
8L-6S		MI	32469	8922	54004	6473	59508	5220	62315	4225	65736	2704	80272	1994	58320
24-#14	3.38	MA	34103	8922	56114	6556	61489	5290	63701	4285	65849	2760	80534	1784	61913
9L-5S		MI	33090	8922	55048	6479	60953	5228	64081	4235	68038	2691	83114	2076	59053

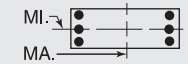
RECTANGULAR TIED COLUMNS 38" x 44"

6-#18	1.44	MA	37158	8220	58408	6096	63354	4961	64877	4124	65300	2926	76954	2742	31906
2L-3S		MI	30069	8220	47734	6018	50900	4934	51249	4101	49683	2895	57364	2453	27333
6-#18	1.44	MA	34948	8220	55145	6088	59171	4993	59775	4152	58377	2948	67732	2521	31993
3L-2S		MI	31922	8220	50478	6029	54418	4906	55540	4077	55418	2873	64945	2674	27213
8-#14	1.08	MA	36101	8013	55891	6005	60360	4900	61313	4094	60544	2966	70853	2814	24334
2L-4S		MI	29233	8013	45506	5958	48279	4859	48142	4057	45791	2952	52806	2511	20964
8-#14	1.08	MA	34829	8013	54028	6001	57972	4894	58399	4112	56581	2980	65521	2690	24402
3E		MI	29990	8013	46791	5939	49917	4867	50132	4067	48326	2939	55663	2636	20892
8-#14	1.08	MA	33935	8013	52511	6023	56038	4913	56049	4104	53556	2994	62051	2565	24448
4L-2S		MI	31059	8013	48362	5944	51931	4849	52589	4051	51642	2927	60070	2760	20816
8-#18	1.91	MA	38667	8497	61670	6269	67537	5085	69980	4199	72224	2903	86175	2691	42156
2L-4S		MI	30026	8497	48226	6224	51549	5043	52054	4156	51035	2889	60045	2169	35782
8-#18	1.91	MA	36475	8497	58408	6261	63354	5118	64877	4228	65300	2925	76954	2469	42157
3E		MI	31333	8497	50478	6191	54418	5058	55540	4176	55418	2867	64945	2390	35927

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

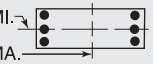


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#18	1.91	MA	34931	8497	55743	6297	59958	5106	60750	4212	60008	2947	70966	2248	41877
4L-2S		MI	33173	8497	53222	6202	57936	5030	59832	4152	61152	2844	72526	2612	35865
10-#14	1.35	MA	36980	8168	57754	6102	62748	4970	64226	4137	64508	2954	76184	2789	30200
2L-5S		MI	29297	8168	45964	6050	48850	4947	48826	4115	46567	2925	54197	2423	25868
10-#14	1.35	MA	35714	8168	55891	6099	60360	4964	61313	4154	60544	2967	70853	2664	30250
3L-4S		MI	29972	8168	47077	6056	50293	4929	50599	4099	49107	2938	57213	2480	25892
10-#14	1.35	MA	34825	8168	54373	6120	58426	4983	58962	4146	57519	2981	67383	2540	30258
4L-3S		MI	30726	8168	48362	6036	51931	4937	52589	4109	51642	2925	60070	2605	25846
10-#14	1.35	MA	34031	8168	53061	6116	56725	4978	56871	4164	54491	2970	63757	2480	30163
5L-2S		MI	31790	8168	49933	6041	53945	4919	55046	4094	54958	2913	64476	2729	25784
10-#18	2.39	MA	40161	8773	64933	6442	71720	5209	75083	4275	79147	2880	95397	2639	52375
2L-5S		MI	30125	8773	49017	6385	52536	5196	53236	4256	52375	2838	62414	2009	42162
10-#18	2.39	MA	37986	8773	61670	6434	67537	5242	69980	4303	72224	2902	86175	2418	52285
3L-4S		MI	31288	8773	50970	6397	55067	5167	56346	4232	56770	2860	67626	2107	44233
10-#18	2.39	MA	36455	8773	59005	6470	64141	5230	65853	4287	66931	2924	80188	2197	51909
4L-3S		MI	32585	8773	53222	6364	57936	5183	59832	4252	61152	2838	72526	2328	44467
10-#18	2.39	MA	35086	8773	56699	6462	61150	5262	62178	4316	61630	2902	73892	2094	49368
5L-2S		MI	34412	8773	55966	6375	61454	5154	64123	4228	66887	2816	80108	2549	44479
12-#11	1.12	MA	36287	8038	56154	6040	60815	4927	61912	4114	61379	2975	72127	2828	25359
2L-6S		MI	29020	8038	45082	5986	47761	4895	47540	4084	44928	2958	51949	2506	21815
12-#11	1.12	MA	35399	8038	54852	6038	59147	4923	59878	4127	58611	2985	68381	2741	25400
3L-5S		MI	29471	8038	45811	5989	48770	4899	48773	4090	46545	2950	53953	2563	21814
12-#11	1.12	MA	34776	8038	53794	6053	57798	4937	58238	4122	56501	2995	65939	2655	25434
4E		MI	29944	8038	46587	5993	49777	4887	50011	4079	48330	2958	56073	2603	21780
12-#11	1.12	MA	34220	8038	52879	6051	56611	4934	56780	4135	54389	2988	63396	2613	25440
5L-3S		MI	30473	8038	47485	5979	50921	4891	51401	4085	50112	2950	58089	2689	21734
12-#11	1.12	MA	33690	8038	52022	6048	55424	4947	55328	4130	52475	2998	60973	2557	25391
6L-2S		MI	31221	8038	48584	5982	52329	4879	53119	4074	52444	2941	61194	2776	21688
12-#14	1.61	MA	37853	8324	59616	6200	65136	5039	67139	4179	68472	2941	81515	2764	36050
2L-6S		MI	29395	8324	46490	6142	49418	5009	49517	4147	47582	2924	55762	2311	30040
12-#14	1.61	MA	36593	8324	57754	6196	62748	5034	64226	4196	64508	2955	76184	2639	36085
3L-5S		MI	30035	8324	47535	6148	50864	5016	51283	4157	49883	2911	58604	2392	30736
12-#14	1.61	MA	35709	8324	56236	6217	60814	5053	61875	4189	61483	2969	72714	2515	36050
4E		MI	30707	8324	48648	6153	52307	4999	53056	4142	52424	2924	61619	2449	30799
12-#14	1.61	MA	34919	8324	54924	6213	59113	5047	59784	4206	58455	2957	69088	2455	35918
5L-3S		MI	31457	8324	49933	6133	53945	5006	55046	4151	54958	2911	64476	2574	30782
12-#14	1.61	MA	34167	8324	53694	6210	57409	5067	57702	4199	55710	2971	65643	2374	35020
6L-2S		MI	32517	8324	51504	6138	55959	4989	57503	4136	58275	2899	68883	2698	30734
12-#18	2.87	MA	41641	9050	68196	6615	75903	5334	80186	4350	86070	2857	104619	2588	62546
2L-6S		MI	30285	9050	49927	6547	53517	5304	54429	4312	54130	2831	65113	1801	48907
12-#18	2.87	MA	39481	9050	64933	6607	71720	5366	75083	4379	79147	2879	95397	2367	62390
3L-5S		MI	31384	9050	51761	6558	56054	5320	57528	4331	58110	2809	69995	1947	50320
12-#18	2.87	MA	37963	9050	62268	6643	68324	5354	70956	4363	73855	2901	89410	2145	61930
4E		MI	32538	9050	53715	6569	58585	5291	60637	4307	62504	2831	75208	2044	52667
12-#18	2.87	MA	36606	9050	59961	6635	65333	5386	67281	4391	68553	2879	83114	2042	59105
5L-3S		MI	33826	9050	55966	6536	61454	5307	64123	4327	66887	2809	80108	2266	52980
12-#18	2.87	MA	35315	9050	57798	6626	62337	5374	63620	4376	63749	2901	77162	1898	57382
6L-2S		MI	35640	9050	58711	6548	64972	5278	68415	4303	72621	2787	87689	2487	53068
14-#11	1.31	MA	36904	8145	57455	6107	62483	4975	63947	4144	64148	2966	75874	2811	29452
2L-7S		MI	29103	8145	45382	6068	48207	4956	48075	4124	45678	2958	52914	2396	24851
14-#11	1.31	MA	36018	8145	56154	6105	60815	4972	61912	4156	61379	2976	72127	2725	29485
3L-6S		MI	29541	8145	46181	6054	49169	4943	49259	4113	47259	2949	55054	2486	25230
14-#11	1.31	MA	35398	8145	55095	6120	59466	4985	60273	4152	59269	2986	69686	2638	29506
4L-5S		MI	29991	8145	46909	6057	50178	4948	50491	4119	48877	2940	57058	2543	25253
14-#11	1.31	MA	34844	8145	54180	6118	58279	4982	58815	4164	57157	2979	67143	2596	29489
5L-4S		MI	30462	8145	47686	6060	51186	4935	51729	4108	50662	2949	59178	2583	25233
14-#11	1.31	MA	34317	8145	53323	6116	57092	4996	57363	4159	55244	2989	64720	2541	29420
6L-3S		MI	30989	8145	48584	6046	52329	4940	53119	4114	52444	2940	61194	2669	25197

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

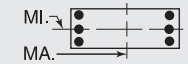
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.31	MA	33803	8145	52384	6131	55959	4992	55970	4172	53375	2999	62136	2451	28913
7L-2S		MI	31735	8145	49682	6049	53738	4927	54837	4103	54775	2932	64299	2755	25156
14-#14	1.88	MA	38721	8480	61479	6297	67524	5109	70052	4221	72435	2929	86846	2738	41888
2L-7S		MI	29510	8480	46917	6259	50052	5096	50277	4205	48649	2922	57132	2150	34202
14-#14	1.88	MA	37467	8480	59616	6293	65136	5104	67139	4239	68472	2943	81515	2614	41895
3L-6S		MI	30131	8480	48061	6240	51432	5079	51974	4190	50898	2910	60169	2280	34764
14-#14	1.88	MA	36587	8480	58099	6314	63202	5123	64788	4231	65447	2956	78045	2489	41831
4L-5S		MI	30768	8480	49106	6245	52878	5086	53740	4199	53200	2897	63011	2362	35594
14-#14	1.88	MA	35801	8480	56787	6311	61501	5117	62698	4249	62418	2945	74419	2429	41665
5L-4S		MI	31437	8480	50219	6250	54321	5069	55513	4184	55740	2910	66026	2418	35688
14-#14	1.88	MA	35054	8480	55557	6307	59797	5137	60615	4241	59674	2959	70974	2349	40632
6L-3S		MI	32183	8480	51504	6230	55959	5076	57503	4194	58275	2897	68883	2543	35704
14-#14	1.88	MA	34325	8480	54210	6328	58171	5131	58617	4259	56993	2972	67298	2219	39888
7L-2S		MI	33239	8480	53075	6236	57973	5059	59960	4179	61591	2885	73289	2668	35671
14-#18	3.35	MA	40963	9327	68196	6780	75903	5490	80186	4454	86070	2856	104619	2315	72479
3L-6S		MI	31542	9327	52672	6720	57035	5428	58720	4387	59865	2803	72695	1739	56887
14-#18	3.35	MA	39456	9327	65531	6816	72507	5478	76059	4438	80778	2878	98632	2094	71931
4L-5S		MI	32632	9327	54506	6731	59572	5444	61819	4407	63844	2780	77577	1884	58507
14-#18	3.35	MA	38111	9327	63224	6807	69516	5510	72384	4467	75477	2856	92336	1991	68872
5L-4S		MI	33778	9327	56459	6742	62103	5415	64929	4383	68239	2803	82789	1982	60867
14-#18	3.35	MA	36830	9327	61061	6799	66520	5498	68723	4451	70672	2878	86384	1847	66944
6L-3S		MI	35056	9327	58711	6709	64972	5431	68415	4403	72621	2780	87689	2203	61473
14-#18	3.35	MA	35584	9327	58691	6835	63661	5531	65208	4480	65977	2900	80028	1615	63814
7L-2S		MI	36858	9327	61455	6721	68490	5402	72707	4378	78356	2758	95270	2425	61617
16-#11	1.49	MA	37518	8253	58756	6175	64151	5024	65982	4173	66916	2957	79621	2795	33536
2L-8S		MI	29194	8253	45764	6132	48639	4999	48638	4165	46329	2940	54038	2329	27895
16-#11	1.49	MA	36635	8253	57455	6173	62483	5020	63947	4186	64148	2968	75874	2708	33561
3L-7S		MI	29624	8253	46481	6135	49615	5004	49793	4154	48009	2949	56019	2376	28183
16-#11	1.49	MA	36017	8253	56396	6188	61134	5034	62307	4181	62037	2978	73432	2622	33567
4L-6S		MI	30061	8253	47279	6121	50578	4991	50977	4142	49590	2940	58159	2466	28629
16-#11	1.49	MA	35465	8253	55481	6185	59947	5030	60850	4194	59925	2970	70889	2580	33531
5E		MI	30508	8253	48008	6124	51587	4996	52210	4149	51208	2931	60163	2523	28679
16-#11	1.49	MA	34940	8253	54624	6183	58760	5044	59398	4189	58012	2980	68467	2524	33442
6L-4S		MI	30978	8253	48785	6127	52594	4984	53447	4138	52993	2940	62283	2563	28677
16-#11	1.49	MA	34428	8253	53685	6198	57627	5041	58005	4201	56143	2990	65883	2434	32861
7L-3S		MI	31503	8253	49682	6113	53738	4988	54837	4144	54775	2931	64299	2649	28651
16-#11	1.49	MA	33924	8253	52841	6196	56478	5054	56645	4214	54157	2983	63505	2385	32472
8L-2S		MI	32247	8253	50781	6117	55146	4976	56556	4133	57106	2923	67404	2735	28617
16-#14	2.15	MA	39583	8635	63342	6394	69912	5179	72966	4264	76399	2917	92177	2713	47720
2L-8S		MI	29637	8635	47460	6351	50666	5159	51078	4263	49575	2895	58720	2052	38046
16-#14	2.15	MA	38334	8635	61479	6390	67524	5173	70052	4281	72435	2930	86846	2588	47694
3L-7S		MI	30246	8635	48488	6357	52066	5166	52734	4247	51966	2908	61538	2119	38961
16-#14	2.15	MA	37459	8635	59962	6412	65590	5193	67702	4274	69410	2944	83376	2464	47604
4L-6S		MI	30864	8635	49632	6337	53446	5149	54431	4232	54215	2895	64575	2249	39499
16-#14	2.15	MA	36678	8635	58650	6408	63889	5187	65611	4291	66382	2933	79751	2404	47408
5E		MI	31497	8635	50677	6342	54892	5156	56197	4242	56516	2883	67417	2331	40405
16-#14	2.15	MA	35934	8635	57420	6404	62185	5206	63529	4284	63638	2946	76305	2323	46256
6L-4S		MI	32163	8635	51790	6347	56335	5139	57970	4227	59057	2895	70433	2388	40567
16-#14	2.15	MA	35210	8635	56072	6425	60560	5201	61530	4301	60957	2960	72630	2193	45540
7L-3S		MI	32906	8635	53075	6328	57973	5146	59960	4236	61591	2883	73289	2512	40612
16-#14	2.15	MA	34496	8635	54862	6422	58911	5220	59579	4318	58107	2948	69240	2123	44406
8L-2S		MI	33957	8635	54646	6333	59987	5129	62417	4221	64908	2871	77696	2637	40598
16-#18	3.83	MA	40937	9603	68794	6989	76690	5602	81162	4514	87701	2854	107854	2043	81570
4L-6S		MI	32787	9603	55416	6893	60553	5553	63012	4462	65600	2774	80276	1677	64900

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

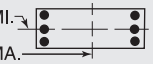


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	3.83	MA	39602	9603	66487	6980	73699	5634	77487	4542	82400	2832	101558	1940	78664
5E		MI	33870	9603	57250	6904	63089	5568	66111	4482	69579	2752	85158	1822	66718
16-#18	3.83	MA	38332	9603	64324	6972	70703	5623	73826	4527	77595	2854	95606	1795	76538
6L-4S		MI	35007	9603	59203	6915	65621	5539	69221	4458	73974	2774	90370	1920	68944
16-#18	3.83	MA	37095	9603	61953	7008	67844	5655	70311	4555	72900	2877	89249	1564	73523
7L-3S		MI	36276	9603	61455	6882	68490	5555	72707	4478	78356	2752	95270	2141	69952
18-#11	1.68	MA	38129	8361	60057	6242	65819	5072	68017	4203	69685	2949	83367	2778	37615
2L-9S		MI	29279	8361	46090	6213	49097	5060	49148	4188	47093	2940	55200	2255	30836
18-#11	1.68	MA	37249	8361	58756	6240	64151	5069	65982	4215	66916	2959	79621	2692	37632
3L-8S		MI	29714	8361	46863	6199	50047	5048	50356	4194	48660	2931	57143	2309	31242
18-#11	1.68	MA	36633	8361	57697	6255	62801	5082	64342	4210	64806	2969	77179	2606	37619
4L-7S		MI	30142	8361	47580	6202	51024	5052	51512	4183	50340	2940	59124	2356	31520
18-#11	1.68	MA	36084	8361	56783	6253	61615	5079	62884	4223	62694	2962	74636	2564	37569
5L-6S		MI	30577	8361	48378	6188	51987	5040	52695	4172	51921	2931	61264	2446	31945
18-#11	1.68	MA	35560	8361	55925	6251	60428	5093	61433	4218	60781	2972	72213	2508	37371
6L-5S		MI	31023	8361	49107	6192	52995	5045	53928	4178	53539	2922	63268	2503	32097
18-#11	1.68	MA	35050	8361	54986	6266	59295	5089	60039	4231	58912	2982	69630	2418	36814
7L-4S		MI	31492	8361	49884	6195	54003	5032	55166	4167	55324	2931	65388	2543	32116
18-#11	1.68	MA	34548	8361	54143	6263	58145	5103	58680	4243	56925	2975	67251	2369	36437
8L-3S		MI	32015	8361	50781	6181	55146	5037	56556	4173	57106	2922	67404	2629	32099
18-#11	1.68	MA	34025	8361	53317	6261	57028	5099	57258	4239	55073	2985	64902	2315	35909
9L-2S		MI	32756	8361	51880	6184	56555	5024	58274	4162	59437	2914	70509	2715	32071
18-#14	2.42	MA	39197	8791	63342	6488	69912	5243	72966	4324	76399	2918	92177	2563	53486
3L-8S		MI	30371	8791	49031	6449	52680	5229	53535	4305	52891	2881	63127	2021	42725
18-#14	2.42	MA	38326	8791	61825	6509	67978	5263	70615	4316	73374	2931	88708	2438	53371
4L-7S		MI	30977	8791	50059	6454	54080	5236	55191	4290	55282	2894	65945	2088	43725
18-#14	2.42	MA	37549	8791	60513	6505	66277	5257	68524	4334	70346	2920	85082	2379	53012
5L-6S		MI	31591	8791	51203	6434	55460	5219	56888	4275	57531	2881	68982	2218	44243
18-#14	2.42	MA	36809	8791	59283	6502	64573	5276	66442	4326	67602	2934	81637	2298	51889
6L-5S		MI	32222	8791	52248	6439	56906	5226	58654	4284	59833	2869	71824	2300	45104
18-#14	2.42	MA	36088	8791	57935	6523	62948	5271	64443	4343	64920	2947	77961	2168	51197
7L-4S		MI	32884	8791	53361	6445	58349	5208	60427	4269	62373	2881	74839	2357	45437
18-#14	2.42	MA	35379	8791	56724	6519	61299	5290	62493	4361	62071	2936	74571	2098	49977
8L-3S		MI	33624	8791	54646	6425	59987	5216	62417	4279	64908	2869	77696	2481	45505
18-#14	2.42	MA	34649	8791	55421	6540	59695	5284	60453	4353	59414	2950	71230	2020	48909
9L-2S		MI	34671	8791	56217	6430	62001	5198	64874	4263	68224	2857	82103	2606	45523
18-#18	4.31	MA	41081	9880	69750	7153	77882	5759	82590	4618	89323	2809	110780	1888	88476
5L-6S		MI	34022	9880	58160	7066	64071	5677	67304	4538	71334	2745	87857	1614	72941
18-#18	4.31	MA	39821	9880	67586	7145	74886	5747	78929	4602	84518	2831	104828	1744	86159
6L-5S		MI	35098	9880	59994	7077	66607	5692	70403	4558	75313	2723	92739	1760	74948
18-#18	4.31	MA	38594	9880	65216	7181	72027	5779	75414	4630	79823	2853	98471	1513	83252
7L-4S		MI	36227	9880	61947	7088	69139	5664	73512	4533	79708	2745	97952	1857	77053
20-#11	1.87	MA	38737	8469	61358	6310	67486	5120	70052	4232	72453	2940	87114	2762	41689
2L-10S		MI	29346	8469	46473	6277	49542	5104	49717	4229	47871	2939	56423	2173	33635
20-#11	1.87	MA	37860	8469	60057	6308	65819	5117	68017	4245	69685	2950	83367	2676	41694
3L-9S		MI	29800	8469	47189	6281	50506	5109	50866	4217	49424	2931	58305	2235	34128
20-#11	1.87	MA	37247	8469	58998	6323	64469	5131	66377	4240	67574	2960	80926	2589	41667
4L-8S		MI	30232	8469	47961	6267	51456	5096	52075	4224	50991	2922	60248	2289	34592
20-#11	1.87	MA	36699	8469	58084	6320	63283	5127	64919	4252	65462	2953	78383	2547	41602
5L-7S		MI	30659	8469	48679	6270	52432	5101	53230	4212	52671	2931	62229	2336	34862
20-#11	1.87	MA	36178	8469	57226	6318	62095	5141	63467	4248	63549	2963	75960	2491	41307
6E		MI	31092	8469	49477	6256	53395	5088	54414	4201	54252	2922	64369	2426	35267
20-#11	1.87	MA	35670	8469	56287	6333	60963	5138	62074	4260	61680	2973	73376	2401	40772
7L-5S		MI	31536	8469	50206	6259	54404	5093	55647	4207	55870	2913	66373	2482	35511
20-#11	1.87	MA	35170	8469	55444	6331	59813	5151	60715	4273	59694	2966	70998	2352	40405
8L-4S		MI	32003	8469	50983	6262	55411	5080	56884	4196	57655	2922	68493	2523	35543
20-#11	1.87	MA	34649	8469	54618	6329	58696	5148	59293	4268	57841	2976	68649	2298	39819
9L-3S		MI	32524	8469	51880	6248	56555	5085	58274	4202	59437	2913	70509	2609	35541

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

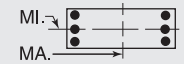
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.87	MA	34097	8469	53694	6344	57562	5162	57940	4280	56005	2986	66373	2237	39183
10L-2S		MI	33263	8469	52979	6251	57964	5072	59993	4191	61768	2905	73614	2695	35519
20-#14	2.69	MA	39188	8946	63687	6606	70366	5332	73528	4359	77338	2919	94039	2413	59132
4L-8S		MI	31101	8946	50602	6546	54694	5298	55992	4347	56208	2867	67533	1990	47413
20-#14	2.69	MA	38415	8946	62375	6602	68665	5327	71437	4376	74309	2908	90413	2353	58607
5L-7S		MI	31703	8946	51630	6551	56094	5306	57648	4332	58599	2880	70352	2057	48494
20-#14	2.69	MA	37679	8946	61145	6599	66961	5346	69355	4368	71565	2921	86968	2272	57531
6E		MI	32315	8946	52774	6531	57474	5288	59344	4317	60848	2867	73388	2187	48995
20-#14	2.69	MA	36962	8946	59798	6620	65336	5341	67357	4386	68884	2935	83292	2143	56859
7L-5S		MI	32943	8946	53819	6537	58920	5296	61111	4327	63149	2855	76230	2269	49815
20-#14	2.69	MA	36256	8946	58587	6616	63687	5360	65406	4403	66034	2924	79902	2073	55558
8L-4S		MI	33602	8946	54932	6542	60363	5278	62884	4311	65689	2867	79246	2326	50302
20-#14	2.69	MA	35531	8946	57284	6637	62083	5354	63366	4396	63378	2937	76562	1995	54520
9L-3S		MI	34338	8946	56217	6522	62001	5286	64874	4321	68224	2855	82103	2450	50391
20-#18	4.78	MA	41298	10157	70849	7318	79069	5871	84032	4677	91442	2808	114050	1693	95806
6E		MI	35249	10157	60904	7239	67589	5801	71595	4613	77069	2717	95439	1552	81007
20-#18	4.78	MA	40080	10157	68479	7354	76210	5903	80517	4706	86746	2830	107693	1461	92999
7L-5S		MI	36317	10157	62738	7250	70125	5816	74694	4633	81048	2694	100321	1697	83194
22-#11	2.05	MA	38468	8577	61358	6375	67486	5165	70052	4274	72453	2942	87114	2659	45749
3L-10S		MI	29865	8577	47572	6345	50950	5152	51435	4258	50202	2930	59528	2153	36947
22-#11	2.05	MA	37857	8577	60299	6390	66137	5179	68412	4269	70343	2952	84672	2573	45710
4L-9S		MI	30319	8577	48288	6348	51914	5157	52585	4247	51755	2922	61410	2215	37426
22-#11	2.05	MA	37311	8577	59385	6388	64951	5176	66954	4282	68231	2944	82129	2531	45631
5L-8S		MI	30747	8577	49060	6334	52864	5145	53793	4253	53322	2913	63353	2269	37943
22-#11	2.05	MA	36792	8577	58528	6385	63763	5189	65502	4277	66318	2954	79707	2475	45249
6L-7S		MI	31172	8577	49778	6337	53841	5149	54949	4242	55003	2922	65334	2316	38206
22-#11	2.05	MA	36287	8577	57588	6400	62630	5186	64109	4290	64449	2965	77123	2385	44734
7L-6S		MI	31604	8577	50576	6323	54804	5137	56132	4231	56583	2913	67474	2406	38595
22-#11	2.05	MA	35788	8577	56745	6398	61481	5200	62749	4302	62462	2957	74745	2336	44375
8L-5S		MI	32047	8577	51305	6326	55813	5141	57365	4237	58201	2904	69478	2462	38920
22-#11	2.05	MA	35270	8577	55919	6396	60364	5196	61327	4297	60610	2967	72396	2282	43736
9L-4S		MI	32512	8577	52081	6330	56820	5129	58603	4226	59986	2913	71598	2503	38964
22-#11	2.05	MA	34720	8577	54995	6411	59230	5210	59975	4310	58774	2977	70119	2221	43115
10L-3S		MI	33031	8577	52979	6316	57964	5133	59993	4232	61768	2904	73614	2589	38978
22-#11	2.05	MA	34183	8577	54168	6409	58118	5207	58571	4305	56815	2970	67800	2169	42383
11L-2S		MI	33768	8577	54078	6319	59372	5121	61711	4221	64099	2896	76719	2675	38964
22-#14	2.96	MA	39276	9102	64238	6700	71053	5397	74351	4418	78273	2895	95744	2328	64214
5L-8S		MI	31826	9102	52173	6643	56708	5368	58449	4390	59524	2853	71940	1959	52110
22-#14	2.96	MA	38544	9102	63008	6696	69349	5416	72268	4411	75529	2909	92299	2247	63180
6L-7S		MI	32426	9102	53201	6648	58108	5376	60105	4375	61915	2866	74758	2026	53214
22-#14	2.96	MA	37830	9102	61661	6717	67724	5410	70270	4428	72848	2922	88623	2117	62526
7L-6S		MI	33035	9102	54345	6629	59488	5358	61801	4359	64164	2853	77795	2156	53753
22-#14	2.96	MA	37128	9102	60450	6714	66075	5430	68319	4446	69998	2911	85233	2047	61148
8L-5S		MI	33660	9102	55390	6634	60934	5366	63568	4369	66466	2841	80637	2238	54537
22-#14	2.96	MA	36418	9102	59146	6735	64471	5424	66279	4438	67341	2925	81893	1969	60097
9L-4S		MI	34316	9102	56503	6639	62377	5348	65341	4354	69006	2853	83653	2295	55161
22-#18	5.26	MA	41555	10433	71742	7527	80393	6027	85620	4781	93670	2807	116915	1410	102763
7L-6S		MI	36467	10433	63648	7412	71107	5925	75887	4689	82803	2688	103020	1490	89095
24-#11	2.24	MA	38465	8685	61600	6457	67805	5228	70447	4299	73111	2943	88419	2556	49749
4L-10S		MI	30382	8685	48671	6412	52359	5201	53154	4287	52533	2921	62633	2133	40263
24-#11	2.24	MA	37921	8685	60686	6455	66619	5224	68989	4311	70999	2936	85876	2514	49658
5L-9S		MI	30841	8685	49386	6416	53323	5206	54303	4276	54087	2913	64515	2194	40728
24-#11	2.24	MA	37404	8685	59829	6453	65431	5238	67537	4306	69086	2946	83453	2458	49197
6L-8S		MI	31260	8685	50159	6402	54273	5193	55511	4282	55653	2904	66458	2249	41296

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.24	MA	36900	8685	58889	6468	64298	5234	66144	4319	67217	2956	80870	2369	48699
7E		MI	31684	8685	50876	6405	55250	5198	56667	4271	57334	2913	68439	2296	41554
24-#11	2.24	MA	36404	8685	58046	6466	63149	5248	64784	4332	65230	2949	78491	2319	48347
8L-6S		MI	32114	8685	51675	6391	56212	5185	57851	4260	58915	2904	70579	2386	41927
24-#11	2.24	MA	35888	8685	57220	6463	62032	5245	63362	4327	63378	2959	76142	2266	47657
9L-5S		MI	32556	8685	52403	6394	57221	5190	59083	4266	60532	2895	72583	2442	42325
24-#11	2.24	MA	35340	8685	56296	6478	60898	5258	62010	4339	61542	2969	73866	2205	47052
10L-4S		MI	33019	8685	53180	6397	58228	5177	60321	4255	62317	2904	74703	2483	42381
24-#11	2.24	MA	34805	8685	55469	6476	59786	5255	60606	4335	59584	2962	71547	2152	46280
11L-3S		MI	33537	8685	54078	6383	59372	5182	61711	4261	64099	2895	76719	2569	42406
24-#14	3.23	MA	39404	9258	64871	6793	71737	5486	75182	4453	79493	2896	97630	2222	68835
6L-8S		MI	32548	9258	53744	6740	58722	5438	60906	4432	62841	2839	76347	1928	56815
24-#14	3.23	MA	38694	9258	63524	6815	70112	5480	73183	4471	76811	2910	93955	2092	68122
7E		MI	33145	9258	54772	6746	60122	5445	62562	4417	65232	2852	79165	1995	57882
24-#14	3.23	MA	37995	9258	62313	6811	68463	5499	71232	4488	73962	2899	90564	2022	66746
8L-6S		MI	33752	9258	55916	6726	61502	5428	64258	4402	67481	2839	82202	2125	58516
24-#14	3.23	MA	37286	9258	61009	6832	66859	5494	69193	4481	71305	2912	87224	1944	65631
9L-5S		MI	34374	9258	56961	6731	62948	5435	66025	4411	69782	2827	85044	2207	59267

RECTANGULAR TIED COLUMNS 38" x 46"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.37	MA	40453	8556	63353	6369	68745	5186	70346	4315	70687	3076	83306	2893	33526
2L-3S		MI	31346	8556	49654	6268	52894	5140	53188	4276	51420	3030	59282	2583	27394
6-#18	1.37	MA	38122	8556	59917	6362	64340	5219	64972	4344	63376	3098	73537	2671	33613
3L-2S		MI	33201	8556	52398	6279	56412	5112	57479	4252	57155	3008	66863	2804	27267
8-#14	1.03	MA	39330	8349	60695	6278	65582	5124	66580	4285	65603	3113	76807	2962	25549
2L-4S		MI	30509	8349	47419	6211	50273	5067	50086	4233	47535	3087	54735	2642	21012
8-#14	1.03	MA	37989	8349	58735	6275	63069	5119	63515	4303	61432	3127	71167	2838	25617
3E		MI	31267	8349	48704	6191	51911	5074	52076	4243	50070	3075	57592	2767	20934
8-#14	1.03	MA	37049	8349	57140	6296	61037	5139	61044	4296	58252	3142	67492	2713	25663
4L-2S		MI	32338	8349	50275	6196	53925	5057	54533	4228	53386	3062	61999	2891	20856
8-#18	1.83	MA	42052	8833	66789	6542	73149	5310	75719	4390	77998	3054	93076	2844	44316
2L-4S		MI	31303	8833	50147	6474	53543	5249	53993	4331	52772	3023	61963	2299	35894
8-#18	1.83	MA	39739	8833	63353	6535	68745	5343	70346	4420	70687	3076	83306	2623	44317
3E		MI	32612	8833	52398	6441	56412	5265	57479	4351	57155	3001	66863	2520	36001
8-#18	1.83	MA	38113	8833	60550	6572	65173	5332	66005	4405	65101	3099	76956	2402	44037
4L-2S		MI	34454	8833	55143	6452	59930	5236	61771	4327	62889	2979	74445	2742	35925
10-#14	1.29	MA	40260	8504	62655	6375	68095	5194	69646	4327	69773	3100	82447	2938	31719
2L-5S		MI	30573	8504	47876	6303	50844	5154	50770	4291	48311	3061	56127	2555	25944
10-#14	1.29	MA	38925	8504	60695	6372	65582	5189	66580	4345	65603	3115	76807	2814	31769
3L-4S		MI	31249	8504	48990	6308	52287	5137	52543	4276	50851	3073	59142	2611	25947
10-#14	1.29	MA	37990	8504	59100	6394	63549	5209	64110	4338	62423	3129	73132	2689	31776
4L-3S		MI	32004	8504	50275	6288	53925	5144	54533	4285	53386	3061	61999	2736	25894
10-#14	1.29	MA	37155	8504	57722	6390	61762	5204	61913	4356	59241	3119	69303	2629	31682
5L-2S		MI	33070	8504	51846	6294	55939	5127	56990	4270	56703	3048	66405	2861	25829
10-#18	2.29	MA	43634	9109	70225	6715	77554	5434	81092	4465	85309	3031	102846	2796	55075
2L-5S		MI	31402	9109	50937	6636	54530	5402	55175	4431	54112	2972	64332	2139	42477
10-#18	2.29	MA	41339	9109	66789	6708	73149	5467	75719	4495	77998	3054	93076	2575	54985
3L-4S		MI	32567	9109	52891	6647	57061	5373	58285	4407	58507	2994	69545	2237	44357
10-#18	2.29	MA	39726	9109	63986	6744	69578	5456	71378	4481	72411	3077	86726	2353	54609
4L-3S		MI	33866	9109	55143	6614	59930	5389	61771	4427	62889	2972	74445	2458	44554
10-#18	2.29	MA	38286	9109	61562	6737	66434	5489	67515	4510	66817	3055	80068	2249	52143
5L-2S		MI	35696	9109	57887	6625	63448	5360	66063	4403	68624	2950	82026	2679	44545
12-#11	1.07	MA	39525	8373	60968	6313	66056	5151	67206	4305	66474	3121	78137	2975	26623
2L-6S		MI	30296	8373	46991	6240	49755	5103	49486	4261	46676	3094	53884	2638	21876
12-#11	1.07	MA	38588	8373	59599	6311	64301	5148	65066	4318	63562	3132	74176	2889	26664
3L-5S		MI	30748	8373	47719	6243	50764	5108	50719	4267	48293	3086	55888	2694	21863

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

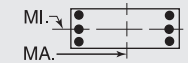
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#11	1.07	MA	37933	8373	58487	6326	62884	5162	63343	4314	61344	3142	71593	2802	26697
4E		MI	31222	8373	48496	6246	51771	5095	51956	4256	50079	3094	58008	2734	21822
12-#11	1.07	MA	37349	8373	57526	6324	61638	5159	61811	4327	59126	3136	68908	2760	26703
5L-3S		MI	31751	8373	49394	6232	52915	5100	53346	4262	51860	3086	60024	2821	21774
12-#11	1.07	MA	36792	8373	56626	6322	60390	5173	60287	4322	57117	3146	66346	2704	26655
6L-2S		MI	32500	8373	50492	6235	54324	5087	55065	4251	54192	3077	63129	2907	21726
12-#14	1.54	MA	41183	8660	64615	6473	70607	5264	72711	4370	73944	3088	88087	2914	37872
2L-6S		MI	30671	8660	48403	6395	51412	5217	51460	4324	49326	3059	57691	2442	30232
12-#14	1.54	MA	39855	8660	62655	6469	68095	5259	69646	4388	69773	3102	82447	2790	37907
3L-5S		MI	31312	8660	49447	6400	52858	5224	53227	4333	51628	3047	60533	2524	30820
12-#14	1.54	MA	38925	8660	61060	6491	66062	5279	67175	4381	66594	3117	78772	2665	37873
4E		MI	31985	8660	50561	6405	54301	5207	55000	4318	54168	3059	63549	2581	30865
12-#14	1.54	MA	38094	8660	59682	6488	64274	5274	64978	4399	63411	3106	74943	2605	37740
5L-3S		MI	32736	8660	51846	6386	55939	5214	56990	4328	56703	3047	66405	2705	30834
12-#14	1.54	MA	37304	8660	58390	6484	62485	5293	62791	4392	60529	3121	71296	2524	36905
6L-2S		MI	33797	8660	53417	6391	57953	5197	59447	4313	60019	3034	70812	2830	30782
12-#18	2.75	MA	45202	9386	73660	6888	81958	5558	86465	4541	92619	3009	112616	2748	65786
2L-6S		MI	31560	9386	51848	6798	55511	5510	56368	4487	55867	2966	67032	1931	49312
12-#18	2.75	MA	42922	9386	70225	6881	77554	5591	81092	4570	85309	3032	102846	2526	65630
3L-5S		MI	32662	9386	53682	6809	58047	5526	59467	4507	59847	2944	71914	2077	50631
12-#18	2.75	MA	41323	9386	67422	6917	73982	5580	76751	4556	79722	3054	96495	2305	65170
4E		MI	33819	9386	55635	6820	60579	5497	62577	4482	64241	2966	77126	2174	52802
12-#18	2.75	MA	39895	9386	64997	6910	70838	5614	72888	4586	74128	3033	89838	2200	62402
5L-3S		MI	35109	9386	57887	6787	63448	5513	66063	4502	68624	2944	82026	2396	53075
12-#18	2.75	MA	38537	9386	62724	6903	67690	5603	69040	4571	69057	3055	83528	2056	60531
6L-2S		MI	36926	9386	60631	6798	66966	5484	70354	4478	74358	2922	89607	2617	53145
14-#11	1.25	MA	40177	8481	62336	6380	67810	5200	69346	4335	69386	3113	82098	2960	30926
2L-7S		MI	30379	8481	47291	6321	50201	5164	50021	4301	47426	3094	54849	2528	24988
14-#11	1.25	MA	39244	8481	60968	6378	66056	5197	67206	4347	66474	3123	78137	2873	30959
3L-6S		MI	30818	8481	48089	6307	51164	5152	51204	4290	49007	3085	56989	2618	25297
14-#11	1.25	MA	38591	8481	59855	6394	64638	5211	65483	4343	64256	3134	75553	2787	30980
4L-5S		MI	31268	8481	48818	6310	52173	5156	52437	4296	50625	3077	58993	2674	25306
14-#11	1.25	MA	38009	8481	58895	6392	63392	5207	63951	4356	62038	3127	72869	2745	30963
5L-4S		MI	31740	8481	49595	6313	53180	5144	53675	4285	52410	3085	61113	2714	25279
14-#11	1.25	MA	37454	8481	57995	6390	62145	5222	62427	4352	60028	3138	70306	2689	30894
6L-3S		MI	32268	8481	50492	6299	54324	5148	55065	4291	54192	3077	63129	2801	25240
14-#11	1.25	MA	36914	8481	57009	6405	60955	5218	60964	4365	58066	3148	67575	2599	30426
7L-2S		MI	33014	8481	51591	6303	55732	5136	56783	4280	56523	3068	66234	2887	25197
14-#14	1.80	MA	42101	8815	66575	6570	73120	5334	75776	4412	78115	3076	93726	2890	44014
2L-7S		MI	30786	8815	48830	6512	52046	5304	52221	4381	50394	3058	59061	2281	34387
14-#14	1.80	MA	40779	8815	64615	6567	70607	5329	72711	4430	73944	3090	88087	2766	44021
3L-6S		MI	31408	8815	49974	6492	53426	5287	53917	4366	52643	3045	62098	2411	34955
14-#14	1.80	MA	39853	8815	63020	6588	68575	5348	70240	4423	70764	3104	84412	2641	43958
4L-5S		MI	32046	8815	51018	6497	54872	5294	55684	4376	54944	3033	64940	2493	35684
14-#14	1.80	MA	39027	8815	61642	6585	66787	5343	68044	4441	67582	3094	80583	2581	43792
5L-4S		MI	32716	8815	52132	6503	56315	5277	57457	4361	57484	3045	67955	2550	35760
14-#14	1.80	MA	38241	8815	60351	6582	64997	5363	65856	4434	64699	3108	76936	2500	42812
6L-3S		MI	33464	8815	53417	6483	57953	5284	59447	4370	60019	3033	70812	2674	35761
14-#14	1.80	MA	37475	8815	58935	6603	63290	5358	63757	4452	61883	3123	73047	2371	41999
7L-2S		MI	34520	8815	54988	6488	59967	5266	61904	4355	63336	3020	75219	2799	35723
14-#18	3.20	MA	44492	9663	73660	7053	81958	5716	86465	4646	92619	3010	112616	2478	76259
3L-6S		MI	32818	9663	54592	6970	59029	5634	60660	4562	61602	2937	74613	1869	57413
14-#18	3.20	MA	42905	9663	70858	7090	78387	5705	82124	4631	87033	3032	106265	2257	75724
4L-5S		MI	33912	9663	56426	6982	61565	5650	63759	4582	65581	2915	79495	2014	58815

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

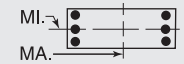


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#18	3.20	MA	41488	9663	68433	7083	75243	5738	78261	4661	81438	3011	99608	2152	72693
5L-4S		MI	35060	9663	58379	6993	64097	5621	66868	4558	69976	2937	84707	2112	61235
14-#18	3.20	MA	40141	9663	66160	7075	72094	5727	74413	4646	76367	3033	93298	2008	70904
6L-3S		MI	36341	9663	60631	6960	66966	5637	70354	4578	74358	2915	89607	2333	61576
14-#18	3.20	MA	38829	9663	63669	7112	69090	5760	70720	4676	71412	3056	86563	1777	67499
7L-2S		MI	38147	9663	63375	6971	70484	5608	74646	4553	80093	2893	97189	2555	61700
16-#11	1.43	MA	40826	8589	63705	6448	69564	5248	71486	4364	72298	3104	86059	2944	35221
2L-8S		MI	30470	8589	47672	6385	50633	5208	50584	4342	48077	3076	55972	2460	28031
16-#11	1.43	MA	39896	8589	62336	6446	67810	5245	69346	4377	69386	3115	82098	2858	35246
3L-7S		MI	30901	8589	48390	6389	51610	5213	51739	4331	49757	3085	57954	2508	28320
16-#11	1.43	MA	39245	8589	61224	6461	66392	5259	67623	4373	67168	3125	79514	2772	35252
4L-6S		MI	31338	8589	49188	6374	52572	5200	52923	4320	51338	3076	60094	2598	28711
16-#11	1.43	MA	38665	8589	60263	6459	65146	5256	66092	4385	64950	3118	76830	2729	35216
5E		MI	31786	8589	49917	6378	53581	5205	54156	4326	52956	3068	62098	2654	28741
16-#11	1.43	MA	38113	8589	59363	6457	63899	5270	64567	4381	62940	3129	74267	2673	35129
6L-4S		MI	32257	8589	50694	6381	54589	5192	55393	4315	54741	3076	64218	2694	28727
16-#11	1.43	MA	37576	8589	58377	6472	62710	5267	63104	4394	60978	3139	71536	2583	34579
7L-3S		MI	32782	8589	51591	6367	55732	5197	56783	4321	56523	3068	66234	2781	28697
16-#11	1.43	MA	37038	8589	57492	6471	61503	5281	61677	4407	58891	3133	69025	2534	34154
8L-2S		MI	33527	8589	52690	6370	57141	5184	58502	4310	58854	3059	69339	2867	28660
16-#14	2.06	MA	43014	8971	68535	6667	75633	5404	78842	4455	82285	3063	99366	2867	50150
2L-8S		MI	30912	8971	49372	6604	52661	5366	53022	4439	51319	3031	60649	2183	38348
16-#14	2.06	MA	41697	8971	66575	6664	73120	5398	75776	4473	78115	3078	93726	2742	50124
3L-7S		MI	31522	8971	50401	6609	54060	5374	54678	4424	53710	3043	63468	2250	39147
16-#14	2.06	MA	40776	8971	64980	6685	71087	5418	73306	4466	74935	3092	90052	2617	50034
4L-6S		MI	32141	8971	51545	6589	55440	5356	56374	4409	55959	3031	66504	2380	39689
16-#14	2.06	MA	39954	8971	63602	6682	69300	5413	71109	4484	71753	3081	86223	2557	49838
5E		MI	32776	8971	52590	6595	56886	5364	58141	4418	58261	3019	69346	2462	40541
16-#14	2.06	MA	39172	8971	62311	6679	67510	5433	68922	4477	68870	3096	82576	2476	48731
6L-4S		MI	33443	8971	53703	6600	58329	5346	59914	4403	60801	3031	72362	2519	40644
16-#14	2.06	MA	38411	8971	60895	6700	65803	5428	66822	4495	66053	3110	78687	2347	47949
7L-3S		MI	34187	8971	54988	6580	59967	5354	61904	4413	63336	3019	75219	2643	40677
16-#14	2.06	MA	37660	8971	59624	6697	64071	5448	64774	4513	63060	3100	75106	2276	46882
8L-2S		MI	35239	8971	56559	6585	61981	5336	64361	4397	66652	3006	79625	2768	40652
16-#18	3.66	MA	44473	9939	74294	7263	82791	5829	87498	4707	94344	3010	116035	2208	86231
4L-6S		MI	34065	9939	57336	7143	62547	5759	64951	4637	67337	2908	82194	1807	65418
16-#18	3.66	MA	43067	9939	71869	7256	79647	5862	83634	4736	88749	2989	109378	2104	83009
5E		MI	35151	9939	59170	7155	65083	5774	68050	4657	71316	2886	87076	1952	67023
16-#18	3.66	MA	41731	9939	69595	7248	76499	5851	79787	4722	83678	3011	103068	1960	81045
6L-4S		MI	36291	9939	61123	7166	67615	5746	71160	4633	75711	2908	92289	2050	69311
16-#18	3.66	MA	40429	9939	67105	7285	73494	5884	76093	4752	78723	3034	96333	1729	77733
7L-3S		MI	37564	9939	63375	7133	70484	5761	74646	4653	80093	2886	97189	2271	70062
16-#18	3.66	MA	39148	9939	64866	7278	70447	5873	72487	4781	73457	3012	90109	1606	74500
8L-2S		MI	39359	9939	66119	7144	74002	5732	78938	4629	85827	2864	104770	2492	70236
18-#11	1.61	MA	41472	8697	65073	6515	71319	5297	73627	4393	75210	3095	90019	2929	39510
2L-9S		MI	30555	8697	47999	6467	51091	5269	51094	4365	48841	3076	57134	2386	31057
18-#11	1.61	MA	40545	8697	63705	6513	69564	5293	71486	4406	72298	3106	86059	2843	39528
3L-8S		MI	30990	8697	48771	6453	52042	5256	52302	4371	50408	3067	59077	2440	31379
18-#11	1.61	MA	39897	8697	62592	6529	68147	5307	69763	4402	70080	3116	83475	2756	39515
4L-7S		MI	31420	8697	49489	6456	53018	5261	53458	4360	52088	3076	61059	2488	31658
18-#11	1.61	MA	39319	8697	61632	6527	66901	5304	68232	4415	67862	3110	80791	2714	39464
5L-6S		MI	31855	8697	50287	6442	53981	5248	54641	4349	53669	3067	63199	2578	32092
18-#11	1.61	MA	38769	8697	60732	6525	65654	5318	66707	4411	65852	3120	78228	2658	39353
6L-5S		MI	32302	8697	51016	6445	54990	5253	55874	4355	55287	3059	65203	2634	32162
18-#11	1.61	MA	38233	8697	59746	6540	64464	5315	65244	4423	63889	3131	75496	2568	38738
7L-4S		MI	32771	8697	51793	6448	55997	5241	57112	4344	57072	3067	67323	2674	32168
18-#11	1.61	MA	37706	8697	58860	6538	63257	5329	63817	4436	61803	3124	72986	2518	38327
8L-3S		MI	33295	8697	52690	6434	57141	5245	58502	4350	58854	3059	69339	2761	32147

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

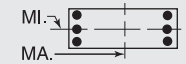
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.61	MA	37147	8697	57994	6536	62084	5326	62324	4432	59858	3135	70501	2465	37859
9L-2S		MI	34037	8697	53789	6438	58549	5233	60220	4339	61185	3050	72444	2847	32116
18-#14	2.32	MA	42610	9127	68535	6761	75633	5468	78842	4515	82285	3065	99366	2718	56219
3L-8S		MI	31647	9127	50943	6701	54675	5436	55479	4482	54636	3017	65056	2152	43024
18-#14	2.32	MA	41693	9127	66940	6783	73600	5488	76371	4508	79106	3079	95692	2594	56105
4L-7S		MI	32254	9127	51972	6706	56074	5444	57135	4466	57027	3029	67874	2219	43913
18-#14	2.32	MA	40876	9127	65562	6779	71812	5483	74174	4526	75923	3069	91862	2533	55881
5L-6S		MI	32870	9127	53116	6687	57454	5426	58831	4451	59276	3017	70911	2349	44433
18-#14	2.32	MA	40098	9127	64271	6776	70023	5503	71987	4519	73041	3083	88216	2452	54661
6L-5S		MI	33502	9127	54161	6692	58900	5434	60598	4461	61577	3005	73753	2431	45316
18-#14	2.32	MA	39340	9127	62855	6798	68316	5498	69888	4537	70224	3098	84327	2323	53905
7L-4S		MI	34166	9127	55274	6697	60343	5416	62371	4445	64117	3017	76769	2488	45519
18-#14	2.32	MA	38594	9127	61584	6794	66584	5517	67839	4555	67231	3087	80746	2252	52748
8L-3S		MI	34907	9127	56559	6677	61981	5424	64361	4455	66652	3005	79625	2612	45574
18-#14	2.32	MA	37813	9127	60340	6791	64900	5512	65696	4548	64440	3102	77210	2174	51584
9L-2S		MI	35955	9127	58130	6683	63995	5406	66818	4440	69969	2992	84032	2737	45574
18-#18	4.12	MA	44633	10216	75305	7429	84052	5986	89008	4812	96060	2967	119148	2055	93347
5L-6S		MI	35303	10216	60080	7316	66065	5883	69243	4713	73071	2880	89776	1744	73453
18-#18	4.12	MA	43307	10216	73031	7421	80903	5975	85160	4797	90989	2989	112838	1911	91187
6L-5S		MI	36381	10216	61914	7327	68601	5898	72342	4733	77050	2858	94658	1890	75251
18-#18	4.12	MA	42016	10216	70540	7458	77899	6008	81466	4827	86034	3012	106103	1680	87988
7L-4S		MI	37514	10216	63867	7339	71133	5870	75452	4708	81445	2880	99870	1987	77415
18-#18	4.12	MA	40745	10216	68302	7451	74851	5997	77860	4857	80768	2990	99879	1557	84639
8L-3S		MI	38778	10216	66119	7306	74002	5885	78938	4728	85827	2858	104770	2209	78536
20-#11	1.78	MA	42115	8805	66442	6583	73073	5345	75767	4423	78122	3087	93980	2913	43795
2L-10S		MI	30622	8805	48382	6531	51536	5313	51663	4406	49619	3075	58358	2305	33847
20-#11	1.78	MA	41191	8805	65073	6581	71319	5342	73627	4436	75210	3097	90019	2827	43800
3L-9S		MI	31076	8805	49098	6534	52500	5317	52812	4395	51172	3067	60239	2366	34348
20-#11	1.78	MA	40545	8805	63961	6596	69901	5356	71903	4431	72992	3108	87436	2741	43773
4L-8S		MI	31509	8805	49870	6520	53450	5305	54020	4401	52739	3058	62182	2420	34730
20-#11	1.78	MA	39969	8805	63000	6594	68655	5353	70372	4444	70774	3101	84751	2698	43708
5L-7S		MI	31936	8805	50588	6523	54427	5309	55176	4390	54419	3067	64164	2468	35000
20-#11	1.78	MA	39422	8805	62100	6592	67408	5367	68848	4440	68764	3112	82189	2642	43494
6E		MI	32370	8805	51386	6509	55390	5297	56360	4378	56000	3058	66304	2558	35414
20-#11	1.78	MA	38888	8805	61114	6607	66218	5364	67385	4453	66801	3122	79457	2553	42902
7L-5S		MI	32816	8805	52114	6513	56398	5301	57592	4385	57618	3049	68308	2614	35580
20-#11	1.78	MA	38363	8805	60229	6605	65012	5378	65957	4466	64715	3115	76947	2503	42502
8L-4S		MI	33283	8805	52891	6516	57406	5289	58830	4373	59403	3058	70428	2654	35604
20-#11	1.78	MA	37806	8805	59362	6603	63838	5375	64464	4461	62770	3126	74462	2449	41975
9L-3S		MI	33805	8805	53789	6502	58549	5294	60220	4380	61185	3049	72444	2741	35591
20-#11	1.78	MA	37226	8805	58392	6619	62648	5389	63044	4474	60842	3137	72054	2388	41280
10L-2S		MI	34545	8805	54888	6505	59958	5281	61938	4368	63516	3041	75549	2827	35567
20-#14	2.57	MA	42605	9282	68901	6880	76113	5558	79436	4550	83276	3067	101332	2570	62170
4L-8S		MI	32378	9282	52514	6798	56688	5506	57936	4524	57952	3003	69463	2121	47710
20-#14	2.57	MA	41792	9282	67522	6877	74325	5553	77240	4568	80094	3057	97502	2509	61792
5L-7S		MI	32982	9282	53543	6804	58088	5514	59592	4509	60343	3015	72281	2188	48682
20-#14	2.57	MA	41018	9282	66231	6873	72536	5573	75052	4562	77211	3071	93856	2429	60599
6E		MI	33595	9282	54687	6784	59468	5496	61288	4493	62592	3003	75318	2318	49185
20-#14	2.57	MA	40264	9282	64815	6895	70828	5568	72953	4579	74395	3085	89967	2299	59867
7L-5S		MI	34224	9282	55732	6789	60914	5503	63055	4503	64894	2990	78160	2400	50026
20-#14	2.57	MA	39522	9282	63544	6892	69097	5587	70904	4597	71401	3075	86386	2228	58625
8L-4S		MI	34885	9282	56845	6794	62357	5486	64828	4488	67434	3003	81175	2457	50388
20-#14	2.57	MA	38746	9282	62300	6888	67412	5582	68762	4591	68610	3089	82850	2150	57493
9L-3S		MI	35622	9282	58130	6775	63995	5493	66818	4497	69969	2990	84032	2581	50464

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

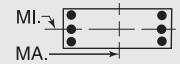


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.57	MA	37925	9282	60908	6910	65704	5602	66724	4609	65843	3103	79424	2062	55978
10L-2S		MI	36667	9282	59701	6780	66009	5476	69275	4482	73285	2978	88438	2706	50490
20-#18	4.58	MA	44871	10493	76467	7594	85308	6099	90533	4873	98300	2967	122608	1863	101354
6E		MI	36532	10493	62824	7489	69582	6007	73535	4788	78806	2851	97357	1682	81512
20-#18	4.58	MA	43589	10493	73976	7631	82303	6133	86839	4902	93344	2990	115873	1632	98261
7L-5S		MI	37603	10493	64658	7500	72119	6022	76634	4808	82785	2829	102239	1827	83496
20-#18	4.58	MA	42328	10493	71738	7624	79256	6122	83234	4932	88079	2968	109649	1509	94799
8L-4S		MI	38728	10493	66612	7511	74651	5994	79743	4784	87180	2851	107451	1925	85548
22-#11	1.96	MA	41834	8913	66442	6648	73073	5390	75767	4465	78122	3089	93980	2812	48065
3L-10S		MI	31142	8913	49481	6598	52945	5361	53381	4435	51950	3066	61463	2285	37159
22-#11	1.96	MA	41191	8913	65329	6663	71655	5404	74044	4461	75904	3099	91397	2725	48026
4L-9S		MI	31595	8913	50196	6602	53909	5366	54531	4424	53503	3058	63344	2346	37644
22-#11	1.96	MA	40617	8913	64369	6661	70410	5401	72512	4474	73686	3093	88712	2683	47948
5L-8S		MI	32025	8913	50969	6588	54859	5353	55739	4430	55070	3049	65287	2400	38083
22-#11	1.96	MA	40072	8913	63469	6659	69162	5415	70988	4469	71676	3103	86150	2627	47641
6L-7S		MI	32451	8913	51686	6591	55835	5358	56894	4419	56751	3058	67269	2448	38345
22-#11	1.96	MA	39540	8913	62483	6675	67973	5412	69525	4482	69713	3114	83418	2537	47071
7L-6S		MI	32883	8913	52485	6577	56798	5345	58078	4408	58331	3049	69409	2538	38742
22-#11	1.96	MA	39016	8913	61597	6673	66766	5426	68097	4495	67627	3107	80907	2487	46680
8L-5S		MI	33327	8913	53213	6580	57807	5350	59311	4414	59949	3040	71413	2594	38992
22-#11	1.96	MA	38463	8913	60731	6671	65593	5423	66604	4491	65682	3117	78423	2434	46096
9L-4S		MI	33793	8913	53990	6583	58814	5337	60548	4403	61734	3049	73533	2634	39027
22-#11	1.96	MA	37884	8913	59760	6686	64402	5437	65184	4504	63754	3128	76015	2373	45419
10L-3S		MI	34313	8913	54888	6569	59958	5342	61938	4409	63516	3040	75549	2721	39031
22-#11	1.96	MA	37319	8913	58892	6684	63235	5434	63710	4499	61698	3121	73566	2320	44737
11L-2S		MI	35051	8913	55986	6572	61367	5329	63657	4398	65847	3032	78654	2807	39013
22-#14	2.83	MA	42703	9438	69482	6974	76838	5623	80305	4611	84265	3044	103142	2485	67692
5L-8S		MI	33104	9438	54085	6896	58702	5576	60393	4566	61268	2989	73869	2090	52405
22-#14	2.83	MA	41933	9438	68191	6971	75048	5642	78118	4604	81382	3058	99496	2405	66545
6L-7S		MI	33706	9438	55114	6901	60102	5583	62049	4551	63660	3001	76688	2157	53456
22-#14	2.83	MA	41183	9438	66775	6992	73341	5637	76018	4622	78565	3073	95606	2275	65833
7L-6S		MI	34316	9438	56258	6881	61482	5566	63745	4536	65909	2989	79724	2287	53943
22-#14	2.83	MA	40444	9438	65504	6989	71609	5657	73970	4640	75572	3062	92026	2204	64511
8L-5S		MI	34943	9438	57303	6886	62928	5573	65512	4545	68210	2976	82566	2369	54746
22-#14	2.83	MA	39673	9438	64260	6986	69925	5652	71827	4633	72781	3077	88490	2127	63408
9L-4S		MI	35600	9438	58416	6892	64371	5556	67285	4530	70750	2989	85582	2426	55251
22-#14	2.83	MA	38855	9438	62868	7007	68217	5672	69789	4651	70014	3091	85063	2039	61836
10L-3S		MI	36335	9438	59701	6872	66009	5563	69275	4540	73285	2976	88438	2550	55346
22-#18	5.03	MA	45151	10769	77412	7804	86708	6257	92213	4978	100655	2967	125643	1584	108550
7L-6S		MI	37752	10769	65569	7662	73100	6131	77826	4864	84540	2822	104938	1620	89595
22-#18	5.03	MA	43899	10769	75174	7796	83660	6246	88607	5007	95389	2946	119419	1461	104977
8L-5S		MI	38817	10769	67403	7673	75637	6147	80925	4884	88519	2800	109820	1765	91754
24-#11	2.14	MA	41833	9021	66698	6731	73410	5453	76184	4490	78816	3091	95358	2710	52276
4L-10S		MI	31659	9021	50580	6666	54353	5409	55099	4464	54281	3057	64568	2265	40475
24-#11	2.14	MA	41262	9021	65737	6729	72164	5450	74653	4503	76597	3084	92673	2667	52185
5L-9S		MI	32112	9021	51295	6669	55317	5414	56249	4453	55835	3049	66449	2326	40946
24-#11	2.14	MA	40718	9021	64838	6727	70917	5464	73128	4499	74588	3094	90111	2612	51794
6L-8S		MI	32538	9021	52068	6655	56267	5402	57457	4459	57401	3040	68392	2380	41438
24-#11	2.14	MA	40189	9021	63851	6742	69727	5461	71665	4512	72625	3105	87379	2522	51242
7E		MI	32963	9021	52785	6658	57244	5406	58613	4448	59082	3049	70374	2428	41693
24-#11	2.14	MA	39667	9021	62966	6740	68520	5475	70237	4525	70539	3098	84868	2472	50861
8L-6S		MI	33394	9021	53583	6644	58207	5394	59796	4437	60663	3040	72514	2518	42074
24-#11	2.14	MA	39116	9021	62099	6738	67347	5471	68744	4520	68594	3109	82384	2418	50222
9L-5S		MI	33836	9021	54312	6647	59216	5398	61029	4443	62280	3031	74518	2574	42401
24-#11	2.14	MA	38539	9021	61129	6754	66157	5486	67324	4533	66666	3119	79975	2357	49562
10L-4S		MI	34301	9021	55089	6651	60223	5386	62267	4432	64065	3040	76638	2614	42447
24-#11	2.14	MA	37977	9021	60261	6752	64989	5482	65850	4529	64609	3113	77527	2305	48839
11L-3S		MI	34819	9021	55986	6637	61367	5390	63657	4438	65847	3031	78654	2701	42467

RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	2.14	MA	37424	9021	59308	6767	63807	5496	64433	4542	62682	3123	74769	2228	47991
12L-2S		MI	35555	9021	57085	6640	62775	5378	65375	4427	68179	3023	81759	2787	42455
24-#14	3.09	MA	42843	9593	70151	7068	77561	5712	81183	4646	85552	3046	105136	2381	72498
6L-8S		MI	33827	9593	55656	6993	60716	5646	62850	4609	64585	2975	78276	2059	57108
24-#14	3.09	MA	42096	9593	68735	7089	75854	5707	79084	4664	82736	3060	101246	2251	71803
7E		MI	34426	9593	56685	6998	62116	5653	64506	4594	66976	2987	81094	2126	58202
24-#14	3.09	MA	41361	9593	67464	7086	74122	5727	77035	4682	79743	3050	97666	2180	70405
8L-6S		MI	35034	9593	57829	6978	63496	5636	66202	4578	69225	2975	84131	2257	58706
24-#14	3.09	MA	40604	9593	66220	7083	72438	5722	74892	4675	76952	3064	94130	2103	69330
9L-5S		MI	35657	9593	58874	6984	64942	5643	67969	4588	71526	2962	86973	2338	59476
24-#14	3.09	MA	39780	9593	64828	7105	70729	5742	72854	4693	74185	3079	90703	2015	67702
10L-4S		MI	36312	9593	59987	6989	66385	5626	69742	4573	74067	2975	89988	2395	60110
24-#18	5.49	MA	45458	11046	78609	7969	88065	6370	93980	5083	102700	2924	129189	1412	115172
8L-6S		MI	38965	11046	68313	7835	76618	6255	82118	4939	90275	2794	112520	1557	97698

RECTANGULAR TIED COLUMNS 38" x 48"

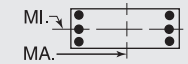
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.32	MA	43884	8892	68490	6642	74344	5410	76022	4505	76206	3222	89875	3043	35146
2L-3S		MI	32624	8892	51574	6519	54888	5346	55127	4451	53157	3164	61200	2713	27454
6-#18	1.32	MA	41431	8892	64881	6636	69718	5444	70378	4536	68527	3246	79557	2821	35233
3L-2S		MI	34480	8892	54319	6530	58406	5318	59419	4427	58892	3142	68781	2934	27319
8-#18	1.75	MA	45572	9169	72098	6815	78970	5534	81666	4581	83885	3200	100193	2997	46476
2L-4S		MI	32580	9169	52067	6725	55537	5455	55933	4506	54509	3158	63882	2429	36000
8-#18	1.75	MA	43138	9169	68490	6808	74344	5569	76022	4611	76206	3224	89875	2776	46477
3E		MI	33891	9169	54319	6692	58406	5471	59419	4526	58892	3136	68781	2650	36070
8-#18	1.75	MA	41430	9169	65549	6846	70597	5558	71468	4598	70345	3248	83161	2554	46197
4L-2S		MI	35735	9169	57063	6703	61924	5442	63710	4502	64626	3113	76363	2872	35984
10-#14	1.23	MA	43674	8840	67748	6648	73650	5419	75274	4518	75229	3247	88925	3087	33238
2L-5S		MI	31850	8840	49789	6555	52838	5362	52714	4467	50056	3196	58056	2686	26015
10-#14	1.23	MA	42271	8840	65690	6645	71013	5414	72056	4537	70852	3262	82976	2962	33287
3L-4S		MI	32527	8840	50902	6561	54282	5345	54487	4452	52596	3209	61071	2743	26001
10-#14	1.23	MA	41289	8840	64018	6667	68881	5434	69466	4530	67518	3277	79096	2838	33295
4L-3S		MI	33282	8840	52187	6541	55919	5352	56477	4462	55131	3196	63928	2867	25941
10-#14	1.23	MA	40414	8840	62574	6664	67008	5430	67163	4549	64181	3267	75063	2777	33200
5L-2S		MI	34349	8840	53759	6546	57933	5335	58934	4447	58447	3184	68335	2992	25872
10-#18	2.19	MA	47243	9445	75707	6988	83596	5659	87309	4656	91563	3178	110511	2951	57775
2L-5S		MI	32678	9445	52858	6886	56523	5608	57115	4606	55849	3107	66250	2269	42784
10-#18	2.19	MA	44827	9445	72098	6981	78970	5693	81666	4687	83885	3202	100193	2730	57685
3L-4S		MI	33845	9445	54811	6897	59055	5579	60224	4582	60244	3129	71463	2367	44475
10-#18	2.19	MA	43133	9445	69158	7019	75223	5683	77111	4673	78023	3226	93479	2509	57309
4L-3S		MI	35147	9445	57063	6864	61924	5595	63710	4602	64626	3107	76363	2588	44638
10-#18	2.19	MA	41621	9445	66616	7012	71926	5717	73060	4704	72155	3206	86460	2403	54936
5L-2S		MI	36979	9445	59807	6876	65442	5566	68002	4578	70361	3085	83944	2810	44611
12-#11	1.03	MA	42897	8709	65973	6586	71505	5376	72707	4496	71759	3268	84362	3122	27887
2L-6S		MI	31573	8709	48899	6493	51750	5312	51432	4438	48424	3230	55819	2770	21933
12-#11	1.03	MA	41913	8709	64537	6584	69665	5373	70462	4509	68704	3279	80187	3036	27927
3L-5S		MI	32025	8709	49628	6496	52759	5316	52665	4444	50041	3222	57823	2826	21909
12-#11	1.03	MA	41225	8709	63371	6600	68178	5387	68655	4505	66379	3290	77461	2950	27961
4E		MI	32499	8709	50405	6500	53766	5304	53902	4433	51827	3230	59943	2866	21863
12-#11	1.03	MA	40612	8709	62365	6598	66873	5385	67051	4518	64054	3284	74635	2907	27967
5L-3S		MI	33029	8709	51302	6486	54909	5308	55292	4439	53608	3222	61959	2952	21812
12-#11	1.03	MA	40029	8709	61422	6596	65566	5399	65453	4514	61948	3295	71933	2851	27919
6L-2S		MI	33778	8709	52401	6489	56318	5296	57011	4428	55940	3213	65064	3039	21763

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

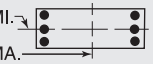


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#14	1.48	MA	44649	8996	69805	6746	76288	5488	78491	4560	79607	3235	94874	3064	39695
2L-6S		MI	31947	8996	50316	6647	53407	5424	53404	4500	51071	3195	59620	2573	30419
12-#14	1.48	MA	43252	8996	67748	6743	73650	5484	75274	4579	75229	3250	88925	2940	39730
3L-5S		MI	32589	8996	51360	6653	54852	5432	55171	4510	53372	3182	62462	2655	30898
12-#14	1.48	MA	42275	8996	66076	6765	71519	5504	72683	4573	71895	3265	85045	2815	39695
4E		MI	33263	8996	52473	6658	56296	5414	56944	4495	55912	3195	65478	2712	30924
12-#14	1.48	MA	41404	8996	64631	6762	69645	5499	70380	4591	68559	3255	81012	2754	39563
5L-3S		MI	34015	8996	53759	6638	57933	5422	58934	4504	58447	3182	68335	2836	30886
12-#14	1.48	MA	40575	8996	63278	6759	67770	5520	68088	4585	65538	3270	77164	2674	38800
6L-2S		MI	35077	8996	55330	6643	59947	5404	61391	4489	61764	3170	72741	2961	30830
12-#18	2.63	MA	48899	9722	79316	7161	88223	5783	92953	4731	99242	3156	120830	2906	69026
2L-6S		MI	32836	9722	53768	7048	57505	5716	58307	4662	57604	3100	68950	2061	49600
12-#18	2.63	MA	46499	9722	75707	7154	83596	5817	87309	4762	91563	3180	110511	2684	68870
3L-5S		MI	33940	9722	55602	7059	60041	5732	61406	4682	61583	3078	73832	2207	50933
12-#18	2.63	MA	44819	9722	72767	7192	79849	5807	82755	4749	85702	3204	103797	2463	68410
4E		MI	35099	9722	57555	7070	62573	5703	64516	4657	65978	3100	79044	2304	52930
12-#18	2.63	MA	43320	9722	70224	7185	76552	5841	78703	4779	79834	3184	96778	2357	65718
5L-3S		MI	36391	9722	59807	7037	65442	5719	68002	4677	70361	3078	83944	2526	53168
12-#18	2.63	MA	41893	9722	67841	7178	73251	5831	74668	4766	74516	3207	90110	2213	63686
6L-2S		MI	38212	9722	62551	7049	68960	5690	72294	4653	76095	3056	91525	2747	53210
14-#11	1.20	MA	43584	8817	67409	6653	73346	5424	74953	4525	74815	3259	88537	3108	32400
2L-7S		MI	31656	8817	49200	6575	52195	5373	51967	4479	49174	3230	56784	2659	25121
14-#11	1.20	MA	42603	8817	65973	6652	71505	5421	72707	4539	71759	3270	84362	3021	32433
3L-6S		MI	32095	8817	49998	6561	53158	5360	53150	4467	50755	3221	58924	2750	25361
14-#11	1.20	MA	41919	8817	64807	6667	70019	5436	70901	4535	69435	3281	81636	2935	32455
4L-5S		MI	32546	8817	50727	6564	54167	5365	54383	4474	52373	3213	60928	2806	25356
14-#11	1.20	MA	41308	8817	63800	6665	68714	5433	69296	4548	67109	3275	78810	2892	32437
5L-4S		MI	33018	8817	51504	6567	55174	5352	55621	4462	54158	3221	63048	2846	25324
14-#11	1.20	MA	40727	8817	62858	6664	67407	5447	67699	4544	65004	3286	76108	2836	32369
6L-3S		MI	33546	8817	52401	6553	56318	5357	57011	4469	55940	3213	65064	2932	25281
14-#11	1.20	MA	40161	8817	61824	6679	66161	5444	66166	4557	62947	3297	73228	2747	31945
7L-2S		MI	34293	8817	53500	6556	57727	5344	58729	4457	58271	3204	68169	3019	25237
14-#14	1.73	MA	45617	9151	71862	6843	78925	5558	81709	4603	83984	3222	100822	3042	46140
2L-7S		MI	32062	9151	50743	6764	54041	5512	54165	4558	52138	3193	60990	2412	34566
14-#14	1.73	MA	44226	9151	69805	6840	76288	5554	78491	4621	79607	3237	94874	2917	46147
3L-6S		MI	32685	9151	51887	6745	55421	5494	55861	4543	54387	3181	64027	2542	35140
14-#14	1.73	MA	43255	9151	68133	6862	74156	5574	75901	4615	76273	3252	90994	2793	46084
4L-5S		MI	33324	9151	52931	6750	56866	5502	57628	4552	56689	3168	66869	2624	35770
14-#14	1.73	MA	42388	9151	66688	6859	72283	5569	73598	4633	72937	3242	86961	2732	45918
5L-4S		MI	33995	9151	54044	6755	58310	5484	59401	4537	59229	3181	69885	2681	35828
14-#14	1.73	MA	41564	9151	65335	6856	70407	5589	71305	4627	69915	3258	83113	2651	45001
6L-3S		MI	34743	9151	55330	6735	59947	5492	61391	4547	61764	3168	72741	2805	35816
14-#14	1.73	MA	40760	9151	63852	6878	68618	5585	69105	4646	66964	3273	79010	2521	44118
7L-2S		MI	35801	9151	56901	6741	61961	5474	63848	4531	65080	3156	77148	2930	35773
14-#18	3.07	MA	48156	9999	79316	7327	88223	5941	92953	4838	99242	3158	120830	2639	80039
3L-6S		MI	34095	9999	56512	7221	61023	5841	62599	4737	63339	3072	76531	1999	57852
14-#18	3.07	MA	46489	9999	76375	7365	84475	5931	88398	4824	93381	3182	114115	2417	79504
4L-5S		MI	35191	9999	58346	7232	63559	5856	65698	4757	67318	3049	81413	2145	59115
14-#18	3.07	MA	45002	9999	73833	7358	81178	5965	84347	4855	87512	3161	107096	2311	76533
5L-4S		MI	36342	9999	60299	7243	66091	5827	68808	4733	71713	3072	86626	2242	61372
14-#18	3.07	MA	43587	9999	71450	7351	77877	5955	80312	4841	82195	3185	100429	2168	74588
6L-3S		MI	37626	9999	62551	7210	68960	5843	72294	4753	76095	3049	91525	2463	61676
14-#18	3.07	MA	42210	9999	68838	7389	74727	5989	76439	4872	76999	3209	93314	1937	71213
7L-2S		MI	39435	9999	65295	7221	72478	5814	76585	4728	81830	3027	99107	2685	61781
16-#11	1.37	MA	44269	8925	68845	6721	75187	5473	77199	4555	77870	3251	92712	3093	36906
2L-8S		MI	31746	8925	49581	6639	52627	5416	52530	4519	49825	3212	57907	2592	28162
16-#11	1.37	MA	43291	8925	67409	6719	73346	5470	74953	4568	74815	3262	88537	3007	36931
3L-7S		MI	32177	8925	50299	6642	53604	5421	53685	4508	51505	3221	59889	2639	28454

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis



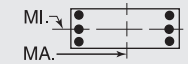
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.37	MA	42608	8925	66243	6735	71860	5484	73147	4564	72490	3273	85811	2921	36937
4L-6S		MI	32615	8925	51097	6628	54567	5409	54869	4497	53086	3212	62029	2730	28779
16-#11	1.37	MA	42000	8925	65236	6733	70555	5481	71542	4577	70165	3266	82985	2878	36901
5E		MI	33064	8925	51826	6631	55576	5413	56102	4503	54704	3204	64033	2786	28796
16-#11	1.37	MA	41421	8925	64294	6731	69248	5496	69945	4573	68059	3277	80283	2822	36814
6L-4S		MI	33535	8925	52602	6634	56583	5401	57339	4492	56489	3212	66153	2826	28775
16-#11	1.37	MA	40858	8925	63260	6747	68001	5493	68412	4586	66003	3288	77403	2732	36304
7L-3S		MI	34061	8925	53500	6620	57727	5405	58729	4498	58271	3204	68169	2912	28741
16-#11	1.37	MA	40293	8925	62333	6745	66737	5507	66916	4600	63817	3282	74760	2682	35841
8L-2S		MI	34806	8925	54599	6624	59135	5393	60447	4487	60602	3195	71274	2999	28703
16-#14	1.97	MA	46580	9307	73920	6940	81562	5628	84926	4645	88362	3210	106771	3019	52580
2L-8S		MI	32188	9307	51285	6856	54655	5574	54966	4616	53063	3167	62579	2314	38643
16-#14	1.97	MA	45195	9307	71862	6937	78925	5623	81709	4664	83984	3225	100822	2895	52554
3L-7S		MI	32799	9307	52314	6862	56055	5582	56622	4600	55455	3179	65397	2381	39327
16-#14	1.97	MA	44228	9307	70190	6959	76794	5644	79118	4657	80650	3240	96943	2770	52464
4L-6S		MI	33419	9307	53458	6842	57435	5564	58318	4585	57704	3167	68434	2511	39874
16-#14	1.97	MA	43366	9307	68746	6956	74920	5639	76815	4676	77314	3230	92910	2709	52268
5E		MI	34055	9307	54502	6847	58880	5572	60085	4595	60005	3154	71276	2593	40633
16-#14	1.97	MA	42546	9307	67392	6953	73044	5659	74523	4670	74293	3245	89062	2629	51216
6L-4S		MI	34723	9307	55615	6852	60323	5554	61858	4579	62545	3167	74291	2650	40717
16-#14	1.97	MA	41747	9307	65909	6975	71256	5655	72323	4688	71341	3260	84959	2499	50366
7L-3S		MI	35468	9307	56901	6833	61961	5561	63848	4589	65080	3154	77148	2774	40741
16-#14	1.97	MA	40960	9307	64577	6972	69441	5675	70176	4707	68204	3250	81187	2427	49375
8L-2S		MI	36522	9307	58472	6838	63975	5544	66305	4574	68397	3142	81554	2899	40706
16-#18	3.51	MA	48145	10275	79984	7538	89101	6055	94042	4900	101059	3160	124433	2372	90593
4L-6S		MI	35343	10275	59256	7394	64540	5965	66891	4812	69074	3043	84113	1937	65926
16-#18	3.51	MA	46669	10275	77442	7531	85804	6089	89991	4930	95191	3139	117414	2266	87374
5E		MI	36432	10275	61090	7405	67077	5980	69990	4832	73053	3021	88994	2082	67321
16-#18	3.51	MA	45266	10275	75058	7524	82503	6079	85956	4917	89874	3163	110747	2122	85506
6L-4S		MI	37575	10275	63044	7416	69609	5952	73099	4808	77448	3043	94207	2180	69671
16-#18	3.51	MA	43899	10275	72447	7562	79353	6113	82083	4948	84678	3187	103633	1891	81973
7L-3S		MI	38851	10275	65295	7383	72478	5967	76585	4828	81830	3021	99107	2401	70169
16-#18	3.51	MA	42554	10275	70101	7555	76158	6103	78303	4978	79156	3167	97070	1767	78787
8L-2S		MI	40650	10275	68040	7394	75995	5939	80877	4804	87564	2999	106688	2623	70323
18-#11	1.54	MA	44950	9033	70281	6788	77028	5521	79444	4584	80925	3242	96887	3079	41406
2L-9S		MI	31830	9033	49907	6720	53086	5477	53040	4542	50589	3212	59069	2518	31273
18-#11	1.54	MA	43975	9033	68845	6786	75187	5518	77199	4597	77870	3253	92712	2992	41423
3L-8S		MI	32267	9033	50680	6706	54036	5465	54248	4548	52156	3203	61012	2572	31511
18-#11	1.54	MA	43295	9033	67679	6802	73701	5533	75392	4593	75545	3264	89986	2906	41410
4L-7S		MI	32697	9033	51397	6709	55013	5470	55403	4537	53836	3212	62994	2619	31791
18-#11	1.54	MA	42689	9033	66672	6800	72395	5530	73788	4607	73220	3258	87160	2863	41359
5L-6S		MI	33133	9033	52196	6695	55975	5457	56587	4526	55417	3203	65134	2710	32192
18-#11	1.54	MA	42113	9033	65730	6799	71089	5544	72190	4603	71115	3269	84458	2807	41255
6L-5S		MI	33580	9033	52924	6699	56984	5462	57820	4532	57035	3195	67138	2766	32224
18-#11	1.54	MA	41551	9033	64696	6814	69842	5541	70658	4616	69058	3280	81578	2718	40668
7L-4S		MI	34050	9033	53701	6702	57992	5449	59058	4521	58820	3203	69258	2806	32219
18-#11	1.54	MA	40991	9033	63769	6812	68578	5556	69162	4629	66872	3273	78935	2667	40221
8L-3S		MI	34574	9033	54599	6688	59135	5454	60447	4527	60602	3195	71274	2892	32194
18-#11	1.54	MA	40403	9033	62861	6811	67349	5553	67598	4625	64835	3284	76315	2614	39821
9L-2S		MI	35317	9033	55697	6691	60544	5441	62166	4516	62933	3186	74379	2979	32161
18-#14	2.22	MA	46158	9463	73920	7034	81562	5693	84926	4706	88362	3212	106771	2872	58953
3L-8S		MI	32923	9463	52856	6954	56669	5644	57422	4658	56380	3153	66985	2283	43316
18-#14	2.22	MA	45196	9463	72247	7056	79431	5714	82335	4700	85028	3227	102892	2748	58838
4L-7S		MI	33531	9463	53885	6959	58069	5651	59079	4643	58771	3165	69804	2350	44093

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

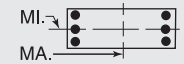


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.22	MA	44338	9463	70803	7053	77557	5709	80033	4718	81692	3218	98859	2687	58615
5L-6S		MI	34149	9463	55029	6939	59449	5634	60775	4627	61020	3153	72840	2480	44618
18-#14	2.22	MA	43522	9463	69450	7051	75682	5729	77740	4712	78670	3233	95010	2606	57442
6L-5S		MI	34782	9463	56073	6944	60894	5641	62541	4637	63321	3140	75682	2562	45489
18-#14	2.22	MA	42727	9463	67967	7073	73893	5725	75540	4730	75719	3248	90908	2476	56620
7L-4S		MI	35447	9463	57186	6950	62337	5624	64314	4622	65862	3153	78698	2619	45598
18-#14	2.22	MA	41944	9463	66635	7070	72078	5745	73393	4749	72581	3238	87136	2405	55537
8L-3S		MI	36189	9463	58472	6930	63975	5631	66305	4631	68397	3140	81554	2743	45642
18-#14	2.22	MA	41112	9463	65332	7067	70314	5740	71148	4743	69657	3253	83405	2327	54273
9L-2S		MI	37239	9463	60043	6935	65989	5614	68762	4616	71713	3128	85961	2868	45630
18-#18	3.95	MA	48322	10552	81050	7704	90431	6213	95634	5006	102870	3117	127732	2220	98237
5L-6S		MI	36583	10552	62000	7567	68058	6089	71182	4888	74808	3014	91694	1874	73954
18-#18	3.95	MA	46930	10552	78667	7697	87129	6203	91599	4992	97552	3141	121065	2076	96256
6L-5S		MI	37665	10552	63834	7578	70595	6104	74281	4908	78787	2992	96576	2020	75547
18-#18	3.95	MA	45574	10552	76056	7735	83979	6237	87727	5023	92356	3165	113951	1846	92753
7L-4S		MI	38800	10552	65788	7589	73126	6076	77391	4883	83182	3014	101788	2117	77770
18-#18	3.95	MA	44239	10552	73710	7728	80784	6227	83946	5054	86835	3145	107388	1721	89451
8L-3S		MI	40067	10552	68040	7556	75995	6091	80877	4903	87564	2992	106688	2339	78649
20-#11	1.71	MA	45628	9141	71716	6856	78869	5570	81690	4614	83981	3233	101062	3064	45901
2L-10S		MI	31898	9141	50291	6784	53531	5521	53608	4583	51367	3211	60293	2437	34053
20-#11	1.71	MA	44656	9141	70281	6854	77028	5567	79444	4627	80925	3244	96887	2978	45906
3L-9S		MI	32352	9141	51006	6788	54494	5526	54758	4572	52920	3203	62174	2498	34562
20-#11	1.71	MA	43979	9141	69115	6869	75542	5581	77638	4623	78601	3255	94161	2891	45879
4L-8S		MI	32786	9141	51779	6774	55445	5513	55966	4578	54487	3194	64117	2552	34863
20-#11	1.71	MA	43375	9141	68108	6868	74236	5578	76033	4636	76276	3249	91336	2849	45814
5L-7S		MI	33214	9141	52496	6777	56421	5518	57122	4567	56167	3203	66099	2599	35134
20-#11	1.71	MA	42801	9141	67166	6866	72929	5593	74436	4632	74170	3260	88633	2793	45689
6E		MI	33649	9141	53294	6763	57384	5505	58305	4556	57748	3194	68239	2689	35558
20-#11	1.71	MA	42241	9141	66132	6881	71683	5590	72903	4645	72114	3271	85753	2703	45039
7L-5S		MI	34095	9141	54023	6766	58393	5510	59538	4562	59366	3186	70243	2746	35645
20-#11	1.71	MA	41690	9141	65205	6880	70419	5604	71408	4659	69928	3265	83110	2653	44604
8L-4S		MI	34562	9141	54800	6769	59400	5497	60776	4551	61151	3194	72363	2786	35658
20-#11	1.71	MA	41098	9141	64297	6878	69190	5601	69843	4655	67890	3276	80490	2599	44142
9L-3S		MI	35085	9141	55697	6755	60544	5502	62166	4557	62933	3186	74379	2872	35641
20-#11	1.71	MA	40489	9141	63281	6894	67943	5616	68356	4668	65870	3287	77950	2538	43387
10L-2S		MI	35826	9141	56796	6758	61952	5490	63884	4546	65264	3177	77484	2959	35614
20-#14	2.47	MA	46158	9618	74305	7154	82068	5783	85553	4742	89406	3215	108840	2725	65207
4L-8S		MI	33655	9618	54427	7051	58683	5714	59879	4700	59696	3139	71392	2252	47999
20-#14	2.47	MA	45304	9618	72860	7151	80195	5779	83250	4761	86069	3205	104807	2664	64958
5L-7S		MI	34260	9618	55456	7056	60083	5721	61536	4685	62087	3151	74210	2319	48864
20-#14	2.47	MA	44492	9618	71507	7148	78319	5799	80958	4754	83048	3220	100959	2583	63677
6E		MI	34875	9618	56600	7036	61463	5704	63232	4670	64336	3139	77247	2450	49369
20-#14	2.47	MA	43701	9618	70024	7170	76530	5794	78758	4773	80096	3235	96857	2454	62881
7L-5S		MI	35505	9618	57644	7042	62908	5711	64998	4680	66638	3126	80089	2531	50232
20-#14	2.47	MA	42923	9618	68692	7167	74716	5815	76611	4791	76959	3225	93085	2382	61710
8L-4S		MI	36167	9618	58757	7047	64351	5694	66771	4664	69178	3139	83104	2588	50471
20-#14	2.47	MA	42095	9618	67389	7164	72951	5810	74366	4785	74034	3240	89353	2305	60479
9L-3S		MI	36906	9618	60043	7027	65989	5701	68762	4674	71713	3126	85961	2712	50534
20-#14	2.47	MA	41234	9618	65930	7186	71161	5830	72230	4804	71135	3256	85737	2217	59011
10L-2S		MI	37952	9618	61614	7032	68003	5684	71219	4659	75029	3114	90368	2837	50554
20-#18	4.39	MA	48581	10828	82276	7870	91755	6327	97243	5068	105231	3119	131383	2031	106945
6E		MI	37814	10828	64745	7740	71576	6213	75474	4963	80543	2986	99275	1812	82008
20-#18	4.39	MA	47235	10828	79664	7908	88606	6362	93370	5098	100035	3143	124269	1800	103553
7L-5S		MI	38888	10828	66579	7751	74113	6229	78573	4983	84522	2963	104157	1958	83790
20-#18	4.39	MA	45910	10828	77318	7901	85411	6351	89590	5129	94513	3123	117706	1676	100136
8L-4S		MI	40017	10828	68532	7762	76644	6200	81683	4959	88917	2986	109370	2055	85899
22-#11	1.88	MA	45335	9249	71716	6921	78869	5615	81690	4656	83981	3236	101062	2963	50382
3L-10S		MI	32418	9249	51390	6852	54939	5570	55327	4612	53698	3202	63398	2417	37364

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

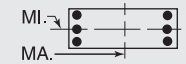
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.88	MA	44659	9249	70551	6937	77383	5629	79884	4652	81656	3247	98336	2877	50343
4L-9S		MI	32872	9249	52105	6855	55903	5574	56477	4601	55251	3194	65279	2478	37857
22-#11	1.88	MA	44058	9249	69544	6935	76077	5627	78279	4665	79331	3240	95511	2834	50264
5L-8S		MI	33302	9249	52877	6841	56853	5562	57685	4607	56818	3185	67222	2532	38218
22-#11	1.88	MA	43486	9249	68601	6933	74770	5641	76682	4661	77226	3251	92808	2778	50041
6L-7S		MI	33729	9249	53595	6844	57830	5566	58840	4596	58499	3194	69204	2579	38479
22-#11	1.88	MA	42928	9249	67568	6949	73524	5638	75149	4675	75169	3262	89928	2688	49413
7L-6S		MI	34162	9249	54393	6830	58793	5554	60024	4585	60080	3185	71344	2669	38885
22-#11	1.88	MA	42379	9249	66641	6947	72260	5653	73653	4688	72983	3256	87285	2638	48990
8L-5S		MI	34607	9249	55122	6833	59802	5558	61257	4591	61697	3177	73348	2726	39061
22-#11	1.88	MA	41790	9249	65733	6945	71031	5650	72089	4684	70945	3267	84665	2585	48468
9L-4S		MI	35073	9249	55899	6837	60809	5546	62494	4580	63482	3185	75468	2766	39088
22-#11	1.88	MA	41183	9249	64717	6961	69784	5664	70601	4697	68925	3278	82125	2524	47732
10L-3S		MI	35594	9249	56796	6823	61952	5551	63884	4586	65264	3177	77484	2852	39083
22-#11	1.88	MA	40591	9249	63808	6959	68561	5661	69057	4693	66771	3272	79547	2471	47108
11L-2S		MI	36333	9249	57895	6826	63361	5538	65603	4575	67595	3168	80589	2939	39062
22-#14	2.71	MA	46265	9774	74918	7248	82832	5849	86468	4803	90447	3193	110756	2641	71185
5L-8S		MI	34382	9774	55998	7148	60697	5784	62336	4743	63013	3124	75799	2221	52692
22-#14	2.71	MA	45457	9774	73564	7245	80957	5869	84175	4797	87426	3208	106908	2561	69920
6L-7S		MI	34985	9774	57027	7153	62097	5791	63993	4728	65404	3137	78617	2288	53639
22-#14	2.71	MA	44670	9774	72081	7267	79168	5864	81975	4815	84474	3223	102805	2431	69146
7L-6S		MI	35597	9774	58171	7134	63477	5774	65689	4712	67653	3124	81654	2419	54127
22-#14	2.71	MA	43895	9774	70749	7264	77353	5884	79828	4834	81337	3213	99034	2360	67891
8L-5S		MI	36225	9774	59215	7139	64922	5781	67455	4722	69954	3112	84496	2500	54951
22-#14	2.71	MA	43073	9774	69446	7261	75588	5880	77583	4827	78412	3228	95302	2282	66693
9L-4S		MI	36884	9774	60329	7144	66365	5764	69228	4707	72495	3124	87511	2557	55338
22-#14	2.71	MA	42215	9774	67987	7283	73798	5900	75447	4846	75512	3243	91686	2194	65165
10L-3S		MI	37619	9774	61614	7124	68003	5771	71219	4716	75029	3112	90368	2681	55420
22-#18	4.82	MA	48884	11105	83273	8080	93232	6486	99014	5174	107714	3121	134587	1754	114369
7L-6S		MI	39037	11105	67489	7912	75094	6337	79766	5039	86277	2957	106857	1750	90085
22-#18	4.82	MA	47569	11105	80927	8074	90037	6476	95234	5204	102192	3101	128024	1630	110839
8L-5S		MI	40104	11105	69323	7924	77631	6353	82865	5059	90256	2935	111738	1895	92047
24-#11	2.05	MA	45337	9357	71987	7004	79223	5678	82130	4682	84712	3238	102512	2862	54803
4L-10S		MI	32935	9357	52488	6919	56348	5618	57045	4642	56029	3193	66503	2396	40679
24-#11	2.05	MA	44738	9357	70980	7003	77918	5675	80525	4695	82386	3232	99686	2819	54712
5L-9S		MI	33389	9357	53204	6923	57312	5623	58195	4631	57583	3185	68384	2458	41158
24-#11	2.05	MA	44168	9357	70037	7001	76611	5689	78927	4691	80281	3243	96983	2764	54399
6L-8S		MI	33816	9357	53976	6909	58262	5610	59403	4637	59149	3176	70327	2512	41573
24-#11	2.05	MA	43612	9357	69004	7016	75365	5687	77395	4704	78224	3254	94104	2674	53792
7E		MI	34242	9357	54694	6912	59238	5615	60559	4626	60830	3185	72309	2559	41828
24-#11	2.05	MA	43066	9357	68077	7015	74101	5701	75899	4717	76038	3248	91461	2624	53378
8L-6S		MI	34674	9357	55492	6898	60201	5602	61742	4614	62411	3176	74449	2649	42218
24-#11	2.05	MA	42479	9357	67169	7013	72871	5698	74335	4713	74001	3259	88840	2570	52800
9L-5S		MI	35117	9357	56221	6901	61210	5607	62975	4621	64028	3168	76453	2706	42474
24-#11	2.05	MA	41874	9357	66153	7028	71624	5712	72847	4727	71981	3269	86300	2509	52081
10L-4S		MI	35582	9357	56998	6904	62217	5594	64213	4609	65813	3176	78573	2746	42510
24-#11	2.05	MA	41283	9357	65243	7027	70402	5710	71303	4723	69826	3263	83723	2456	51415
11L-3S		MI	36101	9357	57895	6890	63361	5599	65603	4616	67595	3168	80589	2832	42521
24-#11	2.05	MA	40704	9357	64245	7042	69164	5724	69818	4736	67807	3274	80815	2379	50495
12L-2S		MI	36838	9357	58994	6893	64770	5586	67321	4604	69927	3159	83694	2918	42506
24-#14	2.96	MA	46417	9929	75622	7342	83594	5939	87393	4839	91803	3195	112857	2538	76170
6L-8S		MI	35106	9929	57569	7245	62711	5854	64793	4785	66329	3110	80205	2190	57393
24-#14	2.96	MA	45634	9929	74139	7364	81805	5934	85193	4858	88851	3210	108754	2409	75416
7E		MI	35706	9929	58598	7251	64111	5861	66449	4770	68720	3123	83023	2257	58417

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#14	2.96	MA	44863	9929	72807	7361	79991	5954	83046	4876	85714	3201	104982	2337	74081
8L-6S		MI	36316	9929	59742	7231	65491	5843	68146	4755	70969	3110	86060	2388	58891
24-#14	2.96	MA	44045	9929	71504	7358	78226	5950	80800	4870	82790	3216	101251	2260	72912
9L-5S		MI	36941	9929	60786	7236	66936	5851	69912	4764	73271	3098	88902	2469	59680
24-#14	2.96	MA	43191	9929	70044	7380	76436	5970	78665	4888	79890	3231	97635	2172	71328
10L-4S		MI	37597	9929	61900	7241	68379	5833	71685	4749	75811	3110	91918	2526	60201
24-#18	5.26	MA	49215	11382	84536	8247	94663	6600	100877	5280	109871	3079	138343	1584	121559
8L-6S		MI	40252	11382	70233	8085	78612	6461	84057	5114	92012	2928	114438	1688	98183

RECTANGULAR TIED COLUMNS 40" x 40"

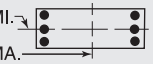
6-#18	1.50	MA	32390	7902	51213	5815	55410	4730	56717	3927	56975	2765	67027	2575	28723
2L-3S		MI	30421	7902	48296	5805	51670	4760	52155	3953	50845	2787	58900	2354	28822
8-#14	1.13	MA	31464	7694	48970	5726	52753	4670	53558	3899	52896	2814	61734	2656	21947
2L-4S		MI	29527	7694	45939	5742	48878	4682	48838	3906	46651	2839	53958	2406	22074
8-#18	2.00	MA	33725	8179	54130	5988	59149	4854	61279	4003	63106	2738	75155	2517	37900
2L-4S		MI	30387	8179	48823	6012	52365	4870	53017	4010	52290	2782	61765	2074	37695
10-#14	1.41	MA	32244	7850	50639	5823	54891	4740	56167	3942	56435	2801	66448	2627	27210
2L-5S		MI	29602	7850	46428	5834	49487	4770	49568	3965	47480	2813	55454	2320	27219
10-#14	1.41	MA	31113	7850	48970	5819	52753	4758	53558	3958	52896	2813	61734	2502	27265
3L-4S		MI	30316	7850	47608	5839	51016	4751	51447	3949	50190	2826	58673	2378	27289
10-#18	2.50	MA	35047	8455	57047	6161	62889	4978	65841	4078	69236	2711	83283	2459	47042
2L-5S		MI	30506	8455	49669	6175	53420	5024	54281	4112	53724	2733	64320	1916	44242
10-#18	2.50	MA	33107	8455	54130	6151	59149	5008	61279	4104	63106	2733	75155	2237	46983
3L-4S		MI	31735	8455	51740	6185	56105	4994	57579	4086	58420	2755	69893	2016	46660

RECTANGULAR TIED COLUMNS 40" x 42"

6-#18	1.43	MA	35561	8256	55989	6103	60609	4966	61992	4128	62209	2924	73174	2735	30343
2L-3S		MI	31837	8256	50419	6070	53880	4978	54307	4138	52774	2929	61032	2491	28889
6-#18	1.43	MA	33470	8256	52899	6093	56648	4997	57160	4155	55682	2946	64499	2514	30442
3L-2S		MI	33808	8256	53336	6080	57619	4948	58869	4112	58904	2907	69160	2713	28779
8-#14	1.07	MA	34569	8048	53605	6013	57783	4907	58632	4100	57816	2971	67483	2812	23162
2L-4S		MI	30941	8048	48054	6009	51088	4901	50994	4093	48588	2982	56102	2545	22128
8-#14	1.07	MA	33364	8048	51839	6009	55520	4925	55871	4117	54060	2984	62460	2688	23233
3E		MI	31744	8048	49417	5988	52824	4908	53105	4102	51293	2970	59163	2670	22063
8-#14	1.07	MA	32516	8048	50399	6030	53685	4919	53641	4109	51189	2996	59195	2563	23289
4L-2S		MI	32881	8048	51085	5993	54963	4890	55714	4086	54833	2957	63877	2794	21990
8-#18	1.90	MA	36984	8532	59079	6275	64570	5090	66825	4204	68735	2900	81848	2681	40060
2L-4S		MI	31802	8532	50946	6277	54575	5088	55169	4195	54219	2924	63898	2212	37823
8-#18	1.90	MA	34910	8532	55989	6266	60609	5122	61992	4231	62209	2922	73174	2459	40084
3E		MI	33189	8532	53336	6243	57619	5102	58869	4214	58904	2902	69160	2433	38007
8-#18	1.90	MA	33444	8532	53462	6301	57389	5109	58079	4214	57220	2944	67549	2238	39855
4L-2S		MI	35146	8532	56253	6253	61359	5072	63431	4188	65035	2880	77287	2655	37963
10-#14	1.34	MA	35398	8204	55370	6111	60047	4976	61394	4142	61573	2958	72506	2785	28729
2L-5S		MI	31016	8204	48543	6101	51697	4989	51724	4151	49417	2957	57598	2458	27306
10-#14	1.34	MA	34200	8204	53605	6107	57783	4995	58632	4159	57816	2971	67483	2660	28784
3L-4S		MI	31731	8204	49723	6106	53226	4971	53603	4135	52127	2969	60817	2516	27353
10-#14	1.34	MA	33356	8204	52165	6127	55948	4989	56402	4151	54946	2984	64218	2536	28807
4L-3S		MI	32530	8204	51085	6086	54963	4978	55714	4144	54833	2957	63877	2641	27316
10-#14	1.34	MA	32601	8204	50919	6123	54333	5008	54417	4168	52071	2972	60796	2477	28738
5L-2S		MI	33661	8204	52753	6090	57101	4960	58323	4128	58372	2944	68592	2765	27257
10-#18	2.38	MA	38393	8809	62169	6448	68532	5215	71657	4279	75262	2875	90523	2626	49742
2L-5S		MI	31920	8809	51792	6440	55630	5242	56433	4297	55653	2876	66452	2054	44595
10-#18	2.38	MA	36334	8809	59079	6439	64570	5246	66825	4306	68735	2897	81848	2405	49683
3L-4S		MI	33151	8809	53863	6450	58314	5212	59731	4271	60350	2898	72025	2154	46801

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

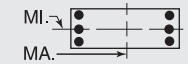
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#18	2.38	MA	34881	8809	56552	6474	61350	5233	62911	4289	63747	2919	76224	2183	49360
4L-3S		MI	34527	8809	56253	6416	61359	5226	63431	4289	65035	2876	77287	2375	47077
10-#18	2.38	MA	33581	8809	54363	6465	58512	5264	59425	4317	58748	2897	70289	2082	46999
5L-2S		MI	36470	8809	59170	6426	65099	5196	67993	4263	71165	2853	85415	2596	47111
12-#11	1.11	MA	34747	8073	53853	6049	58219	4934	59209	4121	58619	2980	68708	2826	24136
2L-6S		MI	30718	8073	47608	6036	50537	4936	50353	4119	47647	2988	55172	2539	23012
12-#11	1.11	MA	33905	8073	52619	6047	56638	4931	57280	4133	55994	2989	65176	2740	24179
3L-5S		MI	31195	8073	48380	6039	51606	4940	51659	4125	49368	2979	57315	2595	23027
12-#11	1.11	MA	33314	8073	51615	6062	55357	4944	55723	4128	53991	2999	62876	2653	24218
4E		MI	31696	8073	49202	6041	52673	4927	52970	4113	51267	2987	59576	2636	23000
12-#11	1.11	MA	32785	8073	50746	6059	54231	4940	54339	4140	51986	2991	60474	2612	24237
5L-3S		MI	32256	8073	50154	6027	53885	4931	54443	4119	53163	2978	61734	2722	22957
12-#11	1.11	MA	32282	8073	49932	6056	53103	4954	52960	4135	50169	3000	58191	2556	24205
6L-2S		MI	33051	8073	51320	6030	55380	4918	56267	4107	55644	2969	65053	2809	22912
12-#14	1.61	MA	36223	8359	57136	6208	62310	5046	64155	4185	65330	2946	77529	2758	34279
2L-6S		MI	31127	8359	49105	6194	52304	5052	52462	4185	50500	2956	59270	2348	31719
12-#14	1.61	MA	35029	8359	55370	6204	60047	5065	61394	4202	61573	2959	72506	2633	34317
3L-5S		MI	31804	8359	50211	6198	53836	5059	54333	4194	52956	2944	62312	2429	32470
12-#14	1.61	MA	34190	8359	53930	6225	58212	5059	59163	4193	58703	2971	69241	2509	34303
4E		MI	32515	8359	51391	6203	55365	5041	56212	4178	55667	2956	65531	2487	32553
12-#14	1.61	MA	33439	8359	52684	6220	56596	5078	57178	4210	55828	2959	65818	2450	34197
5L-3S		MI	33310	8359	52753	6183	57101	5047	58323	4187	58372	2944	68592	2612	32550
12-#14	1.61	MA	32725	8359	51516	6216	54978	5071	55201	4202	53223	2972	62575	2369	33380
6L-2S		MI	34437	8359	54422	6187	59240	5029	60932	4170	61912	2931	73307	2736	32507
12-#18	2.86	MA	39789	9085	65259	6621	72493	5339	76490	4354	81789	2850	99197	2572	59389
2L-6S		MI	32103	9085	52765	6603	56679	5352	57709	4354	57529	2871	69341	1851	51787
12-#18	2.86	MA	37745	9085	62169	6612	68532	5370	71657	4382	75262	2872	90523	2350	59257
3L-5S		MI	33266	9085	54709	6613	59369	5366	60995	4372	61783	2849	74580	1996	53278
12-#18	2.86	MA	36303	9085	59642	6647	65311	5357	67744	4365	70274	2894	84898	2129	58852
4E		MI	34488	9085	56780	6623	62054	5336	64293	4346	66480	2871	80153	2095	55764
12-#18	2.86	MA	35013	9085	57453	6638	62473	5388	64257	4392	65275	2872	78964	2027	56208
5L-3S		MI	35852	9085	59170	6589	65099	5350	67993	4365	71165	2849	85415	2317	56120
12-#18	2.86	MA	33786	9085	55399	6629	59631	5375	60783	4375	60745	2894	73369	1883	54615
6L-2S		MI	37782	9085	62087	6599	68838	5320	72555	4339	77296	2827	93542	2538	56229
14-#11	1.30	MA	35330	8181	55087	6117	59801	4983	61138	4150	61244	2971	72241	2808	28021
2L-7S		MI	30811	8181	47929	6118	51013	4997	50923	4160	48447	2988	56203	2430	26219
14-#11	1.30	MA	34490	8181	53853	6114	58219	4979	59209	4162	58619	2981	68708	2722	28057
3L-6S		MI	31274	8181	48774	6103	52032	4984	52177	4149	50129	2979	58491	2520	26632
14-#11	1.30	MA	33901	8181	52848	6129	56939	4992	57652	4157	56616	2990	66409	2636	28084
4L-5S		MI	31750	8181	49546	6106	53101	4989	53482	4154	51850	2970	60634	2576	26669
14-#11	1.30	MA	33375	8181	51980	6126	55812	4989	56268	4169	54611	2982	64007	2594	28081
5L-4S		MI	32249	8181	50369	6109	54168	4976	54794	4143	53748	2978	62895	2617	26659
14-#11	1.30	MA	32873	8181	51165	6124	54684	5002	54889	4164	52794	2992	61724	2538	28029
6L-3S		MI	32807	8181	51320	6094	55380	4980	56267	4148	55644	2970	65053	2704	26628
14-#11	1.30	MA	32384	8181	50273	6139	53608	4998	53566	4176	51018	3001	59288	2448	27573
7L-2S		MI	33599	8181	52486	6097	56875	4967	58091	4137	58126	2961	68371	2790	26589
14-#14	1.88	MA	37042	8515	58901	6305	64573	5116	66916	4227	69087	2933	82551	2731	39817
2L-7S		MI	31256	8515	49561	6311	52981	5140	53274	4243	51639	2956	60734	2189	36116
14-#14	1.88	MA	35854	8515	57136	6301	62310	5135	64155	4244	65330	2946	77529	2606	39835
3L-6S		MI	31913	8515	50773	6291	54443	5122	55071	4227	54040	2943	63984	2319	36738
14-#14	1.88	MA	35019	8515	55696	6322	60475	5129	61924	4236	62459	2959	74263	2482	39787
4L-5S		MI	32587	8515	51880	6296	55974	5129	56942	4236	56496	2931	67027	2400	37624
14-#14	1.88	MA	34272	8515	54450	6318	58860	5147	59939	4253	59585	2947	70841	2423	39649
5L-4S		MI	33295	8515	53059	6300	57504	5111	58821	4220	59206	2943	70246	2458	37740

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

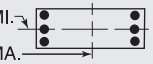


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#14	1.88	MA	33561	8515	53282	6314	57242	5141	57962	4244	56979	2960	67597	2342	38695
6L-3S		MI	34086	8515	54422	6280	59240	5117	60932	4229	61912	2931	73307	2583	37774
14-#14	1.88	MA	32868	8515	52002	6334	55698	5160	56064	4261	54433	2972	64135	2212	38012
7L-2S		MI	35207	8515	56090	6285	61379	5099	63541	4213	65451	2918	78021	2707	37744
14-#18	3.33	MA	39143	9362	65259	6785	72493	5494	76490	4457	81789	2847	99197	2296	68815
3L-6S		MI	33445	9362	55682	6776	60419	5476	62271	4429	63660	2844	77469	1792	60293
14-#18	3.33	MA	37712	9362	62732	6820	69272	5481	72576	4440	76800	2869	93573	2074	68277
4L-5S		MI	34599	9362	57626	6786	63109	5490	65557	4447	67914	2822	82707	1937	61990
14-#18	3.33	MA	36433	9362	60543	6811	66435	5512	69089	4467	71801	2847	87638	1973	65447
5L-4S		MI	35812	9362	59698	6796	65793	5460	68855	4422	72611	2844	88280	2037	64587
14-#18	3.33	MA	35215	9362	58489	6802	63592	5499	65616	4450	67272	2869	82043	1828	63648
6L-3S		MI	37166	9362	62087	6762	68838	5474	72555	4440	77296	2822	93542	2258	65146
14-#18	3.33	MA	34029	9362	56239	6837	60878	5530	62280	4478	62846	2891	76065	1597	60736
7L-2S		MI	39083	9362	65004	6772	72578	5444	77117	4414	83426	2800	101670	2480	65312
16-#11	1.49	MA	35909	8289	56320	6184	61382	5031	63068	4180	63869	2962	75774	2791	31897
2L-8S		MI	30912	8289	48336	6182	51474	5042	51523	4201	49142	2971	57408	2363	29434
16-#11	1.49	MA	35073	8289	55087	6182	59801	5027	61138	4192	61244	2972	72241	2705	31926
3L-7S		MI	31367	8289	49095	6185	52508	5046	52747	4190	50929	2979	59522	2411	29755
16-#11	1.49	MA	34486	8289	54082	6196	58520	5041	59582	4187	59241	2981	69942	2618	31942
4L-6S		MI	31828	8289	49940	6171	53527	5033	54001	4178	52610	2970	61809	2501	30246
16-#11	1.49	MA	33961	8289	53213	6194	57394	5037	58197	4199	57236	2974	67540	2577	31918
5E		MI	32302	8289	50712	6173	54596	5037	55306	4184	54331	2961	63953	2558	30300
16-#11	1.49	MA	33462	8289	52399	6191	56266	5050	56818	4194	55419	2983	65257	2521	31848
6L-4S		MI	32799	8289	51535	6176	55663	5024	56617	4172	56230	2970	66214	2598	30311
16-#11	1.49	MA	32975	8289	51507	6206	55189	5047	55495	4206	53643	2993	62821	2431	31315
7L-3S		MI	33355	8289	52486	6162	56875	5028	58091	4178	58126	2961	68371	2685	30289
16-#11	1.49	MA	32495	8289	50705	6204	54098	5060	54204	4218	51756	2985	60575	2382	30960
8L-2S		MI	34145	8289	53652	6165	58370	5015	59914	4166	60607	2952	71690	2771	30258
16-#14	2.14	MA	37856	8670	60667	6402	66837	5186	69677	4270	72843	2921	87574	2704	45345
2L-8S		MI	31398	8670	50140	6404	53637	5203	54128	4302	52627	2930	62440	2092	40197
16-#14	2.14	MA	36673	8670	58901	6398	64573	5205	66916	4286	69087	2934	82551	2579	45336
3L-7S		MI	32041	8670	51230	6409	55119	5210	55883	4286	55179	2943	65449	2160	41172
16-#14	2.14	MA	35842	8670	57461	6419	62738	5198	64685	4278	66216	2947	79286	2455	45262
4L-6S		MI	32695	8670	52442	6388	56581	5192	57680	4270	57579	2930	68699	2290	41769
16-#14	2.14	MA	35099	8670	56216	6415	61123	5217	62700	4295	63342	2934	75864	2396	45094
5E		MI	33365	8670	53548	6393	58113	5199	59551	4279	60035	2918	71741	2371	42765
16-#14	2.14	MA	34392	8670	55047	6411	59505	5211	60723	4287	60736	2947	72620	2315	44022
6L-4S		MI	34070	8670	54727	6398	59642	5180	61431	4263	62746	2930	74960	2429	42916
16-#14	2.14	MA	33703	8670	53768	6432	57962	5230	58826	4304	58190	2960	69157	2185	43365
7L-3S		MI	34857	8670	56090	6377	61379	5187	63541	4271	65451	2918	78021	2554	42975
16-#14	2.14	MA	33024	8670	52618	6427	56396	5224	56973	4320	55485	2948	65958	2116	42319
8L-2S		MI	35974	8670	57758	6382	63517	5169	66150	4255	68991	2905	82736	2678	42972
16-#18	3.81	MA	39109	9639	65822	6993	73234	5605	77408	4515	83327	2845	102247	2020	77394
4L-6S		MI	34776	9639	58600	6948	64159	5600	66833	4504	69790	2818	85597	1734	68830
16-#18	3.81	MA	37839	9639	63633	6984	70396	5636	73922	4543	78328	2822	96313	1918	74710
5E		MI	35921	9639	60543	6959	66848	5614	70119	4523	74044	2796	90835	1879	70726
16-#18	3.81	MA	36631	9639	61579	6975	67553	5623	70448	4526	73799	2845	90718	1774	72712
6L-4S		MI	37125	9639	62615	6969	69533	5584	73417	4497	78741	2818	96408	1979	73183
16-#18	3.81	MA	35455	9639	59329	7010	64840	5654	67113	4553	69373	2867	84740	1542	69913
7L-3S		MI	38470	9639	65004	6935	72578	5599	77117	4515	83426	2796	101670	2200	74158
18-#11	1.67	MA	36486	8397	57554	6252	62964	5080	64997	4209	66494	2954	79306	2773	35768
2L-9S		MI	31005	8397	48684	6264	51963	5103	52068	4225	49957	2971	58648	2291	32550
18-#11	1.67	MA	35653	8397	56320	6249	61382	5076	63068	4221	63869	2963	75774	2687	35789
3L-8S		MI	31467	8397	49502	6250	52969	5090	53347	4231	51623	2962	60727	2345	32987
18-#11	1.67	MA	35068	8397	55316	6264	60102	5089	61511	4216	61866	2973	73474	2601	35788
4L-7S		MI	31920	8397	50261	6252	54003	5094	54571	4219	53410	2971	62840	2393	33297
18-#11	1.67	MA	34545	8397	54447	6261	58975	5085	60127	4228	59861	2965	71072	2559	35749
5L-6S		MI	32380	8397	51107	6238	55022	5081	55824	4208	55092	2962	65128	2483	33766

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

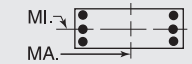


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.67	MA	34048	8397	53632	6259	57847	5099	58748	4223	58044	2975	68789	2503	35576
6L-5S		MI	32851	8397	51878	6241	56091	5085	57130	4213	56813	2953	67272	2539	33925
18-#11	1.67	MA	33563	8397	52740	6273	56771	5095	57424	4235	56268	2984	66353	2413	35062
7L-4S		MI	33347	8397	52701	6244	57158	5072	58441	4202	58711	2961	69533	2580	33956
18-#11	1.67	MA	33085	8397	51939	6271	55679	5108	56133	4247	54381	2976	64107	2365	34719
8L-3S		MI	33901	8397	53652	6229	58370	5077	59914	4207	60607	2952	71690	2666	33945
18-#11	1.67	MA	32597	8397	51075	6286	54617	5105	54782	4242	52622	2986	61894	2311	34242
9L-2S		MI	34688	8397	54818	6232	59865	5064	61738	4196	63089	2943	75009	2752	33920
18-#14	2.41	MA	38666	8826	62432	6500	69100	5256	72438	4312	76600	2909	92597	2677	50863
2L-9S		MI	31547	8826	50636	6521	54333	5291	54903	4335	53788	2930	64205	1985	44262
18-#14	2.41	MA	37488	8826	60667	6496	66837	5274	69677	4329	72843	2921	87574	2552	50828
3L-8S		MI	32181	8826	51809	6501	55775	5273	56737	4344	56167	2917	67155	2063	45172
18-#14	2.41	MA	36661	8826	59227	6516	65002	5268	67446	4321	69973	2934	84309	2428	50731
4L-7S		MI	32821	8826	52898	6506	57258	5280	58492	4328	58718	2930	70164	2131	46233
18-#14	2.41	MA	35922	8826	57981	6512	63386	5287	65462	4337	67098	2922	80887	2369	50395
5L-6S		MI	33472	8826	54110	6486	58720	5262	60289	4312	61119	2917	73413	2261	46809
18-#14	2.41	MA	35218	8826	56813	6508	61769	5281	63485	4329	64493	2935	77643	2288	49358
6L-5S		MI	34139	8826	55216	6490	60252	5268	62161	4321	63575	2905	76456	2343	47758
18-#14	2.41	MA	34533	8826	55533	6529	60225	5300	61587	4346	61947	2948	74180	2158	48725
7L-4S		MI	34840	8826	56396	6495	61781	5250	64040	4305	66285	2917	79675	2401	48086
18-#14	2.41	MA	33857	8826	54383	6525	58659	5294	59734	4363	59241	2935	70981	2089	47591
8L-3S		MI	35623	8826	57758	6475	63517	5257	66150	4314	68991	2905	82736	2525	48168
18-#14	2.41	MA	33171	8826	53145	6545	57136	5312	57797	4355	56718	2948	67836	2011	46601
9L-2S		MI	36735	8826	59427	6479	65656	5239	68759	4298	72530	2892	87450	2650	48194
18-#18	4.29	MA	39235	9915	66723	7157	74357	5761	78754	4618	84855	2798	104987	1864	83994
5L-6S		MI	36096	9915	61517	7121	67898	5724	71395	4580	75921	2791	93724	1676	77396
18-#18	4.29	MA	38036	9915	64669	7148	71514	5747	75281	4601	80326	2820	99392	1719	81805
6L-5S		MI	37233	9915	63460	7131	70588	5738	74681	4598	80175	2769	98962	1821	79483
18-#18	4.29	MA	36868	9915	62419	7183	68801	5779	71945	4628	75900	2842	93414	1488	79110
7L-4S		MI	38428	9915	65532	7142	73272	5708	77979	4572	84871	2791	104536	1920	81812
20-#11	1.86	MA	37061	8504	58788	6319	64545	5128	66926	4239	69119	2945	82839	2756	39633
2L-10S		MI	31071	8504	49093	6329	52437	5147	52674	4266	50786	2971	59954	2211	35506
20-#11	1.86	MA	36230	8504	57554	6317	62964	5124	64997	4251	66494	2955	79306	2669	39647
3L-9S		MI	31561	8504	49850	6331	53458	5151	53892	4255	52438	2962	61967	2272	36047
20-#11	1.86	MA	35647	8504	56549	6331	61683	5138	63440	4246	64491	2964	77007	2583	39628
4L-8S		MI	32019	8504	50668	6317	54464	5138	55171	4260	54105	2954	64045	2326	36542
20-#11	1.86	MA	35126	8504	55680	6329	60557	5134	62056	4258	62486	2956	74605	2542	39575
5L-7S		MI	32470	8504	51428	6320	55498	5143	56395	4249	55892	2962	66159	2374	36844
20-#11	1.86	MA	34631	8504	54866	6326	59428	5147	60677	4252	60669	2966	72322	2486	39307
6E		MI	32928	8504	52273	6305	56517	5130	57648	4237	57573	2953	68447	2464	37293
20-#11	1.86	MA	34148	8504	53974	6341	58352	5143	59354	4265	58893	2975	69886	2396	38814
7L-5S		MI	33399	8504	53044	6308	57586	5134	58954	4243	59294	2944	70590	2520	37545
20-#11	1.86	MA	33672	8504	53172	6338	57261	5157	58062	4277	57006	2968	67640	2347	38480
8L-4S		MI	33892	8504	53867	6311	58653	5121	60265	4231	61193	2953	72851	2561	37586
20-#11	1.86	MA	33186	8504	52309	6353	56199	5153	56711	4272	55247	2977	65426	2293	37946
9L-3S		MI	34444	8504	54818	6297	59865	5125	61738	4237	63089	2944	75009	2647	37595
20-#11	1.86	MA	32662	8504	51510	6351	55122	5166	55427	4284	53503	2987	63282	2232	37356
10L-2S		MI	35229	8504	55985	6300	61360	5112	63562	4225	65570	2935	78328	2734	37577
20-#14	2.68	MA	38298	8982	62432	6593	69100	5344	72438	4371	76600	2909	92597	2525	56313
3L-9S		MI	32329	8982	52304	6619	56471	5361	57512	4378	57327	2916	68919	1956	49275
20-#14	2.68	MA	37475	8982	60992	6614	67265	5338	70208	4363	73730	2922	89332	2401	56193
4L-8S		MI	32960	8982	53477	6598	57914	5343	59346	4387	59706	2904	71869	2034	50158
20-#14	2.68	MA	36739	8982	59747	6609	65650	5357	68223	4380	70855	2910	85910	2342	55695
5L-7S		MI	33597	8982	54566	6603	59397	5350	61101	4371	62258	2916	74878	2102	51299
20-#14	2.68	MA	36039	8982	58578	6605	64032	5351	66246	4372	68250	2922	82666	2261	54703
6E		MI	34244	8982	55778	6583	60859	5331	62898	4355	64658	2904	78128	2233	51856
20-#14	2.68	MA	35357	8982	57299	6626	62488	5369	64348	4388	65704	2935	79203	2131	54089
7L-5S		MI	34908	8982	56884	6587	62390	5338	64770	4363	67114	2892	81171	2314	52763
20-#14	2.68	MA	34685	8982	56149	6622	60922	5363	62495	4405	62998	2923	76004	2062	52874
8L-4S		MI	35606	8982	58064	6592	63920	5320	66649	4347	69825	2904	84389	2372	53249

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

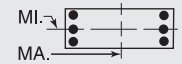
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.68	MA	34020	8982	54910	6643	59399	5382	60558	4397	60475	2936	72858	1984	51913
9L-3S		MI	36385	8982	59427	6572	65656	5327	68759	4356	72530	2892	87450	2496	53353
20-#18	4.76	MA	39430	10192	67759	7321	75475	5872	80113	4677	86852	2795	108067	1664	90922
6E		MI	37406	10192	64434	7294	71638	5848	75957	4655	82051	2765	101852	1618	85986
20-#18	4.76	MA	38271	10192	65509	7356	72762	5903	76778	4704	82426	2817	102089	1433	88325
7L-5S		MI	38535	10192	66378	7304	74327	5863	79243	4674	86305	2742	107090	1763	88256
22-#11	2.04	MA	36805	8612	58788	6384	64545	5173	66926	4280	69119	2946	82839	2652	43494
3L-10S		MI	31625	8612	50259	6396	53932	5196	54498	4296	53267	2963	63273	2192	39025
22-#11	2.04	MA	36224	8612	57783	6399	63265	5186	65370	4275	67116	2956	80539	2566	43464
4L-9S		MI	32114	8612	51016	6399	54953	5200	55716	4284	54920	2954	65286	2253	39551
22-#11	2.04	MA	35705	8612	56914	6396	62138	5182	63985	4287	65111	2948	78137	2524	43398
5L-8S		MI	32569	8612	51834	6384	55959	5187	56995	4290	56586	2945	67364	2307	40100
22-#11	2.04	MA	35211	8612	56100	6394	61010	5196	62606	4282	63294	2957	75854	2468	43044
6L-7S		MI	33018	8612	52594	6387	56993	5191	58219	4278	58373	2953	69478	2355	40394
22-#11	2.04	MA	34730	8612	55208	6408	59934	5192	61283	4294	61518	2967	73419	2378	42570
7L-6S		MI	33475	8612	53439	6373	58012	5178	59472	4266	60055	2944	71766	2445	40825
22-#11	2.04	MA	34256	8612	54406	6406	58842	5205	59991	4306	59631	2959	71173	2330	42244
8L-5S		MI	33943	8612	54211	6376	59081	5182	60778	4272	61776	2936	73909	2501	41161
22-#11	2.04	MA	33773	8612	53543	6421	57780	5201	58641	4301	57872	2968	68959	2276	41655
9L-4S		MI	34435	8612	55033	6379	60148	5169	62089	4260	63674	2944	76170	2542	41215
22-#11	2.04	MA	33250	8612	52744	6418	56703	5215	57356	4313	56128	2978	66814	2215	41082
10L-3S		MI	34985	8612	55985	6364	61360	5174	63562	4266	65570	2935	78328	2629	41241
22-#11	2.04	MA	32739	8612	51958	6415	55647	5211	56022	4308	54268	2970	64625	2163	40408
11L-2S		MI	35768	8612	57151	6367	62855	5161	65386	4254	68052	2926	81646	2715	41230
22-#14	2.95	MA	38285	9137	62758	6711	69528	5408	72969	4405	77486	2909	94354	2374	61651
4L-9S		MI	33107	9137	53972	6716	58610	5431	60121	4420	60867	2903	73634	1927	54231
22-#14	2.95	MA	37553	9137	61512	6707	67913	5427	70984	4422	74612	2897	90932	2315	61006
5L-8S		MI	33734	9137	55145	6696	60053	5413	61955	4429	63246	2891	76584	2005	55151
22-#14	2.95	MA	36856	9137	60344	6703	66295	5421	69007	4414	72006	2910	87688	2234	60054
6L-7S		MI	34369	9137	56234	6700	61535	5419	63710	4413	65797	2903	79593	2074	56362
22-#14	2.95	MA	36177	9137	59064	6723	64752	5439	67109	4431	69460	2923	84226	2104	59457
7L-6S		MI	35013	9137	57446	6680	62997	5401	65507	4397	68198	2891	82842	2204	56911
22-#14	2.95	MA	35509	9137	57914	6719	63186	5433	65256	4448	66755	2911	81026	2035	58166
8L-5S		MI	35674	9137	58553	6685	64529	5408	67379	4406	70654	2879	85885	2285	57779
22-#14	2.95	MA	34846	9137	56676	6740	61663	5452	63319	4439	64232	2923	77881	1957	57188
9L-4S		MI	36368	9137	59732	6689	66058	5390	69258	4390	73364	2891	89104	2343	58408
22-#18	5.24	MA	39663	10469	68599	7529	76723	6027	81610	4779	88953	2792	110763	1378	97557
7L-6S		MI	38707	10469	67351	7467	75377	5972	80519	4731	88182	2738	109979	1559	94600
24-#11	2.23	MA	36798	8720	59017	6466	64846	5234	67299	4304	69741	2947	84072	2548	47296
4L-10S		MI	32176	8720	51425	6463	55427	5244	56322	4325	55749	2954	66592	2173	42547
24-#11	2.23	MA	36281	8720	58148	6464	63720	5231	65914	4316	67736	2939	81670	2507	47218
5L-9S		MI	32665	8720	52183	6466	56448	5248	57539	4314	57401	2945	68604	2235	43059
24-#11	2.23	MA	35789	8720	57333	6461	62591	5244	64536	4311	65919	2949	79387	2451	46786
6L-8S		MI	33116	8720	53001	6452	57454	5235	58819	4319	59068	2936	70683	2289	43659
24-#11	2.23	MA	35310	8720	56441	6476	61515	5240	63212	4323	64143	2958	76951	2361	46329
7E		MI	33564	8720	53760	6455	58488	5239	60043	4307	60855	2945	72796	2337	43947
24-#11	2.23	MA	34838	8720	55640	6473	60424	5254	61921	4335	62256	2950	74705	2312	46010
8L-6S		MI	34019	8720	54605	6440	59507	5226	61296	4296	62536	2936	75084	2427	44362
24-#11	2.23	MA	34357	8720	54776	6488	59362	5250	60570	4330	60497	2960	72492	2258	45369
9L-5S		MI	34486	8720	55377	6443	60576	5231	62602	4301	64257	2927	77228	2483	44774
24-#11	2.23	MA	33835	8720	53977	6485	58285	5263	59285	4342	58753	2969	70347	2197	44811
10L-4S		MI	34976	8720	56200	6446	61643	5218	63913	4290	66156	2935	79489	2524	44839
24-#11	2.23	MA	33327	8720	53191	6483	57228	5259	57952	4337	56893	2962	68157	2146	44097
11L-3S		MI	35524	8720	57151	6432	62855	5222	65386	4295	68052	2926	81646	2610	44872

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
24-#14	3.21	MA	38362	9293	63278	6804	70176	5497	73745	4465	78369	2885	95955	2288	66327
5L-9S		MI	33880	9293	55641	6813	60749	5501	62730	4463	64406	2890	78348	1898	59168
24-#14	3.21	MA	37668	9293	62110	6800	68559	5490	71768	4457	75763	2898	92711	2207	65411
6L-8S		MI	34505	9293	56813	6793	62191	5483	64564	4471	66785	2878	81298	1976	60153
24-#14	3.21	MA	36993	9293	60830	6821	67015	5509	69870	4473	73217	2910	89248	2077	64740
7E		MI	35136	9293	57903	6798	63674	5489	66319	4455	69337	2890	84307	2045	61325
24-#14	3.21	MA	36328	9293	59680	6816	65449	5503	68018	4490	70512	2898	86049	2007	63465
8L-6S		MI	35777	9293	59115	6777	65136	5471	68116	4439	71737	2878	87557	2175	61971
24-#14	3.21	MA	35665	9293	58442	6837	63926	5522	66080	4482	67989	2911	82904	1930	62422
9L-5S		MI	36435	9293	60221	6782	66668	5478	69988	4448	74193	2866	90600	2256	62804

RECTANGULAR TIED COLUMNS 40" x 44"

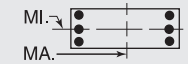
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
6-#18	1.36	MA	38873	8609	60966	6390	66028	5203	67486	4329	67644	3084	79548	2895	31963
2L-3S		MI	33252	8609	52542	6335	56089	5196	56458	4323	54703	3071	63164	2629	28953
6-#18	1.36	MA	36661	8609	57704	6382	61845	5235	62384	4357	60721	3106	70326	2673	32062
3L-2S		MI	35226	8609	55459	6345	59829	5166	61020	4298	60834	3049	71292	2850	28833
8-#14	1.02	MA	37815	8402	58440	6301	63034	5143	63926	4301	62896	3125	73459	2968	24377
2L-4S		MI	32356	8402	50169	6275	53297	5121	53150	4279	50525	3126	58246	2684	22179
8-#14	1.02	MA	36542	8402	56577	6297	60646	5137	61013	4318	58933	3139	68128	2843	24448
3E		MI	33160	8402	51532	6255	55034	5127	55261	4288	53230	3113	61307	2808	22107
8-#14	1.02	MA	35647	8402	55060	6318	58712	5157	58662	4311	55908	3152	64658	2719	24504
4L-2S		MI	34297	8402	53200	6260	57173	5109	57870	4272	56770	3101	66021	2933	22031
8-#18	1.82	MA	40386	8886	64229	6563	70211	5327	72589	4404	74567	3060	88770	2843	42220
2L-4S		MI	33217	8886	53069	6542	56784	5306	57320	4380	56148	3067	66030	2349	37942
8-#18	1.82	MA	38191	8886	60966	6555	66028	5359	67486	4433	67644	3083	79548	2622	42244
3E		MI	34606	8886	55459	6508	59829	5320	61020	4399	60834	3044	71292	2571	38087
8-#18	1.82	MA	36644	8886	58302	6591	62632	5347	63359	4417	62352	3105	73560	2400	42015
4L-2S		MI	36566	8886	58376	6518	63569	5290	65582	4373	66964	3022	79419	2792	38025
10-#14	1.28	MA	38695	8557	60303	6398	65422	5213	66839	4343	66860	3113	78790	2942	30248
2L-5S		MI	32430	8557	50658	6368	53907	5209	53880	4338	51354	3100	59742	2597	27387
10-#14	1.28	MA	37428	8557	58440	6394	63034	5207	63926	4361	62896	3126	73459	2818	30302
3L-4S		MI	33146	8557	51837	6373	55436	5190	55759	4322	54064	3113	62960	2655	27411
10-#14	1.28	MA	36538	8557	56923	6415	61100	5226	61576	4353	59871	3140	69989	2693	30326
4L-3S		MI	33946	8557	53200	6352	57173	5197	57870	4331	56770	3100	66021	2779	27365
10-#14	1.28	MA	35743	8557	55611	6412	59399	5221	59485	4370	56843	3129	66364	2634	30257
5L-2S		MI	35079	8557	54868	6357	59311	5179	60479	4315	60309	3088	70736	2904	27303
10-#18	2.27	MA	41883	9162	67492	6736	74394	5451	77692	4480	81490	3037	97991	2792	52442
2L-5S		MI	33334	9162	53915	6705	57839	5460	58584	4482	57582	3018	68584	2191	44939
10-#18	2.27	MA	39704	9162	64229	6727	70211	5483	72589	4508	74567	3059	88770	2570	52383
3L-4S		MI	34568	9162	55986	6715	60524	5430	61883	4456	62279	3040	74158	2291	46933
10-#18	2.27	MA	38169	9162	61564	6763	66815	5471	68462	4493	69275	3082	82782	2349	52060
4L-3S		MI	35946	9162	58376	6681	63569	5444	65582	4474	66964	3018	79419	2512	47167
10-#18	2.27	MA	36798	9162	59257	6755	63824	5504	64787	4521	63974	3059	76486	2246	49776
5L-2S		MI	37892	9162	61293	6691	67308	5414	70145	4448	73095	2996	87547	2734	47179
12-#11	1.06	MA	38002	8427	58698	6337	63489	5171	64528	4322	63736	3134	74740	2982	25400
2L-6S		MI	32132	8427	49719	6304	52747	5156	52511	4307	49588	3131	57322	2678	23078
12-#11	1.06	MA	37112	8427	57397	6334	61821	5167	62494	4334	60967	3144	70994	2895	25443
3L-5S		MI	32610	8427	50490	6306	53816	5161	53817	4312	51309	3123	59465	2734	23078
12-#11	1.06	MA	36489	8427	56339	6349	60472	5181	60854	4330	58857	3154	68552	2809	25481
4E		MI	33112	8427	51313	6309	54883	5148	55128	4301	53207	3131	61726	2775	23044
12-#11	1.06	MA	35932	8427	55424	6347	59285	5178	59396	4342	56745	3147	66009	2767	25501
5L-3S		MI	33672	8427	52264	6295	56095	5152	56601	4306	55103	3122	63884	2861	22998

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

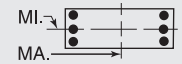


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
12-#11	1.06	MA	35401	8427	54567	6345	58098	5191	57944	4337	54832	3157	63586	2711	25468
6L-2S		MI	34468	8427	53430	6298	57590	5139	58425	4295	57585	3113	67202	2948	22951
12-#14	1.53	MA	39570	8713	62166	6495	67810	5283	69753	4386	70824	3100	84122	2917	36101
2L-6S		MI	32541	8713	51220	6461	54514	5272	54618	4371	52437	3100	61413	2487	31928
12-#14	1.53	MA	38309	8713	60303	6492	65422	5277	66839	4403	66860	3114	78790	2793	36139
3L-5S		MI	33219	8713	52326	6465	56045	5278	56489	4380	54893	3087	64456	2568	32559
12-#14	1.53	MA	37423	8713	58786	6513	63488	5296	64489	4395	63835	3127	75321	2668	36126
4E		MI	33932	8713	53506	6470	57575	5260	58368	4364	57604	3100	67675	2626	32622
12-#14	1.53	MA	36632	8713	57474	6509	61787	5291	62398	4413	60807	3116	71695	2608	36020
5L-3S		MI	34728	8713	54868	6450	59311	5267	60479	4373	60309	3087	70736	2750	32604
12-#14	1.53	MA	35879	8713	56244	6505	60083	5310	60316	4405	58063	3130	68250	2528	35267
6L-2S		MI	35856	8713	56537	6454	61450	5249	63088	4357	63849	3075	75450	2875	32556
12-#18	2.73	MA	43367	9439	70755	6909	78577	5575	82795	4555	88414	3014	107213	2741	62629
2L-6S		MI	33515	9439	54888	6867	58889	5570	59860	4539	59458	3013	71474	1988	52160
12-#18	2.73	MA	41202	9439	67492	6900	74394	5607	77692	4584	81490	3036	97991	2519	62497
3L-5S		MI	34682	9439	56832	6878	61579	5584	63147	4557	63712	2991	76712	2133	53617
12-#18	2.73	MA	39680	9439	64827	6936	70998	5595	73565	4568	76198	3058	92004	2298	62092
4E		MI	35906	9439	58904	6888	64263	5554	66445	4531	68409	3013	82285	2233	55907
12-#18	2.73	MA	38320	9439	62520	6928	68007	5628	69890	4597	70897	3036	85708	2195	59507
5L-3S		MI	37274	9439	61293	6854	67308	5568	70145	4550	73095	2991	87547	2454	56220
12-#18	2.73	MA	37025	9439	60357	6920	65011	5616	66229	4581	66093	3058	79756	2050	57774
6L-2S		MI	39207	9439	64210	6864	71048	5538	74707	4524	79225	2969	95675	2676	56308
14-#11	1.24	MA	38620	8534	59999	6404	65157	5219	66563	4351	66504	3125	78487	2965	29495
2L-7S		MI	32225	8534	50040	6385	53223	5218	53081	4348	50388	3132	58352	2569	26367
14-#11	1.24	MA	37733	8534	58698	6402	63489	5216	64528	4364	63736	3135	74740	2879	29531
3L-6S		MI	32689	8534	50885	6371	54242	5205	54335	4336	52069	3123	60640	2659	26704
14-#11	1.24	MA	37112	8534	57640	6417	62140	5229	62889	4359	61625	3145	72299	2792	29558
4L-5S		MI	33165	8534	51656	6374	55311	5209	55641	4342	53790	3114	62784	2715	26727
14-#11	1.24	MA	36557	8534	56725	6415	60953	5226	61431	4371	59513	3138	69756	2750	29555
5L-4S		MI	33665	8534	52479	6377	56378	5196	56952	4330	55689	3122	65045	2756	26707
14-#11	1.24	MA	36029	8534	55868	6412	59766	5240	59979	4367	57600	3148	67333	2695	29503
6L-3S		MI	34224	8534	53430	6362	57590	5200	58425	4336	57585	3113	67202	2843	26671
14-#11	1.24	MA	35514	8534	54929	6427	58633	5236	58586	4379	55731	3158	64749	2605	29088
7L-2S		MI	35017	8534	54597	6365	59085	5187	60249	4324	60066	3105	70521	2929	26631
14-#14	1.79	MA	40440	8868	64029	6592	70198	5352	72666	4428	74788	3088	89453	2892	41943
2L-7S		MI	32670	8868	51676	6578	55191	5360	55430	4430	53576	3099	62878	2328	36317
14-#14	1.79	MA	39183	8868	62166	6589	67810	5347	69753	4445	70824	3101	84122	2767	41962
3L-6S		MI	33328	8868	52888	6558	56652	5342	57227	4414	55976	3086	66128	2458	36946
14-#14	1.79	MA	38302	8868	60648	6610	65876	5366	67402	4438	67799	3115	80652	2643	41914
4L-5S		MI	34003	8868	53994	6563	58184	5348	59099	4423	58433	3074	69171	2539	37720
14-#14	1.79	MA	37515	8868	59336	6606	64175	5360	65311	4455	64770	3104	77026	2583	41775
5L-4S		MI	34712	8868	55174	6567	59713	5330	60978	4407	61143	3086	72389	2597	37814
14-#14	1.79	MA	36766	8868	58107	6603	62471	5380	63229	4448	62026	3117	73581	2502	40876
6L-3S		MI	35504	8868	56537	6547	61450	5337	63088	4415	63849	3074	75450	2721	37830
14-#14	1.79	MA	36036	8868	56759	6624	60846	5374	61231	4465	59345	3131	69905	2372	40125
7L-2S		MI	36628	8868	58205	6552	63589	5319	65697	4399	67388	3062	80165	2846	37797
14-#18	3.18	MA	42688	9716	70755	7073	78577	5732	82795	4659	88414	3013	107213	2468	72595
3L-6S		MI	34860	9716	57805	7040	62629	5694	64422	4614	65589	2987	79601	1930	60870
14-#18	3.18	MA	41177	9716	68090	7109	75181	5720	78668	4643	83122	3035	101226	2246	72117
4L-5S		MI	36017	9716	59749	7050	65318	5708	67709	4632	69843	2965	84839	2075	62325
14-#18	3.18	MA	39827	9716	65783	7101	72190	5752	74993	4672	77820	3013	94930	2143	69268
5L-4S		MI	37233	9716	61821	7061	68003	5678	71007	4607	74540	2987	90413	2175	64871
14-#18	3.18	MA	38543	9716	63620	7093	69194	5740	71332	4656	73016	3035	88978	1999	67614
6L-3S		MI	38591	9716	64210	7026	71048	5692	74707	4625	79225	2965	95675	2396	65253
14-#18	3.18	MA	37292	9716	61249	7129	66335	5772	67817	4685	68321	3057	82622	1768	64425
7L-2S		MI	40512	9716	67127	7037	74787	5662	79269	4599	85356	2942	103802	2617	65397
16-#11	1.42	MA	39234	8642	61300	6471	66825	5268	68598	4381	69272	3117	82234	2949	33582
2L-8S		MI	32326	8642	50446	6450	53684	5262	53682	4389	51082	3115	59557	2502	29581

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

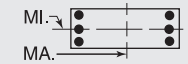
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.42	MA	38351	8642	59999	6469	65157	5264	66563	4393	66504	3127	78487	2862	33611
3L-7S		MI	32781	8642	51206	6453	54718	5266	54905	4377	52869	3123	61671	2550	29904
16-#11	1.42	MA	37732	8642	58941	6484	63808	5278	64923	4388	64394	3137	76046	2776	33627
4L-6S		MI	33244	8642	52051	6438	55737	5253	56159	4365	54551	3114	63959	2641	30323
16-#11	1.42	MA	37179	8642	58026	6482	62621	5274	63465	4401	62282	3130	73502	2734	33602
5E		MI	33718	8642	52823	6441	56806	5257	57465	4371	56272	3105	66102	2697	30363
16-#11	1.42	MA	36653	8642	57169	6480	61434	5288	62014	4396	60369	3140	71080	2678	33533
6L-4S		MI	34216	8642	53645	6444	57873	5244	58776	4359	58170	3114	68363	2738	30362
16-#11	1.42	MA	36140	8642	56230	6495	60301	5285	60621	4409	58499	3150	68496	2588	33035
7L-3S		MI	34773	8642	54597	6430	59085	5249	60249	4365	60066	3105	70521	2824	30336
16-#11	1.42	MA	35635	8642	55386	6493	59152	5298	59261	4421	56513	3142	66118	2539	32644
8L-2S		MI	35563	8642	55763	6433	60580	5236	62073	4353	62548	3096	73840	2910	30302
16-#14	2.05	MA	41304	9024	65891	6690	72586	5422	75579	4470	78751	3075	94784	2866	47775
2L-8S		MI	32811	9024	52255	6671	55846	5423	56284	4488	54564	3073	64584	2231	40527
16-#14	2.05	MA	40053	9024	64029	6686	70198	5417	72666	4488	74788	3089	89453	2742	47766
3L-7S		MI	33456	9024	53344	6675	57329	5429	58039	4472	57116	3086	67593	2299	41374
16-#14	2.05	MA	39176	9024	62511	6707	68264	5436	70315	4480	71763	3103	85983	2617	47692
4L-6S		MI	34111	9024	54556	6655	58791	5411	59836	4456	59516	3073	70842	2429	41975
16-#14	2.05	MA	38393	9024	61199	6704	66563	5430	68225	4498	68734	3091	82357	2558	47524
5E		MI	34783	9024	55663	6660	60323	5418	61708	4465	61972	3061	73885	2510	42875
16-#14	2.05	MA	37648	9024	59969	6700	64859	5450	66142	4490	65990	3105	78912	2477	46498
6L-4S		MI	35488	9024	56842	6664	61852	5400	63587	4449	64683	3073	77104	2568	42997
16-#14	2.05	MA	36921	9024	58622	6721	63234	5444	64144	4508	63309	3118	75236	2347	45777
7L-3S		MI	36277	9024	58205	6644	63589	5407	65697	4458	67388	3061	80165	2693	43042
16-#14	2.05	MA	36206	9024	57411	6717	61585	5463	62193	4525	60459	3107	71846	2277	44798
8L-2S		MI	37395	9024	59873	6649	65727	5389	68306	4442	70928	3049	84879	2817	43028
16-#18	3.64	MA	42661	9992	71353	7282	79364	5844	83770	4719	90045	3012	110448	2195	82051
4L-6S		MI	36193	9992	60723	7213	66368	5818	68984	4689	71719	2960	87729	1872	69400
16-#18	3.64	MA	41321	9992	69046	7274	76373	5876	80096	4747	84743	2990	104152	2092	79055
5E		MI	37342	9992	62666	7223	69058	5832	72271	4708	75973	2938	92967	2017	71058
16-#18	3.64	MA	40047	9992	66882	7266	73377	5864	76435	4732	79939	3012	98200	1948	77221
6L-4S		MI	38549	9992	64738	7233	71742	5802	75569	4682	80670	2960	98540	2116	73585
16-#18	3.64	MA	38806	9992	64512	7302	70518	5896	72920	4760	75244	3034	91844	1717	74126
7L-3S		MI	39897	9992	67127	7199	74787	5816	79269	4700	85356	2938	103802	2338	74272
18-#11	1.60	MA	39847	8750	62601	6539	68493	5316	70633	4410	72041	3108	85980	2932	37663
2L-9S		MI	32418	8750	50795	6532	54173	5323	54226	4412	51897	3115	60798	2430	32791
18-#11	1.60	MA	38966	8750	61300	6537	66825	5313	68598	4422	69272	3118	82234	2846	37685
3L-8S		MI	32881	8750	51612	6517	55179	5310	55506	4418	53564	3106	62876	2484	33135
18-#11	1.60	MA	38349	8750	60242	6552	65476	5326	66958	4418	67162	3128	79792	2760	37683
4L-7S		MI	33335	8750	52372	6520	56213	5315	56729	4406	55351	3114	64990	2532	33446
18-#11	1.60	MA	37798	8750	59327	6549	64289	5323	65500	4430	65050	3121	77249	2718	37644
5L-6S		MI	33796	8750	53217	6506	57232	5302	57983	4395	57032	3106	67278	2622	33926
18-#11	1.60	MA	37274	8750	58470	6547	63102	5337	64049	4426	63137	3131	74826	2662	37558
6L-5S		MI	34268	8750	53989	6509	58301	5306	59288	4400	58753	3097	69421	2678	33993
18-#11	1.60	MA	36763	8750	57531	6562	61969	5333	62655	4438	61268	3141	72243	2572	36988
7L-4S		MI	34764	8750	54812	6512	59368	5293	60600	4389	60652	3105	71682	2719	34011
18-#11	1.60	MA	36260	8750	56687	6560	60820	5347	61296	4451	59281	3134	69864	2523	36610
8L-3S		MI	35319	8750	55763	6497	60580	5297	62073	4394	62548	3096	73840	2805	33994
18-#11	1.60	MA	35736	8750	55862	6558	59702	5343	59874	4446	57429	3144	67515	2469	36195
9L-2S		MI	36108	8750	56929	6500	62075	5284	63897	4383	65029	3087	77158	2892	33966
18-#14	2.30	MA	42163	9180	67754	6787	74974	5492	78492	4513	82715	3063	100115	2841	53597
2L-9S		MI	32960	9180	52751	6788	56542	5511	57059	4522	55725	3073	66348	2124	44575
18-#14	2.30	MA	40918	9180	65891	6783	72586	5486	75579	4530	78751	3077	94784	2716	53562
3L-8S		MI	33595	9180	53923	6768	57985	5493	58893	4531	58104	3060	69299	2202	45499

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

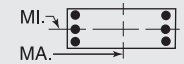


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	2.30	MA	40045	9180	64374	6805	70652	5506	73229	4523	75726	3090	91314	2592	53464
4L-7S		MI	34237	9180	55013	6773	59468	5499	60648	4515	60655	3073	72307	2270	46436
18-#14	2.30	MA	39266	9180	63062	6801	68951	5500	71138	4540	72698	3079	87689	2532	53269
5L-6S		MI	34889	9180	56225	6752	60930	5481	62445	4499	63055	3060	75557	2400	47014
18-#14	2.30	MA	38524	9180	61832	6797	67247	5519	69056	4533	69954	3092	84243	2451	52131
6L-5S		MI	35558	9180	57331	6757	62461	5488	64317	4507	65512	3048	78600	2481	47989
18-#14	2.30	MA	37801	9180	60485	6818	65622	5514	67057	4550	67272	3106	80568	2321	51434
7L-4S		MI	36260	9180	58511	6762	63991	5470	66196	4491	68222	3060	81819	2539	48171
18-#14	2.30	MA	37090	9180	59274	6815	63973	5533	65106	4567	64423	3095	77178	2251	50366
8L-3S		MI	37045	9180	59873	6741	65727	5477	68306	4500	70928	3048	84879	2664	48239
18-#14	2.30	MA	36359	9180	57970	6836	62369	5528	63066	4560	61766	3108	73837	2174	49280
9L-2S		MI	38159	9180	61541	6746	67866	5458	70915	4484	74467	3036	89594	2788	48257
18-#18	4.09	MA	42804	10269	72309	7447	80556	6000	85198	4823	91667	2967	113374	2041	88864
5L-6S		MI	37515	10269	63640	7386	70108	5942	73546	4765	77850	2933	95856	1813	77958
18-#18	4.09	MA	41539	10269	70145	7439	77560	5988	81538	4807	86862	2989	107422	1896	86833
6L-5S		MI	38656	10269	65584	7396	72797	5956	76833	4783	82104	2911	101095	1958	79812
18-#18	4.09	MA	40307	10269	67775	7475	74701	6020	78023	4836	82167	3011	101065	1665	83848
7L-4S		MI	39854	10269	67655	7406	75482	5926	80131	4757	86801	2933	106668	2058	82209
20-#11	1.77	MA	40456	8858	63902	6606	70161	5364	72668	4439	74809	3100	89727	2916	41739
2L-10S		MI	32485	8858	51204	6596	54647	5368	54833	4454	52726	3115	62104	2350	35737
20-#11	1.77	MA	39578	8858	62601	6604	68493	5361	70633	4452	72041	3110	85980	2830	41753
3L-9S		MI	32975	8858	51961	6599	55668	5372	56050	4442	54379	3106	64117	2411	36287
20-#11	1.77	MA	38963	8858	61543	6619	67143	5375	68993	4447	69931	3120	83539	2743	41734
4L-8S		MI	33434	8858	52779	6585	56674	5359	57329	4447	56045	3097	66195	2465	36692
20-#11	1.77	MA	38414	8858	60628	6617	65957	5371	67535	4460	67819	3112	80996	2701	41681
5L-7S		MI	33886	8858	53538	6588	57708	5363	58553	4436	57832	3106	68309	2513	36993
20-#11	1.77	MA	37892	8858	59771	6615	64770	5385	66083	4455	65905	3122	78573	2645	41494
6E		MI	34345	8858	54384	6573	58727	5350	59807	4424	59514	3097	70596	2603	37452
20-#11	1.77	MA	37383	8858	58832	6630	63637	5382	64690	4467	64036	3132	75989	2555	40946
7L-5S		MI	34816	8858	55155	6576	59796	5354	61112	4430	61235	3088	72740	2659	37617
20-#11	1.77	MA	36882	8858	57988	6627	62487	5395	63331	4480	62050	3125	73611	2506	40579
8L-4S		MI	35310	8858	55978	6579	60863	5341	62423	4418	63133	3096	75001	2700	37649
20-#11	1.77	MA	36361	8858	57163	6625	61370	5392	61909	4475	60198	3135	71262	2452	40103
9L-3S		MI	35863	8858	56929	6565	62075	5345	63897	4424	65029	3088	77158	2786	37647
20-#11	1.77	MA	35808	8858	56239	6640	60236	5406	60556	4488	58361	3145	68986	2391	39456
10L-2S		MI	36650	8858	58095	6567	63570	5332	65720	4412	67511	3079	80477	2873	37625
20-#14	2.56	MA	41778	9335	67754	6881	74974	5556	78492	4573	82715	3064	100115	2691	59350
3L-9S		MI	33743	9335	54419	6886	58681	5581	59668	4564	59264	3060	71063	2095	49586
20-#14	2.56	MA	40909	9335	66237	6902	73040	5576	76142	4565	79690	3078	96645	2566	59231
4L-8S		MI	34375	9335	55592	6865	60124	5562	61502	4573	61643	3047	74013	2173	50482
20-#14	2.56	MA	40133	9335	64925	6898	71339	5570	74051	4582	76661	3066	93020	2507	58878
5L-7S		MI	35014	9335	56681	6870	61607	5569	63257	4557	64195	3060	77022	2241	51503
20-#14	2.56	MA	39395	9335	63695	6894	69635	5589	71969	4575	73917	3080	89575	2426	57771
6E		MI	35662	9335	57893	6850	63068	5551	65054	4541	66595	3047	80271	2371	52062
20-#14	2.56	MA	38676	9335	62347	6916	68010	5584	69970	4592	71236	3094	85899	2296	57097
7L-5S		MI	36328	9335	58999	6854	64600	5558	66926	4550	69051	3035	83314	2452	52992
20-#14	2.56	MA	37968	9335	61137	6912	66361	5603	68020	4610	68387	3082	82509	2226	55943
8L-4S		MI	37027	9335	60179	6859	66129	5540	68805	4534	71762	3047	86533	2510	53339
20-#14	2.56	MA	37242	9335	59833	6933	64757	5597	65980	4602	65730	3096	79168	2148	54889
9L-3S		MI	37808	9335	61541	6839	67866	5546	70915	4543	74467	3035	89594	2635	53428
20-#18	4.55	MA	43019	10546	73408	7612	81743	6112	86641	4882	93785	2966	116644	1845	96471
6E		MI	38828	10546	66557	7559	73847	6066	78108	4840	83980	2907	103984	1755	86541
20-#18	4.55	MA	41796	10546	71038	7648	78884	6145	83126	4911	89090	2988	110287	1614	93589
7L-5S		MI	39961	10546	68501	7569	76537	6080	81395	4859	88234	2885	109222	1900	88583
22-#11	1.95	MA	40187	8966	63902	6672	70161	5409	72668	4481	74809	3101	89727	2813	45811
3L-10S		MI	33039	8966	52370	6664	56142	5416	56657	4483	55208	3107	65422	2331	39255
22-#11	1.95	MA	39575	8966	62844	6687	68811	5423	71028	4477	72699	3111	87285	2727	45780
4L-9S		MI	33528	8966	53127	6667	57163	5420	57874	4471	56860	3098	67435	2392	39789

RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

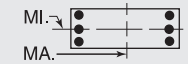
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.95	MA	39028	8966	61929	6684	67625	5420	69570	4489	70587	3104	84742	2685	45715
5L-8S		MI	33984	8966	53945	6652	58169	5407	59153	4477	58527	3089	69514	2446	40250
22-#11	1.95	MA	38508	8966	61072	6682	66437	5433	68118	4484	68674	3114	82320	2629	45436
6L-7S		MI	34435	8966	54705	6655	59203	5411	60377	4465	60314	3097	71627	2494	40544
22-#11	1.95	MA	38001	8966	60133	6697	65305	5430	66725	4497	66805	3124	79736	2539	44908
7L-6S		MI	34892	8966	55550	6641	60222	5398	61630	4454	61995	3088	73915	2584	40984
22-#11	1.95	MA	37501	8966	59289	6695	64155	5444	65365	4509	64818	3117	77358	2490	44551
8L-5S		MI	35362	8966	56321	6644	61291	5403	62936	4459	63716	3079	76059	2641	41237
22-#11	1.95	MA	36983	8966	58464	6693	63038	5440	63943	4505	62966	3127	75009	2436	44017
9L-4S		MI	35854	8966	57144	6646	62358	5390	64247	4448	65615	3088	78320	2681	41280
22-#11	1.95	MA	36431	8966	57540	6708	61904	5454	62591	4517	61130	3137	72732	2375	43388
10L-3S		MI	36405	8966	58095	6632	63570	5394	65720	4453	67511	3079	80477	2768	41295
22-#11	1.95	MA	35893	8966	56713	6705	60792	5451	61187	4512	59172	3129	70413	2323	42765
11L-2S		MI	37189	8966	59261	6635	65065	5381	67544	4442	69992	3070	83796	2854	41280
22-#14	2.81	MA	41768	9491	68100	6999	75428	5645	79055	4608	83654	3065	101977	2541	64992
4L-9S		MI	34521	9491	56087	6983	60820	5650	62277	4607	62804	3047	75777	2066	54605
22-#14	2.81	MA	40996	9491	66788	6995	73727	5640	76964	4625	80625	3054	98351	2481	64483
5L-8S		MI	35151	9491	57260	6963	62262	5632	64111	4615	65183	3034	78728	2144	55473
22-#14	2.81	MA	40262	9491	65558	6992	72023	5659	74882	4617	77881	3068	94906	2400	63420
6L-7S		MI	35786	9491	58349	6967	63745	5639	65866	4599	67734	3047	81736	2212	56574
22-#14	2.81	MA	39546	9491	64210	7013	70398	5654	72884	4635	75200	3081	91230	2271	62765
7L-6S		MI	36432	9491	59561	6947	65207	5621	67663	4583	70134	3034	84986	2342	57116
22-#14	2.81	MA	38842	9491	63000	7009	68749	5673	70933	4652	72350	3070	87840	2201	61530
8L-5S		MI	37095	9491	60668	6952	66739	5628	69535	4592	72591	3022	88029	2423	58007
22-#14	2.81	MA	38131	9491	61696	7030	67145	5667	68893	4645	69693	3083	84500	2123	60505
9L-4S		MI	37790	9491	61847	6956	68268	5609	71414	4576	75301	3034	91248	2481	58502
22-#18	5.00	MA	43275	10822	74301	7820	83067	6269	88229	4986	96013	2965	119509	1563	103346
7L-6S		MI	40131	10822	69474	7732	77587	6190	82670	4916	90111	2880	112112	1697	95148
24-#11	2.13	MA	40184	9074	64145	6754	70479	5472	73062	4506	75468	3102	91032	2710	49823
4L-10S		MI	33590	9074	53536	6731	57637	5464	58480	4512	57689	3098	68741	2312	42777
24-#11	2.13	MA	39639	9074	63230	6752	69293	5468	71605	4518	73356	3095	88489	2668	49745
5L-9S		MI	34080	9074	54293	6734	58658	5469	59698	4501	59342	3089	70754	2374	43296
24-#11	2.13	MA	39121	9074	62373	6750	68105	5482	70153	4514	71442	3105	86066	2612	49383
6L-8S		MI	34532	9074	55111	6720	59664	5456	60977	4506	61008	3080	72832	2428	43811
24-#11	2.13	MA	38616	9074	61434	6765	66972	5478	68760	4526	69573	3115	83483	2523	48873
7E		MI	34981	9074	55871	6723	60698	5460	62201	4495	62795	3089	74946	2476	44097
24-#11	2.13	MA	38118	9074	60590	6762	65823	5492	67400	4539	67587	3108	81104	2473	48524
8L-6S		MI	35437	9074	56716	6708	61717	5447	63454	4483	64477	3080	77234	2566	44521
24-#11	2.13	MA	37602	9074	59765	6760	64706	5489	65978	4534	65735	3118	78755	2420	47937
9L-5S		MI	35905	9074	57487	6711	62786	5451	64760	4489	66198	3071	79377	2622	44853
24-#11	2.13	MA	37052	9074	58841	6775	63572	5502	64626	4547	63898	3128	76479	2359	47323
10L-4S		MI	36396	9074	58310	6714	63853	5438	66071	4477	68096	3079	81638	2663	44908
24-#11	2.13	MA	36516	9074	58014	6773	62460	5499	63222	4542	61940	3121	74160	2306	46660
11L-3S		MI	36945	9074	59261	6699	65065	5442	67544	4483	69992	3070	83796	2749	44933
24-#14	3.07	MA	41855	9647	68650	7093	76115	5710	79878	4667	84589	3042	103682	2456	70098
5L-9S		MI	35296	9647	57755	7080	62958	5720	64886	4649	66343	3034	80492	2037	59621
24-#14	3.07	MA	41124	9647	67421	7089	74411	5729	77795	4660	81845	3055	100237	2375	69074
6L-8S		MI	35922	9647	58928	7060	64401	5702	66720	4658	68722	3021	83442	2115	60472
24-#14	3.07	MA	40412	9647	66073	7110	72786	5723	75797	4677	79163	3069	96561	2245	68436
7E		MI	36555	9647	60018	7064	65884	5709	68475	4642	71274	3034	86451	2183	61648
24-#14	3.07	MA	39711	9647	64862	7106	71137	5743	73846	4695	76314	3057	93171	2175	67125
8L-6S		MI	37198	9647	61230	7044	67346	5691	70272	4626	73674	3021	89701	2313	62176
24-#14	3.07	MA	39001	9647	63559	7128	69533	5737	71806	4687	73657	3071	89831	2097	66126
9L-5S		MI	37857	9647	62336	7049	68877	5697	72144	4635	76130	3009	92743	2394	63031

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

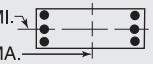


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.30	MA	42328	8963	66145	6677	71667	5439	73200	4530	73253	3241	86148	3053	33583
2L-3S		MI	34668	8963	54665	6600	58299	5414	58610	4508	56632	3213	65297	2766	29014
6-#18	1.30	MA	39995	8963	62709	6670	67263	5472	67826	4559	65943	3264	76379	2831	33682
3L-2S		MI	36643	8963	57582	6610	62039	5384	63172	4483	62763	3191	73424	2988	28887
8-#18	1.74	MA	43930	9239	69581	6850	76072	5563	78573	4605	80564	3219	95918	3004	44380
2L-4S		MI	34632	9239	55192	6807	58994	5523	59472	4565	58078	3209	68162	2487	38054
8-#18	1.74	MA	41614	9239	66145	6843	71667	5596	73200	4635	73253	3242	86148	2783	44404
3E		MI	36023	9239	57582	6773	62039	5538	63172	4584	62763	3187	73424	2708	38161
8-#18	1.74	MA	39985	9239	63342	6879	68096	5585	68859	4620	67667	3264	79798	2561	44175
4L-2S		MI	37985	9239	60499	6783	65778	5508	67734	4558	68893	3165	81552	2930	38085
10-#14	1.22	MA	42134	8911	65437	6685	71017	5449	72505	4544	72348	3267	85302	3099	31767
2L-5S		MI	33845	8911	52773	6635	56117	5428	56037	4524	53291	3243	61885	2735	27462
10-#14	1.22	MA	40798	8911	63477	6682	68505	5444	69439	4562	68177	3281	79662	2975	31821
3L-4S		MI	34562	8911	53952	6640	57646	5410	57916	4508	56001	3256	65104	2793	27466
10-#14	1.22	MA	39862	8911	61882	6704	66472	5464	66969	4555	64998	3296	75987	2850	31845
4L-3S		MI	35362	8911	55315	6619	59382	5417	60026	4517	58707	3243	68165	2918	27413
10-#14	1.22	MA	39026	8911	60504	6700	64684	5459	64772	4573	61815	3285	72158	2790	31775
5L-2S		MI	36496	8911	56983	6624	61521	5399	62635	4501	62246	3231	72880	3042	27347
10-#18	2.17	MA	45516	9516	73016	7023	80476	5687	83946	4681	87875	3197	105688	2956	55142
2L-5S		MI	34748	9516	56038	6970	60049	5678	60736	4667	59511	3160	70717	2329	45274
10-#18	2.17	MA	43216	9516	69581	7016	76072	5721	78573	4710	80564	3219	95918	2735	55083
3L-4S		MI	35985	9516	58110	6980	62733	5648	64034	4641	64208	3182	76290	2429	47057
10-#18	2.17	MA	41600	9516	66778	7052	72500	5710	74232	4696	74977	3242	89567	2513	54760
4L-3S		MI	37365	9516	60499	6945	65778	5662	67734	4659	68893	3160	81552	2650	47254
10-#18	2.17	MA	40157	9516	64353	7045	69356	5743	70369	4725	69383	3220	82910	2409	52574
5L-2S		MI	39314	9516	63416	6956	69518	5632	72296	4633	75024	3138	89679	2871	47245
12-#11	1.02	MA	41398	8780	63744	6624	68978	5407	70067	4522	69053	3288	80999	3137	26664
2L-6S		MI	33546	8780	51829	6571	54957	5377	54669	4494	51529	3275	59471	2817	23140
12-#11	1.02	MA	40461	8780	62376	6622	67224	5404	67927	4535	66141	3299	77038	3050	26707
3L-5S		MI	34025	8780	52601	6574	56026	5381	55975	4499	53250	3266	61615	2873	23126
12-#11	1.02	MA	39805	8780	61264	6637	65806	5418	66204	4531	63924	3309	74454	2964	26745
4E		MI	34527	8780	53424	6577	57093	5368	57286	4488	55148	3275	63875	2914	23086
12-#11	1.02	MA	39220	8780	60303	6635	64560	5415	64673	4544	61705	3303	71770	2921	26764
5L-3S		MI	35088	8780	54375	6563	58305	5372	58759	4493	57044	3266	66033	3000	23037
12-#11	1.02	MA	38663	8780	59403	6633	63313	5429	63148	4540	59696	3313	69207	2866	26732
6L-2S		MI	35884	8780	55541	6566	59800	5359	60583	4482	59526	3257	69352	3087	22989
12-#14	1.47	MA	43060	9066	67397	6783	73530	5519	75570	4586	76519	3255	90942	3075	37924
2L-6S		MI	33955	9066	53335	6728	56724	5491	56774	4558	54374	3243	63557	2625	32131
12-#14	1.47	MA	41730	9066	65437	6779	71017	5514	72505	4604	72348	3269	85302	2951	37962
3L-5S		MI	34635	9066	54441	6732	58255	5498	58646	4567	56830	3230	66600	2706	32642
12-#14	1.47	MA	40798	9066	63842	6801	68985	5534	70034	4597	69168	3283	81627	2826	37948
4E		MI	35348	9066	55621	6737	59785	5480	60525	4551	59541	3243	69819	2764	32687
12-#14	1.47	MA	39966	9066	62464	6798	67197	5529	67837	4615	65986	3273	77798	2766	37842
5L-3S		MI	36145	9066	56983	6717	61521	5487	62635	4559	62246	3230	72880	2889	32657
12-#14	1.47	MA	39174	9066	61172	6794	65407	5548	65650	4608	63103	3287	74151	2685	37164
6L-2S		MI	37274	9066	58651	6721	63660	5468	65244	4543	65786	3218	77594	3013	32605
12-#18	2.61	MA	47087	9793	76452	7196	84881	5811	89319	4756	95185	3175	115458	2908	65869
2L-6S		MI	34928	9793	57011	7132	61099	5787	62012	4724	61388	3156	73606	2126	52473
12-#18	2.61	MA	44803	9793	73016	7188	80476	5845	83946	4786	87875	3197	105688	2686	65737
3L-5S		MI	36097	9793	58955	7142	63788	5802	65298	4742	65642	3133	78844	2271	53946
12-#18	2.61	MA	43200	9793	70214	7225	76905	5834	79605	4771	82288	3220	99337	2465	65332
4E		MI	37325	9793	61027	7152	66473	5772	68596	4716	70339	3156	84417	2370	56042
12-#18	2.61	MA	41768	9793	67789	7218	73761	5867	75742	4801	76694	3198	92680	2360	62826
5L-3S		MI	38695	9793	63416	7118	69518	5786	72296	4735	75024	3133	89679	2592	56315
12-#18	2.61	MA	40406	9793	65516	7210	70612	5856	71894	4786	71623	3221	86370	2216	60932
6L-2S		MI	40632	9793	66333	7128	73257	5756	76858	4709	81154	3111	97807	2813	56385

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

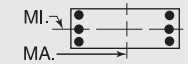


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.19	MA	42052	8888	65113	6691	70733	5456	72207	4552	71965	3280	84959	3121	30969
2L-7S		MI	33639	8888	52150	6653	55433	5438	55240	4535	52329	3275	60502	2708	26511
14-#11	1.19	MA	41117	8888	63744	6689	68978	5452	70067	4565	69053	3290	80999	3035	31005
3L-6S		MI	34104	8888	52995	6639	56452	5425	56493	4523	54010	3267	62790	2798	26771
14-#11	1.19	MA	40464	8888	62632	6705	67561	5466	68344	4560	66835	3301	78415	2949	31032
4L-5S		MI	34581	8888	53767	6642	57521	5429	57799	4529	55731	3258	64933	2854	26780
14-#11	1.19	MA	39881	8888	61672	6703	66315	5463	66813	4573	64617	3294	75731	2906	31029
5L-4S		MI	35081	8888	54590	6645	58588	5416	59110	4517	57630	3266	67194	2895	26753
14-#11	1.19	MA	39326	8888	60772	6701	65067	5477	65288	4569	62608	3305	73168	2850	30977
6L-3S		MI	35640	8888	55541	6630	59800	5421	60583	4523	59526	3257	69352	2982	26714
14-#11	1.19	MA	38785	8888	59785	6716	63878	5474	63825	4582	60645	3315	70436	2760	30609
7L-2S		MI	36434	8888	56707	6633	61295	5408	62407	4511	62007	3248	72671	3068	26671
14-#14	1.71	MA	43980	9222	69357	6880	76043	5589	78635	4629	80689	3242	96582	3051	44069
2L-7S		MI	34084	9222	53791	6845	57401	5579	57586	4616	55513	3242	65022	2466	36511
14-#14	1.71	MA	42655	9222	67397	6877	73530	5584	75570	4647	76519	3256	90942	2927	44088
3L-6S		MI	34743	9222	55003	6825	58862	5561	59383	4600	57913	3230	68272	2596	37147
14-#14	1.71	MA	41728	9222	65802	6898	71497	5603	73099	4640	73339	3271	87267	2802	44040
4L-5S		MI	35419	9222	56109	6829	60394	5568	61255	4609	60370	3217	71315	2678	37811
14-#14	1.71	MA	40900	9222	64424	6895	69710	5598	70903	4658	70157	3260	83438	2742	43901
5L-4S		MI	36129	9222	57289	6834	61923	5550	63134	4593	63080	3230	74533	2735	37886
14-#14	1.71	MA	40113	9222	63132	6892	67920	5618	68715	4651	67274	3275	79791	2661	43068
6L-3S		MI	36923	9222	58651	6814	63660	5556	65244	4602	65786	3217	77594	2860	37887
14-#14	1.71	MA	39345	9222	61717	6913	66213	5613	66616	4669	64457	3289	75902	2532	42246
7L-2S		MI	38047	9222	60320	6818	65798	5538	67853	4586	69325	3205	82309	2985	37849
14-#18	3.04	MA	46376	10069	76452	7361	84881	5969	89319	4861	95185	3175	115458	2638	76375
3L-6S		MI	36274	10069	59929	7305	64838	5912	66574	4799	67518	3129	81733	2067	61253
14-#18	3.04	MA	44785	10069	73650	7398	81309	5958	84978	4846	89599	3198	109107	2416	75897
4L-5S		MI	37435	10069	61872	7315	67528	5926	69860	4818	71772	3107	86972	2212	62651
14-#18	3.04	MA	43364	10069	71225	7391	78165	5991	81115	4876	84004	3176	102450	2312	73110
5L-4S		MI	38653	10069	63944	7325	70212	5896	73158	4792	76469	3129	92545	2312	65015
14-#18	3.04	MA	42013	10069	68951	7383	75017	5980	77267	4862	78934	3199	96140	2168	71302
6L-3S		MI	40014	10069	66333	7291	73257	5910	76858	4810	81154	3107	97807	2533	65356
14-#18	3.04	MA	40696	10069	66461	7420	72012	6013	73574	4891	73978	3221	89405	1937	68146
7L-2S		MI	41939	10069	69250	7301	76997	5880	81420	4784	87285	3085	105934	2755	65480
16-#11	1.36	MA	42702	8996	66481	6759	72487	5504	74348	4581	74877	3271	88920	3106	35267
2L-8S		MI	33740	8996	52557	6718	55894	5482	55840	4576	53023	3259	61707	2642	29722
16-#11	1.36	MA	41770	8996	65113	6757	70733	5501	72207	4594	71965	3282	84959	3019	35296
3L-7S		MI	34196	8996	53316	6721	56928	5487	57064	4564	54810	3267	63821	2690	30048
16-#11	1.36	MA	41119	8996	64001	6772	69315	5515	70484	4590	69747	3292	82376	2933	35312
4L-6S		MI	34659	8996	54162	6706	57947	5474	58317	4553	56492	3258	66109	2780	30396
16-#11	1.36	MA	40538	8996	63040	6770	68069	5512	68953	4603	67529	3285	79691	2891	35287
5E		MI	35134	8996	54933	6709	59016	5478	59623	4558	58213	3249	68252	2836	30426
16-#11	1.36	MA	39985	8996	62140	6768	66822	5526	67428	4598	65519	3296	77129	2835	35218
6L-4S		MI	35632	8996	55756	6712	60083	5465	60934	4547	60111	3258	70513	2877	30412
16-#11	1.36	MA	39447	8996	61154	6783	65632	5523	65965	4611	63557	3306	74397	2745	34761
7L-3S		MI	36190	8996	56707	6698	61295	5469	62407	4552	62007	3249	72671	2963	30382
16-#11	1.36	MA	38908	8996	60268	6781	64426	5537	64538	4624	61470	3300	71887	2695	34333
8L-2S		MI	36982	8996	57873	6700	62790	5456	64231	4541	64489	3240	75989	3049	30345
16-#14	1.96	MA	44894	9378	71317	6977	78555	5659	81701	4671	84860	3230	102221	3027	50205
2L-8S		MI	34224	9378	54370	6938	58056	5642	58440	4675	56501	3217	66728	2369	40848
16-#14	1.96	MA	43575	9378	69357	6974	76043	5653	78635	4689	80689	3244	96582	2903	50196
3L-7S		MI	34870	9378	55459	6942	59539	5649	60195	4659	59052	3229	69737	2437	41568
16-#14	1.96	MA	42652	9378	67762	6995	74010	5673	76165	4682	77510	3258	92907	2778	50122
4L-6S		MI	35526	9378	56671	6922	61001	5631	61992	4643	61453	3217	72986	2567	42175
16-#14	1.96	MA	41829	9378	66384	6992	72222	5668	73968	4700	74327	3248	89078	2718	49954
5E		MI	36200	9378	57778	6927	62533	5638	63864	4652	63909	3204	76029	2649	42971
16-#14	1.96	MA	41045	9378	65092	6989	70433	5688	71780	4693	71445	3262	85431	2637	48985
6L-4S		MI	36906	9378	58957	6931	64062	5620	65743	4635	66619	3217	79248	2707	43074
16-#14	1.96	MA	40282	9378	63677	7010	68726	5683	69681	4711	68628	3277	81542	2508	48195
7L-3S		MI	37696	9378	60320	6911	65798	5626	67853	4644	69325	3204	82309	2831	43107

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

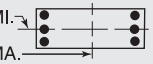
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	1.96	MA	39530	9378	62406	7007	66994	5703	67632	4729	65635	3266	77961	2437	47296
8L-2S		MI	38816	9378	61988	6916	67937	5608	70462	4628	72865	3192	87023	2956	43082
16-#18	3.48	MA	46357	10346	77085	7571	85714	6082	90352	4922	96910	3176	118877	2368	86454
4L-6S		MI	37609	10346	62846	7478	68578	6036	71136	4875	73649	3102	89861	2009	69957
16-#18	3.48	MA	44947	10346	74661	7564	82570	6115	86488	4952	91315	3154	112220	2264	83422
5E		MI	38762	10346	64790	7488	71267	6050	74422	4893	77903	3080	95099	2154	71381
16-#18	3.48	MA	43605	10346	72387	7556	79421	6104	82641	4937	86244	3177	105910	2120	81687
6L-4S		MI	39972	10346	66861	7498	73952	6020	77720	4867	82599	3102	100672	2254	73979
16-#18	3.48	MA	42299	10346	69897	7593	76417	6138	78947	4967	81289	3199	99175	1889	78372
7L-3S		MI	41324	10346	69250	7464	76997	6034	81420	4885	87285	3080	105934	2475	74382
16-#18	3.48	MA	41014	10346	67658	7586	73369	6127	75341	4996	76023	3178	92951	1766	75394
8L-2S		MI	43237	10346	72167	7474	80736	6004	85982	4860	93415	3058	114062	2697	74556
18-#11	1.53	MA	43349	9104	67850	6826	74241	5552	76488	4611	77789	3262	92881	3090	39559
2L-9S		MI	33832	9104	52905	6800	56383	5544	56384	4600	53838	3259	62947	2569	33026
18-#11	1.53	MA	42420	9104	66481	6824	72487	5549	74348	4624	74877	3273	88920	3004	39580
3L-8S		MI	34295	9104	53723	6785	57389	5531	57664	4605	55505	3250	65026	2623	33277
18-#11	1.53	MA	41771	9104	65369	6840	71069	5563	72625	4619	72659	3283	86337	2918	39578
4L-7S		MI	34750	9104	54483	6788	58423	5535	58887	4594	57292	3258	67139	2671	33590
18-#11	1.53	MA	41193	9104	64409	6838	69823	5560	71093	4632	70441	3277	83652	2875	39540
5L-6S		MI	35211	9104	55328	6774	59442	5522	60141	4582	58973	3249	69427	2761	34014
18-#11	1.53	MA	40642	9104	63509	6836	68576	5574	69569	4628	68431	3287	81090	2819	39454
6L-5S		MI	35685	9104	56099	6777	60511	5526	61447	4588	60694	3241	71571	2817	34058
18-#11	1.53	MA	40105	9104	62522	6851	67387	5571	68106	4641	66469	3298	78358	2730	38920
7L-4S		MI	36182	9104	56922	6779	61578	5513	62758	4576	62593	3249	73832	2858	34064
18-#11	1.53	MA	39577	9104	61637	6849	66180	5585	66678	4654	64382	3291	75847	2680	38506
8L-3S		MI	36737	9104	57873	6765	62790	5517	64231	4582	64489	3240	75989	2944	34042
18-#11	1.53	MA	39017	9104	60770	6847	65006	5582	65185	4649	62437	3302	73363	2626	38160
9L-2S		MI	37527	9104	59040	6768	64285	5504	66055	4570	66970	3231	79308	3031	34012
18-#14	2.20	MA	45803	9533	73277	7074	81068	5728	84766	4714	89031	3217	107861	3004	56331
2L-9S		MI	34357	9533	54865	7055	58752	5730	59215	4708	57662	3216	68492	2262	44878
18-#14	2.20	MA	44490	9533	71317	7071	78555	5723	81701	4732	84860	3232	102221	2879	56295
3L-8S		MI	35009	9533	56038	7035	60195	5712	61049	4717	60041	3204	71442	2340	45817
18-#14	2.20	MA	43571	9533	69722	7093	76523	5743	79230	4725	81680	3246	98547	2755	56198
4L-7S		MI	35652	9533	57128	7040	61678	5719	62804	4701	62592	3216	74451	2408	46631
18-#14	2.20	MA	42752	9533	68344	7089	74735	5738	77033	4743	78498	3235	94718	2694	56003
5L-6S		MI	36306	9533	58340	7019	63140	5701	64601	4685	64992	3204	77701	2539	47214
18-#14	2.20	MA	41972	9533	67052	7086	72946	5758	74846	4736	75615	3250	91071	2613	54913
6L-5S		MI	36976	9533	59446	7024	64671	5707	66473	4694	67449	3191	80744	2620	48125
18-#14	2.20	MA	41212	9533	65637	7108	71238	5753	72747	4754	72799	3264	87182	2484	54151
7L-4S		MI	37679	9533	60625	7029	66201	5689	68352	4678	70159	3204	83962	2678	48253
18-#14	2.20	MA	40464	9533	64366	7104	69507	5772	70698	4772	69805	3254	83601	2413	53158
8L-3S		MI	38465	9533	61988	7008	67937	5696	70462	4687	72865	3191	87023	2802	48308
18-#14	2.20	MA	39683	9533	63122	7101	67822	5767	68555	4765	67015	3268	80065	2335	51973
9L-2S		MI	39581	9533	63656	7013	70076	5678	73071	4671	76404	3179	91738	2927	48308
18-#18	3.91	MA	46516	10623	78097	7737	86974	6239	91862	5027	98626	3132	121990	2215	93755
5L-6S		MI	38934	10623	65763	7651	72317	6160	75698	4950	79779	3076	97989	1951	78508
18-#18	3.91	MA	45185	10623	75823	7729	83826	6228	88014	5012	93555	3154	115680	2071	91906
6L-5S		MI	40078	10623	67707	7661	75007	6174	78984	4968	84033	3053	103227	2096	80133
18-#18	3.91	MA	43889	10623	73332	7766	80821	6262	84320	5042	88600	3177	108945	1840	88619
7L-4S		MI	41280	10623	69778	7671	77692	6144	82282	4942	88730	3076	108800	2195	82597
18-#18	3.91	MA	42613	10623	71094	7759	77774	6251	80714	5072	83334	3155	102721	1717	85523
8L-3S		MI	42623	10623	72167	7637	80736	6158	85982	4961	93415	3053	114062	2417	83396
20-#11	1.70	MA	43993	9212	69218	6894	75996	5601	78628	4640	80701	3254	96842	3075	43845
2L-10S		MI	33899	9212	53314	6864	56857	5588	56991	4641	54667	3259	64253	2489	35960

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

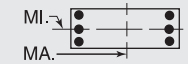
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.70	MA	43068	9212	67850	6892	74241	5598	76488	4653	77789	3264	92881	2989	43859
3L-9S		MI	34389	9212	54071	6867	57878	5592	58208	4629	56320	3250	66266	2550	36520
20-#11	1.70	MA	42421	9212	66738	6907	72824	5612	74765	4649	75571	3275	90298	2902	43840
4L-8S		MI	34849	9212	54889	6853	58884	5579	59488	4635	57986	3241	68344	2604	36835
20-#11	1.70	MA	41844	9212	65777	6905	71578	5609	73233	4662	73353	3268	87613	2860	43787
5L-7S		MI	35302	9212	55649	6856	59918	5583	60711	4623	59773	3250	70458	2652	37137
20-#11	1.70	MA	41295	9212	64877	6903	70331	5623	71709	4657	71343	3279	85051	2804	43686
6E		MI	35761	9212	56494	6841	60937	5570	61965	4611	61455	3241	72746	2742	37607
20-#11	1.70	MA	40761	9212	63891	6918	69141	5620	70246	4670	69380	3289	82319	2714	43083
7L-5S		MI	36233	9212	57266	6844	62006	5575	63271	4617	63176	3232	74889	2798	37686
20-#11	1.70	MA	40234	9212	63005	6916	67934	5634	68818	4683	67294	3282	79808	2664	42682
8L-4S		MI	36728	9212	58088	6847	63073	5562	64582	4605	65074	3240	77150	2839	37710
20-#11	1.70	MA	39677	9212	62139	6914	66761	5630	67325	4679	65349	3293	77324	2611	42273
9L-3S		MI	37282	9212	59040	6833	64285	5566	66055	4611	66970	3231	79308	2926	37697
20-#11	1.70	MA	39096	9212	61168	6930	65570	5645	65905	4692	63421	3304	74915	2550	41566
10L-2S		MI	38069	9212	60206	6835	65780	5553	67879	4599	69452	3223	82627	3012	37673
20-#14	2.45	MA	45400	9689	73277	7168	81068	5793	84766	4774	89031	3219	107861	2855	62388
3L-9S		MI	35156	9689	56534	7152	60891	5800	61824	4751	61201	3203	73207	2233	49888
20-#14	2.45	MA	44485	9689	71682	7190	79035	5813	82295	4767	85851	3233	104187	2731	62268
4L-8S		MI	35790	9689	57706	7132	62334	5782	63658	4760	63580	3191	76157	2311	50797
20-#14	2.45	MA	43670	9689	70304	7187	77248	5808	80099	4785	82669	3223	100357	2670	62048
5L-7S		MI	36430	9689	58796	7137	63817	5789	65413	4744	66131	3203	79166	2380	51699
20-#14	2.45	MA	42894	9689	69013	7183	75458	5828	77911	4778	79786	3237	96711	2590	60851
6E		MI	37080	9689	60008	7117	65278	5771	67210	4727	68532	3191	82415	2510	52261
20-#14	2.45	MA	42138	9689	67597	7205	73751	5823	75812	4796	76969	3252	92822	2460	60113
7L-5S		MI	37747	9689	61114	7121	66810	5777	69082	4736	70988	3178	85458	2591	53216
20-#14	2.45	MA	41393	9689	66326	7202	72019	5842	73763	4814	73976	3241	89241	2389	59031
8L-4S		MI	38448	9689	62294	7126	68339	5759	70961	4720	73698	3191	88677	2649	53425
20-#14	2.45	MA	40617	9689	65082	7198	70335	5837	71621	4807	71185	3256	85705	2311	57880
9L-3S		MI	39231	9689	63656	7106	70076	5766	73071	4729	76404	3178	91738	2773	53501
20-#14	2.45	MA	39793	9689	63689	7220	68627	5857	69582	4825	68418	3270	82279	2223	56519
10L-2S		MI	40343	9689	65325	7110	72214	5748	75680	4713	79943	3166	96452	2898	53528
20-#18	4.35	MA	46752	10899	79259	7902	88230	6353	93387	5088	100866	3132	125450	2023	102064
6E		MI	40249	10899	68680	7824	76057	6284	80260	5025	85909	3049	106116	1893	87085
20-#18	4.35	MA	45465	10899	76768	7939	85226	6386	89693	5118	95910	3155	118715	1792	98884
7L-5S		MI	41386	10899	70624	7834	78747	6298	83546	5044	90163	3027	111354	2038	88901
20-#18	4.35	MA	44199	10899	74530	7931	82178	6375	86088	5147	90645	3133	112491	1669	95672
8L-4S		MI	42580	10899	72695	7844	81431	6268	86844	5018	94860	3049	116928	2137	91245
22-#11	1.87	MA	43712	9320	69218	6959	75996	5646	78628	4682	80701	3256	96842	2973	48127
3L-10S		MI	34453	9320	54480	6932	58352	5636	58815	4670	57149	3250	67572	2470	39478
22-#11	1.87	MA	43068	9320	68106	6974	74578	5660	76905	4678	78483	3266	94258	2887	48097
4L-9S		MI	34943	9320	55238	6935	59373	5641	60032	4658	58801	3242	69585	2531	40020
22-#11	1.87	MA	42493	9320	67146	6972	73332	5657	75374	4691	76265	3260	91574	2844	48031
5L-8S		MI	35400	9320	56056	6920	60379	5628	61312	4664	60468	3233	71663	2585	40395
22-#11	1.87	MA	41946	9320	66246	6970	72085	5671	73849	4687	74255	3270	89011	2788	47836
6L-7S		MI	35851	9320	56815	6923	61413	5632	62535	4652	62255	3241	73777	2633	40688
22-#11	1.87	MA	41413	9320	65259	6986	70895	5668	72386	4700	72292	3281	86280	2699	47252
7L-6S		MI	36309	9320	57660	6909	62432	5619	63789	4641	63936	3232	76065	2724	41139
22-#11	1.87	MA	40889	9320	64374	6984	69689	5682	70959	4712	70206	3274	83769	2649	46861
8L-5S		MI	36780	9320	58432	6911	63501	5623	65094	4646	65657	3223	78208	2780	41309
22-#11	1.87	MA	40334	9320	63507	6982	68515	5679	69465	4708	68261	3284	81285	2595	46392
9L-4S		MI	37273	9320	59255	6914	64568	5610	66406	4635	67556	3232	80469	2820	41343
22-#11	1.87	MA	39755	9320	62537	6997	67325	5693	68045	4721	66333	3295	78876	2534	45704
10L-3S		MI	37825	9320	60206	6900	65780	5614	67879	4640	69452	3223	82627	2907	41348

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

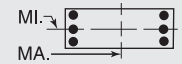


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.87	MA	39189	9320	61669	6995	66158	5690	66571	4717	64277	3288	76428	2482	45141
11L-2S		MI	38610	9320	61372	6903	67275	5601	69703	4629	71933	3214	85945	2993	41330
22-#14	2.69	MA	45394	9845	73642	7287	81548	5883	85361	4809	90022	3221	109827	2707	68333
4L-9S		MI	35936	9845	58202	7250	63030	5870	64433	4793	64741	3190	77921	2204	54905
22-#14	2.69	MA	44583	9845	72264	7284	79761	5878	83164	4827	86839	3211	105997	2646	67975
5L-8S		MI	36567	9845	59375	7229	64472	5852	66268	4802	67120	3178	80871	2282	55786
22-#14	2.69	MA	43810	9845	70973	7281	77971	5897	80976	4821	83957	3225	102351	2566	66796
6L-7S		MI	37204	9845	60464	7234	65955	5859	68022	4786	69671	3190	83880	2351	56771
22-#14	2.69	MA	43058	9845	69557	7302	76264	5892	78877	4838	81140	3239	98462	2436	66080
7L-6S		MI	37851	9845	61676	7214	67417	5840	69819	4770	72071	3178	87130	2481	57315
22-#14	2.69	MA	42317	9845	68286	7299	74532	5912	76828	4856	78147	3229	94881	2365	64913
8L-5S		MI	38515	9845	62782	7218	68949	5847	71691	4779	74528	3165	90173	2562	58229
22-#14	2.69	MA	41545	9845	67042	7296	72848	5907	74686	4850	75356	3243	91345	2287	63793
9L-4S		MI	39213	9845	63962	7223	70478	5829	73570	4763	77238	3178	93391	2620	58592
22-#14	2.69	MA	40725	9845	65649	7317	71139	5927	72648	4868	72589	3257	87919	2200	62373
10L-3S		MI	39992	9845	65325	7203	72214	5836	75680	4772	79943	3165	96452	2744	58687
22-#18	4.78	MA	47031	11176	80204	8112	89630	6510	95067	5193	103221	3133	128485	1744	109167
7L-6S		MI	41555	11176	71597	7997	79796	6408	84822	5101	92040	3022	114244	1834	95685
22-#18	4.78	MA	45773	11176	77965	8104	86583	6499	91461	5223	97955	3111	122261	1621	105841
8L-5S		MI	42685	11176	73541	8007	82486	6422	88108	5119	96294	3000	119482	1979	97685
24-#11	2.03	MA	43712	9427	69475	7042	76332	5709	79045	4707	81395	3258	98219	2871	52350
4L-10S		MI	35005	9427	55647	6999	59847	5685	60639	4700	59630	3242	70891	2452	42999
24-#11	2.03	MA	43139	9427	68514	7040	75086	5705	77514	4720	79177	3251	95535	2829	52272
5L-9S		MI	35495	9427	56404	7002	60868	5689	61856	4688	61283	3233	72904	2513	43526
24-#11	2.03	MA	42594	9427	67614	7038	73839	5720	75989	4716	77167	3261	92972	2773	51988
6L-8S		MI	35949	9427	57222	6988	61874	5676	63135	4693	62949	3224	74982	2567	43957
24-#11	2.03	MA	42064	9427	66628	7053	72650	5716	74526	4729	75204	3272	90241	2683	51424
7E		MI	36398	9427	57981	6990	62908	5680	64359	4682	64736	3232	77096	2615	44242
24-#11	2.03	MA	41541	9427	65742	7051	71443	5730	73099	4742	73118	3265	87730	2633	51043
8L-6S		MI	36855	9427	58827	6976	63927	5667	65613	4670	66418	3224	79383	2705	44676
24-#11	2.03	MA	40989	9427	64876	7049	70270	5727	71606	4737	71173	3276	85245	2580	50517
9L-5S		MI	37324	9427	59598	6979	64996	5671	66918	4676	68139	3215	81527	2761	44928
24-#11	2.03	MA	40411	9427	63906	7065	69079	5741	70186	4750	69245	3286	82837	2519	49845
10L-4S		MI	37816	9427	60421	6982	66063	5658	68229	4664	70037	3223	83788	2802	44974
24-#11	2.03	MA	39847	9427	63037	7063	67912	5738	68712	4746	67189	3280	80389	2466	49240
11L-3S		MI	38366	9427	61372	6967	67275	5663	69703	4670	71933	3214	85945	2888	44994
24-#11	2.03	MA	39293	9427	62085	7078	66730	5752	67294	4759	65261	3290	77630	2389	48375
12L-2S		MI	39149	9427	62538	6970	68770	5650	71526	4658	74415	3205	89264	2974	44982
24-#14	2.93	MA	45491	10000	74224	7381	82273	5948	86229	4870	91010	3198	111637	2622	73884
5L-9S		MI	36711	10000	59870	7347	65168	5940	67042	4836	68280	3177	82636	2175	59928
24-#14	2.93	MA	44722	10000	72933	7378	80484	5967	84042	4863	88127	3212	107991	2542	72747
6L-8S		MI	37339	10000	61043	7327	66611	5922	68877	4844	70659	3165	85586	2254	60783
24-#14	2.93	MA	43974	10000	71517	7399	78777	5962	81943	4881	85311	3227	104101	2412	72050
7E		MI	37974	10000	62132	7331	68094	5928	70631	4828	73210	3177	88595	2322	61846
24-#14	2.93	MA	43236	10000	70246	7396	77045	5982	79894	4899	82317	3216	100521	2341	70804
8L-6S		MI	38618	10000	63344	7311	69556	5910	72428	4812	75611	3165	91844	2452	62375
24-#14	2.93	MA	42468	10000	69002	7393	75361	5977	77751	4892	79527	3231	96985	2264	69712
9L-5S		MI	39280	10000	64451	7316	71087	5917	74300	4821	78067	3152	94887	2533	63252
24-#14	2.93	MA	41652	10000	67610	7414	73652	5997	75713	4910	76759	3245	93559	2176	68234
10L-4S		MI	39974	10000	65630	7320	72617	5899	76179	4805	80777	3165	98106	2591	63755
24-#18	5.22	MA	47336	11452	81401	8277	90987	6623	96834	5298	105266	3089	132031	1572	116027
8L-6S		MI	42853	11452	74514	8170	83536	6532	89384	5176	98170	2996	122371	1776	104306

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis



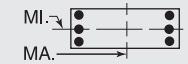
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.25	MA	45925	9316	71525	6964	77527	5675	79132	4730	79004	3395	92976	3210	35203
2L-3S		MI	36083	9316	56788	6865	60509	5631	60761	4694	58562	3356	67429	2904	29074
6-#18	1.25	MA	43469	9316	67916	6958	72900	5709	73488	4761	71326	3419	82658	2989	35302
3L-2S		MI	38061	9316	59705	6875	64248	5601	65324	4668	64692	3333	75556	3125	28939
8-#18	1.67	MA	47617	9593	75133	7137	82153	5800	84776	4806	86683	3373	103294	3164	46540
2L-4S		MI	36047	9593	57316	7072	61203	5741	61624	4751	60007	3351	70294	2624	38160
8-#18	1.67	MA	45179	9593	71525	7131	77527	5834	79132	4837	79004	3397	92976	2943	46564
3E		MI	37440	9593	59705	7037	64248	5756	65324	4769	64692	3329	75556	2846	38230
8-#18	1.67	MA	43468	9593	68584	7168	73779	5824	74578	4823	73143	3421	86262	2722	46335
4L-2S		MI	39404	9593	62622	7048	67988	5726	69886	4743	70823	3307	83684	3067	38144
10-#14	1.17	MA	45715	9264	70772	6973	76833	5685	78389	4745	78037	3421	92040	3255	33285
2L-5S		MI	35259	9264	54888	6902	58327	5648	58193	4711	55228	3387	64029	2874	27533
10-#14	1.17	MA	44311	9264	68715	6970	74195	5681	75171	4763	73659	3436	86091	3131	33340
3L-4S		MI	35977	9264	56067	6906	59856	5630	60072	4695	57938	3399	67248	2932	27519
10-#14	1.17	MA	43328	9264	67043	6992	72064	5701	72581	4757	70325	3451	82211	3006	33364
4L-3S		MI	36778	9264	57430	6886	61592	5636	62182	4704	60643	3387	70309	3056	27460
10-#14	1.17	MA	42451	9264	65598	6989	70190	5696	70278	4775	66989	3442	78178	2945	33294
5L-2S		MI	37913	9264	59098	6891	63731	5618	64791	4688	64183	3374	75023	3181	27391
10-#18	2.08	MA	49291	9870	78742	7310	86779	5924	90419	4881	94362	3351	113613	3119	57842
2L-5S		MI	36162	9870	58161	7234	62258	5895	62888	4852	61440	3302	72849	2466	45600
10-#18	2.08	MA	46871	9870	75133	7304	82153	5958	84776	4912	86683	3375	103294	2897	57783
3L-4S		MI	37401	9870	60233	7244	64943	5865	66186	4826	66137	3324	78422	2566	47175
10-#18	2.08	MA	45173	9870	72193	7341	78405	5948	80221	4899	80822	3399	96580	2676	57460
4L-3S		MI	38784	9870	62622	7210	67988	5880	69886	4844	70823	3302	83684	2787	47338
10-#18	2.08	MA	43658	9870	69651	7334	75108	5982	76170	4929	74954	3379	89561	2570	55390
5L-2S		MI	40736	9870	65539	7220	71727	5850	74448	4818	76953	3280	91811	3009	47311
12-#14	1.41	MA	46692	9420	72829	7070	79470	5755	81606	4787	82414	3409	97988	3233	39746
2L-6S		MI	35369	9420	55450	6994	58934	5711	58930	4744	56311	3386	65701	2764	32328
12-#14	1.41	MA	45293	9420	70772	7067	76833	5751	78389	4806	78037	3424	92040	3108	39784
3L-5S		MI	36050	9420	56556	6999	60465	5718	60802	4753	58767	3374	68744	2845	32721
12-#14	1.41	MA	44315	9420	69100	7089	74701	5771	75798	4799	74703	3439	88160	2984	39771
4E		MI	36764	9420	57735	7004	61995	5699	62681	4737	61477	3386	71962	2903	32746
12-#14	1.41	MA	43442	9420	67655	7086	72827	5766	73496	4818	71367	3429	84127	2923	39665
5L-3S		MI	37562	9420	59098	6983	63731	5706	64791	4746	64183	3374	75023	3027	32708
12-#14	1.41	MA	42612	9420	66302	7083	70952	5786	71203	4811	68345	3444	80279	2842	39072
6L-2S		MI	38692	9420	60766	6988	65870	5688	67400	4730	67722	3361	79738	3152	32652
12-#18	2.50	MA	50951	10146	82351	7483	91405	6048	96063	4957	102040	3329	123931	3073	69109
2L-6S		MI	36342	10146	59135	7397	63308	6005	64163	4909	63317	3298	75738	2263	52776
12-#18	2.50	MA	48546	10146	78742	7477	86779	6082	90419	4987	94362	3353	113613	2852	68977
3L-5S		MI	37513	10146	61078	7407	65998	6020	67450	4927	67571	3276	80976	2408	54268
12-#18	2.50	MA	46862	10146	75802	7514	83031	6072	85865	4974	88500	3377	106898	2630	68572
4E		MI	38743	10146	63150	7417	68682	5990	70748	4901	72268	3298	86550	2508	56170
12-#18	2.50	MA	45359	10146	73259	7507	79735	6106	81813	5005	82632	3357	99879	2524	66165
5L-3S		MI	40116	10146	65539	7383	71727	6004	74448	4920	76953	3276	91811	2729	56408
12-#18	2.50	MA	43929	10146	70876	7501	76433	6096	77778	4991	77315	3381	93212	2381	64103
6L-2S		MI	42056	10146	68456	7393	75467	5974	79010	4894	83083	3254	99939	2951	56450
14-#11	1.14	MA	45625	9242	70427	6979	76528	5692	78071	4753	77626	3434	91658	3277	32443
2L-7S		MI	35053	9242	54261	6921	57643	5659	57398	4722	54269	3419	62651	2847	26651
14-#11	1.14	MA	44643	9242	68991	6977	74687	5689	75825	4766	74571	3445	87483	3190	32479
3L-6S		MI	35519	9242	55106	6907	58662	5646	58651	4710	55951	3410	64939	2937	26835
14-#11	1.14	MA	43958	9242	67826	6992	73201	5703	74019	4762	72247	3456	84758	3104	32506
4L-5S		MI	35996	9242	55878	6910	59731	5650	59957	4716	57672	3402	67083	2994	26830

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

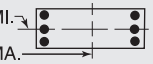


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.14	MA	43346	9242	66819	6991	71896	5701	72414	4775	69921	3450	81932	3061	32503
5L-4S		MI	36497	9242	56700	6912	60798	5637	61268	4704	59570	3410	69344	3034	26798
14-#11	1.14	MA	42764	9242	65877	6989	70589	5715	70816	4771	67816	3461	79229	3005	32452
6L-3S		MI	37056	9242	57652	6898	62010	5641	62742	4710	61466	3401	71501	3121	26756
14-#11	1.14	MA	42198	9242	64843	7005	69343	5712	69284	4784	65759	3472	76350	2916	32136
7L-2S		MI	37851	9242	58818	6901	63505	5628	64565	4698	63948	3392	74820	3207	26711
14-#14	1.64	MA	47662	9576	74887	7167	82107	5825	84824	4829	86792	3396	103937	3210	46195
2L-7S		MI	35498	9576	55906	7112	59610	5799	59742	4803	57450	3386	67166	2605	36698
14-#14	1.64	MA	46269	9576	72829	7164	79470	5820	81606	4848	82414	3411	97988	3086	46214
3L-6S		MI	36158	9576	57118	7092	61072	5781	61539	4787	59850	3373	70415	2735	37343
14-#14	1.64	MA	45296	9576	71157	7186	77338	5841	79016	4842	79080	3426	94109	2961	46166
4L-5S		MI	36835	9576	58224	7096	62604	5787	63411	4796	62307	3361	73458	2816	37896
14-#14	1.64	MA	44427	9576	69713	7183	75465	5836	76713	4860	75744	3417	90076	2900	46027
5L-4S		MI	37546	9576	59404	7101	64133	5769	65290	4780	65017	3373	76677	2874	37954
14-#14	1.64	MA	43601	9576	68359	7180	73589	5856	74420	4854	72723	3432	86228	2819	45270
6L-3S		MI	38341	9576	60766	7081	65870	5776	67400	4788	67722	3361	79738	2999	37942
14-#14	1.64	MA	42797	9576	66876	7202	71800	5852	72220	4872	69771	3447	82125	2690	44374
7L-2S		MI	39467	9576	62435	7085	68008	5758	70009	4772	71262	3348	84452	3123	37900
14-#18	2.92	MA	50208	10423	82351	7649	91405	6206	96063	5063	102040	3331	123931	2806	80155
3L-6S		MI	37689	10423	62052	7570	67048	6130	68725	4984	69447	3271	83866	2205	61555
14-#18	2.92	MA	48536	10423	79410	7687	87658	6196	91509	5049	96179	3355	117216	2585	79677
4L-5S		MI	38852	10423	63996	7580	69737	6144	72012	5003	73701	3249	89104	2350	62969
14-#18	2.92	MA	47044	10423	76868	7680	84361	6230	87457	5080	90311	3335	110197	2479	76972
5L-4S		MI	40074	10423	66067	7590	72422	6114	75310	4977	78398	3271	94677	2450	65152
14-#18	2.92	MA	45625	10423	74485	7674	81059	6220	83422	5067	84993	3358	103530	2335	75003
6L-3S		MI	41438	10423	68456	7556	75467	6128	79010	4995	83083	3249	99939	2671	65456
14-#18	2.92	MA	44244	10423	71873	7711	77909	6254	79549	5097	79798	3382	96416	2104	71897
7L-2S		MI	43366	10423	71373	7566	79206	6098	83572	4969	89214	3227	108067	2892	65561
16-#11	1.30	MA	46311	9350	71863	7046	78369	5740	80316	4782	80682	3425	95834	3262	36952
2L-8S		MI	35154	9350	54667	6986	58104	5703	57998	4763	54964	3402	63856	2781	29858
16-#11	1.30	MA	45332	9350	70427	7044	76528	5737	78071	4795	77626	3436	91658	3176	36980
3L-7S		MI	35610	9350	55427	6989	59138	5707	59222	4751	56751	3411	65970	2829	30187
16-#11	1.30	MA	44648	9350	69262	7060	75042	5752	76264	4791	75302	3447	88933	3089	36997
4L-6S		MI	36074	9350	56272	6974	60157	5694	60475	4740	58432	3402	68258	2919	30464
16-#11	1.30	MA	44039	9350	68255	7058	73737	5749	74660	4805	72977	3441	86107	3047	36972
5E		MI	36550	9350	57044	6977	61226	5698	61781	4745	60153	3393	70402	2975	30480
16-#11	1.30	MA	43460	9350	67312	7056	72430	5763	73062	4801	70871	3452	83405	2991	36902
6L-4S		MI	37049	9350	57867	6980	62293	5685	63092	4734	62052	3401	72662	3016	30460
16-#11	1.30	MA	42895	9350	66279	7072	71184	5761	71529	4814	68815	3463	80525	2901	36493
7L-3S		MI	37607	9350	58818	6966	63505	5689	64565	4739	63948	3392	74820	3102	30426
16-#11	1.30	MA	42329	9350	65352	7070	69920	5775	70034	4827	66629	3457	77882	2851	36027
8L-2S		MI	38399	9350	59984	6968	65000	5676	66389	4728	66429	3384	78139	3188	30387
16-#14	1.88	MA	48627	9731	76944	7264	84745	5895	88041	4872	91169	3384	109886	3188	52635
2L-8S		MI	35637	9731	56485	7205	60266	5862	60596	4861	58438	3360	68872	2508	41161
16-#14	1.88	MA	47239	9731	74887	7261	82107	5890	84824	4890	86792	3399	103937	3063	52626
3L-7S		MI	36285	9731	57574	7209	61749	5869	62351	4845	60989	3372	71880	2576	41755
16-#14	1.88	MA	46271	9731	73214	7283	79976	5911	82233	4884	83458	3414	100058	2939	52552
4L-6S		MI	36942	9731	58786	7189	63211	5850	64148	4829	63390	3360	75130	2706	42370
16-#14	1.88	MA	45407	9731	71770	7281	78102	5906	79930	4903	80122	3404	96025	2877	52384
5E		MI	37617	9731	59892	7194	64743	5857	66020	4838	65846	3348	78173	2787	43063
16-#14	1.88	MA	44585	9731	70417	7278	76227	5926	77638	4896	77100	3419	92176	2797	51483
6L-4S		MI	38324	9731	61072	7198	66272	5839	67899	4822	68556	3360	81392	2845	43147
16-#14	1.88	MA	43784	9731	68934	7300	74438	5921	75438	4915	74149	3434	88074	2667	50621
7L-3S		MI	39115	9731	62435	7178	68008	5846	70009	4831	71262	3348	84452	2970	43171
16-#14	1.88	MA	42995	9731	67602	7297	72623	5942	73291	4933	71011	3424	84302	2596	49812
8L-2S		MI	40237	9731	64103	7183	70147	5828	72618	4815	74801	3335	89167	3094	43136
16-#18	3.33	MA	50195	10700	83019	7860	92284	6320	97152	5125	103858	3333	127534	2539	90774
4L-6S		MI	39026	10700	64969	7743	70787	6254	73287	5060	75578	3244	91993	2147	70349
16-#18	3.33	MA	48715	10700	80477	7853	88987	6354	93101	5155	97989	3312	120515	2433	87808
5E		MI	40181	10700	66913	7753	73477	6268	76574	5078	79832	3222	97231	2292	71696

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis



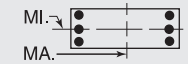
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	3.33	MA	47307	10700	78093	7847	85685	6344	89066	5142	92672	3336	113848	2289	85918
6L-4S		MI	41394	10700	68984	7763	76162	6238	79872	5052	84529	3244	102805	2391	74124
16-#18	3.33	MA	45936	10700	75482	7884	82536	6378	85193	5173	87476	3360	106734	2059	82648
7L-3S		MI	42749	10700	71373	7729	79206	6252	83572	5071	89214	3222	108067	2613	74489
16-#18	3.33	MA	44586	10700	73136	7877	79341	6368	81413	5203	81955	3340	100171	1934	79738
8L-2S		MI	44666	10700	74290	7739	82946	6222	88134	5045	95344	3200	116194	2834	74643
18-#11	1.46	MA	46993	9457	73299	7114	80210	5789	82562	4811	83737	3417	100009	3248	41454
2L-9S		MI	35246	9457	55016	7068	58593	5764	58543	4787	55779	3403	65097	2708	33175
18-#11	1.46	MA	46017	9457	71863	7112	78369	5786	80316	4825	80682	3428	95834	3161	41475
3L-8S		MI	35710	9457	55834	7053	59599	5751	59822	4792	57445	3394	67175	2762	33414
18-#11	1.46	MA	45336	9457	70698	7127	76883	5800	78510	4821	78357	3439	93108	3075	41474
4L-7S		MI	36165	9457	56593	7056	60633	5755	61046	4781	59232	3402	69289	2810	33730
18-#11	1.46	MA	44729	9457	69691	7126	75577	5797	76905	4834	76032	3432	90282	3032	41435
5L-6S		MI	36627	9457	57438	7042	61652	5742	62299	4769	60914	3393	71577	2900	34087
18-#11	1.46	MA	44152	9457	68748	7124	74271	5812	75308	4830	73927	3443	87580	2976	41349
6L-5S		MI	37101	9457	58210	7044	62721	5747	63605	4775	62635	3384	73720	2956	34120
18-#11	1.46	MA	43589	9457	67715	7139	73024	5809	73775	4843	71870	3454	84700	2886	40857
7L-4S		MI	37599	9457	59033	7047	63788	5734	64916	4763	64533	3393	75981	2997	34115
18-#11	1.46	MA	43028	9457	66788	7138	71760	5823	72279	4856	69684	3448	82057	2836	40407
8L-3S		MI	38155	9457	59984	7033	65000	5738	66389	4769	66429	3384	78139	3083	34089
18-#11	1.46	MA	42440	9457	65880	7136	70531	5820	70715	4852	67647	3459	79437	2783	40050
9L-2S		MI	38945	9457	61150	7036	66495	5725	68213	4757	68911	3375	81458	3170	34057
18-#14	2.11	MA	49586	9887	79001	7362	87382	5965	91259	4914	95547	3372	115835	3165	59065
2L-9S		MI	35770	9887	56980	7322	60962	5950	61371	4895	59599	3359	70636	2401	45172
18-#14	2.11	MA	48205	9887	76944	7359	84745	5960	88041	4933	91169	3387	109886	3041	59029
3L-8S		MI	36423	9887	58153	7302	62405	5932	63205	4904	61978	3347	73586	2479	46127
18-#14	2.11	MA	47240	9887	75272	7381	82613	5980	85450	4926	87835	3402	106006	2916	58932
4L-7S		MI	37068	9887	59242	7306	63888	5938	64960	4888	64529	3359	76595	2547	46819
18-#14	2.11	MA	46380	9887	73827	7378	80740	5976	83148	4945	84499	3392	101973	2855	58736
5L-6S		MI	37722	9887	60454	7286	65350	5920	66757	4872	66929	3347	79845	2677	47408
18-#14	2.11	MA	45562	9887	72474	7375	78864	5996	80855	4939	81478	3407	98125	2774	57706
6L-5S		MI	38393	9887	61561	7291	66881	5927	68629	4880	69386	3335	82887	2758	48222
18-#14	2.11	MA	44766	9887	70991	7397	77075	5991	78655	4957	78526	3422	94023	2645	56876
7L-4S		MI	39098	9887	62740	7295	68411	5909	70508	4864	72096	3347	86106	2816	48332
18-#14	2.11	MA	43981	9887	69659	7394	75261	6012	76508	4976	75389	3412	90251	2573	55969
8L-3S		MI	39886	9887	64103	7275	70147	5916	72618	4873	74801	3335	89167	2941	48375
18-#14	2.11	MA	43148	9887	68356	7391	73496	6007	74263	4969	72464	3427	86519	2496	54681
9L-2S		MI	41003	9887	65771	7280	72286	5897	75227	4857	78341	3322	93882	3065	48364
18-#18	3.75	MA	50372	10976	84085	8026	93613	6478	98744	5231	105668	3290	130834	2387	98667
5L-6S		MI	40352	10976	67886	7916	74527	6378	77849	5135	81708	3218	100121	2088	79047
18-#18	3.75	MA	48974	10976	81702	8019	90312	6468	94709	5217	100351	3314	124166	2244	96848
6L-5S		MI	41500	10976	69830	7926	77217	6392	81136	5153	85962	3196	105359	2233	80445
18-#18	3.75	MA	47613	10976	79091	8057	87162	6503	90837	5248	95155	3338	117052	2013	93420
7L-4S		MI	42705	10976	71901	7936	79901	6362	84434	5128	90659	3218	110932	2333	82977
18-#18	3.75	MA	46274	10976	76744	8050	83967	6492	87056	5279	89633	3318	110489	1889	90391
8L-3S		MI	44052	10976	74290	7902	82946	6376	88134	5146	95344	3196	116194	2554	83509
20-#11	1.63	MA	47673	9565	74735	7181	82051	5837	84808	4841	86793	3408	104184	3233	45951
2L-10S		MI	35312	9565	55425	7132	59067	5808	59149	4828	56608	3403	66403	2628	36177
20-#11	1.63	MA	46700	9565	73299	7179	80210	5834	82562	4854	83737	3419	100009	3147	45965
3L-9S		MI	35803	9565	56182	7135	60088	5813	60367	4816	58260	3394	68416	2689	36737
20-#11	1.63	MA	46021	9565	72134	7195	78724	5849	80756	4850	81413	3430	97283	3060	45946
4L-8S		MI	36264	9565	57000	7121	61094	5800	61646	4822	59927	3385	70494	2743	36973
20-#11	1.63	MA	45416	9565	71127	7193	77418	5846	79151	4863	79088	3424	94457	3017	45893
5L-7S		MI	36717	9565	57759	7123	62128	5804	62870	4810	61714	3393	72608	2791	37277

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

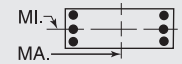


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.63	MA	44841	9565	70184	7191	76111	5860	77554	4859	76982	3435	91755	2962	45792
6E		MI	37178	9565	58605	7109	63147	5791	64123	4799	63395	3385	74896	2881	37705
20-#11	1.63	MA	44280	9565	69151	7207	74865	5857	76021	4873	74926	3446	88875	2872	45227
7L-5S		MI	37650	9565	59376	7112	64216	5795	65429	4804	65116	3376	77039	2937	37751
20-#11	1.63	MA	43723	9565	68224	7205	73601	5872	74525	4886	72739	3439	86232	2822	44790
8L-4S		MI	38146	9565	60199	7115	65283	5782	66740	4793	67015	3384	79300	2978	37764
20-#11	1.63	MA	43135	9565	67316	7203	72372	5869	72961	4882	70702	3450	83612	2768	44439
9L-3S		MI	38701	9565	61150	7100	66495	5786	68213	4798	68911	3375	81458	3065	37747
20-#11	1.63	MA	42526	9565	66300	7219	71125	5883	71473	4895	68682	3461	81072	2707	43686
10L-2S		MI	39489	9565	62316	7103	67990	5773	70037	4787	71392	3366	84776	3151	37720
20-#14	2.34	MA	49164	10043	79001	7456	87382	6030	91259	4975	95547	3374	115835	3018	65425
3L-9S		MI	36570	10042	58649	7419	63101	6020	63980	4937	63138	3346	75350	2372	50180
20-#14	2.34	MA	48204	10043	77329	7478	85251	6050	88668	4969	92213	3389	111955	2894	65306
4L-8S		MI	37205	10042	59821	7399	64544	6002	65815	4946	65517	3334	78301	2450	51104
20-#14	2.34	MA	47349	10042	75885	7475	83377	6046	86365	4987	88877	3379	107922	2832	65085
5L-7S		MI	37847	10042	60911	7404	66026	6008	67569	4930	68068	3346	81309	2518	51888
20-#14	2.34	MA	46535	10042	74531	7472	81501	6066	84073	4981	85855	3394	104074	2752	63940
6E		MI	38498	10043	62123	7383	67488	5990	69366	4914	70469	3334	84559	2648	52455
20-#14	2.34	MA	45742	10042	73048	7494	79713	6061	81873	5000	82904	3409	99971	2622	63136
7L-5S		MI	39166	10043	63229	7388	69020	5997	71238	4923	72925	3322	87602	2729	53377
20-#14	2.34	MA	44961	10043	71716	7491	77898	6081	79726	5018	79766	3400	96200	2551	62137
8L-4S		MI	39868	10043	64409	7393	70549	5979	73117	4907	75635	3334	90821	2787	53508
20-#14	2.34	MA	44133	10042	70413	7488	76133	6077	77481	5012	76842	3415	92468	2473	60884
9L-3S		MI	40653	10043	65771	7372	72286	5985	75227	4916	78341	3322	93882	2912	53572
20-#14	2.34	MA	43269	10043	68954	7510	74343	6097	75345	5030	73942	3430	88852	2385	59582
10L-2S		MI	41766	10043	67439	7377	74424	5967	77836	4900	81880	3309	98596	3036	53591
20-#18	4.17	MA	50629	11253	85311	8192	94938	6593	100353	5293	108029	3292	134484	2198	107699
6E		MI	41670	11253	70803	8089	78266	6502	82411	5210	87839	3191	108248	2030	87617
20-#18	4.17	MA	49278	11253	82699	8230	91788	6627	96480	5324	102833	3316	127370	1967	104212
7L-5S		MI	42810	11253	72747	8099	80956	6516	85698	5229	92093	3169	113487	2175	89212
20-#18	4.17	MA	47948	11253	80353	8223	88593	6617	92700	5354	97312	3296	120807	1843	101065
8L-4S		MI	44008	11253	74818	8109	83641	6486	88996	5203	96790	3191	119060	2275	91620
22-#11	1.79	MA	47379	9673	74735	7247	82051	5883	84808	4884	86793	3410	104184	3132	50444
3L-10S		MI	35867	9673	56591	7200	60562	5857	60973	4857	59089	3394	69721	2609	39693
22-#11	1.79	MA	46703	9673	73569	7262	80565	5897	83001	4880	84468	3421	101458	3046	50413
4L-9S		MI	36357	9673	57348	7202	61583	5861	62190	4846	60742	3385	71734	2671	40245
22-#11	1.79	MA	46100	9673	72563	7260	79259	5894	81397	4893	82143	3415	98632	3003	50348
5L-8S		MI	36815	9673	58166	7188	62589	5848	63470	4851	62408	3377	73813	2724	40534
22-#11	1.79	MA	45527	9673	71620	7259	77952	5909	79799	4889	80038	3426	95930	2947	50233
6L-7S		MI	37267	9673	58926	7191	63623	5852	64693	4840	64195	3385	75926	2773	40828
22-#11	1.79	MA	44968	9673	70587	7274	76706	5906	78267	4902	77981	3437	93050	2857	49602
7L-6S		MI	37726	9673	59771	7176	64642	5839	65947	4828	65877	3376	78214	2863	41290
22-#11	1.79	MA	44418	9673	69659	7273	75442	5920	76771	4915	75795	3431	90407	2807	49176
8L-5S		MI	38197	9673	60542	7179	65711	5843	67253	4834	67598	3367	80358	2919	41378
22-#11	1.79	MA	43828	9673	68752	7271	74213	5917	75207	4911	73757	3442	87787	2754	48779
9L-4S		MI	38692	9673	61365	7182	66778	5830	68564	4822	69496	3375	82619	2960	41404
22-#11	1.79	MA	43220	9673	67736	7286	72966	5932	73719	4925	71737	3453	85247	2693	48029
10L-3S		MI	39245	9673	62316	7168	67990	5835	70037	4828	71392	3367	84776	3046	41399
22-#11	1.79	MA	42626	9673	66826	7285	71743	5929	72175	4921	69583	3447	82669	2640	47433
11L-2S		MI	40030	9673	63483	7171	69485	5822	71861	4816	73874	3358	88095	3132	41378
22-#14	2.58	MA	49163	10198	79386	7575	87888	6120	91885	5011	96591	3377	117904	2871	71675
4L-9S		MI	37350	10198	60317	7517	65240	6089	66589	4980	66678	3333	80065	2343	55196
22-#14	2.58	MA	48312	10198	77942	7572	86014	6115	89583	5030	93254	3367	113871	2810	71431
5L-8S		MI	37983	10198	61490	7496	66682	6071	68424	4988	69057	3321	83015	2421	56091
22-#14	2.58	MA	47501	10198	76589	7569	84139	6136	87290	5023	90233	3382	110023	2729	70182
6L-7S		MI	38621	10198	62579	7501	68165	6078	70178	4972	71608	3333	86024	2489	56961
22-#14	2.58	MA	46712	10198	75105	7591	82350	6131	85090	5042	87281	3397	105920	2600	69402
7L-6S		MI	39270	10198	63791	7481	69627	6060	71975	4956	74008	3321	89274	2619	57509
22-#14	2.58	MA	45935	10198	73774	7588	80535	6151	82943	5060	84144	3387	102148	2528	68315
8L-5S		MI	39936	10198	64897	7485	71159	6067	73847	4965	76465	3309	92316	2700	58446

RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

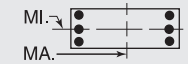
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	2.58	MA	45112	10198	72471	7586	78771	6147	80698	5054	81219	3402	98417	2451	67095
9L-4S		MI	40634	10198	66077	7490	72688	6049	75726	4949	79175	3321	95535	2758	58680
22-#14	2.58	MA	44251	10198	71011	7607	76981	6167	78563	5073	78320	3417	94801	2363	65732
10L-3S		MI	41416	10198	67439	7470	74424	6055	77836	4958	81880	3309	98596	2883	58762
22-#18	4.58	MA	50930	11529	86308	8403	96414	6751	102124	5399	110512	3294	137688	1922	115021
7L-6S		MI	42978	11529	73720	8262	82006	6626	86974	5286	93969	3165	116376	1972	96211
22-#18	4.58	MA	49610	11529	83962	8396	93219	6741	98344	5430	104990	3274	131126	1797	111758
8L-5S		MI	44112	11529	75664	8272	84696	6640	90260	5304	98223	3142	121614	2117	97994
24-#11	1.95	MA	47382	9781	75005	7330	82405	5946	85247	4909	87524	3413	105633	3031	54877
4L-10S		MI	36420	9781	57757	7267	62057	5905	62797	4887	61571	3386	73040	2591	43214
24-#11	1.95	MA	46781	9781	73999	7328	81100	5943	83642	4922	85198	3407	102807	2988	54799
5L-9S		MI	36910	9781	58514	7270	63078	5909	64014	4875	63223	3377	75053	2652	43749
24-#11	1.95	MA	46210	9781	73056	7326	79793	5957	82045	4918	83093	3418	100105	2933	54602
6L-8S		MI	37365	9781	59332	7255	64084	5896	65294	4881	64890	3368	77131	2706	44097
24-#11	1.95	MA	45653	9781	72023	7342	78547	5954	80512	4931	81036	3429	97225	2843	53980
7E		MI	37815	9781	60092	7258	65118	5901	66517	4869	66677	3376	79245	2754	44383
24-#11	1.95	MA	45105	9781	71095	7340	77283	5969	79017	4945	78850	3422	94582	2793	53565
8L-6S		MI	38273	9781	60937	7244	66137	5888	67771	4857	68358	3367	81533	2844	44826
24-#11	1.95	MA	44518	9781	70188	7338	76053	5966	77452	4941	76813	3433	91962	2739	53109
9L-5S		MI	38742	9781	61709	7247	67206	5892	69077	4863	70079	3359	83676	2900	45001
24-#11	1.95	MA	43911	9781	69171	7354	74806	5980	75965	4954	74793	3444	89422	2678	52377
10L-4S		MI	39235	9781	62531	7250	68273	5879	70388	4851	71978	3367	85937	2941	45038
24-#11	1.95	MA	43320	9781	68262	7352	73584	5977	74420	4950	72638	3438	86844	2625	51792
11L-3S		MI	39786	9781	63483	7235	69485	5883	71861	4857	73874	3358	88095	3027	45048
24-#11	1.95	MA	42739	9781	67264	7368	72346	5992	72935	4963	70619	3449	83937	2548	50898
12L-2S		MI	40570	9781	64649	7238	70980	5870	73685	4845	76355	3349	91414	3114	45033
24-#14	2.81	MA	49270	10354	79999	7670	88652	6185	92800	5072	97632	3354	119820	2787	77686
5L-9S		MI	38127	10354	61985	7614	67378	6159	69198	5022	70217	3320	84780	2314	60217
24-#14	2.81	MA	48463	10354	78646	7667	86776	6205	90508	5066	94611	3370	115972	2707	76431
6L-8S		MI	38756	10354	63158	7594	68821	6141	71033	5031	72596	3308	87730	2392	61086
24-#14	2.81	MA	47678	10354	77163	7689	84987	6201	88308	5084	91659	3385	111869	2577	75672
7E		MI	39393	10354	64247	7598	70304	6148	72787	5015	75147	3320	90738	2460	62037
24-#14	2.81	MA	46904	10354	75831	7686	83173	6221	86161	5103	88522	3375	108097	2506	74501
8L-6S		MI	40038	10354	65459	7578	71766	6130	74584	4999	77548	3308	93988	2590	62569
24-#14	2.81	MA	46085	10354	74528	7683	81408	6216	83916	5096	85597	3390	104366	2428	73312
9L-5S		MI	40701	10354	66566	7583	73297	6137	76456	5008	80004	3295	97031	2672	63467
24-#14	2.81	MA	45228	10354	73069	7705	79618	6237	81780	5115	82697	3405	100749	2340	71889
10L-4S		MI	41397	10354	67745	7587	74827	6118	78335	4992	82714	3308	100250	2729	63846
24-#18	5.00	MA	51260	11806	87571	8569	97845	6865	103987	5505	112669	3252	141444	1752	122469
8L-6S		MI	44279	11806	76637	8435	85746	6750	91536	5361	100100	3138	124504	1914	104827

RECTANGULAR TIED COLUMNS 42" x 42"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.36	MA	37124	8627	58325	6382	63045	5196	64367	4323	64340	3074	75531	2880	30399
2L-3S		MI	35031	8627	55235	6373	59084	5227	59535	4351	57814	3096	66857	2659	30509
8-#14	1.02	MA	36130	8419	55932	6295	60220	5138	61012	4296	59956	3122	69853	2958	23205
2L-4S		MI	34076	8419	52726	6311	56121	5150	56020	4305	53329	3147	61565	2709	23343
8-#18	1.81	MA	38550	8903	61415	6555	67007	5320	69199	4399	70867	3049	84206	2826	40123
2L-4S		MI	35005	8903	55798	6581	59825	5338	60453	4409	59352	3094	69907	2383	39983
10-#14	1.28	MA	36961	8575	57697	6392	62483	5208	63773	4339	63713	3109	74876	2931	28776
2L-5S		MI	34161	8575	53246	6404	56769	5239	56796	4364	54211	3123	63165	2623	28825
10-#14	1.28	MA	35761	8575	55932	6388	60220	5226	61012	4356	59956	3122	69853	2807	28835
3L-4S		MI	34916	8575	54492	6409	58385	5220	58781	4348	57085	3135	66587	2682	28872
10-#18	2.27	MA	39962	9180	64505	6728	70968	5444	74032	4474	77394	3025	92880	2771	49811
2L-5S		MI	35140	9180	56699	6744	60948	5494	61799	4512	60879	3047	72647	2227	47374
10-#18	2.27	MA	37899	9180	61415	6718	67007	5475	69199	4501	70867	3047	84206	2550	49777
3L-4S		MI	36443	9180	58888	6754	63786	5462	65286	4484	65878	3069	78581	2328	49501

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

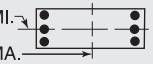
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.30	MA	40589	8998	63525	6683	68702	5444	70095	4534	69988	3241	82142	3047	32019
2L-3S		MI	36592	8998	57571	6652	61520	5457	61909	4546	59945	3246	69214	2804	30573
6-#18	1.30	MA	38374	8998	60262	6675	64519	5476	64992	4563	63065	3263	72920	2826	32129
3L-2S		MI	38687	8998	60661	6661	65482	5426	66742	4518	66472	3224	77889	3025	30453
8-#18	1.73	MA	42104	9275	66788	6856	72885	5568	75198	4609	76911	3218	91364	2996	42283
2L-4S		MI	36565	9275	58134	6860	62261	5568	62828	4604	61483	3244	72264	2528	40102
8-#18	1.73	MA	39905	9275	63525	6848	68702	5601	70095	4638	69988	3240	82142	2774	42327
3E		MI	38035	9275	60661	6825	65482	5581	66742	4621	66472	3222	77889	2749	40247
8-#18	1.73	MA	38356	9275	60860	6884	65306	5589	65968	4622	64696	3262	76154	2553	42143
4L-2S		MI	40115	9275	63751	6834	69443	5550	71574	4594	72998	3199	86563	2971	40185
10-#14	1.22	MA	40411	8946	62853	6694	68096	5456	69453	4550	69212	3271	81397	3096	30294
2L-5S		MI	35720	8946	55573	6686	59206	5470	59176	4561	56350	3274	65535	2769	28906
10-#14	1.22	MA	39142	8946	60990	6690	65708	5450	66540	4567	65249	3285	76066	2971	30353
3L-4S		MI	36477	8946	56819	6690	60821	5452	61161	4544	59225	3286	68957	2828	28929
10-#14	1.22	MA	38251	8946	59472	6711	63774	5470	64189	4560	62223	3299	72596	2847	30391
4L-3S		MI	37323	8946	58259	6669	62656	5458	63391	4552	62095	3273	72222	2953	28884
10-#14	1.22	MA	37454	8946	58160	6707	62073	5464	62098	4577	59195	3287	68970	2787	30344
5L-2S		MI	38524	8946	60025	6673	64920	5439	66152	4535	65852	3260	77245	3077	28821
10-#18	2.16	MA	43604	9551	70051	7029	77068	5692	80301	4685	83834	3195	100586	2944	52511
2L-5S		MI	36699	9551	59035	7024	63385	5723	64174	4707	63011	3197	75005	2372	47738
10-#18	2.16	MA	41421	9551	66788	7021	72885	5725	75198	4713	76911	3217	91364	2723	52477
3L-4S		MI	38005	9551	61224	7033	66222	5692	67661	4679	68010	3219	80939	2473	49633
10-#18	2.16	MA	39884	9551	64123	7057	69489	5713	71071	4698	71619	3239	85376	2501	52201
4L-3S		MI	39464	9551	63751	6998	69443	5705	71574	4696	72998	3197	86563	2695	49867
10-#18	2.16	MA	38509	9551	61816	7049	66498	5745	67396	4726	66318	3217	79080	2398	50173
5L-2S		MI	41530	9551	66841	7007	73404	5674	76407	4669	79525	3175	95238	2916	49879
12-#11	1.01	MA	39716	8815	61243	6633	66163	5415	67144	4529	66092	3293	77353	3136	25440
2L-6S		MI	35400	8815	54577	6621	57976	5418	57723	4529	54456	3304	62943	2849	24342
12-#11	1.01	MA	38826	8815	59942	6631	64495	5411	65110	4541	63323	3303	73607	3049	25485
3L-5S		MI	35905	8815	55391	6623	59104	5405	59102	4534	56273	3294	65226	2905	24342
12-#11	1.01	MA	38201	8815	58883	6646	63146	5425	63470	4537	61213	3313	71165	2963	25527
4E		MI	36435	8815	56260	6626	60230	5408	60486	4522	58278	3302	67628	2946	24307
12-#11	1.01	MA	37644	8815	57968	6644	61960	5422	62012	4549	59101	3306	68622	2921	25554
5L-3S		MI	37027	8815	57265	6611	61511	5395	62043	4527	60281	3292	69927	3033	24261
12-#11	1.01	MA	37113	8815	57111	6642	60772	5435	60560	4545	57188	3316	66199	2865	25539
6L-2S		MI	37871	8815	58498	6614	63092	5399	63972	4515	62906	3283	73460	3119	24215
12-#14	1.46	MA	41287	9102	64715	6791	70484	5526	72366	4592	73176	3259	86728	3071	36152
2L-6S		MI	35843	9102	56171	6779	59851	5534	59960	4595	57502	3274	67314	2661	33828
12-#14	1.46	MA	40024	9102	62853	6787	68096	5520	69453	4609	69212	3273	81397	2946	36195
3L-5S		MI	36560	9102	57339	6783	61469	5540	61937	4603	60107	3261	70558	2742	34381
12-#14	1.46	MA	39137	9102	61335	6808	66162	5539	67103	4602	66187	3286	77927	2821	36198
4E		MI	37313	9102	58584	6787	63085	5522	63922	4586	62982	3273	73980	2801	34444
12-#14	1.46	MA	38344	9102	60023	6805	64461	5534	65012	4619	63159	3275	74302	2762	36115
5L-3S		MI	38155	9102	60025	6766	64920	5528	66152	4595	65852	3261	77245	2925	34427
12-#14	1.46	MA	37590	9102	58793	6801	62757	5553	62929	4612	60415	3288	70856	2681	35506
6L-2S		MI	39351	9102	61790	6770	67183	5509	68913	4578	69609	3248	82268	3050	34379
12-#18	2.60	MA	45091	9828	73314	7202	81251	5817	85404	4760	90757	3172	109807	2893	62709
2L-6S		MI	36902	9828	60071	7187	64503	5834	65533	4765	65008	3194	78084	2173	55322
12-#18	2.60	MA	42923	9828	70051	7194	77068	5849	80301	4789	83834	3194	100586	2672	62600
3L-5S		MI	38136	9828	62125	7197	67346	5847	69007	4782	69538	3172	83679	2317	56935
12-#18	2.60	MA	41397	9828	67386	7230	73672	5837	76174	4773	78542	3216	94598	2450	62244
4E		MI	39431	9828	64314	7206	70184	5816	72493	4755	74537	3194	89613	2419	59147

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

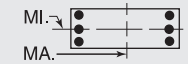
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	2.60	MA	40033	9828	65079	7222	70681	5869	72499	4802	73241	3194	88302	2347	59897
5L-3S		MI	40880	9828	66841	7171	73404	5829	76407	4772	79525	3172	95238	2640	59460
12-#18	2.60	MA	38735	9828	62916	7213	67685	5857	68838	4786	68436	3216	82350	2203	58142
6L-2S		MI	42932	9828	69931	7180	77365	5798	81239	4745	86052	3150	103912	2862	59548
14-#11	1.18	MA	40335	8923	62544	6701	67831	5463	69179	4558	68860	3285	81100	3119	29537
2L-7S		MI	35503	8923	54918	6703	58481	5463	58329	4571	55305	3304	64039	2741	27890
14-#11	1.18	MA	39447	8923	61243	6698	66163	5460	67144	4571	66092	3295	77353	3033	29576
3L-6S		MI	35993	8923	55810	6688	59557	5466	59652	4559	57081	3295	66475	2831	28178
14-#11	1.18	MA	38825	8923	60184	6713	64814	5473	65505	4566	63981	3305	74912	2946	29608
4L-5S		MI	36496	8923	56625	6691	60685	5453	61031	4564	58898	3285	68758	2887	28201
14-#11	1.18	MA	38269	8923	59270	6711	63627	5470	64047	4579	61869	3298	72369	2904	29617
5L-4S		MI	37024	8923	57493	6693	61812	5457	62416	4552	60903	3293	71160	2929	28181
14-#11	1.18	MA	37740	8923	58412	6709	62440	5484	62595	4574	59956	3308	69946	2849	29580
6L-3S		MI	37614	8923	58498	6679	63092	5443	63972	4557	62906	3284	73460	3015	28146
14-#11	1.18	MA	37225	8923	57473	6724	61307	5480	61202	4586	58087	3318	67362	2759	29257
7L-2S		MI	38455	8923	59732	6681	64674	5447	65902	4545	65531	3274	76992	3101	28105
14-#14	1.70	MA	42158	9257	66578	6888	72872	5596	75280	4635	77140	3247	92060	3045	41997
2L-7S		MI	35986	9257	56656	6897	60571	5623	60823	4654	58712	3274	68874	2504	38440
14-#14	1.70	MA	40900	9257	64715	6884	70484	5590	72366	4652	73176	3260	86728	2921	42026
3L-6S		MI	36681	9257	57936	6876	62115	5604	62721	4637	61258	3262	72337	2634	39139
14-#14	1.70	MA	40017	9257	63198	6906	68550	5609	70016	4644	70151	3274	83258	2796	41992
4L-5S		MI	37395	9257	59104	6880	63733	5610	64698	4646	63864	3249	75580	2715	39847
14-#14	1.70	MA	39229	9257	61886	6902	66849	5604	67925	4662	67122	3262	79633	2736	41877
5L-4S		MI	38144	9257	60350	6884	65348	5591	66683	4629	66738	3261	79003	2774	39940
14-#14	1.70	MA	38478	9257	60656	6898	65145	5623	65843	4654	64378	3276	76188	2656	41113
6L-3S		MI	38982	9257	61790	6864	67183	5597	68913	4637	69609	3248	82268	2898	39956
14-#14	1.70	MA	37747	9257	59308	6919	63520	5617	63844	4672	61697	3290	72512	2526	40353
7L-2S		MI	40173	9257	63556	6868	69446	5579	71675	4620	73366	3236	87291	3023	39923
14-#18	3.03	MA	46566	10105	76577	7375	85434	5941	90507	4836	97681	3149	119029	2842	72872
2L-7S		MI	37142	10105	60911	7395	65751	5990	67030	4868	67109	3191	80780	1887	61840
14-#18	3.03	MA	44411	10105	73314	7367	81251	5973	85404	4864	90757	3171	109807	2620	72706
3L-6S		MI	38335	10105	63161	7360	68464	5959	70365	4841	71535	3169	86759	2118	64630
14-#18	3.03	MA	42897	10105	70649	7403	77855	5961	81277	4849	85465	3193	103820	2399	72278
4L-5S		MI	39559	10105	65215	7369	71307	5972	73839	4858	76064	3147	92353	2263	66165
14-#18	3.03	MA	41543	10105	68342	7395	74864	5993	77602	4877	80164	3171	97524	2296	69653
5L-4S		MI	40846	10105	67404	7379	74145	5940	77325	4830	81063	3169	98288	2364	68651
14-#18	3.03	MA	40255	10105	66178	7386	71868	5981	73941	4861	75359	3193	91572	2152	67981
6L-3S		MI	42284	10105	69931	7343	77365	5953	81239	4847	86052	3147	103912	2586	69033
14-#18	3.03	MA	39000	10105	63808	7422	69009	6014	70426	4890	70664	3215	85216	1920	65019
7L-2S		MI	44323	10105	73021	7353	81327	5922	86072	4820	92578	3125	112587	2807	69177
16-#11	1.35	MA	40951	9031	63845	6768	69499	5512	71214	4588	71629	3276	84847	3103	33627
2L-8S		MI	35613	9031	55350	6768	58971	5524	58967	4612	56043	3288	65326	2675	31272
16-#11	1.35	MA	40066	9031	62544	6766	67831	5508	69179	4600	68860	3286	81100	3016	33659
3L-7S		MI	36094	9031	56152	6771	60062	5511	60258	4600	57930	3296	67572	2724	31632
16-#11	1.35	MA	39446	9031	61485	6781	66482	5522	67539	4596	66750	3296	78659	2930	33680
4L-6S		MI	36583	9031	57044	6756	61139	5515	61582	4588	59705	3286	70008	2814	32008
16-#11	1.35	MA	38892	9031	60571	6779	65295	5518	66081	4608	64638	3289	76115	2888	33669
5E		MI	37084	9031	57858	6758	62267	5501	62960	4593	61522	3277	72291	2870	32048
16-#11	1.35	MA	38365	9031	59713	6776	64108	5532	64630	4603	62725	3299	73693	2832	33615
6L-4S		MI	37610	9031	58727	6761	63393	5505	64345	4581	63528	3285	74693	2911	32047
16-#11	1.35	MA	37852	9031	58774	6791	62975	5529	63237	4616	60856	3309	71109	2742	33203
7L-3S		MI	38198	9031	59732	6746	64674	5492	65902	4586	65531	3275	76992	2998	32021
16-#11	1.35	MA	37346	9031	57931	6789	61826	5542	61877	4628	58869	3302	68731	2693	32810
8L-2S		MI	39037	9031	60965	6749	66255	5496	67831	4574	68156	3266	80525	3084	31987

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

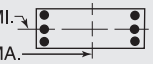


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#14	1.95	MA	43024	9413	68441	6985	75260	5665	78193	4677	81103	3234	97391	3020	47832
2L-8S		MI	36141	9413	57272	6990	61269	5686	61732	4713	59764	3250	70697	2408	43029
16-#14	1.95	MA	41771	9413	66578	6982	72872	5660	75280	4694	77140	3248	92060	2895	47835
3L-7S		MI	36822	9413	58422	6994	62835	5693	63584	4697	62469	3262	73897	2477	43794
16-#14	1.95	MA	40893	9413	65061	7003	70938	5679	72929	4687	74115	3261	88590	2771	47776
4L-6S		MI	37514	9413	59702	6973	64378	5674	65482	4680	65015	3249	77359	2607	44462
16-#14	1.95	MA	40108	9413	63749	6999	69237	5674	70838	4704	71086	3250	84964	2711	47633
5E		MI	38224	9413	60870	6977	65996	5680	67459	4688	67621	3237	80603	2688	45305
16-#14	1.95	MA	39361	9413	62519	6995	67533	5693	68756	4697	68342	3264	81519	2630	46733
6L-4S		MI	38970	9413	62116	6981	67611	5661	69444	4671	70495	3249	84025	2747	45427
16-#14	1.95	MA	38633	9413	61171	7017	65908	5687	66757	4714	65661	3277	77843	2500	46004
7L-3S		MI	39804	9413	63556	6961	69446	5667	71675	4679	73366	3236	87291	2871	45472
16-#14	1.95	MA	37916	9413	59961	7013	64259	5706	64807	4732	62811	3266	74453	2430	45179
8L-2S		MI	40991	9413	65321	6965	71710	5649	74436	4663	77122	3223	92313	2996	45458
16-#18	3.46	MA	45888	10381	76577	7540	85434	6097	90507	4940	97681	3148	119029	2569	82798
3L-7S		MI	38572	10381	64001	7568	69712	6114	71862	4943	73636	3167	89455	1832	71003
16-#18	3.46	MA	44384	10381	73912	7576	82038	6085	86379	4924	92388	3170	113042	2347	82305
4L-6S		MI	39756	10381	66251	7533	72426	6083	75198	4916	78062	3144	95433	2064	73947
16-#18	3.46	MA	43040	10381	71605	7568	79047	6117	82704	4952	87087	3148	106746	2244	79436
5E		MI	40971	10381	68305	7542	75268	6096	78671	4933	82591	3122	101028	2208	75421
16-#18	3.46	MA	41762	10381	69441	7559	76051	6106	79044	4937	82283	3170	100794	2100	77835
6L-4S		MI	42248	10381	70494	7551	78106	6065	82158	4906	87590	3144	106962	2310	78146
16-#18	3.46	MA	40517	10381	67071	7595	73192	6138	75529	4965	77588	3192	94438	1869	74713
7L-3S		MI	43677	10381	73021	7516	81327	6078	86072	4923	92578	3122	112587	2531	78592
18-#11	1.52	MA	41564	9139	65146	6836	71167	5560	73249	4617	74397	3267	88593	3086	37711
2L-9S		MI	35714	9139	55721	6850	59490	5569	59545	4637	56909	3289	66645	2604	34760
18-#11	1.52	MA	40682	9139	63845	6833	69499	5557	71214	4630	71629	3277	84847	3000	37735
3L-8S		MI	36204	9139	56584	6835	60552	5573	60896	4642	58668	3279	68859	2658	35033
18-#11	1.52	MA	40064	9139	62786	6848	68150	5570	69574	4625	69518	3287	82405	2914	37747
4L-7S		MI	36683	9139	57385	6838	61644	5559	62188	4630	60555	3287	71105	2706	35379
18-#11	1.52	MA	39512	9139	61872	6846	66963	5567	68116	4638	67406	3280	79862	2872	37716
5L-6S		MI	37170	9139	58278	6823	62720	5563	63511	4618	62330	3278	73540	2796	35832
18-#11	1.52	MA	38987	9139	61015	6844	65776	5581	66665	4633	65493	3290	77439	2816	37646
6L-5S		MI	37669	9139	59092	6826	63848	5550	64890	4623	64147	3268	75823	2852	35888
18-#11	1.52	MA	38475	9139	60075	6859	64643	5577	65271	4645	63624	3300	74856	2726	37156
7L-4S		MI	38193	9139	59961	6828	64975	5554	66274	4611	66153	3276	78225	2894	35906
18-#11	1.52	MA	37971	9139	59232	6857	63494	5591	63912	4658	61638	3293	72477	2677	36776
8L-3S		MI	38780	9139	60965	6814	66255	5540	67831	4616	68156	3266	80525	2980	35889
18-#11	1.52	MA	37447	9139	58406	6854	62376	5587	62490	4653	59786	3303	70128	2623	36472
9L-2S		MI	39616	9139	62199	6816	67837	5544	69760	4604	70781	3257	84058	3066	35862
18-#14	2.19	MA	43885	9569	70304	7083	77648	5735	81106	4719	85067	3222	102722	2994	53662
2L-9S		MI	36286	9569	57799	7108	62009	5775	62556	4748	60997	3250	72575	2303	47272
18-#14	2.19	MA	42637	9569	68441	7079	75260	5730	78193	4737	81103	3235	97391	2870	53635
3L-8S		MI	36976	9569	59037	7087	63532	5756	64493	4756	63520	3237	75720	2381	48294
18-#14	2.19	MA	41763	9569	66923	7100	73326	5749	75842	4729	78078	3249	93921	2745	53553
4L-7S		MI	37654	9569	60187	7091	65098	5762	66345	4739	66226	3250	78919	2450	49154
18-#14	2.19	MA	40982	9569	65611	7096	71625	5743	73751	4747	75050	3238	90295	2686	53383
5L-6S		MI	38343	9569	61467	7070	66642	5744	68243	4722	68772	3237	82382	2580	49797
18-#14	2.19	MA	40239	9569	64382	7093	69921	5763	71669	4739	72306	3251	86850	2605	52364
6L-5S		MI	39049	9569	62635	7075	68259	5750	70220	4730	71377	3224	85626	2661	50757
18-#14	2.19	MA	39514	9569	63034	7114	68296	5757	69671	4757	69624	3265	83174	2475	51662
7L-4S		MI	39792	9569	63881	7079	69875	5731	72205	4714	74252	3236	89048	2720	50905
18-#14	2.19	MA	38801	9569	61823	7110	66647	5776	67720	4774	66775	3253	79784	2405	50743
8L-3S		MI	40622	9569	65321	7058	71710	5737	74436	4722	77122	3223	92313	2844	50973
18-#14	2.19	MA	38070	9569	60520	7131	65043	5771	65680	4766	64118	3267	76444	2327	49638
9L-2S		MI	41804	9569	67087	7062	73973	5718	77197	4705	80879	3211	97336	2969	50991
18-#18	3.90	MA	45860	10658	77175	7749	86221	6209	91482	4999	99312	3147	122264	2296	92181
4L-7S		MI	39990	10658	67091	7741	73673	6238	76695	5019	80162	3142	98129	1777	80188
18-#18	3.90	MA	44526	10658	74868	7740	83230	6242	87807	5028	94010	3125	115968	2193	89241
5L-6S		MI	41165	10658	69341	7706	76387	6207	80030	4991	84588	3120	104107	2009	83023

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

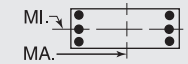
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	3.90	MA	43256	10658	72704	7732	80234	6230	84147	5012	89206	3147	110016	2049	87492
6L-5S		MI	42373	10658	71395	7715	79230	6220	83504	5008	89118	3098	109702	2153	84699
18-#18	3.90	MA	42020	10658	70334	7768	77375	6262	80632	5041	84511	3169	103660	1818	84428
7L-4S		MI	43641	10658	73584	7724	82067	6189	86990	4981	94117	3120	115637	2255	87402
20-#11	1.69	MA	42174	9247	66447	6903	72835	5608	75284	4647	77166	3259	92340	3070	41789
2L-10S		MI	35779	9247	56155	6915	59995	5631	60190	4678	57790	3290	68033	2525	37850
20-#11	1.69	MA	41295	9247	65146	6901	71167	5605	73249	4659	74397	3269	88593	2984	41807
3L-9S		MI	36305	9247	56954	6918	61072	5617	61475	4666	59534	3280	70178	2586	38459
20-#11	1.69	MA	40679	9247	64087	6916	69818	5619	71609	4654	72287	3279	86152	2897	41798
4L-8S		MI	36792	9247	57817	6903	62134	5621	62825	4671	61293	3271	72391	2640	38796
20-#11	1.69	MA	40129	9247	63173	6913	68631	5615	70151	4667	70175	3272	83609	2855	41757
5L-7S		MI	37270	9247	58619	6905	63225	5608	64117	4659	63180	3279	74637	2689	39131
20-#11	1.69	MA	39606	9247	62316	6911	67444	5629	68699	4662	68262	3282	81186	2799	41672
6E		MI	37754	9247	59511	6891	64302	5612	65440	4647	64955	3269	77073	2779	39647
20-#11	1.69	MA	39096	9247	61376	6926	66311	5626	67306	4675	66393	3292	78602	2709	41114
7L-5S		MI	38252	9247	60326	6893	65430	5598	66819	4652	66772	3260	79356	2835	39723
20-#11	1.69	MA	38594	9247	60533	6924	65162	5639	65947	4687	64406	3284	76224	2660	40746
8L-4S		MI	38774	9247	61194	6896	66556	5602	68204	4640	68778	3267	81758	2876	39755
20-#11	1.69	MA	38073	9247	59707	6922	64044	5636	64525	4683	62554	3295	73875	2606	40378
9L-3S		MI	39359	9247	62199	6881	67837	5589	69760	4645	70781	3258	84058	2963	39753
20-#11	1.69	MA	37519	9247	58783	6937	62910	5650	63172	4695	60718	3305	71599	2545	39720
10L-2S		MI	40193	9247	63433	6884	69418	5592	71689	4633	73406	3248	87590	3049	39731
20-#14	2.44	MA	43499	9724	70304	7176	77648	5799	81106	4779	85067	3223	102722	2844	59428
3L-9S		MI	37123	9724	59565	7205	64272	5845	65317	4790	64754	3238	77598	2276	52580
20-#14	2.44	MA	42629	9724	68786	7197	75714	5819	78756	4772	82042	3236	99252	2720	59324
4L-8S		MI	37806	9724	60803	7184	65795	5826	67254	4798	67277	3225	80743	2354	53571
20-#14	2.44	MA	41851	9724	67474	7194	74013	5813	76665	4789	79014	3225	95627	2660	59130
5L-7S		MI	38481	9724	61953	7188	67361	5832	69107	4781	69983	3237	83942	2423	54520
20-#14	2.44	MA	41111	9724	66244	7190	72309	5832	74582	4782	76269	3239	92181	2579	58004
6E		MI	39167	9724	63233	7168	68905	5813	71004	4765	72529	3224	87405	2553	55140
20-#14	2.44	MA	40391	9724	64897	7211	70684	5827	72584	4799	73588	3252	88505	2450	57325
7L-5S		MI	39870	9724	64401	7172	70523	5820	72981	4773	75134	3212	90649	2634	56187
20-#14	2.44	MA	39681	9724	63686	7207	69035	5846	70633	4816	70739	3241	85115	2379	56317
8L-4S		MI	40609	9724	65647	7176	72138	5801	74966	4756	78009	3224	94071	2693	56377
20-#14	2.44	MA	38954	9724	62382	7229	67431	5841	68593	4809	68082	3255	81775	2302	55245
9L-3S		MI	41436	9724	67087	7155	73973	5807	77197	4764	80879	3211	97336	2817	56466
20-#18	4.33	MA	46000	10935	78131	7913	87412	6366	92910	5103	100934	3101	125190	2142	99064
5L-7S		MI	41397	10935	70181	7914	77635	6362	81527	5094	86689	3117	106804	1723	89392
20-#18	4.33	MA	44740	10935	75967	7905	84417	6354	89249	5088	96129	3123	119238	1998	97121
6E		MI	42565	10935	72431	7879	80348	6331	84863	5067	91115	3095	112782	1954	92125
20-#18	4.33	MA	43512	10935	73597	7941	81558	6386	85735	5116	91434	3146	112881	1766	94162
7L-5S		MI	43764	10935	74485	7888	83191	6344	88336	5084	95644	3073	118377	2099	93994
22-#11	1.86	MA	42783	9355	67748	6970	74503	5657	77318	4676	79934	3250	96087	3053	45863
2L-11S		MI	35856	9355	56603	6980	60520	5675	60786	4702	58555	3273	69376	2456	41099
22-#11	1.86	MA	41906	9355	66447	6968	72835	5653	75284	4689	77166	3260	92340	2967	45874
3L-10S		MI	36369	9355	57389	6982	61576	5679	62119	4707	60415	3281	71566	2508	41574
22-#11	1.86	MA	41292	9355	65389	6983	71485	5667	73644	4684	75055	3270	89898	2881	45848
4L-9S		MI	36893	9355	58188	6985	62653	5666	63404	4695	62159	3272	73710	2569	42165
22-#11	1.86	MA	40744	9355	64474	6981	70299	5664	72186	4696	72943	3263	87355	2839	45794
5L-8S		MI	37378	9355	59051	6970	63715	5670	64755	4701	63918	3262	75924	2623	42562
22-#11	1.86	MA	40223	9355	63617	6979	69112	5677	70734	4692	71030	3273	84933	2783	45616
6L-7S		MI	37854	9355	59853	6973	64807	5656	66046	4688	65805	3270	78170	2671	42888
22-#11	1.86	MA	39715	9355	62677	6994	67979	5674	69341	4704	69161	3283	82349	2693	45076
7L-6S		MI	38337	9355	60745	6958	65883	5660	67370	4676	67580	3260	80606	2761	43383

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

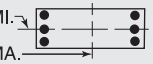


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.86	MA	39214	9355	61834	6991	66829	5688	67981	4717	67174	3276	79971	2644	44718
8L-5S		MI	38832	9355	61559	6961	67011	5647	68748	4681	69397	3251	82889	2817	43553
22-#11	1.86	MA	38695	9355	61008	6989	65712	5684	66559	4712	65322	3286	77622	2590	44290
9L-4S		MI	39353	9355	62428	6963	68138	5650	70133	4669	71403	3259	85291	2859	43597
22-#11	1.86	MA	38143	9355	60084	7004	64578	5698	65207	4724	63486	3296	75345	2529	43650
10L-3S		MI	39936	9355	63433	6948	69418	5637	71689	4675	73406	3249	87590	2945	43611
22-#11	1.86	MA	37604	9355	59257	7002	63466	5695	63803	4720	61528	3289	73026	2477	43136
11L-2S		MI	40767	9355	64666	6951	71000	5641	73619	4662	76031	3240	91123	3031	43597
22-#14	2.68	MA	43490	9880	70649	7295	78102	5889	81669	4814	86006	3224	104583	2694	65090
4L-9S		MI	37966	9880	61330	7302	66536	5915	68078	4832	68511	3225	82620	2249	57895
22-#14	2.68	MA	42716	9880	69337	7291	76401	5883	79578	4831	82977	3213	100958	2635	64744
5L-8S		MI	38632	9880	62569	7282	68059	5896	70015	4841	71034	3213	85766	2327	58857
22-#14	2.68	MA	41980	9880	68107	7287	74697	5902	77496	4824	80233	3226	97513	2554	63652
6L-7S		MI	39304	9880	63719	7286	69625	5902	71868	4824	73739	3225	88965	2396	59890
22-#14	2.68	MA	41262	9880	66760	7308	73072	5897	75497	4841	77552	3240	93837	2424	62993
7L-6S		MI	39986	9880	64998	7265	71168	5883	73766	4807	76285	3212	92428	2526	60491
22-#14	2.68	MA	40556	9880	65549	7305	71423	5916	73546	4859	74702	3229	90447	2354	61900
8L-5S		MI	40686	9880	66166	7269	72786	5889	75743	4815	78891	3199	95671	2607	61494
22-#14	2.68	MA	39833	9880	64245	7326	69819	5910	71507	4851	72045	3242	87106	2276	60859
9L-4S		MI	41422	9880	67412	7273	74401	5871	77728	4798	81765	3211	99094	2666	61843
22-#18	4.76	MA	46213	11211	79230	8078	88600	6478	94352	5163	103052	3100	128460	1946	106773
6L-7S		MI	42795	11211	73271	8087	81596	6486	86360	5169	93216	3092	115478	1668	98613
22-#18	4.76	MA	44994	11211	76860	8114	85741	6510	90838	5192	98357	3122	122103	1715	103913
7L-6S		MI	43955	11211	75521	8052	84309	6455	89695	5142	97642	3070	121456	1900	101250
24-#11	2.03	MA	42514	9463	67748	7036	74503	5702	77318	4718	79934	3252	96087	2951	49927
3L-11S		MI	36444	9463	57836	7047	62101	5724	62715	4732	61180	3265	72909	2439	44783
24-#11	2.03	MA	41902	9463	66690	7051	73153	5716	75678	4713	77824	3262	93645	2864	49894
4L-10S		MI	36955	9463	58622	7050	63158	5728	64048	4737	63040	3272	75098	2490	45301
24-#11	2.03	MA	41356	9463	65775	7048	71967	5712	74221	4726	75712	3254	91102	2822	49828
5L-9S		MI	37479	9463	59421	7052	64235	5714	65333	4725	64784	3263	77243	2551	45877
24-#11	2.03	MA	40837	9463	64918	7046	70779	5726	72769	4721	73799	3264	88679	2766	49563
6L-8S		MI	37961	9463	60285	7038	65297	5718	66684	4730	66543	3254	79457	2605	46330
24-#11	2.03	MA	40331	9463	63979	7061	69647	5722	71376	4734	71930	3274	86096	2677	49042
7E		MI	38435	9463	61086	7040	66388	5705	67976	4718	68430	3261	81703	2654	46647
24-#11	2.03	MA	39832	9463	63135	7059	68497	5736	70016	4746	69943	3267	83717	2627	48693
8L-6S		MI	38917	9463	61979	7026	67464	5708	69299	4706	70205	3252	84138	2744	47124
24-#11	2.03	MA	39315	9463	62309	7057	67380	5733	68594	4741	68091	3277	81368	2574	48208
9L-5S		MI	39411	9463	62793	7028	68593	5695	70678	4711	72022	3242	86421	2800	47380
24-#11	2.03	MA	38764	9463	61385	7072	66246	5746	67242	4754	66255	3287	79092	2513	47584
10L-4S		MI	39930	9463	63662	7031	69719	5699	72062	4699	74028	3250	88823	2841	47435
24-#11	2.03	MA	38227	9463	60558	7069	65134	5743	65838	4749	64296	3280	76773	2460	47028
11L-3S		MI	40511	9463	64666	7016	71000	5685	73619	4704	76031	3241	91123	2928	47461
24-#14	2.92	MA	43576	10035	71200	7388	78789	5953	82491	4874	86941	3200	106289	2609	70357
5L-9S		MI	38790	10035	63096	7400	68799	5984	70839	4875	72267	3213	87643	2222	63216
24-#14	2.92	MA	42843	10035	69970	7384	77085	5972	80409	4866	84197	3214	102844	2529	69305
6L-8S		MI	39453	10035	64334	7379	70322	5966	72776	4883	74791	3200	90788	2300	64151
24-#14	2.92	MA	42129	10035	68622	7406	75460	5967	78410	4884	81516	3227	99168	2399	68665
7E		MI	40122	10035	65484	7383	71888	5972	74629	4866	77496	3212	93988	2369	65263
24-#14	2.92	MA	41426	10035	67412	7402	73811	5986	76460	4901	78666	3216	95778	2329	67492
8L-6S		MI	40801	10035	66764	7362	73432	5953	76527	4850	80042	3200	97450	2499	65847
24-#14	2.92	MA	40716	10035	66108	7423	72207	5980	74420	4894	76009	3230	92437	2251	66479
9L-5S		MI	41499	10035	67932	7366	75049	5959	78504	4858	82648	3187	100694	2580	66812
24-#18	5.19	MA	46465	11488	80123	8287	89924	6634	95940	5267	105280	3099	131325	1664	113680
7E		MI	44183	11488	76361	8260	85557	6610	91192	5245	99743	3067	124153	1614	107849

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

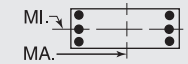
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.24	MA	44203	9369	68937	6985	74590	5692	76054	4745	75819	3406	88990	3213	33639
2L-3S		MI	38152	9369	59907	6931	63957	5687	64284	4741	62076	3396	71572	2949	30634
6-#18	1.24	MA	41867	9369	65501	6978	70186	5726	70680	4775	68509	3429	79221	2991	33749
3L-2S		MI	40249	9369	62997	6940	67918	5655	69117	4713	68603	3374	80246	3170	30507
8-#18	1.66	MA	45807	9646	72373	7158	78995	5816	81427	4820	83130	3384	98760	3164	44443
2L-4S		MI	38125	9646	60470	7139	64697	5798	65203	4799	63615	3394	74622	2673	40214
8-#18	1.66	MA	43488	9646	68937	7151	74590	5850	76054	4850	75819	3407	88990	2943	44487
3E		MI	39597	9646	62997	7104	67918	5811	69117	4816	68603	3371	80246	2894	40321
8-#18	1.66	MA	41856	9646	66134	7187	71018	5839	71713	4835	70233	3429	82640	2721	44303
4L-2S		MI	41680	9646	66087	7113	71879	5780	73949	4789	75130	3349	88921	3116	40245
10-#14	1.16	MA	44009	9317	68219	6995	73940	5704	75364	4760	74923	3433	88157	3260	31813
2L-5S		MI	37280	9317	57900	6967	61642	5702	61555	4757	58490	3425	67905	2915	28981
10-#14	1.16	MA	42671	9317	66259	6992	71427	5699	72298	4778	70752	3448	82517	3136	31872
3L-4S		MI	38037	9317	59146	6971	63258	5683	63540	4741	61364	3437	71327	2974	28985
10-#14	1.16	MA	41734	9317	64664	7014	69395	5719	69827	4772	67573	3462	78842	3011	31910
4L-3S		MI	38884	9317	60586	6950	65093	5689	65771	4749	64235	3424	74592	3099	28932
10-#14	1.16	MA	40897	9317	63286	7010	67607	5714	67631	4790	64390	3452	75013	2951	31862
5L-2S		MI	40087	9317	62352	6954	67356	5670	68532	4732	67992	3411	79615	3223	28866
10-#18	2.07	MA	47397	9923	75808	7331	83399	5941	86800	4896	90441	3362	108530	3116	55211
2L-5S		MI	38258	9923	61371	7303	65821	5953	66549	4902	65142	3347	77362	2517	48093
10-#18	2.07	MA	45093	9923	72373	7324	78995	5974	81427	4925	83130	3385	98760	2894	55177
3L-4S		MI	39566	9923	63560	7312	68659	5922	70035	4875	70141	3369	83296	2618	49757
10-#18	2.07	MA	43474	9923	69570	7360	75423	5963	77086	4911	77544	3407	92409	2673	54901
4L-3S		MI	41028	9923	66087	7277	71879	5935	73949	4892	75130	3347	88921	2840	49954
10-#18	2.07	MA	42028	9923	67145	7353	72279	5996	73223	4941	71949	3386	85752	2568	52992
5L-2S		MI	43097	9923	69177	7286	75840	5904	78781	4864	81656	3325	97595	3061	49945
12-#14	1.40	MA	44936	9473	70179	7092	76453	5774	78429	4803	79093	3421	93797	3236	37974
2L-6S		MI	37402	9473	58498	7060	62288	5765	62339	4792	59641	3425	69683	2807	34041
12-#14	1.40	MA	43604	9473	68219	7089	73940	5769	75364	4821	74923	3435	88157	3112	38018
3L-5S		MI	38120	9473	59666	7064	63906	5772	64316	4800	62247	3412	72927	2888	34465
12-#14	1.40	MA	42671	9473	66624	7111	71907	5789	72893	4814	71743	3450	84482	2987	38020
4E		MI	38874	9473	60912	7068	65521	5753	66301	4783	65121	3425	76349	2947	34510
12-#14	1.40	MA	41838	9473	65246	7108	70120	5784	70696	4832	68561	3439	80653	2927	37937
5L-3S		MI	39717	9473	62352	7047	67356	5759	68532	4791	67992	3412	79615	3071	34479
12-#14	1.40	MA	41045	9473	63954	7104	68330	5803	68509	4825	65678	3454	77006	2846	37415
6L-2S		MI	40915	9473	64117	7052	69620	5740	71293	4774	71748	3399	84637	3196	34427
12-#18	2.48	MA	48972	10199	79244	7504	87804	6065	92173	4971	97751	3340	118300	3067	65949
2L-6S		MI	38460	10199	62407	7467	66939	6064	67908	4960	67140	3344	80442	2318	55650
12-#18	2.48	MA	46683	10199	75808	7496	83399	6098	86800	5001	90441	3363	108530	2846	65840
3L-5S		MI	39697	10199	64461	7476	69782	6077	71381	4977	71669	3322	86037	2462	57285
12-#18	2.48	MA	45076	10199	73006	7533	79827	6087	82459	4986	84854	3385	102179	2625	65484
4E		MI	40995	10199	66650	7485	72620	6046	74868	4950	76668	3344	91971	2564	59282
12-#18	2.48	MA	43641	10199	70581	7526	76683	6120	78596	5016	79260	3364	95522	2520	63237
5L-3S		MI	42446	10199	69177	7450	75840	6059	78781	4967	81656	3322	97595	2785	59555
12-#18	2.48	MA	42275	10199	68308	7518	73535	6109	74748	5001	74189	3386	89212	2376	61317
6L-2S		MI	44503	10199	72267	7459	79802	6028	83614	4940	88183	3300	106270	3007	59625
14-#11	1.13	MA	43926	9295	67889	7002	73655	5711	75069	4769	74544	3447	87821	3283	31012
2L-7S		MI	37062	9295	57241	6985	60917	5695	60711	4768	57449	3456	66415	2888	28041
14-#11	1.13	MA	42991	9295	66521	7000	71901	5708	72928	4782	71632	3457	83860	3196	31050
3L-6S		MI	37553	9295	58133	6971	61994	5699	62034	4756	59224	3446	68851	2978	28246
14-#11	1.13	MA	42336	9295	65409	7016	70483	5722	71205	4778	69415	3468	81277	3110	31082
4L-5S		MI	38056	9295	58947	6973	63122	5685	63413	4761	61041	3437	71134	3034	28254

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

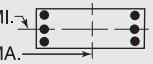


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.13	MA	41752	9295	64448	7014	69237	5719	69674	4791	67196	3461	78592	3068	31091
5L-4S		MI	38584	9295	59816	6976	64248	5689	64797	4749	63046	3445	73536	3075	28228
14-#11	1.13	MA	41197	9295	63548	7012	67990	5733	68149	4786	65187	3472	76030	3012	31055
6L-3S		MI	39176	9295	60821	6961	65529	5676	66354	4754	65049	3435	75835	3162	28188
14-#11	1.13	MA	40655	9295	62562	7027	66800	5730	66687	4799	63224	3482	73298	2922	30786
7L-2S		MI	40017	9295	62054	6963	67110	5679	68283	4742	67674	3426	79368	3248	28146
14-#14	1.63	MA	45857	9629	72139	7190	78965	5844	81494	4845	83264	3409	99437	3212	44123
2L-7S		MI	37544	9629	58984	7178	63008	5854	63203	4851	60852	3425	71243	2650	38643
14-#14	1.63	MA	44531	9629	70179	7186	76453	5839	78429	4863	79093	3423	93797	3088	44152
3L-6S		MI	38241	9629	60263	7157	64551	5835	65100	4834	63398	3413	74706	2780	39350
14-#14	1.63	MA	43602	9629	68584	7208	74420	5858	75958	4856	75914	3437	90122	2963	44118
4L-5S		MI	38956	9629	61431	7161	66169	5841	67077	4842	66003	3400	77950	2861	39937
14-#14	1.63	MA	42773	9629	67206	7205	72632	5853	73761	4874	72732	3427	86293	2903	44003
5L-4S		MI	39706	9629	62677	7165	67784	5823	69062	4825	68878	3412	81372	2920	40012
14-#14	1.63	MA	41984	9629	65914	7202	70843	5873	71574	4867	69849	3441	82646	2822	43317
6L-3S		MI	40545	9629	64117	7145	69620	5829	71293	4833	71748	3399	84637	3044	40013
14-#14	1.63	MA	41215	9629	64499	7223	69136	5868	69475	4885	67032	3455	78757	2692	42482
7L-2S		MI	41738	9629	65883	7149	71883	5810	74054	4817	75505	3387	89660	3169	39975
14-#18	2.90	MA	50534	10476	82680	7677	92208	6189	97547	5046	105062	3318	128070	3019	76652
2L-7S		MI	38699	10476	63247	7675	68187	6219	69405	5063	69241	3341	83138	2032	62371
14-#18	2.90	MA	48260	10476	79244	7669	87804	6222	92173	5076	97751	3341	118300	2798	76486
3L-6S		MI	39895	10476	65497	7640	70901	6188	72740	5036	73666	3319	89116	2263	64957
14-#18	2.90	MA	46664	10476	76442	7706	84232	6211	87832	5062	92165	3363	111949	2576	76058
4L-5S		MI	41122	10476	67551	7649	73743	6201	76214	5053	78196	3297	94711	2408	66510
14-#18	2.90	MA	45240	10476	74017	7699	81088	6244	83969	5091	86570	3341	105292	2472	73516
5L-4S		MI	42412	10476	69740	7658	76581	6170	79700	5025	83195	3319	100645	2509	68795
14-#18	2.90	MA	43884	10476	71743	7691	77939	6233	80121	5077	81500	3364	98982	2328	71684
6L-3S		MI	43853	10476	72267	7623	79802	6183	83614	5042	88183	3297	106270	2730	69136
14-#18	2.90	MA	42564	10476	69253	7728	74935	6267	76428	5106	76544	3387	92247	2097	68775
7L-2S		MI	45897	10476	75357	7632	83763	6152	88446	5015	94710	3275	114944	2952	69260
16-#11	1.29	MA	44577	9403	69258	7070	75410	5760	77209	4799	77456	3438	91782	3267	35312
2L-8S		MI	37172	9403	57673	7050	61407	5757	61348	4810	58187	3440	67702	2822	31419
16-#11	1.29	MA	43645	9403	67889	7068	73655	5757	75069	4811	74544	3449	87821	3181	35344
3L-7S		MI	37654	9403	58474	7053	62499	5743	62640	4797	60074	3447	69948	2870	31782
16-#11	1.29	MA	42992	9403	66777	7083	72238	5771	73346	4807	72326	3459	85238	3095	35365
4L-6S		MI	38143	9403	59366	7038	63575	5747	63963	4785	61849	3438	72383	2960	32080
16-#11	1.29	MA	42411	9403	65817	7081	70992	5768	71814	4820	70108	3452	82553	3052	35354
5E		MI	38645	9403	60181	7041	64703	5734	65342	4790	63666	3428	74667	3016	32111
16-#11	1.29	MA	41857	9403	64917	7079	69744	5782	70290	4816	68099	3463	79991	2996	35300
6L-4S		MI	39171	9403	61050	7043	65830	5737	66727	4778	65671	3436	77069	3058	32097
16-#11	1.29	MA	41317	9403	63931	7094	68555	5779	68827	4829	66136	3473	77259	2906	34937
7L-3S		MI	39761	9403	62054	7028	67110	5724	68283	4784	67674	3427	79368	3144	32066
16-#11	1.29	MA	40778	9403	63045	7092	67348	5793	67399	4842	64049	3467	74748	2857	34505
8L-2S		MI	40600	9403	63288	7031	68692	5728	70212	4771	70299	3417	82901	3230	32030
16-#14	1.86	MA	46774	9784	74099	7287	81478	5914	84560	4888	87435	3396	105077	3188	50262
2L-8S		MI	37699	9784	59599	7271	63705	5918	64111	4910	61903	3401	73067	2554	43369
16-#14	1.86	MA	45453	9784	72139	7284	78965	5908	81494	4906	83264	3410	99437	3064	50265
3L-7S		MI	38382	9784	60749	7275	65271	5924	65964	4893	64609	3413	76266	2623	43997
16-#14	1.86	MA	44528	9784	70544	7305	76933	5928	79024	4899	80084	3425	95762	2939	50206
4L-6S		MI	39075	9784	62029	7254	66815	5905	67862	4876	67155	3400	79729	2753	44673
16-#14	1.86	MA	43703	9784	69166	7302	75145	5923	76827	4917	76902	3414	91933	2879	50063
5E		MI	39787	9784	63197	7259	68432	5911	69839	4885	69760	3388	82973	2834	45401
16-#14	1.86	MA	42918	9784	67874	7299	73356	5943	74639	4910	74019	3429	88286	2798	49232
6L-4S		MI	40534	9784	64443	7263	70048	5893	71824	4868	72635	3400	86395	2893	45504
16-#14	1.86	MA	42153	9784	66459	7320	71648	5938	72540	4928	71203	3443	84397	2669	48431
7L-3S		MI	41369	9784	65883	7242	71883	5899	74054	4876	75505	3387	89660	3017	45537
16-#14	1.86	MA	41399	9784	65188	7317	69917	5958	70491	4946	68209	3432	80816	2598	47698
8L-2S		MI	42557	9784	67648	7246	74146	5880	76815	4859	79262	3374	94683	3142	45512
16-#18	3.31	MA	49824	10753	82680	7842	92208	6346	97547	5152	105062	3318	128070	2749	87118
3L-7S		MI	40131	10753	66337	7848	72148	6344	74237	5138	75767	3316	91812	1977	71528

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis



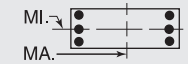
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
16-#18	3.31	MA	48239	10753	79877	7879	88636	6335	93206	5137	99476	3341	121719	2528	86625
4L-6S		MI	41318	10753	68587	7812	74862	6312	77573	5111	80193	3294	97791	2208	74280
16-#18	3.31	MA	46825	10753	77453	7872	85492	6369	89342	5167	93881	3319	115062	2423	83822
5E		MI	42537	10753	70640	7822	77705	6325	81046	5128	84722	3272	103385	2353	75763
16-#18	3.31	MA	45480	10753	75179	7864	82344	6358	85495	5152	88810	3342	108752	2279	82068
6L-4S		MI	43817	10753	72830	7831	80542	6294	84533	5101	89721	3294	109320	2454	78299
16-#18	3.31	MA	44170	10753	72688	7901	79340	6391	81801	5182	83855	3365	102017	2048	78993
7L-3S		MI	45249	10753	75357	7796	83763	6307	88446	5118	94710	3272	114944	2676	78702
16-#18	3.31	MA	42880	10753	70450	7894	76292	6380	78195	5212	78589	3343	95793	1926	76267
8L-2S		MI	47281	10753	78447	7805	87724	6276	93279	5090	101237	3250	123619	2897	78876
18-#11	1.45	MA	45226	9510	70626	7137	77164	5808	79349	4828	80368	3429	95743	3252	39606
2L-9S		MI	37272	9510	58043	7132	61927	5801	61927	4834	59052	3440	69021	2750	34913
18-#11	1.45	MA	44296	9510	69258	7135	75410	5805	77209	4841	77456	3440	91782	3165	39631
3L-8S		MI	37763	9510	58906	7118	62989	5805	63278	4839	60812	3431	71234	2804	35180
18-#11	1.45	MA	43646	9510	68146	7150	73992	5819	75486	4837	75238	3450	89198	3079	39643
4L-7S		MI	38243	9510	59708	7120	64080	5792	64569	4827	62699	3439	73480	2853	35529
18-#11	1.45	MA	43066	9510	67185	7149	72746	5816	73954	4849	73020	3444	86514	3037	39611
5L-6S		MI	38731	9510	60600	7105	65157	5795	65893	4815	64474	3429	75916	2943	35910
18-#11	1.45	MA	42514	9510	66285	7147	71499	5830	72430	4845	71010	3454	83952	2981	39541
6L-5S		MI	39231	9510	61414	7108	66285	5782	67271	4820	66291	3420	78199	2999	35953
18-#11	1.45	MA	41977	9510	65299	7162	70309	5827	70967	4858	69048	3465	81220	2891	39095
7L-4S		MI	39756	9510	62283	7111	67411	5786	68656	4808	68296	3428	80601	3040	35959
18-#11	1.45	MA	41441	9510	64413	7160	69103	5841	69539	4871	66961	3458	78709	2841	38678
8L-3S		MI	40343	9510	63288	7096	68692	5772	70212	4813	70299	3418	82901	3127	35938
18-#11	1.45	MA	40887	9510	63547	7158	67929	5838	68046	4867	65016	3469	76225	2788	38352
9L-2S		MI	41180	9510	64522	7098	70273	5776	72142	4801	72924	3409	86433	3213	35907
18-#14	2.10	MA	47685	9940	76059	7384	83991	5983	87625	4930	91605	3384	110717	3165	56395
2L-9S		MI	37844	9940	60126	7389	64445	6006	64935	4944	63137	3401	74944	2449	47591
18-#14	2.10	MA	46369	9940	74099	7381	81478	5978	84560	4948	87435	3398	105077	3040	56369
3L-8S		MI	38535	9940	61365	7368	65969	5988	66872	4952	65660	3389	78090	2527	48632
18-#14	2.10	MA	45449	9940	72504	7403	79445	5998	82089	4941	84255	3412	101402	2915	56287
4L-7S		MI	39214	9940	62515	7372	67534	5994	68725	4936	68365	3401	81289	2596	49357
18-#14	2.10	MA	44628	9940	71126	7399	77658	5993	79892	4959	81073	3402	97573	2855	56117
5L-6S		MI	39905	9940	63794	7352	69078	5975	70623	4919	70911	3388	84752	2726	50007
18-#14	2.10	MA	43846	9940	69834	7396	75868	6013	77705	4952	78190	3416	93926	2774	55158
6L-5S		MI	40613	9940	64962	7356	70696	5981	72600	4927	73517	3375	87996	2807	50859
18-#14	2.10	MA	43085	9940	68419	7418	74161	6008	75605	4970	75374	3431	90037	2645	54387
7L-4S		MI	41356	9940	66208	7360	72311	5962	74585	4910	76391	3387	91418	2866	50987
18-#14	2.10	MA	42335	9940	67148	7414	72429	6027	73557	4988	72380	3420	86456	2574	53556
8L-3S		MI	42188	9940	67648	7339	74146	5968	76815	4918	79262	3374	94683	2990	51042
18-#14	2.10	MA	41552	9940	65904	7411	70745	6022	71414	4981	69589	3434	82920	2496	52349
9L-2S		MI	43372	9940	69414	7343	76410	5950	79576	4902	83019	3362	99706	3115	51041
18-#18	3.73	MA	49802	11029	83313	8052	93041	6460	98579	5212	106786	3319	131489	2480	97186
4L-7S		MI	41551	11029	69427	8020	76110	6468	79070	5214	82294	3292	100487	1922	80707
18-#18	3.73	MA	48398	11029	80888	8044	89897	6493	94716	5242	101192	3297	124832	2375	94152
5L-6S		MI	42730	11029	71677	7985	78823	6437	82405	5186	86720	3270	106465	2154	83612
18-#18	3.73	MA	47062	11029	78615	8037	86748	6482	90868	5228	96121	3320	118522	2231	92466
6L-5S		MI	43940	11029	73730	7994	81666	6450	85879	5203	91249	3247	112060	2298	85037
18-#18	3.73	MA	45762	11029	76124	8074	83744	6515	87174	5257	91166	3342	111787	2000	89232
7L-4S		MI	45212	11029	75920	8004	84504	6418	89365	5176	96248	3270	117994	2400	87795
18-#18	3.73	MA	44481	11029	73886	8066	80697	6504	83568	5287	85900	3321	105563	1877	86386
8L-3S		MI	46635	11029	78447	7968	87724	6431	93279	5193	101237	3247	123619	2621	88256
20-#11	1.61	MA	45871	9618	71995	7205	78918	5857	81489	4857	83280	3421	99704	3236	43895
2L-10S		MI	37338	9618	58478	7197	62431	5863	62572	4875	59933	3441	70409	2672	38085

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

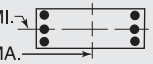


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load ϕM_n
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	
20-#11	1.61	MA	44944	9618	70626	7203	77164	5853	79349	4870	80368	3431	95743	3150	43913
3L-9S		MI	37864	9618	59277	7200	63508	5850	63856	4863	61677	3432	72553	2733	38682
20-#11	1.61	MA	44296	9618	69514	7218	75746	5868	77626	4866	78150	3442	93159	3064	43904
4L-8S		MI	38352	9618	60140	7185	64570	5853	65207	4868	63437	3422	74767	2787	38945
20-#11	1.61	MA	43719	9618	68554	7216	74500	5864	76095	4879	75932	3435	90475	3021	43863
5L-7S		MI	38830	9618	60942	7188	65662	5840	66499	4856	65324	3430	77013	2835	39282
20-#11	1.61	MA	43169	9618	67654	7214	73253	5878	74570	4875	73922	3446	87912	2965	43778
6E		MI	39316	9618	61834	7173	66738	5844	67822	4844	67099	3421	79449	2925	39734
20-#11	1.61	MA	42633	9618	66668	7229	72064	5875	73107	4887	71960	3456	85181	2876	43258
7L-5S		MI	39814	9618	62648	7175	67866	5830	69201	4849	68916	3411	81732	2981	39792
20-#11	1.61	MA	42106	9618	65782	7227	70857	5889	71680	4900	69873	3449	82670	2826	42855
8L-4S		MI	40338	9618	63517	7178	68993	5834	70585	4837	70921	3419	84134	3023	39816
20-#11	1.61	MA	41548	9618	64915	7225	69683	5886	70186	4896	67928	3460	80185	2772	42534
9L-3S		MI	40923	9618	64522	7163	70273	5821	72142	4842	72924	3409	86433	3109	39803
20-#11	1.61	MA	40966	9618	63945	7241	68493	5900	68766	4909	66000	3471	77777	2711	41842
10L-2S		MI	41758	9618	65755	7166	71855	5825	74071	4830	75549	3400	89966	3195	39779
20-#14	2.33	MA	47281	10096	76059	7478	83991	6048	87625	4991	91605	3386	110717	3016	62465
3L-9S		MI	38681	10096	61892	7486	66709	6076	67696	4987	66893	3389	79967	2422	52897
20-#14	2.33	MA	46365	10096	74464	7500	81958	6068	85154	4984	88426	3400	107042	2892	62362
4L-8S		MI	39366	10096	63130	7466	68232	6057	69633	4995	69417	3376	83112	2500	53905
20-#14	2.33	MA	45547	10096	73086	7497	80171	6063	82957	5002	85243	3389	103213	2831	62167
5L-7S		MI	40043	10096	64280	7470	69798	6064	71486	4978	72122	3388	86312	2569	54723
20-#14	2.33	MA	44769	10096	71794	7493	78381	6083	80770	4995	82361	3404	99566	2750	61094
6E		MI	40730	10096	65560	7449	71341	6045	73384	4961	74668	3375	89774	2699	55349
20-#14	2.33	MA	44011	10096	70379	7515	76674	6078	78671	5013	79544	3418	95677	2621	60349
7L-5S		MI	41435	10096	66728	7453	72959	6051	75361	4969	77274	3363	93018	2780	56312
20-#14	2.33	MA	43265	10096	69108	7512	74942	6097	76622	5031	76551	3408	92096	2550	59425
8L-4S		MI	42175	10096	67974	7457	74574	6032	77346	4953	80148	3375	96440	2839	56463
20-#14	2.33	MA	42487	10096	67864	7508	73258	6092	74479	5024	73760	3422	88560	2472	58253
9L-3S		MI	43004	10096	69414	7436	76410	6038	79576	4961	83019	3362	99706	2963	56539
20-#14	2.33	MA	41663	10096	66471	7530	71549	6112	72441	5042	70993	3436	85134	2384	57044
10L-2S		MI	44183	10096	71179	7441	78673	6020	82337	4944	86775	3349	104729	3088	56565
20-#18	4.14	MA	49960	11306	84324	8217	94302	6617	100089	5318	108503	3275	134601	2327	104501
5L-7S		MI	42960	11306	72517	8193	80071	6592	83902	5289	88821	3267	109161	1868	89905
20-#18	4.14	MA	48633	11306	82051	8210	91153	6606	96241	5303	103432	3298	128292	2183	102756
6E		MI	44132	11306	74767	8158	82784	6561	87237	5262	93247	3245	115139	2099	92707
20-#18	4.14	MA	47341	11306	79560	8247	88149	6639	92547	5333	98476	3320	121557	1952	99491
7L-5S		MI	45334	11306	76820	8167	85627	6574	90711	5279	97776	3223	120734	2244	94330
20-#18	4.14	MA	46070	11306	77322	8239	85101	6628	88942	5362	93211	3299	115333	1829	96526
8L-4S		MI	46598	11306	79010	8176	88465	6543	94198	5252	102775	3245	126669	2345	96980
22-#11	1.78	MA	46514	9726	73363	7272	80673	5905	83630	4887	86192	3412	103664	3221	48179
2L-11S		MI	37415	9726	58925	7262	62956	5908	63167	4900	60698	3425	71752	2603	41335
22-#11	1.78	MA	45590	9726	71995	7270	78918	5902	81489	4900	83280	3423	99704	3135	48190
3L-10S		MI	37928	9726	59711	7265	64013	5911	64501	4905	62558	3433	73941	2654	41807
22-#11	1.78	MA	44944	9726	70883	7285	77501	5916	79766	4895	81062	3433	97120	3048	48165
4L-9S		MI	38453	9726	60510	7267	65090	5898	65786	4893	64302	3423	76086	2715	42409
22-#11	1.78	MA	44368	9726	69922	7283	76255	5913	78235	4908	78844	3427	94436	3006	48111
5L-8S		MI	38938	9726	61374	7253	66152	5902	67136	4898	66062	3414	78300	2769	42712
22-#11	1.78	MA	43821	9726	69022	7281	75007	5927	76710	4904	76834	3437	91873	2950	48012
6L-7S		MI	39415	9726	62175	7255	67243	5888	68428	4886	67949	3421	80546	2818	43038
22-#11	1.78	MA	43287	9726	68036	7297	73818	5924	75247	4917	74871	3448	89141	2860	47426
7L-6S		MI	39899	9726	63067	7240	68320	5892	69751	4874	69724	3412	82981	2908	43546
22-#11	1.78	MA	42761	9726	67150	7295	72611	5938	73820	4930	72785	3441	86631	2810	47034
8L-5S		MI	40396	9726	63882	7243	69448	5879	71130	4879	71541	3403	85264	2964	43625
22-#11	1.78	MA	42206	9726	66284	7293	71438	5935	72327	4925	70840	3451	84146	2757	46679
9L-4S		MI	40917	9726	64751	7245	70574	5883	72515	4867	73546	3410	87666	3005	43660
22-#11	1.78	MA	41625	9726	65314	7308	70247	5949	70907	4938	68912	3462	81738	2696	45978
10L-3S		MI	41501	9726	65755	7231	71855	5869	74071	4872	75549	3401	89966	3092	43664
22-#11	1.78	MA	41059	9726	64446	7306	69080	5946	69433	4934	66856	3455	79290	2643	45423
11L-2S		MI	42333	9726	66989	7233	73436	5873	76000	4860	78174	3391	93498	3178	43646

RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

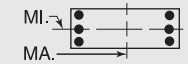


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	2.56	MA	47276	10251	76424	7597	84471	6138	88220	5026	92596	3388	112682	2868	68432
4L-9S		MI	39526	10251	63657	7584	68972	6146	70457	5029	70650	3376	84990	2395	58210
22-#14	2.56	MA	46462	10251	75046	7594	82683	6133	86023	5044	89414	3377	108853	2807	68214
5L-8S		MI	40193	10251	64896	7563	70495	6127	72395	5037	73173	3364	88135	2473	59188
22-#14	2.56	MA	45688	10251	73754	7591	80894	6152	83835	5037	86531	3391	105206	2727	67038
6L-7S		MI	40867	10251	66046	7567	72061	6133	74247	5020	75879	3376	91334	2542	60094
22-#14	2.56	MA	44933	10251	72339	7612	79186	6147	81736	5055	83715	3406	101317	2597	66316
7L-6S		MI	41551	10251	67325	7546	73605	6115	76145	5004	78425	3363	94797	2672	60699
22-#14	2.56	MA	44191	10251	71068	7609	77455	6167	79687	5073	80721	3395	97736	2526	65304
8L-5S		MI	42252	10251	68494	7550	75222	6121	78122	5012	81030	3350	98041	2753	61729
22-#14	2.56	MA	43417	10251	69824	7606	75771	6162	77545	5066	77931	3410	94200	2448	64163
9L-4S		MI	42990	10251	69739	7554	76838	6102	80107	4995	83905	3362	101463	2812	61934
22-#14	2.56	MA	42595	10251	68431	7627	74062	6182	75507	5084	75164	3424	90774	2360	62894
10L-3S		MI	43815	10251	71179	7534	78673	6108	82337	5003	86775	3350	104729	2936	62029
22-#18	4.55	MA	50193	11582	85486	8383	95558	6730	101614	5378	110742	3276	138062	2134	112929
6L-7S		MI	44360	11582	75607	8366	84032	6716	88734	5365	95347	3242	117836	1813	99121
22-#18	4.55	MA	48910	11582	82996	8420	92553	6763	97921	5408	105787	3298	131326	1903	109768
7L-6S		MI	45524	11582	77857	8331	86746	6685	92070	5337	99773	3220	123814	2045	101825
22-#18	4.55	MA	47647	11582	80757	8412	89506	6752	94315	5438	100521	3277	125103	1780	106685
8L-5S		MI	46719	11582	79910	8340	89588	6698	95544	5354	104302	3198	129409	2189	103639
24-#11	1.94	MA	46233	9834	73363	7338	80673	5950	83630	4929	86192	3414	103664	3119	52454
3L-11S		MI	38004	9834	60159	7330	64538	5956	65097	4929	63323	3416	75284	2585	45072
24-#11	1.94	MA	45590	9834	72251	7353	79255	5964	81906	4925	83974	3425	101081	3033	52421
4L-10S		MI	38515	9834	60945	7332	65594	5960	66430	4934	65183	3424	77474	2637	45534
24-#11	1.94	MA	45016	9834	71291	7351	78009	5961	80375	4938	81756	3418	98396	2990	52355
5L-9S		MI	39039	9834	61744	7335	66671	5946	67715	4922	66927	3415	79619	2698	46119
24-#11	1.94	MA	44470	9834	70391	7349	76762	5975	78851	4933	79746	3428	95834	2935	52176
6L-8S		MI	39522	9834	62607	7320	67733	5950	69066	4927	68687	3405	81832	2752	46481
24-#11	1.94	MA	43938	9834	69405	7364	75572	5972	77388	4946	77783	3439	93102	2845	51599
7E		MI	39997	9834	63409	7322	68825	5937	70357	4915	70573	3413	84078	2800	46799
24-#11	1.94	MA	43414	9834	68519	7362	74366	5986	75960	4959	75697	3432	90592	2795	51217
8L-6S		MI	40480	9834	64301	7308	69901	5941	71681	4903	72349	3403	86514	2890	47287
24-#11	1.94	MA	42861	9834	67652	7360	73192	5983	74467	4955	73752	3443	88107	2741	50802
9L-5S		MI	40975	9834	65115	7310	71029	5927	73059	4908	74166	3394	88797	2946	47455
24-#11	1.94	MA	42282	9834	66682	7375	72002	5997	73047	4968	71824	3453	85699	2680	50118
10L-4S		MI	41495	9834	65984	7313	72156	5931	74444	4896	76171	3402	91199	2988	47501
24-#11	1.94	MA	41717	9834	65814	7374	70835	5994	71573	4963	69768	3447	83251	2628	49575
11L-3S		MI	42077	9834	66989	7298	73436	5918	76000	4901	78174	3392	93498	3074	47521
24-#11	1.94	MA	41162	9834	64861	7389	69653	6008	70155	4976	67840	3457	80492	2551	48746
12L-2S		MI	42907	9834	68223	7301	75018	5921	77930	4889	80799	3383	97031	3160	47510
24-#14	2.80	MA	47372	10407	77006	7691	85196	6203	89088	5086	93585	3365	114492	2783	74157
5L-9S		MI	40352	10407	65423	7681	71235	6216	73219	5071	74407	3364	90013	2368	63530
24-#14	2.80	MA	46601	10407	75714	7688	83406	6222	86901	5080	90702	3379	110846	2703	72989
6L-8S		MI	41016	10407	66661	7660	72759	6197	75156	5080	76930	3351	93158	2446	64480
24-#14	2.80	MA	45850	10407	74299	7709	81699	6217	84802	5098	87885	3393	106957	2573	72287
7E		MI	41686	10407	67811	7664	74324	6203	77008	5063	79636	3363	96357	2515	65468
24-#14	2.80	MA	45111	10407	73028	7706	79968	6237	82753	5115	84892	3383	103376	2502	71191
8L-6S		MI	42367	10407	69091	7643	75868	6184	78906	5046	82182	3351	99820	2645	66056
24-#14	2.80	MA	44342	10407	71784	7703	78283	6232	80610	5109	82101	3397	99840	2425	70081
9L-5S		MI	43066	10407	70259	7648	77486	6191	80883	5054	84787	3338	103064	2726	67045
24-#14	2.80	MA	43523	10407	70391	7724	76575	6252	78572	5127	79334	3411	96414	2337	68751
10L-4S		MI	43800	10407	71505	7652	79101	6172	82868	5037	87662	3350	106486	2785	67400
24-#18	4.97	MA	50468	11859	86432	8593	96958	6887	103294	5483	113098	3276	141096	1855	120060
7E		MI	45751	11859	78697	8539	87993	6840	93567	5440	101874	3217	126510	1759	108353
24-#18	4.97	MA	49214	11859	84193	8585	93910	6877	99688	5513	107832	3254	134872	1732	116863
8L-6S		MI	46908	11859	80947	8504	90707	6809	96902	5413	106300	3195	132488	1990	110966

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

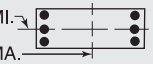
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.19	MA	47966	9741	74559	7287	80709	5941	82242	4956	81803	3568	96077	3377	35259
2L-3S		MI	39713	9741	62243	7210	66393	5916	66659	4936	64208	3546	73929	3094	30694
6-#18	1.19	MA	45508	9741	70951	7280	76083	5975	76598	4986	74124	3592	85759	3156	35369
3L-2S		MI	41812	9741	65333	7219	70354	5885	71491	4909	70735	3524	82604	3315	30559
8-#18	1.59	MA	49660	10017	78168	7460	85335	6065	87886	5031	89481	3546	106395	3332	46603
2L-4S		MI	39685	10017	62806	7418	67134	6027	67578	4994	65746	3544	76979	2818	40320
8-#18	1.59	MA	47219	10017	74559	7453	80709	6099	82242	5062	81803	3570	96077	3110	46647
3E		MI	41159	10017	65333	7383	70354	6040	71491	5011	70735	3521	82604	3039	40390
8-#18	1.59	MA	45506	10017	71619	7491	76962	6089	77688	5048	75942	3594	89363	2889	46463
4L-2S		MI	43244	10017	68423	7392	74315	6009	76324	4984	77261	3499	91278	3261	40304
10-#14	1.12	MA	47756	9689	73796	7297	80015	5952	81504	4971	80844	3595	95154	3424	33332
2L-5S		MI	38839	9689	60227	7248	64079	5933	63934	4954	60629	3576	70274	3061	29052
10-#14	1.12	MA	46350	9689	71739	7294	77377	5948	78287	4990	76467	3610	89206	3299	33391
3L-4S		MI	39598	9689	61473	7252	65694	5914	65919	4937	63504	3588	73696	3120	29038
10-#14	1.12	MA	45366	9689	70067	7316	75246	5968	75696	4983	73133	3625	85326	3175	33428
4L-3S		MI	40445	9689	62913	7231	67529	5921	68150	4945	66374	3575	76962	3245	28978
10-#14	1.12	MA	44488	9689	68622	7313	73372	5963	73393	5002	69796	3616	81293	3113	33381
5L-2S		MI	41649	9689	64679	7236	69793	5902	70911	4928	70131	3562	81984	3369	28910
10-#18	1.98	MA	51339	10294	81777	7633	89961	6189	93529	5107	97160	3524	116714	3286	57911
2L-5S		MI	39818	10294	63706	7582	68257	6183	68924	5097	67274	3497	79720	2662	48439
10-#18	1.98	MA	48914	10294	78168	7626	85335	6223	87886	5137	89481	3548	106395	3065	57877
3L-4S		MI	41128	10294	65896	7591	71095	6151	72410	5070	72273	3519	85654	2763	49875
10-#18	1.98	MA	47214	10294	75228	7663	81588	6213	83331	5124	83620	3572	99681	2843	57601
4L-3S		MI	42592	10294	68423	7556	74315	6165	76324	5087	77261	3497	91278	2985	50038
10-#18	1.98	MA	45695	10294	72685	7657	78291	6247	79280	5154	77752	3552	92662	2737	55832
5L-2S		MI	44664	10294	71513	7565	78277	6133	81156	5059	83788	3475	99953	3206	50011
12-#14	1.34	MA	48734	9844	75854	7394	82652	6022	84721	5014	85222	3583	101103	3401	39797
2L-6S		MI	38961	9844	60825	7341	64724	5997	64719	4988	61781	3576	72053	2953	34249
12-#14	1.34	MA	47333	9844	73796	7391	80015	6017	81504	5032	80844	3598	95154	3277	39840
3L-5S		MI	39680	9844	61993	7345	66342	6003	66696	4996	64386	3563	75297	3034	34543
12-#14	1.34	MA	46354	9844	72124	7413	77883	6038	78913	5026	77510	3613	91275	3152	39843
4E		MI	40435	9844	63239	7349	67958	5984	68681	4979	67261	3576	78719	3093	34569
12-#14	1.34	MA	45480	9844	70680	7410	76010	6033	76611	5044	74174	3603	87242	3091	39760
5L-3S		MI	41279	9844	64679	7329	69793	5990	70911	4988	70131	3563	81984	3217	34531
12-#14	1.34	MA	44649	9844	69326	7407	74134	6053	74318	5038	71153	3618	83394	3010	39335
6L-2S		MI	42478	9844	66444	7333	72056	5972	73672	4971	73888	3550	87007	3342	34475
12-#18	2.38	MA	53002	10571	85386	7805	94587	6313	99173	5182	104839	3502	127032	3240	69189
2L-6S		MI	40019	10571	64743	7746	69376	6294	70282	5155	69271	3494	82799	2463	55967
12-#18	2.38	MA	50593	10571	81777	7799	89961	6347	93529	5213	97160	3526	116714	3019	69080
3L-5S		MI	41257	10571	66796	7755	72218	6307	73756	5172	73800	3472	88394	2607	57626
12-#18	2.38	MA	48905	10571	78837	7836	86214	6337	88975	5199	91299	3550	109999	2798	68724
4E		MI	42559	10571	68986	7764	75056	6276	77243	5145	78799	3494	94328	2709	59410
12-#18	2.38	MA	47398	10571	76294	7830	82917	6371	84923	5230	85431	3530	102980	2692	66598
5L-3S		MI	44012	10571	71513	7729	78277	6289	81156	5162	83788	3472	99953	2930	59648
12-#18	2.38	MA	45965	10571	73911	7823	79616	6361	80888	5216	80113	3554	96313	2548	64504
6L-2S		MI	46072	10571	74603	7738	82238	6258	85989	5135	90315	3450	108627	3151	59690
14-#11	1.08	MA	47666	9666	73446	7304	79710	5960	81188	4980	80438	3609	94780	3446	32486
2L-7S		MI	38621	9666	59563	7268	63354	5927	63092	4965	59592	3608	68791	3034	28188
14-#11	1.08	MA	46683	9666	72010	7302	77870	5957	78942	4993	77383	3620	90605	3359	32524
3L-6S		MI	39112	9666	60455	7253	64430	5931	64416	4953	61367	3598	71227	3124	28309
14-#11	1.08	MA	45996	9666	70844	7318	76384	5971	77136	4989	75058	3631	87879	3273	32556
4L-5S		MI	39616	9666	61270	7255	65558	5917	65794	4958	63184	3589	73510	3180	28305

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

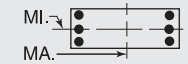


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
14-#11	1.08	MA	45384	9666	69838	7316	75078	5968	75531	5002	72733	3624	85053	3230	32565
5L-4S		MI	40145	9666	62138	7258	66685	5921	67179	4946	65190	3596	75912	3222	28272
14-#11	1.08	MA	44802	9666	68895	7314	73771	5983	73934	4998	70628	3635	82351	3174	32529
6L-3S		MI	40737	9666	63143	7243	67965	5908	68735	4951	67193	3587	78211	3308	28230
14-#11	1.08	MA	44234	9666	67862	7330	72525	5980	72401	5012	68571	3646	79471	3084	32320
7L-2S		MI	41580	9666	64377	7246	69547	5912	70665	4939	69818	3577	81744	3395	28186
14-#14	1.56	MA	49706	10000	77911	7491	85290	6092	87939	5056	89599	3571	107052	3379	46249
2L-7S		MI	39103	10000	61311	7459	65444	6085	65582	5047	62991	3577	73613	2796	38838
14-#14	1.56	MA	48311	10000	75854	7489	82652	6087	84721	5075	85222	3586	101103	3254	46279
3L-6S		MI	39801	10000	62590	7438	66988	6067	67480	5031	65537	3564	77076	2926	39557
14-#14	1.56	MA	47336	10000	74181	7510	80521	6108	82131	5068	81888	3601	97224	3130	46245
4L-5S		MI	40517	10000	63758	7443	68606	6073	69457	5039	68143	3551	80320	3007	40022
14-#14	1.56	MA	46467	10000	72737	7508	78647	6103	79828	5087	78552	3591	93191	3068	46129
5L-4S		MI	41268	10000	65004	7447	70221	6054	71442	5022	71017	3563	83742	3066	40081
14-#14	1.56	MA	45639	10000	71384	7505	76772	6123	77535	5080	75530	3606	89342	2988	45530
6L-3S		MI	42109	10000	66444	7426	72056	6060	73672	5030	73888	3550	87007	3190	40068
14-#14	1.56	MA	44833	10000	69901	7527	74983	6118	75336	5099	72578	3621	85240	2858	44619
7L-2S		MI	43303	10000	68210	7430	74319	6041	76433	5013	77645	3538	92030	3315	40026
14-#18	2.78	MA	54652	10847	88994	7978	99214	6437	104817	5257	112517	3480	137350	3195	80432
2L-7S		MI	40256	10847	65583	7954	70623	6449	71779	5258	71372	3491	85495	2177	62890
14-#18	2.78	MA	52258	10847	85386	7972	94587	6471	99173	5288	104839	3504	127032	2973	80266
3L-6S		MI	41455	10847	67833	7919	73337	6418	75115	5231	75798	3469	91474	2408	65273
14-#18	2.78	MA	50582	10847	82445	8009	90840	6461	94619	5275	98977	3528	120317	2752	79838
4L-5S		MI	42685	10847	69886	7928	76180	6431	78588	5248	80327	3447	97069	2553	66847
14-#18	2.78	MA	49086	10847	79903	8003	87543	6495	90567	5305	93109	3508	113298	2646	77400
5L-4S		MI	43977	10847	72076	7937	79017	6400	82075	5220	85326	3469	103003	2654	68932
14-#18	2.78	MA	47664	10847	77520	7996	84242	6485	86532	5292	87792	3532	106631	2502	75401
6L-3S		MI	45422	10847	74603	7902	82238	6413	85989	5237	90315	3447	108627	2875	69236
14-#18	2.78	MA	46278	10847	74908	8033	81092	6519	82659	5323	82596	3555	99517	2272	72563
7L-2S		MI	47469	10847	77693	7911	86199	6382	90821	5210	96841	3425	117302	3097	69341
16-#11	1.24	MA	48353	9774	74882	7371	81551	6008	83434	5009	83494	3600	98955	3431	36997
2L-8S		MI	38731	9774	59995	7332	63844	5989	63730	5007	60330	3591	70077	2968	31560
16-#11	1.24	MA	47372	9774	73446	7370	79710	6005	81188	5023	80438	3611	94780	3345	37028
3L-7S		MI	39213	9774	60797	7335	64935	5975	65022	4995	62217	3599	72323	3017	31928
16-#11	1.24	MA	46688	9774	72280	7385	78224	6019	79382	5019	78114	3622	92054	3258	37050
4L-6S		MI	39703	9774	61689	7320	66012	5979	66345	4983	63992	3589	74759	3107	32149
16-#11	1.24	MA	46078	9774	71274	7383	76919	6017	77777	5032	75789	3616	89228	3215	37039
5E		MI	40205	9774	62503	7323	67140	5966	67724	4988	65809	3580	77042	3163	32165
16-#11	1.24	MA	45498	9774	70331	7382	75612	6031	76180	5028	73683	3627	86526	3160	36985
6L-4S		MI	40733	9774	63372	7325	68266	5970	69108	4976	67815	3588	79444	3204	32145
16-#11	1.24	MA	44932	9774	69298	7397	74366	6028	74647	5041	71627	3638	83646	3070	36676
7L-3S		MI	41323	9774	64377	7311	69547	5956	70665	4981	69818	3578	81744	3291	32111
16-#11	1.24	MA	44365	9774	68370	7396	73102	6043	73151	5054	69441	3631	81003	3020	36204
8L-2S		MI	42163	9774	65611	7313	71128	5960	72594	4969	72443	3569	85276	3377	32072
16-#14	1.79	MA	50673	10156	79968	7589	87927	6162	91156	5099	93977	3558	113001	3356	52692
2L-8S		MI	39257	10156	61926	7552	66142	6149	66491	5106	64043	3552	75437	2700	43697
16-#14	1.79	MA	49283	10156	77911	7586	85290	6157	87939	5117	89599	3573	107052	3232	52695
3L-7S		MI	39941	10156	63076	7556	67708	6155	68343	5090	66748	3564	78636	2769	44192
16-#14	1.79	MA	48313	10156	76239	7608	83158	6177	85348	5111	86265	3588	103172	3107	52636
4L-6S		MI	40636	10156	64356	7536	69251	6136	70241	5073	69294	3551	82098	2899	44878
16-#14	1.79	MA	47447	10156	74794	7605	81285	6173	83045	5129	82929	3578	99139	3046	52493
5E		MI	41348	10156	65524	7540	70869	6143	72218	5081	71899	3539	85342	2980	45493
16-#14	1.79	MA	46624	10156	73441	7602	79409	6193	80753	5123	79908	3593	95291	2965	51740
6L-4S		MI	42097	10156	66770	7544	72484	6124	74203	5064	74774	3551	88765	3039	45577
16-#14	1.79	MA	45821	10156	71958	7624	77620	6188	78553	5141	76956	3608	91188	2836	50866
7L-3S		MI	42934	10156	68210	7523	74319	6130	76433	5072	77645	3538	92030	3163	45601
16-#14	1.79	MA	45031	10156	70626	7621	75806	6209	76406	5160	73819	3599	87417	2764	50221
8L-2S		MI	44123	10156	69975	7527	76583	6111	79194	5056	81401	3525	97053	3288	45566
16-#18	3.17	MA	53910	11124	88994	8145	99214	6595	104817	5363	112517	3482	137350	2928	91438
3L-7S		MI	41689	11124	68673	8127	74585	6573	76612	5333	77899	3466	94170	2122	72040

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

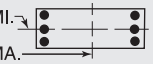
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#18	3.17	MA	52245	11124	86054	8182	95466	6585	100262	5350	106656	3506	130636	2706	90945
4L-6S		MI	42880	11124	70923	8092	77298	6542	79947	5306	82325	3444	100148	2353	74596
16-#18	3.17	MA	50760	11124	83512	8175	92169	6619	96211	5381	100788	3486	123616	2600	88230
5E		MI	44102	11124	72976	8101	80141	6555	83421	5323	86854	3422	105743	2498	76096
16-#18	3.17	MA	49348	11124	81128	8169	88868	6609	92176	5367	95470	3509	116949	2457	86315
6L-4S		MI	45385	11124	75166	8110	82979	6524	86907	5296	91853	3444	111677	2599	78444
16-#18	3.17	MA	47972	11124	78517	8206	85718	6644	88303	5398	90275	3533	109835	2226	83305
7L-3S		MI	46820	11124	77693	8075	86199	6537	90821	5313	96841	3422	117302	2821	78809
16-#18	3.17	MA	46618	11124	76171	8200	82523	6633	84523	5429	84753	3513	103272	2102	80666
8L-2S		MI	48856	11124	80783	8084	90160	6506	95654	5286	103368	3400	125976	3042	78963
18-#11	1.39	MA	49036	9882	76318	7439	83392	6056	85680	5039	86549	3591	103130	3417	41501
2L-9S		MI	38831	9882	60366	7415	64363	6033	64309	5031	61196	3592	71396	2897	35059
18-#11	1.39	MA	48059	9882	74882	7437	81551	6054	83434	5052	83494	3602	98955	3330	41526
3L-8S		MI	39323	9882	61229	7400	65425	6037	65659	5036	62955	3583	73610	2951	35322
18-#11	1.39	MA	47377	9882	73716	7453	80065	6068	81628	5048	81169	3613	96229	3244	41538
4L-7S		MI	39803	9882	62030	7402	66517	6024	66951	5024	64842	3590	75856	2999	35675
18-#11	1.39	MA	46769	9882	72710	7451	78760	6065	80023	5061	78844	3607	93404	3201	41506
5L-6S		MI	40291	9882	62923	7388	67593	6028	68274	5012	66617	3581	78292	3089	35983
18-#11	1.39	MA	46190	9882	71767	7449	77453	6079	78425	5057	76739	3618	90701	3145	41436
6L-5S		MI	40792	9882	63737	7390	68721	6014	69653	5017	68434	3571	80575	3145	36015
18-#11	1.39	MA	45627	9882	70734	7465	76207	6077	76893	5071	74682	3629	87821	3055	41040
7L-4S		MI	41318	9882	64606	7393	69848	6018	71038	5005	70440	3579	82977	3187	36010
18-#11	1.39	MA	45064	9882	69806	7463	74942	6091	75397	5084	72496	3623	85178	3005	40584
8L-3S		MI	41906	9882	65611	7378	71128	6005	72594	5010	72443	3570	85276	3273	35985
18-#11	1.39	MA	44476	9882	68899	7461	73713	6088	73833	5080	70458	3634	82558	2952	40234
9L-2S		MI	42744	9882	66844	7381	72710	6008	74523	4998	75068	3560	88809	3360	35952
18-#14	2.01	MA	51634	10311	82026	7686	90564	6232	94374	5141	98355	3546	118950	3334	59129
2L-9S		MI	39401	10311	62453	7670	66882	6238	67315	5141	65276	3552	77314	2595	47901
18-#14	2.01	MA	50250	10311	79968	7683	87927	6227	91156	5159	93977	3561	113001	3209	59103
3L-8S		MI	40094	10311	63692	7650	68405	6219	69252	5149	67799	3540	80459	2673	48960
18-#14	2.01	MA	49284	10311	78296	7705	85795	6247	88566	5153	90643	3576	109121	3084	59021
4L-7S		MI	40775	10311	64842	7654	69971	6225	71104	5132	70505	3552	83659	2742	49553
18-#14	2.01	MA	48422	10311	76852	7702	83922	6243	86263	5172	87307	3566	105088	3023	58851
5L-6S		MI	41466	10311	66121	7633	71515	6206	73002	5115	73051	3539	87121	2872	50210
18-#14	2.01	MA	47603	10311	75498	7699	82046	6263	83970	5165	84285	3581	101240	2943	57962
6L-5S		MI	42176	10311	67290	7637	73132	6212	74979	5123	75656	3526	90365	2953	50956
18-#14	2.01	MA	46804	10311	74015	7721	80257	6258	81770	5184	81334	3596	97137	2813	57120
7L-4S		MI	42921	10311	68535	7641	74748	6194	76964	5107	78531	3538	93787	3012	51065
18-#14	2.01	MA	46018	10311	72683	7718	78443	6278	79624	5202	78196	3586	93366	2742	56389
8L-3S		MI	43754	10311	69975	7620	76583	6200	79194	5115	81401	3525	97053	3136	51109
18-#14	2.01	MA	45184	10311	71380	7715	76678	6274	77378	5196	75272	3601	89634	2664	55075
9L-2S		MI	44940	10311	71741	7625	78846	6181	81956	5098	85158	3513	102075	3261	51098
18-#18	3.57	MA	53895	11400	89663	8355	100092	6709	105906	5425	114335	3484	140954	2661	102046
4L-7S		MI	43112	11400	71763	8300	78546	6697	81444	5409	84425	3442	102844	2067	81213
18-#18	3.57	MA	52421	11400	87120	8348	96795	6744	101854	5456	108466	3463	133935	2555	99084
5L-6S		MI	44294	11400	74013	8265	81259	6666	84780	5382	88851	3420	108823	2299	83932
18-#18	3.57	MA	51019	11400	84737	8342	93494	6734	97819	5443	103149	3487	127267	2411	97243
6L-5S		MI	45508	11400	76066	8274	84102	6679	88253	5399	93380	3397	114417	2443	85367
18-#18	3.57	MA	49653	11400	82126	8379	90344	6768	93947	5473	97953	3511	120153	2180	94069
7L-4S		MI	46783	11400	78256	8283	86940	6648	91740	5371	98379	3420	120352	2545	87948
18-#18	3.57	MA	48309	11400	79779	8373	87149	6758	90166	5504	92432	3491	113590	2056	91309
8L-3S		MI	48209	11400	80783	8248	90160	6661	95654	5388	103368	3397	125976	2766	88369
20-#11	1.55	MA	49717	9990	77754	7506	85233	6105	87925	5068	89605	3583	107305	3402	46001
2L-10S		MI	38897	9990	60800	7480	64868	6095	64953	5073	62077	3593	72784	2818	38312

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

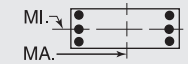


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#11	1.55	MA	48743	9990	76318	7505	83392	6102	85680	5081	86549	3594	103130	3316	46019
3L-9S		MI	39424	9990	61599	7482	65945	6082	66238	5060	63821	3583	74929	2879	38830
20-#11	1.55	MA	48063	9990	75152	7520	81906	6116	83873	5077	84225	3605	100405	3229	46010
4L-8S		MI	39912	9990	62462	7467	67007	6086	67589	5066	65580	3574	77143	2933	39088
20-#11	1.55	MA	47457	9990	74146	7518	80600	6113	82269	5091	81899	3599	97579	3186	45969
5L-7S		MI	40391	9990	63264	7470	68098	6072	68880	5053	67467	3582	79389	2982	39428
20-#11	1.55	MA	46880	9990	73203	7517	79294	6128	80671	5087	79794	3609	94876	3131	45884
6E		MI	40877	9990	64156	7455	69175	6076	70204	5041	69242	3572	81824	3072	39811
20-#11	1.55	MA	46319	9990	72170	7532	78047	6125	79138	5100	77737	3620	91997	3041	45409
7L-5S		MI	41376	9990	64971	7458	70303	6063	71582	5047	71059	3563	84107	3128	39857
20-#11	1.55	MA	45760	9990	71242	7530	76783	6139	77643	5113	75551	3614	89354	2991	44968
8L-4S		MI	41901	9990	65839	7460	71429	6066	72967	5034	73065	3570	86509	3169	39870
20-#11	1.55	MA	45172	9990	70335	7529	75554	6137	76078	5109	73514	3625	86733	2937	44624
9L-3S		MI	42487	9990	66844	7445	72710	6053	74523	5040	75068	3561	88809	3256	39853
20-#11	1.55	MA	44562	9990	69318	7544	74307	6151	74591	5122	71494	3636	84193	2876	43974
10L-2S		MI	43322	9990	68078	7448	74291	6057	76453	5027	77693	3552	92341	3342	39826
20-#14	2.23	MA	51212	10467	82026	7780	90564	6297	94374	5202	98355	3548	118950	3186	65503
3L-9S		MI	40240	10467	64219	7768	69145	6308	70076	5183	69033	3540	82337	2568	53205
20-#14	2.23	MA	50250	10467	80353	7802	88433	6317	91783	5195	95020	3563	115070	3062	65399
4L-8S		MI	40926	10467	65457	7747	70668	6289	72013	5191	71556	3527	85482	2646	54231
20-#14	2.23	MA	49392	10467	78909	7799	86559	6312	89480	5214	91684	3554	111037	3001	65205
5L-7S		MI	41604	10467	66607	7751	72234	6295	73865	5174	74262	3539	88681	2715	54919
20-#14	2.23	MA	48577	10467	77556	7796	84684	6333	87188	5208	88663	3569	107189	2920	64194
6E		MI	42293	10467	67887	7730	73778	6276	75763	5158	76808	3526	92144	2845	55552
20-#14	2.23	MA	47782	10467	76072	7818	82895	6328	84988	5226	85711	3584	103086	2791	63381
7L-5S		MI	42999	10467	69055	7734	75396	6282	77740	5166	79413	3514	95388	2926	56414
20-#14	2.23	MA	46999	10467	74741	7815	81080	6348	82841	5245	82574	3574	99314	2719	62553
8L-4S		MI	43741	10467	70301	7738	77011	6264	79725	5149	82288	3526	98810	2985	56546
20-#14	2.23	MA	46170	10467	73438	7813	79316	6344	80596	5238	79649	3589	95583	2642	61275
9L-3S		MI	44571	10467	71741	7718	78846	6270	81956	5157	85158	3513	102075	3109	56609
20-#14	2.23	MA	45304	10467	71978	7835	77525	6364	78460	5257	76750	3604	91967	2554	60138
10L-2S		MI	45752	10467	73506	7722	81110	6251	84717	5140	88915	3500	107098	3234	56629
20-#18	3.97	MA	54070	11677	90729	8521	101422	6868	107498	5531	116145	3441	144253	2509	109958
5L-7S		MI	44523	11677	74853	8473	82507	6822	86277	5484	90952	3417	111519	2013	90406
20-#18	3.97	MA	52677	11677	88346	8515	98120	6858	103463	5518	110828	3465	137585	2365	108183
6E		MI	45698	11677	77103	8437	85221	6790	89612	5457	95378	3395	117497	2244	93277
20-#18	3.97	MA	51321	11677	85734	8552	94970	6892	99590	5549	105632	3489	130471	2135	104853
7L-5S		MI	46904	11677	79156	8447	88063	6803	93086	5474	99907	3373	123092	2389	94658
20-#18	3.97	MA	49986	11677	83388	8545	91775	6882	95810	5579	100110	3469	123908	2010	101973
8L-4S		MI	48172	11677	81345	8456	90901	6772	96572	5447	104906	3395	129026	2490	97382
22-#11	1.70	MA	50395	10098	79190	7574	87074	6153	90171	5098	92660	3574	111481	3387	50496
2L-11S		MI	38973	10098	61248	7544	65393	6140	65549	5097	62841	3577	74127	2749	41559
22-#11	1.70	MA	49423	10098	77754	7572	85233	6150	87925	5111	89605	3585	107305	3301	50507
3L-10S		MI	39487	10098	62034	7547	66449	6144	66882	5102	64702	3584	76317	2801	42034
22-#11	1.70	MA	48746	10098	76588	7587	83747	6165	86119	5107	87280	3596	104580	3215	50481
4L-9S		MI	40014	10098	62833	7549	67526	6130	68167	5090	66446	3575	78462	2862	42601
22-#11	1.70	MA	48142	10098	75582	7586	82441	6162	84514	5120	84955	3590	101754	3172	50427
5L-8S		MI	40499	10098	63696	7535	68588	6134	69518	5095	68205	3565	80675	2916	42856
22-#11	1.70	MA	47567	10098	74639	7584	81134	6176	82917	5116	82849	3601	99052	3116	50329
6L-7S		MI	40976	10098	64498	7537	69680	6121	70810	5083	70092	3573	82921	2964	43185
22-#11	1.70	MA	47008	10098	73606	7600	79888	6173	81384	5129	80793	3612	96172	3026	49783
7L-6S		MI	41461	10098	65390	7523	70756	6124	72133	5071	71867	3564	85357	3054	43636
22-#11	1.70	MA	46457	10098	72678	7598	78624	6188	79888	5143	78607	3606	93529	2976	49355
8L-5S		MI	41959	10098	66204	7525	71884	6111	73512	5076	73684	3554	87640	3110	43695
22-#11	1.70	MA	45866	10098	71771	7596	77395	6185	78324	5139	76569	3617	90908	2923	49016
9L-4S		MI	42481	10098	67073	7528	73011	6115	74896	5064	75690	3562	90042	3152	43721
22-#11	1.70	MA	45257	10098	70754	7612	76148	6199	76836	5152	74549	3628	88368	2862	48316
10L-3S		MI	43066	10098	68078	7513	74291	6101	76453	5069	77693	3552	92341	3238	43716
22-#11	1.70	MA	44662	10098	69845	7610	74925	6196	75292	5148	72395	3621	85791	2809	47716
11L-2S		MI	43899	10098	69312	7515	75873	6105	78382	5057	80318	3543	95874	3325	43695

RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

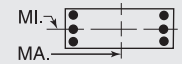


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#14	2.46	MA	51211	10622	82411	7899	91070	6387	95000	5238	99398	3551	121019	3039	71773
4L-9S		MI	41073	10622	65985	7865	71409	6377	72837	5226	72790	3527	87360	2541	58516
22-#14	2.46	MA	50357	10622	80966	7897	89197	6382	92698	5256	96062	3541	116986	2978	71555
5L-8S		MI	41754	10622	67223	7844	72932	6359	74774	5234	75313	3515	90505	2619	59511
22-#14	2.46	MA	49545	10622	79613	7894	87321	6402	90405	5250	93040	3556	113138	2898	70435
6L-7S		MI	42429	10622	68373	7848	74498	6365	76627	5217	78018	3527	93704	2688	60291
22-#14	2.46	MA	48754	10622	78130	7916	85532	6398	88205	5269	90089	3571	109035	2768	69647
7L-6S		MI	43115	10622	69653	7827	76041	6346	78524	5200	80564	3514	97167	2818	60902
22-#14	2.46	MA	47975	10622	76798	7913	83718	6418	86058	5287	86951	3561	105263	2697	68726
8L-5S		MI	43818	10622	70821	7832	77659	6352	80501	5208	83170	3501	100411	2899	61868
22-#14	2.46	MA	47150	10622	75495	7910	81953	6413	83813	5281	84027	3576	101532	2619	67483
9L-4S		MI	44557	10622	72066	7836	79274	6333	82486	5192	86044	3513	103833	2958	62021
22-#14	2.46	MA	46288	10622	74036	7932	80163	6434	81678	5299	81127	3591	97915	2531	66282
10L-3S		MI	45383	10622	73506	7815	81110	6340	84717	5200	88915	3501	107098	3082	62103
22-#18	4.37	MA	54324	11954	91954	8687	102746	6982	109107	5593	118506	3443	147904	2320	119130
6L-7S		MI	45926	11954	77943	8645	86468	6946	91109	5560	97479	3392	120193	1958	99618
22-#18	4.37	MA	52977	11954	89343	8725	99597	7016	105234	5624	113311	3467	140789	2089	115655
7L-6S		MI	47093	11954	80193	8610	89182	6915	94445	5532	101905	3370	126171	2190	102389
22-#18	4.37	MA	51651	11954	86997	8718	96402	7006	101454	5655	107789	3447	134227	1965	112656
8L-5S		MI	48292	11954	82246	8619	92024	6928	97918	5549	106434	3348	131766	2334	103965
24-#11	1.86	MA	50102	10205	79190	7639	87074	6199	90171	5140	92660	3577	111481	3287	54981
3L-11S		MI	39563	10205	62482	7612	66974	6188	67478	5126	65466	3568	77660	2732	45296
24-#11	1.86	MA	49426	10205	78024	7655	85588	6213	88365	5136	90336	3588	108755	3200	54948
4L-10S		MI	40075	10205	63267	7614	68031	6192	68812	5131	67327	3576	79850	2783	45760
24-#11	1.86	MA	48824	10205	77018	7653	84282	6210	86760	5150	88010	3581	105929	3157	54882
5L-9S		MI	40600	10205	64067	7617	69108	6179	70097	5119	69071	3566	81994	2844	46355
24-#11	1.86	MA	48252	10205	76075	7651	82975	6225	85162	5146	85905	3592	103227	3102	54771
6L-8S		MI	41083	10205	64930	7602	70170	6182	71447	5124	70830	3557	84208	2898	46626
24-#11	1.86	MA	47694	10205	75042	7667	81729	6222	83630	5159	83848	3603	100347	3012	54162
7E		MI	41559	10205	65731	7605	71261	6169	72739	5112	72717	3564	86454	2947	46945
24-#11	1.86	MA	47145	10205	74114	7665	80465	6236	82134	5172	81662	3597	97704	2962	53745
8L-6S		MI	42043	10205	66624	7590	72338	6173	74062	5100	74492	3555	88890	3037	47445
24-#11	1.86	MA	46556	10205	73207	7664	79236	6233	80570	5168	79625	3608	95084	2908	53408
9L-5S		MI	42539	10205	67438	7593	73466	6159	75441	5105	76309	3545	91173	3093	47528
24-#11	1.86	MA	45949	10205	72190	7679	77989	6248	79082	5181	77605	3619	92543	2847	52662
10L-4S		MI	43059	10205	68307	7595	74592	6163	76826	5093	78315	3553	93575	3134	47565
24-#11	1.86	MA	45356	10205	71281	7677	76766	6245	77538	5177	75450	3613	89966	2794	52075
11L-3S		MI	43642	10205	69312	7580	75873	6150	78382	5098	80318	3544	95874	3221	47575
24-#11	1.86	MA	44774	10205	70283	7693	75528	6259	76053	5191	73431	3624	87058	2717	51288
12L-2S		MI	44473	10205	70545	7583	77454	6154	80311	5086	82943	3534	99407	3307	47560
24-#14	2.68	MA	51317	10778	83024	7994	91834	6452	95915	5299	100439	3529	122935	2956	77903
5L-9S		MI	41912	10778	67750	7962	73672	6447	75598	5268	76546	3515	92382	2514	63834
24-#14	2.68	MA	50509	10778	81670	7991	89958	6472	93623	5292	97418	3544	119086	2875	76683
6L-8S		MI	42578	10778	68988	7941	75195	6428	77535	5276	79070	3502	95528	2592	64800
24-#14	2.68	MA	49721	10778	80187	8013	88170	6468	91423	5311	94466	3559	114984	2746	75917
7E		MI	43250	10778	70138	7945	76761	6435	79388	5259	81775	3514	98727	2661	65666
24-#14	2.68	MA	48946	10778	78855	8010	86355	6488	89276	5329	91329	3549	111212	2674	74909
8L-6S		MI	43933	10778	71418	7925	78305	6416	81286	5243	84321	3502	102190	2791	66258
24-#14	2.68	MA	48125	10778	77552	8007	84590	6483	87031	5323	88404	3564	107481	2597	73697
9L-5S		MI	44633	10778	72586	7929	79922	6422	83263	5251	86927	3489	105433	2872	67273
24-#14	2.68	MA	47266	10778	76093	8029	82800	6503	84895	5342	85505	3579	103864	2509	72435
10L-4S		MI	45369	10778	73832	7933	81538	6403	85247	5234	89801	3501	108856	2931	67491
24-#18	4.76	MA	54621	12230	92952	8898	104223	7140	110878	5700	120989	3445	151108	2043	126474
7E		MI	47319	12230	81033	8818	90429	7070	95942	5635	104005	3367	128868	1904	108845
24-#18	4.76	MA	53304	12230	90605	8891	101028	7130	107097	5730	115467	3425	144545	1919	123358
8L-6S		MI	48480	12230	83283	8783	93143	7039	99277	5608	108431	3345	134846	2135	111523

RECTANGULAR TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.24	MA	42304	9387	66084	6977	71376	5686	72704	4739	72331	3399	84736	3199	32073
2L-3S		MI	40087	9387	62821	6969	67193	5718	67601	4768	65408	3421	75514	2978	32193
8-#18	1.65	MA	43821	9664	69347	7150	75559	5810	77807	4815	79255	3376	93958	3148	42345
2L-4S		MI	40068	9664	63419	7178	67980	5830	68577	4827	67039	3420	78748	2705	42262
10-#14	1.16	MA	42125	9335	65402	6989	70770	5699	72067	4756	71564	3430	84004	3249	30340
2L-5S		MI	39166	9335	60710	7003	64747	5707	64712	4784	61547	3446	71577	2941	30424
10-#14	1.16	MA	40855	9335	63539	6985	68382	5693	69154	4774	67601	3444	78673	3125	30403
3L-4S		MI	39963	9335	62022	7007	66448	5713	66803	4766	64576	3457	75203	3000	30448
10-#18	2.07	MA	45325	9940	72610	7323	79742	5934	82910	4890	86178	3353	103180	3097	52579
2L-5S		MI	40221	9940	64375	7342	69172	5987	70005	4931	68661	3375	81675	2551	50558
10-#18	2.07	MA	43138	9940	69347	7315	75559	5966	77807	4919	79255	3375	93958	2875	52567
3L-4S		MI	41598	9940	66682	7351	72163	5954	73680	4903	73963	3397	87970	2654	52333

RECTANGULAR TIED COLUMNS 44" x 46"

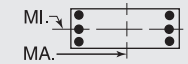
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.19	MA	46077	9776	71729	7293	77513	5946	78908	4960	78385	3572	91832	3372	33693
2L-3S		MI	41800	9776	65380	7262	69867	5959	70210	4973	67752	3579	78108	3130	32254
6-#18	1.19	MA	43739	9776	68293	7286	73108	5979	73534	4990	71075	3594	82062	3151	33813
3L-2S		MI	44019	9776	68643	7271	74050	5927	75313	4944	74675	3557	87330	3352	32127
8-#18	1.58	MA	47684	10053	75164	7466	81917	6070	84281	5035	85696	3550	101602	3324	44505
2L-4S		MI	41780	10053	65978	7471	70654	6072	71186	5033	69383	3578	81342	2858	42374
8-#18	1.58	MA	45362	10053	71729	7459	77513	6103	78908	5065	78385	3572	91832	3103	44567
3E		MI	43334	10053	68643	7435	74050	6084	75313	5048	74675	3556	87330	3079	42481
8-#18	1.58	MA	43728	10053	68926	7495	73941	6092	74567	5051	72799	3595	85481	2881	44422
4L-2S		MI	45539	10053	71906	7443	78233	6051	80416	5020	81598	3533	96552	3300	42405
10-#14	1.11	MA	45883	9724	71001	7305	76863	5959	78222	4977	77497	3600	91012	3421	31859
2L-5S		MI	40877	9724	63259	7299	67421	5950	67326	4990	63899	3605	74184	3094	30500
10-#14	1.11	MA	44544	9724	69041	7302	74350	5954	75157	4995	73327	3614	85372	3297	31921
3L-4S		MI	41676	9724	64571	7302	69122	5956	69417	4973	66928	3616	77809	3154	30504
10-#14	1.11	MA	43606	9724	67446	7323	72317	5974	72686	4988	70147	3629	81697	3172	31967
4L-3S		MI	42569	9724	66089	7281	71056	5937	71767	4980	69953	3602	81279	3278	30450
10-#14	1.11	MA	42767	9724	66068	7320	70530	5969	70490	5006	66965	3618	77868	3112	31943
5L-2S		MI	43840	9724	67951	7285	73444	5942	74680	4963	73916	3589	86611	3403	30385
10-#18	1.98	MA	49277	10329	78600	7639	86322	6194	89654	5111	93007	3528	111372	3276	55279
2L-5S		MI	41932	10329	66934	7636	71846	6228	72614	5137	71005	3532	84269	2703	50934
10-#18	1.98	MA	46969	10329	75164	7631	81917	6227	84281	5141	85696	3550	101602	3054	55267
3L-4S		MI	43312	10329	69241	7644	74837	6196	76289	5108	76306	3555	90564	2806	52457
10-#18	1.98	MA	45347	10329	72362	7668	78346	6216	79940	5126	80110	3573	95251	2833	55033
4L-3S		MI	44855	10329	71906	7608	78233	6208	80416	5124	81598	3532	96552	3028	52654
10-#18	1.98	MA	43898	10329	69937	7661	75202	6249	76077	5156	74515	3551	88594	2728	53399
5L-2S		MI	47045	10329	75169	7616	82416	6175	85519	5095	88522	3510	105774	3249	52645
12-#14	1.33	MA	46811	9880	72961	7402	79375	6029	81288	5019	81668	3587	96652	3397	38024
2L-6S		MI	41012	9880	63892	7392	68105	6039	68157	5025	65119	3606	76070	2988	35963
12-#14	1.33	MA	45478	9880	71001	7399	76863	6024	78222	5037	77497	3602	91012	3273	38072
3L-5S		MI	41769	9880	65122	7396	69809	6020	70239	5033	67863	3592	79515	3069	36287
12-#14	1.33	MA	44544	9880	69406	7421	74830	6044	75752	5031	74318	3616	87337	3148	38089
4E		MI	42564	9880	66434	7399	71510	6026	72330	5015	70891	3604	83141	3128	36332
12-#14	1.33	MA	43709	9880	68028	7417	73042	6038	73555	5049	71136	3606	83508	3088	38026
5L-3S		MI	43453	9880	67951	7378	73444	6006	74680	5023	73916	3590	86611	3253	36302
12-#14	1.33	MA	42915	9880	66736	7414	71253	6058	71368	5042	68253	3620	79861	3007	37659
6L-2S		MI	44719	9880	69814	7382	75832	6012	77594	5005	77880	3576	91942	3378	36250

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

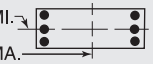


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	2.37	MA	50855	10606	82036	7812	90726	6318	95027	5186	100318	3505	121142	3227	66028
2L-6S		MI	42156	10606	68033	7801	73033	6340	74056	5196	73124	3531	87538	2508	58841
12-#18	2.37	MA	48562	10606	78600	7804	86322	6351	89654	5216	93007	3528	111372	3006	65940
3L-5S		MI	43460	10606	70197	7809	76029	6352	77717	5212	77928	3509	93491	2652	60646
12-#18	2.37	MA	46952	10606	75798	7841	82750	6340	85313	5201	87420	3551	105021	2785	65627
4E		MI	44829	10606	72504	7817	79020	6320	81391	5183	83230	3531	99786	2755	62522
12-#18	2.37	MA	45514	10606	73373	7834	79606	6374	81450	5231	81826	3529	98364	2680	63638
5L-3S		MI	46362	10606	75169	7781	82416	6332	85519	5199	88522	3509	105774	2976	62795
12-#18	2.37	MA	44145	10606	71099	7826	76458	6363	77602	5217	76755	3552	92054	2536	61688
6L-2S		MI	48538	10606	78432	7789	86599	6300	90622	5171	95445	3487	114996	3198	62865
14-#11	1.08	MA	45800	9701	70666	7313	76578	5967	77930	4986	77123	3614	90683	3444	31053
2L-7S		MI	40647	9701	62562	7317	66655	5968	66434	5001	62800	3636	72588	3067	29578
14-#11	1.08	MA	44864	9701	69298	7311	74823	5964	75790	4999	74211	3624	86722	3358	31094
3L-6S		MI	41164	9701	63502	7302	67788	5972	67827	4988	64669	3626	75172	3157	29720
14-#11	1.08	MA	44209	9701	68185	7327	73406	5978	74067	4995	71994	3635	84138	3271	31130
4L-5S		MI	41694	9701	64359	7304	68976	5958	69279	4993	66582	3616	77595	3212	29728
14-#11	1.08	MA	43624	9701	67225	7325	72160	5975	72535	5008	69775	3628	81454	3229	31150
5L-4S		MI	42251	9701	65273	7307	70162	5962	70737	4981	68694	3623	80138	3254	29702
14-#11	1.08	MA	43068	9701	66325	7323	70913	5989	71011	5004	67766	3639	78892	3173	31127
6L-3S		MI	42875	9701	66332	7292	71511	5948	72376	4985	70804	3613	82579	3341	29662
14-#11	1.08	MA	42526	9701	65339	7338	69723	5986	69548	5017	65803	3649	76160	3083	30956
7L-2S		MI	43764	9701	67633	7294	73179	5951	74411	4973	73573	3603	86326	3427	29620
14-#14	1.56	MA	47734	10035	74921	7500	81888	6099	84353	5062	85839	3575	102292	3373	44176
2L-7S		MI	41168	10035	64407	7511	68868	6104	69072	5085	66401	3607	77725	2833	40782
14-#14	1.56	MA	46406	10035	72961	7496	79375	6094	81288	5080	81668	3589	96652	3249	44209
3L-6S		MI	41902	10035	65755	7489	70493	6109	71070	5067	69083	3594	81401	2963	41565
14-#14	1.56	MA	45476	10035	71366	7518	77343	6113	78817	5073	78489	3604	92977	3124	44193
4L-5S		MI	42655	10035	66985	7493	72197	6090	73152	5075	71827	3580	84846	3043	42063
14-#14	1.56	MA	44646	10035	69988	7515	75555	6108	76620	5091	75306	3593	89148	3064	44099
5L-4S		MI	43446	10035	68297	7497	73898	6096	75243	5058	74855	3591	88472	3103	42138
14-#14	1.56	MA	43855	10035	68696	7511	73766	6128	74433	5084	72423	3608	85501	2983	43557
6L-3S		MI	44332	10035	69814	7476	75832	6076	77594	5065	77880	3578	91942	3228	42139
14-#14	1.56	MA	43085	10035	67281	7533	72058	6123	72334	5102	69607	3622	81612	2853	42710
7L-2S		MI	45593	10035	71677	7479	78220	6082	80507	5048	81844	3564	97273	3352	42101
14-#18	2.77	MA	52421	10883	85472	7985	95131	6442	100401	5262	107628	3483	130912	3179	76737
2L-7S		MI	42418	10883	68926	8009	74357	6497	75644	5300	75352	3530	90404	2225	66162
14-#18	2.77	MA	50142	10883	82036	7977	90726	6476	95027	5291	100318	3506	121142	2958	76593
3L-6S		MI	43679	10883	71296	7974	77216	6464	79159	5272	80047	3508	96760	2456	68676
14-#18	2.77	MA	48543	10883	79233	8014	87155	6465	90686	5277	94731	3528	114791	2736	76211
4L-5S		MI	44974	10883	73460	7982	80212	6476	82819	5287	84851	3486	102712	2601	70392
14-#18	2.77	MA	47115	10883	76809	8007	84011	6498	86823	5307	89136	3507	108134	2632	73911
5L-4S		MI	46334	10883	75767	7990	83203	6444	86494	5259	90153	3508	109008	2704	72575
14-#18	2.77	MA	45756	10883	74535	7999	80862	6487	82975	5292	84066	3529	101824	2488	72053
6L-3S		MI	47856	10883	78432	7954	86599	6456	90622	5274	95445	3486	114996	2925	72916
14-#18	2.77	MA	44433	10883	72044	8036	77858	6520	79282	5322	79110	3552	95089	2257	69389
7L-2S		MI	50019	10883	81695	7962	90782	6424	95724	5246	102368	3464	124218	3146	73040
16-#11	1.23	MA	46452	9809	72035	7381	78332	6016	80070	5016	80035	3605	94644	3429	35356
2L-8S		MI	40768	9809	63020	7382	67174	6030	67109	5043	63582	3620	73957	3001	33120
16-#11	1.23	MA	45519	9809	70666	7379	76578	6012	77930	5029	77123	3616	90683	3342	35390
3L-7S		MI	41275	9809	63863	7385	68323	6017	68469	5030	65568	3628	76335	3050	33523
16-#11	1.23	MA	44866	9809	69554	7394	75160	6027	76207	5024	74906	3626	88099	3256	35417
4L-6S		MI	41790	9809	64803	7370	69456	6020	69862	5018	67437	3617	78919	3140	33765
16-#11	1.23	MA	44283	9809	68593	7392	73914	6023	74676	5037	72687	3619	85415	3214	35418
5E		MI	42318	9809	65660	7372	70644	6006	71313	5023	69350	3607	81341	3196	33796
16-#11	1.23	MA	43729	9809	67693	7390	72667	6037	73151	5033	70678	3630	82852	3158	35377
6L-4S		MI	42873	9809	66574	7374	71830	6010	72771	5010	71462	3615	83885	3238	33782
16-#11	1.23	MA	43188	9809	66707	7405	71477	6034	71688	5046	68715	3640	80121	3068	35106
7L-3S		MI	43495	9809	67633	7359	73179	5996	74411	5015	73573	3605	86326	3324	33751

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

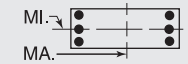


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.23	MA	42648	9809	65822	7403	70271	6048	70260	5059	66628	3634	77610	3018	34669
8L-2S		MI	44382	9809	68934	7361	74847	6000	76446	5002	76341	3595	90073	3411	33715
16-#14	1.78	MA	48652	10191	76881	7597	84401	6169	87418	5104	90009	3563	107932	3349	50318
2L-8S		MI	41337	10191	65059	7604	69607	6193	70034	5145	67515	3583	79666	2737	45889
16-#14	1.78	MA	47330	10191	74921	7594	81888	6163	84353	5122	85839	3577	102292	3225	50332
3L-7S		MI	42057	10191	66270	7608	71256	6174	71985	5127	70365	3595	83056	2807	46433
16-#14	1.78	MA	46403	10191	73326	7615	79855	6183	81882	5115	82659	3591	98617	3100	50287
4L-6S		MI	42787	10191	67618	7587	72881	6179	73983	5110	73046	3581	86732	2937	47182
16-#14	1.78	MA	45577	10191	71948	7612	78068	6178	79686	5133	79477	3581	94788	3040	50165
5E		MI	43537	10191	68848	7590	74585	6160	76066	5117	75790	3567	90178	3018	47831
16-#14	1.78	MA	44790	10191	70656	7609	76278	6198	77498	5126	76594	3595	91141	2959	49470
6L-4S		MI	44324	10191	70160	7594	76286	6165	78156	5100	78819	3579	93803	3078	47934
16-#14	1.78	MA	44024	10191	69241	7630	74571	6193	75399	5144	73778	3609	87252	2829	48659
7L-3S		MI	45206	10191	71677	7573	78220	6146	80507	5107	81844	3565	97273	3202	47967
16-#14	1.78	MA	43269	10191	67969	7627	72839	6213	73350	5162	70784	3599	83671	2759	48064
8L-2S		MI	46462	10191	73540	7577	80608	6152	83420	5090	85807	3552	102604	3327	47942
16-#18	3.16	MA	51710	11159	85472	8150	95131	6600	100401	5367	107628	3484	130912	2909	87232
3L-7S		MI	43939	11159	72189	8182	78540	6621	80747	5376	82275	3507	99626	2174	75841
16-#18	3.16	MA	50121	11159	82669	8187	91559	6589	96060	5352	102042	3506	124561	2688	86786
4L-6S		MI	45191	11159	74559	8146	81399	6589	84262	5347	86970	3485	105982	2405	78528
16-#18	3.16	MA	48703	11159	80245	8180	88415	6622	92196	5382	96447	3485	117904	2583	84212
5E		MI	46477	11159	76723	8155	84395	6600	87922	5363	91775	3463	111934	2549	80166
16-#18	3.16	MA	47354	11159	77971	8172	85267	6611	88349	5367	91376	3507	111594	2439	82436
6L-4S		MI	47828	11159	79030	8163	87386	6568	91597	5334	97076	3485	118230	2652	82619
16-#18	3.16	MA	46040	11159	75480	8209	82262	6644	84655	5397	86421	3530	104859	2208	79598
7L-3S		MI	49339	11159	81695	8127	90782	6580	95724	5350	102368	3463	124218	2874	83022
16-#18	3.16	MA	44746	11159	73242	8201	79215	6633	81049	5427	81155	3508	98635	2085	77120
8L-2S		MI	51490	11159	84958	8135	94965	6548	100827	5321	109291	3441	133440	3095	83196
18-#11	1.39	MA	47102	9917	73403	7448	80086	6064	82210	5045	82947	3596	98605	3413	39653
2L-9S		MI	40870	9917	63495	7448	67724	6075	67722	5068	64498	3622	75354	2931	36797
18-#11	1.39	MA	46171	9917	72035	7446	78332	6061	80070	5058	80035	3607	94644	3327	39680
3L-8S		MI	41395	9917	64321	7450	68842	6079	69144	5072	66350	3612	77703	2985	37088
18-#11	1.39	MA	45520	9917	70922	7461	76915	6075	78347	5054	77817	3617	92060	3241	39697
4L-7S		MI	41900	9917	65164	7452	69991	6065	70503	5060	68337	3619	80082	3034	37475
18-#11	1.39	MA	44939	9917	69962	7459	75669	6072	76816	5067	75599	3611	89376	3198	39679
5L-6S		MI	42413	9917	66104	7437	71124	6069	71897	5047	70206	3609	82665	3124	37805
18-#11	1.39	MA	44387	9917	69062	7458	74421	6086	75291	5062	73590	3621	86813	3142	39623
6L-5S		MI	42940	9917	66961	7439	72311	6055	73348	5052	72119	3599	85088	3180	37848
18-#11	1.39	MA	43848	9917	68076	7473	73232	6083	73828	5075	71627	3632	84081	3052	39264
7L-4S		MI	43493	9917	67876	7441	73498	6058	74806	5040	74231	3606	87631	3222	37855
18-#11	1.39	MA	43312	9917	67190	7471	72025	6097	72401	5088	69540	3625	81571	3003	38843
8L-3S		MI	44113	9917	68934	7426	74847	6045	76446	5044	76341	3596	90073	3308	37833
18-#11	1.39	MA	42758	9917	66324	7469	70852	6094	70908	5084	67596	3636	79086	2949	38522
9L-2S		MI	44997	9917	70235	7429	76515	6048	78481	5032	79110	3586	93819	3394	37803
18-#14	2.00	MA	49566	10347	78841	7694	86914	6238	90484	5147	94180	3550	113572	3325	56458
2L-9S		MI	41491	10347	65619	7723	70391	6257	70907	5180	68822	3585	81657	2634	50320
18-#14	2.00	MA	48248	10347	76881	7691	84401	6233	87418	5165	90009	3564	107932	3201	56440
3L-8S		MI	42224	10347	66922	7701	71995	6263	72947	5187	71479	3571	84998	2712	51466
18-#14	2.00	MA	47326	10347	75286	7713	82368	6253	84948	5158	86830	3579	104257	3076	56372
4L-7S		MI	42940	10347	68133	7705	73644	6243	74898	5170	74329	3582	88388	2782	52091
18-#14	2.00	MA	46503	10347	73908	7709	80581	6248	82751	5176	83648	3568	100428	3016	56225
5L-6S		MI	43667	10347	69480	7684	75269	6249	76897	5152	77010	3569	92064	2912	52810
18-#14	2.00	MA	45720	10347	72616	7706	78791	6268	80564	5169	80765	3583	96781	2935	55395
6L-5S		MI	44413	10347	70710	7688	76973	6230	78979	5160	79754	3555	95509	2993	53593
18-#14	2.00	MA	44957	10347	71201	7728	77084	6263	78464	5187	77948	3597	92892	2806	54615
7L-4S		MI	45197	10347	72022	7691	78674	6235	81070	5142	82782	3566	99134	3052	53720
18-#14	2.00	MA	44206	10347	69930	7724	75352	6282	76416	5205	74955	3587	89311	2735	53943
8L-3S		MI	46075	10347	73540	7670	80608	6216	83420	5150	85807	3553	102604	3177	53776
18-#14	2.00	MA	43422	10347	68686	7721	73668	6277	74273	5198	72164	3601	85775	2657	52713
9L-2S		MI	47327	10347	75403	7674	82996	6222	86333	5132	89771	3539	107936	3301	53775

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis



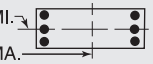
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#18	3.56	MA	51688	11436	86105	8360	95964	6713	101433	5428	109352	3484	134331	2640	97355
4L-7S		MI	45447	11436	75452	8355	82723	6745	85850	5451	89198	3484	108848	2123	85543
18-#18	3.56	MA	50279	11436	83680	8352	92820	6746	97570	5457	103758	3463	127673	2535	94538
5L-6S		MI	46691	11436	77822	8319	85582	6713	89364	5422	93893	3462	115204	2354	88394
18-#18	3.56	MA	48939	11436	81407	8345	89671	6735	93722	5443	98687	3485	121364	2391	92832
6L-5S		MI	47968	11436	79986	8328	88578	6725	93025	5438	98698	3440	121156	2498	89964
18-#18	3.56	MA	47635	11436	78916	8382	86667	6768	90028	5472	93732	3508	114629	2160	89831
7L-4S		MI	49310	11436	82293	8336	91568	6692	96700	5410	103999	3462	127452	2601	92655
18-#18	3.56	MA	46350	11436	76678	8374	83619	6757	86422	5502	88466	3486	108405	2037	87230
8L-3S		MI	50812	11436	84958	8300	94965	6704	100827	5425	109291	3440	133440	2822	93116
20-#11	1.54	MA	47748	10025	74772	7516	81841	6112	84351	5075	85859	3588	102565	3398	43943
2L-10S		MI	40940	10025	63872	7530	68258	6138	68404	5110	65430	3623	76825	2853	40220
20-#11	1.54	MA	46820	10025	73403	7514	80086	6109	82210	5088	82947	3598	98605	3311	43965
3L-9S		MI	41496	10025	64796	7515	69392	6124	69757	5097	67266	3613	79101	2914	40773
20-#11	1.54	MA	46171	10025	72291	7529	78669	6123	80487	5083	80729	3609	96021	3225	43967
4L-8S		MI	42019	10025	65622	7517	70510	6127	71179	5102	69118	3603	81450	2968	41059
20-#11	1.54	MA	45593	10025	71330	7527	77423	6120	78956	5096	78511	3602	93336	3183	43935
5L-7S		MI	42522	10025	66466	7519	71659	6114	72538	5089	71105	3610	83828	3017	41433
20-#11	1.54	MA	45042	10025	70430	7525	76176	6134	77431	5092	76501	3613	90774	3127	43865
6E		MI	43034	10025	67405	7504	72792	6117	73931	5077	72974	3600	86412	3107	41840
20-#11	1.54	MA	44505	10025	69444	7540	74986	6131	75969	5105	74539	3623	88042	3037	43427
7L-5S		MI	43559	10025	68262	7507	73979	6103	75383	5081	74887	3590	88835	3163	41898
20-#11	1.54	MA	43977	10025	68559	7538	73779	6145	74541	5118	72452	3616	85532	2987	43020
8L-4S		MI	44110	10025	69177	7509	75166	6107	76841	5069	76999	3597	91378	3205	41922
20-#11	1.54	MA	43419	10025	67692	7536	72606	6142	73048	5113	70507	3627	83047	2934	42705
9L-3S		MI	44728	10025	70235	7494	76515	6093	78481	5074	79110	3587	93819	3292	41909
20-#11	1.54	MA	42836	10025	66722	7552	71416	6156	71628	5126	68579	3638	80639	2873	42108
10L-2S		MI	45610	10025	71536	7496	78183	6096	80515	5061	81878	3577	97566	3378	41885
20-#14	2.22	MA	49161	10502	78841	7788	86914	6303	90484	5207	94180	3552	113572	3177	62541
3L-9S		MI	42377	10502	67481	7820	72779	6327	73821	5222	72786	3572	86988	2609	55923
20-#14	2.22	MA	48243	10502	77246	7810	84881	6323	88013	5200	91000	3566	109897	3052	62452
4L-8S		MI	43106	10502	68785	7799	74383	6333	75861	5229	75443	3559	90329	2686	57033
20-#14	2.22	MA	47424	10502	75868	7807	83093	6318	85816	5218	87818	3556	106068	2992	62280
5L-7S		MI	43819	10502	69996	7802	76032	6313	77811	5212	78292	3570	93719	2757	57755
20-#14	2.22	MA	46644	10502	74576	7803	81304	6338	83629	5211	84935	3570	102421	2911	61330
6E		MI	44543	10502	71343	7781	77657	6319	79810	5195	80974	3556	97395	2886	58448
20-#14	2.22	MA	45885	10502	73161	7825	79596	6333	81530	5229	82119	3585	98532	2782	60577
7L-5S		MI	45286	10502	72573	7785	79361	6300	81892	5202	83718	3543	100840	2967	59350
20-#14	2.22	MA	45137	10502	71890	7822	77865	6352	79481	5247	79125	3574	94951	2711	59809
8L-4S		MI	46066	10502	73885	7789	81062	6305	83983	5185	86746	3554	104466	3027	59500
20-#14	2.22	MA	44358	10502	70646	7818	76181	6347	77338	5240	76335	3588	91415	2633	58614
9L-3S		MI	46940	10502	75403	7767	82996	6286	86333	5192	89771	3540	107936	3151	59576
20-#14	2.22	MA	43532	10502	69253	7840	74472	6367	75300	5258	73568	3603	87989	2545	57556
10L-2S		MI	48187	10502	77265	7771	85385	6291	89247	5175	93735	3527	113267	3276	59603
20-#18	3.95	MA	51844	11712	87116	8525	97224	6870	102943	5533	111069	3441	137443	2487	104883
5L-7S		MI	46944	11712	78715	8528	86906	6869	90953	5526	96121	3461	118070	2071	95265
20-#18	3.95	MA	50513	11712	84843	8518	94076	6859	99095	5518	105998	3463	131134	2343	103240
6E		MI	48180	11712	81085	8492	89765	6837	94467	5498	100816	3439	124426	2302	98271
20-#18	3.95	MA	49217	11712	82352	8555	91071	6892	95401	5548	101042	3486	124399	2112	100083
7L-5S		MI	49448	11712	83249	8500	92760	6849	98128	5514	105621	3417	130378	2447	99782
20-#18	3.95	MA	47941	11712	80113	8547	88024	6882	91796	5578	95777	3464	118175	1989	97361
8L-4S		MI	50782	11712	85555	8509	95751	6817	101803	5485	110922	3439	136674	2550	102686
22-#11	1.70	MA	48393	10133	76140	7583	83595	6161	86491	5104	88771	3579	106526	3382	48230
2L-11S		MI	41025	10133	64346	7595	68814	6183	69035	5134	66240	3607	78252	2785	43631

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

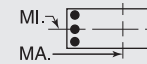


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.70	MA	47467	10133	74772	7581	81841	6158	84351	5117	85859	3590	102565	3296	48245
3L-10S		MI	41566	10133	65173	7597	69926	6186	70439	5139	68199	3615	80571	2837	44148
22-#11	1.70	MA	46820	10133	73659	7596	80423	6172	82628	5113	83641	3600	99982	3210	48230
4L-9S		MI	42120	10133	66098	7582	71060	6172	71791	5126	70035	3604	82848	2898	44752
22-#11	1.70	MA	46243	10133	72699	7594	79177	6169	81096	5126	81423	3594	97297	3167	48186
5L-8S		MI	42640	10133	66923	7585	72178	6176	73213	5131	71887	3594	85197	2952	45033
22-#11	1.70	MA	45695	10133	71799	7592	77930	6183	79572	5121	79413	3604	94735	3111	48103
6L-7S		MI	43142	10133	67767	7587	73327	6162	74573	5119	73874	3602	87575	3001	45395
22-#11	1.70	MA	45160	10133	70813	7608	76740	6180	78109	5134	77451	3615	92003	3022	47595
7L-6S		MI	43652	10133	68706	7572	74460	6165	75966	5106	75743	3592	90159	3091	45872
22-#11	1.70	MA	44633	10133	69927	7606	75534	6194	76681	5147	75364	3608	89492	2972	47200
8L-5S		MI	44175	10133	69563	7574	75647	6152	77418	5111	77656	3582	92581	3147	45942
22-#11	1.70	MA	44078	10133	69061	7604	74360	6191	75188	5143	73419	3618	87008	2918	46891
9L-4S		MI	44725	10133	70478	7576	76834	6155	78876	5098	79768	3589	95125	3189	45977
22-#11	1.70	MA	43496	10133	68090	7619	73170	6205	73768	5156	71491	3629	84600	2857	46243
10L-3S		MI	45341	10133	71536	7561	78183	6141	80515	5103	81878	3579	97566	3275	45981
22-#11	1.70	MA	42928	10133	67222	7617	72003	6201	72294	5151	69435	3622	82151	2805	45685
11L-2S		MI	46220	10133	72837	7564	79851	6145	82550	5091	84647	3569	101313	3361	45963
22-#14	2.45	MA	49156	10658	79206	7907	87393	6393	91078	5243	95171	3554	115537	3029	68526
4L-9S		MI	43258	10658	69344	7917	75167	6397	76734	5264	76750	3560	92320	2583	61532
22-#14	2.45	MA	48340	10658	77828	7904	85606	6388	88882	5261	91989	3543	111708	2968	68332
5L-8S		MI	43983	10658	70648	7896	76771	6402	78774	5272	79407	3546	95660	2661	62611
22-#14	2.45	MA	47564	10658	76536	7900	83816	6407	86694	5254	89106	3558	108061	2887	67273
6L-7S		MI	44693	10658	71859	7900	78420	6383	80725	5254	82256	3557	99050	2731	63425
22-#14	2.45	MA	46808	10658	75121	7922	82109	6402	84595	5272	86290	3572	104172	2758	66544
7L-6S		MI	45414	10658	73206	7878	80045	6389	82723	5237	84937	3544	102726	2861	64094
22-#14	2.45	MA	46064	10658	73850	7919	80378	6422	82546	5290	83296	3562	100591	2687	65684
8L-5S		MI	46153	10658	74436	7882	81749	6369	84805	5245	87681	3530	106171	2942	65102
22-#14	2.45	MA	45289	10658	72606	7916	78693	6417	80404	5283	80505	3576	97055	2609	64522
9L-4S		MI	46931	10658	75748	7886	83451	6375	86896	5227	90710	3541	109797	3001	65275
22-#14	2.45	MA	44466	10658	71213	7937	76985	6437	78366	5301	77738	3590	93629	2521	63401
10L-3S		MI	47801	10658	77265	7865	85385	6356	89247	5235	93735	3528	113267	3126	65370
22-#18	4.35	MA	52076	11989	88278	8691	98480	6983	104468	5594	113309	3441	140904	2294	113598
6L-7S		MI	48431	11989	81978	8701	91089	6993	96055	5602	103045	3438	127292	2020	105005
22-#18	4.35	MA	50789	11989	85788	8728	95476	7017	100775	5623	108353	3464	134168	2063	110353
7L-6S		MI	49659	11989	84348	8665	93948	6961	99570	5573	107740	3416	133648	2251	108015
22-#18	4.35	MA	49521	11989	83549	8720	92428	7006	97169	5653	103087	3442	127945	1940	107511
8L-5S		MI	50919	11989	86511	8673	96943	6973	103231	5589	112544	3394	139600	2395	109616
24-#11	1.85	MA	48111	10241	76140	7648	83595	6206	86491	5146	88771	3581	106526	3281	52515
3L-11S		MI	41649	10241	65647	7663	70482	6231	71070	5164	69009	3599	81999	2768	47575
24-#11	1.85	MA	47467	10241	75028	7664	82178	6220	84768	5142	86553	3592	103943	3194	52489
4L-10S		MI	42189	10241	66474	7665	71594	6234	72474	5168	70967	3606	84318	2821	48080
24-#11	1.85	MA	46892	10241	74067	7662	80932	6217	83236	5155	84335	3585	101258	3152	52434
5L-9S		MI	42741	10241	67399	7650	72728	6221	73826	5156	72803	3596	86594	2882	48727
24-#11	1.85	MA	46345	10241	73167	7660	79684	6231	81712	5151	82325	3595	98696	3096	52338
6L-8S		MI	43259	10241	68224	7652	73845	6224	75248	5161	74655	3586	88943	2935	49010
24-#11	1.85	MA	45812	10241	72181	7675	78495	6228	80249	5164	80362	3606	95964	3006	51767
7E		MI	43760	10241	69068	7654	74995	6210	76608	5148	76642	3593	91322	2985	49361
24-#11	1.85	MA	45287	10241	71296	7673	77288	6242	78821	5176	78276	3599	93453	2956	51383
8L-6S		MI	44268	10241	70007	7639	76128	6214	78001	5136	78511	3583	93905	3074	49900
24-#11	1.85	MA	44733	10241	70429	7671	76115	6239	77328	5172	76331	3610	90969	2903	51077
9L-5S		MI	44789	10241	70864	7642	77315	6200	79453	5140	80424	3573	96328	3130	49983
24-#11	1.85	MA	44154	10241	69459	7686	74924	6253	75908	5185	74403	3620	88560	2842	50382
10L-4S		MI	45337	10241	71779	7644	78501	6204	80910	5128	82536	3580	98871	3172	50028
24-#11	1.85	MA	43588	10241	68591	7684	73757	6250	74434	5181	72347	3614	86112	2789	49836
11L-3S		MI	45951	10241	72837	7629	79851	6190	82550	5132	84647	3570	101313	3259	50049
24-#11	1.85	MA	43032	10241	67638	7700	72575	6264	73016	5194	70419	3624	83354	2712	49106
12L-2S		MI	46828	10241	74138	7631	81519	6193	84585	5120	87415	3560	105059	3345	50037
24-#14	2.67	MA	49252	10813	79788	8001	88119	6458	91947	5303	96159	3531	117348	2944	74381
5L-9S		MI	44135	10813	71207	8014	77556	6467	79647	5307	80713	3547	97651	2558	67148

RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#14	2.67	MA	48480	10813	78496	7998	86329	6477	89760	5296	93277	3545	113701	2864	73223
6L-8S		MI	44856	10813	72511	7993	79159	6472	81687	5314	83370	3534	100991	2636	68197
24-#14	2.67	MA	47727	10813	77081	8019	84622	6472	87660	5314	90460	3560	109812	2734	72515
7E		MI	45563	10813	73721	7997	80808	6453	83638	5297	86220	3545	104381	2706	69098
24-#14	2.67	MA	46986	10813	75810	8016	82890	6492	85612	5332	87467	3549	106231	2663	71568
8L-6S		MI	46280	10813	75069	7976	82433	6458	85636	5280	88901	3531	108057	2836	69747
24-#14	2.67	MA	46215	10813	74566	8013	81206	6487	83469	5325	84676	3564	102695	2585	70437
9L-5S		MI	47017	10813	76299	7979	84137	6439	87719	5287	91645	3518	111502	2916	70852
24-#14	2.67	MA	45395	10813	73173	8034	79498	6507	81431	5343	81909	3578	99269	2497	69254
10L-4S		MI	47791	10813	77611	7983	85839	6445	89809	5270	94674	3529	115128	2976	71045
24-#18	4.74	MA	52350	12266	89223	8901	99880	7141	106148	5699	115664	3441	143938	2015	120640
7E		MI	49909	12266	85240	8874	95272	7117	101158	5677	109968	3415	136514	1969	114761
24-#18	4.74	MA	51091	12266	86985	8893	96833	7130	102542	5728	110398	3420	137714	1892	117680
8L-6S		MI	51128	12266	87611	8838	98131	7085	104673	5649	114663	3393	142870	2200	117675

RECTANGULAR TIED COLUMNS 44" x 48"

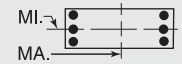
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.14	MA	50007	10165	77594	7609	83891	6206	85352	5181	84601	3741	99178	3545	35313
2L-3S		MI	43512	10165	67939	7556	72541	6201	72819	5178	70096	3736	80702	3283	32314
6-#18	1.14	MA	47546	10165	73986	7602	79265	6240	79708	5212	76923	3765	88860	3323	35433
3L-2S		MI	45733	10165	71202	7564	76724	6169	77922	5150	77019	3714	89924	3504	32179
8-#18	1.52	MA	51704	10442	81203	7782	88517	6330	90996	5256	92280	3719	109497	3499	46665
2L-4S		MI	43493	10442	68537	7765	73328	6313	73795	5238	71727	3735	83936	3010	42480
8-#18	1.52	MA	49260	10442	77594	7775	83891	6364	85352	5287	84601	3743	99178	3278	46727
3E		MI	45049	10442	71202	7729	76724	6325	77922	5253	77019	3713	89924	3231	42550
8-#18	1.52	MA	47544	10442	74654	7813	80144	6354	80798	5274	78740	3767	92464	3056	46582
4L-2S		MI	47255	10442	74465	7737	80907	6293	83025	5225	83942	3691	99146	3453	42464
10-#14	1.07	MA	49796	10113	76821	7621	83197	6219	84619	5198	83652	3770	98269	3592	33378
2L-5S		MI	42589	10113	65809	7594	70095	6194	69939	5197	66251	3764	76791	3248	30571
10-#14	1.07	MA	48389	10113	74763	7618	80560	6214	81402	5216	79274	3785	92320	3467	33440
3L-4S		MI	43388	10113	67121	7598	71796	6199	72030	5179	69280	3775	80416	3307	30557
10-#14	1.07	MA	47404	10113	73091	7640	78428	6235	78811	5210	75940	3800	88441	3343	33486
4L-3S		MI	44282	10113	68638	7577	73730	6180	74381	5187	72305	3761	83886	3432	30497
10-#14	1.07	MA	46525	10113	71647	7637	76555	6230	76508	5229	72604	3790	84408	3282	33462
5L-2S		MI	45554	10113	70501	7580	76119	6185	77294	5169	76268	3748	89217	3556	30429
10-#18	1.89	MA	53385	10718	84812	7955	93144	6454	96639	5332	99958	3697	119815	3453	57979
2L-5S		MI	43643	10718	69493	7929	74520	6470	75223	5342	73349	3690	86863	2856	51300
10-#18	1.89	MA	50957	10718	81203	7948	88517	6488	90996	5362	92280	3721	109497	3232	57967
3L-4S		MI	45026	10718	71800	7938	77511	6437	78897	5313	78650	3712	93158	2959	52575
10-#18	1.89	MA	49253	10718	78263	7986	84770	6478	86441	5349	86419	3745	102782	3011	57733
4L-3S		MI	46571	10718	74465	7902	80907	6449	83025	5329	83942	3690	99146	3180	52738
10-#18	1.89	MA	47732	10718	75720	7979	81473	6512	82390	5380	80550	3725	95763	2905	56261
5L-2S		MI	48764	10718	77728	7910	85090	6417	88128	5300	90865	3668	108368	3402	52711
12-#14	1.28	MA	50776	10269	78878	7718	85834	6289	87837	5240	88029	3757	104218	3570	39846
2L-6S		MI	42724	10269	66442	7688	70779	6283	70770	5232	67471	3765	78677	3141	36182
12-#14	1.28	MA	49374	10269	76821	7716	83197	6284	84619	5259	83652	3772	98269	3445	39894
3L-5S		MI	43481	10269	67671	7691	72483	6263	72853	5239	70215	3751	82122	3222	36366
12-#14	1.28	MA	48393	10269	75148	7738	81066	6304	82028	5252	80318	3787	94390	3320	39912
4E		MI	44277	10269	68983	7695	74185	6269	74944	5222	73243	3762	85747	3282	36391
12-#14	1.28	MA	47518	10269	73704	7735	79192	6300	79726	5271	76981	3777	90357	3259	39849
5L-3S		MI	45167	10269	70501	7674	76119	6250	77294	5229	76268	3749	89217	3406	36353
12-#14	1.28	MA	46685	10269	72351	7732	77317	6320	77433	5265	73960	3792	86508	3179	39590
6L-2S		MI	46434	10269	72364	7678	78507	6255	80207	5212	80232	3735	94549	3531	36297

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis



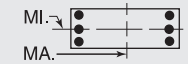
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#18	2.27	MA	55052	10995	88420	8128	97770	6578	102283	5407	107637	3675	130133	3408	69268
2L-6S		MI	43866	10995	70592	8094	75707	6582	76665	5401	75467	3689	90133	2660	59173
12-#18	2.27	MA	52639	10995	84812	8121	93144	6612	96639	5438	99958	3699	119815	3186	69180
3L-5S		MI	45173	10995	72756	8102	78703	6594	80325	5417	80272	3667	96085	2804	61006
12-#18	2.27	MA	50947	10995	81872	8159	89396	6602	92085	5424	94097	3723	113100	2965	68867
4E		MI	46545	10995	75063	8111	81694	6561	84000	5389	85573	3689	102380	2907	62650
12-#18	2.27	MA	49437	10995	79329	8152	86099	6636	88033	5455	88229	3703	106081	2859	67020
5L-3S		MI	48080	10995	77728	8075	85090	6573	88128	5404	90865	3667	108368	3129	62888
12-#18	2.27	MA	48001	10995	76946	8145	82798	6626	83999	5442	82912	3727	99414	2715	64892
6L-2S		MI	50260	10995	80991	8083	89273	6541	93231	5376	97788	3645	117590	3350	62930
14-#11	1.03	MA	49706	10090	76465	7629	82893	6227	84306	5207	83250	3783	97902	3615	32527
2L-7S		MI	42359	10090	65107	7614	69329	6212	69050	5208	65156	3795	75201	3221	29732
14-#11	1.03	MA	48722	10090	75029	7628	81052	6224	82060	5221	80195	3794	93727	3528	32568
3L-6S		MI	42876	10090	66046	7599	70462	6216	70443	5196	67025	3785	77785	3311	29783
14-#11	1.03	MA	48035	10090	73863	7643	79566	6239	80254	5217	77870	3805	91001	3442	32604
4L-5S		MI	43407	10090	66903	7601	71650	6202	71895	5200	68938	3775	80208	3366	29779
14-#11	1.03	MA	47422	10090	72857	7641	78260	6236	78649	5230	75545	3799	88175	3399	32624
5L-4S		MI	43964	10090	67818	7603	72836	6206	73353	5188	71050	3783	82751	3408	29747
14-#11	1.03	MA	46839	10090	71914	7640	76953	6250	77052	5226	73440	3810	85473	3343	32601
6L-3S		MI	44588	10090	68876	7588	74185	6192	74992	5193	73160	3773	85192	3495	29704
14-#11	1.03	MA	46271	10090	70881	7655	75707	6247	75519	5239	71383	3821	82593	3253	32499
7L-2S		MI	45478	10090	70177	7590	75853	6195	77027	5180	75929	3763	88939	3581	29660
14-#14	1.49	MA	51750	10424	80935	7816	88472	6359	91054	5283	92407	3745	110167	3547	46302
2L-7S		MI	42879	10424	66957	7806	71542	6347	71685	5291	68753	3766	80332	2986	40986
14-#14	1.49	MA	50353	10424	78878	7813	85834	6354	87837	5301	88029	3760	104218	3422	46335
3L-6S		MI	43614	10424	68304	7785	73167	6352	73684	5274	71435	3752	84008	3116	41782
14-#14	1.49	MA	49377	10424	77206	7835	83703	6374	85246	5295	84695	3775	100338	3298	46319
4L-5S		MI	44369	10424	69534	7789	74871	6333	75766	5281	74179	3739	87453	3197	42149
14-#14	1.49	MA	48505	10424	75761	7832	81829	6370	82943	5313	81359	3765	96305	3237	46225
5L-4S		MI	45161	10424	70846	7792	76573	6339	77857	5264	77207	3750	91079	3257	42207
14-#14	1.49	MA	47677	10424	74408	7829	79954	6390	80651	5307	78338	3780	92457	3156	45783
6L-3S		MI	46047	10424	72364	7771	78507	6319	80207	5272	80232	3736	94549	3381	42195
14-#14	1.49	MA	46869	10424	72925	7851	78165	6385	78451	5326	75386	3795	88354	3027	44856
7L-2S		MI	47310	10424	74226	7775	80895	6325	83121	5254	84196	3723	99880	3506	42152
14-#18	2.65	MA	56706	11272	92029	8301	102396	6702	107927	5483	115316	3653	140451	3362	80517
2L-7S		MI	44128	11272	71485	8303	77031	6738	78253	5505	77696	3688	92998	2378	66714
14-#18	2.65	MA	54307	11272	88420	8294	97770	6736	102283	5513	107637	3677	130133	3141	80373
3L-6S		MI	45392	11272	73855	8267	79890	6706	81768	5477	82391	3666	99354	2609	69006
14-#18	2.65	MA	52627	11272	85480	8332	94022	6726	97729	5500	101776	3701	123418	2919	79991
4L-5S		MI	46689	11272	76019	8275	82886	6718	85428	5492	87195	3644	105307	2753	70747
14-#18	2.65	MA	51128	11272	82938	8325	90725	6760	93677	5531	95908	3681	116399	2813	77815
5L-4S		MI	48053	11272	78326	8283	85877	6686	89103	5464	92496	3666	111602	2856	72712
14-#18	2.65	MA	49702	11272	80554	8318	87424	6750	89642	5517	90590	3705	109732	2670	75786
6L-3S		MI	49577	11272	80991	8248	89273	6698	93231	5480	97788	3644	117590	3077	73016
14-#18	2.65	MA	48312	11272	77943	8356	84274	6785	85769	5548	85394	3729	102618	2439	73211
7L-2S		MI	51744	11272	84254	8256	93456	6665	98333	5451	104712	3622	126812	3299	73121
16-#11	1.18	MA	50394	10198	77901	7697	84733	6276	86551	5237	86306	3775	102077	3600	37041
2L-8S		MI	42472	10198	65564	7679	69848	6275	69725	5250	65938	3780	76570	3155	33267
16-#11	1.18	MA	49413	10198	76465	7695	82893	6273	84306	5250	83250	3786	97902	3514	37075
3L-7S		MI	42987	10198	66408	7681	70997	6261	71085	5238	67924	3787	78948	3204	33676
16-#11	1.18	MA	48728	10198	75299	7711	81406	6287	82499	5246	80926	3797	95176	3427	37101
4L-6S		MI	43502	10198	67347	7666	72130	6264	72478	5225	69793	3777	81532	3294	33834
16-#11	1.18	MA	48117	10198	74293	7709	80101	6284	80895	5259	78600	3790	92350	3384	37103
5E		MI	44031	10198	68204	7668	73318	6250	73929	5230	71707	3767	83954	3350	33850

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

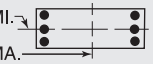


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.18	MA	47536	10198	73350	7707	78794	6299	79297	5255	76495	3801	89648	3329	37062
6L-4S		MI	44587	10198	69119	7671	74504	6254	75387	5217	73819	3774	86498	3392	33830
16-#11	1.18	MA	46969	10198	72317	7723	77548	6296	77765	5268	74439	3812	86768	3239	36854
7L-3S		MI	45209	10198	70177	7656	75853	6240	77027	5222	75929	3764	88939	3478	33796
16-#11	1.18	MA	46402	10198	71389	7721	76284	6310	76269	5282	72252	3806	84125	3189	36374
8L-2S		MI	46097	10198	71479	7658	77521	6244	79062	5210	78697	3754	92686	3565	33757
16-#14	1.70	MA	52718	10580	82993	7913	91109	6429	94271	5325	96784	3732	116116	3524	52748
2L-8S		MI	43048	10580	67609	7900	72281	6436	72648	5351	69868	3742	82273	2891	46098
16-#14	1.70	MA	51327	10580	80935	7910	88472	6424	91054	5344	92407	3747	110167	3400	52762
3L-7S		MI	43768	10580	68820	7903	73930	6417	74598	5334	72717	3753	85663	2961	46637
16-#14	1.70	MA	50355	10580	79263	7932	86340	6444	88463	5337	89073	3762	106287	3275	52717
4L-6S		MI	44500	10580	70167	7882	75555	6422	76597	5316	75398	3740	89339	3091	47397
16-#14	1.70	MA	49487	10580	77819	7929	84467	6440	86161	5356	85737	3753	102254	3214	52595
5E		MI	45251	10580	71397	7886	77259	6403	78679	5324	78142	3726	92784	3171	47923
16-#14	1.70	MA	48662	10580	76465	7926	82591	6460	83868	5349	82715	3768	98406	3134	51990
6L-4S		MI	46040	10580	72709	7890	78961	6409	80770	5306	81171	3737	96410	3231	48007
16-#14	1.70	MA	47859	10580	74982	7948	80802	6455	81668	5368	79763	3783	94303	3004	51102
7L-3S		MI	46922	10580	74226	7868	80895	6389	83121	5314	84196	3724	99880	3356	48031
16-#14	1.70	MA	47067	10580	73650	7945	78988	6475	79521	5386	76626	3773	90531	2932	50463
8L-2S		MI	48180	10580	76089	7872	83283	6395	86034	5297	88160	3710	105211	3480	47996
16-#18	3.03	MA	55963	11548	92029	8467	102396	6861	107927	5589	115316	3655	140451	3095	91552
3L-7S		MI	45650	11548	74748	8476	81214	6862	83356	5581	84619	3665	102220	2326	76386
16-#18	3.03	MA	54294	11548	89089	8504	98649	6850	103372	5575	109454	3679	133737	2874	91106
4L-6S		MI	46905	11548	77118	8440	84073	6830	86870	5552	89314	3643	108576	2557	78857
16-#18	3.03	MA	52805	11548	86546	8498	95352	6885	99321	5606	103586	3659	126717	2768	88640
5E		MI	48194	11548	79282	8448	87069	6842	90531	5568	94118	3621	114528	2702	80518
16-#18	3.03	MA	51389	11548	84163	8491	92050	6875	95286	5592	98269	3683	120050	2624	86697
6L-4S		MI	49548	11548	81589	8456	90060	6810	94206	5539	99420	3643	120824	2805	82764
16-#18	3.03	MA	50009	11548	81552	8529	88900	6909	91413	5623	93073	3706	112936	2393	83945
7L-3S		MI	51063	11548	84254	8420	93456	6822	98333	5555	104712	3621	126812	3026	83129
16-#18	3.03	MA	48651	11548	79206	8522	85705	6899	87633	5654	87551	3686	106373	2269	81370
8L-2S		MI	53218	11548	87516	8429	97639	6789	103436	5527	111635	3599	136034	3248	83283
18-#11	1.33	MA	51079	10306	79337	7764	86574	6324	88797	5266	89361	3766	106252	3585	41548
2L-9S		MI	42581	10306	66040	7744	70398	6319	70338	5275	66854	3781	77967	3085	36948
18-#11	1.33	MA	50100	10306	77901	7762	84733	6321	86551	5279	86306	3777	102077	3499	41576
3L-8S		MI	43106	10306	66865	7746	71516	6323	71760	5280	68706	3771	80316	3139	37235
18-#11	1.33	MA	49417	10306	76735	7778	83247	6336	84745	5275	83981	3788	99351	3413	41593
4L-7S		MI	43612	10306	67709	7749	72665	6309	73119	5267	70693	3778	82695	3188	37628
18-#11	1.33	MA	48808	10306	75729	7776	81942	6333	83140	5289	81656	3782	96525	3370	41574
5L-6S		MI	44126	10306	68648	7734	73798	6313	74513	5255	72562	3768	85278	3278	37878
18-#11	1.33	MA	48229	10306	74786	7775	80635	6347	81543	5285	79551	3793	93823	3314	41518
6L-5S		MI	44653	10306	69505	7736	74985	6299	75964	5259	74475	3758	87701	3334	37910
18-#11	1.33	MA	47665	10306	73753	7790	79389	6344	80010	5298	77494	3804	90943	3224	41216
7L-4S		MI	45207	10306	70420	7738	76172	6302	77422	5247	76587	3765	90244	3376	37906
18-#11	1.33	MA	47101	10306	72825	7788	78125	6359	78515	5311	75308	3798	88300	3174	40755
8L-3S		MI	45828	10306	71479	7723	77521	6289	79062	5251	78697	3755	92686	3462	37880
18-#11	1.33	MA	46513	10306	71918	7787	76895	6356	76950	5307	73270	3809	85680	3121	40409
9L-2S		MI	46713	10306	72780	7725	79189	6292	81097	5239	81466	3745	96432	3548	37847
18-#14	1.92	MA	53682	10736	85050	8010	93747	6498	97489	5368	101162	3720	122064	3502	59192
2L-9S		MI	43202	10736	68168	8018	73066	6500	73521	5386	71174	3743	84264	2788	50646
18-#14	1.92	MA	52295	10736	82993	8007	91109	6494	94271	5386	96784	3735	116116	3377	59174
3L-8S		MI	43935	10736	69472	7997	74669	6506	75561	5394	73831	3730	87604	2865	51769
18-#14	1.92	MA	51327	10736	81320	8029	88978	6514	91681	5380	93450	3750	112236	3253	59106
4L-7S		MI	44653	10736	70682	8001	76318	6487	77512	5376	76681	3741	90994	2935	52295
18-#14	1.92	MA	50464	10736	79876	8026	87104	6509	89378	5398	90114	3740	108203	3192	58958
5L-6S		MI	45381	10736	72030	7979	77943	6492	79510	5359	79362	3727	94670	3065	53024
18-#14	1.92	MA	49643	10736	78522	8023	85229	6530	87085	5392	87093	3755	104355	3111	58210
6L-5S		MI	46129	10736	73260	7983	79647	6473	81592	5366	82106	3714	98115	3146	53690
18-#14	1.92	MA	48843	10736	77039	8045	83440	6525	84886	5410	84141	3770	100252	2982	57356
7L-4S		MI	46914	10736	74572	7987	81349	6478	83683	5349	85135	3725	101741	3206	53799

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

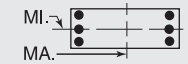
BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#14	1.92	MA	48055	10736	75708	8043	81625	6545	82739	5429	81004	3760	96480	2910	56732
8L-3S		MI	47793	10736	76089	7966	83283	6459	86034	5356	88160	3711	105211	3330	53843
18-#14	1.92	MA	47220	10736	74404	8040	79860	6541	80493	5422	78079	3775	92749	2833	55456
9L-2S		MI	49047	10736	77952	7969	85671	6465	88947	5339	92123	3698	110542	3455	53832
18-#18	3.41	MA	55948	11825	92698	8677	103275	6975	109016	5651	117133	3657	144055	2828	102215
4L-7S		MI	47160	11825	78011	8649	85397	6986	88459	5656	91542	3642	111442	2275	86081
18-#18	3.41	MA	54469	11825	90155	8671	99978	7009	104964	5681	111265	3636	137036	2722	99490
5L-6S		MI	48407	11825	80381	8613	88256	6954	91973	5628	96237	3620	117798	2506	88722
18-#18	3.41	MA	53062	11825	87772	8664	96676	6999	100929	5668	105947	3660	130368	2578	97624
6L-5S		MI	49688	11825	82545	8621	91252	6966	95634	5643	101042	3597	123750	2650	90312
18-#18	3.41	MA	51693	11825	85161	8702	93527	7033	97057	5699	100752	3684	123254	2348	94702
7L-4S		MI	51033	11825	84851	8629	94242	6934	99309	5615	106343	3620	130046	2753	92808
18-#18	3.41	MA	50344	11825	82814	8695	90332	7023	93276	5729	95230	3664	116691	2223	92206
8L-3S		MI	52539	11825	87516	8593	97639	6946	103436	5630	111635	3597	136034	2975	93229
20-#11	1.48	MA	51761	10414	80773	7832	88415	6372	91043	5296	92417	3758	110427	3571	46049
2L-10S		MI	42651	10414	66417	7827	70932	6382	71020	5317	67786	3782	79438	3007	40459
20-#11	1.48	MA	50785	10414	79337	7830	86574	6370	88797	5309	89361	3769	106252	3485	46071
3L-9S		MI	43208	10414	67341	7812	72066	6368	72373	5304	69623	3772	81714	3068	40926
20-#11	1.48	MA	50104	10414	78171	7845	85088	6384	86991	5305	87037	3779	103526	3398	46073
4L-8S		MI	43731	10414	68167	7814	73184	6371	73795	5309	71475	3762	84063	3122	41207
20-#11	1.48	MA	49497	10414	77165	7844	83783	6381	85386	5318	84711	3773	100700	3355	46041
5L-7S		MI	44235	10414	69010	7816	74333	6358	75154	5296	73461	3770	86441	3171	41585
20-#11	1.48	MA	48920	10414	76222	7842	82476	6396	83789	5314	82606	3784	97998	3300	45971
6E		MI	44747	10414	69949	7801	75466	6361	76547	5284	75330	3760	89025	3261	41917
20-#11	1.48	MA	48357	10414	75189	7857	81229	6393	82256	5327	80549	3795	95118	3210	45585
7L-5S		MI	45273	10414	70807	7803	76653	6347	77999	5289	77244	3750	91448	3317	41963
20-#11	1.48	MA	47797	10414	74261	7856	79965	6407	80760	5341	78363	3789	92475	3160	45139
8L-4S		MI	45825	10414	71721	7806	77840	6351	79457	5276	79356	3757	93991	3359	41976
20-#11	1.48	MA	47210	10414	73354	7854	78736	6404	79196	5337	76326	3800	89855	3106	44800
9L-3S		MI	46444	10414	72780	7791	79189	6337	81097	5281	81466	3747	96432	3446	41959
20-#11	1.48	MA	46598	10414	72337	7870	77489	6419	77708	5350	74306	3811	87315	3045	44253
10L-2S		MI	47327	10414	74081	7793	80857	6340	83131	5268	84234	3737	100179	3532	41932
20-#14	2.13	MA	53259	10891	85050	8105	93747	6564	97489	5428	101162	3722	122064	3355	65578
3L-9S		MI	44089	10891	70031	8115	75454	6570	76434	5429	75138	3731	89595	2762	56246
20-#14	2.13	MA	52295	10891	83378	8127	91615	6584	94898	5422	97828	3737	118185	3230	65489
4L-8S		MI	44818	10891	71335	8094	77057	6576	78474	5436	77795	3717	92936	2840	57378
20-#14	2.13	MA	51436	10891	81933	8124	89742	6579	92595	5441	94492	3728	114152	3169	65318
5L-7S		MI	45532	10891	72545	8098	78706	6556	80425	5419	80644	3729	96326	2910	57959
20-#14	2.13	MA	50618	10891	80580	8121	87866	6599	90303	5434	91470	3743	110304	3089	64441
6E		MI	46258	10891	73893	8077	80331	6562	82423	5401	83326	3715	100001	3040	58661
20-#14	2.13	MA	49822	10891	79097	8143	86077	6595	88103	5453	88519	3758	106201	2959	63616
7L-5S		MI	47002	10891	75123	8080	82035	6543	84506	5409	86070	3701	103447	3121	59452
20-#14	2.13	MA	49037	10891	77765	8140	84263	6615	85956	5471	85381	3748	102429	2887	62956
8L-4S		MI	47784	10891	76435	8084	83737	6548	86597	5391	89098	3713	107072	3180	59583
20-#14	2.13	MA	48207	10891	76462	8137	82498	6610	83711	5465	82457	3763	98698	2810	61653
9L-3S		MI	48660	10891	77952	8063	85671	6529	88947	5399	92123	3699	110542	3305	59647
20-#14	2.13	MA	47340	10891	75003	8159	80708	6631	81575	5483	79557	3778	95081	2722	60657
10L-2S		MI	49909	10891	79815	8067	88059	6535	91860	5381	96087	3685	115873	3429	59666
20-#18	3.79	MA	56121	12101	93764	8844	104604	7133	110608	5757	118944	3614	147354	2677	110360
5L-7S		MI	48660	12101	81274	8822	89580	7111	93561	5732	98465	3619	120664	2224	95797
20-#18	3.79	MA	54724	12101	91380	8837	101303	7123	106573	5743	113626	3638	140687	2533	108562
6E		MI	49899	12101	83644	8786	92439	7078	97076	5703	103160	3596	127020	2455	98599
20-#18	3.79	MA	53363	12101	88769	8874	98153	7157	102700	5774	108430	3662	133572	2302	105479
7L-5S		MI	51171	12101	85807	8794	95434	7090	100737	5719	107965	3574	132972	2599	100127

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

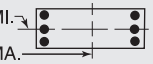


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#18	3.79	MA	52024	12101	86423	8868	94958	7147	98920	5805	102909	3642	127009	2178	102861
8L-4S		MI	52508	12101	88114	8802	98425	7058	104412	5690	113266	3596	139268	2702	102845
22-#11	1.63	MA	52440	10522	82209	7899	90256	6421	93288	5325	95472	3749	114602	3556	50547
2L-11S		MI	42736	10522	66891	7892	71488	6427	71651	5341	68597	3767	80865	2939	43865
22-#11	1.63	MA	51467	10522	80773	7897	88415	6418	91043	5338	92417	3760	110427	3470	50561
3L-10S		MI	43277	10522	67718	7894	72600	6430	73055	5346	70555	3774	83184	2991	44385
22-#11	1.63	MA	50788	10522	79607	7913	86929	6432	89236	5334	90092	3771	107701	3384	50547
4L-9S		MI	43832	10522	68642	7879	73734	6416	74407	5334	72391	3764	85461	3052	44905
22-#11	1.63	MA	50183	10522	78601	7911	85623	6430	87632	5347	87767	3765	104876	3341	50503
5L-8S		MI	44353	10522	69468	7881	74852	6420	75829	5338	74243	3754	87810	3106	45182
22-#11	1.63	MA	49608	10522	77658	7909	84317	6444	86034	5343	85661	3776	102173	3285	50419
6L-7S		MI	44856	10522	70311	7884	76001	6406	77189	5326	76230	3761	90188	3155	45548
22-#11	1.63	MA	49047	10522	76625	7925	83070	6441	84502	5357	83605	3787	99293	3195	49959
7L-6S		MI	45366	10522	71250	7868	77134	6409	78582	5313	78099	3751	92772	3245	45953
22-#11	1.63	MA	48491	10522	75697	7923	81806	6455	83006	5370	81419	3780	96650	3145	49526
8L-5S		MI	45890	10522	72108	7871	78321	6396	80034	5318	80012	3741	95194	3301	46011
22-#11	1.63	MA	47904	10522	74790	7921	80577	6453	81442	5366	79381	3791	94030	3091	49193
9L-4S		MI	46441	10522	73022	7873	79508	6399	81492	5306	82124	3748	97738	3343	46038
22-#11	1.63	MA	47294	10522	73773	7937	79330	6467	79954	5379	77361	3802	91490	3031	48593
10L-3S		MI	47057	10522	74081	7858	80857	6385	83131	5310	84234	3738	100179	3429	46033
22-#11	1.63	MA	46698	10522	72864	7935	78107	6464	78410	5375	75206	3796	88912	2978	47988
11L-2S		MI	47938	10522	75382	7860	82525	6389	85166	5298	87003	3728	103926	3515	46012
22-#14	2.34	MA	53258	11047	85435	8224	94252	6654	98116	5465	102205	3725	124134	3208	71867
4L-9S		MI	44971	11047	71894	8213	77842	6640	79348	5471	79102	3718	94926	2737	61854
22-#14	2.34	MA	52402	11047	83990	8221	92379	6649	95813	5483	98869	3715	120101	3147	71673
5L-8S		MI	45696	11047	73197	8191	79445	6646	81387	5478	81759	3705	98267	2814	62952
22-#14	2.34	MA	51588	11047	82637	8218	90503	6669	93520	5477	95848	3730	116252	3066	70680
6L-7S		MI	46408	11047	74408	8195	81094	6626	83338	5461	84608	3716	101657	2885	63629
22-#14	2.34	MA	50795	11047	81154	8240	88714	6665	91320	5495	92896	3745	112150	2937	69882
7L-6S		MI	47130	11047	75756	8174	82719	6632	85337	5444	87289	3703	105333	3014	64307
22-#14	2.34	MA	50014	11047	79822	8237	86900	6685	89174	5514	89759	3736	108378	2865	69126
8L-5S		MI	47871	11047	76985	8178	84423	6613	87419	5451	90033	3689	108778	3095	65209
22-#14	2.34	MA	49188	11047	78519	8234	85135	6680	86928	5507	86834	3751	104647	2788	67859
9L-4S		MI	48650	11047	78297	8181	86125	6618	89510	5434	93062	3700	112404	3155	65362
22-#14	2.34	MA	48324	11047	77060	8256	83345	6700	84793	5526	83935	3766	101030	2700	66818
10L-3S		MI	49522	11047	79815	8160	88059	6599	91860	5441	96087	3687	115873	3279	65444
22-#18	4.17	MA	56374	12378	94989	9010	105929	7247	112217	5819	121305	3616	151005	2487	119512
6L-7S		MI	50149	12378	84536	8995	93763	7235	98664	5807	105388	3595	129886	2172	105532
22-#18	4.17	MA	55022	12378	92378	9047	102779	7281	108344	5849	116109	3640	143891	2256	116274
7L-6S		MI	51381	12378	86907	8959	96622	7203	102179	5778	110083	3573	136242	2403	108486
22-#18	4.17	MA	53692	12378	90032	9041	99584	7271	104564	5880	110587	3620	137328	2132	113535
8L-5S		MI	52645	12378	89070	8967	99617	7214	105840	5794	114888	3551	142194	2548	109959
24-#11	1.77	MA	52146	10630	82209	7965	90256	6466	93288	5368	95472	3751	114602	3455	55042
3L-11S		MI	43360	10630	68192	7959	73156	6475	73686	5371	71365	3758	84612	2922	47808
24-#11	1.77	MA	51470	10630	81043	7980	88770	6481	91482	5364	93148	3762	111876	3369	55017
4L-10S		MI	43901	10630	69019	7961	74268	6478	75090	5376	73323	3765	86931	2975	48317
24-#11	1.77	MA	50867	10630	80037	7979	87464	6478	89877	5377	90822	3756	109051	3326	54961
5L-9S		MI	44454	10630	69943	7946	75402	6465	76442	5363	75160	3755	89207	3036	48887
24-#11	1.77	MA	50293	10630	79094	7977	86157	6492	88280	5373	88717	3767	106348	3270	54865
6L-8S		MI	44973	10630	70769	7949	76520	6468	77864	5368	77012	3745	91556	3089	49160
24-#11	1.77	MA	49735	10630	78061	7992	84911	6489	86747	5386	86660	3778	103468	3181	54337
7E		MI	45474	10630	71612	7951	77669	6454	79224	5355	78998	3752	93935	3139	49514
24-#11	1.77	MA	49184	10630	77133	7991	83647	6504	85252	5399	84474	3772	100825	3130	53917
8L-6S		MI	45983	10630	72552	7936	78802	6458	80617	5343	80867	3742	96518	3228	49985
24-#11	1.77	MA	48595	10630	76225	7989	82418	6501	83687	5395	82437	3783	98205	3077	53588
9L-5S		MI	46505	10630	73409	7938	79989	6444	82069	5348	82781	3732	98941	3284	50055
24-#11	1.77	MA	47987	10630	75209	8004	81171	6515	82200	5409	80417	3794	95665	3016	52938
10L-4S		MI	47054	10630	74323	7940	81176	6448	83526	5335	84893	3739	101484	3326	50092

RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis



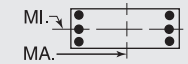
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	1.77	MA	47393	10630	74300	8003	79948	6513	80656	5405	78262	3787	93087	2963	52346
11L-3S		MI	47669	10630	75382	7925	82525	6434	85166	5340	87003	3729	103926	3413	50102
24-#11	1.77	MA	46810	10630	73302	8018	78710	6527	79170	5418	76243	3798	90180	2886	51665
12L-2S		MI	48547	10630	76683	7928	84193	6437	87201	5327	89771	3719	107672	3499	50087
24-#14	2.56	MA	53364	11202	86048	8318	95016	6719	99030	5525	103247	3703	126049	3124	78026
5L-9S		MI	45849	11202	73756	8310	80230	6710	82261	5513	83065	3706	100258	2711	67468
24-#14	2.56	MA	52554	11202	84694	8315	93141	6739	96738	5519	100225	3718	122201	3044	76927
6L-8S		MI	46571	11202	75060	8289	81833	6715	84301	5521	85722	3692	103598	2789	68536
24-#14	2.56	MA	51764	11202	83211	8337	91352	6734	94538	5538	97274	3733	118098	2914	76153
7E		MI	47279	11202	76271	8292	83482	6696	86251	5503	88572	3704	106988	2859	69303
24-#14	2.56	MA	50987	11202	81879	8334	89537	6755	92391	5556	94136	3723	114327	2842	75306
8L-6S		MI	47998	11202	77618	8271	85108	6702	88250	5486	91253	3690	110664	2989	69959
24-#14	2.56	MA	50165	11202	80576	8331	87773	6750	90146	5550	91212	3738	110595	2765	74071
9L-5S		MI	48737	11202	78848	8275	86811	6682	90332	5494	93997	3677	114109	3070	70962
24-#14	2.56	MA	49304	11202	79117	8353	85982	6770	88010	5568	88312	3753	106979	2677	72966
10L-4S		MI	49512	11202	80160	8279	88513	6688	92423	5476	97026	3688	117735	3129	71136
24-#18	4.55	MA	56671	12655	95987	9220	107405	7405	113988	5925	123788	3618	154209	2211	127086
7E		MI	51629	12655	87799	9168	97946	7359	103767	5882	112311	3572	139108	2121	115283
24-#18	4.55	MA	55349	12655	93640	9214	104210	7395	110207	5956	118266	3598	147646	2086	124227
8L-6S		MI	52853	12655	90170	9132	100805	7327	107282	5854	117007	3550	145464	2352	118270
RECTANGULAR TIED COLUMNS 46" x 46"															
6-#18	1.13	MA	47951	10183	74521	7601	80436	6199	81762	5175	80951	3737	94674	3532	33747
2L-3S		MI	45610	10183	71085	7594	76031	6232	76388	5205	73641	3760	84904	3311	33874
8-#18	1.51	MA	49561	10459	77956	7774	84840	6323	87135	5251	88262	3715	104444	3484	44565
2L-4S		MI	45599	10459	71718	7803	76864	6345	77421	5266	75365	3760	88323	3041	44534
10-#14	1.06	MA	47757	10131	73783	7615	79785	6214	81081	5194	80072	3766	93867	3582	31904
2L-5S		MI	44638	10131	68849	7630	73452	6224	73349	5223	69540	3784	80723	3272	32019
10-#14	1.06	MA	46417	10131	71822	7612	77273	6209	78016	5212	75902	3781	88227	3457	31969
3L-4S		MI	45477	10131	70228	7633	75240	6229	75545	5205	72722	3795	84552	3333	32022
10-#18	1.89	MA	51156	10736	81392	7947	89245	6447	92508	5326	95573	3693	114214	3436	55345
2L-5S		MI	45769	10736	72729	7969	78124	6503	78931	5371	77081	3716	91436	2888	53796
10-#18	1.89	MA	48845	10736	77956	7939	84840	6481	87135	5356	88262	3716	104444	3214	55354
3L-4S		MI	47221	10736	75154	7976	81268	6470	82794	5341	82676	3738	98093	2993	55157
RECTANGULAR TIED COLUMNS 46" x 48"															
6-#18	1.09	MA	52047	10589	80629	7931	87074	6471	88462	5406	87400	3915	102279	3712	35367
2L-3S		MI	47482	10589	73877	7901	78954	6486	79242	5420	76207	3925	87746	3471	33934
6-#18	1.09	MA	49584	10589	77021	7925	82448	6505	82819	5437	79721	3939	91961	3491	35494
3L-2S		MI	49825	10589	77312	7909	83358	6452	84616	5390	83517	3903	97516	3692	33799
8-#18	1.45	MA	53747	10866	84238	8104	91700	6595	94106	5482	95078	3892	112598	3666	46725
2L-4S		MI	47471	10866	74510	8111	79786	6599	80275	5481	77931	3926	91165	3201	44640
8-#18	1.45	MA	51300	10866	80629	8098	87074	6629	88462	5512	87400	3916	102279	3445	46801
3E		MI	49109	10866	77312	8074	83358	6610	84616	5496	83517	3903	97516	3422	44710
8-#18	1.45	MA	49581	10866	77689	8135	83326	6619	83908	5499	81538	3940	95565	3224	46694
4L-2S		MI	51437	10866	80748	8082	87763	6576	89989	5466	90828	3880	107286	3644	44624
10-#14	1.02	MA	51837	10537	79845	7946	86379	6486	87734	5425	86459	3944	101384	3760	33422
2L-5S		MI	46509	10537	71631	7940	76375	6479	76207	5439	72114	3951	83578	3433	32090
10-#14	1.02	MA	50428	10537	77788	7943	83742	6481	84517	5443	82081	3959	95435	3636	33488
3L-4S		MI	47349	10537	73009	7943	78163	6484	78404	5421	75297	3961	87408	3494	32076

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	1.02	MA	49442	10537	76115	7965	81611	6501	81926	5437	78747	3974	91555	3511	33541
4L-3S		MI	48289	10537	74604	7922	80195	6464	80875	5428	78476	3947	91082	3618	32016
10-#14	1.02	MA	48562	10537	74671	7962	79737	6497	79623	5455	75411	3964	87523	3450	33537
5L-2S		MI	49630	10537	76564	7925	82708	6469	83940	5410	82647	3933	96722	3743	31947
10-#18	1.81	MA	55431	11143	87847	8277	96326	6719	99750	5557	102757	3870	122916	3621	58045
2L-5S		MI	47640	11143	75521	8277	81047	6756	81785	5586	79647	3882	94278	3048	54183
10-#18	1.81	MA	52999	11143	84238	8270	91700	6753	94106	5588	95078	3894	112598	3399	58054
3L-4S		MI	49094	11143	77946	8284	84191	6723	85648	5556	85242	3903	100935	3153	55275
10-#18	1.81	MA	51293	11143	81298	8308	87953	6743	89551	5574	89217	3918	105883	3178	57857
4L-3S		MI	50721	11143	80748	8247	87763	6734	89989	5571	90828	3881	107286	3374	55438
10-#18	1.81	MA	49769	11143	78755	8301	84656	6777	85500	5605	83349	3898	98864	3072	56680
5L-2S		MI	53035	11143	84184	8255	92167	6701	95362	5541	98139	3858	117056	3595	55411
12-#14	1.22	MA	52817	10693	81902	8043	89017	6556	90952	5467	90837	3931	107333	3738	39895
2L-6S		MI	46656	10693	72300	8034	77098	6568	77085	5475	73402	3953	85572	3329	38069
12-#14	1.22	MA	51414	10693	79845	8040	86379	6551	87734	5485	86459	3946	101384	3613	39947
3L-5S		MI	47452	10693	73591	8037	78888	6548	79273	5482	76285	3939	89218	3410	38188
12-#14	1.22	MA	50432	10693	78173	8062	84248	6571	85143	5479	83125	3961	97504	3489	39977
4E		MI	48289	10693	74970	8041	80675	6554	81470	5464	79467	3949	93047	3470	38214
12-#14	1.22	MA	49556	10693	76728	8059	82374	6567	82841	5498	79789	3952	93471	3428	39932
5L-3S		MI	49225	10693	76564	8019	82708	6534	83940	5471	82647	3935	96722	3595	38176
12-#14	1.22	MA	48722	10693	75375	8056	80499	6587	80548	5491	76767	3967	89623	3347	39787
6L-2S		MI	50561	10693	78524	8022	85221	6539	87006	5453	86818	3920	102362	3719	38120
12-#18	2.17	MA	57101	11419	91455	8450	100952	6843	105393	5632	110436	3848	133234	3575	69345
2L-6S		MI	47884	11419	76683	8442	82303	6869	83310	5647	81887	3882	97738	2856	62393
12-#18	2.17	MA	54684	11419	87847	8443	96326	6877	99750	5663	102757	3872	122916	3354	69275
3L-5S		MI	49259	11419	78957	8450	85452	6880	87158	5661	86958	3860	104048	3000	64409
12-#18	2.17	MA	52989	11419	84906	8481	92579	6867	95195	5650	96896	3896	116201	3132	69002
4E		MI	50703	11419	81381	8457	88596	6847	91021	5632	92552	3881	110705	3104	65890
12-#18	2.17	MA	51476	11419	82364	8474	89282	6901	91143	5680	91027	3876	109182	3026	67432
5L-3S		MI	52319	11419	84184	8420	92167	6858	95362	5646	98139	3859	117056	3326	66128
12-#18	2.17	MA	50037	11419	79981	8468	85980	6891	87109	5667	85710	3900	102515	2883	65266
6L-2S		MI	54619	11419	87620	8428	96572	6825	100735	5617	105450	3836	126826	3547	66170
14-#14	1.43	MA	53793	10849	83959	8140	91654	6626	94169	5509	95214	3919	113282	3715	46354
2L-7S		MI	46826	10849	72844	8153	77904	6633	78051	5535	74756	3955	87322	3175	43141
14-#14	1.43	MA	52394	10849	81902	8137	89017	6621	90952	5528	90837	3934	107333	3591	46392
3L-6S		MI	47598	10849	74260	8131	79611	6638	80151	5517	77573	3940	91211	3305	44019
14-#14	1.43	MA	51417	10849	80230	8159	86885	6641	88361	5522	87503	3949	103453	3466	46391
4L-5S		MI	48391	10849	75551	8135	81401	6618	82338	5524	80456	3926	94858	3386	44275
14-#14	1.43	MA	50544	10849	78786	8156	85012	6636	86058	5540	84166	3939	99420	3405	46316
5L-4S		MI	49223	10849	76930	8138	83188	6623	84535	5506	83638	3937	98687	3446	44333
14-#14	1.43	MA	49714	10849	77432	8153	83136	6657	83766	5534	81145	3954	95572	3325	46028
6L-3S		MI	50156	10849	78524	8116	85221	6604	87006	5513	86818	3922	102362	3571	44321
14-#14	1.43	MA	48906	10849	75949	8175	81347	6652	81566	5552	78193	3969	91469	3195	45084
7L-2S		MI	51487	10849	80484	8120	87734	6609	90071	5495	90988	3908	108002	3695	44278
14-#18	2.54	MA	58759	11696	95064	8623	105578	6967	111037	5708	118114	3826	143552	3529	80600
2L-7S		MI	48170	11696	77628	8652	83703	7027	84990	5752	84242	3883	100773	2576	70571
14-#18	2.54	MA	56356	11696	91455	8616	100952	7002	105393	5738	110436	3850	133234	3308	80476
3L-6S		MI	49499	11696	80119	8615	86708	6993	88683	5722	89198	3860	107508	2807	72754
14-#18	2.54	MA	54672	11696	88515	8654	97205	6991	100839	5725	104574	3874	126519	3087	80135
4L-5S		MI	50865	11696	82393	8622	89856	7004	92531	5737	94269	3838	113818	2951	74671
14-#18	2.54	MA	53169	11696	85973	8647	93908	7026	96787	5756	98706	3854	119500	2981	78221
5L-4S		MI	52299	11696	84817	8630	93000	6971	96394	5707	99863	3859	120475	3056	76492
14-#18	2.54	MA	51740	11696	83589	8640	90606	7016	92752	5742	93389	3878	112833	2837	76157
6L-3S		MI	53905	11696	87620	8593	96572	6982	100735	5722	105450	3837	126826	3277	76796
14-#18	2.54	MA	50347	11696	80978	8678	87457	7050	88879	5773	88193	3902	105719	2606	73844
7L-2S		MI	56192	11696	91056	8600	100976	6949	106109	5692	112760	3814	136596	3499	76901
16-#11	1.13	MA	52435	10622	80920	8022	87915	6543	89669	5464	89118	3949	105198	3769	37084
2L-8S		MI	46388	10622	71375	8025	76116	6560	75983	5493	71786	3968	83333	3341	34979

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

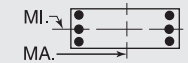
f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
16-#11	1.13	MA	51453	10622	79484	8020	86075	6540	87423	5477	86062	3960	101023	3683	37121
3L-7S		MI	46930	10622	72260	8027	77323	6546	77411	5481	73873	3974	85844	3391	35431
16-#11	1.13	MA	50767	10622	78318	8036	84589	6555	85617	5473	83738	3971	98298	3596	37151
4L-6S		MI	47472	10622	73247	8012	78512	6549	78874	5468	75836	3964	88576	3481	35519
16-#11	1.13	MA	50155	10622	77312	8034	83283	6552	84012	5487	81412	3965	95472	3553	37165
5E		MI	48027	10622	74147	8014	79759	6535	80398	5472	77845	3953	91138	3536	35535
16-#11	1.13	MA	49573	10622	76369	8032	81976	6566	82415	5483	79307	3976	92769	3498	37135
6L-4S		MI	48611	10622	75107	8016	81005	6538	81929	5459	80064	3960	93823	3579	35514
16-#11	1.13	MA	49006	10622	75336	8048	80730	6563	80882	5496	77250	3987	89890	3408	37025
7L-3S		MI	49266	10622	76219	8001	82423	6524	83652	5463	82281	3950	96406	3665	35481
16-#11	1.13	MA	48438	10622	74408	8046	79466	6578	79386	5509	75064	3981	87247	3358	36538
8L-2S		MI	50201	10622	77588	8003	84177	6527	85793	5450	85193	3939	100367	3752	35442
16-#14	1.63	MA	54763	11004	86017	8237	94292	6695	97387	5552	99592	3906	119230	3693	52802
2L-8S		MI	47008	11004	73533	8247	78685	6723	79068	5596	75934	3932	89381	3080	48505
16-#14	1.63	MA	53370	11004	83959	8234	91654	6691	94169	5570	95214	3921	113282	3568	52827
3L-7S		MI	47766	11004	74804	8250	80416	6703	81117	5578	78927	3942	92962	3151	49089
16-#14	1.63	MA	52396	11004	82287	8256	89523	6711	91578	5564	91880	3937	109402	3444	52794
4L-6S		MI	48535	11004	76220	8229	82124	6708	83216	5560	81744	3928	96851	3281	49928
16-#14	1.63	MA	51527	11004	80843	8253	87649	6706	89276	5582	88544	3927	105369	3383	52691
5E		MI	49324	11004	77511	8232	83913	6688	85403	5567	84626	3914	100498	3362	50353
16-#14	1.63	MA	50701	11004	79489	8251	85774	6727	86983	5576	85523	3942	101521	3302	52233
6L-4S		MI	50153	11004	78890	8235	85701	6693	87600	5549	87809	3924	104327	3422	50437
16-#14	1.63	MA	49896	11004	78006	8273	83985	6722	84783	5595	82571	3957	97418	3172	51330
7L-3S		MI	51082	11004	80484	8214	87734	6673	90071	5555	90988	3910	108002	3547	50461
16-#14	1.63	MA	49103	11004	76674	8270	82170	6742	82636	5613	79434	3947	93646	3101	50695
8L-2S		MI	52408	11004	82445	8217	90246	6679	93136	5537	95159	3895	113642	3671	50426
16-#18	2.90	MA	60404	11972	98673	8796	110205	7092	116680	5783	125793	3804	153870	3484	91836
2L-8S		MI	48481	11972	78826	8817	85060	7140	86757	5857	86287	3839	104319	2405	78320
16-#18	2.90	MA	58014	11972	95064	8789	105578	7126	111037	5814	118114	3828	143552	3262	91662
3L-7S		MI	49781	11972	81064	8825	88108	7151	90363	5827	91553	3861	110543	2528	80766
16-#18	2.90	MA	56342	11972	92124	8827	101831	7116	106482	5800	112253	3852	136838	3041	91259
4L-6S		MI	51102	11972	83555	8788	91112	7118	94057	5798	96508	3838	117278	2759	83133
16-#18	2.90	MA	54849	11972	89581	8820	98534	7150	102431	5831	106385	3832	129819	2935	89040
5E		MI	52458	11972	85828	8795	94261	7129	97904	5812	101579	3815	123587	2903	84963
16-#18	2.90	MA	53429	11972	87198	8813	95233	7140	98396	5818	101067	3856	123151	2791	87067
6L-4S		MI	53883	11972	88253	8803	97405	7095	101768	5783	107174	3837	130245	3008	87084
16-#18	2.90	MA	52046	11972	84587	8851	92083	7174	94523	5848	95871	3880	116037	2561	84570
7L-3S		MI	55479	11972	91056	8766	100976	7106	106109	5797	112760	3815	136596	3229	87449
16-#18	2.90	MA	50685	11972	82241	8844	88888	7164	90743	5879	90350	3859	109474	2436	81951
8L-2S		MI	57753	11972	94491	8773	105381	7073	111482	5767	120071	3792	146366	3450	87603
18-#11	1.27	MA	53121	10730	82356	8089	89756	6592	91915	5493	92173	3941	109374	3754	41593
2L-9S		MI	46498	10730	71877	8091	76697	6605	76630	5518	72754	3970	84810	3272	38840
18-#11	1.27	MA	52141	10730	80920	8088	87915	6589	89669	5507	89118	3952	105198	3668	41624
3L-8S		MI	47053	10730	72743	8093	77870	6609	78123	5523	74698	3959	87294	3326	39154
18-#11	1.27	MA	51457	10730	79754	8103	86429	6603	87863	5503	86793	3963	102473	3582	41645
4L-7S		MI	47591	10730	73629	8095	79077	6594	79551	5510	76785	3966	89805	3375	39587
18-#11	1.27	MA	50848	10730	78748	8102	85124	6600	86258	5516	84468	3957	99647	3539	41639
5L-6S		MI	48131	10730	74615	8079	80267	6598	81014	5497	78748	3955	92537	3465	39773
18-#11	1.27	MA	50268	10730	77805	8100	83817	6615	84660	5512	82362	3968	96945	3483	41596
6L-5S		MI	48685	10730	75515	8081	81514	6583	82538	5501	80757	3945	95099	3521	39806
18-#11	1.27	MA	49702	10730	76772	8115	82571	6612	83128	5525	80306	3979	94065	3393	41387
7L-4S		MI	49267	10730	76476	8083	82760	6587	84070	5488	82976	3951	97783	3563	39801
18-#11	1.27	MA	49138	10730	75844	8114	81307	6626	81632	5538	78120	3972	91422	3343	40919
8L-3S		MI	49919	10730	77588	8068	84177	6573	85793	5493	85193	3941	100367	3650	39776

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

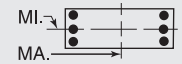


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#11	1.27	MA	48549	10730	74936	8112	80077	6623	80068	5534	76082	3983	88801	3289	40576
9L-2S		MI	50852	10730	78956	8070	85932	6576	87933	5480	88105	3930	104328	3736	39743
18-#14	1.83	MA	55728	11160	88074	8335	96929	6765	100604	5594	103969	3894	125179	3670	59243
2L-9S		MI	47162	11160	74249	8341	79513	6787	79991	5631	77314	3934	91485	2979	53408
18-#14	1.83	MA	54340	11160	86017	8332	94292	6761	97387	5613	99592	3909	119230	3546	59243
3L-8S		MI	47947	11160	75493	8344	81198	6792	82133	5638	80104	3919	95021	3057	54475
18-#14	1.83	MA	53370	11160	84345	8354	92160	6781	94796	5606	96258	3924	115351	3421	59188
4L-7S		MI	48701	11160	76764	8347	82929	6773	84182	5620	83098	3930	98602	3127	55045
18-#14	1.83	MA	52505	11160	82900	8351	90286	6776	92493	5625	92922	3914	111318	3360	59060
5L-6S		MI	49467	11160	78180	8326	84636	6778	86281	5602	85914	3916	102491	3257	55850
18-#14	1.83	MA	51683	11160	81547	8348	88411	6796	90201	5618	89900	3929	107470	3280	58451
6L-5S		MI	50252	11160	79471	8329	86426	6758	88469	5609	88797	3901	106138	3338	56424
18-#14	1.83	MA	50881	11160	80064	8370	86622	6792	88001	5637	86948	3944	103367	3150	57583
7L-4S		MI	51078	11160	80850	8332	88213	6763	90666	5591	91979	3912	109967	3398	56533
18-#14	1.83	MA	50092	11160	78732	8367	84808	6812	85854	5655	83811	3935	99595	3078	56964
8L-3S		MI	52003	11160	82445	8311	90246	6743	93136	5598	95159	3897	113642	3523	56577
18-#14	1.83	MA	49256	11160	77429	8364	83043	6807	83608	5649	80887	3950	95864	3001	55826
9L-2S		MI	53325	11160	84405	8314	92759	6748	96202	5580	99330	3883	119282	3647	56565
18-#18	3.26	MA	59661	12249	98673	8962	110205	7250	116680	5889	125793	3806	153870	3217	102836
3L-8S		MI	50088	12249	82261	8990	89465	7264	92130	5932	93598	3817	114089	2357	88618
18-#18	3.26	MA	57999	12249	95733	9000	106457	7240	112126	5876	119932	3830	147156	2995	102375
4L-7S		MI	51380	12249	84500	8998	92512	7275	95736	5903	98864	3839	120313	2480	90984
18-#18	3.26	MA	56516	12249	93190	8993	103160	7274	108074	5907	114063	3810	140137	2890	99885
5L-6S		MI	52692	12249	86991	8961	95517	7242	99430	5873	103819	3816	127048	2711	93527
18-#18	3.26	MA	55106	12249	90807	8986	99859	7264	104040	5893	108746	3834	133469	2746	97991
6L-5S		MI	54040	12249	89264	8968	98665	7253	103278	5888	108890	3793	133357	2855	95280
18-#18	3.26	MA	53732	12249	88195	9024	96709	7298	100167	5924	103550	3857	126355	2515	95318
7L-4S		MI	55456	12249	91689	8976	101809	7219	107141	5858	114485	3815	140015	2959	97668
18-#18	3.26	MA	52380	12249	85849	9017	93514	7288	96387	5955	98028	3837	119792	2391	92782
8L-3S		MI	57042	12249	94491	8939	105381	7230	111482	5873	120071	3792	146366	3181	98089
20-#11	1.41	MA	53804	10838	83792	8157	91597	6640	94160	5523	95229	3932	113549	3740	46097
2L-10S		MI	46576	10838	72275	8174	77261	6668	77350	5561	73737	3972	86362	3196	42616
20-#11	1.41	MA	52827	10838	82356	8155	89756	6637	91915	5536	92173	3943	109374	3653	46121
3L-9S		MI	47161	10838	73245	8158	78451	6654	78770	5548	75666	3961	88770	3257	43025
20-#11	1.41	MA	52145	10838	81190	8171	88270	6652	90108	5532	89849	3954	106648	3567	46134
4L-8S		MI	47715	10838	74112	8160	79625	6657	80263	5552	77610	3950	91255	3310	43332
20-#11	1.41	MA	51537	10838	80183	8169	86965	6649	88504	5545	87523	3948	103822	3524	46110
5L-7S		MI	48250	10838	74998	8162	80831	6643	81691	5539	79697	3957	93766	3360	43750
20-#11	1.41	MA	50959	10838	79241	8167	85658	6663	86906	5541	85418	3959	101120	3468	46052
6E		MI	48788	10838	75984	8147	82021	6646	83154	5526	81660	3947	96497	3450	44023
20-#11	1.41	MA	50396	10838	78207	8183	84412	6660	85373	5555	83361	3970	98240	3379	45755
7L-5S		MI	49340	10838	76884	8149	83268	6632	84679	5531	83669	3936	99060	3506	44069
20-#11	1.41	MA	49835	10838	77280	8181	83148	6675	83878	5568	81175	3964	95597	3328	45303
8L-4S		MI	49920	10838	77844	8151	84514	6635	86210	5518	85888	3943	101744	3548	44082
20-#11	1.41	MA	49247	10838	76372	8179	81918	6672	82314	5564	79138	3975	92977	3275	44968
9L-3S		MI	50571	10838	78956	8136	85932	6621	87933	5522	88105	3932	104328	3634	44065
20-#11	1.41	MA	48634	10838	75356	8195	80671	6686	80826	5577	77118	3986	90436	3214	44523
10L-2S		MI	51501	10838	80325	8138	87686	6624	90073	5509	91017	3922	108289	3721	44038
20-#14	2.04	MA	56689	11315	90131	8432	99566	6835	103821	5637	108347	3882	131128	3648	65678
2L-10S		MI	47270	11315	74817	8460	80318	6877	81018	5692	78717	3936	93699	2867	58368
20-#14	2.04	MA	55306	11315	88074	8429	96929	6830	100604	5655	103969	3897	125179	3523	65651
3L-9S		MI	48100	11315	76209	8438	82026	6857	83056	5674	81484	3921	97125	2955	59303
20-#14	2.04	MA	54340	11315	86402	8451	94797	6851	98013	5649	100635	3912	121300	3399	65575
4L-8S		MI	48880	11315	77453	8441	83710	6862	85199	5680	84275	3907	100661	3033	60450
20-#14	2.04	MA	53479	11315	84957	8448	92924	6846	95711	5667	97299	3902	117267	3338	65425
5L-7S		MI	49631	11315	78725	8445	85442	6843	87248	5662	87268	3918	104242	3104	61007
20-#14	2.04	MA	52659	11315	83604	8445	91048	6866	93418	5661	94278	3917	113418	3257	64680
6E		MI	50394	11315	80140	8423	87149	6848	89347	5644	90085	3903	108131	3233	61782
20-#14	2.04	MA	51861	11315	82121	8467	89259	6862	91218	5679	91326	3932	109316	3127	63843
7L-5S		MI	51176	11315	81431	8426	88939	6828	91534	5651	92968	3889	111778	3314	62489

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

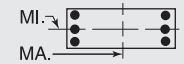


f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
20-#14	2.04	MA	51075	11315	80789	8464	87445	6882	89071	5698	88189	3922	105544	3056	63238
8L-4S		MI	51999	11315	82810	8430	90726	6833	93731	5633	96150	3899	115607	3374	62621
20-#14	2.04	MA	50244	11315	79486	8461	85680	6877	86826	5692	85264	3937	101813	2978	62020
9L-3S		MI	52920	11315	84405	8408	92759	6813	96202	5640	99330	3885	119282	3499	62684
20-#14	2.04	MA	49375	11315	78027	8483	83890	6897	84690	5710	82365	3952	98196	2891	61016
10L-2S		MI	54237	11315	86365	8411	95272	6818	99267	5622	103500	3871	124922	3623	62704
20-#18	3.62	MA	59645	12526	99341	9173	111083	7364	117770	5951	127610	3808	157474	2950	113486
4L-8S		MI	51684	12526	85697	9163	93869	7388	97504	6008	100909	3795	123859	2308	98932
20-#18	3.62	MA	58172	12526	96799	9166	107786	7398	113718	5982	121742	3787	150455	2844	110752
5L-7S		MI	52968	12526	87936	9171	96917	7399	101109	5978	106175	3816	130082	2431	101223
20-#18	3.62	MA	56771	12526	94415	9159	104485	7388	109683	5968	116425	3811	143788	2700	108929
6E		MI	54272	12526	90426	9134	99921	7366	104803	5949	111130	3794	136818	2662	103934
20-#18	3.62	MA	55406	12526	91804	9197	101335	7422	105810	5999	111229	3835	136673	2469	106088
7L-5S		MI	55611	12526	92700	9141	103070	7377	108651	5963	116201	3771	143127	2806	105619
20-#18	3.62	MA	54062	12526	89458	9190	98140	7412	102030	6030	105707	3815	130111	2345	103629
8L-4S		MI	57018	12526	95125	9149	106214	7344	112514	5933	121795	3793	149785	2911	108245
22-#11	1.55	MA	54485	10946	85228	8224	93438	6689	96406	5552	98284	3924	117724	3725	50596
2L-11S		MI	46668	10946	72776	8239	77848	6713	78017	5586	74593	3956	87875	3128	46180
22-#11	1.55	MA	53510	10946	83792	8223	91597	6686	94160	5566	95229	3935	113549	3639	50614
3L-10S		MI	47237	10946	73644	8241	79015	6716	79490	5590	76649	3963	90323	3180	46748
22-#11	1.55	MA	52830	10946	82626	8238	90111	6700	92354	5562	92904	3946	110823	3553	50610
4L-9S		MI	47820	10946	74614	8226	80206	6702	80911	5577	78578	3952	92731	3241	47213
22-#11	1.55	MA	52224	10946	81619	8236	88805	6697	90749	5575	90579	3939	107997	3510	50575
5L-8S		MI	48377	10946	75480	8228	81379	6705	82404	5582	80522	3942	95216	3295	47514
22-#11	1.55	MA	51648	10946	80677	8235	87499	6712	89152	5571	88473	3950	105295	3454	50505
6L-7S		MI	48906	10946	76366	8230	82586	6691	83831	5569	82609	3949	97726	3344	47917
22-#11	1.55	MA	51087	10946	79643	8250	86252	6709	87619	5584	86417	3961	102415	3364	50129
7L-6S		MI	49442	10946	77352	8214	83775	6694	85294	5556	84572	3938	100458	3434	48269
22-#11	1.55	MA	50529	10946	78716	8249	84988	6723	86123	5597	84231	3955	99772	3314	49691
8L-5S		MI	49993	10946	78252	8216	85023	6680	86819	5560	86581	3928	103021	3490	48328
22-#11	1.55	MA	49941	10946	77808	8247	83759	6720	84559	5593	82193	3966	97152	3260	49363
9L-4S		MI	50571	10946	79213	8218	86268	6683	88350	5547	88799	3934	105705	3533	48354
22-#11	1.55	MA	49331	10946	76792	8262	82512	6735	83072	5607	80173	3977	94612	3200	48861
10L-3S		MI	51220	10946	80325	8203	87686	6669	90073	5552	91017	3924	108289	3619	48349
22-#11	1.55	MA	48734	10946	75883	8261	81289	6732	81527	5603	78018	3971	92034	3146	48250
11L-2S		MI	52148	10946	81693	8205	89440	6673	92213	5539	93929	3913	112250	3705	48328
22-#14	2.24	MA	56267	11471	90131	8526	99566	6900	103821	5698	108347	3884	131128	3501	72052
3L-10S		MI	48206	11471	76777	8557	82830	6947	84083	5734	82888	3923	99339	2843	64295
22-#14	2.24	MA	55305	11471	88459	8548	97435	6920	101231	5691	105013	3899	127248	3376	71957
4L-9S		MI	49033	11471	78169	8535	84539	6927	86121	5716	85655	3909	102765	2931	65207
22-#14	2.24	MA	54447	11471	87015	8545	95561	6916	98928	5710	101677	3889	123215	3315	71785
5L-8S		MI	49809	11471	79413	8539	86223	6932	88264	5723	88446	3895	106301	3009	66414
22-#14	2.24	MA	53631	11471	85661	8542	93686	6936	96635	5703	98655	3904	119367	3235	70919
6L-7S		MI	50557	11471	80685	8542	87955	6912	90313	5705	91439	3905	109882	3080	66975
22-#14	2.24	MA	52836	11471	84178	8564	91897	6931	94436	5722	95704	3920	115264	3105	70109
7L-6S		MI	51316	11471	82100	8520	89662	6917	92412	5687	94256	3891	113771	3209	67723
22-#14	2.24	MA	52054	11471	82846	8561	90082	6952	92289	5740	92566	3910	111493	3033	69515
8L-5S		MI	52096	11471	83392	8524	91451	6898	94599	5694	97138	3876	117418	3290	68550
22-#14	2.24	MA	51227	11471	81543	8558	88317	6947	90043	5734	89642	3925	107761	2956	68223
9L-4S		MI	52915	11471	84770	8527	93239	6903	96796	5676	100321	3887	121247	3350	68703
22-#14	2.24	MA	50361	11471	80084	8580	86527	6967	87908	5752	86742	3940	104145	2868	67242
10L-3S		MI	53833	11471	86365	8505	95272	6883	99267	5683	103500	3873	124922	3475	68785
22-#18	3.99	MA	59817	12802	100407	9339	112413	7522	119362	6057	129421	3765	160773	2798	121637
5L-8S		MI	53269	12802	89133	9336	98274	7512	102877	6083	108220	3773	133628	2260	109112
22-#18	3.99	MA	58424	12802	98024	9332	109111	7512	115327	6044	124103	3789	154106	2655	119878
6L-7S		MI	54545	12802	91371	9343	101321	7523	106483	6054	113485	3794	139852	2383	111482
22-#18	3.99	MA	57068	12802	95413	9370	105961	7546	111454	6075	118907	3813	146992	2424	116877
7L-6S		MI	55841	12802	93862	9307	104326	7490	110176	6024	118441	3772	146587	2614	114352
22-#18	3.99	MA	55733	12802	93067	9363	102766	7536	107674	6105	113386	3793	140429	2299	114394
8L-5S		MI	57171	12802	96136	9314	107474	7501	114024	6038	123511	3749	152897	2758	115976

RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis



f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
24-#11	1.70	MA	55163	11054	86663	8292	95279	6737	98652	5582	101339	3915	121899	3711	55091
2L-12S		MI	46771	11054	73191	8322	78420	6776	78739	5628	75578	3958	89077	3035	49794
24-#11	1.70	MA	54191	11054	85228	8290	93438	6734	96406	5595	98284	3926	117724	3624	55103
3L-11S		MI	47328	11054	74144	8306	79602	6762	80157	5615	77505	3948	91836	3112	50330
24-#11	1.70	MA	53513	11054	84062	8306	91952	6748	94600	5591	95959	3937	114998	3538	55083
4L-10S		MI	47896	11054	75012	8308	80770	6765	81631	5620	79561	3954	94284	3165	50885
24-#11	1.70	MA	52909	11054	83055	8304	90646	6746	92995	5604	93634	3931	112172	3495	55037
5L-9S		MI	48478	11054	75982	8293	81960	6751	83051	5607	81489	3944	96692	3226	51403
24-#11	1.70	MA	52334	11054	82113	8302	89339	6760	91398	5600	91529	3942	109470	3439	54954
6L-8S		MI	49032	11054	76849	8295	83133	6754	84544	5611	83434	3933	99177	3279	51698
24-#11	1.70	MA	51775	11054	81079	8318	88093	6757	89865	5613	89472	3953	106590	3350	54507
7E		MI	49559	11054	77735	8297	84340	6740	85972	5598	85521	3940	101687	3329	52090
24-#11	1.70	MA	51223	11054	80152	8316	86829	6772	88369	5627	87286	3946	103947	3299	54082
8L-6S		MI	50094	11054	78721	8282	85530	6743	87434	5585	87483	3929	104419	3419	52512
24-#11	1.70	MA	50633	11054	79244	8314	85600	6769	86805	5623	85249	3957	101327	3246	53759
9L-5S		MI	50643	11054	79621	8284	86777	6729	88959	5590	89493	3919	106981	3475	52582
24-#11	1.70	MA	50024	11054	78228	8330	84353	6783	85317	5636	83229	3968	98787	3185	53205
10L-4S		MI	51220	11054	80581	8286	88023	6732	90490	5577	91711	3926	109666	3517	52619
24-#11	1.70	MA	49430	11054	77319	8328	83130	6780	83773	5632	81074	3962	96209	3132	52607
11L-3S		MI	51866	11054	81693	8270	89440	6718	92213	5581	93929	3915	112250	3604	52630
24-#11	1.70	MA	48846	11054	76321	8344	81892	6795	82288	5645	79055	3973	93302	3055	52032
12L-2S		MI	52792	11054	83062	8272	91195	6721	94354	5568	96841	3905	116210	3690	52615
24-#14	2.45	MA	56265	11627	90517	8645	100072	6990	104448	5734	109390	3887	133197	3354	78335
4L-10S		MI	49138	11627	78737	8654	85343	7017	87149	5776	87058	3911	104979	2819	70222
24-#14	2.45	MA	55411	11627	89072	8642	98199	6986	102145	5752	106054	3877	129164	3293	78142
5L-9S		MI	49961	11627	80129	8633	87051	6997	89187	5758	89825	3896	108405	2907	71118
24-#14	2.45	MA	54598	11627	87719	8640	96323	7006	99853	5746	103033	3892	125316	3212	77164
6L-8S		MI	50734	11627	81373	8636	88736	7002	91329	5765	92616	3882	111941	2985	72292
24-#14	2.45	MA	53807	11627	86236	8662	94534	7001	97653	5764	100081	3907	121213	3082	76380
7E		MI	51479	11627	82645	8639	90467	6982	93378	5747	95610	3893	115522	3056	72948
24-#14	2.45	MA	53028	11627	84904	8659	92720	7021	95506	5783	96944	3897	117441	3011	75692
8L-6S		MI	52235	11627	84060	8618	92174	6987	95477	5729	98426	3878	119411	3185	73672
24-#14	2.45	MA	52205	11627	83601	8656	90955	7017	93261	5776	94019	3912	113710	2933	74433
9L-5S		MI	53011	11627	85352	8621	93964	6967	97665	5736	101309	3864	123058	3266	74607
24-#14	2.45	MA	51342	11627	82141	8678	89165	7037	91125	5795	91120	3927	110094	2846	73474
10L-4S		MI	53827	11627	86730	8624	95752	6973	99862	5718	104491	3874	126887	3327	74781
24-#18	4.35	MA	60067	13079	101633	9505	113737	7636	120970	6119	131782	3767	164424	2609	130836
6L-8S		MI	54844	13079	92569	9509	102678	7636	108250	6159	115530	3751	143398	2212	119264
24-#18	4.35	MA	58719	13079	99021	9543	110588	7670	117098	6150	126586	3791	157310	2378	127683
7E		MI	56112	13079	94807	9516	105726	7647	111856	6129	120796	3772	149622	2335	121757
24-#18	4.35	MA	57393	13079	96675	9536	107393	7660	113318	6181	121064	3771	150747	2254	125078
8L-6S		MI	57400	13079	97298	9480	108730	7614	115550	6099	125751	3750	156357	2566	124778

RECTANGULAR TIED COLUMNS 48" x 48"

BARS	RHO	AXIS	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
			ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.04	MA	54087	11014	83664	8254	90256	6736	91572	5631	90198	4088	105380	3879	35419
2L-3S		MI	51622	11014	80056	8247	85630	6770	85929	5662	82519	4112	95062	3658	35554
8-#18	1.39	MA	55789	11290	87273	8427	94882	6860	97216	5707	97877	4066	115699	3834	46784
2L-4S		MI	51619	11290	80724	8457	86509	6884	87018	5724	84337	4113	98666	3391	46800
10-#18	1.74	MA	57476	11567	90882	8599	99508	6984	102860	5782	105555	4043	126017	3788	58111
2L-5S		MI	51806	11567	81790	8624	87838	7042	88610	5830	86147	4071	101965	3239	57088
10-#18	1.74	MA	55041	11567	87273	8593	94882	7018	97216	5813	97877	4067	115699	3567	58138
3L-4S		MI	53332	11567	84333	8630	91135	7008	92661	5799	92015	4091	108984	3345	57975

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

ROUND SPIRAL COLUMNS 12" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.64	201	312	400	241	465	193	489	155	496	92	423	9	396
6-#6	2.33	203	340	437	255	506	202	536	159	517	79	473	-18	485
6-#7	3.18	206	375	481	274	554	214	590	164	622	75	531	-50	559
6-#8	4.19	210	416	530	296	609	226	653	170	701	64	595	-90	640
6-#9	5.31	216	462	580	319	667	240	718	175	730	47	679	-129	721
6-#10	6.74	224	520	641	348	737	257	798	181	883	32	761	-187	819
7-#5	1.92	205	323	387	260	466	211	503	169	521	102	467	12	438
7-#6	2.72	209	356	427	279	512	224	555	176	546	90	528	-16	540
7-#7	3.71	214	397	474	301	566	240	616	184	662	88	604	-49	633
7-#8	4.89	221	445	528	328	629	258	686	192	699	73	685	-92	728
7-#9	6.19	231	498	585	358	694	278	758	204	785	62	767	-141	818
8-#5	2.19	208	335	392	271	478	219	520	175	509	97	500	5	490
8-#6	3.11	212	372	437	293	530	234	579	183	619	98	571	-27	581
8-#7	4.24	218	418	489	320	591	252	649	193	706	91	655	-67	681
8-#8	5.59	227	473	549	351	661	274	728	203	805	81	749	-115	789

ROUND SPIRAL COLUMNS 14" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.21	323	401	585	323	701	264	746	214	755	139	659	42	497
6-#6	1.71	327	429	633	338	758	274	809	219	779	124	732	18	667
6-#7	2.34	332	464	690	357	826	287	884	228	929	126	817	-13	825
6-#8	3.08	338	505	756	379	902	302	971	235	968	109	914	-49	940
6-#9	3.90	345	550	826	404	983	318	1063	243	1152	107	1015	-90	1057
6-#10	4.95	356	609	914	436	1083	338	1177	253	1208	87	1138	-144	1198
6-#11	6.08	361	671	998	466	1159	351	1259	255	1396	68	1202	-213	1295
7-#5	1.41	329	412	556	348	693	286	756	234	790	153	723	49	560
7-#6	2.00	335	445	609	367	754	300	827	242	877	149	812	25	739
7-#7	2.73	344	485	672	390	827	317	911	251	917	134	916	-6	921
7-#8	3.59	354	533	745	419	911	337	1008	263	1103	137	1035	-43	1065
7-#9	4.55	367	586	822	450	1000	358	1112	275	1232	129	1159	-86	1211
7-#10	5.78	385	654	919	489	1112	386	1242	290	1391	118	1310	-142	1374
7-#11	7.09	395	728	1007	525	1206	408	1336	296	1505	95	1407	-216	1475
8-#5	1.61	332	423	563	361	708	295	777	241	767	146	762	42	627
8-#6	2.29	339	461	623	383	776	311	856	250	860	142	863	14	833
8-#7	3.12	348	507	693	411	858	331	951	262	1041	148	983	-21	995
8-#8	4.11	360	562	773	445	953	354	1060	275	1178	142	1134	-60	1150
8-#9	5.20	373	622	858	481	1053	380	1177	290	1324	135	1280	-108	1308
8-#10	6.60	394	700	964	528	1178	412	1323	308	1404	116	1458	-172	1500

ROUND SPIRAL COLUMNS 16" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#6	1.31	490	531	876	434	1065	355	1153	290	1186	187	1055	58	809
6-#7	1.79	498	566	946	453	1150	368	1250	297	1220	170	1169	30	1054
6-#8	2.36	506	607	1027	476	1248	384	1362	305	1446	175	1300	-3	1302
6-#9	2.98	516	652	1114	501	1354	401	1481	313	1595	167	1438	-41	1459
6-#10	3.79	529	711	1224	533	1487	424	1630	324	1782	156	1609	-92	1649
6-#11	4.66	536	774	1334	563	1606	442	1749	335	1927	136	1719	-158	1787
6-#14	6.71	577	923	1589	645	1898	493	2081	360	2345	100	2079	-295	2187
7-#5	1.08	492	514	763	449	978	372	1078	308	1128	209	1047	89	687
7-#6	1.53	501	547	829	469	1055	386	1165	316	1240	207	1164	68	910
7-#7	2.09	514	587	907	493	1147	404	1271	327	1283	190	1303	40	1169
7-#8	2.75	528	635	996	521	1252	425	1393	339	1531	200	1463	7	1443

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 16" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
7-#9	3.48	544	688	1093	553	1366	448	1524	353	1697	195	1632	-31	1653
7-#10	4.42	566	757	1214	593	1508	478	1689	370	1904	187	1841	-81	1888
7-#11	5.43	580	830	1336	631	1636	502	1832	382	1930	158	1978	-150	2058
7-#14	7.83	645	1004	1618	733	1961	573	2211	421	2534	141	2421	-294	2508
8-#5	1.23	495	525	765	463	995	383	1103	316	1088	200	1097	84	762
8-#6	1.75	505	563	839	486	1081	400	1202	326	1292	212	1230	59	1023
8-#7	2.39	518	609	927	515	1184	421	1320	339	1348	195	1389	28	1318
8-#8	3.14	533	664	1028	549	1303	445	1457	354	1513	192	1572	-11	1578
8-#9	3.98	550	724	1138	587	1430	472	1605	370	1811	202	1765	-55	1790
8-#10	5.05	574	802	1275	636	1590	507	1790	391	2049	196	2004	-113	2046
8-#11	6.21	591	886	1408	681	1733	535	1951	405	2086	166	2199	-183	2236
9-#10	5.68	601	848	1361	657	1695	525	1920	403	2205	186	2178	-136	2216
9-#11	6.98	624	942	1508	707	1863	559	2101	418	2255	154	2360	-222	2416
10-#10	6.32	622	894	1490	670	1817	531	2059	401	2375	170	2313	-180	2358

ROUND SPIRAL COLUMNS 18" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#6	1.04	698	647	1170	544	1445	447	1570	368	1619	248	1451	101	951
6-#7	1.41	708	681	1253	563	1545	460	1688	376	1766	244	1595	75	1245
6-#8	1.86	720	723	1350	585	1662	476	1826	385	1937	238	1760	44	1579
6-#9	2.36	733	768	1454	610	1788	494	1976	395	2121	232	1936	10	1911
6-#10	2.99	750	827	1586	643	1948	516	2165	408	2351	223	2156	-36	2174
6-#11	3.68	759	889	1722	673	2103	536	2322	414	2543	206	2315	-98	2360
6-#14	5.31	805	1039	2033	756	2483	594	2743	441	3072	177	2797	-227	2876
7-#6	1.21	712	663	1090	585	1419	485	1582	401	1679	271	1593	114	1086
7-#7	1.65	728	703	1183	609	1529	503	1709	412	1841	269	1767	89	1398
7-#8	2.17	748	751	1291	637	1656	524	1856	425	1895	249	1969	58	1752
7-#9	2.75	769	804	1407	669	1793	548	2014	440	2235	263	2184	24	2107
7-#10	3.49	796	872	1552	710	1967	579	2215	459	2494	259	2452	-22	2467
7-#11	4.29	813	946	1705	749	2134	605	2396	472	2717	246	2649	-84	2701
7-#14	6.19	888	1120	2047	853	2536	681	2865	516	3085	211	3239	-213	3325
8-#6	1.38	716	679	1095	603	1451	500	1624	412	1626	259	1676	107	1212
8-#7	1.89	733	725	1199	632	1575	522	1766	426	1925	276	1875	78	1579
8-#8	2.48	754	780	1320	666	1719	547	1932	442	2138	275	2105	43	1980
8-#9	3.14	775	840	1450	704	1874	575	2111	459	2368	272	2351	4	2341
8-#10	3.99	803	918	1614	754	2068	611	2337	482	2659	269	2656	-49	2676
8-#11	4.90	823	1002	1788	801	2251	642	2541	498	2915	256	2883	-121	2929
8-#14	7.07	904	1201	2177	926	2704	730	3068	550	3590	240	3558	-271	3634
9-#10	4.49	835	964	1728	776	2187	627	2489	493	2855	261	2859	-75	2898
9-#11	5.52	862	1058	1914	828	2396	663	2726	513	3144	246	3134	-149	3176
10-#10	4.99	858	1010	1891	788	2339	633	2652	490	3075	247	3043	-112	3059
10-#11	6.13	891	1114	2098	844	2570	672	2918	510	3387	227	3329	-201	3373
11-#10	5.49	883	1056	1913	835	2426	673	2762	525	3219	262	3277	-126	3300
11-#11	6.74	923	1171	2137	900	2677	718	3048	550	3570	245	3595	-220	3631
12-#10	5.99	916	1101	1992	869	2518	701	2899	545	3392	268	3489	-149	3508

ROUND SPIRAL COLUMNS 20" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.15	969	811	1618	686	2020	563	2212	463	2163	291	2103	123	1437
6-#8	1.51	985	852	1730	708	2156	579	2371	473	2352	287	2304	95	1829
6-#9	1.91	1002	897	1852	733	2303	597	2545	483	2738	302	2519	62	2245
6-#10	2.43	1023	956	2006	766	2488	620	2766	497	3014	295	2788	20	2731
6-#11	2.98	1035	1019	2170	796	2674	640	2978	507	3035	261	2996	-37	3015
6-#14	4.30	1088	1168	2535	880	3120	699	3499	539	3894	257	3603	-156	3658
6-#18	7.64	1254	1547	3409	1092	4194	848	4696	610	5396	187	4977	-482	5082
7-#7	1.34	993	832	1506	739	1985	613	2233	507	2400	342	2318	140	1635
7-#8	1.76	1017	880	1632	768	2133	635	2406	521	2621	340	2563	112	2051
7-#9	2.23	1042	934	1767	800	2293	659	2593	536	2670	315	2824	80	2493
7-#10	2.83	1078	1002	1938	841	2496	690	2828	556	3165	335	3152	38	3014
7-#11	3.48	1100	1075	2121	880	2699	717	3049	570	3212	303	3409	-19	3422
7-#14	5.01	1186	1249	2526	985	3184	796	3608	618	4164	312	4150	-137	4220
8-#7	1.53	999	854	1515	763	2035	634	2299	523	2331	327	2448	132	1832
8-#8	2.01	1023	909	1655	798	2205	660	2494	540	2747	350	2727	100	2322
8-#9	2.55	1049	970	1807	836	2390	689	2704	558	3017	348	3025	63	2823
8-#10	3.23	1085	1048	1998	886	2620	726	2970	582	3135	323	3399	15	3354
8-#11	3.97	1109	1131	2205	933	2843	758	3218	599	3425	314	3694	-51	3715
8-#14	5.73	1198	1330	2662	1059	3384	850	3847	656	4183	305	4540	-188	4588
9-#10	3.64	1122	1093	2137	908	2761	738	3140	591	3591	340	3643	-11	3650
9-#11	4.47	1154	1188	2365	961	3005	778	3426	612	3943	328	3978	-83	4023
9-#14	6.45	1272	1412	2873	1100	3614	881	4147	677	4865	314	4934	-234	4983
10-#10	4.04	1149	1139	2343	920	2937	746	3334	587	3839	324	3862	-45	3850
10-#11	4.97	1186	1244	2592	976	3216	785	3654	609	4250	311	4236	-126	4248
10-#14	7.16	1318	1493	3172	1125	3900	895	4461	675	5290	291	5298	-298	5319
11-#10	4.45	1177	1185	2351	969	3025	787	3460	625	4020	343	4147	-57	4159
11-#11	5.46	1221	1300	2620	1034	3334	834	3805	653	4449	330	4563	-143	4585
12-#10	4.85	1214	1231	2441	1003	3131	817	3610	645	3944	328	4402	-77	4424
12-#11	5.96	1266	1356	2729	1075	3461	869	3992	677	4377	315	4859	-171	4873
13-#10	5.26	1238	1277	2558	1032	3288	836	3782	659	4440	345	4632	-108	4653
14-#10	5.66	1282	1322	2708	1051	3453	851	3979	664	4672	335	4848	-139	4880

ROUND SPIRAL COLUMNS 22" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.25	1303	995	2173	845	2738	694	3017	570	2990	358	2939	148	2079
6-#9	1.58	1326	1040	2313	870	2906	712	3214	581	3457	379	3193	117	2559
6-#10	2.00	1352	1099	2489	903	3118	735	3466	595	3778	373	3512	78	3155
6-#11	2.46	1369	1162	2681	933	3334	755	3712	605	3792	336	3771	25	3693
6-#14	3.55	1430	1311	3102	1017	3847	814	4322	639	4819	341	4504	-87	4537
6-#18	6.31	1609	1690	4113	1230	5089	965	5784	724	6609	283	6195	-389	6263
7-#7	1.10	1314	975	1879	883	2522	735	2850	611	3060	421	2965	196	1877
7-#8	1.45	1343	1023	2023	912	2691	757	3048	626	3093	392	3252	169	2356
7-#9	1.84	1374	1077	2179	944	2874	781	3263	642	3589	419	3561	140	2867
7-#10	2.34	1414	1145	2374	986	3106	813	3536	662	3938	417	3950	101	3501
7-#11	2.87	1445	1218	2590	1025	3344	841	3799	678	4263	408	4268	48	4080
7-#14	4.14	1544	1392	3056	1131	3902	921	4448	728	4761	373	5162	-62	5197
7-#18	7.37	1810	1834	4174	1401	5249	1122	6003	850	7117	370	7227	-362	7282

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 22" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#7	1.26	1320	997	1878	909	2572	758	2928	630	3173	432	3118	189	2089
8-#8	1.66	1350	1052	2038	944	2765	784	3151	647	3228	403	3445	159	2652
8-#9	2.10	1382	1113	2212	982	2976	813	3393	666	3518	403	3797	125	3255
8-#10	2.67	1421	1191	2430	1032	3243	851	3700	691	4162	431	4240	80	3960
8-#11	3.28	1454	1274	2672	1079	3516	886	3993	709	4528	423	4605	19	4541
8-#14	4.74	1554	1473	3197	1206	4147	980	4724	769	5471	417	5624	-107	5651
9-#10	3.01	1468	1236	2595	1054	3409	863	3886	698	4135	396	4527	55	4302
9-#11	3.69	1506	1331	2861	1107	3706	899	4221	721	4845	414	4942	-12	4949
9-#14	5.33	1637	1555	3451	1248	4416	1003	5053	788	5918	406	6095	-152	6153
10-#10	3.34	1498	1282	2848	1065	3618	869	4113	693	4700	406	4741	14	4700
10-#11	4.10	1541	1387	3142	1122	3946	909	4487	716	4834	368	5242	-53	5222
10-#14	5.92	1685	1636	3814	1273	4738	1022	5421	785	5979	357	6524	-212	6510
11-#10	3.68	1530	1328	2839	1116	3705	913	4255	735	4583	400	5117	12	5070
11-#11	4.51	1581	1443	3153	1182	4065	961	4659	764	5427	419	5632	-68	5643
11-#14	6.51	1754	1717	3866	1354	4929	1090	5669	848	6741	411	7054	-237	7034
12-#10	4.01	1573	1374	2938	1152	3824	943	4416	754	5162	440	5415	-5	5417
12-#11	4.92	1631	1499	3276	1224	4209	997	4861	787	5711	430	5980	-92	6005
13-#10	4.34	1598	1420	3070	1180	4007	963	4615	769	5395	432	5686	-36	5699
13-#11	5.33	1664	1556	3434	1260	4424	1021	5095	805	6000	422	6296	-130	6317
14-#10	4.68	1648	1465	3248	1198	4193	976	4848	774	5661	422	5938	-65	5953
14-#11	5.75	1724	1612	3638	1283	4647	1039	5368	812	6317	409	6593	-167	6628
15-#10	5.01	1669	1511	3325	1241	4307	1012	4983	803	5492	408	6254	-84	6262
16-#10	5.35	1711	1557	3412	1276	4451	1042	5156	822	6114	443	6547	-101	6560

ROUND SPIRAL COLUMNS 24" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.05	1683	1152	2685	995	3418	820	3771	678	3728	434	3675	205	2330
6-#9	1.33	1709	1197	2842	1020	3606	838	3993	688	4287	462	3968	176	2874
6-#10	1.68	1743	1256	3041	1053	3845	861	4275	702	4654	457	4338	138	3552
6-#11	2.07	1765	1318	3261	1082	4092	881	4555	712	4986	445	4648	88	4223
6-#14	2.98	1837	1468	3738	1167	4672	941	5244	747	5857	430	5509	-17	5516
6-#18	5.31	2033	1847	4889	1382	6082	1093	6924	837	7408	356	7521	-300	7565
7-#8	1.22	1730	1180	2469	1071	3338	892	3795	741	4119	508	4048	231	2671
7-#9	1.55	1767	1233	2645	1103	3545	916	4036	757	4429	507	4404	202	3250
7-#10	1.97	1814	1301	2866	1145	3806	948	4343	778	4824	506	4853	166	3972
7-#11	2.41	1849	1375	3114	1183	4079	975	4650	794	5197	498	5234	116	4682
7-#14	3.48	1967	1549	3644	1291	4711	1056	5396	847	5742	460	6283	13	6229
7-#18	6.19	2259	1991	4918	1563	6243	1261	7180	975	7898	440	8736	-267	8811
8-#8	1.40	1739	1209	2472	1104	3412	920	3913	765	4283	522	4261	221	2986
8-#9	1.77	1776	1269	2668	1142	3649	949	4187	784	4633	522	4670	190	3668
8-#10	2.25	1823	1347	2913	1192	3948	987	4535	810	5079	523	5188	148	4519
8-#11	2.76	1858	1431	3191	1239	4263	1022	4873	829	5498	515	5625	91	5281
8-#14	3.98	1976	1630	3784	1366	4991	1119	5708	891	6135	479	6819	-27	6826
8-#18	7.07	2300	2135	5218	1690	6728	1361	7718	1044	8559	466	9615	-350	9618
9-#10	2.53	1873	1393	3126	1210	4146	999	4739	816	5375	515	5517	123	4926
9-#11	3.10	1922	1487	3436	1263	4488	1036	5122	839	5469	474	6013	60	5745
9-#14	4.48	2068	1711	4080	1408	5293	1141	6065	908	7084	503	7366	-71	7395
9-#18	7.96	2499	2280	5693	1768	7210	1415	8352	1081	10037	481	10530	-428	10472

ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sideway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.81	1912	1439	3408	1222	4392	1004	4999	809	5673	495	5760	83	5434
10-#11	3.45	1962	1543	3751	1280	4768	1045	5428	833	6221	485	6304	11	6262
10-#14	4.97	2120	1792	4516	1434	5669	1159	6488	904	7612	475	7859	-128	7817
11-#10	3.09	1943	1485	3379	1277	4472	1050	5152	853	5913	520	6195	83	5818
11-#11	3.79	2006	1600	3741	1343	4884	1098	5620	884	6504	512	6810	8	6777
11-#14	5.47	2194	1874	4549	1517	5863	1229	6767	971	8004	509	8477	-150	8462
12-#10	3.37	1996	1530	3487	1314	4604	1082	5328	873	6194	533	6537	68	6260
12-#11	4.14	2062	1656	3875	1387	5045	1136	5835	907	6845	527	7212	-13	7215
12-#14	5.97	2271	1955	4749	1577	6096	1281	7083	1004	7904	491	9036	-183	8986
13-#10	3.65	2024	1576	3635	1341	4814	1101	5554	888	6461	526	6848	37	6679
13-#11	4.48	2098	1712	4051	1421	5292	1160	6103	925	6679	483	7578	-51	7595
13-#14	6.47	2337	2036	4995	1629	6439	1316	7458	1030	8923	514	9548	-238	9491
14-#10	3.93	2081	1622	3844	1358	5023	1113	5812	892	6763	515	7135	10	7093
14-#11	4.83	2165	1769	4290	1444	5541	1176	6415	932	7516	505	7918	-85	7937
15-#10	4.21	2101	1668	3918	1403	5146	1150	5970	924	6541	496	7501	-8	7503
15-#11	5.17	2196	1825	4395	1497	5695	1220	6598	968	7295	488	8345	-110	8348
16-#10	4.49	2147	1714	4013	1439	5302	1181	6165	944	7264	538	7837	-23	7836
16-#11	5.52	2255	1881	4512	1540	5889	1257	6832	991	8124	530	8740	-130	8748
17-#10	4.77	2172	1760	4180	1467	5500	1197	6374	958	7047	500	8173	-50	8146
18-#10	5.05	2215	1805	4391	1485	5717	1212	6607	964	7861	530	8452	-77	8457

ROUND SPIRAL COLUMNS 26" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#9	1.13	2159	1367	3445	1183	4412	976	4890	805	4873	513	4853	238	3189
6-#10	1.44	2197	1426	3666	1216	4677	999	5203	819	5635	546	5274	202	3949
6-#11	1.76	2228	1489	3916	1245	4955	1018	5518	829	6031	537	5636	154	4708
6-#14	2.54	2312	1638	4450	1330	5603	1078	6285	865	6550	489	6625	55	6422
6-#18	4.52	2529	2017	5741	1546	7182	1232	8164	956	8764	451	8962	-213	8990
7-#9	1.32	2227	1403	3170	1276	4312	1063	4925	882	5392	603	5362	269	3642
7-#10	1.67	2282	1472	3416	1318	4603	1094	5266	903	5444	562	5873	234	4452
7-#11	2.06	2323	1545	3699	1356	4911	1122	5611	920	6254	595	6317	187	5256
7-#14	2.97	2460	1719	4292	1464	5618	1204	6445	974	7325	592	7521	90	7102
7-#18	5.27	2783	2161	5723	1738	7336	1410	8474	1109	9268	539	10366	-174	10415
8-#9	1.51	2237	1439	3179	1317	4416	1098	5096	913	5621	620	5644	256	4087
8-#10	1.91	2292	1517	3452	1367	4748	1136	5484	939	5710	580	6227	217	5042
8-#11	2.35	2334	1601	3766	1413	5102	1170	5868	958	6153	574	6761	165	5988
8-#14	3.39	2468	1800	4428	1541	5914	1268	6806	1023	7799	615	8132	54	7921
8-#18	6.03	2815	2305	6034	1866	7897	1517	9078	1181	10730	610	11373	-249	11363
9-#10	2.15	2349	1563	3698	1384	4980	1148	5706	943	6437	612	6619	194	5529
9-#11	2.64	2401	1657	4048	1436	5366	1185	6138	966	6987	606	7201	135	6520
9-#14	3.81	2571	1881	4805	1577	6268	1291	7193	1038	8372	605	8755	11	8706
9-#18	6.78	3029	2450	6575	1944	8459	1559	9762	1215	10929	554	12425	-325	12392
10-#10	2.39	2387	1609	4026	1393	5264	1150	6002	934	6318	551	6894	155	6102
10-#11	2.94	2452	1714	4417	1452	5690	1191	6485	958	6893	543	7527	86	7168
10-#14	4.24	2628	1963	5283	1607	6700	1307	7673	1032	8346	537	9229	-58	9243
10-#18	7.53	3130	2594	7355	1997	9150	1598	10562	1215	11888	514	13388	-424	13218

ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sideway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#10	2.63	2429	1655	3977	1452	5336	1199	6159	981	6569	578	7356	151	6569
11-#11	3.23	2501	1770	4386	1518	5800	1247	6689	1012	7190	572	8106	85	7688
11-#14	4.66	2708	2044	5290	1693	6894	1380	7981	1103	9384	612	10021	-64	10001
12-#10	2.87	2484	1701	4091	1490	5480	1232	6353	1003	6852	589	7750	141	7123
12-#11	3.53	2565	1826	4530	1563	5977	1286	6924	1037	7539	586	8561	67	8267
12-#14	5.09	2792	2125	5509	1755	7152	1433	8317	1136	9923	633	10655	-93	10658
13-#10	3.11	2515	1747	4256	1516	5711	1251	6607	1017	7651	626	8112	112	7559
13-#11	3.82	2603	1883	4726	1597	6256	1310	7225	1055	8436	620	8977	30	8833
13-#14	5.51	2860	2206	5781	1806	7539	1469	8740	1163	10416	621	11240	-147	11224
14-#10	3.35	2584	1792	4498	1533	5949	1261	6891	1019	7456	574	8450	87	8050
14-#11	4.11	2678	1939	5002	1619	6532	1325	7568	1060	8839	607	9362	-3	9363
14-#14	5.93	2962	2287	6145	1841	7923	1495	9227	1173	10988	604	11788	-194	11782
15-#10	3.59	2604	1838	4567	1578	6080	1301	7064	1053	8250	631	8847	68	8518
15-#11	4.41	2709	1995	5104	1673	6698	1371	7780	1099	8552	584	9848	-26	9854
16-#10	3.83	2654	1884	4670	1615	6273	1325	7289	1075	7967	597	9219	55	8976
16-#11	4.70	2772	2051	5232	1717	6906	1408	8041	1124	8871	592	10296	-44	10288
17-#10	4.07	2682	1930	4858	1643	6469	1348	7515	1089	8857	637	9604	28	9469
17-#11	5.00	2806	2108	5453	1751	7170	1428	8319	1141	9887	631	10745	-78	10696
18-#10	4.31	2727	1976	5095	1660	6721	1363	7777	1094	9192	631	9929	4	9913
18-#11	5.29	2864	2164	5733	1774	7459	1447	8629	1148	10301	625	11118	-110	11110
19-#10	4.54	2766	2021	5169	1704	6843	1398	7979	1121	9466	643	10335	-14	10330
20-#10	4.78	2808	2067	5313	1737	7023	1424	8184	1142	9116	607	10690	-32	10682

ROUND SPIRAL COLUMNS 28" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	1.24	2725	1610	4372	1393	5624	1148	6260	946	6740	642	6329	269	4347
6-#11	1.52	2759	1672	4652	1422	5934	1167	6609	955	7186	633	6743	224	5195
6-#14	2.19	2862	1822	5243	1507	6649	1227	7456	991	7756	583	7862	129	7183
6-#18	3.90	3102	2201	6675	1723	8397	1381	9534	1084	10244	551	10526	-126	10543
7-#9	1.14	2759	1587	3757	1463	5183	1221	5938	1018	6055	659	6426	338	4043
7-#10	1.44	2822	1655	4030	1505	5504	1253	6313	1039	6974	707	7002	305	4942
7-#11	1.77	2871	1729	4347	1543	5848	1281	6697	1056	6947	653	7524	261	5841
7-#14	2.56	3018	1903	5005	1651	6630	1363	7618	1110	8632	698	8885	169	7963
7-#18	4.55	3387	2345	6595	1926	8536	1571	9874	1248	11532	689	12126	-80	12150
8-#9	1.30	2771	1623	3749	1506	5284	1258	6123	1051	6741	725	6745	328	4509
8-#10	1.65	2834	1701	4050	1556	5650	1296	6556	1078	7289	727	7391	289	5567
8-#11	2.03	2884	1785	4401	1602	6044	1331	6986	1098	7819	722	7990	239	6628
8-#14	2.92	3027	1984	5133	1730	6940	1429	8029	1164	9158	724	9556	135	8977
8-#18	5.20	3412	2489	6911	2056	9132	1679	10563	1327	12423	725	13262	-149	13251
9-#10	1.86	2898	1747	4331	1572	5914	1308	6797	1081	7123	669	7826	266	6145
9-#11	2.28	2959	1841	4722	1624	6348	1346	7279	1104	7693	664	8510	211	7256
9-#14	3.29	3150	2065	5559	1765	7348	1453	8446	1177	9122	665	10272	94	9787
9-#18	5.85	3641	2634	7593	2124	9782	1724	11298	1358	13518	710	14452	-224	14464

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 28" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.06	2940	1793	4710	1578	6243	1308	7130	1069	7997	693	8152	229	6754
10-#11	2.53	3008	1898	5147	1636	6720	1350	7669	1094	8683	685	8876	164	8020
10-#14	3.65	3213	2146	6103	1792	7839	1467	8983	1169	10404	681	10800	27	10677
10-#18	6.50	3743	2778	8425	2187	10563	1761	12194	1357	14618	663	15377	-342	15340
11-#10	2.27	2985	1839	4634	1641	6302	1360	7290	1119	8296	725	8649	226	7305
11-#11	2.79	3065	1954	5093	1707	6820	1408	7879	1151	9037	720	9484	159	8622
11-#14	4.02	3299	2228	6094	1883	8028	1542	9305	1242	10170	674	11651	17	11573
11-#18	7.15	3941	2922	8526	2328	10980	1879	12795	1472	15444	721	16842	-360	16580
12-#10	2.48	3051	1885	4755	1680	6457	1394	7502	1142	8621	738	9089	217	7912
12-#11	3.04	3137	2010	5246	1753	7011	1449	8136	1177	9438	734	10005	146	9313
12-#14	4.38	3393	2309	6330	1947	8311	1597	9676	1277	11474	742	12387	-4	12386
13-#10	2.68	3081	1930	4938	1706	6711	1412	7784	1156	8968	733	9493	188	8437
13-#11	3.29	3179	2066	5462	1786	7317	1472	8472	1195	9191	680	10484	110	9901
13-#14	4.75	3464	2390	6628	1996	8741	1633	10147	1304	12043	733	13062	-55	13048
14-#10	2.89	3154	1976	5216	1721	6979	1421	8094	1156	9346	722	9860	164	9046
14-#11	3.55	3269	2123	5778	1807	7628	1485	8845	1197	9608	668	10932	81	10538
14-#14	5.12	3576	2471	7042	2030	9164	1656	10676	1313	12677	717	13674	-101	13671
15-#10	3.09	3177	2022	5276	1768	7117	1463	8282	1193	9626	739	10313	146	9533
15-#11	3.80	3299	2179	5874	1862	7805	1533	9076	1239	9931	686	11455	57	11162
15-#14	5.48	3640	2552	7219	2105	9435	1720	11012	1368	13177	741	14428	-135	14348
16-#10	3.30	3230	2068	5386	1806	7322	1487	8535	1216	9942	748	10728	135	10063
16-#11	4.05	3367	2235	6012	1907	8060	1563	9374	1266	11018	744	11947	40	11755
16-#14	5.85	3764	2634	7425	2168	9760	1773	11427	1403	13710	753	15116	-161	15035
17-#10	3.51	3263	2114	5596	1833	7541	1510	8780	1229	10296	746	11131	104	10580
17-#11	4.31	3403	2292	6259	1942	8320	1591	9673	1282	11443	742	12456	8	12416
18-#10	3.71	3316	2159	5861	1849	7823	1525	9071	1234	9946	689	11492	83	11095
18-#11	4.56	3465	2348	6570	1963	8651	1610	10018	1289	11094	685	12887	-22	12875
19-#10	3.92	3360	2205	5935	1894	7953	1561	9285	1261	10959	752	11958	68	11625
19-#11	4.81	3516	2404	6672	2016	8814	1652	10286	1322	12248	749	13423	-44	13403
20-#10	4.13	3404	2251	6088	1928	8150	1588	9510	1283	11302	762	12368	51	12115
20-#11	5.07	3573	2460	6862	2058	9053	1684	10557	1348	12646	758	13892	-67	13869
21-#10	4.33	3457	2297	6256	1959	8363	1611	9783	1297	11625	758	12767	27	12650
22-#10	4.54	3498	2343	6490	1983	8612	1626	10062	1308	11982	753	13130	0	13129

ROUND SPIRAL COLUMNS 30" DIA.

6-#10	1.08	3330	1807	5162	1584	6693	1308	7456	1082	7453	695	7513	340	4745
6-#11	1.32	3370	1870	5473	1612	7034	1327	7839	1092	8475	736	7978	296	5683
6-#14	1.91	3490	2019	6121	1697	7817	1387	8765	1128	9055	679	9228	205	7878
6-#18	3.40	3759	2398	7696	1913	9736	1542	11043	1221	12705	703	12220	-39	12226
7-#10	1.26	3439	1853	4711	1706	6517	1424	7494	1185	7708	763	8257	380	5441
7-#11	1.54	3497	1926	5063	1744	6898	1451	7917	1202	8191	757	8848	338	6438
7-#14	2.23	3663	2100	5786	1852	7755	1534	8925	1257	10081	811	10384	251	8780
7-#18	3.96	4074	2542	7536	2128	9849	1744	11400	1396	13277	806	14022	14	13953
8-#10	1.44	3453	1899	4711	1759	6661	1469	7748	1225	8604	841	8692	366	6098
8-#11	1.77	3511	1982	5100	1805	7096	1503	8237	1247	9189	836	9356	318	7271

ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.55	3674	2182	5903	1933	8076	1602	9385	1315	9950	784	11085	217	10029
8-#18	4.53	4094	2687	7854	2260	10478	1852	12182	1482	13310	790	15290	-50	15259
9-#10	1.62	3522	1945	5029	1774	6957	1480	8021	1228	8372	774	9169	343	6774
9-#11	1.99	3596	2039	5462	1826	7439	1518	8553	1252	9641	824	9929	290	8005
9-#14	2.86	3799	2263	6380	1967	8539	1626	9832	1325	11317	826	11903	178	10907
9-#18	5.09	4340	2831	8615	2328	11218	1900	12968	1510	14410	774	16618	-124	16625
10-#10	1.80	3572	1990	5466	1777	7337	1478	8393	1215	8744	750	9543	308	7415
10-#11	2.21	3650	2095	5949	1835	7864	1519	8987	1240	9447	743	10359	245	8816
10-#14	3.18	3881	2344	6995	1991	9093	1637	10430	1316	12008	793	12505	114	11940
10-#18	5.66	4446	2975	9551	2388	12093	1935	13962	1508	15532	729	17645	-238	17613
11-#10	1.98	3622	2036	5354	1843	7379	1533	8553	1267	9697	839	10078	304	8057
11-#11	2.43	3714	2151	5863	1910	7950	1581	9201	1299	9812	778	11009	240	9517
11-#14	3.50	3973	2425	6964	2087	9274	1716	10763	1392	12552	838	13420	103	12868
11-#18	6.22	4652	3120	9638	2534	12516	2056	14601	1625	17555	844	19282	-252	19026
12-#10	2.16	3696	2082	5481	1885	7543	1568	8783	1291	10045	851	10516	290	8697
12-#11	2.65	3794	2208	6026	1958	8156	1623	9481	1326	10941	849	11585	229	10325
12-#14	3.82	4077	2506	7216	2152	9580	1772	11167	1428	12291	801	14225	85	13820
12-#18	6.79	4819	3264	10113	2643	13065	2150	15306	1683	17410	820	20609	-301	20205
13-#10	2.34	3729	2128	5711	1906	7820	1585	9094	1305	9729	790	11009	268	9308
13-#11	2.87	3840	2264	6264	1990	8488	1645	9851	1344	10636	787	12115	193	10995
13-#14	4.14	4152	2588	7541	2200	10047	1807	11687	1455	13813	851	14977	34	14796
13-#18	7.36	5012	3408	10658	2735	13869	2216	16190	1733	19715	861	21851	-395	21397
14-#10	2.52	3810	2174	6001	1923	8122	1593	9430	1304	10124	780	11388	242	9951
14-#11	3.09	3929	2320	6622	2009	8837	1658	10257	1345	11100	775	12602	164	11742
14-#14	4.46	4275	2669	8008	2233	10518	1830	12259	1462	14510	835	15698	-6	15697
15-#10	2.70	3829	2219	6049	1972	8264	1637	9632	1342	10402	797	11906	228	10532
15-#11	3.31	3963	2376	6709	2066	9022	1708	10506	1389	12261	851	13191	142	12386
15-#14	4.77	4341	2750	8181	2310	10807	1896	12624	1519	14038	803	16490	-43	16471
16-#10	2.87	3893	2265	6165	2010	8481	1662	9903	1366	11490	863	12373	218	11171
16-#11	3.53	4036	2433	6856	2112	9293	1738	10839	1417	12675	861	13735	127	13071
16-#14	5.09	4472	2831	8403	2374	11206	1938	13092	1557	14585	815	17253	-66	17220
17-#10	3.05	3924	2311	6396	2038	8722	1685	10184	1376	11087	804	12794	187	11725
17-#11	3.75	4084	2489	7130	2146	9580	1766	11160	1433	12265	802	14268	90	13763
17-#14	5.41	4524	2912	8782	2425	11606	1979	13552	1582	15202	813	18006	-120	17912
18-#10	3.23	3974	2357	6692	2053	9031	1698	10497	1383	11446	796	13191	165	12317
18-#11	3.97	4149	2545	7474	2166	9948	1784	11541	1440	13616	850	14743	64	14419
19-#10	3.41	4024	2403	6765	2099	9173	1736	10723	1412	12596	868	13707	152	12872
19-#11	4.19	4206	2602	7576	2221	10121	1828	11824	1473	13079	808	15354	45	15131
20-#10	3.59	4076	2449	6926	2133	9387	1763	10969	1434	12965	878	14165	136	13437
20-#11	4.41	4266	2658	7779	2262	10381	1861	12120	1500	14462	878	15888	24	15761
21-#10	3.77	4135	2494	7112	2164	9616	1786	11269	1448	12436	817	14599	112	14006
21-#11	4.63	4334	2714	7999	2301	10660	1889	12479	1517	14887	873	16415	-6	16411
22-#10	3.95	4184	2540	7370	2187	9892	1801	11569	1458	13715	870	14999	86	14545
23-#10	4.13	4250	2586	7490	2226	10067	1837	11809	1484	14049	881	15495	73	15141
24-#10	4.31	4290	2632	7635	2263	10277	1862	12075	1507	14396	888	15933	52	15674

ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.16	4064	2081	6385	1816	8266	1498	9218	1237	9915	845	9352	373	6171
6-#14	1.68	4202	2230	7092	1900	9117	1559	10222	1274	10496	781	10731	285	8574
6-#18	2.98	4502	2609	8810	2117	11206	1714	12701	1367	14539	817	14054	50	13834
7-#10	1.11	4139	2064	5463	1922	7650	1607	8817	1342	9049	875	9657	459	5954
7-#11	1.36	4206	2137	5852	1959	8068	1634	9279	1358	9578	869	10305	418	7045
7-#14	1.96	4392	2312	6640	2068	9000	1717	10375	1413	10905	869	11992	334	9611
7-#18	3.48	4850	2754	8552	2345	11283	1928	13070	1554	15176	931	16065	109	15452
8-#10	1.26	4155	2110	5439	1977	7789	1655	9083	1384	10072	962	10137	448	6634
8-#11	1.55	4223	2194	5867	2022	8265	1688	9617	1406	10713	958	10868	401	7919
8-#14	2.24	4405	2393	6740	2150	9329	1787	10880	1475	12316	964	12760	303	10942
8-#18	3.98	4867	2898	8866	2478	11942	2038	13945	1646	15169	909	17380	45	17187
9-#10	1.42	4231	2156	5797	1991	8117	1664	9387	1386	9763	885	10657	424	7417
9-#11	1.75	4313	2250	6273	2042	8645	1702	9969	1410	10446	881	11493	372	8769
9-#14	2.52	4543	2474	7273	2184	9844	1811	11361	1484	13014	948	13657	264	11957
9-#18	4.48	5129	3042	9708	2545	12774	2087	14781	1672	17506	955	18927	-22	18916
10-#10	1.58	4286	2201	6298	1990	8552	1659	9800	1370	10892	921	11037	387	8084
10-#11	1.94	4376	2306	6827	2047	9131	1701	10451	1395	11715	914	11985	330	9621
10-#14	2.80	4618	2555	7964	2203	10471	1820	12021	1473	12848	852	14355	204	13254
10-#18	4.97	5243	3187	10747	2601	13748	2120	15876	1668	17563	845	20060	-134	20041
11-#10	1.74	4342	2247	6142	2060	8573	1718	9959	1426	11252	960	11653	387	8826
11-#11	2.13	4442	2362	6701	2127	9199	1766	10666	1457	11333	892	12679	324	10430
11-#14	3.08	4723	2636	7899	2304	10639	1901	12363	1551	13404	898	15325	192	14203
11-#18	5.47	5457	3331	10821	2754	14171	2244	16542	1788	19820	973	21754	-159	21641
12-#10	1.89	4419	2293	6275	2103	8746	1755	10205	1451	11621	973	12134	374	9493
12-#11	2.33	4537	2419	6873	2177	9417	1809	10968	1486	12597	971	13312	316	11281
12-#14	3.36	4838	2717	8169	2371	10966	1960	12800	1589	15017	982	16210	176	15286
12-#18	5.97	5635	3475	11332	2865	14766	2340	17310	1848	19588	939	23248	-196	22909
13-#10	2.05	4461	2339	6527	2124	9047	1771	10545	1465	12033	968	12668	352	10200
13-#11	2.52	4581	2475	7169	2204	9777	1831	11373	1504	12220	901	13893	280	12052
13-#14	3.64	4918	2799	8523	2419	11471	1993	13369	1616	15722	975	17036	125	16301
13-#18	6.47	5828	3619	11920	2955	15635	2405	18278	1899	20704	928	24660	-286	24264
14-#10	2.21	4551	2385	6857	2139	9384	1777	10910	1461	11668	894	13061	325	10871
14-#11	2.72	4685	2531	7539	2225	10165	1842	11811	1503	12735	889	14394	249	12905
14-#14	3.92	5065	2880	9046	2450	11992	2014	13986	1621	15397	896	17793	84	17364
14-#18	6.96	6049	3764	12733	3020	16484	2452	19348	1917	23498	969	25994	-358	25424
15-#10	2.37	4571	2431	6889	2190	9527	1823	11124	1502	11962	911	13633	312	11537
15-#11	2.91	4714	2588	7612	2284	10357	1894	12077	1549	13099	909	15067	230	13636
15-#14	4.20	5133	2961	9213	2528	12297	2083	14379	1681	17057	986	18700	51	18400
16-#10	2.53	4630	2476	7010	2229	9756	1848	11411	1526	13192	987	14164	305	12208
16-#11	3.10	4798	2644	7767	2331	10643	1924	12433	1578	14485	985	15671	218	14430
16-#14	4.48	5267	3042	9449	2594	12720	2125	14895	1721	17696	1000	19538	30	19375
17-#10	2.68	4675	2522	7263	2256	10020	1871	11723	1536	12699	919	14603	273	12849
17-#11	3.30	4844	2700	8067	2365	10957	1952	12799	1590	13994	918	16225	179	15148
17-#14	4.76	5323	3123	9866	2644	13159	2167	15390	1745	17190	932	20357	-23	20332

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.84	4730	2568	7593	2270	10358	1883	12067	1543	13089	910	15035	251	13534
18-#11	3.49	4905	2756	8448	2384	11358	1969	13207	1600	14465	908	16745	153	15895
18-#14	5.04	5437	3205	10376	2675	13715	2195	15974	1756	19150	987	21099	-60	21046
19-#10	3.00	4785	2614	7662	2318	10507	1923	12303	1572	13426	925	15601	239	14146
19-#11	3.69	4976	2813	8549	2440	11546	2015	13504	1634	15931	991	17416	136	16638
19-#14	5.32	5519	3286	10555	2752	13996	2256	16414	1802	19761	1008	22036	-88	21937
20-#10	3.16	4829	2660	7831	2352	10740	1951	12569	1596	14778	1001	16084	223	14800
20-#11	3.88	5047	2869	8762	2481	11827	2049	13825	1662	16415	1003	18017	117	17358
21-#10	3.32	4900	2706	8035	2383	10986	1973	12896	1610	14166	932	16578	201	15394
21-#11	4.07	5122	2925	9004	2520	12126	2077	14217	1679	16883	999	18580	87	18112
22-#10	3.47	4944	2751	8319	2405	11290	1987	13218	1619	15602	994	17015	175	16014
22-#11	4.27	5180	2982	9337	2549	12485	2095	14609	1692	16234	927	19103	55	18798
23-#10	3.63	5018	2797	8442	2445	11471	2024	13477	1645	14893	939	17542	162	16624
23-#11	4.46	5265	3038	9498	2596	12716	2139	14924	1723	16642	940	19749	38	19553
24-#10	3.79	5065	2843	8600	2482	11698	2050	13760	1669	16334	1013	18018	141	17230
25-#10	3.95	5133	2889	8817	2510	11973	2072	14069	1682	16744	1013	18537	126	17853
26-#10	4.11	5190	2935	9107	2530	12248	2091	14397	1695	16018	943	19038	105	18438

ROUND SPIRAL COLUMNS 34" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.03	4846	2306	7394	2033	9638	1681	10754	1393	11517	962	10872	454	6660
6-#14	1.49	4989	2455	8159	2117	10557	1741	11838	1429	12951	954	12382	368	9272
6-#18	2.64	5337	2834	10021	2334	12817	1897	14517	1523	16507	935	16036	142	15359
7-#11	1.20	5003	2362	6716	2189	9364	1829	10795	1524	11117	987	11916	503	7662
7-#14	1.73	5210	2536	7571	2297	10373	1912	11978	1580	12554	989	13747	421	10456
7-#18	3.08	5702	2978	9645	2575	12846	2123	14894	1722	16090	991	18236	205	16999
8-#10	1.12	4945	2335	6237	2209	9040	1852	10567	1553	10924	1018	11739	534	7174
8-#11	1.37	5022	2418	6704	2254	9557	1885	11146	1574	11573	1015	12534	488	8573
8-#14	1.98	5227	2617	7649	2382	10707	1984	12508	1644	14136	1094	14590	393	11862
8-#18	3.52	5712	3123	9952	2710	13532	2236	15859	1820	17181	1035	19625	142	18955
9-#10	1.26	5028	2380	6638	2222	9404	1860	10905	1555	11307	1004	12299	510	8063
9-#11	1.55	5121	2475	7158	2273	9978	1897	11538	1578	12047	1000	13212	459	9548
9-#14	2.23	5377	2699	8239	2414	11272	2007	13043	1653	14875	1076	15566	354	13020
9-#18	3.97	6014	3267	10878	2776	14455	2285	16748	1843	18420	1014	21318	76	20883
10-#10	1.40	5090	2426	7209	2217	9898	1852	11361	1535	12579	1047	12683	470	8761
10-#11	1.72	5191	2531	7786	2274	10528	1894	12068	1560	13470	1040	13719	415	10436
10-#14	2.48	5459	2780	9015	2430	11979	2014	13766	1639	14641	970	16356	297	14386
10-#18	4.41	6138	3411	12025	2828	15534	2317	17945	1837	21158	1036	22631	-28	22627
11-#10	1.54	5152	2472	7003	2292	9893	1915	11516	1595	12969	1088	13382	474	9610
11-#11	1.89	5264	2587	7612	2358	10573	1963	12283	1626	13935	1084	14504	413	11362
11-#14	2.73	5574	2861	8907	2535	12129	2099	14115	1721	15245	1020	17386	284	15498
11-#18	4.85	6361	3556	12078	2987	15954	2443	18636	1960	22248	1108	24412	-57	24373
12-#10	1.68	5236	2518	7138	2336	10073	1953	11778	1621	12470	1029	13907	463	10301
12-#11	2.06	5363	2643	7791	2410	10802	2008	12606	1656	13456	1027	15126	397	12249
12-#14	2.97	5701	2942	9195	2605	12477	2159	14585	1760	17028	1113	18253	257	16801
12-#18	5.29	6553	3700	12623	3101	16592	2542	19464	2022	21919	1065	26044	-89	25779

ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sideway

f'_c = 4,000 psi f_y = 60,000 psi

ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
13-#10	1.82	5283	2564	7414	2356	10398	1968	12148	1635	12885	1024	14467	440	11108
13-#11	2.23	5417	2700	8114	2436	11191	2028	13046	1674	13956	1022	15826	370	13130
13-#14	3.22	5787	3023	9632	2645	13020	2191	15203	1788	17791	1106	19251	220	17848
13-#18	5.73	6748	3844	13257	3189	17524	2605	20518	2073	24804	1131	27590	-178	27403
14-#10	1.96	5380	2609	7789	2370	10772	1973	12542	1629	14314	1086	14887	413	11804
14-#11	2.41	5531	2756	8531	2456	11621	2038	13519	1671	14523	1010	16341	338	14023
14-#14	3.47	5929	3105	10161	2681	13595	2211	15866	1789	17403	1019	20032	177	19046
14-#18	6.17	6983	3989	14154	3253	18454	2651	21663	2089	24493	1034	29069	-245	28713
15-#10	2.10	5399	2655	7801	2422	10915	2022	12767	1672	14651	1106	15515	400	12562
15-#11	2.58	5561	2812	8587	2516	11816	2092	13800	1719	14907	1031	17079	320	14853
15-#14	3.72	6007	3186	10317	2761	13913	2282	16285	1852	19238	1118	21050	148	20123
15-#18	6.61	7169	4133	14560	3383	19074	2763	22417	2187	25478	1071	30683	-312	30233
16-#10	2.24	5467	2701	7926	2462	11154	2047	13070	1696	14053	1043	16101	395	13262
16-#11	2.75	5639	2869	8749	2564	12117	2123	14176	1748	15362	1042	17762	311	15742
16-#14	3.97	6157	3267	10567	2827	14359	2325	16833	1892	19930	1134	21980	130	21225
17-#10	2.38	5512	2747	8200	2489	11443	2070	13413	1707	15497	1114	16567	363	13990
17-#11	2.92	5696	2925	9075	2597	12459	2151	14580	1761	17000	1114	18338	272	16547
17-#14	4.21	6217	3348	11019	2877	14836	2366	17394	1911	20711	1132	22830	75	22393
18-#10	2.52	5576	2793	8566	2502	11810	2080	13788	1713	15947	1105	17035	341	14707
18-#11	3.09	5768	2981	9496	2615	12895	2166	15024	1770	16374	1030	18902	245	17415
18-#14	4.46	6337	3429	11578	2907	15438	2393	18015	1928	21487	1119	23640	38	23423
19-#10	2.66	5633	2839	8629	2551	11964	2122	14034	1743	16338	1122	17651	331	15404
19-#11	3.26	5839	3037	9594	2673	13093	2214	15335	1806	16812	1047	19634	230	18184
19-#14	4.71	6425	3510	11761	2986	15742	2457	18477	1975	22150	1143	24661	13	24597
20-#10	2.80	5684	2884	8806	2585	12217	2151	14320	1767	15638	1056	18160	313	16126
20-#11	3.44	5912	3094	9817	2715	13397	2249	15682	1834	17291	1059	20265	210	19001
20-#14	4.96	6537	3592	12095	3045	16178	2505	18973	2014	22890	1160	25578	-15	25557
21-#10	2.94	5757	2930	9029	2616	12480	2172	14670	1781	17188	1130	18695	293	16788
21-#11	3.61	5988	3150	10081	2753	13716	2276	16106	1851	17773	1056	20901	183	19783
22-#10	3.08	5809	2976	9340	2638	12813	2186	15019	1789	17652	1126	19186	267	17511
22-#11	3.78	6047	3206	10445	2781	14108	2294	16525	1863	19595	1126	21470	151	20572
23-#10	3.22	5882	3022	9465	2678	13019	2220	15296	1817	18027	1137	19741	254	18147
23-#11	3.95	6149	3263	10611	2829	14349	2339	16863	1895	20057	1140	22159	135	21384
24-#10	3.36	5927	3068	9634	2717	13242	2250	15596	1840	17206	1069	20259	234	18829
24-#11	4.12	6214	3319	10818	2875	14644	2370	17233	1923	19178	1072	22775	109	22144
25-#10	3.50	6005	3114	9868	2743	13540	2272	15930	1854	18878	1145	20794	216	19476
25-#11	4.30	6305	3375	11099	2908	15001	2397	17635	1940	21082	1148	23450	90	22952
26-#10	3.64	6060	3159	10187	2764	13837	2290	16290	1867	18034	1065	21346	197	20136
27-#10	3.78	6126	3205	10302	2805	14058	2322	16560	1890	18403	1075	21877	182	20793
28-#10	3.92	6197	3251	10498	2838	14299	2352	16857	1913	18803	1084	22429	163	21427

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sideway

f'_c = 4,000 psi f_y = 60,000 psi

ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.33	5881	2693	9328	2348	12145	1936	13622	1595	13839	1007	14190	455	9970
6-#18	2.36	6268	3072	11336	2564	14577	2091	16501	1689	18647	1060	18176	236	16695
7-#11	1.07	5893	2600	7661	2432	10796	2036	12472	1701	13734	1192	13691	593	8295
7-#14	1.55	6123	2775	8582	2541	11882	2119	13743	1757	14364	1115	15666	512	11313
7-#18	2.75	6665	3217	10820	2819	14545	2331	16880	1900	19476	1200	20523	302	18508
8-#11	1.23	5915	2657	7617	2501	10982	2095	12835	1754	14260	1224	14366	580	9232
8-#14	1.77	6143	2856	8634	2628	12216	2193	14296	1823	16129	1232	16586	487	12784
8-#18	3.14	6674	3361	11113	2956	15254	2446	17912	2001	19355	1167	22037	243	20786
9-#10	1.12	5919	2619	7556	2467	10823	2069	12584	1733	13942	1211	14106	601	8676
9-#11	1.38	6023	2713	8121	2518	11444	2106	13267	1757	13809	1126	15095	551	10340
9-#14	1.99	6299	2937	9285	2659	12835	2215	14886	1832	16909	1213	17639	448	14099
9-#18	3.54	6975	3505	12127	3021	16259	2494	18876	2024	20664	1144	23874	177	22772
10-#10	1.25	5986	2664	8204	2458	11381	2058	13085	1711	13476	1101	14491	558	9445
10-#11	1.53	6100	2769	8829	2515	12063	2099	13849	1736	15399	1173	15609	504	11259
10-#14	2.21	6396	3018	10151	2671	13625	2219	15675	1815	16595	1096	18448	388	15529
10-#18	3.93	7133	3650	13390	3069	17459	2524	20177	2015	23671	1174	25365	80	24911
11-#10	1.37	6055	2710	7940	2538	11345	2125	13233	1774	14860	1225	15277	566	10360
11-#11	1.69	6180	2825	8600	2603	12080	2173	14060	1805	15902	1221	16494	506	12311
11-#14	2.43	6513	3099	9993	2781	13753	2309	16028	1901	18480	1230	19611	380	16786
11-#18	4.32	7368	3794	13405	3233	17871	2655	20891	2141	23194	1167	27236	49	26931
12-#10	1.50	6146	2756	8071	2583	11531	2164	13511	1802	15274	1239	15846	556	11120
12-#11	1.84	6288	2882	8784	2657	12320	2219	14404	1837	16411	1237	17169	491	13231
12-#14	2.65	6661	3180	10296	2853	14121	2370	16530	1941	19213	1251	20553	355	18184
12-#18	4.72	7575	3938	13992	3350	18552	2755	21780	2206	24412	1198	29006	20	28894
13-#10	1.62	6196	2802	8378	2603	11881	2178	13911	1815	15751	1234	16430	531	12005
13-#11	1.99	6348	2938	9136	2682	12737	2238	14880	1854	15854	1149	17901	464	14232
13-#14	2.87	6743	3262	10769	2892	14702	2401	17198	1969	20035	1245	21629	319	19391
13-#18	5.11	7775	4083	14672	3437	19547	2817	22920	2257	27579	1274	30687	-68	30627
14-#10	1.75	6303	2848	8800	2615	12295	2181	14335	1807	15204	1139	16878	504	12752
14-#11	2.15	6473	2994	9604	2700	13212	2245	15387	1849	17649	1219	18451	431	15156
14-#14	3.09	6907	3343	11357	2926	15332	2420	17907	1968	19572	1148	22435	274	20778
14-#18	5.50	8027	4227	15657	3500	20560	2862	24140	2270	29162	1253	32215	-138	32013
15-#10	1.87	6325	2894	8788	2669	12435	2232	14570	1852	16660	1243	17563	493	13609
15-#11	2.30	6504	3051	9639	2763	13408	2303	15684	1900	16876	1159	19256	415	16094
15-#14	3.32	6991	3424	11498	3008	15662	2494	18352	2033	21592	1258	23544	246	21890
15-#18	5.89	8212	4371	16063	3631	21216	2977	24948	2371	30270	1293	34047	-198	33713
16-#10	2.00	6398	2939	8916	2710	12684	2258	14889	1877	17096	1255	18179	488	14333
16-#11	2.45	6588	3107	9807	2811	13723	2334	16080	1929	18607	1255	20018	409	17021
16-#14	3.54	7130	3505	11761	3075	16130	2536	18930	2074	22337	1275	24588	233	23127
16-#18	6.29	8495	4516	16561	3745	22073	3049	25986	2440	29451	1230	35731	-235	35457
17-#10	2.12	6449	2985	9213	2736	12997	2280	15259	1888	17561	1252	18697	458	15155
17-#11	2.61	6651	3163	10158	2844	14094	2362	16521	1942	17900	1169	20616	369	17928
17-#14	3.76	7198	3586	12246	3125	16647	2578	19545	2094	21619	1187	25470	177	24335
18-#10	2.25	6510	3031	9618	2748	13395	2289	15670	1893	18044	1242	19199	435	15904
18-#11	2.76	6728	3219	10622	2861	14564	2376	17003	1951	18445	1158	21224	342	18871
18-#14	3.98	7338	3668	12859	3154	17294	2603	20217	2110	23999	1259	26345	140	25489

ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 4,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
19-#10	2.37	6580	3077	9672	2798	13552	2332	15925	1924	17234	1176	19830	422	16684
19-#11	2.91	6806	3276	10715	2920	14770	2425	17327	1987	18917	1177	22017	328	19737
19-#14	4.20	7434	3749	13043	3234	17617	2669	20701	2158	23065	1198	27452	116	26748
20-#10	2.50	6635	3123	9855	2833	13824	2363	16230	1949	18906	1270	20401	408	17433
20-#11	3.07	6868	3332	10947	2962	15098	2461	17698	2016	20811	1273	22680	307	20690
20-#14	4.42	7549	3830	13394	3293	18087	2718	21233	2197	25496	1301	28413	87	27897
21-#10	2.62	6715	3169	10097	2863	14105	2384	16603	1962	19371	1269	20977	388	18179
21-#11	3.22	6967	3388	11234	3000	15438	2488	18152	2033	19947	1187	23373	282	21501
21-#14	4.64	7666	3911	13789	3348	18571	2758	21880	2223	24535	1211	29392	49	29120
22-#10	2.74	6761	3214	10437	2884	14468	2397	16980	1970	19876	1264	21523	364	18933
22-#11	3.37	7029	3445	11630	3028	15865	2505	18602	2044	21970	1266	24003	250	22378
22-#14	4.86	7774	3992	14324	3391	19159	2786	22515	2242	27135	1291	30271	3	30253
23-#10	2.87	6849	3260	10562	2926	14680	2432	17274	1999	20272	1276	22106	351	19663
23-#11	3.52	7132	3501	11800	3077	16138	2546	18963	2077	22458	1280	24725	234	23220
24-#10	2.99	6899	3306	10739	2964	14918	2462	17591	2022	20709	1285	22667	331	20431
24-#11	3.68	7199	3557	12022	3123	16429	2582	19354	2106	22985	1289	25394	209	24070
25-#10	3.12	6974	3352	10994	2991	15239	2484	17951	2036	21182	1285	23242	314	21136
25-#11	3.83	7285	3613	12323	3156	16814	2609	19786	2123	21989	1203	26121	191	24929
26-#10	3.24	7031	3398	11342	3011	15558	2501	18344	2049	21655	1281	23819	293	21879
26-#11	3.98	7354	3670	12730	3182	17196	2633	20249	2139	22528	1200	26807	164	25763
27-#10	3.37	7105	3444	11457	3053	15791	2534	18626	2073	22080	1292	24398	279	22563
27-#11	4.14	7462	3726	12886	3232	17485	2671	20601	2167	24649	1298	27485	144	26623
28-#10	3.49	7175	3489	11665	3086	16045	2564	18945	2095	22534	1301	25008	262	23267
29-#10	3.62	7239	3535	11891	3118	16350	2586	19302	2110	22990	1300	25523	241	23980
30-#10	3.74	7323	3581	12181	3142	16677	2607	19667	2122	23472	1299	26077	216	24670

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 12" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.64	255	373	505	273	561	219	576	177	565	107	471	18	410
6-#6	2.33	258	400	542	287	602	228	621	180	580	93	520	-8	528
6-#7	3.18	263	434	585	305	649	238	675	185	689	90	591	-37	605
6-#8	4.19	268	475	633	326	703	250	736	190	766	78	658	-76	688
6-#9	5.31	275	520	682	349	759	263	800	195	791	60	727	-120	772
6-#10	6.74	284	577	742	377	828	280	878	201	946	46	808	-177	871
7-#5	1.92	259	384	494	295	565	239	592	193	593	118	521	23	457
7-#6	2.72	265	416	533	312	610	251	643	199	613	104	583	-5	587
7-#7	3.71	272	456	580	334	663	266	703	207	732	104	654	-40	680
7-#8	4.89	281	503	633	360	724	284	771	216	763	87	734	-82	783
7-#9	6.19	291	555	688	389	789	303	843	224	847	76	815	-131	875
8-#5	2.19	262	395	499	306	577	247	610	200	577	113	551	15	514
8-#6	3.11	268	432	543	327	628	261	668	208	690	114	623	-16	634
8-#7	4.24	276	477	594	353	688	279	737	218	776	106	706	-57	730
8-#8	5.59	286	531	652	384	757	299	814	229	873	96	798	-106	842

ROUND SPIRAL COLUMNS 14" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.21	406	483	755	370	857	301	887	247	869	161	739	55	512
6-#6	1.71	412	511	802	384	913	310	949	252	883	144	810	31	689
6-#7	2.34	419	545	858	402	980	323	1023	258	1039	147	893	0	893
6-#8	3.08	427	586	922	424	1055	337	1108	265	1070	129	989	-37	1013
6-#9	3.90	436	630	991	447	1135	352	1199	272	1260	127	1088	-78	1134
6-#10	4.95	449	688	1078	478	1233	371	1310	281	1307	105	1209	-132	1278
6-#11	6.08	455	750	1159	506	1306	383	1390	282	1499	87	1315	-190	1377
7-#5	1.41	412	494	727	397	854	325	903	267	908	176	808	63	582
7-#6	2.00	422	527	780	415	914	338	971	275	994	172	895	39	768
7-#7	2.73	432	566	842	438	985	355	1054	284	1025	155	998	8	977
7-#8	3.59	445	614	913	465	1067	374	1149	296	1217	159	1115	-30	1139
7-#9	4.55	460	666	989	495	1155	395	1251	308	1343	151	1250	-69	1290
7-#10	5.78	479	733	1085	534	1264	421	1379	323	1500	139	1403	-125	1466
7-#11	7.09	490	805	1171	567	1355	442	1469	328	1611	114	1484	-203	1568
8-#5	1.61	415	505	733	411	869	335	925	273	879	168	854	59	649
8-#6	2.29	425	542	792	433	937	350	1002	285	970	164	957	32	867
8-#7	3.12	436	588	861	460	1017	369	1095	297	1157	171	1079	-3	1081
8-#8	4.11	450	642	940	492	1109	392	1202	311	1292	164	1217	-45	1228
8-#9	5.20	466	701	1024	527	1208	416	1317	326	1436	156	1362	-94	1391
8-#10	6.60	487	778	1128	573	1331	447	1460	344	1506	135	1538	-158	1586

ROUND SPIRAL COLUMNS 16" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#6	1.31	614	639	1130	496	1302	404	1367	333	1358	217	1175	76	832
6-#7	1.79	624	673	1198	514	1385	417	1462	340	1378	197	1288	48	1086
6-#8	2.36	636	713	1278	536	1481	432	1572	349	1614	204	1417	14	1373
6-#9	2.98	648	758	1364	560	1585	448	1689	358	1762	195	1552	-25	1569
6-#10	3.79	665	816	1472	591	1716	470	1835	369	1946	184	1721	-76	1764
6-#11	4.66	674	877	1579	619	1831	486	1951	373	2087	162	1827	-143	1906
6-#14	6.71	716	1025	1830	699	2118	535	2277	397	2499	126	2182	-281	2313
7-#5	1.08	614	622	1020	516	1222	426	1301	352	1310	241	1177	109	712
7-#6	1.53	626	654	1084	535	1297	439	1387	360	1420	238	1292	87	943
7-#7	2.09	641	694	1161	558	1387	456	1490	369	1449	219	1429	59	1212
7-#8	2.75	660	741	1250	585	1491	477	1610	381	1706	230	1587	25	1510
7-#9	3.48	680	794	1345	616	1602	499	1738	397	1870	224	1754	-13	1765
7-#10	4.42	705	861	1464	655	1741	527	1900	414	2075	216	1960	-64	2007
7-#11	5.43	720	933	1585	690	1865	549	2039	425	2085	184	2093	-133	2188
7-#14	7.83	784	1105	1861	790	2184	618	2412	464	2693	167	2564	-270	2651

ROUND SPIRAL COLUMNS 16" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#5	1.23	616	633	1021	531	1240	437	1328	360	1260	230	1228	104	786
8-#6	1.75	630	670	1094	553	1324	453	1424	370	1473	244	1359	78	1055
8-#7	2.39	645	715	1180	581	1425	473	1540	382	1515	225	1516	46	1371
8-#8	3.14	665	769	1280	614	1542	497	1675	396	1678	221	1696	7	1685
8-#9	3.98	685	829	1387	651	1667	523	1821	411	1986	232	1886	-37	1908
8-#10	5.05	711	906	1523	698	1824	556	2003	431	2220	225	2159	-86	2170
8-#11	6.21	729	988	1653	741	1963	583	2159	452	2242	192	2321	-165	2364
9-#10	5.68	739	951	1608	718	1927	573	2130	446	2373	214	2297	-119	2350
9-#11	6.98	763	1044	1753	766	2089	606	2306	461	2407	179	2475	-206	2552
10-#10	6.32	759	996	1713	736	2045	578	2265	447	2539	198	2429	-163	2485

ROUND SPIRAL COLUMNS 18" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#6	1.04	870	783	1533	624	1786	511	1879	423	1869	286	1628	124	975
6-#7	1.41	885	817	1615	642	1884	523	1995	431	2014	282	1769	98	1279
6-#8	1.86	900	858	1710	664	1998	539	2131	441	2183	276	1932	67	1624
6-#9	2.36	917	903	1813	688	2122	555	2278	452	2364	269	2105	32	1989
6-#10	2.99	938	960	1942	720	2279	577	2464	466	2592	259	2322	-15	2331
6-#11	3.68	951	1022	2076	748	2430	595	2616	472	2778	241	2476	-77	2523
6-#14	5.31	1002	1169	2381	828	2804	651	3031	501	3301	211	2951	-208	3050
7-#6	1.21	887	799	1455	671	1768	553	1902	457	1941	312	1780	139	1124
7-#7	1.65	907	839	1547	694	1875	571	2026	468	2100	310	1952	113	1446
7-#8	2.17	929	886	1653	722	2000	591	2171	480	2134	286	2152	83	1811
7-#9	2.75	954	938	1768	752	2135	614	2327	494	2489	302	2364	48	2197
7-#10	3.49	988	1005	1911	792	2306	644	2523	512	2744	297	2628	2	2623
7-#11	4.29	1009	1078	2062	828	2468	668	2700	523	2961	283	2820	-61	2869
7-#14	6.19	1087	1249	2399	929	2863	741	3160	572	3306	244	3403	-192	3526
8-#6	1.38	890	815	1458	691	1801	570	1946	470	1873	298	1864	132	1247
8-#7	1.89	911	860	1561	718	1923	590	2086	482	2186	317	2060	103	1625
8-#8	2.48	934	914	1680	752	2064	615	2249	497	2396	315	2287	68	2055
8-#9	3.14	959	974	1808	789	2216	642	2425	514	2623	312	2529	27	2449
8-#10	3.99	994	1051	1970	836	2408	676	2647	535	2910	307	2831	-26	2846
8-#11	4.90	1017	1133	2141	881	2585	705	2845	549	3161	294	3052	-99	3105
8-#14	7.07	1098	1329	2524	1003	3030	790	3364	598	3827	276	3792	-234	3821
9-#10	4.49	1029	1096	2083	857	2523	692	2796	546	3103	299	3052	-48	3069
9-#11	5.52	1059	1188	2266	906	2727	726	3027	563	3386	282	3306	-126	3367
10-#10	4.99	1051	1141	2218	874	2671	696	2954	540	3318	284	3216	-89	3264
10-#11	6.13	1085	1244	2416	928	2897	732	3214	569	3624	262	3497	-179	3553
11-#10	5.49	1078	1186	2253	919	2753	741	3065	577	3464	299	3449	-103	3503
11-#11	6.74	1118	1299	2471	982	2997	783	3345	600	3817	285	3761	-198	3842
12-#10	5.99	1110	1231	2346	948	2850	765	3202	596	3637	305	3661	-126	3717

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 20" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.15	1205	979	2116	786	2490	644	2639	533	2485	336	2347	153	1472
6-#8	1.51	1225	1020	2227	808	2623	659	2796	543	2672	331	2545	124	1876
6-#9	1.91	1249	1064	2347	832	2767	676	2966	554	3078	349	2757	91	2305
6-#10	2.43	1275	1122	2498	864	2950	698	3183	568	3350	341	3022	48	2837
6-#11	2.98	1293	1184	2659	892	3130	716	3390	578	3343	304	3225	-10	3232
6-#14	4.30	1354	1331	3018	972	3569	772	3903	612	4217	301	3823	-131	3891
6-#18	7.64	1519	1704	3877	1178	4626	914	5082	688	5701	228	5177	-460	5334
7-#7	1.34	1234	1000	2006	847	2465	699	2675	578	2762	393	2578	172	1688
7-#8	1.76	1262	1048	2130	874	2610	720	2845	591	2980	390	2819	143	2118
7-#9	2.23	1293	1100	2264	905	2768	743	3028	605	3002	362	3077	111	2572
7-#10	2.83	1331	1167	2432	945	2966	773	3260	624	3516	384	3402	68	3135
7-#11	3.48	1363	1239	2614	981	3165	798	3474	636	3533	347	3653	11	3614
7-#14	5.01	1457	1411	3012	1083	3641	875	4023	681	4499	358	4385	-109	4462
8-#7	1.53	1239	1022	2012	873	2517	721	2744	594	2672	375	2709	164	1882
8-#8	2.01	1268	1076	2150	906	2685	746	2935	610	3109	401	2983	131	2386
8-#9	2.55	1299	1136	2300	943	2866	774	3142	627	3375	399	3278	93	2922
8-#10	3.23	1337	1212	2488	991	3092	810	3404	650	3465	370	3647	44	3502
8-#11	3.97	1371	1295	2693	1036	3309	839	3645	665	3749	359	3935	-22	3949
8-#14	5.73	1466	1491	3142	1159	3842	928	4264	719	4497	348	4770	-161	4838
9-#10	3.64	1383	1257	2627	1012	3221	824	3568	658	3940	388	3889	19	3823
9-#11	4.47	1420	1350	2852	1062	3467	858	3848	678	4285	375	4245	-49	4258
9-#14	6.45	1541	1571	3352	1197	4066	958	4557	740	5195	359	5200	-199	5254
10-#10	4.04	1409	1303	2800	1028	3400	826	3756	652	4181	371	4107	-16	4117
10-#11	4.97	1450	1406	3041	1083	3672	863	4069	672	4585	357	4475	-98	4530
10-#14	7.16	1582	1651	3596	1232	4345	969	4865	749	5613	334	5528	-270	5575
11-#10	4.45	1441	1348	2823	1075	3483	873	3886	692	4366	391	4392	-28	4411
11-#11	5.46	1489	1461	3086	1138	3784	918	4223	717	4787	376	4801	-115	4865
12-#10	4.85	1477	1393	2929	1106	3595	899	4035	712	4266	373	4648	-47	4671
12-#11	5.96	1532	1516	3214	1174	3918	948	4409	741	4692	359	5097	-142	5161
13-#10	5.26	1503	1438	3042	1134	3751	917	4204	725	4783	392	4872	-80	4910
14-#10	5.66	1546	1483	3191	1151	3911	931	4397	729	5010	381	5084	-111	5133

ROUND SPIRAL COLUMNS 22" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.25	1620	1198	2837	968	3365	792	3587	656	3422	412	3266	184	2128
6-#9	1.58	1646	1243	2975	992	3530	809	3782	667	3917	437	3516	153	2622
6-#10	2.00	1682	1301	3147	1024	3738	831	4029	681	4233	431	3831	112	3235
6-#11	2.46	1705	1363	3336	1051	3948	849	4269	691	4211	388	4084	58	3840
6-#14	3.55	1778	1510	3750	1132	4453	906	4870	728	5259	396	4807	-54	4838
6-#18	6.31	1968	1883	4746	1339	5675	1050	6311	818	7028	335	6475	-360	6594
7-#7	1.10	1630	1179	2544	1016	3166	841	3444	699	3549	485	3317	235	1937
7-#8	1.45	1665	1226	2686	1044	3332	862	3638	712	3545	451	3600	208	2431
7-#9	1.84	1701	1279	2840	1075	3512	886	3850	727	4070	481	3905	178	2957
7-#10	2.34	1748	1346	3033	1115	3739	916	4118	747	4414	478	4289	138	3606
7-#11	2.87	1782	1418	3247	1151	3971	941	4374	760	4731	467	4601	84	4244
7-#14	4.14	1898	1590	3708	1254	4520	1019	5013	808	5188	426	5485	-27	5506
7-#18	7.37	2161	2025	4810	1515	5843	1214	6542	924	7549	423	7525	-331	7667
8-#7	1.26	1635	1201	2539	1044	3218	865	3526	718	3666	496	3472	229	2143
8-#8	1.66	1670	1255	2697	1078	3408	890	3745	734	3685	462	3795	198	2721
8-#9	2.10	1708	1314	2868	1115	3615	919	3984	752	3970	461	4142	163	3339
8-#10	2.67	1754	1391	3084	1163	3878	955	4285	776	4642	493	4579	117	4109

ROUND SPIRAL COLUMNS 22" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	3.28	1790	1473	3323	1207	4145	987	4571	792	4999	483	4936	55	4739
8-#14	4.74	1907	1670	3840	1330	4765	1078	5291	849	5930	476	5942	-73	5976
9-#10	3.01	1804	1436	3249	1183	4030	969	4466	783	4577	453	4862	92	4464
9-#11	3.69	1848	1529	3512	1233	4318	1004	4793	803	5310	473	5269	24	5177
9-#14	5.33	1994	1750	4094	1370	5011	1106	5611	867	6370	462	6454	-110	6482
10-#10	3.34	1831	1481	3467	1197	4242	969	4685	775	5165	465	5114	59	4888
10-#11	4.10	1888	1584	3750	1253	4563	1007	5050	795	5260	422	5569	-17	5580
10-#14	5.92	2039	1830	4395	1404	5342	1115	5970	861	6391	408	6840	-177	6841
11-#10	3.68	1870	1526	3473	1248	4323	1018	4831	818	5022	456	5452	49	5243
11-#11	4.51	1932	1640	3781	1311	4674	1064	5226	845	5888	477	5959	-33	5981
11-#14	6.51	2109	1910	4475	1481	5520	1192	6221	925	7186	466	7366	-203	7390
12-#10	4.01	1912	1572	3589	1280	4450	1046	4993	838	5632	500	5752	32	5629
12-#11	4.92	1981	1695	3924	1348	4827	1096	5428	868	6171	488	6308	-56	6336
13-#10	4.34	1947	1617	3717	1307	4631	1064	5187	852	5861	492	6015	0	6015
13-#11	5.33	2018	1751	4077	1384	5040	1119	5658	885	6456	479	6616	-96	6661
14-#10	4.68	1995	1662	3895	1323	4812	1076	5415	855	6122	481	6263	-29	6277
14-#11	5.75	2075	1806	4280	1404	5257	1136	5925	890	6767	466	6908	-133	6965
15-#10	5.01	2021	1707	3951	1371	4927	1112	5551	886	5930	466	6602	-45	6599
16-#10	5.35	2069	1752	4053	1403	5068	1143	5724	904	6576	501	6871	-66	6895

ROUND SPIRAL COLUMNS 24" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.05	2090	1394	3548	1144	4237	939	4519	775	4295	500	4106	248	2380
6-#9	1.33	2121	1439	3704	1168	4422	956	4737	785	4892	532	4395	219	2939
6-#10	1.68	2159	1497	3899	1199	4657	978	5015	798	5254	527	4760	180	3635
6-#11	2.07	2193	1558	4116	1226	4897	995	5287	815	5578	514	5063	129	4329
6-#14	2.98	2281	1705	4586	1308	5468	1052	5965	853	6439	497	5912	23	5830
6-#18	5.31	2497	2079	5718	1516	6855	1198	7622	947	7928	415	7898	-264	7987
7-#8	1.22	2142	1422	3330	1230	4176	1019	4568	846	4756	584	4507	277	2752
7-#9	1.55	2186	1474	3504	1261	4378	1042	4806	861	5062	582	4859	249	3349
7-#10	1.97	2241	1542	3722	1302	4635	1073	5108	880	5451	580	5303	211	4088
7-#11	2.41	2283	1614	3970	1337	4901	1098	5406	895	5815	571	5676	160	4820
7-#14	3.48	2410	1785	4493	1441	5522	1176	6140	945	6307	525	6712	56	6463
7-#18	6.19	2717	2221	5750	1704	7028	1374	7896	1067	8436	501	9138	-227	9254
8-#8	1.40	2149	1450	3328	1266	4252	1049	4692	871	4926	598	4722	268	3060
8-#9	1.77	2193	1510	3521	1303	4485	1077	4962	889	5272	598	5126	236	3759
8-#10	2.25	2248	1587	3764	1351	4779	1114	5303	913	5711	598	5638	193	4631
8-#11	2.76	2291	1669	4039	1395	5087	1146	5633	930	6121	589	6065	135	5497
8-#14	3.98	2418	1865	4623	1519	5804	1240	6455	989	6704	546	7244	15	7188
8-#18	7.07	2755	2363	6036	1834	7512	1473	8435	1134	9098	529	10006	-313	10069
9-#10	2.53	2305	1632	3957	1370	4961	1128	5500	918	6000	589	5962	168	5069
9-#11	3.10	2359	1725	4260	1420	5293	1163	5875	939	6043	541	6448	104	5965
9-#14	4.48	2527	1945	4918	1558	6080	1266	6803	1005	7684	572	7786	-29	7806
9-#18	7.96	2946	2505	6509	1908	7982	1526	9056	1170	10601	545	11001	-376	10958

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.81	2336	1677	4219	1382	5210	1125	5751	908	6287	567	6245	136	5599
10-#11	3.45	2395	1780	4552	1439	5578	1164	6170	930	6825	555	6790	64	6523
10-#14	4.97	2576	2025	5287	1591	6464	1274	7215	998	8200	543	8280	-85	8236
11-#10	3.09	2381	1722	4208	1437	5285	1178	5910	955	6534	593	6640	128	6015
11-#11	3.79	2449	1836	4562	1500	5687	1224	6367	983	7114	584	7245	51	7005
11-#14	5.47	2655	2105	5350	1671	6645	1353	7497	1067	8597	578	8896	-109	8951
12-#10	3.37	2429	1767	4334	1470	5425	1207	6086	975	6816	606	6984	113	6490
12-#11	4.14	2504	1891	4720	1539	5857	1257	6583	1006	7456	599	7648	31	7518
12-#14	5.97	2728	2185	5584	1724	6891	1399	7813	1099	8457	555	9456	-141	9498
13-#10	3.65	2463	1812	4478	1496	5632	1225	6308	989	7079	599	7287	82	6896
13-#11	4.48	2552	1946	4890	1573	6101	1280	6846	1024	7244	549	8005	-8	8010
13-#14	6.47	2795	2265	5822	1775	7231	1432	8181	1125	9508	581	9955	-197	9987
14-#10	3.93	2515	1858	4687	1511	5835	1235	6559	991	7374	587	7569	54	7332
14-#11	4.83	2617	2002	5129	1593	6343	1295	7151	1028	8114	575	8340	-43	8361
15-#10	4.21	2548	1903	4737	1561	5960	1273	6719	1025	7113	563	7934	35	7771
15-#11	5.17	2652	2057	5205	1651	6499	1339	7335	1066	7864	558	8797	-62	8791
16-#10	4.49	2599	1948	4849	1593	6113	1304	6914	1044	7876	610	8270	21	8179
16-#11	5.52	2719	2113	5343	1690	6689	1377	7568	1088	8722	600	9160	-88	9191
17-#10	4.77	2624	1993	5016	1620	6298	1323	7119	1058	7622	570	8604	-7	8607
18-#10	5.05	2675	2038	5183	1643	6500	1339	7347	1062	8464	601	8875	-35	8887

ROUND SPIRAL COLUMNS 26" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#9	1.13	2678	1652	4543	1359	5456	1116	5844	920	5597	592	5404	289	3257
6-#10	1.44	2723	1709	4760	1391	5717	1138	6152	933	6406	630	5819	253	4035
6-#11	1.76	2758	1771	5007	1417	5987	1155	6458	941	6793	619	6172	204	4819
6-#14	2.54	2867	1918	5532	1499	6624	1212	7213	988	7250	564	7149	103	6652
6-#18	4.52	3114	2291	6804	1707	8178	1359	9066	1084	9439	523	9456	-169	9516
7-#9	1.32	2753	1687	4262	1465	5378	1213	5911	1006	6206	693	5948	324	3751
7-#10	1.67	2816	1754	4506	1505	5664	1244	6247	1026	6197	645	6454	289	4583
7-#11	2.06	2867	1827	4787	1540	5964	1269	6582	1040	7051	682	6888	240	5408
7-#14	2.97	3012	1998	5374	1644	6659	1347	7403	1091	8108	677	8078	142	7358
7-#18	5.27	3361	2434	6788	1909	8348	1547	9400	1220	9968	613	10893	-125	10962
8-#9	1.51	2761	1723	4264	1509	5485	1250	6088	1038	6441	711	6234	312	4184
8-#10	1.91	2824	1800	4534	1557	5812	1287	6470	1062	6469	664	6810	271	5160
8-#11	2.35	2876	1882	4846	1600	6158	1318	6844	1080	6902	657	7332	218	6137
8-#14	3.39	3022	2078	5499	1724	6957	1413	7768	1141	8587	702	8686	105	8245
8-#18	6.03	3400	2576	7081	2040	8908	1653	10006	1292	11482	691	11888	-203	11928
9-#10	2.15	2887	1845	4759	1575	6025	1300	6684	1066	7242	700	7195	248	5688
9-#11	2.64	2953	1937	5102	1624	6400	1336	7106	1086	7781	692	7767	187	6708
9-#14	3.81	3135	2158	5838	1762	7282	1440	8144	1154	9149	689	9303	61	9000
9-#18	6.78	3613	2718	7621	2114	9422	1704	10675	1324	11617	626	12933	-280	13005
10-#10	2.39	2924	1890	5067	1583	6312	1295	6968	1053	7056	632	7453	206	6254
10-#11	2.94	2993	1993	5446	1640	6729	1334	7440	1075	7621	622	8147	148	7418
10-#14	4.24	3201	2238	6278	1795	7723	1446	8610	1145	9056	613	9859	7	9828
10-#18	7.53	3697	2860	8268	2183	10133	1727	11458	1319	12560	585	13903	-376	13792

ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#10	2.63	2972	1935	5058	1638	6391	1347	7133	1103	7317	660	7955	209	6754
11-#11	3.23	3055	2048	5436	1706	6832	1398	7652	1132	7927	652	8671	138	7952
11-#14	4.66	3289	2318	6319	1877	7902	1528	8924	1219	10153	695	10567	-13	10575
12-#10	2.87	3030	1980	5170	1677	6532	1381	7329	1125	7601	672	8330	196	7319
12-#11	3.53	3117	2104	5607	1746	7020	1433	7887	1156	8276	666	9128	120	8566
12-#14	5.09	3370	2398	6575	1932	8175	1575	9260	1251	10691	716	11204	-42	11218
13-#10	3.11	3064	2025	5330	1702	6761	1399	7577	1139	8448	714	8682	165	7795
13-#11	3.82	3164	2159	5796	1779	7295	1455	8182	1174	9219	705	9534	82	9113
13-#14	5.51	3443	2478	6837	1982	8559	1609	9675	1277	11177	702	11775	-98	11808
14-#10	3.35	3127	2070	5573	1716	6991	1407	7853	1138	8192	655	9013	140	8330
14-#11	4.11	3233	2215	6073	1797	7563	1468	8517	1176	9613	691	9911	48	9686
14-#14	5.93	3541	2558	7201	2014	8932	1633	10153	1285	11739	685	12315	-146	12351
15-#10	3.59	3160	2116	5614	1767	7125	1448	8029	1174	9043	718	9410	120	8787
15-#11	4.41	3277	2270	6142	1858	7731	1514	8731	1217	9278	662	10396	25	10277
16-#10	3.83	3222	2161	5736	1800	7288	1479	8253	1196	8706	678	9783	107	9273
16-#11	4.70	3349	2326	6293	1898	7935	1553	8991	1241	9595	670	10844	7	10812
17-#10	4.07	3244	2206	5924	1827	7496	1498	8475	1209	9644	723	10165	81	9753
17-#11	5.00	3381	2381	6514	1931	8182	1575	9264	1258	10668	719	11291	-27	11299
18-#10	4.31	3292	2251	6113	1849	7730	1515	8731	1212	9973	716	10480	55	10219
18-#11	5.29	3450	2436	6735	1960	8451	1596	9568	1263	11065	707	11653	-61	11672
19-#10	4.54	3332	2296	6208	1890	7866	1547	8928	1244	10255	732	10889	37	10711
20-#10	4.78	3383	2341	6327	1928	8033	1576	9137	1261	9845	687	11239	18	11152

ROUND SPIRAL COLUMNS 28" DIA.

6-#10	1.24	3375	1939	5741	1598	6929	1311	7454	1080	7712	739	7019	329	4436
6-#11	1.52	3417	2001	6017	1624	7230	1328	7793	1087	8149	730	7422	282	5309
6-#14	2.19	3534	2148	6599	1706	7934	1385	8626	1121	8641	671	8527	186	7352
6-#18	3.90	3825	2521	8010	1914	9654	1532	10675	1232	11101	636	11158	-73	11187
7-#9	1.14	3408	1917	5121	1685	6521	1398	7178	1163	7012	758	7168	403	4161
7-#10	1.44	3482	1984	5392	1725	6836	1429	7547	1183	7993	811	7737	370	5085
7-#11	1.77	3541	2056	5708	1760	7172	1454	7920	1197	7887	749	8248	325	6008
7-#14	2.56	3705	2228	6358	1864	7940	1533	8826	1249	9622	798	9594	231	8181
7-#18	4.55	4101	2663	7930	2130	9813	1734	11046	1381	12486	784	12800	-23	12814
8-#9	1.30	3418	1953	5103	1731	6626	1438	7371	1198	7776	832	7491	393	4613
8-#10	1.65	3491	2029	5402	1779	6986	1474	7797	1223	8317	833	8130	354	5695
8-#11	2.03	3551	2112	5751	1822	7371	1505	8217	1241	8834	826	8716	303	6784
8-#14	2.92	3717	2308	6473	1946	8252	1600	9243	1304	10156	826	10263	196	9350
8-#18	5.20	4141	2806	8226	2263	10410	1842	11739	1459	13382	822	13924	-93	13943
9-#10	1.86	3561	2075	5660	1796	7229	1487	8029	1225	8072	766	8557	330	6320
9-#11	2.28	3635	2167	6044	1845	7651	1523	8499	1246	8630	759	9228	274	7461
9-#14	3.29	3844	2388	6859	1984	8628	1628	9647	1315	10041	758	10971	154	10140
9-#18	5.85	4375	2948	8836	2337	11006	1895	12457	1489	14459	804	15106	-169	15167

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 28" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.06	3602	2120	6019	1800	7561	1479	8346	1210	8997	795	8862	291	6918
10-#11	2.53	3682	2223	6442	1856	8027	1518	8873	1232	9669	785	9572	224	8218
10-#14	3.65	3901	2468	7362	2011	9128	1631	10168	1303	11369	778	11587	102	11098
10-#18	6.50	4467	3090	9594	2406	11810	1916	13333	1482	15537	755	16193	-261	16043
11-#10	2.27	3657	2165	5985	1860	7628	1535	8517	1263	9309	829	9405	293	7511
11-#11	2.79	3747	2278	6441	1923	8120	1585	9093	1292	10036	821	10231	226	8862
11-#14	4.02	4003	2548	7431	2093	9303	1716	10499	1380	11081	766	12390	84	11934
11-#18	7.15	4659	3232	9760	2538	12194	2049	13938	1600	16369	812	17492	-304	17364
12-#10	2.48	3716	2210	6103	1900	7780	1570	8731	1286	9637	842	9824	282	8109
12-#11	3.04	3822	2334	6592	1970	8324	1622	9352	1318	10438	837	10726	209	9617
12-#14	4.38	4095	2628	7665	2157	9602	1765	10869	1414	12451	842	13088	57	12820
13-#10	2.68	3760	2255	6281	1925	8031	1586	9007	1300	9976	836	10217	251	8673
13-#11	3.29	3869	2389	6802	2001	8626	1643	9680	1335	10118	774	11193	172	10223
13-#14	4.75	4175	2708	7953	2206	10029	1799	11331	1441	13010	830	13746	4	13727
14-#10	2.89	3830	2300	6561	1937	8291	1594	9307	1297	10344	824	10575	226	9272
14-#11	3.55	3951	2445	7119	2018	8927	1654	10044	1335	10524	761	11633	141	10896
14-#14	5.12	4295	2788	8367	2236	10439	1820	11849	1446	13633	813	14349	-43	14362
15-#10	3.09	3867	2345	6590	1990	8431	1637	9500	1336	10629	841	11029	209	9807
15-#11	3.80	3994	2500	7178	2081	9107	1704	10278	1379	10852	779	12155	117	11511
15-#14	5.48	4365	2868	8494	2319	10712	1885	12186	1503	14135	837	15099	-78	15085
16-#10	3.30	3924	2390	6720	2024	8605	1668	9753	1359	10945	850	11445	197	10406
16-#11	4.05	4079	2555	7341	2121	9324	1742	10575	1405	12004	844	12648	101	12135
16-#14	5.85	4485	2948	8735	2376	11031	1939	12599	1537	14667	849	15787	-104	15770
17-#10	3.51	3960	2436	6930	2051	8836	1687	9992	1371	11294	848	11870	171	10906
17-#11	4.31	4107	2611	7588	2154	9598	1765	10868	1421	12422	841	13154	68	12781
18-#10	3.71	4014	2481	7143	2071	9099	1703	10276	1374	10870	783	12195	144	11454
18-#11	4.56	4173	2666	7835	2182	9907	1786	11206	1426	12001	777	13571	37	13387
19-#10	3.92	4058	2526	7240	2114	9244	1737	10485	1406	11959	857	12665	129	11965
19-#11	4.81	4232	2722	7964	2232	10087	1825	11467	1464	13231	852	14111	15	14042
20-#10	4.13	4101	2571	7365	2152	9427	1767	10715	1424	12293	863	13069	112	12496
20-#11	5.07	4293	2777	8122	2278	10308	1861	11744	1485	13617	857	14573	-8	14573
21-#10	4.33	4159	2616	7556	2178	9648	1786	10979	1441	12618	862	13466	87	13026
22-#10	4.54	4204	2661	7816	2196	9909	1795	11257	1447	12963	853	13879	69	13525

ROUND SPIRAL COLUMNS 30" DIA.

6-#10	1.08	4123	2186	6848	1822	8305	1498	8933	1238	8579	800	8371	410	4838
6-#11	1.32	4172	2248	7155	1847	8638	1514	9305	1245	9669	848	8824	365	5800
6-#14	1.91	4305	2395	7795	1928	9408	1571	10216	1278	10156	782	10058	272	8052
6-#18	3.40	4635	2768	9346	2137	11295	1719	12461	1365	13850	809	13014	24	12910
7-#10	1.26	4241	2231	6385	1962	8162	1628	9021	1353	8887	876	9171	455	5597
7-#11	1.54	4312	2303	6737	1996	8534	1653	9432	1367	9358	869	9750	412	6624
7-#14	2.23	4495	2475	7452	2100	9376	1732	10423	1419	11314	928	11269	323	9018
7-#18	3.96	4923	2910	9183	2367	11435	1934	12860	1552	14469	918	14869	82	14422
8-#10	1.44	4253	2276	6373	2019	8311	1676	9285	1395	9879	964	9611	442	6234
8-#11	1.77	4323	2359	6761	2061	8736	1707	9762	1414	10450	957	10261	392	7437

ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi

ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.55	4511	2555	7553	2185	9700	1801	10892	1478	11109	895	11969	289	10270
8-#18	4.53	4960	3052	9478	2502	12065	2044	13647	1637	14429	896	16125	17	16048
9-#10	1.62	4331	2321	6667	2034	8584	1687	9546	1396	9550	887	10079	417	6967
9-#11	1.99	4416	2414	7094	2083	9053	1723	10065	1417	10889	943	10825	363	8231
9-#14	2.86	4651	2635	7987	2221	10128	1830	11324	1487	12544	943	12778	249	11208
9-#18	5.09	5240	3195	10160	2575	12746	2099	14413	1664	15509	877	17443	-58	17467
10-#10	1.80	4377	2367	7084	2034	8966	1677	9900	1378	9902	861	10429	379	7592
10-#11	2.21	4469	2470	7553	2090	9482	1715	10481	1400	10592	852	11229	315	9029
10-#14	3.18	4713	2715	8560	2245	10691	1829	11902	1473	13212	907	13351	182	12420
10-#18	5.66	5339	3337	11018	2641	13645	2118	15384	1656	16607	830	18645	-146	18462
11-#10	1.98	4439	2412	7015	2099	9018	1736	10075	1435	10956	959	11016	383	8285
11-#11	2.43	4541	2525	7523	2161	9578	1781	10708	1464	10972	889	11937	318	9782
11-#14	3.50	4828	2795	8612	2333	10882	1911	12247	1553	13770	954	14339	181	13279
11-#18	6.22	5547	3479	11174	2780	14033	2253	16029	1777	18716	952	20103	-186	19978
12-#10	2.16	4504	2457	7140	2141	9180	1773	10307	1459	11306	973	11480	373	8911
12-#11	2.65	4619	2580	7682	2210	9780	1825	10990	1491	12186	968	12485	303	10579
12-#14	3.82	4929	2875	8860	2398	11181	1969	12651	1589	13429	910	15102	156	14300
12-#18	6.79	5701	3621	11727	2876	14612	2336	16731	1833	18492	921	21433	-235	21318
13-#10	2.34	4553	2502	7337	2165	9453	1788	10610	1473	10899	903	11913	342	9568
13-#11	2.87	4676	2636	7913	2241	10108	1845	11352	1508	11790	897	13002	266	11298
13-#14	4.14	5017	2955	9175	2446	11644	2002	13160	1615	15021	966	15836	103	15246
13-#18	7.36	5882	3763	12253	2966	15409	2399	17600	1883	20859	967	22646	-332	22448
14-#10	2.52	4631	2547	7658	2174	9745	1794	10936	1468	11282	891	12281	315	10198
14-#11	3.09	4767	2691	8274	2256	10446	1855	11746	1506	12242	884	13478	235	12095
14-#14	4.46	5129	3035	9643	2474	12101	2022	13720	1618	15704	948	16546	62	16211
15-#10	2.70	4668	2592	7670	2230	9890	1840	11143	1509	11567	909	12802	301	10821
15-#11	3.31	4816	2747	8320	2320	10635	1906	11999	1552	13490	967	14068	213	12778
15-#14	4.77	5213	3115	9761	2559	12393	2089	14087	1678	15156	908	17335	25	17194
16-#10	2.87	4734	2637	7808	2265	10073	1872	11413	1532	12739	983	13270	291	11455
16-#11	3.53	4894	2802	8493	2362	10864	1945	12332	1580	13904	978	14613	199	13505
16-#14	5.09	5347	3195	10021	2617	12731	2143	14553	1715	15702	921	18099	2	18090
17-#10	3.05	4770	2682	8040	2291	10328	1890	11681	1545	12246	915	13713	264	12049
17-#11	3.75	4940	2858	8768	2395	11167	1968	12646	1596	13406	910	15173	166	14177
17-#14	5.41	5407	3275	10400	2666	13156	2177	15005	1739	16311	917	18891	-45	18875
18-#10	3.23	4834	2728	8279	2310	10616	1905	11995	1547	12597	906	14071	237	12700
18-#11	3.97	5011	2913	9043	2421	11511	1989	13019	1600	14829	965	15602	133	14878
19-#10	3.41	4877	2773	8376	2355	10773	1941	12215	1580	13832	986	14592	224	13261
19-#11	4.19	5068	2969	9175	2473	11703	2029	13295	1639	14222	920	16218	115	15564
20-#10	3.59	4930	2818	8507	2393	10972	1972	12466	1599	14200	996	15044	208	13870
20-#11	4.41	5126	3024	9341	2519	11944	2066	13597	1661	15676	993	16745	93	16245
21-#10	3.77	4989	2863	8717	2419	11226	1986	12755	1616	13591	930	15476	183	14421
21-#11	4.63	5201	3079	9591	2551	12235	2089	13943	1682	16104	992	17269	63	16950
22-#10	3.95	5043	2908	9005	2436	11499	1999	13055	1621	14939	987	15930	165	14995
23-#10	4.13	5103	2953	9090	2479	11671	2036	13290	1651	15280	1002	16395	148	15566
24-#10	4.31	5147	2998	9259	2513	11879	2061	13560	1670	15619	1005	16856	131	16133

ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi

ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.16	5030	2512	8430	2086	10221	1713	11007	1414	11376	974	10389	452	6293
6-#14	1.68	5179	2659	9127	2167	11057	1771	11996	1447	11844	900	11752	362	8753
6-#18	2.98	5551	3032	10820	2376	13113	1918	14438	1534	15946	940	15034	124	14449
7-#10	1.11	5103	2495	7494	2215	9653	1842	10681	1534	10491	1005	10777	546	6115
7-#11	1.36	5184	2567	7883	2249	10061	1866	11130	1548	11006	997	11412	503	7246
7-#14	1.96	5389	2739	8663	2353	10978	1945	12207	1600	12315	996	13079	417	9869
7-#18	3.48	5866	3174	10555	2621	13222	2148	14860	1734	16642	1060	17111	189	15984
8-#10	1.26	5119	2540	7454	2275	9798	1892	10958	1579	11631	1104	11265	535	6778
8-#11	1.55	5198	2623	7881	2317	10264	1922	11478	1598	12256	1097	11979	486	8095
8-#14	2.24	5408	2819	8744	2441	11311	2017	12722	1664	13839	1101	13848	386	11190
8-#18	3.98	5907	3316	10843	2758	13883	2260	15741	1827	16546	1033	18414	123	17842
9-#10	1.42	5204	2585	7788	2289	10102	1902	11250	1579	11204	1015	11773	510	7618
9-#11	1.75	5300	2678	8257	2337	10616	1938	11817	1600	11872	1009	12594	457	9016
9-#14	2.52	5556	2899	9231	2476	11787	2044	13187	1671	14519	1082	14734	346	12277
9-#18	4.48	6186	3458	11601	2830	14651	2316	16555	1850	18957	1083	19950	55	19625
10-#10	1.58	5255	2630	8269	2284	10538	1888	11640	1558	12410	1058	12124	469	8273
10-#11	1.94	5359	2733	8783	2340	11104	1927	12276	1580	13216	1049	13055	411	9849
10-#14	2.80	5631	2979	9879	2495	12423	2041	13822	1654	14227	975	15398	282	13562
10-#18	4.97	6322	3601	12556	2891	15649	2332	17622	1840	18889	962	21039	-62	21051
11-#10	1.74	5323	2676	8158	2355	10571	1952	11817	1619	12792	1099	12763	472	9075
11-#11	2.13	5439	2789	8716	2416	11184	1997	12509	1647	12754	1019	13814	414	10721
11-#14	3.08	5748	3059	9902	2588	12603	2128	14180	1737	14800	1022	16451	281	14603
11-#18	5.47	6545	3743	12792	3025	16037	2472	18298	1964	21253	1099	22858	-70	22837
12-#10	1.89	5394	2721	8286	2399	10741	1991	12067	1644	13165	1113	13310	469	9724
12-#11	2.33	5524	2844	8883	2467	11399	2042	12813	1676	14124	1108	14418	401	11555
12-#14	3.36	5870	3139	10168	2656	12923	2187	14618	1775	16515	1117	17291	259	15831
12-#18	5.97	6714	3885	13298	3136	16663	2557	19063	2023	20924	1058	24270	-118	24214
13-#10	2.05	5448	2766	8505	2421	11038	2005	12398	1657	13568	1107	13777	438	10484
13-#11	2.52	5588	2900	9137	2497	11754	2061	13208	1693	13635	1028	14984	364	12384
13-#14	3.64	5955	3219	10510	2702	13423	2218	15175	1801	17207	1108	18097	206	16809
13-#18	6.47	6905	4027	13865	3224	17525	2618	20014	2073	22024	1043	25651	-211	25511
14-#10	2.21	5536	2811	8869	2429	11363	2008	12750	1650	13087	1021	14158	410	11138
14-#11	2.72	5689	2955	9546	2510	12130	2069	13633	1689	14136	1015	15473	331	13221
14-#14	3.92	6088	3299	11036	2729	13929	2237	15777	1802	16768	1018	18841	164	17920
14-#18	6.96	7112	4169	14678	3284	18351	2662	21065	2087	24892	1091	26970	-285	26776
15-#10	2.37	5577	2856	8862	2486	11512	2057	12971	1694	13390	1040	14734	396	11856
15-#11	2.91	5738	3011	9574	2577	12326	2124	13905	1738	14507	1035	16148	312	14008
15-#14	4.20	6169	3379	11141	2816	14237	2307	16174	1864	18532	1117	19746	131	18947
16-#10	2.53	5649	2901	9006	2523	11703	2089	13258	1717	14722	1125	15268	390	12518
16-#11	3.10	5826	3066	9757	2620	12567	2163	14260	1766	15994	1121	16753	300	14847
16-#14	4.48	6327	3458	11419	2875	14595	2361	16688	1904	19170	1132	20585	110	19958
17-#10	2.68	5689	2946	9259	2548	11982	2107	13556	1731	14121	1047	15730	361	13205
17-#11	3.30	5872	3122	10058	2652	12899	2185	14609	1782	15395	1043	17337	267	15597
17-#14	4.76	6375	3538	11835	2924	15059	2395	17174	1927	18556	1053	21447	63	21064

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.84	5750	2991	9529	2566	12297	2120	13898	1732	14501	1037	16119	334	13887
18-#11	3.49	5956	3177	10365	2677	13273	2204	15017	1785	15856	1033	17806	234	16414
18-#14	5.04	6494	3618	12239	2964	15579	2428	17747	1936	20601	1116	22120	17	22026
19-#10	3.00	5807	3037	9622	2612	12463	2158	14130	1766	14842	1052	16691	323	14527
19-#11	3.69	6011	3232	10498	2730	13481	2247	15308	1825	17425	1124	18483	217	17137
19-#14	5.32	6588	3698	12464	3036	15888	2484	18174	1989	21229	1144	23063	-10	23055
20-#10	3.16	5864	3082	9759	2650	12679	2190	14402	1786	16295	1138	17169	306	15206
20-#11	3.88	6081	3288	10672	2776	13742	2285	15636	1848	17907	1136	19076	197	17904
21-#10	3.32	5929	3127	9990	2677	12952	2204	14717	1803	15583	1063	17659	284	15833
21-#11	4.07	6157	3343	10945	2809	14073	2303	16013	1869	18378	1136	19636	167	18637
22-#10	3.47	5976	3172	10306	2693	13252	2216	15039	1807	17104	1129	18084	256	16511
22-#11	4.27	6229	3399	11317	2831	14428	2319	16405	1876	17613	1050	20231	145	19366
23-#10	3.63	6049	3217	10391	2737	13431	2254	15292	1838	16303	1068	18648	248	17103
23-#11	4.46	6305	3454	11433	2883	14655	2364	16713	1912	18029	1067	20835	123	20127
24-#10	3.79	6102	3262	10575	2771	13656	2279	15579	1857	17836	1148	19150	231	17749
25-#10	3.95	6171	3307	10760	2801	13909	2304	15878	1874	18248	1151	19606	208	18356
26-#10	4.11	6220	3353	11019	2823	14197	2319	16205	1882	17410	1067	20102	186	18963

ROUND SPIRAL COLUMNS 34" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.03	5997	2793	9849	2341	11991	1926	12912	1594	13280	1109	12128	543	6786
6-#14	1.49	6163	2940	10604	2421	12895	1983	13979	1628	14696	1099	13619	457	9456
6-#18	2.64	6579	3313	12440	2630	15119	2131	16617	1715	18212	1075	17229	226	15821
7-#11	1.20	6163	2848	9151	2519	11764	2093	13026	1741	12842	1133	13255	600	7879
7-#14	1.73	6393	3020	9998	2623	12756	2172	14189	1794	14258	1133	15066	516	10734
7-#18	3.08	6922	3455	12051	2891	15187	2376	17059	1929	17749	1130	19508	297	17523
8-#10	1.12	6094	2821	8652	2549	11457	2123	12827	1775	12680	1169	13103	633	7326
8-#11	1.37	6183	2903	9120	2590	11964	2153	13391	1794	13314	1163	13881	586	8759
8-#14	1.98	6417	3100	10054	2714	13094	2247	14732	1860	15978	1251	15912	488	12119
8-#18	3.52	6967	3597	12327	3031	15876	2490	18033	2027	18851	1176	20888	232	19698
9-#10	1.26	6187	2866	9029	2561	11795	2131	13151	1775	13047	1153	13651	608	8234
9-#11	1.55	6294	2959	9542	2608	12353	2166	13767	1795	13771	1146	14546	556	9816
9-#14	2.23	6577	3180	10596	2747	13618	2273	15248	1867	16697	1230	16874	448	13366
9-#18	3.97	7270	3739	13165	3102	16729	2547	18896	2048	20065	1152	22566	165	21547
10-#10	1.40	6243	2911	9581	2552	12288	2114	13580	1750	14412	1202	14000	565	8964
10-#11	1.72	6359	3014	10142	2606	12905	2152	14270	1772	15286	1193	15018	508	10679
10-#14	2.48	6660	3260	11327	2761	14333	2267	15943	1846	16311	1111	17625	387	14714
10-#18	4.41	7379	3882	14223	3157	17832	2560	20061	2035	22885	1180	23829	56	23592
11-#10	1.54	6318	2956	9420	2627	12297	2182	13756	1815	14830	1247	14728	572	9832
11-#11	1.89	6448	3070	10028	2689	12964	2227	14506	1843	15777	1241	15830	509	11679
11-#14	2.73	6788	3340	11311	2860	14497	2358	16311	1934	16936	1162	18747	385	15904
11-#18	4.85	7631	4024	14448	3299	18266	2691	20765	2163	23992	1254	25749	45	25472

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	1.68	6395	3002	9550	2673	12475	2222	14023	1842	14212	1178	15324	570	10550
12-#11	2.06	6539	3125	10202	2742	13190	2273	14832	1874	15179	1174	16536	504	12545
12-#14	2.97	6923	3419	11594	2931	14838	2419	16782	1973	18843	1267	19665	366	17237
12-#18	5.29	7818	4166	14988	3412	18889	2791	21592	2224	23546	1202	27293	1	27288
13-#10	1.82	6454	3047	9790	2694	12795	2235	14383	1854	14617	1172	15811	537	11387
13-#11	2.23	6608	3181	10481	2770	13574	2291	15262	1890	15669	1167	17150	466	13493
13-#14	3.22	7014	3499	11966	2975	15375	2449	17388	1999	19593	1258	20543	313	18374
13-#18	5.73	8047	4308	15600	3499	19813	2851	22627	2275	26528	1275	28806	-92	28765
14-#10	1.96	6551	3092	10203	2700	13157	2237	14762	1845	16152	1242	16217	509	12094
14-#11	2.41	6722	3236	10941	2781	13990	2297	15719	1883	16218	1153	17650	432	14365
14-#14	3.47	7160	3579	12553	3000	15933	2466	18033	1997	19067	1159	21308	269	19683
14-#18	6.17	8272	4450	16498	3557	20718	2893	23750	2285	26080	1166	30267	-160	30103
15-#10	2.10	6596	3137	10171	2760	13306	2288	14996	1891	16501	1264	16851	497	12912
15-#11	2.58	6775	3292	10947	2850	14190	2355	16009	1935	16612	1175	18392	415	15262
15-#14	3.72	7248	3659	12641	3090	16256	2539	18457	2063	21028	1269	22326	239	20735
15-#18	6.61	8454	4592	16793	3701	21340	3006	24504	2385	27067	1203	31868	-229	31658
16-#10	2.24	6675	3182	10320	2797	13505	2321	15300	1915	15781	1190	17439	493	13606
16-#11	2.75	6871	3347	11139	2894	14443	2394	16385	1963	17068	1187	19077	406	16138
16-#14	3.97	7398	3739	12935	3150	16632	2594	19003	2102	21719	1285	23257	222	21882
17-#10	2.38	6718	3227	10595	2822	13809	2339	15627	1929	17340	1271	17894	459	14381
17-#11	2.92	6921	3402	11465	2925	14804	2416	16769	1980	18819	1268	19685	372	16992
17-#14	4.21	7470	3819	13386	3198	17136	2627	19540	2127	22489	1282	24154	174	23030
18-#10	2.52	6784	3272	10898	2839	14152	2350	16000	1929	17779	1260	18352	436	15089
18-#11	3.09	7002	3458	11808	2949	15210	2434	17213	1983	18060	1172	20193	338	17900
18-#14	4.46	7597	3899	13832	3237	17698	2658	20163	2135	23251	1268	24887	127	24117
19-#10	2.66	6844	3317	10987	2887	14324	2390	16242	1964	18175	1278	18976	427	15819
19-#11	3.26	7074	3513	11939	3004	15431	2479	17518	2023	18502	1190	20933	324	18705
19-#14	4.71	7685	3979	14064	3311	18032	2717	20612	2189	23916	1291	25916	103	25301
20-#10	2.80	6910	3363	11127	2925	14595	2415	16534	1984	17352	1202	19478	409	16526
20-#11	3.44	7149	3569	12120	3051	15712	2518	17871	2047	18980	1202	21556	303	19605
20-#14	4.96	7819	4059	14338	3376	18437	2771	21117	2221	24654	1308	26820	73	26385
21-#10	2.94	6976	3408	11380	2951	14851	2436	16871	2001	19018	1286	20010	388	17239
21-#11	3.61	7232	3624	12418	3083	16067	2535	18280	2068	19465	1203	22188	276	20368
22-#10	3.08	7032	3453	11726	2966	15179	2448	17219	2004	19473	1280	20487	361	17949
22-#11	3.78	7295	3680	12824	3104	16454	2551	18699	2074	21387	1278	22742	241	21194
23-#10	3.22	7112	3498	11810	3012	15364	2486	17491	2037	19858	1296	21083	353	18644
23-#11	3.95	7394	3735	12941	3158	16691	2597	19030	2111	21861	1296	23478	232	21984
24-#10	3.36	7161	3543	12007	3047	15605	2512	17795	2056	18905	1213	21629	337	19370
24-#11	4.12	7457	3791	13181	3199	16984	2628	19405	2135	20850	1213	24128	211	22793
25-#10	3.50	7243	3588	12207	3076	15879	2537	18118	2073	20701	1303	22123	314	20031
25-#11	4.30	7555	3846	13421	3236	17312	2658	19793	2155	22875	1303	24722	182	23597
26-#10	3.64	7297	3633	12492	3098	16189	2551	18477	2081	19721	1208	22643	291	20726
27-#10	3.78	7371	3679	12636	3136	16390	2587	18748	2104	20097	1222	23170	275	21378
28-#10	3.92	7429	3724	12795	3173	16646	2613	19042	2127	20489	1227	23721	256	22041

ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.33	7263	3238	12235	2692	14930	2209	16176	1819	15786	1159	15671	555	10160
6-#18	2.36	7694	3611	14215	2900	17323	2357	19011	1906	20688	1219	19609	332	17052
7-#11	1.07	7260	3146	10550	2806	13653	2334	15133	1946	15941	1369	15293	703	8501
7-#14	1.55	7514	3318	11463	2910	14720	2413	16382	1999	16402	1278	17247	620	11613
7-#18	2.75	8097	3753	13680	3178	17339	2618	19469	2135	21606	1369	22053	406	18967
8-#11	1.23	7285	3201	10483	2880	13847	2397	15513	2002	16488	1404	15980	691	9428
8-#14	1.77	7542	3398	11489	3004	15061	2492	16951	2068	18332	1410	18172	595	13055
8-#18	3.14	8146	3895	13938	3321	18052	2735	20513	2237	21359	1328	23559	345	21622
9-#10	1.12	7286	3164	10397	2850	13671	2374	15261	1982	16169	1391	15723	712	8855
9-#11	1.38	7405	3257	10955	2897	14275	2409	15926	2003	15869	1292	16693	660	10599
9-#14	1.99	7716	3478	12090	3035	15634	2516	17519	2074	19089	1387	19209	555	14473
9-#18	3.54	8474	4037	14858	3391	18981	2791	21448	2258	22638	1301	25378	278	23520
10-#10	1.25	7347	3209	11027	2835	14227	2353	15731	1953	15520	1265	16068	666	9662
10-#11	1.53	7476	3312	11636	2890	14895	2391	16476	1975	17569	1346	17165	609	11519
10-#14	2.21	7807	3557	12910	3044	16432	2507	18275	2050	18594	1255	19972	490	15879
10-#18	3.93	8592	4179	16028	3441	20207	2801	22712	2241	25745	1338	26813	176	25823
11-#10	1.37	7429	3254	10808	2917	14207	2427	15905	2023	17084	1404	16888	677	10588
11-#11	1.69	7573	3368	11468	2978	14929	2471	16714	2051	18103	1398	18084	615	12645
11-#14	2.43	7946	3637	12848	3149	16577	2602	18652	2142	20650	1404	21168	486	17229
11-#18	4.32	8864	4322	16225	3588	20634	2937	23443	2373	25150	1322	28836	163	27748
12-#10	1.50	7513	3299	10932	2964	14391	2468	16189	2051	17504	1420	17535	676	11387
12-#11	1.84	7672	3423	11645	3033	15164	2519	17061	2083	18618	1415	18850	611	13548
12-#14	2.65	8079	3717	13144	3222	16937	2666	19155	2183	21387	1426	22235	477	18620
12-#18	4.72	9068	4464	16805	3705	21299	3039	24331	2436	26368	1354	30514	123	29785
13-#10	1.62	7577	3345	11201	2985	14736	2480	16578	2063	17969	1413	18041	642	12276
13-#11	1.99	7748	3479	11950	3060	15577	2536	17526	2099	17903	1314	19490	572	14624
13-#14	2.87	8193	3797	13548	3266	17512	2694	19810	2209	22194	1417	23182	424	19914
13-#18	5.11	9283	4606	17462	3790	22285	3097	25450	2487	29654	1438	32158	31	31951
14-#10	1.75	7681	3390	11665	2988	15136	2480	16984	2052	17255	1304	18471	613	13065
14-#11	2.15	7872	3534	12466	3069	16036	2540	18015	2090	19822	1393	20021	538	15525
14-#14	3.09	8352	3877	14200	3288	18123	2709	20499	2204	21566	1308	23970	378	21329
14-#18	5.50	9558	4748	18450	3846	23271	3138	26646	2495	31209	1414	33665	-41	33625
15-#10	1.87	7732	3435	11605	3051	15283	2533	17230	2100	18872	1422	19164	603	13930
15-#11	2.30	7930	3589	12446	3140	16239	2600	18321	2144	18918	1323	20833	522	16540
15-#14	3.32	8447	3957	14267	3381	18458	2785	20951	2273	23739	1430	25080	350	22528
15-#18	5.89	9749	4890	18736	3992	23930	3254	27455	2598	32322	1455	35485	-102	35375
16-#10	2.00	7817	3480	11758	3089	15490	2567	17550	2125	19310	1434	19784	599	14704
16-#11	2.45	8034	3645	12645	3185	16501	2640	18718	2173	20795	1432	21597	517	17448
16-#14	3.54	8606	4037	14576	3442	18852	2840	21528	2312	24483	1447	26126	337	23863
16-#18	6.29	10021	5032	19316	4095	24656	3348	28488	2666	31362	1381	37169	-138	37070
17-#10	2.12	7866	3525	12056	3113	15818	2584	17902	2138	19766	1430	20289	567	15547
17-#11	2.61	8089	3700	12997	3216	16892	2662	19139	2190	19933	1332	22180	475	18422
17-#14	3.76	8674	4117	15062	3489	19398	2874	22115	2338	23611	1346	27057	288	25046

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 5,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.25	7937	3570	12395	3128	16191	2595	18311	2138	20235	1418	20779	543	16312
18-#11	2.76	8175	3756	13379	3238	17331	2678	19619	2192	20465	1320	22776	448	19358
18-#14	3.98	8821	4197	15554	3527	20002	2902	22789	2345	26116	1428	27850	242	26266
19-#10	2.37	8002	3615	12475	3178	16367	2636	18562	2174	19285	1342	21448	535	17135
19-#11	2.91	8255	3811	13505	3295	17561	2725	19937	2234	20942	1340	23579	435	20268
19-#14	4.20	8906	4277	15789	3602	20358	2964	23259	2400	25045	1356	28966	219	27493
20-#10	2.50	8074	3661	12619	3217	16660	2662	18875	2195	21103	1448	21984	517	17868
20-#11	3.07	8336	3867	13692	3342	17866	2765	20316	2258	22979	1448	24233	413	21205
20-#14	4.42	9028	4357	16075	3668	20794	3019	23802	2433	27614	1470	29913	188	28712
21-#10	2.62	8146	3706	12929	3239	16933	2683	19233	2211	21561	1445	22556	496	18674
21-#11	3.22	8420	3922	14016	3374	18244	2781	20753	2279	21963	1348	24922	387	22088
21-#14	4.64	9146	4437	16523	3716	21332	3044	24426	2465	26518	1374	30887	150	29950
22-#10	2.74	8206	3751	13271	3257	17290	2693	19609	2214	22056	1440	23087	471	19410
22-#11	3.37	8493	3978	14457	3394	18665	2796	21202	2284	24119	1438	25534	354	23029
22-#14	4.86	9274	4517	17122	3748	21913	3069	25063	2475	29230	1458	31744	102	31104
23-#10	2.87	8293	3796	13352	3304	17479	2733	19898	2247	22463	1456	23675	458	20192
23-#11	3.52	8595	4033	14574	3449	18909	2843	21556	2322	24619	1457	26309	344	23886
24-#10	2.99	8345	3841	13558	3339	17736	2759	20220	2267	22891	1461	24305	447	20948
24-#11	3.68	8670	4088	14832	3491	19223	2875	21952	2346	25134	1462	27013	324	24794
25-#10	3.12	8434	3886	13777	3368	18032	2784	20568	2284	23365	1464	24837	425	21692
25-#11	3.83	8767	4144	15088	3528	19577	2905	22370	2367	23996	1368	27653	296	25635
26-#10	3.24	8494	3931	14089	3389	18365	2797	20959	2292	23822	1455	25379	400	22448
26-#11	3.98	8835	4199	15452	3555	19977	2923	22832	2377	24518	1359	28333	268	26494
27-#10	3.37	8568	3976	14235	3428	18577	2834	21243	2316	24255	1470	25953	386	23178
27-#11	4.14	8932	4255	15646	3601	20240	2966	23185	2405	26790	1473	29005	247	27358
28-#10	3.49	8637	4022	14403	3465	18846	2860	21558	2339	24699	1475	26563	369	23939
29-#10	3.62	8709	4067	14660	3493	19129	2885	21910	2352	25157	1478	27068	346	24652
30-#10	3.74	8791	4112	14917	3519	19468	2901	22267	2364	25624	1472	27617	321	25399

ROUND SPIRAL COLUMNS 12" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.64	308	433	613	298	654	241	655	193	625	119	519	28	422
6-#6	2.33	313	460	649	312	693	250	700	196	635	103	570	2	563
6-#7	3.18	320	494	690	329	739	261	752	201	747	101	630	-30	641
6-#8	4.19	327	534	738	350	792	274	812	205	823	89	697	-69	727
6-#9	5.31	336	578	785	371	847	288	875	210	842	70	765	-113	812
6-#10	6.74	347	634	844	399	914	306	951	215	1000	55	847	-170	914
7-#5	1.92	314	444	604	323	661	260	676	210	658	131	563	30	472
7-#6	2.72	321	476	641	340	705	272	725	216	673	117	623	2	618
7-#7	3.71	331	515	686	362	757	286	784	223	796	117	694	-33	722
7-#8	4.89	342	561	736	388	817	303	851	231	823	100	773	-75	824
7-#9	6.19	354	613	789	416	879	321	920	240	906	89	853	-125	922
8-#5	2.19	316	455	611	333	675	268	694	217	636	124	594	23	529
8-#6	3.11	324	491	654	354	724	282	751	225	753	126	664	-9	671
8-#7	4.24	334	536	703	379	783	298	818	234	837	118	746	-49	779
8-#8	5.59	346	589	760	409	850	318	894	245	933	107	838	-99	897

ROUND SPIRAL COLUMNS 14" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.21	488	566	931	406	1010	329	1018	270	968	177	803	65	524
6-#6	1.71	496	593	976	420	1064	338	1079	275	975	160	872	40	707
6-#7	2.34	506	626	1031	437	1129	350	1151	280	1136	163	955	9	919
6-#8	3.08	517	666	1093	458	1203	363	1235	287	1159	143	1049	-28	1070
6-#9	3.90	529	710	1161	481	1280	377	1323	294	1353	143	1146	-70	1194
6-#10	4.95	544	767	1245	511	1376	405	1433	303	1392	119	1311	-113	1342
6-#11	6.08	553	828	1324	537	1446	418	1509	302	1587	101	1377	-180	1443
7-#5	1.41	496	576	907	437	1013	356	1040	292	1013	193	876	74	600
7-#6	2.00	507	608	957	455	1071	368	1107	299	1098	189	969	51	791
7-#7	2.73	522	647	1016	478	1140	384	1188	308	1119	171	1073	21	1013
7-#8	3.59	538	694	1084	505	1221	402	1281	319	1317	175	1192	-17	1198
7-#9	4.55	555	745	1157	534	1306	422	1381	330	1441	166	1315	-59	1353
7-#10	5.78	578	812	1249	573	1413	448	1506	345	1605	159	1466	-115	1537
7-#11	7.09	591	883	1330	605	1500	467	1593	349	1714	134	1545	-194	1644
8-#5	1.61	498	587	916	450	1030	366	1064	300	978	184	924	70	666
8-#6	2.29	509	624	973	471	1095	380	1139	310	1068	180	1026	42	890
8-#7	3.12	524	668	1040	498	1173	399	1230	321	1260	188	1147	7	1129
8-#8	4.11	541	722	1117	529	1264	420	1336	334	1393	181	1284	-35	1309
8-#9	5.20	560	780	1199	563	1360	444	1448	349	1534	172	1427	-84	1479
8-#10	6.60	584	856	1300	607	1480	474	1589	367	1596	149	1603	-149	1655

ROUND SPIRAL COLUMNS 16" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#6	1.31	737	746	1395	545	1533	442	1566	364	1509	239	1273	89	850
6-#7	1.79	750	780	1462	562	1613	454	1659	371	1518	217	1383	61	1112
6-#8	2.36	765	820	1540	583	1707	468	1767	379	1762	225	1510	26	1408
6-#9	2.98	781	864	1623	606	1809	484	1882	388	1907	216	1644	-13	1654
6-#10	3.79	801	920	1729	636	1938	504	2025	398	2088	204	1810	-64	1854
6-#11	4.66	815	981	1832	663	2048	519	2136	401	2226	182	1913	-132	2000
6-#14	6.71	863	1126	2077	740	2329	584	2457	424	2633	144	2354	-251	2414
7-#5	1.08	736	730	1292	570	1465	467	1512	386	1471	265	1283	123	728
7-#6	1.53	751	761	1354	588	1538	480	1596	394	1579	262	1396	101	969
7-#7	2.09	769	801	1428	611	1625	496	1697	404	1596	240	1532	73	1245
7-#8	2.75	791	847	1513	638	1727	516	1814	416	1861	253	1687	39	1556

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 16" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
7-#9	3.48	813	899	1604	669	1835	537	1940	429	2023	246	1852	0	1852
7-#10	4.42	845	965	1718	708	1971	564	2099	445	2224	237	2055	-51	2101
7-#11	5.43	865	1036	1833	742	2090	585	2233	454	2220	203	2215	-114	2287
7-#14	7.83	934	1205	2098	841	2402	652	2599	492	2831	186	2657	-258	2767
8-#5	1.23	738	740	1298	585	1485	479	1541	397	1412	252	1346	121	805
8-#6	1.75	753	777	1368	606	1567	494	1635	407	1635	267	1480	96	1081
8-#7	2.39	772	822	1453	633	1666	513	1749	419	1663	246	1640	65	1405
8-#8	3.14	794	875	1550	665	1780	536	1882	434	1824	242	1824	28	1747
8-#9	3.98	818	934	1655	701	1902	561	2024	450	2139	254	2019	-16	2030
8-#10	5.05	850	1009	1787	747	2055	593	2203	470	2371	247	2260	-73	2268
8-#11	6.21	872	1090	1913	788	2190	618	2354	482	2378	211	2419	-152	2466
9-#10	5.68	883	1054	1871	765	2155	610	2327	476	2529	240	2393	-106	2474
9-#11	6.98	910	1145	2011	811	2312	641	2497	490	2550	202	2567	-194	2662
10-#10	6.32	901	1098	1971	782	2269	614	2458	477	2683	218	2523	-150	2614

ROUND SPIRAL COLUMNS 18" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#6	1.04	1042	920	1916	688	2120	560	2169	464	2090	315	1771	141	994
6-#7	1.41	1059	953	1996	705	2216	572	2282	472	2232	310	1910	115	1305
6-#8	1.86	1080	993	2089	726	2328	587	2415	481	2398	304	2070	84	1660
6-#9	2.36	1100	1037	2189	749	2449	603	2560	491	2577	296	2241	48	2036
6-#10	2.99	1126	1094	2315	779	2603	623	2743	504	2802	286	2455	1	2452
6-#11	3.68	1144	1155	2444	806	2749	640	2890	509	2983	267	2605	-62	2651
6-#14	5.31	1205	1300	2742	883	3115	693	3298	537	3499	236	3072	-194	3189
7-#6	1.21	1061	935	1845	740	2118	607	2207	502	2174	343	1933	157	1153
7-#7	1.65	1084	974	1933	763	2222	623	2328	513	2331	340	2103	132	1484
7-#8	2.17	1111	1021	2035	791	2344	643	2469	525	2347	314	2300	100	1859
7-#9	2.75	1139	1072	2145	821	2476	665	2622	539	2713	332	2510	65	2256
7-#10	3.49	1175	1138	2283	861	2642	694	2815	557	2965	326	2771	18	2707
7-#11	4.29	1206	1210	2426	895	2799	717	2985	567	3176	310	2958	-45	3002
7-#14	6.19	1289	1379	2750	996	3185	787	3437	610	3499	268	3533	-177	3672
8-#6	1.38	1064	951	1854	760	2154	624	2254	517	2093	327	2018	151	1275
8-#7	1.89	1087	995	1955	787	2273	643	2391	530	2419	348	2211	121	1662
8-#8	2.48	1115	1049	2071	819	2411	667	2551	545	2626	345	2435	85	2102
8-#9	3.14	1144	1107	2196	855	2559	693	2723	563	2850	341	2674	44	2550
8-#10	3.99	1181	1183	2354	901	2746	726	2941	585	3133	336	3025	2	3020
8-#11	4.90	1214	1264	2520	944	2918	753	3133	599	3378	322	3251	-70	3244
8-#14	7.07	1305	1457	2894	1062	3354	835	3642	651	4035	302	3932	-217	3970
9-#10	4.49	1222	1227	2466	921	2858	741	3085	590	3322	326	3194	-31	3222
9-#11	5.52	1261	1319	2643	967	3055	773	3310	607	3611	315	3444	-110	3535
10-#10	4.99	1246	1272	2594	936	2999	743	3238	588	3532	311	3355	-72	3405
10-#11	6.13	1286	1373	2786	988	3218	777	3490	606	3831	288	3632	-163	3737
11-#10	5.49	1278	1316	2632	982	3085	789	3352	621	3689	331	3587	-87	3653
11-#11	6.74	1324	1428	2845	1042	3321	830	3624	643	4028	312	3894	-183	3997
12-#10	5.99	1307	1361	2697	1019	3182	813	3490	644	3853	333	3800	-110	3865

ROUND SPIRAL COLUMNS 20" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.15	1442	1147	2645	866	2952	705	3039	584	2770	369	2545	174	1499
6-#8	1.51	1465	1187	2753	887	3082	720	3193	593	2954	364	2740	145	1912
6-#9	1.91	1491	1231	2870	910	3223	736	3361	604	3378	384	2949	111	2353
6-#10	2.43	1526	1288	3017	940	3402	757	3574	617	3646	376	3211	68	2899
6-#11	2.98	1550	1349	3172	966	3576	773	3774	626	3614	335	3409	9	3379
6-#14	4.30	1624	1494	3524	1044	4007	827	4279	659	4499	333	3998	-113	4074
6-#18	7.64	1808	1861	4364	1244	5044	964	5438	732	5965	257	5333	-445	5536
7-#7	1.34	1473	1168	2542	934	2948	766	3096	634	3085	431	2790	195	1730
7-#8	1.76	1505	1215	2661	962	3090	786	3263	647	3299	428	3028	166	2170
7-#9	2.23	1539	1266	2790	992	3243	808	3442	662	3297	396	3284	133	2636
7-#10	2.83	1582	1333	2952	1032	3438	837	3669	680	3828	420	3604	90	3212
7-#11	3.48	1617	1404	3125	1067	3629	861	3876	692	3818	380	3849	31	3727
7-#14	5.01	1722	1573	3508	1168	4095	934	4415	737	4794	392	4573	-90	4652
8-#7	1.53	1477	1189	2557	960	3004	788	3170	653	2977	412	2922	187	1922
8-#8	2.01	1510	1243	2693	992	3168	813	3357	670	3432	439	3193	153	2437
8-#9	2.55	1546	1301	2839	1028	3346	840	3560	688	3695	437	3483	115	2986
8-#10	3.23	1591	1377	3023	1074	3567	874	3817	711	3759	405	3848	66	3641
8-#11	3.97	1627	1458	3221	1117	3776	902	4051	727	4036	393	4129	-2	4131
8-#14	5.73	1741	1651	3661	1236	4298	987	4659	783	4774	380	5057	-122	5036
9-#10	3.64	1639	1421	3159	1093	3690	887	3976	714	4250	424	4115	45	3934
9-#11	4.47	1683	1513	3378	1141	3928	920	4248	733	4587	409	4442	-27	4468
9-#14	6.45	1824	1730	3868	1273	4515	1016	4944	795	5486	391	5389	-179	5468
10-#10	4.04	1661	1466	3325	1107	3861	887	4156	711	4483	406	4306	6	4285
10-#11	4.97	1717	1567	3558	1160	4125	922	4460	731	4879	391	4667	-77	4724
10-#14	7.16	1861	1809	4101	1305	4786	1025	5243	795	5895	366	5711	-251	5848
11-#10	4.45	1701	1510	3352	1156	3949	936	4291	748	4683	431	4590	-7	4596
11-#11	5.46	1762	1622	3608	1216	4241	979	4619	772	5097	416	4991	-95	5068
12-#10	4.85	1735	1555	3425	1195	4062	961	4441	771	4553	406	4846	-26	4864
12-#11	5.96	1802	1677	3697	1263	4375	1008	4805	800	4970	390	5289	-122	5364
13-#10	5.26	1767	1599	3553	1219	4206	983	4605	780	5095	432	5093	-54	5109
14-#10	5.66	1812	1644	3684	1239	4369	992	4793	787	5309	415	5274	-91	5330

ROUND SPIRAL COLUMNS 22" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.25	1935	1402	3544	1065	3985	868	4125	718	3805	453	3532	210	2165
6-#9	1.58	1965	1446	3678	1088	4146	884	4316	729	4323	480	3779	179	2672
6-#10	2.00	2003	1503	3847	1118	4350	905	4559	742	4636	474	4090	137	3300
6-#11	2.46	2039	1563	4028	1144	4552	921	4790	751	4579	428	4336	83	3924
6-#14	3.55	2127	1708	4433	1222	5047	975	5381	786	5644	436	5049	-31	5073
6-#18	6.31	2344	2076	5407	1423	6246	1113	6800	873	7392	372	6695	-340	6856
7-#7	1.10	1943	1383	3266	1124	3817	924	4014	768	3987	532	3605	264	1973
7-#8	1.45	1981	1429	3402	1151	3979	944	4204	781	3950	494	3885	236	2489
7-#9	1.84	2022	1481	3550	1182	4154	966	4411	796	4499	527	4187	206	3026
7-#10	2.34	2072	1547	3736	1222	4377	996	4674	816	4839	523	4566	165	3694
7-#11	2.87	2115	1618	3940	1256	4600	1019	4921	829	5147	512	4871	110	4346
7-#14	4.14	2233	1787	4382	1358	5137	1094	5547	876	5566	466	5745	-2	5747
7-#18	7.37	2528	2216	5442	1619	6433	1282	7050	993	7928	461	7762	-309	7966

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 22" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#7	1.26	1948	1404	3271	1152	3875	949	4101	790	4109	544	3763	257	2185
8-#8	1.66	1988	1457	3426	1184	4060	973	4316	807	4094	507	4081	226	2776
8-#9	2.10	2031	1516	3593	1220	4263	1000	4550	826	4376	505	4424	191	3407
8-#10	2.67	2084	1591	3803	1266	4520	1035	4846	850	5071	539	4855	144	4192
8-#11	3.28	2127	1673	4036	1308	4778	1065	5122	867	5419	528	5204	81	4926
8-#14	4.74	2252	1866	4541	1428	5386	1153	5829	926	6339	519	6197	-50	6229
9-#10	3.01	2141	1636	3966	1285	4666	1048	5020	851	4972	495	5167	124	4568
9-#11	3.69	2194	1727	4222	1332	4944	1081	5337	871	5723	517	5572	56	5324
9-#14	5.33	2349	1945	4792	1465	5623	1180	6141	935	6769	504	6714	-85	6738
10-#10	3.34	2164	1680	4174	1297	4868	1046	5228	846	5578	509	5385	86	5038
10-#11	4.10	2223	1782	4449	1349	5178	1081	5583	867	5636	462	5834	9	5801
10-#14	5.92	2400	2023	5080	1497	5942	1186	6488	934	6755	446	7094	-153	7184
11-#10	3.68	2208	1725	4186	1349	4956	1097	5382	887	5413	497	5725	75	5384
11-#11	4.51	2279	1836	4485	1409	5296	1141	5766	912	6311	526	6222	-7	6229
11-#14	6.51	2479	2102	5166	1575	6126	1265	6744	992	7599	515	7616	-180	7712
12-#10	4.01	2251	1769	4266	1390	5083	1124	5544	910	6052	545	6025	59	5786
12-#11	4.92	2324	1891	4585	1457	5449	1172	5968	941	6581	531	6573	-30	6594
13-#10	4.34	2284	1814	4410	1412	5251	1146	5735	919	6286	540	6282	25	6174
13-#11	5.33	2369	1946	4757	1486	5647	1199	6193	951	6873	527	6912	-64	6928
14-#10	4.68	2330	1858	4567	1430	5434	1152	5956	926	6532	524	6525	-4	6528
14-#11	5.75	2419	2000	4937	1511	5867	1210	6453	960	7166	507	7161	-109	7230
15-#10	5.01	2363	1903	4658	1470	5544	1194	6094	952	6316	507	6868	-19	6881
16-#10	5.35	2418	1947	4760	1501	5692	1220	6266	975	6987	545	7132	-41	7156

ROUND SPIRAL COLUMNS 24" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.05	2495	1637	4472	1261	5050	1031	5225	856	4799	550	4458	280	2419
6-#9	1.33	2530	1681	4624	1284	5231	1047	5439	866	5427	585	4743	250	2990
6-#10	1.68	2575	1738	4815	1314	5461	1068	5712	880	5784	579	5103	211	3702
6-#11	2.07	2611	1798	5024	1339	5692	1083	5975	888	6100	565	5398	159	4415
6-#14	2.98	2723	1943	5483	1418	6251	1138	6642	924	6950	546	6237	52	6040
6-#18	5.31	2974	2311	6592	1619	7613	1277	8272	1015	8383	459	8197	-238	8318
7-#8	1.22	2547	1664	4267	1360	5024	1118	5312	929	5328	641	4884	312	2816
7-#9	1.55	2595	1716	4435	1391	5222	1141	5544	944	5629	639	5232	283	3426
7-#10	1.97	2654	1782	4645	1430	5473	1170	5840	964	6013	636	5671	245	4184
7-#11	2.41	2704	1853	4881	1464	5729	1193	6128	977	6367	625	6036	193	4936
7-#14	3.48	2841	2022	5384	1567	6337	1268	6848	1028	6810	574	7061	87	6652
7-#18	6.19	3183	2451	6593	1829	7812	1460	8573	1150	8910	546	9460	-200	9603
8-#8	1.40	2557	1692	4280	1395	5108	1150	5443	952	5505	656	5102	303	3118
8-#9	1.77	2606	1751	4468	1431	5335	1176	5708	969	5845	656	5500	270	3831
8-#10	2.25	2668	1826	4706	1477	5624	1212	6043	1002	6278	654	6006	226	4722
8-#11	2.76	2720	1908	4973	1519	5921	1241	6361	1019	6679	644	6423	167	5609
8-#14	3.98	2865	2101	5545	1639	6623	1332	7169	1080	7211	596	7588	45	7409
8-#18	7.07	3239	2591	6928	1946	8299	1558	9115	1231	9575	574	10315	-287	10425
9-#10	2.53	2730	1871	4896	1494	5798	1224	6231	1001	6560	644	6326	201	5184
9-#11	3.10	2798	1962	5191	1541	6118	1258	6594	1021	6556	591	6845	143	6107
9-#14	4.48	2976	2180	5836	1675	6889	1358	7506	1087	8217	624	8186	11	8136
9-#18	7.96	3441	2731	7396	2016	8755	1610	9722	1251	11098	590	11323	-348	11342

ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.81	2759	1915	5146	1503	6033	1219	6468	993	6834	621	6606	169	5713
10-#11	3.45	2828	2017	5469	1557	6390	1255	6875	1015	7361	608	7142	96	6720
10-#14	4.97	3018	2258	6189	1706	7259	1362	7903	1085	8720	594	8621	-55	8657
11-#10	3.09	2810	1960	5142	1560	6118	1274	6637	1038	7090	648	7003	160	6151
11-#11	3.79	2888	2071	5487	1621	6508	1318	7082	1064	7659	637	7598	83	7190
11-#14	5.47	3112	2337	6259	1787	7447	1443	8194	1147	9146	636	9234	-79	9292
12-#10	3.37	2859	2004	5228	1602	6260	1303	6816	1062	7373	661	7349	146	6675
12-#11	4.14	2945	2126	5596	1670	6679	1351	7299	1093	8001	652	8003	63	7724
12-#14	5.97	3182	2416	6423	1855	7694	1488	8509	1187	8948	602	9794	-111	9851
13-#10	3.65	2897	2049	5389	1624	6452	1324	7032	1071	7642	657	7644	113	7078
13-#11	4.48	2990	2181	5788	1698	6906	1378	7556	1104	7760	603	8350	22	8241
13-#14	6.47	3258	2495	6692	1897	8010	1528	8870	1204	10046	639	10282	-169	10351
14-#10	3.93	2949	2093	5576	1641	6656	1329	7275	1076	7918	640	7920	85	7526
14-#11	4.83	3052	2235	6000	1721	7151	1386	7853	1113	8646	626	8681	-13	8690
15-#10	4.21	2986	2138	5665	1682	6777	1372	7439	1106	7633	617	8316	72	7957
15-#11	5.17	3096	2290	6122	1769	7300	1436	8040	1145	8364	606	9141	-32	9165
16-#10	4.49	3041	2182	5777	1715	6937	1399	7633	1129	8423	663	8621	52	8381
16-#11	5.52	3171	2344	6260	1808	7498	1469	8272	1173	9256	651	9498	-58	9532
17-#10	4.77	3076	2226	5918	1745	7111	1421	7834	1138	8130	619	8953	24	8834
18-#10	5.05	3126	2271	6102	1763	7314	1432	8056	1146	9002	653	9215	-5	9218

ROUND SPIRAL COLUMNS 26" DIA.

6-#9	1.13	3194	1936	5720	1498	6494	1224	6746	1016	6241	650	5853	327	3308
6-#10	1.44	3245	1993	5933	1528	6749	1245	7048	1029	7090	692	6263	290	4104
6-#11	1.76	3288	2054	6171	1553	7009	1260	7344	1038	7467	680	6607	240	4907
6-#14	2.54	3406	2199	6685	1631	7633	1315	8086	1073	7868	620	7572	138	6785
6-#18	4.52	3706	2566	7929	1833	9157	1455	9909	1166	10031	576	9850	-137	9927
7-#9	1.32	3265	1971	5455	1618	6461	1331	6861	1105	6937	760	6430	365	3835
7-#10	1.67	3334	2037	5690	1658	6740	1360	7189	1125	6873	707	6930	329	4684
7-#11	2.06	3393	2108	5958	1691	7029	1383	7513	1138	7764	747	7355	279	5534
7-#14	2.97	3550	2277	6522	1794	7709	1458	8318	1189	8806	740	8532	179	7522
7-#18	5.27	3923	2706	7882	2058	9363	1652	10280	1318	10588	668	11317	-91	11389
8-#9	1.51	3280	2006	5475	1661	6577	1369	7048	1134	7181	779	6718	353	4261
8-#10	1.91	3351	2082	5740	1708	6897	1404	7422	1157	7153	727	7287	311	5257
8-#11	2.35	3412	2163	6043	1748	7231	1433	7784	1184	7575	718	7798	257	6257
8-#14	3.39	3578	2356	6682	1868	8014	1524	8691	1247	9292	766	9136	142	8503
8-#18	6.03	3980	2846	8231	2176	9928	1757	10891	1404	12151	751	12299	-171	12369
9-#10	2.15	3422	2126	5960	1723	7100	1416	7625	1159	7965	767	7667	287	5815
9-#11	2.64	3496	2218	6294	1770	7463	1450	8034	1184	8491	757	8228	225	6858
9-#14	3.81	3705	2435	7016	1904	8326	1551	9055	1251	9842	752	9815	108	9253
9-#18	6.78	4231	2986	8765	2246	10425	1807	11543	1421	12226	679	13454	-230	13479
10-#10	2.39	3454	2171	6254	1728	7371	1408	7892	1153	7716	692	7980	256	6377
10-#11	2.94	3534	2272	6623	1782	7775	1444	8351	1175	8269	681	8605	187	7568

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	4.24	3749	2514	7438	1932	8750	1552	9502	1247	9687	670	10303	44	10101
10-#18	7.53	4308	3126	9388	2312	11116	1825	12305	1426	13151	637	14316	-342	14241
11-#10	2.63	3512	2215	6232	1790	7451	1467	8072	1196	7988	721	8426	249	6904
11-#11	3.23	3602	2327	6623	1850	7890	1511	8576	1229	8586	711	9131	176	8139
11-#14	4.66	3857	2592	7488	2018	8940	1637	9827	1314	10838	756	11010	23	10891
12-#10	2.87	3560	2260	6322	1834	7606	1497	8269	1218	8275	734	8803	235	7466
12-#11	3.53	3667	2381	6739	1902	8079	1545	8813	1259	8937	726	9591	159	8805
12-#14	5.09	3934	2671	7667	2088	9213	1684	10164	1354	11377	778	11648	-5	11651
13-#10	3.11	3609	2304	6502	1854	7819	1518	8511	1231	9176	783	9147	204	7967
13-#11	3.82	3717	2436	6953	1928	8336	1572	9101	1270	9934	774	9986	119	9351
13-#14	5.51	4020	2750	7963	2129	9571	1724	10570	1372	11875	770	12205	-63	12246
14-#10	3.35	3668	2348	6720	1869	8049	1520	8777	1238	8850	715	9472	178	8531
14-#11	4.11	3787	2491	7199	1950	8606	1578	9425	1276	10304	753	10357	85	9937
14-#14	5.93	4104	2829	8286	2165	9950	1738	11036	1386	12405	744	12738	-112	12793
15-#10	3.59	3707	2393	6804	1913	8179	1566	8959	1266	9764	787	9904	164	9001
15-#11	4.41	3837	2545	7320	2000	8768	1631	9644	1312	9938	726	10883	68	10519
16-#10	3.83	3771	2437	6926	1946	8351	1593	9183	1287	9369	738	10241	145	9508
16-#11	4.70	3910	2600	7471	2040	8982	1663	9904	1341	10243	729	11288	43	11074
17-#10	4.07	3806	2482	7086	1977	8556	1610	9400	1300	10359	791	10622	118	9980
17-#11	5.00	3958	2654	7658	2077	9213	1691	10171	1352	11359	781	11733	9	11683
18-#10	4.31	3867	2526	7293	1993	8782	1627	9649	1302	10672	779	10926	91	10482
18-#11	5.29	4025	2709	7902	2099	9484	1705	10467	1362	11747	768	12083	-26	12099
19-#10	4.54	3898	2571	7366	2039	8920	1659	9848	1334	10957	795	11338	74	10960
20-#10	4.78	3949	2615	7505	2072	9085	1689	10056	1351	10498	746	11754	66	11425

ROUND SPIRAL COLUMNS 28" DIA.

6-#10	1.24	4021	2269	7214	1760	8229	1437	8584	1192	8576	813	7581	373	4506
6-#11	1.52	4071	2330	7481	1784	8518	1452	8911	1199	9002	802	7975	325	5401
6-#14	2.19	4205	2474	8050	1862	9207	1506	9730	1235	9425	737	9066	227	7488
6-#18	3.90	4548	2842	9430	2064	10895	1647	11746	1329	11855	699	11664	-35	11686
7-#9	1.14	4043	2247	6620	1865	7884	1536	8375	1275	7874	832	7778	451	4236
7-#10	1.44	4119	2313	6880	1904	8192	1566	8737	1294	8909	889	8341	417	5196
7-#11	1.77	4189	2384	7183	1937	8515	1588	9096	1312	8730	821	8842	371	6144
7-#14	2.56	4366	2553	7809	2040	9266	1664	9985	1363	10509	873	10172	275	8359
7-#18	4.55	4788	2982	9321	2304	11101	1859	12166	1495	13334	854	13345	19	13246
8-#9	1.30	4061	2282	6623	1911	8001	1577	8581	1311	8710	913	8105	441	4695
8-#10	1.65	4142	2358	6916	1957	8353	1612	8999	1335	9243	913	8736	401	5796
8-#11	2.03	4212	2439	7255	1997	8725	1641	9404	1350	9748	904	9310	348	6911
8-#14	2.92	4399	2632	7963	2117	9588	1732	10412	1410	11052	903	10838	240	9531
8-#18	5.20	4851	3122	9679	2425	11704	1966	12866	1588	14237	894	14456	-54	14481
9-#10	1.86	4220	2402	7169	1971	8584	1624	9218	1335	8926	839	9157	377	6460
9-#11	2.28	4305	2493	7543	2017	8992	1657	9673	1354	9471	830	9815	319	7627
9-#14	3.29	4534	2711	8342	2151	9949	1759	10801	1429	10863	827	11539	198	10374
9-#18	5.85	5104	3262	10282	2495	12281	2018	13563	1602	15294	872	15758	-112	15713
10-#10	2.06	4256	2446	7512	1971	8896	1612	9514	1327	9892	872	9521	347	7051
10-#11	2.53	4347	2548	7924	2024	9347	1648	10025	1348	10550	860	10234	281	8379

ROUND SPIRAL COLUMNS 28" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#14	3.65	4589	2789	8825	2175	10428	1757	11299	1422	12230	850	12154	146	11413
10-#18	6.50	5216	3402	11012	2560	13060	2034	14414	1605	16349	821	16725	-220	16803
11-#10	2.27	4321	2491	7463	2039	8967	1675	9703	1373	10221	906	10004	340	7682
11-#11	2.79	4425	2603	7903	2099	9456	1719	10263	1399	10932	897	10818	272	9057
11-#14	4.02	4701	2868	8862	2267	10617	1846	11645	1492	11897	834	12957	128	12228
11-#18	7.15	5397	3542	11188	2694	13454	2169	15029	1711	17189	878	18013	-265	18078
12-#10	2.48	4374	2535	7558	2085	9135	1707	9921	1396	10551	920	10427	329	8268
12-#11	3.04	4488	2657	8025	2152	9662	1755	10525	1425	11337	913	11316	255	9809
12-#14	4.38	4797	2947	9053	2340	10917	1895	12017	1517	13326	915	13657	101	13148
13-#10	2.68	4427	2580	7758	2104	9367	1726	10189	1409	10883	913	10809	297	8860
13-#11	3.29	4553	2712	8262	2177	9943	1781	10845	1442	10964	849	11771	217	10454
13-#14	4.75	4881	3026	9379	2379	11314	1935	12469	1552	13898	910	14300	45	14042
14-#10	2.89	4495	2624	8009	2117	9626	1727	10477	1404	11240	900	11160	271	9456
14-#11	3.55	4630	2766	8545	2197	10246	1785	11196	1452	11344	830	12202	185	11183
14-#14	5.12	4985	3104	9748	2414	11730	1946	12973	1563	14485	883	14894	-1	14895
15-#10	3.09	4538	2669	8086	2163	9764	1776	10676	1444	11543	923	11653	260	10016
15-#11	3.80	4681	2821	8662	2250	10420	1841	11436	1485	11690	854	12772	168	11786
15-#14	5.48	5068	3183	9954	2482	11990	2019	13315	1613	15010	916	15707	-27	15714
16-#10	3.30	4610	2713	8217	2197	9948	1803	10930	1467	11847	927	12031	243	10621
16-#11	4.05	4766	2876	8824	2290	10648	1874	11733	1510	12888	919	13217	145	12441
16-#14	5.85	5196	3262	10195	2538	12324	2065	13726	1638	15520	920	16327	-63	16335
17-#10	3.51	4649	2758	8396	2227	10175	1820	11163	1479	12201	928	12453	216	11157
17-#11	4.31	4814	2930	9035	2328	10918	1895	12020	1526	13313	920	13721	112	13077
18-#10	3.71	4708	2802	8629	2242	10428	1836	11439	1480	11700	853	12766	187	11753
18-#11	4.56	4896	2985	9306	2348	11216	1915	12349	1529	12812	844	14125	79	13726
19-#10	3.92	4752	2846	8701	2290	10577	1870	11651	1513	12852	932	13241	173	12247
19-#11	4.81	4936	3039	9406	2404	11400	1954	12612	1568	14103	925	14668	57	14364
20-#10	4.13	4808	2891	8848	2323	10757	1900	11881	1531	13184	938	13718	167	12792
20-#11	5.07	5004	3094	9590	2444	11618	1991	12887	1589	14487	929	15218	47	14966
21-#10	4.33	4854	2935	9037	2348	10976	1918	12139	1548	13505	937	14071	136	13314
22-#10	4.54	4906	2980	9240	2374	11202	1935	12411	1552	13842	926	14449	113	13836

ROUND SPIRAL COLUMNS 30" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#10	1.08	4912	2565	8669	2010	9915	1645	10335	1366	9580	880	9071	461	4910
6-#11	1.32	4969	2626	8965	2032	10235	1659	10694	1374	10730	932	9514	415	5894
6-#14	1.91	5120	2771	9590	2110	10988	1713	11589	1410	11132	859	10732	320	8192
6-#18	3.40	5482	3138	11109	2312	12839	1854	13797	1503	14861	888	13652	69	13334
7-#10	1.26	5020	2609	8227	2170	9842	1787	10497	1481	9950	962	9924	510	5717
7-#11	1.54	5098	2680	8564	2202	10199	1809	10893	1493	10407	953	10490	466	6766
7-#14	2.23	5299	2849	9253	2305	11023	1885	11865	1551	12419	1016	11993	376	9210
7-#18	3.96	5770	3278	10918	2570	13038	2081	14257	1684	15532	1001	15555	131	14801
8-#10	1.44	5047	2654	8243	2226	10005	1837	10776	1525	11031	1057	10367	497	6341
8-#11	1.77	5127	2735	8620	2265	10415	1865	11237	1542	11588	1049	11004	446	7570
8-#14	2.55	5337	2928	9396	2385	11359	1956	12346	1602	12152	979	12691	341	10456
8-#18	4.53	5841	3418	11282	2693	13678	2190	15055	1785	15429	975	16799	64	16490

ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
9-#10	1.62	5133	2698	8532	2238	10264	1847	11023	1525	10612	972	10827	472	7119
9-#11	1.99	5230	2790	8947	2283	10717	1880	11524	1543	12011	1032	11559	416	8411
9-#14	2.86	5486	3007	9824	2417	11770	1983	12761	1610	13644	1030	13491	300	11444
9-#18	5.09	6121	3558	11956	2761	14336	2244	15797	1795	16489	953	18107	-11	18115
10-#10	1.80	5173	2743	8930	2233	10621	1831	11350	1512	10942	944	11239	443	7733
10-#11	2.21	5276	2844	9386	2285	11121	1867	11914	1534	11617	933	12042	380	9201
10-#14	3.18	5547	3086	10373	2436	12307	1977	13311	1609	14287	992	14184	251	12658
10-#18	5.66	6200	3698	12781	2822	15206	2257	16738	1796	17561	903	19316	-98	19355
11-#10	1.98	5246	2787	8847	2307	10680	1899	11548	1563	12091	1050	11764	437	8471
11-#11	2.43	5363	2899	9336	2366	11220	1943	12163	1589	12015	972	12671	371	9995
11-#14	3.50	5671	3164	10391	2535	12491	2071	13676	1675	14863	1040	15051	232	13601
11-#18	6.22	6442	3838	12950	2964	15608	2396	17398	1906	19749	1031	20764	-140	20810
12-#10	2.16	5303	2832	8946	2355	10860	1933	11784	1587	12445	1064	12233	428	9082
12-#11	2.65	5432	2953	9464	2422	11443	1981	12449	1617	13307	1057	13223	357	10786
12-#14	3.82	5765	3243	10594	2610	12817	2121	14082	1710	14450	991	15818	208	14681
12-#18	6.79	6590	3978	13340	3087	16185	2478	18099	1976	19455	995	22095	-188	22057
13-#10	2.34	5363	2876	9166	2372	11113	1951	12079	1600	11954	987	12653	396	9774
13-#11	2.87	5502	3008	9724	2445	11747	2005	12801	1633	12828	979	13726	318	11539
13-#14	4.14	5869	3322	10950	2647	13248	2160	14580	1736	16130	1059	16534	153	15605
13-#18	7.36	6787	4118	13939	3161	16930	2552	18951	2009	21918	1059	23281	-289	23202
14-#10	2.52	5439	2920	9455	2383	11403	1950	12390	1593	12324	974	13012	369	10397
14-#11	3.09	5590	3063	10048	2463	12085	2007	13179	1629	13266	965	14193	287	12333
14-#14	4.46	5984	3401	11367	2680	13709	2169	15123	1753	16772	1031	17233	111	16602
15-#10	2.70	5485	2965	9521	2432	11546	2002	12606	1636	12628	996	13534	354	11050
15-#11	3.31	5646	3117	10157	2518	12269	2066	13442	1677	14611	1060	14834	271	13046
15-#14	4.77	6076	3479	11573	2751	13989	2246	15497	1798	16178	994	18093	83	17593
16-#10	2.87	5564	3009	9659	2467	11740	2029	12878	1659	13864	1073	14004	345	11691
16-#11	3.53	5740	3172	10331	2560	12511	2099	13775	1704	15009	1066	15329	250	13849
16-#14	5.09	6196	3558	11832	2808	14345	2292	15962	1834	16702	999	18782	50	18506
17-#10	3.05	5608	3054	9857	2496	11991	2046	13139	1671	13301	1002	14444	317	12309
17-#11	3.75	5793	3226	10564	2597	12809	2121	14082	1719	14443	996	15886	217	14511
17-#14	5.41	6286	3637	12153	2864	14763	2324	16405	1857	17320	1001	19572	3	19554
18-#10	3.23	5673	3098	10118	2509	12267	2060	13442	1672	13633	988	14789	288	12950
18-#11	3.97	5871	3281	10866	2615	13140	2140	14444	1721	15916	1051	16300	183	15265
19-#10	3.41	5718	3143	10189	2560	12430	2096	13667	1706	14955	1079	15314	276	13537
19-#11	4.19	5928	3336	10966	2674	13337	2181	14723	1761	15242	1001	16920	165	15924
20-#10	3.59	5784	3187	10343	2593	12626	2128	13918	1724	15313	1084	15761	259	14181
20-#11	4.41	6003	3390	11161	2714	13575	2218	15025	1782	16765	1079	17543	157	16621
21-#10	3.77	5834	3232	10552	2618	12862	2145	14201	1741	14626	1012	16231	240	14746
21-#11	4.63	6068	3445	11408	2746	13861	2240	15364	1803	17189	1078	18010	119	17321
22-#10	3.95	5891	3276	10776	2643	13112	2161	14493	1745	16038	1074	16647	217	15347
23-#10	4.13	5953	3320	10892	2682	13301	2194	14730	1775	16382	1089	17107	199	15918
24-#10	4.31	6004	3365	11031	2719	13494	2223	14999	1794	16718	1091	17568	182	16496

ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.16	5990	2942	10637	2299	12172	1880	12706	1561	12675	1071	11236	509	6388
6-#14	1.68	6158	3087	11318	2377	12991	1934	13677	1597	13041	988	12581	418	8898
6-#18	2.98	6559	3455	12975	2578	15006	2075	16078	1691	17189	1031	15824	177	14868
7-#10	1.11	6044	2926	9769	2449	11705	2024	12486	1682	11792	1103	11700	609	6211
7-#11	1.36	6131	2997	10113	2485	12096	2046	12917	1694	12292	1094	12321	566	7400
7-#14	1.96	6355	3166	10865	2588	12993	2122	13973	1743	13582	1090	13971	478	10084
7-#18	3.48	6879	3595	12685	2853	15190	2318	16578	1886	17953	1157	17961	246	16410
8-#10	1.26	6075	2970	9732	2513	11867	2078	12781	1729	13043	1211	12194	598	6891
8-#11	1.55	6165	3052	10148	2552	12315	2105	13284	1745	13651	1203	12893	548	8235
8-#14	2.24	6399	3245	10993	2672	13341	2196	14505	1808	15212	1204	14740	446	11388
8-#18	3.98	6957	3735	13049	2980	15863	2430	17472	1963	17780	1124	19253	178	18359
9-#10	1.42	6170	3015	10059	2523	12154	2085	13056	1728	12506	1114	12692	573	7748
9-#11	1.75	6278	3106	10517	2568	12650	2118	13604	1746	13158	1105	13498	518	9211
9-#14	2.52	6562	3324	11472	2702	13797	2221	14949	1814	15872	1183	15615	406	12533
9-#18	4.48	7264	3875	13797	3047	16605	2485	18260	2000	20254	1178	20776	110	20128
10-#10	1.58	6213	3059	10519	2513	12561	2066	13415	1702	13776	1160	13015	530	8424
10-#11	1.94	6329	3161	11020	2565	13109	2102	14031	1733	14564	1149	14042	484	10032
10-#14	2.80	6628	3402	12093	2716	14401	2213	15551	1809	15462	1067	16406	360	13813
10-#18	4.97	7348	4015	14716	3102	17568	2494	19291	1999	20069	1048	22102	25	21963
11-#10	1.74	6294	3104	10394	2593	12605	2139	13620	1767	14184	1203	13719	540	9244
11-#11	2.13	6425	3215	10932	2652	13196	2182	14291	1793	14035	1115	14718	476	10961
11-#14	3.08	6765	3481	12081	2821	14578	2311	15934	1879	16055	1115	17331	341	14904
11-#18	5.47	7614	4155	14879	3252	17974	2639	19986	2097	22533	1192	23682	-15	23683
12-#10	1.89	6356	3148	10495	2643	12795	2174	13876	1793	14562	1218	14235	532	9909
12-#11	2.33	6499	3270	11066	2710	13433	2222	14601	1822	15501	1212	15327	463	11777
12-#14	3.36	6867	3560	12297	2898	14928	2363	16376	1916	17862	1217	18175	319	16178
12-#18	5.97	7776	4295	15296	3378	18600	2722	20751	2154	22118	1145	25096	-63	25086
13-#10	2.05	6422	3193	10738	2660	13069	2192	14197	1805	14955	1211	14689	500	10701
13-#11	2.52	6577	3325	11351	2732	13762	2245	14985	1838	14910	1123	15878	424	12648
13-#14	3.64	6983	3639	12685	2934	15392	2401	16920	1942	18542	1206	18962	264	17226
13-#18	6.47	7989	4435	15944	3449	19404	2795	21683	2204	23245	1142	26446	-159	26408
14-#10	2.21	6502	3237	11125	2659	13391	2188	14531	1795	14366	1117	15057	471	11354
14-#11	2.72	6675	3379	11719	2748	14136	2245	15391	1831	15395	1108	16355	391	13479
14-#14	3.92	7109	3717	13155	2965	15902	2408	17502	1939	17996	1109	19693	222	18361
14-#18	6.96	8165	4575	16666	3519	20247	2822	22711	2244	26131	1180	27751	-233	27686
15-#10	2.37	6557	3282	11118	2720	13552	2238	14764	1841	14692	1141	15638	458	12116
15-#11	2.91	6736	3434	11816	2806	14329	2307	15675	1881	15791	1135	17031	372	14302
15-#14	4.20	7201	3796	13355	3039	16199	2488	17908	2004	19880	1223	20675	198	19379
16-#10	2.53	6643	3326	11263	2756	13743	2271	15053	1864	16105	1229	16173	452	12773
16-#11	3.10	6839	3488	11999	2848	14584	2341	16031	1909	17354	1222	17637	360	15142
16-#14	4.48	7340	3875	13632	3097	16576	2535	18422	2042	20493	1229	21434	167	20428
17-#10	2.68	6689	3370	11479	2785	14017	2288	15343	1877	15416	1147	16631	423	13486
17-#11	3.30	6897	3543	12256	2885	14910	2362	16372	1925	16670	1142	18218	326	15931
17-#14	4.76	7429	3954	13987	3152	17033	2566	18897	2065	19801	1150	22293	120	21520

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.84	6762	3415	11772	2796	14318	2300	15673	1876	15774	1132	17006	394	14154
18-#11	3.49	6982	3598	12591	2902	15270	2380	16767	1926	17106	1125	18670	292	16787
18-#14	5.04	7582	4032	14433	3182	17536	2597	19455	2071	21900	1211	22945	72	22524
19-#10	3.00	6812	3459	11838	2848	14491	2338	15911	1912	16130	1152	17584	384	14830
19-#11	3.69	7040	3652	12690	2962	15485	2423	17062	1967	18782	1229	19353	276	17524
19-#14	5.32	7644	4111	14608	3263	17850	2653	19886	2126	22534	1240	23892	45	23648
20-#10	3.16	6885	3504	12000	2882	14705	2371	16183	1931	17663	1240	18055	365	15502
20-#11	3.88	7127	3707	12895	3003	15742	2462	17390	1989	19250	1236	19938	255	18328
21-#10	3.32	6939	3548	12229	2907	14958	2387	16491	1947	16856	1158	18586	349	16166
21-#11	4.07	7191	3761	13166	3034	16049	2483	17760	2010	19716	1236	20548	232	19053
22-#10	3.47	7001	3593	12477	2930	15233	2402	16804	1950	18458	1230	19040	326	16838
22-#11	4.27	7266	3816	13455	3065	16374	2503	18142	2015	18851	1142	21093	204	19811
23-#10	3.63	7070	3637	12595	2971	15431	2437	17060	1982	17570	1163	19529	308	17475
23-#11	4.46	7347	3871	13610	3112	16624	2543	18451	2052	19270	1159	21691	181	20574
24-#10	3.79	7124	3682	12747	3009	15639	2466	17346	2001	19191	1249	20031	291	18159
25-#10	3.95	7199	3726	12958	3034	15903	2486	17639	2017	19599	1251	20478	267	18754
26-#10	4.11	7258	3770	13184	3059	16170	2504	17958	2024	18662	1160	20969	244	19385

ROUND SPIRAL COLUMNS 34" DIA.

6-#11	1.03	7143	3279	12507	2584	14344	2116	14963	1760	14851	1219	13155	609	6883
6-#14	1.49	7327	3424	13245	2661	15229	2170	16010	1796	16249	1207	14627	521	9604
6-#18	2.64	7770	3792	15041	2862	17409	2311	18604	1890	19722	1180	18193	287	16104
7-#11	1.20	7295	3334	11877	2782	14220	2298	15185	1908	14398	1244	14358	672	8039
7-#14	1.73	7540	3503	12655	2891	15189	2374	16325	1957	15794	1241	16149	586	10964
7-#18	3.08	8120	3932	14632	3156	17569	2571	19142	2086	19237	1234	20546	363	17872
8-#10	1.12	7235	3307	11392	2821	13952	2334	15029	1946	14273	1283	14230	706	7447
8-#11	1.37	7335	3389	11848	2858	14440	2361	15573	1962	14889	1276	14991	657	8906
8-#14	1.98	7593	3582	12763	2978	15546	2452	16889	2025	17642	1369	16997	557	12327
8-#18	3.52	8207	4072	14990	3286	18273	2686	20134	2184	20353	1282	21915	296	20284
9-#10	1.26	7338	3352	11761	2828	14270	2340	15331	1944	14622	1265	14765	680	8369
9-#11	1.55	7458	3443	12262	2872	14809	2372	15927	1962	15327	1256	15643	626	10017
9-#14	2.23	7770	3661	13296	3006	16047	2476	17381	2030	18338	1346	17946	516	13643
9-#18	3.97	8523	4212	15817	3351	19097	2741	20967	2204	21540	1254	23580	228	22105
10-#10	1.40	7385	3396	12289	2813	14728	2317	15723	1914	16065	1319	15082	634	9125
10-#11	1.72	7513	3498	12836	2864	15325	2352	16392	1933	16918	1308	16081	575	10874
10-#14	2.48	7843	3739	13996	3014	16725	2463	18036	2021	17809	1216	18831	473	14981
10-#18	4.41	8632	4352	16836	3400	20160	2747	22089	2214	24425	1287	25094	151	24192
11-#10	1.54	7471	3441	12115	2899	14753	2395	15935	1984	16515	1366	15882	649	10001
11-#11	1.89	7618	3552	12702	2957	15396	2438	16662	2009	17440	1358	16974	585	11938
11-#14	2.73	7992	3818	13944	3126	16890	2567	18436	2096	18460	1269	19818	454	16231
11-#18	4.85	8898	4492	16982	3559	20566	2896	22818	2316	25554	1361	26759	109	26050
12-#10	1.68	7540	3485	12215	2951	14954	2432	16209	2011	15790	1290	16446	643	10748
12-#11	2.06	7699	3607	12840	3017	15647	2480	16995	2040	16737	1284	17640	575	12782
12-#14	2.97	8102	3897	14174	3206	17264	2621	18912	2135	20480	1382	20742	435	17565
12-#18	5.29	9099	4632	17427	3687	21240	2982	23645	2376	25004	1303	28307	65	27928

ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
13-#10	1.82	7613	3530	12482	2966	15249	2448	16557	2023	16185	1283	16918	609	11591
13-#11	2.23	7784	3662	13151	3038	16001	2502	17412	2056	17215	1276	18237	536	13780
13-#14	3.22	8224	3976	14594	3241	17762	2657	19503	2161	21215	1372	21598	381	18763
13-#18	5.73	9302	4772	18125	3757	22101	3053	24660	2426	28121	1395	29785	-31	29784
14-#10	1.96	7699	3574	12918	2963	15605	2442	16915	2011	17812	1359	17310	579	12327
14-#11	2.41	7891	3716	13641	3039	16414	2499	17847	2046	17745	1261	18723	501	14641
14-#14	3.47	8368	4054	15121	3269	18322	2663	20124	2155	20561	1263	22349	335	20100
14-#18	6.17	9519	4912	18925	3824	23022	3078	25756	2432	27496	1263	31230	-100	31165
15-#10	2.10	7760	3619	12888	3027	15770	2495	17164	2059	18190	1387	17949	568	13150
15-#11	2.58	7958	3771	13648	3112	16613	2564	18151	2100	18168	1289	19468	484	15583
15-#14	3.72	8467	4133	15312	3346	18634	2746	20561	2223	22664	1390	23364	305	21216
15-#18	6.61	9722	5052	19392	3941	23612	3207	26516	2534	28528	1313	32968	-152	32735
16-#10	2.24	7854	3663	13038	3064	15969	2529	17471	2083	17345	1301	18539	563	13873
16-#11	2.75	8070	3825	13840	3156	16881	2599	18529	2128	18608	1296	20155	475	16466
16-#14	3.97	8618	4212	15606	3405	19031	2793	21107	2261	23329	1398	24296	288	22409
17-#10	2.38	7904	3707	13273	3092	16266	2545	17789	2096	19020	1394	19027	535	14673
17-#11	2.92	8134	3880	14119	3192	17236	2619	18904	2144	20476	1389	20758	440	17356
17-#14	4.21	8715	4291	15990	3460	19528	2824	21632	2285	24111	1401	25189	239	23538
18-#10	2.52	7983	3752	13601	3102	16594	2555	18147	2094	19432	1377	19431	505	15379
18-#11	3.09	8226	3935	14492	3207	17625	2635	19333	2144	19579	1279	21248	405	18249
18-#14	4.46	8858	4369	16481	3488	20070	2853	22238	2291	24835	1377	25899	191	24675
19-#10	2.66	8038	3796	13660	3156	16775	2596	18397	2131	19847	1400	20062	496	16151
19-#11	3.26	8289	3989	14587	3270	17854	2681	19644	2186	20039	1302	21994	392	19090
19-#14	4.71	8948	4448	16659	3571	20411	2913	22692	2346	25523	1409	26934	167	25862
20-#10	2.80	8110	3841	13828	3190	17007	2629	18690	2151	18902	1312	20558	478	16847
20-#11	3.44	8385	4044	14801	3311	18133	2720	19998	2209	20503	1309	22610	369	19983
20-#14	4.96	9080	4527	16980	3628	20810	2967	23195	2377	26238	1417	27825	136	26990
21-#10	2.94	8177	3885	14078	3215	17277	2645	19020	2167	20682	1406	21087	457	17604
21-#11	3.61	8454	4098	15096	3342	18461	2741	20399	2230	20983	1309	23296	349	20806
22-#10	3.08	8245	3930	14351	3237	17578	2660	19357	2169	21116	1396	21641	440	18302
22-#11	3.78	8536	4153	15414	3371	18816	2760	20806	2234	23001	1390	23887	321	21690
23-#10	3.22	8315	3974	14470	3279	17784	2695	19632	2202	21506	1412	22157	422	19026
23-#11	3.95	8624	4208	15573	3420	19077	2802	21139	2272	23478	1409	24525	299	22479
24-#10	3.36	8378	4019	14633	3318	18008	2725	19936	2221	20441	1321	22703	406	19748
24-#11	4.12	8695	4262	15771	3467	19350	2838	21513	2295	22356	1318	25175	278	23312
25-#10	3.50	8459	4063	14861	3343	18293	2745	20253	2237	22342	1418	23188	382	20436
25-#11	4.30	8791	4317	16045	3497	19691	2862	21894	2316	24484	1416	25756	247	24108
26-#10	3.64	8516	4108	15111	3367	18580	2762	20603	2244	21244	1315	23701	358	21158
27-#10	3.78	8601	4152	15283	3401	18798	2794	20868	2272	21622	1329	24270	348	21842
28-#10	3.92	8660	4196	15474	3433	19038	2824	21167	2290	22011	1333	24775	323	22555

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.33	8636	3782	15382	2963	17717	2421	18603	2007	17520	1274	16881	629	10312
6-#18	2.36	9120	4149	17319	3164	20062	2562	21390	2102	22500	1338	20771	402	17341
7-#11	1.07	8598	3692	13794	3103	16583	2567	17712	2135	17935	1503	16614	783	8631
7-#14	1.55	8865	3861	14691	3203	17626	2643	18936	2184	18241	1401	18546	700	11858
7-#18	2.75	9503	4289	16769	3477	20189	2840	21965	2313	23521	1496	23303	481	19340
8-#11	1.23	8644	3746	13730	3184	16801	2633	18119	2193	18507	1540	17310	772	9583
8-#14	1.77	8926	3939	14716	3303	17990	2724	19530	2255	20325	1544	19475	674	13273
8-#18	3.14	9598	4429	17116	3610	20921	2958	23030	2417	23163	1448	24800	419	22114
9-#10	1.12	8645	3709	13648	3152	16624	2611	17865	2174	18186	1527	17058	793	8995
9-#11	1.38	8777	3801	14193	3196	17207	2642	18508	2191	17732	1417	18009	740	10776
9-#14	1.99	9118	4018	15307	3329	18537	2746	20071	2260	21055	1518	20498	633	14771
9-#18	3.54	9939	4569	18024	3674	21817	3012	23932	2435	24412	1417	26604	351	24077
10-#10	1.25	8696	3754	14252	3131	17138	2583	18290	2139	17364	1388	17365	744	9834
10-#11	1.53	8837	3855	14846	3181	17785	2618	19012	2158	19523	1477	18442	686	11726
10-#14	2.21	9197	4097	16094	3331	19292	2729	20781	2230	20390	1374	21217	565	16161
10-#18	3.93	10057	4709	19150	3717	22996	3014	25146	2442	27599	1460	28305	281	26495
11-#10	1.37	8789	3798	14019	3224	17140	2667	18508	2214	19099	1539	18266	763	10766
11-#11	1.69	8949	3910	14657	3282	17834	2709	19292	2240	20095	1531	19450	701	12865
11-#14	2.43	9360	4176	15994	3450	19441	2838	21196	2327	22609	1534	22527	573	17582
11-#18	4.32	10345	4849	19265	3883	23398	3169	25908	2549	26907	1437	30058	236	28389
12-#10	1.50	8864	3843	14112	3278	17349	2706	18800	2243	19527	1556	18879	759	11599
12-#11	1.84	9038	3965	14796	3344	18099	2753	19648	2272	20617	1550	20175	693	13801
12-#14	2.65	9478	4254	16234	3533	19837	2895	21706	2368	23352	1557	23531	556	18969
12-#18	4.72	10566	4989	19743	4015	24118	3257	26798	2611	28126	1469	31741	197	30502
13-#10	1.62	8943	3887	14410	3292	17667	2720	19176	2254	19979	1548	19369	723	12492
13-#11	1.99	9131	4019	15136	3364	18479	2773	20098	2287	19755	1438	20796	652	14900
13-#14	2.87	9611	4333	16689	3566	20370	2929	22343	2393	24141	1546	24454	501	20325
13-#18	5.11	10782	5129	20492	4083	25036	3327	27894	2660	31514	1558	33347	102	32634
14-#10	1.75	9036	3932	14899	3285	18059	2712	19557	2239	19109	1428	19782	694	13327
14-#11	2.15	9243	4074	15683	3362	18933	2769	20561	2274	21783	1524	21311	617	15821
14-#14	3.09	9768	4412	17389	3574	20981	2932	23005	2384	23360	1426	25224	454	21722
14-#18	5.50	11018	5269	21374	4148	26038	3350	29059	2663	33040	1533	34835	29	34658
15-#10	1.87	9103	3976	14840	3353	18225	2768	19822	2290	20876	1556	20483	683	14183
15-#11	2.30	9320	4128	15664	3437	19154	2831	20885	2331	20781	1452	22127	601	16898
15-#14	3.32	9874	4491	17453	3671	21335	3011	23473	2455	25702	1566	26334	426	22984
15-#18	5.89	11235	5409	21845	4268	26665	3482	29877	2769	34207	1588	36804	-16	36637
16-#10	2.00	9205	4021	14994	3391	18431	2803	20146	2315	21317	1569	21105	679	14990
16-#11	2.45	9441	4183	15864	3482	19416	2872	21284	2360	22774	1564	22894	596	17800
16-#14	3.54	10039	4569	17762	3732	21724	3067	24050	2494	26419	1575	27381	413	24384
16-#18	6.29	11484	5549	22423	4369	27425	3562	30906	2835	33073	1492	38326	-71	38303
17-#10	2.12	9259	4065	15250	3418	18753	2819	20488	2328	21777	1568	21645	652	15835
17-#11	2.61	9507	4238	16165	3517	19799	2892	21695	2376	21787	1460	23521	560	18809
17-#14	3.76	10143	4648	18176	3786	22261	3098	24625	2519	25429	1472	28307	363	25607
18-#10	2.25	9345	4109	15615	3426	19108	2827	20879	2325	22217	1551	22077	622	16625
18-#11	2.76	9610	4292	16579	3531	20220	2906	22157	2376	22287	1441	24047	524	19734
18-#14	3.98	10296	4727	18717	3812	22843	3125	25279	2523	28021	1553	29074	315	26943

ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
19-#10	2.37	9404	4154	15664	3483	19295	2869	21141	2363	21154	1470	22755	614	17460
19-#11	2.91	9679	4347	16667	3596	20459	2954	22484	2419	22785	1466	24858	512	20687
19-#14	4.20	10395	4806	18894	3898	23207	3187	25756	2580	26848	1481	30198	293	28112
20-#10	2.50	9481	4198	15838	3517	19547	2904	21454	2384	23094	1581	23284	595	18216
20-#11	3.07	9773	4401	16889	3637	20761	2995	22863	2443	24939	1578	25504	489	21614
20-#14	4.42	10536	4884	19231	3956	23638	3243	26297	2612	29522	1595	31131	260	29382
21-#10	2.62	9552	4243	16109	3542	19834	2919	21805	2399	23556	1582	23852	575	19055
21-#11	3.22	9858	4456	17210	3668	21110	3015	23291	2463	23797	1474	26250	471	22554
21-#14	4.64	10637	4963	19675	4001	24136	3273	26910	2643	28292	1491	32189	232	30577
22-#10	2.74	9628	4287	16408	3562	20161	2933	22168	2400	24027	1571	24465	559	19791
22-#11	3.37	9946	4511	17557	3696	21496	3034	23727	2466	26057	1566	26902	443	23476
22-#14	4.86	10767	5042	20139	4047	24670	3304	27531	2651	31113	1581	33105	192	31770
23-#10	2.87	9705	4332	16526	3606	20374	2969	22462	2435	24441	1588	25008	541	20610
23-#11	3.52	10037	4565	17718	3747	21768	3076	24085	2506	26563	1586	27572	421	24378
24-#10	2.99	9772	4376	16697	3646	20613	3000	22783	2454	24866	1592	25599	526	21356
24-#11	3.68	10118	4620	17932	3795	22059	3113	24480	2529	27074	1590	28277	400	25333
25-#10	3.12	9860	4421	16945	3670	20921	3020	23124	2470	25334	1595	26120	502	22142
25-#11	3.83	10222	4674	18225	3825	22428	3137	24890	2549	25802	1487	28904	371	26189
26-#10	3.24	9921	4465	17220	3694	21228	3035	23506	2477	25780	1585	26655	477	22893
26-#11	3.98	10306	4729	18544	3856	22798	3158	25341	2558	26312	1477	29577	342	27082
27-#10	3.37	10010	4509	17396	3729	21459	3069	23784	2506	26217	1601	27275	468	23652
27-#11	4.14	10407	4784	18774	3896	23083	3197	25687	2592	28715	1600	30303	328	27940
28-#10	3.49	10078	4554	17598	3761	21712	3099	24105	2524	26658	1605	27835	445	24410
29-#10	3.62	10158	4598	17815	3792	22020	3114	24445	2541	27111	1607	28376	428	25145
30-#10	3.74	10229	4643	18100	3813	22352	3129	24800	2547	27568	1600	28873	396	25925

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 12" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.64	414	553	816	327	813	263	783	210	712	130	570	35	438
6-#6	2.33	423	580	848	340	850	272	825	213	715	114	621	9	587
6-#7	3.18	434	612	887	362	894	282	876	217	831	112	680	-23	703
6-#8	4.19	446	651	931	383	943	295	933	221	904	99	746	-62	797
6-#9	5.31	459	694	976	405	995	308	993	225	916	78	814	-106	891
6-#10	6.74	476	749	1030	434	1058	324	1066	229	1076	64	895	-164	970
7-#5	1.92	420	564	818	354	831	285	812	229	752	144	616	37	494
7-#6	2.72	432	595	853	370	872	296	859	234	759	128	675	9	649
7-#7	3.71	446	633	894	391	921	310	915	240	886	129	757	-22	771
7-#8	4.89	462	678	940	415	977	327	978	247	904	111	839	-64	885
7-#9	6.19	479	728	990	442	1036	345	1045	255	986	99	921	-113	995
8-#5	2.19	423	574	829	365	847	294	832	236	724	136	647	30	552
8-#6	3.11	435	610	868	384	893	308	887	243	845	138	716	-2	718
8-#7	4.24	450	653	914	408	948	325	950	252	926	129	797	-43	832
8-#8	5.59	468	705	967	436	1012	346	1023	261	1019	117	905	-87	954

ROUND SPIRAL COLUMNS 14" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#5	1.21	652	730	1267	448	1275	363	1232	295	1115	194	899	78	541
6-#6	1.71	664	757	1309	460	1326	373	1290	299	1109	175	973	55	731
6-#7	2.34	678	789	1359	477	1388	385	1359	304	1277	179	1060	25	953
6-#8	3.08	695	828	1418	496	1458	399	1439	310	1288	158	1160	-11	1170
6-#9	3.90	713	871	1481	518	1531	414	1524	317	1488	157	1264	-50	1306
6-#10	4.95	736	926	1560	546	1623	433	1629	324	1515	132	1392	-103	1423
6-#11	6.08	753	985	1629	585	1683	445	1698	323	1712	114	1456	-171	1529
7-#5	1.41	659	741	1264	483	1297	391	1270	319	1174	213	970	86	624
7-#6	2.00	674	772	1309	500	1351	404	1333	325	1257	208	1056	61	825
7-#7	2.73	692	810	1364	521	1416	419	1410	334	1266	189	1159	31	1055
7-#8	3.59	713	855	1428	546	1492	437	1499	343	1472	195	1275	-7	1283
7-#9	4.55	735	905	1496	575	1572	457	1594	354	1594	186	1397	-50	1448
7-#10	5.78	766	969	1581	611	1673	482	1714	367	1747	174	1545	-107	1643
7-#11	7.09	789	1038	1651	641	1751	500	1792	369	1849	148	1660	-176	1767
8-#5	1.61	663	751	1277	496	1317	403	1296	328	1127	202	1015	81	691
8-#6	2.29	679	787	1330	516	1379	418	1368	336	1214	197	1115	53	924
8-#7	3.12	698	830	1393	541	1453	436	1455	347	1413	205	1234	18	1187
8-#8	4.11	721	882	1464	571	1538	458	1556	359	1542	197	1369	-25	1391
8-#9	5.20	745	939	1541	603	1629	482	1663	372	1679	187	1510	-75	1568
8-#10	6.60	779	1012	1636	645	1744	513	1798	389	1726	162	1682	-140	1779

ROUND SPIRAL COLUMNS 16" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#6	1.31	981	961	1908	601	1939	488	1893	398	1734	262	1396	101	876
6-#7	1.79	999	994	1970	617	2015	501	1982	404	1724	238	1503	72	1147
6-#8	2.36	1020	1032	2042	637	2104	516	2085	411	1979	247	1626	38	1457
6-#9	2.98	1044	1075	2121	658	2201	532	2196	419	2120	237	1815	10	1786
6-#10	3.79	1073	1130	2219	687	2323	554	2334	429	2296	224	1991	-39	1966
6-#11	4.66	1096	1189	2310	710	2423	569	2435	431	2427	201	2102	-104	2119
6-#14	6.71	1164	1329	2542	783	2690	619	2744	451	2822	161	2475	-238	2543
7-#5	1.08	975	945	1843	633	1905	515	1868	423	1720	291	1428	139	749
7-#6	1.53	994	976	1899	650	1972	528	1947	430	1826	288	1541	117	1007
7-#7	2.09	1016	1014	1967	671	2055	544	2043	439	1824	265	1678	90	1292
7-#8	2.75	1042	1059	2046	697	2150	563	2155	450	2104	279	1835	56	1616
7-#9	3.48	1070	1109	2131	726	2253	584	2275	462	2262	273	2001	18	1942
7-#10	4.42	1105	1173	2238	763	2381	611	2427	477	2461	264	2206	-33	2242
7-#11	5.43	1136	1242	2338	794	2488	630	2550	484	2435	227	2335	-103	2441
7-#14	7.83	1224	1406	2587	888	2784	696	2901	519	3056	213	2770	-247	2914

ROUND SPIRAL COLUMNS 16" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#5	1.23	979	956	1855	648	1931	529	1902	434	1645	276	1487	136	831
8-#6	1.75	1000	991	1920	668	2008	545	1992	443	1880	292	1619	111	1118
8-#7	2.39	1024	1034	1998	694	2101	564	2100	455	1888	269	1776	80	1454
8-#8	3.14	1052	1086	2089	724	2209	587	2227	469	2044	264	1958	41	1832
8-#9	3.98	1083	1143	2188	758	2325	613	2363	484	2369	276	2150	-2	2152
8-#10	5.05	1122	1216	2312	802	2470	645	2535	502	2594	267	2387	-60	2436
8-#11	6.21	1155	1295	2423	839	2591	670	2674	513	2577	229	2541	-140	2648
9-#10	5.68	1161	1259	2378	824	2562	655	2651	507	2750	260	2510	-95	2604
9-#11	6.98	1202	1348	2502	867	2705	685	2809	518	2746	220	2721	-175	2826
10-#10	6.32	1176	1302	2475	833	2665	662	2773	506	2893	236	2636	-140	2748

ROUND SPIRAL COLUMNS 18" DIA.

6-#6	1.04	1385	1193	2665	762	2715	620	2648	508	2419	345	1953	158	1021
6-#7	1.41	1407	1225	2739	778	2805	632	2757	515	2558	339	2088	131	1342
6-#8	1.86	1432	1264	2825	797	2911	647	2884	524	2719	332	2244	99	1710
6-#9	2.36	1459	1307	2918	819	3026	664	3023	533	2893	324	2410	62	2103
6-#10	2.99	1494	1362	3037	847	3172	686	3199	545	3112	314	2618	15	2572
6-#11	3.68	1529	1421	3150	870	3304	703	3334	549	3284	293	2864	-31	2809
6-#14	5.31	1612	1561	3431	944	3654	759	3727	574	3786	260	3361	-157	3362
7-#6	1.21	1400	1208	2641	822	2755	669	2723	550	2536	377	2130	175	1188
7-#7	1.65	1427	1246	2722	843	2853	685	2838	559	2690	374	2296	149	1536
7-#8	2.17	1459	1291	2817	869	2968	705	2973	571	2680	346	2514	122	1925
7-#9	2.75	1493	1341	2919	898	3092	726	3119	584	3067	366	2725	87	2337
7-#10	3.49	1536	1405	3047	935	3250	754	3303	600	3314	360	2988	41	2832
7-#11	4.29	1573	1473	3173	966	3390	776	3459	608	3518	344	3174	-22	3201
7-#14	6.19	1675	1637	3476	1062	3757	845	3893	647	3811	300	3755	-152	3858
8-#6	1.38	1408	1223	2660	842	2801	689	2778	565	2430	357	2242	174	1314
8-#7	1.89	1438	1266	2753	867	2912	709	2909	577	2775	380	2439	145	1715
8-#8	2.48	1472	1317	2862	898	3043	733	3061	592	2976	376	2668	111	2172
8-#9	3.14	1509	1374	2979	932	3184	759	3226	608	3193	371	2912	71	2659
8-#10	3.99	1557	1448	3127	976	3361	793	3435	628	3468	365	3216	19	3154
8-#11	4.90	1597	1526	3275	1014	3516	819	3612	641	3701	348	3435	-53	3482
8-#14	7.07	1710	1714	3627	1127	3931	903	4102	689	4341	325	4107	-202	4250
9-#10	4.49	1601	1491	3217	999	3462	801	3570	632	3663	359	3373	-16	3391
9-#11	5.52	1653	1579	3373	1043	3642	831	3779	646	3930	341	3613	-96	3717
10-#10	4.99	1620	1534	3339	1006	3588	806	3709	629	3848	337	3528	-57	3582
10-#11	6.13	1673	1632	3512	1054	3789	840	3945	645	4134	312	3796	-149	3926
11-#10	5.49	1663	1577	3381	1059	3685	848	3832	661	4013	358	3794	-66	3861
11-#11	6.74	1728	1685	3571	1116	3902	886	4087	681	4339	336	4097	-162	4193
12-#10	5.99	1691	1620	3456	1090	3783	877	3970	685	4174	358	3969	-97	4050

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 20" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#7	1.15	1913	1484	3684	958	3779	781	3707	640	3199	404	2798	195	1538
6-#8	1.51	1943	1523	3784	978	3902	796	3854	648	3377	399	2987	165	1964
6-#9	1.91	1975	1565	3893	999	4035	812	4015	658	3825	420	3191	131	2422
6-#10	2.43	2016	1620	4031	1028	4205	834	4220	670	4086	411	3446	86	2992
6-#11	2.98	2053	1679	4168	1050	4362	851	4405	677	4014	367	3634	26	3542
6-#14	4.30	2150	1820	4498	1124	4773	907	4892	708	4911	365	4208	-98	4298
6-#18	7.64	2400	2176	5293	1312	5767	1051	6010	774	6341	283	5798	-388	5790
7-#7	1.34	1937	1504	3647	1036	3835	844	3815	694	3580	471	3065	217	1788
7-#8	1.76	1974	1549	3758	1062	3968	864	3973	706	3788	467	3297	188	2242
7-#9	2.23	2015	1599	3877	1091	4113	886	4145	719	3762	437	3547	154	2725
7-#10	2.83	2065	1663	4027	1128	4296	914	4362	736	4321	463	3860	110	3324
7-#11	3.48	2110	1732	4180	1159	4468	936	4551	746	4269	420	4150	60	3897
7-#14	5.01	2231	1896	4538	1256	4910	1009	5068	788	5269	435	4879	-60	4948
8-#7	1.53	1950	1525	3676	1063	3904	871	3900	714	3447	450	3237	216	1978
8-#8	2.01	1990	1576	3802	1093	4059	896	4079	730	3928	479	3513	184	2511
8-#9	2.55	2035	1633	3939	1127	4227	923	4273	746	4183	476	3810	147	3080
8-#10	3.23	2090	1706	4111	1171	4437	958	4519	768	4206	439	4182	100	3788
8-#11	3.97	2140	1785	4288	1209	4626	985	4734	782	4468	426	4467	34	4346
8-#14	5.73	2273	1972	4702	1323	5122	1071	5318	834	5187	410	5310	-102	5392
9-#10	3.64	2141	1750	4221	1194	4546	963	4665	769	4735	466	4372	65	4086
9-#11	4.47	2201	1838	4415	1239	4763	994	4918	785	5059	450	4688	-9	4699
9-#14	6.45	2362	2049	4871	1367	5322	1089	5589	842	5942	432	5618	-163	5781
10-#10	4.04	2163	1793	4375	1198	4695	966	4826	764	4937	441	4555	25	4456
10-#11	4.97	2227	1891	4586	1247	4938	1000	5111	781	5316	423	4906	-59	4965
10-#14	7.16	2397	2125	5100	1385	5570	1104	5866	842	6307	394	5933	-235	6117
11-#10	4.45	2215	1836	4411	1255	4800	1011	4975	801	5148	467	4880	19	4797
11-#11	5.46	2288	1944	4641	1312	5069	1051	5282	822	5546	449	5277	-69	5353
12-#10	4.85	2241	1879	4497	1289	4915	1041	5126	825	4984	438	5093	-8	5101
12-#11	5.96	2326	1997	4745	1351	5206	1088	5469	851	5385	420	5523	-105	5617
13-#10	5.26	2286	1922	4607	1316	5052	1056	5283	832	5553	466	5339	-36	5377
14-#10	5.66	2319	1965	4734	1328	5201	1069	5459	838	5797	460	5505	-75	5573

ROUND SPIRAL COLUMNS 22" DIA.

6-#8	1.25	2562	1809	4940	1179	5097	960	5023	786	4381	496	3871	235	2219
6-#9	1.58	2600	1851	5064	1200	5249	977	5206	796	4934	526	4111	203	2741
6-#10	2.00	2647	1906	5222	1228	5443	999	5439	808	5238	518	4414	161	3394
6-#11	2.46	2691	1965	5382	1250	5625	1015	5652	815	5128	467	4649	105	4049
6-#14	3.55	2804	2106	5763	1324	6096	1072	6222	848	6213	477	5345	-12	5357
6-#18	6.31	3100	2462	6682	1513	7244	1217	7593	928	7919	407	6948	-327	7180
7-#7	1.10	2556	1790	4761	1251	5020	1021	4990	842	4661	582	3981	292	2024
7-#8	1.45	2598	1835	4887	1276	5172	1041	5171	855	4572	540	4254	264	2568
7-#9	1.84	2645	1885	5024	1305	5337	1063	5368	868	5158	575	4549	232	3124
7-#10	2.34	2704	1949	5196	1343	5547	1091	5620	886	5487	570	4921	191	3813
7-#11	2.87	2758	2018	5376	1373	5747	1113	5846	897	5807	564	5213	135	4496
7-#14	4.14	2897	2182	5790	1470	6256	1186	6446	941	6172	515	6155	33	6004
7-#18	7.37	3235	2597	6786	1718	7491	1373	7891	1049	8554	515	8191	-269	8319
8-#7	1.26	2571	1811	4785	1280	5096	1050	5094	866	4795	595	4185	292	2245
8-#8	1.66	2618	1862	4929	1311	5271	1075	5299	882	4726	553	4509	262	2854
8-#9	2.10	2669	1919	5085	1344	5462	1102	5522	899	4999	551	4858	228	3505
8-#10	2.67	2734	1992	5282	1388	5706	1138	5805	922	5728	587	5298	184	4319

ROUND SPIRAL COLUMNS 22" DIA.

Short columns – no sideway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#11	3.28	2792	2071	5489	1426	5940	1167	6060	936	6059	574	5652	122	5126
8-#14	4.74	2947	2258	5964	1540	6518	1256	6739	991	6953	561	6667	-3	6670
9-#10	3.01	2790	2036	5412	1410	5834	1143	5963	921	5590	543	5522	150	4718
9-#11	3.69	2861	2124	5639	1454	6088	1174	6258	937	6371	568	5914	81	5527
9-#14	5.33	3044	2335	6168	1584	6734	1270	7031	997	7399	554	7037	-63	7109
10-#10	3.34	2817	2079	5603	1412	6007	1143	6146	913	6202	553	5730	111	5216
10-#11	4.10	2892	2177	5851	1460	6292	1177	6478	931	6201	501	6167	32	6029
10-#14	5.92	3088	2411	6448	1601	7023	1283	7352	995	7293	481	7406	-131	7522
11-#10	3.68	2877	2122	5629	1473	6119	1191	6320	955	6023	544	6068	99	5591
11-#11	4.51	2963	2230	5899	1530	6433	1232	6680	977	6932	569	6611	25	6494
11-#14	6.51	3189	2487	6536	1691	7226	1353	7623	1051	8191	554	8003	-147	8064
12-#10	4.01	2905	2165	5726	1508	6251	1223	6486	979	6692	589	6370	83	6001
12-#11	4.92	2997	2283	6016	1571	6589	1270	6884	1006	7198	573	6902	-8	6911
13-#10	4.34	2956	2208	5849	1535	6409	1238	6666	986	6920	584	6657	55	6387
13-#11	5.33	3060	2336	6164	1605	6776	1288	7098	1015	7485	568	7239	-42	7286
14-#10	4.68	2996	2251	5998	1545	6574	1248	6872	991	7150	565	6850	18	6771
14-#11	5.75	3104	2389	6337	1620	6978	1303	7342	1023	7818	562	7468	-89	7554
15-#10	5.01	3039	2294	6075	1596	6694	1284	7018	1017	6920	552	7198	3	7181
16-#10	5.35	3081	2337	6171	1627	6843	1316	7190	1040	7650	598	7545	-5	7550

ROUND SPIRAL COLUMNS 24" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#8	1.05	3302	2122	6310	1400	6517	1142	6411	938	5561	602	4908	311	2475
6-#9	1.33	3345	2165	6451	1421	6687	1158	6615	948	6236	640	5186	280	3062
6-#10	1.68	3399	2220	6628	1449	6905	1180	6877	960	6583	633	5537	240	3797
6-#11	2.07	3449	2279	6812	1470	7112	1196	7119	967	6882	617	5819	187	4542
6-#14	2.98	3579	2419	7243	1543	7644	1252	7761	1000	7711	597	6637	77	6281
6-#18	5.31	3894	2775	8289	1733	8947	1399	9336	1085	9047	500	8548	-219	8723
7-#8	1.22	3343	2149	6222	1512	6599	1235	6591	1018	6211	701	5375	346	2891
7-#9	1.55	3395	2199	6377	1541	6785	1257	6812	1032	6503	697	5715	316	3531
7-#10	1.97	3462	2263	6572	1579	7021	1286	7094	1050	6875	693	6145	276	4313
7-#11	2.41	3525	2331	6780	1608	7250	1307	7358	1061	7209	680	6495	223	5094
7-#14	3.48	3685	2495	7250	1706	7826	1381	8048	1108	7571	623	7498	115	6928
7-#18	6.19	4072	2911	8385	1955	9230	1570	9705	1221	9689	606	10017	-153	10035
8-#8	1.40	3366	2175	6259	1550	6707	1272	6743	1049	6403	717	5594	336	3201
8-#9	1.77	3424	2232	6435	1583	6921	1299	6995	1067	6733	715	5983	302	3936
8-#10	2.25	3498	2306	6657	1627	7194	1335	7316	1090	7153	713	6581	273	4855
8-#11	2.76	3566	2384	6895	1664	7463	1364	7609	1104	7533	701	7003	215	5777
8-#14	3.98	3743	2572	7432	1778	8132	1456	8384	1162	7981	645	8192	97	7765
8-#18	7.07	4172	3046	8736	2070	9731	1685	10258	1305	10285	616	10982	-222	11120
9-#10	2.53	3561	2349	6809	1647	7346	1340	7484	1087	7439	706	6837	239	5348
9-#11	3.10	3641	2437	7069	1691	7637	1370	7820	1103	7360	649	7306	173	6305
9-#14	4.48	3850	2648	7669	1821	8371	1468	8697	1165	9058	685	8624	39	8427
9-#18	7.96	4366	3182	9123	2153	10153	1716	10833	1318	11892	650	11708	-326	11939

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sideway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.81	3591	2392	7034	1645	7543	1336	7688	1076	7667	675	7068	200	5881
10-#11	3.45	3677	2490	7326	1694	7871	1371	8068	1095	8172	660	7590	126	6976
10-#14	4.97	3901	2724	8006	1836	8701	1478	9059	1161	9497	642	9046	-27	9073
11-#10	3.09	3660	2435	7053	1712	7662	1388	7885	1122	7960	709	7466	191	6349
11-#11	3.79	3759	2543	7362	1768	8020	1429	8301	1145	8507	697	8043	111	7463
11-#14	5.47	4017	2801	8085	1930	8917	1552	9373	1223	9944	686	9649	-54	9709
12-#10	3.37	3690	2478	7159	1749	7810	1423	8069	1147	8228	716	7814	177	6879
12-#11	4.14	3795	2596	7493	1812	8197	1469	8522	1175	8831	704	8450	92	8007
12-#14	5.97	4069	2877	8275	1989	9167	1606	9690	1263	9686	646	10210	-86	10284
13-#10	3.65	3749	2521	7295	1774	7989	1437	8272	1154	8489	712	8143	150	7316
13-#11	4.48	3865	2649	7657	1844	8410	1488	8765	1183	8527	652	8839	58	8531
13-#14	6.47	4173	2953	8508	2038	9466	1634	10035	1277	10828	686	10757	-134	10868
14-#10	3.93	3794	2564	7470	1782	8171	1444	8495	1157	8746	693	8362	113	7790
14-#11	4.83	3919	2702	7858	1857	8631	1500	9042	1190	9447	675	9101	13	9040
15-#10	4.21	3843	2607	7546	1836	8306	1483	8671	1187	8416	666	8764	100	8232
15-#11	5.17	3977	2755	7961	1920	8793	1544	9240	1222	9149	661	9568	-5	9574
16-#10	4.49	3889	2650	7653	1867	8468	1515	8866	1211	9305	728	9162	94	8689
16-#11	5.52	4033	2808	8091	1957	8992	1583	9471	1251	10118	716	10037	-15	10051
17-#10	4.77	3940	2693	7805	1891	8632	1531	9058	1218	8925	674	9437	58	9123
18-#10	5.05	3988	2736	7956	1912	8819	1546	9266	1225	9859	715	9727	35	9553

ROUND SPIRAL COLUMNS 26" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#9	1.13	4221	2505	8071	1662	8371	1356	8264	1113	7217	712	6428	363	3383
6-#10	1.44	4281	2560	8269	1690	8612	1378	8554	1126	8125	757	6828	325	4201
6-#11	1.76	4338	2619	8477	1710	8845	1393	8825	1132	8483	743	7157	274	5035
6-#14	2.54	4484	2759	8959	1783	9438	1449	9539	1165	8793	677	8098	169	6988
6-#18	4.52	4840	3116	10132	1973	10895	1596	11299	1251	10903	627	10322	-112	10422
7-#9	1.32	4277	2539	7955	1799	8478	1469	8499	1210	8068	830	7058	405	3949
7-#10	1.67	4352	2603	8173	1836	8740	1498	8812	1228	7917	772	7547	367	4824
7-#11	2.06	4422	2672	8409	1865	8998	1519	9107	1239	8859	814	7956	317	5705
7-#14	2.97	4605	2836	8935	1962	9641	1593	9878	1287	9871	803	9109	214	7766
7-#18	5.27	5041	3251	10212	2213	11214	1783	11764	1407	11600	739	11836	-62	11910
8-#9	1.51	4311	2573	8007	1844	8624	1504	8712	1249	8331	851	7348	391	4371
8-#10	1.91	4394	2646	8254	1888	8926	1537	9070	1272	8213	793	7903	349	5396
8-#11	2.35	4471	2725	8523	1924	9228	1578	9402	1287	8613	782	8534	312	6433
8-#14	3.39	4670	2912	9123	2037	9972	1670	10273	1347	10371	831	9899	201	8869
8-#18	6.03	5156	3387	10583	2330	11799	1907	12390	1495	13156	807	13131	-99	13200
9-#10	2.15	4462	2689	8429	1906	9103	1554	9249	1267	9104	841	8326	332	5993
9-#11	2.64	4553	2778	8724	1949	9431	1585	9627	1284	9609	831	8878	270	7074
9-#14	3.81	4788	2988	9394	2079	10252	1683	10607	1347	10936	824	10392	143	9582
9-#18	6.78	5358	3523	11024	2413	12255	1934	13005	1505	13197	746	13971	-201	14159
10-#10	2.39	4497	2732	8689	1899	9325	1546	9472	1254	8727	754	8583	294	6556
10-#11	2.94	4595	2831	9023	1948	9694	1581	9900	1272	9256	740	9191	223	7790
10-#14	4.24	4846	3065	9793	2091	10625	1690	11009	1340	10639	725	10863	78	10472
10-#18	7.53	5461	3658	11641	2454	12893	1964	13718	1508	14022	683	14815	-315	15023

ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#10	2.63	4575	2775	8699	1972	9449	1603	9690	1303	9041	789	9032	286	7121
11-#11	3.23	4687	2884	9050	2028	9851	1644	10160	1327	9616	778	9717	211	8400
11-#14	4.66	4977	3141	9859	2191	10853	1768	11366	1407	11911	826	11562	55	11254
12-#10	2.87	4606	2818	8814	2011	9613	1626	9895	1330	9313	796	9413	273	7682
12-#11	3.53	4726	2936	9192	2073	10049	1686	10404	1358	9949	786	10179	194	9110
12-#14	5.09	5033	3217	10069	2252	11133	1824	11707	1448	12418	837	12202	27	12067
13-#10	3.11	4673	2862	8965	2035	9810	1653	10122	1336	10280	850	9793	247	8209
13-#11	3.82	4805	2989	9374	2104	10288	1704	10676	1366	11009	838	10620	161	9668
13-#14	5.51	5145	3294	10324	2299	11470	1852	12094	1462	12905	829	12824	-21	12846
14-#10	3.35	4720	2905	9166	2041	10012	1658	10362	1337	9859	775	10053	213	8790
14-#11	4.11	4865	3042	9605	2115	10529	1714	10974	1371	11354	814	10915	117	10281
14-#14	5.93	5228	3370	10635	2322	11818	1872	12532	1474	13406	799	13253	-84	13327
15-#10	3.59	4778	2948	9254	2091	10161	1700	10561	1370	10858	852	10494	199	9282
15-#11	4.41	4930	3095	9707	2181	10709	1761	11207	1407	10931	784	11449	101	10878
16-#10	3.83	4830	2991	9357	2130	10336	1720	10787	1396	10388	798	10819	179	9856
16-#11	4.70	4992	3148	9850	2219	10925	1800	11468	1437	11289	800	11978	93	11475
17-#10	4.07	4883	3034	9528	2153	10520	1748	10992	1402	11468	861	11252	159	10306
17-#11	5.00	5059	3201	10053	2248	11143	1819	11723	1445	12439	849	12347	49	12060
18-#10	4.31	4939	3077	9696	2172	10736	1763	11224	1408	11786	853	11587	138	10820
18-#11	5.29	5123	3254	10253	2274	11394	1838	12001	1454	12835	842	12736	21	12624
19-#10	4.54	4991	3120	9800	2214	10875	1788	11430	1435	12053	864	11948	113	11312
20-#10	4.78	5050	3163	9921	2252	11048	1812	11638	1457	11535	814	12327	99	11783

ROUND SPIRAL COLUMNS 28" DIA.

6-#10	1.24	5306	2928	10163	1951	10585	1592	10490	1305	9888	889	8301	415	4606
6-#11	1.52	5369	2987	10396	1970	10843	1606	10789	1311	10292	877	8678	366	5530
6-#14	2.19	5533	3127	10929	2043	11497	1663	11576	1344	10603	805	9743	265	7696
6-#18	3.90	5930	3483	12229	2232	13108	1810	13520	1431	12975	761	12280	-3	12283
7-#9	1.14	5300	2907	9775	2078	10434	1694	10449	1403	9213	909	8576	498	4335
7-#10	1.44	5383	2971	10016	2115	10723	1728	10793	1422	10328	971	9127	463	5346
7-#11	1.77	5462	3040	10281	2143	11010	1748	11120	1432	10031	895	9609	415	6328
7-#14	2.56	5664	3203	10865	2240	11720	1822	11970	1480	11869	950	10913	317	8619
7-#18	4.55	6155	3619	12283	2491	13463	2014	14065	1602	14617	923	14021	55	13709
8-#9	1.30	5339	2941	9818	2127	10589	1737	10689	1446	10169	998	8908	488	4811
8-#10	1.65	5431	3014	10090	2171	10922	1770	11088	1470	10686	997	9523	446	5943
8-#11	2.03	5518	3093	10392	2205	11256	1794	11459	1485	11163	986	10075	392	7095
8-#14	2.92	5741	3280	11055	2319	12076	1902	12426	1546	12430	981	11568	280	9798
8-#18	5.20	6283	3755	12672	2611	14094	2140	14787	1698	15532	963	15480	25	15359
9-#10	1.86	5505	3057	10291	2186	11120	1779	11277	1462	10274	921	9990	429	6663
9-#11	2.28	5608	3145	10621	2228	11489	1816	11696	1479	10796	911	10638	371	7859
9-#14	3.29	5869	3356	11362	2359	12398	1916	12780	1543	12164	907	12356	251	10689
9-#18	5.85	6503	3890	13168	2693	14623	2169	15440	1705	16627	956	16434	-76	16514

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 28" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
10-#10	2.06	5545	3100	10590	2174	11371	1774	11519	1445	11270	950	10289	392	7240
10-#11	2.53	5654	3198	10961	2222	11783	1809	11995	1464	11898	936	10984	325	8615
10-#14	3.65	5935	3432	11812	2365	12814	1918	13222	1533	13536	922	12874	187	11834
10-#18	6.50	6619	4026	13885	2732	15335	2196	16231	1705	17559	883	17377	-185	17514
11-#10	2.27	5629	3143	10585	2254	11499	1830	11758	1499	11654	993	10780	385	7911
11-#11	2.79	5757	3251	10980	2310	11947	1877	12279	1523	12338	982	11571	315	9340
11-#14	4.02	6080	3509	11876	2473	13054	2001	13610	1604	13175	911	13672	167	12666
11-#18	7.15	6864	4162	14058	2889	15769	2316	16878	1809	18478	958	18638	-235	18811
12-#10	2.48	5665	3186	10708	2295	11680	1861	11985	1528	11969	1001	11207	374	8498
12-#11	3.04	5799	3304	11132	2357	12164	1905	12550	1556	12722	991	12073	298	10091
12-#14	4.38	6140	3585	12103	2536	13362	2059	13988	1647	14662	987	14375	141	13596
13-#10	2.68	5739	3229	10875	2317	11893	1880	12236	1534	12304	998	11629	348	9124
13-#11	3.29	5887	3357	11331	2386	12424	1937	12851	1564	12247	921	12576	267	10769
13-#14	4.75	6266	3661	12381	2582	13736	2087	14418	1661	15222	982	15089	95	14504
14-#10	2.89	5790	3272	11105	2321	12117	1889	12492	1532	12619	977	11907	314	9734
14-#11	3.55	5949	3410	11594	2395	12692	1945	13170	1566	12599	899	12923	225	11532
14-#14	5.12	6358	3738	12734	2602	14114	2105	14888	1671	15774	951	15567	34	15377
15-#10	3.09	5856	3315	11189	2374	12281	1928	12714	1567	12940	1001	12412	302	10318
15-#11	3.80	6026	3463	11714	2455	12889	1995	13431	1605	12961	924	13503	208	12179
15-#14	5.48	6462	3814	12903	2692	14394	2169	15246	1720	16315	985	16390	9	16339
16-#10	3.30	5913	3358	11300	2414	12468	1954	12971	1595	13241	1004	12777	284	10925
16-#11	4.05	6094	3516	11851	2503	13121	2019	13729	1637	14244	992	13932	183	12892
16-#14	5.85	6557	3890	13130	2746	14729	2224	15656	1762	16913	1010	16986	-31	17005
17-#10	3.51	5971	3402	11491	2437	12671	1976	13191	1601	13614	1011	13255	264	11482
17-#11	4.31	6165	3569	12077	2531	13363	2054	14002	1644	14693	1001	14505	159	13498
18-#10	3.71	6033	3445	11679	2454	12911	1983	13445	1606	13022	935	13602	242	12096
18-#11	4.56	6239	3622	12298	2556	13649	2073	14309	1652	14107	925	14950	133	14162
19-#10	3.92	6091	3488	11788	2498	13064	2023	13668	1633	14251	1014	14021	220	12638
19-#11	4.81	6308	3675	12437	2606	13834	2103	14581	1684	15466	1004	15426	103	14803
20-#10	4.13	6155	3531	11916	2537	13254	2048	13897	1656	14600	1025	14458	208	13196
20-#11	5.07	6386	3727	12597	2653	14062	2132	14855	1711	15870	1014	15927	85	15428
21-#10	4.33	6209	3574	12090	2560	13452	2070	14145	1666	14891	1017	14794	175	13727
22-#10	4.54	6281	3617	12281	2584	13669	2079	14401	1675	15231	1011	15166	152	14262

ROUND SPIRAL COLUMNS 30" DIA.

6-#10	1.08	6483	3323	12329	2232	12844	1823	12706	1499	11106	963	9972	510	5012
6-#11	1.32	6553	3382	12588	2251	13128	1836	13033	1504	12340	1019	10396	463	6026
6-#14	1.91	6734	3522	13172	2323	13843	1893	13892	1537	12605	938	11584	366	8402
6-#18	3.40	7173	3878	14600	2512	15608	2040	16021	1624	16370	968	14436	109	13886
7-#10	1.26	6567	3366	12120	2415	12991	1969	13058	1630	11602	1051	10907	564	5864
7-#11	1.54	6655	3435	12415	2443	13307	1995	13417	1639	12032	1040	11453	518	6963
7-#14	2.23	6877	3598	13057	2540	14084	2069	14345	1688	14123	1106	12926	426	9488
7-#18	3.96	7422	4014	14618	2791	15997	2262	16642	1811	17150	1083	16416	174	15319
8-#10	1.44	6621	3409	12185	2475	13201	2021	13379	1681	12832	1155	11355	550	6495
8-#11	1.77	6718	3487	12519	2509	13568	2045	13801	1697	13357	1144	11967	497	7763

ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
8-#14	2.55	6965	3675	13245	2622	14464	2130	14864	1759	13765	1065	13615	388	10734
8-#18	4.53	7564	4150	15020	2914	16673	2390	17469	1915	16956	1053	18042	151	17236
9-#10	1.62	6702	3452	12412	2489	13420	2028	13589	1672	12291	1066	11863	532	7313
9-#11	1.99	6815	3540	12778	2530	13829	2057	14050	1689	13783	1133	12584	476	8661
9-#14	2.86	7103	3751	13591	2660	14829	2166	15237	1754	15386	1129	14508	361	11783
9-#18	5.09	7804	4285	15575	2995	17276	2421	18160	1918	18051	1044	19109	51	18790
10-#10	1.80	6746	3495	12754	2470	13702	2019	13849	1651	12548	1030	12200	496	7934
10-#11	2.21	6867	3593	13164	2517	14157	2054	14373	1670	13192	1017	12983	432	9449
10-#14	3.18	7177	3827	14095	2660	15289	2164	15718	1740	15929	1078	15092	300	13009
10-#18	5.66	7932	4421	16377	3028	18063	2444	19027	1916	18992	974	20149	-56	20195
11-#10	1.98	6837	3538	12729	2557	13834	2080	14110	1710	13879	1150	12738	490	8715
11-#11	2.43	6978	3646	13167	2612	14327	2119	14682	1734	13655	1064	13619	422	10300
11-#14	3.50	7335	3904	14152	2776	15538	2252	16138	1816	16580	1137	15957	279	14016
11-#18	6.22	8200	4556	16552	3194	18518	2569	19730	2025	21376	1124	21571	-102	21667
12-#10	2.16	6877	3581	12861	2601	14030	2114	14360	1740	14219	1159	13212	481	9328
12-#11	2.65	7026	3699	13331	2662	14564	2157	14980	1768	15044	1149	14177	408	11086
12-#14	3.82	7402	3980	14397	2841	15876	2289	16554	1861	16021	1071	16729	256	15185
12-#18	6.79	8322	4692	16998	3298	19100	2667	20434	2096	20908	1064	22904	-149	22943
13-#10	2.34	6959	3624	13044	2622	14259	2131	14634	1746	13611	1079	13675	455	10073
13-#11	2.87	7123	3752	13548	2690	14844	2180	15310	1776	14453	1070	14732	376	11881
13-#14	4.14	7540	4056	14699	2886	16278	2327	17025	1875	17797	1145	17521	210	16118
13-#18	7.36	8563	4828	17516	3385	19808	2720	21249	2123	23456	1131	24228	-232	24285
14-#10	2.52	7013	3667	13304	2622	14507	2125	14906	1741	13936	1059	13953	419	10694
14-#11	3.09	7189	3805	13846	2696	15139	2193	15650	1775	14841	1047	15104	335	12697
14-#14	4.46	7634	4133	15095	2904	16695	2354	17528	1881	18399	1113	18092	154	17138
15-#10	2.70	7085	3710	13383	2678	14684	2180	15151	1780	14261	1083	14533	410	11379
15-#11	3.31	7276	3858	13962	2759	15354	2239	15938	1817	16320	1150	15760	320	13439
15-#14	4.77	7756	4209	15293	2984	17001	2410	17923	1933	17715	1072	18965	127	18132
16-#10	2.87	7149	3753	13501	2720	14884	2207	15427	1808	15612	1164	14946	394	12011
16-#11	3.53	7350	3911	14109	2808	15601	2271	16275	1851	16715	1153	16238	297	14249
16-#14	5.09	7860	4285	15510	3052	17358	2454	18388	1979	18230	1074	19629	91	19152
17-#10	3.05	7213	3796	13711	2742	15106	2228	15674	1814	14923	1087	15382	366	12663
17-#11	3.75	7427	3964	14359	2836	15867	2298	16565	1858	16058	1085	16869	273	14957
17-#14	5.41	7972	4361	15858	3094	17736	2494	18811	1990	18884	1087	20525	57	20153
18-#10	3.23	7280	3840	13920	2757	15366	2234	15951	1818	15284	1083	15827	350	13304
18-#11	3.97	7508	4017	14603	2858	16183	2308	16900	1865	17652	1151	17327	245	15753
19-#10	3.41	7344	3883	14034	2804	15536	2277	16190	1847	16708	1175	16294	331	13935
19-#11	4.19	7584	4069	14749	2911	16383	2356	17192	1898	16840	1088	17875	218	16432
20-#10	3.59	7414	3926	14169	2842	15744	2302	16441	1870	17085	1185	16783	320	14573
20-#11	4.41	7669	4122	14919	2958	16633	2386	17493	1926	18499	1178	18444	203	17138
21-#10	3.77	7473	3969	14361	2865	15957	2324	16713	1880	16248	1100	17148	288	15177
21-#11	4.63	7740	4175	15147	2987	16894	2414	17819	1938	18883	1169	18888	163	17851
22-#10	3.95	7550	4012	14571	2888	16195	2332	16985	1888	17779	1172	17556	264	15824
23-#10	4.13	7606	4055	14692	2928	16385	2371	17240	1919	18105	1182	18067	252	16408
24-#10	4.31	7680	4098	14837	2966	16586	2394	17496	1937	18456	1189	18466	227	17024

ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.16	7901	3804	15071	2551	15718	2083	15577	1711	14653	1172	12324	565	6523
6-#14	1.68	8098	3944	15707	2623	16494	2140	16508	1744	14855	1081	13637	472	9109
6-#18	2.98	8581	4300	17264	2812	18414	2286	18820	1831	19055	1124	16805	224	15293
7-#10	1.11	7915	3788	14503	2737	15563	2234	15627	1853	13822	1206	12911	672	6349
7-#11	1.36	8011	3857	14828	2764	15908	2252	16017	1862	14291	1195	13509	627	7609
7-#14	1.96	8254	4021	15528	2861	16753	2334	17025	1910	15542	1188	15125	537	10371
7-#18	3.48	8847	4436	17233	3112	18837	2527	19522	2035	19958	1254	19037	298	16907
8-#10	1.26	7975	3831	14554	2802	15784	2290	15974	1907	15255	1324	13412	660	7052
8-#11	1.55	8082	3910	14922	2835	16185	2313	16433	1923	15828	1313	14084	608	8436
8-#14	2.24	8352	4097	15712	2947	17156	2398	17603	1987	17344	1311	15888	502	11678
8-#18	3.98	9011	4572	17646	3239	19557	2618	20456	2146	19675	1216	20300	225	19190
9-#10	1.42	8061	3874	14810	2813	16024	2296	16205	1898	14567	1222	13961	642	7936
9-#11	1.75	8187	3963	15213	2853	16470	2324	16708	1914	15190	1213	14753	587	9494
9-#14	2.52	8502	4173	16098	2983	17558	2421	17998	1979	18016	1297	16862	475	12896
9-#18	4.48	9269	4707	18261	3318	20234	2690	21184	2146	22322	1290	22006	180	20775
10-#10	1.58	8110	3917	15199	2787	16338	2282	16483	1872	15892	1267	14292	603	8637
10-#11	1.94	8244	4015	15649	2834	16836	2316	17054	1890	16644	1254	15203	544	10295
10-#14	2.80	8583	4250	16661	2976	18069	2426	18517	1961	17354	1160	17531	417	14183
10-#18	4.97	9411	4843	19144	3344	21098	2709	22126	2140	21851	1132	23145	76	22688
11-#10	1.74	8208	3960	15148	2882	16472	2349	16767	1936	16380	1319	14921	602	9475
11-#11	2.13	8364	4068	15629	2936	17011	2387	17390	1959	16053	1221	15892	535	11281
11-#14	3.08	8756	4326	16702	3100	18328	2508	18970	2042	18032	1220	18458	397	15349
11-#18	5.47	9703	4979	19325	3519	21573	2839	22878	2253	24551	1300	24701	32	24494
12-#10	1.89	8253	4003	15288	2928	16684	2384	17040	1968	16746	1328	15445	594	10170
12-#11	2.33	8416	4121	15805	2989	17267	2427	17715	1995	17643	1318	16508	523	12096
12-#14	3.36	8827	4402	16967	3168	18694	2560	19424	2089	19945	1318	19309	375	16623
12-#18	5.97	9834	5114	19807	3627	22207	2899	23648	2327	23933	1228	26118	-16	26124
13-#10	2.05	8342	4046	15488	2948	16930	2400	17336	1973	17139	1325	15874	560	10982
13-#11	2.52	8523	4174	16042	3015	17568	2449	18073	2003	16913	1228	17114	491	13017
13-#14	3.64	8979	4478	17294	3211	19125	2596	19938	2103	20635	1316	20178	331	17717
13-#18	6.47	10098	5250	20363	3712	22968	2992	24540	2355	25040	1224	27617	-94	27655
14-#10	2.21	8400	4089	15782	2945	17201	2392	17624	1965	16351	1216	16223	530	11670
14-#11	2.72	8594	4227	16376	3018	17890	2443	18433	1999	17340	1204	17487	448	13864
14-#14	3.92	9080	4555	17736	3226	19580	2620	20471	2106	19879	1199	20768	273	18959
14-#18	6.96	10283	5386	21070	3757	23750	3031	25512	2377	27993	1262	28689	-193	28751
15-#10	2.37	8479	4132	15853	3005	17391	2450	17893	2007	16704	1241	16867	523	12447
15-#11	2.91	8690	4280	16487	3085	18122	2509	18750	2044	17762	1232	18236	436	14725
15-#14	4.20	9215	4631	17934	3310	19912	2681	20906	2162	21923	1321	21766	250	19976
16-#10	2.53	8550	4176	15978	3047	17603	2478	18189	2036	18260	1335	17342	510	13115
16-#11	3.10	8771	4333	16643	3135	18384	2542	19111	2079	19462	1325	18770	415	15569
16-#14	4.48	9328	4707	18167	3379	20292	2725	21422	2209	22527	1325	22499	216	21144
17-#10	2.68	8618	4219	16205	3068	17846	2498	18461	2042	17417	1246	17795	481	13870
17-#11	3.30	8854	4386	16916	3162	18675	2568	19432	2086	18626	1238	19344	381	16389
17-#14	4.76	9449	4784	18549	3421	20704	2765	21873	2220	21737	1250	23472	183	22182

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.84	8691	4262	16439	3082	18125	2502	18761	2045	17804	1241	18277	465	14535
18-#11	3.49	8942	4439	17186	3183	19015	2576	19796	2092	19102	1233	19928	363	17245
18-#14	5.04	9571	4860	18913	3457	21190	2782	22397	2233	23988	1325	24195	144	23263
19-#10	3.00	8761	4305	16555	3131	18310	2547	19017	2075	18146	1256	18794	447	15262
19-#11	3.69	9025	4492	17338	3238	19236	2627	20108	2126	20896	1338	20534	338	18037
19-#14	5.32	9691	4936	19151	3529	21501	2849	22840	2278	24579	1344	25028	104	24349
20-#10	3.16	8837	4348	16697	3170	18537	2574	19290	2099	19845	1356	19310	435	15924
20-#11	3.88	9116	4545	17516	3286	19508	2658	20436	2155	21389	1351	21174	324	18885
21-#10	3.32	8902	4391	16907	3193	18765	2595	19585	2109	18857	1260	19728	405	16621
21-#11	4.07	9194	4597	17766	3314	19787	2685	20790	2167	21811	1342	21647	285	19637
22-#10	3.47	8984	4434	17137	3214	19025	2602	19874	2116	20604	1344	20172	382	17321
22-#11	4.27	9298	4650	18038	3343	20098	2696	21149	2178	20811	1246	22182	256	20417
23-#10	3.63	9046	4477	17263	3255	19226	2643	20140	2142	19556	1264	20718	370	17977
23-#11	4.46	9367	4703	18199	3390	20347	2743	21480	2215	21208	1256	22847	240	21177
24-#10	3.79	9127	4520	17422	3294	19443	2666	20426	2166	21335	1362	21153	345	18671
25-#10	3.95	9183	4563	17616	3317	19686	2690	20718	2182	21711	1358	21643	326	19301
26-#10	4.11	9257	4606	17829	3341	19941	2701	21008	2186	20636	1263	22065	296	19990

ROUND SPIRAL COLUMNS 34" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.03	9423	4253	17866	2872	18636	2347	18439	1931	17249	1335	14477	673	7022
6-#14	1.49	9638	4394	18553	2944	19473	2403	19442	1964	18609	1321	15915	583	9818
6-#18	2.64	10163	4750	20240	3131	21547	2549	21939	2052	21997	1287	19399	343	16537
7-#11	1.20	9542	4306	17539	3106	18835	2534	18941	2099	16824	1360	15803	742	8222
7-#14	1.73	9806	4470	18297	3203	19747	2605	20028	2147	18177	1354	17557	654	11269
7-#18	3.08	10451	4885	20147	3454	22002	2809	22727	2273	21522	1338	21869	424	18404
8-#10	1.12	9501	4280	17216	3150	18690	2578	18895	2149	16776	1404	15712	777	7615
8-#11	1.37	9620	4359	17618	3182	19125	2600	19390	2164	17355	1394	16442	726	9116
8-#14	1.98	9915	4546	18474	3294	20172	2684	20650	2227	20236	1493	18402	623	12629
8-#18	3.52	10634	5021	20567	3585	22765	2904	23769	2391	22669	1389	23210	353	21057
9-#10	1.26	9596	4323	17504	3158	18952	2581	19146	2138	17117	1389	16299	758	8563
9-#11	1.55	9732	4412	17944	3198	19435	2608	19691	2153	17790	1379	17162	704	10265
9-#14	2.23	10075	4623	18901	3327	20610	2705	21084	2219	20940	1476	19455	595	14030
9-#18	3.97	10911	5157	21244	3662	23514	2976	24532	2387	23891	1374	25069	308	22819
10-#10	1.40	9649	4367	17945	3126	19300	2549	19439	2107	18632	1442	16620	716	9349
10-#11	1.72	9795	4465	18435	3171	19842	2595	20058	2125	19445	1428	17614	658	11150
10-#14	2.48	10164	4699	19528	3314	21175	2706	21640	2197	20114	1324	20205	539	15369
10-#18	4.41	11065	5292	22214	3681	24459	2991	25549	2378	26766	1392	26378	211	25002
11-#10	1.54	9754	4410	17863	3229	19435	2635	19748	2176	19178	1498	17345	719	10242
11-#11	1.89	9923	4518	18387	3282	20019	2673	20422	2199	20064	1488	18406	654	12244
11-#14	2.73	10347	4775	19546	3446	21441	2794	22127	2283	20865	1389	21200	519	16707
11-#18	4.85	11382	5428	22393	3866	24953	3106	26351	2496	28021	1485	28022	164	26847

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
12-#10	1.68	9803	4453	18008	3277	19661	2672	20044	2210	18265	1408	17919	714	11025
12-#11	2.06	9981	4571	18573	3337	20295	2715	20775	2238	19169	1399	19081	644	13120
12-#14	2.97	10428	4852	19831	3517	21836	2848	22620	2332	23021	1500	22131	501	18036
12-#18	5.29	11522	5564	22910	3976	25639	3189	27187	2572	27233	1400	29575	122	28799
13-#10	1.82	9900	4496	18227	3295	19925	2687	20363	2214	18658	1404	18364	678	11886
13-#11	2.23	10097	4624	18831	3362	20616	2735	21162	2244	19648	1395	19646	602	14183
13-#14	3.22	10594	4928	20184	3558	22296	2882	23175	2345	23764	1497	23075	456	19290
13-#18	5.73	11810	5699	23507	4060	26450	3259	28155	2600	30485	1499	31212	44	30902
14-#10	1.96	9962	4539	18557	3290	20220	2676	20666	2204	20397	1481	18731	647	12662
14-#11	2.41	10173	4677	19204	3362	20967	2727	21540	2238	20113	1372	20108	567	15050
14-#14	3.47	10701	5004	20674	3570	22791	2882	23738	2345	22861	1368	23671	396	20642
14-#18	6.17	12012	5835	24285	4102	27300	3317	29186	2619	29637	1353	32404	-51	32401
15-#10	2.10	10048	4582	18616	3353	20422	2738	20960	2249	20811	1511	19442	642	13485
15-#11	2.58	10275	4729	19306	3432	21215	2796	21887	2286	20568	1401	20935	557	16038
15-#14	3.72	10849	5080	20870	3658	23148	2969	24213	2405	25160	1504	24793	377	21834
15-#18	6.61	12250	5971	24714	4234	27922	3408	29971	2704	30693	1405	34160	-102	34176
16-#10	2.24	10125	4625	18747	3397	20646	2766	21275	2279	19791	1416	19969	631	14239
16-#11	2.75	10366	4782	19471	3484	21492	2830	22272	2321	21006	1407	21544	540	16911
16-#14	3.97	10972	5157	21117	3728	23550	3014	24762	2453	25817	1510	25611	346	23189
17-#10	2.38	10199	4668	18993	3417	20909	2786	21573	2285	21628	1516	20450	602	15061
17-#11	2.92	10456	4835	19766	3510	21807	2855	22625	2329	23031	1508	22140	505	17852
17-#14	4.21	11102	5233	21530	3769	23997	3053	25260	2464	26582	1512	26496	298	24264
18-#10	2.52	10278	4711	19254	3429	21209	2788	21895	2286	22071	1510	20967	585	15787
18-#11	3.09	10550	4888	20065	3528	22171	2861	23016	2334	22003	1402	22770	486	18739
18-#14	4.46	11234	5309	21930	3803	24517	3069	25826	2477	27377	1508	27411	273	25490
19-#10	2.66	10352	4754	19369	3480	21406	2835	22169	2318	22472	1527	21535	569	16596
19-#11	3.26	10642	4941	20221	3586	22412	2915	23349	2370	22442	1419	23435	463	19643
19-#14	4.71	11364	5386	22179	3878	24859	3139	26297	2523	28023	1529	28325	235	26614
20-#10	2.80	10434	4797	19517	3520	21655	2863	22464	2343	21374	1436	22080	556	17300
20-#11	3.44	10739	4994	20408	3634	22707	2947	23704	2399	22932	1431	24110	448	20526
20-#14	4.96	11503	5462	22457	3945	25277	3182	26798	2563	28774	1547	29299	215	27777
21-#10	2.94	10505	4840	19746	3542	21897	2884	22778	2353	23290	1532	22534	528	18096
21-#11	3.61	10824	5047	20679	3663	23004	2973	24087	2411	23367	1424	24648	411	21397
22-#10	3.08	10594	4883	19997	3562	22178	2890	23088	2358	23724	1526	23030	505	18819
22-#11	3.78	10931	5100	20976	3690	23341	2983	24466	2420	25558	1518	25228	382	22295
23-#10	3.22	10661	4926	20128	3605	22391	2932	23377	2386	24097	1536	23607	493	19569
23-#11	3.95	11011	5153	21144	3739	23604	3032	24811	2452	26012	1530	25938	368	23144
24-#10	3.36	10750	4970	20299	3645	22625	2956	23680	2410	22877	1442	24082	469	20289
24-#11	4.12	11117	5206	21350	3787	23887	3061	25183	2481	24740	1437	26502	337	24058
25-#10	3.50	10809	5013	20508	3667	22887	2980	23984	2420	24917	1541	24612	451	21008
25-#11	4.30	11190	5259	21603	3815	24202	3091	25563	2501	26997	1534	27139	314	24821
26-#10	3.64	10890	5056	20742	3690	23159	2989	24313	2430	23648	1434	25051	419	21734
27-#10	3.78	10960	5099	20910	3722	23379	3027	24596	2460	24010	1442	25696	417	22451
28-#10	3.92	11035	5142	21095	3753	23625	3052	24882	2476	24411	1451	26252	398	23174

ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.33	11362	4870	21730	3284	22799	2682	22717	2199	20163	1394	18432	699	10529
6-#18	2.36	11932	5226	23547	3471	25028	2828	25396	2286	25238	1461	22234	466	17782
7-#11	1.07	11258	4783	20565	3471	22106	2835	22210	2352	21052	1645	18351	863	8817
7-#14	1.55	11543	4947	21382	3567	23086	2905	23376	2400	21103	1530	20243	777	12182
7-#18	2.75	12242	5362	23378	3817	25512	3089	26276	2525	26473	1625	24907	552	19901
8-#11	1.23	11342	4836	20626	3551	22409	2905	22692	2420	21677	1685	19058	851	9802
8-#14	1.77	11663	5023	21546	3663	23532	2989	24041	2483	23442	1685	21172	749	13587
8-#18	3.14	12443	5498	23800	3953	26317	3208	27404	2648	25957	1571	26377	485	22690
9-#10	1.12	11315	4800	20511	3526	22224	2884	22432	2393	21352	1670	18815	873	9195
9-#11	1.38	11464	4889	20989	3564	22746	2910	23019	2408	20683	1555	19827	828	11031
9-#14	1.99	11834	5099	22019	3693	24006	3007	24515	2474	24177	1666	22304	721	15184
9-#18	3.54	12739	5633	24543	4028	27127	3258	28226	2644	27241	1553	28387	441	24743
10-#10	1.25	11373	4843	21008	3486	22607	2846	22740	2357	20237	1519	19198	836	10070
10-#11	1.53	11532	4942	21540	3531	23192	2876	23407	2375	22556	1613	20269	779	12016
10-#14	2.21	11931	5176	22714	3673	24627	3003	25106	2447	23163	1498	23057	661	16568
10-#18	3.93	12907	5769	25603	4040	28166	3289	29315	2630	30430	1581	29863	350	27391
11-#10	1.37	11485	4886	20889	3597	22742	2940	23075	2432	22289	1688	20025	844	11017
11-#11	1.69	11669	4994	21458	3650	23372	2976	23799	2455	23243	1678	21175	780	13179
11-#14	2.43	12126	5252	22704	3813	24899	3098	25628	2539	25704	1680	24197	648	18090
11-#18	4.32	13248	5905	25767	4233	28677	3411	30169	2753	29684	1568	31600	302	29264
12-#10	1.50	11538	4929	21034	3648	22983	2979	23394	2468	22708	1700	20650	840	11914
12-#11	1.84	11732	5047	21652	3708	23666	3020	24180	2495	23747	1690	21911	772	14158
12-#14	2.65	12215	5328	23007	3887	25322	3154	26160	2590	26411	1692	25211	632	19466
12-#18	4.72	13398	6040	26327	4347	29415	3497	31072	2832	30827	1583	33289	263	31468
13-#10	1.62	11644	4972	21278	3665	23264	2992	23736	2471	23157	1695	21109	802	12801
13-#11	1.99	11857	5100	21932	3731	24008	3039	24595	2501	22677	1574	22496	728	15284
13-#14	2.87	12394	5405	23388	3927	25811	3187	26757	2602	27208	1689	26088	573	20892
13-#18	5.11	13710	6176	26966	4429	30277	3565	32116	2860	34435	1694	35065	186	33639
14-#10	1.75	11709	5016	21647	3656	23583	2978	24053	2458	22006	1558	21494	771	13669
14-#11	2.15	11938	5153	22347	3727	24388	3028	24993	2491	24834	1659	22983	692	16254
14-#14	3.09	12508	5481	23929	3935	26347	3183	27351	2599	26134	1547	26829	525	22296
14-#18	5.50	13907	6312	27817	4468	31195	3579	33205	2875	35827	1647	36279	87	35689
15-#10	1.87	11802	5059	21691	3723	23797	3043	24372	2506	24039	1702	22274	768	14536
15-#11	2.30	12049	5206	22438	3801	24652	3101	25369	2543	23667	1580	23890	684	17331
15-#14	3.32	12666	5557	24118	4027	26728	3274	27865	2662	28713	1697	28056	507	23647
15-#18	5.89	14183	6447	28255	4604	31864	3715	34056	2964	37027	1704	38270	44	37936
16-#10	2.00	11885	5102	21826	3768	24033	3073	24707	2537	24465	1710	22830	756	15382
16-#11	2.45	12147	5259	22610	3854	24944	3136	25778	2579	25865	1700	24574	670	18274
16-#14	3.54	12802	5633	24380	4098	27152	3320	28448	2711	29422	1704	28982	481	25056
16-#18	6.29	14404	6583	28735	4722	32624	3791	35082	3046	35683	1596	39735	-17	39740
17-#10	2.12	11965	5145	22092	3787	24316	3092	25026	2542	24910	1708	23362	729	16244
17-#11	2.61	12244	5312	22928	3880	25284	3161	26163	2587	24656	1586	25192	634	19340
17-#14	3.76	12941	5710	24823	4139	27634	3359	28993	2723	28214	1592	29898	432	26325

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 60,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
18-#10	2.25	12050	5188	22381	3797	24637	3092	25375	2543	25312	1688	23759	697	17061
18-#11	2.76	12345	5365	23258	3896	25672	3164	26582	2590	25197	1580	25867	614	20257
18-#14	3.98	13083	5786	25261	4170	28189	3372	29600	2734	31079	1701	30884	406	27757
19-#10	2.37	12129	5231	22495	3851	24846	3142	25666	2576	24096	1605	24525	697	17909
19-#11	2.91	12441	5418	23415	3957	25929	3221	26936	2628	25675	1599	26594	593	21282
19-#14	4.20	13224	5862	25520	4248	28558	3445	30099	2782	29662	1609	31879	371	28934
20-#10	2.50	12218	5274	22649	3891	25116	3171	25984	2602	26272	1731	25107	684	18700
20-#11	3.07	12548	5471	23610	4005	26250	3255	27317	2658	28066	1726	27303	578	22194
20-#14	4.42	13372	5939	25811	4316	29010	3490	30639	2823	32577	1742	32902	349	30248
21-#10	2.62	12294	5317	22896	3913	25373	3190	26316	2611	26689	1725	25595	656	19557
21-#11	3.22	12640	5524	23904	4033	26565	3280	27726	2670	26667	1605	27891	542	23180
21-#14	4.64	13503	6015	26222	4358	29463	3529	31227	2842	31075	1617	33735	297	31476
22-#10	2.74	12389	5360	23170	3931	25676	3196	26648	2615	27159	1719	26144	634	20344
22-#11	3.37	12754	5576	24226	4058	26928	3289	28129	2677	29133	1712	28530	514	24140
22-#14	4.86	13672	6091	26662	4401	29978	3547	31812	2857	34106	1723	34637	257	32685
23-#10	2.87	12461	5403	23303	3976	25899	3239	26959	2645	27556	1730	26753	622	21170
23-#11	3.52	12842	5629	24400	4110	27206	3339	28501	2710	29616	1724	29278	499	25070
24-#10	2.99	12559	5446	23483	4016	26150	3263	27281	2669	28002	1739	27269	599	21936
24-#11	3.68	12957	5682	24623	4158	27509	3368	28895	2740	30150	1734	29890	470	26031
25-#10	3.12	12622	5489	23711	4038	26432	3287	27606	2679	28433	1735	27839	581	22751
25-#11	3.83	13034	5735	24893	4186	27848	3398	29304	2760	28631	1614	30577	447	26919
26-#10	3.24	12709	5532	23967	4060	26722	3295	27963	2689	28878	1729	28293	548	23500
26-#11	3.98	13138	5788	25192	4215	28202	3410	29713	2766	29144	1609	31153	409	27883
27-#10	3.37	12784	5575	24139	4094	26956	3335	28263	2719	29298	1739	28919	539	24310
27-#11	4.14	13228	5841	25414	4254	28486	3456	30081	2801	31725	1734	31978	405	28750
28-#10	3.49	12865	5619	24337	4125	27217	3359	28571	2736	29754	1749	29611	530	25058
29-#10	3.62	12944	5662	24546	4156	27487	3383	28907	2753	30207	1751	30070	505	25838
30-#10	3.74	13025	5705	24806	4173	27790	3396	29231	2757	30632	1741	30611	479	26604

ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	2.07	2461	1888	5210	1362	5903	1042	6092	804	5668	401	5737	117	5246
6-#14	2.98	2475	2072	5730	1449	6517	1094	6809	827	6546	358	6718	-9	6718
6-#18	5.31	2499	2540	6957	1667	7976	1223	8522	880	9262	256	9027	-346	8874
7-#11	2.41	2419	1957	5102	1491	6016	1152	6334	891	6021	453	6464	130	5816
7-#14	3.48	2425	2173	5680	1603	6697	1226	7129	929	7493	447	7670	-4	7669
7-#18	6.19	2443	2719	7045	1885	8316	1408	9028	1019	9319	314	10509	-362	10165
8-#11	2.76	2421	2027	5210	1547	6221	1196	6604	928	6822	497	6896	104	6480
8-#14	3.98	2430	2273	5870	1678	6993	1283	7507	977	7470	428	8259	-46	8241
8-#18	7.07	2506	2897	7417	2006	8829	1498	9661	1092	10830	347	11471	-449	11128
9-#11	3.10	2457	2096	5468	1574	6472	1216	6888	930	7208	481	7400	58	7113
9-#14	4.48	2473	2373	6211	1720	7342	1315	7908	982	8554	436	8974	-111	8823
9-#18	7.96	2700	3075	7959	2084	9411	1558	10342	1104	10987	287	12681	-564	11831
10-#11	3.45	2450	2166	5755	1589	6767	1214	7202	922	7581	442	7745	12	7693
10-#14	4.97	2466	2473	6575	1750	7747	1319	8354	976	9095	384	9477	-176	9376
11-#11	3.79	2471	2236	5826	1660	6933	1278	7442	967	7939	468	8272	-19	8258
11-#14	5.47	2503	2574	6723	1842	7992	1401	8687	1032	9581	414	10193	-228	9973
12-#11	4.14	2506	2305	5963	1713	7152	1313	7713	995	8287	465	8734	-42	8713
12-#14	5.97	2556	2674	6929	1915	8303	1448	9067	1070	9394	381	10832	-263	10552
13-#11	4.48	2502	2375	6191	1745	7396	1338	7997	1002	8671	453	9136	-95	9064
13-#14	6.47	2577	2774	7242	1963	8644	1486	9467	1081	10609	391	11401	-340	10988
14-#11	4.83	2516	2444	6442	1773	7671	1347	8304	1004	8447	396	9538	-139	9436
15-#11	5.17	2536	2514	6583	1824	7860	1398	8551	1037	8776	409	10046	-165	9834
16-#11	5.52	2547	2583	6760	1867	8084	1429	8823	1062	9753	433	10482	-206	10237

ROUND SPIRAL COLUMNS 26" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.76	3156	2143	6396	1578	7277	1214	7496	946	7403	532	6983	198	5991
6-#14	2.54	3189	2328	6987	1665	7974	1268	8309	971	8468	488	8106	77	7775
6-#18	4.52	3244	2796	8392	1887	9640	1401	10264	1030	11032	370	10773	-245	10652
7-#11	2.06	3102	2213	6213	1719	7387	1336	7771	1043	7846	596	7830	216	6621
7-#14	2.97	3125	2428	6877	1833	8160	1412	8672	1083	8423	523	9208	88	8748
7-#18	5.27	3152	2974	8442	2120	10008	1600	10837	1181	11864	461	12484	-253	12248
8-#11	2.35	3110	2282	6320	1779	7612	1384	8074	1083	8266	611	8322	194	7417
8-#14	3.39	3136	2528	7064	1911	8488	1473	9096	1134	9603	576	9881	50	9656
8-#18	6.03	3196	3152	8847	2246	10583	1695	11552	1258	12822	476	13586	-333	13299
9-#11	2.64	3143	2352	6617	1804	7898	1403	8393	1084	8696	594	8842	141	8072
9-#14	3.81	3178	2629	7461	1952	8884	1504	9548	1140	10219	554	10689	-14	10612
9-#18	6.78	3295	3330	9471	2324	11245	1756	12323	1271	13885	439	14965	-446	14240
10-#11	2.94	3146	2421	6968	1817	8234	1397	8745	1074	9111	554	9272	103	8768
10-#14	4.24	3172	2729	7900	1980	9346	1505	10050	1132	10102	468	11253	-77	11207
10-#18	7.53	3425	3509	10118	2390	12009	1772	13186	1270	14944	352	15957	-558	14941
11-#11	3.23	3166	2491	7016	1892	8414	1466	9015	1123	9518	583	9873	75	9500
11-#14	4.66	3215	2829	8031	2076	9614	1593	10425	1193	11376	535	12069	-124	11938
12-#11	3.53	3210	2560	7165	1947	8657	1503	9318	1153	9909	583	10401	54	10137
12-#14	5.09	3265	2929	8256	2151	9962	1642	10852	1233	11922	532	12799	-157	12660

ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
13-#11	3.82	3214	2630	7424	1979	8933	1528	9637	1160	10339	571	10853	3	10841
13-#14	5.51	3288	3030	8612	2199	10348	1680	11302	1244	12533	516	13441	-231	13156
14-#11	4.11	3232	2699	7708	2004	9245	1536	9982	1162	10763	542	11307	-42	11280
14-#14	5.93	3327	3130	8995	2242	10780	1696	11791	1250	12265	444	14089	-294	13686
15-#11	4.41	3249	2769	7863	2058	9453	1589	10259	1197	11161	559	11882	-64	11822
16-#11	4.70	3260	2838	8059	2103	9703	1622	10564	1223	11555	555	12379	-104	12263
17-#11	5.00	3292	2908	8273	2143	9975	1650	10882	1233	11982	546	12867	-140	12694
18-#11	5.29	3315	2977	8547	2168	10274	1663	11221	1240	12450	534	13313	-195	13042

ROUND SPIRAL COLUMNS 28" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.52	3936	2419	7745	1811	8847	1400	9099	1098	8911	641	8387	283	6606
6-#14	2.19	3996	2604	8410	1899	9627	1455	10008	1124	10101	600	9653	166	8853
6-#18	3.90	4083	3071	9993	2123	11502	1592	12206	1188	12116	456	12681	-143	12606
7-#11	1.77	3894	2489	7469	1965	8949	1535	9408	1206	8796	667	9363	308	7358
7-#14	2.56	3923	2704	8209	2080	9814	1612	10415	1249	10741	682	10915	184	9848
7-#18	4.55	3985	3250	9989	2372	11894	1806	12848	1352	13928	591	14631	-143	14533
8-#11	2.03	3908	2558	7572	2029	9184	1585	9744	1250	9235	683	9919	288	8398
8-#14	2.92	3940	2804	8401	2162	10172	1677	10886	1303	11388	700	11673	151	10924
8-#18	5.20	4028	3428	10395	2500	12529	1904	13645	1435	14002	570	15874	-216	15671
9-#11	2.28	3943	2628	7911	2053	9513	1604	10098	1250	9678	667	10496	236	9066
9-#14	3.29	3997	2904	8853	2202	10616	1707	11389	1308	11265	633	12500	76	12078
9-#18	5.85	4109	3606	11119	2579	13272	1965	14507	1448	16185	575	17423	-328	16794
10-#11	2.53	3936	2697	8318	2062	9894	1595	10488	1237	10823	673	10966	197	9889
10-#14	3.65	3994	3005	9377	2228	11138	1705	11947	1298	12736	624	13196	24	13073
10-#18	6.50	4148	3784	11876	2643	14133	1980	15471	1445	17363	488	18531	-436	17725
11-#11	2.79	3977	2767	8351	2143	10083	1669	10787	1291	11282	706	11645	173	10651
11-#14	4.02	4045	3105	9483	2328	11427	1798	12363	1364	13356	663	14115	-18	14095
11-#18	7.15	4319	3963	12209	2797	14660	2120	16168	1540	18374	539	20031	-528	18972
12-#11	3.04	4015	2836	8510	2199	10343	1707	11124	1322	10937	660	12238	153	11402
12-#14	4.38	4094	3205	9726	2405	11810	1850	12838	1406	13965	661	14938	-49	14893
13-#11	3.29	4030	2906	8801	2230	10656	1732	11478	1329	12193	696	12740	104	12226
13-#14	4.75	4126	3305	10127	2453	12242	1888	13338	1417	14642	646	15653	-121	15505
14-#11	3.55	4062	2975	9118	2253	11010	1739	11860	1330	11816	622	13245	59	12923
14-#14	5.12	4165	3406	10549	2493	12727	1902	13882	1423	15316	607	16379	-184	16157
15-#11	3.80	4077	3045	9278	2310	11231	1794	12168	1367	12231	640	13889	39	13700
15-#14	5.48	4189	3506	10812	2567	13059	1976	14314	1470	15930	629	17269	-217	16855
16-#11	4.05	4091	3114	9501	2357	11504	1828	12506	1395	12640	637	14447	0	14445
16-#14	5.85	4224	3606	11128	2631	13451	2022	14791	1508	16545	623	18047	-274	17565
17-#11	4.31	4128	3184	9731	2396	11809	1856	12859	1405	14016	674	14990	-34	14952
18-#11	4.56	4148	3253	10043	2421	12149	1870	13235	1412	13564	618	15487	-89	15364
19-#11	4.81	4178	3323	10189	2481	12387	1918	13549	1442	14949	669	16093	-109	15933
20-#11	5.07	4226	3392	10411	2525	12665	1949	13889	1468	14382	626	16739	-135	16400

ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.32	4833	2715	9270	2061	10628	1599	10916	1261	10610	759	9962	372	7221
6-#14	1.91	4903	2900	10008	2150	11491	1655	11922	1289	11925	719	11371	260	9984
6-#18	3.40	5031	3368	11772	2377	13577	1796	14363	1357	15123	614	14762	-39	14742
7-#11	1.54	4802	2785	8883	2231	10713	1748	11259	1382	11202	841	11076	404	8101
7-#14	2.23	4849	3000	9700	2346	11673	1827	12373	1426	12656	811	12802	285	10988
7-#18	3.96	4945	3546	11670	2639	13985	2024	15075	1534	16192	726	16960	-31	16938
8-#11	1.77	4822	2854	8976	2299	10954	1801	11628	1428	11724	861	11698	388	9207
8-#14	2.55	4873	3100	9892	2432	12042	1894	12891	1484	12481	776	13648	255	12246
8-#18	4.53	4994	3724	12099	2772	14680	2128	15955	1621	17382	751	18347	-98	18250
9-#11	1.99	4855	2924	9361	2321	11322	1819	12017	1428	12217	838	12332	335	10045
9-#14	2.86	4920	3201	10400	2470	12552	1925	13445	1488	14084	802	14560	181	13440
9-#18	5.09	5066	3902	12909	2850	15506	2188	16907	1635	17440	668	19925	-227	19576
10-#11	2.21	4855	2993	9825	2324	11760	1807	12447	1412	12733	800	12839	296	11056
10-#14	3.18	4937	3301	10988	2491	13137	1919	14060	1475	13856	704	15320	129	14598
10-#18	5.66	5092	4081	13798	2913	16465	2200	17973	1630	19982	629	21289	-314	20611
11-#11	2.43	4900	3063	9840	2412	11945	1885	12775	1470	13245	837	13599	276	11839
11-#14	3.50	4983	3401	11090	2599	13437	2017	14517	1546	15536	798	16345	91	15854
11-#18	6.22	5228	4259	14110	3071	17038	2347	18742	1730	21104	686	22958	-399	22112
12-#11	2.65	4947	3132	10007	2470	12228	1925	13145	1503	13727	839	14259	257	12714
12-#14	3.82	5048	3501	11351	2678	13846	2070	15039	1590	15128	745	17262	62	16917
12-#18	6.79	5348	4437	14597	3202	17769	2433	19634	1800	22241	679	24488	-458	23589
13-#11	2.87	4965	3202	10324	2500	12574	1950	13534	1510	14247	829	14810	209	13582
13-#14	4.14	5086	3602	11791	2724	14330	2108	15590	1602	16953	783	18049	-8	18038
13-#18	7.36	5565	4615	15331	3290	18575	2503	20579	1824	23526	653	25844	-586	24626
14-#11	3.09	4991	3271	10686	2521	12975	1955	13954	1509	14757	798	15364	164	14382
14-#14	4.46	5134	3702	12262	2762	14880	2122	16189	1606	17690	743	18851	-71	18771
15-#11	3.31	5016	3341	10847	2581	13206	2013	14292	1549	15249	819	16080	146	15295
15-#14	4.77	5154	3802	12536	2839	15226	2198	16664	1656	18369	768	19838	-101	19606
16-#11	3.53	5034	3410	11085	2629	13504	2048	14664	1578	15731	818	16700	108	16053
16-#14	5.09	5188	3902	12893	2906	15652	2245	17189	1695	17778	713	20704	-157	20429
17-#11	3.75	5076	3480	11344	2667	13840	2076	15051	1588	16250	810	17296	75	16890
17-#14	5.41	5258	4003	13243	2963	16125	2287	17738	1711	19786	752	21552	-206	21179
18-#11	3.97	5107	3549	11694	2691	14209	2088	15465	1595	16765	786	17845	21	17722
19-#11	4.19	5140	3619	11845	2754	14475	2139	15810	1627	17275	806	18513	3	18499
20-#11	4.41	5191	3688	12078	2798	14780	2171	16183	1653	17781	808	19224	-21	19059
21-#11	4.63	5203	3758	12375	2833	15107	2201	16569	1665	18275	796	19768	-58	19673

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.16	5853	3032	10982	2329	12634	1813	12962	1436	11681	824	11721	467	7837
6-#14	1.68	5939	3216	11793	2419	13581	1869	14065	1465	13025	789	13273	358	10885
6-#18	2.98	6107	3684	13741	2647	15878	2013	16750	1536	17471	745	17028	69	16681
7-#11	1.36	5833	3101	10464	2515	12687	1976	13341	1569	13191	976	12983	506	8851
7-#14	1.96	5899	3317	11358	2630	13744	2055	14562	1614	14783	947	14884	390	12090
7-#18	3.48	6037	3863	13519	2925	16298	2257	17534	1727	18670	869	19484	84	18958
8-#11	1.55	5861	3171	10544	2587	12942	2033	13735	1618	13767	998	13673	493	10021
8-#14	2.24	5933	3417	11546	2721	14130	2126	15127	1676	15571	972	15820	364	13689
8-#18	3.98	6095	4041	13967	3062	17030	2363	18496	1818	19977	897	21017	23	20898
9-#11	1.75	5894	3240	10977	2607	13349	2049	14168	1617	14300	974	14362	439	10989
9-#14	2.52	5982	3517	12114	2757	14691	2155	15732	1679	16345	941	16816	289	14844
9-#18	4.48	6163	4219	14867	3139	17959	2424	19539	1832	21401	863	22752	-106	22592
10-#11	1.94	5899	3310	11503	2605	13847	2034	14635	1598	14854	934	14904	400	12137
10-#14	2.80	5980	3617	12772	2772	15357	2148	16403	1663	17168	892	17636	238	16178
10-#18	4.97	6186	4397	15864	3198	19020	2433	20706	1824	22813	775	24241	-191	23678
11-#11	2.13	5953	3379	11490	2699	14026	2116	14994	1661	15422	975	15748	383	13052
11-#14	3.08	6061	3718	12864	2887	15656	2250	16902	1739	17930	939	18770	204	17481
11-#18	5.47	6325	4576	16178	3363	19635	2586	21548	1931	24049	837	26084	-270	25582
12-#11	2.33	6004	3449	11668	2760	14331	2158	15389	1695	15949	979	16476	366	14072
12-#14	3.36	6114	3818	13139	2968	16098	2304	17471	1785	18667	942	19782	176	18703
12-#18	5.97	6421	4754	16703	3497	20411	2673	22523	2004	25296	833	27776	-326	27199
13-#11	2.52	6029	3519	12011	2788	14710	2182	15819	1703	15414	904	17076	318	14967
13-#14	3.64	6161	3918	13613	3013	16630	2342	18073	1797	19477	927	20641	108	20068
13-#18	6.47	6546	4932	17512	3585	21311	2745	23559	2027	26701	809	29264	-450	28287
14-#11	2.72	6065	3588	12421	2807	15142	2185	16279	1700	17066	937	17678	273	15890
14-#14	3.92	6238	4018	14142	3049	17238	2355	18728	1800	20278	887	21518	45	21241
14-#18	6.96	6765	5110	18333	3662	22310	2778	24689	2043	28110	743	30796	-557	29486
15-#11	2.91	6081	3658	12579	2870	15399	2247	16644	1743	17607	961	18410	250	16840
15-#14	4.20	6254	4119	14425	3130	17608	2434	19245	1853	19622	853	22604	18	22507
16-#11	3.10	6114	3727	12826	2918	15721	2283	17044	1772	18134	960	19149	221	17710
16-#14	4.48	6291	4219	14801	3197	18070	2483	19819	1894	21765	911	23559	-37	23506
17-#11	3.30	6153	3797	13120	2957	16084	2310	17470	1783	17452	889	19799	188	18681
17-#14	4.76	6365	4319	15195	3255	18588	2524	20418	1909	22571	901	24485	-84	24335
18-#11	3.49	6173	3866	13511	2980	16484	2321	17925	1789	19257	929	20398	134	19529
18-#14	5.04	6392	4420	15718	3292	19150	2544	21060	1921	23375	868	25346	-161	25012
19-#11	3.69	6223	3936	13658	3044	16770	2373	18297	1822	19790	944	21129	119	20446
19-#14	5.32	6457	4520	15969	3379	19567	2614	21591	1965	24155	895	26367	-187	25979
20-#11	3.88	6276	4005	13908	3089	17112	2407	18699	1849	20368	954	21794	82	21365
21-#11	4.07	6305	4075	14234	3124	17471	2430	19123	1861	20906	941	22503	60	22200
22-#11	4.27	6338	4144	14571	3158	17849	2452	19574	1872	21488	927	23151	19	23062
23-#11	4.46	6372	4214	14778	3211	18161	2493	19950	1900	20529	870	23826	-8	23811

ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.03	7004	3369	12893	2615	14879	2040	15253	1621	14640	1016	13676	567	8454
6-#14	1.49	7106	3553	13778	2705	15911	2097	16453	1651	16206	979	15372	460	11766
6-#18	2.64	7319	4021	15910	2934	18420	2243	19383	1726	20039	884	19491	179	18496
7-#11	1.20	6996	3438	12260	2812	14894	2218	15669	1769	15407	1119	15097	614	9612
7-#14	1.73	7082	3654	13195	2933	16040	2298	16996	1815	17137	1092	17172	501	13138
7-#18	3.08	7237	4200	15548	3229	18845	2503	20239	1931	21374	1019	22215	203	20833
8-#11	1.37	7032	3508	12284	2894	15161	2279	16083	1821	16038	1144	15857	604	10839
8-#14	1.98	7126	3754	13374	3028	16448	2373	17593	1879	17999	1119	18201	478	14997
8-#18	3.52	7302	4378	16011	3371	19600	2612	21284	2026	22802	1051	23898	147	23049
9-#11	1.55	7065	3578	12768	2912	15607	2293	16559	1819	16611	1119	16599	549	11949
9-#14	2.23	7177	3854	14005	3063	17063	2401	18264	1882	18833	1088	19280	403	16290
9-#18	3.97	7402	4556	17003	3447	20627	2673	22418	2039	22654	935	25789	18	25665
10-#11	1.72	7075	3647	13364	2905	16162	2274	17070	1796	16054	1005	17053	494	13155
10-#14	2.48	7179	3955	14740	3072	17812	2390	18992	1863	18401	968	20156	351	17813
10-#18	4.41	7428	4734	18097	3499	21812	2680	23687	2029	25870	928	27399	-65	27313
11-#11	1.89	7139	3717	13311	3005	16338	2363	17448	1863	16639	1047	18105	496	14201
11-#14	2.73	7264	4055	14803	3194	18108	2497	19533	1944	20553	1089	21404	322	19152
11-#18	4.85	7577	4913	18424	3673	22436	2837	24601	2142	25409	929	29420	-138	29150
12-#11	2.06	7182	3786	13501	3068	16664	2406	17873	1899	18401	1127	18903	479	15403
12-#14	2.97	7331	4155	15101	3278	18583	2554	20135	1991	21354	1093	22512	295	20545
12-#18	5.29	7666	5091	18985	3809	23275	2927	25660	2217	28580	994	31276	-192	30937
13-#11	2.23	7224	3856	13872	3095	17078	2429	18339	1906	19011	1116	19550	433	16390
13-#14	3.22	7386	4255	15611	3321	19162	2591	20798	2003	22230	1079	23443	228	22000
13-#18	5.73	7783	5269	19848	3895	24257	2999	26786	2242	30105	971	32896	-313	32226
14-#11	2.41	7273	3925	14408	3099	17543	2429	18849	1903	19603	1084	20199	386	17444
14-#14	3.47	7446	4356	16202	3354	19812	2600	21512	2005	23094	1037	24393	165	23294
14-#18	6.17	7982	5447	20757	3971	25380	3032	28015	2256	31632	905	34568	-420	33570
15-#11	2.58	7290	3995	14485	3178	17816	2494	19232	1947	20193	1110	21002	367	18424
15-#14	3.72	7477	4456	16488	3439	20221	2684	22066	2061	22313	996	25495	130	24747
15-#18	6.61	8045	5626	21371	4100	26085	3159	28973	2340	32989	945	36547	-476	35149
16-#11	2.75	7310	4064	14740	3227	18169	2532	19665	1978	20766	1111	21808	338	19416
16-#14	3.97	7517	4556	16879	3507	20720	2734	22679	2102	24712	1066	26624	87	26048
17-#11	2.92	7374	4134	15065	3266	18554	2559	20126	1988	21376	1103	22512	306	20445
17-#14	4.21	7614	4656	17322	3565	21273	2775	23335	2118	25584	1056	27629	41	27383
18-#11	3.09	7395	4203	15504	3287	18992	2568	20622	1993	21977	1078	23160	251	21417
18-#14	4.46	7642	4757	17899	3601	21881	2794	24040	2130	26453	1023	28565	-36	28501
19-#11	3.26	7440	4273	15644	3353	19297	2623	21021	2029	22558	1096	23955	239	22438
19-#14	4.71	7712	4857	18149	3689	22329	2866	24605	2175	27261	1043	29673	-58	29547
20-#11	3.44	7489	4342	15911	3398	19660	2657	21457	2057	23131	1094	24677	204	23374
20-#14	4.96	7787	4957	18542	3753	22858	2915	25224	2214	28146	1057	30690	-112	30426

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
21-#11	3.61	7521	4412	16267	3434	20056	2680	21916	2069	22181	1021	25449	181	24336
22-#11	3.78	7558	4481	16632	3466	20467	2701	22397	2078	22767	1008	26149	142	25329
23-#11	3.95	7606	4551	16855	3521	20801	2744	22811	2109	24945	1086	26887	115	26237
24-#11	4.12	7636	4620	17102	3571	21143	2782	23250	2135	25541	1089	27642	89	27173
25-#11	4.30	7701	4690	17438	3607	21542	2807	23704	2148	26126	1079	28331	48	28057

ROUND SPIRAL COLUMNS 36" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.33	8414	3911	15974	3008	18496	2340	19100	1849	18689	1121	17678	568	12649
6-#18	2.36	8672	4379	18291	3239	21218	2487	22276	1926	22841	1029	22162	294	20383
7-#11	1.07	8295	3796	14210	3134	17349	2476	18251	1980	16674	1185	17429	728	10384
7-#14	1.55	8406	4011	15278	3247	18584	2556	19691	2027	19732	1245	19679	617	14199
7-#18	2.75	8605	4557	17768	3552	21614	2763	23205	2147	24320	1176	25167	326	22763
8-#11	1.23	8342	3865	14207	3221	17624	2541	18691	2035	18552	1298	18263	720	11664
8-#14	1.77	8460	4111	15384	3355	19013	2635	20317	2095	20669	1275	20804	597	16158
8-#18	3.14	8684	4735	18239	3699	22417	2876	24326	2246	24145	1131	27002	275	25273
9-#11	1.38	8375	3935	14745	3236	18111	2553	19203	2032	19164	1273	19058	665	12924
9-#14	1.99	8504	4212	16082	3387	19682	2661	21048	2097	21563	1243	21964	522	17651
9-#18	3.54	8758	4914	19328	3773	23533	2936	25558	2258	27452	1163	29047	147	27979
10-#11	1.53	8392	4005	15418	3223	18713	2529	19765	2005	19786	1227	19531	609	14182
10-#14	2.21	8520	4312	16901	3390	20503	2646	21842	2074	21002	1111	22711	449	19502
10-#18	3.93	8822	5092	20525	3819	24855	2940	26929	2245	29168	1087	30777	65	30361
11-#11	1.69	8465	4074	15317	3330	18897	2624	20160	2078	20474	1277	20684	614	15378
11-#14	2.43	8618	4412	16926	3519	20805	2759	22407	2160	23417	1246	24260	444	20868
11-#18	4.32	8985	5270	20853	4001	25484	3103	27916	2364	30641	1160	32979	-3	32972
12-#11	1.84	8510	4144	15517	3396	19243	2669	20617	2115	21095	1284	21552	599	16626
12-#14	2.65	8691	4513	17246	3606	21313	2818	23055	2208	24284	1252	25466	419	22443
12-#18	4.72	9071	5448	21451	4140	26386	3195	29052	2441	29968	1084	35001	-55	34901
13-#11	1.99	8561	4213	15918	3421	19688	2692	21120	2121	20299	1188	22246	552	17748
13-#14	2.87	8740	4613	17793	3648	21940	2855	23771	2220	25225	1238	26468	353	23943
13-#18	5.11	9191	5627	22371	4224	27449	3266	30275	2466	33753	1139	36751	-174	36369
14-#11	2.15	8623	4283	16515	3422	20191	2689	21670	2116	20888	1156	22941	505	19007
14-#14	3.09	8829	4713	18563	3661	22635	2861	24558	2222	26151	1195	27489	289	25405
14-#18	5.50	9399	5805	23372	4298	28646	3297	31603	2480	35397	1073	38563	-281	37948
15-#11	2.30	8633	4352	16575	3505	20476	2757	22081	2164	23023	1267	23816	488	20048
15-#14	3.32	8845	4813	18736	3767	23068	2948	25137	2280	25231	1146	28687	257	27010
15-#18	5.89	9431	5983	24013	4431	29423	3429	32637	2567	34410	1042	40710	-332	39637
16-#11	2.45	8665	4422	16836	3554	20863	2797	22546	2196	23640	1269	24690	460	21171
16-#14	3.54	8909	4914	19140	3835	23616	3000	25797	2322	27902	1228	29913	215	28372
16-#18	6.29	9567	6161	24783	4547	30360	3513	33783	2636	35797	1036	42627	-431	41364
17-#11	2.61	8730	4491	17192	3593	21270	2822	23043	2206	24295	1261	25447	429	22245
17-#14	3.76	8992	5014	19625	3893	24200	3040	26504	2338	28840	1218	30996	170	29890
18-#11	2.76	8760	4561	17683	3613	21746	2830	23566	2209	24940	1236	26144	374	23326
18-#14	3.98	9044	5114	20267	3928	24860	3058	27263	2349	29773	1185	32006	93	31339

ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
19-#11	2.91	8803	4630	17813	3681	22070	2887	24004	2247	23864	1171	27004	364	24409
19-#14	4.20	9119	5214	20513	4018	25337	3132	27873	2396	30648	1207	33203	74	32752
20-#11	3.07	8863	4700	18097	3727	22449	2922	24476	2276	26186	1254	27784	330	25436
20-#14	4.42	9197	5315	20932	4082	25893	3181	28539	2436	31521	1204	34303	22	34195
21-#11	3.22	8894	4769	18483	3762	22885	2945	24962	2287	25076	1171	28617	308	26530
21-#14	4.64	9258	5415	21468	4135	26498	3215	29242	2454	30328	1125	35488	-9	35466
22-#11	3.37	8947	4839	18877	3793	23332	2965	25476	2296	27541	1240	29368	268	27544
22-#14	4.86	9328	5515	22004	4185	27121	3248	29977	2470	33463	1186	36571	-65	36406
23-#11	3.52	8974	4908	19109	3849	23679	3009	25922	2328	26262	1165	30171	243	28581
24-#11	3.68	9007	4978	19379	3901	24045	3048	26405	2356	28780	1252	30986	218	29647
25-#11	3.83	9075	5047	19736	3936	24476	3073	26883	2368	29408	1241	31731	177	30651
26-#11	3.98	9112	5117	20108	3971	24925	3097	27393	2380	28075	1147	32478	143	31645
27-#11	4.14	9161	5186	20409	4017	25277	3136	27844	2409	28634	1152	33355	117	32621

ROUND SPIRAL COLUMNS 38" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.19	9868	4289	18393	3330	21351	2596	22023	2058	21419	1270	20205	681	13532
6-#18	2.12	10147	4757	20896	3561	24286	2744	25445	2137	24164	1102	25055	413	22342
7-#14	1.39	9878	4389	17507	3587	21389	2829	22653	2252	22583	1406	22420	738	15284
7-#18	2.47	10125	4935	20188	3893	24644	3037	26448	2374	25687	1251	28352	455	24746
8-#11	1.10	9800	4243	16322	3566	20347	2818	21574	2262	21323	1461	20904	842	12493
8-#14	1.59	9943	4489	17589	3700	21836	2913	23316	2322	22023	1344	23643	722	17324
8-#18	2.82	10219	5113	20662	4045	25493	3155	27619	2475	27248	1289	30342	408	27570
9-#11	1.24	9834	4313	16919	3580	20877	2828	22124	2257	21972	1435	21750	787	13915
9-#14	1.79	9987	4590	18356	3731	22562	2937	24101	2323	24549	1407	24883	646	19006
9-#18	3.17	10295	5291	21851	4117	26701	3213	28975	2489	28830	1243	32541	279	30393
10-#11	1.38	9856	4382	17676	3560	21529	2798	22736	2227	21118	1294	22239	729	15219
10-#14	1.98	10011	4690	19267	3727	23445	2915	24968	2297	23841	1261	25667	572	21007
10-#18	3.53	10372	5470	23158	4156	28162	3215	30448	2472	30538	1170	34385	198	33016
11-#11	1.51	9940	4452	17518	3674	21715	2900	23148	2304	21819	1344	23497	737	16566
11-#14	2.18	10122	4790	19245	3863	23763	3037	25558	2388	26539	1411	27351	572	22600
11-#18	3.88	10515	5648	23463	4347	28793	3382	31498	2596	32027	1243	36773	135	35953
12-#11	1.65	9986	4521	17725	3742	22080	2947	23637	2344	24047	1448	24437	723	17861
12-#14	2.38	10182	4890	19585	3953	24302	3097	26252	2438	25640	1324	28655	548	24397
12-#18	4.23	10638	5826	24113	4489	29757	3477	32695	2675	33502	1246	38963	85	38372
13-#11	1.79	10042	4591	18158	3766	22553	2969	24176	2349	24744	1437	25178	677	19124
13-#14	2.58	10258	4991	20170	3993	24973	3133	27019	2450	26579	1311	29727	482	25955
13-#18	4.59	10767	6004	25090	4571	30903	3548	34024	2701	35148	1226	40843	-32	40772
14-#11	1.93	10122	4661	18820	3765	23100	2963	24755	2341	25414	1402	25915	629	20436
14-#14	2.78	10364	5091	21018	4004	25719	3136	27861	2449	29463	1361	30819	418	27573
14-#18	4.94	10991	6183	26187	4642	32171	3575	35468	2714	36791	1164	42793	-138	42499

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 38" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#11	2.06	10131	4730	18859	3851	23396	3035	25206	2393	26109	1433	26865	614	21627
15-#14	2.98	10380	5191	21178	4113	26174	3227	28484	2510	30416	1397	32116	389	29229
15-#18	5.29	11008	6361	26850	4780	33016	3712	36555	2803	41005	1293	44940	-204	44422
16-#11	2.20	10169	4800	19125	3901	23810	3076	25703	2425	26772	1435	27808	587	22955
16-#14	3.17	10423	5291	21594	4182	26771	3281	29191	2554	29260	1305	33438	347	30756
16-#18	5.64	11134	6539	27651	4896	34026	3799	37777	2874	39762	1203	47184	-283	46340
17-#11	2.34	10240	4869	19511	3939	24246	3101	26232	2435	27472	1428	28617	557	24072
17-#14	3.37	10523	5392	22121	4240	27386	3320	29950	2570	30197	1295	34598	304	32468
17-#18	6.00	11287	6717	28521	5003	35116	3874	39090	2905	44352	1273	49204	-363	48120
18-#11	2.48	10262	4939	20059	3958	24761	3107	26786	2437	28159	1402	29362	501	25285
18-#14	3.57	10558	5492	22833	4274	28100	3336	30748	2579	33350	1355	35682	227	33939
19-#11	2.61	10324	5008	20176	4027	25118	3160	27255	2476	26913	1328	30288	494	26398
19-#14	3.77	10642	5592	23071	4366	28605	3413	31413	2629	34292	1379	36970	210	35531
20-#11	2.75	10389	5078	20475	4074	25498	3201	27770	2507	29499	1422	31127	460	27550
20-#14	3.97	10744	5693	23515	4431	29187	3462	32131	2670	32881	1285	38152	160	37155
21-#11	2.89	10428	5147	20892	4109	25966	3225	28281	2518	30199	1417	31956	431	28712
21-#14	4.17	10810	5793	24094	4483	29848	3497	32872	2687	36271	1378	39427	129	38634
22-#11	3.03	10468	5217	21318	4139	26457	3244	28831	2526	28883	1314	32823	399	29812
22-#14	4.36	10910	5893	24668	4531	30521	3529	33657	2702	37307	1359	40586	74	40180
23-#11	3.16	10516	5286	21556	4197	26816	3289	29309	2559	29482	1323	33692	375	31000
23-#14	4.56	10958	5993	25049	4609	31058	3589	34334	2746	38206	1368	41795	35	41579
24-#11	3.30	10554	5356	21848	4249	27207	3328	29818	2587	32277	1422	34567	351	32069
25-#11	3.44	10617	5425	22226	4284	27670	3353	30338	2600	32949	1411	35368	311	33198
26-#11	3.58	10669	5495	22632	4318	28145	3376	30885	2612	33667	1399	36167	277	34321
27-#11	3.71	10709	5564	22947	4365	28527	3418	31367	2641	34310	1405	37110	253	35400
28-#11	3.85	10777	5634	23271	4409	28928	3456	31866	2668	34997	1409	37906	223	36481

ROUND SPIRAL COLUMNS 40" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.07	11479	4687	21046	3669	24490	2866	25236	2279	22783	1332	22965	799	14416
6-#18	1.91	11799	5155	23738	3901	27640	3015	28904	2360	29200	1341	28180	536	24234
7-#14	1.25	11500	4787	19945	3947	24470	3118	25900	2488	23990	1470	25406	866	16372
7-#18	2.23	11803	5333	22931	4237	27950	3325	29982	2613	30993	1514	31783	588	26783
8-#14	1.43	11582	4888	19996	4065	24933	3206	26606	2562	25009	1505	26730	853	18498
8-#18	2.55	11914	5512	23290	4410	28844	3449	31203	2717	32790	1557	33931	545	29939
9-#11	1.12	11448	4711	19295	3942	23916	3119	25335	2495	25051	1605	24689	914	14921
9-#14	1.61	11626	4988	20837	4093	25716	3227	27445	2561	27805	1579	28048	776	20379
9-#18	2.86	11992	5690	24583	4480	30144	3505	32660	2730	32290	1407	36282	416	32822
10-#11	1.24	11476	4781	20148	3915	24622	3082	25998	2461	25734	1553	25191	854	16265
10-#14	1.79	11658	5088	21848	4083	26664	3200	28386	2532	28853	1519	28867	700	22465
10-#18	3.18	12018	5868	26009	4512	31711	3501	34259	2710	36540	1427	37874	298	35744

ROUND SPIRAL COLUMNS 40" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#11	1.37	11570	4850	19924	4037	24808	3192	26428	2544	26552	1612	26558	867	17772
11-#14	1.97	11783	5189	21769	4227	26996	3329	28999	2627	29931	1585	30689	704	24246
11-#18	3.50	12242	6046	26281	4711	32378	3677	35350	2839	38260	1511	40816	277	38773
12-#11	1.49	11618	4920	20126	4107	25191	3241	26949	2585	27264	1621	27570	854	19111
12-#14	2.15	11846	5289	22127	4319	27565	3391	29740	2680	28869	1488	32093	682	26323
12-#18	3.82	12331	6225	26979	4857	33402	3774	36629	2920	39954	1516	43174	229	41462
13-#11	1.61	11682	4989	20602	4130	25692	3261	27523	2589	26143	1502	28357	808	20523
13-#14	2.33	11934	5389	22752	4358	28273	3426	30559	2691	32001	1580	33235	617	27991
13-#18	4.14	12512	6403	28015	4937	34632	3845	38051	2946	41836	1495	45184	114	44451
14-#11	1.74	11779	5059	21333	4125	26284	3252	28131	2579	28717	1573	29136	759	21881
14-#14	2.51	12059	5489	23683	4365	29079	3426	31443	2687	30843	1433	34395	552	29798
14-#18	4.46	12754	6581	29438	4975	35973	3868	39626	2959	43711	1428	47270	7	47215
15-#11	1.86	11786	5128	21343	4215	26589	3328	28619	2633	27502	1499	30163	746	23212
15-#14	2.69	12075	5590	23825	4478	29554	3521	32122	2753	34070	1573	35793	525	31496
15-#18	4.77	12766	6759	29894	5147	36866	4009	40757	3051	45413	1478	49580	-55	49441
16-#11	1.99	11831	5198	21616	4267	27020	3369	29152	2667	30171	1610	31175	720	24599
16-#14	2.86	12123	5690	24252	4548	30191	3577	32876	2798	32732	1470	37212	485	33199
16-#18	5.09	12891	6938	30724	5264	37966	4099	42062	3123	47123	1475	51993	-132	51630
17-#11	2.11	11906	5267	22034	4304	27495	3394	29706	2676	28859	1496	32037	690	25858
17-#14	3.04	12232	5790	24820	4605	30847	3615	33680	2813	36139	1566	38450	442	34980
17-#18	5.41	13039	7116	31661	5371	39110	4172	43466	3154	48992	1460	54153	-210	53511
18-#11	2.23	11932	5337	22633	4321	28051	3399	30296	2677	31648	1576	32828	634	27247
18-#14	3.22	12273	5890	25605	4638	31614	3630	34523	2820	37198	1532	39606	365	36601
18-#18	5.73	13149	7294	32872	5442	40399	4211	44969	3180	47475	1313	56194	-342	55047
19-#11	2.36	12004	5406	22742	4393	28421	3454	30797	2718	32375	1598	33821	629	28432
19-#14	3.40	12366	5991	25833	4732	32172	3700	35233	2873	38208	1558	40985	351	38411
20-#11	2.48	12073	5476	23056	4441	28820	3496	31350	2750	33079	1598	34719	596	29714
20-#14	3.58	12438	6091	26302	4798	32754	3758	36014	2915	36596	1453	42251	302	40034
21-#11	2.61	12114	5545	23500	4475	29321	3519	31891	2760	33828	1593	35605	568	30908
21-#14	3.76	12526	6191	26923	4850	33461	3793	36790	2932	40276	1550	43516	261	41690
22-#11	2.73	12167	5615	23964	4504	29856	3538	32478	2767	34623	1584	36526	536	32132
22-#14	3.94	12611	6291	27539	4897	34196	3825	37628	2946	41423	1539	44850	217	43409
23-#11	2.86	12209	5684	24205	4563	30227	3584	32986	2802	35309	1594	37461	512	33382
23-#14	4.12	12662	6392	27933	4976	34752	3885	38351	2991	42385	1550	46151	180	44973
24-#11	2.98	12262	5754	24510	4616	30643	3624	33520	2831	36040	1599	38397	489	34545
24-#14	4.30	12750	6492	28387	5050	35350	3941	39124	3031	40532	1452	47474	145	46591
25-#11	3.10	12321	5824	24920	4651	31137	3649	34081	2844	34309	1483	39254	449	35807
25-#14	4.48	12873	6592	28952	5102	36049	3978	39913	3051	44451	1541	48695	87	48120
26-#11	3.23	12362	5893	25361	4684	31639	3671	34667	2855	35023	1472	40104	416	36952
27-#11	3.35	12421	5963	25683	4732	32045	3713	35172	2885	38211	1584	41114	393	38157
28-#11	3.48	12504	6032	26025	4777	32477	3753	35704	2912	38941	1588	41968	364	39353
29-#11	3.60	12543	6102	26393	4820	32951	3778	36264	2926	39663	1579	42891	331	40526
30-#11	3.72	12583	6171	26868	4850	33441	3802	36857	2941	37732	1464	43702	291	41729

ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.73	13615	5574	26826	4258	31293	3301	32669	2593	30600	1408	31551	665	25789
7-#14	1.14	13291	5206	22602	4326	27841	3421	29453	2736	29107	1753	28650	999	17475
7-#18	2.02	13648	5752	25790	4616	31547	3629	33802	2862	34748	1694	35473	726	28660
8-#14	1.30	13386	5307	22616	4449	28318	3514	30203	2815	30273	1794	30079	990	19677
8-#18	2.31	13776	5930	26132	4794	32483	3757	35093	2971	36673	1742	37782	688	32379
9-#11	1.01	13226	5130	21885	4322	27245	3424	28852	2745	28415	1784	27889	1047	15940
9-#14	1.46	13430	5407	23531	4474	29160	3533	31095	2812	29257	1642	31474	912	21772
9-#18	2.60	13858	6109	27533	4862	33877	3812	36645	2982	38589	1692	40283	559	35309
10-#11	1.13	13261	5200	22845	4290	28007	3382	29553	2706	29124	1729	28399	985	17320
10-#14	1.62	13471	5507	24655	4457	30176	3499	32110	2779	32444	1696	32323	834	23934
10-#18	2.89	13890	6287	29086	4887	35542	3801	38377	2960	40643	1609	41961	440	38545
11-#11	1.24	13365	5269	22545	4420	28184	3499	30013	2795	28010	1672	29879	1002	18997
11-#14	1.79	13610	5607	24509	4609	30517	3636	32747	2880	33608	1767	34288	843	25915
11-#18	3.18	14139	6465	29315	5094	36253	3986	39509	3094	39658	1584	45121	424	41654
12-#11	1.35	13415	5339	22737	4491	28589	3550	30566	2838	28710	1682	30966	991	20373
12-#14	1.95	13674	5708	24867	4703	31116	3701	33534	2934	34669	1777	35793	821	28072
12-#18	3.46	14232	6643	30061	5244	37336	4085	40871	3177	44299	1705	47649	378	44628
13-#11	1.46	13487	5408	23260	4513	29118	3568	31177	2842	31557	1791	31798	945	21943
13-#14	2.11	13776	5808	25550	4741	31861	3734	34405	2944	33423	1645	37004	757	29952
13-#18	3.75	14388	6822	31157	5322	38636	4155	42384	3203	43212	1572	49788	264	47964
14-#11	1.58	13600	5478	24066	4505	29759	3557	31814	2828	30151	1636	32616	894	23343
14-#14	2.27	13921	5908	26567	4745	32729	3731	35331	2937	36913	1717	38230	691	32079
14-#18	4.04	14688	7000	32699	5356	40065	4175	44048	3213	48288	1616	52007	157	50750
15-#11	1.69	13607	5547	24038	4599	30070	3636	32332	2886	33101	1788	33722	884	24834
15-#14	2.44	13924	6008	26681	4862	33222	3829	36064	3007	38011	1758	39732	667	33811
15-#18	4.33	14704	7178	33154	5533	41005	4320	45265	3309	50108	1669	54483	98	53789
16-#11	1.80	13658	5617	24319	4651	30517	3678	32906	2922	31591	1673	34805	858	26252
16-#14	2.60	13991	6109	27122	4933	33885	3886	36868	3053	39068	1761	41250	627	35700
16-#18	4.62	14835	7356	34011	5651	42196	4413	46654	3383	51931	1669	57065	23	56885
17-#11	1.91	13738	5686	24771	4688	31032	3703	33486	2930	34644	1785	35718	829	27652
17-#14	2.76	14093	6209	27734	4990	34596	3925	37708	3068	40210	1751	42564	585	37528
17-#18	4.91	14983	7535	35016	5757	43394	4485	48150	3415	50324	1543	59366	-53	59213
18-#11	2.03	13768	5756	25420	4703	31629	3706	34114	2929	35423	1758	36554	772	29088
18-#14	2.92	14156	6309	28585	5021	35418	3938	38605	3074	38576	1602	43790	507	39377
18-#18	5.20	15089	7713	36340	5828	44772	4523	49722	3438	55909	1600	61542	-186	60900
19-#11	2.14	13843	5825	25521	4778	32007	3763	34645	2972	36188	1781	37617	769	30427
19-#14	3.09	14242	6409	28809	5117	35999	4010	39359	3128	42409	1745	45263	497	41240
19-#18	5.49	15292	7891	36892	5981	45839	4635	51026	3519	53881	1528	64030	-219	63285
20-#11	2.25	13924	5895	25848	4826	32429	3806	35223	3004	34474	1664	38574	738	31879
20-#14	3.25	14334	6510	29302	5185	36609	4069	40196	3172	43469	1744	46613	449	42975

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
21-#11	2.36	13973	5964	26319	4860	32963	3829	35807	3015	37731	1777	39517	709	33166
21-#14	3.41	14415	6610	29960	5236	37362	4104	41015	3189	44609	1738	47961	408	44819
22-#11	2.48	14032	6034	26825	4887	33536	3847	36431	3021	36011	1650	40491	677	34505
22-#14	3.57	14529	6710	30624	5281	38160	4135	41906	3202	45824	1727	49375	364	46569
23-#11	2.59	14078	6103	27068	4948	33925	3894	36969	3058	39304	1779	41493	655	35787
23-#14	3.74	14563	6810	31030	5362	38734	4197	42673	3249	46849	1739	50769	329	48320
24-#11	2.70	14121	6173	27382	5001	34365	3935	37529	3086	37410	1665	42490	633	37075
24-#14	3.90	14632	6911	31504	5437	39368	4253	43482	3289	47952	1745	52179	295	50157
25-#11	2.81	14202	6242	27826	5036	34891	3960	38124	3099	38122	1656	43403	592	38394
25-#14	4.06	14758	7011	32114	5488	40113	4290	44331	3309	49044	1731	53482	237	51794
26-#11	2.93	14246	6312	28303	5069	35421	3980	38756	3110	41657	1762	44303	560	39639
26-#14	4.22	14816	7111	32753	5539	40864	4325	45219	3327	46864	1601	54782	191	53509
27-#11	3.04	14311	6381	28630	5118	35848	4024	39283	3141	39561	1652	45309	530	40978
28-#11	3.15	14379	6451	28991	5163	36313	4065	39848	3169	40286	1656	46293	509	42227
29-#11	3.27	14432	6520	29385	5206	36810	4089	40443	3183	41000	1648	47274	477	43496
30-#11	3.38	14490	6590	29890	5236	37334	4113	41064	3196	44735	1755	48136	437	44770
31-#11	3.49	14544	6659	30146	5294	37776	4154	41606	3225	42440	1643	49174	416	45995
32-#11	3.60	14608	6729	30519	5338	38230	4192	42175	3252	43164	1647	50118	382	47292

ROUND SPIRAL COLUMNS 44" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.58	15605	6013	30174	4633	35261	3600	36755	2837	36659	1683	35180	798	27344
7-#14	1.04	15253	5645	25490	4723	31516	3739	33327	2996	32809	1940	32167	1138	18591
7-#18	1.84	15667	6191	28880	5014	35449	3948	37937	3123	36214	1758	39435	870	30503
8-#14	1.18	15362	5746	25459	4852	32003	3837	34121	3080	34039	1983	33703	1132	20863
8-#18	2.10	15813	6370	29199	5198	36425	4081	39305	3237	40855	1935	41908	836	34889
9-#14	1.33	15407	5846	26448	4873	32907	3854	35066	3074	32841	1818	35173	1053	23183
9-#18	2.37	15876	6548	30712	5262	37913	4134	40953	3246	42880	1884	44558	706	37851
10-#11	1.03	15217	5639	25779	4683	31698	3696	33425	2963	32810	1912	31875	1123	18385
10-#14	1.48	15456	5946	27698	4850	33995	3814	36138	3036	33909	1756	36049	974	25415
10-#18	2.63	15938	6726	32401	5280	39680	4116	42817	3221	45042	1798	46319	586	41419
11-#11	1.13	15329	5708	25391	4821	31860	3820	33920	3059	33758	1980	33475	1144	20180
11-#14	1.63	15610	6047	27475	5010	34336	3958	36817	3144	37585	1957	38161	986	27607
11-#18	2.89	16183	6904	32577	5495	40431	4310	43991	3361	47021	1892	49700	576	44594
12-#11	1.23	15383	5778	25570	4895	32288	3874	34505	3104	32253	1859	34637	1133	21648
12-#14	1.78	15676	6147	27828	5106	34968	4026	37649	3201	38695	1968	39769	967	29836
12-#18	3.16	16311	7083	33367	5649	41573	4412	45434	3446	48944	1902	52399	531	47869
13-#11	1.33	15465	5847	26142	4916	32847	3891	35151	3107	35396	1980	35513	1087	23383
13-#14	1.92	15783	6247	28572	5143	35752	4057	38573	3210	39913	1954	41048	902	31912
13-#18	3.42	16450	7261	34526	5725	42936	4479	47040	3471	51062	1881	54666	419	51310
14-#11	1.44	15583	5917	27028	4904	33537	3876	35818	3090	36190	1941	36368	1035	24821
14-#14	2.07	15956	6347	29681	5144	36683	4051	39541	3200	41078	1907	42338	835	34150
14-#18	3.68	16722	7439	36191	5756	44463	4497	48779	3478	49620	1691	57018	311	54363

ROUND SPIRAL COLUMNS 44" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#11	1.54	15599	5986	26958	5001	33853	3960	36366	3151	37031	1978	37556	1028	26468
15-#14	2.22	15958	6448	29758	5265	37193	4153	40316	3273	39424	1820	43946	814	36112
15-#18	3.95	16780	7617	36641	5938	45447	4646	50096	3580	51429	1744	59662	256	57796
16-#11	1.64	15658	6056	27244	5055	34315	4003	36982	3189	35303	1851	38710	1003	27925
16-#14	2.37	16034	6548	30216	5337	37880	4211	41181	3321	43356	1954	45562	775	38259
16-#18	4.21	16917	7796	37523	6056	46708	4741	51569	3655	57040	1869	62413	181	60872
17-#11	1.74	15738	6125	27731	5091	34870	4027	37587	3195	38666	1976	39674	973	29473
17-#14	2.52	16143	6648	30872	5393	38647	4249	42058	3335	44567	1945	46954	734	40125
17-#18	4.47	17120	7974	38597	6162	47980	4813	53142	3686	59145	1855	64854	107	64034
18-#11	1.85	15778	6195	28433	5104	35510	4029	38252	3193	36857	1818	40550	916	30951
18-#14	2.66	16190	6748	31785	5422	39526	4261	43009	3339	42713	1783	48249	656	42159
18-#18	4.74	17227	8152	40037	6232	49449	4849	54798	3707	61252	1801	67165	-26	67084
19-#11	1.95	15860	6264	28523	5181	35895	4088	38814	3239	40300	1973	41687	915	32431
19-#14	2.81	16309	6849	32009	5521	40122	4335	43807	3396	43769	1809	49817	647	44069
19-#18	5.00	17435	8330	40585	6387	50573	4964	56180	3791	58976	1717	69809	-55	69617
20-#11	2.05	15948	6334	28863	5231	36339	4131	39418	3271	38355	1843	42705	884	33929
20-#14	2.96	16407	6949	32524	5590	40765	4395	44681	3440	48018	1939	51251	601	45979
20-#18	5.26	17585	8509	41533	6501	51722	5063	57706	3865	65138	1836	72269	-143	71733
21-#11	2.15	16003	6403	29362	5264	36906	4153	40044	3282	41934	1969	43704	856	35360
21-#14	3.11	16496	7049	33219	5640	41565	4429	45561	3457	49223	1933	52682	560	47967
22-#11	2.26	16072	6473	29910	5290	37511	4170	40705	3287	42821	1959	44730	824	36866
22-#14	3.26	16589	7149	33936	5684	42416	4460	46505	3470	50525	1922	54176	517	49793
23-#11	2.36	16121	6542	30153	5353	37924	4219	41266	3325	43600	1972	45801	803	38238
23-#14	3.40	16659	7250	34352	5767	43018	4523	47317	3518	51596	1935	55664	482	51730
24-#11	2.46	16168	6612	30477	5406	38389	4261	41858	3354	41462	1846	46859	782	39658
24-#14	3.55	16736	7350	34841	5842	43688	4581	48161	3558	52766	1942	57161	450	53602
25-#11	2.56	16259	6682	30956	5441	38940	4285	42489	3367	45231	1968	47827	741	41010
25-#14	3.70	16848	7450	35499	5894	44478	4618	49061	3578	53922	1928	58544	392	55477
26-#11	2.67	16306	6751	31471	5472	39505	4305	43166	3378	46076	1955	48777	709	42381
26-#14	3.85	16932	7550	36186	5944	45267	4651	50015	3597	55161	1913	59920	346	57402
27-#11	2.77	16369	6821	31801	5523	39953	4350	43715	3409	46859	1964	49847	681	43782
27-#14	4.00	17013	7651	36715	6011	45924	4711	50809	3638	52499	1793	61420	302	59152
28-#11	2.87	16449	6890	32179	5568	40444	4391	44313	3437	44507	1838	50895	660	45127
28-#14	4.14	17116	7751	37270	6075	46629	4768	51662	3677	57417	1927	62900	271	60938
29-#11	2.98	16501	6960	32599	5611	40971	4415	44944	3452	48488	1960	51932	628	46524
30-#11	3.08	16574	7029	33136	5640	41529	4439	45593	3464	49335	1950	52845	588	47826
31-#11	3.18	16621	7099	33402	5699	41993	4481	46170	3494	50118	1956	53949	568	49180
32-#11	3.28	16675	7168	33796	5744	42467	4519	46777	3521	47554	1830	54952	535	50519
33-#11	3.39	16751	7238	34252	5781	43007	4545	47393	3536	51749	1952	55971	507	51830
34-#11	3.49	16819	7307	34707	5817	43572	4572	48036	3550	52596	1943	57069	478	53206

ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.44	17775	6473	33793	5026	39558	3913	41177	3093	40835	1866	39079	936	28901
7-#18	1.68	17867	6651	32212	5430	39670	4282	42409	3397	43167	2081	43682	1019	32364
8-#14	1.08	17518	6205	28535	5274	36005	4176	38375	3357	38119	2181	37616	1281	22056
8-#18	1.93	18032	6829	32500	5620	40682	4421	43854	3515	45341	2136	46323	989	36946
9-#14	1.22	17563	6306	29602	5292	36971	4190	39375	3350	39338	2145	39156	1201	24612
9-#18	2.17	18095	7007	34121	5681	42268	4471	45597	3523	47485	2084	49119	859	40301
10-#14	1.35	17622	6406	30989	5262	38134	4143	40495	3305	37827	1936	40056	1119	26907
10-#18	2.41	18169	7186	35965	5691	44140	4446	47595	3494	46435	1862	50958	737	44365
11-#11	1.03	17475	6168	28472	5241	35852	4158	38163	3335	35265	2026	37280	1284	21343
11-#14	1.49	17791	6506	30677	5430	38467	4295	41223	3421	41859	2155	42322	1136	29338
11-#18	2.65	18437	7364	36077	5916	44926	4649	48809	3639	48408	1955	54566	733	47594
12-#11	1.13	17532	6237	28636	5317	36303	4214	38780	3382	38667	2191	38597	1282	22937
12-#14	1.62	17859	6606	31022	5529	39135	4366	42101	3480	43036	2168	44034	1118	31617
12-#18	2.89	18576	7542	36881	6072	46126	4753	50334	3727	53894	2107	57438	690	51184
13-#11	1.22	17622	6307	29259	5337	36892	4229	39455	3384	39549	2178	39516	1236	24753
13-#14	1.76	17978	6707	31829	5565	39960	4395	43078	3488	44318	2153	45379	1054	33900
13-#18	3.13	18727	7720	38131	6147	47552	4819	52033	3752	56139	2086	59833	579	54711
14-#11	1.31	17755	6376	30230	5322	37634	4211	40159	3364	40389	2137	40406	1183	26316
14-#14	1.90	18174	6807	33036	5562	40956	4386	44088	3474	45557	2105	46731	985	36209
14-#18	3.37	19016	7899	39926	6175	49180	4833	53847	3755	58352	2015	62314	470	58053
15-#11	1.41	17773	6446	30111	5423	37952	4298	40736	3429	41276	2177	41678	1177	28090
15-#14	2.03	18174	6907	33070	5687	41479	4493	44906	3551	46776	2150	48448	967	38365
15-#18	3.61	19048	8077	40352	6361	50206	4987	55260	3862	60413	2075	65129	418	61822
16-#11	1.50	17839	6516	30402	5479	38429	4342	41395	3468	42117	2183	42904	1153	29618
16-#14	2.17	18260	7007	33542	5761	42191	4551	45831	3602	47958	2155	50164	929	40704
16-#18	3.85	19237	8255	41270	6480	51515	5083	56820	3939	62453	2077	68051	345	64939
17-#11	1.60	17923	6585	30924	5514	39021	4367	42026	3474	40135	2030	43919	1124	31321
17-#14	2.30	18375	7108	34244	5816	43014	4589	46745	3614	45952	2003	51631	888	42766
17-#18	4.09	19400	8433	42414	6586	52883	5155	58459	3969	64687	2063	70632	272	68418
18-#11	1.69	17969	6655	31682	5523	39708	4366	42728	3469	40930	2003	44833	1067	32837
18-#14	2.44	18428	7208	35223	5842	43950	4599	47750	3617	50505	2111	52991	810	45001
18-#18	4.33	19468	8612	43956	6654	54445	5190	60210	3989	66910	2009	73076	139	71827
19-#11	1.78	18060	6724	31759	5604	40099	4427	43320	3518	44727	2173	46046	1066	34465
19-#14	2.57	18560	7308	35443	5945	44560	4676	48592	3676	48247	1998	54659	803	46952
19-#18	4.57	19781	8790	44514	6811	55616	5307	61671	4075	68962	2050	75877	113	75073
20-#11	1.88	18141	6794	32111	5655	40565	4471	43949	3550	45567	2176	47124	1037	36004
20-#14	2.71	18665	7409	35980	6014	45237	4736	49502	3721	52881	2142	56178	758	49043
20-#18	4.81	19932	8968	45509	6927	56815	5407	63299	4150	71014	2047	78484	27	78321
21-#11	1.97	18215	6863	32637	5687	41165	4494	44614	3561	46452	2170	48179	1008	37575
21-#14	2.84	18763	7509	36711	6064	46084	4770	50444	3738	54152	2136	57692	718	51082
21-#18	5.05	20117	9146	46761	7021	58271	5472	64891	4182	73239	2037	81121	-44	80957

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.07	18294	6933	33231	5711	41804	4508	45316	3566	44150	2004	49100	962	39126
22-#14	2.98	18866	7609	37484	6106	46979	4799	51441	3750	55507	2124	59264	674	53081
22-#18	5.30	20378	9325	47976	7111	59796	5536	66628	4212	70589	1888	83913	-118	82910
23-#11	2.16	18346	7002	33472	5776	42239	4560	45900	3604	48203	2173	50398	956	40635
23-#14	3.11	18926	7709	37907	6191	47618	4865	52286	3799	56659	2139	60847	641	55191
24-#11	2.25	18399	7072	33804	5830	42728	4602	46524	3634	49081	2180	51517	936	42209
24-#14	3.25	19026	7810	38412	6266	48323	4923	53177	3840	57894	2147	62432	609	57112
25-#11	2.35	18490	7141	34313	5865	43305	4625	47190	3647	49920	2170	52541	895	43664
25-#14	3.38	19128	7910	39117	6318	49150	4959	54127	3860	59115	2133	63896	552	59172
26-#11	2.44	18549	7211	34872	5895	43905	4645	47897	3657	50810	2156	53540	863	45218
26-#14	3.52	19194	8010	39854	6368	49987	4992	55148	3879	60403	2117	65346	506	61135
27-#11	2.53	18617	7280	35204	5947	44373	4691	48484	3690	51638	2166	54675	836	46610
27-#14	3.66	19324	8110	40393	6436	50676	5053	55973	3921	61566	2127	66936	464	63104
28-#11	2.63	18703	7350	35600	5993	44884	4732	49116	3718	52524	2172	55785	816	48083
28-#14	3.79	19433	8211	40975	6500	51421	5111	56874	3960	62806	2134	68506	433	65148
29-#11	2.72	18763	7419	36046	6035	45448	4757	49780	3733	53358	2163	56879	785	49516
29-#14	3.93	19528	8311	41596	6563	52210	5147	57823	3982	64019	2121	70073	388	66983
30-#11	2.82	18824	7489	36616	6063	46040	4780	50458	3744	54250	2152	57843	744	50941
31-#11	2.91	18893	7558	36888	6123	46520	4822	51067	3775	55078	2159	59012	725	52409
32-#11	3.00	18952	7628	37306	6169	47018	4861	51716	3803	55949	2164	60076	692	53792
33-#11	3.10	19035	7697	37784	6205	47589	4887	52358	3817	56799	2155	61152	665	55251
34-#11	3.19	19084	7767	38271	6241	48187	4913	53036	3831	53846	2004	62310	636	56636
35-#11	3.29	19167	7836	38630	6293	48685	4947	53651	3860	58553	2158	63365	612	58048
36-#11	3.38	19253	7906	38988	6343	49213	4979	54290	3887	59381	2156	64494	586	59473

ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.33	20133	6953	37695	5436	44199	4240	45951	3361	42305	1920	43261	1080	30458
7-#18	1.55	20257	7131	35795	5865	44224	4630	47233	3683	47859	2286	48227	1174	34245
8-#18	1.77	20441	7309	36045	6061	45270	4775	48755	3806	50134	2344	51039	1148	38997
9-#14	1.12	19909	6786	33004	5730	41367	4541	44035	3638	43802	2350	43438	1355	26060
9-#18	1.99	20504	7488	37773	6119	46955	4822	50594	3812	52418	2293	53980	1017	42669
10-#14	1.24	19976	6886	34537	5692	42609	4487	45204	3587	45052	2276	44358	1270	28411
10-#18	2.21	20592	7666	39788	6122	48935	4790	52700	3777	54786	2200	55893	894	47296
11-#14	1.37	20160	6986	34124	5870	42928	4648	45981	3710	46409	2353	46665	1282	31075
11-#18	2.43	20884	7844	39823	6355	49746	5002	53980	3930	57038	2305	59733	894	50653
12-#11	1.03	19869	6718	31944	5759	40647	4569	43407	3673	43107	2398	42859	1437	24238
12-#14	1.49	20231	7086	34458	5970	43633	4721	46905	3771	47707	2376	48600	1275	33414
12-#18	2.65	20987	8022	40636	6513	51009	5110	55586	4020	59149	2318	62779	853	54574
13-#11	1.12	19968	6787	32621	5777	41266	4582	44111	3673	44030	2384	43820	1390	26133
13-#14	1.62	20362	7187	35331	6005	44498	4748	47923	3778	49052	2361	50012	1211	35914
13-#18	2.87	21198	8201	41983	6588	52500	5174	57378	4044	61538	2298	65300	743	58174
14-#11	1.21	20115	6857	33681	5758	42063	4561	44852	3650	44901	2342	44742	1336	27845
14-#14	1.74	20576	7287	36641	5998	45562	4736	48987	3761	47004	2157	51422	1141	38288
14-#18	3.09	21503	8379	43912	6612	54230	5185	59268	4044	63868	2226	67910	633	61820
15-#11	1.29	20135	6926	33508	5864	42381	4652	45459	3719	42793	2225	46102	1333	29673
15-#14	1.87	20580	7387	36627	6128	46096	4847	49848	3842	51641	2359	53251	1126	40648
15-#18	3.32	21548	8557	44305	6802	55296	5343	60757	4154	66035	2289	70898	585	65686
16-#11	1.38	20209	6996	33802	5921	42872	4697	46154	3759	46738	2391	47400	1309	31330
16-#14	1.99	20676	7488	37112	6203	46831	4906	50834	3894	52889	2365	55068	1088	43077
16-#18	3.54	21680	8735	45260	6923	56653	5439	62424	4235	68172	2291	73991	513	69086
17-#11	1.47	20297	7065	34361	5955	43499	4721	46816	3764	47667	2383	48465	1280	33135
17-#14	2.11	20798	7588	37860	6257	47707	4944	51785	3906	54231	2356	56611	1048	45311
17-#18	3.76	21881	8913	46476	7028	58117	5513	64129	4263	65833	2127	76711	441	72897
18-#11	1.55	20349	7135	35179	5962	44238	4719	47556	3758	48546	2352	49415	1223	34746
18-#14	2.24	20857	7688	38908	6281	48707	4952	52843	3907	55545	2319	58030	969	47742
18-#18	3.98	21997	9092	48111	7094	59772	5545	65975	4282	72895	2224	79288	308	76354
19-#11	1.64	20448	7204	35235	6046	44632	4782	48178	3809	46184	2223	50707	1224	36543
19-#14	2.36	20991	7788	39121	6387	49329	5031	53729	3969	56821	2352	59803	965	49884
19-#18	4.20	22229	9270	48688	7255	60979	5665	67514	4371	75039	2267	82248	286	79906
20-#11	1.72	20534	7274	35600	6098	45119	4827	48832	3842	50370	2385	51846	1196	38104
20-#14	2.49	21114	7889	39679	6457	50039	5092	54675	4013	58073	2354	61407	921	52169
20-#18	4.42	22434	9448	49729	7372	62240	5766	69208	4446	77198	2265	85002	202	83616
21-#11	1.81	20616	7343	36156	6129	45754	4849	49533	3853	47870	2220	52957	1167	39822
21-#14	2.61	21206	7989	40448	6506	50933	5126	55676	4031	55450	2191	63004	880	54251
21-#18	4.64	22680	9626	51041	7465	63776	5831	70909	4479	79544	2256	87789	131	86835

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 6,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.90	20707	7413	36798	6152	46426	4862	50280	3856	52180	2355	53920	1120	41413
22-#14	2.74	21337	8089	41278	6547	51872	5153	56730	4042	60714	2317	64418	816	56432
22-#18	4.86	22950	9805	52338	7553	65395	5893	72741	4509	82091	2242	90728	57	90345
23-#11	1.98	20754	7482	37033	6218	46882	4916	50885	3896	53132	2382	55296	1115	43063
23-#14	2.86	21400	8189	41705	6634	52548	5222	57607	4092	57907	2194	66333	804	58616
23-#18	5.08	23056	9983	53240	7690	66591	5997	74310	4587	78527	2108	93557	-9	93521
24-#11	2.07	20819	7552	37372	6273	47396	4958	51542	3926	54068	2390	56477	1096	44681
24-#14	2.98	21511	8290	42225	6709	53289	5280	58545	4134	63352	2360	68005	774	60687
25-#11	2.16	20918	7621	37913	6307	47999	4981	52244	3939	54939	2379	57556	1055	46283
25-#14	3.11	21617	8390	42974	6761	54152	5316	59546	4154	64621	2346	69550	717	62929
26-#11	2.24	20968	7691	38518	6337	48635	5000	52981	3948	55871	2366	58604	1023	47925
26-#14	3.23	21690	8490	43767	6810	55038	5348	60612	4171	65973	2329	71074	672	64934
27-#11	2.33	21057	7760	38850	6390	49123	5047	53605	3983	56747	2377	59804	997	49457
27-#14	3.36	21809	8590	44314	6880	55758	5410	61490	4215	67202	2341	72755	631	67088
28-#11	2.41	21148	7830	39262	6436	49653	5089	54270	4012	57671	2383	60978	977	51094
28-#14	3.48	21946	8691	44923	6944	56532	5468	62438	4255	68524	2349	74414	600	69170
29-#11	2.50	21216	7899	39735	6478	50254	5113	54961	4025	58557	2374	62129	946	52558
29-#14	3.61	22026	8791	45581	7007	57373	5505	63438	4277	69785	2335	76065	556	71238
30-#11	2.59	21282	7969	40340	6505	50880	5136	55676	4037	55527	2205	63143	906	54112
30-#14	3.73	22141	8891	46406	7050	58251	5541	64459	4296	71136	2322	77529	499	73440
31-#11	2.67	21348	8038	40616	6567	51376	5179	56316	4068	60368	2371	64378	888	55632
31-#14	3.85	22220	8991	46849	7134	58986	5599	65372	4337	72369	2330	79267	470	75358
32-#11	2.76	21421	8108	41058	6613	51899	5218	57001	4097	61275	2375	65502	855	57123
33-#11	2.84	21501	8177	41559	6649	52501	5244	57674	4111	58030	2210	66634	828	58673
34-#11	2.93	21563	8247	42079	6685	53127	5270	58389	4125	63117	2359	67853	799	60126
35-#11	3.02	21642	8316	42448	6737	53654	5304	59036	4154	59748	2212	68966	776	61670
36-#11	3.10	21745	8386	42819	6787	54209	5337	59700	4181	64887	2368	70156	751	63122
37-#11	3.19	21793	8455	43329	6825	54779	5369	60392	4196	65822	2367	71207	718	64619

ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	2.07	3337	2368	6998	1493	7247	1148	7125	875	6286	442	6158	145	5485
6-#14	2.98	3414	2548	7490	1575	7834	1203	7819	895	7145	397	7118	16	7049
6-#18	5.31	3557	3005	8654	1780	9235	1338	9479	942	9858	293	9378	-327	9332
7-#11	2.41	3330	2436	7001	1635	7456	1259	7446	966	6716	504	6924	160	6064
7-#14	3.48	3390	2646	7547	1741	8106	1331	8212	1000	8226	501	8107	24	7985
7-#18	6.19	3533	3178	8837	2011	9655	1512	10046	1082	9980	366	11066	-315	10691
8-#11	2.76	3355	2504	7132	1693	7682	1311	7732	1004	7544	544	7475	152	6752
8-#14	3.98	3423	2744	7757	1817	8420	1400	8604	1049	8119	469	8863	6	8835
8-#18	7.07	3594	3352	9226	2130	10180	1619	10688	1156	11463	383	12138	-384	11641
9-#11	3.10	3388	2572	7347	1723	7911	1322	7996	1003	7920	527	7861	89	7380
9-#14	4.48	3469	2842	8044	1865	8744	1419	8982	1051	9238	479	9412	-83	9387
9-#18	7.96	3672	3526	9686	2222	10730	1657	11338	1162	11567	320	13066	-542	12381
10-#11	3.45	3397	2639	7612	1726	8168	1323	8278	993	8264	485	8193	42	7991
10-#14	4.97	3503	2939	8393	1880	9110	1428	9395	1043	9746	423	9901	-149	9871
11-#11	3.79	3445	2707	7701	1808	8364	1382	8542	1038	8641	512	8717	9	8680
11-#14	5.47	3561	3037	8549	1986	9381	1502	9748	1098	10250	455	10608	-203	10482
12-#11	4.14	3480	2775	7860	1854	8588	1424	8817	1067	8984	508	9181	-14	9180
12-#14	5.97	3610	3135	8781	2049	9695	1559	10130	1137	10109	438	11248	-238	11104
13-#11	4.48	3511	2843	8060	1892	8818	1440	9105	1080	9396	504	9624	-59	9601
13-#14	6.47	3654	3233	9057	2104	10020	1585	10539	1156	11311	440	11876	-304	11517
14-#11	4.83	3537	2911	8300	1909	9071	1454	9375	1073	9134	449	9959	-114	9933
15-#11	5.17	3566	2978	8421	1974	9272	1498	9647	1113	9438	455	10473	-139	10390
16-#11	5.52	3592	3046	8591	2016	9496	1536	9903	1130	10483	488	11021	-163	10750

ROUND SPIRAL COLUMNS 26" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.76	4225	2709	8702	1735	9015	1339	8835	1030	8263	585	7533	232	6173
6-#14	2.54	4310	2889	9262	1818	9681	1395	9621	1053	9305	539	8633	109	8116
6-#18	4.52	4501	3345	10595	2027	11281	1535	11515	1106	11816	416	11245	-220	11213
7-#11	2.06	4232	2776	8663	1892	9252	1464	9214	1133	8809	661	8431	253	6848
7-#14	2.97	4311	2986	9290	2001	9989	1538	10082	1170	9309	583	9784	123	9080
7-#18	5.27	4501	3519	10771	2275	11757	1724	12173	1259	12785	526	13003	-224	12902
8-#11	2.35	4264	2844	8800	1954	9504	1520	9538	1175	9207	668	9058	248	7726
8-#14	3.39	4354	3084	9504	2080	10341	1610	10525	1223	10513	630	10643	110	10100
8-#18	6.03	4577	3693	11199	2399	12351	1836	12901	1338	13662	523	14418	-261	13927
9-#11	2.64	4292	2912	9047	1983	9762	1529	9833	1173	9625	651	9493	186	8370
9-#14	3.81	4401	3182	9839	2127	10706	1629	10949	1224	11116	607	11267	21	11146
9-#18	6.78	4653	3867	11729	2491	12974	1875	13636	1345	14710	484	15483	-417	15068
10-#11	2.94	4310	2980	9367	1983	10051	1527	10145	1160	10003	607	9858	139	9106
10-#14	4.24	4418	3280	10255	2139	11119	1635	11410	1214	10901	513	11813	-43	11805
10-#18	7.53	4705	4041	12371	2531	13684	1904	14453	1341	15717	391	16456	-531	15969
11-#11	3.23	4361	3048	9443	2070	10271	1591	10447	1210	10436	638	10459	110	9856
11-#14	4.66	4499	3378	10402	2250	11424	1715	11812	1275	12256	586	12621	-92	12560
12-#11	3.53	4406	3115	9618	2118	10522	1635	10756	1241	10823	636	10990	89	10507
12-#14	5.09	4549	3475	10658	2315	11777	1774	12243	1315	12794	580	13353	-125	13298

ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
13-#11	3.82	4436	3183	9845	2155	10781	1652	11059	1246	11283	632	11487	45	11271
13-#14	5.51	4603	3573	10972	2370	12143	1800	12702	1335	13449	575	14060	-189	13915
14-#11	4.11	4482	3251	10113	2170	11065	1663	11380	1246	11717	608	11865	-9	11863
14-#14	5.93	4691	3671	11345	2399	12546	1822	13137	1328	13139	507	14604	-266	14358
15-#11	4.41	4503	3319	10250	2239	11291	1711	11687	1288	12087	618	12448	-31	12433
16-#11	4.70	4545	3387	10438	2283	11542	1750	11975	1307	12505	620	13069	-54	12897
17-#11	5.00	4583	3455	10667	2314	11801	1770	12296	1323	12892	603	13481	-100	13403
18-#11	5.29	4608	3522	10898	2344	12080	1788	12603	1321	13327	585	13966	-148	13819

ROUND SPIRAL COLUMNS 28" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.52	5254	3076	10661	1997	11048	1545	10798	1198	10005	705	9090	324	6789
6-#14	2.19	5355	3256	11288	2080	11793	1602	11676	1222	11169	661	10330	205	9238
6-#18	3.90	5591	3713	12792	2292	13594	1746	13805	1280	13057	508	13297	-111	13283
7-#11	1.77	5276	3144	10568	2171	11314	1685	11240	1313	9935	737	10131	352	7588
7-#14	2.56	5375	3354	11266	2280	12138	1761	12210	1352	11946	757	11655	226	10250
7-#18	4.55	5586	3887	12952	2559	14128	1951	14560	1447	15101	667	15307	-107	15287
8-#11	2.03	5316	3212	10708	2238	11584	1744	11605	1359	10355	747	10684	331	8644
8-#14	2.92	5429	3452	11493	2364	12529	1837	12707	1409	12553	765	12403	190	11422
8-#18	5.20	5673	4061	13388	2686	14790	2068	15377	1531	15015	623	16897	-137	16428
9-#11	2.28	5343	3280	10989	2265	11879	1753	11929	1356	10783	731	11320	288	9397
9-#14	3.29	5469	3550	11873	2410	12936	1854	13177	1410	12337	693	13317	129	12507
9-#18	5.85	5784	4234	14005	2778	15486	2107	16196	1539	17253	631	18098	-292	17788
10-#11	2.53	5367	3348	11356	2259	12201	1746	12269	1340	11963	737	11716	241	10268
10-#14	3.65	5499	3648	12364	2418	13396	1857	13683	1397	13836	684	13917	65	13552
10-#18	6.50	5846	4408	14748	2816	16281	2133	17103	1533	18370	538	19184	-401	18879
11-#11	2.79	5428	3415	11427	2353	12442	1817	12611	1395	12455	772	12398	216	11043
11-#14	4.02	5584	3745	12497	2534	13734	1943	14137	1463	14487	725	14830	21	14730
11-#18	7.15	5989	4582	15079	2992	16846	2258	17828	1626	19408	591	20656	-498	19991
12-#11	3.04	5464	3483	11616	2404	12713	1862	12956	1428	12029	720	12995	196	11816
12-#14	4.38	5648	3843	12776	2601	14125	2004	14617	1506	15088	721	15656	-10	15652
13-#11	3.29	5512	3551	11870	2439	13006	1878	13291	1432	13353	760	13546	154	12653
13-#14	4.75	5699	3941	13129	2656	14533	2030	15096	1514	15814	717	16442	-72	16386
14-#11	3.55	5573	3619	12167	2451	13326	1889	13644	1431	12946	694	13965	99	13373
14-#14	5.12	5785	4039	13536	2682	14981	2051	15608	1518	16506	685	17052	-148	16962
15-#11	3.80	5594	3687	12330	2516	13570	1939	13988	1476	13335	705	14621	80	14192
15-#14	5.48	5813	4137	13761	2777	15332	2115	16080	1576	17074	697	17952	-181	17764
16-#11	4.05	5624	3754	12527	2570	13845	1979	14309	1497	13769	709	15163	39	14932
16-#14	5.85	5884	4234	14063	2839	15725	2171	16529	1602	17724	700	18706	-242	18392
17-#11	4.31	5683	3822	12773	2600	14135	1999	14664	1512	15181	743	15774	13	15701
18-#11	4.56	5713	3890	13034	2628	14452	2017	15003	1510	14617	676	16313	-34	16293
19-#11	4.81	5755	3958	13220	2683	14701	2058	15340	1547	16076	729	16851	-63	16786
20-#11	5.07	5803	4026	13418	2734	14977	2096	15663	1565	15433	682	17448	-97	17329

ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.32	6436	3471	12892	2279	13367	1767	13033	1378	11977	833	10844	421	7405
6-#14	1.91	6553	3651	13589	2363	14192	1825	14005	1403	13263	791	12224	305	10299
6-#18	3.40	6837	4108	15264	2577	16194	1972	16369	1465	16394	680	15547	1	15542
7-#11	1.54	6470	3539	12734	2471	13659	1923	13546	1507	12722	928	12039	457	8339
7-#14	2.23	6594	3749	13504	2581	14574	2000	14618	1547	14158	898	13735	335	11407
7-#18	3.96	6854	4282	15369	2861	16786	2194	17227	1647	17658	814	17821	12	17742
8-#11	1.77	6522	3607	12875	2543	13945	1985	13952	1556	13225	941	12661	439	9460
8-#14	2.55	6659	3847	13741	2669	14985	2079	15170	1608	13846	849	14572	302	12800
8-#18	4.53	6957	4456	15837	2993	17515	2316	18134	1736	18757	820	19589	-11	19149
9-#11	1.99	6547	3675	13192	2568	14273	1993	14305	1552	13724	923	13356	395	10351
9-#14	2.86	6697	3945	14167	2713	15450	2096	15684	1608	15563	886	15577	241	13912
9-#18	5.09	7039	4629	16528	3084	18286	2354	19036	1743	18703	732	20927	-165	20753
10-#11	2.21	6577	3742	13603	2556	14637	1982	14672	1533	14162	875	13780	348	11454
10-#14	3.18	6736	4042	14710	2715	15960	2095	16235	1592	15149	771	16228	178	15132
10-#18	5.66	7149	4803	17393	3120	19165	2377	20032	1735	21263	690	22122	-272	21909
11-#11	2.43	6649	3810	13671	2658	14890	2058	15056	1593	14716	915	14547	327	12269
11-#14	3.50	6834	4140	14852	2839	16323	2187	16742	1663	16960	871	17251	138	16389
11-#18	6.22	7275	4977	17712	3301	19789	2508	20840	1834	22420	749	23765	-361	23294
12-#11	2.65	6685	3878	13874	2710	15187	2105	15436	1627	15196	916	15213	308	13173
12-#14	3.82	6903	4238	15154	2909	16743	2249	17272	1708	16451	811	18172	109	17499
12-#18	6.79	7400	5151	18255	3413	20524	2611	21732	1906	23535	738	25297	-419	24699
13-#11	2.87	6743	3946	14148	2744	15509	2121	15803	1632	15704	905	15816	267	14040
13-#14	4.14	6962	4336	15540	2963	17199	2275	17798	1717	18356	854	19036	49	18772
13-#18	7.36	7531	5325	18908	3515	21293	2660	22643	1923	24916	732	26791	-529	25685
14-#11	3.09	6820	4014	14483	2753	15868	2130	16188	1629	16266	887	16276	211	14881
14-#14	4.46	7070	4434	15989	2985	17705	2295	18358	1719	19177	833	19710	-28	19694
15-#11	3.31	6832	4082	14652	2822	16129	2182	16569	1677	16731	902	17005	195	15800
15-#14	4.77	7096	4532	16257	3073	18077	2362	18881	1780	19808	848	20710	-57	20657
16-#11	3.53	6874	4149	14864	2877	16431	2224	16923	1699	17243	906	17608	155	16632
16-#14	5.09	7148	4629	16571	3149	18503	2419	19377	1808	19158	796	21550	-117	21425
17-#11	3.75	6929	4217	15138	2907	16750	2244	17312	1714	17713	890	18279	131	17495
17-#14	5.41	7233	4727	16948	3194	18956	2449	19932	1832	21197	829	22505	-152	22177
18-#11	3.97	6975	4285	15431	2934	17090	2260	17683	1711	18236	872	18872	83	18328
19-#11	4.19	7023	4353	15628	2991	17371	2304	18055	1751	18696	878	19468	57	19132
20-#11	4.41	7074	4421	15836	3042	17675	2343	18411	1770	19202	881	20125	25	20006
21-#11	4.63	7124	4489	16114	3075	17989	2364	18798	1787	19722	874	20646	-14	20630

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.16	7782	3893	15416	2581	15993	2004	15561	1570	13249	904	12809	523	8022
6-#14	1.68	7915	4073	16182	2665	16898	2063	16626	1597	14563	867	14329	411	11184
6-#18	2.98	8216	4530	18030	2880	19101	2212	19226	1662	19045	823	18009	116	17358
7-#11	1.36	7829	3961	15179	2793	16302	2176	16151	1714	15056	1075	14171	567	9101
7-#14	1.96	7977	4171	16022	2902	17309	2254	17325	1756	16628	1047	16038	449	12458
7-#18	3.48	8289	4704	18067	3183	19751	2452	20194	1859	20473	969	20560	136	19624
8-#11	1.55	7891	4029	15318	2869	16613	2243	16591	1767	15616	1092	14864	553	10282
8-#14	2.24	8054	4269	16265	2996	17747	2338	17933	1821	17378	1062	16968	420	14234
8-#18	3.98	8410	4878	18564	3321	20528	2578	21191	1953	21687	979	22064	70	21813
9-#11	1.75	7916	4097	15673	2892	16971	2249	16981	1762	16153	1073	15617	508	11314
9-#14	2.52	8090	4367	16740	3038	18256	2353	18491	1819	18166	1039	18063	359	15362
9-#18	4.48	8493	5052	19330	3410	21394	2617	22176	1960	23084	944	23982	-35	23962
10-#11	1.94	7952	4165	16132	2874	17380	2234	17372	1738	16616	1022	16065	460	12476
10-#14	2.80	8138	4465	17340	3033	18830	2348	19084	1799	18881	976	18761	295	16770
10-#18	4.97	8554	5226	20292	3440	22358	2635	23261	1949	24412	849	25284	-140	25174
11-#11	2.13	8034	4232	16187	2983	17644	2316	17800	1804	17236	1066	16921	443	13453
11-#14	3.08	8250	4562	17485	3166	19209	2446	19647	1877	19693	1026	19898	260	18066
11-#18	5.47	8764	5399	20624	3630	23039	2774	24153	2055	25694	913	27103	-223	26798
12-#11	2.33	8070	4300	16407	3038	17967	2364	18209	1840	17764	1069	17657	426	14579
12-#14	3.36	8302	4660	17809	3238	19666	2510	20228	1924	20424	1026	20916	232	19347
12-#18	5.97	8854	5573	21214	3746	23823	2878	25132	2129	26918	905	28798	-279	28476
13-#11	2.52	8132	4368	16702	3071	18319	2380	18615	1844	17094	987	18312	385	15466
13-#14	3.64	8392	4758	18223	3290	20166	2536	20800	1932	21218	1011	21858	174	20776
13-#18	6.47	9003	5747	21932	3847	24680	2928	26128	2147	28304	880	30435	-385	29553
14-#11	2.72	8223	4436	17078	3077	18700	2385	19031	1840	18919	1039	18810	329	16439
14-#14	3.92	8508	4856	18723	3310	20720	2554	21409	1933	22107	989	22593	97	21941
14-#18	6.96	9234	5921	22737	3900	25620	2974	27205	2160	29883	849	31734	-517	30778
15-#11	2.91	8241	4504	17250	3149	18995	2443	19427	1883	19435	1056	19616	315	17409
15-#14	4.20	8547	4954	19003	3401	21124	2624	21983	1997	21283	940	23696	70	23271
16-#11	3.10	8291	4572	17471	3205	19323	2485	19830	1913	19995	1062	20281	276	18345
16-#14	4.48	8605	5052	19335	3478	21589	2683	22526	2027	23589	1013	24623	12	24540
17-#11	3.30	8349	4639	17780	3235	19666	2504	20257	1929	19139	976	20925	243	19313
17-#14	4.76	8684	5149	19757	3523	22083	2712	23131	2050	24320	990	25665	-21	25505
18-#11	3.49	8386	4707	18106	3260	20032	2519	20663	1925	21071	1027	21656	205	20194
18-#14	5.04	8757	5247	20198	3567	22608	2739	23712	2049	25140	966	26596	-88	26466
19-#11	3.69	8457	4775	18306	3320	20338	2565	21067	1966	21578	1035	22311	181	21129
19-#14	5.32	8835	5345	20513	3645	23039	2800	24278	2103	25839	974	27503	-128	27302
20-#11	3.88	8511	4843	18530	3371	20680	2606	21452	1986	22130	1039	23030	152	22041
21-#11	4.07	8560	4911	18835	3404	21011	2627	21876	2003	22696	1033	23602	112	22944
22-#11	4.27	8628	4979	19154	3436	21375	2647	22289	2005	23217	1010	24241	71	23865
23-#11	4.46	8666	5046	19367	3489	21686	2687	22686	2040	22180	954	24982	51	24685

ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.03	9303	4343	18251	2903	18945	2257	18402	1775	16678	1114	14998	631	8639
6-#14	1.49	9452	4523	19087	2987	19930	2316	19559	1802	18208	1075	16659	522	12070
6-#18	2.64	9792	4979	21108	3204	22335	2468	22395	1870	21961	973	20697	235	19250
7-#11	1.20	9362	4411	17922	3136	19272	2447	19075	1935	17617	1224	16542	684	9876
7-#14	1.73	9530	4621	18838	3245	20363	2525	20351	1977	19374	1205	18580	568	13523
7-#18	3.08	9901	5153	21063	3527	23044	2727	23480	2084	23564	1133	23538	264	21562
8-#11	1.37	9436	4478	18055	3218	19607	2519	19545	1990	18284	1251	17309	673	11109
8-#14	1.98	9625	4718	19084	3345	20836	2613	21002	2045	20199	1223	19606	543	15404
8-#18	3.52	10041	5327	21587	3671	23856	2855	24570	2183	24895	1146	25193	203	24056
9-#11	1.55	9459	4546	18450	3238	19996	2522	19971	1984	18858	1231	18119	627	12293
9-#14	2.23	9659	4816	19610	3384	21389	2627	21618	2043	21045	1199	20789	481	16797
9-#18	3.97	10125	5501	22431	3758	24810	2893	25637	2189	24646	1037	27278	98	26550
10-#11	1.72	9502	4614	18962	3213	20443	2502	20391	1957	18054	1099	18586	578	13507
10-#14	2.48	9716	4914	20271	3372	22028	2618	22252	2019	20351	1058	21530	418	18464
10-#18	4.41	10194	5675	23475	3780	25879	2909	26808	2174	27835	1014	28683	-5	28680
11-#11	1.89	9595	4682	18996	3330	20724	2590	20854	2028	18698	1145	19537	564	14626
11-#14	2.73	9843	5012	20405	3513	22422	2721	22873	2103	22703	1189	22786	387	19825
11-#18	4.85	10404	5849	23834	3980	26587	3053	27787	2287	27295	1012	30683	-82	30567
12-#11	2.06	9631	4750	19234	3388	21073	2641	21298	2065	20610	1231	20344	549	15835
12-#14	2.97	9894	5110	20758	3588	22917	2788	23490	2151	23500	1191	23902	361	21253
12-#18	5.29	10525	6023	24468	4099	27438	3160	28853	2363	30580	1079	32544	-136	32387
13-#11	2.23	9702	4818	19552	3419	21455	2656	21735	2069	21203	1219	20959	499	16880
13-#14	3.22	9999	5208	21201	3638	23459	2813	24120	2159	24358	1176	24921	303	22729
13-#18	5.73	10693	6197	25231	4198	28371	3210	29934	2382	32083	1055	34323	-239	33690
14-#11	2.41	9800	4885	19971	3422	21859	2658	22193	2063	21750	1183	21585	452	18046
14-#14	3.47	10123	5305	21755	3655	24046	2827	24778	2159	25312	1153	25716	225	24062
14-#18	6.17	10863	6371	26117	4249	29424	3256	31101	2394	33790	1024	35742	-371	35098
15-#11	2.58	9827	4953	20144	3498	22179	2719	22615	2109	22416	1219	22469	440	19041
15-#14	3.72	10162	5403	22046	3751	24498	2903	25366	2215	24338	1096	26924	202	25593
15-#18	6.61	10998	6544	26694	4393	30159	3365	32139	2495	35037	1045	37739	-426	36883
16-#11	2.75	9884	5021	20371	3555	22542	2763	23053	2140	23025	1226	23197	402	20109
16-#14	3.97	10241	5501	22390	3829	25002	2963	25981	2257	26930	1181	27939	145	26878
17-#11	2.92	9946	5089	20712	3584	22904	2781	23514	2155	23576	1210	23893	370	21107
17-#14	4.21	10324	5599	22862	3874	25527	2992	26642	2281	27721	1159	28936	99	28317
18-#11	3.09	9987	5157	21077	3608	23301	2795	23954	2151	24183	1191	24682	332	22112
18-#14	4.46	10408	5697	23347	3916	26092	3017	27279	2280	28605	1134	30078	46	29743
19-#11	3.26	10061	5225	21278	3670	23631	2843	24391	2194	24737	1201	25396	311	23162
19-#14	4.71	10495	5794	23669	3996	26559	3080	27885	2335	29368	1144	31065	10	31008
20-#11	3.44	10126	5292	21518	3722	23996	2885	24809	2215	25337	1205	26177	282	24114
20-#14	4.96	10572	5892	24019	4069	27088	3138	28474	2362	30213	1149	32165	-33	32104

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
21-#11	3.61	10181	5360	21850	3755	24360	2905	25268	2232	24171	1112	26801	243	25150
22-#11	3.78	10261	5428	22194	3785	24755	2925	25705	2233	24741	1098	27490	203	26114
23-#11	3.95	10300	5496	22426	3840	25090	2967	26144	2270	27105	1190	28300	184	27089
24-#11	4.12	10351	5564	22682	3891	25442	3005	26565	2289	27655	1185	28968	149	28092
25-#11	4.30	10423	5631	22996	3924	25815	3028	27018	2308	28264	1180	29714	114	28986

ROUND SPIRAL COLUMNS 36" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.33	11175	4999	22322	3330	23309	2585	22824	2021	21093	1230	19229	638	12956
6-#18	2.36	11555	5456	24519	3547	25917	2738	25896	2091	25157	1132	23624	358	21216
7-#11	1.07	11076	4887	20981	3501	22589	2735	22332	2169	19148	1297	19166	807	10662
7-#14	1.55	11265	5097	21970	3610	23764	2813	23717	2212	22336	1361	21376	694	14603
7-#18	2.75	11696	5630	24377	3892	26659	3016	27105	2322	26947	1304	26770	397	23557
8-#11	1.23	11166	4955	21103	3588	22948	2811	22840	2228	21248	1420	20010	799	11942
8-#14	1.77	11382	5195	22215	3715	24272	2906	24407	2283	23314	1394	22501	673	16576
8-#18	3.14	11861	5804	24923	4042	27532	3149	28283	2425	26505	1234	28579	341	26374
9-#11	1.38	11188	5023	21541	3605	23368	2812	23294	2220	21857	1399	20875	753	13287
9-#14	1.99	11414	5293	22794	3751	24869	2917	25075	2280	24218	1369	23770	610	18159
9-#18	3.54	11921	5978	25847	4126	28563	3186	29439	2430	30022	1287	30831	236	28939
10-#11	1.53	11238	5091	22111	3573	23842	2786	23747	2189	22361	1343	21358	701	14548
10-#14	2.21	11480	5391	23521	3732	25560	2903	25758	2253	23351	1214	24551	545	20099
10-#18	3.93	12024	6152	26978	4141	29749	3199	30693	2412	31549	1188	32335	134	31387
11-#11	1.69	11339	5159	22118	3698	24151	2882	24247	2265	23125	1396	22408	692	15819
11-#14	2.43	11623	5489	23637	3882	25982	3013	26421	2341	26008	1361	25930	519	21596
11-#18	4.32	12258	6326	27355	4351	30483	3348	31762	2531	33090	1264	34520	62	34153
12-#11	1.84	11377	5226	22373	3759	24526	2935	24727	2304	23751	1402	23288	678	17077
12-#14	2.65	11673	5586	24020	3960	26514	3083	27089	2391	26872	1364	27146	494	23217
12-#18	4.72	12388	6499	28036	4473	31401	3458	32909	2610	32236	1177	36549	11	36473
13-#11	1.99	11458	5294	22714	3788	24934	2948	25196	2307	22760	1297	23947	628	18263
13-#14	2.87	11783	5684	24492	4008	27099	3107	27765	2399	27792	1350	28102	424	24732
13-#18	5.11	12537	6673	28845	4570	32410	3508	34082	2629	36157	1238	38469	-90	38047
14-#11	2.15	11555	5362	23179	3788	25365	2947	25684	2299	23300	1263	24613	580	19556
14-#14	3.09	11925	5782	25103	4022	27719	3118	28488	2398	28659	1303	29094	359	26243
14-#18	5.50	12752	6847	29815	4617	33524	3549	35337	2640	37990	1206	40007	-222	39692
15-#11	2.30	11599	5430	23349	3869	25708	3012	26143	2348	25692	1391	25579	571	20664
15-#14	3.32	11976	5880	25401	4122	28206	3197	29109	2456	27668	1259	30409	339	27853
15-#18	5.89	12871	7021	30423	4767	34341	3665	36463	2745	36724	1149	42177	-273	41641
16-#11	2.45	11664	5498	23583	3926	26107	3058	26616	2380	26350	1399	26370	534	21923
16-#14	3.54	12065	5978	25757	4201	28761	3259	29774	2499	30567	1358	31513	283	29354
16-#18	6.29	13075	7195	31095	4900	35277	3766	37542	2795	38189	1158	44036	-377	43155
17-#11	2.61	11723	5566	23954	3955	26488	3075	27112	2396	26942	1383	27118	503	22945
17-#14	3.76	12153	6076	26272	4246	29314	3287	30484	2524	31418	1336	32587	238	30913
18-#11	2.76	11775	5633	24362	3978	26916	3087	27571	2389	27588	1363	27964	464	24082
18-#14	3.98	12219	6173	26812	4286	29924	3311	31167	2521	32364	1311	33816	185	32362

ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
19-#11	2.91	11858	5701	24562	4041	27271	3138	28054	2435	26312	1283	28739	445	25186
19-#14	4.20	12344	6271	27139	4368	30427	3376	31824	2579	33192	1323	34885	152	33816
20-#11	3.07	11917	5769	24818	4095	27654	3180	28507	2457	28839	1380	29583	418	26240
20-#14	4.42	12425	6369	27513	4443	30983	3434	32460	2607	34105	1329	36074	111	35371
21-#11	3.22	11989	5837	25177	4127	28055	3201	28992	2474	27479	1275	30258	379	27386
21-#14	4.64	12527	6467	28015	4491	31542	3465	33165	2634	32637	1222	37034	55	36692
22-#11	3.37	12078	5905	25547	4155	28481	3219	29457	2473	30095	1351	30996	339	28396
22-#14	4.86	12635	6565	28527	4539	32147	3496	33840	2637	35915	1289	38103	-1	38100
23-#11	3.52	12123	5972	25791	4212	28833	3262	29932	2512	28692	1275	31877	322	29505
24-#11	3.68	12179	6040	26070	4264	29211	3302	30398	2533	31334	1362	32600	287	30548
25-#11	3.83	12248	6108	26404	4297	29613	3324	30873	2551	31988	1357	33404	253	31625
26-#11	3.98	12314	6176	26756	4330	30045	3347	31344	2554	30426	1248	34055	210	32731
27-#11	4.14	12380	6244	27049	4374	30396	3386	31815	2589	31021	1258	35031	194	33683

ROUND SPIRAL COLUMNS 38" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.19	13094	5503	25907	3692	27055	2870	26440	2251	24275	1393	22052	761	13840
6-#18	2.12	13515	5960	28280	3909	29867	3024	29749	2323	26740	1211	26806	486	23257
7-#14	1.39	13196	5601	25435	3996	27532	3118	27432	2460	25679	1537	24440	826	15697
7-#18	2.47	13680	6134	28026	4278	30639	3321	31090	2573	28598	1385	30272	535	25607
8-#11	1.10	13093	5459	24480	3980	26655	3121	26496	2479	24525	1599	22985	932	12780
8-#14	1.59	13336	5699	25676	4107	28074	3216	28173	2535	24960	1469	25668	808	17754
8-#18	2.82	13880	6308	28590	4434	31574	3460	32330	2679	30067	1406	32238	484	28768
9-#11	1.24	13113	5527	24964	3994	27107	3119	26977	2469	25167	1576	23802	875	14298
9-#14	1.79	13366	5797	26311	4140	28716	3224	28884	2530	27702	1548	27022	745	19541
9-#18	3.17	13936	6482	29597	4516	32685	3494	33600	2684	31686	1373	34655	379	31387
10-#11	1.38	13171	5595	25598	3954	27608	3087	27461	2434	23974	1415	24396	831	15599
10-#14	1.98	13442	5895	27110	4113	29446	3204	29621	2499	26638	1378	27837	678	21565
10-#18	3.53	14054	6655	30820	4523	33987	3504	34936	2662	33199	1278	36253	277	34137
11-#11	1.51	13281	5662	25571	4089	27946	3190	27999	2516	24760	1469	25551	826	17031
11-#14	2.18	13600	5992	27200	4272	29909	3323	30329	2593	29624	1541	29346	657	23265
11-#18	3.88	14313	6829	31193	4742	34746	3660	36088	2788	34764	1354	38630	211	37076
12-#11	1.65	13321	5730	25840	4152	28346	3245	28516	2557	27206	1582	26505	813	18332
12-#14	2.38	13650	6090	27611	4354	30479	3394	31048	2645	28520	1444	30663	633	25239
12-#18	4.23	14403	7003	31935	4868	35731	3772	37300	2868	36222	1354	40828	161	39589
13-#11	1.79	13410	5798	26206	4180	28775	3257	29016	2559	27880	1570	27207	764	19669
13-#14	2.58	13773	6188	28114	4400	31101	3417	31771	2653	29436	1430	31685	564	26783
13-#18	4.59	14614	7177	32791	4963	36816	3821	38572	2887	37840	1333	42889	63	42473
14-#11	1.93	13512	5866	26721	4175	29238	3253	29523	2548	28490	1531	27911	715	21008
14-#14	2.78	13926	6286	28785	4410	31760	3424	32538	2649	32458	1484	32742	498	28484
14-#18	4.94	14842	7351	33848	5007	37989	3859	39933	2897	39668	1302	44542	-70	44445

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 38" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#11	2.06	13568	5934	26885	4261	29605	3322	30032	2601	29281	1572	28961	708	22258
15-#14	2.98	13989	6384	29086	4515	32280	3508	33213	2711	33526	1533	34167	481	30137
15-#18	5.29	14985	7525	34484	5162	38885	3981	41058	2985	43971	1423	46888	-116	46676
16-#11	2.20	13641	6002	27124	4319	30033	3370	30540	2635	29989	1581	29817	672	23595
16-#14	3.17	14088	6482	29454	4594	32888	3573	33927	2755	32216	1440	35361	426	31818
16-#18	5.64	15129	7699	35182	5296	39895	4084	42277	3057	42615	1339	48901	-219	48413
17-#11	2.34	13702	6069	27525	4348	30439	3386	31065	2649	30620	1565	30616	641	24784
17-#14	3.37	14181	6579	30010	4639	33468	3599	34687	2779	33065	1420	36511	382	33497
17-#18	6.00	15306	7873	36117	5380	40938	4137	43605	3103	47253	1398	50908	-299	50205
18-#11	2.48	13761	6137	27979	4368	30899	3396	31547	2641	31306	1544	31317	582	26103
18-#14	3.57	14254	6677	30608	4678	34123	3621	35400	2775	36435	1496	37825	328	35046
19-#11	2.61	13853	6205	28176	4434	31278	3450	32068	2689	29829	1454	32355	585	27234
19-#14	3.77	14381	6775	30938	4762	34661	3689	36120	2836	37330	1510	38979	299	36690
20-#11	2.75	13913	6273	28447	4489	31680	3492	32565	2712	32655	1564	33262	559	28420
20-#14	3.97	14479	6873	31336	4837	35244	3747	36807	2865	35756	1415	40257	259	38274
21-#11	2.89	13995	6341	28834	4521	32110	3512	33074	2728	33299	1550	33987	521	29598
21-#14	4.17	14575	6971	31877	4886	35856	3779	37550	2891	39234	1497	41291	204	39822
22-#11	3.03	14090	6409	29231	4547	32575	3530	33569	2727	31728	1432	34774	481	30734
22-#14	4.36	14704	7069	32423	4931	36506	3809	38267	2893	40245	1478	42434	148	41499
23-#11	3.16	14137	6476	29485	4606	32942	3575	34081	2768	32378	1447	35727	464	31950
23-#14	4.56	14784	7166	32812	5008	37040	3868	38981	2947	41213	1496	43758	121	42937
24-#11	3.30	14206	6544	29788	4659	33348	3615	34572	2789	35327	1547	36505	431	33093
25-#11	3.44	14279	6612	30141	4691	33778	3637	35089	2807	36026	1543	37369	397	34254
26-#11	3.58	14337	6680	30524	4723	34234	3659	35592	2809	36677	1522	38063	354	35384
27-#11	3.71	14426	6748	30832	4769	34616	3700	36097	2846	37364	1535	39013	330	36496
28-#11	3.85	14494	6815	31150	4811	35026	3739	36579	2865	38004	1530	39980	318	37672

ROUND SPIRAL COLUMNS 40" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.07	15219	6034	29861	4074	31190	3171	30427	2495	25919	1461	25143	889	14725
6-#18	1.91	15683	6491	32410	4292	34205	3326	33973	2568	32457	1473	30256	620	24886
7-#14	1.25	15334	6132	29253	4404	31687	3439	31519	2721	27392	1608	27789	964	16805
7-#18	2.23	15863	6665	32028	4686	35007	3643	35454	2836	34512	1652	34058	679	27601
8-#14	1.43	15497	6230	29484	4521	32263	3542	32319	2801	28469	1646	29123	950	18939
8-#18	2.55	16107	6839	32606	4848	36004	3788	36758	2946	36361	1699	36186	633	31235
9-#11	1.12	15246	6058	28733	4405	31233	3443	31040	2732	28806	1763	27109	1013	15342
9-#14	1.61	15525	6328	30178	4551	32951	3549	33074	2794	31515	1736	30407	872	20941
9-#18	2.86	16160	7013	33698	4927	37194	3820	38116	2950	35659	1552	38765	527	33895
10-#11	1.24	15310	6126	29440	4357	31762	3404	31552	2692	29336	1699	27714	968	16660
10-#14	1.79	15612	6426	31054	4516	33720	3521	33862	2758	32386	1661	31405	817	23042
10-#18	3.18	16294	7187	35019	4925	38575	3822	39557	2925	39916	1559	40453	425	36964

ROUND SPIRAL COLUMNS 40" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#11	1.37	15430	6194	29372	4501	32127	3516	32131	2780	30262	1762	28980	967	18263
11-#14	1.97	15785	6524	31112	4684	34224	3649	34618	2858	33570	1731	33048	800	24944
11-#18	3.50	16579	7361	35382	5154	39397	3988	40772	3056	41735	1646	43027	364	39982
12-#11	1.49	15471	6261	29645	4567	32553	3573	32687	2823	30986	1771	30009	955	19602
12-#14	2.15	15835	6621	31550	4769	34830	3723	35388	2913	32268	1623	34468	778	27030
12-#18	3.82	16668	7534	36182	5285	40449	4103	42072	3138	43411	1648	45396	317	42785
13-#11	1.61	15570	6329	30080	4585	33004	3583	33217	2825	29592	1642	30754	906	21098
13-#14	2.33	15971	6719	32085	4813	35483	3743	36158	2919	35615	1724	35555	710	28812
13-#18	4.14	16904	7708	37087	5377	41610	4151	43430	3158	45260	1626	47322	195	46023
14-#11	1.74	15676	6397	30614	4584	33498	3576	33741	2811	32343	1718	31494	855	22478
14-#14	2.51	16121	6817	32819	4819	36188	3748	36955	2912	34145	1562	36674	643	30783
14-#18	4.46	17145	7882	38234	5418	42841	4185	44909	3168	47042	1552	49364	87	48648
15-#11	1.86	15745	6465	30765	4674	33888	3649	34298	2867	30934	1637	32630	851	23878
15-#14	2.69	16210	6915	33121	4929	36742	3836	37697	2979	37737	1726	38212	629	32511
15-#18	4.77	17312	8056	38895	5578	43798	4311	46088	3258	48925	1624	51889	44	51565
16-#11	1.99	15826	6533	31012	4734	34337	3698	34845	2902	33953	1772	33551	816	25259
16-#14	2.86	16321	7013	33498	5009	37392	3902	38461	3025	36212	1622	39497	575	34343
16-#18	5.09	17467	8230	39618	5712	44902	4417	47393	3331	50733	1638	54057	-57	53957
17-#11	2.11	15889	6601	31444	4762	34778	3714	35368	2908	32320	1639	34402	785	26590
17-#14	3.04	16418	7111	34096	5053	38010	3928	39264	3048	39767	1716	40723	532	36066
17-#18	5.41	17623	8404	40622	5797	45993	4470	48811	3377	52434	1601	56203	-135	55893
18-#11	2.23	15955	6668	31939	4780	35270	3722	35904	2906	35353	1734	35144	726	27988
18-#14	3.22	16498	7208	34756	5091	38709	3948	40013	3041	40836	1689	41818	450	37792
18-#18	5.73	17818	8578	41655	5879	47205	4521	50182	3380	50726	1458	58685	-226	57415
19-#11	2.36	16056	6736	32137	4849	35669	3778	36464	2956	36057	1750	36259	731	29273
19-#14	3.40	16638	7306	35086	5178	39283	4019	40786	3105	41799	1705	43360	451	39605
20-#11	2.48	16118	6804	32423	4904	36092	3821	36999	2981	36796	1757	37230	706	30652
20-#14	3.58	16744	7404	35507	5254	39892	4078	41535	3137	39990	1599	44729	413	41242
21-#11	2.61	16204	6872	32834	4936	36551	3841	37536	2997	37486	1743	38005	668	31857
21-#14	3.76	16848	7502	36088	5302	40546	4109	42312	3161	43831	1694	45837	358	43024
22-#11	2.73	16311	6940	33263	4961	37056	3858	38062	2994	38223	1727	38839	628	33126
22-#14	3.94	16984	7600	36669	5345	41253	4139	43075	3163	44905	1674	47052	302	44689
23-#11	2.86	16365	7007	33526	5021	37439	3904	38610	3037	38969	1744	39866	613	34399
23-#14	4.12	17077	7697	37076	5425	41810	4199	43840	3218	45943	1694	48478	276	46370
24-#11	2.98	16442	7075	33843	5075	37871	3945	39125	3057	39646	1741	40698	580	35645
24-#14	4.30	17174	7795	37544	5500	42425	4255	44582	3247	43777	1576	49651	228	48093
25-#11	3.10	16519	7143	34225	5107	38330	3967	39683	3076	37701	1621	41622	547	36898
25-#14	4.48	17291	7893	38073	5548	43079	4289	45370	3274	47971	1683	50969	180	49640
26-#11	3.23	16583	7211	34705	5122	38809	3987	40220	3078	38347	1602	42360	504	38095
27-#11	3.35	16681	7279	34957	5185	39219	4030	40751	3116	41819	1730	43378	481	39341
28-#11	3.48	16753	7347	35293	5228	39661	4069	41265	3135	42501	1726	44414	469	40540
29-#11	3.60	16828	7414	35651	5271	40105	4092	41822	3155	43246	1723	45225	427	41765
30-#11	3.72	16923	7482	36092	5298	40577	4115	42373	3160	41018	1591	46095	393	42980

ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.73	18070	7049	36928	4695	38951	3643	38587	2826	34155	1545	33988	759	26448
7-#14	1.14	17690	6691	33440	4833	36251	3778	36006	2996	33364	1918	31437	1109	17927
7-#18	2.02	18270	7223	36401	5114	39784	3981	40196	3112	38868	1850	38144	829	29479
8-#14	1.30	17877	6788	33657	4956	36860	3887	36866	3080	34602	1961	32881	1098	20131
8-#18	2.31	18555	7397	36988	5283	40842	4132	41587	3226	40855	1901	40436	787	33744
9-#11	1.01	17596	6616	32867	4837	35766	3784	35502	3009	32792	1959	30716	1158	16303
9-#14	1.46	17903	6886	34408	4983	37593	3890	37662	3071	33296	1804	34237	1019	22362
9-#18	2.60	18603	7571	38168	5359	42111	4162	43027	3229	42808	1864	43176	681	36460
10-#11	1.13	17668	6684	33655	4781	36324	3738	36028	2963	33328	1892	31329	1110	17730
10-#14	1.62	18000	6984	35372	4939	38402	3855	38501	3031	36574	1855	35268	963	24531
10-#18	2.89	18754	7745	39593	5349	43562	4157	44576	3200	44604	1756	44949	577	39866
11-#11	1.24	17793	6752	33540	4934	36712	3858	36664	3059	32052	1829	32711	1114	19476
11-#14	1.79	18178	7082	35391	5117	38946	3992	39306	3137	37863	1930	37053	950	26647
11-#18	3.18	19061	7919	39938	5588	44457	4332	45857	3337	43464	1727	47726	522	42952
12-#11	1.35	17840	6820	33813	5003	37166	3902	37258	3104	32766	1839	33818	1103	20884
12-#14	1.95	18239	7180	35839	5205	39590	4068	40129	3194	38930	1939	38576	930	28806
12-#18	3.46	19153	8093	40797	5723	45575	4450	47244	3422	48362	1854	50268	477	46060
13-#11	1.46	17948	6888	34288	5019	37639	3927	37819	3104	35872	1957	34603	1054	22569
13-#14	2.11	18387	7278	36472	5236	40273	4087	40944	3200	37370	1796	39728	861	30788
13-#18	3.75	19416	8267	41750	5813	46798	4497	48688	3441	46969	1710	52316	357	49471
14-#11	1.58	18059	6955	34877	5015	38167	3916	38359	3087	34105	1787	35376	1002	23965
14-#14	2.27	18544	7375	37223	5250	41025	4088	41770	3189	41056	1873	40907	793	32977
14-#18	4.04	19670	8441	42992	5850	48102	4527	50242	3448	52209	1757	54486	248	52299
15-#11	1.69	18137	7023	35008	5110	38578	3993	38959	3147	37398	1953	36603	1001	25524
15-#14	2.44	18651	7473	37515	5364	41611	4181	42578	3260	42211	1916	42561	782	34863
15-#18	4.33	19828	8615	43673	6015	49119	4658	51519	3543	54226	1833	57193	209	55552
16-#11	1.80	18230	7091	35264	5171	39047	4027	39550	3184	35707	1840	37590	966	26943
16-#14	2.60	18773	7571	37908	5446	42291	4247	43395	3308	43421	1940	43937	729	36928
16-#18	4.62	20030	8788	44420	6150	50316	4768	52910	3618	56155	1848	59517	109	58556
17-#11	1.91	18295	7159	35729	5198	39524	4059	40096	3189	38974	1956	38491	936	28424
17-#14	2.76	18864	7669	38548	5489	42959	4273	44196	3318	44455	1919	45238	687	38688
17-#18	4.91	20192	8962	45494	6234	51456	4818	54418	3664	54100	1691	61802	33	61537
18-#11	2.03	18367	7227	36262	5213	40047	4065	40660	3185	39746	1933	39272	876	29865
18-#14	2.92	18962	7767	39261	5524	43704	4292	45025	3322	42544	1765	46398	604	40601
18-#18	5.20	20408	9136	46624	6315	52748	4868	55846	3665	59995	1772	64443	-58	63598
19-#11	2.14	18478	7295	36464	5285	40463	4123	41260	3238	40491	1950	40466	883	31293
19-#14	3.09	19115	7865	39600	5615	44307	4365	45852	3387	46615	1909	48046	608	42461
19-#18	5.49	20626	9310	47325	6453	53804	4978	57233	3764	57591	1671	66655	-114	66344
20-#11	2.25	18542	7362	36763	5342	40912	4151	41821	3262	38526	1827	41502	859	32741
20-#14	3.25	19205	7962	40043	5692	44948	4424	46657	3421	47725	1918	49505	571	44275

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
21-#11	2.36	18636	7430	37198	5372	41400	4187	42399	3278	42009	1944	42327	821	34104
21-#14	3.41	19341	8060	40657	5739	45643	4456	47474	3445	48776	1899	50687	517	46245
22-#11	2.48	18750	7498	37662	5396	41937	4202	42955	3275	39944	1800	43207	781	35571
22-#14	3.57	19486	8158	41282	5781	46407	4485	48283	3446	49912	1879	51974	462	47945
23-#11	2.59	18814	7566	37932	5459	42343	4250	43539	3319	43585	1946	44198	757	36873
23-#14	3.74	19592	8256	41706	5862	46987	4546	49099	3502	51020	1901	53501	437	49815
24-#11	2.70	18898	7634	38261	5513	42802	4276	44079	3340	41352	1814	45196	736	38253
24-#14	3.90	19697	8354	42194	5938	47640	4603	49876	3531	52039	1896	54753	390	51610
25-#11	2.81	18979	7702	38675	5545	43290	4314	44671	3359	42092	1811	46179	702	39537
25-#14	4.06	19806	8452	42765	5986	48336	4637	50723	3560	53175	1890	56158	342	53385
26-#11	2.93	19048	7769	39190	5559	43792	4333	45248	3361	45832	1919	46960	659	40863
26-#14	4.22	19929	8549	43474	6012	49061	4670	51544	3565	50622	1739	57292	281	55319
27-#11	3.04	19148	7837	39446	5623	44226	4376	45806	3399	43505	1804	48047	638	42190
28-#11	3.15	19233	7905	39801	5666	44703	4401	46352	3419	44182	1801	49152	626	43468
29-#11	3.27	19313	7973	40183	5709	45167	4439	46944	3439	44920	1798	50013	585	44829
30-#11	3.38	19414	8041	40650	5735	45669	4462	47519	3443	48867	1908	50938	551	46066
31-#11	3.49	19488	8108	40927	5795	46112	4494	48083	3479	46389	1800	51876	521	47374
32-#11	3.60	19564	8176	41291	5837	46574	4525	48633	3498	47119	1803	52890	495	48659

ROUND SPIRAL COLUMNS 44" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.58	20686	7635	41855	5117	44126	3975	43612	3096	41078	1847	38016	903	28010
7-#14	1.04	20274	7276	38016	5284	41243	4133	40911	3284	37741	2122	35400	1260	19064
7-#18	1.84	20907	7809	41163	5565	44989	4337	45350	3401	40681	1920	42543	985	31353
8-#14	1.18	20485	7374	38213	5414	41884	4225	41834	3374	39056	2169	36958	1253	21329
8-#18	2.10	21232	7983	41754	5741	46108	4494	46836	3521	45715	2113	45005	947	35797
9-#14	1.33	20510	7472	39020	5436	42664	4248	42671	3362	37517	1997	38383	1173	23801
9-#18	2.37	21277	8157	43026	5813	47456	4521	48358	3521	47773	2074	47606	816	39011
10-#11	1.03	20254	7270	38262	5226	41314	4088	40917	3247	37679	2093	35255	1259	18811
10-#14	1.48	20617	7570	40082	5384	43513	4206	43539	3316	38380	1920	39442	1114	26032
10-#18	2.63	21445	8331	44560	5794	48977	4508	50012	3488	49651	1963	49756	736	42844
11-#11	1.13	20385	7338	38092	5390	41721	4218	41616	3351	38774	2166	36760	1267	20645
11-#14	1.63	20803	7668	40056	5573	44091	4351	44414	3430	42520	2139	41374	1106	28374
11-#18	2.89	21768	8505	44881	6043	49945	4694	51362	3632	51767	2063	52743	686	45983
12-#11	1.23	20438	7405	38363	5461	42208	4265	42249	3398	36953	2033	37945	1258	22181
12-#14	1.78	20872	7765	40509	5663	44776	4408	45290	3489	43641	2149	43003	1087	30599
12-#18	3.16	21870	8678	45795	6182	51129	4814	52837	3720	53678	2069	55459	642	49412
13-#11	1.33	20556	7473	38880	5476	42703	4279	42840	3397	40397	2165	38771	1209	23957
13-#14	1.92	21034	7863	41196	5693	45491	4448	46152	3494	44821	2134	44218	1019	32791
13-#18	3.42	22135	8852	46800	6270	52407	4859	54366	3738	55753	2047	57629	523	52909
14-#11	1.44	20671	7541	39526	5467	43263	4273	43395	3376	41102	2121	39574	1155	25468
14-#14	2.07	21197	7961	42015	5702	46289	4445	47005	3479	45890	2080	45454	950	35052
14-#18	3.68	22428	9026	48138	6303	53792	4886	55981	3741	53890	1839	59923	414	56031

ROUND SPIRAL COLUMNS 44" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#11	1.54	20760	7609	39635	5567	43696	4346	44040	3440	42014	2161	40893	1156	27181
15-#14	2.22	21322	8059	42291	5821	46908	4542	47870	3554	43977	1985	47228	941	37134
15-#18	3.95	22605	9200	48836	6473	54869	5022	57370	3842	55901	1913	62816	379	59638
16-#11	1.64	20863	7677	39899	5630	44185	4389	44677	3479	40067	2036	41948	1122	28647
16-#14	2.37	21455	8157	42700	5905	47617	4587	48751	3604	48398	2151	48696	889	39418
16-#18	4.21	22826	9374	49606	6610	56139	5133	58848	3919	61943	2067	65296	280	62670
17-#11	1.74	20930	7745	40396	5655	44697	4413	45244	3483	43684	2165	42898	1093	30309
17-#14	2.52	21548	8255	43384	5947	48336	4636	49584	3613	49494	2130	50072	847	41362
17-#18	4.47	22996	9548	50750	6693	57348	5183	60432	3964	63859	2031	67720	206	65973
18-#11	1.85	21010	7812	40970	5668	45253	4424	45836	3478	41530	1999	43714	1032	31765
18-#14	2.66	21657	8352	44145	5979	49126	4652	50458	3615	47314	1962	51295	764	43471
18-#18	4.74	23165	9722	51980	6773	58719	5231	61930	3962	66004	1991	69926	66	69448
19-#11	1.95	21130	7880	41173	5744	45684	4477	46476	3532	45291	2160	44992	1041	33343
19-#14	2.81	21823	8450	44497	6073	49754	4728	51339	3684	48329	1980	53050	771	45372
19-#18	5.00	23463	9896	52692	6913	59838	5345	63406	4064	63306	1878	72874	62	72440
20-#11	2.05	21196	7948	41485	5801	46159	4514	47063	3558	43051	2024	46093	1019	34831
20-#14	2.96	21916	8548	44962	6152	50432	4765	52180	3717	52957	2131	54600	736	47371
20-#18	5.26	23621	10070	53535	7044	61029	5445	64861	4118	69861	2024	75530	-7	75507
21-#11	2.15	21299	8016	41944	5831	46677	4541	47683	3574	46897	2155	46967	980	36338
21-#14	3.11	22065	8646	45608	6198	51169	4819	53058	3742	54069	2113	55856	681	49392
22-#11	2.26	21411	8084	42446	5852	47239	4563	48268	3569	47714	2137	47893	941	37884
22-#14	3.26	22218	8744	46279	6238	51979	4847	53911	3742	55284	2093	57214	626	51268
23-#11	2.36	21492	8151	42721	5917	47675	4605	48881	3615	48505	2149	48953	917	39315
23-#14	3.40	22324	8841	46718	6322	52592	4911	54778	3800	56446	2115	58678	589	53338
24-#11	2.46	21584	8219	43061	5972	48160	4640	49454	3636	46043	2012	50013	897	40858
24-#14	3.55	22451	8939	47225	6398	53284	4946	55590	3829	57527	2111	60175	557	55159
25-#11	2.56	21664	8287	43545	5996	48670	4669	50080	3655	50168	2152	51055	863	42226
25-#14	3.70	22566	9037	47840	6446	54021	5002	56486	3857	58729	2106	61665	509	57169
26-#11	2.67	21744	8355	44060	6017	49202	4679	50696	3657	50929	2130	51878	820	43688
26-#14	3.85	22673	9135	48598	6471	54780	5033	57367	3863	59857	2078	62865	449	59112
27-#11	2.77	21852	8423	44318	6082	49662	4732	51282	3695	51767	2146	53035	800	45073
27-#14	4.00	22834	9233	49007	6558	55435	5092	58199	3915	56947	1956	64484	416	60951
28-#11	2.87	21929	8491	44691	6126	50166	4766	51861	3716	49039	2000	53980	770	46453
28-#14	4.14	22940	9331	49550	6619	56155	5127	59021	3943	62104	2090	66145	399	62923
29-#11	2.98	22030	8558	45098	6168	50658	4796	52486	3736	53369	2140	55121	748	47874
30-#11	3.08	22136	8626	45593	6193	51190	4810	53084	3739	54144	2121	56100	714	49213
31-#11	3.18	22212	8694	45882	6255	51657	4859	53688	3776	54971	2134	57099	685	50658
32-#11	3.28	22301	8762	46269	6298	52140	4890	54275	3796	52147	2003	58176	659	51966
33-#11	3.39	22388	8830	46660	6340	52648	4922	54886	3816	56632	2135	59197	631	53388
34-#11	3.49	22467	8898	47131	6367	53192	4939	55485	3822	57469	2126	60093	585	54760

ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.44	23541	8248	47207	5560	49749	4323	49066	3378	45926	2047	42356	1053	29574
7-#18	1.68	23784	8422	46331	6037	50642	4709	50942	3704	48685	2273	47272	1146	33246
8-#14	1.08	23334	7987	43169	5894	47356	4604	47243	3681	43893	2386	41369	1414	22534
8-#18	1.93	24150	8596	46922	6220	51822	4873	52526	3829	50948	2332	49908	1113	37858
9-#14	1.22	23357	8085	44036	5911	48182	4624	48119	3667	45098	2356	42858	1333	25259
9-#18	2.17	24192	8770	48280	6288	53250	4897	54129	3827	53120	2293	52649	981	41399
10-#14	1.35	23474	8183	45203	5850	49072	4573	49006	3614	42976	2118	43942	1272	27545
10-#18	2.41	24377	8943	49939	6260	54841	4875	55887	3790	51403	2033	54889	899	45896
11-#11	1.03	23217	7950	43047	5867	47178	4586	47009	3657	40683	2224	41141	1427	21821
11-#14	1.49	23667	8280	45123	6050	49679	4728	49963	3736	47542	2356	46028	1269	30125
11-#18	2.65	24717	9117	50227	6520	55881	5072	57308	3940	53524	2132	58092	855	49075
12-#11	1.13	23275	8018	43312	5941	47697	4644	47682	3706	44462	2396	42407	1419	23490
12-#14	1.62	23745	8378	45580	6142	50411	4787	50893	3798	48735	2367	47765	1251	32408
12-#18	2.89	24829	9291	51170	6661	57131	5195	58872	4030	59366	2293	60984	814	52842
13-#11	1.22	23403	8086	43874	5954	48214	4657	48294	3704	45305	2382	43271	1370	25344
13-#14	1.76	23920	8476	46323	6171	51157	4826	51799	3801	49975	2352	49041	1183	34822
13-#18	3.13	25116	9465	52349	6728	58464	5238	60485	4048	61565	2271	63274	696	56412
14-#11	1.31	23523	8154	44582	5941	48808	4646	48871	3680	46044	2336	44101	1315	26989
14-#14	1.90	24091	8574	47213	6175	52002	4819	52679	3783	51104	2297	50332	1112	37179
14-#18	3.37	25428	9639	53691	6777	59930	5261	62159	4047	63648	2192	65691	585	59844
15-#11	1.41	23621	8222	44663	6046	49263	4725	49561	3748	47013	2379	45517	1319	28774
15-#14	2.03	24229	8672	47469	6300	52653	4910	53603	3862	52402	2346	52228	1107	39437
15-#18	3.61	25618	9813	54392	6953	61067	5402	63659	4153	65778	2255	68773	554	63625
16-#11	1.50	23736	8290	44933	6110	49771	4769	50245	3788	47983	2400	46640	1286	30372
16-#14	2.17	24378	8770	47893	6385	53391	4967	54548	3914	53758	2372	53790	1056	41788
16-#18	3.85	25866	9987	55194	7091	62390	5514	65227	4232	68104	2294	71411	456	66868
17-#11	1.60	23804	8357	45465	6135	50315	4792	50833	3791	45524	2225	47639	1256	32148
17-#14	2.30	24474	8867	48621	6427	54160	5004	55413	3922	51251	2194	55240	1014	43938
17-#18	4.09	26044	10161	56410	7173	63688	5565	66801	4255	70137	2259	73972	383	70616
18-#11	1.69	23892	8425	46081	6144	50907	4801	51452	3784	46304	2201	48487	1195	33688
18-#14	2.44	24593	8965	49434	6455	54997	5030	56330	3922	56180	2322	56520	931	46317
18-#18	4.33	26224	10335	57723	7251	65139	5611	68454	4273	72396	2218	76303	243	74034
19-#11	1.78	24017	8493	46283	6224	51354	4856	52134	3841	50473	2379	49733	1196	35424
19-#14	2.57	24772	9063	49795	6553	55648	5096	57267	3993	53506	2187	58388	940	48381
19-#18	4.57	26542	10509	58461	7394	66313	5727	70020	4378	74335	2241	79428	243	77351
20-#11	1.88	24090	8561	46608	6282	51854	4894	52747	3867	51358	2389	51018	1184	36948
20-#14	2.71	24868	9161	50282	6633	56364	5146	58144	4027	58573	2353	60030	906	50532
20-#18	4.81	26713	10683	59348	7527	67560	5829	71576	4433	76476	2254	82242	176	81005
21-#11	1.97	24201	8629	47091	6311	52401	4921	53404	3883	52169	2375	51942	1146	38605
21-#14	2.84	25021	9259	50960	6678	57142	5188	59082	4053	59745	2335	61359	851	52596
21-#18	5.05	26945	10856	60524	7615	68912	5887	73174	4479	78535	2223	84561	80	83949

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.07	24318	8696	47632	6331	52989	4925	54022	3877	49479	2199	52911	1106	40190
22-#14	2.98	25193	9356	51680	6717	57990	5226	59980	4051	61006	2314	62786	797	54657
22-#18	5.30	27203	11030	61689	7700	70398	5948	74774	4487	75403	2046	87115	-14	87071
23-#11	2.16	24411	8764	47911	6398	53455	4986	54664	3924	53860	2370	54043	1084	41765
23-#14	3.11	25310	9454	52132	6803	58645	5280	60887	4111	62163	2327	64346	760	56791
24-#11	2.25	24511	8832	48261	6453	53966	5021	55271	3946	54741	2377	55165	1064	43350
24-#14	3.25	25448	9552	52657	6880	59375	5328	61745	4141	63399	2335	65931	729	58775
25-#11	2.35	24593	8900	48775	6477	54498	5049	55930	3965	55610	2372	56265	1030	44871
25-#14	3.38	25569	9650	53374	6916	60145	5372	62691	4169	64667	2330	67508	682	60985
26-#11	2.44	24681	8968	49330	6497	55061	5059	56570	3965	56409	2350	57129	988	46477
26-#14	3.52	25683	9748	54123	6951	60946	5414	63631	4175	65835	2301	68771	622	62956
27-#11	2.53	24798	9036	49590	6563	55545	5113	57198	4006	57299	2367	58358	969	47968
27-#14	3.66	25858	9846	54540	7040	61638	5463	64500	4227	67076	2321	70488	591	64982
28-#11	2.63	24878	9103	49981	6608	56070	5147	57810	4027	58129	2366	59361	939	49497
28-#14	3.79	25970	9943	55111	7102	62399	5510	65368	4255	68232	2316	71902	546	67037
29-#11	2.72	24987	9171	50413	6650	56596	5177	58468	4047	58989	2362	60564	917	50948
29-#14	3.93	26104	10041	55716	7164	63138	5554	66313	4285	69486	2312	73627	515	68986
30-#11	2.82	25100	9239	50936	6674	57158	5190	59091	4049	59803	2342	61596	883	52419
31-#11	2.91	25183	9307	51235	6736	57644	5240	59730	4087	60681	2356	62656	855	53905
32-#11	3.00	25280	9375	51646	6780	58153	5272	60359	4108	61624	2369	63798	830	55393
33-#11	3.10	25371	9443	52056	6822	58690	5303	60995	4127	62433	2358	64754	793	56872
34-#11	3.19	25456	9510	52558	6849	59264	5320	61625	4133	59093	2193	65821	756	58289
35-#11	3.29	25574	9578	52883	6908	59740	5367	62263	4168	64123	2353	66968	739	59745
36-#11	3.38	25659	9646	53285	6951	60255	5398	62881	4187	64990	2357	67981	704	61179

ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.33	26648	8888	53005	6023	55843	4687	54970	3673	47744	2105	47020	1209	31139
7-#18	1.55	26912	9062	51925	6530	56765	5099	56994	4020	54180	2498	52346	1315	35159
8-#18	1.77	27320	9236	52508	6721	58004	5269	58676	4151	56558	2561	55160	1286	39929
9-#14	1.12	26454	8725	49474	6408	54169	5016	54028	3985	50385	2581	47679	1500	26736
9-#18	1.99	27358	9410	53950	6785	59513	5290	60359	4147	58865	2522	58039	1152	43813
10-#14	1.24	26582	8823	50753	6338	55101	4957	54931	3925	51364	2490	48783	1436	29070
10-#18	2.21	27561	9584	55748	6747	61175	5260	62192	4103	60892	2402	60363	1069	48502
11-#14	1.37	26783	8921	50610	6548	55735	5110	55972	4057	52964	2582	51029	1438	31899
11-#18	2.43	27919	9757	55995	7019	62279	5466	63713	4262	63327	2515	63788	1031	52190
12-#11	1.03	26363	8658	48680	6443	53654	5041	53576	4029	49733	2623	47218	1588	24814
12-#14	1.49	26869	9018	51068	6644	56514	5184	56956	4120	54230	2596	52876	1422	34234
12-#18	2.65	28040	9931	56959	7162	63602	5593	65367	4355	65433	2524	66859	991	56348
13-#11	1.12	26500	8726	49287	6455	54193	5052	54209	4024	50612	2608	48120	1538	26742
13-#14	1.62	27058	9116	51869	6671	57291	5209	57897	4122	55528	2579	54213	1354	36880
13-#18	2.87	28350	10105	58227	7228	64990	5634	67065	4371	67769	2503	69269	873	59980
14-#11	1.21	26625	8794	50060	6436	54822	5037	54806	3997	51369	2560	48974	1481	28526
14-#14	1.74	27235	9214	52834	6671	58184	5210	58812	4100	52935	2355	55555	1281	39294
14-#18	3.09	28682	10279	59670	7272	66538	5653	68796	4366	69956	2423	71805	761	63736
15-#11	1.29	26731	8862	50110	6546	55297	5121	55543	4069	48918	2433	50490	1488	30381
15-#14	1.87	27380	9312	53066	6801	58867	5305	59796	4184	58087	2575	57577	1279	41771
15-#18	3.32	28885	10453	60364	7453	67733	5799	70388	4477	72204	2489	75079	734	67602
16-#11	1.38	26860	8930	50385	6612	55824	5166	56268	4111	53439	2629	51682	1455	32116
16-#14	1.99	27553	9410	53504	6888	59633	5364	60806	4238	59519	2602	59233	1229	44183
16-#18	3.54	29161	10627	61201	7593	69109	5912	72068	4559	74644	2528	77876	638	71148
17-#11	1.47	26930	8997	50952	6636	56398	5187	56882	4113	54269	2612	52729	1426	33959
17-#14	2.11	27651	9507	54277	6928	60450	5401	61703	4245	60730	2580	60756	1188	46540
17-#18	3.76	29346	10801	62489	7675	70496	5964	73701	4581	71674	2328	80574	566	75254
18-#11	1.55	27025	9065	51614	6642	57030	5179	57529	4104	55127	2585	53607	1365	35633
18-#14	2.24	27781	9605	55144	6953	61337	5424	62663	4243	62038	2550	62090	1104	48985
18-#18	3.98	29539	10975	63877	7749	72028	6007	75438	4596	79186	2453	83028	425	78705
19-#11	1.64	27157	9133	51809	6725	57491	5253	58224	4156	52319	2434	54936	1367	37457
19-#14	2.36	27970	9703	55512	7055	62011	5493	63655	4317	63275	2574	64076	1115	51266
19-#18	4.20	29846	11149	64651	7897	73245	6126	77095	4704	81216	2478	86332	429	82349
20-#11	1.72	27235	9201	52148	6785	58017	5291	58892	4190	56991	2618	56294	1356	39091
20-#14	2.49	28071	9801	56019	7136	62763	5544	64570	4351	64590	2585	65810	1082	53715
20-#18	4.42	30062	11323	65580	8031	74558	6229	78714	4760	83469	2492	89305	363	86063
21-#11	1.81	27355	9269	52657	6813	58593	5318	59581	4206	53977	2430	57266	1317	40916
21-#14	2.61	28237	9899	56731	7180	63584	5586	65564	4377	61433	2395	67212	1027	55856
21-#18	4.64	30308	11497	66810	8118	75985	6287	80420	4807	85642	2461	91757	268	89500

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 8,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.90	27477	9337	53237	6831	59208	5320	60236	4199	58712	2584	58278	1277	42525
22-#14	2.74	28419	9997	57501	7217	64469	5598	66510	4374	67125	2544	68707	973	58110
22-#18	4.86	30579	11670	68049	8201	77558	6347	82104	4815	88040	2431	94444	175	93122
23-#11	1.98	27581	9404	53518	6901	59700	5383	60909	4247	59611	2599	59482	1256	44251
23-#14	2.86	28547	10094	57965	7306	65167	5678	67457	4435	63804	2388	70365	937	60290
23-#18	5.08	30826	11844	68963	8338	78740	6449	83752	4910	84224	2300	97214	104	96470
24-#11	2.07	27689	9472	53879	6956	60240	5419	61548	4270	60552	2608	60667	1237	45873
24-#14	2.98	28698	10192	58506	7383	65935	5727	68361	4466	69672	2568	72038	907	62554
25-#11	2.16	27774	9540	54423	6980	60794	5447	62241	4288	61454	2602	61826	1204	47539
25-#14	3.11	28824	10290	59267	7419	66737	5770	69357	4494	70990	2562	73700	860	64737
26-#11	2.24	27869	9608	55020	6998	61388	5455	62904	4288	62289	2580	62730	1161	49185
26-#14	3.23	28947	10388	60069	7453	67581	5788	70335	4498	72214	2533	75026	801	66870
27-#11	2.33	27995	9676	55280	7066	61896	5511	63576	4330	63232	2598	64030	1143	50816
27-#14	3.36	29120	10486	60492	7543	68309	5861	71262	4553	73526	2554	76842	771	69092
28-#11	2.41	28078	9744	55689	7112	62443	5545	64221	4351	64098	2596	65092	1114	52465
28-#14	3.48	29254	10584	61090	7606	69101	5909	72177	4582	74762	2551	78339	727	71178
29-#11	2.50	28190	9811	56146	7153	63002	5575	64905	4371	65011	2593	66357	1092	54042
29-#14	3.61	29396	10681	61730	7668	69888	5953	73171	4611	76064	2546	80155	696	73314
30-#11	2.59	28315	9879	56698	7176	63595	5588	65559	4373	61473	2402	67441	1058	55684
30-#14	3.73	29555	10779	62494	7706	70732	5976	74118	4618	77305	2521	81724	649	75478
31-#11	2.67	28407	9947	57006	7240	64100	5639	66233	4411	66791	2588	68563	1031	57229
31-#14	3.85	29700	10877	62968	7792	71465	6044	75066	4669	78604	2538	83294	606	77581
32-#11	2.76	28512	10015	57442	7285	64635	5671	66899	4433	67775	2601	69769	1006	58822
33-#11	2.84	28608	10083	57870	7326	65200	5702	67565	4452	64056	2418	70776	969	60335
34-#11	2.93	28698	10150	58403	7352	65798	5718	68227	4457	69560	2581	71898	933	61881
35-#11	3.02	28817	10218	58739	7412	66305	5766	68899	4493	65712	2413	73108	917	63429
36-#11	3.10	28915	10286	59157	7455	66847	5797	69543	4513	71318	2589	74177	883	64933
37-#11	3.19	29016	10354	59643	7490	67406	5829	70228	4534	72181	2580	75307	857	66514

ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	2.07	4106	2848	8418	1805	8659	1393	8436	1071	7286	569	7040	241	5680
6-#14	2.98	4181	3024	8899	1881	9230	1444	9112	1089	8127	521	7978	110	7487
6-#18	5.31	4307	3469	10035	2073	10592	1571	10728	1128	10864	419	10186	-241	10210
7-#11	2.41	4095	2914	8385	1967	8876	1519	8785	1174	7760	640	7857	264	6309
7-#14	3.48	4145	3119	8919	2067	9507	1586	9529	1204	9324	644	9017	124	8385
7-#18	6.19	4261	3638	10176	2322	11011	1756	11312	1275	10962	493	11964	-216	11717
8-#11	2.76	4116	2980	8504	2027	9100	1575	9074	1216	8661	691	8437	259	7137
8-#14	3.98	4172	3214	9116	2145	9818	1658	9922	1257	9138	601	9808	112	9291
8-#18	7.07	4309	3808	10548	2441	11529	1866	11951	1353	12496	516	13047	-283	12602
9-#11	3.10	4144	3047	8717	2055	9320	1581	9326	1211	9029	672	8797	193	7711
9-#14	4.48	4218	3310	9396	2190	10129	1672	10285	1253	10322	620	10324	19	10227
9-#18	7.96	4382	3978	10994	2530	12057	1897	12578	1352	12522	443	13922	-448	13639
10-#11	3.45	4152	3113	8987	2050	9568	1577	9593	1197	9348	625	9111	144	8386
10-#14	4.97	4223	3405	9748	2196	10485	1677	10682	1241	10800	558	10796	-50	10800
11-#11	3.79	4191	3179	9057	2139	9762	1640	9862	1245	9740	656	9637	111	9062
11-#14	5.47	4284	3501	9883	2308	10751	1754	11036	1299	11317	593	11497	-105	11461
12-#11	4.14	4234	3245	9209	2185	9982	1683	10134	1275	10077	651	10104	89	9653
12-#14	5.97	4332	3596	10106	2370	11059	1812	11414	1338	11120	571	12139	-139	12120
13-#11	4.48	4251	3311	9404	2221	10204	1697	10418	1287	10492	648	10544	43	10350
13-#14	6.47	4370	3691	10373	2424	11372	1834	11817	1357	12373	579	12763	-206	12673
14-#11	4.83	4277	3377	9644	2233	10450	1708	10673	1276	10148	581	10853	-15	10855
15-#11	5.17	4299	3443	9752	2302	10647	1753	10948	1318	10449	587	11375	-39	11368
16-#11	5.52	4331	3510	9915	2343	10866	1792	11197	1334	11566	631	11941	-60	11934

ROUND SPIRAL COLUMNS 26" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.76	5204	3274	10509	2107	10819	1631	10515	1265	9641	748	8673	347	6299
6-#14	2.54	5284	3449	11056	2183	11468	1683	11281	1283	10662	699	9747	221	8632
6-#18	4.52	5464	3894	12358	2378	13025	1815	13126	1328	13122	568	12301	-114	12317
7-#11	2.06	5207	3340	10421	2288	11067	1773	10931	1382	10248	835	9637	378	7056
7-#14	2.97	5276	3545	11035	2390	11783	1843	11775	1414	10631	743	10964	244	9543
7-#18	5.27	5411	4064	12480	2649	13501	2017	13808	1492	14149	690	14122	-111	14136
8-#11	2.35	5237	3406	10542	2354	11317	1834	11260	1428	10646	843	10298	377	8017
8-#14	3.39	5314	3640	11232	2472	12132	1920	12221	1471	11924	801	11864	237	10636
8-#18	6.03	5468	4234	12887	2774	14087	2134	14535	1576	15007	684	15597	-139	15135
9-#11	2.64	5262	3472	10788	2379	11565	1839	11540	1422	11054	824	10703	311	8734
9-#14	3.81	5361	3735	11561	2516	12483	1932	12627	1467	12517	776	12449	143	11607
9-#18	6.78	5579	4403	13402	2862	14686	2165	15243	1575	16043	644	16602	-303	16399
10-#11	2.94	5276	3538	11118	2370	11844	1830	11834	1404	11402	775	11046	261	9568
10-#14	4.24	5369	3831	11983	2517	12884	1933	13067	1452	12175	665	12973	76	12575
10-#18	7.53	5615	4573	14044	2891	15379	2188	16035	1566	17002	542	17552	-419	17380
11-#11	3.23	5324	3604	11168	2465	12062	1900	12143	1458	11853	810	11652	233	10267
11-#14	4.66	5435	3926	12104	2636	13183	2017	13473	1515	13639	753	13778	27	13659
12-#11	3.53	5359	3671	11333	2514	12308	1946	12451	1490	12236	807	12187	213	10983
12-#14	5.09	5497	4022	12348	2701	13530	2078	13900	1558	14166	745	14514	-5	14513

ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
13-#11	3.82	5395	3737	11556	2549	12558	1959	12743	1492	12698	805	12679	169	11741
13-#14	5.51	5531	4117	12653	2754	13883	2099	14352	1576	14827	743	15216	-70	15185
14-#11	4.11	5434	3803	11827	2558	12835	1967	13052	1489	13120	779	13027	110	12407
14-#14	5.93	5585	4212	13026	2777	14276	2118	14766	1564	14413	661	15722	-152	15684
15-#11	4.41	5455	3869	11947	2631	13055	2016	13363	1534	13488	788	13622	90	13166
16-#11	4.70	5474	3935	12127	2674	13302	2057	13644	1552	13906	791	14263	70	13873
17-#11	5.00	5528	4001	12355	2702	13552	2073	13959	1567	14279	772	14653	21	14545
18-#11	5.29	5551	4067	12581	2730	13825	2090	14252	1562	14706	752	15130	-27	15124

ROUND SPIRAL COLUMNS 28" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.52	6479	3733	12916	2434	13312	1888	12911	1473	11743	896	10533	460	6919
6-#14	2.19	6574	3909	13532	2511	14038	1941	13767	1493	12883	849	11744	338	9615
6-#18	3.90	6802	4354	15002	2708	15791	2076	15842	1543	14604	677	14645	15	14573
7-#11	1.77	6498	3800	12760	2636	13590	2049	13400	1606	11630	929	11657	499	7817
7-#14	2.56	6587	4004	13445	2738	14392	2120	14344	1640	13736	959	13152	370	10667
7-#18	4.55	6768	4524	15092	3002	16326	2298	16630	1724	16833	861	16736	28	16568
8-#11	2.03	6535	3866	12881	2707	13858	2114	13772	1657	12051	939	12213	478	8841
8-#14	2.92	6636	4100	13650	2826	14779	2202	14845	1702	14339	967	13894	332	12044
8-#18	5.20	6841	4693	15503	3130	16979	2421	17446	1813	16613	802	18395	7	18358
9-#11	2.28	6558	3932	13162	2730	14142	2118	14079	1649	12468	921	12851	435	9693
9-#14	3.29	6672	4195	14025	2867	15170	2213	15294	1697	13993	880	14818	273	13037
9-#18	5.85	6922	4863	16105	3218	17650	2451	18234	1812	18951	821	19528	-155	19435
10-#11	2.53	6578	3998	13542	2714	14453	2104	14398	1627	13732	935	13220	385	10701
10-#14	3.65	6696	4290	14527	2864	15617	2208	15776	1678	15567	877	15390	207	14185
10-#18	6.50	7007	5032	16851	3243	18425	2470	19112	1801	20012	719	20585	-268	20474
11-#11	2.79	6637	4064	13582	2818	14692	2180	14749	1687	14248	975	13912	362	11505
11-#14	4.02	6775	4386	14626	2990	15949	2300	16236	1748	16241	923	16304	163	15322
11-#18	7.15	7096	5202	17141	3428	18975	2598	19833	1895	21070	777	22036	-367	21707
12-#11	3.04	6671	4130	13759	2869	14958	2227	15093	1721	13698	909	14515	343	12366
12-#14	4.38	6843	4481	14892	3057	16333	2363	16713	1793	16832	917	17135	133	16361
13-#11	3.29	6717	4196	14009	2903	15241	2240	15416	1723	15133	962	15059	300	13151
13-#14	4.75	6883	4577	15236	3110	16727	2384	17175	1797	17563	915	17915	70	17555
14-#11	3.55	6771	4262	14311	2908	15553	2247	15755	1718	14604	882	15444	241	13942
14-#14	5.12	6957	4672	15645	3128	17165	2401	17671	1797	18240	881	18481	-12	18479
15-#11	3.80	6783	4329	14458	2976	15791	2299	16104	1767	14992	894	16114	223	14798
15-#14	5.48	6985	4767	15847	3228	17506	2467	18147	1859	18801	892	19395	-43	19372
16-#11	4.05	6815	4395	14641	3031	16060	2341	16417	1786	15427	898	16641	181	15562
16-#14	5.85	7019	4863	16137	3289	17891	2524	18583	1883	19451	896	20126	-106	20071
17-#11	4.31	6866	4461	14886	3058	16342	2358	16765	1801	16941	942	17265	157	16370
18-#11	4.56	6903	4527	15143	3084	16651	2373	17089	1795	16249	861	17795	109	17124
19-#11	4.81	6937	4593	15317	3140	16893	2415	17427	1834	17821	927	18321	78	17875
20-#11	5.07	6985	4659	15503	3191	17164	2454	17741	1851	17061	867	18919	45	18684

ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.32	7946	4227	15666	2786	16162	2164	15648	1697	14133	1054	12638	579	7540
6-#14	1.91	8055	4403	16349	2863	16966	2218	16594	1719	15392	1010	13987	461	10506
6-#18	3.40	8299	4848	17989	3062	18916	2356	18899	1772	18460	891	17237	149	16434
7-#11	1.54	7975	4293	15426	3011	16468	2345	16219	1848	14973	1166	13938	628	8591
7-#14	2.23	8090	4498	16182	3113	17359	2417	17262	1883	16382	1132	15601	502	11731
7-#18	3.96	8319	5017	18007	3378	19510	2599	19801	1971	19817	1041	19611	172	18486
8-#11	1.77	8025	4359	15542	3088	16752	2415	16633	1902	15482	1181	14565	610	9670
8-#14	2.55	8150	4593	16392	3206	17765	2503	17820	1949	15920	1069	16435	469	13369
8-#18	4.53	8410	5187	18444	3512	20230	2727	20708	2065	20897	1045	21458	158	20572
9-#11	1.99	8046	4425	15861	3108	17067	2416	16967	1893	15965	1161	15262	567	10670
9-#14	2.86	8183	4689	16815	3246	18213	2513	18310	1942	17769	1120	17449	410	14515
9-#18	5.09	8491	5356	19120	3598	20973	2757	21576	2064	20685	940	22720	-4	22719
10-#11	2.21	8072	4492	16291	3084	17421	2397	17309	1866	16361	1106	15651	516	11733
10-#14	3.18	8215	4784	17374	3235	18709	2503	18833	1919	17162	981	18066	343	15859
10-#18	5.66	8524	5526	19992	3619	21831	2771	22538	2049	23322	903	23880	-115	23835
11-#11	2.43	8141	4558	16320	3198	17669	2480	17705	1933	16945	1151	16434	497	12675
11-#14	3.50	8308	4880	17474	3371	19065	2602	19349	1996	19146	1103	19094	304	17066
11-#18	6.22	8700	5696	20261	3812	22437	2907	23344	2151	24505	968	25504	-206	25311
12-#11	2.65	8174	4624	16508	3251	17961	2530	18085	1969	17420	1152	17107	479	13733
12-#14	3.82	8357	4975	17760	3440	19477	2667	19876	2043	18481	1026	20022	276	18246
12-#18	6.79	8786	5865	20783	3922	23159	3012	24227	2224	25596	953	27040	-263	26852
13-#11	2.87	8224	4690	16779	3283	18273	2542	18439	1970	17919	1140	17703	437	14605
13-#14	4.14	8430	5070	18138	3492	19919	2688	20384	2047	20521	1083	20878	215	19550
13-#18	7.36	8903	6035	21417	4022	23904	3054	25110	2235	26990	951	28526	-374	27820
14-#11	3.09	8302	4756	17122	3285	18623	2546	18807	1963	18475	1122	18123	377	15532
14-#14	4.46	8526	5166	18591	3506	20413	2704	20925	2046	21340	1062	21502	133	20650
15-#11	3.31	8310	4822	17271	3357	18878	2602	19195	2016	18941	1137	18870	363	16417
15-#14	4.77	8552	5261	18838	3597	20775	2773	21453	2111	21965	1077	22520	105	21912
16-#11	3.53	8348	4888	17467	3414	19173	2645	19540	2036	19455	1143	19458	321	17309
16-#14	5.09	8592	5356	19131	3675	21192	2831	21936	2138	21171	1010	23336	43	23059
17-#11	3.75	8403	4955	17741	3440	19483	2662	19923	2051	19907	1124	20142	299	18187
17-#14	5.41	8666	5452	19505	3715	21631	2857	22482	2160	23331	1056	24312	11	24249
18-#11	3.97	8429	5021	18030	3464	19815	2675	20276	2044	20417	1103	20723	250	19024
19-#11	4.19	8488	5087	18214	3523	20088	2721	20650	2086	20873	1110	21308	223	19912
20-#11	4.41	8539	5153	18408	3575	20387	2760	20996	2103	21379	1113	21967	192	20738
21-#11	4.63	8576	5219	18683	3605	20691	2779	21377	2120	21894	1106	22464	150	21596

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.16	9617	4755	18780	3163	19395	2460	18750	1937	15709	1142	15007	706	8161
6-#14	1.68	9741	4930	19532	3240	20277	2515	19787	1960	16995	1102	16493	590	11393
6-#18	2.98	10022	5375	21343	3440	22424	2655	22323	2016	21582	1067	20093	287	18379
7-#11	1.36	9659	4821	18441	3413	19721	2662	19411	2106	17808	1349	16498	764	9378
7-#14	1.96	9791	5026	19269	3515	20701	2735	20553	2142	19350	1317	18329	642	12812
7-#18	3.48	10078	5545	21272	3780	23078	2920	23346	2234	23124	1232	22767	321	20468
8-#11	1.55	9719	4887	18549	3495	20029	2737	19862	2164	18376	1368	17200	750	10506
8-#14	2.24	9869	5121	19480	3614	21134	2825	21170	2213	20100	1334	19259	613	14545
8-#18	3.98	10187	5715	21732	3921	23845	3053	24346	2334	24320	1241	24249	252	22871
9-#11	1.75	9739	4953	18909	3513	20374	2736	20230	2154	18895	1346	17953	706	11681
9-#14	2.52	9900	5216	19954	3650	21625	2833	21701	2205	20869	1308	20361	553	15900
9-#18	4.48	10249	5884	22484	4005	24680	3082	25293	2332	25697	1203	26194	151	25124
10-#11	1.94	9772	5019	19393	3481	20771	2711	20592	2122	19308	1288	18359	653	12777
10-#14	2.80	9941	5312	20576	3631	22184	2819	22262	2177	21528	1236	21018	485	17596
10-#18	4.97	10308	6054	23459	4018	25621	3091	26337	2313	26951	1097	27453	43	27186
11-#11	2.13	9851	5085	19400	3604	21030	2802	21036	2195	19965	1339	19237	639	13867
11-#14	3.08	10049	5407	20669	3778	22555	2924	22837	2261	22376	1293	22166	452	18828
11-#18	5.47	10482	6223	23732	4221	26284	3236	27231	2422	28265	1168	29257	-42	29217
12-#11	2.33	9883	5152	19603	3660	21348	2854	21445	2233	20489	1341	19983	623	14977
12-#14	3.36	10096	5503	20974	3850	23004	2992	23415	2310	23096	1292	23192	425	20196
12-#18	5.97	10603	6393	24295	4335	27053	3342	28200	2499	29465	1156	30958	-97	30891
13-#11	2.52	9942	5218	19896	3690	21688	2865	21836	2234	19627	1240	20629	581	15991
13-#14	3.64	10184	5598	21380	3900	23487	3012	23968	2314	23878	1276	24124	366	21542
13-#18	6.47	10702	6562	24995	4434	27884	3385	29166	2510	30833	1130	32585	-204	32358
14-#11	2.72	10035	5284	20283	3688	22060	2865	22233	2225	21625	1309	21082	521	17134
14-#14	3.92	10299	5693	21888	3910	24029	3025	24554	2310	24762	1254	24804	283	22817
14-#18	6.96	10892	6732	25798	4476	28803	3426	30213	2519	32419	1101	33804	-345	33419
15-#11	2.91	10043	5350	20430	3765	22348	2926	22632	2271	22144	1327	21909	509	18077
15-#14	4.20	10311	5789	22143	4006	24422	3099	25136	2379	23758	1187	25928	259	24243
16-#11	3.10	10089	5416	20632	3823	22669	2971	23032	2302	22706	1334	22559	469	19113
16-#14	4.48	10373	5884	22451	4085	24878	3159	25664	2407	26241	1279	26830	199	25522
17-#11	3.30	10147	5482	20942	3850	23002	2986	23451	2317	21651	1228	23195	435	20016
17-#14	4.76	10452	5980	22870	4126	25357	3184	26259	2430	26946	1253	27894	168	26825
18-#11	3.49	10176	5548	21266	3871	23360	2998	23838	2309	23748	1295	23933	398	20983
18-#14	5.04	10523	6075	23304	4165	25870	3208	26816	2424	27750	1226	28811	99	28121
19-#11	3.69	10238	5615	21449	3933	23657	3046	24244	2353	24252	1303	24578	374	21963
19-#14	5.32	10588	6170	23601	4245	26290	3269	27382	2480	28439	1233	29697	58	29335
20-#11	3.88	10300	5681	21658	3985	23992	3087	24619	2371	24804	1308	25299	344	22853
21-#11	4.07	10342	5747	21960	4015	24314	3105	25037	2388	25364	1301	25845	302	23850
22-#11	4.27	10401	5813	22275	4045	24669	3123	25433	2386	25862	1275	26473	260	24720
23-#11	4.46	10439	5879	22475	4098	24972	3164	25829	2423	24653	1202	27221	242	25657

ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#11	1.03	11505	5317	22283	3565	23036	2776	22242	2193	19859	1404	17657	840	8785
6-#14	1.49	11646	5492	23105	3642	23996	2831	23370	2216	21356	1362	19280	727	12281
6-#18	2.64	11964	5937	25087	3842	26341	2972	26136	2275	25034	1252	23230	432	20408
7-#11	1.20	11561	5383	21828	3841	23382	3000	23002	2381	20926	1534	19356	909	10178
7-#14	1.73	11715	5587	22729	3943	24444	3073	24244	2418	22661	1513	21355	789	13909
7-#18	3.08	12058	6107	24911	4208	27055	3261	27290	2513	26774	1433	26222	477	22605
8-#11	1.37	11632	5449	21922	3931	23713	3080	23486	2443	21618	1566	20137	899	11348
8-#14	1.98	11808	5683	22935	4049	24912	3169	24905	2493	23491	1534	22385	765	15728
8-#18	3.52	12186	6276	25390	4356	27856	3398	28385	2618	28089	1446	27856	413	25255
9-#11	1.55	11650	5515	22326	3944	24088	3076	23888	2431	22170	1543	20944	853	12694
9-#14	2.23	11835	5778	23463	4082	25446	3174	25492	2483	24315	1507	23573	704	17284
9-#18	3.97	12242	6446	26221	4437	28777	3426	29410	2615	27605	1314	29968	312	27565
10-#11	1.72	11689	5581	22872	3904	24523	3046	24272	2394	21090	1383	21361	798	13831
10-#14	2.48	11886	5874	24153	4054	26069	3155	26088	2450	23342	1337	24265	635	19074
10-#18	4.41	12316	6616	27285	4442	29822	3431	30534	2591	30922	1300	31322	204	29925
11-#11	1.89	11779	5647	22847	4037	24799	3144	24757	2474	21777	1435	22342	789	15081
11-#14	2.73	12008	5969	24226	4211	26453	3268	26725	2542	25951	1495	25538	606	20552
11-#18	4.85	12514	6785	27574	4657	30510	3582	31518	2709	30213	1286	33312	126	32524
12-#11	2.06	11811	5713	23064	4097	25142	3198	25201	2514	23906	1542	23161	774	16236
12-#14	2.97	12055	6064	24556	4287	26939	3338	27339	2592	26739	1496	26665	582	22211
12-#18	5.29	12644	6955	28178	4774	31345	3692	32575	2788	33682	1369	35181	74	34671
13-#11	2.23	11879	5780	23380	4125	25512	3209	25621	2513	24486	1529	23743	721	17399
13-#14	3.22	12146	6160	24992	4334	27464	3357	27948	2596	27581	1480	27673	523	23589
13-#18	5.73	12755	7124	28922	4871	32249	3735	33622	2800	35165	1344	36948	-30	36914
14-#11	2.41	11969	5846	23815	4119	25906	3205	26058	2503	24996	1488	24339	671	18589
14-#14	3.47	12281	6255	25557	4341	28038	3366	28582	2591	28528	1456	28406	439	25050
14-#18	6.17	12956	7294	29810	4909	33280	3775	34756	2807	36876	1314	38277	-171	38125
15-#11	2.58	11996	5912	23958	4201	26218	3270	26484	2552	25693	1529	25250	663	19673
15-#14	3.72	12304	6351	25817	4442	28478	3445	29170	2649	27339	1379	29639	419	26523
15-#18	6.61	13023	7463	30352	5056	33993	3885	35798	2914	38103	1334	40297	-223	40004
16-#11	2.75	12049	5978	24164	4259	26573	3317	26919	2585	26305	1537	25962	623	20858
16-#14	3.97	12375	6446	26135	4522	28971	3507	29778	2692	30147	1486	30627	360	27979
17-#11	2.92	12103	6044	24506	4286	26924	3331	27372	2599	26835	1518	26650	591	21887
17-#14	4.21	12458	6541	26605	4563	29481	3531	30428	2715	30909	1460	31615	313	29465
18-#11	3.09	12144	6110	24872	4305	27312	3341	27790	2590	27424	1497	27445	553	22999
18-#14	4.46	12508	6637	27085	4600	30033	3553	31038	2708	31774	1433	32772	262	30797
19-#11	3.26	12214	6176	25052	4369	27634	3392	28230	2636	27977	1507	28150	531	24007
19-#14	4.71	12615	6732	27385	4682	30488	3617	31645	2767	32528	1443	33739	224	32198
20-#11	3.44	12269	6242	25275	4423	27991	3434	28638	2655	28577	1513	28933	503	25027
20-#14	4.96	12692	6828	27712	4756	31005	3676	32219	2792	33371	1448	34841	182	33614

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
21-#11	3.61	12329	6309	25605	4453	28345	3452	29089	2672	27178	1396	29529	461	26077
22-#11	3.78	12400	6375	25945	4480	28730	3469	29508	2668	27735	1381	30205	420	27052
23-#11	3.95	12440	6441	26162	4536	29057	3512	29947	2708	30319	1494	31025	402	28128
24-#11	4.12	12483	6507	26402	4588	29401	3551	30358	2726	30856	1488	31671	365	29125
25-#11	4.30	12548	6573	26713	4618	29763	3571	30803	2744	31458	1483	32412	330	30118

ROUND SPIRAL COLUMNS 36" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#14	1.33	13782	6088	27091	4069	28148	3166	27367	2488	24854	1554	22367	871	13171
6-#18	2.36	14139	6533	29246	4270	30692	3309	30364	2549	28836	1448	26667	582	22187
7-#11	1.07	13689	5979	25609	4297	27476	3359	27011	2672	22835	1624	22532	1061	10990
7-#14	1.55	13867	6183	26583	4398	28621	3432	28358	2710	26244	1707	24698	944	15021
7-#18	2.75	14271	6703	28946	4663	31441	3621	31658	2808	30790	1644	29994	639	24599
8-#11	1.23	13777	6045	25685	4393	27831	3445	27535	2739	25228	1777	23395	1055	12195
8-#14	1.77	13979	6279	26781	4511	29122	3534	29062	2789	27250	1746	25831	924	16918
8-#18	3.14	14419	6872	29440	4819	32302	3764	32842	2918	30079	1552	31785	581	27722
9-#11	1.38	13793	6111	26135	4403	28237	3438	27962	2725	25812	1752	24254	1008	13725
9-#14	1.99	14003	6374	27365	4541	29699	3536	29698	2778	28127	1717	27104	862	18690
9-#18	3.54	14470	7042	30353	4897	33299	3789	33952	2914	33824	1624	34063	480	30074
10-#11	1.53	13839	6177	26748	4354	28697	3400	28375	2683	26248	1686	24677	951	14896
10-#14	2.21	14063	6469	28130	4504	30373	3510	30337	2740	26929	1529	27826	791	20557
10-#18	3.93	14558	7211	31511	4892	34457	3790	35154	2885	35256	1513	35505	372	32750
11-#11	1.69	13934	6243	26684	4497	29001	3508	28900	2769	27067	1748	25766	946	16317
11-#14	2.43	14201	6565	28172	4671	30785	3632	31021	2838	29894	1707	29231	768	22236
11-#18	4.32	14781	7381	31805	5119	35170	3949	36231	3011	36845	1597	37687	300	35431
12-#11	1.84	13970	6309	26915	4560	29369	3565	29382	2812	27691	1754	26660	934	17510
12-#14	2.65	14246	6660	28528	4751	31308	3705	31686	2892	30750	1710	30460	745	24091
12-#18	4.72	14865	7551	32452	5240	36071	4062	37369	3093	35717	1485	39726	251	37864
13-#11	1.99	14047	6375	27256	4586	29765	3573	29832	2810	26423	1625	27283	881	18851
13-#14	2.87	14350	6756	28995	4796	31875	3723	32340	2894	31653	1694	31368	670	25657
13-#18	5.11	15044	7720	33242	5333	37049	4104	38505	3105	39865	1567	41632	149	40669
14-#11	2.15	14142	6441	27742	4576	30185	3566	30296	2797	26925	1584	27915	829	20064
14-#14	3.09	14496	6851	29622	4798	32481	3727	33034	2887	32472	1640	32325	603	27350
14-#18	5.50	15258	7890	34218	5368	38140	4139	39723	3110	41700	1536	43070	7	43015
15-#11	2.30	14181	6508	27876	4663	30520	3636	30762	2850	29611	1742	28912	824	21297
15-#14	3.32	14530	6946	29882	4905	32954	3812	33657	2949	31264	1581	33671	586	28900
15-#18	5.89	15348	8059	34785	5521	38932	4257	40856	3222	40169	1456	45269	-40	45218
16-#11	2.45	14241	6574	28086	4723	30911	3684	31232	2884	30274	1751	29687	785	22527
16-#14	3.54	14612	7042	30209	4986	33498	3876	34315	2994	34422	1704	34747	527	30505
16-#18	6.29	15455	8229	35413	5657	39849	4360	41903	3268	41633	1466	47073	-149	46876
17-#11	2.61	14297	6640	28458	4748	31280	3698	31718	2898	30841	1733	30426	753	23697
17-#14	3.76	14700	7137	30723	5026	34034	3899	35014	3017	35241	1678	35811	482	32036
18-#11	2.76	14344	6706	28870	4766	31699	3705	32153	2886	31468	1710	31275	715	24944
18-#14	3.98	14755	7233	31259	5061	34631	3919	35666	3008	36166	1651	37054	430	33543

ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
19-#11	2.91	14423	6772	29045	4833	32043	3759	32640	2935	29933	1608	32043	696	26074
19-#14	4.20	14863	7328	31560	5146	35119	3985	36326	3069	36986	1662	38104	396	35145
20-#11	3.07	14479	6838	29282	4888	32418	3802	33083	2956	32719	1729	32891	669	27260
20-#14	4.42	14959	7423	31909	5222	35664	4045	36946	3096	37897	1669	39295	355	36582
21-#11	3.22	14549	6904	29639	4917	32809	3820	33560	2972	31082	1598	33534	627	28338
21-#14	4.64	15034	7519	32407	5266	36208	4072	37639	3122	36151	1536	40213	296	38134
22-#11	3.37	14634	6971	30007	4942	33225	3835	34004	2967	33940	1695	34257	586	29446
22-#14	4.86	15152	7614	32911	5310	36799	4100	38288	3120	39662	1624	41265	238	39619
23-#11	3.52	14666	7037	30232	5000	33567	3880	34480	3009	32287	1598	35150	570	30587
24-#11	3.68	14723	7103	30495	5053	33937	3920	34935	3028	35173	1706	35850	534	31679
25-#11	3.83	14792	7169	30825	5083	34328	3940	35402	3046	35820	1701	36650	499	32793
26-#11	3.98	14838	7235	31174	5114	34751	3961	35855	3045	33979	1566	37265	452	33840
27-#11	4.14	14914	7301	31457	5157	35091	3999	36325	3082	34578	1577	38272	440	34923

ROUND SPIRAL COLUMNS 38" DIA.

6-#14	1.19	16163	6718	31513	4521	32761	3522	31804	2776	28722	1757	25770	1022	14062
6-#18	2.12	16560	7163	33844	4722	35503	3665	35032	2838	30808	1544	30421	739	23758
7-#14	1.39	16260	6813	30855	4881	33256	3812	32911	3019	30302	1926	28378	1107	16149
7-#18	2.47	16721	7333	33400	5145	36284	4001	36475	3119	32847	1743	34102	808	26462
8-#11	1.10	16167	6675	29859	4883	32407	3832	32035	3053	29230	1999	26993	1219	13049
8-#14	1.59	16396	6909	31039	5001	33791	3920	33670	3103	29306	1838	29619	1091	18116
8-#18	2.82	16900	7502	33903	5308	37206	4151	37725	3234	34307	1764	36054	756	30265
9-#11	1.24	16181	6741	30360	4889	32843	3821	32487	3036	29844	1973	27777	1160	14688
9-#14	1.79	16417	7004	31683	5026	34412	3920	34345	3090	32329	1939	30973	1028	20116
9-#18	3.17	16945	7672	34902	5382	38280	4174	38943	3229	35896	1728	38495	654	32647
10-#11	1.38	16234	6807	31047	4830	33331	3775	32925	2988	28265	1775	28325	1112	15972
10-#14	1.98	16487	7099	32530	4980	35124	3885	35032	3047	30875	1733	31718	955	22054
10-#18	3.53	17049	7841	36160	5368	39554	4169	40220	3195	37309	1620	40022	545	35660
11-#11	1.51	16339	6873	30936	4984	33662	3893	33493	3082	29112	1839	29529	1112	17535
11-#14	2.18	16640	7195	32533	5158	35576	4017	35766	3152	34227	1931	33263	937	23947
11-#18	3.88	17297	8011	36437	5606	40290	4336	41385	3329	38929	1705	42402	480	38409
12-#11	1.65	16375	6939	31177	5051	34055	3952	34013	3127	31868	1978	30501	1101	18799
12-#14	2.38	16684	7290	32913	5242	36135	4093	36484	3208	32809	1808	34596	916	25875
12-#18	4.23	17379	8180	37140	5732	41256	4452	42588	3413	40362	1703	44613	433	41145
13-#11	1.79	16461	7005	31545	5075	34471	3959	34493	3124	32526	1964	31162	1048	20310
13-#14	2.58	16800	7386	33412	5284	36738	4110	37182	3210	33707	1792	35565	842	27641
13-#18	4.59	17584	8350	37978	5823	42309	4494	43821	3425	41958	1680	46657	333	44201
14-#11	1.93	16560	7071	32085	5059	34923	3948	34972	3107	33088	1919	31826	995	21557
14-#14	2.78	16942	7481	34104	5282	37383	4110	37916	3199	36980	1864	36581	773	29600
14-#18	4.94	17811	8520	39045	5854	43456	4524	45140	3429	43785	1650	48202	191	46673

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 38" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#11	2.06	16612	7137	32206	5153	35280	4023	35490	3165	33920	1967	32914	992	22949
15-#14	2.98	17004	7576	34361	5394	37889	4199	38595	3265	38093	1921	38043	759	31277
15-#18	5.29	17892	8689	39633	6013	44326	4648	46257	3518	48364	1796	50582	148	49525
16-#11	2.20	16680	7204	32419	5214	35700	4073	35995	3200	34634	1977	33753	955	24218
16-#14	3.17	17096	7672	34696	5477	38484	4266	39303	3312	36482	1804	39208	702	33098
16-#18	5.64	18041	8859	40283	6149	45315	4754	47460	3592	46716	1688	52538	40	52216
17-#11	2.34	16737	7270	32823	5238	36094	4085	36510	3214	35239	1958	34542	923	25561
17-#14	3.37	17178	7767	35251	5516	39047	4287	40050	3334	37299	1780	40347	657	34666
17-#18	6.00	18190	9028	41211	6227	46328	4801	48768	3636	51591	1766	54530	-40	54471
18-#11	2.48	16791	7336	33283	5253	36544	4090	36965	3200	35901	1934	35195	860	26828
18-#14	3.57	17250	7862	35849	5550	39687	4305	40729	3323	40947	1879	41674	605	36360
19-#11	2.61	16879	7402	33450	5323	36912	4147	37493	3252	34120	1819	36277	867	28101
19-#14	3.77	17370	7958	36148	5637	40210	4375	41454	3388	41836	1893	42809	574	38021
20-#11	2.75	16936	7468	33700	5379	37305	4191	37978	3274	37254	1956	37189	842	29395
20-#14	3.97	17452	8053	36518	5714	40780	4435	42123	3416	39960	1774	44090	535	39623
21-#11	2.89	17010	7534	34086	5408	37723	4208	38477	3289	37875	1940	37881	801	30608
21-#14	4.17	17556	8149	37055	5758	41375	4462	42853	3441	43709	1878	45080	476	41376
22-#11	3.03	17111	7600	34483	5431	38179	4223	38951	3283	35983	1794	38649	760	31956
22-#14	4.36	17685	8244	37595	5800	42012	4490	43543	3438	44700	1856	46203	419	42883
23-#11	3.16	17146	7667	34715	5492	38535	4269	39464	3327	36642	1811	39617	744	33069
23-#14	4.56	17750	8339	37959	5878	42530	4549	44255	3494	45676	1877	47541	393	44532
24-#11	3.30	17210	7733	35000	5546	38931	4310	39944	3346	39881	1936	40371	709	34295
25-#11	3.44	17283	7799	35349	5575	39350	4329	40451	3364	40573	1930	41229	675	35440
26-#11	3.58	17334	7865	35729	5604	39796	4349	40935	3363	41197	1907	41885	628	36616
27-#11	3.71	17412	7931	36026	5649	40168	4390	41439	3401	41888	1921	42844	606	37801
28-#11	3.85	17488	7997	36335	5690	40568	4430	41909	3419	42514	1915	43837	596	38932

ROUND SPIRAL COLUMNS 40" DIA.

6-#14	1.07	18803	7382	36396	4999	37857	3897	36704	3079	30784	1840	29508	1180	14955
6-#18	1.91	19240	7827	38902	5200	40799	4041	40162	3143	37574	1870	34509	903	25329
7-#14	1.25	18912	7477	35567	5390	38376	4213	37932	3345	32452	2013	32412	1279	17293
7-#18	2.23	19409	7996	38295	5653	41612	4403	41765	3447	39819	2076	38565	985	28347
8-#14	1.43	19071	7572	35731	5518	38944	4328	38753	3435	33565	2058	33766	1266	19321
8-#18	2.55	19641	8166	38801	5824	42595	4559	43083	3566	41699	2129	40683	937	32328
9-#11	1.12	18828	7405	35017	5402	37934	4226	37486	3364	34286	2205	31774	1331	15649
9-#14	1.61	19090	7668	36438	5539	39609	4324	39468	3419	36941	2173	35009	1185	21564
9-#18	2.86	19680	8336	39889	5895	43745	4579	44385	3560	40606	1950	43285	835	35220
10-#11	1.24	18888	7471	35789	5333	38449	4171	37946	3310	34725	2130	32324	1281	17059
10-#14	1.79	19169	7763	37374	5482	40360	4281	40200	3370	37714	2086	35962	1127	23563
10-#18	3.18	19800	8505	41256	5870	45097	4566	45759	3521	45098	1970	44889	725	38654

ROUND SPIRAL COLUMNS 40" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
11-#11	1.37	19002	7537	35623	5499	38807	4299	38562	3412	35727	2204	33651	1286	18709
11-#14	1.97	19329	7859	37330	5672	40851	4424	40986	3482	38971	2167	37653	1114	25684
11-#18	3.50	20075	8675	41507	6120	45895	4744	46992	3662	46985	2068	47476	667	41455
12-#11	1.49	19040	7603	35863	5569	39224	4362	39121	3459	36453	2214	34701	1276	20103
12-#14	2.15	19381	7954	37732	5760	41446	4503	41757	3541	37304	2029	39091	1095	27678
12-#18	3.82	20154	8844	42264	6251	46926	4864	48282	3749	48636	2068	49861	621	44514
13-#11	1.61	19135	7669	36310	5580	39662	4366	39629	3456	34676	2053	35400	1223	21700
13-#14	2.33	19510	8049	38264	5800	42080	4517	42499	3542	40989	2157	40121	1021	29656
13-#18	4.14	20362	9014	43151	6339	48053	4904	49598	3760	50458	2044	51699	492	47655
14-#11	1.74	19238	7735	36868	5570	40146	4351	40122	3434	37737	2152	36094	1169	23069
14-#14	2.51	19658	8145	39025	5793	42769	4513	43260	3527	39104	1960	41193	950	31718
14-#18	4.46	20626	9183	44313	6365	49258	4929	51032	3763	52161	1959	53689	380	50422
15-#11	1.86	19297	7801	36967	5669	40524	4431	40691	3497	36000	2047	37275	1169	24607
15-#14	2.69	19737	8240	39275	5911	43307	4608	44008	3599	43101	2160	42775	940	33560
15-#18	4.77	20726	9353	44918	6531	50186	5059	52204	3856	54103	2042	56256	342	53627
16-#11	1.99	19378	7868	37185	5732	40964	4482	41235	3534	39402	2214	38180	1132	25932
16-#14	2.86	19841	8336	39617	5995	43945	4676	44766	3647	41224	2028	44030	884	35609
16-#18	5.09	20893	9523	45588	6668	51267	5168	53492	3932	55912	2057	58363	236	56348
17-#11	2.11	19437	7934	37621	5755	41392	4494	41740	3536	37379	2049	39017	1101	27435
17-#14	3.04	19924	8431	40215	6033	44543	4697	45555	3669	45099	2147	45242	840	37354
17-#18	5.41	21048	9692	46585	6745	52326	5214	54889	3976	57554	2015	60493	157	59274
18-#11	2.23	19497	8000	38126	5767	41873	4497	42252	3530	40746	2170	39706	1037	28738
18-#14	3.22	20005	8526	40877	6065	45228	4712	46267	3655	46139	2118	46272	753	39246
18-#18	5.73	21170	9862	47602	6822	53513	5260	56207	3969	55473	1841	63014	70	62417
19-#11	2.36	19594	8066	38290	5841	42261	4557	42820	3585	41456	2187	40871	1047	30163
19-#14	3.40	20138	8622	41171	6155	45785	4786	47046	3723	47098	2134	47874	760	40991
20-#11	2.48	19653	8132	38552	5898	42675	4601	43344	3608	42196	2195	41848	1023	31497
20-#14	3.58	20222	8717	41562	6234	46381	4846	47777	3753	44936	2000	49247	722	42735
21-#11	2.61	19734	8198	38963	5926	43122	4618	43871	3623	42862	2179	42587	981	32854
21-#14	3.76	20340	8813	42139	6277	47017	4873	48540	3777	49098	2120	50307	663	44551
22-#11	2.73	19843	8264	39394	5947	43616	4632	44373	3616	43578	2161	43400	940	34245
22-#14	3.94	20477	8908	42715	6317	47709	4900	49273	3773	50149	2098	51500	606	46222
23-#11	2.86	19886	8330	39631	6010	43988	4679	44923	3661	44336	2180	44444	926	35530
23-#14	4.12	20540	9003	43094	6397	48249	4960	50037	3831	51197	2121	52941	582	48070
24-#11	2.98	19958	8397	39928	6065	44410	4721	45427	3681	44999	2176	45252	892	36916
24-#14	4.30	20638	9099	43536	6474	48851	5018	50761	3858	48660	1972	54077	530	49703
25-#11	3.10	20035	8463	40307	6094	44857	4740	45974	3699	42689	2026	46168	858	38144
25-#14	4.48	20742	9194	44059	6518	49487	5048	51535	3884	53192	2106	55387	482	51504
26-#11	3.23	20090	8529	40802	6102	45325	4758	46490	3697	43307	2004	46865	812	39455
27-#11	3.35	20177	8595	41024	6168	45723	4801	47021	3737	47140	2162	47893	790	40700
28-#11	3.48	20259	8661	41350	6210	46156	4842	47522	3755	47806	2157	48958	781	41933
29-#11	3.60	20325	8727	41695	6252	46587	4862	48069	3774	48543	2153	49735	736	43209
30-#11	3.72	20420	8793	42138	6275	47049	4883	48602	3776	45938	1989	50593	702	44405

ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.73	22193	8525	44447	5702	46605	4436	45781	3463	39715	1958	38950	1074	26901
7-#14	1.14	21836	8175	40741	5926	44006	4636	43452	3688	39668	2400	36820	1458	18452
7-#18	2.02	22383	8694	43654	6189	47451	4825	47533	3791	45051	2321	43402	1169	30253
8-#14	1.30	22020	8270	40879	6062	44606	4758	44337	3783	40954	2452	38291	1450	20533
8-#18	2.31	22656	8864	44158	6368	48493	4989	48941	3916	47076	2380	45690	1127	34401
9-#11	1.01	21747	8103	40132	5942	43535	4652	42985	3710	39161	2450	36148	1511	16615
9-#14	1.46	22036	8366	41649	6079	45316	4750	45090	3765	39187	2257	39600	1367	23034
9-#18	2.60	22690	9034	45338	6435	49721	5006	50321	3907	48986	2338	48451	1023	37624
10-#11	1.13	21814	8169	40999	5863	44078	4588	43452	3649	39594	2369	36693	1457	18156
10-#14	1.62	22125	8461	42685	6011	46106	4698	45864	3710	42775	2326	40575	1306	25086
10-#18	2.89	22826	9203	46821	6399	51141	4983	51796	3863	50648	2215	50127	912	41701
11-#11	1.24	21935	8235	40768	6041	44457	4727	44130	3759	37983	2287	38149	1468	19893
11-#14	1.79	22298	8557	42586	6214	46636	4852	46707	3830	44149	2414	42419	1299	27447
11-#18	3.18	23127	9373	47037	6662	52009	5173	53100	4012	49181	2166	52926	860	44570
12-#11	1.35	21976	8301	41003	6113	44902	4772	44729	3809	38701	2297	39280	1460	21456
12-#14	1.95	22351	8652	42993	6304	47267	4934	47531	3891	45213	2424	43966	1281	29499
12-#18	3.46	23204	9542	47846	6797	53106	5296	54478	4102	54462	2323	55487	817	47969
13-#11	1.46	22081	8367	41493	6123	45361	4795	45266	3804	42209	2446	40016	1406	23095
13-#14	2.11	22494	8747	43638	6329	47930	4946	48316	3891	43211	2246	45055	1208	31701
13-#18	3.75	23434	9712	48783	6882	54293	5335	55876	4112	52635	2145	57442	689	51182
14-#11	1.58	22188	8433	42112	6108	45878	4775	45771	3779	39963	2236	40736	1350	24600
14-#14	2.27	22647	8843	44409	6331	48666	4938	49102	3872	47246	2346	46179	1136	33825
14-#18	4.04	23718	9881	50045	6904	55569	5355	57380	4111	58192	2212	59552	576	54260
15-#11	1.69	22258	8499	42184	6213	46277	4860	46385	3846	43715	2440	42014	1354	26210
15-#14	2.44	22744	8938	44641	6455	49235	5038	49920	3949	48438	2396	47884	1129	35879
15-#18	4.33	23836	10051	50662	7076	56556	5491	58652	4210	60277	2299	62308	542	57667
16-#11	1.80	22349	8566	42407	6277	46736	4893	46975	3885	41625	2299	42986	1318	27668
16-#14	2.60	22859	9034	44994	6540	49901	5107	50730	3999	49676	2424	49231	1074	37994
16-#18	4.62	24021	10221	51351	7214	57729	5604	60026	4288	62207	2316	64569	437	60573
17-#11	1.91	22409	8632	42877	6300	47199	4924	47501	3886	45283	2444	43872	1287	29272
17-#14	2.76	22944	9129	45636	6578	50549	5128	51505	4005	50669	2399	50517	1030	39947
17-#18	4.91	24184	10390	52419	7291	58835	5647	61511	4332	59689	2122	66835	360	63953
18-#11	2.03	22476	8698	43424	6308	47712	4925	48039	3878	46024	2418	44595	1222	30674
18-#14	2.92	23035	9224	46354	6606	51279	5141	52305	4004	48313	2210	51605	942	42088
18-#18	5.20	24315	10560	53535	7365	60099	5691	62881	4322	65945	2231	69516	273	67031
19-#11	2.14	22583	8764	43586	6386	48115	4987	48649	3935	46777	2436	45844	1234	32258
19-#14	3.09	23181	9320	46651	6701	51865	5217	53138	4075	52796	2387	53319	952	43979
19-#18	5.49	24585	10729	54188	7505	61124	5802	64267	4426	63123	2098	71676	213	69989
20-#11	2.25	22643	8830	43859	6445	48554	5013	49198	3959	44395	2282	46886	1211	33628
20-#14	3.25	23266	9415	47062	6780	52491	5278	53925	4107	53905	2396	54783	916	45919

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
21-#11	2.36	22733	8896	44294	6471	49029	5049	49765	3974	48271	2429	47673	1170	35161
21-#14	3.41	23389	9510	47672	6823	53168	5305	54727	4130	54922	2374	55913	857	47777
22-#11	2.48	22838	8962	44764	6490	49555	5061	50295	3966	45767	2250	48529	1129	36566
22-#14	3.57	23543	9606	48295	6860	53916	5331	55503	4124	56033	2351	57175	801	49634
23-#11	2.59	22900	9028	45004	6556	49949	5111	50882	4013	49838	2431	49512	1104	37997
23-#14	3.74	23618	9701	48686	6943	54478	5393	56319	4184	57153	2376	58721	778	51557
24-#11	2.70	22980	9095	45311	6611	50397	5134	51410	4033	47174	2265	50512	1083	39424
24-#14	3.90	23726	9797	49146	7021	55117	5452	57077	4211	58147	2369	59934	728	53443
25-#11	2.81	23053	9161	45722	6640	50872	5173	51991	4051	47905	2261	51487	1049	40804
25-#14	4.06	23835	9892	49711	7064	55794	5481	57909	4239	59273	2362	61329	679	55345
26-#11	2.93	23121	9227	46255	6647	51364	5189	52546	4049	52028	2398	52223	1002	42250
26-#14	4.22	23922	9987	50437	7081	56504	5511	58701	4239	56275	2175	62406	614	57119
27-#11	3.04	23216	9293	46477	6715	51786	5234	53103	4089	49296	2253	53323	982	43605
28-#11	3.15	23287	9359	46821	6757	52252	5255	53637	4108	49958	2249	54458	973	44998
29-#11	3.27	23376	9425	47190	6798	52704	5295	54217	4127	50687	2245	55284	929	46305
30-#11	3.38	23476	9491	47661	6820	53195	5315	54772	4128	55018	2384	56194	894	47633
31-#11	3.49	23531	9558	47909	6883	53625	5346	55333	4165	52147	2247	57114	863	49002
32-#11	3.60	23608	9624	48262	6924	54076	5375	55871	4183	52875	2251	58128	837	50324

ROUND SPIRAL COLUMNS 44" DIA.

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.58	25433	9257	50500	6230	52947	4850	51913	3799	47962	2335	43762	1252	28475
7-#14	1.04	25046	8907	46399	6489	50171	5080	49495	4048	45019	2655	41621	1646	19606
7-#18	1.84	25643	9426	49499	6751	53824	5269	53818	4151	47352	2406	48631	1361	32181
8-#14	1.18	25254	9002	46505	6633	50802	5180	50447	4150	46390	2710	43215	1642	21753
8-#18	2.10	25958	9596	49994	6939	54926	5440	55325	4283	52909	2642	51095	1324	36484
9-#14	1.33	25267	9098	47338	6645	51558	5198	51236	4128	44319	2498	44586	1557	24512
9-#18	2.37	25986	9766	51271	7001	56232	5453	56782	4271	54919	2598	53640	1189	40057
10-#11	1.03	25026	8901	46698	6419	50242	5026	49474	4004	44913	2620	41450	1643	19264
10-#14	1.48	25366	9193	48487	6567	52388	5136	52033	4065	45066	2407	45577	1493	26621
10-#18	2.63	26139	9935	52877	6954	57720	5421	58353	4222	56648	2470	55752	1106	44289
11-#11	1.13	25152	8967	46394	6610	50638	5176	50224	4124	46110	2707	43044	1658	21085
11-#14	1.63	25547	9289	48323	6782	52950	5301	52952	4195	49783	2673	47582	1492	29236
11-#18	2.89	26464	10105	53049	7230	58659	5624	59733	4379	58859	2583	58773	1060	47713
12-#11	1.23	25199	9033	46621	6686	51115	5225	50863	4176	43806	2539	44259	1652	22790
12-#14	1.78	25607	9384	48730	6876	53622	5357	53831	4259	50902	2684	49239	1476	31338
12-#18	3.16	26542	10274	53908	7370	59820	5750	61200	4472	60745	2588	61513	1019	51509
13-#11	1.33	25313	9099	47157	6694	51596	5235	51428	4170	47715	2705	45029	1598	24503
13-#14	1.92	25763	9479	49432	6899	54316	5396	54659	4257	52055	2666	50385	1402	33777
13-#18	3.42	26794	10444	54898	7453	61060	5786	62679	4481	62787	2564	63581	892	54781
14-#11	1.44	25424	9165	47840	6673	52145	5220	51944	4140	48352	2653	45771	1540	26150
14-#14	2.07	25922	9575	50278	6895	55097	5383	55469	4234	53048	2604	51559	1329	35956
14-#18	3.68	27098	10613	56263	7468	62417	5802	64239	4475	60364	2311	65808	778	58188

ROUND SPIRAL COLUMNS 44" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
15-#11	1.54	25506	9231	47880	6784	52565	5301	52606	4212	49311	2700	47151	1547	27828
15-#14	2.22	26031	9670	50484	7025	55698	5489	56346	4316	50699	2480	53392	1325	38232
15-#18	3.95	27237	10783	56888	7647	63461	5944	65625	4581	62446	2396	68758	748	61677
16-#11	1.64	25606	9298	48107	6850	53043	5345	53241	4253	46901	2542	48190	1512	29427
16-#14	2.37	26164	9766	50849	7113	56392	5531	57221	4368	55630	2687	54831	1271	40407
16-#18	4.21	27439	10953	57594	7787	64706	6059	67086	4660	68959	2586	71173	645	65106
17-#11	1.74	25667	9364	48612	6871	53541	5366	53787	4253	50972	2704	49124	1481	31095
17-#14	2.52	26251	9861	51537	7149	57090	5580	58026	4373	56682	2661	56189	1228	42570
17-#18	4.47	27610	11122	58734	7863	65878	6101	68645	4703	70807	2544	73576	569	68610
18-#11	1.85	25742	9430	49203	6876	54086	5374	54351	4242	48300	2498	49875	1415	32635
18-#14	2.66	26352	9956	52308	7174	57865	5590	58867	4369	53988	2454	57334	1139	44776
18-#18	4.74	27752	11292	59952	7935	67222	6143	70081	4691	72910	2500	75671	420	71740
19-#11	1.95	25853	9496	49361	6958	54504	5429	55003	4303	52554	2697	51215	1430	34286
19-#14	2.81	26511	10052	52611	7273	58473	5670	59757	4444	55004	2473	59161	1152	46869
19-#18	5.00	28014	11461	60610	8078	68307	6258	71557	4799	69731	2352	78718	426	75028
20-#11	2.05	25919	9562	49644	7018	54968	5466	55578	4328	49834	2527	52324	1408	35788
20-#14	2.96	26598	10147	53041	7354	59136	5704	60579	4476	60110	2661	60718	1118	49077
20-#18	5.26	28203	11631	61399	8212	69472	6361	72976	4849	76739	2533	81377	357	78380
21-#11	2.15	26018	9628	50105	7044	55472	5492	56185	4343	54137	2690	53157	1366	37441
21-#14	3.11	26732	10242	53684	7395	59853	5759	61440	4499	61185	2638	61918	1059	51065
22-#11	2.26	26127	9694	50614	7060	56023	5511	56742	4333	54927	2670	54055	1325	38919
22-#14	3.26	26898	10338	54355	7430	60648	5782	62259	4492	62372	2616	63247	1002	53119
23-#11	2.36	26201	9760	50855	7129	56445	5554	57360	4382	55719	2683	55109	1301	40504
23-#14	3.40	26983	10433	54757	7517	61241	5847	63126	4555	63548	2641	64691	963	55134
24-#11	2.46	26288	9827	51171	7185	56919	5588	57920	4403	52776	2511	56172	1281	41966
24-#14	3.55	27102	10529	55233	7594	61917	5878	63918	4582	64604	2635	66190	932	57160
25-#11	2.56	26364	9893	51662	7204	57416	5616	58534	4420	57372	2686	57205	1247	43521
25-#14	3.70	27217	10624	55842	7638	62635	5936	64799	4609	65794	2629	67670	884	59122
26-#11	2.67	26439	9959	52187	7219	57937	5621	59126	4417	58098	2660	57979	1201	44979
26-#14	3.85	27311	10719	56620	7653	63378	5964	65649	4610	66877	2597	68807	819	61066
27-#11	2.77	26543	10025	52408	7288	58383	5677	59711	4459	58946	2678	59151	1182	46476
27-#14	4.00	27454	10815	56985	7745	64015	6024	66477	4664	63506	2442	70439	787	63084
28-#11	2.87	26616	10091	52769	7331	58876	5710	60278	4478	55724	2496	60071	1150	47963
28-#14	4.14	27575	10910	57512	7804	64718	6054	67279	4690	69107	2609	72144	774	64965
29-#11	2.98	26707	10157	53162	7372	59355	5739	60891	4497	60521	2670	61232	1130	49408
30-#11	3.08	26820	10223	53663	7392	59875	5749	61468	4497	61266	2647	62194	1095	50960
31-#11	3.18	26882	10290	53921	7457	60330	5800	62068	4536	62098	2662	63174	1064	52325
32-#11	3.28	26966	10356	54296	7499	60800	5830	62643	4554	58812	2499	64252	1039	53783
33-#11	3.39	27053	10422	54673	7540	61296	5861	63243	4574	63748	2663	65266	1011	55142
34-#11	3.49	27123	10488	55146	7563	61828	5875	63822	4576	64572	2653	66120	962	56555

ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.44	28972	10023	57086	6782	59850	5285	58582	4151	53828	2584	48961	1437	30045
7-#18	1.68	29203	10192	55852	7340	60759	5734	60652	4529	56893	2846	54272	1561	34130
8-#14	1.08	28778	9769	52633	7232	57559	5653	57108	4533	52305	2981	48556	1842	22981
8-#18	1.93	29560	10362	56332	7537	61919	5913	62260	4667	59211	2915	56918	1529	38576
9-#14	1.22	28798	9864	53532	7239	58360	5666	57932	4508	53458	2945	49984	1757	25887
9-#18	2.17	29583	10532	57701	7594	63303	5922	63792	4652	61328	2870	59595	1392	42520
10-#14	1.35	28908	9959	54803	7150	59230	5594	58740	4437	50648	2653	50986	1689	28170
10-#18	2.41	29754	10701	59448	7535	64861	5880	65458	4597	58910	2555	61785	1307	46895
11-#11	1.03	28668	9733	52522	7206	57380	5636	56868	4506	48534	2778	48355	1857	22285
11-#14	1.49	29095	10055	54563	7378	59820	5771	59748	4577	55877	2944	53161	1694	30939
11-#18	2.65	30095	10871	59566	7825	65869	6095	66915	4763	61134	2667	65036	1268	50665
12-#11	1.13	28721	9799	52738	7285	57888	5699	57549	4561	52884	2992	49654	1852	24139
12-#14	1.62	29163	10150	54967	7475	60537	5831	60682	4644	57070	2956	54930	1679	33196
12-#18	2.89	30181	11040	60447	7968	67095	6225	68473	4858	67496	2865	67956	1229	54991
13-#11	1.22	28844	9865	53322	7291	58390	5707	58132	4553	53698	2975	50459	1799	25923
13-#14	1.76	29333	10245	55729	7496	61261	5868	61553	4641	58279	2938	56132	1605	35885
13-#18	3.13	30456	11210	61637	8024	68388	6258	70033	4867	69657	2841	70137	1103	58452
14-#11	1.31	28959	9931	54075	7264	58973	5687	58666	4519	54361	2921	51219	1738	27718
14-#14	1.90	29498	10341	56654	7487	62090	5850	62384	4613	59324	2874	57351	1530	38109
14-#18	3.37	30744	11379	62990	8060	69825	6270	71646	4856	71635	2750	72477	987	62203
15-#11	1.41	29052	9997	54077	7382	59412	5774	59377	4596	55385	2971	52705	1748	29462
15-#14	2.03	29622	10436	56830	7623	62720	5947	63323	4700	60674	2930	59316	1530	40620
15-#18	3.61	30939	11549	63606	8245	70926	6418	73146	4968	73808	2821	75625	962	65763
16-#11	1.50	29163	10064	54307	7451	59909	5819	60059	4639	56384	2996	53813	1714	31207
16-#14	2.17	29770	10532	57205	7713	63442	6005	64262	4755	62063	2961	60848	1477	42846
16-#18	3.85	31161	11719	64340	8387	72222	6534	74697	5050	76180	2866	78196	860	69520
17-#11	1.60	29226	10130	54847	7470	60439	5839	60625	4637	53330	2778	54793	1683	32938
17-#14	2.30	29858	10627	57939	7748	64190	6039	65098	4758	58958	2739	62278	1434	45231
17-#18	4.09	31339	11888	65552	8462	73482	6577	76225	5066	78140	2825	80734	786	73109
18-#11	1.69	29308	10196	55486	7471	61020	5844	61213	4624	54074	2750	55570	1617	34622
18-#14	2.44	29969	10722	58766	7768	65011	6061	65980	4752	64396	2903	63473	1344	47495
18-#18	4.33	31492	12058	66858	8531	74905	6616	77830	5077	80351	2780	82945	636	76544
19-#11	1.78	29426	10262	55636	7558	61452	5903	61908	4688	58811	2970	56854	1621	36333
19-#14	2.57	30142	10818	59072	7872	65641	6129	66926	4829	61178	2730	65421	1360	49798
19-#18	4.57	31776	12227	67534	8678	76043	6734	79398	5188	82270	2802	86178	646	80179
20-#11	1.88	29496	10328	55929	7619	61941	5940	62509	4713	59701	2981	58179	1612	38021
20-#14	2.71	30231	10913	59520	7955	66340	6179	67784	4862	66794	2937	67071	1326	52069
20-#18	4.81	31978	12397	68363	8814	77262	6838	80915	5241	84406	2816	88996	579	83574
21-#11	1.97	29602	10394	56415	7643	62473	5966	63153	4728	60482	2964	59058	1571	39688
21-#14	2.84	30377	11009	60197	7995	67099	6219	68705	4886	67927	2914	68340	1268	54266
21-#18	5.05	32179	12567	69528	8894	78578	6890	82487	5285	86404	2779	91218	476	86996

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	2.07	29716	10460	56966	7658	63050	5963	63740	4717	57210	2746	59996	1529	41303
22-#14	2.98	30554	11104	60919	8028	67930	6255	69565	4878	69156	2890	69735	1211	56581
22-#18	5.30	32437	12736	70675	8974	80034	6946	84029	5285	82710	2562	93736	381	90600
23-#11	2.16	29798	10527	57206	7729	63501	6029	64388	4767	62146	2957	61124	1507	42974
23-#14	3.11	30650	11199	61329	8117	68565	6308	70473	4942	70308	2903	71277	1174	58716
24-#11	2.25	29897	10593	57531	7786	64000	6063	64982	4789	63028	2965	62250	1487	44543
24-#14	3.25	30780	11295	61821	8195	69278	6354	71311	4970	71541	2912	72864	1143	60953
25-#11	2.35	29975	10659	58054	7804	64519	6091	65628	4806	63886	2960	63341	1453	46237
25-#14	3.38	30890	11390	62547	8225	70027	6397	72240	4997	72795	2907	74429	1095	62955
26-#11	2.44	30057	10725	58622	7818	65070	6094	66242	4802	64646	2934	64152	1407	47745
26-#14	3.52	31001	11485	63306	8253	70812	6439	73147	4997	73915	2873	75625	1030	65089
27-#11	2.53	30169	10791	58840	7889	65539	6152	66871	4846	65548	2953	65397	1389	49391
27-#14	3.66	31156	11581	63673	8346	71483	6485	74012	5052	75165	2895	77357	1001	67164
28-#11	2.63	30245	10857	59217	7933	66053	6185	67470	4866	66361	2950	66374	1357	50915
28-#14	3.79	31262	11676	64227	8406	72228	6530	74860	5079	76296	2888	78732	953	69218
29-#11	2.72	30344	10923	59636	7974	66565	6214	68115	4885	67211	2945	67598	1338	52504
29-#14	3.93	31405	11772	64810	8467	72947	6574	75788	5108	77536	2883	80488	925	71397
30-#11	2.82	30465	10989	60166	7992	67116	6223	68715	4883	67992	2922	68611	1303	54096
31-#11	2.91	30535	11056	60431	8058	67588	6276	69351	4923	68876	2938	69653	1274	55615
32-#11	3.00	30626	11122	60829	8101	68084	6306	69967	4943	69834	2953	70795	1249	57198
33-#11	3.10	30717	11188	61224	8142	68608	6337	70590	4961	70616	2940	71715	1209	58677
34-#11	3.19	30793	11254	61730	8164	69170	6350	71200	4963	66717	2735	72766	1171	60246
35-#11	3.29	30898	11320	62025	8226	69632	6399	71833	5000	72279	2933	73922	1155	61703
36-#11	3.38	30994	11386	62414	8268	70135	6428	72437	5018	73143	2937	74906	1118	63176

ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
6-#18	1.33	32824	10823	64229	7360	67340	5738	65813	4519	56158	2654	54567	1630	31615
7-#18	1.55	33076	10993	62736	7957	68280	6220	68060	4923	63548	3126	60344	1769	36100
8-#18	1.77	33476	11162	63195	8163	69497	6407	69771	5068	65990	3199	63176	1742	40679
9-#14	1.12	32643	10664	60253	7860	65748	6157	65204	4906	59916	3226	55815	1964	27267
9-#18	1.99	33494	11332	64654	8214	70961	6412	71377	5050	68236	3154	65983	1604	45011
10-#14	1.24	32762	10759	61654	7759	66660	6074	66018	4826	60739	3118	56821	1892	29732
10-#18	2.21	33682	11501	66556	8143	72589	6359	73109	4987	70080	3015	68244	1516	49518
11-#14	1.37	32957	10855	61329	8001	67274	6248	67120	4977	62470	3226	59174	1903	32627
11-#18	2.43	34023	11671	66610	8447	73659	6587	74674	5163	72641	3144	71732	1484	53652
12-#11	1.03	32556	10599	59377	7912	65245	6194	64811	4963	59335	3276	55487	2062	25502
12-#14	1.49	33033	10950	61727	8102	68037	6327	68109	5047	63739	3241	61058	1890	35071
12-#18	2.65	34135	11840	67505	8594	74955	6721	76322	5262	74725	3152	74835	1447	58118
13-#11	1.12	32689	10665	60011	7916	65769	6200	65412	4953	60182	3258	56324	2007	27355
13-#14	1.62	33216	11046	62551	8120	68792	6346	69011	5041	65003	3221	62314	1816	37874
13-#18	2.87	34433	12010	68788	8648	76301	6751	77963	5270	77020	3128	77128	1321	61987
14-#11	1.21	32808	10731	60839	7883	66387	6175	65962	4915	60854	3200	57099	1945	29305
14-#14	1.74	33387	11141	63560	8105	69668	6338	69873	5009	61692	2945	63575	1739	40285
14-#18	3.09	34731	12180	70248	8678	77820	6758	79628	5254	79090	3036	79578	1204	66306
15-#11	1.29	32909	10798	60798	8008	66845	6268	66724	4997	57829	3038	58695	1958	31112
15-#14	1.87	33524	11236	63700	8249	70328	6441	70875	5102	67527	3215	65676	1742	42976
15-#18	3.32	34953	12349	70846	8870	78977	6913	81223	5371	81390	3110	82928	1183	69924
16-#11	1.38	33026	10864	61029	8078	67360	6315	67448	5042	63018	3281	59873	1925	33009
16-#14	1.99	33689	11332	64084	8340	71078	6501	71880	5159	68997	3247	67303	1690	45313
16-#18	3.54	35198	12519	71609	9015	80324	7030	82884	5456	83879	3157	85656	1082	74024
17-#11	1.47	33097	10930	61606	8097	67919	6334	68038	5039	63808	3260	60899	1894	34800
17-#14	2.11	33780	11427	64865	8374	71873	6534	72746	5160	70157	3221	68804	1648	47973
17-#18	3.76	35356	12688	72895	9088	81672	7073	84470	5470	80222	2908	88329	1009	77687
18-#11	1.55	33186	10996	62296	8094	68540	6316	68650	5024	64621	3229	61698	1827	36634
18-#14	2.24	33900	11522	65751	8390	72743	6553	73667	5152	71418	3186	70044	1558	50245
18-#18	3.98	35549	12858	74279	9153	83174	7110	86155	5480	88291	3070	90653	858	81441
19-#11	1.64	33313	11062	62432	8185	68985	6398	69355	5080	61197	3038	63072	1833	38402
19-#14	2.36	34087	11618	66057	8499	73394	6625	74671	5233	72663	3212	72118	1575	52769
19-#18	4.20	35855	13027	74983	9306	84353	7231	87815	5594	90303	3095	94074	872	85307
20-#11	1.72	33385	11128	62737	8247	69499	6437	70017	5116	66509	3267	64472	1825	40237
20-#14	2.49	34178	11713	66522	8583	74130	6675	75566	5266	73980	3224	73861	1543	55096
20-#18	4.42	36012	13197	75851	9443	85637	7336	89394	5647	92552	3110	97052	808	88865
21-#11	1.81	33501	11194	63249	8271	70060	6461	70693	5131	62831	3032	65396	1783	41959
21-#14	2.61	34336	11809	67233	8622	74929	6715	76542	5290	70158	2988	75199	1484	57502
21-#18	4.64	36285	13367	77070	9522	87025	7388	91072	5693	94658	3073	99402	705	92752

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

f'_c = 10,000 psi f_y = 75,000 psi
ϕM_n in inch-kips ϕP_n in kips

BARS	RHO	Max Cap		0% f_y		25% f_y		50% f_y		100% f_y		ε_t = 0.005		Zero Axial Load
		ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n	ϕP_n	ϕM_n
22-#11	1.90	33619	11260	63844	8282	70663	6456	71314	5118	68165	3226	66373	1741	43718
22-#14	2.74	34503	11904	68009	8652	75797	6720	77446	5280	76438	3176	76658	1428	59936
22-#18	4.86	36556	13536	78294	9599	88567	7443	92694	5691	97013	3040	102049	610	96285
23-#11	1.98	33711	11327	64081	8357	71140	6525	71993	5170	69070	3243	67576	1720	45444
23-#14	2.86	34632	11999	68425	8745	76473	6805	78396	5346	72493	2979	78299	1392	62214
23-#18	5.08	36787	13706	79153	9737	89713	7544	94335	5791	92614	2872	104764	535	99947
24-#11	2.07	33820	11393	64413	8414	71667	6560	72619	5193	70012	3252	68766	1702	47153
24-#14	2.98	34772	12095	68931	8824	77224	6852	79280	5375	78979	3202	79975	1362	64636
25-#11	2.16	33900	11459	64967	8432	72207	6587	73298	5210	70901	3246	69913	1668	48902
25-#14	3.11	34886	12190	69702	8853	78004	6894	80257	5402	80282	3195	81626	1314	66836
26-#11	2.24	33989	11525	65580	8444	72789	6589	73934	5204	71694	3219	70760	1621	50548
26-#14	3.23	35007	12286	70516	8879	78832	6905	81200	5401	81454	3161	82879	1250	69188
27-#11	2.33	34110	11591	65794	8517	73281	6649	74607	5250	72651	3239	72081	1605	52297
27-#14	3.36	35174	12381	70885	8974	79538	6983	82124	5458	82777	3184	84713	1221	71359
28-#11	2.41	34188	11657	66188	8562	73815	6682	75238	5270	73500	3237	73115	1573	53907
28-#14	3.48	35283	12476	71464	9035	80312	7028	83018	5485	83987	3179	86168	1175	73550
29-#11	2.50	34296	11723	66631	8602	74361	6711	75909	5289	74402	3233	74401	1554	55675
29-#14	3.61	35440	12572	72082	9096	81079	7072	83995	5514	85274	3173	88016	1147	75778
30-#11	2.59	34411	11790	67193	8619	74941	6719	76538	5286	70204	2995	75464	1519	57274
30-#14	3.73	35599	12667	72852	9128	81905	7089	84909	5515	86470	3143	89564	1098	77904
31-#11	2.67	34501	11856	67463	8686	75431	6773	77210	5328	76154	3226	76569	1491	58939
31-#14	3.85	35714	12763	73279	9217	82617	7160	85851	5569	87774	3162	91101	1054	80181
32-#11	2.76	34601	11922	67884	8731	75953	6804	77861	5348	77153	3241	77776	1466	60559
33-#11	2.84	34688	11988	68298	8771	76505	6835	78515	5366	72784	3013	78744	1426	62180
34-#11	2.93	34777	12054	68836	8792	77091	6847	79154	5367	78894	3218	79848	1389	63820
35-#11	3.02	34890	12120	69140	8856	77583	6897	79822	5405	74412	3006	81069	1374	65425
36-#11	3.10	34975	12186	69543	8897	78111	6927	80452	5424	80637	3226	82107	1338	67059
37-#11	3.19	35084	12253	70026	8930	78657	6958	81124	5444	81474	3214	83229	1311	68616